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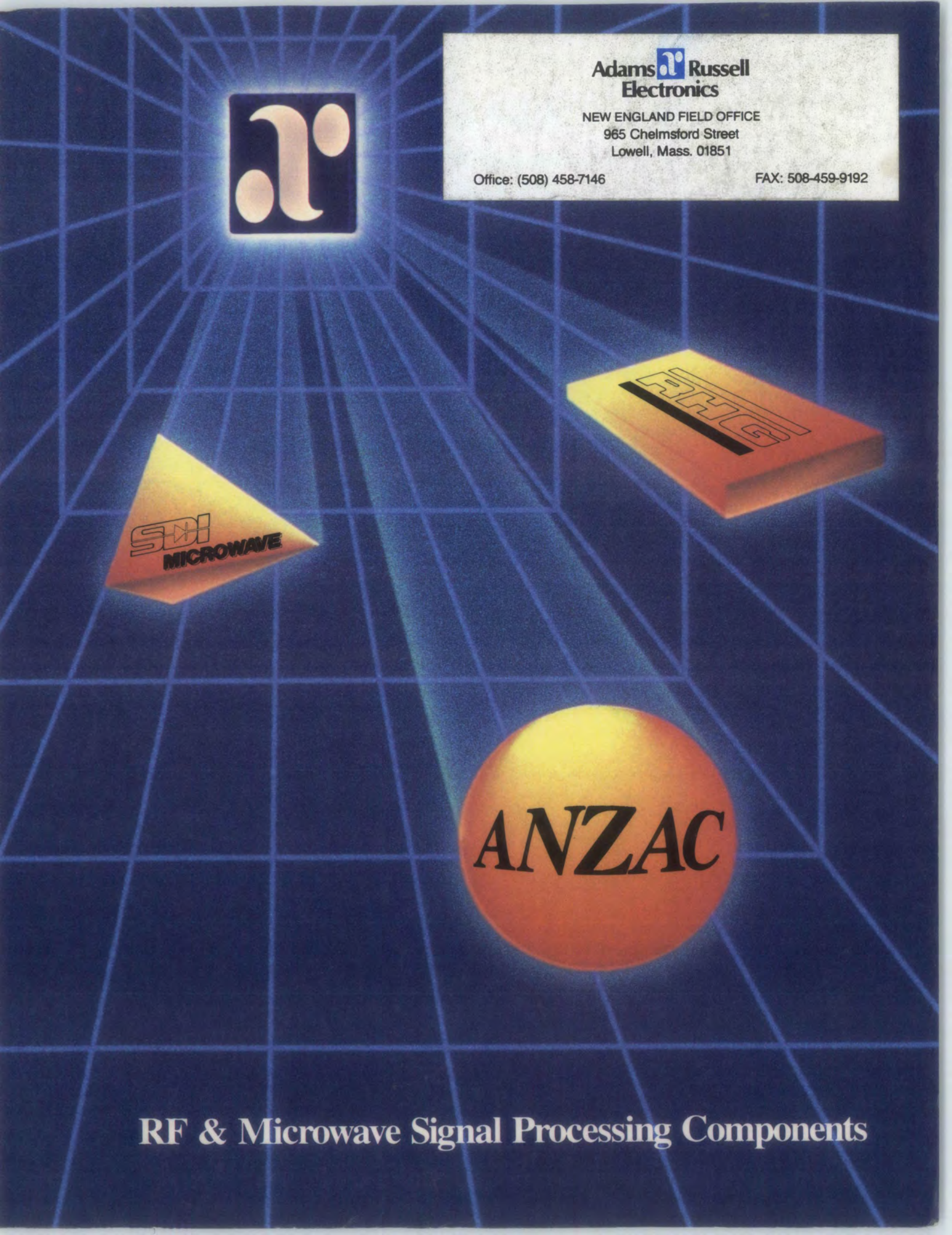

RF & Microwave Signal Processing Components

WARRANTY

During every step in the production of our products, from initial concept through design, material selection, manufacturing, inspection, and test procedures, cardinal importance is placed on performance and reliability. All products carry this warranty:

Seller warrants that the supplies to be delivered hereunder shall, at the time of delivery, be free from defects in workmanship and material and shall conform to the specifications made a part of Buyer's contract or purchase order. This warranty shall remain in effect for a period of one year from the date of delivery of the supplies; provided however, that notice of any such defect must be provided to the Seller within thirty days of its discovery by Buyer.

Seller's liability under this warranty is limited to the furnishing of replacement parts on an exchange basis, or at Seller's option, to the repair or replacement of defective articles at Seller's plant, in which event all costs of packing and shipment to and from Seller's plant will be borne by Buyer. Seller shall have no liability for defects which arise, directly, or indirectly, as a result of accident, improper use, or unauthorized repairs.

THE WARRANTIES STATED HEREIN ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL SELLER BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES.

SECTION FINDER

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INTRODUCTION

A CONTINUING TRADITION. . . . As an industry leader in the RF & Microwave Signal Processing market, Adams-Russell is extremely pleased to continue a long standing tradition with our new 1989 standard product catalog. This edition features more than 500 products, including 100 new products, vertically integrating each division of the Adams-Russell Components Group. Such industry familiar names as Anzac, RHG, and SDI Microwave are now featured in our 1989 catalog with a product selection of RF & Microwave Signal Processing components which is second to none. These devices are built to the highest quality standards and have a proven performance and quality rating established through 3 decades of technical accomplishments and manufacturing experience. All are available from stock.

In addition to the outstanding selection of components, we've taken yet another step to make it easy for you, our valued customer, to utilize the components we manufacture. Three domestic distributors across the U.S.A. have joined our standard product distribution network centered in Burlington, MA. Coupled with our International Distribution Network, we now offer an "off-the-shelf" inventory of more than 1,000,000 components. Stock delivery of high performance, state-of-the-art components and "we accept Visa and MasterCard," now make it easier than ever to utilize Adams-Russell's technology in your system today.

In addition to the many components you will find in this catalog, there are numerous technical articles to assist you, the components user, in the use and application of our components in your various system applications. We have also included articles on our subassembly manufacturing, our Space Center (the only RF & Microwave components operation dedicated solely to producing space qualified hardware), and our GaAs MMIC Semiconductor Center. Throughout this catalog you will see many products featuring the technology edge offered by our GaAs MMIC and Silicon Semiconductor Center.

THE COMPANY

As stated, Adams-Russell has nearly 30 years of technical accomplishments and experience in the development and manufacture of RF & Microwave Signal Processing components in the industry. Our continuous growth is a result of providing quality, off-the-shelf components, coupled with the major focus on customer requirements for competitive price and delivery. This combination of customer and technology focus preserves our flexibility to adjust to the various market needs and requirements. Additionally, various groups within Adams-Russell foster a uniformly high standard for customer service, marketing, technology, planning and people development. Today through an active internal growth plan and prudent acquisitions of such companies as RHG, and SDI Microwave, the Adams-Russell business units form a network offering the most extensive line of RF & Microwave components and subsystems. The units are:

COMPONENTS GROUP

The Adams-Russell Components Group consists of five operations designed to provide the widest breadth of RF and Microwave Signal Processing Products in the industry. They are:

ANZAC - Burlington, MA and Bangor, ME

- RF and Microwave components
- IF, RF, and microwave Amplifiers
- RF Double balanced Mixers and Passive Components
- Frequency Multipliers and Dielectric Resonant Oscillators
- RF and Microwave Control Devices
- Modpak RF Shield Enclosures
- RF and Microwave Subassemblies

RHG ELECTRONICS - Deer Park, NY

- RF and Microwave Components
- Log and Linear Amplifiers
- Microwave Mixers
- Subsystems

SDI MICROWAVE - Billerica, MA

- RF and Microwave Diodes
- Microwave Control Devices
- Microwave Integrated Subassemblies

SEMICONDUCTOR CENTER - Burlington, MA

- Gallium Arsenide Monolithic Microwave Integrated Circuits (MMIC)
- GaAs Foundry services

ADAMS-RUSSELL BV - Cork, Ireland

- Microelectronics manufacturing

AEROSPACE PRODUCTS GROUP

The Aerospace Products Group consists of three operations serving the RF and Microwave cable and antenna markets, the Microwave subassembly and complex metal fabrication and brazed assembly markets. They are:

ANTENNA & MICROWAVE - Amesbury, MA

- High reliability coaxial cable
- Broadband EW and CNI antennas
- Double ridge and broadband waveguide components

BRAZONICS - Amesbury, MA

- Complex metal fabrication
- Dip and vacuum brazing
- Avionics chassis and heat exchangers

MICROWAVE PRODUCTS DIVISION - Chatsworth, CA

- Slotted waveguide arrays
- Microwave subassemblies
- Antenna subsystems

SURVEILLANCE PRODUCTS GROUP

The Surveillance Products Group consists of three operations serving the UHF/VHF and microwave surveillance receiver, signal distribution and switching equipment and calibration equipment market. It also provides unique digital signal processing systems as well as space qualified components and subassemblies. The operational divisions are:

MICRO-TEL - Hunt Valley, MD

- Surveillance Receivers
- Precision measurement equipment
- Microwave signal generators

REACTION INSTRUMENTS - Reston, VA

- Surveillance Receivers
- Displays
- Switch Matrices
- Frequency Converters and Processors

COMMUNICATIONS PROGRAMS DIVISION Waltham, MA

- Signal Intelligence Processing systems
- High Speed Signal Analysis computers

SPACE CENTER - Waltham, MA

- Space Qualified RF and Microwave components

THE PRODUCTS AND TECHNOLOGY

Adams-Russell's first products and patents, dating back to the early 1960's, were for broadband RF hybrid components. The company founders and first employees were innovative engineers with an in-depth understanding of magnetic materials. Their unique designs using transformer, inductive, and transmission mediums, led to a line of extremely broadband RF components, which at the time, were not generally available. These techniques, and other more recent developments, form the core of Adams-Russell Components Group technology. Adams-Russell has been granted numerous U.S. patents for unique circuit techniques which provide us with the base on which our state-of-the-art RF & Microwave Signal Processing components are designed.

ADAMS-RUSSELL'S ADVANTAGE

Adams-Russell has, for 30 years, supplied components designed to operate in a military environment. Over this period of time, Adams-Russell has developed a reputation on all major programs for excellence in performance and quality. Part of the outstanding reputation developed from the belief that an informed and knowledgeable customer, is our best customer. For that reason, all the components in this catalog are fully specified over the temperature range required in a military environment. In addition, typical performance curves are provided for all key parameters to aid you in the design and analysis of your unique system application. To further aid in the components selection and ordering, small quantity pricing and stock delivery is provided for each component.

Adams-Russell invests a considerable portion of our annual revenues into the development of new products as dictated by you, our valued customer. This commitment to new products has lead to over 100 new and exciting products in this catalog with over 200 new products since the 1987 catalog edition. Each of the component product lines represented by Adams-Russell, has products available from stock to meet the majority of most systems requirements. Adams-Russell's eight component product lines with catalog representative parts are:

- RF Amplifiers
  - Low noise
  - High dynamic range
  - Broadband GaAs FET amplifiers
  - High Isolation amplifiers
  - Low DC power consumption
- RF Mixers
  - Doubly balanced
  - Termination insensitive
  - Biasable
  - Phase detectors
- Microwave Mixers
  - Doubly balanced
  - Microwave doubly balanced
  - Image reject
  - Biasable
  - Harmonic mixers
- RF Control Devices
  - Pin diode switches
  - GaAs MMIC switches
  - Data modulators
  - Digital and voltage variable attenuators
- Microwave Control Devices
  - Pin diode switches
  - High power switches
  - 2-26 GHz switches
  - Low, medium, and high power limiters
  - Microwave switch drivers
- IF Products
  - Logarithmic amplifiers
  - Constant phase limiters
  - Frequency discriminators
- Passive Components
  - Power dividers
  - Couplers
  - 90° and 180° hybrids
  - RF transformers
- Frequency Generation Products
  - Frequency multipliers
  - Dielectric resonator oscillators

"EXCELLENCE THROUGH TEAMWORK" – A COMMITMENT TO QUALITY

The quality aspects of all the products included in this catalog are from a teamwork approach within each of our operations and product lines. Adams-Russell recognizes that a commitment to "Excellence Through Teamwork" must be matched with a commitment of the resources to accomplish the job. Our Total Quality Management system is a comprehensive approach to quality in manufacturing. Our quality program requirements are based on MIL-Q-9858, MIL-M-38510, MIL-STD-202, and MIL-STD-883. Each operation has developed workmanship and quality control manuals and procedures consistent with the various military documents required to maintain a fully compliant MIL-STD program. The manuals and procedures define the methods of assembly and the criteria for evaluating our workmanship. The manuals are available from the quality assurance department of each operation and become an integral part of our day-to-day activity. Each member of the team is fully familiar with the requirements of our operating procedures and workmanship standards. At Adams-Russell, *Total Quality Management* and *Excellence Through Teamwork* are not merely slogans but are established guidelines about which we do business everyday.

As we move into the 1990's, Adams-Russell will remain a leading manufacturer of quality, high performance parts through Total Quality Management programs, Excellence Through Teamwork, and MIL-STD-1772 certification. MIL-STD-1772 certifications require product assurance programs that guarantee the involvement of quality in all aspects of the contracts performance. Adams-Russell is actively involved with JEDEC, the government liaison branch of the electronics industry association, to help develop the standards and techniques to be used not only by Adams-Russell but the entire RF and Microwave industry. When the word "quality" is used at Adams-Russell, it's not just a word, it's a company commitment.

ADAMS-RUSSELL'S GOAL FOR TODAY AND TOMORROW

In order to secure our foothold in the marketplace today and ensure our growth for the future, Adams-Russell has established the following goals: (1) To serve our customers with the highest quality products modern technology can produce, and (2) To be a high-performance company in terms of price, delivery and quality of our components as compared with those available within our industry. This is an Adams-Russell commitment and our catalog serves as its cornerstone. With the addition of over 100 new products, we are in the best position in our history to serve your needs. We will continue to extend our product base through research and development and appropriate business acquisitions. Adams-Russell will continue to add products and commit to our "from stock delivery" policy to meet the industries changing needs.

Just in case it's not in the catalog, Adams-Russell Components Group is more than just this catalog. Custom designs, and other catalog products are available on a special order basis from each of our operations. If for any reason your system needs are not met within the next 500 pages of RF & Microwave components, contact any of our operations directly through our world wide field sales offices or manufacturers representative organization. Each of our salespersons is trained and dedicated to providing you the latest up-to-date information on our products, technologies, and capabilities. A list of addresses and phone numbers for each of our field sales offices, distributors, and manufacturers representatives is provided in the back of this catalog.

In summary; Quality, Performance, Reliability and "from stock delivery" can be yours now via the Adams-Russell Components Group. This catalog is the solution to more of your RF and Microwave Signal Processing problems than ever before. Open the pages and solve your design problem today.

CUSTOM SUBASSEMBLY PRODUCTS

The Adams-Russell technical staff offers an unsurpassed capability in the areas of custom design and subassembly integration. This capability is based on the standard products included in this catalog and many custom products designed and manufactured for specialized applications. Adams-Russell's vast product base provides a unique library of amplifier, switch, mixer, and passive designs to form an exceptional foundation for subassembly integration.

Adams-Russell's competent staff of highly qualified technical and manufacturing professionals along with highly skilled and trained production teams will assist the customer in the choice of a design approach for multi-function assemblies that will meet the customer's technical, cost, and delivery requirements. The highly qualified technical and manufacturing teams are supported by in-house facilities and equipment to perform and control product life cycle from electrical design and fabrication through environmental testing. These in-house capabilities include:

- Thin and thick film substrate fabrication
- GaAs MMIC design and fabrication
- CAD/CAE design
- Automated Test and Production
- Hermetic Welding and Sealing
- Screening and environmental testing

MIC AND MMIC DESIGN EXPERTISE

The major strength of Adams-Russell's subassembly capability is that critical IF, RF, and microwave components are internally designed and produced. Technology capabilities include stripline and microstrip design expertise and, additionally, a broad range of GaAs MMIC building blocks such as amplifiers, switches, and passives to complement the hybrid circuits. The MMIC products are designed and fabricated by Adams-Russell.

Our experience in interconnection and packaging technology and system interface performance makes Adams-Russell an excellent choice for critical subassembly production requirements. Packaging techniques range from multiple modules integrated in a connectorized package to several interconnected carriers in a hermetically sealed package. The combination of microwave components may include hybrids, MMICs, or hybrids complemented by MMICs.

ADVANTAGES OF INTEGRATION

Several different levels of integraton can be achieved. Packages may be connectorized housings or flatpack housings. Adams-Russell's experience with interconnection and packaging and the broad product library provides many advantages of integration.

- Enhanced Performance – improves RF match by reducing interconnections and physical size, allows design optimization for specific requirements, and reduces parametric tolerance build-up.
- Reduced Size and Weight – eliminates separate packages, cabling, connectors, feed-throughs, and redundant circuitry.
- Improved Reliability – reduces number of parts and interconnects.
- Improved Efficiency – reduces power requirements through optimized designs, lowers RF losses, and eliminates redundant circuitry.
- Availability of Technical Resources – customers can concentrate their critical engineering resources to their system needs.

THE ADAMS-RUSSELL SUBASSEMBLY INTEGRATION ADVANTAGE

Adams-Russell has years of experience and a strong technology base in component interconnection, subassembly packaging, and system interfacing. We will work with our customer in the design phase, continuing through the production phase, and offer support during the critical system integration phase.

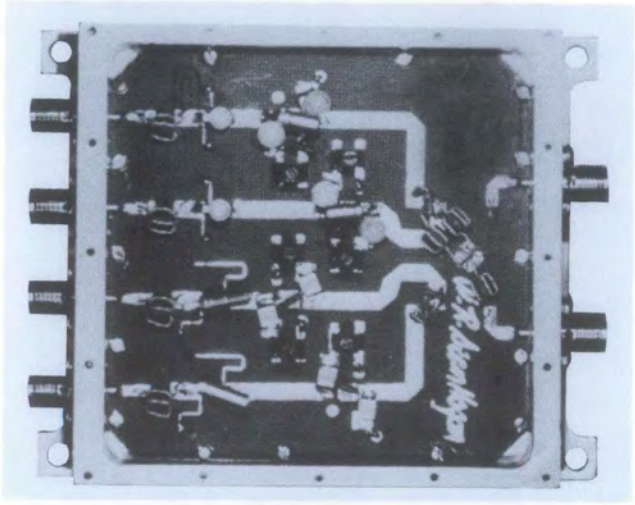
- Broad standard and custom product base.
- Experience with military and high reliability applications.
- Expertise in packaging, interconnect, and system interface.
- Thick and thin film hybrid and MMIC GaAs semiconductor fabrication and production facilities.
- Emphasis on design for manufacturability.
- Fast prototype turn-around
- Availability of technical experts to meet your design needs.

Several examples of subassemblies designed and manufactured by Adams-Russell are shown on the following pages. These examples illustrate the technologies and techniques available to meet your needs.

CUSTOM SUBASSEMBLY EXAMPLES

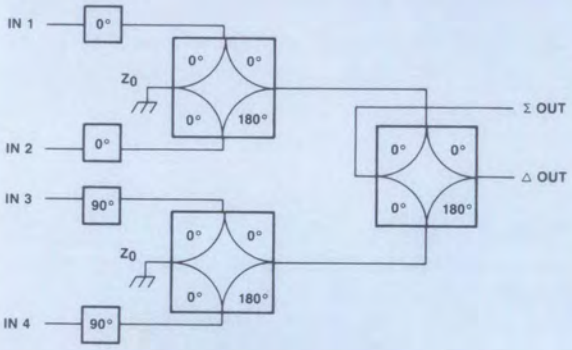
BEAMFORMING NETWORKS

Adams-Russell's traditional passive ferrite, transformer, microstrip and hybrid component technologies are combined to produce broadband and narrowband beamforming networks. These are used in applications where signal amplitudes and phase relationships from several channels are processed and combined vectorially to provide information such as direction, altitude, range, speed and depth in systems used for guidance, direction finding (DF), navigation and communication.

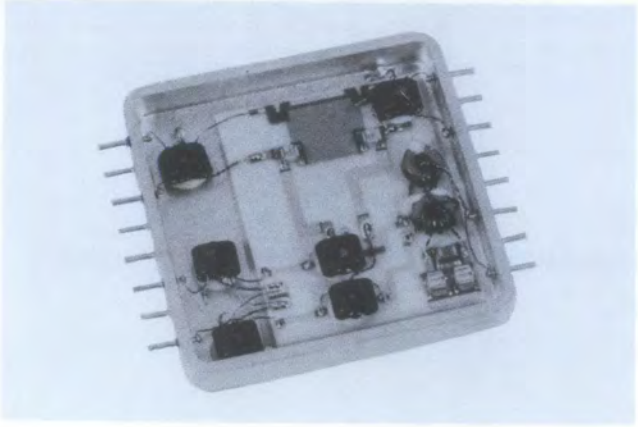


FEATURES

- **Frequency: A to C-Band**
- **Loss: <1 dB**
- **Isolation: >23 dB**
- **VSWR: <1.3:1**
- **Computer Aided Network Design**

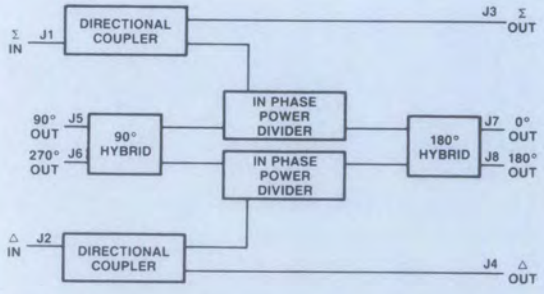


SPACE QUALIFIED BEAMFORMER

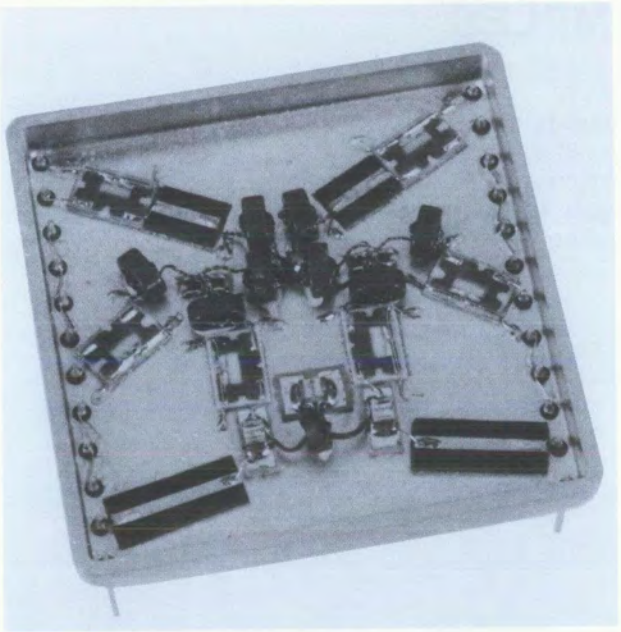


FEATURES

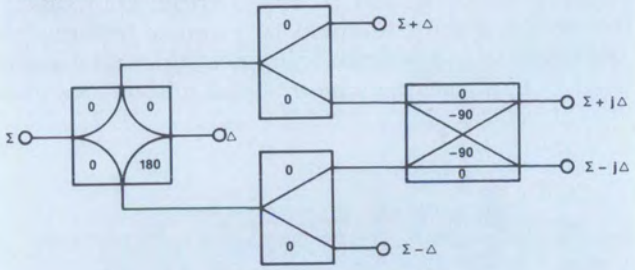
- **Small 1" x 1" Flatpack**
- **Hi Rel Qualified**
- **Optimized For IF Frequencies**



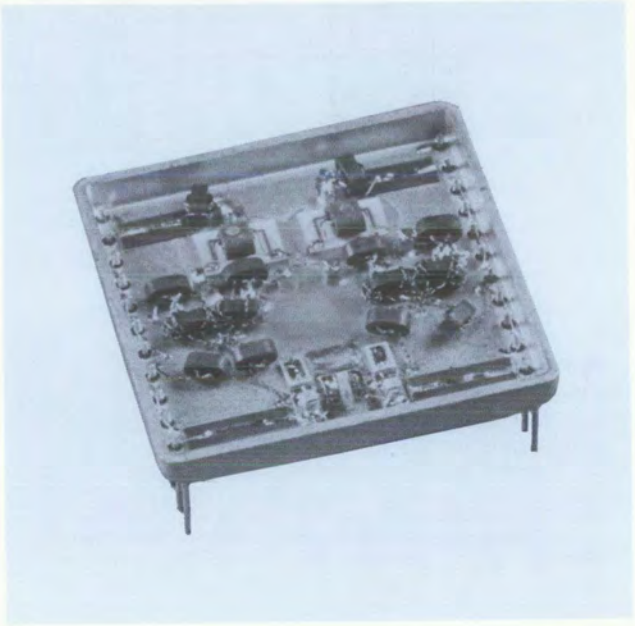
AIRBORNE/SEEKER BEAMFORMER



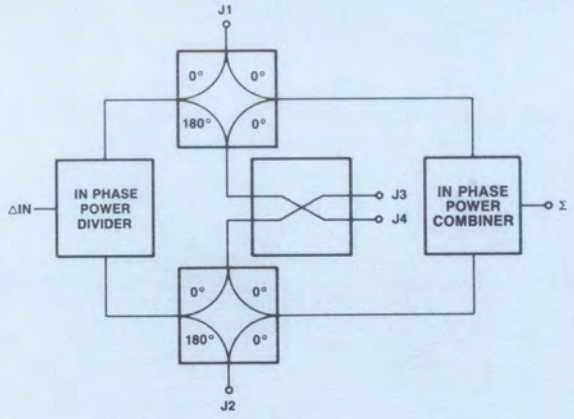
FEATURES
- Octave Bandwidth
- Low Loss
- High DF Accuracy



MONOPULSE BEAMFORMER



FEATURES
- Octave Bandwidth
- Low Loss
- Phase Tracking ≤8°
- Null Depth > – 30 dB

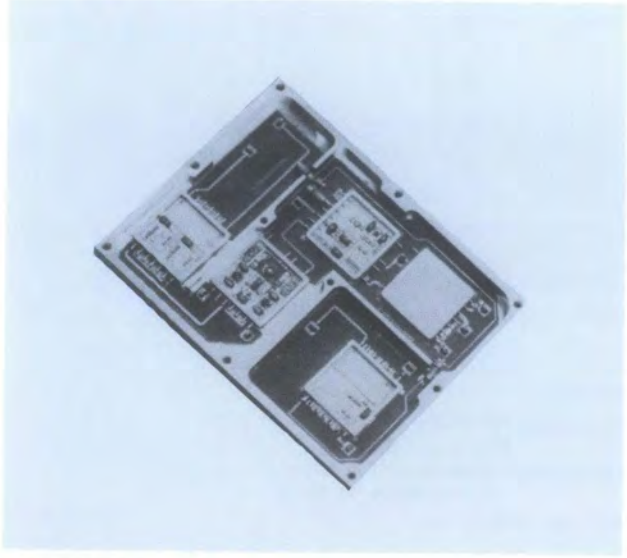


NAVIGATION GUIDANCE BEAMFORMER

UP AND DOWN CONVERTER FRONT-ENDS

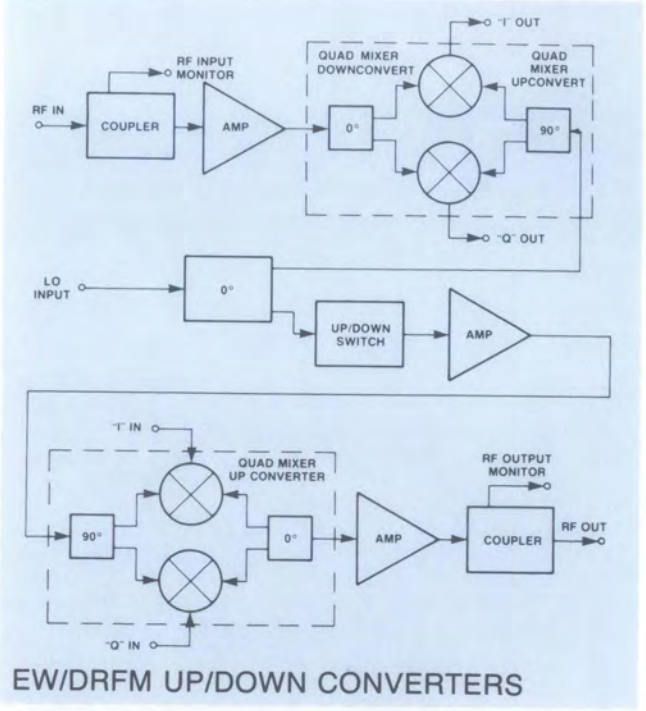
Adams-Russell's thick and thin film process technologies are combined with MIC and packaging experience to produce multifunctional up and down converter supercomponents and subsystems.

Applications include receivers used in EW, radar, navigation, guidance, communication and ground support equipment, Digital RF Memories (DRFM's), test and measurement equipment, etc.

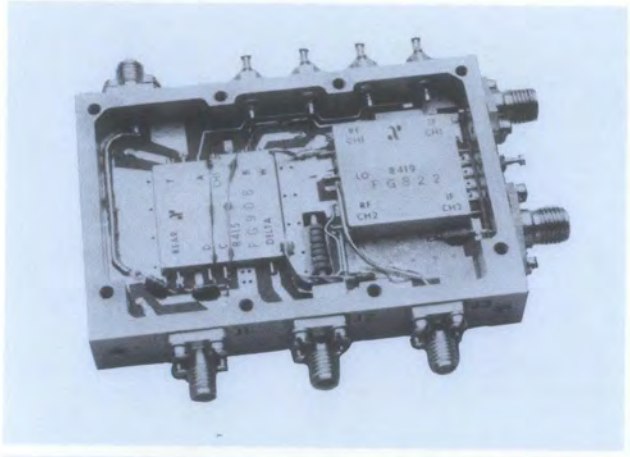


FEATURES

- **Frequency: C and D-Band**
- **Image Rejection: >20 dB**
- **High Dynamic Range**
- **Pulse/CW Operation**



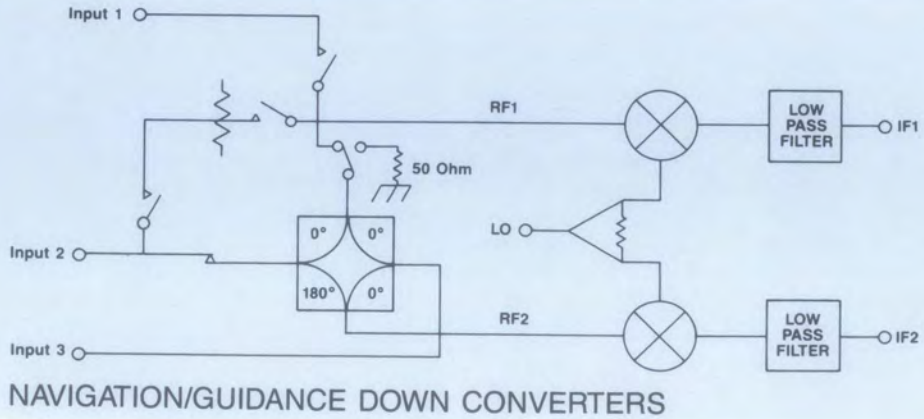
EW/DRFM UP/DOWN CONVERTERS



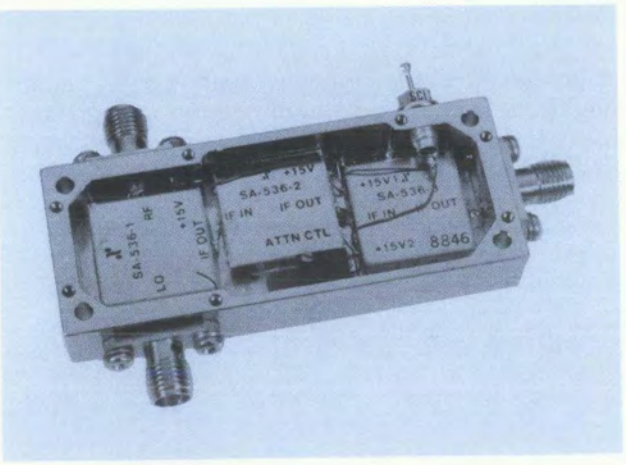
FEATURES

- **Channel-to-Channel Tracking of 5° and 0.5 dB**
- **Isolation: > 50 dB**
- **Designed for Severe Airborne Environment**
- **L-Band RF, S-Band LO and P-Band IF**

This down converter features switched inputs and a test port on the RF with a high isolation pin diode switch module. The 180° hybrid has amplitude balance of 0.1 dB typical with 1° phase accuracy typical. The mixer/filter outputs are phase and amplitude matched with the filters providing LO and RF isolation > 50 dB.

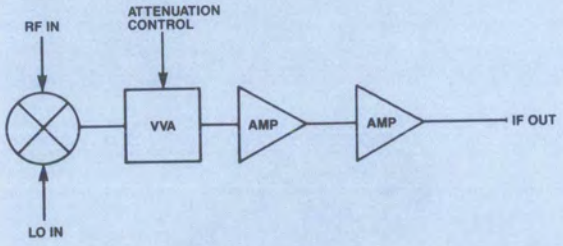


NAVIGATION/GUIDANCE DOWN CONVERTERS

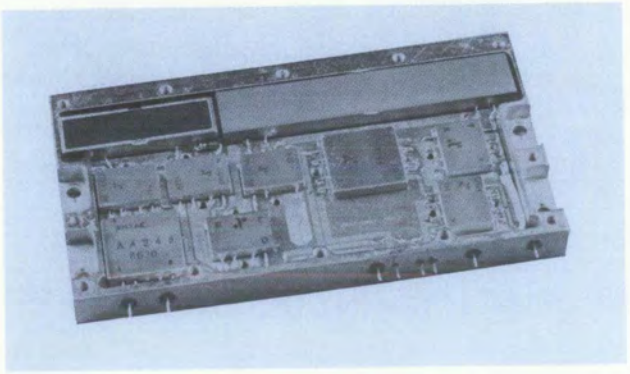


FEATURES

- **Input Frequency: 40% BW, C-Band**
- **IF Frequency: HF to L-Band**
- **Output Power: +16 dBm**
- **–40 dBC In Band Spurious and Harmonics**
- **Linear Attenuation: +15 dB**

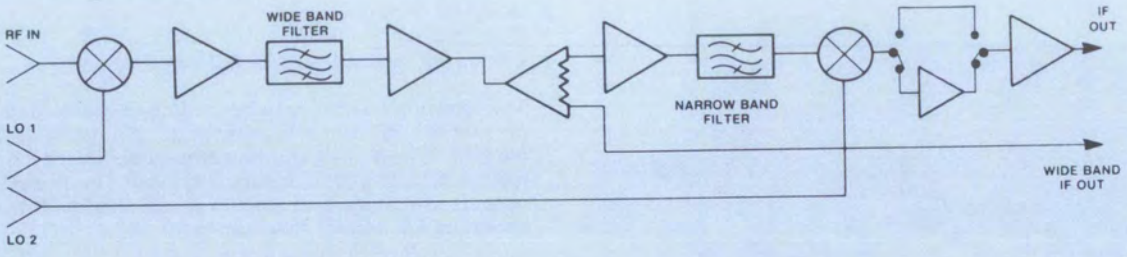


C-BAND DOWN CONVERTER

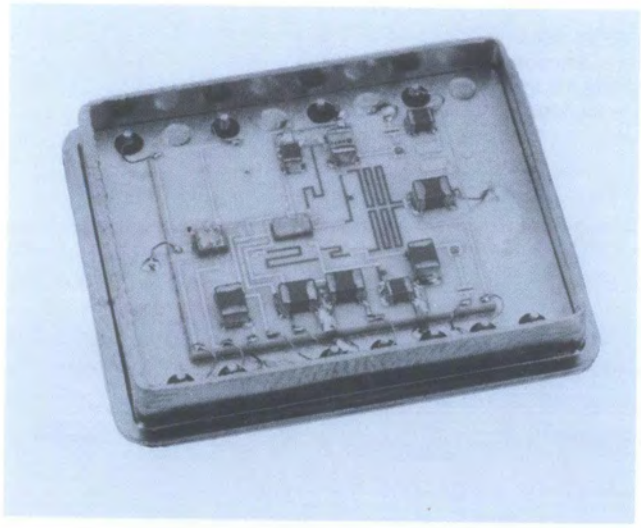


FEATURES

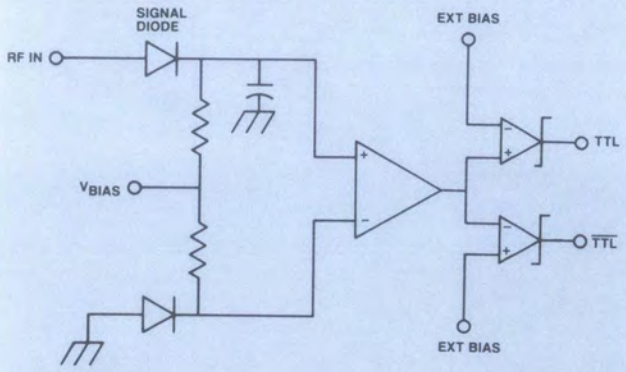
- **Frequency, RF: D-Band**
  IF: A and B-Band
- **Bandwidths: Wideband, 100 MHz**
  Narrowband, 20 MHz
- **High Dynamic Range**



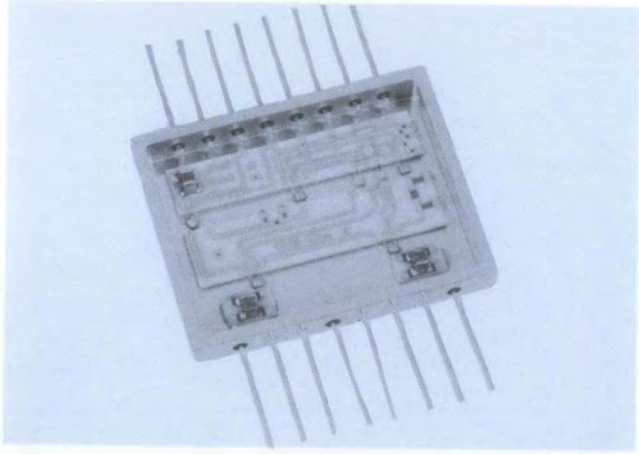
ELINT RECEIVER SUBASSEMBLY



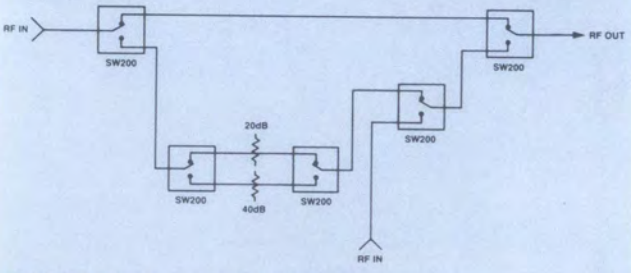
FEATURES
- **IF Frequency Range**
- **Temperature Compensated**
- **Fast Rise Time: < 50 ns**



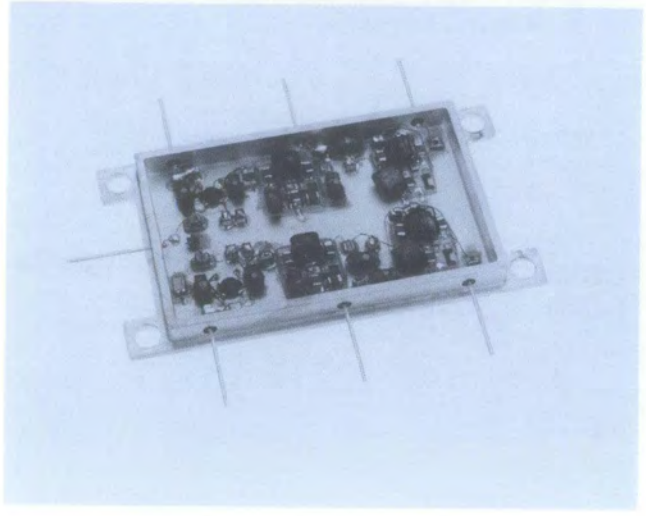
POWER SENSOR



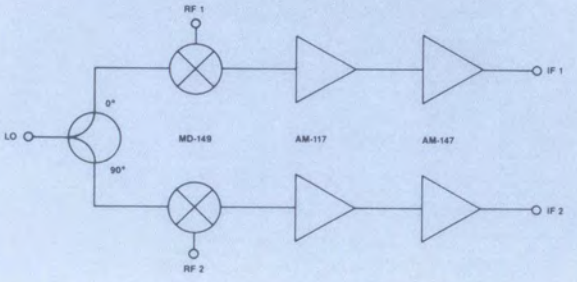
FEATURES
- **Wide Bandwidth**
- **Low Current: < 5 mA**
- **Fast Switching: < 50 ns**



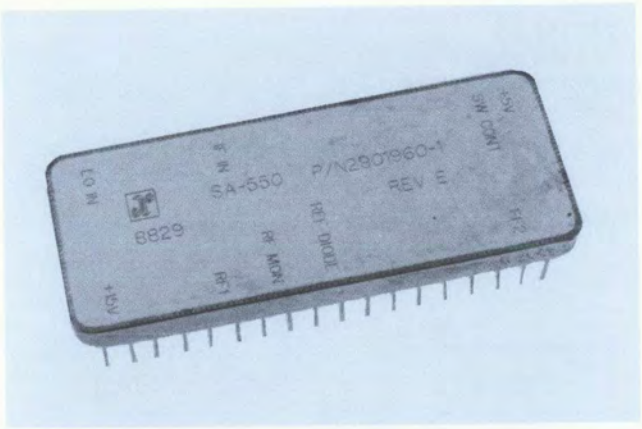
SWITCHED ATTENUATOR

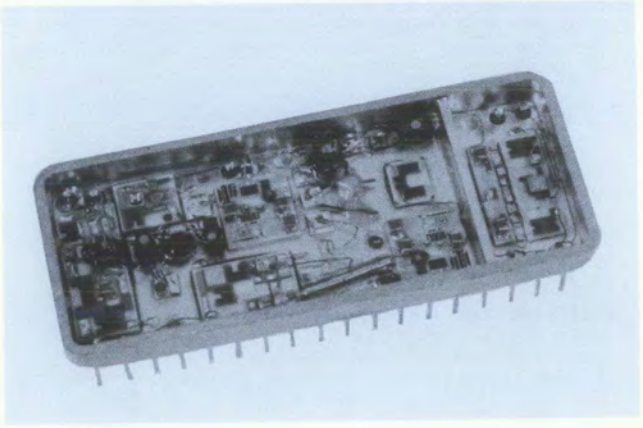


FEATURES
- **L-Band Inputs**
- **Quadrature IF Outputs**
- **+15 dBm typical 1 dB Compression**
- **Amplitude Tracking**
- **Low Risk – Features Standard Components**



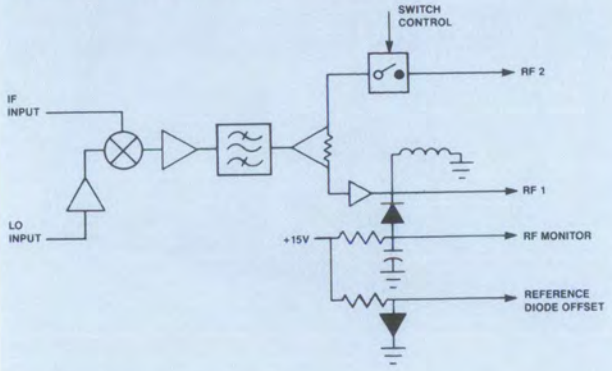
DUAL CHANNEL DOWNCONVERTER



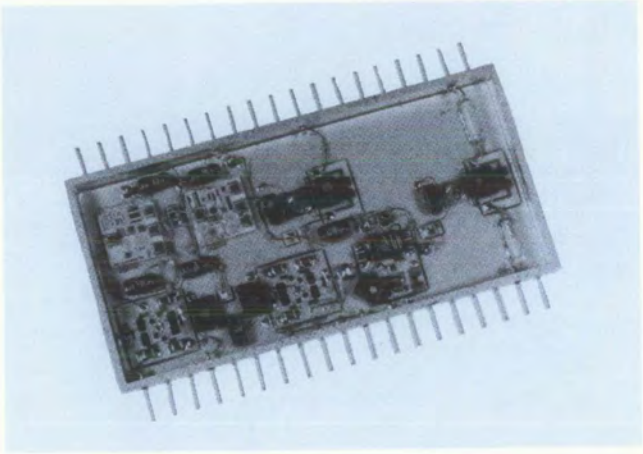


FEATURES

- **Compact Packaging**
- **30 dB Image Rejection**
- **Switched Output has 55 dB Isolation**

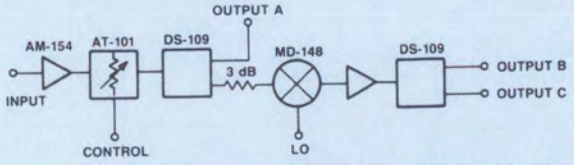


IF CONVERTER



FEATURES

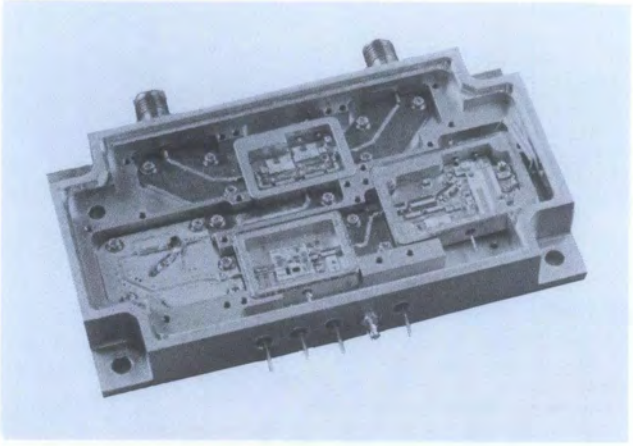
- **Frequency to E-Band**
- **Broadband/Narrowband IF's**
- **Low Noise/High Output Amplitude**
- **>30 dB Attenuation Range**



COMMUNICATIONS SYSTEM ATTENUATOR/ DOWN CONVERTER SUBASSEMBLY

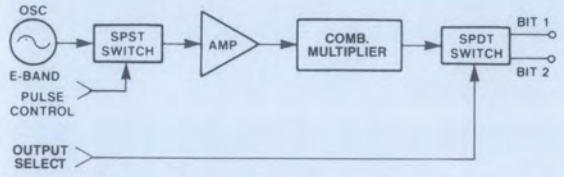
BIT OSCILLATOR AND MULTIPLIER ASSEMBLIES

Low noise sources and multipliers are an integral part of most system's architecture. Adams-Russell's Frequency Generation product experience offers a wide range of active and passive multipliers which can be integrated with low noise sources and other catalog components to satisfy the OEM's needs in the areas of receiver and transmitter applications.

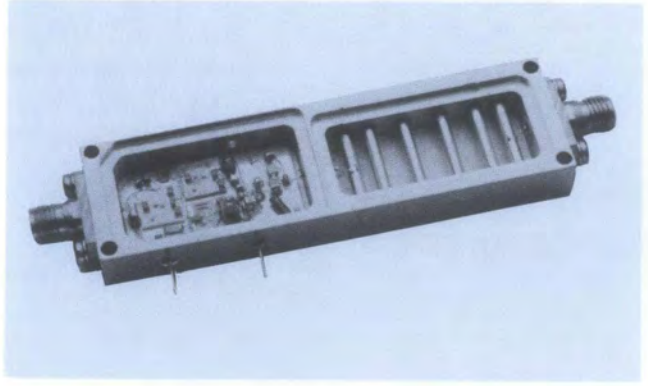


FEATURES

- **Spurious Free Output**
- **CW/Pulse Operation**
- **Stable Freq. and Amplitude**

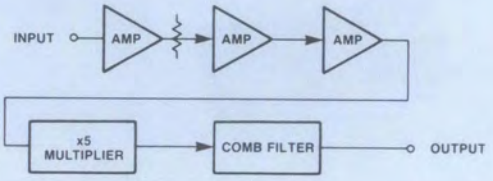


BIT OSCILLATOR

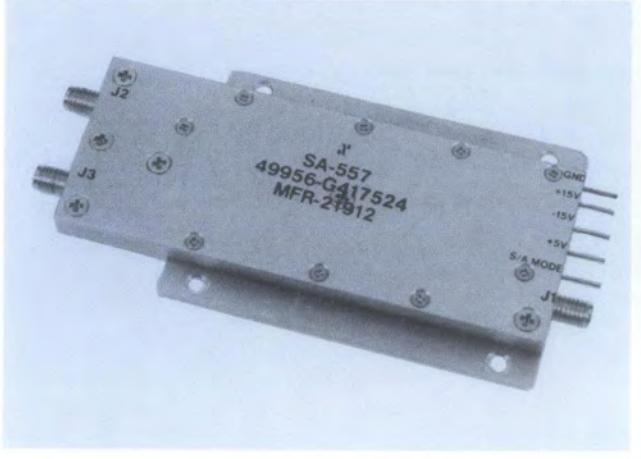


FEATURES

- **Input Freq: C-Band**
- **Output Freq: 3,600-3,850 MHz**
- **Output Power: + 13 dBm**
- **Spurious Outputs: <80 dBc**

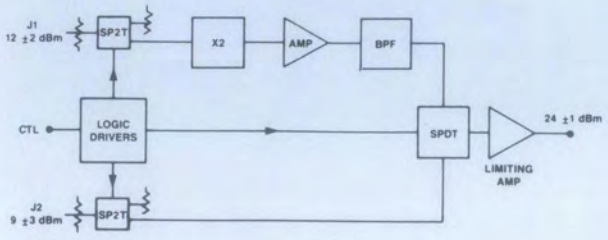


TRANSMITTER/RECEIVER MULTIPLIERS

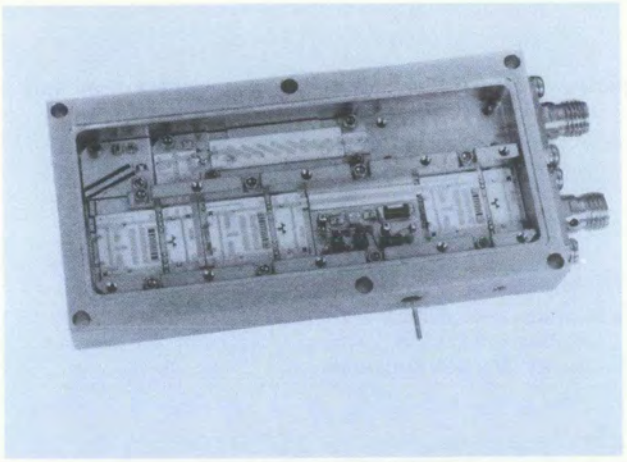


FEATURES

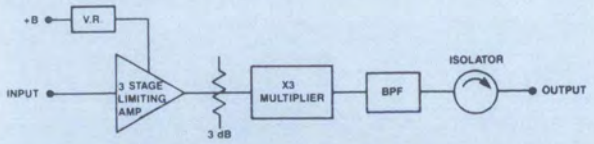
- **Output Power: +24 dBm ±1 dB**
- **J1/J2 to J3 Isolation: 90 db**
- **Spurious Outputs: –60 dBC**
- **Phase Noise @ 1 KHz from Carrier: –145 dBc/Hz**
- **Size: 3.2″ x 1.25″ x 0.3″**



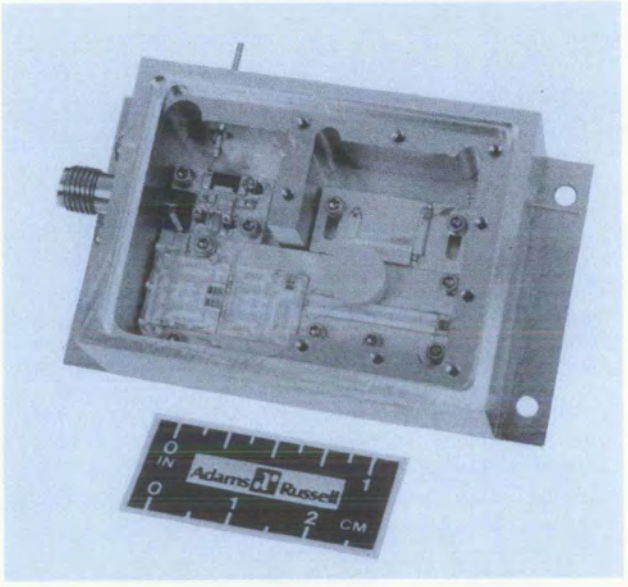
MULTIPLIER SUBASSEMBLY



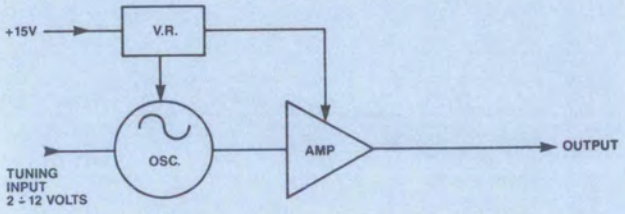
FEATURES
- Input Frequency: 7% BW, @ C-Band
- Input Power: 0 ±2 dBm
- Output Frequency: 7% BW, @ Ku-Band
- Output Power: 10 ±2 dBm
- Spurious Outputs: < −50 dBC



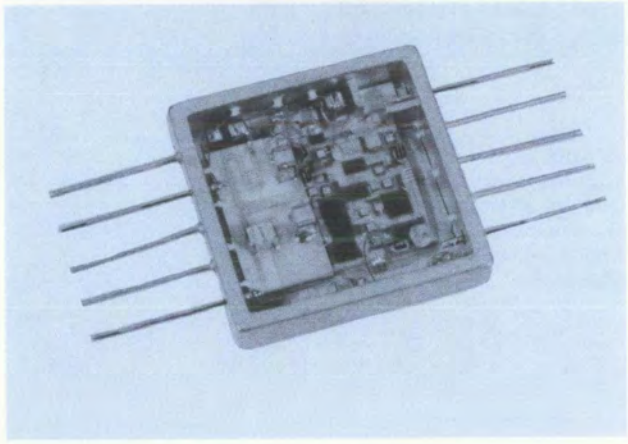
LIMITING MULTIPLIER



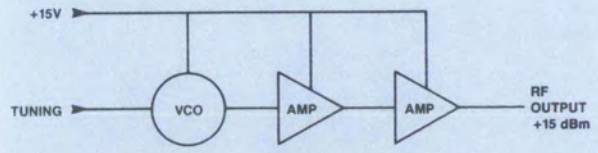
FEATURES
- Output Frequency: C, X Band
- Output Power: +20 dBm Min.
- Phase Noise: −90 dBc/Hz @ 10 KHz Offset
- Frequency Tuning: ±3 MHz Min.
  Tuning will exceed all oscillator frequency drifts



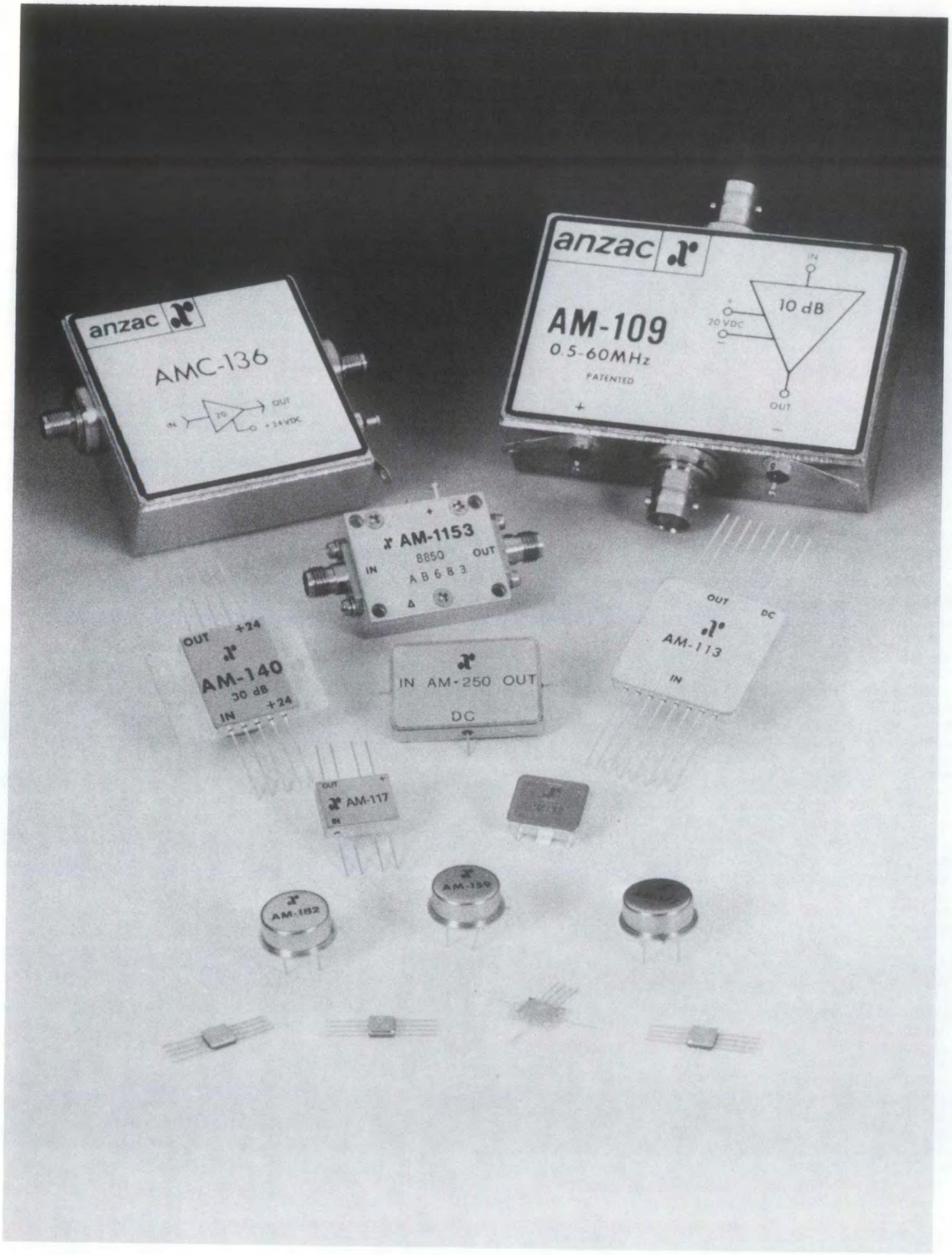
VOLTAGE TUNED DRO C-X BAND



FEATURES
- L Band 5% BW VCO
- Frequency vs. Temp: ±0.2% over −40 to +85°C
- Tuning Sensitivity vs. Temp: ±2.5%
- Pulling ±250 KHz (into 3:1 VSWR, all phases)



5% BANDWIDTH VCO/AMPLIFIER


anzac
AMC-136
anzac
AM-109
0.5-60MHz
PATENTED
10 dB
20 VDC
AM-1153
8850
A B 6 8 3
AM-140
30 dB
AM-250
DC
AM-113
AM-117
AM-152
AM-159

AMPLIFIER SELECTION GUIDE

MODEL NO.	FREQUENCY RANGE (MHz)	GAIN (dB) TYP	NOISE FIGURE (dB) TYP	3RD ORDER INTERCEPT (dBm) TYP	1dB COMPRESSION (dBm)	CASE* STYLE	PAGE NO.
AM-109	0.5-60	10	4.6	+50	+31	C-15	31
AM-124	0.5-100	16	3.8	+12	–2	RH-1	39
AM-110	0.5-100	30	4.5	+40	+23	C-23	32
AM-107	1-100	10	1.4	+15	+1	C-6	30
AM-162	10-100	12.5	1.3	+32	+15	TO-8-1	59
AMC-162	10-100	12.5	1.3	+32	+15	C-6	59
AMS-162	**10-100**	**12.5**	**1.3**	**+32**	**+15**	**SF-1**	60
AM-113	10-100	30	1.5	+33	+18	FP-6	34
AM-132	5-200	10	4.5	+49	+29	FP-8	40
AMC-132	5-200	10	4.5	+49	+29	C-25	40
AM-134	5-200	15	4.8	+47	+28	FP-8	41
AMC-134	5-200	15	4.8	+47	+28	C-25	41
AM-136	5-200	20	4.8	+49	+29	FP-9	42
AMC-136	5-200	20	4.8	+49	+29	C-25	42
AM-138	5-200	25	5.3	+48	+29	FP-9	43
AMC-138	5-200	25	5.3	+48	+29	C-25	43
AM-140	5-200	29	5.4	+47	+28	FP-9	44
AMC-140	5-200	29	5.4	+47	+28	C-25	44
AM-117	10-200	8	1.3	+30	+11	FP-2	35
AMC-117	10-200	8	1.3	+30	+11	C-6	35
AMS-117	**10-200**	**8**	**1.3**	**+30**	**+11**	**SF-1**	36
AM-112	10-200	16	2.0	+24	+9	C-16	33
AM-119	30-250	8	2.3	+40	+23	TO-8-1	37
AMC-119	30-250	8	2.3	+40	+23	C-6	37
AM-102	5-300	9.5	6.0	+33	+17	C-6	27
AM-105	5-300	19	5.0	+33	+17	C-16	29
AM-108	5-300	28	5.0	+33	+17	C-16	29
AM-181	10-400	8.5	1.5	+30	+12	TO-8-1	70
AMC-181	10-400	8.5	1.5	+30	+12	C-6	70
AMS-181	**10-400**	**8.5**	**1.5**	**+30**	**+12**	**SF-1**	71
AM-210	5-500	15	1.8	+20	+7	TO-8-1	78
AMC-210	5-500	15	1.8	+20	+7	C-6	78
AM-143	5-500	16	1.9	+22	+6	TO-8-1	46
AMC-143	5-500	16	1.9	+22	+6	C-6	46
AM-103	5-500	10	2.7	+25	+11	FP-2	28
AMC-103	5-500	10	2.7	+25	+11	C-6	28
AM-101	5-500	10	3.5	+40	+22	FP-7	26
AM-123	5-500	10	3.5	+42	+22	FP-7	38
AMC-123	5-500	10	3.5	+42	+22	C-6	38
AM-131	5-500	10	3.5	+42	+22	TO-8-1	38
AM-151	5-500	12	5.0	+38	+21	TO-8-1	52
AMC-151	5-500	12	5.0	+38	+21	C-6	52
AM-147	5-500	17	3.5	+35	+21	TO-8-1	49
AMC-147	5-500	17	3.5	+35	+21	C-6	49
AM-148	5-500	14	3.5	+16	+3	TO-8-1	50
AM-171	5-500	15	2.4	+12	0	TO-8-1	61
AMC-171	5-500	15	2.4	+12	0	C-6	61
AM-149	5-500	15	5.0	+30	+16	TO-8-1	51
AM-156	10-500	12.5	2.0	+18	+4	TO-8-1	56
AMC-156	10-500	12.5	2.0	+18	+4	C-6	56
AM-146	10-500	21	4.0	+38	+24	FP-9	48
AMC-146	10-500	21	4.0	+38	+24	C-25	48
AM-157	20-500	12.5	5.5	+42	+24	TO-8-1	57
AMC-157	20-500	12.5	5.5	+42	+24	C-6	57
AM-212	100-600	8	2.0	+20	+4	TO-8-1	81
AMC-212	100-600	8	2.0	+20	+4	C-6	81
AMS-212	**100-600**	**8**	**2.0**	**+20**	**+4**	**SF-1**	82
AM-191	100-600	23.5	2.5	+32	+23	FP-3	77
AM-160	100-600	28	1.6	+30	+19	FP-9	58
AM-211	5-1000	12	3.2	+12	+2	TO-8-1	79
AMC-211	5-1000	12	3.2	+12	+2	C-6	79
AMS-211	**5-1000**	**12**	**3.2**	**+12**	**+2**	**SF-1**	80
AM-176	5-1000	13	4.0	+30	+13	TO-8-1	65
AMC-176	5-1000	13	4.0	+30	+13	C-6	65
AM-173	5-1000	15	2.4	+12	0	TO-8-1	62
AMC-173	5-1000	15	2.4	+12	0	C-6	62

*CASE STYLE: FP = FLATPACK; C = CONNECTORIZED; RH = RELAY HEADER; TO-8 = TO-8 PLUG-IN
CHIP = IC CHIP; CR-1,2,3 = CERAMIC PACKAGE; SF = SURFACE MOUNT

**DENOTES GaAs MMIC BASED PRODUCT

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

BOLD TYPE = NEW PRODUCT

AMPLIFIER SELECTION GUIDE (continued)

MODEL NO.	FREQUENCY RANGE (MHz)	GAIN (dB) TYP	NOISE FIGURE (dB) TYP	3RD ORDER INTERCEPT (dBm) TYP	1dB COMPRESSION (dBm)	CASE* STYLE	PAGE NO.
AM-174	5-1000	15	2.5	+17	+4	TO-8-1	63
AMC-174	5-1000	15	2.5	+17	+4	C-6	63
AM-175	5-1000	15	3.0	+22	+8	TO-8-1	64
AMC-175	5-1000	15	3.0	+22	+8	C-6	64
AM-182	5-1000	28	2.7	+22	+10	TO-8-1	72
AMC-182	5-1000	28	2.7	+22	+10	C-6	72
AM-183	10-1000	28.5	2.9	+25	+14	TO-8-1	73
AMC-183	10-1000	28.5	2.9	+25	+14	C-6	73
AM-145	10-1000	11	4.5	+35	+17	TO-8-1	47
AMC-145	10-1000	11	4.5	+35	+17	C-6	47
AM-177	10-1000	12	7.5	+40	+22	TO-8-1	66
AM-154	20-1000	9.5	2.0	+20	+8	TO-8-1	54
AMC-154	20-1000	9.5	2.0	+20	+8	C-6	54
AM-142	200-1000	12	2.2	+20	+6	TO-8-1	45
AMC-142	200-1000	12	2.2	+20	+6	C-6	45
AM-155	300-1000	12.5	2.5	+37	+21	TO-8-1	55
AMC-155	300-1000	12.5	2.5	+37	+21	C-6	55
AM-188	10-1200	13	6.5	+29	+18	TO-8-1	76
AM-153	300-1800	12	1.9	+19	+7	TO-8-1	53
AM-178	10-2000	10	3.9	+17	+3	TO-8-1	67
AMC-178	10-2000	10	3.9	+17	+3	C-6	67
AM-179	10-2000	10	4.2	+23	+8	TO-8-1	68
AMC-179	10-2000	10	4.2	+23	+8	C-6	68
AM-180	10-2000	10	4.8	+30	+14	TO-8-1	69
AMC-180	10-2000	10	4.8	+30	+14	C-6	69
AM-185	10-2000	19	5.0	+28	+15	TO-8-1	75
AM-184	10-2000	20	4.5	+22	+12	TO-8-1	74
AMC-184	10-2000	20	4.5	+22	+12	C-6	74
AM-280**	**1100-1700**	**20**	**1.5**	**+23**	**+11**	**CHIP**	86
AM-281**	**1100-1700**	**18**	**1.5**	**+23**	**+11**	**CR-3**	91
AM-282**	**1100-1700**	**18**	**1.5**	**+23**	**+11**	**CR-2**	91
AM-250	150-5200	11	6.0	+30	+19	FP-18	83
AMC-250	150-5200	11	6.0	+30	+19	C-4	83
AM-260**	2000-8000	8	6.5	+25	+12	CHIP	84
AM-261**	2000-6000	8	6.5	+25	+12	CR-1	90
AM-290**	**700-5250**	**10**	**5.0**	**+25**	**+10**	**CHIP**	88
AM-291**	**700-5250**	**10**	**4.5**	**+25**	**+10**	**TO-8-1**	92
AM-292**	**700-5250**	**10**	**4.5**	**+25**	**+10**	**FP-20**	93

SURFACE MOUNT RF AMPLIFIERS

AMS-162	**10-100**	**12.5**	**1.3**	**+32**	**+15**	**SF-1**	60
AMS-117	**10-200**	**8**	**1.3**	**+30**	**+11**	**SF-1**	36
AMS-181	**10-400**	**8.5**	**1.5**	**+30**	**+12**	**SF-1**	71
AMS-212	**100-600**	**8**	**2.0**	**+20**	**+4**	**SF-1**	82
AMS-211	**5-1000**	**12**	**3.2**	**+12**	**+2**	**SF-1**	80

*CASE STYLE: FP = FLATPACK; C = CONNECTORIZED; RH = RELAY HEADER; TO-8 = TO-8 PLUG-IN
CHIP = IC CHIP; CR-1,2,3 = CERAMIC PACKAGE; SF = SURFACE MOUNT
**DENOTES GaAs MMIC BASED PRODUCT
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AMPLIFIER APPLICATION NOTE

INTRODUCTION

Broadband radio frequency amplifiers, designed for operation below microwave frequencies, generally use high-gain bipolar transistors in combination with negative feedback circuitry. This note presents a discussion of feedback with emphasis on the unique circuits, which Anzac has developed, having fundamental advantage in noise figure and dynamic range performance. Also included are basic amplifier definitions and information useful for predicting the noise figure and intermodulation performance of amplifier cascades.

FEEDBACK AMPLIFIERS

The bipolar and field effect transistors, which are the basic gain producing devices used in virtually all RF receiving amplifiers, are not particularly attractive for that use from a design standpoint. They are characterized by frequency dependent gain, poor impedance match, and non-linear operation. Negative feedback circuits are designed to overcome these effects and it is the designer's task to provide amplifiers having flat gain, good impedance match, and reduced distortion for acceptable systems operation.

Most such amplifiers are designed using a technique commonly known as resistive feedback, shown in Figure 1. One feedback resistor connects between collector and base; a second connects between emitter and the ground of the common emitter transistor. Selection of these two resistors controls the gain and terminal impedances as given by the approximate equations in Figure 1. These feedback resistors are inherent noise producers and power dissipators. As feedback is increased in order to decrease gain and distortion, these resistors add more noise and dissipate more output power. With feedback sufficient to reduce gain to 10 dB, the noise figure will have increased by about 3 dB and the available output power will have decreased by about 3 dB compared to the performance of the same transistor operating without feedback.

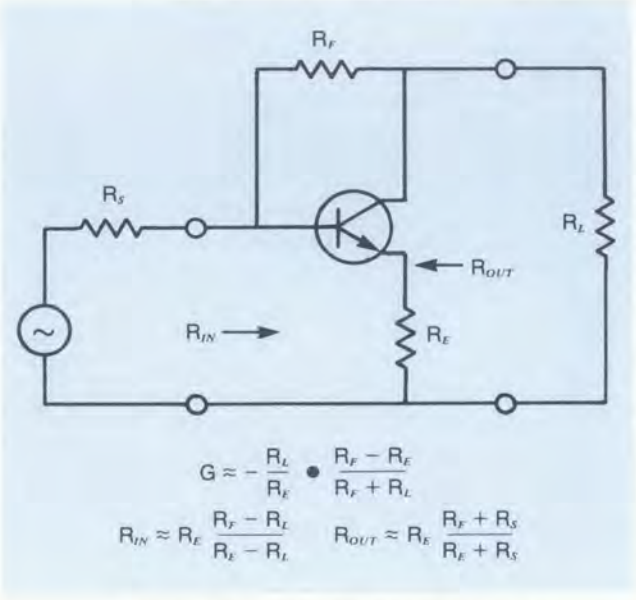


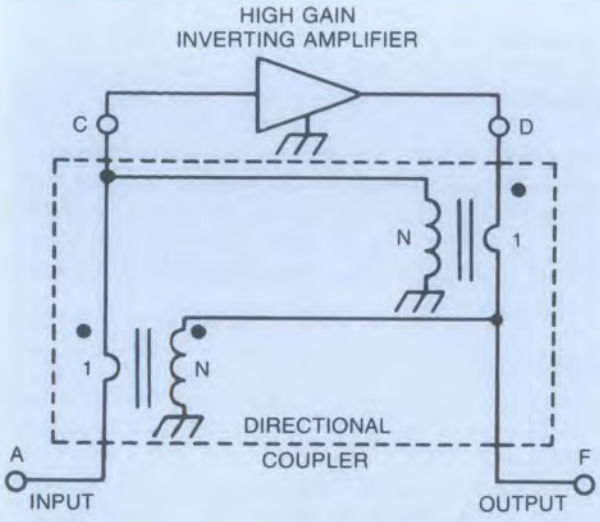
Figure 1. Resistive Feedback Amplifier

To avoid this degradation of performance, Anzac developed a negative feedback structure based on its ferrite transformer capabilities. This patented technique, known as "lossless feedback," provides lower noise figure and higher linear output than can be achieved using resistive feedback with the same transistors. Figure 2 shows a block diagram of a transformer feedback circuit in which a directional coupler is the feedback network. The coupling ratio between ports D and C determines the magnitude of the feedback, and hence, the gain. The feedback is negative due to the in-phase coupling between ports D and C and the inversion of the active device.

The isolation of the coupler prevents output power from the active element applied to port D from appearing at the input port A; therefore, impedance match can be maintained in the presence of feedback. Finally, the signal transfer properties of the coupler are such that all of the input signal at A is added to the transistor output signal at D to yield a total output signal at B which is greater than the active device output; this is in contrast to the resistive feedback configuration in which the output power is less than that delivered by the active device. The only noise figure degradation is that produced by the very small incidental losses in the coupler.

The directional coupler feedback circuit gives great flexibility in application. The gain can be varied over a wide range by changing the transformer turns ratio and therefore the coupling ratio. Taps are regularly added to the transformers allowing the source and load impedances presented to the transistor to be changed. This allows noise figure and output linearity characteristics to be optimized. The couplers are very broadband devices allowing wide bandwidths, limited only by the active device, to be achieved.

A more detailed discussion of these circuits is contained in the reference (1), of which a reprint is available upon request from the Anzac Sales Department.



GAIN:

$$G = \frac{A}{1-A\beta}$$

FOR $|A\beta| >> |$

$$G \cong -\frac{1}{\beta}$$

G: Gain in the Presence of Feedback

A: Gain without Feedback or Open Loop Gain

β: Feedback Transfer Function or Coupling Ratio

DISTORTION:

$$D = \frac{d}{1-A\beta}$$

D: Distortion in the Presence of Feedback

d: Distortion without Feedback

Figure 2.

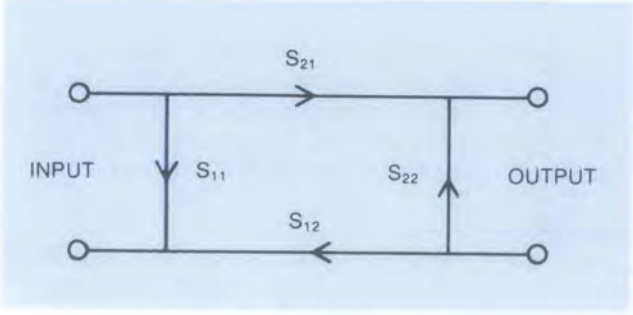


Figure 3.

DEFINITION AND MEASUREMENT OF AMPLIFIER PARAMETERS

Gain

A network analyzer is used to measure the two-port scattering parameters of the amplifier as shown in the accompanying flow graph (Figure 3). The small signal insertion gain is defined as the ratio of the power delivered to the load to the power available from the source, in a 50 ohm measuring system on dB,

$$G = 20 \log_{10} |S_{21}| \text{ dB}$$

Return Loss and VSWR

The input and output return loss and VSWR are related to the input and output scattering parameters as follows:

$$\rho in = |S_{11}| \qquad \rho out = |S_{22}|$$

$$\text{Return Loss} = 20 \log_{10} \rho \text{ dB}$$

$$\text{VSWR} = \frac{1+\rho}{1-\rho}$$

Noise Figure

The noise factor is the ratio of the signal to noise at the input to that at the output.

$$f = \frac{\text{Signal-to-noise ratio at input}}{\text{Signal-to-noise ratio at output}}$$

The noise figure is the noise factor expressed in dB

$$F = 10 \log f \text{ dB}$$

For very low noise figure determination, measurement is made using a highly accurate hot-cold noise source. For less critical determination of higher noise figures, an accurately calibrated diode noise source is used.

Intermodulation Intercept

The intermodulation intercept is an expression of the low level linearity of the amplifier. The intermodulation ratio is the difference in dB between the fundamental output signal level and the generated distortion product level. The relationship between intercept and intermodulation ratio is illustrated in Figure 4, which shows product output levels plotted versus the level of the fundamental output for two equal strength output signals at different frequencies. The upper line shows the fundamental output plotted against itself with a 1 dB to 1 dB slope. The second and third order products lie below the fundamentals and exhibit a 2:1 and

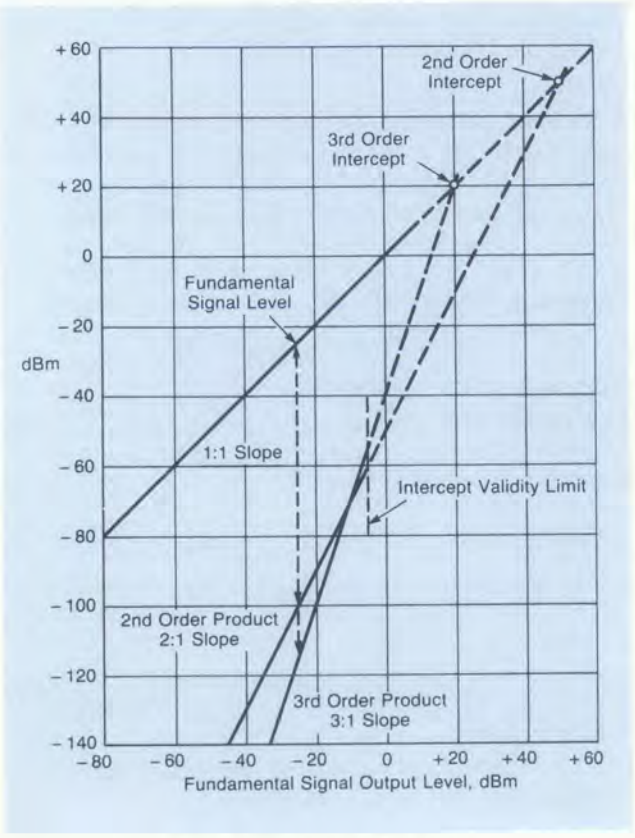


Figure 4. Intercept Diagram

3:1 slope respectively. The intercept point for either product is the intersection of the extensions of the product curve with the fundamental output.

The intercept point is determined by measuring the intermodulation ratio at a single output level and projecting along the appropriate product slope to the point of intersection with the fundamental. When the intercept point is known the intermodulation ratio can be determined by the reverse process. The second order IMR is equal to the difference in dB between the second order intercept and the fundamental output level. The third order IMR is equal to twice the difference between the third order intercept and the fundamental output level. These are expressed as:

$$IP_2 = P_{OUT} + IMR_2$$
$$IP_3 = P_{OUT} + \tfrac{1}{2} IMR_3$$

where P_{OUT} is the power level in dBm of each of a pair of equal level fundamental output signals, IP_2 and IP_3 are the second and third order output intercepts in dBm, and IMR_2 and IMR_3 are the second and third order intermodulation ratios in dB.

The intermodulation intercept is a valid indicator of intermodulation performance only in the small signal operating range of the amplifier. Above some output level which is below the 1 dB compression point, the active device moves into large signal operation attended by signal strength dependent bias level shifts. At this point the intermodulation products no longer follow the straight line output slopes, and the intercept description is no longer valid.

The intermodulation ratios are determined by measurement using a conventional spectrum analyzer. The measurement dynamic range is enhanced using appropriate cancellation techniques when required to accomodate high dynamic range amplifiers.

Compression

The 1 dB compression point is the output level at which the amplifier gain drops 1 dB below its small signal value. It is an indication of the signal level at which small signal conditions no longer apply. At this level, the intermodulation intercepts no longer adequately predict the amplifier distortion behavior.

The measurement of the compression level is made using a frequency discriminating detector in order to detect the gain decrease at the fundamental frequency. This is preferable to using a total power detection measurement, since it is the fundamental frequency which is probably of most interest to the user.

Maximum Signal

The maximum signal level is the largest CW or pulsed RF signal which may be safely applied to the amplifier. Larger signals will exceed the emitter base breakdown voltage of the transistor and will result in permanent degradation of noise figure and, for large enough signals, reduction of gain and increase in distortion.

The specified level is determined by applying successively larger CW signals and measuring the noise figure until 0.5 dB degradation is observed. The maximum signal level is specified 3 dB below the level which causes the 0.5 dB degradation.

Stability

Broadband feedback amplifiers, in general, may not be unconditionally stable at all frequencies, particularly outside of their specified operating bandwidth. When lossless feedback techniques are employed, stability margins tend to be smaller

than when resistive methods are used. Indeed, it has been observed that when completely lossless feedback networks are utilized, for the purpose of achieving the lowest possible noise figures and highest dynamic range, it may not also be possible to achieve unconditional stability simultaneously. Unconditional stability may well be a trade-off against the noise figure requirement in particular.

For this reason, Anzac has utilized the analysis capability of automatic network analyzers in order to calculate the stability conditions for amplifiers from their measured S-parameters. Using equations from reference (2) it is possible to compute the K factor and the stability circle locations directly from the S-parameters at all frequencies of measurement. If the K factor is greater than unity, the amplifier is unconditionally stable at that frequency. If K is less than unity, then the stability circles, which are the boundaries between the stable and the potentially unstable load regions, may be calculated and plotted on the source and load plane Smith charts. This information, along with the system designer's knowledge of the source and load impedances in which the amplifier will be embeded, make it possible to utilize, with confidence, amplifiers whose desirable characteristics outweigh their lack of unconditional stability. Intelligent utilization of this information has allowed Anzac to supply the lowest noise, highest dynamic range amplifiers to the industry.

Survivability

Recent published work (3) has been done at Anzac on the topic of amplifier survivability and protection against strong RF signal inputs. It was found that the most probable overload failure mechanism is breakdown of the emitter base junction when the applied signal negative peaks drive the base beyond the BV_{EBO} rating of the transistor. The majority of Anzac amplifiers utilize transistors with breakdown voltages in excess of 3 volts, and these devices can withstand signals up to + 20 dBm. Recently designed high frequency amplifiers use very high f_t devices with 1.5 volt breakdown voltages. These devices are susceptible to damage with signals in the vicinity of + 13 dBm.

The problem is related to peak voltages rather than average power and is therefore as severe for low duty cycle pulses as for CW signals. Indeed, it may be more severe for repetitive pulses if the transient response of the input biasing circuitry is not well controlled.

Special protection technique against overdrive is not included in Anzac standard amplifiers. However, such techniques have been developed and can be incorporated in special designs as required. The most effective protection has been obtained by placing a low resistance Schottky diode directly across the emitter-base junction in the reverse bias direction. This diode has no effect on the small signal operation of the amplifier; specifically, it does not degrade noise figure or intermodulation intercept. When overloading signals are applied, however, the diode conducts on the negative peaks and limits the emitter-base voltage below the level of breakdown. By proper application of this technique, including the design of the bias circuitry, it is possible to protect very low noise amplifiers against overloading signals in excess of one watt.

FIGURES OF MERIT

There are two figures of merit which are useful for comparing the performance capabilities of similar amplifiers. These have been designated the dynamic range number and the intercept efficiency.

The first combines the third order intercept, the gain, and the noise figure into a single number which compares the dynamic range capabilities of one amplifier with another. The second compares amplifiers based on their conversion of applied DC power to third order intercept. These concepts are described in the following sections.

DYNAMIC RANGE NUMBER

The dynamic range of an amplifier is the range of signal levels over which the signal quality meets some specified criteria of usability. The low signal limit relates to noise while the high limit relates to nonlinearities. The lowest usable signal level is determined by the device noise figure, the detection bandwidth, and the required signal-to-noise ratio.

The largest usable signal level is determined by the device nonlinearity according to criteria which reflect the system operation requirements. Linearity requirements are variously expressed by 2nd and 3rd order harmonic and and intermodulation limits, cross-modulation, desensitization, or output compression criteria. The dynamic range can be determined only after a large signal criterion has been selected. Since most system requirements are expressed in terms of low-level non-linearities with observed results in a relatively narrow frequency window, it becomes advantageous to typify the device in terms of its third-order output intermodulation intercept, IP_3. Although this is an arbitrary choice not necessarily suitable to all needs, it does yield a readily found measure upon which device comparisons can conveniently be made.

An expression of dynamic range based on the third-order intercept will involve terms expressing noise figure, gain, output intercept, detection bandwidth, signal-to-noise ratio, and intermodulation ratio.

The last three of these quantities are system or user determined while the first three are attributes of the device. Therefore, it is useful to introduce the Dynamic Range Number concept with the following definition:

$$D = IP_3 - G - F$$

where IP_3 is the third-order output intercept in dBm, G is the gain in dB, and F is the amplifier noise figure, also in dB. The Dynamic Range Number "D" is a positive or a negative number. Since the output intercept minus the gain is the input intercept, it is seen that the Dynamic Range Number is simply the input intercept minus the noise figure.

The dynamic range of an amplifier is directly proportional to its dynamic range number. The dynamic range may be maximized by increasing the output intercept and lowering the noise figure. It may also be increased by lowering the gain, but this leads to a conflict. In a single stage, it may not be possible to vary the gain at will without impacting both the distortion intercept and the noise figure.

In general, the object is not to maximize the dynamic range of a single stage, but to maximize that of a chain of components. Hence, the main usage for the Dynamic Range Number will be found in the comparison of similar devices.

Intercept Efficiency

In single stage amplifiers, the range of variation of gain, noise figure, and intercept point, the elements contained in the Dynamic Range Number, is relatively small for the first two items, but is large for the third. Stage gains usually lie within a 10 dB range from 6 to 18 dB, while noise figures vary by about the same amount, lying roughly between 1 and 10 dB. A much larger variation is found in the third order intermodulation intercept point, which may lie anywhere in a 60 dB range upward from about 0 dBm. This intercept is roughly proportional to the amount of DC power applied to the device.

In many applications there is little concern for the DC power required to achieve the desired amplifier performance. In some cases however, this may be a prime consideration. Instances where this can be true are in missile, satellite, and man-pack equipment, where the matter of prime power requirement of thermal dissipation may be very important. Also, in any system where a very large number of amplifiers is required, the total amount of power supplied may be subject to limitation. Under these circumstances, it will be desirable to maximize the intercept point relative to the applied power.

As a measurement of the relationship between the third-order intercept and the DC applied power, it is useful to define the Intercept Efficiency as follows:

$$\text{Intercept Efficiency} = 10 \log \frac{I_P}{P_{DC}} \text{ dB}$$

where I_P is the third order intercept power expressed in milliwatts and P_{DC} is the total DC power applied to the amplifier, also in milliwatts. As an example, an amplifier dissipating 1200 mW or +30.8 dBm having a third-order intercept of +32 dBm will have an Intercept Efficiency of +1.2 dB. If it were found possible to improve the design so that a +35 dBm intercept could be achieved with the same dissipation, a 3 dB improvement in efficiency would be obtained with important implications to the power-limited system designer.

Anzac amplifiers, which utilize lossless feedback, will exhibit higher dynamic range numbers and intercept efficiencies than similar amplifiers using resistive feedback.

CASCADING AMPLIFIERS

Two graphs are presented here which are useful in designing cascades of amplifiers or other components. The first graph is an easily used presentation of the added noise figure due to the second stage in a cascade of two units. The standard formula for the total noise figure, f_t, in terms of the first and second stage noise figures and the first stage gain is:

$$f_t = f_1 + \frac{f_2 - 1}{g_1}$$

Since noise figure is normally given in dB rather than in power terms, it is useful to reformulate the above to:

$F_t = F_1 + \Delta$ in dB, where Δ is given by

$$\Delta = 10 \log \left(1 + \frac{f_2 - 1}{f_1 g_1} \right)$$

Figure 5 allows Δ to be read directly on the ordinate in dB at the crossing of the abscissa, which represents the sum of the first stage gain and noise figure in dB, and the diagonal, which represents the second stage noise figure.

The second graph shows the effect on the intermodulation intercept caused by the cascading of two stages. It can be shown that the total cascade

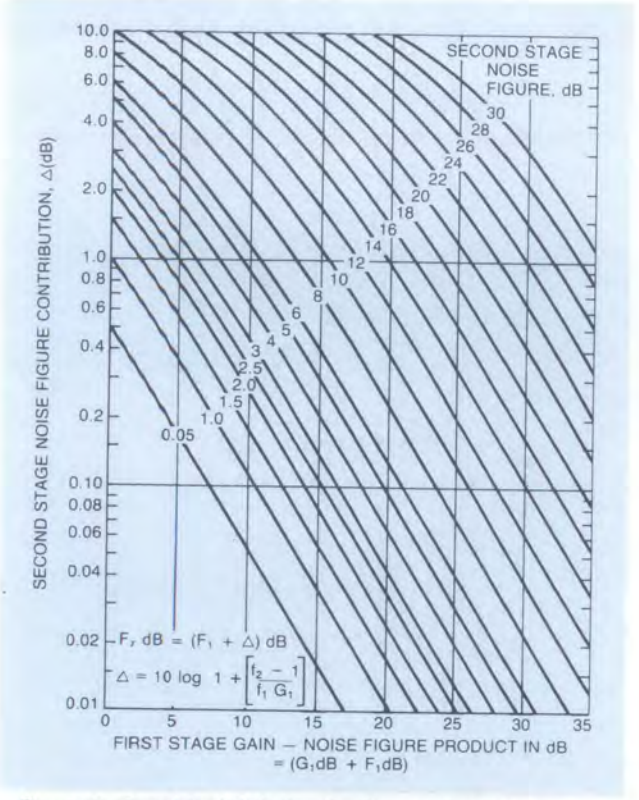


Figure 5. Graphical Solution for Cascaded Noise Figure

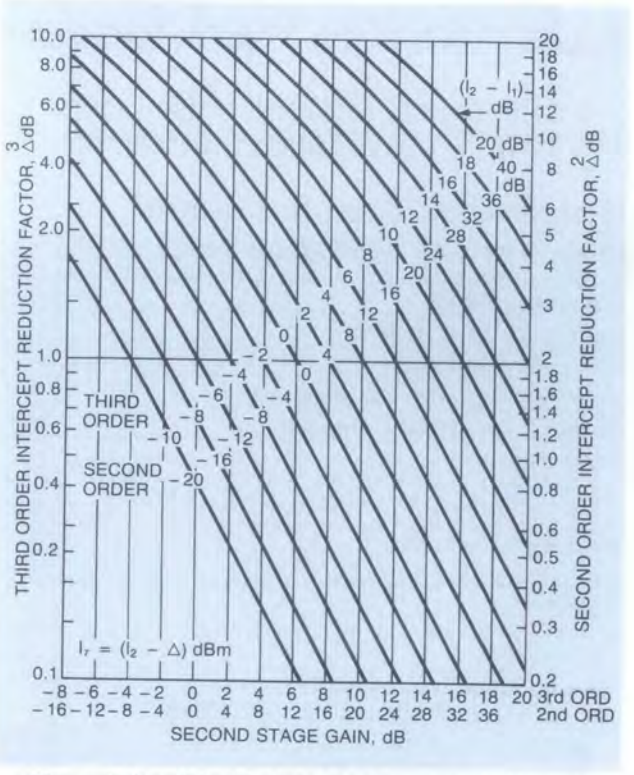


Figure 6. Graphical Solution for Cascaded Intercept

intercept, I_T, is related to that of the second stage, I_2 by:

$$I_T = I_2 - \Delta$$

where I_T and I_2 are in dBm and Δ is in dB, where

$$\overset{2}{\Delta} = 20 \log \left[1 + \sqrt{\frac{1}{g_2} \bullet \frac{\overset{2}{i}_2}{\overset{2}{i}_1}} \right] \quad \text{for second order}$$

$$\text{and } \overset{3}{\Delta} = 10 \log \left[1 + \frac{1}{g_2} \bullet \frac{\overset{3}{i}_2}{\overset{3}{i}_1} \right] \quad \text{for third order}$$

Here i_1, i_2, and g_2 are the first stage intercept, the second stage intercept, and the second stage gain, respectively, expressed as powers and power ratio. The superscripts 2 and 3 identify the product order. Δ is seen to represent the reduction in the cascade intercept from that of the second stage alone.

Figure 6 allows Δ to be read directly in dB at the intersection of the abcissa which represents the second stage gain and the diagonals which represent the difference between the third and second stage intercept in dB. Both second and third order products are represented.

CONCLUSION

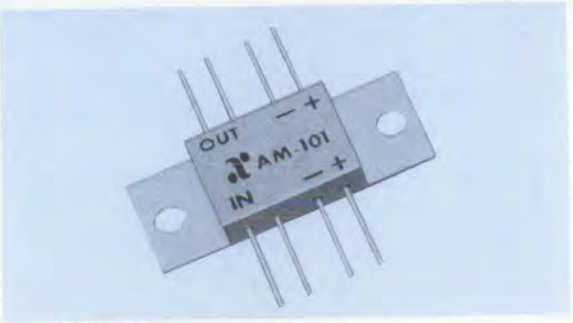
Low noise amplifiers utilizing various negative feedback techniques are available. Anzac produces both resistive and "lossless" coupler feedback designs. Understanding the advantages of coupler feedback allows the system designer to achieve improved system performance and when necessary the ultimate possible amplifier performance. As with all our products, Anzac's applications engineers are ready to assist the systems engineer in proper selection, specification and use of our devices.

REFERENCES

1. D.E. Norton, **High Dynamic Range Transistor Amplifier Using Lossless Feedback,** Microwave Journal, May, 1976, pp. 53-57.
2. Hewlett Packard application note 154.
3. D.E. Norton, **Strong Signal Survivability Design for Lossless Feedback Amplifiers,** Proceedings, Eleventh Annual European Microwave Conference.

MODEL AM-101 — HIGH PERFORMANCE AMPLIFIER
5-500 MHz GAIN: 10 dB

- 3.5 dB Typical Midband Noise Figure
- +42 dBm Typical Midband Intercept



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 10 MHz	10.0 ±0.6 dB
Frequency Response	±0.75 dB Max
Gain Variation with Temperature	+0.5, −1.0 dB Max
Output Power (1 dB Compression)	+17 dBm Min
Noise Figure	
5-500 MHz	7.5 dB Max
10-300 MHz	5.5 dB Max
Reverse Transmission	−15 dB Max −18 dB Typ
VSWR	
5-500 MHz	2.5:1 Max
5-400 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order (5-500 MHz)	+33 dBm Min
Second Order (10-300 MHz)	+40 dBm Min
Third Order (5-500 MHz)	+22 dBm Min
Third Order (10-300 MHz)	+32 dBm Min
Bias Power	+15 VDC @ 75 mA Max (62 mA, 930 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm
Package Type	Flatpack (FP-7) (See page 475 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

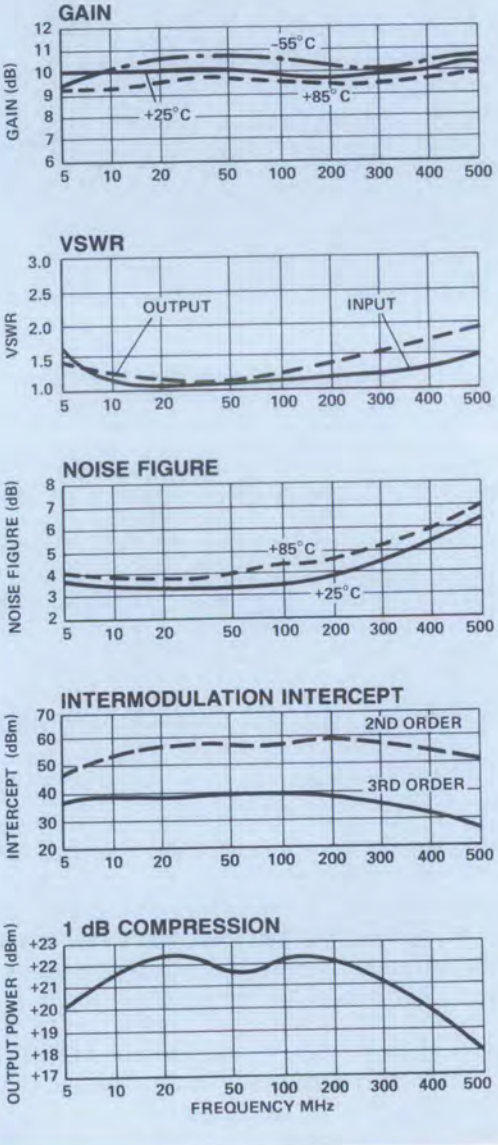
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see page 96.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-101	9169	Pin	$158

Delivery is from stock.

MODEL AM-102 — GENERAL PURPOSE AMPLIFIER
5-300 MHz GAIN: 9.5 dB

- 5.3 dB Typical Midband Noise Figure
- +17 dBm Typical Compression Level

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-300 MHz
Gain (+25°C) @ 50 MHz	9.5 ±0.4 dB
Frequency Response	±1.0 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	+15 dBm Min
Noise Figure	
5-300 MHz	14 dB Max
5-100 MHz	9 dB Max
Reverse Transmission	−13 dB Max −15 dB Typ
VSWR	
5-300 MHz	2.0:1 Max
5-100 MHz	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order (5-300 MHz)	+34 dBm Min
Second Order (5-100 MHz)	+40 dBm Min
Third Order (5-300 MHz)	+24 dBm Min
Third Order (5-100 MHz)	+28 dBm Min
Bias Power	−20 VDC @ 75 mA Max (60 mA, 1.2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+22 dBm Max
Package Type	Connectorized (C-6) (See page 481 for physical dimensions.)

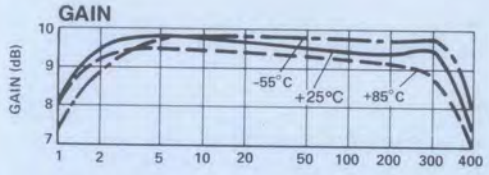
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

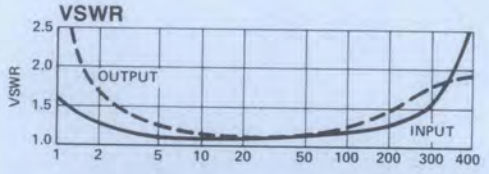
*All specifications apply when operated at −20 VDC, with 50 ohm source and load impedance.

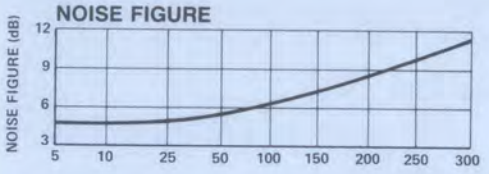
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.2 W. Must be provided in use.

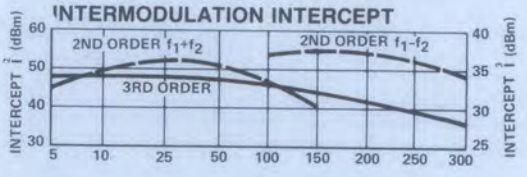
S-Parameters: For typical S-Parameter data, see page 96.

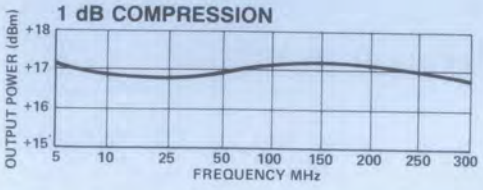
Typical Performance











Ordering Information

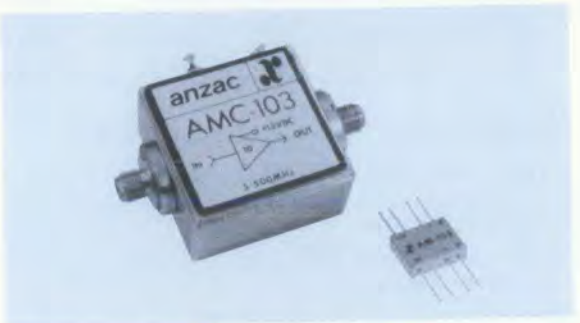
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-102	9601	BNC	$140
AM-102	9604	SMA	$144

Delivery is from stock.

MODELS AM-/AMC-103

LOW NOISE AMPLIFIER
5-500 MHz GAIN: 10 dB

- 2.7 dB Typical Midband Noise Figure
- +11 dBm Typical Compression Level
- Lower Dissipation Version of AM-101



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 100 MHz	10.0 ±0.5 dB
Frequency Response	±0.75 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+8 dBm Min
Noise Figure	
5-500 MHz	5.0 dB Max
5-200 MHz	3.5 dB Max
Reverse Transmission	−15 dB Max −18 dB Typ
VSWR	2.1:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order (5-500 MHz)	+20 dBm Min
Second Order (5-200 MHz)	+30 dBm Min
Third Order (5-500 MHz)	+15 dBm Min
Third Order (5-200 MHz)	+21 dBm Min
Bias Power	+15 VDC @ 25 mA Max (20 mA, 300 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+22 dBm
Package Type	Flatpack (FP-2) Connectorized (C-6) (See pages 474 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	Output; P1, Input; P5, +DC IN; P4 & P8, −DC IN; P3 & P7, GND; P2 & P6

*All specifications apply when operated at +15 VDC with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.32 W. Must be provided in use.

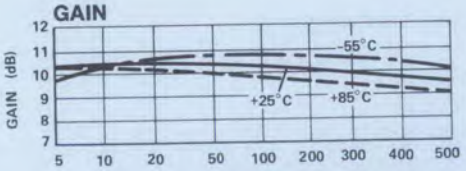
S-Parameters: For typical S-Parameter data, see page 96.

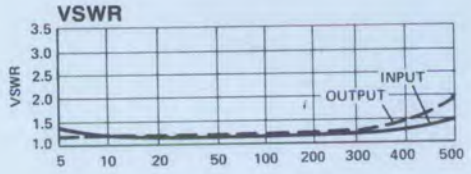
Ordering Information

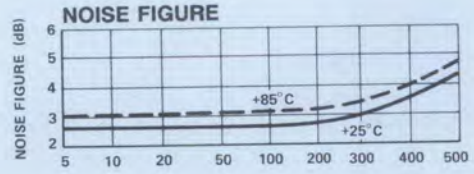
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-103	8549	Pin	$131
AMC-103	8544	SMA	225

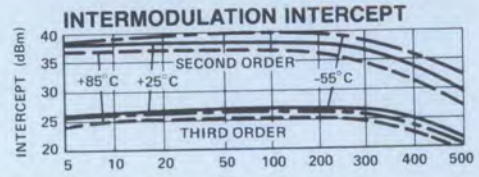
Delivery is from stock.

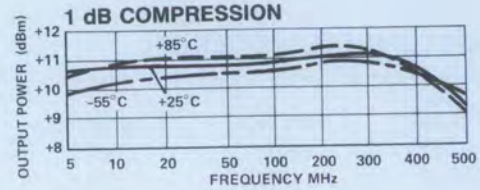
Typical Performance











MODELS AM-105/108

GENERAL PURPOSE AMPLIFIERS
5-300 MHz GAIN: 19/28 dB

- 5.2 dB Typical Midband Noise Figure
- +17 dBm Typical Compression Level

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

MODEL	AM-105	AM-108
Frequency Range	5-300	5-300 MHz
Gain (+25°C) @ 50 MHz	19 ±0.5	28.5 ±0.5 dB
Frequency Response	±1.5	±2.5 dB Max
Gain Variation with Temperature	+1.0, −1.5	±1.5 dB Max
Output Power (1 dB Compression)	+15	+15 dBm Min
Noise Figure		
5-300 MHz	14	14 dB Max
10-100 MHz	9	9 dB Max
Reverse Transmission	−29	−42 dB Max
	−30	−44 dB Typ
VSWR		
Input (5-300 MHz)	1.5:1	2.0:1 Max
Input (10-100 MHz)		1.5:1 Max
Output (5-300 MHz)	2.5:1	2.5:1 Max
Output (10-100 MHz)	1.5:1	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power to +5 dBm)		
Second Order (5-300 MHz)		+28 dBm Min
Second Order (10-100 MHz)		+36 dBm Min
Third Order (5-300 MHz)		+23 dBm Min
Third Order (10-100 MHz)		+27 dBm Min
Bias Power		
AM-105		−20 VDC @ 130 mA Max (105 mA, 2.1W Typical)
AM-108		−20 VDC @ 180 mA Max (105 mA, 2.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+19 dBm
Package Type	Connectorized (C-16) (See page 483 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at −20 VDC, with 50 ohm source and impedance.

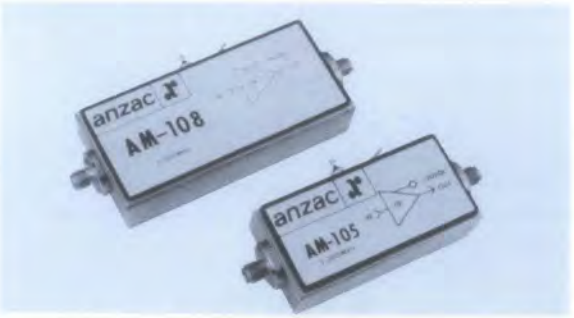
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.6 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see page 96.

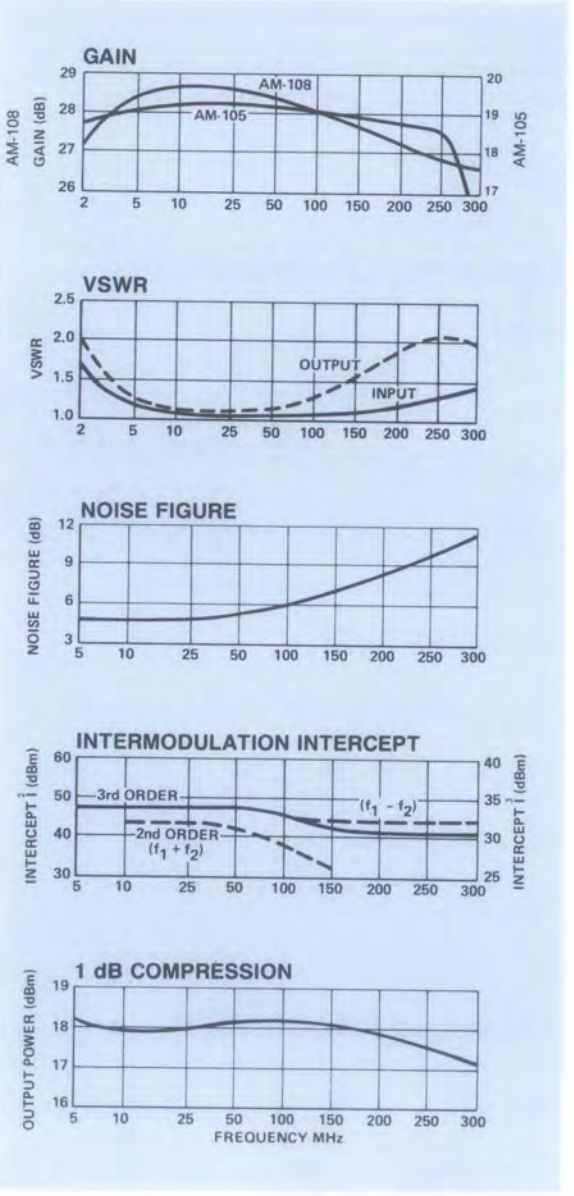
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-105	8391	BNC	$189
AM-105	8394	SMA	194
AM-108	8411	BNC	198
AM-108	8414	SMA	203

Delivery is from stock.



Typical Performance



MODEL AM-107 — LOW NOISE AMPLIFIER 1-100MHz GAIN: 10 dB

- 1.5 dB Typical Midband Noise Figure

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	1-100 MHz
Gain (+25°C) @ 50 MHz	10.6 ±0.7 dB
Frequency Response	±0.8 dB
Gain Variation with Temperature	+0.5, −0.7 dB
Output Power (1 dB Compression)	−2 dBm Min
Noise Figure	2.5 dB Max
Reverse Transmission	−14 dB Max −17 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to −12 dBm)	
Second Order	+15 dBm Min
Third Order	+10 dBm Min
Bias Power	+15 VDC @ 12 mA Max (10 mA, 150 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Connectorized (C-6) (See page 481 for physical dimensions.)

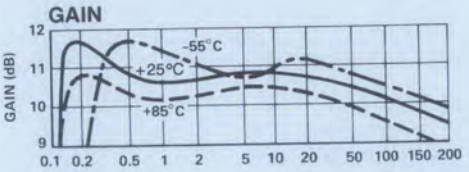
Environmental

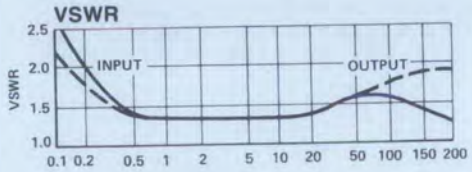
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

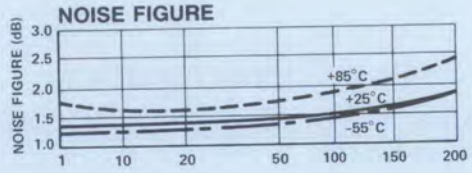
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

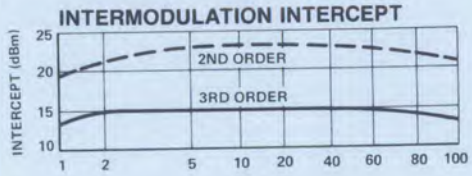
S-Parameters: For typical S-Parameter data, see page 96.

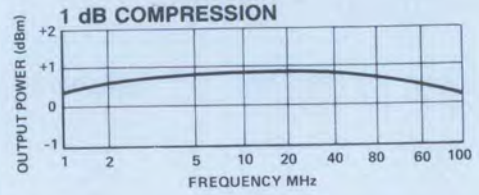
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-107	8401	BNC	$140
AM-107	8404	SMA	144

Delivery is from stock.

MODEL AM-109 — HIGH PERFORMANCE AMPLIFIER
0.5-60 MHz GAIN: 10 dB

- Push-Pull Circuitry
- Ideal for HF Antenna Distribution

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	0.5-60 MHz
Gain (+25°C) @ 10 MHz	10.7 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
0.5-60 MHz	+27 dBm Min
2-32 MHz	+28 dBm Min
Noise Figure	
0.5-60 MHz	7 dB Max
2-32 MHz	6 dB Max
Reverse Transmission	−15 dB Max
	−18 dB Typ
VSWR	
0.5-60 MHz	1.6:1 Max
2-32 MHz	1.3:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order (0.5-60 MHz)	+70 dBm Min
Second Order (2-32 MHz)	+75 dBm Min
Third Order (0.5-60 MHz)	+40 dBm Min
Third Order (3-32 MHz)	+45 dBm Min
Bias Power	+20 VDC @ 225 mA Max (180 mA, 3.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+24 dBm Max
Package Type	Connectorized (C-15) (See page 483 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +20 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 3.6 W. Must be provided in use.

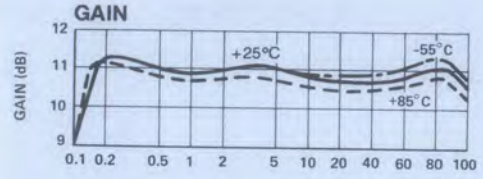
S-Parameters: For typical S-Parameter data, see page 96.

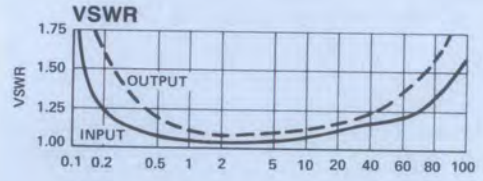
Ordering Information

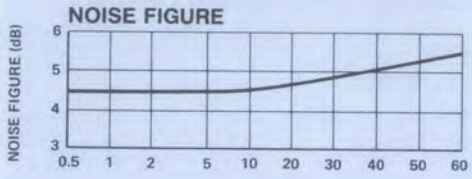
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-109	8421	BNC	$252
AM-109	8424	SMA	257

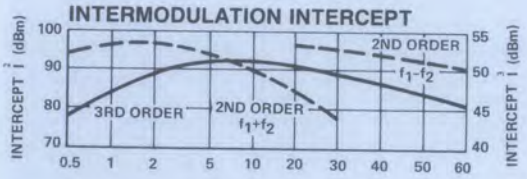
Delivery is from stock.

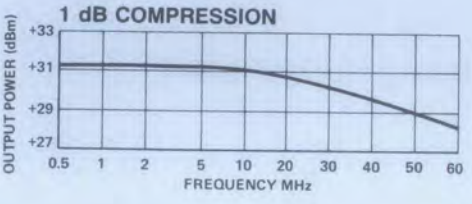
Typical Performance











MODEL AM-110 — GENERAL PURPOSE AMPLIFIER
0.5-100 MHz GAIN: 30 dB

- 4.5 dB Typical Midband Noise Figure
- +23 dBm Typical Compression Level

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	0.5-100 MHz
Gain (+25°C) @ 10 MHz	29.7 ±0.5 dB
Frequency Response	
0.5-100 MHz	±0.5 dB Max
1-60 MHz	±0.3 dB Max
Gain Variation with Temperature	
0.5-100 MHz	±0.8 dB Max
1-60 MHz	±0.4 dB Max
Output Power (1 dB Compression)	+21 dBm Min
Noise Figure	5.5 dB Max
Reverse Transmission	−35 dB Max −37 dB Typ
VSWR	
0.5-100 MHz	1.7:1 Max
1-60 MHz	1.4:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order (0.5-100 MHz)	+33 dBm Min
Second Order (1-60 MHz)	+42 dBm Min
Third Order	+33 dBm Min
Bias Power	20 VDC @ 130 mA Max (110 mA, 2.2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+18 dBm Max
Package Type	Connectorized (C-23) (See page 484 for physical dimensions.)

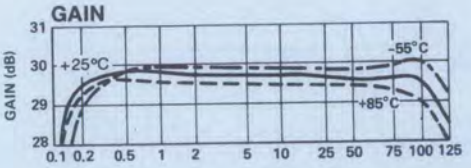
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

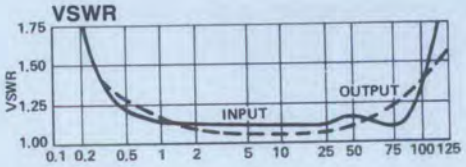
*All specifications apply when operated at 20 VDC, with 50 ohm source and load impedance.

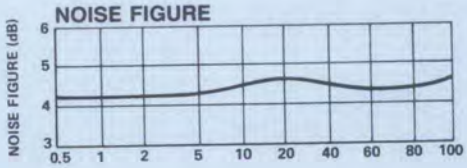
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.2 W. Must be provided in use.

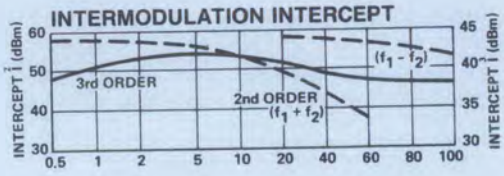
S-Parameters: For typical S-Parameter data, see page 96.

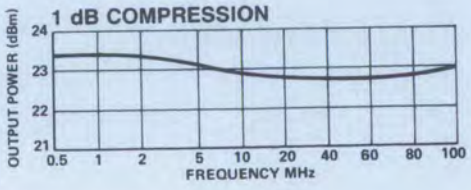
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-110	9651	BNC	$189
AM-110	9654	SMA	194

Delivery is from stock.

MODEL AM-112 — LOW NOISE AMPLIFIER
10-200 MHz GAIN: 16 dB

- 2.0 dB Typical Midband Noise Figure
- +22 dBm Typical Midband Intercept
- +9 dBm Typical Compression Level

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-200 MHz
Gain (+25°C) @ 50 MHz	16.4 ±0.5 dB
Frequency Response	+0.25, −1.0 dB Max
Gain Variation with Temperature	±0.75 dB Max
Output Power (1 dB Compression)	+7 dBm Min
Noise Figure	
10-200 MHz	4.0 dB Max
10-100 MHz	3.5 dB Max
Reverse Transmission	−18 dB Max −23 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order	+25 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @ 33 mA Max (27 mA, 405 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Connectorized (C-16) (See page 483 for physical dimensions.)

Environmental

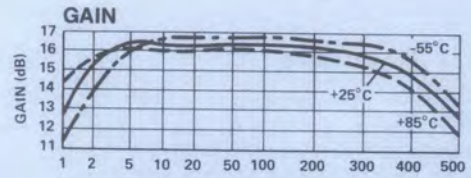
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

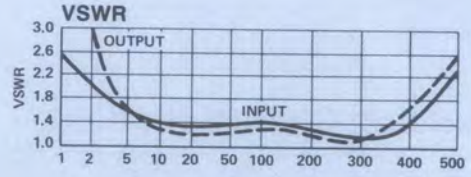
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

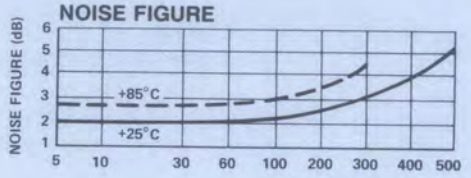
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.4 W. Must be provided in use.

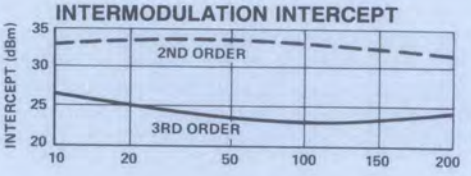
S-Parameters: For typical S-Parameter data, see page 96.

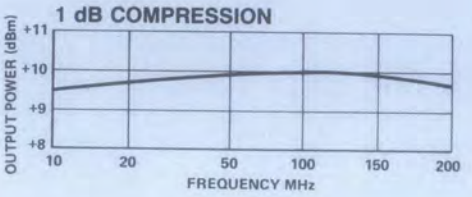
Typical Performance











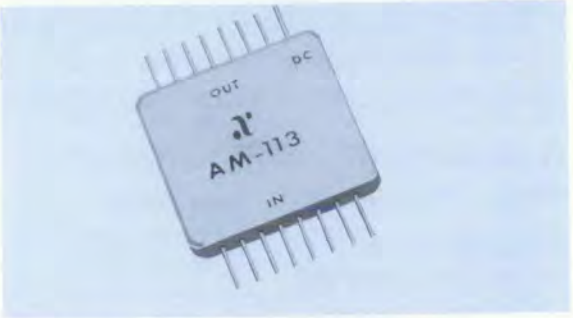
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-112	9661	BNC	$185

Delivery is from stock.

MODEL AM-113 — LOW NOISE AMPLIFIER
10-100 MHz GAIN: 30 dB

- 1.5 dB Typical Midband Noise Figure
- +18 dBm Compression Level
- Ideal for Broadband IF Applications



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-100 MHz
Gain (+25°C) @ 60 MHz	30.6 ±0.5 dB
Frequency Response	±0.8 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+14 dBm Min
Noise Figure	
−55 to +30°C	1.8 dB Max
+30 to +85°C	2.3 dB Max
Reverse Transmission	−37 dB Max −40 dB Typ
VSWR	2.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+45 dBm Min
Third Order	+28 dBm Min
Bias Power	+15 VDC @ 70 mA Max (50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Flatpack (FP-6) (See page 475 for physical dimensions.)
Environmental	
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.	
Pin Configuration	IN; P12, Out; P4, DC IN; P8, All other pins are ground.

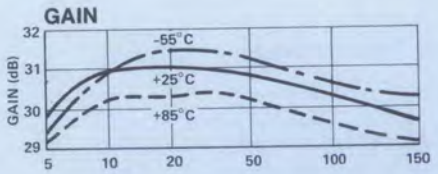
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

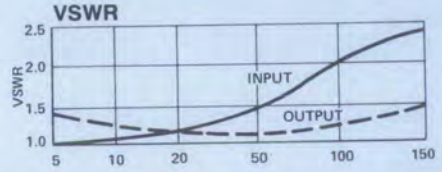
This product contains elements protected by United States Patent Number 3,891,934.

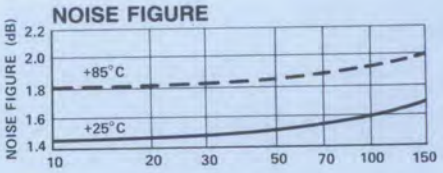
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.75 W. Must be provided in use.

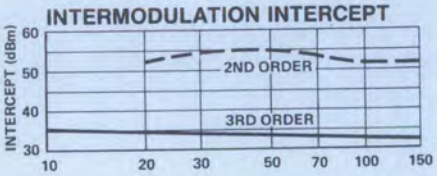
S-Parameters: For typical S-Parameter data, see page 96.

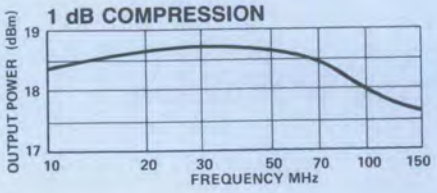
Typical Performance











Ordering Information

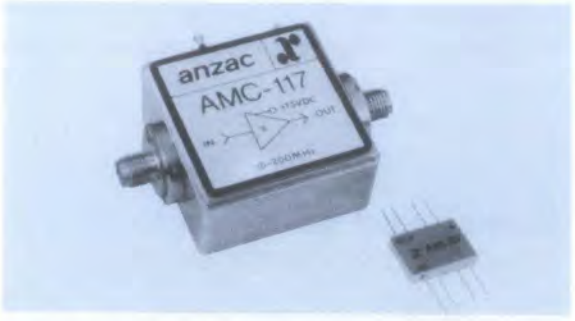
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-113	8619	Pin	$235

Delivery is from stock.

MODELS AM-/AMC-117

LOW NOISE AMPLIFIER
10-200 MHz GAIN: 8 dB

- 1.3 dB Typical Midband Noise Figure
- +30 dBm Typical Midband Intercept
- Ideal for Broadband IF Applications



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

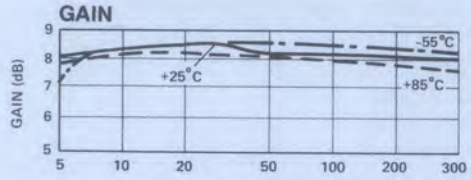
Frequency Range	10-200 MHz
Gain (+25°C) @ 60 MHz	8.2 ±0.5 dB
Frequency Response	±0.3 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
10-200 MHz	+7 dBm Min
10-100 MHz	+9 dBm Min
Noise Figure	
10-200 MHz	2.5 dB Max
10-100 MHz	2.0 dB Max
Reverse Transmission	−9 dB Max −11 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order (10-200 MHz)	+32 dBm Min
Second Order (10-100 MHz)	+35 dBm Min
Third Order (10-200 MHz)	+20 dBm Min
Third Order (10-100 MHz)	+23 dBm Min
Bias Power	+15 VDC @ 13 mA Max (11 mA, 165 mW Typical)

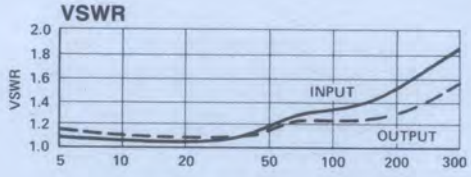
Operating Characteristics

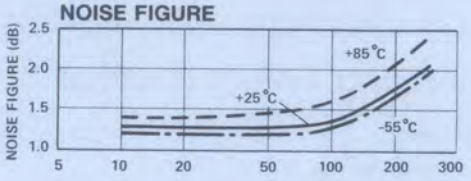
Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Flatpack (FP-2) Connectorized (C-6) (See pages 474 and 481 for physical dimensions.)
Environmental	These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.
Pin Configuration	IN; P5, Out; P1, DC IN; P4, All other pins are ground.

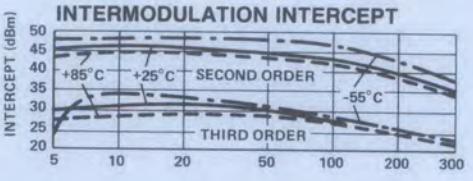
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,891,934.
S-Parameters: For typical S-Parameter data, see page 96.

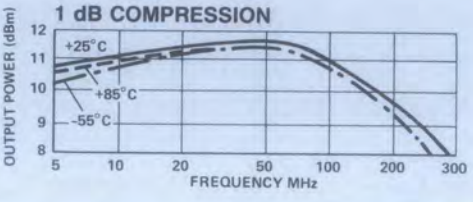
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-117	8539	Pin	$ 80
AMC-117	8534	SMA	177

Delivery is from stock.

NEW

MODEL AMS-117

SURFACE MOUNT LOW NOISE AMPLIFIER 10 - 200 MHz GAIN: 8 dB

- Fully Hermetic Package
- 1.3 dB Typical Midband Noise Figure
- +30 dBm Typical Midband Intercept
- Ideal for Broadband IF Applications

Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	10 - 200 MHz
Gain (+25°C) @ 60 MHz	8.2 ±0.5 dB
Frequency Response	±0.3 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
10-200 MHz	+7 dBm Min
10-100 MHz	+9 dBm Min
Noise Figure	
10-200 MHz	2.5 dB Max
10-100 MHz	2.0 dB Max
Reverse Transmission	–9 dB Max –11 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to –5 dBm)	
Second Order (10-200 MHz)	+32 dBm Min
Second ORder (10-100 MHz)	+35 dBm Min
Third Order (10-200 MHz)	+20 dBm Min
Third Order (10-100 MHz)	+23 dBm Min
Bias Power	+15 VDC @ 13 mA Max (11 mA, 165 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN; P3, Out; P1, DC IN; P2, All other pins are ground.

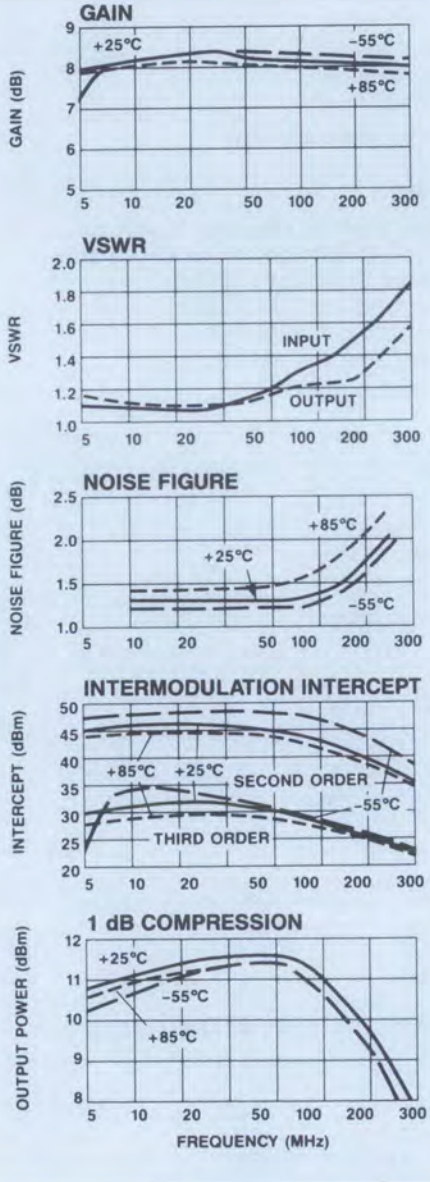
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,891,934.

S-Parameters: For typical S-Parameter data, see page 96.

Ordering Information

Model No.	Connector	Unit Price (5-9 Units)
AMS-117	PIN	$90

Typical Performance



MODELS AM-/AMC-119

HIGH PERFORMANCE AMPLIFIER
30-250 MHz GAIN: 8 dB

- 2.3 dB Typical Midband Noise Figure
- +23 dBm Typical Midband Output Power
- +40 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	30-250 MHz
Gain (+25°C) @250 MHz	8.0 ±0.5 dB
Frequency Response	±0.75 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+20 dBm Min
Noise Figure	3.5 dB Max
Reverse Transmission	−9.5 dB Max −11.0 dB Typ
VSWR	2.3:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+39 dBm Min
Third Order	+34 dBm Min
Bias Power	+15 VDC @60 mA Max (50 mA, 750 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

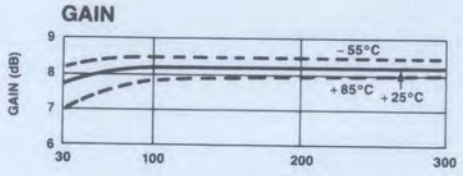
Environmental

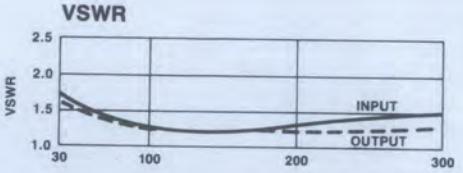
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

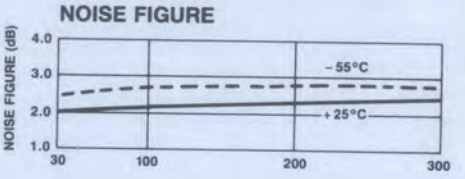
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by United States Patent Number 3,891,934.

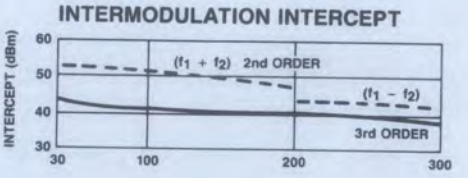
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1 W. Must be provided in use.

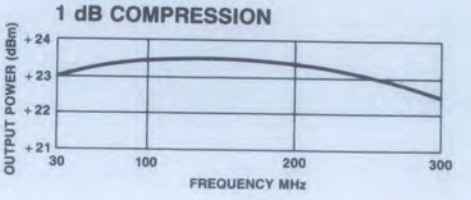
Typical Performance











Ordering Information

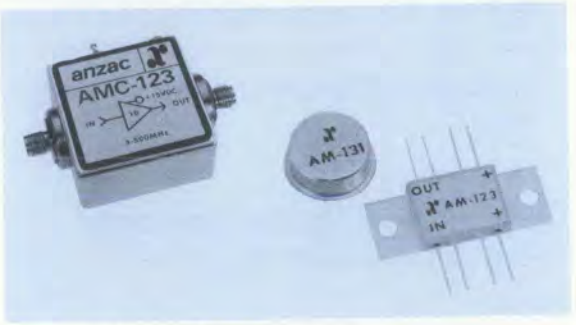
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-119	9849	Pin	$134
AMC-119	9844	SMA	231

Delivery is from stock.

MODELS AM-/AMC-123/131

HIGH PERFORMANCE AMPLIFIER
5-500 MHz GAIN: 10 dB

- 3.5 dB Typical Midband Noise Figure
- +42 dBm Typical Midband Intercept



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	10.0 ±0.6 dB
Frequency Response	±0.7 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	
5-500 MHz	+16 dBm Min
10-300 MHz	+19 dBm Min
Noise Figure	
5-500 MHz	7.5 dB Max
10-300 MHz	5.5 dB Max
Reverse Transmission	−15 dB Max −18 dB Typ
VSWR	
5-500 MHz	2.5:1 Max
10-400 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to 10 dBm)	
Second Order (5-500 MHz)	+33 dBm Min
Second Order (10-300 MHz)	+40 dBm Min
Third Order (5-500 MHz)	+22 dBm Min
Third Order (10-300 MHz)	+32 dBm Min
Bias Power	+15 VDC @ 75 mA Max (62 mA, 930 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm
Package Type	AM-123 Flatpack (FP-7) AMC-123 Connectorized (C-6) AM-131 Pin (TO-8-1) (See pages 475, 481 and 472 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	(AM-123 only) IN; P5, Out; P1 DC IN; P4/P8 All other pins are ground.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.0 W must be provided in use.

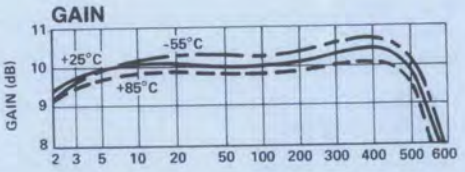
S-Parameters: For typical S-Parameter data, see page 96 and 97.

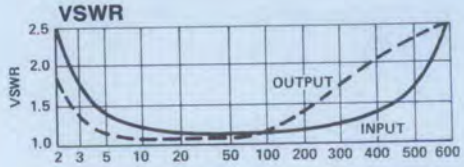
Ordering Information

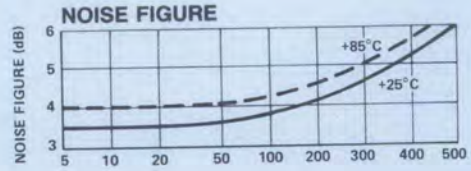
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-123	8669	Pin	$ 94
AMC-123	8664	SMA	191
AM-131	8859	Pin	100

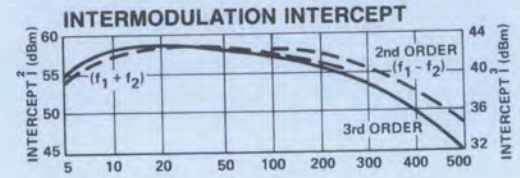
Delivery is from stock.

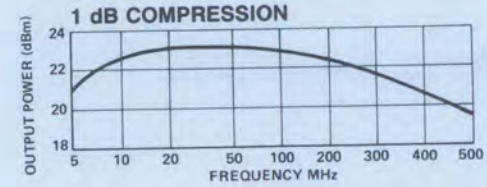
Typical Performance





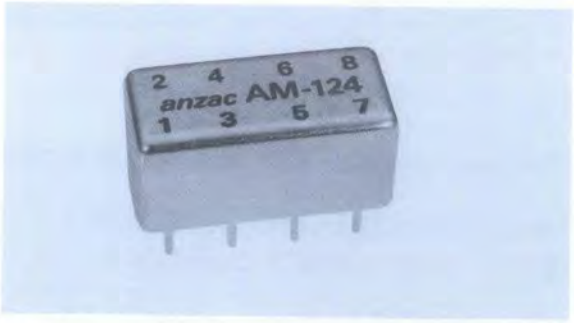






MODEL AM-124 — GENERAL PURPOSE AMPLIFIER
0.5-100 MHz GAIN: 16 dB

- 3.8 dB Typical Noise Figure
- Low Cost



Guaranteed Specifications*
(@25°C)

Frequency Range	0.5-100 MHz
Gain	16 ± 1 dB
Output Power (1 dB Compression)	– 5 dBm Min
Noise Figure	4.5 dB Max
Reverse Transmission	– 19 dB Max – 22 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to – 15 dBm)	
Second Order	+ 8 dBm Min
Third Order	+ 8 dBm Min
Bias Power	+ 15 VDC @ 15 mA Max (10 mA, 150 mW Typical)

Operating Characteristics

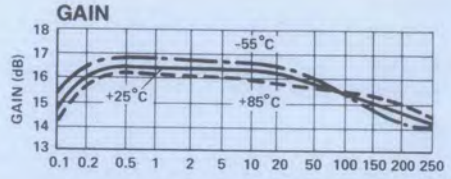
Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+ 13 dBm Max
Package Type	Relay Header (RH-1) (See page 472 for physical dimensions.)

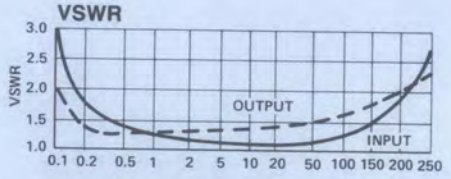
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

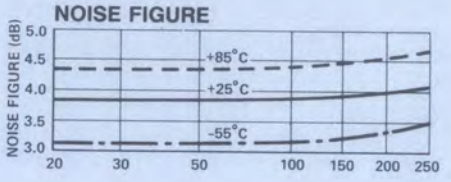
Pin Configuration	IN; P6, Out; P5, VDC; P1, All other pins are ground.

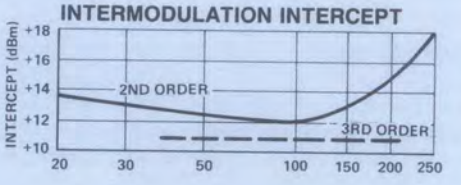
*All specifications apply when operated at + 15 VDC, with 50 ohm source and load impedance.

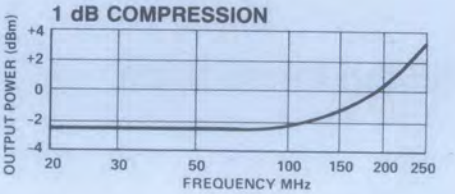
Typical Performance











Ordering Information

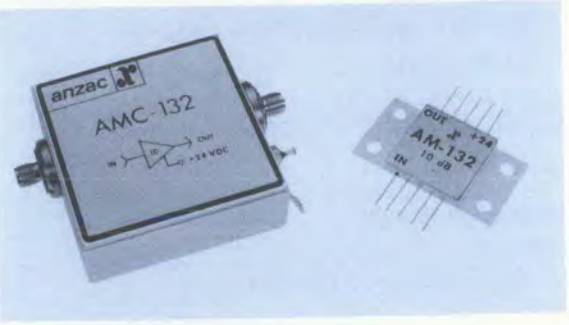
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-124	8609	Pin	$44

Delivery is from stock.

MODELS AM-/AMC-132

HIGH PERFORMANCE AMPLIFIERS 5-200 MHz GAIN: 10 dB

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 4.5 dB Typical Midband Noise Figure



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	10 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±0.6 dB Max
Output Power (1 dB Compression)	+25 dBm Min
Noise Figure	6 dB Max
Reverse Transmission	−13 dB Max −14 dB Typ
VSWR	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order	+54 dBm Min
Third Order (5-200 MHz)	+38 dBm Min
Third Order (5-70 MHz)	+45 dBm Min
Bias Power	+24 VDC @ 130 mA Max (110 mA, 2.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm Max
Bias	26 VDC Max
Package Type	Flatpack (FP-8) Connectorized (C-25)
	(See pages 475 and 484 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P6; OUT, P1; VDC, P5

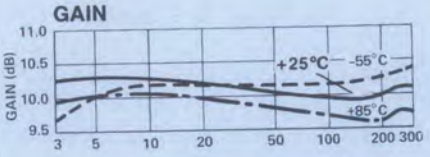
*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

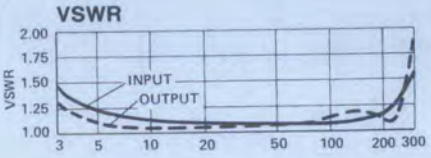
This product contains elements protected by United States Patent Number 3,624,536.

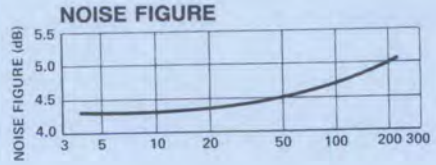
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.6 W. Must be provided in use.

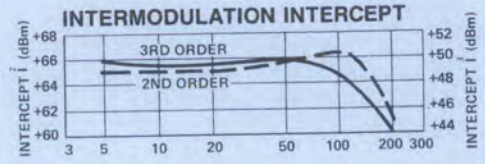
S-Parameters: For typical S-Parameter data, see page 97.

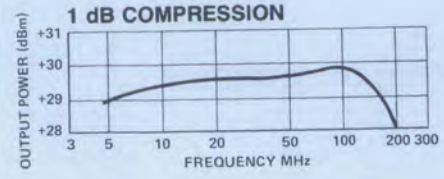
Typical Performance











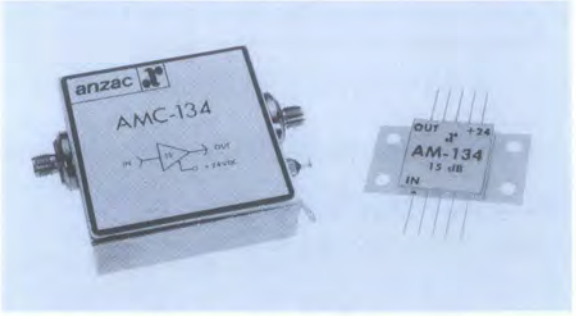
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-132	8869	Pin	$147
AMC-132	8864	SMA	244

Delivery is from stock.

MODELS AM-/AMC-134 — HIGH PERFORMANCE AMPLIFIERS 5-200 MHz GAIN: 15 dB

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 4.8 dB Typical Midband Noise Figure



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	14.6 ± 0.6 dB
Frequency Response	± 0.5 dB Max
Gain Variation with Temperature	+0.5, −1.0 dB Max
Output Power (1 dB Compression)	+23 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−19 dB Max −21 dB Typ
VSWR	2.5:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order	+55 dBm Min
Third Order (5-200 MHz)	+37 dBm Min
Third Order (5-70 MHz)	+42 dBm Min
Bias Power	+24 VDC @ 130 mA Max (110 mA, 2.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm Max
Bias	26 VDC Max
Package Type	Flatpack (FP-8) Connectorized (C-25) (See pages 475 and 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P6; OUT, P1; VDC, P5

*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.6 W. Must be provided in use.

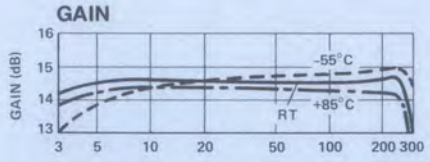
S-Parameters: For typical S-Parameter data, see page 97.

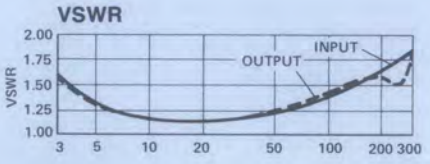
Ordering Information

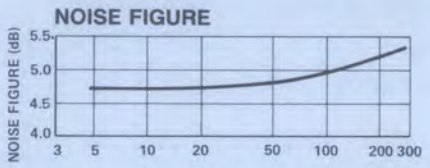
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-134	8889	Pin	$147
AMC-134	8884	SMA	244

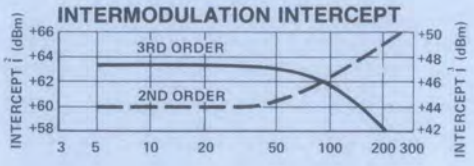
Delivery is from stock.

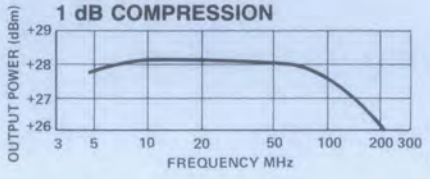
Typical Performance







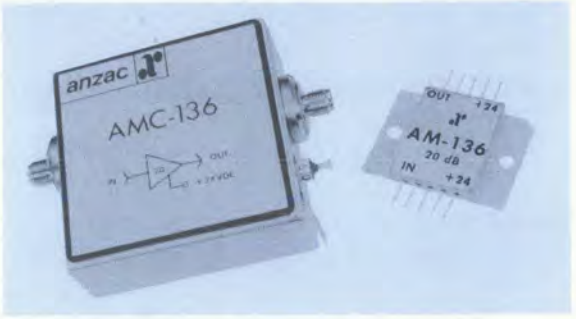




MODELS AM-/AMC-136

HIGH PERFORMANCE AMPLIFIERS 5-200 MHz GAIN: 20 dB

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 4.8 dB Typical Midband Noise Figure



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	20 ± 0.8 dB
Frequency Response	± 0.8 dB Max
Gain Variation with Temperature	± 1.0 dB Max
Output Power (1 dB Compression)	
5-200 MHz	+23 dBm Min
5-70 MHz	+25 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−26 dB Max −28 dB Typ
VSWR	
5-200 MHz	2.5:1 Max
5-70 MHz	1.7:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order (5-200 MHz)	+53 dBm Min
Second Order (5-70 MHz)	+57 dBm Min
Third Order (5-200 MHz)	+36 dBm Min
Third Order (5-70 MHz)	+44 dBm Min
Bias Power	+24 VDC @ 250 mA Max (210 mA, 5W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+15 dBm Max
Bias	26 VDC Max
Package Type	Flatpack (FP-9) Connectorized (C-25)

(See pages 475 and 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

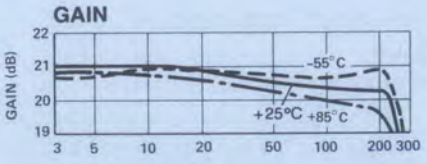
*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 5 W. Must be provided in use.

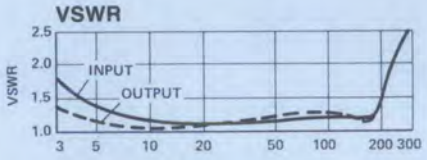
Ordering Information

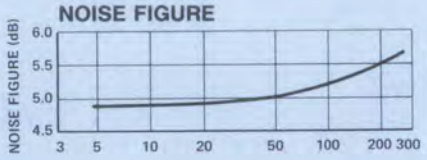
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-136	8909	Pin	$192
AMC-136	8904	SMA	289

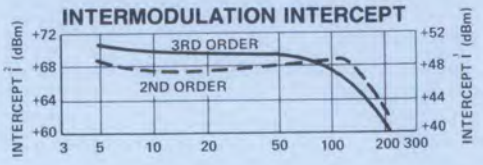
Delivery is from stock.

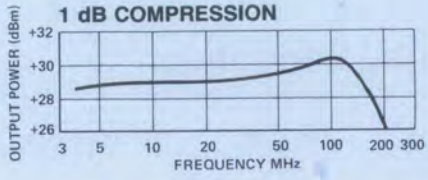
Typical Performance





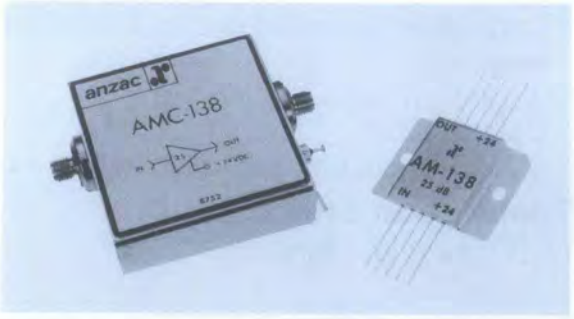






MODELS AM-/AMC-138 — HIGH PERFORMANCE AMPLIFIERS 5-200 MHz GAIN: 25 dB

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 5.3 dB Typical Midband Noise Figure



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	25 ± 0.8 dB
Frequency Response	± 1.0 dB Max
Gain Variation with Temperature	+1.0, −1.4 dB Max
Output Power (1 dB Compression)	
5-200 MHz	+23 dBm Min
5-70 MHz	+25 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−33 dB Max −35 dB Typ
VSWR	
5-200 MHz	2.5:1 Max
5-70 MHz	1.8:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order (5-200 MHz)	+50 dBm Min
Second Order (5-70 MHz)	+56 dBm Min
Third Order (5-200 MHz)	+35 dBm Min
Third Order (5-70 MHz)	+41 dBm Min
Bias Power	+24 VDC @ 250 mA Max (210 mA, 5W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Bias	26 VDC Max
Package Type	Flatpack (FP-9) Connectorized (C-25)

(See pages 475 and 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 5 W. Must be provided in use.

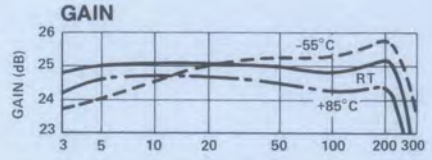
S-Parameters: For typical S-Parameter data, see page 97.

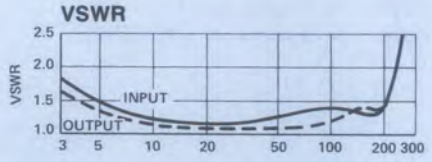
Ordering Information

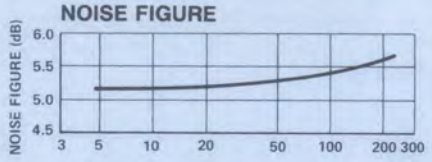
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-138	8929	Pin	$192
AMC-138	8924	SMA	289

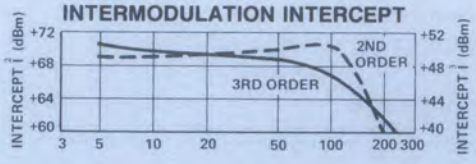
Delivery is from stock

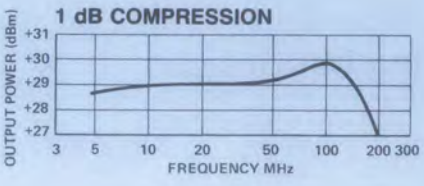
Typical Performance







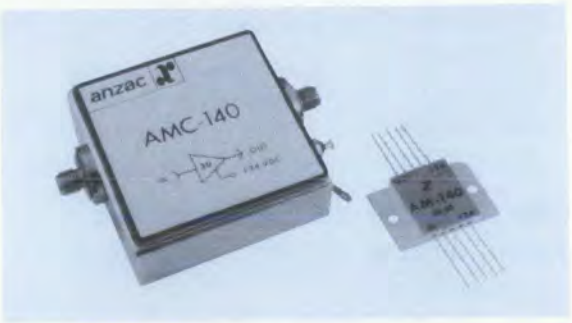




MODELS AM-/AMC-140

HIGH PERFORMANCE AMPLIFIERS
5-200 MHz GAIN: 29 dB

- +47 dBm Typical Midband Third Order Intercept
- +28 dBm Typical Midband 1 dB Compression
- 5.4 dB Typical Midband Noise Figure



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	29.3 ±1 dB
Frequency Response	±1.2 dB Max
Gain Variation with Temperature	±1.2 dB Max
Output Power (1 dB Compression)	
5-200 MHz	+23 dBm Min
5-70 MHz	+24 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−38 dB Max −42 dB Typ
VSWR	
5-200 MHz	2.5:1 Max
5-70 MHz	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+52 dBm Min
Third Order (5-200 MHz)	+36 dBm Min
Third Order (5-70 MHz)	+40 dBm Min
Bias Power	+24 VDC @ 250 mA Max (210 mA, 5W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+5 dBm Max
Bias	26 VDC Max
Package Type	Flatpack (FP-9) Connectorized (C-25)

(See pages 475 and 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

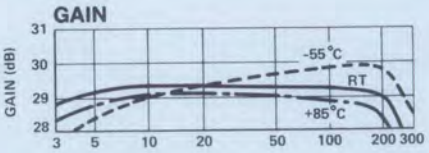
Pin Configuration IN, P6; OUT, P1, VDC, P5, P10

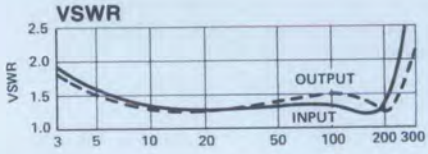
*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

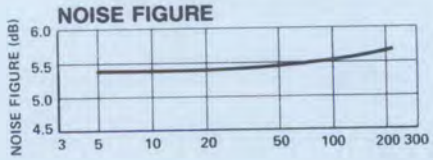
This product contains elements protected by United States Patent Number 3,624,536.

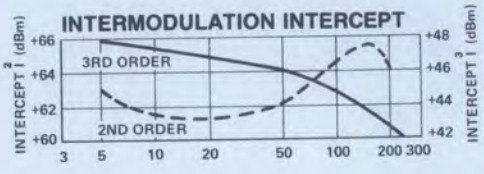
S-Parameters: For typical S-Parameter data, see page 97.

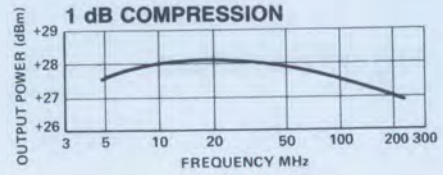
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-140	8949	Pin	$192
AMC-140	8944	SMA	289

Delivery is from stock.

MODELS AM-/AMC-142

LOW NOISE AMPLIFIER 200-1000 MHz GAIN: 12 dB

- 2.2 dB Typical Midband Noise Figure
- +6 dBm Typical Midband Output Power
- +20 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	200-1000 MHz
Gain (+25°C) @ 600 MHz	12 ±0.6 dB
Frequency Response	+0.5, −0.8 dB Max
Gain Variation with Temperature	+0.8, −0.6 dB Max
Output Power (1 dB Compression)	+2 dBm Min
Noise Figure	3.8 dB Max
Reverse Transmission	−13 dB Max −15 dB Typ
VSWR	3.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+25 dBm Min
Third Order	+15 dBm Min
Bias Power	+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

Environmental

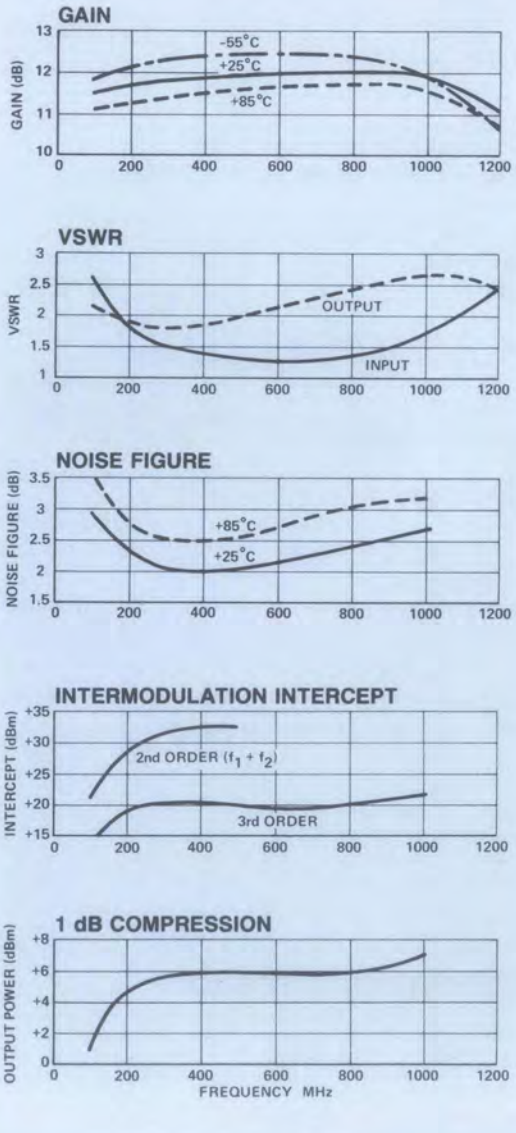
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

S-Parameters: For typical S-Parameter data, see page 97.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-142	8969	Pin	$ 95
AMC-142	8964	SMA	192

Delivery is from stock.

MODELS AM-/AMC-143

LOW NOISE AMPLIFIER
5-500 MHz GAIN: 16 dB

- 1.9 dB Typical Midband Noise Figure
- +7 dBm Typical Midband Output Power
- +20 dBm Typical Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	15.8 ±0.5 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±0.8 dB Max
Output Power (1 dB Compression)	+4 dBm Min
Noise Figure	
5-500 MHz	3.5 dB Max
5-100 MHz	2.7 dB Max
Reverse Transmission	−16 dB Max −21 dB Typ
VSWR	2.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+24 dBm Min
Third Order	+16 dBm Min
Bias Power	+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm Max
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

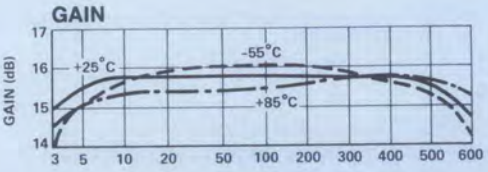
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

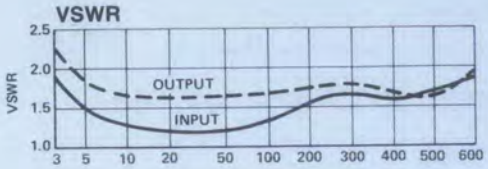
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

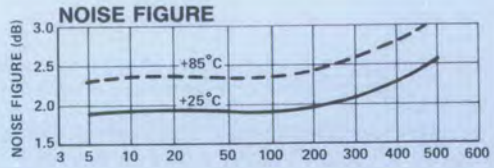
This product contains elements protected by United States Patent Number 3,624,536.

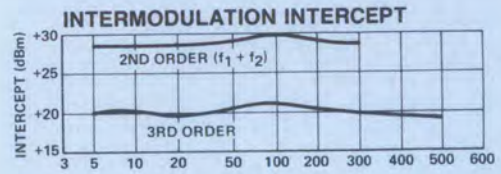
S-Parameters: For typical S-Parameter data, see page 97.

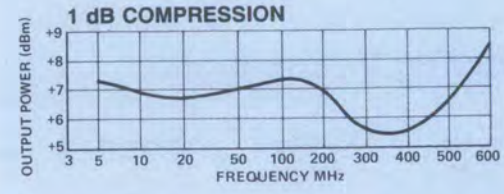
Typical Performance











Ordering Information

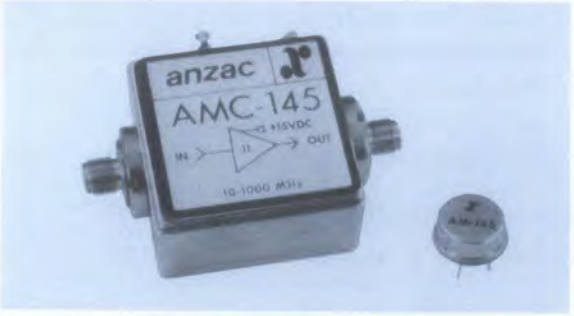
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-143	8979	Pin	$ 89
AMC-143	8974	SMA	186

Delivery is from stock.

MODELS AM-/AMC-145

HIGH PERFORMANCE AMPLIFIER
10-1000 MHz GAIN: 11 dB

- 2.5 dB Typical Midband Noise Figure
- +19 dBm Typical Midband Output Power
- +37 dBm Typical Midband Third Order Intercept



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1000 MHz
Gain (+25°C) @ 300 MHz	10.7 ±0.6 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	+1.0, −0.8 dB
Output Power (1 dB Compression)	
10-1000 MHz	+14 dBm Min
100-1000 MHz	+17 dBm Min
Noise Figure	
10-1000 MHz	5.5 dB Max
10-500 MHz	4.0 dB Max
Reverse Transmission	−11 dB Max −13.5 dB Typ
VSWR	
10-1000 MHz	3:1 Max
10-500 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+38 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @ 60 mA Max (50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connecotrized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.8 W. Must be provided in use.

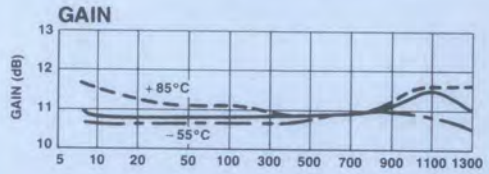
S-Parameters: For typical S-Parameter data, see page 97.

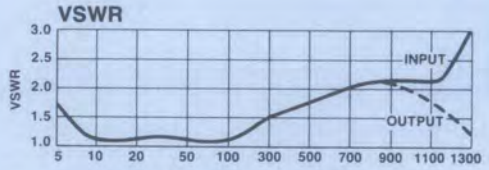
Ordering Information

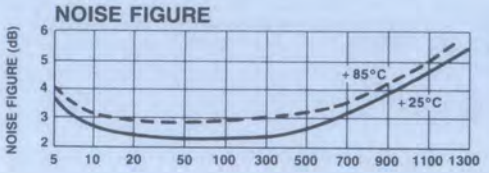
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-145	8379	Pin	$115
AMC-145	8374	SMA	212

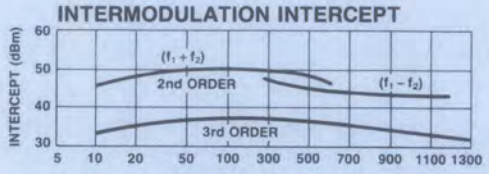
Delivery is from stock.

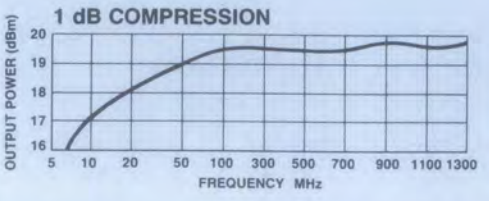
Typical Performance







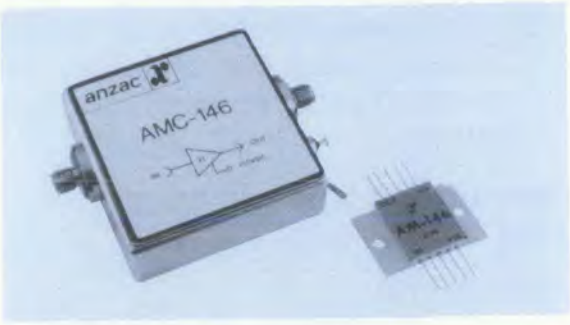




MODELS AM-/AMC-146

HIGH PERFORMANCE AMPLIFIER
10-500 MHz GAIN: 21 dB

- 4 dB Typical Midband Noise Figure
- +38 dBm Typical Midband Third Order Intercept
- +24 dBm Typical Midband 1 dB Compression



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-500 MHz
Gain (+25°C) @ 50 MHz	21 ±0.7 dB
Frequency Response	±1 dB
Gain Variation with Temperature	+0.8, −1.2 dB
Output Power (1 dB Compression)	+20.0 dBm Min
Noise Figure	
10-500 MHz	7 dB Max
10-300 MHz	5.5 dB Max
Reverse Transmission	−30 dB Max −35 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+40 dBm Min
Third Order	+30 dBm Min
Bias Power	+15 VDC @ 140 mA Max (130 mA, 2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Package Type	Flatpack (FP-9) Connectorized (C-25) (See pages 475 and 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

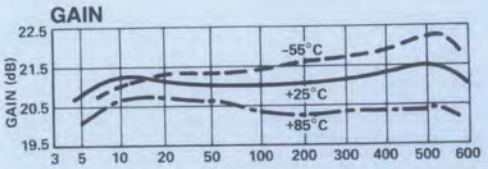
Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

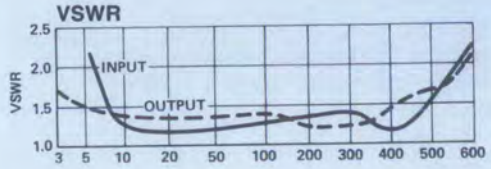
*All specifications apply when operated at +15 VDC with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

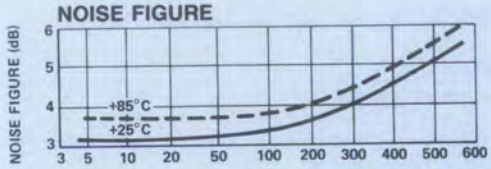
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2 W. Must be provided in use.

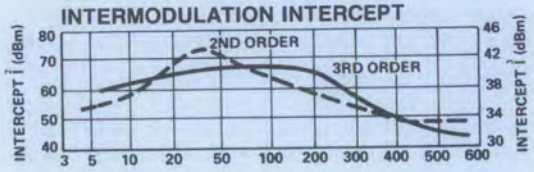
S-Parameters: For typical S-Parameter data, see page 97.

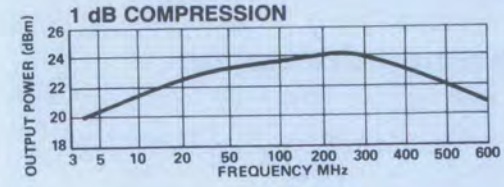
Typical Performance











Ordering Information

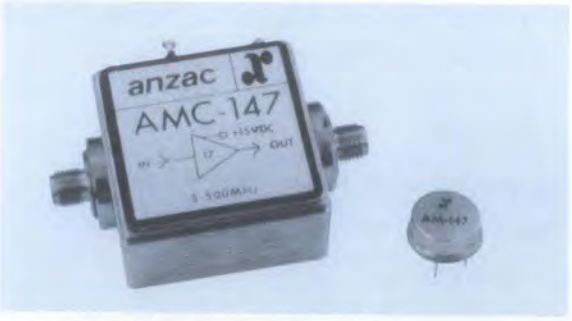
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-146	8139	Pin	$185
AMC-146	8134	SMA	282

Delivery is from stock.

MODELS AM-/AMC-147

HIGH PERFORMANCE AMPLIFIER
5-500 MHz GAIN: 17 dB

- 2 dB Typical Midband Noise Figure
- +20 dBm Typical Midband Output Power
- +38 dBm Typical Midband Third Order Intercept



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5 - 500 MHz
Gain (+25°C) @ 50 MHz	17 ±0.6 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	−1.2, +.5dB
Output Power (1 dB Compression)	+19 dBm Min
Noise Figure	
5-500 MHz	4.5 dB Max
5-300 MHz	3.5 dB Max
Reverse Transmission	−16 dB Max
	−20 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+38 dBm Min
Third Order	+28 dBm Min
Bias Power	+15 VDC @ 60 mA Max
	(50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1)
	Connectorized (C-6)
	(See pages 472 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

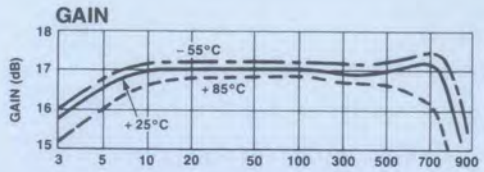
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

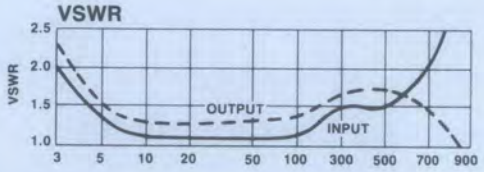
This product contains elements protected by United States Patent Number 3,624,536.

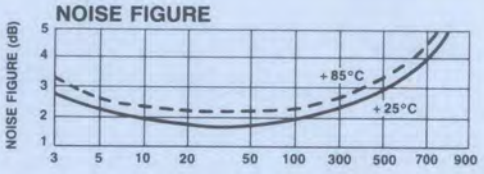
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.75 W. Must be provided in use.

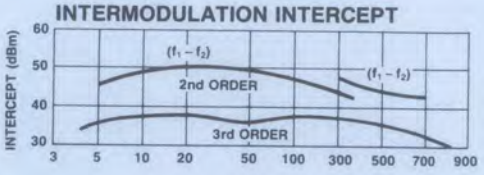
S-Parameters: For typical S-Parameter data, see page 97.

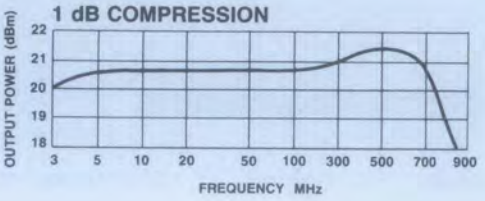
Typical Performance











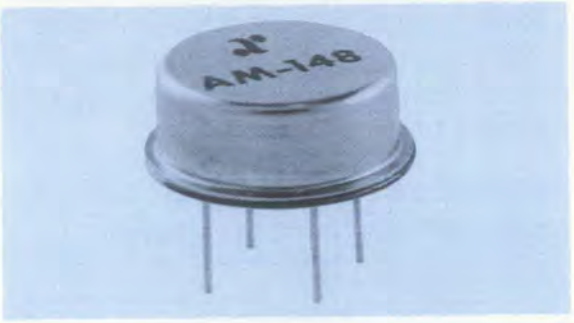
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-147	8739	Pin	$ 94
AMC-147	8734	SMA	191

Delivery is from stock.

MODEL AM-148 — CASCADABLE THIN FILM AMPLIFIER 5-500 MHz GAIN: 14 dB

- 3.5 dB Typical Midband Noise Figure
- 1.2 Typical Midband VSWR
- +16 dBm Typical Midband Third Order Intercept



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	13.7 ±0.5 dB
Frequency Response	±1 dB
Gain Variation with Temperature	±0.8 dB
Output Power (1 dB Compression)	+1.5 dBm Min
Noise Figure	
5-500 MHz	4.5 dB Max
Reverse Transmission	−15 dB Max −19 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order	+20 dBm Min
Third Order	+14 dBm Min
Bias Power	+15 VDC @ 16 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Pin (TO-8-1) (See page 472 for physical dimensions.)

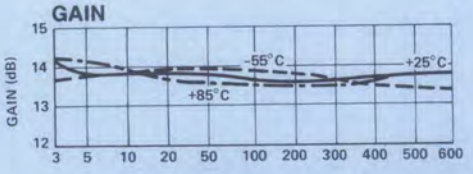
Environmental

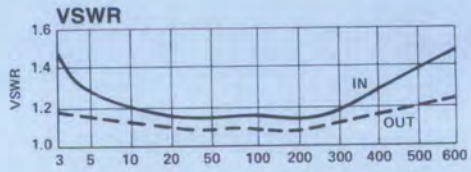
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

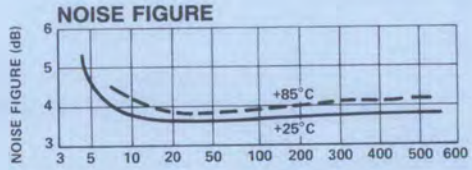
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

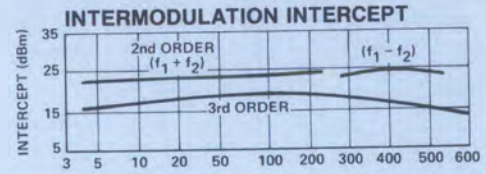
S-Parameters: For typical S-Parameter data, see page 97.

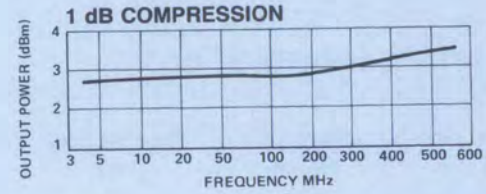
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-148	8749	Pin	$61

Delivery is from stock.

MODEL AM-149 — CASCADABLE THIN FILM AMPLIFIER 5-500 MHz GAIN: 15 dB

- 5 dB Midband Noise Figure
- +16 dBm Midband Output Power
- +30 dBm Typical Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	15.25 ±0.5 dB
Frequency Response	±1 dB
Gain Variation with Temperature	±0.8 dB
Output Power (1 dB Compression)	+14.5 dBm Min
Noise Figure	
5-500 MHz	6.5 dB Max
Reverse Transmission	−15 dB Max −19 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+35 dBm Min
Third Order	+28 dBm Min
Bias Power	+15 VDC @ 49 mA Max (47 mA, 700 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Pin (TO-8-1) (See page 472 for physical dimensions.)

Environmental

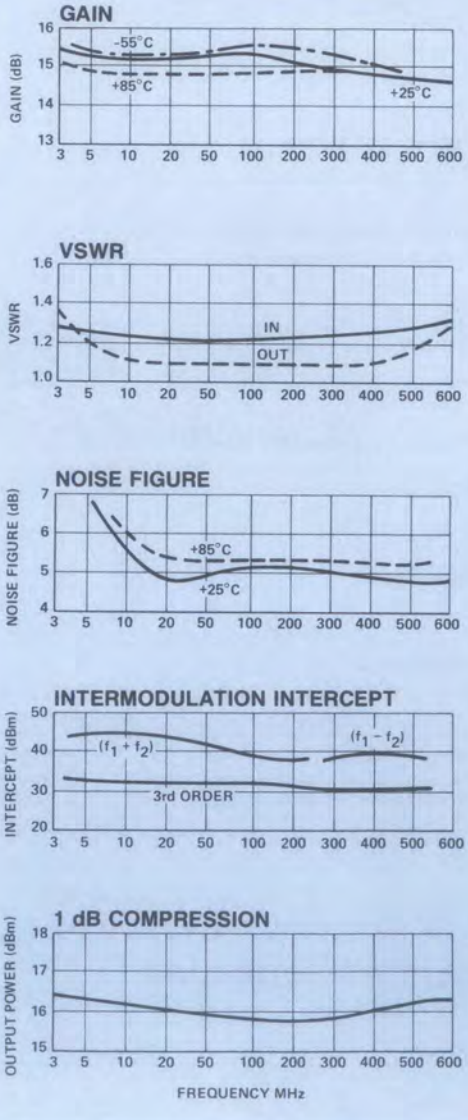
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.7 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see page 97.

Typical Performance



Ordering Information

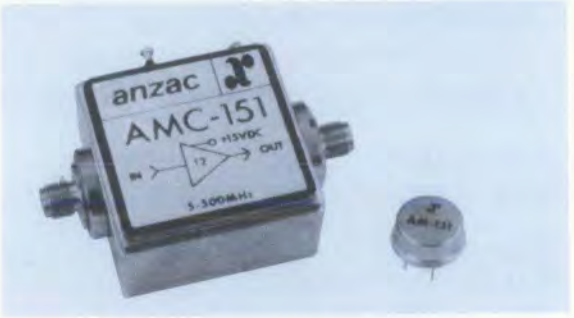
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-149	8989	Pin	$76

Delivery is from stock.

MODELS AM-/AMC-151

CASCADABLE THIN FILM AMPLIFIER 5-500 MHz GAIN: 12 dB

- 5 dB Typical Midband Noise Figure
- +38 dBm Typical Midband Third Order Intercept
- +21 dBm Typical Midband 1 dB Compression



Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	12 ±0.5 dB
Frequency Response	±1 dB
Gain Variation with Temperature	±0.8 dB
Output Power (1 dB Compression)	
5-500 MHz	+19 dBm Min
10-500 MHz	+20 dBm Min
Noise Figure	
5-500 MHz	7 dB Max
Reverse Transmission	–13 dB Max –16 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+48 dBm Min
Third Order	+34 dBm Min
Bias Power	+15 VDC @ 100 mA Max (85 mA, 1275 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

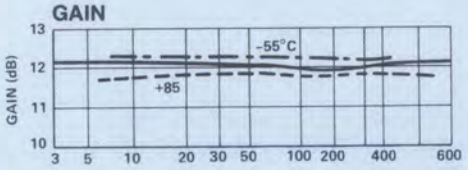
Environmental

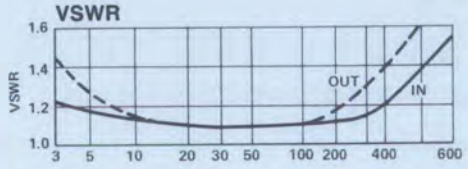
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

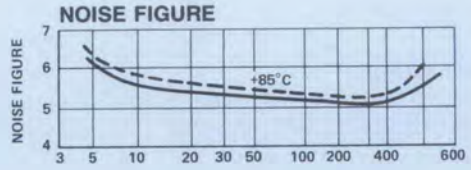
*All specifications apply when operated at +15 VDC, with 50 ohm source and impedance.

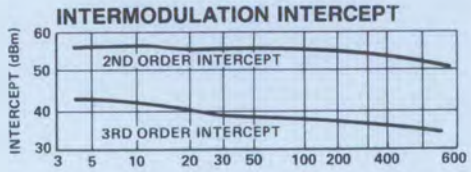
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.3 W. Must be provided in use.

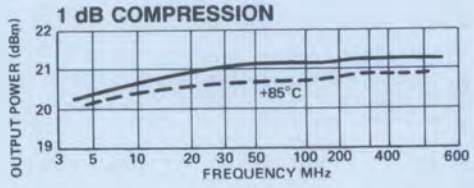
Typical Performance











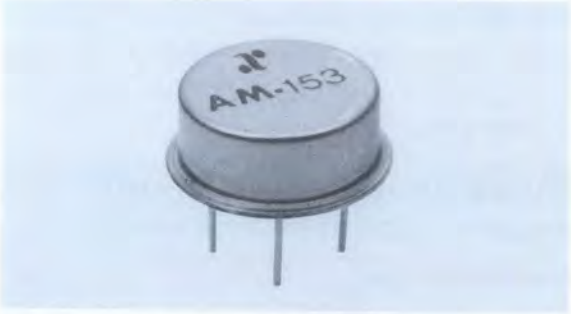
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-151	9059	Pin	$ 76
AMC-151	9054	SMA	173

Delivery is from stock.

MODEL AM-153 — LOW NOISE AMPLIFIER
300-1800 MHz GAIN: 12 dB

- 1.9 dB Typical Midband Noise Figure
- +7.5 dBm Typical Midband Output Power
- +19 dBm Typical Midband Third Order Intercept



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		300 - 1800 MHz
Gain (+25°C) @ 600 MHz		12.4 ±0.5 dB
Frequency Response		±1.2 dB Max
Gain Variation with Temperature		+0.5, −0.7 dB Max
Output Power (1 dB Compression)		+6 dB Min
Noise Figure		
300-1500 MHz		3.0 dB
1500-1800 MHz		3.5 dB
Reverse Transmission		−12 dB Max −14 dB Typ
VSWR		
Output	300-400 MHz	3.5:1
	400-1500 MHz	3.0:1
	1500-1800 MHz	2.5:1
Input	300-1500 MHz	2.5:1
	1500-1800 MHz	3.3:1
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)		
Second Order		+22 dBm Min
Third Order		
300-1000 MHz		+17 dBm Min
1000-1800 MHz		+15 dBm Min
Bias Power		+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) (See page 472 for physical dimensions.)

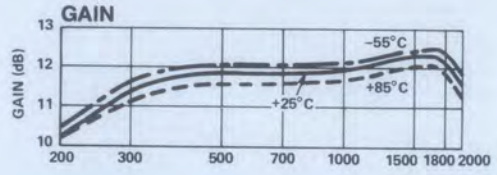
Environmental

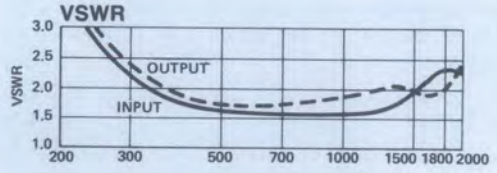
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

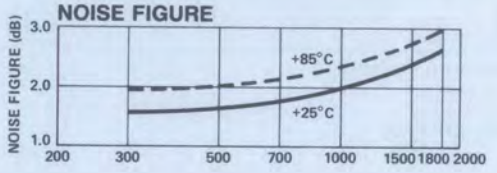
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

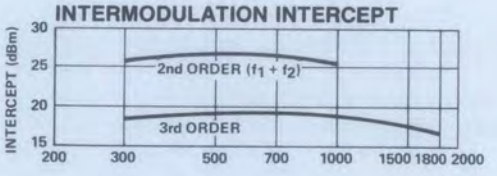
This product contains elements protected by United States Patent Number 3,624,536.

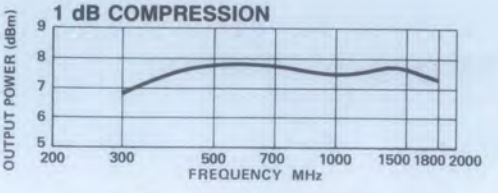
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-153	9319	Pin	$125

Delivery is from stock.

MODELS AM-/AMC-154

LOW NOISE AMPLIFIER
20-1000 MHz GAIN: 9.5 dB

- 2 dB Typical Midband Noise Figure
- +8 dBm Typical Midband Output Power
- +20 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		20-1000 MHz
Gain (+25°C) @ 300 MHz		9.5 ±1.0 dB
Frequency Response		±1.0 dB Max
Gain Variation with Temperature		+0.5, −1 dB Max
Output Power (1 dB Compression)		+4 dB Min
Noise Figure		
20-500 MHz		3.0 dB Max
500-1000 MHz		3.8 dB Max
Reverse Transmission		−10 dB Max −14 dB Typ
VSWR	Input	Output
20-500 MHz	2:1	2.5:1 Max
500-1000 MHz	2.5:1	3.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)		
Second Order		+22 dBm Min
Third Order		+18 dBm Min
Bias Power		+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

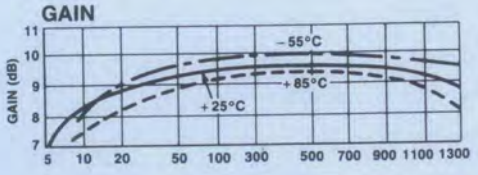
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

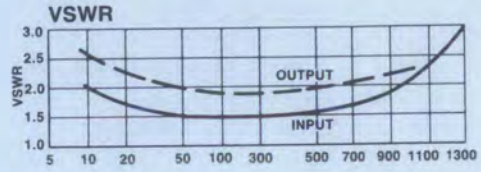
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

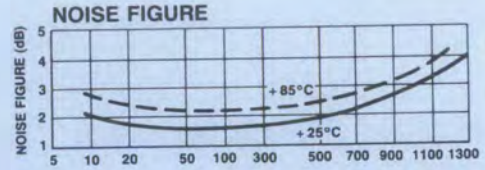
This product contains elements protected by United States Patent Number 3,624,536.

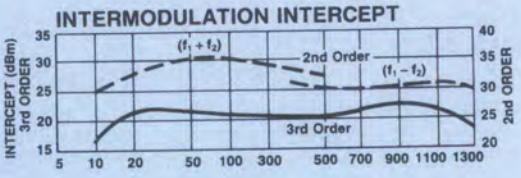
S-Parameters: For typical S-Parameter data, see page 98.

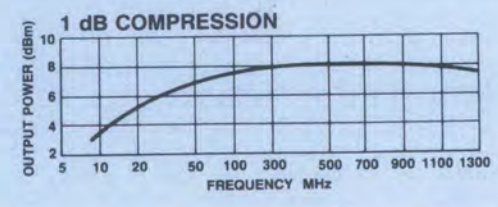
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-154	6209	Pin	$ 95
AMC-154	6204	SMA	192

Delivery is from stock.

MODELS AM-/AMC-155

HIGH DYNAMIC RANGE AMPLIFIER 300-1000 MHz GAIN: 12.5 dB

- 2.5 dB Typical Midband Noise Figure
- +21 dBm Typical Midband Output Power
- +37 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		300-1000 MHz
Gain (+25°C) @ 600 MHz		12.25 ± 1.0 dB
Frequency Response		±0.5 dB Max
Gain Variation with Temperature		±0.7 dB Max
Output Power (1 dB Compression)		+18 dBm Min
Noise Figure		
300-700 MHz		4.0 dB Max
300-1000 MHz		5.5 dB Max
Reverse Transmission		−10 dB Max
		−14 dB Typ
VSWR	Input	Output
	2.0:1	3.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)		
Second Order		+40 dBm Min
Third Order		+27 dBm Min
Bias Power		+15 VDC @ 60 mA Max
		(50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1)
	Connectorized (C-6)
	(See pages 472 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

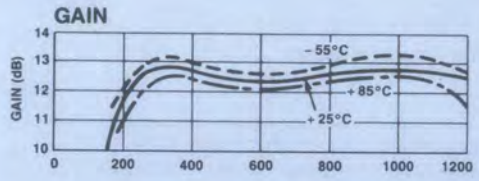
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

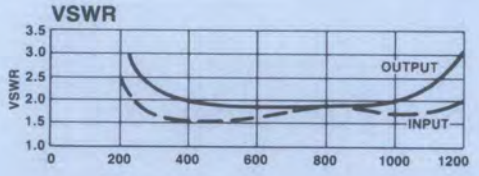
This product contains elements protected by United States Patent Number 3,624,536.

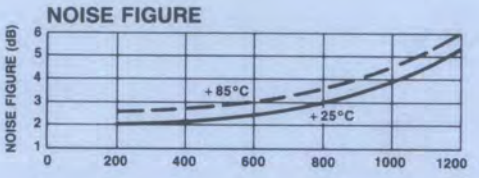
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.90 W. Must be provided in use.

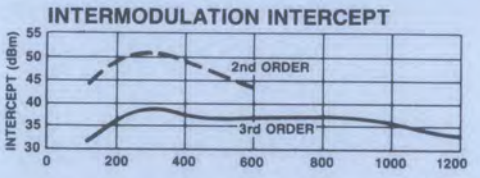
S-Parameters: For typical S-Parameter data, see page 98.

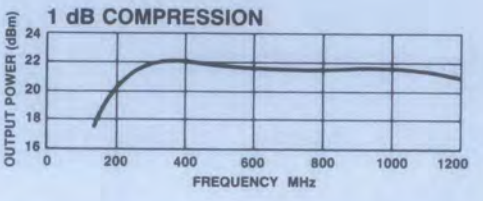
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-155	6219	Pin	$133
AMC-155	6214	SMA	230

Delivery is from stock.

MODELS AM-/AMC-156

LOW NOISE ISOLATION AMPLIFIER 10-500 MHz GAIN: 12.5 dB

- 35 dB Typical Reverse Isolation
- 2 dB Typical Noise Figure
- 1.2:1 Typical VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-500 MHz
Gain (+25°C) @ 50 MHz	12.5 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	+0.75, −1.0 dB Max
Output Power (1 dB Compression)	
10-100	+3 dBm Min
100-500	0 dBm Min
Noise Figure	4.0 dB Max
Reverse Transmission	−25 dB Max −35 dB Typ
VSWR	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+17 dBm Min
Third Order	+12 dBm Min
Bias Power	+15 VDC @ 20 mA Max (15 mA, 225 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

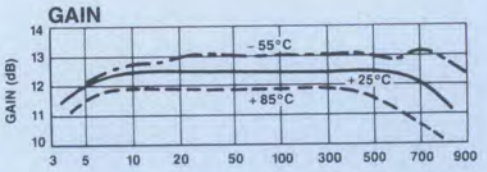
Environmental

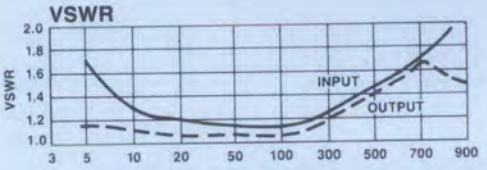
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

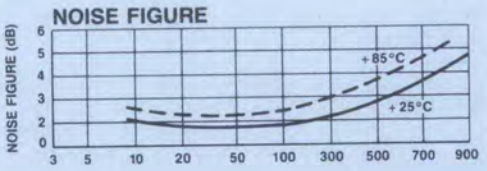
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

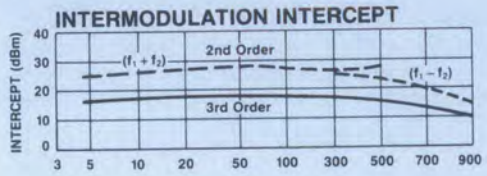
This product contains elements protected by United States Patent Number 3,426,298.

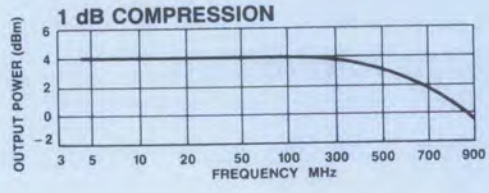
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-156	6229	Pin	$ 89
AMC-156	6224	SMA	186

Delivery is from stock.

MODELS AM-/AMC-157

HIGH PERFORMANCE ISOLATION AMPLIFIER 20-500 MHz GAIN: 12.5 dB

- 35 dB Typical Reverse Isolation
- +42 dBm Typical Third Order Intercept
- +24 dBm Typical 1 dB Compression
- 1.2:1 Typical VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	20-500 MHz
Gain (+25°C) @ 50 MHz	12.5 ±0.8 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+21 dBm Min
Noise Figure	7.5 dB Max
Reverse Transmission	−22 dB Max −30 dB Typ
VSWR	
20-30 MHz	2.0:1 Max
30-500 MHz	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+40 dBm Min
Third Order	+30 dBm Min
Bias Power	+15 VDC @ 90 mA Max (80 mA, 1.2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

Environmental

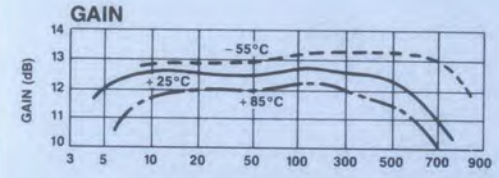
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

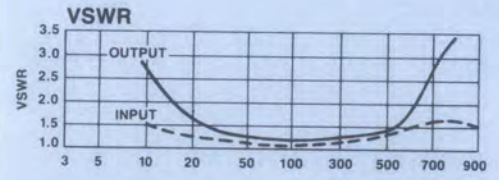
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

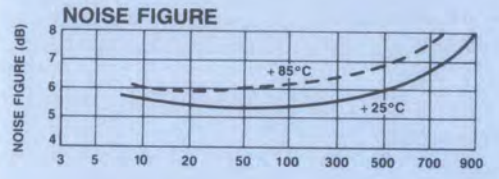
This product contains elements protected by United States Patent Number 3,426,298.

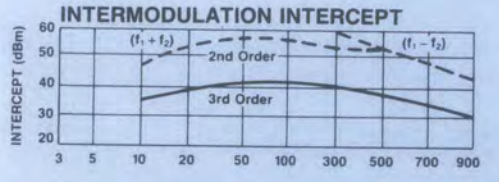
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 1.2 W must be provided in use.

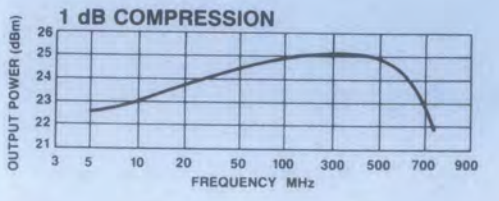
Typical Performance











Ordering Information

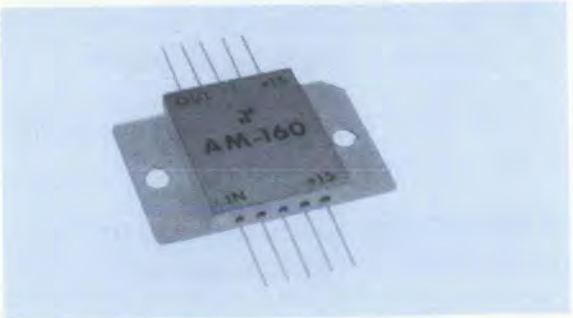
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-157	6239	Pin	$103
AMC-157	6234	SMA	200

Delivery is from stock.

MODEL AM-160

LOW NOISE AMPLIFIER
100-600 MHz GAIN: 28 dB

- 1.6 Typical Midband Noise Figure
- +19 dBm Typical 1 dB Compression Point
- +30 dBm Typical Third Order Intercept Point



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	100-600 MHz
Gain (+25°C) @ 250 MHz	28.2 ±1 dB
Frequency Response	±1.25 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	+16 dBm Min
Noise Figure	3.0 dB Max
Reverse Transmission	−32 dB Max −38 dB Typ
VSWR	
100-600 MHz	2.5:1 Max
100-400 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+36 dBm Min
Third Order	+27 dBm Min
Bias Power	+15 VDC @ 75 mA Max (70 mA, 1050 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Flatpack (FP-9) (See pages 475 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

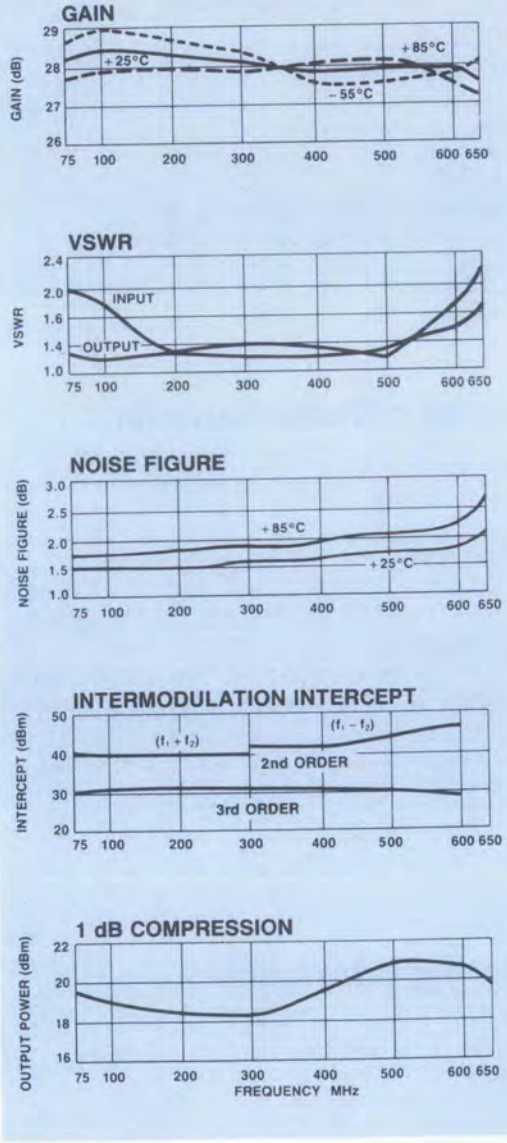
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.2 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see page 98.

Typical Performance



Ordering Information

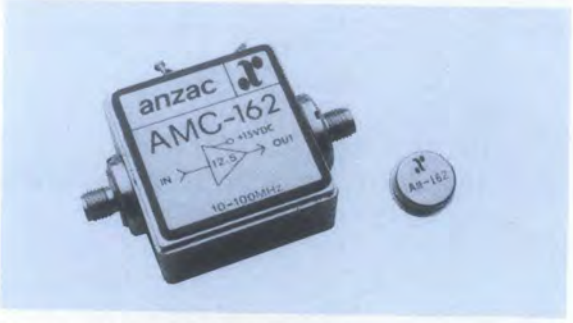
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-160	6189	Pin	$170

Delivery is from stock.

MODELS AM-/AMC-162

LOW NOISE AMPLIFIER
10-100 MHz GAIN: 12.5 dB

- Low Noise Figure — 1.1 dB Typical @ 50 MHz
- High Output Power — +15 dBm Typical @ 50 MHz
- +32 dBm Typical 3rd Order Intercept @ 50 MHz



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-100 MHz
Gain (+25°C) @50 MHz	12.5 ±0.5 dB
Frequency Response	±0.6 dB Max
Gain Variation with Temperature	±0.6 dB Max
Output Power (1 dB Compression)	+13 dBm Min
Noise Figure	1.6 dB Max
Reverse Transmission	−14 dB Max −15 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+40 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @15 mA Max (11 mA, 165 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

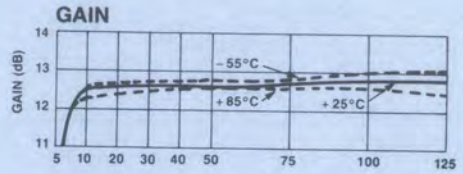
Environmental

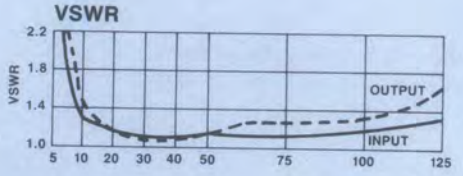
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

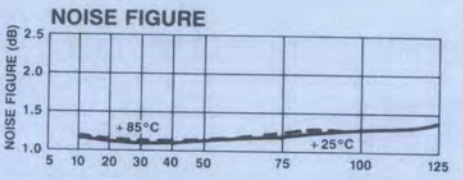
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by U.S. Patent Number 3,891,934.

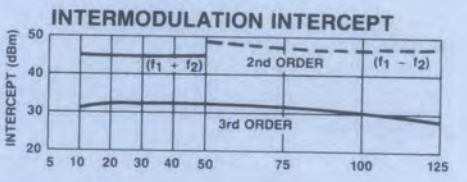
S-Parameters: For typical S-Parameter data, see page 98.

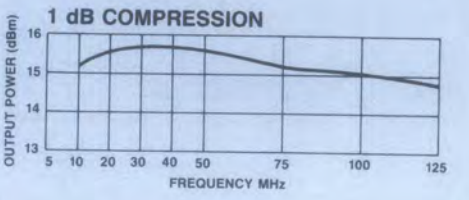
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-162	9589	Pin	$103
AMC-162	9584	SMA	200

Delivery is from stock.

NEW

MODEL AMS-162

SURFACE MOUNT LOW NOISE AMPLIFIER 10 - 100 MHz GAIN: 12.5 dB

- Fully Hermetic Package
- Low Noise Figure – 1.1 dB Typical at 50 MHz
- High Output Power – +15 dBm Typical at 50 MHz
- +32 dBm Typical 3rd Order Intercept at 50 MHz

Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	10 - 100 MHz
Gain (+25°C) @ 60 MHz	12.5 ±0.5 dB
Frequency Response	±0.6 dB Max
Gain Variation with Temperature	±0.6 dB Max
Output Power (1 dB Compression)	+13 dBm Max
Noise Figure	1.6 dB Max
Reverse Transmission	–14 dB Max –15 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+40 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @ 15 mA Max (11 mA, 165 mW Typ)

Operating Characteristics

IF Impedance	50 Ohms Nominal
Maximum Rating RF Input	+10 dBm
Package Type	Pin (SF-1) (See page 490 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P3; OUT, P1; VDC, P2

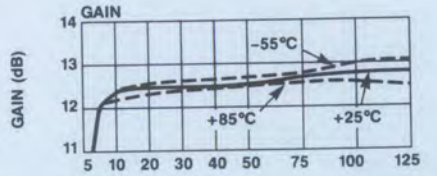
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,891,934.

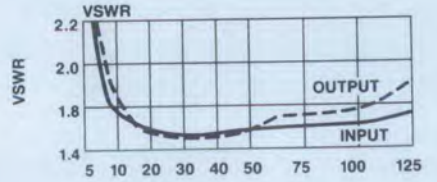
S-Parameters: For typical S-Parameter data, see page 98.

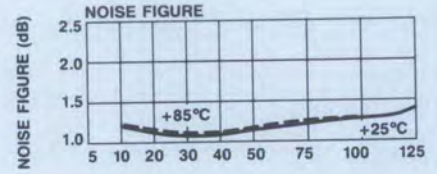
Ordering Information

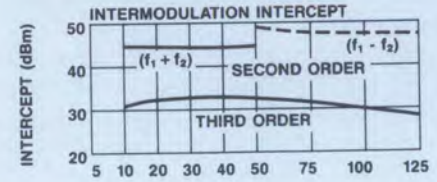
Model No.	Connector	Unit Price (5-9 Units)
AMS-162	PIN	$113

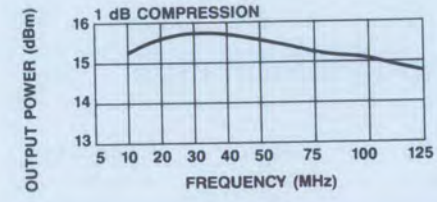
Typical Performance











MODELS AM-/AMC-171

CASCADABLE THIN FILM AMPLIFIER 5-500 MHz GAIN: 15 dB

- 2.3 dB Typical Midband Noise Figure
- 1.2:1 Typical Midband Output VSWR

Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 250 MHz	15.2 ±0.7 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	±1.0 dB
Output Power (1 dB Compression)	–3 dBm Min
Noise Figure	3.0 dB Max
Reverse Transmission	–17 dB Max –20 dB Typ
VSWR	
Input	2.0:1 Max
Output	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to –10 dBm)	
Second Order	+11.5 dBm Min
Third Order	+8.5 dBm Min
Bias Power	+15 VDC @ 12.5 mA Max (11 mA, 180 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

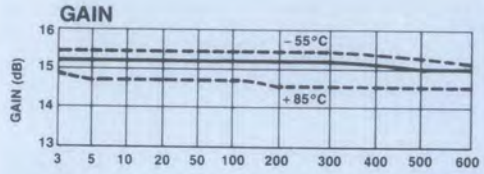
Environmental

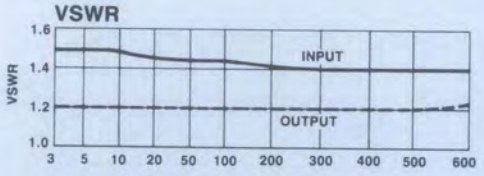
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

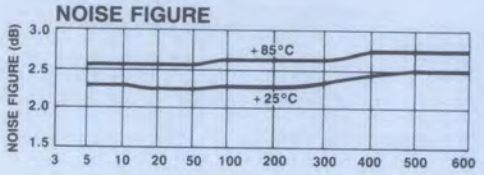
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

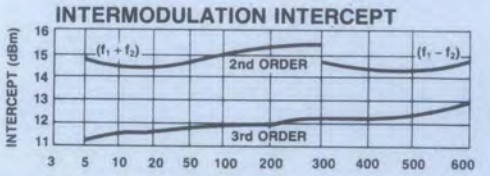
S-Parameters: For typical S-Parameter data, see page 98.

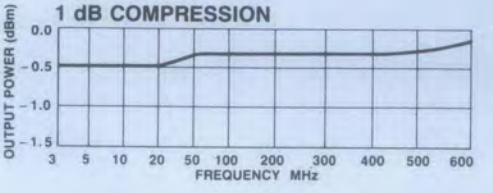
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-171	6249	Pin	$ 76
AMC-171	6244	SMA	173

Delivery is from stock.

MODELS AM-/AMC-173

CASCADABLE THIN FILM AMPLIFIER 5-1000 MHz GAIN: 15 dB

- 2.4 dB Typical Midband Noise Figure
- 1.2:1 Typical Midband Output VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @ 500 MHz	15.1 ±0.7 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	±1.0 dB
Output Power (1 dB Compression)	−3 dBm Min
Noise Figure	3.3 dB Max
Reverse Transmission	−17 dB Max −20 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+11.5 dBm Min
Third Order	+8.5 dBm Min
Bias Power	+15 VDC @ 12.5 mA Max (11 mA, 180 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)
	(See pages 472 and 481 for physical dimensions.)

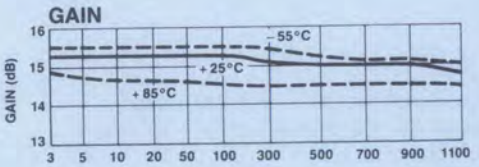
Environmental

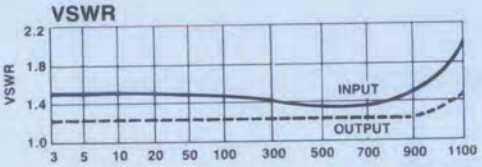
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

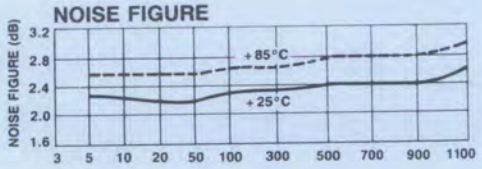
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

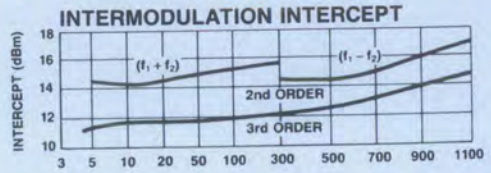
S-Parameters: For typical S-Parameter data, see page 98.

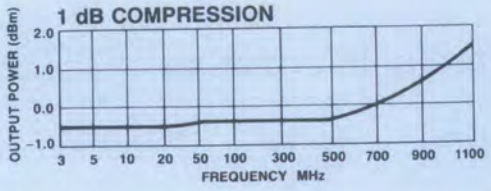
Typical Performance











Ordering Information

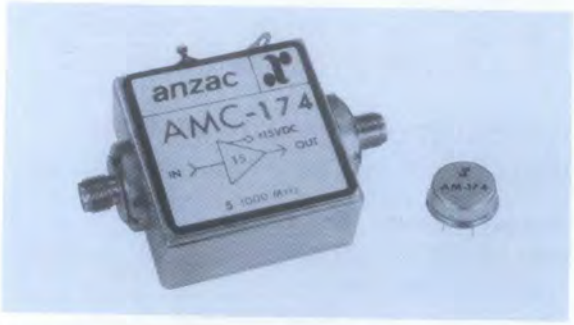
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-173	6259	Pin	$ 89
AMC-173	6254	SMA	186

Delivery is from stock.

MODELS AM-/AMC-174

CASCADABLE THIN FILM AMPLIFIER 5-1000 MHz GAIN: 15 dB

- 2.5 dB Typical Midband Noise Figure
- ±0.3 dB Typical Gain Flatness



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @ 500 MHz	15.2 ±0.5 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	±1.0 dB
Output Power (1 dB Compression)	+2 dBm Min
Noise Figure	3.8 dB Max
Reverse Transmission	−17 dB Max −20 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+18 dBm Min
Third Order	+14 dBm Min
Bias Power	+15 VDC @ 18 mA Max (16 mA, 290 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

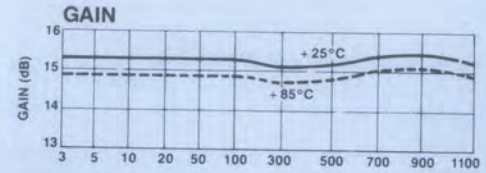
Environmental

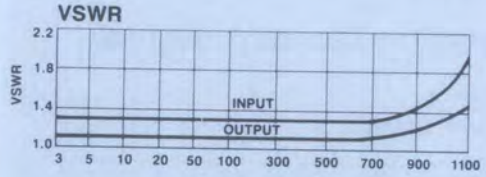
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

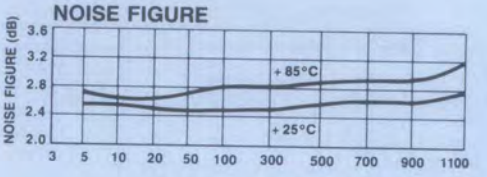
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

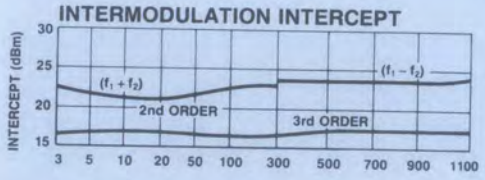
S-Parameters: For typical S-Parameter data, see page 98.

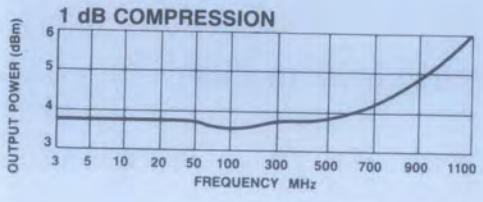
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-174	6269	Pin	$ 89
AMC-174	6264	SMA	186

Delivery is from stock.

