# SECTION II
# THEORY OF OPERATION

The Model TMR-6 Telemetry Receiver is a crystal-controlled double-superheterodyne receiver designed for the reception of AM or FM telemetry signals within a 1 mc band. The functioning of the receiver circuitry is described in detail in the following paragraphs.

## Model TMH-A6 136-mc Tuning Unit.

RF Amplifier. The RF amplifier is a cascode circuit using a pair of type 7077 low-noise high-$G_m$ triodes. The cascode is ideally suited for this purpose because of its inherent low-noise characteristics, and because the input-tuned circuit provides selectivity ahead of the first stage -- particularly important because of the attenuation provided to undesired signals outside the band. An additional feature of the cascode is that it can be easily gain-controlled, which provides a considerable increase in the signal handling capability of the receiver.

The input network is a single-tuned circuit with the antenna connection tapped down to provide optimum source resistance at the grid of the first tube. The output circuit is double-tuned. The combination of the single-tuned input circuit and the double-tuned output circuit produces a response that is more than 65 db down at the image frequency. The gain of the cascode is great enough that the mixer does not contribute to the noise-figure of the receiver, and the gain control characteristics are such that the RF amplifier gain is not decreased until the signal level is large enough to eliminate noise-figure considerations.

First Mixer. The first mixer circuit uses a type 5654/6AK5W pentode. Both the local oscillator and the signal voltages are applied to grid number one. A test point is provided at the mixer grid to monitor oscillator injection and to facilitate alignment of the RF amplifier. An over-coupled double-tuned circuit in the plate of the mixer is tuned to the first intermediate frequency of 30 mc. An output is taken from a capacitive voltage divider in the secondary side of this double-tuned circuit for coupling to a Telemetry Display Unit.

Local Oscillator-Multiplier Chain. The first local oscillator injection frequency is 30 mc higher than the received signal. The basic oscillator is crystal-controlled and operates at one-fourth the injection frequency. The circuit consists of a type 12AT7WA dual-triode in a Butler configuration with output taken at the second harmonic of the crystal frequency. The crystals used are series-mode DEI type PXC-1, for use without an oven, and type PCO-1 for use with oven.

V-206 operates as a frequency doubler with its output circuit tuned by L-215, and V-207 operates as a doubler with its output circuit tuned by L-216. The injection voltage is taken from the plate circuit of V-207.

First IF Amplifier. The first IF amplifier has the response shape of two slightly over-coupled double-tuned circuits and is centered at 30 megacycles. The transformers are capacitively coupled using high impedance coupling. With this configuration the primary is in one can and the secondary is in another can with coupling in the form of a capacitive T using the capacity-to-ground of one of the transformer terminals as the shunt element.

The amplifier is nominally 1.1 megacycles wide across the top of the response so that the first IF amplifier does not affect the selectivity of the receiver as determined by the second IF amplifier.

AGC is applied to the grid of V-204. A suitable value of unbypassed cathode resistor compensates for input capacity variations that occur with changes in tube transconductance, minimizing IF response shape change with gain control. Screen-grid neutralization is also used to improve shape stability.

Second Mixer. The second mixer, V-205, is of the pentode type with the oscillator and signal voltages applied to separate grids. This type of mixer was chosen because its use minimizes the spurious responses associated with double superheterodyne receivers.

The signal voltage is applied to grid number one which is biased for class A operation. The oscillator voltage is applied to grid number three and develops self bias.

A double-tuned circuit in the plate of the second mixer is tuned to 10 mc, the second intermediate frequency.

Second Local Oscillator. The second local oscillator, V-208, is also a type 12AT7WA dual-triode in a Butler circuit. Output is taken at the 40 mc fundamental frequency of the oscillator using a third-overtone crystal. The plate circuit is tuned by L-225.

SECOND (10 mc) INTERMEDIATE FREQUENCY AMPLIFIERS.

Seven different IF amplifiers are available for use with the TMR-6 receiver to satisfy varying bandwidth requirements. The bandwidth and number series of each model is listed in table 2-1.

Table 2-1
IF Amplifier Bandwidths

| Model | 3db Bandwidth | Number Series |
|---|---|---|
| IFA-A6 | 100 kc | 1300 |
| IFA-B6 | 200 kc | 800 |
| IFA-C6 | 300 kc | 300 |
| IFA-D6 | 500 kc | 1000 |
| IFA-J6 | 40 kc (1 db) | 500 |
| IFA-K6 | 10 kc | 700 |
| IFA-L6 | 20 kc | 900 |

Each IF amplifier is in the form of a complete subassembly plug-in module, and may be inserted or removed from the main receiver chassis in a matter of minutes. An 8-pin receptacle makes all operating voltage and output connections; one IF output and the IF input connections are made with short lengths of coaxial cable.

The second IF amplifier has the response shape of five slightly over-coupled, double-tuned circuits (peak to valley ratio approximately 1.01 to 1.05) and is centered at 10 mc.

AGC is applied to the first three stages. The output stage drives an AM detector, an AGC detector, and the first limiter. A suitable value of unbypassed cathode resistor is provided for each gain-controlled stage to compensate for input capacity variations that occur with changes in tube transconductance, minimizing IF response shape change with gain control. Screen grid neutralization is also employed for all stages to improve shape stability.

All of the IF amplifiers are similar, and except for the crystal filter in the narrower bandwidths, the major differences are the capacities associated with the tuned circuits and the degree of decoupling of the tubes from these circuits. These capacities and the amount of decoupling are adjusted to give the desired nominal gain for the various bandwidth strips.

All of the IF transformers are capacitively coupled using "top" or high impedance coupling. With this configuration the primary is in one can and the secondary is in another can, with coupling in the form of a capacitive "tee" using the capacity-to-ground of one transformer terminal as the shunt element.

The crystal filter stages use a pi impedance matching network at both the input and output of the crystal filter.

B+, heater, and AGC decoupling is provided as required to prevent regeneration. This decoupling, in combination with input capacity compensation and neutralization, produces a response that is extremely stable from the condition of maximum gain to minimum gain.

The low level 10 mc IF output is taken from a suitable voltage divider in the secondary of the last IF transformer. The AGC output (for signal strength recording) is taken as a separate feed from the AGC detector. R-532 and R-537 are adjusted to set up the signal level meter for the 40 kc bandwidth amplifier. Corresponding adjustments are provided for each IF amplifier.

Model FMD-A6 Demodulator: Limiter-Discriminator.

This demodulator is made in the form of a plug-in module subassembly which may be removed and replaced with another demodulator in a matter of minutes. The unit consists of a first limiter, V-601, a type 6BN6 gated-beam tube; V-602 and V-603, two type 6BN6's in a parallel second-limiter circuit; and V-604, a type 5726/6AL5W dual-diode in a Grandlund discriminator configuration.

As a compromise between the various factors affecting limiter discriminator operation and good capture performance, a peak separation of approximately 2.0 mc was chosen for the discriminator. The inter-stage network between the first and second limiter is a double-tuned, overcoupled transformer, with a nominal bandwidth of 2 mc between the points on the response curve where the amplitude is equal to that at center frequency. The receiver has sufficient gain to saturate both limiters on noise.

Type 6BN6 gated-beam tubes were selected for use as limiters because the unique characteristics of this tube type approach those of the ideal limiter. The characteristics of 6BN6 are such that a relatively small change in limiter-grid voltage (grid number 1) changes the plate current from a condition of saturation to cut-off while the cathode current remains essentially constant. This allows the operating point of the tube to be set by cathode bias such that plate-current saturation and cut-off occur symmetrically about the zero-crossings of the input signal. Furthermore, the limiter grid draws essentially no current when it is driven positive so the loading on the tuned circuits connected to the limiters is essentially constant.

Since the grid time constants associated with grid-leak type of limiters are not required for the gated-beam limiter, the AM rejection characteristics of the limiter are not deteriorated for high AM frequencies.

The discriminator used is a form of ratio-detector employing a pair of side-tuned circuits and fixed bias instead of the more conventional balanced phase-shift type of circuit with self bias. In addition, the time constants associated with the more conventional ratio detector or discriminator have been avoided and the required damping of the tuned circuits is accomplished by current flow into the Zener diodes used as a bias source.

C-631 is used to adjust the lc ratio of Z-601, and C-626 is used to adjust the lc ratio of Z-602 as required to give the most linear discriminator curve.

The dc voltage across C-623 is approximately equal to one-half the bias (+ 5.9 volts) for a signal input at center frequency and goes more positive as frequency is decreased.

The discriminator output is direct-coupled to the tuning meter amplifier and is RC-coupled to the deviation meter amplifier and video amplifier.

Model FMD-B6 Crystal Demodulator.

