MICRO-TEL

FOR

MSR-904A

MICROWAVE RECEIVER

MICROWAVE MEASUREMENT
& SURVEILLANCE EQUIPMENT

MICRO-TEL CORPORATION
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INSTRUCTION MANUAL

FOR

MSR-904A

MICROWAVE RECEIVER

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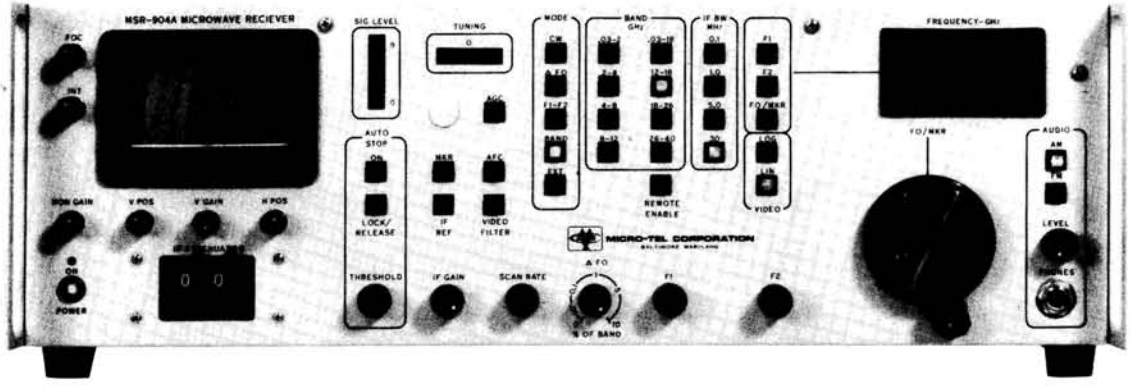
SECTION I
GENERAL DESCRIPTION



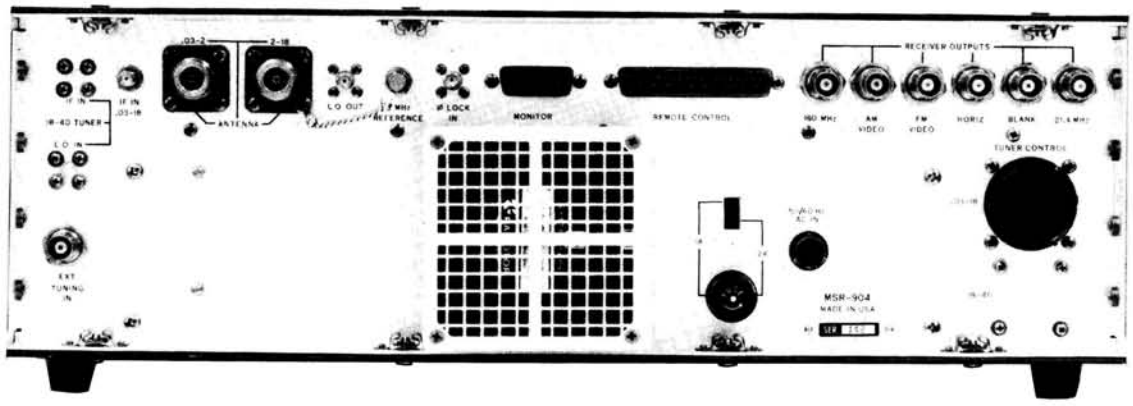


FIGURE 1.1 MSR-904A, FRONT AND REAR VIEWS

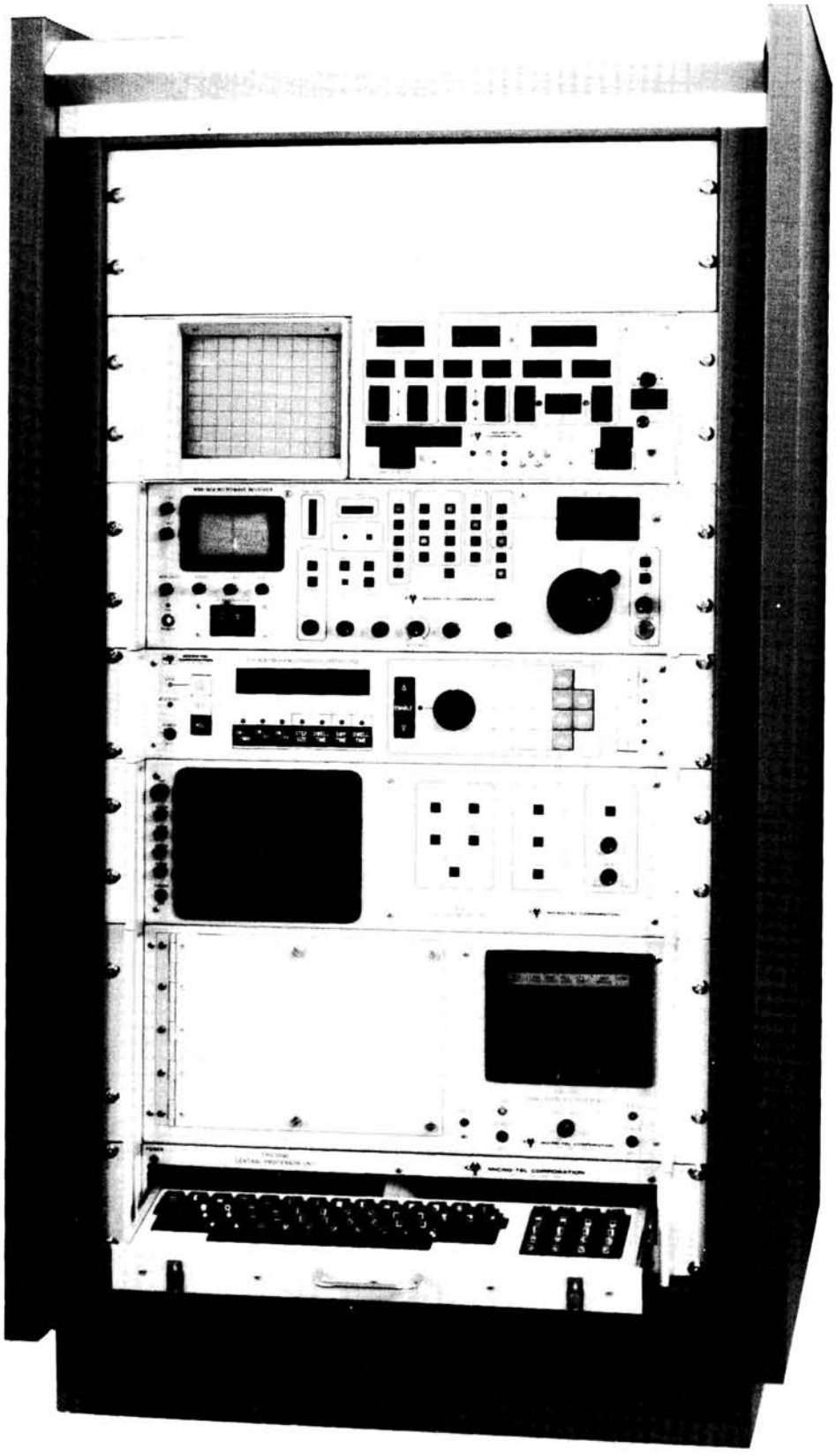


FIGURE 1.2 MODEL ARS-2064 MICROPROCESSOR CONTROLLED SURVEILLANCE RECEIVING SYSTEM

1.0 GENERAL DESCRIPTION

This section describes major features of the MSR-904A Microwave Receiver and its electical and mechanical specifications. It also contains an electrical description of a simplified block diagram and a physical description and location of major subassemblies.

1.1 STANDARD FEATURES AND OPTIONS

The MSR-904A is a compact heterodyne receiver covering a frequency range from 0.50 to 18.0 GHz in its standard form, with fundamental mixing. This coverage can be extended down to 30 MHz by installation of an internal option, and up to 40 GHz via an external Frequency Extender, model FE-904K/Ka.

The all-solid-state receiver employs electronically tuned YIG oscillators and tracked YIG filters providing rapid surveillance of the microwave bands.

The MSR-904A is housed in a 19 x 17 x 5 1/4 inch cabinet, suitable for rack mounting. This cabinet includes an AC/DC power supply, the remotable-removable RF Tuner and a miniature panoramic spectrum display.

Electronic tuning is provided in five modes: full octave band scan at variable sweep rates (BAND), adjustable width scanning with manually tuned center frequency (ΔF0); adjustable width scaning with presettable lower and upper limits (F1-F2); unswept manual tuning (CW); and external tuning (EXT). A five-digit LED display indicates tuning frequency for all modes.

Other standard features include:

a. Pushbutton selection of tuning mode, band, IF bandwidth, audio and other special functions.

b. IF attenuator with a range of 0 to 99 dB.

c. Selectable IF bandwidths of 0.1, 1.0, 5 and 30 MHz, in both linear or logarithmic detection modes.

d. AM and FM audio and video outputs in all four selectable bandwidths.

e. Auxiliary wide-band 250 MHz IF output for connection to lower frequency receivers, when additional demodulation or signal processing is desired.

f. Tuning and signal strength bar-graph displays.

g. Remotable RF Tuner, covering 0.5 to 18 GHz, housed within the receiver but capable of being placed up to 200 ft. away from the main receiver.

h. Automatic bandswitching and circuitry to drive an external storage CRT, thus displaying all five bands simultaneously in a vertical, sequential band-by-band display.

i. Remote digital control.

j. Capable of frequency synthesis with the inclusion of an external frequency counter/synthesizer, model FCS-904.

k. Fully RFI shielded cabinet and RF Tuner.

l. Auto-Stop feature allows the scanning receiver to stop on any signal exceeding a settable threshold.

The following options are available for installation in a standard MSR-904A receiver:

Option 2: Local Oscillator Sample - Utilized with the FCS-904 Frequency Counter/ Synthesizer.

Option 3: Low Frequency Coverage - Extends the coverage down to 30 MHz.

Option 4B: 160 MHz IF Output - Phase-lockable, 20 MHz bandwidth IF output.

Option 4C: 70 MHz IF Output - Phase lockable utilizing FS-1000 Frequency Synthesizer or FCS-904 Frequency Counter/ Synthesizer.

Option 6: IF Reference - Provides a means of calibrating RF amplitude within ±1 dB, with the use of calibration charts.

Option 8: Provisions for 18-40 Coverage

1.2 2904 SYSTEM CONFIGURATION

The Model 2904 Automated, Computer-Controlled, Synthesized Surveillance Receiving System consists of the interconnection of several or all of the following units:

1. MSR-904A Microwave Surveillance Receiver.
2. FCS-904 Frequency Counter/Synthesizer.
3. MPC-1100 Computer Controller, including a dual-disk drive.
4. DC-904 Digitally Refreshed Display.
5. FE-904K/Ka Frequency Extender.
6. PA-904 Pulse Analyzer

Figure 1.2 illustrates a system containing all of the items listed above.

The 2904 System automatically sweeps all microwave bands, detects signals above a pre-determined threshold and stores in disk memory the frequency and amplitude of the encountered signals. It also returns to each signal, in the synthesized mode, to allow time or frequency domain analysis. The PA-904 measures width and PRF of pulsed signals utilizing the 160 MHz IF output of the receiver.

Interconnections among the units listed above is described in section 2.0. Refer to the 2904 System Manual for operational details.

1.3 DESCRIPTION OF SIMPLIFIED BLOCK DIAGRAM

Refer to Figure 1.3.

Microwave signals enter the receiver via one of the antennas and are applied to the RF Tuner A8, where YIG filters and oscillators reject undesired signals and generate an intermediate frequency of 250 MHz. The IF is applied through a remotely-controlled attenuator to the linear and log IF amplifiers (A3). The AM video output is available at the rear panel and at the front panel panoramic display (A10). It is also applied to a peak detector (A36) prior to display at an external monitor.

The control section consists of several PC boards performing the automatic switching necessary to select the appropriate RF components (A4B1), IF attenuation (A53B1), IF bandwidth (A4B2) and to control the peak detector and some remote functions (A4B5).

The tuning section consists also of several PC boards. Tuning generator (A6) provides the tuning waveforms necessary to tune the receiver in one of its five modes of operation, as described in section 1.1. Crossband switching (A4B3) provides tuning control in the 0.5-18 MHz (or 0.03 to 18 MHz) multiband sweep. Tracking and high-current drive is provided to the YIG oscillators and filters via (A7B1) and (A7B3).

The display section consists of: function selector (A11), a group of PC boards mounted to the front panel, containing all pushbutton controls and generating all codes needed by the control and tuning sections; meter tracking (A4B4) and frequency display (A5); and scope module (A10).

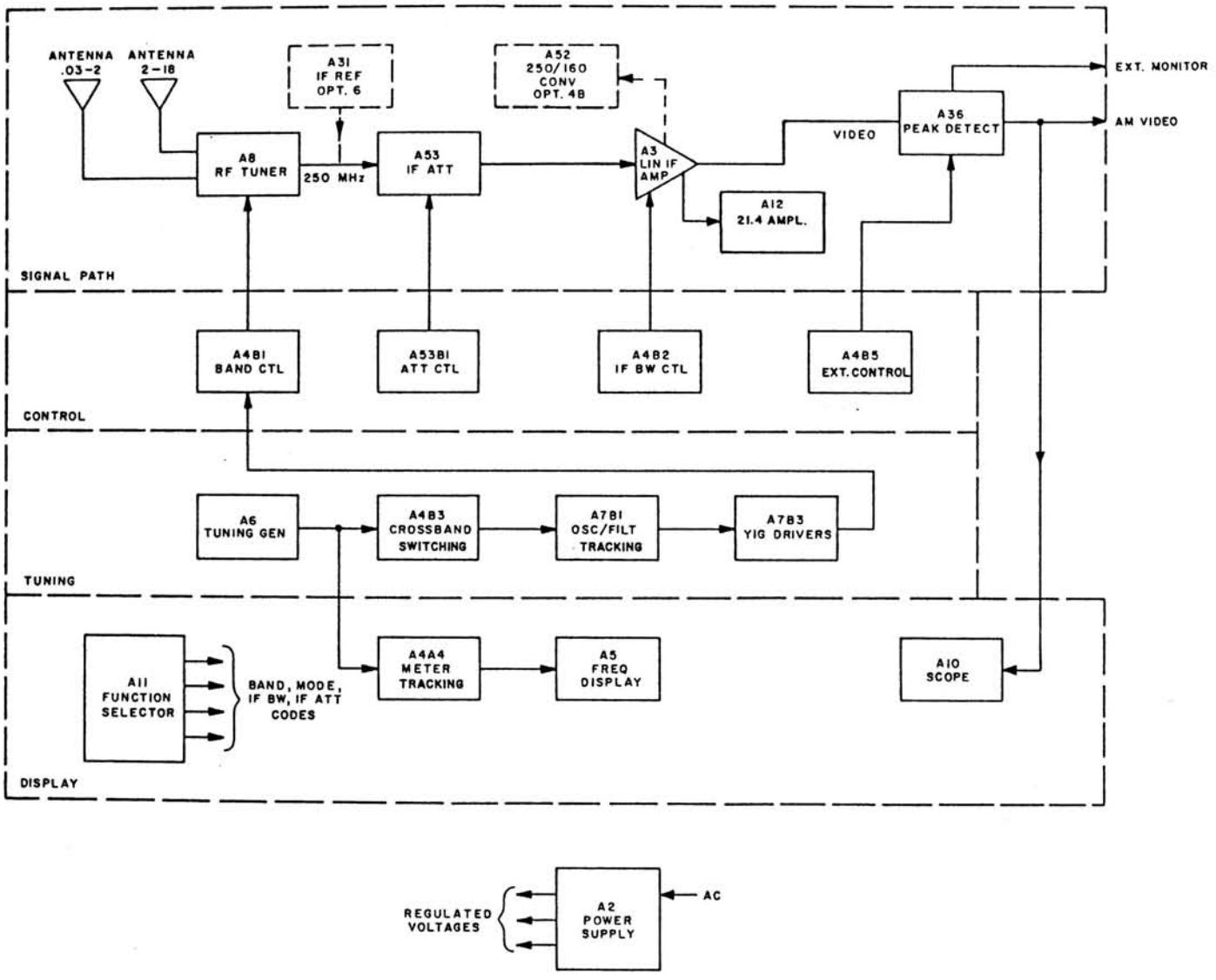


Figure 1.3. MSR-904A Simplified Block Diagram 92B10-001

Power supply (A2) is operated from 115 or 230Vac. It generates all the regulated dc voltages utilized by the other assemblies.

In the signal path, optional assemblies are indicated with dashed lines:

Option 4B: Adds a 250/160 MHz converter, assembly (A52), between the 250 MHz wideband output of the IF amplifier and the rear panel.

Option 4C: Adds a 250/70 MHz converter assembly (A51), between the 250 MHz wideband output of the IF amplifier and the rear panel.

Option 6: Inserts a 250 MHz oscillator in the signal path, ahead of the IF attenuator, generating a calibrated video output.

1.4 SPECIFICATIONS

1.4.1 PERFORMANCE

1.4.1.1 RF SECTION

Frequency Coverage	0.5-18 GHz (standard) 0.03-18 GHz (option 3) Extended to 40 GHz with external FE-904 Frequency Extender.
RF Bands	0.5-2 (.03-2 with option 3), 2-4, 4-8, 8-12, 12-18 GHz, .5-18 (.03-18), 18-26.5, 26.5-40 GHz.
Frequency Indicator	5 digit LED display indicates true RF center frequency to an accuracy of $\pm$0.5% $\pm$1 count, in "CW" mode. Displays marker frequency in "BAND" or "F1-F2" modes, frequency limits in "F1-F2" mode, according to F1/F2/FO pushbutton selection.
Band Overlap	10 MHz minimum.
First Image Rejection	0.5-12 GHz, 70 dB minimum 12-18 GHz, 65 dB minimum 0.03-0.5 GHz, 70 dB minimum (option 3)
Preselection	0.5-18 GHz automatically tracked in all tuning modes. 3 ball YIG filters with 18 dB/octave selectivity. .03-0.5 GHz, low-pass filter (option 3).
I.F. Rejection	70 dB, minimum
LO Radiation	.03-12 GHz, -70 dBm, maximum 12-18 GHz, -60 dBm, maximum
RF Input Impedance	50 ohms nominal, unbalanced to ground
Noise Figure (dB)	20 dB typical over 90% of band, 23 dB maximum.
LO Sample (Opt. 2)	Frequency: 2.25-18.25 GHz Minimum output: -12 dBm, min.
3rd Order Intercept Point	+5 dBm typical at RF input.

1.4.1.2 FREQUENCY STABILITY AND NOISE

(Measured in "CW" mode, with AFC off)

Residual FM:	RF Band:	Max Residual FM:
	.03-4.0 GHz	20 kHz p-p
	4.0-8.0 GHz:	40 kHz p-p
	8.0-12.0 GHz:	75 kHz p-p
	12-18 GHz:	100 kHz p-p
Frequency Stability ..... (Short Term)	1 part in 10^{-5} of RF, maximum, drift per second. With 5 minute warm-up, at 25°C ambient.	
(Long Term)	5 parts in 10^{-5} of RF, maximum, drift per 3 minute interval. After 30 minute warm-up at 25°C ambient, at fixed RF frequency.	
Frequency Pulling	1 part in 10^{-5} of RF, maximum, with either (a) input VSWR change from 1.0 to (b) in-band RF signal of -20 dBm.	

1.4.1.3 250 MHz IF OUTPUT

Bandwidth at 3 dB	40 MHz minimum, limited only by the YIG pre-selector.
RF/IF Gain	7 $\pm$ 2 dB, with IF GAIN at maximum setting, IF attenuator set for 0 dB.
1 dB Compression Point	-3 dBm minimum at output.
Impedance	50 ohms nominal, unbalanced to ground.

1.4.1.4 21.4 MHz IF OUTPUT

Bandwidth at 3 dB	8 MHz, nominal
Output Level	Gain is automatically controlled to provide an output level of -20 $\pm$2 dBm for an input level of 0 dBm; output reduces by 5 db maximum when input is reduced by 50 dB.

1.4.1.5 160 MHz IF OUTPUT (Option 4B)

Bandwidth at 3 dB	20 MHz, nominal
RF/IF Gain	10 $\pm$ 3 dB, with IF ATTENUATOR set for 0 dB.
Dynamic Range	60 dB, minimum.
Impedance	50 ohms nominal, unbalanced to ground.
1 dB Compression Point	0 dBm, minimum at output

Impedance ..... 50 ohms nominal, unbalanced to ground.

1 dB Compression Point ..... 0 dBm, minimum at output

1.4.1.6 70 MHz IF OUTPUT (Option 4C)

Bandwidth at 3 dB ..... 20 MHz, nominal

RF/IF Gain ..... 10 $\pm$ 3 dB, with IF ATTENUATOR set for 0 dB.

Dynamic Range ..... 60 dB, minimum.

Impedance ..... 50 ohms nominal, unbalanced to ground.

1 dB Compression Point ..... 0 dBm, minimum at output

1.4.1.7 IF SELECTIVITY AND IMAGE REJECTION

IF Selectivity ..... 1) 100 $\pm$10 kHz @ -3 dB

2) 1.0 $\pm$0.2 MHz @ -3 dB

3) 5.0 MHz $\pm$ 1 MHz at -3 dB.

4) 30 MHz $\pm$ 2 MHz at -3 dB.

Image Rejection ... . Second IF images, and all subsequent IF images, are at least 65 dB down.

1.4.1.8 AM VIDEO OUTPUT

Linear or logarithmic video output is available at the rear panel; selection is made at the front panel.

Output Impedance ..... 50 ohm unbalanced to ground.

Amplitude ..... 0.2 to 4.0V maximum, unloaded.

Baseband ..... One half the selected IF bandwidth, dc coupled.

Video Filter ..... Switchable from front panel; reduces baseband to 50 kHz in all IF bandwidths.

Logarithmic Range ..... 70 dB, minimum

Logarithmic Accuracy ... $\pm$2 dB

Linear Gain Control .... 60 dB, minimum, front panel controllable.

1.4.1.9 FM VIDEO OUTPUT

Output Impedance ..... 50 ohm unbalanced to ground.

Amplitude	.....	2.0 V/p-p minimum, unloaded, with input at -40 dB and frequency deviation of ±0.5 times selected IF bandwidth.
Baseband	.....	dc to 0.5 times selected IF bandwidth, minimum.
AM Rejection	.....	20 dB, minimum

1.4.1.10 AUTOMATIC FREQUENCY CONTROL

When receiver is in CW mode, AFC control ON, the AFC provides at least 10:1 correction (i.e. frequency drift is reduced by a factor of 10 or more) in all IF bandwidth modes. Capture range is minimum of ±50% of selected IF bandwidth.

When receiver is in any other mode, AFC is disabled by the MODE selector.

1.4.1.11 SPURIOUS AND RESIDUAL RESPONSES

Spurious	.....	1) Due to out-of-band signals above 0.5 GHz: 50 dB rejection, minimum.
		2) Due to out-of-band signals below 0.5 GHz (including all IF frequencies): 70 dB rejection, minimum.
		3) Due to two in-band signals, spaced by 10 MHz, with amplitudes of -30 dBm: all inter-mod products are at least 20 dB down, with IF GAIN adjusted for no larger than full scale display at AM VIDEO output.
Residual	.....	With 50 ohm termination of ANTENNA input, internally generated residual responses do not exceed -90 dBm equivalent input, at any RF frequency.

1.4.1.12 AUDIO OUTPUT (at phone jack)

Output Level	.....	±0.40V, maximum output capability into 600 ohms unbalanced load, without clipping.
Sensitivity	.....	With passive 50 ohm termination on ANTENNA jack, audio noise level at all RF frequencies is 0.1 milliwatts, minimum into 600 ohm load in all signal modulation modes, with IF GAIN and AUDIO GAIN maximum.
Response	.....	±3 dB, 250 Hz to 10 kHz.

1.4.1.13 DRIVE CIRCUITRY FOR PANORAMIC DISPLAY

Sweep Widths	BAND mode: Fixed sweep of the entire width of the RF band selected. F1-F2 mode: Fixed sweep of the entire range selected. ΔF0 mode: Sweep width variable from 0 to ±5% of width of RF band selected. Calibration accuracy ±20% or better. MAN mode: Same width as VAR-SCAN mode, but sweep is manual.
Display Shift	In ΔF0 mode, shift of center frequency of display is less than 1% of width of RF band selected, as sweep width is varied from maximum to minimum.
Sweep Rate	In BAND, F1-F2 and ΔF0 modes, variable over the range of 0.1 Hz or less to 30 Hz or greater.
Horizontal Output	±3 volts dc coupled and centered at 0 volts dc, with 1000 ohms, minimum load impedance. Sweep amplitude is independent of actual frequency range swept. Positive-going sweep voltage (negative going flyback) corresponds to increasing RF frequency on all RF bands.
Horizontal Linearity	5% maximum.
RF Marker	In BAND and F1-F2 modes, negative marker pulse of 0.1 volts amplitude and 0.5 millisecond nominal duration is added to the vertical output signal.
Blanking	+10 volt retrace blanking pulse is applied in BAND, F1-F2 and ΔF0 modes.

1.4.1.14 POWER SOURCE SPECIFICATIONS

Line Frequency	50-400 Hz.
Line Voltage	115 or 230 volts, switch selectable ± 10%
Period of Operation	Indefinite.
Line Input Protection	Fuses: 115V, 2A, 3AG, slo-blo 230V, 1A, 3AG, slo-blo
Power Consumption	120 watts, nominal

1.4.2 MECHANICAL SPECIFICATIONS

1.4.2.1 WEIGHT

Total receiver weight is 45 pounds, nominal. The remotable RF tuner weighs 12 pounds.

1.4.2.2 CONTROL, CONNECTOR AND INDICATOR LAYOUT

Within the limitations imposed by space restrictions, placement and identification of all functional controls, connectors, and indicators (sections 3.1 and 3.2) have been made to facilitate proper operation of the system by nonspecialized personnel.

1.4.2.3 ENVIRONMENTAL PROTECTION

Impact	No impact protection beyond that afforded by the standard cabinet.
Shock and Vibration	Subchassis and circuit board assemblies are constructed and mounted to prevent shock and vibration damage when the system is transported via commercial carrier.
Humidity and Dust	Dust and water-resistant subchassis assemblies are utilized whenever possible. Circuits not afforded this protection are appropriately coated providing moisture resistance.

1.4.2.4 TEMPERATURE RANGE

Operating temperature range of the MSR-904A is 0 to 50°C. All specifications listed previously are maintained in this range, unless otherwise stated.

1.5 DESCRIPTION AND LOCATION OF MAJOR SUBASSEMBLIES

Refer to Figures 1-4 and 1-5 for location of subassemblies.

A1, Mainframe: Includes front, rear and side panels, plus internal chassis harness and several components mounted to the internal chassis.

A2, Power Supply: Metal enclosure, shielded, attached to the rear panel.

A3, IF Amplifier: Several metal enclosures, mounted at the rear of the receiver, above the power supply.

A4, Control Circuitry: Consists of 5 printed circuit boards, mounted on the PC bucket located in the center of the receiver.

- A4B1 - Band Control
- A4B2 - IF Bandwidth Control
- A4B3 - Crossband Switching
- A4B4 - Meter Tracking Board
- A4B5 - External Control

A5, Frequency Display: Metal enclosure mounted to the front panel, right side.

A6, Tuning Generator: Consists of 3 printed circuit boards, mounted on the PC bucket located in the center of the receiver.

A7B1, Oscillator/Filter Tracking: Printed circuit board located in the PC bucket.

A7B3, YIG Drivers: PC Board attached to the left side panel, near the oscilloscope (A10).

A8, RF Tuner: Metal enclosure mounted to the right side panel.

A10, Oscilloscope: Metal chassis with connector, mounted behind the CRT and shield on the left side of the receiver.

A11, Function Selector: Consists of 4 printed circuit boards, all plugged together and mounted to the central area of the front panel.

A12, 21.4 MHz Amplifier: Metal enclosure mounted in the central area of the receiver, to the right of the oscilloscope A10.

A13, Audio Selector/Amplifier: Consists of two printed circuit boards, one mounted to the front panel one to the right side panel.

A14, 250 MHz Relay: Metal enclosure mounted to the left side panel, near the power supply.

A15, Video Filter Switching: Small metal chassis mounted under the oscilloscope A10.

A31, 250 MHz Reference Oscillator (Option 6): Metal chassis mounted to the left side panel, near the CRT shield.

A36, Peak Detector: Metal Chassis mounted in the central area of the receiver, behind the PC bucket.

A52, 250/160 MHz Converter (Option 4B): Assembly consisting of 4 metal chassis, mounted in the central area of the receiver, behind the PC bucket.

A51, 250/70 MHz Converter (Option 4C): Assembly consisting of 4 metal chassis, mounted in the central area of the receiver, behind the P.C. bucket. NOTE: Options 4C and 4B are not available simultaneously.

A53, IF Attenuator Control: Consists of one printed circuit board and the remote-controlled attenuator, both mounted on the right side of the receiver, behind the front panel.

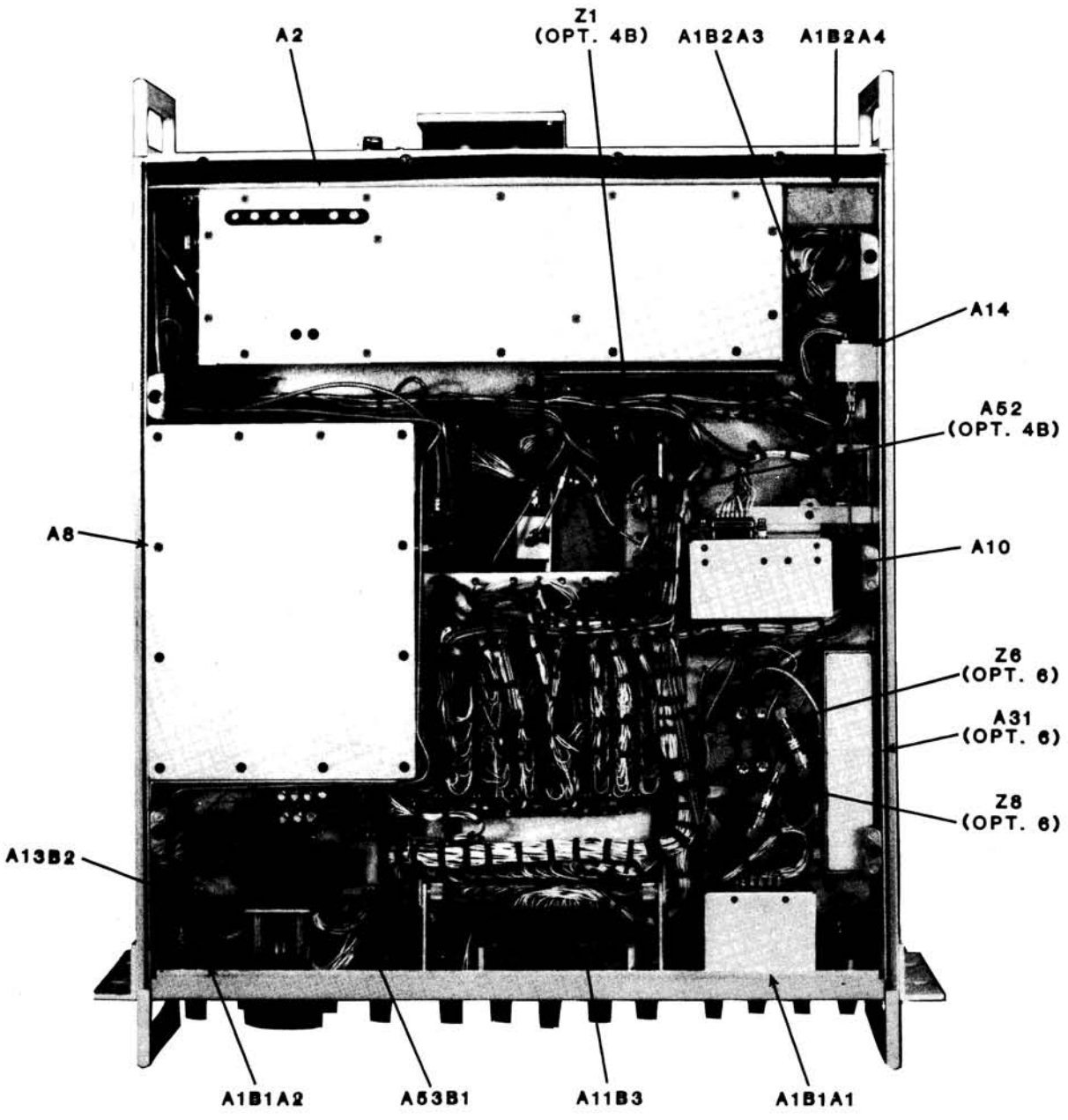


FIGURE 1.4 MSR-904A, BOTTOM VIEW

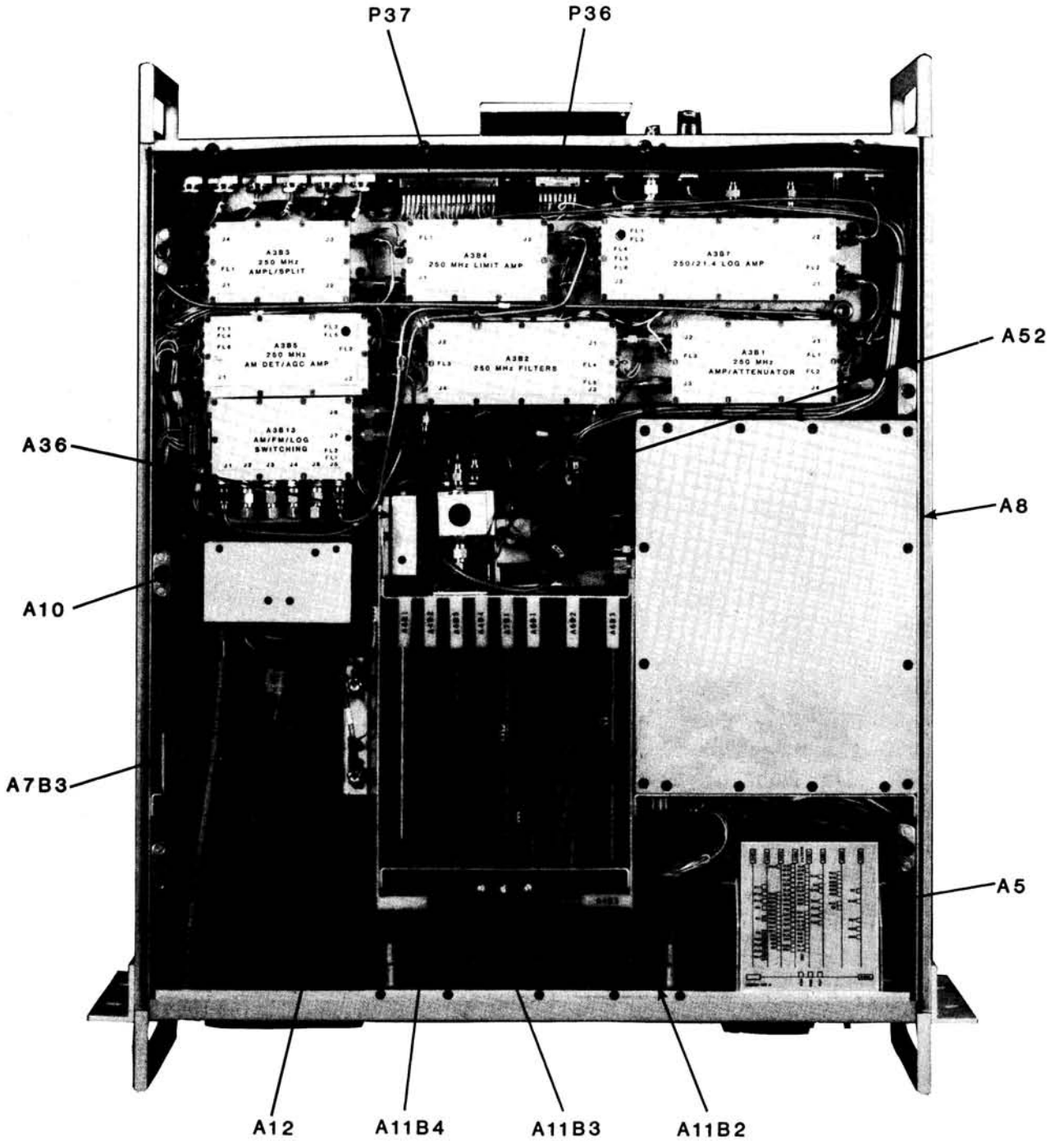


FIGURE 1.5 MSR-904A, TOP VIEW

2.0 INSTALLATION

This section describes the unpacking, inspection and installation of the MSR-904A Receiver, including auxiliary cables and connectors necessary for interconnection to other system components or for remote operation.

2.1 UNPACKING AND INSPECTION

The receiver should be unpacked and visually inspected for any damage during shipment. Remove the top and bottom covers and inspect for loose components. Check all coaxial connectors to ensure that they are firmly mated.

The following accessories should be present with the MSR-904A:

a. AC Power Cord, constructed as illustrated in Figure 2.1.(a).

b. 37 pin "D" type connector, part number DCM-37S, for connection to external controls (FCS-904, DDI-1000 or other equipment). A hood is also supplied.

c. 15 pin "D" type connector, part number DBM-15S, for connection to an external monitor (MD-904 variable persistance display or DC-904 digitally refreshed display). A hood is also supplied.

d. Two extender printed-circuit boards, with 36 and 50 pin connections, to aid in troubleshooting. The 36 pin extender fits all boards in the PC bucket (A4B1,2,3,4; A6B1,2, 3; A7B1). The 50 pin extender fits A4B5, mounted to the front of the PC bucket.

The receiver is designed for rack mounting. Allow space for air flow into the top and bottom covers; allow space for air flow behind the fan mounted at the rear panel. No other consideration need be given to cooling unless the receiver is placed next to equipment radiating excessive heat.

2.2 POWER REQUIREMENTS

Prior to connecting the receiver to a power source set the 115/230 slide switch on the rear panel to the correct voltage, and install the correct fuse:

2A, 3AG, slow blow for 115 Vac

1A, 3AG, slow blow for 230 Vac

2.3 REMOTING THE 0.03-18 GHz RF TUNER

The MSR-904A is shipped with the RF Tuner installed inside the main cabinet. If it is necessary to remote the Tuner, follow the steps listed below:

1. Remove the receiver's top and bottom covers and the right side inlay. Stand the receiver on its left side.

2. Remove the three flat-head #8 screws holding the Tuner to right side panel and unscrew the two captive screws holding the Tuner to the internal partitions.

3. Disconnect the (pendant) control cable and all RF cables from the Tuner. The SMA plug which was connected to the "IF OUT" port must be connected to the SMA jack available near it; the SMA plug connected to the "5 MHz OUT" port, which is attached to a flexible RG-316/U coaxial cable, must be connected to the inside port of the rear panel connector labeled "5 MHz REFERENCE".

4. Slide the RF Tuner out of the receiver and replace covers and inlay.

5. Interconnect the main cabinet and RF Tuner by means of the following cables (RCC-904):

   a) Control cable - wired as shown in Figure 2.2, utilizing Alpha 5355 or National NQP-2720SJ shielded, multiconductor cable, consisting of 27 twisted pairs. Plugs are PT06A-20-41P(SR) and PT06A-20-41S(SR).

   b) I.F. Cable - 50 ohm coaxial cable with maximum insertion loss of 2 dB/100 ft. at 250 MHz.

   c) 5 MHz reference cable - only required if the receiver contains Option 4B (160 MHz I.F. output) and it it necessary to phase-lock the 160 MHz output. Utilize 50 ohm coaxial cable type RG-223/U or equivalent.

CAUTION: If the separation between the main cabinet and the RF Tuner is larger than 200 ft., consult the factory for recommended wire and plug sizes.

2.4 SYSTEM CABLING CONFIGURATIONS

The MSR-904A is the central unit in the ARS-2904 Automated, Computer-controlled, Synthesized Surveillance Receiving System. The ARS system contains two or more pieces of equipment, as listed in Section 1.2.

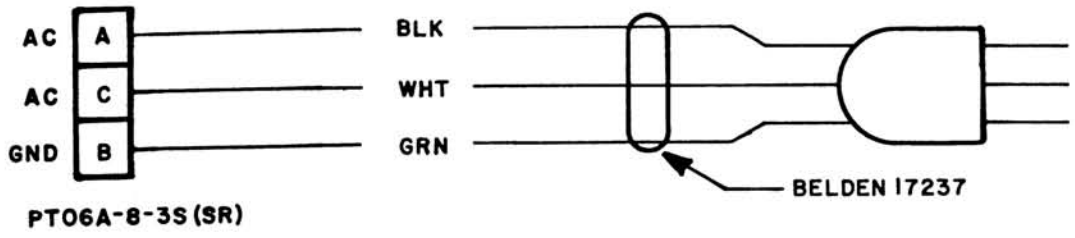
Figures 2.3 and 2.4 illustrate the simplest version of remote control of the MSR-904A using the IO-1000-904. This Input/Output interface may be controlled via an IEEE bus and supplies the parallel input commands required by the MSR-904A.

Figure 2.5 illustrates the interconnection of an MSR-904A Receiver, FCS-904 Frequency Counter/Synthesizer and DC-904 Digitally Refreshed Display. In this configuration, the FCS-904 is the controlling element, receiving IEEE data and transmitting it to the MSR-904A by parallel commands and to the DC-904 by RS-232 serial commands.

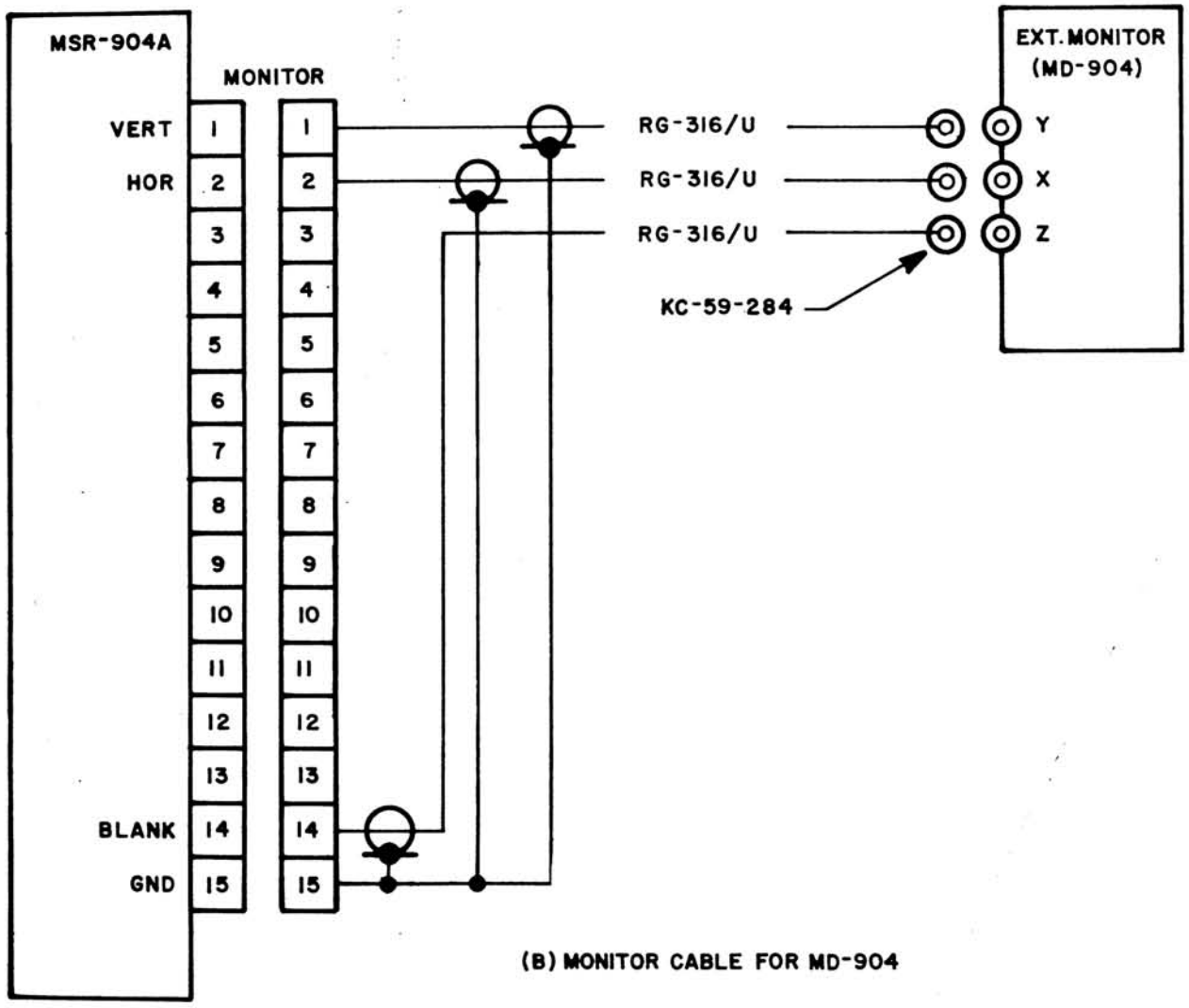
Figure 2.6 illustrates the interconnection of an MSR-904A and FCS-904 when their tuners are remoted from the main cabinets. Cables RCC-904 (described in Section 2.3.5) and RCC-1000 (described in the FCS-904 manual) are utilized, plus coaxial cables and control cable W19.

Figures 2.7 and 2.8 illustrate the interconnections of an ARS-2904 system, computer-controlled via the MPC-1100, with frequency extension to cover up to 40 GHz (FE-904). Both local and remote tuner configurations are illustrated.

Cable W16, when an MD-904 Variable Persistance Storage display is utilized is wired as illustrated in Figure 2.1 (B). Refer to the DC-904 Digitally Refreshed Display manual for details on cable W16 when the DC-904 Digitally Refreshed Display is utilized in place of the MD-904.



(A) AC POWER CABLE



(B) MONITOR CABLE FOR MD-904

Figure 2.1. MSR-904A AC and Monitor Cables

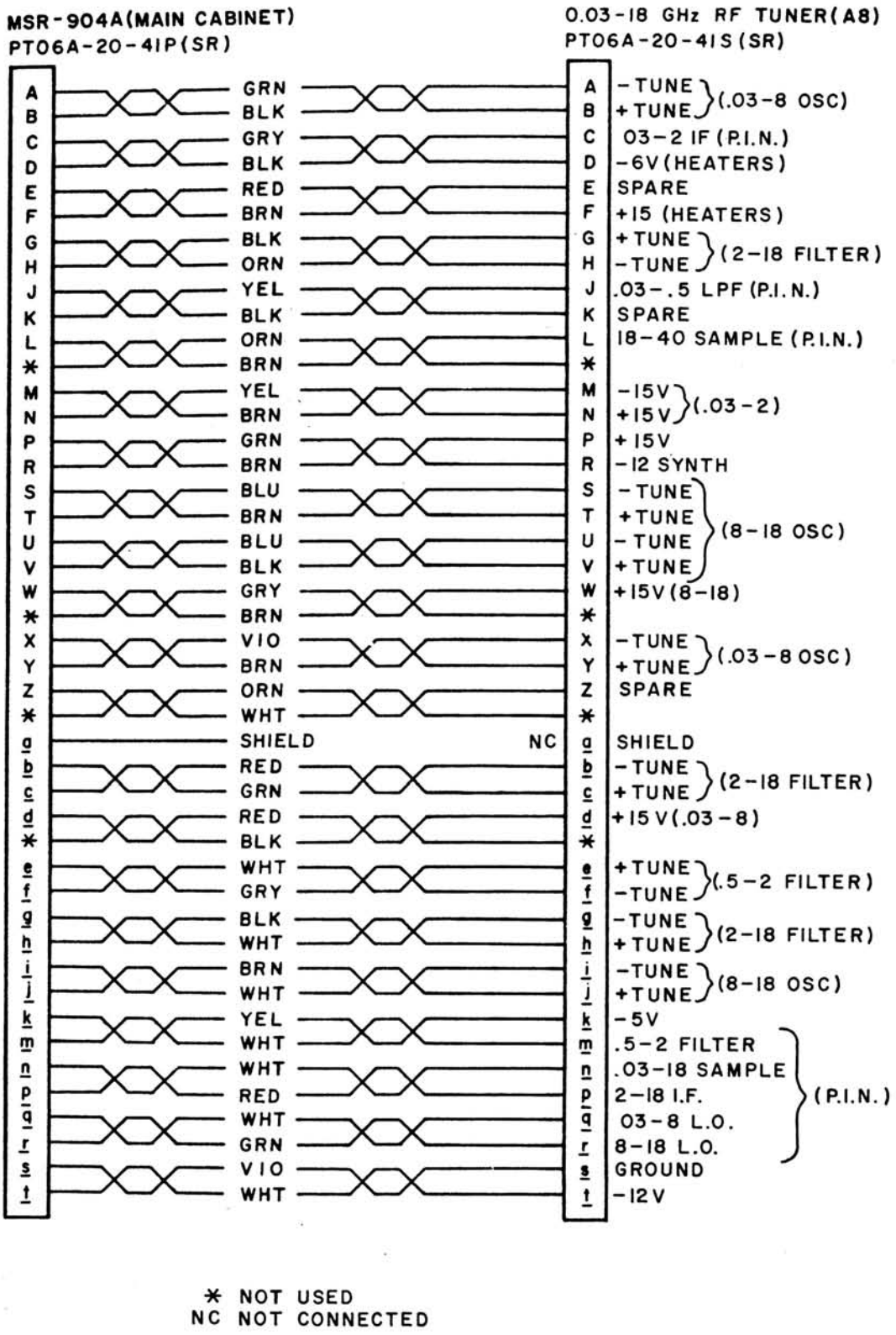


Figure 2.2. MSR-904A Remote Tuner Control Cable, 0.03 - 18 GHz

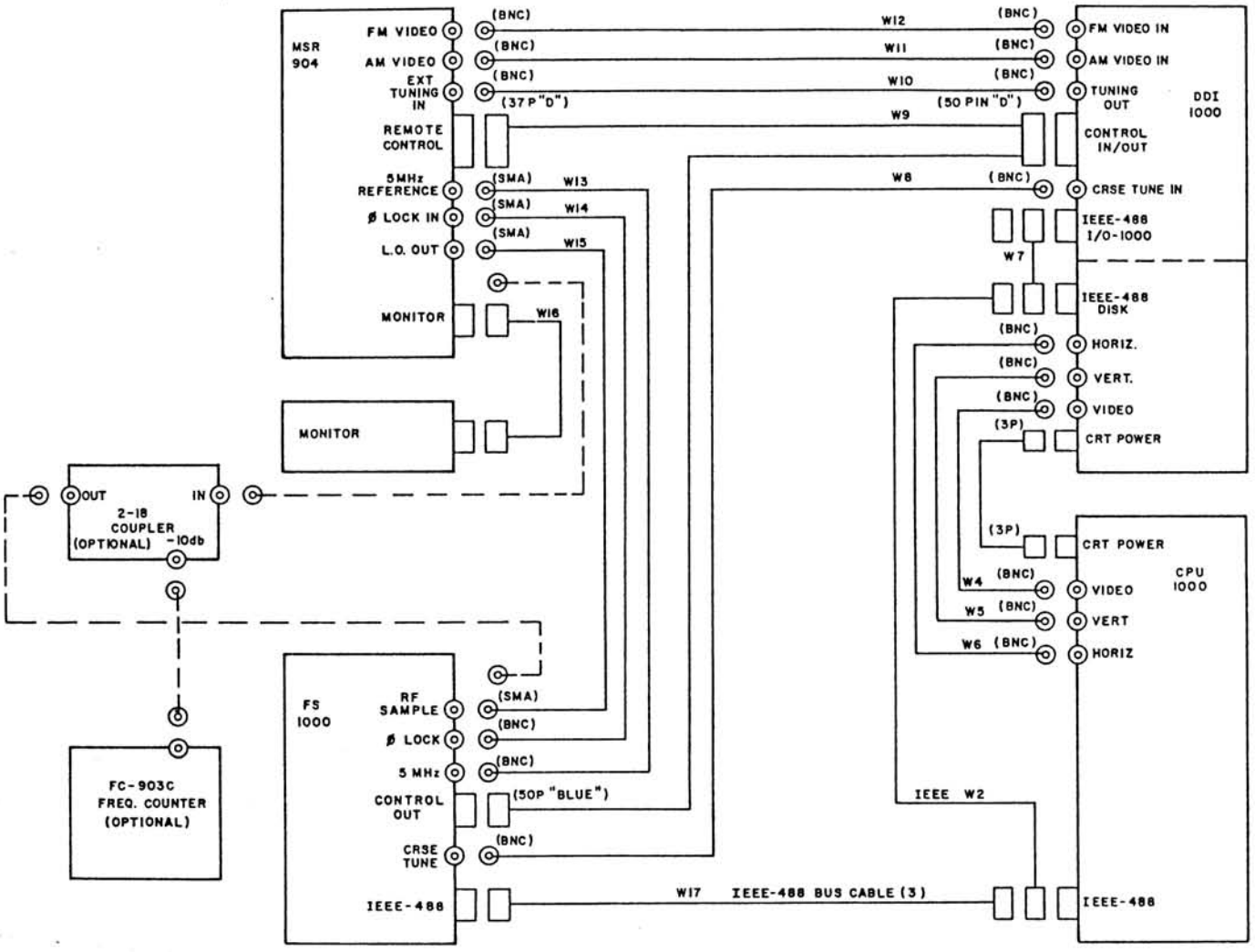


Figure 2.3. MSR-904A/IO-1000-904 System
Interconnection Diagram 92A10-085

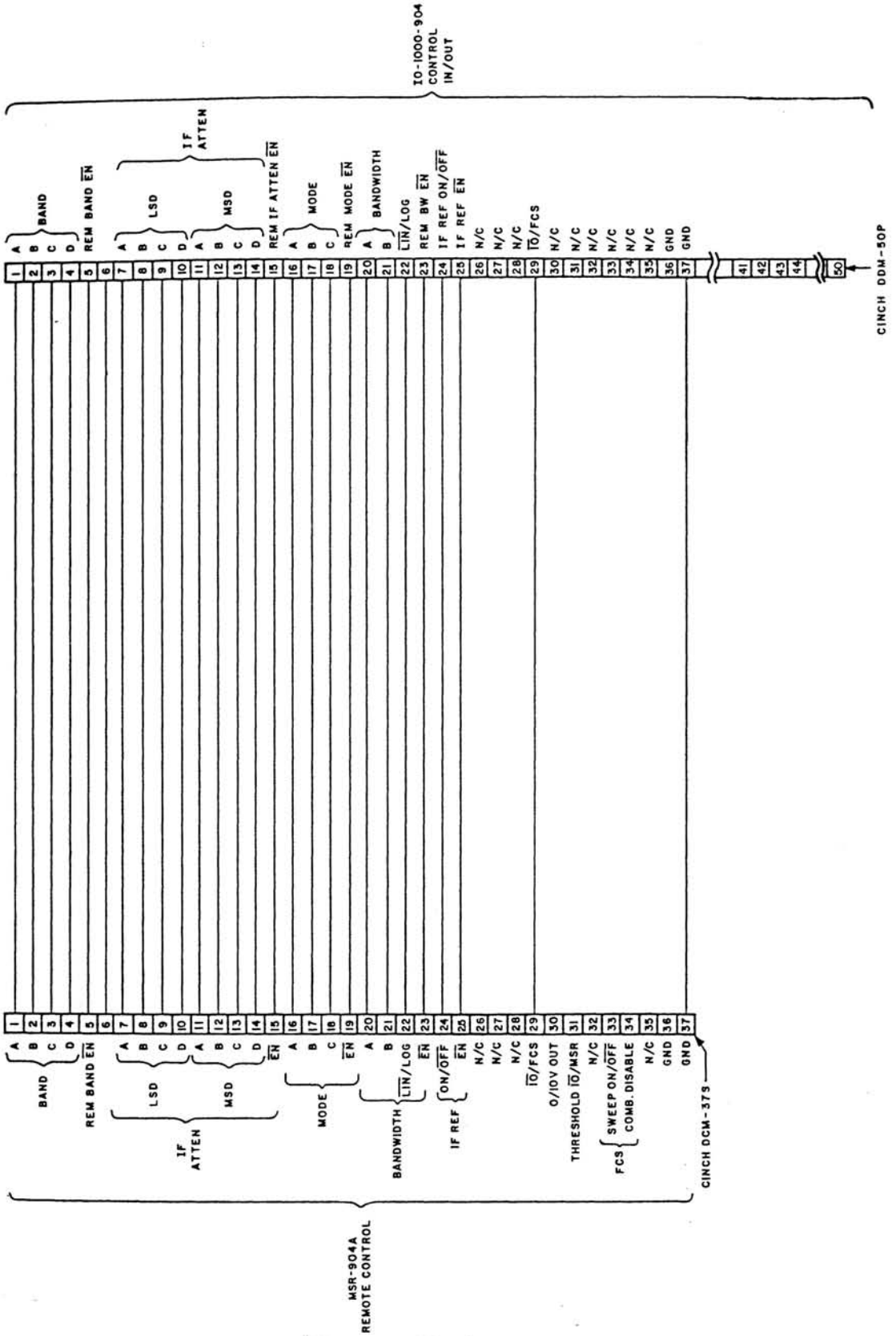


Figure 2.4. MSR-904A/IO-1000-904 (W9)
Cable Wiring Diagram 92B10-084

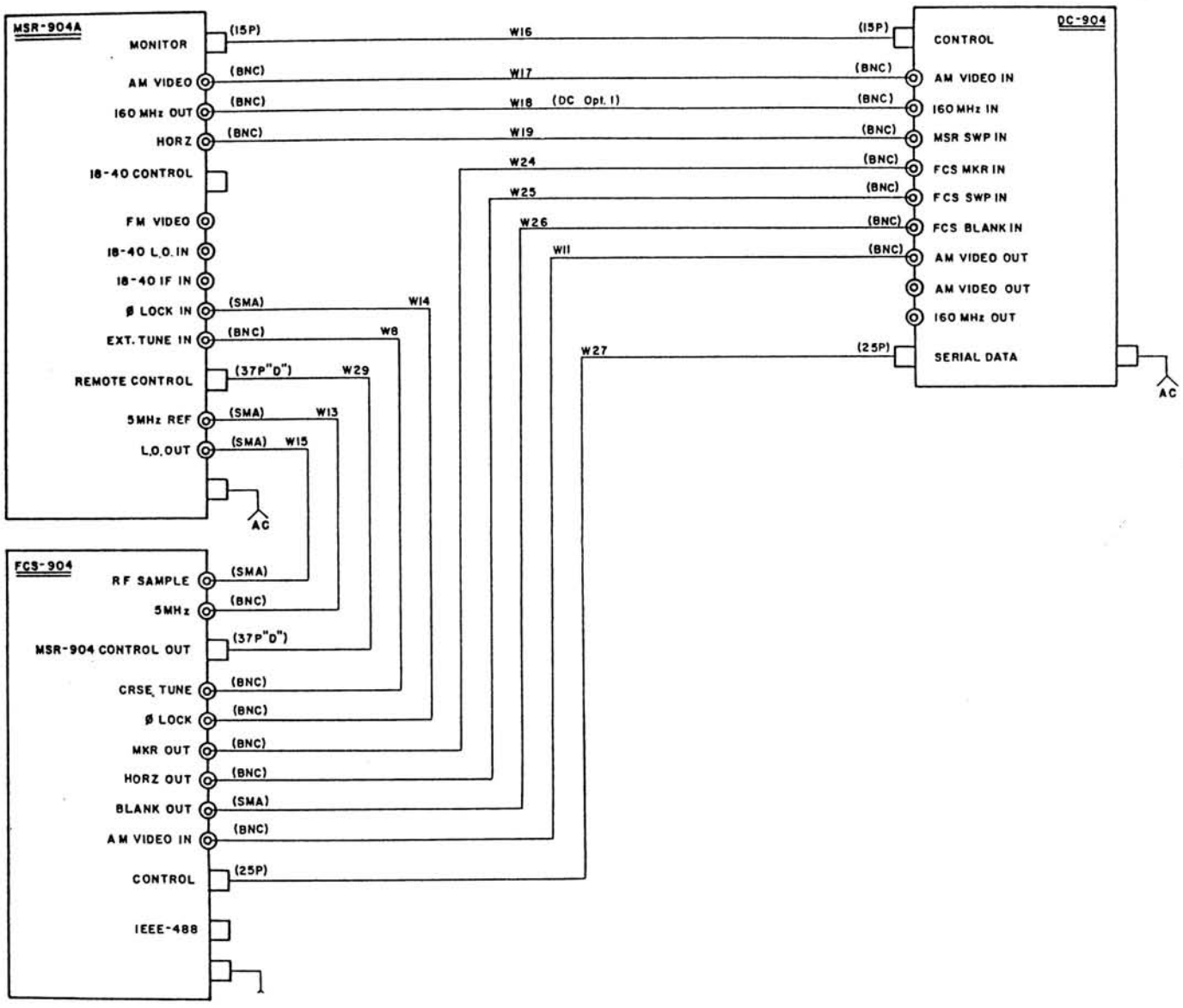


Figure 2.5. ARS-2904 System (A1)
Interconnection Diagram 92B10-091

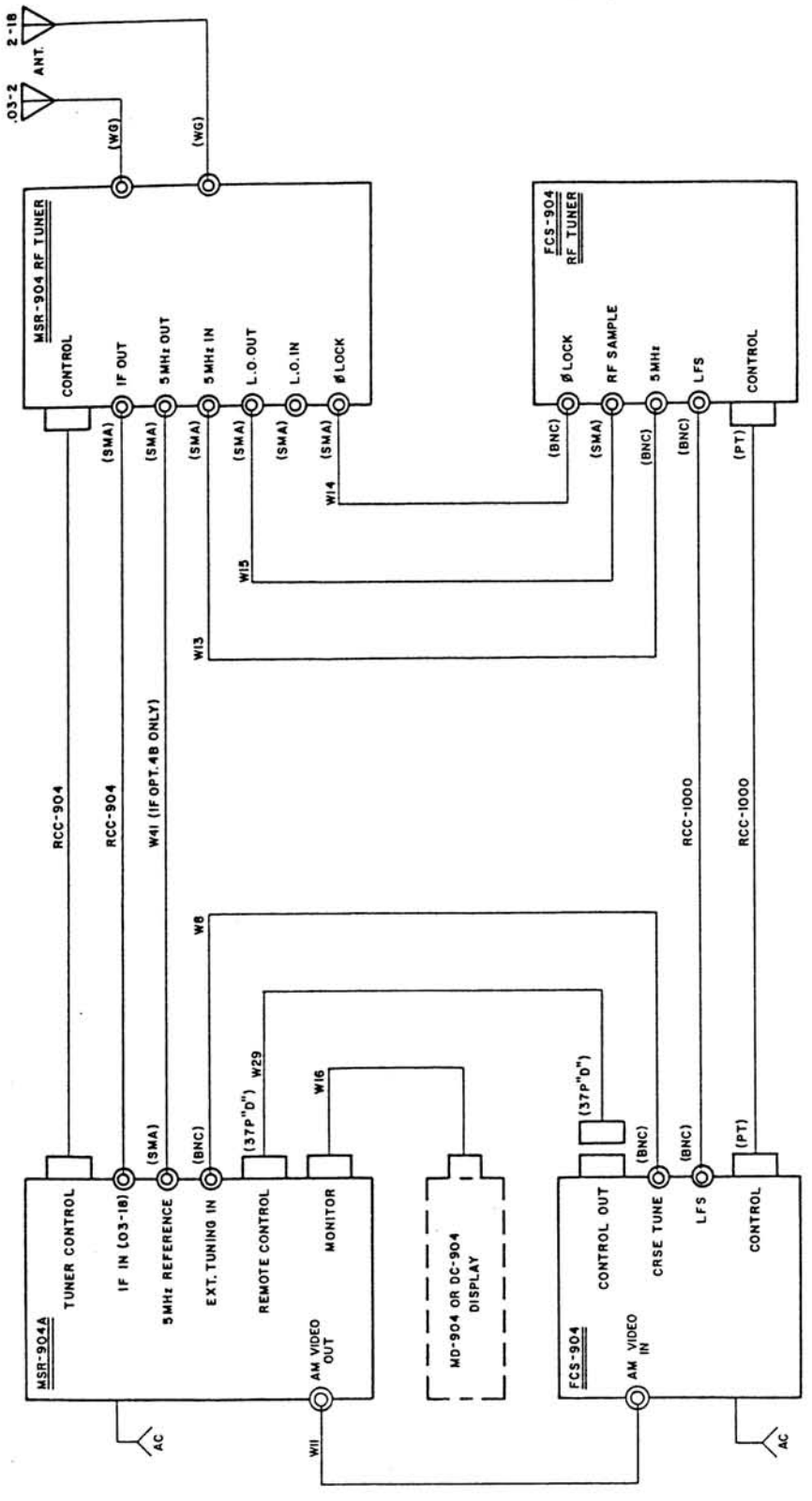


Figure 2.6. ARS-2904 Remote Tuner Connections 92B10-046

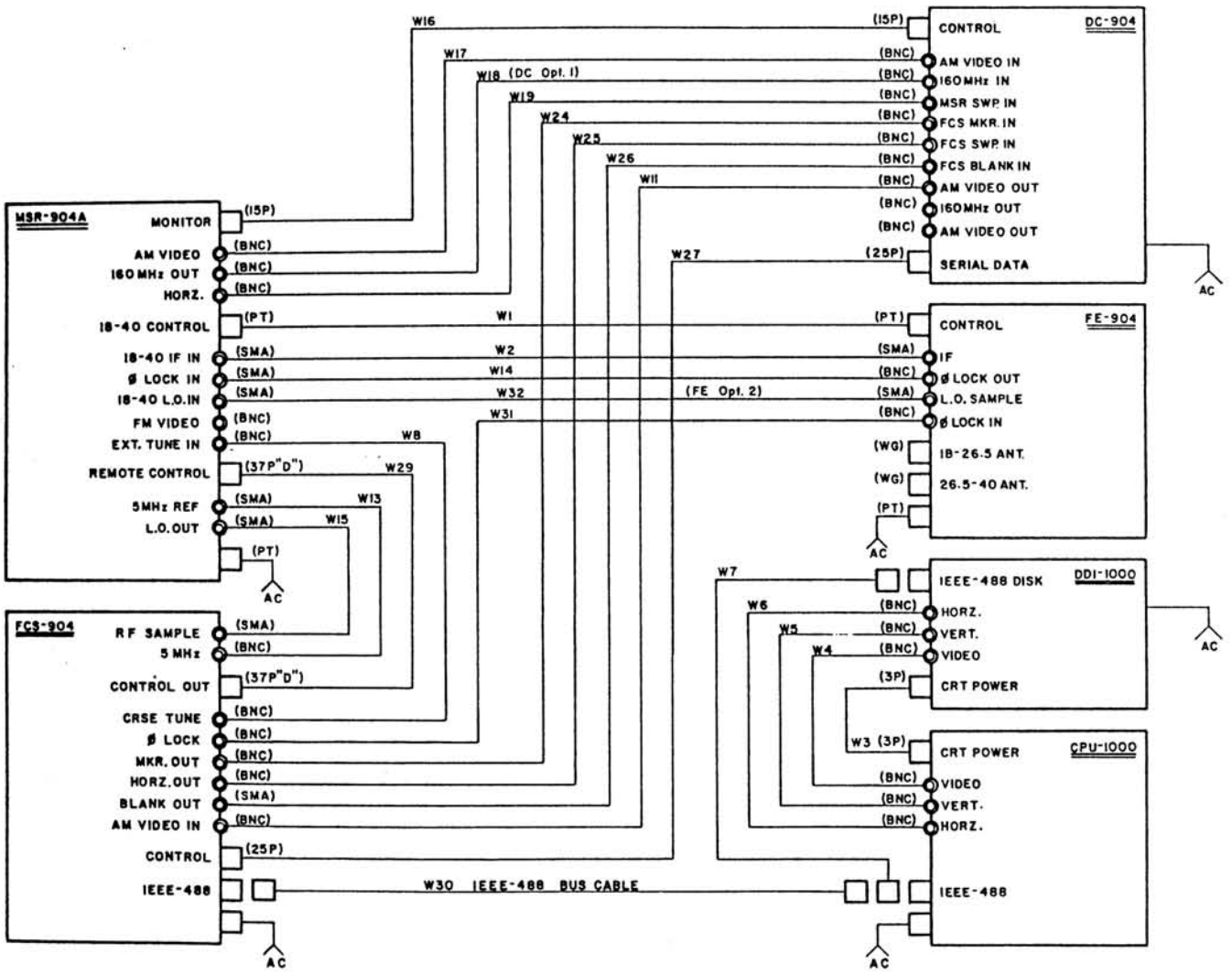


Figure 2.7. ARS-2904 System (A1)
Interconnection Diagram 92B10-042

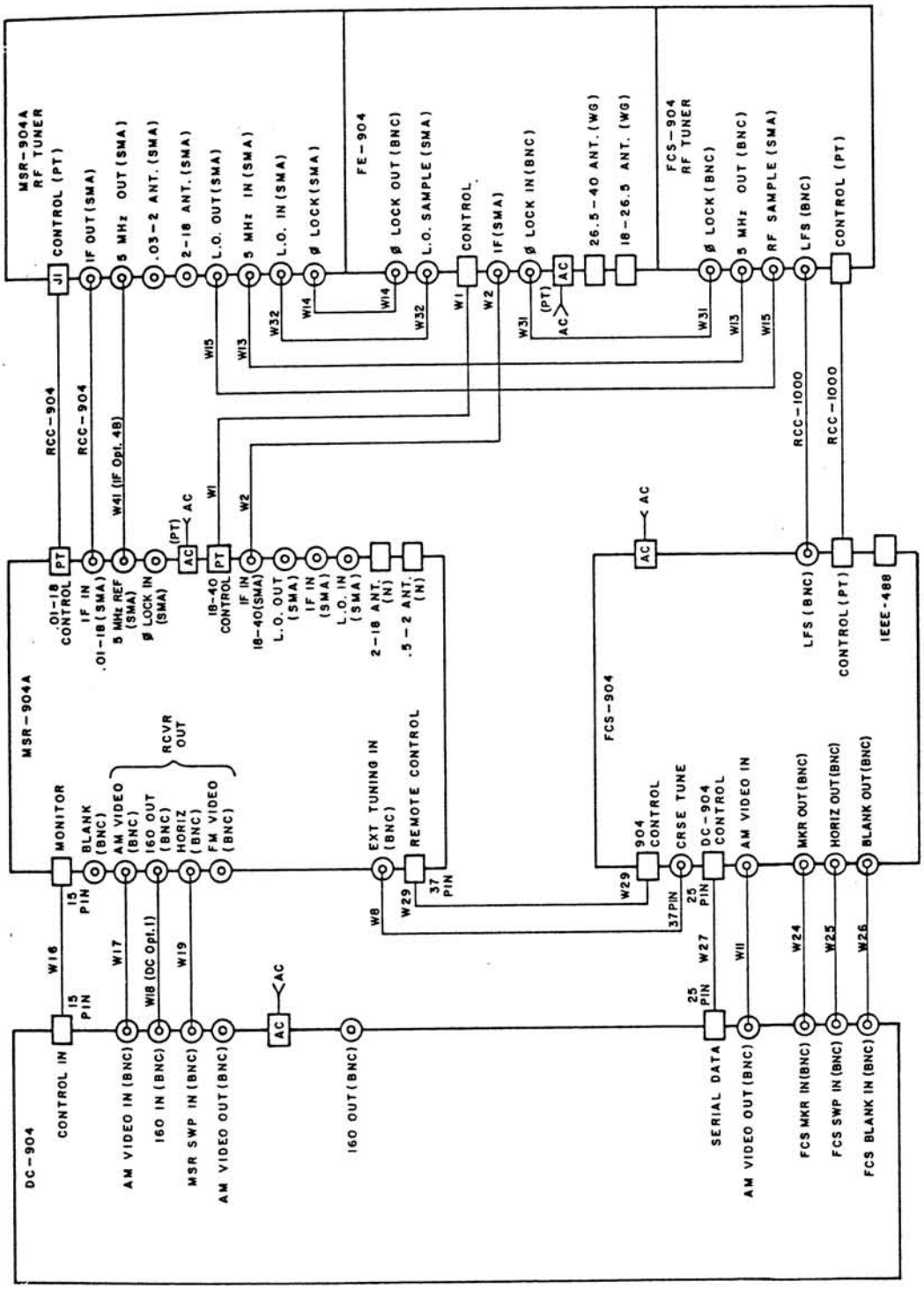


Figure 2.8. ARS-2904 System Remote RF Tuners 92B10-037

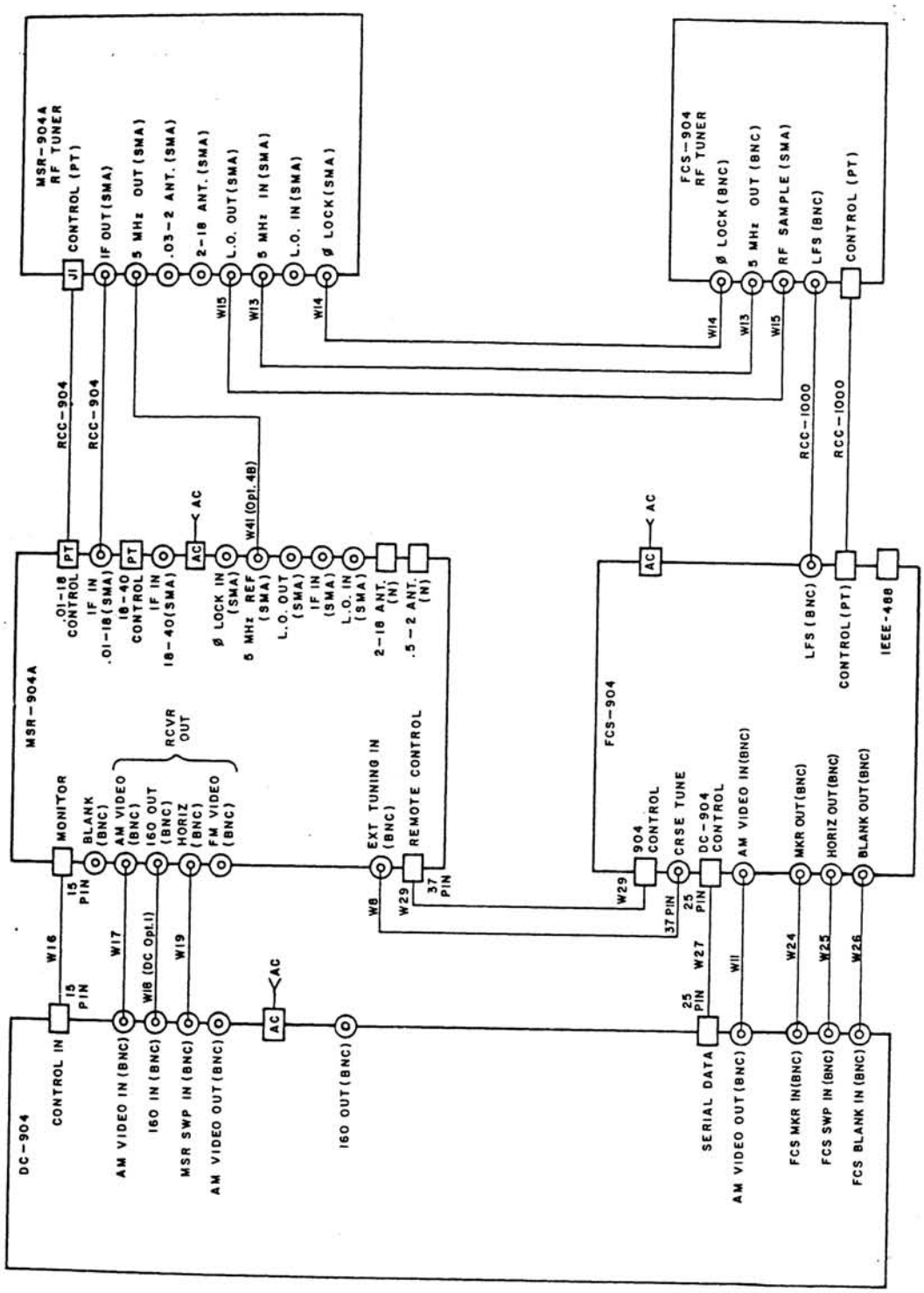


Figure 2-9. ARS-2904 System Remote RF Tuners 92B10-057

SECTION III
OPERATION

3.0 OPERATION

This section describes the operation of the MSR-904A, as an individual receiver, in its five different modes. When the MSR-904A is part of the 2904 Automated Surveillance System, refer to the system manual for operating instructions. A listing of all controls, indicators and connectors is included in this section.

3.1 INPUT AND OUTPUT CONNECTORS

Refer to Figures 1-1 and 1-2 for location of connectors.

3.1.1 RF TUNER, A8 (For Remote Operation)

DESIGNATION	TYPE	DESCRIPTION
.03-2 ANT (A8J1)	SMA	RF input to receiver. Frequency range is 0.5-2 standard, 0.03-2 if Option 3 (.03-.5 Coverage) is installed.
2-18 (A8J6)	SMA	RF input to receiver.
LO IN (J2)	SMA	Local oscillator input from FE-904 Frequency Extender. Present when Option 2 (LO Sample) is installed.
LO OUT (J4)	SMA	Combined local oscillator output (from MSR and FE-904) to drive a frequency counter or synthesizer. Present when option 2 (LO Sample) is installed.
Ø LOCK (J6)	SMA	Low frequency input from a synthesizer, to phase-lock the YIG oscillators in the RF Tuner.
5 MHz IN (A8J2)	SMA	5 MHz reference signal input from a synthesizer to phase-lock the second LO in the 0.03-2 band.
IF OUT (J8)	SMA	250 MHz IF output to the receiver cabinet.
5 MHz OUT (A8J8)	SMA	5 MHz reference signal output to the receiver cabinet.
CONTROL	41 Pin PT-Pygmy	Power and tuning controls from the receiver cabinet to the RF Tuner.

3.1.2 RECEIVER REAR PANEL (RF Tuner not Remoted)

DESIGNATION	TYPE	DESCRIPTION
IF IN (18-40) (J1)	SMA	250 MHz IF input from the FE-904 Frequency Extender.
LO IN (J2)	SMA	Local oscillator input from FE-904. Present if Option 2 (LO Sample) is installed.
IF IN (.03-18) (J11)	SMA	250 MHz IF input from the RF Tuner, when remoted. Inoperative if the RF Tuner is installed inside the receiver cabinet.
0.03-2 ANT (A8J1)	N	RF input to receiver. Frequency range is 0.5-2 standard, .03-2 if Option 3 is installed).
2-18 ANT (A8J6)	N	RF input to receiver.
LO OUT (J4)	SMA	Combined local oscillator output (from MSR and FE-904) to drive a frequency counter or synthesizer. Present if Option 2 (LO Sample) is installed.
5 MHz REFERENCE (A8J2)	SMA	5 MHz reference signal input from a synthesizer, to phase-lock the second LO in the 0.03-2 band and the 250/160 converter (Option 4B).
Ø LOCK IN (J6)	SMA	Low frequency input from a synthesizer to phase-lock the YIG oscillators in the RF Tuner.
MONITOR	15 Pin "D" Connector	X, Y and Z signals to drive an external monitor; band and mode information to the DC-904 Digitally Refreshed Display.
REMOTE CONTROL	37 Pin "D" Connector	Parallel logic input for remote control of mode, band, IF bandwidth, IF attenuator and IF reference functions of the receiver.
250 OUT (J8) (or 160 OUT)	BNC	Auxiliary IF output, wideband, centered at 250 MHz in a standard unit, 160 MHz if Option 4B is installed.
21.4 OUT (J15)	BNC	Auxiliary IF output centered at 21.4 MHz.