MODELS AM-/AMC-175

CASCADABLE THIN FILM AMPLIFIER 5-1000 MHz GAIN: 15 dB

- 3.0 dB Typical Midband Noise Figure
- +8.5 dB Typical 1 dB Compression

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @ 500 MHz	15.4 ±0.7 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	±1.0 dB
Output Power (1 dB Compression)	+7.0 dBm Min
Noise Figure	4.2 dB Max
Reverse Transmission	−17 dB Max −20 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order	+28 dBm Min
Third Order	+19 dBm Min
Bias Power	+15 VDC @ 29 mA Max (25 mA, 375 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

Environmental

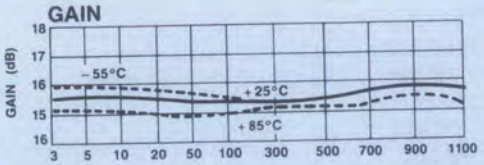
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

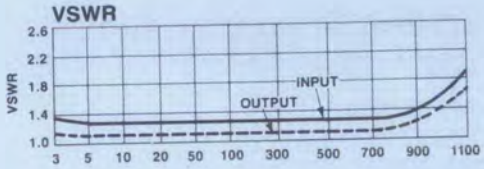
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

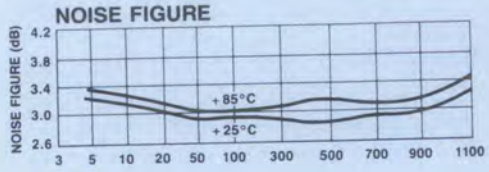
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 0.375 W must be provided in use.

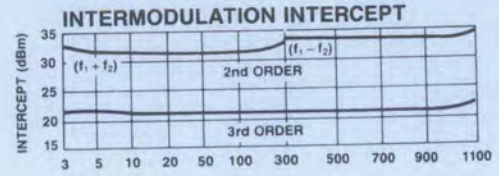
S-Parameters: For typical S-Parameter data, see page 98.

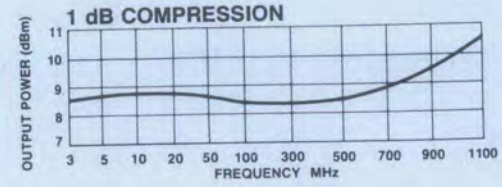
Typical Performance











Ordering Information

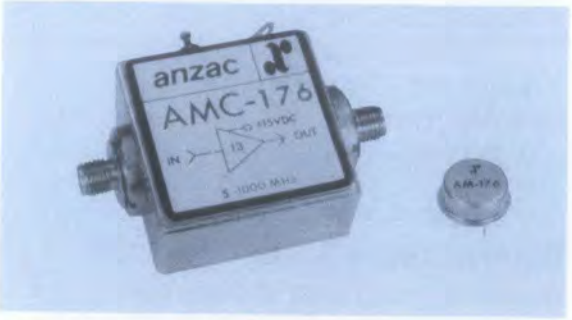
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-175	6279	Pin	$ 89
AMC-175	6274	SMA	186

Delivery is from stock.

MODELS AM-/AMC-176

CASCADABLE THIN FILM AMPLIFIER 5-1000 MHz GAIN: 13 dB

- 4.0 dB Typical Noise Figure
- 13.5 dBm Typical Midband 1 dB Compression
- 1.25:1 Typical VSWR



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @ 500 MHz	13.2 ±1 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	
5-1000 MHz	+12 dBm Min
Noise Figure	
5-1000 MHz	5.0 dB Max
Reverse Transmission	−14 dB Max −17 dB Typ
VSWR	1.8:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+37 dBm Min
Third Order	+25 dBm Min
Bias Power	+15 VDC @ 43 mA Max (38 mA, 570 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

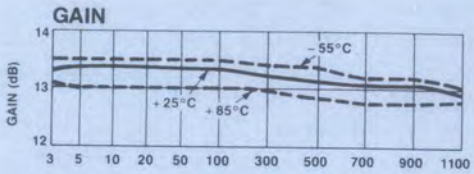
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

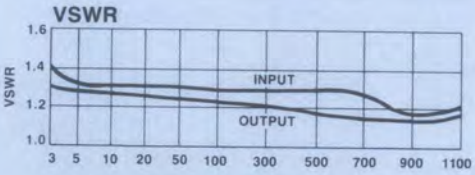
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

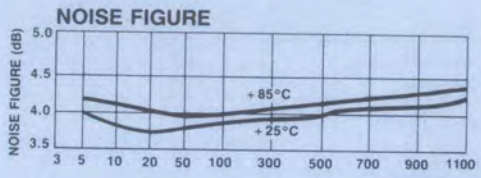
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 0.575 W must be provided in use.

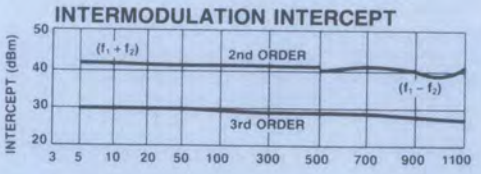
S-Parameters: For typical S-Parameter data, see page 98.

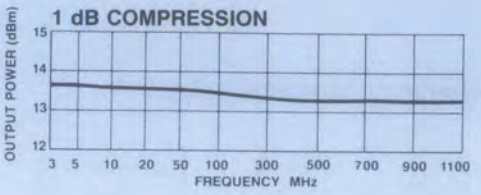
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-176	6289	Pin	$ 98
AMC-176	6284	SMA	195

Delivery is from stock.

MODEL AM-177 — CASCADABLE THIN FILM AMPLIFIER 10-1000 MHz GAIN: 12 dB

- High 1dB Compression — +22 dBm Typical
- High 3rd Order Intercept — +38 dBm Typical
- 1.2:1 Typical VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1000 MHz
Gain (+25°C) @500 MHz	12.0 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±0.8 dB Max
Output Power (1 dB Compression)	+20 dBm Min
Noise Figure	8.5 dB Max
Reverse Transmission	−14 dB Max −16 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+42 dBm Min
Third Order	+30 dBm Min
Bias Power	+15 VDC @115 mA Max (105 mA, 1575 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Package Type	Pin (TO-8-1) (See page 472 for physical dimensions.)

Environmental

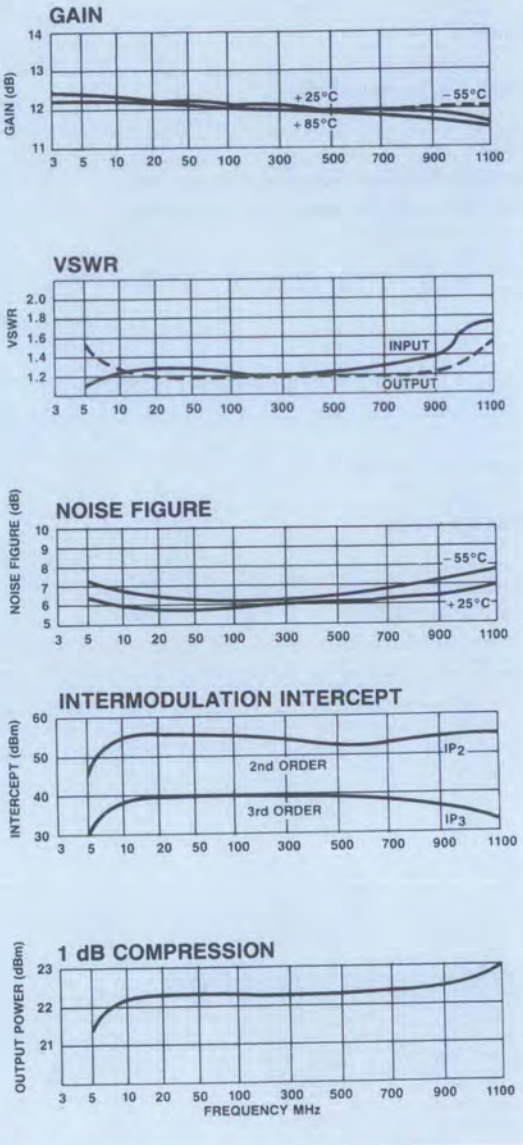
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by U.S. Patent Number 3,891,934.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.75 W. Must be provided in use.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-177	9469	Pin	$121

Delivery is from stock.

MODELS AM-/AMC-178

CASCADABLE THIN FILM AMPLIFIER 10-2000 MHz GAIN: 10 dB

- 3.9 dB Typical Midband Noise Figure
- ±0.3 dB Typical Gain Flatness
- +17 dBm Typical Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @ 1000 MHz	10 ± 1 dB
Frequency Response	± 1 dB Max
Gain Variation with Temperature	± 1 dB Max
Output Power (1 dB Compression)	
10-2000 MHz	+2 dBm Min
Noise Figure	
10-2000 MHz	5.3 dB Max
Reverse Transmission	−13 dB Max −15 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+20 dBm Min
Third Order	+13 dBm Min
Bias Power	+15 VDC @ 17 mA Max (14.5 mA, 220 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

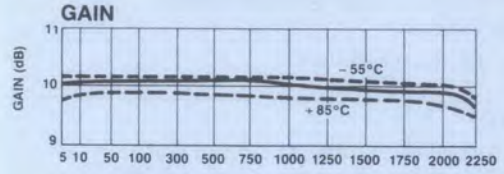
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

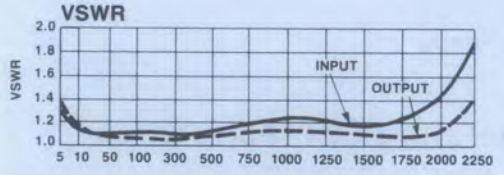
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

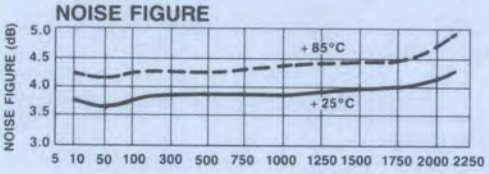
This product contains elements protected by United States Patent Number 3,426,298.

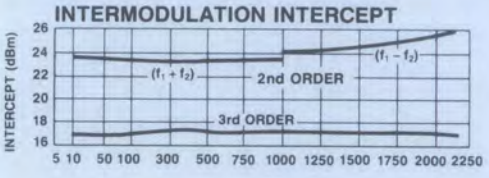
S-Parameters: For typical S-Parameter data, see page 98.

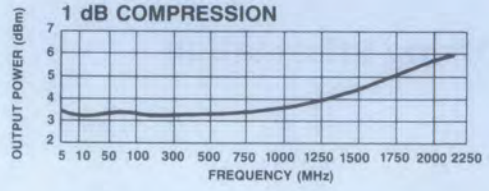
Typical Performance











Ordering Information

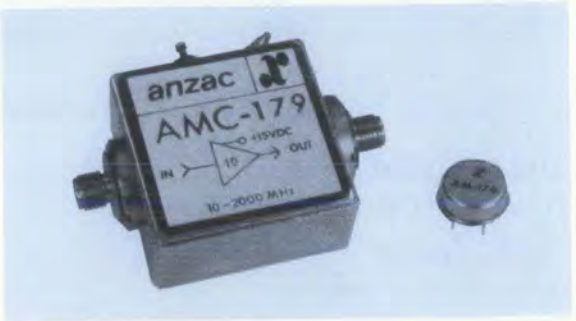
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-178	6309	Pin	$107
AMC-178	6304	SMA	204

Delivery is from stock.

MODELS AM-/AMC-179

CASCADABLE THIN FILM AMPLIFIER 10-2000 MHz GAIN: 10 dB

- 4.2 dB Typical Midband Noise Figure
- +23 dBm Typical Midband Third Order Intercept
- +8.0 dBm Typical Midband 1 dB Compression



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @ 1000 MHz	10 ±1 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	+7.0 dBm Min
Noise Figure	6.0 dB Max
Reverse Transmission	−13 dB Max −15 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order	+30 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @ 26 mA Max (23 mA, 350 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

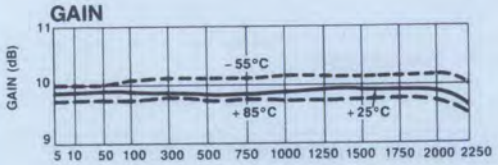
(See pages 472 and 481 for physical dimensions.)

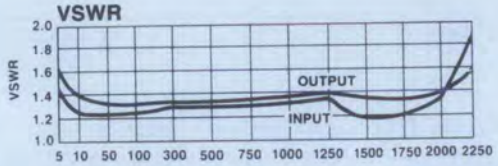
Environmental

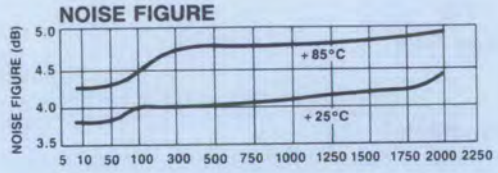
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

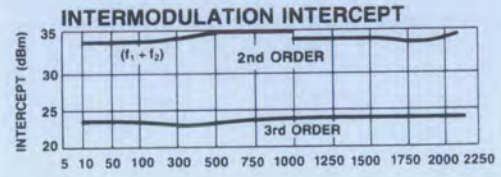
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

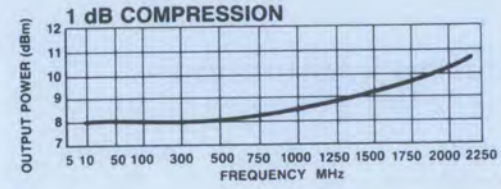
Typical Performance











Ordering Information

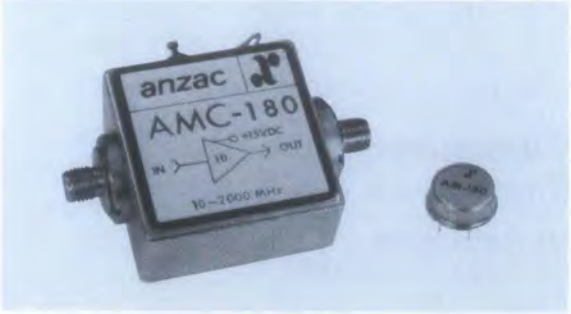
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-179	6319	Pin	$ 95
AMC-179	6314	SMA	192

Delivery is from stock

MODELS AM-/AMC-180

CASCADABLE THIN FILM AMPLIFIER 10-2000 MHz GAIN: 10 dB

- +14 dBm Typical 1 dB Compression
- 5 dB Typical Noise Figure
- 1.4:1 Typical VSWR



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @ 1000 MHz	9.7 ±1 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	
10-2000 MHz	+13 dB Min
Noise Figure	
10-2000 MHz	7.0 dB Max
Reverse Transmission	−12 dB Max −14 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+39 dBm Min
Third Order	+25 dBm Min
Bias Power	+15 VDC @ 50 mA Max (45 mA, 680 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

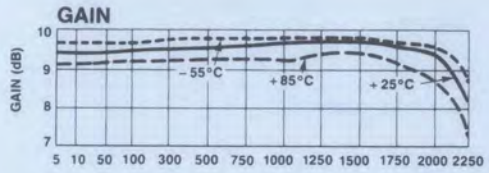
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

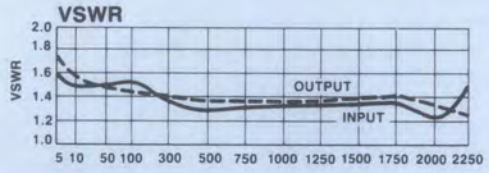
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

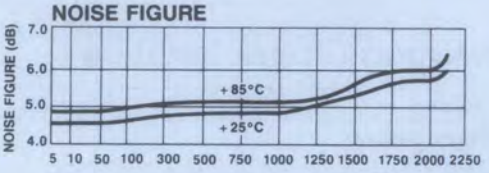
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.75 W. Must be provided in use.

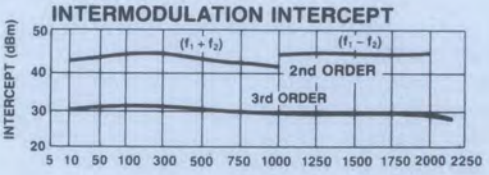
S-Parameters: For typical S-Parameter data, see page 98.

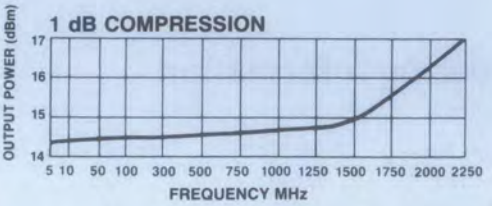
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-180	6329	Pin	$116
AMC-180	6324	SMA	213

Delivery is from stock

MODELS AM-/AMC-181

LOW NOISE AMPLIFIER
10-400 MHz GAIN: 8.5 dB

- 1.5 dB Typical Midband Noise Figure
- +31 dBm Typical Midband Intercept
- Ideal for Broadband IF Applications

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-400 MHz
Gain (+25°C) @ 100 MHz	8.5 ±0.5 dB
Frequency Response	+1.0, −0.5 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
10-400 MHz	+6 dBm Min
10-200 MHz	+9 dBm Min
Noise Figure	
10-400 MHz	2.5 dB Max
10-200 MHz	2.2 dB Max
Reverse Transmission	−9 dB Max −11 dB Typ
VSWR	
10-400 MHz	2.2:1 Max
10-300 MHz	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order 10-400 MHz	+25 dBm Min
Second Order 10-200 MHz	+35 dBm Min
Third Order 10-400 MHz	+15 dBm Min
Third Order 10-200 MHz	+23 dBm Min
Bias Power	+15 VDC @ 15 mA Max (11 mA, 165 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,891,934.

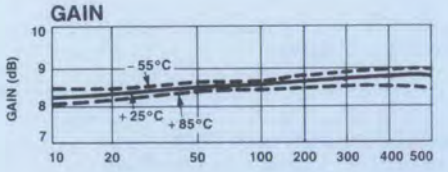
S-Parameters: For typical S-Parameter data, see page 98.

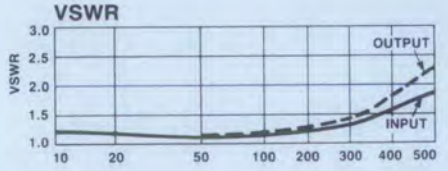
Ordering Information

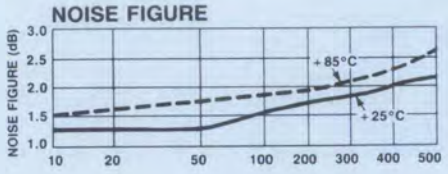
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-181	6339	Pin	$118
AMC-181	6334	SMA	215

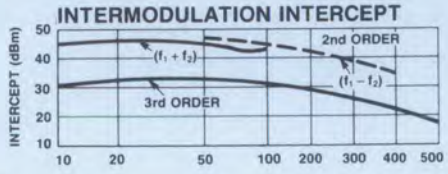
Delivery is from stock.

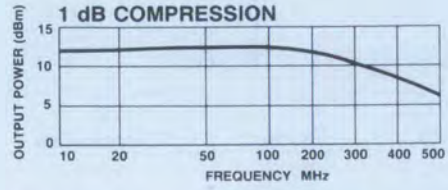
Typical Performance







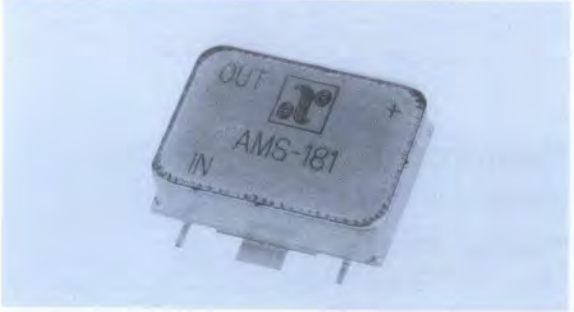




NEW

MODEL AMS-181 SURFACE MOUNT LOW NOISE AMPLIFIER 10 - 400 MHz GAIN: 8.5 dB

- Fully Hermetic Package
- 1.5 dB Typical Midband Noise Figure
- +31 dBm Typical Midband Intercept
- Ideal for Broadband IF Applications



Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	10 - 400 MHz
Gain (+25°C) @ 60 MHz	8.5 ±0.5 dB
Frequency Response	+1.0, –0.5 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
10-400 MHz	+6 dBm Min
10-200 MHz	+9 dBm Min
Noise Figure	
10-400 MHz	2.5 dB Max
10-200 MHz	2.2 dB Max
Reverse Transmission	–9 dB Max –11 dB Typ
VSWR	
10-400 MHz	2.2:1 Max
10-300 MHz	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order (10-400 MHz)	+25 dBm Min
Second Order (10-200 MHz)	+35 dBm Min
Third Order (10-400 MHz)	+15 dBm Min
Third Order (10-200 MHz)	+23 dBm Min
Bias Power	+15 VDC @ 15 mA Max (11 mA, 165 mW Typ)

Operating Characteristics

IF Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental

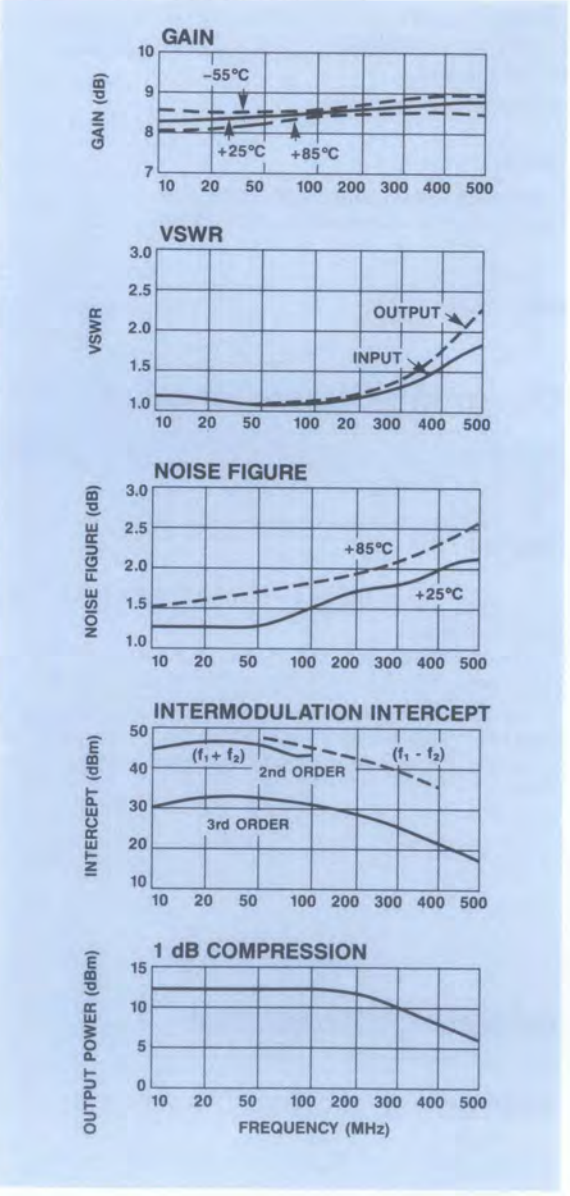
These units are designed to meet the environmental requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P3; OUT, P1; VDC, P2

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by United States Patent Number 3,891,934.

S-Parameters: For typical S-Parameter data, see page 98.

Typical Performance



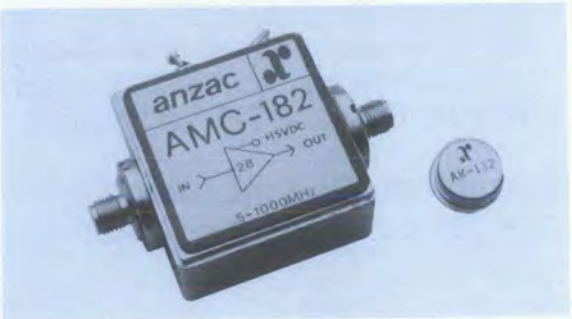
Ordering Information

Model No.	Connector	Unit Price (5-9 Units)
AMS-181	PIN	$126

MODELS AM-/AMC-182

CASCADABLE THIN FILM AMPLIFIER 5-1000 MHz GAIN: 28 dB

- High Gain — 28.5 dB Typical
- Low Noise — 2.7 dB Typical



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @300 MHz	28.2±1.0 dB
Frequency Response	±1.2 dB Max
Gain Variation with Temperature	±1.2 dB Max
Output Power (1 dB Compression)	+9 dBm Min
Noise Figure	4.5 dB Max
Reverse Transmission	−32 dB Max −36 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+28 dBm Min
Third Order	+18 dBm Min
Bias Power	+15 VDC @50 mA Max (44 mA, 660 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

Environmental

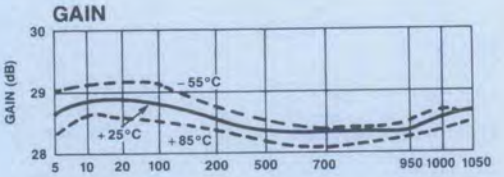
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

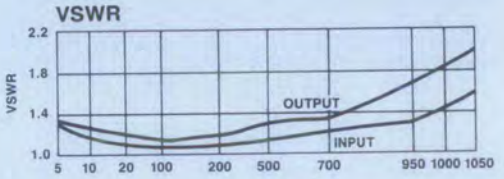
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

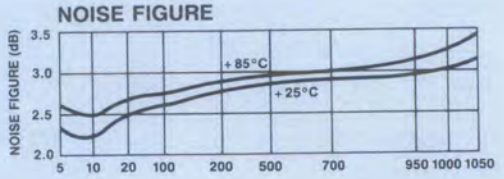
This product contains elements protected by U.S. Patent Number 3,891,934.

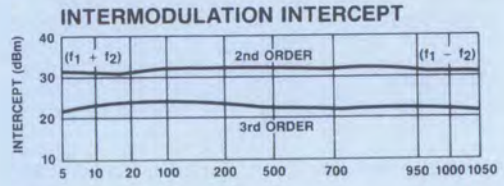
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.8 W. Must be provided in use.

Typical Performance









Ordering Information

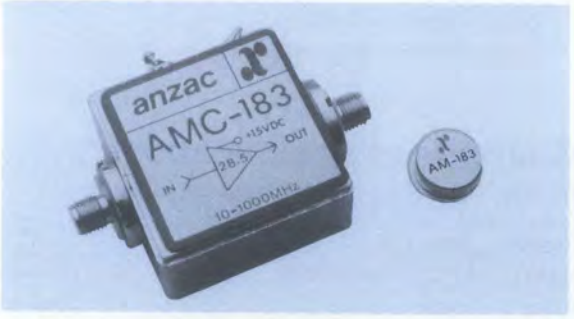
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-182	9389	Pin	$192
AMC-182	9384	SMA	289

Delivery is from stock.

MODELS AM-/AMC-183

CASCADABLE THIN FILM AMPLIFIER 10-1000 MHz GAIN: 28.5 dB

- High Gain — 28 dB Typical
- High Compression — +15 dBm Typical



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1000 MHz
Gain (+25°C) @700 MHz	28.5 ± 1.0 dB
Frequency Response	± 1.5 dB Max
Gain Variation with Temperature	± 1.2 dB Max
Output Power (1 dB Compression)	+13 dBm Min
Noise Figure	10-500 MHz 4.5 dB Max 10-1000 MHz 5.0 dB Max
Reverse Transmission	−32 dB Max −35 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+30 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @80 mA Max (72 mA, 1.1W Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

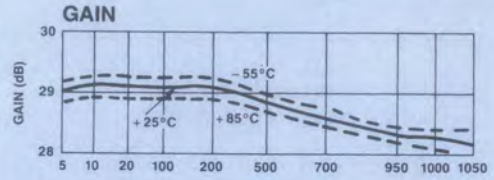
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

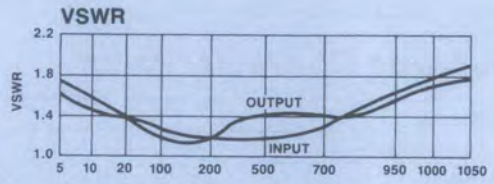
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by U.S. Patent Number 3,891,934.

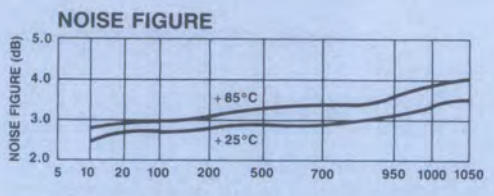
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.25 W. Must be provided in use.

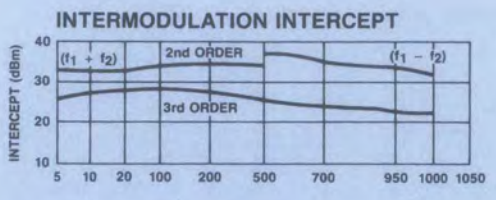
S-Parameters: For typical S-Parameter data, see page 99.

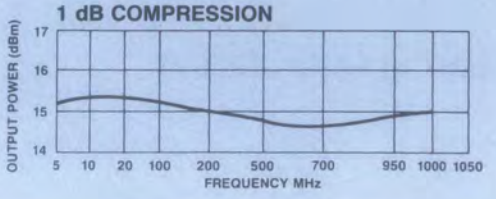
Typical Performance











Ordering Information

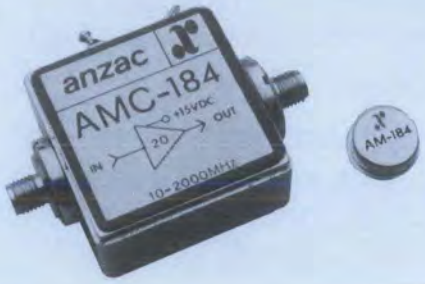
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-183	9269	Pin	$185
AMC-183	9264	SMA	282

Delivery is from stock.

MODELS AM-/AMC-184

CASCADABLE THIN FILM AMPLIFIER 10-2000 MHz GAIN: 20 dB

- High Gain, 20 dB
- Low Power, 60 mA Max



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @1000 MHz	20 ±1.0 dB Max
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±1.5 dB Max
Output Power (1 dB Compression)	+10 dBm Min
Noise Figure	6.0 dB Max
Reverse Transmission	−27 dB Max −30 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+30 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @ 60 mA Max (52 mA, 780 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

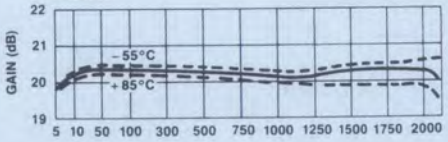
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1 W. Must be provided in use.

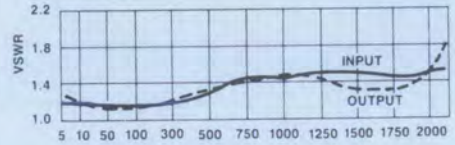
S-Parameters: For typical S-Parameter data, see page 99.

Typical Performance

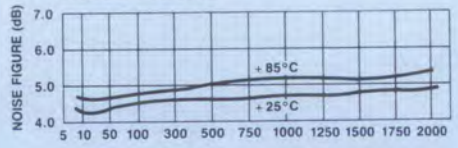
GAIN



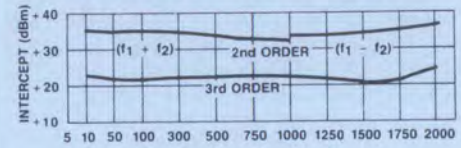
VSWR



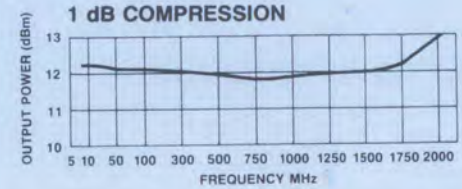
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-184	9079	Pin	$174
AMC-184	9074	SMA	271

Delivery is from stock.

MODEL AM-185 CASCADABLE THIN FILM AMPLIFIER 10-2000 MHz GAIN: 19 dB

- High Gain, 19 dB
- High Power, +15 dBm Typical
- High 3rd Order Intercept Point, +28 dBm Typical

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @1000 MHz	19 ±1.0 dB Max
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±2.0 dB Max
Output Power (1 dB Compression)	+13 dBm Min
Noise Figure	6.8 dB Max
Reverse Transmission	−26 dB Max −29 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+33 dBm Min
Third Order	+22 dBm Min
Bias Power	+15 VDC @ 90 mA Max (76 mA, 1.14 W Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Package Type	Pin (TO-8-1) (See page 472 for physical dimensions.)

Environmental

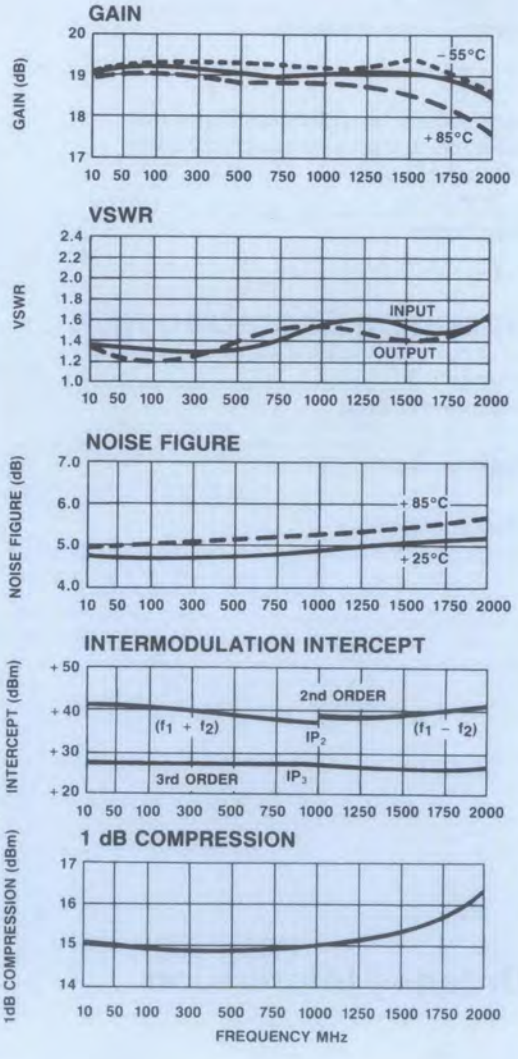
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.5 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see page 99.

Typical Performance



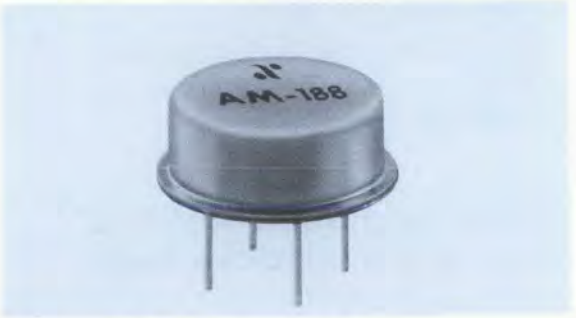
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-185	8919	Pin	$201

Delivery is from stock.

MODEL AM-188 HIGH REVERSE ISOLATION AMPLIFIER 10-1200 MHz GAIN: 13 dB

- 26 dB Typical Reverse Isolation
- +18 dBm Typical 1 dB Compression
- 1.2:1 Typical VSWR



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1200 MHz
Gain (+25°C) @500 MHz	12.8 ±0.5 dB
Frequency Response	±1.0 dB Max
Gain Variation with Temperature	+0.5, −1.0 dB Max
Output Power (1 dB Compression)	+16.0 dBm Min
Noise Figure	8.0 dB Max
Reverse Transmission	−24 dB Max −26 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+40 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @150 mA Max (130 mA, 1950 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Pin (TO-8-1) (See page 472 for physical dimensions.)

Environmental

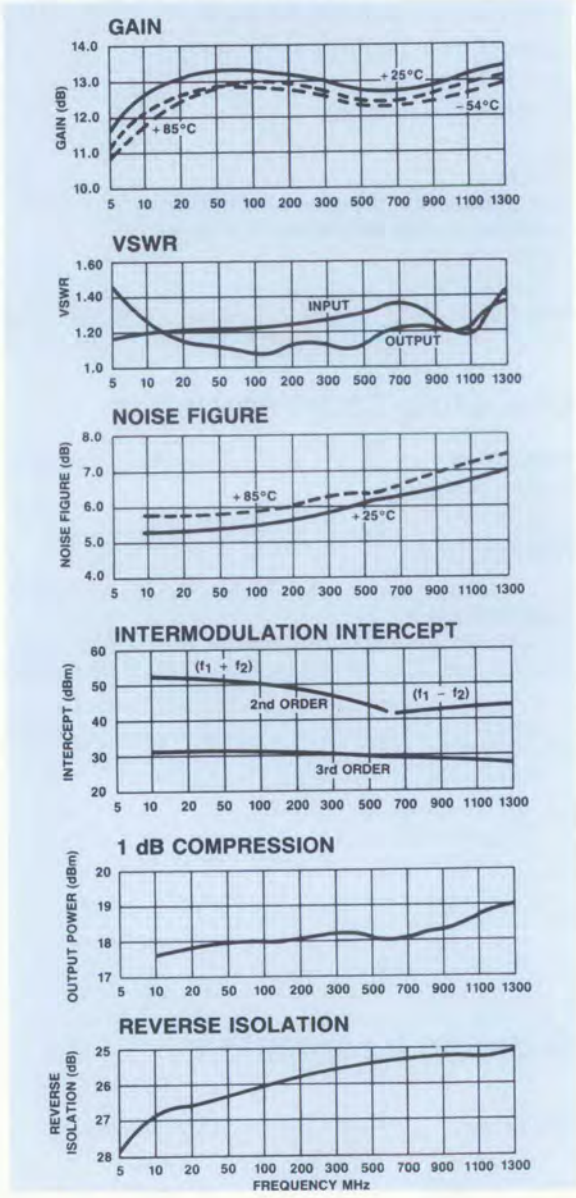
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by U.S. Patent Number 3,891,934.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2 W. Must be provided in use.

Typical Performance



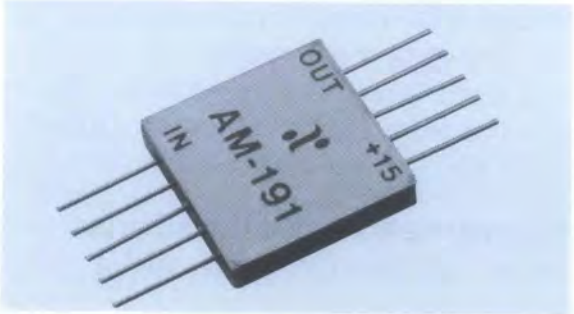
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-188	9039	Pin	$138

Delivery is from stock.

MODEL AM-191 — LOW NOISE AMPLIFIER
100-600 MHz GAIN: 23.5 dB

- 2.5 dB Typical Midband Noise Figure
- +23 dBm Typical 1 dB Compression Point
- +32 dBm Typical 3rd Order Intercept Point



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		100-600 MHz
Gain (+25°C) @ 250 MHz		23.5 ±0.5 dB
Frequency Response		±1.0 dB Max
Gain Variation with Temperature		±1.0 dB Max
Output Power (1 dB Compression)		+20 dBm Min
Noise Figure		4.5 dB Max
Reverse Transmission		−35 dB Max −38 dB Typ
VSWR	100-600 MHz 200-500 MHz	2.5:1 Max 2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)		
Second Order		+38 dBm Min
Third Order		+28 dBm Min
Bias Power		+15 VDC @90 mA Max (77 mA, 1155 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Flatpack (FP-3) (See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration (AM-191) IN, P6; OUT, P1; VDC, P5

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,891,934 and 3,624,536.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.25 W. Must be provided in use.

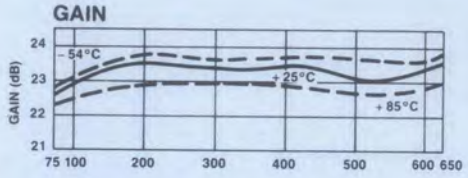
S-Parameters: For typical S-Parameter data, see page 99.

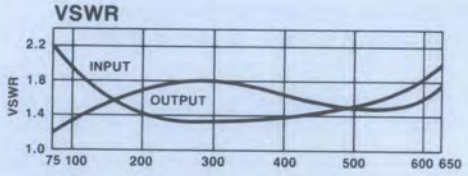
Ordering Information

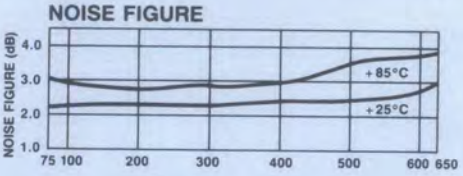
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-191	6499	Pin	$196

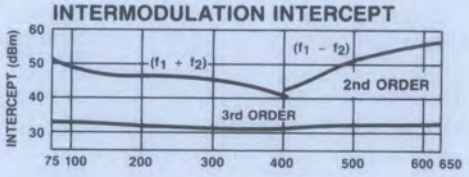
Delivery is from stock.

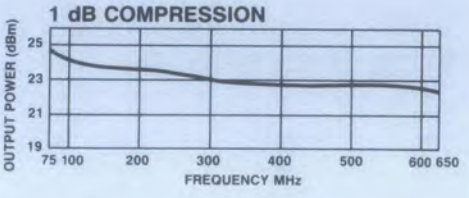
Typical Performance







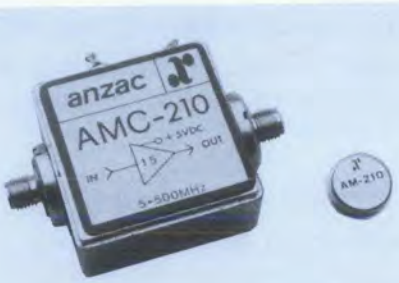




MODELS AM-/AMC-210

LOW NOISE 5V AMPLIFIER
5-500 MHz GAIN: 15 dB

- Low DC Power Requirements — +5V @12 mA Typical
- 1.8 dB Typical Midband Noise Figure
- +6.5 dBm Typical Midband Output Power



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		5-500 MHz
Gain (+25°C) @250 MHz		15.25 ±0.5 dB
Frequency Response		±1.0 dB Max
Gain Variation with Temperature		±1.0 dB Max
Output Power (1 dB Compression)	5-250 MHz 5-500 MHz	+3 dBm Min 0 dBm Min
Noise Figure	5-250 MHz 5-500 MHz	2.8 dB Max 3.5 dB Max
Reverse Transmission		−17 dB Max −19 dB Typ
VSWR		2.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)		
Second Order		+18 dBm Min
Third Order		+12 dBm Min
Bias Power		+5 VDC @15 mA Max (12 mA, 60 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Package Type	Pin (TO-8-1) Connectorized (C-6)

(See pages 472 and 481 for physical dimensions.)

Environmental

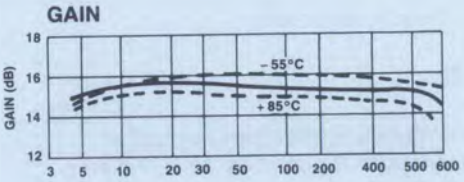
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

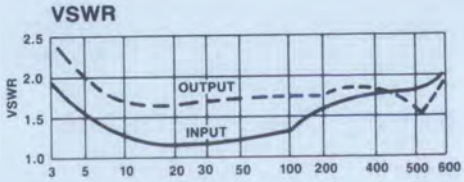
*All specifications apply when operated at +5 VDC, with 50 ohm source and load impedance.

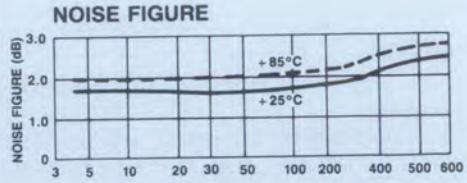
This product contains elements protected by United States Patent Number 3,624,536.

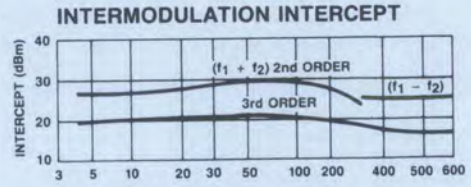
S-Parameters: For typical S-Parameter data, see page 99.

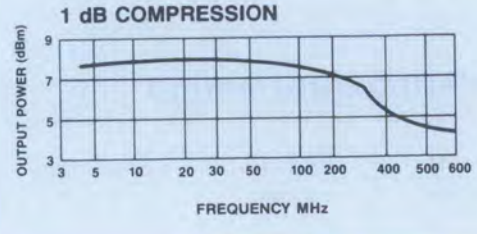
Typical Performance











Ordering Information

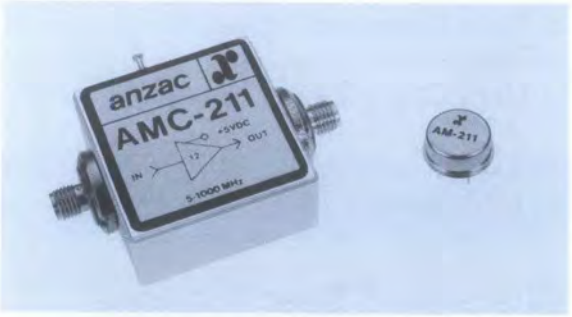
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-210	8999	Pin	$ 89
AMC-210	8994	SMA	186

Delivery is from stock.

MODELS AM-/AMC-211

CASCADABLE THIN FILM + 5 Vdc AMPLIFIER 5-1000 MHz GAIN: 12 dB

- Ultra Low DC Power Requirements, 55 mW Typical
- 3.2 dB Typical Midband Noise Figure
- 1.2:1 Typical Midband VSWR



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @500 MHz	12.0 ±0.7 dB Max
Frequency Response	±1 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	0 dBm Min
Noise Figure	4.5 dB Max
Reverse Transmission	−13 dB Max −15 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+15 dBm Min
Third Order	+7 dBm Min
Bias Power	+5 VDC @ 12 mA Max (11 mA, 55 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Package Type	Pin (TO-8-1) Connectorized (C-6) (See pages 472 and 481 for physical dimensions.)

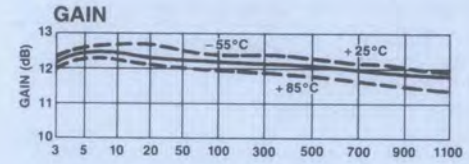
Environmental

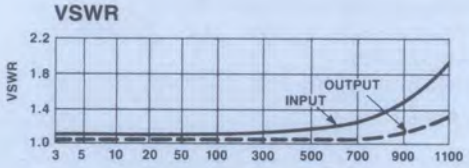
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

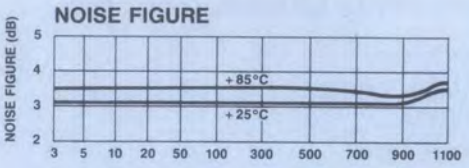
*All specifications apply when operated at +5 VDC, with 50 ohm source and load impedance.

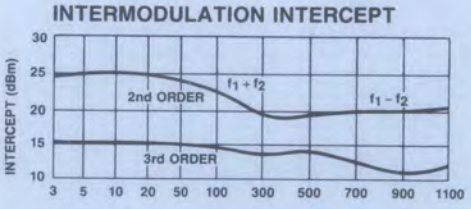
S-Parameters: For typical S-Parameter data, see page 99.

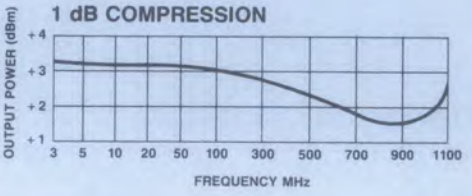
Typical Performance











Ordering Information

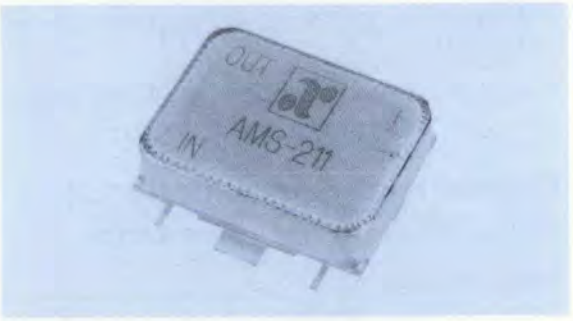
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-211	6509	Pin	$ 85
AMC-211	6504	SMA	182

Delivery is from stock.

NEW

MODEL AMS-211 CASCADABLE SURFACE MOUNT AMPLIFIER 5 - 1000 MHz GAIN: 12 dB

- Fully Hermetic Package
- Thin Film
- Ultra Low DC Power Requirements, +5 Vdc: 55 mW Typical
- 3.2 dB Typical Midband Noise Figure
- 1.2:1 Typical Midband VSWR



Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	5 - 1000 MHz
Gain (+25°C) @ 60 MHz	12.0 ±0.7 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	0 dBm Min
Noise Figure	4.5 dB Max
Reverse Transmission	–13 dB Max –15 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to –10 dBm) Second Order Third Order	 +15 dBm Min +7 dBm Min
Bias Power	+5 VDC @ 12 mA Max (11 mA, 55 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating RF Input	 +10 dBm Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

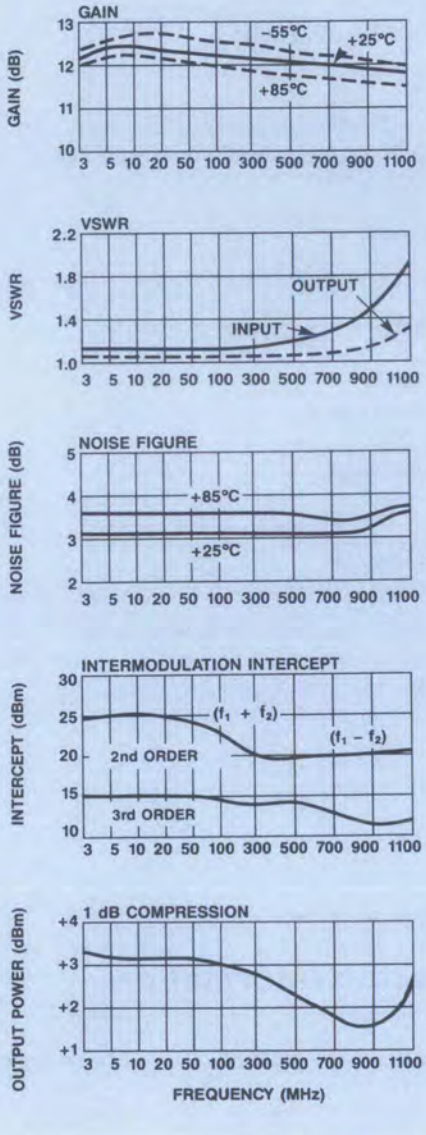
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

Pin Configuration	IN, P3; OUT, P1; VDC, P2

*All specifications apply when operated at +5 VDC, with 50 ohm source and load impedance.

S-Parameters: For typical S-Parameter data, see page 99.

Typical Performance



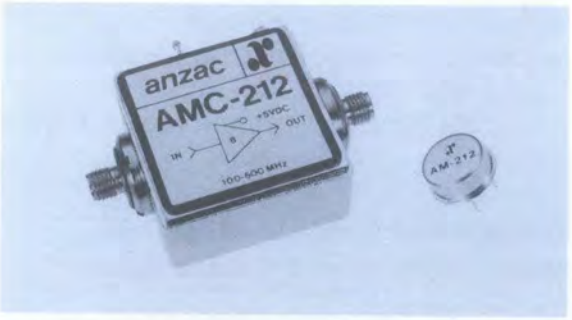
Ordering Information

Model No.	Connector	Unit Price (5-9 Units)
AMS-211	PIN	$95

MODELS AM-/AMC-212

LOW NOISE +5 Vdc AMPLIFIER
100-600 MHz GAIN: 8.0 dB

- Low DC Power Requirements — 35 mW Typical
- 1.5 dB Typical Midband Noise Figure



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		100-600 MHz
Gain (+25°C) @300 MHz		8.0 ±0.5 dB
Frequency Response		±0.7 dB Max
Gain Variation with Temperature		±1.0 dB Max
Output Power (1 dB Compression)	100-600 MHz	−2 dBm Min
	100-300 MHz	+2 dBm Min
Noise Figure		3.0 dB Max
Reverse Transmission		−9 dB Max
		−11.5 dB Typ
VSWR		2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)		
Second Order	100-600 MHz	+24 dBm Min
Second Order	100-300 MHz	+30 dBm Min
Third Order	100-600 MHz	+10 dBm Min
Third Order	100-300 MHz	+15 dBm Min
Bias Power		+5 VDC @8 mA Max (7 mA, 35 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Package Type	Pin (TO-8-1)
	Connectorized (C-6)
	(See pages 472 and 481 for physical dimensions.)

Environmental

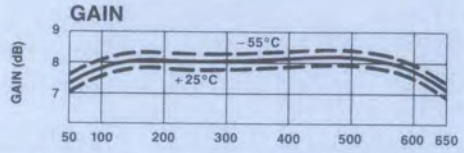
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

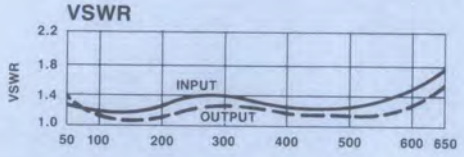
*All specifications apply when operated at +5 VDC, with 50 ohm source and load impedance.

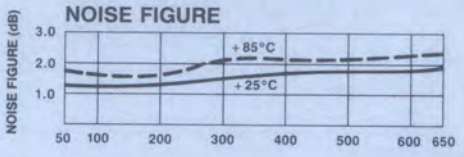
This product contains elements protected by United States Patent number 3,891,934.

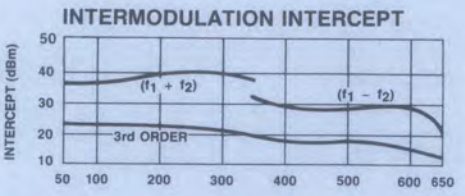
S-Parameters: For typical S-Parameter data, see page 99.

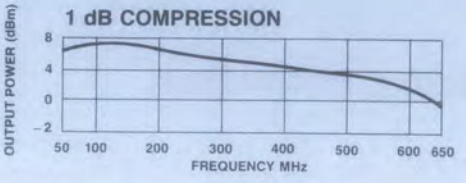
Typical Performance











Ordering Information

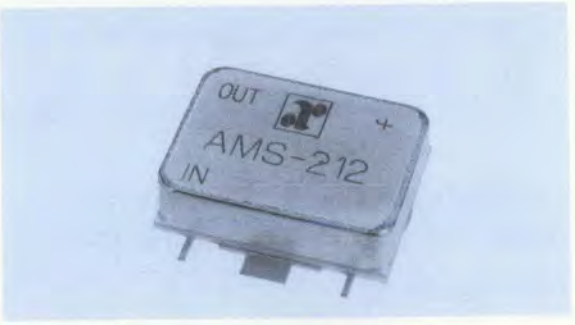
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-212	6519	Pin	$111
AMC-212	6514	SMA	208

Delivery is from stock.

NEW

MODEL AMS-212 SURFACE MOUNT AMPLIFIER
100 - 600 MHz GAIN: 8.0 dB

- Fully Hermetic Package
- Low DC Power Requirements, +5 Vdc: 35 mW Typical
- 1.7 dB Typical Midband Noise Figure



Guaranteed Specifications*
(From –55°C to +85°C Case Temp)

Frequency Range		100 - 600 MHz
Gain (+25°C) @ 60 MHz		8.0 ±0.5 dB
Frequency Response		±0.7 dB Max
Gain Variation with Temperature		±1.0 dB Max
Output Power (1 dB Compression)	100-600 MHz	–2 dBm Min
	100-300 MHz	+2 dBm Min
Noise Figure		3.0 dB Max
Reverse Transmission		–9 dB Max –11.5 dB Typ
VSWR		2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to –10 dBm)		
Second Order	100-600 MHz	+24 dBm Min
Second Order	100-300 MHz	+30 dBm Min
Third Order	100-600 MHz	+10 dBm Min
Third Order	100-300 MHz	+15 dBm Min
Bias Power		+5 VDC @ 8 mA Max (7 mA, 35 mW Typ)

Operating Characteristics

IF Impedance	50 Ohms Nominal
Maximum Rating RF Input	+10 dBm Max
Package Type	Pin (SF-1) (See page 490 for physical dimensions.)

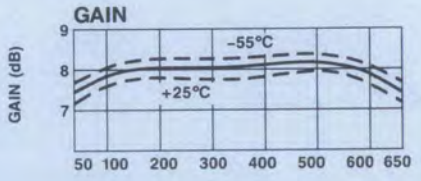
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

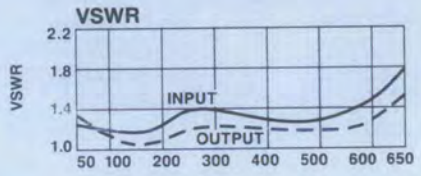
Pin Configuration IN, P3; OUT, P1; VDC, P2

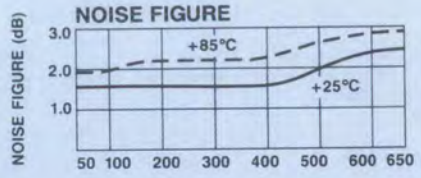
*All specifications apply when operated at +5 VDC, with 50 ohm source and load impedance.

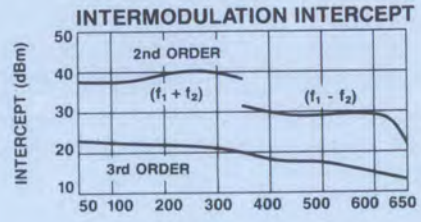
S-Parameters: For typical S-Parameter data, see page 99.

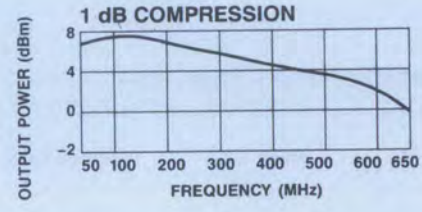
Typical Performance











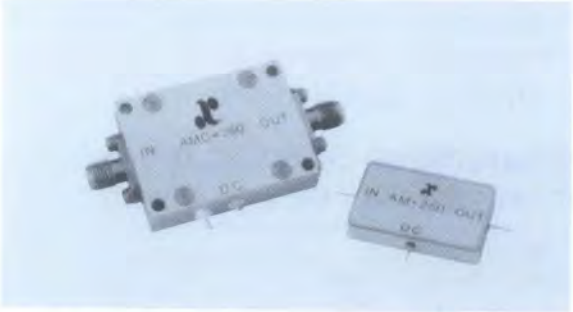
Ordering Information

Model No.	Connector	Unit Price (5-9 Units)
AMS-212	PIN	$122

MODELS AM-/AMC-250

BROADBAND GaAs FET AMPLIFIER
150 MHz-5.2 GHz GAIN:11 dB

- >2 Decade Bandwidth
- +19 dBm Compression Point
- +30 dBm Typical Intercept
- Internal Voltage Regulator



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		150 MHz-5.2 GHz
Gain	150 MHz - 5.2 GHz	11 dB Min
	300 MHz - 4.8 GHz	12 dB Min
Frequency Response	150 MHz - 5.2 GHz	±1.75 dB Max
	300 MHz - 4.8 GHz	±1.5 dB Max
Gain Variation with Temperature		±2.0 dB Max
Output Power (1 dB Compression)		+15 dBm Min
Noise Figure		7.5 dB Max
Reverse Transmission		−25 dB Max
VSWR		2.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)		
Second Order		+30 dBm Min
Third Order		+25 dBm Min
Bias Voltage		+7 to +20 VDC
Bias Current		160 mA Typ 250 mA Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Package Type	Flatpack (FP-18) Connectorized (C-4) (See pages 477 and 481 for physical dimensions.)

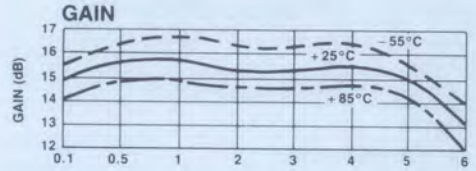
Environmental

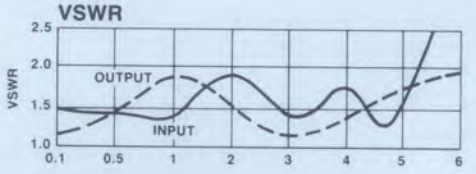
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

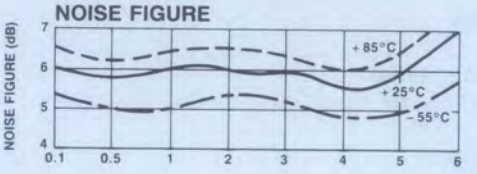
Pin Configuration	IN; P1, Out; P3, DC IN; P2, Case Ground.

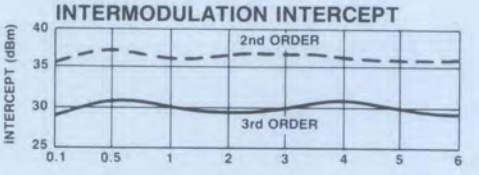
*All specifications apply when operated at +7 to +20 VDC, with 50 ohm source and load impedance.

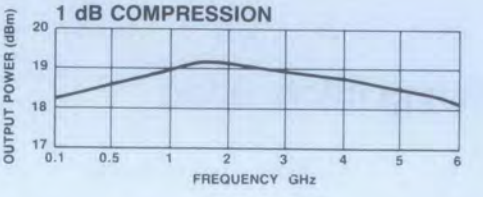
Typical Performance











Ordering Information

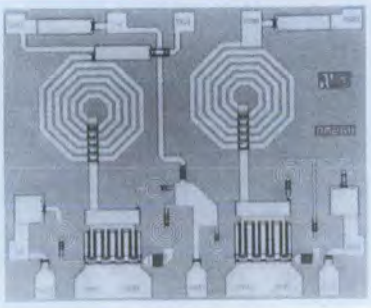
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-250	9399	Pin	$ 933
AMC-250	9394	SMA	1030

Delivery is from stock.

MODEL AM-260

GaAs MMIC AMPLIFIER CHIP
2-8 GHz GAIN: 8 dB

- Monolithic Amplifier Chip
- 10 dB Gain Block
- On Chip Bias Network



Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	2-8 GHz
Gain (+25°C) @4 GHz	8.0 dB Min
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±2.0 dB Max
VSWR	2.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Output Power (1 dB Compression)	+12 dBm Typ
Noise Figure	6.5 dB Typ
Reverse Transmission	−35 dB Typ
Maximum Rating	
RF Input	+10 dBm Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+30 dBm Typ
Third Order	+25 dBm Typ
Bias Power	
V_{D1}	+3 to +5 VDC @ 35 mA Typ, 70 mA Max
V_{D2}	+3 to +5 VDC @ 45 mA Typ, 80 mA Max
V_G	−1 to −2 VDC @ 10 μA Typ, 200 μA Max
Die Size	0.058 x 0.048 x 0.010 inch (1.45 x 1.20 x 0.25 mm)

Environmental

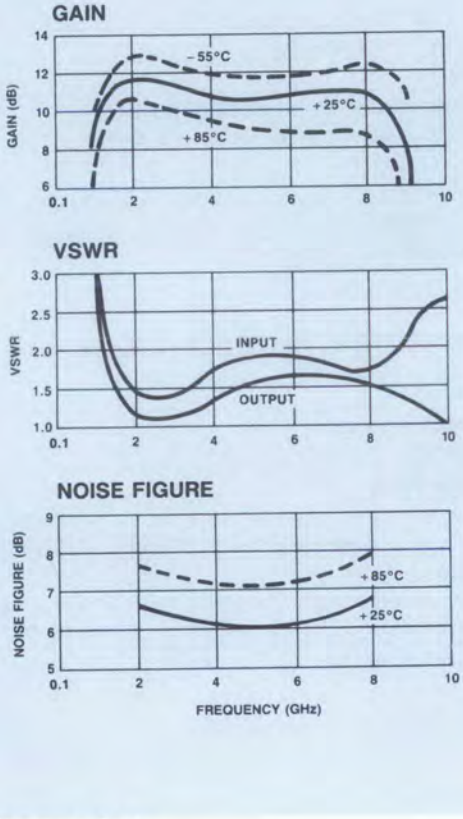
These units are designed to meet or exceed the following:

Test	Notes
Electrical	100% probing @25°C for selected parameters
Visual Inspection	100% with reference to MIL-STD-883 Method 2010, Condition B.
Lot Traceability	Supplied on request.

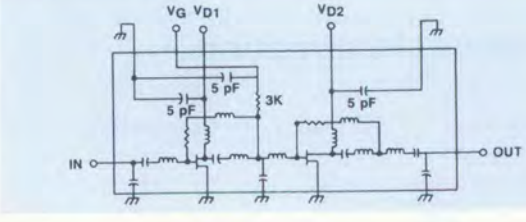
*All specifications apply when operated at $V_{D1} = V_{D2} = 4$ VDC, $V_G = -1.5$ VDC, with 50 ohm source and load impedance connected to IC with 0.0007 inch Au wire bonds.

For mounting and bonding instructions, see page 85.

Typical Performance



Schematic



Ordering Information

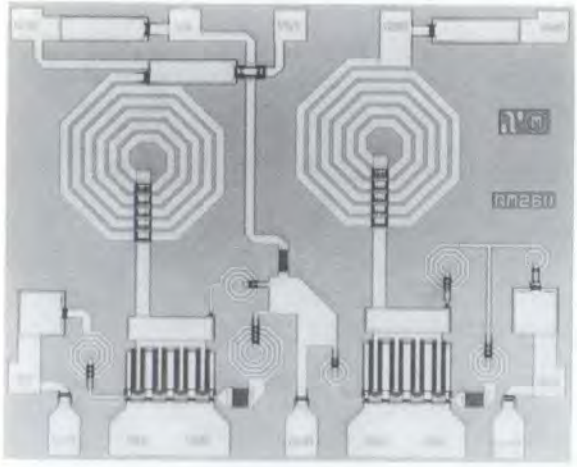
Model No.	Part No.	Connector	Unit Price (1-24 Units)
AM-260	8950	Chip	$75

Delivery is from stock.

AM-260 Handling, Mounting, Bonding Procedure

Maximum Ratings

A. Drain Voltages: +5 Vdc
B. Drain Currents: +80 mA
C. RF Input Power: +13dBm
D. Operating Temperature: +125 °C
E. Storage Temperature: -65 °C to +175 °C



BondPad Dimensions Inches (mm)

0.003 x 0.003
(0.080 x 0.080)

0.003 x 0.012
(0.080 x 0.294)

Die Size Inches (mm)

0.058 x 0.048 x 0.010
(1.47 x 1.22 x 0.25)

Handling Precautions

Permanent damage to the AM-260 may occur if the following precautions are not adhered to:

A. Cleanliness — The AM-260 should be handled in a clean environment. DO NOT attempt to clean unit after the AM-260 is installed.
B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.
C. Transients — Avoid instrument and power supply transients while bias is applied to the AM-260. Use shielded signal and bias cables to minimize inductive pick-up.

Mounting

The AM-260 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290 °C.
B. DO NOT expose the AM-260 to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Preheat assembly to 125-150 °C. Apply a minimum amount of epoxy and place the AM-260 into position. A thin epoxy fillet should be visible around the perimeter of the chip.
B. Cure epoxy per manufacturer's recommended schedule.
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

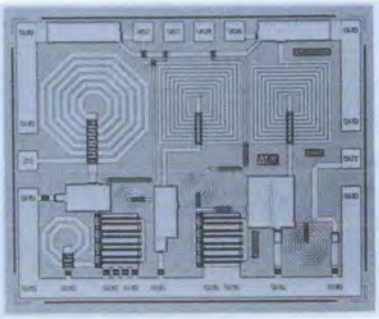
A. Thermosonic wedge wire bonding of 0.001 diameter pure gold wire is recommended with a nominal stage temperature of 150 °C and a bonding force of 18 to 22 grams. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.
B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; every ground pad should be bonded to the package.

NEW

MODEL AM-280

GaAs L-BAND LOW NOISE AMPLIFIER 1.1-1.7 GHz

- Low Noise Amplifier, 1.4 dB Typical
- Monolithic Amplifier Chip
- On Chip Bias Network



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				1.1-1.7 GHz
Minimum Gain (@25°C)	1.1-1.3 GHz			20 dB
	1.3-1.5 GHz			18 dB
	1.5-1.7 GHz			16 dB
Gain Variation with Temp.				±3 db Max
VSWR				
INPUT	1.1-1.5 GHz			2.0:1
	1.5-1.7 GHz			2.3:1
OUTPUT	1.1-1.7 GHz			2.0:1
Noise Figure	**@25°C**	**@85°C**	**@ −54°C**	
1.1-1.5 GHz	1.7	2.1	1.5	dB Max
1.5-1.7 GHz	2.0	2.5	1.8	dB Max
Output Power for 1 dB Compression				
1.1-1.7 GHz				10.0 dBm Min

Operating Characteristics

Impedance	50 Ohms Nominal
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+35 dBm Typ
Third Order	+22 dBm Typ
Bias Power	VD1 = 2.0-5.0 Vdc @ ID1 = 20-50 mA VD2 = 2.0-5.0 Vdc @ ID2 = 20-50 mA
(Set VG1 and VG2 in the range of 0Vdc to −3Vdc to achieve desired ID1 and ID2 bias setting).	
Die Size	0.058 x 0.048 x 0.010" (1.47 x 1.22 x 0.25mm)

Environmental

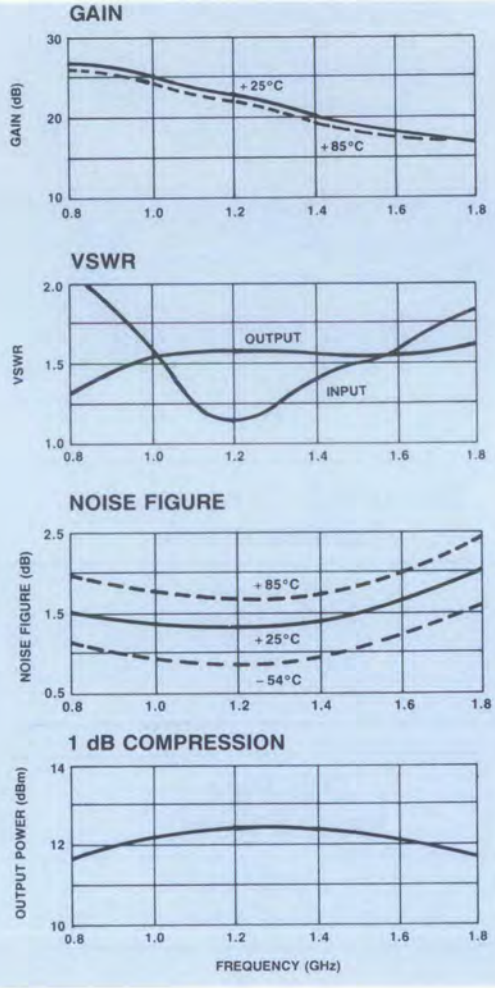
These units are designed to meet or exceed the following:

Test	Notes
Electrical	100% probing @ 25°C for selected parameters.
Visual Inspection	100% with reference to MIL-STD-883 Method 2010, Condition B.
Lot Traceability	Supplied on request.

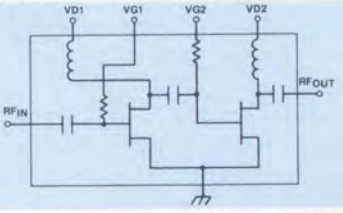
*All specifications apply when operated at VD1 = VD2 = 3 Vdc and VG1, VG2 set so ID1 = ID2 = 30 mA.

For mounting and bonding instructions, see page 87.

Typical Performance



Schematic



Ordering Information

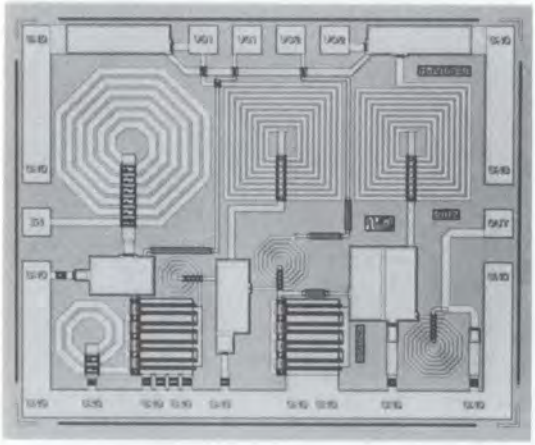
Model No.	Part No.	Connector	Unit Price (1-24 Units)
AM-280	6876	Chip	$75

Delivery is from stock.

AM-280 Handling, Mounting, Bonding Procedure

Maximum Ratings

A. Drain Voltages : +5Vdc
B. Drain Currents: +50mA
C. RF Input Power: +13dBm
D. Operating Temperature: +125°C
E. Storage Temperature: −65°C to +175°C



BondPad Dimensions Inches (mm)

0.003 x 0.003
(0.080 x 0.080)

Die Size Inches (mm)

0.058 x 0.048 x 0.010
(1.47 x 1.22 x 0.25)

Handling Precautions

Permanent damage to the AM-280 may occur if the following precautions are not adhered to:

A. Cleanliness – The AM-280 should be handled in a clean environment. DO NOT attempt to clean unit after the AM-280 is installed.
B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.
C. Transients – Avoid instrument and power supply transients while bias is applied to the AM-280. Use shielded signal and bias cables to minimize inductive pick-up.

Mounting

The AM-280 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.
B. DO NOT expose the AM-280 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Preheat assembly to 125-150°C. Apply a minimum amount of epoxy and place the AM-280 into position. A thin epoxy fillet should be visible around the perimeter of the chip.
B. Cure epoxy per manufacturer's recommended schedule.
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

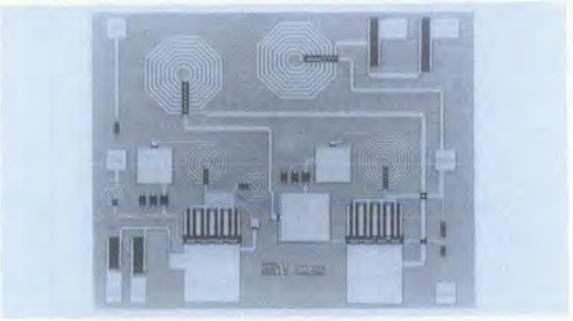
A. Thermosonic wedge wire bonding of 0.001 diameter pure gold wire is recommended with a nominal stage temperature of 150°C and a bonding force of 18 to 22 grams. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.
B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; every ground pad should be bonded to the package.

NEW

MODEL AM-290

GaAs WIDEBAND MMIC AMPLIFIER
0.7 - 5.25 GHz GAIN: 10.0 dB

- Monolithic Amplifier Chip
- 10 dB Minimum Gain
- On Chip Bias Network



Guaranteed Specifications*
(From –55°C to +85°C Case Temp)

Frequency Range	0.7 - 5.25 GHz
Gain	10 dB Min
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±1.5 dB Max
VSWR	2.0:1 Max
Output Power (1 dB Compression)	+10 dBm Min
Noise Figure	6 dB Max
Reverse Transmission	30 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Intermodulation Intercept Point	
(for two-tone output power up to 0 dBm)	
Second Order	+35 dBm Typ
Third Order	+25 dBm Typ
Bias Power*	VD = 12 to 15 Volts @ 65 mA Max, 40 mA Typ, using on-chip bias circuitry VD = 8 to 15 Volts @ 65 mA Max, 40 mA Typ via output pad using off-chip bias circuitry Bias current adjustable via on-chip resistor network.
Die Size	0.058 x 0.048 x 0.010 inch (1.45 x 1.20 x 0.25 mm)

Environmental

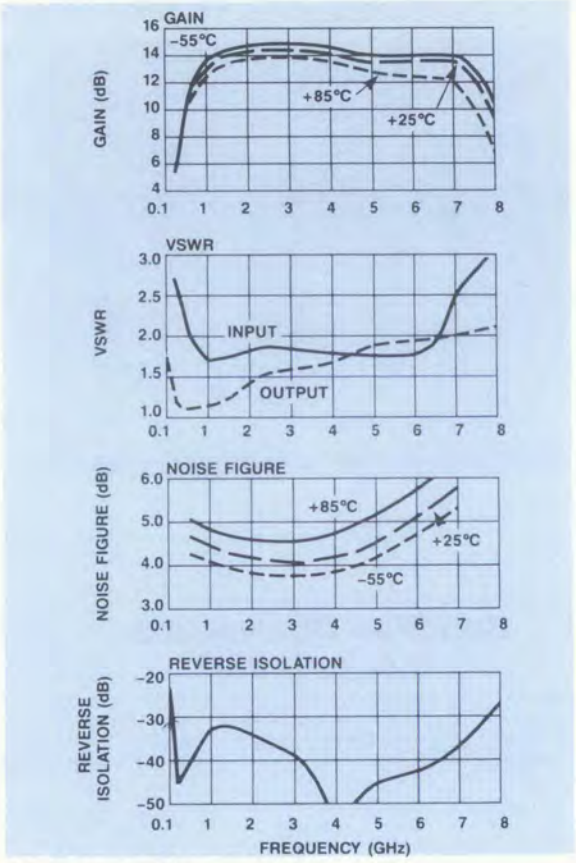
These units are designed to meet or exceed the following:

Test	Notes
Electrical	100% probing @ 25°C for selected parameters
Visual Inspection	100% with reference to MIL-STD-883 Method 2010, Condition B.
Lot Traceability	Supplied on request.

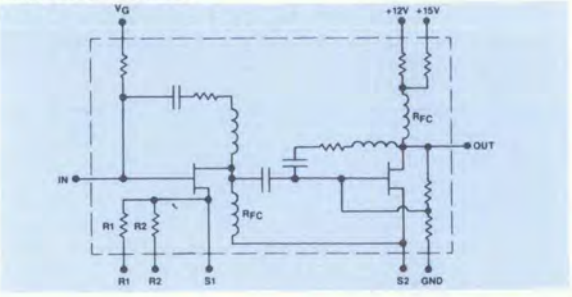
*All specifications apply when operated at recommended bias, see Application Note on page 94 for details.

For bonding and mounting instructions, see page 89.

Typical Performance



Schematic



Ordering Information

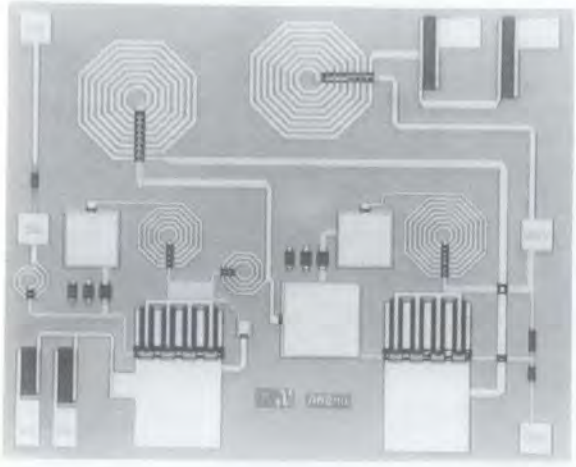
Model No.	Connector	Unit Price (1-24 Units)
AM-290	Chip	$75

Delivery is from stock.

AM-290 Handling, Mounting, Bonding Procedure

Maximum Ratings

A. Bias Voltage: +20 V
B. Bias Current: +100 mA
C. RF Input Power: +13dBm
D. Operating Temperature: +125 °C
E. Storage Temperature: -65 °C to +175 °C



BondPad Dimensions Inches (mm)

0.003 x 0.003
(0.080 x 0.080)

0.010 x 0.010
(0.250 x 0.250)

Die Size Inches (mm)

0.058 x 0.048 x 0.010
(1.47 x 1.22 x 0.25)

Handling Precautions

Permanent damage to the AM-290 may occur if the following precautions are not adhered to:

A. Cleanliness — The AM-290 should be handled in a clean environment. DO NOT attempt to clean unit after the AM-290 is installed.
B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.
C. Transients — Avoid instrument and power supply transients while bias is applied to the AM-290. Use shielded signal and bias cables to minimize inductive pick-up.

Mounting

The AM-290 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290 °C.
B. DO NOT expose the AM-290 to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Preheat assembly to 125-150 °C. Apply a minimum amount of epoxy and place the AM-290 into position. A thin epoxy fillet should be visible around the perimeter of the chip.
B. Cure epoxy per manufacturer's recommended schedule.
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Thermosonic wedge wire bonding of 0.001 diameter pure gold wire is recommended with a nominal stage temperature of 150 °C and a bonding force of 18 to 22 grams. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.
B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; every ground pad should be bonded to the package.

MODEL AM-261

GaAs MMIC AMPLIFIER
2-6 GHz GAIN: 8 dB

- +5 Vdc Operation
- General Purpose 10 dB Gain Block
- Ceramic Package

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	2-6 GHz
Gain (+25°C) @4 GHz	8.0 dB Min
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±2.0 dB Max
VSWR	2.5:1 Max

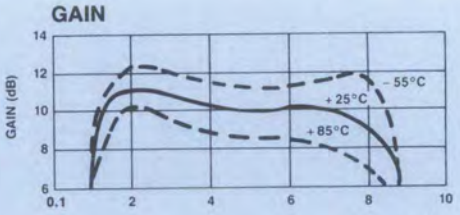
Operating Characteristics

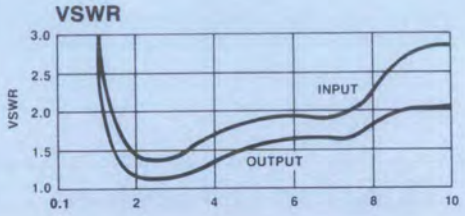
Impedance	50 Ohms Nominal
Output Power (1 dB Compression)	+12 dBm Typ
Noise Figure	6.5 dB Typ
Reverse Transmission	−35 dB Typ
Maximum Rating	
RF Input	+10 dBm Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+30 dBm Typ
Third Order	+25 dBm Typ
Bias Power	+5 VDC @ 125 mA Max (80 mA Typ, 400 mW Typ)
Package Type	Ceramic (CR-1) (See page 489 for physical dimensions.)

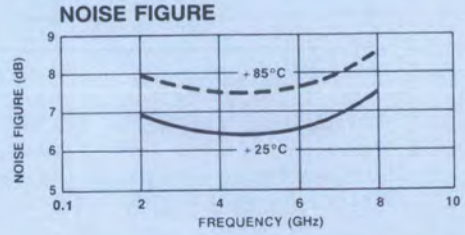
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +5 VDC, with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AM-261	8939	Pin	$225

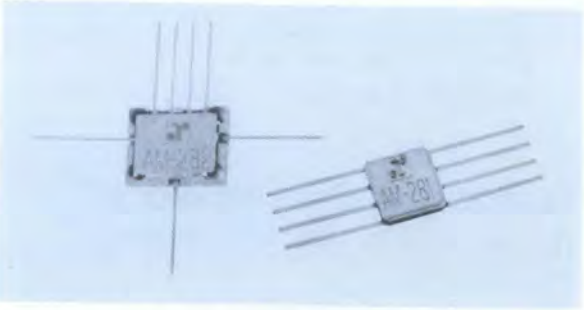
Delivery is from stock.

NEW

MODELS AM-281/282

GaAs LOW NOISE AMPLIFIER
1.1-1.7 GHz GAIN: 16 dB

- Low Noise Amplifier, 1.5 dB Typical
- Monolithic Amplifier Chip In Miniature Ceramic Package



Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range				1.1-1.7 GHz
Minimum Gain (@25°C)	1.1-1.3 GHz			18 dB
	1.3-1.5 GHz			16 dB
	1.5-1.7 GHz			14 dB
Gain Variation with Temp.				±3 db Max
VSWR				
INPUT	1.1-1.5 GHz			2.0:1
	1.5-1.7 GHz			2.3:1
OUTPUT	1.1-1.7 GHz			2.0:1
Noise Figure	**@25°C**	**@85°C**	**@ −54°C**	
1.1-1.5 GHz	1.9	2.3	1.7	dB Max
1.5-1.7 GHz	2.2	2.7	2.0	dB Max
Output Power for 1 dB Compression				
1.1-1.7 GHz				10.0 dBm Min

Operating Characteristics

Impedance	50 Ohms Nominal
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+35 dBm Typ
Third Order	+22 dBm Typ
Bias Power	VD1 = 2.0-5.0 Vdc @ ID1 = 20-50 mA VD2 = 2.0-5.0 Vdc @ ID2 = 20-50 mA

(Set VG1 and VG2 in the range of 0Vdc to −3Vdc to achieve desired ID1 and ID2 bias setting).

Package Type	AM-281: Ceramic (CR-3); AM-282: Ceramic (CR-2)

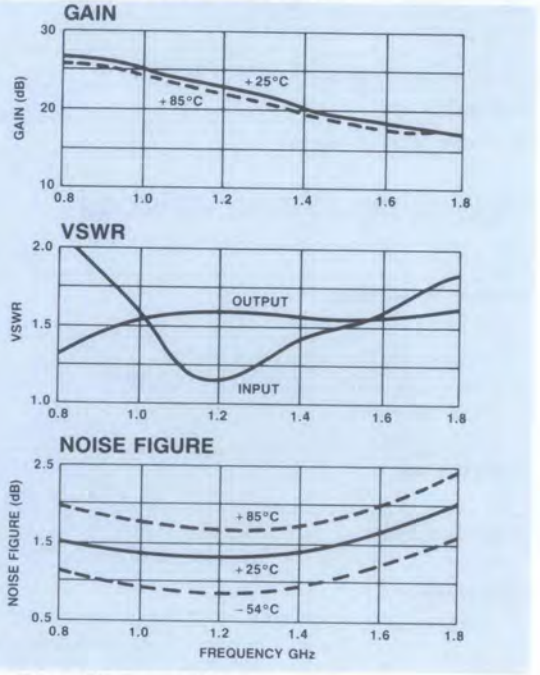
(See pages 490 and 489 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

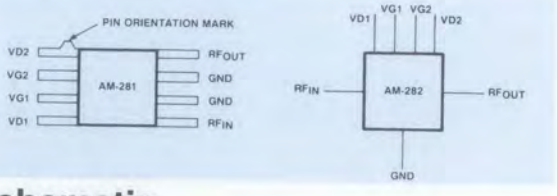
*All specifications apply when operated at VD1 = VD2 = 3 Vdc and VG1, VG2 set so ID1 = ID2 = 30 mA.

S-Parameters: For typical S-Parameter data, see page 99.

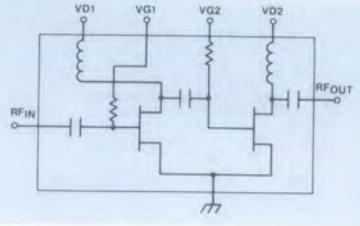
Typical Performance



Pin Configuration



Schematic



Ordering Information

Model No.	Part No.	Connector	Unit Price (5-9 Units)
AM-281	6877	Pin	$113
AM-282	9063	Pin	$ 95

Delivery is from stock.

NEW

MODEL AM-291

GaAs BROADBAND AMPLIFIER
0.7 - 5.25 GHz GAIN: 10 dB

- +15 Vdc Operation
- 10 dB Minimum Gain
- Monolithic Amplifier Chip in TO-8

Guaranteed Specifications*
(From –55°C to +85°C Case Temp)

Frequency Range	0.7 - 5.25 GHz
Gain	10 dB Min
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±1.5 dB Max
VSWR	2.3:1 Max
Output Power (1 dB Compression)	+10 dBm Min
Noise Figure	6 dB Max
Reverse Transmission	30 dB Min

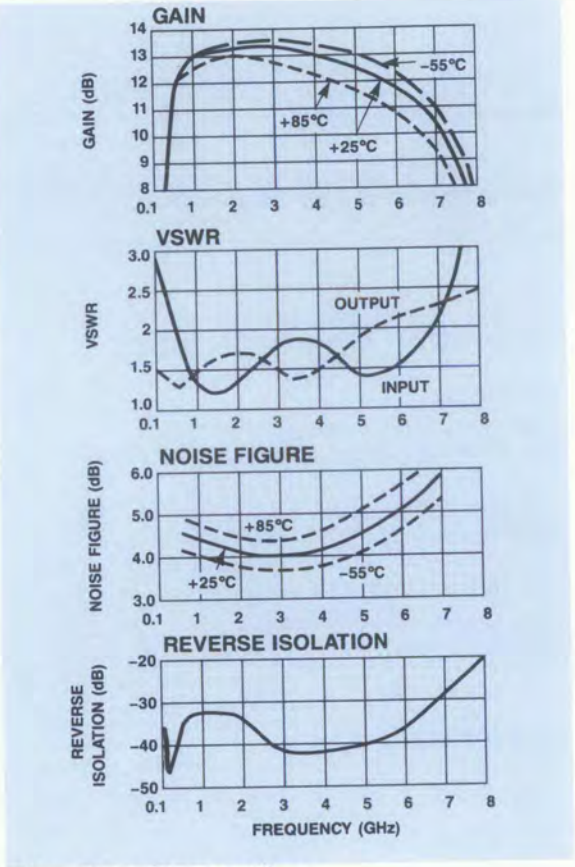
Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating RF Input	+13 dBm Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+35 dBm Typ
Third Order	+25 dBm Typ
Bias Power	+15 VDC @ 65 mA Max (30 mA Typ, 600 mW Typ)
Package Type	TO-8-1 (See pages 472 for physical dimensions.)

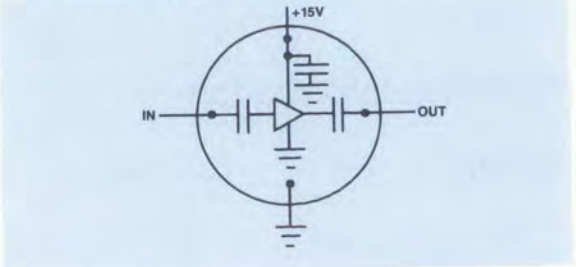
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

Typical Performance



Pin Configuration



Ordering Information

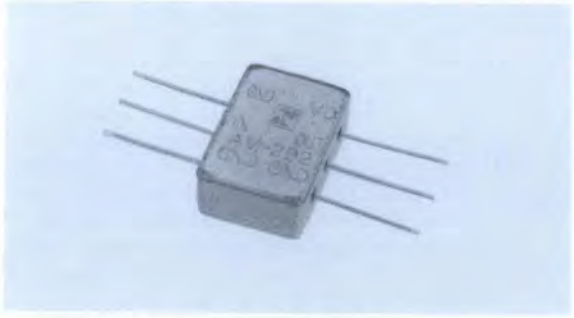
Model No.	Connector	Unit Price (5-9 Units)
AM-291	PIN	$180

NEW

MODEL AM-292

GaAs BROADBAND AMPLIFIER
0.7 - 5.25 GHz GAIN: 10 dB

- +15 Vdc Operation
- 10 dB Minimum Gain
- Monolithic Amplifier Chip in Flatpack



Guaranteed Specifications*
(From –55°C to +85°C Case Temp)

Frequency Range	0.7 - 5.25 GHz
Gain	10 dB Min
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±1.5 dB Max
VSWR	2.3:1 Max
Output Power (1 dB Compression)	+10 dBm Min
Noise Figure	6 dB Max
Reverse Transmission	30 dB Min

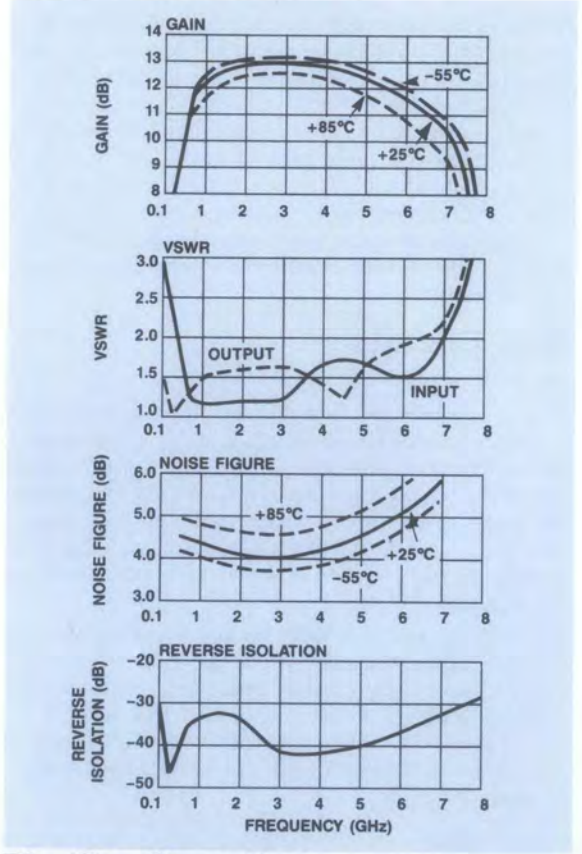
Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Intermodulation Intercept Point	
(for two-tone output power up to 0 dBm)	
Second Order	+35 dBm Typ
Third Order	+25 dBm Typ
Bias Power	+15 VDC @ 65 mA Max (40 mA Typ, 600 mW Typ)
Package Type	Flatpack (FP-20) (See page 477 for physical dimensions.)

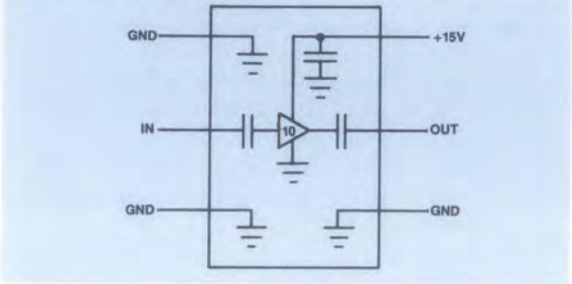
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 0.6 W must be provided in use.

Typical Performance



Pin Configuration



Ordering Information

Model No.	Connector	Unit Price (5-9 Units)
AM-292	PIN	$194

AM-290 Application, Features, DC Biasing

Application and Features

The AM-290 is a two stage, unconditionally stable broadband GaAs MMIC amplifier ideal for use as a cascadable gain block from 0.7 to 5.25 GHz. The schematic is shown on page 88. Although the stages are configured in an RF cascade, the first stage acts as a DC current source for the second stage. This feature allows both stages to share the same bias current. In normal operation, the chip is biased from a single positive power supply of either +12 or 15V volts with total bias current adjustable between 30 and 65 mA.

DC blocking and source bypass capacitors are not incorporated on-chip which allows the chip to be employed in a variety of circuit configurations. Requirements for external capacitors will vary with application. External capacitors should be single layer microwave chip capacitors with a minimum value of 100 pF (Dielectric Laboratories P/N D30BH101K5PX, for example). Source bypass and bias line decoupling capacitors should be mounted on the same ground plane as the AM-290 chip. To insure good high frequency performance it is essential that these capacitors be placed as close as possible to the chip to minimize bond wire length and inductance. A minimum of four wire bonds per source connection is recommended.

Bias Circuits

SELF BIAS

Figure 1 shows the AM-290 in the self-bias configuration. Source bypass capacitors C1 and C2 are required at the source connections of the chip (S1 and S2). Also shown are DC blocking capacitors C3 and C4 at the input and the output. The bias voltage can either be from a +12V or +15V supply, the proper bonding pad for either supply should be used. C5 provides additional bias line decoupling.

The bias current for both stages is set by altering the gate to source voltage Vgs of the first stage. Since the Vg connection of the chip is grounded, Vgs is set by selecting and bonding to ground one of the on-chip source resistances; R1 or R2. Alternatively, off-chip source resistors can be employed to realize any desired bias setting.

DUAL BIAS

Figure 2 shows the AM-290 in the dual bias configuration. In this mode, S1 is directly grounded, eliminating the need for the source bypass capacitor C1. The source resistances have no connection as the bias current is set directly by adjusting the voltage at Vg in the range of -0.5V to -2.5V until the desired bias current is achieved.

Like the self bias configuration, a supply voltage of +12V or +15V is required and must be connected to the proper bonding pad.

EXTERNAL BIAS

Figure 3 shows the AM-290 employed in the external bias configuration. This mode can be used in applications where the available bias voltage is less than +12V and as low as +7V. The positive voltage bias is brought onto the chip via the output bonding pad. Supply line decoupling must be done off-chip and C5 is required to eliminate any passband resonance caused by the unused drain coil.

Figure 1 shows the bias current being set by the self bias method, however, the dual bias method may be used as well.

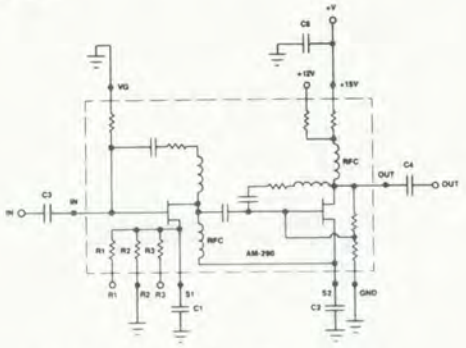


Figure 1. Self Bias Configuration

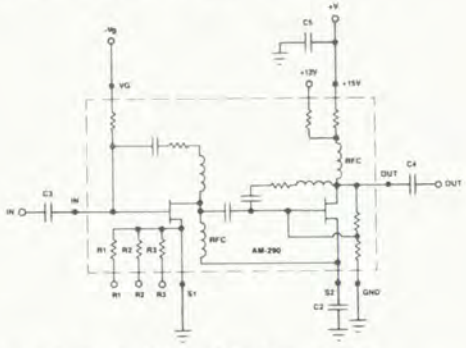


Figure 2. Dual Bias Configuration

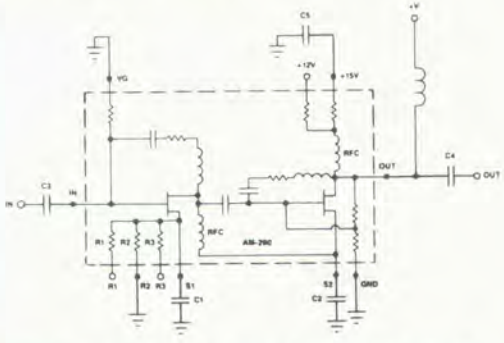


Figure 3. External Bias Configuration

Amplifier Selected S-Parameter Data

SELECTED S-PARAMETER DATA

AM-101

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.10	-77.9	3.22	-159.5	0.12	176.3	0.19	90.2
10.0	0.08	-73.1	3.22	-172.6	0.13	177.0	0.05	128.5
20.0	0.06	-64.9	3.21	178.1	0.13	172.9	0.04	151.6
50.0	0.04	-70.5	3.19	162.6	0.13	161.4	0.04	166.4
100.0	0.03	-79.2	3.14	143.4	0.13	144.6	0.03	164.3
200.0	0.02	-74.3	3.07	106.3	0.14	109.1	0.03	-42.7
300.0	0.05	-42.3	3.05	69.5	0.14	76.8	0.10	-71.9
400.0	0.08	-59.6	3.09	31.2	0.14	44.2	0.12	-105.3
500.0	0.10	-70.7	3.11	-13.9	0.14	8.6	0.17	-167.6

AM-102

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.05	-153.9	3.05	5.1	0.18	-179.1	0.11	148.9
10.0	0.04	176.5	3.05	-2.0	0.18	-178.4	0.07	149.3
20.0	0.04	144.0	3.02	-9.9	0.18	176.6	0.05	142.7
50.0	0.04	69.7	2.97	-28.5	0.18	167.4	0.05	106.1
100.0	0.08	-4.8	2.94	-57.7	0.18	153.8	0.06	58.1
150.0	0.12	-53.7	2.91	-85.3	0.18	138.8	0.10	19.5
200.0	0.13	-91.0	2.90	-113.6	0.18	123.0	0.15	-10.8
250.0	0.15	-126.7	2.91	-143.6	0.18	108.7	0.18	-41.3
300.0	0.20	-47.1	2.99	-176.6	0.18	93.8	0.21	-68.8

AM-103

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.13	-73.9	3.24	-164.5	0.12	-172.7	0.03	148.3
10.0	0.07	-64.3	3.25	-174.4	0.13	-178.4	0.04	162.1
20.0	0.04	-46.1	3.26	177.7	0.13	175.7	0.04	156.7
50.0	0.02	-9.1	3.26	164.2	0.13	164.3	0.05	133.9
100.0	0.04	36.4	3.18	147.0	0.13	148.9	0.06	92.7
200.0	0.09	34.5	3.15	114.2	0.13	117.1	0.11	25.1
300.0	0.14	12.0	3.09	82.2	0.14	89.8	0.13	-22.5
400.0	0.17	-7.8	3.05	49.8	0.14	62.9	0.15	-68.3
500.0	0.18	-18.4	3.04	23.5	0.15	36.9	0.17	-129.4

AM-105

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.05	-159.0	8.84	10.1	0.03	14.3	0.07	130.9
10.0	0.04	139.2	8.92	-2.6	0.03	4.1	0.05	134.9
20.0	0.03	-65.6	8.87	-17.4	0.03	-5.3	0.05	138.4
50.0	0.03	-41.2	8.72	-50.2	0.03	-24.7	0.05	122.6
100.0	0.04	-52.9	8.58	-102.8	0.03	-53.3	0.09	71.1
150.0	0.06	-80.0	8.32	-154.4	0.03	-80.9	0.15	19.8
200.0	0.07	-117.5	8.16	153.2	0.03	-109.8	0.22	-26.6
250.0	0.08	-169.2	8.06	99.6	0.03	-139.0	0.29	-69.4
300.0	0.08	-9.6	8.13	41.0	0.03	-173.0	0.28	-111.7

AM-107

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
1.0	0.11	-6.3	3.59	11.1	0.15	4.9	0.07	12.7
2.0	0.10	4.7	3.64	5.3	0.15	1.8	0.07	17.1
5.0	0.11	3.2	3.66	-0.6	0.16	-1.5	0.08	16.5
10.0	0.12	1.7	3.66	-4.9	0.16	-4.7	0.09	17.4
20.0	0.12	1.1	3.63	-11.7	0.16	-10.5	0.11	21.1
40.0	0.12	-1.0	3.53	-23.8	0.16	-20.8	0.14	22.5
60.0	0.11	-2.2	3.45	-34.8	0.16	-30.7	0.16	21.3
80.0	0.11	-2.8	3.35	-45.6	0.16	-41.1	0.19	16.1
100.0	0.11	-3.3	3.28	-56.8	0.16	-49.8	0.21	9.0

AM-108

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.03	143.0	25.53	29.6	0.01	-142.2	0.04	-159.8
10.0	0.02	157.8	26.01	0.4	0.01	-168.7	0.04	-167.0
20.0	0.02	156.4	25.83	-27.9	0.01	168.5	0.04	175.7
50.0	0.01	171.5	25.40	-88.7	0.01	129.4	0.06	138.6
100.0	0.03	108.3	25.22	176.6	0.01	73.0	0.11	69.4
150.0	0.05	-2.4	24.35	81.8	0.01	17.4	0.19	-6.8
200.0	0.05	-103.0	22.49	-14.9	0.01	-35.6	0.26	-80.1
250.0	0.05	28.2	21.71	-112.6	0.01	-84.4	0.28	-149.4
300.0	0.15	-48.1	21.30	135.2	0.01	-141.2	0.25	129.1

AM-109

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
0.5	0.01	36.2	3.47	14.2	0.13	5.9	0.07	18.8
1.0	0.01	160.9	3.41	5.8	0.14	1.7	0.04	12.2
2.0	0.01	169.6	3.41	0.5	0.14	-1.7	0.04	4.4
5.0	0.01	-153.3	3.40	-7.4	0.14	-7.9	0.04	-5.3
10.0	0.01	-112.8	3.39	-17.0	0.14	-16.6	0.04	-17.1
20.0	0.03	-105.2	3.36	-34.7	0.13	-33.8	0.04	-51.6
40.0	0.07	-129.1	3.38	-69.4	0.13	-67.7	0.08	-168.4
50.0	0.09	-145.9	3.42	-87.1	0.13	-84.9	0.11	162.0
60.0	0.10	-163.6	3.45	-106.4	0.12	-103.0	0.18	141.9

AM-110

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
0.5	0.11	-114.6	29.74	29.7	0.01	26.8	0.08	70.2
1.0	0.06	-138.4	30.01	14.3	0.01	13.8	0.04	56.9
2.0	0.04	-158.0	30.03	4.6	0.01	6.4	0.03	42.8
5.0	0.04	172.5	30.04	-5.8	0.01	0.5	0.02	9.9
10.0	0.04	145.1	29.52	-16.0	0.01	-3.3	0.02	-3.7
25.0	0.04	91.6	29.24	-42.7	0.01	-12.6	0.03	-31.5
50.0	0.05	39.6	28.81	-85.5	0.01	-27.8	0.06	-57.4
75.0	0.05	-31.0	29.00	-130.5	0.01	-44.0	0.11	-80.4
100.0	0.08	-152.5	29.00	-178.4	0.01	-61.8	0.20	-111.0

AM-112

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.14	37.9	6.80	-1.0	0.08	-0.8	0.12	101.8
20.0	0.15	26.5	6.75	-12.2	0.08	-10.1	0.11	88.9
50.0	0.17	12.1	6.70	-30.0	0.08	-31.8	0.15	57.0
75.0	0.19	6.7	6.64	-57.9	0.08	-48.5	0.19	36.7
100.0	0.20	-0.9	6.52	-78.0	0.08	-65.8	0.21	17.4
125.0	0.21	-9.0	6.46	-96.1	0.08	-80.7	0.23	-1.0
150.0	0.22	-19.5	6.37	-115.4	0.08	-96.7	0.22	-18.5
175.0	0.22	-29.1	6.32	-134.4	0.08	-112.7	0.20	-34.3
200.0	0.21	-41.4	6.24	-154.1	0.09	-129.0	0.17	-48.9

AM-113

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.05	-90.1	34.57	-176.6	0.01	6.0	0.13	104.0
20.0	0.08	-101.1	34.81	167.6	0.01	-5.4	0.08	101.9
30.0	0.12	-106.0	34.47	157.8	0.01	-10.2	0.06	81.8
40.0	0.17	-110.0	33.92	147.8	0.01	-16.2	0.04	53.7
50.0	0.20	-113.6	33.57	138.5	0.01	-22.9	0.04	24.8
60.0	0.23	-122.2	33.27	130.1	0.01	-29.4	0.07	1.6
70.0	0.25	-124.2	32.56	121.7	0.01	-33.8	0.09	-15.2
85.0	0.30	-129.9	31.84	109.7	0.01	-41.4	0.12	-32.8
100.0	0.33	-135.8	31.20	97.8	0.01	-48.4	0.14	-46.7

AM-117

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.04	-166.2	2.59	3.7	0.29	4.1	0.04	-172.2
20.0	0.03	-151.6	2.60	-1.5	0.29	-1.0	0.04	-170.2
50.0	0.03	-133.5	2.61	-9.6	0.29	-8.3	0.03	-163.4
75.0	0.04	-128.7	2.60	-15.2	0.29	-13.4	0.03	-164.6
100.0	0.06	-124.3	2.59	-20.9	0.29	-18.1	0.05	-167.0
125.0	0.08	-124.1	2.59	-26.3	0.29	-22.7	0.06	-168.0
150.0	0.11	-121.6	2.60	-31.4	0.29	-27.5	0.06	-169.3
175.0	0.13	-123.3	2.60	-36.8	0.29	-32.2	0.07	-170.0
200.0	0.14	-124.6	2.59	-42.2	0.28	-37.0	0.07	-171.1

AM-123

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.21	-69.6	3.15	-158.8	0.11	171.3	0.15	92.8
10.0	0.11	-81.5	3.17	-172.2	0.11	175.0	0.06	116.1
20.0	0.08	-88.5	3.18	-178.4	0.12	171.7	0.04	139.8
50.0	0.06	-108.4	3.17	162.9	0.13	159.9	0.03	174.7
100.0	0.05	-122.8	3.14	142.8	0.13	141.4	0.04	-163.9
200.0	0.05	-141.8	3.11	104.8	0.13	102.1	0.04	-119.4
300.0	0.07	-155.4	3.09	66.9	0.12	64.9	0.14	-114.6
400.0	0.15	177.2	3.08	26.7	0.11	27.3	0.22	-153.2
500.0	0.20	151.3	3.05	-21.9	0.09	-20.9	0.25	83.4

FREQUENCY IN MHz

SELECTED S-PARAMETER DATA (continued)

AM-131

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.23	-71.9	3.15	-157.9	0.11	173.2	0.15	90.6
10.0	0.12	-65.2	3.16	-171.9	0.12	175.7	0.07	105.5
20.0	0.08	-55.5	3.17	178.4	0.13	172.0	0.04	124.1
50.0	0.05	-61.3	3.17	162.9	0.13	160.8	0.02	-178.6
100.0	0.04	-78.3	3.15	143.5	0.13	143.9	0.03	-103.7
200.0	0.02	41.9	3.12	106.2	0.13	108.1	0.12	-83.4
300.0	0.10	5.0	3.10	68.8	0.13	75.7	0.20	-108.0
400.0	0.15	-28.7	3.09	29.8	0.14	42.3	0.24	-144.5
500.0	0.20	-18.6	3.07	-16.4	0.14	5.3	0.27	15.0

AM-132

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.13	-73.5	3.32	-171.2	0.19	-177.7	0.06	-8.0
10.0	0.07	-58.3	3.31	179.9	0.20	177.7	0.05	-4.1
20.0	0.06	-12.3	3.31	171.0	0.21	170.8	0.05	29.2
50.0	0.06	24.2	3.24	152.6	0.23	146.6	0.07	54.3
75.0	0.07	16.6	3.22	138.1	0.28	124.9	0.09	37.0
100.0	0.08	8.3	3.17	124.5	0.29	117.5	0.09	32.4
125.0	0.10	-4.0	3.15	110.6	0.21	114.8	0.10	21.6
150.0	0.14	-20.2	3.15	97.3	0.21	106.2	0.10	14.7
200.0	0.17	-50.3	3.19	68.8	0.21	83.6	0.11	35.2

AM-134

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.16	-80.9	5.29	-165.4	0.08	-73.5	0.13	-21.8
10.0	0.10	-94.2	5.33	-177.2	0.08	179.6	0.09	-36.4
20.0	0.08	-104.1	5.37	172.3	0.09	171.0	0.09	-50.5
50.0	0.12	-122.4	5.35	150.7	0.09	151.7	0.12	-85.7
75.0	0.14	-133.6	5.26	134.8	0.08	137.8	0.15	-107.0
100.0	0.18	-143.5	5.24	120.3	0.08	122.8	0.17	-120.9
125.0	0.20	-153.4	5.17	105.8	0.08	108.5	0.19	-137.7
150.0	0.22	-164.9	5.23	90.2	0.08	91.7	0.21	-150.7
200.0	0.24	178.7	5.36	55.2	0.07	58.9	0.23	162.8

AM-138

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.20	-60.7	17.49	26.0	0.01	11.6	0.17	-7.2
10.0	0.14	-69.0	17.73	5.6	0.01	2.2	0.10	-25.6
20.0	0.10	-73.0	17.85	-12.4	0.02	10.3	0.07	-32.9
50.0	0.13	-96.4	17.91	-47.3	0.01	-35.8	0.05	-82.3
75.0	0.16	-112.3	17.76	-74.6	0.01	-58.0	0.04	-146.0
100.0	0.20	-130.9	17.63	-103.3	0.01	-82.4	0.06	149.3
125.0	0.22	-148.5	17.82	-131.8	0.01	-115.9	0.11	109.4
150.0	0.21	-168.4	17.91	-168.8	0.01	179.5	0.15	78.5
200.0	0.19	159.9	17.90	132.4	0.01	95.3	0.18	15.8

AM-140

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.20	-68.5	28.34	30.2	0.01	11.8	0.16	-17.7
10.0	0.13	-85.6	29.26	8.0	0.01	4.4	0.12	-41.0
20.0	0.12	-99.8	29.37	-10.2	0.01	-7.3	0.12	-63.3
50.0	0.19	-126.8	29.36	-45.4	0.01	-30.5	0.19	-109.6
75.0	0.25	-145.8	29.26	-71.6	0.01	-48.3	0.24	-136.5
100.0	0.29	-165.0	29.68	-97.9	0.01	-68.5	0.26	-161.0
125.0	0.30	174.9	29.71	-125.2	0.01	102.5	0.25	172.4
150.0	0.25	154.5	29.48	-156.3	0.01	89.0	0.18	143.1
200.0	0.14	143.4	29.12	133.2	0.01	64.8	0.13	-171.7

AM-142

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
200.0	0.24	41.0	3.95	175.9	0.18	160.6	0.25	34.6
300.0	0.12	16.0	3.93	156.0	0.18	147.1	0.28	7.4
400.0	0.08	-6.4	3.97	140.8	0.17	134.9	0.31	-15.4
500.0	0.07	142.1	3.98	126.6	0.17	112.7	0.33	-35.9
600.0	0.06	127.8	4.04	112.9	0.17	110.4	0.33	-54.7
700.0	0.12	109.4	4.07	99.1	0.17	98.2	0.34	-73.6
800.0	0.18	90.1	4.12	84.5	0.16	86.5	0.36	-92.0
900.0	0.24	69.4	4.20	68.9	0.15	74.7	0.37	-110.7
1000.0	0.31	47.9	4.15	50.4	0.15	63.9	0.38	-129.9

AM-143

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.20	-60.7	5.90	-161.0	0.09	-160.5	0.32	-24.9
10.0	0.12	-63.8	6.07	-171.8	0.09	-172.6	0.27	-24.9
20.0	0.09	-65.3	6.16	-179.8	0.10	178.9	0.26	-17.4
50.0	0.10	-82.7	6.08	167.5	0.10	166.3	0.25	-28.0
100.0	0.14	-101.0	6.06	153.3	0.10	150.5	0.26	-49.3
200.0	0.21	-130.6	6.00	126.7	0.10	119.8	0.26	-82.3
300.0	0.23	-149.2	6.01	100.9	0.10	93.6	0.24	-104.5
400.0	0.20	-155.5	6.09	70.7	0.10	67.4	0.22	-100.5
500.0	0.22	-142.9	6.11	36.8	0.10	43.3	0.20	-79.8

AM-145

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.03	59.0	3.53	-160.8	0.21	-168.6	0.05	60.4
20.0	0.02	107.8	3.42	-171.3	0.22	-175.4	0.04	94.5
50.0	0.03	81.9	3.43	179.0	0.22	177.3	0.04	83.4
100.0	0.04	55.5	3.47	171.3	0.22	170.1	0.05	61.5
200.0	0.07	30.2	3.48	157.2	0.22	157.5	0.08	36.2
400.0	0.10	-18.6	3.5	131.8	0.22	134.3	0.11	-1.5
600.0	0.14	-64.1	3.54	106.9	0.23	111.8	0.14	-32.1
800.0	0.17	-115.9	3.49	82.1	0.23	90.6	0.16	-62.0
1000.0	0.21	162.9	3.51	55.5	0.23	69.3	0.18	-89.9

AM-146

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.13	-118.5	11.44	16.8	0.02	7.1	0.14	164.6
20.0	0.12	-144.0	11.63	-1.0	0.02	-4.0	0.16	168.2
50.0	0.13	-175.5	11.56	-27.1	0.02	-25.3	0.15	155.9
75.0	0.14	169.0	11.49	-44.3	0.02	-41.3	0.13	143.8
100.0	0.15	163.8	11.45	-59.9	0.02	-55.7	0.08	132.5
200.0	0.16	121.4	11.24	-120.3	0.02	-113.3	0.05	160.6
300.0	0.18	86.3	11.34	176.4	0.02	-170.1	0.07	167.7
400.0	0.20	55.2	11.33	110.4	0.02	133.3	0.12	159.2
500.0	0.23	13.1	10.84	31.1	0.01	75.6	0.23	174.8

AM-147

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.19	-68.2	6.75	-153.1	0.09	-152.0	0.20	-21.0
10.0	0.11	-78.1	7.05	-167.3	0.09	-168.0	0.12	-22.9
20.0	0.07	-83.8	7.17	-176.4	0.10	-177.7	0.10	-13.5
50.0	0.06	-95.0	7.15	171.4	0.10	170.1	0.09	-1.9
100.0	0.07	-100.1	7.14	159.2	0.10	156.7	0.10	2.6
200.0	0.11	-122.1	7.17	136.3	0.11	130.3	0.13	3.8
300.0	0.14	-141.7	7.08	114.7	0.11	108.4	0.14	-5.5
400.0	0.15	-166.3	7.16	91.0	0.11	86.6	0.17	-19.9
500.0	0.17	164.6	7.24	67.9	0.12	66.5	0.19	-38.9

AM-148

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.10	-12.8	4.89	-176.5	0.13	5.3	0.06	-0.3
10.0	0.08	-3.2	4.88	-179.6	0.13	2.5	0.06	-0.5
20.0	0.07	9.2	4.86	177.3	0.14	0.8	0.06	-2.0
50.0	0.08	34.9	4.84	170.1	0.14	-1.0	0.06	-5.7
100.0	0.11	46.3	4.80	161.0	0.14	-3.0	0.06	-10.9
200.0	0.21	38.3	4.75	142.9	0.14	-6.4	0.04	-32.0
300.0	0.28	24.2	4.73	125.9	0.15	-10.6	0.02	31.5
400.0	0.30	5.9	4.76	107.8	0.16	-15.0	0.06	126.6
500.0	0.30	-18.6	4.86	91.0	0.18	-21.3	0.13	114.1

AM-149

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.08	-46.1	5.82	-173.6	0.11	8.4	0.06	50.8
10.0	0.05	-27.8	5.87	-177.9	0.11	4.3	0.06	28.4
20.0	0.04	-8.9	5.84	178.6	0.11	2.5	0.06	15.8
50.0	0.05	25.2	5.82	170.8	0.11	1.4	0.06	8.6
100.0	0.07	39.8	5.82	161.3	0.12	0.6	0.07	10.1
200.0	0.12	32.0	5.80	142.6	0.12	-0.6	0.07	15.1
300.0	0.13	13.6	5.75	124.4	0.13	-3.0	0.06	42.2
400.0	0.14	-13.7	5.74	103.8	0.14	-6.9	0.07	57.0
500.0	0.14	-66.1	5.73	84.0	0.15	-13.0	0.10	49.8

FREQUENCY IN MHz

SELECTED S-PARAMETER DATA (continued)

AM-154

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
20.0	0.25	62.1	2.72	-165.1	0.17	-165.3	0.37	163.8
50.0	0.22	28.6	2.86	-177.4	0.17	-177.2	0.34	160.0
100.0	0.21	2.7	2.94	173.5	0.18	173.5	0.30	151.0
150.0	0.20	-14.0	2.96	166.3	0.18	166.3	0.29	140.7
200.0	0.19	-27.7	2.97	159.4	0.19	159.4	0.27	130.4
400.0	0.19	-74.5	2.92	134.2	0.21	134.2	0.24	82.3
600.0	0.20	-117.3	2.85	109.3	0.22	109.3	0.27	17.8
800.0	0.23	-156.9	2.82	86.1	0.25	86.4	0.30	-54.0
1000.0	0.26	159.5	2.80	63.8	0.27	63.8	0.32	-107.7

AM-155

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
300.0	0.30	42.3	4.05	166.3	0.18	173.3	0.36	87.8
350.0	0.26	12.9	4.12	153.2	0.18	161.3	0.33	80.5
400.0	0.24	-25.7	4.13	142.0	0.19	150.6	0.30	76.2
500.0	0.20	-88.2	4.03	122.0	0.20	131.8	0.28	73.4
600.0	0.23	-123.0	3.94	104.9	0.20	115.3	0.27	67.8
700.0	0.26	-144.7	3.88	89.4	0.21	100.1	0.28	51.3
800.0	0.29	-163.9	3.88	74.5	0.21	85.2	0.28	21.3
900.0	0.27	175.6	4.01	59.5	0.22	69.8	0.30	-20.2
1000.0	0.25	147.1	4.22	41.3	0.23	53.6	0.32	-63.0

AM-160

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0	0.14	126.3	28.21	-5.6	0.01	-18.0	0.07	-73.4
150.0	0.12	56.7	28.30	-53.5	0.01	-68.5	0.08	-144.7
200.0	0.08	-15.5	27.45	-93.3	0.01	-108.2	0.09	150.5
250.0	0.17	-67.8	26.79	-126.3	0.01	-143.8	0.10	101.3
300.0	0.18	-87.7	25.37	-155.5	0.01	-178.1	0.12	64.4
350.0	0.18	-96.1	25.42	172.0	0.01	149.5	0.14	34.6
400.0	0.23	-115.4	24.92	141.7	0.02	120.6	0.11	4.7
500.0	0.27	175.5	25.67	78.7	0.02	59.1	0.10	-101.1
600.0	0.32	19.1	25.58	0.7	0.02	-14.6	0.24	143.7

AM-162

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.07	165.0	4.06	6.6	0.16	6.8	0.11	169.1
20.0	0.09	-166.8	4.13	-6.5	0.17	-5.8	0.09	-158.2
30.0	0.08	-151.5	4.18	-15.8	0.17	-15.2	0.09	-129.5
40.0	0.10	-146.9	4.20	-24.0	0.17	-23.3	0.11	-120.3
50.0	0.11	-147.9	4.23	-32.2	0.17	-30.9	0.12	-117.7
60.0	0.11	-152.0	4.19	-39.8	0.17	-38.6	0.13	-118.5
70.0	0.12	-159.7	4.20	-47.7	0.17	-46.0	0.14	-120.3
85.0	0.12	-171.5	4.17	-59.5	0.16	-57.7	0.14	-122.6
100.0	0.12	174.1	4.15	-72.1	0.16	-69.8	0.15	-123.6

AM-171

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.17	-1.1	5.75	-176.9	0.10	4.1	0.02	-77.1
10.0	0.17	-2.7	5.74	-179.3	0.10	1.9	0.01	-62.8
20.0	0.17	-4.3	5.70	178.5	0.10	0.7	0.00	-27.3
50.0	0.16	-7.3	5.69	173.0	0.10	-1.3	0.01	56.9
100.0	0.15	-14.7	5.62	166.7	0.10	-3.7	0.03	68.2
200.0	0.15	-26.8	5.57	154.5	0.10	-7.5	0.05	60.1
300.0	0.14	-39.9	5.52	143.1	0.10	-11.5	0.08	50.8
400.0	0.14	-54.9	5.53	129.7	0.10	-15.1	0.10	39.1
500.0	0.14	-75.4	5.48	118.1	0.10	-18.8	0.12	24.0

AM-173

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.17	-0.4	5.70	-177.3	0.10	3.6	0.08	-19.7
10.0	0.17	-2.6	5.70	180.0	0.10	1.7	0.08	-9.0
20.0	0.17	-6.5	5.65	177.9	0.10	0.5	0.07	-3.1
50.0	0.17	-7.8	5.64	173.1	0.10	-0.8	0.07	-8.0
100.0	0.17	-12.6	5.63	167.0	0.10	-2.6	0.07	-16.8
250.0	0.17	-30.7	5.55	147.6	0.10	-6.7	0.07	-38.5
500.0	0.18	-78.3	5.53	115.5	0.10	-14.4	0.08	-43.0
750.0	0.19	-139.2	5.47	83.1	0.11	-24.0	0.09	38.3
1000.0	0.22	160.9	5.39	49.0	0.11	-37.5	0.12	0.6

AM-174

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.14	-1.0	6.06	-176.9	0.09	4.3	0.09	-168.5
10.0	0.14	-2.9	6.08	-179.7	0.10	2.2	0.09	-175.1
20.0	0.14	-2.6	6.02	178.2	0.10	0.9	0.08	-179.5
50.0	0.13	-2.4	6.00	173.4	0.10	-0.2	0.08	175.8
100.0	0.13	-6.6	5.98	167.3	0.10	-1.4	0.08	170.0
250.0	0.13	-5.0	5.89	148.1	0.10	-4.5	0.09	153.7
500.0	0.14	-35.1	5.85	117.3	0.10	-10.6	0.09	126.2
750.0	0.15	-87.2	5.85	86.3	0.11	-20.6	0.12	86.5
1000.0	0.20	-159.3	5.84	61.8	0.12	-35.6	0.16	30.8

AM-175

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.14	-0.6	6.01	-177.2	0.09	3.0	0.05	177.7
10.0	0.13	-1.7	5.99	-179.9	0.09	1.7	0.04	-171.3
20.0	0.12	-2.9	5.92	178.2	0.09	0.6	0.04	-173.0
50.0	0.12	-2.9	5.92	173.7	0.09	-0.6	0.04	-169.0
100.0	0.12	-7.9	5.89	167.9	0.10	-1.9	0.04	-166.8
250.0	0.12	-17.0	5.83	149.3	0.10	-5.3	0.04	-167.4
500.0	0.12	-49.0	5.80	119.2	0.10	-11.9	0.04	163.7
750.0	0.13	-108.5	5.78	89.3	0.10	-21.6	0.05	94.4
1000.0	0.17	-175.3	5.82	57.4	0.11	-36.0	0.13	22.0

AM-176

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.14	151.3	4.59	-168.1	0.13	-0.9	0.12	144.6
10.0	0.14	168.4	4.67	-175.5	0.13	0.1	0.10	156.3
20.0	0.14	178.2	4.61	-179.6	0.13	0.0	0.09	166.5
50.0	0.14	167.9	4.61	174.5	0.13	-0.1	0.09	170.5
100.0	0.13	161.6	4.58	168.6	0.13	-1.0	0.08	166.8
250.0	0.12	132.4	4.56	150.1	0.14	-3.5	0.08	149.9
500.0	0.10	83.9	4.57	119.8	0.15	-9.0	0.07	121.3
750.0	0.08	39.7	4.52	89.1	0.16	-17.7	0.05	76.1
1000.0	0.04	-91.4	4.39	58.4	0.16	-28.4	0.07	-9.9

AM-178

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.05	-146.0	3.19	-176.9	0.17	5.2	0.08	153.2
20.0	0.05	-153.1	3.21	180.0	0.17	2.3	0.08	160.1
40.0	0.05	-176.0	3.22	176.9	0.18	0.2	0.06	163.7
100.0	0.05	172.4	3.23	169.6	0.18	-3.0	0.06	162.1
200.0	0.04	143.7	3.19	158.4	0.18	-7.0	0.05	151.1
500.0	0.07	77.9	3.02	128.4	0.18	-18.5	0.09	96.6
1000.0	0.08	-47.5	2.99	75.3	0.18	-40.0	0.17	-71.1
1500.0	0.09	-109.6	3.03	17.6	0.17	-64.9	0.24	-119.1
2000.0	0.17	174.5	2.99	-51.1	0.17	-86.3	0.28	-156.1

AM-180

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.20	-156.1	2.97	-173.1	0.17	8.6	0.24	166.9
20.0	0.21	-169.7	2.98	-177.4	0.17	4.4	0.23	170.3
40.0	0.22	-174.2	3.01	179.0	0.18	1.7	0.22	171.1
100.0	0.23	174.3	3.02	171.6	0.18	-1.4	0.21	166.1
200.0	0.18	170.9	3.01	162.0	0.18	-4.5	0.20	154.5
500.0	0.13	149.3	3.05	134.3	0.19	-14.1	0.18	113.3
1000.0	0.07	-140.6	3.12	86.4	0.20	-35.9	0.17	5.5
1500.0	0.18	-133.3	3.05	32.4	0.18	-59.6	0.20	-93.3
2000.0	0.24	-168.2	3.01	-23.7	0.17	-76.2	0.26	-147.3

AM-181

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.13	111.1	2.58	12.4	0.29	13.1	0.14	112.3
20.0	0.08	121.6	2.59	2.7	0.29	3.5	0.10	113.0
50.0	0.07	170.9	2.62	-9.0	0.29	-8.2	0.03	127.1
100.0	0.06	-128.6	2.63	-22.8	0.29	-21.7	0.05	-117.5
150.0	0.09	-131.5	2.64	-35.8	0.29	-34.2	0.09	-122.8
200.0	0.12	-136.6	2.64	-49.3	0.28	-46.8	0.13	-134.3
250.0	0.17	-141.8	2.64	-62.3	0.27	-59.3	0.15	-148.8
300.0	0.19	-146.8	2.65	-76.1	0.27	-72.6	0.16	-168.4
400.0	0.22	-151.6	2.68	-105.9	0.25	-102.4	0.17	116.1

FREQUENCY IN MHz

SELECTED S-PARAMETER DATA (continued)

AM-183

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.14	-148.3	31.43	17.9	0.01	1.9	0.20	177.2
10.0	0.13	170.1	32.36	6.3	0.01	1.6	0.12	92.7
20.0	0.13	-178.3	32.65	-2.6	0.01	1.3	0.09	69.8
50.0	0.12	179.2	33.31	-13.6	0.01	-0.5	0.06	-72.9
100.0	0.11	-178.0	33.09	-29.3	0.01	-2.1	0.05	-98.1
250.0	0.12	171.1	31.87	-71.9	0.01	-9.3	0.06	-123.4
500.0	0.12	129.7	29.37	-144.8	0.01	-22.1	0.17	-153.9
750.0	0.14	-44.0	27.01	145.8	0.01	-45.8	0.25	178.1
1000.0	0.23	150.0	30.09	65.9	0.01	-97.1	0.28	80.0

AM-184

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
10.0	0.13	-171.5	10.33	6.2	0.03	4.5	0.10	80.7
20.0	0.12	-175.9	10.48	0.3	0.03	2.8	0.08	47.2
40.0	0.12	174.9	10.48	-4.6	0.03	1.4	0.08	7.2
100.0	0.12	165.0	10.51	-15.7	0.03	-1.8	0.06	-38.9
200.0	0.12	149.1	10.42	-32.4	0.03	-4.8	0.05	-76.4
500.0	0.12	105.1	10.13	-79.8	0.03	-12.1	0.10	-131.1
1000.0	0.12	9.8	9.60	-156.4	0.03	-27.2	0.12	173.5
1500.0	0.14	-99.8	9.53	126.5	0.02	-51.5	0.14	-89.3
2000.0	0.28	176.9	9.63	53.4	0.01	-75.0	0.30	-142.7

AM-185

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
10.0	0.08	179.9	9.00	6.0	0.03	6.7	0.12	160.6
20.0	0.07	172.6	9.03	0.1	0.03	3.6	0.10	168.3
40.0	0.07	167.7	9.07	-5.0	0.03	1.8	0.08	178.4
100.0	0.07	161.8	9.07	-16.5	0.03	-1.3	0.09	-171.7
200.0	0.09	138.6	8.95	-34.4	0.03	-4.3	0.10	-163.8
500.0	0.11	91.0	8.71	-84.2	0.03	-10.3	0.17	-169.7
1000.0	0.16	20.4	8.73	-163.9	0.03	-22.7	0.18	155.3
1500.0	0.18	-80.6	8.32	116.8	0.03	-44.2	0.16	150.0
2000.0	0.25	157.6	8.59	34.4	0.02	-48.8	0.27	-158.9

AM-191

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
100.0	0.33	-115.7	14.54	-143.3	0.02	-143.4	0.20	-171.1
150.0	0.25	-128.6	15.35	167.9	0.02	-168.5	0.25	121.6
200.0	0.17	-148.7	15.32	133.1	0.02	-130.5	0.27	8.5
250.0	0.16	-165.8	15.47	103.0	0.01	96.3	0.29	-43.6
300.0	0.16	177.3	15.07	76.5	0.01	63.3	0.29	-79.5
350.0	0.17	165.0	14.37	51.7	0.01	30.8	0.26	-109.7
400.0	0.18	157.2	14.16	27.6	0.01	0.9	0.24	-140.3
500.0	0.21	176.3	14.33	-17.6	0.02	-44.7	0.21	-4.6
600.0	0.30	-174.0	15.11	-68.9	0.02	-86.9	0.23	-59.4

AM-210

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.20	-58.3	5.66	-164.1	0.09	-164.2	0.30	-24.6
10.0	0.14	-60.9	5.90	-174.1	0.09	-174.5	0.26	-19.6
20.0	0.13	-64.0	5.97	178.3	0.10	177.3	0.27	-19.7
50.0	0.13	-81.0	5.95	165.8	0.10	163.3	0.27	-32.9
100.0	0.16	-101.9	5.89	149.5	0.10	144.3	0.27	-56.7
200.0	0.24	-130.1	5.74	119.1	0.10	110.6	0.28	-95.7
300.0	0.27	-152.0	5.72	88.0	0.10	81.2	0.29	-124.2
400.0	0.29	-172.5	5.83	54.4	0.10	54.3	0.23	-140.4
500.0	0.32	156.6	5.75	14.3	0.09	30.7	0.20	-63.5

AM-211

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.05	8.2	4.09	-173.0	0.14	2.3	0.04	64.1
10.0	0.05	1.5	4.12	-177.6	0.14	1.0	0.04	31.9
20.0	0.05	-0.1	4.12	178.8	0.14	-0.1	0.04	11.2
50.0	0.06	8.3	4.12	172.9	0.14	-1.6	0.04	-8.6
100.0	0.07	-10.2	4.09	165.1	0.14	-3.7	0.05	-24.7
250.0	0.09	-15.9	4.07	143.1	0.14	-9.7	0.06	-57.7
500.0	0.12	-48.1	4.07	105.4	0.15	-20.3	0.07	-94.9
750.0	0.14	-100.5	4.11	65.7	0.16	-33.9	0.07	-117.4
1000.0	0.18	-156.7	4.05	18.9	0.16	-57.4	0.08	-103.5

AM-212

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
100.0	0.10	169.4	2.35	-17.9	0.25	-19.3	0.09	160.0
150.0	0.08	180.0	2.40	-30.7	0.25	-32.6	0.06	-166.2
200.0	0.10	-179.7	2.42	-43.2	0.25	-45.9	0.09	-142.3
250.0	0.17	175.6	2.45	-55.5	0.25	-58.9	0.09	-135.8
300.0	0.17	168.5	2.48	-69.0	0.25	-71.9	0.09	-137.5
350.0	0.16	162.5	2.48	-82.5	0.25	-85.4	0.08	-142.9
400.0	0.15	153.4	2.44	-94.5	0.24	-97.9	0.09	-143.7
500.0	0.17	150.5	2.49	-125.7	0.26	-127.9	0.10	-175.8
600.0	0.22	159.0	2.40	-160.1	0.26	-163.4	0.15	74.5

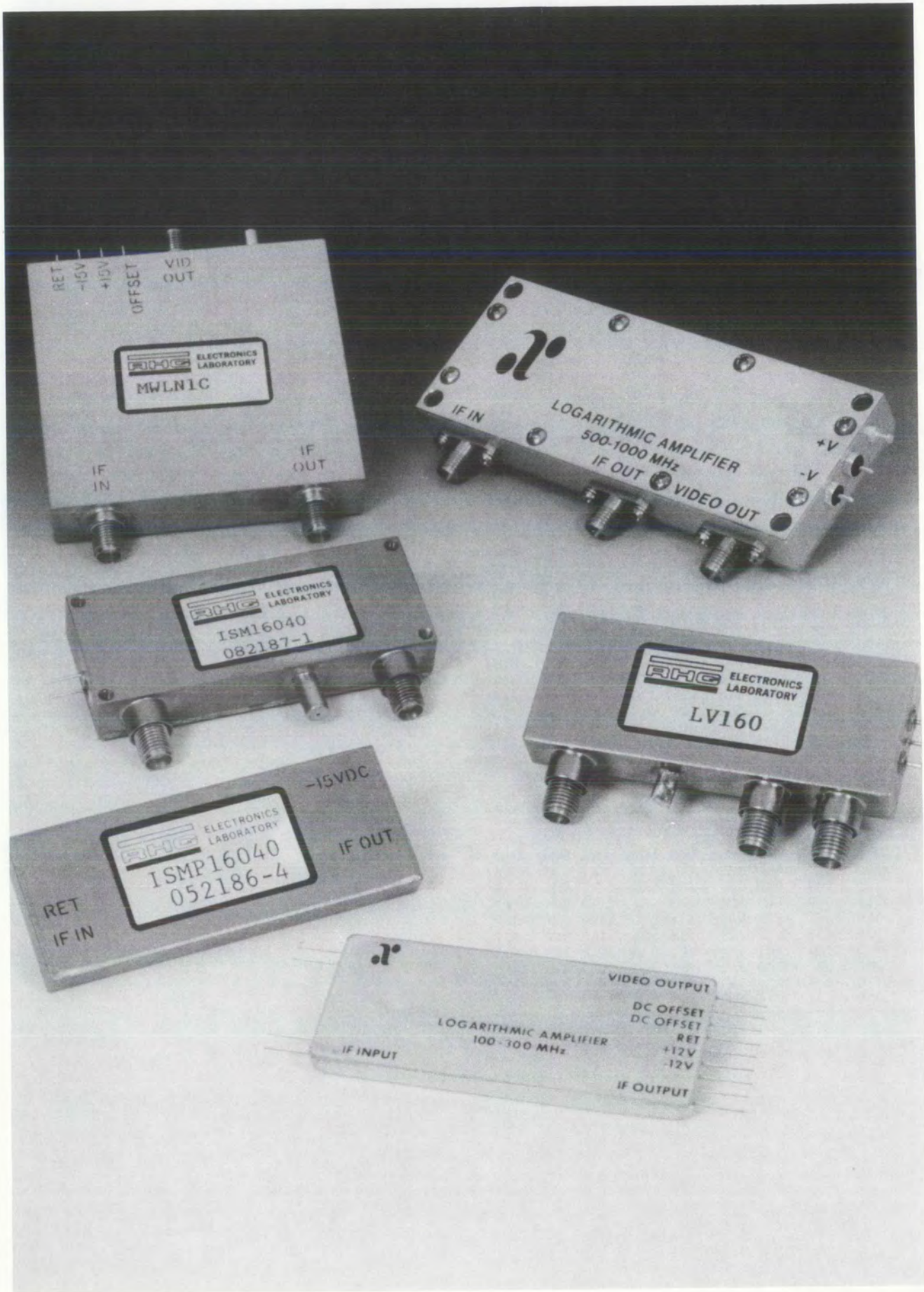
AM-281

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
Vds1 = Vds2 = 3.0 Volts					Id1 = Id2 = 30 mA			
1100.0	0.20	-103	12.95	-136	0.015	77	0.24	98
1200.0	0.08	-154	11.50	173	0.014	40	0.24	49
1300.0	0.03	83	11.50	123	0.014	3	0.25	2
1400.0	0.10	-5	9.00	76	0.013	-33	0.28	-37
1500.0	0.16	-48	8.01	29	0.012	-68	0.30	-73
1600.0	0.22	-84	7.17	-17	0.011	-102	0.32	-105
1700.0	0.28	-119	6.43	-62	0.009	-133	0.35	-135

AM-282

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
Vds1 = Vds2 = 3.0 Volts					Id1 = Id2 = 30 mA			
1100.0	0.22	-26	12.30	-39	0.012	146	0.24	-163
1200.0	0.12	-78	11.71	-87	0.011	114	0.27	164
1300.0	0.09	-157	10.70	-128	0.011	82	0.27	113
1400.0	0.13	136	9.65	-169	0.011	49	0.27	80
1500.0	0.19	91	8.74	150	0.011	17	0.27	47
1600.0	0.25	55	7.77	111	0.010	-15	0.26	19
1700.0	0.32	21	7.04	76	0.010	-45	0.30	-10

FREQUENCY IN MHZ


RET
-15V
+15V
OFFSET
VID OUT
ELECTRONICS LABORATORY
MWLN1C
IF IN
IF OUT
IF IN
LOGARITHMIC AMPLIFIER
500-1000 MHz
IF OUT
VIDEO OUT
+V
-V
ELECTRONICS LABORATORY
ISM16040
082187-1
ELECTRONICS LABORATORY
LV160
-15VDC
ELECTRONICS LABORATORY
ISMP16040
052186-4
IF OUT
RET
IF IN
VIDEO OUTPUT
DC OFFSET
DC OFFSET
RET
+12V
-12V
LOGARITHMIC AMPLIFIER
100-300 MHz
IF INPUT
IF OUTPUT

IF PRODUCT SELECTION GUIDE

LOG AMPLIFIERS

MODEL NO.	FREQUENCY RANGE (MHz)	DYNAMIC RANGE (dB) TYP	LINEARITY (dB) TYP	SLOPE (mV/dB) NOM	SLOPE VARIATION (%) TYP	RISE TIME (nsec)	CASE[1] STYLE	PAGE NO.
ICLX3010B	30	80	±0.5	25	5	100	C-24	106
ICLA310	60	80	±1.0	22	10	25	C-22	107
ICLAP310	60	85	±1.0	22	10	25	FP-12	107
ICLX6020B	60	80	±0.5	25	5	50	C-24	108
ICLX16040B	160	70	±0.5	25	5	30	C-24	109
ILM16040	**160**	**70**	**±1.0**	**25**	**10**	**30**	**FP-23**	110
LV160	**110-210**	**75**	**±1.0**	**15**	**10**	**20**	**C-36**	111
ICLA351	100-300	75	±1.0	22	10	10	C-22	112
ICLAP351	100-300	75	±1.0	22	10	10	FP-12	112
ICLA352	100-300	75	±1.0	22	10	10	C-22	113
ICLAP352	100-300	75	±1.0	22	10	10	FP-12	113
ICLLW300	**100-500**	**70**	**±1.0**	**15**	**10**	**20**	**C-36**	114
ICLLWP300	**100-500**	**70**	**±1.0**	**15**	**10**	**20**	**FP-21**	114
ICLA361	250-500	70	±1.0	25	15	10	C-22	115
ICLAP361	250-500	70	±1.0	25	15	10	FP-12	115
ICLA371	500-1000	65	±1.5	25	15	10	C-22	116
ICLAP371	500-1000	65	±1.5	25	15	10	FP-12	116
ICLLW750	**500-1000**	**65**	**±1.0**	**15**	**10**	**20**	**C-36**	117
ICLLWP750	**500-1000**	**65**	**±1.0**	**15**	**10**	**20**	**FP-21**	117
MWL1000	**500-1500**	**65**	**±1.0**	**15**	**10**	**15**	**C-36**	118
MWLN1C	**650-1350**	**60**	**±1.0**	**15**	**10**	**1**	**C-38**	119

FREQUENCY DISCRIMINATORS

MODEL NO.	FREQUENCY RANGE (MHz)	PEAK-TO-PEAK BANDWIDTH (MHz)	LINEAR BANDWIDTH (MHz)	SLOPE (mV/MHz) NOM	RISE TIME (nsec)	CASE[1] STYLE	PAGE NO.
ICDL16035	**160**	**60**	**35**	**100**	**25**	**C-37**	120
ICDLP16035	**160**	**60**	**35**	**100**	**25**	**FP-22**	120
ICDS1000	**1000**	**500**	**300**	**10**	**5**	**C-24**	121

CONSTANT PHASE LIMITERS

MODEL NO.	FREQUENCY RANGE (MHz)	MINIMUM BANDWIDTH (MHz)	DYNAMIC RANGE (dB) TYP	OUTPUT (dBm) NOM	OUTPUT LEVEL VARIATION (dB)	PHASE VARIATION (Deg)	CASE STYLE	PAGE NO.
ISM16040	**160**	**40**	**75**	**±10**	**±0.5**	**<10**	**C-35**	122
ISMP16040	**160**	**40**	**75**	**±10**	**±0.5**	**<10**	**FP-24**	122

[1] CASE STYLE: C = CONNECTORIZED: FP = FLATPACK
BOLD = NEW PRODUCT
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
*For additional RHG products, see the latest RHG Electronics Laboratory, Inc. catalog.

LOGARITHMIC IF AMPLIFIERS

INTRODUCTION

This article is presented to give a basic understanding of logarithmic IF amplifiers. It describes the design technique utilized to produce these units, as well as the definitions of terms and design applications.

A logarithmic IF amplifier/detector, conventionally called a log amp, is a device that produces a video output that is proportional to the logarithm of the RF input amplitude. This can be represented by the equation:

$$\Delta E_o = K \log \frac{E_{IN\ 1}}{E_{IN\ 2}}$$

Where: E_o = video output voltage

K = constant which determines log slope

$\frac{E_{IN\ 1}}{E_{IN\ 2}}$ = ratio of RF input signals

$E_{IN\ 2}$ can be approximated by the equivalent amplifier input noise and the expression can be rewritten:

$$E_o = K \log \frac{E_{IN}}{E_{Noise}}$$

where E_o will be 0 when the input signal is equal to noise. This non-linear response enables the device to accept an extremely wide dynamic range of input signals (70 to 80 dB) without limiting or overloading. Because the log amp has no AGC, it can respond to a single pulse or a train of pulses of widely differing amplitudes on a pulse to pulse basis. It can also be used to measure CW signals, and a combination of pulses in the presence of CW or noise without overload problems.

TWO DISTINCT DESIGN APPROACHES

The log IF amplifiers offered in this catalog are based on two differerent approaches both using the successive detection techniques. The first approach provides a piecewise approximation of a logarithmic funciton of output vs. input. This is achieved by using a number of iterative cascaded stages, each consisting of an amplifier, detector, and limiter, as shown in Figure 1. Each stage will have a gain and a linear dynamic range of about 10 dB, and the output of each detector/limiter is fed to a video delay line called a sum line. The sum of all the detector/limiter outputs will be fed to an operational video amplifier.

Since the output of each stage is linear, rather than logarithmic, there is a limit to the dynamic range of a single detector that can be utilized before deviating excessively from the desired logarithmic response. Figure 2 shows a linear input/output curve with an ideal log curve superimposed. Examination, of these curves shows the ideal linear logarithmic approximation deviates ±1 dB over a 12 dB range, therefore the gain and dynamic range of each stage must be held to less than this value to insure log accuracy, and a sufficient number of stages must be used to provide the required dynamic range (Figure 3).

A unique feature of this circuit is the use of video limiting rather than RF or IF limiting. This eliminates the constraint of designing an RF amplifier stage with controlled limiting characteristics, while maintaining the desired linear response. Video limiting will begin while the RF stage is operating in its linear region, thus making the transistor limiting characteristics unimportant.

This technique allows design of a logarithmic amplifier at any frequency and bandwidth where it is practical to build a linear amplifier, and eliminates RF limiting problems such as bandwidth variations with signal level, and limiting variation with temperature.

The mechanical design of the log amp uses thick film hybrid integrated circuitry mounted in hermetically sealed flatpacks. These flatpacks are mounted on a printed circuit board which is assembled into a machined housing for the connectorized units.

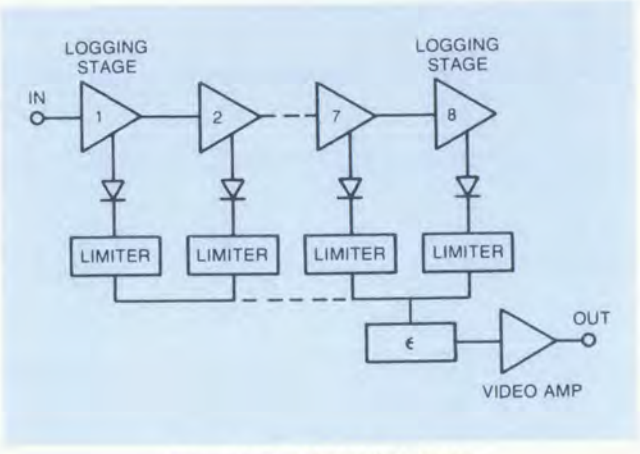


Figure 1. Functional Schematic

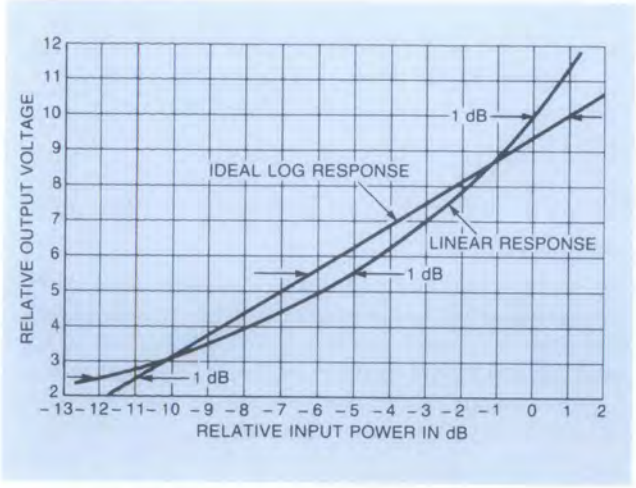


Figure 2. Linear-Logarithmic Approximation

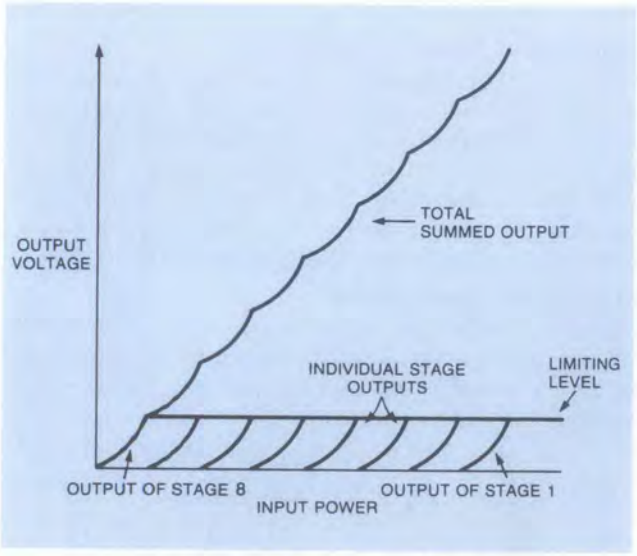


Figure 3. Successive Detecting Logging

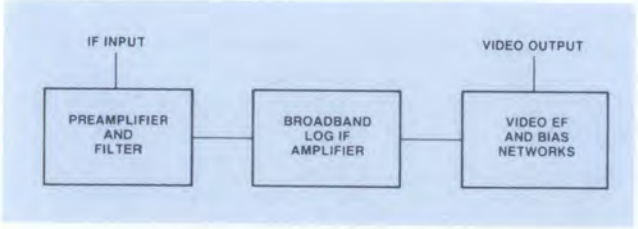


Figure 4. Typical Block Diagram

The second approach is based on the development of a successive detection technique which uses a highly advanced differential amplifier configuration. Using wideband differential amplifiers eliminates video delay lines which lead to improved pulse performance.

A block diagram of this technique is shown in Figure 4. The input preamp and filter serves three purposes:

- It adjusts the sensitivity of the overall amplifier
- It proves a good input power match (typical VSWR 1.5:1).
- The filter is used to align the overall bandpass of the amplifier.

The broadband log section consists of several identical differential IF stages which amplify and detect the incoming signal. The video emitter follower is then used to provide a low impedance video output capable of supplying 2V into the typical 50 ohm or 93 ohm video load. Video amplification is usually not required.

An individual log IF amplifier stage (with the attendant video bias and output circuitry) is shown in Figure (5). Detection in each stage occurs when the signal level at the base of the IF transistor increases causing the base-emitter junction to be overdriven. This results in an increase in the collector current on the IF side of the differential pair which causes a corresponding decrease in video current until the video transistor is turned off.

The composite log curve is obtained by connecting all the video collectors to the sum line and driving the appropriate video load depending on the log slope required. This technique results in unsurpassed stability, accuracy, and pulse fidelity.

The circuit configuration uses an alumina substrate with selective etching techniques to provide the conductors and resistive elements. Discrete semiconductors, coils and capacitors are then added. The IC board is then enclosed in a housing providing RFI protection and SMA connectors or pins are used to bring out the RF and video signals.

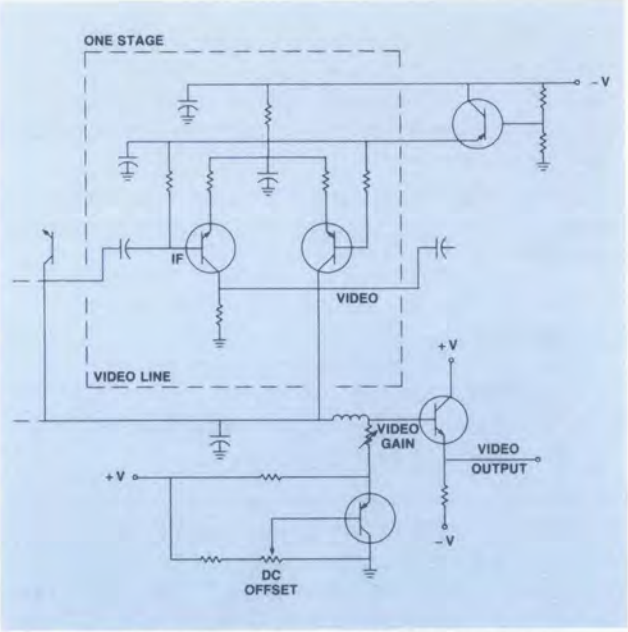


Figure 5. Individual Log IF Amplifier Stages Provide Amplification and Detection

DEFINITION OF TERMS RELATED TO LOG AMPS

Log IF Amplifier

A log IF amplifier is an amplifier that provides a video output voltage that varies proportionally to the log of an IF or RF input signal. This is not to be confused with a log video amplifier that provides video out with video in. The log video amplifier is sometimes used in conjunction with an RF detector, however this technique has limited sensitivity (−45 dBm Typ.).

Log Linearity

Log linearity is the maximum deviation in dB (referred to the input) from a best fit straight line of the input/output characteristic over the dynamic range. See Figure 6.

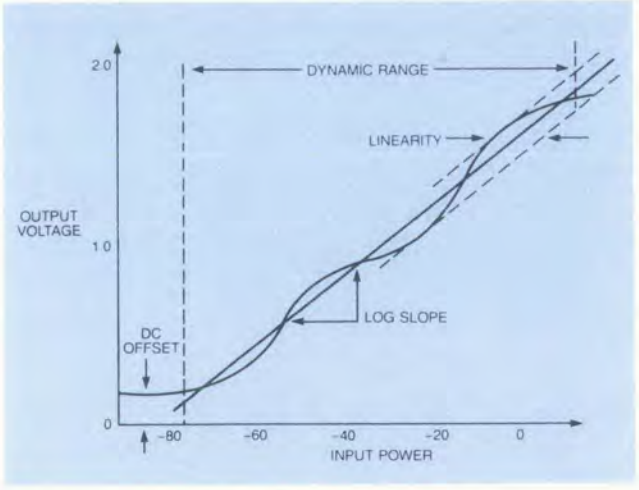


Figure 6. Definition of Terms

Log Slope

The log slope is the average slope of the input/output characteristic over the dynamic range, expressed in millivolts per dB. See Figure 6.

D.C. Offset

D.C. offset is the residual D.C. output of a log amp with no signal applied to the input. See Figure 6.

Log Accuracy

Log accuracy is the absolute accuracy with which the output voltage represents the input power. Note that log accuracy is a combined effect of log linearity, log slope, and D.C. offset. Changes in any of these parameters over frequency and temperature will affect the log accuracy.

Dynamic Range

The dynamic range is the input signal range in dB over which the output linearity requirements are met.

Tangential Sensitivity (TSS)

TSS defines the input level that results in an output signal to noise ratio of 7 dB. TSS is related to bandwidth and noise figure and aids in defining the lower limit of the input dynamic range of a log amp. Since noise figure is not easily measured in a log amp because it provides video out, TSS is a convenient way of specifying noise performance.

Equivalent Input Noise

The equivalent input noise is the equivalent RMS noise power appearing at the input of an amplifier, related to noise figure and bandwidth. Input noise is defined by the equation:

$$P_n = -174 + 10 \log BW + NF$$

Applications of Log IF Amplifiers

Logarithmic IF amplifiers are designed for operation in military environments and for systems requiring high precision. Log amplifiers have been found useful in applications which require the compression of high/input dynamic ranges into smaller, more manageable ranges without loss of level information and in systems that need high sensitivity and instantaneous pulse to pulse response.

Some typical examples are:

Monopulse Receivers

A monopulse receiver often has very wide variations in signal level from channel to channel and within any channel. In this type of system the outputs of matched sets of log amps can be subtracted to give the necessary ratio or angle information ($\log \frac{A}{B} = \text{Log A} - \text{Log B}$). The pulse response capability of the log amp allows this information to be made available on a pulse to pulse basis so important in today's difficult threat environments.

Instantaneous Frequency Discriminators

By using log amplifiers, after a bank of filters each tuned to a different frequency, the output of the log amps can provide single pulse frequency information proportional to output level. Further, if the system's signal processor can handle the information, multiple signals can be discriminated simultaneously.

ECM Receivers

In general, the log amplifier allows the ECM receiver to handle low level pulse signals in the presence of CW or noise jamming without overload. This feature can be most advantageous in today's complex EW environment.

Spectrum Analysis

Spectrum analysis requires high sensitivity and the capability to handle a wide input dynamic range as well as preserve low level signals in the presence of noise and other signals. The log amplifier allows this to be done as well as compressing the input dynamic range into a more useable output range.

CONCLUSION

Now you have a choice in logarithmic amplifier techniques from one source. Adams-Russell can supply you the right unit for your specific requirement. So if you require fast response, or broadband hermetic flatpack's or need to operate at +5V, we've got the Logarithmic Amplifier to meet your needs.

Our application engineering staff can supply more detailed information and technical assistance in using these devices in systems application and in adapting circuits to specific system problems.

MODEL ICLX3010B — LOGARITHMIC AMPLIFIER 30 MHz

- 80 dB Dynamic Range
- High Pulse Fidelity
- Linearity ±0.5 dB

Guaranteed Specifications*

(From −30°C to +71°C Case Temp)

Frequency	30 MHz
Bandwidth	10 MHz
Input Dynamic Range	80 dB Min (−80 to 0 dBm)
Log Output	
Linearity	
(@ room temp)	±0.5 dB Max
(−30°C to +71°C)	±1.0 dB Max
Slope (@ room temp)	25 mV/dB Nom
Slope Variation vs. Temperature	
(−30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 2V Nom
Rise Time (10-90%)	100 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ −12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	Connectorized (C-24) (See page 484 for physical dimensions.)

Environmental

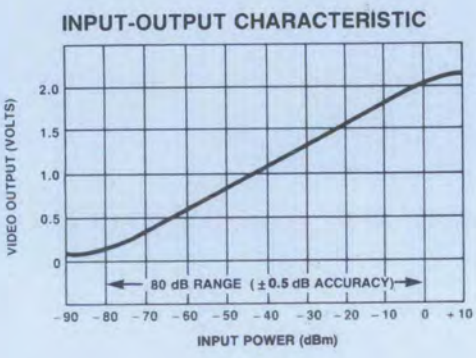
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

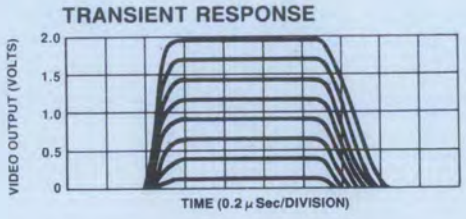
*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

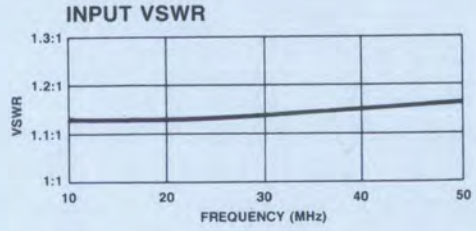
**±15 VDC option available. Consult factory.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance







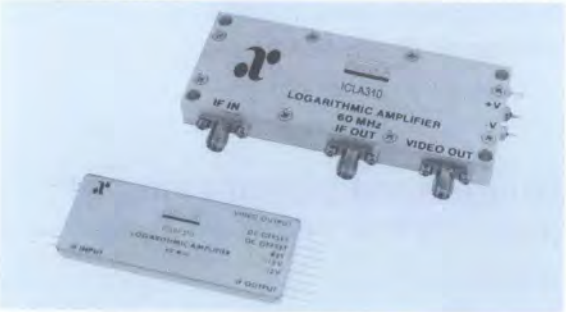
Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ICLX3010B	SMA	$1225

Delivery is from stock.

MODEL ICLAP310/ICLA310 — LOGARITHMIC AMPLIFIER 60 MHz

- Linearity ± 1.0 dB Typical
- Dynamic Range 85 dB Typical
- Hermetically Sealed Microcircuit Construction



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	60 MHz
Input Dynamic Range	80 dB Min (−80 to 0 dBm)
Tangential Sensitivity	−80 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	± 1.50 dB Max
Slope	22 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	± 7% Max
−55 to +85°C	± 10% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	25 nsec Max
Limited IF Output	0 dBm ± 1.5 dB
Bias Power	+12 VDC @ 45 mA Max −12 VDC @ 160 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max
Package Type	Flatpack (FP-12); Connectorized (C-22) (See pages 476 and 484 for physical dimensions.)

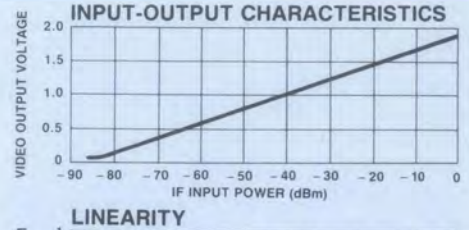
Environmental

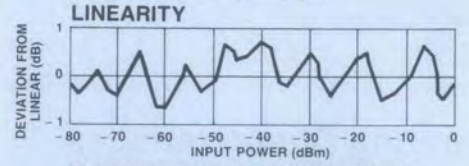
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

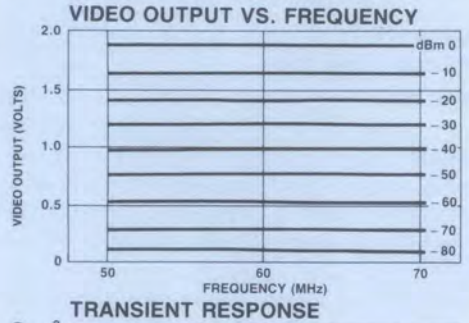
*All specifications apply when operated at ± 12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

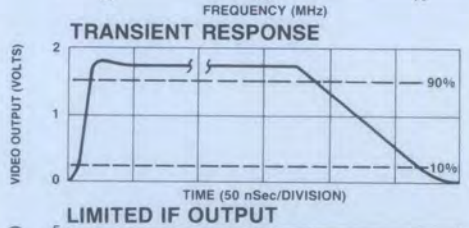
**Previously ANZAC model AM/AMC-310

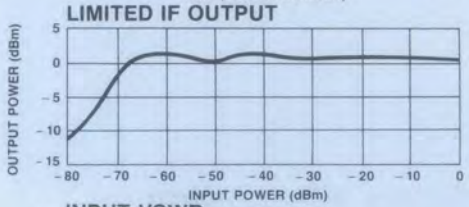
Typical Performance

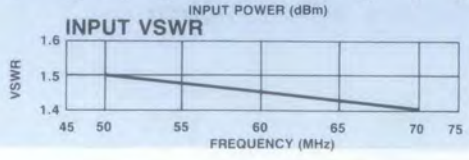












Ordering Information

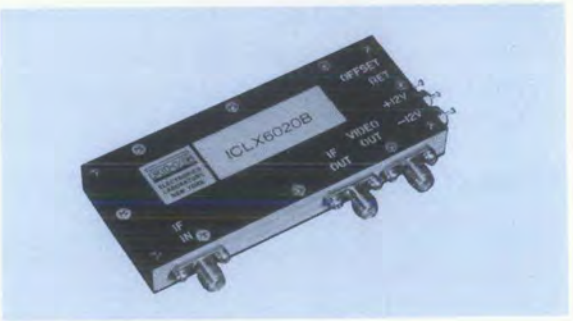
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
ICLAP310	6079	Pin	$1225
ICLA310	6074	SMA	1415

Delivery is from stock.

MODEL ICLX6020B

LOGARITHMIC AMPLIFIER
60 MHz

- 80 dB Dynamic Range
- High Pulse Fidelity
- Linearity ±0.5 dB



Guaranteed Specifications*

(From −30°C to +71°C Case Temp)

Frequency	60 MHz
Bandwidth	20 MHz
Input Dynamic Range	(−80 to 0 dBm)
Log Output	
Linearity	
(@ room temp)	±0.5 dB Max
(−30°C to +71°C)	±1.0 dB Max
Slope (@ room temp)	25 mV/dB Nom
Slope Variation vs. Temperature	
(−30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 2V Nom
Rise Time (10-90%)	50 nsec Max
Limited IF Output	0 dBm Nom
Bias Power **	+12 VDC @ 60 mA Typ −12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	Connectorized (C-24) (See page 484 for physical dimensions.)

Environmental

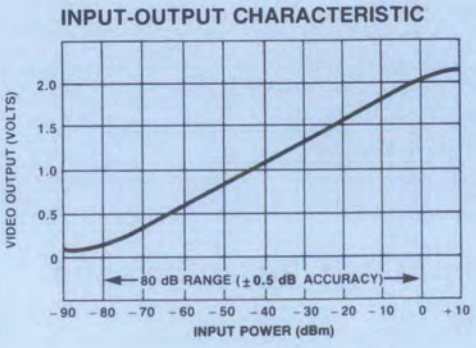
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

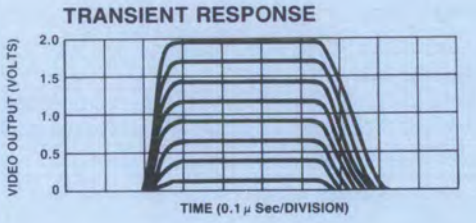
*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

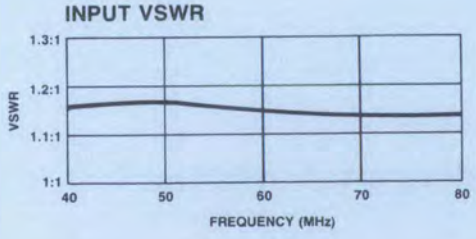
**±15 VDC option available. Consult factory.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance







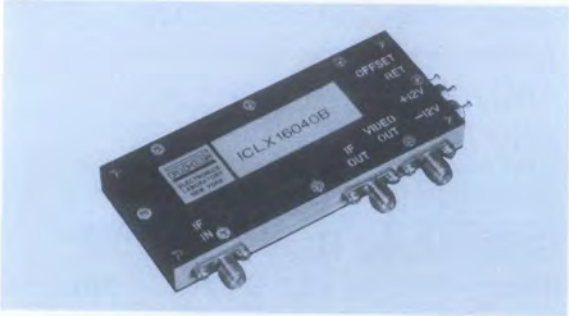
Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ICLX6020B	SMA	$1270

Delivery is from stock.

MODEL ICLX16040B — LOGARITHMIC AMPLIFIER 160 MHz

- 70 dB Dynamic Range
- High Pulse Fidelity
- Linearity ±0.5 dB



Guaranteed Specifications*

(From −30°C to +71°C Case Temp)

Frequency	160 MHz
Bandwidth	40 MHz
Input Dynamic Range	70 dB Min (−70 to 0 dBm)
Log Output	
Linearity	
(@ room temp)	±0.5 dB Max
(−30°C to +71°C)	±1.0 dB Max
Slope (@ room temp)	25 mV/dB Nom
Slope Variation vs. Temperature	
(−30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 2V Nom
Rise Time (10-90%)	30 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ −12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	Connectorized (C-24) (See page 484 for physical dimensions.)

Environmental

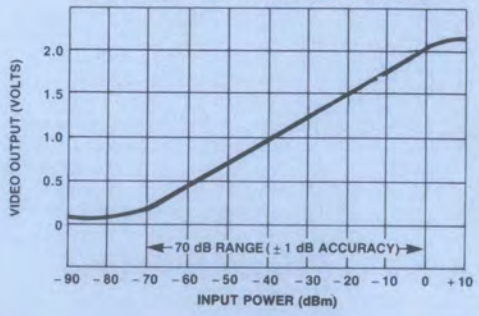
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

**±15 VDC option available. Consult factory.

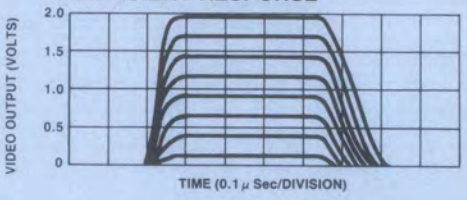
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance

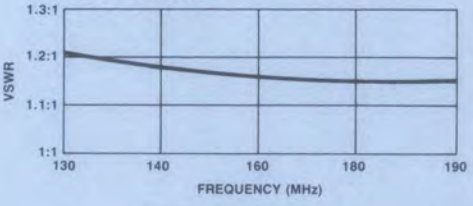
INPUT-OUTPUT CHARACTERISTIC



TRANSIENT RESPONSE



INPUT VSWR



Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ICLX16040B	SMA	$1325

Delivery is from stock.

NEW

MODEL ILM16040

SMALLEST HIGH PERFORMANCE LOG AMPLIFIER 160 MHz

- Less than 0.5 cubic inches
- Weight < 1.0 oz.
- Hermetically Sealed
- P.C. Mount

Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency	160 MHz
Bandwidth	40 MHz Min
Input Dynamic Range	–70 dBm to 0 dBm
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(–30°C to +71°C)	±2 dB Max
Slope (@ room temp)	25 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 2V Nom
Rise Time (10-90%)	30 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ –12 VDC @ 100 mA Typ

Operating Characteristics

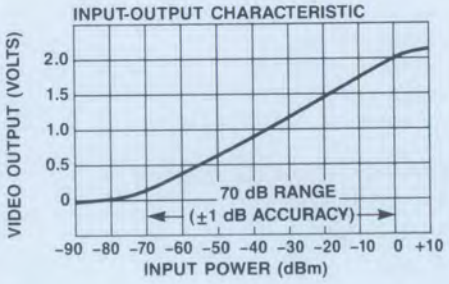
IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	P.C. Mount (FP-23) (See page 477 for physical dimensions.)

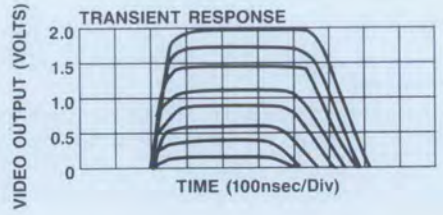
Environmental

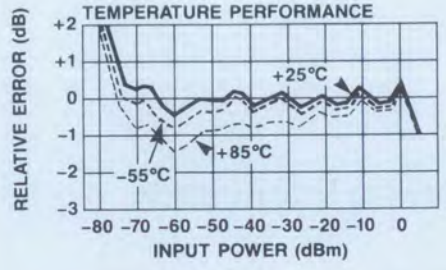
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.
**±15 VDC option available. Consult factory.

Typical Performance







Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ILM16040	P.C. Mount	$1950

NEW

MODEL LV160 — LOW VOLTAGE WIDEBAND LOG AMPLIFIER 110 - 210 MHz

- ±5 VDC Operation
- Low Power Dissipation; 0.5 Watts
- Wideband Operation
- Hermetically Sealed

Guaranteed Specifications*

(From –30°C to +71°C Case Temp)

Frequency Range	110 - 210 MHz
Input VSWR	≤1.5:1
Input Dynamic Range	–70 dBm to +5 dBm
Log Output	
Linearity	
(@ room temp)	±1.5 dB Max
(–30°C to +71°C)	±2.25 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1.15V Nom
Rise Time (10-90%)	20 nsec Max
Limited IF Output	0 dBm Nom
DC Power	
Quiescent	+5 VDC @ 30 mA Typ
	–5 VDC @ 80 mA Typ
Max. Signal	+5 VDC @ 45 mA Typ
	–5 VDC @ 105 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	Connectorized (C-36) (See page 486 for physical dimensions.)

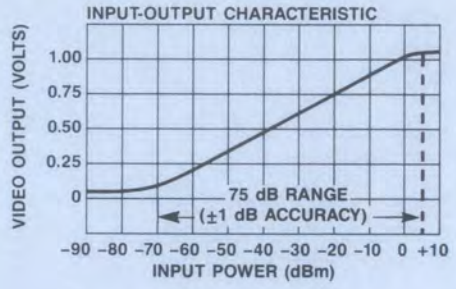
Environmental

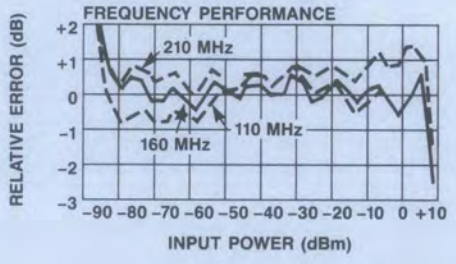
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

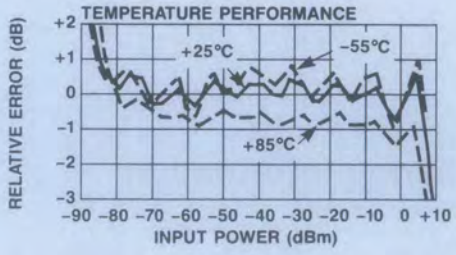
*All specifications apply when operated at ±5 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

For additional RHG products see the latest RHG Electronic Laboratory, Inc. Catalog.

Typical Performance







Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
LV160	SMA	$2850

MODEL ICLAP351/ICLA351 — LOGARITHMIC AMPLIFIER 100-300 MHz

- Linearity ±1.0 dB Typical
- Dynamic Range 80 dB Typical
- Hermetically Sealed Microcircuit Construction

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	100-300 MHz
Input Dynamic Range	75 dB Min (−70 to +5 dBm)
Tangential Sensitivity	−75 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.5 dB Max
Slope	22 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±10% Max
−55 to +85°C	±15% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	0 dBm ±1.5 dB
Bias Power	+12 VDC @ 45 mA Max −12 VDC @ 160 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max
Package Type	Flatpack (FP-12); Connectorized (C-22)

(See pages 476 and 484 for physical dimensions.)

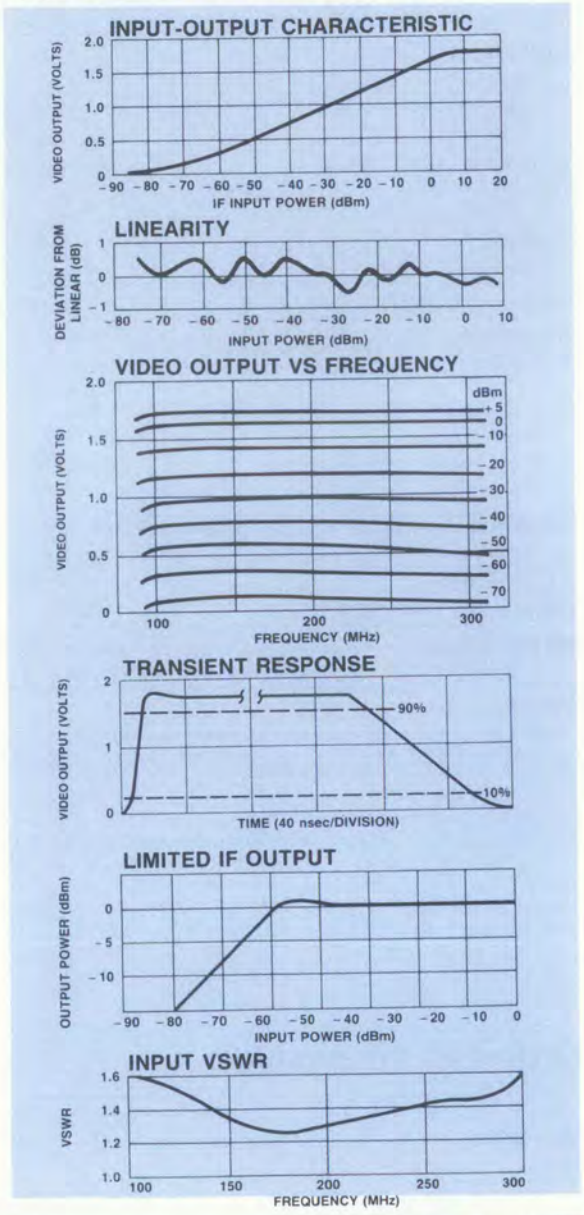
Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

**Previously ANZAC model AM/AMC-351

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
ICLAP351	6049	Pin	$1290
ICLA351	6044	SMA	1477

Delivery is from stock.

RHG — Make the Connection . . . — Adams Russell COMPONENTS GROUP
161 E. Industry Court Deer Park, NY 11729 Fax (516) 242-1222
For Technical Information, Call (516) 242-1100
For Ordering Information, Call (617) 273-3333

MODELS ICLAP352/ICLA352

5Vdc LOGARITHMIC AMPLIFIER
100-300 MHz

- Linearity ±1.0 dB Typical
- Dynamic Range 80 dB Typical
- Hermetically Sealed Microcircuit Construction
- 0.55 Watt Quiescent DC Power

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	100-300 MHz
Input Dynamic Range	75 dB Min (−70 to +5 dBm)
Tangential Sensitivity	−75 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.5 dB Max
Slope	22 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±7% Max
−55 to +85°C	±10% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	0 dBm ±1.5 dB
Bias Power: Quiescent	+5 VDC @ 16 mA Max −5 VDC @ 95 mA Max
+5 dBm C.W. Signal In	+5 VDC @ 40 mA Max −5 VDC @ 130 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max
Package Type	Flatpack (FP-12); Connectorized (C-22) (See pages 476 and 484 for physical dimensions.)

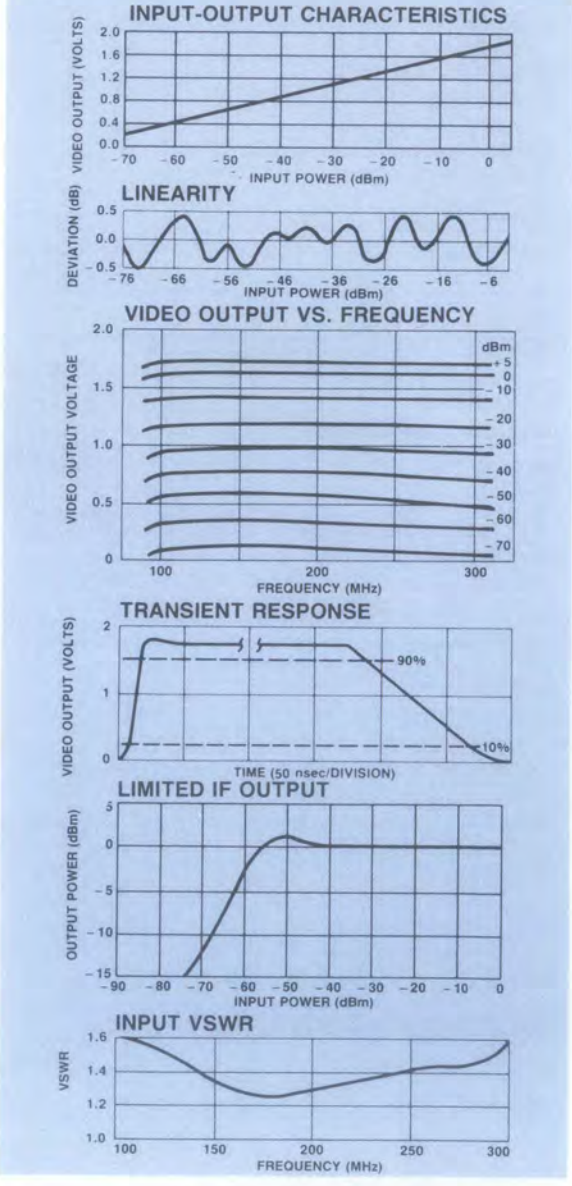
Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ±5 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

**Previously ANZAC model AM/AMC-352

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
ICLAP352	6099	Pin	$1384
ICLA352	6094	SMA	1571

Delivery is from stock.

NEW

MODEL ICLLW300 ICLLWP300 WIDEBAND LOG AMPLIFIER 100 - 500 MHz

- Hermetic Ultraminiature Design
- Linearity ±1 dB
- Greater than Two Octave Operating Band

Guaranteed Specifications*

(From –30°C to +71°C Case Temp)

Frequency Range	100 - 500 MHz
Input Dynamic Range	–70dBm to 0dBm
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(–30°C to +71°C)	±2 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1V Nom
Rise Time (10-90%)	20 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ –12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	ICLLWP300 (FP-21) ICLLW300 (C-36)

(See pages 477 and 486 for physical dimensions.)

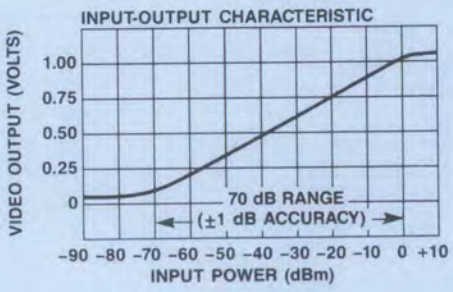
Environmental

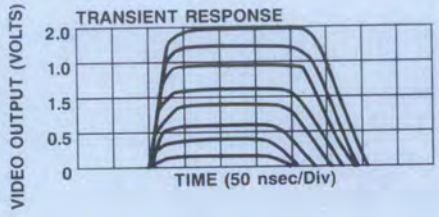
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

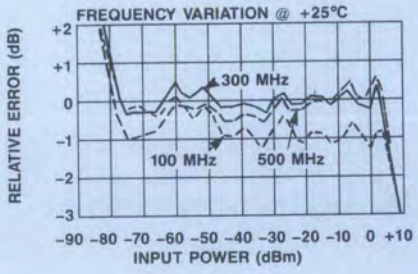
*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

**±15 VDC option available. Consult factory.

Typical Performance







Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ICLLW300	SMA	$2195
ICLLWP300	P.C. Mount	$2295

MODEL ICLAP361/ICLA361 — LOGARITHMIC AMPLIFIER 250-500 MHz

- Linearity ± 1.0 dB Typical
- Dynamic Range 70 dB Typical
- Hermetically Sealed Microcircuit Construction

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	250-500 MHz
Input Dynamic Range	65 dB Min (−65 to 0 dBm)
Tangential Sensitivity	−70 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	± 1.5 dB Max
Slope	25 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	± 10% Max
−55 to +85°C	± 15% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	0 dBm ± 1.5 dB
Bias Power	+12 VDC @ 45 mA Max −12 VDC @ 160 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max
Package Type	Flatpack (FP-12); Connectorized (C-22) (See pages 476 and 484 for physical dimensions.)

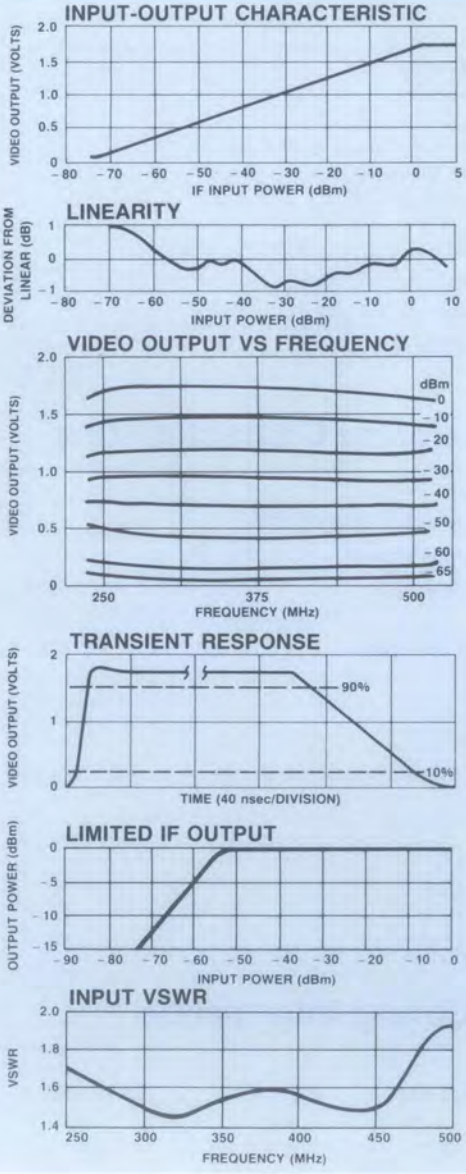
Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ± 12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

**Previously ANZAC model AM/AMC-361

Typical Performance



Ordering Information

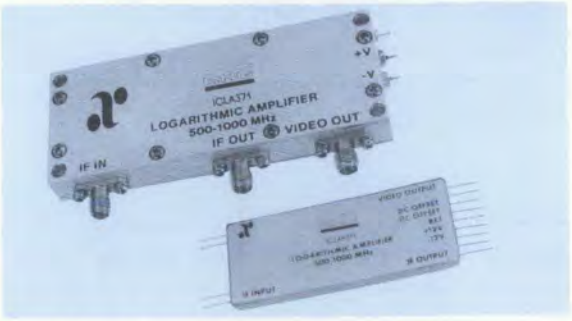
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
ICLAP361	6059	PIN	$1330
ICLA361	6054	SMA	1517

Delivery is from stock.

MODELS ICLAP371/ICLA371

LOGARITHMIC AMPLIFIER 500-1000 MHz

- Linearity ±1.0 dB Typical
- Dynamic Range 70 dB Typical
- Hermetically Sealed Microcircuit Construction



Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	500-1000 MHz
Input Dynamic Range	65 dB Min (−65 to 0 dBm)
Tangential Sensitivity	−70 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.75 dB Max
Slope	25 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±10% Max
−55 to +85°C	±15% Max
Voltage Range (Direct Coupled)	0 to 1.70V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	−3 dBm Min
Bias Power	+12 VDC @ 45 mA Max −12 VDC @ 240 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max
Package Type	Flatpack (FP-12); Connectorized (C-22)

(See pages 476 and 484 for physical dimensions.)

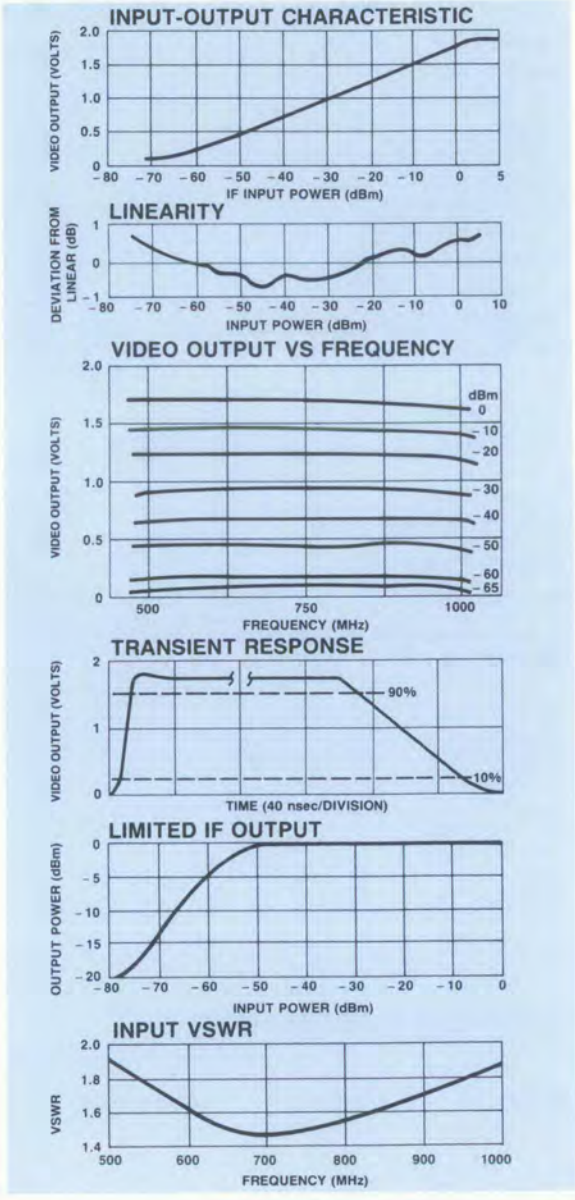
Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

**Previously ANZAC model AM/AMC-371

Typical Performance



Ordering Information

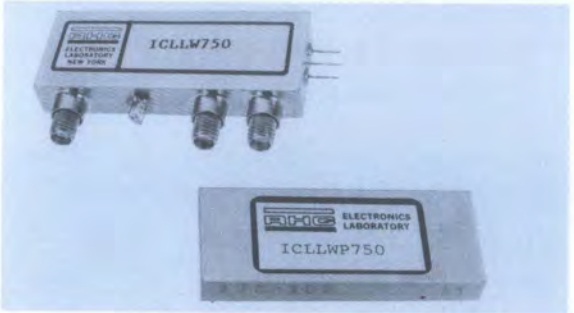
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
ICLAP371	6069	PIN	$1845
ICLA371	6064	SMA	2031

Delivery is from stock.

NEW

MODEL ICLLW750 ICLLWP750 WIDEBAND LOG AMPLIFIER 500 - 1000 MHz

- Hermetic Ultraminiature Design
- Linearity ±1 dB
- Wideband Log Characteristics



Guaranteed Specifications*

(From –30°C to +71°C Case Temp)

Frequency Range	500 - 1000 MHz
Input Dynamic Range	–65dBm to 0dBm
Log Output Linearity @ room temp.	±1.0dB
–30°C to +71°C	±2.0dB
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(–30°C to +71°C)	±2 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1V Nom
Rise Time (10-90%)	20 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ
	–12 VDC @ 100 mA Typ

Operating Characteristics

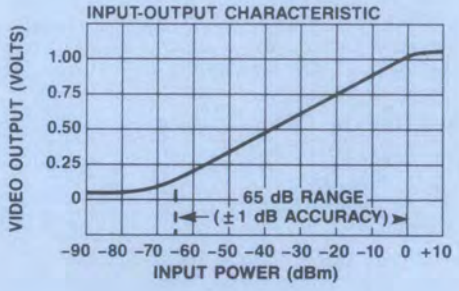
IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	ICLLWP750 (FP-21)
	ICLLW750 (C-36)
	(See page 477 and 486 for physical dimensions.)

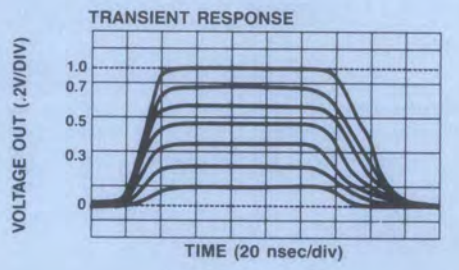
Environmental

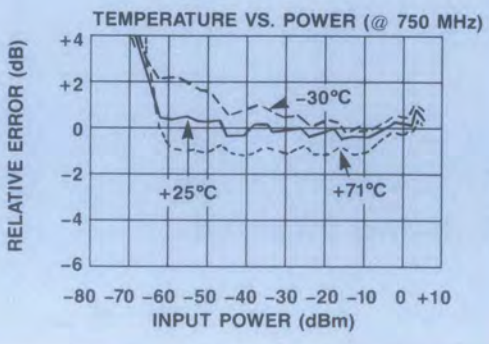
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.
**±15 VDC option available. Consult factory.

Typical Performance







Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ICLLW750	SMA	$2550
ICLLWP750	P.C. Mount	$2650

NEW

MODEL MWL1000

WIDEBAND LOGARITHMIC AMPLIFIER 500 - 1500 MHz

- 1 GHz Operating Bandwidth
- Hermetic Ultraminiature Design
- Clean Pulse Response

Guaranteed Specifications*

(From –30°C to +71°C Case Temp)

Frequency Range	500 - 1500 MHz
Input VSWR	2.0:1 Max
Input Dynamic Range	–65 dBm to 0 dBm
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(–30°C to +71°C)	±2 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1V Nom
Rise Time (10-90%)	15 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 50 mA Typ –12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	Connectorized (C-36) (See pages 486 for physical dimensions.)

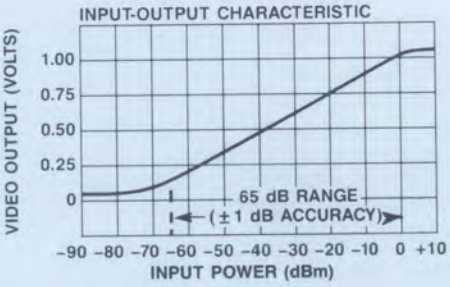
Environmental

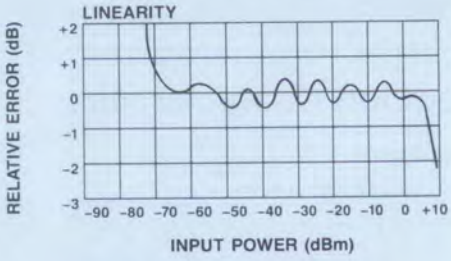
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

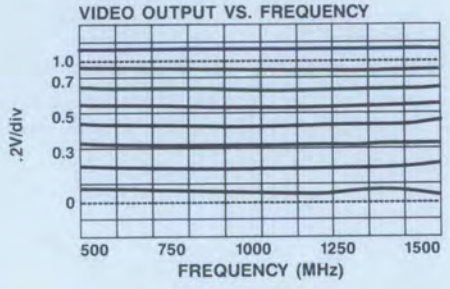
*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.
**±15 VDC option available, consult factory.

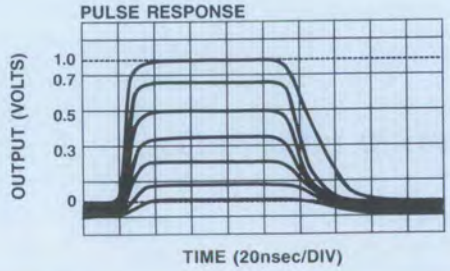
For additional information of the RHG MWL Series 10 Amps (up to 3 GHz) see the latest RHG Electronic Laboratory Catalog.

Typical Performance









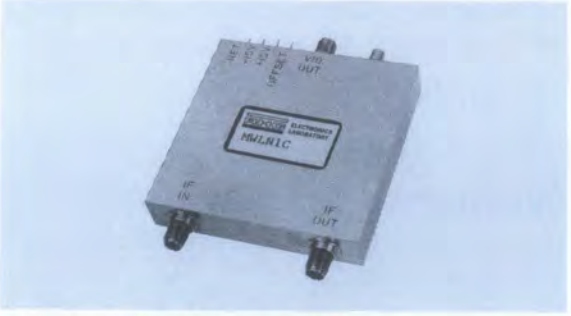
Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
MWL1000	SMA	$2675

NEW

MODEL MWLN1C — 1 nsec RISE TIME LOG AMPLIFIER 1000 MHz

- 1 nsec Rise Time
- 60 dB Dynamic Range
- MIL Grade



Guaranteed Specifications*

(From –30°C to +71°C)

Frequency		1000 MHz
Bandwidth		700 MHz Nom
Input Dynamic Range		–60 dBm to 0 dBm
Log Output		
Linearity		
(@ room temp)		±1 dB Max
(–30°C to +71°C)		±2 dB Max
Slope (@ room temp)		15 mV/dB Nom
Slope Variation vs. Temperature		
(–30°C to +71°C)		5% Max
Voltage Range (Direct Coupled)		0 to 1V Nom
Input VSWR (50 Ohms)		≤ 2:1
Rise Time		1 nsec Max
Bias Power	+15 VDC	75 mA Typ
	–15 VDC	150 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	50 Ohms Nominal
Package Type	Connectorized (C-38) (See page 486 for physical dimensions.)

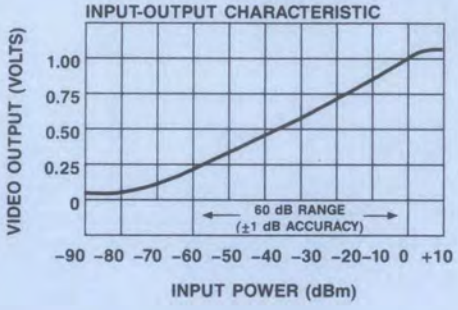
Environmental

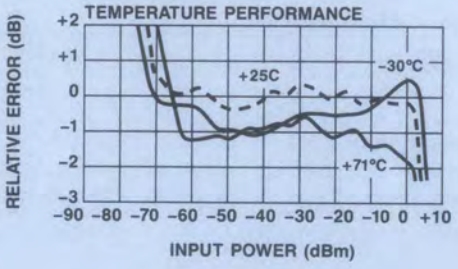
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

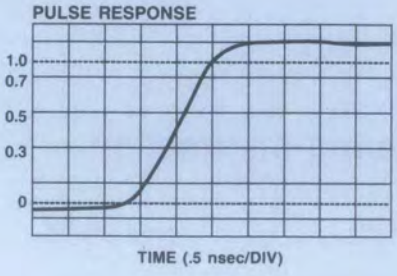
*All specifications apply when operated at ±15 VDC and with a 50 ohm IF source and load impedance and 50 ohm video load impedance.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog. Call RHG for information on 1nsec Logs at other operating frequencies.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
MWLN1C	SMA	$3,750

Delivery is from stock.

NEW

MODEL ICDL16035 ICDLP16035

FREQUENCY DISCRIMINATOR
160 MHz

- Hermetic Ultraminiature Discriminator
- Connector and P.C. Mount Designs
- 1 Cubic Inch (16.4 ml)

Guaranteed Specifications*
(From –40°C to +71°C Case Temp)

Crossover Frequency	160 MHz
Rated Input	0 dBm (usable –20 to 0dBm)
Output Linear Bandwidth	35 MHz Min
Peak to Peak Bandwidth	60 MHz Min
Linearity	≤ ±3% over linear bandwidth at room temperature ≤ ±6% over linear bandwidth at –40°C to +71°C
Video Output	DC coupled emitter follower, rated output into 93 on load
Minimum Video Output	0.100 Volts/MHz
Rise Time	25 nsec Max
Bias Power**	+12 VDC @ 100 mA Typ –12 VDC @ 100 mA Typ

Operating Characteristics

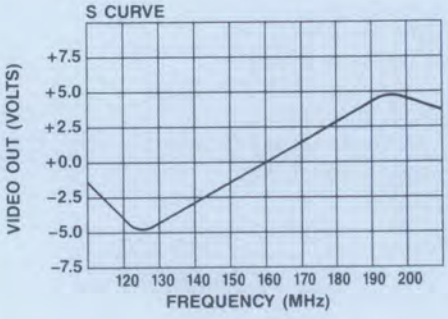
IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	ICDLP16035 (FP-22) ICDL16035 (C-37)

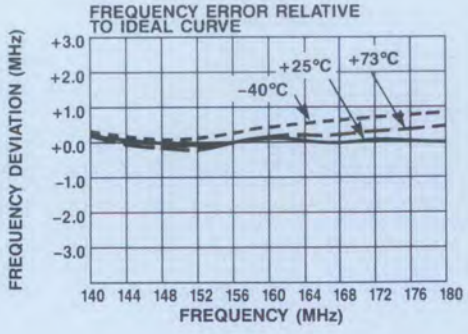
(See pages 477 and 486 for physical dimensions.)

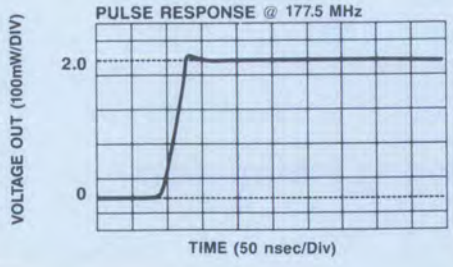
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.
**±15 VDC option available. Consult factory.

Typical Performance







Ordering Information

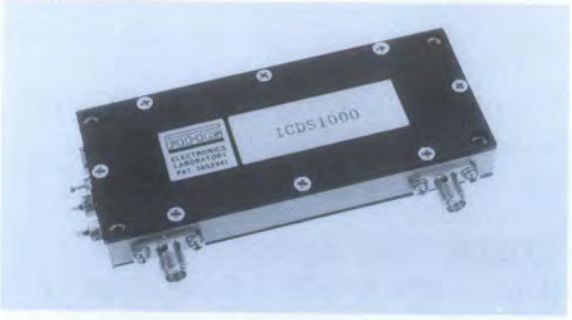
Model No.	Connector	Unit Price (1-9 Units)
ICDL16035	SMA	$1425
ICDLP16035	P.C. Mount	$1525

NEW

MODEL ICDS1000

DELAY LINE FREQUENCY DISCRIMINATOR 1000 MHz

- Fast Rise Time: ≤ 5 nanoseconds
- Direct Coupled Video
- Excellent Transient Response



Guaranteed Specifications*
(From –54°C to +71°C Case Temp)

Crossover Frequency	1000 MHz
Linear Bandwidth	300 MHz
Rated Input	0 dBm (usable to –10 dBm)
Discriminator Output Slope	10 mV/MHz Min
Linear Bandwidth	300 MHz Min
Peak to Peak Bandwidth	500 MHz Min
Frequency Accuracy	≤ ±12 MHz over linear bandwidth @ +25°C ≤ ±30 MHz over linear bandwidth and temperature°C
Rise Time	5 nsec Max
Bias Power*	+12 VDC @ 40 mA Typ –12 VDC @ 190 mA Typ

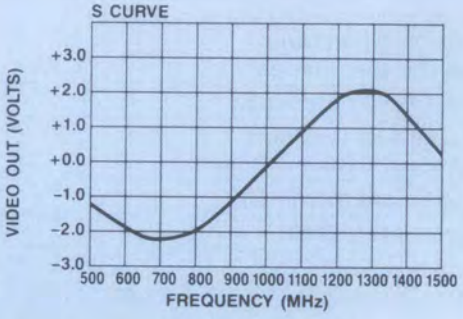
Operating Characteristics

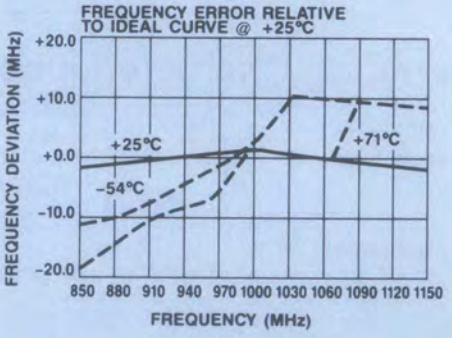
IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Package Type	Connectorized (C-24) (See page 484 for physical dimensions.)

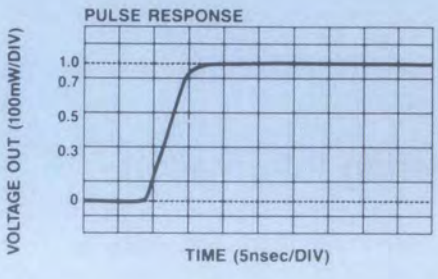
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*±15 VDC option available. Consult factory.
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance







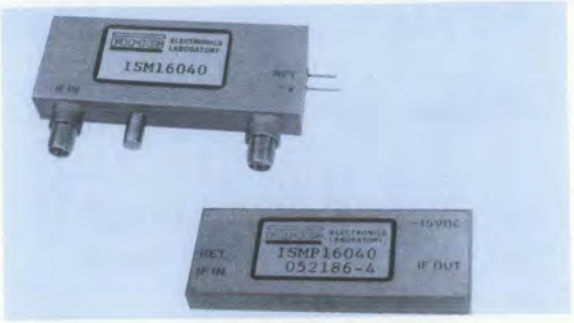
Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ICDS1000	SMA	$1995

NEW

MODEL ISM16040 / ISMP16040 — CONSTANT PHASE LIMITER 160 MHz

- High Performance
- Hermetically-Sealed
- Connector and P.C. Mount Designs
- 1 Cubic Inch (16.4 ml)



Guaranteed Specifications*

(From –40°C to +71°C Case Temp)

Frequency	160 MHz
Bandwidth	40 MHz
Input Dynamic Range	–70 to –5 dBm
Output Phase Variation Over Input Dynamic Range	< 10°
Output Power (nominal)	+10 dBm
Output Level Variation Over Input Dynamic Range	±0.5 dB
Noise Figure (nominal)	10 dB
Input/Output VSWR	≤ 1.5:1
Phase Tracking**	
Two Channels	±2.5° (room temperature) ±5.0° (–40°C to +70°C)
Three Channels	±3.0° (room temperature) ±6.0° (–40°C to +70°C)
Bias Power*	–12 VDC @ 150 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Package Type	ISM16040 Connectorized (C-35) ISMP16040 P.C. Mount (FP-24) (See pages 486 and 478 for physical dimensions.)