Limiter-Discriminator. As a compromise between the various factors affecting limiter discriminator operation and good capture performance, a peak separation of 65 kc was chosen for the discriminator. The interstage network between the first and second limiter is a double-tuned, overcoupled transformer, with a nominal bandwidth of 200 kc between the points on the response curve where the amplitude is equal to that at center frequency. Limiter characteristics are the same as those in the FMD-A6, and the receiver has sufficient gain to saturate both limiters on noise.

The discriminator uses a crystal detector employing a pair of side-tuned circuits and fixed bias instead of the more conventional balanced phase-shift type of circuit with self bias.

The dc voltage across C-621 is approximately equal to one-half the bias (+ 5.9 volts) for a signal input at center frequency and goes more positive as frequency is increased.

The discriminator output is direct-coupled to the tuning meter amplifier and is RC-coupled to the deviation meter amplifier and video amplifier.

Model PLD-A6 Phase-Lock Demodulator.

Phase-Lock demodulation provides an attractive means of detecting a small signal in noise. The unit available for use with Model TMR-6 Receiver, is primarily intended to improve the performance of the receiver at low input signal strengths when used for the reception of IRIG FM/FM telemetry data. This improvement appears as a lowering of the receiver threshold and is the result of optimizing the phase-lock circuit to provide a reduction in the effective noise-bandwidth of the receiver. For IRIG FM/FM telemetry, the predetection noise-bandwidth can be reduced to approximately 200 kc with this type of demodulator.

The Phase-Lock Demodulator circuitry is contained in a plug-in module of the same size and form as the Limiter-Discriminator sub-chassis, and consists of a limiter, a phase-detector, a reactance tube, and a voltage-controlled oscillator.

A type 6BN6 gated-beam pentode, V-1101, is used as the input stage. Operation of this circuit is identical to the first limiter circuit of the FMD-A6 demodulator. The circuits are made identical so that changing demodulators does not affect the response curve of the second IF.

The phase detector, V-1102, is a type 5726/6AL5W dual-diode which detects the phase difference between the 10 mc output of the limiter and a 10 mc signal generated by the voltage-controlled oscillator, V-1103. The output of the phase detector is a voltage proportional to the phase difference between the two signals. This voltage, either positive or negative depending on the sign of the phase difference, is used to control the frequency of the oscillator and maintain its output in phase synchronism with the limiter output.

A simplified schematic diagram of the phase-lock circuitry is shown in figure 2-1. The secondary winding of T-1101 is inductively coupled to the primary with less than critical coupling, and their voltages are in phase. The oscillator voltage is introduced at the center-tap of the secondary. When this voltage differs from the signal voltage by a phase angle at 90°, the rectified currents through the diodes are equal and of opposite polarity so that the net voltage at the output of the phase detector

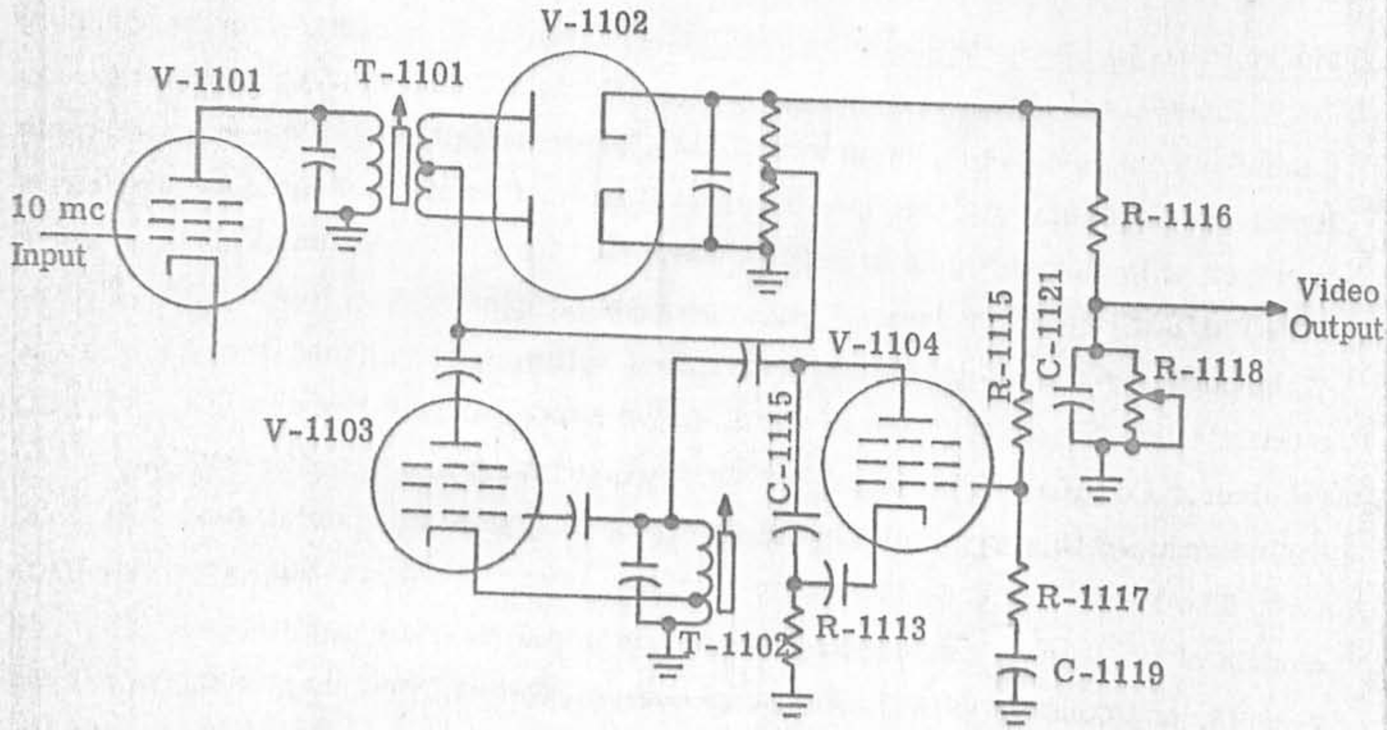



Figure 2-1. Phase-Lock Demodulator, Simplified Schematic Diagram.

is equal to the reference voltage placed on the detector. Variations in the phase difference produce positive and negative voltages proportional to the frequency of the incoming signal.

The video output level is reduced by the voltage divider R-1116 and R-1118 to a value equal to that of the limiter-discriminator for the same deviation. R-1118 is adjustable for a more exact setting. C-1121 equalizes the video output for a normally flat response 3 db down at 100 kc.

CR-1101 amd CR-1102 provide + 6 and + 12 bias voltages. The phase detector is biased at + 6 volts so that the video output is referenced thereto as required by the receiver. This also provides reference voltage for the tuning meter. The + 12 volts provides the cathode return for the tuning meter output tube.

R-1120 is used to minimize the 60-cycle hum; this circuit is identical to that of R-625 in the limiter-discriminator.

The oscillator, V-1103, is a type 6AU6WA pentode in an electron-coupled Hartley circuit. The tank circuit consists of T-1102, the inductive reactance provided by the reactance tube, and input and stray capacitances.

Output is connected to the center tap of T-1101B to provide the reference signal in the phase detector. Frequency of the oscillator is varied by changes in plate current of the reactance tube, which appear as changes in the inductive reactance of the tank circuit.

Current through the reactance tube, V-1104, is controlled by signal voltage on the grid. This voltage is obtained from the output of the phase detector and filtered by the loop filter consisting of R-1115, R-1117, and C-1119. The plate current is made to have the correct phase relationship to produce an inductive reactance with respect to the voltage across the oscillator tank circuit by making the grid-cathode voltage lag the oscillator voltage by 90°. C-1115 and R-1113 provide the proper phase shift. L-1106 and C-1120 serve to correct phase errors caused by stray reactance in the phase-shift circuit.

Model TMR-6 Main Chassis.

Video Amplifier. The video amplifier is common to both the AM and FM circuitry, and is switched by S-106. In FM, the video output from the discriminator is direct-coupled to V-104 which is in turn AC-coupled to a cathode follower V-103B. This is AC-coupled to video amplifier V-108 which in turn is AC-coupled to cathode follower V-109. The output of the cathode follower V-109, is coupled by C-128 and C-129 to the Video Output Jack J-112. Video gain control R-142 is provided to set the video output level as required.

A fraction of the ripple voltage present on the + 310-volt B supply is applied to the grid of V-108 to provide hum cancellation at the plate and consequently at the video output jack.

The gain of the video amplifier is such that a received signal having 25 kc deviation will produce a nominal 1/5 volts RMS output with the gain control set to maximum, with either the FMD-A6 or PLD-A6 Demodulator installed.