DESIGNATION	TYPE	DESCRIPTION
AM VIDEO (J9)	BNC	Video output (linear or log) for panoramic display (or time-base analysis in the CW mode).
FM VIDEO (J10)	BNC	Video output of FM discriminators.
HOR (J3)	BNC	Sweep output of the receiver, to be connected to the horizontal input of an external oscilloscope for panoramic display. Present in the BAND, F1-F2 and ΔFO modes.
BLANK (J5)	BNC	Retrace blanking pulse, present in the BAND, F1-F2 and ΔFO modes, to be connected to the Z-axis input of an external oscilloscope for panoramic display.
EXT TUNING IN (J14)	BNC	Tuning voltage input (from an external source). Accepts a 0 to 10V input to tune the receiver, in the EXT mode, from the low to the high end of each band selected.
AC (J3)	3 Pin PT-Pygmy	AC power input, 115/230Vac, 50-400 Hz.
TUNER CONTROL (.03-18)	41 Pin PT-Pygmy	Power and tuning controls to the RF Tuner, when remoted. Inoperative if the RF Tuner is installed inside the receiver cabinet.
TUNER CONTROL (18-40)	19 Pin PT-Pygmy	Power and tuning controls to the FE-904 Frequency Extender.

3.1.3 RECEIVER FRONT PANEL

PHONES	Standard Phone Jack	Audio output of AM or FM detectors for 600 ohms headset.

3.2 CONTROLS AND INDICATORS

All controls and indicators are located on the front and rear panels of the main cabinet. No controls or indicators exist in the RF Tuner.

3.2.1 RECEIVER FRONT PANEL

DESIGNATION	TYPE	DESCRIPTION
POWER ON (S1)	ON/OFF Pushbutton	Turn power supply "ON" in the MSR-904A. It also turns "ON" the FE-904 Extender, when it is connected to the "TUNER CONTROL - 18-40" jack at the rear panel.
FOC (A10B2R12)	1 Turn Pot	Focus control of panoramic display.
INT (A10B2R9)	1 Turn Pot	Intensity control of panoramic display.
V POS (R1)	1 Turn Pot	Vertical position control of panoramic display.
V GAIN (R2)	1 Turn Pot	Vertical gain control of panoramic display.
MON GAIN (R20)	1 Turn Pot	Vertical gain control of the external monitor. (MD-904 or DC-904).
H POS (R3)	1 Turn Pot	Horizontal position control of panoramic display.
IF ATTENUATOR	0-99 Digital Switch	IF attenuator control, 0 to 99 dB of insertion loss.
SIG LEVEL	Bar Display	Indicates relative signal strength of input signal.
TUNING (A5B1DS1 thru DS5)	Bar Display	Indicates tuning of the receiver around the input signal frequency.
AUTO-STOP ON (A11B2S1)	ON/OFF Pushbutton	Turns "ON" the "Pulse or CW Auto-Stop" feature.
AUTO-STOP LOCK/RELEASE (A11B2S2)	Momentary Pushbutton	LED illuminates when the receiver stops on a signal. Momentarily pressing the button allows the receiver to continue searching for other signals. Inoperative if the "Auto-Stop On" button is not illuminated.

DESIGNATION	TYPE	DESCRIPTION
THRESHOLD (R11)	20 Turn Pot	Adjusts threshold level above which the receiver stops on a signal (Auto-Stop).
AGC (A11B2S5)	ON-OFF Pushbutton	When "OFF" allows manual gain control of the IF via the "I.F. GAIN" potentiometer. When "ON" disables the "IF GAIN" and enables the automatic gain control.
MKR (A11B2S3)	ON-OFF pushbutton	Turns "ON" a negative-going video marker in the SCAN and F1-F2 modes of operation. Inoperative in the other three modes.
AFC (A11B2S6)	ON-OFF Pushbutton	Turns "ON" the automatic frequency control in the CW mode of operation. Inoperative in the other modes.
IF REF (A11B2S4)	ON-OFF Pushbutton	Turns "ON" a 250 MHz IF reference signal for calibration (Option 6). If this option is not installed, the pushbutton is blank and inoperative.
VIDEO FILTER (A11B2S7)	ON-OFF Pushbutton	Reduces AM video bandwidth to 50 kHz, when "ON".
MODE CW, ΔFO, F1-F2, BAND, EXT (A11B2S8 thru S12)	Momentary Pushbuttons (5)	Select the receiver's mode of operation. Only one button at a time is illuminated. CW: unswept manual tuning, via the FO/MKR dual-knob tuning control. ΔFO: adjustable width scanning via the ΔFO control with manually tuned center frequency (via the FO/MKR dual-knob tuning control. Sweep rate adjustable by the SCAN RATE control. F1-F2: adjustable width scanning of the receiver, with lower and upper limits set by the F1 and F2 controls. Operates in the octave bands or in crossband. Sweep rate adjustable by the SCAN RATE control in octave bands, automatically adjusted in crossband.

DESIGNATION	TYPE	DESCRIPTION
		BAND: full octave or crossband scan at sweep rates adjustable by the SCAN RATE control. EXT: tuning control in each is transferred to an external source.
BAND (A11B2) 0.3-2, (S13) 2-4, (S14) 4-8, (S15) 8-12, (S16) 12-18, (S18) 0.5-18, (S17) 18-26.5, (S19) 26.5-40 (S20)	Momentary Pushbuttons (8)	Selects the microwave band of operation. 0.5-2 and 0.5-18 labels are changed to 0.03-2 and 0.03-18 if Option 3 (0.03-0.5 coverage) is installed. 0.05-18 (or 0.03-18): selects the "crossband" mode, where all bands are swept in succession, automatically. 18-26.5 and 26.5-40: (Option 8) if this option is not installed in the receiver, push-buttons are blank and inoperative.
REMOTE ENABLE (A11B2S1)	ON-OFF Pushbutton	Enables remote commands of mode, band, IF bandwidth, IF attenuation and IF reference to be entered via the "REMOTE CONTROL" plug at the rear panel. Local control is maintained, even when this light is illuminated, but the appropriate "ENABLE" inputs at the "REMOTE CONTROL" plug are not present.
IF BW 0.1, 1.0, 5.0, 25 (A11B2S22 thru S25)	Momentary Pushbuttons (4)	Select the IF and video bandwidths of the receiver in AM (LIN and LOG) and FM modes.
VIDEO LIN, LOG (A11B2S30, S29)	Momentary Pushbuttons (2)	Select linear or logarithmic IF amplification and video display.
F1,F2, FO/MKR (A11B2S26 thru S28)	Momentary Pushbuttons (3)	Select the frequency to be displayed at the front panel ("FREQUENCY-GHz"). F1, F2 buttons are inoperative in the CW mode of operation. All three pushbuttons are inoperative when "AUTO-STOP" is "on"; in this mode the frequency display follows the tuning.

DESIGNATION	TYPE	DESCRIPTION
IF GAIN (R5)	1 Turn Pot	Provides at least 60 dB of manual gain control for both pan display and audio demodulation, in the LIN mode of operation. Inoperative in the LOG mode. Should be turned fully CW for operation in the FM mode.
SCAN RATE (R6)	4 Turn Pot	Varies sweep rate from 0.1 Hz or less to 30 Hz or more in the BAND, FO and F1-F2 modes of operation, for all octave bands selected. Upper limit is automatically reduced when 0.5-18 (or 0.03-18 with Option 3) band is selected. The same is true with the selection of "AUTO-STOP". Inoperative when F1-F2 and 0.5-18 are selected simultaneously; in this case the Scan rate is automatically controlled by the receiver.
ΔFO (R7)	1 Turn Pot	In ΔFO mode controls the width of the frequency being swept; width adjustable from 0 to $\pm$5% of the band selected. Inoperative in the BAND, F1-F2, CW and EXT modes.
F1 (R8)	1 Turn Pot	Adjusts the lower limit of the F1-F2 scan. Operative only when F1-F2 mode is selected. "F1" pushbutton should be illuminated to obtain a frequency display reading.
F2 (R9)	1 Turn Pot	Adjusts upper frequency limit of the F1-F2 scan. "F2" pushbutton should be illuminated to obtain a frequency display reading.
FO/MKR (R4)	Dual Speed Control: 10 Turns (fast) or 100 Turns (slow)	In BAND and F1-F2 modes, positions a video marker on the pan display. In ΔFO mode adjusts the display's center frequency. In CW mode provides manual receiver tuning. "FREQUENCY-GHz" displays the setting of this control when the FO button is illuminated.

DESIGNATION	TYPE	DESCRIPTION
AUDIO AM, FM (A13B1S1, S2)	Momentary Pushbuttons (2)	Select AM or FM demodulator for audio output. Has no effect on AM or FM video outputs or on pan display.
AUDIO LEVEL (R10)	1 Turn pot	Controls audio output at "Phones" jack; has no effect on AM or FM video outputs or on pan display.

3.2.2 RECEIVER REAR PANEL

DESIGNATION	TYPE	DESCRIPTION
115/230 (A2S1)	2 Position Slide Switch, recessed	Selects ac line voltage for the receiver. CAUTION: Fuse size must be compatible with voltage selected, as printed on the rear panel.

3.3 TURN ON

Before energizing the receiver, verify that the 115/230 switch is in the correct position, and that the correct fuse is installed.

CAUTION: SEVERE DAMAGE TO THE POWER SUPPLY WILL OCCUR IF 230 VAC IS APPLIED TO THE RECEIVER WHEN THE 115/230 SWITCH IS IN THE 115 POSITION.

3.4 NORMAL OPERATION PROCEDURES

This section describes recommended procedures for operating the receiver under various conditions. If the receiver is part of a 2904 Automated Surveillance System, refer to the system manual for more details.

3.4.1 PRELIMINARY CHECKS

Refer to sections 3.1 and 3.2 for identification of controls, indicators and connectors. Connect a suitable antenna to the appropriate ANTENNA jack and a 600 ohms headset to the PHONES jack, if audio demodulation is desired. The 250, 160 or 21.4 MHz IF output jacks may be connected to ancillary equipment if desired.

Select the appropriate pushbuttons for the type of operation desired; set the IF GAIN control fully CW and the AUDIO GAIN for a comfortable noise level at the headset.

Adjust the panoramic display controls for comfortable viewing. If an external monitor is utilized, adjust its controls of position, intensity and if desired, storage and variable persistence.

3.4.2 "BAND" MODE OF OPERATION

In this mode the receiver scans the entire RF band selected. Optimum performance is obtained by selecting 30 MHz IF bandwidth, VIDEO FILTER "ON", IF GAIN maximum (fully CW) and SCAN RATE to a moderately slow rate. LOG or LIN mode may be selected.

Narrower IF bandwidths do not noticeably increase the sensitivity in this mode if the video filter remains "on", because of normal sweep speed/resolution limitations.

In the BAND mode the AFC is disabled. A video marker may be switched "ON" to identify the position of the FO/MKR control. Marker frequency is displayed if the FO button is depressed.

If the 0.5-18 (0.03-18 with Option 3) band is selected, all bands are automatically swept in succession, as indicated by the pushbuttons, which illuminate as the particular band is swept.

3.4.3 ΔFO MODE OF OPERATION

In this mode the receiver scans a region centered about the FO/MKR control (or marker position). The scan width is variable from 0 to ±5% of the RF band being scanned by adjustment of the SCAN WIDTH control.

This mode generally provides greater sensitivity than the BAND mode since narrower IF bandwidths may be utilized without the sensitivity losses associated with the sweep speed/resolution limitation.

The center frequency of the scan is displayed by the FREQUENCY indictator, if the FO LED is illuminated. Marker and AFC are disabled in this mode.

3.4.4 F1/F2 MODE OF OPERATION

This mode allows the operator to choose a particular band to be swept, usually less than the entire band selected. If the crossband (0.5-18 or 0.03-18) button is depressed this mode allows observation of several octave bands or parts of bands in one sweep.

To adjust the upper and lower limits of the sweep:

a. Select the band desired.

b. Depress F1; adjust F1 control to the desired frequency, as displayed in the FREQUENCY indicator.

c. Depress F2; adjust F2 control to the desired frequency, as displayed in the FREQUENCY indicator.

d. Depress FO/MKR..

The receiver now sweeps between the F1 and F2 frequencies chosen, and the FREQUENCY display indicates the marker frequency. Upper or lower frequency limits may be recalled by depressing the F1 or F2 button. It is advisable to always depress FO/MKR after checking F1 or F2, in order to have the frequency of the marker readily available.

In this mode, AFC is disabled. Marker and video filter are available.

Scan rate control is available in the F1/F2 mode only if one of the octave bands (0.5-2 through 2-18) is selected. If the crossband (0.5-18) band is selected, the receiver automatically adjusts the scan rate to the width of the band being swept preventing an apparent loss of sensitivity due to the sweep speed/resolution limitation.

3.4.5 CW MODE OF OPERATION

In this mode, the internal sweep and marker are disabled; audio output and AFC are available. The panoramic display becomes inoperative, and time base analysis of the signal must be accomplished utilizing an external oscilloscope connected to the AM or FM video outputs at the rear panel, or ancillary equipment connected to the 250, 160 or 21.4 MHz IF outputs.

The audio selector provides either AM or FM to the PHONES jack; it has no effect on the AM or FM video outputs.

3.4.6 EXT MODE OF OPERATION

In this mode the receiver is tuned by means of an external 0-10V signal, applied to the "EXT TUNING IN" jack at the rear panel. This voltage tunes the receiver across each band, from the low end (0V) to the high end (+10V). Band is still selected via front panel controls.

3.4.7 REMOTE MODE OF OPERATION

The "REMOTE ENABLE" pushbutton on the front panel allows external control of several receiver functions: mode, band, IF bandwidth, IF attenuation and IF reference can be remotely controlled through the 37 pin "REMOTE CONTROL" plug at the rear panel. The front panel pushbutton labeled "REMOTE ENABLE", when illuminated, only allows remote control of these functions; local control is retained until one or all the remote enable lines in the 37 pin connector are driven to a TTL "low" state:

PIN #	FUNCTION
5	Band enable
15	IF attenuator enable
19	Mode enable
23	IF bandwidth enable (also controls LIN/LOG functions)
25	IF reference enable

Operation of the MSR-904A with the FCS-904 Frequency Counter/Synthesizer, or as part of the 2904 Automated, Computer-Controlled Surveillance System, requires activation of the "REMOTE ENABLE" function, as well as the "EXT" mode. The FCS-904 Synthesizer or the MPC-1100 provides a 0 to 10V tuning voltage, as well as band information to tune the receiver. Control of IF bandwidth, IF attenuation and IF reference may be local or remote, as required by the operator, by providing the correct signal to pins 15, 23 and 25 of the "REMOTE CONTROL" connector.

3.4.8 OPERATION OF THE AUTO-STOP FEATURE

When the AUTO-STOP pushbutton is enabled the automatic search and lock feature is activated. This feature is most useful when modes "BAND" or "F1/F2" are selected. It is only marginally useful in the " ΔF0" mode and should not be utilized in the "CW" mode. It is most useful with a selection of 30 MHz IF bandwidth, LOG video mode; however, it may be utilized with any IF bandwidth.

Threshold setting is accomplished as follows:

a. Select the band, mode and IF bandwidth desired. Recommended settings are "BAND" or "F1/F2" mode, "30 MHz LOG" IF bandwidth.

b. Rotate the threshold pot fully CW;

c. Enable the auto-stop feature by depressing the "AUTO-STOP ON" button;

d. If the receiver is not sweeping, momentarily depress the LOCK/RELEASE pushbutton to start the search.

e. Rotate the threshold pot slowly CCW until the LOCK/RELEASE light illuminates and the scan stops.

f. Depress the LOCK/RELEASE button and observe that the scan resumes.

g. Rotate the threshold pot slightly CW until the LOCK/RELEASE light turns extinguishes.

The receiver is now sweeping, with a minimum threshold setting. Higher threshold settings are obtained by rotating the threshold pot CW.

Two modes of operation of the auto-stop feature are possible:

1st The receiver searches the band; if a signal crosses the threshold the search is stopped until the LOCK/RELEASE button is depressed; at that time search is resumed.

2nd The receiver searches the band, stops for two seconds when a signal crosses the threshold, then resumes the search.

Each of the above modes may be obtained by selecting a particular combination of switches in assembly A6B1. Refer to section 4.8 and/or to schematic 92R61-018 in Section 7.0 of this manual.

3.4.9 OPERATION OF THE EXTERNAL MONITOR

The MSR-904A is pre-adjusted at the factory to operate with the MD-904 Multiband Display, even when such monitor is not supplied with the receiver. The MD-904 is manufactured by Hewlett Packard, with model number 1335A. A full manual is supplied with the MD-904.

The monitor is most useful in the crossband (.03-18 or 0.5-18) mode, when each band is displayed on the CRT displaced vertically from the previous one. Monitor adjustment is described below. Refer to Figure 3.1 in the Model 1335A manual for a listing of the controls.

a. Select "BAND" and "0.03-18" at the MSR-904A front panel.

b. Connect cable W16, as indicated in Figure 2.1.B of this manual.

c. Adjust vertical and horizontal position controls at the front panel of the MD-904 for a centered horizontal display, with the first trace (.03-2) near the bottom of the CRT.

d. Adjust X and Y gain controls at the MD-904 to obtain full horizontal display and a vertical display of 5 traces, leaving approximately the same space between the top of the CRT and the 5th (upper) trace as there is between traces.

e. Adjust focus, intensity and astigmatism for a sharp display. Intensity must be changed if "CONV" or "WRITE" mode is selected, to avoid "blooming" of the trace after a few sweeps in the "WRITE" mode.

The MSR-904A may also drive a DC-904 Digitally Refreshed Display. Refer to the DC-904 manual for operating instructions.

3.4.10 OPERATION OF THE IF REFERENCE (OPTION 6)

When "IF REF" is enabled, a calibrated 250 MHz signal is inserted ahead of the IF attenuator, providing a DC output at the AM VIDEO jack (rear panel). Calibration tables are provided, covering the entire frequency range of the receiver. These tables represent the input level at the antenna input necessary to produce a 0.5 Vdc at the AM VIDEO output, in the LINEAR mode.

3.4.10.1 IF REFERENCE CHECK

a) Connect a DC voltmeter to the AM VIDEO jack at the rear panel and select the following controls:

CW mode

LINEAR video

1.0 MHz IF bandwidth

IF GAIN fully CW

I.F. ATTENUATOR set at 5 dB

CAUTION: THE 5 dB setting of the I.F attenuator simulates an RCC-904 cable, if the RF Tuner is remoted. The I.F. cable loss should be subtracted from the 5 dB setting whenever the Tuner is remoted, to obtain the correct calibration. Cable loss, added to the IF attenuator setting, should always be 5 dB.

b) Enable the IF REFERENCE and verify that the DC voltmeter reads a voltage larger than 0.5 Vdc.

c) Rotate the IF GAIN CCW until the voltmeter reads exactly 0.5Vdc. The receiver's IF is now calibrated and ready to be utilized for input power measurements.

3.4.10.2 RF POWER INPUT MEASUREMENT

To measure the amplitude of an incoming RF signal:

a) Tune the receiver to the signal, in the CW mode, selecting 1.0 MHz IF BW in the LIN mode.

b) Utilizing an IF attenuator, insert as much attenuation as necessary to make the dc voltmeter at the AM VIDEO jack read 0.5 Vdc.

c) The power of the signal input is calculated as follows:

$$\left.\begin{matrix}\text{Input}\\ \text{Power}\end{matrix}\right\} = \text{(IF att. setting)} + X - 5$$

where

X = RF input equivalent to the calibrated IF reference per tables. X is a negative number, expressed in dBm.

d) If the input signal level is smaller than the IF reference, a more accurate procedure is as follows:

Rotate the IF GAIN fully CW.

Tune to the signal, in the CW mode, and record the DC voltmeter reading.

Enable the IF REFERENCE and, utilizing the IF attenuator, insert as much attenuation as necessary to obtain the same reading at the DC voltmeter.

The RF power input is then:

$$\left.\begin{matrix}\text{Input}\\ \text{Power}\end{matrix}\right\} = X - \text{(IF att. setting)} + 5$$

SECTION IV
THEORY OF OPERATION

4.0 THEORY OF OPERATION

4.1 A2, POWER SUPPLY

Refer to schematic diagram 92R20-078 in section 7.0 of this manual.

The power supply utilizes a switching regulator to maintain high efficiency over the specified range of input voltages. Series voltage regulators are utilized for some regulated outputs in order to improve regulation and reduce source impedance.

The ac line voltage connects through isolation transformer T1 to rectifier DA1. The primary windings of T1 are switched in parallel for 115V operation and in series for 230V operation. The rectified output from DA1 is filtered by capacitor C1 and switched by transistors Q7 and Q9.

Regulation is achieved by varying the duty cycle, i.e. on-time, of the switching transistors.

4.1.1 A2B1, CONTROL CIRCUITS

The control circuits generate the driving waveform to the switching transistors. This waveform connects to the switching transistors through transformer T2. The on-time of this signal varies inversely as the sample voltage applied to pin 11 of A2B1. The control circuits are powered by the low voltage winding of T1, rectifier DA2 and filter capacitor C2.

The basic switching waveform is generated by integrated circuit U1 which is a switch-mode regulator designed specifically for this purpose. It generates two out-of-phase switching signals at pins 11 and 13. Refer to Figure 4.1. The on-time of these switching signals varies inversely as the input voltage to pin 6. The switching frequency is determined by resistor R4 and by the voltage applied to pin 7. This voltage is adjusted to allow sufficient off-time for the ringing and switching transients to decay. U1 contains an internal voltage reference which is available at pin 9. This voltage is the source for the dead time adjustment via trimmer R15 and also supplies the reference voltage for the comparator U2B. The output switching signals at pins 11 and 13 drive transistor switches Q2 and Q3 which switch the primary transformer T2. Integrated circuit U1 does not have the power capability to drive the transformer directly. Diodes D6 and D7 and transistor Q6 comprise an AND circuit to turn on transistors Q4 and Q5 when both Q2 and Q3 are in their off states. During this time, Q4 and Q5 short the primary winding of T2 connected to their collector and thus dampen any ringing or transient during the off-time of the switching transistors.

A sample of the power supply output voltage connects through pin 11 of A2B1 to U2B where it is compared to the reference source from U1. Comparator U2B amplifies any error voltage in the correct polarity to drive the regulator input to U1 reducing the error signal at pin 11 of A2B1 to zero. Operational amplifier U2A adds a positive offset voltage as required by the input at pin 6 to U1. Trimmer R22 adjusts the power supply output voltage to exactly 12 volts.

Transistors Q7 and Q9 switch the voltage rectified from the ac line alternately to each side of the center tap primary winding of T3. In order to insure minimum turn-off time for each of these high voltage switches, a turn-off circut is included in A2B1. For example when Q7 is on, its base current is limited by R25, and the potential across R25 charges C6. Q8 does not conduct because it is biased off by the drop across D11. When the drive winding goes to zero to turn Q7 off, Q8 is forward biased by R24 and conducts to force a reverse current through the emitter-base junction of Q8.

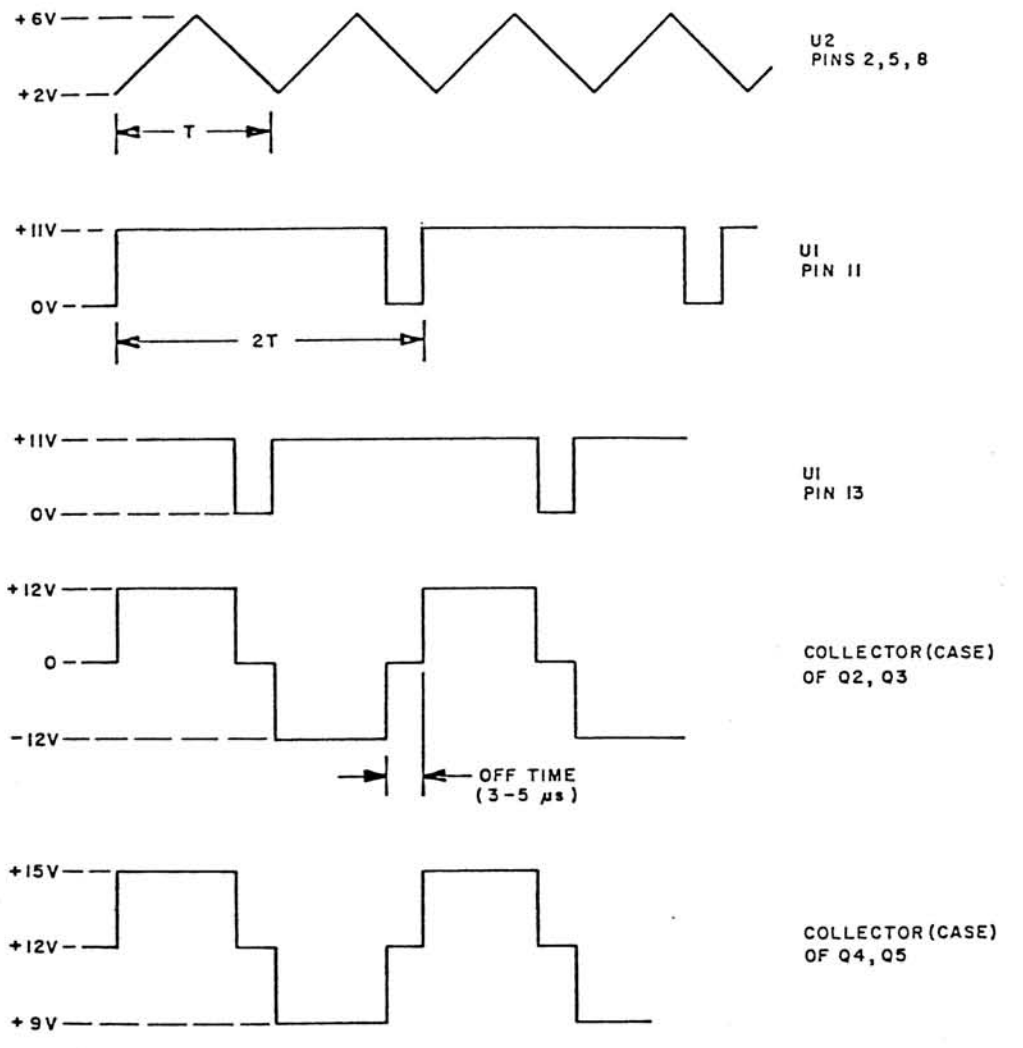


Figure 4.1. MSR-904A Waveforms, A2 Power Supply

4.1.2 A2B2, RECTIFIERS/FILTERS

The secondaries of the power transformer T3 each connect to full wave rectifiers, DA3, D17 and D18. The outputs of these rectifiers are constant amplitude pulses with varying duty cycle. It is necessary to utilize inductor input filters if the filtered dc output is to be proportional to the duty cycle. Output voltages are ±18V at pins 5 and 6, and +12V at pin 3.

4.1.3 A2B3, REGULATORS

Series integrated circuit regulators provide additional filtering, as well as regulation of individual outputs and a low source impedance. Dissipation in these regulators is minimized because the input voltages to the regulators are held essentially constant by the switching regulator.

4.2 A3, IF ASSEMBLY

Refer to Figure 4.2, Block Diagram.

The IF assembly consists of modules necessary to provide AM (linear or log) and FM video outputs, plus IF outputs at 250 and 21.4 MHz.

Each MSR-904A receiver may have a maximum of four IF bandwidths, customer specified in the range of 30 to 0.1 MHz. Standard bandwidths are 30, 5, 1.0 and 0.1 MHz. Other choices may be made, according to the following criteria:

a) a maximum of three IF bandwidths in the 250 MHz strip (30 to 4 MHz), labeled 250 wide (W), 250 medium (M) and 250 narrow (N) in the description below (A3B2).

b) a maximum of two IF bandwidths in the 21.4 MHz strip (3 to 0.1 MHz), labeled 21.4 wide (W) and 21.4 narrow (N) in the desription below (A3B10).

To determine how many bandwidths are provided in each strip, refer to the bandwidths listed at the front panel: all bandwidths of 4 MHz or larger are in the 250 strip; all 3 MHz or smaller are in the 21.4 strip.

Bandwidth control is provided by A4B2 to switching relays contained in the IF assembly, as described in Section 4.4.

The IF assembly is discussed in detail in the following sections.

4.2.1 A3B1, 250 MHz AMPLIFIER/ATTENUATOR

Refer to schematic diagram 92R31-063.

The 250 MHz AMPLIFIER/ATTENUATOR consists of amplifiers, attenuators and power splitters to provide 250 MHz outputs to the 250 MHz filters(A3B2), 250 MHz Wide Band I.F. Output and the 250 to 21.4 MHz converter (A3B8). The attenuators provide 60 dB of gain control, either manually or automatically.

4.2.2 A3B2, 250 MHz FILTERS

Refer to schematic diagrams 92B30-082 and 92R32-064.

Assembly A3B2 provides selection of 3 filters for wide, medium and narrow band operation. The filter for narrow band operation is actually external to the A3B2 module. All the filters are switched from the module via relays K1, K2, K3 and K4.

When all relays are de-energized the wide band filter is selected. When FL5 is grounded, the 250 narrow band is selected and when FL4 is grounded, the 250 medium band is selected.

The 250 MHz output goes to the 250 MHz Amplifier/Splitter.

4.2.3 A3B3, 250 MHz AMPLIFIER/SPLITTER

Refer to schematic diagram 92R33-065.

The 250 MHz Amplifier/Splitter provides gain and outputs to the 250/21.4 Log Amplifier (A3B7) and the 250 MHz AM AGC Amplifier (A3B5).

4.2.4 A3B4, 250 MHz LIMITTER AMPLIFIER

Refer to schematic diagram 92B34-066.

The 250 MHz Limitter Amplifier is comprised of a 70 MHz wide bandpass filter and three stages of limiting to enhance AM rejection. Overall gain is 35 dB with a limiting level of +12 dBm.

The 250 MHz Limitter Amplifier outputs to the 250 MHz FM discriminator (A3B6).

4.2.5 A3B5, 250 MHz AM DETECTOR/AGC AMPLIFIER

Refer to schematic diagram 92R35-067.

The incoming 250 MHz signal is amplified by U1 and Q1 and the tank circuit formed by L1 and C7. Series diode detection is provided by D1 with C9 bypassing the RF component to ground. The signal then splits and goes to the AGC section where it is integrated by 1/2 U2, filtered by R27 and C16, and buffered by 1/2 U2. Also, the signal is filtered by R8 and C10 and applied to the non inverting terminal of U3. The gain of U3 is varied by switching FETs Q3 or Q4 "on" when FL5 or FL6 are grounded. The buffered output signal is applied to A3B13.

4.2.6 A3B6, FM DISCRIMINATOR

Refer to schematic diagram 92R36-068.

The 250 MHz input signal is split by quadrature hybrid HY1. The signal at the 0° port is delayed by coaxial delay lines DL1 or DL2, according to the bandwidth selected. Phase of the signal at the 90° port lags the 0° port by 90°; its phase is shifted back to 0° by L1 and C7. The two inputs at quadrature hybrid HY2 are then out of phase by the delay introduced by DL1 or DL2, which is proportional to frequency. The two outputs of HY2 are in phase, but their amplitudes vary proportionally to the phase difference of the inputs. Diodes D2 and D3 detect and add the two outputs providing a video output which is proportional to the phase shift introduced by DL1 or DL2, therefore proportional to the frequency of the input signal.

The video output is amplified by U1 and buffered by U2. Gain of U1 is changed by switching Q1 or Q2 "on" for medium and narrow IF bandwidths in the 250 MHz strip, as described in Section 4.2.

4.2.7 A3B7, LOG AMPLIFIER

Refer to schematic diagram 92R37-069.

Log amplification is accomplished via U1 through U6. The output of these devices is a log current proportional to the input signal voltage. These currents are summed at the emitter of Q1. The voltage at the collector of Q1 is therefore inversely proportional to the input signal voltage. The signal is then inverted and amplified via U7, buffered

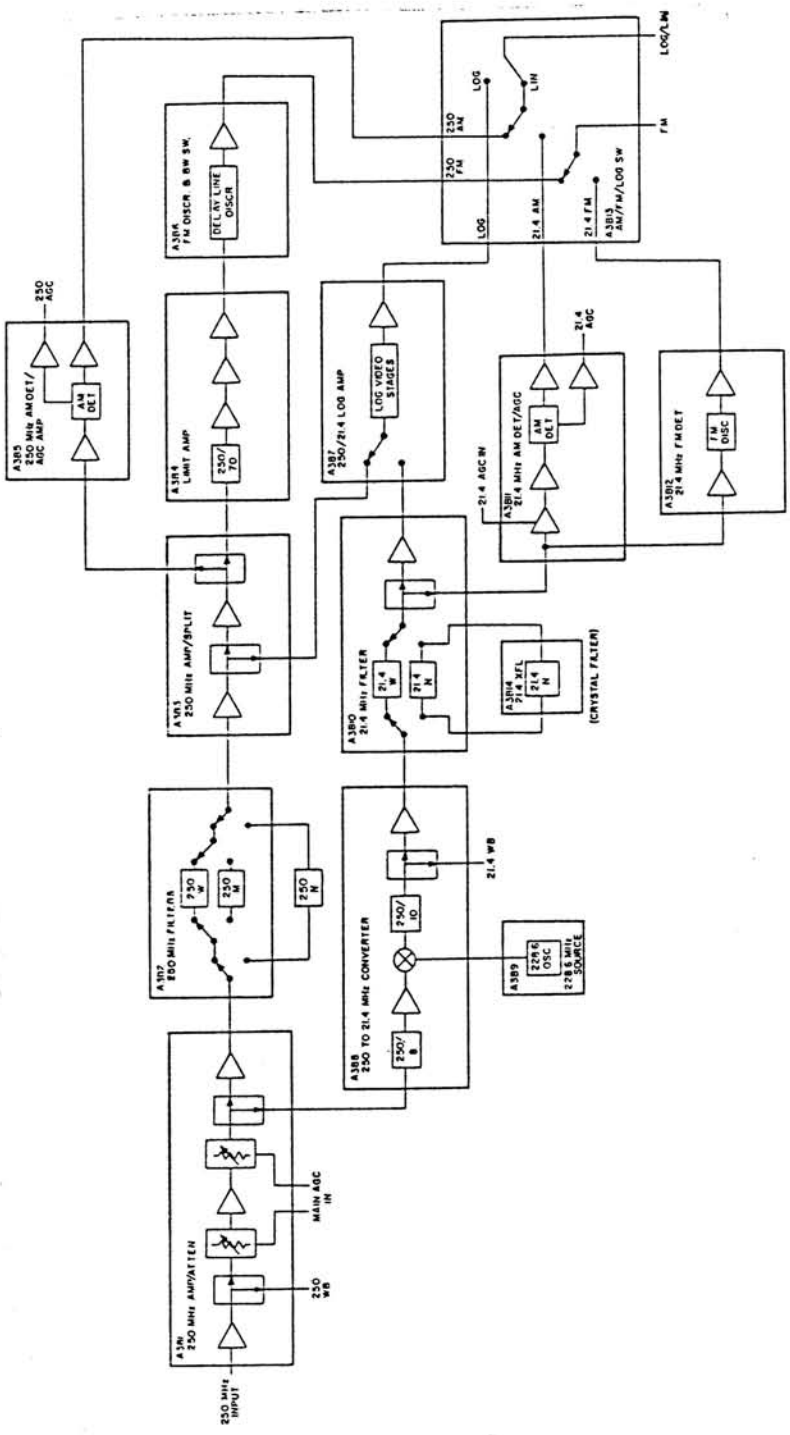


Figure 4.2. MSR-904A, IF Assembly, A3
Block Diagram 92B30-082

via U8 and applied to swithing box A3B13. In the 21.4 MHz mode, U3 is bypassed utilizing relays K2 and K3. Also in the 21.4 MHz range Q2, acting as a voltage controlled switch, shorts one end of C19 to ground thereby providing filtering. The circuit comprised of C7, C8, R7 and L1 serves to lower noise and match impedances in the 250 MHz range.

4.2.8 A3B8, 250 TO 21.4 CONVERTER

Refer to schematic diagram 92R38-070.

The incoming 250 MHz signal is amplified by U1. Mixer Z1 mixes the incoming signal with the 228.6 MHz local oscillator producing a 21.4 MHz output. This output is filtered and split via U3. Part of the signal is amplified and applied to A3B10 (21.4 MHz filters) and part is applied to A12 (21.4 MHz amplifier).

4.2.9 A3B9, 228.6 MHz SOURCE

Refer to schematic diagram 92R39-071.

The 228.6 MHz source is comprised of a crystal oscillator Q1, tripler amplifier Q2, harmonic filter and an output amplifier.

4.2.10 A3B10, 21.4 MHz FILTERS

Refer to schematic diagram 92R310-072.

Relays K1 and K2 select one or two filters in this assembly, according to the IF bandwidths specified. Only one filter is connected to each pole of the relays: K1-4 and K2-5 provide the widest 21.4 IF bandwidth (filter L1,2,3 or L4, 5,6); K1-8 and K2-1 provide the narrowest 21.4 MHz bandwidth (filter L7,8,9 or external crystal filter A3B14, usually a 100 kHz wide filter).

The output of K2 is split by U1; part of the signal is applied to the AM detector (A3B11); part is amplified by U2 and applied to the log amplifier (A3B7).

4.2.11 A3B11, 21.4 MHz AM DETECTOR/AGC

Refer to schematic diagram 92R311-073.

The input signal is split and applied to A3B12 (FM discriminator) and to amplifiers U1 and U2. The amplified signal is applied to U3, the AM Detector. The Video Out at pin 1 is filtered and applied to the non-inverting terminal of U4. The signal is then buffered and applied to the switching box A3B13.

An AGC voltage is developed from pin 4 of U3 and integrated by U6. Diode D1 is a zener diode that sets the maximum AGC voltage at 10 volts. The AGC is switchable from the front panel. When switched, the AGC voltage developed from U6 is applied to pin 2 of U2.

4.2.12 A3B12, 21.4 MHz FM DETECTOR

Refer to schematic diagram 92R312-074.

The 21.4 MHz input signal is amplified by U1 and applied to the quadrature detector U2. A 90° phase shift occurs from pin 8 to pin 9. The tuned circuit across pins 9 and 10 serves to further shift the IF signal an amount proportional to the frequency difference between the 21.4 MHz center frequency and the input signal frequency. The detected output from pin 6 is amplified by U4, buffered by U5 and applied to the switching module A3B13. Q1 is switched "on" when the narrow 21.4 MHz bandwidth is selected, to increase the gain of video amplifier U4.

4.2.13 A3B13, AM/FM/LOG SWITCHING

Refer to schematic diagram 92R313-075.

The AM/FM/LOG switching module consists of relays K1, K2 and various outputs. K1 selects video outputs from the 250 or 21.4 MHz strips (FM and linear AM); K2 selects linear or log AM video outputs. Audio filters for AM and FM provide 10 kHz audio signals through A2P2. AFC signals are derived from the common FM video output for each of the IF bandwidths selected.

4.3 A4B1, BAND CONTROL

Refer to schematic diagram 92R41-012 in section 7.0, and also to Figure 4.3.

Assembly A4B1 provides the automatic switching needed by the RF Tuner (A8) to:

a. Apply bias currents to PIN switches.

b. Provide +15V supply voltages to YIG oscillators.

c. Route the YIG oscillator driver in assembly A7B3 to the selected YIG oscillator in the RF Tuner.

d. Route the YIG filter driver in assembly A7B3 to the selected YIG filter in the RF Tuner.

e. Provide $\pm$15V to phase-locked 2.08 GHz oscillator.

Switching is accomplished via two types of band codes, generated in assembly A11 (Function Selector):

a. BCD code providing a binary number from 1 to 8, according to the band selected, as listed in Table 4.1.

b. "One of eight" code, providing a TTL "low" whenever a particular band is selected, "high" otherwise.

In addition, a ramp comparator input provides a TTL "high" when the receiver is tuned from 0.03 to 0.5 GHz, "low" above 0.5 GHz. This provides the logic necessary to switch in a 0.5-2 GHz YIG filter in the RF Tuner (A8). It is only operational if Option 3 (.03-0.5 GHz coverage) is installed.

Figure 4.3 contains a simplified logic diagram of assembly A4B1. PIN switch outputs are "low" when the switch is turned "on", high otherwise. $\pm$15V are switched "on" when required, as listed on the right side of Figure 4.3.

4.4 A4B2, IF BANDWIDTH CONTROL

Refer to schematic diagram 92R42-076 in section 7.0 and Figure 4.3.A.

Assembly A4B2 provides the automatic switching necessary to select one of the four IF bandwidths, in either linear or logarithmic mode. It contains a programmable ROM which provides the appropriate logic from a BCD input code as listed in Table 4.2.

An extra input (labeled L/$\overline{R}$) provides additional information: TTL "high" in the local mode of operation, "low" when the IF bandwidths are selected by external means, through the REMOTE CONTROL plug on the rear panel.

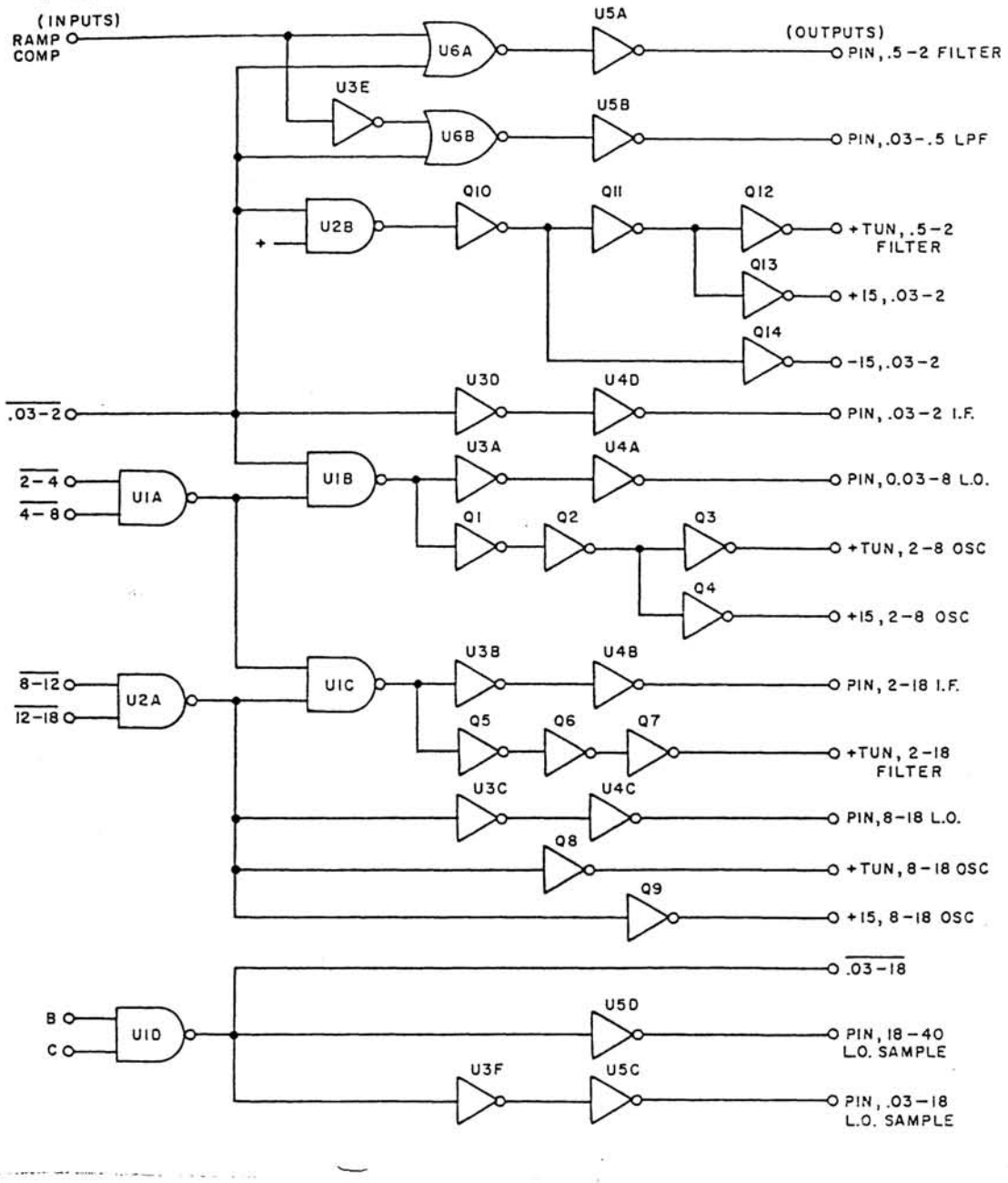


Figure 4.3. MSR-904A, Band Control, A4B1
Logic Diagram 92A41-053

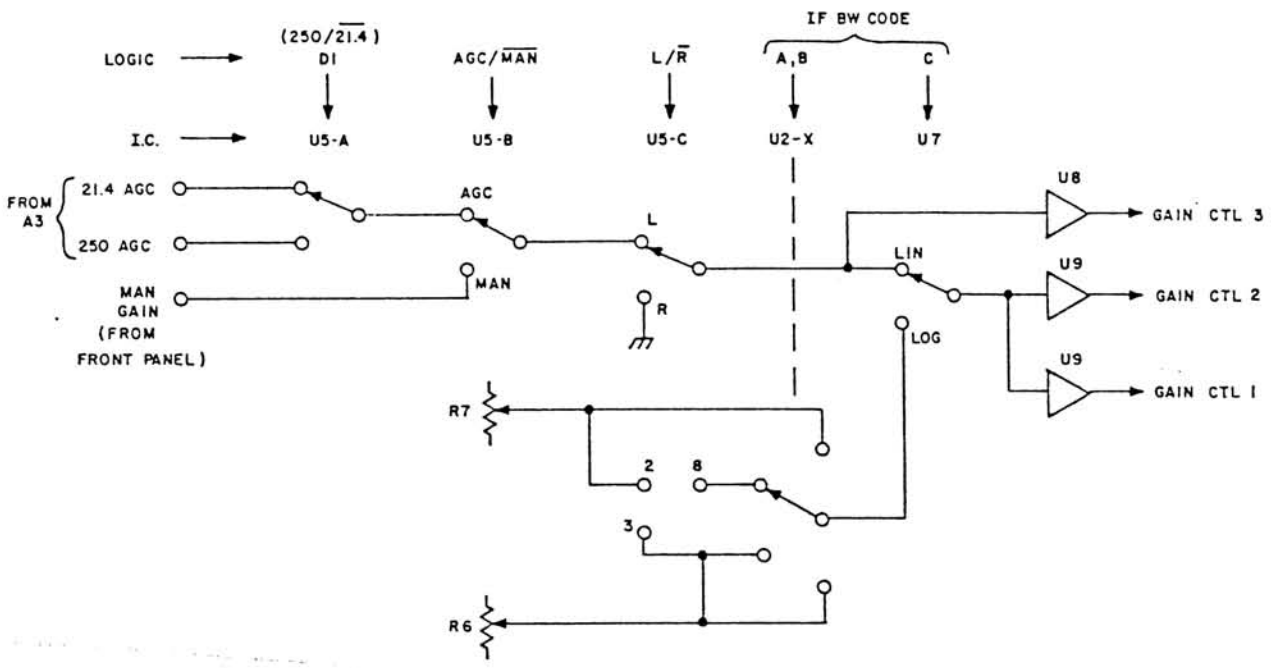


Figure 4.3A. IF Bandwidth Control, A4B2
Simplified Diagram

Another input to the PROM (A4) is hard wired in the PC board: terminal 10 is tied to 11 (high) when three 250 MHz IF bandwidths are supplied, and only one 21.4 MHz, as described in Section 4.2. Terminal 10 is tied to 12 (low) when two bandwidths are provided in each strip.

The PROM outputs D1 through D4 provide logic signals to switching transistors Q1 through Q11 and Q15, selecting dc voltages to be applied to assembly A3 (IF Amplifier).

Integrated circuits U2, U5 and U7 provide the switching necessary to apply manual gain control or AGC to the appropriate assemblies in A3 (IF Amplifier). Switches are shown in the simplified gain control diagram, Figure 4.3.A. Amplfiers U8 and U9 invert and offset the gain control signals before application to A3B1 (gain control 1 and 2) and A3B11 (gain control 3).

The second half of U2 selects the appropriate adjustable voltages to control attenuators Z6 and Z8, if Option 6 (IF Reference) is installed. Refer to Section 4.21.

TABLE 4.1

BAND CODE (INPUT) to ASSEMBLY A4B1

BAND GHz	BAND NUMBER	BCD CODE A	B	C
0.5-2*	1	1	0	0
2-4	2	0	1	0
4-8	3	1	1	0
8-12	4	0	0	1
12-18	5	1	0	1
18-26.5	6	0	1	1
26.5-40	7	1	1	1
0.5-18*	8	0	0	0

*Lower limit is 0.03 GHz if Option 3 is present

TABLE 4.2

IF BANDWIDTH CODE INPUT TO ASSEMBLY A4B2

IF BW		MODE	BCD CODE		
1 X 21.4 3 X 250	2 X 21.4 2 X 250		A	B	C
21.4	21.4N	LIN	0	0	0
250N	21.4W	LIN	1	0	0
250M	250M	LIN	0	1	0
250W	250W	LIN	1	1	0
21.4	21.4N	LOG	0	0	1
250N	21.4W	LOG	1	0	1
250M	250M	LOG	0	1	1
250W	250W	LOG	1	1	1

4.5 A4B3, CROSSBAND SWITCHING

Refer to schematic 92R43-014 in section 7.0.

This assembly provides the switching and band code necessary for crossbanding (0.5-18 or 0.03-18 band selector at the front panel). It is only operational when this particular selector is illuminated, bypassed in any of the octave bands.

Quad comparator U1 provides switching points at 1.0, 2.0, 4.0 and 6.0V, when the dc voltages set up by R1 through R9 are compared with the 0 to 9V tuning ramp. The outputs of U1 are applied to 8-bit-priority encoder U2 and inverter U3 providing a BCD band code which is automatically and sequentially switched from band 1 to band 5. Code and band ranges are listed in Table 4.1.

8-channel-multiplexers U5 and U9, together with operational amplifiers U6 and U8, and current amplifier U10, transform the 0 to 9V tuning ramp into 5 individual 0 to 9V tuning ramps, one per band, to tune the receiver across each entire band, sequentially, when the crossband mode of operation is selected. Potentiometers R28 through R34 adjust the low end (0V) of each of the ramps by applying an offset voltage to U8; potentiometers R44 through R52 adjust the high end (9V) of each of the ramps by varying the feedback resistance connected from output to inverting input of U8.

Triple-2-channel-multiplexer U11 selects a single 0 to 9V tuning ramp in all octave bands, or the 5 sequential 0 to 9V ramps when the crossband mode of operation (0.5-18 or 0.03-18) is selected. It also selects a manual or automatic Scan rate control in the F1/F2 mode of operation, as described in section 4.9 (A6, Tuning Generator).

Operational amplifiers U12 and U13 provide a balanced 0 to 9V ramp to the FE-904 Frequency Extender; only an individual ramp is provided, as there is no crossbanding in the 18-40 GHz range.

One-shot U4 provides a 2-3 msec pulse whenever a switch point is reached at 2.0, 4.0, 8.0 and 12.0 GHz) to momentarily stop the sweep and blank the intervals between bands. This momentary stop provides a settling time for the YIG oscillator and filter drivers, after the appropriate devices are switched "on" by the circuitry in A4B1 (band control, section 4.3).

4.6 A4B4, METER TRACKING BOARD

Refer to schematic diagram 92R44--015 in section 7.0.

This assembly provides adjustable voltages to track the front panel digital Frequency Display (A5) to the receiver's tuning frequency. It also provides a 0 to 10V analog voltage, proportional to the tuning frequency to the REMOTE CONTROL plug on the rear panel.

Two input voltages are utilized to provide the frequency display tracking: a +11.0 Vdc utilized to track the low end of each band, and a -11 to +11 variable voltage. This voltage is -11V at the low end of each band and +11V at the high end, for all octave bands and crossband; it is generated by one of five sources:

a. FO/MKR dual-knob control, when the FO/MKR pushbutton is illuminated; the frequency display will read the position of the marker in BAND or F1/F2 modes, the tuning frequency in ΔFO, CW and EXT modes.

b. F1 control, when the F1 pushbutton is illuminated; the frequency display shows the lower limit of the F1/F2 scan, when such mode of operation is selected;

c. F2 control, when the F2 pushbutton is illuminated; the display shows the upper limit of the F1/F2 scan.

d. A -11/+11V ramp, originating in the Tuning Generator (A6), when the receiver is in the Auto-Stop mode (option 7).

Selection of the appropriate voltage is accomplished in assembly A11B4, as described in section 4.15.3.

U1A buffers the -11/+11V input which is then summed with a dc voltage (buffer U1B) providing a 0/9V voltage to the divider network 1H1 throught 8H1.

A +11Vdc precision reference is supplied to the divider network 1LO through 8LO.

Corresponding LO and HI voltages per band are selected by U5 and U6, buffered by U4A and U4B and then summed. 8LO and 8HI, which correspond to the crossband mode (0.03 or 0.5 to 18) are buffered by U3A and U3B, then summed.

Relay K1 selects one of the two summed voltages, which is then amplified by U7A and applied to the input of the frequency display (A5).

U7B provides a 0/10V analog voltage to the rear panel (P7-30, remote control, and also P36-8, monitor).

4.7 A4B5, EXTERNAL CONTROL

Refer to schematic diagram 92R45-079 in section 7.0.

Assembly A4B5 performs several unrelated functions, as listed below:

a. Timer U1 generates 2 usec negative going pulses, spaced by 80 usec, to drive switch U4 in assembly A36 (Peak Detector), after inversion by U2A. Refer to section 4.19 for an explanation of the peak detector operation. U1 is shut-off by the mode code "C" input which is "low" in SCAN, F1-F2 and ΔFO modes, "high" in CW and EXT. This signal is inverted by U2F and applied to the RESET input of timer U1 to turn it off in the CW and EXT modes of operation.

b. Multiplexer U7 switches to ground resistors R50 through R55 in assembly A6B2 to change the AFC amplifier gain in each band of operation.

c. Gates U3, U9, U11 plus multiplexer U8 change the IF bandwidth code. When AUTO-STOP is selected, the receiver is searching and the mode selected is not "external", the output of U9C is high and the BCD code for IF bandwidth is reduced by one count (U3B, U11C and U11D). This allows the receiver to search in a narrower bandwidth, then switch to the next higher bandwidth when lock is acquired. In this manner, even a low threshold setting allows analysis of the signal close to the center of the bandpass, when the search is stopped.

d. Operational amplifier U5 and multiplexer U6 provide a vertical (Y-axis) drive to the external monitor. U6 adds a stepping dc voltage to the AM video signal, for each band covered, to provide a separate display of each band (0.03-18) at the monitor's CRT.

e. Operational amplifier U10 inverts and shapes the positive-going blanking pulse to provide a blanking signal to the DC-904: 0V to blank, +0.7V to display.

f. "AND" gate U11A and transistor Q1 combine two logic signals to enable the FM coil driver U1 in assembly A8B11, as described in section 4.12. Output of Q1 is -6V when "REMOTE" mode is selected at the MSR-904Afront panel and "SYNTH" mode is selected through the REMOTE CONTROL plug at the rear panel. For any of the other three possible combinations the output of Q1 is +5VDC, which shuts off the input to coil driver U1 in A8B11.

g. Operational amplifier U5 and multiplexer U8 provide horizontal (X-axis) drive to the external monitor. In BAND, F1/F2 and EXT modes, a 0/9V signal is offset to supply the monitor with $\pm$0.75V horizontal drive. In the ΔFO mode a $\pm$5V horizontal signal generated by the receiver is switched to the monitor by U8 and attenuated to $\pm$0.75V.

h. Comparator U12 provides a logic signal to assembly A4B1 (Band Control), as described in section 4.3, to switch in the 0.5-2 GHz YIG filter.

4.8 A5, FREQUENCY DISPLAY

Refer to schematic diagram 92R50-017 in section 7.0.

The frequency display is a 4 1/2 digit voltmeter utilizing dual-slope integration. Integrated circuits U2 and U3 are specifically designed to operate together to form the analog-to-digital conversion. The input signal to the basic meter function connects between pins 10 and 11 of U2, and at this point has a range of 0 to +1.9999 volts.

The input voltage from the meter tracking circuits varies from about 0 to +9 volts. Resistors R1 and R2 divide this input by 5 to bring it within the range of the basic circuit. Operational amplifier U1 buffers the input to U2 and any zero offset is compensated by trimmer R3.

Timer U4 supplies the clock signal for the analog-to-digital conversion and the multiplexing of the display. The multiplexed BCD output appears at pins 20, 21, 22, and 23 of U2, with the digit select outputs at pins 19, 24, 25, 26 and 27. The digit select outputs of U2 connect to display driver U6 through BCD adder U9. On bands 1-5 (0.03-18 GHz), there is no addition. On band 6 (18-26.5 GHz) 14000 is added to the display. On band 7 (26.5-40 GHz) 24000 is added to the display. U6 converts the BCD output to drive the 7-segment LED displays. The five digits are sequentially scanned by the digit select outputs and switching transistors Q1 through Q5. Trimmer R10 adjusts the full scale meter range. Regulator U5 supplies +5 volts to the meter circuits.

For bands 6 and 7, the BCD addition is done by U7, U9, U10 and associated circuits. U7 is a nines complement and selects the number to the input of BCD adder U9. U8, a dual flip-flop, detects and temporarily stores a carry out of U9. U9 adds two BCD numbers to the output of U8 providing the sum plus a carry output. U10 is a quad 2-input NAND gate which decodes the BCD band input controlling the adder circuits.

4.9 A6, TUNING GENERATOR

Refer to Figure 4.4 (block diagram) and schematic diagrams 92R61-018, 92R62-019 and 92R63-020 in section 7.0. The tuning generator consists of 3 printed circuits board providing all the tuning functions necessary for the 5 modes of operation: BAND, ΔFO, F1-F2, CW and EXTERNAL.

4.9.1 A6B1, CLOCK AND CONTROL

Assembly A6B1 contains the clock generator and circuitry to start and stop the clock (and therefore the main sweep) under several conditions. Clock U9 is a voltage-controlled function generator providing pulses at rates determined by a dc voltage applied to pin 8 (scan rate control). These pulses are applied to a 0-10,000 counter and D-A converter in assembly A6B2, thus generating the main tuning ramp.

The scan rate control voltage applied to pin 8 of U9 is generated by one of two sources:

a. Scan rate potentiometer at the front panel - controls the clock generator in SCAN, ΔFO and F1-F2 modes.

b. An automatically adjusted voltage when F1-F2 mode and 0.03-18 (crossband) are selected simultaneously.

Switching of the appropriate scan rate voltage is accomplished by K1-1B in A6B2 and U11 in assembly A4B3. The automatically adjusted voltage for F1-F2/.03-18 combination is generated by U1, U2 and U3 in A6B1, as follows: -11 to +11 VDC is obtained from potentiometers F1 and F2 at the front panel and applied through buffers to differential amplifier U1B. The resulting voltage is added to an offset voltage and multiplied by two, then applied to the clock rate control. It varies from approximately +11.2V (slow scan, when F2 is fully CW and F1 fully CCW) to +7V (fast scan, when F1 and F2 are set to cover only an octave band or less).

Stop and start clock control is applied to U9 through MOS-FET Q4, inverter Q5 and "AND" gates U8B and C. Refer to Figure 4.5 (A6B1 voltage waveforms). The logic waveforms in Figure 4.5 show a SCAN display of the 0.03-18 GHz band, with a signal display and the auto-stop feature.

Blanking: when 10,000 clock pulses have filled the counter in A6B2 a scan retrace pulse is generated which activates one-shot U11-1. Its "Q" output goes high, causing the output of U8C to go high and stop the clock pulses. After 8-10 msec. one-shot U11-1 reverts to its original state and the scan is resumed.

Crossband stop sweep: assembly A4B3 generates a stop sweep pulse whenever a switch point between bands is reached, as described in section 4.5. This pulse also produces a TTL "high" at the output of U8C, stopping the scan for 2-3 msec., allowing the appropriate YIG

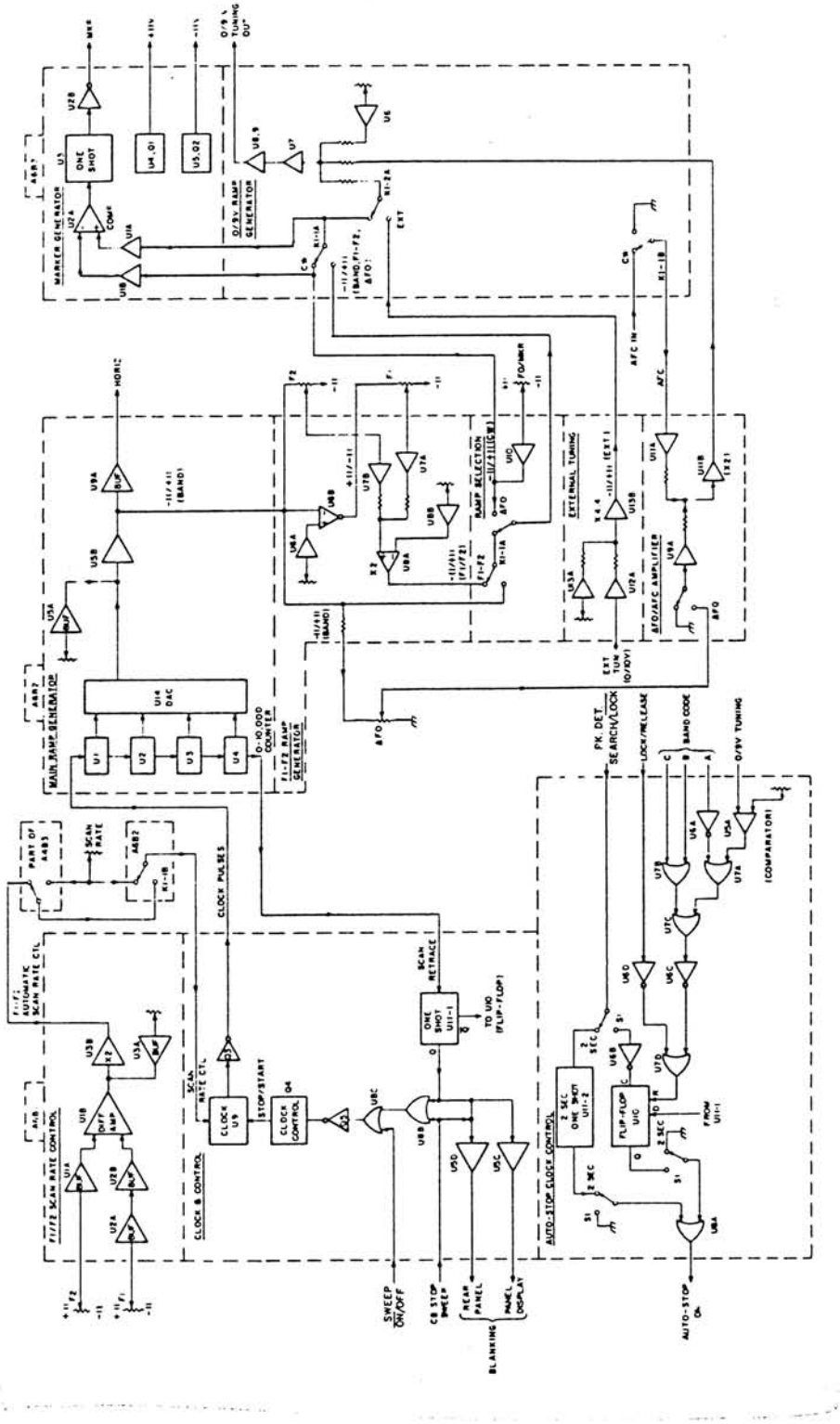


Figure 4.4. MSR-904A, Tuning Generator, A6
Block Diagram 92D60-060

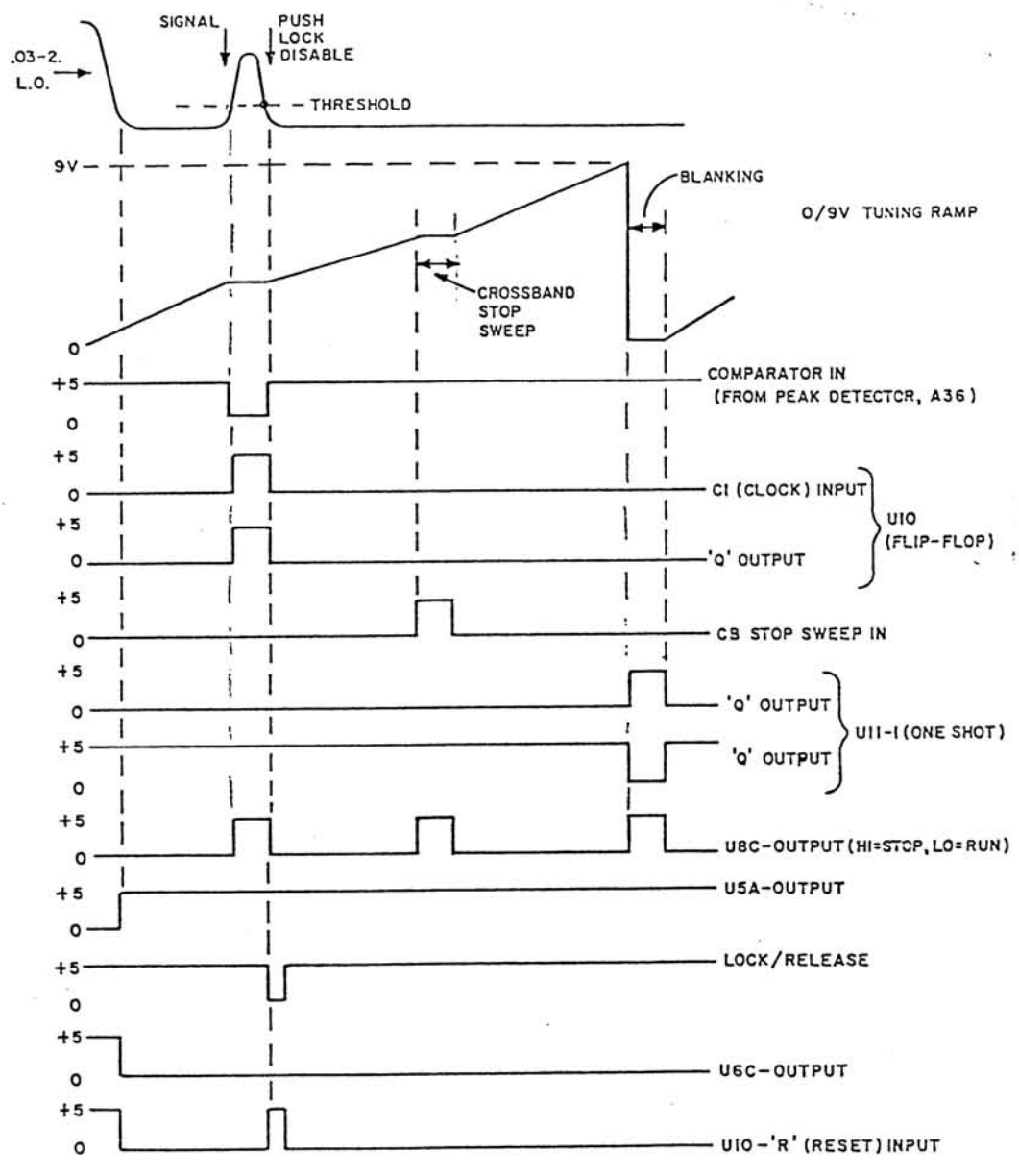


Figure 4.5. Voltage Waveforms, A6B1

oscillator and filter to settle, before starting to scan the band.

Auto-Stop mode: when the AUTO-STOP pushbutton at the front panel is illuminated, the output of U8A is connected to the "SWEEP ON/OFF" input of U8C, through circuitry in assembly A11. If a signal is present and the threshold control is set to a level lower than the signal amplitude, peak detector A36 generates a "low" voltage applied at "COMP IN" which is applied to the clock input C1 of flip-flop U10 through inverter U6B. This produces a "high" at the "Q" output of U10 and at the output of U8C, thus stopping the clock. To re-start the scan, the "Lock/ Release" button at the front panel is momentarily depressed, applying a "low" voltage to U6D and a "high" voltage to the RESET input of U10, thus starting the clock. Switch S1 selects one of the two modes of operation of the "Auto-Stop" feature as described in section 3.4.8. To obtain a 2 second stop and automatically resume the search, the peak detector input is routed to a 2 second one-shot (U11-2), which applies a TTL "high" to U8A and U8C, stopping the clock for 2 seconds, then allowing it to continue the search.

Local oscillator leakage in the 0.03-2 band (if option 3 is present): band 0.03-2 is obtained by up-conversion of the 0.03-2 signal to an IF frequency of 2.33 GHz. The YIG oscillator varies from 2.36 to 4.33 GHz, generating an apparent large signal at the beginning of the band. To prevent the receiver from stopping at that point, in the Auto-Stop mode of operation, comparator U5A is held "low" at the beginning of the scan. This voltage is combined, through "OR" gates U7A, U7B and U7C, with the 0.03-2 band code (100) producing a "high" at the output of U6C and at the "reset" input of U10, holding the output of U10 low while scanning that small portion of the band.

4.9.2 A6B2, RAMP GENERATOR

Refer to Figure 4.4.

Counter U1,2,3,4 receives clock pulses from A6B1 which are applied to D-A converter U14. A -10/0V ramp is generated, offset and buffered by U5 to become the main -11/+11V tuning ramp (BAND mode).

The F1/F2 mode ramp is generated as follows: the -11/+11 ramp is applied to potentiometer F2 in the front panel, inverted by U6B and applied to potentiometer F1. The wiper of pots F1 and F2 are summed and offset at U8A generating a ramp of variable end points. Its maximum excursion is -11/+11, when F1 is fully CCW and F2 fully CW, thus covering an entire band. If F1 is rotated, CW the lower limit is raised; if F2 is rotated CCW the upper limit is lowered, to cover less than an entire band. It is possible, but not advisable, to completely reverse the sweep.

Analog switch U15 selects the appropriate -11/+11 voltage to be applied to assembly A6B3 in BAND, F1-F2 and ΔF0 modes. In the ΔF0 mode a dc voltage generated at the front panel potentiometer F0/MKR is buffered by U10 and applied to assembly A6B3, where it is added to a small portion of the main tuning ramp (refer to section 4.9.3).

The -11/+11V main ramp is applied to the ΔF0 potentiometer on the front panel to generate a small, variable amplitude ramp which is added to a dc voltage in A6B3 to scan a $\pm$5% region of the spectrum in the ΔF0 mode. This voltage is summed to the AFC voltage in

U11B and applied to assembly A6B3.

An external tuning voltage of 0/10V is offset and shaped by U12 and U13 to provide a -11/+11 voltage, also applied to assembly A6B3.

4.9.3 A6B3, 0/9V RAMP GENERATOR

Refer to Figure 4.4.

Assembly A6B3 transforms the -11/+11V ramp into a 0/9V tuning voltage, utilized throughout the receiver for tracking YIG filters and oscillators. This voltage is also applied, in balanced form, to the FE-904 Frequency Extender.

Analog switches U10 and U11 select the appropriate -11/+11V signal to be transformed into a 0/9V signal, in BAND, F1/F2, ΔFO, CW or EXT modes of operation. This -11/+11 voltage is summed with an offset voltage (U6) and the FO/AFC voltage in amplifier U7. U8 and U9 form a low-noise, high-current buffer for the 0/9V tuning voltage.

The -11/+11V generated by the FO/MKR potentiometer on the front panel is compared by U2A to the main tuning ramp. When the ramp exceeds the voltage set by FO/MKR the output of U2A goes "high"; a 3 msec. marker pulse is then generated by one-shot U3 and inverted by U2B. This negative-going marker is added to the AM video output in assembly A11 to display, in the BAND and F1-F2 modes, the position of the FO/MKR control.

Precision ±11V dc voltages are generated by U4, U5, Q1 and Q2, for utilization in several sub-assemblies.

4.10 A7B1, OSCILLATOR/FILTER TRACKING

Refer to schematic diagram 92R71-021 in section 7.0.

Assembly A7B1 contains resistive dividers producing the tuning voltages for the YIG oscillators and filters in the RF Tuner A8. A +11V precision voltage produces a fixed dc voltage utilized to tune the low end of each band (1 LO - 5 LO, oscillators and filters). The 0/9V tuning ramp produces a ramp utilied to tune each band from the low end to the high end (1 HI - 5 HI, oscillators and filters). Multiplexers U1 through U4 select the appropriate voltages. Low and high voltages are added together and the resulting voltage is multiplied by two in U6 (oscillator) and U7 (filter).

Multiplexer U5 selects the appropriate feedback voltage generated across the YIG sample resistor by the tuning current. Refer to Figure 4.6, simplified diagram of YIG tracking and driver, which is applicable for oscillators or filters.

4.11 A7B3, YIG DRIVERS

Refer to schematic diagram 92R73-022 in section 7.0.

Assembly A7B3 contains two identical YIG driver circuits, for oscillator and filter. The drivers consist of a low-noise operational amplifier and a current amplifier capable of delivering in excess of 1A to the YIG coils.

The YIG oscillator driver contains a relay (K1) and tantalum capacitor (C5) to reduce the bandwidth of the operational amplifier in the CW mode, thus reducing incidental FM.

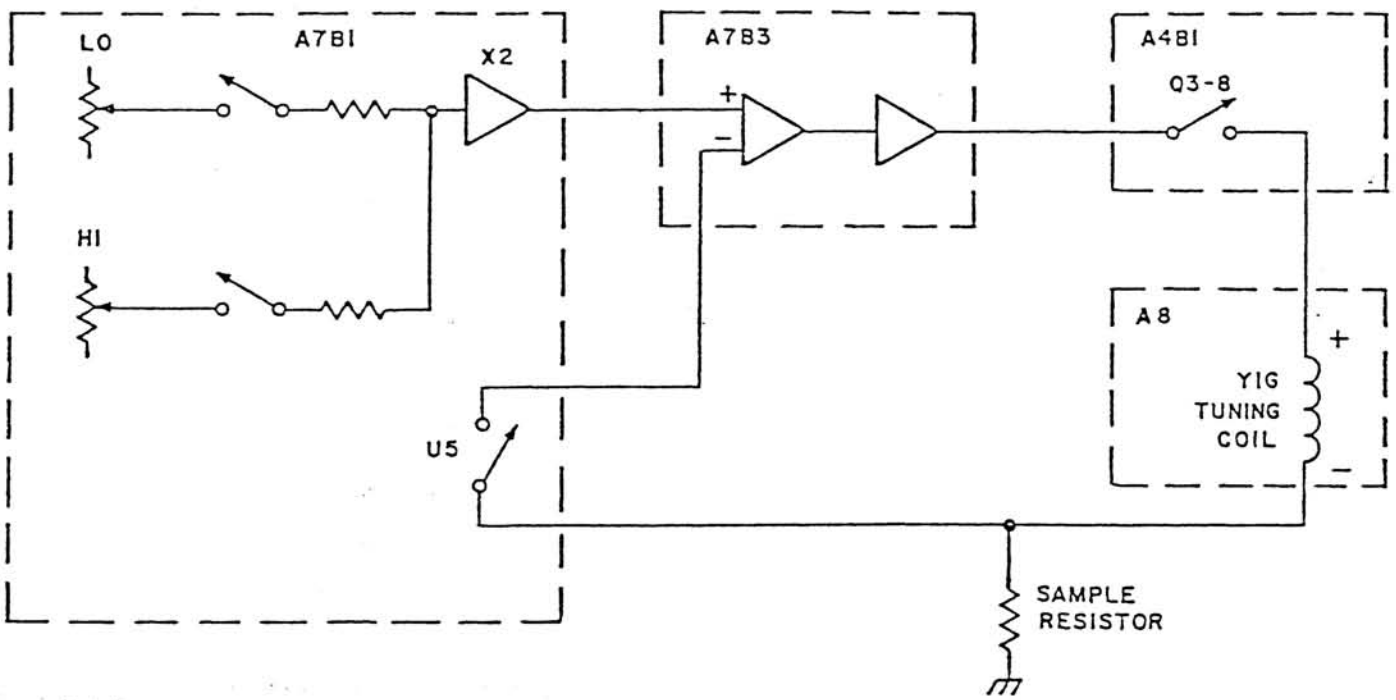


Figure 4.6. YIG Tracking and Driver Simplified Diagram

4.12 A8, RF TUNER

Refer to Figure 4.7 and schematic diagram 92R80-023 in section 7.0.

RF signals enter the receiver through the antenna jacks (0.03-2 or 2-18 GHz) and are applied to YIG filters (FL43, 44) which reject undesired signals and reduce local oscillator radiation from the antenna terminals. In the 2-18 GHz range, the filtered signal enters a double-balanced mixer (Z4) where it is combined with a local oscillator signal forming an intermediate frequency of 250 MHz, which is amplified by low-noise amplifier A8B1. The local oscillator signal is derived from one of two YIG oscillators (Y1, Y3) which are automatically tracked with the YIG filter; oscillator frequency is 250 MHz above the received frequency. PIN switch Z3 selects one of the two YIG oscillators and applies it to the LO port of mixer Z4.

In the 0.03-2 GHz range signals below 500 MHz are applied around YIG filter FL44 by PIN switches Z6 and Z7, which are only present with Option 3 (0.03-0.5 GHz coverage). Signals in the range of 0.5-2 GHz are filtered by FL44. Low-pass filter FL40 reduces local oscillator radiation from the antenna terminal. The signal is then amplified by A8B4, which is a 0.03-2 GHz, 9 dB gain amplifier, and applied to mixer Z1 to form an intermediate frequency of 2.33 GHz. The local oscillator signal is derived from YIG oscillator Y1, through coupler DC1; oscillator frequency is 2.330 GHz above the received frequency. The IF signal is filtered by FL41 and converted down to 250 MHz in assembly A8B6, which consists of two amplifiers and one mixer, as illustrated in schematic diagram 92B86-036. Local oscillator signal is derived from oscillator Y4, at a fixed frequency of 2.58 GHz.

Optional components are indicated in dashed lines in schematic 92R80-023.

OPTION 2 (LO Sample) - directional coupler DC2 is inserted between LO switch Z3 and mixer Z4. The 10 dB coupled output of DC2 is applied through PIN switch Z5 to the "LO OUT" jack of the RF Tuner. Switch Z5 selects an LO Sample from the Tuner A8 or from the external FE-904 Frequency Extender to provide a single LO output to a counter or frequency synthesizer.

OPTION 3 (0.03-0.5 GHz Coverage) - PIN switches Z6, Z7 and amplifier A8B2 are inserted before and after YIG filter FL44 to by-pass this filter when the receiver is tuned below 0.5 GHz. Amplifier A8B2 has a gain of 9 dB and covers the range 0.03-2 GHz.

Auxiliary assembly A8B11 (refer to schematic diagram 92R811-024) contains limiting resistors for all PIN switch drivers, plus an FM coil driver (U1) and a 5 MHz reference signal buffer (U2). U1 receives a low-frequency signal from the FS-1000 Frequency Synthesizer to phase-lock YIG oscillators Y1 and Y3 to the reference oscillator in the synthesizer. Transistor Q1 is driven by the logic signal described in section 4.7. (assembly A4B5): when "SYNTH" and "REMOTE" are selected, the "PHASE-LOCK" signal is allowed to drive U1; in any other combination the input of U1 is essentially shorted to ground preventing spurious signals from driving the YIG oscillator's FM coils.