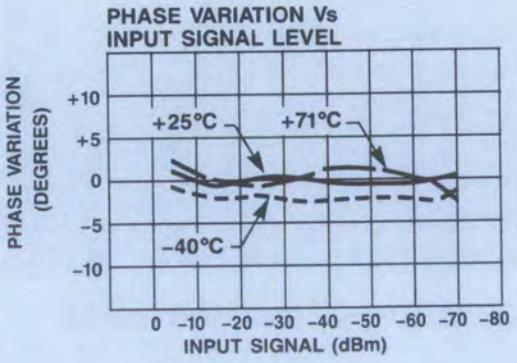
Environmental

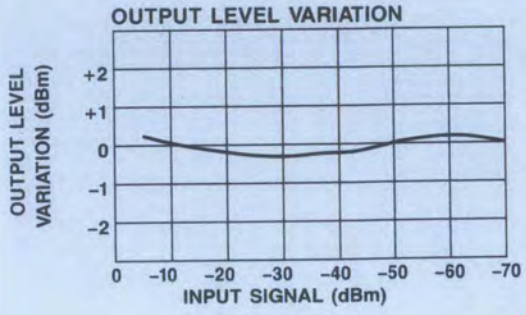
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

*–15 VDC option available, consult factory.
**Special order requirement — Option "M"

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

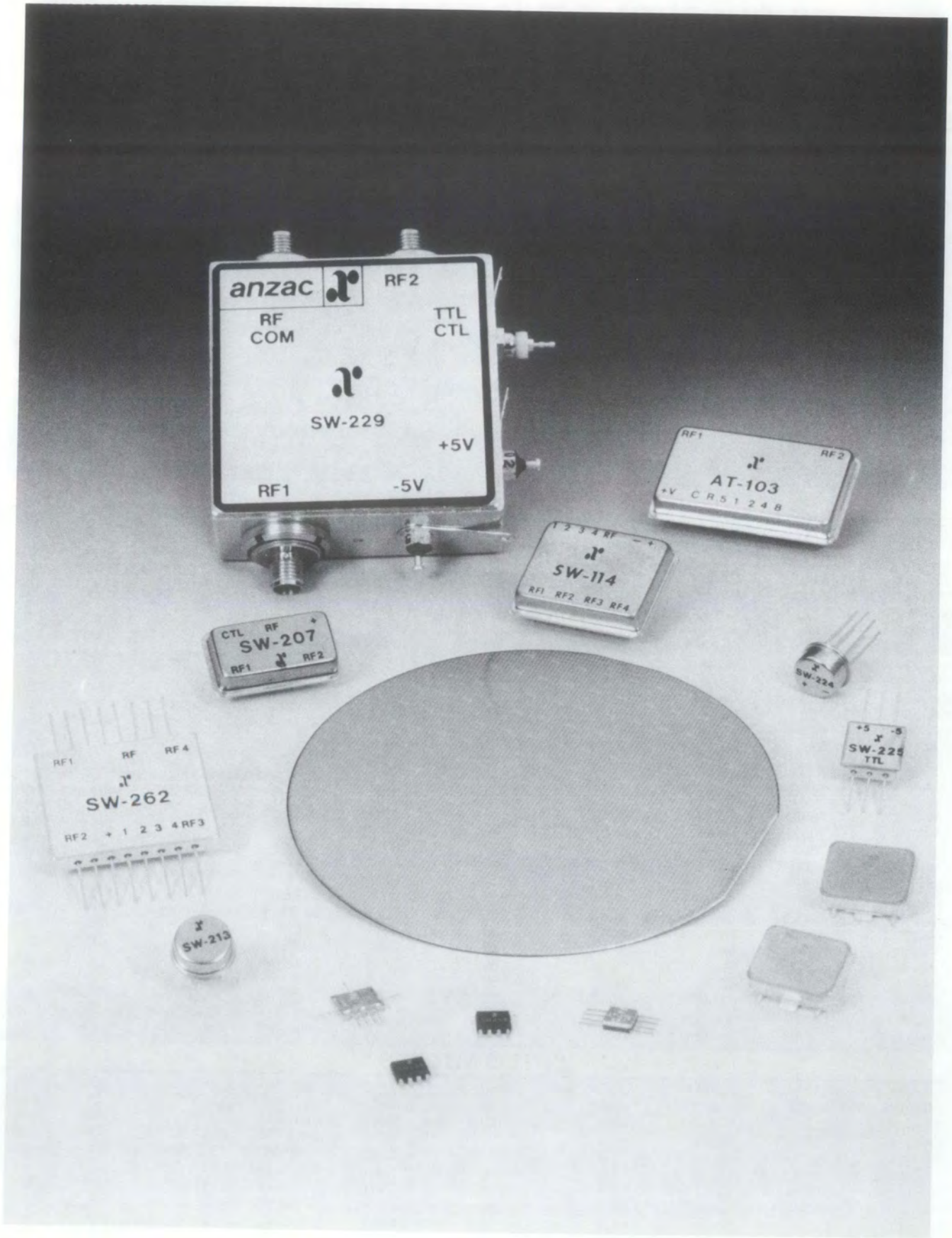
Typical Performance





Ordering Information

Model No.	Connector	Unit Price (1-9 Units)
ISM16040	SMA	$1615
ISMP16040	P.C. Mount	$1715


anzac
RF2
RF COM
TTL CTL
SW-229
+5V
RF1
-5V
RF1
RF2
AT-103
+V CR51248
1 2 3 4 RF
SW-114
RF1 RF2 RF3 RF4
CTL RF
SW-207
RF1 RF2
SW-224
RF1 RF RF4
SW-262
RF2 + 1 2 3 4 RF3
+5 -5
SW-225
TTL
SW-213

RF CONTROL DEVICE SELECTION GUIDE

MODEL NO.	FREQUENCY RANGE (MHz)	SILICON/ GaAs	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	TERM	DRIVER	CASE[1] STYLE	PAGE NO.
SPST SWITCHES									
SW-121	5-1000	Si	0.5	60	1.1:1	OPEN	TTL	DI-1	144
SW-161	10-1500	Si	0.8	60	1.1:1	50 OHM	TTL	DI-1	152
SW-111	5-2000	Si	1.2	80	1.1:1	OPEN	TTL	DI-1	138
SW-131	200-2000	Si	0.5	50	1.15:1	OPEN	TTL	DI-1	148
SW-209	**DC-3000**	**GaAs**	**0.7**	**45**	**1.15:1**	**50 OHM**	**0/–5V**	**CR-3**	168
SW-209B	**DC-3000**	**GaAs**	**0.7**	**45**	**1.15:1**	**50 OHM**	**0/–5V**	**CR-3**	168
SW-211	**DC-3000**	**GaAs**	**0.5**	**45**	**1.15:1**	**OPEN**	**0/–5V**	**TO-5-3**	169
SW-212	**DC-3000**	**GaAs**	**0.5**	**45**	**1.15:1**	**OPEN**	**0/–5V**	**FP-13**	170
SW-213	**DC-3000**	**GaAs**	**0.7**	**55**	**1.15:1**	**50 OHM**	**0/–5V**	**TO-5-3**	169
SW-214	**DC-3000**	**GaAs**	**0.7**	**55**	**1.15:1**	**50 OHM**	**0/–5V**	**FP-13**	170
SWS-278**	**DC-3000**	**GaAs**	**0.9**	**55**	**1.1:1**	**50 OHM**	**0/–5V**	**SF-1**	192
SW-221	**DC-4000**	**GaAs**	**0.7**	**55**	**1.15:1**	**50 OHM**	**0/–5V**	**CR-2**	174
SW-222	**DC-4000**	**GaAs**	**0.7**	**60**	**1.15:1**	**OPEN**	**0/–5V**	**CR-2**	174
SW-223	**DC-4000**	**GaAs**	**0.5**	**45**	**1.15:1**	**OPEN**	**0/–5V**	**CR-2**	174
SW-215	**5-4000**	**GaAs**	**1.0**	**60**	**1.2:1**	**50 OHM**	**TTL**	**DI-1**	171
SW-216	**5-4000**	**GaAs**	**1.0**	**60**	**1.2:1**	**50 OHM**	**CMOS**	**DI-1**	171
SW-231	**5-4000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**TTL**	**FP-16**	178
SW-232	**5-4000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**CMOS**	**FP-16**	178
SW-210	**DC-6000**	**GaAs**	**0.7**	**55**	**1.1:1**	**50 OHM**	**0/–5V**	**CHIP**	158
SPDT SWITCHES									
SW-239	**DC-1000**	**GaAs**	**0.5**	**55**	**1.1:1**	**OPEN**	**0/–5V**	**SF-2**	182
SW-122	5-1000	Si	0.5	60	1.1:1	OPEN	TTL	DI-1	145
SW-162	10-1500	Si	0.8	60	1.1:1	50 OHM	TTL	DI-1	153
SW-224	**DC-2000**	**GaAs**	**0.6**	**40**	**1.2:1**	**OPEN**	**TTL**	**TO-5-3**	175
SW-225	**DC-2000**	**GaAs**	**0.6**	**35**	**1.1:1**	**OPEN**	**TTL**	**FP-13**	175
SW-229	**DC-2000**	**GaAs**	**0.8**	**45**	**1.15:1**	**OPEN**	**TTL**	**C-34**	177
SW-112	5-2000	Si	1.2	80	1.1:1	OPEN	TTL	DI-1	139
SW-217	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**TTL**	**DI-1**	172
SW-218	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**CMOS**	**DI-1**	172
SW-233	**5-2000**	**GaAs**	**1.0**	**50**	**1.2:1**	**50 OHM**	**TTL**	**FP-16**	179
SW-234	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**TTL**	**FP-16**	180
SW-236	**5-2000**	**GaAs**	**1.0**	**50**	**1.2:1**	**50 OHM**	**CMOS**	**FP-16**	179
SW-237	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**CMOS**	**FP-16**	180
SW-118	10-2000	Si	0.8	50	1.1:1	OPEN	TTL	DI-4	142
SW-132	200-2000	Si	0.5	50	1.15:1	OPEN	TTL	DI-1	149
SW-201	DC-3000	GaAs	0.5	50	1.15:1	OPEN	0/–5V	TO-5-3	164
SW-202	DC-3000	GaAs	0.5	50	1.15:1	OPEN	0/–5V	FP-13	165
SW-203	**DC-3000**	**GaAs**	**0.8**	**50**	**1.15:1**	**50 OHM**	**0/–5V**	**TO-5-3**	164
SW-204	**DC-3000**	**GaAs**	**0.8**	**50**	**1.15:1**	**50 OHM**	**0/–5V**	**FP-13**	165
SW-219	**DC-3000**	**GaAs**	**0.5**	**40**	**1.1:1**	**OPEN**	**0/–5V**	**CR-3**	173
SW-219B	**DC-3000**	**GaAs**	**0.5**	**40**	**1.1:1**	**OPEN**	**0/–5V**	**CR-3**	173
SW-235	**5-3000**	**GaAs**	**0.9**	**50**	**1.2:1**	**OPEN**	**TTL**	**FP-16**	181
SW-238	**5-3000**	**GaAs**	**0.9**	**50**	**1.2:1**	**OPEN**	**CMOS**	**FP-16**	181
SW-226	**DC-4000**	**GaAs**	**0.8**	**55**	**1.15:1**	**50 OHM**	**0/–5V**	**CR-2**	176
SW-227	**DC-4000**	**GaAs**	**0.8**	**60**	**1.15:1**	**OPEN**	**0/–5V**	**CR-2**	176
SW-228	**DC-4000**	**GaAs**	**0.5**	**45**	**1.1:1**	**OPEN**	**0/–5V**	**CR-2**	176
SW-205	5-4000	GaAs	1.2	55	1.2:1	50 OHM	TTL	DI-1	166
SW-206	5-4000	GaAs	1.2	55	1.2:1	50 OHM	CMOS	DI-1	166
SW-207	5-4000	GaAs	0.8	45	1.2:1	OPEN	TTL	DI-1	167
SW-208	5-4000	GaAs	0.8	45	1.2:1	OPEN	CMOS	DI-1	167
SW-200	DC-6000	GaAs	0.5	50	1.15:1	OPEN	0/–5V	CHIP	156
SP3T SWITCHES									
SW-123	5-1000	Si	0.6	60	1.1:1	OPEN	TTL	DI-2	146
SW-163	10-1500	Si	0.5	45	1.2:1	50 OHM	TTL	DI-2	154
SW-113	5-2000	Si	1.3	60	1.1:1	OPEN	TTL	DI-2	140
SW-241	**5-2000**	**GaAs**	**1.0**	**60**	**1.2:1**	**50 OHM**	**TTL**	**DI-5**	183
SW-242	**5-2000**	**GaAs**	**1.0**	**60**	**1.2:1**	**OPEN**	**TTL**	**DI-5**	184
SW-244	**5-2000**	**GaAs**	**1.0**	**60**	**1.2:1**	**50 OHM**	**CMOS**	**DI-5**	183
SW-245	**5-2000**	**GaAs**	**1.0**	**60**	**1.2:1**	**OPEN**	**CMOS**	**DI-5**	184
SW-247	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**TTL**	**FP-17**	186
SW-248	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**TTL**	**FP-17**	187
SW-251	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**CMOS**	**FP-17**	186
SW-252	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**CMOS**	**FP-17**	187
SW-133	200-2000	Si	0.6	45	1.2:1	OPEN	TTL	DI-2	150

[1]CASE STYLE: FP = FLATPACK; DI = DUAL INLINE; TO = TO-5/8; CHIP = IC CHIP

**DENOTES SURFACE MOUNT

BOLD = NEW PRODUCTS

RF CONTROL DEVICE SELECTION GUIDE (continued)

SP4T SWITCHES

MODEL NO.	FREQUENCY RANGE (MHz)	SILICON/ GaAs	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	TERM	DRIVER	CASE[1] STYLE	PAGE NO.
SW-124	5-1000	Si	0.6	60	1.1:1	OPEN	TTL	DI-2	147
SW-164	10-1500	Si	0.9	60	1.1:1	50 OHM	TTL	DI-2	155
SW-114	5-2000	Si	1.2	80	1.1:1	OPEN	TTL	DI-2	141
SW-254	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**TTL**	**DI-5**	188
SW-255	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**TTL**	**DI-5**	187
SW-257	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**CMOS**	**DI-5**	188
SW-258	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**CMOS**	**DI-5**	189
SW-261	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**TTL**	**FP-17**	190
SW-262	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**TTL**	**FP-17**	191
SW-264	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**50 OHM**	**CMOS**	**FP-17**	190
SW-265	**5-2000**	**GaAs**	**1.0**	**55**	**1.2:1**	**OPEN**	**CMOS**	**FP-17**	191
SW-134	200-2000	Si	0.6	45	1.2:1	OPEN	TTL	DI-2	151
SW-240	**DC-4000**	**GaAs**	**0.6**	**50**	**1.2:1**	**OPEN**	**0/–5V**	**CHIP**	160
SW-243	**DC-4000**	**GaAs**	**0.7**	**40**	**1.2:1**	**OPEN**	**0/–5V**	**CR-4**	185

DPDT SWITCHES

MODEL NO.	FREQUENCY RANGE (MHz)	SILICON/ GaAs	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	TERM	DRIVER	CASE[1] STYLE	PAGE NO.
SW-281	**DC-4000**	**GaAs**	**0.5**	**50**	**1.15:1**	**OPEN**	**0/–5V**	**CR-4**	193
SW-280	**DC-6000**	**GaAs**	**0.5**	**50**	**1.15:1**	**OPEN**	**0/–5V**	**CHIP**	162

TRANSFER SWITCHES

MODEL NO.	FREQUENCY RANGE (MHz)	SILICON/ GaAs	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	TERM	DRIVER	CASE[1] STYLE	PAGE NO.
SW-119	10-2000	Si	0.9	50	1.1:1	OPEN	TTL	DI-4	143
SW-283	**DC-3000**	**GaAs**	**0.8**	**55**	**1.15:1**	**OPEN**	**0/–5V**	**CR-4**	194

ATTENUATORS

MODEL NO.	FREQUENCY RANGE (MHz)	SILICON/ GaAs	INSERTION LOSS (dB) TYP	ATTENUATION RANGE (dB) TYP	VSWR TYP	TYPE	CASE[1] STYLE	PAGE NO.
AT-101	1.5-1000	Si	2.0	60	1.5:1	VVA	FP-2	196
AT-102	20-1000	Si	3.8	31	1.3:1	DIGITAL	DI-3	197
AT-103	20-1000	Si	3.8	15.5	1.3:1	DIGITAL	DI-3	198
AT-104	20-2000	GaAs	8.0	31	1.3:1	DIGITAL	DI-3	199
AT-200	DC-5000	GaAs	1.0	25	1.3:1	VVA	CHIP	200
AT-201	DC-5000	GaAs	1.25	25	1.3:1	VVA	CR-2	202
AT-202	DC-5000	GaAs	1.25	25	1.3:1	VVA	CR-3	203

PHASE SHIFTERS

MODEL NO.	FREQUENCY RANGE (MHz)	PHASE RANGE (Deg)	INSERTION LOSS (dB) TYP	VSWR TYP	CASE STYLE	PAGE NO.
PM-111	28.5-31.5	0.180	0.8	1.3:1	FP-4	195

[1]CASE STYLE: FP = FLATPACK; DI = DUAL INLINE; TO = TO-5/8; CHIP = IC CHIP
**DENOTES SURFACE MOUNT
BOLD = NEW PRODUCTS

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

PIN DIODE RF SWITCHES

INTRODUCTION

PIN diode RF switches are devices which control the path of RF signals through transmission line media. The switching is performed by biased PIN diodes in the RF path and is totally solid state in operation.

PIN diode RF switches are typically used in small signal (less than +10 dBm) applications, although higher power switches have been designed. System designers use PIN switches at frequencies between 5 MHz and 18 GHz in any application requiring RF switches. Some of these include the following:

- High Band/Low Band Receiver Switches
- Selecting Various Bandwidth IF Filters
- Controlling Antenna Arrays
- Pulse Modulation
- Signal Sampling
- Selecting Local Oscillators

The purpose of this application note is to familiarize the systems designer with the capabilities of RF PIN switches. We will define performance parameters, outline design tradeoffs and determine typical specification margins.

SWITCH DESIGN CONFIGURATIONS

To understand the basic performance limitations, the systems designer needs to be familiar with the various switch configurations and their capabilities and limitations. This will be a brief introduction with a more detailed treatment available in the literature.[4,6]

Series

The series PIN diode switch is shown in Figure 1a. This circuit can provide excellent isolation at lower frequencies (below 2 GHz). Because of its simplicity, this switch has very low insertion loss over a very broad frequency range with values below 0.5 dB possible. When re-applied as a multithrow as in Figure 1b, the circuit performs as a broadband switch having the same properties of the single throw switch in each arm. In fact, this configuration is the simplest way to design a broadband multithrow switch.

Shunt

The shunt switch is the workhorse configuration for PIN diode switches. Shown in Figure 2a, the shunt switch has excellent isolation properties over a very broad frequency range (approximately 20 dB for a single diode & switch). In addition, insertion loss is low because of the lack of any elements in series with the transmission line. In-

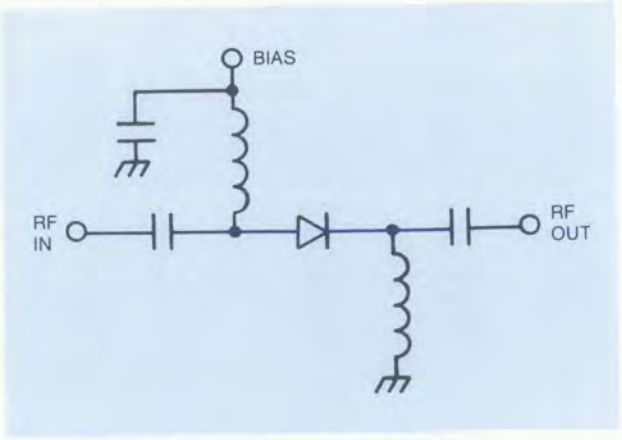


Figure 1a. Series SPST

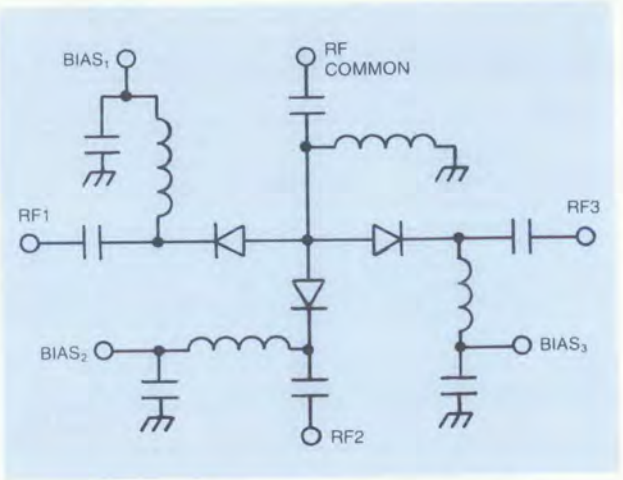


Figure 1b. Multithrow Series Switch

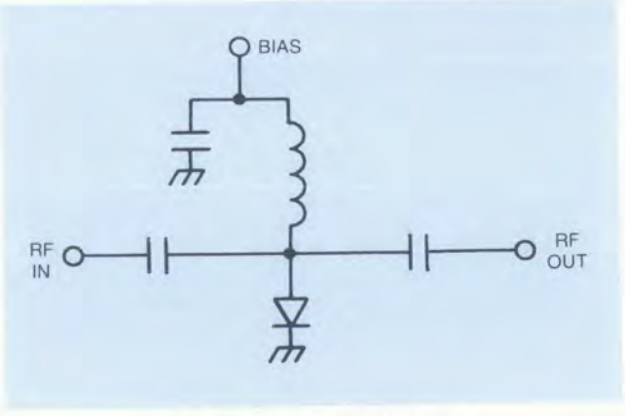


Figure 2a. Shunt SPST

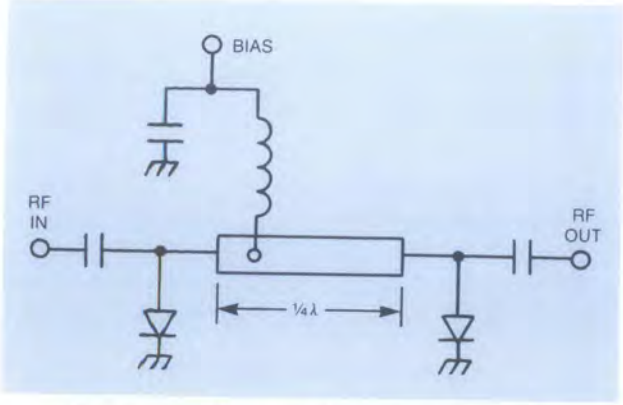


Figure 2b. Shunt ¼λ Spaced Diodes

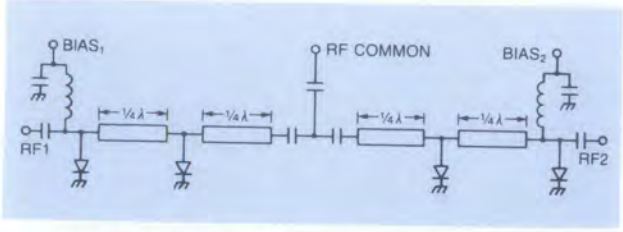


Figure 2c. Band-Limited Shunt Multithrow

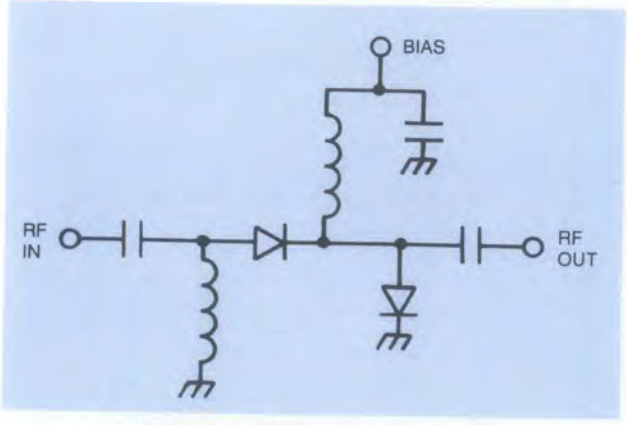


Figure 3a. Series-Shunt SPST

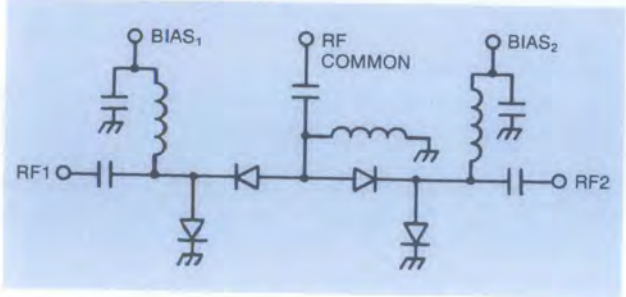


Figure 3b. Multithrow Seris-Shunt

sertion loss and VSWR are limited at 10 GHz and above by the shunt capacitance of the diode. Good performance with moderate VSWR to 18 GHz is possible.

To enhance isolation over octave bandwidths, several shunt diodes separated by quarter-wave transmission lines may be incorporated. One such switch is shown in Figure 2b. The isolation is approximately double that of the single shunt diode plus 6 dB.[4] Although limited in bandwidth, this configuration can achieve very high isolation values (70-90 dB) with additional shunt diodes and transmission line sections. However, insertion loss will increase as more components are added to the circuit.

Multithrow switches are difficult to realize using only shunt diodes. A band-limited shunt multithrow as shown in Figure 2c uses quarter-wave transmission lines to give the "off" arm a high input impedance at the common port to prevent loading of the "on" arm. Because this is achieved with quarter-wave sections, the switch is inherently band-limited to approximately one octave.[7]

Series-Shunt

To combine the broadband insertion loss of the series switch with the broadband isolation of the shunt switch, plus adding multithrow capability, a PIN diode switch is given the series-shunt configuration as shown in Figure 3a. The increased complexity degrades insertion loss and VSWR but overall performance is greatly enhanced. Like the shunt switch, isolation can be increased with the addition of diode/quarter-wave transmission line sections at the expense of insertion loss and VSWR.

Multithrow series-shunt switches are configured as shown in Figure 3b. Arms may be added to construct a switch of the desired order. Multithrow series-shunt switches are the best overall performers when broadband isolation is required and reasonable (1-2 dB) insertion loss is tolerable.

Additional variations are possible from those shown here. Modifications and innovations can be made to optimize a particular parameter. However, with the adoption of a given configuration comes a set of performance characteristics which the designer has to live with. Although he can modify them somewhat, the designer is often limited to what he can achieve without a total change in his design.

UNDERSTANDING PARAMETERS

Insertion Loss

Insertion Loss, as well as Isolation, and VSWR are the primary parameters which describe a PIN switch. Insertion Loss is a measure of RF signal loss when passing through the switch when it is in the "on" condition. Although it is desirable for Insertion Loss to be ideally non-existent, it is nevertheless a necessary evil. Some amount of Insertion Loss must be tolerated in order to allow tradeoffs for other parameters. Typical values are between 0.5 dB and 2 dB. See Figure 4a.

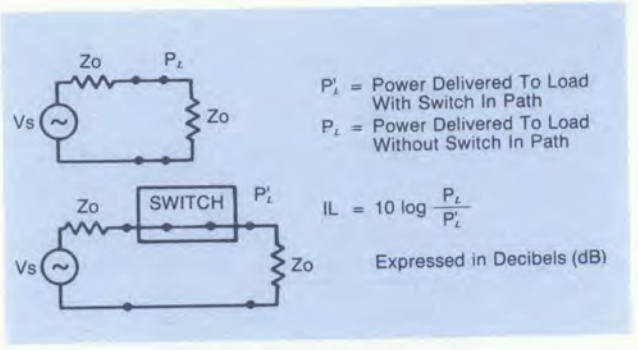


Figure 4a. Insertion Loss

Isolation

Isolation is a measure of the degree which an unwanted RF signal is attenuated when the switch path is in the "off" condition. Being the difference in power levels appearing at a load with the switch "off" as compared to the switch "on", isolation is sometimes referred to as the on/off ratio. A minimum amount of isolation is required by the system designer to provide adequate rejection of unwanted signals in a given RF path. Because realizable isolation values are finite and are at the expense of other parameters, no higher isolation than necessary should be specified. Isolation levels range from 20 dB to 70 dB or more with values above 90 dB achievable but designs to achieve these levels are at the expense of other parameters, principally insertion loss. A switch in the isolated state presents a reflective termination at each port at which no alternate RF path exists. In cases where this is a problem, a switch can be designed to present a matched termination in both "on" and "off" states (at the expense of other design parameters, of course). This type of switch is commonly called a "matched" or "terminated switch". See Figure 4b.

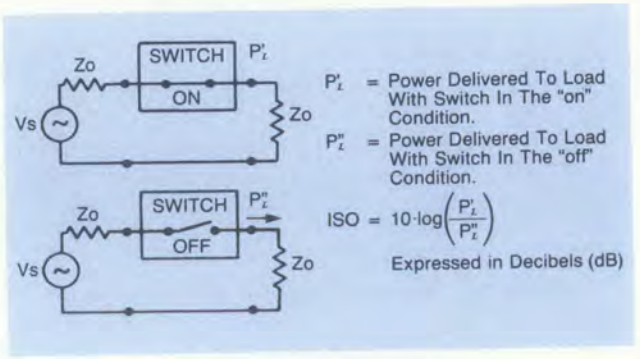


Figure 4b. Isolation

VSWR

VSWR (Voltage Standing Wave Ratio) measures the degree of impedance match present at a PIN switch RF port. Because a switch is used to merely control the path of RF signals, VSWR levels of the switch are expected to be better than other devices used in the system. As a switch design parameter, VSWR usually follows from good insertion loss design. It has a major impact when considering internal switch transmission line media, component parasitics and RF port transitions and therefore is very sensitive to the layout of the switch. Minimizing VSWR is a case of reducing parasitics and designing a good layout. See Figure 4c.

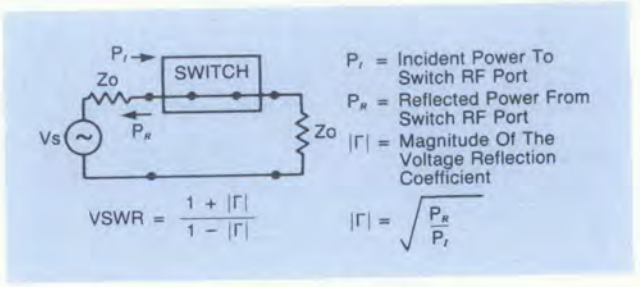


Figure 4c. VSWR

Switching Speed

One of the features of PIN diode RF switches is the ability to switch quickly and reliably. The all-solid-state electronics allows frequent switching with no impact on reliability and as such, PIN diode switches find application as pulse modulators, time multiplexers and any application requiring many switching operations.

To specify switching characteristics, an understanding of the various parameters is required. Terminology and definitions vary, but the most popular parameters are listed as follows and are defined in Figure 5:

τ_{Rise} = Rise Time
τ_{Fall} = Fall Time
τ_{On} = On Time
τ_{Off} = Off Time

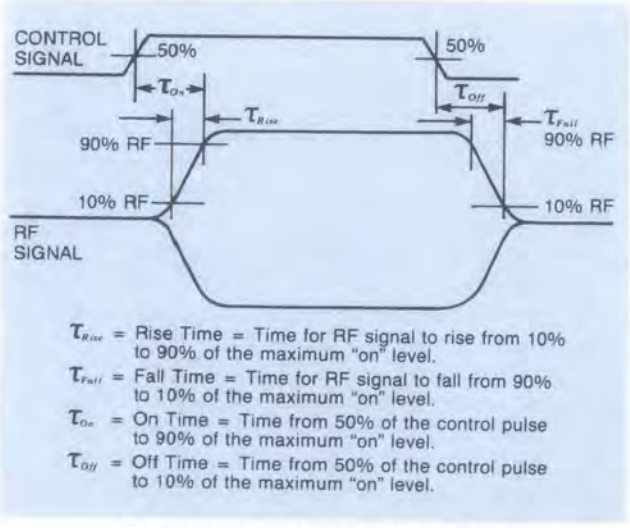


Figure 5. Switching Parameters

The most significant parameters are rise time and fall time. They determine the upper limit in switching rate and dictate the minimum time necessary for the switch to change state. On and Off time measures the total switching time starting at control pulse transition (50% point) to RF level stabilization (90% point). Although the on/off time parameter includes control pulse delay which is internal to the RF switch, this delay may be designed out at the system level by allowing adequate control lead time to anticipate this delay.

Typical τ_{on} and τ_{off} *are around 1* μs to 2 μs for switches below 1 GHz. Switches above 1 GHz can easily achieve 100-500 ns switching times while faster times of 10-30 ns have been designed. High speeds of 1-10 ns can be achieved at lower frequencies (1-500 MHz) by using Schottky diodes in a balanced configuration similar to that of a double balanced mixer. These switches are inherently limited in bandwidth (one or two octaves) due to the use of input and output ferrite transformers.

Switching Transients

One of the consequences of fast switching is the switching transients which appear at the RF ports. The transients are due to the DC shifts which occur internally in the switch during switching. Transients can cause problems because their spectral content can cause false signals to occur during switching. The problem is particularly serious when the spectral content is inside the RF band of the switch. The frequency of the transient spectral content is a function of the speed of the switch. Faster switching produces transient energy at higher frequencies. The amplitude of the transients are higher for faster switching speeds and for switches designed for lower frequencies.

Transients are specified several ways. One approach is to specify the maximum allowable amplitude of the transient found at each of the RF ports. Alternately, when the majority of the spectral content is outside the switch RF band, transient amplitude can be specified in-band only. This can be measured by filtering off the out-of-band transient energy. An additional method specifies the spectral content, in dBm, in the RF band of interest.

RF Power Handling

PIN diode switches are usually considered to be small signal devices and generally handle RF power levels up to +20 dBm (100 mW) with optimum performance below +5 dBm. The basic power limitation is the use of the PIN diode devices in series with the RF path. Any power loss due to the diodes themselves is dissipated by the diode. Heat sinking can improve this somewhat but the real solution is to change the design approach.

Switches specifically designed for high power use specially designed high power PIN diodes mounted in shunt with the RF line. As opposed to series mounting, shunt mounting offers fewer obstacles to RF power passing through the switch. Because of the limitations of shunt mounting and the use of high power devices, electrical performance is severly limited when compared to small signal switch designs.

"Hot Switching" is a term used to describe switching states with RF power applied. This is the most stringent condition for a high power switch because, in the transition, the diodes are in an intermediate resistance state and bear the brunt

of the RF power for a short period of time. High power switches may or may not be designed for hot switching and are specified accordingly.

INTERMODULATION PRODUCTS

PIN diode switches by nature are low distortion devices. The reason is that the PIN diodes themselves have excellent distortion characteristics. The letters PIN stand for Positive-Intrinsic-Negative and refer to the layers of doped silicon which comprise the diode structure. The intrinsic (undoped) layer is incorporated to provide exceptionally low back bias capacitance which allows high isolation and low insertion loss RF performance. A benefit of the intrinsic layer is that it provides spacing between the P and N layers. This causes the transition time of carriers crossing the intrinsic layer to be lengthened which reduces the effect of non-linear diode resistance on an RF signal. Thus, switches in the 2 to 18 GHz range are seldom specified for intermodulation.

PIN diode switches used at lower frequencies have more of a problem. As the RF signal approaches lower frequencies, the transition time is no longer long enough to prevent non-linear effects. Second and third order intercept points degrade for lower frequencies and can determine the lower frequency limit of operation. Typical values are a +30 dBm third order intercept and a +60 dBm second order intercept.

UNDERSTANDING SWITCH DESIGN TRADEOFFS

As can be expected, each parameter has a possible tradeoff relative to other parameters. It helps to understand some of the fundamental tradeoffs made by switch designers because it yields insight as to what is feasible and where to emphasize switch performance.

Insertion loss and isolation are fundamental tradeoff parameters. Changes of 0.6 dBm in insertion loss can mean a 10 dB change in isolation. It is seldom that a change in one does not affect another. Another pair is switching speed vs. switching transients. Faster switches yield larger transients and can be critical for systems design. Specifying unnecessary low end frequency operation will aggravate both achievable speed and transients. RF power level may dictate switch design and has severe consequences for all other parameters, particularly isolation. Bandwidth considerations may dictate broadband or narrowband designs. Narrowband design, where possible, offers higher performance with less complexity. This is especially true at microwave frequencies where distributed line lengths can be used to great advantage to improve overall performance.

CONCLUSION

The PIN diode switch proves to be an excellent choice when fast switching or frequent switching is required. Optimum performance can be achieved by understanding the trade-offs inherent in PIN diode switch operation and by specifying only what is actually needed for system operation. Anzac's switch line adds the versatility of broadband operations, internal driver and hermetic packaging to further simplify usage and improve reliability. The devices shown in this catalog are only a few of the many switch devices Anzac can supply. Custom versions are available and our Applications Engineers can help the designer in specifying the design of a custom unit, if necessary, or application of one of our standard units to your system needs.

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THE SW-200 GaAs SPDT MMIC SWITCH, MIC APPLICATIONS AND PRODUCTS

INTRODUCTION

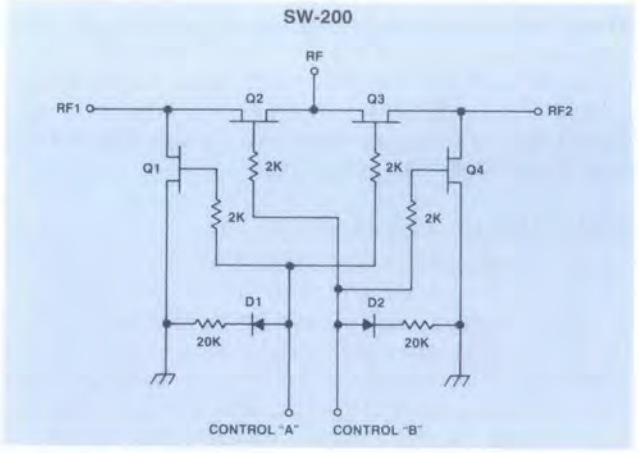
Adams-Russell Semiconductor Center has developed a GaAs monolithic microwave integrated circuit (MMIC) SPDT switch, the SW-200 and, in a joint effort with the Anzac Division, has implemented it in a family of MMIC/MIC hybrid switch products in this catalog. These products include versions with and without TTL/CMOS input compatible drivers. RF performance of this GaAs switch product family is comparable to high performance PIN diode switch designs with the additional benefits of nanosecond switching and minimal power consumption. Potential applications include; phased array radar, electronic countermeasures, switching matrices, general microwave and RF switching applications, or any other signal processing system where the demand for faster and more reliable components of reduced size, weight, and DC power consumption cannot be compromised.

MMIC SPDT SWITCH DESIGN

The SW-200 is based on the use of Metal-Semiconductor Field Effect Transistors (MESFET) as the active elements. As shown in the schematic of Figure 1a, four MESFETs are arranged in two mirror-image series-shunt configurations originating at the common RF node. The series MESFET provides a through path for the "on" arm while the shunt MESFET provides isolation for the "off" arm. Four 2kohm resistors connect control inputs A and B to the MESFET gates while providing isolation between the RF path and the control circuitry. Each series MESFET gate is connected to the shunt MESFET gate on the opposite arm of the switch. Prevention of long term electrostatic build-up on the gates is achieved through the connection of a Schottky diode-20kohm resistor circuit between each control/gate network and respective ground. Although gate leakage current is present, DC power consumption is dominated by the "micro" currents in the 20kohm resistors. These currents are shown beneath the truth-table of Figure 1a.

MESFET SWITCH OPERATION

Arrangement of the control network is such that complementary gate control voltages of 0/−5 to −8 Vdc applied at control inputs A and B switch the series-shunt MESFETs "on" or "off" per the truth table shown in Figure 1a. Therefore, if the RF to RF1 path of Figure 1 is "on" MESFETs Q2 and Q4 are "on" while Q1 and Q3 are "off". Control of an individual MESFET is demonstrated by the MESFET equivalent circuit/truth table of figure 1b. The "on" or low impedance state occurs when 0 to −0.2 Vdc is applied to the MESFET gate. Conversely, the "off" or high impedance state occurs



Truth Table

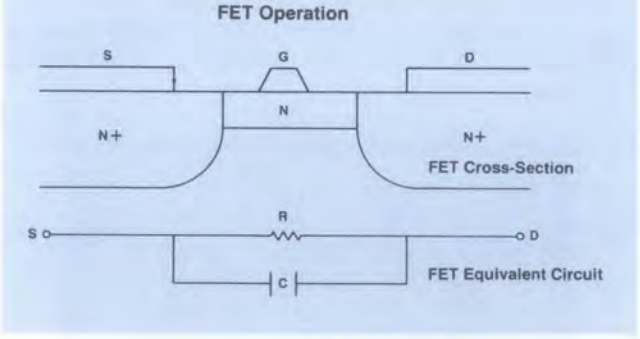
CONTROL INPUT		CONDITION OF SWITCH	
		RF COMMON TO EACH RF PORT	
A	B	RF1	RF2
HI	LOW	ON	OFF
LOW	HI	OFF	ON

Control Voltages (Complementary Logic)

V_{IN} Low 0 to −0.2V @ 20μA Max

V_{IN} Hi −5V @ 40μA Typ to −8V @ 200μA Max

Figure 1a.



Equivalent Circuit Truth Table

RF STATE	V_G	R	C
"ON"	0V	4Ω	0.2pF
"OFF"	−5V	100KΩ	0.2pF

Figure 1b.

when a voltage (−5 to −8 Vdc) greater than the MESFET pinch-off voltage is applied to the gate. The pinch-off voltage is determined by the ion-implantation dose of the MESFET channel and is designed to be −4.0 Vdc maximum. This voltage provides the highest channel conductance and lowest "on" resistance that can be reliably turned "off" by a −5.0 Vdc gate bias.

GaAs MMIC TECHNOLOGY

N-channel depletion mode GaAs MESFETs with 1 μm Schottky gates are used in the SW-200. Implanted resistors and Schottky diodes along with the MESFETs are configured into a switch circuit utilizing air bridge interconnects to form a GaAs monolithic integrated circuit. MMIC wafer fabrication follows an eight-mask process using direct ion implantation into semi-insulating GaAs substrates. Contact lithography with deep UV optics defines circuit patterns by exposing photoresist in areas determined by each mask. An E-beam evaporation system deposits metals that are later defined by the liftoff of the unexposed photo-resist, removing undesired metal.

MMIC LAYOUT

A photograph of the 30x30x10 mil SW-200 chip is shown in Figure 2. Each of the four MESFETs is defined as a 1 μm gate length by 1200 μm gate width device with four 1 x 300 μm gate fingers centered in 3 μm drain-source channels to minimize parasitic series resistance. Air bridge interconnects tie MESFET drains to the RF "out" ports and provide a crossover for the control network. Bondpads are configured to accomodate RF coplanar wafer probing. Ground pads are large, 0.004 x 0.013 mils, to provide for low inductance grounding, maximizing isolation.

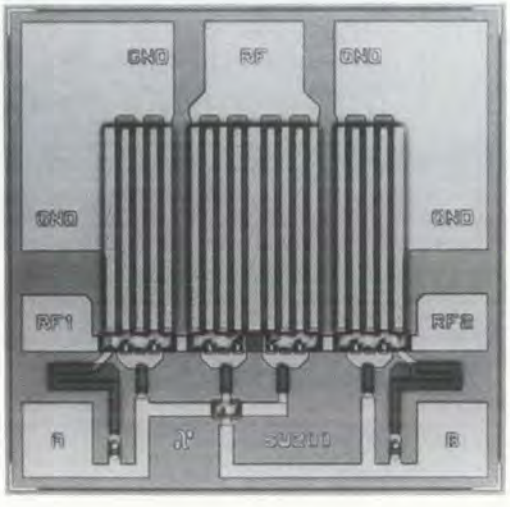


Figure 2. SW-200

MMIC SWITCH PERFORMANCE

Figure 3 shows measured performance for the SW-200 GaAs SPDT switch. With less than 1dB insertion loss and more than 30 dB isolation at 4 GHz, the SW-200 demonstrates impressive RF performance in a small package. The absence of DC blocking capacitors and bias chokes enables broadband performance literally down to DC and minimizes the area occupied by the circuit. The upper frequency is limited to 6 GHz by parasitic source-drain capacitance. Direct coupling such as this enables the SW-200 to achieve high switching speeds of Trise/fall=2ns typical at frequencies down to DC. (The RC time constant of the 2kohm resistor and the 1pF input gate capacitance defines the speed of the SW-200) This accomplishment has only been approximated by more complex balanced mixer type switches.

Input power for 1dB compression is+25 dBm for standard 0/−5 Vdc control voltages. A maximum power capacity of +31dBm occurs at 0/−8 Vdc control (midway between pinch-off and gate breakdown voltage). Second and third order intermodulation intercept points are +66 and +41 dBm typical, respectively. This is excellent power handling capability for a control device of this simplicity and speed, and with such low current consumption.

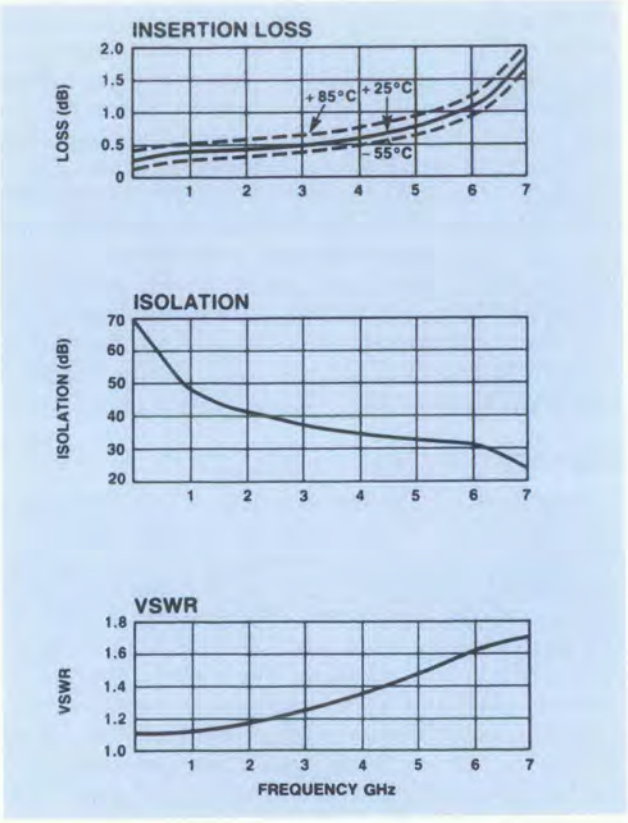


Figure 3. SW-200 Typical Performance

DRIVER CIRCUIT DESIGN

In order to integrate the SW-200 into a signal processing system, a driving circuit must be provided. The circuit must supply bias voltages of 0 to −0.2 Vdc and −5 to −8 Vdc to the SW-200. It would be desirable for such a driver circuit to be compatible with a popular logic family such as TTL or CMOS, require only a single supply voltage, introduce little switching delay, and consume little DC current.

One driver technique that satisfies the above requirements "floats" the channel of each MESFET on the MMIC switch above ground potential. Through the use of pull-up resistors and DC blocking and bypass capacitors, −5 Vdc control now becomes 0 Vdc and 0 Vdc control becomes +5 Vdc at the SW-200's control nodes. Therefore, the MESFETs will now turn "off" with 0 Vdc and turn "on" with +5 Vdc applied to the respective control port.

Figure 4 shows a schematic of the SW-200 being driven by a QMOS CD54HCT04 hex inverter. QMOS, (Quick-cMOS), is a LSTTL input compatible logic family. Characteristics include the fast speed of LSTTL and the low DC power consumption and +5 Vdc output voltage of CMOS. Unlike CMOS, the QMOS bias supply is limited to +5 Vdc +/− 10%. This driver makes an ideal partner for the fast, low DC current SW-200.

As shown in figure 4, DC blocking capacitors, C1, C2, C3, required at each RF port, are chosen to give minimum insertion loss at the desired low frequency. Bypass capacitors, C5 and C6, required to float the SW-200 ground above circuit ground, are chosen to give maximum isolation at the desired high frequency. A bypass capacitor, C4, of the same value as C1, C2, C3, is required between DC bias and ground to bypass any RF signal leakage on the DC bias line.

The floating bias circuit must hold the drain/source potentials to +5 Vdc, and must also isolate the RF ports from each other and ground (see Figure 4). Resistors, R2 and R3, that connect DC bias to the sources of Q1 and Q4 may be approximately 1kohm. However, the resistors, R1 and R4, that connect DC bias to the drains of Q1, Q2, Q3, Q4 must be much larger in value, approximately 10kohm; these resistors are critical in reducing crosstalk between the RF paths. The sources of Q2 and Q3 do not need a direct connection to DC bias; they are alternately pulled to +5 Vdc by R1 and R4 during each respective switching condition.

Driver selection is determined by tradeoffs of switching speed, DC power consumption, and maximum allowable RF input power. Alternate drivers to the QMOS CD54HCT04 include the LSTTL 54LS04 hex inverter and the CMOS CD4041UB

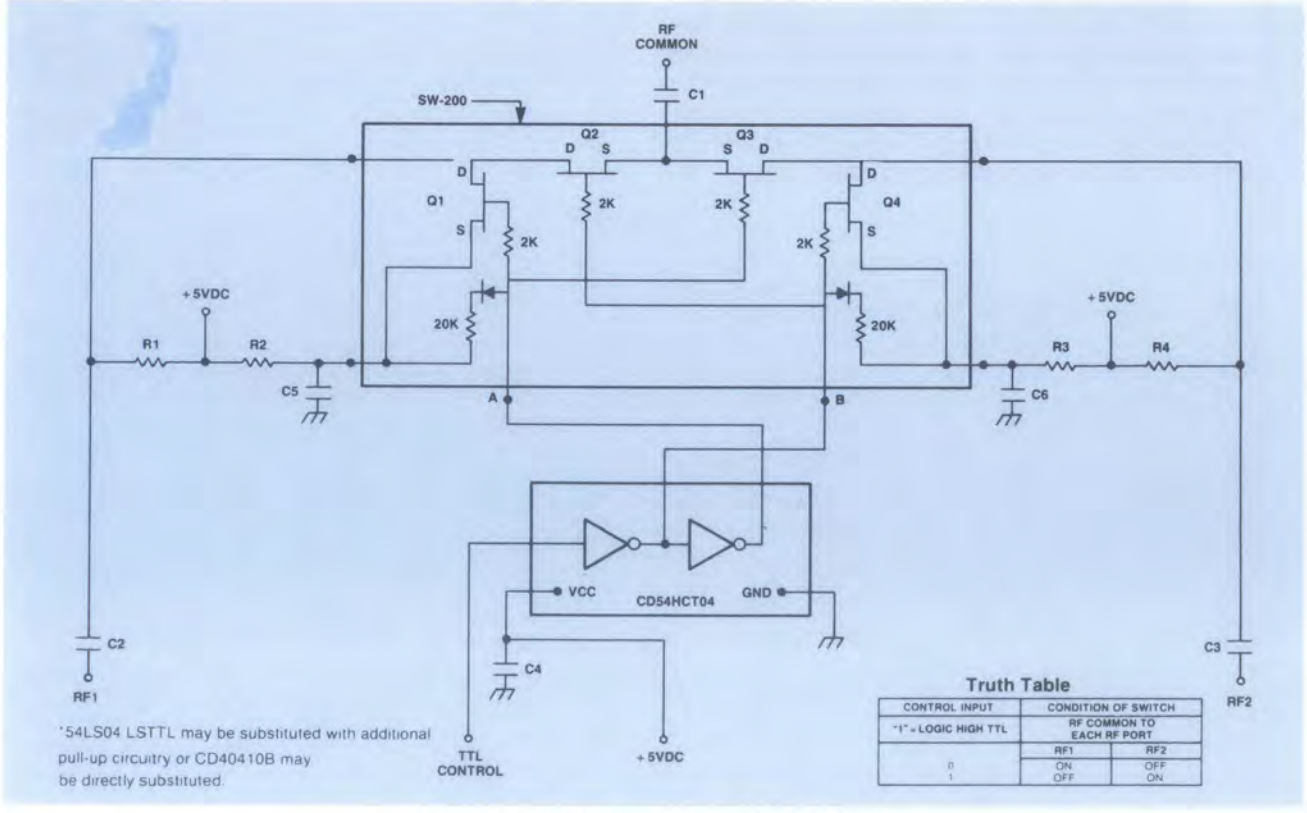


Figure 4. GaAs SPDT Switch with QMOS Driver*

quad true/complement buffer. The logic gates of these devices are also connected as true/complement buffers as shown in figure 4.

With additional pull-up circuitry connected between the 54LS04 outputs and +5 Vdc, the LSTTL driver can be substituted for the pin compatible QMOS driver. However, a degradation in switching speed and an increase in DC current consumption from the QMOS performance will result.

The CMOS driver can be implemented in place of the QMOS driver with no additional circuitry. The CD4041UB interface to the SW-200 connects the complement output to control B and the true output to control A. Due to the SW-200's control voltage input limitations the CMOS driver may only be biased up to +8 Vdc. This delivers +8 Vdc to the SW-200 and increases the maximum allowable RF input power from +25 to +31 dBm.

In some applications, the two previously discussed LSTTL and CMOS driver circuits may be sufficient, but they do not take full advantage of SW-200's fast switching speed and ultra-low DC power consumption. A QMOS driver circuit makes optimal use of these high performance characteristics with a total switching speed of 20 nS and DC current consumption of less than 1 mA at +5 Vdc.

A thick or thin-film MIC assembly approach can be utilized to transform the driver circuit from paper to proto. Five I/O's are required consisting of RF common, RF1, RF2, +Vdc, and control input. RF I/O's should be separated from each other as much as possible for isolation purposes; layout symmetry is important in a SPDT application. Both the QMOS and CMOS unused logic gate inputs must be grounded for static protection purposes.

When wire bonding the SW-200, it is important to keep bonds as short as possible. For the RF ports this minimizes insertion loss and VSWR. For the ground ports, three short bonds from the SW-200 to ground (capacitor) are recommended. This provides for low inductance grounding which maximizes isolation.

CONCLUSION

With the growing demand for faster, smaller, more complex signal processing systems, the SW-200 is an important milestone. Incorporation of the switching function on a GaAs MMIC is a step towards integrating both switches and amplifiers in a monolithic format. Packaged versions are offered by Adams-Russell, Anzac Division to relieve the user from handling GaAs dice and from designing driver circuitry. Monolithic switches from the Adams-Russell Semiconductor Center provide performance previously unavailable on the market place, such as nanosecond switching, microwatt DC power consumption, monolithic construction reliability, and low volume cost. It is now up to the system designer to exploit the application of monolithic GaAs technology to the systems of today and tomorrow.

REFERENCES

Bedard, B.E., Barlas, A.D., and Gold, R.B., "A High Performance Monolithic GaAs SPDT Switch", 15th European Microwave Conference, Paris, 1985, Digest of Technical Papers.

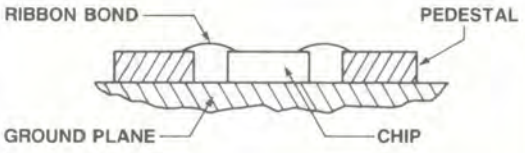
Techniques to Achieve High Isolation With GaAs MMIC Switch Chips

Mounting Techniques

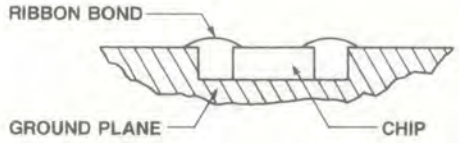
1. Mount the base of the chip directly on the ground plane (i.e. the metal floor of the package) and use short connections from the ground pads of the MMIC to the ground plane.

2. Use short ribbon bonds (0.005 to 0.010" wide) instead of wirebonds in the connection of the ground pads to ground.

3. Elevate the ground plane to be at the same level as the ground pads on the chip surface. This can be done by:
   A. Using ground plane pedestals next to the chip, as shown.



   B. Depressing the chip into a channel in the ground plane, as shown.



Isolation performance of a GaAs MMIC switch can be degraded by parasitic effects introduced by the circuit in which the MMIC is used. Two primary causes of isolation degradation are excessive ground path inductances and crosstalk between RF paths (external to the MMIC). This note will focus on techniques to reduce ground path inductances.

The achievable isolation of a GaAs MMIC switch is a function of how low an inductance one can achieve between the ground pad of the MMIC and the ground plane within a particular circuit. The lower the inductance, of course, the higher the isolation that can be achieved.

For example, the curves shown for the SW-200 chip in the catalog were obtained using coplanar RF probes directly on the chip. Because this is a coplanar probe configuration (which also includes the ground plane), there is virtually no ground inductance in the measurement. Thus, the isolation obtained for SW-200 data sheet was for the case in which very small ground inductances exists and should be considered optimum.

However, the isolation curves for the SW-210 chip in the catalog were obtained with the chip mounted in a package having a flat ground plane on the floor of the package. Short wirebonds were used from the ground pads to the ground plane. Thus, the isolation obtained in the SW-210 data sheet was for the case in which a finite inductance exists in the ground path.

In practice, when a chip is mounted into a circuit, there will always be some finite inductance which can degrade the isolation performance. Several precautions can be taken to improve the isolation within a particular circuit. (See box.)

The technique used by Anzac in most of the packaged MMIC switch products (SW-200 series) is that of #1 above. Catalog performance of these products can be used as an indicator of what can be expected if technique #1 is used. However, improvements can be expected in isolation performance if techniques 2 or 3 are used.

This note briefly described techniques to obtain the maximum possible isolation when using GaAs MMIC switch chips. Several options were outlined which involved varying degrees of complexity. Crosstalk, not addressed here, can also degrade isolation, and must be minimized to obtain overall performance.

Terminated (T) Configuration

The SW-210 Terminated (T) Configuration is achieved by switching between RF1 and RF2 with GND1 and TERM grounded. ALT RF and GND2 remain open in this configuration.

Figure 1A. Terminated Circuit

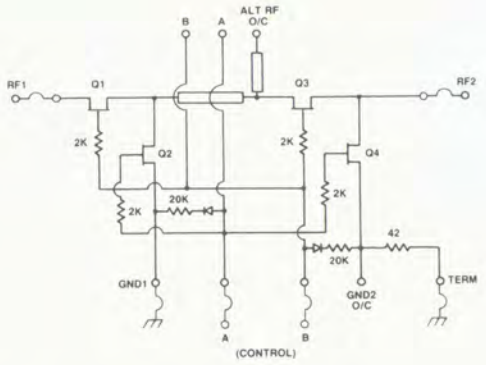


Figure 1B. Terminated Schematic

High Isolation Unterminated (H) Configuration

The SW-210 High Isolation (H) Configuration is achieved by switching between RF1 and RF2 with GND1 and GND2 grounded. ALT RF and TERM remain open in this configuration.

Figure 2A. High Isolation Circuit

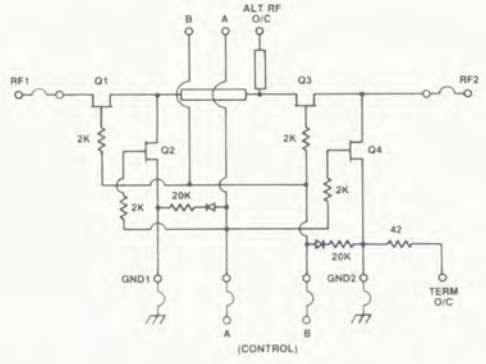


Figure 2B. High Isolation Schematic

Low Loss Unterminated (L) Configuration

The SW-210 Low Loss (L) Configuration is achieved by switching between ALT RF and RF2 with GND2 grounded. RF1, GND1 and TERM remain open in this configuration.

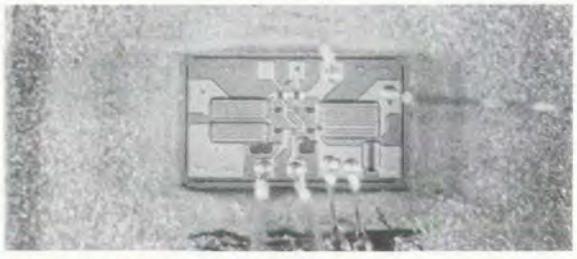


Figure 3A. Low Loss Circuit

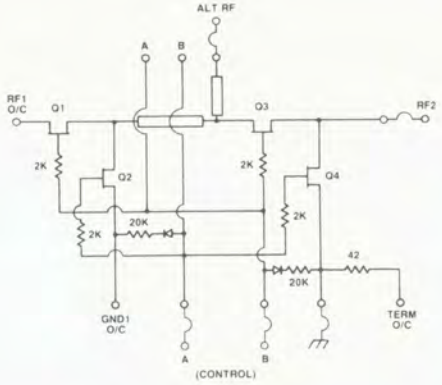


Figure 3B. Low Loss Schematic

SCHEMATIC KEY: O/C = OPEN-CIRCUIT

= WIREBOND CONNECTION

MODEL SW-111 — SPST RF SWITCH 5-2000 MHz

- Ultra Broadband
- High Isolation — 80 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.0 dB Max
	5-1000 MHz	1.8 dB Max
	10-500 MHz	1.6 dB Max
VSWR	5-2000 MHz	1.5:1 Max
	5-1000 MHz	1.2:1 Max
Isolation	5-2000 MHz	50 dB Min
	5-1000 MHz	60 dB Min
	5-500 MHz	70 dB Min

Operating Characteristics

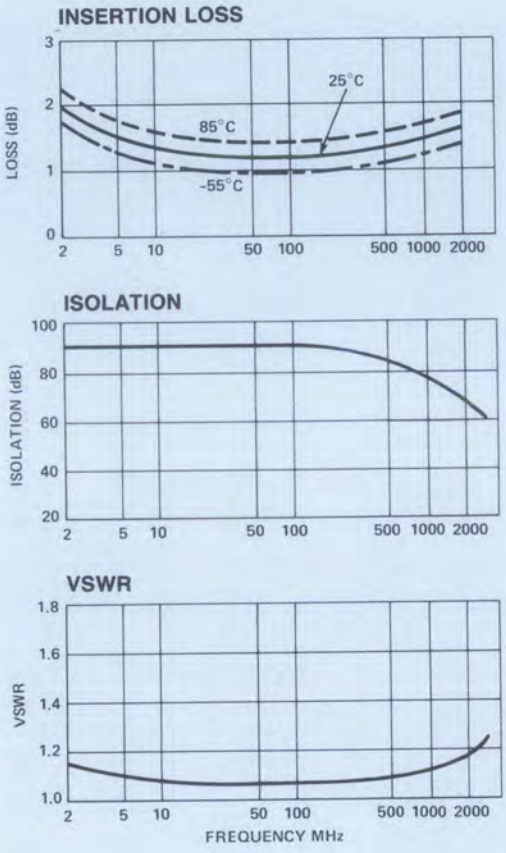
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (450 mW Typical)
Package Type	Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF1 TO RF2
0	OFF
1	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-111	9429	Pin	$230

Delivery is from stock.

MODEL SW-112 — SPDT RF SWITCH 5-2000 MHz

- Ultra Broadband
- High Isolation — 70 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.2 dB Max
	5-1000 MHz	2.0 dB Max
	10-500 MHz	1.8 dB Max
VSWR	5-2000 MHz	1.5:1 Max
	5-1000 MHz	1.2:1 Max
Isolation	5-2000 MHz	50 dB Min
	5-1000 MHz	60 dB Min
	5-500 MHz	70 dB Min

Operating Characteristics

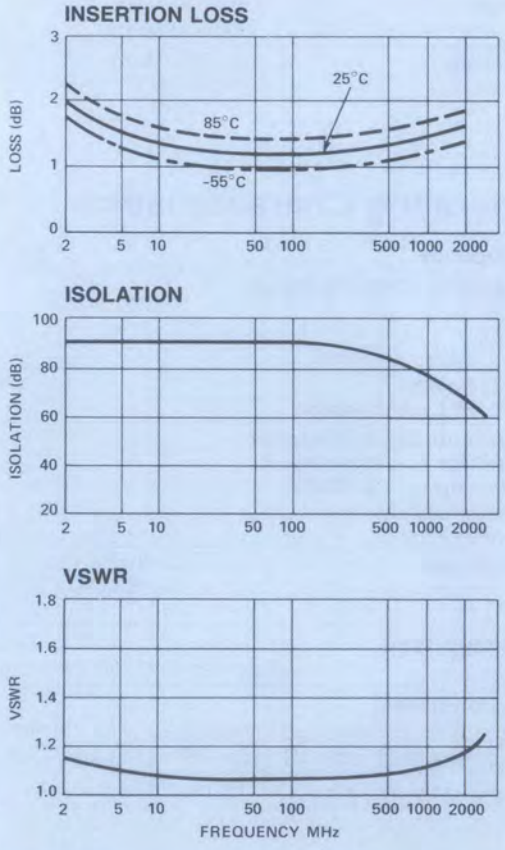
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max –5 VDC ±5% @ 35 mA Max (500 mW Typical)
Package Type	Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and –5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT	CONDITION OF SWITCH	
"1" = TTL LOGIC HIGH	RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

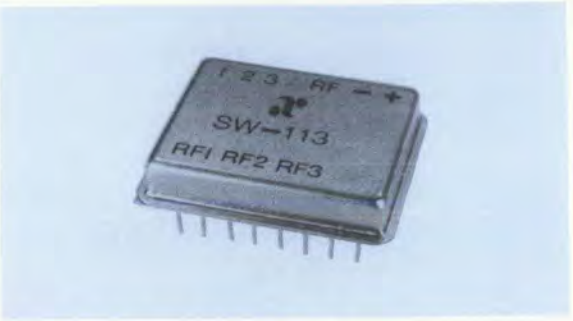
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-112	9439	Pin	$252

Delivery is from stock.

MODEL SW-113 — SP3T RF SWITCH 5-2000 MHz

- Ultra Broadband
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.8 dB Max
	5-1000 MHz	2.1 dB Max
	10-500 MHz	1.8 dB Max
VSWR	5-2000 MHz	1.8:1 Max
	5-1000 MHz	1.2:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-500 MHz	45 dB Min
	5-100 MHz	60 dB Min

Operating Characteristics

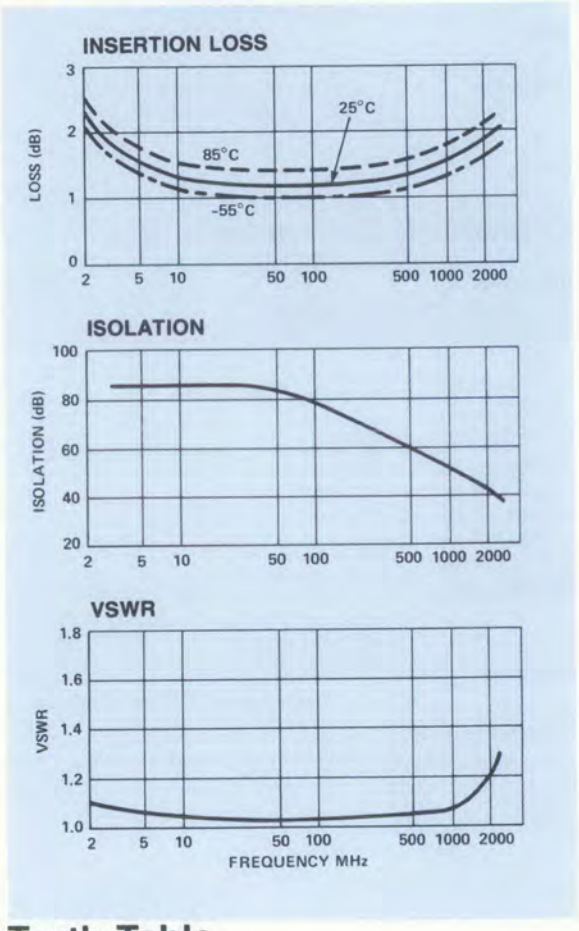
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 45 mA Max −5 VDC ±5% @ 25 mA Max (540 mW Typical)
Package Type	Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-113	9491	Pin	$333

Delivery is from stock.

MODEL SW-114 — SP4T RF SWITCH 5-2000 MHz

- Ultra Broadband
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.8 dB Max
	5-1000 MHz	2.1 dB Max
	10-500 MHz	1.8 dB Max
VSWR	5-2000 MHz	1.8:1 Max
	5-1000 MHz	1.2:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-500 MHz	45 dB Min
	5-100 MHz	60 dB Min

Operating Characteristics

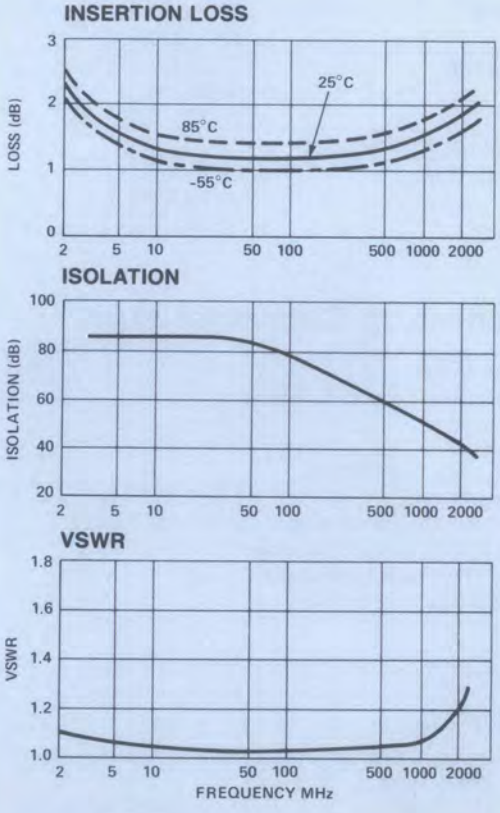
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 50 mA Max −5 VDC ±5% @ 25 mA Max (550 mW Typical)
Package Type	Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-114	9459	Pin	$375

Delivery is from stock.

MODEL SW-118 — SPDT RF SWITCH 10-2000 MHz

- Integral Driver, TTL
- Low Loss — 0.6 dB Typical
- High Isolation — 50 dB Typical
- Fast Switching Speed — 50 nSec Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	1.6 dB Max
	20-2000 MHz	1.1 dB Max
	50-1000 MHz	1.0 dB Max
VSWR	10-2000 MHz	1.5:1 Max
	20-1000 MHz	1.3:1 Max
Isolation	10-2000 MHz	35 dB Min
	10-800 MHz	40 dB Min
	10-300 MHz	50 dB Min
Amplitude Balance		±0.2 dB
Phase Balance	10-2000 MHz	±8°
	10-1000 MHz	±4°
	10-100 MHz	±1°

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}, t_{OFF}		60 nS Typ
t_{RISE}, t_{FALL}		50 nS Typ
Transients (In-Band)		300 mV Typ
Input Power for 1 dB Compression	10-2000 MHz	+4 dBm Typ
	200-2000 MHz	+25 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-2000 MHz)	+42 dBm Typ
	(50-2000 MHz)	+65 dBm Typ
Third Order	(10-2000 MHz)	+16 dBm Typ
	(50-2000 MHz)	+35 dBm Typ
Bias Power		+5 to +15 VDC @ 20 mA Max (150 mW Typical)
Package Type		Dual Inline (DI-4) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

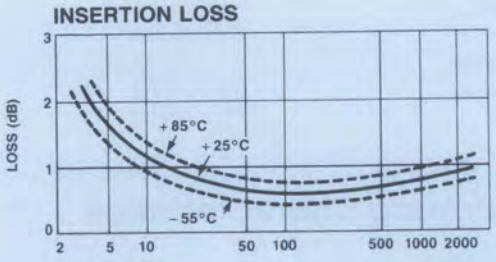
* All specifications apply when operated with bias voltage of +15 VDC and 50 ohm impedance at all RF ports.

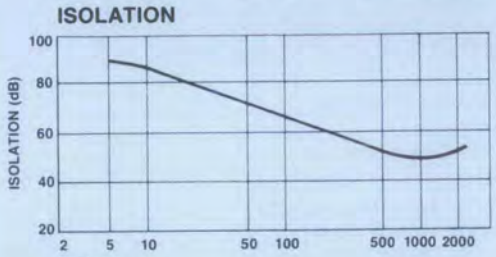
Ordering Information

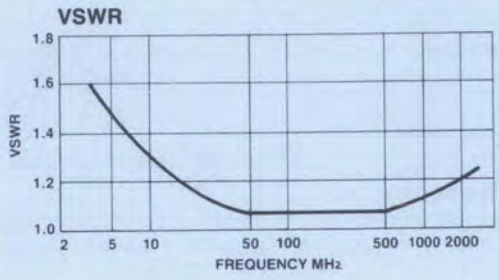
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-118	6349	Pin	$314

Delivery is from stock.

Typical Performance







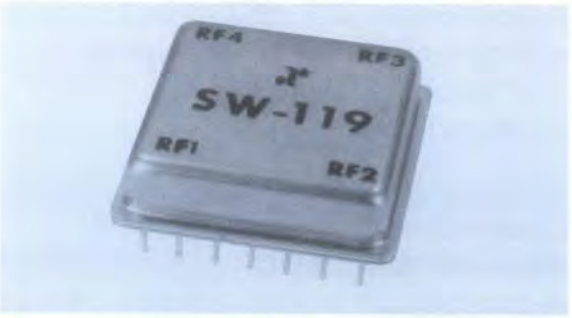
Truth Table

CONTROL INPUT	CONDITION OF SWITCH RF PATH	
	RF-IN TO RF1	RF-IN TO RF2
LOGIC HIGH	OFF	ON
LOGIC LOW	ON	OFF

Control logic is CMOS or open collector TTL with external pull up to +V.

MODEL SW-119 — RF TRANSFER SWITCH 10-2000 MHz

- High Isolation — 60 dB Typical
- Low Loss — 0.7 dB Typical
- Fast Switching — 50 nSec Typical
- Integral Driver, TTL



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	1.6 dB Max
	20-2000 MHz	1.1 dB Max
	50-1000 MHz	1.0 dB Max
VSWR	10-2000 MHz	1.5:1 Max
	20-1000 MHz	1.3:1 Max
Isolation	10-2000 MHz	35 dB Min
	10-800 MHz	40 dB Min
	10-300 MHz	50 dB Min
Amplitude Balance		±0.2 dB
Phase Balance	10-2000 MHz	±8°
	10-1000 MHz	±4°
	10-100 MHz	±1°

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}, t_{OFF}		60 nS Typ
t_{RISE}, t_{FALL}		50 nS Typ
Transients (In-Band)		300 mV Typ
Input Power for 1 dB Compression	10-2000 MHz	+4 dBm Typ
	200-2000 MHz	+25 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-2000 MHz)	+42 dBm Typ
	(50-2000 MHz)	+65 dBm Typ
Third Order	(10-2000 MHz)	+16 dBm Typ
	(50-2000 MHz)	+35 dBm Typ
Bias Power		+5 to +15 VDC @ 20 mA Max (150 mW Typical)
Package Type		Dual Inline (DI-4) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

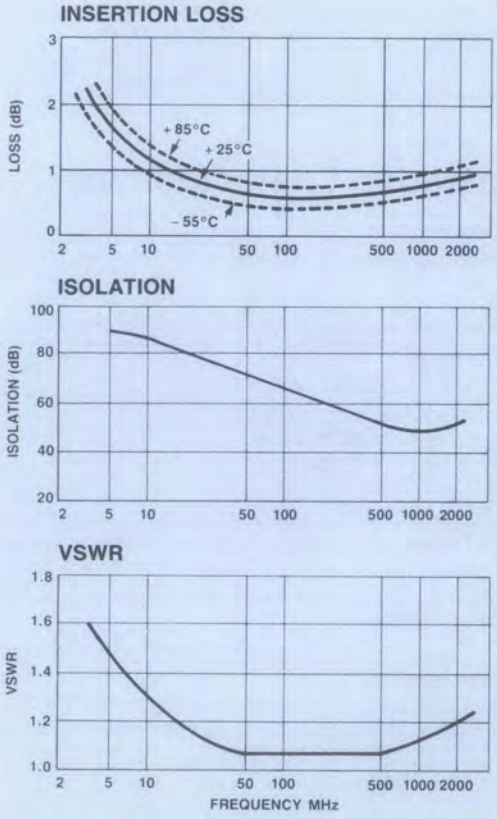
*All specifications apply when operated with a bias voltage of +15 VDC and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-119	6359	Pin	$314

Delivery is from stock.

Typical Performance



Truth Table

CONTROL INPUT	CONDITION OF SWITCH — RF PATH —			
	RF1-RF2	RF2-RF3	RF3-RF4	RF4-RF1
LOGIC HIGH	ON	OFF	ON	OFF
LOGIC LOW	OFF	ON	OFF	ON

Control logic is CMOS or open collector TTL with external pull up to +V.

MODEL SW-121 — SPST RF SWITCH 5-1000 MHz

- Low Loss — 0.5 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss	5-1000 MHz	1.0 dB Max
	5-500 MHz	0.8 dB Max
VSWR	5-1000 MHz	1.25:1 Max
	5-500 MHz	1.2:1 Max
Isolation	5-1000 MHz	40 dB Min
	5-500 MHz	50 dB Min
	5-100 MHz	60 dB Min

Operating Characteristics

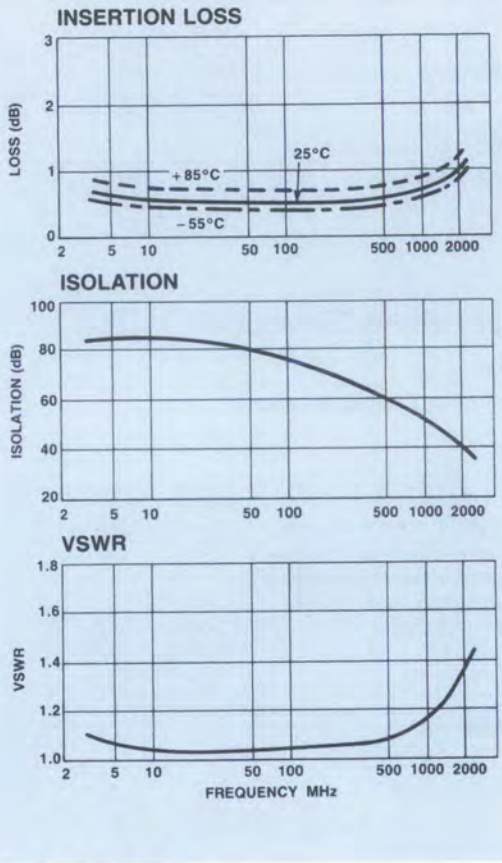
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (450 mW Typical)
Package Type	Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF1 TO RF2
0	OFF
1	ON

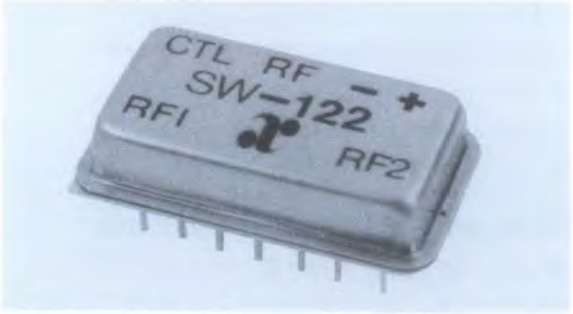
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-121	9759	Pin	$220

Delivery is from stock.

MODEL SW-122 — SPDT RF SWITCH 5-1000 MHz

- Low Loss — 0.5 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss	5-1000 MHz	1.0 dB Max
	5-500 MHz	0.8 dB Max
VSWR	5-1000 MHz	1.25:1 Max
	5-500 MHz	1.2:1 Max
Isolation	5-1000 MHz	40 dB Min
	5-500 MHz	50 dB Min
	5-100 MHz	60 dB Min

Operating Characteristics

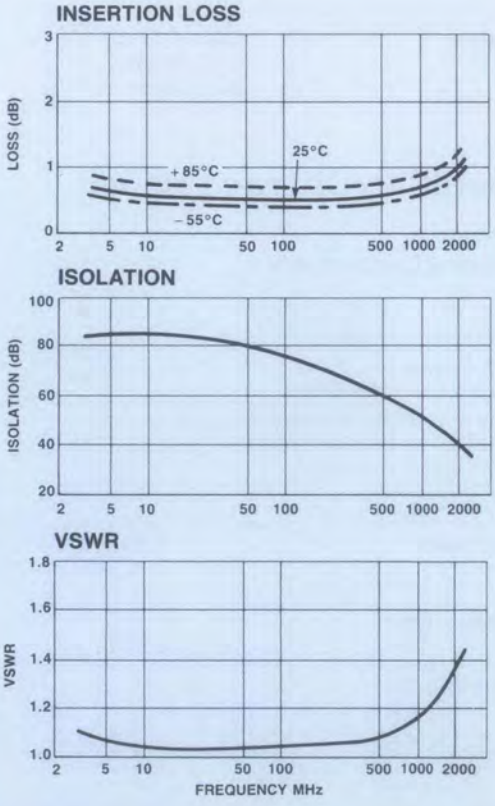
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (500 mW Typical)
Package Type	Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT	CONDITION OF SWITCH	
"1" = TTL LOGIC HIGH	RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-122	9769	Pin	$242

Delivery is from stock.

MODEL SW-123

SP3T RF SWITCH
5-1000 MHz

- Low Loss — 0.6 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss	5-1000 MHz	1.4 dB Max
	5-500 MHz	1.0 dB Max
VSWR	5-1000 MHz	1.5:1 Max
	5-500 MHz	1.2:1 Max
Isolation	5-1000 MHz	40 dB Min
	5-500 MHz	50 dB Min
	5-100 MHz	60 dB Min

Operating Characteristics

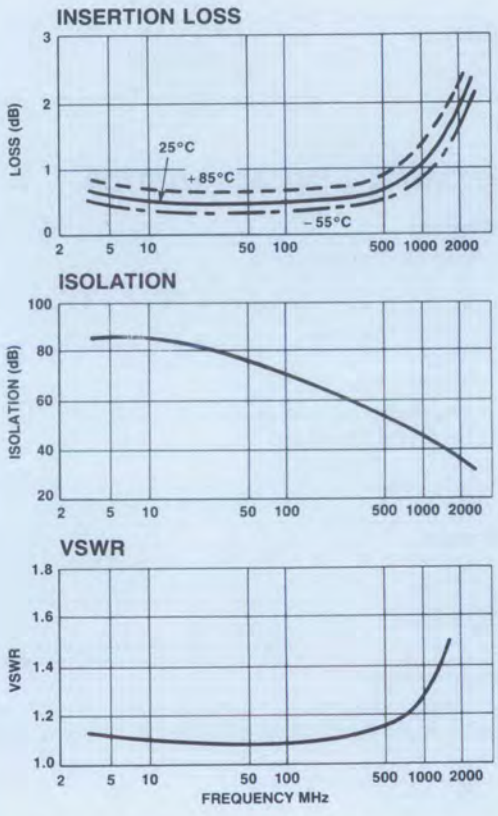
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 40 mA Max –5 VDC ±5% @ 25 mA Max (540 mW Typical)
Package Type	Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and –5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

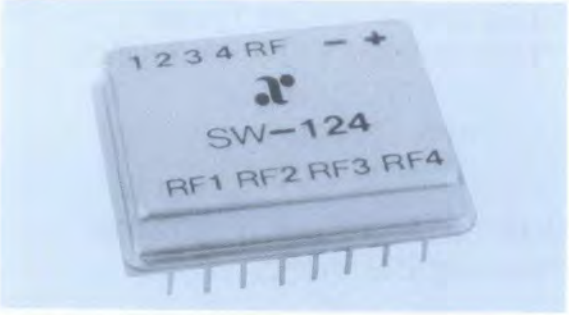
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-123	9779	Pin	$317

Delivery is from stock.

MODEL SW-124 — SP4T RF SWITCH 5-1000 MHz

- Low Loss — 0.6 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss	5-1000 MHz	1.4 dB Max
	5-500 MHz	1.0 dB Max
VSWR	5-1000 MHz	1.5:1 Max
	5-500 MHz	1.2:1 Max
Isolation	5-1000 MHz	40 dB Min
	5-500 MHz	50 dB Min
	5-100 MHz	60 dB Min

Operating Characteristics

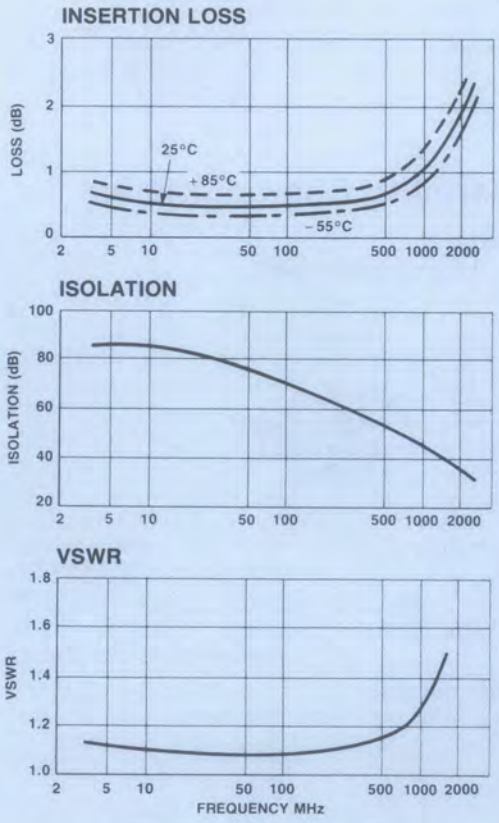
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 50 mA Max −5 VDC ±5% @ 25 mA Max (450 mW Typical)
Package Type	Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

Ordering Information

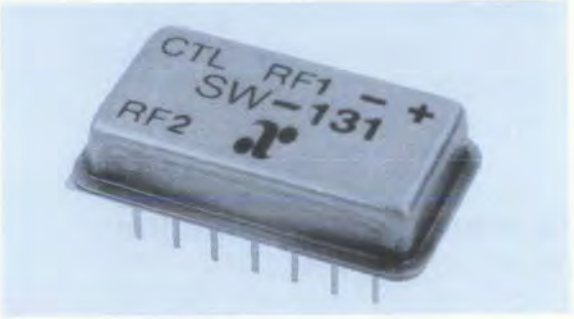
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-124	9789	Pin	$356

Delivery is from stock.

MODEL SW-131

SPST RF SWITCH
200-2000 MHz

- Low Loss — 0.5 dB Typical
- High Isolation — 50 dB Typical
- Integral TTL Driver
- Hermetic Package



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.0 dB Max
	200-1000 MHz	0.8 dB Max
VSWR	200-2000 MHz	1.65:1 Max
	300-1500 MHz	1.35:1 Max
Isolation	200-2000 MHz	30 dB Min
	200-1000 MHz	40 dB Min
	200-500 MHz	50 dB Min

Operating Characteristics

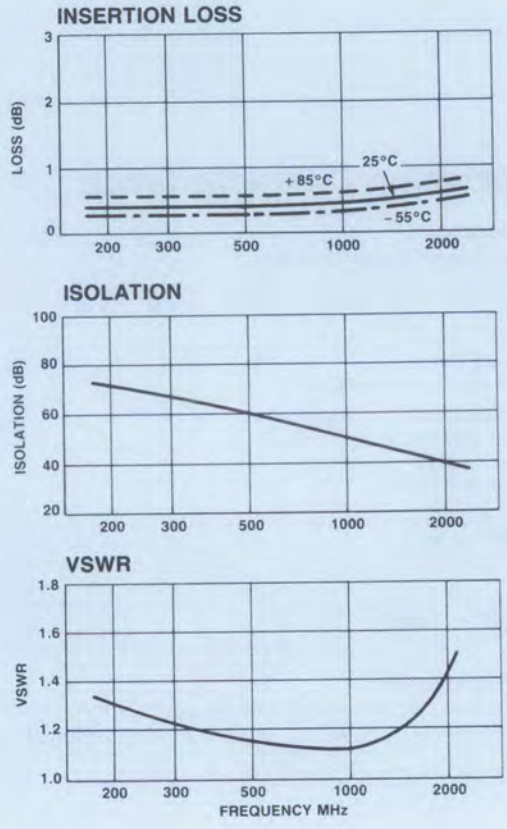
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (450 mW Typical)
Package Type	Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF1 TO RF2
0	OFF
1	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-131	9799	Pin	$220

Delivery is from stock.

MODEL SW-132 — SPDT RF SWITCH 200-2000 MHz

- Low Loss — 0.5 dB Typical
- High Isolation — 50 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.0 dB Max
	200-1000 MHz	0.8 dB Max
VSWR	200-2000 MHz	1.65:1 Max
	300-1500 MHz	1.35:1 Max
Isolation	200-2000 MHz	35 dB Min
	200-1000 MHz	40 dB Min
	200-500 MHz	50 dB Min

Operating Characteristics

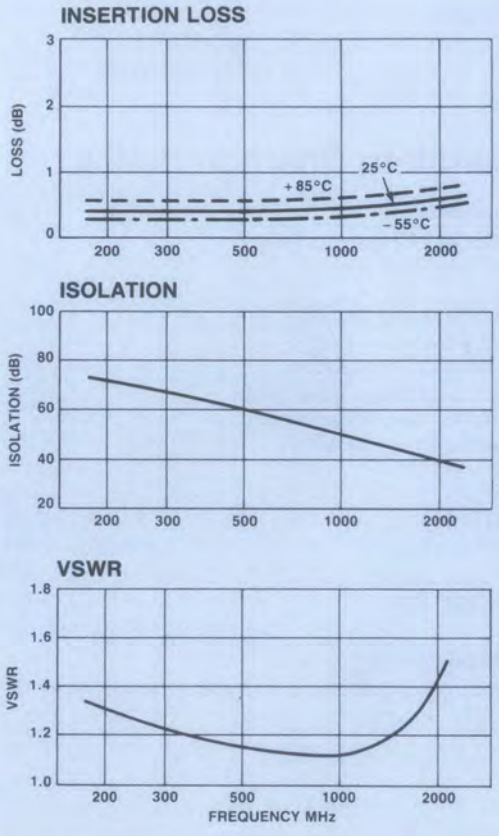
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (500 mW Typical)
Package Type	Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT	CONDITION OF SWITCH	
"1" = TTL LOGIC HIGH	RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Ordering Information

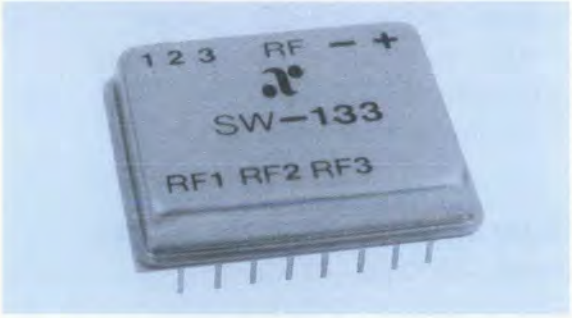
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-132	9869	Pin	$242

Delivery is from stock.

MODEL SW-133

SP3T RF SWITCH
200-2000 MHz

- Low Loss — 0.6 dB Typical
- High Isolation — 45 dB Typical
- Integral TTL Driver
- Hermetic Package



Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.5 dB Max
	200-1000 MHz	1.0 dB Max
VSWR	200-2000 MHz	1.6:1 Max
Isolation	200-2000 MHz	30 dB Min
	200-1000 MHz	35 dB Min
	200-500 MHz	45 dB Min

Operating Characteristics

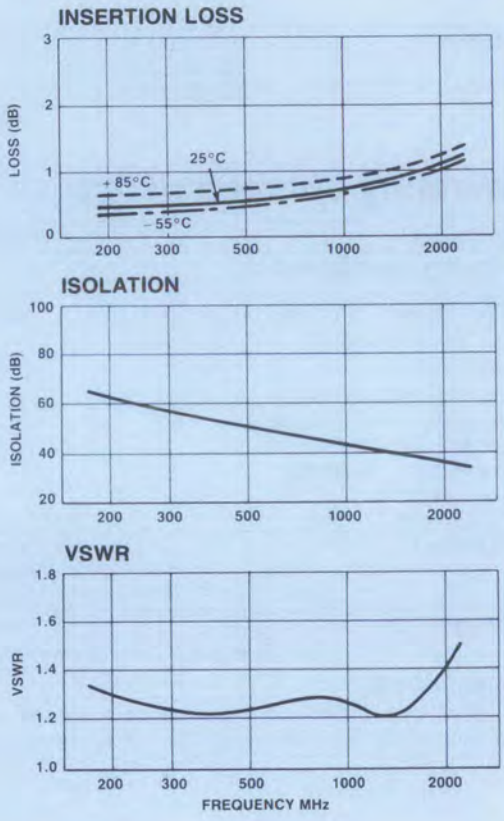
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 50 mA Max –5 VDC ±5% @ 25 mA Max (550 mW Typical)
Package Type	Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and –5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Ordering Information

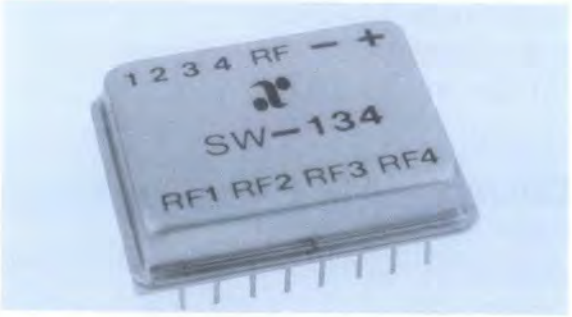
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-133	9879	Pin	$319

Delivery is from stock.

MODEL SW-134

SP4T RF SWITCH
200-2000 MHz

- Low Loss — 0.6 dB Typical
- High Isolation — 45 dB Typical
- Integral TTL Driver
- Hermetic Package



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.5 dB Max
	200-1000 MHz	1.0 dB Max
VSWR	200-2000 MHz	1.6:1 Max
Isolation	200-2000 MHz	30 dB Min
	200-1000 MHz	35 dB Min
	200-500 MHz	45 dB Min

Operating Characteristics

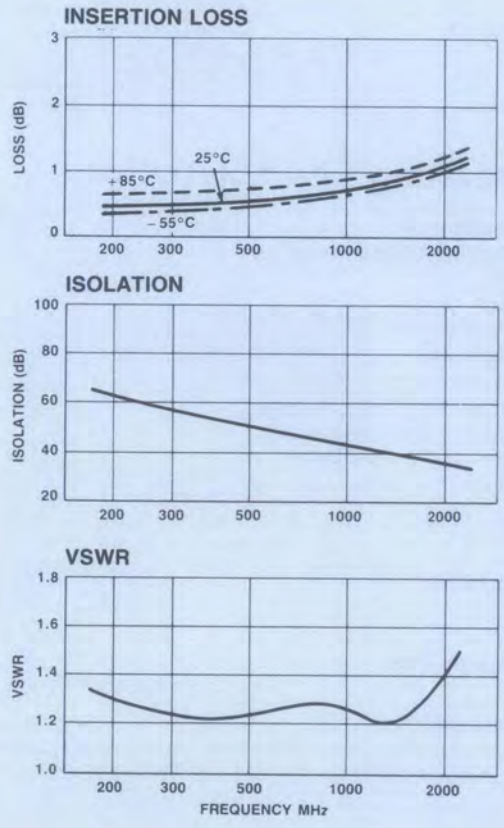
Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 45 mA Max −5 VDC ±5% @ 25 mA Max (540 mW Typical)
Package Type	Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-134	9889	Pin	$356

Delivery is from stock.

MODEL SW-161 — MATCHED SPST RF SWITCH 10-1500 MHz

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.8 dB Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-1500 MHz
Insertion Loss	10-1500 MHz	1.5 dB Max
	10-1000 MHz	1.2 dB Max
	20-500 MHz	1.0 dB Max
VSWR (All States)	10-1500 MHz	1.50:1 Max
	20-1000 MHz	1.25:1 Max
Isolation	10-1500 MHz	40 dB Min
	10-1000 MHz	50 dB Min
	10-500 MHz	60 dB Min

Operating Characteristics

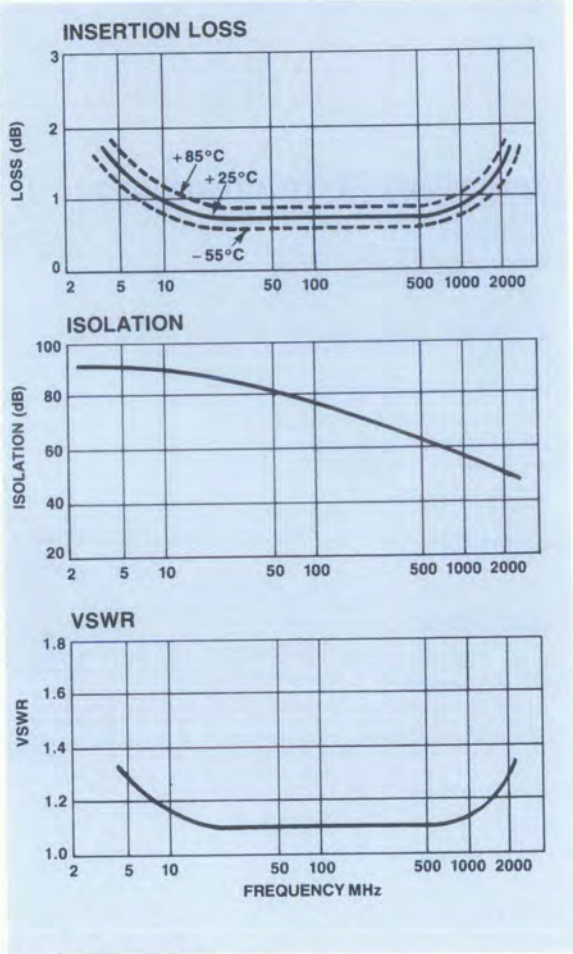
Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 μS Typ
t_{OFF}		1.5 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression	10-1500 MHz	+5 dBm Typ
	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(10-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (450 mW Typical)
Package Type		Dual Inline (DI-1) (See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF PATH RF1 TO RF2
0	OFF
1	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-161	6369	Pin	$244

Delivery is from stock.

MODEL SW-162 — MATCHED SPDT RF SWITCH 10-1500 MHz

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.8 dB Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-1500 MHz
Insertion Loss	10-1500 MHz	1.5 dB Max
	10-1000 MHz	1.2 dB Max
	20-500 MHz	1.0 dB Max
VSWR (All States)	10-1500 MHz	1.50:1 Max
	20-1000 MHz	1.25:1 Max
Isolation	10-1500 MHz	40 dB Min
	10-1000 MHz	50 dB Min
	10-500 MHz	60 dB Min

Operating Characteristics

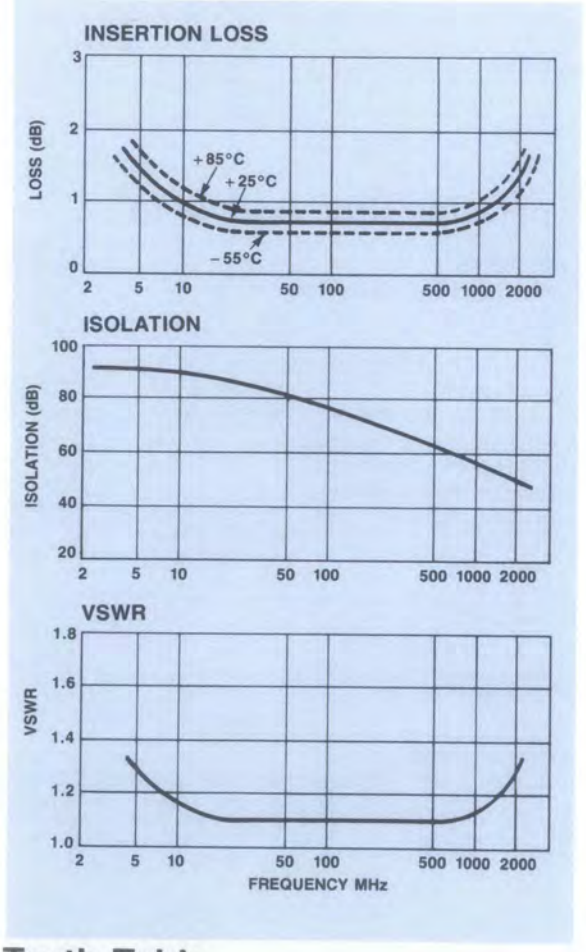
Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 μS Typ
t_{OFF}		1.5 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression	10-1500 MHz	+5 dBm Typ
	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(10-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 35 mA Max
		−5 VDC ±5% @ 35 mA Max
		(500 mW Typical)
Package Type		Dual Inline (DI-1)
		(See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUT	CONDITION OF SWITCH	
"1" = TTL LOGIC HIGH	RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-162	6379	Pin	$271

Delivery is from stock

MODEL SW-164 — MATCHED SP4T RF SWITCH
10-1500 MHz

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.9 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		10-1500 MHz
Insertion Loss	10-1500 MHz	2.0 dB Max
	10-1000 MHz	1.5 dB Max
	10-500 MHz	1.2 dB Max
VSWR (All States)	10-1500 MHz	1.80:1 Max
	10-1000 MHz	1.50:1 Max
	20-500 MHz	1.25:1 Max
Isolation	10-1500 MHz	35 dB Min
	10-1000 MHz	40 dB Min
	10-500 MHz	50 dB Min

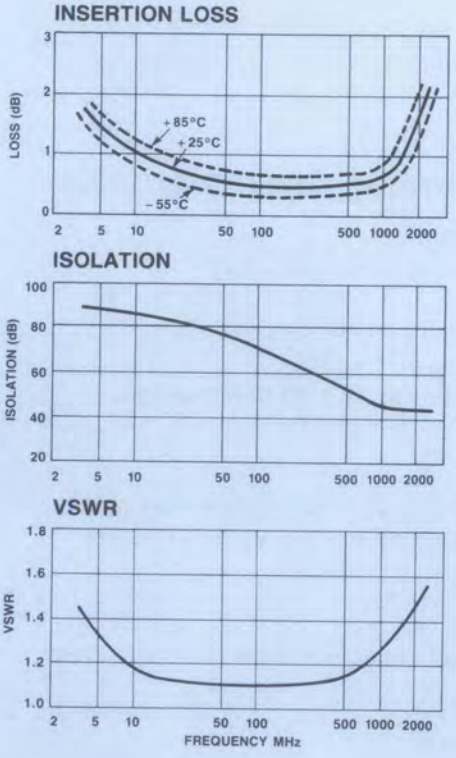
Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 μS Typ
t_{OFF}		1.5 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression	10-1500 MHz	+5 dBm Typ
	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(10-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 50 mA Max −5 VDC ±5% @ 25 mA Max (550 mW Typical)
Package Type		Dual Inline (DI-2) (See page 480 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

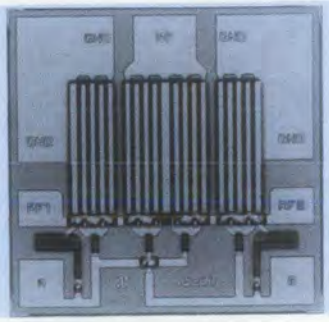
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-164	6399	Pin	$392

Delivery is from stock.

MODEL SW-200 — GaAs SPDT SWITCH CHIP
DC-6 GHz

- Low Insertion Loss, 0.5 dB Typical
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption
- Integral Static Protection



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		DC-6 GHz
Insertion Loss	DC-6 GHz	1.4 dB Max
	DC-2 GHz	0.8 dB Max
	DC-1 GHz	0.6 dB Max
VSWR	DC-6 GHz	1.8:1 Max
	DC-2 GHz	1.3:1 Max
	DC-1 GHz	1.2:1 Max
Isolation* **	DC-6 GHz	30 dB Min
	DC-2 GHz	40 dB Min
	DC-1 GHz	45 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			4 ns Typ
Transients (In-Band)			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-6 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-6 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to −0.2V @ 20 μA Max
V_{IN} Hi			−5V @ 50 μA Typ to −8V @ 300 μA Max
Die Size			0.030″ x 0.030″ x 0.010″ (0.76 mm x 0.76 mm x 0.25 mm)

Environmental: These units are designed to meet or exceed the following: Electrical 100% probing @25°C for selected parameters. Visual 100% per MIL-STD-883 Method 2010 Condition B. Lot traceability supplied on request.

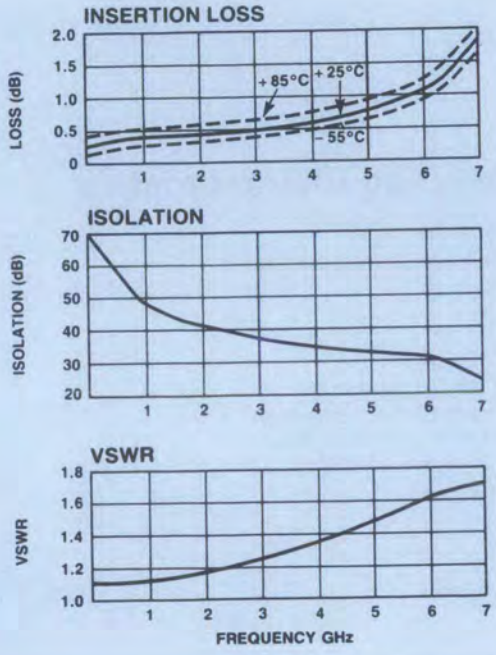
*All specifications apply with 50 ohm impedance at all RF ports with 0 and -5 VDC control voltages.
**When either RF1 or RF2 is "OFF" it is shorted to ground through Q1 or Q2.
***Application note for high isolation techniques, see page 135.
†Faster switching speed can be achieved with enhanced driver waveform.

Ordering Information

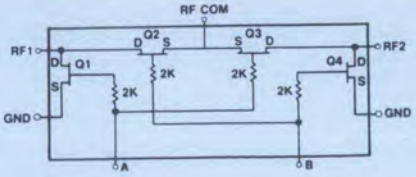
Model No.	Part No.	Connectors	Unit Price (1-49 Units)
SW-200	6840	Chip	$25

Delivery is from stock.

Typical Performance



Schematic



Truth Table**

Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

SW-200 Handling, Mounting, Bonding Procedure

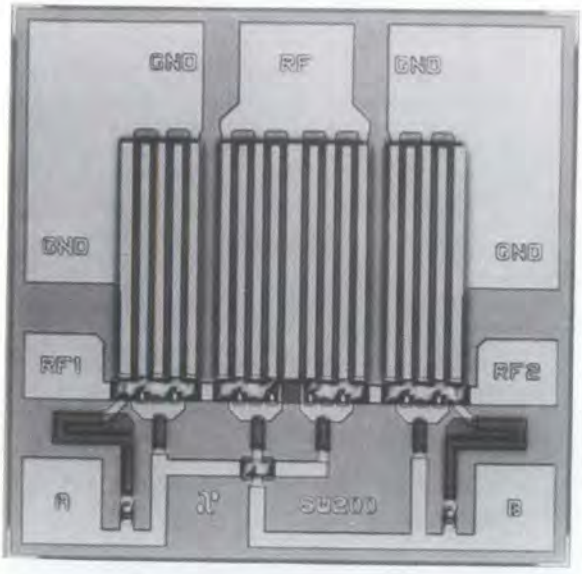
Maximum Ratings

A. Control Voltage (A or B): −8.5 Vdc

B. Max Input RF Power: +34dBm (500 MHz - 6 GHz)

C. Storage Temperature: −65°C to +175°C

D. Maximum Operating Temperature: +175°C



BondPad Dimensions Inches (mm)

RF1: 0.005 x 0.005 (0.130 x 0.130)

GND: 0.004 x 0.013 (0.100 x 0.320)

RF1, RF2: 0.004 x 0.004 (0.100 x 0.100)

A,B: 0.004 x 0.004 (0.100 x 0.100)

Die Size Inches (mm)

0.030 x 0.030 x 0.010 (0.76 x 0.76 x 0.25)

Handling Precautions

Permanent damage to the SW-200 may occur if the following precautions are not adhered to:

A. Cleanliness – The SW-200 should be handled in a clean environment. DO NOT attempt to clean unit after the SW-200 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transients – Avoid instrument and power supply transients while bias is applied to the SW-200. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port A or B only when the other is grounded. Neither A nor B should be allowed to "float".

E. General Handling – It is recommended that the SW-200 chip be handled with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The SW-200 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the SW-200 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Preheat assembly to 125-150°C. Apply a minimum amount of epoxy and place the SW-200 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

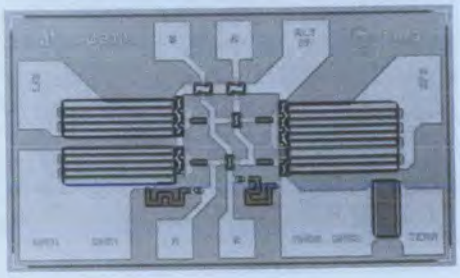
A. Thermosonic wedge wire bonding of 0.001 diameter pure gold wire is recommended with a nominal stage temperature of 150°C and a bonding force of 18 to 22 grams. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

NEW

MODEL SW-210 — GaAs SPST SWITCH CHIP DC-6 GHz

- Three Configurations on Single Chip Terminated(T), High Isolation(H), Low Loss(L)
- Fast Switching Speed, 6nS Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range					DC-6 GHz
Switching Configuration‡		**(T)**	**(H)**	**(L)**	
Insertion Loss	DC-6 GHz	1.8	1.6	1.3	dB Max
	DC-2 GHz	1.0	1.0	0.7	dB Max
	DC-1 GHz	0.9	0.9	0.6	dB Max
VSWR	DC-6 GHz	2.5:1	2.0:1	1.8:1	Max
	DC-2 GHz	1.4:1	1.4:1	1.2:1	Max
	DC-1 GHz	1.2:1	1.2:1	1.15:1	Max
Isolation**	DC-6 GHz	17	23	10	dB Min
	DC-2 GHz	43	45	20	dB Min
	DC-1 GHz	55	55	27	dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			3 nS Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			6 nS Typ
Transients (In-Band)			30 mV TYp
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-6 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.5-6 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to −0.2V @ 20 μA Max
V_{IN} Hi			−5V @ 50 μA Typ to −8V @ 300 μA Max
Die Size			0.030″ x 0.050″ x 0.010″ (0.76 mm x 1.27 mm x 0.25 mm)

Environmental: These units are designed to meet or exceed the following: Electrical: 100% probing @25°C for selected parameters. Visual: 100% per MIL-STD-883 Method 2010, Condition B. Lot traceability supplied on request.

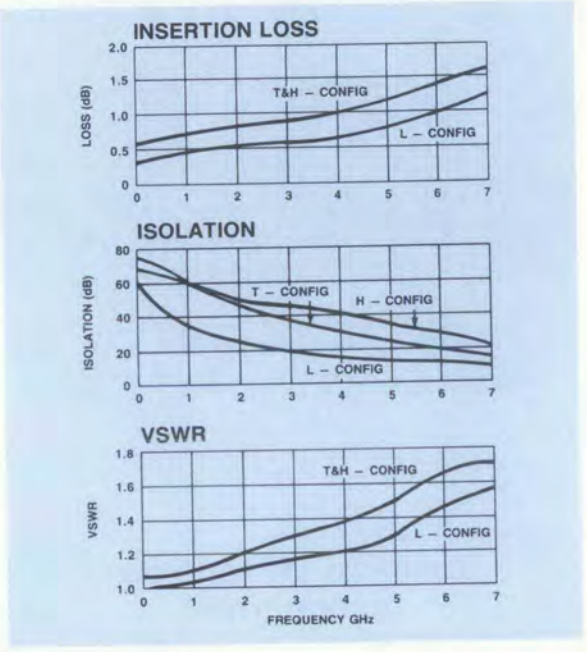
*All specifications apply with 50 ohm impedance connected to all RF ports, 0 and −5 Vdc control voltages, and chip interconnections made with 0.001″ Dia. wirebonds.
†Faster switching speed can be achieved with enhanced driver waveform.
‡Configuration Guide on page 136.
**Application note for high isolation techniques, see page 135.

Ordering Information

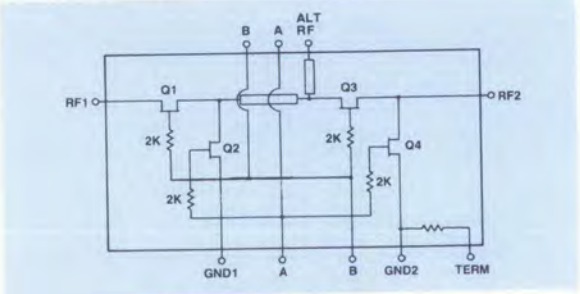
Model No.	Part No.	Connectors	Unit Price (1-49 Units)
SW-210	6760	Chip	$25

Delivery is from stock.

Typical Performance



Schematic



Truth Table

Control Input		Condition Of Switch
A	B	RF1 or ALT RF to RF2
Hi	Low	ON
Low	Hi	OFF

SW-210 Handling, Mounting, Bonding Procedure

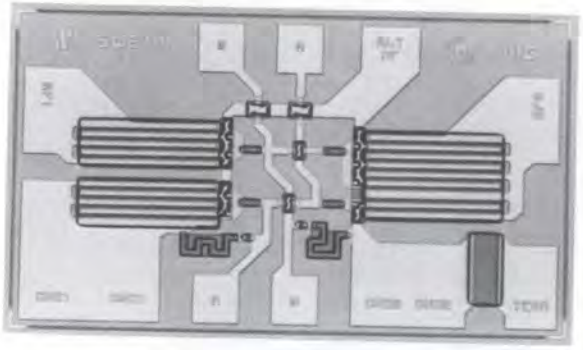
Maximum Ratings

A. Control Voltage (A or B): –8.5 Vdc

B. Max Input RF Power: +34dBm (500 MHz - 6 GHz)

C. Storage Temperature: –65 °C to +175 °C

D. Maximum Operating Temperature: +175 °C



BondPad Dimensions Inches (mm)

RF1, RF6:	0.004 x 0.008 (0.100 x 0.200)
ALT RF:	0.004 x 0.005 (0.100 x 0.130)
A,B:	0.004 x 0.004 (0.100 x 0.100)
GND1:	0.008 x 0.012 (0.200 x 0.304)
GND2:	0.007 x 0.010 (0.184 x 0.252)
TERM:	0.005 x 0.007 (0.130 x 0.184)

Die Size Inches (mm)

0.030 x 0.050 x 0.010
(0.76 x 1.27 x 0.25)

Handling Precautions

Permanent damage to the SW-210 may occur if the following precautions are not adhered to:

A. Cleanliness — The SW-210 should be handled in a clean environment. DO NOT attempt to clean unit after the SW-210 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transients — Avoid instrument and power supply transients while bias is applied to the SW-210. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port A or B only when the other is grounded. Neither A nor B should be allowed to "float".

E. General Handling — It is recommended that the SW-210 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The SW-210 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with termally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290 °C.

B. DO NOT expose the SW-210 to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Preheat assembly to +125-150 °C. Apply a minimum amount of epoxy and place the SW-210 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 Mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

NEW

MODEL SW-240 — GaAs SP4T SWITCH CHIP
DC - 4 GHz

- Low Insertion Loss, 0.6 dB Typical
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 4 GHz
Insertion Loss	DC - 4 GHz	1.2dB Max
	DC - 2 GHz	0.9dB Max
	DC - 1 GHz	0.8dB Max
	DC - 0.5 GHz	0.7dB Max
VSWR	DC - 4 GHz	1.8:1 Max
	DC - 2 GHz	1.4:1 Max
	DC - 1 GHz	1.2:1 Max
	DC - 0.5 GHz	1.2:1 Max
Isolation	DC - 4 GHz	25dB Min
	DC - 2 GHz	35dB Min
	DC - 1 GHz	43dB Min
	DC - 0.5 GHz	48dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			25mv Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5 to 4 GHz	+26	+32	dBm Typ
0.05 GHz	+20	+23	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBm)			
intercept points	IP_2	IP_3	
0.5 to 4 GHz	+68	+50	dBm Typ
0.05 GHz	+55	+37	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 5 μA Max
V_{IN} Hi			–5V @ 10 μA Typ to –8V @ 100 μA Max
Die Size			0.040"x0.040"x0.010" (1.02mm x 1.02mm x 0.25mm)

Environmental
These units are designed to meet or exceed the following: Electrical, 100% probing at 25°C for selected parameters. Visual, 100% per MIL-STD-883 Method 2010 Condition B. Lot traceability supplied on request.

*All specifications apply with 50 ohm impedance connected to all RF ports, 0 and –5 Vdc control voltages, and chip interconnections made with 0.001" Dia. wirebonds.

†Faster switching speed can be achieved with enhanced driver waveform.

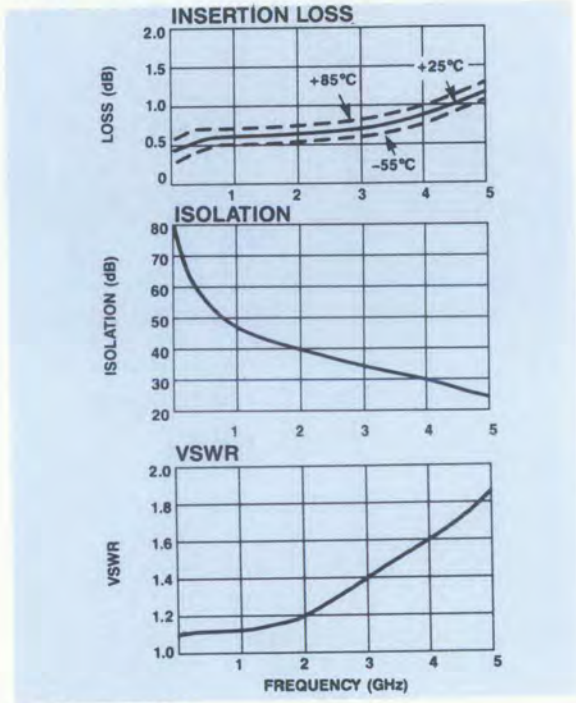
**When an RF output port is "off" it is shorted to ground through an "on" shunt MESFET.

Ordering Information

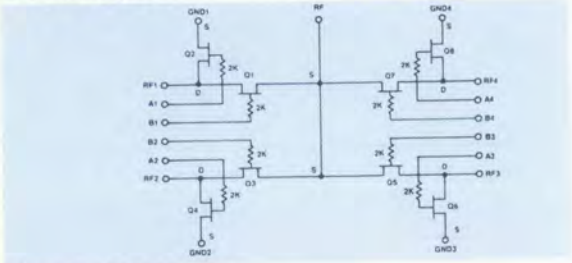
Model No.	Connectors	Unit Price (1-9 Units)
SW-240	CHIP	$75

Delivery is from stock.

Typical Performance



Schematic



Truth Table**

Control Input								Condition of Switch RF Common to Each RF Port			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
Hi	Low	Low	Hi	Low	Hi	Low	Hi	ON	OFF	OFF	OFF
Low	Hi	Hi	Low	Low	Hi	Low	Hi	OFF	ON	OFF	OFF
Low	Hi	Low	Hi	Hi	Low	Low	Hi	OFF	OFF	ON	OFF
Low	Hi	Low	Hi	Low	Hi	Hi	Low	OFF	OFF	OFF	ON

SW-240 Handling, Mounting, Bonding Procedure

Maximum Ratings

A. Control Voltage (A or B): -8.5 Vdc

B. Max Input RF Power: +33dBm (0.5 - 4.0 GHz with 0/-8V CTL)

C. Storage Temperature: -65 °C to +175 °C

D. Maximum Operating Temperature: +175 °C

BondPad Dimensions Inches (mm)

RF, RF1-RF4: .004 x .004 (.100 x .100)

GND1-GND4: 0.004 x 0.008 (.100 x .200)

A1, B1, A2, B2
A3, B3, A4, B4: 0.004 x 0.004 (0.100 x 0.100)

Die Size Inches (mm)

0.040 x 0.040 x 0.010
(1.02 x 1.02 x 0.25)

Handling Precautions

Permanent damage to the SW-240 may occur if the following precautions are not adhered to:

A. Cleanliness — The SW-240 should be handled in a clean environment. DO NOT attempt to clean unit after the SW-240 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transients — Avoid instrument and power supply transients while bias is applied to the SW-240. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port A or B only when the other is grounded. Neither A nor B should be allowed to "float".

E. General Handling — It is recommended that the SW-240 chip be handled with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The SW-240 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290 °C.

B. DO NOT expose the SW-240 to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the SW-240 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 Mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.

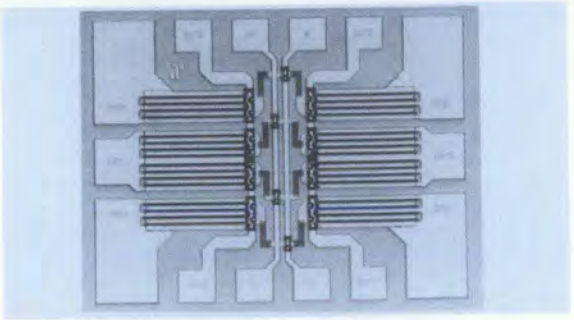
B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

NEW

MODEL SW-280

GaAs DPDT SWITCH CHIP
DC - 6 GHz

- Low Insertion Loss, 0.5 dB Typical
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 6 GHz
Insertion Loss	DC - 6 GHz	1.5dB Max
	DC - 4 GHz	1.0dB Max
	DC - 2 GHz	0.8dB Max
	DC - 1 GHz	0.6dB Max
VSWR	DC - 6 GHz	1.8:1 Max
	DC - 4 GHz	1.5:1 Max
	DC - 2 GHz	1.4:1 Max
	DC - 1 GHz	1.2:1 Max
Isolation	DC - 6 GHz	20dB Min
	DC - 4 GHz	25dB Min
	DC - 2 GHz	35dB Min
	DC - 1 GHz	40dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			15mV Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5 to 6 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 6 GHz	+68	+40	dBm Typ
0.05 GHz	+62	+45	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 5 μA Max
V_{IN} Hi			–5V @ 10 μA Typ to –8V @ 100 μA Max
Die Size	0.036"x0.046"x0.010" (0.91mm x 1.17mm x 0.25mm)		

Environmental

These units are designed to meet or exceed the following: Electrical, 100% probing at 25°C for selected parameters. Visual, 100% per MIL-STD-883 Method 2010 Condition B. Lot traceability supplied on request.

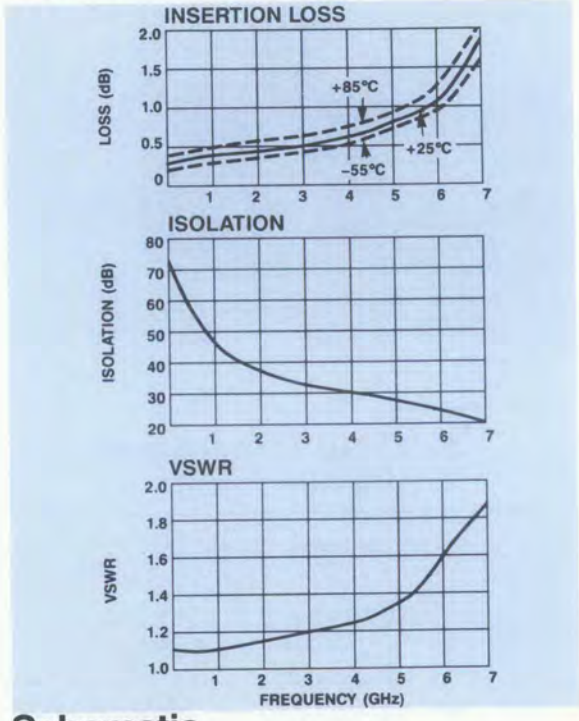
*All specifications apply with 50 ohm impedance connected to all RF ports. 0 and –5 Vdc control voltages, and chip interconnections made with 0.001" Dia. wirebonds.
†Faster switching speed can be achieved with enhanced driver waveform.
**When an RF output port is "off" it is shorted to ground through an "on" shunt MESFET.

Ordering Information

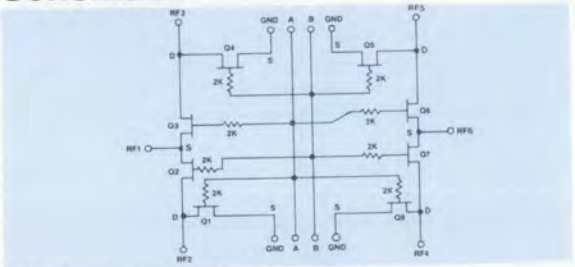
Model No.	Connectors	Unit Price (1-9 Units)
SW-280	CHIP	$45

Delivery is from stock.

Typical Performance



Schematic



Truth Table**

Control Input		Condition of Switch			
		RF1 to		RF6 to	
A	B	RF2	RF3	RF4	RF5
Hi	Low	ON	OFF	ON	OFF
Low	Hi	OFF	ON	OFF	ON

SW-280 Handling, Mounting, Bonding Procedure

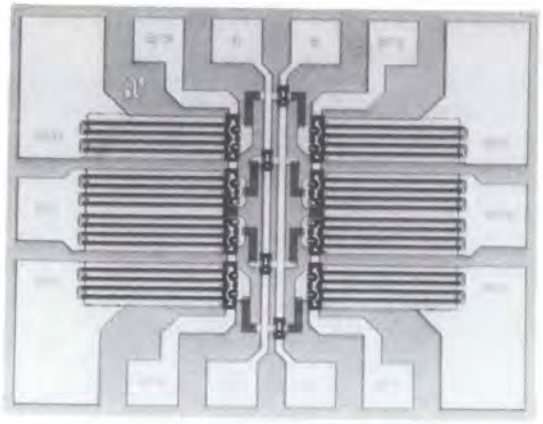
Maximum Ratings

A. Control Voltage (A or B): -8.5 Vdc

B. Max Input RF Power: +34dBm (0.5 - 6.0 GHz with 0/-8V CTL)

C. Storage Temperature: -65 °C to +175 °C

D. Maximum Operating Temperature: +175 °C



BondPad Dimensions Inches (mm)

RF1, RF6: (.005 x .006)
(.130 x .150)

RF2-RF5: (.004 x .004)
(.100 x .100)

GND: (.005 x .013)
(.130 x .320)

Die Size Inches (mm)

0.036 x 0.046 x 0.010
(0.91 x 1.17 x 0.25)

Handling Precautions

Permanent damage to the SW-280 may occur if the following precautions are not adhered to:

A. Cleanliness — The SW-280 should be handled in a clean environment. DO NOT attempt to clean unit after the SW-280 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transients — Avoid instrument and power supply transients while bias is applied to the SW-280. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port A or B only when the other is grounded. Neither A nor B should be allowed to "float".

E. General Handling — It is recommended that the SW-280 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The SW-280 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255 °C and a tool temperature of 265 °C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290 °C.

B. DO NOT expose the SW-280 to a temperature greater than 320 °C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the SW-280 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 Mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.

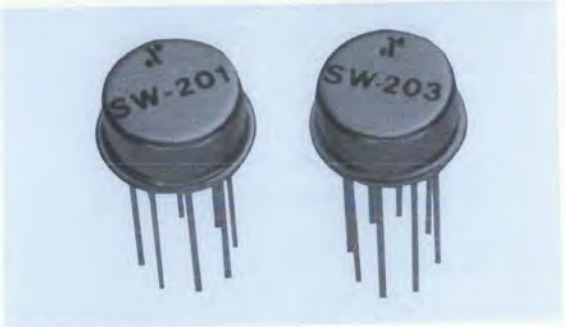
B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

NEW

MODELS SW-201/203

GaAs SPDT SWITCH
DC-3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-201), Terminated (SW-203)



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				DC-3 GHz
Model Number		**SW-201 (L)**	**SW-203 (T)**	
Insertion Loss	DC-3 GHz	1.1	1.9	dB Max
	DC-2 GHz	0.9	1.5	dB Max
	DC-1 GHz	0.8	1.1	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-3 GHz	2.0:1	2.5:1	Max
	DC-2 GHz	1.5:1	2.0:1	Max
	DC-1 GHz	1.3:1	1.3:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	Max
Isolation	DC-3 GHz	28	33	dB Min
	DC-2 GHz	30	38	dB Min
	DC-1 GHz	38	45	dB Min
	DC-0.5 GHz	45	50	dB Min

Operating Characteristics

Impedance 50 Ohms Nominal

Switching Characteristics†

t_{RISE}, t_{FALL}	3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	6 ns Typ
Transients (In-Band) SW-203	30 mV Typ
Transients (In-Band) SW-201	10 mV Typ

Input Power for 1 dB Compression

Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ

Control Voltages (Complementary Logic)

V_{IN} Low (SW-201/203)	0 to −0.2V @ 20 μA Max
V_{IN} Hi (SW-201)	−5V @ 50 μA Typ to −8V @ 300 μA Max
V_{IN} Hi (SW-203)	−5V @ 110 μA typ to −8V @ 600 μA Max

Package Type (See page 472) TO-5-3

Environmental

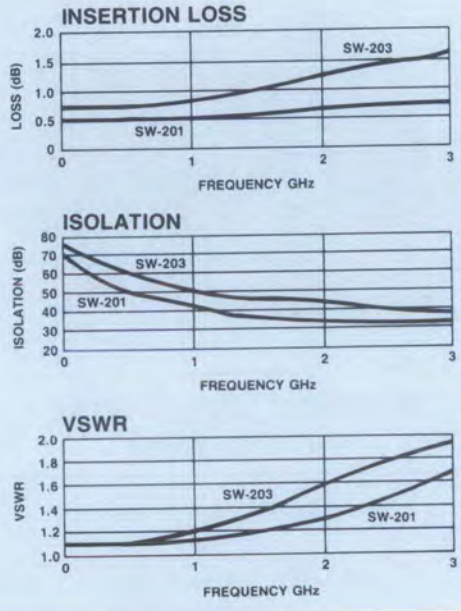
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages.

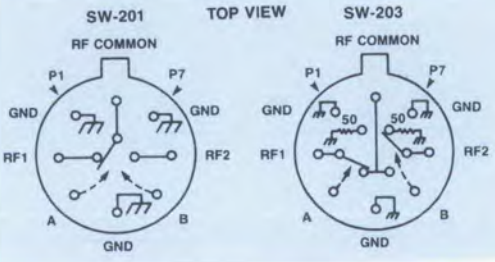
†Faster switching speed can be achieved with enhanced driver waveform.

**For the SW-201 only, when an RF output is "OFF" it is shorted to case ground.

Typical Performance



Pin Configuration



Truth Table**

Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

Ordering Information

Delivery is from stock.

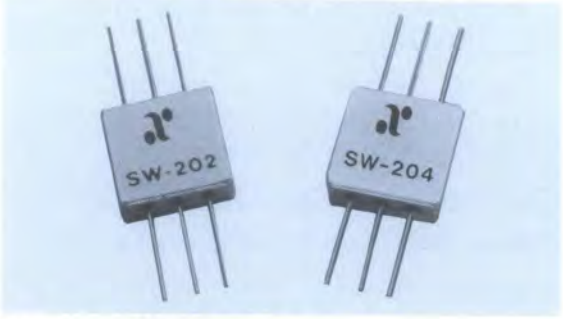
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-201	6859	Pin	$52
SW-203	6089	Pin	52

NEW

MODELS SW-202/204

GaAs SPDT SWITCH
DC-3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-202), Terminated (SW-204)



Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range				DC-3 GHz
Model Number		**SW-202**	**SW-204**	
Insertion Loss	DC-3 GHz	1.0	1.5	dB Max
	DC-2 GHz	0.9	1.2	dB Max
	DC-1 GHz	0.7	1.0	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-3 GHz	2.0:1	2.0:1	Max
	DC-2 GHz	1.5:1	1.5:1	Max
	DC-1 GHz	1.3:1	1.4:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	Max
Isolation	DC-3 GHz	22	28	dB Min
	DC-2 GHz	28	35	dB Min
	DC-1 GHz	38	45	dB Min
	DC-0.5 GHz	45	45	dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-204			30 mV Typ
Transients (In-Band) SW-202			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low (SW-202/204)		0 to −0.2V @ 20 μA Max	
V_{IN} Hi (SW-202)		−5V @ 50 μA Typ to −8V @ 300 μA Max	
V_{IN} Hi (SW-204)		−5V @ 110 μA typ to −8V @ 600 μA Max	
Package Type		(See page 476)	Flatpack (FP-13)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

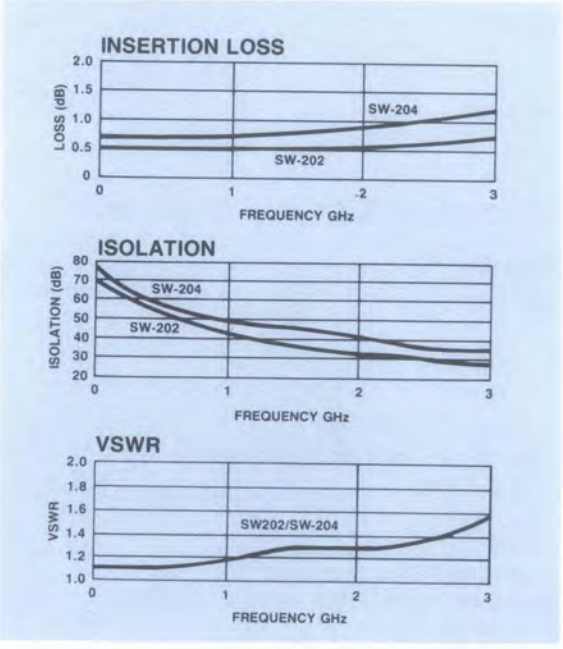
*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages.
†Faster switching speed can be achieved with enhanced driver waveform.
**For the SW-202 only, when an RF output is "OFF" it is shorted to case ground.

Ordering Information

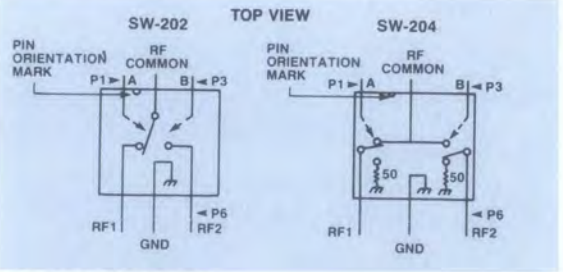
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-202	6869	Pin	$62
SW-204	6109	Pin	62

Delivery is from stock.

Typical Performance



Pin Configuration



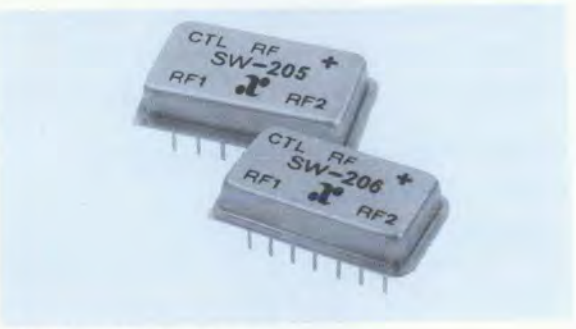
Truth Table**

Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

MODELS SW-205/206

MATCHED GaAs SPDT SWITCH 5-4000 MHz

- High Isolation, 50 dB Typical
- Fast Switching Speed
- Low DC Power Consumption
- Integral TTL (SW-205) or CMOS (SW-206) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-4000 MHz
Insertion Loss	5-4000 MHz	2.6 dB Max
	5-2000 MHz	2.1 dB Max
	5-1000 MHz	1.6 dB Max
VSWR	5-4000 MHz	2.5:1 Max
	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.5:1 Max
Isolation	5-4000 MHz	35 dB Min
	5-2000 MHz	40 dB Min
	5-1000 MHz	45 dB Min

Operating Characteristics

Impedance 50 Ohms Nominal

Switching Characteristics	**SW-205 (TTL)**	**SW-206 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	70 mV	70 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-205	SW-206	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-4 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ

Bias Power

SW-205 +5 VDC @ 1 mA Max

SW-206 +5 to +8 VDC @ 0.150 to 0.400 mA Typ, 1 mA Max

Package TYpe Dual Inline (DI-1)

(See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

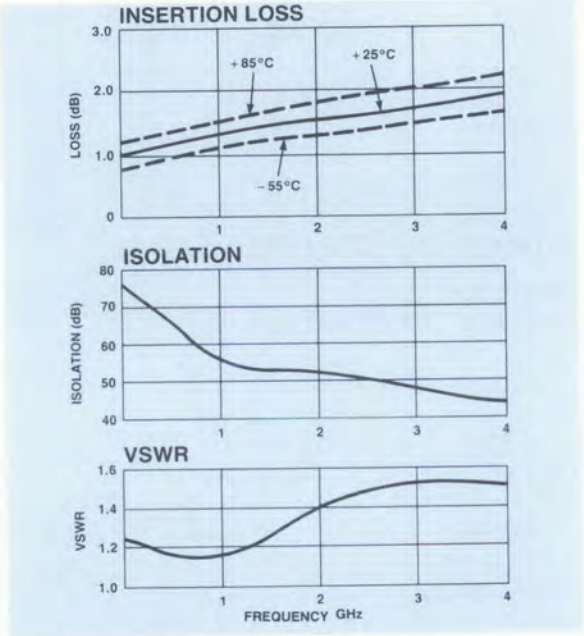
*All specifications apply when operated with bias voltages of +5 VDC (SW-205) or +8 VDC (SW-206) and 50 ohm impedance at all RF ports.

Ordering Information

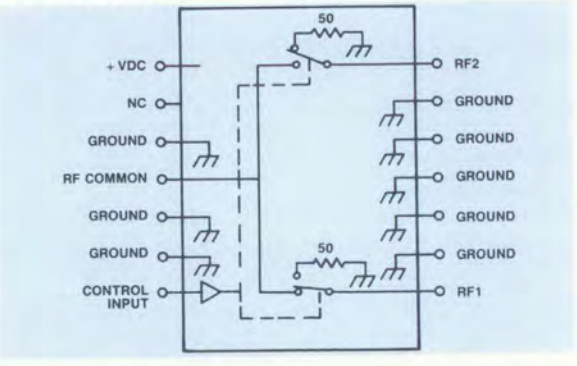
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-205	6899	Pin	$300
SW-206	6909	Pin	300

Delivery is from stock.

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-205)/CMOS (SW-206)	Condition Of Switch RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

MODELS SW-207/208

GaAs SPDT SWITCH 5-4000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed
- Low DC Power Consumption
- Integral TTL (SW-207) or CMOS (SW-208) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-4000 MHz
Insertion Loss	5-4000 MHz	2.3 dB Max
	5-2000 MHz	1.4 dB Max
	5-1000 MHz	1.0 dB Max
VSWR	5-4000 MHz	2.5:1 Max
	5-2000 MHz	1.7:1 Max
	5-1000 MHz	1.5:1 Max
Isolation	5-4000 MHz	18 dB Min
	5-2000 MHz	28 dB Min
	5-1000 MHz	38 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-207 (TTL)**	**SW-208 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	70 mV	35 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-207	SW-208	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-4 GHz	+68	+46	dBm Typ
0.05 GHz	+60	+40	dBm Typ

Bias Power	
SW-207	+5 VDC @ 1 mA Max
SW-208	+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1mA Max
Package Type	Dual Inline (DI-1)
	(See page 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

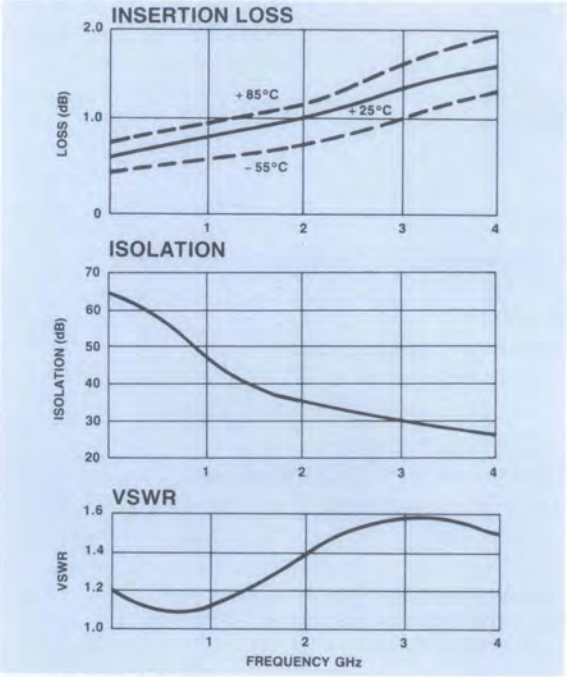
*All specifications apply when operated with bias voltages of +5 VDC (SW-207) or +8 VDC (SW-208) and 50 ohm impedance at all RF ports.

Ordering Information

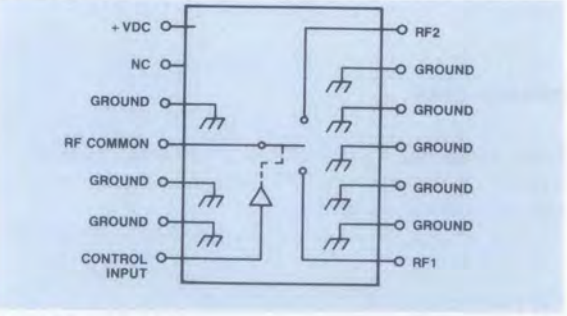
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-207	6919	Pin	$269
SW-208	6929	Pin	269

Delivery is from stock.

Typical Performance



Schematic



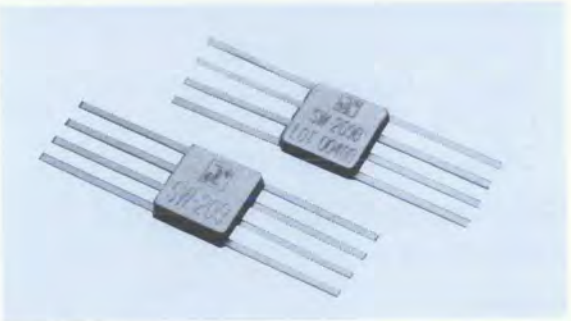
Truth Table

Control Input "1" = Logic High TTL (SW-207)/CMOS (SW-208)	Condition Of Switch RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

NEW

MODEL SW-209/209B — MATCHED GaAs SPST SWITCH DC-3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.180″ (4.6mm) Sq



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		DC-3 GHz
Insertion Loss	DC-3 GHz	1.5 dB Max
	DC-2 GHz	1.2 dB Max
	DC-1 GHz	1.1 dB Max
	DC-0.5 GHz	0.9 dB Max
VSWR	DC-3 GHz	1.6:1 Max
	DC-2 GHz	1.5:1 Max
	DC-1 GHz	1.2:1 Max
	DC-0.5 GHz	1.2:1 Max
Isolation	DC-3 GHz	27 dB Min
	DC-2 GHz	32 dB Min
	DC-1 GHz	40 dB Min
	DC-0.5 GHz	45 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band)			30 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to −0.2V @ 20 μA Max
V_{IN} Hi			−5V @ 50 μA Typ to −8V @ 300 μA Max
Package TYpe			Ceramic (CR-3)
			(See page 490 for physical dimensions.)

Environmental: SW-209 is available screened to MIL-STD-883C, Method 5008.4, Table VII, Class B Hybrids. Specify SW-209B when ordering.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages.

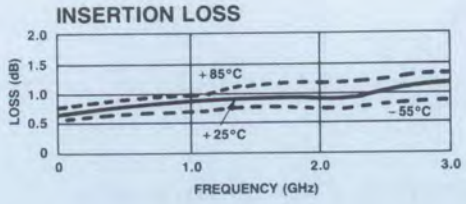
†Faster switching speed can be achieved with enhanced driver waveform.

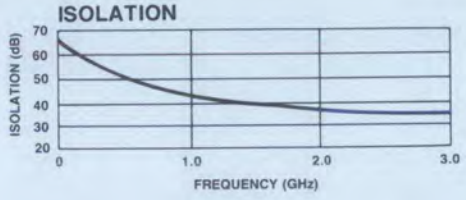
Ordering Information

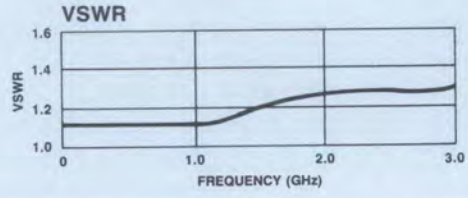
Model No.	Part No.	Connectors	Unit Price (1-49 Units)
SW-209	6969	Pin	$28.95
SW-209B	6989	Pin	55.00

Delivery is from stock.

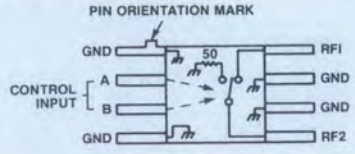
Typical Performance







Pin Configuration



Truth Table

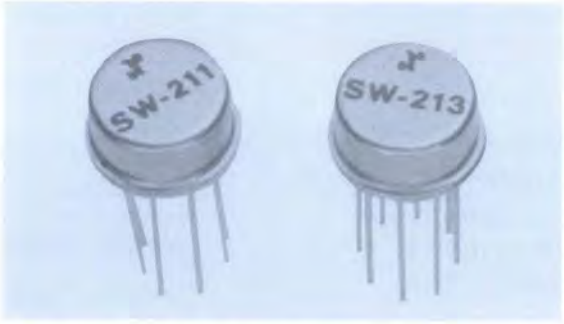
Control Input		Condition Of Switch
A	B	RF1 to RF2
Hi	Low	ON
Low	Hi	OFF

NEW

MODELS SW-211/213

GaAs SPST SWITCH
DC-3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-211), Terminated (SW-213)



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				DC-3 GHz
Model Number		**SW-211**	**SW-213**	
Insertion Loss	DC-3 GHz	1.1	1.6	dB Max
	DC-2 GHz	0.9	1.2	dB Max
	DC-1 GHz	0.8	1.0	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-3 GHz	2.0:1	2.0:1	Max
	DC-2 GHz	1.6:1	1.6:1	Max
	DC-1 GHz	1.4:1	1.5:1	Max
	DC-0.5 GHz	1.2:1	1.3:1	Max
Isolation	DC-3 GHz	25	30	dB Min
	DC-2 GHz	27	38	dB Min
	DC-1 GHz	35	45	dB Min
	DC-0.5 GHz	43	50	dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-213			30 mV Typ
Transients (In-Band) SW-211			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low		0 to −0.2V @ 20 μA Max	
V_{IN} Hi		−5V @ 50 μA Typ to −8V @ 300 μA Max	

Package Type (See page 472 for physical dimensions.) (TO-5-3)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages.

†Faster switching speed can be achieved with enhanced driver waveform.

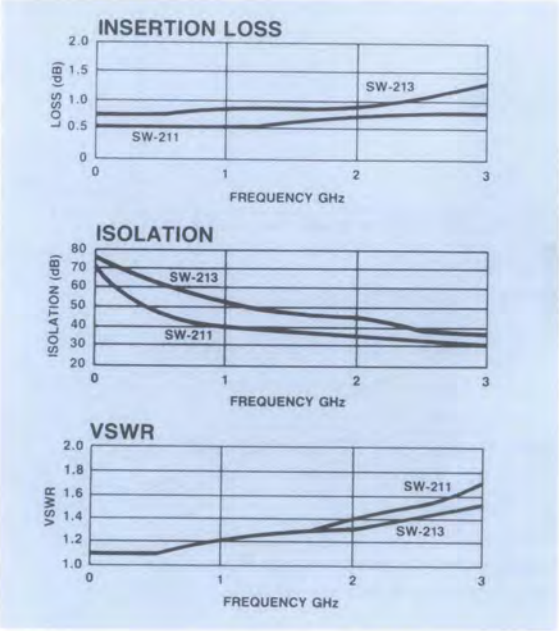
**For the "Off" switch condition of the SW-211 only, RF1 is an open circuit and RF2 is shorted to case ground

Ordering Information

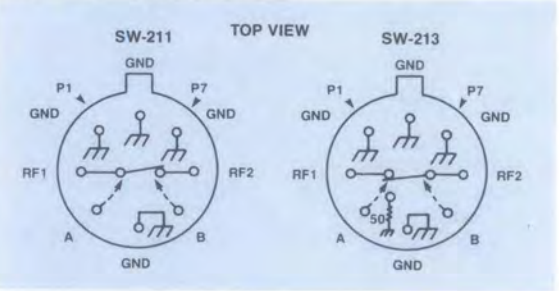
Delivery is from stock

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-211	6119	Pin	$52
SW-213	6139	Pin	52

Typical Performance



Pin Configuration



Truth Table**

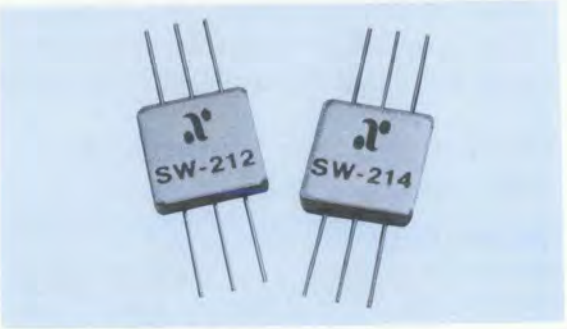
Control Input		Condition Of Switch
A	**B**	**RF1 to RF2**
Hi	Low	ON
Low	Hi	OFF

NEW

MODELS SW-212/214

GaAs SPST SWITCH
DC-3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-212), Terminated (SW-214)



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				DC-3 GHz
Model Number		**SW-212**	**SW-214**	
Insertion Loss	DC-3 GHz	1.0	1.3	dB Max
	DC-2 GHz	0.9	1.2	dB Max
	DC-1 GHz	0.7	0.9	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-3 GHz	1.8:1	2.0:1	Max
	DC-2 GHz	1.5:1	1.7:1	Max
	DC-1 GHz	1.3:1	1.3:1	Max
	DC-0.5 GHz	1.2:1	1.3:1	Max
Isolation	DC-3 GHz	20	25	dB Min
	DC-2 GHz	22	38	dB Min
	DC-1 GHz	32	45	dB Min
	DC-0.5 GHz	40	50	dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/100% RF)			6 ns Typ
Transients (In-Band) SW-214			30 mV Typ
Transients (In-Band) SW-212			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to −0.2V @ 20 μA Max
V_{IN} Hi			−5V @ 50 μA Typ to −8V @ 300 μA Max
Package Type			Flatpack (FP-13)
			(See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages.

†Faster switching speed can be achieved with enhanced driver waveform.

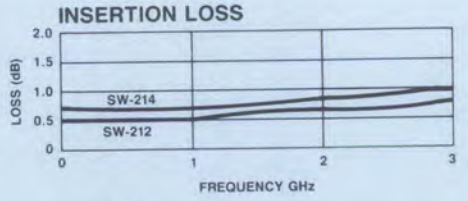
**For the "Off" switch condition of the SW-212 only, RF1 is an open circuit and RF2 is shorted to case ground.

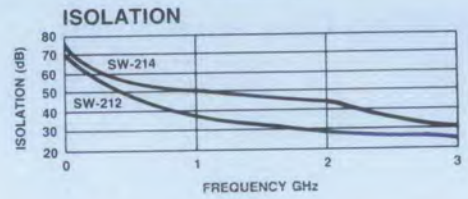
Ordering Information

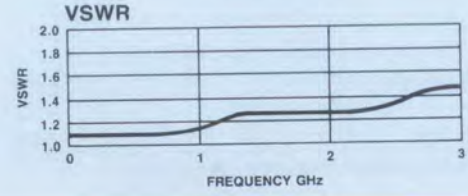
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-212	6129	Pin	$62
SW-214	6199	Pin	62

Delivery is from stock.

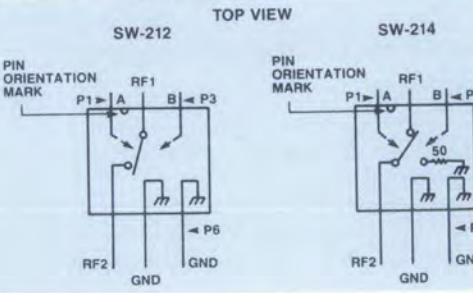
Typical Performance







Pin Configuration



Truth Table**

Control Input		Condition Of Switch
A	**B**	**RF1 to RF2**
Hi	Low	ON
Low	Hi	OFF

NEW

MODELS SW-215/216

MATCHED GaAs SPST SWITCH 5-4000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07mA Typical
- Integral TTL (SW-215) or CMOS (SW-216) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-4000 MHz
Insertion Loss	5-4000 MHz	2.9 dB Max
	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-4000 MHz	2.0:1 Max
	5-2000 MHz	1.9:1 Max
	5-1000 MHz	1.4:1 Max
	5- 500 MHz	1.25:1 Max
Isolation	5-4000 MHz	27 dB Min
	5-2000 MHz	45 dB Min
	5-1000 MHz	55 dB Min
	5- 500 MHz	60 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics		**SW-215 (TTL)**	**SW-216 (CMOS)**
t_{RISE}, t_{FALL}		7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		20 ns	40 ns Typ
Transients (In-Band)		70 mV	35 mV Typ
Input Power for 1 dB Compression			
Model #'s	SW-215	SW-216	
500-4000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-4000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
SW-215		+5 VDC @ 0.07 mA Typ, 1 mA Max	
SW-216		+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1 mA Max	
Package Type	(See page 480 for physical dimensions.)		Dual Inline (DI-1)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

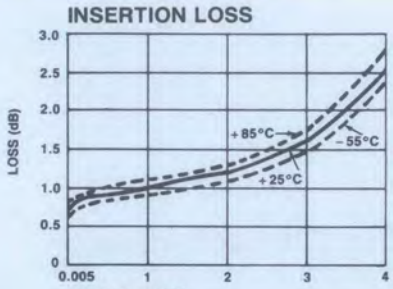
*All specifications apply when operated with bias voltages of +5 VDC (SW-215) or +8 VDC (SW-216) and 50 ohm impedance at all RF ports.

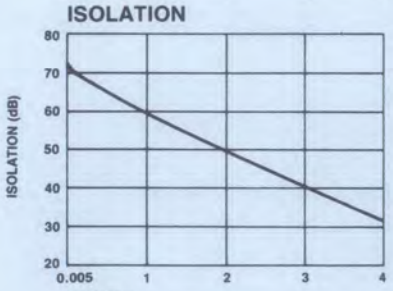
Ordering Information

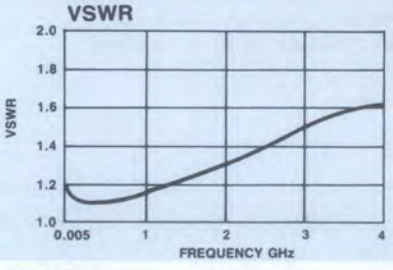
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-215	6529	Pin	$271
SW-216	6539	Pin	271

Delivery is from stock

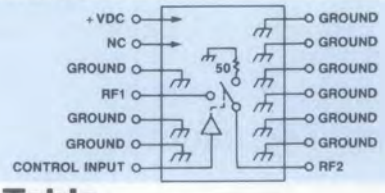
Typical Performance







Schematic



Truth Table

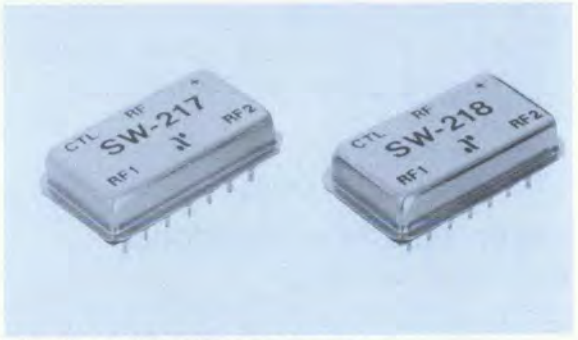
Control Input	Condition Of Switch
"1" = Logic High TTL (SW-215)/CMOS (SW-216)	RF1 to RF2
1	ON
0	OFF

NEW

MODELS SW-217/218

GaAs SPDT SWITCH 5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12mA Typical
- Integral TTL (SW-217) or CMOS (SW-218) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-2000 MHz	1.8:1 Max
	5-1000 MHz	1.4:1 Max
	5- 500 MHz	1.25:1 Max
Isolation	5-2000 MHz	40 dB Min
	5-1000 MHz	45 dB Min
	5- 500 MHz	53 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-217 (TTL)**	**SW-218 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	100 mV	70 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-217	SW-218	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

SW-217	+5 VDC @ 0.12 mA Typ, 1 mA Max
SW-218	+5 to +8 VDC @ 0.12 to 0.40 mA Typ, 1 mA Max

Package Type Dual Inline (DI-1)
(See page 480 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

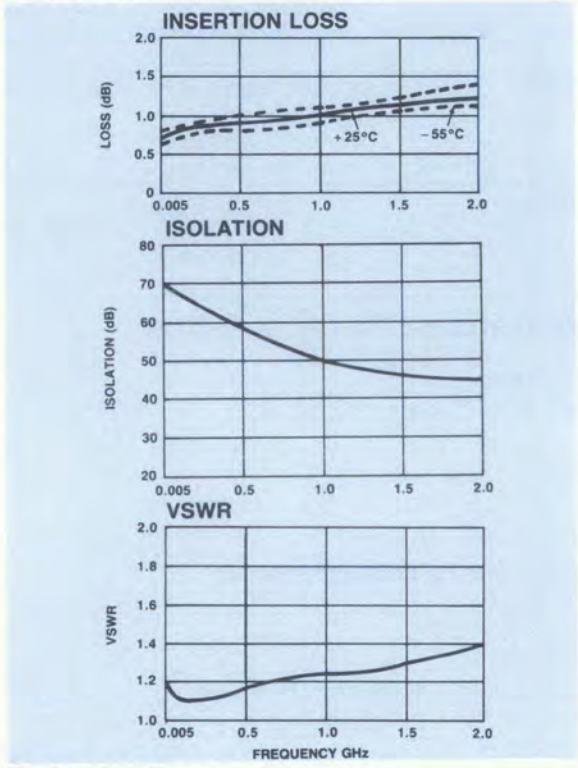
*All specifications apply when operated with bias voltages of +5 VDC (SW-217) or +8 VDC (SW-218) and 50 ohm impedance at all RF ports.

Ordering Information

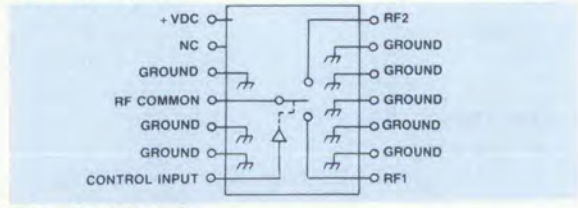
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-217	6659	Pin	$269
SW-218	6669	Pin	269

Delivery is from stock

Typical Performance



Schematic



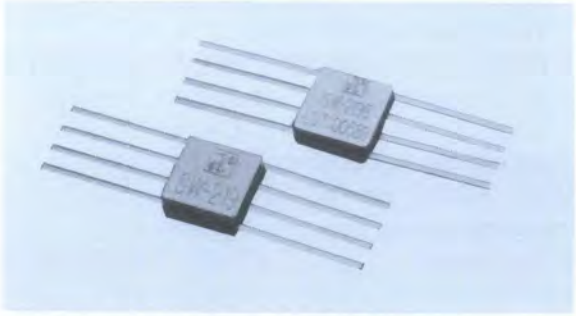
Truth Table

Control Input	Condition Of Switch	
"1" = Logic High TTL (SW-217)/CMOS (SW-218)	RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

NEW

MODEL SW-219/219B — GaAs SPDT RF SWITCH CHIP DC-3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.180″ (4.6mm) Sq



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		DC-3 GHz
Insertion Loss	DC-3 GHz	0.9 dB Max
	DC-2 GHz	0.8 dB Max
	DC-1 GHz	0.8 dB Max
	DC-0.5 GHz	0.7 dB Max
VSWR	DC-3 GHz	1.6:1 Max
	DC-2 GHz	1.3:1 Max
	DC-1 GHz	1.2:1 Max
	DC-0.5 GHz	1.2:1 Max
Isolation	DC-3 GHz	23 dB Min
	DC-2 GHz	28 dB Min
	DC-1 GHz	38 dB Min
	DC-0.5 GHz	43 dB Min

Operating Characteristics

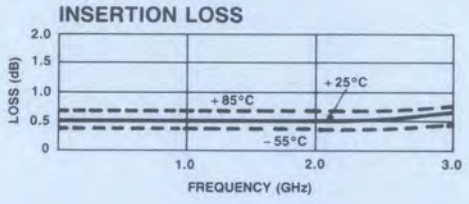
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band)			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to −0.2V @ 20 μA Max
V_{IN} Hi			−5V @ 50 μA Typ to −8V @ 300 μA Max
Package Type			Ceramic (CR-3)
			(See page 490 for physical dimensions.)

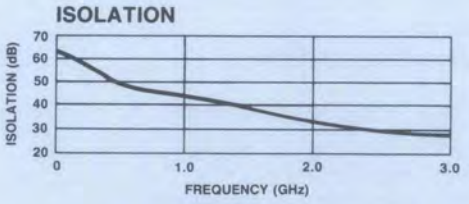
Environmental: SW-219 is available screened to MIL-STD-883C, Method 5008.4, Table VII, Class B Hybrids. Specify SW-219B with ordering.

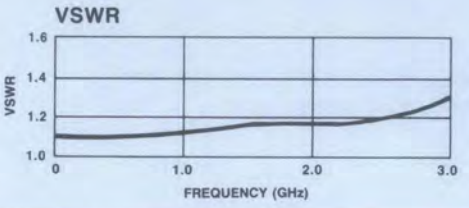
*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages.

†Faster switching speed can be achieved with enhanced driver waveform

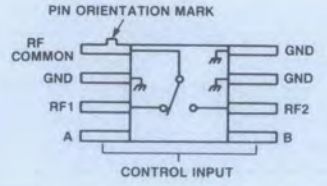
Typical Performance







Pin Configuration



Ordering Information

Model No.	Part No.	Connectors	Unit Price (1-49 Units)
SW-219	6979	Pin	$28.95
SW-219B	6999	Pin	55.00

Delivery is from stock.

Truth Table

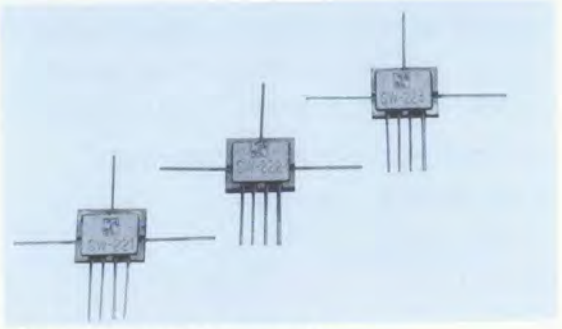
Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

NEW

MODELS SW-221/222/223

GaAs SPST SWITCH DC-4 GHz

- Miniature Ceramic Package
- Terminated (SW-221), High Isolation (SW-222), Low Loss (SW-223)
- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				DC-3 GHz	
Model Number		**SW-221**	**SW-222**	**SW-223**	
Insertion Loss	DC-4 GHz	1.2	1.2	1.0	dB Max
	DC-2 GHz	1.0	1.0	0.8	dB Max
	DC-1 GHz	0.9	0.9	0.7	dB Max
	DC-0.5 GHz	0.9	0.9	0.7	dB Max
VSWR	DC-4 GHz	1.9:1	1.6:1	1.8:1	Max
	DC-2 GHz	1.4:1	1.4:1	1.3:1	Max
	DC-1 GHz	1.2:1	1.2:1	1.2:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	1.2:1	Max
Isolation	DC-4 GHz	22	32	22	dB Min
	DC-2 GHz	40	45	28	dB Min
	DC-1 GHz	55	55	38	dB Min
	DC-0.5 GHz	60	65	45	dB Min

Operating Characteristics

Impedance 50 Ohms Nominal

Switching Characteristics†

t_{RISE}, t_{FALL}	3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	6 ns Typ
Transients (In-Band) SW-221/222	30 mV Typ
Transients (In-Band) SW-223	10 mV Typ

Input Power for 1 dB Compression

Control Voltages (Vdc)	0/−5	0/−8	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-4 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ

Control Voltages (Complementary Logic)

V_{IN} Low	0 to −0.2V @ 20 μA Max
V_{IN} Hi	−5V @ 50 μA Typ to −8V @ 300 μA Max

Package Type Ceramic (CR-2)

(See page 489 for physical dimensions.)

Environmental

These units are designed to meet the environmental requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages. †Faster switching speed can be achieved with enhanced driver waveform.

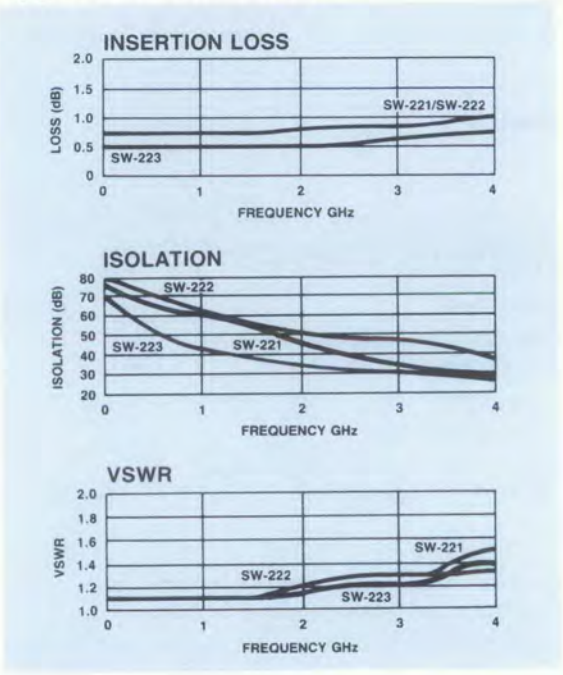
**For the SW-222 and SW-223 only, RF1 is an open circuit and RF2 is shorted to case ground for the "OFF" switch condition.

Ordering Information

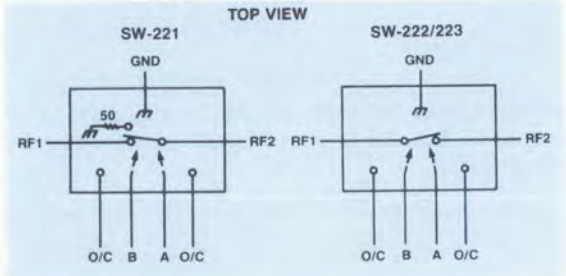
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-221	6299	Pin	$52
SW-222	6419	Pin	51
SW-223	6459	Pin	51

Delivery is from stock.

Typical Performance



Pin Configuration



Truth Table

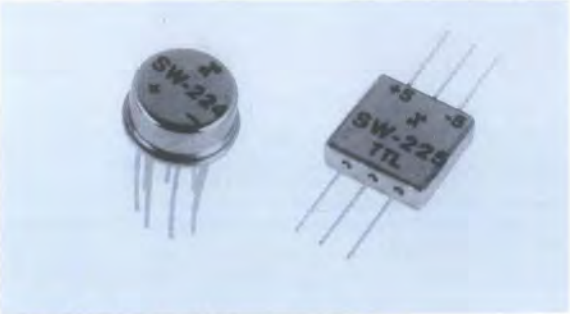
Control Input		Condition Of Switch
A	**B**	**RF1 to RF2**
Hi	Low	ON
Low	Hi	OFF

NEW

MODELS SW-224/225

GaAs SPDT SWITCH
DC-2 GHz

- Low Insertion Loss, 0.5 dB Typical
- Integral TTL Driver
- Low DC Power Consumption



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				DC-2 GHz
Model Number		**SW-224**	**SW-225**	
Insertion Loss	DC-2 GHz	0.9	0.8	dB Max
	DC-1 GHz	0.8	0.7	dB Max
	DC-0.5 GHz	0.7	0.7	dB Max
VSWR	DC-2 GHz	1.5:1	1.5:1	Max
	DC-1 GHz	1.25:1	1.15:1	Max
	DC-0.5 GHz	1.15:1	1.15:1	Max
Isolation	DC-2 GHz	30	30	dB Min
	DC-1 GHz	38	35	dB Min
	DC-0.5 GHz	45	40	dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{RISE}, t_{FALL}	10 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	150 ns Typ
Transients (In-Band)	15 mV Typ
Input Power for 1 dB Compression	
0.5-2 GHz	+27 dBm Typ
0.05 GHz	+21 dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-2 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ

Bias Power	+5 VDC @ 1 mA Max −5 VDC @ 1 mA Max
Package Type	SW-224 (TO-5-3) SW-225 (FP-13)

(See pages 472 and 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

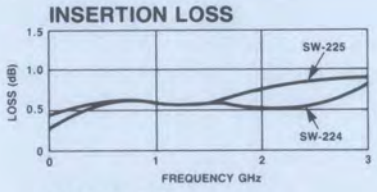
*All specifications apply when operated with bias voltages of +5 VDC and −5 VDC and 50 ohm impedance at all RF ports.

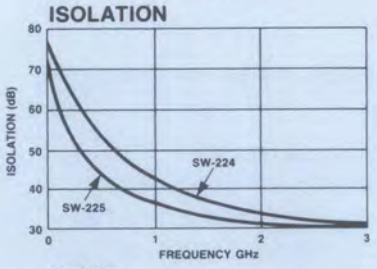
Ordering Information

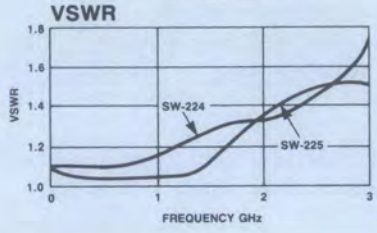
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-224	6888	Pin	$ 98
SW-225	6889	Pin	125

Delivery is from stock

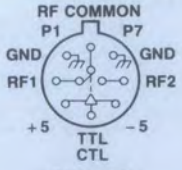
Typical Performance



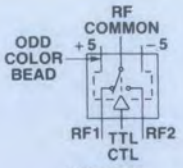




Pin Configuration



SW-224



SW-225

Truth Table

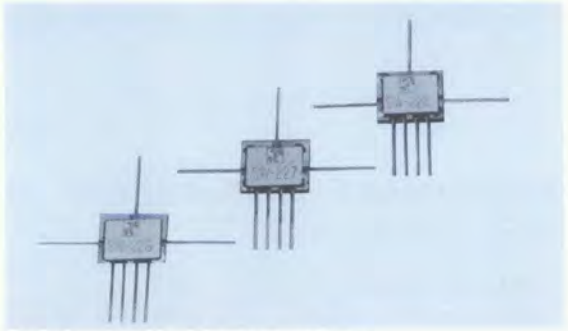
TTL Control Input	Condition Of Switch	
"1" = TTL Logic High	RF Common To Each RF Port	
	RF1	RF2
1	ON	OFF
0	OFF	ON

NEW

MODELS SW-226/227/228

GaAs SPDT SWITCH DC-4 GHz

- Miniature Ceramic Package
- Terminated (SW-226), High Isolation (SW-227), Low Loss (SW-228)
- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range				DC-4 GHz	
Model Number		**SW-226**	**SW-227**	**SW-228**	
Insertion Loss	DC-4 GHz	1.5	1.4	1.0	dB Max
	DC-2 GHz	1.2	1.1	0.8	dB Max
	DC-1 GHz	1.0	1.0	0.7	dB Max
	DC-0.5 GHz	0.9	0.9	0.7	dB Max
VSWR	DC-4 GHz	2.3:1	2.0:1	1.9:1	Max
	DC-2 GHz	1.6:1	1.6:1	1.3:1	Max
	DC-1 GHz	1.4:1	1.4:1	1.2:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	1.2:1	Max
Isolation	DC-4 GHz	25	35	22	dB Min
	DC-2 GHz	40	40	32	dB Min
	DC-1 GHz	48	50	42	dB Min
	DC-0.5 GHz	53	55	50	dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics†	
t_{RISE}, t_{FALL}	3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	6 ns Typ
Transients (In-Band) SW-226/227	30 mV Typ
Transients (In-Band) SW-228	10 mV Typ

Input Power for 1 dB Compression

Control Voltages (Vdc)	0/−5	0/−8	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-4 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ

Control Voltages (Complementary Logic)

V_{IN} Low (SW-226/227/228)	0 to −0.2V @20 μA Max
V_{IN} HI (SW-226-227)	−5V @110 μA Typ to −8V @600 μA Max
V_{IN} HI (SW-228)	−5V @ 50 μA Typ to −8V @300 μA Max
Package Type (See page 489 for physical dimensions.)	Ceramic (CR-2)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages. †Faster switching speed can be achieved with enhanced driver waveform.

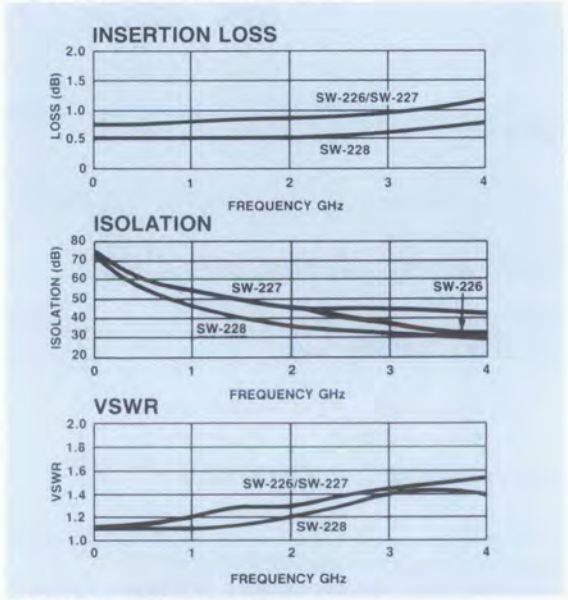
**For the SW-227 and SW-228 only, when an RF output if "OFF" it is shorted to case ground.

Ordering Information

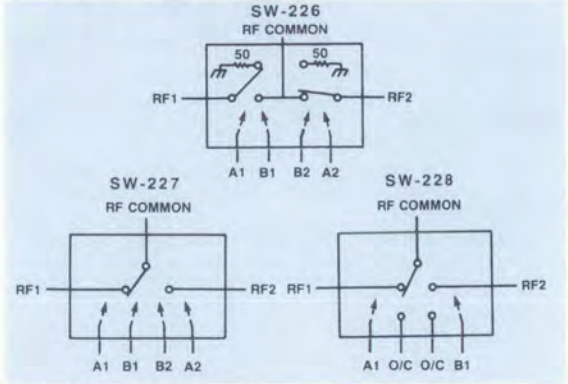
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-226	6469	Pin	$52
SW-227	6479	Pin	51
SW-228	6489	Pin	51

Delivery is from stock.

Typical Performance



Pin Configuration



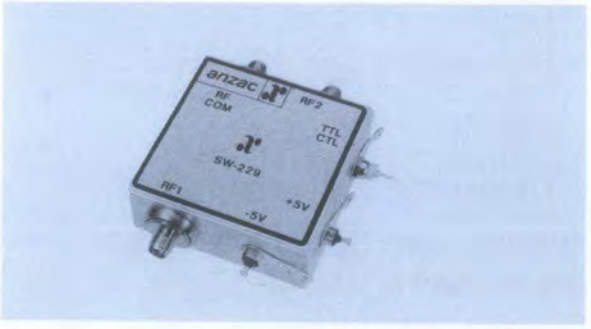
Truth Table**

	Control Input				Condition Of Switch RF Common To Each RF Port	
	A1	B1	A2	B2	RF1	RF2
SW-226/227	HI	LO	LO	HI	ON	OFF
	LO	HI	HI	LO	OFF	ON
SW-228	HI	LO	NC	NC	ON	OFF
	LO	HI	NC	NC	OFF	ON

NEW

MODEL SW-229 — Conn. SPDT GaAs SWITCH DC-2 GHz

- Integrated TTL Driver
- Ultra Low DC Power Consumption



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		DC-2 GHz
Insertion Loss	DC-2 GHz	1.5 dB Max
	DC-1 GHz	1.2 dB Max
	DC-0.5 GHz	0.9 dB Max
VSWR	DC-2 GHz	2.0:1 Max
	DC-1 GHz	1.5:1 Max
	DC-0.5 GHz	1.2:1 Max
Isolation	DC-2 GHz	25 dB Min
	DC-1 GHz	35 dB Min
	DC-0.5 GHz	40 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{RISE}	20 nS Typ
t_{FALL} (50% CTL to 90% RF)	45 nS Typ
t_{ON} (50% CTL to 10% RF)	150 nS Typ
t_{OFF}	175 nS Typ
Transients (In-Band)	25 mV Typ
Input Power for 1 dB Compression	
0.5-2 GHz	+27 dBm Typ
0.05 GHz	+21 dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
0.5-2 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ

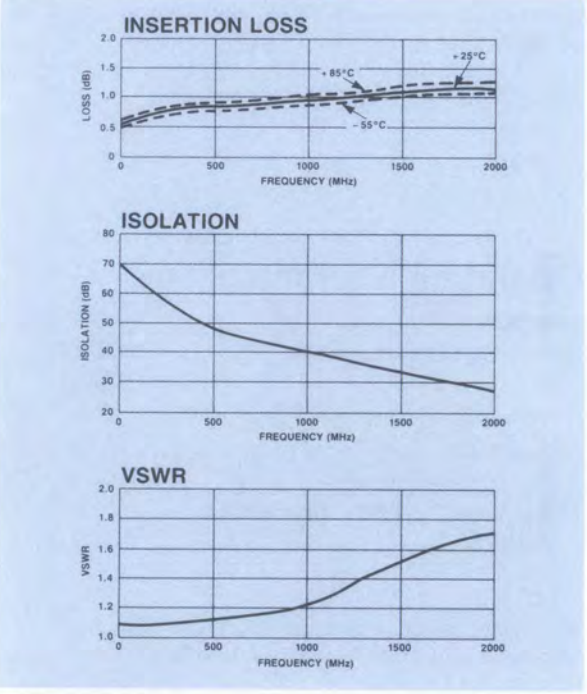
Bias Power	+5 VDC @ 1 mA Max −5 VDC @ 1 mA Max
Package Type	(C-34); (See page 486 for physical dimensions.)

Environmental

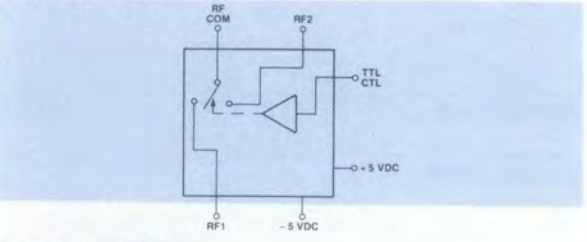
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with TTL control voltages.

Typical Performance



Schematic



Truth Table

Control Input	Condition Of Switch	
"1" Logic High	RF Common To Each RF Port	
	RF1	RF2
1	ON	OFF
0	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (1-9 Units)
SW-229	6026	SMA	$149

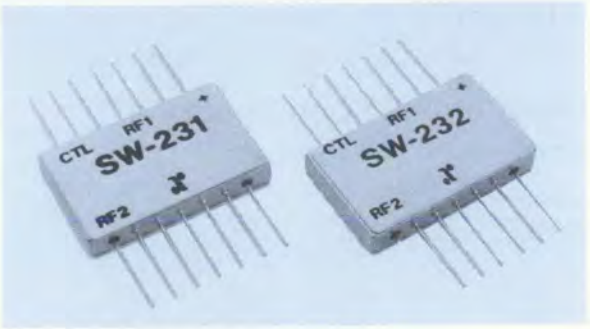
Delivery is from stock.

NEW

MODELS SW-231/232

MATCHED GaAs SPST SWITCH
5-4000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07mA Typical
- Integral TTL (SW-231) or CMOS (SW-232) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-4000 MHz
Insertion Loss	5-4000 MHz	2.8 dB Max
	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-4000 MHz	2.3:1 Max
	5-2000 MHz	1.9:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-4000 MHz	22 dB Min
	5-2000 MHz	37 dB Min
	5-1000 MHz	50 dB Min
	5- 500 MHz	60 dB Min

Operating Characteristics

Impedance 50 Ohms Nominal

Switching Characteristics	**SW-231 (TTL)**	**SW-232 (CMOS)**
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	7 ns	20 ns Typ
t_{ON}, t_{OFF}	20 ns	40 ns Typ
Transients (In-Band)	70 mV	35 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-231	SW-232	
500-4000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-4000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

SW-231	+5 VDC @ 0.07 mA Typ, 1 mA Max
SW-232	+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1 mA Max

Package Type Flatpack (FP-16)
(See page 476 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

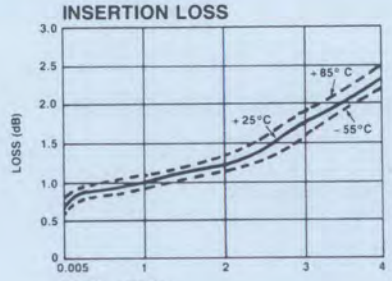
*All specifications apply when operated with bias voltages of +5 VDC (SW-231) or +8 VDC (SW-232) and 50 ohm impedance at all RF ports.

Ordering Information

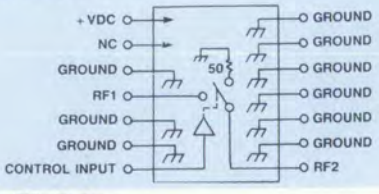
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-231	6679	Pin	$288
SW-232	6689	Pin	288

Delivery is from stock.

Typical Performance



Schematic



Truth Table

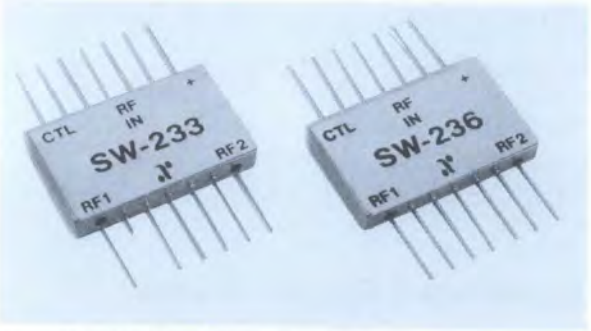
Control Input	Condition Of Switch
"1" = Logic High TTL (SW-231)/CMOS (SW-232)	RF1 to RF2
1	ON
0	OFF

NEW

MODELS SW-233/236

MATCHED GaAs SPDT SWITCH 5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12mA Typical
- Integral TTL (SW-233) or CMOS (SW-236) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-2000 MHz	1.9:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	40 dB Min
	5-1000 MHz	45 dB Min
	5- 500 MHz	53 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-233 (TTL)**	**SW-236 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	100 mV	70 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-233	SW-236	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power	
SW-233	+5 VDC @ 0.12 mA Typ, 1 mA Max
SW-236	+5 to +8 VDC @ 0.12 to 0.40 mA Typ, 1 mA Max
Package Type	Flatpack (FP-16)
	(See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

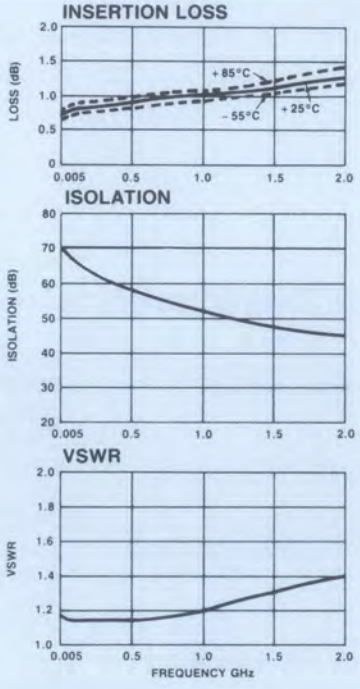
* All specifications apply when operated with bias voltages of +5 VDC (SW-233) or +8 VDC (SW-236) and 50 ohm impedance at all RF ports.

Ordering Information

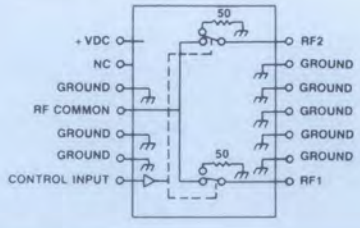
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-233	6729	Pin	$320
SW-236	6779	Pin	320

Delivery is from stock.

Typical Performance



Schematic



Truth Table

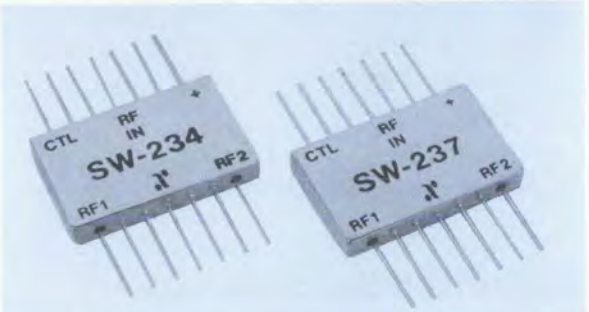
Control Input	Condition Of Switch	
"1" = Logic High TTL (SW-233)/CMOS (SW-236)	RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

NEW

MODELS SW-234/237

GaAs SPDT SWITCH 5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12mA Typical
- Integral TTL (SW-234) or CMOS (SW-237) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-2000 MHz	1.7:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	40 dB Min
	5-1000 MHz	48 dB Min
	5- 500 MHz	53 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-234 (TTL)**	**SW-237 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	100 mV	70 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-234	SW-237	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

SW-234	+5 VDC @ 0.12 mA Typ, 1 mA Max
SW-237	+5 to +8 VDC @ 0.12 to 0.40 mA Typ, 1 mA Max

Package Type Flatpack (FP-16)

(See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

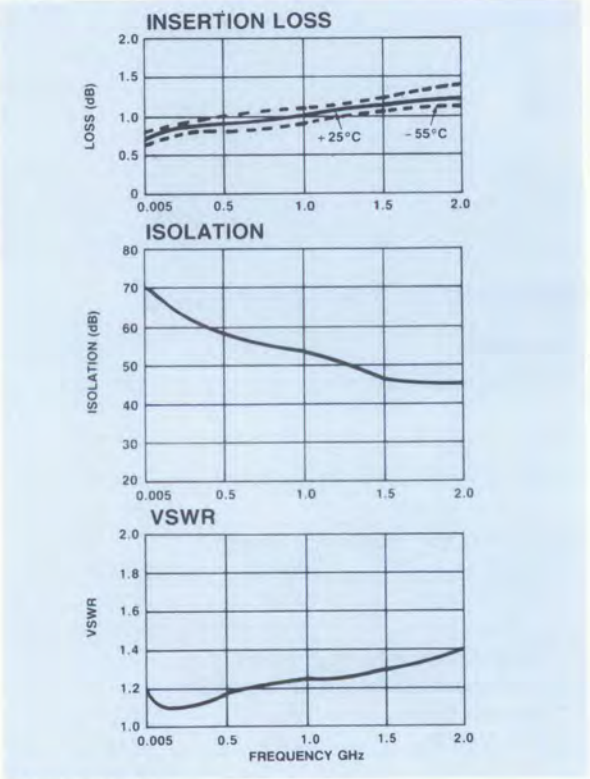
*All specifications apply when operated with bias voltages of +5 VDC (SW-234) or +8 VDC (SW-237) and 50 ohm impedance at all RF ports.

Ordering Information

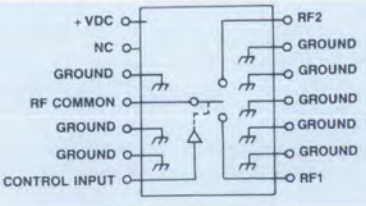
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-234	6739	Pin	$285
SW-237	6789	Pin	285

Delivery is from stock.

Typical Performance



Schematic



Truth Table

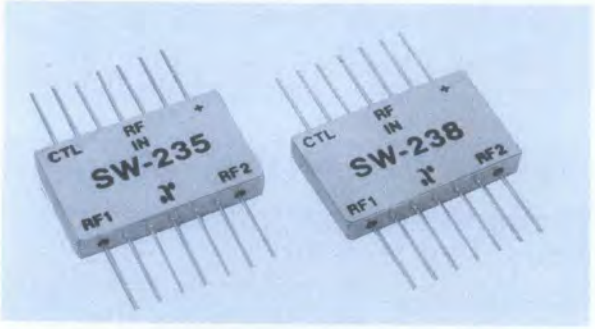
Control Input	Condition Of Switch	
"1" = Logic High TTL (SW-234)/CMOS (SW-237)	RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

NEW

MODELS SW-235/238

GaAs SPDT SWITCH 5-3000 MHz

- Low Insertion Loss, 0.8 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07mA Typical
- Integral TTL (SW-235) or CMOS (SW-238) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-3000 MHz
Insertion Loss	5-3000 MHz	1.5 dB Max
	5-2000 MHz	1.2 dB Max
	5-1000 MHz	1.0 dB Max
	5- 500 MHz	0.9 dB Max
VSWR	5-3000 MHz	1.8:1 Max
	5-2000 MHz	1.6:1 Max
	5-1000 MHz	1.4:1 Max
	5- 500 MHz	1.25:1 Max
Isolation	5-3000 MHz	22 dB Min
	5-2000 MHz	30 dB Min
	5-1000 MHz	40 dB Min
	5- 500 MHz	50 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-235 (TTL)**	**SW-238 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	70 mV	35 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-235	SW-238	
500-3000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-3000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power	
SW-235	+5 VDC @ 0.07 mA Typ, 1 mA Max
SW-238	+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1 mA Max
Package Type	Flatpack (FP-16) (See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

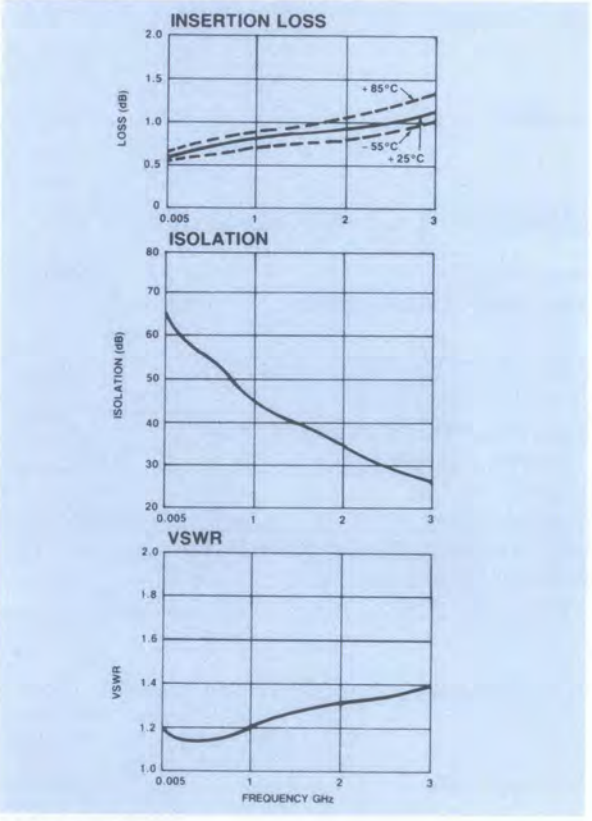
*All specifications apply when operated with bias voltages of +5 VDC (SW-235) or +8 VDC (SW-238) and 50 ohm impedance at all RF ports.

Ordering Information

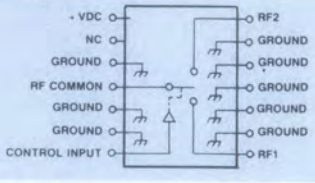
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-235	6749	Pin	$285
SW-238	6799	Pin	285

Delivery is from stock

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-235)/CMOS (SW-238)	Condition Of Switch RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

NEW

MODEL SW-239

GaAs SPDT RF SWITCH
DC-1000 MHz

- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.150″ x 0.190″ (3.8mm x 4.8mm)
- Surface Mount Package

Guaranteed Specifications*
(From –30°C to +71°C)

Frequency Range		DC-1000 MHz
Insertion Loss	DC-1000 MHz	0.8 dB Max
	DC- 500 MHz	0.7 dB Max
	DC- 100 MHz	0.7 dB Max
VSWR	DC-1000 MHz	1.2:1 Max
	DC- 500 MHz	1.2:1 Max
	DC- 100 MHz	1.15:1 Max
Isolation	DC-1000 MHz	30 dB Min
	DC- 500 MHz	40 dB Min
	DC- 100 MHz	50 dB Min

Operating Characteristics

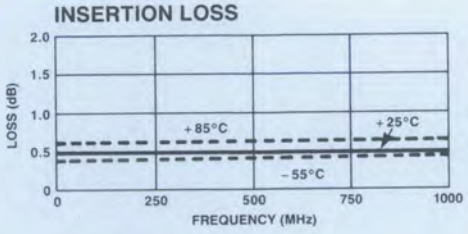
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			2 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			4 ns Typ
Transients (In-Band)			15 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5-1 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-1 GHz	+65	+46	dBm Typ
0.05 GHz	+55	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 20 μA Max
V_{IN} Hi			–5V @ 200 μA Typ to –8V @ 800 μA Max
Package Type			Surface Mount (SF-2) (See page 490 for physical dimensions.)

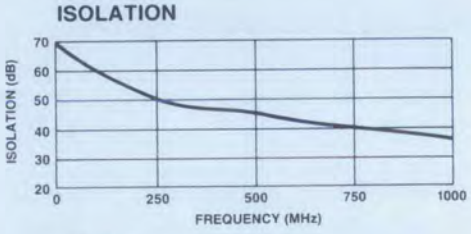
*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and –5 VDC control voltages. Data achieved from unit soldered into test fixture.

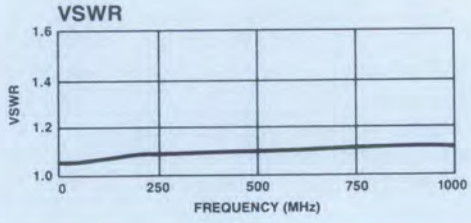
†Faster switching speed can be achieved with enhanced driver waveform.

**Note that when either output port (RF1 or RF2) is "OFF" it is shorted to package ground.

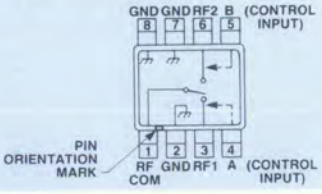
Typical Performance







Pin Configuration**



Truth Table

Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-239	6012	PIN	$9.50

Delivery is from stock.

NEW

MODELS SW-241/244

MATCHED GaAs SP3T SWITCH 5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22mA Typical
- Integral TTL (SW-241) or CMOS (SW-244) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.8 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.6:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	45 dB Min
	5- 500 MHz	55 dB Min

Operating Characteristics

Impedance 50 Ohms Nominal

Switching Characteristics	**SW-241 (TTL)**	**SW-244 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-241	SW-244	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

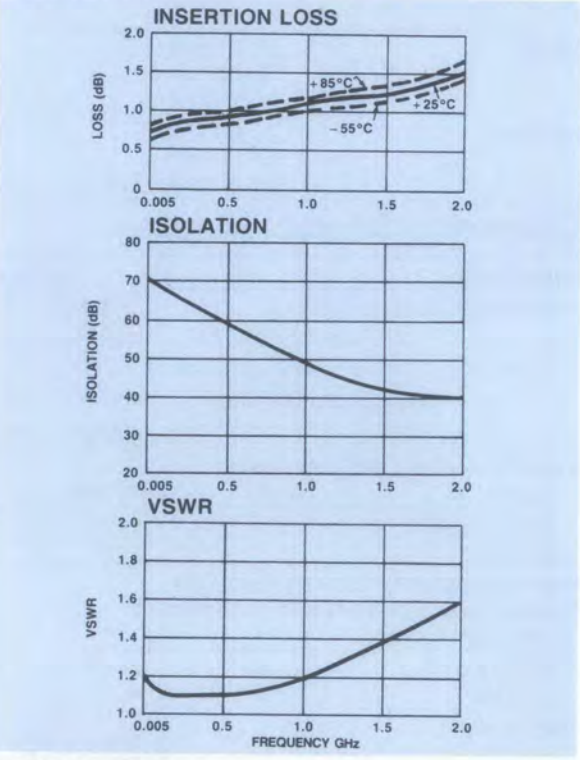
SW-241	+5 VDC @ 0.22 mA Typ, 1 mA Max
SW-244	+5 to +8 VDC @ 0.22 to 0.40 mA Typ, 1 mA Max

Package Type Dual Inline (DI-5)
(See page 490 for physical dimensions.)

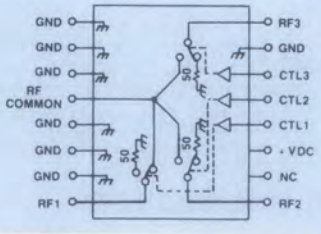
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +5 VDC (SW-241) or +8 VDC (SW-244) and 50 ohm impedance at all RF ports.

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-241)/CMOS (SW-244)			Condition of Switch RF Common To Each RF Port		
CTL1	CTL2	CTL3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-241	6800	Pin	$393
SW-244	6802	Pin	393

Delivery is from stock.

NEW

MODELS SW-242/245

GaAs SP3T SWITCH
5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22mA Typical
- Integral TTL (SW-242) or CMOS (SW-245) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.8 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	45 dB Min
	5- 500 MHz	55 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-242 (TTL)**	**SW-245 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-242	SW-245	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

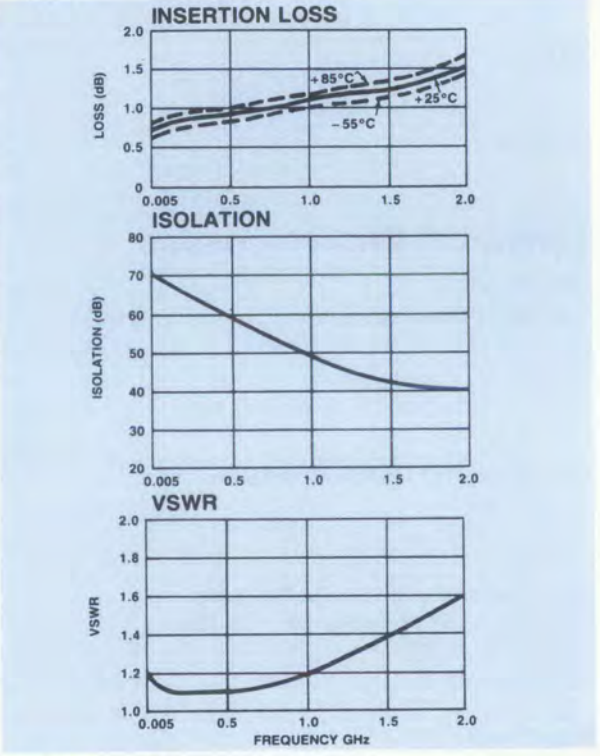
Bias Power	
SW-242	+5 VDC @ 0.22 mA Typ, 1 mA Max
SW-245	+5 to +8 VDC @ 0.22 to 0.40 mA Typ, 1 mA Max
Package Type	Dual Inline (DI-5) (See page 490 for physical dimensions.)

Environmental

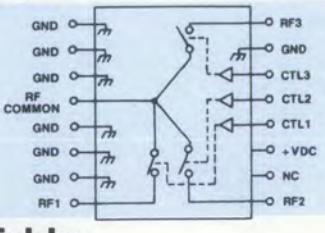
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltages of +5 VDC (SW-242) or +8 VDC (SW-245) and 50 ohm impedance at all RF ports.

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-242)/CMOS (SW-245)			Condition of Switch RF Common To Each RF Port		
CTL1	CTL2	CTL3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-242	6801	Pin	$352
SW-245	6803	Pin	352

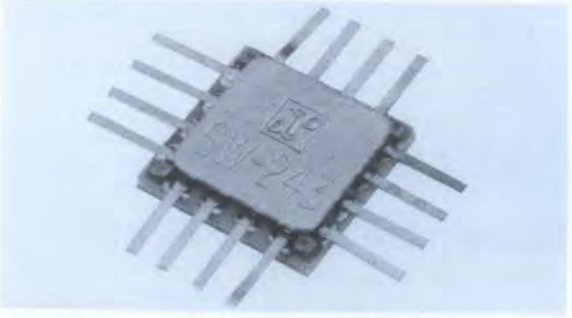
Delivery is from stock.

NEW

MODEL SW-243

GaAs SP4T SWITCH
DC - 4 GHz

- Low Insertion Loss, 0.7 dB Typical
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.250″ Square



Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 4 GHz
Insertion Loss	DC - 4 GHz	1.3dB Max
	DC - 2 GHz	1.0dB Max
	DC - 1 GHz	0.9dB Max
	DC - 0.5 GHz	0.8dB Max
VSWR	DC - 4 GHz	1.9:1 Max
	DC - 2 GHz	1.5:1 Max
	DC - 1 GHz	1.25:1 Max
	DC - 0.5 GHz	1.25:1 Max
Isolation	DC - 4 GHz	20dB Min
	DC - 2 GHz	25dB Min
	DC - 1 GHz	30dB Min
	DC - 0.5 GHz	35dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			25mv Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5 to 4 GHz	+26	+32	dBm Typ
0.05 GHz	+20	+23	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 4 GHz	+68	+50	dBm Typ
0.05 GHz	+55	+37	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 5 μA Max
V_{IN} Hi			–5V @ 10 μA Typ to –8V @ 100 μA Max
Package Type			Flat-pack (CR-4)
			(See page 490 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

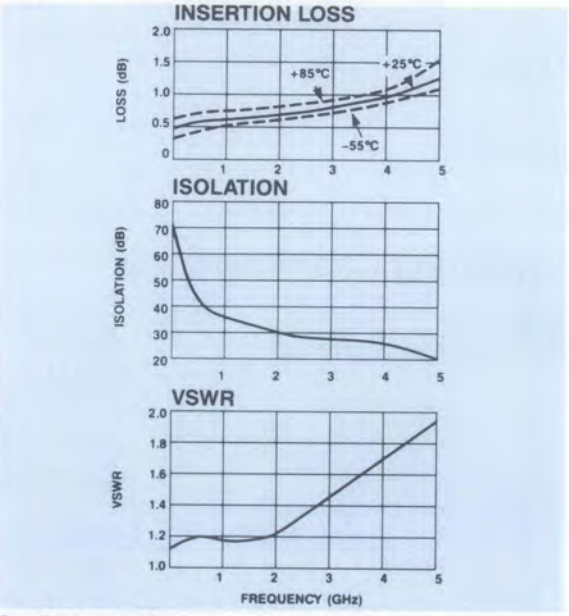
*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and –5 Vdc control voltages.
†Faster switching speed can be achieved with enhanced driver waveform.
**When an RF output port is "off" it is shorted to ground through an "on" shunt MESFET.

Ordering Information

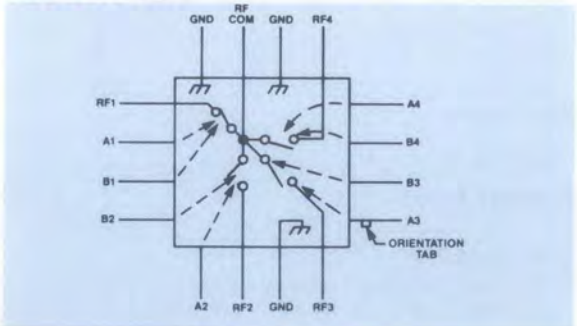
Model No.	Connectors	Unit Price (1-9 Units)
SW-243	PIN	$113.00

Delivery is from stock.

Typical Performance



Schematic



Truth Table**

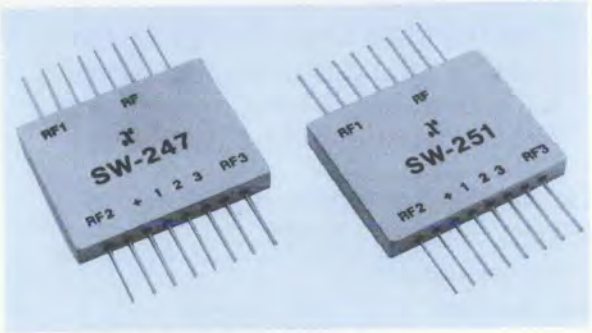
Control Input								Condition of Switch RF Common to Each RF Port			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
Hi	Low	Low	Hi	Low	Hi	Low	Hi	ON	OFF	OFF	OFF
Low	Hi	Hi	Low	Low	Hi	Low	Hi	OFF	ON	OFF	OFF
Low	Hi	Low	Hi	Hi	Low	Low	Hi	OFF	OFF	ON	OFF
Low	Hi	Low	Hi	Low	Hi	Hi	Low	OFF	OFF	OFF	ON

NEW

MODELS SW-247/251

MATCHED GaAs SP3T SWITCH
5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22mA Typical
- Integral TTL (SW-247) or CMOS (SW-251) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.8 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.6:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	42 dB Min
	5- 500 MHz	52 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-247 (TTL)**	**SW-251 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-247	SW-251	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

SW-247	+5 VDC @ 0.22 mA Typ, 1 mA Max
SW-251	+5 to +8 VDC @ 0.22 to 0.40 mA Typ, 1 mA Max

Package Type Flatpack (FP-17)
(See page 476 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

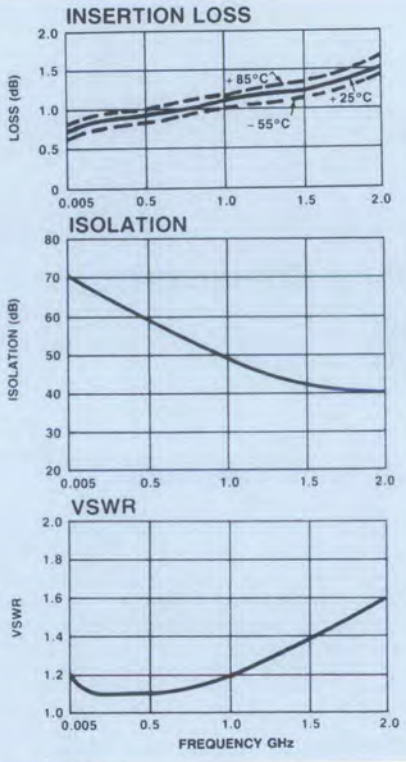
*All specifications apply when operated with bias voltages of +5 VDC (SW-247) or +8 VDC (SW-251) and 50 ohm impedance at all RF ports.

Ordering Information

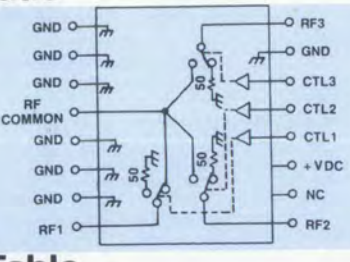
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-247	6804	Pin	$418
SW-251	6806	Pin	418

Delivery is from stock.

Typical Performance



Schematic



Truth Table

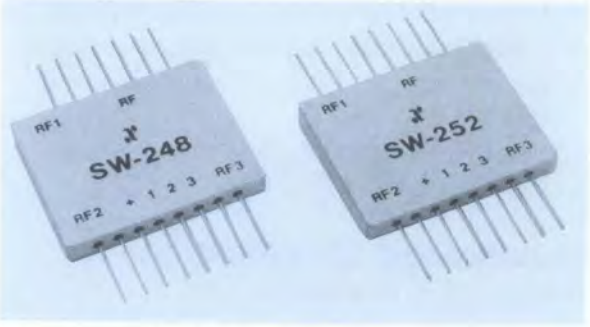
Control Input "1" = Logic High TTL (SW-247)/CMOS (SW-251)			Condition of Switch RF Common To Each RF Port		
CTL1	CTL2	CTL3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

NEW

MODELS SW-248/252

GaAs SP3T SWITCH
5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22mA Typical
- Integral TTL (SW-248) or CMOS (SW-252) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.8 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	42 dB Min
	5- 500 MHz	52 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-248 (TTL)**	**SW-252 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-248	SW-252	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power	
SW-248	+5 VDC @ 0.22 mA Typ, 1 mA Max
SW-252	+5 to +8 VDC @ 0.22 to 0.40 mA Typ, 1 mA Max
Package Type	Flatpack (FP-17)
	(See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

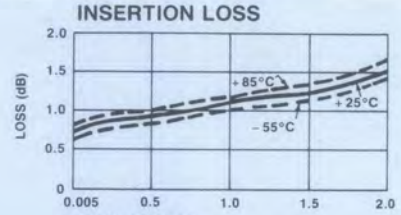
*All specifications apply when operated with bias voltages of +5 VDC (SW-248) or +8 VDC (SW-252) and 50 ohm impedance at all RF ports.