Deviation Meter. The deviation meter is a peak-to-peak voltmeter calibrated to read peak deviation. The meter will indicate the peak deviation (one-half the peak-to-peak deviation) of PDM/FM or PCM signals.

The meter will indicate the peak deviation of a single FM/FM sub-carrier but will not read accurately the peak deviation of a number of simultaneous subcarriers.

Deviation Range Switch, S-106, selects the full-scale range of the deviation meter. Pentode amplifier V-106, is direct-coupled to cathode follower V-107A. Flat frequency response is maintained in this amplifier by partially by-passing the cathode resistor.

CR-117 and CR-118 operate as a voltage doubler charging C-122 to a dc voltage very nearly equal to the peak-to-peak voltage appearing at the cathode of V-107A. R-141 is adjusted as required to calibrate the deviation meter.

Tuning Meter. The tuning meter circuit is designed to operate on CW, FM/FM, PDM/FM, or PCM signals and reads zero when the signal is centered in the IF pass band. The tuning meter reading is essentially independent of pulse width for PDM/FM signals or of pulse coding for PCM signals.

The discriminator output is direct coupled to triode amplifier, V-104A, which is in turn, direct coupled to cathode follower, V-105A; V-104B and V-105B are not part of the signal circuit but function to stabilize the amplifier by reducing the effects of B+ supply and heater voltage variations on tuning-meter indication.

The tuning meter is connected between the signal cathode and the non-signal cathode of V-105. A dc voltage taken from the bias regulators for the discriminator is applied to the non-signal grid of V-104. This voltage is set by R-127 for zero current through the tuning meter when a CW signal at center frequency is fed to the discriminator.

When a video signal is present at the signal cathode, C-116 is charged through CR-115 to the maximum voltage at the cathode and C-117 is charged through CR-116 to the minimum voltage at the cathode. As a result, there is a current flow from the non-signal cathode through the tuning meter and R-131 toward C-116, and there is a current flow from C-117 through R-132 and the tuning meter (in the opposite direction) toward the non-signal cathode. If the received signal is centered in the IF passband the deviation is symmetrical about the center frequency of the discriminator and the voltage differences between C-116 and C-117 (with respect to the voltage at the non-signal cathode) are equal and opposite. The net current through the tuning meter therefore is zero, the indication for proper tuning.

Signal Level Meter. The signal level meter, M-101, is essentially a voltmeter that indicates the AGC voltage. The meter scale is calibrated in dbm and reads from -110 to -15 dbm.

Output Meter. The output meter is a VU meter which may be calibrated arbitrarily for various conditions of operation. The OUTPUT CALIBRATE control sets the zero db reference from 1 volt rms minimum to 2 volts rms maximum.

# SECTION III

# OPERATION

The Model TMR-6 Telemetry Receiver is a crystal-controlled double-superheterodyne. Tuning to different frequencies within the 1-mc range of the Tuning Unit is done by changing crystals. The VERNIER TUNING control on the front panel of the Tuning Unit varies the frequency of the first local oscillator to provide an additional tuning range of ± 5 kc and is used primarily for precise tuning of the receiver.

The crystals used should be DEI Type PXC-1 for operation without a crystal oven. If an oven is required for increased stability, DEI Type PCO-1 crystal-and-oven combination should be used.

The frequency of the crystal required to tune to a particular signal frequency may be determined from the following formula:

$$f_x = \frac{f + 30}{4}$$

where: $f_x$ = crystal frequency in mc,

$f$ = signal frequency.

Initial Activation. Make sure the desired IF amplifier and FM demodulator are plugged in and connected. Make sure a crystal of the proper type and frequency is in its socket and the VERNIER TUNING control is set at zero. Set the AUDIO GAIN control about one-third clockwise, and the IF GAIN control to the AGC position. All other controls may be left in any position until after power is applied to the receiver.

Power is applied by operating the POWER switch to the ON position and is indicated when the red pilot light, located directly above the plug-in tuning unit comes on.

If there is no signal at the operating frequency the only output of the receiver will be noise that can be heard as a hiss in the speaker. In the presence of a carrier, this noise will disappear, and if the carrier is modulated by an audible signal, audio output will be obtained.



## FRONT PANEL CONTROLS

| | |
|---|---|
| VERNIER TUNING (C-243) | adjusts the frequency of the first local oscillators within ± 5 kc. |
| DEVIATION RANGE (S-106) | selects AM or FM operation and sets the full scale range of the DEVIATION meter. |
| VIDEO LEVEL (R-142) | adjusts the video output level. |
| VIDEO CUTOFF (S-103) | sets the low-frequency cutoff point of the video amplifier. |
| AGC DECAY (S-107) | selects the AGC decay time constant. |
| AUDIO GAIN (R-161) | adjusts the audio output from the speaker and the level of the 600-ohm audio output. |
| IF GAIN (R-141) | selects between AGC or manual gain control and adjusts the receiver gain manually. |
| OUTPUT CALIBRATE (R-154) | adjusts reference level for output meter. |

## INTERNAL ADJUSTMENTS

### Main Chassis

| | |
|---|---|
| R-138 | DEVIATION Meter full scale adjustment |
| R-113 | Hum-bucking adjustment for AM operation |
| R-127 | TUNING meter zero adjustment |

### FM Demodulator

| | |
|---|---|
| R-627 | hum-bucking adjustment for FM operation |
| R-624 | discriminator balance |

### 10 mc IF Amplifier

| | |
|---|---|
| R-532 | signal level meter full scale adjustment |
| R-537 | signal level meter low end adjustment |

METERS

Tuning Meter. The tuning meter circuit is designed to operate on CW, FM/FM or PCM signals. When receiving PCM signals the tuning meter reading is essentially independent of the pulse-width or pulse-coding, and reads zero when the signal is centered in the IF passband.

Signal Level Meter. The signal level meter indicates the AGC voltage applied to the second IF amplifier, the first IF amplifier and the RF amplifier. The meter is calibrated (approximately) in dbm at the antenna terminals.

Deviation Meter. The deviation meter is a voltmeter calibrated to read peak deviation of an FM carrier. The meter will read the peak deviation of PCM and FM/FM signals with a single subcarrier, but will NOT read accurately the peak deviation of a number of simultaneous subcarriers.

OUTPUTS.

Video Output. The video amplifier is designed to produce a nominal 1 volt rms output across a 100-ohm load for FM signals with 25 kc deviation or AM signals with 50% modulation. The design is such that 150 kc deviation or 100% amplitude modulation can be accepted without substantial increase in distortion. The video level control can be used to reduce the output if necessary.

AGC Output. This output is provided for connection to an external preamplifier. The source impedance is approximately 200K ohms; short-circuiting this output has essentially no effect on the receiver.

TDU Output. This output is provided for connection to a DEI Model TDU-3 Telemetry Display Unit. Output is taken from a capacitive voltage divider at the secondary of the first IF transformer in the first (30 mc) IF stage of the receiver. Short circuiting this output has essentially no effect on the operation of the receiver.

First Local Oscillator Output. This output is provided for the purpose of measuring the injection frequency with a counter. The output impedance is approximately 50 ohms and short-circuiting the output has essentially no effect on the operation of the receiver.

40-mc Output. This output is provided for monitoring the frequency of the second local oscillator with a counter. The output impedance is approximately 50 ohms and short-circuiting the output has essentially no effect on the operation of the receiver.

Recorder Output. This output is provided for signal level recording. The output is taken from the same voltage source that drives the signal level meter. The output is a nominal .1 to 1 volt from a 200K-ohm source impedance.

600-ohm Audio Output. This output is provided for recording the audio in addition to aural monitoring. The output is taken from a seperate 600-ohm winding on the audio transformer, and should be terminated when not in use.

Filament Output. Three AC filament windings are used in the TMR-6 Receiver. Tube filament connections are brought out to a barrier terminal strip on the rear apron of the chassis for connection to an external DC filament supply if desired.

# SECTION IV
# MAINTENANCE

## PERIODIC ADJUSTMENTS

The various components contained in the TMR-6 Receiver are designed to operate with the utmost stability, and will ordinarily not need adjustment or alignment for long periods of time. However, certain adjustment checks should be made periodically to keep the equipment operating at peak performance. Critical circuits which should be checked regularly and which must be made after tube replacement are as follows:

Deviation Meter Adjustment

Recommended Equipment

Boonton 202-E Signal Generator

Procedure. With the receiver off, check the zero adjustment on the deviation meter movement and set if required.

Connect the signal generator to the antenna input. Set the generator frequency to that of the receiver and adjust its output to 5 millivolts.