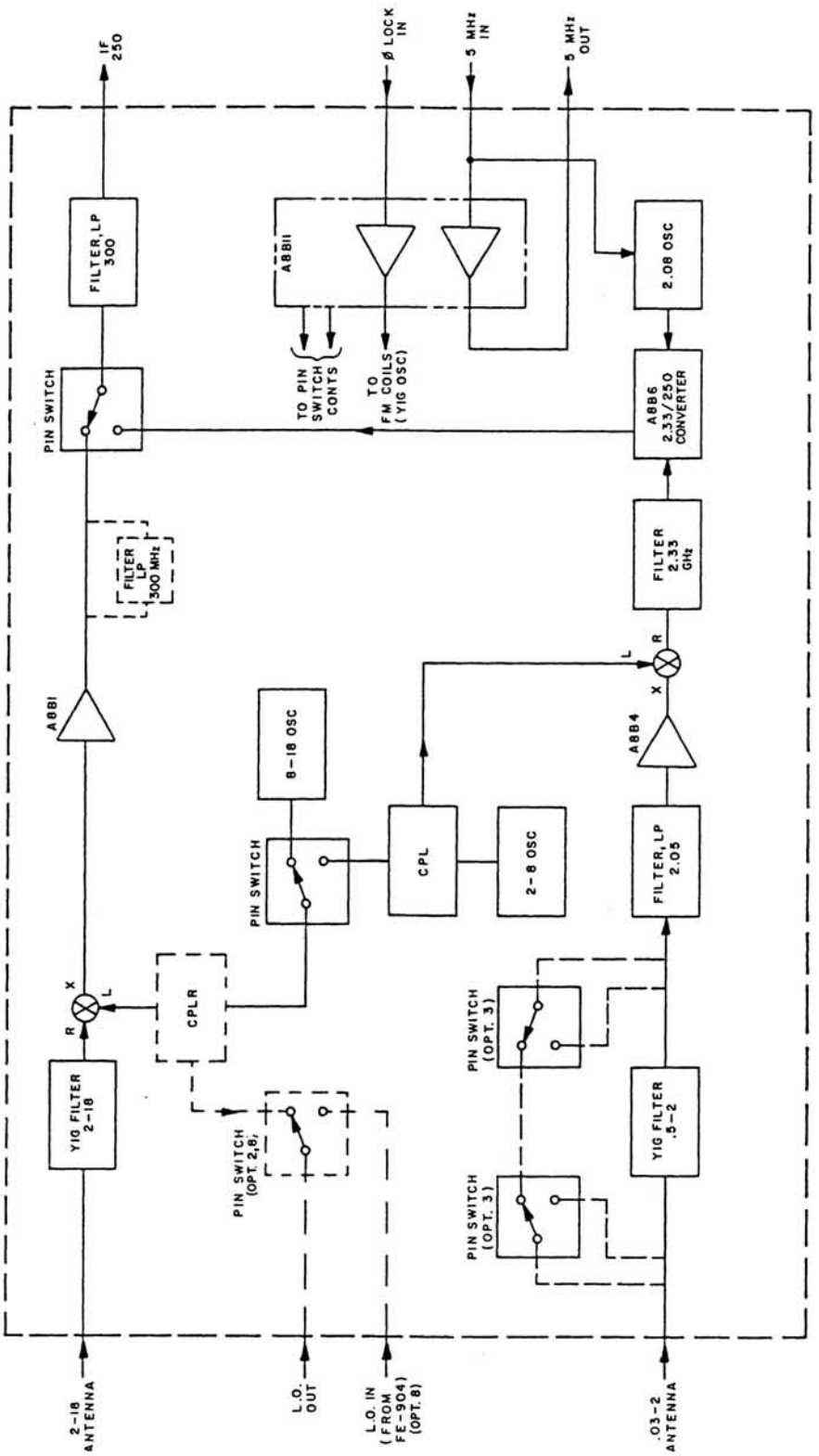


Figure 4.7. MSR-904A, RF Tuner, A8
Simplified Block Diagram 92B80-054

4.13 A10, PAN DISPLAY

Refer to schematic diagram 92R100-026 in section 7.0. The oscilloscope consists of two PC boards and contains its own power supply.

4.13.1 A10B1, HORIZONTAL AND VERTICAL AMPLIFIERS

This PC board contains horizontal and vertical differential amplifiers to drive the deflection coils of CRT V1, plus a vertical preamplifier U6.

Each differential amplifier consists of a differential pair (Q12 and Q14 for the vertical), driven by emitter followers (Q11 and Q15) and a current source (Q13). The amplitude of the vertical input signal is controlled by potentiometer R2 (V. GAIN) at the front panel. Horizontal amplitude is adjusted within A10B1 by means of R54.

Vertical and horizontal positioning are also front panel controlled via potentiometers R3 (HOR POS) and R1 (VERT POS).

4.13.2 A10B2, HIGH VOLTAGE POWER SUPPLY

Refer to Figure 4.8.

Clock U1 generates negative-going pulses at a rate of approximately 40 kHz; these pulses are applied to "D" flip-flop U2 which generates two out-of-phase square waves, at a rate of 20 kHz, at output pins 1 and 2.

The two outputs of U2 are applied to dual one-shot U13 which generates a negative-going pulse (output pins 4 and 12) every time the input waveform switches from low to high.

The two outputs of U3 are applied to "AND" gates U4, as well as the outputs of U2, thus generating positive going pulses, at a 20 kHz rate, out-of-phase by approximately one half-period. The outputs of U4 (pins 6 and 11) drive transistors Q1 through Q4, which in turn drive transformer T1.

The alternating voltage applied to transformer T1 is rectified and filtered at two of the secondaries providing -1000 Vdc to the CRT and +100V to the collectors of the vertical and horizontal differential amplifiers in assembly A10B1.

The blanking signal generated by the receiver turns "on" photo-transistor U5. 0 Vdc turns U5 "on" and unblanks the CRT by applying the high voltage between cathode and grid.

Focus and intensity controls are front panel controlled. Astigmatism and trace rotation are adjusted via R16 and R48 on this PC board.

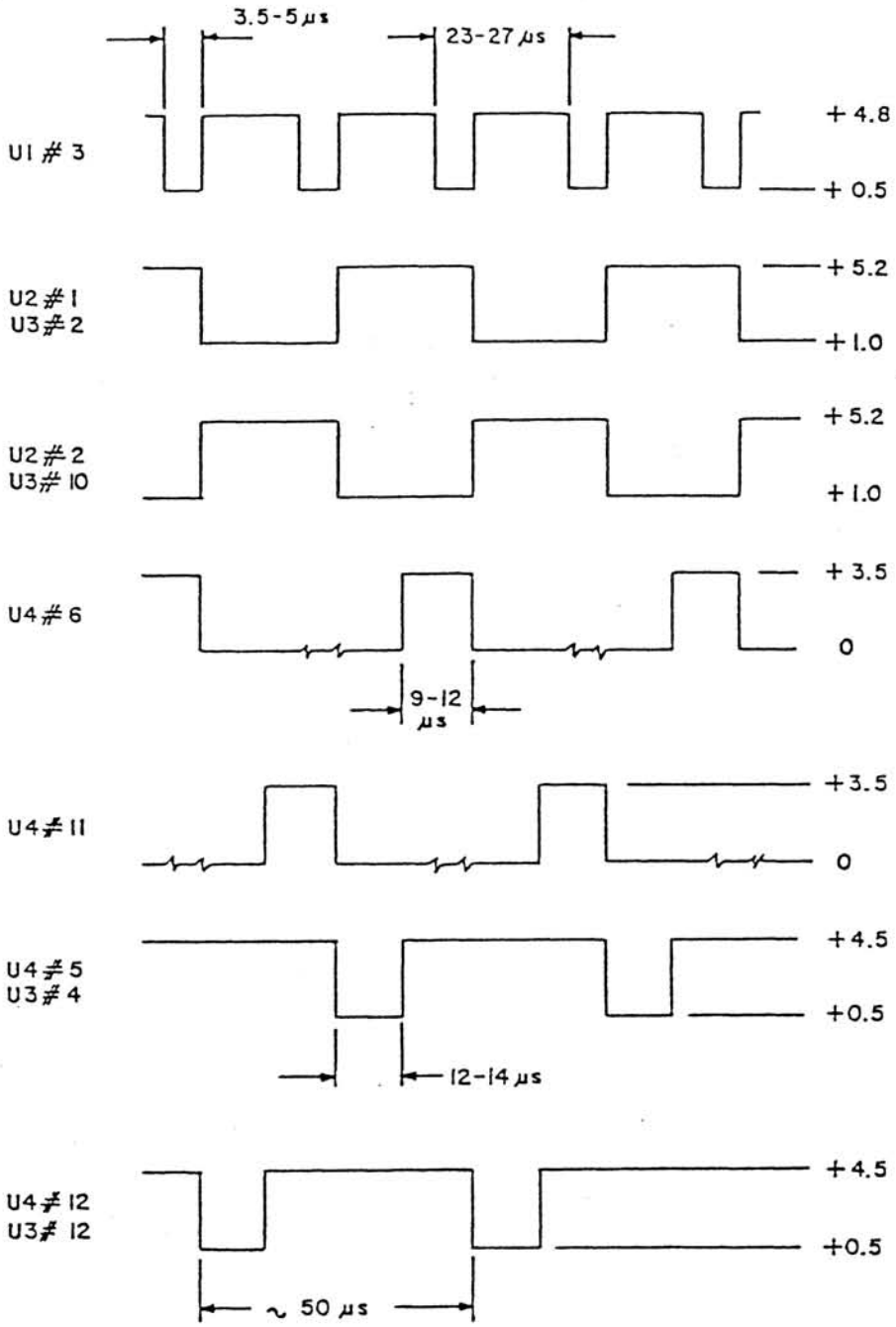


Figure 4.8. High Voltage Power Supply, A10B2 Voltage Waveforms

4.14 A11, FUNCTION SELECTOR

This assembly consists of four PC boards, plugged into each other and mounted to the front panel. They provide the logic and display functions necessary to switch mode, band, IF bandwidth and other features, either locally or remotely. Refer to interconnection diagram 92A110-004 which illustrates the interconnecting plugs between boards.

4.14.1 A11B1, GRAPH DISPLAY

Refer to schematic diagram 92R111-027 in section 7.0.

This PC board contains two 10-element bar-graph displays (DS1 and DS2) to provide relative amplitude and tuning displays. DS1 (signal strength) is driven by a logarithmic display driver, U2. DS2 (tuning) is driven by a linear display driver, U1.

Input signal to U2 (signal strength) is the AM video signal filtered via R10 and C1 and buffered via U1A in assembly A11B3. It reaches U2 in A11B1 through P2 pin 9 and P1 pin 4. The AM video signal is offset by R13 and buffer U1B in A11B3.

Input signal to U1 (tuning) is the FM video signal, amplified via U2A and limited by D1 and D2 in assembly A11B3. R22 and buffer U2B provide an offset to this signal, which reaches U1 in A11B1 through P2 pin 8 and P1 pin 3.

4.14.2 A11B2, KEYBOARD

Refer to schematic diagram 92R112-028 in section 7.0 and to Figure 4.9. This PC board contains all the pushbuttons necessary to select mode, band, IF bandwidth, video display, marker, AFC, video filter, F1/F2/F0 DVM display, remote operation plus optional functions auto-stop, lock disable IF reference (option 6) and 21.4 MHz AGC. Each pushbutton contains a high-efficiency light-emitting diode (LED) which illuminates indicating the function selected.

Operation of integrated circuits U1 and U2 is described in section 4.14.3 below.

4.14.3 A11B3 and A11B4 LOGIC BOARDS

Refer to schematic diagrams 92R113-029, 92R114-030 in section 7.0 and Figure 4.9. These two PC boards contain all the logic necessary to encode the pushbutton information into "BCD" and "1 of N" codes for the several functions of the MSR-904A. They also provide switching between "local" (push buttons operated through the front panel) and "remote" mode (parallel BCD codes entering the MSR-904A via the rear panel "REMOTE CONTROL" connector).

Circuitry to obtain "BCD" and "1 of N" codes for mode, band, IF bandwidth and F1/F2/F0 functions is very similar. Band encoding is described below. When one of the eight pushbuttons which select a band of operation is depressed, a +5V is applied to encoder U1 in A11B2, generating the appropriate BCD code. A change of any of these lines is detected by "OR" gate U7, applying a positive going signal to the clock input of flip-flop U16. The input code to U16 is then transferred to the output and latched. 4-channel multiplexer U6 selects local or remote BCD code; U17 switches in a sequential BCD code when the "crossband" (.5-18 or .03-18) mode of operation is selected. This sequential code is generated by assembly A4B3 (section 4.5) and allows the receiver to scan all five bands in succession, up to 18 GHz. The resulting "BCD" code is applied to

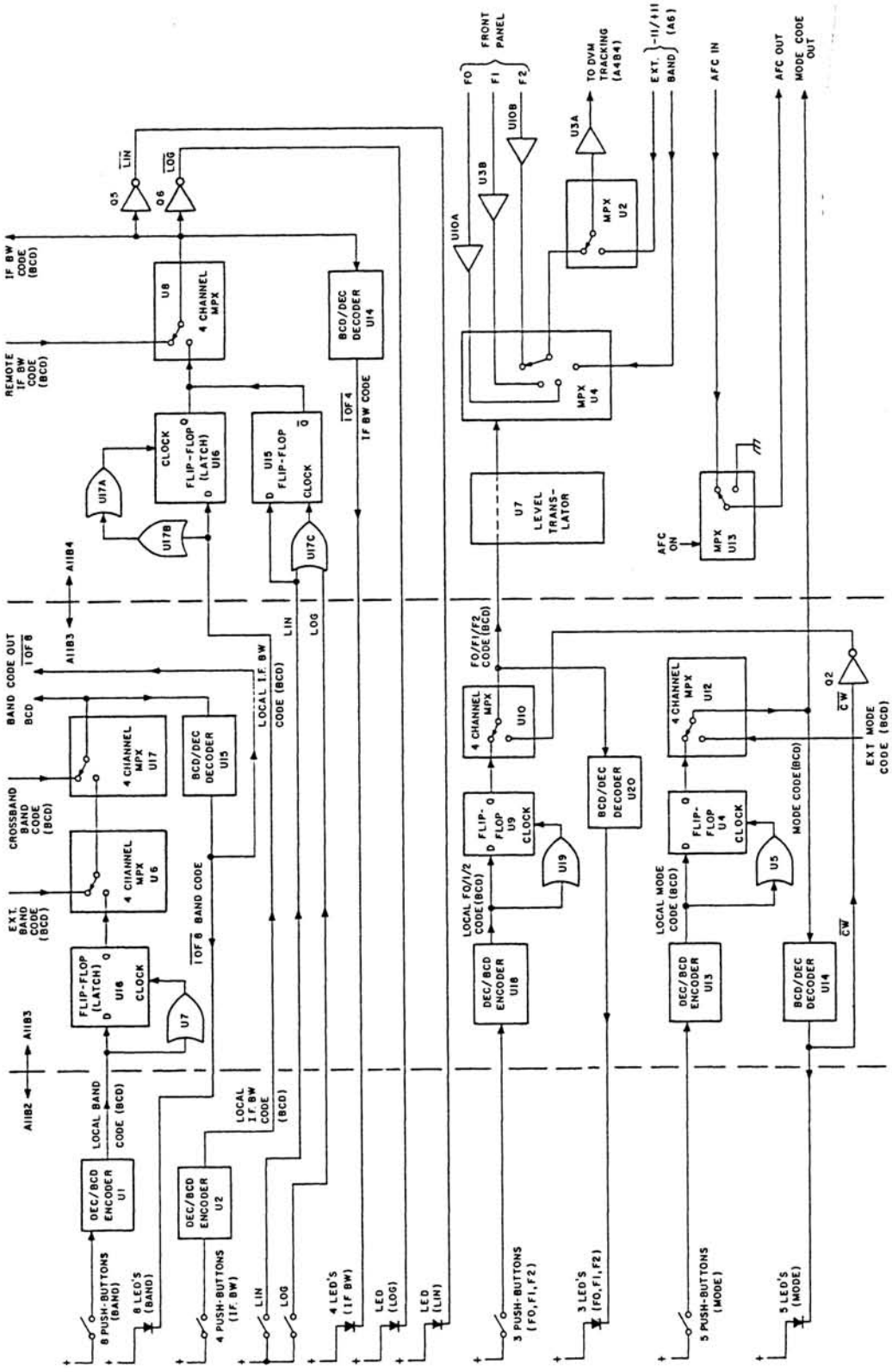


Figure 4.9. Function Selector, A11
Simplified Block Diagram 92B110-061

decoder U15 which generates a "1 of 8" code driving the appropriate LED on the display board A11B2, and other circuitry in the receiver.

BCD codes for band and IF bandwidth are listed in Tables 4.1 and 4.2 of this manual. The code for mode selection is listed in Table 5.4.

F_0/F1/F2 logic is similar to that described above, utilizing encoder U18, flip-flop U9, "OR" gate U19, multiplexer U10 and decoder U20. Multiplexer U10 is controlled by the CW "1 of 5" mode code. When "CW" mode is selected, U10 switches to apply the F0 code (100) to the output. F1 and F2 cannot be selected in the "CW" mode.

Multiplexers U2 and U4 in A11B4 select the appropriate voltage to be applied to the DVM tracking board A4B4 (section 4.6). -11/+11V voltages generated at the wiper of the front panel potentiometers labeled F0/MKR, F1 and F2 are divided by two, buffered by U10A, U3B and U10B and selected by U4. If the auto-stop mode is selected, the -11/+11V ramp generated in the tuning generator A6 is divided by two and switched through U4 to U2. In this mode the DVM reading follows the tuning, and displays the correct frequency when a signal crosses the threshold and the scan stops.

The -11/+11V external signal is also divided by 2 and selected by U2. Amplifier U3A doubles the signal to restore the -11/+11V signal needed by the DVM tracking board A4B4.

AFC control is switched by U13. The AFC control is enabled by U13 when the AFC switch is depressed.

Auxiliary functions in A11B3, not shown in the simplified block diagram (Figure 4.9) are:

a. U11 enables the marker pulse in the BAND and F_1/F_2 modes (codes numbers 1 and 2 from Table 4.3 are applied to the logic inputs A and B). The "inhibit" input of U11 is driven high when the MARKER switch on the front panel is depressed, allowing the marker pulse to be selected in the BAND and F1/F2 modes.

b. U13 enables the AGC function in assembly A4B2 (IF Bandwidth Control). Refer to section 4.4 of this manual.

c. U8 provides enabling function to remotely control band, mode, IF bandwidth and IF attenuator. In local control pin "S" of U8 is low; inputs 1A through 4A are enabled, and held high by RA1; outputs 1y through 4y are applied to:

   pin "S" of U6 in A11B3 (band enable);

   pin "S" of U12 in A11B3 and pin "L" of A4B5 (mode enable);

   pin "7" of A4B2 (IF bandwidth enable);

   pin "11" of A53B1 (IF attenuator enable).

   When the "REMOTE ENABLE" button is depressed, the front panel of the MSR-904A inputs 1B through 4B are enabled in U8 of A11B3, but they are still held "high" by RA1 until the appropriate "remote enable" line is driven "low" by external means (via the REMOTE CONTROL plug on the rear panel). In this manner each function may be independently enabled for remote control.

TABLE 4.3

MODE AND FO/F1/F2 CODES

MODE	A	B	C	CODE NUMBER
BAND	1	0	0	1
F1/F2	0	1	0	2
ΔFO	1	1	0	3
CW	0	0	1	4
EXT	1	1	1	5

FO/F1/F2	A	B	CODE NUMBER
FO	1	0	1
F1	0	1	2
F2	1	1	3

Auxiliary functions in assembly A11B4, not shown in the simplified block diagram, are:

a. Multiplexer U6 selects one of four limiting resistor networks in assembly A6B1 (R23 through R29) for different combinations of BAND and AUTO-STOP functions. These resistors limit the maximum scan rate obtainable with the front panel control, when auto-stop and/or crossband (.03-18) modes are selected.

b. Amplifier U1 provides an adjustable voltage to drive the scan rate potentiometer. This voltage limits the minimmum scan rate to a value of 0.05 to 0.1 Hz.

c. Multiplexer U13 provides a remote enable function, similar to that described for U8 in A11B3, for the IF reference (option 6). Buffer U12A and transistors Q1 to Q4 enable relay K3 and assembly A31 (250 MHz oscillator) when the "IF REF" pushbutton is depressed.

4.15 A12, 21.4 MHz AMPLIFIER

Refer to schematic diagram 92R120-086 in Section 7.0 of this manual.

Assembly A12 provides 50 to 60 dB of gain to the 21.4 MHz output of the 250/21.4 converter, (Assembly A3B8), described in Section 4.2.8.

Amplifiers U1 and U2 are automatically gain-controlled providing a minimum of 50 dB of gain control and maintaining the output at J2 within 2 dB of -20 dBm.

4.16 A13, AUDIO SELECTOR/AMPLIFIER

Refer to schematic diagram 92R130-032 in section 7.0.

Assembly A13 consists of two PC boards: A13B1, audio selector, containing 2 pushbutton switches and mounted to the front panel; and A13B2, audio amplifier, mounted to the right side panel.

When S1 is momentarily depressed, inputs D1 and C1 of U1 are "high", as well as output Q1. When S2 is depressed, only the C1 input of U1 is "high", driving Q1 low and $\overline{Q1}$ high In this manner the LED's in S1 or S2 are illuminated driven by transistors Q1 or Q2.

Output Q1 of U1 drives the "A" input of multiplexer U4, which switches AM or FM audio signals (originating in the IF amplifier A3) to the audio gain control at the front panel. The wiper of the audio gain potentiometer returns to A13B2 for amplification by U3. The output of U3 is connected to the "PHONES" jack on the front panel.

4.17 A31, 250 MHz OSCILLATOR (OPTION 6)

Refer to schematic diagram 92R310-040 in section 7.0.

Assembly A31 is part of Option 6 (IF Reference), to be fully described in section 4.21.

A31 consists of a Colpitts crystal oscillator at 83.333 MHz (Q1, Y1 and associated circuitry). The oscillator signal is tripled in frequency by Q2; the resulting 250 MHz signal is amplified by Q3 and Q4. Diodes D1 and D2 limit the amplitude of the signal providing a stable reference signal at 250 MHz. This signal provides a reference video output which may be utilized to calibrate the MSR-904A, as described in section 4.23.

4.18 A36, PEAK DETECTOR

Refer to schematic diagram 92R360-045 in section 7.0.

AM video is applied through J1 to buffer U1, then through J2 to the rear panel "AM VIDEO" output jack.

The output of buffer U1 is applied to peak detector (U2, U3 and associated circuitry). Capacitor C1 is allowed to charge to the peak of the signal for 10 usec., then is discharged for 1 usec. via R4 and U4. The control voltage to turn U4 on or off is generated in assembly A4B5 (External Control), as described in section 4.7.a. The peak detector output at J3 consists of pulses 10 usec. wide, spaced by 1 usec., even when the input signal is unmodulated. In this manner the peak detector acts as a pulse stretcher when a pulse-modulated signal is received, providing higher intensity display of very narrow pulses.

Comparator U5A supplies a TTL "high" when the signal level is below the threshold set by the front panel control. Its output switches to "low" when a signal crosses the threshold, as illustrated in Figure 4.5. The comparator output is utilized to stop the clock in assembly A6B1 as described in section 4.9.1. Transistor Q1 is enabled if the auto-stop feature is not enabled, effectively disabling comparator U5A in the "high" output state; when the AUTO-STOP button is depressed. Q1 is disabled and the comparator is allowed to operate as described above.

4.19 A52, 250/160 MHz CONVERTER (OPTION 4B)

Refer to schematic diagram 92R520-077 in section 7.0.

The 250/160 converter consists of three separate assemblies, A52B1 through B3, plus oscillator Z2.

4.19.1 A52B1, MIXER

The RF input to this mixer is a 250 MHz signal originating in assembly A3B1 of the IF amplifier A3. It mixes with a 410 MHz local oscillator signal generated by Z2, which is crystal controlled and capable of being phase-locked by an external 5 MHz reference.

4.19.2 A52B2, 5 MHz AMPLIFIER

This assembly provides buffering and a small amount of amplification to the 5 MHz reference signal, which is applied to the MSR-904A by external means (FCS-904 Counter/Synthesizer, for example) to phase-lock the 410 MHz oscillator Z2. The 5 MHz reference is buffered in the RF Tuner A8 via assembly A8B11 (section 4.12).

4.19.3 A52B3, 160 MHz AMPLIFIER

Assembly A52B3 consists of a single amplifier, with a gain of 14 dB and 1 dB compression point of +10 dBm. The output signal is applied to the rear panel via bandpass filter Z1, as illustrated in wiring diagram 92R10-081, sheet 2 of 10.

4.20 A51, 250/70 MHz CONVERTER (OPTION 4C)

Refer to schematic diagram 92B510-095 in section 7.0. The 250/70 MHz Converter subassembly consists of three separate assemblies, A51B1, A51B2 and A51B3, plus oscillator Z2.

4.20.1 A51B1, MIXER

The RF input to this mixer is a 250 MHz signal originating in assembly A3B1 of the IF Amplifier (A3). It mixes

with a 320 MHz local oscillator signal generated via Z2. Z2 is crystal controlled and is capable of being phase-locked via an external 5 MHz reference.

4.20.2 A51B2, 5 MHz AMPLIFIER

This assembly provides buffering and a small amount of amplification to the 5 MHz reference signal. This signal is applied to the MSR-904A via external equipment (FCS-904 Counter/ Synthesizer) to phase-lock the 320 MHz oscillator, Z2. The 5 MHz reference is buffered in the RF Tuner (A8) via assembly A8B11.

4.20.3 A51B3, 70 MHz AMPLIFIER

This assembly consists of an amplifier with a gain of 14 dB and 1 dB compression point of +10 dBm. The output signal is applied to the rear panel via bandpass filter Z1, as illustrated in wiring diagram 92R10-081, sheet 2.

4.21 A53, ATTENUATOR AND CONTROL

Refer to wiring diagram 92R10-003 sheet 1 of 4 and schematic 92R531-051 in section 7.0.

Remotely-controlled IF attenuator A53 is connected in the 250 MHz IF line just prior to the IF amplifier (A3). Therefore all video outputs and the 250 or 160 MHz IF outputs are affected by its setting.

Control of attenuator A53 is accomplished by the circuitry on PC board A53B1, which receives BCD commands from the front panel A1B1A1 assembly (local mode) or through the remote control plug on the rear panel. Two BCD numbers (LSD and MSD) are applied to A53B1 via plug P1. Multiplexers U4 and U5 select local or remote BCD information, as controlled by a TTL level logic signal applied to pin 11 of P1. This logic signal is generated by U8 in A11B3 (section 4.15.3): "low" when the REMOTE ENABLE button on the front panel is illuminated and pin 15 of the REMOTE CONTROL plug on the rear panel is "low" (attenuator remote enable); the logic signal is "high" otherwise, for local operation of the IF attenuator.

The BCD numbers (LSD and MSD) are applied to programmable ROM's U1 and U2 which transform this BCD information into a binary number (0 to 99). Inverter U3 and transistors Q2 through Q8 provide the necessary drive to the attenuator relays. Transistor Q1 is an inverter, similar in function to any of the six inverters in U3.

4.22 OPTION 6, IF REFERENCE

Refer to system wiring diagram 92B10-081, sheet 2 of 10. Option 6 consists of a 250 MHz crystal oscillator, A31, as described in Section 4.17, plus two electronically controlled attenuators, Z6 and Z8. Relay K3, which normally connects the IF signal from A14 to the programmable attenuator A53, enables this 250 MHz reference signal when the "IF REF" push button is depressed.

Attenuators Z6 and Z8 are controlled by potentiometers R9,11,13 and 15 in assembly A4B2 (see schematic diagram 92R42-076). Each potentiometer controls the signal level injected into A53 in one of the four IF bandwidths selected.

SECTION V
ADJUSTMENT AND MAINTENANCE

5.0 ADJUSTMENT AND MAINTENANCE

This section contains instructions for limited corrective maintenance and re-alignment of the MSR-904A Receiver. Procedures, diagrams and tables contained in this section are considered adequate to enable a qualified technician to maintain the receiver in normal operating condition. In some sub-assemblies the actual location of malfunctions, replacement of components and subsequent re-alignment is beyond the scope of this handbook. A note to this effect is present where applicable in this chapter.

Maintenance personnel should be familiar with the material contained in sections 1.0 through 4.0 of this manual prior to attempting repair or adjustment. A good understanding of the simplified block diagrams (Figures 1.3, 4.2, 4.3, 4.4, 4.7 and 4.9), wiring diagram and control functions aid in localizing faults to particular modules. It is suggested that the Theory of Operation (section 4.0) for the suspected faulty module be read before proceeding with the maintenance.

Reference is made to the schematic diagrams in section 7.0, as listed in the table of contents. Most component locations are located in the same drawing as the schematic, or immediately preceding it, as listed in the table of contents. Figures 1-4 and 1-5 aid in locating the sub-assemblies.

Voltage measurements are made with a digital voltmeter with a minimum input impedance of 100K ohms. Waveforms are observed utilizing an oscilloscope with a minimum probe impedance of 1 Megohm and a capacitance of 47pf or less.

Troubleshooting of PC boards A4B1 through A4B4, A6B1 through A6B3 and A7B1 are accomplished utilizing the extender board 79C10-137, supplied with this manual. PC board A4B5 may be lifted with the aid of extender board 82C217, also supplied with this manual.

Any failure in the receiver may be the cause or effect of improper power supply performance; therefore the power supply (A2) should be checked prior to, and following any other procedure.

5.1 A2, POWER SUPPLY

5.1.1 POWER SUPPLY PRELIMINARY CHECK

a. Check the position of the 115/230 switch at the rear panel.

b. Check appropriate fuse for 115 or 230V operation.

c. Remove the receiver's bottom cover.

d. Connect a voltmeter between ground and the following test points, accessible through the power supply cover, near the rear panel.

TEST POINT COLOR	VOLTAGE	TOLERANCE
Red	+12V	±0.1V
Orange	+6V	±0.1V
Green	-15V	±0.1V
Yellow	-12V	±0.1V
Blue	-6V	±0.1V
Violet	-5V	±0.1V

e. Check voltage at distribution points E1 and E4 under the PC bucket assembly. E1 (red/white wires) must have +15 ± 0.2V, E4 (green wires) must have 5V ± 0.1V.

5.1.2 POWER SUPPLY MAINTENANCE

5.1.2.1 PREREGULATOR CHECK

If an abnormal voltage was measured by procedure 5.1.1, a fault probably exists in the power supply. Proceed as follows:

a. De-energize the receiver and remove the power supply from the receiver as follows:
- Set receiver upside-down as shown in Figure 1.4.
- Remove four nuts holding the fan to rear panel.
- Pull the fan assembly back slowly until a 2-pin pendant plug/jack is visible. Then unplug the fan from the power supply.
- Remove six phillips head screws that hold the power supply to the rear panel.
- Remove bracket holding Z1 (if applicable, when Opt. 4B is present.)
- Remove the power supply from the receiver.

b. Reconnect the ac line cord and maintain the 25 pin plug connected to the power supply.

c. Remove the power supply side covers and magnetic shielding.

d. Refer to assembly drawing 92R20-078 in Section 7.0. Connect a X10 scope probe to the collector of one of the two power transistors in A2B4; energize the receiver and observe the waveform shown in Figure 5.1. "Off Time" is approximately 10-15 usec, depending on the loading of the power supply.

e. Verify that the "Off Time" varies when bands "2-4" and "12-18" are selected at the front panel, indicating that the pulse width modulation control is operational.

5.1.2.2 REGULATORS (A2B3)

If the pre-regulator, as tested per 5.1.2.1, is operational but one or more of the regulated voltages, as measured in 5.1.1.d, is not correct, proceed as follows:

a. With the aid of the power supply lay-out (92R20-078, sheet 1 of 3) in section 7.0, locate FL2 and FL7 (or pins 18 and 19 in A2B3).

b. Voltages at FL2 and FL7 should be -18 and +18 Vdc, respectively. If these voltages are correct a problem exists in one of the 4-pin regulators, U5 through U10, in assembly A2B3.

c. If the voltages at FL2 and FL7 are incorrect a problem exists in assembly A2B4, which comprises the high voltage switching transistors Q7 and Q9 bridge rectifiers and filters to generate the pre-regulated +12 and ±18 Vdc.

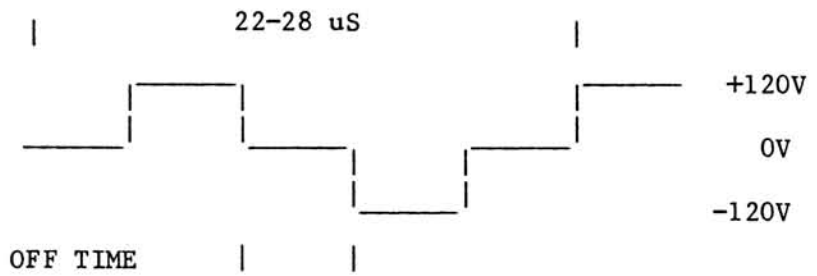


FIGURE 5.1

PULSED WAVEFORM AT COLLECTORS Q7, Q9

5.2 A3, IF ASSEMBLY

5.2.1 PRELIMINARY CHECKS

If a problem is suspected in the IF Assembly A3, utilize Figure 5.2 (flowchart) to perform preliminary checks prior to disassembling. The flowchart describes procedures to locate the fault in the 250 or 21.4 strips, as described in Section 4.2 for the particular combination of IF bandwidths present in the receiver.

CAUTION: A problem in the IF assembly could be caused by a faulty switching in assembly A4B2 (IF Bandwidth Control). Check output voltages in A4B2 according to Table 5.2 before disassembling the IF.

5.2.1.1 IF SENSITIVITY TEST

1) Disconnect the semi-rigid cable from the IF OUT port of the RF Tuner (A8).
2) Inject a 250 MHz signal into the semi-rigid cable.
3) Connect an oscilloscope to the receiver "AM VIDEO" connector on the rear panel.
4) Set the receiver to the "2-4" BAND, "CW" MODE, 30 MHz IF BW, LINEAR VIDEO, IF GAIN fully CW and VIDEO FILTER OFF.
5) Adjust the level of the 250 MHz input signal until the baseline noise begins to increase. The input signal level should be approximately -90 dBm.
6) Reconnect the semi-rigid cable to the IF OUT port on the RF Tuner (A8).

5.2.2 MODULE GAINS

Figure 5.3 provides information on approximate gains of each module. Gain (G) beside each "J" output connector is the gain between the input of the appropriate module and the connector. Some modules have more than one output.

5.2.3 ADJUSTMENTS

5.2.3.1 LINEAR AM VIDEO BASELINE ADJUSTMENT

The AM video offset of the 250 MHz IF strip may be adjusted around 0 Vdc via R11 in A3B5, accessible through a top cover hole.

The AM video offset of the 21.4 MHz IF strip may be adjusted around 0 Vdc via R11 in A3B11, also accessible through a top cover hole. Assembly A3B11 is located in the bottom IF tray. To remove the top tray, loosen the three thrumb screws and remove four phillips head screws attaching the top and bottom layers; then remove the "camloc" receptacle at left side panel, near the rear panel. The top tray may be lifted partway and R11 adjusted with a short screwdriver.

CAUTION: Do not attempt to lift the top tray too much, in order not to deform the semi-rigid coaxial cables interconnecting the top and bottom trays.

5.2.3.2 LOG VIDEO BASELINE ADJUSTMENT

Adjust the log video offset via R25 in A3B7. This pot, accessible through a top cover hole, adjusts the offset in all bandwidths and should be set for the best possible average offset.

5.2.3.3 LOG VIDEO SENSITIVITY and BASELINE NOISE

If the log video baseline noise, as observed with a 20 MHz scope at the rear panel "AM VIDEO" output jack, is too large (more than 0.5V/p-p), or the logarithmic video output has less sensitivity than the liner AM video display, inject a signal through the antenna port of the receiver, select FO mode and tune the receiver to the signal. Adjust the input signal level to 3 to 6 dB above sensitivity, then adjust R6 (250 MHz IF strip) or R7 (21.4 MHz IF strip) to obtain maximum sensitivity and still keep the baseline noise under 0.5V/p-p.

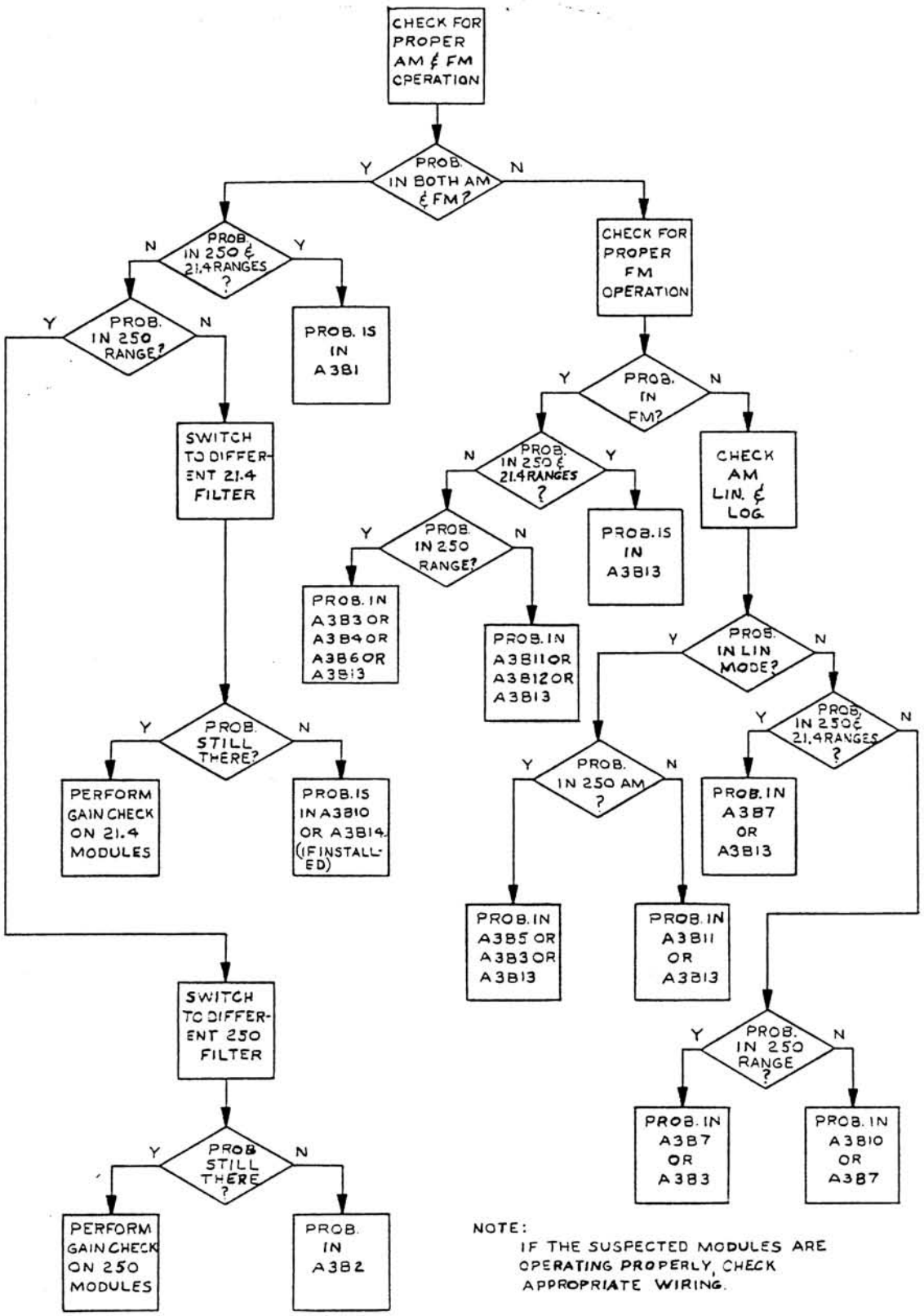


Figure 5.2. IF Preliminary Checks, Flow Chart

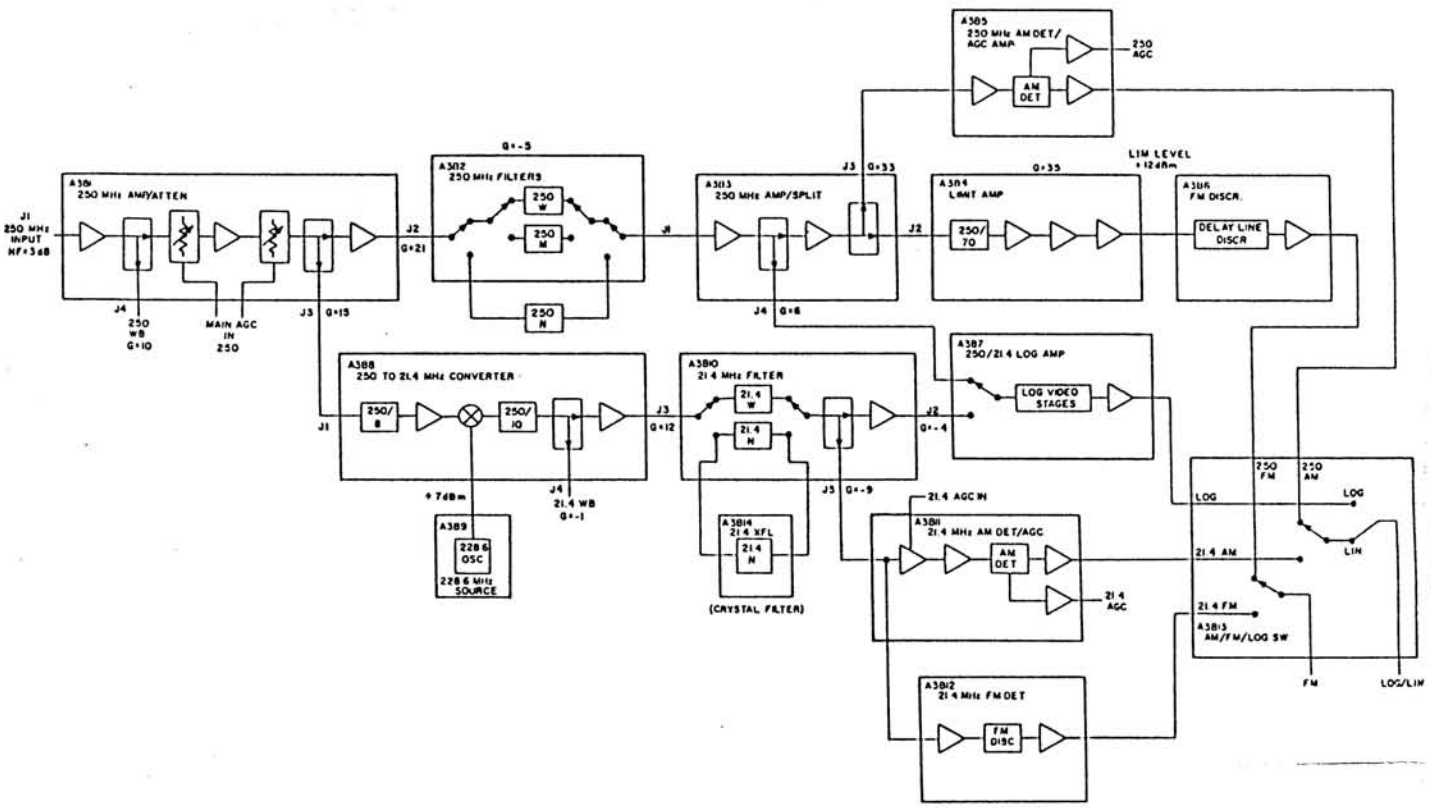


Figure 5.3. IF Gain Chart

5.2.3.4 AGC ADJUSTMENT 250 MHz IF STRIP

1) Disconnect the semi-rigid cable that connects to the IF OUT port on the RF tuner (A8).

2) Into this cable, inject a 250 MHz signal AM modulated at 70%, with a 20 kHz sinewave.

3) Monitor the AM VIDEO OUT (rear of receiver) with external oscilloscope.

4) Set controls on receiver as follows: IF GAIN fully clockwise; CW Mode; any BAND; 250 MHz wide IF BW; LINEAR; LOCAL; VIDEO FILTER OFF.

5) Adjust the RF Level on the 250 MHz source for a 2.0 to 4.0 V/p-p display on the scope. Be sure that the sinewave is not distorted on the top or bottom.

6) Adjust R53 on A4B2 board until the display on the scope just starts to decrease. Back off pot until the display JUST returns to normal.

7) Increae the 250 MHz level to -10dBm. Adjust the IF GAIN at the front panel for an undistorted display on the scope.

8) Energize AGC button. The display should level at approximately the same peak to peak level as in step 7 above.

9) Decrease the 250 MHz level in 10dB steps until the display has dropped to half the original level; note at least a 60 dB difference in RF level from the 250 MHz source.

5.2.3.5 AGC ADJUSTMENT, 21.4 MHz IF STRIP

1) Set up exactly as in steps one through 5 in Section 5.2.3.4 above; set receiver to 21.4 MHz wide bandwidth.

2) Adjust R46 on the A4B2 board for the maximum UNDISTORTED peak to peak signal.

3) Energize AGC button. Set 250 MHz source at -20 dBm.

4) Adjust R47 on A4B2 board for approximately 3V/p-p undistorted display.

5) Decrease the 250 MHz level in 10 dB steps until the display has dropped to about 1.5V/p-p; note at least 60 dB difference in RF level from the 250 MHz source.

5.3 A4B1, BAND CONTROL - MAINTENANCE

This PC board supplies switching voltages to the RF Tuner A8, providing band information. Therefore it should be investigated for problems if one or more, but not all bands, are inoperative.

Refer to schematic diagram 92R41-012 in section 7.0. Table 5.1 contains voltage measurements taken at the output pins of the PC board, in the CW mode, selecting each band in succession, with the FO/MKR dual knob control turned fully counterclockwise.

If a problem is found in one of the outputs, check the logic inputs at pins N and P (BCD Code); 13, 15, 14, 10, K (1 of 8 band code), as described in section 4.3. If all logic inputs are present and the supply voltages (±15, ±5 Vdc) are also present, utilize Figure 4.3 (logic diagram) as a troubleshooting aid.

5.4 A4B2, IF BANDWIDTH CONTROL

If a problem is suspected in the IF Bandwidth Control, measure applicable switching voltages at the points specified in Table 5.2. If the measured voltages are not correct, check the IF bandwidth code input (pins 3,4,5 and 6) according to Table 4.2 in Section 4.0. Tables 5.3 and 5.4 provide a further troubleshooting aid, listing the logic output of programmable ROM, U3. Refer to Section 4.2 for identification of IF bandwidths (21.4N, 21.4W, 250N, 250M and 250W).

TABLE 5.1
A4B1, BAND CONTROL OUTPUT VOLTAGES

BAND	PIN NUMBER													
	3	4	5	6	7	8	17	B	D	E	F	H	S	T
.5-2 (.03-2)	+15	+15	-5	+3.17	+15	-5	2.8	-15	0.5	1.17	+15	-5	0	0
2-4	0	+15	+15	+3.17	-5	-5	2.2	0	0.5	0	+15	-5	0	+.82
4-8	0	+15	+15	+3.17	-5	-5	4.3	0	0.5	0	+15	-5	0	+1.7
8-12	0	0	+15	-5	-5	+3.15	0	0	+15	0	+15	-5	+3.63	+3.45
12-18	0	0	+15	-5	-5	+3.15	0	0	+15	0	+15	-5	+5.44	+5.2
18-26.5 & 26.5-40	0	0	+15	+3.17	+15	+3.15	0	0	0	0	-5	+15	0	0

NOTE

Measurements taken in CW mode, with FO/MKR control turned fully counterclockwise.

TABLE 5.2
A4B2, IF BANDWIDTH CONTROL VOLTAGES

IF BW	PIN NUMBER						
	C	D	2	F	B	A	E
21.4N	0	15	0	12	-15	-15	0
21.4W	0	15	0	12	-15	-15	-15
250M	+15	0	15	0	0	-15	-15
250W	+15	0	15	12	-15	-15	-15
FUNCTION	+15V SW 250	+15V SW 21.4	250/$\overline{21.4}$	$\overline{250MN}$	250M	250N	21.4N

NOTE

All above measurements are in the "LIN" mode. Pins P and R contain "LOG" information. P is low, R is +6Vdc in the "LOG" mode.

TABLE 5.3
PROM (U2) LOGIC

Combination of two 250 MHz and two 21.4 MHz filters.

L/R	VIDEO	IF BW	INPUTS					OUTPUTS			
			A0	A1	A2	A3	A4	D1	D2	D3	D4
LOCAL	LIN	21.4N	0	0	0	1	0	0	1	1	0
		21.4W	1	0	0	1	0	0	1	1	1
		250M	0	1	0	1	0	1	1	0	1
		250W	1	1	0	1	0	1	1	1	1
	LOG	21.4N	0	0	1	1	0	0	1	1	0
		21.4W	1	0	1	1	0	0	1	1	1
		250M	0	1	1	1	0	1	1	0	1
		250W	1	1	1	1	0	1	1	0	1
REMOTE	LIN	21.4N	0	0	0	0	0	0	1	1	0
		21.4W	1	0	0	0	0	0	1	1	1
		250M	0	1	0	0	0	1	1	0	1
		250W	1	1	0	0	0	1	1	1	1
	LOG	21.4N	0	0	1	0	0	0	1	1	0
		21.4W	1	0	1	0	0	1	1	1	1
		250M	0	1	1	0	0	1	1	0	1
		250W	1	1	1	0	0	1	1	0	1

TABLE 5.3
PROM (U2) LOGIC

Combination of three 250 MHz and one 21.4 MHz filters.

L/R	VIDEO	IF BW	INPUTS					OUTPUTS			
			A0	A1	A2	A3	A4	D1	D2	D3	D4
LOCAL	LIN	21.4	0	0	0	1	1	0	1	1	1
		250N	1	0	0	1	1	1	0	1	1
		250M	0	1	0	1	1	1	1	0	1
		250W	1	1	0	1	1	1	1	1	1
	LOG	21.4	0	0	1	1	1	0	1	1	1
		250N	1	0	1	1	1	1	0	1	1
		250M	0	1	1	1	1	1	1	0	1
		250W	1	1	1	1	1	1	1	1	1
REMOTE	LIN	21.4	0	0	0	0	1	0	1	1	1
		250N	1	0	0	0	1	1	0	1	1
		250M	0	1	0	0	1	1	1	0	1
		250W	1	1	0	0	1	1	1	1	1
	LOG	21.4	0	0	1	0	1	0	1	1	1
		250N	1	0	1	0	1	1	0	1	1
		250M	0	1	1	0	1	1	1	0	1
		250W	1	1	1	0	1	1	1	1	1

5.5 A4B3, CROSSBAND SWITCHING

Most of the circuitry in this board is only operational in the cross-band mode (0.5-18 or 0.03-18), therefore no troubleshooting should be attempted if the receiver operates normally when octave bands are selected. Exceptions to the above statement are:

a. Multiplexer U11 provides scan rate control switching in the F1-F2 mode as listed in Table 5.4. The scan rate control voltage is applied to VCO U9 in assembly A6B1, as described in section 5.9.

b. Unbalanced-to-balanced tuning voltage buffers U12 and U13, which provide a 0 to 9V balanced tuning voltage to the FE-904 Frequency Extender. In the CW mode the voltage between pins 4 and C, as measured with a DVM insulated from ground, should vary between 0 and 9 Vdc as the FO/MKR dual knob control is rotated. This voltage should be equal to the voltage at pin 6, as measured between pin 6 and ground, and may be adjusted via of R54.

5.5.1 LOGIC TESTS

If a problem is suspected in the "CROSSBAND" mode (0.03-18 or 0.5-18 GHz), proceed as follows:

1. Check supply voltage inputs to A4B3:

Pin U at +5V	Pin F at +6V
Pin V at +11V	Pin 18 at +15V
Pin 8 at -11V	Pin A at -12V

2. Check voltages at pins 5, 7, 9 and 11 of U1: 6, 4, 2 and 1 Vdc, approximately. Voltage at pins 4, 6, 8 or 10 should vary from 0 to +9 Vdc when the FO/MKR control is rotated, in the CW mode.

3. Check logic voltages at U2 and U3 according to Table 5.5, with the following front panel settings:

BAND	0.03-18 (or 0.5-18)
MODE	CW
FO/MKR	Rotated from fully counterclockwise.

   Verify that "BAND" LED's labeled 0.03-2 (or 0.5-2), 2-4, 4-8, 8-12 and 12-18 illuminate in succession when the FO/MKR dual control is rotated.

TABLE 5.4
MODE SELECTION OF SCAN RATE CONTROL

MODE	BAND	A6B2-4	U11-9 (A4B3)	SCAN RATE CONTROL AT A6B1-8
F1-F2	0.03-18	LO	LO	Automatically controlled by F1-F2 settings
	Any Octave	LO	HI	
BAND, ΔFO	0.03-18	HI	LO	+11 to +7V, controlled by "SCAN RATE" Pot at front panel
	Any Octave	HI	HI	

TABLE 5.5
LOGIC VOLTAGES AT U2, U3

BAND	U2							U3		
LED ON	D3	D4	D5	D6	Q0	Q1	Q2	2	4	6
.03-2	1	1	1	1	0	1	1	1	0	0
2-4	1	1	1	0	1	0	1	0	1	0
4-8	1	1	0	0	0	0	1	1	1	0
8-12	1	0	0	0	1	1	0	0	0	1
12-18	0	0	0	0	0	1	0	1	0	1

TABLE 5.6
A4B3 CROSSBAND ALIGNMENT

BAND	LOW END	HIGH END
(0.03-2 with Opt. 3) 0.5-2	R26	R45
2-4	R34	R47
4-8	R32	R49
8-12	R30	R51
12-18	R28	R53

NOTE: Low and High end pots could be interactive; more than one adjustment might be necessary.

5.5.2 CROSSBAND RE-ALIGNMENT

Operation in the crossband mode is described in section 3.4.9 of this manual, if an external monitor is utilized. A crossband display may also be obtained at the front panel pan display, or by utilizing an external oscilloscope connected to the "BLANK", "HOR" and "AM VIDEO" output jacks on the rear panel. In these last two types of display, full receiver coverage is displayed in one horizontal line, without the vertical steps and horizontal return obtainable by utilizing the external monitor; therefore the frequency resolution is much poorer, but sufficient to re-align the receiver if necessary.

If the band coverage is correct when octave bands are selected, but not correct in the crossband mode (0.5-18 or 0.03-18), proceed as follows:

1. Set band to "0.5-18" (or 0.03-18), mode to "BAND", IF bandwidth to "30 MHz", "LINEAR" video.

2. Insert signals of known frequency accuracy at the low and high end of each band and adjust potentiometers on A4B3 as listed in Table 5.6. Bands are displayed in succession as described in the first paragraph of this section.

3. CAUTION: ANTENNA INPUTS ARE DIFFERENT FOR THE 0.5-2 BAND AND FOR THE UPPER BANDS (2-18).

5.6 A4B4, METER TRACKING BOARD

Alignment and repair of this board is done in the "CW" mode, with all other PC boards in place.

5.6.1 ALIGNMENT

If Option 2 (LO Sample) is installed in the receiver, connect a frequency counter to the "LO OUT" jack on the rear panel and adjust potentiometers in A4B4 according to Table 5.7. In each band, rotate the FO/MKR dual-tuning knob to obtain the LO frequency listed, then adjust the corresponding potentiometer to obtain the DVM reading, listed in the third column, on the front panel. The "FO" pushbutton must be illuminated.

If option 2 is not installed, insert a signal of known frequency accuracy at the appropriate antenna terminal and tune the receiver to it, selecting a "1.0 MHz" IF bandwidth, "LINEAR" mode. Reduce input signal level to prevent video saturation, in order to obtain a sharp peak when tuning. Then adjust potentiometers as listed in Table 5.7. DVM reading and input frequency are listed in the same column. The "FO" pushbutton must be illuminated.

CAUTION:

1. Always adjust the "LO" potentiometer first, if needed. The "LO" pot affects both low and high readings of the DVM, in the band selected.

2. Always adjust band "0.5-2" (".03-2" if option 3 is present) first, if needed. Adjustment of "1 LO" and "1 HI" pots affect all other (upper) bands.

The 0 to +10V analog output at pin 30 of the "REMOTE CONTROL" plug on the rear panel is adjusted via R30 on A4B4: set FO/MKR control to obtain +9V at pin R, then adjust R30 to obtain +10V at pin 18 of A4B4.

5.6.2 MAINTENANCE

If a problem is suspected in the DVM tracking board (A4B4), first verify that the receiver's band coverage is correct. Then check the voltage at pin V of A4B4; it should be approximately one-half of the frequency display reading.

TABLE 5.7

DVM FREQUENCY DISPLAY ADJUSTMENT

BAND	LO FREQUENCY (Option 2)	INPUT FREQUENCY (if no option 2) & DVM READING	ADJUST POT
.5-2 (standard)	2.830	0.500	1 LO
	4.330	2.000	1 HI
0.03-2 (option 3)	2.360	0.030	1 LO
	4.330	2.000	1 HI
2-4	2.250	2.000	2 LO
	4.250	4.000	2 HI
4-8	4.250	4.000	3 LO
	8.250	8.000	3 HI
8-12	8.250	8.000	4 LO
	12.250	12.000	4 HI
12-18	12.250	12.000	5 LO
	18.250	18.000	5 HI
18-26.5*	9.125	18.000	6 LO
	13.375	26.000	6 HI
26.5-40*	8.917	26.000	7 LO
	13.417	40.000	7 HI
0.5-18 (standard)	2.830	0.500	8 LO
	18.250	18.000	8 HI
0.3-18 (Option 3)	2.360	0.030	8 LO
	18.250	18.000	8 HI

*If FE-904 Frequency Extender is connected to MSR-904. If the FE-904 is not a part of the system, these two band controls are not available at the front panel.

If this voltage is correct, the problem is probably located in the DVM assembly (A5); refer to section 5.8 for corrective maintenance.

If the voltage at pin V is not correct, proceed as listed below.

5.6.2.1 DC INPUTS AND LOGIC

Check DC input voltages at the following edge connector pins:

2, B	+15 Vdc
3, C	+5 Vdc
4, D	-5 Vdc
5, E	-15 Vdc
6, F	+11 Vdc
7, 14	-11 Vdc
13	0V for any band below 18,+6V above 18 GHz
P	-11 to +11, controlled by the FO/MKR dual tuning knob

Check logic voltages at pins 11, 10 and 9 of integrated circuits U4 and U5 according to the band code listed in Table 4.1. Pins 11, 10 and 9 correspond respectively to BCD codes A, B and C. Table 4.1 lists "1" as TTL logic (+5V) and "0" as TTL low (0V).

5.6.2.2 TRACKING VOLTAGES

Adjust the FO/MKR control to obtain exactly +5.0V at pin P of A4B4, select band "2-4", measure dc voltages at various integrated circuits according to Table 5.8.

If the voltages at U6 and U7 are not correct, check voltages at U4 and U5 for each frequency band, according to Table 5.9, to verify that multiplexers U4 and U5 are operating properly. Voltages at pins 3 of U4 and U5 should be equal to the voltages at pins 14, 15, 12, 1, 5, 2 and 4, respectively, as the are selected in the order listed in Table 5.6.3. The last band (.5-18 or .03-18) is not switched through U4 or U5.

5.7 A4B5, EXTERNAL CONTROL

A4B5 is a multi-function board, as described in section 4.7. In general, problems with the external monitor driving voltages, logic switching to an external counter or FE-904 Frequency Extender and AFC switching could be traced to malfunctions in this PC board. If an FS-1000 Frequency Synthesizer is connected to the MSR-904A a lack of phase-locking signal to the YIG oscillators in the RF Tuner, A8, could also be traced to a malfunction in this board.

5.7.1 MONITOR DRIVER VOLTAGES (U5, U6)

If a monitor (type HP 1335A) is connected to the MSR-904A rear panel, the following adjustments and checks are made:

a. Centering of Horizontal Display - disconnect the BNC jack to input "X" at the monitor rear panel and adjust the front panel "HOR" control to obtain a dot at the center of the screen. Reconnect "X" and adjust R19 in A4B5 to obtain a centered horizontal display when the receiver is in the "BAND" mode. Switch to " ΔFO" mode and adjust R16 to obtain the same horizontal deflection. Multiplexer U8 selects the appropriate ramp to be applied to the X-axis of the monitor. Logic signal at pins 10 and 11 is low in the "BAND", "F1/F2" and "EXT" modes; high in " ΔFO" and "CW" modes.

b. Blanking Voltage - input at pin

TABLE 5.8
A4B4 TRACKING VOLTAGES

I.C.	1,2,3	5,6,7
U1	4.99	7.62
U2	6.54	-
U3	0.177	4.12
U4	0.65	0.480

I.C.	1	2	3	4	5	6	7	8
U7	1.687	0.566	0.566	-15.0	6.463	6.470	7.288	+15.0

TABLE 5.9
A4B4 MULTIPLEXER VOLTAGES

BAND	U6 #3	U5 #3
.5-2	0.367	0.164
2-4*	0.482	0.653
4-8	0.953	1.304
8-12	0.955	2.602
12-18	1.426	3.903
18-26	-	-
26-40	-	-

*Band 2-4 - CW mode F_o "on"
Adjust F_o/MKR to obtain +5V at pin P

"Z" of A4B5 is a 5V positive going blanking pulse, generated by assembly A6B1 (tuning generator), in the "BAND", " ΔF0" and "F1-F2" modes. Blanking output to monitor (pin 19) is a 0.7V negative going pulse, with +0.7 Vdc during the sweep. If the "crossband" mode (.5-18 or .03-18) is selected, four additional pulses of the same amplitude but shorter duration should be present to blank the monitor during the transitions between bands (2, 4, 8 and 12 GHz).

c. Vertical Output - the offset voltages added to the AM video output to obtain five vertical displays at the monitor are provided by U6, driven by a BCD band code as listed in Table 4.1. Offset at pin 3 of U6 is approximately 0.2 Vdc per band, starting at 0 Vdc for band 0.5-2 (or 0.03-2).

5.7.2 PEAK DETECTOR PULSE GENERATOR

The output of one-shot multivibrator U1 consists of 2 usec. pulses, negative-going, with an amplitude of 5V. U1 is enabled by a TTL high signal at pin 4 (RESET), in modes "BAND", "F1/F2" and " ΔF0" (mode code input "C" is low in these three modes). In "CW" and "EXT" the output of U1 remains high (+5V). U3A inverts the output of U1 to drive switch U4 in assembly A36 (peak detector).

5.7.3 PHASE-LOCK ENABLE

The collector of Q1 switches to -12V under the following input conditions:

PIN	VOLTAGE	DESCRIPTION
R	TTL high	Synthesizer control
L	TTL low	Remote mode

The collector of Q1 switches to +5V under any other combination of conditions at pins R & L.

5.8 A5, FREQUENCY DISPLAY

Alignment and maintenance of the Frequency Display may be accomplished by removing it from its mounting bracket at the front panel. Loosen the two knurled screws and pull the assembly back; do not disconnect the 9 pin power plug.

5.8.1 ALIGNMENT

Refer to schematic diagram 92R50-017 in section 7.0.

Remove PC board A4B4 (meter tracking) and short pin V to ground. Adjust R3 in A5 (accessible through a hole in the right side) until the frequency display indicates 0.000.

Remove the short, replace A4B4, select 12-18 band and tune the front panel FO/MKR dual knob to obtain a reading of 9.00 Vdc at pin V of A4B4. Adjust R10 in A5, accessible through a hole on the left side, until the frequency display indicates 18.000.

CAUTION: It may be necessary to re-align the A4B4 Meter Tracking Board if adjustments are made to the frequency display assembly.

5.8.2 MAINTENANCE

Remove the sheet metal covers from assembly A5, reconnect the 9 pin power plug and measure voltages according to Table 5.10, in the 12-18 band, with the receiver tuned to 18.0 GHz.

5.9 A6, TUNING GENERATOR

Refer to schematic diagrams

TABLE 5.10

A5, FREQUENCY DISPLAY, VOLTAGE MEASUREMENTS

PIN NO.	1	2	3	4	5	6	7	8	9
PLUG	+15	-15	0	0	+5	+9.0	+5	0	0
U1	-	+2.0	+2.0	-15	-	+2.0	15	-	-
U5	+15	+5	-	-	-	-	-	-	-

For additional voltages and waveforms for the dual-slope integration and multiplexing circuits, refer to the manufacturer's data sheets.

TABLE 5.11

A6B1, MAXIMUM SCAN RATE ADJUSTMENT

BAND	AUTO-STOP	ADJUST POT	SCAN RATE
Any Octave	ON	R26	10 Hz
.5-18	OFF	R24	3.3 Hz
or 0.03-18	ON	R28	1.0 Hz

92R61-018, 92R62-019 and 92R63-020 in section 7.0.

5.9.1 ADJUSTMENT

5.9.1.1 SCAN RATE ADJUSTMENT (A6B1)

Adjustment of the minimum scan rate (0.1 Hz or less) is obtained by means of R15 in A11B4, a printed-circuit board attached to the front panel of the MSR-904. Turn the SCAN RATE control fully counterclockwise and select any of the octave bands. Locate R15 with the aid of the component location in schematic 92R114-030. The dot at the front panel pan display should take 10 sec. or longer to travel from left to right, as adjusted by R15.

Adjustment of the maximum scan rate in the crossband and auto-stop modes of operation is accomplished via R24, 26 and 28, as listed in Table 5.11. Scan rate control at the front panel must be rotated fully clockwise.

5.9.1.2 F1/F2 AUTOMATIC SCAN RATE ADJUSTMENT (A6B1)

When mode "F1/F2" and band "0.5-18" (or 0.03-18) are selected at the same time, the scan rate control is automatically adjusted between 0.1 and 30 Hz. The slow scan rate is obtained when enabled F1 is fully CCW, F2 fully CW (maximum frequency scan). The rate increases as F1 is turned CW or F2 counterclockwise, until it reaches 30 Hz. Voltage at pin 4 of A6B1 should vary from approximately +11 Vdc (F1 CCW, F2 CW) to +7 Vdc when the F1 and F2 frequency settings are within an octave or less.

The lowest scan rate (F1 CCW, F2 CW) is set via potentiometer R16 in A6B1.

If the highest scan rate needs re-adjustment, proceed as follows:

a. Set F1 fully CCW; adjust F2 to obtain 0 Vdc at U1 pin 1 in A6B1; then adjust R13 to obtain +2 Vdc at U1 pin 7.

b. Set F2 fully CW; adjust F1 to obtain 0 Vdc at U2 pin 7; then adjust R4 to obtain +2 Vdc at U1 pin 7.

c. Verify that the voltage at U1 pin 7 increases to +4 Vdc when F1 is rotated fully CCW, and that it decreases to 0 Vdc when F1 is rotated fully CW.

d. Rotate F1 fully CCW; verify that the voltage at U1 pin 7 is +4 Vdc; rotate F2 fully CCW and verify that the voltage at U1 pin 7 reduces to 0 Vdc.

e. After the above adjustment, R16 must be re-adjusted to obtain the low scan rate of 0.1 Hz (F1 must be fully CCW, F2 fully CW).

5.9.1.3 AUTO-STOP ADJUSTMENT in 0.5-2 (0.03-2) BAND

Potentiometer R32 in A6B1 should be adjusted if the scan stops at the low frequency end of the 0.03-2 band, without any signal present, when the auto-stop pushbutton is enabled. It has no effect in any of the upper bands.

5.9.1.4 TUNING RAMP (-11/+11) ADJUSTMENT (A6B2)

If the frequency coverage in the CW mode differs from the coverage in the BAND mode, adjustment of the -11/+11V ramp might be necessary, as described below:

a. Verify that the voltages at pins 17 and T of A6B3 are +11 and -11

Vdc Respectively, within ± 0.02V Potentiometers R34 and R39 adjust these two voltages.

b. Connect a scope probe to TP1 in A6B3; select dc coupling to the vertical input.

c. Select "BAND" mode and observe a -11 to +11V ramp display.

d. Increase the scope sensitivity as much as possible to display only the negative edge of the ramp.

e. Adjust the scope's offset control as necessary. Switch between BAND and CW, alternately, and adjust R3 in A6B2 until the lower edge of the ramp, in BAND mode, coincides with the straight line displayed in CW mode.

f. Repeat (d) to display only the positive edge of the ramp, in BAND mode.

g. Repeat (e), adjusting R11 in A6B2 for coincidence.

h. Repeat (d) through (g) until both extremes of the ramp are optimally adjusted.

5.9.1.5 EXTERNAL TUNING ADJUSTMENT (A6B2)

The adjustment described in this section should only be performed if the MSR-904A is connected to a FS-1000 Synthesizer, and it is failing to lock at some frequencies, or some bands.

Adjustment is performed as follows:

a. Interconnect MSR to FS as illustrated in 91A10-009 (Figure 2.5 of manual), utilizing W8, W9, W13, W14 and W15. Connect a 2-18 coupler between LO OUT and RF SAMPLE, as illustrated.

b. Remove the FS's top cover: locate PC board A3, standing vertically immediately behind the front panel. Switch toggle switch at rear of PC board to "TEST".

c. Disconnect the "Ø LOCK" cable (W14) from either end.

d. Connect a frequency counter to the coupled port of the 2-18 coupler.

e. Select "REM ENABLE" at the MSR front panel.

f. Select 18.000 GHz at the synthesizer by depressing "FO", "18" and "GHz", in this order.

g. Counter frequency should be in the range of 18.225 to 18.275. If not, adjust R68 in A6B2 (MSR) to get as close as possible to 18.250.

h. Select 12 GHz on the FS front panel, and adjust (if necessary) R56 in A6B2 to get as close to 12.250 as possible.

i. Caution: R56 and R68 are interdependent. Repeat g. and h. as necessary to obtain both readings correctly.

j. Switch to "OPERATE" in assembly A3 of the FS-1000 and reconnect the "Ø LOCK" cable. The system should lock at the last frequency selected by the FS front panel, as indicated by the green "LOCK" light. The DVM at the MSR front panel should read a frequency close to the frequency displayed at the FS (within ±1%).

k. Check the extremes of each band, by selecting frequencies at the FS front panel: 0.03 (or 0.5),

1.999, 2, 3.999, 4, 7.999, 8, 11.999, 12 and 18 GHz. Also spot-check in-between values to make sure LOCK is maintained at all times.

If the FS/MSR system fails to lock in any band, after the above adjustment procedure is followed, refer to section 5.10 of this manual for possible retracking of the YIG oscillators.

5.9.1.6 F1/F2 GENERATOR ADJUSTMENT (A6B2)

The F1/F2 ramp is available at TP1 of A6B3. It has an amplitude of -11/+11V when F1 is fully CCW, F2 fully CW. Its lower limit is reduced when F1 is rotated CW; its upper limit is reduced when F2 is rotated CCW. If adjustment is necessary, proceed as follows:

a. Select F1/F2 mode.

b. Connect a scope probe to pin 2 of A6B2 and observe a +11/-11 ramp.

c. Adjust R15 to center it around 0 Vdc, and R21 to obtain the exact limits of +11 and -11V when compared with the waveform at pin 6 of A6B2. The latter -11/+11V ramp should have been adjusted previously, as described in section 5.9.1.4.

d. Connect the scope probe to TP1 in A6B3.

e. Set F2 fully CW, F1 fully CCW and observe a -11/+11V ramp. Adjust R33 to center it around 0 Vdc and R30 to obtain the exact limits of -11 and +11V. Compare this waveform to the one displayed when "BAND" mode is displayed.

f. Rotate F1 slowly CW, F2 slowly CCW and observe the -11/+11V ramp amplitude reduces to zero, then reverses until it becomes a +11/-11V ramp, when F1 is fully CW and F2 fully CCW.

5.9.1.7 0/+9V TUNING VOLTAGE (A6B3)

Adjustment of the tuning voltage, if necessary, changes the tracking of all YIG filters and oscillators. It is advisable not to attempt to adjust this voltage unless integrated circuits U6, U7, U8 or U9 in A6B3 have been changed, and the voltage is more than 0.2V off its nominal values.

If adjustment is necessary, proceed as follows:

a. Place PC board A6B3 in its extender.

b. Verify that voltages at pins 17 and T are $\pm$ 11 Vdc; adjust if necessary, as described in section 5.9.1.4.a.

c. Select CW mode and rotate the FO/MKR dual knob at the front panel fully CCW.

d. Monitor pin N of A6B3 and adjust R16 to obtain 0 Vdc.

e. Rotate FO/MKR fully CW.

f. Adjust R27 to obtain +9 Vdc at pin N.

g. Repeat d. through f. until both voltages are correct.

h. Refer to section 5.10; adjust all low and high end tracking resistors of both YIG oscillator and preselector in every band.

5.9.1.8 MARKER ADJUSTMENT (A6B3)

Select 12-18 GHz, " ΔFO" mode,

"MKR" on. Insert signals at 12 and 18 GHz and tune the receiver to each signal until it is centered on the CRT screen. Switch to "BAND" and verify that the marker coincides with the signal. If necessary, adjust R7 and A6B3 to obtain coincidence.

5.9.2 MAINTENANCE

5.9.2.1 AUTO STOP

Auto-Stop blanking and L.O. disable in the 0.03-2 band.

Refer to Figures 4.4 and 4.5 when troubleshooting the logic waveforms associated with the functions above (integrated circuits U5, 6, 7, 8, 10 and 11).

5.9.2.2 CLOCK AND CONTROL

Integrated circuit U9 and transistor Q3 produce TTL level clock pulses at pin 9 whenever the following conditions are met:

INPUT PIN	VOLTAGE
8	+11 to +7 Vdc, adjustable by SCAN RATE Control
18	TTL low
17	TTL low

The repetition rate of the pulses at pin 9 varies between 1 and 30 kHz according to: the setting of the SCAN RATE control; selection of band (octave or crossband) and auto-stop feature, as shown in Table 5.11; setting of the F1 and F2 controls. This rate is 10,000 times faster than the scan rate of the receiver.

5.10 A7B1, OSCILLATOR/FILTER TRACKING

5.10.1 OSCILLATOR TRACKING

Adjustment of the oscillator tracking resistors in this PC board should only be attempted if the band coverage of any or all the octave bands is incorrect. If the coverage is incorrect only in the crossband mode (0.5-18 or 0.03-18), refer to section 5.5.2 for realignment.

Before attempting to re-align the oscillator tracking in an octave band, verify that the 0/9V tuning ramp is present at pin K of A7B1, selecting "CW" mode and rotating the FO/MKR dual knob fully CCW and CW, as described in section 5.9.1.7 above.

If a minor frequency adjustment is necessary, connect a frequency counter (2-18 GHz coverage) to the "LO OUT" SMA jack on the rear panel. If the "LO OUT" (Option 2) is not installed in the receiver, remove the RF Tuner from the main cabinet, remove its covers and locate the semi-rigid coaxial cable between Z3-common (J1) and Z4-LO input. Connect the frequency count to Z3-common and re-install the RF Tuner in the main cabinet.

In the CW mode, rotate FO/MKR fully CCW and fully CW to obtain the voltages at pin K, as listed in Table 5.12. The correct local oscillator frequencies are listed in the same table, as well as the potentiometer to be adjusted.

CAUTION:

1. The group of potentiometers on the right side of the test points is the only one to be adjusted by the above procedure.

2. If a "LO" potentiometer (R2, 5, 8, 11, or 14) is adjusted, the corresponding "HI" for the same band must be re-adjusted; if only the "HI" is re-adjusted, there is no need to re-adjust the corresponding "LO" potentiometer.

5.10.2 FILTER TRACKING

If the receiver exhibits low sensitivity in one or more bands, or the bandpass as displayed in the 30 MHz bandwidth is skewed, a misalignment of the YIG filter could be the cause. Before aligning the filter, verify that the band coverage is correct as described in Section 5.10.1.

Follow the steps below to re-align the YIG filter:

a. Connect a signal generator to the appropriate antenna input at the rear panel.

b. Select "30 MHz" IF bandwidth and " ΔFO" mode.

c. Tune the receiver to the frequencies listed in Table 5.13, increasing the signal generator output until a bandpass is visible in the pan display, without limiting.

d. Adjust potentiometers listed in Table 5.13 as necessary.

The first band coverage is 0.5-2 GHz in a standard unit; it is extended to 0.03 with Option 3. In both cases, the YIG filter operates only from 0.5-2; coverage from 0.03-2 has no tunable preselection. In a standard unit no signals (or greatly attenuated signals) will be visible in the pan display, below 0.5 GHz. If Option 3 is present, the YIG filter automatically switches "on" at 0.5 GHz; adjustment of the switching point is accomplished as follows:

a. Tune the receiver to a signal at 0.5 GHz in the ΔFO mode, with ΔFO control fully CW.

TABLE 5.12

YIG OSCILLATOR ALIGNMENT

CAUTION: Label column below refers to "OSCILLATORS," not "FILTERS"

BAND	VOLT. AT K	A7B1 POT	LABEL	LO FREQUENCY
0.5-2 or 0.03-2	0.025	R2	1 L	2.350
	9.0	R17	1 H	4.340
2-4	0	R5	2 L	2.240
	9.00	R20	2 H	4.260
4-8	0	R8	3 L	4.240
	9.00	R23	3 H	8.260
8-12	0	R11	4 L	8.240
	9.00	R26	4 H	12.260
12-18	0	R14	5 L	12.240
	9.00	R29	5 H	18.260

If there is no oscillator output in one or more bands, refer to sections 5.11 and/or 5.12.

TABLE 5.13

YIG FILTER ALIGNMENT

CAUTION: LABEL column below refers to "FILTERS", not "OSCILLATORS".

BAND	ANTENNA INPUT	INPUT FREQUENCY	A7B1 POT	LABEL
.5-2 or .03-2	.03-2	.50	R32	1 L
		2.00	R47	1 H
2-4	2-18	2.00	R35	2 L
		4.00	R50	2 H
4-8		4.00	R38	3 L
		8.00	R53	3 H
8-12		8.00	R41	4 L
		12.00	R56	4 H
12-18		12.00	R44	5 L
		18.00	R59	5 H

b. Locate the switching point by rotating tuning the FO/MKR dual knob around 0.5 GHz until the point is apparent by a sudden discontinuity of the display level; larger on the left side of the switching point than on the right.

c. Adjust R31 in P.C. board A4B5 to move the switching point horizontally; a signal at 0.5 GHz should be fully visible on the right side of the switch point.

5.11 A7B3, YIG DRIVERS

Refer to schematic diagram 92B73-022 in section 7.0 of this manual.

Table 5.14 lists the approximate voltages that can be measured at the connector terminals of the PC board. The receiver must be set to the "CW" mode, bands selected in succession and the FO/MKR dual knob rotated fully CW or CCW as listed.

TABLE 5.14

YIG DRIVER VOLTAGES

BAND	Fo/MKR POSITION	PIN NUMBER			
		A,B	L,K	1	F
.05-2 (.03-2)	CCW	.87	.01	2.27	.02
	CW	1.64	3.64	4.23	4.55
2 - 4	CCW	.83	.22	2.16	1.02
	CW	1.60	.46	4.16	2.10
4 - 8	CCW	1.60	.46	4.14	2.09
	CW	3.14	.93	8.13	4.26
8 - 12	CCW	.90	.93	3.68	4.24
	CW	1.36	1.41	5.51	6.41
12 - 18	CCW	1.35	1.41	5.53	6.42
	CW	2.03	2.13	8.34	9.77

YIGs for bands 18-26 and 26-40 have their own drivers mounted in the FE-904 Frequency Extender. They are not driven by A7B3. Refer to the FE-904 manual.

5.12 A8, RF TUNER ADJUSTMENT AND MAINTENANCE

All checks should be made with the RF Tuner open. For ease of inspection and accessibility, it is preferred to remove the RF tuner from the receiver and interconnect it with control and IF cables.

5.12.1 PRELIMINARY CHECKS

The following items should be checked prior to testing the RF assembly:

1. Check the receiver IF sensitivity (section 5.2.1).

2. Check all RF cables for tightness.

5.12.2 ADJUSTMENT AND MAINTENANCE

Operating performance of the RF components may be verified as follows:

5.12.2.1 YIG FILTER, FL-44 (0.5-2 GHz)

1. Measure the dc voltage at the YIG filter terminals in "CW" mode, 0.5-2 (or 0.03-2) band and FO/MKR fully clockwise. Voltages should be approximately +2.2Vdc at the "+TUNE" terminal and +0.85 Vdc at the "-TUNE" terminal.