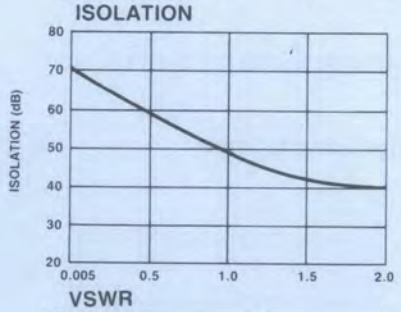
Ordering Information

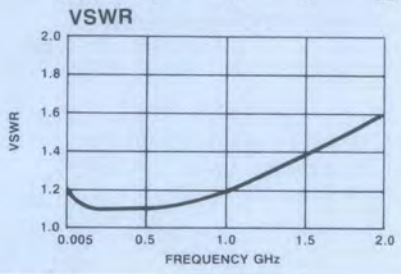
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-248	6805	Pin	$375
SW-252	6807	Pin	375

Delivery is from stock.

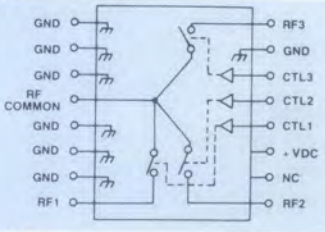
Typical Performance







Schematic



Truth Table

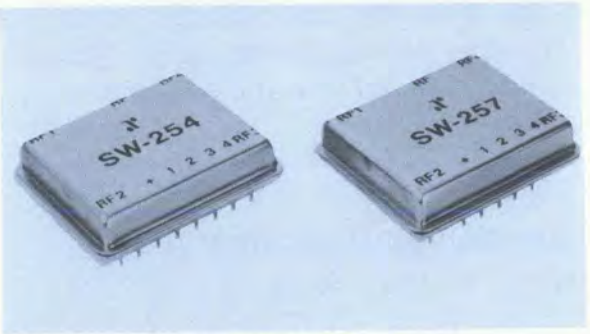
Control Input			Condition of Switch		
"1" = Logic High TTL (SW-248)/CMOS (SW-252)			RF Common To Each RF Port		
CTL1	CTL2	CTL3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

NEW

MODELS SW-254/257

MATCHED GaAs SP4T SWITCH 5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA Typical
- Integral TTL (SW-254) or CMOS (SW-257) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.9 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.3:1 Max
	5-1000 MHz	1.6:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	37 dB Min
	5- 500 MHz	45 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-254 (TTL)**	**SW-257 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-254	SW-257	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power	
SW-254	+5 VDC @ 0.30 mA Typ, 1 mA Max
SW-257	+5 to +8 VDC @ 0.30 to 0.60 mA Typ, 1 mA Max
Package Type	Dual Inline (DI-5)
	(See page 490 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

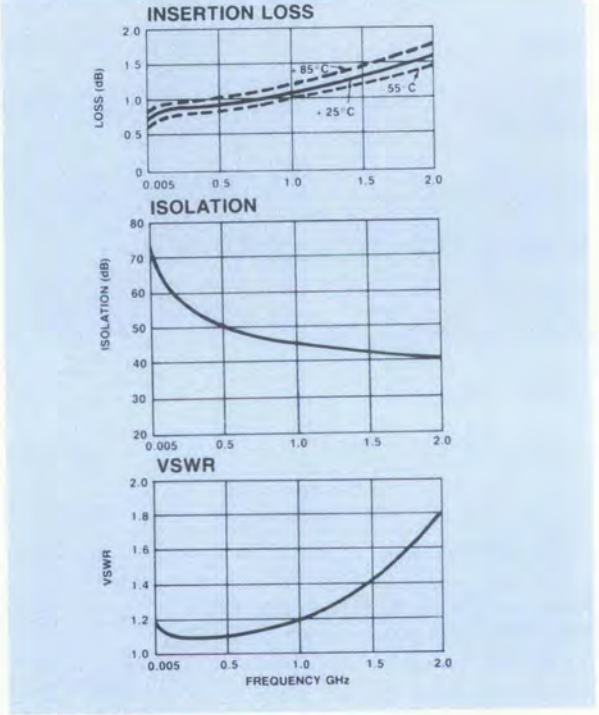
*All specifications apply when operated with bias voltages of +5 VDC (SW-254) or +8 VDC (SW-257) and 50 ohm impedance at all RF ports.

Ordering Information

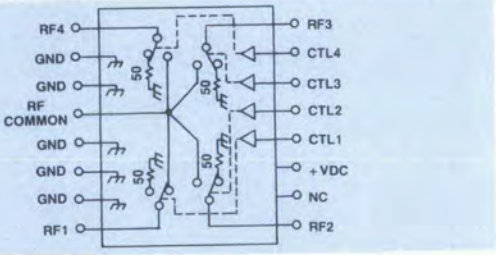
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-254	6808	Pin	$435
SW-257	6809	Pin	435

Delivery is from stock.

Typical Performance



Schematic



Truth Table

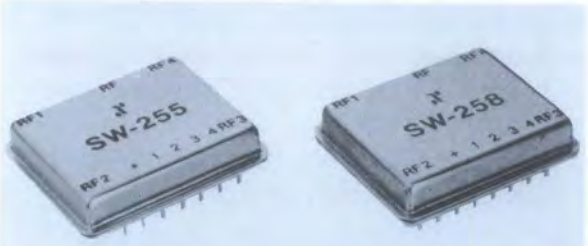
Control Input "1" = Logic High TTL (SW-254)/CMOS (SW-257)				Condition of Switch RF Common To Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

NEW

MODELS SW-255/258

GaAs SP4T SWITCH
5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA Typical
- Integral TTL (SW-255) or CMOS (SW-258) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.9 dB Max
	5-1000 MHz	1.4 dB Max
	5-500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.3:1 Max
	5-1000 MHz	1.4:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	37 dB Min
	5- 500 MHz	45 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics		**SW-255 (TTL)**	**SW-258 (CMOS)**
t_{RISE}, t_{FALL}		7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		20 ns	40 ns Typ
Transients (In-Band)		80 mV	40 mV Typ
Input Power for 1 dB Compression			
Model #'s	SW-255	SW-258	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
SW-255		+5 VDC @ 0.30 mA Typ, 1 mA Max	
SW-258		+5 to +8 VDC @ 0.30 to 0.60 mA Typ, 1 mA Max	
Package Type			Dual Inline (DI-5)
			(See page 490 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

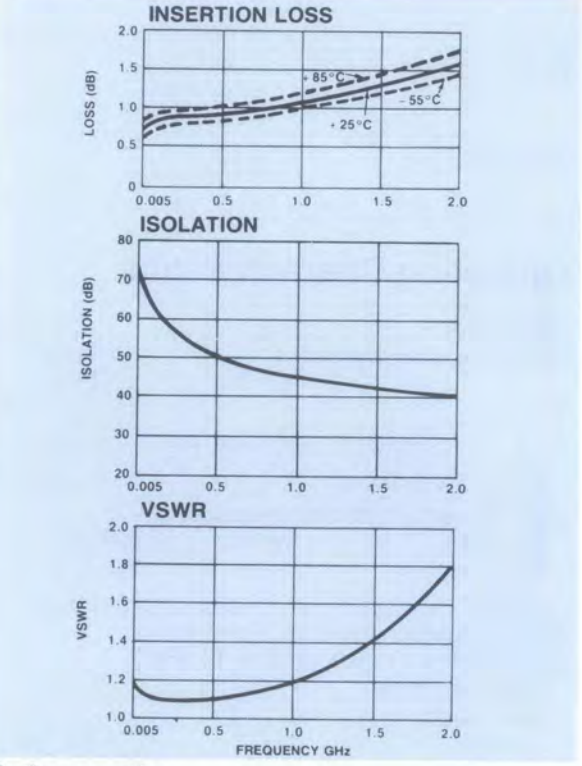
*All specifications apply when operated with bias voltages of +5 VDC (SW-255) or +8 VDC (SW-258) and 50 ohm impedance at all RF ports.

Ordering Information

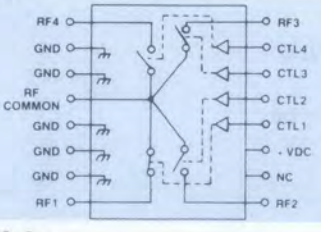
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-255	6449	Pin	$395
SW-258	6880	Pin	395

Delivery is from stock

Typical Performance



Schematic



Truth Table

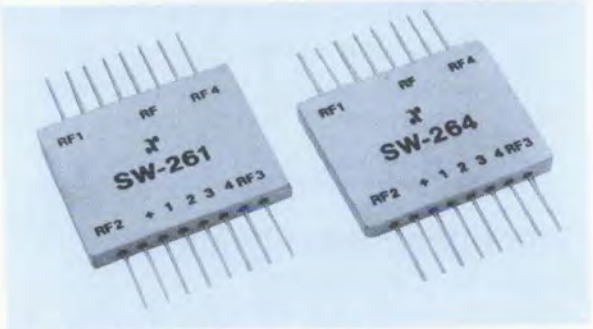
Control Input "1" = Logic High TTL (SW-255)/CMOS (SW-258)				Condition of Switch RF Common To Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

NEW

MODELS SW-261/264

MATCHED GaAs SP4T SWITCH 5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA Typical
- Integral TTL (SW-261) or CMOS (SW-264) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.0 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.5:1 Max
	5-1000 MHz	1.6:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	37 dB Min
	5- 500 MHz	42 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-261 (TTL)**	**SW-264 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-261	SW-264	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

SW-261	+5 VDC @ 0.30 mA Typ, 1 mA Max
SW-264	+5 to +8 VDC @ 0.30 to 0.60 mA Typ, 1 mA Max

Package Type Flatpack (FP-17)

(See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

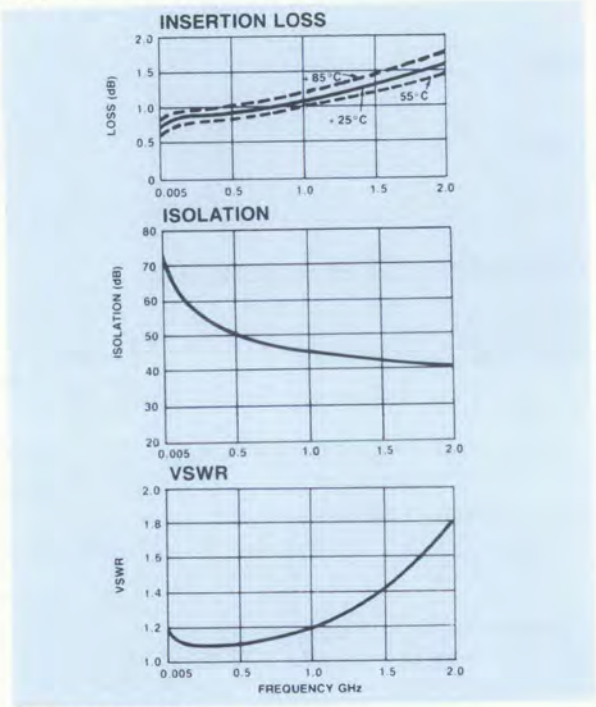
*All specifications apply when operated with bias voltages of +5 VDC (SW-261) or +8 VDC (SW-264) and 50 ohm impedance at all RF ports.

Ordering Information

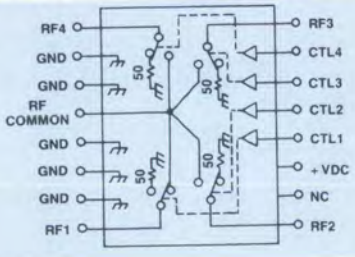
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-261	6881	Pin	$462
SW-264	6883	Pin	462

Delivery is from stock.

Typical Performance



Schematic



Truth Table

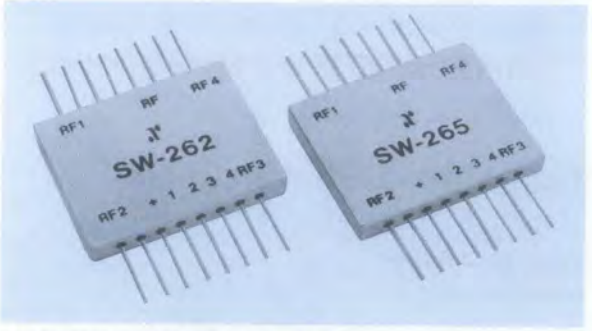
Control Input "1" = Logic High TTL (SW-261)/CMOS (SW-264)				Condition of Switch RF Common To Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

NEW

MODELS SW-262/265

GaAs SP4T SWITCH
5-2000 MHz

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA Typical
- Integral TTL (SW-262) or CMOS (SW-265) Driver



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.0 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.5:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	37 dB Min
	5- 500 MHz	42 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-262 (TTL)**	**SW-265 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-262	SW-265	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power	
SW-262	+5 VDC @ 0.30 mA Typ, 1 mA Max
SW-265	+5 to +8 VDC @ 0.30 to 0.60 mA Typ, 1 mA Max
Package Type	Flatpack (FP-17)
	(See page 476 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

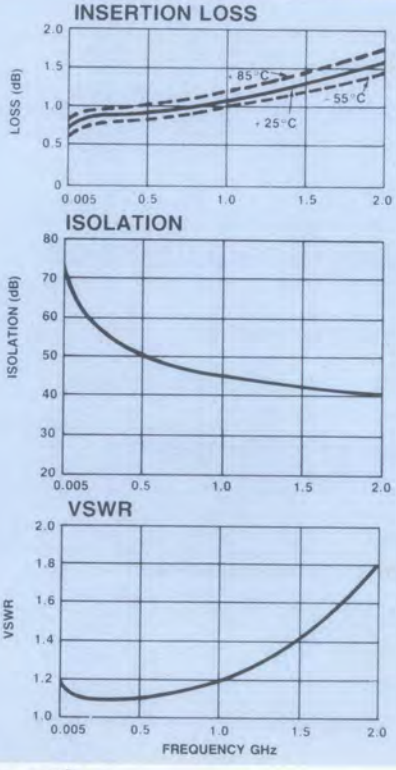
*All specifications apply when operated with bias voltages of +5 VDC (SW-262) or +8 VDC (SW-265) and 50 ohm impedance at all RF ports.

Ordering Information

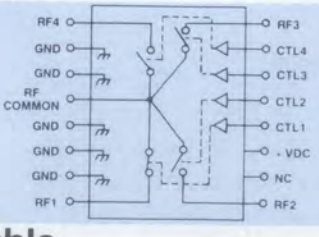
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
SW-262	6882	Pin	$420
SW-265	6884	Pin	420

Delivery is from stock.

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-262)/CMOS (SW-265)				Condition of Switch RF Common To Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

NEW

MODEL SWS-278 — MATCHED GaAs SPST SWITCH
DC - 3 GHz

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Surface Mount Package

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 3 GHz
Insertion Loss	DC - 3 GHz	1.4dB Max
	DC - 2 GHz	1.1dB Max
	DC - 1 GHz	1.0dB Max
	DC - 0.5 GHz	1.0dB Max
VSWR	DC - 3 GHz	1.5:1 Max
	DC - 2 GHz	1.3:1 Max
	DC - 1 GHz	1.2:1 Max
	DC - 0.5 GHz	1.2:1 Max
Isolation	DC - 3 GHz	23dB Min
	DC - 2 GHz	30dB Min
	DC - 1 GHz	40dB Min
	DC - 0.5 GHz	50dB Min

Operating Characteristics

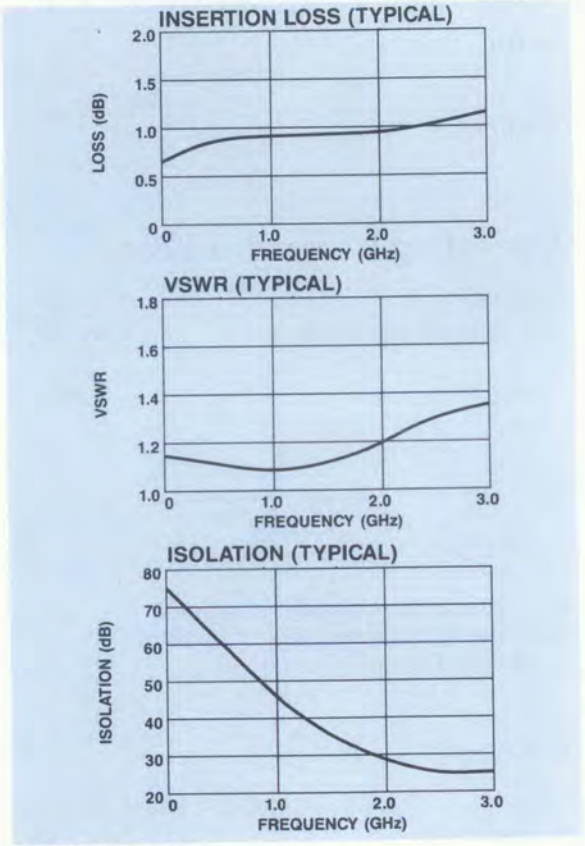
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3ns Typ
t_{ON}, t_{OFF} (50% CTL to 90%/10% RF)			6ns Typ
Transients (In-Band)			30mv Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5 to 3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +13dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 20 μA Max
V_{IN} Hi			–5V @ 50 μA Typ to –8V @ 300 μA Max
Package Type			Surface Mount (SF-1)
			(See page 490 for physical dimensions.)

Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

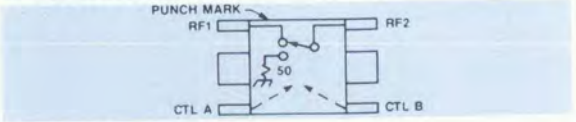
*All specifications apply with 50 ohm connected to all RF ports.

†Faster switching speed can be achieved with enhanced driver waveform.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
SWS-278	PIN	$68

Delivery is from stock.

Truth Table

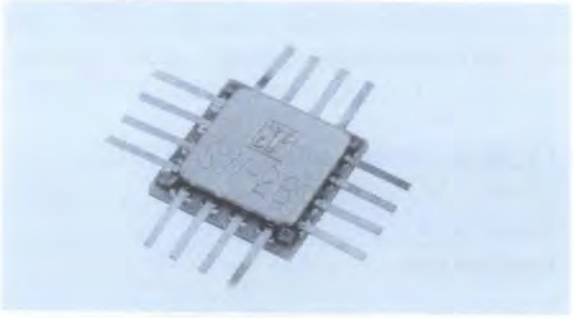
Control Input		Condition Of Switch
A	B	RF1 to RF2
Hi	Low	ON
Low	Hi	OFF

NEW

MODEL SW-281

GaAs DPDT SWITCH
DC - 4 GHz

- Low Insertion Loss, 0.5 dB Typical
- Miniature Relay Replacement, 0.250″ Sq. Pkg.
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 4 GHz
Insertion Loss	DC - 4 GHz	1.2dB Max
	DC - 2 GHz	0.8dB Max
	DC - 1 GHz	0.7dB Max
	DC - 0.5 GHz	0.6dB Max
VSWR	DC - 4 GHz	1.8:1 Max
	DC - 2 GHz	1.5:1 Max
	DC - 1 GHz	1.2:1 Max
	DC - 0.5 GHz	1.2:1 Max
Isolation	DC - 4 GHz	20dB Min
	DC - 2 GHz	30dB Min
	DC - 1 GHz	40dB Min
	DC - 0.5 GHz	50dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			15mV Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5 to 4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 4 GHz	+68	+48	dBm Typ
0.05 GHz	+62	+45	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 5 μA Max
V_{IN} Hi			–5V @ 10 μA Typ to –8V @ 100 μA Max
Package Type			Flatpack (CR-4)
			(See page 490 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

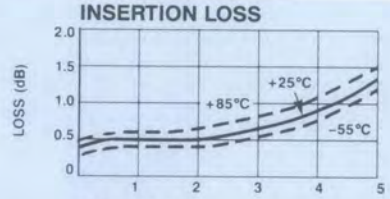
*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and –5 Vdc control voltages
†Faster switching speed can be achieved with enhanced driver waveform.
**When an RF output port is "off" it is shorted to ground through an "on" shunt MESFET.

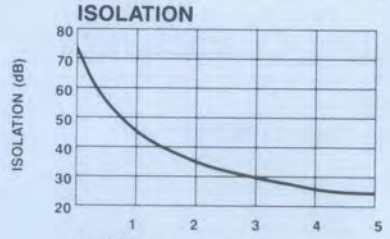
Ordering Information

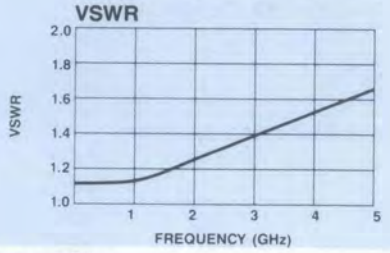
Model No.	Connectors	Unit Price (5-9 Units)
SW-281	PIN	$90

Delivery is from stock

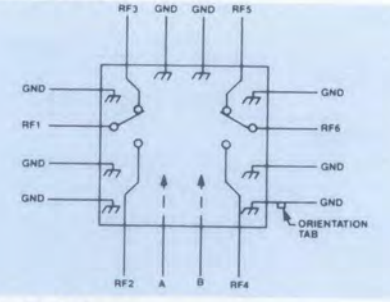
Typical Performance







Schematic



Truth Table**

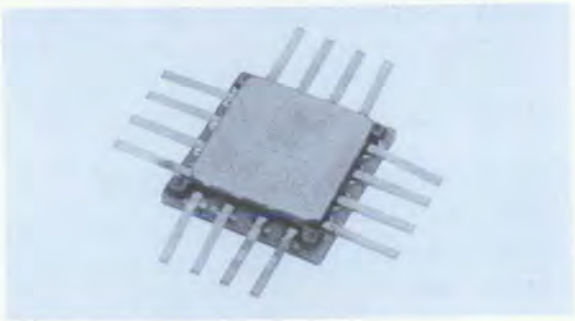
Control Input		Condition of Switch			
		RF1 to		RF6 to	
A	B	RF2	RF3	RF4	RF5
Hi	Low	ON	OFF	ON	OFF
Low	Hi	OFF	ON	OFF	ON

NEW

MODEL SW-283

GaAs TRANSFER SWITCH
DC - 3 GHz

- Small Ceramic Package, 0.250″ Sq
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 3 GHz
Insertion Loss	DC - 3 GHz	2.1 dB Max
	DC - 2 GHz	1.8 dB Max
	DC - 1 GHz	1.3 dB Max
	DC - 0.5 GHz	1.0 dB Max
VSWR	DC - 3 GHz	1.9:1 Max
	DC - 2 GHz	1.7:1 Max
	DC - 1 GHz	1.3:1 Max
	DC - 0.5 GHz	1.25:1 Max
Isolation	DC - 3 GHz	20 dB Min
	DC - 2 GHz	25 dB Min
	DC - 1 GHz	40 dB Min
	DC - 0.5 GHz	45 dB Min

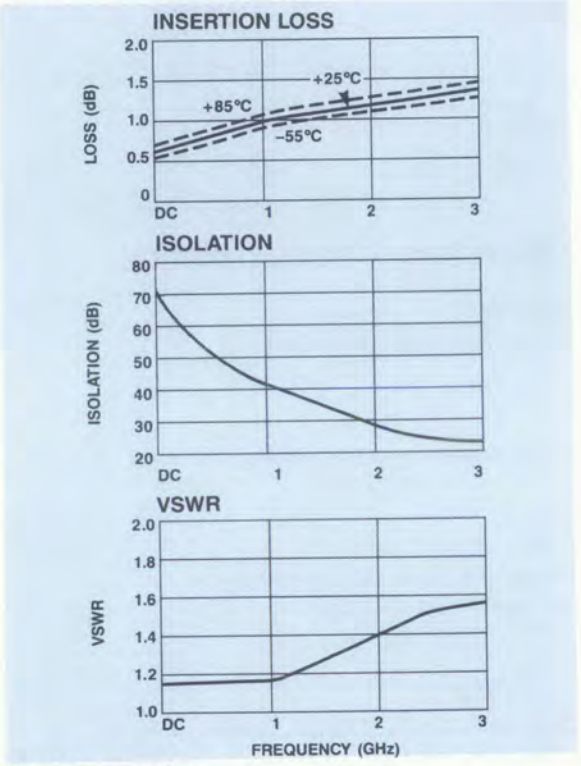
Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2 nS Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4 nS Typ
Transients (In-Band)			30 mV Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/–5	0/–8	
0.5 - 3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBM)			
Intercept Points	Ip2	Ip3	
0.5 - 3 GHz	+68	+50	dBm Typ
0.05 GHz	+62	+45	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to –0.2V @ 5 μA Max
V_{IN} Hi			–5V @ 10 μA Typ to –8V @ 200 μA Max
Package Type			Flatpack (CR-4)
			(See page 490 for physical dimensions.)

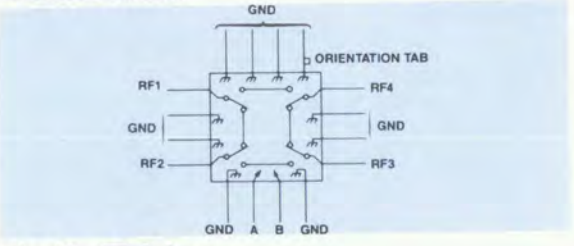
Environmental
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell Catalog.

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and –5 Vdc control voltages
†Faster switching speed can be achieved with enhanced driver waveform

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
SW-283	PIN	$158

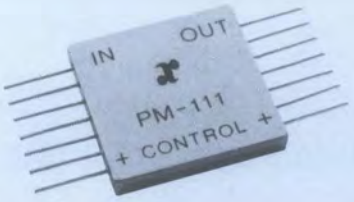
Delivery is from stock.

Truth Table

Control Input		Condition of Switch			
A	B	RF1-RF2	RF2-RF3	RF1-RF4	RF3-RF4
Hi	Low	OFF	ON	ON	OFF
Low	Hi	ON	OFF	OFF	ON

MODEL PM-111 — PHASE SHIFTER 28.5-31.5 MHz

- Low Loss — 0.8 dB Typical
- 180° Phase Range
- Hermetic Flatpack



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	28.5-31.5 MHz
Insertion Loss	1.2 dB Max
VSWR (All Ports)	1.6:1 Max
Phase Shift Range	180° Min

Operating Characteristics

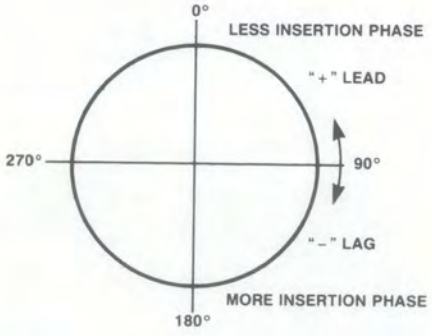
Impedance	50 Ohms Nominal
Maximum Rating RF Input	1 mW
Control Voltage	0 to +30 VDC
Control Bandwidth	DC to 80 kHz
Package Type	Flatpack (FP-4) (See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

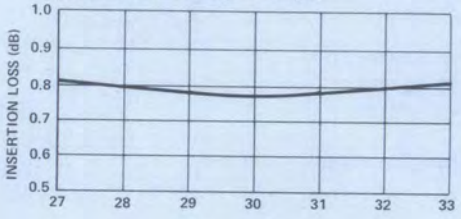
Pin Configuration	IN: P7, Out: P14, Control DC IN: P1 & P8. All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

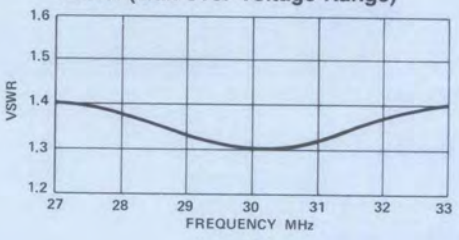


Typical Performance

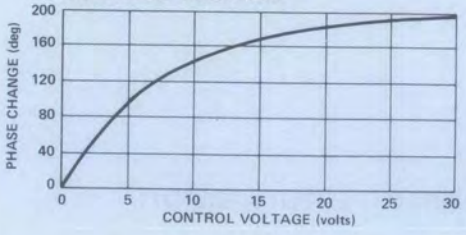
INSERTION LOSS (Max over Voltage Range)



VSWR (Max over Voltage Range)



PHASE CHANGE VS CONTROL VOLTAGE**



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PM-111	9679	Pin	$125

Delivery is from stock.

MODEL AT-101 VOLTAGE VARIABLE ATTENUATOR
1.5-1000 MHz

- 2 dB Typical Midband Minimum Attenuation
- 60 dB Typical Midband Attenuation Range
- 1.5:1 Typical Midband VSWR Over Entire Attenuation Range

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		1.5-1000 MHz
Minimum Attenuation (+15 V Control)	1.5-1000 MHz 5-100 MHz	4.5 dB Max 2.7 dB Max
Maximum Attenuation (0 V Control)	1.5-1000 MHz 1.5-5 MHz 5-100 MHz 100-500 MHz	35 dB Min 55 dB Min 55 dB Min 40 dB Min
VSWR (0-15 V Control)	1.5-1000 MHz 5-100 MHz 100-500 MHz	2.8:1 Max 2.0:1 Max 2.0:1 Max
Control Bandwidth		0-100 kHz
Third Order IM (0-15 V Control)		70 dB Typ Below Input Levels for −10 dBm input signals
Bias Requirement		+15 VDC @ 1 mA Max
Control		0-15 VDC @ 10 mA Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Ratings RF Input	250 mW @ 25°C Derated Linearly to 115 mW @ +85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

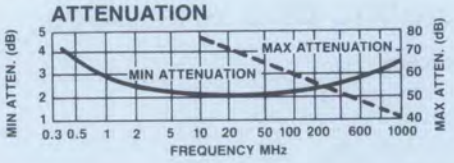
Environmental

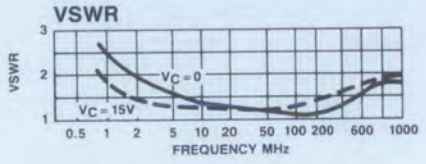
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

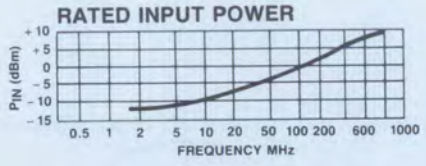
Pin Configuration	IN; P5, Out; P1, +DC IN BIAS; P3 & P7, Control; P4 & P8, GND; P2 & P6

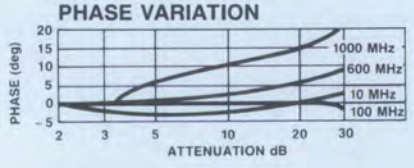
*All specifications apply with 50 ohm source and load impedance with input power up to the level shown in the Rated Input Power Curve.

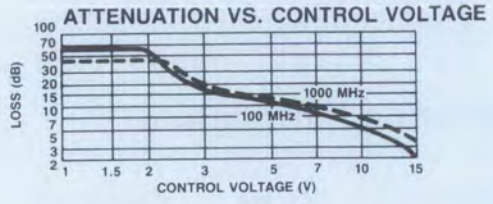
Typical Performance











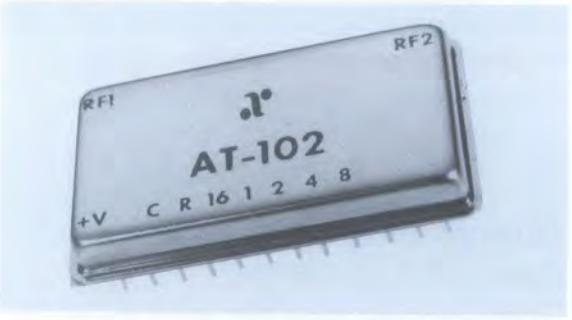
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AT-101	8489	Pin	$155

Delivery is from stock.

MODEL AT-102 — 5 BIT DIGITAL ATTENUATOR
20-1000 MHz

- Attenuation 1 dB Steps to 31 dB
- CMOS Control Interface
- Internal Latch on Control Input
- Hermetic Case



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-1000 MHz
Nominal Attenuation**		1 dB Steps to 31 dB
Attenuation Accuracy	20-500 MHz	±0.25 dB ±2% Max
	20-1000 MHz	±0.35 dB ±2% Max
VSWR	20-500 MHz	1.6:1 Max
	20-1000 MHz	2.0:1 Max
Reference Insertion Loss		5.0 dB Max

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
Switching Time (50% CTL to 90%/10% RF)		8μ S Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression	20-1000 MHz	+18 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order		+40 dBm Typ
Third Order		+30 dBm Typ
Bias Power		+5 to +15 VDC @ 30 mA Max (330 mW Typ)
Control		5 line, CMOS Data Bus with Internal Latch controlled by Clock (Data Strobe) and reset inputs.
Package Type		Dual Inline (DI-3) (See page 480 for physical dimensions.)

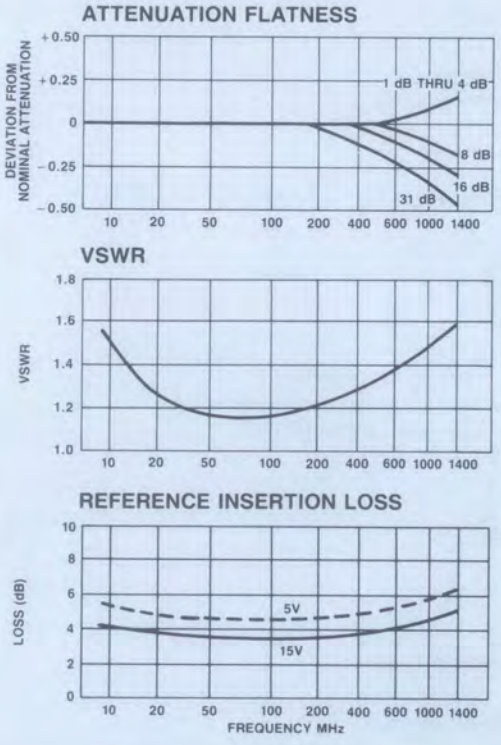
Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

*All specifications apply when operated with bias voltage of +15 VDC and a 50 ohm impedance at both RF ports.

**Above reference insertion loss.

Typical Performance



Truth Table

CONTROL INPUT							ATTENUATOR SETTING
1	2	4	8	16	C*	R	
0	0	0	0	0	1	1	REFERENCE
1	0	0	0	0	1	1	1 dB
0	1	0	0	0	1	1	2 dB
0	0	1	0	0	1	1	4 dB
0	0	0	1	0	1	1	8 dB
0	0	0	0	1	1	1	16 dB
ANY COMBINATION					1	1	SUM OF BITS SELECTED
X	X	X	X	X	0	1	NO CHANGE IN ATTENUATION
X	X	X	X	X	X	0	RESET TO REFERENCE

"1" = LOGIC HIGH
"0" = LOGIC LOW
"X" = DON'T CARE
*CLOCK INPUT STROBES DATA ON RISING EDGE

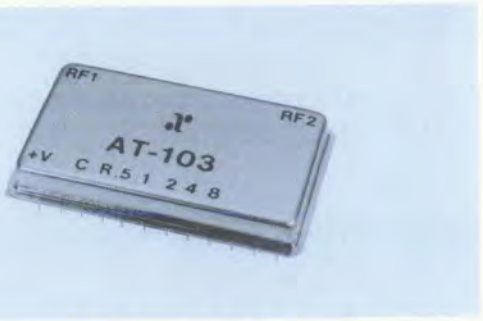
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AT-102	9709	Pin	$400

Delivery is from stock.

MODEL AT-103 — 5 BIT DIGITAL ATTENUATOR 20-1000 MHz

- Attenuation 0.5 dB Steps to 15.5 dB
- CMOS Control Interface
- Internal Latch on Control Input
- Hermetic Case



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range			20-1000 MHz
Nominal Attenuation**			0.5 dB Steps to 15.5 dB
Attenuation Accuracy	20-500 MHz	±0.25 dB	±2% Max
	20-1000 MHz	±0.35 dB	±2% Max
VSWR	20-500 MHz		1.6:1 Max
	20-1000 MHz		2.0:1 Max
Reference Insertion Loss			5.0 dB Max

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
Switching Time (50% CTL to 90%/10% RF)		8 μS Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression	20-1000 MHz	+18 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order		+40 dBm Typ
Third Order		+30 dBm Typ
Bias Power		+5 to +15 VDC @ 30 mA Max (330 mW Typ)
Control		5 line, CMOS Data Bus with Internal Latch controlled by Clock (Data Strobe) and reset inputs.
Package Type		Dual Inline (DI-3) (See page 480 for physical dimensions.)

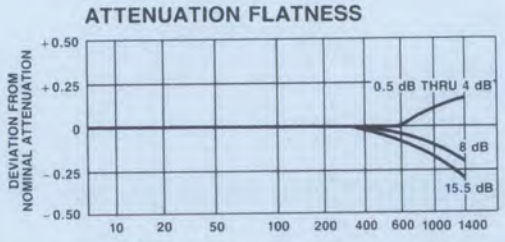
Environmental

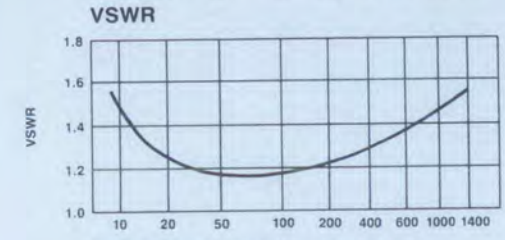
These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

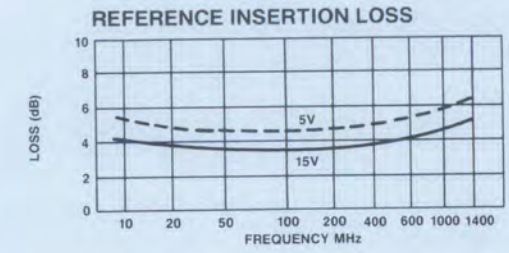
*All specifications apply when operated with bias voltage of +15 VDC and a 50 ohm impedance at both RF ports.

**Above reference insertion loss.

Typical Performance







Truth Table

CONTROL INPUT							ATTENUATOR SETTING
0.5	1	2	4	8	C*	R	
0	0	0	0	0	1	1	REFERENCE
1	0	0	0	0	1	1	0.5 dB
0	1	0	0	0	1	1	1 dB
0	0	1	0	0	1	1	2 dB
0	0	0	1	0	1	1	4 dB
0	0	0	0	1	1	1	8 dB
ANY COMBINATION					1	1	SUM OF BITS SELECTED
X	X	X	X	X	0	1	NO CHANGE IN ATTENUATION
X	X	X	X	X	X	0	RESET TO REFERENCE

"1" = LOGIC HIGH
"0" = LOGIC LOW
"X" = DON'T CARE
*CLOCK INPUT STROBES DATA ON RISING EDGE

Ordering Information

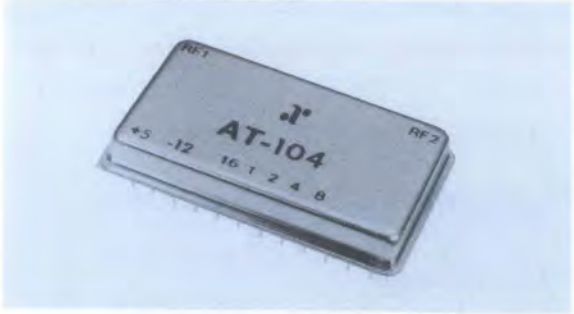
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AT-103	6599	Pin	$485

Delivery is from stock.

NEW

MODEL AT-104 — 5 BIT GaAs DIGITAL ATTENUATOR
20-2000 MHz

- Attenuation 1 dB Steps to 31 dB
- TTL Control Interface
- Fast Switching Speed, 20 ns TYP
- Phase Balance, +2/–4 Degrees TYP @ 500 MHz



Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		20 to 2000 MHz
Nominal Attenuation**		1 dB Steps to 31 dB
Attenuation Accuracy	20-2000 MHz	±0.35 dB Max
	20-1000 MHz	±0.30 dB Max
	20-500 MHz	±0.30 dB Max
VSWR	20-2000 MHz	1.6:1 Max
	20-1000 MHz	1.6:1 Max
	20-500 MHz	1.6:1 Max
Reference Insertion Loss	20-2000 MHz	8.5 dB Max
	20-1000 MHz	8.0 dB Max
	20-500 MHz	7.5 dB Max

Operating Characteristics

Impedance			50 Ohms Nominal
Phase Balance (For any bit or combinations of bits per unit)			
2000 MHz			+2/–12 Degrees Typ
1000 MHz			+2/–7 Degrees Typ
500 MHz			+2/–4 Degrees Typ
100 MHz			±2.0 Degrees Typ
Switching Characteristics			
Switching Time (50% control to 90/10% RF)			20 nS Typ
Switching Transients (unfiltered)			350 mV Typ
Input Power for 1dB Compression			
500-2000 MHz			+27 dBm Typ
20-50 MHz			+20 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP2	IP3	
500-2000 MHz	+58	+50	dBm Typ
20-50 MHz	+41	+35	dBm Typ
Bias Power			+5 Vdc @ 5 mA Max
			–12 Vdc @ 8 mA Max
Control			5 Line, TTL Data Bus
Package Type			Dual-In-Line (DI-3)
			(See page 480 for physical dimensions.)

Environmental
These units are designed to meet the environmental requirements of Table 1B, page 497 of the Adams-Russell catalog.

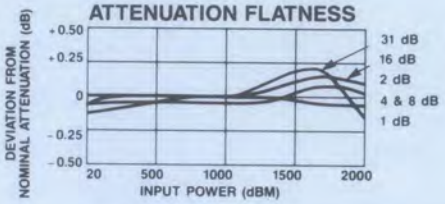
*All specifications apply when operated with bias voltages of +5 Vdc and –12 Vdc and a 50 ohm impedance at both RF ports.
**Above reference insertion loss.

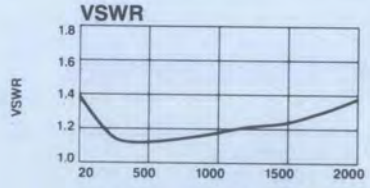
Ordering Information

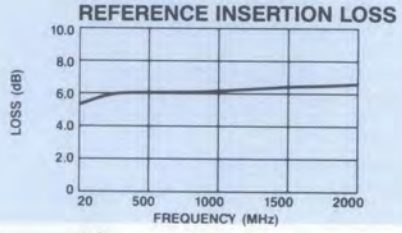
Model No.	Connectors	Unit Price (5-9 Units)
AT-104	PIN	$495

Delivery is from stock.

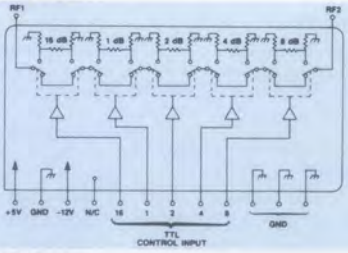
Typical Performance







Schematic



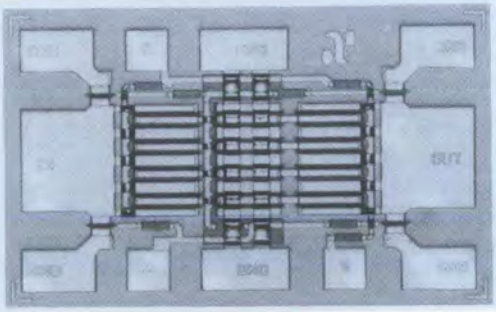
Truth Table

Control Input 1	2	4	8	16	Attenuator Setting
0	0	0	0	0	REFERENCE
1	0	0	0	0	1 dB
0	1	0	0	0	2 dB
0	0	1	0	0	4 dB
0	0	0	1	0	8 dB
0	0	0	0	1	16 dB
Any Combination "1" = Logic High (TTL)					Sum of Bits Selected "0" = Logic Low (TTL)

NEW

MODEL AT-200 — GaAs MMIC ABSORPTIVE VVA
DC - 5 GHz

- Low Insertion Loss, 1.2 dB Typical
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption
- Outstanding Flatness



Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		DC - 5 GHz
Insertion Loss	DC - 5 GHz	1.8dB Max
	DC - 2 GHz	1.5dB Max
	DC - 1 GHz	1.1dB Max
VSWR	DC - 5 GHz	1.7:1 Max
	DC - 2 GHz	1.5:1 Max
	DC - 1 GHz	1.2:1 Max
Attenuation	DC - 5 GHz	20dB Min
Flatness (Peak - Peak)	DC - 5 GHz	2.5dB Max
	DC - 2 GHz	1.5dB Max
	DC - 1 GHz	1.0dB Max
Attenuation vs. Temperature	0 to 10dB Att.	±0.6dB
	20dB Att.	±2.5dB

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
t_{rise}, t_{fall} (10% to 90%)			4ns Typ
t_{on}, t_{off} (50% CTL to 90%/10% RF)			8ns Typ
Transients (in band)			10mv Typ
Input Power for 1dB Compression			
Attenuation Level	0dB	20dB	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBm)			
Intercept points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			–1.5 to –4V @ 100 µA Max
B Input (Series FETS)			0 to –4V @ 100 µA Max
Die Size			0.040" x 0.025" x 0.010" (1.00mm x 0.60mm x 0.25 mm)

Environmental
These units are designed to meet or exceed the following: Electrical 100% probing @ 25°C for selected parameters. Visual 100% per MIL-STD-883 Method 2010 Condition B. Lot traceability supplied on request.

*All specifications apply with 50 ohm impedance at RF ports and 0 and –5 VDC control voltages.

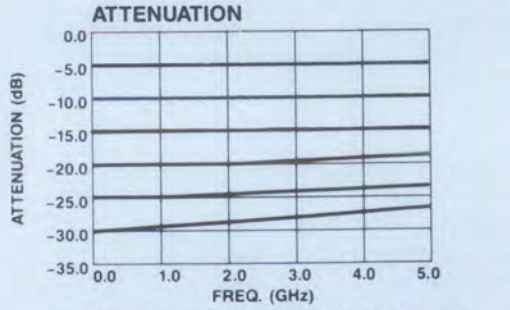
†Faster switching speed can be achieved with enhanced driver waveform. Switching speed is measured between 20dB and 2dB attenuation levels.

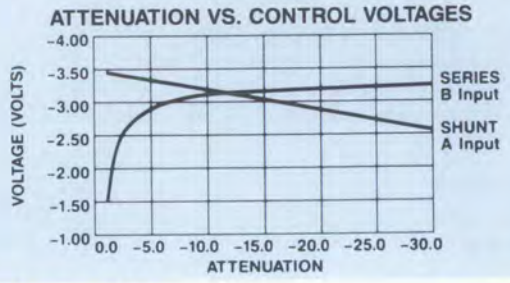
Ordering Information

Model No.	Part No.	Connectors	Unit Price (1-49 Units)
AT-200	6032	CHIP	$25

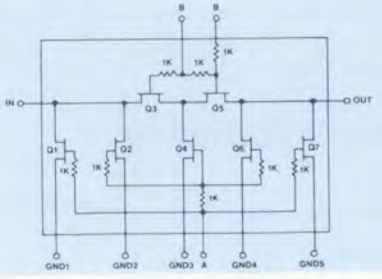
Delivery is from stock.

Typical Performance





Schematic



ANZAC — Make the Connection . . .
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Adams Russell COMPONENTS GROUP
For Technical Information, Call (617) 273-3333
For Ordering Information, Call (617) 273-3333

MODEL AT-200 Handling, Mounting, Bonding Procedure

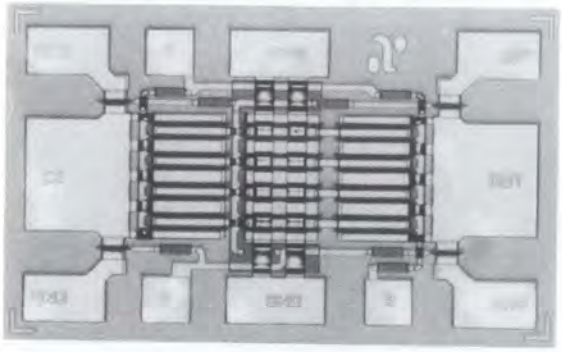
Maximum Ratings

A. Control Voltage (A or B): -8.5Vdc

B. Max Input RF Power: +25 dBm

C. Storage Temperature: -65°C to +175°C

D. Maximum Operating Temperature: +175°C



BondPad Dimensions Inches (mm)

In, Out:	0.007 x 0.007 (0.18 x 0.18)
GND:	0.003 x 0.006 (0.08 x 0.16)
A, B:	0.003 x 0.003 (0.08 x 0.08)

Die Size Inches (mm)

0.040 x 0.025 x 0.010
(1.00 x 0.60 x 0.25)

Handling Precautions

Permanent damage to the AT-200 may occur if the following precautions are not adhered to:

A. Cleanliness – The AT-200 should be handled in a clean environment. DO NOT attempt to clean unit after the AT-200 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transients – Avoid instrument and power supply transients while bias is applied to the AT-200. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port A or B only when the other is biased. Neither A nor B should be allowed to "float."

E. General Handling – It is recommended that the AT-200 chip be handled with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The AT-200 is back-metallized with TiPtAu (300/1000/5000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the AT-200 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Preheat assembly to 120-150°C. Apply a minimum amount of epoxy and place the AT-200 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

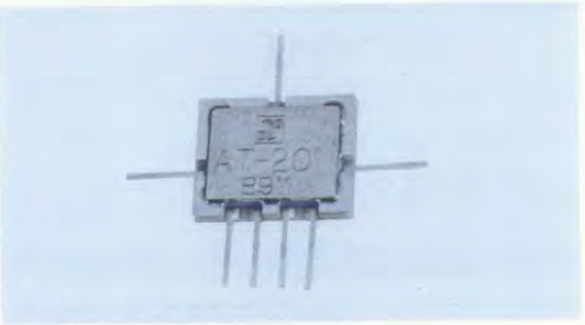
A. Thermosonic wedge wire bonding of 0.001 diameter pure gold wire is recommended with a nominal stage temperature of 150°C and a bonding force of 18 to 22 grams. Ultrasonic energy and time should be adjusted to the minimum levels required to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. RF bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

NEW

MODEL AT-201 — VOLTAGE VARIABLE ABSORPTIVE ATTENUATOR DC - 5 GHz

- Miniature Ceramic Package
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		DC - 5 GHz
Insertion Loss	DC - 5 GHz	2.5dB Max
	DC - 2 GHz	1.7dB Max
	DC - 1 GHz	1.3dB Max
VSWR	DC - 5 GHz	2.0:1 Max
	DC - 2 GHz	1.5:1 Max
	DC - 1 GHz	1.3:1 Max
Attenuation	DC - 5 GHz	20dB Min
Flatness (Peak to Peak)	DC - 5 GHz	2.5dB Max
	DC - 2 GHz	1.5dB Max
	DC - 1 GHz	1.0dB Max
Attenuation vs. Temperature	0 to 10dB Att.	±0.6dB
	20dB Att.	±2.5dB

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
t_{rise}, t_{fall} (10% to 90%)			4ns Typ
t_{on}, t_{off} (50% C+L to 90%/10% RF)			8ns Typ
Transients (in band)			10mv Typ
Input Power for 1dB Compression			
Attenuation Level	0db	20db	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			–1.5 to –4V @ 100 μA Max
B Input (Series FETS)			0 to –4V @ 100 μA Max
Package Type			Ceramic (CR-2)
			(See page 489 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell Electronics catalog.

*All specifications apply with 50 ohm connected to all RF ports.

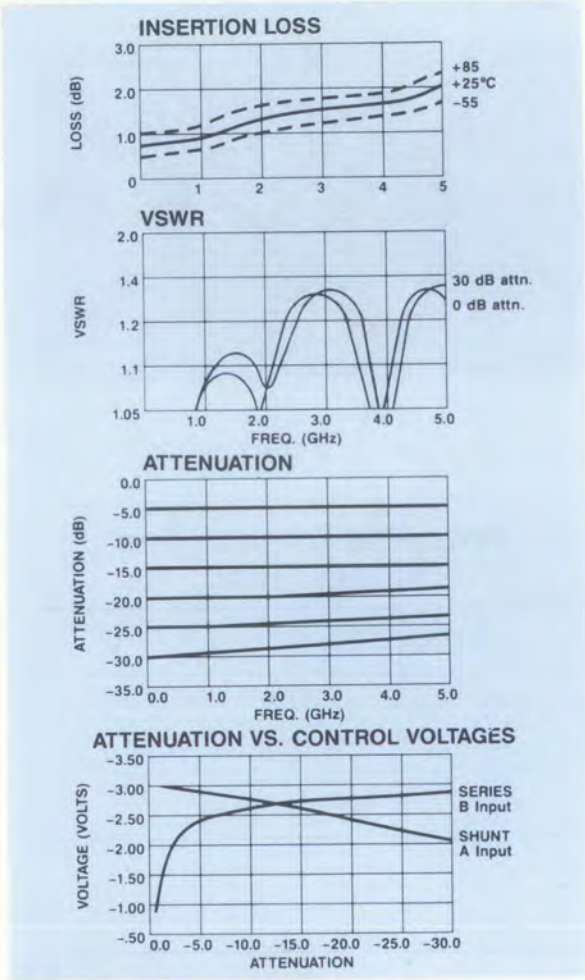
†Faster switching speed can be achieved with enhanced driver waveform. Switching speed is measured between 20dB and 2dB attenuation levels.

Ordering Information

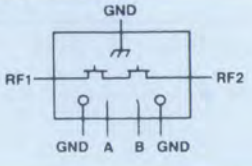
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AT-201	6879	Pin	$59

Delivery is from stock.

Typical Performance



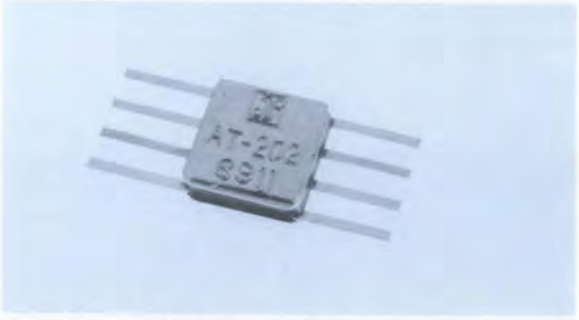
Pin Configuration



NEW

MODEL AT-202 VOLTAGE VARIABLE ABSORPTIVE ATTENUATOR DC - 5 GHz

- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.180″ (4.6mm) Sq



Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		DC - 5 GHz
Insertion Loss	DC - 5 GHz	2.0dB Max
	DC - 2 GHz	1.7dB Max
	DC - 1 GHz	1.3dB Max
VSWR	DC - 5 GHz	2.0:1 Max
	DC - 2 GHz	1.5:1 Max
	DC - 1 GHz	1.3:1 Max
Attenuation	DC - 5 GHz	20dB Min
Flatness (Peak to Peak)	DC - 5 GHz	2.5dB Max
	DC - 2 GHz	1.5dB Max
	DC - 1 GHz	1.0dB Max
Attenuation vs. Temperature	0 to 10dB Att.	±0.6dB
	20dB Att.	±2.5dB

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
t_{rise}, t_{fall} (10% to 90%)			4ns Typ
t_{on}, t_{off} (50% C+L to 90%/10% RF)			8ns Typ
Transients (in band)			10mv Typ
Input Power for 1dB Compression			
Attenuation Level	0dB	20dB	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			–1.5 to –4V @ 100 μA Max
B Input (Series FETS)			0 to –4V @ 100 μA Max
Package Type			Ceramic (CR-3)
			(See page 490 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell Electronics catalog.

*All specifications apply with 50 ohm connected to all RF ports.

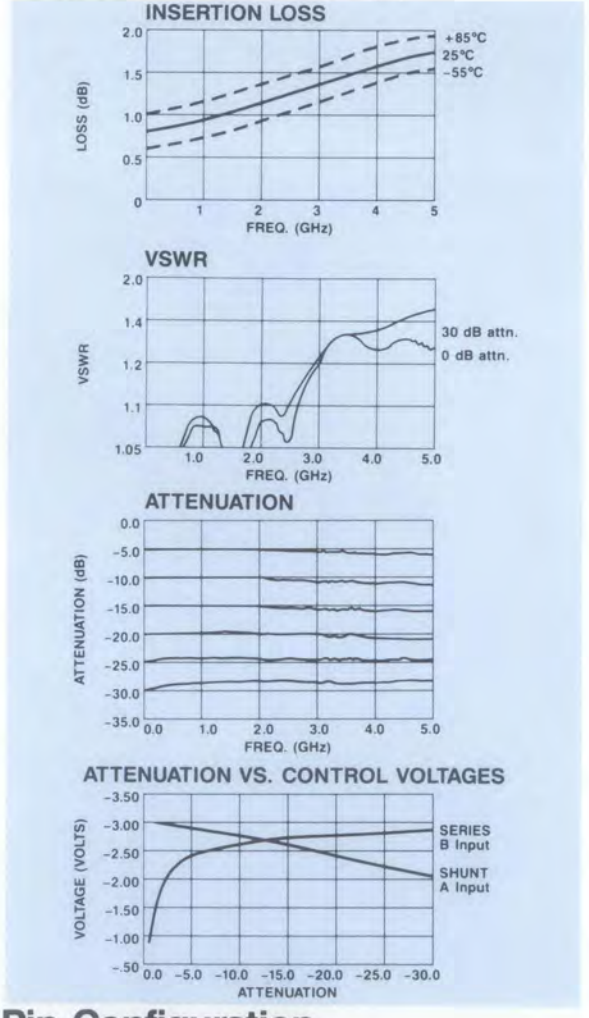
†Faster switching speed can be achieved with enhanced driver waveform. Switching speed is measured between 20dB and 2dB attenuation levels.

Ordering Information

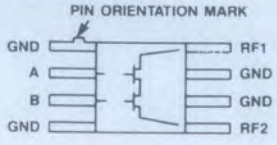
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
AT-202	6010	Pin	$50

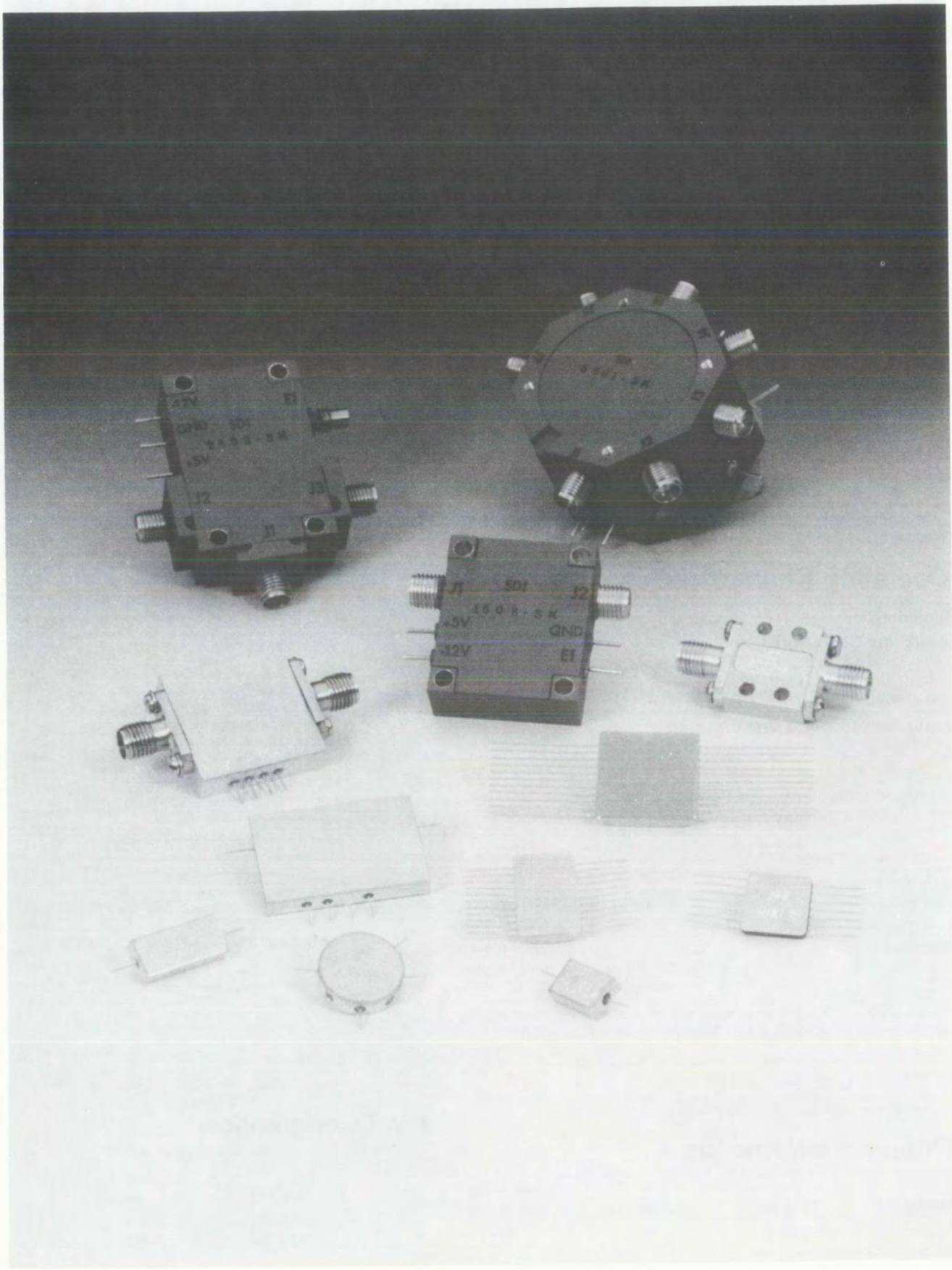
Delivery is from stock

Typical Performance



Pin Configuration




J1
SDI
J2
+5V
GND
-12V
E1

MICROWAVE CONTROL DEVICE SELECTION GUIDE

BROADBAND 2-18 GHz SWITCHES

TYPE	MODEL NO.	FREQ. RANGE (GHz)	INSERTION LOSS (dB) 2-4	4-8	8-12	12-18	ISOLATION (dB) 2-4	4-8	8-12	12-18	VSWR 2-4	4-8	8-12	12-18	DRIVER TYPE	REFLECT. OR TERM	SWITCHING SPEED (ns)	CASE[1] STYLE	PAGE NO.
SPST	**1101-SK**	**2-18**	**1.0**	**1.4**	**1.8**	**2.0**	**50**	**60**	**60**	**60**	**1.7**	**1.8**	**1.9**	**2.0**	**NO**	**REFL**	**30**	**FP-32**	208
SPST	1308-SK	2-18	1.4	1.8	2.0	2.3	55	60	60	60	1.7	1.8	1.9	2.0	TTL	REFL	50	FP-28	209
SPST	1508-SK	2-18	1.4	1.8	2.1	2.4	55	60	60	60	1.7	1.8	1.9	2.0	TTL	REFL	50	C-44	210
SPDT	**2103-SK**	**2-18**	**1.2**	**1.7**	**2.3**	**2.8**	**55**	**55**	**50**	**50**	**1.7**	**1.8**	**1.9**	**2.0**	**NO**	**REFL**	**50**	**FP-26**	212
SPDT	2303-SK	2-18	1.4	2.0	2.5	2.9	55	55	50	50	1.7	1.8	1.9	2.0	TTL	REFL	50	FP-29	213
SPDT	2308-SK	2-18	2.3	3.0	3.7	4.0	70	70	70	65	1.9	1.9	2.0	2.1	TTL	TERM	250	FP-29	214
SPDT	2508-SK	2-18	2.3	3.0	3.7	4.0	70	70	70	65	1.9	1.9	2.0	2.1	TTL	TERM	250	C-49	214
SPDT	2503-SK	2-18	1.7	2.0	2.7	3.1	55	55	50	50	1.7	1.8	1.9	2.0	TTL	REFL	50	C-45	215
SP4T	**4103-SK**	**2-18**	**1.8**	**2.0**	**2.7**	**3.5**	**55**	**55**	**50**	**50**	**1.8**	**1.9**	**2.0**	**2.0**	**NO**	**REFL**	**50**	**FP-27**	216
SP4T	4303-SK	2-18	1.6	2.3	2.8	3.4	55	55	50	50	1.8	1.9	2.0	2.0	TTL	REFL	50	FP-30	217
SP4T	4308-SK	2-18	2.6	3.4	4.1	4.4	70	70	70	65	1.9	2.0	2.1	2.1	TTL	TERM	250	FP-30	218
SP4T	4508-SK	2-18	2.6	3.4	4.1	4.4	70	70	70	65	1.9	2.0	2.1	2.1	TTL	TERM	250	C-46	218
SP4T	4503-SK	2-18	1.6	2.3	2.9	3.5	55	55	50	50	1.8	1.9	2.0	2.0	TTL	REFL	50	C-46	219
SP6T	**6501-SK**	**2-18**	**1.9**	**2.7**	**3.2**	**4.0**	**55**	**55**	**50**	**50**	**1.9**	**2.0**	**2.1**	**2.1**	**TTL**	**REFL**	**250**	**C-47**	221

BROADBAND HIGH POWER 2-18 GHz SWITCH

TYPE	MODEL NO.	FREQ. RANGE (GHz)	INSERTION LOSS (dB) 2-4	4-8	8-12	12-18	ISOLATION (dB) 2-4	4-8	8-12	12-18	VSWR 2-4	4-8	8-12	12-18	DRIVER TYPE	AVG Po	SWITCHING SPEED (ns)	CASE STYLE	PAGE NO.
SP4T	4509-SK	2-18	2.5	2.7	3.5	3.7	45	45	45	45	2.0	2.0	2.0	2.0	TTL	40	2000	C-46	220

ULTRA BROADBAND 2-26 GHz SWITCH

TYPE	MODEL NO.	FREQ. RANGE (GHz)	INSERTION LOSS (dB) 2-6	2-12	12-18	18-26	ISOLATION (dB) 2-6	2-12	12-18	18-26	VSWR 2-6	2-12	12-18	18-26	DRIVER TYPE	REFLECT. OR TERM	SWITCHING SPEED (ns)	CASE STYLE	PAGE NO.
SPST	1557-SK	2-26	1.8	2.1	2.4	2.9	50	50	50	50	2.0	2.0	2.0	2.1	TTL	REFL	20	C-48	211

BROADBAND 2-18 GHz LIMITERS

MODEL NO.	FREQ. RANGE (GHz)	INSERTION LOSS (dB) 2-4	4-8	8-12	12-18	FLAT LEAKAGE (mW) 2-4	4-8	8-12	12-18	VSWR 2-4	4-8	8-12	12-18	SURV. POWER (WATTS)	RECOVERY TIME (ns)	CASE STYLE	PAGE NO.
8001-SK	2-18	0.9	1.1	1.4	1.7	150	125	125	125	1.7	1.8	1.9	2.0	150	100	FP-31	223
9001-SK	2-18	1.0	1.4	1.8	2.3	150	125	125	125	1.7	1.8	1.9	2.0	150	100	C-50	224
8003-SK	2-18	1.2	1.6	2.0	2.6	150	125	125	125	1.7	1.8	1.9	2.0	500	200	FP-32	225
9003-SK	2-18	1.3	1.8	2.2	2.7	150	125	125	125	1.7	1.8	1.9	2.0	500	200	C-50	226
8109-SK	2-18	2.0	2.1	2.5	3.1	100	100	100	100	1.7	1.8	1.9	2.0	40 CW	6000	C-51	227

LOW FREQUENCY 0.001-2.0 GHz LIMITER

MODEL NO.	FREQ. RANGE (GHz)	INSERTION LOSS (dB) DC-0.1	0.1-0.5	0.5-1	1 - 2	FLAT LEAKAGE (mW) DC-0.1	0.1-0.5	0.5-1	1 - 2	VSWR DC-0.1	0.1-0.5	0.5-1	1 - 2	SURV. POWER (WATTS)	RECOVERY TIME (ns)	CASE STYLE	PAGE NO.
9008-LF	0.001-2.0	0.5	0.6	0.6	0.8	50	100	100	100	1.3	1.3	1.4	1.5	4	N/A	C-50	222

MICROWAVE PIN DIODE DRIVERS

TYPE	MODEL NO.	OUTPUT CURRENT (mA) NEG	POS	PEAK I (mA) NEG	POS	OPEN CIRCUIT OUTPUT VOLT NEG	POS	SWITCH TIME T_{ON}	T_{OFF}	REP RATE (MHz)	OPERATING VOLTAGE AND I Vcc	(mA)	Vee	(mA)	TTL UNIT LOAD	CASE STYLE	PAGE NO.
SPST	4010-15M	10	10	200	200	3.5	3.5	8 ns	7 ns	30	+5	18	-5-15	6	1	FP-33	228
SPDT	4020-11M	10	10	200	200	3.5	3.5	8 ns	7 ns	30	+5	15	-5-15	8	1	FP-34	229
SP4T	4040-11M	10	10	200	200	3.5	3.5	8 ns	7 ns	30	+5	35	-5-15	15	1	FP-35	230

[1]CASE STYLE: C = CONNECTORIZED; FP = FLATPACK

BOLD = NEW PRODUCTS

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

PARAMETER DEFINITIONS

SWITCHING SPEED

Switches Without Integral Drivers

Switching times for devices without drivers are defined as the elapsed time required for the switch to transition between the insertion loss and isolation states. In order to provide a consistent frame work for measuring these transitions, the 10% and 90% RF voltage points have been selected as standard reference points. Figure 1 below illustrates the RF envelope, as displayed on a sampling oscilloscope, showing the transitions from isolation to insertion loss and back again. The switching speeds listed in the specification section are guaranteed only with drivers from this catalog.

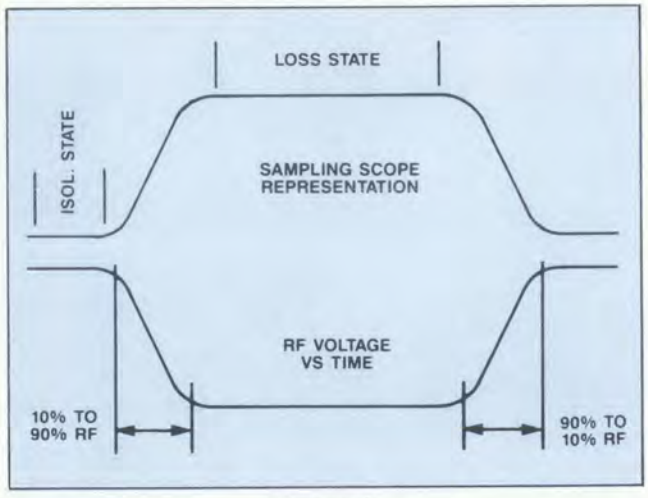


Figure 1.

Switches With Internal Drivers

Switching times for devices equipped with logic compatible drive circuitry can be specified by the use of several different reference points. Convention normally specifies products of this nature by the total time required from the input of the logic signal to the completion of the RF transition. The actual points chosen are the 50% transition point of the logic input and either the 10% or 90% points of the RF voltage envelope. This method of measurement must, by definition, include all delays inherent in the driver portion of the device as well as the actual transition times of the RF circuitry.

Figure 2 below illustrates the relation between the logic input signal and the resultant RF transition, as it would be displayed on a sampling oscilloscope, when executing actual measurements.

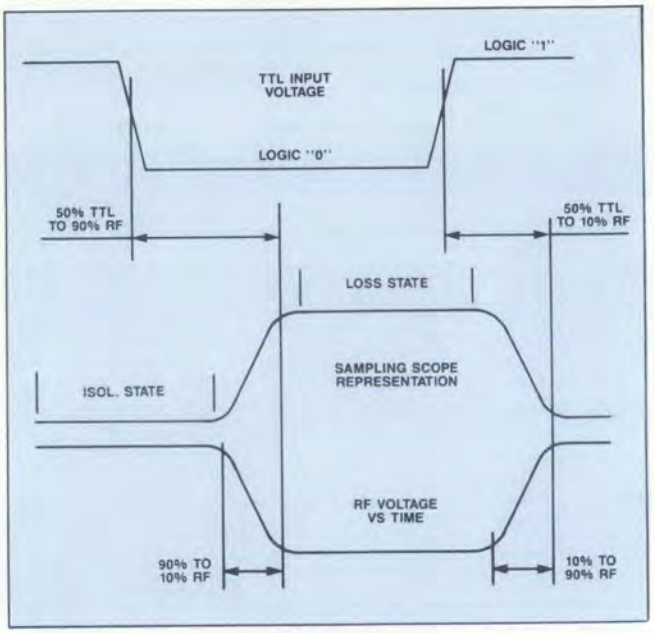


Figure 2.

The switching speed parameter limits listed in the guaranteed specifications section of the data sheet are for the modulating mode only, not the commutating mode. The modulating mode is defined as switching one arm of a switch on and off while holding all other arms in the isolated state. The commutating mode is defined as switching between any two arms on a given switch. Commutating and modulating modes are the same for a single pole single throw switch.

When measuring any parameter on a switch requiring biasing, make sure the bias supply voltage and current outputs are the correct value and polarity. Switches with internal drivers have some reverse polarity and over voltage protection but they are protected only to a certain point and can be permanently damaged if the protection limits are exceeded.

LIMITER RECOVERY TIME

Recovery time is defined as that time required for a limiter to transition from a high loss state to a low loss state after the cesation of high power. This transition time exists because of the time required to dissipate energy stored in the diodes. As with every parameter it is necessary to have consistent reference points. Therefore **recovery time** is defined as the time from the end of the high power pulse to the point where the limiter returns to within 3 dB of the insertion loss state.

LIMITER SPIKE LEAKAGE

Spike leakage is that amount of energy passed by the limiter for a short period of time when the high power pulse is first incident on the limiter. This time period represents the time required for the limiter to transition from the low loss state to a high loss state. The amplitude of the spike will depend on a number of factors including the use time of the high power pulse. This **spike leakage** is defined in ergs as a function of the amplitude of the spike and the width of the spike at its half power point (half the spike's amplitude).

Spike leakage is calculated using the following formula:

$$\text{SPIKE LEAKAGE (ERGS)} = t_S \times P_S \times 10^7$$

where t_S = Spike width at the half power point in seconds.
P_S = Maximum spike amplitude in watts.

Figure 3 demonstrates both recovery time and spike leakage parameters.

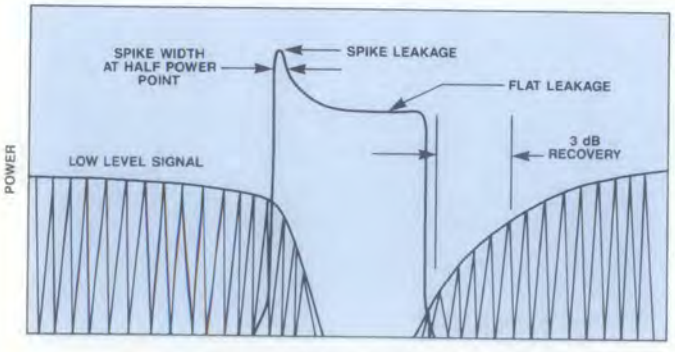


Figure 3.

LIMITER POWER HANDLING CONSIDERATIONS

There is one factor often overlooked when calculating the maximum input power a limiter will see in a given circuit. That factor is the VSWR looking back into the high power source. When a limiter is fully saturated, its input impedance is typically 1.5 ohms, i.e. a short circuit. The vast majority of the power is reflected back toward the source. If the source does not present a good match to this reflected power, standing waves will be set up on the transmission path between the source and the limiter. Depending on the phase relationship between the source and the limiter, a current maximum could occur at the limiter resulting in significantly higher power dissipated.

The relationship between potential dissipated power and source VSWR is close to linear for any VSWR up to 2.0:1, i.e. a 2.0:1 source VSWR has the potential to increase the dissipation power at the limiter by a factor of two. For any VSWR above 2.0:1, the following formula must be used:

$$P_A = \frac{P_S}{[\,1 \pm \Gamma_L \Gamma_S\,]^2}$$

Where: P_A = Actual Power
P_S = Source Power
Γ_L = Load (Limiter) Power Factor, 0.96 Typical
Γ_S = Source Power Factor

LIMITER INSERTION LOSS, VSWR AND ISOLATION

Insertion loss, VSWR and isolation should all be measured with standard microwave test equipment into a 50 Ohm system. The only special precaution worth noting, from an RF standpoint, is when measuring insertion loss or VSWR on any limiter, make sure the RF power is -10 dBm or lower. At some point above -10 dBm a limiter will start to compress thus giving false insertion loss or VSWR data.

NEW

MODEL 1101-SK

SPST REFLECTIVE SWITCH MODULE WITHOUT DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- SDI Driver Compatible
- High Isolation
- Hermetic Package

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.0 dB Max
	4 - 8 GHz	1.4 dB Max
	8 - 12 GHz	1.8 dB Max
	12 - 18 GHz	2.0 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	50 dB Min
	4 - 8 GHz	60 dB Min
	8 - 12 GHz	60 dB Min
	12 - 18 GHz	60 dB Min

Operating Characteristics

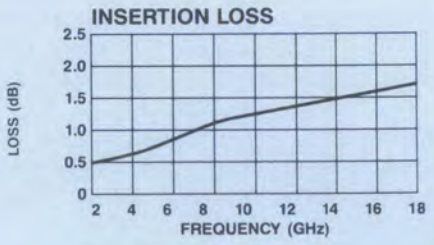
Impedance		50 Ohms Nominal
Switching Time**	t_{on}, t_{off}	50 nsec Max 20 nsec Typ
Input Power for 1dB Compression		
	2 - 18 GHz	+27 dBm Typ
Bias	Insertion Loss	–10 mA
	Isolation	+45 mA
Package Type***		Modular (FP-32) (See page 479 for physical dimensions.)

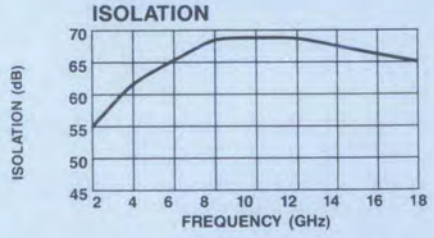
Environmental

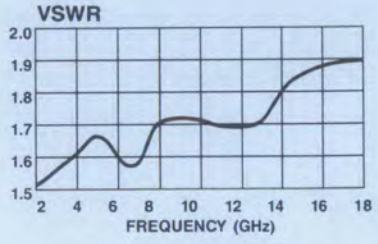
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

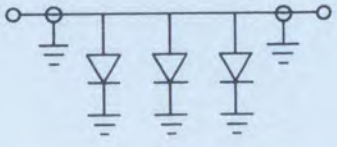
Typical Performance







Schematic



Ordering Information

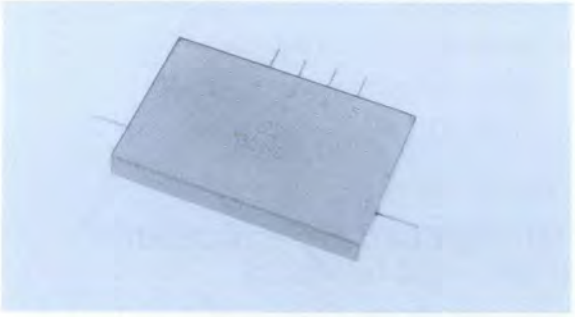
Model No.	Connectors	Unit Price (5-9 Units)
1101-SK	PIN	$165

Delivery is from stock.

NEW

MODEL 1308-SK — SPST REFLECTIVE SWITCH MODULE WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- Hermetic Package



Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.4 dB Max
	4 - 8 GHz	1.8 dB Max
	8 - 12 GHz	2.0 dB Max
	12 - 18 GHz	2.3 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	60 dB Min
	8 - 12 GHz	60 dB Min
	12 - 18 GHz	60 dB Min

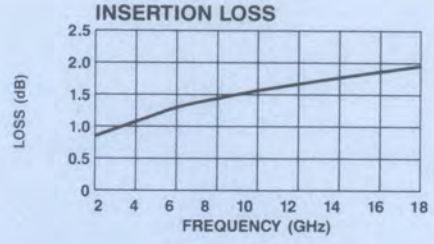
Operating Characteristics

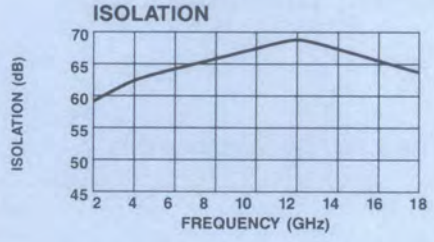
Impedance	50 Ohms Nominal
Switching Time**	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+27 dBm Typ
Bias Voltage	+5 Vdc @ 75 mA Max –12 Vdc @ 50 mA Max
Package Type***	Module (FP-28) (See page 478 for dimensions.)
Pin Configuration	RF IN; P1, RF OUT; P7, +5 VDC; P4, –12 VDC; P5, CTRL; P2, GND; P3

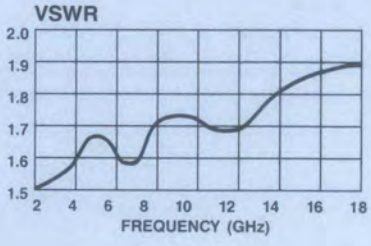
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
1308-SK	PIN	$375

Delivery is from stock.

Truth Table

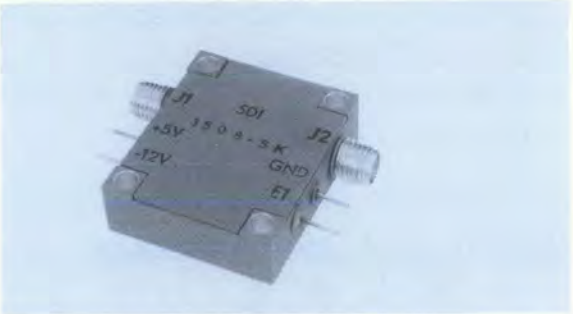
TTL Input	Switch State
1 = HIGH	RF Common to RF Port
1	RF1
1	OFF
0	ON

NEW

MODEL 1508-SK

SPST REFLECTIVE SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- SMA Connectorized Package



Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.4 dB Max
	4 - 8 GHz	1.8 dB Max
	8 - 12 GHz	2.1 dB Max
	12 - 18 GHz	2.4 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	60 dB Min
	8 - 12 GHz	60 dB Min
	12 - 18 GHz	60 dB Min

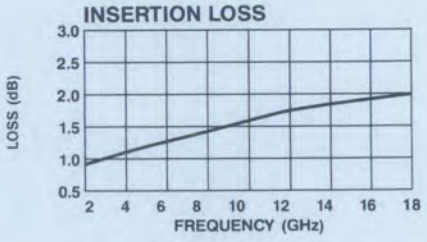
Operating Characteristics

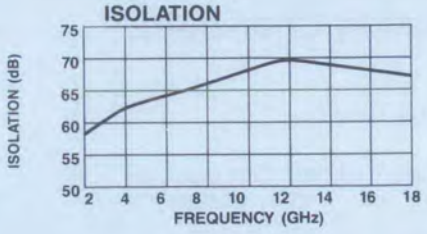
Impedance		50 Ohms Nominal
Switching Time**		100 nsec Max 50 nsec Typ
Input Power for 1dB Compression	2 - 18 GHz	+27 dBm Typ
Bias Voltage		+5 Vdc @ 75 mA Max –12 Vdc @ 50 mA Max
Package Type***		Connectorized (C-44) (See page 487 for dimensions.)

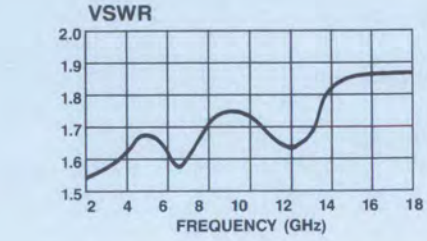
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

Typical Performance







Truth Table

TTL Input	Switch State
1 = HIGH	RF Common to RF Port
1	RF1
1 0	OFF ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
1508-SK	SMA	$415

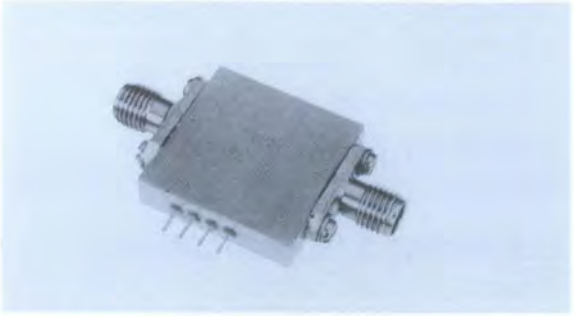
Delivery is from stock.

NEW

MODEL 1557-SK

SPST REFLECTIVE SWITCH WITH TTL DRIVER 2 - 26 GHz

- 2-26 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- Removable SMA Connectors
- Miniature Package



Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 26 GHz
Insertion Loss	2 - 6 GHz	1.8 dB Max
	6 - 12 GHz	2.1 dB Max
	12 - 18 GHz	2.4 dB Max
	18 - 26 GHz	2.9 dB Max
VSWR	2 - 6 GHz	2.0:1 Max
	6 - 12 GHz	2.0:1 Max
	12 - 18 GHz	2.0:1 Max
	18 - 26 GHz	2.1:1 Max
Isolation	2 - 6 GHz	50 dB Min
	6 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min
	18 - 26 GHz	50 dB Min

Operating Characteristics

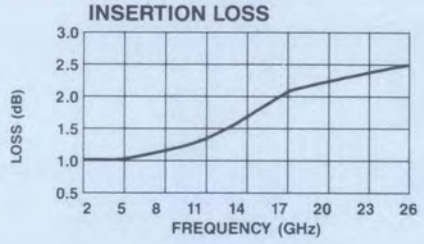
Impedance	50 Ohms Nominal
Switching Time**	50 nsec Max 20 nsec Typ
Input Power for 1dB Compression 2 - 26 GHz	+27 dBm Typ
Bias Voltage	+5 Vdc @ 75 mA Max –5 Vdc @ 50 mA Max
Package Type***	Connectorized (C-48) (See page 488 for dimensions.)

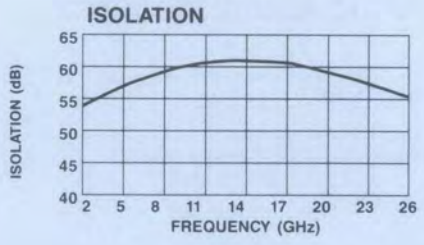
Environmental

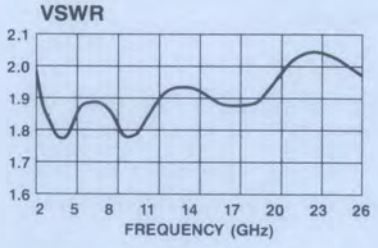
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

Typical Performance







Truth Table

TTL Input	Switch State
1 = HIGH	RF Common to RF Port
0	ON
1	OFF

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
1557-SK	SMA	$1090

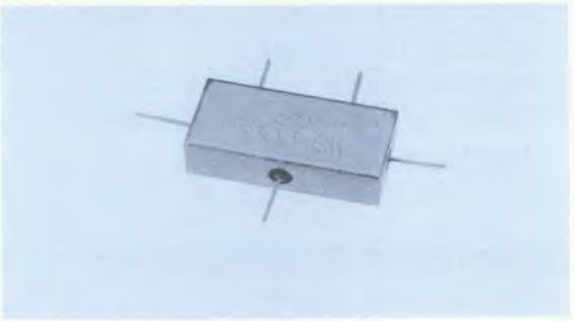
Delivery is from stock.

NEW

MODEL 2103-SK

SPDT REFLECTIVE SWITCH MODULE WITHOUT DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- SDI Driver Compatible
- High Isolation
- Hermetic Package



Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.2 dB Max
	4 - 8 GHz	1.7 dB Max
	8 - 12 GHz	2.3 dB Max
	12 - 18 GHz	2.8 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

Operating Characteristics

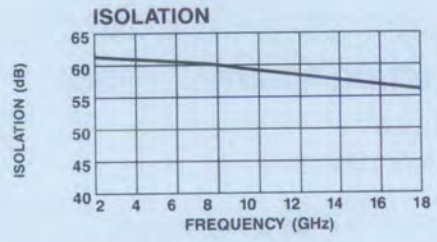
Impedance		50 Ohms Nominal
Switching Time**	t_{on}, t_{off}	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression	2 - 18 GHz	+13 dBm Typ
Bias	Insertion Loss	–20 mA
	Isolation	+20 mA
Package Type***		Module (FP-26) (See page 478 for dimensions.)
Pin Configuration		RF IN; P3; RF1; P1, RF2; P3 CONTROL 1; P5, CONTROL 2; P4

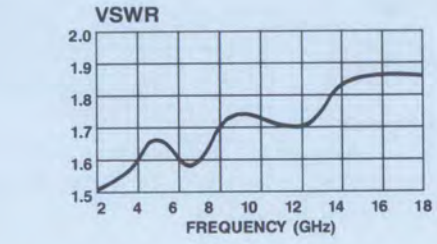
Environmental

All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

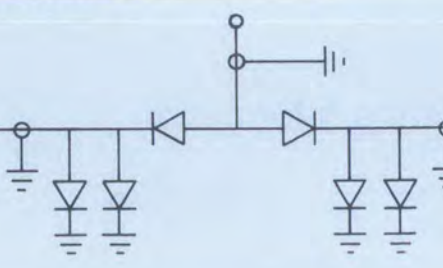
*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

Typical Performance





Schematic



Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
2103-SK	PIN	$225

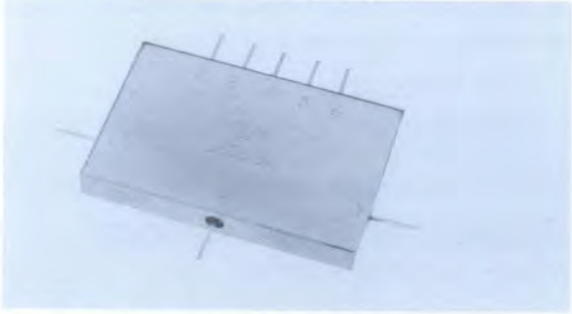
Delivery is from stock

NEW

MODEL 2303-SK

SPDT REFLECTIVE SWITCH MODULE WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- Hermetic Package



Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.4 dB Max
	4 - 8 GHz	2.0 dB Max
	8 - 12 GHz	2.5 dB Max
	12 - 18 GHz	2.9 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

Operating Characteristics

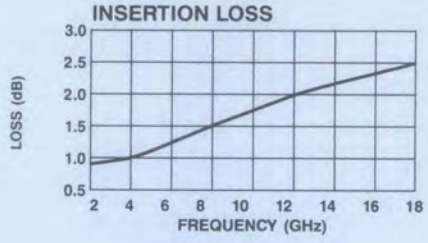
Impedance	50 Ohms Nominal
Switching Time**	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Bias Voltage	+5 Vdc @ 75 mA Max –12 Vdc @ 50 mA Max
Package Type***	Module (FP-29) (See page 478 for dimensions.)
Pin Configuration	RF IN; P8, RF1; P1, RF2; P7, CONTROL 1; P2, CONTROL 2; P3, +5 Vdc; P5, –12 Vdc; P6, GND; P4

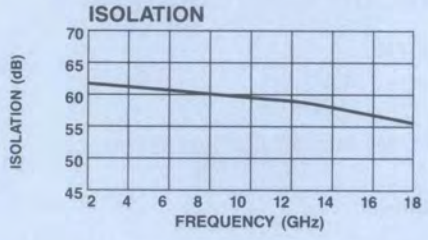
Environmental

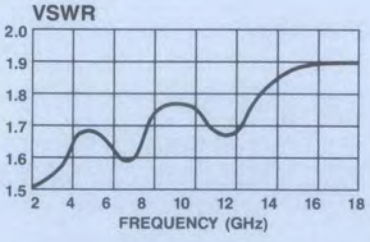
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

Typical Performance







Truth Table[1]

TTL Input	Switch State	
1= HIGH	RF Common to RF Port	
	RF1	RF2
1	ON	OFF
0	OFF	ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
2303-SK	PIN	$475

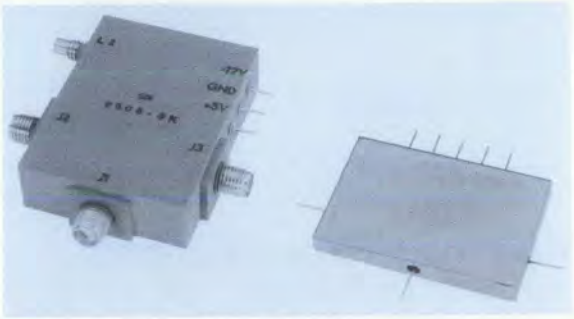
Delivery is from stock.

NEW

MODEL 2308-SK/2508-SK

SPDT ABSORPTIVE SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- Non-Reflective
- Hermetic and Connectorized Package



Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	2.3 dB Max
	4 - 8 GHz	3.0 dB Max
	8 - 12 GHz	3.7 dB Max
	12 - 18 GHz	4.0 dB Max
VSWR	2 - 4 GHz	1.9:1 Max
	4 - 8 GHz	1.9:1 Max
	8 - 12 GHz	2.0:1 Max
	12 - 18 GHz	2.1:1 Max
Isolation	2 - 4 GHz	70 dB Min
	4 - 8 GHz	70 dB Min
	8 - 12 GHz	70 dB Min
	12 - 18 GHz	65 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Time**	500 nsec Max 250 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Bias Voltage	+5 Vdc @ 85 mA Max –12 Vdc @ 60 mA Max
Package Type***	2308-SK Module (FP-29) 2508-SK Connectorized (C-49) (See page 478 and 489 for dimensions.)
Pin Configuration	RF IN; P8, RF1; P1, RF2; P7 CONTROL 1; P2, CONTROL 2; P3, +5 Vdc; P5, –12 Vdc; P6, GND; P4

Environmental

All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.

**See pages 206 and 207 for switching speed definition.

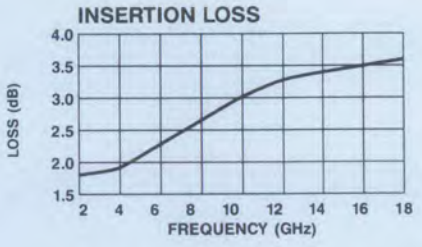
***(2308-SK) Hermetic

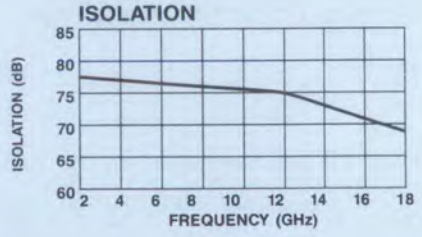
Ordering Information

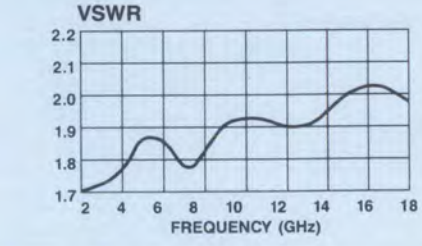
Model No.	Connectors	Unit Price (5-9 Units)
2308-SK	PIN	$545
2508-SK	SMA	$735

Delivery is from stock.

Typical Performance







Truth Table

TTL Input	Switch State	
1 = HIGH	RF Common to RF Port	
	RF1	RF2
0	OFF	ON
1	ON	OFF

NEW

MODEL 2503-SK

SP2T REFLECTIVE SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- SMA Connectorized Package

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.4 dB Max
	4 - 8 GHz	2.0 dB Max
	8 - 12 GHz	2.7 dB Max
	12 - 18 GHz	3.1 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Time**	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Bias Voltage	+5 Vdc @ 75 mA Max –12 Vdc @ 50 mA Max
Package Type	Connectorized (C-45) (See page 487 for dimensions.)

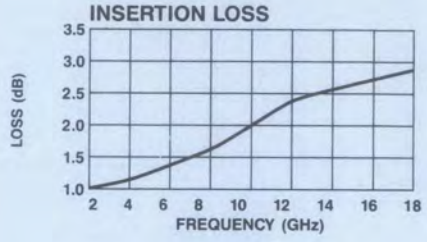
Environmental

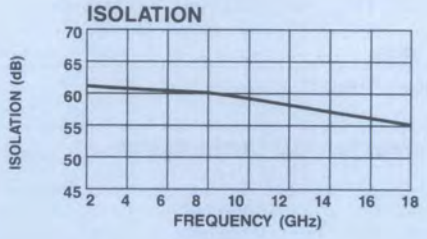
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

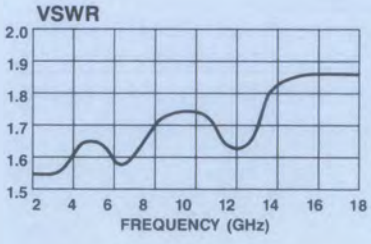
*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.

**See pages 206 and 207 for switching speed definition

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
2503-SK	SMA	$590

Delivery is from stock.

Truth Table

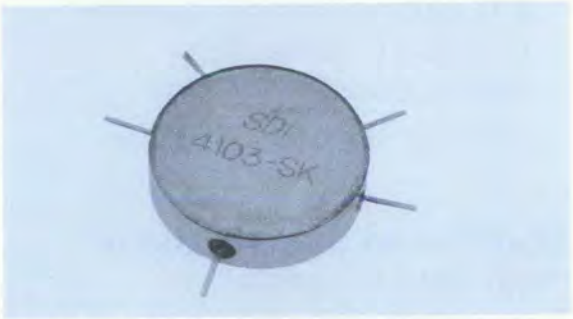
TTL Input	Switch State	
1 = HIGH	RF Common to RF Port	
	RF1	RF2
1	ON	OFF
0	OFF	ON

NEW

MODEL 4103-SK

SP4T REFLECTIVE SWITCH MODULE WITHOUT DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- SDI Driver Compatible
- High Isolation
- Hermetic Package



Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.8 dB Max
	4 - 8 GHz	2.0 dB Max
	8 - 12 GHz	2.7 dB Max
	12 - 18 GHz	3.5 dB Max
VSWR	2 - 4 GHz	1.8:1 Max
	4 - 8 GHz	1.9:1 Max
	8 - 12 GHz	2.0:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

Operating Characteristics

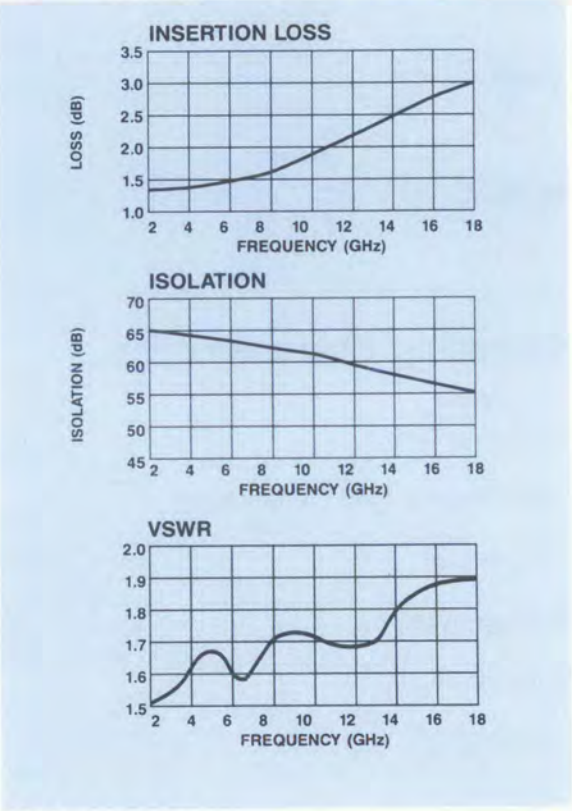
Impedance		50 Ohms Nominal
Switching Time**	t_{on}, t_{off}	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression		
	2 - 18 GHz	+13 dBm Typ
Bias	Insertion Loss	–20 mA
	Isolation	+20 mA
Package Type***		Module (FP-27) (See page 478 for dimensions.)

Environmental

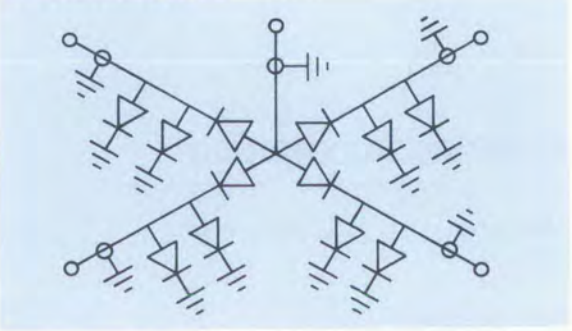
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition.
***Hermetic

Typical Performance



Schematic



Ordering Information

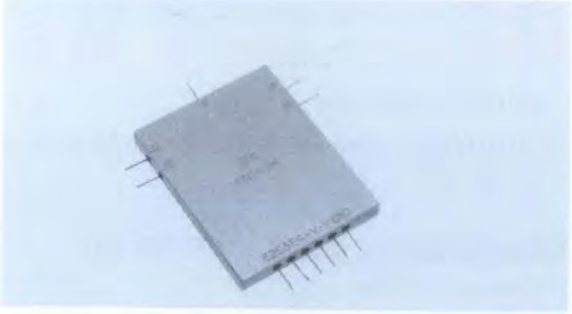
Model No.	Connectors	Unit Price (5-9 Units)
4103-SK	PIN	$430

Delivery is from stock.

NEW

MODEL 4303-SK — SP4T REFLECTIVE SWITCH MODULE WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- Hermetic Package



Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.6 dB Max
	4 - 8 GHz	2.3 dB Max
	8 - 12 GHz	2.8 dB Max
	12 - 18 GHz	3.4 dB Max
VSWR	2 - 4 GHz	1.8:1 Max
	4 - 8 GHz	1.9:1 Max
	8 - 12 GHz	2.0:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

Operating Characteristics

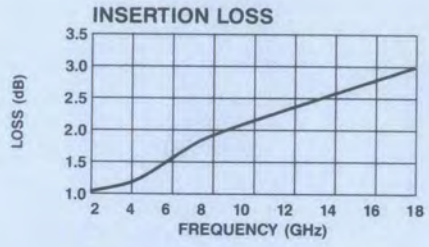
Impedance	50 Ohms Nominal
Switching Time**	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Bias Voltage	+5 Vdc @ 160 mA Max –12 Vdc @ 60 mA Max
Package Type***	Module (FP-30) (See page 479 for dimensions.)

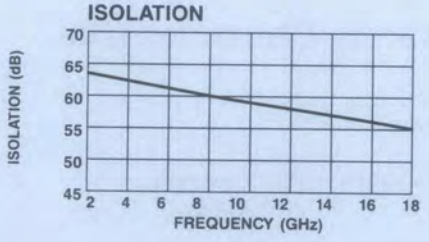
Environmental

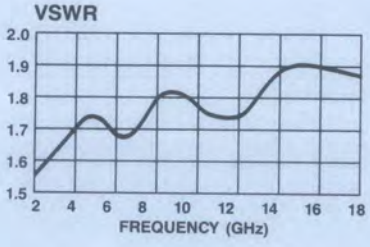
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***Hermetic

Typical Performance







Truth Table[1]

TTL Input 1=HIGH				Switch State RF Common to RF Port			
1	2	3	4	RF1	RF2	RF3	RF4
0	1	1	1	ON	OFF	OFF	OFF
1	0	1	1	OFF	ON	OFF	OFF
1	1	0	1	OFF	OFF	ON	OFF
1	1	1	0	OFF	OFF	OFF	ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
4303-SK	PIN	$695

Delivery is from stock.

NEW

MODEL 4308-SK/4508-SK — SP4T ABSORPTIVE SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- Non-Reflective
- Hermetic and Connectorized Package

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	2.6 dB Max
	4 - 8 GHz	3.4 dB Max
	8 - 12 GHz	4.1 dB Max
	12 - 18 GHz	4.4 dB Max
VSWR	2 - 4 GHz	1.9:1 Max
	4 - 8 GHz	2.0:1 Max
	8 - 12 GHz	2.1:1 Max
	12 - 18 GHz	2.1:1 Max
Isolation	2 - 4 GHz	70 dB Min
	4 - 8 GHz	70 dB Min
	8 - 12 GHz	70 dB Min
	12 - 18 GHz	65 dB Min

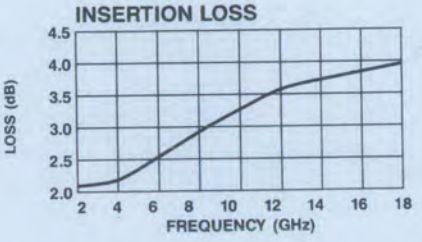
Operating Characteristics

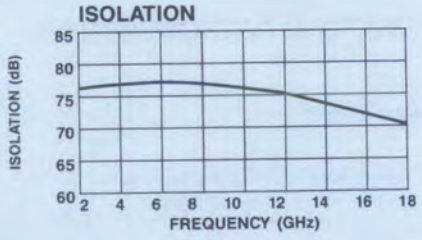
Impedance	50 Ohms Nominal
Switching Time**	500 nsec Max 250 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Bias Voltage	+5 Vdc @ 160 mA Max –12 Vdc @ 60 mA Max
Package Type***	4308-SK Module (FP-30) 4508-SK Connectorized (C-46) (See pages 479 and 488 for dimensions.)

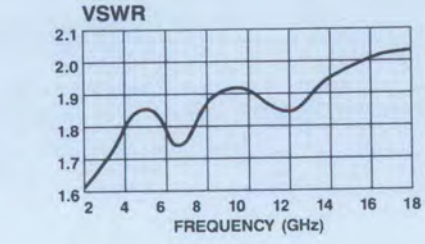
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***(4308-SK) Hermetic

Typical Performance







Truth Table

TTL Input (1 = HIGH)				Switch State (RF Common to RF Port)			
1	2	3	4	RF1	RF2	RF3	RF4
0	1	1	1	ON	OFF	OFF	OFF
1	0	1	1	OFF	ON	OFF	OFF
1	1	0	1	OFF	OFF	ON	OFF
1	1	1	0	OFF	OFF	OFF	ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
4308-SK	PIN	$1090
4508-SK	SMA	$1245

Delivery is from stock.

NEW

MODEL 4503-SK

SP4T REFLECTIVE SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- SMA Connectorized Package

Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.6 dB Max
	4 - 8 GHz	2.3 dB Max
	8 - 12 GHz	2.9 dB Max
	12 - 18 GHz	3.5 dB Max
VSWR	2 - 4 GHz	1.8:1 Max
	4 - 8 GHz	1.9:1 Max
	8 - 12 GHz	2.0:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

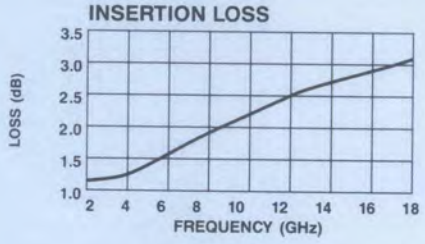
Operating Characteristics

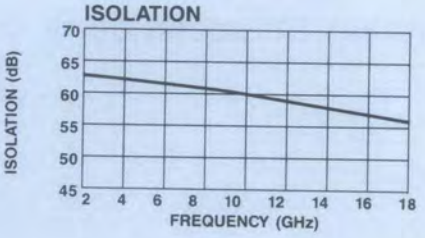
Impedance	50 Ohms Nominal
Switching Time**	100 nsec Max 50 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Control Voltage	+5 Vdc @ 160 mA Max –12 Vdc @ 60 mA Max
Package Type	Connectorized (C-46) (See page 488 for dimensions.)

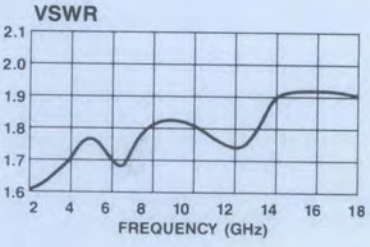
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition

Typical Performance







Truth Table

TTL Input 1 = HIGH				Switch State RF Common to RF Port			
1	2	3	4	RF1	RF2	RF3	RF4
0	1	1	1	ON	OFF	OFF	OFF
1	0	1	1	OFF	ON	OFF	OFF
1	1	0	1	OFF	OFF	ON	OFF
1	1	1	0	OFF	OFF	OFF	ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
4503-SK	SMA	$890

Delivery is from stock

NEW

MODEL 4509-SK

HIGH POWER SP4T SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- 40 Watts Peak Power
- Internal Driver
- Reflective

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	2.5 dB Max
	4 - 8 GHz	2.7 dB Max
	8 - 12 GHz	3.5 dB Max
	12 - 18 GHz	3.7 dB Max
VSWR	2 - 4 GHz	2.0:1 Max
	4 - 8 GHz	2.0:1 Max
	8 - 12 GHz	2.0:1 Max
	12 - 18 GHz	2.0:1 Max
Isolation	2 - 4 GHz	45 dB Min
	4 - 8 GHz	45 dB Min
	8 - 12 GHz	45 dB Min
	12 - 18 GHz	45 dB Min

Operating Characteristics

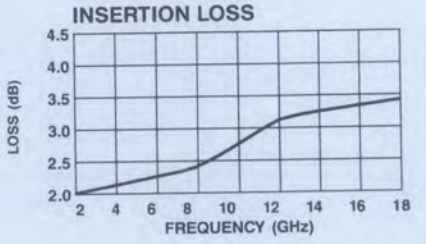
Impedance		50 Ohms Nominal
Switching Time**		2 *u*sec Max 1 *u*sec Typ
Input Power***	2 - 18 GHz	40 Watts Max
Control Voltage		+5 Vdc @ 150 mA –12 Vdc @ 75 mA
Package Type		Connectorized (C-46) (See page 488 for dimensions.)

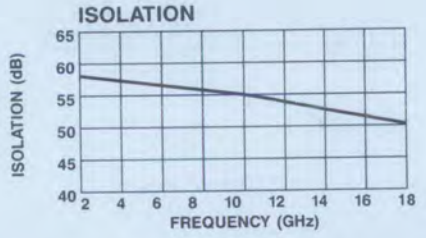
Environmental

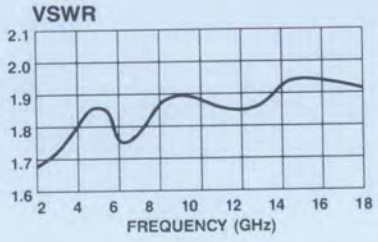
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.
**See pages 206 and 207 for switching speed definition
***50 nsec pulse at 0.1 duty cycle (cold switch)

Typical Performance







Truth Table

TTL Input 1 = HIGH				Switch State RF Common to RF Port			
1	2	3	4	RF1	RF2	RF3	RF4
0	1	1	1	ON	OFF	OFF	OFF
1	0	1	1	OFF	ON	OFF	OFF
1	1	0	1	OFF	OFF	ON	OFF
1	1	1	0	OFF	OFF	OFF	ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
4509-SK	SMA	$1950

Delivery is from stock.

NEW

MODEL 6501-SK

SP6T REFLECTIVE SWITCH WITH TTL DRIVER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Internal TTL Driver
- High Isolation
- SMA Connectorized Package

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.9 dB Max
	4 - 8 GHz	2.7 dB Max
	8 - 12 GHz	3.2 dB Max
	12 - 18 GHz	4.0 dB Max
VSWR	2 - 4 GHz	1.9:1 Max
	4 - 8 GHz	2.0:1 Max
	8 - 12 GHz	2.1:1 Max
	12 - 18 GHz	2.1:1 Max
Isolation	2 - 4 GHz	55 dB Min
	4 - 8 GHz	55 dB Min
	8 - 12 GHz	50 dB Min
	12 - 18 GHz	50 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Time**	500 nsec Max 250 nsec Typ
Input Power for 1dB Compression 2 - 18 GHz	+13 dBm Typ
Bias Voltage	+5 Vdc @ 240 mA Max –12 Vdc @ 80 mA Max
Package Type	Connectorized (C-47) (See page 488 for dimensions.)

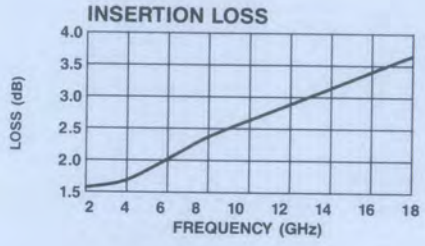
Environmental

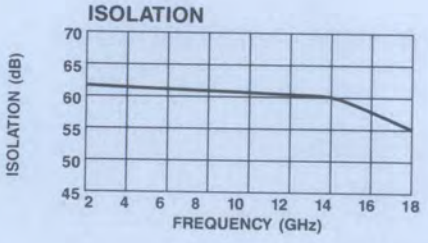
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

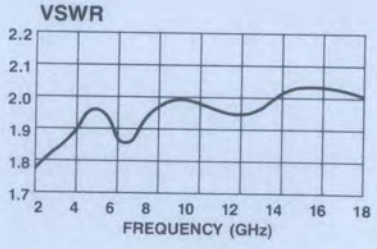
*All specifications apply when operated at the recommended bias and 50 ohm impedance at all RF ports.

**See pages 206 and 207 for switching speed definition.

Typical Performance







Truth Table

TTL Input 1 = HIGH				Switch State RF Common to RF Port			
1	2	X	6	RF1	RF2	RFX	RF6
0	1	.	1	ON	OFF	.	OFF
1	0	.	1	OFF	ON	.	OFF
1	1	.	1	OFF	OFF	.	OFF
1	1	.	0	OFF	OFF	.	ON

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
6501-SK	SMA	$1290

Delivery is from stock.

NEW

MODEL 9008-LF

LOW FREQUENCY LIMITER 0.001 - 2.0 GHz

- Low Frequency Coverage
- Low Insertion Loss
- 5 Watt CW
- Removeable SMA Connectors

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		0.001 - 2.0 GHz
Insertion Loss	0.001 - 0.1 GHz	0.5 dB Max
	0.1 - 0.5 GHz	0.6 dB Max
	0.5 - 1.0 GHz	0.6 dB Max
	1.0 - 2.0 GHz	0.8 dB Max
VSWR	0.001 - 0.1 GHz	1.3:1 Max
	0.1 - 0.5 GHz	1.3:1 Max
	0.5 - 1.0 GHz	1.4:1 Max
	1.0 - 2.0 GHz	1.5:1 Max
Flat Leakage (@ 5 Watt CW Input)	0.001 - 0.1 GHz	50 mW Max
	0.1 - 0.5 GHz	100 mW Max
	0.5 - 1.0 GHz	100 mW Max
	1.0 - 2.0 GHz	100 mW Max

Operating Characteristics

Survival Power 4 Watts CW Min

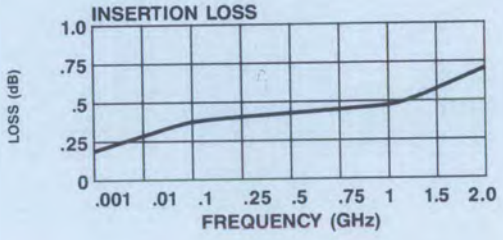
1 dB Compression +7 dBm Min

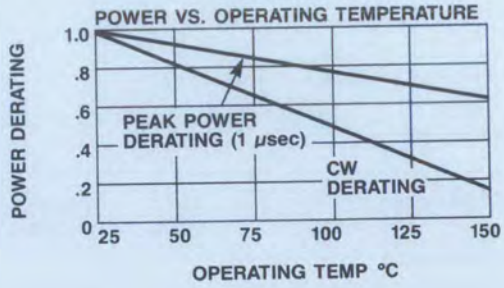
Package Type** Connectorized (C-50) (See page 489 for dimensions.)

Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated with a 50 ohm impedance at all RF ports.
**Hermetic

Typical Performance





Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
9008-LF	SMA	$149

Delivery is from stock.

NEW

MODEL 8001-SK — 200 WATT PEAK POWER LIMITER MODULE 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Low Insertion Loss
- Fast Recovery Time
- Hermetic Package

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	0.9 dB Max
	4 - 8 GHz	1.1 dB Max
	8 - 12 GHz	1.4 dB Max
	12 - 18 GHz	1.7 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Flat Leakage** (@ 100 Watt Input)	2 - 4 GHz	150 mW Max
	4 - 8 GHz	125 mW Max
	8 - 12 GHz	125 mW Max
	12 - 18 GHz	125 mW Max

Operating Characteristics

Recovery Time** (@ 100 W Input to 3 dB Recovery Point)
200 nsec Max
100 nsec Typ

Survival Power (1 *u*sec Pulse @ 0.001 Duty Cycle)
150 Watts Max

Spike Leakage 0.1 ergs Max

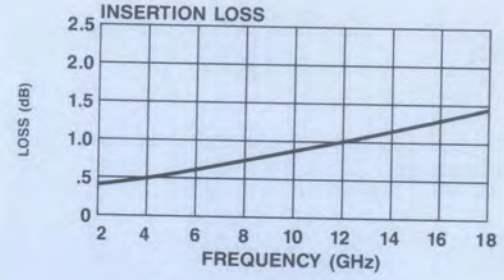
1 dB Compression +7 dBm Min

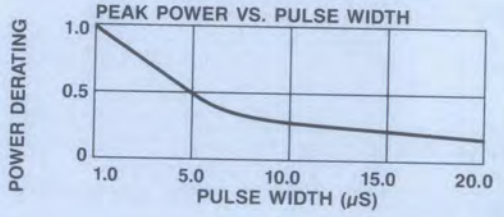
Package Type*** Module (FP-31)
(See page 479 for dimensions.)

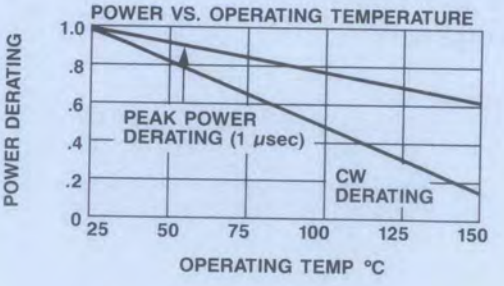
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

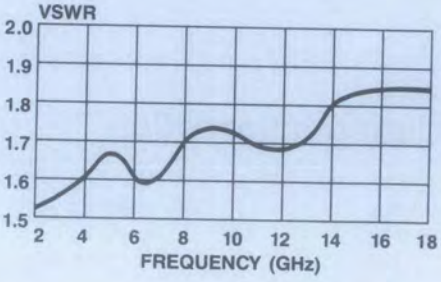
*All specifications apply when operated with a 50 ohm impedance at all RF ports.
**See pages 206 and 207 for recovery time definition
***Hermetic
****External DC Bias Return Required (less than 1 Ohm)

Typical Performance









Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
8001-SK	PIN	$190

Delivery is from stock.

NEW

MODEL 9001-SK

200 WATT PEAK POWER LIMITER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Low Insertion Loss
- Fast Recovery Time
- Removeable SMA Connectors

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.0 dB Max
	4 - 8 GHz	1.4 dB Max
	8 - 12 GHz	1.8 dB Max
	12 - 18 GHz	2.3 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Flat Leakage (@ 100 Watt Input)	2 - 4 GHz	150 mW Max
	4 - 8 GHz	125 mW Max
	8 - 12 GHz	125 mW Max
	12 - 18 GHz	125 mW Max

Operating Characteristics

Recovery Time** (@ 100 W Input to 3 dB Recovery Point)
200 nsec Max
100 nsec Typ

Survival Power (1 *u*sec Pulse @ 0.001 Duty Cycle)
150 Watts Max

Spike Leakage 0.1 ergs Max

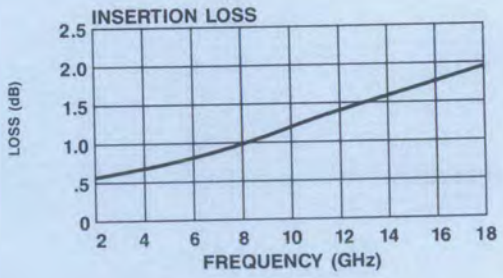
1 dB Compression +7 dBm Min

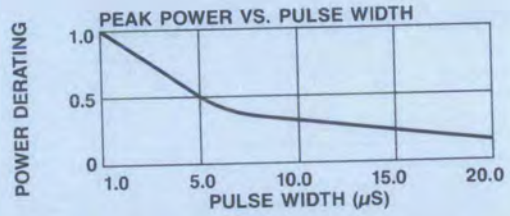
Package Type*** Connectorized (C-50)
(See page 489 for dimensions.)

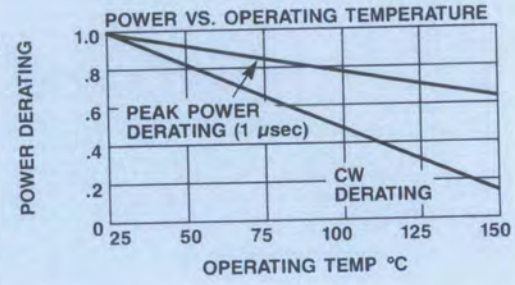
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

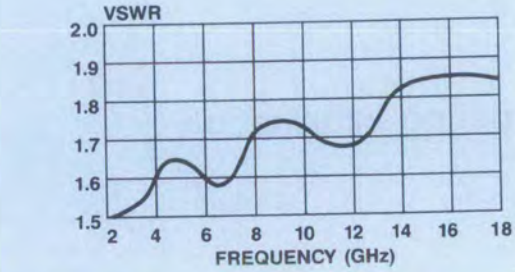
*All specifications apply when operated with a 50 ohm impedance at all RF ports.
**See pages 206 and 207 for recovery time definition
***Hermetic

Typical Performance









Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
9001-SK	SMA	$245

Delivery is from stock.

NEW

MODEL 8003-SK

600 WATT PEAK POWER LIMITER MODULE 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Low Insertion Loss
- Fast Recovery Time
- Hermetic Package

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.2 dB Max
	4 - 8 GHz	1.6 dB Max
	8 - 12 GHz	2.0 dB Max
	12 - 18 GHz	2.6 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Flat Leakage **** (@ 400 Watt Input)	2 - 4 GHz	150 mW Max
	4 - 8 GHz	125 mW Max
	8 - 12 GHz	125 mW Max
	12 - 18 GHz	125 mW Max

Operating Characteristics

Recovery Time** (@ 400 W Input to 3 dB Recovery Point)
400 nsec Max
200 nsec Typ

Survival Power (1 μsec Pulse @ 0.001 Duty Cycle)
500 Watts Max

Spike Leakage 0.1 ergs Max

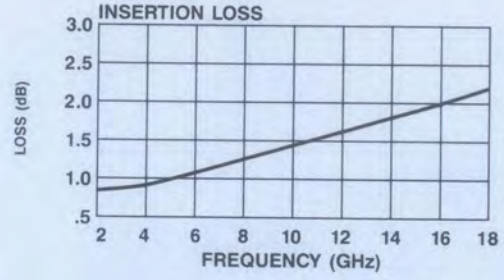
1 dB Compression +7 dB Min

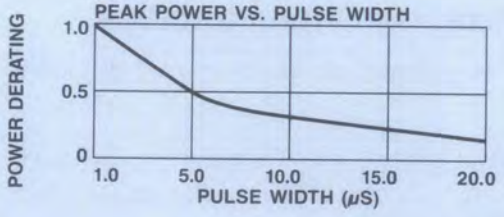
Package Type*** Module (FP-32)
(See page 479 for dimensions.)

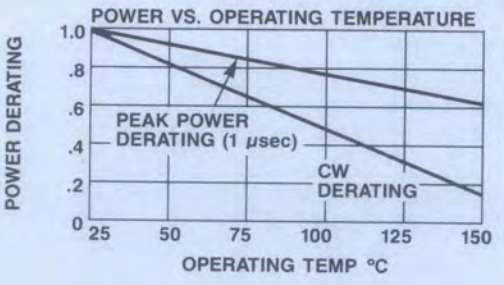
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

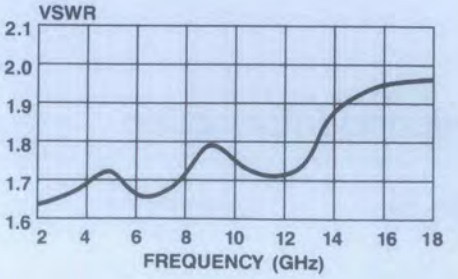
*All specifications apply when operated with a 50 ohm impedance at all RF ports.
**See pages 206 and 207 for recovery time definition
***Hermetic
****External DC Bias Return Required (less than 1 Ohm)

Typical Performance









Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
8003-SK	PIN	$265

Delivery is from stock.

NEW

MODEL 9003-SK

600 WATT PEAK POWER LIMITER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Low Insertion Loss
- Fast Recovery Time
- Removeable SMA Connectors

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	1.3 dB Max
	4 - 8 GHz	1.8 dB Max
	8 - 12 GHz	2.2 dB Max
	12 - 18 GHz	2.7 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Flat Leakage (@ 400 Watt Input)	2 - 4 GHz	150 mW Max
	4 - 8 GHz	125 mW Max
	8 - 12 GHz	125 mW Max
	12 - 18 GHz	125 mW Max

Operating Characteristics

Recovery Time** (@ 400 W Input to 3 dB Recovery Point)
400 nsec Max
200 nsec Typ

Survival Power (1 μsec Pulse @ 0.001 Duty Cycle)
500 Watts Max

Spike Leakage 0.1 ergs Max

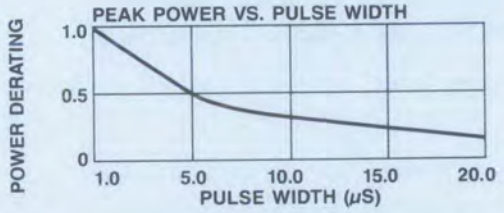
1 dB Compression +7 dBm Min

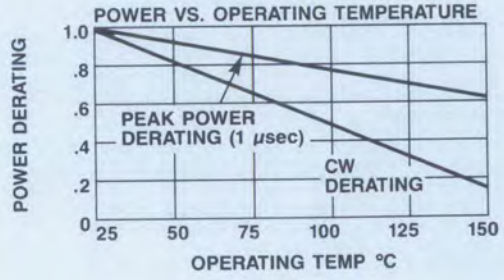
Package Type*** Connectorized (C-50)
(See page 489 for dimensions.)

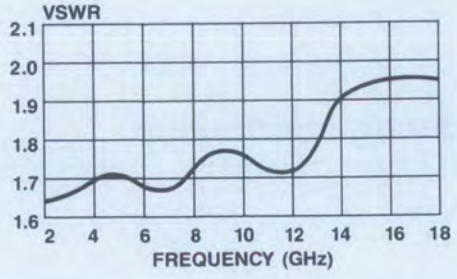
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*All specifications apply when operated with a 50 ohm impedance at all RF ports.
**See pages 206 and 207 for recovery time definition
***Hermetic

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
9003-SK	SMA	$310

Delivery is from stock

NEW

MODEL 8109-SK — 40 WATT CW HIGH POWER LIMITER 2 - 18 GHz

- 2-18 GHz Frequency Coverage
- Low Insertion Loss
- High Average Power
- Removable SMA Connectors

Guaranteed Specifications*

(From –54°C to +85°C)

Frequency Range		2 - 18 GHz
Insertion Loss	2 - 4 GHz	2.0 dB Max
	4 - 8 GHz	2.1 dB Max
	8 - 12 GHz	2.5 dB Max
	12 - 18 GHz	3.1 dB Max
VSWR	2 - 4 GHz	1.7:1 Max
	4 - 8 GHz	1.8:1 Max
	8 - 12 GHz	1.9:1 Max
	12 - 18 GHz	2.0:1 Max
Flat Leakage (@ 400 Watt Input)	2 - 4 GHz	100 mW Max
	4 - 8 GHz	100 mW Max
	8 - 12 GHz	100 mW Max
	12 - 18 GHz	100 mW Max

Operating Characteristics

Recovery Time** (@ 400 W Input to 1 dB Recovery Point)
8 μsec Max
6 μsec Typ

Survival Power (1.5 μsec Pulse @ 0.1 Duty Cycle)
400 Watts CW Max

Spike Leakage 0.5 ergs Max

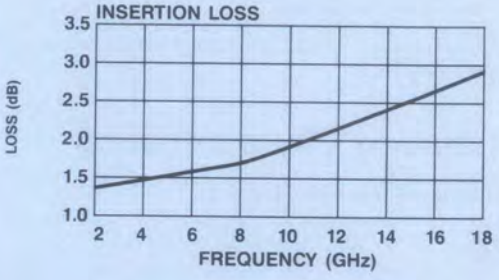
1 dB Compression +7 dBm Min

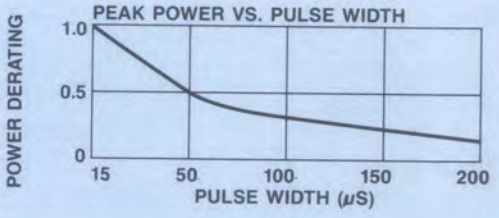
Package Type*** Connectorized (C-51)
(See page 489 for dimensions.)

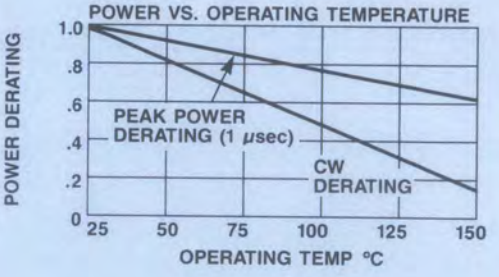
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

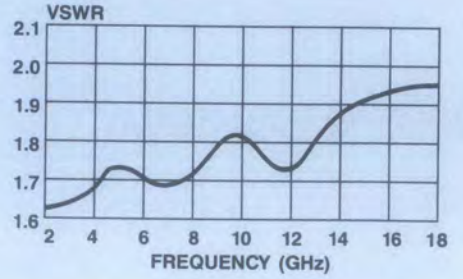
*All specifications apply when operated with a 50 ohm impedance at all RF ports.
**See pages 206 and 207 for recovery time definition.
***Hermetic

Typical Performance









Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
8109-SK	SMA	$890

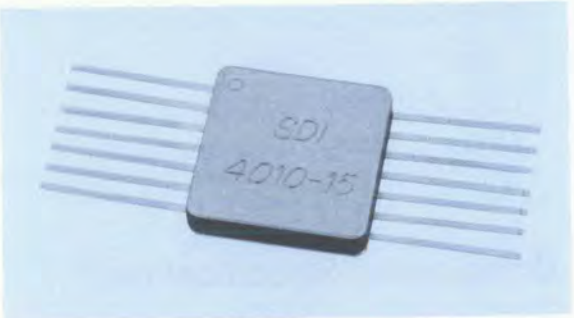
Delivery is from stock.

NEW

MODEL 4010-15M

MICROWAVE PIN DIODE SPST SWITCH DRIVER

- Reverse Voltage Protection
- 30 MHz Repetition Rate
- TTL Control Port Protection
- Test Port Short Circuit Protection



Guaranteed Specifications*

(From –54°C to +85°C)

Output Current	±10 mA Min
Peak Output Current	±200 mA Min
Open Circuit Output Voltage	±3.5 Vdc Min
Internal Current Drain	+18 mA Max – 6 mA Max
Repetition Rate	30 MHz Max

Operating Characteristics

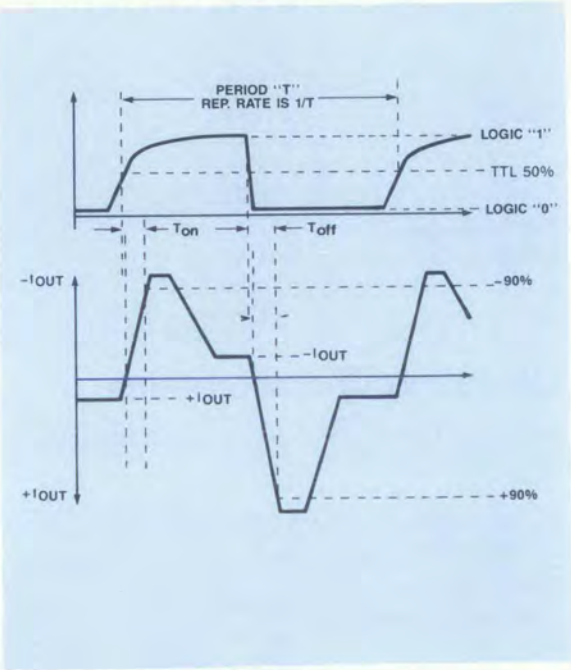
Switching Characteristics**	
T_{on}	8 nsec Max
T_{off}	7 nsec Max
Mode Control	
Logic "1"	Driver Non-Inverting
Logic "0"	Driver Inverting
TTL Control Port	1 Unit Load Max
Operating Voltage	+5 Vdc @18 mA –5 to –15 Vdc @ 6 mA
Package Type***	Module (FP-33) (See page 479 for dimensions.)

Environmental

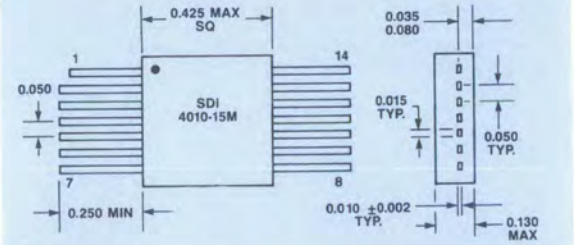
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*Measured at a 1 MHz repetition rate into a 10 Ohm resisitive load.
**Measured at 1 MHz Rep rate into opposite polarity in 4148 diodes.
***Hermetic

Output Waveform



Pin Configuration



PIN IDENTIFICATION
1 –5V TO –15V
2 OUTPUT
3 GROUND
4 N.C.
5 TTL - INPUT
6 MODE CONTROL
7 Vcc (+5V)
8-10 N.C.
11 TEST POINT
12-14 N.C.

NOTES:
1. INDICATES NO SILVER OVERLAY
2. MODE CONTROL "1" DRIVER IS NON-INVERTING
3. MODE CONTROL "0" DRIVER IS INVERTING
4. INDICATES UNSCREENED UNIT

Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
4010-15M	PIN	$89

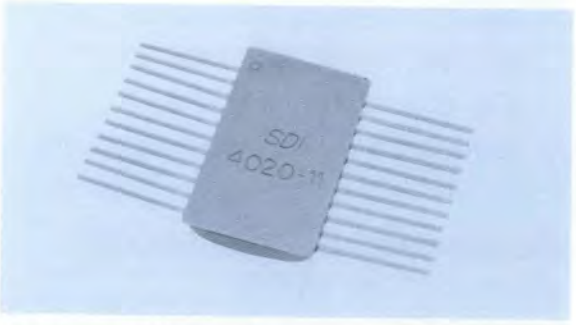
Delivery is from stock.

NEW

MODEL 4020-11M

MICROWAVE PIN DIODE SP2T SWITCH DRIVER

- Reverse Voltage Protection
- 30 MHz Repetition Rate
- TTL Control Port Protection
- Test Port Short Circuit Protection



Guaranteed Specifications*
(From –54°C to +85°C)

Output Current	±10 mA Min
Peak Output Current	±200 mA Min
Open Circuit Output Voltage	±3.5 Vdc Min
Internal Current Drain	+15 mA Max – 8 mA Max
Repetition Rate	30 MHz Max

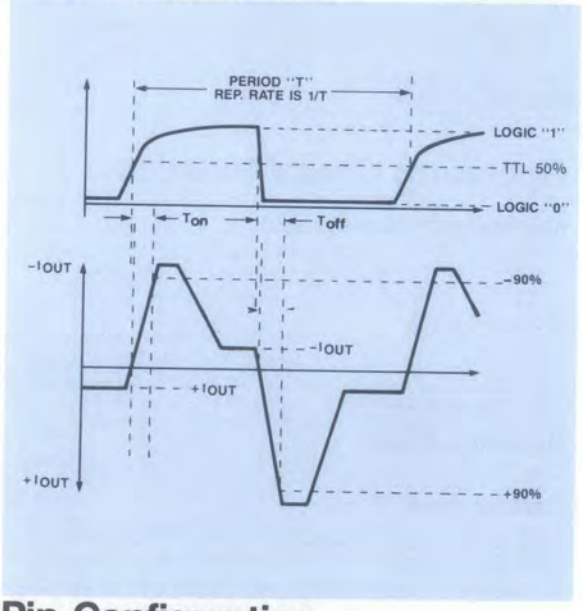
Operating Characteristics

Switching Characteristics**	
T_{on}	8 nsec Max
T_{off}	7 nsec Max
Mode Control	
Logic "1"	Channel Non-Inverting
Logic "0"	Channel Inverting
TTL Control Port	1 Unit Load Max
Operating Voltage	+5 Vdc @ 15 mA –5 to –15 Vdc @ 8 mA
Package Type***	Module (FP-34) (See page 479 for dimensions.)

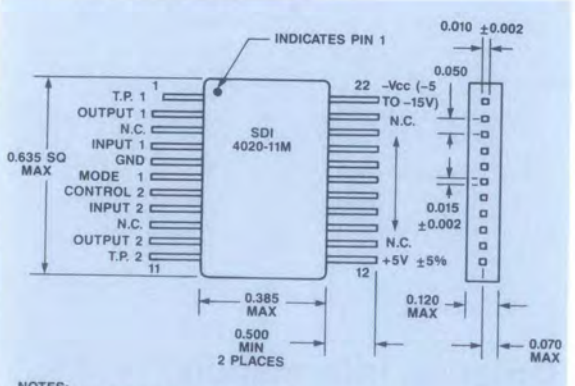
Environmental
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*Measured at a 1 MHz repetition rate into a 10 Ohm resistive load.
**Measured at 1 MHz Rep. Rate into opposite polarity in 4148 diodes.
***Hermetic

Output Waveform



Pin Configuration



NOTES:
1. INPUTS ARE NON INV WHEN MODE CONTROL IS AT LOGIC "1"
2. INPUTS ARE INV. WHEN MODE CONTROL IS AT LOGIC "0"
3. INDICATES NO SILVER OVERLAY
4. "U" INDICATES UNSCREENED UNIT.

Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
4020-11M	PIN	$109

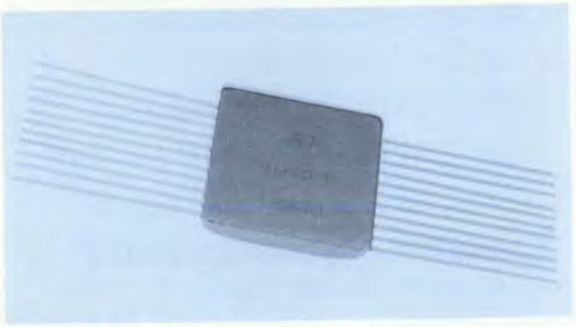
Delivery is from stock.

NEW

MODEL 4040-11M

MICROWAVE PIN DIODE SP4T SWITCH DRIVER

- Reverse Voltage Protection
- 30 MHz Repetition Rate
- TTL Control Port Protection
- Test Port Short Circuit Protection



Guaranteed Specifications*

(From –54°C to +85°C)

Output Current	±10 mA Min
Peak Output Current	±200 mA Min
Open Circuit Output Voltage	±3.5 Vdc Min
Internal Current Drain	+35 mA Max –15 mA Max
Repetition Rate	30 MHz Max

Operating Characteristics

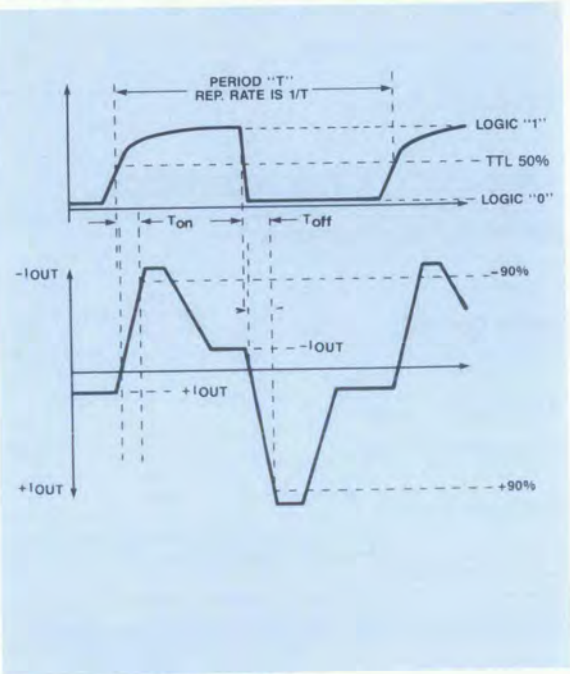
Switching Characteristics**	
T_{on}	8 nsec Max
T_{off}	7 nsec Max
Mode Control	
Logic "1"	Channel Non-Inverting
Logic "0"	Channel Inverting
TTL Control Port	1 Unit Load Max
Operating Voltage	+5 Vdc @ 30 mA –5 to –15 Vdc @ 15 mA
Package Type***	Module (FP-35) (See page 479 for dimensions.)

Environmental

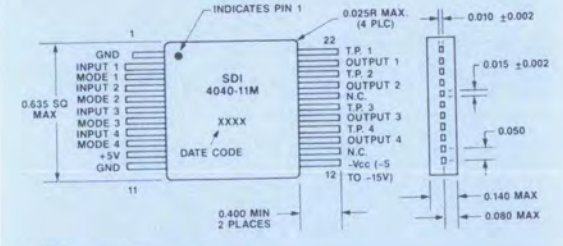
All units are designed to meet the environmental and screening requirements of Table 1B, page 497 of this catalog.

*Measured at a 1 MHz repetition rate into a 10 Ohm resisitive load.
**Measured at 1 MHz Rep. Rate into opposite polarity in 4148 diodes.
***Hermetic

Output Waveform



Pin Configuration

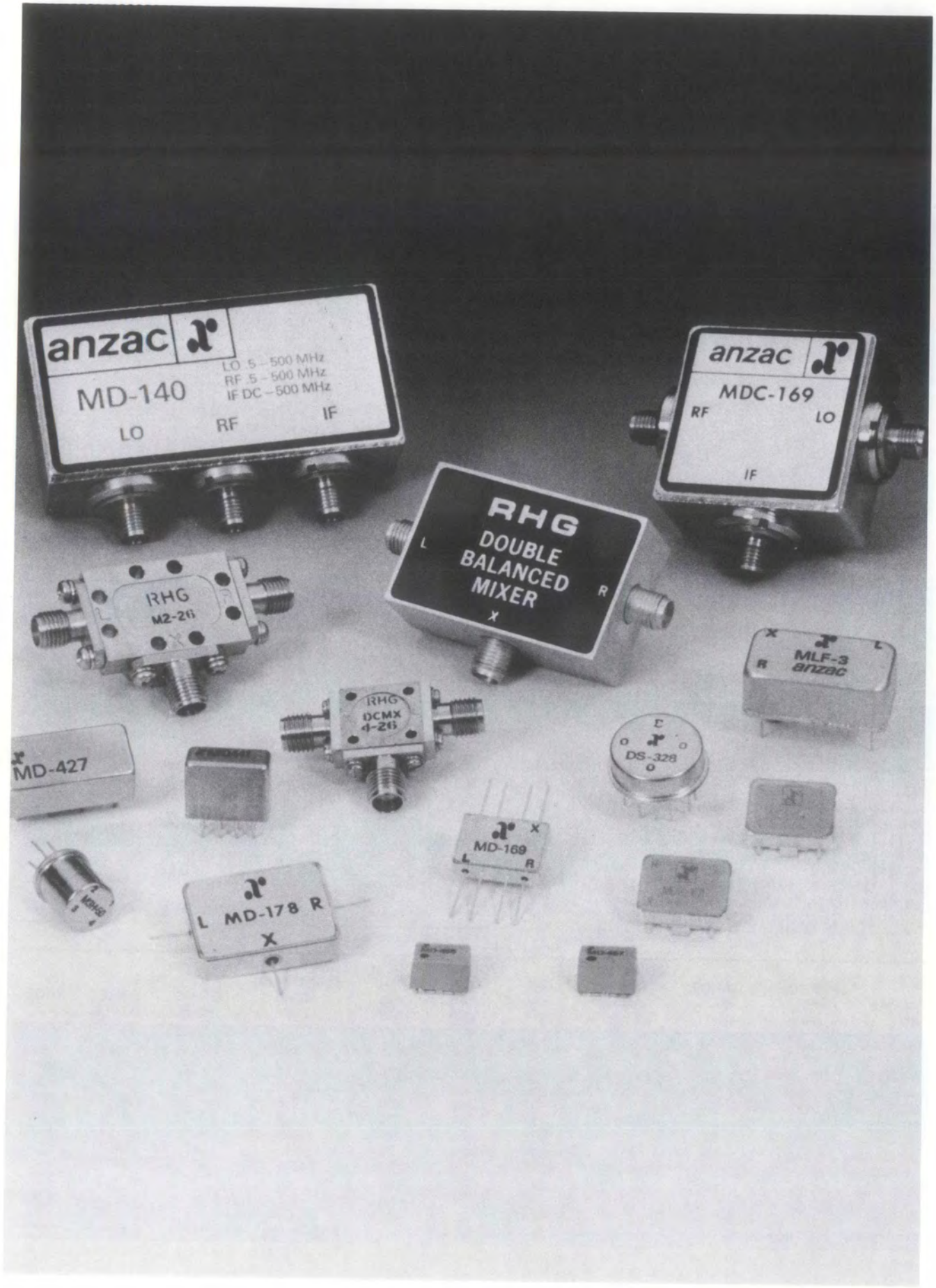


NOTE:
1. INPUTS ARE NON INV WHEN MODE CONTROL IS AT LOGIC "1"
2. INPUTS ARE INV. WHEN MODE CONTROL IS AT LOGIC "0"
3. INDICATES NO SILVER OVERLAY
4. "U" INDICATES UNSCREENED UNIT.

Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
4040-11M	PIN	$179

Delivery is from stock.


anzac
MD-140
LO .5 – 500 MHz
RF .5 – 500 MHz
IF DC – 500 MHz
LO
RF
IF
anzac
MDC-169
RF
LO
IF
RHG
DOUBLE
BALANCED
MIXER
L
R
X
RHG
M2-26
RHG
DCMX
4-26
MD-427
MLF-3
anzac
DS-328
MD-169
L MD-178 R
X

RF MIXER SELECTION GUIDE

STANDARD RF MIXERS

MODEL NO.	FREQUENCY RANGE RF/LO (MHz)	IF (MHz)	CONVERSION LOSS (dB) TYP	ISOLATION LO-RF (dB) TYP	LO-IF (dB) TYP	RF-IF (dB) TYP	COMPRESSION POINT - 1dB (dBm) TYP	LO DRIVE (dBm)	CASE[1] STYLE	PAGE NO.
RF MIXERS										
MLLF-3	0.02-65	DC-65	5.0	55	50	45	+4.5	+7	RH-2	249
MAC-50	0.2-200	DC-200	5.0	48	40	30	+1	+7	TO-5-2	246
MD-109	0.2-200	DC-200	4.5	55	45	30	+2	+7	RH-3	253
MLF-3	0.2-200	DC-200	5.5	60	40	35	+4.5	+7	RH-2	248
MD-100	1-400	DC-400	6.0	35	34	30	+7	+13	RH-3	250
MD-101	0.5-350	DC-350	6.0	40	35	28	+5	+10	RH-3	251
MD-124	0.5-500	DC-500	5.6	38	35	22	+2	+7	FP-2	257
MD-140	0.5-500	DC-500	5.6	38	35	22	+2	+7	C-9	257
MD-125	0.5-500	DC-500	6.0	45	38	32	+11	+13	FP-2	258
MD-138	1-500	DC-500	5.8	40	50	32	+19	+23	RH-3	259
MD-139	1-500	DC-500	6.0	45	33	33	+20	+10	FP-3	260
MAC-51	5-500	DC-500	5.7	36	35	32	+2	+7	TO-5-2	246
MD-108	5-500	DC-500	5.6	45	40	25	+2.5	+7	RH-3	252
MD-143	5-500	DC-500	5.6	45	40	25	+2.5	+7	C-9	252
MD-146	5-500	DC-500	5.6	45	40	25	+2.5	+7	RH-3	252
MHF-3	5-500	DC-500	6.4	45	38	35	+4.5	+7	RH-2	247
MD-151	5-500	DC-500	8.2	40	38	25	+13	+17	RH-3	267
MD-155	5-500	3-200	6.7	32	53	48	+23	+27	FP-5	269
MD-113	5-1000	DC-1000	6.6	37	32	28	0	+7	FP-2	255
MD-141	5-1000	DC-1000	6.6	37	32	28	0	+7	C-9	255
MD-159	5-1000	DC-1000	6.0	42	35	30	+1.5	+7	FP-2	274
MD-110	10-1000	DC-1000	7.0	40	27	20	0	+7	RH-3	254
MD-173	5-1200	1-1000	6.0	21	27	32	+8	+17	RH-3	283
MD-158	5-1500	DC-1000	6.2	35	25	25	+1	+7	FP-2	272
MD-149	10-1500	DC-1500	6.0	40	40	30	0	+7	FP-2	264
MDC-149	10-1500	DC-1500	6.0	40	40	30	0	+7	C-7	264
MD-152	10-1500	DC-1500	6.0	40	40	30	0	+7	TO-8-2	264
MD-148	10-1500	DC-1500	6.0	35	30	28	+5	+10	FP-2	262
MD-150	700-2000	DC-300	6.2	35	20	24	0	+7	C-9	266
MD-153	700-2000	DC-300	6.2	35	20	24	0	+7	TO-8-2	266
MD-614	700-2000	DC-300	6.2	35	20	24	0	+7	FP-2	266
MD-123	10-3000	10-3000	7.4	35	32	28	+7	+10	FP-2	256
MDC-123	10-3000	10-3000	7.4	35	32	28	+7	+10	C-7	256
MD-525-4	5-4000	5-1900	6.5	35	42	38	+6	+10	C-9	295
MD-156	600-3000	DC-1000	6.0	32	22	24	0	+7	FP-2	270
MD-157	800-4000	DC-1500	5.8	32	23	28	0	+7	FP-2	271
MD-179	1-4000	5-1500	6.5	40	40	35	+5	+7	FP-2	287
MDC-179	1-4000	5-1500	6.5	40	40	35	+5	+7	C-7	287
MD-176	2000-4000	DC-300	4.5	25	29	27	+2.5	+7	FP-10	285
MDC-176	2000-4000	DC-300	4.5	25	29	27	+2.5	+7	C-3	285
MD-185	3700-4200	DC-1300	5.0	30	28	23	+2	+7	FP-10	288
MDC-185	3700-4200	DC-1300	5.0	30	28	23	+2	+7	C-3	288
MD-154	300-5000	0.1-3000	6.0	27	28	28	+7	+10	FP-3	268
MDC-154	300-5000	0.1-3000	6.0	27	28	28	+7	+10	C-9	268
MD-178	2600-5200	DC-300	4.5	27	26	35	+2.5	+7	FP-10	286
MDC-178	2600-5200	DC-500	4.5	29	26	35	+2.5	+7	C-3	286

SURFACE MOUNT MIXERS

MODEL NO.	FREQUENCY RANGE RF/LO (MHz)	IF (MHz)	CONVERSION LOSS (dB) TYP	ISOLATION LO-RF (dB) TYP	LO-IF (dB) TYP	RF-IF (dB) TYP	COMPRESSION POINT - 1dB (dBm) TYP	LO DRIVE (dBm)	CASE[1] STYLE	PAGE NO.
MDS-222	**0.2-200**	**DC-200**	**4.8**	**55**	**45**	**30**	**+2**	**+7**	**SF-1**	292
MDS-220	**1-400**	**DC-400**	**6.0**	**35**	**34**	**30**	**+7**	**+13**	**SF-1**	290
MDS-221	**0.5-350**	**DC-350**	**6.0**	**40**	**35**	**28**	**+5**	**+10**	**SF-1**	291
MD-455	1-500	DC-500	7.0	50	45	40	+1	+7	SF-3	319
MDS-223	**5-500**	**DC-500**	**5.6**	**45**	**40**	**30**	**+2.5**	**+7**	**SF-1**	293
MDS-159	**5-1000**	**DC-1000**	**6.0**	**42**	**35**	**30**	**+1.5**	**+7**	**SF-1**	275
MD-456	5-1000	DC-1000	7.0	40	35	30	+2	+7	SF-3	320
MDS-158	**5-1500**	**DC-1000**	**6.0**	**35**	**25**	**25**	**+1**	**+7**	**SF-1**	273
MDS-147	**10-1500**	**DC-1500**	**6.0**	**40**	**35**	**30**	**+10**	**+17**	**SF-1**	261
MDS-148	**10-1500**	**DC-1500**	**6.0**	**35**	**30**	**28**	**+5**	**+10**	**SF-1**	263
MDS-149	**10-1500**	**DC-1500**	**6.0**	**40**	**40**	**30**	**0**	**+7**	**SF-1**	265
MDS-217	**600-2000**	**DC-1000**	**6.0**	**35**	**30**	**N/A**	**0**	**+7**	**SF-1**	289
MDS-614	**700-2000**	**DC-300**	**6.0**	**35**	**20**	**24**	**0**	**+7**	**SF-1**	294

[1]CASE STYLE: SF = SURFACE MOUNT; C = CONNECTORIZED; TO = TO-5 OR TO-8 PLUG-IN
RF = RELAY HEADER; FP = FLATPACK

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

BOLD = NEW PRODUCT

RF MIXER SELECTION GUIDE (continued)

TERMINATION INSENSITIVE MIXERS

MODEL NO.	FREQUENCY RANGE RF/LO (MHz)	FREQUENCY RANGE IF (MHz)	CONVERSION LOSS (dB) TYP	ISOLATION LO-RF (dB) TYP	ISOLATION LO-IF (dB) TYP	ISOLATION RF-IF (dB) TYP	COMPRESSION POINT - 1dB (dBm) TYP	LO DRIVE (dBm)	CASE[1] STYLE	PAGE NO.
MD-161	1-500	DC-500	5.7	35	44	35	+10	+13	FP-2	277
MDC-161	1-500	DC-500	5.7	35	44	35	+10	+13	C-7	277
MD-160	1-1500	1-1000	6.5	28	28	25	+15	+13	RH-3	276
MD-174	1-2800	1-2000	6.5	32	38	30	+16	+20	FP-3	284
MDC-174	1-2800	1-2000	6.5	32	38	30	+16	+20	C-9	284
MD-169	1-3500	5-1500	6.5	30	30	35	+7	+10	FP-2	282
MDC-169	1-3500	5-1500	6.5	30	30	35	+7	+10	C-7	282
MD-179	**1-4000**	**5-1500**	**6.5**	**40**	**40**	**35**	**+5**	**+7**	**FP-2**	287
MDC-179	**1-4000**	**5-1500**	**6.5**	**40**	**40**	**35**	**+5**	**+7**	**C-7**	287
MD-163	1000-6000	10-2000	7.0	20	25	22	-2	0	FP-19	279
MDC-163	1000-6000	10-2000	7.0	20	25	22	-2	0	C-2	279
MD-162	1000-7000	10-2000	6.0	25	20	22	+8	+13	FP-18	278
MDC-162	1000-7000	10-2000	6.0	25	20	22	+8	+13	C-2	278
MD-165	500-8000	2-2000	9.0	25	24	24	-2	0	FP-11	281
MDC-165	500-8000	2-2000	9.0	25	24	24	-2	0	C-3	281
MD-164	500-9000	10-2000	6.5	22	27	25	+8	+13	FP-10	280
MDC-164	500-9000	10-2000	6.5	22	27	25	+8	+13	C-3	280

LOW COST "SERIES 400" MIXERS

MODEL NO.	FREQUENCY RANGE RF/LO (MHz)	FREQUENCY RANGE IF (MHz)	CONVERSION LOSS (dB) TYP	ISOLATION LO-RF (dB) TYP	ISOLATION LO-IF (dB) TYP	ISOLATION RF-IF (dB) TYP	COMPRESSION POINT - 1dB (dBm) TYP	LO DRIVE (dBm)	CASE[1] STYLE	PAGE NO.
MD-405	**0.1-250**	**DC-250**	**5.0**	**48**	**45**	**25**	**+13**	**+17**	**RH-6**	301
MD-401	**0.2-400**	**DC-400**	**6.0**	**50**	**45**	**30**	**0**	**+7**	**RH-6**	297
MD-428	**1-400**	**DC-400**	**5.5**	**55**	**45**	**35**	**-1**	**+7**	**RH-1**	314
MD-410	**0.5-500**	**DC-500**	**5.0**	**50**	**40**	**30**	**-2**	**+7**	**RH-1**	304
MD-413	**0.5-500**	**DC-500**	**6.0**	**50**	**45**	**35**	**+9**	**+17**	**RH-1**	307
MD-411	**0.6-500**	**DC-500**	**5.0**	**50**	**35**	**30**	**-2**	**+7**	**RH-1**	305
MD-426	**1-500**	**DC-500**	**5.5**	**50**	**40**	**35**	**0**	**+7**	**RH-5**	312
MD-455	**1-500**	**DC-500**	**7.0**	**50**	**45**	**40**	**+1**	**+7**	**SF-3**	319
MD-403	**2-500**	**DC-500**	**6.5**	**50**	**45**	**30**	**+13**	**+17**	**RH-6**	299
MD-441	**2.5-500**	**DC-500**	**6.0**	**60**	**45**	**30**	**+1**	**+7**	**RH-9**	317
MD-450	**5-500**	**DC-500**	**6.5**	**45**	**45**	**35**	**+17**	**+23**	**RH-1**	318
MD-435	**0.5-600**	**DC-600**	**5.5**	**55**	**45**	**40**	**+2**	**+7**	**RH-8**	315
MD-440	**1-1000**	**DC-1000**	**5.5**	**45**	**40**	**35**	**-1**	**+7**	**RH-9**	316
MD-400	**1-1000**	**DC-1000**	**6.5**	**50**	**45**	**25**	**+2**	**+7**	**RH-6**	296
MD-412	**1-1000**	**0.5-500**	**5.0**	**40**	**30**	**25**	**-1**	**+7**	**RH-1**	306
MD-414	**2-1000**	**DC-1000**	**6.5**	**45**	**35**	**35**	**+9**	**+17**	**RH-1**	308
MD-404	**5-1000**	**DC-1000**	**6.5**	**48**	**45**	**25**	**+14**	**+17**	**RH-6**	300
MD-456	**5-1000**	**DC-1000**	**7.0**	**40**	**35**	**30**	**+2**	**+7**	**SF-3**	320
MD-427	**10-1000**	**5-500**	**5.5**	**50**	**40**	**35**	**+1**	**+7**	**RH-5**	313
MD-406	**5-1200**	**DC-1200**	**7.5**	**45**	**40**	**25**	**+13**	**+17**	**RH-7**	302
MD-402	**5-1250**	**DC-1250**	**6.5**	**45**	**40**	**30**	**+2**	**+7**	**RH-6**	298
MD-415	**2-2000**	**0.5-500**	**7.0**	**45**	**35**	**30**	**+5**	**+10**	**RH-1**	309
MD-425	**5-2000**	**10-600**	**8.0**	**45**	**35**	**30**	**+2**	**+7**	**RH-5**	311
MD-407	**10-3000**	**10-800**	**7.5**	**40**	**25**	**25**	**+5**	**+10**	**RH-7**	303
MD-416	**10-3000**	**10-1000**	**7.5**	**35**	**25**	**20**	**+10**	**+17**	**RH-1**	310

MODULATORS

MODEL NO.	FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP	VSWR TYP	AMP BALANCE (dB) TYP	PHASE DEVIATION (Deg) TYP	DRIVE TYPE	CASE[1] STYLE/ OUTLINE DRAWING	PAGE NO.
PM-101	10-750	2.5	1.1:1	0.1	0.5	DC	TO-8-2	321
PM-102	10-750	2.5	1.1:1	0.1	0.5	ECL	TO-8-2	321
PM-103	**10-750**	**2.5**	**1.1:1**	**0.1**	**0.5**	**TTL**	**TO-8-2**	321
PM-104	2000-3000	3.5	1.5:1:1	0.1	1.0	DC	FP-2	322
PM-105	20-40	5.0	1.3:1	0.15	2.0	DC	FP-6	323
PM-106	20-40	5.0	1.3:1	0.15	2.0	ECL	FP-6	323
PM-108	50-100	5.2	1.2:1	0.25	2.0	DC	FP-6	324
PM-109	50-100	5.2	1.2:1	0.25	2.0	ECL	FP-6	324
PM-110	50-100	5.2	1.2:1	0.25	2.0	TTL	FP-6	324

PHASE DETECTORS

MODEL NO.	FREQUENCY RANGE RF/LO (MHz)	IMPEDANCE L & R (Ohms)	IMPEDANCE X (Ohms)	SIGNAL DRIVE LEVELS (dBm)	ISOLATION L - R (dB)	DC OUTPUT (mV)	DC OFFSET (mV)	DC OUTPUT POLARITY	CASE[1] STYLE	PAGE NO.
PD-120	5-1000	50	500	+7	30	250	1.0	Negative	FP-2	325
PD-121	3-200	50	500	+7	35	900	1.0	Positive	FP-2	326

[1]CASE STYLE: SF = SURFACE MOUNT; C = CONNECTORIZED; TO = TO-5 OR TO-8 PLUG-IN
RF = RELAY HEADER; FP = FLATPACK

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

BOLD = NEW PRODUCT

DOUBLE BALANCED MIXERS

INTRODUCTION

Specifying a double-balanced mixer to provide cost effective system performance can only be accomplished by carefully considering and understanding how mixers behave in practical system environments. This note is intended to provide a basic understanding of trade-offs and various design approaches.

MIXER OPERATION

Diode-type double-balanced mixers belong to the general classification of "Resistive Switching" mixers wherein an LO input signal is applied that is sufficiently large to cause strong conduction of the alternate diode pairs (Figure 1) thereby changing them from a low to a high resistance state during each half of the LO cycle. A virtual ground is, therefore, switched or commutated between the RF/IF transformer windings at a rate corresponding to the LO frequency. Since this switching causes a 180° phase reversal of the RF to IF port transmission during each half of the LO cycle, the mixing process is called bi-phase modulation.

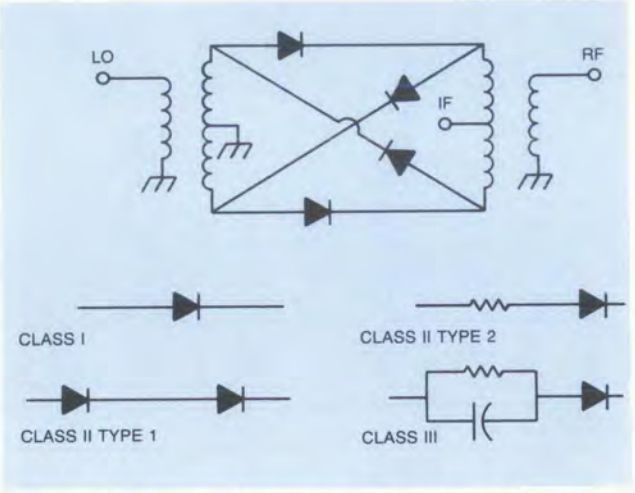


Figure 1. Standard Double Balanced Mixer Schematic

For low frequency operation, these devices typically use ferrite core flux coupled transformers which exhibit leakage inductance and stray capacitance limiting upper frequency operation to approximately 4 GHz. For higher frequency operation, true transmission line realizations of the transformer functions (Figure 2) will allow 4 diode mixer operation to beyond 18 GHz. The low frequency performance is determined by the high pass nature of the RF and LO transmission line structure.

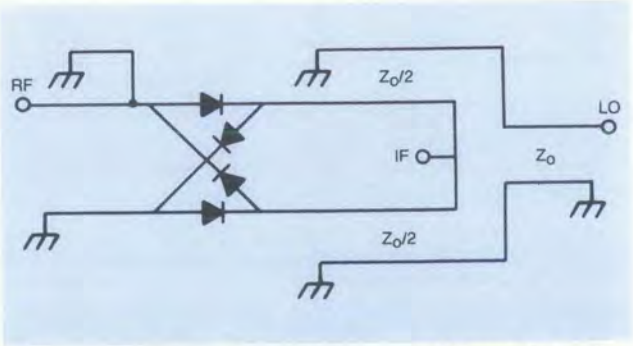


Figure 2. Typical 4 Diode Microwave Mixer Schematic

Overlapping RF-IF or LO-IF frequency coverage is very difficult to attain because the IF output encounters both the RF and LO structures in series for the IF signal path. To produce an overlapping IF frequency range, a more complex 8 diode mixer (Figure 3) was developed. Examination of this structure reveals that this time, the LO is switching 2 diode pairs at a time which are in series with the RF-IF signal path. By tracing out the RF to IF signal connections for each half of the LO input cycle, we see that bi-phase modulation is again being performed. The IF port can be seen to be an RF and LO null. The principle advantage of this design is its large RF-IF frequency range overlap, but with twice as many diodes it requires 3 dB more LO drive.

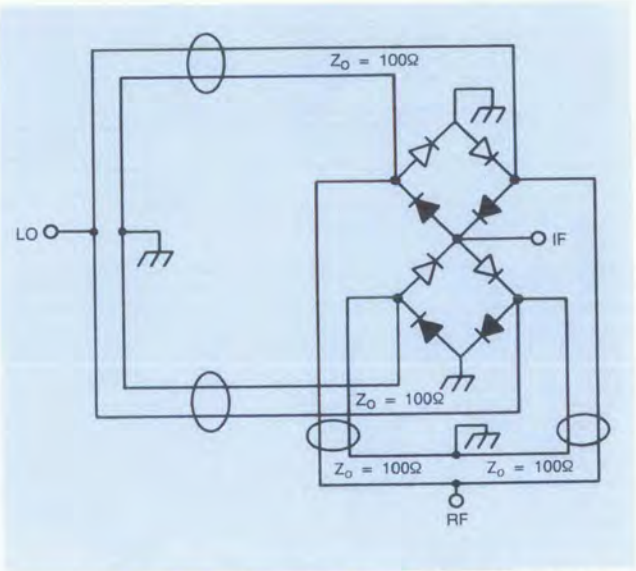


Figure 3. Typical 8 Diode Microwave Mixer Schematic

MIXER CLASSES

These basic mixer types can be further sub-divided into categories by the nature of their mixing elements. (Figure 1).

Class I

The most common design consists of a pair (or more) of the ferrite-core wideband transformers with four diodes connected in a "ring" configuration. Nominally, these components require about +7 dBm LO (Local Oscillator) drive power.

Class II, Type 1

This type also uses the ring topology with two series-connected diodes in each arm. The eight diodes may be similar or different. LO drive levels typically range from +13 to +17 dBm.

Class II, Type 2

These rely on a ring configuration, but feature a precision resistor in series with a single diode in each arm. These four-diode designs are typically driven at +17 dBm.

Class III

These are essentially Class II, type 2 circuits with a large capacitor connected in parallel with the precision series resistor; and they are driven by an LO signal in the +20 to +30 dBm range.

Class IV – Termination Insensitive Mixers

This mixer circuit, called TIM, consists of a transmission line hybrid network driving two sets of diodes (Figure 4). Isolation between each hybrid's opposite ports allows the LO to independently control the switching action of alternately conducting diode sets. The reverse bias applied to the "off" diodes is determined only by available LO input power and not by the diode's forward potential as in the conventional "ring" type mixers. An internal resistor absorbs mixer generated, even-order LO frequency terms, and improves LO VSWR by terminating the hybrid port opposite its LO input. These circuit features improve performance by closely approximating a "square wave" LO drive.

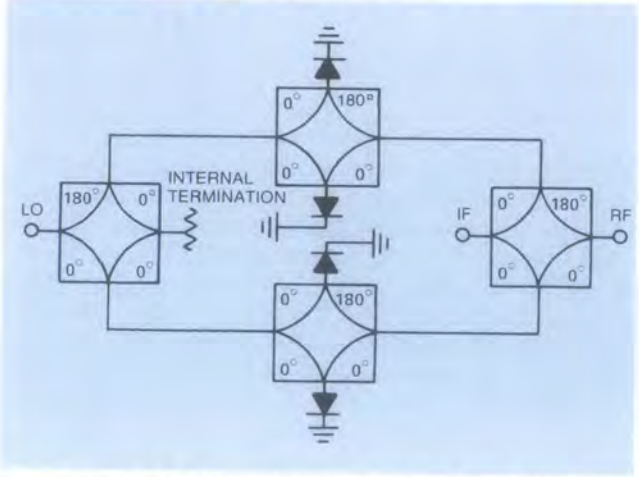


Figure 4. Termination Insensitive Mixer (TIM) Schematic, Class IV

In Classes I-III, the inclusion of additional series or parallel combinations of diodes does not alter the classification of a given mixer. Such modifications may allow the component to accept a higher LO drive level to reduce intermodulation distortion. These additional complexities offer little advantage and usually reduce the upper frequency of operation. The Class IV, TIM Mixer, is also available in a "high level" +20 to +30 dBm LO drive model (MD-174) that offers further advantages over the Class II and III types. Microwave TIM's have similar advantages with standard +13 dBm and biasable 0 dBm models offered in both connectorized and "drop-in" versions.

A more detailed discussion which compares various aspects of mixer performance by mixer type is found in Reference 1 or in a brochure entitled "Meet Tim", available from the Anzac Sales Department.

FREQUENCY CONVERTERS – GENERAL CONSIDERATIONS

Double-balanced mixers are most commonly used to convert an input RF signal frequency to another frequency called the intermediate (IF) frequency. The RF signal and a higher level local oscillator (LO) signal interact to produce the sum and dif-

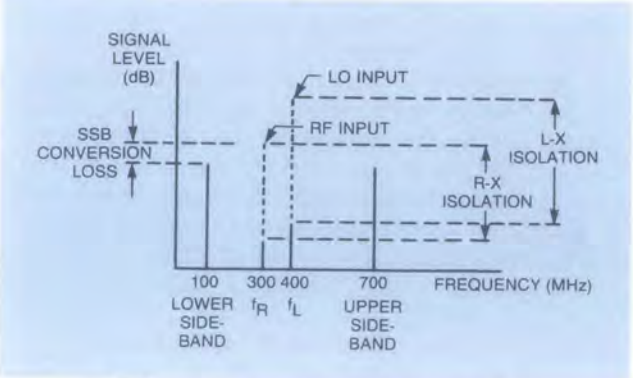


Figure 5. Typical Output Spectrum of Double Balanced Mixer

ference frequencies at the output, as shown in Figure 5. When the mixer is being used as an up-converter, the LO + RF frequency output (upper sideband) is the frequency of interest. A down-converter uses the LO-RF signal (lower sideband). Generally, the two sidebands are of equal amplitude, the amplitude being a function of the sideband frequencies and the frequency response of the output port.

Anzac's line of double-balanced mixers have interchangeable ports. For example, the input signal may be inserted at the IF port (commonly called the X port) and the output taken at the RF port as is generally done in up-converter applications. The high level LO signal may be fed into any port, but it is generally fed into the LO port because of the higher isolation between this port and the remaining two ports.

SPURIOUS SIGNAL GENERATION

The output spectrum of practical double balanced mixers unfortunately contains many frequency terms other than $F_{LO} \pm F_{RF}$. Some are produced by "Irrevocable Laws of Mother Nature", some by mixer design, and others may be caused by reflective terminations at one or more of the mixer's ports when interfaced with other system components.

Ideal mixers would generate only the desired IF output of $F_{LO} \pm F_{RF}$. Practical diode mixers, however, internally generate harmonics of their LO and RF input signals which mix and cause the harmonic modulation products $NF_{RF} \pm MF_{LO}$ in their output frequency spectrum.

Double-balanced mixers have a reasonable (20 to 30 dB) suppression of internally generated, even-order harmonic modulation products compared to a single diode mixer. An $NF_{RF} \pm MF_{LO}$ mixing product will be suppressed if it is caused by an even order RF harmonic, an even order LO harmonic, and, obviously, even orders of both (if these products are being generated within the mixer). This cancellation is obtained by the symmetry of matched diodes coupled with phase and amplitude balanced transformers but depends on frequency. The frequency dependence of "even order" suppression implies that only products caused by odd orders of RF and LO harmonics will be predictably suppressed by most high level mixer designs – a fact confirmed by subsequent measurements. ("Odd order" suppression depends only on LO and RF power.)

Most mixer manufacturers show N x M product data using fixed RF and LO frequencies of about 50 MHz for a very good reason. As frequency increases, even-order harmonic suppression degrades drastically because conventional mixers use flux-coupled transformers. The balance of these devices becomes 10 to 20 dB worse at higher frequencies due to their unavoidable leakage inductance and parasitic capacitances. Since single frequency specifications can be misleading, swept techniques were utilized to measure the various mixer classes over a more practical range of 300 to 500 MHz.

Four classes of mixers were tested with LO drive level appropriate to the type of mixer as listed below:

Type	LO Drive Level
Class I	+10 dBm
Class II, Type I	+17 dBm
Class II, Type II	+17 dBm
Class IV, TIM	+10 dBm

Some spurious products such as 3 RF x 2 LO can be reduced by increasing LO drive levels; thus a comparison of test results of the four classes of mixers will show variation with frequency but not necessarily absolute levels achievable with the circuit. For example, a high level TIM mixer circuit operating at +17 dBm LO drive would show nearly a 14 dB improvement in 3 RF x 2 LO spurious performance over the TIM tested at +10 dBm LO drive.

The four classes of mixers were tested from 300 to 500 MHz for the following products:

Product	Figure Number
$2 F_{RF} \times F_{LO}$	6A
$3 F_{RF} \times 2 F_{LO}$	6B
$F_{RF} \times 2 F_{LO}$	6C
$2 F_{RF} \times 2 F_{LO}$	6D

The reference level is taken relative to a desired IF side-band, and RF input power is indicated on the data. Not unexpectedly, the Class I; Class II, Type I; and Class II, Type II mixers exhibit widely varying results with frequency due to their transformer construction. The Class IV TIM mixer, on the other hand, is well-behaved with only 3 to 5 dB variation over frequency as well as excellent suppression levels. Only in the LO drive sensitive 3 $F_{RF} \times 2 F_{LO}$ case is the performance of the TIM exceeded by the Class II mixers and, as was mentioned, a +17 dBm LO drive TIM would match or exceed these levels.

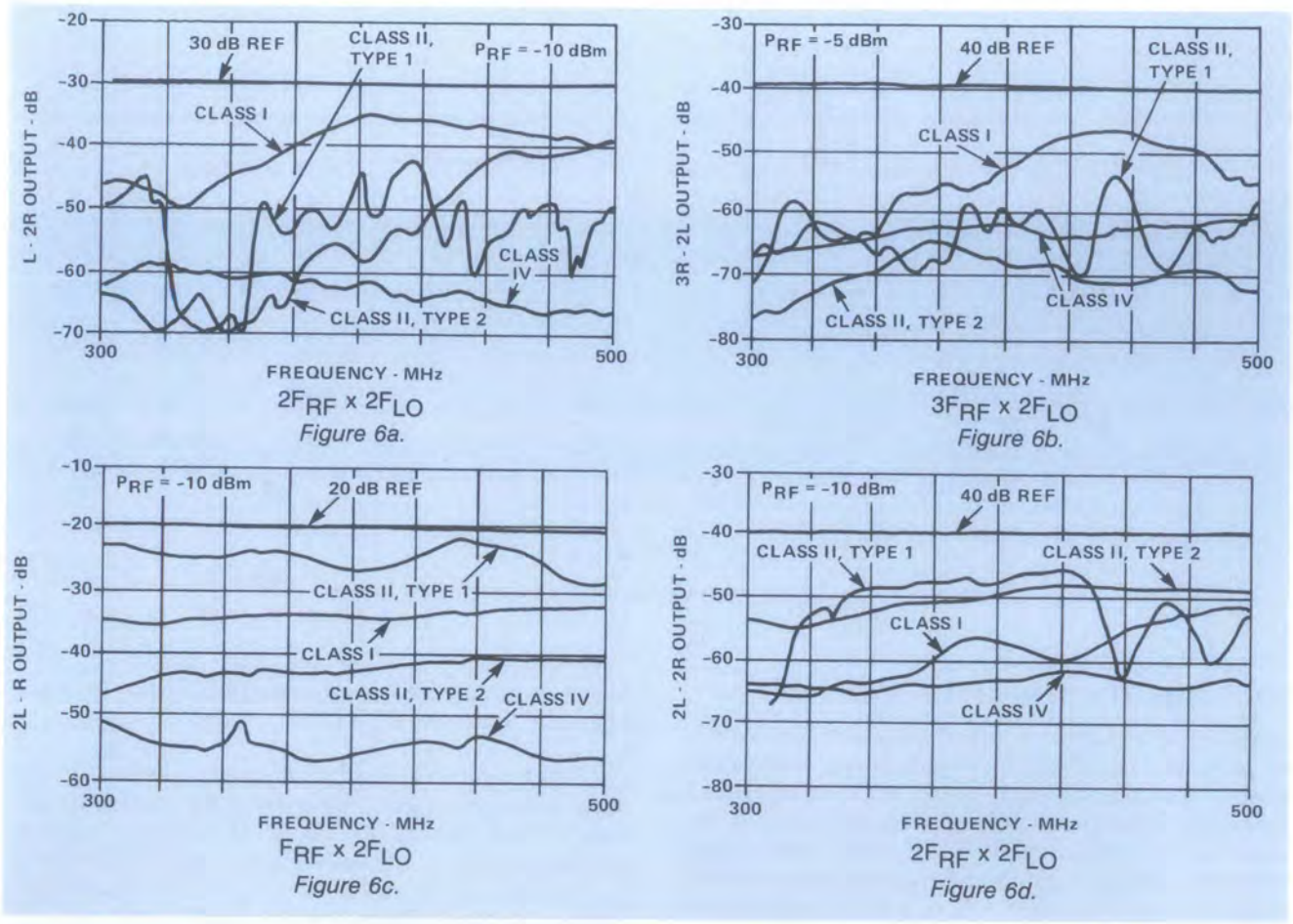


Figure 6. N x M Harmonic Intermodulation Products

The preceding data suggests that publicized "spur-charts" are not even useful as a design "guideline" and should probably be totally disregarded in favor of actual measurements at system operating frequencies and power levels. Also, the data presented is only for 50 ohms terminations at all mixer ports, and reflective terminations will greatly effect some mixer N x M output products. A more detailed explanation of mixer N x M performance is contained in Reference 3.

INTERMODULATION DISTORTION

Study a data sheet for even the best low-distortion mixer and you will discover that the third-order IM response specified by the manufacturer is carefully qualified by a string of test conditions such as tone separation and frequency, LO level, LO frequency, and termination impedances. Such specifications do not tell the system designer how well the mixer will operate over a band of frequencies with the realistic source and load mismatches of the other components that interface to the mixer.

For this reason, an investigation of swept IM performance of mixers both in a well matched 50 ohm environment and with variable mismatches presented to the ports of the mixer was undertaken. An outgrowth of these efforts was the development of the Class IV, or TIM, mixer. While conventional Class I mixers may have 10 dB or more variation in IMR (Intermodulation Distortion Ratio) even over the range of 100 to 500 MHz, the TIM mixer has only 1 or 2 dB variation. The presence of a 3:1 IF port load mismatch can increase the IMR variation over frequency in a Class I mixer to 20 dB or more, while the TIM normally exhibits only a 3 dB degradation making it a very "predictable" mixer for IM performance. A more detailed explanation of mixer IM performance and swept frequency mixer IMR measurements for all mixer types can be found in the references or the "Meet TIM" brochure.

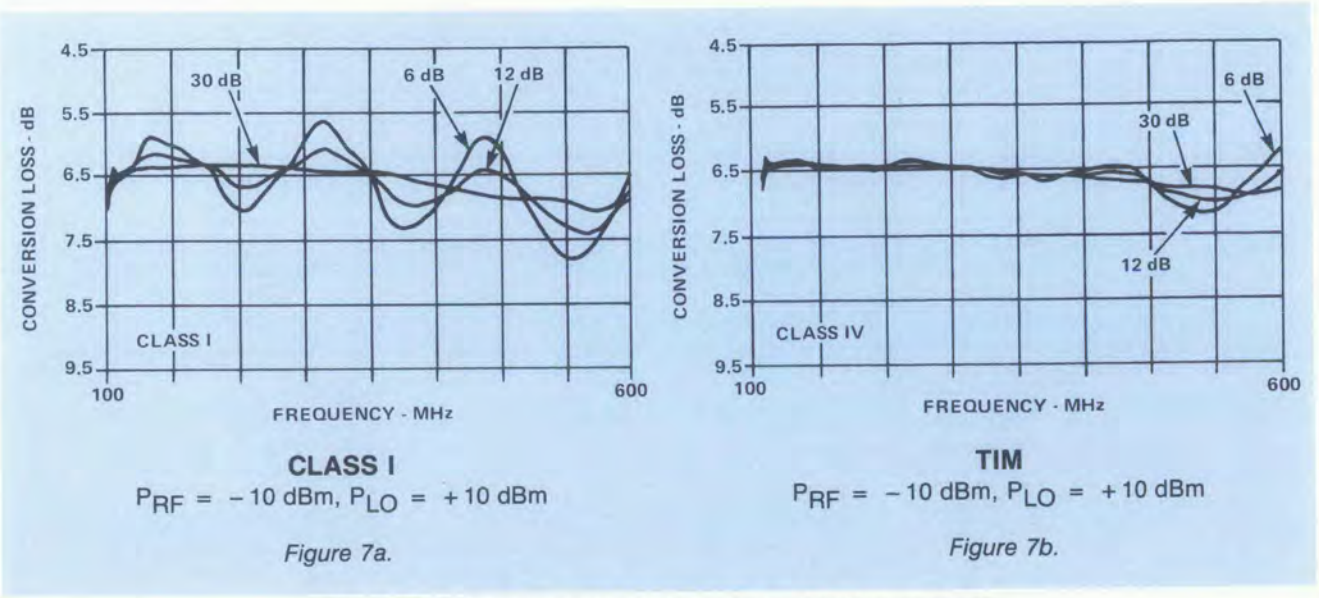


Figure 7. Conversion Loss Variation Due to RF Source Match

CONVERSION LOSS CAN VARY

Manufacturers always specify converison loss in an ideal 50 or 75 ohm system for a very good reason; it varies greatly with port mismatches. Amplitude ripple, much larger than one would expect from a simple VSWR problem, can appear over the frequency range. During mismatch calculations, designers often fail to use the worst-case equivalent which must be determined by multiplying the source VSWR by the mixer VSWR. A mixer VSWR of 2:1, a source VSWR of 2:1, and a source/mixer electrical separation of one-quarter wavelength or more can produce a 4:1 system VSWR and about 1.95 dB conversion loss variation or ripple if the frequency band is an octave or more. In narrow-band systems, properly designed reflective terminations can actually decrease a mixer's conversion loss compared to matched conditions.

Figure 7a shows a Class I mixer's relative conversion loss from 100 to 600 MHz at a −10 dBm RF input. The LO and IF ports are terminated at 50 ohms. The RF source return loss is varied from 30 dB (a nearly perfect 50 ohm impedance) to a value of 12 dB and 6 dB. By assuming a mixer RF input VSWR of 2:1 and multiplying the VSWR's, the 12 dB source termination should produce about 1.5 dB; and the 6 dB case should cause nearly 3 dB conversion loss ripple. The actual mixer performed a little better than theory predicts, particularly at lower frequencies probably, due to the Class I mixer VSWR measuring closer to 1.5:1 then the assumed 2:1 value.

Class II and III mixers showed essentially the same conversion loss changes as RF source match was varied. The Class IV, TIM, Mixer's relative conversion loss is measured with the LO drive level at +10 dBm (Figure 7b). The 12 dB RF source termination causes about 0.4 dB ripple, and the 6 dB case has under 1 dB variation for most of the frequency range. Since this performance approximates a 1.0:1 mixer VSWR for the 12 dB ripple and betters the theoretical 1.25 dB ripple possible in the 6 dB source example, some other things must be happening.

MIXER INTERFACING EFFECTS

To achieve reproducible system performance, particularly using conventional mixers, designers should consider how reflective terminations may affect mixer performance. All mixer source and load terminations can modify mixer operation, but mismatches at certain ports affect some mixer performance greatly, others only slightly. The tabulation (Figure 8) shows the relative effects of broadband source and load mismatches upon various mixer parameters for both conventional and Class IV, TIM, Mixers. Obviously, system interfacing circuit aids are required to varying degrees for all mixer types. Some solutions to common system problems now follow.

MIXER INTERFACE CIRCUITS

The IF output port of a double-balanced mixer is most sensitive to reflective terminations. In most applications, only one sideband, either ($F_{LO} + F_{RF}$) or ($F_{LO} - F_{RF}$) is desired, but many mixers produce both with equal conversion efficiency, especially in the up-converter case. Additionally, all mixers have a very large ($3F_{LO} \pm F_{RF}$) output (−13 dBc).

Parameter	LO Source		RF Source		IF Load	
	Conv.	Tim	Conv.	Tim	Conv.	Tim
Conv. Loss	S	S	L	S	M	S
Harmonic (N x M) Intermodulation	S	S	M	S	L	M
3rd Order IMD	S	S	M	S	L	S
RF Port VSWR	S	S	N/A	N/A	L	L
IF Port VSWR	S	S	L	L	N/A	N/A

S = Small M = Moderate L = Large

Figure 8. Variation Vs. Port Mismatch

These four frequency terms $F_{LO} - F_{RF}$, $F_{LO} + F_{RF}$, $3F_{LO} - F_{RF}$, and $3F_{LO} + F_{RF}$ exit the mixer's IF port (Figure 9a). The non-broadband IF load terminates only one of these frequency terms ideally, while the others are reflected back into the mixers IF port where they then remix with the local oscillator. This condition greatly affects the mixer parameters of N x M harmonic modulation products, 3rd order IMD and conversion loss. A "Di-plexer" type filter network is required to achieve non-reflective broadband mixer terminations while still preserving frequency selectivity. When the system frequency plan allows, such as in a down-converter, a 3rd order high-pass/low-pass configuration (Figure 9b) can be used. The desired $F_{LO} - F_{RF}$ can be well matched by the next stage interface component, and since $F_{LO} + F_{RF}$ and $3F_{LO} \pm F_{RF}$ typically fall above the high-pass filter cut-off, they are well terminated by the additional 50 ohm load. When a bandpass function is required, the circuit (Figure 9c) can be used. Only the desired frequency term is passed by the series resonant circuit since it becomes a high impedance below and above F_o. The parallel L-C circuit exhibits a high impedance at resonance and becomes a low impedance above and below F_o, therefore doubly terminating the mixer and interface component at unwanted frequencies. Narrow bandwidths are difficult to attain using this circuit because of the extremely high element Q's required for the anti-resonant section.

Another effective but more complex filtering technique, particularly useful for up-converters, consists of two reflection coefficient matched filters interconnected between a pair of 90° hybrids (Figure 9d). Very narrowband filtering is possible using helical resonators or transmission line filters in this configuration.

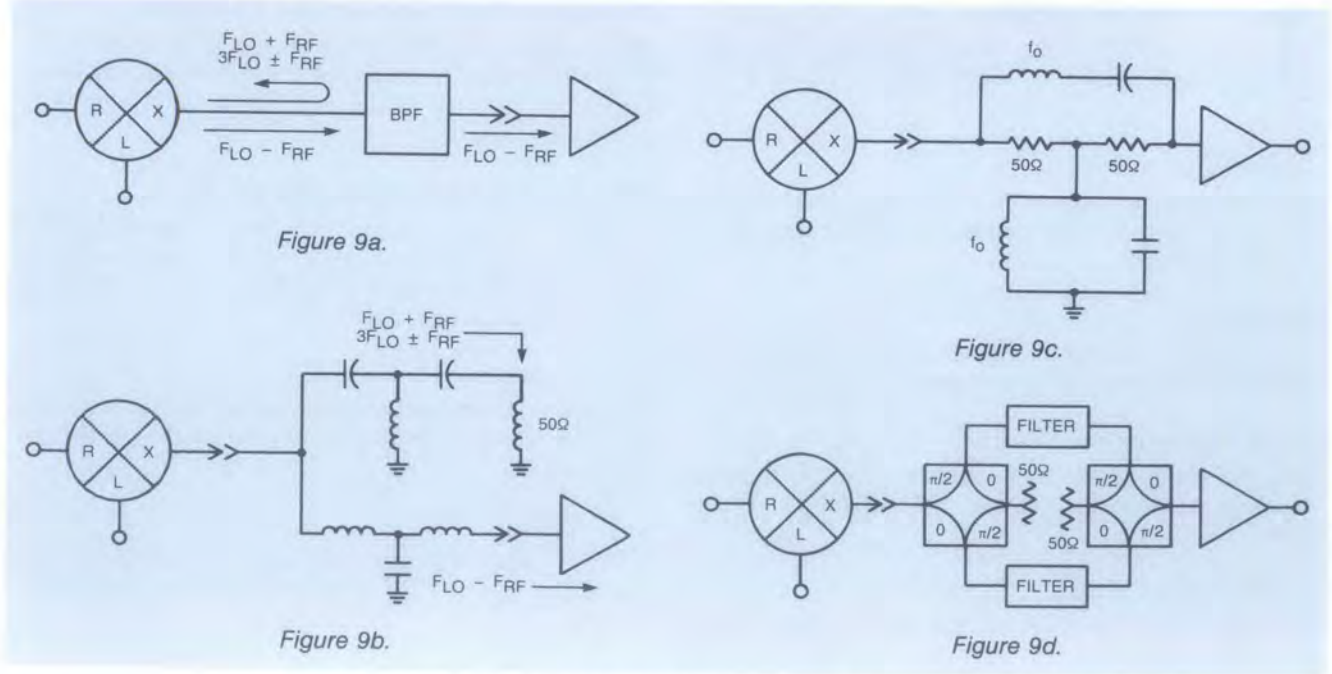


Figure 9. IF Matching Circuits Improve Mixer Performance

Broadband matching may also be required at the mixer's RF and LO ports. Even order NF_{RF} x MF_{LO} harmonics are suppressed in a mixer's IF output spectrum, therefore, they must exit at another mixer port. The output spectrum at each of an "ideal" mixer's 3 ports (Figure 10) reveals that IM products containing odd order RF and even order LO harmonics appear at the R or low level port while products having even order RF and odd order LO harmonics exit at the high level or LO mixer port. Odd order RF and LO harmonic mixing products appear at the IF port, even order products only are suppressed. Broadband LO port matching is often required particularly if the system LO has a very high harmonic content, or is a poor source impedance for mixer generated harmonics exiting the mixer's LO port. These multiple reflections can inhibit the mixing process causing an increase in 3rd order IMD and N x M harmonic modulation products.

These circuits and techniques are only intended to illustrate design philosophies that allow a mixer to be non-reflectively terminated while directly interfaced to a frequency selective network. Class IV TIM Mixers are generally the best choice, as they

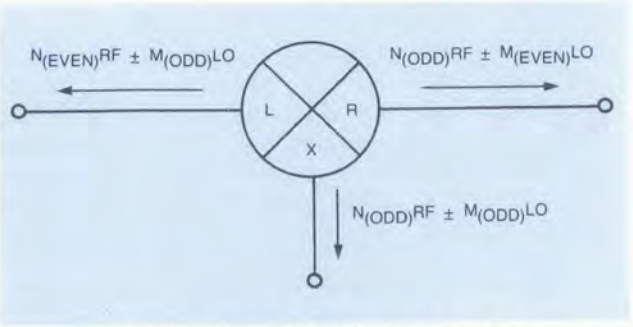


Figure 10. Harmonic Output of a Double Balanced Mixer

are less susceptible to non-ideal terminations than other mixer classes.

ELECTROMECHANICAL EFFECTS

Improper physical interfacing will also create reflective mixer terminations, causing changes in conversion loss, N x M harmonic suppression and 3rd order IMD. Inadequate case grounding and long signal lead lengths are the common offenders.

MIXER TERMINOLOGY

Conversion Loss (SSB)

The ratio of RF input power to the IF output power of one sideband. (either $F_{LO} - F_{RF}$ or $F_{LO} + F_{RF}$).

Noise Figure (SSB)

The ratio of the signal to noise ratio at the mixer input divided by the signal to noise ratio of one mixer sideband.

Isolation

The amount an input signal is attenuated when measured at another mixer port.

1 dB Compression Point

The RF input power that causes a one dB increase above a mixer's small signal (−15 dBm) conversion loss.

1 dB Desensitization Level

The RF input level of an interfering signal that causes a mixer's small signal (−15 dBm) conversion loss to increase by one dB.

Harmonic Intermodulation Products

Mixer output signals other than the desired $F_{LO} \pm F_{RF}$, which are harmonically related to either or both of the input signals. (Also termed $N_{RF} + M_{LO}$, N x M or "Spurs").

Two-Tone Intermodulation Products

Undesired mixer output products caused by the simultaneous presence of two RF input signals (3rd order IM consists of $[(2F_{RF1} \pm F_{RF2}) \pm (F_{LO})]$ and $[(F_{RF1} \pm 2F_{RF2}) \pm (F_{LO})]$.

D.C. Polarity

The mixer IF output voltage sense, either positive or negative when in phase LO and RF signals are applied.

D.C. Offset

The IF output voltage measured with only the LO operating and the RF port terminated in 50 ohms.

PHASE DETECTORS

Application of two identical-frequency, constant-amplitude signals to a mixer's RF and LO ports, results in a D.C. IF output that is proportional to their phase difference. The LO input causes currents to flow through diode pair D1, D2 during one half of the LO cycle and through diode pair D3, D4 during the other half cycle (Figure 11). The LO voltage at nodes B or C is approximately zero because of diode and transformer balance. Since the diode pairs D1, D2, and D3, D4 are in alternate conduction states, the RF transformers secondary terminals B or C are alternately commutated to a virtual ground at a rate equal to the LO input frequency. When an RF input signal is applied, the instantaneous IF output voltage depends upon the instantaneous level and polarity at the RF transformer secondary and whether terminal B or C is switched to ground by the LO at that moment. The IF output contains both $F_{LO} + F_{RF}$ and $F_{LO} - F_{RF}$ and when F_{LO} and F_{RF} are identical frequencies $F_{LO} - F_{RF}$ is zero Hz or a D.C. output proportional to their phase difference. The sum frequency $F_{LO} + F_{RF}$ may be filtered if it falls within the mixer's IF port response. Recommended input levels for this application are nominal specified as a LO drive for one signal and an input at or below the 1 dB compression point for the other. The D.C. IF port TIM Mixer (MD-161) and conventional model MD-125 are good mixer choices, having a 1 dB compression point very close to their LO drive levels.

OTHER MIXER APPLICATIONS

Double-balanced mixers can be combined with other signal processing components to realize functions such as Single Sideband Modulators, Image Rejection Mixers, and QPSK modulators/demodulators. The article on pages 8 to 16 discusses our capabilities in integrated sub-assemblies.

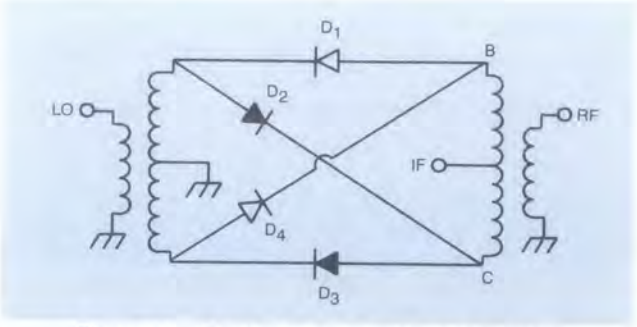


Figure 11. Double Balanced Mixer Operates as Biphase Modulator

CONCLUSION

Correct selection of a double balanced mixer to fit the application can greatly improve system performance. Once a proper selection is made, careful installation and matching can further improve performance. Utilizing the Class IV, TIM Mixer will, in many cases, provide improved system performance and often significant improvement under mismatch environments. Regardless of which mixer is used, understanding mixer operation and tradeoffs can save system designers from major performance problems.

REFERENCES

1. P. Will, "Mixers for High Performance Radio" IEEE/Wescon '81, Session Record #24, Section 24/3
2. R.E. Snyder, "Sweep Dynamic Range into Mixer Measurements", **Microwaves**, Vol. 17, No. 5, pp. 94-98 (May 1978).
3. P. Will, "Swept Tests on Mixers Yield More Honest Specs", **Microwaves**, Vol. 19, No. 6, pp. 62-68 (June 1980).
4. P. Will, "Uncover Mixer Intermod with Swept Measurements", **Microwaves**, Vol. 17, No. 11, pp. 84-91 (November 1978).
5. P. Will, "Reactive Loads – The Big Mixer Menace", **Microwaves**, Vol. 10, No. 4, pp. 38-42 (April 1971).

BIPHASE AND QUADRIPHASE DIGITAL MODULATORS

INTRODUCTION

Anzac has recently developed a line of miniature, hybrid circuit, digital modulators. These modulators include biphase and quadriphase units with integral ECL series 10,000 digital drivers to facilitate their use with data systems, as well as similar models without drivers. They provide the basic building blocks for bridging the boundary between the quantized video world of the data user or digital designer and the RF oriented discipline of the communicator or communications system designer. The modulators will accept a digital data stream and an RF carrier input and produce a phase modulated output. The properties of the output signal are dependent upon those of the inputs, and the only variable source will be the data waveform.

DESCRIPTION

Biphase Modulators

Biphase Modulators utilize a circuit similar to that of doubly balanced mixers as the basic modulating device as shown in Figure 1. A carrier signal injected at the RF input will appear at the RF output reduced slightly in amplitude due to inherent diode and transformer losses and in one of two possible phase states with the modulating signal and the carrier suppressed. In the 0° phase state, control current is supplied to the diode ring to turn on a pair of diodes (either D1/D4 or D2/D3) which directly connect the input and output transformers. In the 180° phase state, current of opposite polarity switches on the other pair of diodes causing a 180° phase inversion relative to the 0° state. If the modulating bit rate is near the carrier frequency, a waveform of the sort shown in Figure 1 might be obtained. This waveform can be interpreted as a biphase signal or as a double sideband suppressed carrier modulation since in this case they are equivalent.

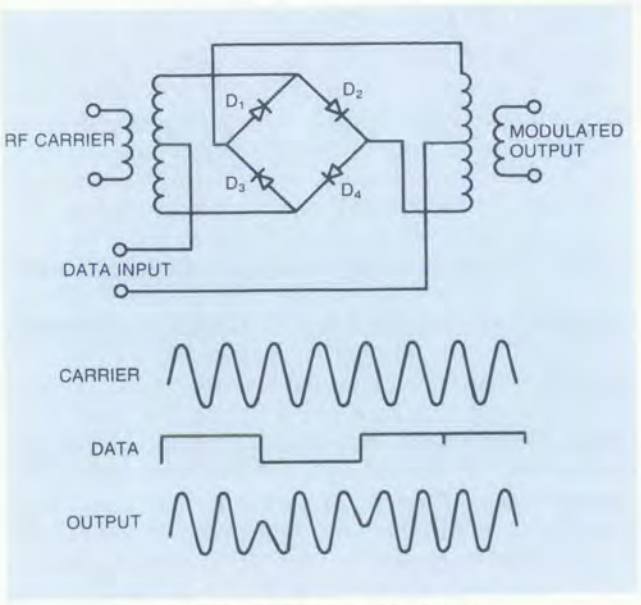


Figure 1. Biphase Modulator

Quadriphase Modulators

The basic modulating elements in a quadriphase or QPSK modulator are a pair of matched biphase modulators similar to those previously described. The carrier signal applied to the RF input first passes through a quadrature hybrid. The two resulting carrier signals, now having a 90° phase relation, then pass through the matched pair of biphase modulators, and finally the resulting signals are added vectorially in an output power combiner as shown in Figure 2. In this case, two control bits at a time are used, each controlling the phase of one of the orthogonal components of the output signal. It is assumed that any serial to parallel conversion required to generate the simultaneous modulating bits will be performed with external logic.

Four phase states are possible with this configuration. The reference or 0° state occurs when both biphase modulators are in the straight through or 0° state. In this case, the two signals from the quadrature hybrid at 0° and −90° relative phase appear unshifted at the output power combiner and add vectorially to give a resultant insertion phase shift of −45°. The other three states occur when the biphase modulators are in the 0° and 180° states, 180° and 180° states, and 180° and 0° states, giving respective insertion phase shifts of +45°, −135° and +135°.

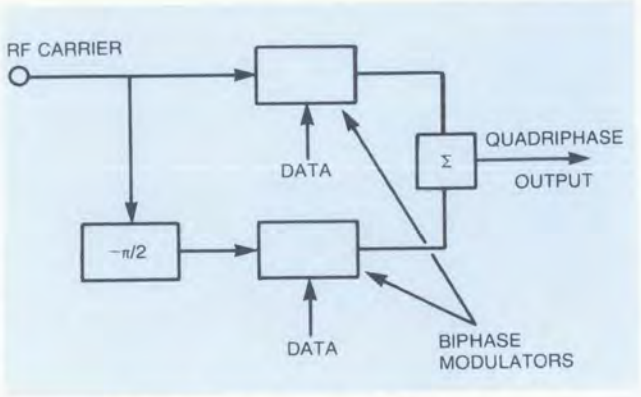


Figure 2. Quadriphase Modulator

The circuit element that generally limits the usable range of carrier frequency in a QPSK modulator is the quadrature hybrid. Anzac models utilize a patented, compact, octive bandwidth circuit and thus can be used over a full octave range.

Function as Digital Modulators

Both biphase and QPSK modulators transform a stream of digital "1" and "0" bits into phase shift keyed modulation on an RF carrier. While the RF parameters of a biphase or QPSK modulator can be determined by static measurements, it is important to consider the actual operation with digital signals applied. The bit pattern of the data waveform will tend to be random with the exception of any overhead bits used for framing or synchronization.

Figure 3 shows the envelope of the baseband spectrum and the output from the phase modulators. As indicated, the quadriphase modulators will produce the same spectrum as the biphase unit with the appropriate 2 to 1 scale change for frequency. The width of the main lobe envelope of the $((\sin x)/x)^2$ distribution is determined by the bit rate of the modulating sequence and the line spacing under the envelope is determined by the repetition rate of the sequence.

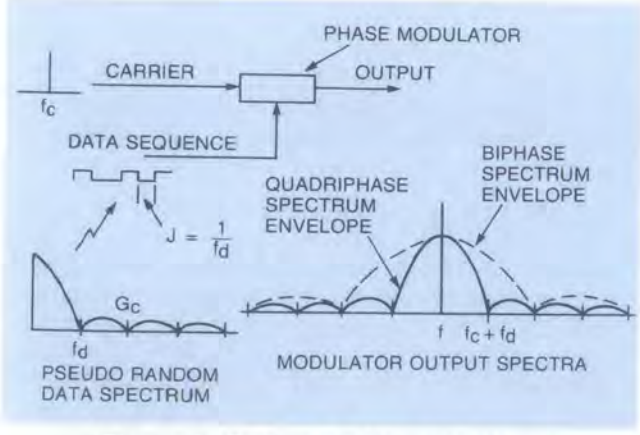


Figure 3. Data and Modulator Spectra

Most of the energy in the spectra is contained in the main lobe, only about 10% is contained in the sidelobes; and the spectral bandwidth is directly dependent upon the data bit rate.

The data rate often is an indication of the type of logic which will be supplying the modulating signal and the type of driver used in the modulator. The two major types of drivers used are TTL and ECL. The TTL logic employing Schottky type elements will function at bit rates up to near 100 mbps, while emitter coupled logic can extend operation into the 500 mbps region. Anzac modulators are available with or without integral ECL series 10,000 drivers.

Spurious Spectrum Components

The previous section has described the general character of the input data stream and the resulting spectra observable at the modulator output. The data user or digital designer is often less interested in the spectra shown in Figure 3 than in the measurement of the quality of the recovered data sequence at the demodulator output. However, there are spectral properties which may affect system operation which are not readily deduced by studying the recovered data stream. A modulator output spectrum contains a variety of spurious signals which might be treated by a demodulating system as interference. The component most often specified is the suppressed carrier. The carrier component is in band and can be reduced by improving modulator balance. Levels of 30 dB or more carrier suppression are commonly achieved in well designed biphase and QPSK modulators.

Insertion Loss

Insertion loss of a biphase or QPSK modulator is measured statically in either of the possible phase states and represents the worst case loss for any state.

Biphase modulators theoretically would have no loss when measured in this manner. However, finite losses do occur because of transformer and diode dissipation. Typical losses of 3-3.5 dB are to be expected. QPSK modulators have a theoretical insertion loss of 3 dB due to the quadrature phase relation of the two signals fed to the output power combiner. Additional dissipative losses in the biphase modulator, quadrature hybrid and power combiner increase this loss. Typical losses of 5.5-6.5 dB are to be expected.

VSWR

VSWR is a measure of the impedance mismatch at the RF input and output ports of the modulator. It is of importance because the presence of imperfect source and load impedances in real system application combined with mismatches at the input and

output of the modulator may introduce phase errors due to multiple reflections. For this reason, the VSWR of modulators should be tightly controlled with typical results being 1.3:1.

Amplitude Balance

Amplitude balance is a measure of the variation in insertion loss between the possible phase states of the modulator. For biphase modulators, it is simply the variation in insertion loss between the 0° and 180° states, while for QPSK modulators it is a measure of the worst case variation between any of the four possible states.

Phase Deviation

Phase deviation is a measure of the offset from the desired carrier relative phase shift in any of the possible phase states. It is measured with respect to a reference or 0° phase state.

Carrier Suppression

Carrier suppression is the difference in level in dB between the modulation sidebands and the suppressed carrier. It is dependent upon symmetry in both the modulator circuitry and in the modulating waveform. Carrier suppression is typically 35 dB or greater in well designed biphase and QPSK modulators.

Logic Interface for Anzac Modulators

All Anzac biphase and QPSK modulators are available in two versions: with and without integral ECL series 10,000 drivers. The modulators containing ECL drivers simplify the designers task by standardizing the logic interface while still allowing the high data rates typical of ECL logic. The interface to the control ports of these devices should follow standard ECL practices with the control voltages being −0.9 V typically for a high state and −1.75 typically for a low state. (See Figure 4).

The modulators without integral drivers require an external driver capable of delivering +10 and −10 mA. Care should be taken in design of the external driver to maintain symmetry of the positive and negative half cycles of the driving waveform and RF interfacing practices appropriate to the data rate should be used in connecting the driver to the modulator.