With the receiver on, set the deviation range switch to the 25 kc position and check the incidental reading with no modulation. The meter indication should be less than the equivalent of 500 cycles of deviation. If there is an excessively high meter indication this condition should be investigated and corrected before the following adjustment is made.

Set the deviation range switch to the 25 kc position. Set the generator modulation for 24 kc deviation at 1000 cycles. Adjust R-138 for a deviation meter reading of 24 kc.

Tuning Meter Adjustment

Recommended Equipment

Hewlett-Packard 606-A Signal Generator

Procedure. The tuning meter zero and discriminator balance should be checked periodically following this procedure. While both adjustments affect the tuning meter, the tuning meter zero adjusts the tuning meter amplifier, and the discriminator balance control adjusts the output of the limiter-discriminator subassembly. The two adjustments are provided to allow different demodulators to be used without the necessity of immediate adjustments.

Disconnect the input cable to the FM demodulator at J-502 located on the second IF amplifier subassembly. Press S-105 and adjust R-127 for a zero reading on the tuning meter. Reconnect the cable to J-502.

Disconnect the input cable to the second IF amplifier at P-501. Feed 200 millivolts at 10.00 mc into the second IF amplifier and adjust R-627 for zero reading on the tuning meter.

Signal Strength Meter Adjustment. The signal level meter should be checked periodically. The meter should read -105 dbm with 1.3 microvolts of input and -15 dbm with 40 millivolts of input signal. If the meter does not read correctly, adjust R-537 located on the 2nd IF subassembly to make the meter read -105 dbm with 1.3 microvolts of input signal and adjust R-532 to make the meter read -15 dbm with 40 millivolts of input signal. These adjustments interact and both ends of the scale should then be rechecked.

## ALIGNMENT PROCEDURES

The TMR-6 Telemetry Receiver is exceptionally stable and will normally maintain good alignment for long periods of time. Changing a tube will cause only minor detuning of the RF and IF circuits, and only minor adjustments will be necessary. However, replacement of other components can cause serious deterioration of performance, and alignment may become necessary. In this case, these procedures should be followed.

## MODEL FMD-A6 LIMITER-DISCRIMINATOR ALIGNMENT

Recommended Equipment

Boonton 202F Signal Generator

Boonton 207F Univerter

Hewlett-Packard 415-B Standing Wave Indicator (used as a 1000 cps tuned amplifier)

Recommended Equipment (continued)

Hewlett-Packard 524-B Electronic Counter with 525-A Frequency Converter

RCA WR-59C Sweep Generator

HP 120A Oscilloscope

An auxiliary tuned amplifier with approximately 30 db gain having an essentially flat response from 8.5 mc to 11.5 mc when connected to the limiter input cable W-601. The amplifier output should have a low resistance dc return to ground.

General Instructions. Z-601 and Z-602 are adjusted to set the discriminator peaks to 11.0 and 9.0 mc. C-626 and C-631 are set as required to optimize discriminator linearity.

Discriminator linearity is evaluated by checking the slope of the discriminator curve at a number of points over a frequency range of ± 300 kc around 10.0 mc and plotting the change in slope with respect to the slope at center frequency as a graph. The slope is sampled by using an FM signal having a very small deviation where any change in audio output occurring as input frequency is varied, reflects a change in the slope of the discriminator curve at that point. C-626 and C-631 are adjusted as required to produce a slope plot of predetermined shape.

If the discriminator response curve is viewed visually it is necessary to use the direct coupled vertical amplifier of the oscilloscope. Connection is made between pin 7 of V-104 and ground. Since the output of the discriminator is approximately +6 volts dc at center frequency it is necessary to adjust the oscilloscope vertical position and gain controls simultaneously. The baseline produced by sweep blanking does not fall at center frequency but rather at a point determined by the division of R-621 and R-622. The discriminator peaks are approximately equal in amplitude about the center frequency.

Alignment of T-601. Connect the auxiliary tuned amplifier to the limiter input cable W-601. Connect the sweep generator to the auxiliary amplifier. Connect the oscilloscope to feed-thru capacitor C-609.

Adjust the sweep generator for a sweep width of approximately 3 mc centered at 10 mc. Set the sweep generator output to maximum. Adjust the tuning cores in T-601A and B to produce a response curve having equal amplitude at the 9 and 11 mc points. The response is that of an overcoupled double tuned circuit.

Check of V-602 and V-603. The plate current output of V-602 and V-603 should be approximately equal under conditions of full limiting. A simple way of checking this is to substitute one of the tubes in the socket of V-601 and note the amplitude of the visual response at feed-thru capacitor C-609 with full limiting signal applied. Then substitute the other tube and note the response amplitude.

If the response amplitudes are not reasonably the same, other tubes should be tried and a matched pair selected.

> NOTE: All three sockets should contain tubes when the response amplitudes are being checked.

Alignment of Z-601 and Z-602.

1. Connect the Univerter output to the auxiliary amplifier. Set the output to maximum. Set the output frequency to 10 mc with a deviation of 10 kc at 1000 cps. Connect the high impedance input of the 415B to the discriminator video output, at pin 7 of V-104. Set the attenuator (normally on the 30 db range) of the 415B as required to produce a convenient meter indication.

2. Set the input frequency to 11.0 mc ± 1 kc. Set the attenuator (normally on the 50 db range) of the 415B as required to produce a convenient meter indication and adjust Z-601 for a minimum indication.

3. Set the input frequency to 9.0 mc ± 1 kc. Set the attenuator (normally on the 50 db range) of the 415B as required to produce a convenient meter indication and adjust Z-602 for a minimum indication.

4. Recheck the adjustment of Z-601 noting the frequency at which minimum meter reading occurs. If the frequency is more than 2 kc removed from 11 mc readjust Z-601. If Z-601 requires readjustment recheck Z-602 and readjust if required.

5. Set the input frequency to 10 mc ± 1 kc. Set the selector switch on the 415B to Expanded scale and adjust the gain (normally on the 40 db range) for a convenient indication on the expanded db scale. Vary the input frequency using the Univerter and plot the variation in meter reading as a function of input frequency over a range of ± 300 kc.

> NOTE: A 0.1 db change in meter reading is really a 0.2 db change in output since the meter is calibrated for a square law detector. The true change in output should be plotted. A more complete curve can be plotted if desired by carrying the plot out to ± 500 kc.

If the adjustment of both C-626 and C-631 is correct, the slope plot will show an increase on either side of center frequency reaching a maximum increase of 0.1 to 0.15 db, and the curve will look approximately symmetrical.

Increasing the capacity of C-631 will increase the slope on the low frequency side. Increasing the capacity of C-626 will increase the slope in the high frequency side. There is, however, some interaction between these adjustments. The discriminator peak frequencies must be readjusted following steps 2 thru 4 of this procedure each time an adjustment of C-626 or C-631 is made.

Adjust C-626 and/or C-631 as required.

## MODEL FMD-B6 CRYSTAL DEMODULATOR ALIGNMENT

Recommended Equipment

- Boonton 202E Signal Generator
- Boonton 207E Univerter
- Hewlett-Packard 330B Distortion Analyzer
- Hewlett-Packard 200 CD Audio Oscillator
- Hewlett-Packard 606A Signal Generator
- HP 120A Oscilloscope

An auxiliary tuned amplifier with approximately 30 db gain having an essentially flat response from 9.5 to 10.5 mc when connected to the limiter input cable P-601. The amplifier output should have a low resistance dc return to ground.

General Instructions. Connect the 200 CD, tuned to 5 cps to the external FM terminals on the Boonton 202E. Connect a .033 ufd capacitor and a .25 meg potentiometer across the external FM terminals on the Boonton. Connect the Horizontal input of the oscilloscope across the .25 meg potentiometer. See figure 4-1 for diagram of test set-up.

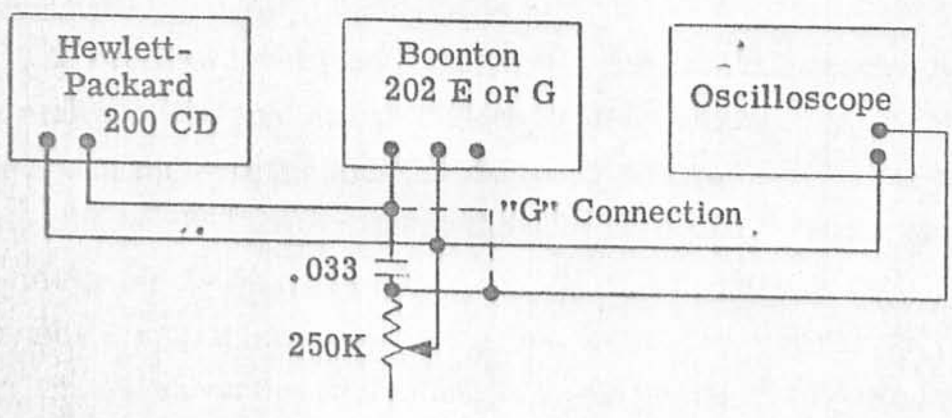



Figure 4-1. Test Set-Up.