2. Rotate the FO/MKR control counterclockwise and observe both voltages decrease continuously.

3. Filter insertion loss may be measured by conventional attenuation techniques utilizing a signal source and a power meter. Input level must remain below 0 dBm to prevent YIG saturation. Insertion loss is 7 dB, maximum. The YIG must be tuned with the receiver in the (CW) mode to make this measurement.

5.12.2.2 A8B1, 250 MHz PREAMPLIFIER

If a problem is suspected in this subassembly, the following checks should be performed:

1. Check IF sensitivity as described in Section 5.2.1.1.

2) Remove top cover of the RF Tuner (A8).

3) Disconnect the semi-rigid cable from the input to A8B1 module (from the Z4 mixer IF PORT).

4) Inject a 250 MHz signal into the input port of A8B1 module.

5) With the oscilloscope still connected as described in Section 5.2.1.1, adjust the signal level until the baseline noise begins to increase. The input signal level should be approximately -100 dBm.

5.12.2.3 MIXER, Z4 (2-18 GHz)

Double balanced mixer, Z4 may be checked as follows:

1. Measure receiver IF sensitivity as described in section 5.12.2.2.

2. Inject an RF signal into the RF port of the mixer and measure receiver sensitivity in the manual mode by tuning the receiver and generator to the same frequency. Sensitivity should be typically 10 dB less than the IF sensitivity. Make certain the BAND switch is selecting a band in the 2 to 18 GHz range.

3. If mixer sensitivity is not correct, inject a +5 dBm local oscillator signal in the LO port 250 MHz above the RF frequency and measure sensitivity. If greater than 10 dB less than IF sensitivity, the mixer is probably defective.

5.12.2.4 YIG FILTER, FL43 (2-18 GHz)

1. Measure the dc voltage of the YIG filter terminals under the following conditions: mode selector in (CW) RF Tuning 2-18 GHz. Correct voltages are +5 Vdc at the positive terminal, +1.4 Vdc at the negative terminal.

2. Measure the voltage at the positive terminal while operating the RF tuning control. The voltage should decrease as the receiver is tuned down from the high end of the band.

3. Filter insertion loss may be measured by conventional attenuation techniques, utilizing a power source and power meter. With the receiver int he (CW) mode, insertion is 6 dB, maximum.

5.12.2.5 YIG OSCILLATOR, Y1 (2 to 8 GHz)

Filter and mixer performance should be checked prior to measuring the oscillator performance.

1. The 2 to 8 GHz oscillator output is measured by disconnecting the LO input to the mixer (Z4) and connecting a power meter to the semi-rigid cable. With the receiver in the 2-4 band, Manual mode, tune accoss the band. Oscillator power should remain above 1 milliwatt.

2. Connect a frequency counter in place of the power meter and tune across the band. Frequency should vary from 2.25 to 4.25 GHz.

3. If no output is present, measure power and frequency at the oscillator output terminal to isolate the fault to either the oscillator or the coaxial PIN diode switch Z3.

4. If the problem is in the oscillator, check dc voltages: +15 Vdc supply, +1.7 to 3.3 volts at the positive tuning terminal, +16 Vdc at the positive heater terminal and -6 Vdc at the negative heater terminal.

5.12.2.6 YIG OSCILLATOR, Y3 (8 to 18 GHz)

1. Disconnect the output cable at isolator, AT1.

2. Measure power output in Band 3 (8 to 18 GHz) with the receiver in the Manual mode, tune across the band. Correct output is 20 milliwatts, minimum.

3. Measure the frequency of the output, it should be 2.75 to 4.75 GHz.

4. If no output is present, check dc voltages: +15 Vdc supply, +4.2 V at the positive tuning terminal with the RF Tuning set to the high end of the band. With the receiver in the Manual mode, measure +24Vdc at the positive heater terminal.

5.12.2.7 COUPLER, DC1

1. Note the power output of the 2 to 8 GHz oscillator (Y1) at some point in Band 2 (2 to 8 GHz).

2. Measure the power out at the MAIN terminal of the coupler with the oscillator reconnected. The correct output is 2 to 3 dB less than the oscillator output.

3. Measure the output at the -6 dB port with the MAIN and INPUT ports reconnected. Power output should be 6 to 9 dB less than the oscillator output.

5.12.2.8 A8B11, AUXILIARY ASSEMBLY

1. Potentiometer R9 adjusts the noise level of band 1 (.03 to 2 GHz).

2. Inject +3V into the EXT TUN input and manually tune the receiver to 4 GHz, CW mode, band 2. Note the frequency. Inject -3V to the EXT TUN input and note the frequency. The range of the frequency for -3V and 3V should be 5 to 6 MHz, nominal. This is adjusted via potentiometer R19.

3. Inject +3V into the EXT TUNE input and manually tune the receiver to 10 GHz, CW mode, band 3. The range of the frequency is the same as Step 2. This is adjusted via potentiometer R21.

5.13 A10, OSCILLOSCOPE

To perform the following checks, set the front panel FOCUS potentiometer to mid-range. Rotate the INTENSITY potentiometer fully CW. On P.C. board A10B2, set potentiometer R48 to mid-range. R48 is accessible via the side of the enclosure.

5.13.1 A10B2, HIGH VOLTAGE POWER SUPPLY

WARNING

VOLTAGES IN EXCESS OF 100 Vdc PRESENT IN THIS SUBASSEMBLY. USE EXTREME CAUTION WHEN ATTEMPTING REPAIR.

a. Disconnect the +15Vdc line at terminal E1.

b. Carefully lift the A10B1 P.C. board out of the enclosure and remove the metal shield between the two P.C. boards.

c. Utilizing the oscilloscope, verify waveforms in A10B2 as illustrated in Figure 5.4. Utilize the first waveform (U1, pin 3) as a reference in one scope channel to check the phase of the remaining waveforms. U4, pins 2 and 5 are illustrated as troubleshooting aids only.

5.13.2 A10B2, HIGH VOLTAGE POWER SUPPLY

a. Connect the +15Vdc line (E1) to an external power supply. Set the supply to 0Vdc. Slowly increase the voltage to +10Vdc and monitor the supply current which must not exceed 125 mA.

b. Check voltage level across capacitor C10. This level should be +80V, $\pm$ 15Vdc.

c. Check voltage from INTENSITY potentiometer (R9, pin 1) to ground. This level should be -810V, $\pm$ 40Vdc.

5.13.3 A10B2, HIGH VOLTAGE POWER SUPPLY

Remount metal shield and P.C. board A10B1 in their respective places.

a. Connect the BLANK test point to ground.

b. Connect a function generator to the HORIZ (connector pin 15), adjust generator output to triangle wave, 30 Hz $\pm$ 1.5V amplitude (3Vp-p) and verify that a horizontal line is displayed.

c. Adjust R54 (horizontal gain) to obtain a straight line across the CRT, slightly larger than full deflection.

d. Momentarily remove the ground from the BLANK test point and verify the trace disappears.

e. Adjust R48 on A10B2 (trace rotation) to make the horizontal

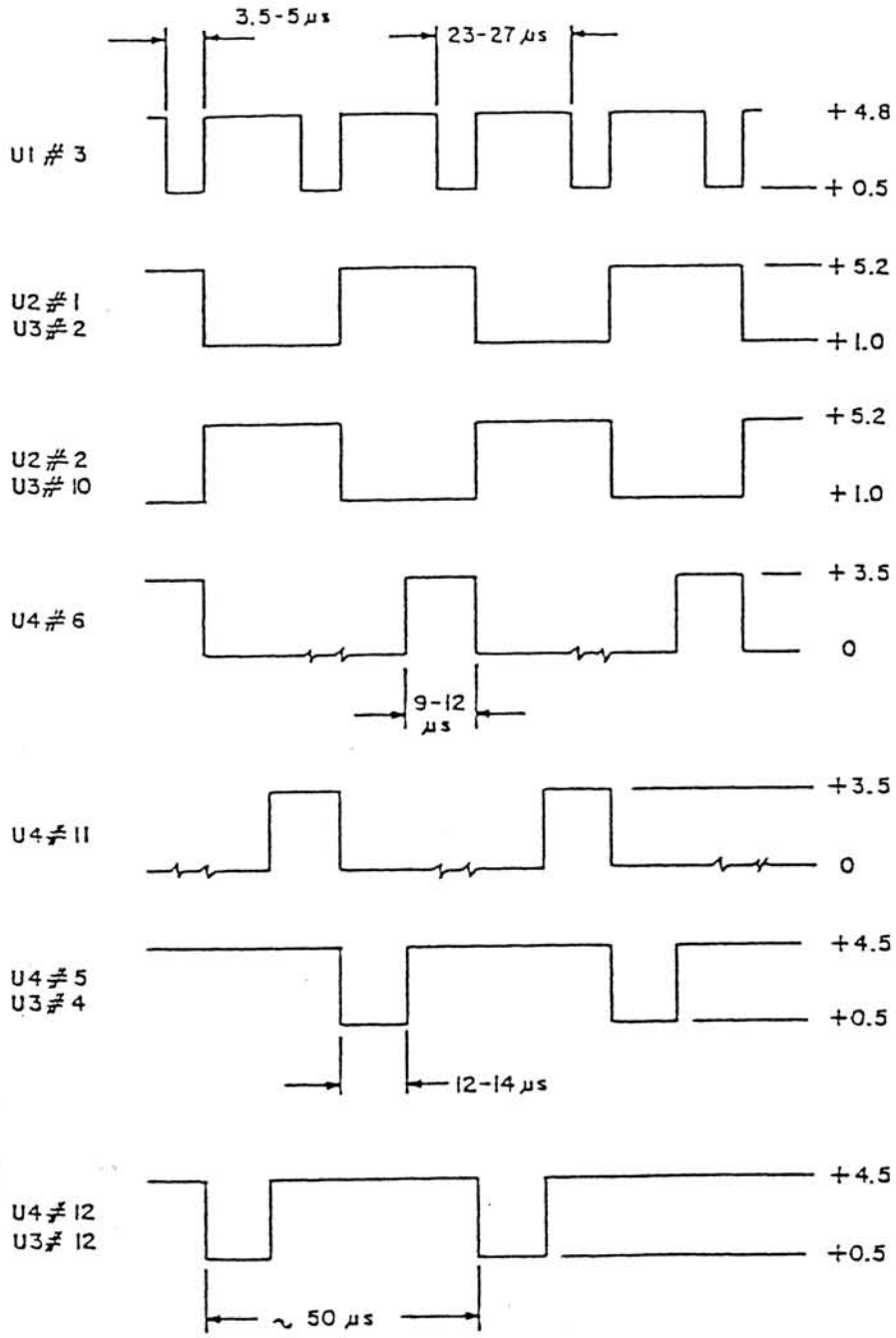


FIGURE 5.4 A10B2, POWER SUPPLY WAVEFORMS

line coincide with the main horizontal graticule. If unable to level trace, remove power, rotate R48 to mid-range and reverse J2 (2 pin connector near CRT). Apply power and adjust R48.

5.13.4 A10B1, VERTICAL FUNCTIONS

a. Connect a second function generator to the VERT (connector pin 14), set function to SINE, frequency to 500 Hz and level to obtain a display. Vary the frequency slightly until the display remains stationary for easy observation.

b. Increase the level of the function generator to obtain a full scale display.

c. Momentarily remove the cable from the VERT (connector pin 14) and observe the CRT display (horizontal line) is centered within $\pm$ 0.5 vertical divisions.

SOME FUNCTION GENERATORS HAVE A A DC OFFSET, WHICH MUST BE TAKEN INTO ACCOUNT.

5.14 A11, FUNCTION SELECTION

If the receiver does not require Option 6 (IF Reference) or Option 8 (18-40), the corresponding pushbuttons are black and inoperative.

a. Energize receiver.

b. Depress each pushbutton twice (once - ON, once - OFF) and observe the pushbutton LEDs illuminate and extinguish, with the exception of the LOCK-RELEASE, MODE, BAND, IF BW, VIDEO, AUDIO and FREQ DISPLAY pushbuttons.

c. Select CW mode and verify F1 and F2 frequency display buttons cannot be selected.

d. Select .1-18 band and observe both .1-18 and 2-4 LEDs illuminate.

e. If the pushbuttons do not illuminate, the probable cause of the malfunction is the switching logic on the A11B2 Keyboard assembly (U1 and U2).

5.14.1 A11B2, KEYBOARD

Switching logic for encoders U1 and U2 originate in the A4B1 Band Control and A4B2 IF Bandwidth Control assemblies. Refer to Sections 5.3 and 5.4.

5.14.2 A11B3, AM VIDEO

a. Connect DVM to AM VIDEO (connector for J6, pin 7).

b. Adjust potentiometer R13 so that the lowest bar on the SIG LEVEL display is illuminated.

c. Select MKR ON and BAND mode.

d. Toggle MARKER switch on and observe a 1/4 scale deflection on the bar display.

5.14.3 A11B3, AGC

a. Enable AGC via the front panel and measure +15Vdc at the rear of connector P8, pin 22 (or connector P8, pin 25 on the PC board).

b. Disable AGC via the front panel and verify 0 Vdc at connector P8, pin 22.

5.14.4 A11, FRONT PANEL - REMOTE TEST

a. Select REM EN and verify only one pushbutton in each group listed below is illuminated: MODE, BAND, IF BW and VIDEO.

TABLE 5.15 NOMINAL SUPPLY CURRENT

VOLTAGE (Vdc)	CURRENT (mA)
+15	145
+12	15
+6	70
-12	20

TABLE 5.16 A10B1U6 VOLTAGE LEVELS (No Input Signals)

PIN	LEVEL	PIN	LEVEL	PIN	LEVEL	PIN	LEVEL
1	-11.6	5	-11.6	9	-11.6	13	-11.6
2	<0.1	6	-0.1	10	<0.1	14	<0.1
3	<0.1	7	12.0	11	<0.1	15	12.0
4	-12.0	8	-2.6	12	-12.0	16	-2.6

TABLE 5.17 A10B1 TRANSISTOR PIN VOLTAGE LEVELS (No Input Signals)

TRANSISTOR	E	B	C
Q6	-0.33	+0.30	+12.0
Q7	-0.87	-0.33	+50*
Q8	-10.3	-9.73	-0.87
Q9	-0.87	-0.33	+50*
Q10	-0.33	+0.29	+12.0
Q11	≃0	+0.63	+12.0
Q12	-0.60	≃0	+48**
Q13	-10.4	-9.77	-0.60
Q14	-0.60	≃0	+48**
Q15	≃0	+0.62	+12.0

*With H. POS potentiometer at mid-range. 12V to 87V when rotated to both endstops.

**With V. POS potentiometer at mid-range. 20V to 76V when rotated to both endstops.

b. Verify that all pushbuttons, except the IF REF, outside of the four groups listed above are still controllable from the front panel.

5.15 A12, 21.4 MHz WB LEVELED OUTPUT

a. Connect +15Vdc to FL1.

b. Connect the signal generator to J1. Tune the generator to 21.4 MHz, with an output level of -70 dBm.

c. Connect the power meter to J2 and adjust to display 21.4 MHz.

d. With an input level of -70 dBm, adjust potentiometer R13 for a -20 dBm output.

e. Increase the input signal in 10 dB steps from -70 to 0 dBm while observing the output. The output should remain at -20 dBm, $\pm$2 dB.

5.16 A31, 250 MHz OSCILLATOR (Option 6)

a. Apply -12 Vdc to capacitor C25.

b. Connect spectrum analyzer to J1 (250 MHz).

c. Adjust L2, C11, C12, C17 and C22 to obtain maximum output at 250 MHz. Power output should be between -9 to -11 dBm and the frequency should be between 249.99 to 250.01 MHz.

d. Verify the output is free of spurious oscillations. Heat and cool the entire subassembly and verify the power output does not change more than $\pm$ 1 dB.

e. Utilize Q-dope to lock the tuning slug of L2.

SECTION VI
PARTS LIST

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
Avantek	Avantek Inc.	3175 Bowers Ave. Santa Clara, CA 95051	24539
Beck	Beckman Instruments Inc. Helipot Div.	2500 Harbor Blvd. Fullerton, CA 92634	73138
Belden	Belden Corp.	P.O. Box 1327 Richmond, IN 47374	70903
Bendix	Bendix Corp Electrical Components Div. RF Connector Sales	Sherman Ave. Sidney, NY 13838	77820
Berg	Winfred M. Berg, Inc.	499 Ocean Ave. East Rockaway L.I., NY 11518	29440
Bergquist	Bergquist	5300 Edina Ind'l. Minneapolis, MN 55435	55285
Bourns	Bourns Inc. Trimpot Div.	1200 Columbia Ave. Riverside, CA 02138	32997
Buckeye	Buckeye Stamping Co.	555 Marion Rd. Columbus, OH 43207	21604
Cambion	Cambion	445 Concord Ave. Cambridge, MA 02138	71279
Camloc	Rex Chainbelt, Inc. Camloc Div.	22 Spring Valley Rd. Paramus, NJ 07652	71286
Cannon	ITT Cannon Electric	666 E Dyer Rd. Santa Ana, CA 92702	71468
CDE	Cornell-Dubilier Electronics	150 Avenue "L" Newark, NJ 17101	14655
Cen-Lab	Centralab Electronics Div.	Box 858, Hwy. 20W Fort Dodge, IA 50501	71590
C-H	Cutler-Hammer	Specialty Products Div. Milwaukee, WI 53201	81640
Cinch	TRW/Cinch Connectors Electronic Components Div.	1501 Morse Ave. Elk Grove Village, IL 60007	71785
C-L	Centralab Electronics Div.Globe Union, Inc.	5757 N. Green Bar Ave. Milwaukee, WI 53201	71590
Clrstat	Clarostat Mfg.	1 Washington St. Dover, NH 03820	12697

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
CML	Chicago Minature/Drake	4433 N. Ravenswood Chicago, IL 60640	71744
Corcom	Corcom Inc.	2635 N. Kildare Ave. Chicago, IL 60639	05245
CTS	CTS Knights, Inc.	400 Reimann Ave. Sandwich, IL 60548	75378
Dale	Dale Electronics	P.O. Box 609 Columbus, NB 68601	91637
Datel	Datel Intersil	11 Cabot Blvd. Mansfield, MA 02048	50721
Del	Delevan Div. of American Precision Ind., Inc	270 Quaker Rd. Aurora, NY 12052	99800
DEL-BLIN	Delbert Blinn Co.	Box 2007 Pomona,, CA 91766	08289
Delco	Delco Electronics Div. General Motors Corp.	700 Firmin St. Kokomo, IN 46901	16758
Dennison	Dennison Mfg. Co.	300 Howard St. Framingham, MA 01701	05975
Dim-Gry	Dimco-Gray Co.	8200 S. Suburbon Rd. Dayton, OH 45459	80813
EFJ	E F Johnson Co.	299 10th Ave., SW Waseca, MN 56093	74970
Electroid	Electroid Co.	95 Progress St. Union, NJ 07083	16554
Elmenco	El-Menco	P.O. Box 7600 Lauter Ave. Florence, SC 29501	72136
EMC	Electronic Molding Co.	88 Mill St. Woonsocket, RI 20895	17117
EMF	EMF Systems, Inc.	P.O. Box 1009 State College, PA 16801	52747
Erie	Erie Technological Prods. Inc.	644 W 12th St. Erie, PA 16512	72982
Fairchild	Fairchild Semiconductor	464 Ellis St. Mountain View, CA 94040	07263

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
F-Dyne	F-Dyne Electronics	449 Howard Ave. Bridgeport, CT 06605	27735
FED	Federal Screw Prods. Inc.	3917 N Kedzie Ave. Chicago, IL 60618	73734
Fen	Fenwall Electronics	63 Fountain St. Framingham, MA 01701	15801
Ferox	Ferroxcube	5083 Kings Hwy. Saugerties, NY 12477	02114
G-B	Gordos Corp.	250 Glenwood Ave. Bloomfield, NJ 07003	95348
	G-C Electronics		72653
GE	General Electric Co. Electronic Capacitor Dept.	P.O. Box 158 Irmo, SC 29063	06001
G-M/Gen Mic	General Microwave Corp.	155 Marine St. Farmingdale, NY 11735	11332
Gray	Grayhill Inc.	565 Hillgrove Ave. Lagrange, IL 60525	81073
Guardian	Guardian Electric Co.	1550 W Carrol Ave. Chicago, IL 60607	73949
Haydon	A.W. Haydon Co.	232 N. Elm St. Waterbury, CT 06720	82227
	Honeywell - Spacekom	214 E. Gutierrez St. Santa Barbara, CA 93101	50245
HHS	Smith Inc., Herman H.	812 Snediker Ave. Brooklyn, NY 11207	83330
H-P	Hewlett Packard Co.	1501 Page Mill Rd. Palo Alto, CA 94304	28480
IEE	Industrial Electronic Engineers, Inc.	7740 Lemona Ave. Van Nuys, CA 91405	05464
IERC	Internat'l. Electronic Research Corp.	135 West Magnolia Blvd. Burbank, CA 91502	98978
Intersil	Intersil, Inc.	10900 N Tantave Ave. Cupertino, CA 95014	32293

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
JBT	JBT Switches Div. of Cutler-Hammer	P.O. Box 1904 New Haven, CT 06509	55459
JFD	JFD Electronics Corp.	15th at 62nd St. Brooklyn, NY 11219	73889
JM Hart	Joseph M. Hart & Son Inc.	95 S Hoffman Ln. Central Islip, NY 11722	81245
Kemet	Union Carbide Corp. Material System Div. Components Dept.	Hwy 276 SE Greenville, SC 29606	31433
Keystone	Keystone Electronics Corp.	49 Bleeker St. New York, NY 10012	91833
Kings	Kings Electronics Co. Inc.	40 Marbledale Rd. Tuckahoe, NY 10707	91836
K&L	K & L Microwave, Inc.	408 Coles Circle Salisbury, MD 21801	50140
Kry	Krytar	574 Weddel Dr. Unit 5 Sunnyvale, CA 94086	2R550
Littelfuse	Littelfuse, Inc.	800 E Northwest Hwy. Des Plaines, IL 60016	75915
Magnetics	Magnetics, Div. of Industries, Inc.	Box 391 Butler, PA 16001	90797
Mallory	Mallory Capacitor Co.	3029 E Washington Box 372 Indianapolis, IN 46201	90201
Mepco	Mepco/Electra, Inc.	P.O. Box 82927 San Diego, CA 92138	30983
Mic-Lab	Microlab/FXR	Ten Microlab Rd. Livingston, NJ 07039	00929
Mil	Mil Electronics	176 Walker St. Lowell, MA 01854	07862
M-M	Micrometals	1190 N. Hawk Anaheim, CA 92807	12856
M-O	Marco-Oak Div. of Oak Electro/Netics	207 S Helena St. Anaheim, CA 92803	76854

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
Mot	Motorola, Inc. Semiconductor Products Div.	P.O. Box 20912 Phoenix, AZ 85036	04713
MTC	Micro-Tel Corp.	10713 Gilroy Road Hunt Valley, MD 21030	29644
Narda	Narda Microwave Corp.	Plainview, NY 11803	99899
Nat/NSC	National Semiconductor Corp.	2900 Semiconductor Dr. Santa Clara, CA 95051	27014
Nobex	Nobex/Div. Griffith Plastics Corp.	1027 California Dr. Box 4365 Burlingame, CA 94010	32767
Norsal	Norsal Inds.	85 Hoffman Lane S. Central Islip, NY 11722	19136
Ohmite	Ohmite Mfg. Co.	3601 W. Howard St. Skokie, IL 60076	44655
	Omni-Yig	3350 Scott Blvd. Bldg. 66 Santa Clara, CA 95051	55682
OSM	Omni Spectra Inc. Microwave Comp. Div.	21 Continental Blvd. Merrimack, NH 03054	16179
Piezo Tech	Piezo Technology, Inc.	2525 Shader Rd. Box 7877 Orlando, FL 32804	25120
Plessey	Plessey Semiconductor Prods. Div. of Plessey Microsystems	1674 McGaw Ave. Santa Ana CA 92705	52648
Promenco	Inductive Components Inc.	181 Bridge Rd. Hauppauge, NY 11787	25159
RCA	RCA Solid State Div.	Route 202 Sommerville, NJ 08875	02735
RFD	RFD, Inc.	5024 Nassau St. Tampa, FL 33607	21992
RHG	RHG Electronic Lab, Inc.	161 Industry Ct. Deer Park, NY 11729	15286
Richco	Richco Plastic Co.	5825 N. Tripp Ave. Chicago, IL 60646	06915

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
RMF	RMF Products, Inc.	1275 Paramount Pkwy. Batavia, IL 60510	60662
Robinson/ROB	Robinson-Nugent, Inc.	802 E 8th St. New Albany, IN 47150	06776
Rodan	Rodan Industries	2905 Blue Star St. Anaheim, CA 92806	15454
Rogan	Rogan Corp.	3455 Woodhead Dr. Northbrook, IL 60062	86797
Schadow	Schadow Inc./ITT	8081 Wallace Rd. Eden Prairie, MN 55344	31918
S-D	Systron-Donner Microwave Div.	14844 Oxnard St. Van Nuys, CA 91409	01220
	Semtech		14099
Signetics	Signetics Corp.	811 E Arques Ave. Sunnyvale, CA 94086	18324
Sol	Solitron/Microwave	Box 278 Port Salerno, FL 33492	95077
Sou-Co	Southco Inc.	Concordville, PA 19331	94222
Spec. Cont.	Spectrum Control, Inc.	8061 Avonia Rd. Fairview, PA 16415	33095
Spr	Sprague Electronic Corp.	North Adams, MA 01247	56289
Stackpole	Stackpole Carbon Electronic Comp. Div.	Stackpole St. St. Marys, PA 15857	78488
Stimpson	Stimpson Co. Inc.	Bayport, NY 11705	57771
Struth	Struthers Electronics Corp.	Railroad Place Mamaroneck, NY 10534	00341
Sunbank	Sunbank Electronics, Inc.	3110 Winona Ave. Burbank, CA 91504	
Swcr	Switchcraft, Inc.	5555 N Elston Chicago, IL 60630	82389
Tek	Tektronix	Box 500 Beaverton, OR 97077	80009

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
Tel	Teledyne Microwave	3155 W El Segundo Blvd. Hawthorne, CA 90250	11532
Therm	Thermalloy, Inc.	2021 W Valley View Dallas, TX 75222	13103
TI	Texas Instruments, Inc. Semiconductor Comp. Div.	Box 5012-MS84 Dallas, TX 75222	01295
Trio	Trio Metal Prod. Co. Inc.	Falls & Clarkview Rd. Baltimore, MD 21209	26430
Unirode	Unitrode Corp.	590 Pleasant St. Watertown, MA 02172	12969
Unif-Tub	Uniform Tubes Microdelay Div	Collegeville, PA, 19426	93306
USECO	Useco Div. Litton Industries	13536 Saticoy St. Van Nuys, CA 91409	88245
USM	USM Corp. Fastener Group	510 River Rd. Shelton, CN 06484	07707
UTC	United Transformer Div. of TRW	150 Varick St. New York, NY 10013	80223
Vari-L	Vari-L Co.	3883 Monaco Pkwy. Denver, CO 80207	05375
Varo	Varo Semiconductor, Inc.	1000 N. Shiloh Rd. Garland, TX 75040	30857
Vema	Vemaline Products, Co.	455 W. Main St. Wyckoff, NJ 07481	08730
Vernitron	Vernitron Corp.	300 Marcus Blvd. Deer Park, NY 11729	10651
Vik/Viking	Viking Industries, Inc.	9324 Topanga Canyon Blvd. Chatsworth, CA 91311	05574
	Wakefield	60 Audobon Road Wakefield, MA 01880	05820
Win	Winchester Electronics Div. of Litton Industries	Main St. & Hillside Ave. Oakville, CT 06779	81312
W-J	Watkins-Johnson Co.	3333 Hillview Ave. Palo Alto, CA 94304	14482

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
W-M	Western Microwave Labs.	1260 Birchwood Sunnyvale, CA 94086	16453
YIG-Tek	Eaton Corp/YIG-Tek Plant	610 N. Mary Ave. Sunnyvale, CA 94086	34657
Zierick	Zierick Mfg. Corp.	44 Radio Circle Mt. Kisco, NY 10549	79963

MANUFACTURER'S FSC CODE

ABB.	FULL NAME	ADDRESS	CODE
AB	Allen-Bradley Co.	1201 South 2nd St. Milwaukee, WI 53204	01121
AEC	Applied Engineering Consultants	10237 Southard Dr. Beltsville, MD 20705	58168
Add.	Addington Laboratories, Inc Microwave Components Div.	785 Palomar Ave. Sunnyvale, CA 94086	51859
AEP	Applied Engineerings Products	2600 State St. P.O. Box 6071 Hamden, CT 06517	19505
ALCO	Alco Electronic Products, Inc. Div. Augat, Inc.	1551 Osgood St. North Andover, MA 01845	95146
ALGO	Hamilton Electronic Corp. Algo Div.	50 Schrieffer St. S. Hackensack, NJ 07606	29715
Amatom	Amatom Electronic Hardware Div. of Mite Corp.	446 Blake St. New Haven, CN 06515	06540
AMP	AMP Incorporated	Harrisburg, PA 17105	00779
Amph	Bunker Ramo, RF Div. Amphenol Connector System	33 E. Franklin St. Danbury, CT 06810	74868
Ampx	Amperex Electronic Corp. Electro-Optical Devices Div.	P.O. Box 278 Slatersville, RI 02876	25403
Anaren	Anaren Microwave Inc	6635 Kirkville Rd. E. Syracuse, NY 13057	31597
Ansley	Ansley Electronics Corp.	3208 Humboldt St. Los Angeles, CA 90031	15912
Anzac	Anzac Electronics Div. of Adams Russell	39 Green St. Waltham, MA 02154	21912
APC	Active & Passive Comp. Inc.	6 Aerial Way Syosset, NY 11791	50369
Arco	Arco Electronics Inc.	400 Moreland Rd. Commack, NY 11725	84171
Arnold	Arnold Magnetics Corp.	11520 Jefferson Blvd. Culver City, CA 90230	04879
Augat	Augat Inc. Interconnection Cmpnts Div.	33 Perry Ave. Attleboro, MA 02703	91506

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A1, MAINFRAME			
W1	CORD, AC Power	MTC	M93A10-339
	Cord, 2 Conductor	Belden	17237
	Plug, 3 Pin, Female	Bendix	PT06A-8-3S(SR)
	PLUG, Female, 41 Pin, .03-18 Tuner	Bendix	PT06A-20-41S(SR)
	PLUG, Male, 41 Pin .03-18 Tuner	Bendix	PT06A-20-41P(SR)
	Plug, 15 Pin, Female	Cinch	DAM-15S
	Hood, 15 Pin Plug	Cinch	DA-19678-1
	Extender Board, 18 Pin	Proto	79C10-137
	Plug, 18 Pin	Viking	2VH18/1AN5
	Extender Board, 28 Pin	Proto	MTD-443
	Plug, 28 Pin	Viking	3VH28/1CN5
A1B1, FRONT PANEL			
	BEZEL, Frequency Display	Nobex	910-60
R2,20	RESISTOR, Variable, 500 ohms	Clarostat	RV6NAYSD501A
R5	RESISTOR, Variable, 2K	Clarostat	RV6NAYSD202C
R6	RESISTOR, Variable, 10K	Bourns	3511S-1-103
R7	RESISTOR, Variable, 25K	A-B	GA2G040P253AA
R8,9	RESISTOR, Variable, Dual, 10K/10K	Beckman	8106R10K/10K L.25
R10	RESISTOR, Variable, 100K	A-B	GA2G040P104AA
R11	RESISTOR, Variable, 10K	Vishay	1202YB-1-10K

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R21	RESISTOR, Composition, 5.6K, 5%, 1/4W	A-B	RC07GF562J
R22	RESISTOR, Composition, 51 ohm, 5%, 1/4W	A-B	RC07GF510J
S1	SWITCH, Pushbutton, Push/Push, 2 poles	Schadow	F2UEE
	LAMPLESS INDICATOR, Yellow	Schadow	08-01-06-01
	BRACKET, MTG, Switch 1 Module	Schadow	S010-10
	KNOB, Round, with dot 1/8" Shaft	Rogan	PR-67-0-DC-M-D-1/8"
	KNOB, Round, without dot 1/8" Shaft	Rogan	PR-67-0-DC-M-1/8"
	KNOB, Round, without dot 1/4" Shaft	Rogan	PR-67-0-DC-M-1/4"
	KNOB, Round, with dot, 1/8" Shaft	Rogan	GR-50-WD
	CRT WITH SOCKET	Amperex	D7-222-GY
	Bezel, CRT	MTC	81C11-612
	Grid, CRT	MTC	81B100-104
	Filter, CRT	MTC	MTA-557
	Shield, CRT	Gerome	17D7

A1B1A1, ATTENUATOR SWITCH, FILTER BOX

FL1-FL10	FILTERCON	Erie	1203-050
S1	SWITCH, Dual, 0-99	Digitran	28501-2

A1B1A2, PHONE ASSEMBLY

	PHONE JACK, Shielded	Switchcraft	CN12-A
	CAPACITOR, Ceramic, 0.05uf, 20%, 100V	SPR	TG-S50
	DIODE, Germanium		1N3592

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
	FILTERCON	Erie	1201-066
	RESISTOR, Composition, 560 ohms, 5%, 1/4W		RC07GF561J

A1B1A3, PLANETARY DRIVE

	PLANETARY DRIVE SLIP CLUTCH	Vemaline Vemaline	C-4151-2 2022-B
	KNOB, Dual Speed, Outer	D&M	60C10-43
	KNOB, Dual Speed, Inner	Alco	KN1750-B-S
R4	RESISTOR, Variable, Film 10K, 10T	Beckman	8103R10KL.25

A1B2, REAR PANEL

CP1,2	ADAPTER, Panel Mount, N/SMA	Solitron	1132-6001
CP3,4	ADAPTER, Panel Mount, SMA/SMA	Solitron	SF2990-6005

A1B2A3, FILTER BOX, 0.03-18 GHz

FL1 to FL39	FILTER, LP, With Solder Ring	Erie	1203-050
J1	JACK, Panel Mount, Female, 41 Pin	Bendix	PT02A-20-41S

A1B3

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A1B3, INTERNAL CHASSIS			
E21	TERMINAL, Blue, #2-56	EMC	2503-91-6
R12	RESISTOR, Wirewound, 20 ohms, 1%, 10W	Dale	RH-10-20 ohms
R13	RESISTOR Wirewound, 7.5 ohms, 1%, 10W	Dale	RH-10-7.5 ohms
R14	RESISTOR, Wirewound, 2 ohms, 1%, 10W	Dale	RH-10-2 ohms
R15	RESISTOR, Wirewound, 3 ohms, 1%, 10W	Dale	RH-10-3 ohms
R16	RESISTOR, Composition, 2.2K, 5%, 1/4W		RC07GF222J
R22	RESISTOR, Metal Film, 9.7K, 1%, 1/8W		RN55D9761J
R23	RESISTOR, Metal Film, 4.99K, 1%, 1/8W		RN55D4991J
U1	INTEGRATED CIRCUIT, 1A, (3 pin) Voltage Regulator, 5V	Fairch	UA7805KC
U2	INTEGRATED CIRCUIT 5A, (4 pin), Voltage Regulator	Fairch	UA78HGASC
Z1	FILTER, BP, 160 MHz	K&L	4B120-160/20-S-P
A1B3, INTERNAL CHASSIS			
A11J9	JACK, Female, 16 Pin	Berg	65846-011
A53J1	JACK, Female, 20 Pin	Berg	65846-006
A53J2	JACK, Female, 14 Pin	Berg	65846-007
C1	CAPACITOR, Electrolytic, 10uf, 25V	Mallory	TT25X10
C2,4	CAPACITOR, Electrolytic, 1.0uf, 25V	Mallory	TT25X1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
C3	CAPACITOR, Electrolytic, 2uf, 50V	Mallory	TT50X2
D4	DIODE, Silicon	GE	1N4148
E8	TERMINAL, Ground, #4-40	Cambion	160-2380-01-05

A1B3A1, PC BUCKET ASSEMBLY

A4B1J1, A4B2J1, A4B3J1, A4B4J1, A6B1J1, A6B2J1, A6B3J1, A7B1J1	JACK, PC Edge, 2x18 Pin	Viking	2VH18/1AN5
A4B5J1	JACK, PC Edge, 2x28 Pin	Viking	3VH28/1CN5
E1-7, E9	TERMINAL, Blue	EMC	2503-91-6

A1B6, SEMI-RIGID COAXIAL HARNESS

J6	JACK, Panel Mount, .085	Solitron	2933-6004
P3,4,5,6,9, 10,11,14,21, 28,A3B1P1	PLUG, Straight, .085, SMA	Solitron	SF2906-6002
A36P1	PLUG, Straight, .085, SMC	AEP	152-085

A1B7, WIRING HARNESS

A2P2	PLUG, Male, "D", 25 Pin	Cinch	DBM25P
A3J2, A5P1	JACK, Female, "D", 9 Pin	Cinch	DEM 9S
A3P1	PLUG, Female, "D", 25 Pin	Cinch	DBM25S
A7B3J1	JACK, Edge, P.C., 2 X 10 Pin	Viking	2VH10/1AN5
A8P1	JACK, Female, 41 Pin	Bendix	PT06A-20-41S
A10P1	JACK, Female, 15 Pin	Cinch	DAM15S

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A11J8, A11J10	JACK, Female, 44 Pin	Berg	65846-004
A13J1	JACK, Female, 20 Pin	Berg	65846-006
P7	PLUG, Male, Filtered, 37 Pin	Amp-C	859758-1
P36	PLUG, Male, Filtered, 15 Pin	Amp-C	859756-1

A1B9, COAXIAL FLEXIBLE HARNESS

J3,5,8,9, 10,14,15	JACK, BNC, Bulkhead, BNC	AMPH	86350-1050
P1,2,A12P1,	PLUG, Right Angle, RG-316/U, SMA	Solitron	SF2913-6001
A36P3	PLUG, STR., RG-316/U, SMC	AMP	51749-1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A2, POWER SUPPLY			
C1	CAPACITOR, Electrolytic, 210uf, 200V	Mallory	TCG211T200N2C3P
C25	CAPACITOR, Tantalum, 15uf, 20V	Kemet	T310B156K020AS
D13	SURGE SUPPRESSOR	Semtech	1N6150
D23,24	SURGE SUPPRESSOR	Gen Sem	1.5KE250A
E1,2	TERMINAL	EMC	2503-91-6
E3,4	TERMINAL	Cambion	572-4838-01-0516
E5,6,7,8	TERMINAL, 2-56	Cambion	572-4887-01-0516
F2	FUSE, AC Line, 2A, SB, 250V	Littelfuse	313002.
FL2-8	FILTERCON	Amp-C	859618-1
J1	JACK, DC Input, 4 Pin	Cinch	JFA2-S
J2	JACK, Power, 25 Pin	Cinch	DAM-25S
L1,8	CHOKE, 68uh, 5A	JW Miller	5248
L5	COIL ASSEMBLY Toroid	M-T Arnold	M88A20-308-4 A206068-2
R31	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
S1	SWITCH, Slide, DPDT	Switchcraft	46206LRF
T1	TRANSFORMER, Power 115/230V	BTC	BX-8629
T3	TRANSFORMER, Switching Core Bobbin	MTC Ferrox Ferrox	M92B20-302 EC52-3C8 52-PTB
XF1,2	FUSEHOLDER	Littelfuse	342004

A2B1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A2B1, CONTROL			
C2	CAPACITOR, Electrolytic, 150uf, 35V	C-D	WBR-150-35
C3	CAPACITOR, Tantalum, 10uf, 10%, 35V	Kemet	T310C106K035AS
C4	CAPACITOR, Film, 3300pf, 10%, 80V	Spr	192P3329R8
C5	CAPACITOR, Ceramic, 0.1uf, 20%, 100V	Erie	8131-100-651-104M
C6,7	CAPACITOR, Tantalum, 2.2uf, 10%, 20V	Kemet	T310A225K020AS
C27	CAPACITOR, Tantalum, 6.8uf, 10%, 6V	Kemet	T310A686K006AS
D1,2,3,4,6,7, 8,9,10,11,12	DIODE, Silicon, Signal	GE	1N4148
D5	DIODE, Silicon	Mot	1N4001
D22	DIODE, Zener, 7.5V, 0.5W	Mot	1N5236
DA1	FWBR, 1.5A, 400V	Mot or Semtech	MDA942A-5 SBEB-4
DA2	FWBR, 1.5A, 100V	Mot or Semtech	MDA942A-2 SBEB-1
E1-12	TERMINAL, Rollover	Useco	2520B
L1	INDUCTOR Toroid	M-T Arnold	M88A20-308-1 A143067-2
Q1,2,3,4,5	TRANSISTOR, TO-5, PNP	Mot	2N2905A
Q6	TRANSISTOR, Plastic, NPN	Mot	2N3904
Q8,10	TRANSISTOR, TO-18, NPN	Mot	2N2222
R1	THERMISTOR, 5 ohms at RT	Rodan	SG-4
R2	RESISTOR, Composition, 100K ohms, 5%, 1/2W		RC20GF104J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R3,62	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R4	RESISTOR, Met. Film, 8.25K, 1%, 1/8W		RN55D8251F
R5,12,13	RESISTOR, Composition, 47K, 5%, 1/4W		RC07GF473J
R6,7	RESISTOR, Composition, 6.8K, 5%, 1/4W		RC07GF682J
R8,9	RESISTOR, Composition, 2.2K, 5%, 1/4W		RC07GF222J
R10,11	RESISTOR, Composition, 2.7K, 5%, 1/4W		RC07GF272J
R14	RESISTOR, Met. Film, 10.0K, 1%, 1/8W		RN55D1002F
R15	RESISTOR, Variable, 10K, 1/2W	Beckman	62PAR10K
R16,18,20	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R17	RESISTOR, Composition, 33K, 5%, 1/4W		RC07GF333J
R19	RESISTOR, Composition, 200K, 5%, 1/4W		RC07GF204J
R21	RESISTOR, Met. Film, 1650 ohms, 1%, 1/8W		RN55D1651F
R22	RESISTOR, Variable, 2K, 1/2W	Beckman or Bourns	62PAR2K 3329W1-202
R23	RESISTOR, Met. Film, 4320 Ohms, 1%, 1/8W		RN55D4321J
R24,25,26,27	RESISTOR, Composition, 56 ohms, 5%, 1/4W		RC07GF560J
T2	TRANSFORMER	M-T	M92A21-393
	Core	Ferrox	RM8P-L00-3B9
	Bobbin	Ferrox	RM8-8CB1-4
	Clip	Ferrox	991-393-00

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U1	INTEGRATED CIRCUIT Regulator Control	Mot	MC3420P
U2	INTEGRATED CIRCUIT, Dual OP AMP	Mot	MC3403P

A2B2, RECTIFIER & FILTERS

E2,3,5,6, 8,9,10	TERMINAL Rollover	Cambion	1457-2
C9	CAPACITOR, Electrolytic, 200uf, 2%V	C-D	NLW200-25
C11,13	CAPACITOR, Electrolytic, 100uf, 50V	C-D	NLW100-50
DA3	FWBR, 5A	Varo	VH248-X
L2	COIL ASSEMBLY Toroid	M-T Arnold	M92A20-394-2 A442105-2
L3,4	COIL ASSEMBLY Toroid	M-T Arnold	M92A20-394-3 A442105-2

A2B3, REGULATORS

C12,15	CAPACITOR, Ceramic, .33uf, 50V	Spr	2CZ5U334D8050C4
C16,28	CAPACITOR, Tantlaum, 2.2uf, 10%, 35V	Kemet	T310B225K035AS
C17,19	CAPACITOR, Ceramic, .1uf, 20%, 100V	Erie	8131-100-651-104M
C18,21,22	CAPACITOR, Tantalum, 10uf, 10%, 35V	Kemet	T310C106K035AS
C20,23,24	CAPACITOR, Tantalum, 10uf, 10%, 20V	Kemet	T310B106K020AS
R45	RESISTOR, Metal Film, 8.87K, 1%, 1/8W		RN55D8871F

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R37,43,46	RESISTOR, Variable, 2K, 1/2W	Beckman	62PAR2K
R38,41	RESISTOR, Metal Film, 5.11K, 1%, 1/8W		RN55D5111F
R36	RESISTOR, Metal Film, 5.90K, 1%, 1/8W		RN55D5901F
R39	RESISTOR, Metal Film, 649 ohms, 1%, 1/8W		RN55D6491F
R40	RESISTOR, Variable, 500 ohms, 1%, 1/8W	Beckman	62PAR500
R42	RESISTOR, Metal Film, 11.8K, 1%, 1/8W		RN55D1182F
R44,47,50,51,53	RESISTOR, Metal Film, 2.21K, 1%, 1/8W		RN55D2211F
R48	RESISTOR, Metal Film, 3.32K, 1%, 1/8W		RN55D3321F
R49,52	RESISTOR, Variable, 1K, 1/2W	Beckman	62PAR1K
TP2 thru TP7	TEST POINT, Several Colors	EF Johns	105-11XX-001
U5,6	VOLTAGE REGULATOR, 4 Pin, Positive	Fairchd	UA78GU1C
U7,8,9,10	VOLTAGE REGULATOR, 4 Pin, Negative	Fairchd	UA79GU1C
XU7,8,9,10	INSULATOR, Plastic	Bergquist	7403-09FR-54

A2B4, INVERTERS & RECTIFIERS

C26,27	CAPACITOR, Electrolytic, 50uf, 25V	C-D	NWL50-25
D14,19	DIODE, Silicon, 400V	Mot	1N4936

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
DA-4	FWBR, 5A	Varo	VH-248X
E2,3,4,5,9,11	TERMINAL, 2-56	EMC	2503-14-1
E6,10	TERMINAL, Ground	Cambion	160-2380-01-05
L6,7	COIL ASSEMBLY	MTC	M92A20-394-5
Q7,9	TRANSISTOR, Power, TO-3, 1KV	Mot	MJ12002

A2B5, FILTER BOX, AC

C2,3	CAPACITOR, Metal Mylar, .47uf, 20%, 400V	Electrocube	230B1E474
FL10,11	FILTER, LP (AC), 1A	Spectrum Control	51-321-610
J3	JACK, (AC Input), 3 Pin, Male	Bendix	PT02A-8-3P
R1,2	RESISTOR, Composition, 1 Meg, 5%, 1/4W		RC07GF105J

A2-T3, TRANSFORMER

T3	TRANSFORMER		
	Core	Ferroxcube	EC52-3C8
	Bobbin	Ferroxcube	52-PTB
	U-bolt	Ferroxcube	52-U
	Terminal	Ferroxcube	991-430-00
D17,18	DIODE, Power	Unitrode	1N5816

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B1, 250 MHz AMPLIFIER/ATTENUATOR			
C1, 2, 3, 4, 5, 6	CAPACITOR, Ceramic, 1000 pf, 10%, 100V	Erie	8111-100-X7R0102K
C7, 8, 9, 10, 11,	CAPACITOR, Ceramic .1uf, 20%, 100V	Erie	8121-100-Z5U104M
C12	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390C106M025AS
FL1, 2, 3	FILTERCON	Amp	859618-1
J1, 2, 3, 4	CONNECTOR, SMA	OSM	2052-1350-02
R1, 2, 3, 4 5	RESISTOR, Composition, 10 ohms, 5%, 1/8W	A-B	RC05GF100JS
R6, 7	RESISTOR, Composition, 15 ohms, 5%, 1/8W	A-B	RC05GF150JS
R8	RESISTOR, Composition, 68 ohms, 5%, 1/8W	A-B	RC05GF680JS
U1	AMPLIFIER	Q-Bit	QBH-101
U2, 4	ATTENUATOR	W-J	WJ-G1
U3	AMPLIFIER	W-J	EA-5
U5	AMPLIFIER	Avantek	GPD-464
U6, 7	DIVIDER	Anzac	DS-109
A3B2, 250 MHz FILTERS			
C1, 2, 3	CAPACITOR, Ceramic, 100 pf, 20%	Erie	8121-100-651-102M
FL1	FILTER, Miniature, 30 MHz	K&L	A4IB10-250/30-P/P
FL2	FILTER, Miniature, 5 MHz	K&L	B4IB10-250/5-P/P
FL3, 4, 5	FILTERCON	Amp-C	859618-1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
J1, 2	CONNECTOR, SMA	OSM	2052-1350-02
K1, 2, 3, 4	RELAY, DPDT 15V	G-E	3SBC1833A2

A3B3, 250 MHz FILTERS

C1, 3	CAPACITOR, Ceramic, 1000 pf, 10%, 100V	Erie	8111-100XR0102K
C2, 4, 6	CAPACITOR, Ceramic, .1 uf, 20%, 100V	Erie	8121-100-Z5U104M
C9	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390C106M025AS
FL1	FILTER, Feed Thru	Amp	859618-1
J1, 2, 3, 4	CONNECTOR, SMA	OSM	2052-1350-02
R1, 2, 3	RESISTOR, Composition 10 ohm, 5%, 1/8W	A-B	RC05GF100JS
U1	AMPLIFIER	Avantek	GPD-464
U2, 4	POWER SPLITTER	Anzac	DS-109
U3, 5	AMPLIFIER	Avantek	GPD-201

A3B4, 250 MHz LIMITING AMPLIFIER

C1, 3, 5, 7	CAPACITOR, Ceramic, 1000 pf, 100V	Erie	8111-100X7R0102K
C2, 4, 6	CAPACITOR, Ceramic, .1uf, 20%, 100V	Erie	8121-100-Z5U104M
C7	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390C106M025AS
FL1	FILTERCON	Amp	859618-1
FL2	FILTER, Miniature, 250/70	K&L	3IB10-250/70-P/P

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
J1, 2	CONNECTOR, SMA	OSM	2052-1350-02
R1, 2, 3	RESISTOR, Composition 10 ohms, 5%, 1/8W	A-B	RC05GF100JS
U1, 2, 3	LIMITER AMPLIFIER	W-J	WJ-LA7

A3B5, 250 MHz AM DETECTOR/AGC AMPLIFIER

C1, 2, 5	CAPACITOR, Ceramic, 1000 pf	Erie	8121-100-X7RA-102K
C3, 11, 13, 16	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390C106M025AS
C4	CAPACITOR, Ceramic, 470 pf	Erie	8111-050-C0G0-471K
C6, 12, 14, 15	CAPACITOR, Ceramic, .1 uf,	Erie	8121-M100651-104
C7	CAPACITOR, Variable, 5-25 pf	Erie	518-000A-5-25
C8	CAPACITOR, Tantalum, 1 uf, 25V	Kemet	T390A105M025AS
C9, 10	CAPACITOR, Ceramic, 10 pf, 5%, 500V	Q-C	Gimmick 10pf
D1	DIODE, Schottky	H-P	HSCH-3486
FL1,2,3,4,5,6	FILTERCON	Amp	859618-1
J1, 2	CONNECTOR, SMA	OSM	2052-1350-02
Q1	TRANSISTOR	Mot	2N6304
Q3, 4	TRANSISTOR, FET		2N5432
R1	RESISTOR, Composition, 3.3K, 5%, 1/8W	A-B	RC05GF332J
R2	RESISTOR, Composition, 6.8K, 5%, 1/8W	A-B	RC05GF682J

A3B5

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R3	RESISTOR, Composition, 390 ohms, 5%, 1/8W	A-B	RC05GF391J
R4	RESISTOR, Composition, 270 ohms, 5%, 1/8W	A-B	RC05GF271J
R5,24,26	RESISTOR, Composition, 47K, 5%, 1/8W	A-B	RC05GF473J
R6	RESISTOR, Composition, 1.8K, 5%, 1/8W	A-B	RC05GF182K
R7, 12, 13, 23, 25, 27	RESISTOR, Composition, 10K, 5%, 1/8W	A-B	RC05GF103J
R8	RESISTOR, Composition, 180 ohms, 5%, 1/8W	A-B	RC05GF181J
R9, 15	RESISTOR, Composition, 1K, 5%, 1/8W	A-B	RC05GF102J
R10, 16, 17, 19, 20	RESISTOR, Composition, 10 ohms, 5%, 1/8W	A-B	RC05GF100J
R11	RESISTOR, Variable, 2K	Bourns	3339P-1-202
R14	JUMPER		
R29,31,32	RESISTOR, Composition, 300 ohms, 5%, 1/8W	A-B	RC05GF301J
R30	RESISTOR, Composition, 18 ohms, 5%, 1/8W	A-B	RC05GF180J
U1	AMPLIFIER	Avantek	GPD-202
U2	INTEGRATED CIRCUIT, Op-Amp	Nat	LM1458N
U3	INTEGRATED CIRCUIT, Video Amp	Signetics	NE5539N
U4	INTEGRATED CIRCUIT, Buffer	Nat	LH0002CH
Q3, 4	TRANSISTOR, FET		2N5432

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B6, FM DISCRIMINATOR			
	PRINTED CIRCUIT BOARD		95B36-213B
C1, 2	CAPACITOR, Variable, 5-25 pf	Erie	518-000A-5-25
C3	CAPACITOR, Ceramic, 12 pf, 5%, 300V	Arco	DM05-120J
C4, 5, 8, 9	CAPACITOR, Ceramic, .1 uf, 20%, 100V	Erie	8121-100-6510104M
C6, 7	CAPACITOR, Variable, 2.5-9 pf	Erie	518-000A-2.5-9
C10	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390B-106M025AS
D1, 4	DIODE, Silicon	G-E	iN4148
D2, 3	DIODE, Schottky	H-P	HSCH-3486
FL1, 2, 3, 4 5, 6	FITERCON	Amp	859618-1
HY1, 2	COUPLER, 90° Hybrid	Anaren	1J0263-3
J1, 2	CONNECTOR, Jack, Bulkhead, SMA	EFJ	142-0293-001
K1	RELAY, DPDT, 12V	Teledyne	712-12
Q1, 2	TRANSISTOR, FET		2N5432
R1, 2, 3, 4	RESISTOR, Composition, 51 ohms, 5%, 1/4W	A-B	RC07GF510J
R5	RESISTOR, Composition, 510 ohms, 5%, 1/4W	A-B	RC07GF511J
R6	RESISTOR, Composition, 150 ohms, 5%, 1/4W	A-B	RC07GF151J
R7	RESISTOR, Composition, 22 ohms, 5%, 1/4W	A-B	RC07GF220J

A3B6

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R8, 13, 16	RESISTOR, Composition, 10K, 5%, 1/4W	A-B	RC07GF103J
R10	RESISTOR, Metal Film, 274 ohm, 1%, 1/8W	A-B	RN55D2740F
R11	JUMPER		
R12	RESISTOR, Metal Film, 150 ohm, 1%, 1/8W	A-B	RN55D1500F
R14, 15	RESISTOR, Composition 47K, 5%, 1/4W	A-B	RC07GF473J
U1	INTEGRATED CIRCUIT, Video Amp	Plessey	SL541C
U2	INTEGRATED CIRCUIT, 50 ohm Line Driver	Nat	LH0002CH
XU1, 2	PAN	Robison	RCT05030-2A

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B7, 250/21.4 MHz LOG AMPLIFIER			
	PRINTED CIRCUIT BOARD	Proto	92B37-231A
C1, 4, 9, 12 14	CAPACITOR, Ceramic, 1000 pf	Erie	8121-100-X7RA-102K
C2	CAPACITOR, Ceramic 5.1 pf, 5%, 300V	Q-C	Gimmick - 5.1 pf
C3, 7, 8	CAPACITOR, Variable, 2.5-9 pf	Erie	518-000A-2.5-9
C5, 15, 23, 24,	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390U06M025AS
C6, 10, 11, 13, 16, 20, 21, 22	CAPACITOR, Ceramic, .1 uf	Erie	8121M100-651-104
C17	CAPACITOR, Ceramic, .01 f	Erie	8121-100-651-103
C18, 25	CAPACITOR, Mica 91 pf	Arco	DM05-910J
C19	CAPACITOR, Mica 240 pf	Arco	DM05-241J
FL1, 2, 3, 4, 5, 6	FILTERCON	Amp	859618-1
J1, 2, 3	CONNECTOR, SMA	OSM	2052-1350-02
K1, 2, 3	RELAY	G-E	3SBC1833A2
L1	INDUCTOR, Air-Loop, .08 uH	M-T	
L2	INDUCTOR, Choke, 100 uh	Delevan	1025-68
Q1	TRANSISTOR	Mot	2N3904
Q2	TRANSISTOR	Mot	2N5179

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R1	RESISTOR, Composition, 51 ohms, 5%, 1/8W	A-B	RC05GF510J
R2, 3, 5, 8, 10, 12	RESISTOR, Composition, 27 ohms, 5%, 1/8W	A-B	RC05GF270J
R4, 6, 9, 11, 13, 29	RESISTOR, Composition, 1K, 5%, 1/8W	A-B	RC05GF102J
R7	RESISTOR, Composition, 620 ohms, 5%, 1/8W	A-B	RC05GF621J
R14,32	RESISTOR, Composition, 1.8K, 5%, 1/8W	A-B	RC05GF182J
R15, 28	RESISTOR, Composition, 470 ohms, 5%, 1/8W	A-B	RC05GF471J
R16	RESISTOR, Composition, 1.5K, 5%, 1/8W	A-B	RC05GF152J
R17	RESISTOR, Composition, 820 ohms, 5%, 1/8W	A-B	RC05GF821J
R18	RESISTOR, Composition, 220 ohms, 5%, 1/8W	A-B	RC05GF221J
R19	RESISTOR, Composition, 20K, 5%, 1/8W	A-B	RC05GF203J
R20, 23	RESISTOR, Composition, 13K, 5%, 1/8W	A-B	RC05GF133J
R21	RESISTOR, Composition, 4.7K, 5%, 1/8W	A-B	RC05GF472J
R22, 24	RESISTOR, Composition, 10K, 5%, 1/8W	A-B	RC05GF103J
R25	RESISTOR, Variable, 2K	Bourns	3339P-1-202
R26, 27, 30, 31	RESISTOR, Composition, 10 ohms, 5%, 1/8W	A-B	RC05GF100J
R32	RESISTOR, Composition, 1.8K, 5%, 1/8W	A-B	RC05GF182J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U1, 2, 6	INTEGRATED CIRCUIT, Log Amp, Dual	Plessey	SL1521C
U3, 4, 5	INTEGRATED CIRCUIT, Log Amp, Dual	Plessey	SL1523C
U7	INTEGRATED CIRCUIT, Video Amp	Signetics	NE5539N
U8	INTEGRATED CIRCUIT, Buffer, Driver	Nat	LH0002CH
XK2	INSULATOR	Thermalloy	7717-129
XU3	INSULATOR	Robison	RC-T05030-2

A3B8, 250 to 21.4 CONVERTER

	PRINTED CIRCUIT BOARD		92B38-224A
C1, 3, 7, 9	CAPACITOR, Ceramic, 1000 pf, 10%, 100V	Erie	8111-100X7R0102K
C2, 8	CAPACITOR, Ceramic, .1 uf, 20%, 100V	Erie	8121-100-Z5U-104M
C4, 6	CAPACITOR, Mica 330 pf, 5%, 300V	Arco	DM10-331J
C5	CAPACITOR, Mica, 56 pf, 5%, 300V	Arco	DM05-560J
C10	CAPACITOR, Tantalum, 10 uf, 20%, 25V	Kemet	T390C106M025AS
FL1	FILTERCON	Amp	859618-1
FL2	FILTER, Miniature	K & L	5IB10-250/8-P/P
J1, 2, 3, 4	CONNECTOR, SMA	OSM	2052-135-02
R1, 2	RESISTOR, Composition 10 ohms, 5%, 1/8W	A-B	RC05GF100J
R3, 4	RESISTOR, Composition, 300 ohms, 5%, 1/8W	A-B	RC05GF301J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R5	RESISTOR, Composition, 18 ohms, 5%, 1/8W	A-B	RCO5GF180J
U1, 2	INTEGRATED CIRCUIT, Amplifier	Avantek	GPD-462
U3	POWER DIVIDER	Anzac	DS-109
Z1	MIXER	Anzac	MD-108

A3B9, 228.6 MHz OSCILLATOR

	PRINTED CIRCUIT BOARD		95B113-217A
C1, 2	CAPACITOR, Ceramic, .01 uf	Erie	8121-050-651-103M
C3	CAPACITOR, Mica, 62 pf, 5%, 500V	Elm	DM5-620J
C4	CAPACITOR, Mica, 22 pf, 5%, 500V	Elm	DM5-220J
C5	CAPACITOR, Mica, 8.2 pf, 5%, 100V	Erie	8101-100-COHO-829D
C6, 7, 8, 15	CAPACITOR, Ceramic, 1000 pf, 100V	Erie	8121-100-X7RO-102M
C9	CAPACITOR, Tantalum, 2.2 uf, 25V	Kemet	T390B225M025AS
C10, 11, 13	CAPACITOR, Variable, 5-25 pf	Erie	518-000A-5-25
C12, 14	CAPACITOR, Ceramic, 1.5 pf, 5%, 500V	STKP	C80-51
FL1	FILTER, RFI	Amp	859618-1
J1	CONNECTOR, SMA, Female	EFJ	142-0293-001
L1	INDUCTOR, Molded, 1 uh	Delevan	1025-20
L2	INDUCTOR, Variable, .47 uh	Cambion	7107-09

A3B9

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
Q1	TRANSISTOR, NPN		2N3478
Q2, 3	TRANSISTOR, NPN		2N6304
R1	RESISTOR, Composition, 12K, 5%, 1/8W	A-B	RC05GF123JS
R2	RESISTOR, Composition, 2.2K, 5%, 1/8W	A-B	RC05GF222JS
R3	RESISTOR, Composition, 390 ohms, 5%, 1/8W	A-B	RC05GF391JS
R4	RESISTOR, Composition, 1K, 5%, 1/8W	A-B	RC05GF102JS
R5	RESISTOR, Composition, 51 ohms, 5%, 1/8W	A-B	RC05GF510JS
R6	RESISTOR, Composition, 27 ohms, 5%, 1/8W	A-B	RC05GF270JS
R7, 8	RESISTOR, Composition, 18 ohms, 5%, 1/8W	A-B	RC05GF180JS
R9	RESISTOR, Composition, 8.2K, 5%, 1/8W	A-B	RC05GF822JS
R10	RESISTOR, Composition, 3.9K, 5%, 1/8W	A-B	RC05GF392JS
R11	RESISTOR, Composition, 270 ohms, 5%, 1/8W	A-B	RC05GF271JS
R12	RESISTOR, Composition, 39 ohms, 5%, 1/8W	A-B	RC05GF390JS
R13	RESISTOR, Composition, 10K, 5%, 1/8W	A-B	RC05GF103JS
VR1	VOLTAGE REGULATOR, Negative, -12V		LM320-LZ-12
Y1	CRYSTAL 76.2 MHz	INT. CR	Type CS

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B10, 21.4 MHz FILTERS			
C1, 4, 7	CAPACITOR, Mica 47 pf, 5%, 300V	Arco	DM15-470J
C2, 5, 8	CAPACITOR, Variable, 7-40pf	Erie	518-000A-7-40
C3, 6	CAPACITOR, Gimmick	QC	2.2pf, 5%, 500V
C22	CAPACITOR, Ceramic, .1 uf, 20%, 100V	Erie	8111-100-Z5U-104M
C23	CAPACITOR, Tantalum, 10 uf, 20%, 25V	Kemet	T390C106M025AS
C24, 25	CAPACITOR, Ceramic, 1000 pf, 10%, 100V	Erie	8121-100-XR07-102M
FL1, 2, 3	FILTERCON	Amp-C	859640-1
J1, 2, 3	CONNECTOR, SMA	OSM	205201350-02
J4, 5	CONNECTOR, SMA	OSM	2052-1350-02
K1, 2	RELAY, DPDT, 15V	G-E	3SBC1833A2
R1	RESISTOR, Composition, 300 ohms, 5%, 1/8W	A-B	RC05GF301J
R2	RESISTOR, Composition, 18 ohms, 5%, 1/8W	A-B	RC05GF180J
R3	RESISTOR, Composition, 300 ohms, 5%, 1/8W	A-B	RC05GF301J
R7	RESISTOR, Composition, 10 ohm, 5%, 1/4W	A-B	RC07GF100J
U1	POWER DIVIDER	Anzac	DS-109
U2	INTEGRATED CIRCUIT, Amplifier	Avantek	GPD-462

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B11, 21.4 AM DET/AGC			
C1, 19	CAPACITOR, Tantalum, 10 uf, 20%, 25V	Kemet	T390B106M025AS
C3, 9, 11, 15, 16	CAPACITOR, Ceramic, .1 uf, 20%, 50V	Erie	8121-050-651-104M
C4, 5, 7, 8, 10	CAPACITOR, Ceramic, .01 uf, 20%, 50V	Erie	8121-050-651-103M
C12	CAPACITOR, Tantalum, 47 uf, 20%, 10V	Kemet	T390D476M010AS
C13	CAPACITOR, Tantalum, 10 uf, 20%, 25V	Kemet	T390A105M025AS
C14, 17	CAPACITOR, Mica, 160 pf, 5%, 300V	Arco	DM05-161J
C18	CAPACITOR, Tantalum, 4.7uf, 20%, 25V	Kemet	T350B475K025AS
D1	DIODE, Zener,	Mot	1N5240
D2	DIODE		!N4148
FL1, 3, 4, 5	FILTERCON	Amp-C	859618-1
J1, 2, 3	CONNECTOR, SMA	OSM	2052-1350-02
R1	RESISTOR, Composition, 51 ohms, 5%, 1/8W		RC05GF510J
R2, 6, 9, 12, 14	RESISTOR, Composition, 10 ohms, 5%, 1/8W		RC05GF100J
R7	RESISTOR, Composition, 20K, 5%, 1/8W		RC05GF203J
R8	RESISTOR, Composition, 390 ohm, 5%, 1/8W		RC05GF391J
R10	RESISTOR, Variable, 10K, 4 turns	Bourns	3339P-1-103
R11	RESISTOR, Variable, 1K, 4 turns	Bourns	339P-1-102

A3B11

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R13	RESISTOR, Composition, 27K, 5%, 1/8W		RC05GF273J
R15, 21, 23, 24	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
R16	RESISTOR, Composition, 510 ohms, 5%, 1/8W		RC05GF511J
R17	RESISTOR, Composition, 1K, 5%, 1/8W		RC05GF102J
R18, 19	RESISTOR, Composition, 10 ohms, 5%, 1/8W		RC05GF100J
R20	RESISTOR, Variable, 2K, 4 turns	Bourns	3339P-1-202
R22	RESISTOR, Composition, 4.3K, 5%, 1/8W		RC05GF432J
R25	RESISTOR, Composition, 5.1K, 5%, 1/8W		RC05GF512J
U1	INTEGRATED CIRCUIT, Amplifier	Avantek	GPD-201
U2	INTEGRATED CIRCUIT Amplifier	Mot	MC1590G
U3	INTEGRATED CIRCUIT, AM Detector	Mot	SL623
U4	INTEGRATED CIRCUIT, Video Amp	Signetics	NE5539N
U5	INTEGRATED CIRCUIT, Buffer	Nat	LH0002CH
U6	INTEGRATED CIRCUIT, Op Amp		LM741CP

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B12, 21.4 MHz FM DISCRIMINATOR			
C1, 6, 9, 10	CAPACITOR, Ceramic, .1 uf	Erie	8121-M100-651-104
C2	CAPACITOR, Ceramic, 4.7pf, 1%, 100V	Erie	8101-100-COHO-487D
C3, 4, 5	CAPACITOR, Ceramic, .01 uf	Erie	8121-M100-651-103
C7,8	CAPACITOR, Variable, 2.5-9 pf	Erie	518-000A-2.5-9
C11, 12	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390C106M025AS
C13	CAPACITOR, 15 pf		15N750
C14, 15	CAPACITOR, Ceramic, 22 pf	Erie	8111-100X7RO-102K
C16	CAPACITOR, 39uf		39N750
C17,18	CAPACITOR, Ceramic, 1.0 uf, 1%, 100V	Erie	8131-100-651-105M
FL1, 2, 3	FILTERCON	Amp-C	859640-1
J1, 2	CONNECTOR, SMA	OSM	2052-1350-02
L1	INDUCTOR, Molded, 1.0uh	Delevan	1025-20
L2	INDUCTOR, Molded, 2.2 uh	Delevan	1025-28
Q1	TRANSISTOR, FET		2N5432
R1,23	RESISTOR, Composition, 1K, 5%, 1/8W	A-B	RC05GF102J
R2	RESISTOR, Composition, 2K, 5%, 1/8W		RC05GF202J
R3, 5	RESISTOR, Composition, 51 ohm, 5%, 1/8W	A-B	RC05GF510J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R4, 8, 21, 22, 24, 25	RESISTOR, Carbon, 10 ohms, 5%, 1/8W	A-B	RC05GF100J
R6	RESISTOR, Composition, 2.2K, 5%, 1/8W	A-B	RC05GF222J
R7	RESISTOR, Composition, 4.7K, 5%, 1/8W	A-B	RC05GF472J
R9,16,19	RESISTOR, Composition 10K, 5%, 1/8W	A-B	RC05GF103J
R13	RESISTOR, Composition, 5.1K, 5%, 1/8W	A-B	RC05GF512J
R14	RESISTOR, Variable, 2K	Bourns	3339P-1-202
R15	RESISTOR, Composition, 22 ohms, 5%, 1/8W	A-B	RC05GF220J
R17	RESISTOR, Composition, 200 ohms, 5%, 1/8W	A-B	RC05GF201J
R18	RESISTOR, Composition, 2.4K, 5%, 1/8W	A-B	RC05GF242J
R20	RESISTOR, Composition, 47K, 5%, 1/8W	A-B	RC05GF473J
U1	INTEGRATED CIRCUIT, IF Amplifier	Mot	MC1590G
U2	INTEGRATED CIRCUIT, FM Detector	RCA	CA3089E
U4	INTEGRATED CIRCUIT, Video Amp	Plessey	SL541C
U5	INTEGRATED CIRCUIT, Buffer	Nat	LH0002CH
XU2	SOCKET		10316-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A3B13, AM/FM/LOG SWITCHING			
C1, 2	CAPACITOR, Ceramic,	Erie	8121-M100-651-103M
FL1, 2	FILTERCON	Amp-C	859640-1
J1, 2, 3, 4, 5, 6, 7	JACK, SMA	EFJ	142-0293-001
K1, 2	RELAY, DPDT, 15V	GE	3SBC1833A2
P1	PLUG, Filtered, 9 Pin, Male	AMP	859755-1
R1	RESISTOR, Composition, 470 ohm, 5%, 1/4W	A-B	RC07GF471J
R2, 3	RESISTOR, Composition, 1K, 5%, 1/4W	A-B	RC07GF102J
R4	RESISTOR, Composition, 9.1K, 5%, 1/4W	A-B	RC07GF912J
R5	RESISTOR, Composition, 56K, 5%, 1/4W	A-B	RC07GF563J
R6	RESISTOR, Composition, 180K, 5%, 1/4W	A-B	RC07GF184J
R7	RESISTOR, Composition, 820K, 5%, 1/4W	A-B	RC07GF824J
R8, 10	RESISTOR, Composition, 51 ohms, 5%, 1/4W	A-B	RC07GF510J
R9	RESISTOR, Composition, 10K, 5%, 1/4W	A-B	RC07GF103J
A3B14, CRYSTAL FILTER			
FL1	FILTER, Crystal, 100 KHz BW	V.S. Network	VSC-297
J1, 2	CONNECTOR, SMA	OSM	2062-0000-00

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REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A4B1, BAND CONTROL			
C1, 2, 3, 4	CAPACITOR, Electrolytic, 10 uf, -10/+75, 25V	Mallory	TT25 X 10
D1, 2, 3, 4, 5	DIODE, Silicon	GE	1N4148
Q1, 5, 10,	TRANSISTOR, PNP	Mot	2N3906
Q2, 6, 11	TRANSISTOR, NPN	Mot	2N3904
Q3, 7, 8	TRANSISTOR, PNP, Power	Mot	MJE2901
Q4, 9, 12, 13	TRANSISTOR, PNP, Power	Mot	2N5193
Q14	TRANSISTOR, NPN, Power	Mot	2N5190
R1, 2, 4, 9, 10, 12, 20, 21,24,27,30	RESISTOR, Composition, 10K, 5%, 1/4W	A-B	RC07GF103J
R3, 11	RESISTOR, Composition, 2.2K, 5%, 1/4W	A-B	RC07GF222J
R5, 13, 25	RESISTOR, Composition, 20K, 5%, 1/4W	A-B	RC07GF203J
R6	RESISTOR, Composition, 470 ohms, 5%, 1/2W	A-B	RC20G471J
R7, 15, 17	RESISTOR, Composition, 10K, 5%, 1/8W	A-B	RC05GF103J
R8, 28	RESISTOR, Composition, 2K, 5%, 1/4W	A-B	RC07GF202J
R14	RESISTOR, Composition, 270 ohms, 5%, 1/2W	A-B	RC20GF271J
R16	RESISTOR, Composition, 150 ohms, 5%, 1/2W	A-B	RC20GF151J
R18	RESISTOR, Composition, 1.5K, 5%, 1/4W	A-B	RC07GF152J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R19	RESISTOR, Composition, 1K, 5%, 1/4W	A-B	RC07GF102J
R22, 23	RESISTOR, Composition, 7.5K, 5%, 1/4W	A-B	RC07GF752J
R26	RESISTOR, Composition, 620 ohms, 5%, 1/4W	A-B	RC07GF621J
R29	RESISTOR, Composition, 3K, 5%, 1/4W	A-B	RC07GF302J
R31	RESISTOR, Composition, 100K, 5%, 1/4W	A-B	RC07GF104J
R32	RESISTOR, Composition, 47K, 5%, 1/4W	A-B	RC07GF473J
RA1, 2, 3, 4	RESISTOR NETWORK, 5 X 4.7K, 2%	Mepco	9S06E13A4701GL002
U1	INTEGRATED CIRCUIT, Dual-Input "and" Gate	Nat	MM74C08
U2	INTEGRATED CIRCUIT, Dual Peripheral Driver	Mot	MC75451
U3	INTEGRATED CIRCUIT, Hex Driver, CMOS	RCA	CD4049UB
U4, 5	INTEGRATED CIRCUIT, Quan PIN Driver	SPR	UDN-5791A
U6	INTEGRATED CIRCUIT, Quan Dual Input "NOR" Gate	Nat	MM74C02N
XU1, 6	SOCKET, 14 Pin DIL	EMC	10314-01-445
XU2	SOCKET, 8 Pin, DIL	EMC	10308-01-445
XU3, 4, 5	SOCKET, 16 Pin, DIL	EMC	10316-01-445
XQ1, 2, 5, 6, 10, 11	SPREADER	Goudebrod	EXP-002

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
XQ3, 7, 8	INSULATOR	Bergquist	7403-09FR-54
XQ4, 9, 12, 13	INSULATOR	Bergquist	7403-09FR-50

A4B2, I.F. BANDWIDTH CONTROL

C1, 2, 3, 4	CAPACITOR, Tantalum, 10 uf, 25V	Kemet	T390C106M025AS
C5, 6	CAPACITOR, 470 pf		DM10-470
D1, 2, 3, 4, 5, 6	DIODE		1N4148
Q1, 3, 5	TRANSISTOR		2N3906
Q2, 4, 6, 7, 9, 11, 12, 13, 15	TRANSISTOR		2N3904
Q8, 10, 14	TRANSISTOR		2N2905
R1, 2, 3, 4, 20,22,23,25, 26,28,29,30,37, 45,48,49,50,54, 55,57,58,62,63	RESISTOR, Composition, 10K, 5%, 1/8W	A-B	RC05GF103J
R6, 7, 47, 53, 56	RESISTOR, Variable, 4 turns, 2K	Bourns	3339W-1-202
R8, 10, 12, 14, 35	RESISTOR, Composition, 1.2K, 5%, 1/8W	A-B	RC05GF122J
R9, 11, 13	RESISTOR, Variable, 1K, 10 turn	Mepco	8035EKP102F1
R15, 16, 17, 18, 36	RESISTOR, Composition, 4.7K, 5%, 1/8W	A-B	RC05GF472J
R19, 51, 52	RESISTOR, Composition, 1K, 5%, 1/8W	A-B	RC05GF102J
R21, 24, 27	RESISTOR, Composition, 2.7K, 5%, 1/8W	A-B	RC05GF272J

A4B2

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R31, 33, 34, 42, 59	RESISTOR, Composition, 15K, 5%, 1/8W	A-B	RC05GF153J
R32, 43	RESISTOR, Composition, 750 ohms, 5%, 1/8W	A-B	RC05GF751J
R38, 39, 40, 41	RESISTOR, Composition, 33K, 5%, 1/8W	A-B	RC05GF333J
R44	RESISTOR, Composition, 30K, 5%, 1/8W	A-B	RC05GF303J
R46	RESISTOR, Variable, 5K	Bourns	3339W-1-502
R60, 61	RESISTOR, Composition, 2K, 5%, 1/8W	A-B	RC05GF202J
U1	INTEGRATED CIRCUIT, TTL	T-I	7407
U2, 6	INTEGRATED CIRCUIT, CMOS	RCA	CD4052B
U3	INTEGRATED CIRCUIT, Prom		TBP18SA030N
U4	INTEGRATED CIRCUIT, CMOS	RCA	CD4011B
U5, 7	INTEGRATED CIRCUIT, CMOS	RCA	CD4053B
U8, 9	INTEGRATED CIRCUIT, Op Amp	Nat	LM1458N
XQ1, 2, 3, 4, 5, 6, 7, 9, 11, 12, 13, 15	SPREADER		EXP-002
XQ8, 10, 14	INSULATOR		RCT0505A
XU1, 4	SOCKET, 14 Pin	EMC	10314-01-445
XU2, 3, 5, 6, 7	SOCKET, 16 Pin	EMC	10316-01-445
XU8, 9	SOCKET, 8 Pin	EMC	10308-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A4B3, CROSSBAND SWITCHING			
C1, 8, 13, 17	CAPACITOR, Electrolytic, 1uf, -10+75, 50V	Mallory	TT50 X 1
C2, 6, 7, 12, 18	CAPACITOR, Ceramic, .1 uf, 10%, 100V	Erie	8131-100-651-104M
C3, 4, 15	CAPACITOR, Ceramic, .01 uf, 20%, 100V	Sprague	TG-S10
C5	CAPACITOR, Ceramic, .001 uf, 20%, 1KV	Sprague	5GA-D10
C9, 10, 11, 14, 16	CAPACITOR, Mica, 300 pf, 5%, 500V	Elm	DM15-301J
D1, 2	DIODE, Silicon	GE	1N4148
D3	DIODE, Zener, 11V	Mot	1N5241
Q1, 2	TRANSISTOR, NPN, TO-18, Plastic	Mot	2N3904
R1, 24, 43, 59, 60, 61	RESISTOR, Metallic Film, 4.99K, 1%, 1/8W		RN55D4991F
R2,4,6,8,26, 28,30,32,34	RESISTOR, Variable, 500 ohms	Dale	784-500
R3, 29	RESISTOR, Metallic Film, 1.74K, 1%, 1/8W		RN55D1741F
R5, 31	RESISTOR, Metallic Film, 1.65K, 1%, 1/8W		RN55D1651F
R7, 33	RESISTOR, Metallic Film, 590 ohms, 1%, 1/8W		RN55D5900F
R9, 35	RESISTOR, Metallic Film, 845 ohms, 1%, 1/8W		RN55D8450F
R10, 11, 12	RESISTOR, Composition, 2M, 5%, 1/8W		RC05GF205J
R13	RESISTOR, Composition, 1M, 5%, 1/8W		RC05GF105J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R14, 15, 16, 18, 19, 20	RESISTOR, Composition, 100K, 5%, 1/8W		RC05GF104J
R17, 22	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
R21	RESISTOR, Composition, 22K, 5%, 1/8W		RC05GF223J
R23	RESISTOR, Composition, 33K, 5%, 1/8W		RC05GF333J
R25, 27	RESISTOR, Metal Film, 11.5K, 1%, 1/8W		RN55D1152F
R36, 38, 39, 41	RESISTOR, Metal Film, 10K, 1%, 1/8W		RN55D1002F
R37, 40, 42, 55,56,57,58	RESISTOR, Metal Film, 1K, 1%, 1/8W		RN55D1001F
R44, 46	RESISTOR, Metal Film, 75K, 1%, 1/8W		RN55D7502F
R45, 47	RESISTOR, Variable, 20K	Dale (or) Mepco	784-20K 8035-EKP-203
R48, 50	RESISTOR, Metal Film, 34K, 1%, 1/8W		RN55D3402F
R49, 51, 54	RESISTOR, Variable,	Dale (or) Mepco	784-10K 8035-EKP-103
R52	RESISTOR, Metal Film, 22.6K, 1%, 1/8W		RN55D2262F
R53	RESISTOR, Variable, 5K	Dale (or) Mepco	784-5K 8035-EKP-502
RA1	RESISTIVE NETWORK 8 X 10K	A-B (or) Bourns	316B103 4116R-001-103
RA2	RESISTIVE NETWORK 7 X 100K	A-B (or) Bourns	314B104 4114R-001-104
U1	INTEGRATED CIRCUIT, Quad Voltage Comparator	Nat	LM339N