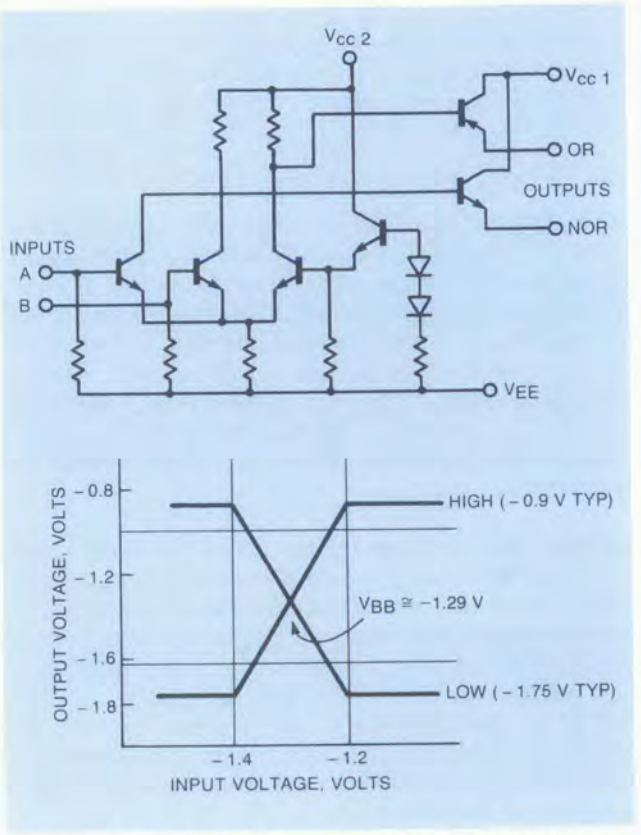


Figure 4. Typical ECL & Transfer Characteristic

CONCLUSION

Phase modulators provide the designer with a compact component capable of providing complex waveform modulations needed for today's systems. Anzac's products bridge the Digital-RF boundary to allow engineers from both fields to utilize these devices. Specific or customized versions of both biphase and quadriphase modulators are available from Anzac. Our Applications Engineers are ready to assist the designer in adapting Anzac's capabilities to the specific system requirements.

MODELS MAC-50/51

TO-5 DOUBLE-BALANCED MIXERS
MAC-50 0.2 - 200 MHz MAC-51 5-500 MHz

- Convenient Microstrip or Stripline Mounting
- Low Conversion Loss — 6 dB (MAC-50)
  7 dB (MAC-51)

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL		MAC-50	MAC-51
Frequency Range			
RF, LO Ports		0.2-200	5-500 MHz
IF Port		DC-200	DC-500 MHz
Conversion Loss		6.0	7.0 dB Max
Isolation			
LO to RF	(0.2-50 MHz)	35	35 dB Min
	(50-200 MHz)	25	25 dB Min
LO to IF	(0.2-50 MHz)	35	35 dB Min
	(50-200 MHz)	25	25 dB Min
RF to IF	(0.2 MHz)	25	20 dB Min
	(50-200 MHz)	20	20 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated Linearly to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset	⩽ 1	⩽ 3 mV Typ
RF Input**		
1 dB Compression	+1	+2 dBm Typ
1 dB Desensitization	−3	−1.5 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Package Type		(TO-5-2) (See page 472 for physical dimensions.)

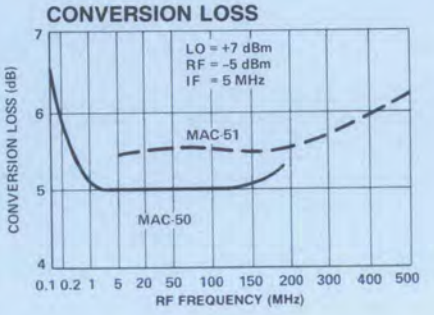
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

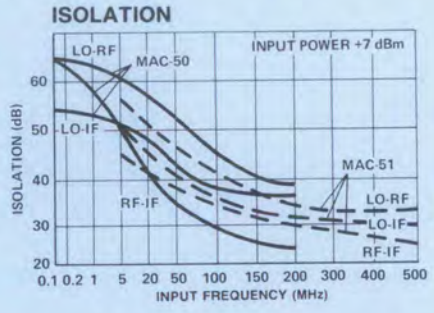
Pin Configuration	LO; P1, IF; P2, RF; P3, P4 and case ground.

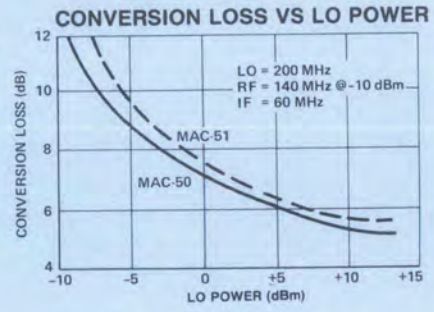
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**Measured at 100 MHz.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MAC-50	9109	Pin	$40
MAC-51	9549	Pin	$40

Delivery is from stock.

MODEL MHF-3 PLUG-IN DOUBLE-BALANCED MIXER 5-500 MHz

- 5 MHz to 500 MHz Coverage
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss		(5-150 MHz)	7.0 dB Max
		(150-500)	9.0 dB Max
Isolation	LO to RF	(5-150 MHz)	40 dB Min
		(150-500 MHz)	35 dB Min
	LO to IF	(5-150 MHz)	35 dB Min
		(150-500 MHz)	25 dB Min
	RF to IF	(5-150 MHz)	30 dB Min
		(150-500 MHz)	25 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		≤ 1 mV Typ
RF Input**		
1 dB Compression		+4.5 dBm Typ
1 dB Desensitization		+2 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 30 MHz and 35 MHz IF)	(200 MHz)	≥ 46 dB
Package Type		Relay Header (RH-2) (See page 473 for physical dimensions.)

Environmental

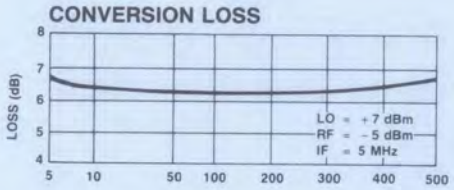
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

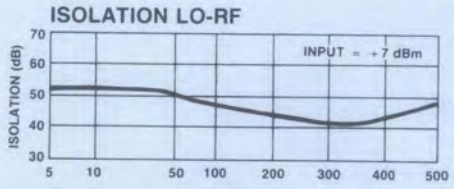
Pin Configuration RF; P1, IF; P2, LO; P3. Case and all others are ground.

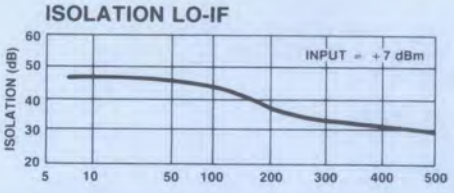
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

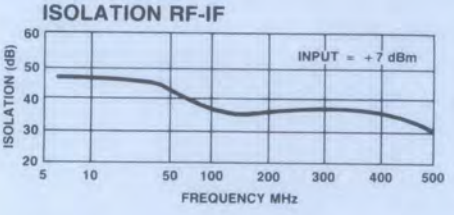
**Measured at 200 MHz.

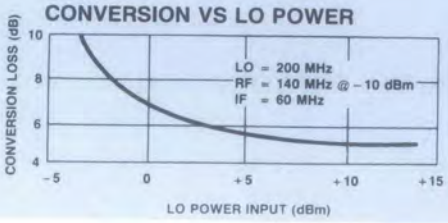
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MHF-3	9299	Pin	$62

Delivery is from stock.

MODEL MLF-3 — PLUG-IN DOUBLE-BALANCED MIXER 0.2-200 MHz

- 200 kHz to 200 MHz Coverage
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.2-200 MHz
	IF Port		DC-200 MHz
Conversion Loss		(0.2-50 MHz)	6.0 dB Max
		(50-200)	7.5 dB Max
Isolation	LO to RF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	30 dB Min
	LO to IF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	25 dB Min
	RF to IF	(0.2-50 MHz)	25 dB Min
		(50-200 MHz)	20 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		⩽ 1 mV Typ
RF Input**		
1 dB Compression		+4.5 dBm Typ
1 dB Desensitization		+2 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 30 MHz and 35 MHz IF)	(100 MHz)	⩾ 46 dB
Package Type		Relay Header (RH-2) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

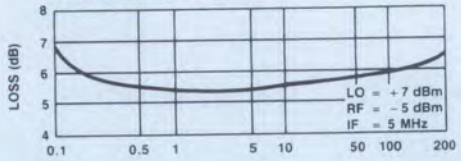
Pin Configuration	RF; P1, IF; P2, LO; P3. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

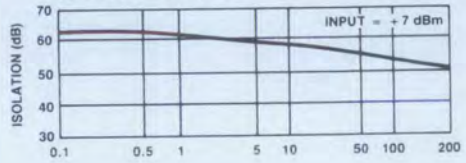
**Measured at 100 MHz.

Typical Performance

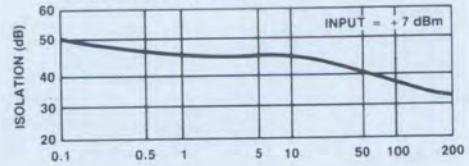
CONVERSION LOSS



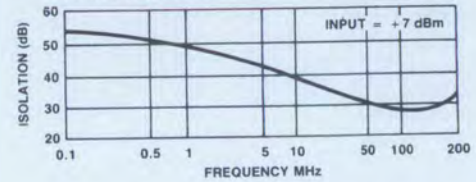
ISOLATION LO-RF



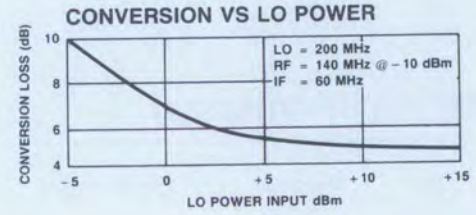
ISOLATION LO-IF



ISOLATION RF-IF



CONVERSION VS LO POWER



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MLF-3	9289	Pin	$62

Delivery is from stock.

MODEL MLLF-3 — PLUG-IN DOUBLE-BALANCED MIXER 20 kHz-65 MHz

- 20 kHz to 65 MHz Coverage
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports IF Port		0.02-65 MHz DC-65 MHz
Conversion Loss		(0.02-65 MHz)	6.5 dB Max
Isolation	LO to RF	(0.2-1 MHz) (1-65 MHz)	45 dB Min 40 dB Min
	LO to IF	(0.02-1 MHz) (1-65 MHz)	45 dB Min 35 dB Min
	RF to IF	(0.01-1 MHz) (1-65 MHz)	40 dB Min 25 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		⩽ 2 mV Typ
RF Input**		
1 dB Compression, RF = 30 MHz		+4.5 dBm Typ
1 dB Desensitization, RF = 30 MHz		+2 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 30 MHz and 35 MHz IF)	(50 MHz)	⩾ 49 dB
Package Type		Relay Header (RH-2) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

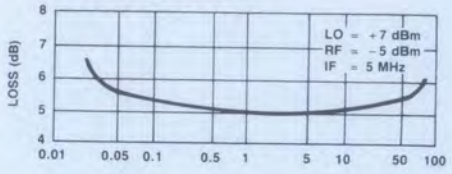
Pin Configuration	RF; P1, IF; P2, LO; P3. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

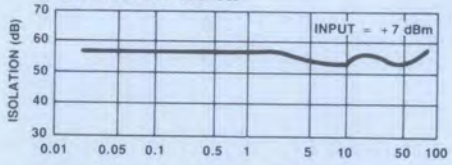
**Measured at 30 MHz

Typical Performance

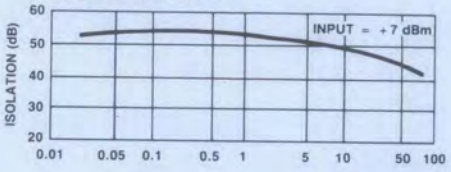
CONVERSION LOSS



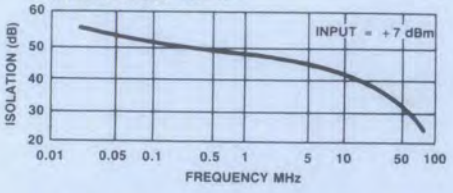
ISOLATION LO-RF



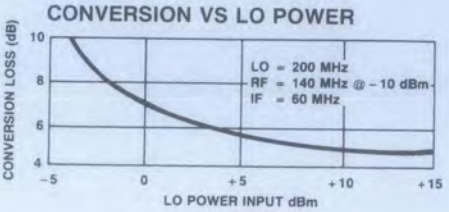
ISOLATION LO-IF



ISOLATION RF-IF



CONVERSION VS LO POWER



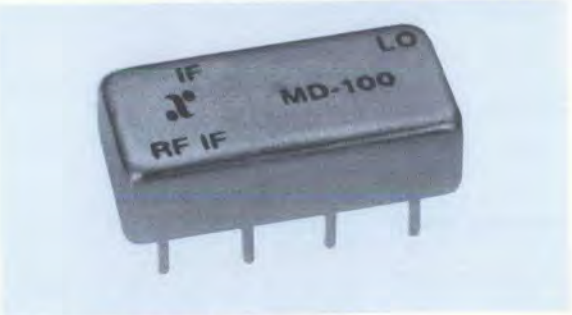
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MLLF-3	9529	Pin	$62

Delivery is from stock

MODEL MD-100 — DOUBLE-BALANCED MIXER 1-400 MHz

- Low Cost, High Level
- + 17 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
- + 7 dBm Typical Compression Point



Guaranteed Specifications*

(From – 55°C to + 85°C)

Frequency Range	RF, LO Ports		1-400 MHz
	IF Port		DC-400 MHz
Conversion Loss	3-300 MHz		7 dB Max
	1-400 MHz		8 dB Max
Isolation	LO to RF	(1-300 MHz)	32 dB Min
		(300-400 MHz)	28 dB Min
	LO to IF	(1-300 MHz)	30 dB Min
		(300-400 MHz)	25 dB Min
	RF to IF	(1-150 MHz)	25 dB Min
		(150-400 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+ 7 dBm Typical
1 dB Desensitization	+ 5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with – 10 dBm input, each input)	⩾ 55 dB Min
Package Type	Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

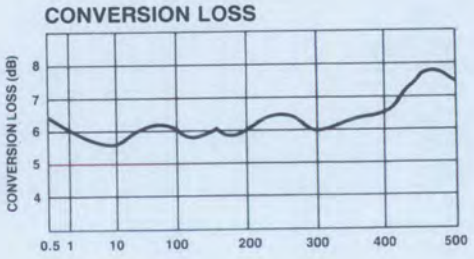
Pin Configuration	RF; P1, LO; P8, IF; P2 & P6** Case and all other pins are ground.

*All specifications apply when operated at + 13 dBm available LO power with 50 ohm source and load impedance.

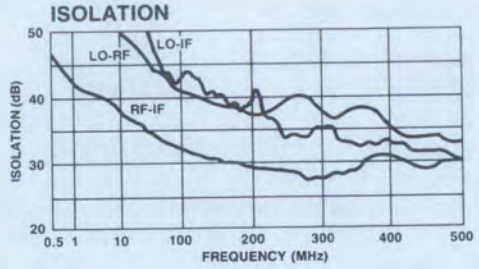
**P2 & P6 are connected together externally to make an IF Port.

Typical Performance

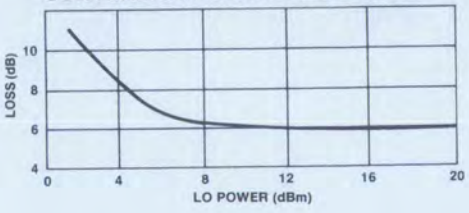
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



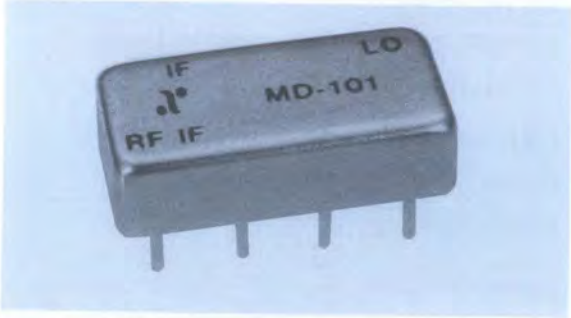
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-100	8309	Pin	$25

Delivery is from stock.

MODEL MD-101 — DOUBLE-BALANCED MIXER 0.5-350 MHz

- Low Cost, Medium Level
- +15 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
- +5 dBm Typical Compression Point



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-350 MHz
	IF Port		DC-350 MHz
Conversion Loss	2-300 MHz		7 dB Max
	0.5-350 MHz		8 dB Max
Isolation	LO to RF	(0.5-100 MHz)	35 dB Min
		(100-350 MHz)	28 dB Min
	LO to IF	(0.5-100 MHz)	32 dB Min
		(100-350 MHz)	25 dB Min
	RF to IF	(0.5-100 MHz)	25 dB Min
		(100-350 MHz)	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input)	⩾ 50 dB Min
Package Type	Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

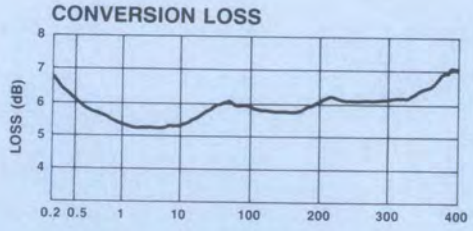
Pin Configuration	RF; P1, LO; P8, IF; P2 & P6** Case and all other pins are ground.

*All specifications apply when operated at **+10 dBm available LO power** with 50 ohm source and load impedance.

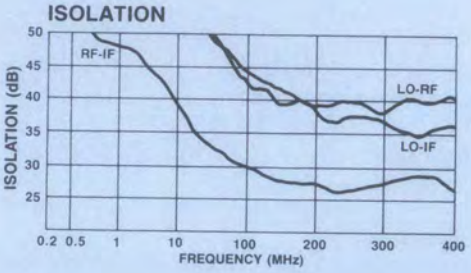
**P2 & P6 are connected together externally to make an IF Port.

Typical Performance

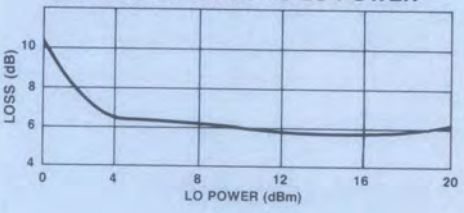
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



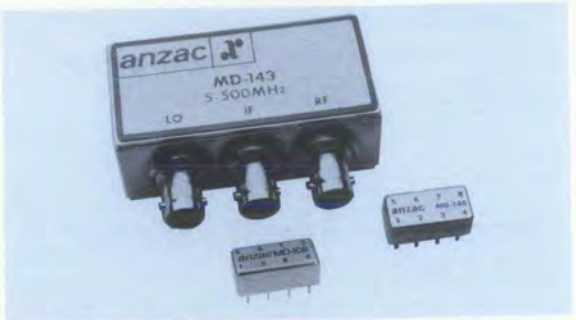
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-101	8329	Pin	$25

Delivery is from stock.

MODELS MD-108/143/146 — DOUBLE-BALANCED MIXERS 5-500 MHz

- Low Cost
- 7 dB Typical Conversion Loss
- Available in Three Models



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	5-150 MHz		7.0 dB Max
	150-500 MHz		9.0 dB Max
Isolation	LO to RF	(5-150 MHz)	40 dB Min
		(150-500 MHz)	35 dB Min
	LO to IF	(5-150 MHz)	35 dB Min
		(150-500 MHz)	25 dB Min
	RF to IF	(5-150 MHz)	25 dB Min
		(150-500 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative (Positive if LO input at pin 5)
DC Offset	⩽ 1 mV Typical
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 25 MHz and 35 MHz IF)	100-350 MHz ⩾ 55 dB 350-500 MHz ⩾ 40 dB
Package Type	MD-108/-146 Relay Header (RH-3) MD-143 Connectorized (C-9) (See page 473 and 482 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration
(MD-108) LO; P1 & P5, RF; P8, IF; P3 & P7***
(MD-146) LO; P1 & P5, RF; P8 & P4, IF; P3 & P7***

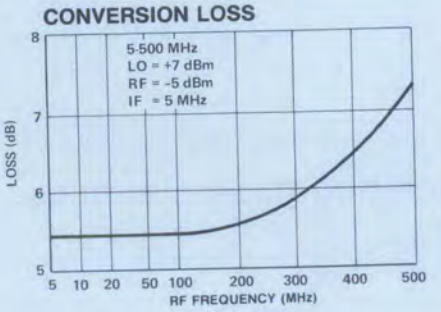
All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**No internal connection.
***P3 and P7 are connected together to make IF port.

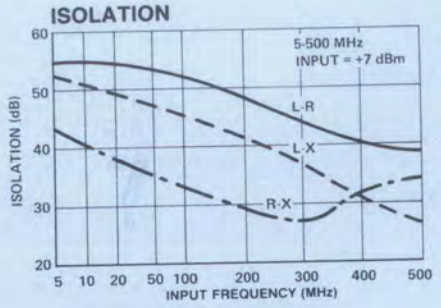
Ordering Information

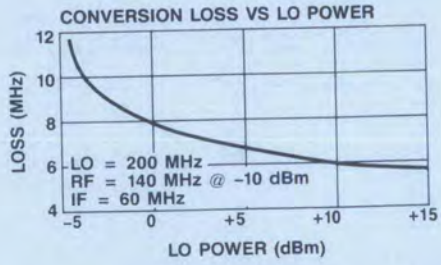
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-108	9729	Pin	$14
MD-143	8331	BNC	40
MD-146	9749	Pin	14

Delivery is from stock.

Typical Performance

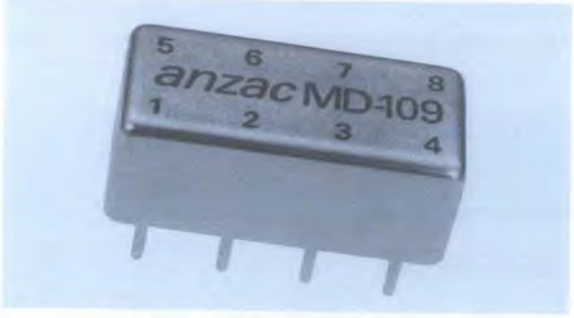






MODEL MD-109 — PLUG-IN DOUBLE-BALANCED MIXER 200 kHz-200 MHz

- Three Decade Coverage
- All Internal Connections Accessible



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.2-200 MHz
	IF Port		DC-200 MHz
Conversion Loss	0.2-50 MHz		6.0 dB Max
	50-200 MHz		7.5 dB Max
Isolation	LO to RF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	30 dB Min
	LO to IF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	25 dB Min
	RF to IF	(0.2-50 MHz)	25 dB Min
		(50-200 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated linearly to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative (When connected as indicated under Mech. Data)
DC Offset	⩽3 mV Typical
RF Input†	
1 dB Compression	+2 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-200 MHz ⩾50 dB 200-300 MHz ⩾36 dB
Package Type	Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P8, LO; P1 & P5, IF; P3 & P7** All other pins are ground.***

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**P3 & P7 connected together externally to make IF Port.

***No internal case connections.

†Measured at 100 MHz.

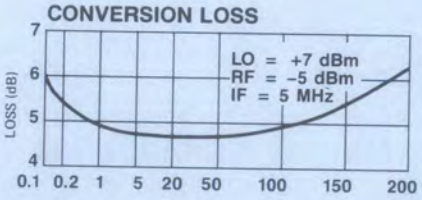
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-109	9579	Pin	$25

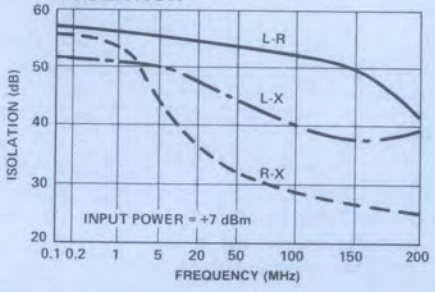
Delivery is from stock.

Typical Performance

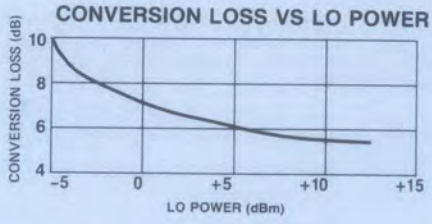
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



MODEL MD-110 — DOUBLE-BALANCED MIXER 10-1000 MHz

- Low Cost
- 7 dB Typical Conversion Loss
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1000 MHz
	IF Port		DC-1000 MHz
Conversion Loss	10-50 MHz		8.0 dB Max
	50-800 MHz		7.5 dB Max
	800-1000 MHz		9.0 dB Max
Isolation	LO to RF	(10-100 MHz)	45 dB Min
		(100-400 MHz)	40 dB Min
		(400-800 MHz)	30 dB Min
		(800-1000 MHz)	25 dB Min
	LO to IF	(10-100 MHz)	40 dB Min
		(100-400 MHz)	27 dB Min
		(400-800 MHz)	25 dB Min
		(800-1000 MHz)	20 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-400 MHz)	20 dB Min
		(400-800 MHz)	15 dB Min
		(800-1000 MHz)	12 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		⩽ 1 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 50 MHz and 60 MHz IF)		200 MHz ⩾ 55 dB 600 MHz ⩾ 40 dB
Package Type		Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration RF; P8, LO; P1, IF; P3 & P7**. Case and all other pins are ground.

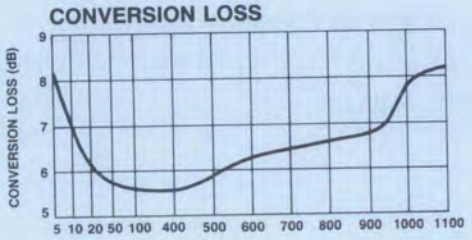
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**P3 & P7 are connected together externally to make and IF Port.

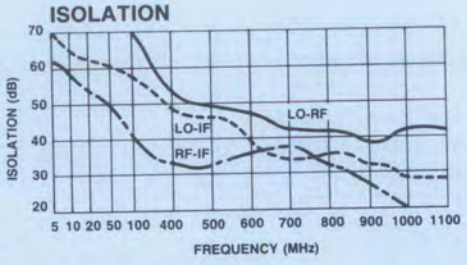
Ordering Information

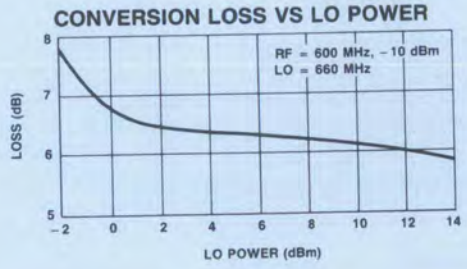
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-110	6429	Pin	$18

Delivery is from stock.

Typical Performance



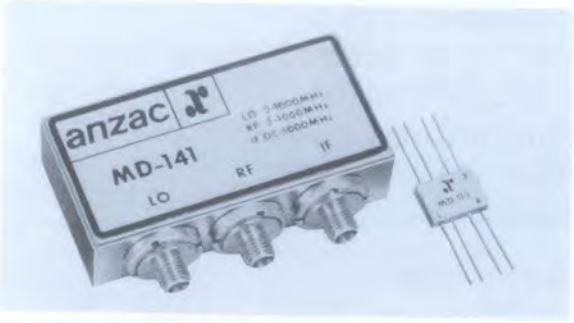




MODEL MD-113/141

HIGH PERFORMANCE DOUBLE-BALANCED MIXERS 5-1000 MHz

- 7 dB Typical Conversion Loss
- Low Cost Flatpack (MD-113)
- Connectorized Package (MD-141)



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-1000 MHz
	IF Port		DC-1000 MHz
Conversion Loss	5-50 MHz		7.5 dB Max
	50-500 MHz		7.5 dB Max
	500-1000 MHz		8.0 dB Max
Isolation	LO to RF	(5-50 MHz)	35 dB Min
		(50-500 MHz)	30 dB Min
		(500-1000 MHz)	25 dB Min
	LO to IF	(5-50 MHz)	30 dB Min
		(50-500 MHz)	25 dB Min
		(500-1000 MHz)	20 dB Min
	RF to IF	(5-50 MHz)	25 dB Min
		(50-500 MHz)	20 dB Min
		(500-1000 MHz)	15 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated linearly to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		≤2 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)		100-550 MHz ≥47 dB 550-800 MHz ≥38 dB 800-1000 MHz ≥44 dB
Package Type		MD-113 Flatpack (FP-2) MD-141 Connectorized (C-9)

(See pages 474 and 482 for physical dimensions.)

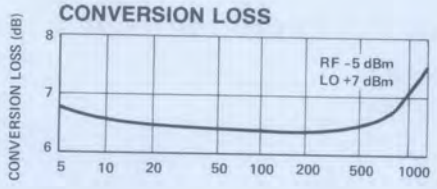
Environmental

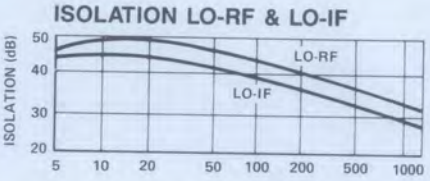
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

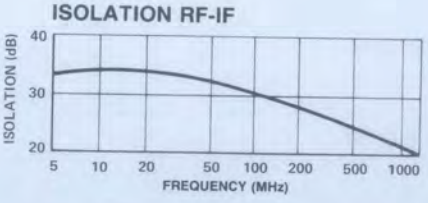
Pin Configuration RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

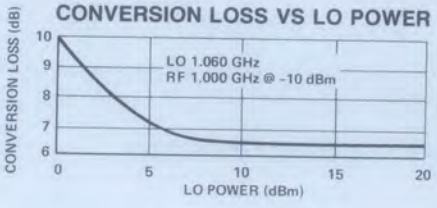
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance









Ordering Information

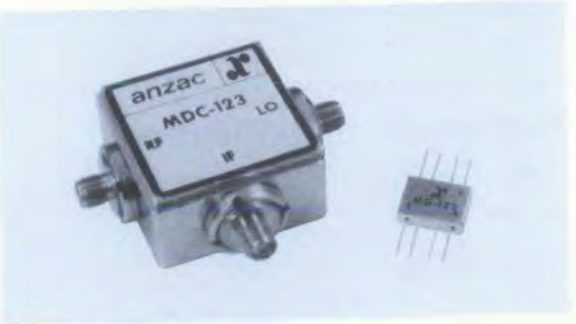
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-113	9819	Pin	$26
MD-141	8021	BNC	67
MD-141	8024	SMA	71

Delivery is from stock.

MODEL MD-/MDC-123

HIGH PERFORMANCE DOUBLE-BALANCED MIXER 10 MHz-3 GHz

- Usable to 4 GHz
- +7 dBm Typical Compression Level
- Excellent Intermodulation Rejection



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.01 - 3 GHz
	IF Port		0.01 - 3 GHz
Conversion Loss**			8 dB Max†
Isolation	LO to RF	(10-500 MHz)	25 dB Min
		(500-1000 MHz)	30 dB Min
		(1000-3000 MHz)	25 dB Min
	LO to IF	(10-500 MHz)	20 dB Min
		(500-1000 MHz)	25 dB Min
		(1000-3000 MHz)	25 dB Min
	RF to IF	(10-500 MHz)	20 dB Min
		(500-1000 MHz)	25 dB Min
		(1000-3000 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 7 mV Typical
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-2000 MHz ≥ 56 dB
Package Type	Flatpack (FP-2) Connectorized (C-7)

(See pages 474 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

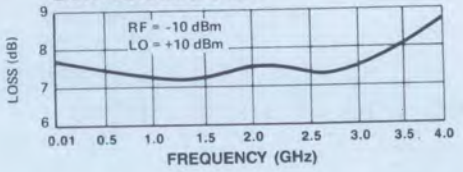
*All specifications apply when operated at +10 to +13 dBm available LO power with 50 ohm source and load impedance.

**Specified for IF frequency of 10 MHz to 2 GHz. See IF Port Bandwidth Graph.

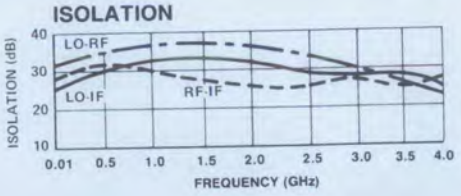
†8.5 dB for MDC-123, 1500-3000 MHz.

Typical Performance

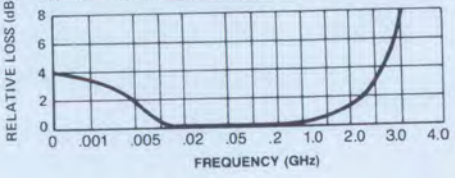
CONVERSION LOSS



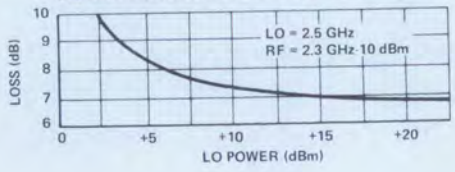
ISOLATION



IF PORT RESPONSE



CONVERSION LOSS VS LO POWER



Ordering Information

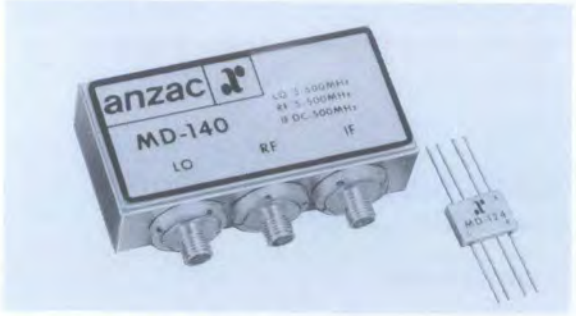
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-123	9859	Pin	$ 98
MDC-123	9854	SMA	185

Delivery is from stock.

MODELS MD-124/140

DOUBLE-BALANCED MIXERS
500 kHz-500 MHz

- Usable Down to 200 kHz
- 6.5 dB Typical Conversion Loss
- Available in Flatpack (MD-124) and Connectorized (MD-140) Versions



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss			7 dB Max
Isolation	LO to RF	(0.5-10 MHz)	35 dB Min
		(10-200 MHz)	30 dB Min
		(200-500 MHz)	25 dB Min
	LO to IF	(0.5-10 MHz)	30 dB Min
		(10-200 MHz)	25 dB Min
		(200-500 MHz)	20 dB Min
	RF to IF	(0.5-10 MHz)	25 dB Min
		(10-200 MHz)	15 dB Min
		(200-500 MHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	+2 dBm Typical
1 dB Desensitization	−2 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-400 MHz ≥50 dB 400-500 MHz ≥40 dB
Package Type	MD-124 Flatpack (FP-2) MD-140 Connectorized (C-9) (See pages 474 and 482 for physical dimensions.)

Environmental

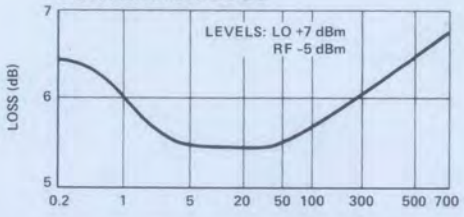
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

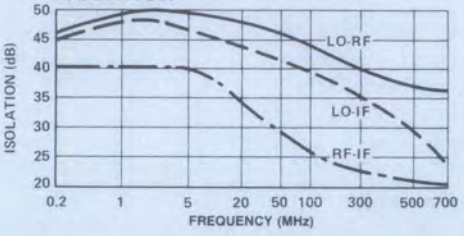
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance

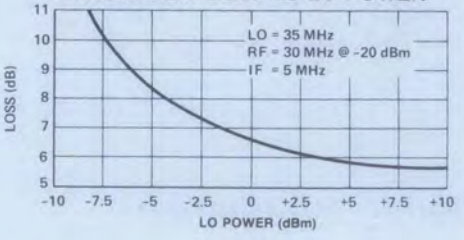
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



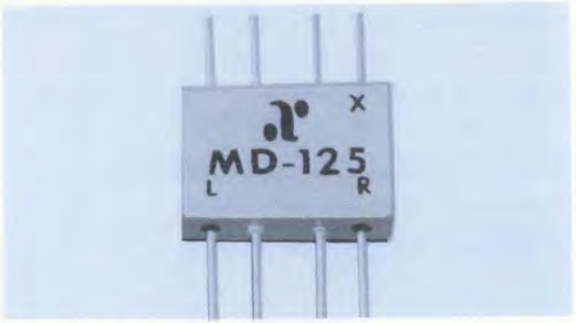
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-124	9939	Pin	$68
MD-140	8294	SMA	83
MD-140	8291	BNC	79

Delivery is from stock.

MODEL MD-125 HIGH LEVEL DOUBLE-BALANCED MIXER 500 kHz-500 MHz

- 17.5 dBm Typical 3rd Order Intercept
- High Input Compression Point
- 6 dB Typical Conversion Loss
- High Level Phase Detector



Guaranteed Specifications*

(From −54°C to +85°C)

Frequency Range	RF, LO Ports	0.5-500 MHz
	IF Port	DC-500 MHz
Conversion Loss	0.5-500 MHz	9 dB Max
	1-200 MHz	7 dB Max
Isolation	LO to RF (0.5-500 MHz)	30 dB Min
	LO to IF (0.5-500 MHz)	30 dB Min
	RF to IF (0.5-500 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Positive
DC Offset	⩽2 mV Typical
RF Input	
1 dB Compression†	+11 dBm Typical
1 dB Desensitization†	+8 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	20-30 MHz⩾65 dB 80-430 MHz⩾55 dB
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental

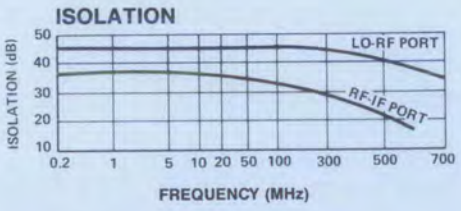
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

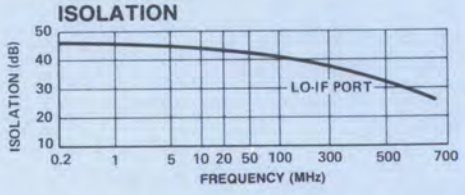
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

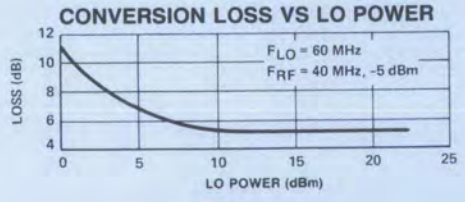
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

†These characteristics apply at +20 dBm LO power.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-125	8229	Pin	$97

Delivery is from stock.

MODEL MD-138 HIGH LEVEL DOUBLE-BALANCED MIXER 1-500 MHz

- Low Third Order Distortion — Typical +24 dBm Third Order Intercept Point
- High Compression Point — +14 dBm Minimum

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	1-400 MHz		8.5 dB Max
	400-500 MHz		9.5 dB Max
Isolation	LO to RF	(1-150 MHz)	45 dB Min
		(150-400 MHz)	25 dB Min
		(400-500 MHz)	20 dB Min
	LO to IF	(1-150 MHz)	45 dB Min
		(150-400 MHz)	25 dB Min
		(400-500 MHz)	20 dB Min
	RF to IF	(1-150 MHz)	25 dB Min
		(150-400 MHz)	20 dB Min
		(400-500 MHz)	20 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive (with P5 grounded)
DC Offset		⩾ 2 mV Typical
RF Input		
1 dB Compression		
1-100 MHz		+19 dBm Typical
100-500 MHz		+14 dBm Typical
1 dB Desensitization		+12 dBm Typical
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −5 dBm input, each input, 60 MHz and 70 MHz IF)	80-125 MHz	⩾ 55 dB
	175-350 MHz	⩾ 60 dB
Package Type		Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration RF; P8, LO; P1 & P5, IF; P3 & P7. Case and all other pins are ground.

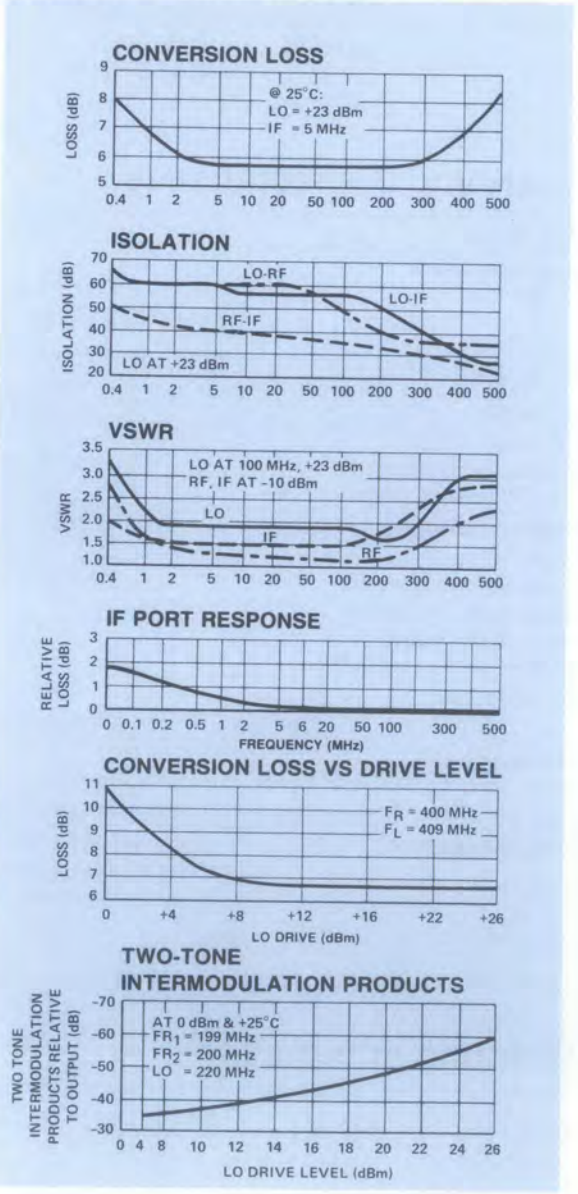
*All specifications apply when operated at +23 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-138	8279	Pin	$62

Delivery is from stock.

Typical Performance



MODEL MD-139 — HIGH LEVEL DOUBLE-BALANCED MIXER 1-500 MHz

- High Compression Level — Typically +20 dBm
- Typical +24 dBm Third Order Intercept Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	1-200 MHz		7 dB Max
	200-500 MHz		9 dB Max
Isolation	LO to RF	(1-50 MHz)	45 dB Min
		(50-500 MHz)	30 dB Min
	LO to IF	(1-50 MHz)	35 dB Min
		(50-500 MHz)	25 dB Min
	RF to IF	(1-50 MHz)	45 dB Min
		(50-500 MHz)	30 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Positive
DC Offset	≤ 2 mV Typical
RF Input**	
1 dB Compression	+20 dBm Typical
1 dB Desensitization	+17 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −5 dBm input, each input, 60 MHz and 70 MHz IF)	80-300 MHz ≥ 58 dB
Package Type	Flatpack (FP-3) (See page 474 for physical dimensions.)

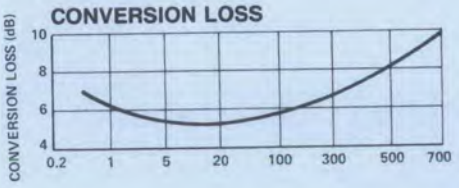
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

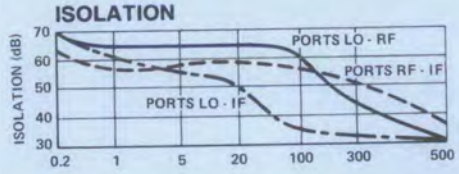
Pin Configuration — RF; P10, LO; P6, IF; P3. Case and all other pins are ground.

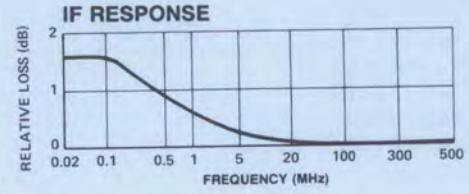
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

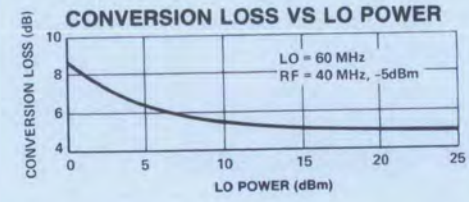
**These specifications apply at +23 dBm LO power.

Typical Performance









Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-139	8289	Pin	$85

Delivery is from stock.

NEW

MODEL MDS-147

SURFACE MOUNT DOUBLE-BALANCED MIXER 10 - 1500 MHz

- Fully Hermetic Package
- +5 dBm 1 dB Compression Point
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF, LO-IF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-800 MHz		7.5 dB Max
	800-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	25 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤10 mV Typical
RF Input	
1 dB Compression	+10 dBm Typical
1 dB Desensitization	+8 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 50 MHz and 60 MHz IF)**	≥ 54 dB
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

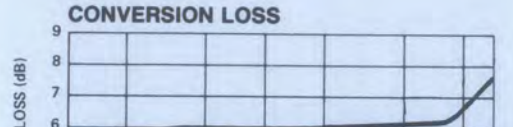
Environmental

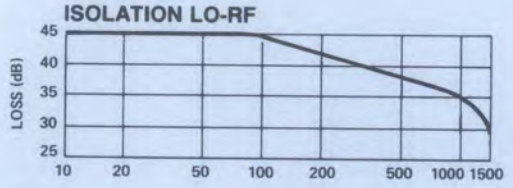
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

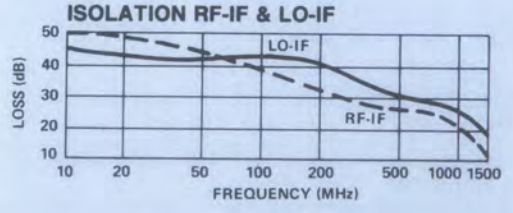
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

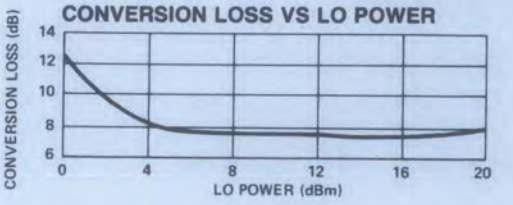
*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.
**Measured at 1500 MHz

Typical Performance









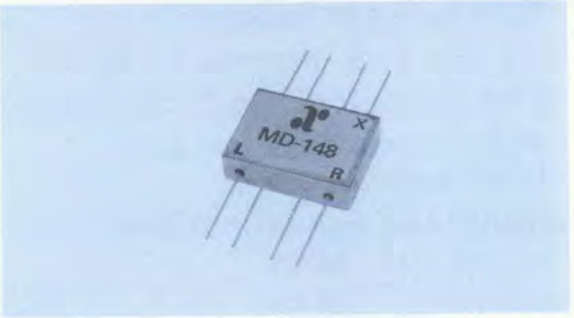
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-147	PIN	$86

Delivery is from stock.

MODEL MD-148 — FLATPACK DOUBLE-BALANCED MIXER 10-1500 MHz

- +5 dBm 1 dB Compression Point
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF, LO-IF Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-800 MHz		7.5 dB Max
	800-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	25 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

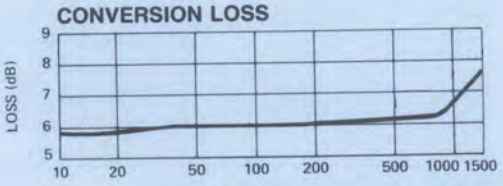
Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤10 mV Typical
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio ** **(with −10 dBm input, each input, 50 MHz and 60 MHz IF)**	≥ 50 dB
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)
Environmental	These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

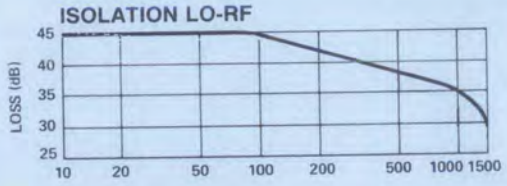
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**Measured at 1500 MHz.

Typical Performance

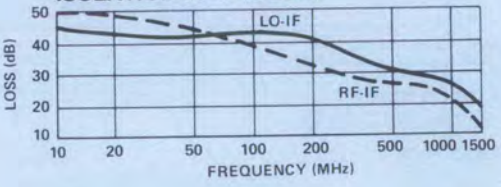
CONVERSION LOSS



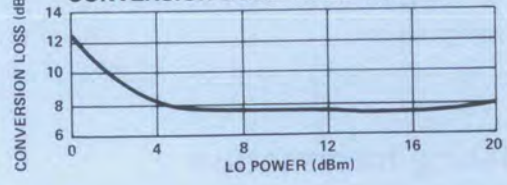
ISOLATION LO-RF



ISOLATION RF-IF & LO-IF



CONVERSION LOSS VS LO POWER



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-148	9539	Pin	$47

Delivery is from stock.

NEW

MODEL MDS-148

SURFACE MOUNT DOUBLE-BALANCED MIXER 10 - 1500 MHz

- Fully Hermetic Package
- +5 dBm 1 dB Compression Point
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF, LO-IF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-800 MHz		7.5 dB Max
	800-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	25 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤10 mV Typical
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 50 MHz and 60 MHz IF)**	≥ 50 dB @ 1500 MHz
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground

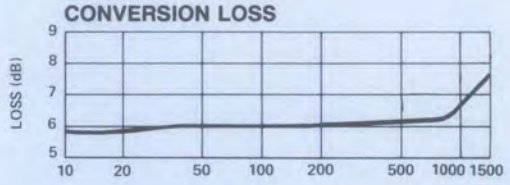
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**Measured at 1500 MHz

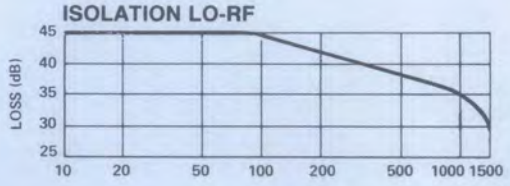
Ordering Information

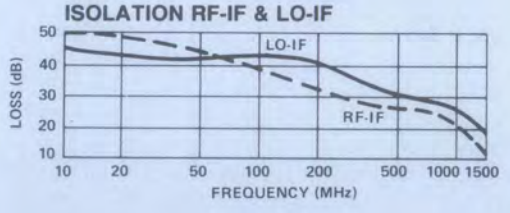
Model No.	Connectors	Unit Price (5-9 Units)
MDS-148	PIN	$55

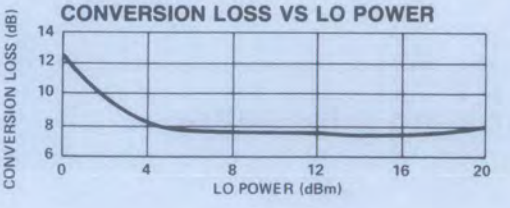
Delivery is from stock.

Typical Performance





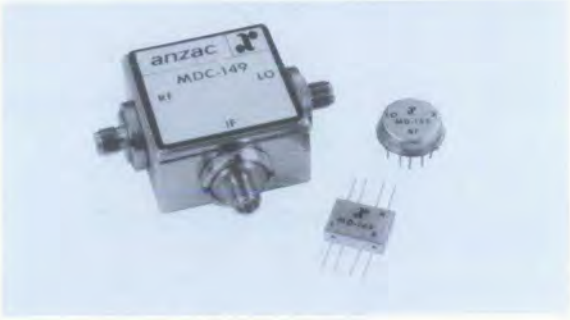




MODELS MD-/MDC-149 MD-152

BROADBAND DOUBLE-BALANCED MIXERS 10-1500 MHz

- Over Two-Decade Frequency Range
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-1000 MHz		7.5 dB Max
	1000-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	30 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max
		Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		≤ 4 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)		100-500 MHz ≥48 dB 500-1000 MHz ≥43 dB 1000-1500 MHz ≥35 dB
Package Type		MD-149 Flatpack (FP-2) MDC-149 Connectorized (C-7) MD-152 Pin (TO-8-2)

(See pages 474, 481 and 472 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration MD-149 RF; P8, LO; P5, IF; P4.
MD-152 RF; P11, LO; P8, IF; P2.
All other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

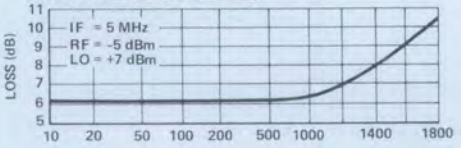
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-149	8599	Pin	$ 47
MDC-149	8594	SMA	134
MD-152	8769	Pin	45

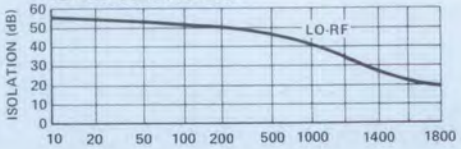
Delivery is from stock.

Typical Performance

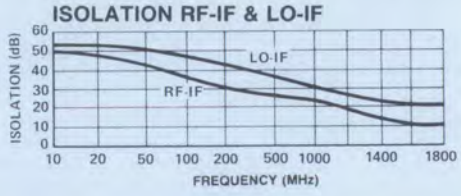
CONVERSION LOSS



ISOLATION LO-RF



ISOLATION RF-IF & LO-IF



CONVERSION LOSS VS LO POWER

NEW

MODEL MDS-149 — SURFACE MOUNT DOUBLE-BALANCED MIXER 10 - 1500 MHz

- Fully Hermetic Package
- Over Two-Decade Frequency Range
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-1000 MHz		7.5 dB Max
	1000-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	30 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max
		Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		⩽ 4 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)		100-500 MHz ⩾48 dB 500-1000 MHz ⩾43 dB 1000-1500 MHz ⩾35 dB
Package Type		Surface Mount (SF-1)
		(See page 490 for physical dimensions.)

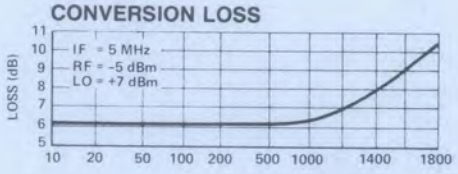
Environmental

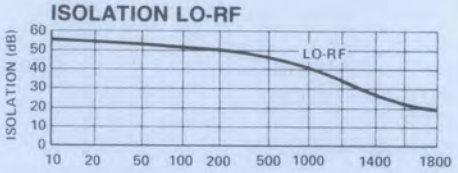
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

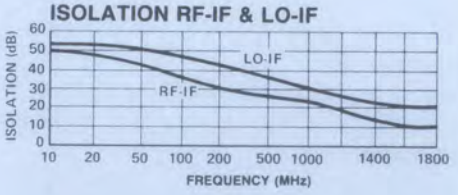
Pin Configuration	RF; P4, LO; P3, IF; P2
	All other pins are ground.

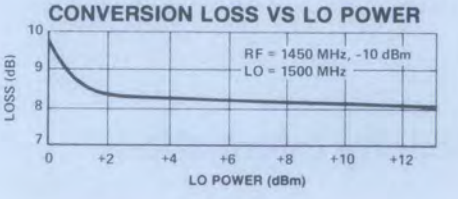
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance









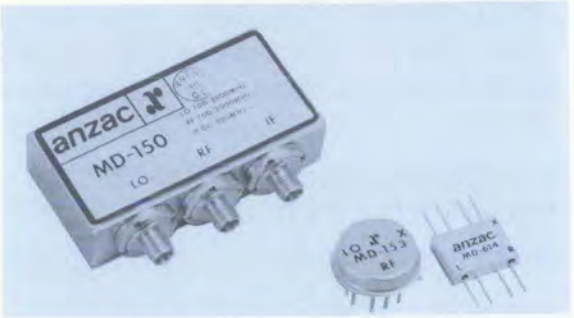
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-149	PIN	$55

Delivery is from stock.

MODELS MD-150/153/614 — BROADBAND DOUBLE-BALANCED MIXERS 0.7-2 GHz

- 6 dB Typical Midband Conversion Loss
- 25 dB Typical Midband Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		700 MHz-2 GHz
	IF Port		DC-300 MHz
Conversion Loss			8 dB Max
Isolation	LO to RF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	20 dB Min
	LO to IF	(0.7-1 GHz)	20 dB Min
		(1-2 GHz)	12 dB Min
	RF to IF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	600-2000 MHz ≥ 36 dB
Package Type	MD-150 Connectorized (C-9) MD-153 Pin (TO-8-2) MD-614 Flatpack (FP-2) (See pages 482, 472 and 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

MD-153	RF; P11, LO; P8, IF; P2. Case and all other pins are ground.
MD-614	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

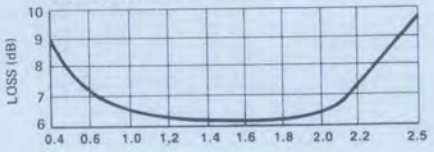
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-150	8654	SMA	$107
MD-153	8779	Pin	58
MD-614	9719	Pin	62

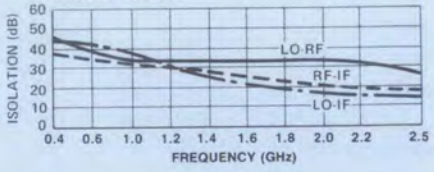
Delivery is from stock.

Typical Performance

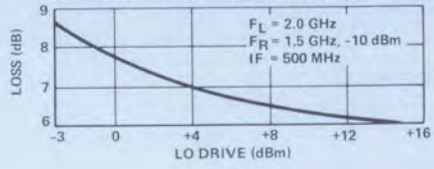
CONVERSION LOSS



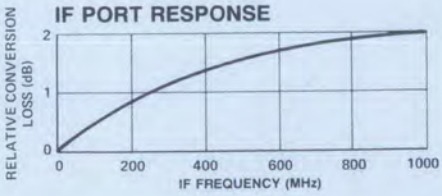
ISOLATION



CONVERSION LOSS VS DRIVE LEVEL



IF PORT RESPONSE



MODEL MD-151 — HIGH LEVEL DOUBLE-BALANCED MIXER 5-500 MHz

- + 19 dBm Typical Third Order IM Intercept
- + 13 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss			
	5-200 MHz		8.8 dB Max
	200-500 MHz		9.8 dB Max
Isolation	LO to RF	(5-200 MHz)	30 dB Min
		(200-500 MHz)	25 dB Min
	LO to IF	(5-200 MHz)	25 dB Min
		(200-500 MHz)	15 dB Min
	RF to IF	(5-200 MHz)	18 dB Min
		(200-500 MHz)	13 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 3 mV Typical
RF Input	
1 dB Compression	+ 13 dBm Typical
1 dB Desensitization	+ 10 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	80-250 MHz ≥ 48 dB 250-430 MHz ≥ 51 dB
Package Type	Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration RF; P8, LO; P1, IF; P3 & P7**, P5; External ground. Case and all other pins are ground.

*All specifications apply when operated at + 17 dBm available LO power with 50 ohm source and load impedance.

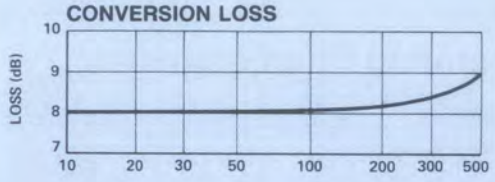
**P3 & P7 are connected together externally to make an IF Port.

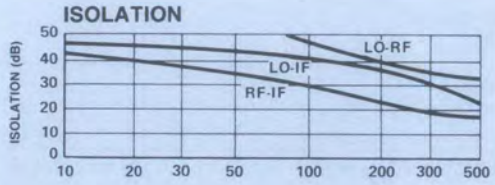
Ordering Information

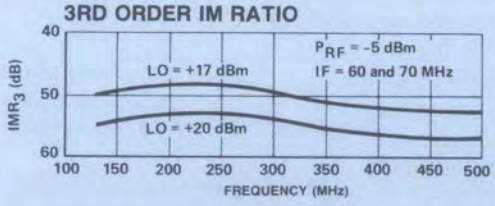
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-151	8689	Pin	$43

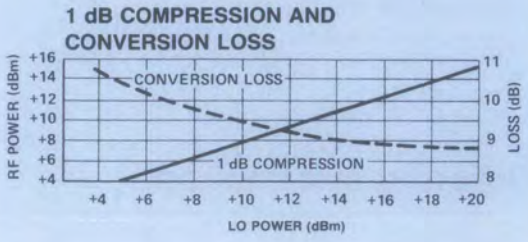
Delivery is from stock.

Typical Performance





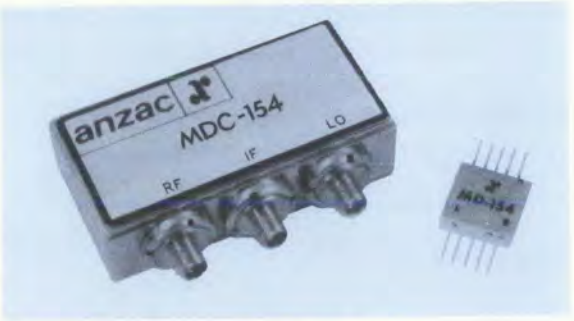




MODELS MD-/MDC-154

BROADBAND DOUBLE-BALANCED MIXER 0.3-5 GHz

- Broadband Frequency Coverage
- 6.5 dB Typical Midband Conversion Loss



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.3-5 GHz
	IF Port		0.1-3000 MHz
Conversion Loss†	0.3-4 GHz		8 dB Max
	0.3-5 GHz		10 dB Max**
Isolation	LO to RF	(0.8-2 GHz)	20 dB Min
		(0.5-5 GHz)	14 dB Min
		(0.3-0.5 GHz)	11 dB Min
	LO to IF	(0.8-2 GHz)	20 dB Min
		(0.3-5 GHz)	15 dB Min
	RF to IF	(0.5-4 GHz)	20 dB Min
		(0.3-5 GHz)	17dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+4.5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input each tone and 10 MHz IF)	62 dB Typical @ 400 MHz 57 dB Typical @ 1500 MHz
Package Type	MD-154 Flatpack (FP-3) MDC-154 Connectorized (C-9) (See pages 474 and 482 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P10, LO; P6, IF; P5. Case and all other pins are ground.

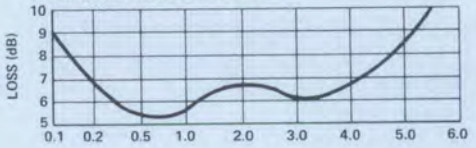
All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

**11 dB for MDC-154.

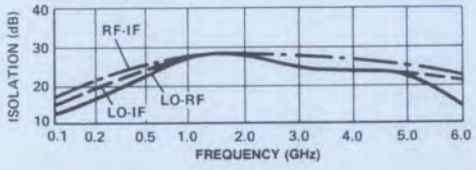
†For IF Frequencies to 500 MHz.

Typical Performance

CONVERSION LOSS

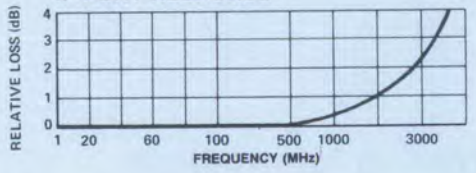


ISOLATION



CONVERSION LOSS VS LO POWER

IF PORT RESPONSE



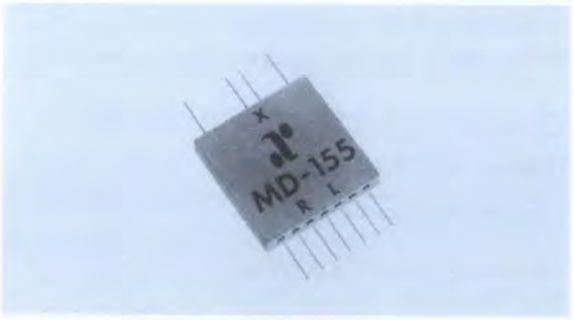
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-154	8109	Pin	$134
MDC-154	8104	SMA	221

Delivery is from stock.

MODEL MD-155 HIGH LEVEL DOUBLE-BALANCED MIXER 5-500 MHz

- +35 dBm Typical Third Order IM Intercept
- +23 dBm Typical Midband 1 dB Compression
- +27 dBm LO Power



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	5-500 MHz
	IF Port	3-200 MHz
Conversion Loss	5-100 MHz	8.0 dB Max
	5-500 MHz	9.5 dB Max
Isolation	LO to RF (5-500 MHz)	20 dB Min
	LO to IF (5-500 MHz)	25 dB Min
	RF to IF (5-500 MHz)	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	1 Watt Max
	Derated to 85°C @ 4.8 mW/°C
RF Input	
1 dB Compression	+23 dBm Typical
1 dB Desensitization	+23 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Two-Tone IM Ratio (with 0 dBm input, each tone and 60 MHz IF)	70 dB Typical
Package Type	Flatpack (FP-5)
	(See page 475 for physical dimensions.)

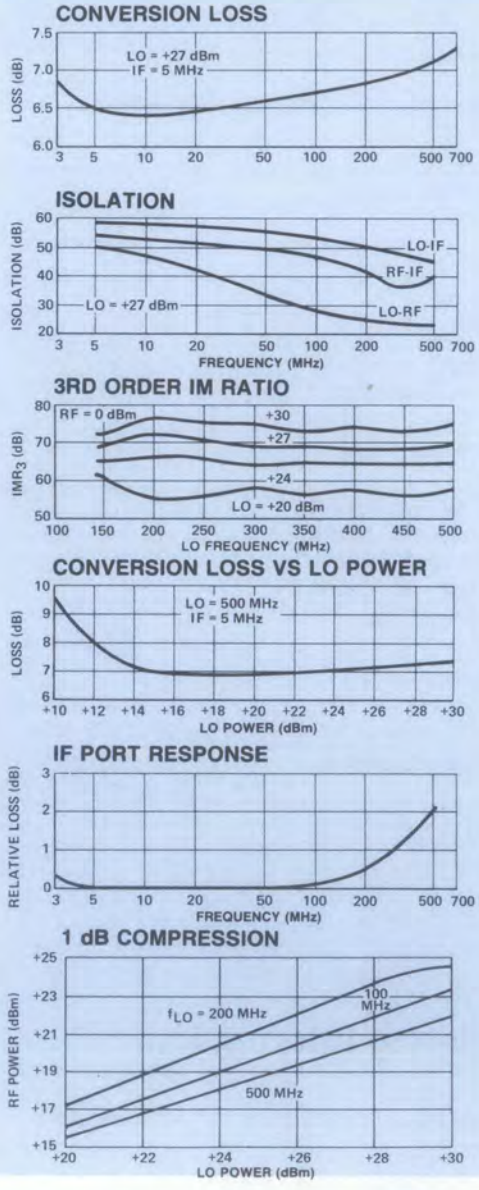
Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P10, LO; P12, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +27 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



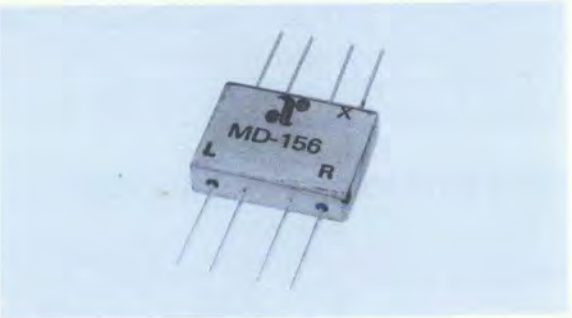
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-155	8049	Pin	$174

Delivery is from stock.

MODEL MD-156 FLATPACK DOUBLE-BALANCED MIXER 0.6-3 GHz

- 6.5 dB Typical Noise Figure
- 30 dB Typical LO-RF Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		600-3000 MHz
	IF Port		DC-1000 MHz
Conversion Loss and SSB Noise Figure	800-2000 MHz		8.0 dB Max
	600-3000 MHz		9.0 dB Max
Isolation	LO to RF	(600-2000 MHz)	25 dB Min
		(2000-3000 MHz)	20 dB Min
	LO to IF	(600-2000 MHz)	20 dB Min
		(2000-3000 MHz)	17 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽ 6 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−4 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 60 MHz and 70 MHz IF)	44 dB @ 800 MHz 40 dB @ 1500 MHz 40 dB @ 2500 MHz
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental

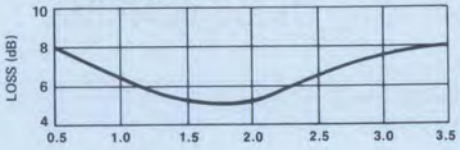
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

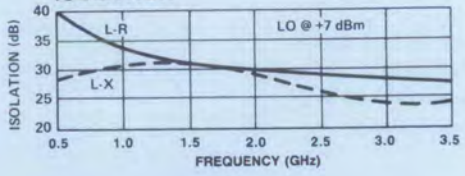
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance

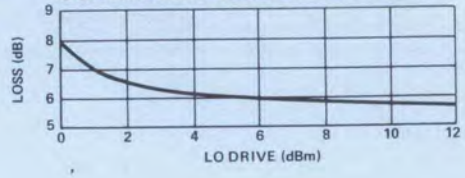
CONVERSION LOSS



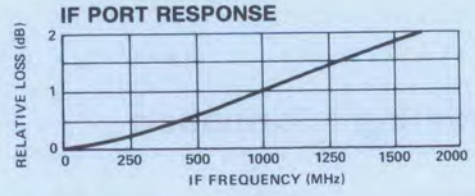
ISOLATION



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



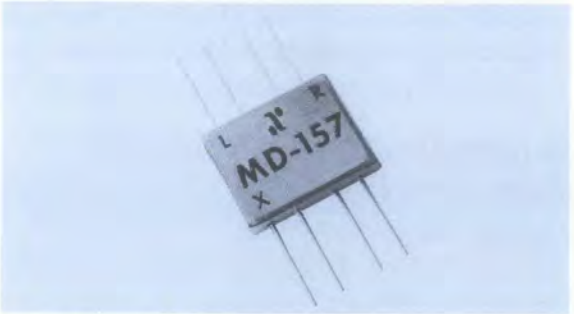
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-156	8039	Pin	$85

Delivery is from stock.

MODEL MD-157 DOUBLE-BALANCED MIXER 0.8-4 GHz

- 6 dB Typical Midband Conversion Loss
- 30 dB Typical Midband LO-RF Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.8-4 GHz
	IF Port		DC-1500 MHz
Conversion Loss**	800-4000 MHz		8 dB Max
	1500-3500 MHz		7 dB Max
Isolation	LO to RF	(800-4000 MHz)	20 dB Min
		(800-2000 MHz)	25 dB Min
	LO to IF	(800-4000 MHz)	12 dB Min
		(800-2000 MHz)	17 dB Min
	RF to IF	(800-4000 MHz)	15 dB Min
		(800-3000 MHz)	20 dB Min

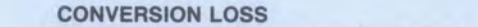
Operating Characteristics

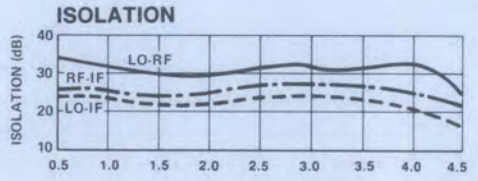
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 8 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−4 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	36 dB @ 2 GHz 32 dB @ 4 GHz
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)
Environmental	These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.
Pin Configuration	RF; P5, LO; P8, IF; P4. Case and all other pins are ground.

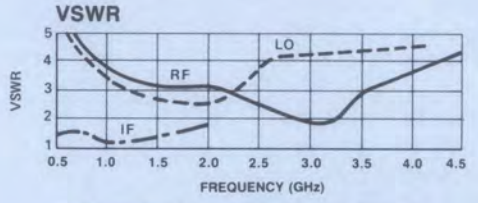
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

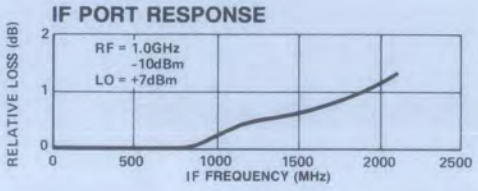
**For IF Frequencies to 500 MHz.

Typical Performance









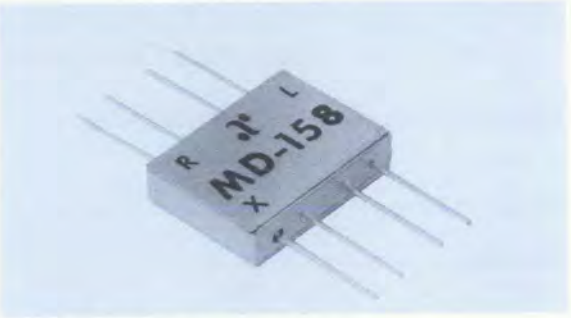
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-157	8709	Pin	$107

Delivery is from stock.

MODEL MD-158 DOUBLE-BALANCED MIXER 5-1500 MHZ

- 6 dB Typical Midband Conversion Loss
- 35 dB Typical Midband LO-RF Isolation
- 1.5 dB Typical Conversion Loss Flatness



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-1500 MHz
	IF Port		DC-1000 MHz
Conversion Loss	5-1500 MHz		9 dB Max
	5-1000 MHz		7 dB Max
Isolation	LO to RF	(5-1500 MHz)	20 dB Min
		(5-1000 MHz)	25 dB Min
		(5-600 MHz)	30 dB Min
	LO to IF	(5-1500 MHz)	17 dB Min
		(5-1000 MHz)	20 dB Min
	RF to IF	(5-1500 MHz)	8 dB Min
		(5-1000 MHz)	18 dB Min
		(5-600 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽1 mV Typical
RF Input	
1 dB Compression	+1 dBm Typical
1 dB Desensitization	−1 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	50 dB @ 300 MHz 48 dB @ 1000 MHz
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

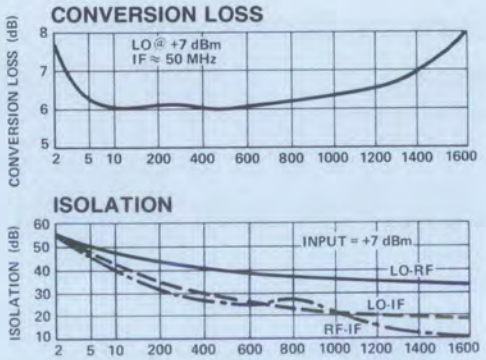
Environmental

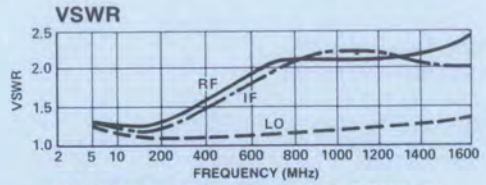
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

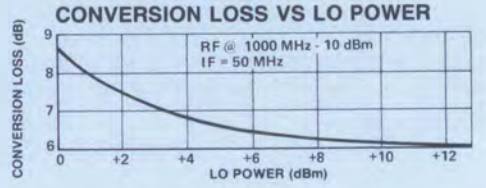
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

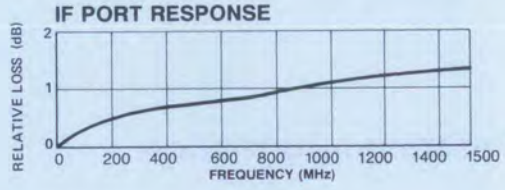
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance









Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-158	8719	Pin	$62

Delivery is from stock.

NEW

MODEL MDS-158 DOUBLE BALANCED MIXER 5-1500 MHZ

- Surface Mount Package
- 6 dB Typical Midband Conversion Loss
- 30 dB Typical Midband LO-RF Isolation
- 1.5 dB Typical Conversion Loss Flatness

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
RF, LO Ports		5-1500 MHz
IF Port		DC-1000 MHz
Conversion Loss	5-1500 MHz	9 dB Max
	5-1000 MHz	7.5 dB Max
Isolation		
LO to RF	(5-1500 MHz)	20 dB Min
	(5-1000 MHz)	25 dB Min
LO to IF	(5-1500 MHz)	15 dB Min
	(5-600 MHz)	20 dB Min
RF to IF	(5-1500 MHz)	8 dB Min
	(5-1000 MHz)	16 dB Min
	(5-600 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽1 mV Typical
RF Input	
1 dB Compression	+1 dBm Typical
1 dB Desensitization	−1 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	50 dB @ 300 MHz 48 dB @ 1000 MHz
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

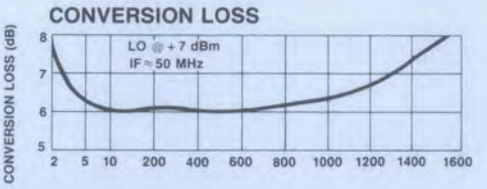
Environmental

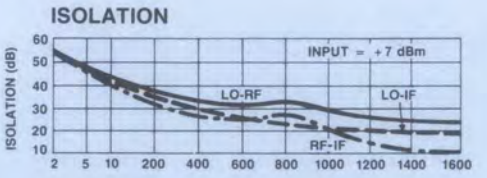
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

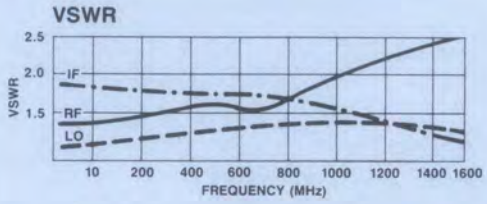
Pin Configuration	RF; P4, LO; P3, IF; P2. Case and all other pins are ground.

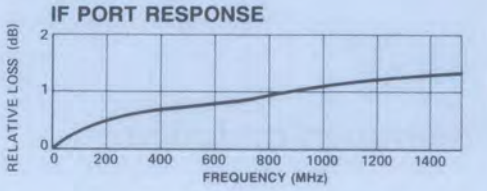
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance









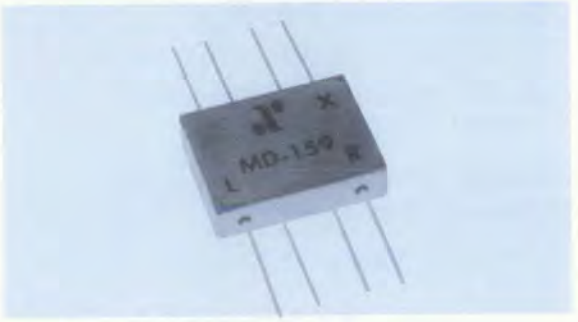
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MDS-158	6179	Pin	$68

Delivery is from stock.

MODEL MD-159 — DOUBLE-BALANCED MIXER 5-1000 MHZ

- Guaranteed VSWR
- 45 dB Typical Midband L-R Isolation
- 6 dB Typical Midband Conversion Loss



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	5-1000 MHz
	IF Port	DC-1000 MHz
Conversion Loss	10-500 MHz	7.5 dB Max
	5-1000 MHz	8.5 dB Max
Isolation	**5-500 MHz**	**500-1000 MHz**
LO to RF	35 dB Min	30 dB Min
LO to IF	30 dB Min	22 dB Min
RF to IF	25 dB Min	20 dB Min
VSWR (LO, RF)	**10-500 MHz**	**5-1000 MHz**
LO Port	1.8:1 Max	2.0:1 Max
RF Port**	1.7:1 Max	3.0:1 Max
VSWR (IF Port)**	DC-100 MHz	1.5:1 Max
	DC-500 MHz	2.0:1 Max
	DC-1000 MHz	2.5:1 Max

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		⩽1 mV Typical
RF Input	1 dB Compression	+1.5 dBm Typ
	1 dB Desensitization	−1.5 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each tone and 10 MHz separation)		50 dB @ 10 MHz 50 dB @ 100 MHz 45 dB @ 500 MHz
Package Type		Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

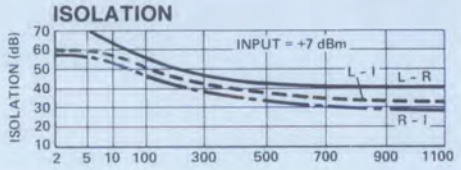
**Specified for LO power @ +7 dBm, 250 MHz; test port power @ −10 dBm.

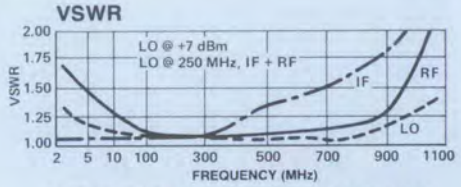
Ordering Information

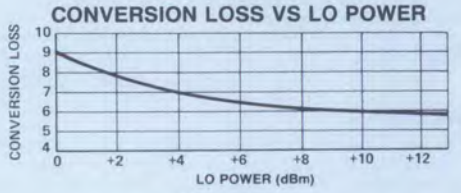
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-159	8649	Pin	$58

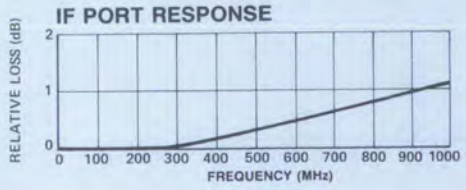
Delivery is from stock.

Typical Performance









NEW

MODEL MDS-159

SURFACE MOUNT DOUBLE-BALANCED MIXER 5 - 1000 MHz

- Fully Hermetic Package
- Guaranteed VSWR
- 45 dB Typical Midband L-R Isolation
- 6 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	5-1000 MHz
	IF Port	DC-1000 MHz
Conversion Loss	10-500 MHz	7.5 dB Max
	5-1000 MHz	8.5 dB Max
Isolation	**5-500 MHz**	**500-1000 MHz**
LO to RF	35 dB Min	30 dB Min
LO to IF	30 dB Min	22 dB Min
RF to IF	25 dB Min	20 dB Min
VSWR (LO, RF)	**10-500 MHz**	**5-1000 MHz**
LO Port	1.8:1 Max	2.0:1 Max
RF Port**	2.5:1 Max	3.0:1 Max
VSWR (IF Port)**	DC-100 MHz	1.5:1 Max
	DC-500 MHz	2.0:1 Max
	DC-1000 MHz	3.0:1 Max

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		⩽1 mV Typical
RF Input	1 dB Compression	+1.5 dBm Typ
	1 dB Desensitization	−1.5 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each tone and 10 MHz separation)		50 dB @ 10 MHz 50 dB @ 100 MHz 45 dB @ 500 MHz
Package Type		Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental

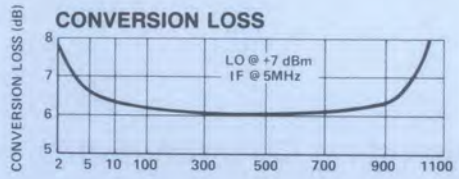
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

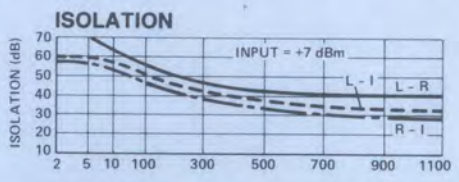
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

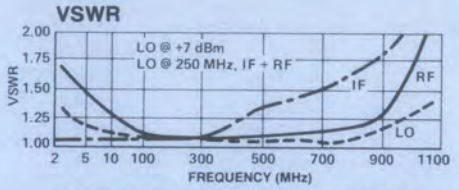
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

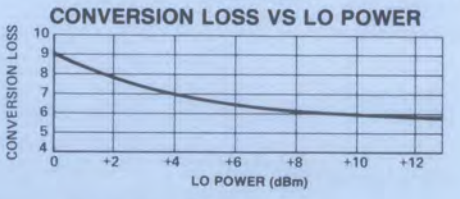
**Specified for LO power @ +7 dBm, 250 MHz, test port power @ −10 dBm

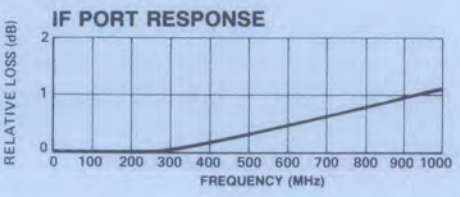
Typical Performance











Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-159	PIN	$68

Delivery is from stock.

MODEL MD-160 — TERMINATION-INSENSITIVE MIXER
1-1500 MHz

- Third Order Intermodulation Ratio is Insensitive to Port Mismatches
- 7.5 dB Typical Midband Conversion Loss
- VSWR Typically Less Than 1.5:1

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-1500 MHz
	IF Port (3 dB BW)		1-1000 MHz
Conversion Loss**	5-1000 MHz		7.5 dB Max
	1-1500 MHz		9.0 dB Max
Isolation	LO to RF	(1-5 MHz)	20 dB Min
		(5-500 MHz)	28 dB Min
		(500-1500 MHz)	25 dB Min
	LO to IF	(1-5 MHz)	20 dB Min
		(5-500 MHz)	28 dB Min
		(500-1500 MHz)	17 dB Min
	RF to IF	(1-5 MHz)	20 dB Min
		(5-500 MHz)	25 dB Min
		(500-1500 MHz)	17 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Maximum Input			
Total Power			350 mW Max @ 25°C
			Derated 3.5 mW/°C
RF Input	1 dB Compression***		+15 dBm Typ
	1 dB Desensitization***		+13 dBm Typ
SSB Noise Figure			Within 1 dB of Conversion Loss Max
3rd Order Input Intercept			
P_{LO} +13 dBm	P_{LO} +20 dBm		
+18 dBm Typ	+23 dBm Typ	@ 15 MHz	
+20 dBm Typ	+25 dBm Typ	@ 500 MHz	
+19 dBm Typ	+25 dBm Typ	@ 1000 MHz	
3rd Order Intercept Degradation			3 dB Typ @ IF VSWR 3.0:1
Package Type			Relay Header (RH-3)
			(See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration — RF; P8, LO; P1, IF; P3 & P7. Case and all other pins are ground.

*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.
**For IF frequencies of 5-1000 MHz and an RF of −10 dBm or lower.
***These characteristics apply @ +20 dBm LO power.

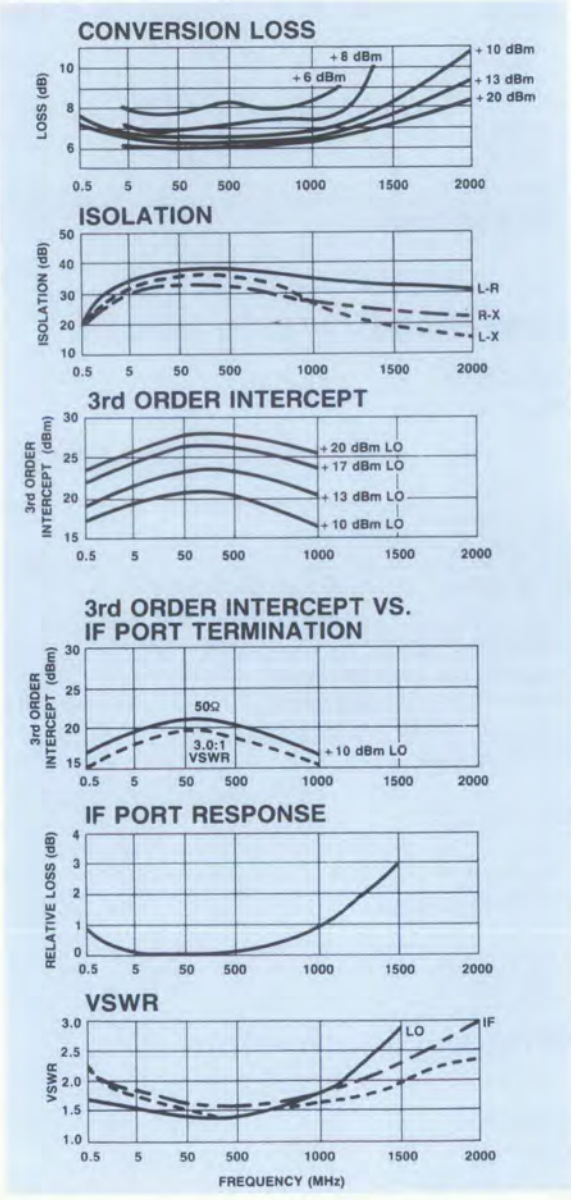
This product contains elements protected by United States Patent Number 4,224,572.

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-160	6409	Pin	$85

Delivery is from stock.

Typical Performance



MODELS MD-/MDC-161

TERMINATION-INSENSITIVE MIXER
1-500 MHz

- Third Order Intermodulation Ratio is Insensitive to Port Mismatches
- 6 dB Typical Midband Conversion Loss
- DC Coupled IF Port
- High Level Phase Detector

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	5-300 MHz		7 dB Max
	1-500 MHz		8 dB Max
Isolation	LO to RF	(1-500 MHz)	25 dB Min
	LO to IF	(1-500 MHz)	30 dB Min
	RF to IF	(1-300 MHz)	20 dB Min
		(300-500 MHz)	17 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		350 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power		+24 dBm Max
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		≤ 5 mV Typ
RF Input	1 dB Compression	+10 dBm Typ
	1 dB Desensitization	+7 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio (with −10 dBm input, each tone and 60 MHz IF)		50 dB @ 100 MHz 55 dB @ 500 MHz
3rd Order Intermodulation Ratio Degradation		3 dB Typ @ IF VSWR 3:1
Package Type		MD-161 Flatpack (FP-2) MDC-161 Connectorized (C-7) (See pages 474 and 481 for physical dimensions.)

Environmental

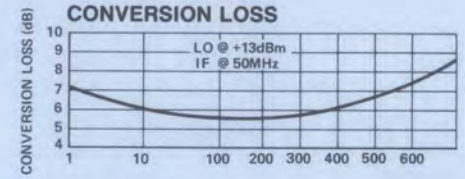
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

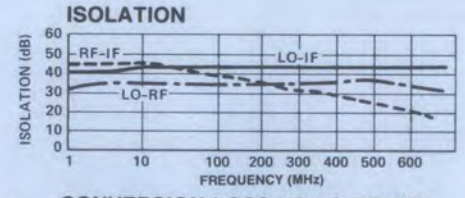
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

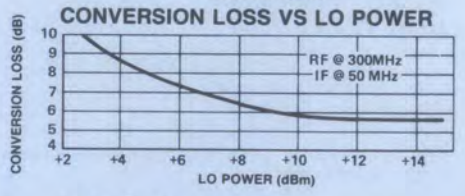
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

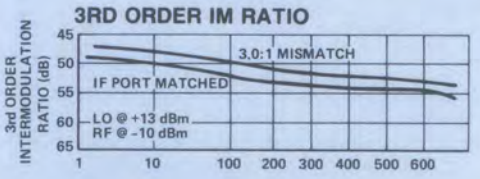
This product contains elements protected by United States Patent Number 4,224,572.

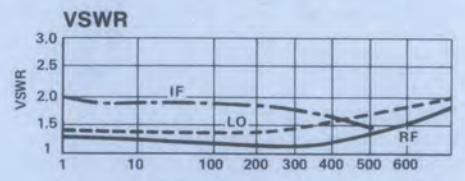
Typical Performance

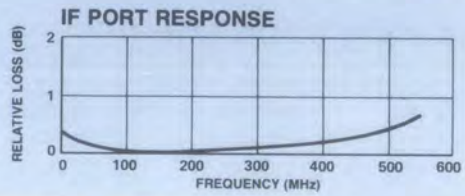












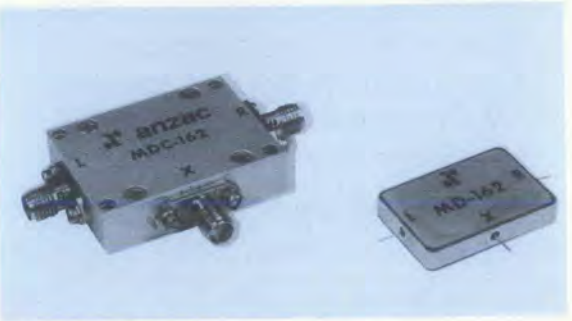
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-161	8729	Pin	$121
MDC-161	8724	SMA	207

Delivery is from stock.

MODELS MD-/MDC-162 — TERMINATION-INSENSITIVE MIXER 1-7 GHz

- Intermodulation Ratio Insensitive to IF Port Mismatches
- 6 dB Typical Midband Conversion Loss



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-7 GHz
	IF Port		10-2000 MHz
Conversion Loss**	1.5-5.5 GHz		7.5 dB Max
	1-7 GHz		8.5 dB Max
Isolation	LO to RF	(1-3 GHz)	15 dB Min
		(3-7 GHz)	17 dB Min
	LO to IF	(1-3 GHz)	20 dB Min
		(3-7 GHz)	13 dB Min
	RF to IF	(1-3 GHz)	17 dB Min
		(3-7 GHz)	12 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max @ 25°C Derated 3.5 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+8 dBm Typical
1 dB Desensitization	+6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+16.5 dBm Typical
7.0 Ghz	+18.0 dBm Typical
3rd Order Intercept Degradation	1.5 dB Typical @ IF Termination VSWR 3:1
Package Type	MD-162 Flatback (FP-18) MDC-162 Connectorized (C-2) (See pages 477 and 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

† Independent of sum frequency match.

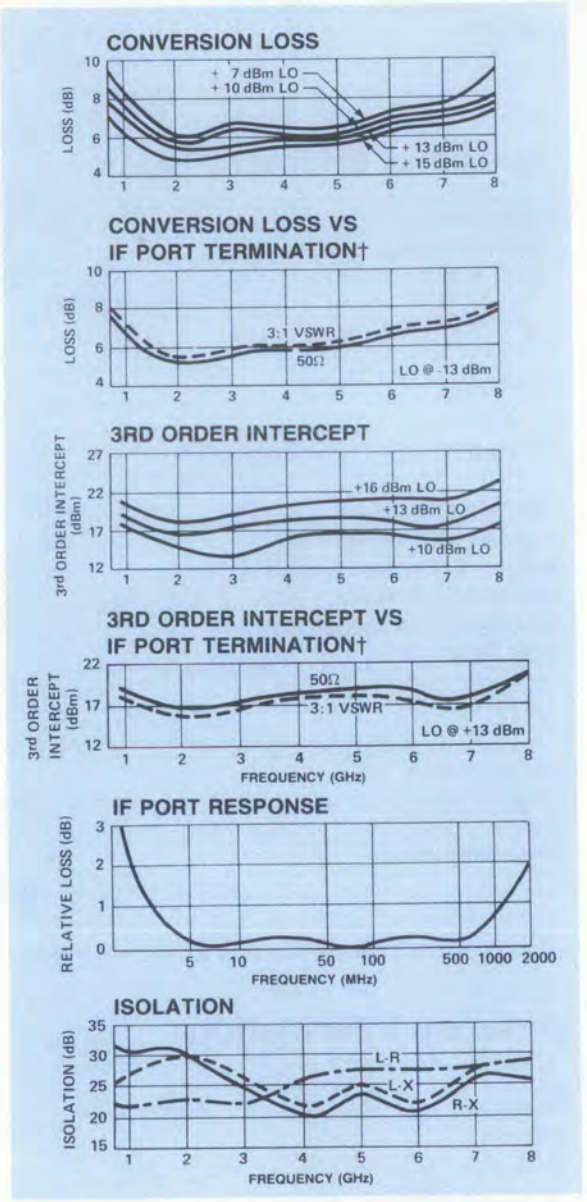
This product contains elements protected by United States Patent Number 4,224,572.

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-162	9149	Pin	$341
MDC-162	9144	SMA	428

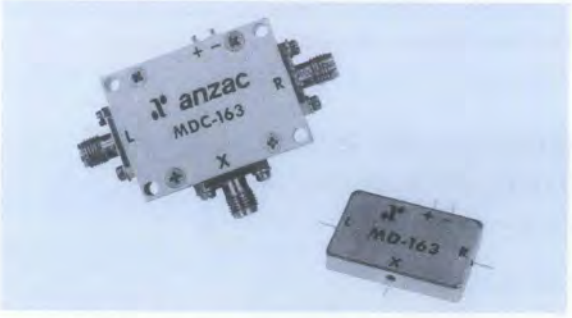
Delivery is from stock.

Typical Performance



MODELS MD-/MDC-163 — TERMINATION-INSENSITIVE BIASABLE MIXER 1-6 GHz

- LO DRIVE 0 dBm
- Intermodulation Ratio Insensitive to IF Port Mismatches
- 7 dB Typical Midband Conversion Loss



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-6 GHz
	IF Port		10-2000 MHz
Conversion Loss**	1-3 GHz		9.0 dB Max
	1-6 GHz		10.5 dB Max
Isolation	LO to RF	(1-2 GHz)	10 dB Min
		(2-6 GHz)	13 dB Min
	LO to IF	(1-6 GHz)	13 dB Min
	RF to IF	(1-6 GHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	500 mW Max @ 25°C Derated 6.4 mW/°C
DC Bias	+5, −5 VDC @ 12 mA each
RF Input	
1 dB Compression	−2 dBm Typical
1 dB Desensitization	−6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+7.0 dBm Typical
4.0 GHz	+8.0 dBm Typical
6.0 GHz	+5.0 dBm Typical
3rd Order Intercept Degradation	1.5 dB Typical @ IF Termination VSWR 3:1
Package Type	MD-162 Flatback (FP-19) MDC-162 Connectorized (C-2) (See pages 477 and 480 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Bias connection as marked, case ground.

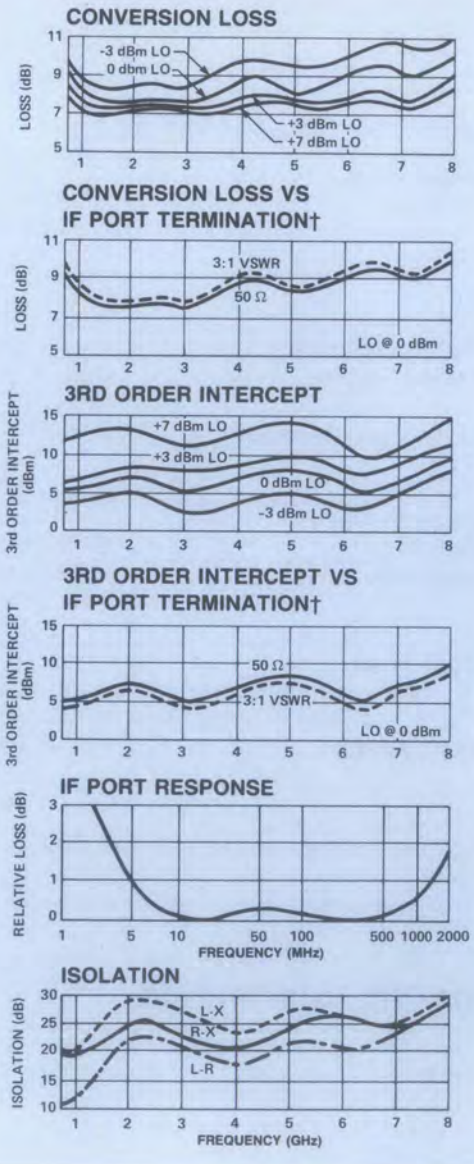
*All specifications apply when operated at 0 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

† Independent of sum frequency match.

This product contains elements protected by United States Patent Number 4,224,572.

Typical Performance



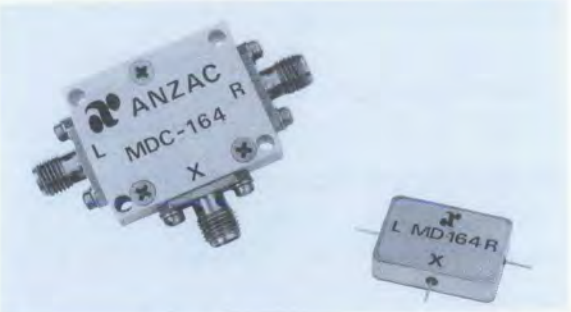
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-163	9159	Pin	$428
MDC-163	9154	SMA	515

Delivery is from stock.

MODELS MD-/MDC-164 — TERMINATION-INSENSITIVE MIXER 0.5-9 GHz

- Intermodulation Ratio Insensitive to IF Port Mismatches
- 6.5 dB Typical Midband Conversion Loss



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-9 GHz
	IF Port		10-2000 MHz
Conversion Loss**	1-7 GHz		8.5 dB Max
	0.5-1 GHz		10 dB Max
	7-9 GHz		11 dB Max
Isolation	LO to RF	(1.5-7 GHz)	17 dB Min
		(0.5-9 GHz)	13 dB Min
	LO to IF	(1-7 GHz)	20 dB Min
		(0.5-9 GHz)	17 dB Min
	RF to IF	(0.5-9 GHz)	17 dB Min

Operating Characteristics

Maximum Input	
Total Power	350 MW Max @ 25°C Derated 3.5 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+8 dBm Typical
1 dB Desensitization	+6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+15 dBm Typical
8.0 GHz	+17 dBm Typical
3rd Order Intercept Degradation	+1.5 dB Typical @ IF Termination VSWR 3:1
Package Type	MD-164 Flatpack (FP-10) MDC-164 Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

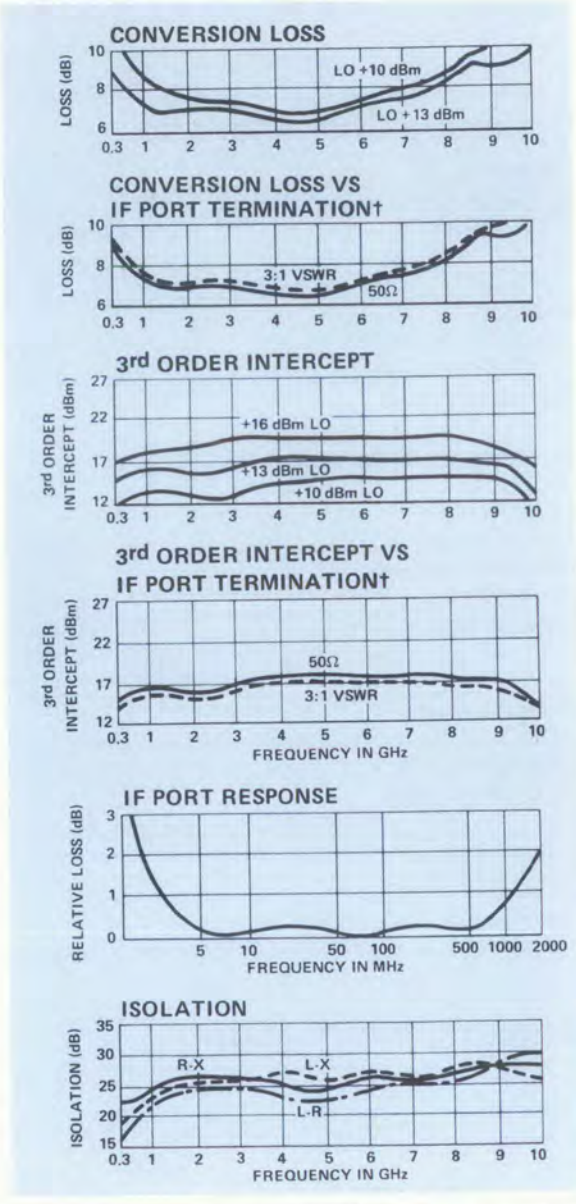
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

† Independent of sum frequency match.

This product contains elements protected by United States Patent Number 4,224,572.

Typical Performance



Ordering Information

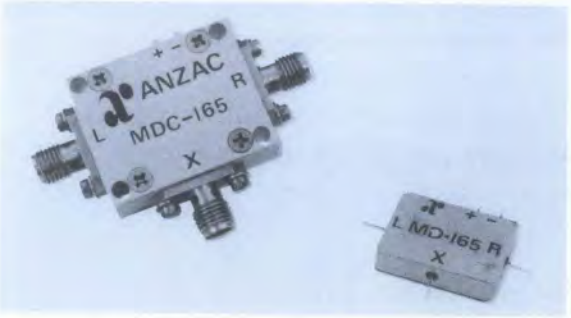
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-164	9229	Pin	$357
MDC-164	9224	SMA	444

Delivery is from stock.

MODELS MD-/MDC-165

TERMINATION-INSENSITIVE BIASABLE MIXER 0.5-8 GHz

- LO DRIVE 0 dBm
- Intermodulation Ratio Insensitive to IF Port Mismatches
- 9 dB Typical Midband Conversion Loss



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-8 GHz
	IF Port		2-2000 MHz
Conversion Loss**	1-7 GHz		11.0 dB Max
	0.5-8 GHz		12.5 dB Max
Isolation	LO to RF	(1-7 GHz)	17 dB Min
		(0.5-8 GHz)	13 dB Min
	LO to IF	(0.5-7 GHz)	17 dB Min
		(0.5-8 GHz	12 dB Min
	RF to IF	(0.5-7 GHz)	17 dB Min
		(0.5-8 GHz)	13 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	500 mW Max @ 25°C Derated 6.4 mW/°C
RF Input	
1 dB Compression	−2 dBm Typical
1 dB Desensitization	−6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+7.0 dBm Typical
8.0 GHz	+5.0 dBm Typical
3rd Order Intercept Degradation	1.5 dB Typical @ IF Termination VSWR 3:1
Package Type	MD-165 Flatpack (FP-11) MDC-165 Connectorized (C-3) (See pages 476 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Bias voltages as marked, Case ground.

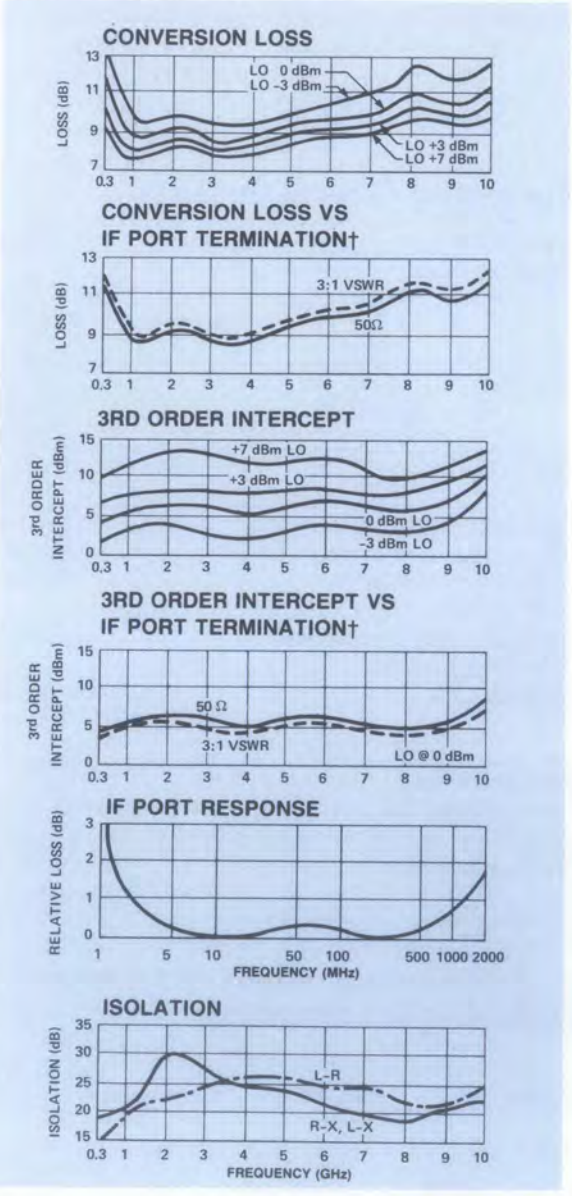
*All specifications apply when operated at 0 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

†Independent of sum frequency match.

This product contains elements protected by United States Patent Number 4,224,572.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-165	9239	Pin	$424
MDC-165	9234	SMA	511

Delivery is from stock.

MODELS MD-/MDC-169

TERMINATION INSENSITIVE MIXER 1 MHz - 3.5 GHz

- Intermodulation Ratio is Insensitive to Port Mismatches
- Typical Midband VSWR < 2.0:1
- 35 dB Typical Midband Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.001 - 3.5 GHz
	IF Port		5-1500 MHz
Conversion Loss	5-1000 MHz		7 dB Max
	5-3000 MHz		8 dB Max**
	1-3500 MHz		10 dB Max
Isolation	LO to RF	(5-1000 MHz)	30 dB Min
		(1-3500 MHz)	20 dB Min
	LO to IF	(5-1000 MHz)	30 dB Min
		(1-3500 MHz)	20 dB Min
	RF to IF	(10-500 MHz)	30 dB Min
		(1-3000 MHz)	20 dB Min
		(1-3500 MHz)	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio: (with −10 dBm input, each tone and 60 MHz IF)	55 dB @ 10 MHz 58 dB @ 500 MHz 56 dB @ 3000 MHz
3rd Order Intermodulation Ratio Degradation	3 dB Typical @ IF VSWR 3:1
Package Type	MD-169 Flatpack (FP-2) MDC-169 Connectorized (C-7) (See pages 474 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

**8.5 dB for MDC-169.

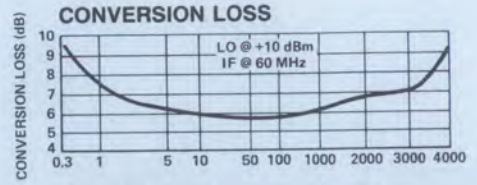
This product contains elements protected by United States Patent Number 4,224,572.

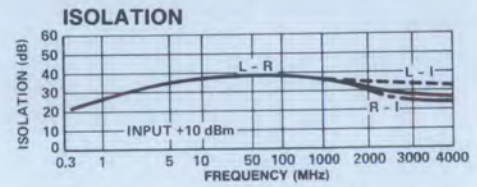
Ordering Information

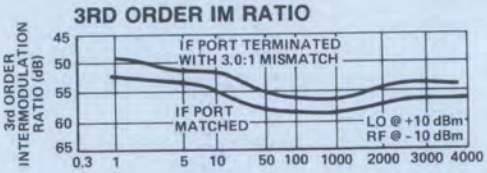
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-169	9099	Pin	$134
MDC-169	9094	SMA	221

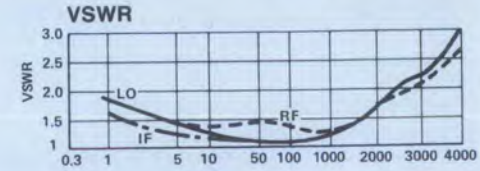
Delivery is from stock.

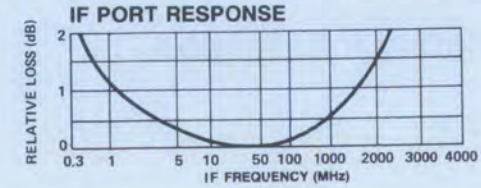
Typical Performance











MODEL MD-173 — HIGH LEVEL DOUBLE-BALANCED MIXER 5-1200 MHz

- 6 dB Midband Conversion Loss
- +25 dBm Typical Third Order Intercept
- 1 GHz Bandwidth in Relay Header Case

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-1200 MHz
	IF Port		1-1000 MHz
Conversion Loss**	5-1200 MHz		9.0 dB Max
	10-900 MHz		7.0 dB Max
Isolation	LO to RF	(5-1200 MHz)	15 dB Min
		(5-300 MHz)	20 dB Min
	LO to IF	(2-1200 MHz)	20 dB Min
	RF to IF	(5-1200 MHz)	20 dB Min
		(5-900 MHz)	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
RF Input	
1 dB Compression	+8.0 dBm Typical
1 dB Desensitization	+7.0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio* (with 0 dBm input, each tone and 10 MHz IF)**	50 dB @ 100 MHz 50 dB @ 500 MHz 40 dB @ 1000 MHz
Package Type	Relay Header (RH-3) (See page 473 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance, and pin configuration No. 1.

**Specified for IF of 1-250 MHz.

***Pin configuration No. 2 typically 10 dB lower.

†P2 and P6 are connected internally.

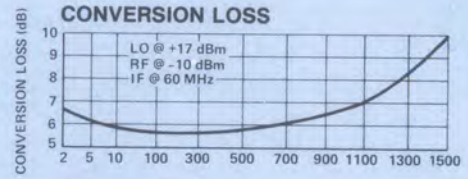
Pin Configuration †		
	1	2
RF	1	1
LO	2,6	8
IF	8	2,6
GND	3,4,5,7	3,4,5,7

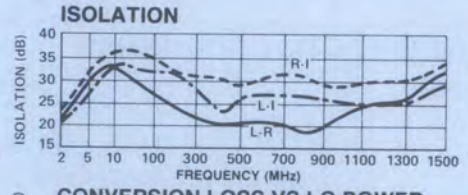
Ordering Information

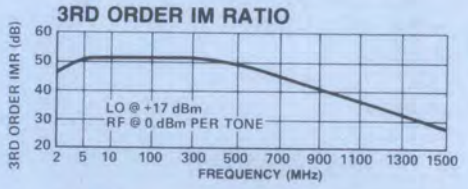
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-173	9069	Pin	$31

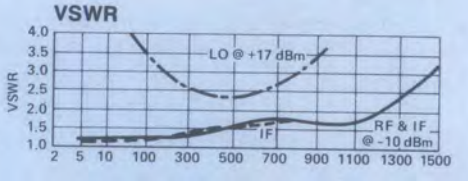
Delivery is from stock.

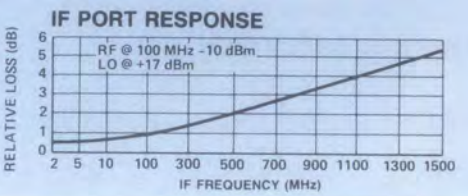
Typical Performance







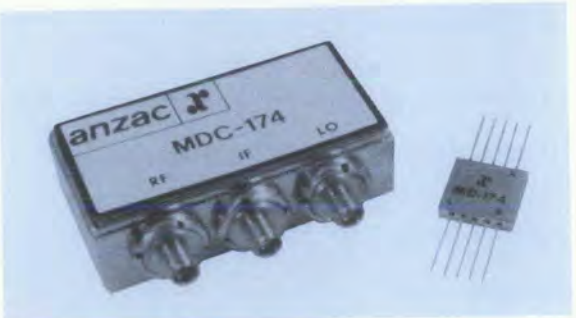




MODELS MD-/MDC-174

HIGH LEVEL TERMINATION INSENSITIVE MIXER 1-2800 MHz

- Intermodulation Ratio Insensitive to Port Mismatches
- Typical Midband VSWR < 2.0:1
- LO Drive to +27 dBm



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-2800 MHz
	IF Port		1-2000 MHz
Conversion Loss**		**MDC-174**	**MD-174**
	5-1200 MHz	7.5 dB Max	7.5 Max
	5-2000 MHz	8.5 dB Max	8.0 Max
	1-2800 MHz	9.5 dB Max	9.0 Max
Isolation	LO to RF	(1-1000 MHz)	30 dB Min
		(1-2000 MHz)	20 dB Min
		(1-2800 MHz)	15 dB Min
	LO to IF	(1-1500 MHz)	30 dB Min
		(1-2800 MHz)	25 dB Min
	RF to IF	(5-1000 MHz)	25 dB Min
		(1-2000 MHz)	20 dB Min
		(1-2800 MHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	0.5 Watt Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power	+26 dBm Max
RF Input	
1 dB Compression	+16 dBm Typical
1 dB Desensitization	+14 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio (with 0 dBm input, each tone and 10 MHz IF)	60 dB @ 100 MHz 55 dB @ 1000 MHz 52 dB @ 2800 MHz
Package Type	MD-174 Flatpack (FP-3) MDC-174 Connectorized (C-9) (See pages 474 and 482 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

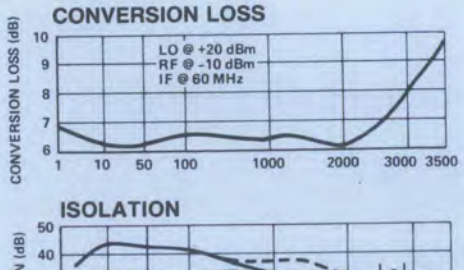
Pin Configuration	RF; P10, LO; P6, IF; P5. Case and all other pins are ground.

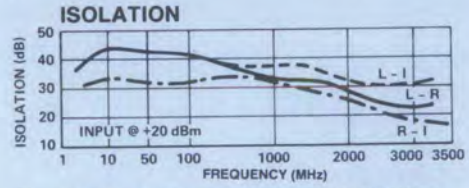
*All specifications apply when operated at +20 dBm available LO power with 50 ohm source and load impedance.

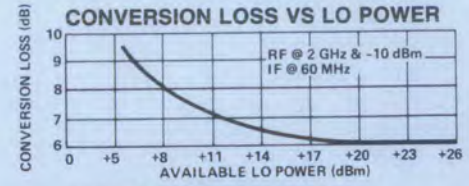
**Conversion loss for 60 MHz IF.

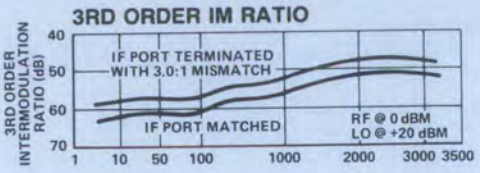
This product contains elements protected by United States Patent Number 4,224,572.

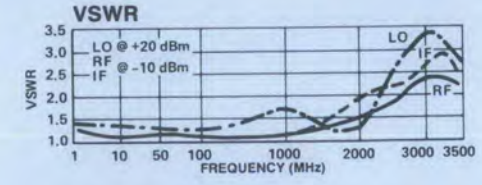
Typical Performance

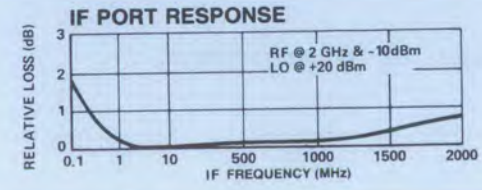












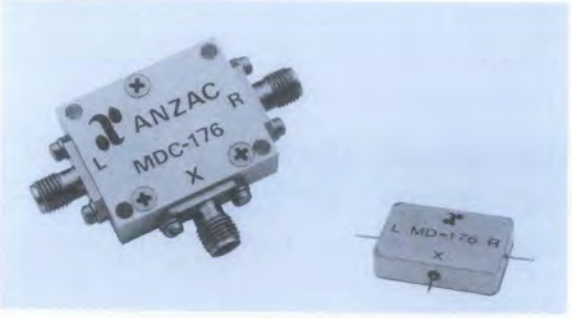
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-174	9199	Pin	$165
MDC-174	9194	SMA	252

Delivery is from stock.

MODELS MD-/MDC-176 — DOUBLE-BALANCED MIXER 2.0-4.0 GHz

- 4.5 dB Typical Midband Conversion Loss
- 25 dB Typical Midband L-R Isolation
- Operable with Starved LO



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		2.0-4.0 GHz
	IF Port (3 dB BW)		DC-300 MHz
Conversion Loss**			6.0 dB Max
Isolation	LO to RF	(2.0-3.0 GHz)	15 dB Min
		(3.0-4.0 GHz)	20 dB Min
	LO to IF	(2.0-2.5 GHz)	17 dB Min
		(2.5-4.0 GHz)	20 dB Min
	RF to IF	(2.0-4.0 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+7 dBm Typical
4.0 GHz	+7 dBm Typical
Package Type	MD-176 Flatpack (FP-10) MDC-170 Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

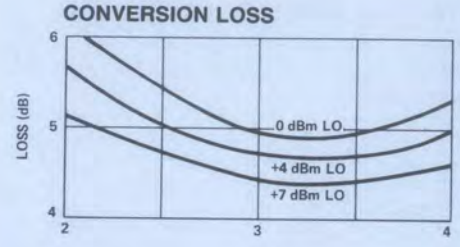
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

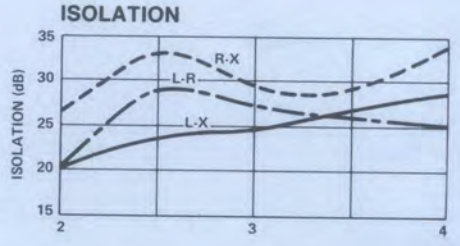
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

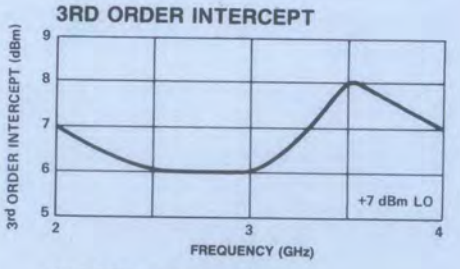
**For IF frequencies of DC-100 MHz and an RF of −10 dBm or lower.

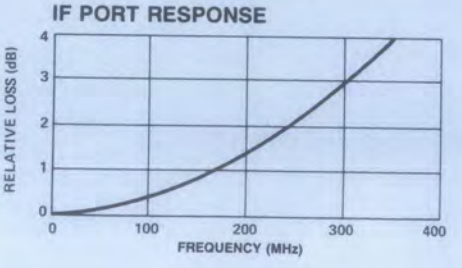
This product contains elements protected by United States Patent Number 4,224,572.

Typical Performance









Ordering Information

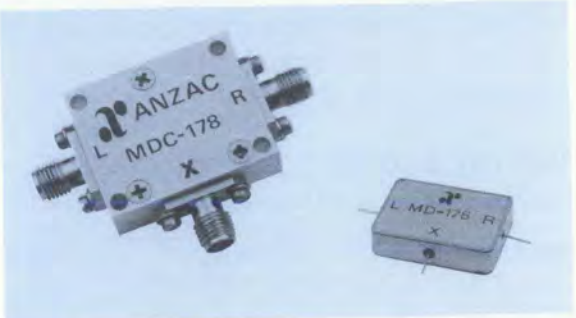
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-176	9089	Pin	$200
MDC-176	9084	SMA	287

Delivery is from stock.

MODELS MD-/MDC-178

DOUBLE-BALANCED MIXER 2.6-5.2 GHz

- 4.5 dB Typical Midband Conversion Loss
- 27 dB Typical Midband L-R Isolation
- Operable with Starved LO



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		2.6-5.2 GHz
	IF Port (3 dB BW)		DC-300 MHz
Conversion Loss**			6 dB Max
Isolation	LO to RF	(2.6 - 5.2 GHz)	20 dB Min
	LO to IF	(2.6 - 5.2 GHz)	20 dB Min
	LO to IF	(2.6 - 5.2 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.5 GHz	+9 dBm Typical
4.0 GHz	+8 dBm Typical
5.2 Ghz	+12 dBm Typical
Package Type	MD-178 Flatpack (FP-10) MDC-178 Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

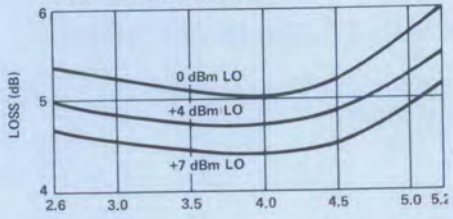
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

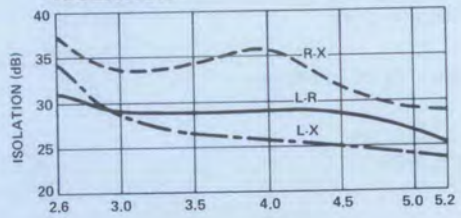
**For IF frequencies of DC-100 MHz and an RF of −10 dBm or lower.

Typical Performance

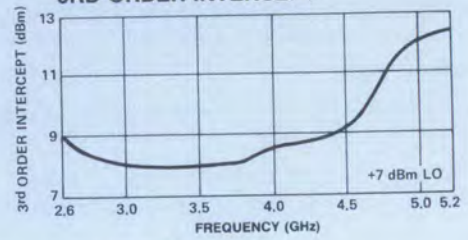
CONVERSION LOSS



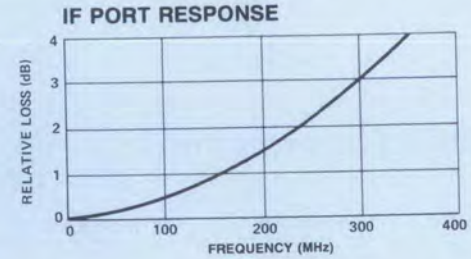
ISOLATION



3RD ORDER INTERCEPT



IF PORT RESPONSE



Ordering Information

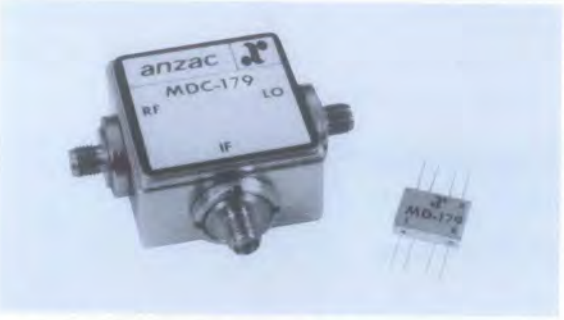
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-178	9279	Pin	$179
MDC-178	9274	SMA	265

Delivery is from stock.

NEW

MODELS MD-/MDC-179 — TERMINATION INSENSITIVE MIXER 1-4000 MHz

- Intermodulation Ratio is Insensitive to Port Mismatches
- Typical Midband VSWR < 2.0:1
- 35 dB Typical Midband Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-4000 MHz
	IF Port		5-1500 MHz
Conversion Loss**	5 - 1000 MHz		7.5 dB Max
	5 - 2500 MHz		8.5 dB Max
	5 - 3500 MHz		9.5 dB Max
	1 - 4000 MHz		10.5 dB Max
Isolation	LO to RF	(5-1000 MHz)	30 dB Min
		(1-4000 MHz)	20 dB Min
	LO to IF	(5-1000 MHz)	30 dB Min
		(1-4000 MHz)	20 dB Min
	RF to IF	(10-500 MHz)	30 dB Min
		(1-4000 MHz)	16 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio: (with −10 dBm input, each tone and 60 MHz IF)	49 dB @ 10 MHz 52 dB @ 500 MHz 50 dB @ 3000 MHz
3rd Order Intermodulation Ratio Degradation	3 dB Typical @ IF VSWR 3:1
Package Type	MD-179 Flatpack (FP-2) MDC-179 Connectorized (C-7) (See pages 474 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

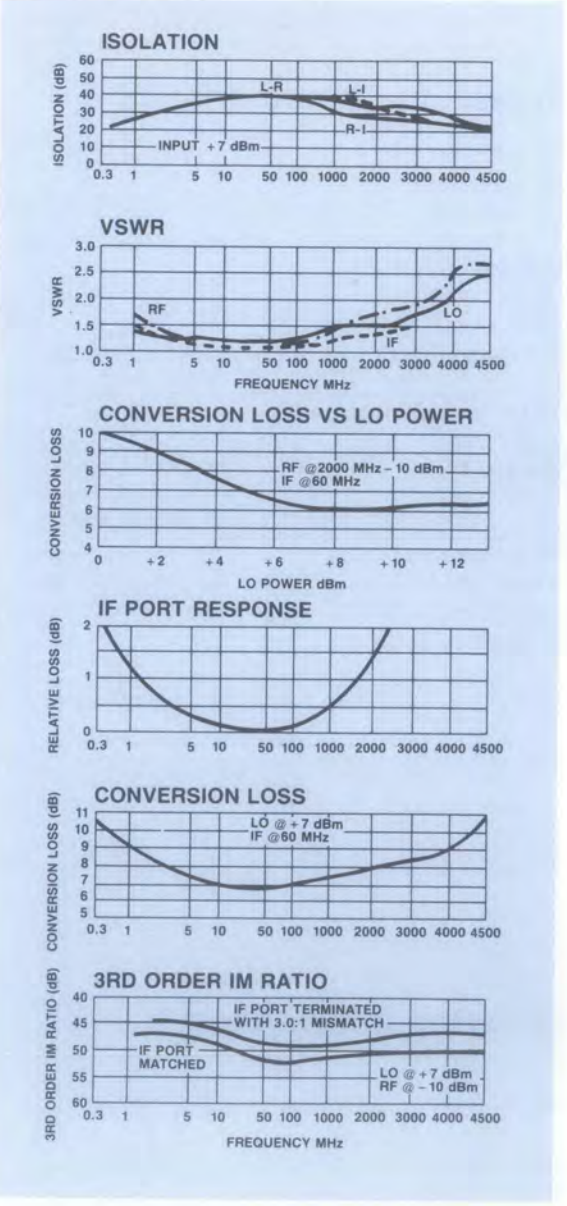
Pin Configuration — RF; P8, LO: P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 5-300 MHz and an RF of −10 dBm or lower.

This product contains elements protected by United States Patent Number 4,224,572.

Typical Performance



Ordering Information

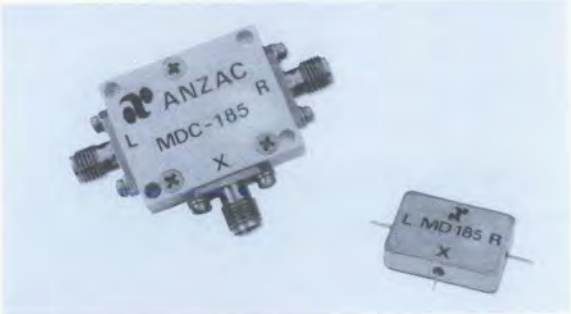
Model No.	Connectors	Unit Price (5-9 Units)
MD-179	Pin	$185
MDC-179	SMA	252

Delivery is from stock.

MODELS MD-/MDC-185

DOUBLE-BALANCED MIXER 3.7-4.2 GHz

- 5.0 dB Typical Midband Conversion Loss
- 29 dB Typical Midband L-R Isolation
- Operable with Starved LO



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF Port		3.7-4.2 GHz
	LO Port		3.0-5.5 GHz
	IF Port		DC-1300 MHz
Conversion Loss**			6.5 dB Max
Isolation	LO to RF	(3.0-5.5 GHz)	20 dB Min
	LO to IF	(3.0-5.5 GHz)	18 dB Min
	RF to IF	(3.7-4.2 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.0 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
4.0 GHz	+9 dBm Typical
Package Type	MD-185 Flatpack (FP-10) MDC-185 Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

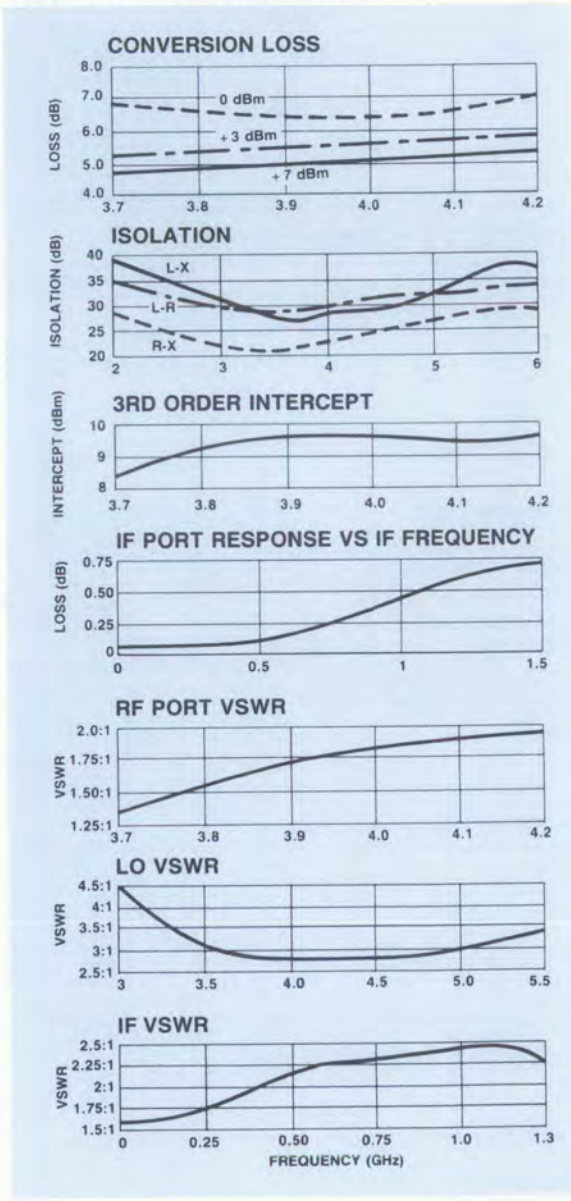
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of DC-500 MHz and an RF of −10 dBm or lower.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-185	9509	Pin	$179
MDC-185	9504	SMA	265

Delivery is from stock.

NEW

MODEL MDS-217

SURFACE MOUNT DOUBLE-BALANCED MIXER 600-2000 MHz

- Fully Hermetic Package
- 6.5 dB Typical Noise Figure
- 30 dB Typical LO-RF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		600-2000 MHz
	IF Port		DC-1000 MHz
Conversion Loss and SSB Noise Figure	600-2000 MHz		8.0 dB Max
Isolation	LO to RF	(600-2000 MHz)	25 dB Min
	LO to IF	(600-2000 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽ 6 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−4 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 60 MHz and 70 MHz IF)	44 dB @ 800 MHz 40 dB @ 1500 MHz
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental

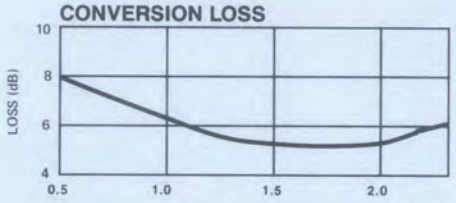
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

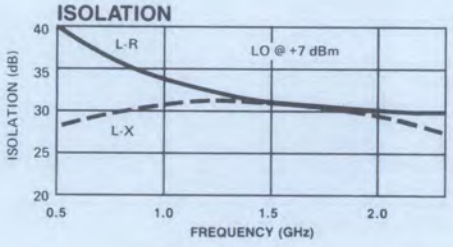
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance

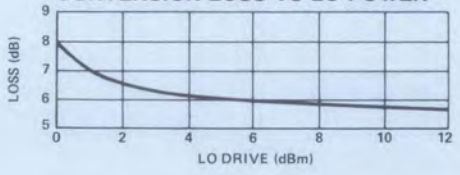
CONVERSION LOSS



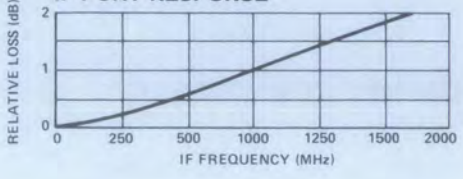
ISOLATION



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-217	PIN	$113

Delivery is from stock.

NEW

MODEL MDS-220

SURFACE MOUNT DOUBLE-BALANCED MIXER 1-400 MHz

- Fully Hermetic Package
- Low Cost, High Level
- +17 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
- +7 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-400 MHz
	IF Port		DC-400 MHz
Conversion Loss	3-300 MHz		7 dB Max
	1-400 MHz		8 dB Max
Isolation	LO to RF	(1-300 MHz)	32 dB Min
		(300-400 MHz)	28 dB Min
	LO to IF	(1-300 MHz)	30 dB Min
		(300-400 MHz)	25 dB Min
	RF to IF	(1-150 MHz)	25 dB Min
		(150-400 MHz)	20 dB Min

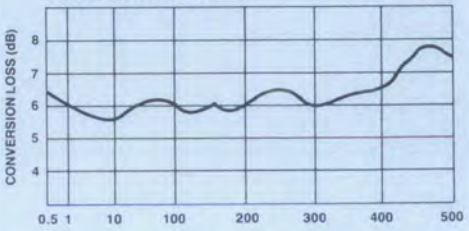
Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input)	⩾ 55 dB Min
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)
Environmental	These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

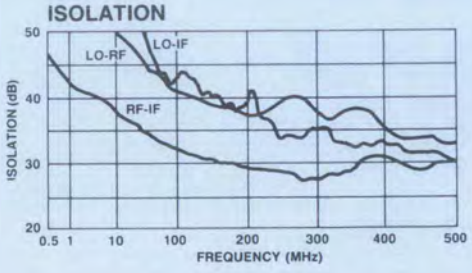
*All specifications apply when operated at + 13 dBm available LO power with 50 ohm source and load impedance.

Typical Performance

CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER

Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-220	PIN	$45

Delivery is from stock.

NEW

MODEL MDS-221

SURFACE MOUNT DOUBLE-BALANCED MIXER 0.5-350 MHz

- Fully Hermetic Package
- Low Cost, Medium Level
- +15 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
- +5 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-350 MHz
	IF Port		DC-350 MHz
Conversion Loss	2-300 MHz		7 dB Max
	0.5-350 MHz		8 dB Max
Isolation	LO to RF	(0.5-100 MHz)	35 dB Min
		(100-350 MHz)	28 dB Min
	LO to IF	(0.5-100 MHz)	32 dB Min
		(100-350 MHz)	25 dB Min
	RF to IF	(0.5-100 MHz)	25 dB Min
		(100-350 MHz)	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input)	⩾ 50 dB Min
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

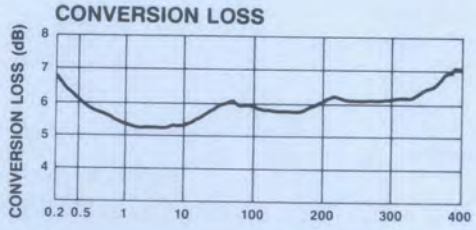
Environmental

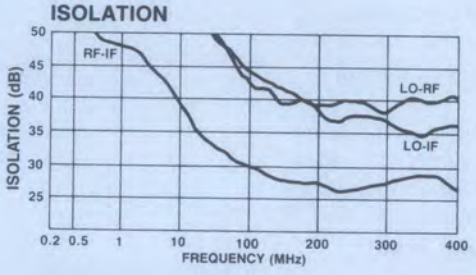
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

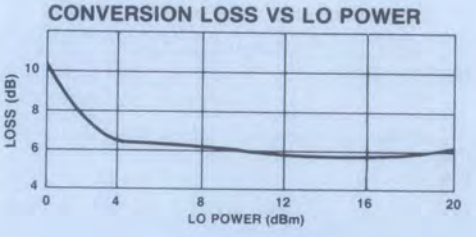
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**P3 & P4 are connected together externally to make an IF Port.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-221	PIN	$45

Delivery is from stock.

NEW

MODEL MDS-222

SURFACE MOUNT DOUBLE-BALANCED MIXER 200 KHz - 200 MHz

- Fully Hermetic Package
- Three Decade Coverage

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.2-200 MHz
	IF Port		DC-200 MHz
Conversion Loss	0.2-50 MHz		6.0 dB Max
	50-200 MHz		7.5 dB Max
Isolation	LO to RF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	30 dB Min
	LO to IF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	25 dB Min
	RF to IF	(0.2-50 MHz)	25 dB Min
		(50-200 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated linearly to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative (When connected as indicated under Mech. Data)
DC Offset	⩽ 3 mV Typical
RF Input†	
1 dB Compression	+2 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-200 MHz ⩾ 50 dB 200-300 MHz ⩾ 36 dB
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental

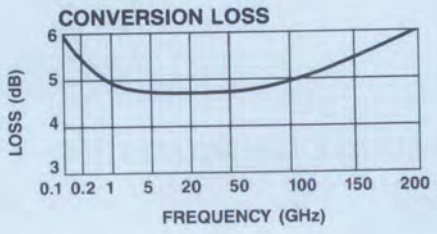
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

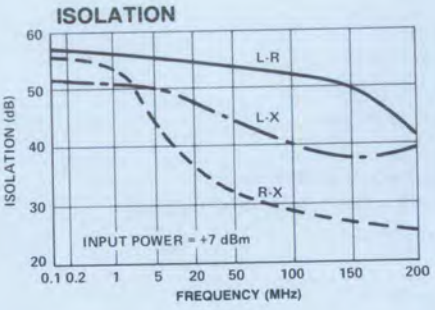
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

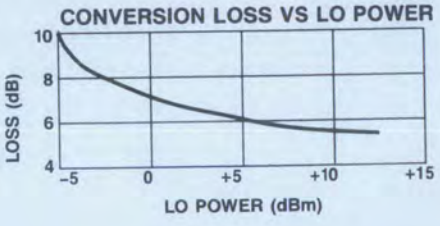
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

†Measured at 100 MHz.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-222	PIN	$45

Delivery is from stock.

NEW

MODEL MDS-223

SURFACE MOUNT DOUBLE-BALANCED MIXER 5 - 500 MHz

- Fully Hermetic Package
- Low Cost
- 7 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	5-150 MHz		7.0 dB Max
	150-500 MHz		9.0 dB Max
Isolation	LO to RF	(5-150 MHz)	40 dB Min
		(150-500 MHz)	35 dB Min
	LO to IF	(5-150 MHz)	35 dB Min
		(150-500 MHz)	25 dB Min
	RF to IF	(5-150 MHz)	25 dB Min
		(150-500 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽ 1 mV Typical
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 25 MHz and 35 MHz IF)	100-350 MHz ⩾ 55 dB 350-500 MHz ⩾ 40 dB
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

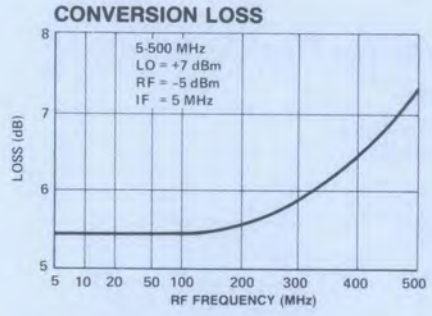
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground All other pins are ground.

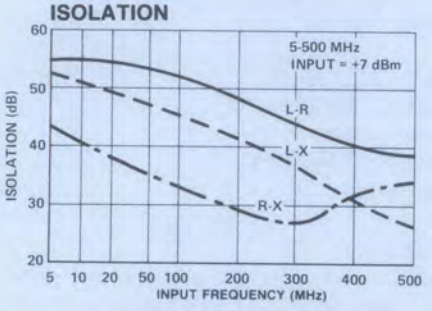
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance

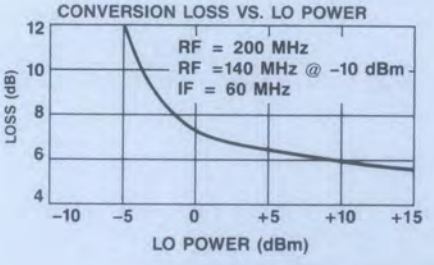
**No internal connection.

***P3 and P7 are connected together to make IF port.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-223	PIN	$45

Delivery is from stock.

NEW

MODEL MDS-614

SURFACE MOUNT DOUBLE-BALANCED MIXER 0.7-2 GHz

- Fully Hermetic Package
- 6 dB Typical Midband Conversion Loss
- 25 dB Typical Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.7 - 2 GHz
	IF Port		DC-300 MHz
Conversion Loss			8 dB Max
Isolation	LO to RF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	20 dB Min
	LO to IF	(0.7-1 GHz)	20 dB Min
		(1-2 GHz)	12 dB Min
	RF to IF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	600-2000 MHz ≥ 36 dB
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

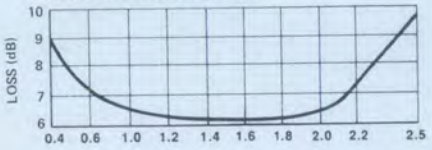
Pin Configuration

MDS-614 — RF; P4, LO; P3, IF; P2
Case and all other pins are ground

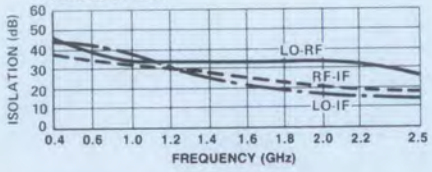
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance

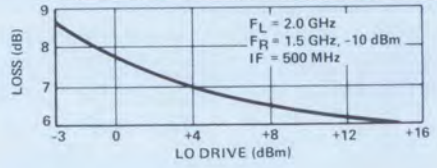
CONVERSION LOSS



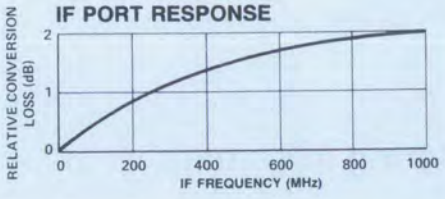
ISOLATION



CONVERSION LOSS VS DRIVE LEVEL



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
MDS-614	PIN	$68

Delivery is from stock.

MODEL MD-525-4

HIGH LEVEL DOUBLE-BALANCED MIXER 5-4000 MHz

- Broadband Frequency Range
- +17 dBm Typical Third Order Intercept Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-4000 MHz
	IF Port		5-1900 MHz
Conversion Loss	5-2000 MHz		9 dB Max
	2000-4000 MHz		10 dB Max
Isolation	LO to RF	(5-50 MHz)	20 dB Min
		(50-2000 MHz)	25 dB Min
		(200-4000 MHz)	20 dB Min
	LO to IF	(5-50 MHz)	20 dB Min
		(50-2000 MHz)	30 dB Min
		(200-4000 MHz)	25 dB Min
	RF to IF	(5-50 MHz)	20 dB Min
		(50-2000 MHz)	25 dB Min
		(200-4000 MHz)	20 dB Min

Operating Characteristics

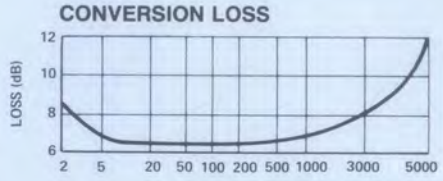
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽5 mV Typical
RF Input	
1 dB Compression	+6 dBm Typical
1 dB Desensitization	+0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio: (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	80-430 MHz⩾53 dB
Package Type	Connectorized (C-9) (See pages 482 for physical dimensions.)

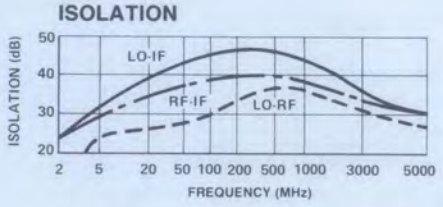
Environmental

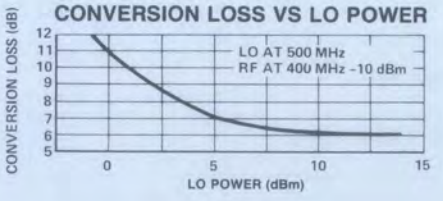
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

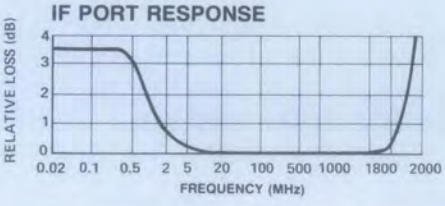
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

Typical Performance









Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MD-525-4	9134	SMA	$171
MD-525-4	9132	TNC	171

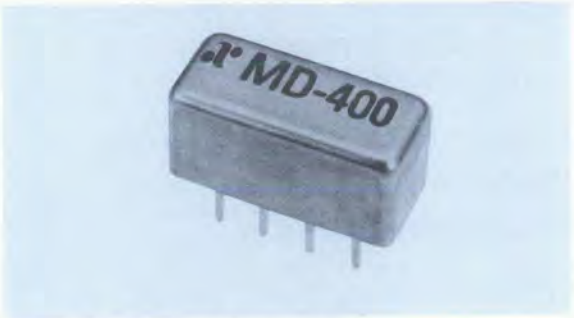
Delivery is from stock.

NEW

MODEL MD-400 DOUBLE BALANCED MIXER

RF, LO 1-1000 MHz IF DC-1000 MHz

- LO Power +7 dBm
- 4-Pin Half Relay Header
- MCL Model TFM-2 Replacement



Guaranteed Specifications*

(From –55°C to +85°C)

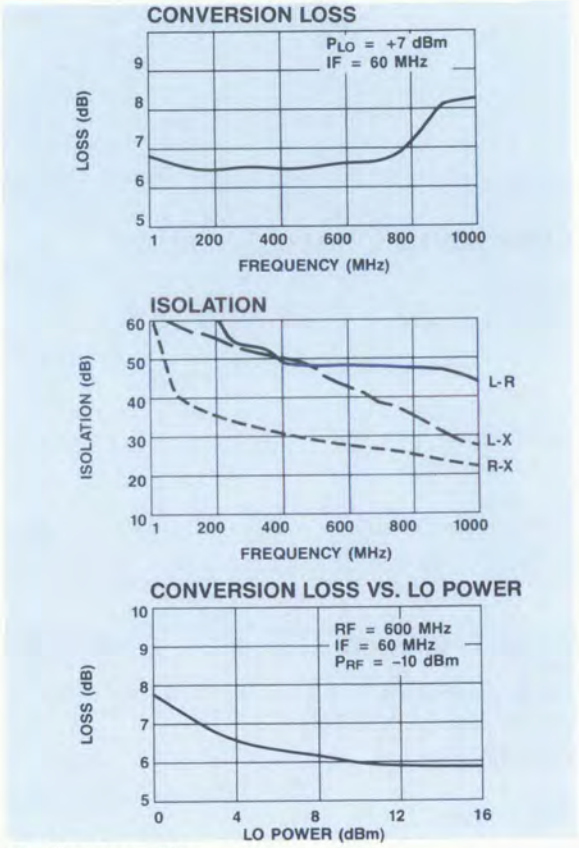
Frequency Range	RF, LO Ports		1 - 1000 MHz
	IF Port		DC - 1000 MHz
Conversion Loss	1 - 500 MHz		7.5 dB Max
	500 - 1000 MHz		8.5 dB Max
Isolation	LO to RF	1 - 10 MHz	45 dB Min
		10 - 500 MHz	25 dB Min
		500 - 1000 MHz	25 dB Min
	LO to IF	1 - 10 MHz	40 dB Min
		10 - 500 MHz	25 dB Min
		500 - 1000 MHz	20 dB Min
	RF to IF	1 - 10 MHz	30 dB Min
		10 - 500 MHz	20 dB Min
		500 - 1000 MHz	15 dB Min

Operating Characteristics

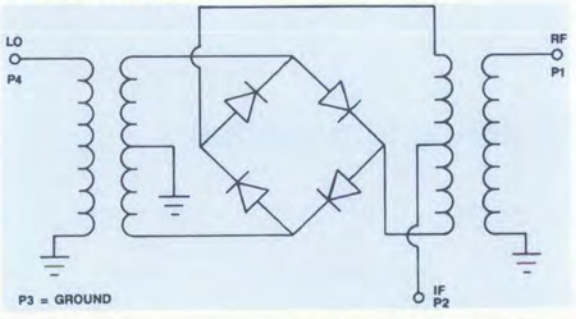
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 1.0 mV Typ
RF Input for 1dB Compression	+2.0 dBm Typ
RF Input for 1 dB Desensitization	–2.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	58 dB Typ at 160 MHz
(with –10 dBm input, each	50 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	38 dB Typ at 1000 MHz
Package Type	(RH-6)
	(See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2
	P3 = Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-400	PIN	$15.90

Delivery is from stock.

NEW

MODEL MD-401

DOUBLE BALANCED MIXER
RF, LO 0.2 - 400 MHz IF, DC - 400 MHz

- LO Power +7 dBm
- Half Relay Header
- MCL Model TFM-3 Replacement

Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range	RF, LO Ports		0.2 - 400 MHz
	IF Port		DC - 400 MHz
Conversion Loss	0.2 - 10 MHz		8.0 dB Max
	10 - 200		7.0 dB Max
	200 - 400 MHz		8.0 dB Max
Isolation	LO to RF	0.2 - 10 MHz	50 dB Min
		10 - 200 MHz	35 dB Min
		200 - 400 MHz	25 dB Min
	LO to IF	0.2 - 10 MHz	40 dB Min
		10 - 200 MHz	35 dB Min
		200 - 400 MHz	20 dB Min
	RF to IF	0.2 - 10 MHz	30 dB Min
		10 - 200 MHz	15 dB Min
		200 - 400 MHz	12 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	0 dBm Typ
RF Input for 1 dB Desensitization	–2.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50 & 60 MHz IF)	45 dB Typ at 160 MHz 42 dB Typ at 400 MHz
Package Type	(RH-6)
	(See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2 P3 = Case ground.

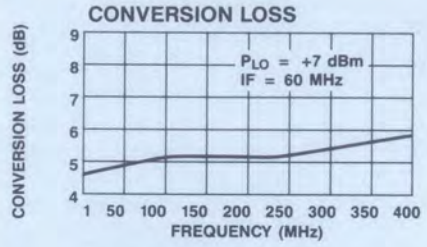
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

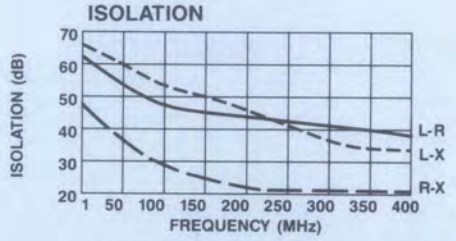
Ordering Information

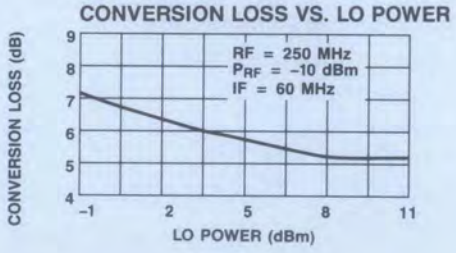
Model No.	Connectors	Unit Price (1-24 Units)
MD-401	PIN	$25.90

Delivery is from stock.

Typical Performance







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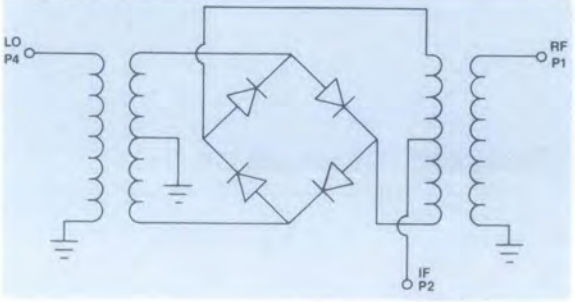


NEW

MODEL MD-402

DOUBLE BALANCED MIXER
RF, LO 5-1250 MHz IF DC-1250 MHz

- LO Power +7 dBm
- Half Relay Header
- MCL Model TFM-4 Replacement

Guaranteed Specifications*
(From –54°C to +85°C)

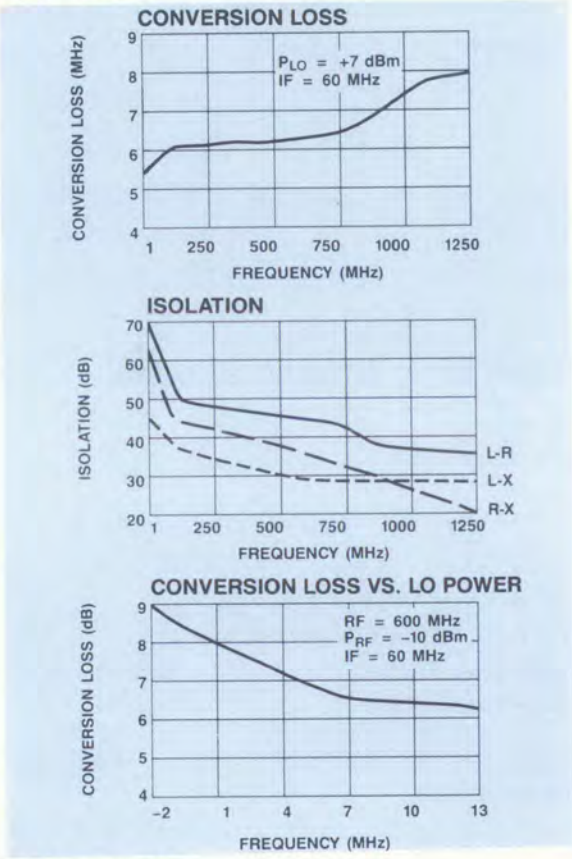
Frequency Range	RF, LO Ports		5 - 1250 MHz
	IF Port		DC - 1250 MHz
Conversion Loss	5 - 10 MHz		8.5 dB Max
	10 - 625 MHz		7.5 dB Max
	625 - 1250 MHz		9.5 dB Max
Isolation	LO to RF	5 - 10 MHz	45 dB Min
		10 - 625 MHz	30 dB Min
		625 - 1250 MHz	25 dB Min
	LO to IF	5 - 10 MHz	40 dB Min
		10 - 625 MHz	25 dB Min
		625 - 1250 MHz	20 dB Min
	RF to IF	5 - 10 MHz	30 dB Min
		10 - 625 MHz	15 dB Min
		625 - 1250 MHz	10 dB Min

Operating Characteristics

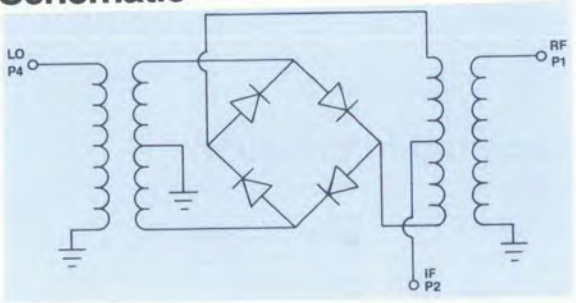
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 1.0 mV Typ
RF Input for 1dB Compression	+2.0 dBm Typ
RF Input for 1 dB Desensitization	+1 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	56 dB Typ at 160 MHz
(with –10 dBm input, each	51 dB Typ at 500 MHz
tone and 50 and 60 MHz IF)	35 dB Typ at 1000 MHz
Package Type	(RH-6)
	(See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2
	All other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-402	PIN	$25.90

Delivery is from stock

NEW

MODEL MD-403 DOUBLE BALANCED MIXER

RF, LO 2-500 MHz IF DC-500 MHz

- LO Power +17 dBm
- 4-Pin Half Relay Header
- Low Cost
- MCL Model TFM-1H Replacement

Guaranteed Specifications*

(From –55°C to +85°C)

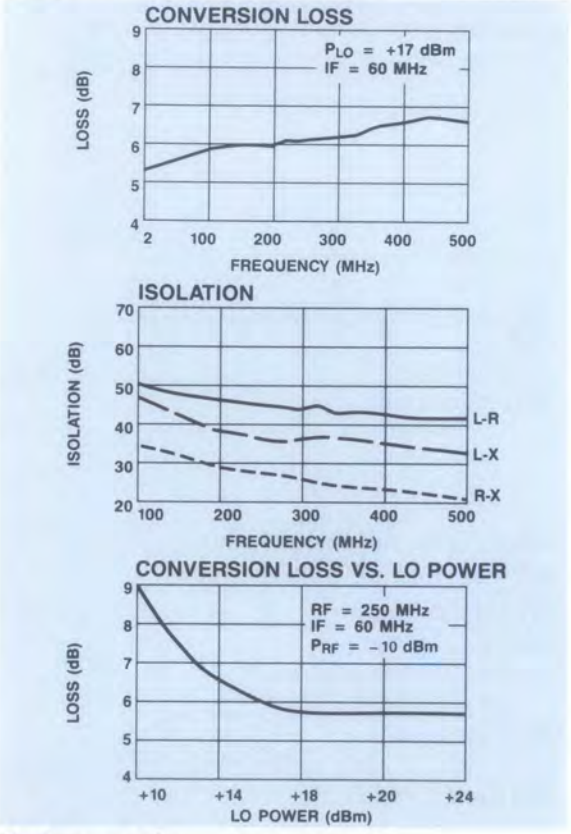
Frequency Range	RF, LO Ports		2 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	2 - 250 MHz		7.5 dB Max
	250 - 500 MHz		8.5 dB Max
Isolation	LO to RF	2 - 20 MHz	45 dB Min
		20 - 250 MHz	30 dB Min
		250 - 500 MHz	20 dB Min
	LO to IF	2 - 20 MHz	40 dB Min
		20 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	2 - 20 MHz	30 dB Min
		20 - 250 MHz	20 dB Min
		250 - 500 MHz	15 dB Min

Operating Characteristics

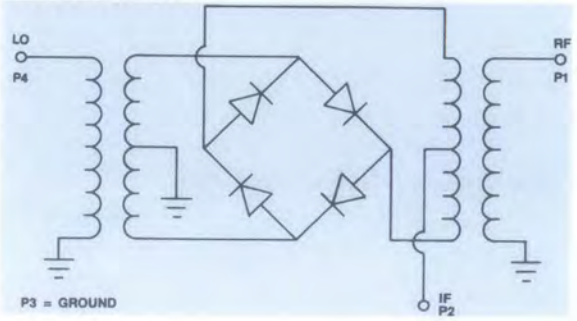
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 1.0 mV Typ
RF Input for 1dB Compression	+13.0 dBm Typ
RF Input for 1 dB Desensitization	+12.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50, 60 MHz IF)	58 dB Typ at 160 MHz 60 dB Typ at 500 MHz
Package Type	(RH-6) (See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2 P3 = Case ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-403	PIN	$29.90

Delivery is from stock

NEW

MODEL MD-404

DOUBLE BALANCED MIXER
RF, LO 5-1000 MHz IF DC-1000 MHz

- LO Power +17 dBm
- Half Relay Header
- MCL Model TFM-2H Replacement

Guaranteed Specifications*
(From –55°C to +85°C)

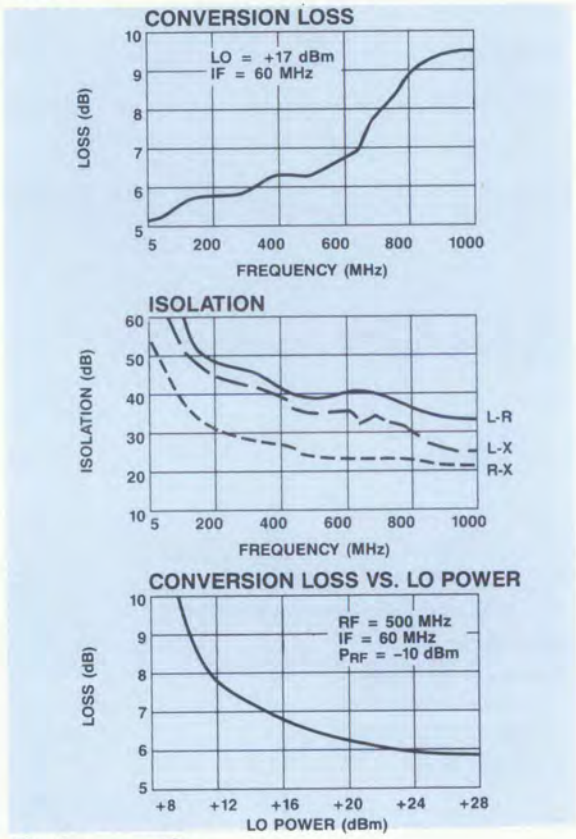
Frequency Range	RF, LO Ports		5 - 1000 MHz
	IF Port		DC - 1000 MHz
Conversion Loss	5 - 500 MHz		7.0 dB Max
	500 - 1000 MHz		10.0 dB Max
Isolation	LO to RF	5 - 50 MHz	45 dB Min
		50 - 500 MHz	30 dB Min
		500 - 1000 MHz	20 dB Min
	LO to IF	5 - 50 MHz	40 dB Min
		50 - 500 MHz	25 dB Min
		500 - 1000 MHz	20 dB Min
	RF to IF	5 - 50 MHz	30 dB Min
		50 - 500 MHz	20 dB Min
		500 - 1000 MHz	15 dB Min

Operating Characteristics

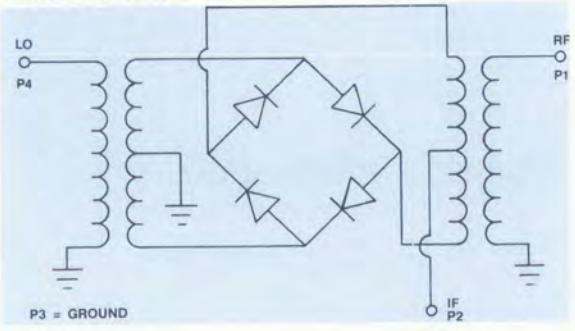
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	2.0 mV Typ
RF Input for 1dB Compression	+14.0 dBm Typ
RF Input for 1 dB Desensitization	+12.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	62 dB Typ at 160 MHz
(with –10 dBm input, each	60 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	52 dB Typ at 1000 MHz
Package Type	(RH-6)
	(See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2
	P3 = Case ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-404	PIN	$38.90

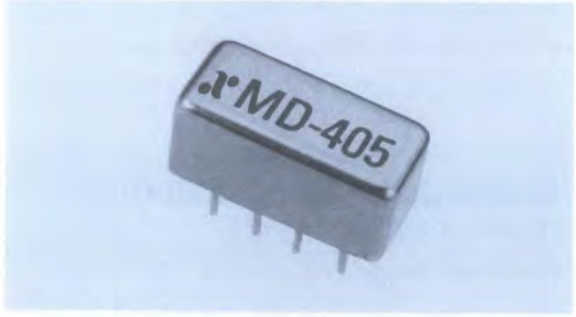
Delivery is from stock.

NEW

MODEL MD-405 DOUBLE BALANCED MIXER

RF, LO 0.1-250 MHz IF DC-250 MHz

- LO Power +17 dBm
- 4-Pin Half Relay Header
- MCL Model TFM-3H Replacement



Guaranteed Specifications*

(From –55°C to +85°C)

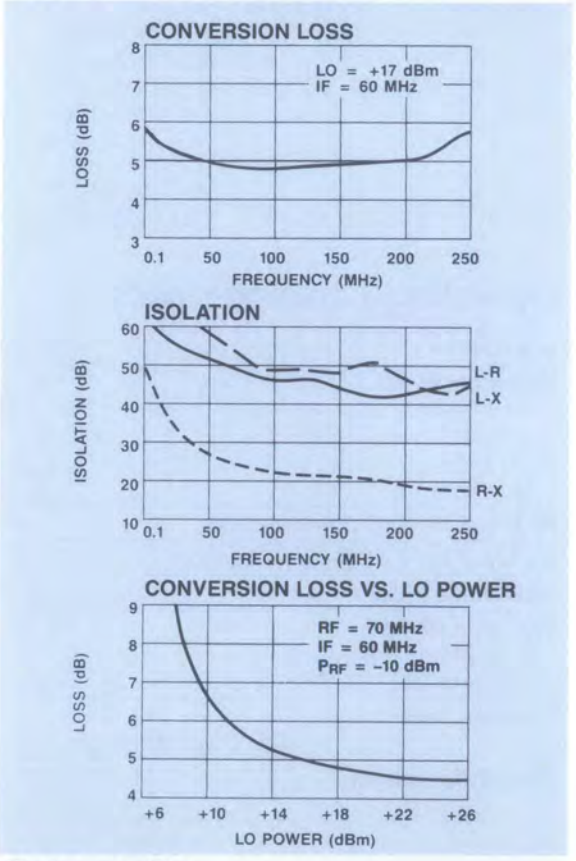
Frequency Range	RF, LO Ports		0.1 - 250 MHz
	IF Port		DC - 250 MHz
Conversion Loss	0.1 - 125 MHz		7.0 dB Max
	125 - 250 MHz		8.5 dB Max
Isolation	LO to RF	0.1 - 1.0 MHz	45 dB Min
		1.0 - 125 MHz	30 dB Min
		125 - 250 MHz	20 dB Min
	LO to IF	0.1 - 1.0 MHz	40 dB Min
		1.0 - 125 MHz	25 dB Min
		125 - 250 MHz	20 dB Min
	RF to IF	0.1 - 1.0 MHz	30 dB Min
		1.0 - 125 MHz	20 dB Min
		125 - 250 MHz	15 dB Min

Operating Characteristics

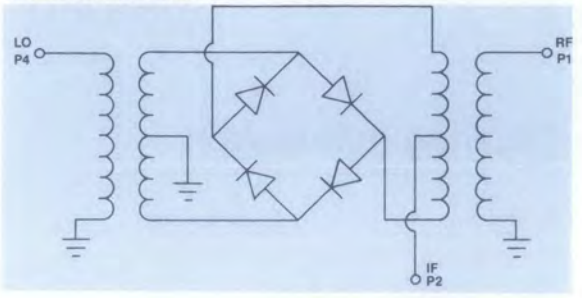
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+13.0 dBm Typ
RF Input for 1 dB Desensitization	+12.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50 & 60 MHz IF)	55 dB Typ at 100 MHz 59 dB Typ at 250 MHz
Package Type	(RH-6) (See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2 P3 = Case ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-405	PIN	$29.90

Delivery is from stock.

NEW

MODEL MD-406 DOUBLE BALANCED MIXER

RF, LO 5-1200 MHz IF DC-1200 MHz

- LO Power +17 dBm
- 4-Pin Half Relay Header
- MCL Model TFM-4H Replacement

Guaranteed Specifications*

(From –55°C to +85°C)

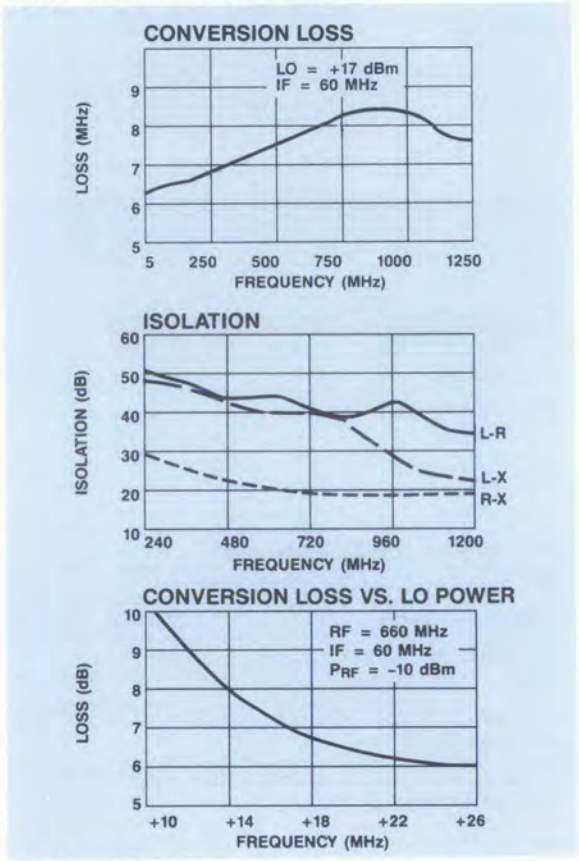
Frequency Range	RF, LO Ports		5 - 1200 MHz
	IF Port		DC - 1200 MHz
Conversion Loss	5 - 600 MHz		8.0 dB Max
	600 - 1200 MHz		9.0 dB Max
Isolation	LO to RF	5 - 50 MHz	40 dB Min
		50 - 600 MHz	25 dB Min
		600 - 1200 MHz	20 dB Min
	LO to IF	5 - 50 MHz	40 dB Min
		50 - 600 MHz	25 dB Min
		600 - 1200 MHz	20 dB Min
	RF to IF	5 - 50 MHz	35 dB Min
		50 - 600 MHz	20 dB Min
		600 - 1200 MHz	15 dB Min

Operating Characteristics

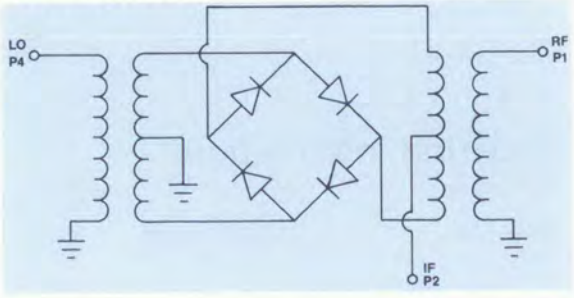
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 1.0 mV Typ
RF Input for 1dB Compression	+13.0 dBm Typ
RF Input for 1 dB Desensitization	+11.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	58 dB Typ at 160 MHz
(with –10 dBm input, each	56 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	54 dB Typ at 1000 MHz
Package Type	(RH-7)
	(See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P4, IF; P2
	P3 = Case ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-406	PIN	$41.90

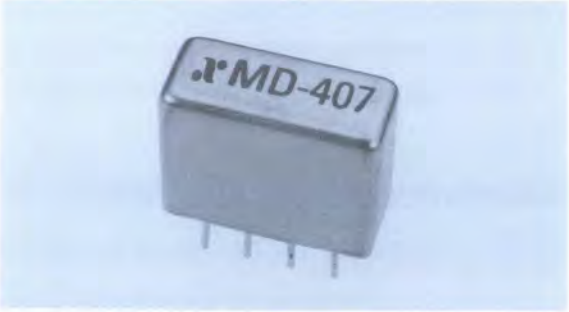
Delivery is from stock.

NEW

MODEL MD-407 DOUBLE BALANCED MIXER

RF, LO 10-3000 MHz IF 10-800 MHz

- LO Power +17 dBm
- 4-Pin Half Relay Header
- Broadband LO, RF Response
- MCL Model TFM-15 Replacement



Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range	RF, LO Ports		10 - 3000 MHz
	IF Port		10 - 800 MHz
Conversion Loss	10 - 20 MHz		8.5 dB Max
	20 - 1500 MHz		8.0 dB Max
	1500 - 3000 MHz		8.5 dB Max
Isolation	LO to RF	10 - 100 MHz	25 dB Min
		100 - 1500 MHz	25 dB Min
		1500 - 3000 MHz	25 dB Min
	LO to IF	10 - 100 MHz	20 dB Min
		100 - 1500 MHz	20 dB Min
		1500 - 3000 MHz	20 dB Min
	RF to IF	10 - 100 MHz	20 dB Min
		100 - 1500 MHz	20 dB Min
		1500 - 3000 MHz	20 dB Min

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 4.0 mV Typ
RF Input for 1dB Compression	+5.0 dBm Typ
RF Input for 1 dB Desensitization	+3.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	60 dB Typ at 160 MHz
(with –10 dBm input, each	54 dB Typ at 1060 MHz
tone and 50 & 60 MHz IF)	46 dB Typ at 3000 MHz
Package Type	(RH-7)
	(See page 473 for physical dimensions.)
Pin Configuration	RF; P4, LO; P1, IF; P2
	P3 = Case ground.

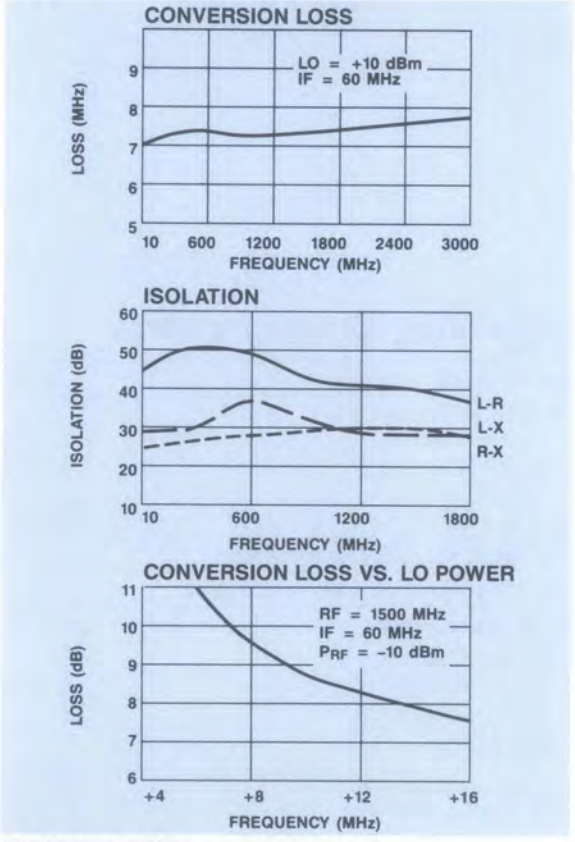
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

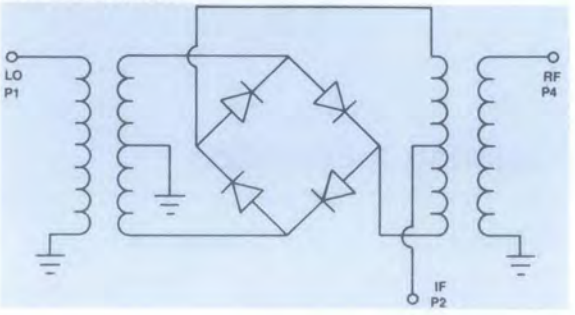
Model No.	Connectors	Unit Price (1-24 Units)
MD-407	PIN	$59.90

Delivery is from stock.

Typical Performance



Schematic



NEW

MODEL MD-410

DOUBLE BALANCED MIXER
RF, LO 0.5-500 MHz IF DC-500 MHz

- LO Power +7 dBm
- Typical Midband Conversion Loss of 5.5 dB
- MCL Model SRA-1 Replacement

Guaranteed Specifications*
(From –54°C to +85°C)

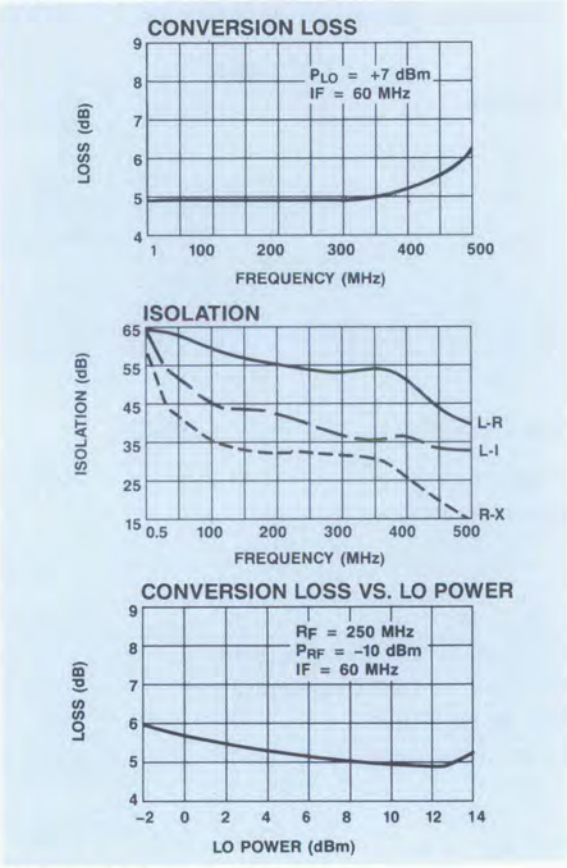
Frequency Range	RF, LO Ports		0.5 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	0.5 - 10 MHz		8.5 dB Max
	10 - 850 MHz		6.5 dB Max
	250 - 500 MHz		8.0 dB Max
Isolation	LO to RF	0.5 - 10 MHz	45 dB Min
		10 - 250 MHz	35 dB Min
		250 - 500 MHz	25 dB Min
	LO to IF	0.5 - 10 MHz	35 dB Min
		10 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	0.5 - 10 MHz	30 dB Min
		10 - 250 MHz	20 dB Min
		250 - 500 MHz	10 dB Min

Operating Characteristics

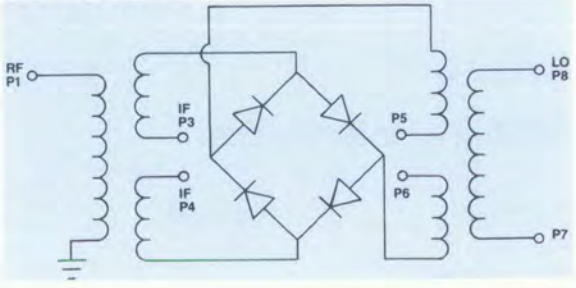
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	–2.0 dBm Typ
RF Input for 1 dB Desensitization	–4.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	dB Typ at 100 MHz
(with –10 dBm input, each	41 dB Typ at 160 MHz
tone and 50 & 60 MHz IF)	26 dB Typ at 500 MHz
Package Type	(RH-1)
	(See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4**
	P2 = Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-410	PIN	$15.90

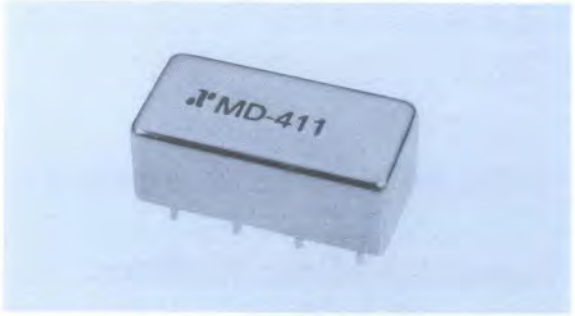
Delivery is from stock.

NEW

MODEL MD-411

DOUBLE BALANCED MIXER
RF, LO 0.6 - 500 MHz IF DC - 500 MHz

- LO Power +7 dBm
- Relay Header
- Low Cost
- MCL Model SRA-1-1 Replacement



Guaranteed Specifications*
(From –54°C to +85°C)

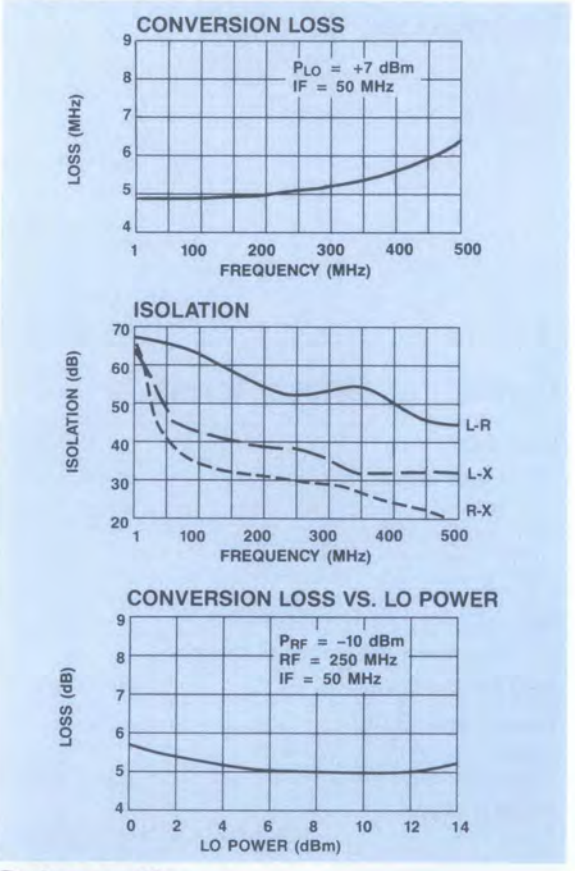
Frequency Range	RF, LO Ports		0.6 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	0.6 - 10 MHz		8.5 dB Max
	10 - 250 MHz		7.5 dB Max
	250 - 500 MHz		8.0 dB Max
Isolation	LO to RF	0.6 - 10 MHz	45 dB Min
		10 - 250 MHz	30 dB Min
		250 - 500 MHz	25 dB Min
	LO to IF	0.6 - 10 MHz	30 dB Min
		10 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	0.6 - 10 MHz	25 dB Min
		10 - 250 MHz	20 dB Min
		250 - 500 MHz	7 dB Min

Operating Characteristics

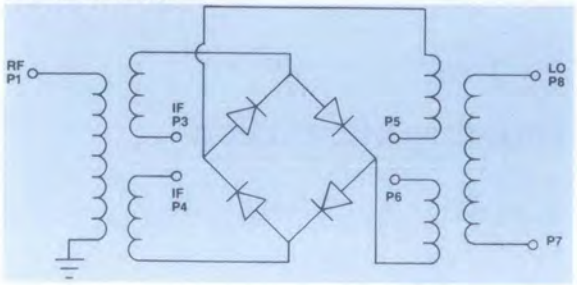
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	–2.0 dBm Typ
RF Input for 1 dB Desensitization	–4.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50 & 60 MHz IF)	38 dB Typ at 160 MHz 27 dB Typ at 500 MHz
Package Type	(RH-1) (See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** P2 = Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-411	PIN	$17.90

Delivery is from stock.

NEW

MODEL MD-412

DOUBLE BALANCED MIXER
RF, LO 1 - 1000 MHz IF 0.5 - 500 MHz

- LO Power +7 dBm
- Relay Header
- Low Cost
- MCL Model SRA-2 Replacement

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	RF, LO Ports		1 - 1000 MHz
	IF Port		0.5 - 500 MHz
Conversion Loss	1 - 10 MHz		8.5 dB Max
	10 - 500 MHz		7.5 dB Max
	500 - 1000 MHz		8.5 dB Max
Isolation	LO to RF	1 - 10 MHz	30 dB Min
		10 - 500 MHz	20 dB Min
		500 - 1000 MHz	20 dB Min
	LO to IF	1 - 10 MHz	30 dB Min
		10 - 500 MHz	20 dB Min
		500 - 1000 MHz	20 dB Min
	RF to IF	1 - 10 MHz	25 dB Min
		10 - 500 MHz	15 dB Min
		500 - 1000 MHz	10 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 1.0 mV Typ
RF Input for 1dB Compression	–1.0 dBm Typ
RF Input for 1 dB Desensitization	–4.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	44 dB Typ at 160 MHz
(with –10 dBm input, each	36 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	38 dB Typ at 1000 MHz
Package Type	(RH-1)
	(See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4**
	Case and all other pins are ground.

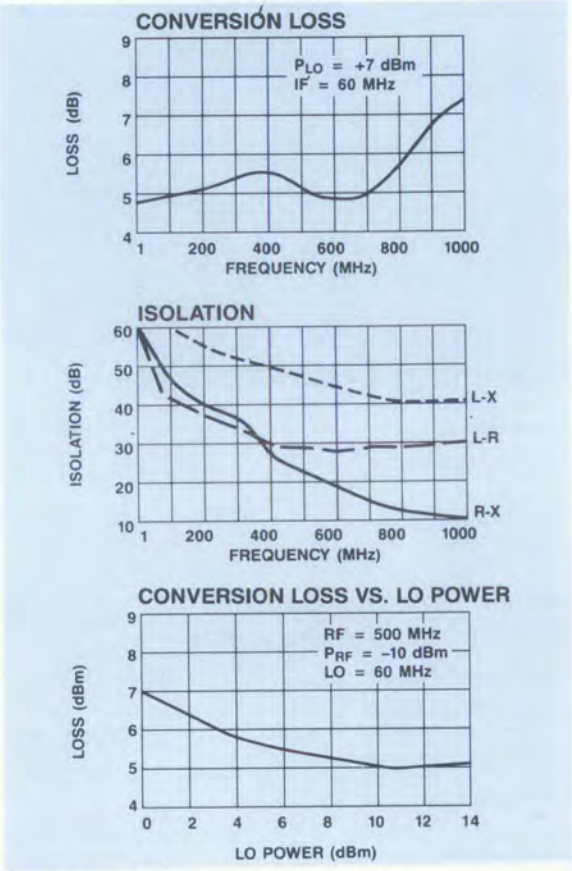
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**Pins 3 & 4 must be connected together externally.

Ordering Information

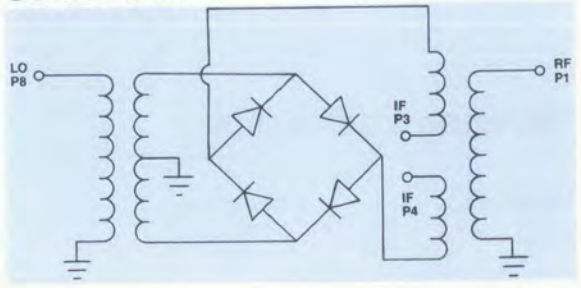
Model No.	Connectors	Unit Price (1-24 Units)
MD-412	PIN	$18.90

Delivery is from stock.

Typical Performance



Schematic



NEW

MODEL MD-413 DOUBLE BALANCED MIXER

RF, LO 0.5-500 MHz IF DC-500 MHz

- LO Power +17 dBm
- Relay Header
- MCL Model SRA-1H Replacement

Guaranteed Specifications*

(From –55°C to +85°C)

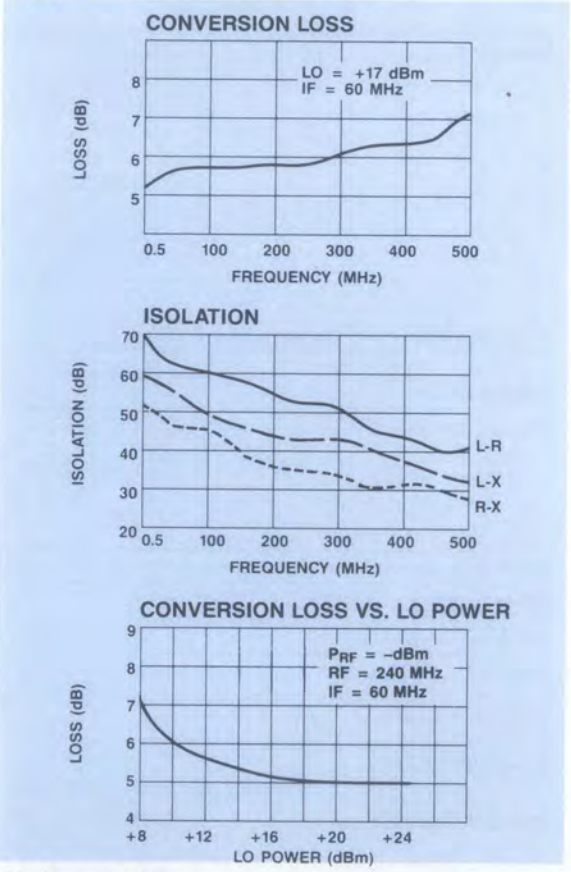
Frequency Range	RF, LO Ports		0.5 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	0.5 - 1.0 MHz		8.5 dB Max
	5 - 250 MHz		7.5 dB Max
	250 - 500 MHz		8.5 dB Max
Isolation	LO to RF	0.5 - 5.0 MHz	45 dB Min
		5 - 250 MHz	30 dB Min
		250 - 500 MHz	25 dB Min
	LO to IF	0.5 - 5.0 MHz	35 dB Min
		5 - 250 MHz	30 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	0.5 - 5.0 MHz	30 dB Min
		5 - 250 MHz	25 dB Min
		250 - 500 MHz	25 dB Min

Operating Characteristics

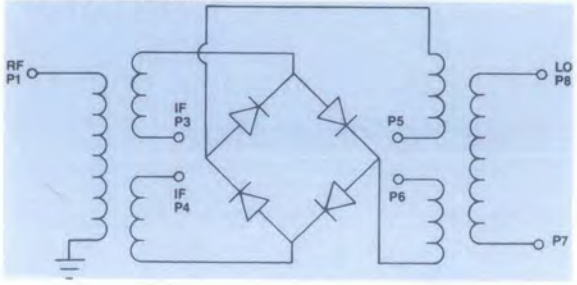
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+9.0 dBm Typ
RF Input for 1 dB Desensitization	+7.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50 & 60 MHz IF)	58 dB Typ at 160 MHz 50 dB Typ at 500 MHz
Package Type	(RH-1) (See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** P2 = Case ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance, and with pins 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-413	PIN	$22.90

Delivery is from stock.

NEW

MODEL MD-414

DOUBLE BALANCED MIXER
RF, LO 2 - 1000 MHz IF DC - 1000 MHz

- LO Power +17 dBm
- Relay Header
- MCL Model SRA-2H Replacement

Guaranteed Specifications*
(From –55°C to +85°C)

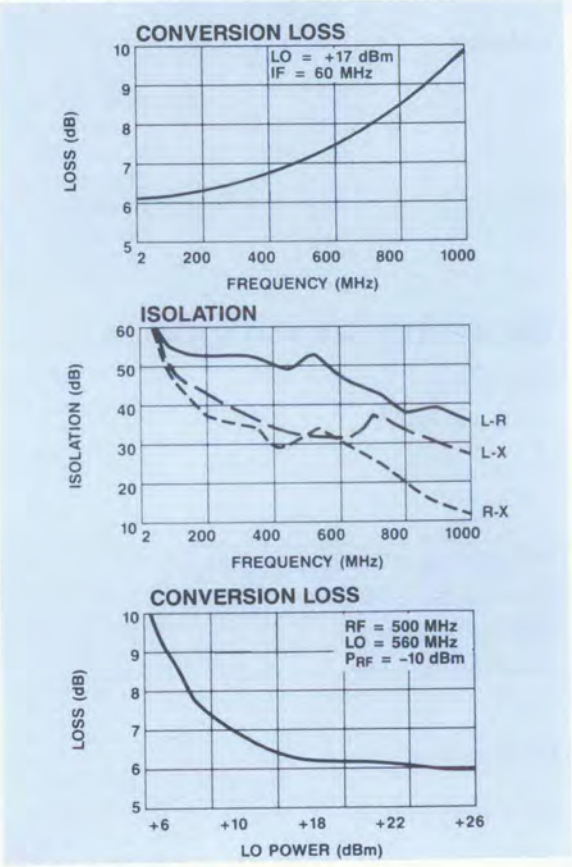
Frequency Range	RF, LO Ports		2 - 1000 MHz
	IF Port		DC - 1000 MHz
Conversion Loss	2.0 - 4.0 MHz		7.5 dB Max
	4.0 - 500 MHz		7.5 dB Max
	500 - 1000 MHz		10 dB Max
Isolation	LO to RF	2 - 20 MHz	40 dB Min
		20 - 500 MHz	25 dB Min
		500 - 1000 MHz	25 dB Min
	LO to IF	2 - 20 MHz	30 dB Min
		20 - 500 MHz	20 dB Min
		500 - 1000 MHz	20 dB Min
	RF to IF	2 - 20 MHz	35 dB Min
		20 - 500 MHz	25 dB Min
		500 - 1000 MHz	10 dB Min

Operating Characteristics

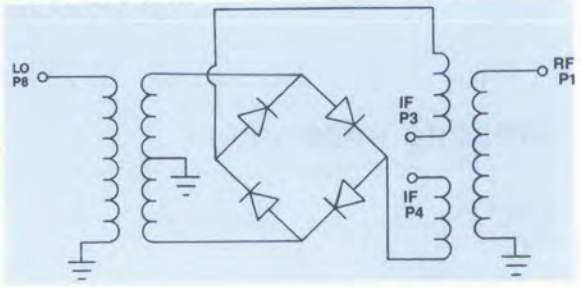
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤1.0 mV Typ
RF Input for 1dB Compression	+9.0 dBm Typ
RF Input for 1 dB Desensitization	+8.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	64 dB Typ at 160 MHz
(with –10 dBm input, each	58 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	58 dB Typ at 1000 MHz
Package Type	(RH-1)
	(See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4**
	All other pins are ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-414	PIN	$38.90

Delivery is from stock

NEW

MODEL MD-415

DOUBLE BALANCED MIXER
RF, LO 2 - 2000 MHz IF 0.5 - 500 MHz

- LO Power +10 dBm
- Relay Header
- MCL Model SRA-220 Replacement

Guaranteed Specifications*
(From –54°C to +85°C)

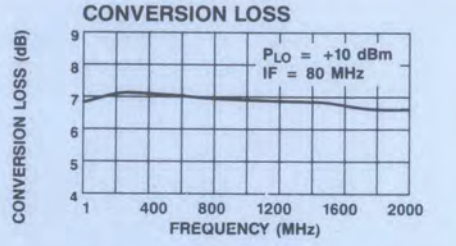
Frequency Range	RF, LO Ports		2 - 2000 MHz
	IF Port		DC - 500 MHz
Conversion Loss	2 - 10 MHz		9.0 dB Max
	10 - 1000 MHz		7.5 dB Max
	1000 - 2000 MHz		9.0 dB Max
Isolation	LO to RF	2 - 10 MHz	30 dB Min
		10 - 1000 MHz	30 dB Min
		1000 - 2000 MHz	20 dB Min
	LO to IF	2 - 10 MHz	30 dB Min
		10 - 1000 MHz	25 dB Min
		1000 - 2000 MHz	15 dB Min
	RF to IF	2 - 10 MHz	25 dB Min
		10 - 1000 MHz	15 dB Min
		1000 - 2000 MHz	10 dB Min

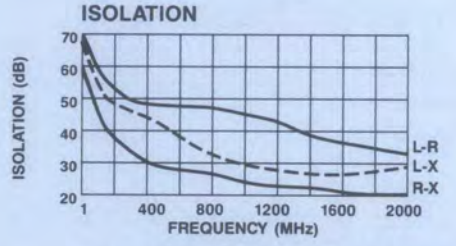
Operating Characteristics

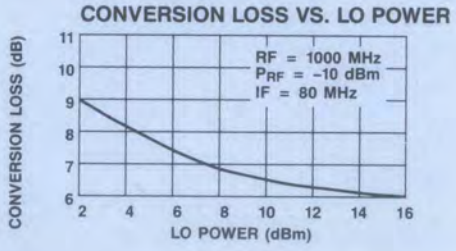
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+5.0 dBm Typ
RF Input for 1 dB Desensitization	+3.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	59 dB Typ at 160 MHz
(with –10 dBm input, each	51 dB Typ at 1000 MHz
tone and 50 & 60 MHz IF)	56 dB Typ at 2000 MHz
Package Type	(RH-1)
	(See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3
	Case and all other pins are ground.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

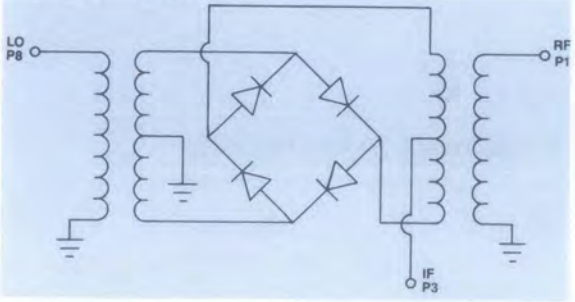
Typical Performance







Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-411	PIN	$31.90

Delivery is from stock.

NEW

MODEL MD-416

DOUBLE BALANCED MIXER
RF, LO 10-3000 MHz IF 10-1000 MHz

- LO Power +17 dBm
- Relay Header
- MCL Model SRA-11H Replacement

Guaranteed Specifications*
(From –55°C to +85°C)

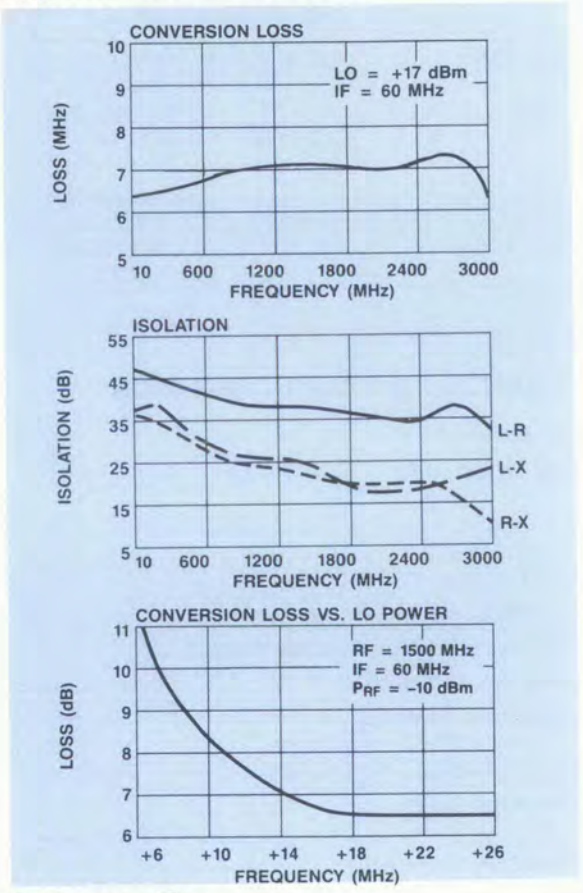
Frequency Range	RF, LO Ports		10 - 3000 MHz
	IF Port		10 - 1000 MHz
Conversion Loss	10 - 1500 MHz		10 dB Max
	1500 - 3000 MHz		12 dB Max
Isolation	LO to RF	10 - 100 MHz	20 dB Min
		100 - 1500 MHz	18 dB Min
		1500 - 3000 MHz	16 dB Min
	LO to IF	10 - 100 MHz	20 dB Min
		100 - 1500 MHz	18 dB Min
		1500 - 3000 MHz	16 dB Min
	RF to IF	10 - 100 MHz	15 dB Min
		100 - 1500 MHz	12 dB Min
		1500 - 3000 MHz	8 dB Min

Operating Characteristics

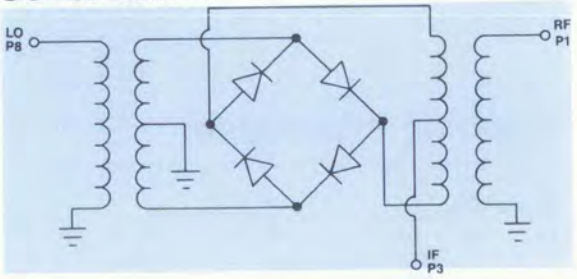
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	200 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 4.0 mV Typ
RF Input for 1dB Compression	+10.0 dBm Typ
RF Input for 1 dB Desensitization	+9.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	60 dB Typ at 160 MHz
(with –10 dBm input, each	58 dB Typ at 1000 MHz
ton and 50 & 60 MHz IF)	52 dB Typ at 2900 MHz
Package Type	(RH-1)
	(See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3
	Case and all other pins are ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-416	PIN	$49.90

Delivery is from stock.

NEW

MODEL MD-425 DOUBLE BALANCED MIXER

RF, LO 5-2000 MHz IF 10-600 MHz

- LO Power +7 dBm
- Relay Header
- MCL Model SRA-11 Replacement

Guaranteed Specifications*

(From –55°C to +85°C)

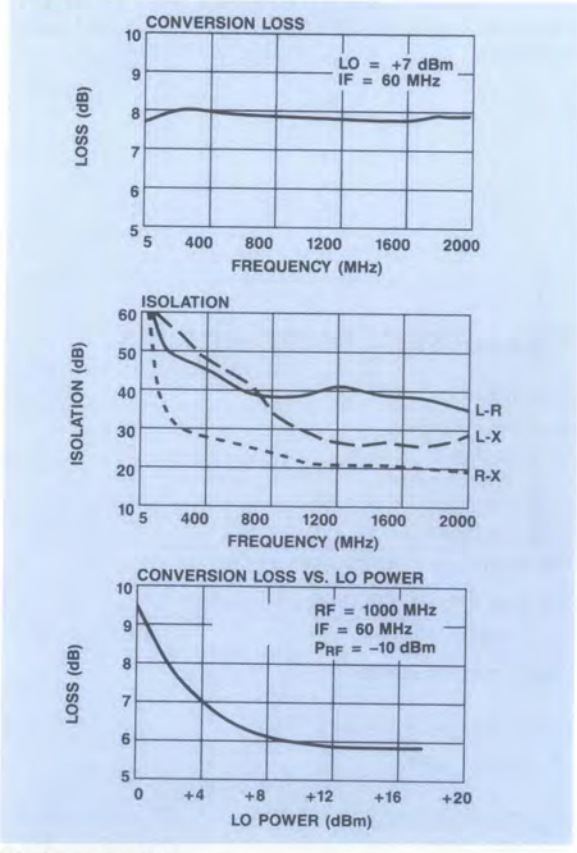
Frequency Range	RF, LO Ports		5 - 2000 MHz
	IF Port		10 - 600 MHz
Conversion Loss	5 - 1000 MHz		8.5 dB Max
	1000 - 2000 MHz		9.0 dB Max
Isolation	LO to RF	5 - 50 MHz	45 dB Min
		50 - 1000 MHz	30 dB Min
		1000 - 2000 MHz	25 dB Min
	LO to IF	5 - 50 MHz	30 dB Min
		50 - 1000 MHz	25 dB Min
		1000 - 2000 MHz	20 dB Min
	RF to IF	5 - 50 MHz	30 dB Min
		50 - 1000 MHz	20 dB Min
		1000 - 2000 MHz	15 dB Min

Operating Characteristics

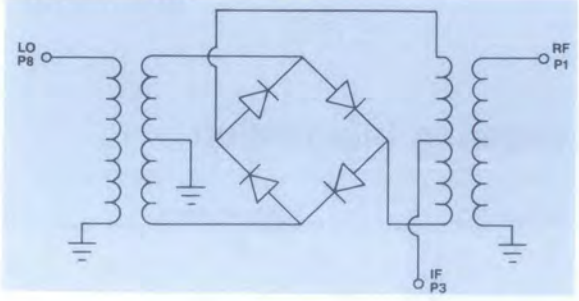
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤1.0 mV Typ
RF Input for 1dB Compression	+2.0 dBm Typ
RF Input for 1 dB Desensitization	+1.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	56 dB Typ at 160 MHz
(with –10 dBm input, each	46 dB Typ at 1000 MHz
ton and 50 & 60 MHz IF)	50 dB Typ at 2000 MHz
Package Type	(RH-5)
	(see page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3
	Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-425	PIN	$31.90

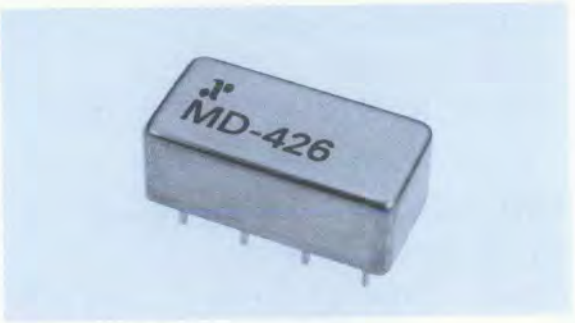
Delivery is from stock.