Connect the Boonton 202E to the Univerter 207E. Use the QBJ adapter and 4-foot of RG-62/U coaxial cable and an open termination as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct coupled operation.

When the discriminator response curve is viewed visually it is necessary to use the direct coupled vertical amplifier of the oscilloscope. Connection is made between pin 7 of V-104 and ground. Since the output of the discriminator is approximately +6 volts dc at center frequency it is necessary to depress S-601 while adjusting Z-601 and Z-602.

Alignment of T-601A and T-601B. Connect the Boonton 202E signal generator to the Boonton 207E univerter and connect the univerter to the auxiliary amplifier. Connect the oscilloscope to the test point on the amplifier. The response of the auxiliary amplifier should be flat from approximately 9.5 to 10.5 mc at approximately 10V peak-to-peak output. If the response is not flat adjust the secondary of the output stage to make it flat. Disconnect the oscilloscope from the auxiliary amplifier and connect it to the feed-thru capacitor C-609 on the limiter subchassis. Connect the auxiliary tuned amplifier to the limiter input cable W-601.

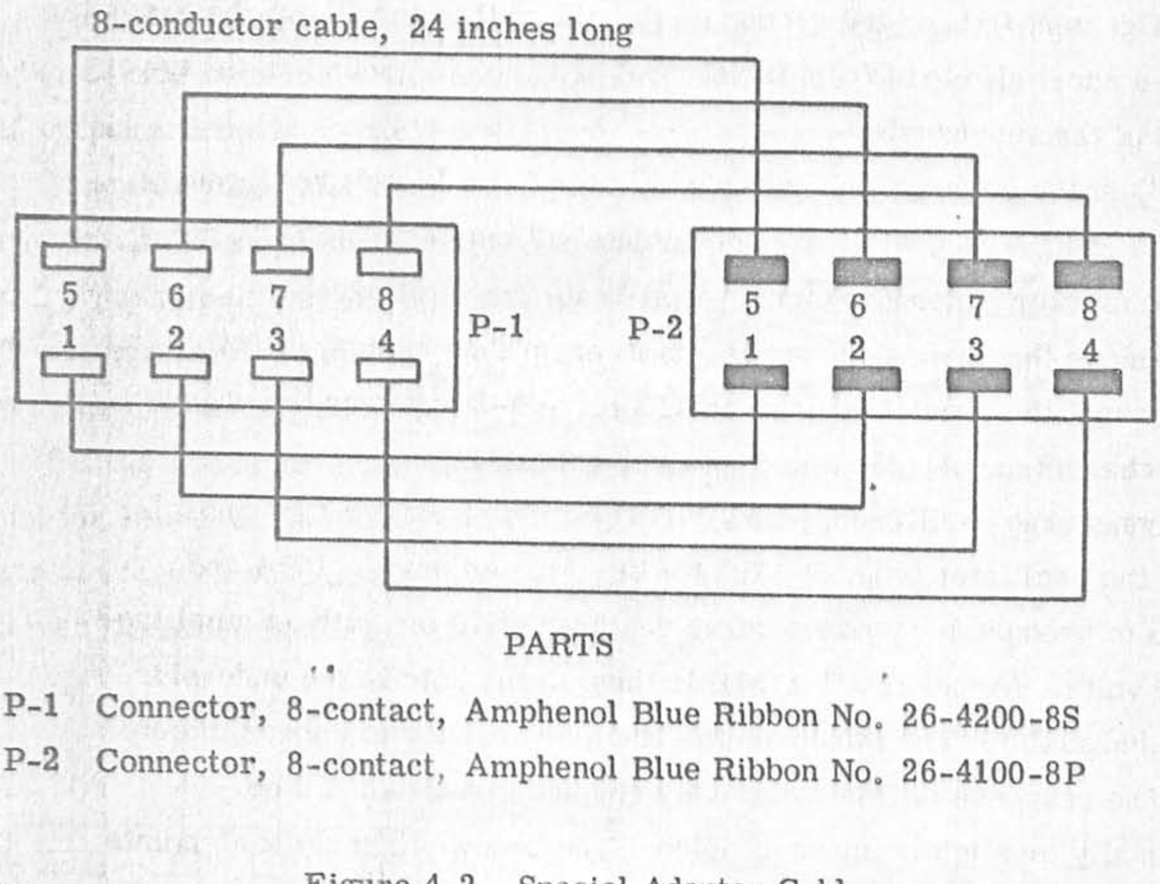
With the generator still set for approximately 10V peak-to-peak out of the amplifier, adjust T-601A and T-601B for a symmetrical response centered at 10 mc. The response should be about 200 kc wide, and have a 7 or 8% dip in the middle of the response. Disconnect the oscilloscope from C-609.

Alignment of Z-601 and Z-602. Connect the oscilloscope to C-626. Depress S-601 and adjust Z-602 for zero output at 10 mc and adjust Z-601 for best linearity. Feed in an accurate 10 mc signal into the auxillary amplifier approximately the same level and with S-601 still depressed the DC level on the oscilloscope should remain the same when the 10 mc is connected and disconnected. Disconnect the 200 CD and the oscilloscope horizontal leads from the Boonton signal generator. Set the Boonton signal generator for 10 kc deviation at 1 kc. Disconnect the oscilloscope from C-626. Connect the distortion analyzer to C-626 and measure the distortion; it should be less than 1%. If the distortion is greater than 1% then adjust Z-601 for minimum distortion. This should normally be a very slight adjustment of Z-601.

# MODEL PLD-A6 PHASE-LOCK DEMODULATOR, ALIGNMENT PROCEDURE

## Recommended Equipment

- Signal Generator, Boonton 202F
- Univerter, Boonton 207E
- VTVM, HP 415B
- Sweep Generator, RCA WR-59C
- Oscilloscope, HP 120A
- 1.5 mc Bandwidth IF Amplifier, DEI Model IFA-G2
- Electronic Counter, HP 524B, with Frequency Converter 525-A
- Nonmetallix alignment Tool
- Two 6-inch clip leads
- Special Adapter Cable (figure 4-2)




PARTS

P-1 Connector, 8-contact, Amphenol Blue Ribbon No. 26-4200-8S

P-2 Connector, 8-contact, Amphenol Blue Ribbon No. 26-4100-8P

Figure 4-2. Special Adapter Cable

Adjustment of T-1101. Remove the second IF amplifier subassembly from the receiver. Remove the bottom cover from the 1.5 mc bandwidth second IF amplifier subassembly and set it on the top edge of the receiver side cover dropping the studs on the subchassis sidewall thru the holes in the top of the side cover provided for this purpose. Connect the IF amplifier test cable (figure 4-3). Connect the phase-lock subchassis input cable to J-901. Solder a 10K resistor to the feed-thru terminal on the test cable and connect the oscilloscope to this resistor and ground on the sidewall of the subchassis. Short out the AGC line by connecting a short clip lead from feed-thru capacitor C-942 to ground on the subchassis sidewall.

Connect the 91-ohm alignment fixture (figure 4-6) between the grid pin 1 of V-903 and ground on the strap nut for this tube. Connect the sweep generator. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-903 to ground on the upper sidewall of the subchassis.

Adjust the output of the sweep generator for a 12 volt response amplitude and a sweep width of approximately 3 mc centered at 10 mc using the marker generator signal to calibrate the oscilloscope.

Remove the phase-lock subassembly from the receiver.

Connect the special adapter cable (figure 4-2) between the phase-lock subchassis and J-103 on the receiver chassis.

Connect the oscilloscope to TP-1101 on the phase-lock subchassis. Remove the oscillator tube, V-1103 (6AU6WA). Adjust T-1101A and T-1101B to produce a response curve centered at 10 mc with an amplitude of 7 to 9 volts. (Access to T-1101B is through the hole in the underside of the subchassis). The sweep width should be reduced to approximately 1 mc. The response of this inductively coupled circuit should be transitionally or slightly under-coupled. The bandwidth at the 2 db points should be at least 600 kc.