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U2	INTEGRATED CIRCUIT, 8 Bit Priority Encoder	Mot	MC14532BCP
U3	INTEGRATED CIRCUIT, Hex Inverter	RCA	CD4049UB
U4	INTEGRATED CIRCUIT, Dual One-Shot	RCA	CD4098BE
U5, 9	INTEGRATED CIRCUIT, 8 Channel Multiplexer	RCA	CD4051BE
U6, 7, 8, 12, 13	INTEGRATED CIRCUIT, Low-Noise Op Amp	Nat	LM308AH
U10	INTEGRATED CIRCUIT, Current Amplifier	Nat	LH0002CH
U11	INTEGRATED CIRCUIT, Triple, 2 Chanel Multiplexer	RCA	CD4053BE
XQ1, 2	SPREADER	Gudebrod	EXP-002
XU1	SOCKET, 14 Pin	EMC	10314-01-445
XU2, 3, 4, 5, 9, 11	SOCKET, 16 Pin	EMC	10316-01-445
XU6, 7, 8, 12, 13	SPREADER, 8 Pin	Thermalloy	7717-245N
XU10	spacer	Robison	RC-T05030-2A

A4B4, DVM TRACKING

C1, 2, 3, 4	CAPACITOR, Tantalum, 1 uf, 10%, 35V	Kemet	T310A105K035AS
C5, 6, 7, 8	CAPACITOR, Ceramic, .1 uf, 10%, 100V	Erie	8131-100-651-104M
D1	DIODE, Silicon	GE	1N4148
K1	RELAY, Reed, SPST	GB	GB-835C-1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R1, 8, 17, 24	RESISTOR, Metal Film, 20K, 1%, 1/8W		RN55D2002F
R7, 37, 38	RESISTOR, Metal Film, 18.2K, 1%, 1/8W		RN55D1822F
R3, 6	RESISTOR, Metal Film, 17.4K, 1%, 1/8W		RN55D1742F
R4, 30, 41	RESISTOR, Metal Film, 15K, 1%, 1/8W		RN55D1502F
R5, 60	RESISTOR, Metal Film, 12.4K, 1%, 1/8W		RN55D1242F
R9,10,11,12, 13,14,15,16, 29,45,46,47, 48,49,50,51,52	RESISTOR, Variable, 1K	Mepco	8035-EKP-102
R18	RESISTOR, Metal Film, 715 ohms, 1%, 1/8W		RN55D7150F
R19, 22	RESISTOR, Metal Film, 1.91K, 1%, 1/8W		RN55D1911F
R20	RESISTOR, Metal Film, 4.32K, 1%, 1/8W		RN55D4321F
R21, 44	RESISTOR, Metal Film, 6.65K, 1%, 1/8W		RN55D6651F
R23, 26, 32, 34, 35, 36, 54, 62, 65	RESISTOR, Metal Film, 1K, 1%, 1/8W		RN55D1001F
R25, 31, 61, 63,64,66,67, 68,69,71,73	RESISTOR, Metallic Film. 10K, 1%, 1/8W		RN55D1002F
R27	RESISTOR, Metallic Film, 10.2K, 1%, 1/8W		RN55D1022F
R28	RESISTOR, Metallic Film, 6.04K, 1%, 1/8W		RN55D6041F

A4B4

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R33	RESISTOR, Metal Film, 7.15K, 1%, 1/8W		RN55D7151F
R39, 40	RESISTOR, Metal Film, 16.5K, 1%, 1/8W		RN55D1652F
R42	RESISTOR, Metal Film, 13.7K, 1%, 1/8W		RN55D1372F
R43, 59	RESISTOR, Metal Film, 9.53K, 1%, 1/8W		RN55D9531F
R53	RESISTOR, Metal Film, 787 ohms, 1%, 1/8W		RN55D7870F
R55, 56	RESISTOR, Metal Film, 2.49K, 1%, 1/8W		RN55D2491F
R57	RESISTOR, Metal Film, 3.92K, 1%, 1/8W		RN55D3921F
R58	RESISTOR, Metal Film, 5.76K, 1%, 1/8W		RN55D5761F
R70	RESISTOR, Metal Film, 4.99K, 1%, 1/8W		RN55D4991F
R72	RESISTOR, Variable, 2K	Mepco	8035-EKP-202
R74, 75, 76	RESISTOR, Composition, 10K, 5%, 1/4W	A-B	RCO7GF103J
U1, 2, 3, 4, 7	INTEGRATED CIRCUIT, Dual Op-Amp	RCA	CA1458E
U5, 6	INTEGRATED CIRCUIT, 8 Channel MPX	RCA	CD4051BE
XU1, 2, 3 4, 7	SOCKET, D.I.L., 8 Pin	EMC	10308-01-445
XU5, 6	SOCKET, D.I.L., 16 Pin	EMC	10316-01-445

A4B5

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A4B5, EXTERNAL CONTROL			
C1, 5, 6, 7	CAPACITOR, Ceramic, .1 uf, 10%, 100V	Erie	8131-M100-651-104M
C2	CAPACITOR, Electrolytic, 10uf, -10/+75, 25V	Mallory	TT22X10
C3, 4, 8	CAPACITOR, Ceramic, .01uf, 10%, 100v	Erie	8121-100-651-103M
D1, 2	DIODE, Silicon	GE	1N4148
Q1	TRANSISTOR, PNP	Mot	2N3906
Q2	TRANSISTOR, NPN	Mot	2N3904
R1,3,10,17,18, 21,23,28,33, 34,35,36,37, 40,41,42	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R2	RESISTOR, Composition, 220 ohm, 5%, 1/4W		RC07GF221J
R4, 5, 9, 29	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R6, 8, 31	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF104J
R7	RESISTOR, Composition, 300 ohm, 5%, 1/4W		RC07GF301J
R11, 12, 13, 14	RESISTOR, Composition, 200 ohm, 5%, 1/4W		RC07GF201J
R15, 25	RESISTOR, Composition, 3.9K, 5%, 1/4W		RC07GF392J
R16	RESISTOR, Composition, 470K, 5%, 1/4W		RC07GF474J
R19, 24, 32, 38	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R20	RESISTOR, Variable, 5K	Bourns	3329W-1-502

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R22	RESISTOR, Composition, 1.5K, 5%, 1/4W		RC07GF152J
R26	RESISTOR, Variable, 2K	Bourns	3329W-1-202
R27	RESISTOR, Variable, 10K	Bourns	3329W-1-103
R30	RESISTOR, Composition, 3.9M, 5%, 1/4W		RC07GF395J
R39	RESISTOR, Composition, 47K, 5%, 1/4W		RC07GF473J
R42	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
U1	INTEGRATED CIRCUIT, Timer	Signetics	NE555N
U2	INTEGRATED CIRCUIT, Hex Inverter, CMOS	RCA	CD4049UBE
U3	INTEGRATED CIRCUIT, Quad, 2-INP. "NOR"	Nat	MM74C02N
U4	INTEGRATED CIRCUIT, Hex Buffer	RCA	CD4050BE
U5, 10	INTEGRATED CIRCUIT, Dual Op-Amp	Nat	LM1458N
U6, 7	INTEGRATED CIRCUIT, 7 Channel MPX	RCA	CD4051BE
U8	INTEGRATED CIRCUIT, Triple 2 Channel MPX	RCA	CD4053BE
U9, 11	INTEGRATED CIRCUIT, Quad, 2- Inp. "AND"	Nat	MM74C08N
U12	INTEGRATED CIRCUIT, Dual Comparator	Nat	LM393N
XQ1, 2	SPREADER	Robison	RC-T018080-1
XU1, 5, 10, 12	SOCKET, 8 Pin	EMC	10308-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
XU2, 4, 6, 7, 8	SOCKET, 16 Pin	EMC	10316-01-445
XU3, 9, 11	SOCKET, 14 Pin	EMC	10314-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A5, FREQUENCY DISPLAY			
P1	PLUG, 9 Pin, Male	Cinch	DEM-9-P
A5B1, A/D CONVERTER			
C1	CAPACITOR, Ceramic, 0.1uf, 20%, 100V	Erie	8131-100-651-104M
C2	CAPACITOR, Film, 0.001uf, 10%, 100V	Spr	225P-1029/WD3
C3,5	CAPACITOR, Film, 1.00uf, 10%, 100V	GE	BA14A105A
C4	CAPACITOR, Mica, 300pf, 5%, 500V	Elm	DM15-301J
C6	CAPACITOR, Film, 0.22uf, 10%, 100V	Spr	225P2249/XD3
C7,8,9	CAPACITOR, Tantalum, 10uf, 10%, 20V	Kemet	T310B106K020AS
C10	CAPACITOR, Ceramic, 0.1uf, 20%, 50V	Erie	8101-100-651-104M
D1,2	DIODE, Silicon	GE	1N4148
DS1,2,3,4,5	DISPLAY, 7 Segment	HP	5082-7730
Q1,2,3,4,5,6	TRANSISTOR, NPN, Plastic	Mot	2N3904
R1	RESISTOR, Metallic Film, 20.0K, 1%, 1/8W		RN55D2002F
R2	RESISTOR, Metallic Film, 4.99K, 1%, 1/8W		RN55D4991F
R3	RESISTOR, Variable, 10K, 10%, 3/4W	Mepco	8035-EKP-103
R4,11	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF104J

A5B1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R5	RESISTOR, Composition, 2K, 5%, 1/4W		RC07GF202J
R6	RESISTOR, Composition, 2.7K, 5%, 1/4W		RC07GF272J
R7	RESISTOR, Composition, 36K, 5%, 1/4W		RC07GF363J
R8	RESISTOR, Composition, 300K, 5%, 1/4W		RC07GF304J
R9	RESISTOR, Composition, 510 ohms, 5%, 1/4W		RC07GF511J
R10	RESISTOR, Variable, 1K, 10%, 3/4W	Mepco	8035-EKP-102
R15,16,17,18, 19,20,21	RESISTOR, Composition, 220 ohms, 5%, 1/8W		RC05GF221J
R22	RESISTOR, Composition, 47K, 5%, 1/4W		RC07GF473J
R34	RESISTOR, Composition, 330 ohms, 5%, 1/8W		RC05GF331J
U1	INTEGRATED CIRCUIT, Amplifier	Fairch	UA741HC
U2	INTEGRATED CIRCUIT, Digital Processor	Intersil	ICL71C03ACPI
U3	INTEGRATED CIRCUIT, Digital Processor	Intersil	ICL8052CPD
U4	INTEGRATED CIRCUIT, Timer	Sign	NE555V
U6	INTEGRATED CIRCUIT Decoder, TTL	NSC	74LS47
XDS1,2,3,4,5,6	SOCKET, 14 Pin	EMC	10314-01-445
XU1	INSULATOR, 8 PIN	Robison	RC-T05140-8
XU2	SOCKET, 28 PIN	EMC	10628-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A5B2, REGULATOR AND 18-40 GHz OFFSET			
C10,11,12	CAPACITOR, Electrolytic, 100uf, -10/+150%, 25V	CDE	WBR-100-25
C13	CAPACITOR, Ceramic, 0.33uf, 10%, 50V	GE	75F4R5A334
C14	CAPACITOR, Tantalum, 22uf, 10%, 10V	Kemet	T310C226K010AS
C15	CAPACITOR, Film, 0.001uf, 10%, 100V	Spr	225P10291WD3
D3,4,5,6,7	DIODE, Silicon	GE	1N4148
R12,13,14	RESISTOR, Composition, 22 ohms, 5%, 1/2W		RC20GF220J
R23,24	RESISTOR, Composition, 2K, 5%, 1/4W		RC07GF202J
R25,26,27,28, 30,31,32	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF104J
R29	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
U5	INTEGRATED CIRCUIT REGULATOR, 5V	Fairch	UA7805UC
U7	INTEGRATED CIRCUIT 9's COMPLEMENTER	Nat	MC14561BCP
U8	INTEGRATED CIRCUIT FLIP-FLOP	Nat	MC14013BCP
U9	INTEGRATED CIRCUIT ADDER	Nat	MC14560BCP
U10	INTEGRATED CIRCUIT "NAND" Gate	Nat	MC14011BCP
XU5	INSULATOR		7403-09FR-54

A6B1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A6B1, TUNING GENERATOR, BOARD #1			
C1,5,11,14	CAPACITOR, Tantalum, 15u, 10%, 20V	Kemet	T310B156K020AS
C2,3,6,8,9, 10,13	CAPACITOR, Ceramic, 0.1uf, 10%, 50V	Erie	8131-100-651-104M
C4	CAPACITOR, Tantalum, 22uf, 10%, 15V	Kemet	T310B226K015AS
C7	CAPACITOR, Tantalum, 10u, 10%, 20V	Kemet	T310B106K020AS
C12	CAPACITOR, Mica, 510pf, 5%, 500V	Elm	DM15-511J
D1,2	DIODE, Silicon	GE	1N4148
Q3	TRANSISTOR, Plastic, NPN	Mot	2N3904
Q4	TRANSISTOR, Field Effect	Mot	2N4352
Q5	TRANSISTOR, Plastic, PNP	Mot	2N3906
R1,6,35,49, 50,51,52, 57,58,62, 63,64,65	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R2	RESISTOR, Metallic Film, 40.2K, 1%, 1/8W		RN55D4022F
R3	RESISTOR, Metallic Film, 3.01K		RN55D3011F
R4,13	RESISTOR, Variable, 20T, 10K	Mepco	8035-EKP-103
R5,7,10.18,55, 56	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R8,9,14,20, 21	RESISTOR, Metallic Film, 10.0K, 1%, 1/8W		RN55D1002F
R11	RESISTOR, Metallic Film, 20.0K, 1%, 1/8W		RN55D2002F

A6B1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R12	RESISTOR, Metallic Film, 4.99K, 1%, 1/8W		RN55D4991F
R15,22	RESISTOR, Metallic Film, 9.09K, 1%, 1/8W		RN55D9091F
R16	RESISTOR, Variable, 20T, 1K	Mepco	8035-EKP-102
R17	RESISTOR, Metal Film, 7.5K, 1%, 1/8W		RN55D7501
R23	RESISTOR, Composition, 20K, 5%, 1/4W		RC07GF203J
R24, 26, 28	RESISTOR, Variable, 20T,100K	Mepco	8035-EKP-104
R25	RESISTOR, Composition, 270K, 5%, 1/4W		RC07GF274J
R27	RESISTOR, Composition, 56K, 5%, 1/4W		RC07GF563J
R29	RESISTOR, Composition, 750K, 5%, 1/4W		RC07GF754J
R30	RESISTOR, Composition, 10M, 5%, 1/4W		RC07GF106J
R31	RESISTOR, Composition, 15K, 5%, 1/4W		RC07GF153J
R32	RESISTOR, Variable, 20T, 2K	Mepco	8035-EKP-202
R33,54	RESISTOR, Composition, 2.7K, 5%, 1/4W		RC07GF272J
R34,42,43, 44,47,59	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R45	RESISTOR, Composition, 510K, 5%, 1/4W		RC07GF514J
R46	RESISTOR, Composition, 220K, 5%, 1/4W		RC07GF224J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R48,53	RESISTOR, Composition, 150K, 5%, 1/4W		RC07GF154J
R60,61	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF104J
S1	SWITCH, 8 Poles	Vernitron	7095-8
U1,2,3	INTEGRATED CIRCUIT, Dual OP AMP	RCA	CA1458E
U5	INTEGRATED CIRCUIT, Quad Comparator	Nat	LM339N
U6	INTEGRATED CIRCUIT, Hex Inverter, TTL		74L05N
U7,8	INTEGRATED CIRCUIT, Quad, 2-Input "OR", CMOS		CD4071BE
U9	INTEGRATED CIRCUIT VCO	Intersil	ICL8038
U10	INTEGRATED CIRCUIT, Dual Flip-Flop, CMOS	RCA	CE4013BE
U11	INTEGRAED CIRCUIT, Dual One Shot, CMOS	RCA	CD4098BE
XQ3,4,5	SPREADER	Grodebrod	EXP002
XU1,2,3	SOCKET, 8 PIN	EMC	10308-01-445
XU5,6,7,8,9,10	SOCKET, 14 PIN	EMC	1034-01-445
XU11	SOCKET, 16 PIN	EMC	10316-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A6B2, TUNING GENERATOR, BOARD #2			
C1,2,3,4,7	CAPACITOR, Tantalum, 22uf, 20%, 25V	Kemet	T350B226K025AS
C5	CAPACITOR, Mica, 300uf, 5%, 300V	Elm	DM05-301J
C6	CAPACITOR, Tantalum, 22uf, 10%, 15V	Kemet	T310B226K015AS
C8,9	CAPACITOR, Ceramic, 0.001uf, 20%, 1KV	Spr	5GA-D10
R1,10,22,36	RESISTOR, Composition, 33 ohms, 5%, 1/4W		RC07GF330J
R2	RESISTOR, Metallic Film, 7.15K, 1%, 1/8W		RN55D7151F
R3,56	RESISTOR, Variable, 1K	Mepco	8035-EKP-102
R4,9,57,67	RESISTOR, Metallic Film, 4.99K, 1%, 1/8W		RN55D4991F
R5,8,18,19,23, 24,27,28,31, 41,60,63,64	RESISTOR, Metallic Film, 10K, 1%, 1/8W		RN55D1002F
R6,17,25,26, 35,39,43 59,62	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R7,20,29	RESISTOR, Metallic Film, 9.09K, 1%, 1/8W		RN55D9091F
R11	RESISTOR, Variable, 10K	Mepco	8035-EKP-103
R12	RESISTOR, Metallic Film, 16.9K, 1%, 1/8W		RN55D1692F
R13,44,46,58, 61,65,69	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R14,16,32	RESISTOR, Metal Film, 30.1K, 1%, 1/8W		RN55D3012F

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R15,21,30,33	RESISTOR, Variable, 2K	Mepco	8035-EKP-202
R34	RESISTOR, Metal Film, 3.92K, 1%, 1/8W		RN55D3921F
R37	RESISTOR, Composition, 22k, 5%, 1/4W		RC07GF223J
R38	RESISTOR, Composition, 18K, 5%, 1/4W		RC07GF183J
R40	RESISTOR, Composition, 150K, 5%, 1/4W		RC07GF154J
R42,49	RESISTOR, Metal Film, 1K, 1%, 1/8W		RN55D1001F
R45	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R47	RESISTOR, Metal Film, 2.94K, 1%, 1/8W		RN55D2941F
R48	RESISTOR, Composition, 2K, 5%, 1/4W		RC07GF202J
R50	RESISTOR, Metal Film, 1.50K, 1%, 1/8W		RN55D1501F
R51	RESISTOR, Metal Film, 3.01K, 1%, 1/8W		RN55D3011F
R52,53	RESISTOR, Metal Film, 4.42K, 1%, 1/8W		RN55D4421F
R54	RESISTOR, Metal Film, 6.04K, 1%, 1/8W		RN55D6041F
R55	RESISTOR, Metal Film, 10.5K, 1%, 1/8W		RN55D1052F
R66	RESISTOR, Metallic Film, 15.0K, 1%, 1/8W		RN55D1502F
R68	RESISTOR, Variable, 5K	Dale	784-5K

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R70,71	RESISTOR, Composition, 100K, 5%, 1/4W		RC05GF104J
TP1	TEST POINT, White	HHS	430
U1,2,3,4	DECADE COUNTER, CMOS	Nat	MM74C192N
U5,6,7,8,9, 11,12,13	DUAL OP AMP	RCA	CA1458E
U10	LOW NOISE OP AMP	Nat	LM308AH
U14	DECADE BCD D/A CONVERTER	Micronetwks	MN3300
U15,16	ANALOG SWITCH	A-D	AD7592DI
XU1,2,3,4,	SOCKET, 16 PIN, DIL	EMC	10316-01-445
XU5,6,7,8,9, 11,12,13	SOCKET, 8 PIN, DIL	EMC	10308-01-445
XU10	SPREADER	Cambion	7717-245N
XU14	SOCKET, 24 PIN, DIL	EMC	7024-265-5
XU15,16	SOCKET, 14 PIN, DIL	EMC	10314-01-445

A6B3, TUNING GENERATOR BOARD #3

C2,4	CAPACITOR, 25uf, -10/+75%, 25V	Mallory	TT25X25B
C3	CAPACITOR, .01uf, 100V	Spr	TG-S10
C5,6,7,9,11	CAPACITOR, 300pf, 5%, 500V	Elm	DM15-301J
C8,10	CAPACITOR, 10uf, -10/+75%, 25V	Mallory	TT25X10
D3	DIODE, Silicon, Signal	Mot	1N4148
D4,5	DIODE, Zener, Low Noise, 6.2V	Mot	1N827

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
Q1	TRANSISTOR, NPN	Mot	2N3904
Q2	TRANSISTOR, PNP	Mot	2N3906
R1, 2, 6, 10, 12, 13	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R3, 11, 42, 43	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF104J
R4, 40, 41	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R7, 16, 27	RESISTOR, Variable, 2K	Mepco	8035-EKP-202
R8	RESISTOR, Composition, 270K, 5%, 1/4W		RC07GF274J
R9, 15	RESISTOR, Composition, 33 ohms, 5%, 1/4W		RC07GF330J
R14	RESISTOR, Composition, 4.7K, 5%, 1.4W		RC07GF472J
R17, 20	RESISTOR, Metallic Film, 9.09K, 1%, 1/8W		RN55D9091F
R18, 19, 28, 29	RESISTOR, Metallic Film, 1K, 1%, 1/8W		RN55D1001F
R21, 22, 26, 32, 37	RESISTOR, Metallic Film, 10K, 1%, 1/8W		RN55D1002F
R23	RESISTOR, Metallic Film, 3.01K, 1%, 1/8W		RN55D3011F
R24	RESISTOR, Metallic Film, 5.90K, 1%, 1/8W		RN55D5901F
R25	RESISTOR, Composition, 2K, 5%, 1/4W		RC07GF202J
R30, 35	RESISTOR, Metallic Film, 1.21K, 1%, 1/8W		RN55D1211F
R31, 36	RESISTOR, Metallic Film, 4.99K, 1%, 1/8W		RN55D4991F

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R33,38	RESISTOR, Metallic Film, 7.15K, 1%, 1/8W		RN55D7151F
R34,39	RESISTOR, Variable, 1K	Dale	784-1K
U1,2	INTEGRATED CIRCUIT, Dual, OP AMP	RCA	CA1458E
U3	INTEGRATED CIRCUIT, Dual One-Shot	RCA	CD4098BE
U4,5,6,7,8	INTEGRATED CIRCUIT, Low-Noise, OP AMP	Nat	LM308AH
U9	INTEGRATED CIRCUIT, Current Amplifier	Nat	LH0002CH
U10,11	INTEGRATED CIRCUIT, Analog Switch	A-D	AD7592DI
TP1	TEST POINT, White	HHS	430
XU1,2	SOCKET, 8 PIN, DIL	EMC	10308-01-445
XU3,XK1	SOCKET, 16 PIN, DIL	EMC	10316-01-445
XU4,5,6,7,8,9	SPREADER, 8 PIN	Thermalloy	7717-245N
XU10,11	SOCKET, 14 PIN, DIL	EMC	10314-01-445
XQ1,2	SPREADER	Gudebrod	EXP-002

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A7B1, OSCILLATOR/FILTER TRACKING			
C1,2	CAPACITOR, Mica 300pf, 5%, 500V	Elm	DM15-301J
C3	CAPACITOR, Ceramic, 0.1uf, 10%, 100V	Erie	8131-100-651-104M
C4	CAPACITOR, Electrolytic, 10uf, -10/+75%, 25V	Mallory	TT25X10
R1,19,40, 58	RESISTOR, Metallic Film, 8.87K, 1%, 1/8W		RN55D8871F
R2,5,8,11,14, 17,20,23,26, 29,32,35,38, 41,44,47,50, 53,56,59	RESISTOR, Variable, Film, 500 ohms	Mepco	8035-EKP-501
R3	RESISTOR, Metallic Film, 1.00K, 1%, 1/8W		RN55D1001F
R4,10,16,28	RESISTOR, Metallic Film, 9.09K, 1%, 1/8W		RN55D9091F
R6,18	RESISTOR, Metallic Film, 787 ohms, 1%, 1/8W		RN55D7870F
R7	RESISTOR, Metallic Film, 7.87K, 1%, 1/8W		RN55D7871F
R9	RESISTOR, Metallic Film, 1.78K, 1%, 1/8W		RN55D1781F
R12,60	RESITOR, Metallic Film, 562 ohms, 1%, 1/8W		RN55D5620F
R13,43	RESISTOR, Metallic Film, 8.45K, 1%, 1/8W		RN55D8451F
R15	RESISTOR, Metallic Film, 931 ohms, 1%, 1/8W		RN55D9310F
R21	RESISTOR, Metallic Film, 887 ohms, 1%, 1/8W		RN55D8870F

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R22	RESISTOR, Metallic Film, 8.06K, 1%, 1/8W		RN55D8061F
R24	RESISTOR, Metallic Film, 2.10K, 1%, 1/8W		RN55D2101F
R25,37,52,55	RESISTOR, Metallic Film, 9.31K, 1%, 1/8W		RN55D9311F
R27	RESISTOR, Metallic Film, 232 ohms, 1%, 1/8W		RN5D2320F
R30	RESISTOR, Metallic Film, 487 ohms, 1%, 1/8W		RN55D4870F
R31,33	RESISTOR, Metallic Film, 9.76K, 1%, 1/8W		RN55D9761F
R34,49	RESISTOR, Metallic Film, 9.53K, 1%, 1/8W		RN55D9531F
R36,51	JUMPER		#26 AWG
R39	RESISTOR, Metallic Film, 196 ohms, 1%, 1/8W		RN55D1960F
R42	RESISTOR, Metallic Film, 634 ohms, 1%, 1/8W		RN55D6340F
R45	RESISTOR, Metallic Film, 1.07K, 1%, 1/8W		RN55D1071F
R46	RESISTOR, Metallic Film, 5.49K, 1%, 1/8W		RN55D5491F
R48	RESISTOR, Metallic Film, 3.92K, 1%, 1/8W		RN55D3921F
R54,57	RESISTOR, Metallic Film, 287 ohms, 1%, 1/8W		RN55D2870F
R61,62,65,66	RESISTOR, Metallic Film, 20.0K, 1%, 1/8W		RN55D2002F
R63,64,67,68, 71	RESISTOR, Metallic Film, 10.0K, 1%, 1/8W		RN55D1002F

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R69	RESISTOR Composition, 33 ohms, 5%, 1/4W		RCO7GF330J
R70	RESISTOR, Metallic Film, 1.5M, 1%, 1/8W		RN55D1504F
R72,73	RESISTOR, Metal Film, 1M, 1%, 1/8W		RN55D1004F
R74	RESISTOR, Metallic Film, 499K, 1%, 1/8W		RN55D4993F
TP1,2	TEST POINT, White	HHS	430
U1,2,3,4	INTEGRATED CIRCUIT, CMOS, Switch	RCA	CD4051BE
U5	INTEGRATED CIRCUIT, CMOS, Switch	RCA	CD4053BBE
U6,7	INTEGRATED CIRCUIT,	Nat	LM308AH
XU1,2,3,4,5	SOCKET, 16 PIN, DIL	EMC	10316-01-445
XU6,7	SPREADER	Cambion	7717-245N

A7B3, YIG DRIVERS

C1,9	CAPACITOR, Mica, 300pf, 5%, 500V	Elm	DM15-301J
C2,6	CAPACITOR, Mica, 0.1uf, 5%, 500V	Erie	8131-100-651-104M
C3,7	CAPACITOR, Tantalum, 15uf, 10%, 25V	Kemet	T390B156K025AS
C4,8	CAPACITOR, Ceramic, 0.001uf, 20%, 1KV	Spr	5GA-D10
C5	CAPACITOR, Tantalum, 10uf, 10%, 25V	Kemet	T390B106K025AS
K1	RELAY, SPDT	G-B	GB831A-4

A7B3

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R1,8	RESISTOR, Metallic Film, 10.0K, 1%, 1/8W		RN55D1002F
R3,5,7,10,12, 14	RESISTOR, Metallic Film, 1.00K, 1%, 1/8W		RN55D1001F
R4,11	RESISTOR, Metallic Film, 499K, 1%, 1/8W		RN55D4993F
R6,13	RESISTOR, Metallic Film, 1.05K, 1%, 1/8W		RN55D1051F
U1,3	INTEGRATED CIRCUIT, Low Noise OP AMP	Nat	LM308AH
U2,4	INTEGRATED CIRCUIT, Current Driver	Nat	LH0021CK
XK1	SOCKET, 14 PIN, DIL	EMC	10314-01-445
XU1,3	SOCKET, 8 Pin, DIL	EMC	10308-01-445
XU2,4	INSULATOR	Bergquist	7403-09FR-05

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A8, RF TUNER			
AT1	ISOLATOR, 8-19 GHz	West. Micr.	2JC-8019
C1	CAPACITOR, Ceramic, .1uf, 20%, 100V	Erie	8131-100-651-104M
CP2	ADAPTER, Straight, SMA, M/M	Solitron	SF2993-6001
D1,2,3,4	DIODE, Zener, Back-to-Back 60V	Unitrode	UDZ-860
DC1	COUPLER, Directional, 6 dB, 2-8 GHz	Narda	4244-6
DC2	COUPLER, Directional, 10 dB, 2-18 GHz	Narda	4203-10
FL40	FILTER, LP, Tubular, 2050 MHz	K&L	8L120-2050-0
FL41	FILTER, BP, Tubular, BW 3 = 25, 2330 MHz	K&L	5B120-2330/25-0/OP
FL42	FILTER, LP,Tubular 300 MHz	K&L	5L120-300-0
FL43	FILTER, YIG, 2-18 GHz	Avantek	SO82-1630
FL44	FILTER, BP, YIG, .48-2 GHz	S-D Mocrosource	SDYF-4021-103 MSP-95022
FL45	FILTER, LP	K&L	5L120-300-0
J1,3,6	JACK, Flange Mount, .085", SMA	Solitron	2933-6004
J2,7,8	JACK, Flange Mount, RG-316, SMA	Solitron	SF2950-6081
J9	JACK, .085 Cable, SMA	Solitron	2921-6002
P1-20,30-47	PLUG, .085", Coax, SMA	Solitron	SF2906-6002
P48	PLUG, SMA, Rt. Angle	Solitron	SF2913-6001
Q1	TRANSISTOR, PNP	Motorola	2N5193

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
RT1,2	TEMP. TRANSDUCER	A-D	AD590IF
Y1	OSCILLATOR, YIG, 2-8.25 GHz	Avantek	SO82-2391
Y2	OSCILLATOR, YIG, 8.25-18.25 GHz	Avantek	SO82-2392
Y4	OSCILLATOR, Phase Locked, 2080 MHz	Anghel	LOS2-004
Z1	MIXER, 0.03-2 GHz	Vari-L	DBM-601
Z2	SWITCH, PIN, SPDT, 250 MHz	Am Micr	SW-250-2R
Z3	SWITCH, PIN, SPDT, 2-18 GHz	Robinson	2016-KO5
Z4	MIXER, Double-Balanced, 2-18 GHz	Avantek	SX81-1612M
Z5	PAD, Miniature, SMA, 6dB	Midwest	444-6
Z6	SWITCH, PIN, SPDT, .03-2 GHz	Am Micr	SW-2000-2RA

A8B1, 250 MHz AMPLIFIER

FL1	FILTERCON	Amp-C	859640-1
J1,2	JACK, Bulkhead, SMA	EFJ	142-0293-001
U1	INTEGRATED CIRCUIT, Amplifier, 250 MHz	Q-Bit	QBH-101

A8B3, FILTER BOX, RF TUNER

FL1 to 39	FILTERCON	Erie	1203-050
J1	JACK, Panel Mount, 41 PIN, Male	Bendix	PT02A-20-41P

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A8B4, 0.03 - 2 GHz AMPLIFIER			
FL1	FILTERCON	Amp-C	859640-1
J1	JACK, Bulkhead, SMA	EFJ	142-0293-001
J2	JACK, Flange Mount, Right Angle, SMA	OSM	224SF
U1	INTEGRATED CIRCUIT, Amplifier, 10-2000 MHz	W-J	A34
A8B6, 2330 AMPLIFIER, MIXER AND 250 AMPLIFIER			
FL1	FILTERCON	AMP-C	859640-1
J1,2,3	JACK, Bulkhead, SMA	EFJ	142-0293-001
U1	INTEGRATED CIRCUIT, Amplifier, 1.7-2.3 GHz	Avantek	UTO-2311
U2	INTEGRATED CIRCUIT, Amplifier, 250 MHz	Avantek	UTO-511
Z1	MIXER	Anzac	MD-157
A8B11, FM/5 MHz DRIVER			
C1,4,5	CAPACITOR, Ceramic, 0.1uf, 10%, 100V	Erie	8131-100-651-104M
C2,3	CAPACITOR, Electrolytic, 10uf, -10/+75%, 25V	Mallory	TT25X10
C7,8	CAPACITOR, Ceramic, .01uf, 10%, 100V	Erie	8121-100-651-103M
Q1	TRANSISTOR, NPN, Signal	Mot	2N3904
R1,2,3,4,6, 7,8	RESISTOR, Composition, 470 ohms, 5%, 1/4W		RC07GF471J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R5	RESISTOR, Composition, 200 ohms, 5%, 1/4W		RC07GF201J
R9	RESISTOR, Variable, 25K	Beckman	62PR25K
R11	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R12	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R13	RESISTOR, Metallic Film, 1.91K, 1%, 1/8W		RN55D1911F
R14	RESISTOR, Composition, 5.1K, 5%, 1/4W		RC07GF512J
R15	RESISTOR, Wirewound, 150 ohms, 5%, 1.5W	Ohmite	995-1A-150
R16,18	RESISTOR, Composition, 10 ohms, 5%, 1/4W		RC07GF100J
R19,21	RESISTOR, Variable, 50 ohms	Beckman	62PR50
R22	RESISTOR, Wirewound, 120 ohms, 5%, 1.5W	Ohmite	995-1A-120
R23,26	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R24	RESISTOR, Composition, 39 ohms,, 5%, 1/4W		RC07GF390J
R25	RESISTOR, Composition, 330 ohm, 5%, 1/4W		RC07GF331J
R27,28	RESISTOR, Composition, Selected Value, 5%, 1/4W		RC07GFXXXJ
U1,2	INTEGRATED CIRCUIT, Current Amplifier	Nat	LH0002CH
XU1,2	SOCKET, TO-5, 8 Pin	EMC	6139-188-1
XR1,XR2,XR3, XQ1,XR9	SOCKET, TO-18, 3 Pin	EMC	6120-188-1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A10, PAN SCOPE			
C1	CAPACITOR, Electrolytic, 10uf, 25V	Mallory	TT25X10
J1	PLUG, Power, 15 Pin, Male	Cinch	DAM-15P
L1	INDUCTOR, Molded, 100uh	Delevan	1537-76
A10B1, HORIZONTAL & VERTICAL AMPS			
C13,17,24	CAPACITOR, Ceramic, 0.1uf, 10%, 100V	Erie	8131-100-651-104M
C14,16,18,19,26	CAPACITOR, Tantalum, 15uf, 20%, 20V	Kemet	T310B156K020AS
C15,20,22	CAPACITOR, Ceramic, 0.01uf, 20%, 100V	Sprague	TG-S10
C21	CAPACITOR, Ceramic, 10 pf, 10%, 100V	Erie	8101-100-COGO-100D
C27,28	CAPACITOR, Ceramic, .005uf, 20%, 100V	Sprague	TG-D50
C29	CAPACITOR, Ceramic, 3.3pf, 5%, 100V	Stkp	C80-51
D9	DIODE, Silicon	Mot	1N4004
Q6,10,11,15	TRANSISTOR, NPN, Plastic	Mot	2N3904
Q7,8,9,13	TRANSISTOR, NPN, H.V., TO-5	RCA	2N3440
Q12,14	TRANSISTOR, NPN, H.V., Plastic	Mot	2N5551
R22,31,33, 36,51,57	RESISTOR, Composition, 22K, 5%, 1/4W		RCO7GF223J
R23,34	RESISTOR, Composition, 12K, 5%, 1/4W		RCO7GF105J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R24,32	RESISTOR, Composition, 1M, 5%, 1/4W		RC07GF104J
R25,26,53	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF273J
R27,30,41,47	RESISTOR, Composition, 15K, 5%, 1/4W		RC07GF153J
R28,39,43,52	RESISTOR, Composition, 2.2K, 5%, 1/4W		RC07GF222J
R29	RESISTOR, Composition, 2K, 5%, 1/4W		RC07GF202J
R35,46	RESISTOR, Composition, 9.1K, 5%, 1/4W		RC07GF912J
R37	RESISTOR, Metal Film, 4.75K, 1%, 1/8W		RN55D4751F
R38	RESISTOR, Metal Film, 4.3K, 1%, 1/8W		RN55D4321F
R40,50	RESISTOR, Composition, 150K, 5%, 1/4W		RC07GF154J
R42,44	RESISTOR, Composition, 27K, 5%, 1/4W		RC07GF273J
R45	RESISTOR, Composition, 560 ohhms, 5%, 1/4W		REC07GF561J
R54	RESISTOR, Variable, 10K	Bourns	3329-1-103
R55	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R56	RESISTOR, Composition, 5.1K, 5%, 1/4W		RC07GF512J
R61	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
U6	INTEGRATED CIRCUIT Wide-Band OP-AMP	RCA	CA3100S

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
XQ6,10,11,12, 14,15	PAD, TO-18		EXP-002
XQ7,8,9,13	PAD, TO-5	Robison	RC-TO5075-5A

A10B2, HIGH VOLTAGE POWER SUPPLY

C1	CAPACITOR, Ceramic, 0.1uf, 10%, 100V	Erie	8131-100-651-104M
C2	CAPACITOR, Mica, 0.0022uf, 10%, 200V	Spr	192P22292
C3,7	CAPACITOR, Ceramic, 0.01uf, 20%, 100V	Spr	TG-S10
C4,5	CAPACITOR, Ceramic, 0.001uf, 20%, 1KV	Spr	5GA-D10
C6	CAPACITOR, Electrolytic, 500uf, 20%, 25V	Spr	TVA-1209
C8	CAPACITOR, Ceramic, 0.05uf, 20%, 500V	Spr	5HK-S50
C9,12	CAPACITOR, Ceramic, 0.01uf, 20%, 1KV		5GA-S10
C10	CAPACITOR, Tantalum, 5uf, 150V	Spr	500D505F150-CC7
C11	CAPACITOR, Ceramic, 0.01uf, 20%, 500V	Spr	5GAS-S10
C29	CAPACITOR, Film, 0.1uf, 10%, 1600V	F'Dynne	MPE-11H
DA1	RECTIFIER, Bridge, 1A, 400V	Varo	VE48X
D1,2	DIODE, Silicon, 1A, 100V	Mot	1N4934
D3,4	DIODE, Silicon, 25mA, 4KV	Varo	VB40X
J2	RECEPTACLE, 2 Pin	Winch	JF2S

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
Q1,3	TRANSISTOR, NPN, Plastic	Mot	2N3904
Q2,4	TRANSISTOR, NPN	GE	D44C6
R1	RESISTOR, Composition, 1.8K, 5%, 1/4W		RC07GF182J
R2	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R3,6	RESISTOR, Composition, 470 ohms, 5%, 1/4W		RC07GF471J
R4,5,11,49	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R7	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R8	RESISTOR, Composition, 2.7M, 5%, 1/4w		RC07GF275J
R9	RESISTOR, Variable, 250K	Clarostat	RV6NAYSD254A
R10	RESISTOR, Composition, 240K, 5%, 1/2W		RC20GF244J
R12	RESISTOR, Variable, 1M, 5%, 1/2W	Clarostat	RV6NAYSD105A
R13	RESISTOR, Composition, 3M, 5%, 1/2W		R20GF305J
R14	RESISTOR, Composition, 470K, 5%, 1/2W		RC20GF474J
R15	RESISTOR, Composition, 220K, 5%, 1/2W		RC20GF224J
R16	RESISTOR, Variable, 250K	Bourns	3329W-1-254
R17,18	RESISTOR, Composition, 39K, 5%, 1/4W		RC07GF393J
R19	RESISTOR, Composition, 3K, 5%, 1/4W		RC07GF302J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R20,21	RESISTOR, Composition, 2.7K, 5%, 1/4W		RC07GF272J
R48	RESISTOR, Variable, 20K	Bourns	3329W-1-203
T1	TRANSFORMER	M-T	M81A100-358
	Core	Ferrox	3019P-L00-3B7
	Bobbin	Ferrox	3019 FID
	Plate, Terminal		991-1906-00
U1	INTEGRATED CIRCUIT Timer	Signetics	NE555N
U2	INTEGRATED CIRCUIT, Flip-Flop	Fairchild	MM74C74
U3	INTEGRATED CIRCUIT, Dual One-Shot	TI	SN74L123N
U4	INTEGRATED CIRCUIT, Quad Gate	Nat	SN74LS08N
U5	PHOTO-TRANSISTOR	GE	4N38A
XQ1,3	INSULATOR		EXP-002
XV1	SOCKET, CRT (part of VI, Assembly A1B1)	Amperex	(D7-221-GH)
XV1	INSULATOR	MT	92A102-534

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A11B1, DISPLAY			
C1	CAPACITOR, Tantalum, 2.2 uf, 10%, 35V	Kemet	T310A225K035AS
C2,3	CAPACITOR, Tantalum, 39 uf, 10%, 10V	Kemet	T310A396K010AS
DS1,2	LINEAR BAR DISPLAY, RED	Litronix	OBG-1000
J1	SOCKET STRIP (5 Pin)	Samtec	SS120G-2
R1,2	RESISTOR, Metallic Film, 1.24K, 1%, 1/8W		RN55D1241F
R3,4	RESISTOR, Composition, 100 ohms, 5%, 1/4W		RC07GF101J
U1	DOT/BAR DISPLAY DRIVER, Linear	Nat	LM3914
U2	DOT/BAR DISPLAY DRIVER, Log	Nat	LM3915
A11B2, KEYBORAD			
C1,2	CAPACITOR, Tantalum, 10uf, 10%, 10V	Kemet	T392B106K010AS
C3	CAPACITOR, Ceramic, .1uf, 10%, 100V	Erie	8131-M100-651-104M
J2	JACK, 10 Pin	ITT-Cannon	UBS4B010-C4DL
J3	JACK, 34 Pin	ITT-Cannon	UBS4B034-C4DL
J4	JACK, 26 Pin	ITT-Cannon	UBS4B026-C4DL
P1	PLUG, Stripline, 5 Pin	Samtec	TS120G-A
Q1	TRANSISTOR, PNP	Mot	2N3906
R1,6,12	RESISTOR, Composition, 1.2K, 5%, 1/8W		RC05GF122J
R2,7,11,14,55	RESISTOR, Composition, 1K, 5%, 1/8W		RC05GF102J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R3,13,16,22, 25,27,29,30, 37,38,39,41, 45,46,48,50,53, 60,61,62,63,66	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
R4,5,10,15, 23,31,40,42, 52,54,67,68	RESISTOR, Composition, 300 ohms, 5%, 1/8W		RC05GF301J
R8,9,17,18, 19,20,21,24, 26,28,32,34, 35,36,43,44, 47,49,51,56, 57,58,59,64,65	RESISTOR, Composition, 100K, 5%, 1/8W		RC05GF104J
S1,3,5,6,7,21	SWITCH, Pushbutton, Maintained	Licon	39-13111
S2,8,9,10,11, 12,13,14,15, 16,17,18,19, 20,22,23,24, 25,26,27,28,29,	SWITCH, Pushbutton, Momentary	Licon	39-12111
S4,19,20	SWITCH, Pushbutton, Momentary	Licon	39-12509
U1,2	INTEGRATED CIRCUIT, 8 Bit Priority Encoder	Mot	MC14532 BCP
XU1,2	SOCKET, 16 Pin, DIL	EMC	10316-01-445
XQ1	SPREADER	Thermalloy	7717-44

A11B3, LOGIC BOARD #1

C1,3,4,5,6	CAPACITOR, Ceramic, 0.1uf, 20%, 100V	Erie	8131-M100-651-104M
C7	CAPACITOR, Electrolytic, 1.0uf, 15V	Mallory	TT15X1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
C8,9	CAPACITOR, Mica, 47pf, 300V	Elm	DM05-470J
D1,2	DIODE, Zener, 5.1V	Mot	1N5231
D3,4	DIODE, Silicon	GE	1N4148
J5,6	JACK, 10 Pin	ITT-Cannon	UBS4B010-C4DL
J7	JACK, 16 Pin	ITT-Cannon	UBS4B016-C4DL
P2	PLUG, 2X5 Pin	Circ. Assy	CA-D36SP100-230-530
P3	PLUG, 2X17 Pin	Circ. Assy	CA-D36SP100-230-530
P4	PLUG, 2X13 Pin	Circ. Assy	CA-D36SP100-230-530
P8	PLUG, With Latches, 40 Pin	Berg	65863-085
P9	PLUG, 16 Pin	Ansley	609-1627
Q1	TRANSISTOR, NPN	Mot	2N2222
Q2	TRANSISTOR, PNP	Mot	2N3906
R1,25,26,27, 33,34,37	RESISTOR, Composition, 100K, 5%, 1/8W		RC05GF104J
R2,3,4,9,12, 14,15,23,28, 29,30,31,35, 36,38,39,40	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
R5	RESISTOR, Composition, 2K, 5%, 1/8W		RC05GF202J
R7	RESISTOR, Variable, 5K	Mepco	8035-EKP-502
R8,10,32	RESISTOR, Composition, 4.7K, 5%, 1/8W		RC05GF472J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R11,16,18,24	RESISTOR, Composition, 1K, 5%, 1/8W		RC05GF102J
R13	RESISTOR, Variable, 10K	Mepco	8035-EKP-103
R17	RESISTOR, Composition, 20K, 5%, 1/8W		RC05GF203J
R19	RESISTOR, Variable, 100K	Mepco	8035-EKP-100K
R20	RESISTOR, Composition, 68K, 5%, 1/8W		RC05GF683J
R21	RESISTOR, Composition, 12K, 5%, 1/8W		RC05GF123J
R22	RESISTOR, Variable, 2K	Mepco	8035-EKP-202
RA-1	RESISTOR NETWORK, 14 Pin, 13X100K	A-B	314A104
RA-2	RESISTOR NETWORK, 14 Pin, 7X10K	A-B	314B103
U1,2	INTEGRATED CIRCUIT, Dual OP AMP	RCA	CA1458E
U4,16	INTEGRATED CIRCUIT, Quad, Type "D", Flip-Flop, CMOS	Mot	MC14175BCP
U5,7	INTEGRATED CIRCUIT, Dual, 4-Input, "OR" Gate, CMOS	RCA	CD4072BE
U6,8,10,12,17	INTEGRATED CIRCUIT, Quad, 2-Input Multiplexer, CMOS	Nat	MM74C157N
U9	INTEGRATED CIRCUIT, Dual, Type "D", Flip-Flop, CMOS	Mot	MC14013BCP
U11	INTEGRATED CIRCUIT, 2P4T, Multiplexer, CMOS	RCA	CD4052BE
U13,18	INTEGRATED CIRCUIT, 8-Bit, Priority Encoder, CMOS	Mot	MC14532BCP

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U14,15,20	INTEGRATED CIRCUIT, BCD-Decimal Decoder, TTL		74LS145N
U19	INTEGRATED CIRCUIT, Quad, 2-Input, "O" Gate, CMOS	RCA	CD4071BE
XQ1	SPREADER	Robison	RC-T018080-1
XQ2	SPREADER	Gudebrod	EXP002
XU1,2	SOCKET, 8 Pin, DIL	EMC	10308-01-445
XU4,6,8,10,11, 12,13,14,15, 16,17,18,20	SOCKET, 16 Pin, DIL	EMC	10316-01-445
XU5,7,9,19	SOCKET, 14 Pin DIL	EMC	10314-01-445

A11B4, LOGIC BOARD #2

C1,2,3,4,5,7	CAPACITOR, Ceramic, 0.1uf, 20%, 100V	Erie	8131-M100-651-104M
C6	CAPACITOR, Electrolytic, 1.0uf, 15V	Mallory	TT15X1
C8	CAPACITOR, Mica, 200pf, 5%, 300V	Elm	DM05-201J
P5,6	PLUG, 2X5 Pin	Circ. Assy	CA-D36-SP100-230-530
P7	PLUG, 2X8 Pin	Circ. Assy	CA-D36-SP100-230-530
P10	PLUG WITH LATCHES, 40 Pin	Berg	65863-085
Q5	TRANSISTOR, PNP	Mot	2N3906
Q6	TRANSISTOR, NPN	Mot	2N3904
R1,4,16,17,22 26,34,39,40 41,42	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
R2	RESISTOR, Composition, 2.4K, 5%, 1/8W		RC05GF242J

A11B4

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R3,19,21,23,27	RESISTOR, Composition, 1K, 5%, 1/8W		RC05GF102J
R4,12,13,37, 38	RESISTOR, Composition, 100K, 5%, 1/8W		RC05GF104J
R5,8,10	RESISTOR, Composition, 56K, 5%, 1/8W		RC05GF563J
R6	RESISTOR, Composition, 6.8K, 5%, 1/8W		RC05GF682J
R7	RESISTOR, Composition, 33K, 5%, 1/8W		RC05GF333J
R9,11	RESISTOR, Composition, 39K, 5%, 1/8W		RC05GF393J
R14	RESISTOR, Variable, 500 ohms	Mepco	8035-EXP-501
R15	RESISTOR, Composition, 5K	Dale	784-5K
R18,20,24,25, 28,29,30,31, 33,35,36	RESISTOR, Metallic Film, 10.0K, 1%, 1/8W		RN55D1002F
R32	RESISTOR, Metallic Film, 10.2K, 1%, 1/8W		RN55D1022F
RA-1	RESISTOR NETWORK, 14 Pin, 7X4.7K	A-B	314B472
U1,3,10,11,12	INTEGRATED CIRCUIT, Dual OP AMP	RCA	CA1458E
U2,5,6,13	INTEGRATED CIRCUIT, 3PDT, Multiplexer, CMOS	RCA	CD4053BE
U4	INTEGRATED CIRCUIT, SP7T, Mulltiplexer, CMOS	RCA	CD4051BE
U7	INTEGRATED CIRCUIT, TTL/CMOS, Level Shifter	RCA	CD40109
U8	INTEGRATED CIRCUIT, Quad, 2-Input, Multiplexer, CMOS	Nat	MM74C157N

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U14	INTEGRATED CIRCUIT, BCD, Decimal Decoder, TTL		74LS145N
U15,16	INTEGRATED CIRCUIT, Dual Type "D", Flip-Flop, CMOS	Mot	MC14013BCP
U17	INTEGRATED CIRCUIT, Quad, 2-Input "OR" Gate, CMOS	RCA	CD4071BE
XQ5,6	SPREADER	Robison	RC-T018080-1
XU1,3,10,11,12	SOCKET, 8 Pin, DIL	EMC	10308-01-445
XU2,4,5,6,7, 8,13,14	SOCKET, 16 Pin, DIL	EMC	10316-01-45
XU15,16,17	SOCKET, 14 Pin, DIL	EMC	10314-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A12, 21.4 MHz LEVELED AMP			
C1,2,4,5 7,11	CAPACITOR, Ceramic, .01 uf	Erie	8121-M100-651-103
C3,6,12,13	CAPACITOR, Ceramic, .1 uf	Erie	8121-M100-651-104
C8	CAPACITOR, Tantalum, 4.7 uf, 25V	Kemet	T390C475M025AS
C9	CAPACITOR, Ceramic, 68 pf, 50V	Murata	RPE110G0G680J50V
C10	CAPACITOR, Ceramic, 100 pf, 50V	Murata	RPE110C0G101K50V
D1	DIODE, Zero Bias	H-P	HSCH-3486
FL1	FILTERCON	AMP	859618-1
J1,2	CONNECTOR, SMA	OSM	2052-1350-02
L1	INDUCTOR, Toroidal	Micro-Metals	T25-6
R1	RESISTOR, Composition, 51 ohms, 5%, 1/8W	A-B	RC05GF510J
R2,6,14	RESISTOR, Composition, 10 ohms, 5%, 1/8W	A-B	RC05GF100J
R3,7	RESISTOR, Composition, 1K, 5%, 1/8W	A-B	RC05GF102J
R4	RESISTOR, Composition, 27K, 5%, 1/8W	A-B	RC05GF273J
R5	RESISTOR, Composition, 51K, 5%, 1/8W	A-B	RC05GF513J
R8	RESISTOR, Composition, 750K, 5% 1/8W	A-B	RC05GF754J
R9	RESISTOR, Composition, 100K, 5%, 1/8W	A-B	RC05GF104J
R10	RESISTOR, Composition, 330 ohms, 5%, 1/8W	A-B	RC05GF331J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R11	RESISTOR, Composition, 33K, 5%, 1/8W	A-B	RC05GF333J
R12	RESISTOR, Composition, 390 ohms, 5%, 1/8W	A-B	RC05GF391J
R13	RESISTOR, Variable, 10K	Bourns	3329P-1-103
R15,16	RESISTOR, Composition, 150 ohms, 5%, 1/8W	A-B	RC05GF151J
R17	RESISTOR, Composition, 39 ohms, 5%, 1/8W	A-B	RC05GF390J
U1,2	INTEGRATED CIRCUIT, IF Amp	Mot	MC1590G
U3	INTEGRATED CIRCUIT, Amp	Avantek	GPD-462
U4	INTEGRATED CIRCUIT, Op Amp	RCA	CA3140E

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A13B1, AUDIO SELECTOR			
R1	RESISTOR, Composition 680 ohms, 5%, 1/4W		RC07GF681J
R2	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
S1,2	SWITCH, Pushbutton, Momentary	Licon	39-12111
	DIODE, LED, HI EFF (S1,2)	H-P	HLMP-1340
A13B2, AUDIO AMPLIFIER			
C1	CAPACITOR, Tantalum, 68uf, 15V	Kemet	T310C686M015AS
C2	CAPACITOR, Electrolytic, 10uf, -10/+75%, 25V	Mallory	TT25X10
C3	CAPACITOR, Tantalum, 0.47uf, 20%, 50V	Spr	196D474X0050HA1
C4	CAPACITOR, Mica, 270pf, 5%, 500V	Elm	DM15-271J
C5	CAPACITOR, Tantalum, 1.0uf, 20%, 50V	Spr	196D105X0050HA1
Q1,2	TRANSISTOR, NPN	Mot	2N3904
R1,2,9	RESISTOR, Composition, 100K, 5%, 1/4W		RC07GF104J
R3,5	RESISTOR, Composition, 20K, 5%, 1/4W		RC07GF203J
R4,6,7,8,11	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R10	RESISTOR, Composition, 560 ohms, 5%, 1/4W		RC07GF561J
P1	PLUG, 2X10 PIN	Circ. Assy	CA-D36SP100-230-530

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U1	INTEGRATED CIRCUIT, Dual, Type "D", Flip-Flop, CMOS	Mot	MC14013BCP
U2	INTEGRATED CIRCUIT, Quad, 2 Input "OR" Gate, CMOS	RCA	CD 4071BE
U3	INTEGRATED CIRCUIT, Audio Amplifier	RCA	CA3030
U4	INTEGRATED CIRCUIT, 3PDT, Multiplexer, CMOS	RCA	CD 4053BE
XQ1,2	SPREADER	Robison	RC-T018080-1
XU1,2,3	SOCKET, 14 Pin, DIL	EMC	10314-01-445
XU4	SOCKET, 16 Pin, DIl	EMC	10316-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
250 MHz RELAY			
FL1,2	FILTERCON	AMP	859640-1
J1,2,3	JACK, Bulkhead, SMA	Cannon	150-592-7000
		(or) OSM	2058-5027-00
		(or) EFJ	142-0293-001
K1	RELAY, SPDT, 15V	G-E	3SBC-1833A2

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A15, SWITCHING VIDEO			
C1	CAPACITOR, Ceramic, .luf, 100V	Erie	8131-M100-651-104M
L1	INDUCTOR, Choke, 100 uh	Delevan	1025-68
Q1	TRANSISTOR		2N3906
Q2	TRANSISTOR		2N3904
R1,3,5	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R2	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R4	RESISTOR, Composition, 2K, 5%, 1/4W		RC07GF202J

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A36, PEAK DETECTOR			
C1	CAPACITOR, Mica, 560 pf, 5%	Elmenco	DM15-561J
C2,3,4,6	CAPACITOR, Ceramic, 0.1uf, 10%, 100V	Erie	8131-M100-651-104M
C5	CAPACITOR, Ceramic, 2.2 pf, 5%, 500V	Stackpole	C80-51-2.2pf
D1	DIODE, Silicon	GE	1N4148
FL2-7	FILTER	Amp	859618-1
J1,2,3	JACK, Bulkhead, SMC	Aep	UG-1464/U
Q1	TRANSISTOR, PNP, Plastic	Mot	2N3906
R1,2,4	RESISTOR, Composition, 1K, 5%, 1/4W		RC07GF102J
R3	RESISTOR, Composition, 51 ohms, 5%, 1/4W		RC07GF510J
R5,6	RESISTOR, Composition, 20K, 5%, 1/4W		RC07GF203J
R7,9	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R8	RESISTOR, Composition, 100 ohms, 5%, 1/4W		RC07GF101J
R10	RESISTOR, Composition, 2.7M, 5%, 1/4W		RC07GF275J
R11	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R12,13	RESISTOR, Composition, 22K, 5%, 1/4W		RC07GF223J
U1	INTEGRATED CIRCUIT, Voltage Follower	Nat	LM310N
U2	INTEGRATED CIRCUIT, FET Input Op Amp	Nat	LF357N

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
U3	INTEGRATED CIRCUIT, FET Input Op-Amp	Nat	LF356N
U4	INTEGRATED CIRCUIT, Analog Switch	Analog Devices	AD7590DIKN
U5	INTEGRATED CIRCUIT, Quad, Voltage Comparator	Nat	LM393N
XQ1	SPACER, Spreader	Robison	RC-T018080-1
XU1,2,3,5	SOCKET, 8 Pin, DIL	EMC	10308-01-445
XU4	SOCKET, 16 Pin, DIL	EMC	10316-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A53, IF ATTENUATOR AND CONTROL			
Z1	ATTENUATOR, 0-127 dB, Remotely Controllable	Alan	50DA127SMA
	ADAPTER, Right Angle, SMA	CDI (or) Solitron	5490 SF2994-6002
A53B1, ATTENUATOR CONTROL			
P1	PLUG, Right Angle, 20 Pin	Ansley	609-2007
P2	PLUG, Right Angle, 14 Pin	Ansley	609-1407
Q1	TRANSISTOR, NPN, TO-18, Plastic	Mot	2N3904
Q2-8	TRANSISTOR, PNP, TO-18, Plastic	Mot	2N2907
R1,2	RESISTOR, Composition, 4.7K, 5%, 1/4W		RC07GF472J
R3	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
RA1-2	RESISTOR NETWORK, Cermet, 8X100K	A-B	316B104
RA3	RESISTOR, NETWORK, Cermet, 7X4.7K	A-B	314B472
RA4	RESISTOR NETWORK, Cermet, 7X10K	A-B	314B103
U1,2	INTEGRATED CIRCUIT, BCD-To-Binary Converter		74184N
U3	INTEGRATED CIRCUIT, Hex Inverter		74L04N
U4,5	INTEGRATED CIRCUIT, Quad, Data Selector	Nat	MM74C157N
XQ1	SPREADER		EXP-002

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
XQ1	SPREADER		EXP-002
XQ2-8	SPREADER	Thermalloy (or) Robison	7717-40 RC-T018080-1
XU1,2,4,5	SOCKET, 16 Pin, DIL	EMC	10316-01-445
XU3	SOCKET, 14 Pin, DIL	EMC	10314-01-445

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 2, LO SAMPLE			
A1B2 REAR PANEL			
Z12	50 Ohm Load with Chain	Solitron	8018-6009
A1B6, COAXIAL HARNESS			
	ADD THE FOLLOWING COMPONENTS:		
J4	JACK, Panel Mount, (.085)	Solitron	2933-6004
P7	PLUG, Straight, (.085)	Solitron	SF2906-6002
A8, RF TUNER, 2-18 GHz			
	ADD THE FOLLOWING COMPONENTS:		
DC2	COUPLER, Directional, 2-18 GHz, 10 dB	Narda	4203-10
J4	JACK, Flange Mount, .085" Coax, SMA	Solitron	2933-6004
P21,22,23	PLUG, .085" Coax, SMA	Solitron	SF2906-6002

Opt. 3

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 3, 0.03-0.5 GHz COVERAGE			
A8, RF TUNER			
	ADD THE FOLLOWING COMPONENTS:		
FL45	FILTER, LP, 300 MHz	K&L	5L120-300-0
P24-29	PLUG, .085" Coax, SMA	Solitron	SF2906-6002
Z6,7	SWITCH, PIN, SPDT, .03-2 GHz	Am. Micr.	SW-2000-2RA

Opt. 4B

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 4B A52, 250/160 MHz CONVERTER			
A1B3, INTERNAL CHASSIS			
Z1	FILTER, BP, 160 MHz, BW3 = 20, SMC	K&L	4B120-160/20-S
A1B9, FLEXIBLE COAXIAL HARNESS			
P20,22,35	PLUG, Right Angle, RG-316/U	Solitron or OSM	SF2913-6001 521-3
Z1P1,Z1P2,	PLUG, Straight, SMC	Amp	51749-1
OPTION 4B			
A52, 250/160 MHz CONVERTER			
Z2	OSCILLATOR, 410 MHz, Phase-Locked	Anghel	LOS1-009
Z3	ATTENTUATOR, 6dB	Midwest	444-6
P1-5	PLUG, .085" Coax, SMA	Solitron	SF2906-6002
A52B1, MIXER			
J1-3	JACK, Bulkhead, SMA	EFJ	142-0293-001
Z1	MIXER, Double-Balanced TO-5	Anzac	MAC-51
A52B2, 5 MHz AMPLIFIER			
C1,3,4	CAPACITOR, Ceramic, 0.1uf, 10%, 100V	Erie	8131-100-651-104M
C2	CAPACITOR, Electrolytic, 1.0uf, -10/+75, 25V	Mallory	TT25X1
Q1	TRANSISTOR, NPN	Mot	2N3904

Opt. 4B

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R1	RESISTOR, Composition, 5.1K, 5%, 1/4W		RC07GF512J
R2	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R3	RESISTOR, Composition, 27 ohms, 5%, 1/4W		RC07GF270J
R4	RESISTOR, Composition, 270 ohms, 5%, 1/4W		RC07GF271J
R5	RESISTOR, Composition, 100 ohms, 5%, 1/4W		RC07GF101J
R6	RESISTOR, Composition, 470 ohm, 5%, 1/8W		RC07GF471J

A52B3, 160 MHz AMPLIFIER

FL1	FILTERCON	Amp-C	859 640-1
J1,2	JACK, Bulkhead, SMA	EFJ	142-0293-001
U1	INTEGRATED CIRCUIT, Amplifier	Avantek	UTO-516

Opt. 4C

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 4C, 250/70 MHz CONVERTER			
A1B3, INTERNAL CHASSIS			
Z1	FILTER, Bandpass, 70 MHz, BW3 = 50	K&L	5B120-70/50-S
A1B9, FLEXIBLE COAXIAL HARNESS			
P20,22,35	PLUG, Right Angle, RG-316/U, SMA	Solitron (or) OSM	SF 2913-6001 521-3
Z1P1,Z1P2	PLUG, Straight, RG-316/U, SMC	Amp	51749-1
A51, 250/70 CONVERTER			
P1,2,3,4,5	PLUG, .085" Coax SMA	Solitron	SF2906-6002
Z2	OSCILLATOR, Ø Locked, 320 MHz	RFD	L06102-2
Z3	ATTENUATOR, 6 dB	Midwest	444-6
A51B1, MIXER			
J1,2,3	JACK, Panel Mount, SMA	OSM	2052-1350-02
Z1	MIXER, Doubly Balanced, TO-5	Anzac	MAC-51

Opt. 4C

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A51B2, 5 MHz AMPLIFIER			
C1,3,4	CAPACITOR, Ceramic, .luf, 10%, 100V	Erie	8131-100-651-104M
C2	CAPACITOR, Electrolytic, luf, -10/+75, 25V	Mallory	TT25X1
Q1	TRANSISTOR, NPN	Mot	2N3904
R1	RESISTOR, Composition, 5.1K, 5%, 1/4W		RC07GF512J
R2	RESISTOR, Composition, 10K, 5%, 1/4W		RC07GF103J
R3	RESISTOR, Composition, 27pf, 5%, 1/4W		RC07GF270J
R4	RESISTOR, Composition, 270 ohm, 5%, 1/4W		RC07GF271J
R5	RESISTOR, Composition, 100 ohm, 5%, 1/4W		RC07GF101J
R6	RESISTOR, Composition, 470 ohm, 5%, 1/4W		RC07GF471J
A51B3, 70 MHz AMPLIFIER			
FL1	FILTERCON	AMP-C	859640-1
J1,2	JACK, Bulkhead, SMA	EFJ	142-0293-001
U1	INTEGRATED CIRCUIT	Avantek	UTO-516

Opt. 6

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 6, IF REFERENCE			
A1B3, INTERNAL CHASSIS			
CP5,6	ADAPTER, Right Angle, Male - Female, SMA	Solitron	SF2994-6001
CP7,8	PLUG, .141 Coax, Right Angle, SMA, Male	OSM	221-1A (or) 2912-6001
D3	DIODE, Silicon	GE	1N4148
FL71,72	FILTERCON	Erie	1203-050
P15	PLUG, Straight, SMC	AMP	51749-1
P16,17,18	PLUG, Right Angle, SMA	Solitron (or) OSM	SF2913-6001 521-3
Z6,8	ATTENUATOR, PIN Diode	Mini-Ckts	ZMAS-1B
Z7	PAD, 10 dB, SMA	Midwest	444-10
Z9	PAD, 20 dB, SMA	Midwest	444-20
A1B6, COAX SEMI-RIGID			
P12,13	PLUG, STRAIGHT, SMC	AEP	152-085
A1B8, RELAY COAX ASSEMBLY			
K3	RELAY, Coax, SPDT, 15V	GE	3SAV1932A2
J12,13	JACK, Straight, RG-316, SMC	AEP	10-1123-188
P19	PLUG, Right Angle, RG-316, SMA	Solitron	SF2913-6001

Opt. 6

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A1B9, FLEXIBLE COAXIAL HARNESS			
	ADD THE FOLLOWING COMPONENTS:		
P15	PLUG, Straight, RG-316/U, SMC	Amp	51749-1
P16,17,18	PLUG, Right Angle, RG-316/U, SMA	Solitron (or) OSM	SF 2913-6001 521-3
A11B2, KEYBOARD			
S4	SWITCH, Pushbutton, Maintained	Licon	39-13111
	DIODE, LED	H-P	HLMP-1340
A11B4, LOGIC BOARD #2			
Q1,4	TRANSISTOR, NPN	Mot	2N2222
Q2	TRANSISTOR, NPN	Mot	2N3904
Q3	TRANSISTOR, PNP	Mot	2N3906
R43,44,45,48	RESISTOR, Composition, 100K, 5%, 1/8W		RC05GF104J
R46,50,51,52, 53,56,57	RESISTOR, Composition, 10K, 5%, 1/8W		RC05GF103J
R47,49	RESISTOR, Composition, 1K, 5%, 1/8W		RC05GF102J
R54,55	RESISTOR, Composition, 22K, 5%, 1/8W		RC05GF223J
XQ1,2,3,4	SPREADER	Robison	RC-T018080-1

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
A31, 250 MHz OSCILLATOR			
C1,2	CAPACITOR, Ceramic, 0.005uf, 20%, 100V	Spr	TG-D50
C3	CAPACITOR, Ceramic, 8.2pf, 5%, 500V	Stkp	C80-51-8.2
C4	CAPACITOR, Mica, 33pf, 5%, 500V	Elm	DM15-330J
C5	CAPACITOR, Mica, 120pf, 5%, 500V	Elm	DM15-121J
C6,7,15,16, 24,25	CAPACITOR, Feedthrough, 500pf, +80/-20%, 500V	Erie	2425-003
C21	CAPACITOR, Ceramic, 2.7pf, 5%, 500V	Stkp	C80-51
C11,13,17,22	CAPACITOR, Variable, 1-10pf	Johanson	5202
C12	CAPACITOR, Ceramic, .22pf, 5%, 500V	Stkp	C80-51-.22
C14	CAPACITOR, Ceramic, 1.5pf, 5%, 500V	Stkp	C80-51-1.5
D1,2	DIODE, Hot Carrier	HP	5082-2810
J1	CONNECTOR, SMC, Right Angle, Bulkhead	Automatic	H-4643-000-000
L1	INDUCTOR, Molded, 1uh	Delevan	1025-20
L2	INDUCTOR, Variable, .47uh	Cambion	7107-09
L3,4,5,6	INDUCTOR, Air Coil Form	M-T Cambion	60-A-30-82-1 1530-1
Q2,3	TRANSISTOR, NPN	Mot	2N6304
Q4	TRANSISTOR, NPN	Mot	2N5109

Opt. 6

REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
R1	RESISTOR, Composition, 12K, 5%, 1/4W		RC07GF123J
R2	RESISTOR, Composition, 2.2K, 5%, 1/4W		RC07GF222J
R3	RESISTOR, Composition, 1.2K, 5%, 1/4W		RC07GF122J
R4	RESISTOR, Metal Film, 887 ohm, 1%, 1/8W		RN55D8870F
R5,11,15	RESISTOR, Composition, 18 ohm, 5%, 1/4W		RC07GF180J
R6	RESISTOR, Composition, 51 ohm, 5%, 1/4W		RC07GF510J
R7	RESISTOR, Composition, 47 ohm, 5%, 1/4W		RC07GF470J
R12	RESISTOR, Composition, 8.2K, 5%, 1/4W		RC07GF822J
R13	RESISTOR, Composition, 3.9K, 5%, 1/4W		RC07GF392J
R14	RESISTOR, Composition, 6.2K, 5%, 1/4W		RC07GF561J
R16	RESISTOR, Composition, 6.2K, 5%, 1/4W		RC07GF622J
R17	RESISTOR, Composition, 3.3K, 5%, 1/4W		RC07GF332J
R21	RESISTOR, Composition, 100 ohm, 5%m 1/4W		RC07GF101J
R22	RESISTOR, Composition, 910 ohm, 5%, 1/4W		RC07GF911J
XQ4	INSULATOR, Transistor	Robision	RC-T05075-4A
XY1	CLIP, Crystal	Augut	8004-5-P-2
Y1	CRYSTAL, 83.333 MHz	Int. Crystal	CS-Series
Z1	TRANSISTOR, NPN	RCA	2N3478

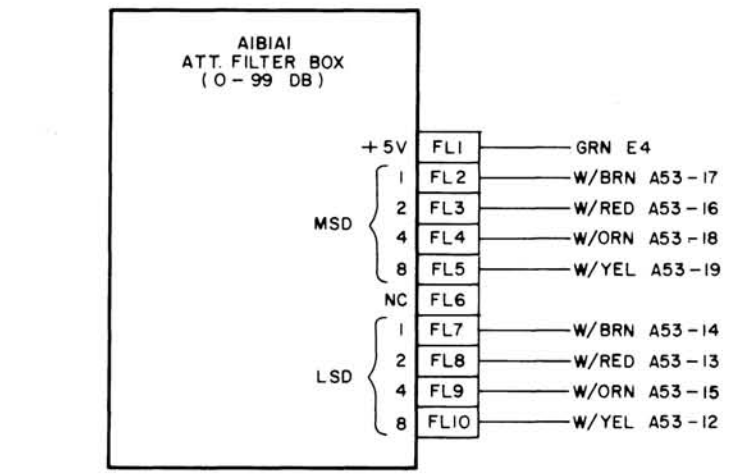
Opt. 8

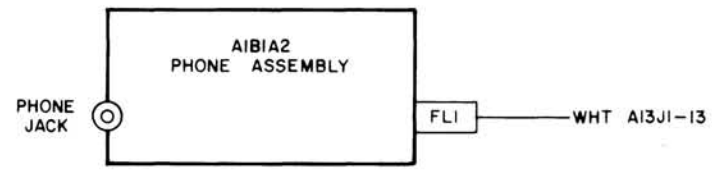
REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 8, PROVISIONS for 18-40 GHZ			
A1B2 REAR PANEL			
J1	JACK, Flange Mount, SMA	Solitron	2933-6004
A1B2A4, FILTER BOX, 18-40 GHz			
FL41 to 54	FILTER, LP	Erie	1251-001
J1	JACK, Panel Mount, Female, 19 Pin	Bendix	PT02A-14-19S
A1B6, SEMI-RIGID COAXIAL HARNESS			
P37	PLUG, SMA	Solitron	SF2906-6002
A11B2, KEYBOARD			
	DELETE the FOLLOWING COMPONENTS		
S19,20	SWITCH, Push-button	Licon	39-12509
	ADD the FOLLOWING COMPONENTS		
S19,20	SWITCH, Push-button, Momentary	Licon	39-12111
	DIODE, LED, High Efficiency	HP	HLMP-1340

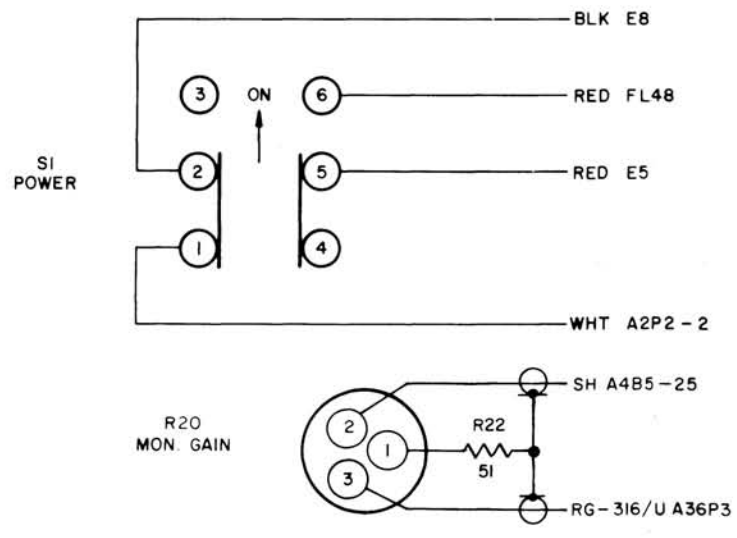
Opt. 9

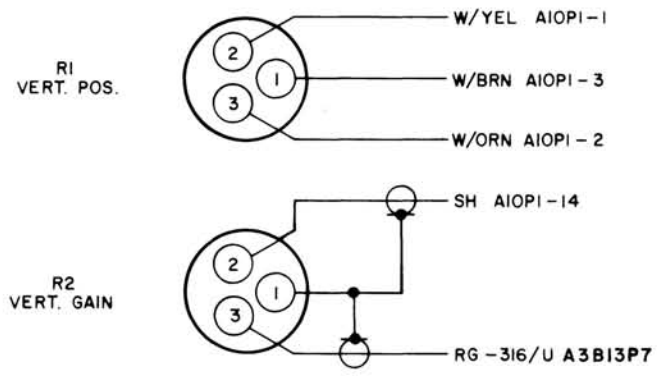
REF. DESIGN.	DESCRIPTION	MFR.	DRAWING/ PART NO.
OPTION 9, SINGLE RF INPUT (.2 to 18 GHz)			
A8, RF TUNER			
	ADD the FOLLOWING COMPONENTS		
AT-2	ATTENTUATOR, 1 dB	Midwest	MM444-1dB
FL46	DIPLEXER	K&W	KW106535
P49,50,51	PLUG, .085" Coax, SMA	Solitron	2906-6002
	DELETE the FOLLOWING COMPONENTS		
J1	JACK, Flange Mount, SMA	Solitron	2933-6004