NEW

MODEL MD-426

DOUBLE BALANCED MIXER
RF, LO 1 - 500 MHz IF DC - 500 MHz

- LO Power +7 dBm
- Relay Header
- Low Cost
- MCL Model SBL-1 Replacement



Guaranteed Specifications*
(From –54°C to +85°C)

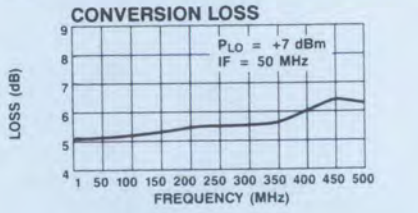
Frequency Range	RF, LO Ports		1 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	1 - 10 MHz		8.0 dB Max
	10 - 250 MHz		6.5 dB Max
	250 - 500 MHz		8.0 dB Max
Isolation	LO to RF	1 - 10 MHz	45 dB Min
		10 - 250 MHz	35 dB Min
		250 - 500 MHz	25 dB Min
	LO to IF	1 - 10 MHz	35 dB Min
		10 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	1 - 10 MHz	30 dB Min
		10 - 250 MHz	20 dB Min
		250 - 500 MHz	15 dB Min

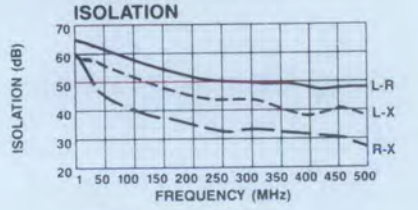
Operating Characteristics

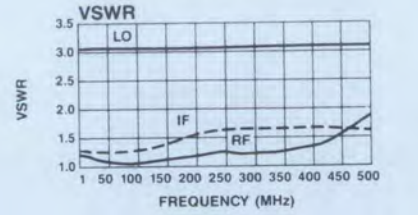
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	0 dBm Typ
RF Input for 1 dB Desensitization	–4.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio (with –10 dBm input, each ton and 50 & 60 MHz IF)	41 dB Typ at 160 MHz 33 dB Typ at 500 MHz
Package Type	(RH-5) (See page 473 for physical dimensions.)
Pin Configuration	RF, P1; LO, P8; RF, P3, P4**

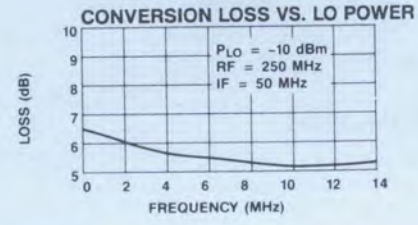
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Typical Performance

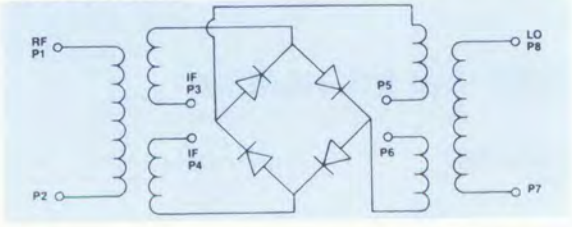








Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-411	PIN	$5.90

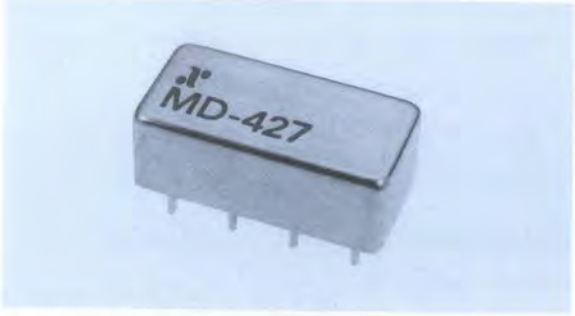
Delivery is from stock.

NEW

MODEL MD-427

DOUBLE BALANCED MIXER
RF, LO 10 - 1000 MHz IF 5 - 500 MHz

- LO Power +7 dBm
- Relay Header
- Low Cost
- MCL Model SBL-1X Replacement



Guaranteed Specifications*
(From –54°C to +85°C)

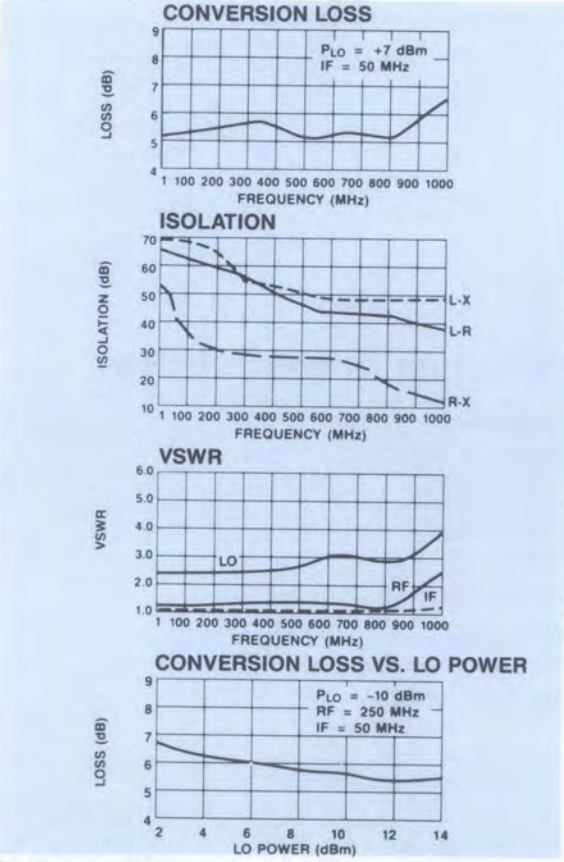
Frequency Range	RF, LO Ports		10 - 1000 MHz
	IF Port		5 - 500 MHz
Conversion Loss	10 - 500 MHz		7.5 dB Max
	500 - 1000 MHz		8.0 dB Max
Isolation	LO to RF	10 - 500 MHz	30 dB Min
		500 - 1000 MHz	20 dB Min
	LO to IF	10 - 500 MHz	35 dB Min
		500 - 1000 MHz	25 dB Min
	RF to IF	10 - 500 MHz	15 dB Min
		500 - 1000 MHz	5 dB Min

Operating Characteristics

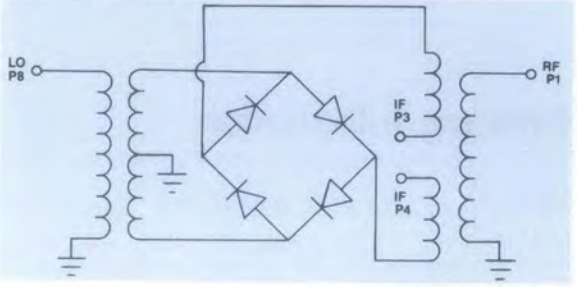
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+1.0 dBm Typ
RF Input for 1 dB Desensitization	0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each ton and 50 & 60 MHz IF)	46 dB Typ at 160 MHz 41 dB Typ at 500 MHz
Package Type	(RH-5) (See page 473 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** All other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-427	PIN	$7.90

Delivery is from stock

NEW

MODEL MD-428

DOUBLE BALANCED MIXER
RF, LO 1 - 400 MHz; IF DC - 400 MHz

- LO Power +7 dBm
- Relay Header
- Low Cost
- MCL Model SBL-1-1 Replacement

Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range	RF, LO Ports		1 - 400 MHz
	IF Port		DC - 400 MHz
Conversion Loss	1 - 10 MHz		8.5 dB Max
	10 - 200 MHz		7.0 dB Max
	200 - 400 MHz		8.5 dB Max
Isolation	LO to RF	1 - 10 MHz	45 dB Min
		10 - 200 MHz	30 dB Min
		200 - 400 MHz	25 dB Min
	LO to IF	1 - 10 MHz	30 dB Min
		10 - 200 MHz	25 dB Min
		200 - 400 MHz	20 dB Min
	RF to IF	1 - 10 MHz	25 dB Min
		10 - 200 MHz	20 dB Min
		200 - 400 MHz	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	–1.0 dBm Typ
RF Input for 1 dB Desensitization	–3.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio (with –10 dBm input, each ton and 50 & 60 MHz IF)	43 dB Typ at 160 MHz 33 dB Typ at 500 MHz
Package Type	(RH-1) (See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** All other pins are ground.

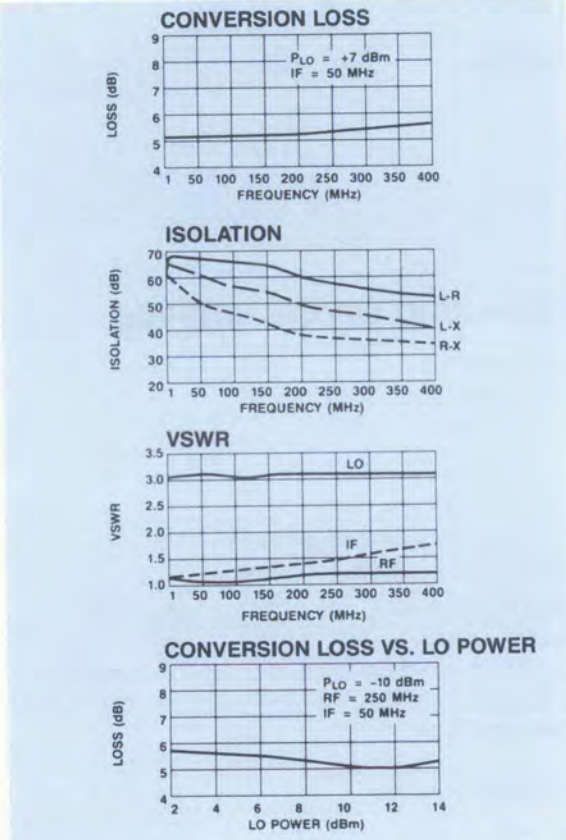
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Ordering Information

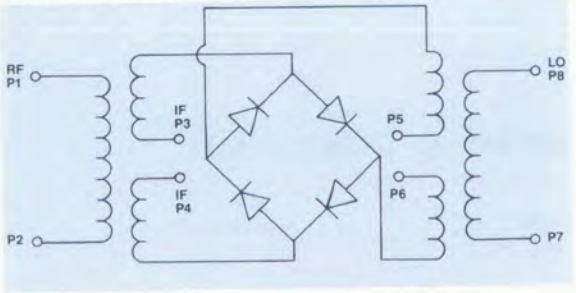
Model No.	Connectors	Unit Price (1-24 Units)
MD-428	PIN	$8.90

Delivery is from stock.

Typical Performance



Schematic



NEW

MODEL MD-435 DOUBLE BALANCED MIXER

RF, LO 0.5-600 MHz IF DC-600 MHz

- LO Power +7 dBm
- Relay Header
- MCL Model TAK-6 Replacement

Guaranteed Specifications*

(From –55°C to +85°C)

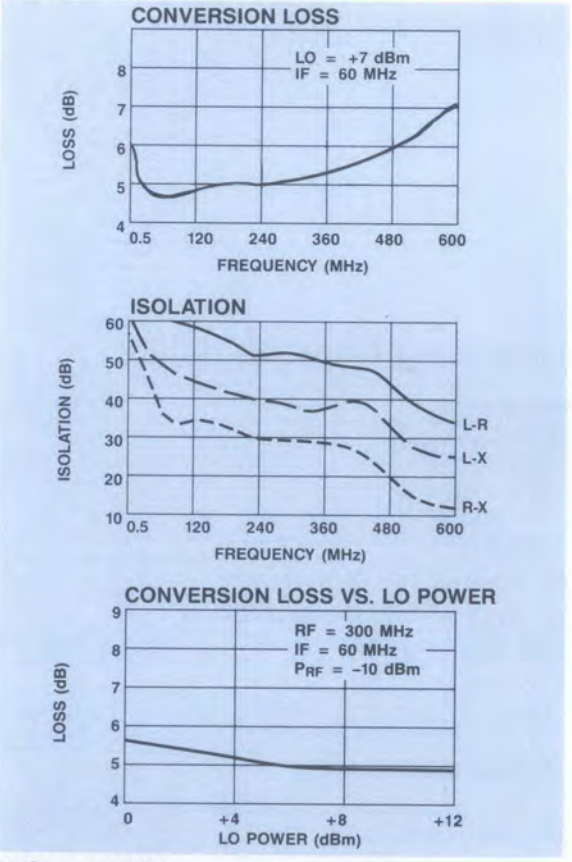
Frequency Range	RF, LO Ports		0.5 - 600 MHz
	IF Port		DC - 600 MHz
Conversion Loss	0.5 - 300 MHz		7.5 dB Max
	300 - 600 MHz		8.5 dB Max
Isolation	LO to RF	0.5 - 5 MHz	50 dB Min
		5 - 300 MHz	30 dB Min
		300 - 600 MHz	25 dB Min
	LO to IF	0.5 - 5 MHz	45 dB Min
		5 - 300 MHz	30 dB Min
		300 - 600 MHz	20 dB Min
	RF to IF	0.5 - 5 MHz	40 dB Min
		5 - 300 MHz	25 dB Min
		300 - 600 MHz	10 dB Min

Operating Characteristics

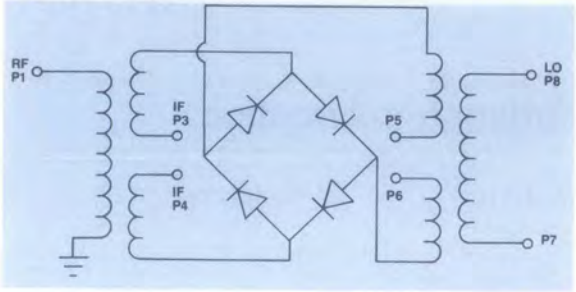
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 3.0 mV Typ
RF Input for 1dB Compression	+2.0 dBm Typ
RF Input for 1 dB Desensitization	–4.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio (with –10 dBm input, each tone and 50 & 60 MHz IF)	46 dB Typ at 160 MHz 42 dB Typ at 500 MHz
Package Type	(RH-8) (See page 474 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** P2 = Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-435	PIN	$24.90

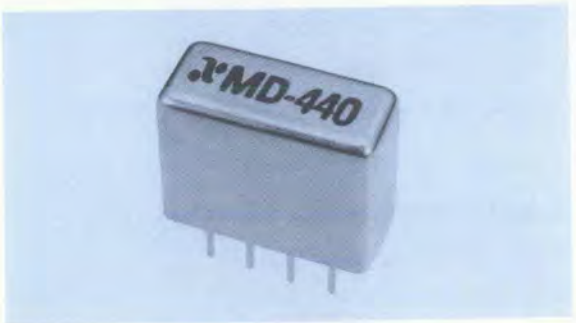
Delivery is from stock

NEW

MODEL MD-440

DOUBLE BALANCED MIXER
RF, LO 1 - 1000 MHz IF DC - 1000 MHz

- LO Power +7 dBm
- Relay Header
- MCL Model SAM-2 Replacement



Guaranteed Specifications*
(From +54°C to +85°C)

Frequency Range	RF, LO Ports		1 - 1000 MHz
	IF Port		DC - 1000 MHz
Conversion Loss	1 - 10 MHz		7.5 dB Max
	10 - 500 MHz		7.5 dB Max
	500 - 1000 MHz		9.0 dB Max
Isolation	LO to RF	1 - 10 MHz	45 dB Min
		10 - 500 MHz	25 dB Min
		500 - 1000 MHz	15 dB Min
	LO to IF	1 - 10 MHz	40 dB Min
		10 - 500 MHz	25 dB Min
		500 - 1000 MHz	25 dB Min
	RF to IF	1 - 10 MHz	35 dB Min
		10 - 500 MHz	15 dB Min
		500 - 1000 MHz	5 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 1.0 mV Typ
RF Input for 1dB Compression	−1.0 dBm Typ
RF Input for 1 dB Desensitization	−3.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	43 dB Typ at 160 MHz
(with −10 dBm input, each	35 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	42 dB Typ at 1000 MHz
Package Type	(RH-9)
	(See page 474 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4**
	P2 = Case ground.

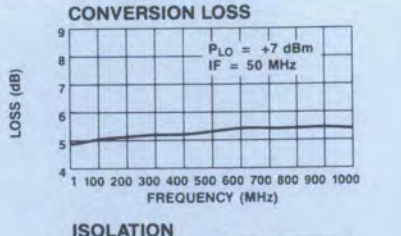
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

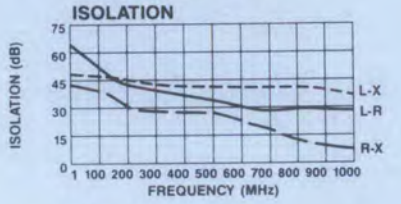
Ordering Information

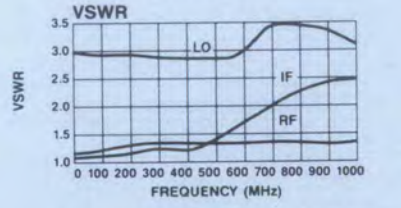
Model No.	Connectors	Unit Price (1-24 Units)
MD-440	PIN	$22.90

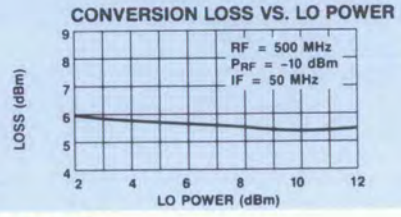
Delivery is from stock.

Typical Performance

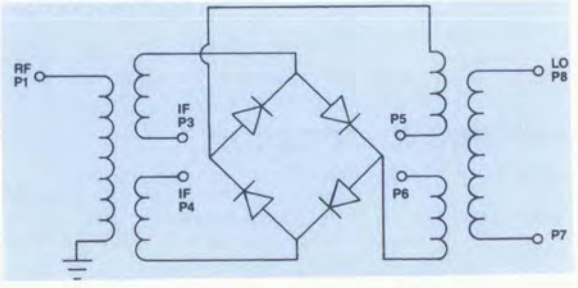








Schematic



NEW

MODEL MD-441

DOUBLE BALANCED MIXER
RF, LO 2.5 - 500 MHz IF DC - 500 MHz

- LO Power +7 dBm
- Relay Header
- MCL Model SAM-3 Replacement

Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range	RF, LO Ports		2.5 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	2.5 - 10 MHz		7.5 dB Max
	10 - 250 MHz		7.0 dB Max
	250 - 500 MHz		8.5 dB Max
Isolation	LO to RF	2.5 - 10 MHz	50 dB Min
		10 - 250 MHz	35 dB Min
		250 - 500 MHz	30 dB Min
	LO to IF	2.5 - 10 MHz	40 dB Min
		10 - 250 MHz	30 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	2.5 - 10 MHz	30 dB Min
		10 - 250 MHz	20 dB Min
		250 - 500 MHz	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+1.0 dBm Typ
RF Input for 1 dB Desensitization	–1.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50 & 60 MHz IF)	52 dB Typ at 160 MHz 40 dB Typ at 500 MHz
Package Type	(RH-9) (See page 474 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** P2 = Case ground.

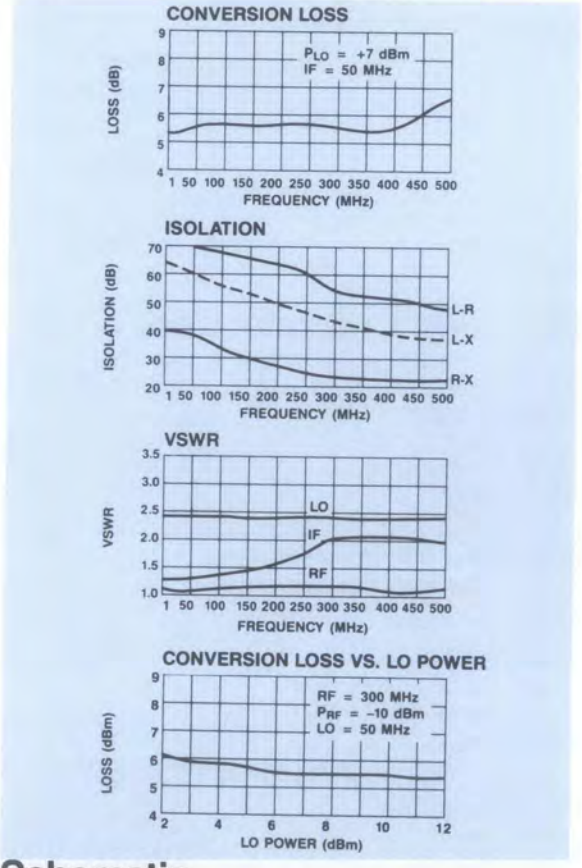
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 5, 6 & 7 grounded.
**Pins 3 & 4 must be connected together externally.

Ordering Information

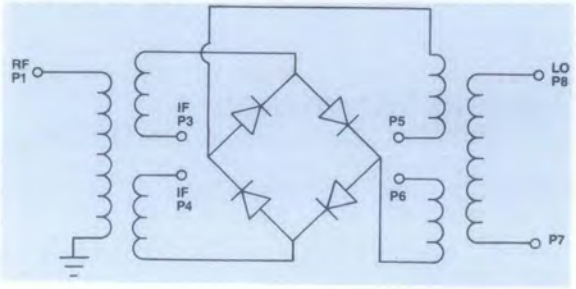
Model No.	Connectors	Unit Price (1-24 Units)
MD-441	PIN	$22.90

Delivery is from stock.

Typical Performance



Schematic

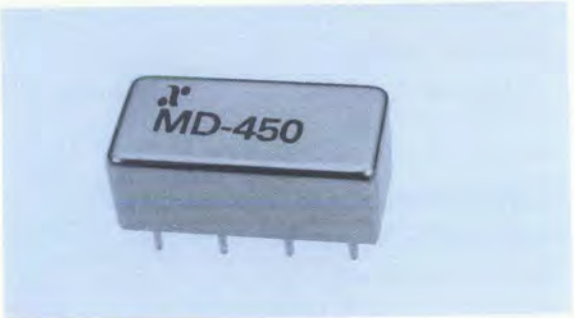


NEW

MODEL MD-450 — DOUBLE BALANCED MIXER

RF, LO 5-500 MHz; IF DC-500 MHz

- LO Power +23 dBm
- Relay Header
- MCL Model RAY-1 Replacement



Guaranteed Specifications*

(From –55°C to +85°C)

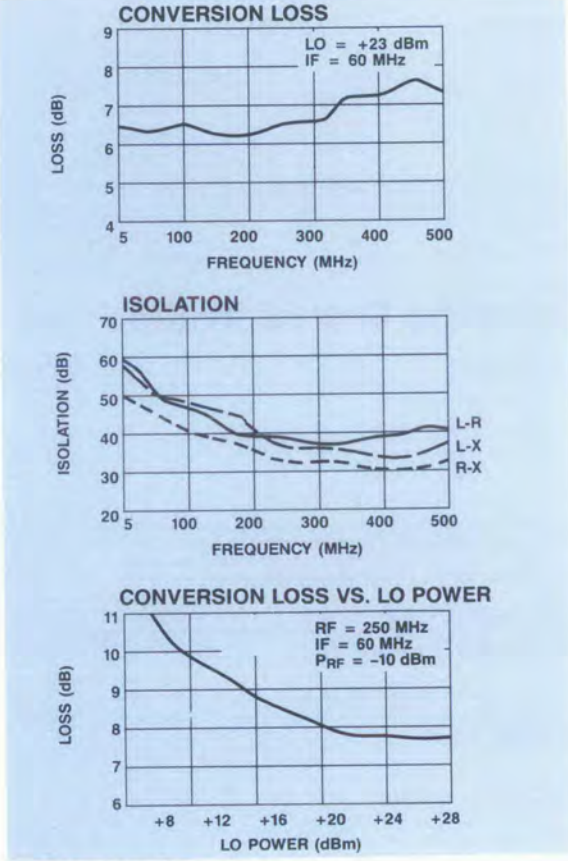
Frequency Range	RF, LO Ports		5 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	5 - 50 MHz		7.5 dB Max
	50 - 250 MHz		7.5 dB Max
	250 - 500 MHz		8.5 dB Max
Isolation	LO to RF	5 - 50 MHz	45 dB Min
		50 - 250 MHz	30 dB Min
		250 - 500 MHz	25 dB Min
	LO to IF	5 - 50 MHz	45 dB Min
		50 - 250 MHz	30 dB Min
		250 - 500 MHz	20 dB Min
	RF to IF	5 - 50 MHz	30 dB Min
		50 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min

Operating Characteristics

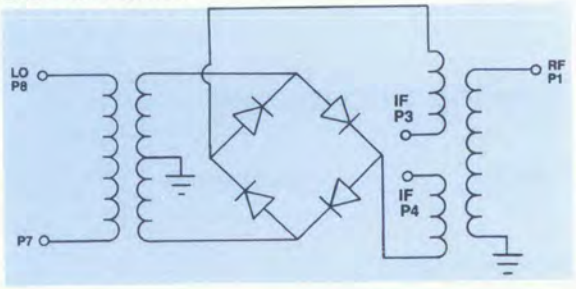
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 4.0 mV Typ
RF Input for 1dB Compression	+17.0 dBm Typ
RF Input for 1 dB Desensitization	+14.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio (with –10 dBm input, each tone and 90 & 100 MHz IF)	65 dB Typ at 500 MHz
Package Type	(RH-1) (See page 472 for physical dimensions.)
Pin Configuration	RF; P1, LO; P8, IF; P3, P4** P2 = Case ground.

*All specifications apply when operated at +23 dBm available LO power with 50 ohm source and load impedance, and with pin 7 grounded.
**Pins 3 & 4 must be connected together externally.

Typical Performance



Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-450	PIN	$42.90

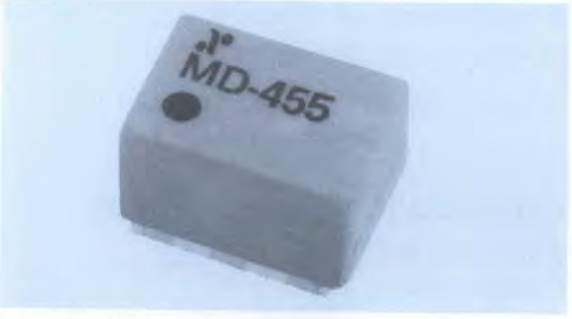
Delivery is from stock

NEW

MODEL MD-455

DOUBLE BALANCED MIXER
RF, LO 1.0-500 MHz IF DC-500 MHz

- LO Power +7 dBm
- Surface Mount
- MCL Model RMS-1 Replacement



Guaranteed Specifications*
(From –55°C to +85°C)

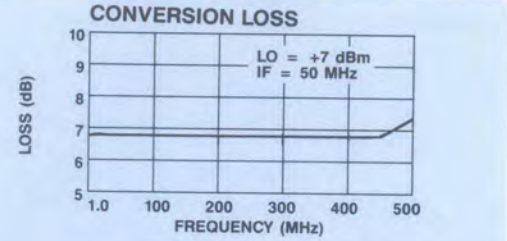
Frequency Range	RF, LO Ports		1.0 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	1.0 - 250 MHz		7.5 dB Max
	250 - 500 MHz		8.0 dB Max
Isolation	LO to RF	1.0 - 5.0 MHz	50 dB Min
		5.0 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min
	LO to IF	1.0 - 5.0 MHz	45 dB Min
		5.0 - 250 MHz	23 dB Min
		250 - 500 MHz	19 dB Min
	RF to IF	1.0 - 5.0 MHz	40 dB Min
		5.0 - 250 MHz	20 dB Min
		250 - 500 MHz	15 dB Min

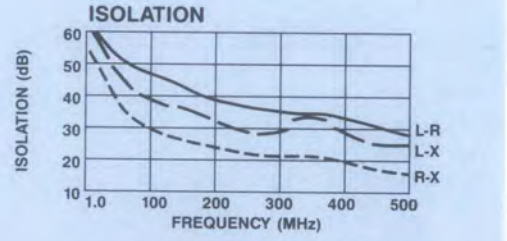
Operating Characteristics

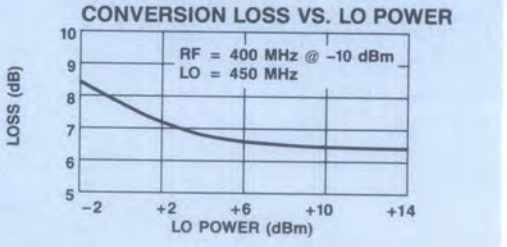
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 10.0 mV Typ
RF Input for 1dB Compression	+1.0 dBm Typ
RF Input for 1 dB Desensitization	–2.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with –10 dBm input, each tone and 50 & 60 MHz IF)	50 dB Typ at 160 MHz 44 dB Typ at 500 MHz
Package Type	(SF-3)
	(See page 490 for physical dimensions.)
Pin Configuration	RF; P4, LO; P1, IF; P5

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 3 & 6 grounded.

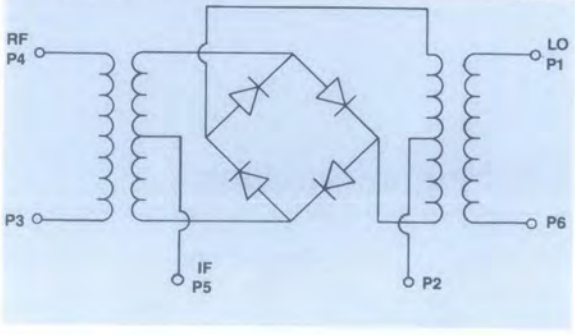
Typical Performance







Schematic



Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-455	PIN	$8.90

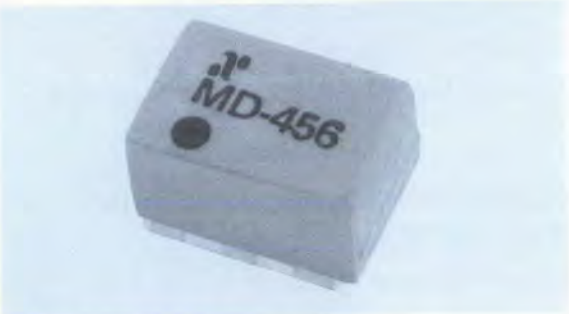
Delivery is from stock.

NEW

MODEL MD-456

DOUBLE BALANCED MIXER
RF, LO 5-1000 MHz IF DC-1000 MHz

- LO Power +7 dBm
- Surface Mount
- MCL Model RMS-2 Replacement



Guaranteed Specifications*
(From –55°C to +85°C)

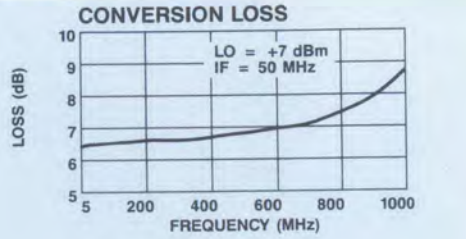
Frequency Range	RF, LO Ports		5 - 1000 MHz
	IF Port		DC - 1000 MHz
Conversion Loss	5 - 500 MHz		8.0 dB Max
	500 - 1000 MHz		9.5 dB Max
Isolation	LO to RF	5 - 50 MHz	40 dB Min
		50 - 500 MHz	20 dB Min
		500 - 1000 MHz	18 dB Min
	LO to IF	5 - 50 MHz	30 dB Min
		50 - 500 MHz	20 dB Min
		500 - 1000 MHz	12 dB Min
	RF to IF	5 - 50 MHz	30 dB Min
		50 - 500 MHz	17 dB Min
		500 - 1000 MHz	10 dB Min

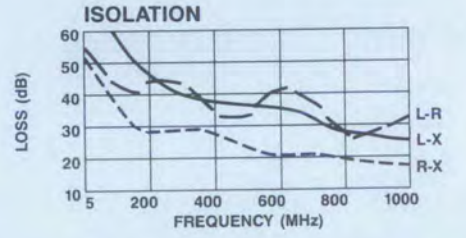
Operating Characteristics

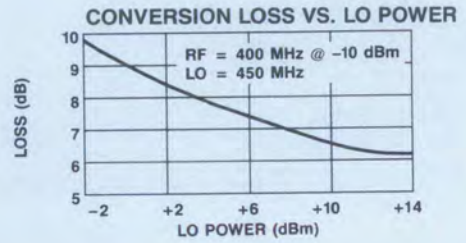
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+2.0 dBm Typ
RF Input for 1 dB Desensitization	0.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	60 dB Typ at 160 MHz
(with –10 dBm input, each	52 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	42 dB Typ at 1000 MHz
Package Type	(SF-3)
	(See page 490 for physical dimensions.)
Pin Configuration	RF; P4, LO; P1, IF; P5

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 3 & 6 grounded.

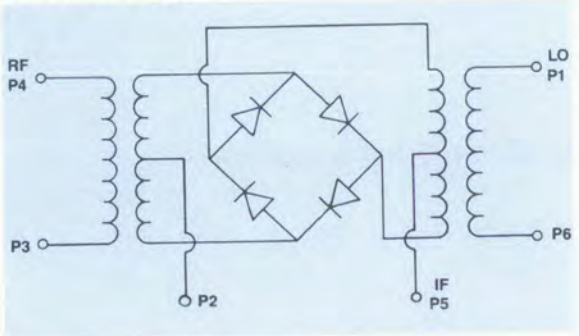
Typical Performance







Schematic



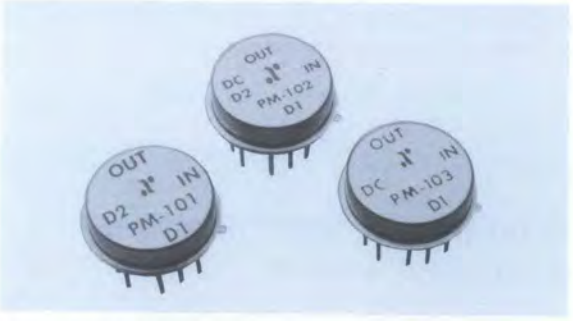
Ordering Information

Model No.	Connectors	Unit Price (1-24 Units)
MD-456	PIN	$9.90

Delivery is from stock.

MODELS PM-101/102/103 — BIPHASE MODULATORS 10-750 MHz

- Variety of Drivers: PM-101; Current, PM-102; ECL, PM-103; TTL
- Phase Deviation — 1° Typical
- TO-8 Case



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-750 MHz
Insertion Loss	10-500 MHz	3.0 dB Max
	10-750 MHz	3.5 dB Max
VSWR	50-500 MHz	1.3:1 Max
	10-750 MHz	1.6:1 Max
Amplitude Balance		0.2 dB Max
Phase Deviation	10-500 MHz	2° Max
	10-750 MHz	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
RF Input Level	
Operating	−3 dBm Max
Non-Destruct	+17 dBm Max
Carrier Suppression (100 MHz RF, 1 MHz Modulation)	35 dB Typ
Control Input	
PM-101	
Logic 1	+10 mA Drive Current
Logic 0	−10 mA Drive Current
PM-102 (ECL Series 10,000)	
Logic 1	ECL High
Logic 0	ECL Low
PM-103 (LS TT L)	
Logic 1	TTL High
Logic 0	TTL Low
Bias Power	
PM-102	−4.7 to −6.2 VDC @ 50 mA Max (260 mW Typ)
PM-103	+5.0 VDC ±5% @ 30 mA Max (125 mW Typ)
Package Type	TO-8-2
	(See page 472 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

PM-101	RF IN; P2, RF Out; P5, D1; P11, D2; P8
PM-102	RF IN; P2, RF Out; P5, D1; P11, D2; P8, DC; P7
PM-103	RF IN; P2, RF Out; P5, D1, P11, DC; P8
	All other pins are ground.

*All specifications apply with 50 ohm source and load impedance and inputs to −3 dBm.

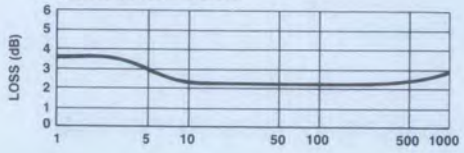
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PM-101	9689	Pin	$94
PM-102	9699	Pin	116
PM-103	9249	Pin	116

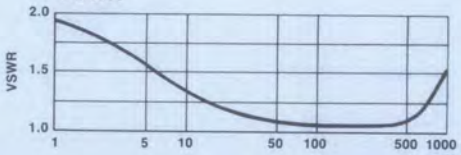
Delivery is from stock.

Typical Performance

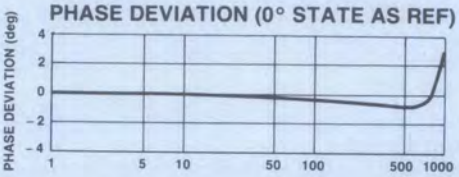
INSERTION LOSS



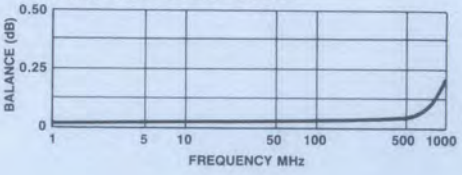
VSWR



PHASE DEVIATION (0° STATE AS REF)



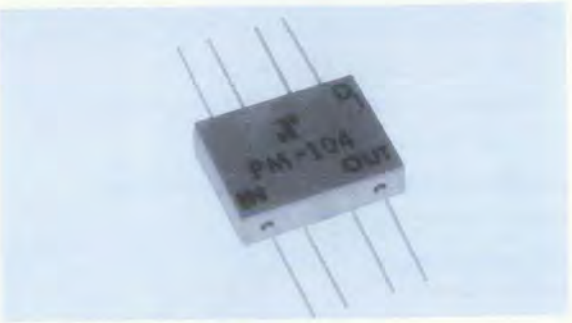
AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE D1	LOGIC STATE D2
0°	1	0
+180°	0	1

MODEL PM-104 BIPHASE MODULATOR 2.0-3.0 GHz

- 3.5 dB Typical Insertion Loss
- 1.5:1 Typical VSWR
- 1° Typical Phase Deviation
- 3 nS Switch Speed



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2.0-3.0 GHz
Insertion Loss	2.0-2.8 GHz 2.8-3.0 GHz	5.5 dB Max 6.0 dB Max
VSWR	2.0-2.8 GHz 2.8-3.0 GHz	2.0:1 Max 2.25:1 Max
Amplitude Balance		0.6 dB Max
Phase Deviation		5° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max Derated to 85°C @ 3.2 mW/°C
Bias Port Current	50 mA Max
Carrier Suppression (2.5 GHz RF, 5 MHz Modulation)	28 dB Typ
Switching Speed	3 nS Typ
Input Power for 1 dB Compression	+6 dBm Typ
Control Input	
Logic 1	+20 mA Drive Current
Logic 0	−20 mA Drive Current
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

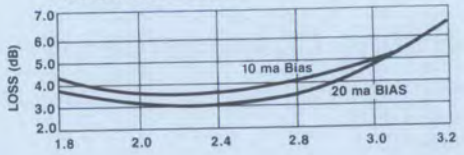
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	IN; P5, Out; P8 D1; P4, All other pins are ground.

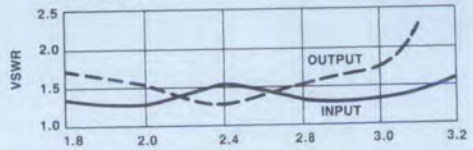
*All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm

Typical Performance

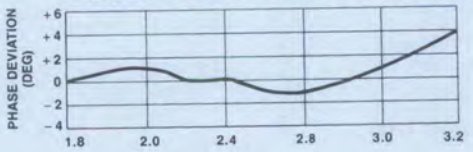
INSERTION LOSS



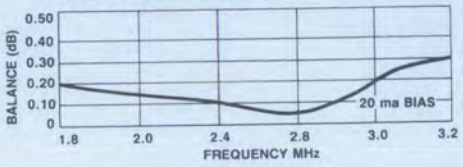
VSWR



PHASE DEVIATION (0° STATE AS REF)



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE D1
0°	1
+180°	0

Ordering Information

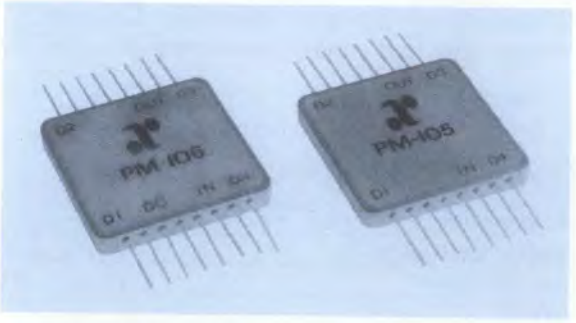
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PM-104	6949	Pin	$156

Delivery is from stock.

MODELS PM-105/106

QPSK MODULATOR
20-40 MHz

- Hermetic Module
- 2° Phase Deviation
- Integral ECL Series 10,000 Driver (PM-106)



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-40 MHz
Insertion Loss		5.8 dB Max
VSWR		
Input		1.25:1 Max
Output		1.70:1 Max
Amplitude Balance		0.5 dB Max
Phase Deviation**	30 MHz	2° Max
	20-40 MHz	6° Max

Operating Characteristics

Impedance	50 Ohms Nominal
RF Input Level	
Operating	0 dBm Max
Non-Destruct	+20 dBm Max
Carrier Suppression (30 MHz RF, 1 MHz Modulation)	35 dB Typ
Bias Power (PM-106 only)	−4.7 to −6.2 VDC @ 120 mA Max (520 mW Typical)
Control Input	
PM-105	
Logic 1	+10 mA Drive Current
Logic 0	−10 mA Drive Current
PM-106 (ECL Series 10,000)	
Logic 1	ECL High
Logic 0	ECL Low
Package Type	Flatpack (FP-6) (See page 475 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

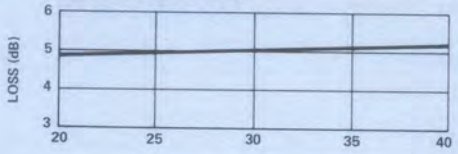
PM-105	IN; P14, OUT; P6, DI; P9, D2; P1 D3; P8, D4; P16
PM-106	IN; P14, OUT; P6, DI; P9, D2; P1 D3; P8, D4; P16, DC; P11 All other pins are ground.

†PM-106 only, ground on PM-105.
*All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm.
**All states relative to 0° state.

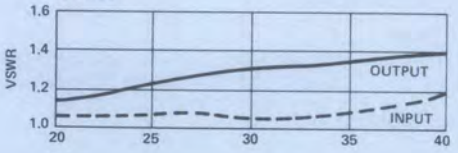
This product contains elements protected by United States Patent Number 3,484,724.

Typical Performance

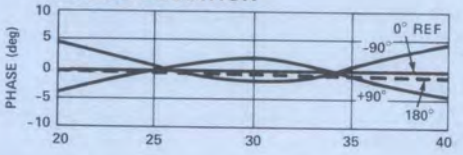
INSERTION LOSS



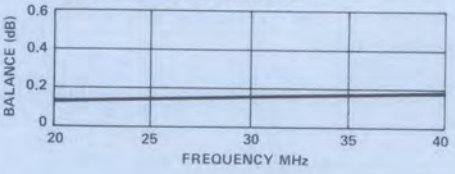
VSWR



PHASE DEVIATION



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE			
	D1	D2	D3	D4
0°	1	0	1	0
-90°	0	1	1	0
+90°	1	0	0	1
+180°	0	1	0	1

Ordering Information

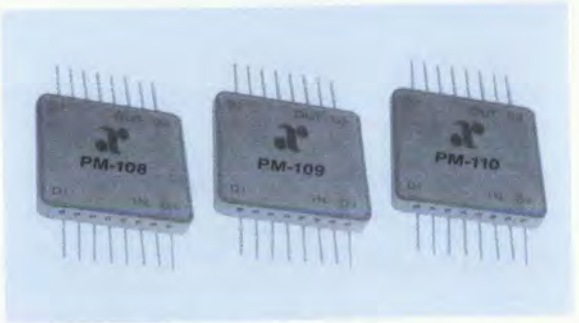
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PM-105	9619	Pin	$179
PM-106	9629	Pin	201

Delivery is from stock.

MODELS PM-108/109/110

QPSK MODULATORS 50-100 MHz

- Variety of Drivers: PM-108; Current, PM-109; ECL, PM-110; TTL
- Hermetic Module
- 2.5° Phase Deviation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		50-100 MHz
Insertion Loss		6.25 dB Max
VSWR		
Input		1.4:1 Max
Output		1.6:1 Max
Amplitude Balance		0.5 dB Max
Phase Deviation**	70 MHz	2.5° Max
	50-100 MHz	6.5° Max

Operating Characteristics

Impedance		50 Ohms Nominal
RF Input Level		
Operating		0 dBm Max
Non-Destruct		+20 dBm Max
Carrier Suppression (70 MHz RF, 1 MHz Modulation)		35 dB Typ
Bias Power		
PM-109	−4.7 to −6.2 VDC @ 120 mA Max	(520 mW Typ)
PM-110	+5.0 VDC ±5% @ 50 mA Max	(200 mW Typ)
Control Input		
PM-108		
Logic 1		+10 mA Drive Current
Logic 0		−10 mA Drive Current
PM-109 (ECL Series 10,000)		
Logic 1		ECL High
Logic 0		ECL Low
PM-110 (LS TT L)		
Logic 1		TTL High
Logic 0		TTL Low
Package Type		Flatpack (FP-6)
		(See page 475 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	
PM-108/PM-109	IN; P14, OUT; P6, DI; P9, D2; P1, D3; P8, D4; P16
PM-110	IN; P14, OUT; P6, DI; P9, D2; P16, DC; P11 All other pins are ground.

†PM-109 only, ground on PM-108.
*All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm.
**All states relative to 0° state.
This product contains elements protected by United States Patent Number 3,484,724.

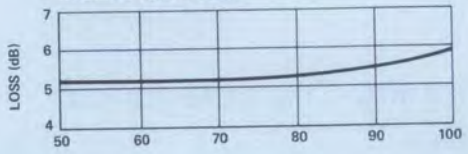
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PM-108	9639	Pin	$179
PM-109	9649	Pin	201
PM-110	9259	Pin	201

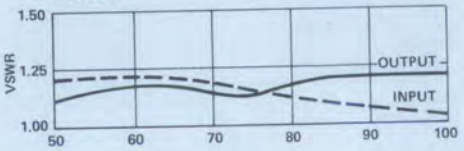
Delivery is from stock.

Typical Performance

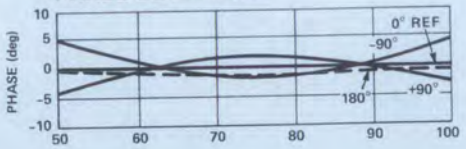
INSERTION LOSS



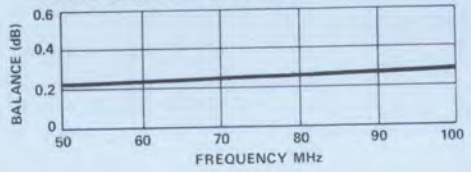
VSWR



PHASE DEVIATION



AMPLITUDE BALANCE

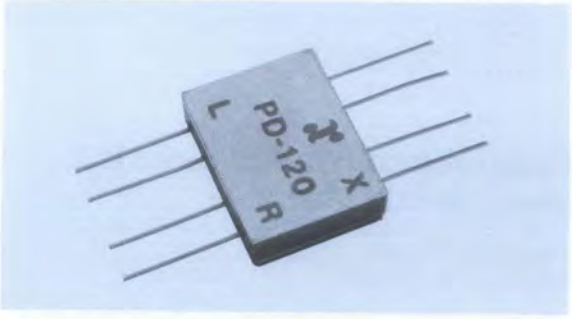


PHASE STATE	LOGIC STATE			
	D1	D2[1]	D3[1]	D4[2]
0°	1	0	1	0
-90°	0	1	1	0
+90°	1	0	0	1
+180°	0	1	0	1

1. Not used on PM-110
2. D2 for PM-110

MODEL PD-120 PHASE DETECTOR 5-1000 MHz

- Wide Bandwidth
- Low DC Offset



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Maximum DC Output	5-500 MHz	300 mV Min
	5-1000 MHz	250 mV Min
Isolation (L-R)	5-200 MHz	50 dB Min
	200-500 MHz	40 dB Min
	500-1000 MHz	30 dB Min
DC Offset (100 MHz RF)		1.0 mV Max

Operating Characteristics

Impedance	
(L,R Ports)	50 Ohms Nominal
Load (X Port)	500 Ohms
Input Power (L & R Ports)	+7 dBm Nominal
Maximum Input (Non-Destruct)	
Total Power	300 mW Max @ 25°C
	Derated to 85°C @ 3.2 mW/°C
DC Output Polarity	Negative
Package Type	Flatpack (FP-2)
	(See page 474 for physical dimensions.)

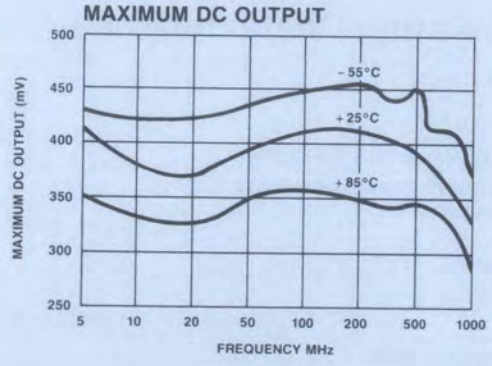
Environmental

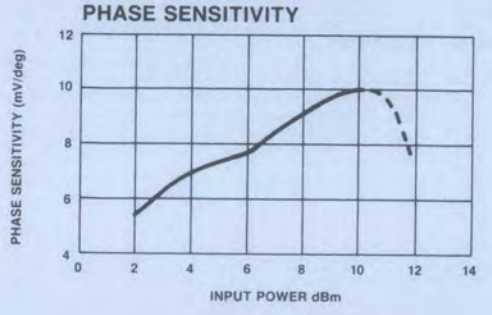
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

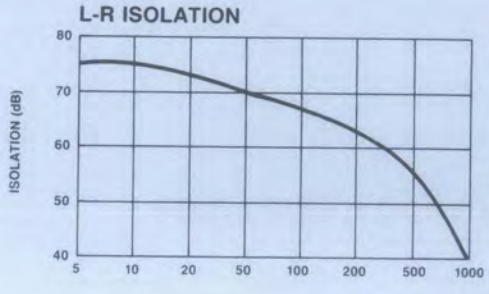
Pin Configuration RF; P8, LO; P5, IF; P4. All other pins and case are ground.

*All specifications apply when operated at +7 dBm available LO and RF power and 50 ohms impedance at the L & R ports and with 500 ohm load at the X port.

Typical Performance







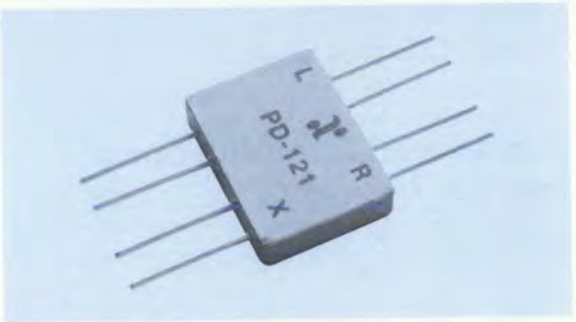
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PD-120	8519	Pin	$62

Delivery is from stock.

MODEL PD-121 — PHASE DETECTOR 3-200 MHz

- High DC Output Voltage
- Low DC Offset



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		3-200 MHz
Maximum DC Output	10-100 MHz 3-200 MHz	900 mV Min 800 mV Min
Isolation (L-R)	3-100 MHz 100-200 MHz	40 dB Min 35 dB Min
DC Offset (50 MHz RF)		1.0mV Max

Operating Characteristics

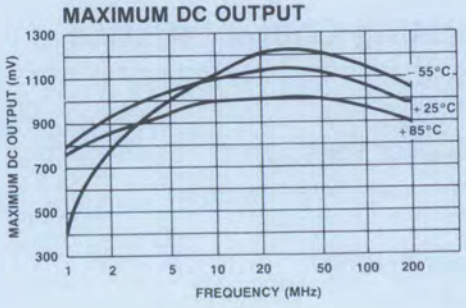
Impedance (L,R Ports) Load (X Port)	 50 Ohms Nominal 500 Ohms
Input Power (L & R Ports)	+7 dBm Nominal
Maximum Input (Non-Destruct) Total Power	 600 mW Max @ 25°C Derated to 85°C @ 6.4mW/°C
DC Output Polarity	Positive
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

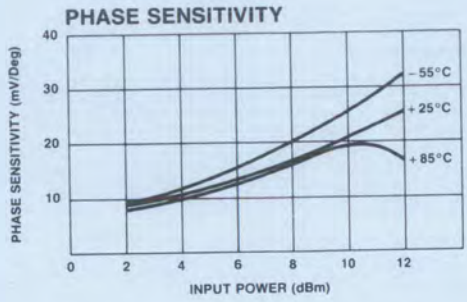
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

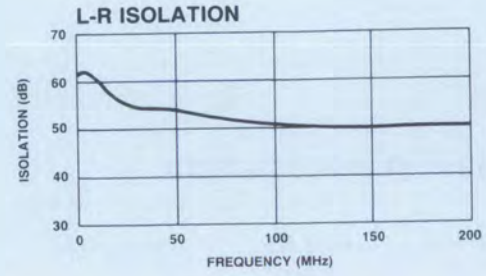
Pin Configuration	RF; P5, LO; P8, IF; P1. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO and RF power and 50 ohms impedance at the L & R ports and with 500 ohm load at the X port.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
PD-121	8529	Pin	$156

Delivery is from stock.

MICROWAVE MIXER SELECTION GUIDE

MODEL NO.	FREQUENCY RANGE RF/LO (GHz)	IF (MHz)	CONVERSION LOSS (dB) TYP	ISOLATION LO-RF (dB) TYP	ISOLATION LO-IF (dB) TYP	ISOLATION RF-IF (dB) TYP	1dB COMPRESSION POINT (dBm) TYP	LO DRIVE (dBm)	CASE[1] STYLE	PAGE NO.
DM1-8A	1-8	DC-500	5.0	28	28	N/A	+2	+7	C-27	331
M-177	2-8	DC-500	5.0	25	18	28	+3	+7	FP-10	348
M-177C	2-8	DC-500	5.0	25	18	28	+3	+7	C-3	348
DM4-8A	4-8	DC-500	5.0	28	29	N/A	+2	+7	C-27	334
M-186	4-8	DC-3000	5.2	33	32	29	+2	+7	FP-10	350
M-186C	4-8	DC-3000	5.2	33	32	29	+2	+7	C-3	350
DM1-12A	1-12	DC-500	5.5	28	27	N/A	+2	+7	C-27	332
DM8-12A	8-12	DC-500	6.5	28	28	N/A	+3	+7	C-27	335
M-182	3-13	DC-400	6.5	22	25	25	+3	+7	FP-10	349
M-182C	3-13	DC-400	6.5	22	25	25	+3	+7	C-3	349
M-166	0.5-18	2-5000	8.0	22	28	32	+9.5	+13	FP-10	344
M-166C	0.5-18	2-5000	8.0	22	28	32	+9.5	+13	C-3	344
M-167	0.5-18	500-8000	8.2	22	26	30	+9.5	+13	FP-10	345
M-167C	0.5-18	500-8000	8.2	22	26	30	+9.5	+13	C-3	345
M-170	0.5-18	2-5000	7.5	28	22	29	+12	+19	FP-10	346
M-170C	0.5-18	2-5000	7.5	28	22	29	+12	+19	C-3	346
DM1-18A	1-18	DC-500	6.0	28	25	N/A	+2	+7	C-27	333
DMB2-18A	2-18	1-500	8.0	25	27	N/A	–5	0	C-27	337
M2-18	**2-18**	**DC-500**	**8.0**	**30**	**25**	**N/A**	**+5**	**+8**	**C-42**	342
M-171	4-18	DC-4000	5.5	32	33	27	+2	+7	FP-10	347
M-171C	4-18	DC-4000	5.5	32	33	27	+2	+7	C-3	347
TBM4-18	**4-18**	**500-8000**	**8.0**	**25**	**25**	**N/A**	**0**	**+13**	**C-42**	351
DME4-18	4-18	DC-500	8.0	60	55	N/A	0	+5	C-26	338
DM12-18A	12-18	DC-500	6.5	28	27	N/A	+3	+7	C-27	336
DMH2-22	2-22	500-10000	7.5	25	24	N/A	+8	+10	C-26	340
DMS1-26A	1-26	DC-500	7.0	22	18	N/A	+3	+8.5	C-26	341
M2-26	**2-26**	**DC-500**	**8.0**	**30**	**25**	**N/A**	**+5**	**+8.5**	**C-42**	343
DCMX4-26	**4-26**	**DC-2000**	**8.5**	**30**	**N/A**	**N/A**	**+5**	**+8.5**	**C-43**	330
DME4-26	**6-26**	**DC-4000**	**9.0**	**30**	**55[2]**	**N/A**	**0**	**+12**	**C-42**	339

[1]CASE STYLE: C = CONNECTORIZED; FP = FLATPACK; TO-8 = TO-8 PLUB-IN
[2]2LO TO RF

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
BOLD = NEW PRODUCT

2 TO 18 AND 2 TO 26 GHz BIASABLE BRIDGE QUAD SCHOTTKY DIODE MIXERS

INTRODUCTION

The DBL and DBLX series of biasable and hermetic mixers were designed to be used in wide RF bandwidth system applications where very little LO power is available. This mixer also functions well at higher LO powers when the LO source has power peaks as it is tuned across the band. Figures 1a, 1b, 1c show the typical performance parameters at two LO power extremes for the 18 and 26 GHz models.

The DBL and DBLX differ mainly in their IF bandwidths. The DBL IF bandwidth is 0.01 to 500 MHz, whereas the DBLX has IF ranges up to 8 GHz. The minimum RF frequency on the DBLX series is equal to the highest IF frequency. The maximum RF frequency limits are 18 and 26 GHz, dependent upon whether a discrete or monolithic Schottky diode bridge quad is used. Both configurations require a diplexer to separate the signals at one of the diode bridge terminals.

Unlike a ring mixer, the DBL series of bridge mixers does not simultaneously suppress even harmonics of both the RF and LO and, therefore, will have spurious signal levels that are dependent upon which ports receive the LO and RF signals. In the normal mode of operation, mixing products having even harmonics of the RF will be suppressed. The third LO harmonic mixing efficiencies of the ring and bridge (DBL) mixers are similar and approximately 10 dB lower than fundamental mixing. However, any unbiased ring mixer will exhibit a peak in conversion loss of almost 25 dB if the LO power range is not optimized, whereas the bridge design can be biased to eliminate this effect.

The bridge mixing circuit will not permit simultaneous overlap of all three frequencies – LO, RF and IF. Therefore, the normal mode of operation for the DBL series is contiguous RF and IF bandwidth with an overlapping and isolated LO. In the next section, other modes of operation are discussed where the DBL is useful with contiguous RF and LO ranges with the IF overlapping and isolated.

DBL/DBLX

The bias voltage for the DBL mixer series also is useful for controlling the conversion loss of the mixer in a manner similar to an attenuator. It is, therefore, theoretically possible to store a sequence of digital bias voltages in a system ROM, each corresponding to a unique LO/RF combination, so that an overall flat system amplitude response is possible.

THEORY OF OPERATION

In general, a mixer is a device that periodically connects an input (RF) circuit to an output (IF) circuit. The output becomes the product of the input signal and some periodic switching function that is under control of a higher level third signal (LO). Often, the switching function is performed by a DPDT ring diode connection as used in a conventional double-balanced mixer. However, RF energy also can be alternately coupled to the output circuit by reflection from a periodically changing load impedance, such as the single diode circuit shown in Figure 2a. The diagram shows how the local oscillator voltage would cause a diode to alternately act as a short and open circuit corresponding to reflection coefficients of −1 and +1, respectively. The output IF signal for this mixer is the product of the RF incident signal and the periodic square wave reflection coefficient. Since the alternating or time varying reflection coefficient is "square like," it produces reflection coefficients in the frequency domain of odd harmonics only. Desirable frequency components are then separated via the diplexer.

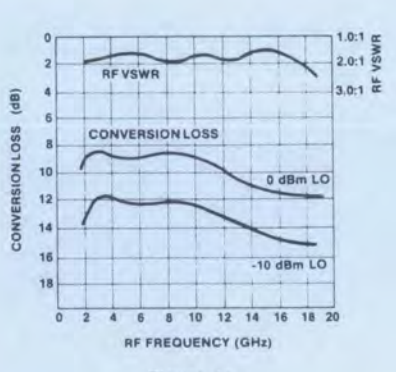


Figure 1a

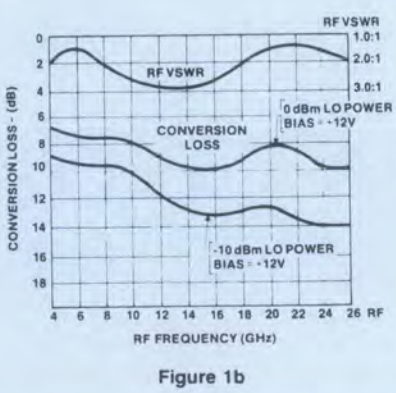


Figure 1b

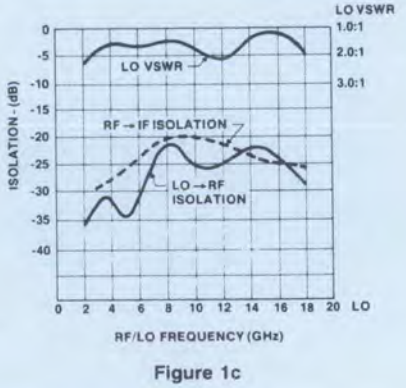


Figure 1c

Figure 1a. Conversion loss and RF VSWR as a function of frequency of DBL 2-18 at 0 and −10 dBm LO power (IF = 100 MHz)
Figure 1b. Conversion loss and RF VSWR of DBL 2-26 biasable mixer as a function of RF frequency at 0 and −10 dBm LO power.
Figure 1c. LO VSWR, LO and RF to IF isolation of DBL 2-18 bridge mixer as a function of LO frequency.

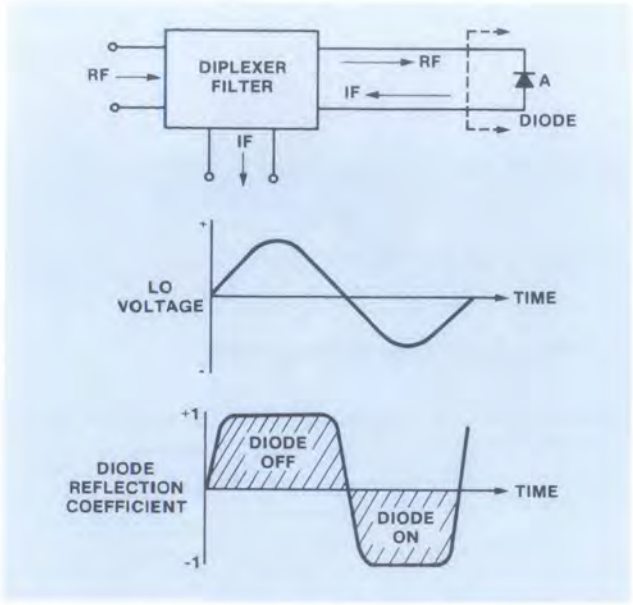


Figure 2a. Conventional Single-Diode Reflection Mixer

Typically, the third harmonic or LO is 10 dB below the fundamental LO mixing product. If desired, a DC voltage bias can be applied to the diode to produce even harmonic components.

Figure 2b shows a way of coupling LO power to the diodes without altering the RF operating characteristics. The mixing characteristics of the multiple diode bridge quad shown can be analyzed by calculating the large signal individual diode conductances as a function of time and converting this to an equivalent time-varying reflection coefficient at the RF terminals. Since all diodes receive the same LO signal, this mixer will have the same LO harmonics as the single diode version. However, large RF signal levels modulate the conductance and reflection coefficient of each diode differently and, therefore, even RF harmonics are cancelled.

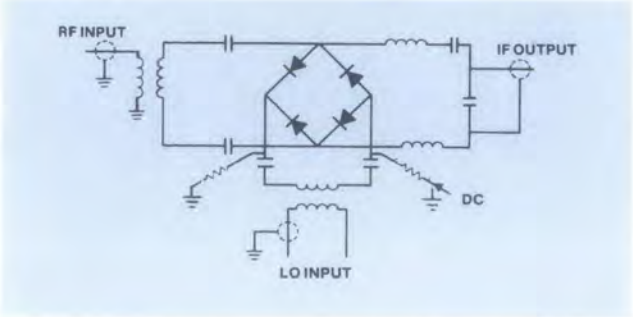


Figure 2b. Multiple Diode (Bridge Quad) Reflection Mixer

DESIGN

The electrical and mechanical design used is intended to satisfy the requirements of broadband ECM and EW hardware used in MIL-STD-810 environments. Therefore, a hermetically sealed package was designed that would support the microwave circuit board internally with tolerance to thermal and mechanical shocks. The internal microwave diplexer of the DBLX series mixer uses ultrasonic bonded interconnections for maximum reliability. Both the beam-lead diodes and capacitors are thermocompression-bonded in place. No silver epoxy is used in the construction. The external SMA connectors are removable to allow integration with other front-end components.

The mixer incorporates a wideband tapered balun and is of multioctave design with no tuned circuits. A special diode package that provided nearly ideal "on" and "off" reflection coefficients when driven by the low level LO was designed. If the diode time varying reflection coefficient is expressed as a Fourier series, then the conversion loss of the mixer is proportional to the first LO harmonic (Γ_1) and the average reflection coefficient (Γ_0):

$$CL \approx 10 \log \frac{|\Gamma_1|^2}{(1-|\Gamma_0|^2)} .$$

Therefore, an ideal diode driven between reflection coefficients of ± 1 by the LO will have an average $\Gamma_0 = 0$ and $\Gamma_1 = 2/\pi$ yielding a conversion loss of:

$$10 \log \left| \frac{2}{\pi} \right|^2 = 3.9 \text{ dB}.$$

Thus, one half of the total RF input power is reflected into the upper and lower sidebands, i.e., (LO+RF), (LO−RF) and a small part of the remaining powers appears at the odd harmonic sidebands (3LO±RF) (5LO±RF) (7LO±RF) etc.

NEW

MODEL DCMX4-26

MULTIOCTAVE DOUBLE BALANCED MIXER 4-26 GHz

- Subminiature .5 x .5 x .2
- Hermetic
- Removable Connectors
- Low RF VSWR

Guaranteed Specifications

(From –55°C to +85°C)

Frequency Range	RF, LO Ports	4 - 26 GHz
	IF Port	DC - 2 GHz
Conversion Loss		9 dB Max
Isolation	LO to RF	20 dB Min

Operating Characteristics (@ 25°)

LO Power*		+8.5 dBm
Isolation	LO-RF	30 dB Typ
RF Input		
1 dB Compression*		+5 dBm Typ
SSB Noise Figure		7.5 dB Typ
Conversion Loss		7.0 dB Typ
Typical Intercept Point		
3rd Order		+15 dBm
2nd Order		+40 dBm
Package Type		(C-43)
		(See page 487 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

Notes:

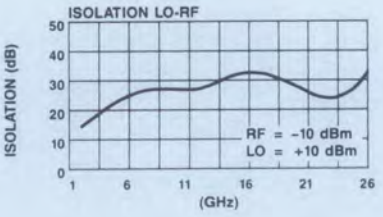
*6 dB improvement available with an equal LO power increase. (Option "H")

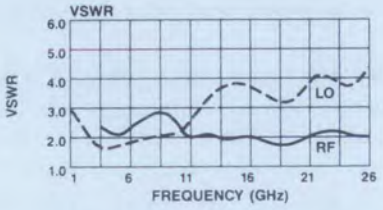
**Ideally suited for direct integration with microstrip or coplanar transmission lines (Optional Cost).

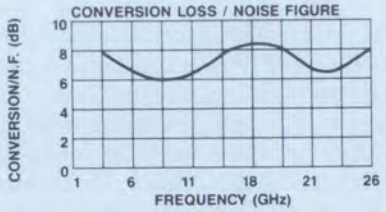
***Single tone intermodulation matrix shown at RF bandwidth extremes with LO and IF held constant at –10 dBm RF input (harmonics –dBc).

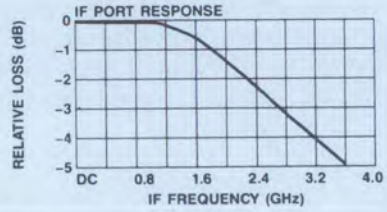
For additional information see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance









HARMONICS***

LO HARMONICS	(IF = 0.1 GHz, LO = 8 GHz) RF HARMONICS 1	2	3	(IF = 0.3 GHz, LO = 24 GHz) RF HARMONICS 1	2	3
3	12	46	50	—	—	50
2	22	54	55	—	48	65
1	0	45	53	0	55	55

Ordering Information

Model No.	Connectors	Unit Price (1-9)
DCMX4-26	SMA	$650

MODEL DM1-8A

DOUBLE-BALANCED MICROWAVE MIXER 1-8 GHz

- 5.0 dB Typical Midband Conversion Loss
- 28 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	1-8 GHz
	IF Port	DC-500 MHz
Conversion Loss**		8.0 dB Max
Isolation	LO to RF	25 dB Min
	LO to IF	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	+23 dBm Max @ 25°C
RF Input	
1 dB Compression	+2 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

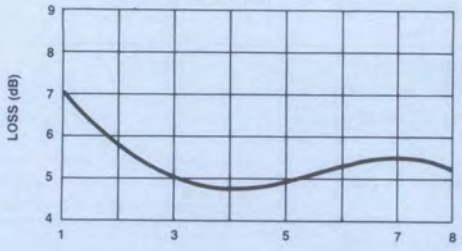
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

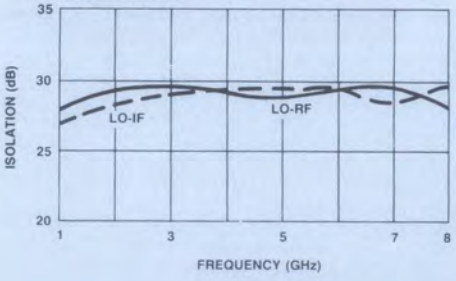
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance

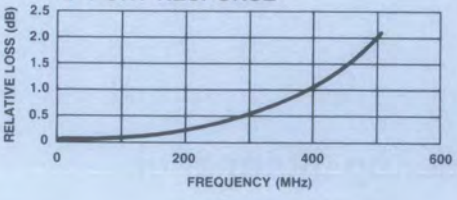
CONVERSION LOSS



ISOLATION



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DM1-8A	SMA	$325

Delivery is from stock.

MODEL DM1-12A

DOUBLE-BALANCED MICROWAVE MIXER 1-12 GHz

- 5.5 dB Typical Midband Conversion Loss
- 28 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	1-12 GHz
	IF Port	DC-500 MHz
Conversion Loss**		8.5 dB Max
Isolation	LO to RF	25 dB Min
	LO to IF	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+23 dBm Max @ 25°C
RF Input 1 dB Compression	+2 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)

Environmental

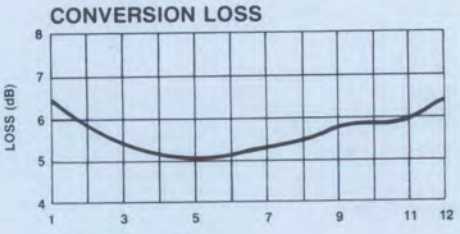
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

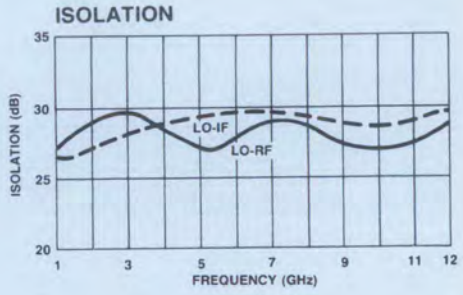
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

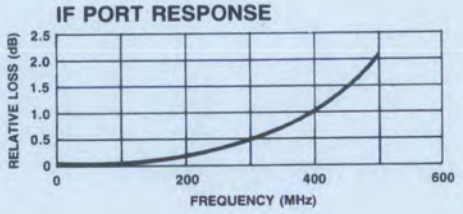
**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DM1-12A	SMA	$385

Delivery is from stock.

MODEL DM1-18A — DOUBLE-BALANCED MICROWAVE MIXER 1-18 GHz

- 6.0 dB Typical Midband Conversion Loss
- 28 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	1-18 GHz
	IF Port	DC-500 MHz
Conversion Loss**	6-16 GHz	8.0 dB Max
	1-18 GHz	9.5 dB Max
Isolation	LO to RF	22 dB Min
	LO to IF	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	+23 dBm Max @ 25°C
RF Input	
1 dB Compression	+2 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

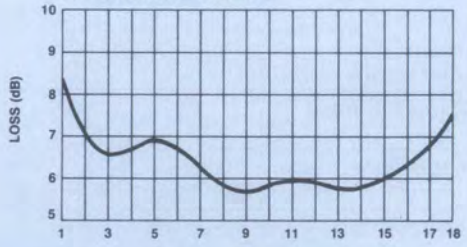
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

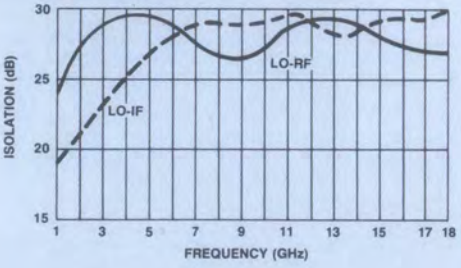
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance

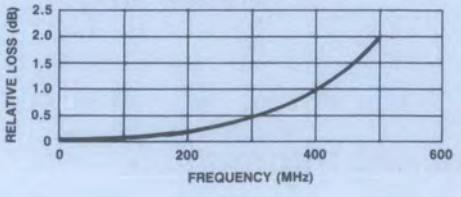
CONVERSION LOSS



ISOLATION



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DM1-18A	SMA	$495

Delivery is from stock.

MODEL DM4-8A — DOUBLE-BALANCED MICROWAVE MIXER 4-8 GHz

- 5.0 dB Typical Midband Conversion Loss
- 28 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	4-8 GHz
	IF Port	DC-500 MHz
Conversion Loss**		6.5 dB Max
Isolation	LO to RF	25 dB Min
	LO to IF	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+23 dBm Max @ 25°C
RF Input 1 dB Compression	+2 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)

Environmental

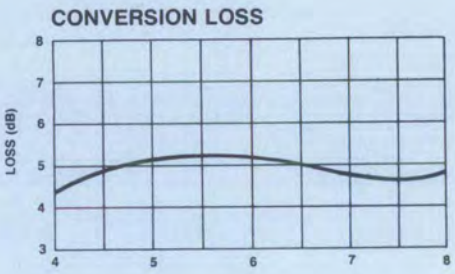
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

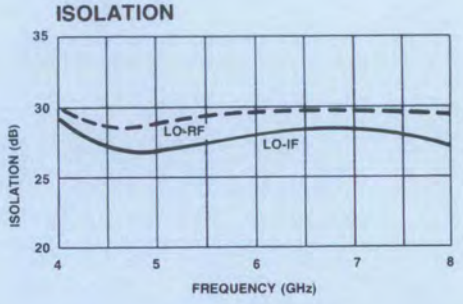
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

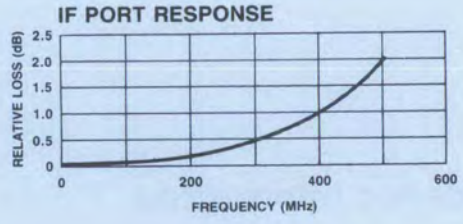
**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DM4-8A	SMA	$310

Delivery is from stock.

MODEL DM8-12A

DOUBLE-BALANCED MICROWAVE MIXER 8-12 GHz

- 6.5 dB Typical Midband Conversion Loss
- 28 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	8-12 GHz
	IF Port	DC-500 MHz
Conversion Loss**		8.0 dB Max
Isolation	LO to RF	25 dB Min
	LO to IF	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+23 dBm Max @ 25°C
RF Input 1 dB Compression	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)

Environmental

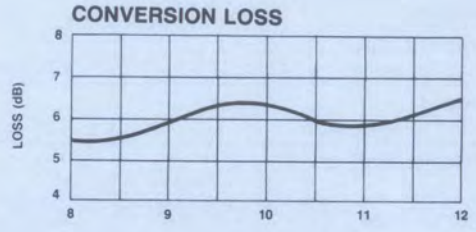
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

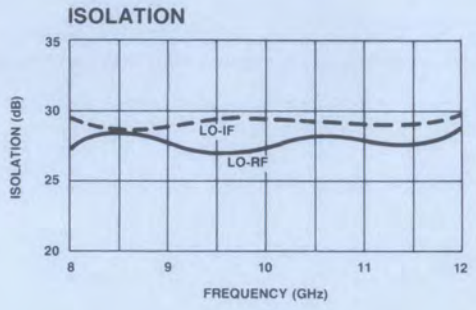
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

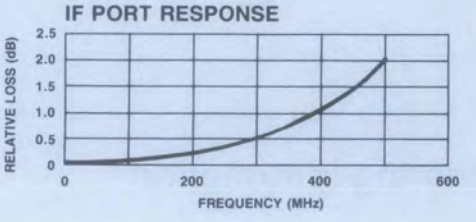
**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DM8-12A	SMA	$345

Delivery is from stock.

RHG

Make the Connection . . .

161 E. Industry Court Deer Park, NY 11729 Fax (516) 242-1222

Adams Russell COMPONENTS GROUP

For Technical Information, Call (516) 242-1100

For Ordering Information, Call (617) 273-3333

MODEL DM12-18A

DOUBLE-BALANCED MICROWAVE MIXER 12-18 GHz

- 6.5 dB Typical Midband Conversion Loss
- 28 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	12-18 GHz
	IF Port	DC-500 MHz
Conversion Loss**		9.5 dB Max
Isolation	LO to RF	20 dB Min
	LO to IF	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+23 dBm Max @ 25°C
RF Input 1 dB Compression	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

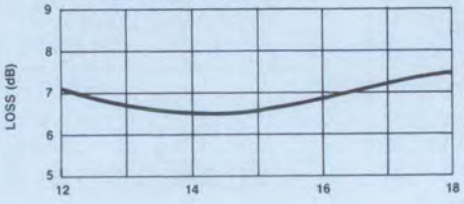
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

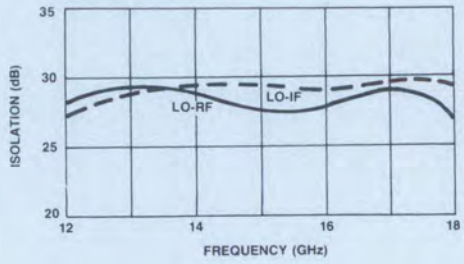
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance

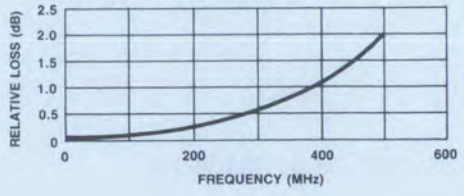
CONVERSION LOSS



ISOLATION



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DM12-18A	SMA	$435

Delivery is from stock.

MODEL DMB2-18A

BIASABLE MICROWAVE MIXER
2-18 GHz

- 8.0 dB Typical Midband Conversion Loss
- 25 dB Typical Midband L-R Isolation

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports	2-18 GHz
	IF Port	1-500 MHz
Conversion Loss**	2-10 GHz	9.5 dB Max
	10-18 GHz	10.5 dB Max
Isolation	LO to RF	22 dB Min
	LO to IF	25 dB Min
	RF to IF	16 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+20 dBm Max @ 25°C
RF Input 1 dB Compression	−5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-27) (See page 485 for physical dimensions.)
DC Bias	+12 Vdc @ 8mA (Typ.)

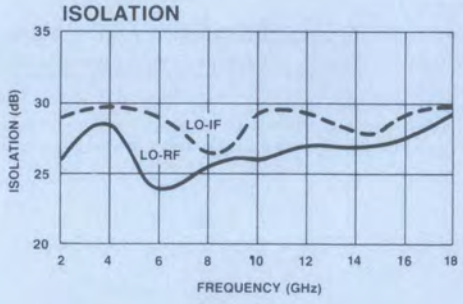
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

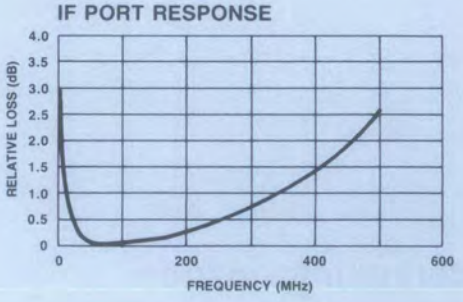
*All specifications apply when operated at 0 dBm available LO power with 50 ohm source and load impedance and +12 VDC bias.

**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance





Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DMB2-18A	SMA	$800

Delivery is from stock.

MODEL DME4-18

EVEN HARMONIC MICROWAVE MIXER 4-18 GHz

- Even Harmonic Mixer
- 8.0 dB Typical Midband Conversion Loss
- 60 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF Ports	4-18 GHz
	LO Port	2-9 GHz
	IF Port	DC-500 MHz
Conversion Loss**	4-6 GHz	12 dB Max
	6-18 GHz	10 dB Max
Isolation	2 LO to RF	50 dB Min
	2 LO to IF	50 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+23 dBm Max @ 25°C
RF Input 1 dB Compression	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-26) (See page 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

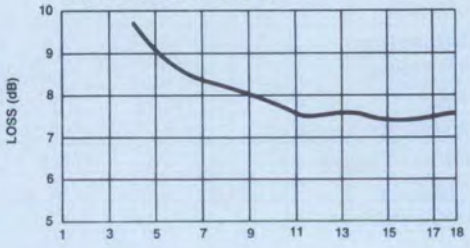
*All specifications apply when operated at +5 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

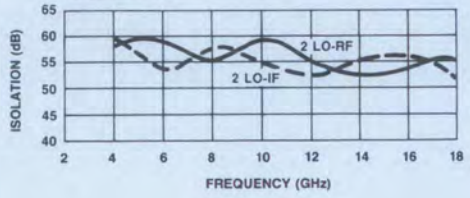
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance

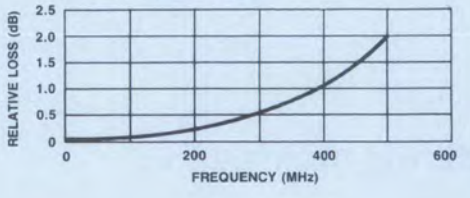
CONVERSION LOSS



ISOLATION



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DME4-18	SMA	$765

Delivery is from stock.

NEW

MODEL DME4-26

MULTIOCTAVE EVEN LO HARMONIC MIXER 6-26 GHz

- 55 dB 2 LO-RF Isolation
- Hermetic
- Removable Connectors
- Dual Quad Diodes

Guaranteed Specifications *
(From –55°C to +85°C)

Frequency Range	LO Port	2 - 13 GHz
	RF Port	6 - 26 GHz
	IF Port	DC - 4 GHz
Conversion Loss		11 dB Max
Isolation	LO to RF	23 dB Min

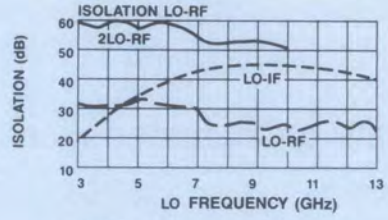
Operating Characteristics (@ 25°)

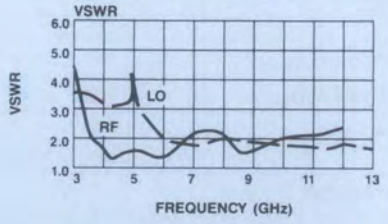
Impedance		50 Ohms Nominal
LO Power **		+12 dBm
Isolation	LO-RF	30 dB Typ
	2 LO-RF	55 dB Typ
RF Input 1 dB Compression		0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss
Conversion Loss		9.0 dB Typ
Typical Intermodulation		
	LO-RF	–30 dBc
	3 LO-RF	–35 dBc
	4 LO-RF	–12 dBc
	P3RD (2RF-RF)-2LO	+13 dBm
Package Type		Connectorized (C-42)
		(See page 487 for physical dimensions.)

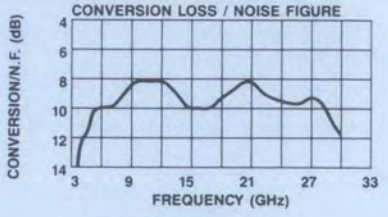
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

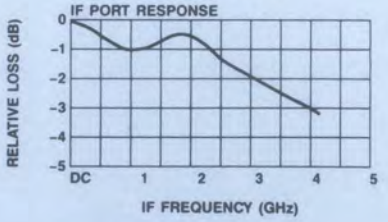
Notes:
*All specifications apply when operated at +12 dBm available LO power with 50 ohm source and load impedance.
**Single tone intermodulation matrix shown at RF bandwidth extremes with LO and IF held constant at –10 dBm RF input (harmonics –dBc).

Typical Performance









HARMONICS**

LO HARMONICS	(IF = 0.1 GHz, LO = 4.0 GHz) RF HARMONICS 1	2	3	4	(IF = 0.3 GHz, LO = 12 GHz) RF HARMONICS 1	2	3	4
4	15	63	53	80	—	54	54	>80
3	52	42	76	80	—	43	70	>80
2	0	60	66	—	0	60	70	>80
1	50	—	—	—	40	45	64	>80

Ordering Information

Model No.	Connectors	Unit Price (1-9)
DME4-26	SMA	$995

NEW

MODEL DMH2-22

DOUBLE BALANCED MICROWAVE MIXER 2-22 GHz

- 7.5 dB Typical Midband Conversion Loss
- 25 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range	RF, LO Ports	2 - 22 GHz
	IF Port	0.5 - 10 GHz
Conversion Loss		
RF/IF	6-18 GHz/2-6 GHz	9.0 dB Max
	2-22 GHz/0.5-8 GHz	10.5 dB Max
Isolation	LO to RF	20 dB Min
	LO to IF	18 dB Min

Operating Characteristics (@ 25°)

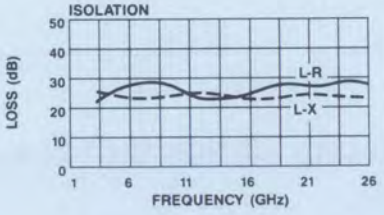
Impedance	50 Ohms Nominal
LO Power**	+10 dBm
RF Input	
1 dB Compression*	+8 dBm Typ
SSB Noise Figure	Within 1 dB of Conversion Loss
Package Type	Connectorized (C-26) (See page 484 for physical dimensions.)

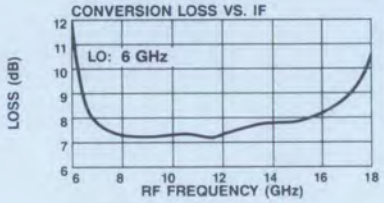
Environmental

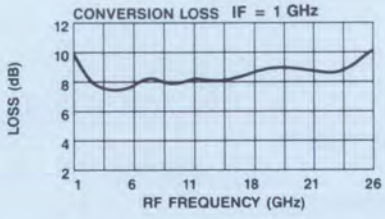
These units are designed to meet the environmental requirements of Table 1C, page 498 of the Adams-Russell catalog.

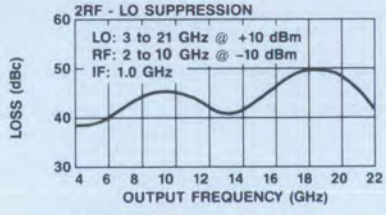
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**6 dB improvement available with an equal LO power increase (Option "H").
***Single tone intermodulation matrix shown at RF bandwidth extremes with LO and IF held constant at –10 dBm RF input (harmonics –dBc).
For additional information see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance (@ 25°C)









HARMONICS***

LO HARMONICS	(IF = 2 GHz, LO = 6 GHz) RF HARMONICS 1	2	3	(IF = 6 GHz, LO = 18 GHz) RF HARMONICS 1	2	3
3	–10	–52	–60	—	—	–56
2	–30	–65	–80	—	–45	–75
1	0	–40	–65	0	–45	–52

RF HARMONICS

Ordering Information

Model No.	Connectors	Unit Price (1-9)
DMH2-22	SMA	$615

Delivery is from stock.

MODEL DMS1-26A — DOUBLE-BALANCED MICROWAVE MIXER 1-26 GHz

- 7.0 dB Typical Midband Conversion Loss
- 22 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports	1-26 GHz
	IF Port	DC-500 MHz
Conversion Loss**	1-6 GHz	8.5 dB Max
	6-18 GHz	9.0 dB Max
	18-26 GHz	10.0 dB Max
Isolation	LO to RF	18 dB Min
	LO to IF	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	+23 dBm Max @ 25°C
RF Input 1 dB Compression	+3 dBm Min
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Package Type	Connectorized (C-26) (See page 484 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

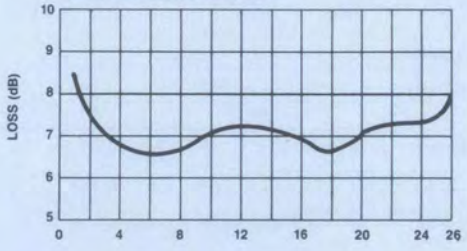
*All specifications apply when operated at +8.5 dBm LO power with 50 ohm source and load impedance.

**For IF frequencies of 100 MHz and an RF power of −10 dBm or lower.

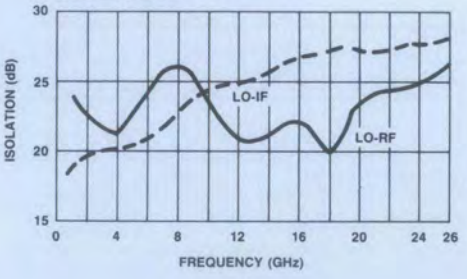
For additional RHG products see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance

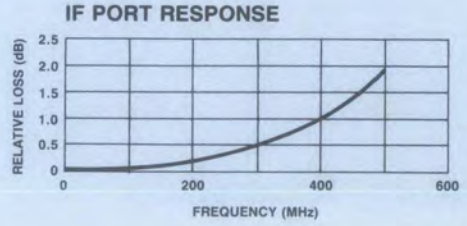
CONVERSION LOSS



ISOLATION



IF PORT RESPONSE



Ordering Information

Model No.	Connectors	Unit Price (1-9 Units)
DMS1-26A	SMA	$650

Delivery is from stock.

NEW

MODEL M2-18

LOW COST MULTIOCTAVE MIXER
2-18 GHz

- 35 dB LO/RF Isolation Typical
- Hermetic
- Removable Connectors
- Low Cost

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	RF, LO Ports	2 - 18 GHz
	IF Port	DC - 0.5 GHz
Conversion Loss		8.5 dB Max
Isolation	LO to RF	23 dB Min

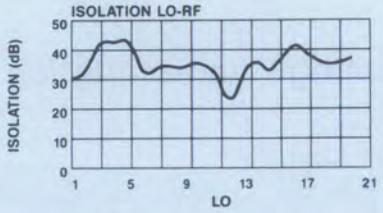
Operating Characteristics (@ 25°)

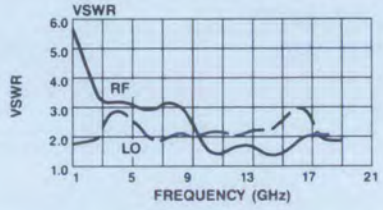
LO Power		+8 dBm
Isolation	LO-RF	35 dB Typ
	LO-IF	25 dB Typ
RF Input		
1 dB Compression*		+5 dBm Typ
SSB Noise Figure		7.5 dB Typ
Conversion Loss		7.0 dB Typ
Typical Intercept Point		
3rd Order		+10 dBm
Package Type		(C-42)
		(See page 487 for physical dimensions.)

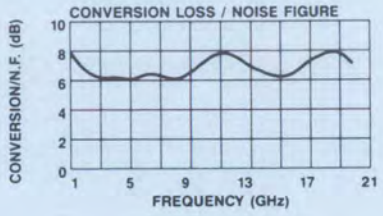
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

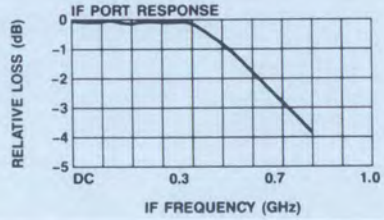
Notes:
*6 dB improvement available with an equal LO power increase (Option "H").
**Single tone intermodulation matrix shown at RF bandwidth extremes with LO and IF held constant at –10 dBm RF input (harmonics –dBc).
For additional information see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance









HARMONICS**

LO HARMONICS	(IF = 0.1 GHz, LO = 4 GHz)			(IF = 0.2 GHz, LO = 16 GHz)		
3	10	41	50	—	—	61
2	28	47	55	—	50	60
1	0	45	—	0	55	54
	1	2	3	1	2	3

RF HARMONICS

Ordering Information

Model No.	Connectors	Unit Price (1-9)
M2-18	SMA	$375

NEW

MODEL M2-26

LOW COST MULTIOCTAVE MIXER
2-26 GHz

- 7 dB Conversion Loss
- Hermetic
- Removable Connectors
- Low Cost

Guaranteed Specifications
(From –55°C to +85°C)

Frequency Range	RF, LO Ports	2 - 26 GHz
	IF Port	DC - 0.5 GHz
Conversion Loss		9.0 dB Max
Isolation	LO to RF	23 dB Min

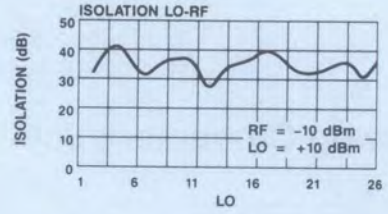
Operating Characteristics (@ 25°)

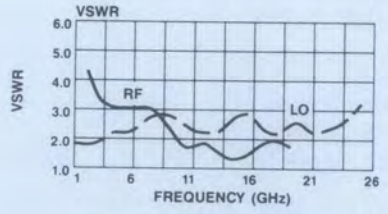
LO Power*		+8.5 dBm
Isolation	LO-RF	35 dB Typ
	LO-IF	25 dB Typ
RF Input*		
1 dB Compression		+5 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss
Conversion Loss		7.0 dB Typ
Typical Intercept Point		
3rd Order		+10 dBm
Package Type		(C-42)
		(See page 487 for physical dimensions.)

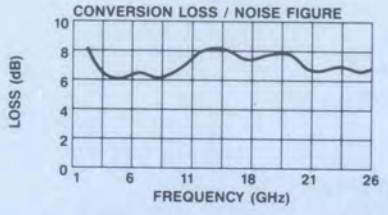
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

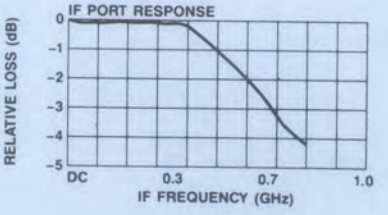
Notes:
*6 dB improvement available with an equal LO power increase (Option "H").
**Single tone intermodulation matrix shown at RF bandwidth extremes with LO and IF held constant at –10 dBm RF input (harmonics –dBc).
For additional information see the latest RHG Electronics Laboratory, Inc. catalog.

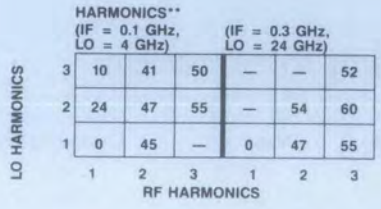
Typical Performance











Ordering Information

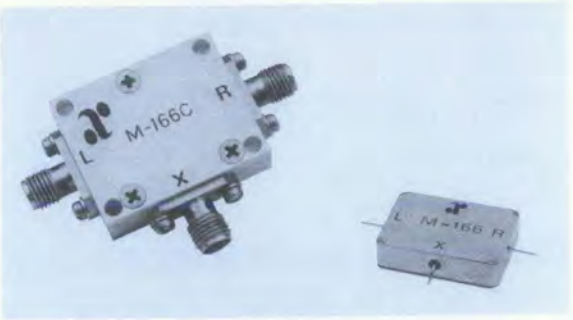
Model No.	Connectors	Unit Price (1-9)
M2-26	SMA	$425

Delivery is from stock.

MODELS M-166/M-166C

DOUBLE-BALANCED MICROWAVE MIXER 0.5-18.0 GHz

- 8 dB Typical Midband Conversion Loss
- 22 dB Typical Midband L-R Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-18.0 GHz
	IF Port (3 dB BW)		2-5000 MHz
Conversion Loss**	0.5-8.0 GHz		9 dB Max
	8.0-18 GHz		10 dB Max
Isolation	LO to RF	(0.5-1 GHz)	10 dB Min
		(1-15 GHz)	15 dB Min
		(15-18 GHz)	13 dB Min
	LO to IF	(0.5-8 GHz)	18 dB Min
		(8-14 GHz)	16 dB Min
		(14-18 GHz)	20 dB Min
	RF to IF	(0.5-18 GHz)	17 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated 6.4 mW/°C
RF Input	
1 dB Compression	9.5 dBm Typical
1 dB Desensitization	9 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+20 dBm Typical
8.0 GHz	+20 dBm Typical
18.0 GHz	+18 dBm Typical
Package Type	M-166 Flatpack (FP-10) M-166C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

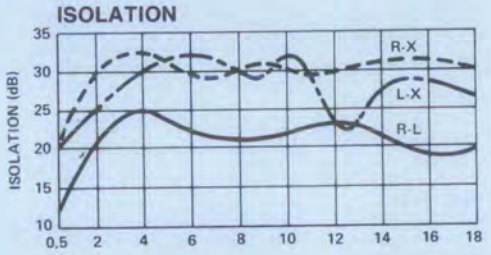
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

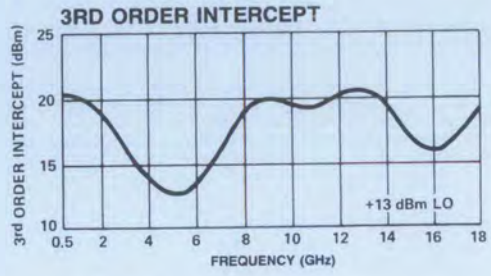
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

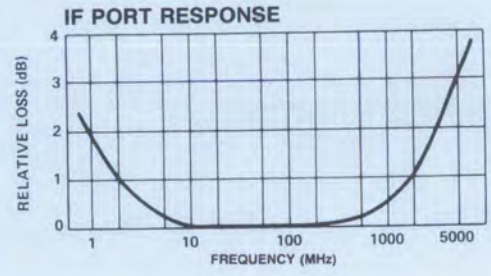
**For IF frequencies of 5-1000 MHz and an RF of −10 dBm or lower.

Formerly Anzac Model MD-166, MDC-166.

Typical Performance







Ordering Information

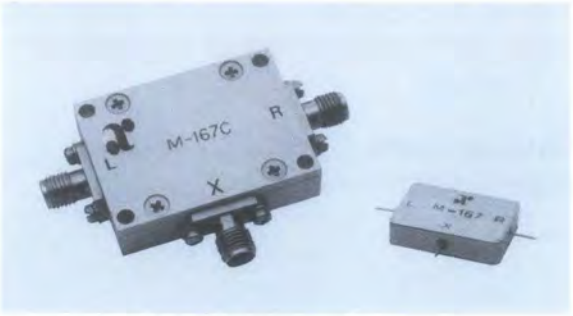
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-166	9309	Pin	$379
M-166C	9304	SMA	466

Delivery is from stock.

MODELS M-167/M-167C

HIGH IF DOUBLE-BALANCED MICROWAVE MIXER 0.5-18.0 GHz

- 8 dB Typical Midband Conversion Loss
- 22 dB Typical Midband L-R Isolation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-18.0 GHz
	IF Port		0.5-8.0 GHz
Conversion Loss**	0.5-18 GHz		10.5 dB Max
	1-6 GHz		9.0 dB Max
	6-16 GHz		10.0 dB Max
Isolation	LO to RF	(0.5-1 GHz)	13 dB Min
		(1-18 GHz)	15 dB Min
	LO to IF	(0.5-1 GHz)	12 dB Min
		(1-13 GHz)	18 dB Min
		(13-18 GHz)	15 dB Min
	RF to IF	(0.5-1 GHz)	14 dB Min
		(1-18 GHz)	16 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated 6.4 mW/°C
RF Input	
1 dB Compression	9.5 dBm Typical
1 dB Desensitization	9 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+20 dBm Typical
8.0 GHz	+20 dBm Typical
18.0 GHz	+18 dBm Typical
Package Type	M-167 Flatpack (FP-10) M-167C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

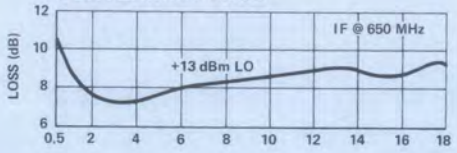
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 650 MHz and an RF of −10 dBm or lower.

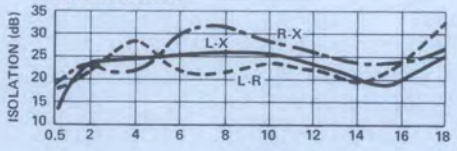
Formerly Anzac Model MD-167, MDC-167

Typical Performance

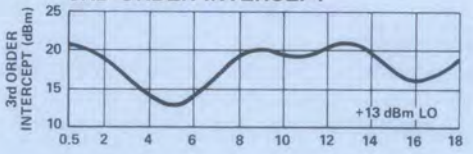
CONVERSION LOSS



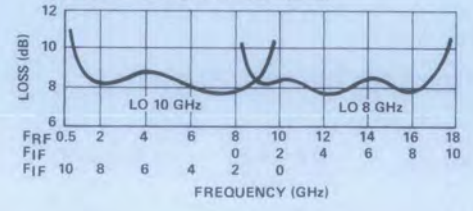
ISOLATION



3RD ORDER INTERCEPT



CONVERSION LOSS VS IF



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-167	9359	Pin	$393
M-167C	9354	SMA	480

Delivery is from stock.

MODELS M-170/M-170C — HIGH LEVEL DOUBLE-BALANCED MICROWAVE MIXER 0.5-18.0 GHz

- 8 dB Typical Midband Conversion Loss
- 22 dB Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-18.0 GHz
	IF Port (3 dB BW)		2-5000 MHz
Conversion Loss**	0.5-8 GHz		9 dB Max
	8-16 GHz		11 dB Max
	16-18 GHz		12 dB Max
Isolation	LO to RF	(0.5-2 GHz)	10 dB Min
		(2-15 GHz)	20 dB Min
		(15-18 GHz)	17 dB Min
	LO to IF	(0.5-4 GHz)	22 dB Min
		(4-12 GHz)	17 dB Min
		(12-18 GHz)	22 dB Min
	RF to IF	(0.5-18 GHz)	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	600 mW Max @ 25°C Derated 6.4 mW/°C
RF Input	
1 dB Compression	+12 dBm Typical
1 dB Desensitization	+9.5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept 0.5-18 GHz	+22 dBm Typical
Package Type	M-170 Flatpack (FP-10) M-170C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

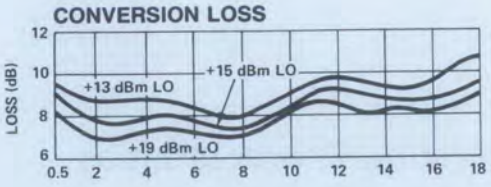
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

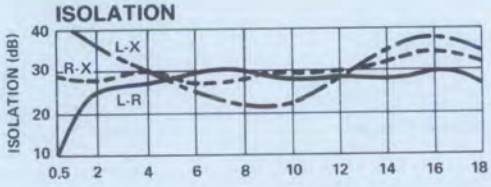
*All specifications apply when operated at +19 dBm available LO power with 50 ohm source and load impedance.

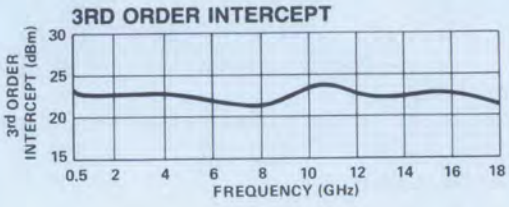
**For IF frequencies of 5-1000 MHz and an RF of −10 dBm or lower.

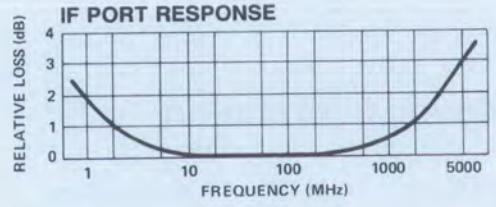
Formerly Anzac Model MD-170, MDC-170

Typical Performance









Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-170	9349	Pin	$503
M-170C	9344	SMA	590

Delivery is from stock.

MODEL M-171/M-171C — HIGH IF DOUBLE-BALANCED MICROWAVE MIXER 4.0-18.0 GHz

- 5.3 dB Typical Midband Conversion Loss
- 30 dB Typical Midband L-R Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		4.0-18.0 GHz
	IF Port		DC-4.0 GHz
Conversion Loss**	4.0-18 GHz		7.5 dB Max
Isolation	LO to RF	(4.0-18.0 GHz)	22 dB Min
	LO to IF	(4.0-7.0 GHz)	20 dB Min
		(7.0-18.0 GHz)	12 dB Min
	RF to IF	(4.0-9.0 GHz)	17 dB Min
		(9.0-18.0 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.0 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
4.0 GHz	+15 dBm Typical
10.0 GHz	+12 dBm Typical
18.0 GHz	+16 dBm Typical
Package Type	M-171 Flatpack (FP-10) M-171C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

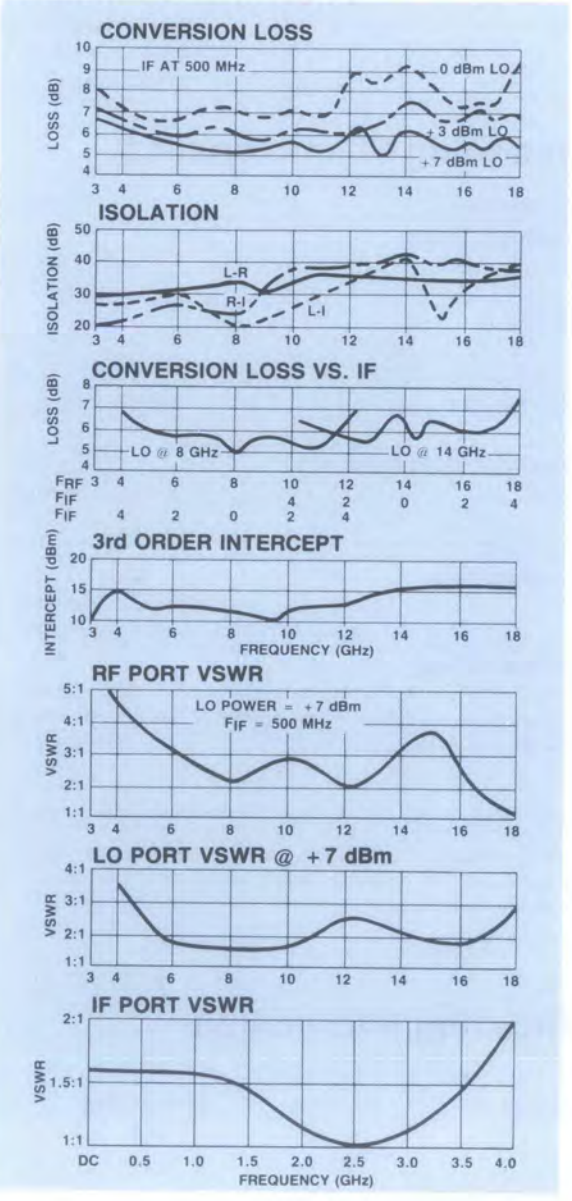
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 500 MHz and an RF of −10 dBm or lower.

Formerly Anzac Model MD-171, MDC-171

Typical Performance



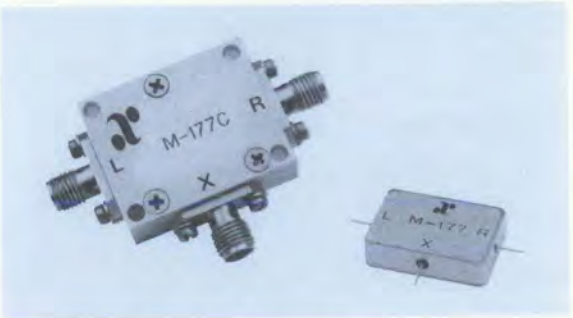
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-171	9409	Pin	$330
M-171C	9404	SMA	417

Delivery is from stock.

MODELS M-177/M-177C — DOUBLE-BALANCED MICROWAVE MIXER 2.0-8.0 GHz

- 5 dB Typical Midband Conversion Loss
- 25 dB Typical Midband L-R Isolation
- Operable with Starved LO



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		2.0-8.0 GHz
	IF Port (3 dB BW)		DC-500 MHz
Conversion Loss**	2.0-4.0 GHz		8 dB Max
	4.0-8.0 GHz		6.5 dB Max
Isolation	LO to RF	(2.0-4.5 GHz)	12 dB Min
		(4.5-8.0 GHz)	20 dB Min
	LO to IF	(2.0-4.0 GHz)	10 dB Min
		(4.0-8.0 GHz)	15 dB Min
	RF to IF	(2.0-8.0 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+3 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+9 dBm Typical
4.0 GHz	+6 dBm Typical
8.0 Ghz	+9 dBm Typical
Package Type	M-177 Flatpack (FP-10) M-177C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

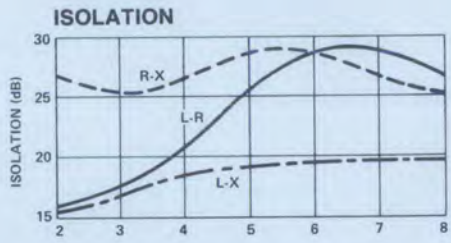
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

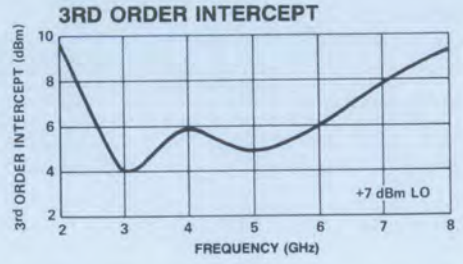
**For IF frequencies of DC-100 MHz and an RF of −10 dBm or lower.

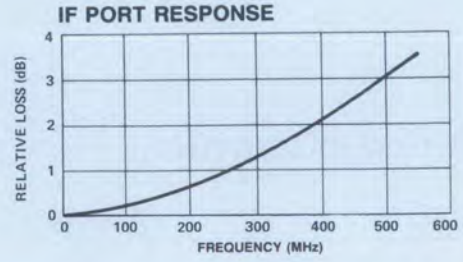
This product contains elements protected by United States Patent Number 4,224,572.

Formerly Anzac Model MD-177, MDC-177

Typical Performance







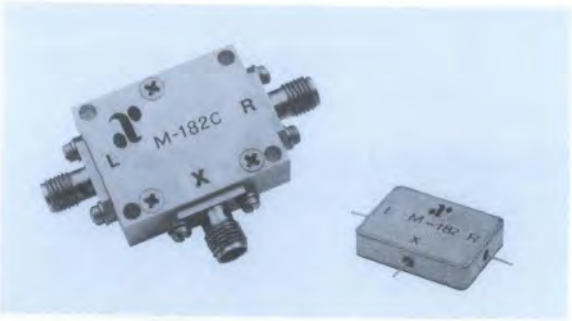
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-177	9209	Pin	$201
M-177C	9204	SMA	288

Delivery is from stock.

MODELS M-182/M-182C — DOUBLE-BALANCED MICROWAVE MIXER 3-13 GHz

- 6.5 dB Typical Midband Conversion Loss
- 22 dB Typical Midband L-R Isolation
- Starved LO Operation



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		3-13 GHz
	IF Port (3 dB BW)		DC-400 MHz
Conversion Loss**	4-12 GHz		7.5 dB Max
	3-13 GHz		8.5 dB Max
Isolation	LO to RF	(3-8 GHz)	18 dB Min
		(8-13 GHz)	15 dB Min
	LO to IF	(3-8 GHz)	18 dB Min
		(8-13 GHz)	20 dB Min
	RF to IF	(3-13 GHz)	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	3 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
6 GHz	11.5 dBm Typical
12 GHz	11.5 dBm Typical
Package Type	M-182 Flatpack (FP-10) M-182C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

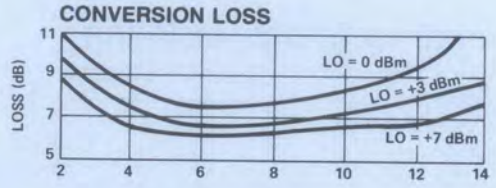
Pin Configuration — RF; P3, LO; P1, IF; P2. Case ground.

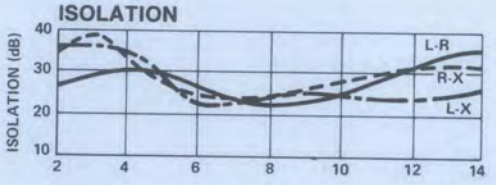
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

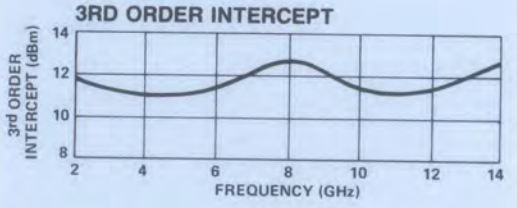
**For IF frequencies of DC-100 MHz and an RF of −10 dBm or lower.

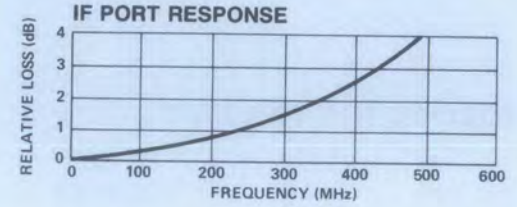
Formerly Anzac Model MD-182, MDC-182

Typical Performance









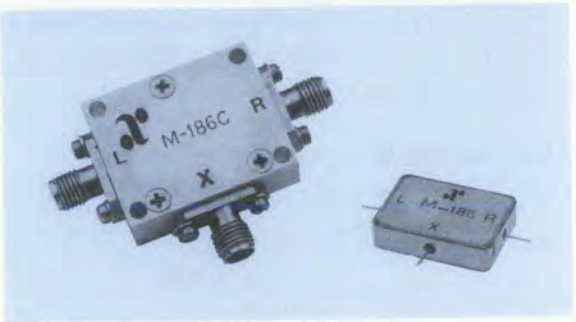
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-182	9369	Pin	$203
M-182C	9364	SMA	290

Delivery is from stock.

MODELS M-186/M-186C — DOUBLE-BALANCED MICROWAVE MIXER 4.0-8.0 GHz

- 5.0 dB Typical Midband Conversion Loss
- 29 dB Typical Midband L-R Isolation
- Operable with Starved LO



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF Port		4-8 GHz
	LO Port		4-11 GHz
	IF Port		DC-3.0 GHz
Conversion Loss**			7.0 dB Max
Isolation	LO to RF	(4-8 GHz)	25 dB Min
	LO to IF	(4-8 GHz)	15 dB Min
	RF to IF	(4-8 GHz)	17 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.0 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
4.0 GHz	+15 dBm Typical
6.0 GHz	+12 dBm Typical
8.0 GHz	+11 dBm Typical
Package Type	M-186 Flatpack (FP-10) M-186C Connectorized (C-3) (See pages 475 and 481 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

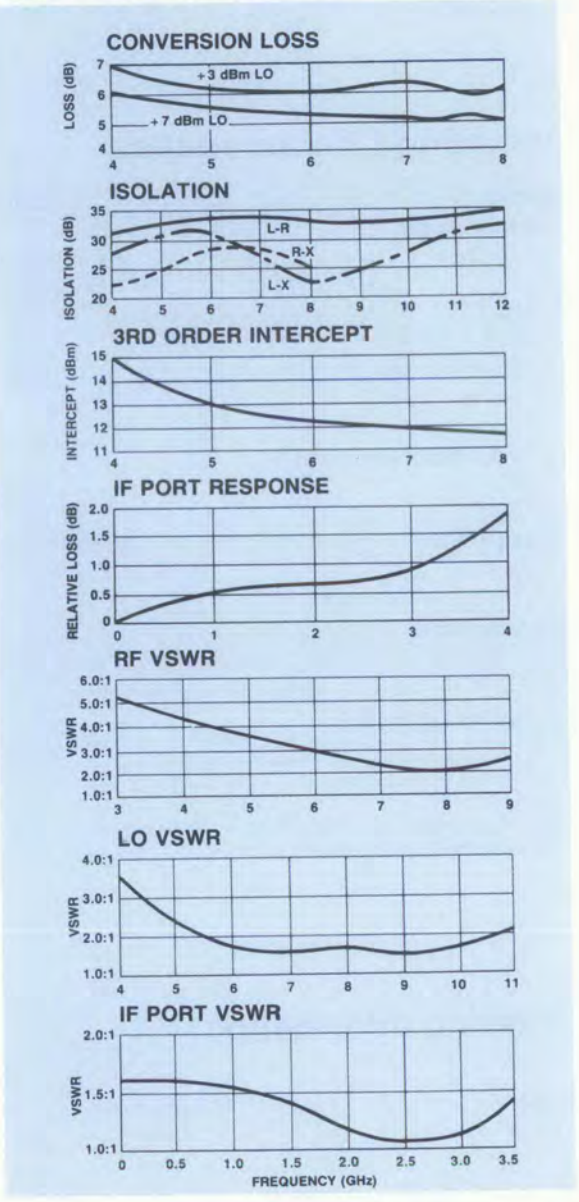
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of DC-500 MHz and an RF of −10 dBm or lower.

Formerly Anzac Model MD-186, MDC-186

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
M-186	9519	Pin	$200
M-186C	9514	SMA	287

Delivery is from stock.

NEW

MODEL TBM4-18

TRIPLE BALANCED MICROWAVE MIXER 4-18 GHz

- 30 dB Typical LO/RF Isolation
- Hermetic
- Removable Connectors
- Low Cost

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	RF, LO Ports	4 - 18 GHz
	IF Port	0.5 - 8 GHz
Conversion Loss		9 dB Max
Isolation	LO to RF	20 dB Min
	LO to IF	20 dB Min

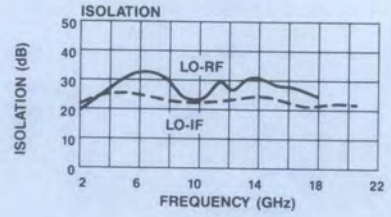
Operating Characteristics (@ 25°)

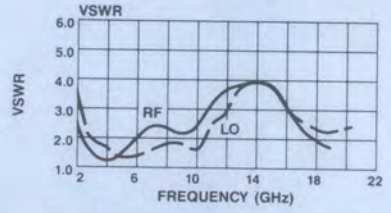
LO Power*		+13 dBm
Isolation	LO-RF	25 dB Typ
	LO-IF	25 dB Typ
RF Input 1 dB Compression*		0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss
Conversion Loss		7.0 dB Typ
Typical Intercept Point* 3rd Order		+17 dBm
Package Type		(C-42) (See page 487 for physical dimensions.)

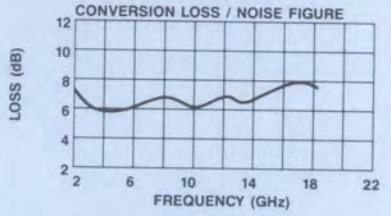
Environmental
These units are designed to meet the environmental and screening requirements of Table 1C, page 498 of the Adams-Russell catalog.

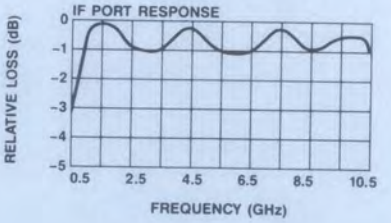
Notes:
*6 dB improvement available with an equal LO power increase. (Option "H")
**Single tone intermodulation matrix shown at RF bandwidth extremes with LO and IF held constant at –10 dBm RF input (harmonics –dBc).
For additional information see the latest RHG Electronics Laboratory, Inc. catalog.

Typical Performance









HARMONICS**

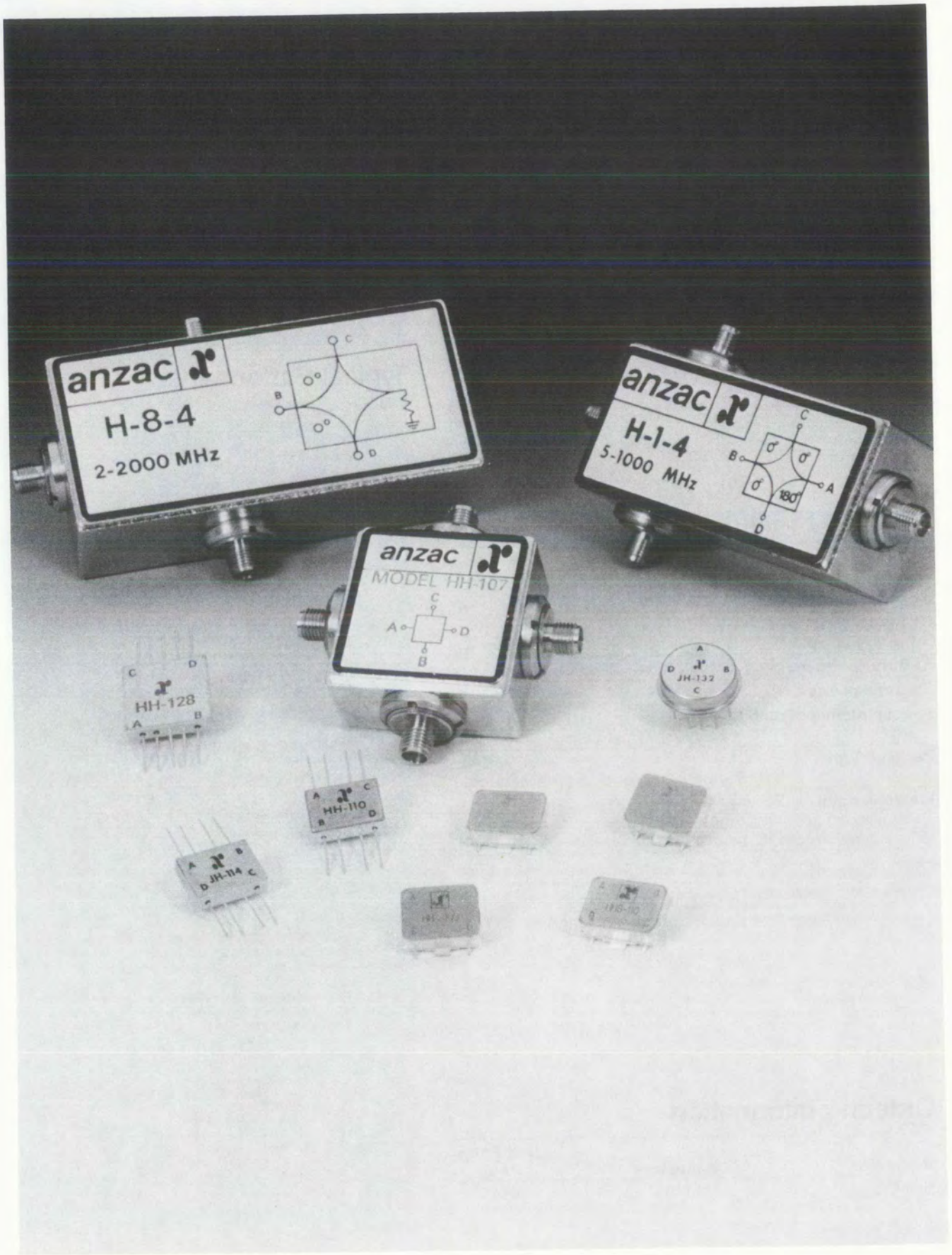
LO HARMONICS	(IF = 2 GHz, LO = 6 GHz) 1	2	3	(IF = 6 GHz, LO = 18 GHz) 1	2	3
3	10	50	56	—	—	56
2	44	65	68	—	45	70
1	0	52	63	0	40	50

RF HARMONICS

Ordering Information

Model No.	Connectors	Unit Price (1-9)
TBM4-18	SMA	$545

Delivery is from stock.


anzac
H-8-4
2-2000 MHz
anzac
H-1-4
5-1000 MHz
anzac
MODEL HH-107
HH-128
JH-132
HH-110
JH-114

HYBRID SELECTION GUIDE

180° HYBRIDS

MODEL NO.	FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	PHASE BALANCE (Deg) TYP	AMPLITUDE BALANCE (dB) TYP	CASE[1] STYLE	PAGE NO.
HH-108	0.2-35	0.1	40	1.07:1	2	0.05	C-11	362
HH-106	2-200	0.5	45	1.05:1	1	0.05	FP-2	361
HH-107	2-200	0.5	45	1.1:1	1	0.05	C-8	361
HH-109	5-200	0.8	45	1.3:1	1	0.10	FP-2	363
HHS-109	**5-200**	**0.8**	**45**	**1.3:1**	**1**	**0.10**	**SF-1**	364
HH-105	20-300	0.4	45	1.25:1	1	0.10	TO-5-2	360
HH-110	10-500	0.6	45	1.25:1	3	0.10	FP-2	365
HHS-110	**10-500**	**0.6**	**40**	**1.25:1**	**3**	**0.10**	**SF-1**	366
HH-127	10-500	0.6	45	1.25:1	3	0.10	TO-8-2	365
H-1-4	5-1000	1.2	45	N/A	1	0.30	C-33	368
H-9	2-2000	0.4	55	1.2:1	1	0.10	C-21	369
HH-128	20-2000	1.5	30	1.3:1	7.5	0.50	FP-3	367
H-183-4	30-3000	0.7	35	1.3:1	7	0.10	C-11	370

QUADRATURE HYBRIDS

MODEL NO.	FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	PHASE DEVIATION (Deg) TYP	AMPLITUDE BALANCE (dB) TYP	CASE[1] STYLE	PAGE NO.
JH-113	7-14	0.5	25	1.02:1	1	0.75	FP-2	373
JHS-113	**7-14**	**0.5**	**25**	**1.05:1**	**3**	**0.75**	**SF-1**	374
JH-6-4	2-32	0.4	30	1.05:1	1	0.3	C-10	371
JH-114	20-40	0.2	30	1.15:1	0.5	0.4	FP-2	375
JHS-114	**20-40**	**0.2**	**30**	**1.15:1**	**0.5**	**0.4**	**SF-1**	376
JH-133	20-40	0.2	30	1.15:1	0.5	0.4	TO-8-2	375
JH-115	40-80	0.25	30	1.15:1	1.2	0.4	FP-2	377
JHS-115	**40-80**	**0.3**	**25**	**1.15:1**	**1.2**	**0.5**	**SF-1**	378
JH-132	40-80	0.25	30	1.1:1	1.2	0.4	TO-8-2	377
JH-10-4	20-140	0.5	35	1.1:1	1	0.1	C-10	372
JH-119	80-160	0.3	35	1.2:1	2	0.5	FP-2	379
JHS-119	**80-160**	**0.3**	**35**	**1.2:1**	**2**	**0.5**	**SF-1**	380
JH-131	20-200	0.5	35	1.1:1	0.5	0.1	C-13	383
JH-121	100-200	0.45	24	1.2:1	0.5	0.7	FP-2	381
JHS-121	**100-200**	**0.45**	**24**	**1.2:1**	**0.5**	**0.7**	**SF-1**	382
JH-136	175-350	0.5	30	1.1:1	2	0.6	FP-2	384
JHS-136	**175-350**	**0.5**	**30**	**1.1:1**	**2**	**0.6**	**SF-1**	385
JH-142	200-400	0.3	25	1.25:1	3	0.5	FP-2	390
JHS-142	**200-400**	**0.3**	**25**	**1.25:1**	**3**	**0.5**	**SF-1**	391
JH-139	250-500	0.3	30	1.1:1	1	0.5	FP-2	386
JHS-139	**250-500**	**0.3**	**30**	**1.1:1**	**1**	**0.5**	**SF-1**	387
JH-140	500-1000	0.2	25	1.2:1	2	1	FP-2	388
JH-141	1000-2000	0.2	25	1.15:1	3	1	FP-2	389
JH-151	2000-10000	0.5	25	1.15:1	3	0.5	C-20	392

SURFACE MOUNT 180° HYBRIDS

MODEL NO.	FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	PHASE BALANCE (Deg) TYP	AMPLITUDE BALANCE (dB) TYP	CASE STYLE	PAGE NO.
HHS-109	**5-200**	**0.8**	**45**	**1.3:1**	**1**	**0.10**	**SF-1**	364
HHS-110	**10-500**	**0.6**	**40**	**1.25:1**	**3**	**0.1**	**SF-1**	366

SURFACE MOUNT QUADRATURE HYBRIDS

MODEL NO.	FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	QUADRATURE DEVIATION (Deg) TYP	AMPLITUDE BALANCE (dB) TYP	CASE STYLE	PAGE NO.
JHS-113	**7-14**	**0.5**	**25**	**1.05:1**	**3**	**0.75**	**SF-1**	374
JHS-114	**20-40**	**0.2**	**30**	**1.15:1**	**0.5**	**0.4**	**SF-1**	376
JHS-115	**40-80**	**0.3**	**25**	**1.1:1**	**1.2**	**0.5**	**SF-1**	378
JHS-119	**80-160**	**0.3**	**35**	**1.2:1**	**2**	**0.5**	**SF-1**	380
JHS-121	**100-200**	**0.45**	**24**	**1.2:1**	**0.5**	**0.7**	**SF-1**	382
JHS-136	**175-350**	**0.5**	**30**	**1.1:1**	**2**	**0.6**	**SF-1**	385
JHS-142	**200-400**	**0.3**	**25**	**1.25:1**	**3**	**0.5**	**SF-1**	391
JHS-139	**250-500**	**0.3**	**30**	**1.1:1**	**1**	**0.5**	**SF-1**	387

[1] CASE STYLE: C = CONNECTORIZED; FP = FLATPACK; TO-5 = TO-5 PLUG-IN; TO-8 = TO-8 PLUG-IN; SF = SURFACE MOUNT
BOLD = NEW PRODUCT
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

HYBRID DEVICES

INTRODUCTION

The 90° and 180° hybrids are two forms of passive, reciprocal four-port devices which have wide application in RF and microwave system design. The devices described in this article are equal power split versions of the general four-port hybrid configuration. Directional couplers, described in a separate article, are actually 180° hybrids having unequal power splits. Power dividers/summers generally represent another variation of the basic 180° hybrid with an internal termination on one port. These devices are also described in detail in a separate article.

The purpose of this article is to provide the designer with basic information describing the function of these devices, the basic specification parameters with possible tradeoffs and the relationships that apply for various combinations of signal inputs and port terminations. Signal flow descriptions in this article assume the ideal, lossless version of the 180° and 90° hybrid. This is a reasonable approximation for this purpose because of the generally low loss, well matched characteristics of the actual circuits.

FUNCTIONAL DESCRIPTION

180° Hybrid

A 180° hybrid is a reciprocal four-port device which provides two equal amplitude in-phase signals when fed from its sum port and two equal amplitude 180° out-of-phase signals when fed from its difference port. Opposite ports of the hybrid are isolated. Figure 1 is a functional diagram which will be used in this article to represent the 180° hybrid. Port B can be considered the sum port with port A the difference port. Ports A and B and ports C and D are isolated pairs of ports.

Utilizing the functional diagram of Figure 1, we can consider the application of signal at one or more of the ports of the hybrid. The convention used for explaining signal flow is based on Figure 2. The cases that are important to consider are the following:

1. Operation as a power divider – One source operating at ports A, B, C or D.
2. Operation as a power summer – Two sources operating at ports A and B, or C and D.

For these cases, the impedances Z_A, Z_B, Z_C, and Z_D, are assumed to be Z_O, the characteristic impedance of the 180° hybrid. Under this matched condition, the source voltage of 2E cos ωt will supply a voltage of E cos ωt to the input of the hybrid.

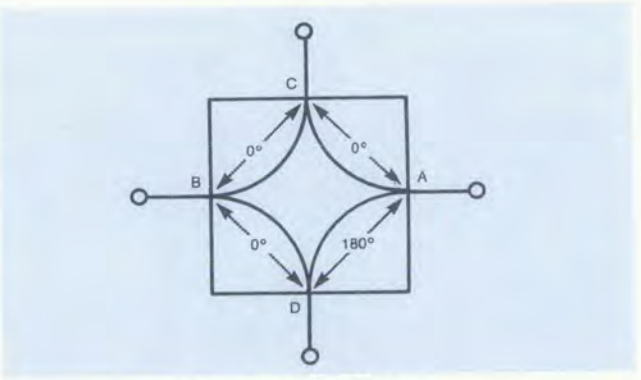


Figure 1. 180° Hybrid

As a power divider, the hybrid will equally split the input signal and deliver one half the power to each load. Since all ports are considered to be at Z_o impedance, the voltages at the outputs will be proportional to the square root of the output power and will be phase shifted by the amount indicated for that path of the hybrid, since $P_{OUT} = \frac{1}{2} P_{IN}$, $V_{OUT} = \frac{1}{\sqrt{2}} V_{IN}$. For example, if an input signal at Port A of E cos ωt is injected, the resultant output at Port C is $\frac{1}{\sqrt{2}}$ E cos ωt and the output at Port D is $\frac{1}{\sqrt{2}}$ E cos (ωt − 180°). No signal will appear at Port B. The various power divider relationships are summarized in Table 1.

When used as a power summer, the function of the 180° hybrid is somewhat less obvious due to the vector addition of the two signals. Figure 3 shows the signal flow and resultant outputs for the

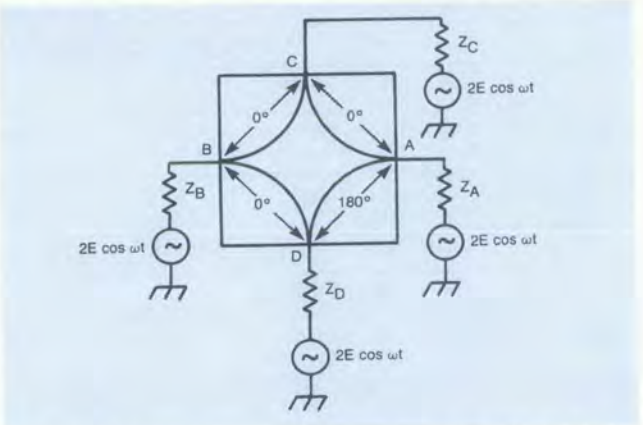
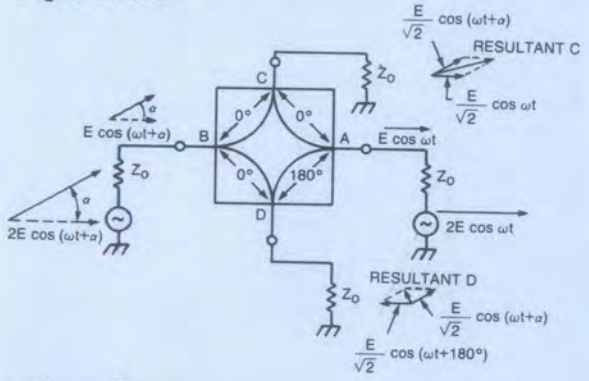


Figure 2. Signal Source Configurations for 180° Hybrid (Reference Tables I, II, III, IV)

general case of two equal amplitude, equal frequency signals of arbitrary phase. The vector representation of the input signals as well as the resultant output signals is shown graphically together with the algebraic expression for the signal. It should be noted that, in the general case, the phases of the resultant outputs are in quadrature. Table II lists the relationships for various combinations of signals applied in pairs to Ports A and B or Ports C and D.

Tables III and IV provide useful relations for determining isolation and VSWR under varying loading conditions. One point to note from the expressions in these tables is that equal mismatches on opposite ports of the hybrid do not effect isolation since the reflected signal will cancel at the isolated port while they will add at the port where the signal is injected. Thus, for example, if we inject a signal at Port A with equal mismatches at Ports C and D ($\rho_C = \rho_D$), then no signal will appear at Port B because the reflected components are 180° out-of-phase. The VSWR at Port A will be degraded because the reflections add in phase at this port. In general, equal mismatches may not be present. The relations in Tables III and IV may be used to calculate VSWR and isolation for any known combination of load impedance.

- Equal Amplitude, Equal Frequency Input
- Resultant Output Phases are in Quadrature
- Resultant Output Magnitudes vary based on Input Phase



Resultant C

$$= \frac{E}{\sqrt{2}} [\cos \omega t + \cos (\omega t + \alpha)]$$

$$= \frac{E}{\sqrt{2}} [2 \cos \tfrac{1}{2} (2\omega t + \alpha) \cos \tfrac{1}{2} (- \alpha)]$$

$$= \sqrt{2}\, E \cos (- \frac{\alpha}{2}) \cos (\omega t + \frac{\alpha}{2})$$

Resultant D

$$= \frac{E}{\sqrt{2}} [\cos (\omega t + 180°) + \cos (\omega t + \alpha)]$$

$$= \frac{E}{\sqrt{2}} [2 \cos \tfrac{1}{2} (2\omega t + \alpha + 180°) \cos \tfrac{1}{2} (180° - \alpha)]$$

$$= \sqrt{2}\, E \cos (90° - \frac{\alpha}{2}) \cos (\omega t + \frac{\alpha}{2})$$

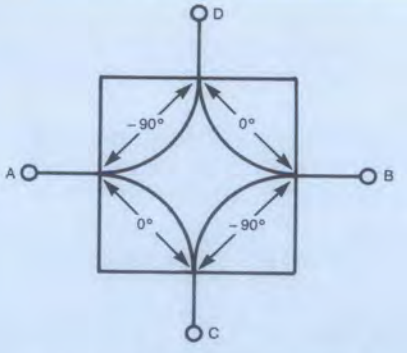
∴ Phase of Resultant D = Phase of Resultant C + 90°

Figure 3. 180° Hybrid

90° Hybrid

A 90° hybrid functions in much the same manner as 180° hybrid since it is also a reciprocal four-port device. Equal amplitude outputs result when a signal is fed to one of the inputs. Opposite ports of the 90° hybrid are also isolated as in the 180° hybrid. The different phase relationship of the 90° hybrid does however, cause important functional differences.

Figure 4 shows the circuit diagram and truth table that will be used in explaining the operation of the 90° hybrid. As can be seen from this diagram, a signal applied to any input will result in two quadrature or 90° outputs. Ports A and B and Ports C and D are isolated. Following an analysis



	A	B	C	D
A		ISO.	0	-90
B	ISO.		-90	0
C	0	-90		ISO.
D	-90	0	ISO.	

ISO. = ISOLATION

Truth Table

Figure 4. 90° Hybrid

Power Divider

The relationships given in Table I apply when the 180° hybrid is used as a power divider. The following conditions apply.

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Only one generator at a time is operating.
3. Infinite isolation is assumed in the junction.

Table I — Power Divider Relationships for 180° Hybrids

Input Signal	Input Port	Output Signals			
		Port A	Port B	Port C	Port D
E cosωt	A	–	0	$\frac{1}{\sqrt{2}}$ E cosωt	$\frac{1}{\sqrt{2}}$ E cos(ωt+180°)
	B	0	–	$\frac{1}{\sqrt{2}}$ E cosωt	$\frac{1}{\sqrt{2}}$ E cosωt
	C	$\frac{1}{\sqrt{2}}$ E cosωt	$\frac{1}{\sqrt{2}}$ E cosωt	–	0
	D	$\frac{1}{\sqrt{2}}$ E cos(ωt+180°)	$\frac{1}{\sqrt{2}}$ E cosωt	0	–

Power Summer

The relationships given in Table II apply when the 180° hybrid is used as a power summer. The following conditions apply.

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Two generators are operating simultaneously.
3. Infinite isolation is assumed in the junction.
* Reference Figure 3.

Table II — Power Summer Relationships for 180° Hybrids

Input Signal	Input Port	Output Signals			
		Port A	Port B	Port C	Port D
*E cosωt	A	–	–	$\sqrt{2}$ E cos(−α/2) [cos(ωt+α/2)]	$\sqrt{2}$ E cos(90°−α/2) [cos(ωt+α/2+90°)]
*E cos(ωt+α)	B				
E cosωt	A	–	–	$\sqrt{2}$ E cosωt	0
E cosωt	B				
E cos(ωt+180°)	A	–	–	0	$\sqrt{2}$ E cosωt
E cosωt	B				
E cosωt	C	0	$\sqrt{2}$ E cosωt	–	–
E cosωt	D				
E cosωt	C	$\sqrt{2}$ E cosωt	0	–	–
E cos(ωt+180°)	D				
E cosω_1t	A	–	–	$\frac{1}{\sqrt{2}}$ E(cosω_1t+cosω_2t)	$\frac{1}{\sqrt{2}}$ E(cosω_1t+cosω_2t)
E cosω_1t	B				

Isolation

Isolation between ports is expressed by those relationships given in Table III. The following conditions and definitions apply.

1. Only one generator is operating at a time.
2. $\rho = \frac{Z - Z_O}{Z + Z_O}$

Table III — Isolation Between Ports of 180° Hybrids

Terminations				Isolation (dB)	
A	B	C	D	A to B	C to D
Z_O	Z_O	Z_C	Z_D	6+20 log $\frac{1}{\lvert\rho_C - \rho_D\rvert}$	∞
Z_O	Z_O	Z_O	Z_D	6+20 log $\frac{1}{\lvert\rho_D\rvert}$ = 6+return loss of Z_D	∞
Z_A	Z_B	Z_O	Z_O	∞	6+20 log $\frac{1}{\lvert\rho_B - \rho_A\rvert}$
Z_O	Z_B	Z_O	Z_O	∞	6+20 log $\frac{1}{\lvert\rho_B\rvert}$ = 6+return loss of Z_B

VSWR-With Various Terminations

Voltage Standing Wave Ratio (VSWR) with various terminations is expressed by using those relationships given in Table IV.

Table IV — VSWR with Various Terminations for 180° Hybrids

Port Terminations				VSWR	
A	B	C	D	A to B	C to D
Z_O	Z_O	Z_O	Z_O	1:1	1:1
Z_A	Z_B	Z_O	Z_O	1:1	$\frac{1 + \frac{\lvert\rho_A + \rho_B\rvert}{2}}{1 - \frac{\lvert\rho_A + \rho_B\rvert}{2}}$
Z_O	Z_O	Z_C	Z_D	$\frac{1 + \frac{\lvert\rho_C + \rho_D\rvert}{2}}{1 - \frac{\lvert\rho_C + \rho_D\rvert}{2}}$	1:1

similar to that applied to the 180° hybrid, we can apply signal sources in various combinations to ports of the 90° hybrid and determine the resultant outputs. Figure 5 shows the arrangement used for this analysis, and once again we will consider the operation of the hybrid as a power divider and power summer, with all terminating impedances assumed equal to Z_o.

The analysis of the 90° hybrid as a power divider is straightforward and, as previously mentioned, two equal amplitude outputs result when any one of the ports is fed by a signal source. These outputs are in quadrature as indicated in Table V.

To analyze to 90° hybrid as a power summer, we will once again make use of a diagram showing the vector and algebraic relationships of the signals at all ports when two equal amplitude, equal frequency, arbitrary phase signals are applied.

In Figure 6, these two signals are shown applied to Ports A and B of the 90° hybrid. The amplitudes of the resultant outputs at Ports C and D vary based on the phase of the inputs, while the phases of the outputs are always equal. This can be a useful property in certain applications since the relative phase of the input signals can be determined by measuring the relative amplitudes of the outputs. The relationships for a 90° hybrid with signals applied to Ports A and B or C and D are shown in Table VI.

Tables VII and VIII provide the relations for analysis of VSWR and Isolation in 90° hybrids. If we consider the same condition described for the 180° hybrid, two equal mismatches on opposite ports of the hybrid, we get an interesting result. The reflected signal will appear at the normally isolated port, but will not be present at the input. Thus, if we inject a signal at Port A, and apply equal mismatches at Ports C and D with a Z_o termination at Port B, the reflected components from the mismatches will be in phase at Port B and will be 180° out of phase at Port A. The isolation between Ports A and B is reduced, but the VSWR at Port A is unchanged by the presence of the mismatches. This property allows 90° hybrids to be

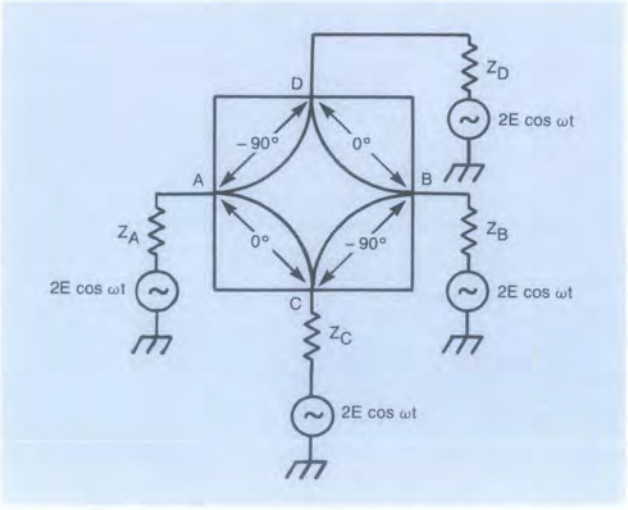
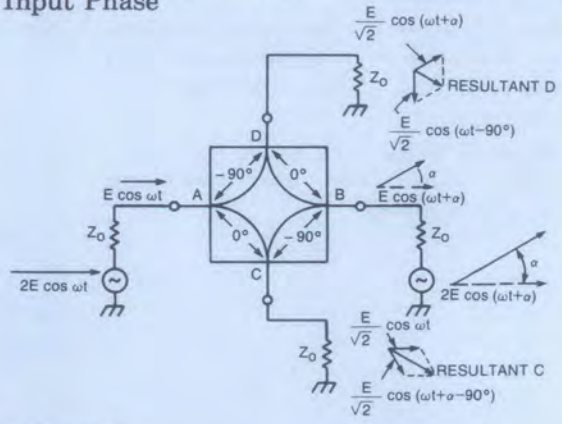


Figure 5. Signal Source Configuration for 90° Hybrid (Reference Tables V, VI, VII, VIII)

- Equal Amplitude, Equal Frequency Input
- Resultant Output Phases are Equal
- Resultant Output Magnitudes vary based on Input Phase



Resultant C

$$= \frac{E}{\sqrt{2}} [\cos \omega t + \cos (\omega t + \alpha - 90°)]$$

$$= \frac{E}{\sqrt{2}} [2 \cos ½ (2\omega t + \alpha - 90°) \cos ½ (- \alpha + 90°)]$$

$$= \sqrt{2}\, E \cos (45° - \frac{\alpha}{2}) \cos (\omega t + \frac{\alpha}{2} - 45°)$$

Resultant D

$$= \frac{E}{\sqrt{2}} [\cos (\omega t - 90°) + \cos (\omega t + \alpha)]$$

$$= \frac{E}{\sqrt{2}} [2 \cos ½ (2\omega t + \alpha - 90°) \cos ½ (- \alpha - 90°)]$$

$$= \sqrt{2}\, E \cos (-45° - \frac{\alpha}{2}) \cos (\omega t + \frac{\alpha}{2} - 45°)$$

$\therefore$ Phase of Resultant C = Phase of Resultant D $= (\omega t + \frac{\alpha}{2} - 45°)$

Figure 6. 90° Hybrid

Power Divider

Table V shows applicable relationships when the 90° hybrid is used as a power divider. The following conditions apply:

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Only one generator at a time is operating.

Table V — 90° Hybrid as a Power Divider

Input Signal	Input Port	Output Signals			
		Port A	Port D	Port C	Port B
E cosωt	A		$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$	$\frac{E}{\sqrt{2}}\cos\omega t$	0
	B	$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$		0	$\frac{E}{\sqrt{2}}\cos\omega t$
	C	$\frac{E}{\sqrt{2}}\cos\omega t$	0		$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$
	D	0	$\frac{E}{\sqrt{2}}\cos\omega t$	$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$	

Power Summer

Table VI shows applicable relationships when the 90° hybrid is used as a power summer. The following conditions apply:

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Two generators are operating simultaneously.

Table VI — 90° Hybrid as a Power Summer

Input Signal	Input Port	Output Ports			
		Port A	Port D	Port C	Port B
E cosωt	A		$\sqrt{2}$ E cos(−45°−α/2)	$\sqrt{2}$ E cos(45°−α/2)	
E cos(ωt+α)	B		[cos(ωt+α/2−45°)]	[cos(ωt+α/2+45°)]	
E cosωt	A		0	$\sqrt{2}$ E cosωt	
E cosωt	B				
E cos(ωt+90°)	A		$\sqrt{2}$ E cosω	0	
E cosωt	B				
E cosωt	D	0			$\sqrt{2}$ E cosωt
E cosωt+90°)	C				
E cosωt	D	$\sqrt{2}$ E cosωt			0
E cos(ωt+90°)	C				
E cosω₁t	B		$\frac{E}{\sqrt{2}}\left[\cos\omega_1 t+\cos(\omega_2 t-90°)\right]$	$\frac{E}{\sqrt{2}}\left[\cos(\omega_1 t+90°)+\cos\omega_2 t\right]$	
E cosω₁t	A				

VSWR

Table VII shows relationships used in determining port Voltage Standing Wave Ratios (VSWR's) for 90° hybrids. The following condition applies:

$$\rho = \frac{Z - Z_O}{Z + Z_O}$$

Table VII — VSWR of 90° Hybrids

Port Terminations				Port VSWR's			
A	B	C	D	Port A	Port D	Port C	PortB
Z_O	Z_O	Z_O	Z_O	1:1	1:1	1:1	1:1
Z_O	Z_D	Z_C	Z_O	$\frac{1+\frac{\lvert\rho_D-\rho_C\rvert}{2}}{1-\frac{\lvert\rho_D-\rho_C\rvert}{2}}$	1:1	1:1	$\frac{1+\frac{\lvert\rho_D-\rho_C\rvert}{2}}{1-\frac{\lvert\rho_D-\rho_C\rvert}{2}}$
Z_A	Z_O	Z_O	Z_B	1:1	$\frac{1+\frac{\lvert\rho_A-\rho_B\rvert}{2}}{1-\frac{\lvert\rho_A-\rho_B\rvert}{2}}$	$\frac{1+\frac{\lvert\rho_A-\rho_B\rvert}{2}}{1-\frac{\lvert\rho_A-\rho_B\rvert}{2}}$	

Isolation

Table VIII shows relationships used in determining isolation between ports of 90° hybrids. The following conditions apply:

1. Only one generator at a time is operating.
2. $\rho = \frac{Z - Z_O}{Z + Z_O}$
3. Return loss = $20 \log \frac{1}{|\rho|}$

Table VIII — Isolation for 90° Hybrids

Terminations				Isolation (dB)	
A	B	C	D	Ports A to B	Ports C to D
Z_O	Z_O	Z_O	Z_O	∞	∞
Z_O	Z_O	Z_C	Z_D	$6+20 \log \frac{1}{\lvert\rho_D+\rho_C\rvert}$	∞
Z_O	Z_D	Z_O	Z_O	$6+20 \log \frac{1}{\lvert\rho_D\rvert}$ = 6+return loss of Z_D	∞
Z_A	Z_O	Z_O	Z_B	∞	$6+20 \log \frac{1}{\lvert\rho_B+\rho_A\rvert}$
Z_O	Z_O	Z_O	Z_B	∞	$6+20 \log \frac{1}{\lvert\rho_B\rvert}$ = 6+return loss of Z_B

used in applications such as balanced amplifiers, where two equal impedance but mismatched amplifier stages are combined at inputs and outputs with 90° hybrids to achieve a low VSWR. VSWR and Isolation can be determined based on the relationships in Tables VII and VIII.

PERFORMANCE PARAMETERS

The 180° or 90° hybrid electrical parameters of principal importance to the designer or components engineer and commonly specified by manufacturers are the following:

Frequency Range

This is the range over which specifications are guaranteed for the particular device.

Insertion Loss

The amount of attenuation, in excess of signal splitting losses, of an input signal from a source of characteristic impedance Z_o measured at an output port terminated in Z_o.

Isolation

Isolation between two ports of a passive device is the amount of attenuation that a signal from a source of characteristic impedance Z_o applied to one port undergoes when measured at the other port terminated in Z_o.

Impedance

This is the nominal characteristic impedance (Z_o) for the device.

VSWR

Voltage Standing Wave Ratio – VSWR is a measure of the impedance of a device relative to Z_o. It can be expressed as $\text{VSWR} = \frac{1 + |\rho|}{1 - |\rho|}$

where $|\rho|$ is the magnitude of the reflection coefficient at the frequency of interest.

Amplitude Balance

The difference in attenuation between two or more output signals fed from a common input generally expressed as a maximum variation.

Phase Balance

The difference in phase between two or more output signals fed from a common input generally expressed as a maximum variation relative to the nominal phase difference between the paths. This nominal phase difference may be 0, 90, or 180°.

Some performance tradeoffs may be made between certain of these parameters. The principal tradeoff is between frequency range, insertion loss and amplitude balance for 90° hybrids. Several different design approaches are used for quadrature hybrids. These can generally be separated into narrow band and broadband designs. For single frequency applications the 10% bandwidth design can achieve very low insertion loss (0.1 to 0.2 dB), but the amplitude balance will degrade rapidly away from the center frequency. Octave bandwidth designs have slightly more loss, but the amplitude balance is maintained over the octave range. For this design, two crossover points occur where the output signals are equal. The broadband design is normally used only where frequency ranges of a decade or more are required. It is a more complex design generally consisting of a pair of 180° hybrids interconnected with a pair of phase tracking 90° all pass lattice filter networks, and will usually have higher insertion loss because of this complexity.

CONCLUSION

The 90° and 180° hybrids are basic system and component building blocks. Understanding their basic relationships allows the designer, through clearer application, to overcome system problems and/or improve system performance with these simple devices. The reader is urged to study the tables of relationships carefully since some of the hybrid's unique capabilities are not inherently obvious. There are special cases of these devices discussed in more detail in the power divider, coupler, and custom subassembly sections of this catalog.

MODEL HH-105 — TO-5 HYBRID JUNCTION 20-300 MHz

- 0°-180° Hybrid in TO-5 Package
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	20-300 MHz
Insertion Loss (Less coupling)	1.0 dB Max
Isolation	28 dB Min
Amplitude Balance	0.25 dB Max**
VSWR	1.3:1 Max
Phase Balance	2° Max**

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	0.5 Watts Max
Package Type	TO-5-2 (See page 472 for physical dimensions.)

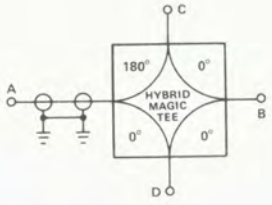
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, D; P3, C; P4. Case ground.

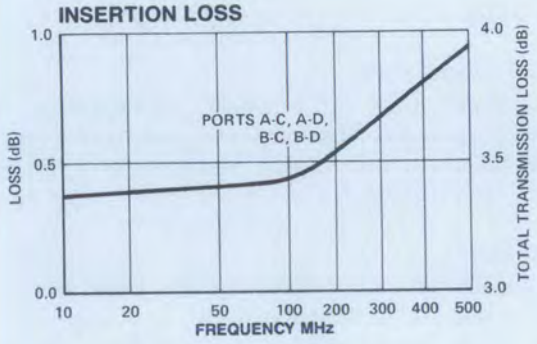
*All specifications apply with 50 ohm source and load impedance.

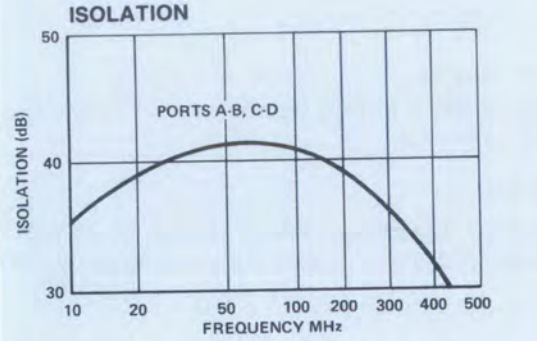
**Differences measure between C & D feeding A or B.

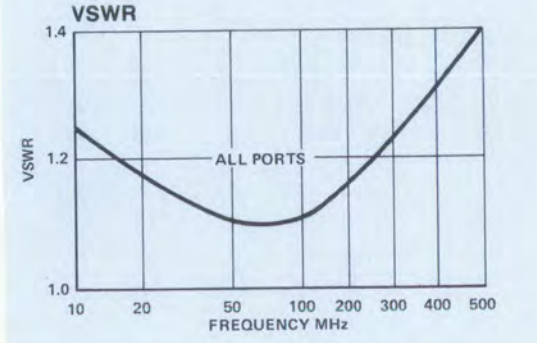
Functional Diagram



Typical Performance







Ordering Information

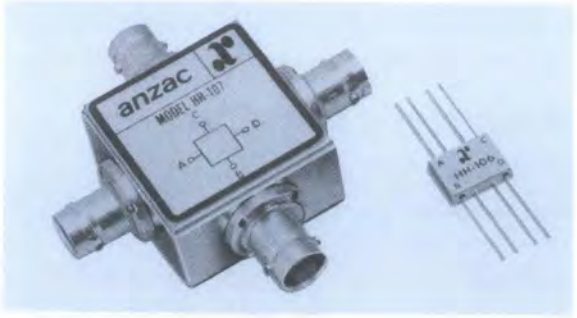
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
HH-105	9599	Pin	$65

Delivery is from stock.

MODELS HH-106/107

180° HYBRID JUNCTIONS 2-200 MHz

- 0°-180° Hybrid with Symmetrical Time Delay Between Ports
- Available in Flatpack and Connectorized Packages



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range			2-200 MHz
Insertion Loss (Less coupling)			1.0 dB Max
Isolation	A-B	2-200 MHz	25 dB Min
		5-50 MHz	30 dB Min
	C-D	2-200 MHz	30 dB Min
		5-50 MHz	35 dB Min
Amplitude Balance			0.3 dB Max
VSWR		2-200 MHz	1.5:1 Max
		5-50 MHz	1.3:1 Max
Phase Balance			3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max
Package Type	HH-106 Flatpack (FP-2) HH-107 Connectorized (C-8) (See pages 474 and 481 for physical dimensions.)

Environmental

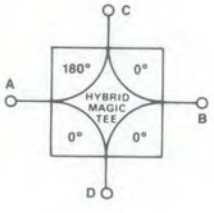
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

HH-106: A; P1, C; P4, B; P5, D; P8. All other pins and case ground.

*All specifications apply with 50 ohm source and load impedance.

Functional Diagram

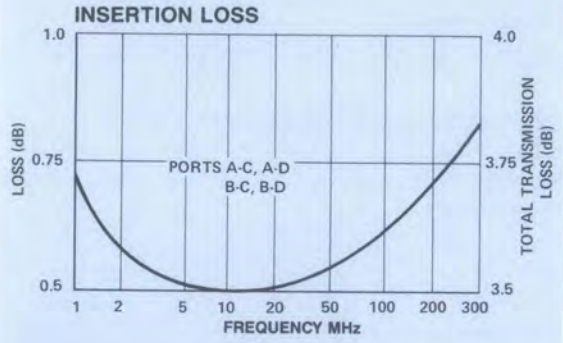


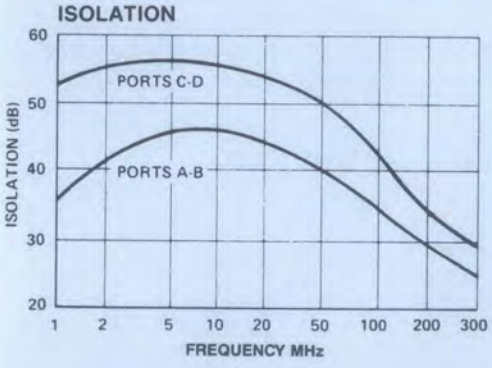
Ordering Information

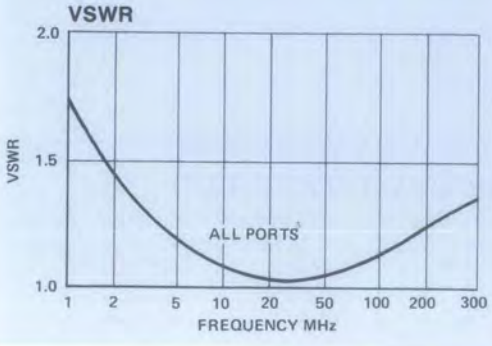
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
HH-106	9419	Pin	$ 79
HH-107	8001	BNC	121
HH-107	8004	SMA	125

Delivery is from stock.

Typical Performance







MODEL HH-108 — HIGH POWER HYBRID JUNCTION
200 kHz-35 MHz

- High Power Handling Capability
- Low VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200 kHz-35 MHz
Insertion Loss (Less coupling)		0.4 dB Max
Isolation	200 kHz-10 MHz	30 dB Min
	10 MHz-35 MHz	20 dB Min
Amplitude Balance	200 kHz-10 MHz	0.1 dB Max
	10 MHz-35 MHz	0.2 dB Max
VSWR		1.3:1 Max
Phase Balance	200 kHz-10 MHz	3° Max
	10 MHz-35 MHz	10° Max

Operating Characteristics

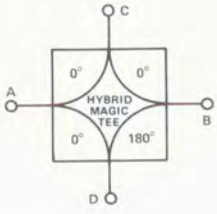
Impedance	50 Ohms Nominal
Input Power	25 Watts Max Up to 50°C 20 Watts Max Up to 85°C
Package Type	Connectorized (C-11) (See page 482 for physical dimensions.)

Environmental

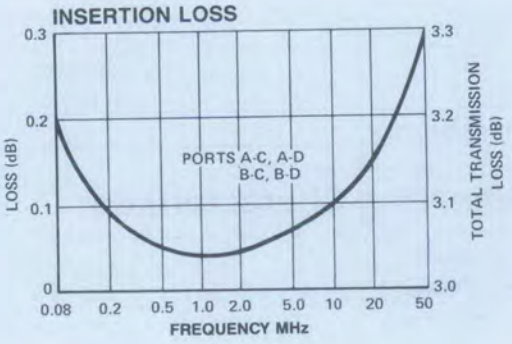
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

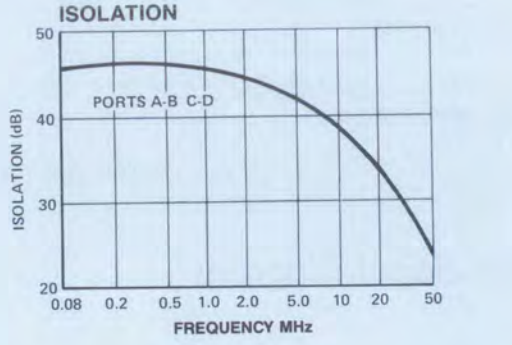
*All specifications apply with 50 ohm source and load impedance.

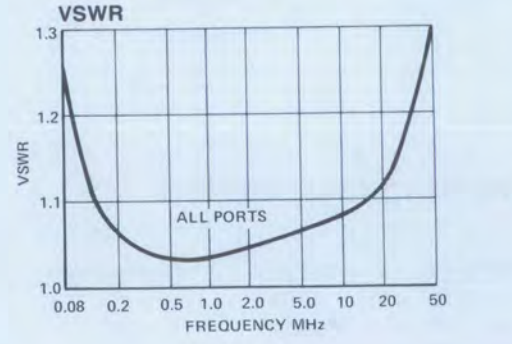
Functional Diagram



Typical Performance







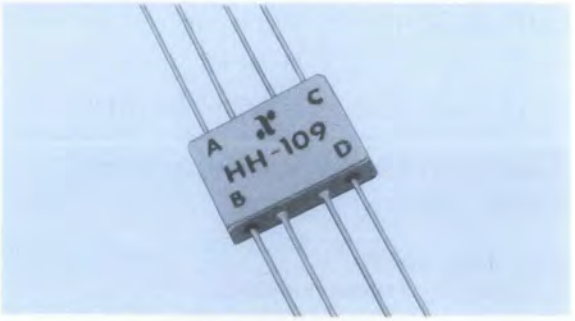
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
HH-108	8381	BNC	$153
HH-108	8384	SMA	158

Delivery is from stock

MODEL HH-109 — FLATPACK HYBRID JUNCTION 5-200 MHz

- 0°-180° Hybrid with High Isolation
- Usable from 500 kHz-500 MHz



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-200 MHz
Insertion Loss (Less coupling)		1.4 dB Max
Isolation	5-100 MHz	30 dB Min
	100-200 MHz	25 dB Min
Amplitude Balance		0.3 dB Max
VSWR	5-100 MHz	1.5:1 Max
	100-200 MHz	1.7:1 Max
Phase Balance	5-100 MHz	4° Max
	100-200 MHz	8° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	0.5 Watts Max
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

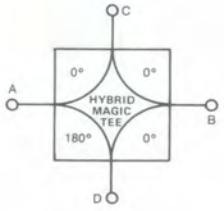
Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

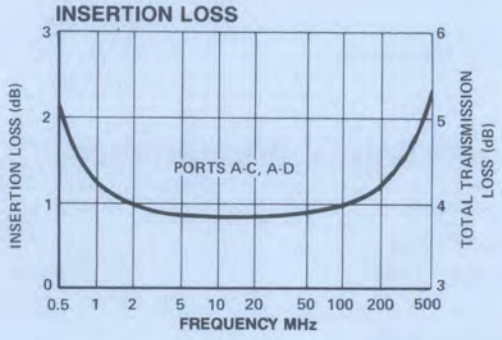
Pin Configuration	A; P1, C; P4, B; P5, D; P8. All other pins and case ground.

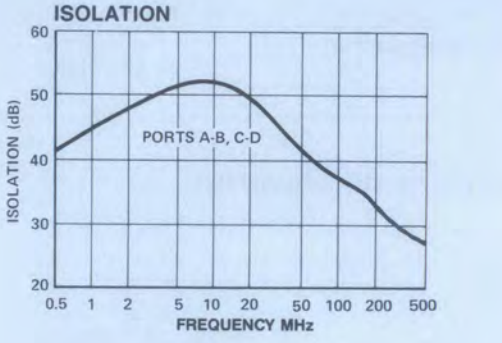
*All specifications apply with 50 ohm source and load impedance.

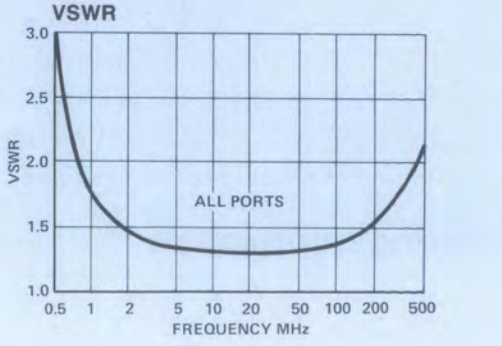
Functional Diagram



Typical Performance







Ordering Information

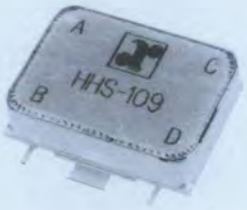
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
HH-109	8499	Pin	$36

Delivery is from stock.

NEW

MODEL HHS-109 — SURFACE MOUNT HYBRID JUNCTION 5-200 MHz

- Fully Hermetic Package
- 0°-180° Hybrid with High Isolation
- Usable from 500 kHz-500 MHz



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-200 MHz
Insertion Loss (Less coupling)		1.4 dB Max
Isolation	5-100 MHz	30 dB Min
	100-200 MHz	25 dB Min
Amplitude Balance		0.3 dB Max
VSWR	5-100 MHz	1.5:1 Max
	100-200 MHz	1.7:1 Max
Phase Balance	5-100 MHz	4° Max
	100-200 MHz	8° Max

Operating Characteristics

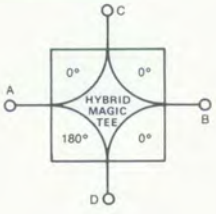
Impedance	50 Ohms Nominal
Input Power	0.5 Watts Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

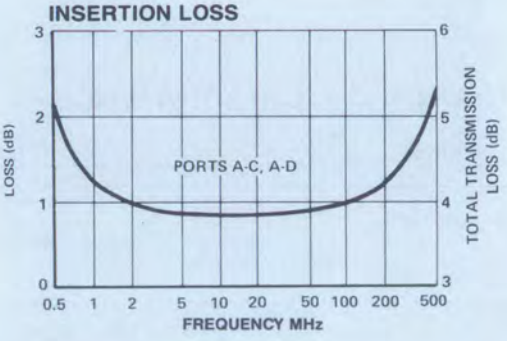
Pin Configuration	A; P1, C; P2, B; P3, D; P4 All other pins and case ground.

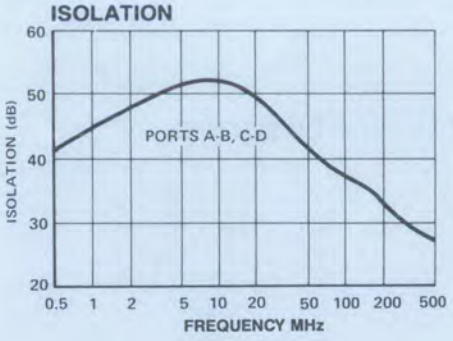
*All specifications apply with 50 ohm source and load impedance.

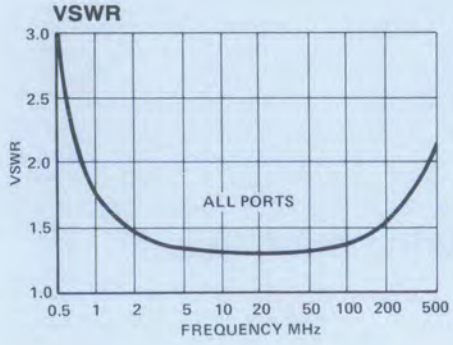
Functional Diagram



Typical Performance







Ordering Information

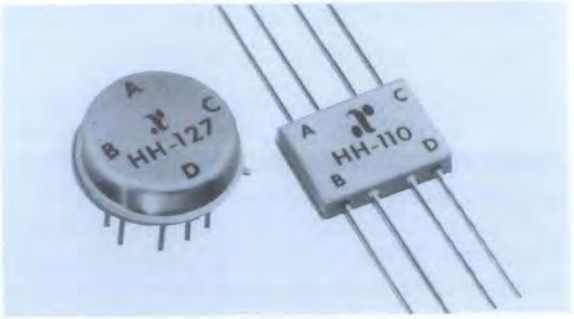
Model No.	Connectors	Unit Price (5-9 Units)
HHS-109	PIN	$45

Delivery is from stock.

MODEL HH-110/127

HYBRID JUNCTION 10-500 MHz

- Broad Frequency Range
- High Isolation — Typically 30 dB
- Available in Flatpack and TO-8 Packages



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-500 MHz
Insertion Loss (Less coupling)	10-500 MHz	1.4 dB Max
	25-200 MHz	1.0 dB Max
Isolation	10-500 MHz	20 dB Min
	25-200 MHz	30 dB Min
Amplitude Balance	10-500 MHz	0.6 dB Max
	25-200 MHz	0.4 dB Max
VSWR	10-500 MHz	2.0:1 Max
	25-200 MHz	1.6:1 Max
Phase Balance	10-500 MHz	7° Max
	25-200 MHz	5° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max
Package Type	HH-110 Flatpack (FP-2) HH-127 (TO-8-2)

(See pages 474 and 472 for physical dimensions.)

Environmental

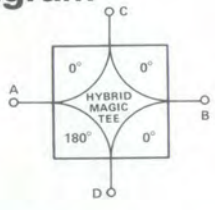
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

HH-110	A; P1, C; P4, B; P5, D; P8. All other pins and case ground.
HH-127	A; P5, B; P8, C; P2, D; P11. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

Functional Diagram

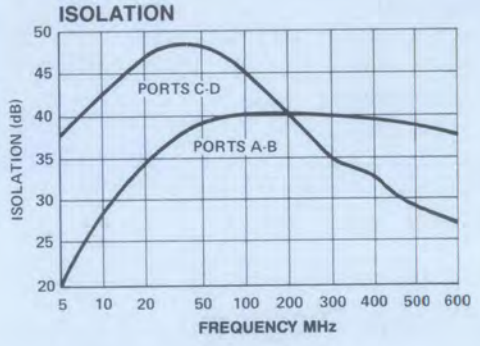


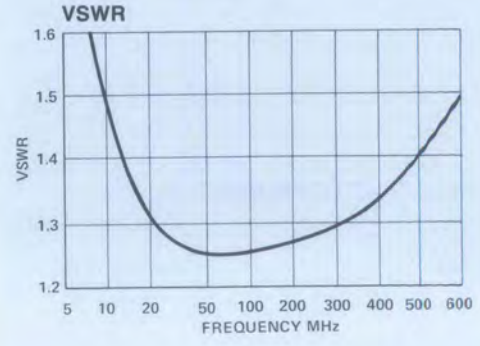
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
HH-110	9839	Pin	$49
HH-127	8819	Pin	45

Delivery is from stock.

Typical Performance



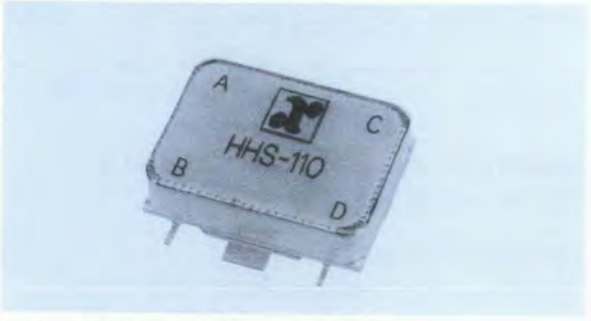


NEW

MODEL HHS-110

SURFACE MOUNT HYBRID JUNCTION 10-500 MHz

- Fully Hermetic Package
- Broad Frequency Range
- High Isolation — Typically 30 dB



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-500 MHz
Insertion Loss (Less coupling)	10-500 MHz	1.4 dB Max
	25-200 MHz	1.0 dB Max
Isolation	10-500 MHz	20 dB Min
	25-200 MHz	30 dB Min
Amplitude Balance	10-500 MHz	0.6 dB Max
	25-200 MHz	0.4 dB Max
VSWR	10-500 MHz	2.0:1 Max
	25-200 MHz	1.6:1 Max
Phase Balance	10-500 MHz	7° Max
	25-200 MHz	5° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max
Package Type	HHS-110 Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental

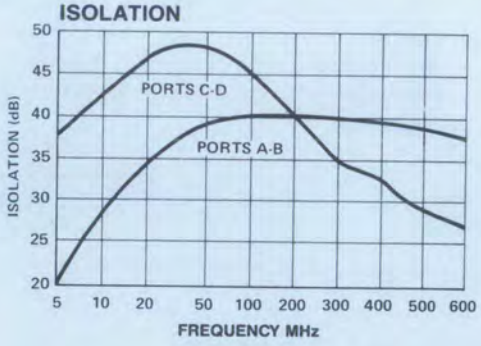
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

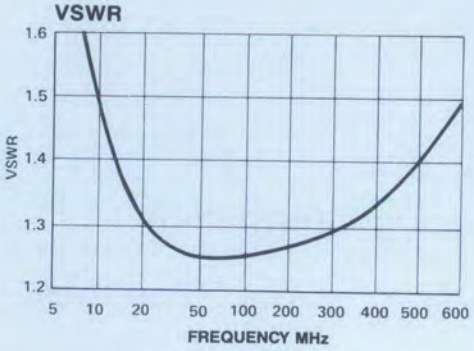
Pin Configuration

A; P1, C; P2, B; P3, D; P4. All other pins and case ground.

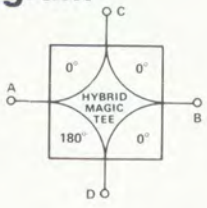
*All specifications apply with 50 ohm source and load impedance.

Typical Performance





Functional Diagram



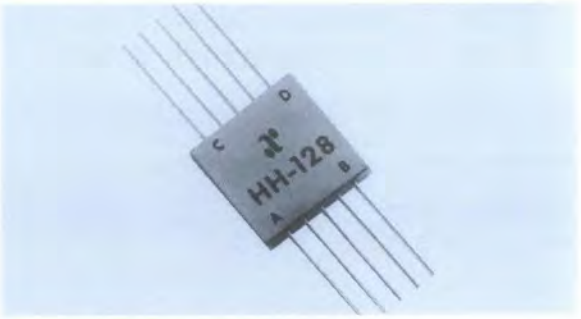
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
HHS-110	PIN	$54

Delivery is from stock.

MODEL HH-128 — FLATPACK HYBRID JUNCTION
20-2000 MHz

- 1.5 dB Typical Midband Insertion Loss
- 30 dB Typical Midband Isolation
- 1.3:1 Typical Midband VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-2000 MHz
Insertion Loss (Less coupling)	20-2000 MHz	3.0 dB Max
	20-1000 MHz	2.5 dB Max
Isolation	20-2000 MHz	15 dB Min
	20-1000 MHz	20 dB Min
Amplitude Balance	20-2000 MHz	1.2 dB Max
	20-1000 MHz	0.5 dB Max
VSWR	20-2000 MHz	2.0:1 Max
Phase Balance	20-2000 MHz	20° Max
	20-1000 MHz	15° Max
	20-500 MHz	10° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	0.5 Watts Max
Package Type	Flatpack (FP-3) (See page 474 for physical dimensions.)

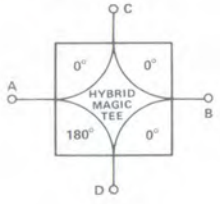
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	C; P1, D; P5, A; P6, B; P10. All other pins and case ground.

*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,508,171.

Functional Diagram

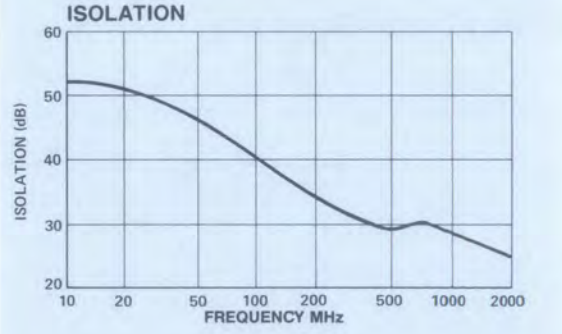


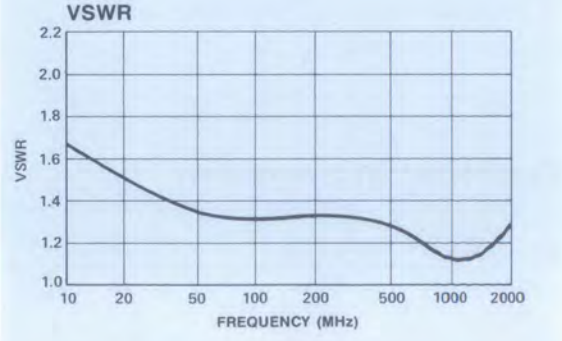
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
HH-128	8249	Pin	$116

Delivery is from stock.

Typical Performance



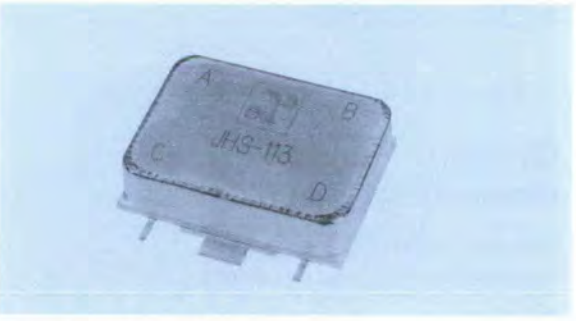


NEW

MODEL JHS-113

SURFACE MOUNT QUADRATURE HYBRID 7-14 MHz

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.2:1
- Low Loss — 0.5 dB Maximum



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	7-14 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, D; P4, C; P3 All other pins and case ground

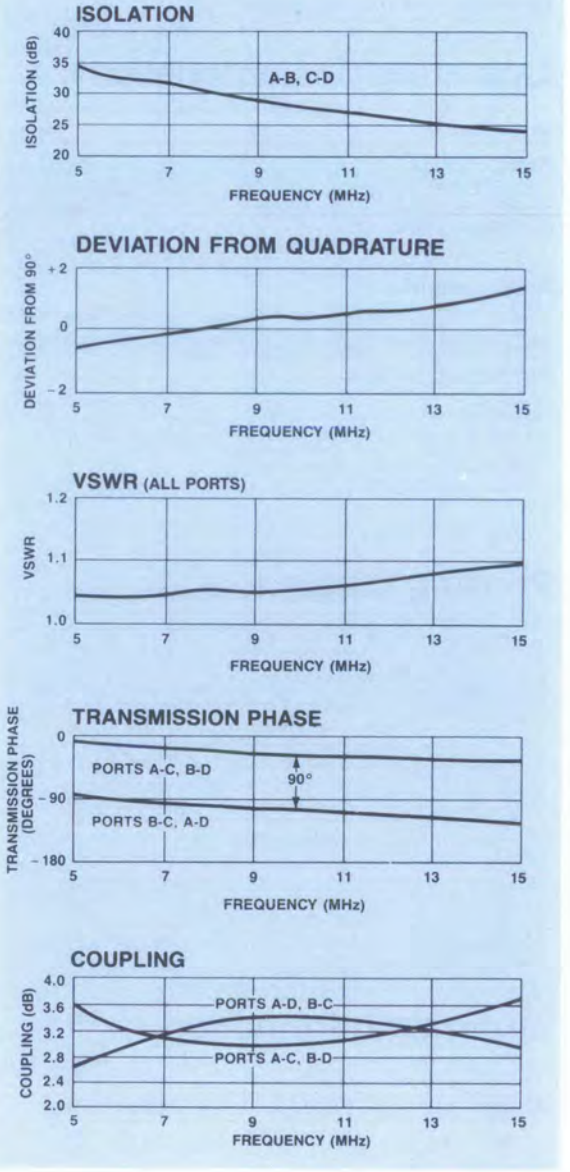
*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



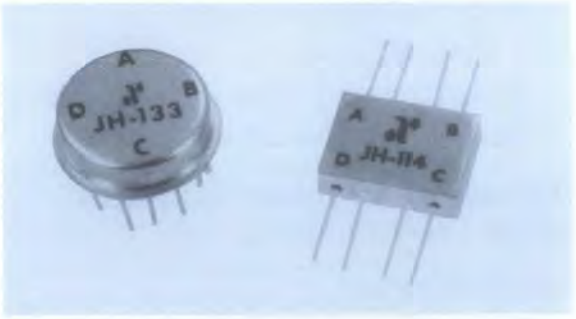
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
JHS-113	PIN	$54

Delivery is from stock.

MODEL JH-114/133 — QUADRATURE HYBRID 20-40 MHz

- Octave Bandwidth
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	20-40 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @ 25°C Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line
Package Type	JH-114 Flatpack (FP-2) JH-133 (TO-8-2) (See pages 474 and 472 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

JH-114	A; P1, B; P4, C; P8, D; P5. All other pins are ground.
JH-133	A; P5, B; P2, C; P11, D; P8. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

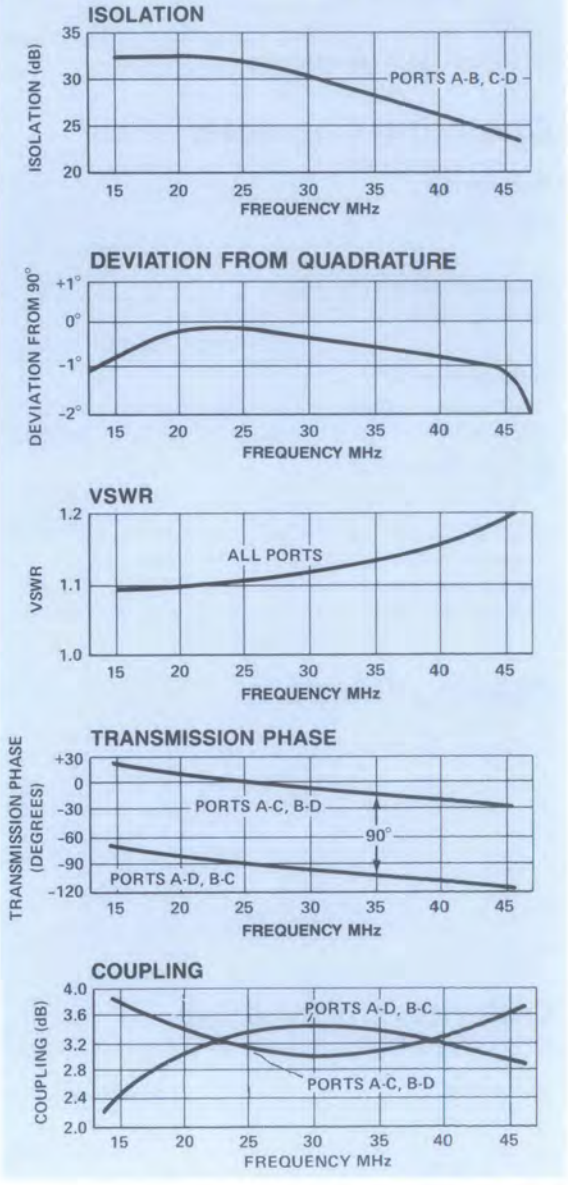
IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-114	9119	Pin	$54
JH-133	8799	Pin	52

Delivery is from stock.

Typical Performance



NEW

MODEL JHS-114

SURFACE MOUNT QUADRATURE HYBRID 20-40 MHz

- Fully Hermetic Package
- Octave Bandwidth
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	20-40 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @ 25°C Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line
Package Type	JHS-114 (SF-1) (See page 490 for physical dimensions)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

JHS-114 — A; P1, B; P2, C; P4, D; P3
All other pins are ground

*All specifications apply with 50 ohm source and load impedance.

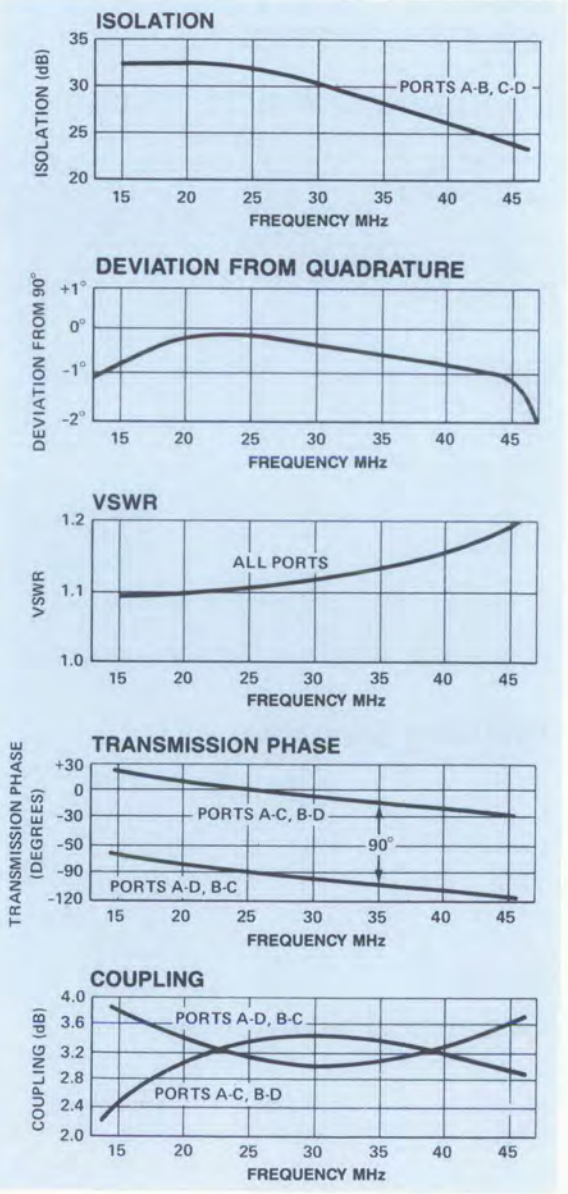
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Typical Performance



Ordering Information

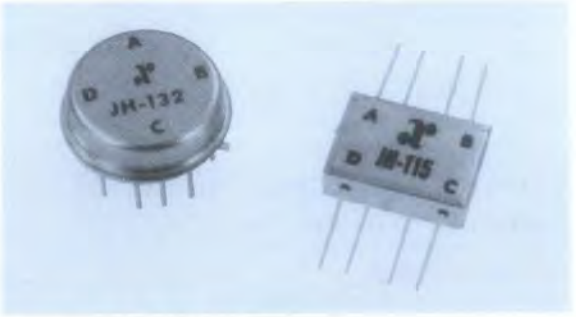
Model No.	Connectors	Unit Price (5-9 Units)
JHS-114	PIN	$59

Delivery is from stock.

MODEL JH-115/132

QUADRATURE HYBRID 40-80 MHz

- Octave Bandwidth
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	40-80 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @25°C Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line
Package Type	JH-115 Flatpack (FP-2) JH-132 (TO-8-2) (See pages 474 and 472 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

JH-115	A; P1, B; P4, C; P8, D; P5. All other pins are ground.
JH-132	A; P5, B; P2, C; P11, D; P8. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

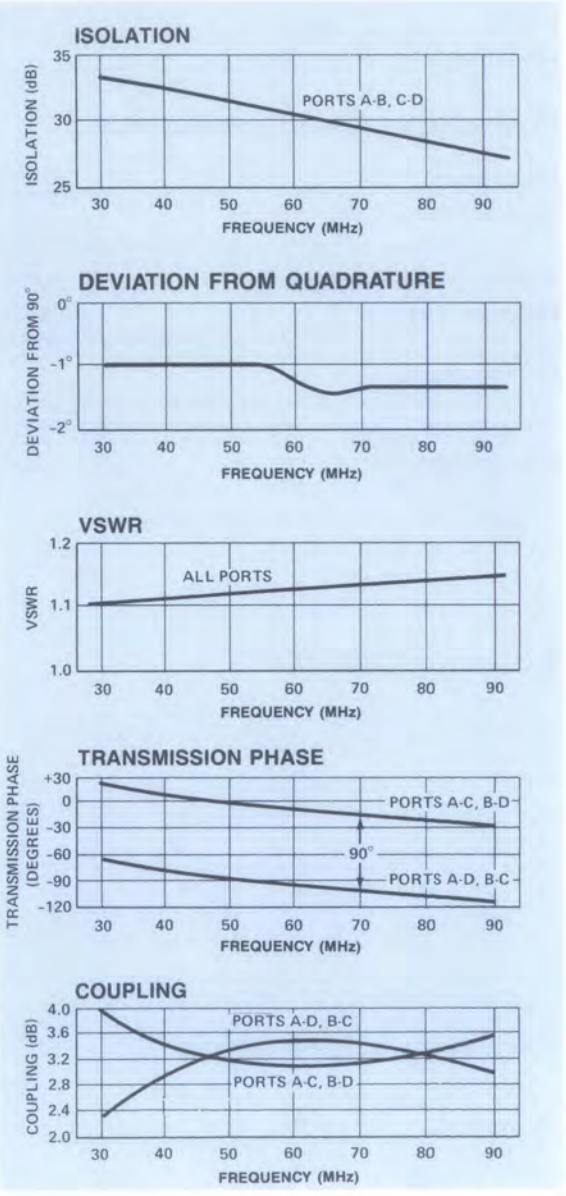
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-115	9129	Pin	$58
JH-132	8789	Pin	54

Delivery is from stock.

NEW

MODEL JHS-115 SURFACE MOUNT QUADRATURE HYBRID 40-80 MHz

- Fully Hermetic Package
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	40-80 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.8 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3

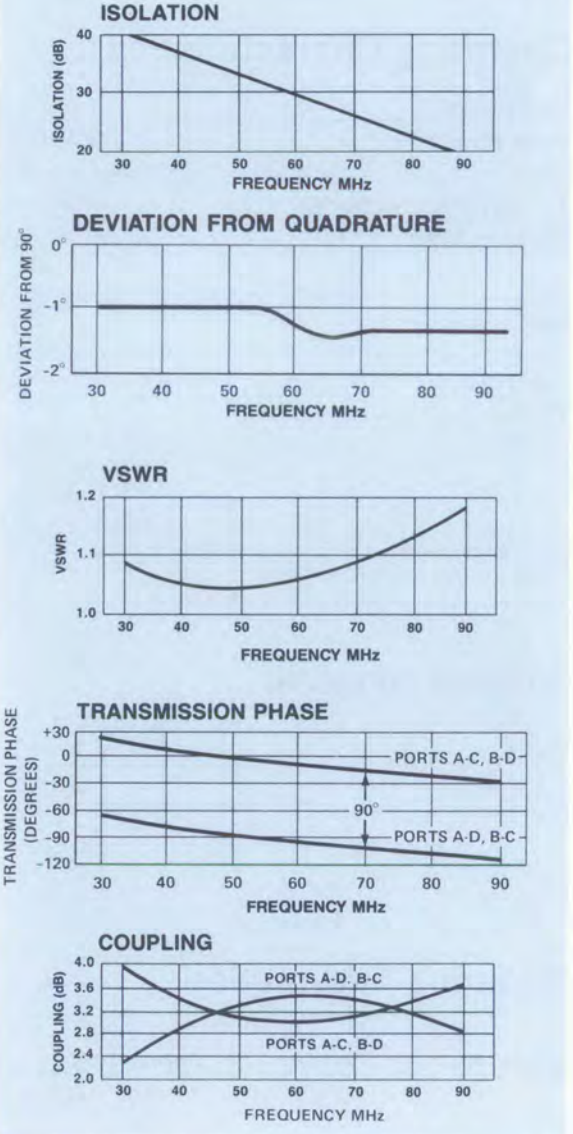
*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



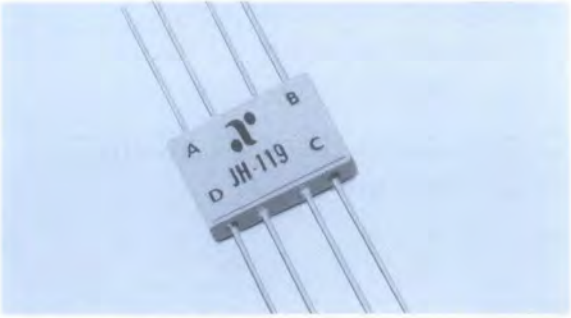
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JHS-115	6149	Pin	$63

Delivery is from stock.

MODEL JH-119 — FLATPACK QUADRATURE HYBRID
80-160 MHz

- Octave Bandwidth
- Low VSWR — 1.3:1



Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	80-160 MHz
Insertion Loss (Less coupling)	0.75 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

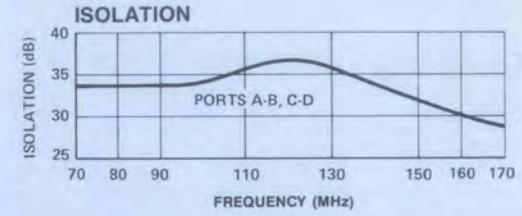
**Average of coupled loss exceeding 3 dB.

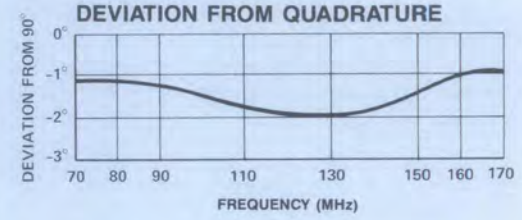
This product contains elements protected by United States Patent Number 3,484,724.

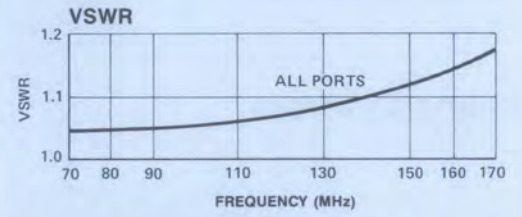
Phasing Diagram

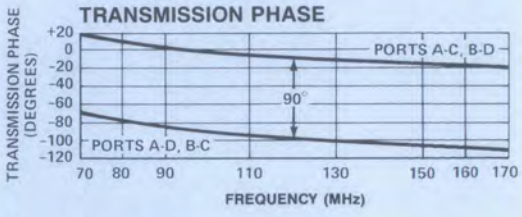
IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

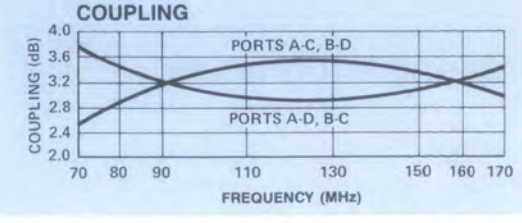
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-119	9219	Pin	$62

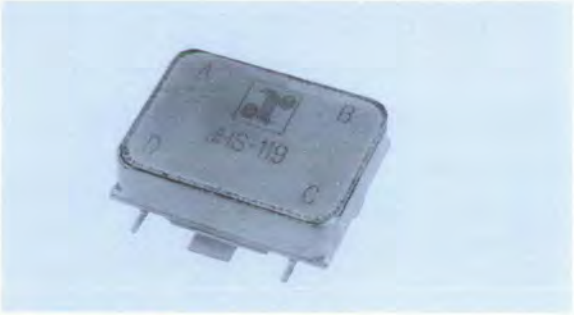
Delivery is from stock.

NEW

MODEL JHS-119

SURFACE MOUNT QUADRATURE HYBRID 80-160 MHz

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.3:1



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	80-160 MHz
Insertion Loss (Less coupling)	0.75 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C Derated to 1 Watt @ 85°C
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

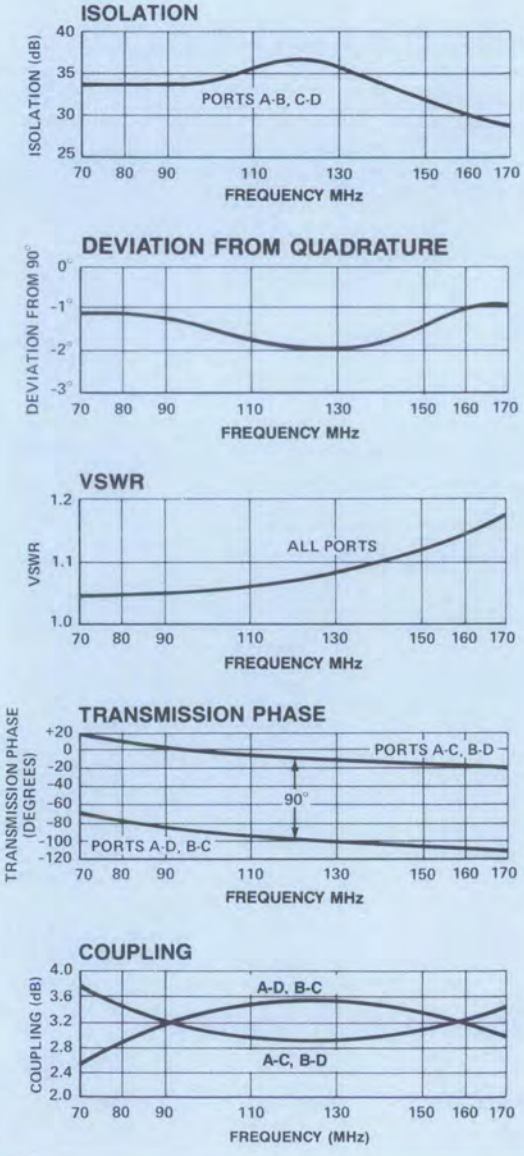
**Average of coupled loss exceeding 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Typical Performance



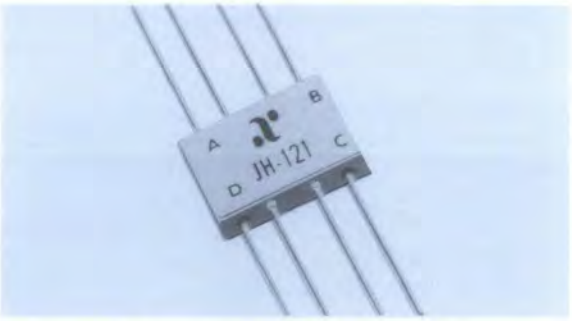
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
JHS-119	PIN	$58

Delivery is from stock.

MODEL JH-121 — FLATPACK QUADRATURE HYBRID
100-200 MHz

- Octave Bandwidth
- Low VSWR — 1.2:1



Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	100-200 MHz
Insertion Loss (Less coupling)	0.75 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

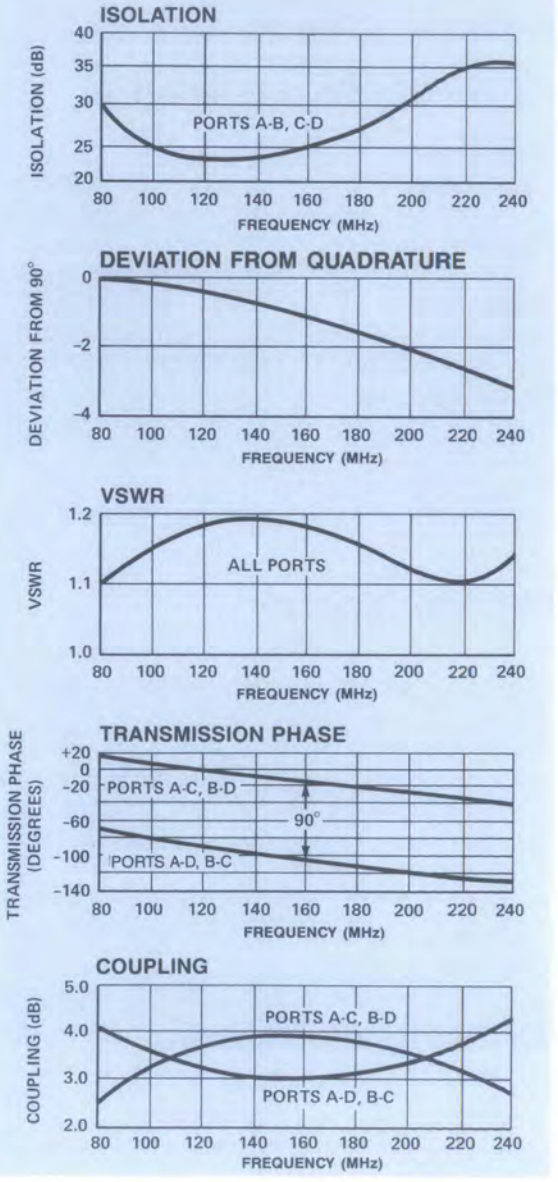
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-121	9339	Pin	$71

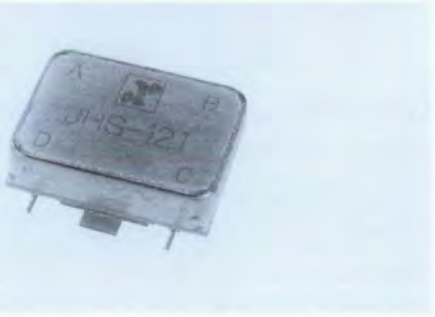
Delivery is from stock.

NEW

MODEL JHS-121

SURFACE MOUNT QUADRATURE HYBRID 100-200 MHz

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.2:1



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	100-200 MHz
Insertion Loss (Less coupling)	0.75 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C Derated to 1 Watt @ 85°C
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

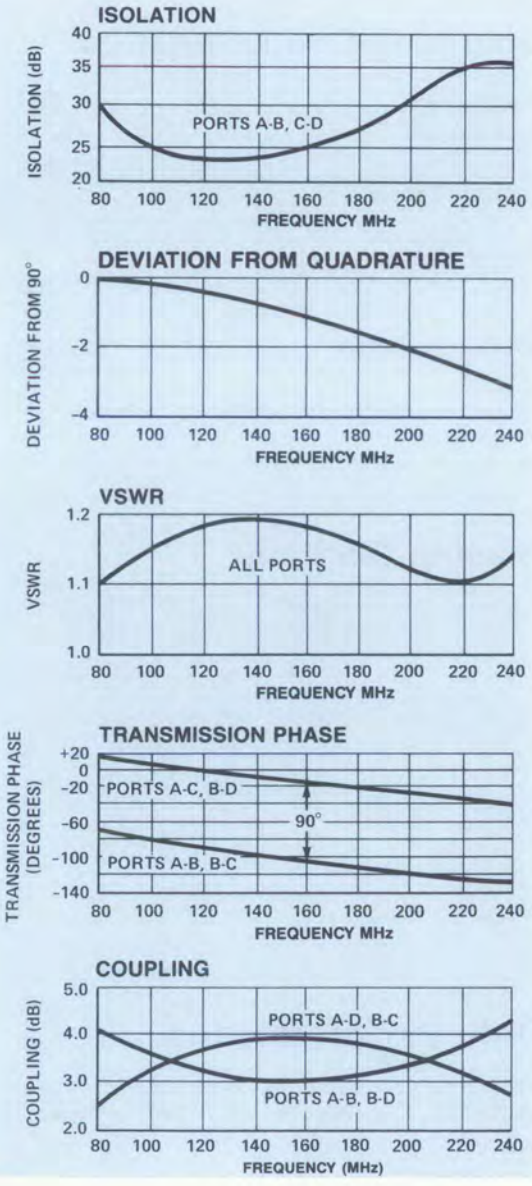
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
JHS-121	PIN	$77

Delivery is from stock.

MODEL JH-131 — THREE-PORT QUADRATURE HYBRID 20-200 MHz

- Internally Terminated Fourth Port
- Amplitude Balance 0.4 dB

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	20-200 MHz
Insertion Loss (Less coupling)	1.0 dB Max
Isolation	20 dB Min
Amplitude Balance	0.4 dB Max
VSWR	1.4:1 Max
Deviation from Quadrature	6° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	250 mW Max
Package Type	Connectorized (C-13) (See page 482 for physical dimensions.)

Environmental

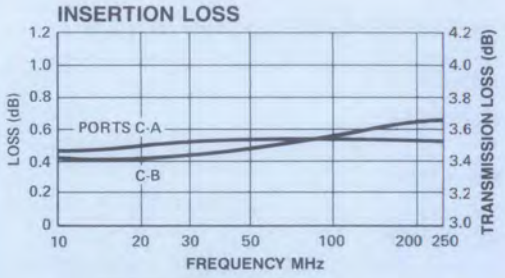
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

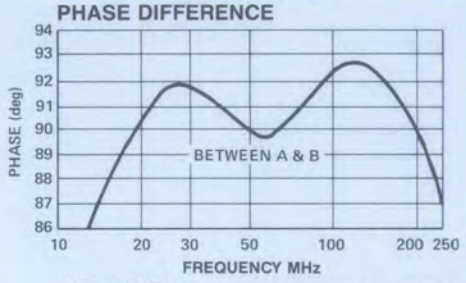
*All specifications apply with 50 ohm source and load impedance.