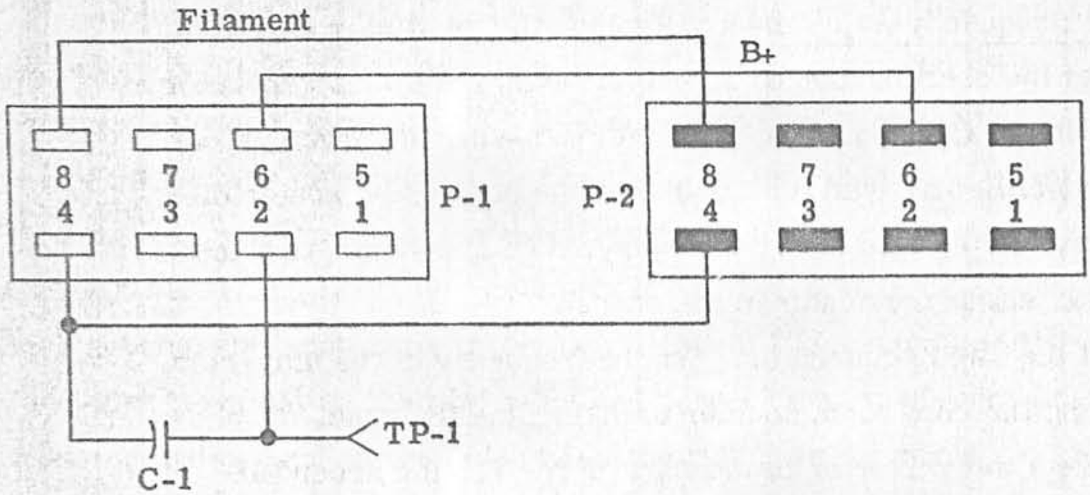
Oscillator Frequency Adjustment. Replace the oscillator tube, V-1103. Connect the oscilloscope to TP-1102. With the sweep generator blanking control in the OFF position, check for a Z-shaped curve. Make the preliminary oscillator adjustment of T-1102 by setting the center of the Z-shaped curve at the center of the display. (This assumes that the 10 mc marker was set at the center of the scope).

Disconnect the sweep generator. Set the frequency of the univerter to 10.000 mc using the electronic counter to determine the exact frequency. Connect the univerter to the input of the 1.5 mc second IF amplifier. Check the TUNING meter zero indication by disconnecting P-1101 and pressing switch S-106. Observe the reading of the meter and adjust R-114, the tuning meter zero control, if necessary, for zero indication. Reconnect P-1101 and adjust T-1102 so that the meter is again centered.

Video Level and Hum-Bucking Adjustments. After alignment of the phase-lock demodulator is completed, the adjustment of the video level output and the hum-bucking controls should be checked.

Place the phase-lock subchassis in the receiver and install and reconnect the IF amplifier for normal receiver operation. Connect the signal generator to the antenna input of the receiver. Connect the FM OUT receptacle to the oscilloscope input. Adjust R-1120 for minimum hum pattern as displayed on the oscilloscope.

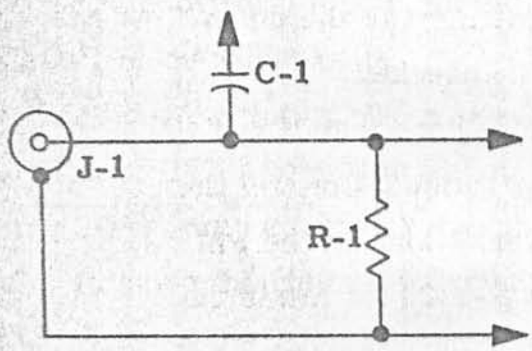
Set the signal generator for 1000 cps frequency modulation and adjust for 100 kc deviation. Set the RF output to 3 millivolts. Adjust R-1118 on the phase-lock subchassis to give an indication of 100 kc on the receiver Deviation Meter.




Parts

| | |
|---|---|
| C-1 | Capacitor, ceramic disc, .0015 uf, Erie CK61Y152Z |
| P-1 | Connector, 8-contact, Amphenol Blue Ribbon No. 26-4200-8S |
| P-2 | Connector, 8-contact, Amphenol Blue Ribbon No. 26-4100-8P |
| TP-1 | Feed-thru terminal, USECO No. 1430 |

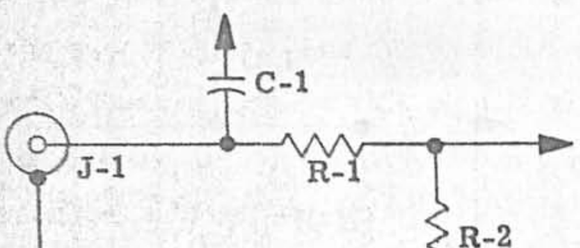
Figure 4-3. Second IF Amplifier Test Cable




Parts

| | |
|---|---|
| C-1 | Ceramic Tubular, 4.7 pf, Erie NPOA |
| R-1 | Fixed comp., 51 ohms, 1/2W, 5% |
| J-1 | UG-1094/U Connector |

Figure 4-4. 51-ohm Alignment Fixture




Parts

| | |
|---|---|
| C-1 | Ceramic tubular, 4.7 pf, Erie NPOA |
| R-1 | Fixed comp., 47 ohms, 1/2W, 5% |
| R-2 | Fixed comp., 2.7 ohms, 1/2W, 5% |
| J-1 | UG-1094/U Connector |



Figure 4-5. 47-dbm + 2.7-ohm Alignment Fixture

Recommended Equipment

VTVM RCA WV-98-B

Oscilloscope HP 120-A

Signal Generator, Boonton 202-E or G

Univerter, Boonton 207-E or G

Signal Generator HP 606-A

Audio Oscillator HP 200-CD

Second IF Test Cable, (figure 4-3)

51-ohm Alignment Fixture, (figure 4-4)

47-ohm + 2.7-ohm Alignment Fixture, (figure 4-5)

2 6-inch clip leads

Resistor, 10K, 1/2W

Various Coaxial Adapters (BNC to N and C)

Adapter BNC to shielded double plug, GR-274-QBJ

Alignment tool, Walsco #2541

General Instructions. Connect the 200 CD, tuned to 25 cps, to the external FM terminals on the Boonton 202-E or 202-G. Set the FM modulation control on the generator to maximum and set the modulation to ± 240 kc, using the output control on the 200 CD.

Connect a .033 and a .25 meg potentiometer across the external FM terminals on the Boonton. See figure 4-1. (Omit for 202-G FM Generator).

Connect the Horizontal input of the oscilloscope across the .25 meg potentiometer. Connect the Boonton 202E to the Univerter 207E. Use the QBJ adapter, and a 4-foot RG-62/U coax for the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Solder the 10K resistor to the feed-thru on the test cable receptacle. Connect the scope input between this resistor and ground on the subchassis sidewall next to C-1342.

CAUTION: A Model FMD-A6 limiter subchassis must be installed in the receiver before the receiver is turned on.

Alignment Procedure.

1. Set the IFA subchassis on the top edge of the receiver side gusset, dropping the studs on the subchassis sidewall through the holes provided for this purpose. Connect the 2nd IF Amplifier Test Cable (figure 4-3). Connect the limiter-discriminator input cable to J-1302. Set R-1332 and R-1337 to the center of their range. Remove the crystal (CR-201) if one is installed.

2. Connect the 51-ohm alignment fixture (figure 4-4) between the grid (pin 1) of V-1304 and ground on the strap nut for this tube. Connect the univerter output to the alignment fixture. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-1304B to ground on the upper sidewall of the subchassis. Set the output of the Boonton generator for maximum generator output. Feed the marker signal as required. Adjust the tuning cores in T-1305A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped.

> NOTE: If the sideband marker generator is used, the response should be equal at the markers. Reducing the FM modulation to about ± 100 will give increased resolution and allow a more accurate tuning of the transformers.

Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-1303 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-1303B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for the same response amplitude used in step 2 above. Feed in marker signal as required. Adjust the tuning cores in T-1304A and B as required to produce a response curve centered at 10 mc with

respect to the 10% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Adjust the output of the Boonton generator for a 10-volt response amplitude. Adjust the tuning core in T-1305B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

4. Connect the 47 + 2.7 ohm alignment fixture (figure 4-5) between the grid (pin 1) of V-1302 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-1302B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required and adjust the tuning cores in T-1303A and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

5. Connect the same alignment fixture between the grid (pin 1) of V-1301 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-1301B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-1302A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output of the IF Amplifier between R-110 on the terminal board and the feed-thru on the main chassis. Connect the 47 + 2.7 ohm alignment fixture between the grid (pin 1) of V-205 and ground at terminal D of

T-204. Connect a short clip lead between terminal B of T-204 and ground on the sidewall of the front end subassembly. Connect the univerter. Connect the marker generator between the 4.7 pf capacitor on the alignment fixture and ground on the sidewall of the front end subassembly. Set the receiver IF GAIN control to the full clockwise position. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-1301A and B as required to produce a response curve centered at 10 mc with respect to the 3 db down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Disconnect the scope. Disconnect the sweep and marker generator from the termination.