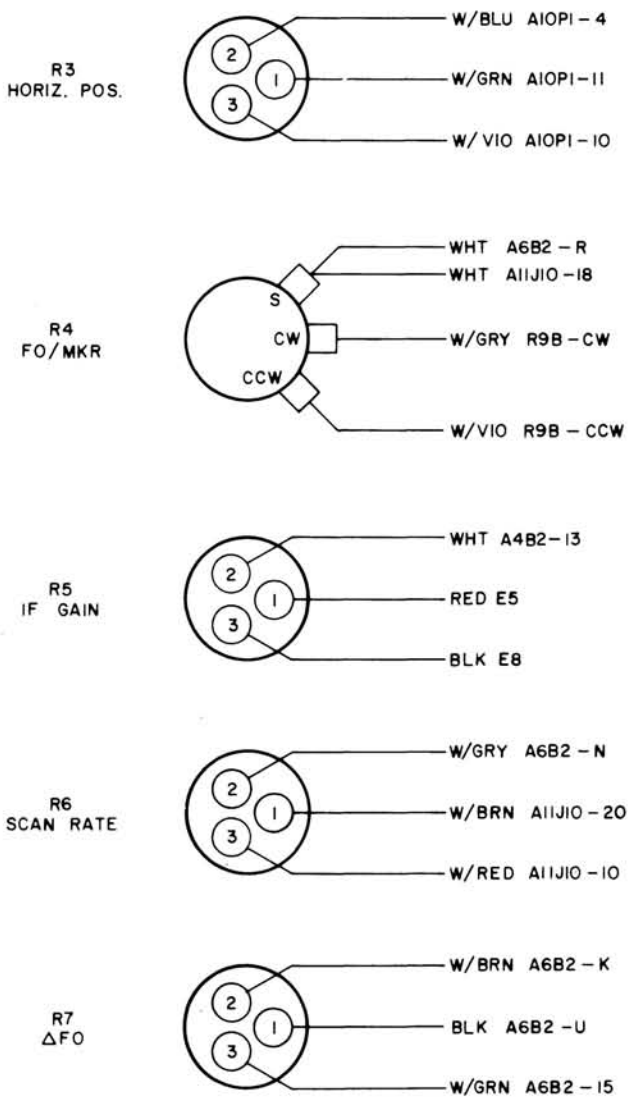
SECTION VII
SCHEMATIC DIAGRAMS

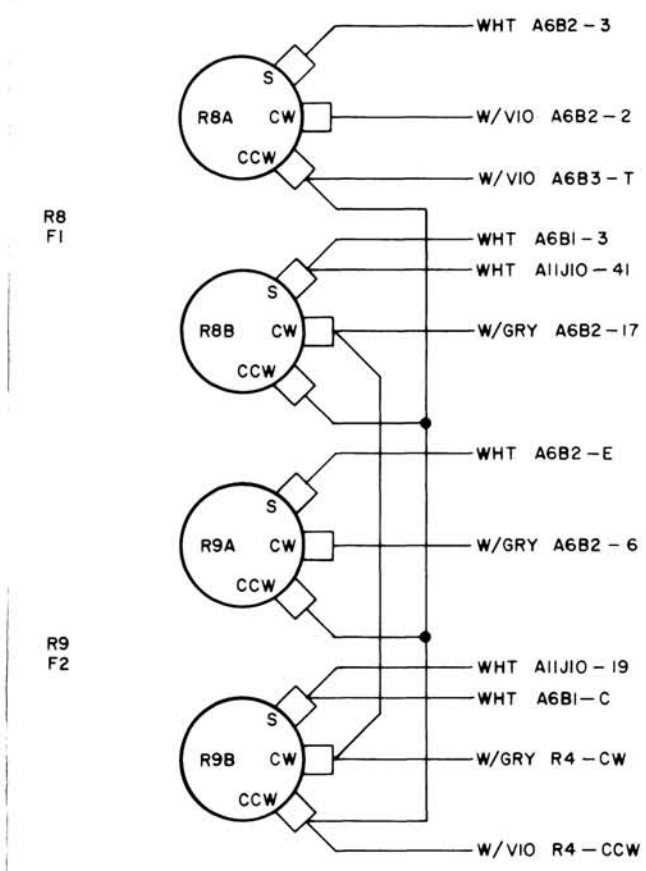












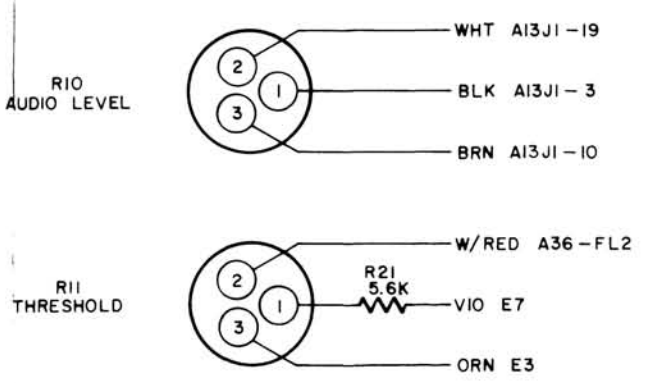


Figure 7-1. MSR-904A, Wiring Diagram 92B10-081
Sheet 1 of 10

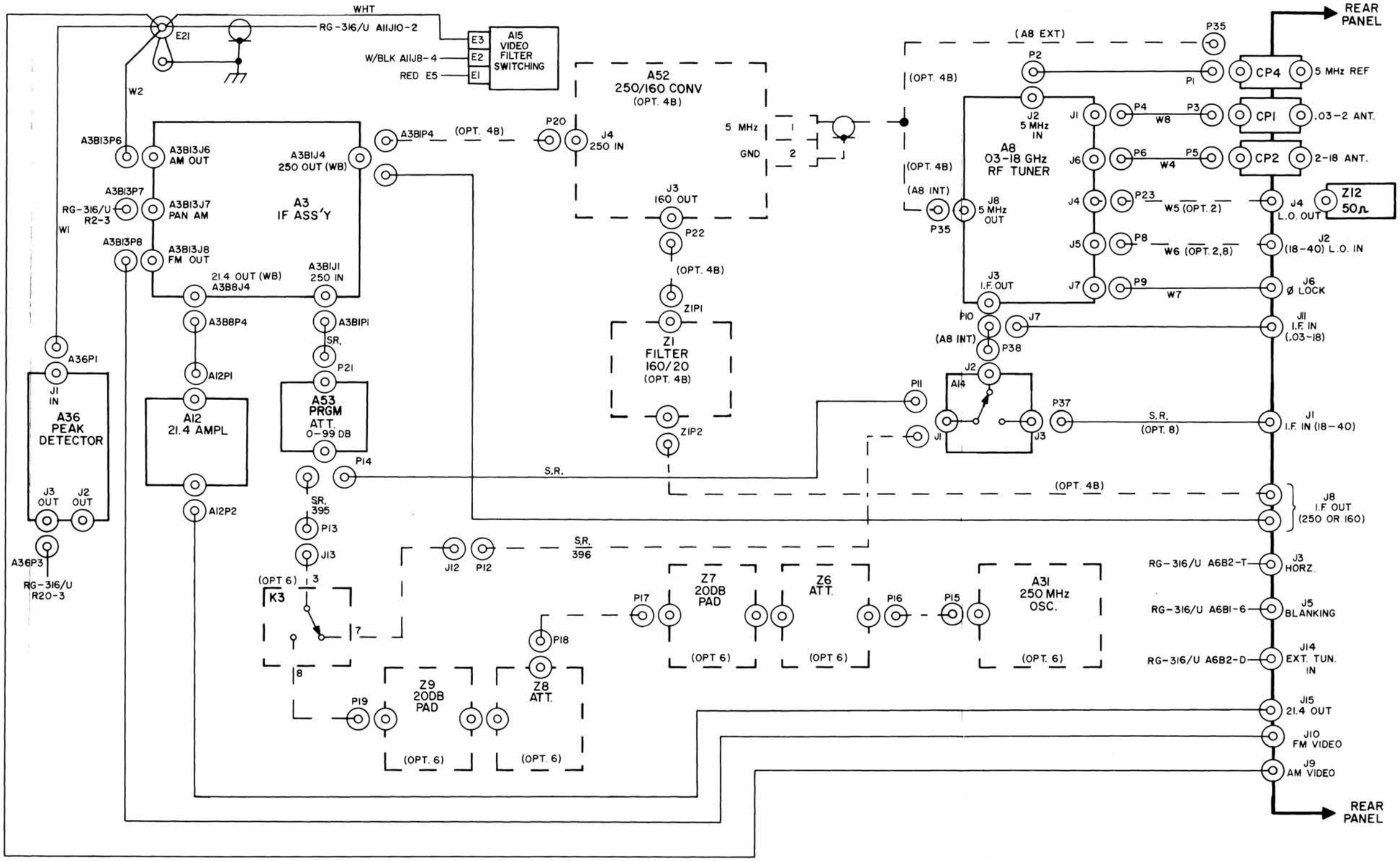


Figure 7.1 MSR-904A, Wiring Diagram 92B10-081
Sheet 2 of 10

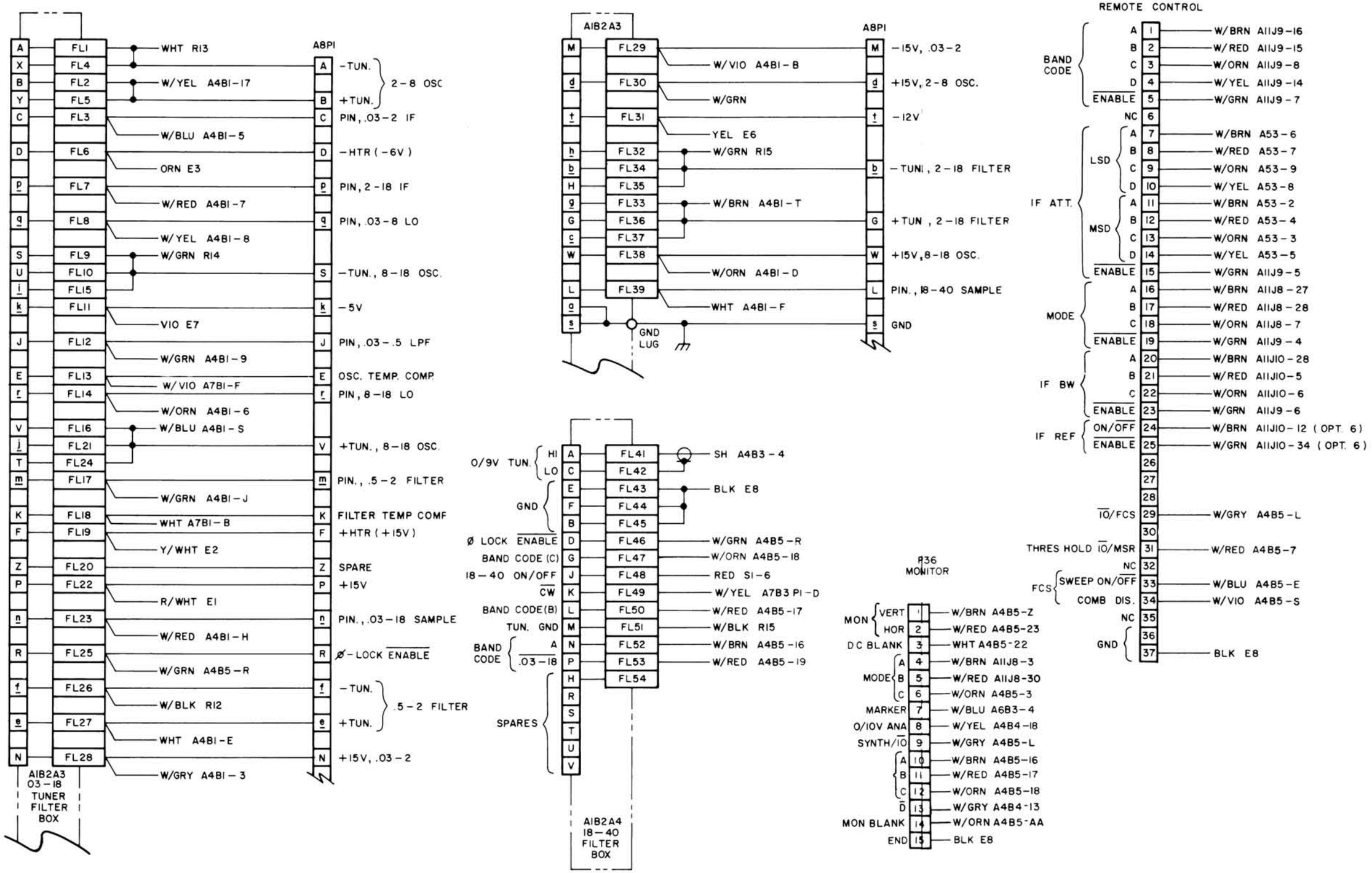


Figure 7. MSR-904A, Wiring Diagram 92B10-081
Sheet 3 of 10

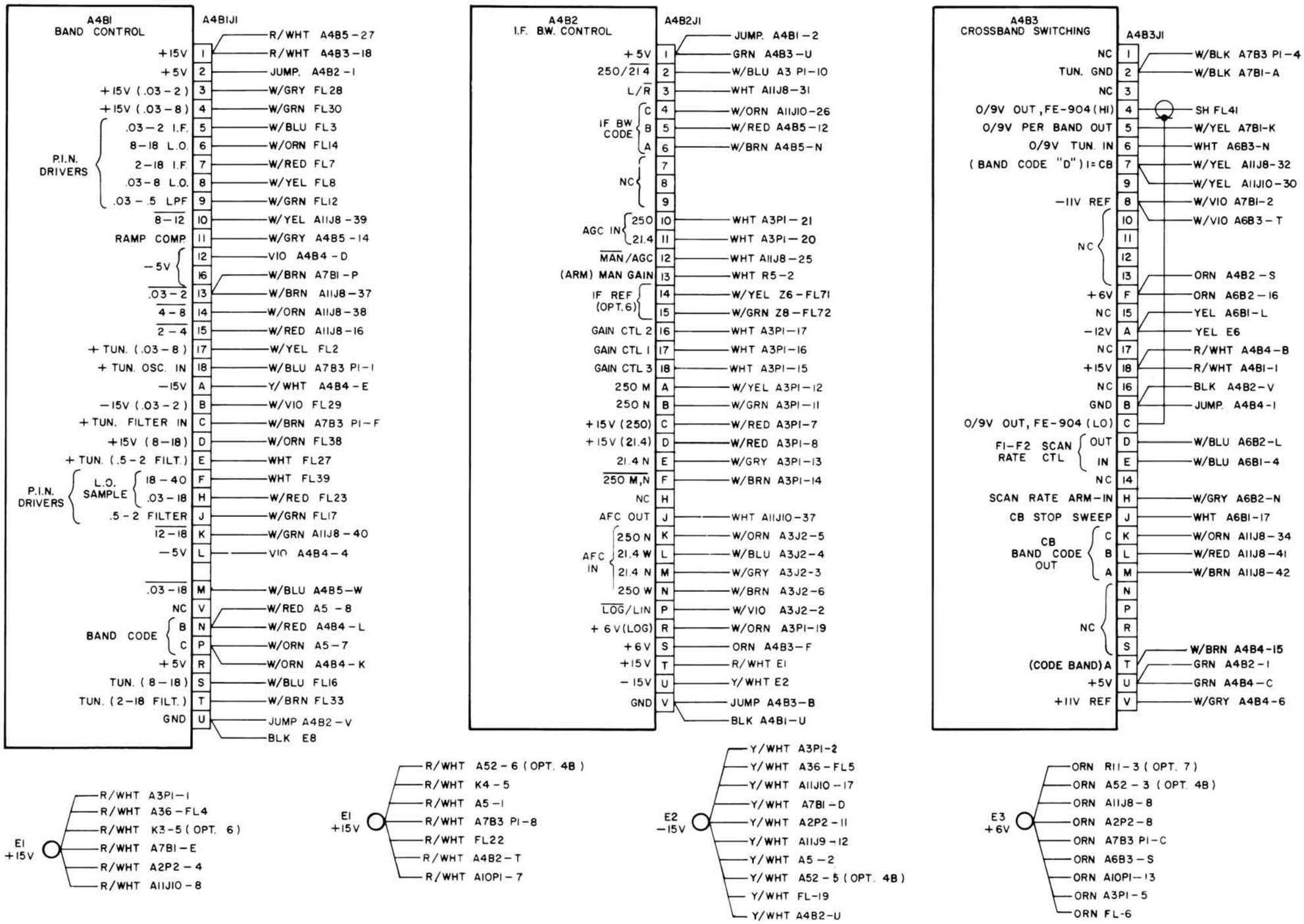


Figure 7.1 MSR-904A, Wiring Diagram 92B10-081
Sheet 4 of 10

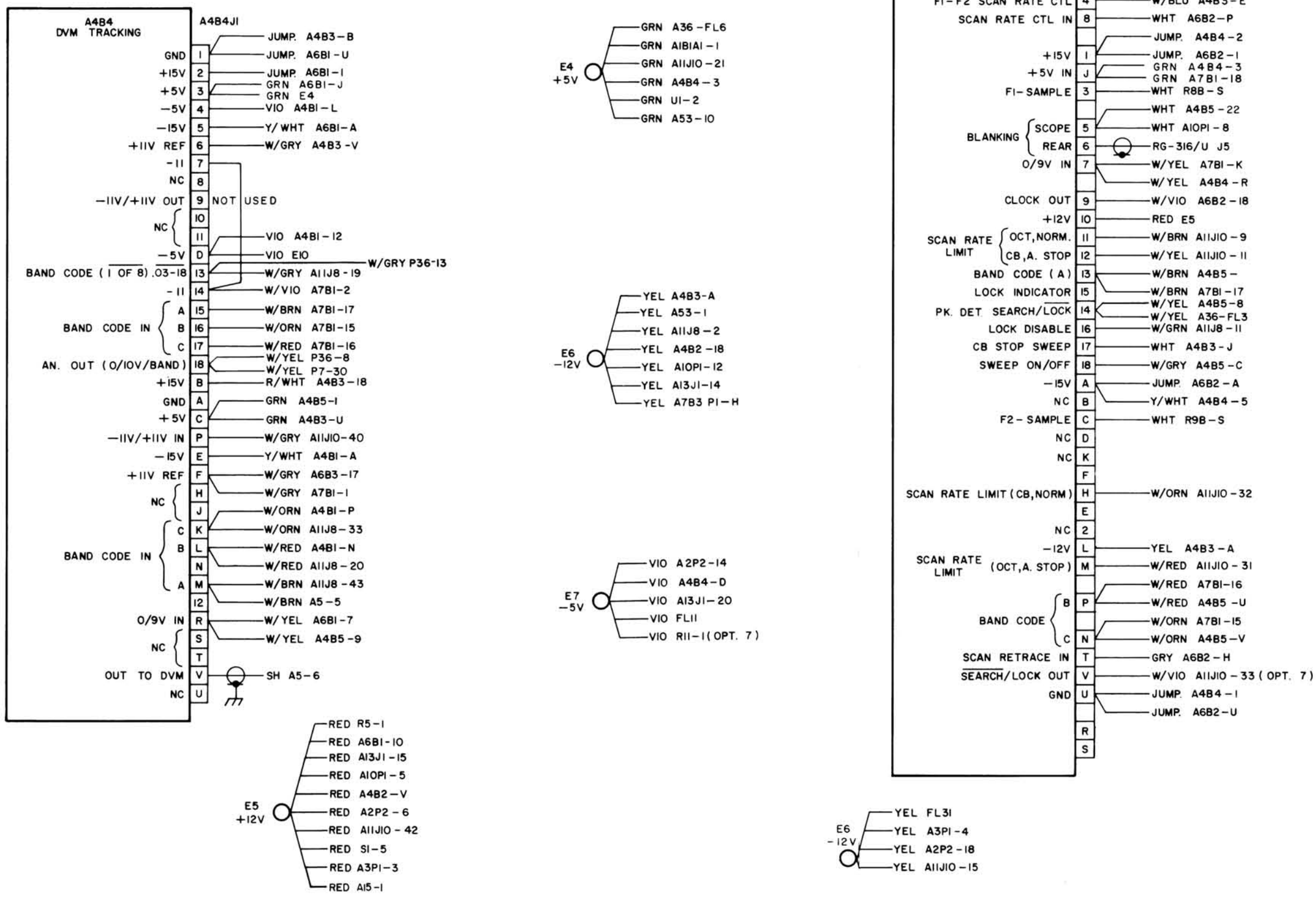


Figure 7-1 MSR-904A, Wiring Diagram 92B10-081
Sheet 5 of 10

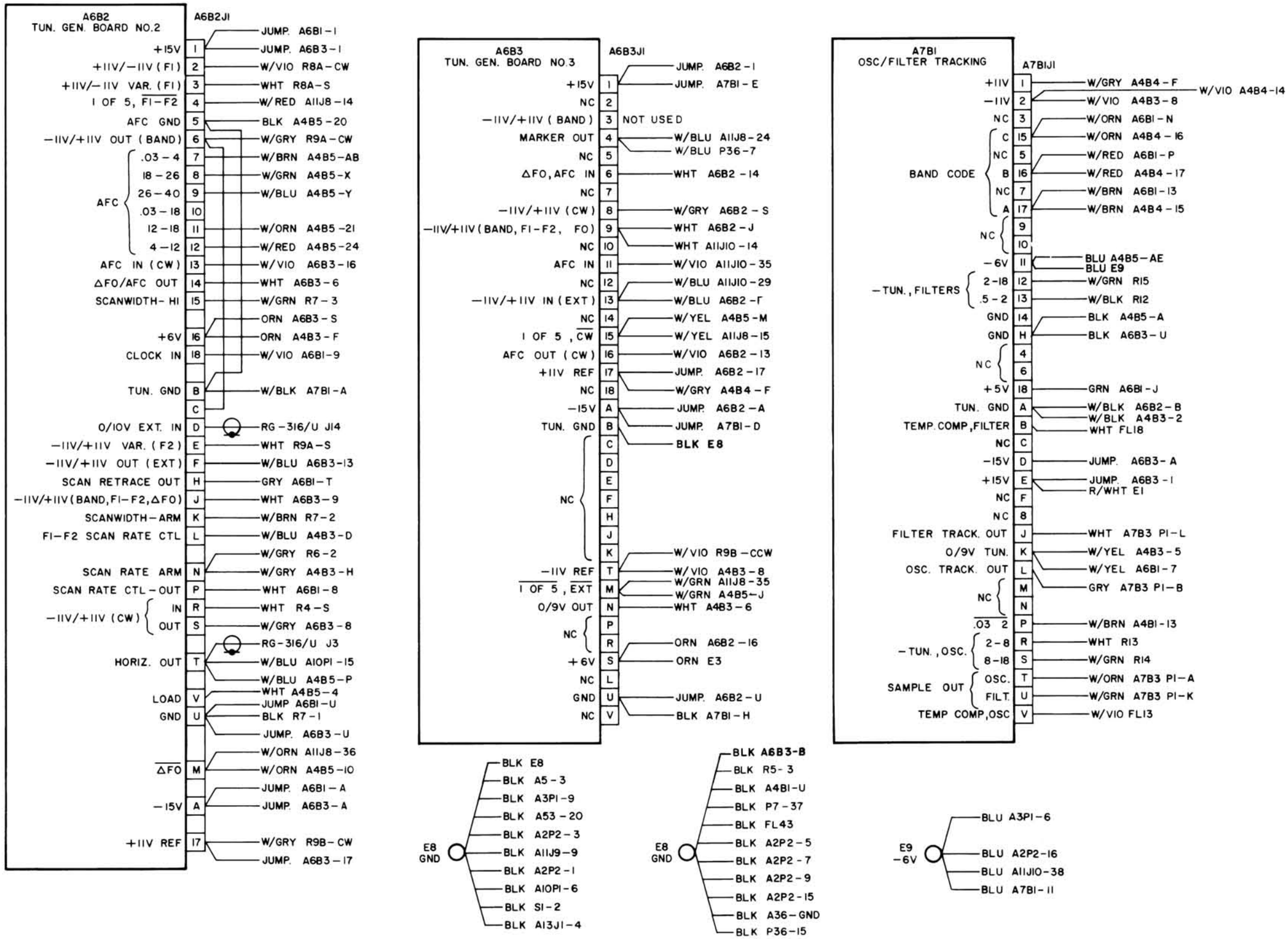


Figure 7.1 MSR-904A, Wiring Diagram 92B10-081
Sheet 6 of 10

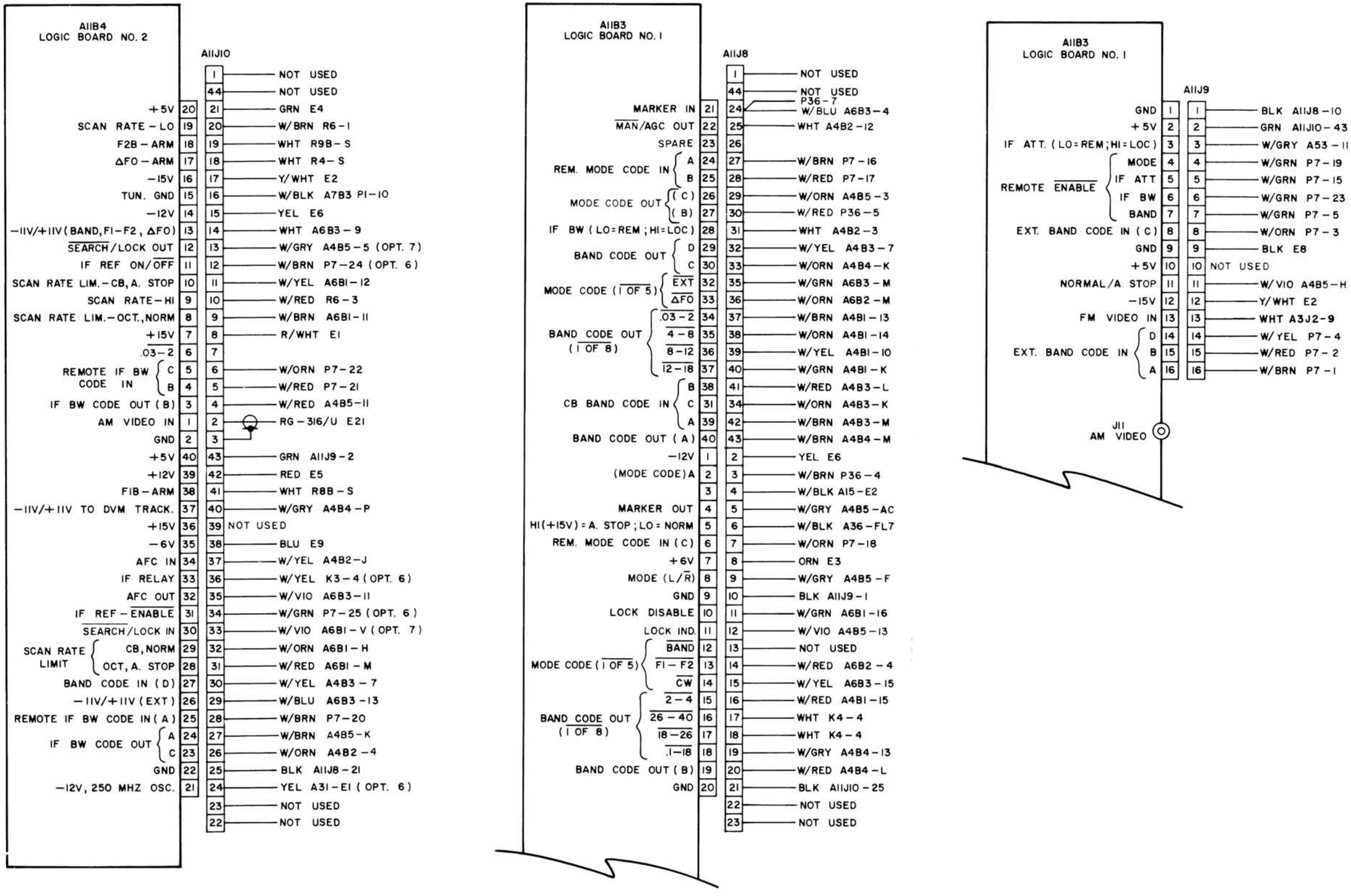


Figure 7.1 MSR-904A, Wiring Diagram 92B10-081
Sheet 7 of 10

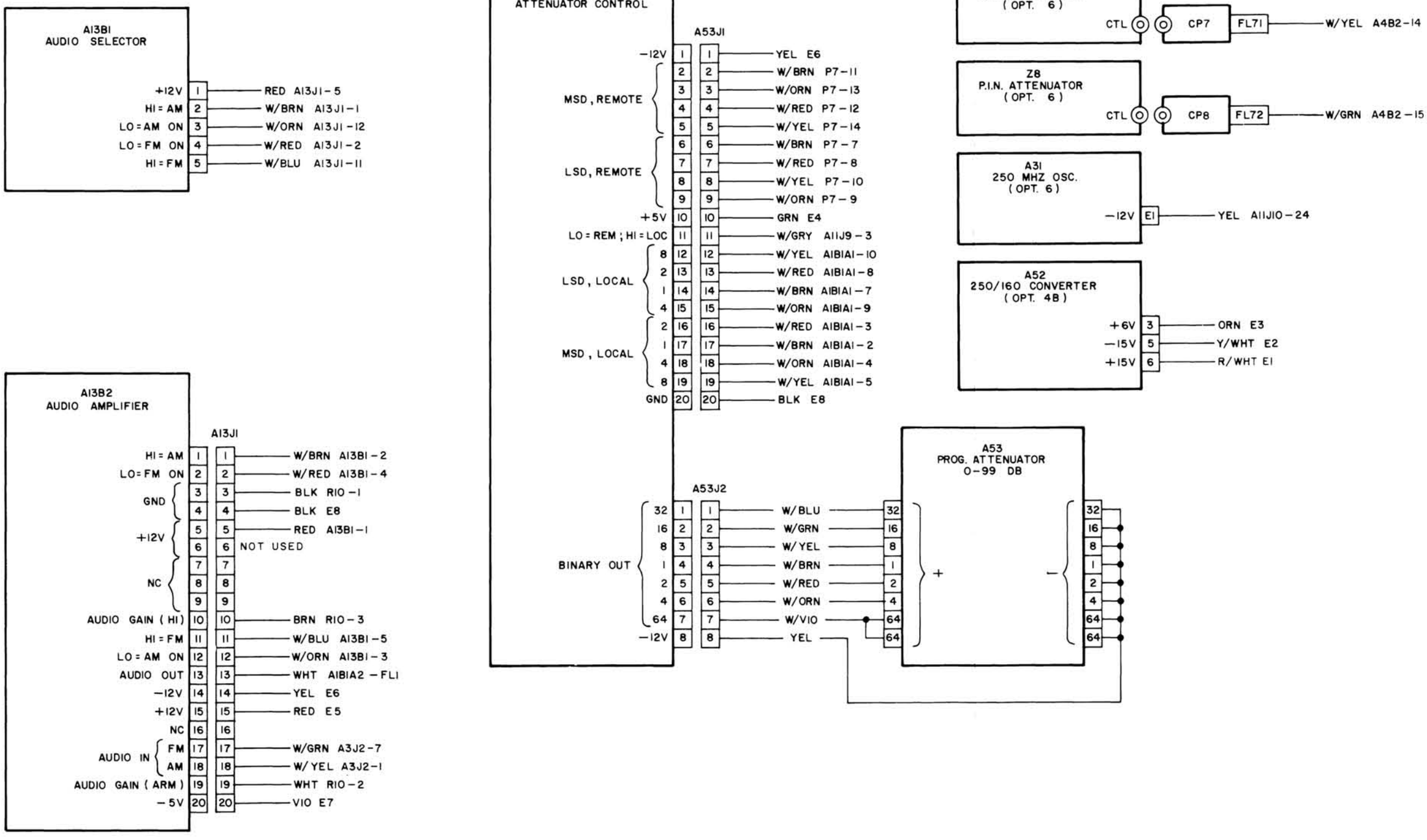


Figure 7

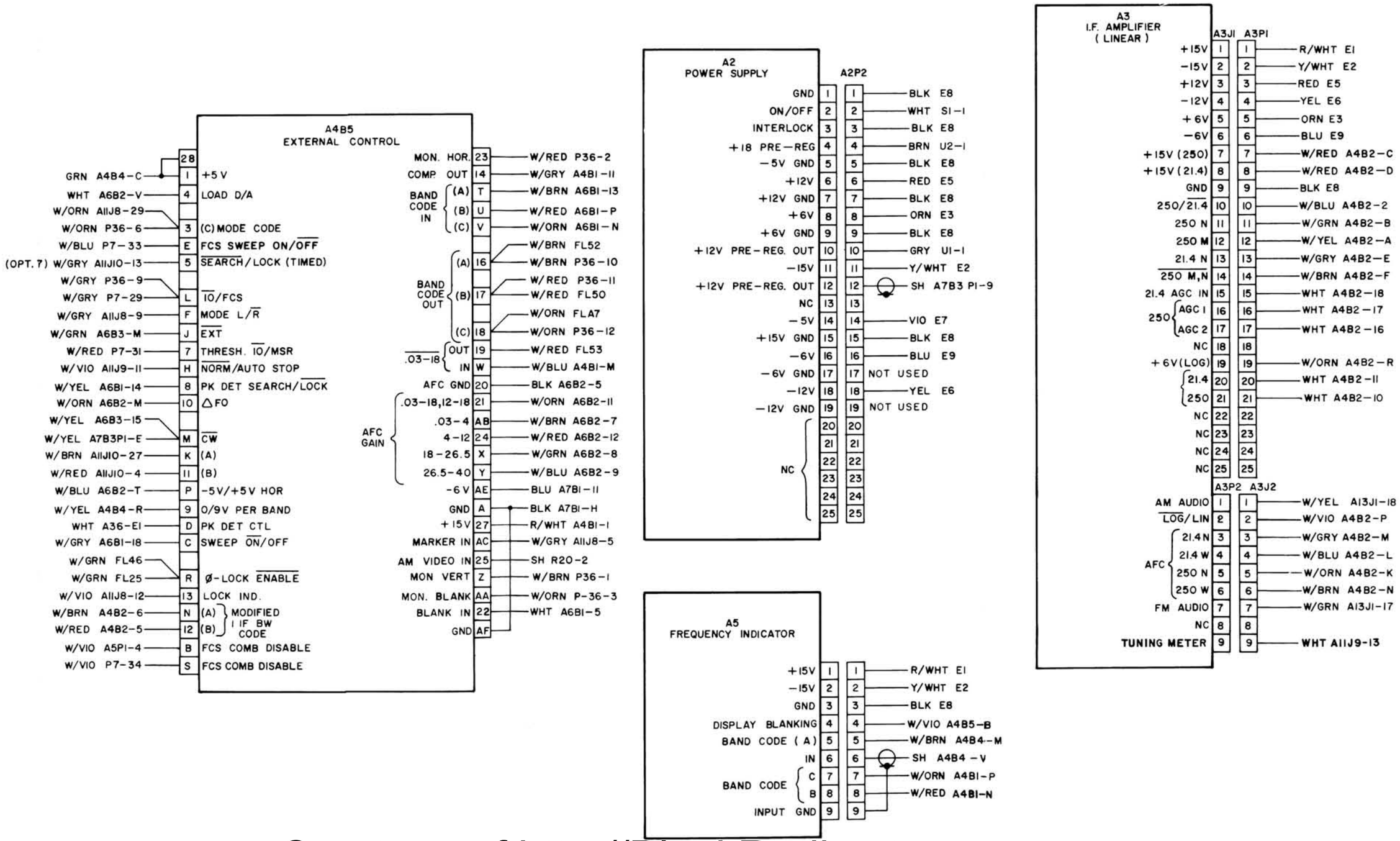
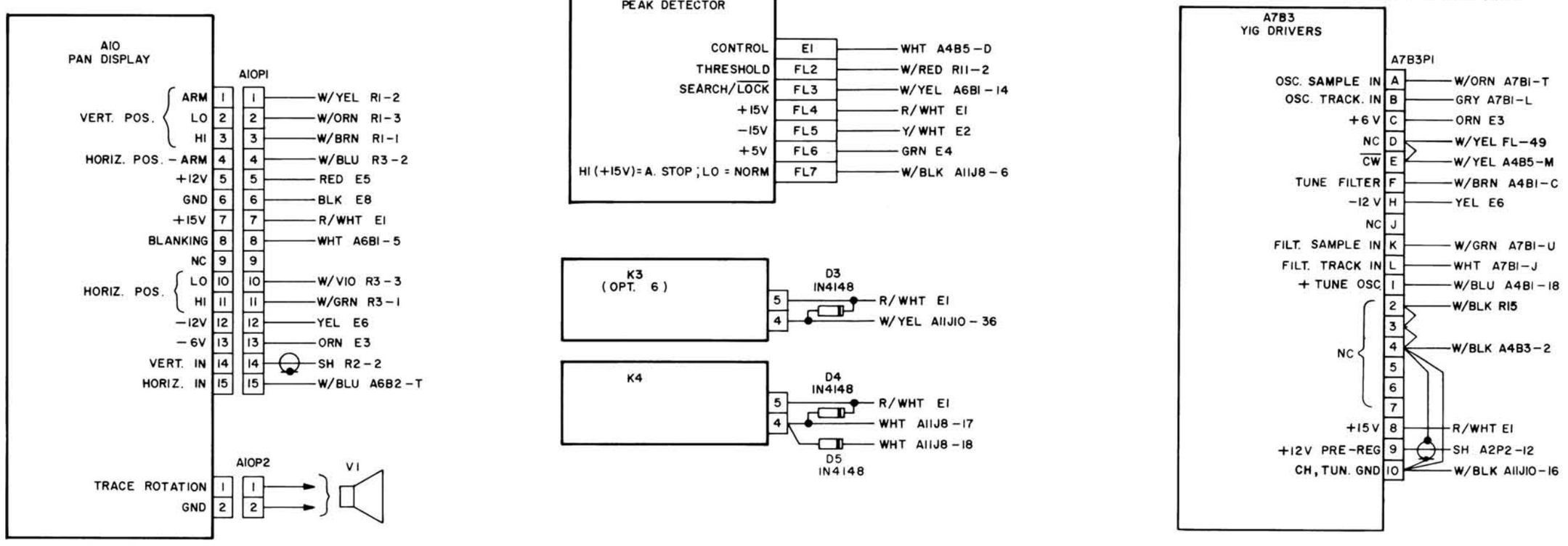


Figure 7.1 MSR-904A, Wiring Diagram 92B10-081
Sheet 9 of 10

REV. G PER. CO. NO. 236 10/18/83 WMW
REV. H PER CO NO 290 7/3/84 WMW

REV A CO NO. 126 WMW 12-02-82
REV B CO NO. 147 JFF 1-10-83
REV C CO NO. 160 WMW 2-1-83
REV D CO NO 177 WMW 3-2-83
REV E CO NO 206 JFF 7/14/83
REV F CO NO 148 WMW 9/1/83



REF DESIGNATIONS	
LAST USED	NOT USED
A53	A9, A14–A30, A32–A35 A37–A51
C4	
CP8	CP6
E9	
K4	K1, K2
R23	R16–R19
S1	
U2	
Z12	Z2–Z5, Z10, Z11

Figure 7.1 MSR-904A, Wiring Diagram 92B10-081
Sheet 10 of 10

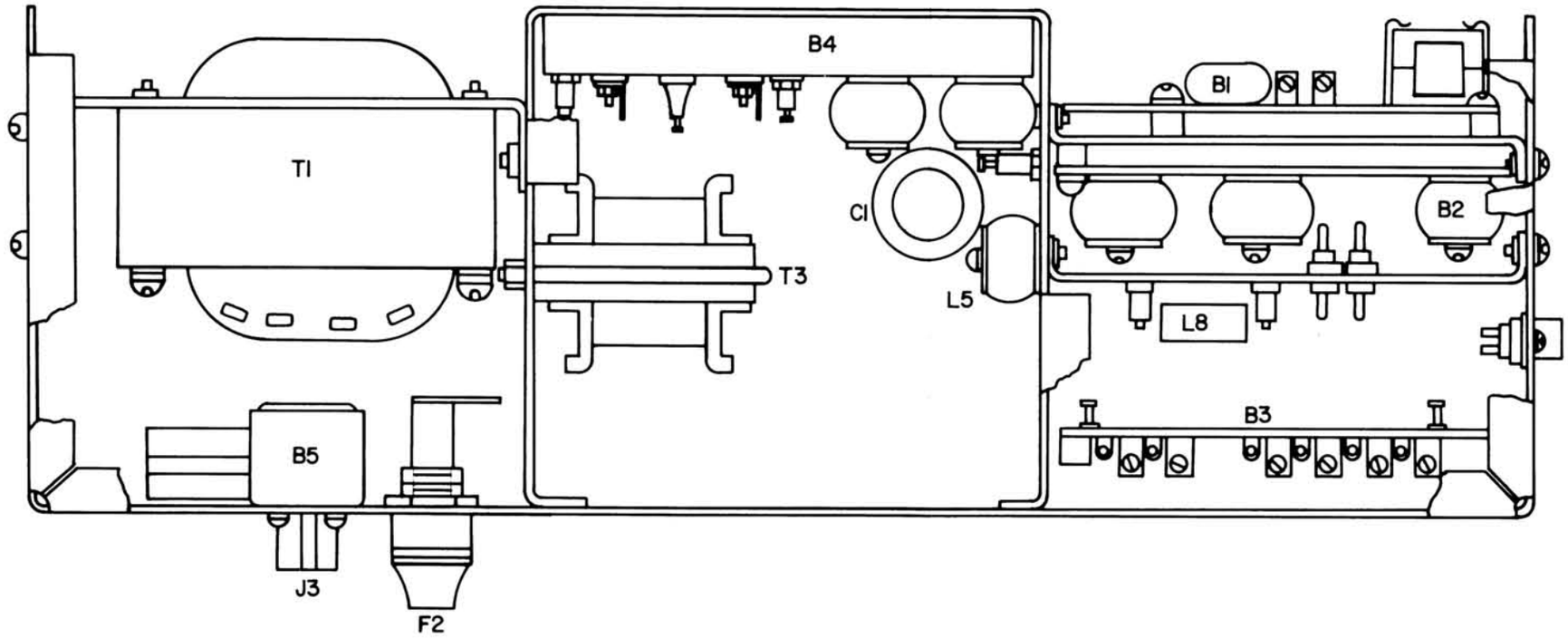
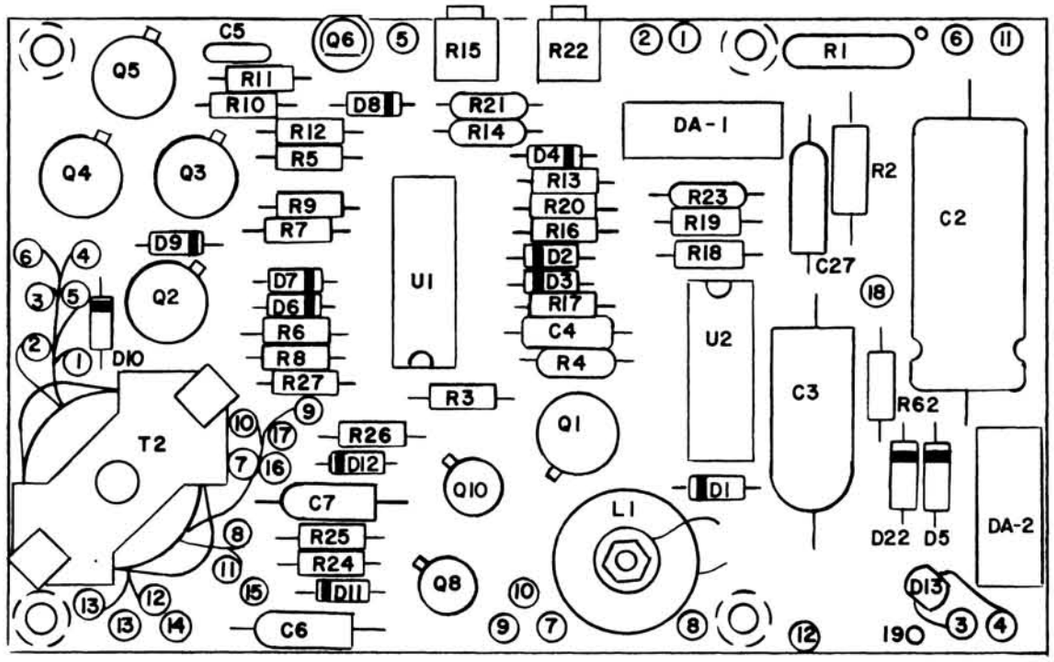
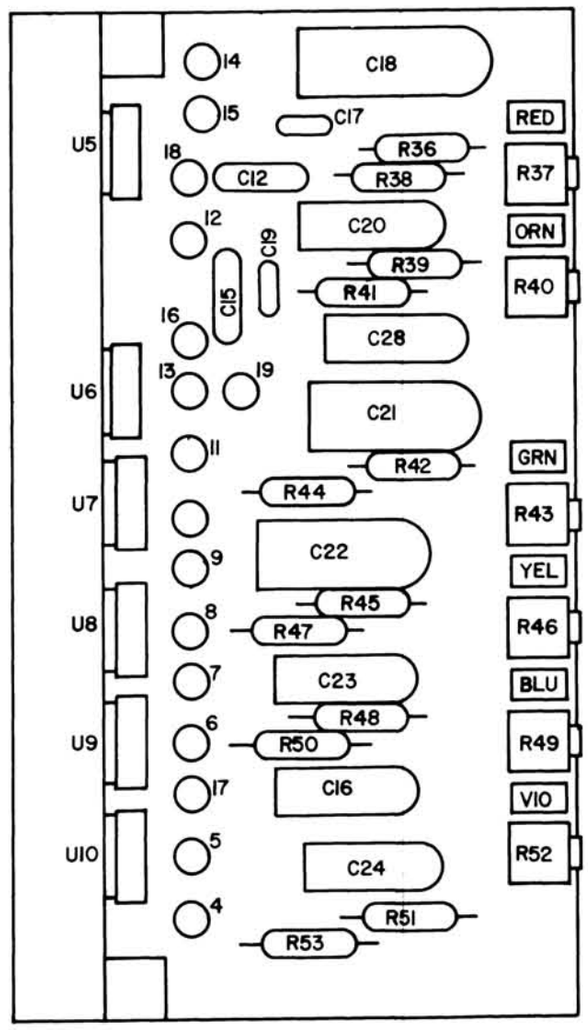


Figure 7.2 Overall Layout, A2 Power Supply 92R20-078
Sheet 1 of 3

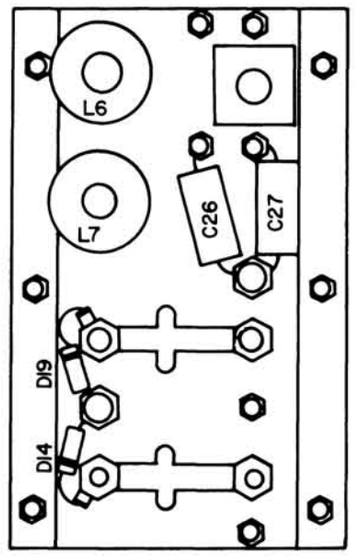


ASSEMBLY A2B1
DWG. NO. 92A21-389

ASSEMBLY A2B2
DWG. NO. 92A22-304



ASSEMBLY A2B3
DWG. NO. 92B23-390



ASSEMBLY A2B4
DWG. NO. 92B24-391

Figure 7.2 Overall Layout, A2 Power Supply 92R20-078
Sheet 2 of 3

REV PER CO 151 1/13/83 WMW

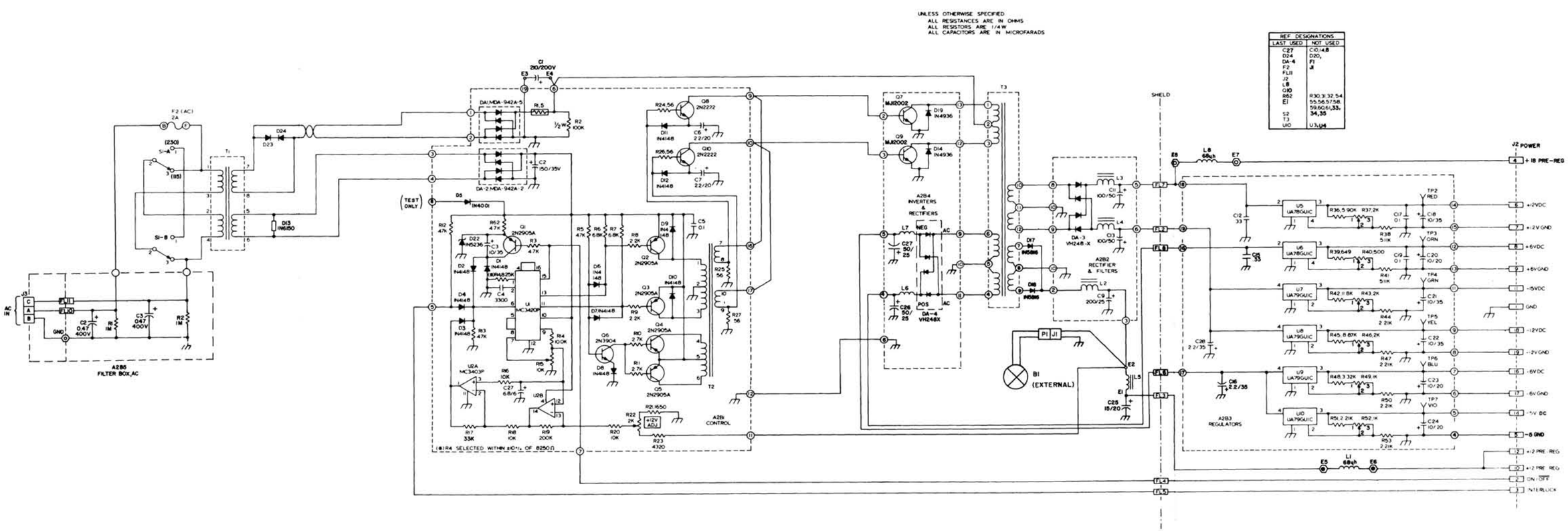


Figure 7.2 Overall Layout, A2 Power Supply 92R20-078
Sheet 3 of 3

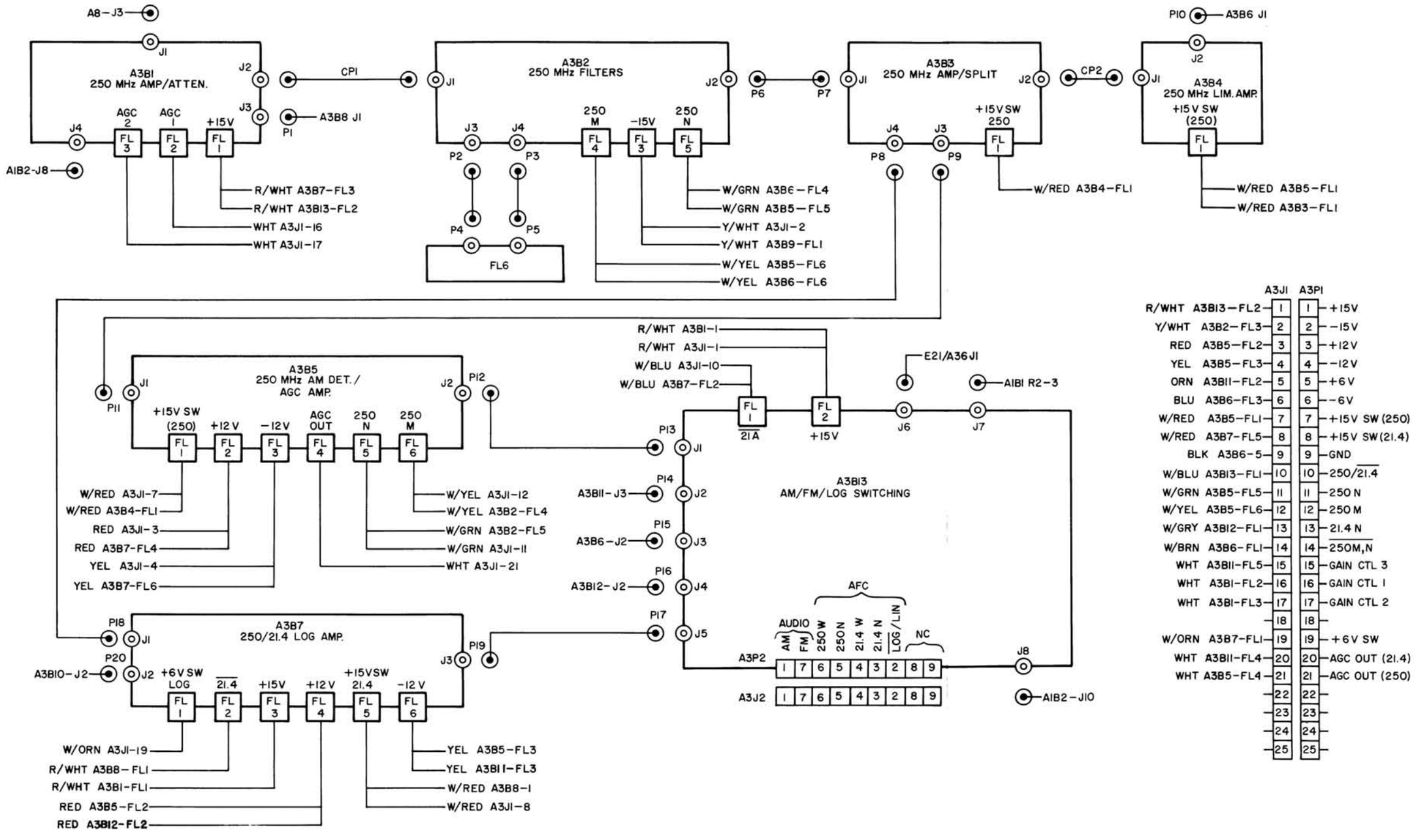


Figure 7.3 Wiring Diagram, A3 92B30-083
Sheet 1 of 2

REV. A PER. CO NO. 156 1/31/83 WMW
REV. B PER. CO NO 292 7/2/84 JFF

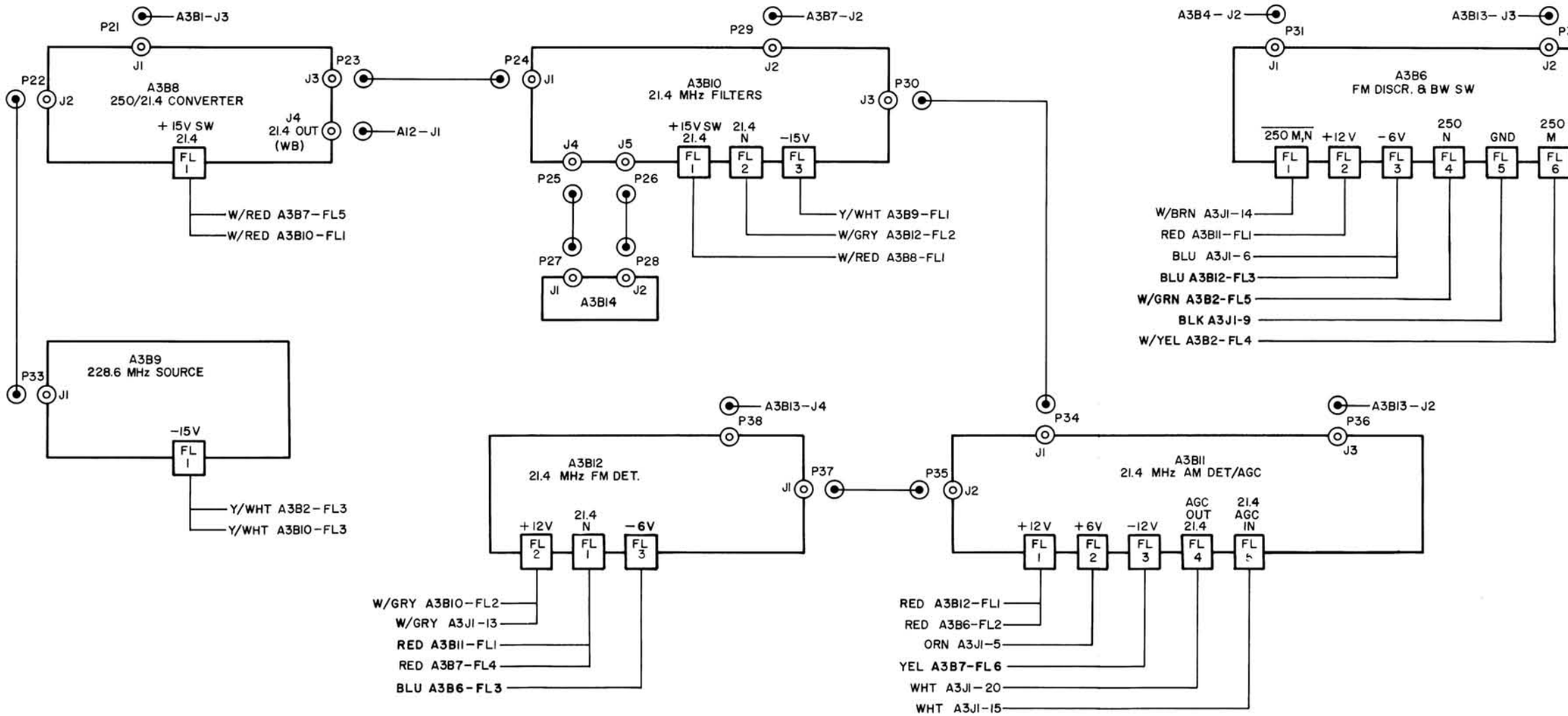
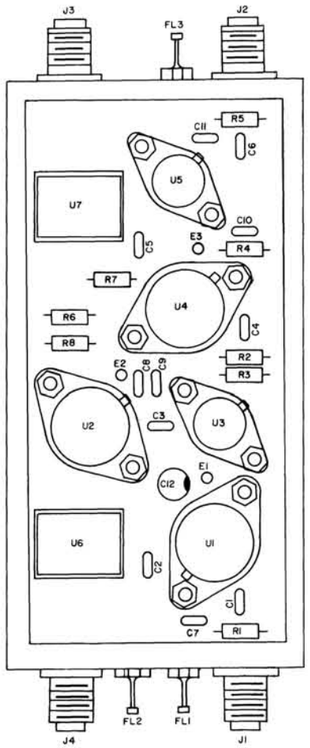
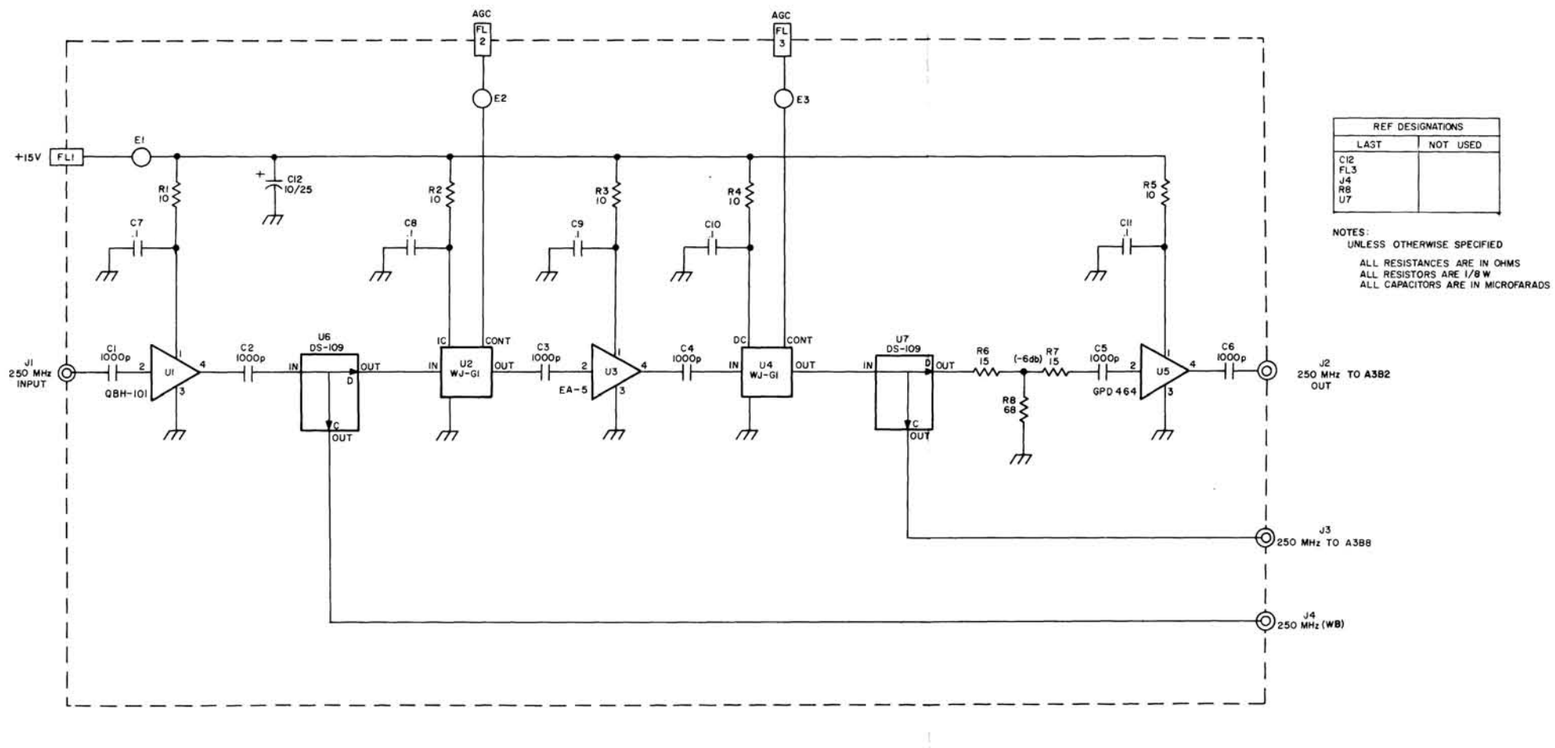


Figure 7.3 Wiring Diagram, A3 92B30-083
Sheet 2 of 2



ASSEMBLY DWG. NO.
92B31-382

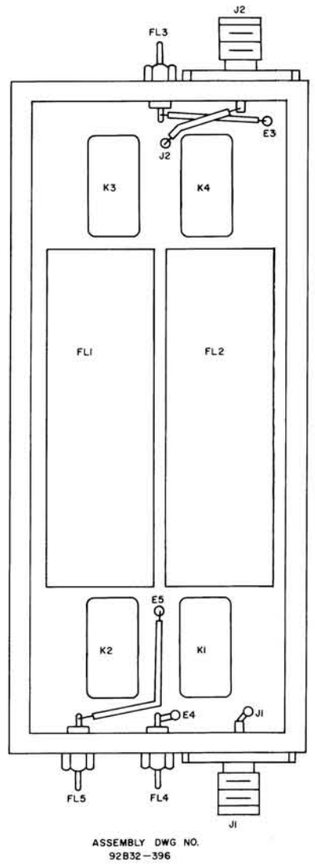


REF DESIGNATIONS	
LAST	NOT USED
C12 FL3 J4 R8 U7	

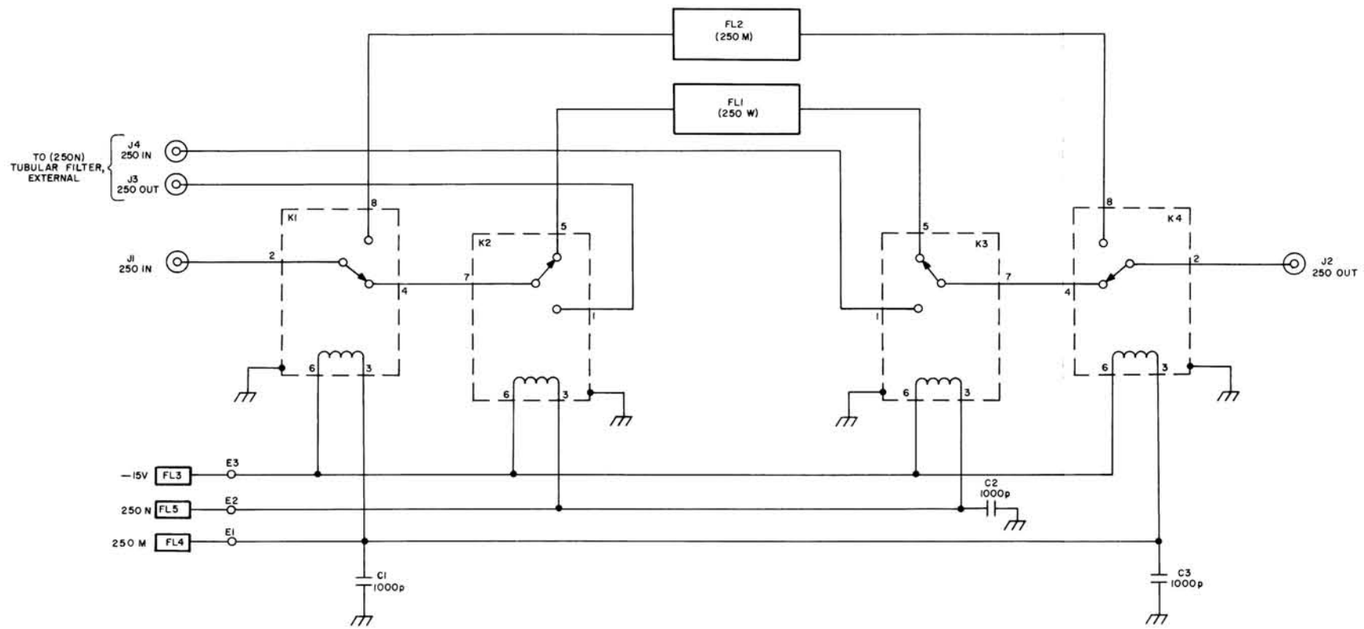
NOTES:
UNLESS OTHERWISE SPECIFIED

ALL RESISTANCES ARE IN OHMS
ALL RESISTORS ARE 1/8 W
ALL CAPACITORS ARE IN MICROFARADS

Figure 7.4 250 MHz Amp/Attenuator, A3B1
Schematic Diagram 92R31-063

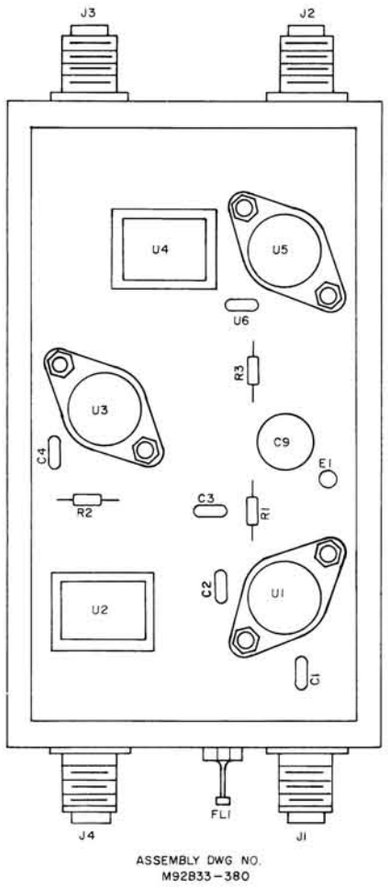


ASSEMBLY DWG NO.
92B32-396

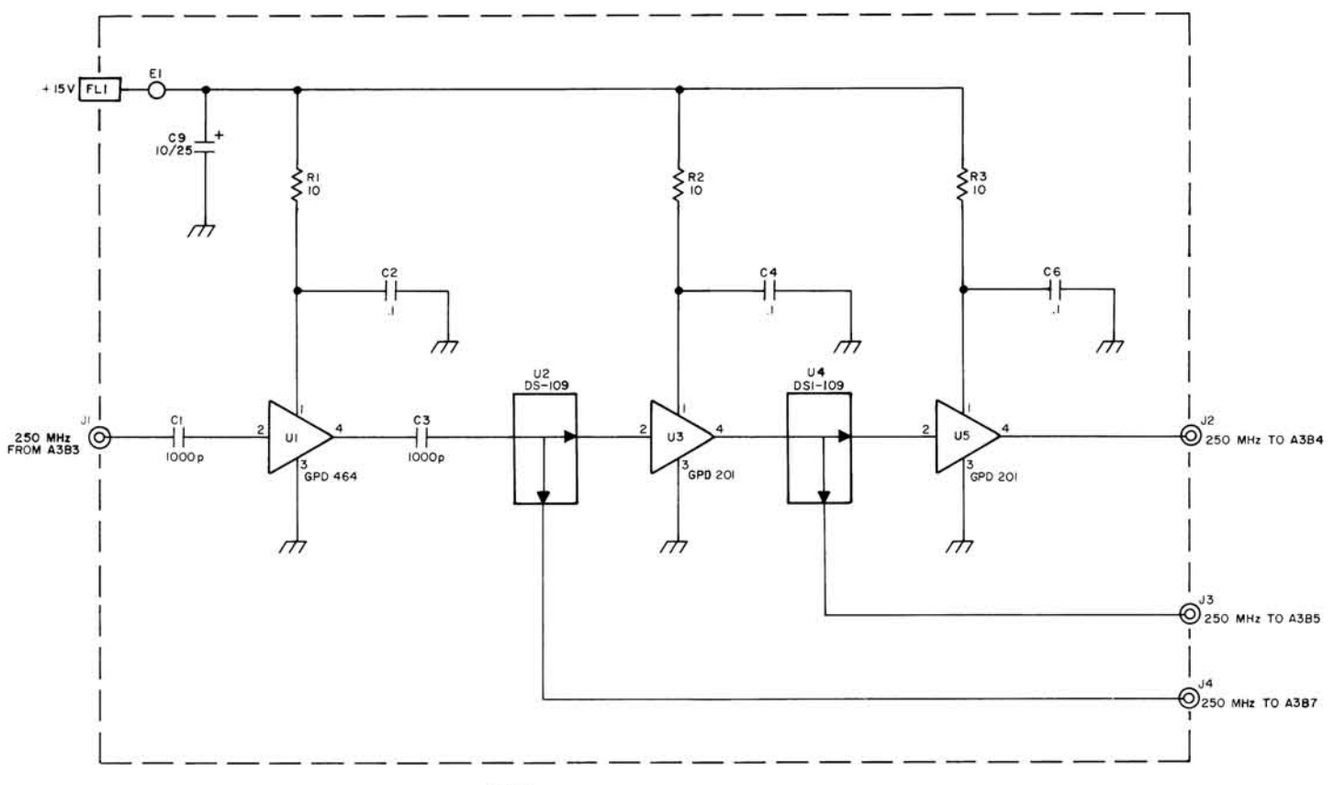


NOTE:
ALL RELAYS ARE UNENERGIZED.

Figure 7.5 250 MHz Filters, A3B2
Schematic Diagram 92R32-064



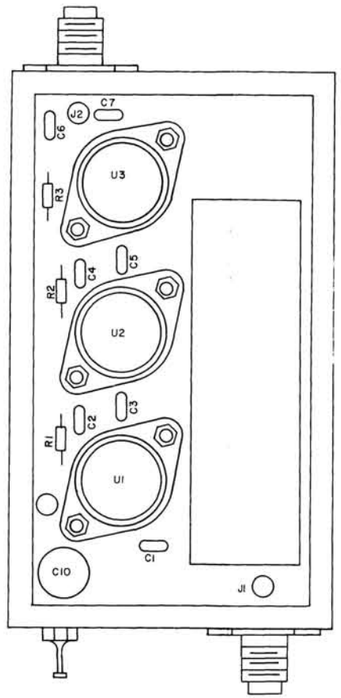
ASSEMBLY DWG NO.
M92833-380



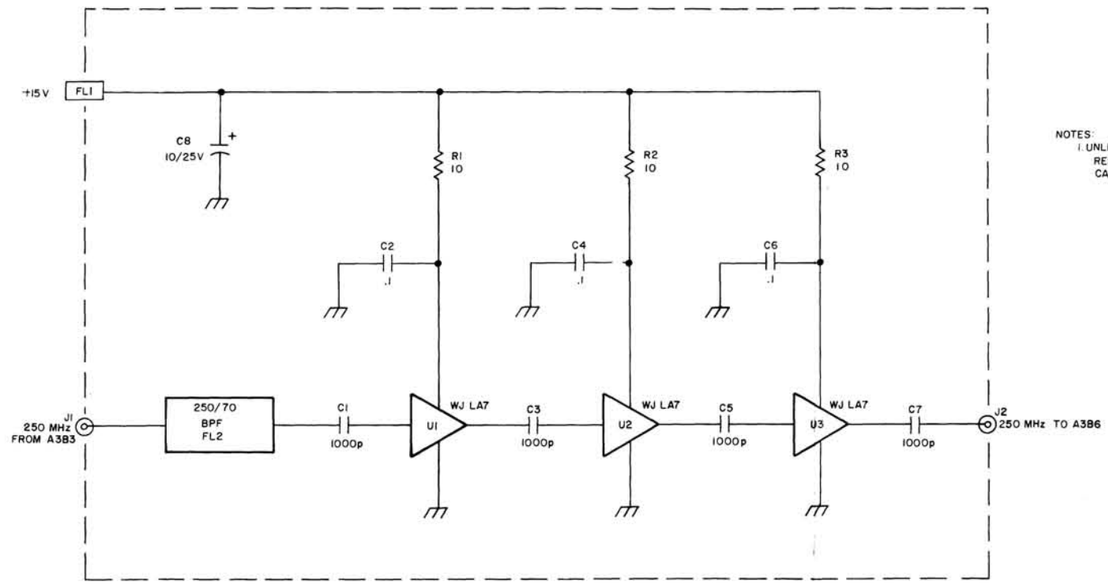
NOTES
1.UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS, 1/8W, 5%.
CAPACITORS ARE IN MICROFARADS

Figure 7.6 250 MHz Amplifier/Splitter, A3B3
Schematic Diagram 92R33-065

REV. PER CO. NO. 227 WMW 9/27/83
REV. PER CO NO 283 WMW 6/6/84

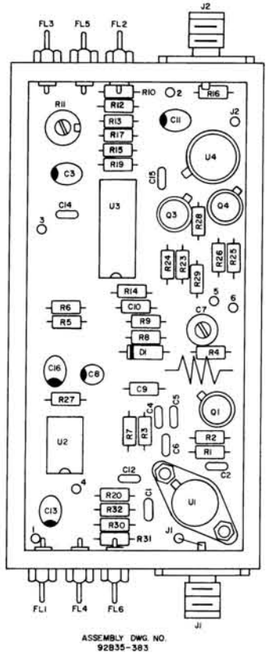


ASSEMBLY DWG. NO.
M92834-381

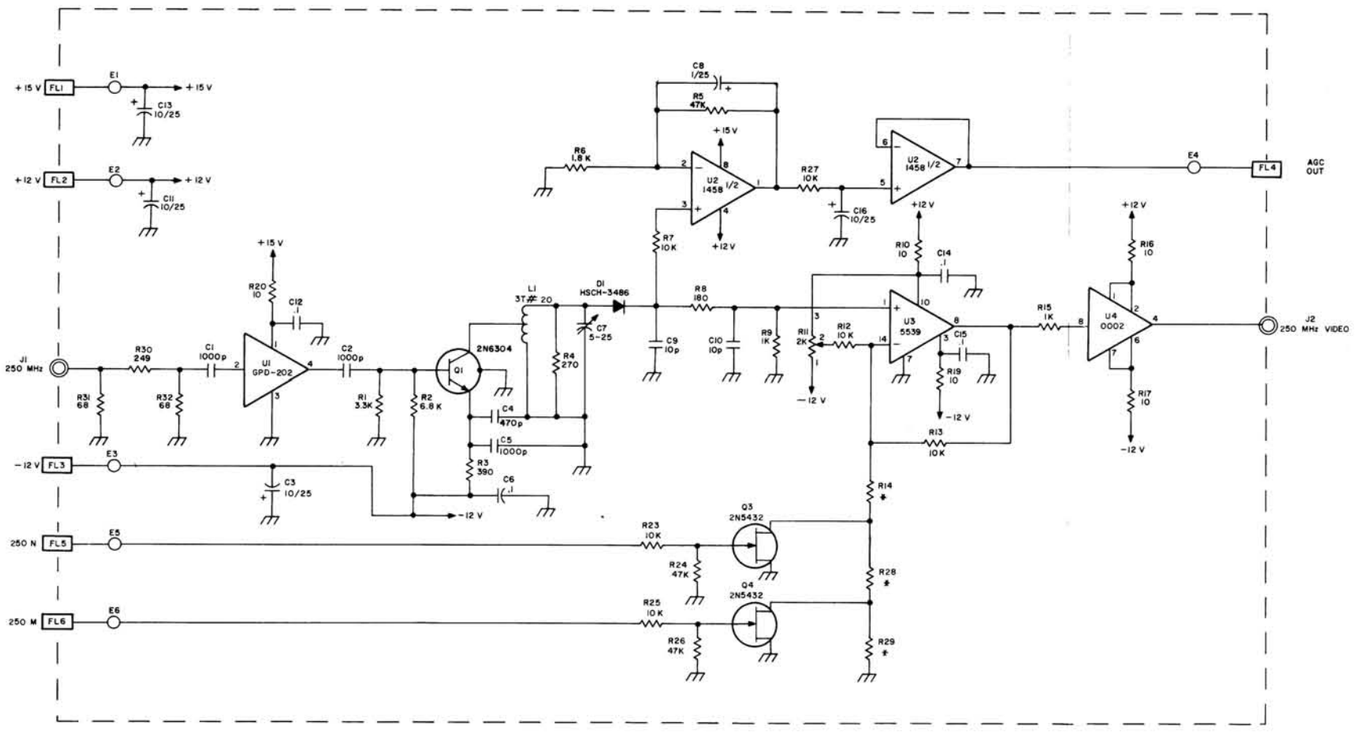


NOTES:
1. UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS, 1/8W, 5%.
CAPACITORS ARE IN MICROFARADS

Figure 7.7 250 MHz Limiter Amplifier, A3B4
Schematic Diagram 92R34-066



ASSEMBLY DWG. NO.
92B35-383



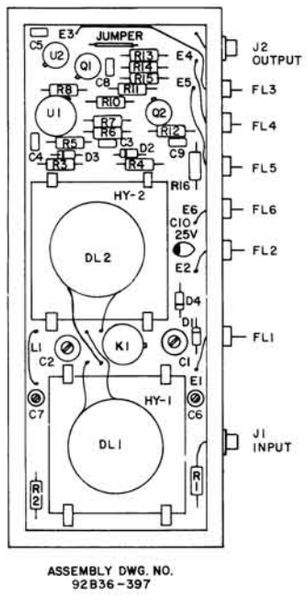
REV A PER. CO NO. 133 1/4/83 WMW
REV B PER. CO NO. 210 8/10/83 WMW
REV C PER. CO NO. 238 11/29/83 WMW
REV D PER. CO NO. 246 1/9/83 WMW
REV E PER. CO NO. 248 2/9/84 WMW
REV F PER. CO NO. 262 3/20/84 WMW

REF DESIGNATIONS	
LAST USED	NOT USED
C16 D1 FL6 J2 L1 Q4 R32 U4	Q2 R18,R21,R22

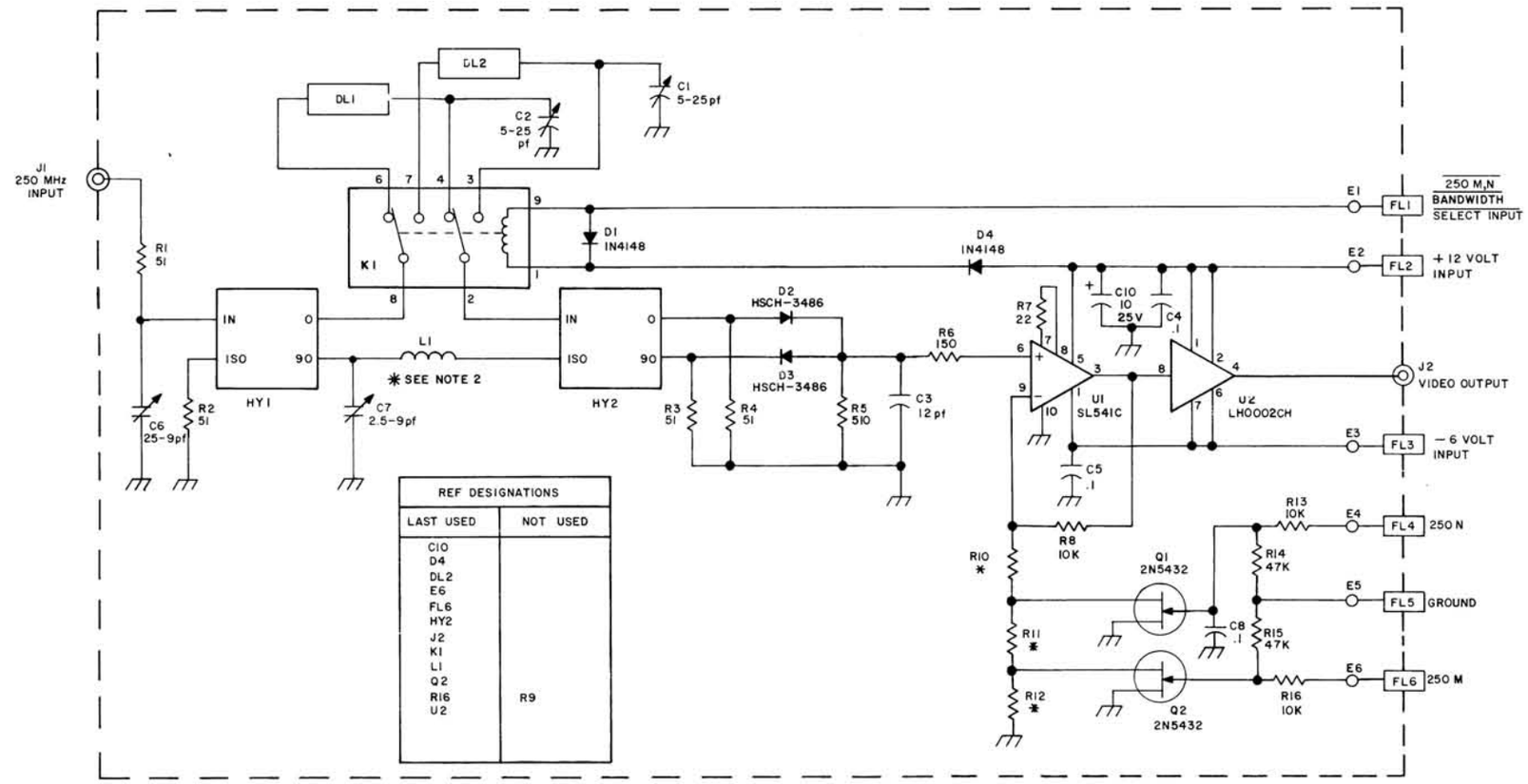
NOTES
UNLESS OTHERWISE SPECIFIED

ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/8 W
ALL CAPACITORS ARE IN MICROFARADS
* VALUE SELECTED PER BANDWIDTH, IN TEST.