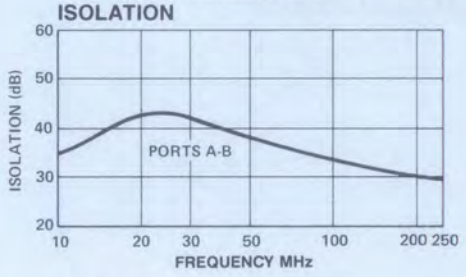
Phasing Diagram

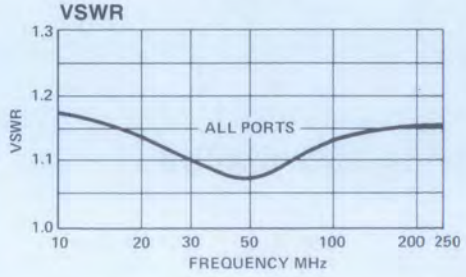
IN \ OUT	A	B	C
A		ISO.	90°
B	ISO.		0°
C	90°	0°	

Typical Performance









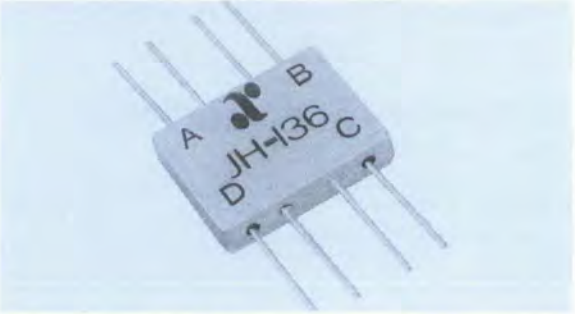
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-131	8671	BNC	$212
JH-131	8674	SMA	216

Delivery is from stock.

MODEL JH-136 — FLATPACK QUADRATURE HYBRID
175-350 MHz

- Octave Bandwidth
- Low VSWR — 1.2:1 Typical



Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	175-350 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

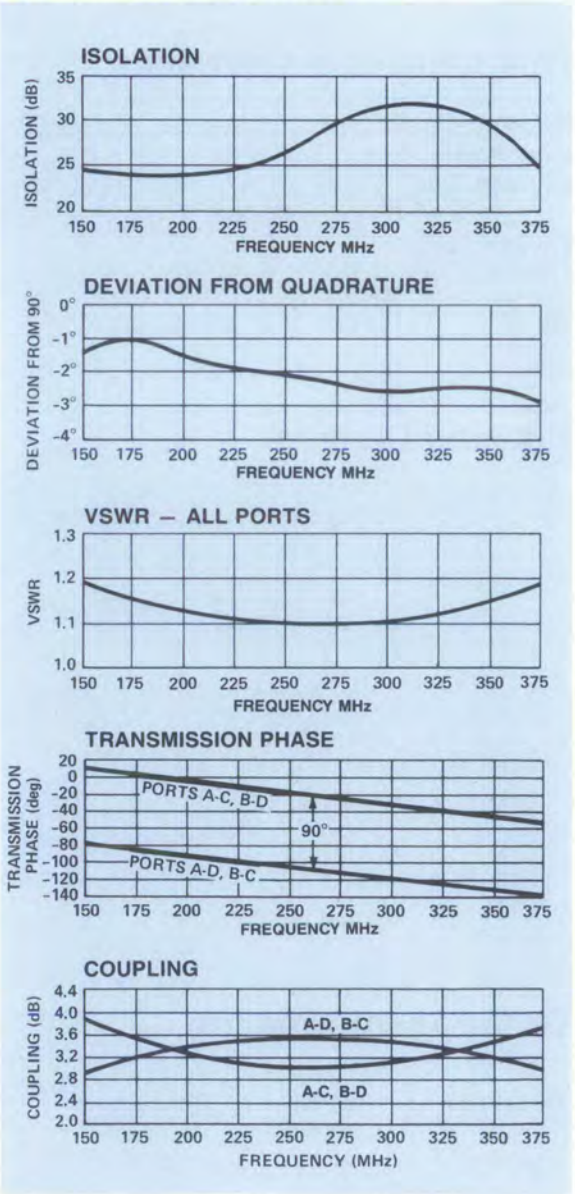
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-136	9379	Pin	$76

Delivery is from stock.

NEW

MODEL JHS-136 — SURFACE MOUNT QUADRATURE HYBRID 175-350 MHz

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.2:1 Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	175-350 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 All other pins are ground

*All specifications apply with 50 ohm source and load impedance.

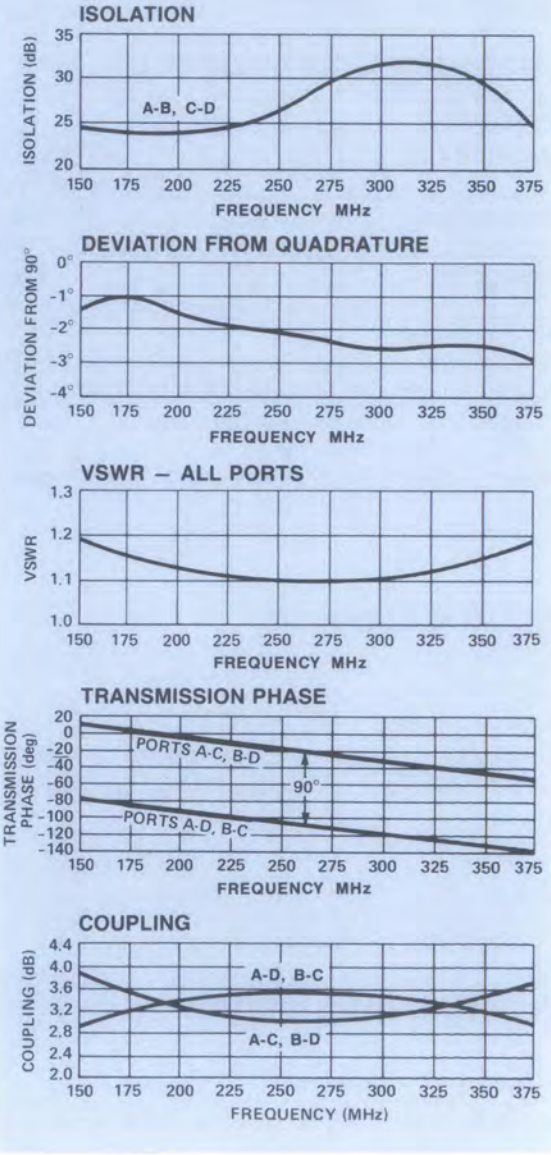
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



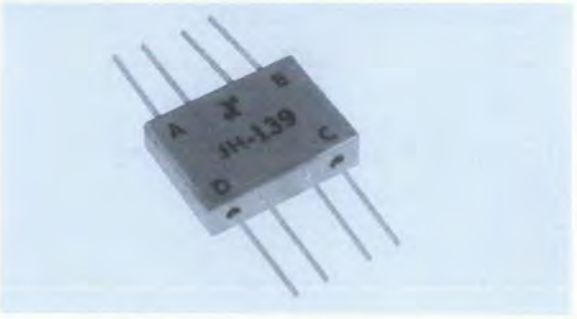
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
JHS-136	PIN	$81

Delivery is from stock.

MODEL JH-139 — FLATPACK QUADRATURE HYBRID
250-500 MHz

- Octave Bandwidth
- Low VSWR — 1.1:1 Typical
- High Isolation — 30 dB Typical



Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	250-500 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See pages 340 to 349 for physical dimensions.)
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

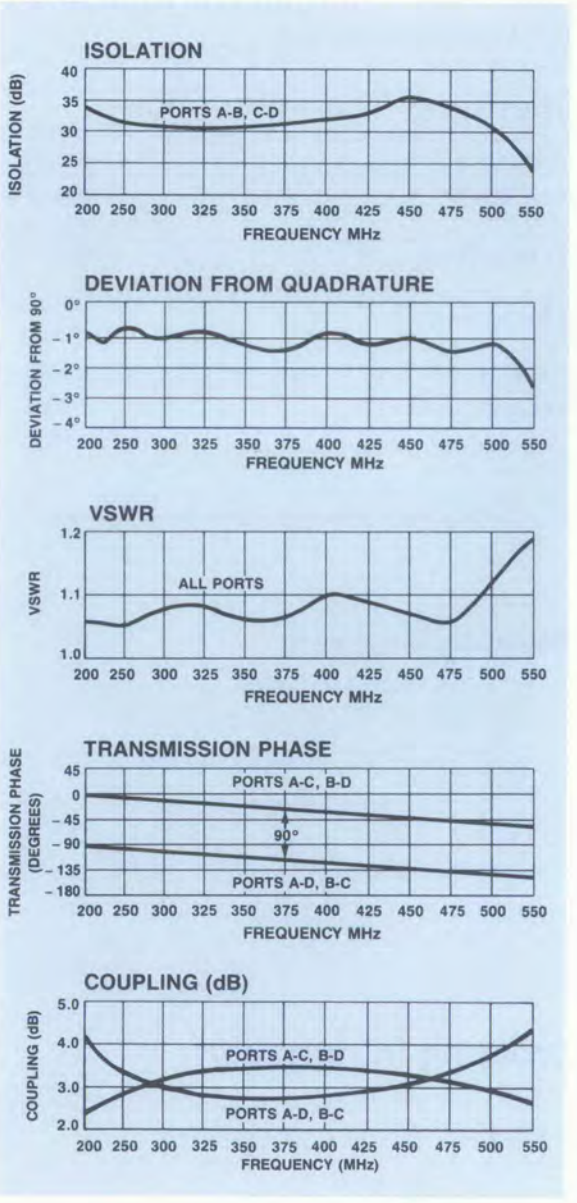
**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-139	6649	Pin	$76

Delivery is from stock.

NEW

MODEL JHS-139 — SURFACE MOUNT QUADRATURE HYBRID 250-500 MHz

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.1:1 Typical
- High Isolation — 30 dB Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	250-500 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 Case and all other pins are ground

*All specifications apply with 50 ohm source and load impedance.

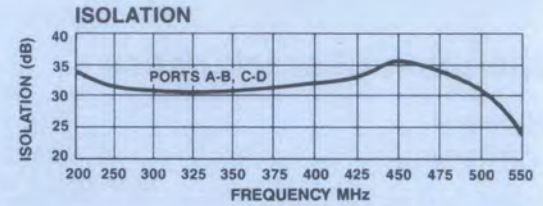
**Average of coupled outputs less 3 dB.

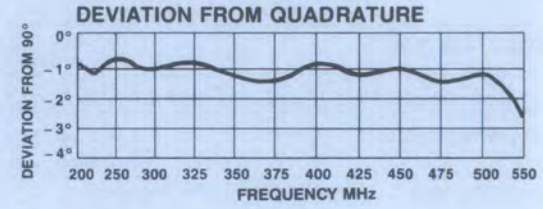
This product contains elements protected by United States Patent Number 3,484,724.

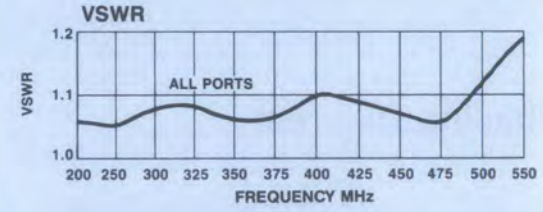
Phasing Diagram

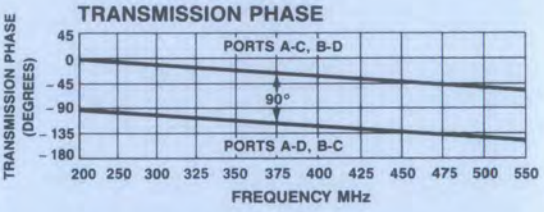
OUT / IN	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

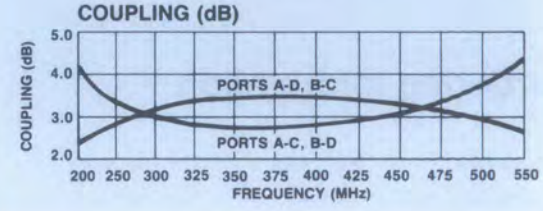
Typical Performance











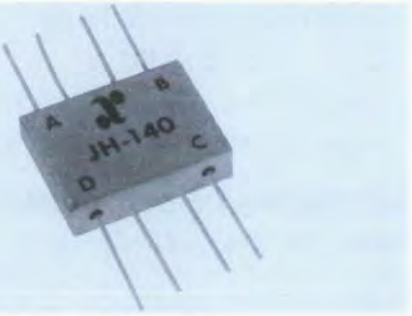
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
JHS-139	PIN	$81

Delivery is from stock.

MODEL JH-140 — HIGH FREQUENCY QUADRATURE HYBRID 500-1000 MHz

- Octave Bandwidth
- Low VSWR — 1.2:1 Typical
- Miniature Size — ½″ x ⅜″ Flatpack



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	500-1000 MHz
Insertion Loss (Less coupling)	0.3 dB Max Avg**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	2° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	25 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

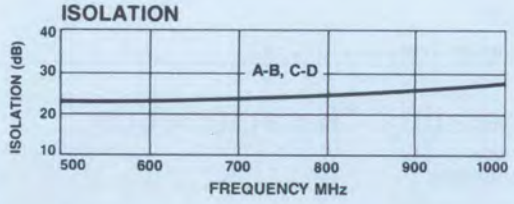
*All specifications apply with 50 ohm source and load impedance.

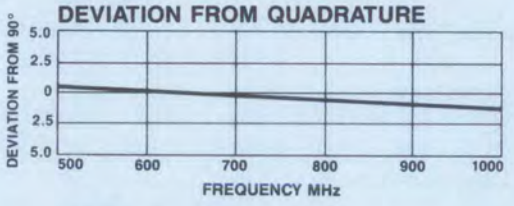
**Average of coupled outputs less 3 dB.

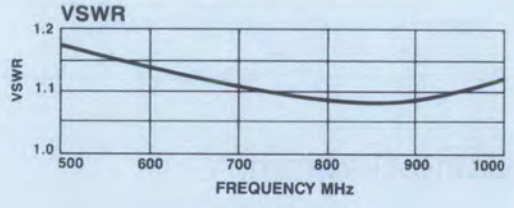
Phasing Diagram

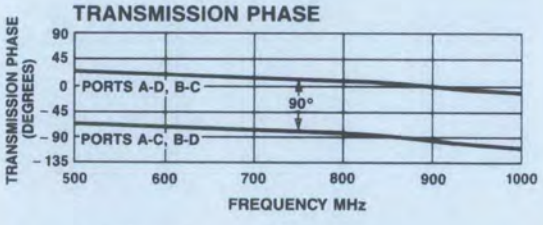
IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

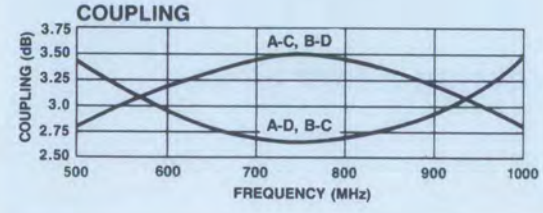
Typical Performance











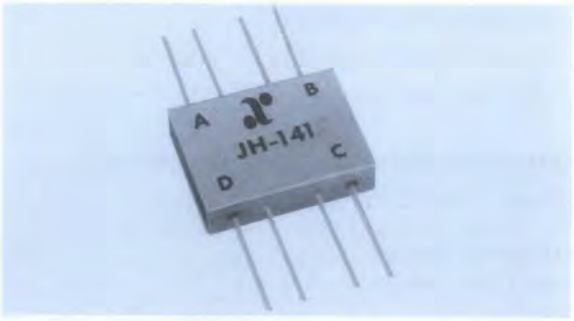
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-140	6619	Pin	$76

Delivery is from stock.

MODEL JH-141 — HIGH FREQUENCY QUADRATURE HYBRID 1-2 GHz

- Octave Bandwidth
- Low VSWR — 1.25:1 Typical
- Miniature Size — ½″ x ⅜″ Flatpack



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	1-2 GHz
Insertion Loss (Less coupling)	0.3 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.25:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	25 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

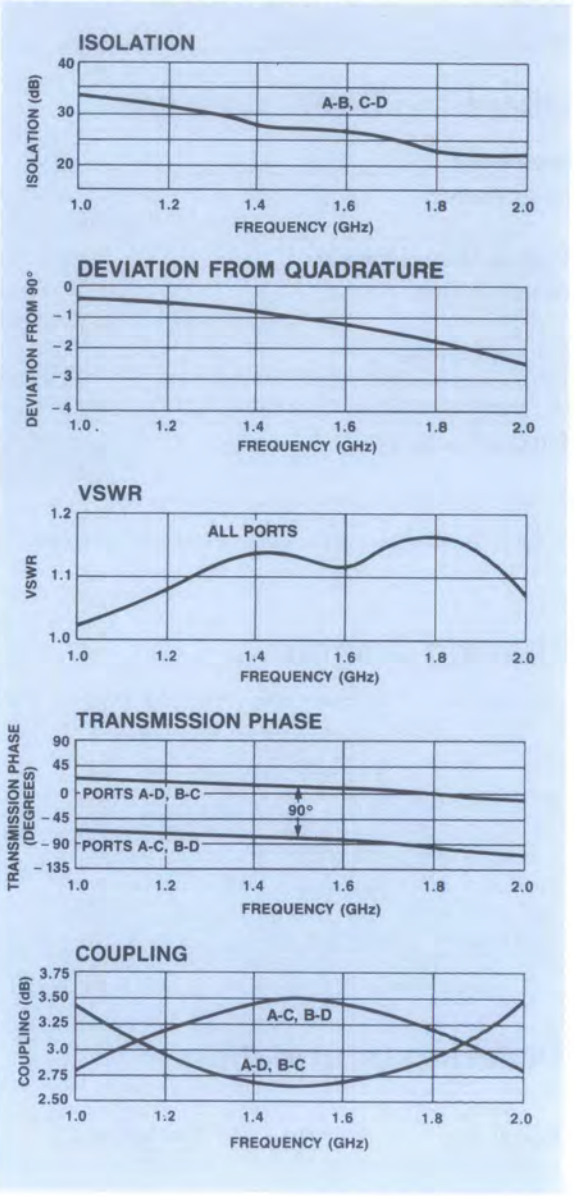
*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

Typical Performance



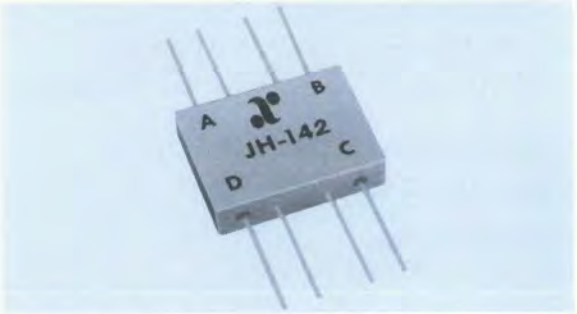
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-141	6629	Pin	$76

Delivery is from stock.

MODEL JH-142 — QUADRATURE HYBRID
200-400 MHz

- Octave Bandwidth
- Low VSWR — 1.1:1 Typical
- Miniature Size — 3/8″ x 1/2″ Flatpack



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	200-400 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @25° Derated to 1 Watt @ 85°C
Typical Phase Linearity	3° from Straight Line
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

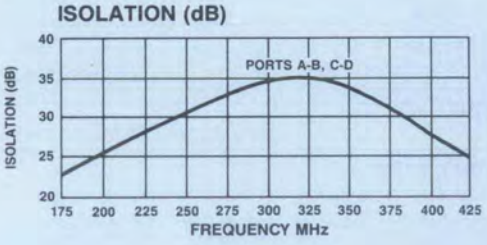
**Average of coupled outputs less 3 dB.

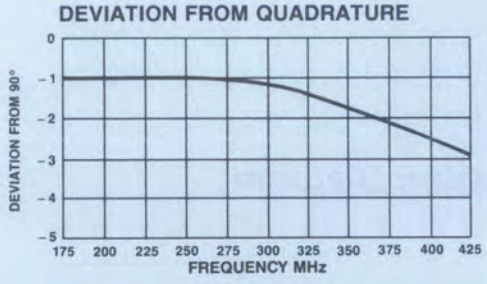
This product contains elements protected by United States Patent Number 3,484,724.

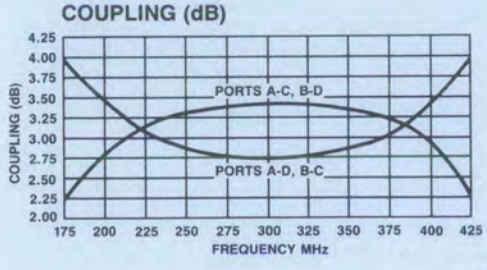
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
JH-142	6959	Pin	$76

Delivery is from stock.

NEW

MODEL JHS-142 — SURFACE MOUNT QUADRATURE HYBRID 200-400 MHz

- Fully Hermetic
- Octave Bandwidth
- Low VSWR — 1.1:1 Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	200-400 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @ 25°C Derated to 1 Watt @ 85°C
Typical Phase Linearity	3° from Straight Line
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

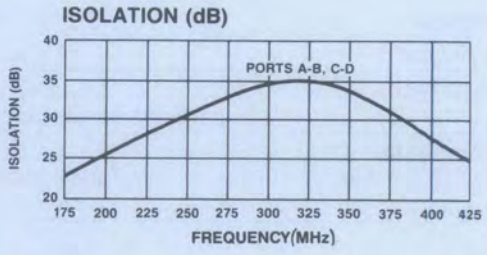
Pin Configuration	A; P1, B; P2, C; P4, D; P3 Case and all other pins are ground

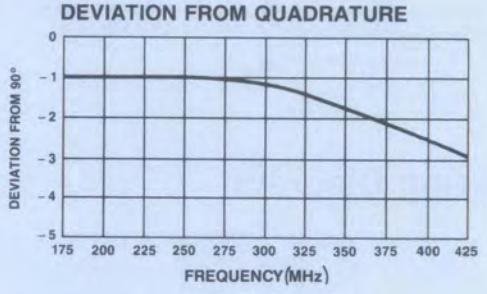
*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

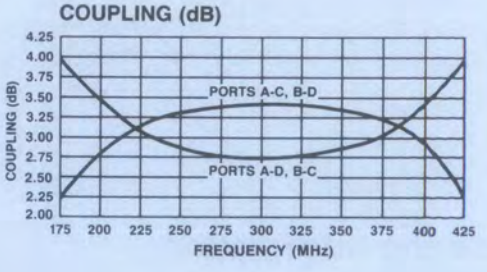
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

Typical Performance







Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
JHS-142	PIN	$81

Delivery is from stock.

MODEL JH-151 — BROADBAND QUADRATURE HYBRID 2.0-10.0 GHz

- Multi-Octave Bandwidth
- 25 dB Typical Isolation
- Removable Connectors on Drop-in Housing

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	2.0-10.0 GHz
Insertion Loss (Less coupling)	0.8 dB Max**
Isolation	18 dB Min
Amplitude Balance	±0.8 dB Max
VSWR	1.50:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	2.5 Watts Max (CW)
Package Type	Connectorized (C-20) (See page 483 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	A; P1, B; P2, C; P4, D; P3. Case ground.

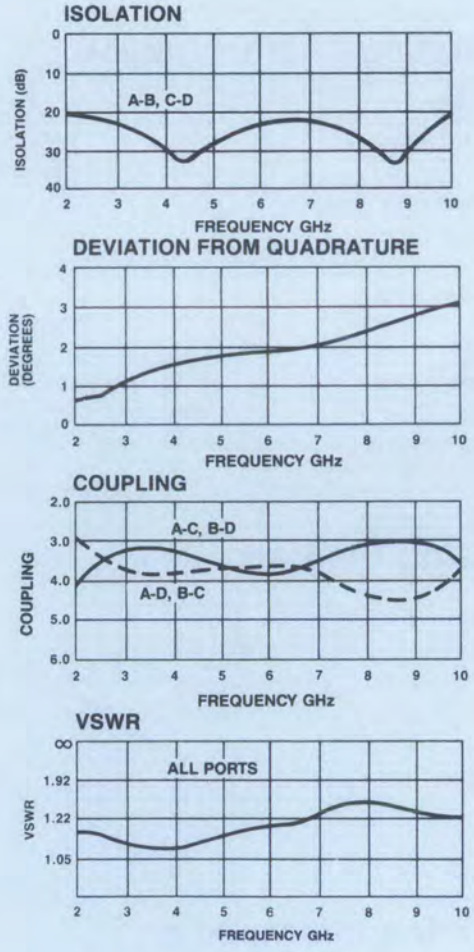
*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB.

Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

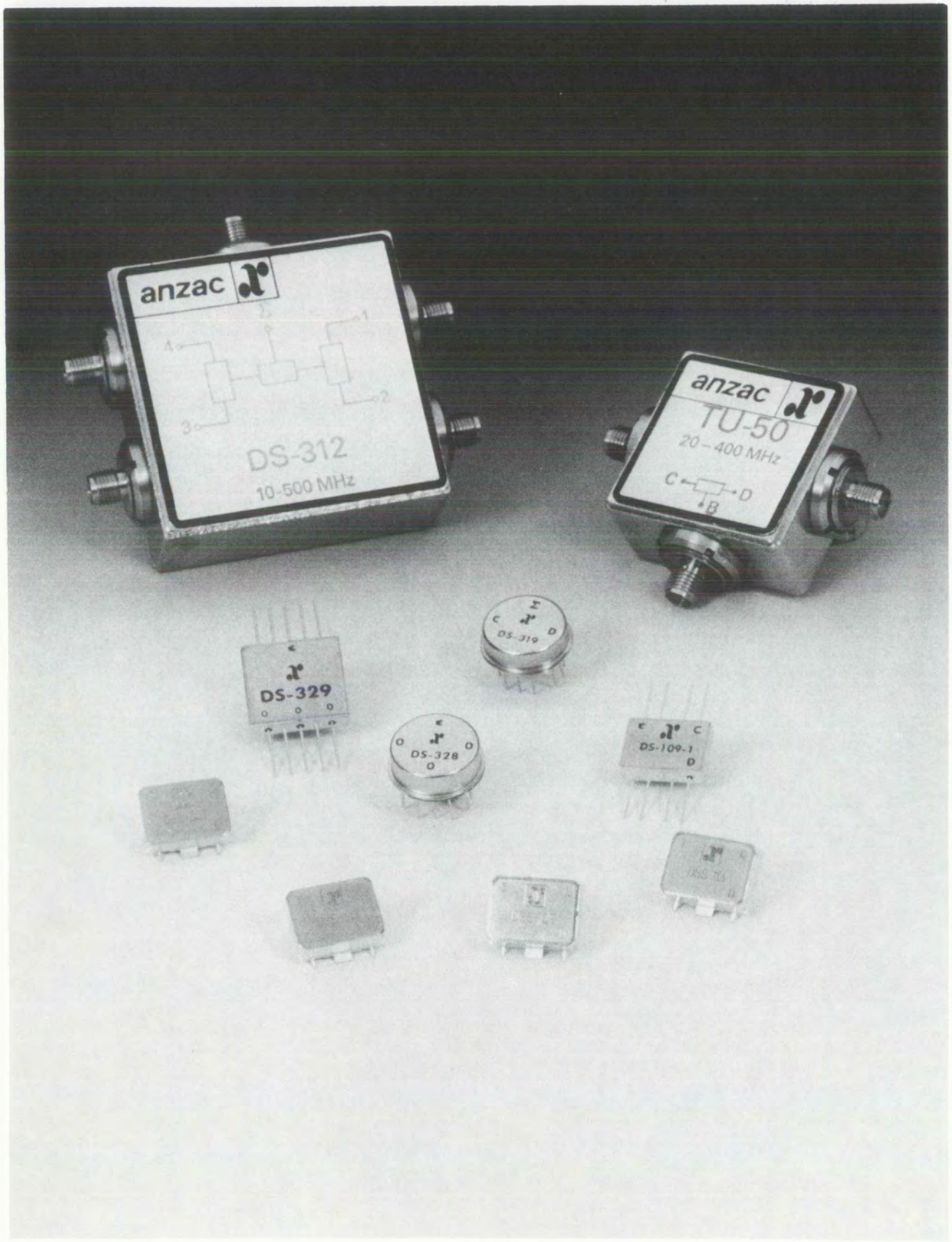
Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (1-9 Units)
JH-151	6634	SMA	335

Delivery is from stock.


anzac
DS-312
10-500 MHz
anzac
TU-50
20 – 400 MHz
C
D
B
DS-329
DS-319
DS-328
DS-109-1

POWER DIVIDER SELECTION GUIDE

MODEL NO.	FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP	ISOLATION (dB) TYP	VSWR TYP	PHASE BALANCE (Deg) TYP	AMPLITUDE BALANCE (dB) TYP	CASE[1] STYLE	PAGE NO.
IN PHASE TWO-WAY POWER DIVIDERS								
MTH-50	1-100	0.15	35	1.05:1	0.5	0.05	TO-5-1	413
THV-50	2-200	0.2	35	1.05:1	0.5	0.1	C-7	414
DS-113	0.4-400	0.15	35	1.05:1	0.5	0.05	FP-2	401
DSS-113	**0.4-400**	**0.15**	**35**	**1.05:1**	**0.5**	**0.1**	**SF-1**	402
TU-50	20-400	0.3	40	1.1:1	1	0.1	C-7	414
MTV-50	40-400	0.4	40	1.2:1	1	0.1	TO-5-1	413
DS-318	5-500	0.3	30	1.15:1	1	0.1	RH-1	405
DS-109	10-500	0.2	40	1.05:1	0.5	0.05	FP-2	400
DSS-333	**10-500**	**0.2**	**40**	**1.05:1**	**0.5**	**0.05**	**SF-1**	410
DS-319	10-500	0.2	40	1.05:1	0.5	0.05	TO-8-2	400
DS-327	5-1000	0.3	35	1.1:1	1.5	0.1	FP-2	406
DSS-327	**5-1000**	**0.3**	**25**	**1.25:1**	**1.5**	**0.15**	**SF-1**	407
T-1000	10-1000	0.3	45	1.1:1	1	0.1	C-7	415
DS-331	750-1500	0.3	20	1.25:1	2	0.1	TO-8-2	408
H-8-4	2-2000	0.5	35	1.1:1	1	0.05	C-19	411
DS-313	10-2000	0.6	28	1.15:1	2	0.1	FP-2	403
DSS-313	**10-2000**	**0.6**	**28**	**1.15:1**	**2**	**0.1**	**SF-1**	404
DS-332	1000-2000	0.25	20	1.25:1	2	0.1	TO-8-2	409
180° TWO-WAY POWER DIVIDERS								
H-81-4	5-1000	0.6	25	1.15:1	2	0.1	C-19	412
IN PHASE THREE-WAY POWER DIVIDERS								
M3H-50	1-100	0.25	55	1.05:1	0.5	0.1	TO-5-2	419
DS-117	1-300	0.3	45	1.05:1	2	0.2	FP-3	416
DS-308	1-300	0.3	45	1.05:1	2	0.2	C-8	416
M3V-50	50-300	0.4	40	1.10:1	1	0.1	TO-5-2	419
DS-328	3-700	0.3	30	1.2:1	3	0.2	TO-8-2	418
DS-329	3-700	0.3	30	1.2:1	3	0.2	FP-3	418
DS-323	25-1000	0.3	35	1.3:1	2.0	0.3	FP-3	417
IN PHASE FOUR-WAY POWER DIVIDERS								
4H-50-4	2-50	0.2	40	1.05:1	1	0.1	C-14	425
DS-310	0.2-300	0.2	35	1.05:1	2	0.1	FP-5	421
DS-112	10-500	0.5	35	1.1:1	2	0.1	FP-5	420
DS-312	10-500	0.5	35	1.1:1	3	0.2	C-14	420
DS-324	25-1000	0.5	35	1.15:1	2	0.1	FP-5	422
DS-4-4	2-2000	0.5	30	1.05:1	2	0.5	C-17	424
DS-409-4	10-2000	0.5	30	1.2:1	2	0.1	C-17	423
IN PHASE EIGHT-WAY POWER DIVIDERS								
DS-309	2-500	0.5	40	1.1:1	1	0.1	C-18	426
DS-808-4	20-2000	1.0	30	1.2:1	2	0.1	C-18	427
SURFACE MOUNT POWER DIVIDERS								
DSS-113	**0.4-400**	**0.15**	**35**	**1.05:1**	**0.5**	**0.1**	**SF-1**	402
DSS-333	**10-500**	**0.2**	**40**	**1.05:1**	**0.5**	**0.1**	**SF-1**	410
DSS-327	**5-1000**	**0.3**	**25**	**1.25:1**	**1.5**	**0.15**	**SF-1**	407
DSS-313	**10-2000**	**0.6**	**28**	**1.15:1**	**2**	**0.1**	**SF-1**	404

[1] CASE STYLE: C = CONNECTORIZED: FP = FLATPACK; TO-5 = TO-5 PLUG-IN; TO-8 = TO-8 PLUG-IN; SF = SURFACE MOUNT
BOLD = NEW PRODUCT
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

POWER DIVIDERS

INTRODUCTION

A power divider is ideally a lossless reciprocal device which can also perform vector summation of two or more signals and thus is sometimes called a power combiner or summer. Two forms of power dividers are considered in this discussion; binary and N-way. A binary power divider is composed of one or more terminated 180° hybrids and may have 2, 4, 8, 16, --- 2^k outputs. An N-way power divider has an odd number of outputs, generally 3, and utilizes Anzac's unique patented transformer circuit for frequencies below 1 GHz. Although power dividers could be composed of 90° hybrids the term normally refers to a device that splits an input signal into two or more in-phase outputs. The purpose of this article is to provide the designer with basic information describing the function of these devices and to define the performance parameters and trade-offs critical to specifying a power divider.

FUNCTIONAL DESCRIPTION

Binary Power Dividers

A binary power divider is in fact an internally terminated 180° hybrid and thus much of the material covered in the discussion of 180° hybrids on pages 354 to 359 is pertinent. Figure 1 shows the standard diagram for a 180° hybrid with a termination at Port A.

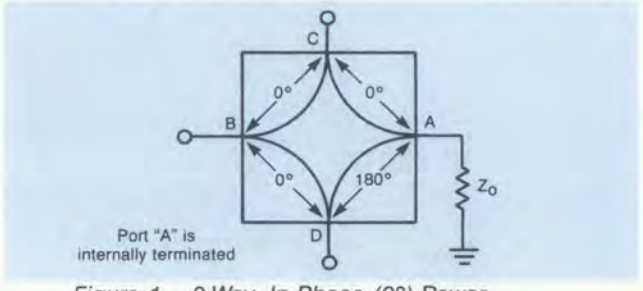


Figure 1. 2-Way, In-Phase (0°) Power Divider/Summer, or ISO-T

Physically the 2-way power divider appears to be a three terminal device, since the Z_O termination at Port A is normally mounted inside the package. Also, although a conventional 180° hybrid can be used as a power divider, the usual form of 2-way power divider does not have a Z_O impedance level at all four ports. Figure 2 shows a simplified schematic for a transformer design realization of a 2-way power divider together with impedance, voltage and current levels. Elements such as shunt capacitors used to tune out the parasitic elements of non-ideal transformers are not shown.

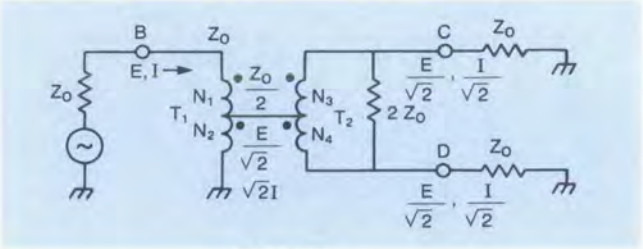


Figure 2.

The internal termination shown as Z_O to ground on Port A in Figure 1 is actually realized by connecting a termination equal to $2\,Z_O$ between ports C and D. This structure is utilized because of its greater simplicity and the fact Port A, the difference port, does not need to be used externally. Port A can be thought of as a balanced output of impedance $2\,Z_O$ which has been terminated. T_1 is an autotransformer which steps the Z_O impedance at Port B down to $Z_O/2$ at its tap. Its turns ratio must be equal to the square root of the desired impedance ratio; Thus:

$$\frac{N_2}{N_1 + N_2} = \sqrt{\frac{Zo/2}{Z_O}} = \frac{1}{\sqrt{2}}$$

In practice a turns ratio approximating this value is used. T_2 is a center tapped transformer therefore $N_3 = N_4$ and thus:

$$Z_{C\text{-}D} = \left(\frac{N_3 + N_4}{N_4}\right)^2 \frac{Z_O}{2} = \frac{2^2 Z_O}{2} = 2\,Z_O$$

The use of an internal termination of $2\,Z_O$ satisfies the required conditions for impedance match at all ports.

Higher order binary power dividers, such as 4-way and 8-way power dividers, are realized by cascading 2-way dividers of various circuit configurations. The functional diagram for a 4-way divider is shown in Figure 3 while the 8-way diagram would simply have the "B" port of additional 2-way dividers connected at ports 1, 2, 3, and 4.

N-Way Dividers

Power dividers having an odd number of outputs, 3, 5, 7, etc. are sometimes classified as N-way power dividers. Because of the complexity of higher order circuits, the 3-way power divider is the only type of this class of divider normally used. The circuit actually used to realize a true 3-way divider, as opposed to a terminated 4-way power divider, is a unique transformer circuit covered by Anzac's U.S. patent number 3,428,920. It is beyond the scope of this article to review in detail the transformer operation of this circuit, however,

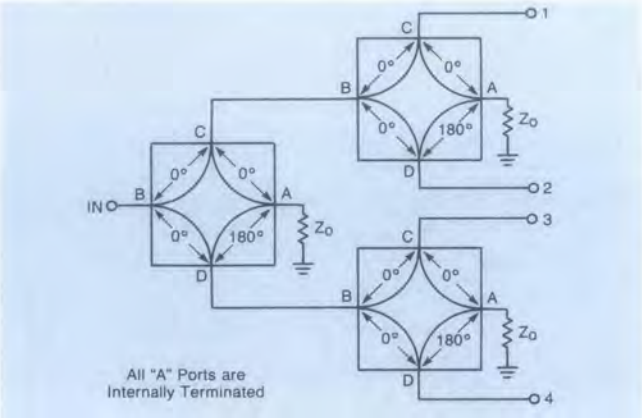


Figure 3. 4-Way Divider Functional Diagram

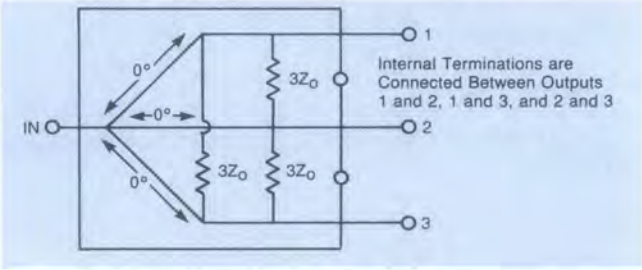


Figure 4. 3-Way Power Divider Functional Diagram

Figure 4 shows a functional diagram of a 3-way power divider.

The transformer circuit is interconnected in such a manner as to produce three mutually isolated outputs. Three internal terminations of value 3 Z_0 must be connected between ports 1 and 2, 1 and 3, and 2 and 3 in order to maintain port match and port-to-port isolation. We can see the operation of the divider by considering signals injected at two ports.

First, if we inject a signal at the input with outputs 1, 2, and 3 loaded in Zo, three equal phase and amplitude outputs appear at ports 1, 2, and 3. Since all signals are equal, no voltage differential appears across the internal terminations and thus no power is dissipated in them.

In the second case if we inject a signal at output 1 with all other ports terminated in Z_0, ⅓ of the current will flow in the 3 Z_0 internal terminations connected between ports 1 and 2, and 1 and 3, and ⅓ will flow directly into the transformer connection at port 1. The power injected is I^2 Z_0 while the power dissipated in each of the internal terminations is $(I/3)^2$ (3 Z_0) = ⅓ I^2 Z_0. Thus ⅔ of the power is lost in the internal loads and ⅓ appears at the input. This satisfies the requirement for a lossless reciprocal device.

Performance Parameters

The performance parameters previously defined for 180° and 90° hybrids on page 356 apply equally to power dividers. The critical parameters in selecting a power divider are normally frequency range, insertion loss, isolation and VSWR. In addition to these parameters the following two parameters are often specified and are related to the power rating of the internal load resistors.

Matched Power Rating Or Input Power

This is the highest power level that can be applied to the input and still maintain other performance limits. It is stated with Z_0 terminations on all outputs to avoid reflected signals from unbalanced loads which may exceed the limit for power dissipation in the internal terminations.

Internal Load Dissipation

This is simply the power rating of any one of the internal terminations. These two parameters are related and the input power rating is normally several times larger than the internal load dissipation. The reason for this is intuitively obvious since most of the input power is delivered to the output loads not the internal termination.

There are three considerations affecting the amount of input power that a power divider can withstand.

I. Insertion Loss

The first consideration is the total power dissipated in the power divider. Total power dissipation in a power divider under matched conditions can be determined to a reasonable approximation from the insertion loss and the known input power as follows:

$$\text{Insertion Loss (dB)} = 10 \log \frac{P_{IN}}{P_{OUT}}$$

Therefore:

$$P_{OUT} = \frac{P_{IN}}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}$$

$$P_{Dissipated} = P_{IN} - P_{OUT}$$

$$= P_{IN} - \frac{P_{IN}}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}$$

$$= P_{IN}\left(1 - \frac{1}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}\right)$$

As an example consider a power divider with the following conditions:

$$\text{Ins. Loss} = 0.5 \text{ dB}$$

$$P_{IN} = 2 \text{ Watts}$$

$$P_{Dissipated} = 2\left(1 - \frac{1}{\frac{.5}{10}}\right)$$

$$= .218 \text{ Watts}$$

Most of this power will be dissipated in the wire and ferrite cores making up the transformer circuits and not in the internal load.

II. Amplitude Balance

A second consideration for input power dissipation in a power divider operating under matched conditions is the power that is dissipated in the internal load. If we consider a 2-Way power divider similar to that shown in Figure 3, we observe that ideally no power would be dissipated in the 2 Z_0 load between Ports C and D because the voltages at C and D would be equal. In practice a small differential may occur because of imperfect Amplitude Balance. The approximate dissipation due to this unbalance can be calculated from the following:

Let Voltage at Port C = V_C
Let Voltage at Port D = V_D
Let Power at Port C = P_C
Let Power at Port D = P_D

If we make the simplifying assumption:

$$P_D = \frac{V_D^2}{Z_0} \cong \frac{P_{OUT}}{2}$$

then 1)

$$V_D \cong \sqrt{\frac{P_{OUT\ (Z_0)}}{2}}$$

The relationship for Amplitude Balance is as follows:

$$\text{Amp Bal (dB)} = 10 \text{ Log } \frac{P_c}{P_d} = 20 \text{ Log } \frac{V_c}{V_d}$$

$$\text{Therefore } V_C = V_D\ 10^{\left(\frac{\text{Amp Bal}}{20}\right)}$$

$$\text{and } V_C - V_D = V_D\ 10^{\left(\frac{\text{Amp Bal}}{20}\right)} - V_D$$

$$= V_D\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)$$

Substituting from 1)

2) $$V_C - V_D \cong \sqrt{\frac{P_{OUT\ (Z_0)}}{2}}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)$$

This gives the voltage drop across the internal termination of 2 Z_0 between C and D. The power dissipated in this load is then given by the following:

$$P_{INT\ LOAD} = \frac{(V_C - V_D)^2}{2\ Z_0}$$

$$\cong \frac{1}{2\ Z_0}\left[\sqrt{\frac{P_{OUT\ (Z_0)}}{2}}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)\right]^2$$

or 3)

$$P_{INT\ LOAD} \cong \frac{P_{OUT}}{4}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)^2$$

A very small amount of power is normally dissipated due to this effect. Consider the following example:

Let

$$P_{OUT} = 2 \text{ Watts}$$

$$\text{Amp Bal} = .25 \text{ dB}$$

$$P_{INT\ LOAD} \cong \tfrac{1}{2}\left(10^{\frac{.25}{20}} - 1\right)^2$$

$$= 0.4 \text{ mW}$$

III. The third and perhaps most important case to consider when determining input power limits is the condition of mismatched loads at the outputs of the power divider. Reflections from these mismatches can cause a considerably larger voltage differential to appear across the internal load. If the VSWR of the two loads is K_1 and K_2 the limit on input power P_{IN}, is given in the following:

$$P_{IN} \leqslant \frac{\text{Internal Load Rating (Watts)}}{\left[\frac{K_1 - 1}{K_1 + 1}\right]^2 + \left[\frac{K_2 - 1}{K_2 + 1}\right]^2}$$

As an example, if the internal load rating is 0.5 Watts and the VSWR of K_1 and K_2 is 2.0:1 then:

$$P_{IN} \leqslant \frac{0.5}{\left[\frac{2 - 1}{2 + 1}\right]^2 + \left[\frac{2 - 1}{2 + 1}\right]^2}$$

$$\leqslant 2.25 \text{ Watts}$$

This is the worst case formula, which assumes that the two load reflections are out of phase at the output port. If they are identical impedances P_{IN} may be several times larger without causing damage.

From the preceeding discussion of power divider input power ratings, we can draw two conclusions:

1. Under matched loading conditions (Z_0 terminations at all ports) the input power is limited by heating effects in the ferrite transformers not by the internal load dissipation. Absolute maximum temperatures for ferrite core transformers are limited by the curie temperature of the ferrite, generally in 130°C to 500°C range, and the temperature rating of the magnet wire which is usually 130°C. It is advisable to stay well below these temperature limits (20°C or more) to avoid performance degradation; particularly increased insertion loss. The actual temperature rise in the ferrite core is dependent on the heat transfer path from the core to the heat sink or surrounding air. This determination involves measuring or calculating the thermal resistance, θ expressed in °C/Watt of this path. Thermal resistance will be highly dependent on the mounting of the power divider as well as its internal construction. For this reason, manufacturers normally provide a very conservative maximum input power rating that applies under absolute worst case conditions with no specific heatsinking of the unit. In many instances powers several times higher than this rating can be applied with little, if any, performance degradation.

2. Under conditions where mismatches are present at the power divider output, the internal load power dissipation rating may limit the input power than can be applied. A simple worst case calculation can be performed to determine if this is the case using the formula provided.

A final point relative to power ratings that should be considered is the application as a power summer. In this case signals are applied to the ports we have been calling outputs (for example Ports C and D in Figure 2) with the vector sum appearing at the input or Σ port (Port B in Figure 2). In this case equal signals are normally applied and little if any power is dissipated in the internal load. A possible condition may occur where one or more of the signal sources fails or is removed. For example, if two equal sources are applied at Ports C and D and the source at D fails, 50% of the power supplied by the source at C will be dissipated in the $2\ Z_0$ internal load. Thus the power injected at each port should not exceed twice the rating of the internal load to avoid this condition.

Performance Trade-offs

Since power dividers are low loss passive devices, few trade-offs in performance are possible once the frequency range is selected. One trade-off that is sometimes possible is between isolation and VSWR. If we consider the 2-way divider schematic of Figure 2, we see that an internal load of $2\ Z_0$ is shown between Ports C and D. This is correct for an ideal lossless transformer circuit, however the actual transformers have parasitic dissipative and reactive elements. For this reason the value of the $2\ Z_0$ load is sometimes varied and additional small amounts of shunt capacitance and series inductance are added in an attempt to optimize VSWR and isolation. The optimum compensation for isolation is often slightly different than that required for VSWR. In fact, it is possible over limited frequency ranges to improve isolation by in effect "balancing the bridge" while VSWR may be slightly degraded.

CONCLUSIONS

Power dividers are often considered the simplest of the many RF devices that may be required in designing a system and in some respects this is true. Despite the functional simplicity of power dividers and generally rugged and reliable components used in their construction, their specification and application in systems can still lead to unexpected problems.

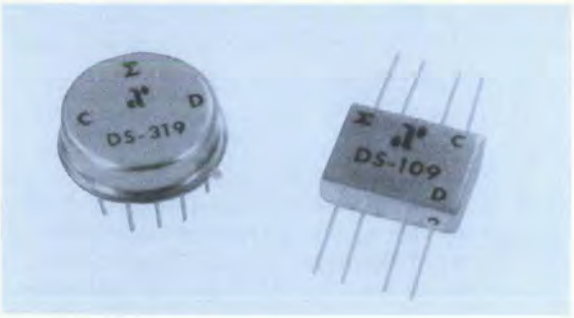
In this article we have presented some basic information to give the system designer insight into the internal construction of power dividers and how this influences the operation of the device and its function in the real world of imperfect matches and less than ideal physical installation. On this latter point, the consideration of power dividers was dealt with both analytically and in terms of expected results in the normally mounted configuration. The devices described in this article are generally intended for receive rather than transmit applications and are thus quite conservatively rated for power handling. Care must be taken, however, in using them at higher powers because both internal designs and external mounting provisions are not optimally suited for heat transfer.

Many of the points made and expressions derived for the operation of 180° hybrids can be applied to power dividers, particularly 2 way power dividers and questions that may arise pertaining to points not covered in this article such as isolation in the presence of mismatch or other signal flow relationships can be analyzed by reference to the tables contained in that article.

MODELS DS-109/319

TWO-WAY POWER DIVIDER
10-500 MHz

- 1° Phase Balance Max
- 35 dB Typical Midband Isolation
- 1.1 Typical Midband VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	DS-109	DS-319
Frequency Range	10-500	10-500 MHz
Insertion Loss (Less coupling)		
10-200 MHz		0.6 dB Max
10-500 MHz	0.6	0.9 dB Max
Isolation	25	25 dB Min
Amplitude Balance		
10-200 MHz		0.15 dB Max
10-500 MHz	0.15	0.2 dB Max
Phase Balance	1°	1° Max
VSWR (All Ports)		
10-200		1.3:1 Max
10-500	1.3:1	1.6:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Package Type	DS-109 Flatpack (FP-2) DS-319 Pin (TO-8-2) (See pages 474 and 472 for physical dimensions.)

Environmental

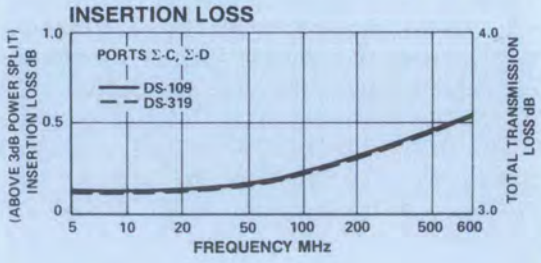
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 the Adams-Russell catalog.

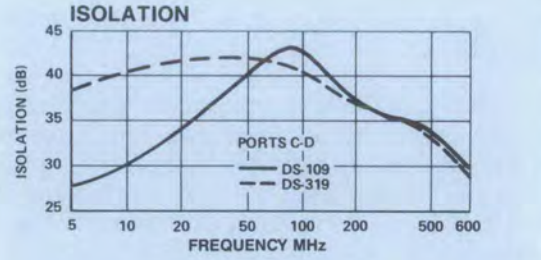
Pin Configuration

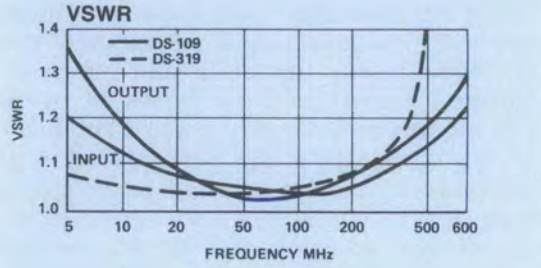
DS-109	ΣIN; P1, Output C; P4, Output D; P8, Case and all other pins ground.
DS-319	ΣIN; P5, Output 'C'; P8, Output 'D'; P2 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







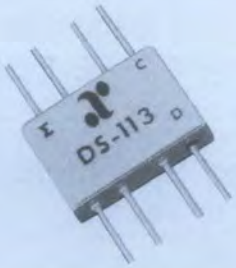
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-109	9829	Pin	$29
DS-319	8809	Pin	22

Delivery is from stock.

MODEL DS-113 — FLATPACK TWO-WAY POWER DIVIDER 400 kHz-400 MHz

- Three Decade Bandwidth
- Low Loss — 0.25 dB Typically



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	0.4-400 MHz
Insertion Loss (Less coupling)	0.75 dB Max
Isolation	25 dB Min
Amplitude Balance	0.15 dB Max
Phase Balance	1.0° Max
VSWR (All Ports)	1.5:1 Max

Operating Characteristics

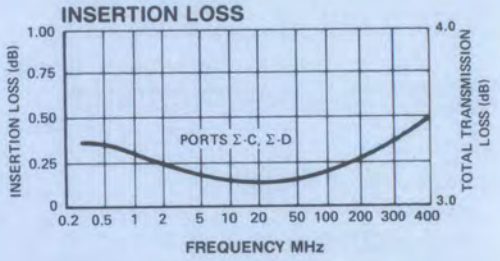
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

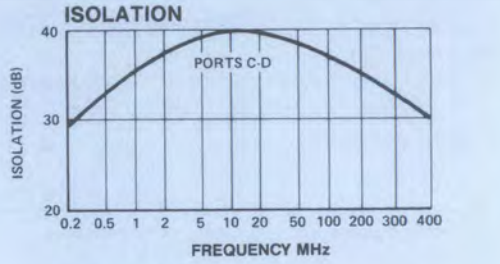
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

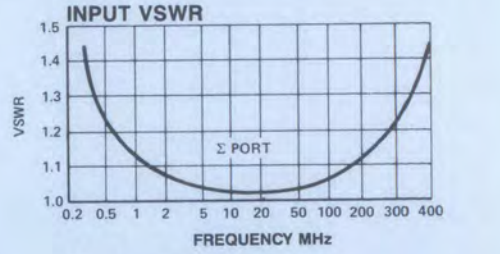
Pin Configuration	Σ; P1, Output 'C'; P4; Output 'D'; P8 Case and all other pins ground.

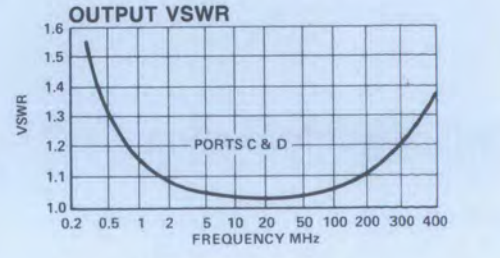
*All specifications apply with 50 ohm source and load impedance.

Typical Performance









Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-113	9929	Pin	$45

Delivery is from stock.

NEW

MODEL DSS-113

SURFACE MOUNT TWO-WAY POWER DIVIDER 400 kHz - 400 MHz

- Fully Hermetic Package
- Three Decade Bandwidth
- Low Loss — 0.25 dB Typically

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range	0.4-400 MHz
Insertion Loss (Less Coupling)	0.75 dB Max
Isolation	25 dB Min
Amplitude Balance	0.15 dB Max
Phase Balance	1.5 Max
VSWR (All Ports)	1.6:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

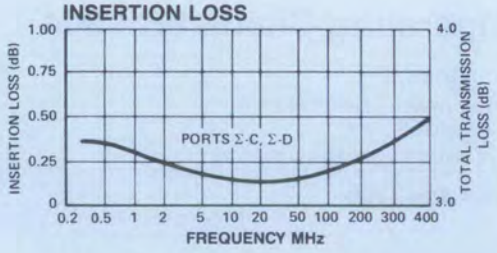
Environmental

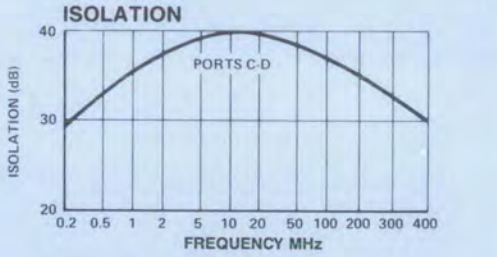
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

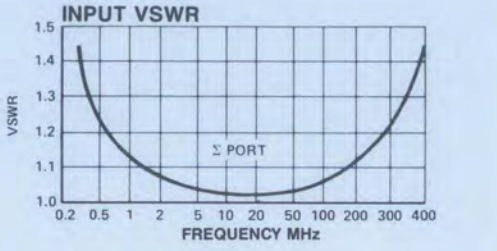
Pin Configuration	Σ ; P1, Output C; P2 Output D; P4 Case and all other pins ground.

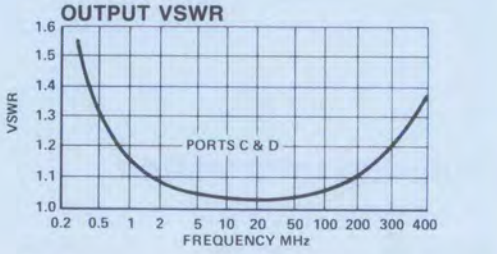
*All specifications apply with 50 ohm source and load impedance

Typical Performance









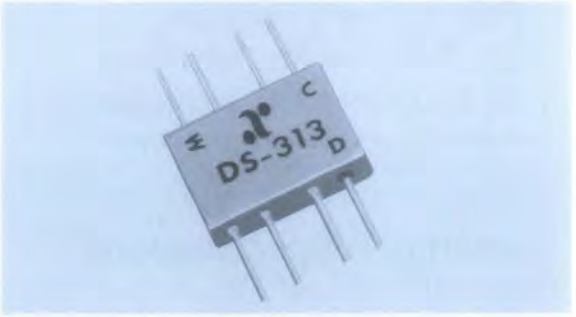
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
DSS-113	PIN	$50

Delivery is from stock.

MODEL DS-313 TWO-WAY IN-PHASE POWER DIVIDER 10-2000 MHz

- 0.6 dB Typical Midband Loss
- 28 dB Typical Midband Isolation
- 1.2:1 Typical Midband VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss (Less coupling)	20-1000 MHz	1.1 dB Max
	10-1500 MHz	1.3 dB Max
	1500-2000 MHz	1.8 dB Max
Isolation	20-1000 MHz	23 dB Min
	10-1500 MHz	18 dB Min
	1500-2000 MHz	12 dB Min
Amplitude Balance	20-1000 MHz	0.3 dB Max
	10-1500 MHz	0.4 dB Max
	1500-2000 MHz	0.6 dB Max
Phase Balance	20-1000 MHz	4° Max
	10-1500 MHz	6° Max
	1500-2000 MHz	8° Max
VSWR (All Ports)	20-1000 MHz	1.5 Max
	10-1500 MHz	1.6 Max
	1500-2000 MHz	1.8 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	250 mW Max
Internal Load Dissipation	50 mW Max
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

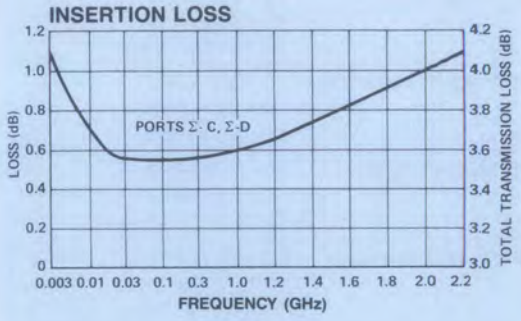
Environmental

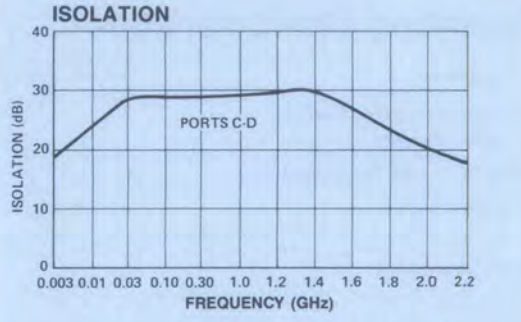
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

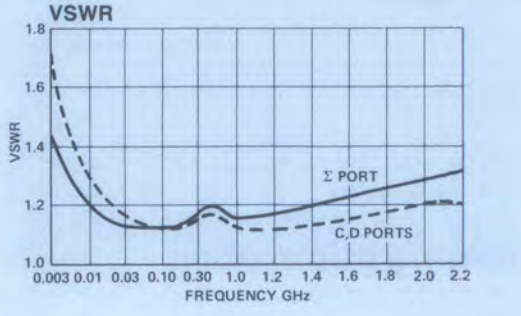
Pin Configuration Σ; P1, Output 'C'; P4, Output 'D'; P8 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-313	8559	Pin	$67

Delivery is from stock.

MODEL DS-318 PLUG-IN TWO-WAY POWER DIVIDER 5-500 MHz

- Low Cost
- Convenient Plug-In Mounting

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-500 MHz
Insertion Loss	10-200 MHz	0.5 dB Max
(Less coupling)	5-500 MHz	1.0 dB Max
Isolation		18 dB Min
Amplitude Balance		0.2 dB Max
Phase Balance		2° Max
VSWR (All Ports)		1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.125 Watts Max
Package Type	Relay Header (RH-1) (See page 472 for physical dimensions.)

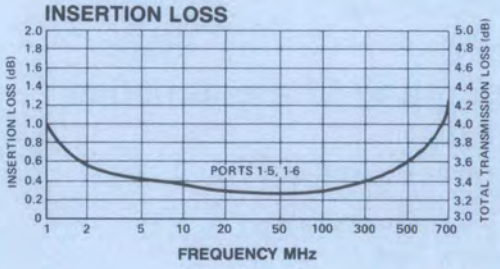
Environmental

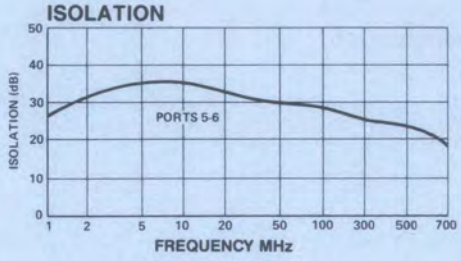
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

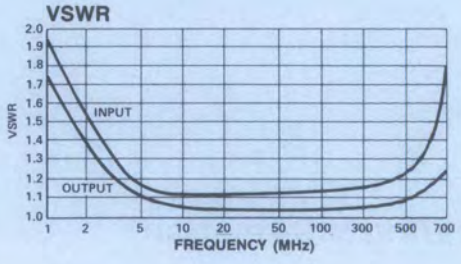
Pin Configuration	Σ; P1, Outputs P5 & P6, All other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







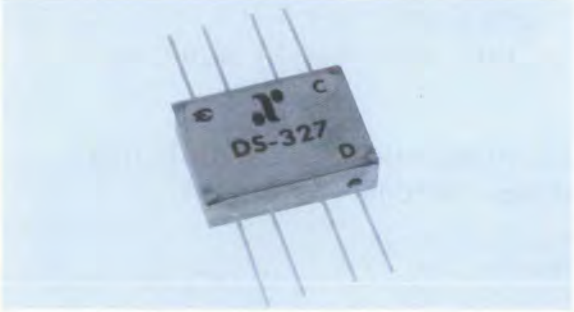
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-318	9919	Pin	$22

Delivery is from stock.

MODEL DS-327 FLATPACK TWO-WAY POWER DIVIDER 5-1000 MHz

- Broadband, IN Phase Divider
- Low Loss — 0.3 dB Typical
- Amplitude Balance — 0.05 dB Typical



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss (Less coupling)	5-500 MHz 500-1000 MHz	0.5 dB Max 1.0 dB Max
Isolation	5-500 MHz 500-1000 MHz	25 dB Min 20 dB Min
Amplitude Balance	5-1000 MHz	0.2 dB Max
Phase Balance	5-500 MHz 500-1000 MHz	2° Max 3° Max
VSWR (All Ports)	10-500 MHz 5-1000 MHz	1.3:1 Max 1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watt Max
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

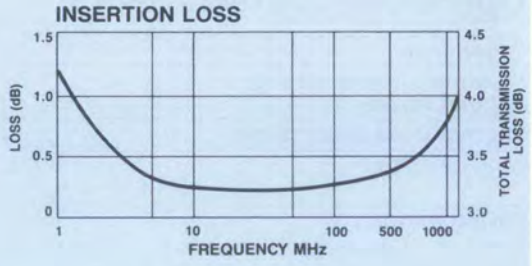
Environmental

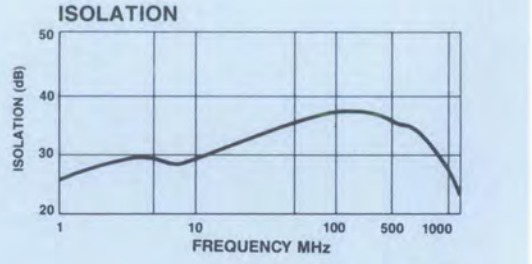
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

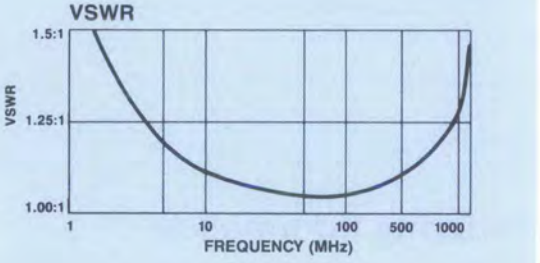
Pin Configuration	Σ; P1, Output 'C'; P4, Output 'D'; P8 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

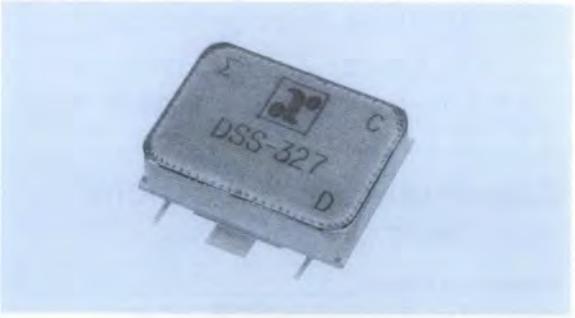
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-327	6699	Pin	$58

Delivery is from stock.

NEW

MODEL DSS-327 SURFACE MOUNT TWO-WAY POWER DIVIDER 5-1000 MHz

- Fully Hermetic Package
- Low Loss — 0.3 dB Typical
- Amplitude Balance — 0.05 dB Typical



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss	5-500 MHz	0.5 dB Max
	500-1000 MHz	1.0 dB Max
Insertion Loss (Less coupling)	5-500 MHz	20 dB Min
	500-1000 MHz	16 dB Min
Amplitude Balance	5-1000 MHz	0.3 dB Max
Phase Balance	5-500 MHz	2° Max
	500-1000 MHz	3° Max
VSWR (All Ports)	5-500 MHz	1.4:1 Max
	500-1000 MHz	1.6:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watt Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

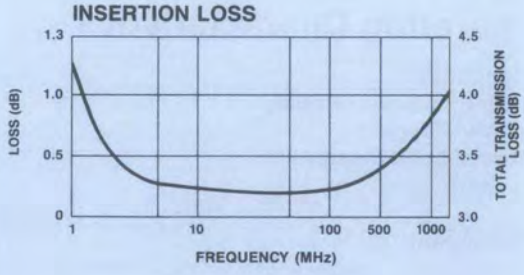
Environmental

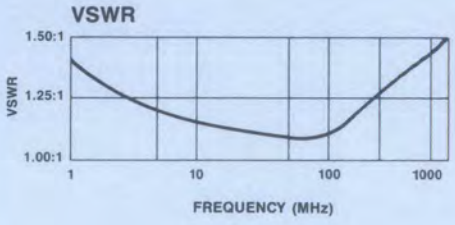
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

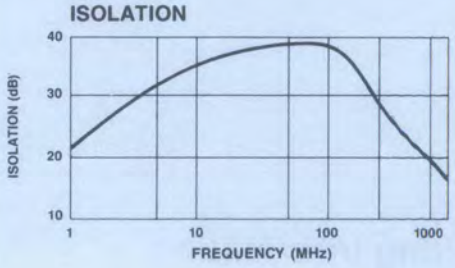
Pin Configuration	Σ; P1, Output 'C'; P2, Output 'D'; P4, P3 & Case ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DSS-327	6159	Pin	$63

Delivery is from stock.

MODEL DS-331 — TWO-WAY POWER DIVIDER
750-1500 MHz

- 2° dB Phase Balance Typical
- 20 dB Typical Midband Isolation
- 1.5:1 Typical Midband VSWR, Input

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	750-1500 MHz
Insertion Loss (Less coupling)	0.4 dB Max
Isolation	10 dB Min
Amplitude Balance	0.2 dB Max
Phase Balance	6° Max
VSWR (All Ports)	
Input	1.7:1 Max
Output	1.3:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.1 Watt Max
Package Type	Pin (TO-8-2) (See page 472 for physical dimensions.)

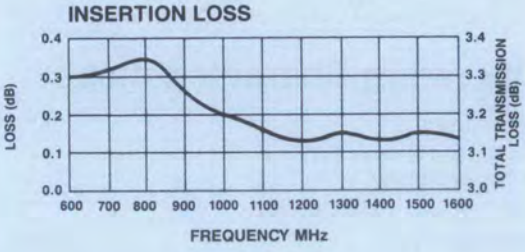
Environmental

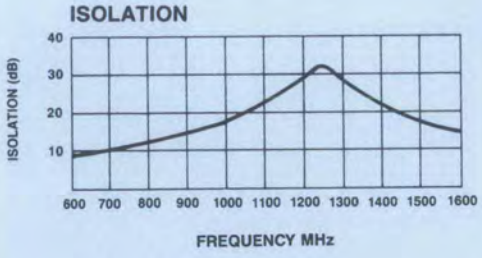
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

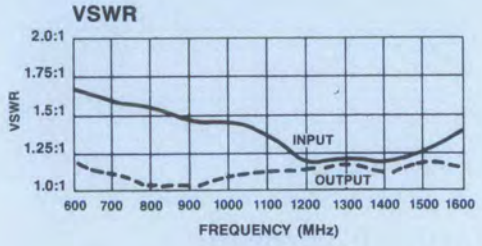
Pin Configuration Σ; P5, Output C; P9, Output D; P1 Pins P2, P4, P6 & P8 are ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-331	8569	Pin	$50

Delivery is from stock.

MODEL DS-332 — TWO-WAY POWER DIVIDER
1000-2000 MHz

- 2° Phase Balance Typical
- 20 dB Typical Midband Isolation
- 1.25:1 Typical Midband VSWR, Input

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	1000-2000 MHz
Insertion Loss (Less coupling)	0.5 dB Max
Isolation	10 dB Min
Amplitude Balance	0.2 dB Max
Phase Balance	6° Max
VSWR (All Ports)	
Input	1.7:1 Max
Output	1.4:1 Max

Operating Characteristics

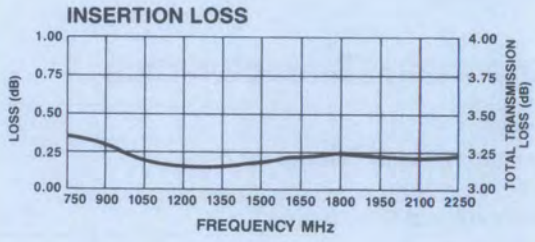
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.1 Watt Max
Package Type	Pin (TO-8-2) (See page 472 for physical dimensions.)

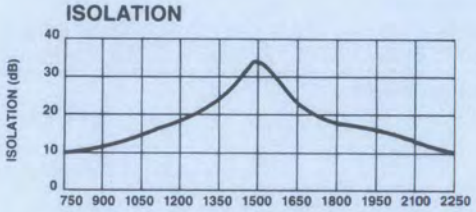
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

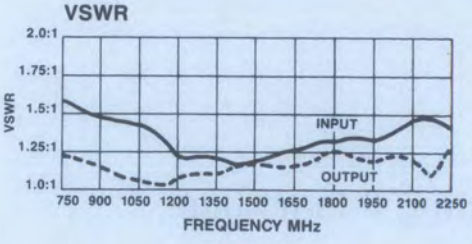
Pin Configuration	Σ; P5, Output C; P9, Output D; P1 Pins P2, P4, P6 & P8 are ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-332	8629	Pin	$55

Delivery is from stock.

NEW

MODEL DSS-333

SURFACE MOUNT TWO-WAY POWER DIVIDER 10-500 MHz

- Fully Hermetic Package
- 0.5° Typical Phase Balance
- 40 dB Typical Midband Isolation
- 1.05:1 Typical Midband VSWR

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range	10-500 MHz
Insertion Loss (Less Coupling) 10-500 MHz	0.6 dB Max
Isolation	25 dB Max
Amplitude Balance 10-500 MHz	0.15 Max
Phase Balance	2° Max
VSWR (All Ports) 10-500 MHz	1.4:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or INput Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Package Type	Surface Mount (SF-1)

(See page 490 for physical dimensions.)

Environmental

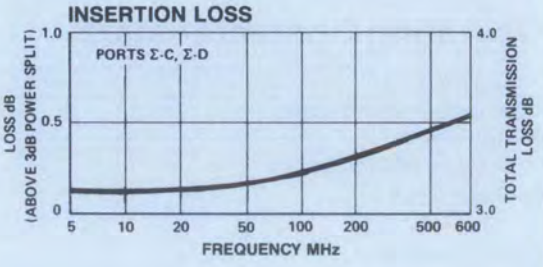
These units are designed to meet the environmental requirements of Table 1A, page 496 of the Adams-Russell catalog.

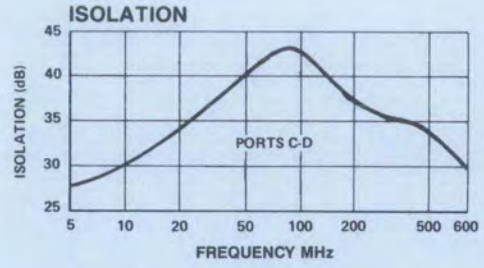
Pin Configuration

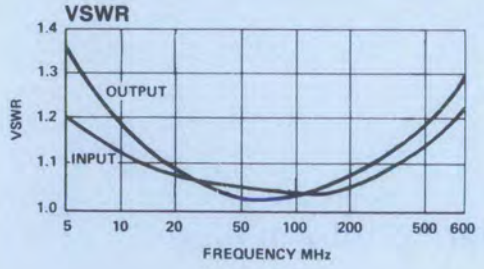
Σ IN P1, Output C; P2
Output D; P4
Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







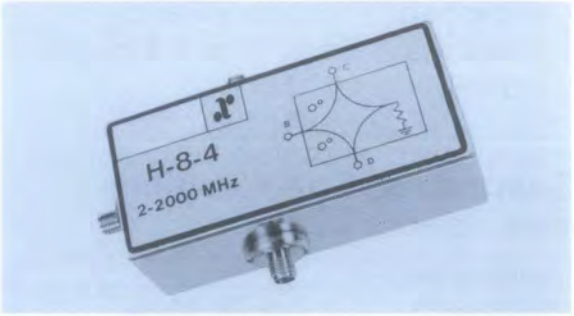
Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
DSS-333	PIN	$45

Delivery is from stock.

MODEL H-8-4 — BROADBAND TWO-WAY POWER DIVIDER 2 MHz-2 GHz

- 11 Octave Coverage
- Low Loss — 1.25 dB Max
- High Isolation — 20 dB Min



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2 MHz-2 GHz
Insertion Loss (Less coupling)	2-10 MHz	1.0 dB Max
	10-1000 MHz	1.0 dB Max
	2 MHz-2 GHz	1.5 dB Max
Isolation	2-10 MHz	20 dB Min
	10-1000 MHz	25 dB Min
	2 MHz-2 GHz	20 dB Min
Amplitude Balance	2-10 MHz	0.1 dB Max
	10-1000 MHz	0.1 dB Max
	2 MHz-2 GHz	0.5 dB Max
Phase Balance	2-1000 MHz	2.5° Max
	2 MHz-2 GHz	5° Max
VSWR (All Ports)	2-10 MHz	2.5:1 Max
	10-1000 MHz	1.3:1 Max
	2 MHz-2 GHz	1.5:1 Max

Operating Characteristics

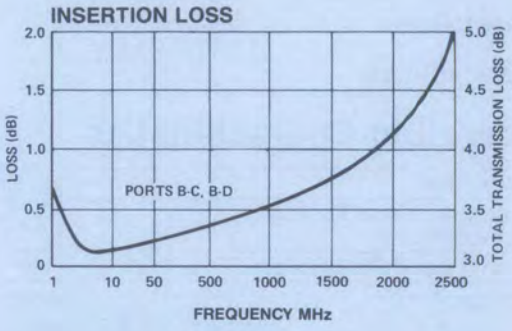
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.0 Watts Max
Internal Load Dissipation	0.5 Watt Max
Package Type	Connectorized (C-19) (See page 483 for physical dimensions.)

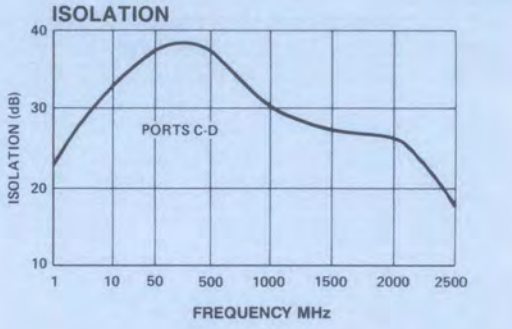
Environmental

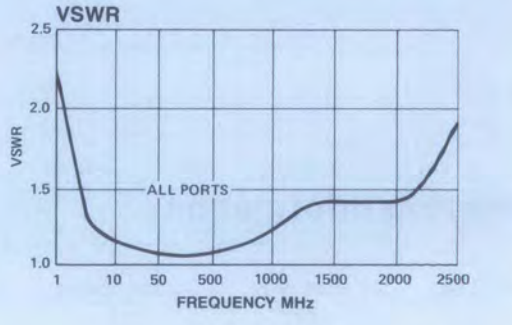
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
H-8-4	8053	N	$216
H-8-4	8054	SMA	$216

Delivery is from stock.

MODEL H-81-4

180° TWO-WAY POWER DIVIDER 5-1000 MHz

- Broadband Frequency Range
- Low Loss — Less Than 1.3 dB Max
- VSWR — 1.4:1 Max

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss (Less coupling)	5-100 MHz 100-1000 MHz	0.7 dB Max 1.3 dB Max
Isolation	5-100 MHz 100-1000 MHz	20 dB Min 25 dB Min
Amplitude Balance	5-100 MHz 100-1000 MHz	0.2 dB Max 0.5 dB Max
Phase Balance	5-100 MHz 100-1000 MHz	5° Max 2.5° Max
VSWR (All Ports)		1.4:1 Max

Operating Characteristics

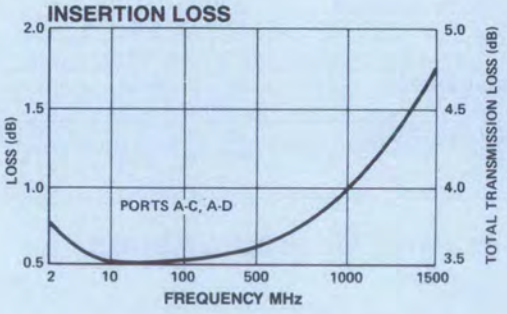
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.0 Watts Max
Internal Load Dissipation	0.5 Watt Max
Package Type	Connectorized (C-19) (See page 483 for physical dimensions.)

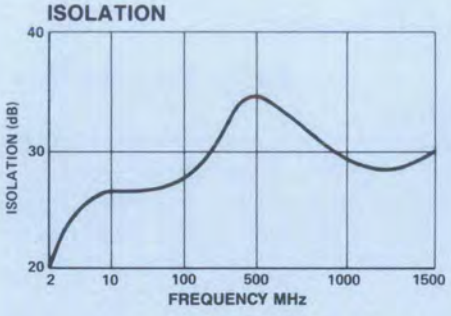
Environmental

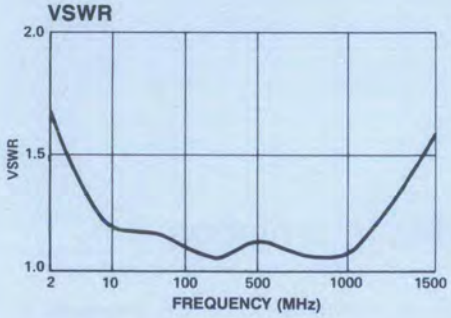
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
H-81-4	8063	N	$225
H-81-4	8064	SMA	225

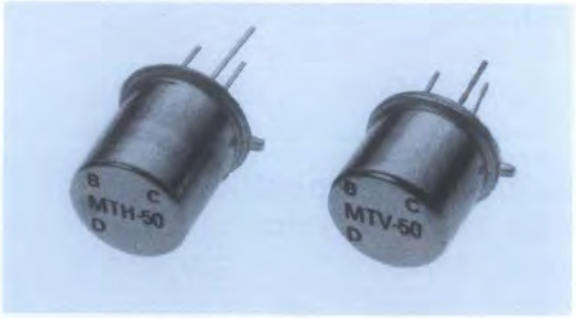
Delivery is from stock.

MODELS MTH-50/MTV-50

TO-5 TWO-WAY POWER DIVIDERS

MTH-50 1-100 MHz MTV-50 40-400 MHz

- Ideal for High Density Packaging
- High Isolation — 30 dB Min
- VSWR — 1.3:1 Max



Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	MTH-50	MTV-50
Frequency Range	1-100	40-400 MHz
Insertion Loss (Less coupling)	0.5	0.6 dB Max
Isolation	30	30 dB Min
Amplitude Balance	0.1	0.2 dB Max
Phase Balance	1.0	2.0° Max
VSWR	1.3:1	1.3:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Package Type	Pin (TO-5-1) (See page 472 for physical dimensions.)

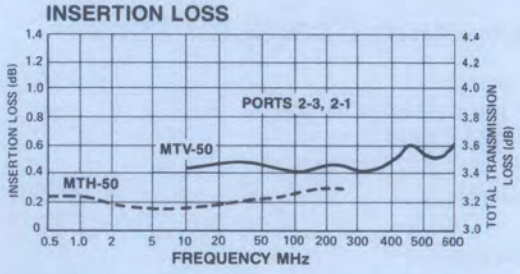
Environmental

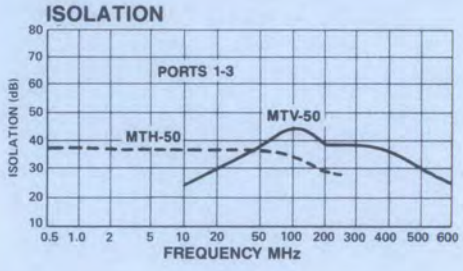
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

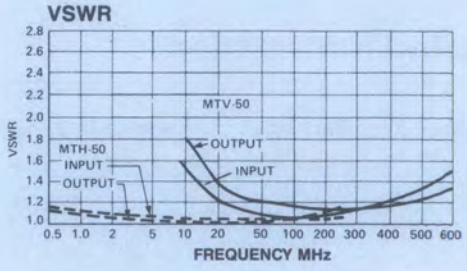
Pin Configuration	IN; P2, Out; P1 & P3 Case Ground

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

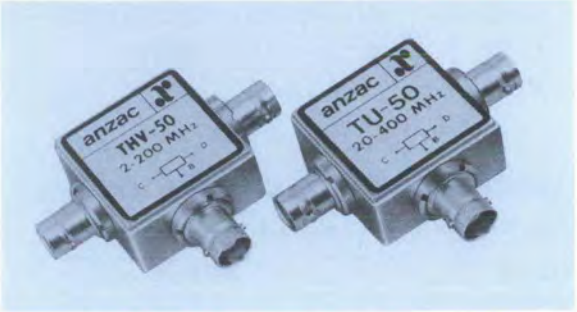
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
MTH-50	9749	Pin	$45
MTV-50	9489	Pin	36

Delivery is from stock.

MODELS THV-50/TU-50

TWO-WAY POWER DIVIDERS
THV-50 2-200 MHz TU-50 20-400 MHz

- Isolation — 30 dB Min
- Loss — 0.5 dB Max
- Low VSWR — 1.3:1 Max



Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	THV-50	TU-50
Frequency Range	2-200	20-400 MHz
Insertion Loss (Less coupling)	0.5	0.5 dB Max
Isolation	30	30 dB Min
Amplitude Balance	0.2	0.2 dB Max
Phase Balance	1.0	2.0° Max
VSWR (All Ports)	1.3:1	1.3:1 Max

Operating Characteristics

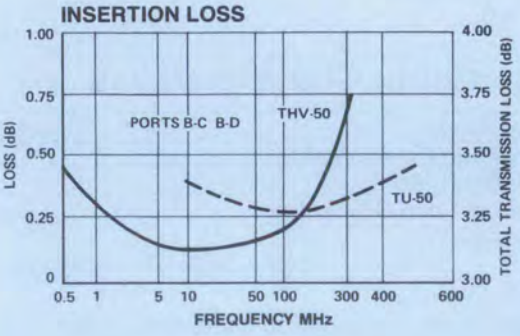
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.5 Watts Max
Internal Load Dissipation	0.5 Watts Max
Package Type	Connectorized (C-7)
	(See page 481 for physical dimensions.)

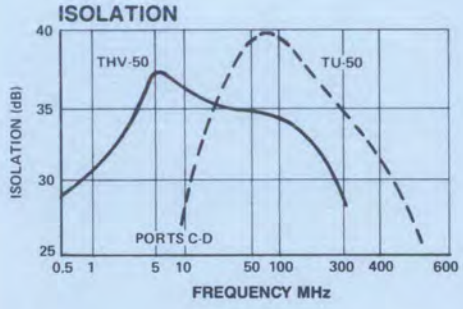
Environmental

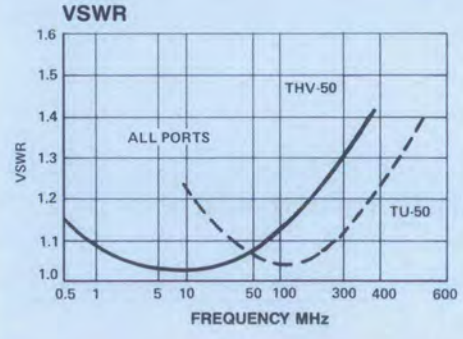
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TU-50	9021	BNC	$72
TU-50	9022	TNC	77
TU-50	9023	N	77
TU-50	9024	SMA	77
THV-50	9011	BNC	77
THV-50	9013	N	81
THV-50	9014	SMA	81

Delivery is from stock.

MODEL T-1000

TWO-WAY POWER DIVIDER
10-1000 MHz

- Broadband Frequency Range
- Isolation — 25 dB Min
- Insertion Loss — 0.8 dB Max

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-1000 MHz
Insertion Loss (Less coupling)	10-500 MHz 500-1000 MHz	0.5 dB Max 0.8 dB Max
Isolation		25 dB Min
Amplitude Balance		0.2 dB Max
Phase Balance		2° Max
VSWR (All Ports)	10-500 MHz 500-1000 MHz	1.5:1 Max 1.3:1 Max

Operating Characteristics

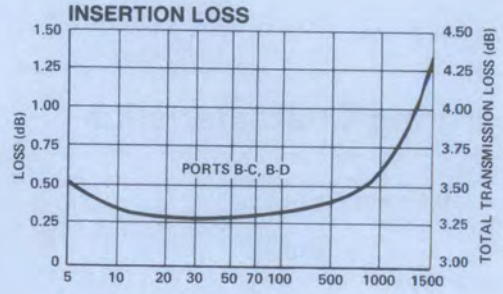
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.5 Watts Max
Internal Load Dissipation	0.5 Watts Max
Package Type	Connectorized (C-7) (See page 481 for physical dimensions.)

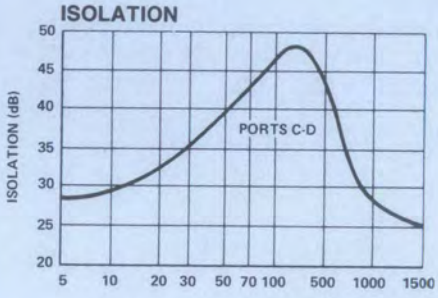
Environmental

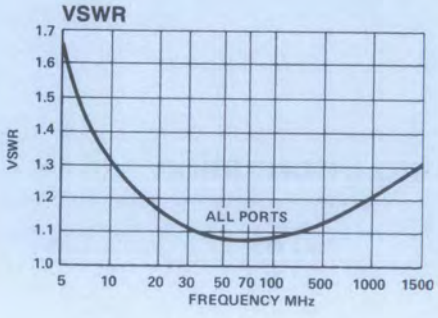
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

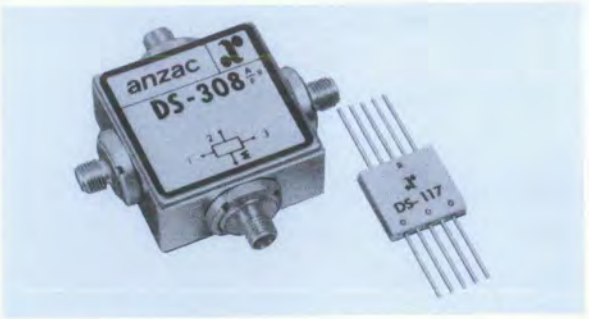
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
T-1000	9041	BNC	$90
T-1000	9042	TNC	95
T-1000	9043	N	95
T-1000	9044	SMA	95

Delivery is from stock.

MODELS DS-117/308

THREE-WAY POWER DIVIDERS 1-300 MHz

- Low Loss — Typically Less Than 0.5 dB
- Available in Flatpack and Connectorized Versions



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		1-300 MHz
Insertion Loss (Less coupling)	2-200 MHz 1-300 MHz	0.75 dB Max 1.0 dB Max
Isolation	2-200 MHz 1-300 MHz	30 dB Min 20 dB Min
Amplitude Balance		0.25 dB Max
Phase Balance	2-200 MHz 1-300 MHz	3° Max 4° Max
VSWR (All Ports)	2-200 MHz 1-300 MHz	1.3:1 Max 1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.05 Watt Max
Package Type	DS-117 Flatpack (FP-3) DS-308 Connectorized (C-8) (See pages 474 and 481 for physical dimensions.)

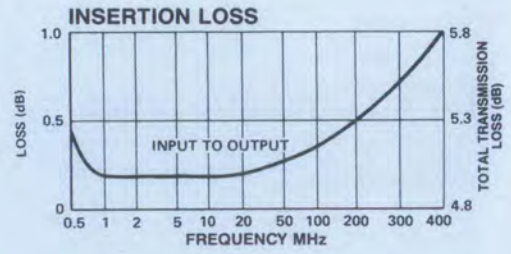
Environmental

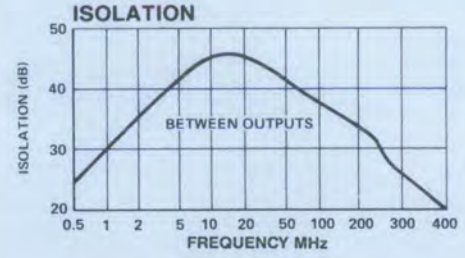
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

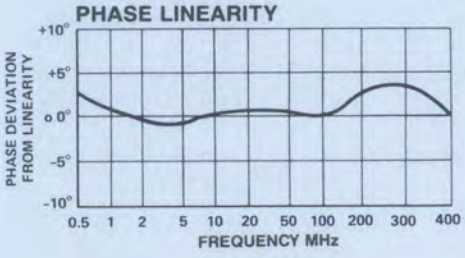
Pin Configuration (DS-117)	IN; P3, Outputs P6, P8 & P10 Case and all other pins are ground.

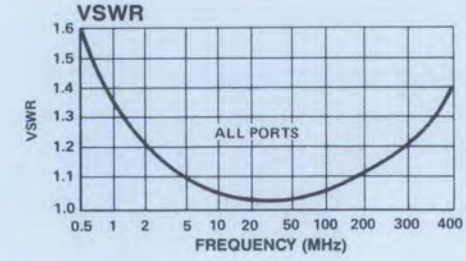
*All specifications apply with 50 ohm source and load impedance.

Typical Performance









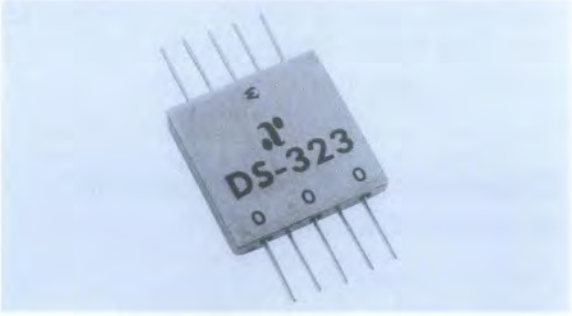
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-117	8209	Pin	$ 62
DS-308	8231	BNC	103
DS-308	8233	N	109
DS-308	8234	SMA	109

Delivery is from stock.

MODEL DS-323 FLATPACK THREE-WAY POWER DIVIDER 25-1000 MHz

- 0.4 dB Typical Midband Insertion Loss
- 35 dB Typical Midband Isolation
- 1.2:1 Typical Input VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		25-1000 MHz
Insertion Loss (Less coupling)	25-200 MHz	0.5 dB Max
	200-1000 MHz	1.0 dB Max
Isolation	25-50 MHz	15 dB Min
	50-200 MHz	22 dB Min
	200-1000 MHz	24 dB Min
Amplitude Balance	25-200 MHz	0.25 dB Max
	200-1000 MHz	0.4 dB Max
Phase Balance	25-200 MHz	2° Max
	200-1000 MHz	4° Max
VSWR		
Input	25-1000 MHz	1.4:1 Max
Output	25-50 MHz	1.9:1 Max
	50-200 MHz	1.7:1 Max
	200-1000 MHz	1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.05 Watt Max
Package Type	Flatpack (FP-3) (See page 474 for physical dimensions.)

Environmental

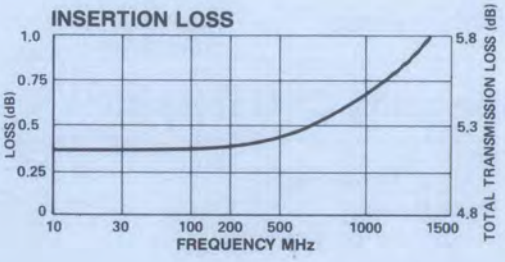
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

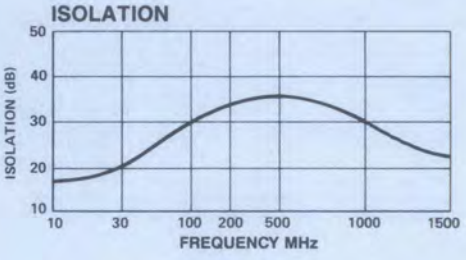
Pin Configuration IN; P3, Outputs P6, P8 & P10
Case and all other pins are ground.

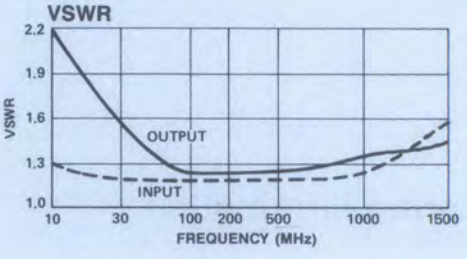
*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,428,920.

Typical Performance







Ordering Information

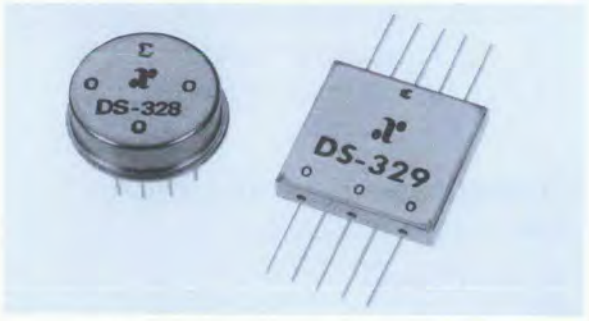
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-323	9179	Pin	$129

Delivery is from stock.

MODELS DS-328/329

FLATPACK THREE-WAY POWER DIVIDERS 3-700 MHz

- 0.4 dB Typical Midband Insertion Loss
- 28 dB Typical Midband Isolation
- 1.2:1 Typical Input VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		3-700 MHz
Insertion Loss (Less coupling)	3-500 MHz 500-700 MHz	0.70 dB Max 1.0 dB Max
Isolation	3-700 MHz	20 dB Min
Amplitude Balance	3-500 MHz 500-700 MHz	0.25 dB Max 0.4 dB Max
Phase Balance	3-500 MHz 500-700 MHz	3° Max 4° Max
VSWR (All Ports)	10-500 MHZ 3-700 MHz	1.3:1 Max 1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.125 Watt Max
Package Type	DS 328 Pin (TO-8-2) DS 329 Flatpack (FP-3) (See page 472 and 474 for physical dimensions)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

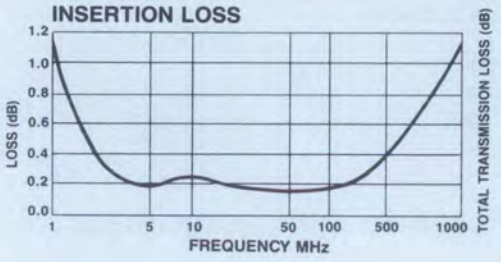
Pin Configuration

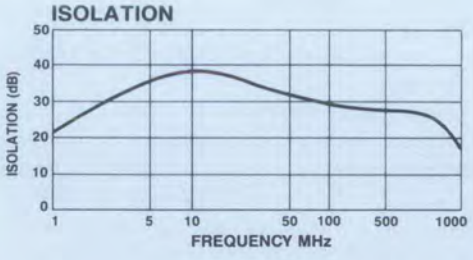
DS 328	IN;P11, Outputs, P2, P5, P8
DS-329	IN; P3, Outputs; P6, P8 & P10 All other pins are ground.

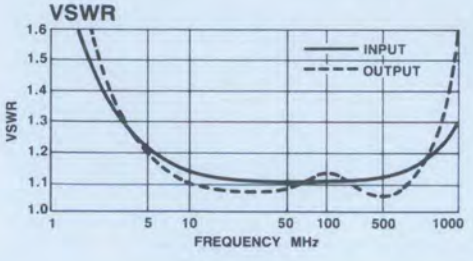
*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,428,920.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-328	6709	Pin	$85
DS-329	6719	Pin	89

Delivery is from stock.

MODELS M3H-50/M3V-50

TO-5 THREE-WAY POWER DIVIDERS

M3V-50 50-300 MHz
M3H-50 1-100 MHz

- Ideal for High Density Packaging
- High Isolation
- VSWR — 1.3:1 Max

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	M3H-50	M3V-50
Frequency Range	1-100	50-300 MHz
Insertion Loss (Less coupling)	0.5	0.75 dB Max
Isolation	30	25 dB Min
Amplitude Balance	0.2	0.2 dB Max
Phase Balance	1.0	2.0° Max
VSWR	1.3:1	1.3:1 Max

Operating Characteristics

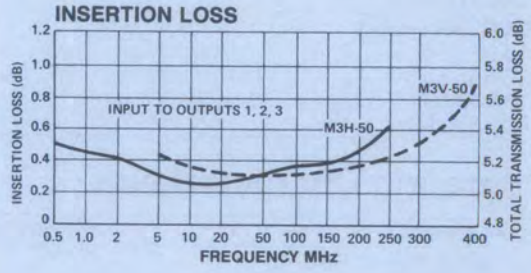
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Package Type	Pin (TO-5-2) (See page 472 for physical dimensions.)

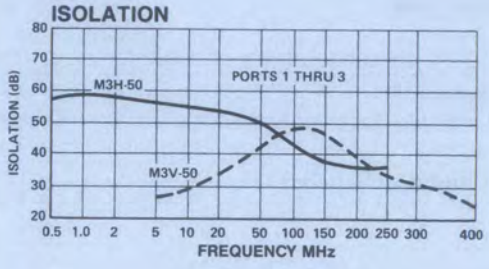
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

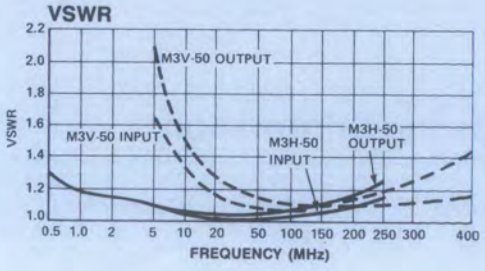
Pin Configuration	IN; P2, Outputs P1, P3 & P4 Case ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

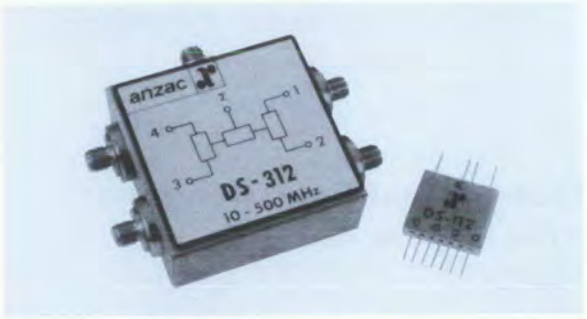
Model No.	Connectors	Unit Price (5-9 Units)
M3H-50	Pin	$105
M3V-50	Pin	107

Delivery is from stock.

MODELS DS-112/312

FOUR-WAY POWER DIVIDERS
10-500 MHz

- Low Loss — 0.6 dB Typical
- High Isolation — 30 dB Typical
- Low VSWR — 1.2:1 Typical



Guaranteed Specifications*

(From −55°C to +85°C)

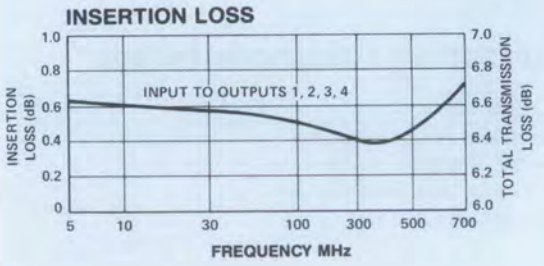
MODEL	DS-112	DS-312
Frequency Range	10-500	10-500 MHz
Insertion Loss (Less coupling)		
10-400 MHz	0.75	0.75 dB Max
400-500 MHz	0.85	0.85 dB Max
Isolation	25	25 dB Min
Amplitude Balance	0.2	0.2 dB Max
Phase Balance	5°	2° Max
VSWR (All Ports)		
10-25 MHz	1.5:1 Max	
25-500 MHz	1.35:1 Max	
10-400 MHz		1.5:1 Max
400-500 MHz		1.35:1 Max

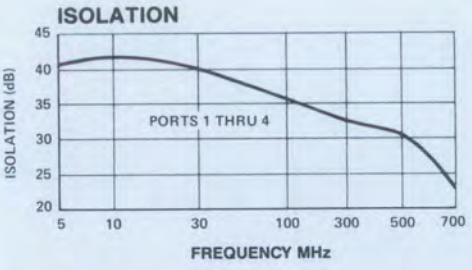
Operating Characteristics

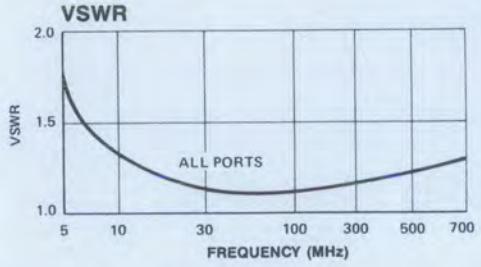
Impedance		50 Ohms Nominal
Maximum Power Rating or Input Power		1.0 Watt Max
Internal Load Dissipation	0.05	0.25 Watt Max
Package Type		DS-112 Flatpack (FP-5) DS-312 Connectorized (C-14) (See pages 475 and 482 for physical dimensions.)
Environmental		These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.
Pin Configuration (DS-112)		IN; P4 Outputs; P8, P10, P12 & P14 All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







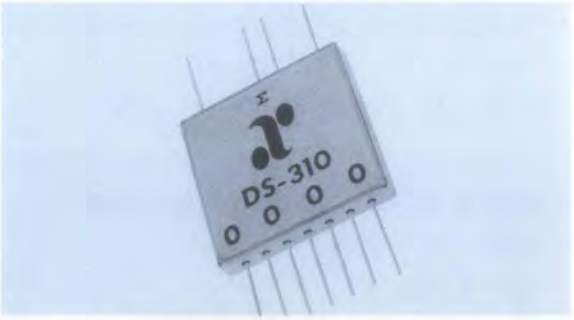
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-112	9739	Pin	$ 89
DS-312	8261	BNC	133
DS-312	8262	TNC	133
DS-312	8263	N	141
DS-312	8264	SMA	141

Delivery is from stock.

MODEL DS-310 — FOUR-WAY POWER DIVIDER
0.2-300 MHz

- 0.5 dB Typical Insertion Loss
- 1.1:1 Typical Midband VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		0.2-300 MHz
Insertion Loss (Less coupling)	0.2-0.5 MHz	1.0 dB Max
	0.5-100 MHz	0.5 dB Max
	100-300 MHz	1.0 dB Max
Isolation	0.2-0.5 MHz	20 dB Min
	0.5-100 MHz	25 dB Min
	100-300 MHz	15 dB Min
Amplitude Balance	0.2-0.5 MHz	0.2 dB Max
	0.5-100 MHz	0.2 dB Max
	100-300 MHz	0.4 dB Max
Phase Balance	0.2-0.5 MHz	1.5° Max
	0.5-100 MHz	4.0° Max
	100-300 MHz	6.0° Max
VSWR (All Ports)	0.2-0.5 MHz	2.0:1 Max
	0.5-100 MHz	1.3:1 Max
	100-300 MHz	1.4:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	50 mW Max
Package Type	Flatpack (FP-5) (See page 475 for physical dimensions.)

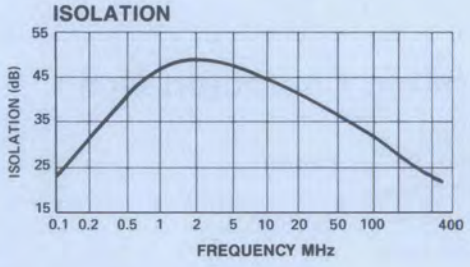
Environmental

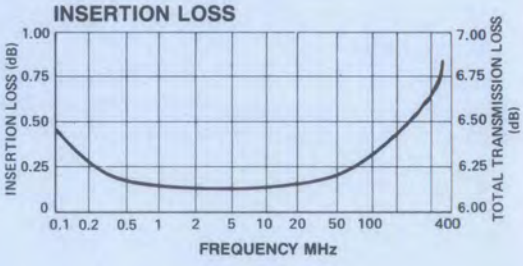
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

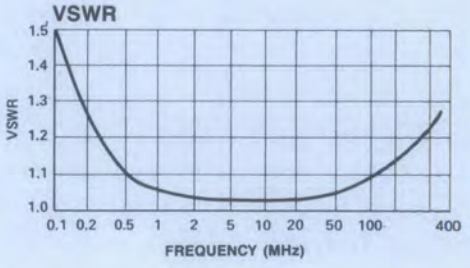
Pin Configuration	IN; P4 Outputs; P8, P10, P12 & P14 All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







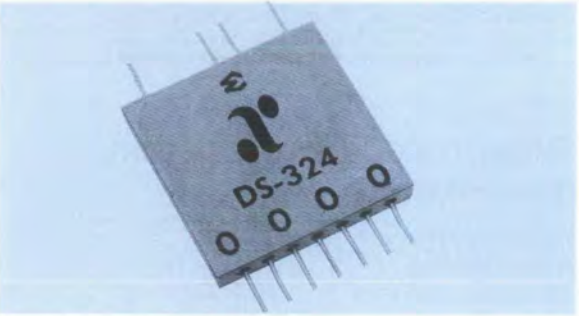
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-310	8219	Pin	$121

Delivery is from stock.

MODEL DS-324 FLATPACK FOUR-WAY POWER DIVIDER 25-1000 MHz

- 0.5 dB Typical Midband Insertion Loss
- 38 dB Typical Midband Isolation
- 1.2:1 Typical Midband VSWR



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		25-1000 MHz
Insertion Loss (Less coupling)	25-500 MHz 25-1000 MHz	0.75 dB Max 1.0 dB Max
Isolation	25-1000 MHz	20 dB Min
Amplitude Balance	25-1000 MHz	0.25 dB Max
Phase Balance	25-500 MHz 500-1000 MHz	3° Max 6° Max
VSWR (All Ports)		
In		1.3:1 Max
Out		1.4:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.05 Watt Max
Package Type	Flatpack (FP-5) (See page 475 for physical dimensions.)

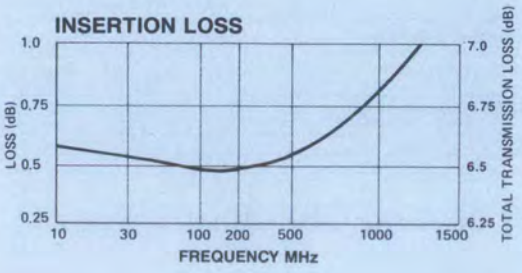
Environmental

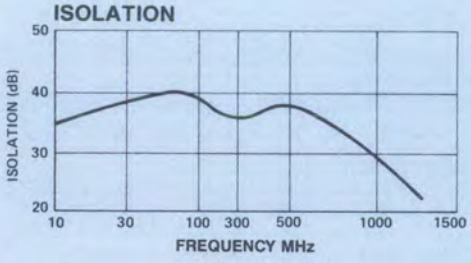
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

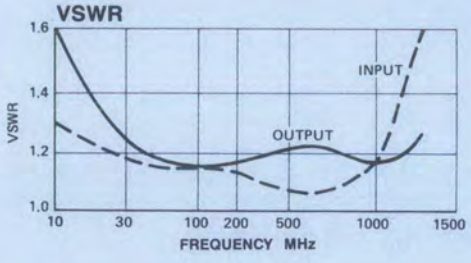
Pin Configuration	IN; P4 Outputs; P8, P10, P12 & P14 All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-324	9189	Pin	$214

Delivery is from stock.

MODEL DS-409-4 — FOUR-WAY POWER DIVIDER 10-2000 MHz

- Broad Frequency Range
- Low Loss — Typically 1.0 dB

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss (Less coupling)	10-30 MHz	0.6 dB Max
	30-100 MHz	0.6 dB Max
	100-1000 MHz	1.25 dB Max
	1000-2000 MHz	1.5 dB Max
Isolation	10-30 MHz	15 dB Min
	30-100 MHz	20 dB Min
	100-1000 MHz	25 dB Min
	1000-2000 MHz	20 dB Min
Amplitude Balance	10-30 MHz	0.25 dB Max
	30-100 MHz	0.25 dB Max
	100-1000 MHz	0.5 dB Max
	1000-2000 MHz	1.0 dB Max
Phase Balance	10-30 MHz	2.5° Max
	30-100 MHz	2.5° Max
	100-1000 MHz	5.0° Max
	1000-2000 MHz	10.0° Max
VSWR (All Ports)	10-30 MHz	2.0:1 Max
	30-100 MHz	1.5:1 Max
	100-1000 MHz	1.5:1 Max
	1000-2000 MHz	1.75:1 Max

Operating Characteristics

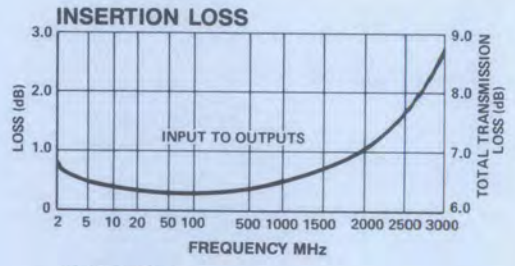
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	5.0 Watts Max
Internal Load Dissipation	0.5 Watt Max
Package Type	Connectorized (C-17)
	(See page 483 for physical dimensions.)

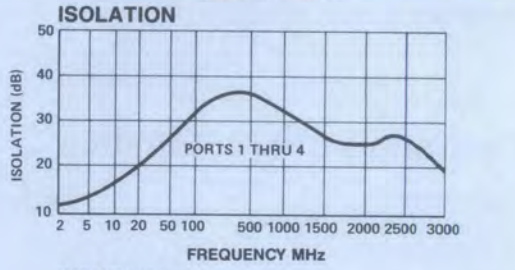
Environmental

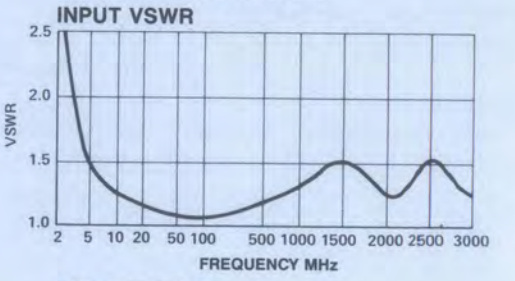
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

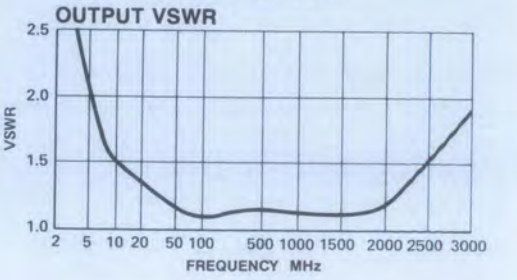
*All specifications apply with 50 ohm source and load impedance.

Typical Performance









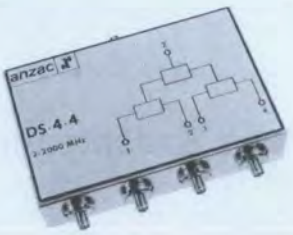
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-409-4	8841	BNC	$189
DS-409-4	8844	SMA	194

Delivery is from stock.

MODEL DS-4-4 BROADBAND FOUR-WAY POWER DIVIDER 2-2000 MHz

- 3 Decade Frequency Range
- Low Loss — 1 dB Maximum to 1000 MHz
- High Isolation — 25 dB Midband Minimum



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2-2000 MHz
Insertion Loss (Less coupling)	2-30 MHz	0.75 dB Max
	30-400 MHz	0.5 dB Max
	400-1000 MHz	1.0 dB Max
	1000-2000 MHz	2.0 dB Max
Isolation	2-30 MHz	15 dB Min
	30-400 MHz	30 dB Min
	400-1000 MHz	25 dB Min
	1000-2000 MHz	20 dB Min
Amplitude Balance	2-30 MHz	0.6 dB Max
	30-400 MHz	1.0 dB Max
	400-1000 MHz	1.0 dB Max
	1000-2000 MHz	1.0 dB Max
Phase Balance	2-30 MHz	10° Max
	30-400 MHz	5° Max
	400-1000 MHz	5° Max
	1000-2000 MHz	5° Max
VSWR (All Ports)	2-30 MHz	2.0:1 Max
	30-400 MHz	1.3:1 Max
	400-1000 MHz	1.3:1 Max
	1000-2000 MHz	1.9:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.25 Watt Max
Package Type	Connectorized (C-17) (See page 483 for physical dimensions.)

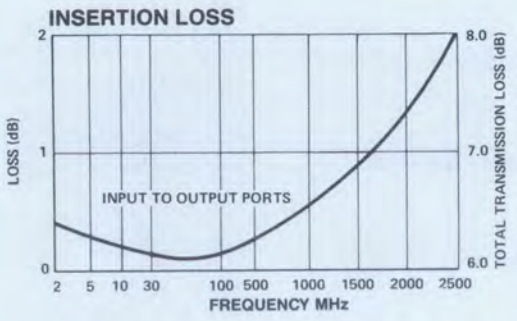
Environmental

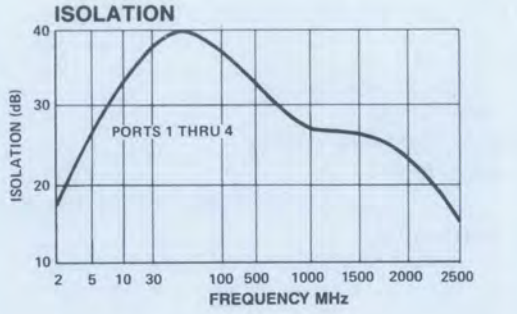
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

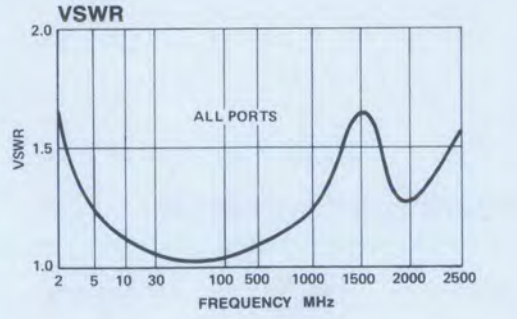
*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,325,587.

Typical Performance







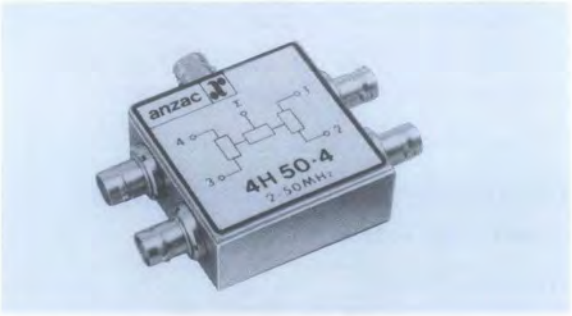
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-4-4	8083	N	$257
DS-4-4	8084	SMA	257

Delivery is from stock.

MODEL 4H-50-4 — FOUR-WAY POWER DIVIDER 2-50 MHz

- Low Loss — 0.5 dB Max
- Low VSWR — 1.1:1 Max
- High Isolation — 40 dB Typical



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	2-50 MHz
Insertion Loss (Less coupling)	0.5 dB Max
Isolation	30 dB Min
Amplitude Balance	0.2 dB Max
Phase Balance	2.0° Max
VSWR	1.1:1 Max

Operating Characteristics

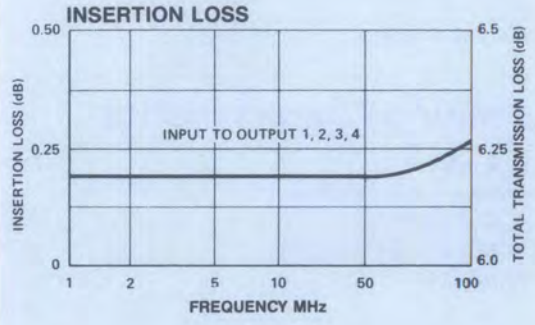
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.12 Watt Max
Package Type	Connectorized (C-14) (See page 482 for physical dimensions.)

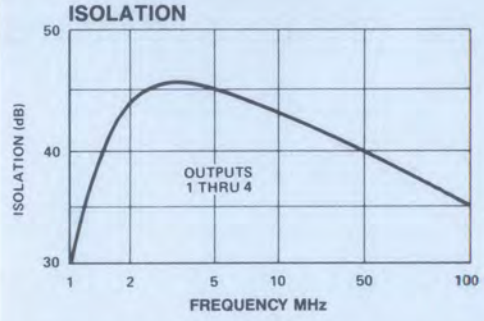
Environmental

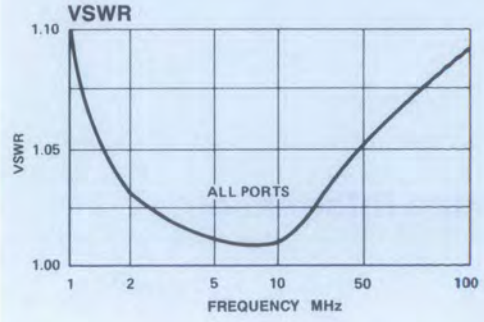
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







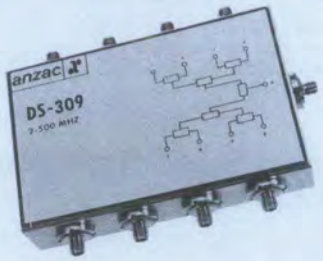
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
4H-50-4	9801	BNC	$108
4H-50-4	9804	SMA	113

Delivery is from stock.

MODEL DS-309 EIGHT-WAY POWER DIVIDER
2-500 MHz

- Low Loss — Typically 1 dB
- High Isolation — Typically 30 dB
- Low VSWR — Typically 1.3:1



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2-500 MHz
Insertion Loss (Less coupling)		1.2 dB Max
Isolation	2-100 MHz	30 dB Min
	100-500 MHz	25 dB Min
Amplitude Balance	2-100 MHz	0.15 dB Max
	100-500 MHz	0.25 dB Max
Phase Balance	2-100 MHz	2.0° Max
	100-500 MHz	3.5° Max
VSWR (All Ports)	2-5 MHz	1.6:1 Max
	5-500 MHz	1.35:1 Max

Operating Characteristics

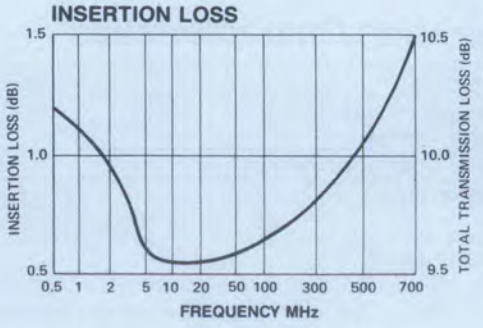
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.0 Watts Max
Internal Load Dissipation	0.25 Watt Max
Package Type	Connectorized (C-18)
	(See page 483 for physical dimensions.)

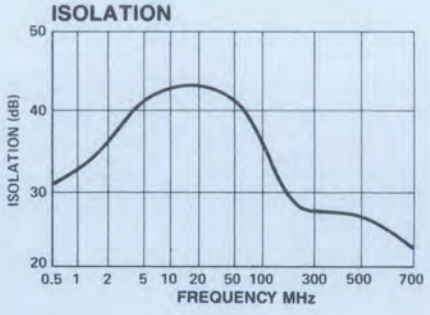
Environmental

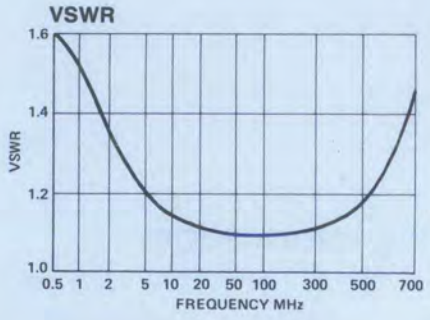
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

Typical Performance







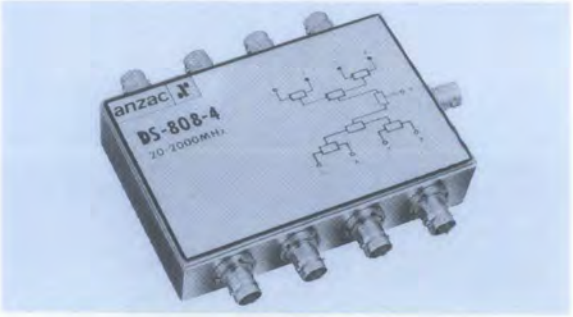
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-309	8251	BNC	$248
DS-309	8254	SMA	261

Delivery is from stock.

MODEL DS-808-4 BROADBAND EIGHT-WAY POWER DIVIDER 20-2000 MHz

- Two-Decade Frequency Range
- High Isolation — 20 dB Min
- Typical Midband VSWR 1.2:1



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-2000 MHz
Insertion Loss (Less coupling)	20-600 MHz	1.0 dB Max
	600-1000 MHz	1.3 dB Max
	1000-2000 MHz	3.0 dB Max
Isolation		20 dB Min
Amplitude Balance	20-600 MHz	0.6 dB Max
	600-1000 MHz	0.6 dB Max
	1000-2000 MHz	1.2 dB Max
Phase Balance	20-600 MHz	5° Max
	600-1000 MHz	5° Max
	1000-2000 MHz	15° Max
VSWR (All Ports)	20-60 MHz	1.7:1 Max
	60-600 MHz	1.4:1 Max
	600-1000 MHz	2.0:1 Max
	1000-2000 MHz	2.0:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	5.0 Watts Max
Internal Load Dissipation	0.5 Watt Max
Package Type	Connectorized (C-18) (See page 483 for physical dimensions.)

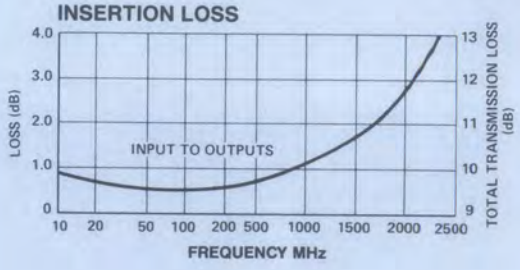
Environmental

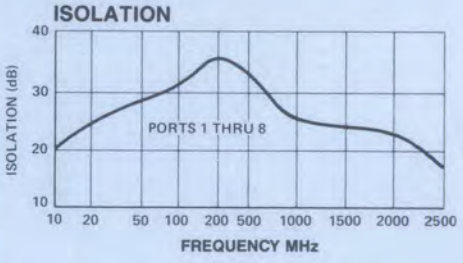
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

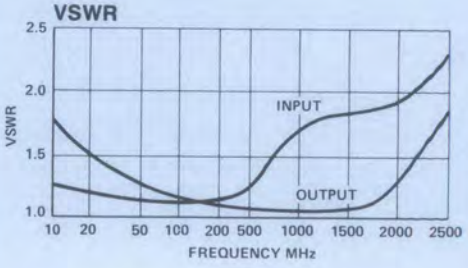
*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,325,587.

Typical Performance



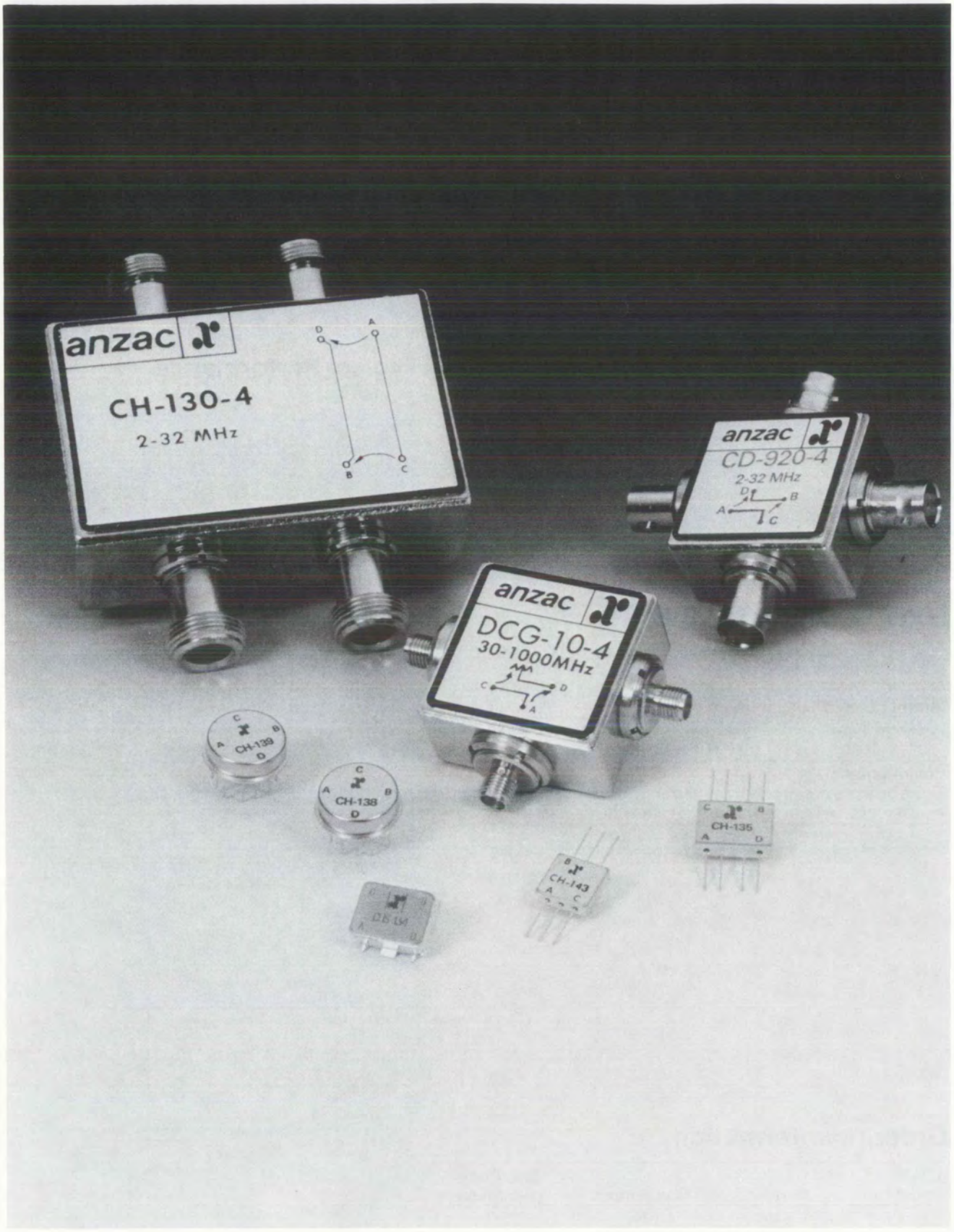




Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DS-808-4	8451	BNC	$360
DS-808-4	8454	SMA	374

Delivery is from stock.


anzac
CH-130-4
2-32 MHz
anzac
CD-920-4
2-32 MHz
anzac
DCG-10-4
30-1000MHz
CH-139
CH-138
CH-143
CH-135

DIRECTIONAL COUPLER SELECTION GUIDE

MODEL NO.	FREQUENCY RANGE (MHz)	COUPLING (dB) NOM	MAIN LINE LOSS (dB) TYP	DIRECTIVITY (dB) TYP	VSWR TYP	POWER RATING (W)	CASE[1] STYLE	PAGE NO.
CD-920-4	2-32	20	0.15	40	1.05:1	50	C-8	432
CH-130-4	2-32	30	0.08	30	1.05:1	500	C-12	433
CH-136	0.5-400	12	0.75	30	1.15:1	1	RH-1	438
CH-137	**0.5-400**	**20**	**0.30**	**30**	**1.15:1**	**3**	**RH-1**	**438**
CHS-137	**0.5-400**	**20**	**0.30**	**35**	**1.15:1**	**3**	**SF-1**	**439**
CH-134	10-500	11	0.8	30	1.2:1	1	FP-2	435
CHS-134*	**10-500**	**11**	**0.8**	**30**	**1.2:1**	**1**	**SF-1**	**436**
CH-138	10-500	11	0.8	30	1.3:1	1	TO-8-2	435
CH-135	10-500	20	0.3	30	1.15:1	3	FP-2	437
CH-139	10-500	20	0.3	30	1.15:1	3	TO-8-2	437
CH-132	1-1000	20	0.3	30	1.1:1	5	C-8	434
CH-140	5-1000	20	0.3	30	1.05:1	3	FP-2	440
DCG-10-4	30-1000	10	1.1	30	1.3:1	5	C-7	442
CH-143	**500-2000**	**21**	**0.25**	**20**	**1.3:1**	**2**	**FP-1**	**441**

[1]CASE STYLE: C = CONNECTORIZED; FP = FLATPACK; TO-8 = TO-8 PLUG-IN; SF = SURFACE MOUNT
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
BOLD = NEW PRODUCT
*DENOTES SURFACE MOUNT PRODUCT

DIRECTIONAL COUPLERS

INTRODUCTION

Directional Couplers as described in this article are actually a particular form of 180° hybrid. While a 180° hybrid splits an input into two equal amplitude outputs, a directional coupler normally splits into two unequal amplitude outputs. This terminology "directional coupler" and "180° hybrid" is based on convention, however, the 180° hybrid could be thought of as a 3 dB directional coupler. Despite these similarities, the parameters used to describe signal flow in directional couplers and the application, in actual use, is sufficiently different to warrant separate considerations.

FUNCTIONAL DESCRIPTION

A directional coupler is ideally a lossless reciprocal four-port device which normally provides two unequal amplitude outputs when a signal is fed to one of its inputs. Depending upon which port is fed, the outputs may be in-phase or 180° out-of-phase. Directional couplers are usually described by indicating the coupling ratio to the low signal level output. Thus a 20 dB directional coupler will provide a "coupled path" output which is 20 dB below the input, while the "main line" or through path has very little loss (.04 dB theoretically).

At this point it is useful to consider the terminology and functional diagram normally used for directional couplers. First, for comparison, consider the diagram used for 180° hybrids. Figure 1 shows a four-port 180° hybrid.

This diagram can be utilized for analyzing the function of a directional coupler by simply noting which paths are coupled or high loss paths and which paths are main line or low loss paths. However, a different form of diagram is often used to denote graphically this information.

In Figure 2, path C to A is the mainline or low loss path while C to B is the coupled path. For a signal fed to Port A, Port D is the coupled output, but the signal undergoes a 180° phase shift. Ports C, D and A, B are isolated pairs. The phase shift of paths C to A and B to D is 0° although this is not

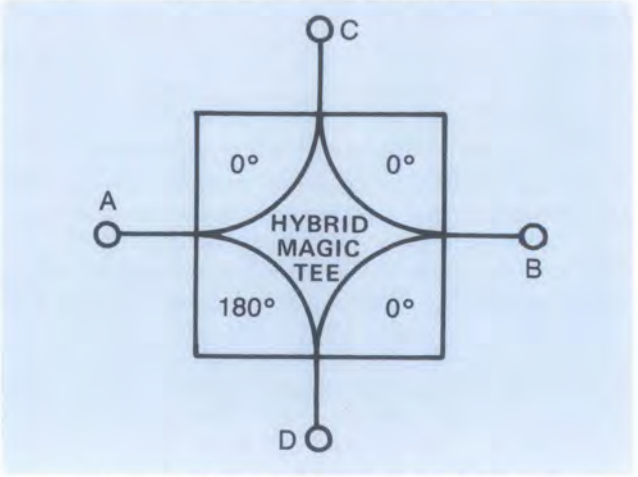


Figure 1. General Diagram for 180° Hybrid

usually noted on the conventional diagram. If we compare Figure 2 with Figure 1, we see that the relative phase for all possible paths between similar ports is the same and the same pairs of ports are isolated. Figure 2 does, however, clearly indicate the main line and coupled paths.

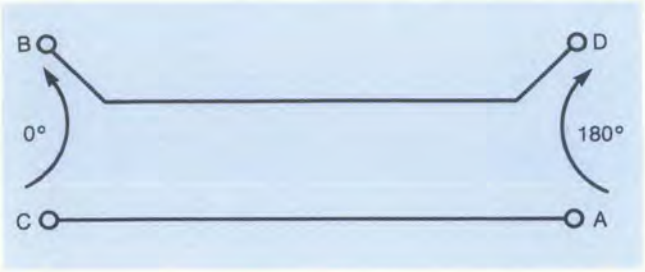


Figure 2. Directional Coupler Functional Diagram

It was earlier mentioned that a directional coupler is ideally a lossless device. Once again, as was the case with 180° and 90° hybrids, this approximation is a reasonable one to make when describing the function of the actual device. If we assume a lossless condition, then the signal splitting losses are easily determined knowing only the coupling ratio. Using the equations below, a calculation of the losses can be easily performed for any given coupling ratio, with Table 1 providing the power splitting losses for several common coupling ratios.

$$\text{Coupling Ratio (dB)} = 10 \log \frac{P_{OUT}\text{ (coupled path)}}{P_{IN}}$$

$$\text{Main line loss} = 10 \log \frac{P_{OUT}\text{ (Main Line)}}{P_{IN}}$$

Table 1

Coupling Ratio	Coupled Path Output (dB)	Coupled Path Power Ratio	Main Line Power Ratio	Main Line Loss
3 dB	−3 dB	0.50 P_{IN}	0.50 P_{IN}	3.0 dB
6 dB	−6 dB	0.25 P_{IN}	0.75 P_{IN}	1.25 dB
10 dB	−10 dB	0.10 P_{IN}	0.90 P_{IN}	0.46 dB
20 dB	−20 dB	0.01 P_{IN}	0.99 P_{IN}	0.04 dB
30 dB	−30 dB	0.001 P_{IN}	0.999 P_{IN}	0.004 dB

A "Directional Coupler" has the ability to separate and sample signal components based on the direction of signal flow. Refering to Figure 3, the diagram shows a 20 dB directional coupler with a signal source at Port A. Ports B and D are terminated in Z_o while Port C is terminated in an unknown impedance, Z_C. As we observed in Table 1, a 20 dB directional coupler splits a signal into two unequal components with the coupled output attenuated by 20 dB and the main line output attenuated by 0.04 dB theoretically. Thus the incident signal at Port A, V_{IN}, is split into two components, V_{IN} −20 dB which is delivered to the Z_o load at Port D and V_{IN} −0.04 dB which appears at the unknown load Z_C at Port C. If Z_C is any value other than Z_o part of the incident signal is reflected and appears back at Port C as V_{REFL}. The magnitude of the return loss of Z_C can be determined knowing either Z_C or ρ_C (the reflection coefficient) as follows:

$$\rho_C = \frac{Z_C - Z_o}{Z_C + Z_o}$$

$$\text{Return loss of } Z_C = 20 \log \frac{1}{|\rho_C|} = 20 \log \left| \frac{Z_C + Z_o}{Z_C - Z_o} \right|$$

$$V_{REFL} = V_{IN} - 0.04\text{ dB} - \text{Return Loss of } Z_C = V_{IN} - 0.04\text{ dB} - 20 \log \left| \frac{Z_C + Z_o}{Z_C - Z_o} \right|$$

The signal V_{REFL}, which enters Port C, is in turn split with (V_{REFL} − 20 dB) appearing at the Z_o termination on Port B and (V_{REFL} − 0.04 dB) being dissipated in the source impedance, Z_o at Port A. If we compare signal levels at Ports D and B, we find the following:

$$V_D = V_{IN} - 20\text{ dB}$$
$$V_B = V_{REFL} - 20\text{ dB} = V_{IN} - 20.04\text{ dB} - \text{Return Loss of } Z_C$$

Thus we find that a comparison of signal levels at Ports B and D gives us a direct measure of the return loss or complex impedance of Z_C. In fact, the signal levels are offset only by the return loss and the small main line loss.

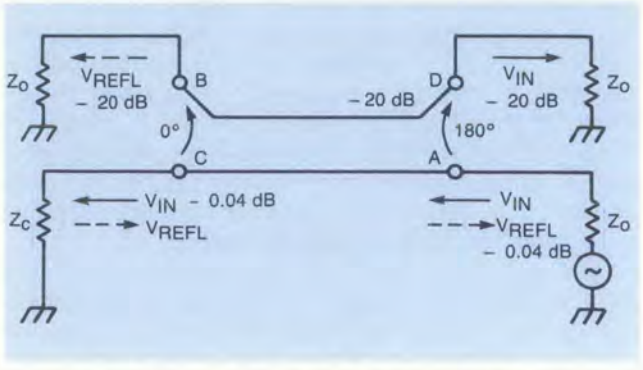


Figure 3. Incident and Reflected Signal Flow

We can also see that if $Z_C = Z_O$ the return loss of Z_C becomes infinite and no signal will reach Port B. This, of course, should follow from the consideration that Ports A and B and C and D are isolated when the directional coupler is terminated in Z_O impedance loads. Practical directional couplers have finite isolation and this introduces an error in the comparative levels at Ports B and D.

Directional couplers are often used for measurements where an unknown mismatch is expected at one port as was illustrated in Figure 3. The directivity of the coupler is a limiting parameter in the ability to accurately measure the return loss of this unknown.

As an example, consider the coupler shown in Figure 3. We will assume the following parameters:

Isolation, A to B = 40 dB
Coupling, A to D or C to B = 20 dB

Therefore:

Directivity, A to B = 40 dB − 20 dB = 20 dB

If we connect an unknown impedance which has an actual return loss of 20 dB, we observe that two equal amplitude signal components are present at Port B, the first, V_{INT}, due to internal mismatches and unbalance in the coupler as measured by the directivity and the second, V_{EXT}, due to reflection from the external unknown. For stated conditions:

$$|V_{INT}| = |V_{EXT}|$$

Since the relative phase of the complex voltages V_{INT} and V_{EXT} is unknown, the resultant voltage can vary over a wide range. Two extremes exist: in-phase and 180° out-of-phase.

1. In-Phase
   $V_{INT} = V_{EXT} = V$
   $V_{RESULTANT} = V_{INT} + V_{EXT}$
   Apparent Return Loss =
   Actual Return Loss − 6 dB
2. 180° Out-Of-Phase
   $V_{INT} = V_{EXT}$
   $V_{RESULTANT} = V_{INT} + (-V_{EXT}) = 0$
   Apparent Return Loss = ∞

The apparent return loss of the unknown can be seen to vary from 6 dB worse than the actual return loss to infinity or an apparent perfect match. As a rule-of-thumb the directivity of the coupler should be 20 dB greater than the return loss of the unknown load. This will keep directivity errors below 1 dB.

PERFORMANCE PARAMETERS

The parameters of frequency range, impedance and VSWR previously defined also apply to directional couplers (see pages 294 to 302). In addition, four new parameters are defined.

Coupling

This is the attenuation of a signal at the coupled port relative to the input signal level.

Coupling Flatness

This is the variation in coupling over the frequency range specified.

Directivity

This is the signal level at an isolated port relative to the signal level at a coupled port when the signal is injected at an input. (Example: The signal at B relative to D when A Port is fed).

Main Line Loss

This is the total insertion loss in the main line.

CONCLUSION

The directional coupler is a unique type of 180° hybrid. It can be used effectively in systems to monitor power or match, branch signals, feedback power in amplifiers and for signal injection. The designer who understands the unique features of directional couplers will find many other applications where a coupler's properties can solve difficult system problems.

MODEL CD-920-4 — 20 dB BI-DIRECTIONAL COUPLER 2-32 MHz

- Low Loss — 0.2 dB Max
- High Directivity — 35 dB Min
- Constant Coupling — Typically Within ±0.15 dB

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	2-32 MHz
Coupling (Input to Output)	20 ±0.15 dB
Coupling Flatness	±0.15 dB Max
VSWR	1.07:1 Max
Directivity (Both Directions)	35 dB Min
Main Line Loss	0.2 dB Max

Operating Characteristics

Input Power	50 Watts Max
Package Type	Connectorized (C-8) (See page 481 for physical dimensions.)

Environmental

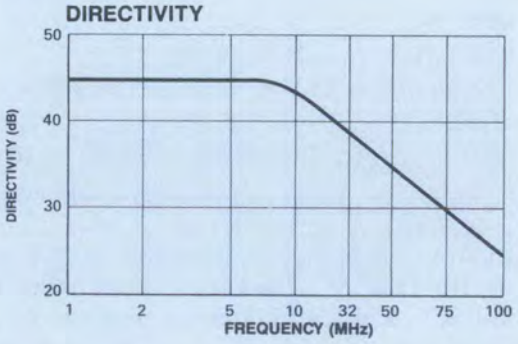
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

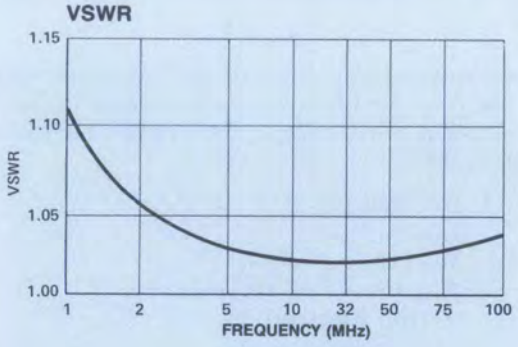
*All specifications apply with 50 ohm source and load impedance.

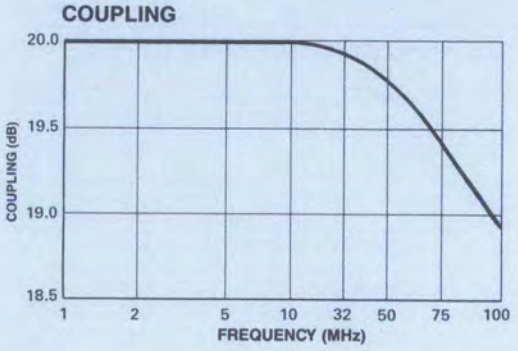
This product contains elements protected by United States Patent Number 3,426,298.

Functional Diagram

Typical Performance







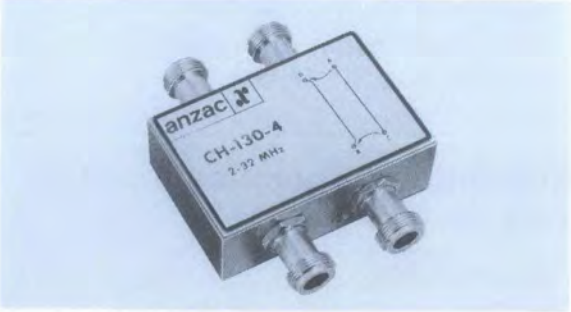
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CD-920-4	8141	BNC	$104

Delivery is from stock.

MODEL CH-130-4 — 500 WATT, 30 dB BI-DIRECTIONAL COUPLER 2-32 MHz

- High Power Handling Capability — 500 Watts
- Very Low Insertion Loss — 0.1 dB Max
- Low VSWR — 1.1:1 Max



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	2-32 MHz
Coupling (Input to Output)	30 ±0.5 dB
Coupling Flatness	±0.25 dB Max
VSWR (All Ports)	1.1:1 Max
Directivity (Both Directions)	25 dB Min
Main Line Loss	0.1 dB Max

Operating Characteristics

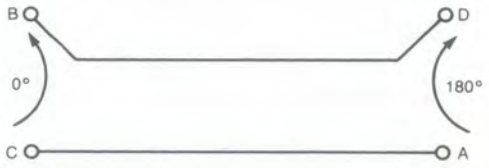
Input Power	500 Watts Max
Package Type	Connectorized (C-12) (See page 482 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.

Functional Diagram

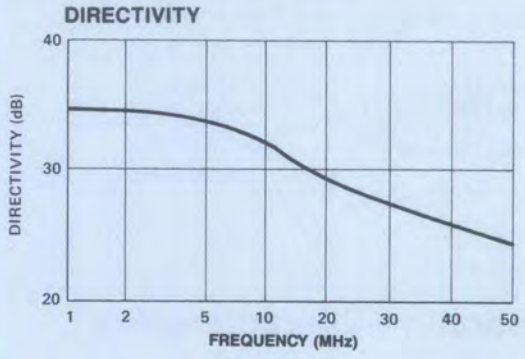


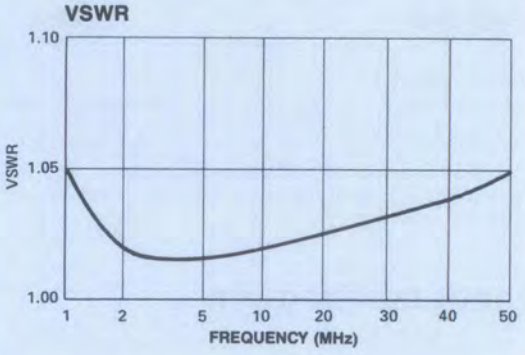
Ordering Information

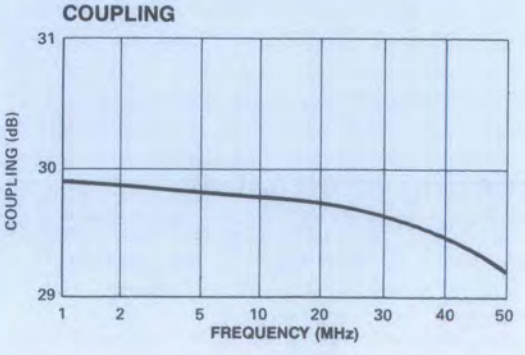
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CH-130-4	8113	N	$280

Delivery is from stock.

Typical Performance







MODEL CH-132 — 20 dB BI-DIRECTIONAL COUPLER 1-1000 MHz

- Broad Frequency Range
- Constant Coupling — Within ±0.5 dB Max
- VSWR — 1.3:1 Max

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		1-1000 MHz
Coupling (Input to Output)		20 ±1.0 dB
Coupling Flatness	10-500 MHz	±0.25 dB Max
	1-1000 MHz	±0.5 dB Max
VSWR (All Ports)	10-500 MHz	1.2:1 Max
	1-1000 MHz	1.3:1 Max
Directivity (Both Directions)	10-500 MHz	25 dB Min
	1-1000 MHz	20 dB Min
Main Line Loss**	10-500 MHz	0.5 dB Max
	1-1000 MHz	0.7 dB Max

Operating Characteristics

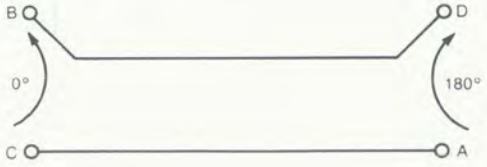
Input Power	5.0 Watts Max
Package Type	Connectorized (C-8) (See page 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes transitional power split.

Functional Diagram

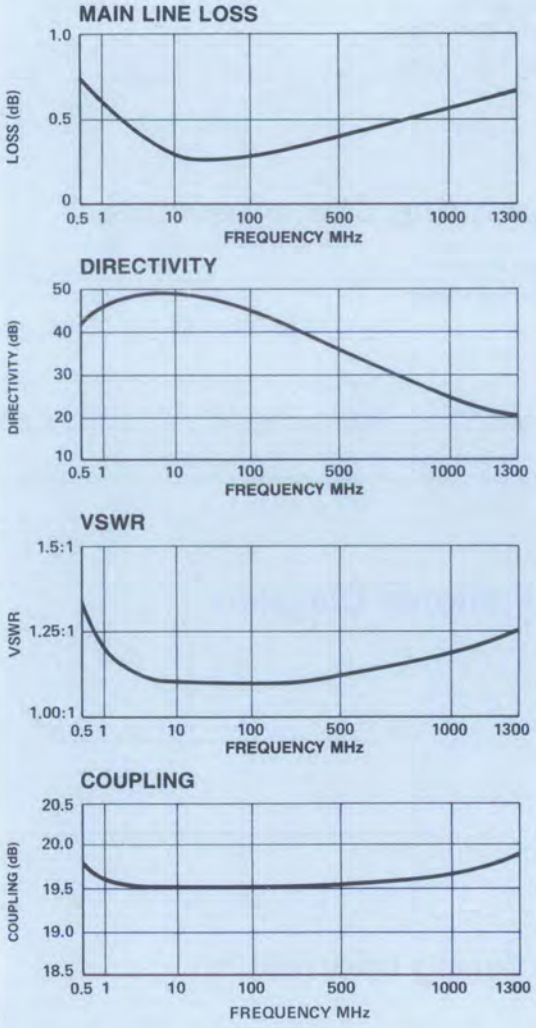


Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CH-132	8361	BNC	$135
CH-132	8363	N	140
CH-132	8364	SMA	140

Delivery is from stock.

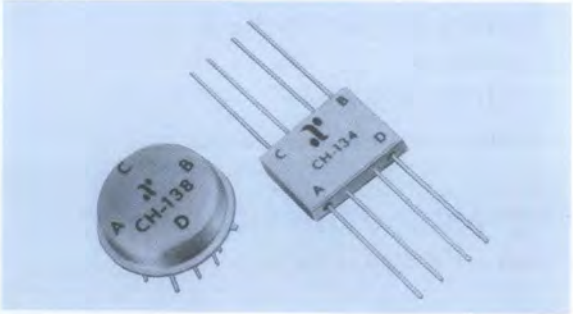
Typical Performance



MODELS CH-134/138

11 dB DIRECTIONAL COUPLERS
10-500 MHz

- Constant Coupling — Within ±0.5 dB Max
- Available in Flatpack (CH-134) and TO-8 (CH-138) Packages



Guaranteed Specifications*

(From −54°C to +85°C)

MODEL	CH-134	CH-138
Frequency Range	10-500	10-500 MHz
Coupling (Input to Output)	10.8 ±0.7	10.8 ±1.0 dB
Coupling Flatness	±0.5	±0.5 dB Max
VSWR (All Ports)		
10-500 MHz	1.8:1	1.8:1 Max
25-200 MHz	1.5:1	1.5:1 Max
Directivity (Both Directions)	20	17 dB Min
Main Line Loss**	1.6	1.6 dB Max

Operating Characteristics

Input Power	1.0 Watt Max
Package Type	CH-134 Flatpack (FP-2) CH-138 Pin (TO-8-2) (See pages 474 and 472 for physical dimensions.)

Environmental

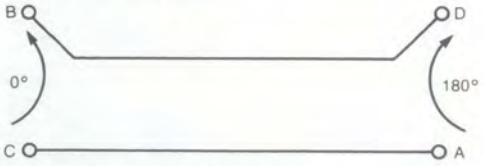
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

CH-134	C; P1, B; P4, A; P5, D; P8. Case and all other pins ground.
CH-138	A; P8, B; P2, C; P5, D; P11. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

Functional Diagram

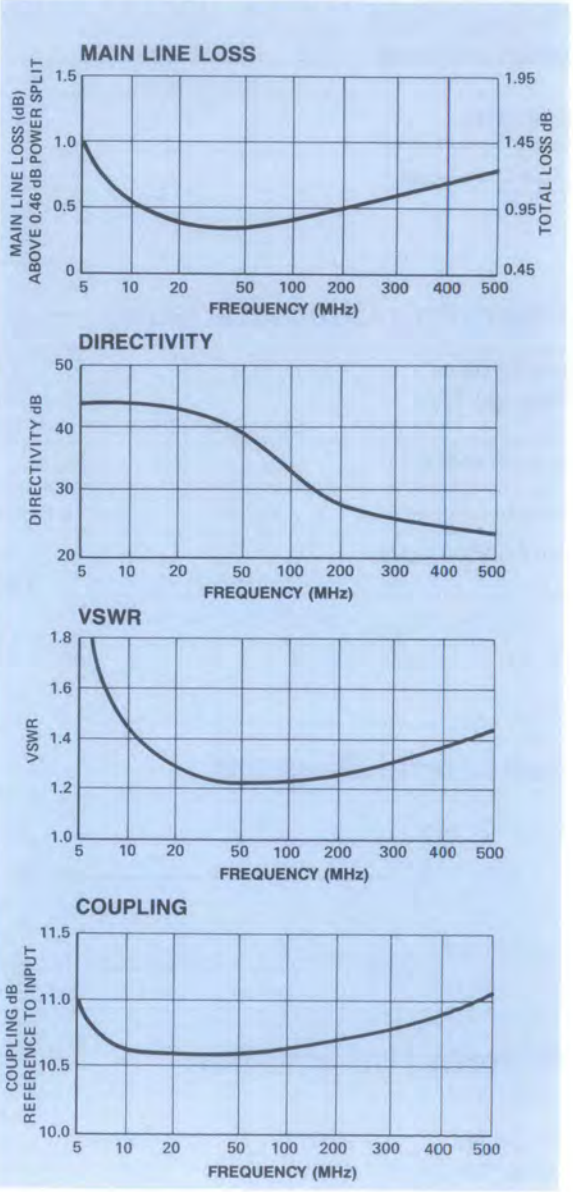


Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CH-134	8129	Pin	$49
CH-138	8829	Pin	49

Delivery is from stock.

Typical Performance



NEW

MODEL CHS-134

11 dB BI-DIRECTIONAL COUPLER
10-500 MHz

- Surface Mount Package
- Low Loss
- High Directivity
- Fully Hermetic Package

Guaranteed Specifications*

(From −54°C to +85°C)

Frequency Range		10-500 MHz
Coupling (Input to Output)		10.8 ±0.7 dB
Coupling Flatness		±0.5 dB Max
VSWR (All Ports)	10-500 MHz	1.8:1 Max
	25-200 MHz	1.5:1 Max
Directivity (Both Directions)		20 dB Min
Main Line Loss **		1.6 dB Max

Operating Characteristics

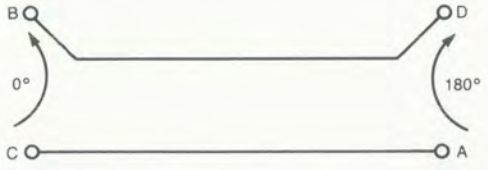
Input Power	1.0 Watt Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	C; P1, B; P2, A; P3, D; P4. Case ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

Functional Diagram

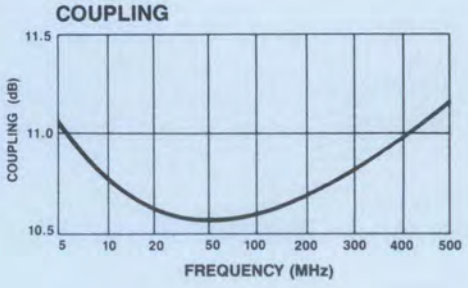


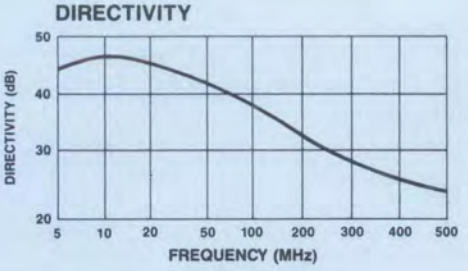
Ordering Information

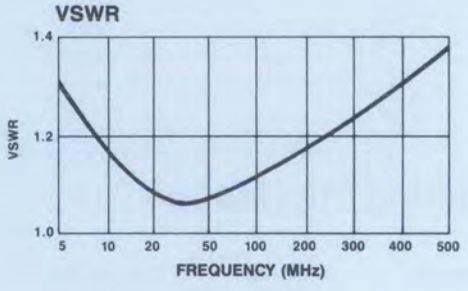
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CHS-134	6169	Pin	$54

Delivery is from stock.

Typical Performance



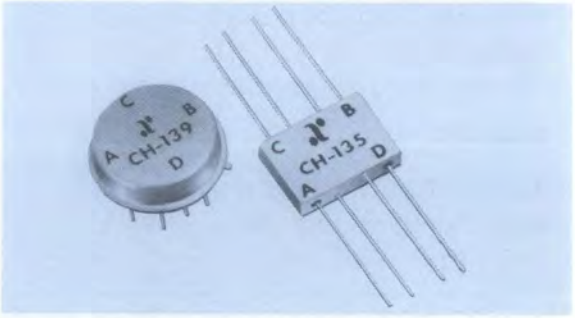




MODELS CH-135/139

20 dB DIRECTIONAL COUPLERS
10-500 MHz

- Constant Coupling — Within ±0.5 dB Max
- 30 dB Typical Midband Directivity
- Available in Flatpack (CH-135) and TO-8 (CH-139) Packages



Guaranteed Specifications*

(From −54°C to +85°C)

MODEL	CH-135	CH-139
Frequency Range	10-500	10-500 MHz
Coupling (Input to Output)	20.3 ±0.7	20.0 ±1.0 dB
Coupling Flatness	±0.4	±0.5 dB Max
VSWR (All Ports)	1.3:1	1.3:1 Max
Directivity (Both Directions)	20	17 dB Min
Main Line Loss**	0.5	0.6 dB Max

Operating Characteristics

Input Power	3.0 Watts Max
Package Type	CH-135 Flatpack (FP-2) CH-139 Pin (TO-8-2) (See pages 474 and 472 for physical dimensions.)

Environmental

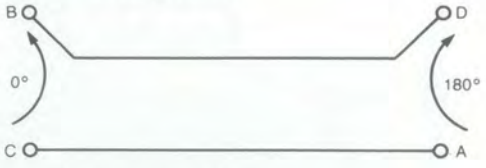
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration

CH-135	C; P1, B; P4, A; P5, D; P8. Case and all other pins ground.
CH-139	A; P8, B; P2, C; P5, D; P11. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

Functional Diagram

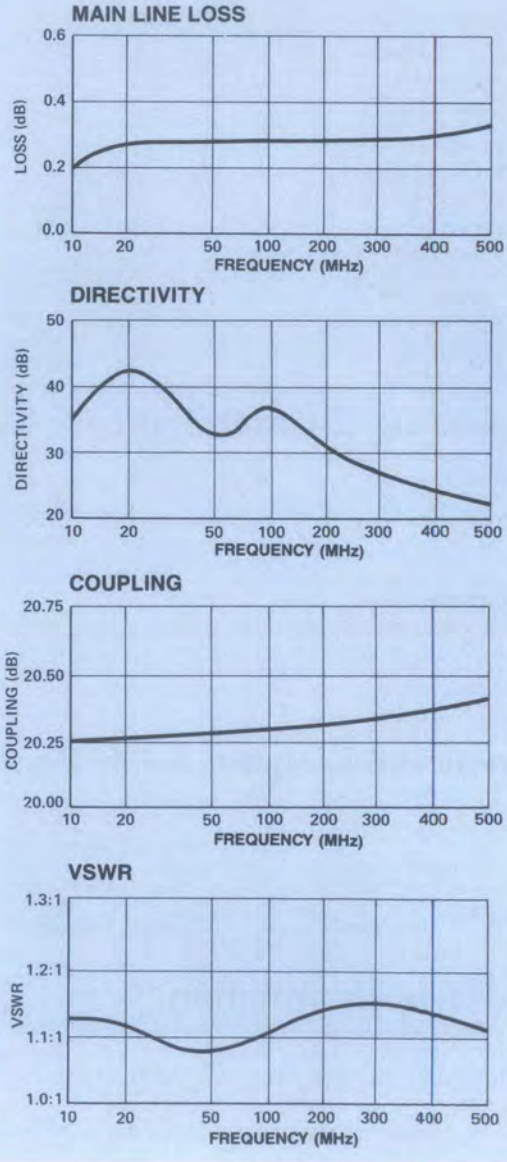


Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CH-135	8349	Pin	$49
CH-139	8839	Pin	49

Delivery is from stock.

Typical Performance



MODELS CH-136/137

LOW COST DIRECTIONAL COUPLERS 0.5-400 MHz

- 11.5 dB (CH-136), 19.5 dB (CH-137)
- Low Cost
- Convenient Plug-In Mounting

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	CH-136	CH-137
Frequency Range	0.5-400	0.5-400 MHz
Coupling (Input to Output)		
0.5-200 MHz	11.5 ±0.5	19.5 ±0.5 dB
200-400 MHz	12 ±1.0	20 ±1.0 dB
VSWR (All Ports)		
5-200 MHz	1.3:1	1.2:1 Max
0.5-400 MHz	1.5:1	1.5:1 Max
Directivity (Both Directions)		
0.5-50 MHz	30	30 dB Min
50-200 MHz	20	20 dB Min
200-400 MHz	15	15 dB Min
Main Line Loss**		
0.5-50 MHz	1.1	0.5 dB Max
50-200 MHz	0.8	0.4 dB Max
200-400 MHz	1.1	0.6 dB Max

Operating Characteristics

Input Power	1	3.0 Watts Max
Package Type		CH-136 Relay Header (RH-1) CH-137 Relay Header (RH-1) (See page 472 for physical dimensions.)

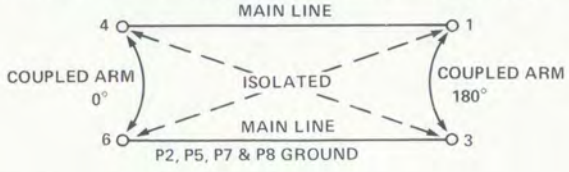
Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.

**Includes theoretical power spit.

Functional Diagram & Pin Configuration

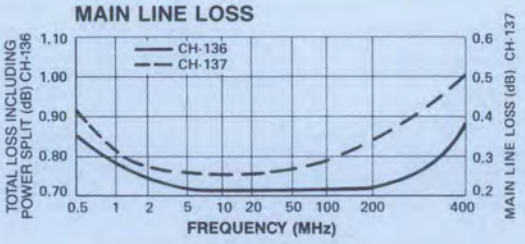


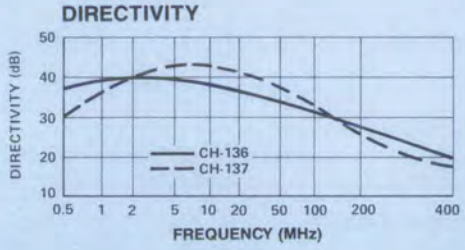
Ordering Information

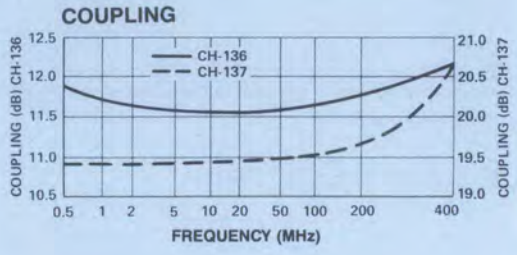
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CH-136	8579	Pin	$22
CH-137	8589	Pin	22

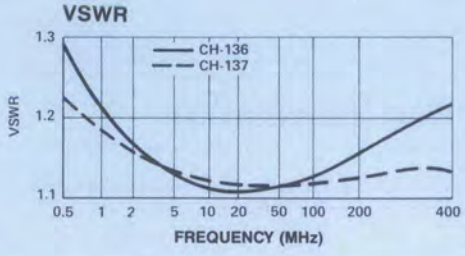
Delivery is from stock.

Typical Performance









NEW

MODEL CHS-137 — SURFACE MOUNT 20 dB DIRECTIONAL COUPLER 0.5-400 MHz

- Fully Hermetic Package

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	0.5-400 MHz
Coupling (Input to Output)	
0.5-200 MHz	19.5 ±0.5 dB
200-400 MHz	20 ±1.0 dB
VSWR (All Ports)	
5-200 MHz	1.2:1 Max
0.5-400 MHz	1.5:1 Max
Directivity (Both Directions)	
0.5-50 MHz	30 dB Min
50-200 MHz	20 dB Min
200-400 MHz	15 dB Min
Main Line Loss**	
0.5-50 MHz	0.5 dB Max
50-200 MHz	0.4 dB Max
200-400 MHz	0.7 dB Max

Operating Characteristics

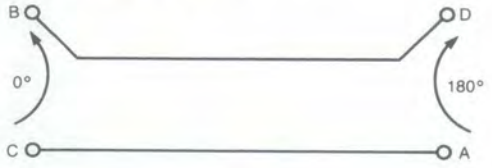
Input Power	3.0 Watts Max
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	C; P1, B; P2 A; P3, D; P4

*All specifications apply with 50 ohm source and load impedance.
**Includes theoretical power split.

Functional Diagram

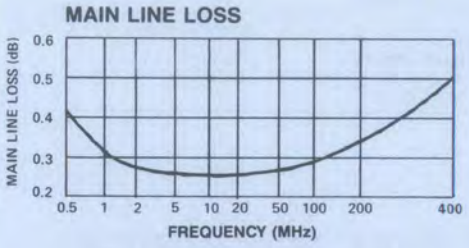


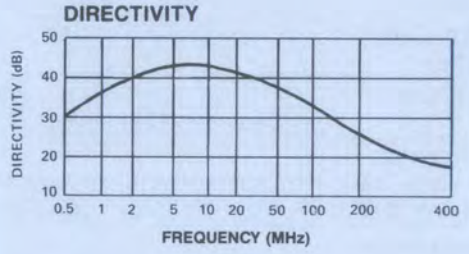
Ordering Information

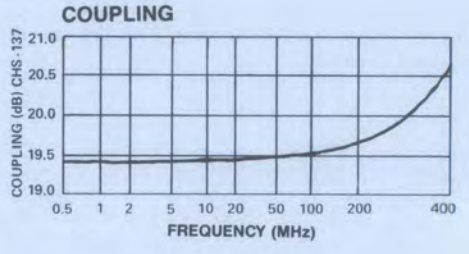
Model No.	Connectors	Unit Price (5-9 Units)
CHS-137	PIN	$54

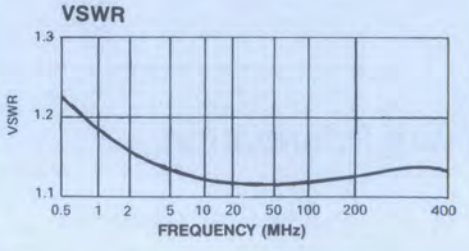
Delivery is from stock.

Typical Performance



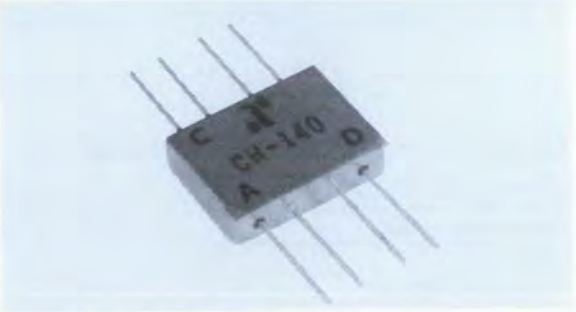






MODEL CH-140 — 20 dB DIRECTIONAL COUPLER 5-1000 MHz

- Broadband Flat Coupling
- 0.3 dB Typical Insertion Loss
- 30 dB Typical Directivity



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Coupling (Input to Output)		19.75 ±1 dB
Coupling Flatness		±0.5 dB
VSWR (All Ports)		1.35:1 Max
Directivity (Both Directions)	5-800 MHz	20 dB Min
	800-1000 MHz	17 dB Min
Main Line Loss**		0.75 dB Max

Operating Characteristics

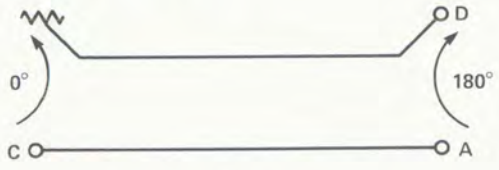
Input Power	3.0 Watts Max
Internal Power Dissipation	0.25 Watts
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	C; P1, A; P5, D; P8. Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

Functional Diagram

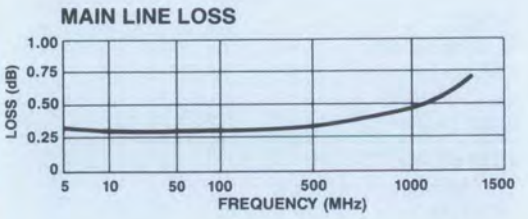


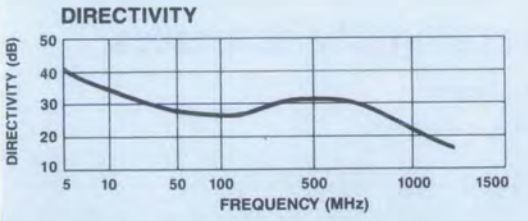
Ordering Information

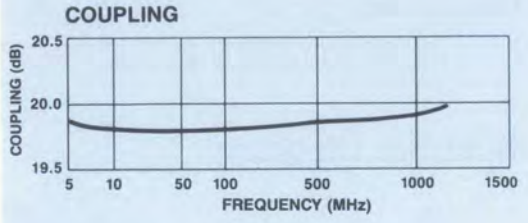
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
CH-140	6759	Pin	$60

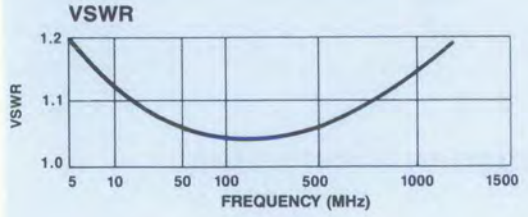
Delivery is from stock.

Typical Performance







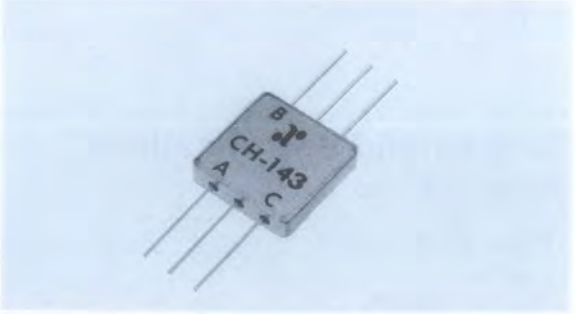


NEW

MODEL CH-143

20 dB DIRECTIONAL COUPLERS
500-2000 MHz

- Constant Coupling — Within ±0.75 dB Typical
- 20 dB Typical Midband Directivity
- Available in Flatpack
- Low Loss — 0.25 dB Typical



Guaranteed Specifications*
(From –54°C to +85°C)

Frequency Range	500-2000 MHz
Coupling (Input to Output)	22 dB ±1 dB
Coupling Flatness	±1.0 dB (Max)
VSWR (All Ports)	1.6:1 Max
Directivity	16 dB (Min)
Main Line Loss**	0.5 dB (Max)

Operating Characteristics

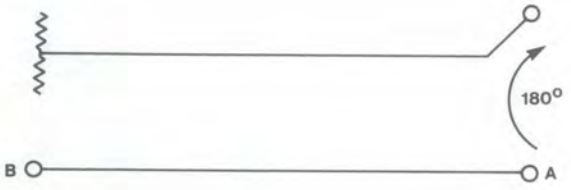
Input Power	2.0 Watts Max
Package Type	Flatpack (FP-1) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental requirements of Table 1A, page 496 of the Adams-Russell Catalog.

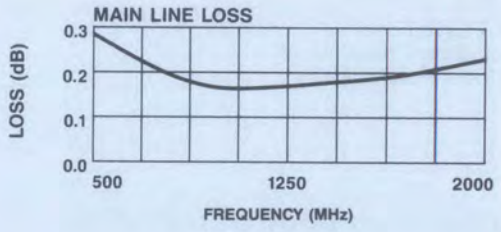
Pin Configuration
A; P4, B; P1, C; P3
Case and all other pins ground.

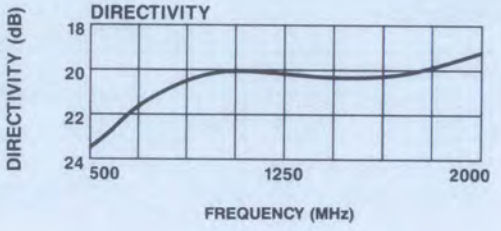
*All specifications apply with 50 ohm source and load impedance.
**Includes theoretical power split.

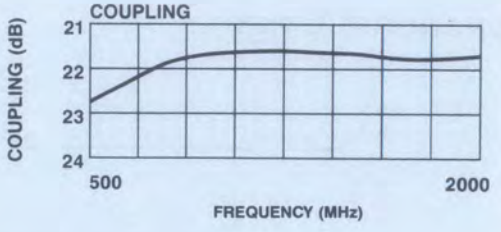
Functional Diagram

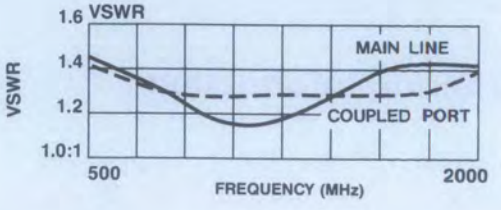


Typical Performance









Ordering Information

Model No.	Connectors	Unit Price (5-9 Units)
CHS-143	PIN	$75

Delivery is from stock.

MODEL DCG-10-4 — 11 dB DIRECTIONAL COUPLER 30-1000 MHz

- Wide Frequency Range
- Constant Coupling — Within ±0.5 dB

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	30-1000 MHz
Coupling (Input to Output)	11.25 ±0.5 dB
Coupling Flatness	±0.5 dB Max
VSWR (All Ports)	1.35:1 Max
Directivity (Both Directions)	20 dB Min
Main Line Loss (Including Theoretical 0.46 dB Power Split)	1.5 dB Max

Operating Characteristics

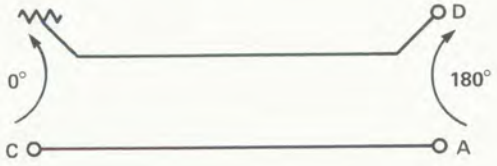
Input Power	5.0 Watts Max
Package Type	Connectorized (C-7) (See page 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

Functional Diagram

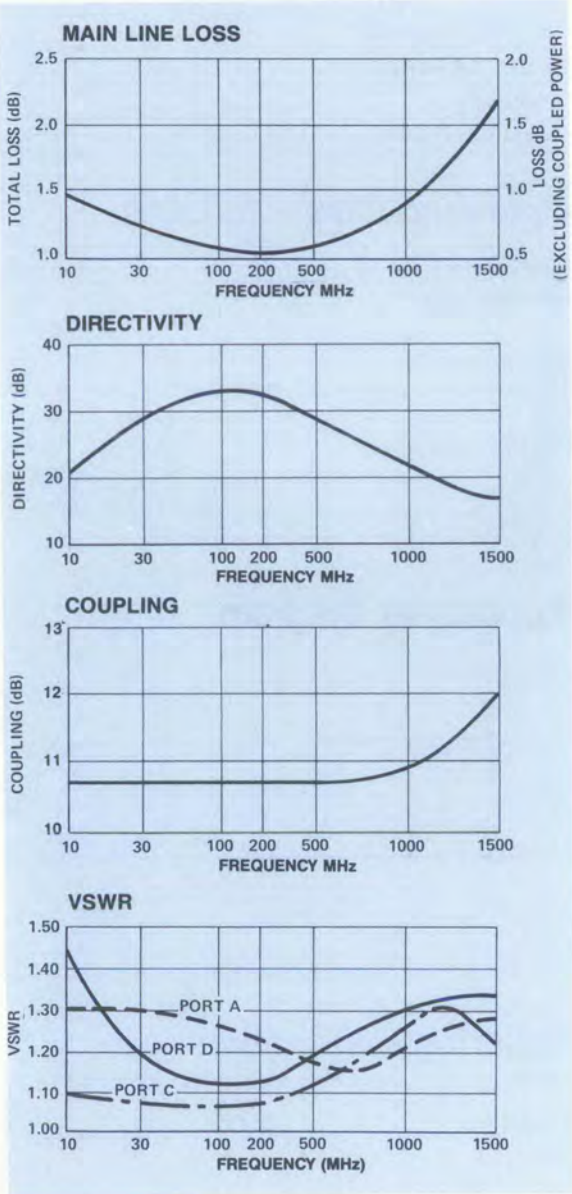


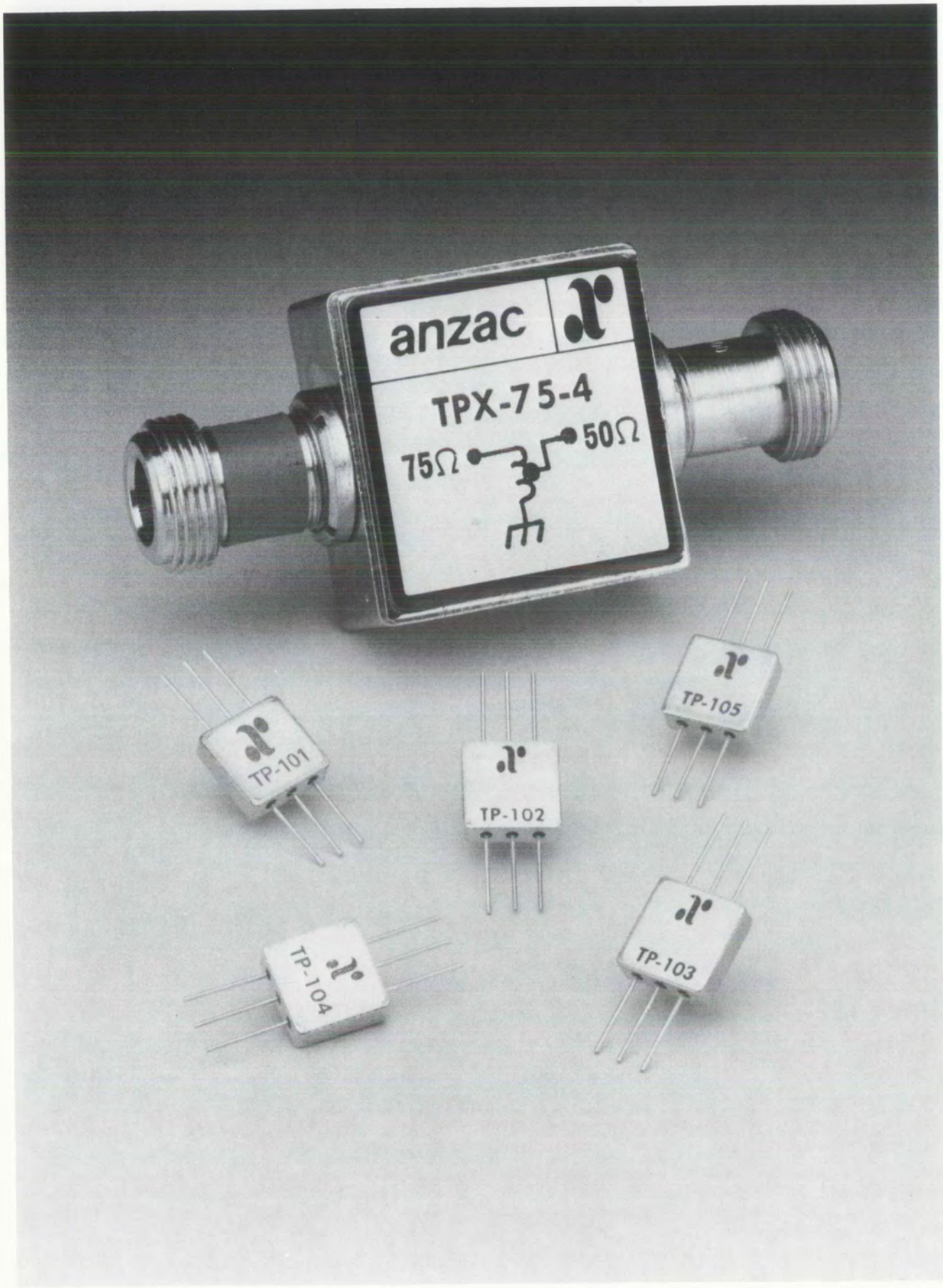
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DCG-10-4	8151	BNC	$131
DCG-10-4	8154	SMA	135

Delivery is from stock.

Typical Performance




anzac
TPX-75-4
75Ω
50Ω
TP-101
TP-102
TP-103
TP-104
TP-105

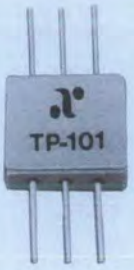
IMPEDANCE TRANSFORMER SELECTION GUIDE

MODEL NO.	FREQUENCY RANGE (MHz)	IMPEDANCE* PRIMARY (Ohms)	IMPEDANCE* SECONDARY (Ohms)	INSERTION LOSS (dB) TYP	VSWR TYP	POWER RATING (W)	CASE** STYLE	PAGE NO.
TRANSFORMERS								
TP-75	2-200	50 UNBAL	75 UNBAL	0.25	1.1:1	10	C-1	452
TP-104	0.75-400	50 UNBAL	200 BAL	0.4	1.2:1	1	FP-1	449
TP-102	1-500	50 UNBAL	200 UNBAL	0.6	1.2:1	1	FP-1	447
TP-103	0.5-1000	50 UNBAL	200 BAL	0.4	1.1:1	3	FP-1	448
TP-105	0.5-1000	50 UNBAL	12.5 UNBAL	0.2	1.1:1	1.5	FP-1	450
TP-108	350-1125	50 UNBAL	200 BAL	0.6	1.2:1	3	FP-1	451
TP-101	0.5-1500	50 UNBAL	50 BAL	0.4	1.1:1	3	FP-1	446
TPX-75-4	10-1500	50 UNBAL	75 UNBAL	0.25	1.1:1	2	C-5	453

*IMPEDANCE: BAL = BALANCED; UNBAL = UNBALANCED
**CASE STYLE: C = CONNECTORIZED; FP = FLATPACK
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL TP-101 — RF PULSE TRANSFORMER
500 kHz-1.5 GHz

- 50 Ohms Unbalanced/50 Ohms Balanced
- Fast Rise Time — 0.18 nS
- Low Insertion Loss — 0.4 dB Typ



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		500 kHz-1.5 GHz
Impedance		
Input		50 Ohms Unbalanced
Output		50 Ohms Balanced
Insertion Loss	10-50 MHz	0.5 dB Max
VSWR	1 MHz-1 GHz	1.4:1 Max
	750 kHz-1.5 GHz	1.6:1 Max

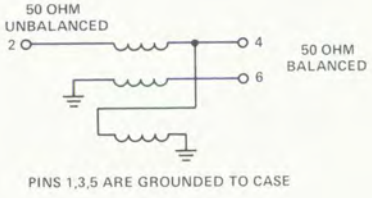
Operating Characteristics

Input Power	750 kHz-1 MHz	1.0 Watt Max
	1 MHz-5 MHz	1.5 Watts Max
	5 MHz-1.5 GHz	3.0 Watts Max
Rise Time (10-90%)		0.18 nS Typ
Droop (10%)		300 nS Typ
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)

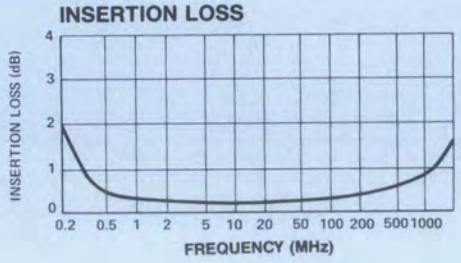
Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

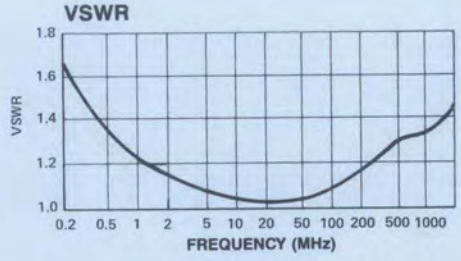
Schematic

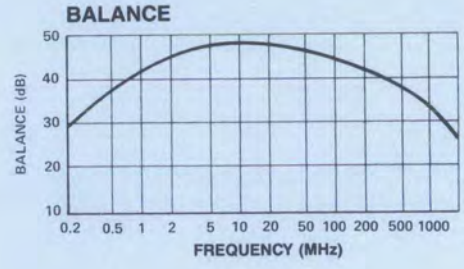
PIN CONFIGURATION:



Typical Performance







Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-101	9959	Pin	$29

Delivery is from stock.

MODEL TP-102 — RF PULSE TRANSFORMER 1-500 MHz

- 50 Ohms Unbalanced/ 200 Ohms Unbalanced
- Fast Rise Time — 0.35 nS
- Low Insertion Loss — 0.75 dB Typ

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		1-500 MHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Unbalanced
Insertion Loss	10-50 MHz	0.75 dB Max
VSWR	5-250 MHz	1.3:1 Max
	2-500 MHz	1.6:1 Max
	1-2 MHz	2.0:1 Max

Operating Characteristics

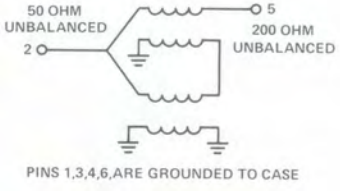
Input Power	1-5 MHz	0.5 Watt Max
	5 MHz-1 GHz	1.0 Watt Max
Rise Time (10-90%)		0.35 nS Typ
Droop (10%)		150 nS Typ
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

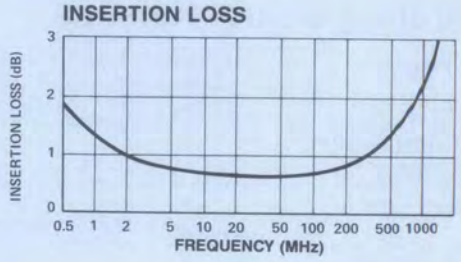
Schematic

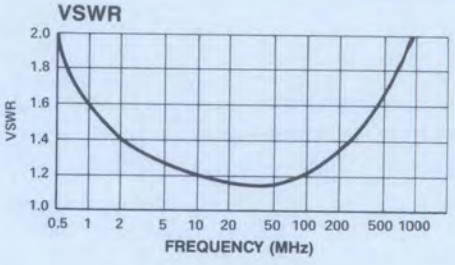
PIN CONFIGURATION:



PINS 1,3,4,6,ARE GROUNDED TO CASE

Typical Performance





Ordering Information

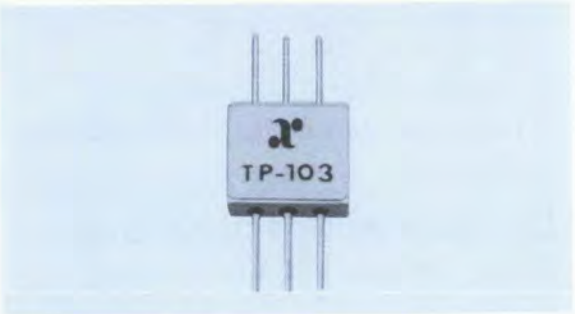
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-102	9969	Pin	$24

Delivery is from stock.

MODEL TP-103

RF PULSE TRANSFORMER
500 kHz-1 GHz

- 50 Ohms Unbalanced/ 200 Ohms Balanced
- Fast Rise Time — 0.18 nS
- Low Insertion Loss — 0.4 dB Typ



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		500 kHz-1 GHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Balanced
Insertion Loss	10-50 MHz	0.6 dB Max
VSWR	2-500 MHz	1.4:1 Max
	500 kHz-1 GHz	2.0:1 Max

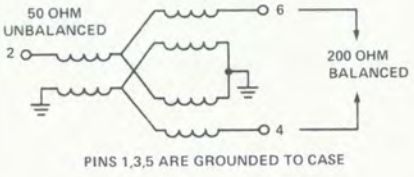
Operating Characteristics

Input Power	500 kHz-1 MHz	1.0 Watt Max
	1 MHz-5 MHz	1.5 Watts Max
	5 MHz-1 GHz	3.0 Watts Max
Rise Time (10-90%)		0.18 nS Typ
Droop (10%)		160 nS Typ
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

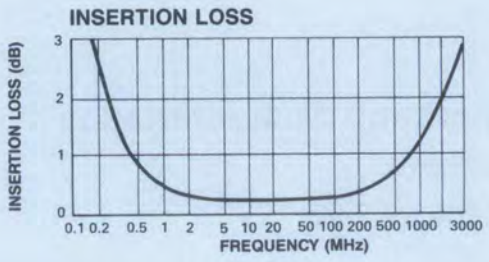
Schematic

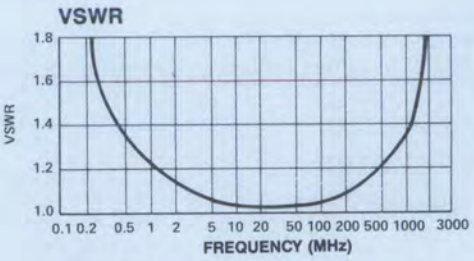
PIN CONFIGURATION:

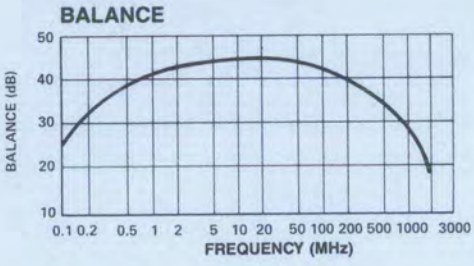


PINS 1,3,5 ARE GROUNDED TO CASE

Typical Performance







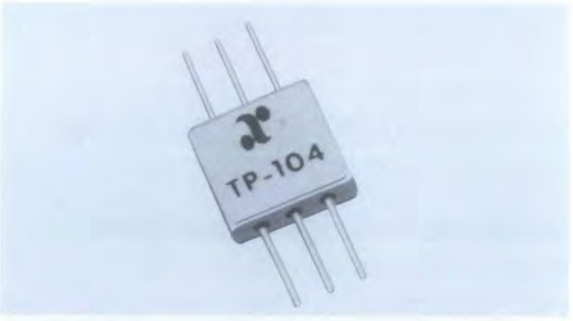
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-103	9979	Pin	$31

Delivery is from stock.

MODEL TP-104 — RF PULSE TRANSFORMER
750 kHz-400 MHz

- 50 Ohms Unbalanced/ 200 Ohms Balanced
- Low Insertion Loss — 0.4 dB Typ
- DC Isolation — Input to Output



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		750 kHz-400 MHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Balanced
Insertion Loss	10-50 MHz	0.55 dB Max
VSWR	5-200 MHz	1.3:1 Max
	750 kHz-400 MHz	2.0:1 Max

Operating Characteristics

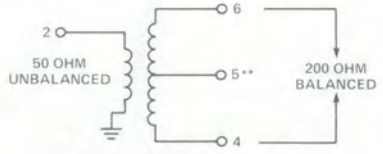
Input Power	750 kHz-4 MHz	0.4 Watts Max
	4-400 MHz	1.0 Watts Max
Rise Time (10-90%)		0.55 nS Typ
Droop (10%)		130 nS Typ
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

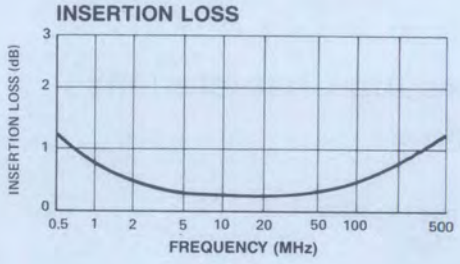
Schematic

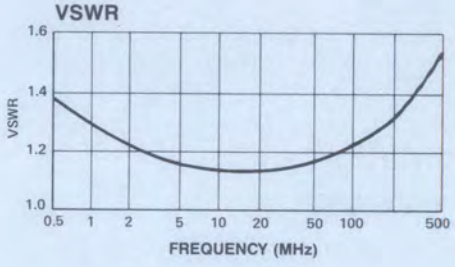
PIN CONFIGURATION:

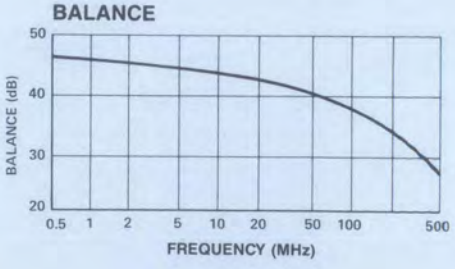


PINS 1 & 3 ARE GROUNDED TO CASE
**PIN 5 TO BE EXTERNALLY GROUNDED

Typical Performance







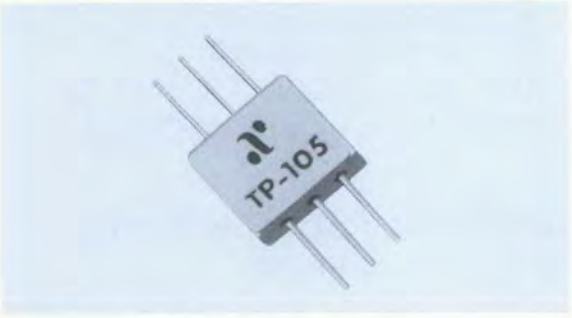
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-104	9989	Pin	$31

Delivery is from stock.

MODEL TP-105 — RF PULSE TRANSFORMER
500 kHz-1 GHz

- 50 Ohms Unbalanced/ 12.5 Ohms Unbalanced
- Low VSWR — 1.1:1 Typ
- Low Insertion Loss — 0.4 dB Typ



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		500 kHz-1 GHz
Impedance		
Input		50 Ohms Unbalanced
Output		12.5 Ohms Unbalanced
Insertion Loss	500 kHz-1 GHz	0.50 dB Max
VSWR	1-500 MHz	1.4:1 Max
	500 kHz-1 GHz	1.6:1 Max

Operating Characteristics

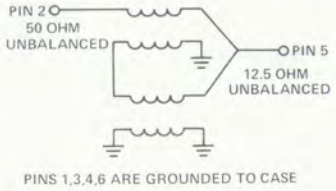
Input Power	500 kHz-1 MHz	0.375 Watts Max
	1 MHz-5 MHz	0.75 Watts Max
	5 MHz-1 GHz	1.5 Watts Max
Rise Time (10-90%)		0.3 nS Typ
Droop (10%)		350 nS Typ
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Schematic

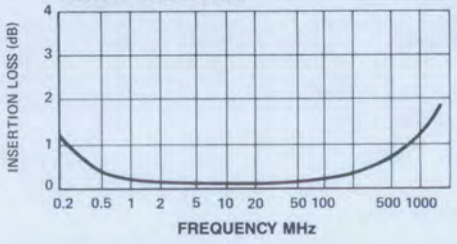
PIN CONFIGURATION:



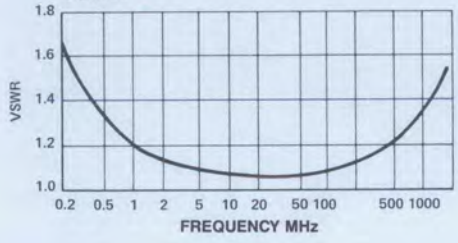
PINS 1,3,4,6 ARE GROUNDED TO CASE

Typical Performance

INSERTION LOSS



VSWR



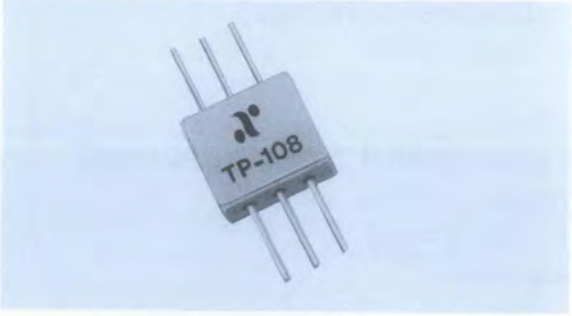
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-105	9949	Pin	$31

Delivery is from stock.

MODEL TP-108 — RF TRANSFORMER 350-1125 MHz

- 50 Ohms Unbalanced to Dual 100 Ohms Unbalanced or 200 Ohms Balanced
- Low Insertion Loss
- Accessible Center Tap for DC Bias



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		350-1125 MHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Balanced
Insertion Loss	500-1000 MHz	1.0 dB Max
VSWR	500-1000 MHz	1.5:1 Max
	350-1125 MHz	2.5:1 Max

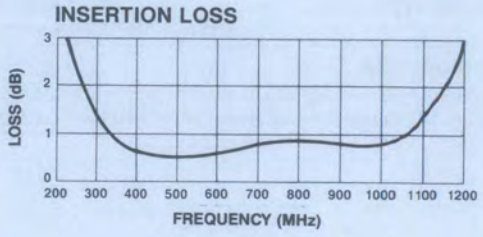
Operating Characteristics

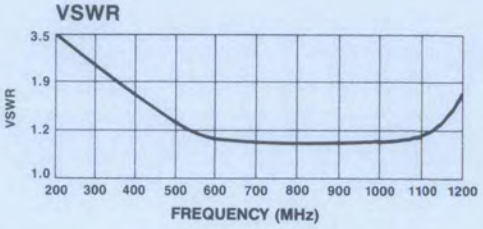
Input Power	350-1125 MHz	3.0 Watts Max
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

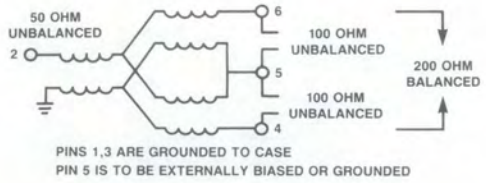
Typical Performance





Schematic

PIN CONFIGURATION:



Ordering Information

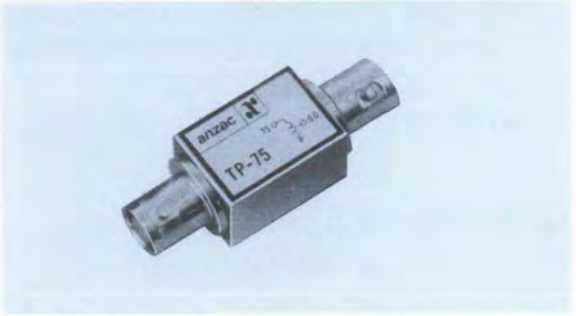
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-108	8099	Pin	$36

Delivery is from stock.

MODEL TP-75

50/75 OHM TRANSFORMER
2-200 MHz

- Low Insertion Loss
- Low VSWR



Guaranteed Specifications*
(From –55°C to +85°C)

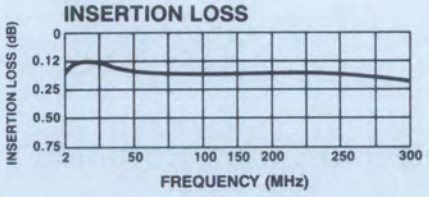
Frequency Range	2 - 200 MHz
Impedance	
Input	50 Ohms
Output	75 Ohms
Insertion Loss	
2-200 MHz	0.25 dB Max
VSWR	
2-100 MHz	1.35:1 Max
100-200 MHz	1.35:1 Max

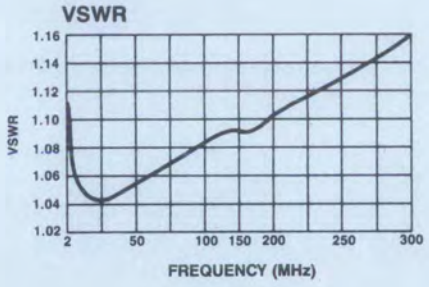
Operating Characteristics

Input Power	10 W Max
Package Type	TP-75 Connectorized (C-1) (See page 480 for physical dimensions.)

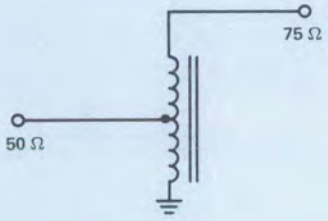
Environmental
These units are designed to meet the environmental requirements of Table 1A, page 496 of the Adams-Russell catalog.

Typical Performance





Schematic



Ordering Information

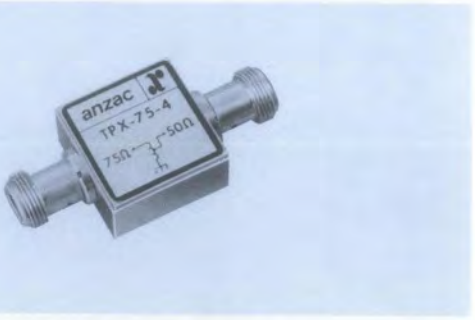
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TP-75	9321	BNC	$63
TP-75	9323	N	68
TP-75	9324	SMA	68

Delivery is from stock.

MODEL TPX-75-4

50/75 OHM TRANSFORMER
10-1500 MHz

- Low Insertion Loss
- Low VSWR



Guaranteed Specifications*
(From –55°C to +85°C)

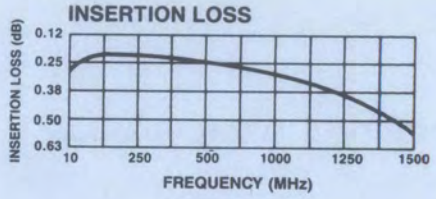
Frequency Range	10 -1500 MHz
Impedance	
Input	50 Ohms
Output	75 Ohms
Insertion Loss	
50-500 MHz	0.3 dB Max
10-1500 MHz	0.75 dB Max
VSWR	
10-1500 MHz	1.35:1 Max

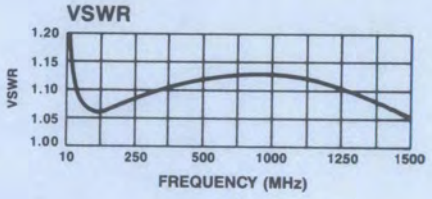
Operating Characteristics

Input Power	2 Watts Max
Package Type	TPX-75-4 Connectorized (C-5) (See page 481 for physical dimensions.)

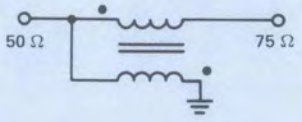
Environmental
These units are designed to meet the environmental requirements of Table 1A, page 496 of the Adams-Russell catalog.

Typical Performance





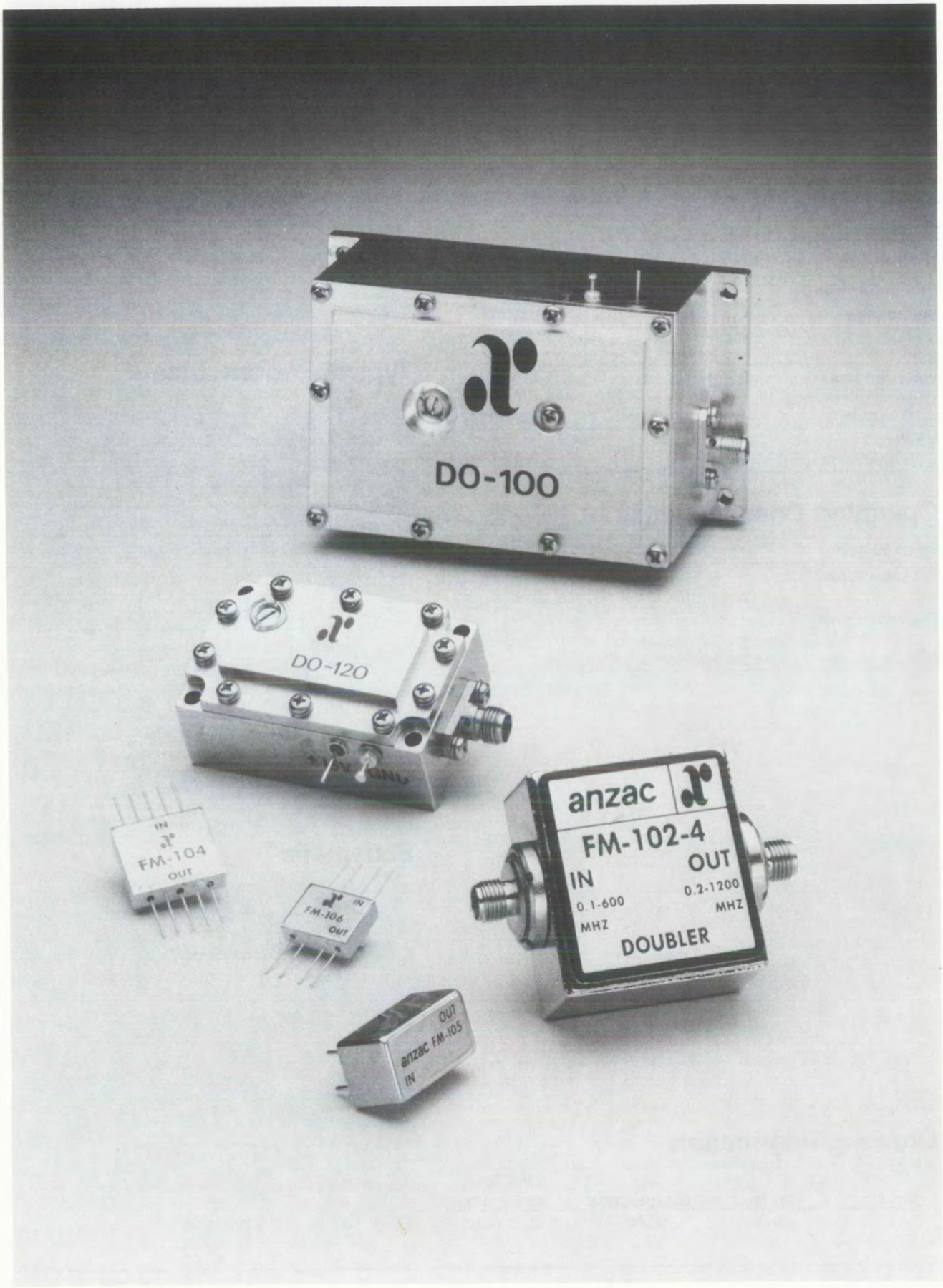
Schematic



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
TPX-75-4	8463	N	$104

Delivery is from stock.