Bandwidth and Symmetry Measurement.

1. Connect the signal generator (HP 606A) to the 47 + 2.7 ohm alignment fixture at pin 1 of V-205. Connect the VTVM to the AM output of the IF amplifier between R-110 and feed-thru. Set the generator frequency to 10 mc + .5 kc. Adjust the generator output to produce a 10-volt reading on the VTVM. Vary the input frequency until the VTVM reading drops to 7.07V. Note the frequency to an accuracy of .5 kc. Tune the generator thru 10 mc to the other side of the response curve. Adjust the frequency for a VTVM reading of 7.07 volts and note the frequency to an accuracy of .5 kc.

> NOTE: The frequencies involved may be read to the required accuracy by shifting the generator output to the counter and increasing the generator output with the attenuator until the counter reads. Return the attenuator to the reference position before reconnecting the generator to the receiver.

2. Note the readings as + and - kc from the 10-mc reference. The difference in the absolute frequencies is the bandwidth; the difference between the -3 db points divided by the bandwidth and multiplied by 100 is the symmetry.

$$\frac{f_1 - f_2}{BW} \times 100 = \%\ \text{Symmetry}$$

# MODEL IFA-B6 200KC IF AMPLIFIER, ALIGNMENT PROCEDURE

## Recommended Equipment

VTVM RCA WV 98-B

Oscilloscope HP 120-A

Signal Generator Boonton 202E or G

Univerter, Boonton 207E or G

Signal Generator HP 606-A

Audio Oscillator HP 200 CD

Second IF Test Cable, (figure 4-3)

51-ohm Alignment Fixture, (figure 4-4)

47-ohm + 2.7-ohm Alignment Fixture, (figure 4-5)

Resistor, 10K, 1/2W

Various Coaxial Adapters (BNC to N and C)

Adapter BNC to shielded double plug. GR-274-QBJ

Alignment tool Walsco #2541

Two Clip leads, 6-inch

## General Instructions.

Connect the 200 CD, tuned to 25 cps, to the external FM terminals on the Boonton 202E or 202G. Set the FM modulation control on the generator to maximum and set the modulation to ± 240 kc, using the output control on the 200 CD.

Connect a .033 uf paper capacitor and a .25 meg potentiometer across the external FM terminals on the Boonton. See figure 4-1. (Omit for 202G FM Generator). Connect the horizontal input of the oscilloscope across the .25 meg potentiometer. Connect the Boonton 202E to the Univerter 207E.

Use the QBJ adapter and a 4-foot RG-62/U coax as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Solder the 10K resistor to the feed-thru on the test cable receptacle. Connect the scope input between the resistor and ground on the subchassis sidewall next to C-842.

CAUTION: A limiter subchassis, Model FMD-A6, must be installed in the receiver before the receiver is turned on.

Alignment Procedure.

1. Set the subchassis on the top edge of the receiver side gusset, dropping the studs on the subchassis sidewall provided for this purpose. Connect the IF Amplifier test cable, figure 4-3. Connect the limiter-discriminator input cable to J-802. Set R-832 and R-837 to the center of their range. Remove the crystal (CR-201) if one is installed.

2. Connect the 51-ohm alignment fixture (figure 4-4) between the grid (pin 1) of V-804 and ground on the strap nut for this tube. Connect the univerter output to the alignment fixture. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-804B to ground on the upper sidewall of the subchassis. Set the output of the Boonton generator for maximum generator output. Feed the marker signal as required. Adjust the tuning cores in T-805A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped or slightly overcoupled.

NOTE: If the sideband marker generator is used, the response should be equal at the markers. Reducing the FM modulation to about ± 200 kc will give increased resolution and allow a more accurate tuning of the transformers.

Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-803 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-803B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton Generator for the same response amplitude used in step 2 above. Feed in marker signal as required. Adjust the tuning cores in T-804A

and B as required to produce a response curve centered at 10 mc with respect to the 10% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Adjust the output of the Boonton generator for a 10-volt response amplitude. Adjust the tuning core in T-805B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

4. Connect the same alignment fixture between the grid (pin 1) of V-802 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B to T-802B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required and adjust the tuning cores in T-803A and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

5. Connect the 47 + 2.7-ohm alignment fixture (figure 4-5) between the grid (pin 1) of V-801 and ground on the strap-nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-801B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-802A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be flat-topped or slightly overcoupled. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output of the IF Amplifier between R-110 on the terminal board and the feed-thru on the main chassis. Connect the 47 + 2.7-ohm alignment fixture between the grid (pin 1) of V-205 and ground at terminal D of T-204.

Connect a short clip lead between terminal B of T-204 and ground on the sidewall of the front end subassembly. Connect the univerter. Connect the marker generator between the 4.7 pf capacitor on the alignment fixture and ground on the sidewall of the front end subassembly. Set the receiver IF GAIN control to the maximum clockwise position. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-801A and B as required to produce a response curve centered at 10 mc with respect to the 3-db down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Disconnect the scope. Disconnect the sweep and marker generator from the termination.

<u>Bandwidth and Symmetry Measurement.</u>

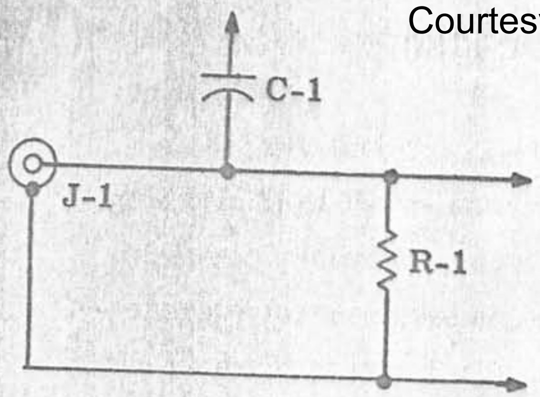
1. Connect the signal generator (HP 606-A) to the alignment fixture at pin 1 of V-205. Connect the VTVM to the AM output of the IF amplifier between R-110 and the feed-thru. Set the generator frequency to 10 mc ± 0.5 kc. Adjust the generator output to produce a 10-volt VTVM reading. Vary the input frequency until the VTVM reading drops to 7.07 volts. Note the frequency to an accuracy of 0.5 kc. Tune the generator thru 10 mc to the other side of the response curve. Adjust the frequency for a VTVM reading of 7.07 volts and note the frequency to an accuracy of 0.5 kc.

> NOTE: The frequencies involved may be read to the required accuracy by shifting the generator output to the counter and increasing the generator output with the attenuator until the counter reads. Return the attenuator to the reference position before reconnecting the generator to the receiver.

2. Note the readings as + and - kc from the 10-mc reference. The difference in the absolute frequencies is bandwidth; the difference between the -3 db points divided by the bandwidth and multiplied by 100 is symmetry.

$$\frac{f_1 - f_2}{BW} \times 100 = \%\ \text{Symmetry}$$

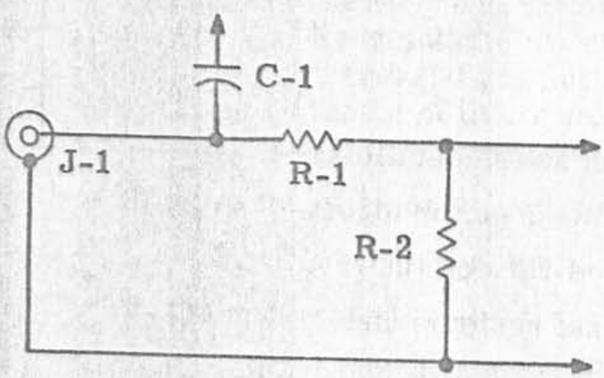
Disconnect the alignment fixture from pin 1 of V-205.