Figure 7.8 250 MHz AM Det/AGC Amp, A3B5
Schematic Diagram 92R35-067



ASSEMBLY DWG. NO.
92836-397

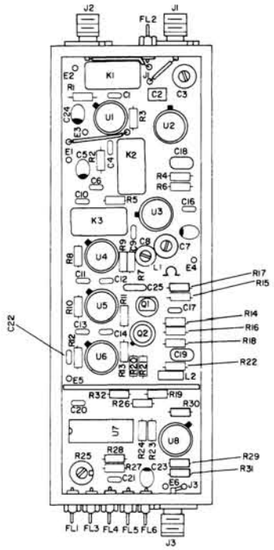


REF DESIGNATIONS	
LAST USED	NOT USED
C10	
D4	
DL2	
E6	
FL6	
HY2	
J2	
K1	
L1	
Q2	
R16	R9
U2	

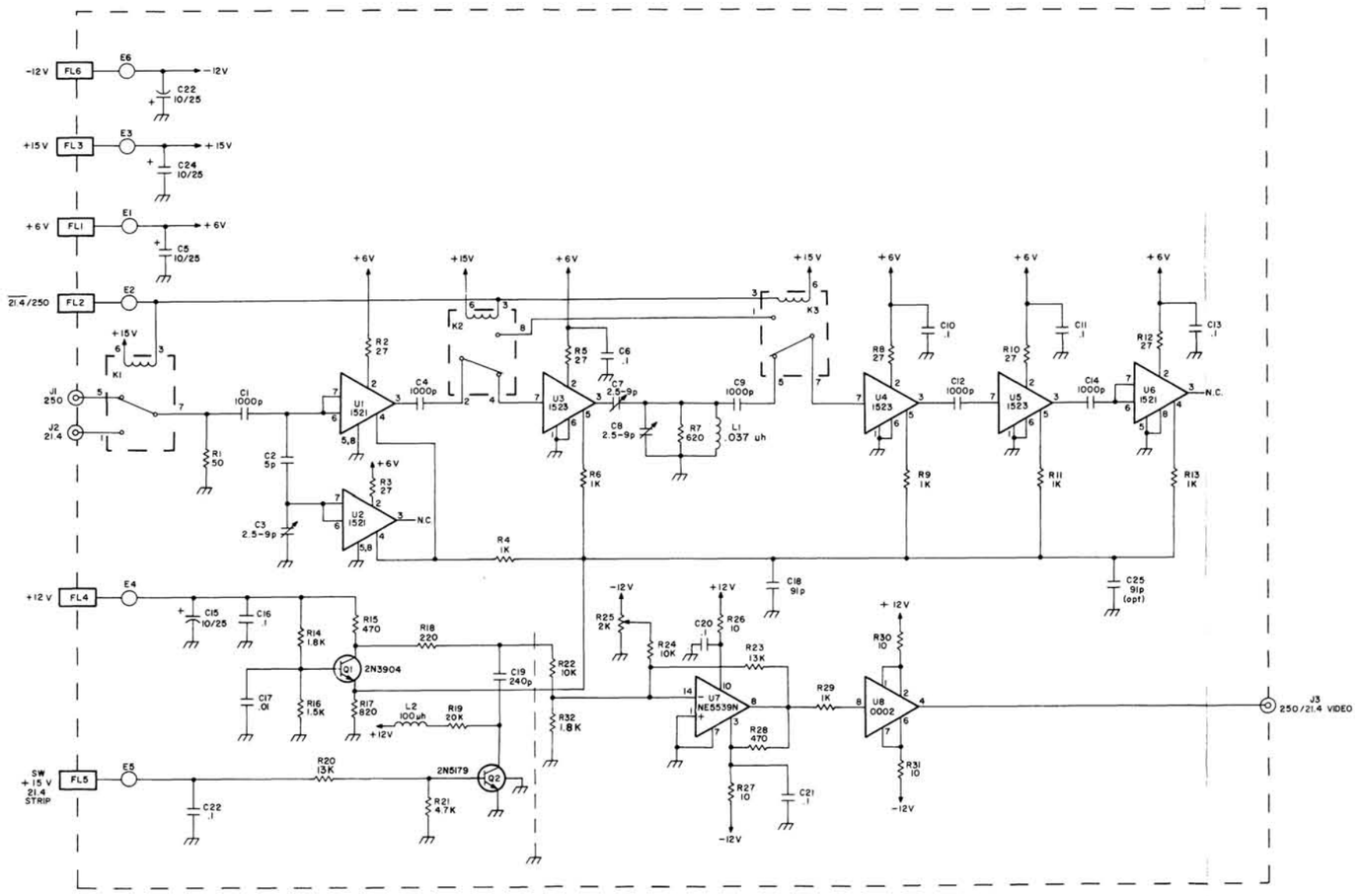
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   RESISTANCE VALUES ARE IN OHMS 1/4W 5%
   1% RESISTORS ARE 1/8W
   CAPACITORS ARE IN MICROFARADS
2. 1" OF NO. 22 MAGNET WIRE TINNED 1/10 ON EACH END.

✱ VALUE SELECTED, IN TEST PER. BANDWIDTH.

Figure 7.9 250 MHz FM Discriminator, A3B6
Schematic Diagram 92R36-068



ASSEMBLY DWG. NO.
92B37-398

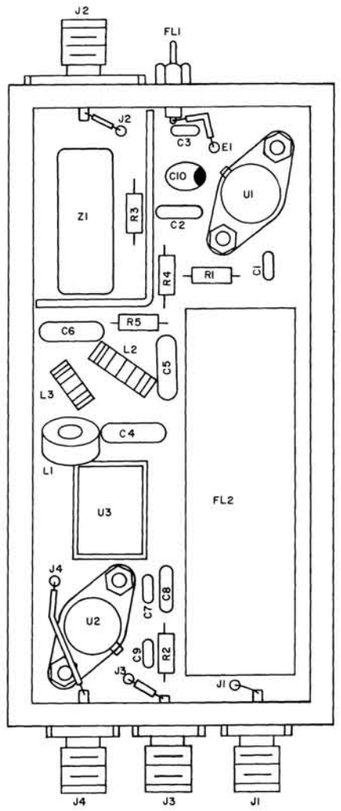


REV. PER. CO. NO. 249 2/9/84 WMW
REV. PER. CO. NO. 256 2/15/84 WMW
REV. PER. CO. NO. 250 3/9/84 WMW

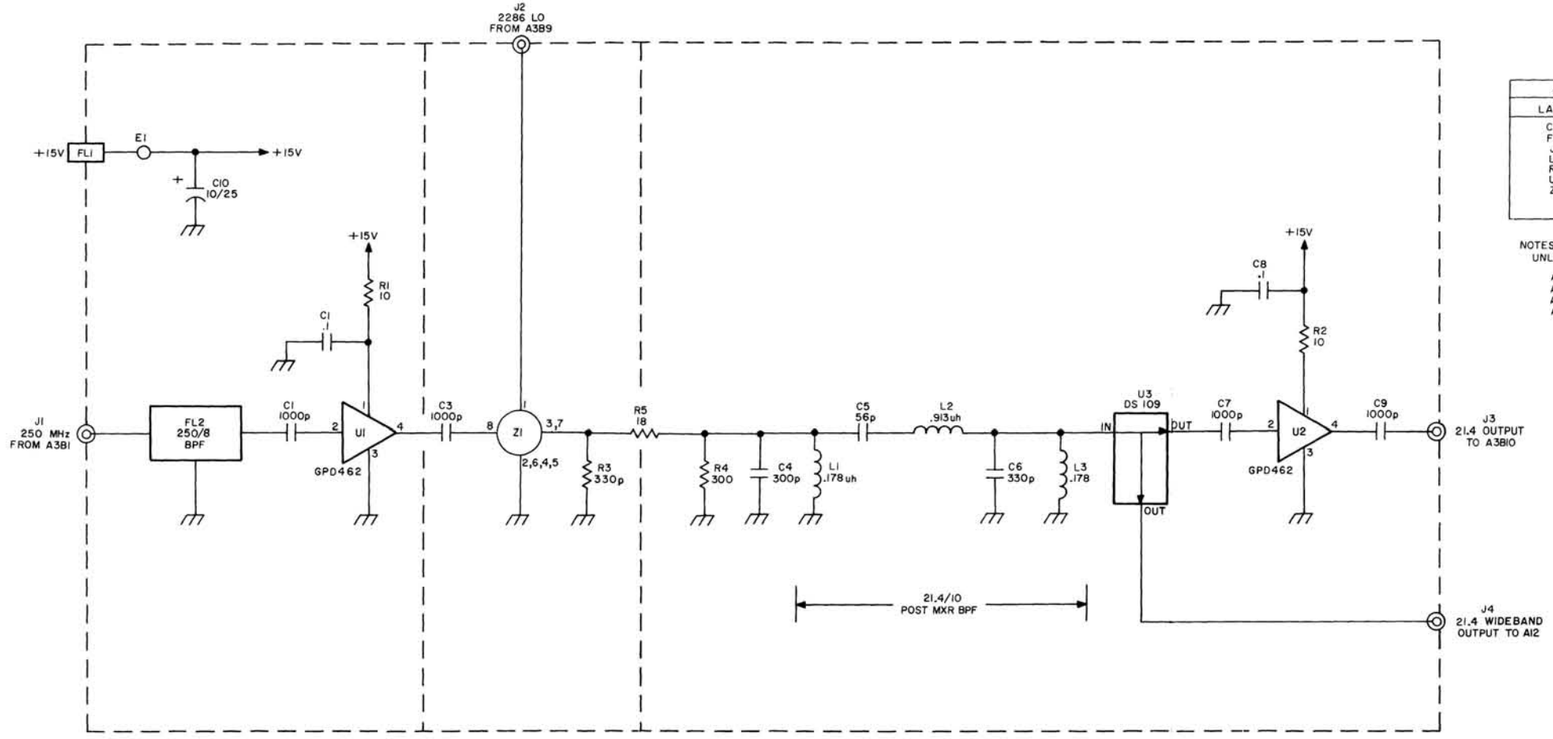
REF DESIGNATION	
LAST	NOT USED
C25	
FL6	
J3	
K3	
L2	
Q2	
R32	
U8	

NOTES:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCES ARE IN OHMS
ALL RESISTORS ARE 1/8 W
ALL CAPACITORS ARE IN MICROFARADS
ALL RELAYS ARE UNENERGIZED

Figure 7.10 250/21.4 Log Amplifier, A3B7
Schematic Diagram 92R37-069



ASSEMBLY DWG. NO.
92838-384

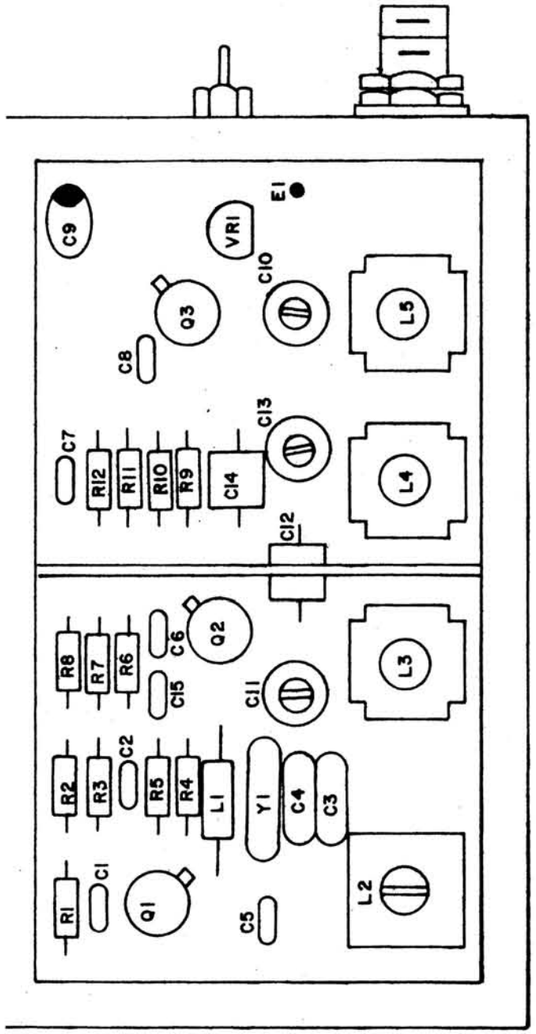


REF DESIGNATIONS	
LAST	NOT USED
C10 FL2 J4 L3 R5 U3 Z1	

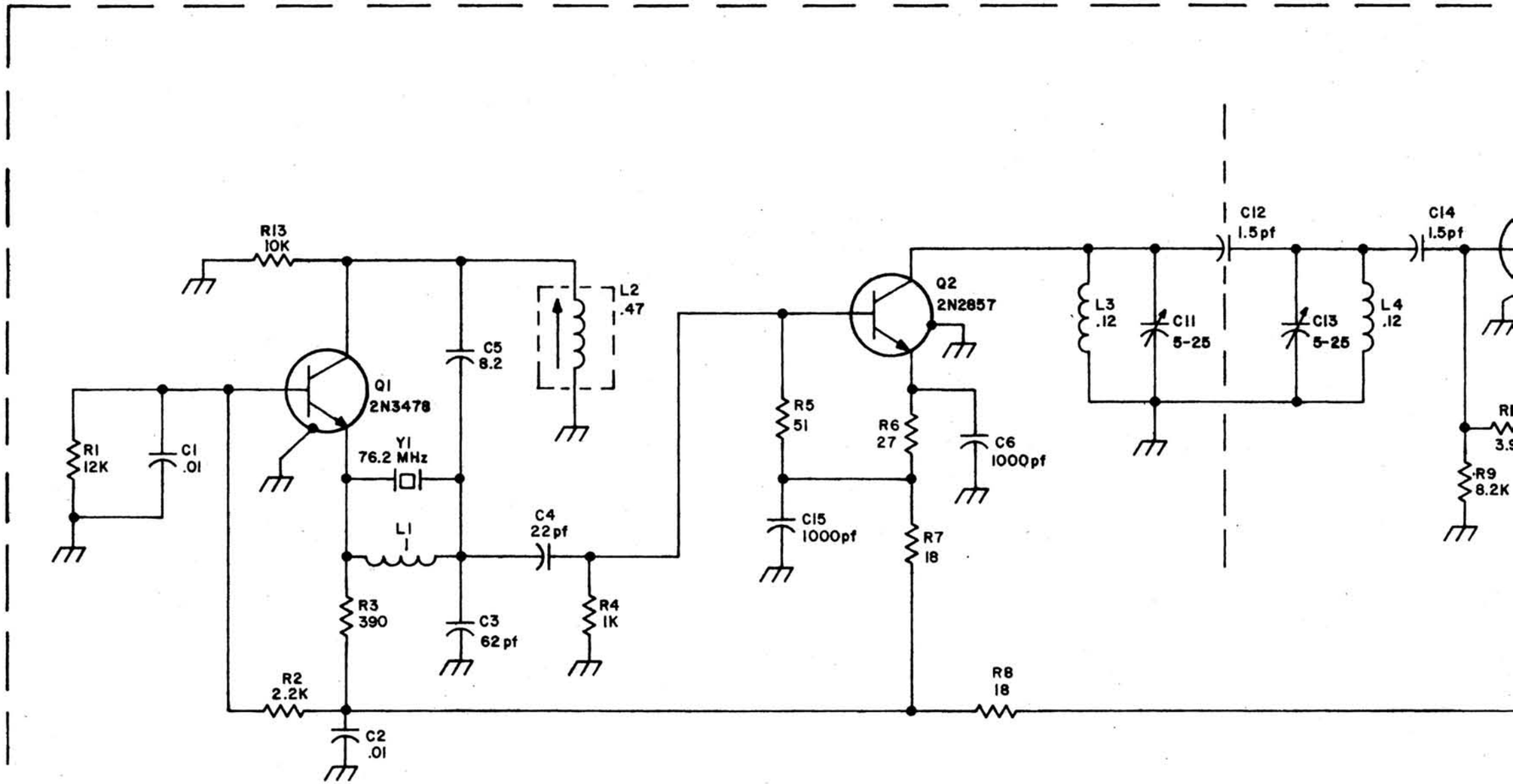
NOTES:
UNLESS OTHERWISE SPECIFIED:

ALL RESISTANCES ARE IN OHMS
ALL RESISTORS ARE 1/8W
ALL CAPACITORS ARE IN MICROFARADS
ALL INDUCTERS ARE IN nh

Figure 7.11 250 to 21.4 Converter, A3B8
Schematic Diagram 92R38-070

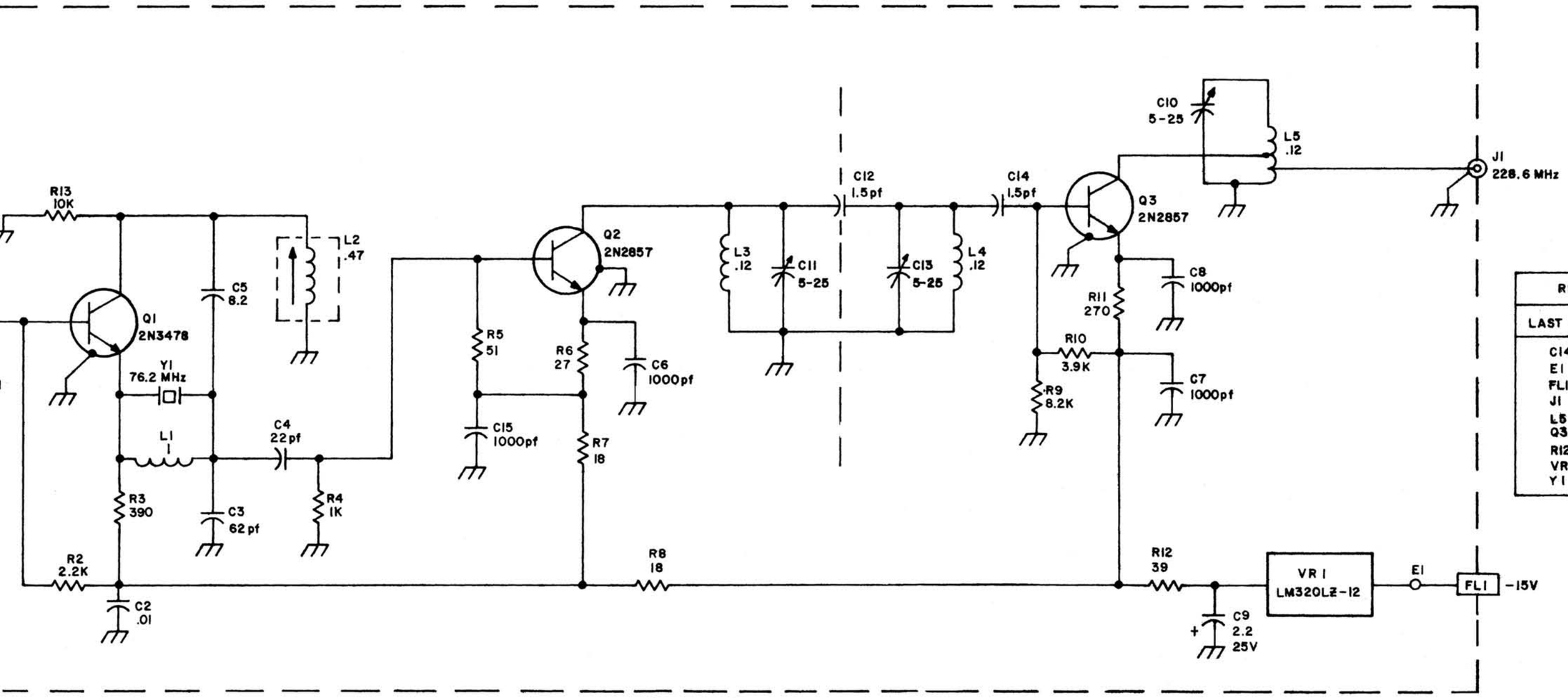


ASSEMBLY DWG NO. 92B39-399



NOTES:

1. UNLESS OTHERWISE SPECIFI
   RESISTANCE VALUES ARE IN
   RESISTORS ARE 5%, 1/8 W
   CAPACITORS ARE IN MICROF
   INDUCTANCE VALUES ARE IN

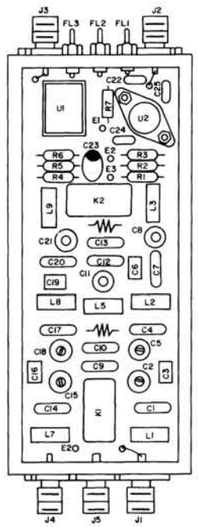


REF. DESIGNATIONS	
LAST USED	NOT USED
C14 E1 FL1 J1 L5 Q3 R12 VR1 Y1	

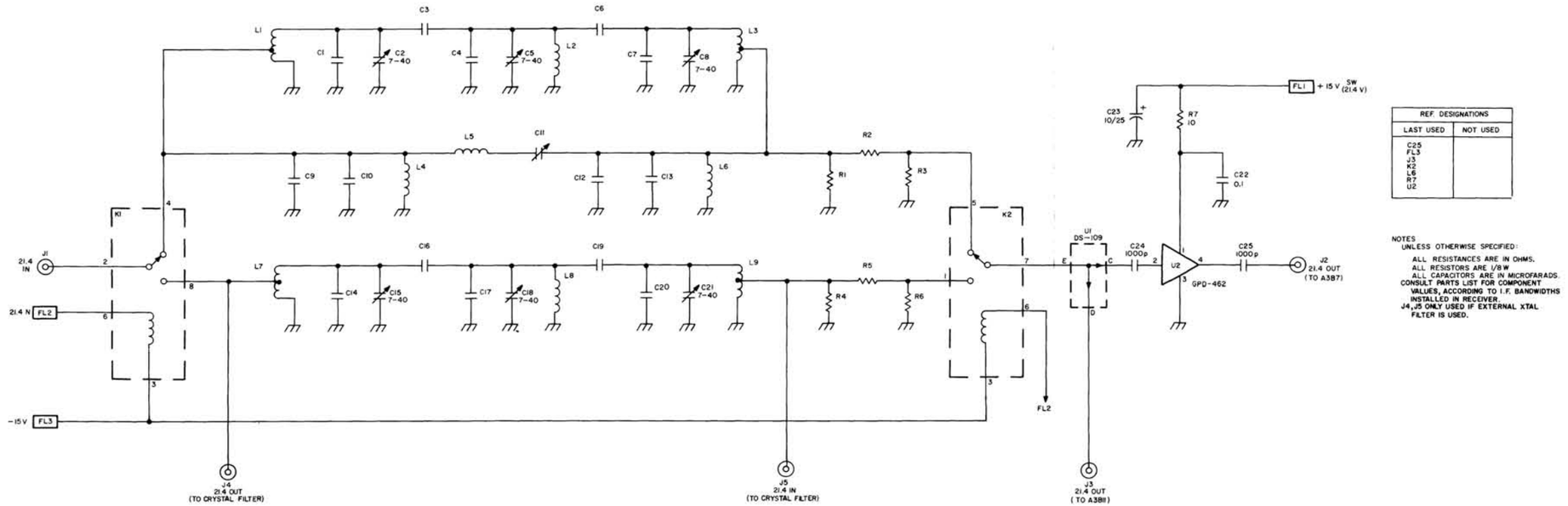
NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTANCE VALUES ARE IN OHMS
   RESISTORS ARE 5%, 1/8 W
   CAPACITORS ARE IN MICROFARADS
   INDUCTANCE VALUES ARE IN MICROHENRYS

MSR-904A IF
SCHEMATIC, A3B9
228.6 MHz SOURCE
92R39-071



ASSEMBLY DWG NO.
92830-385

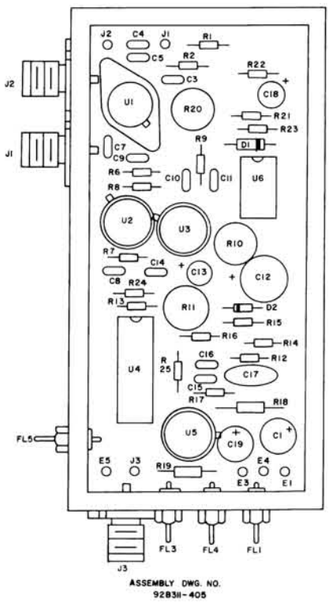


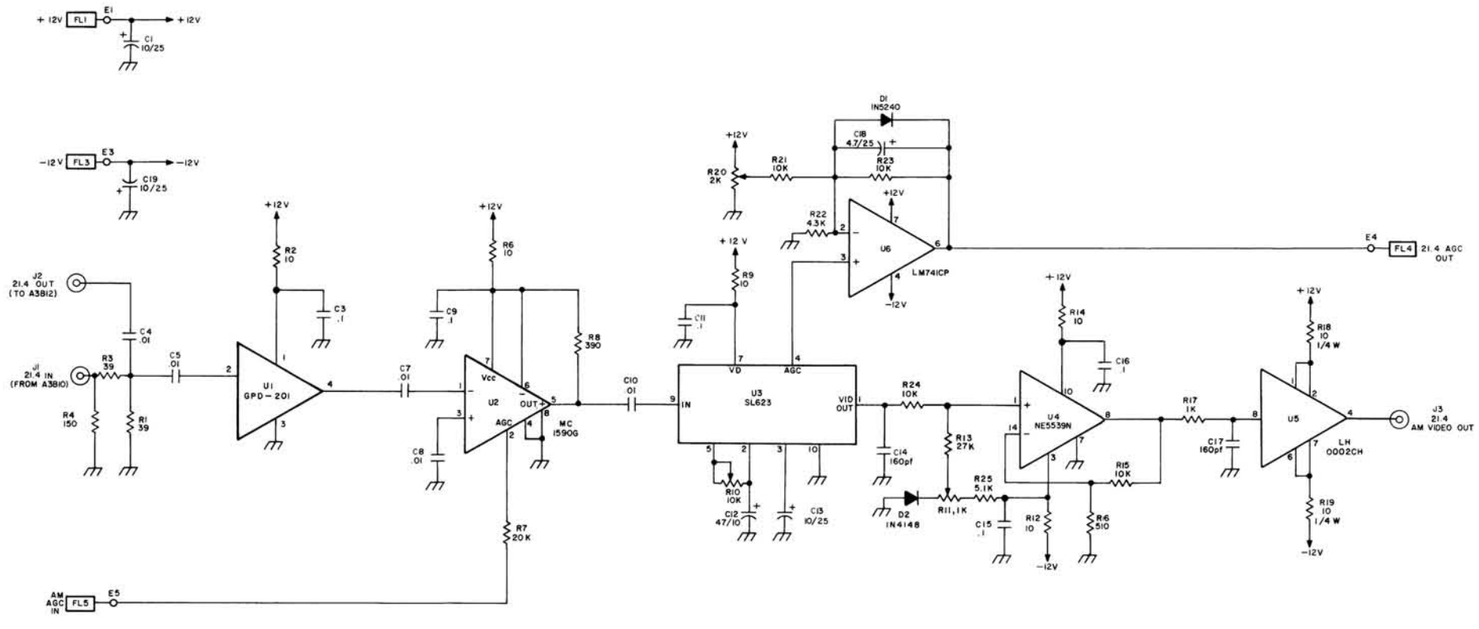
REF. DESIGNATIONS	
LAST USED	NOT USED
C25 FL3 J3 K2 L6 R7 U2	

NOTES
UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/8 W
ALL CAPACITORS ARE IN MICROFARADS.
CONSULT PARTS LIST FOR COMPONENT VALUES, ACCORDING TO I.F. BANDWIDTHS INSTALLED IN RECEIVER.
J4,J5 ONLY USED IF EXTERNAL XTAL FILTER IS USED.

Figure 7.13 21.4 MHz Filters, A3B10
Schematic Diagram 92R310-072

REV. PER C.O. 173 2/17/83 PS
REVISED PER CO. NO. 211,214 8/10/83 WMW
REV. PER. CO. NO. 218 8/19/83 WMW
REV. PER. CO. NO. 239 11/29/83 WMW



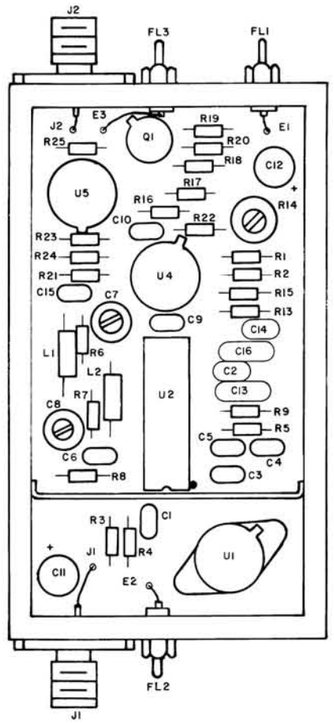


REF DESIGNATIONS	
LAST	NOT USED
C19	C2,6
D2	E2
E5	FL2
FL5	
J3	
R25	R3,4,5
U6	

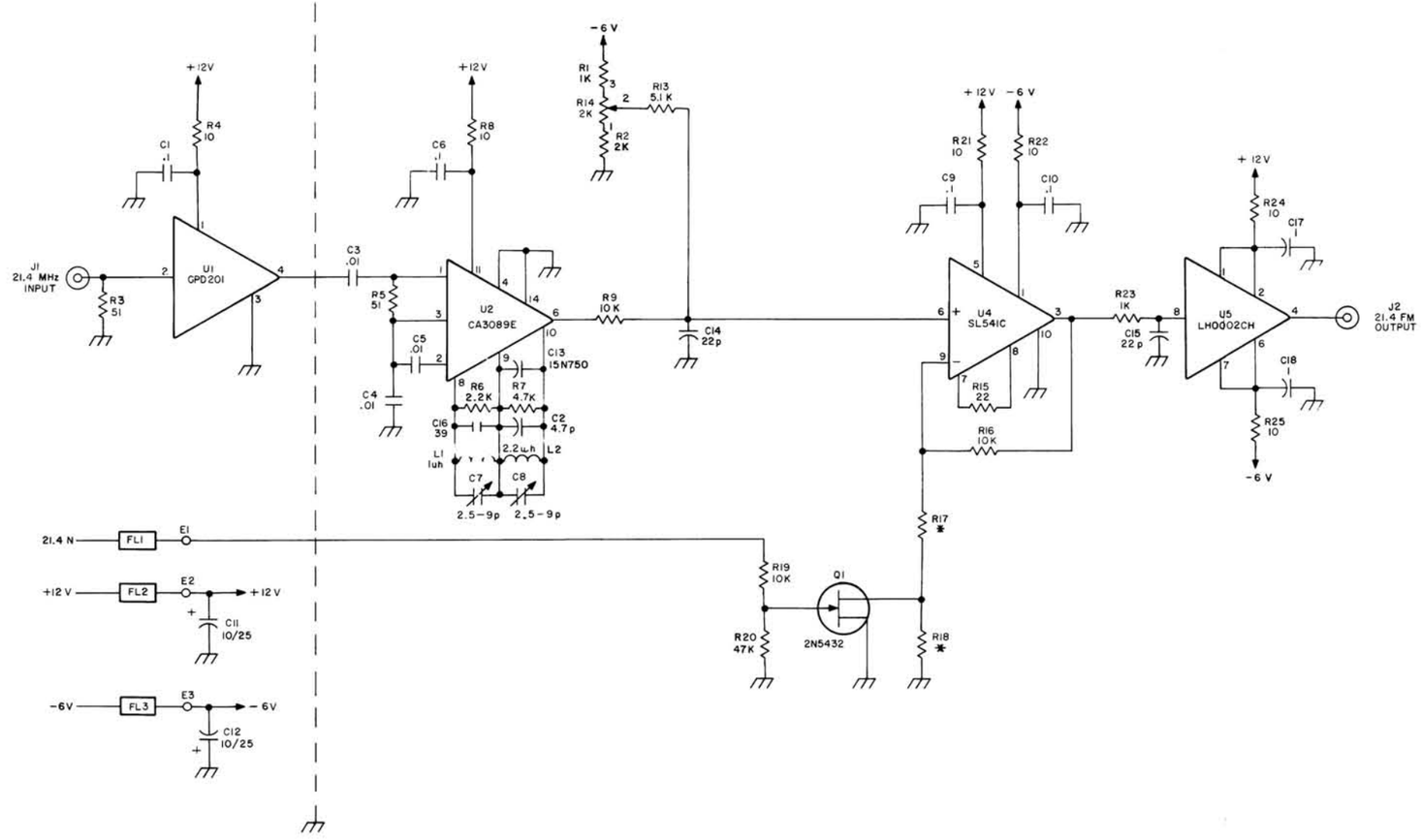
NOTES:
UNLESS OTHERWISE SPECIFIED
ALL RESISTANCES ARE IN OHMS
ALL RESISTORS ARE 1/8W
ALL CAPACITORS ARE IN MICROFARADS

Figure 7.14 21.4 MHz AM Det/AGC, A3B11
Schematic Diagram 92R311-073

REV PER CO NO. 138 1/7/83 JFF
REV PER CO NO 174 2/18/83 WMW
REV PER CO NO. 197 6/10/83 GB
REV. PER CO NO 242 12/6/83 WMW
REV. PER CO NO 253 3/19/84 WMW
REV. PER CO NO 280 6/6/84 WMW
REV. PER CO NO 292 7/2/84 JFF



ASSEMBLY DWG. NO. M92B312-406



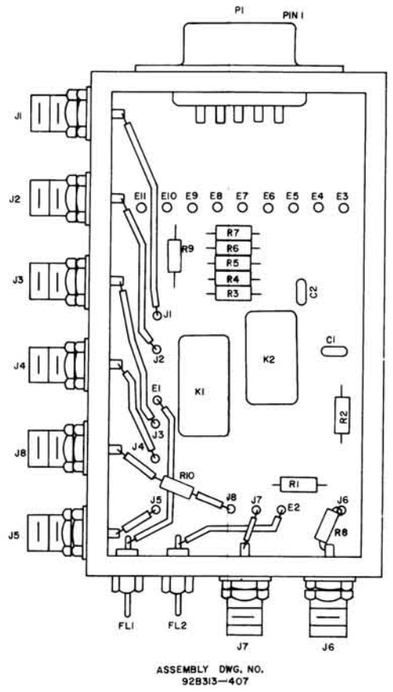
REF DESIGNATIONS	
LAST USED	NOT USED
C18	
FL3	
J2	
L2	
Q1	
R25	R10,11,12
U5	U3

NOTES:
UNLESS OTHERWISE SPECIFIED:

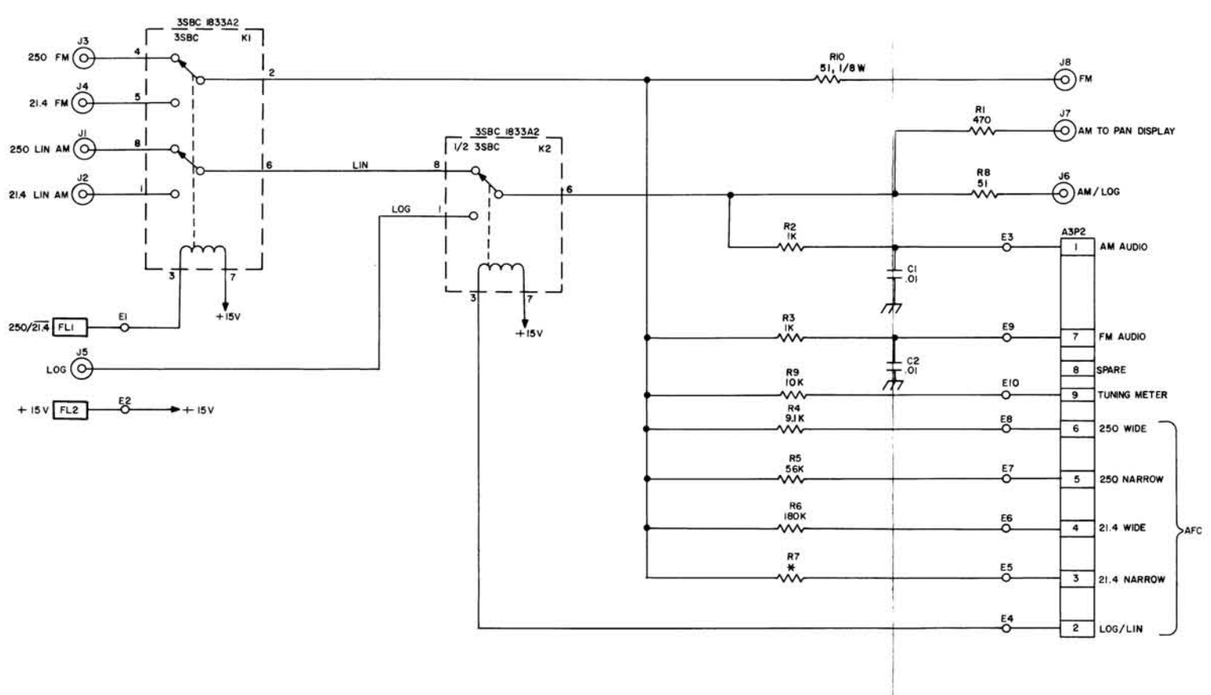
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/8 W.
ALL CAPACITORS ARE IN MICROFARADS.
* VALUE SELECTED IN TEST PER. BANDWIDTH.

Figure 7.15 21.4 MHz FM Discriminator, A3B12
Schematic Diagram 92R312-074

A- REV PER CO NO. 144 & 146 1/4/83 JFF
B- REV PER CO NO. 158 2/10/83 WMW
C- REV PER CO NO. 209 7/14/83 JFF
D- REV. PER CO NO. 252 3/19/84 WMW



ASSEMBLY DWG. NO.
92B313-407



NOTES:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/4 W.
ALL CAPACITORS ARE IN MICROFARADS.
ALL RELAYS ARE UNENERGIZED.

* RESISTANCE VALUES PER BANDWIDTHS
R7, 2.2 M ≠ (0.1 MHz)
R7, 820K ≠ (0.5 MHz)

Figure 7.16 AM/FM/LOG Switching, A3B13
Schematic Diagram 92R313-075

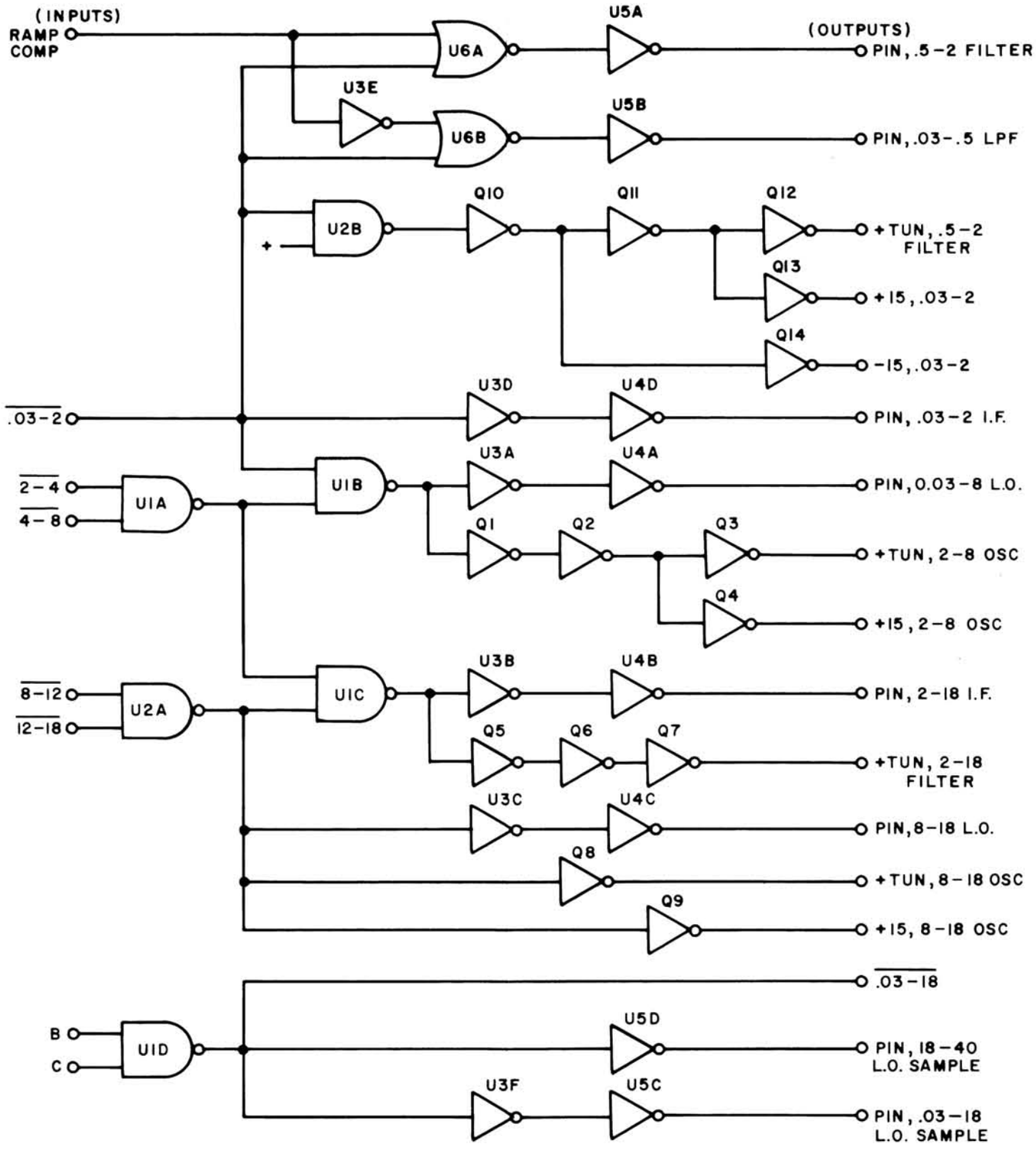
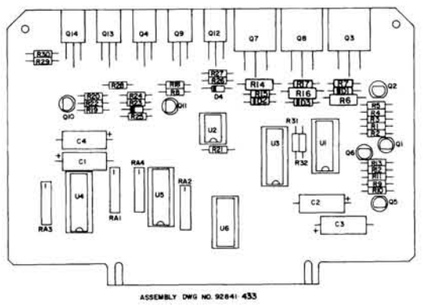


Figure 7.17 Band Control, A4B1
Logic Diagram 92A41-053



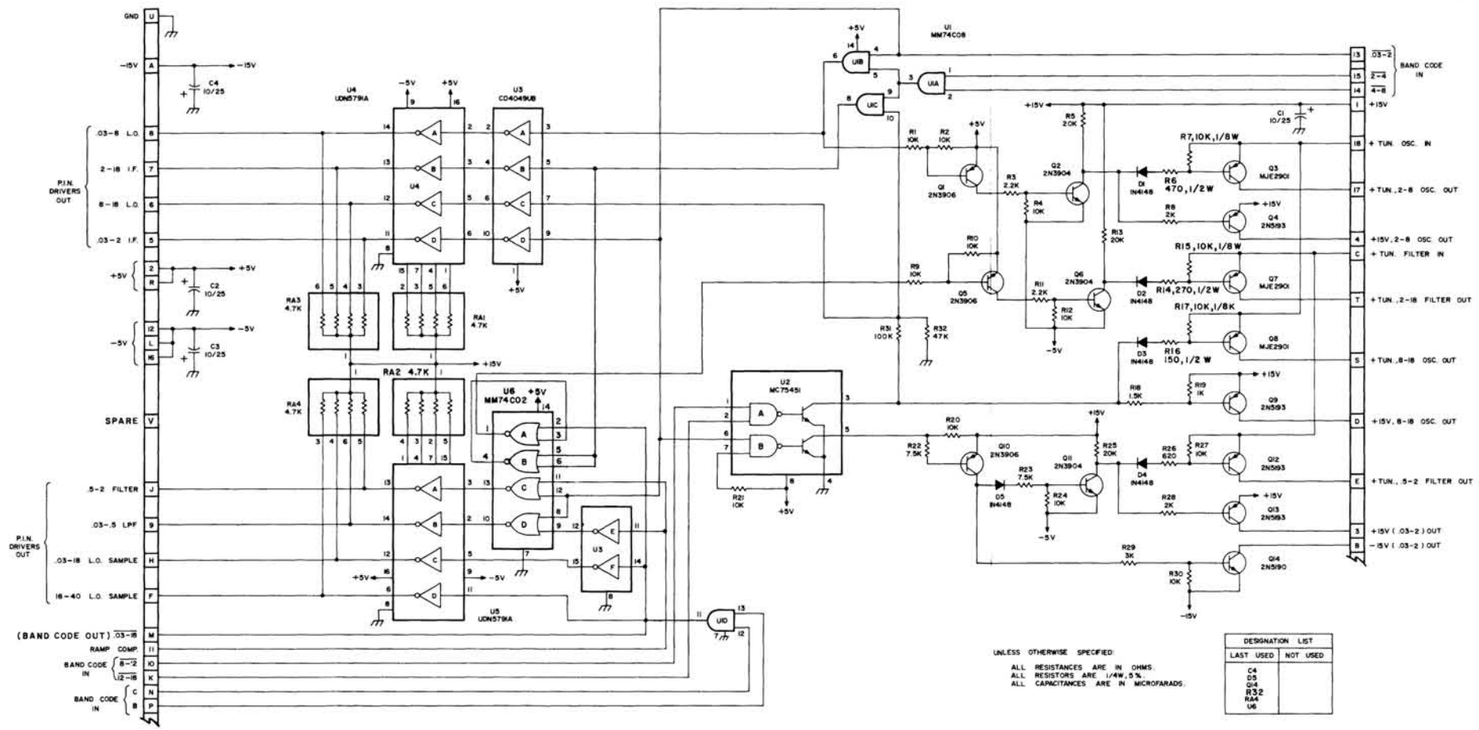
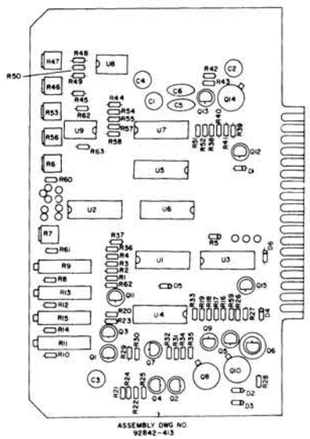
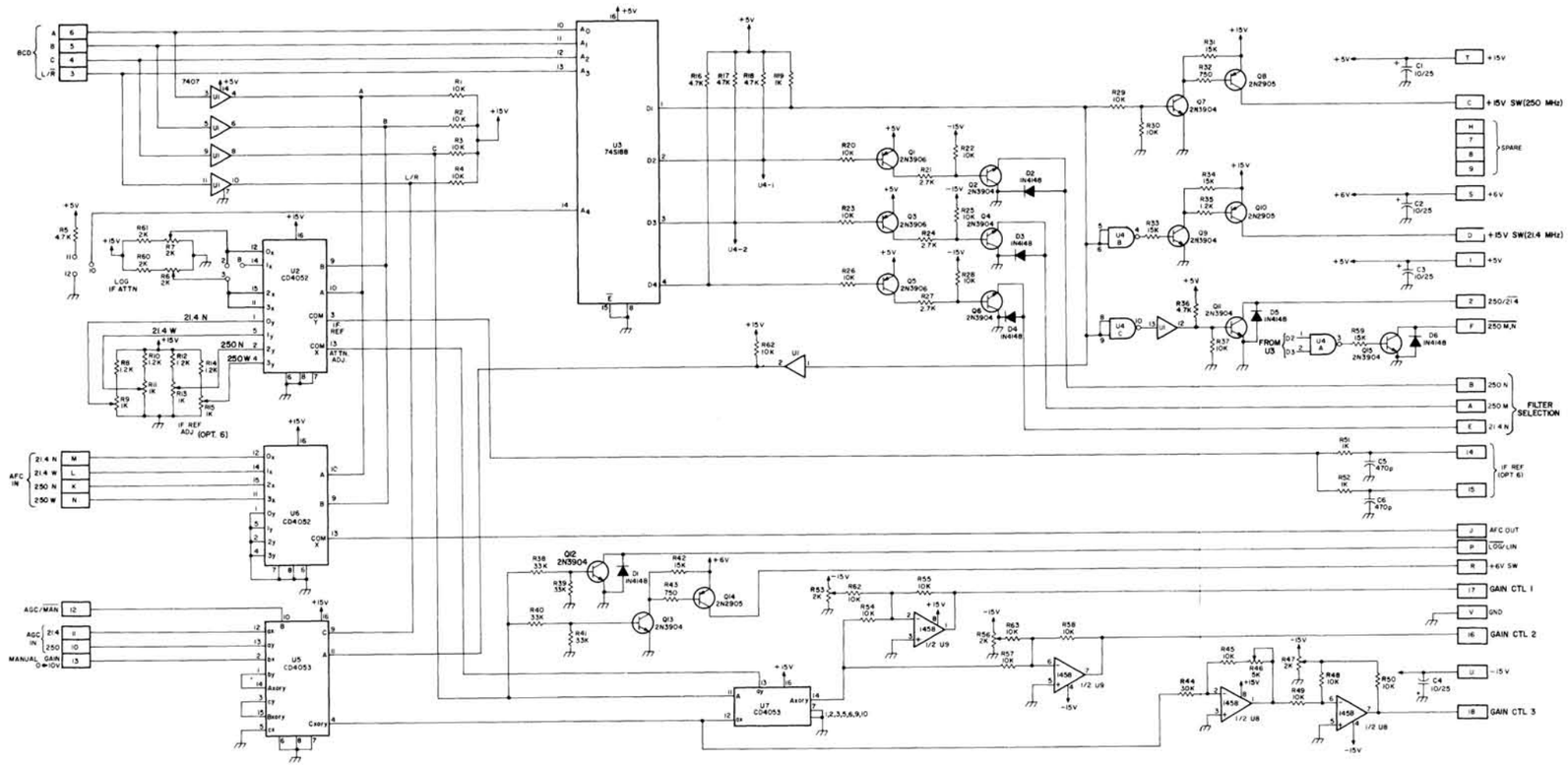
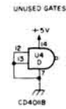


Figure 7.18 Band Control, A4B1
Schematic Diagram 92R41-012





UNUSED GATES

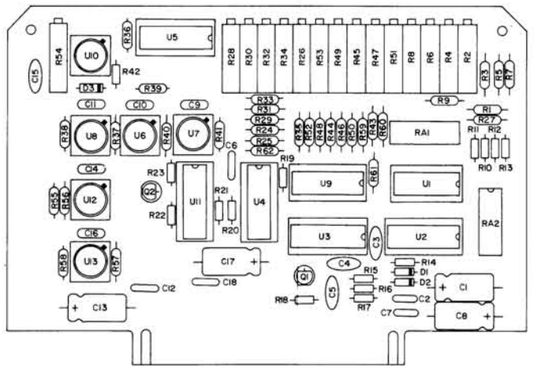


REF. DESIGNATION	
LAST USED	NOT USED
C6 Q15 R63 U9 D6	

NOTES:
UNLESS OTHERWISE SPECIFIED
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/8 W.
ALL CAPACITORS ARE IN MICROFARADS.

PIN CONNECTIONS USED	
COMBINATION OF (2)250 & (2)21.4 MHz FILTERS	COMBINATION OF (1)250 & (1)21.4 MHz FILTERS
2-8	5-8
10-12	10-11

Figure 7.19 Bandwidth Control, A4B2
Schematic Diagram 92R42-076



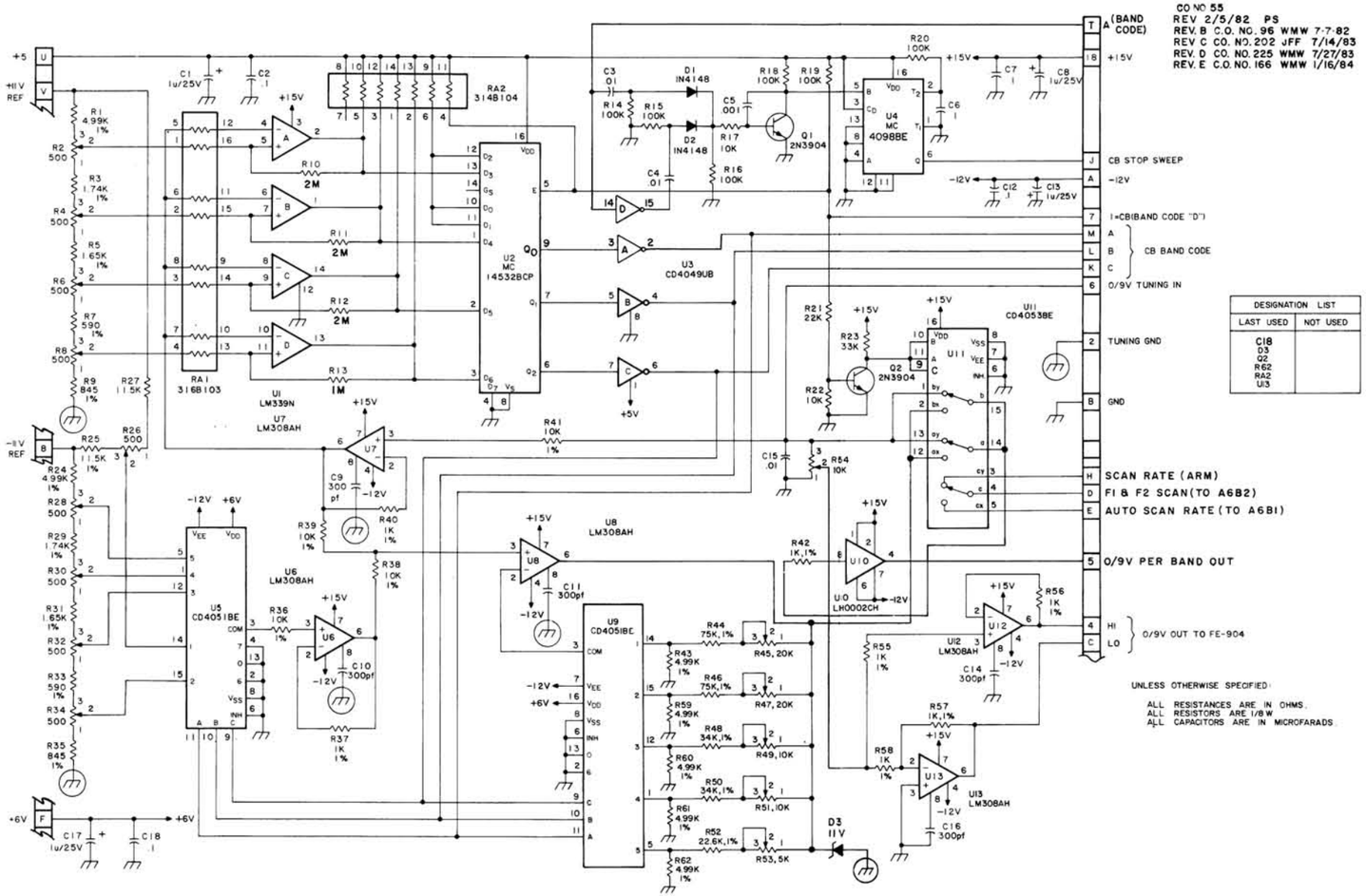
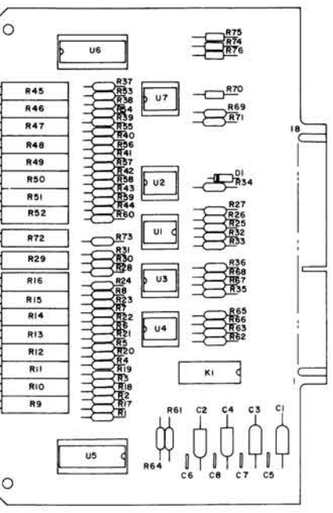
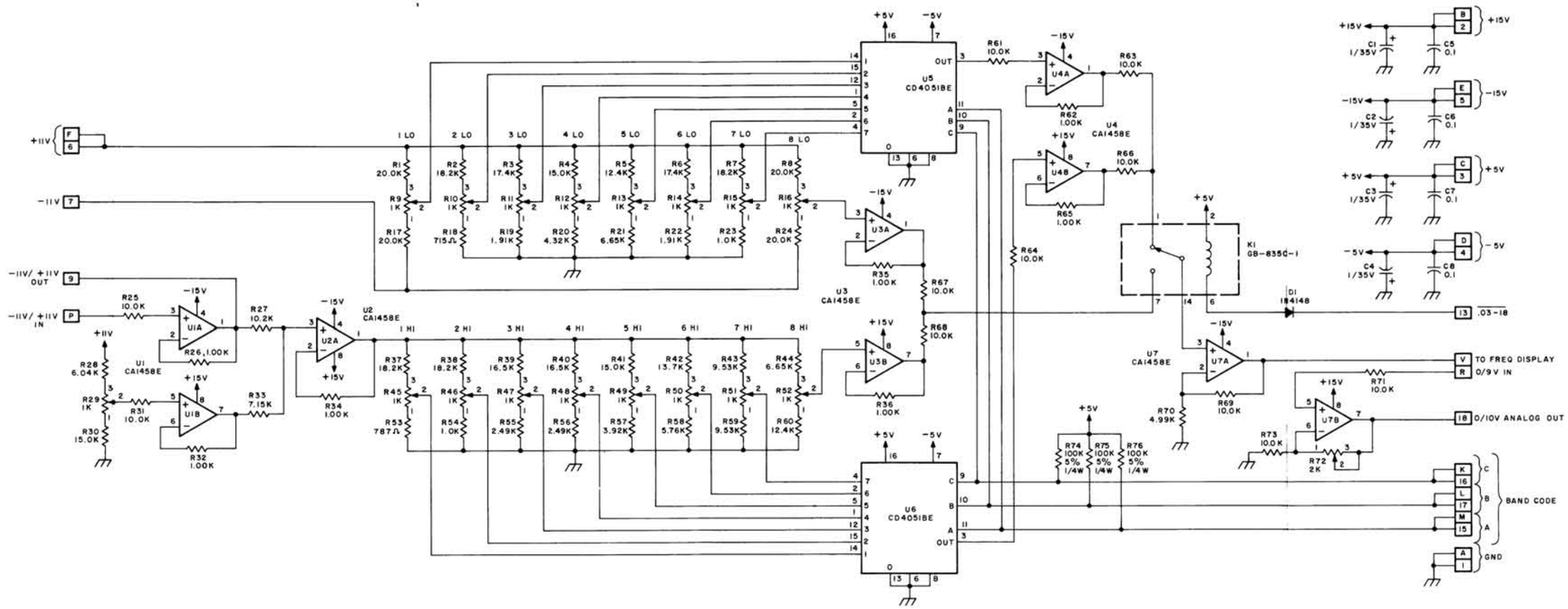


Figure 7.20 Crossband Switching, A4B3
Schematic Diagram 92R43-014



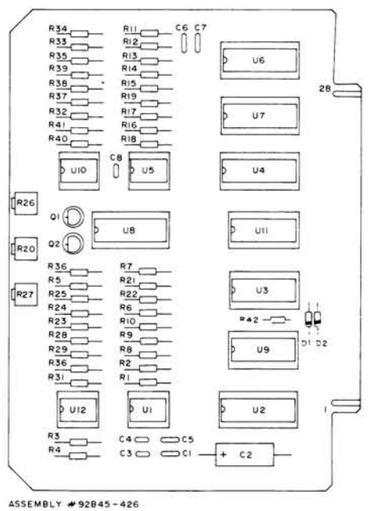


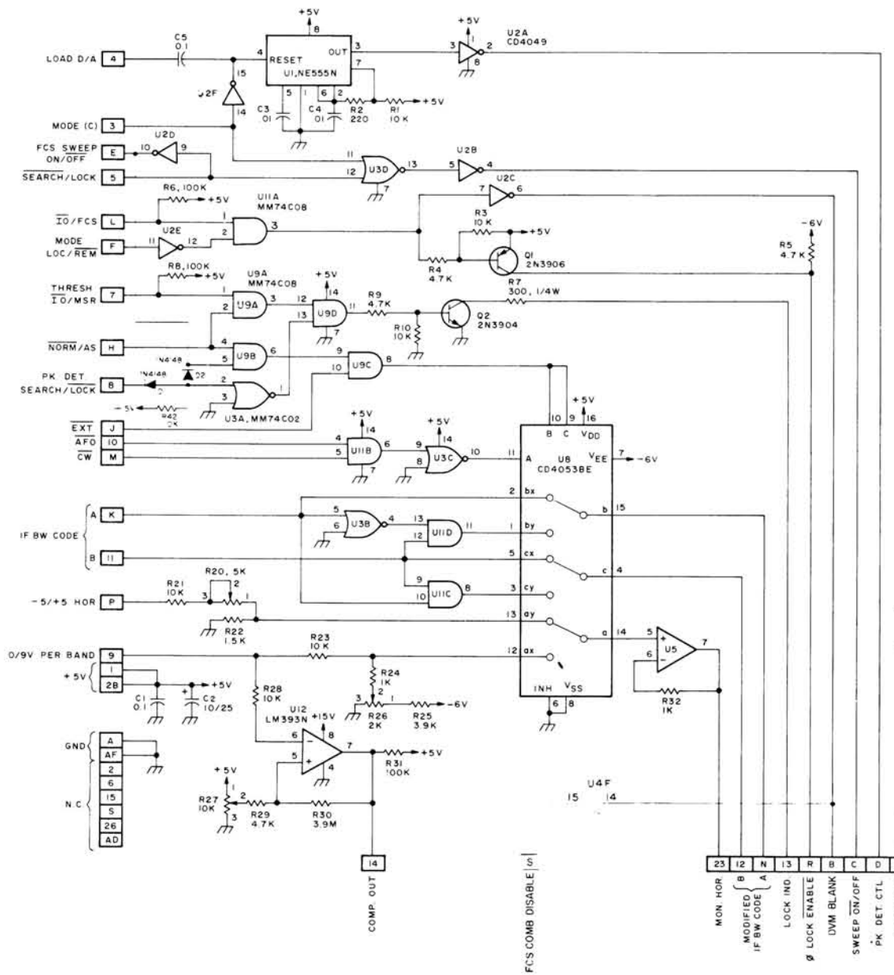
REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C8 D1 K1 R76 U7	

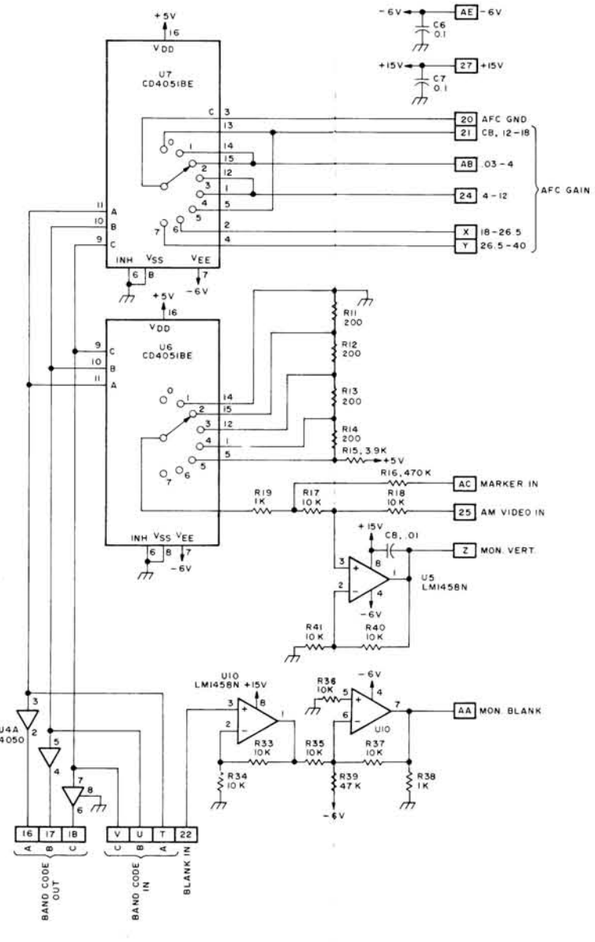
UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE 1/8W, 1%
ALL CAPACITORS ARE IN MICROFARADS

Figure 7.21 DVM Tracking, A4B4
Schematic Diagram 92R44-015
7-67

REV PER CO NO. 147 1/10/83 JFF
REV PER CO NO. 232 9/29/83 WMW





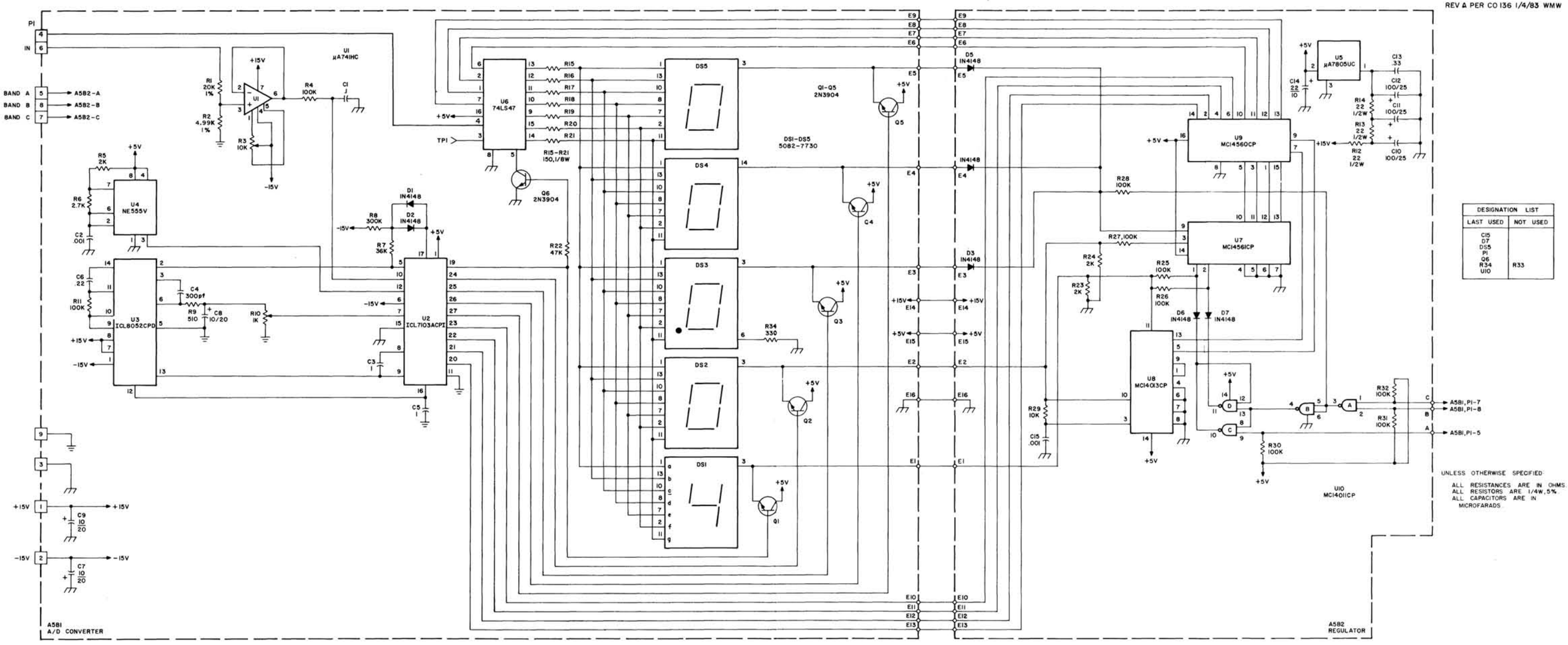


REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C8	
Q2	
R42	
U12	
D2	

UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS & 1/4W
ALL CAPACITOR VALUES ARE IN MICROFARADS

Figure 7.22 External Control, A4B5
Schematic Diagram 92R45-079

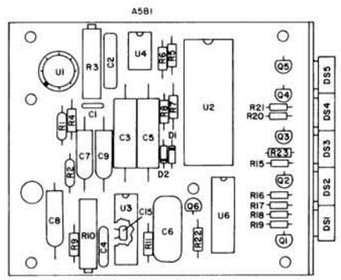
REV A PER CO 136 1/4/83 WMW



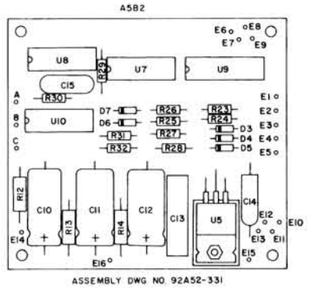
DESIGNATION LIST	
LAST USED	NOT USED
C15 D7 DS5 P1 Q6 R34 U10	R33

UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCES ARE IN OHMS
ALL RESISTORS ARE 1/4W, 5%
ALL CAPACITORS ARE IN MICROFARADS

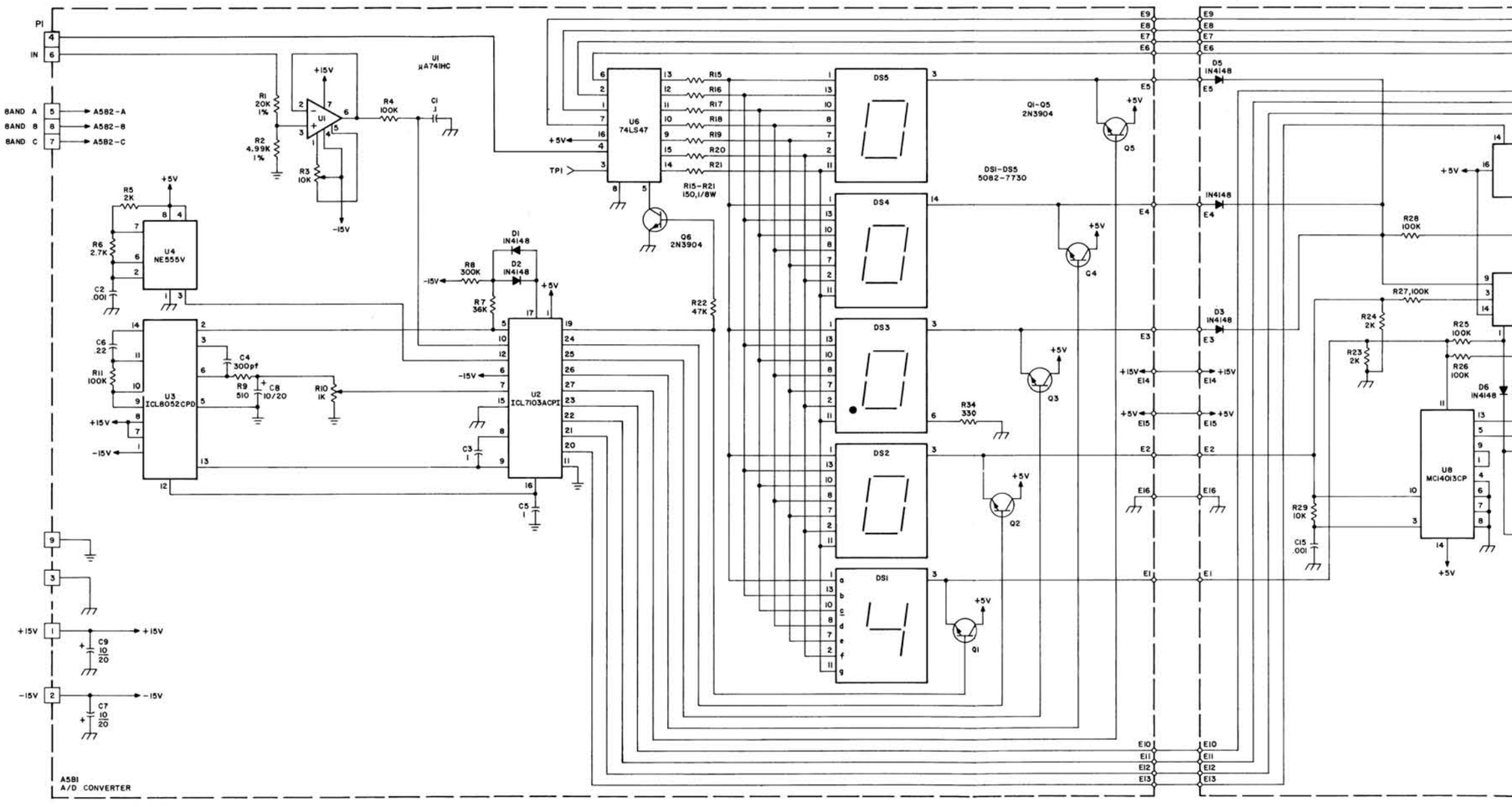
Figure 7.23 Frequency Display, A5
Schematic Diagram 92R50-017
7-71



ASSEMBLY DWG NO 92851-330



ASSEMBLY DWG NO 92A52-331



Courtesy of http://BlackRadios.terryo.org

REV 2/5/82 PS
REV PER C.O. NO. 69 5/14/82 JFF
REV 10/1/82 PS
REV PER CO NO 172 2/14/83 WMW

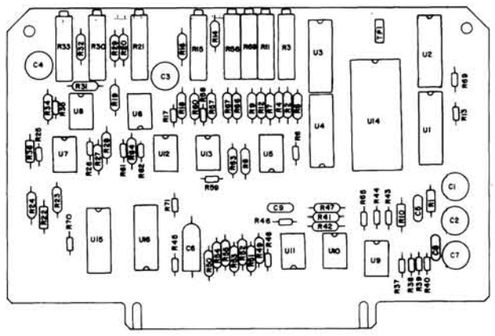
SI SETTINGS

OPTION COMBINATION	SWITCH 1	2	3	4	5	6	7	8
NO OPT. 7 (AUTO STOP)								
OPT. 7 LOCK & STOP		ON		ON	ON			
OPT. 7 2 SEC LOCK	ON		ON			ON		

DESIGNATION LIST	
LAST USED	NOT USED
C14 D6 Q5 R65 SI UII	D3-6 Q1,2 R36-41

UNLESS OTHERWISE SPECIFIED
RESISTANCE VALUES ARE IN OHMS
RESISTORS ARE 5%, 1/8W
CAPACITORS ARE IN MICROFARADS.