DO-100
DO-120
IN
FM-104
OUT
IN
FM-106
OUT
anzac
FM-102-4
IN
OUT
0.1-600
MHZ
0.2-1200
MHZ
DOUBLER
OUT
anzac FM-105
IN

FREQUENCY GENERATION SELECTION GUIDE

MODEL NO.	FREQUENCY INPUT (MHz)	FREQUENCY OUTPUT (MHz)	CONVERSION LOSS (dB) TYP	SPURIOUS F1 (dB) TYP	REJECTION F3 (dB) TYP	VSWR TYP	CASE[1] STYLE	PAGE NO.
FREQUENCY DOUBLERS								
FM-102-4	0.1-600	0.2-1200	10	30	45	1.7:1	C-5	467
FM-105	10-750	20-1500	12	20	30	2.0:1	RH-3	469
D-1-4	**5-1000**	**10-2000**	**12**	**25**	**30**	**1.8:1**	**C-5**	**464**
D-6-4	50-1300	100-2600	12	35	40	1.8:1	C-5	466
FM-104	75-1500	150-3000	10	35	35	1.7:1	FP-3	468
D-5-4	30-2100	60-4200	11	35	40	1.8:1	C-5	465
FM-106	2000-3000	4000-6000	10	20	35	2.0:1	FP-2	470

MODEL NO.	FREQUENCY (GHz)	OUTPUT POWER (dBm) MIN	PHASE NOISE (dBc/Hz@10KHz) TYP	FREQUENCY STABILITY (ppm/°C)	SECOND HARMONIC (dBc) TYP	CASE[1] STYLE	PAGE NO.
DIELECTRIC RESONATOR OSCILLATORS							
DO-100	2.65	+10	-125	5	-90	C-31	460
DO-110	4.0	+10	-120	5	-90	C-29	461
DO-120	8.5	+10	-100	5	-90	C-30	462
DO-130	12.0	+10	-100	5	-90	C-30	463

[1]CASE STYLE: C = CONNECTORIZED; FP = FLATPACK; RH = RELAY HEADER
PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

DIELECTRIC RESONANT OSCILLATORS

INTRODUCTION

The Anzac Division of Adams-Russell has long been a supplier of frequency generation products through its doubler product line based on mixer technology and complete line of dielectric resonant oscillators. This article will focus on these oscillators to enhance the understanding of how they function and how best to use and specify the parameters of performance.

Dielectric Resonant Oscillators (DRO's) are microwave oscillators that use the unique properties of high-Q dielectric material as a resonator to stabilize the frequency of the free running sources. The DRO's offer an attractive alternate to conventional crystal multipliers or cavity stabilized oscillators by providing a high efficiency, low noise, very stable source with small size and lower cost as added benefits.

DRO OPERATION

A dielectric resonator oscillator is a free running oscillator stabilized by the insertion of a high Q dielectric resonator into the circuit. A block diagram of a typical DRO is shown in Fig. 1. As shown in the figure, the basic oscillator consists of an active device coupled to the dielectric resonator (DR) through a transmission line coupling structure. Fine tuning adjustments are made via mechanical means which affect the resonance of the DR. Also shown is an optional electrical tuning function accomplished using additional circuitry. Finally, a buffer stage is normally required to isolate the oscillator from the load circuits. This buffer stage can be implemented using an attenuator pad, an isolator, or an amplifier.

Other options not shown in Fig. 1 are temperature compensation circuits such as ovens and electrical (analog or digital) compensation circuits which provide tight control of the oscillation frequency. A PIN modulator can be added in the output to provide amplitude modulation.

Dielectric resonant oscillators can operate from 1 to 35 GHz. Due to the dimensions of the dielectric resonators (see Figure 4) required at these frequencies, size of the resonators usually restrict the use of DRO's to between 3-18 GHz. Anzac, in this catalog, offers units from 2.65 GHz (3.5″ x 1.92″ x 1.66″) to 12 GHz (1.88″ x 1.15″ x 0.77″).

Power output of a DRO is dependent on the type of active element selected, frequency of operation required, buffering required and efficiency desired. A DRO will have an output of +1 to +17 dBm, depending on active device and frequency of operation. Buffering can be either active or passive and can be used to set desired output level. Typical Anzac DRO output levels are +10 dBm.

The performance of a DRO is determined by many factors. The most important factors are: resonator characteristics (temperature coefficient and Q-factor), the active device characteristics, substrate material, enclosure dimensional temperature coefficient, circuit topology, circuit design and mechanical design.

TYPES OF OSCILLATORS

There are three basic types of oscillators. Shunt feedback DRO (Fig. 2.1) Series feedback DRO (Fig 2.2), and reflection type DRO (Fig 2.3).

In all three cases, the dielectric resonator is placed close to a section of microstrip line in such a way that it is operated in its lowest order cylindrical TE01δ mode. The electromagnetic field of the coupling pattern to the microstrip line is shown in Fig. 3.

In the shunt feedback DRO, the DR is coupled to two microstrip lines while in two other types of DROs it is coupled only to one microstrip line.

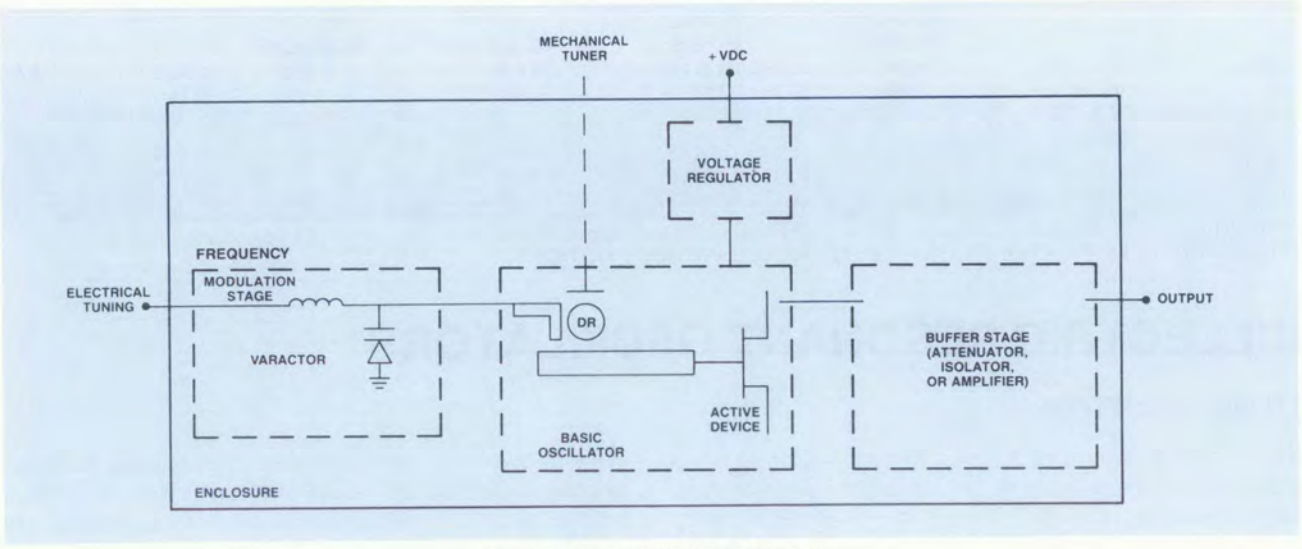


Figure 1. Basic DRO Block Diagram.

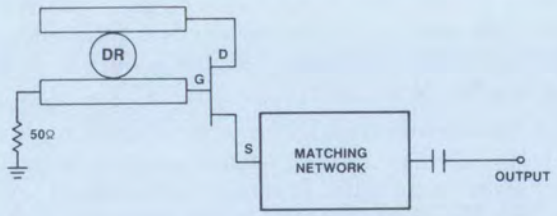


Figure 2.1. Shunt Feedback DRO

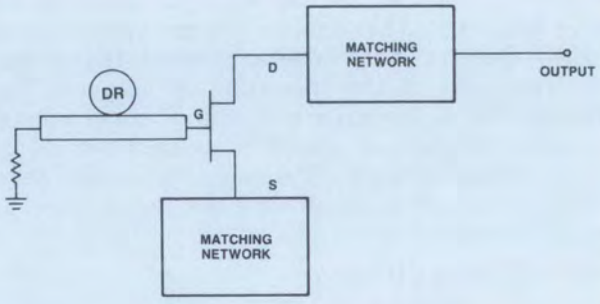


Figure 2.2. Series Feedback DRO

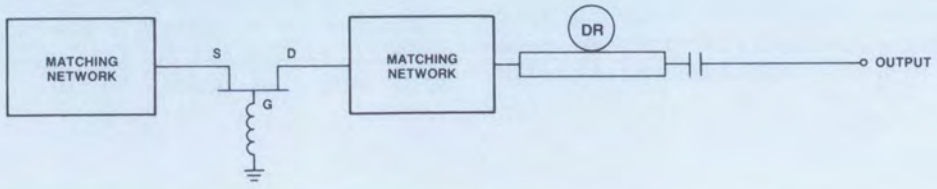


Figure 2.3. Reflection Type DRO

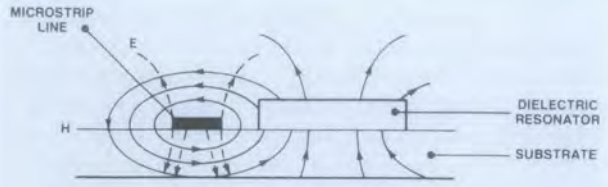


Figure 3. Coupling of a TE01δ Mode Between DR and Microstrip Line.

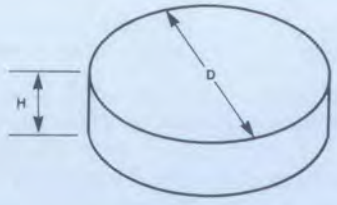
ACTIVE DEVICES

The most commonly used active devices are bipolar transistors up to 10 GHz, and GaAs MESFETS from 4 GHz up to K band. The bipolar transistor has better FM noise than the GaAs FET but can not deliver sufficient power with a good efficiency above 8 GHz. A GUNN diode is used in X to K band only in applications where the DRO has to have very low FM and AM noise and the efficiency is not a critical parameter.

RESONATOR PARAMETERS

The heart of a DRO is the dielectric resonator. The resonator is characterized by its mechanical dimensions (height and diameter) and the material it is made of; usually a barium titanate based material with dielectric constant of about 38. Sizes of several commonly used resonators appear in Fig. 4.

The unloaded Q of such a resonator is about 7000 at 4GHz, giving the oscillator its excellent phase noise performance. The temperature coefficients of dielectric resonators vary between −10 to +10ppm/°C, giving the oscillator its good temperature stability.



FREQ.	DIAMETER (D)	HEIGHT (H)
4 GHz	0.550	0.240
6 GHz	0.360	0.160
8 GHz	0.280	0.120
10 GHz	0.220	0.095
12 GHz	0.185	0.083
17 GHz	0.125	0.050

Figure 4. Dielectric Resonator Dimensions.

PHASE NOISE AND QUALITY FACTORS

One of the most important characteristics of a DRO is its phase noise. The phase noise is determined by several factors, among which are the active device parameters, its bias point, and the noise induced by the voltage regulator. But the most important factor is the oscillator loaded Q-factor. The oscillator Q-factor is determined by the DRO Q-factor and by the loading elements in the tuning circuit as described in Fig. 5.

From Fig. 5, it can be shown that a high unloaded Q-factor of a resonator does not guarantee a high loaded Q-factor of the overall oscillator circuit. For example, both R_S and R_L, which effect Q-loaded, are determined by circuitry external to the resonator itself. A high Q-loaded is desirable to obtain maximum stability and low phase noise. Setting the level of Q-loaded is considered the most critical step in the oscillator design.

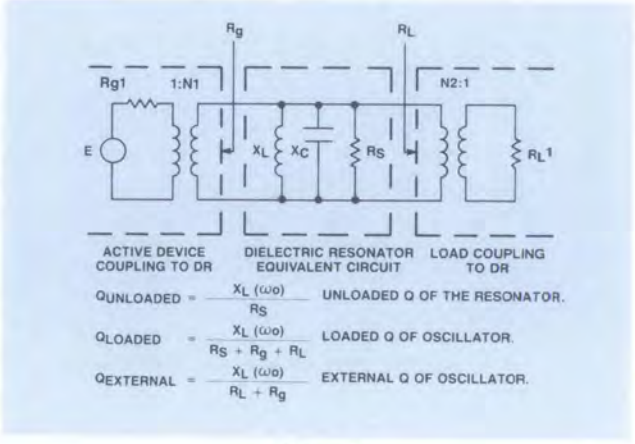


Figure 5.

MECHANICAL TUNING

Figure 6 is a diagram showing the typical mechanical construction of a dielectric resonator oscillator. A mechanical tuner is used which varies the air gap above the resonator and ground potential. Varying the air gap affects the fields in the vicinity of the resonator, and thus, slightly changes its resonant frequency.

Figure 7 shows the mechanical tuning characteristics of a 12 GHz DRO. Resonant frequency shifts upward for decreasing air gap d. As noted in the figure, as the air gap diminishes, the resonator loses it's good Q factor and temperature stability because of the excessive influence of the mechanical tuner. As a result, for good phase noise and temperature stability, mechanical tuning range is limited to about ± 1%.

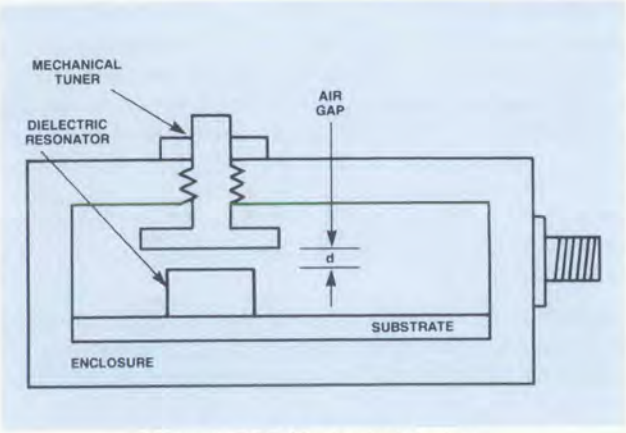


Figure 6. DRO Mechanical Tuning.

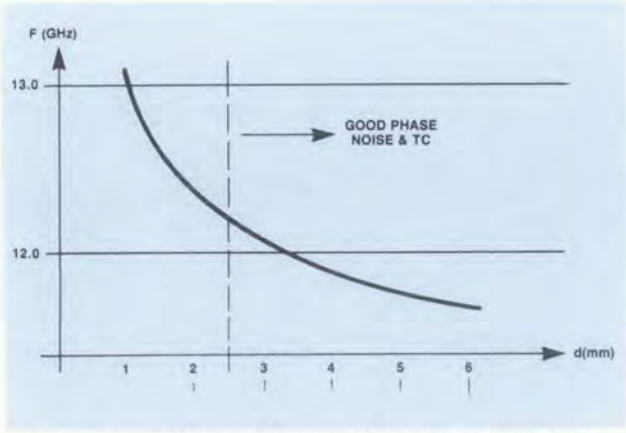


Figure 7. 12 GHz DRO Mechanical Tuning Characteristic.

ELECTRICAL TUNING

Electrical tuning of a DRO is achieved by coupling a varactor to the dielectric resonator. In order to maintain desired performance of the dielectric resonator (Q-factor & temperature stability), the varactor can only be slightly coupled giving a limited range of electrical tuning. Usually the electrical tuning range will be about ± 1%.

BUFFER STAGE

To reduce pulling effects due to load impedance changes, a buffer stage is added in the output of the oscillator. The three most commonly used devices as buffers are attenuators, isolators and amplifiers. An attenuator pad is the most economical approach. It is used when output power or overall efficiency is not important. An amplifier is used especially at lower frequencies (below 12 GHz) where gain and output power are easily achieved. This is especially true in cases where the required output power cannot be achieved with a single FET oscillator. An isolator is the most DC power efficient method of buffering. Since isolators become larger at lower frequencies, isolators are used at higher frequencies or when overall DRO size is not critical. Anzac uses isolators in it higher frequency units and pads in the lower frequency units where output power is more readily available.

SUMMARY

Understanding the basic principle of DRO design and operation illustrates the basis of DRO performance and the possible trade-offs. A well designed DRO offers state-of-the-art phase noise performance and frequency stability in the smallest achievable size. Standard catalog models offers such performance and cover frequencies from 2 to 12 GHz. Catalog units can be set to any frequency within this range on a custom order basis.

DROs can also be custom-designed to meet a specific requirement. Custom design can involve:

1. Setting of desired frequency
2. Setting of output power
3. Trade-offs in parameters
   (e.g. phase noise vs. tuning range)
4. Specification of options
   (e.g. temperature compensation, varactor tuning)
5. Custom package outline
6. Environmental requirements

A glossary of DRO parameters are provided in the appendix. The listed parameters are those most commonly used to specify a DRO.

Anzac's Dielectrically Resonant Oscillator product line was developed for the performance applications of today's systems. The catalog units offer the highest performance available today. Anzac's DRO's offer the following performance:

- Frequency Stability: 5 ppm/°C
- FM Phase Noise: −90 dBc/Hz (@fo ±10 KHz)
- Power Output: +10 dBm Minimum
- Power Variation: ±2 dB (−55 to +85°C)

This performance is guaranteed and ready for delivery from stock. Modified units for specific frequency of operation other than those listed are available on short delivery. Frequency Generation Products from Adams-Russell Electronics, Anzac Division. . .State of the Art products for your source needs.

APPENDIX

DEFINITIONS OF DRO PARAMETERS

Mechanical Tuning Range: The output frequency range over which the oscillator can be mechanically tuned and meet all of its specifications.

Output Power: The minimum output power that the oscillator will deliver under all conditions.

Output Power vs. Temperature: Peak to peak deviation in the output power when the temperature varies from minimum to maximum operational temperature.

Frequency Stability: The maximum frequency change over the specified operating temperature range. Usually expressed as parts per-million-per one degree Celsius (ppm/°C).

Pushing: The change in the output frequency caused by a change in the supply voltage. Measured in terms of MHz/V.

Pulling: The peak to peak change in the output frequency when the phase angle of the load reflection coefficient is changed through 360°. Usually the load will be 2:1 VSWR.

The peak to peak change in the frequency is given approximately by:

$$Fp\text{-}p = 0.5\ (S\text{-}1/S)\ Fo/Qext$$

where S is the load VSWR, Fo is the output frequency and Qext is the external Q-factor.

Phase Noise: The random fluctuations in an oscillator output frequency. It is measured either in dBc or as RMS frequency deviation in a specified bandwidth at a specified frequency away from the carrier. See Figure 8.

Harmonics: The amplitude level of signals at frequencies which are an integer multiplication of the output frequency. Usually measured relative to the amplitude of the output frequency signal and is expressed in decibels relative to the carrier (dBc).

Spurious Signals: Signals which are not an integer multiplication of the output frequency. Again measured in terms of dBc.

Aging: The long term frequency stability of an oscillator. Usually expressed in terms of ppm per day, month or year.

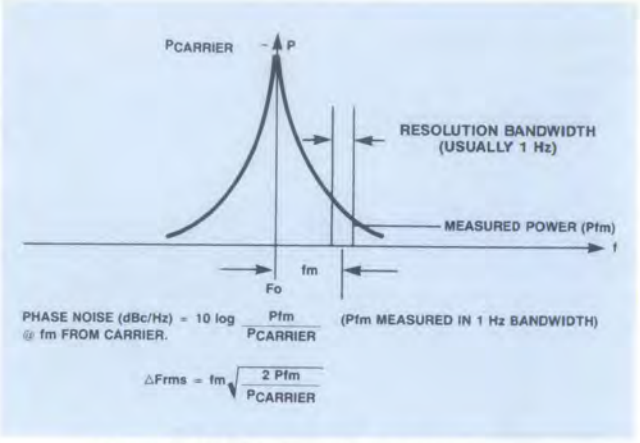


Figure 8. Defining Phase Noise Parameters

MODEL DO-100 DIELECTRICALLY STABILIZED OSCILLATOR 2.65 GHz

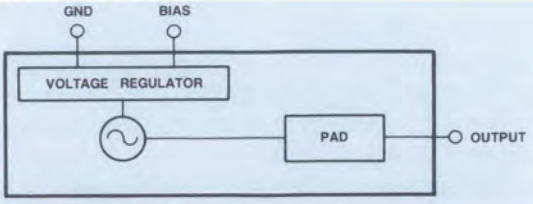
- Low Phase Noise, – 120 dBc/Hz Typ (@ fo ± 10 kHz)
- Stable With Temperature, 2 ppm/°C Typ
- Internal Voltage Regulator
- Custom Models Available in the Frequency Range of 2.5 to 4.0 GHz

Guaranteed Specifications*

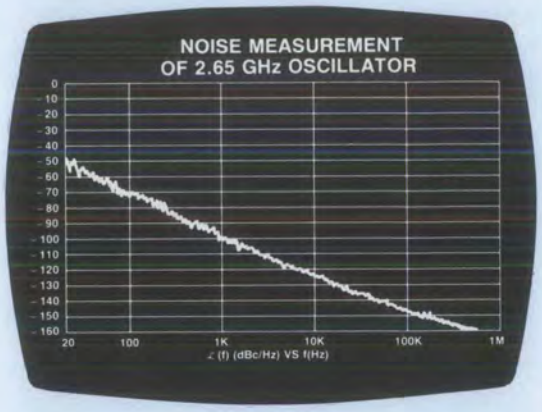
(From – 55°C to + 85°C Case Temp)

Frequency	2.65 GHz
Mechanical Tuning	± 5 MHz Min
Output	
Power	+ 10 dBm Min
Power vs Temperature	± 1 dB Max
Frequency Stability	5 ppm/°C
Pushing (@ ± 1V)	± 5 kHz Max
Pulling (@ 2:1 all phases)	± 200 kHz Max
Phase Noise (@ fo ± 10 kHz)	– 110 dBc/Hz Max
Bias	+ 15 to + 20 VDC, 75 mA Max Reverse Voltage Protected

Schematic



Typical Performance



Operating Characteristics

Harmonics	– 20 dBc Typ
Spurious	– 90 dBc Typ
Connectors	
RF	SMA
DC	Solder Feedthru
Package Type	Connectorized (C-31) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply at + 15 VDC and 50 ohm load impedance unless noted. Customized versions at other frequencies, output power and temperature stabilities are available. Consult factory.

Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DO-100	6564	SMA	$1071

Delivery is from stock.

MODEL DO-110 DIELECTRICALLY STABILIZED OSCILLATOR 4.0 GHz

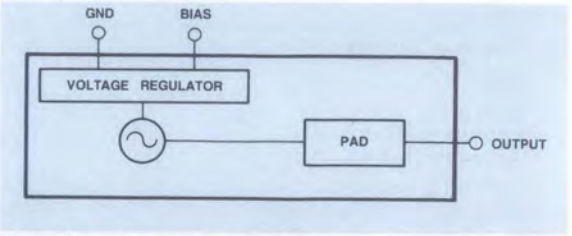
- Low Phase Noise, – 110 dBc/Hz Typ (@ fo ± 10 kHz)
- Stable With Temperature, 2 ppm/°C Typ
- Internal Voltage Regulator
- Custom Models Available in the Frequency Range of 4 to 8 GHz

Guaranteed Specifications*

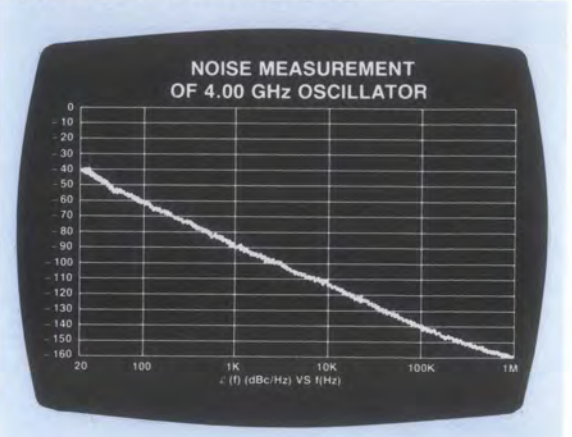
(From – 55°C to + 85°C Case Temp)

Frequency	4.00 GHz
Mechanical Tuning	± 5 MHz Min
Output	
Power	+ 10 dBm Min
Power vs Temperature	± 1.5 dB Max
Frequency Stability	5 ppm/°C
Pushing (@ ± 1V)	± 10 kHz Max
Pulling (@ 2:1 all phases)	± 300 kHz Max
Phase Noise (@ fo ± 10 kHz)	– 100 dBc/Hz Max
Bias	+ 10 to + 18 VDC, 75 mA Max Reverse Voltage Protected

Schematic



Typical Performance



Operating Characteristics

Harmonics	– 25 dBc Typ
Spurious	– 90 dBc Typ
Connectors	
RF	SMA (Removable)
DC	Solder Feedthru
Package Type	Connectorized (C-29) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply at + 15 VDC and 50 ohm load impedance unless noted. Customized versions at other frequencies, output power and temperature stabilities are available. Consult factory.

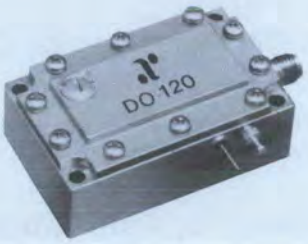
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DO-110	6574	SMA	$1160

Delivery is from stock.

MODEL DO-120 DIELECTRICALLY STABILIZED OSCILLATOR 8.5 GHz

- Low Phase Noise, –95 dBc/Hz Typ (@ fo ± 10 kHz)
- Stable With Temperature, 2 ppm/°C Typ
- Internal Isolator
- Internal Voltage Regulator
- Custom Models Available in the Frequency Range of 8 to 10 GHz

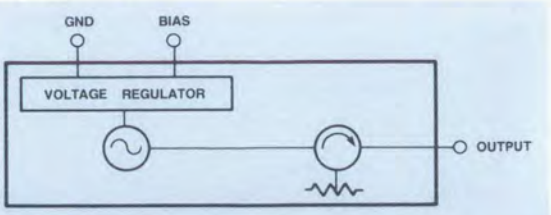


Guaranteed Specifications*

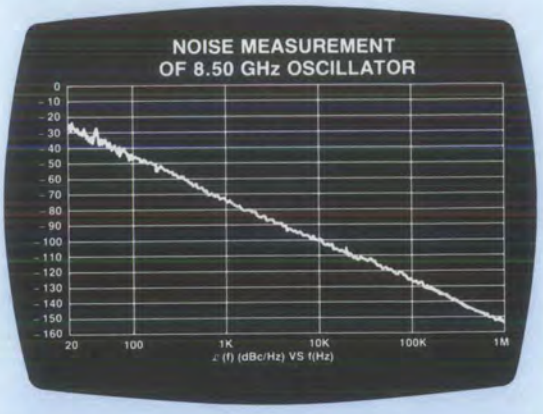
(From –55°C to +85°C Case Temp)

Frequency	8.50 GHz
Mechanical Tuning	± 10 MHz Min
Output	
Power	+ 10 dBm Min
Power vs Temperature	± 2 dB Max
Frequency Stability	5 ppm/°C
Pushing (@ ± 3V)	± 20 kHz Max
Pulling (@ 2:1 all phases)	± 500 kHz Max
Phase Noise (@ fo ± 10 kHz)	– 90 dBc/Hz Max
Bias	+ 10 to + 18 VDC, 75 mA Max Reverse Voltage Protected

Schematic



Typical Performance



Operating Characteristics

Harmonics	– 25 dBc Typ
Spurious	– 90 dBc Typ
Connectors	
RF	SMA (Removable)
DC	Solder Feedthru
Package Type	Connectorized (C-30) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply at + 15 VDC and 50 ohm load impedance unless noted. Customized versions at other frequencies, output power and temperature stabilities are available. Consult factory.

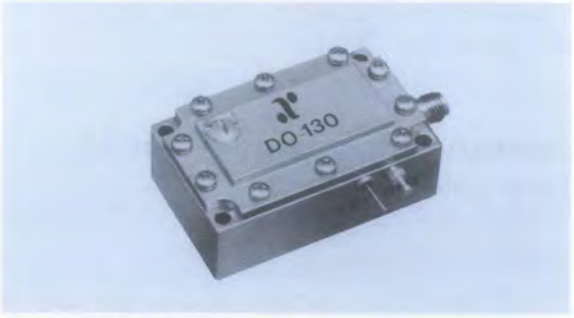
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DO-120	6584	SMA	$1384

Delivery is from stock.

MODEL DO-130 DIELECTRICALLY STABILIZED OSCILLATOR 12.0 GHz

- Low Phase Noise, –95 dBc/Hz Typ (@ fo ± 10 kHz)
- Stable With Temperature, 2 ppm/°C Typ
- Internal Isolator
- Internal Voltage Regulator
- Custom Models Available in the Frequency Range of 10 to 13 GHz

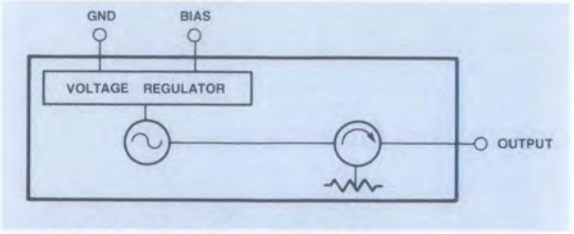


Guaranteed Specifications*

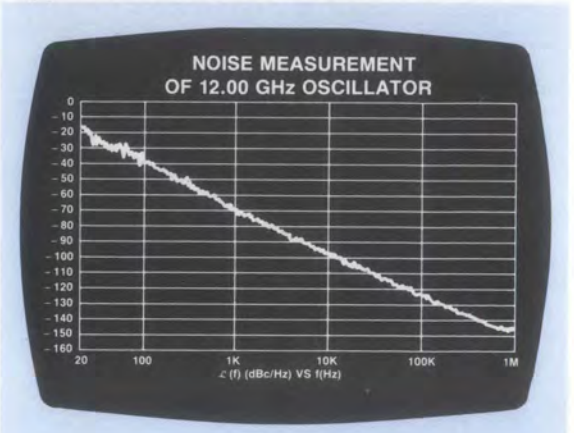
(From – 55°C to + 85°C Case Temp)

Frequency	12.0 GHz
Mechanical Tuning	± 15 MHz Min
Output	
Power	+ 10 dBm Min
Power vs Temperature	± 2 dB Max
Frequency Stability	5 ppm/°C
Pushing (@ ± 3V)	± 20 kHz Max
Pulling (@ 2:1 all phases)	± 500 kHz Max
Phase Noise (@ fo ± 10 kHz)	– 90 dBc/Hz Max
Bias	+ 10 to + 18 VDC, 75 mA Max Reverse Voltage Protected

Schematic



Typical Performance



Operating Characteristics

Harmonics	– 25 dBc Typ
Spurious	– 90 dBc Typ
Connectors	
RF	SMA (Removable)
DC	Solder Feedthru
Package Type	Connectorized (C-30) (See page 485 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply at + 15 VDC and 50 ohm load impedance unless noted. Customized versions at other frequencies, output power and temperature stabilities are available. Consult factory.

Ordering Information

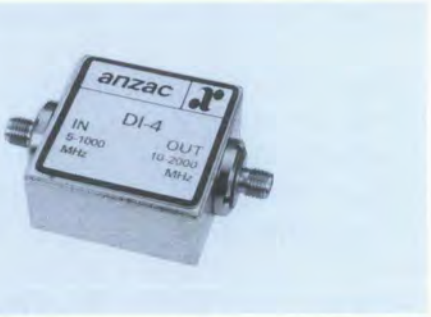
Model No.	Part No.	Connectors	Unit Price (5-9 Units)
DO-130	6594	SMA	$1518

Delivery is from stock.

NEW

MODEL D-1-4 BROADBAND FREQUENCY DOUBLER 10 MHz-2.0 GHz OUTPUT

- Conversion Loss — 13 dB Max
- Untuned



Guaranteed Specifications*

(From −55°C to +85°C)

Input Frequency Range		5 MHz-1 GHz
Output Frequency Range		10 MHz-2 GHz
Conversion Loss*		13 dB Max @ 20 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	5-500 MHz	−20 dB
	0.5-1.0 GHz	−10 dB
F_3	15-1500 MHz	−20 dB
	1.5-3.0 GHz	−15 dB

Operating Characteristics

Typical Input VSWR	5-500 MHz	1.8:1
	500 MHz-1 GHz	2.5:1
Typical Conversion Loss as Quadrupler		25 dB
Input/Output Impedance		50 Ohms
Maximum Input Power		0.5 Watt
Package Type		Connectorized (C-5)
		(See page 481 for physical dimensions.)

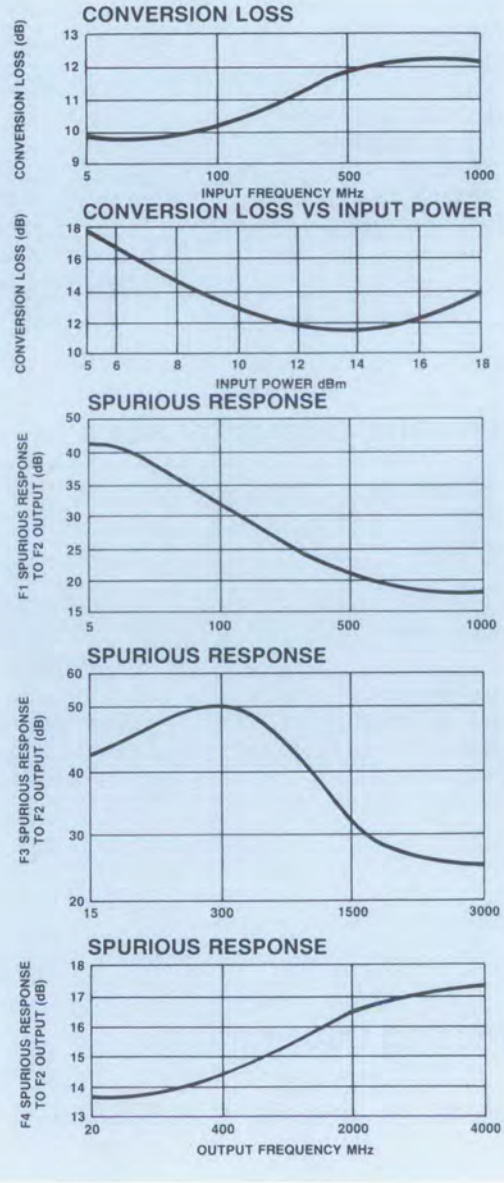
Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*Optimum Input. Output 3 dB down @ 7 mW and @ 100 mW input.

*All specifications apply when operated at +13 dBm input power 50 ohm source and load impedance.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
D-1-4	8181	BNC	$54
D-1-4	8184	SMA	59

Delivery is from stock.

MODEL D-5-4 BROADBAND FREQUENCY DOUBLER 60 MHz - 4.2 GHz OUTPUT

- Conversion Loss — 13 dB Max
- Untuned

Guaranteed Specifications*

(From −55°C to +85°C)

Input Frequency Range		30 MHz-2.1 GHz
Output Frequency Range		60 MHz-4.2 GHz
Conversion Loss*		13 dB Max @ 30 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	30-500 MHz	−25 dB
	0.5-2.1 GHz	−15 dB
F_3	90-1500 MHz	−30 dB
	1.5-6.3 GHz	−20 dB

Operating Characteristics

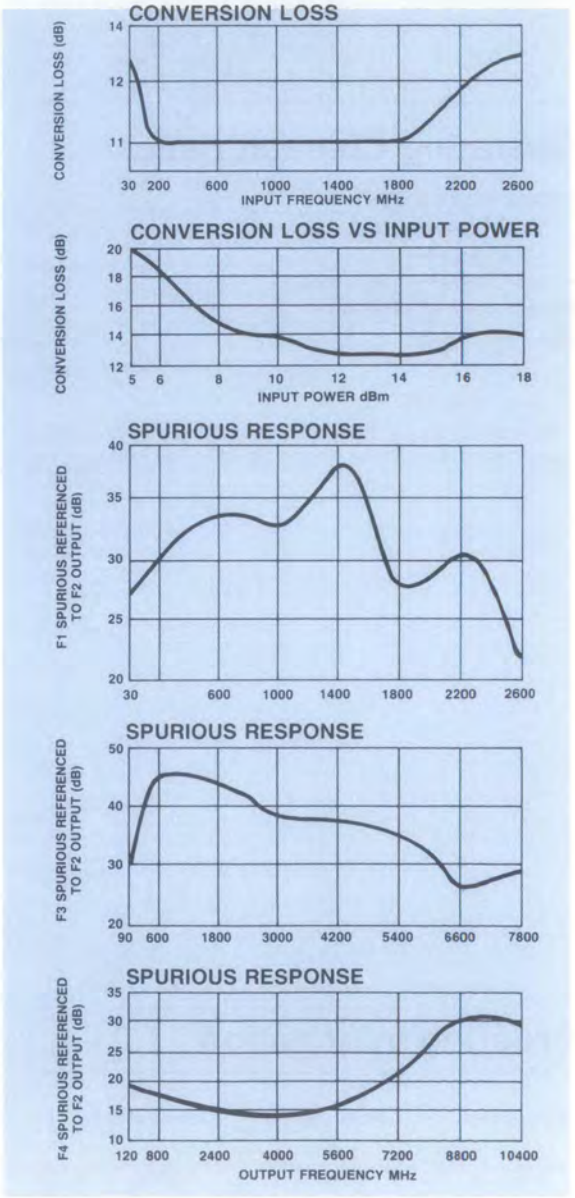
Typical Input VSWR	30 MHz-1 GHz	1.5:1
	1-2.1 GHz	1.8:1
Typical Conversion Loss as Quadrupler		26 dB
Input/Output Impedance		50 Ohms
Maximum Input Power		1.0 Watt
Package Type		Connectorized (C-5)
		(See page 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply when operated at +13 dBm input power 50 ohm source and load impedance.

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
D-5-4	8193	N	$308
D-5-4	8194	SMA	308

Delivery is from stock.

MODEL D-6-4 BROADBAND FREQUENCY DOUBLER 100 MHz-2.6 GHz OUTPUT

- Conversion Loss — 13 dB Max
- Untuned

Guaranteed Specifications*

(From −55°C to +85°C)

Input Frequency Range		50 MHz-1.3 GHz
Output Frequency Range		100 MHz-2.6 GHz
Conversion Loss*		13 dB Max @ 20 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	50-500 MHz	−25 dB
	0.5-1.3 GHz	−15 dB
F_3	150-1500 MHz	−30 dB
	1.5-3.9 GHz	−20 dB

Operating Characteristics

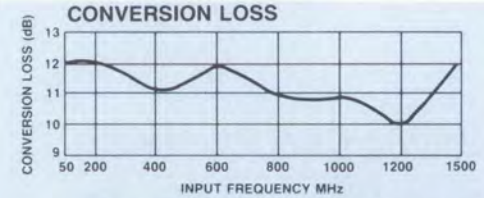
Typical Input VSWR	1.7:1
Typical Conversion Loss as Quadrupler	26 dB
Input/Output Impedance	50 Ohms
Maximum Input Power	1.0 Watt
Package Type	Connectorized (C-5) (See page 481 for physical dimensions.)

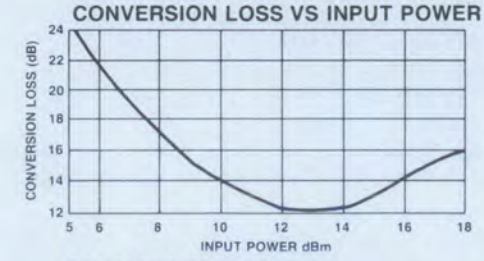
Environmental

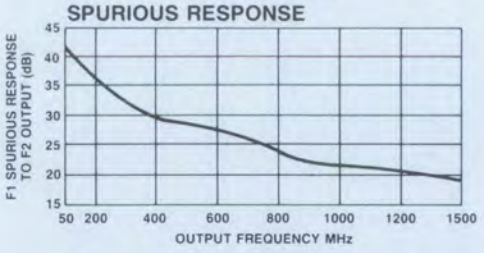
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

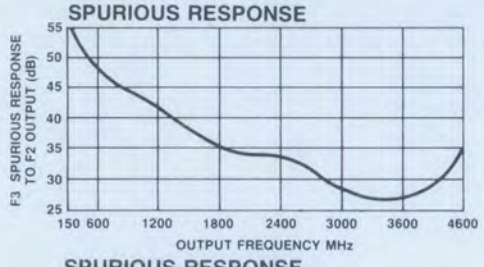
*All specifications apply when operated at +13 dBm input power 50 ohm source and load impedance.

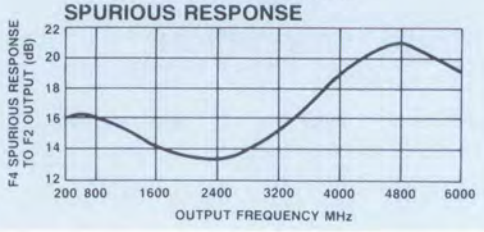
Typical Performance











Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
D-6-4	8353	N	$107
D-6-4	8354	SMA	107

Delivery is from stock.

MODEL FM-102-4 BROADBAND FREQUENCY DOUBLER 200 kHz-1.2 GHz OUTPUT

- Conversion Loss — 13 dB Max
- Untuned

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		100 kHz-600 MHz
Output		200 kHz-1.2 GHz
Conversion Loss*		12 dB Max @ 20 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	0.1-200 MHz	−24 dB
	200-600 MHz	−18 dB
F_3	0.3-600 MHz	−35 dB
	600-1800 MHz	−24 dB

Operating Characteristics

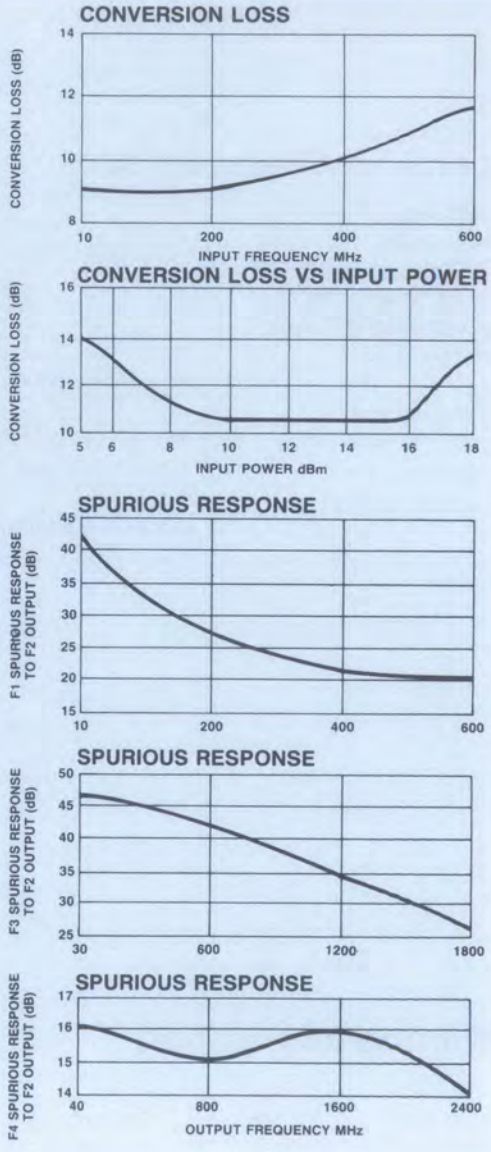
Maximum Input Power	0.5 Watt
Typical Input VSWR	1.5:1
Input/Output Impedance	50 Ohms
Package Type	Connectorized (C-5) (See page 481 for physical dimensions.)

Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

*All specifications apply when operated at +13 dBm input power 50 ohm source and load impedance.

Typical Performance



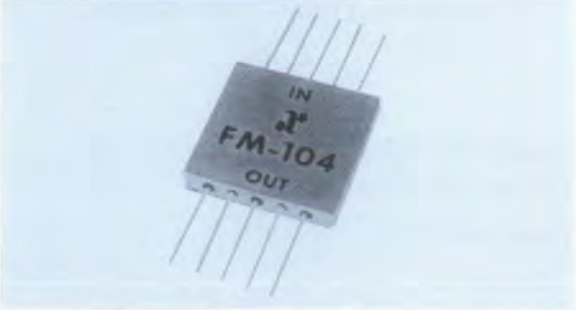
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
FM-102-4	8754	SMA	$137

Delivery is from stock.

MODEL FM-104 BROADBAND FREQUENCY DOUBLER 150-3000 MHz OUTPUT

- Hermetic Flatpack
- Multioctave Frequency Coverage
- Midband Conversion Loss — 10 dB



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		75-1500 MHz
Output		150-3000 MHz
Conversion Loss	75-1000 MHz	12 dB Max
	1000-1500 MHz	14 dB Max
Spurious (Referred to Output F_2 Level)		
F_1	75-1000 MHz	20 dB Min
	1000-1500 MHz	17 dB Min
F_3	225-3000 MHz	20 dB Min
	3000-4500 MHz	17 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
VSWR, Input	2.5:1
Typical Conversion Loss as Quadrupler	26 dB
Maximum Input Power	300 mW
Package Type	Flatpack (FP-3) (See page 474 for physical dimensions.)

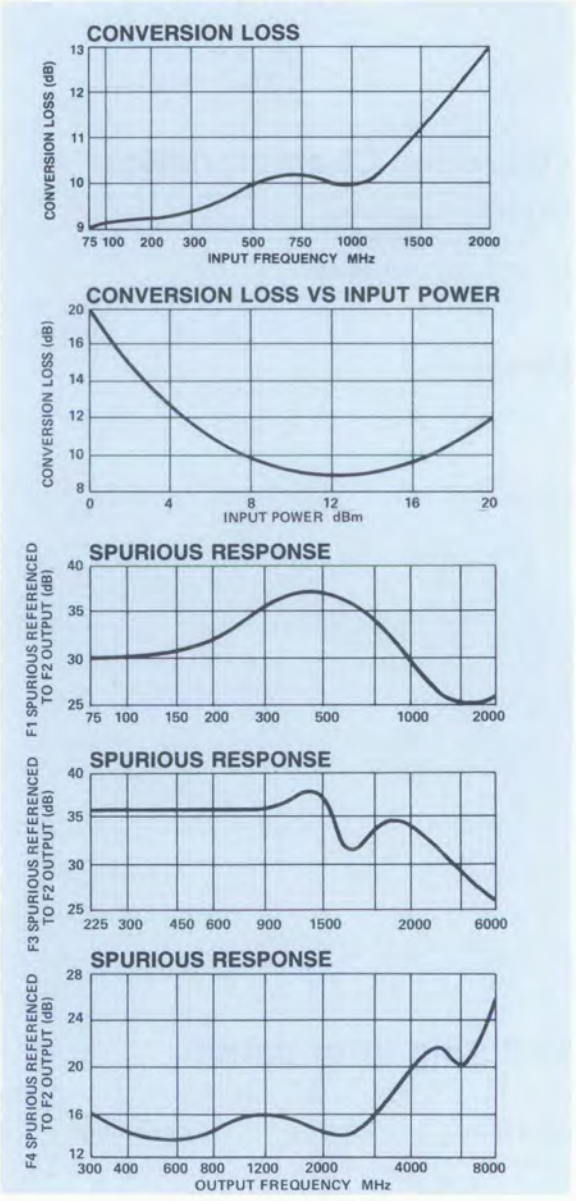
Environmental

These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration	IN; P3, Out P8 Case and all other pins are ground.

*All specifications apply when operated at +13 dBm input power with 50 ohm source and load impedance

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
FM-104	9569	Pin	$66

Delivery is from stock.

MODEL FM-105

PLUG-IN FREQUENCY DOUBLER
20-1500 MHz OUTPUT

- Relay Header Case
- Multioctave Frequency Coverage
- Midband Conversion Loss — 12 dB
- Typical Input VSWR — Less Than 1.8

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		10-750 MHz
Output		20-1500 MHz
Conversion Loss	10-500 MHz	14.5 dB Max
	500-750 MHz	15.5 dB Max
Spurious (Referred to Output F_2 Level)		
F_1	10-100 MHz	25 dB Min
	100-300 MHz	20 dB Min
	300-500 MHz	15 dB Min
	500-750 MHz	10 dB Min
F_3	30-300 MHz	35 dB Min
	300-900 MHz	30 dB Min
	900-1500 MHz	25 dB Min
	1500-2250 MHz	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
VSWR, Input	2.0:1
Typical Conversion Loss as Quadrupler	30 dB
Maximum Input Power	300 mW
Package Type	Relay Header (RH-3) (See page 473 for physical dimensions.)

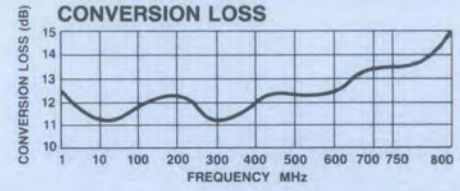
Environmental

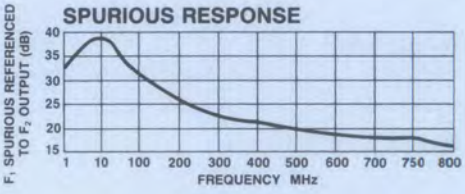
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

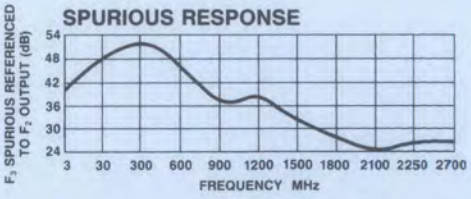
Pin Configuration	IN; P1, Out; P8 Case and all other pins are ground.

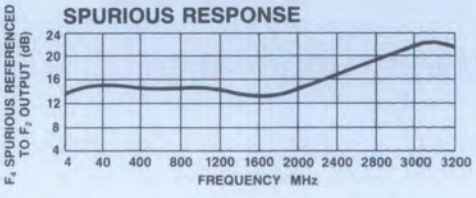
*All specifications apply when operated at +13 dBm input power with 50 ohm source and load impedance

Typical Performance









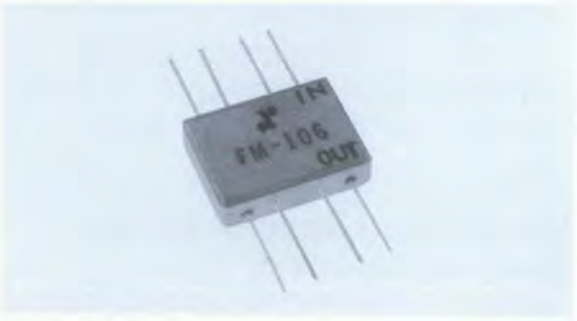
Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
FM-105	6829	Pin	$34

Delivery is from stock.

MODEL FM-106 — BROADBAND FREQUENCY DOUBLER 400-6000 MHz OUTPUT

- Hermetic Flatpack
- Multioctave Operation
- Typical Conversion Loss — 11 dB



Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		200-3000 MHz
Output		400-6000 MHz
Conversion Loss	200-400 MHz	14.5 dB Max
	400-2500 MHz	13.0 dB Max
	2500-3000 MHz	15.5 dB Max
Spurious (Referred to Output F_2 Level)		
F_1	200-500 MHz	20 dB Min
	50-3000 MHz	15 dB Min
F_3	600-2400 MHz	25 dB Min
	2400-9000 MHz	20 dB Min

Operating Characteristics

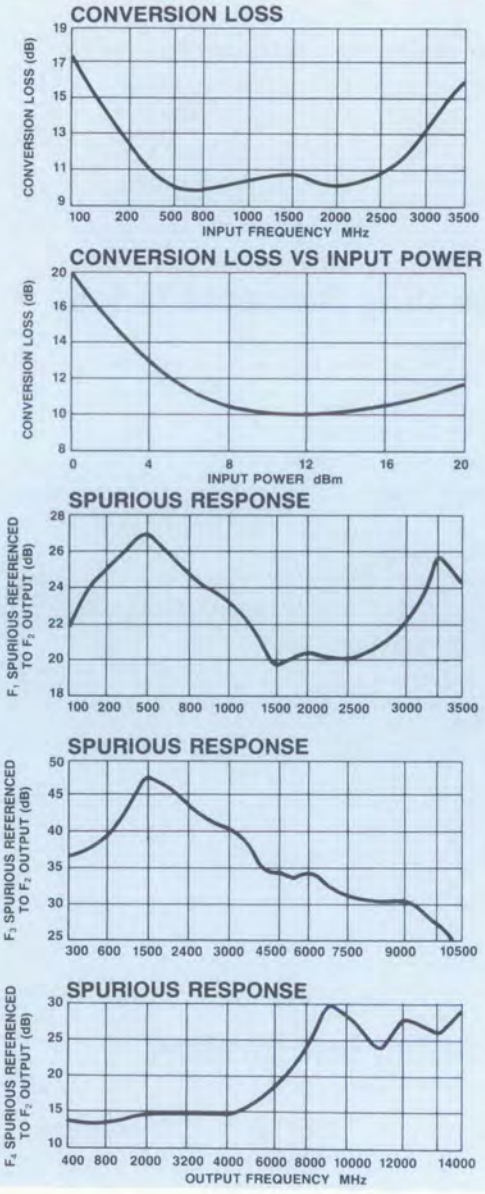
Impedance		50 Ohms Nominal
VSWR, Input	200-500 MHz	3.0:1 Typ
	500-3000 MHz	2.0:1 Typ
Typical Conversion Loss as Quadrupler		30 dB
Maximum Input Power		300 mW
Package Type		Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
These units are designed to meet the environmental and screening requirements of Table 1A, page 496 of the Adams-Russell catalog.

Pin Configuration — IN; P4, Out; P8, Case and all other pins are ground.

*All specifications apply when operated at +13 dBm input power with 50 ohm source and load impedance

Typical Performance



Ordering Information

Model No.	Part No.	Connectors	Unit Price (5-9 Units)
FM-106	6839	Pin	$80

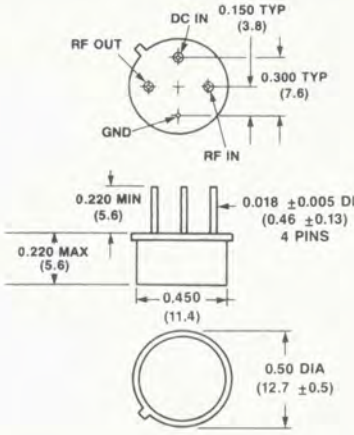
Delivery is from stock.

Mechanical Data

MECHANICAL DATA

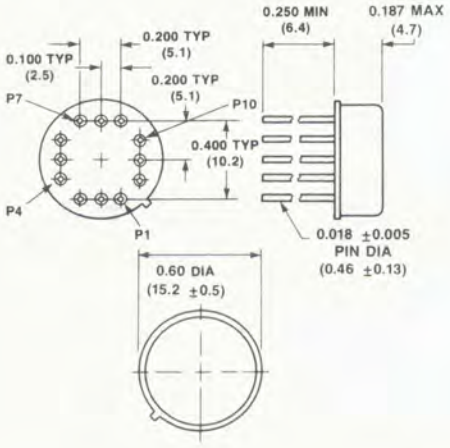
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

TO-8-1



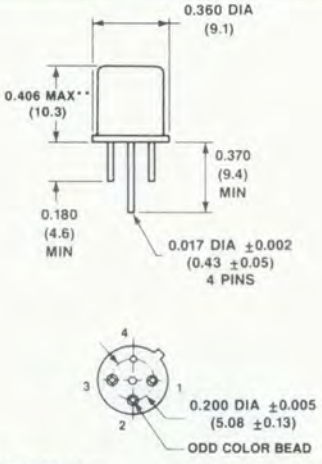
WEIGHT (APPROX.): 0.10 OUNCES 2.8 GRAMS

TO-8-2



WEIGHT (APPROX.): 0.11 OUNCES 3 GRAMS

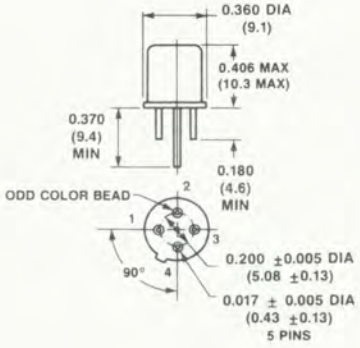
TO-5-1



**FOR MTH-50; 0.343" MAX FOR MTV-50
(PIN 4 NOT ON ALL PACKAGES)

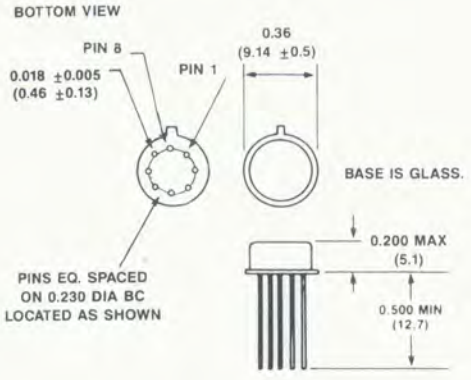
MOUNTING AREA: 0.1 SQ. IN. 0.6 SQ. CM.
WEIGHT (APPROX.): 0.11 OUNCES 3 GRAMS

TO-5-2



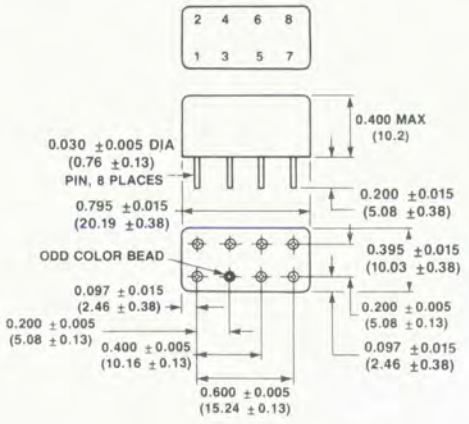
MOUNTING AREA: 0.1 SQ. IN. 0.6 SQ. CM.
WEIGHT (APPROX): 0.11 OUNCES 3 GRAMS

TO-5-3



WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

RH-1

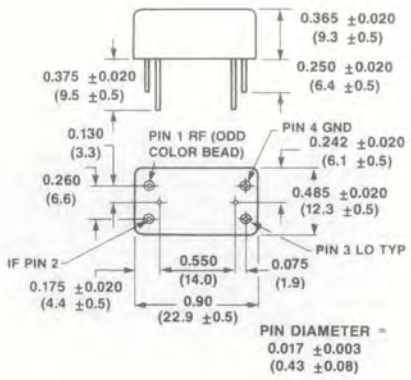


WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

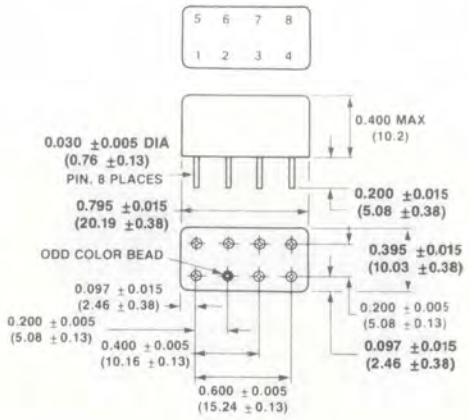
MECHANICAL DATA

RH-2



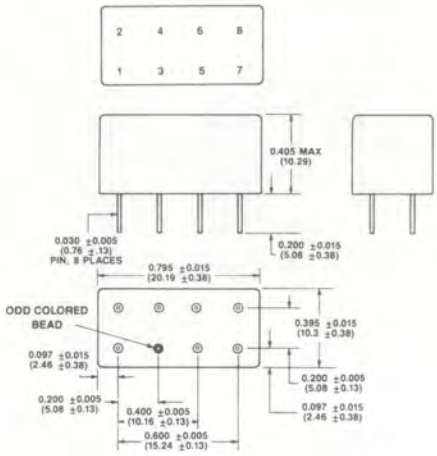
WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

RH-3



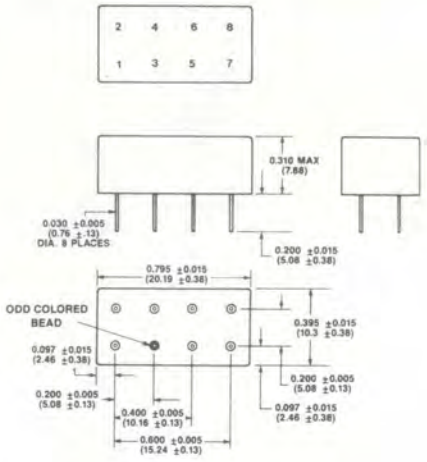
WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

RH-4



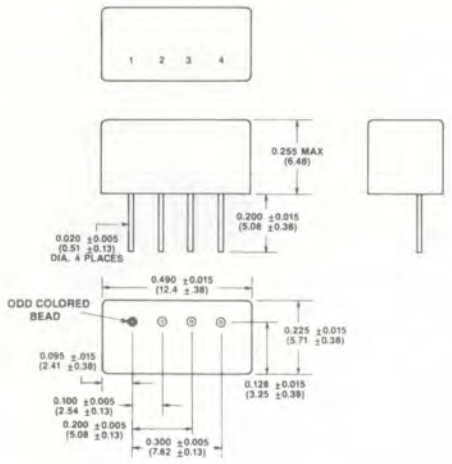
WEIGHT (APPROX): 0.23 OUNCES 6.5 GRAMS

RH-5



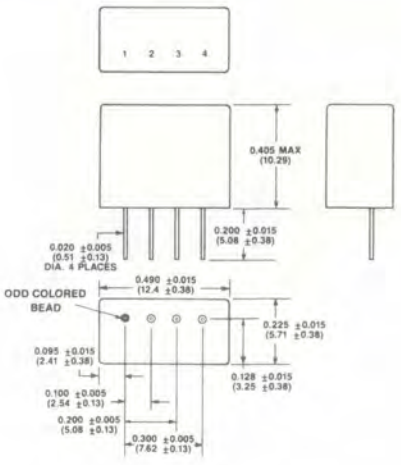
WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

RH-6



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

RH-7

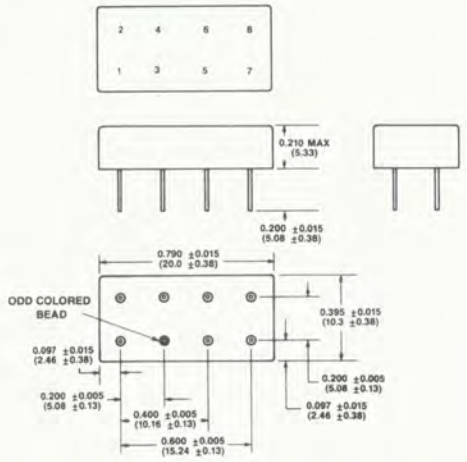


WEIGHT (APPROX.): 0.04 OUNCES 1.3 GRAMS

MECHANICAL DATA

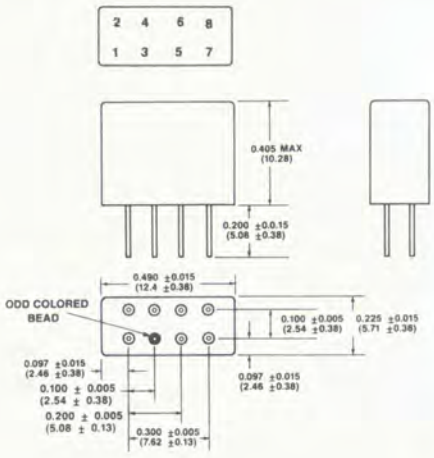
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

RH-8



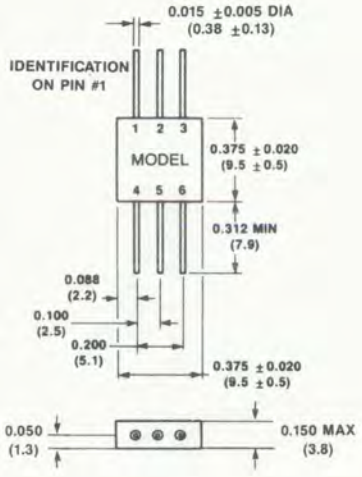
WEIGHT (APPROX.): 0.13 OUNCES 3.5 GRAMS

RH-9



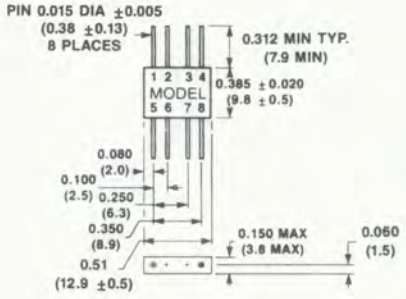
WEIGHT (APPROX.): 0.06 OUNCES 1.6 GRAMS

FP-1



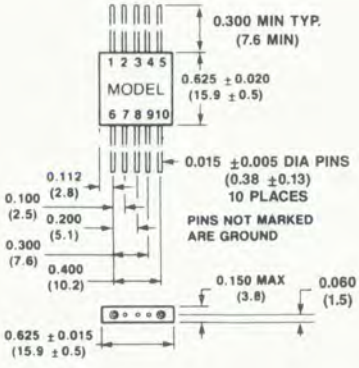
WEIGHT (APPROX.): 0.07 OUNCES 2 GRAMS

FP-2



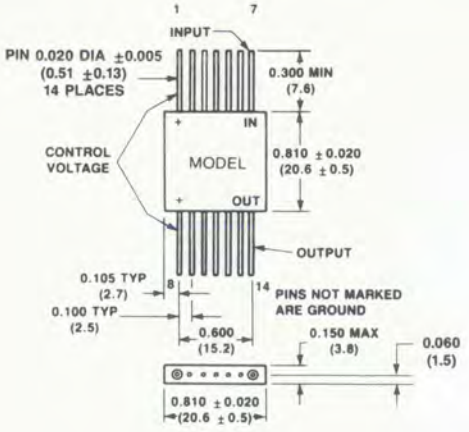
WEIGHT (APPROX.): 0.09 OUNCES 2.5 GRAMS

FP-3



WEIGHT (APPROX.): 0.12 OUNCES 3.4 GRAMS

FP-4

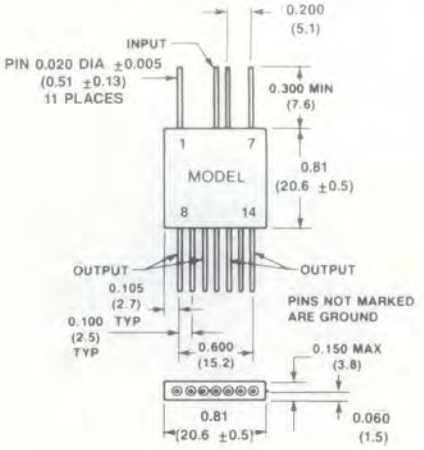


WEIGHT (APPROX.): 0.21 OUNCES 6 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

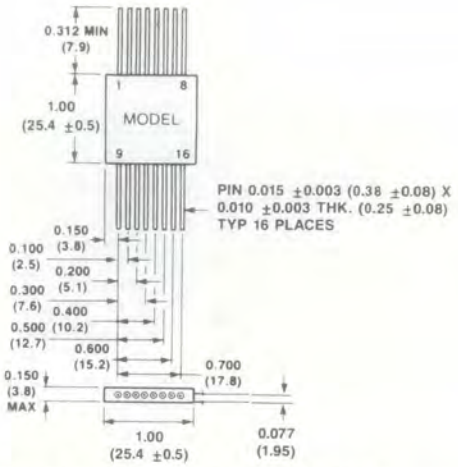
MECHANICAL DATA

FP-5



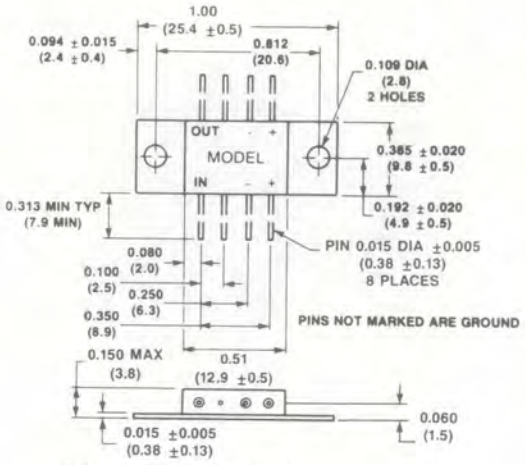
WEIGHT (APPROX.): 0.21 OUNCES 6 GRAMS

FP-6



WEIGHT (APPROX.): 0.24 OUNCES 6.8 GRAMS

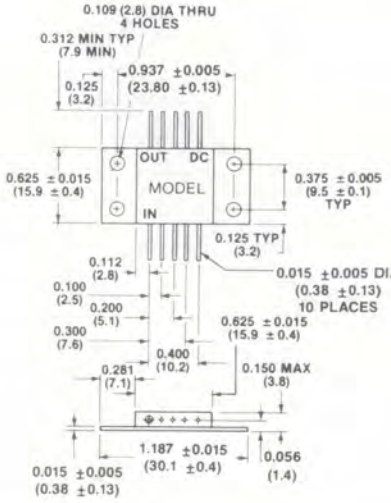
FP-7



(NOTE: AM-123 POSITIVE VOLTAGE ONLY.)

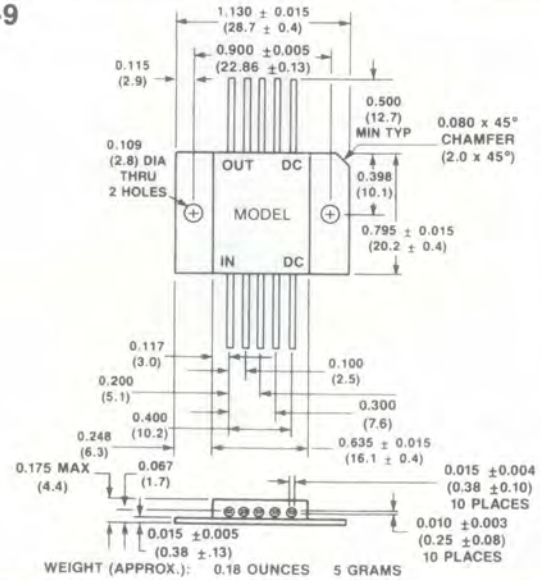
WEIGHT (APPROX.): 0.09 OUNCES 2.5 GRAMS

FP-8



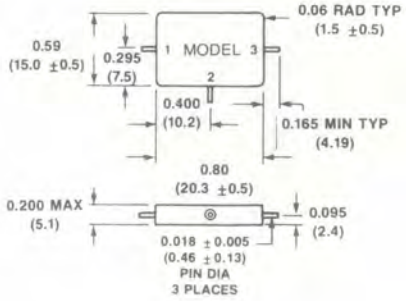
WEIGHT (APPROX.): 0.17 OUNCES 4.8 GRAMS

FP-9



WEIGHT (APPROX.): 0.18 OUNCES 5 GRAMS

FP-10

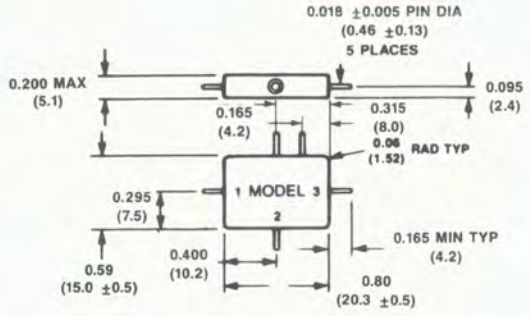


WEIGHT (APPROX.): 0.35 OUNCES 10 GRAMS

MECHANICAL DATA

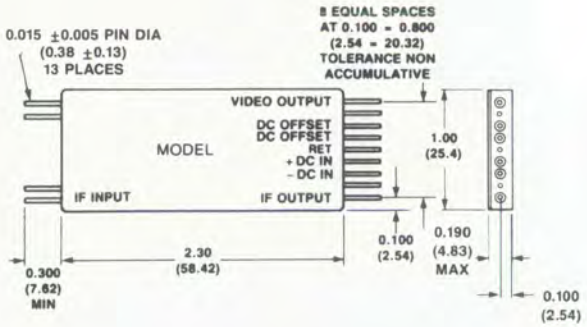
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

FP-11



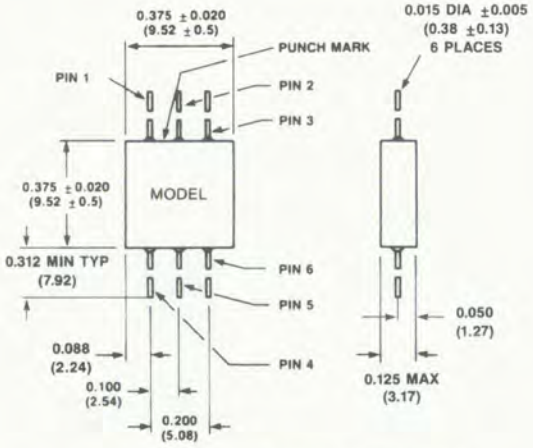
WEIGHT (APPROX.): 0.35 OUNCES 10 GRAMS

FP-12



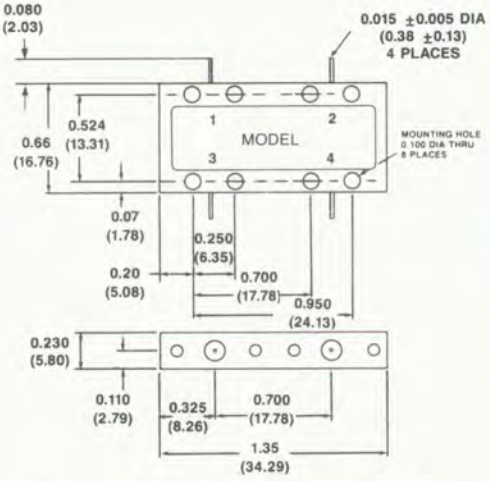
WEIGHT (APPROX.): 0.81 OUNCES 23 GRAMS

FP-13



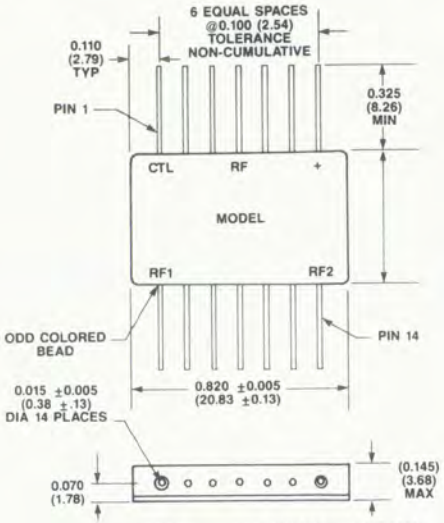
WEIGHT (APPROX.): 0.03 OUNCES 0.8 GRAMS

FP-14



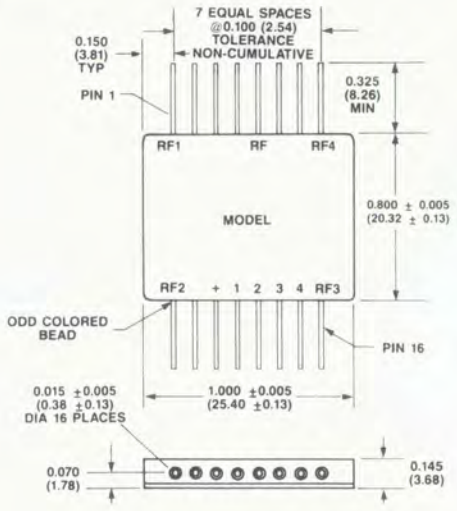
WEIGHT (APPROX.): 0.63 OUNCES 18 GRAMS

FP-16



WEIGHT (APPROX): 0.14 OUNCES 4 GRAMS

FP-17

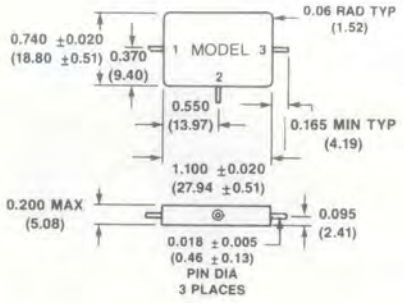


WEIGHT (APPROX): 0.21 OUNCES 6 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

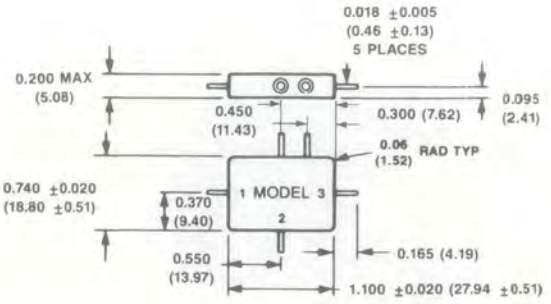
MECHANICAL DATA

FP-18



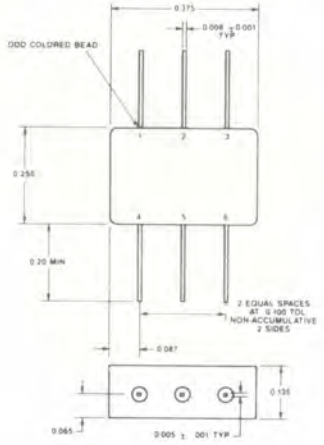
WEIGHT (APPROX): 0.35 OUNCES 10 GRAMS

FP-19



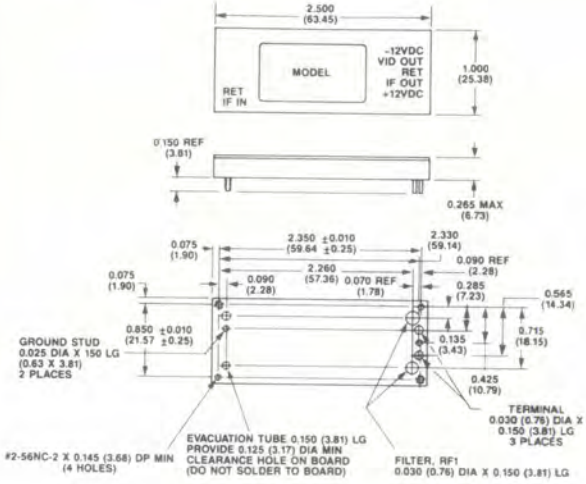
WEIGHT (APPROX): 0.35 OUNCES 10 GRAMS

FP-20



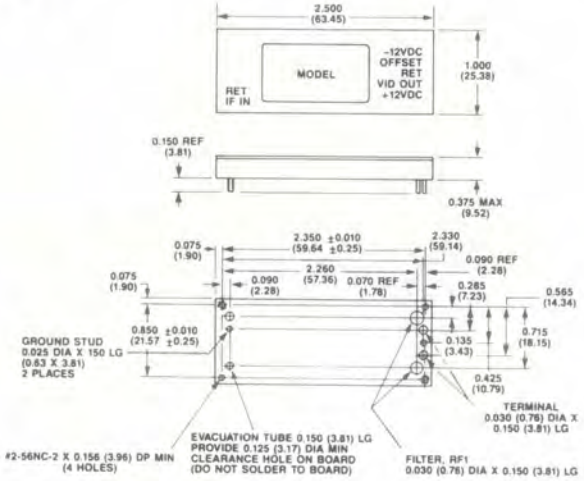
WEIGHT (APPROX): 0.03 OUNCES 0.86 GRAMS

FP-21



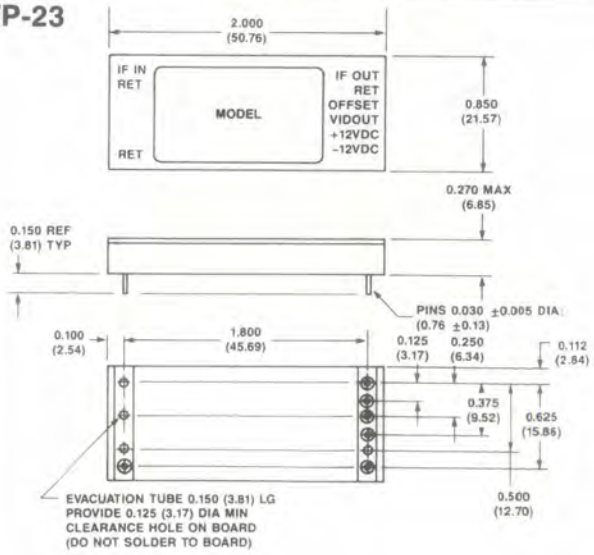
WEIGHT (APPROX.): 2.1 OUNCES 60 GRAMS

FP-22



WEIGHT (APPROX.): 2.0 OUNCES 57 GRAMS

FP-23

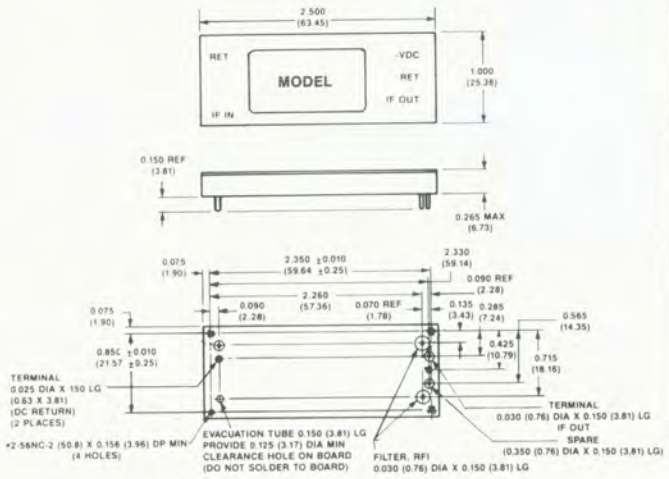


WEIGHT (APPROX.): 1.0 OUNCES 28 GRAMS

MECHANICAL DATA

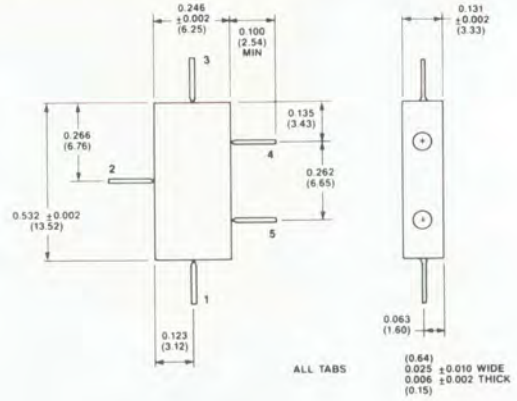
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

FP-24

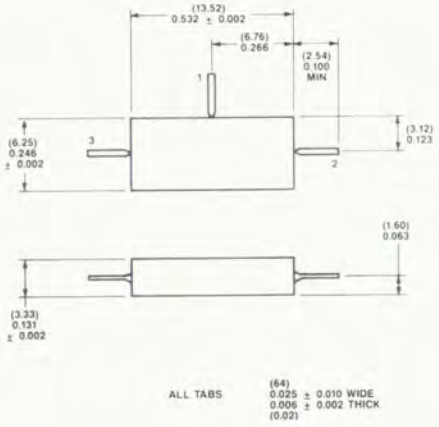


WEIGHT (APPROX.): 2.0 OUNCES 57 GRAMS

FP-25

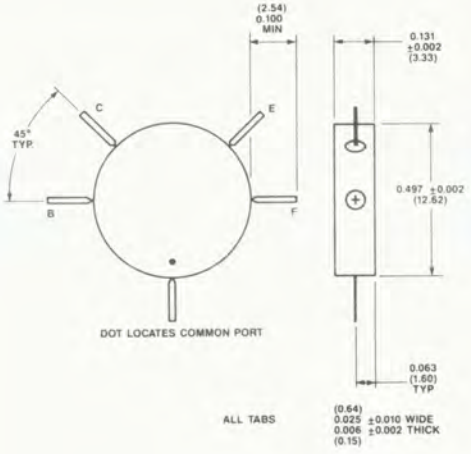


FP-26



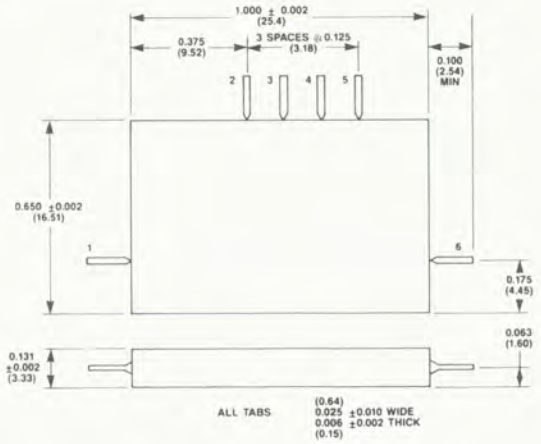
WEIGHT (APPROX.): 0.57 OUNCES 16 GRAMS

FP-27



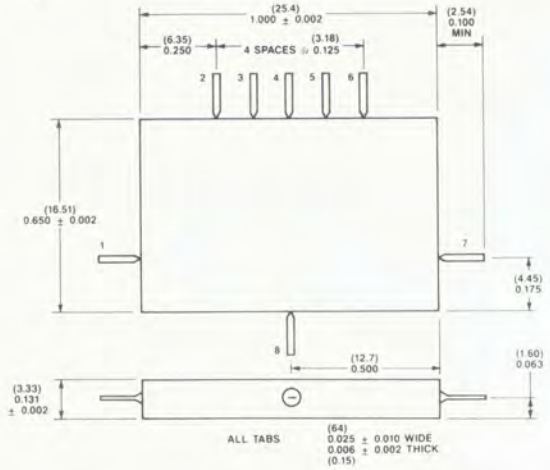
WEIGHT (APPROX.): 0.58 OUNCES 16.5 GRAMS

FP-28



WEIGHT (APPROX.): 1.25 OUNCES 35 GRAMS

FP-29

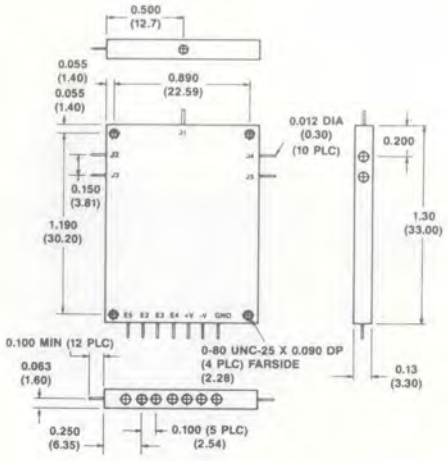


WEIGHT (APPROX.): 1.25 OUNCES 35 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

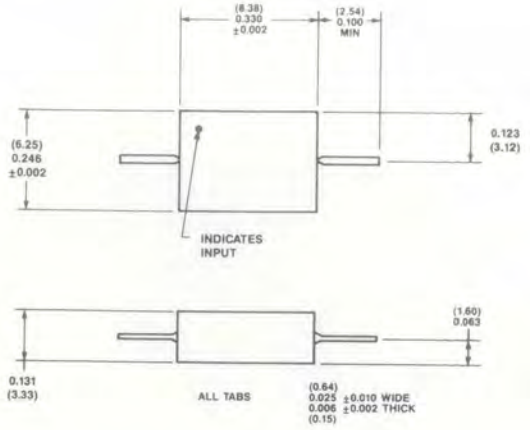
MECHANICAL DATA

FP-30



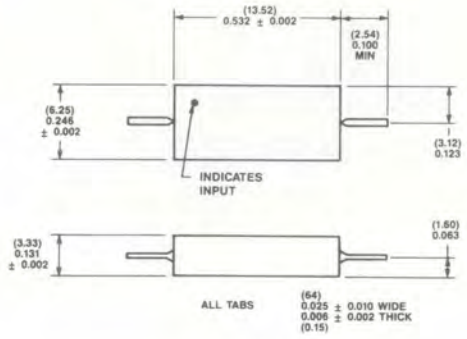
WEIGHT (APPROX.): 2 OUNCES 50 GRAMS

FP-31



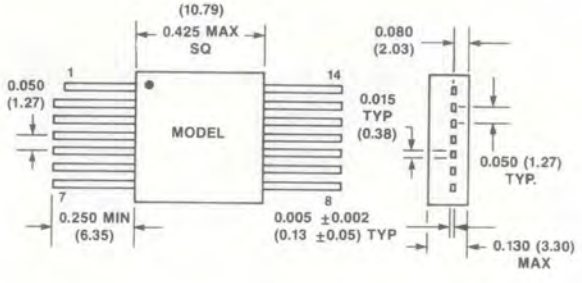
WEIGHT (APPROX.): 0.54 OUNCES 15 GRAMS

FP-32



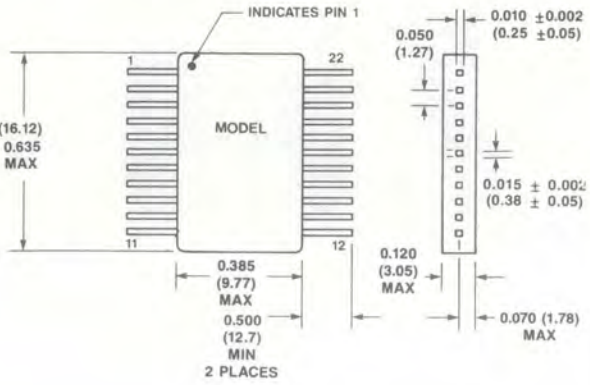
WEIGHT (APPROX.): 0.57 OUNCES 16 GRAMS

FP-33



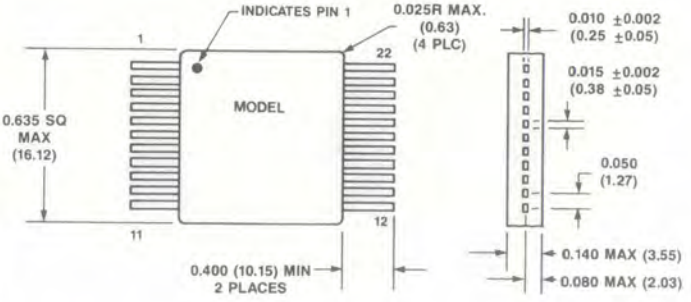
WEIGHT (APPROX.): 1.02 OUNCES 29 GRAMS

FP-34



WEIGHT (APPROX.): 1.07 OUNCES 30 GRAMS

FP-35

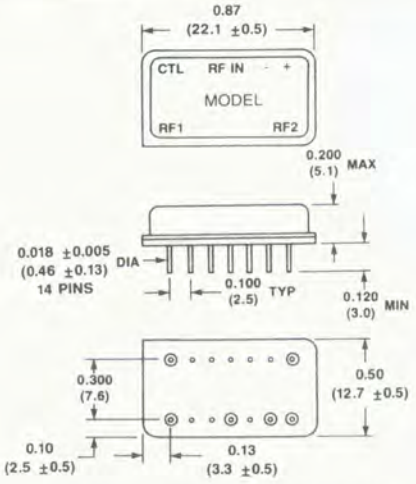


WEIGHT (APPROX.): 1.08 OUNCES 31 GRAMS

MECHANICAL DATA

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

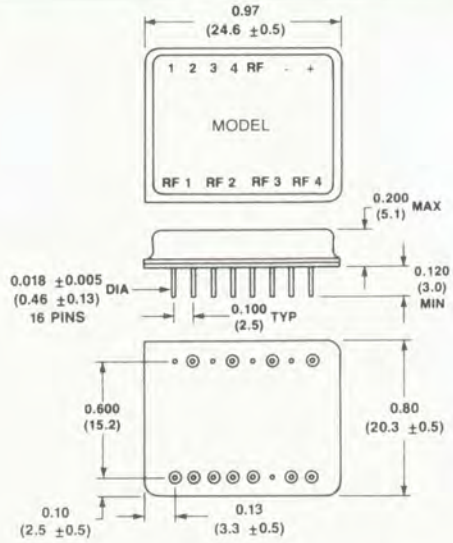
DI-1



(POSITIVE VOLTAGE ONLY SW-205 & 206, 207 & 208)

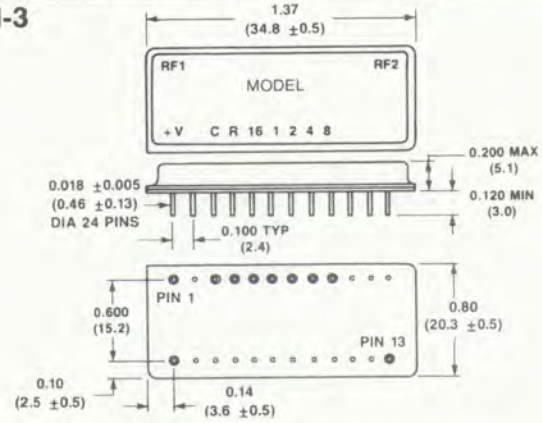
WEIGHT (APPROX.): 0.14 OUNCES 4 GRAMS

DI-2



WEIGHT (APPROX): 0.28 OUNCES 8 GRAMS

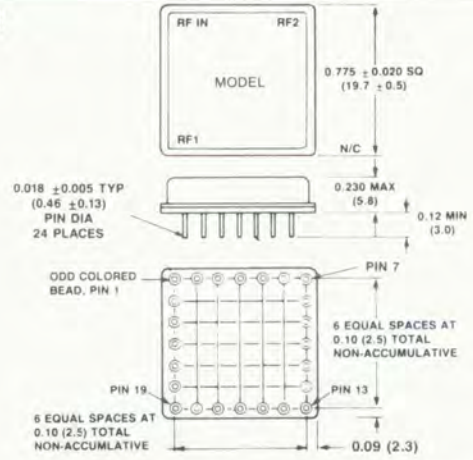
DI-3



	RF1	RF2	+5V	-12V	C	R	16	1	2	4	8	0.5
AT-102	24	13	1	N/A	3	4	5	6	7	8	9	N/A
AT-103	24	13	1	N/A	3	4	N/A	6	7	8	9	5
AT-104	24	13	1	3	N/A	N/A	5	6	7	8	9	N/A
PINS UNMARKED ARE GROUND												

WEIGHT (APPROX): 0.39 OUNCES 11 GRAMS

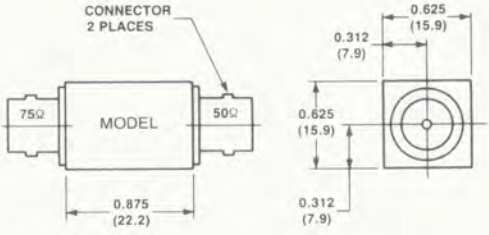
DI-4



	RF IN	RF 1	RF 2	RF 3	RF 4	+V	CTL
SW-118	19	1	13	N/A	N/A	3	4
SW-119	N/A	1	7	13	19	3	4
PINS UNMARKED ARE GROUND							

WEIGHT (APPROX): 0.21 OUNCES 6 GRAMS

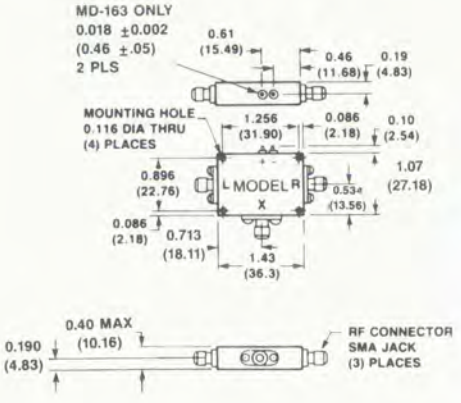
C-1



TOLERANCE = ±0.015
*(.X = ±0.4)

WEIGHT (APPROX.): 0.75 OUNCES 21 GRAMS

C-2

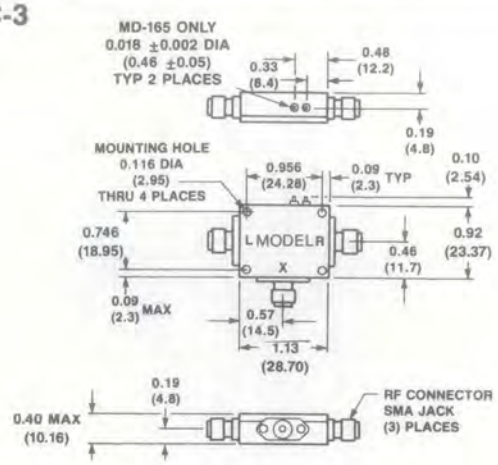


WEIGHT (APPROX): 1.2 OUNCES 34 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

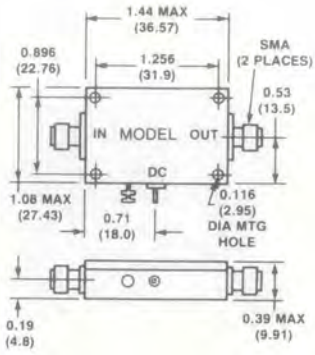
MECHANICAL DATA

C-3



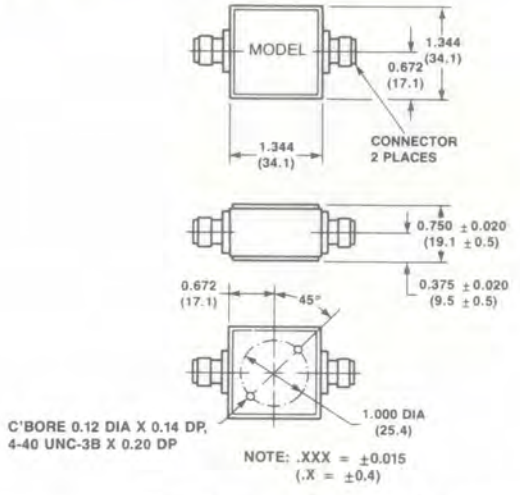
WEIGHT (APPROX): 1.2 OUNCES 34 GRAMS

C-4



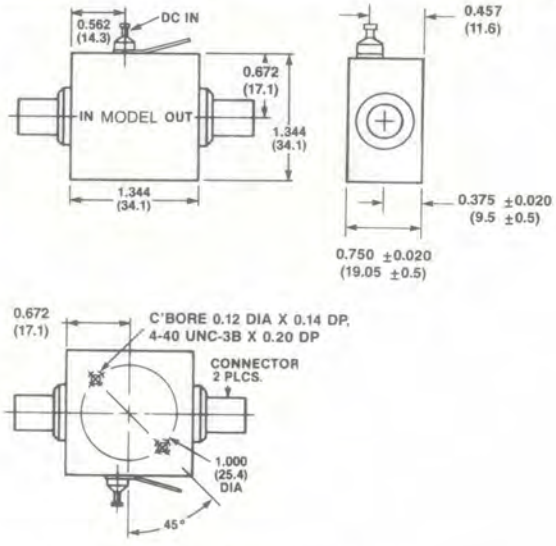
WEIGHT (APPROX.): 1.2 OUNCES 34 GRAMS

C-5



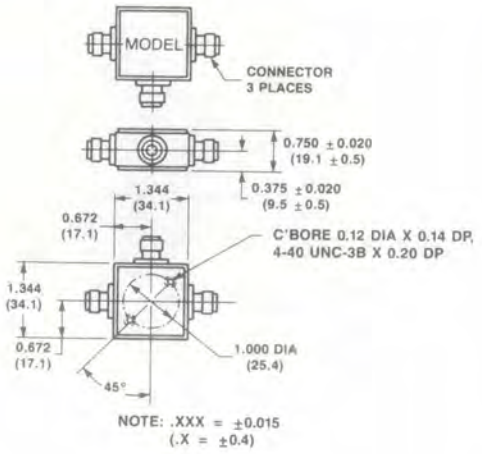
WEIGHT (APPROX.): 1.8 OUNCES 51 GRAMS

C-6



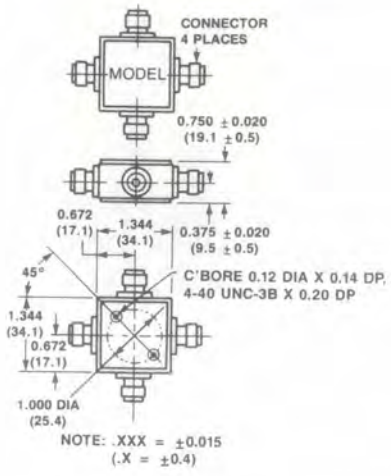
WEIGHT (APPROX.): 1.76 OUNCES 50 GRAMS

C-7



WEIGHT (APPROX.): 2.5 OUNCES 71 GRAMS

C-8

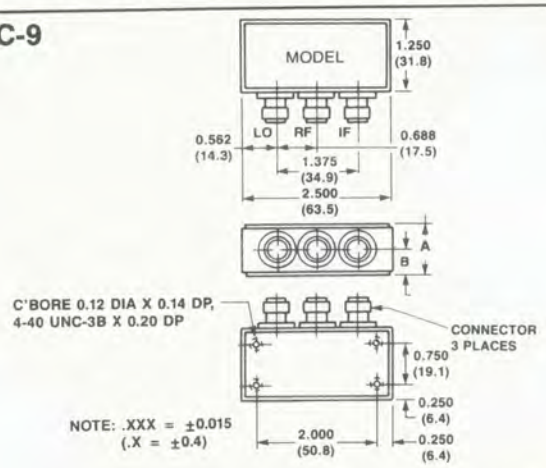


WEIGHT (APPROX.): 2.5 OUNCES 71 GRAMS

MECHANICAL DATA

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

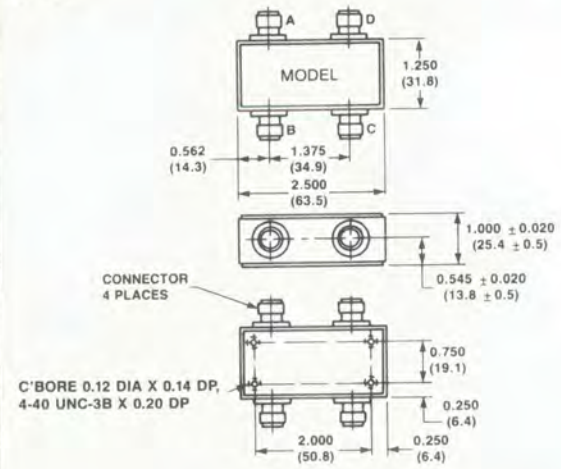
C-9



	MD-140	MD-141	MD-143	MD-150	MD-154	MD-174	MD-525-4
A	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)	1.000±0.020 (25.4±0.5)	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)
B	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)	0.485±0.020 (12.3±0.5)	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)

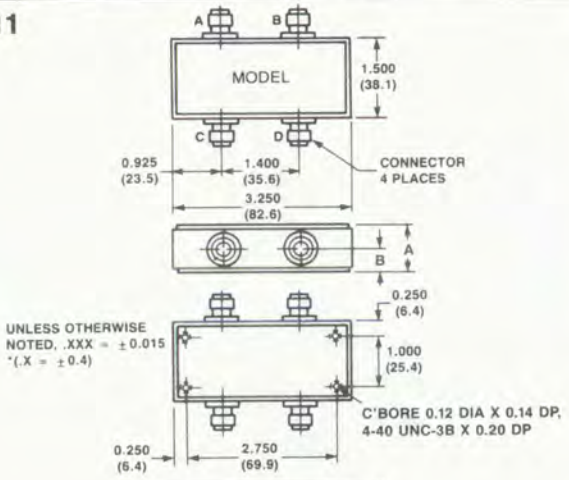
WEIGHT (APPROX): 3 OUNCES 85 GRAMS

C-10



WEIGHT (APPROX): 3.6 OUNCES 102 GRAMS

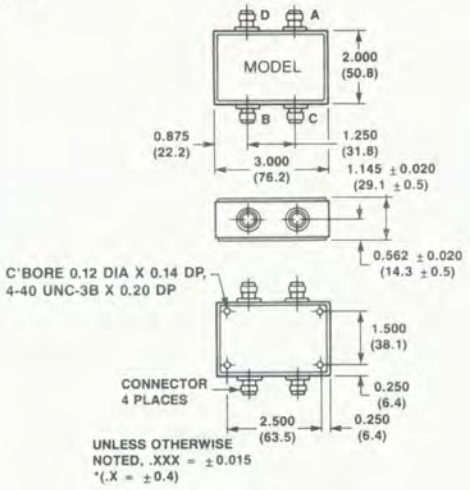
C-11



	A	B
HH-108	0.770±0.020 (19.6 ±0.5)	0.375 ±0.020 (9.5 ±0.5)
H-183	1.207 ±0.020 (30.6 ±0.5)	0.592 ±0.020 (15.03 ±0.5)

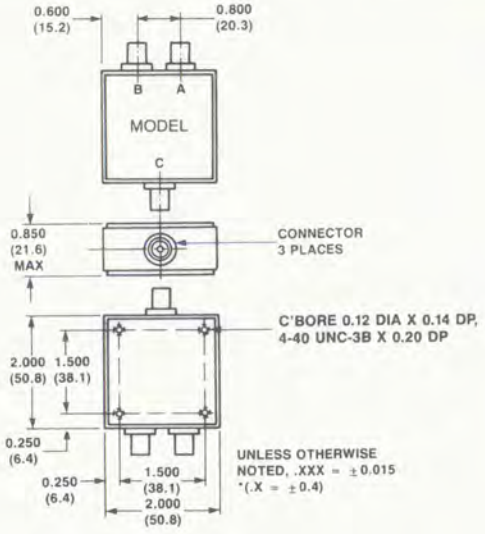
WEIGHT (APPROX): 7 OUNCES 198 GRAMS

C-12



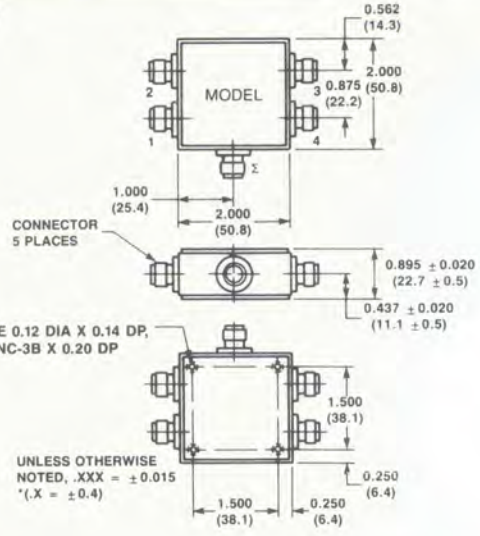
WEIGHT (APPROX): 10 OUNCES 283 GRAMS

C-13



WEIGHT (APPROX): 3.28 OUNCES 93 GRAMS

C-14

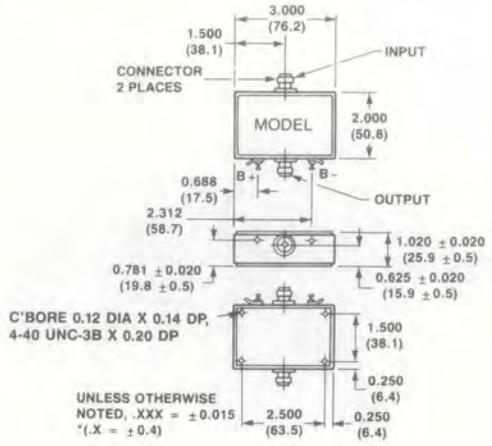


WEIGHT (APPROX): 4 OUNCES 113 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

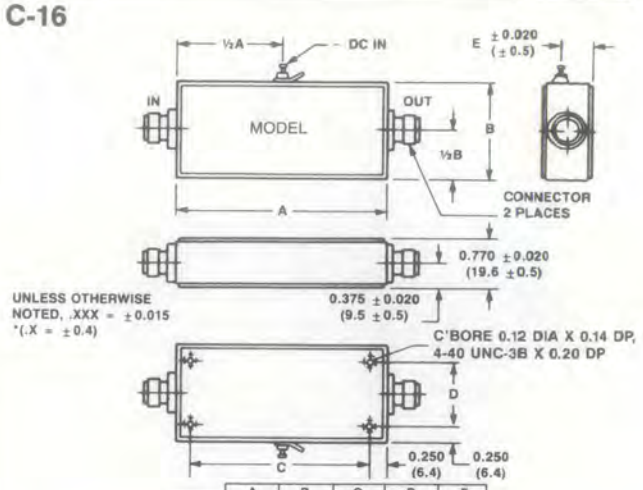
MECHANICAL DATA

C-15



WEIGHT (APPROX): 9 OUNCES 255 GRAMS

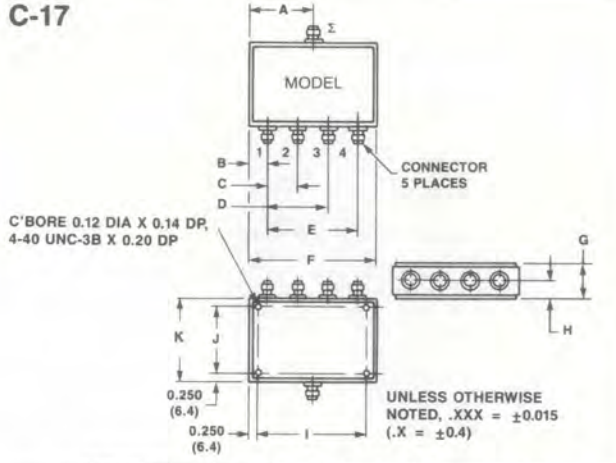
C-16



	A	B	C	D	E
AM-105 AM-112	2.500 (63.5)	1.250 (31.8)	2.000 (50.8)	0.750 (19.1)	0.437 (11.1)
AM-108	3.250 (82.6)	1.500 (38.1)	2.750 (69.9)	1.000 (25.4)	0.469 (11.9)

WEIGHT (APPROX): 4.27 OUNCES 121 GRAMS

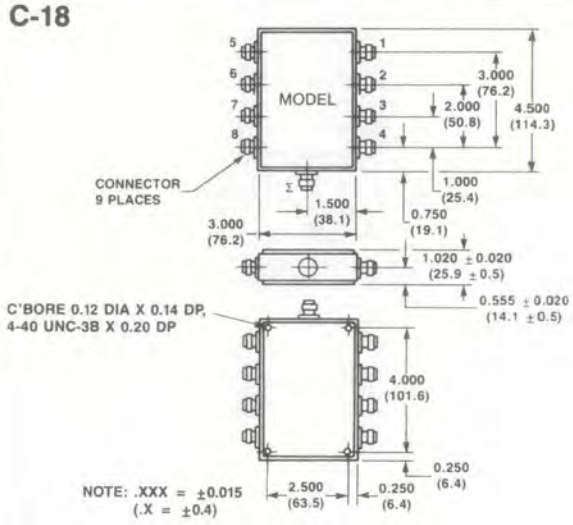
C-17



	A	B	C	D	E	F	G	H	I	J	K
DS-4-4	2.250 (57.2)	0.656 (16.7)	1.062 (27.0)	2.125 (54.0)	3.188 (8.10)	4.500 (114.3)	1.145±0.020 (29.1±0.5)	0.562±0.020 (14.3±0.5)	4.000 (101.6)	2.500 (63.5)	3.000 (76.1)
DS-409-4	1.525 (40.34)	0.593 (15.06)	0.688 (17.47)	1.376 (34.95)	2.064 (52.42)	3.250 (82.6)	0.770±0.020 (19.6±0.5)	0.375±0.020 (9.5±0.5)	2.750 (69.9)	1.000 (25.4)	1.500 (38.1)

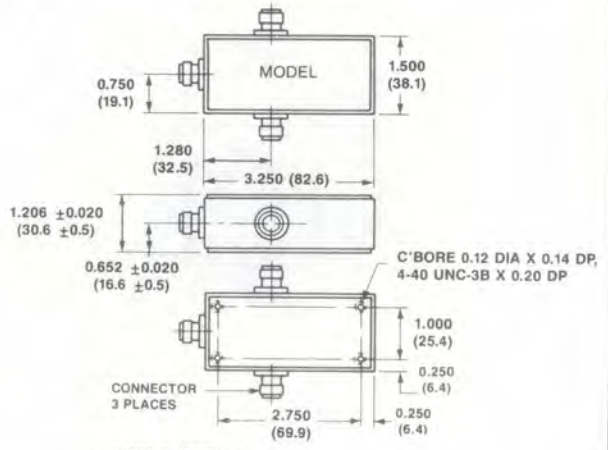
WEIGHT (APPROX): 10.58 OUNCES 300 GRAMS

C-18



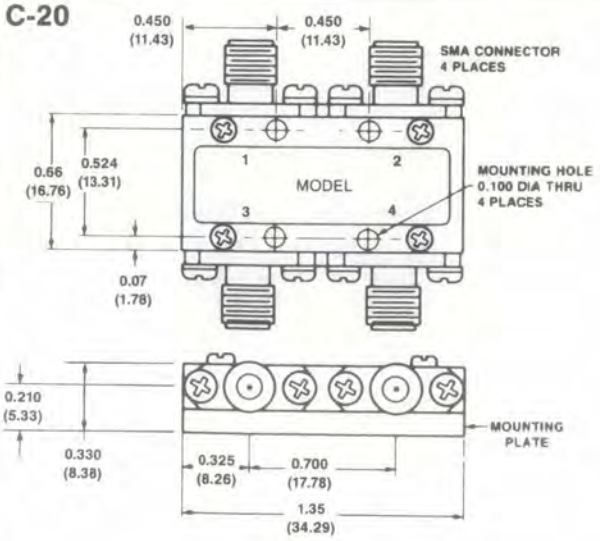
WEIGHT (APPROX): 9 OUNCES 255 GRAMS

C-19



WEIGHT (APPROX): 5.47 OUNCES 155 GRAMS

C-20

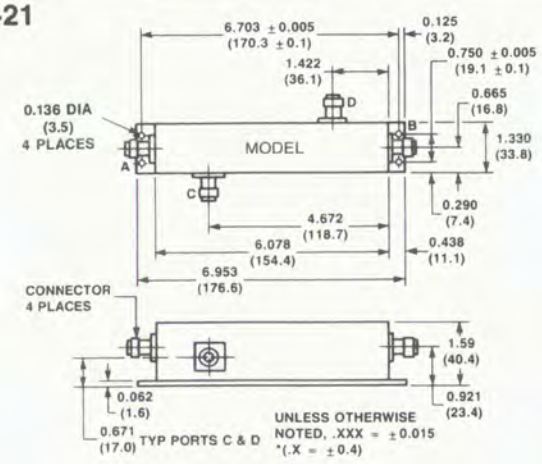


WEIGHT (APPROX): 0.92 OUNCES 26 GRAMS

MECHANICAL DATA

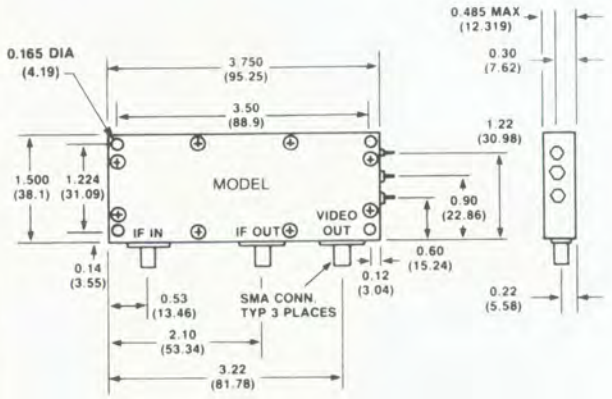
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

C-21



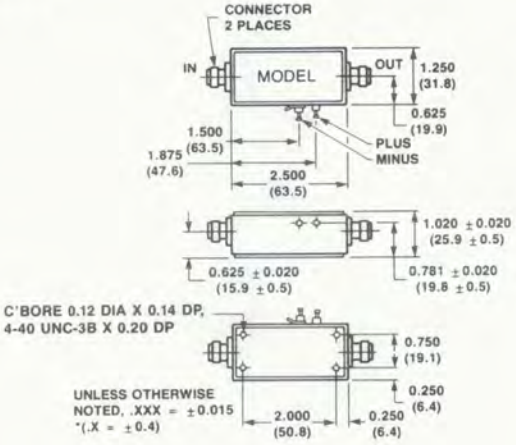
MOUNTING AREA:	9.25 SQ. IN.	60 SQ. CM.
VOLUME:	12.9 CU. IN.	211 CU. CM.
WEIGHT (APPROX):	8.7 OUNCES	247 GRAMS

C-22



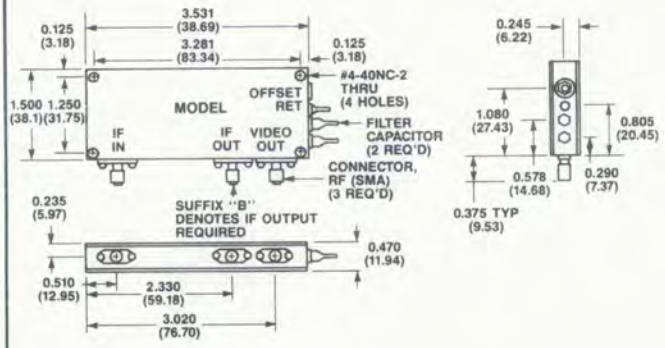
WEIGHT (APPROX): 3.5 OUNCES 99 GRAMS

C-23



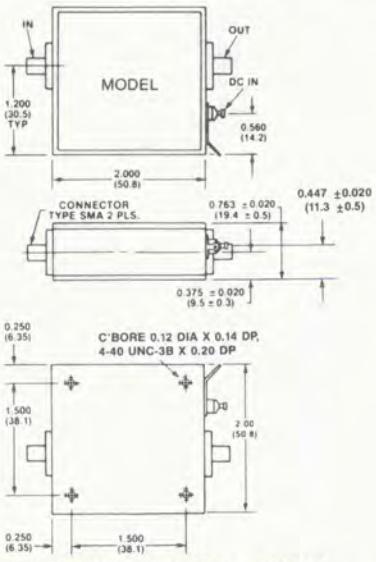
WEIGHT (APPROX): 5 OUNCES 142 GRAMS

C-24



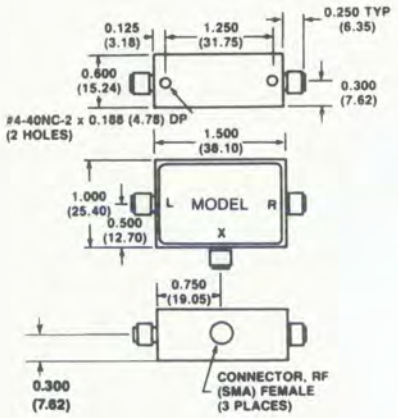
WEIGHT (APPROX): 3 OUNCES 85 GRAMS

C-25



WEIGHT (APPROX): 3.2 OUNCES 90 GRAMS

C-26

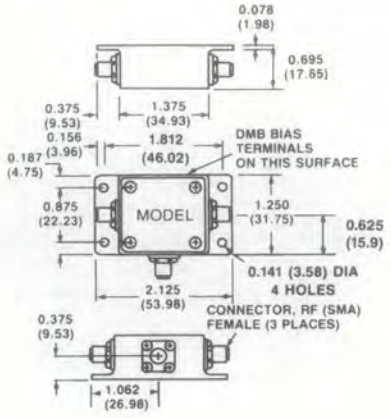


WEIGHT (APPROX): 1.4 OUNCES 40 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

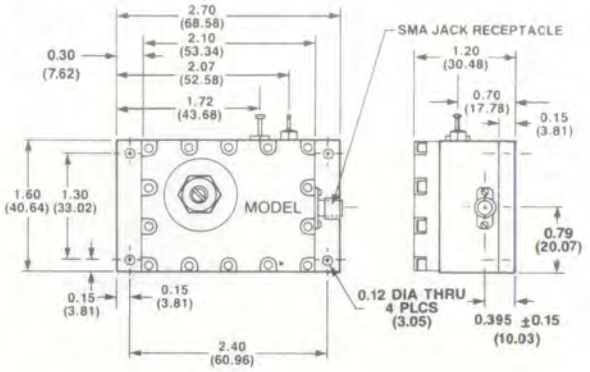
MECHANICAL DATA

C-27



WEIGHT (APPROX): 1.6 OUNCES 46 GRAMS

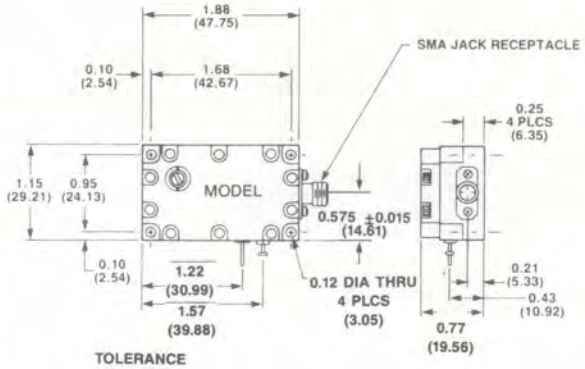
C-29



TOLERANCE
.XX ±.015
(.XX ±0.4)

WEIGHT (APPROX): 7.58 OUNCES 215 GRAMS

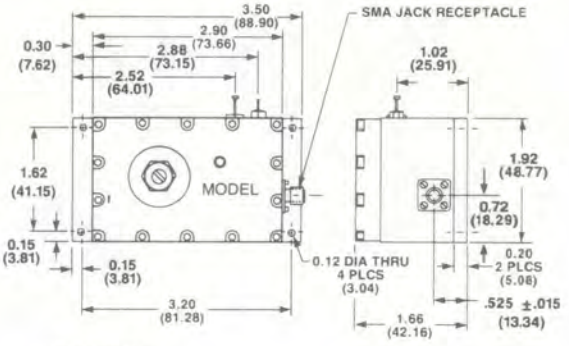
C-30



TOLERANCE
.XX ±0.015
(.XX ±0.4)

WEIGHT (APPROX): 2.50 OUNCES 71 GRAMS

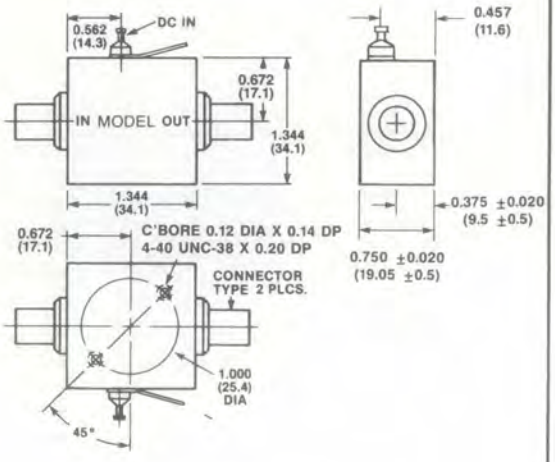
C-31



TOLERANCE
.XX ±.015
(.XX ±0.4)

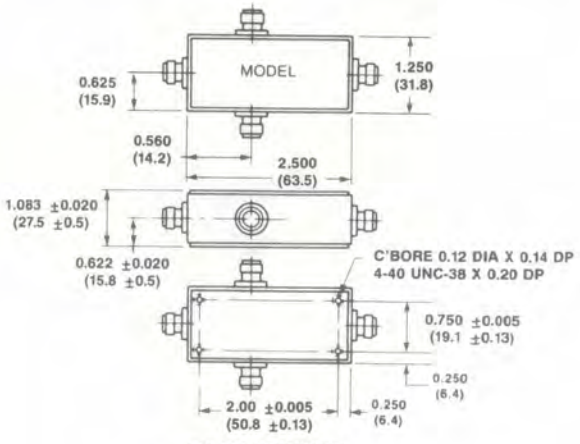
WEIGHT (APPROX): 9.17 OUNCES 260 GRAMS

C-32



WEIGHT (APPROX): 1.62 OUNCES 46 GRAMS

C-33



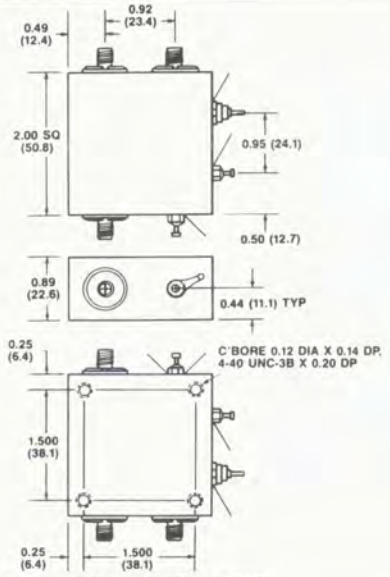
UNLESS OTHERWISE
NOTED, .XXX = ±0.015
(.X = ±0.4)

WEIGHT (APPROX): 5.47 OUNCES 155 GRAMS

MECHANICAL DATA

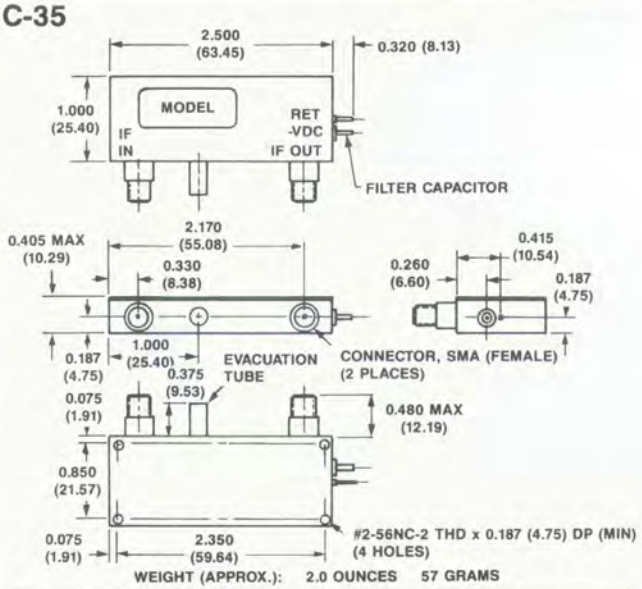
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

C-34



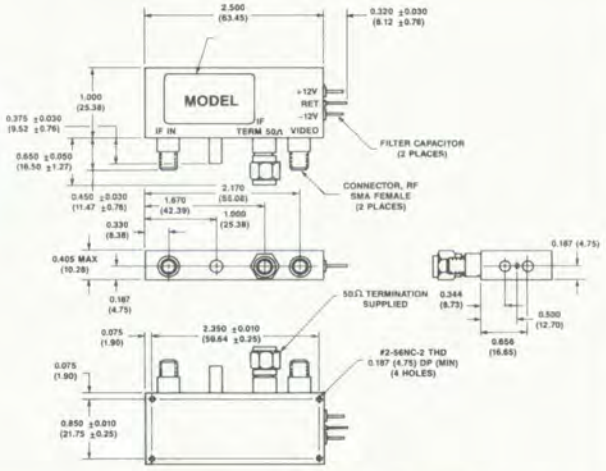
WEIGHT (APPROX): 4 OUNCES 114 GRAMS

C-35



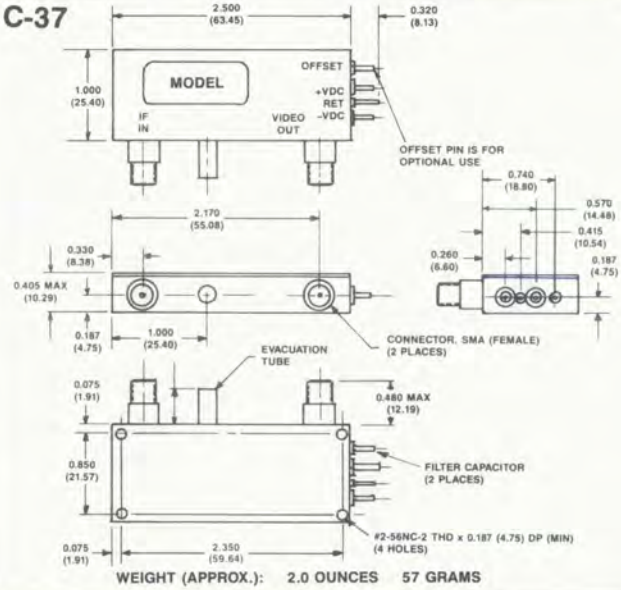
WEIGHT (APPROX.): 2.0 OUNCES 57 GRAMS

C-36



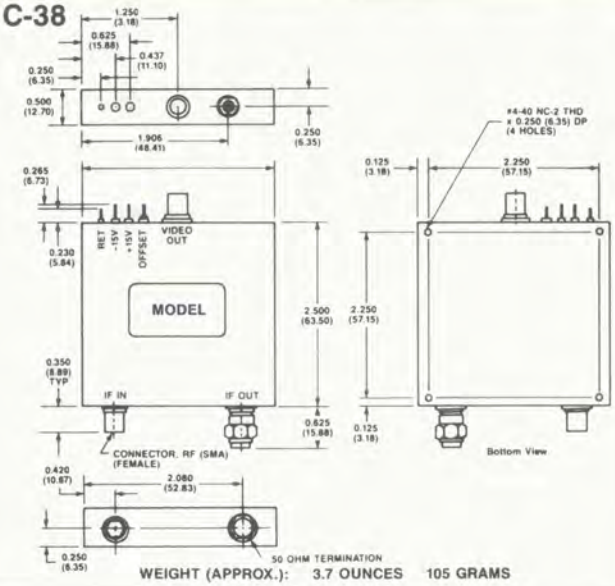
WEIGHT (APPROX.): 2.1 OUNCES 60 GRAMS

C-37



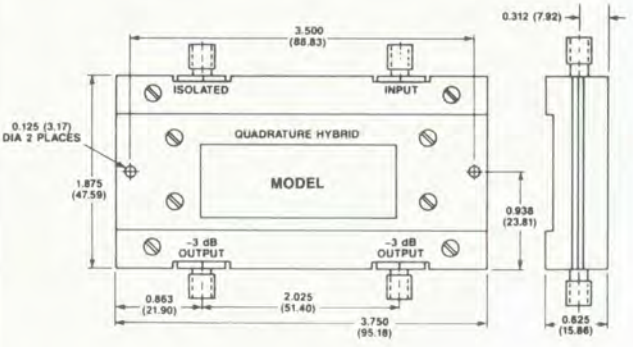
WEIGHT (APPROX.): 2.0 OUNCES 57 GRAMS

C-38



WEIGHT (APPROX.): 3.7 OUNCES 105 GRAMS

C-39

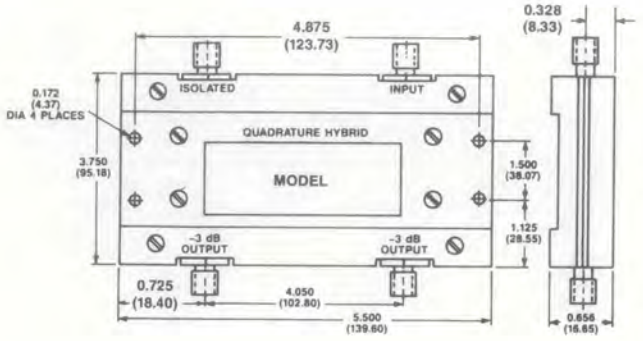


WEIGHT (APPROX.): 7.4 OUNCES 210 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

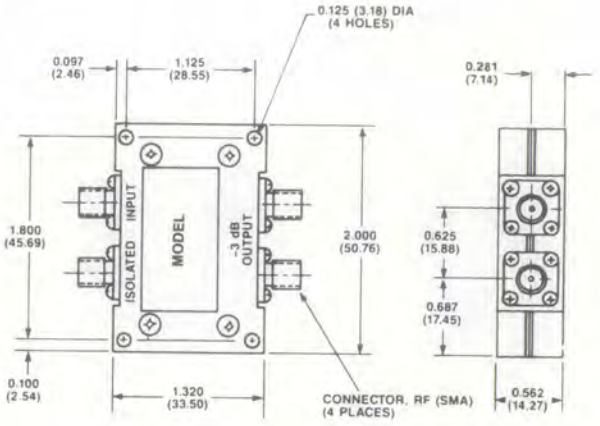
MECHANICAL DATA

C-40



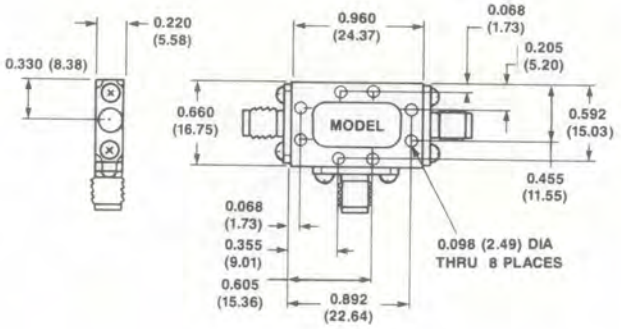
WEIGHT (APPROX.): 23 OUNCES 643 GRAMS

C-41



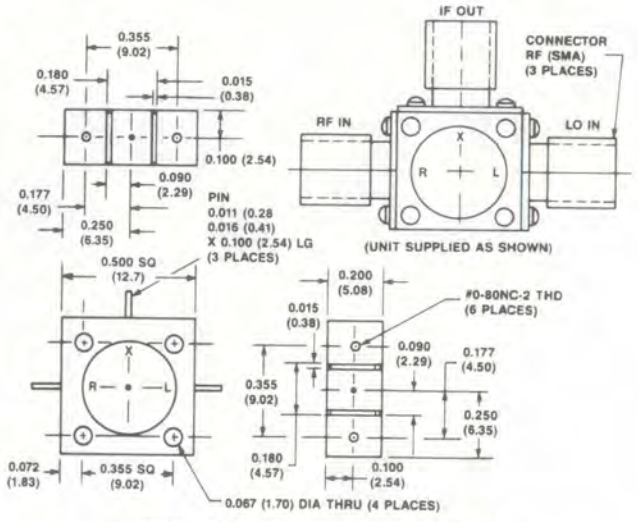
WEIGHT (APPROX): 3.5 OUNCES 100 GRAMS

C-42



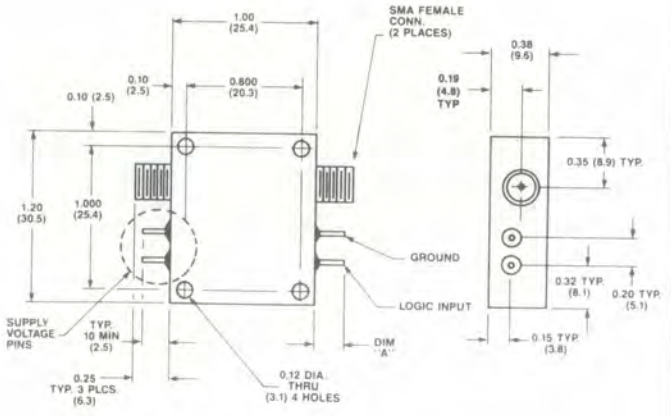
WEIGHT (APPROX.): 0.60 OUNCES 17 GRAMS

C-43



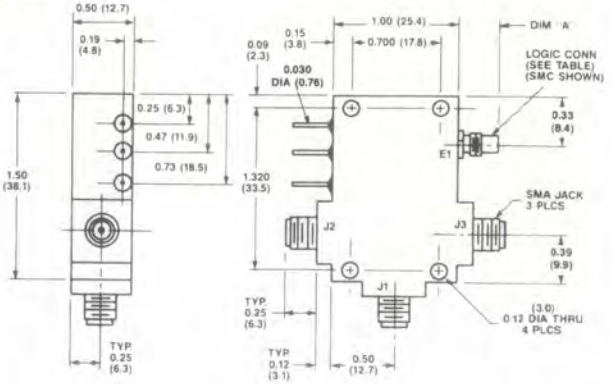
WEIGHT (APPROX.): 0.32 OUNCES 9 GRAMS

C-44



WEIGHT (APPROX.): 1.53 OUNCES 44 GRAMS

C-45

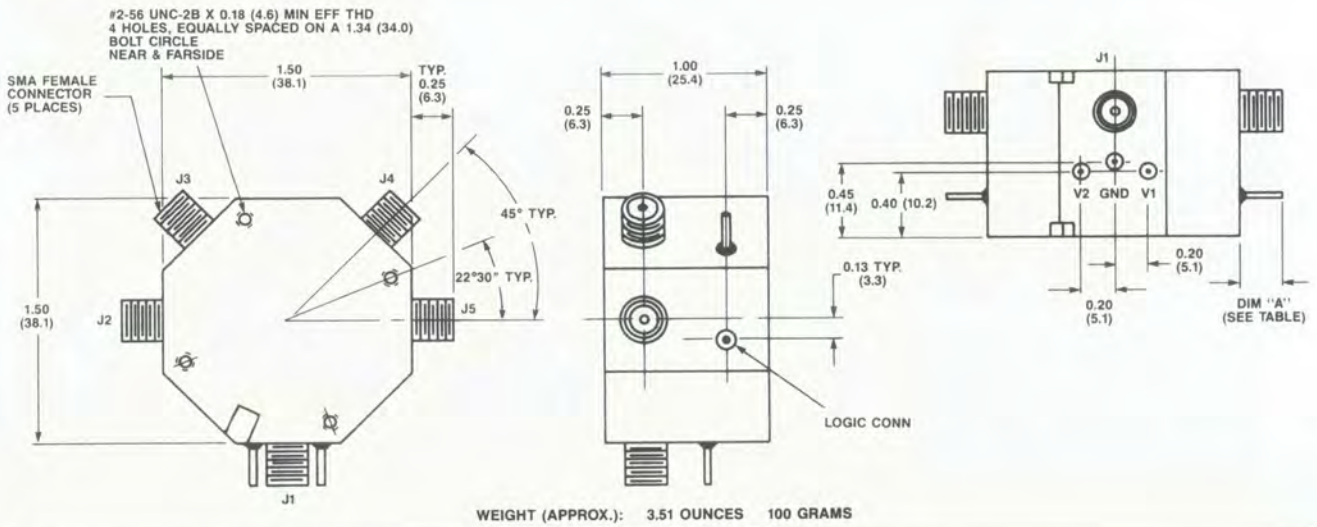


WEIGHT (APPROX.): 2.2 OUNCES 62.5 GRAMS

MECHANICAL DATA

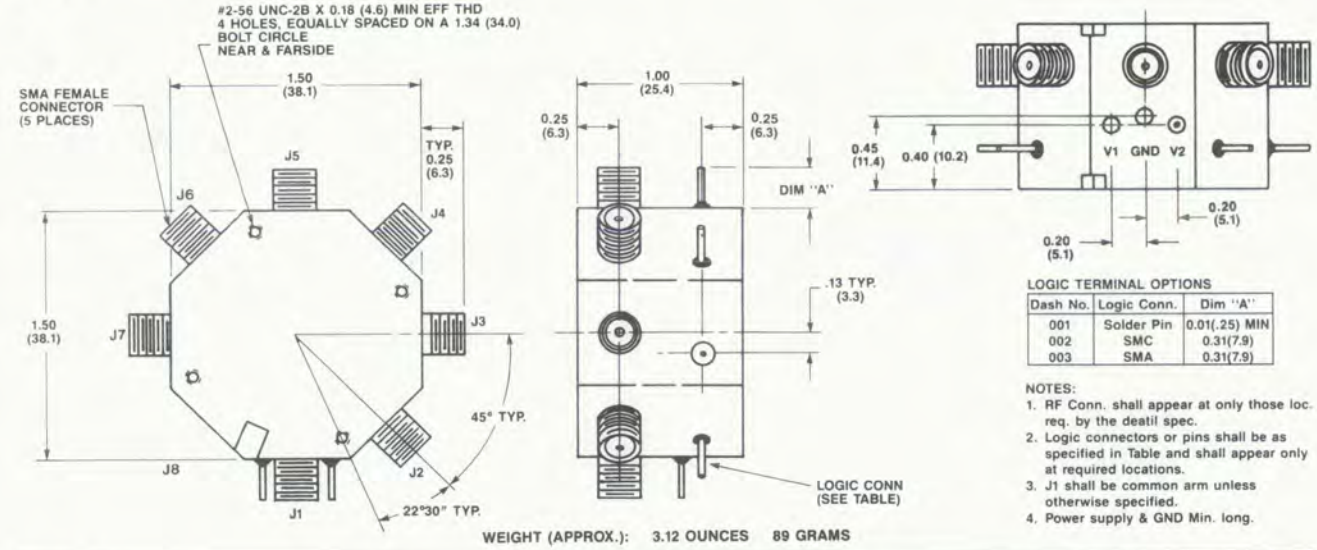
UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

C-46



WEIGHT (APPROX.): 3.51 OUNCES 100 GRAMS

C-47



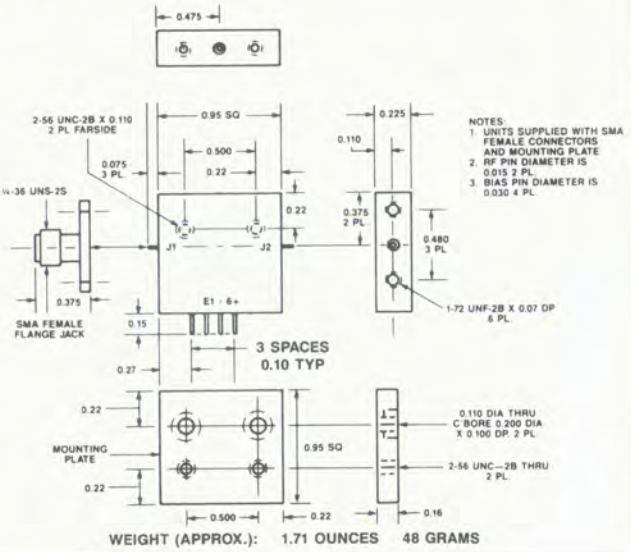
LOGIC TERMINAL OPTIONS

Dash No.	Logic Conn.	Dim "A"
001	Solder Pin	0.01(.25) MIN
002	SMC	0.31(7.9)
003	SMA	0.31(7.9)

NOTES:
1. RF Conn. shall appear at only those loc. req. by the deatil spec.
2. Logic connectors or pins shall be as specified in Table and shall appear only at required locations.
3. J1 shall be common arm unless otherwise specified.
4. Power supply & GND Min. long.

WEIGHT (APPROX.): 3.12 OUNCES 89 GRAMS

C-48

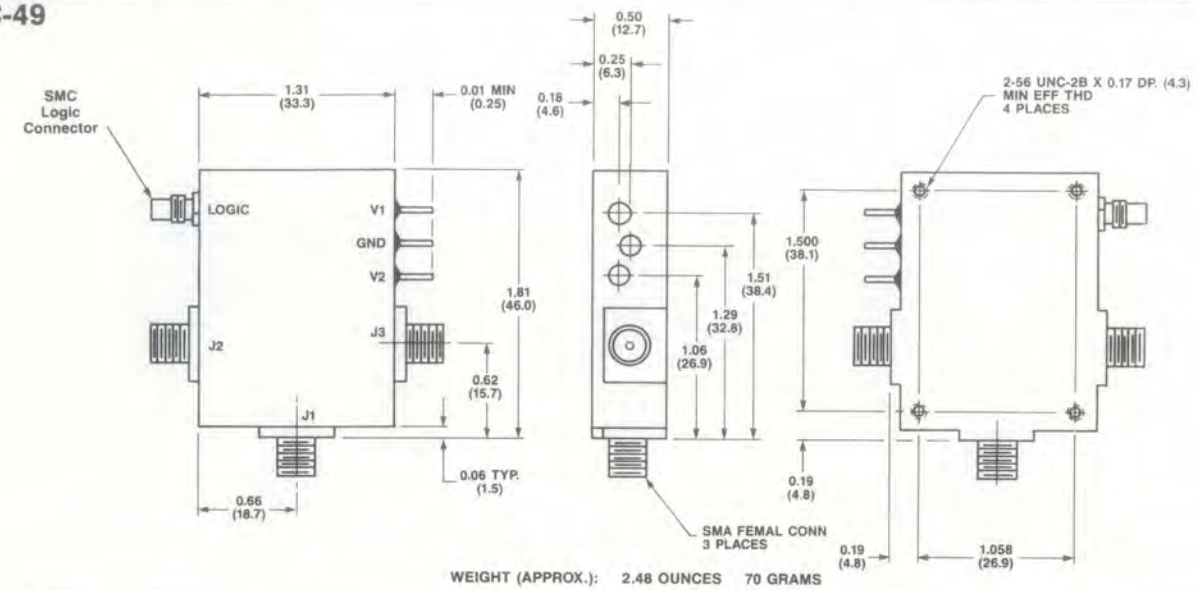


WEIGHT (APPROX.): 1.71 OUNCES 48 GRAMS

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

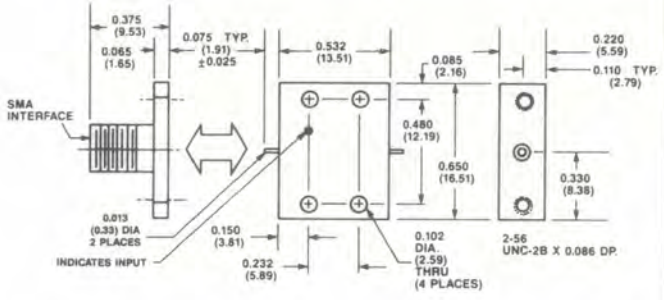
MECHANICAL DATA

C-49



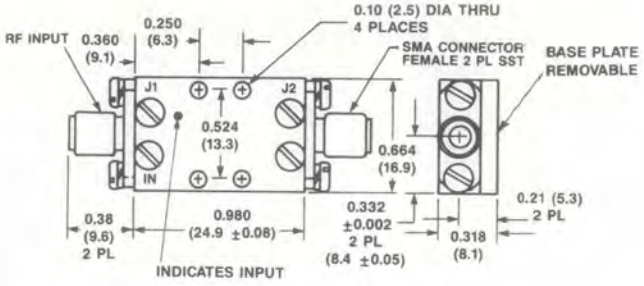
WEIGHT (APPROX.): 2.48 OUNCES 70 GRAMS

C-50



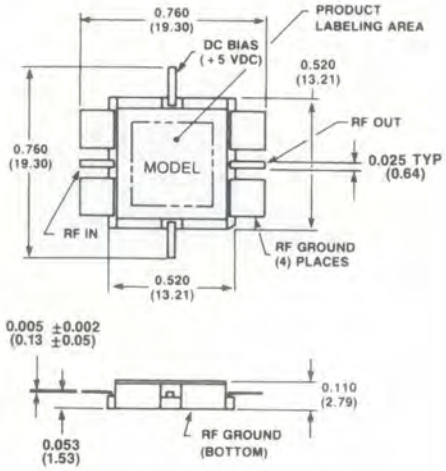
WEIGHT (APPROX.): 0.96 OUNCES 27 GRAMS

C-51



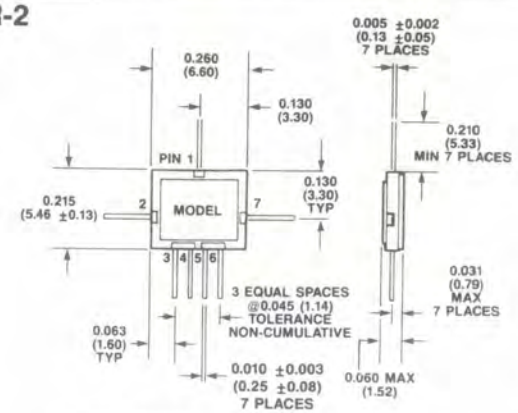
WEIGHT (APPROX.): 0.74 OUNCES 21 GRAMS

CR-1



WEIGHT (APPROX): 0.07 OUNCES 2 GRAMS

CR-2



PIN CONFIGURATION

	RF COM	RF1	RF2	A1	B1	A2	B2
SPST	N/A	2	7	5	4	N/A	N/A
SW-226/227	1	2	7	3	4	6	5
SW-228	1	2	7	3	6	OC	OC

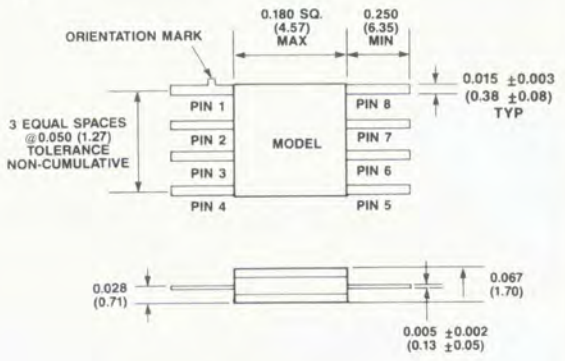
ALL OTHER PINS ARE GROUND.

WEIGHT (APPROX): 0.01 OUNCES 0.3 GRAMS

MECHANICAL DATA

UNLESS OTHERWISE NOTED:
.XXX = ±0.010, .XX = ±0.020
(.X = ±0.3), (.XX = ±0.5)
DIMENSIONS IN ( ) ARE IN MM.

CR-3



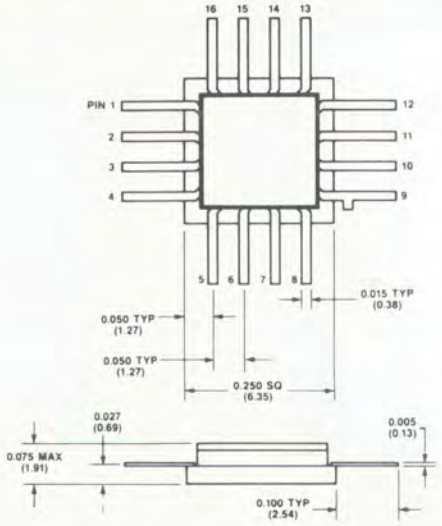
PIN CONFIGURATION

	RF COM	RF1	RF2	A	B
SPST	N/A	8	5	2	3
SPDT	1	3	6	4	5

ALL OTHER PINS ARE GROUND.

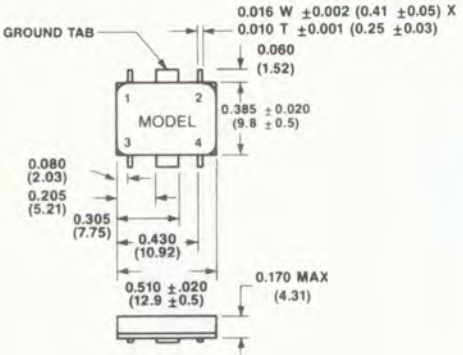
WEIGHT (APPROX): 0.007 OUNCES 0.2 GRAMS

CR-4



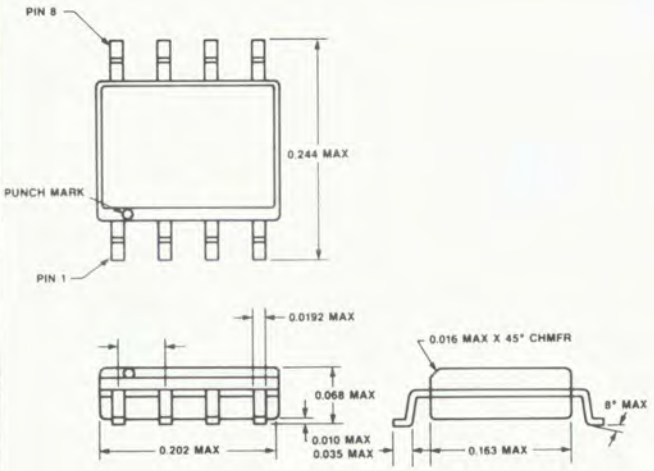
WEIGHT (APPROX): 0.01 OUNCE 0.3 GRAMS

SF-1



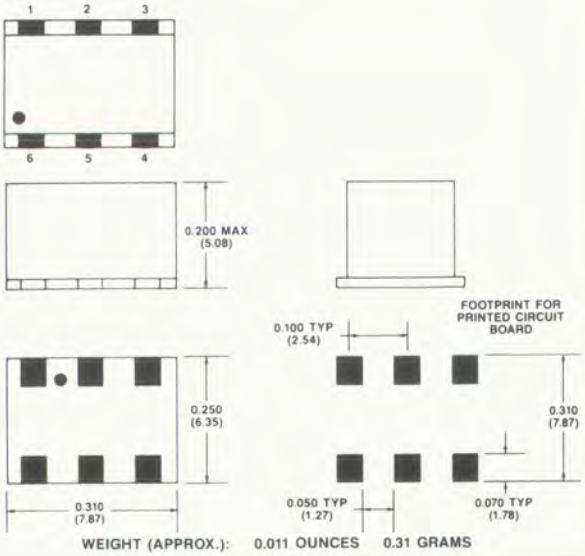
WEIGHT (APPROX): 0.07 OUNCES 2 GRAMS

SF-2



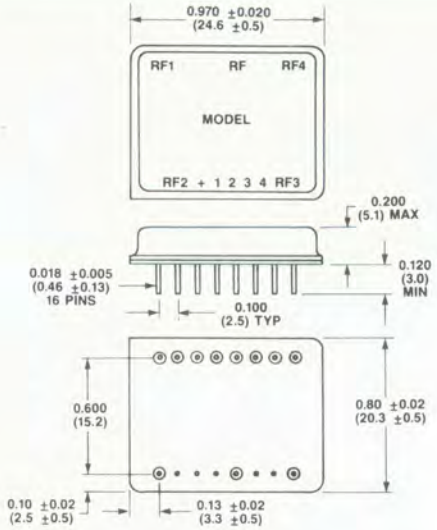
WEIGHT (APPROX.): 0.003 OUNCES 0.08 GRAMS

SF-3



WEIGHT (APPROX.): 0.011 OUNCES 0.31 GRAMS

DI-5



WEIGHT (APPROX.): 0.26 OUNCES 73 GRAMS

ANZAC AMPLIFIER FLATPACK INSTALLATION DATA

Anzac products come in a variety of package styles, but they can be separated into three general categories: flatpacks, plug-in packages, and connectorized packages. The flatpack units can further be separated into RF/IF flatpacks and microwave flatpacks. RF/IF flatpacks have ground leads for installation while microwave flatpacks require direct grounding to the case. Plug-in packages include TO-5 and TO-8 packages, relay headers and other types of dual-in-line packages.

The installation of plug-in packages, except for amplifiers, is self evident and follows conventional printed circuit board mounting practices. Information describing mounting and heat sinking amplifiers is presented below:

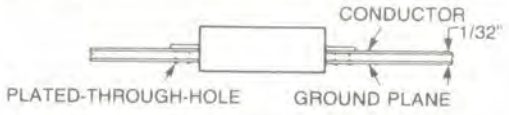
INSTALLING RF/IF FLATPACK DEVICES

The Anzac series of RF/IF flatpack signal processing components are designed for maximum RF performance plus convenient installation in microstrip, stripline or printed circuit board configurations. While they physically resemble familiar integrated circuit packages, the techniques used to achieve maximum performance are somewhat different and perhaps unfamiliar. Their interface to circuitry becomes increasingly important when operating at frequencies above several hundred Megahertz. Since all circuitry contained within the Anzac flatpacks is impedance matched, maximum performance is achieved by minimizing the discontinuities between the 50 ohm flatpack and associated circuitry. Three alternate methods of mounting and interfacing are described, categorized by their upper frequency limits of operation.

METHOD I	Specification performance over entire frequency range
METHOD II	Convenient installation-specification performance to 500 MHz
METHOD III	Lowest cost installation-specification performance to 100 MHz

METHOD I

This microstrip interface to the flatpack provides full performance over the unit's entire frequency range and requires no external compensation. The ground paths must be as direct as possible, using plated-through-holes or foil extending from the ground plane through the dielectric material to the lead attachment point as shown in Figure 1. Note that the flatpack is installed in a cut-out area of the circuit board. The purpose of this is to minimize discontinuities and also to provide the extremely low inductance ground paths necessary for good high frequency operation. Also observe the slight chamfer of the microstrip signal conductors that prevents their shorting to the flatpack case. This technique of interfacing to the Anzac flatpack allows high performance to above 3 GHz.

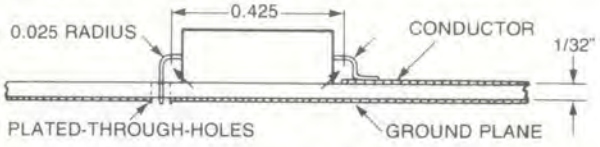


METHOD I – High performance microstrip installation in 1/32" glass teflon board, copper clad 2 sides

Figure 1

METHOD II

Method II is a microstrip interfacing technique for frequencies up to 500 MHz. The package installation is easier, but full performance to 500 MHz requires external compensation. The minimal lead inductance added by this method does not adversely affect performance below 250 MHz and requires no external compensation. For operation to 500 MHz, compensation is needed and is added in the form of a lumped capacitance of 1 to 2 pf from the signal leads to ground. This can be either a discrete capacitor or a distributed form using a stepped discontinuity in the connecting transmission lines to add the required capacitance. This technique transforms the undesirable signal lead inductance into an element of lowpass filter having a cutoff frequency of 1 GHz, if dimensions are followed closely. An excellent way to accomplish this compensation is to extend the microstrip conductors at right angles at the flatpack lead attachment point to form a lumped capacitance as in Figure 2, point A. This capacitance can be easily altered in prototyping by varying the area of the stepped discontinuity to achieve maximum performance.

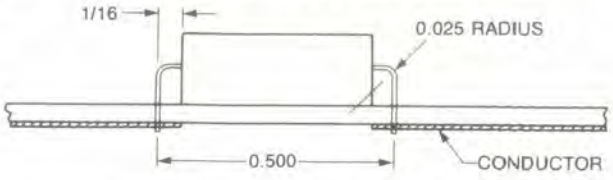


METHOD II – Installation in 1/32" glass teflon board, copper clad 2 sides

Figure 2

METHOD III

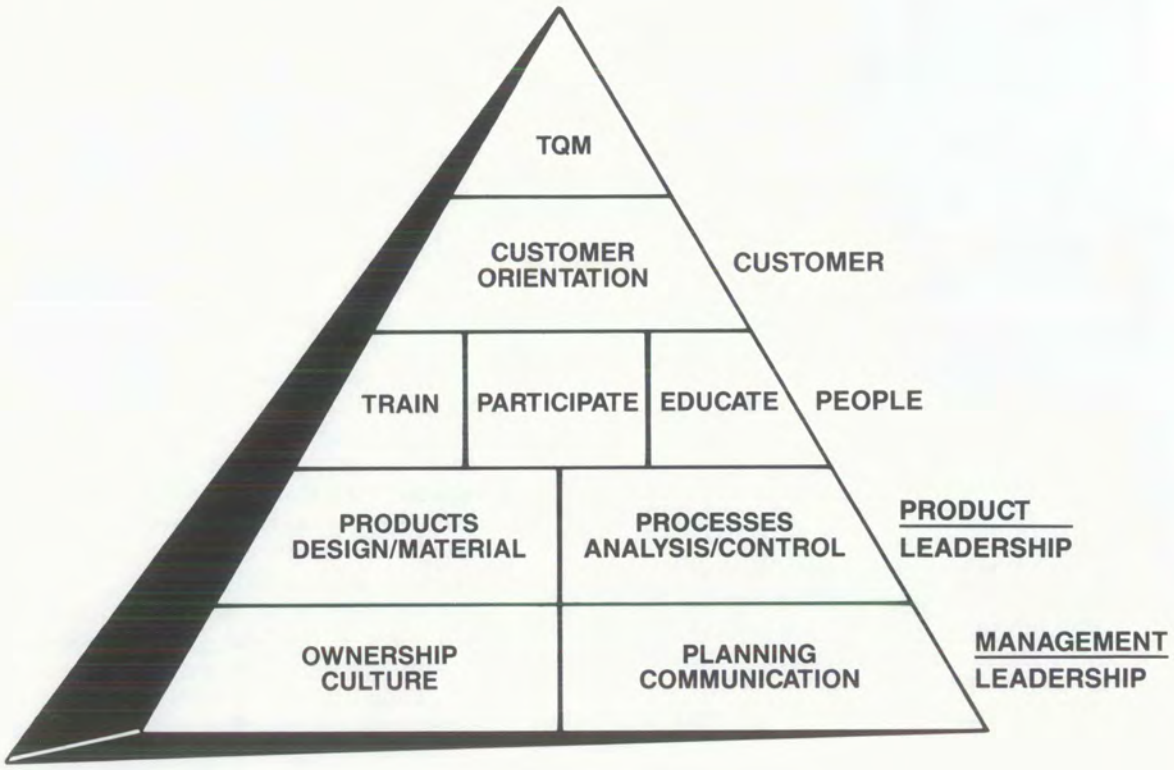
Method III consists of mounting the flatpack on a conventional PC board, using the low package profile to gain higher packaging densities that result from closer center-to-center spacing of the printed circuit boards. The leads are formed by a bending fixture to the dimensions shown in Figure 3 and the flatpack is then installed in the conventional manner. This technique is usable to 100 MHz covering the majority of IF signal processing requirements. When high frequency operation is desired, refer to Methods I and II.

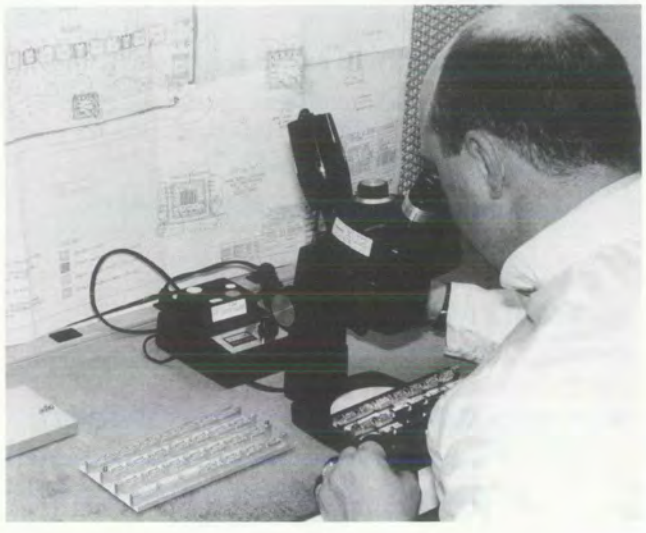


METHOD III – Printed circuit board installation

Figure 3

TOTAL QUALITY MANAGEMENT





At Adams-Russell, we know that the quality of a product depends upon more than just its design. It takes dedicated people working together in a quality environment to design, manufacture, test, and inspect it. With this in mind, we begin our quest for quality with a commitment:

EXCELLENCE THROUGH TEAMWORK

It is not a slogan. It is an attitude. When you meet with our Sales representatives and consult with our Product Engineers, you will realize that this commitment is for the entire team, not just the operators on the floor building our products. In the performance of our products, excellence is the standard. Whether you need a spare cable for a receiver or a complex sub-assembly for a missile, you get the same standard of quality from Adams-Russell: EXCELLENCE.

TOTAL QUALITY MANAGEMENT

Adams-Russell recognizes that a commitment to excellence must be matched with the commitment of resources to do the job. Our Total Quality Management System is a comprehensive approach to quality in manufacturing. Based upon MIL-Q-9858, MIL-M-38510, and MIL-H-38534, the new General Specification for Hybrids, it requires thorough Initial Quality Planning and participation by Quality Assurance and Quality Control personnel in all aspects of contract performance:

- Custom requirements are converted directly into internal documentation placed under revision control;
- Designs are reviewed for maximum producibility and resistance to process variation, as well as conformance to application requirements;
- Analyses such as Mean Time Between Failures, Component Derating, Worst Case Power, and Thermal based upon accepted military guidelines such as MIL-STD-217 are available upon request for all designs;
- Suppliers and their raw materials are qualified and evaluated through Quality Systems such as: Surveys, Vendor Quality Rating; Lot Qualification and Element Evaluation programs by Quality Assurance to assure flowdown of applicable requirements through general and detail specifications.
- Devices are manufactured by trained and certified operators using processes controlled using detailed statistical analyses; then thoroughly tested and inspected in accordance with test methods and inspection criteria applicable to their product type using calibrated equipment and approved written procedures;
- Inspections and tests are performed by trained and certified personnel using approved test methods to the inspection levels suggested by the statistical profile of the process being monitored. All devices are inspected 100% by Manufacturing prior to presentation to Quality Control for lot disposition;
- All test and inspection equipment is calibrated using standards traceable to the National Bureau of Standards in accordance with MIL-STD-45662;
- Failure Identification, Analysis, and Corrective Action is required to be performed and documented in accordance with MIL-STD-1520 for all nonconformances whether identified prior to or following delivery.
- Finished devices are reviewed by Final Quality Control for total compliance to Customer requirements prior to delivery or Customer Source Inspection.

MILITARY PROGRAMS/QUALIFICATIONS

Adams-Russell' components are currently qualified for use on airborne and aerospace applications such as:

EW/ ELINT	AIRCRAFT/ RADAR	MISSILES	SATELLITES/ SPACE	COMMUNICATION
EXCITER	F-14	SPARROW	FLEET SATCOM	MANPACK
ADCAP	F-15	PHOENIX	MARISAT	SCOT
WILD WEASEL	F-16	AMRAAM	EXOSAT	NESP
MRCA	F-18	HARM	METEOSAT	MSE
INEWS	B1	HARPOON	SHUTTLE	AF IFF
LANTIRN	B2	MILSTAR		
	B-52	PATRIOT		
	EA6B	STANDARD		
	MMRS	L.C.S.		
	JSTARS	TACIT/RAINBOW		
	MODE-S			

These programs require qualification to the following Department of Defense requirements:

GENERAL

MIL-E-5400
MIL-M-38510 (CLASS B AND CLASS S)

COMPONENT	QUALITY PROGRAM
MIL-M-28837	MIL-Q-9858
MIL-P-23971	MIL-I-45208
MIL-C-15370	MIL-STD-45662
MIL-A-28875	MIL-STD-480

WORKMANSHIP/ENVIRONMENTAL

MIL-STD-454
MIL-STD-883
MIL-STD-202
MIL-S-45743
WS-6536
FED-STD-209
MIL-HDBK-263
MIL-STD-1285
MIL-STD-129

FACILITIES/TEST

Adams-Russell component manufacturing facilities are fully compliant with FED-STD-209 requirements for cleanliness and environmental control. All processes exposing semiconductor elements are carried out in Class 100,000 clean rooms. All monolithic Gallium Arsenide processing is performed in a Class 100 clean room. Corrective Action limits are established based upon historical data and specific corrective actions are identified, including the disposition of work-in-process.

Adams-Russell maintains Electircal and Environmental Test Laboratories staffed by skilled technicians working with state-of-the-art equipment identified and/or calibrated in accordance with MIL-STD-45662. Tests are documented via travelers, inspection logs, and/or Acceptance Test Procedures. Test methods are based upon MIL-STD-883. The tables on the page following identify Standard Quality Test Plans appropriate for the device types noted.

A LOOK TO THE FUTURE

Adams-Russell is now moving towards certification to the MIL-STD-1772 Qualified Manufacturer's program requiring full compliance to MIL-M-38510, MIL-STD-883, and to MIL-H-38534. These certifications require a Product Assurance Program that guarantees the involvement of Quality in all aspects of contract performance. Adams-Russell is also working with JEDEC, the government liaison branch of the Electronic Industries Association (EIA), to develop standards that are appropriate for the techniques and technologies used by the RF/Microwave industry. These programs, combined with our Total Quality Management approach, will assure Adams-Russell's position as a World Class Manufacturer of quality RF/Microwave components.

Excellence Through Teamwork
With Our Customers, Our Suppliers, and Among Our Employees.

PASSIVE AND MIXER PRODUCTS

TABLE 1A
DEVICE SCREENING

(Reference Document MIL-STD-202)

TEST	SAMPLE SIZE	METHOD/CONDITION
Stabilization Bake [1]	100%	24 hours @ 125° C
Thermal Shock	100%	107/B 5 cycles
Electrical Test	100%	Product Data Sheet
Seal Test — Gross [1]	100%	112/D
External Visual	1% AQL	Divisional Workmanship Manual
External Mechanical	1% AQL	Device Outline Drawing

NOTE: [1] This test does not apply to connectorized units. Connectorized units using hermetically sealed products will be screened to Table 1 at that level.

TABLE 2A
QUALITY CONFORMANCE INSPECTION

(Reference Document MIL-STD-202)

SUBGROUP	SAMPLE SIZE	METHOD/CONDITION
Electrical over Temp.	1% AQL	Product Data Sheet
Solderability	1%, S-4 AQL	208
Resistance to Solvents	3 Devices	215
Vibration	1%, S-4 AQL	204/A or D
Electrical at Room	1%, S-4 AQL	Product Data Sheet
Seal Test — Gross [1]	1%, S-4 AQL	112/D

NOTE: [1] This test does not apply to connectorized units. Connectorized units using hermetically sealed products will be screened to Table 1 at that level.

TABLE 3
QUALIFICATION [1]

(Reference Document MIL-STD-202)

TEST	SAMPLE SIZE	METHOD/CONDITION
Subgroup 1		
Moisture Resistance	2.5%, S-4 AQL	106
Subgroup 2		
Salt Spray	2.5%, S-4 AQL	101
Subgroup 3		
Shock	2.5%, S-4 AQL	213/C
Terminal Strength	2.5%, S-4 AQL	211

NOTE [1]: Table 2, Quality Conformance Inspection is part of the qualification testing and is done prior to these tests.

AMPLIFIER, SWITCH LIMITER AND HYBRID MICROCIRCUIT PRODUCTS

TABLE 1B
DEVICE SCREENING

(Reference Document MIL-STD-883)

TEST	SAMPLE SIZE	METHOD/CONDITION
Stabilization Bake [1]	100%	1008/B 125° C for 24 hrs
Temperature Cycling	100%	1010/B
Constant Acceleration [1]	100%	2001/A Y1 Plane only
Burn In	100%	1015 85° C for 160 hrs
Final Electrical	100%	Product Data Sheet
Seal Test — Fine [1]	100%	1014/A
Seal Test — Gross [1]	100%	1014/C
External Visual	100%	Device Outline Drawing

NOTES: [1] This test does not apply to connectorized units. Connectorized units using hermetically sealed hybrid microcircuits will be screened to Table 1 at the hybrid level.

TABLE 2B
QUALITY CONFORMANCE INSPECTION

(Reference Document MIL-STD-883)

TESTS	SAMPLE SIZE	METHOD/CONDITION
Group A, Electrical Testing		
Subgroup 7	LTPD = 5	Product Data Sheet @ 25°C
Subgroup 8	LTPD = 10	Testing at –55°, +85°C
Group B, Physical Testing [1]		
Subgroup 1 Physical Dimensions	2 Devices	2016
Subgroup 2 Resistance to Solvents	4 Devices	2015
Subgroup 3 Internal Visual and Mechanical	1 Device	2014
Subgroup 4 Bond Strength	2 Devices/ 22 Wire	2011
Subgroup 5 Die Shear Strength	2 Devices/ 22 Components	2019 (2 Devices minimum)
Subgroup 6 Solderability	1 Device/15 Leads	2003 (2 Devices minimum)
Subgroup 7 Seal Test		
Seal Test — Fine [2]	15 Devices	1014/A
Seal Test — Gross [2]	15 Devices	1014/C

NOTES: [1] No failures allowed.
[2] This test does not apply to connectorized units. Connectorized units using hermetically sealed hybrid microcircuits will be screened to Table 1 at the hybrid level.

TABLE 3B
QUALIFICATION [1]

(Reference Document MIL-STD-883)

TEST	SAMPLE SIZE	METHOD/CONDITION
Group C, Life Test [2]		
Subgroup 1	15 Devices	
Temperature Cycling		1010/C
Constant Acceleration		2001/E (Y 1 plane only)
Seal Test – Gross		1014/C
Seal Test – Fine		1014/A
External Visual		Device Outline Drawing
End Point Electrical		Product Data Sheet
Subgroup 2	10 Devices	
Steady State Life		1005 (125°C for 1000 hrs)
End Point Electrical		Product Data Sheet
Subgroup 3	5 Devices	
Internal Water Vapor Content		1018
Group D, Package Testing		
Subgroup 1	5 Devices	
Thermal Shock		1011/C
Stabilization Bake		1008/C (1 hr)
Lead Integrity		2004/B2 (15 leads)
Seal Test – Gross [3]		1014/C
Seal Test – Fine [3]		1014/A

NOTES: [1] Table 2, Quality Conformance Inspection is part of the qualification testing and is done prior to these tests.
[2] No failures allowed.

RHG PRODUCTS

TABLE 1C
DEVICE SCREENING

(Reference Document MIL-STD-883)

TEST	SAMPLE SIZE	METHOD/CONDITION
Temperature Cycling	100%	1010/A
Seal Test – Fine [1]	100%	1014/A
Seal Test – Gross [1]	100%	1014/C
Mechanical Shock [2]	100%	2002/A
Burn In	100%	1015/85°C for 160 hrs

NOTES: [1] This test does not apply to non-hermetic connectorized units. Non-hermetic units using hermetically sealed hybrid microcircuits will be screened to Table 1 at the hybrid level.
[2] This test will be performed at manufacturer's option.

SEMICONDUCTOR CENTER

The Adams-Russell Semiconductor Center, established in 1982, specializes in the design and manufacture of GaAs MMICs for military and space applications. Its key personnel have brought many years of GaAs experience to Adams-Russell Electronics and have made a number of significant contributions to the advancement of this technology.

The Semiconductor Center provides a focal point for microelectronics technology within Adams-Russell and operates as an independent business unit supplying custom MMICs (using Adams-Russell designs) to major military electronics manufacturers. In addition, it supplies MMICs for use within Adams-Russell and for sale as standard products by Adams-Russell's Anzac Division, co-located with the Semiconductor Center in Burlington, MA. This relationship enables Adams-Russell to offer its customers complete environmentally-screened MIL-SPEC hybrid assemblies incorporating GaAs MMICs.

In 1984, Adams-Russell became one of the first U.S. manufacturers to deliver MMICs for use in a military production program and has since provided foundry services to over twenty-five (25) of the leading military electronics systems manufacturers. These initiatives in GaAs technology reflect Adams-Russell's commitment to a position of leadership in advanced RF and microwave components and a realization that GaAs MMICs will be crucial to achieving the performance, size and cost requirements of future defense systems.

GaAs MMIC FACILITIES AND CAPABILITIES

The Adams-Russell Semiconductor Center is located in a 54,000 sq. ft. building in Burlington, MA. This facility includes a 6,000 sq. ft. FED-STD-209B Class 10,000 clean room for hybrid microwave integrated circuit (MIC) assembly and MMIC packaging, a 4,000 sq. ft. Class 100 clean room for GaAs wafer fabrication, a 1,000 sq. ft. Class 10,000 clean room for MMIC testing and approximately 6,000 sq. ft. of service areas for clean room support equipment. Adams-Russell also operates additional hybrid MIC manufacturing facilities in Bangor, ME and Cork, Ireland, comprising a total of 180,000 sq. ft.

All semiconductor processing and production test operations, from substrate characterization to die separation, are performed in the Class 100 clean room. This facility is sized to support an eventual throughput of approximately 100 wafer starts per week. It includes a broad spectrum of advanced semiconductor processing equipment, including deep-UV mask aligners, electron-beam evaporators, plasma-CVD deposition and etching systems and ion implantation/annealing systems. Cassette-to-cassette wafer handling is incorporated for maximum wafer throughput and reproducibility. DC wafer-level testing is performed automatically using a Keithley 350i Parametric Test System with Electroglass and Rucker and Kolls Automatic Wafer Probers. RF wafer-level testing capability includes Cascade Microtech RF probers and Automatic Network Analyzers (HP 8510 and 8753).

Adams-Russell has made a major commitment to CAD/CAM technology for MMIC design and test. A total of 12 work stations can access three VAX computers via an ETHERNET link, permitting ready access to design, process and test information. Software includes SuperCOMPACT and SPICE for circuit analysis and optimization, KIC2 for IC layout, Keithley KDA for statistical analysis and database management and proprietary software for on-line wafer process documentation, lot tracking and finished goods inventory.

Adams-Russell has high-volume packaging and screening capabilities at its disposal within the company's Anzac Division, which has long been a leader in the area of RF and microwave hybrid MIC components and assemblies. Anzac routinely handles semiconductor chips of various sizes in both thick-film and thin-film hybrids and can provide fully tested and screened hermetically

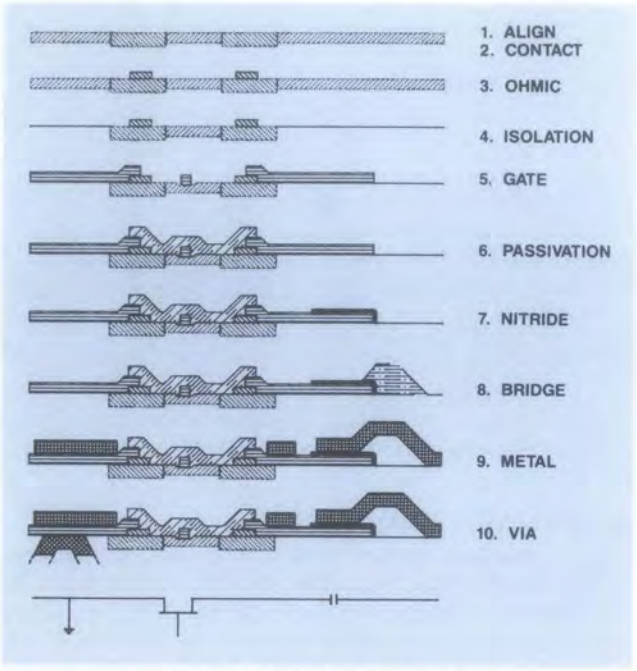


Figure 1. Wafer Fab Sequence

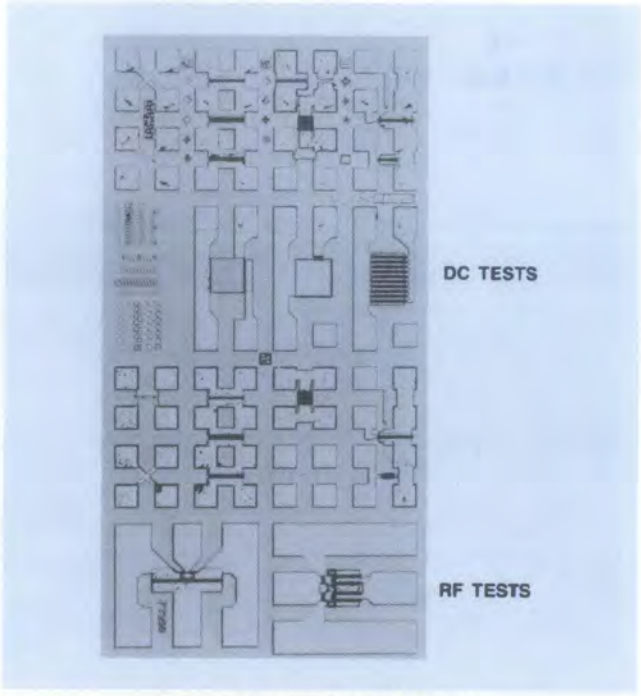


Figure 2. Process Control Monitor

sealed packages to the exacting requirements of the military electronics marketplace. The QA organization has been approved to MIL-Q-9858A and is capable of environmental screening to MIL-STD-883 up to and including "S" level.

GaAs MMIC TECHNOLOGY

Design and manufacture of GaAs MMICs involve a large number of complex and interdependent steps, including design, simulation and optimization, layout, wafer fab, packaging and DC/RF tests. The design rules dictated by the process technology have to be closely coupled with circuit optimization and layout in order to realize a cost-effective, high-yield MMIC technology; a "design for production" approach is the integrating concept for Adams-Russell's GaAs IC technology development.

Adams-Russell's production GaAs IC technology is based on direct implanted n-channel depletion mode MESFETs with selectively implanted n+ ohmic contacts. Implanted resistors, spiral inductors and dielectric capacitors are integrated on the same chip using air-bridge interconnects to form a monolithic integrated circuit. Key features of wafer fabrication are highlighted in Figure 1.

Adams-Russell offers three standard GaAs MMIC processes, Process 1 (1.0um) and Process 2 (0.5um), and Process 1P (1.0um, power). These processes offer customers the ability to realize integrated microwave signal-processing circuits at frequencies from DC to 20 GHz.

The Process Control Monitor (PCM) is a group of DC/RF devices (Fig. 2) fabricated on the wafer at the same time as the IC, which allows Adams-Russell to completely characterize each process step and guarantee the electrical performance of the wafer.

The circuit "building blocks" for GaAs MMICs consist of FETs, resistors, capacitors, inductors, transmission lines, and diodes. Equivalent circuit models have been developed on the basis of extensive RF characterization of the standard circuit elements and are contained in the Adams-Russell GaAs IC Design Manual.

DEVICE TYPE	RANGE	TYPICAL SPECIFICATION
MESFET (SINGLE OR DUAL GATE)	W_G = 100-1200 μm	F_T = 12 GHz, V_P = −3V (PROCESS 1) F_T = 18 GHz, V_P = −2V (PROCESS 2)
SCHOTTKY DIODE n (CHANNEL) n^+ (CONTACT)	W = 50-200 μm W = 10-50 μm	RF VARACTOR DC LEVEL SHIFT
IMPLANT RESISTOR n (CHANNEL) n^+ (CONTACT)	R = 100-10K ohm R = 10-1K ohm	R_{SI} = 750 ohm/sq. (PROCESS 1) R_{SI} = 800 ohm/sq. (PROCESS 2) R_{SC} = 125 ohm/sq. (PROCESS 1 & 2)
MIM CAPACITOR	C = 0.05-50 pF	C_N = 600 pF/mm²
INTERDIGITATED CAPACITOR	C = 0.05pF-0.2pF	PITCH = 25μm
SPIRAL INDUCTOR	L = 0.05-8nH	PITCH = 12-30 μm

Figure 3. Standard Circuit Elements

GaAs MMIC PRODUCT EXPERIENCE

As indicated previously, the Adams-Russell Semiconductor Center is committed to providing advanced MMIC products to the defense systems market in three areas: foundry services, standard products, and custom designs.

FOUNDRY SERVICES

Approximately 50% of the Semiconductor Center's production of GaAs MMICs involves wafer fabrication of circuits designed by external "foundry" customers. The logistics of this operation are illustrated in Fig. 4; formal design training is also part of the service, and has been offered to over twenty groups of engineers since 1984. A partial list of circuits produced to date for foundry customers is as follows:

- 2 to 12 GHz feedback amplifier
- 5.9 to 6.4 GHz low-noise amplifier
- 1 to 10 GHz distributed amplifier
- 6 GHz reactively-matched amplifier
- C-band 4-bit digital phase shifter with on-chip logic
- 6 to 8 GHz LO buffer amplifier
- 100 MHz to 3 GHz amplifier
- 14 GHz low-noise amplifier
- Fiber-optic receiver ship with integrated detector/amplifier
- X-band mixer, switch, differential amplifier
- L-band low-noise amplifier
- X-band receiver module
- X-band amplifier, switch, attenuator
- 14 to 22 GHz amplifier

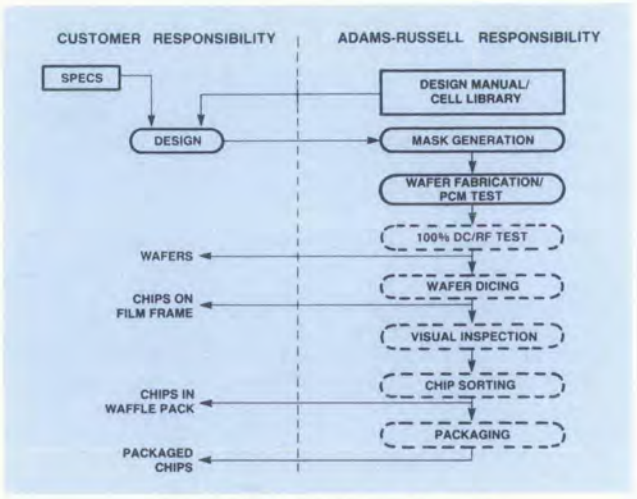


Figure 4. GaAs IC Foundry Service

STANDARD PRODUCTS

Adams-Russell is developing a family of standard MMIC products, in both packaged and chip form, for sale through Adams-Russell's Anzac Division. Products already announced include the SW-200 family of RF switches and the AM-260 broadband EW amplifier. MMIC products currently being developed under IR&D funding include:

- Broadband distributed amplifiers
- Broadband feedback amplifiers
- Narrow-band low-noise amplifiers
- High-performance SPST RF switch
- Multithrow RF switches
- Voltage-variable attenuator
- Digital attenuator
- Low-noise VCO
- Broadband mixer

CUSTOM PRODUCTS

Custom designs, in many cases based on standard products listed above, have also been an important aspect of Adams-Russell's business activity. These products have complete form-fit-function specifications, and in most cases have been sold as packaged, screened units. The Adams-Russell Semiconductor Center has successfully contributed GaAs MMICs to the following military programs:

HARM	ADVCAP
MILSTAR	GPS/NAVSTAR
SFW	LANTIRN
JSTARS	A6F UPGRADE
ICNIA	SP3
ARC-172	SCOTT
ALR-66VE	AGN-139/GBU-15
OTHR-MOD	JTIDS

SPACE CENTER

INTRODUCTION

As a result of nearly two decades of successful high reliability Space Program experience, Adams-Russell has created The Space Center to serve the growing needs of our customers. The Space Center is exclusively dedicated to the design, manufacture, test and qualification of Adams-Russell components and products to Level S quality for space applications. The Space Center is equipped to provide these components and products both as derivatives of the components shown in this catalog or as special components and subsystems to meet specific customer requirements.

FACILITY

Processing, manufacturing, testing and qualification are performed in a 3900 square foot facility in Waltham, Massachusetts. Featured in this facility is a 2500 square foot FED-STD-209 Class 10,000 clean room. This includes a Class 100 pre-cap inspection area with full Electrostatic Sensitive Device (ESD) protection. Inside the clean room are areas for assembly, bonding and welding as well as, epoxy, eutectic and solder stations. Full RF test capability for the product line is also contained within the clean room environment. The custom thick film fabrication/trim facility is contiguous to the assembly area.

Environmental testing of finished products is accomplished on site in the Space Centers' environmental test area. This area is outfitted with the latest in equipment and trained personnel to accomplish the space level environmental testing in-house.

SATISFYING CUSTOMER NEEDS

There is no universally applied standard for electronic components utilized in spacecraft payloads. There are, however, many common aspects to customer requirements whether for military, commercial or scientific payloads derived from the last thrity years of space activitiy. In general, products intended for space use must have very high mean-time-between-failure (MTBF) in order to allow for years of unattended operation in space. This is true in spite of the fact that most satellites and systems are designed with redundancy to prevent single point failures.

While the statement "You can't test in reliability, you must build it in" may have been overused, in fact, it is particularly true of space qualified products. Both 100% screening tests and lot evaluation sample tests are a critical part of producing these products, but they are not sufficient to achieve the required reliability levels. Careful documentation and control of purchased parts, materials and manufacturing processes are essential to reducing the probability of failure.

The Space Center has developed an operating system geared to the necessary documentation and record keeping for precise control and verifications of each and every unit produced at the facility. This discipline is invoked throughout the product life cycle. This entire system is subjected to the close scrutiny of our Quality Assurance Department. The Quality Assurance Department is responsible for review and approval of documentation, inspections and audits of hardware and facilities, and verification of conformance to the configuration control documentation.

The baseline specifications used by the Space Center in designing the facility, selecting equipment and documenting and controlling parts materials and processes are MIL-M-38510 and MIL-STD-883 for Class S hybrids. Similar approaches are also used for the manufacture of non-hybridized products such as passive components and mixers. Many customers have specific requirements relating to parts and materials or end item testing that may modify and amplify the requirements of MIL-STD-883, but manufacturing controls such as process tests for wire bonding and component mounting, cleaning methods and electrostatic protection are applied uniformly to all products. The quality assurance program structured in accordance with MIL-Q-9858 and MIL-I-45208 is also applied to all programs.

The steps involved in producing space qualified products follow the same general outline shown in Figure 1 and are modified to fit the variations in specific customer requirements. The steps related to design and documentation may be reduced, depending upon the history of previous manufacture for a space application, saving cost and schedule. The product flow shown in Fig. 1 includes the basic requirements of MIL-STD-883 for element evaluation, process control, device screening and quality conformance evaluation, as well as the preparation necessary prior to production. Many programs requiring significant design work will require formal customer design reviews and may include extensive circuit analysis for parts derating, end-of-life considerations and reliability. End-of-life performance changes are a significant factor on satellite systems expected to perform to specification for as long as ten years in orbit and this may drive the circuit design and parts selection.

SCREENING, INSPECTIONS, AND PROCESS CONTROLS

All of the methods employed are designed, implemented and controlled to meet the requirements of MIL-STD-883 Method 5008 and the applicable portions of MIL-M-38510 Appendix G. The application of specific documentation, screening, inspections and process controls are tailored to specific customer requirements. The descriptions that follow demonstrate the typical methodology employed at The Space Center in producing high reliability components.

Piece Parts

Piece parts, meeting customer specific requirements, are selected in accordance with program requirements. Additional screenings inspections and element evaluations are performed to MIL-STD-883 and/or MIL-M-38510 as required by the customer.

Process Controls

Standard Hi-Reliability process controls have been established at all Space Center manufacturing and test work centers. Personnel are trained and monitored to these standards for all manufactured products. Each of the processes are designed, tested, monitored, and audited in accordance with the requirements of MIL-STD-883 Class S.

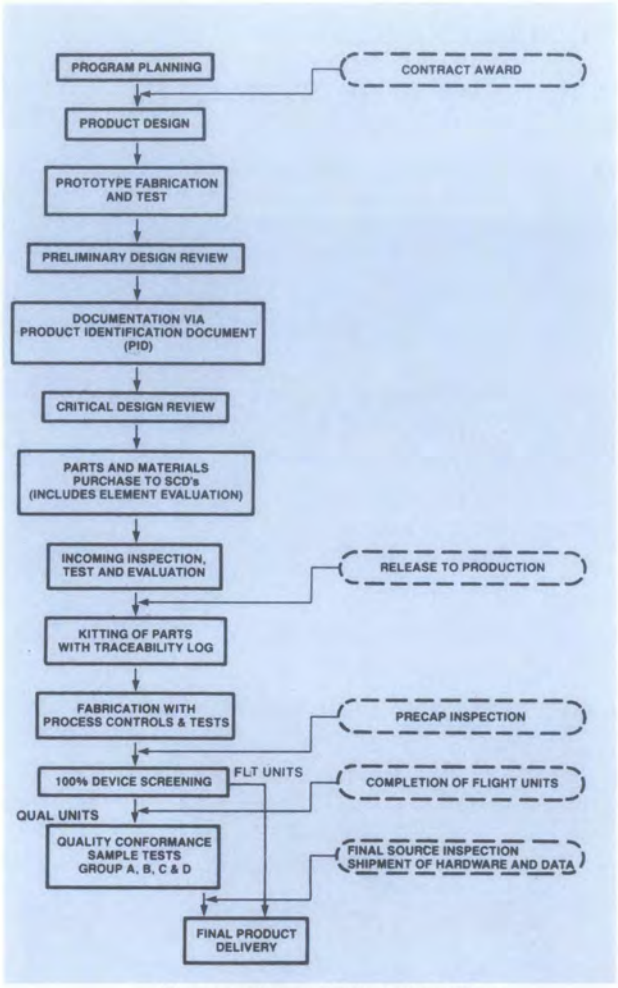
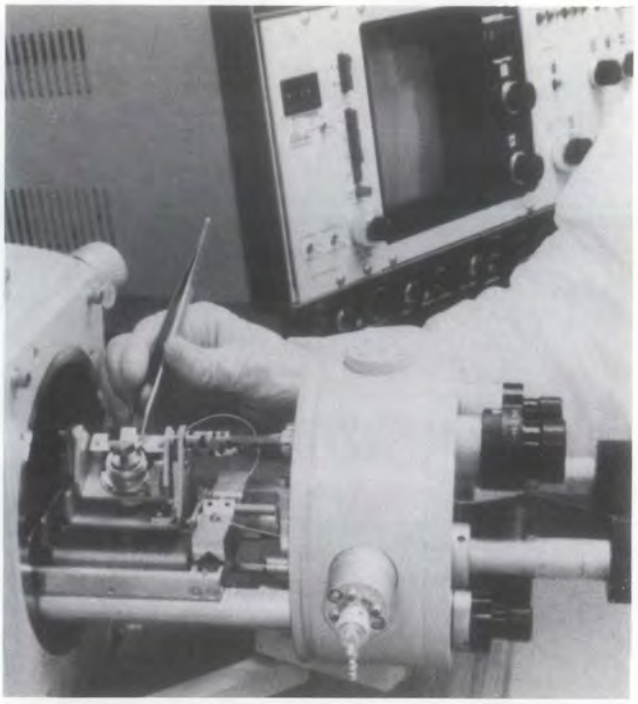


Figure 1. Space Product Flow Chart



Hybrid Screening

Completed products are subjected to the Device Screening Requirements of MIL-STD-883 Method 5508 (as listed in Table I) for Class S devices or as directed by the customer. Additional quality conformance inspections are conducted as dictated by customer requirements.

MANAGEMENT

The Space Center is staffed with a team of management, engineering, manufacturing and product assurance personnel who have been associated with the high reliability space business for many years. Hands-on assembly and inspection personnel are fully trained in an intensive course at the Adams-Russell Training Center prior to assignment at The Space Center. This unique training is reinforced by additional periodic off-site training sessions as well as on the job reinforcement to maintain proficiency and certification in critical operations.

TABLE I CLASS S HYBRID SCREENING

Test Inspection	MIL-STD-883 REQUIREMENTS Method	Condition	Class S
Pre-Seal Burn-In	1030		Optional
Non-Destructive Bond Pull	2023		100%
Internal Visual	2017		100%
Stabilization Bake	1008	C	100%
Temperature Cycling	1010	C	100%
Constant Acceleration	2001	A or D	100%
Particle Impact Noise Detection (PIND)	2020	A or B	100%
Electrical			100%
Burn-In	1015	125°C	100%
Final Electrical Test	Per Applicable Device Specification		100%
Seal	1014		100%
a. Fine			
b. Gross			
Radiographic	2012		100%
External Visual	2009		100%

The Space Center management is structured as a line-matrix organization to coordinate the various internal disciplines in accordance with customer dictates. A Program Manager is assigned to every Space Center contract. This Program Management function within the organization is not an added task for an engineer or manufacturing supervisor, but rather a specific organizational function with full time managers. The Program Manager provides the necessary customer interface and coordinates internal activities and resources to optimize delivery schedules for products and documentation.

SUMMARY

The Space Environment is one that offers no second chances. If you have a program that needs to operate in that environment the first time, every time and for extended periods of time, the Space Center is your source for RF and Microwave Signal Processing Components. When your program demands the controls, documentation and performance of Level "S" hardware, we are ready to handle your requirements. We have the people, products and equipment dedicated to providing space hardware and 20 years of failure-free space experience to draw on. If you need hardware to work out there. . . . then the Adams-Russell Space Center is for you.

SPACE MODEL NUMBER	CLOSEST CATALOG NUMBER	TYPE	FREQUENCY RANGE
AMPLIFIERS			
AM-1081	N/A	RF CASCADABLE AMP	2-22 MHz
AM-1057	AM-173	RF CASCADABLE AMP	10-1000 MHz
AM-1064	AM-176	RF CASCADABLE AMP	10-1024 MHz
AM-1067	AM-175	RF CASCADABLE AMP	10-1000 MHz
AM-S5000	N/A	LOW NOISE AMP	330-400 MHz
LA-514	AM-351	LOGARITHMIC AMP	130-170 MHz
LA-528	AM-371	LOGARITHMIC AMP	675-825 MHz
ATTENUATORS			
AT-S5000	AT-102	5 BIT DIGITAL ATTEN	10-700 MHz
AT-537	AT-102	5 BIT DIGITAL ATTEN	20-600 MHz
AT-540	AT-102	5 BIT DIGITAL ATTEN	900-1000 MHz
PASSIVE PRODUCTS			
CH-704	CH-135	DIRECTIONAL COUPLER	10-500 MHz
DS-S5000	DS-113	2 WAY PWR DIVIDER	.4-400 MHz
DS-1231	DS-113	2 WAY PWR DIVIDER	.4-400 MHz
DS-1303	DS-113	2 WAY PWR DIVIDER	.4-400 MHz
DS-1177	DS-109	2 WAY PWR DIVIDER	10-500 MHz
DS-1178	DS-313	2 WAY PWR DIVIDER	10-2000 MHz
DS-1232	DS-117	3 WAY PWR DIVIDER	1-300 MHz
DS-1180	DS-323	3 WAY PWR DIVIDER	200-1024 MHz
DS-S5001	DS-310	4 WAY PWR DIVIDER	.5-130 MHz
HH-597	HH-106	180° HYBRID	2-200 MHz
JH-708	JH-113	QUADRATURE HYBRID	4-21 MHz
JH-S5000	JH-113	QUADRATURE HYBRID	7-14 MHz
JH-S5001	JH-115	QUADRATURE HYBRID	40-80 MHz
JH-709	JH-140	QUADRATURE HYBRID	900-1030 MHz
MIXERS AND PHASE MODULATORS			
MD-1271	MAC-50	DBL BALANCED MIXER	.2-200 MHz
MD-1221	MD-124	DBL BALANCED MIXER	.5-500 MHz
MD-1270	MD-124	DBL BALANCED MIXER	.5-500 MHz
MD-1361	MD-124	DBL BALANCED MIXER	.5-500 MHz
MD-1355	MD-614	DBL BALANCED MIXER	.7-2.2 GHz
MD-1357	MAC-51	DBL BALANCED MIXER	5-500 MHz
MD-1356	MD-113	DBL BALANCED MIXER	5-1000 MHz
MD-1301	MD-113	DBL BALANCED MIXER	5-1000 MHz
MD-1339	MD-113	DBL BALANCED MIXER	5-1000 MHz
MD-1214	MD-149	DBL BALANCED MIXER	10-1500 MHz
MD-1215	MD-152	DBL BALANCED MIXER	10-1500 MHz
MD-1213	MD-123	DBL BALANCED MIXER	10-3000 MHz
MD-1058	MD-162	DBL BALANCED MIXER	1-7 GHz
MD-1216	MDC-178	DBL BALANCED MIXER	2.6-5.2 GHz
PM-591	N/A	QPSK MODULATOR	10-20 MHz
PM-589	PM-108	QPSK MODULATOR	50-100 MHz
SWITCHES			
SW-580	SW-122	SPDT SWITCH	5-1000 MHz
SW-584	SW-123	SP3T SWITCH	5-1000 MHz
SW-582	SW-119	TRANSFER SWITCH	2-100 MHz
SW-581	N/A	PULSE MODULATOR	70-90 MHz
SW-583	N/A	PULSE MODULATOR	900-1000 MHz

ORDERING INFORMATION

How to Order
Orders may be placed with either our local distributors, sales representatives, or directly with Adams-Russell.

Adams Russell
COMPONENTS GROUP

80 Cambridge Street
Burlington, MA 01803-4107
Telephone: 617-273-3333
TLX: 200-155
TWX: 710-332-0258
FAX: 617-273-1921

Shipping Information
Unless instructed by the customer Adams-Russell Electronics will ship UPS in the U.S. or UPS Blue where available. Air Parcel Post will be used as the primary international means of shipment. Also available are Air Freight, Air Express and Special Service methods. Please indicate at time of purchase what method you require.

Pricing and Terms
Prices in this catalog are subject to change without notice.

A quotation on any item in the catalog is available from our local representative or directly from the Adams-Russell Sales Department. All quotations, unless otherwise noted, are valid for 60 days from date of issue, FOB Burlington. Pricing does not include customer or government source inspection unless noted otherwise. Our terms are net 30 days if credit has been extended. On international orders, an irrevocable letter of credit may be required.

Government Source Inspection
Government source inspection is available on any item upon receipt of the complete written confirmation of purchase order items, including the prime government contract number. Government source inspection with respect to some products increases unit price and extends delivery because of duplicate standard final inspection and testing. It is recommended wherever possible that a Certificate of Compliance be substituted for government source inspection to minimize price and delivery delay.

Returned Material
When returning material for repair or replacement, it is necessary first to contact the sales department. We require that complete information be included with the shipment giving a detailed description of the reason for its return, the date and purchase order on which it was obtained, and the exact address to which the material is to be re-shipped. All returns must arrive postage, duties and handling pre-paid.

Applications Engineering
Adams-Russell maintains a large support staff of technical sales engineers, both domestically and internationally, who are expert in specific areas of microwave technology. Each has an engineering background that combines formal engineering education with training in microwave specialties – often with many years of product design experience. As further technical support, Adams-Russell makes available the services of its engineering and scientific staff who may be consulted on more advanced circuit designs or application problems.

Federal Supply Code
Adams-Russell Federal Supply Code numbers are:

Anzac Division — 21912
Modpak — 21912
RHG Electronics Laboratory — 15286
SDI Microwave — 54558
Semiconductor Center — 21912
Space Center — 50567

PRODUCT INDEX

PRODUCT INDEX (continued)

PRODUCT INDEX (continued)

LIST OF WORLD-WIDE SALES OFFICES

Distributors

SOUTHEAST

Precision Components
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Coral Springs, FL 33075
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FAX: 305-753-4107

SOUTHERN CALIFORNIA

L & M Components
8939 S. Sepulveda Blvd.
Suite 104
Los Angeles, CA 90045
TEL: 213-417-3044
FAX: 213-417-3470

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TW Components
625 Ellis Street, Suite 101
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New England Field Office
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Lowell, MA 01851
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Lightstone Corporation
Box-484 - Tuttle Road
Bridgeport, NY 13030
TEL: 315-699-5747

METROPOLITAN NY, NORTHERN NEW JERSEY
ANZAC and SDI Microwave

Phase Four, Inc.
277 Northern Blvd.
Suite 302
Great Neck, NY 11021
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FAX: 516-482-1813

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RHG

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Hartsdale, NY 10530
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FAX: 914-472-0461

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Ambler, PA 19002
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FAX: 215-646-3889

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Davidsonville, MD 21035
TEL: 301-760-5533 (Baltimore)
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Precision Marketing
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Coral Springs, FL 33075-9258
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FAX: 305-753-4107

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550 Frontage Road
Suite 2052
Northfield, IL 60093
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FAX: 312-446-1916

Feller Associates
21 Beachway Drive, Suite G
Indianapolis, IN 46224
TEL: 317-248-0101

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1010 29th Street, N.E.
Cedar Rapids, IA 52402
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FAX: 319-364-1644

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Suite 109
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J. Smith Associates
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Colorado Springs, CO 80907
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FAX: 719-597-4208

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7375 E. Sixth Ave.
Suite 5
Scottsdale, AZ 85251
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FAX: 602-941-4428

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Northwest Field Office
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Boulder Creek, CA 95006
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FAX: 408-338-7656

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Suite 104
Los Angeles, CA 90045
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FAX: 213-417-3470

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1190 Brussels, Belgium
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TLX: 26970

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Louis Albert Associates, Inc.
5411 Canotek Road
Gloucester, Ontario
Canada K1J 8Y5
TEL: (613) 748-9751
FAX: (613) 748-3117

Montreal
Louis Albert Associates, Inc.
4060 Ste. Catherine Quest
Suite 515
Westmount, Quebec
Canada H3Z 273
TEL: (514) 931-6541
FAX: (613) 748-3117

REPUBLIC OF CHINA

Evergo Corporation
P.O. Box 96-546
Taipei (10655)
Taiwan, R.O.C.
TEL: (02) 715-0283
FAX: (02) 7122-66

DENMARK

S.C. Metric A.S.
Skodsborgvej 305
2850 Naerum, Denmark
TEL: (02)804200
FAX: (02)804131

FINLAND

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Lammittajankatu 4
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TEL: (0)7557711
TLX: 121836
FAX: (0)7553581

FRANCE

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127 RUE DE Buzenval
92380 Garches, France
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TLX: 204004
FAX: (01)4701-1622

GERMANY (Austria)

Transtech Hochfrequenztechnik GmbH & Co KG
Alee 18, PO Box 3403
D-7100 Heilbronn,
W-Germany
TEL: (07131)68052
FAX: (07131)68059

Transtech Hochfrequenztechnik GmbH Co KG
Burgweg 4, PO Box 2509
D-8034 Germering,
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TLX: 5213600
FAX: (089)8417568

Transtech Hochfrequenztechnik GmbH & Co KG
Bramfelder Strasse 102B
D-2000 Hamburg 60,
W. Germany
TEL: (040)690434 or 6904342
TLX: 2173973
FAX: (040)6902933

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10-2-289/43 Shantinagar
Hyderabad, 500 028 (AP) India
TEL: (0842)36942
TLX: 1556450

Kashinath & Company
95 Third Cross
Basavanagudi
Bangalor 560 004 India
TEL: (0812)604668
TLX: 8458120

ISRAEL (MIDDLE EAST)

MTI Engineering
Atidim Industrial Park
Bldg 3 Entrance 2
Neve Sharett, Tel-Aviv
61430 Israel
TEL: (03)492101
TLX: 342200
FAX: (03)492199 or 490012

ITALY

Microelit S.R.L.
Via Sardegna, 1
20146 Milano, Italy
TEL: (02)4817900
TLX: 334284
FAX: (02)4813594

Rome
Microelit S.R.L.
Via Nicola Marchese
10-001414 Roma, Italy
TEL: (06)8894323 or 8894326
FAX: (06)8275270
TLX: 616104

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Rikei Corporation
Shinjuku Numura Bldg
1-26-2 Nishi Shinjuku
Shinjuku-ku
Tokyo 163 Japan
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Doornakkersweg 26
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P.O. Box 46, Holmlia
1201 Oslo 12, Norway
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Pza. Espana, 18
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