Figure 7.24 Tuning Generator, A6B1
Schematic Diagram 92R61-018-1
7-73



ASSEMBLY DWG. NO. 92B62-423 'A'

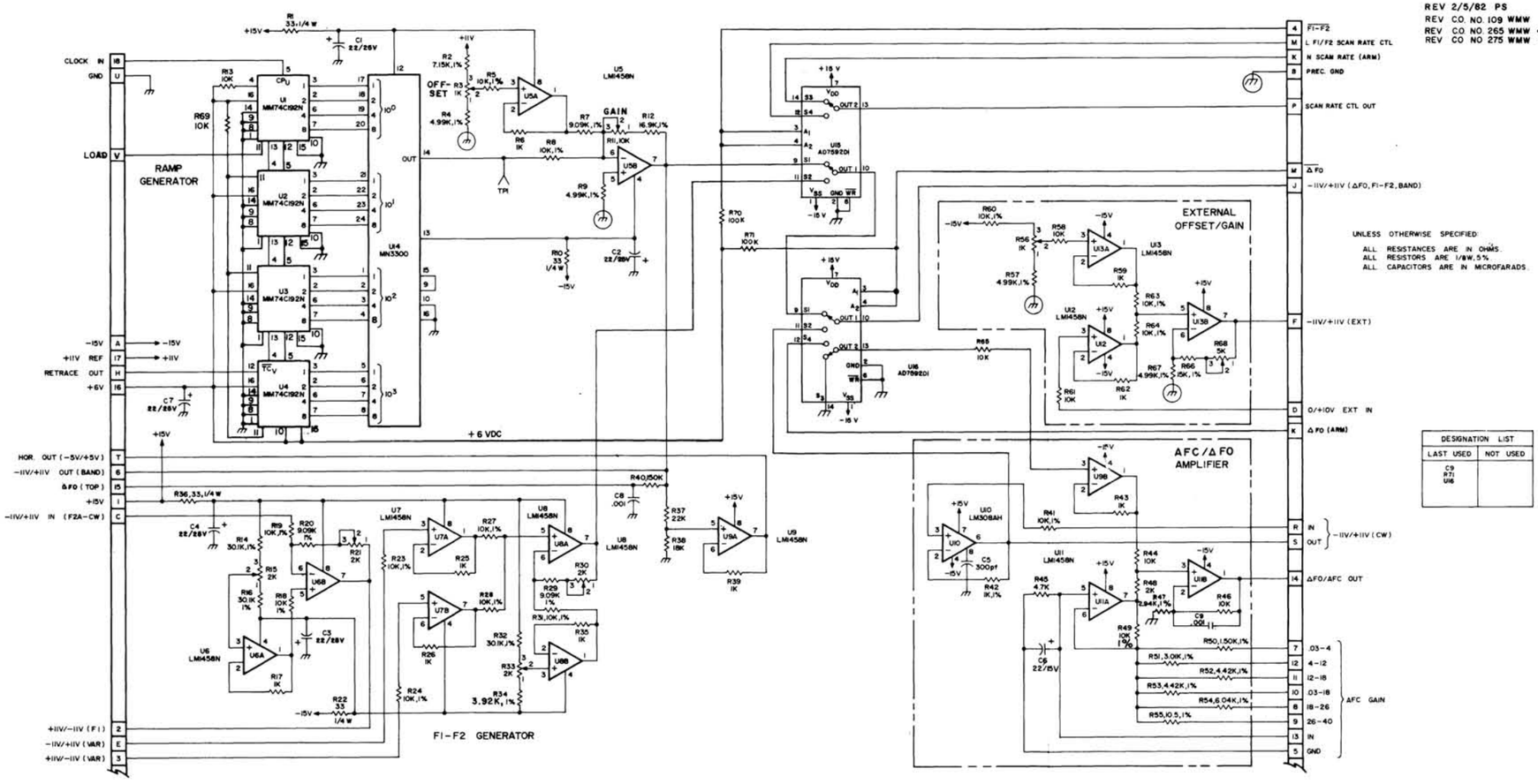
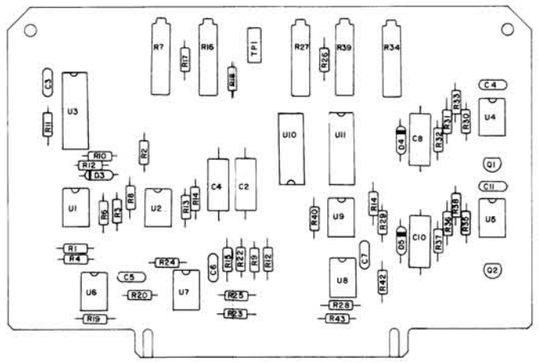
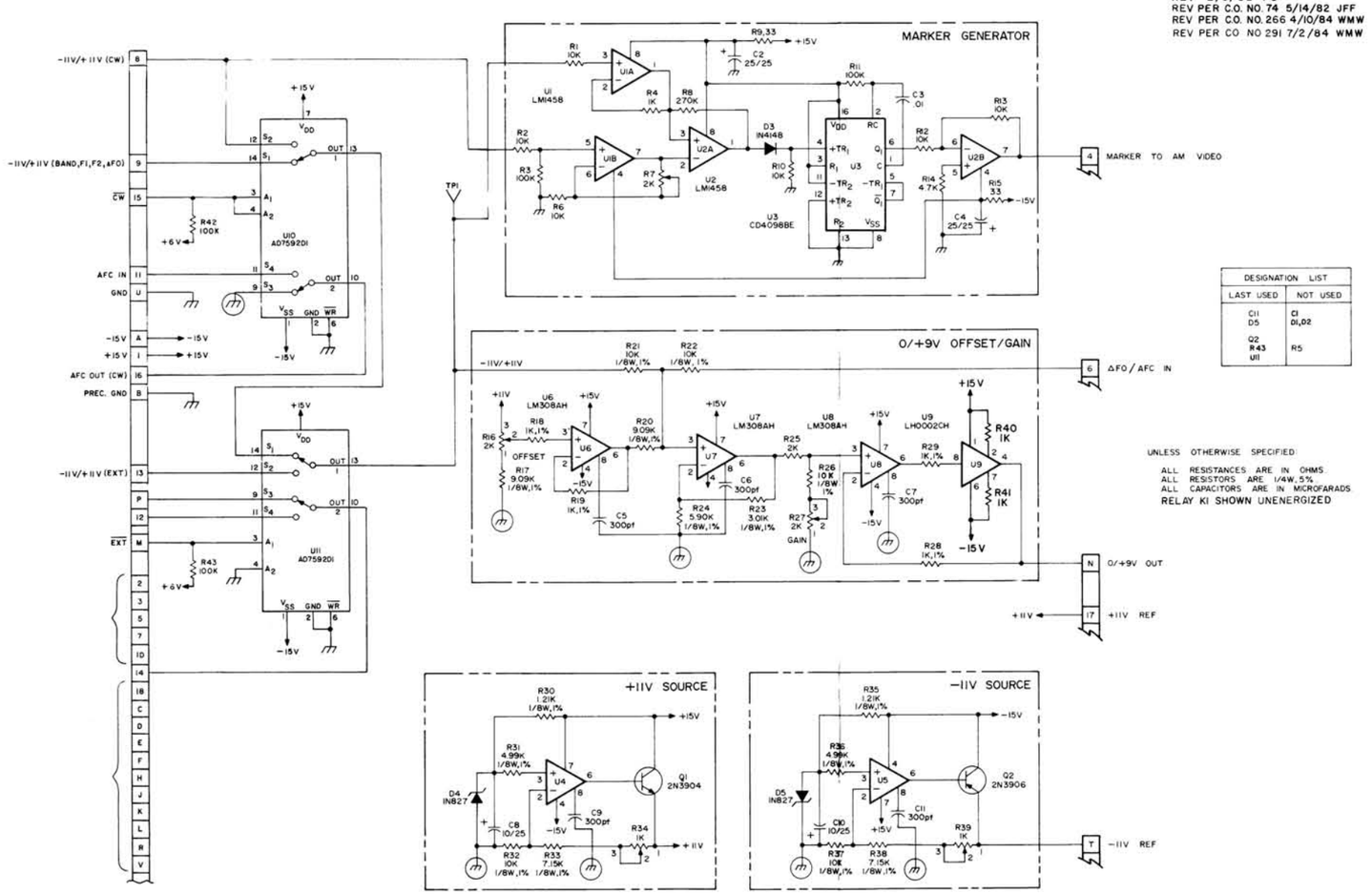


Figure 7.25 Tuning Generator, A6B2
Schematic Diagram 92R62-019
7-75

REV 2/5/82 PS
REV PER C.O. NO. 74 5/14/82 JFF
REV PER C.O. NO. 266 4/10/84 WMW
REV PER CO NO 291 7/2/84 WMW



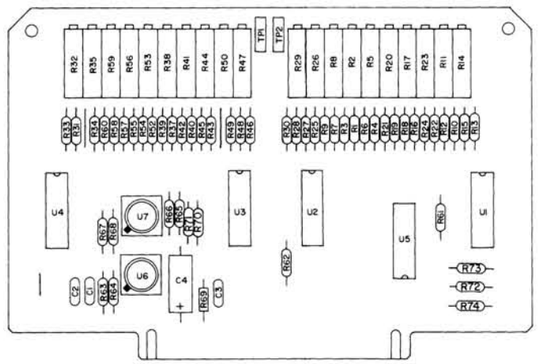
ASSEMBLY DWG. NO. 92863-424 'A'



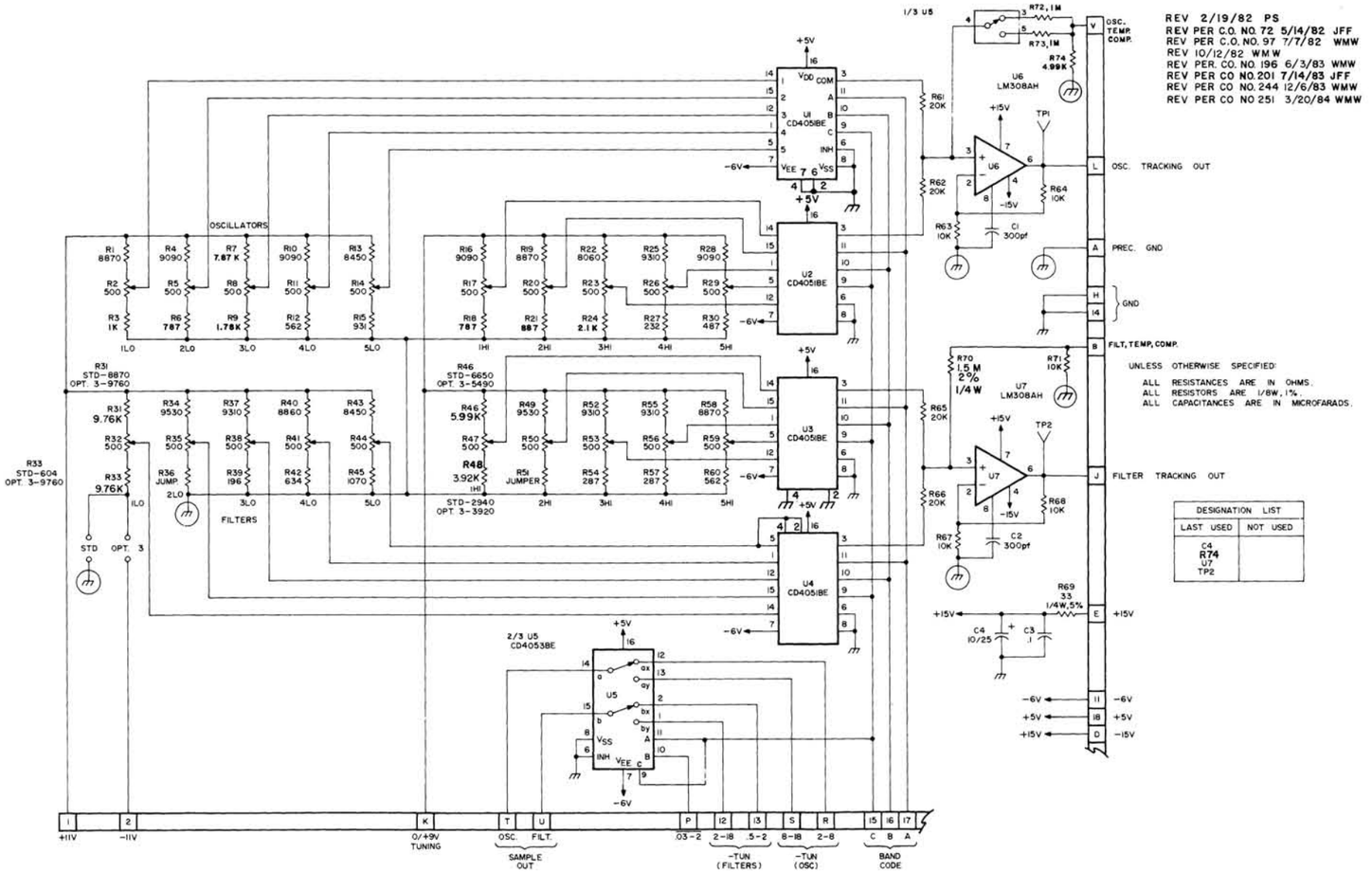
DESIGNATION LIST	
LAST USED	NOT USED
C11 D5 Q2 R43 U11	C1 D1,D2 R5

UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCES ARE IN OHMS
ALL RESISTORS ARE 1/4W,5%
ALL CAPACITORS ARE IN MICROFARADS
RELAY K1 SHOWN UNENERGIZED

Figure 7.26 Tuning Generator, A6B3
Schematic Diagram 92R63-020
7-77



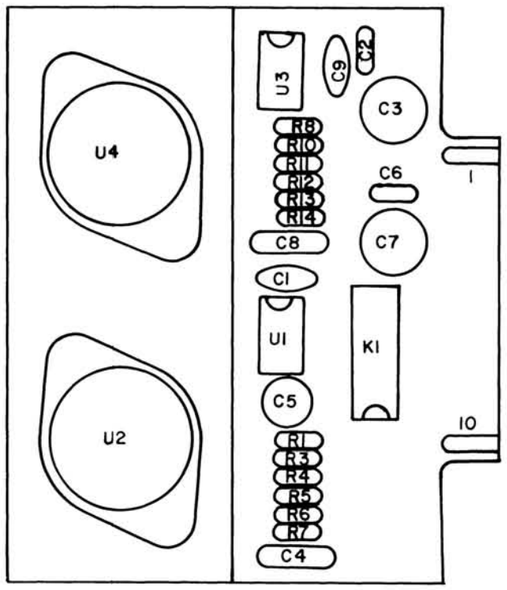
ASSEMBLY DWG. NO. 92B71-343



Courtesy of http://BlackRadios.terryo.org

Figure 7.27 Oscillator/Filter Tracking, A7B1
Schematic Diagram 92R71-021

REVISED 10/4/82 W.M.W.



ASSEMBLY DWG. NO.
M92B73-222

REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C8 K1 R14 U4	R2,R9

UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS
RESISTORS ARE 5%, 1/8W
CAPACITORS ARE IN MICROFARADS

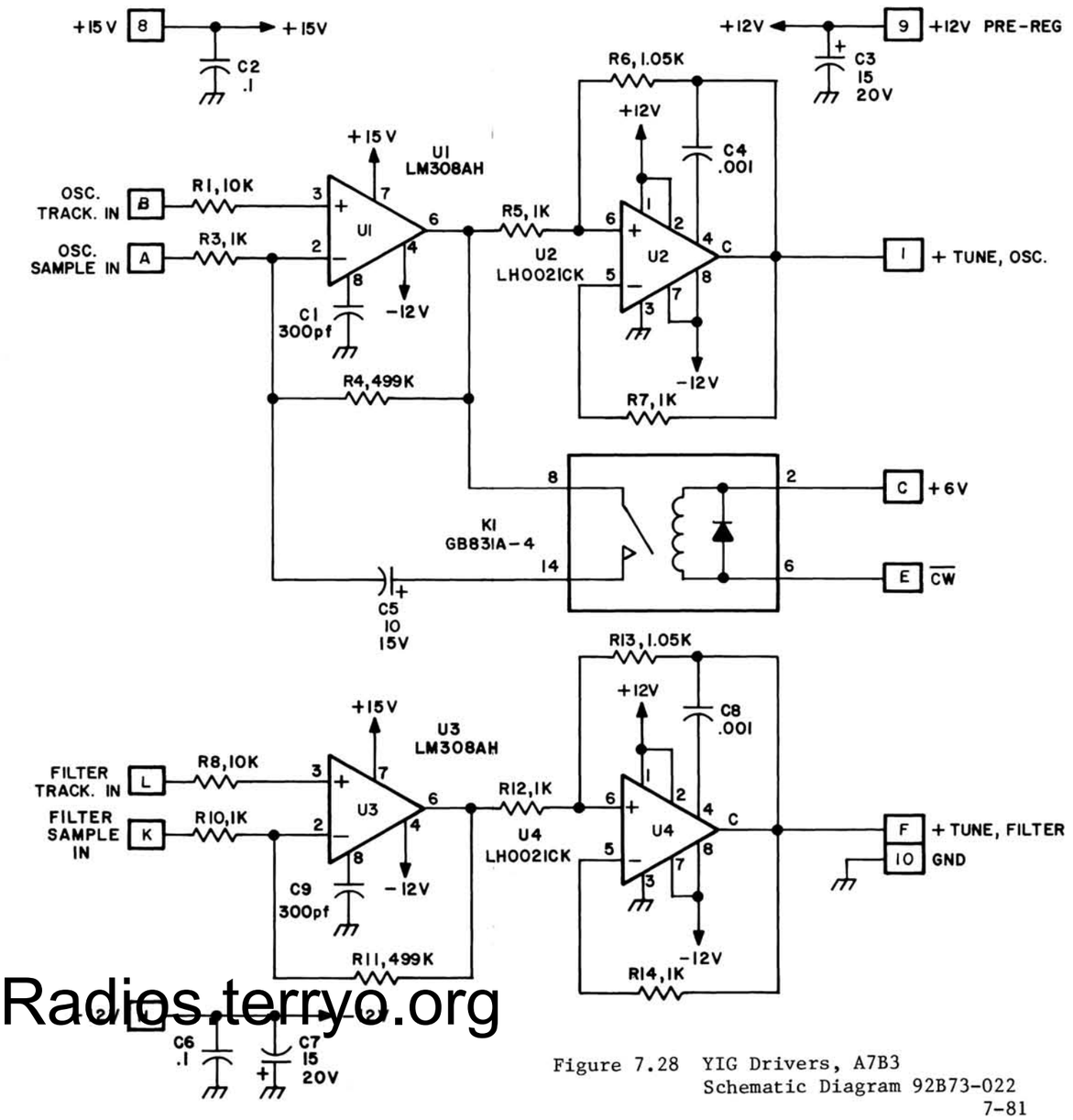


Figure 7.28 YIG Drivers, A7B3
Schematic Diagram 92B73-022

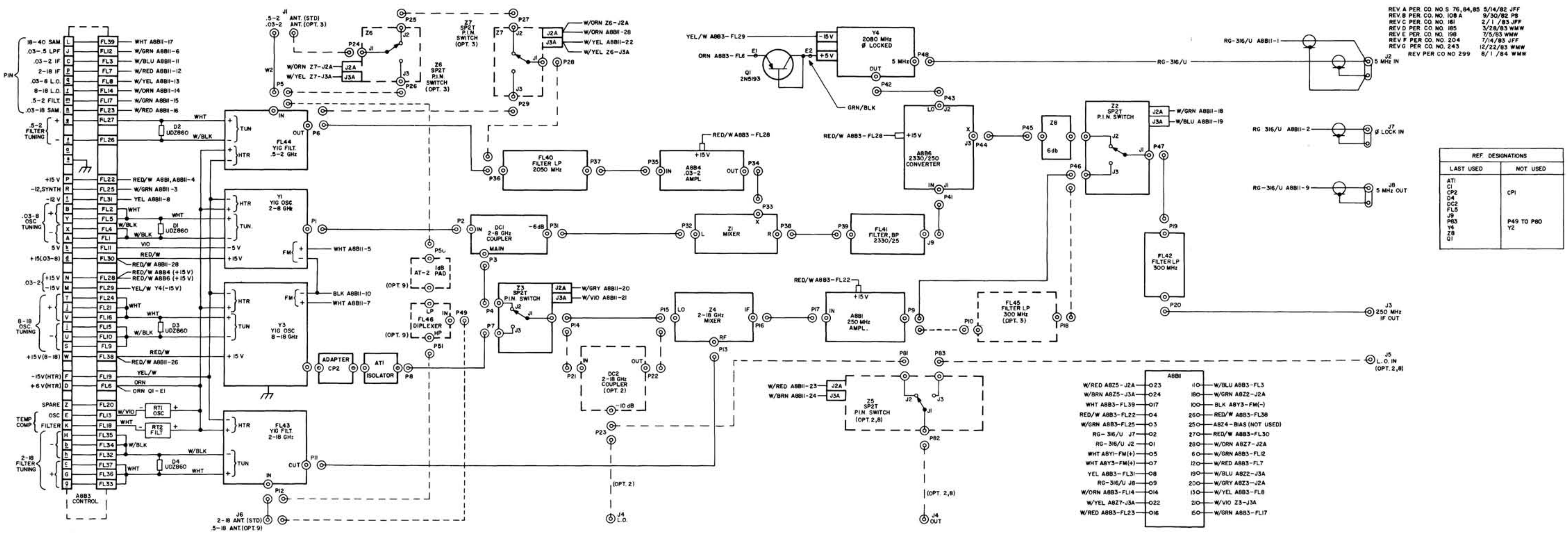
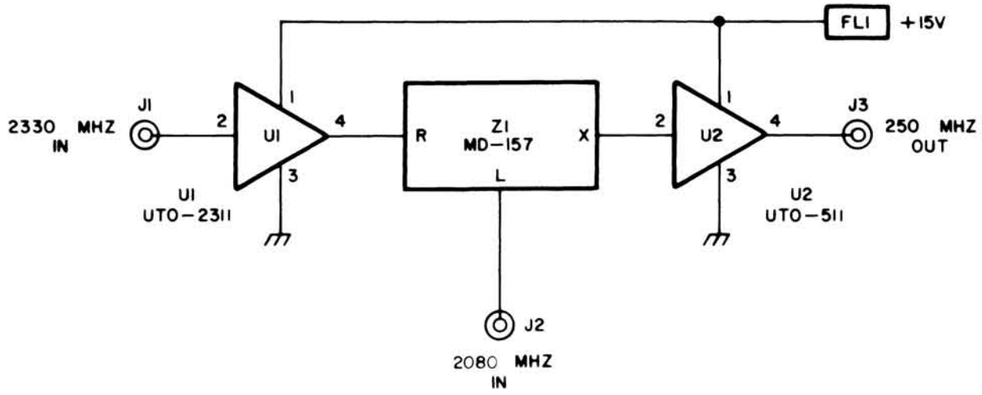
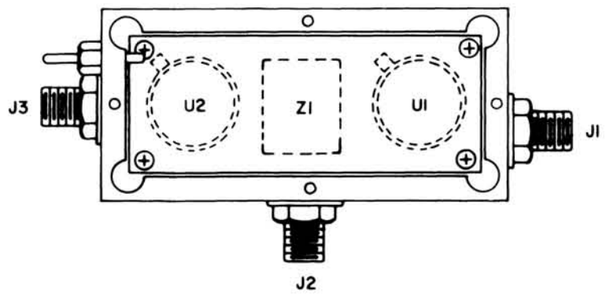


Figure 7.29 RF Tuner, A8
Schematic Diagram 92R80-088

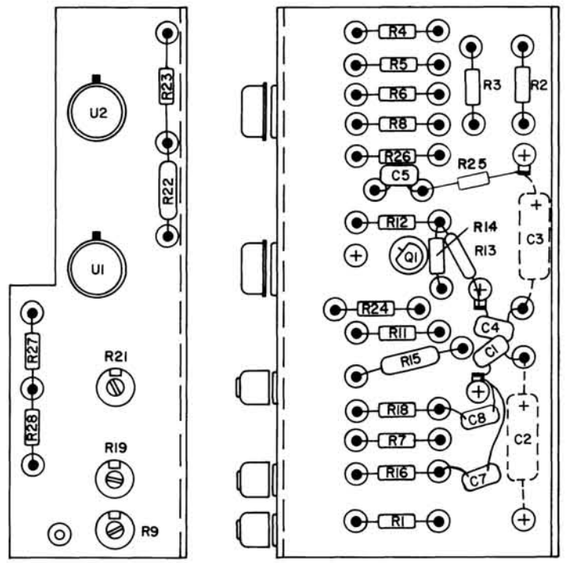




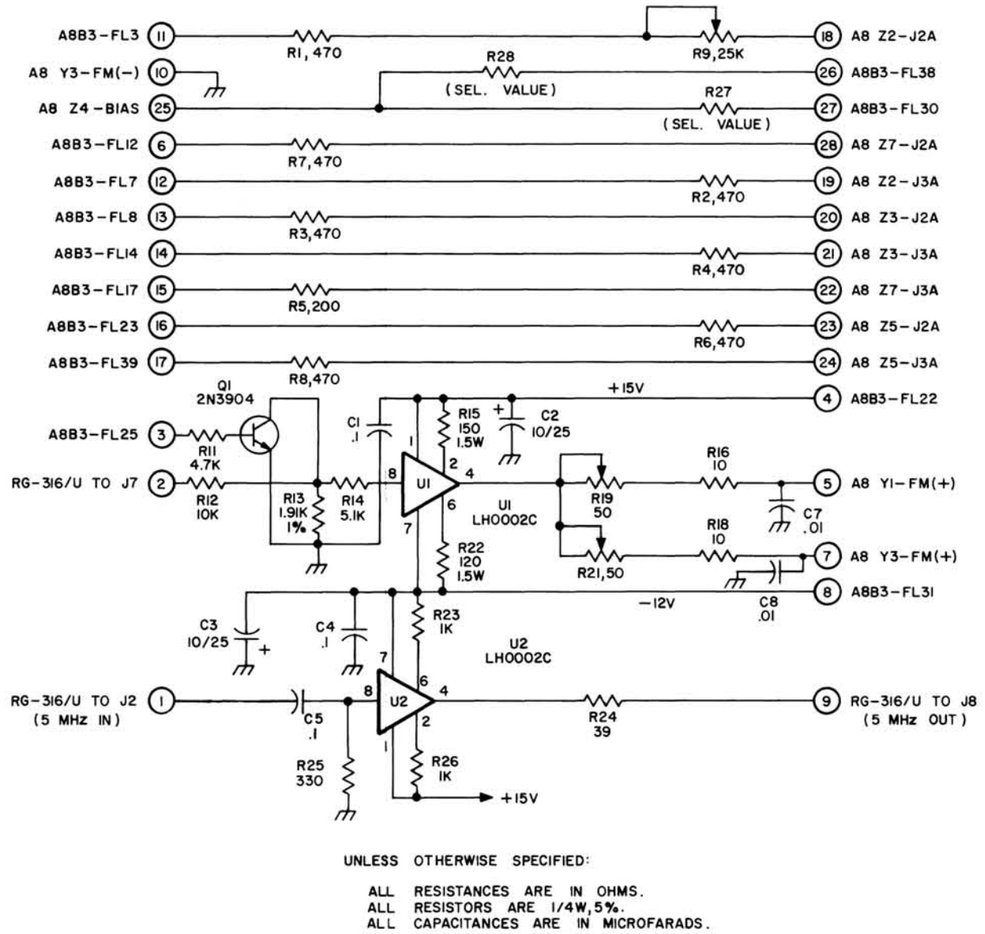
ASSEMBLY DWG. NO. 92A86-349

Figure 7.30 2330/250 MHz Converter, A8B6
Schematic Diagram 92B86-036
7-85

REV PER C.O. NO. 61 4/2/82 JFF
REV PER C.O. NO. 81 5/14/82 JFF
REV PER C.O. NO. 205 7/15/83 JFF
REV PER C.O. NO. 247 3/19/84 WMW
REV PER C.O. NO. 261 3/20/84 WMW
REV PER C.O. NO. 270 4/10/84 WMW



ASSEMBLY DWG. NO. 92B811-335

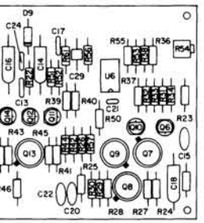


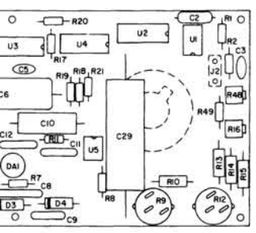
UNLESS OTHERWISE SPECIFIED:

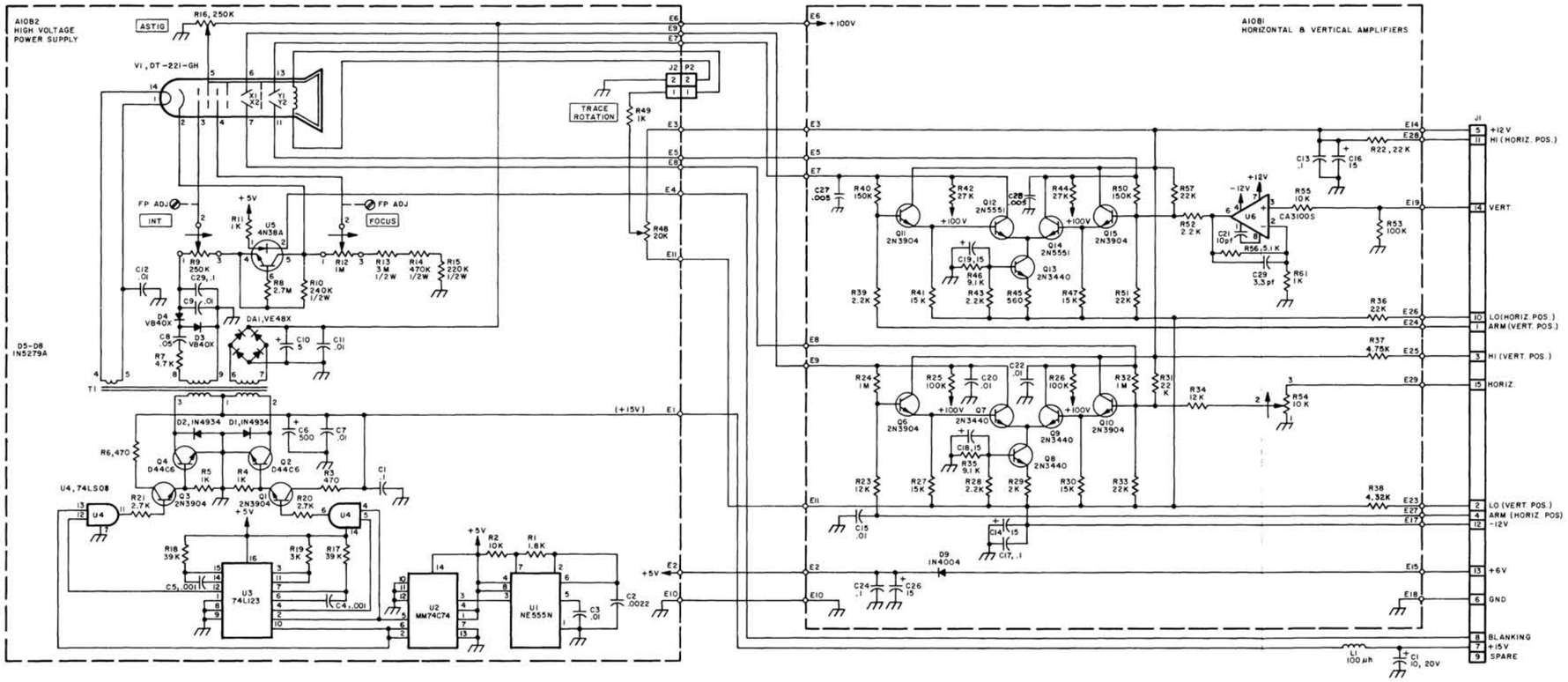
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/4W, 5%.
ALL CAPACITANCES ARE IN MICROFARADS.

DESIGNATION LIST	
LAST USED	NOT USED
C8 Q1 R28 U2	C6 R10,17,20

Figure 7.31 FM/5 MHz Driver, A8B11
Schematic Diagram 92B811-024
7-87







REV (C.O. 18) 2/19/82 PS
REV (C.O. 60) 4/5/82 JFF
REV (C.O. 203) 7/14/83 JFF

	REF. DESIGNATIONS	
	LAST USED	NOT USED
A10B1	C30	C1-12, 23, 25, 27, 28
	D9	D1-8
	E29	E1, 4, 12, 13, 16, 20-22
	Q15	Q1-5
	R61	R1-21, 48, 49 58-60
	U6	U1-5
A10B2	C29	C13-28
	D4	
	DA1	
	E11	
	J2	J1
	Q4	
	R49	R22-47
	T1	
	U5	
	V1	

UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS & 1/4 W
ALL CAPACITORS ARE IN MICROFARADS

Figure 7.32 Oscilloscope, A10
Schematic Diagram 92R100-026

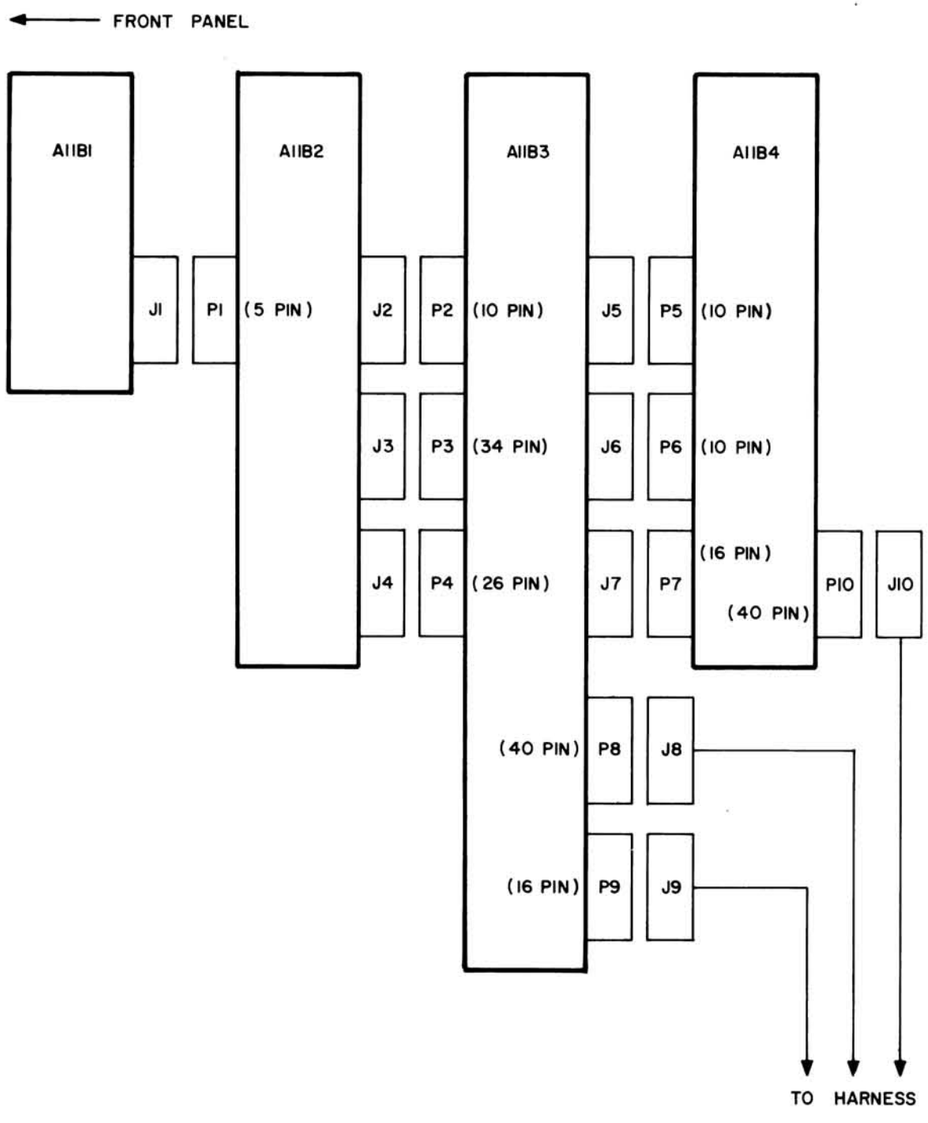
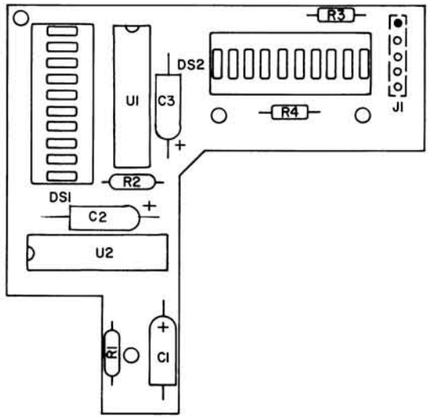
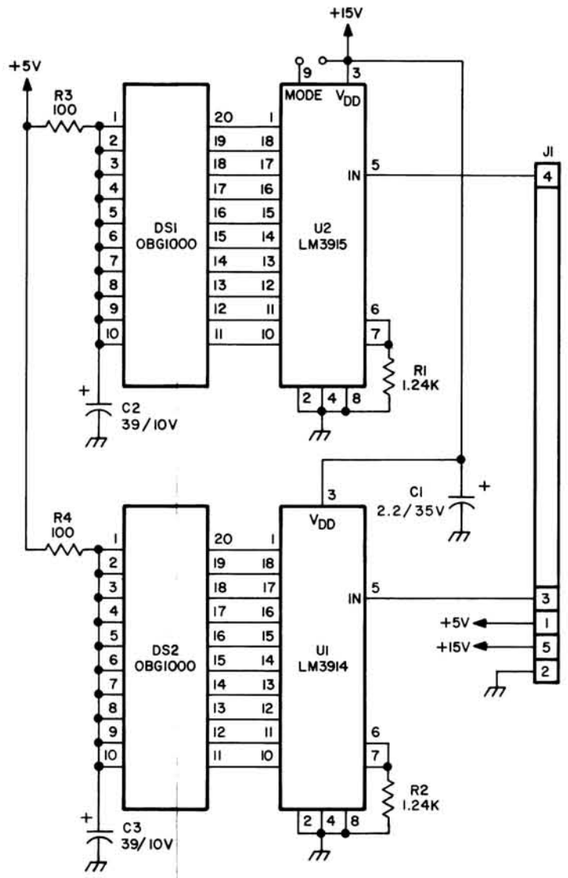


Figure 7.33 Function Selector, A11
Schematic Diagram 92A110-004

REV 2/19/82 PS
REV PER CO NO.145 1/4/83 FF



ASSEMBLY DWG. NO. 92A111-319



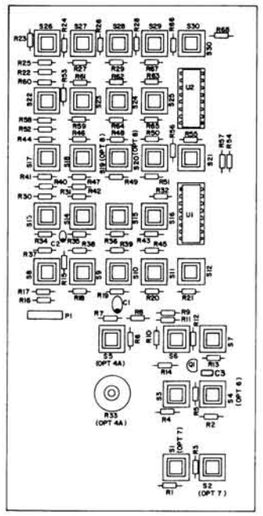
UNLESS OTHERWISE SPECIFIED:

ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/8W,5%.
ALL CAPACITANCES ARE IN MICROFARADS.

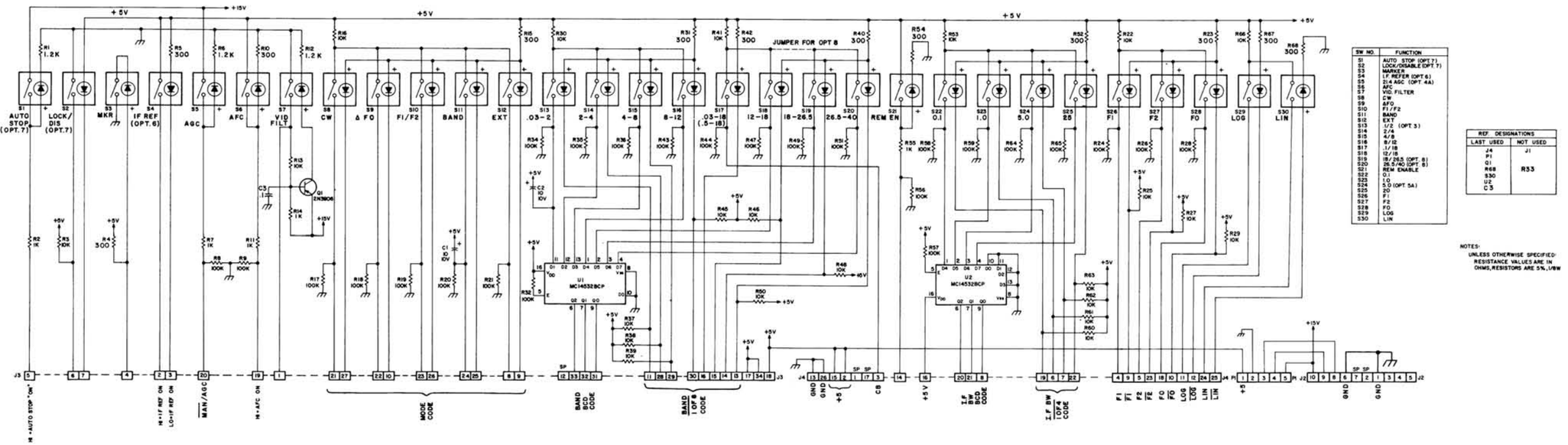
DESIGNATION LIST	
LAST USED	NOT USED
C3 DS2 J1 R4 U2	

Figure 7.34 Bar Graph Meter, A11B1
Schematic Diagram 92B111-027
7-93

REV 2/19/82 PS
REV 9/30/82 PS
REV PER CO 163 & 166 2/7/83 FF



ASSEMBLY DWG NO 92C112-430



SW NO.	FUNCTION
S1	AUTO STOP (OPT 7)
S2	LOCK/DISABLE (OPT 7)
S3	MARKER
S4	I.F. REFER (OPT 6)
S5	0 & AGC (OPT 4A)
S6	AFC
S7	VID. FILTER
S8	CW
S9	ΔFO
S10	FI/F2
S11	BAND
S12	EXT
S13	.1/2 (OPT 3)
S14	2/4
S15	4/8
S16	8/12
S17	.1/18
S18	12/18
S19	18/26.5 (OPT. 8)
S20	26.5/40 (OPT. 8)
S21	REM ENABLE
S22	0.1
S23	1.0
S24	5.0 (OPT. 5A)
S25	20
S26	F1
S27	F2
S28	FO
S29	LOG
S30	LIN

REF. DESIGNATIONS	
LAST USED	NOT USED
J4	J1
P1	
Q1	R33
R68	
S30	
U2	
C5	

NOTES:
UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS, RESISTORS ARE 5%, 1/8W

Figure 7.35 Keyboard, A11B2
Schematic Diagram 92R112-028
7-95

REV 2/19/82 PS
REV PER CO NO 86 5/14/82 JFF
REV. PER CO. NO. 106 1/9/82 WMW
REV. PER CO. NO. 121 11/24/82 WMW
REV. PER CO. NO. 186 5/5/83 WMW

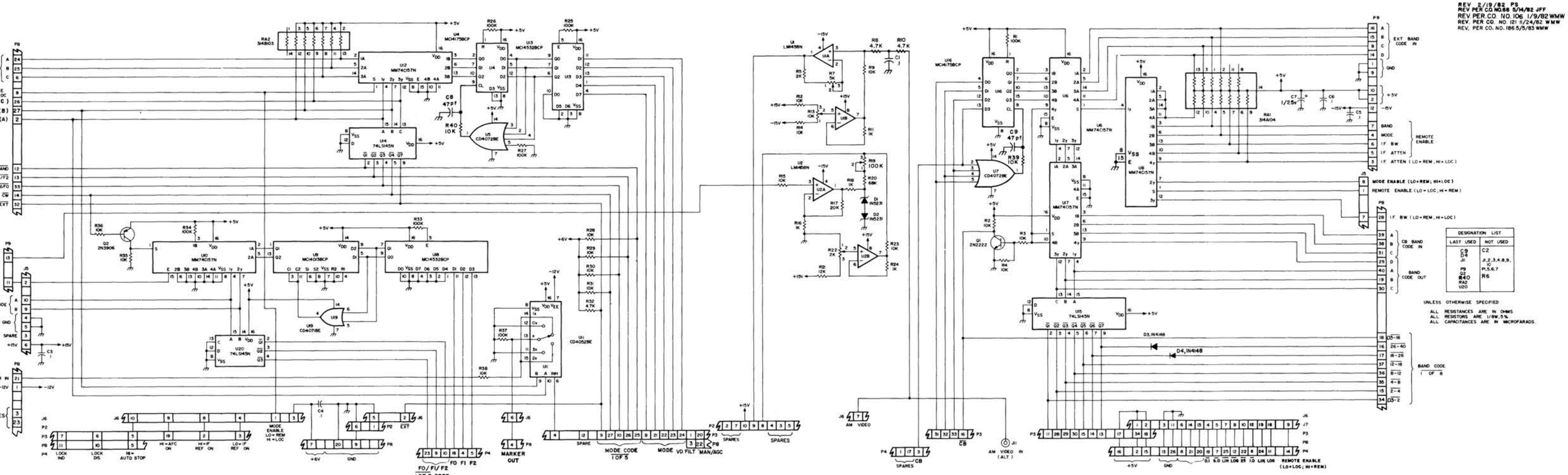
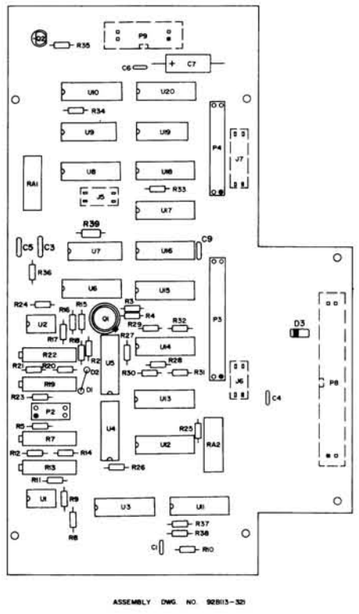
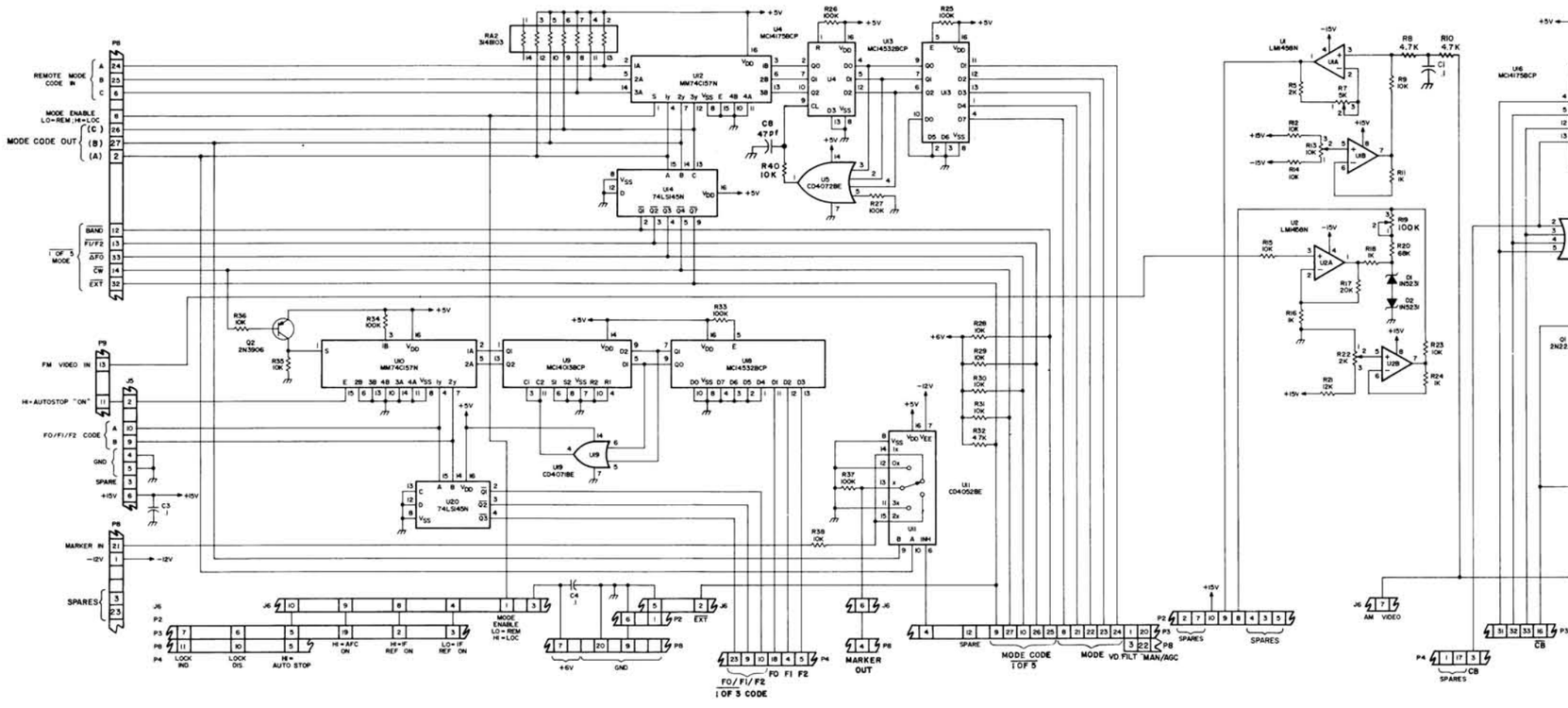
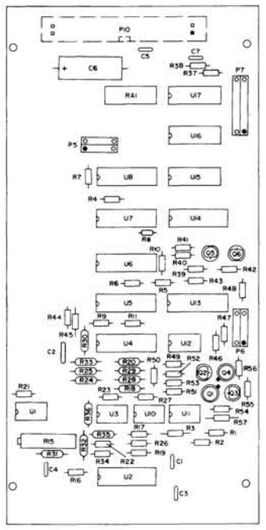


Figure 7.36 Logic Board #1, A11B3
Schematic Diagram 92R113-029
7-97



ASSEMBLY DWG. NO. 928113-321





ASSEMBLY DWG NO 92B114-523

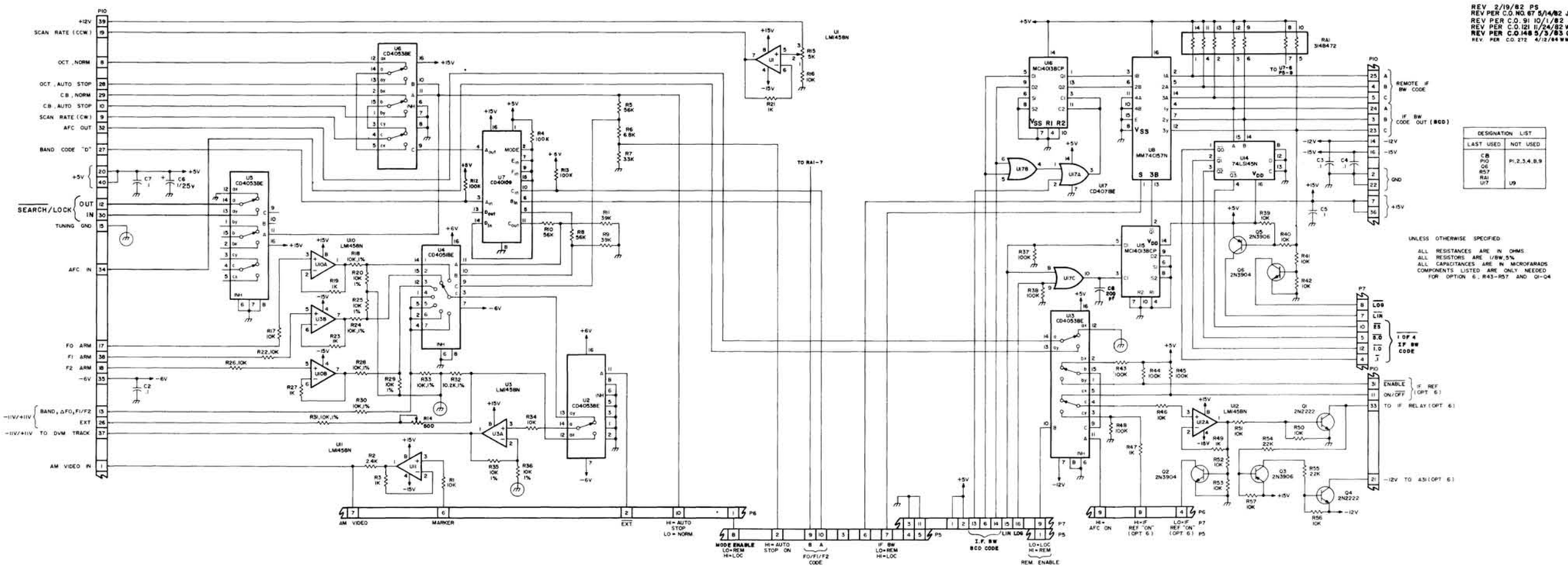
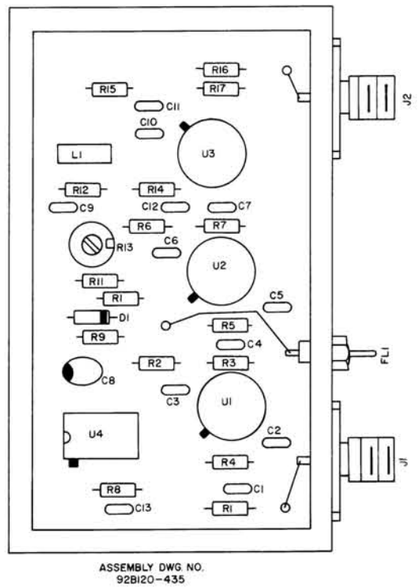
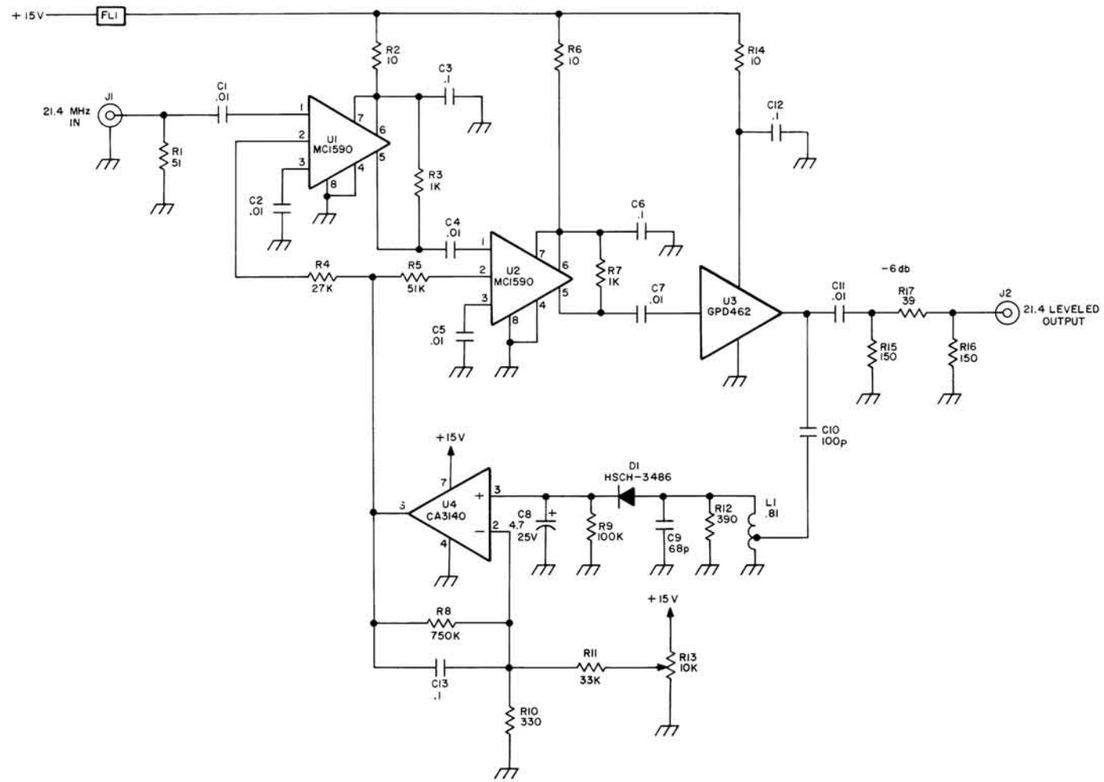


Figure 7.37 Logic Board #2, A11B4
Schematic Diagram 92R114-030
7-99



ASSEMBLY DWG NO.
92B120-435

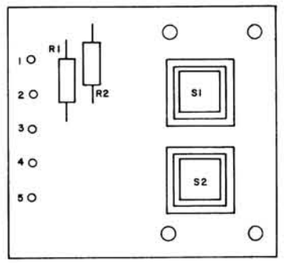


REF. DESIGNATIONS	
LAST USED	NOT USED
C13 D1 FL1 J2 L1 R17 U4	

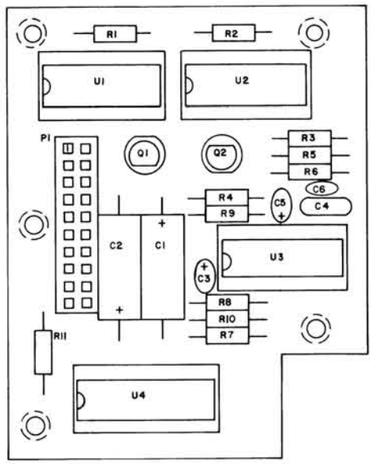
NOTES
UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/8 W
ALL CAPACITORS ARE IN MICROFARADS.

Figure 7.38 21.4 MHz WB Leveled Output, A12
Schematic Diagram 92R120-086

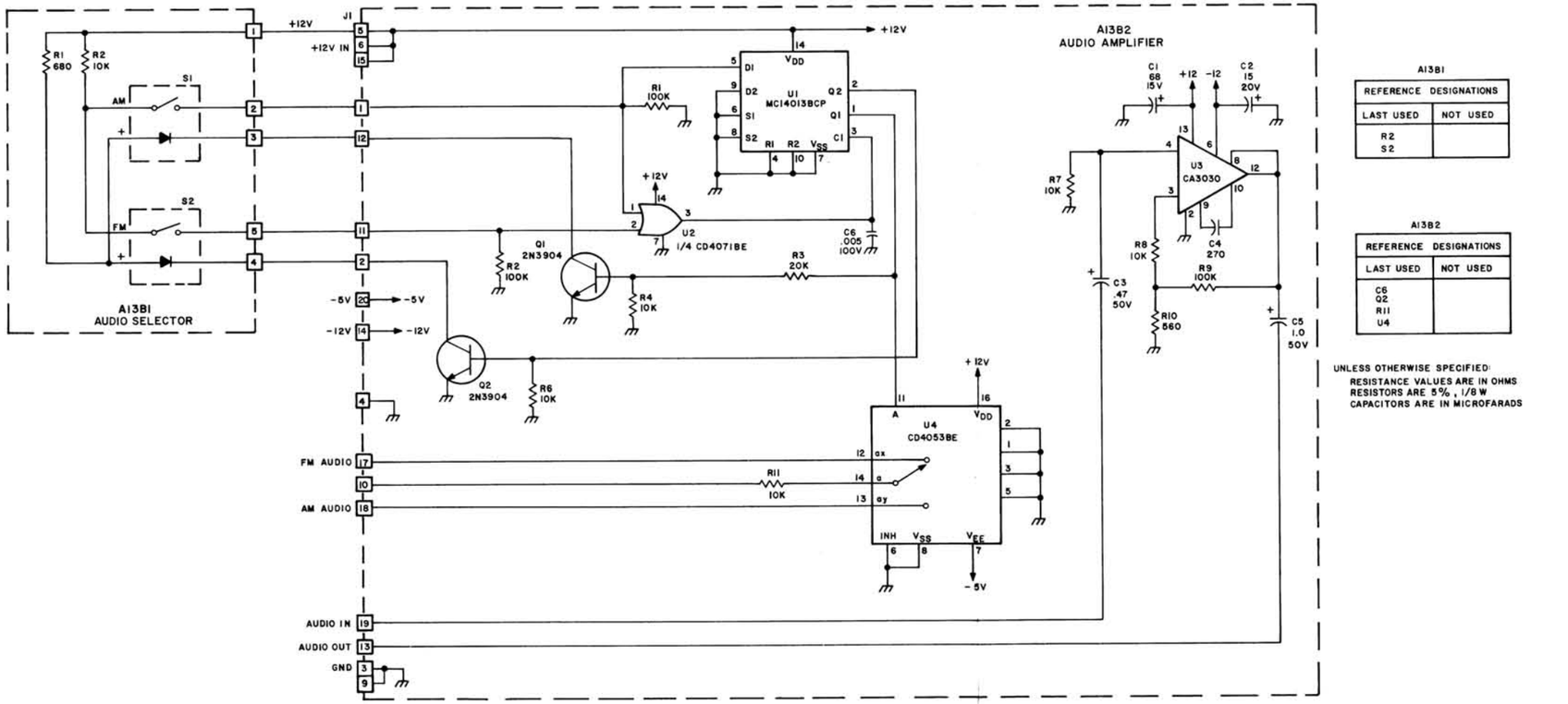
REV A CO. NO. 177 3/2/83 WMW
REV B CO NO 277 5/9/84 WMW
REV C CO NO 297 7/17/84 WMW



ASSEMBLY DWG. NO. 92A13-347



ASSEMBLY DWG. NO. 92A13-348



A13B1

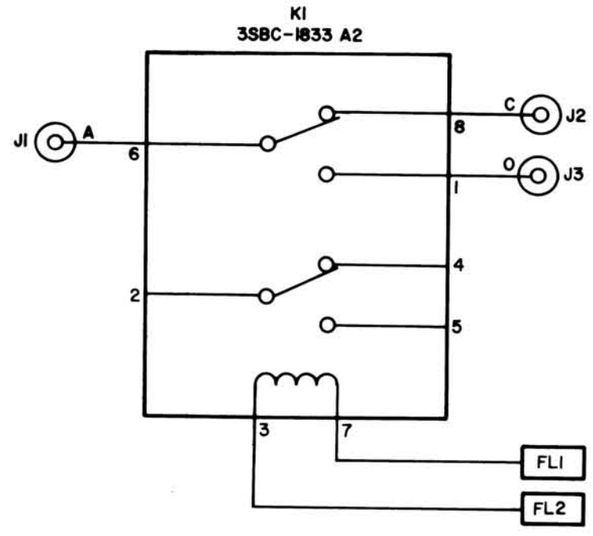
REFERENCE DESIGNATIONS	
LAST USED	NOT USED
R2 S2	

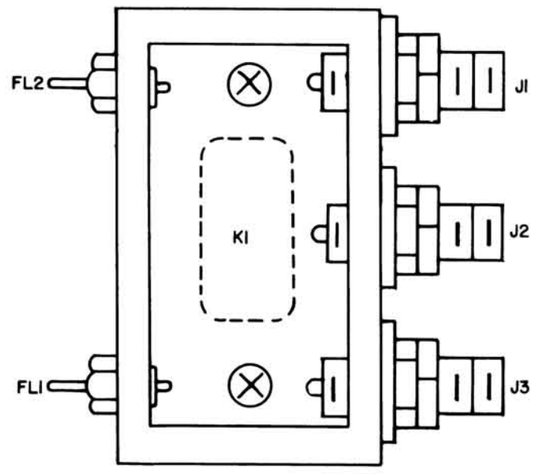
A13B2

REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C6 Q2 R11 U4	

UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS
RESISTORS ARE 5%, 1/8 W
CAPACITORS ARE IN MICROFARADS

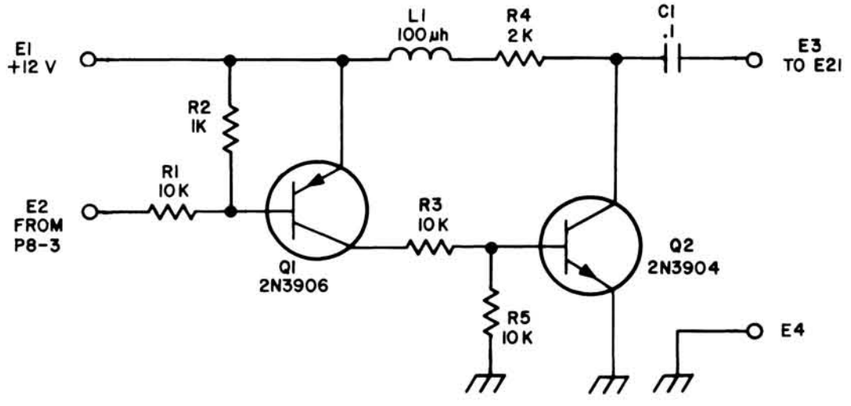
Figure 7.39 Audio Selector/Amplifier, A13
Schematic Diagram 92R130-032





ASSEMBLY DWG. NO.
92A140-034

Figure 7.40 250 MHz Relay, A14
Schematic Diagram 92A140-034



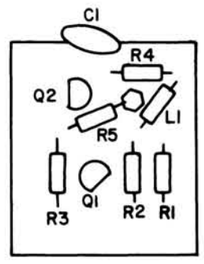
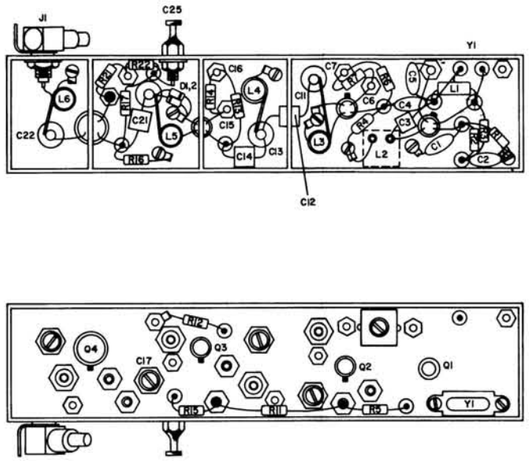
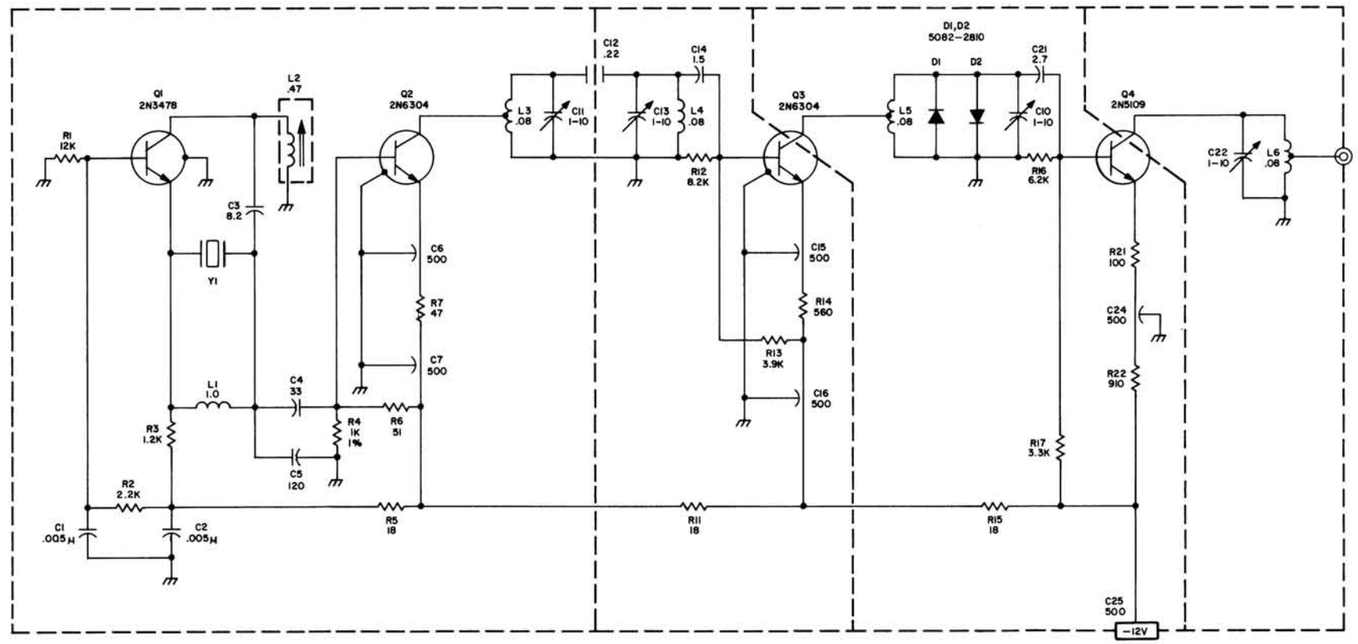


Figure 7.41 Video Filter Switching, A15
Schematic Diagram 92A150-062

REV. PER. CO. NO. 246 1/9/84 WMW
REV PER CO NO 286 6/22/84 WMW



ASSEMBLY DWG. NO. 60A310-3550



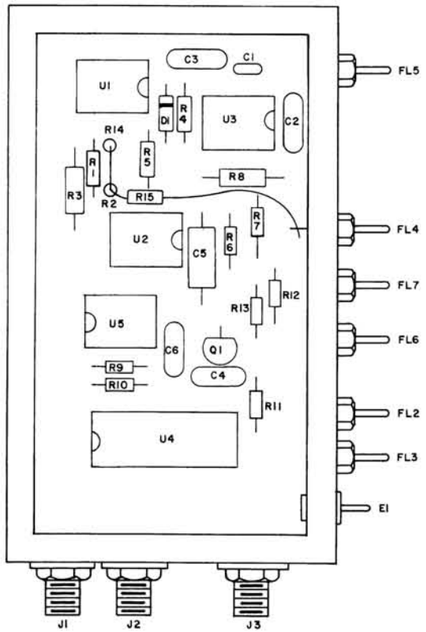
DESIGNATION LIST	
LAST USED	NOT USED
C25	C8,9,10,18, 19,20,23
D2	
J1	
L6	
Q4	
R22	R8,9,10,18, 19,20
Y1	

UNLESS OTHERWISE SPECIFIED:

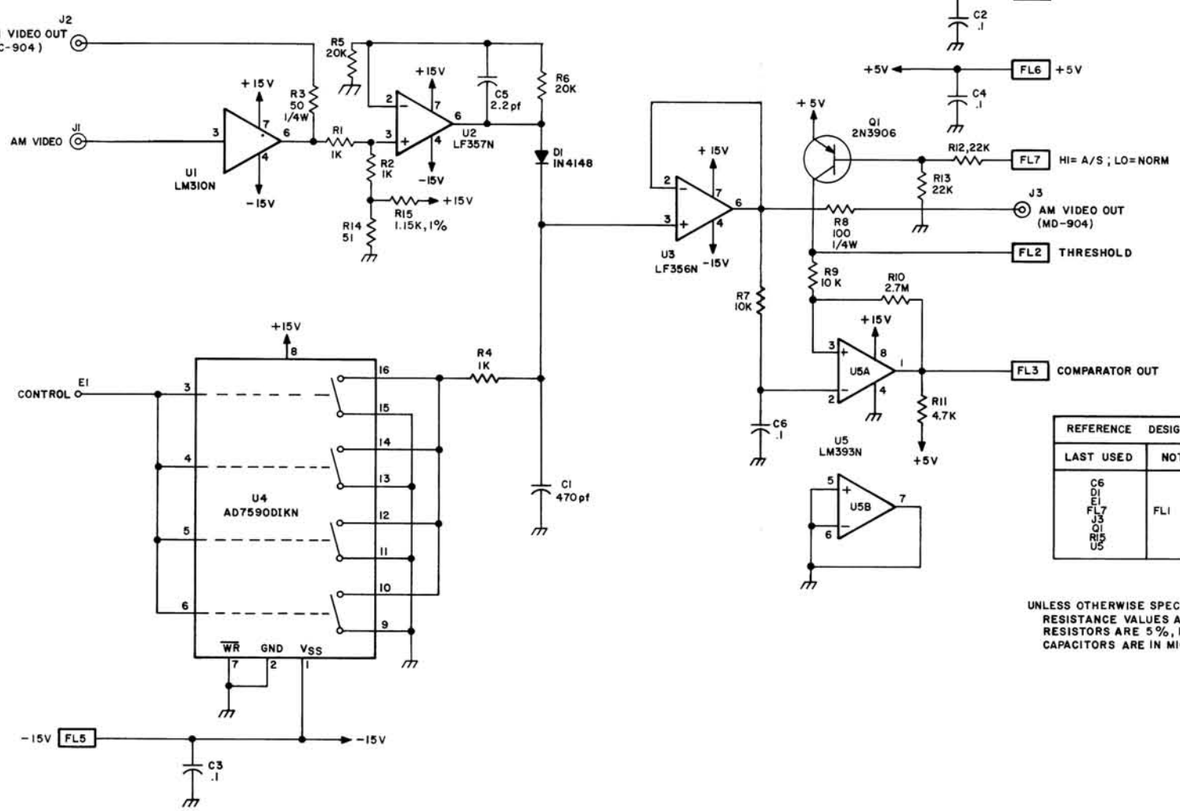
ALL RESISTANCES ARE IN OHMS @ 1/4W.
ALL CAPACITANCES ARE IN PICOFARADS.

Figure 7.42 250 MHz Oscillator, A31 (Option 6)
Schematic Diagram 92R310-040

REV 2/19/82 PS
REV. PER. CO. NO. 257 3/9/84 WMW
REV PER CO NO 263 & 264 3/23/84 JFF
REV PER CO NO 285 7/3/84
REV PER C.O. NO. 298 7/9/84 PS



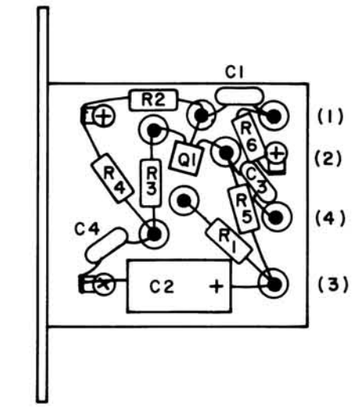
ASSEMBLY DWG. NO. 92A360-340



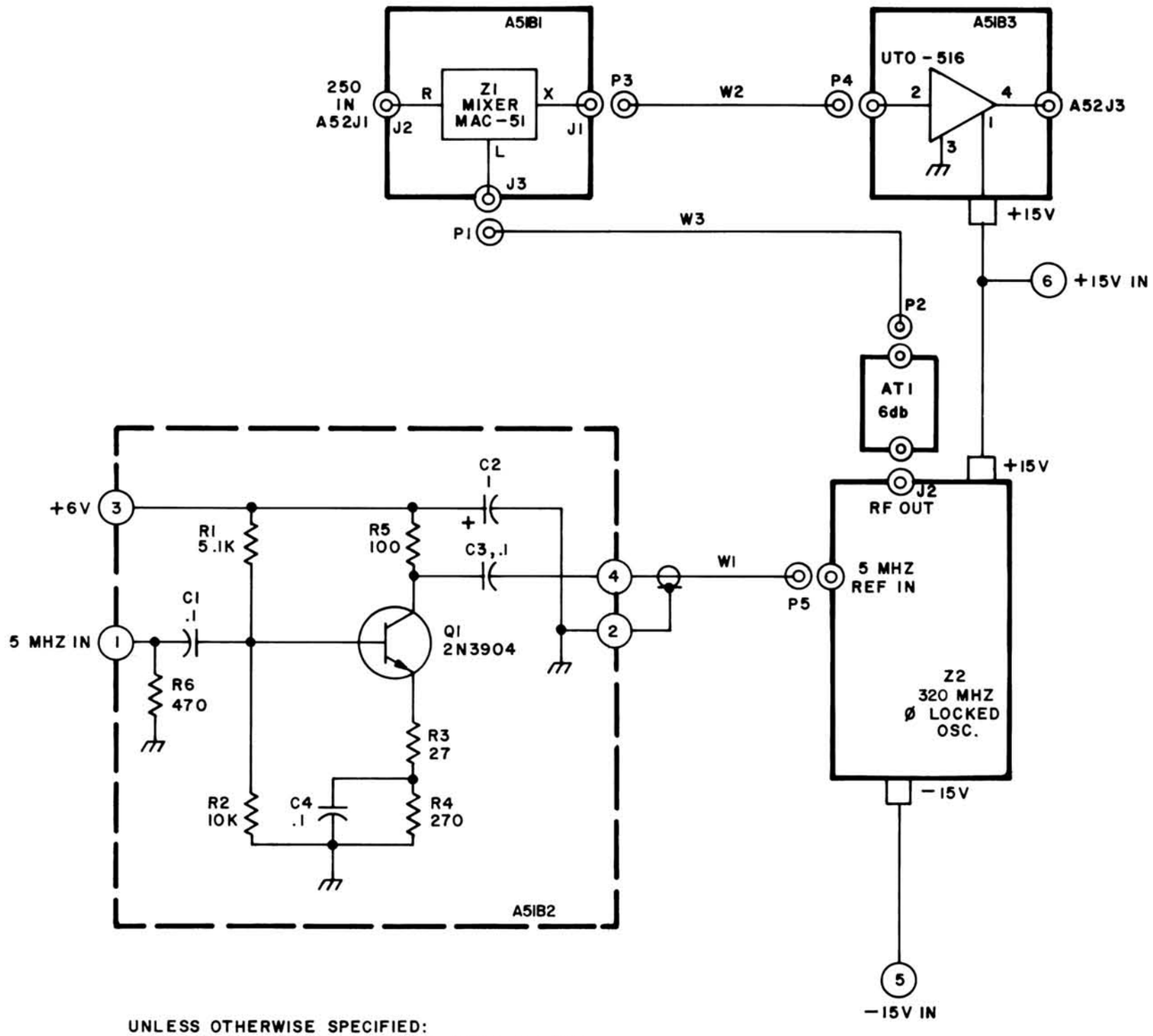
REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C6 D1 E1 FL7 J3 Q1 R15 U5	FL1

UNLESS OTHERWISE SPECIFIED:
RESISTANCE VALUES ARE IN OHMS:
RESISTORS ARE 5%, 1/8 W
CAPACITORS ARE IN MICROFARADS

Figure 7.43 Peak Detector, A36
Schematic Diagram 92R360-045



ASSEMBLY DWG. NO. A512-450

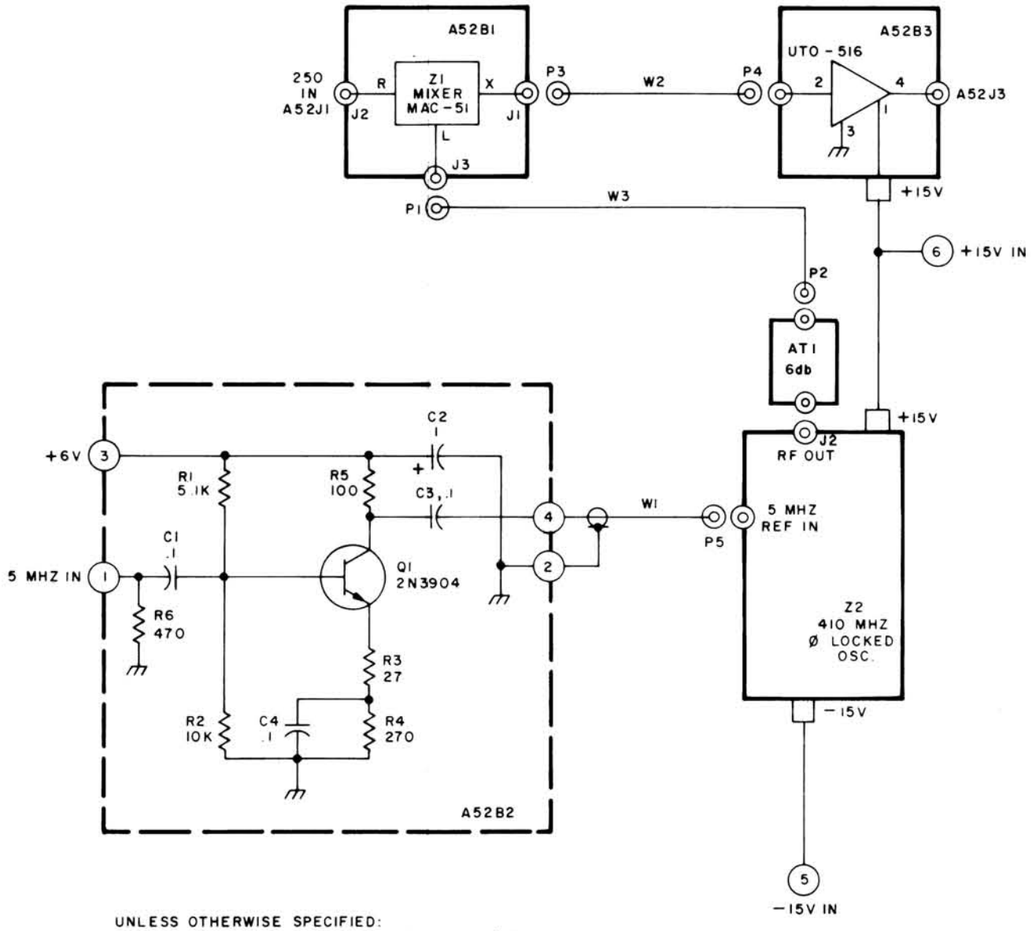


UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS & 1/4W
ALL CAPACITOR VALUES ARE IN MICROFARADS

Figure 7.44 · 250/70 MHz Converter, A51 (Option 4C)
Schematic Diagram 92B510-095

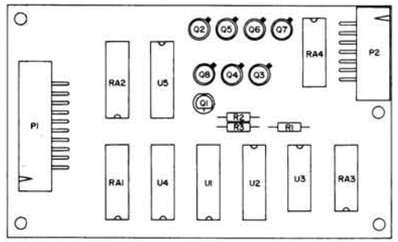
REV PER CO NO. 200 7/14/83 JFF

ASSEMBLY DWG. NO. 92A522-318

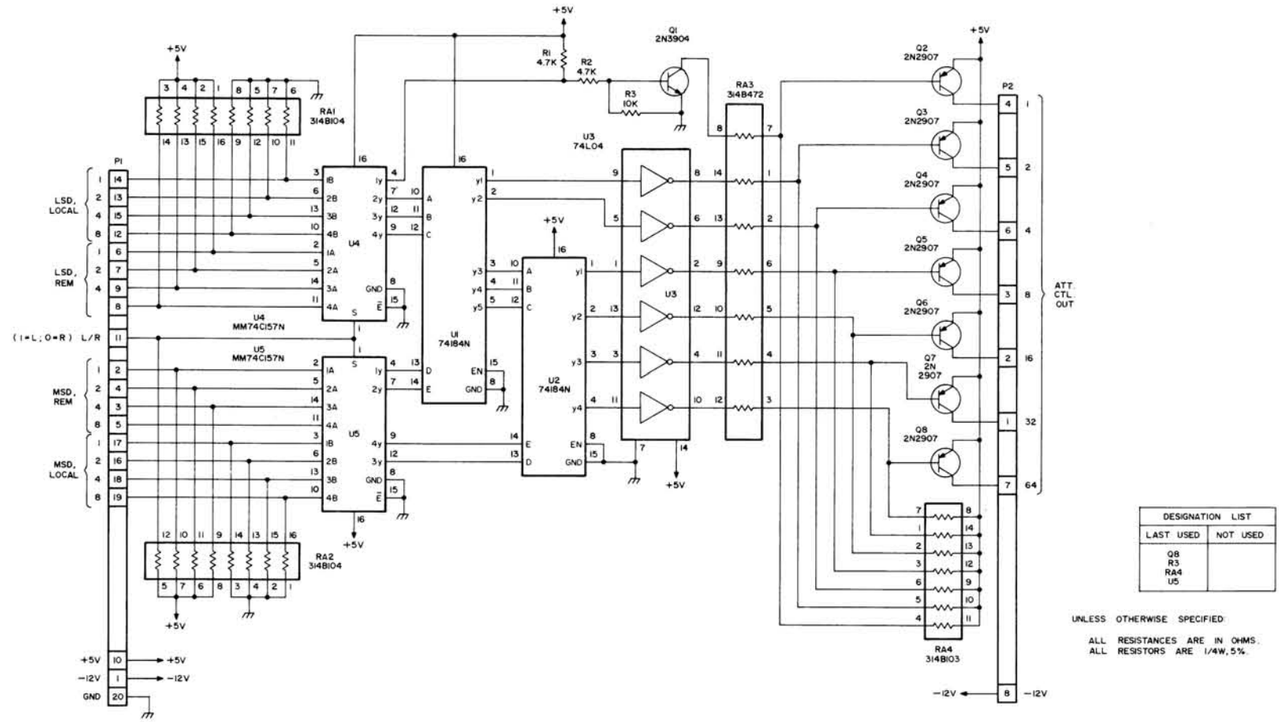


UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS & 1/4W
ALL CAPACITOR VALUES ARE IN MICROFARADS

Figure 7.45 250/160 MHz Converter, A52 (Option 4B)
Schematic Diagram 92B520-077



ASSEMBLY DWG. NO. 92A531-339



DESIGNATION LIST	
LAST USED	NOT USED
Q8 R3 RA4 U5	

UNLESS OTHERWISE SPECIFIED
ALL RESISTANCES ARE IN OHMS.
ALL RESISTORS ARE 1/4W, 5%.

Figure 7.46 IF Attenuator Control, A53B1
Schematic Diagram 92R531-051

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