Parts

| | |
|---|---|
| C-1 | Ceramic tubular, 4.7 pf, Erie NPOA |
| R-1 | Fixed comp., 91 ohms, 1/2W, 5% |
| J-1 | UG-1094/U, Connector |

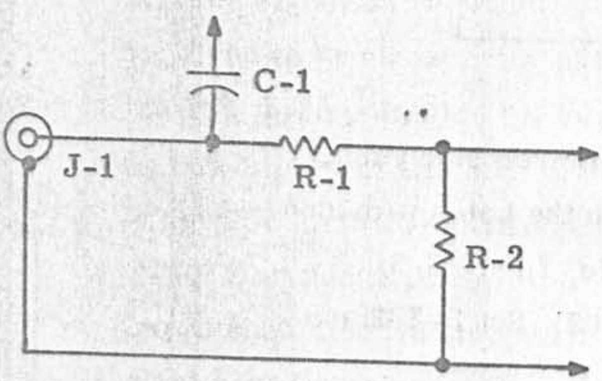
Figure 4-6. 91-ohm Alignment Fixture




Parts

| | |
|---|---|
| C-1 | Ceramic tubular, 4.7 pf, Erie NPOA |
| R-1 | Fixed comp., 82 ohms, 1/2 watt, 5% |
| R-2 | Fixed comp., 10 ohms, 1/2 watt, 5% |
| J-1 | UG-1094/U, Connector |

Figure 4-7. Alignment Fixture




Parts

| | |
|---|---|
| C-1 | Ceramic tubular, 4.7 pf, Erie NPOA |
| R-1 | Fixed comp., 91 ohms, 1/2 W, 5% |
| R-2 | Fixed comp., 2.7 ohms, 1/2W, 5% |
| J-1 | UG-1094/U, Connector |

Figure 4-8. Alignment Fixture

# MODEL IFA-C6 300-KC IF AMPLIFIER, ALIGNMENT PROCEDURE

## Recommended Equipment

VTVM RCA WV 98-B

Sweep Generator WR-59C

Oscilloscope HP 120-A

Signal Generator HP 606-A

Second IF Test Cable, (figure 4-3)

91-ohm Alignment Fixture, (figure 4-6)

82-ohm + 10-ohm Alignment Fixture (figure 4-7)

91-ohm + 2.7-ohm Alignment Fixture, (figure 4-8)

51-ohm Alignment Fixture, (figure 4-4)

Two 6-inch clip leads

Resistor, 10K, 1/2W

Various coaxial adapters (BNC to N and C)

Adapter BNC to shielded double plug, GR-274-QBJ

Alignment tool Walsco #2541

## General Instructions.

Use the QBJ adapter and a 4-foot RG-62/U coax as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Solder the 10K resistor to the feed-thru on the test cable receptacle. Connect the scope input between this resistor and ground on the subchassis sidewall next to C-342.

> CAUTION: A Model FMD-A6 limiter subchassis must be installed in the receiver before the receiver is turned on.

## Alignment Procedure.

1. Set the subchassis on the top edge of the receiver side gusset, dropping the studs on the subchassis sidewall through the holes provided for this purpose. Connect the IF Amplifier test cable, figure 4-3. Connect the limiter-discriminator input cable to J-302. Set R-332 and

R-337 to the center of their range. Remove the crystal (CR-201) if one is installed.

2. Connect the 91-ohm alignment fixture (figure 4-6) between the grid (pin 1) of V-304 and ground on the strap nut for this tube. Connect the sweep generator output to the alignment fixture. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-304B to ground on the upper sidewall of the subchassis. Set the output of the sweep generator for maximum generator output. Feed the marker signal as required. Adjust the tuning cores in T-305A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped or slightly double peaked.

> NOTE: If the sideband marker generator is used, the response should be equal at the markers. Reducing the sweep to about ± 300 kc will give increased resolution and allow a more accurate tuning of the transformers.

Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-303 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-303B to ground on the upper sidewall of the subchassis. Adjust the output of the sweep generator for the same response amplitude used in step 2 above. Feed in marker signal as required. Adjust the tuning cores in T-304A and B as required to produce a response curve centered at 10 mc with respect to the 10% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Adjust the output of the sweep generator for a 10-volt response amplitude. Adjust the tuning core in T-305B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

4. Connect the 82 + 10-ohm alignment fixture (figure 4-7) between the grid (pin 1) of V-302 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-302B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required and adjust the tuning cores in T-303A and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

5. Connect the same alignment fixture between the grid (pin 1) of V-301 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-301B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-302A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be flat-topped or slightly overcoupled. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output of the IF amplifier between R-110 on the terminal board and the feed-thru on the main chassis. Connect the 91 + 2.7-ohm alignment fixture (figure 4-8) between the grid (pin 1) of V-205 and ground at terminal D of T-204. Connect a short clip lead between terminal B of T-204 and ground on the sidewall of the front end subassembly. Connect the univerter. Connect the marker generator between the 4.7 pf capacitor on the alignment fixture and ground on the sidewall of the front end subassembly. Set the receiver IF GAIN control to the maximum clockwise position. Adjust the output of the sweep generator for a 10-volt

response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-[illegible] and B as required to produce a response curve centered at 10 mc with respect to the 3 db down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Disconnect the scope. Disconnect the sweep and marker generator from the termination.

Bandwidth and Symmetry Measurement.

1. Connect the signal generator (HP 606-A) to the alignment fixture at pin 1 of V-205. Connect the VTVM to the AM output of the IF amplifier between R-110 and the feed-thru. Set the generator frequency to 10 mc + .5 kc. Adjust the generator output to produce a 10 volt VTVM reading. Vary the input frequency until the VTVM reading drops to 7.07 volts. Note the frequency to an accuracy of 0.5 kc. Tune the generator thru 10 mc to the other side of the response curve. Adjust the frequency for a VTVM reading of 7.07 volts and note the frequency to an accuracy of 0.5 kc.

> NOTE: The frequencies involved may be read to the required accuracy by shifting the generator output to the counter and increasing the generator output with the attenuator until the counter reads. Return the attenuator to the reference position before reconnecting the generator to the receiver.

2. Record the readings as + and - kc from the 10-mc reference. The difference in the absolute frequencies is the bandwidth; the difference between the -3 db points divided by the bandwidth and multiplied by 100 is symmetry.

$$\frac{f_1 - f_2}{BW} \times 100 = \%\ \text{Symmetry}$$

Disconnect the alignment fixture from pin 1 of V-205.

# MODEL IFA-D6 500-KC IF AMPLIFIER, ALIGNMENT PROCEDURE

## Recommended Equipment

VTVM RCA WV 98-B

Sweep Generator WR-59 C

Oscilloscope HP 120-A

Signal Generator HP 606-A

Second IF Test Cable

51-ohm Alignment Fixture (figure 4-4)

91-ohm Alignment Fixture (figure 4-6)

82-ohm + 10-ohm Alignment Fixture (figure 4-7)

91-ohm + 2.7-ohm Alignment Fixture (figure 4-8)

Two clip leads, 6-inch

Resistor, 10K, 1/2W

Various Coaxial Adapters (BNC to N and C)

Adapter BNC to shielded double plug, GR-274-QBJ

Alignment tool Walsco #2541

## General Instructions.

Use the QBJ adapter and a 4-foot RG-62/U coax as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Connect the scope input between the feed-thru on the test cable receptacle and ground on the subchassis sidewall next to C-1042.

> CAUTION: A Model FMD-A6 limiter subchassis must be installed in the receiver before the receiver is turned on.

## Alignment Procedure.

1. Set the subchassis on the top edge of the receiver side gusset, dropping the studs on the subchassis sidewall through the holes provided for this purpose. Connect the IF Amplifier test cable, figure 4-3. Connect the limiter-discriminator input cable to J-1002. Set R-1032 and R-1037 to the center of their range. Remove the crystal (CR-201) if one is installed.

2. Connect the 91-ohm alignment fixture (figure 4-3) between the grid (pin 1) of V-1004 and ground on the strap nut for this tube. Connect the sweep generator output to the alignment fixture. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-1004B to ground on the upper sidewall of the subchassis. Set the output of the sweep generator for maximum generator output. Feed the marker signal as required. Adjust the tuning cores in T-1005A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-1003 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-1003B to ground on the upper sidewall of the subchassis. Adjust the output of the sweep generator for the same response amplitude used in step 2 above. Feed marker signal as required. Adjust the tuning cores in T-1004A and B as required to produce a response curve centered at 10 mc with respect to the 10% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Adjust the output of the sweep generator for a 10 volt response amplitude. Adjust the tuning core in T-1005B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

4. Connect the 82 + 10-ohm alignment fixture between the grid (pin 1) of V-1002 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-1002B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required and adjust the tuning cores in T-1003A

and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead.

5. Connect the same alignment fixture between the grid (pin 1) of V-1001 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-1001B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-1002A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output of the IF amplifier between R-110 on the terminal board and the feed-thru on the main chassis. Connect the 91 + 2.7 ohm alignment fixture (figure 4-8) between the grid (pin 1) of V-205 and ground at terminal D of T-204. Connect a short clip lead between terminal B of T-204 and ground on the sidewall of the front end subassembly. Connect the sweep generator. Connect the marker generator between the 4.7 pf capacitor on the alignment fixture and ground on the sidewall of the front end subassembly. Set the receiver IF GAIN control to the maximum clockwise position. Adjust the output of the sweep generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-1001A and B as required to produce a response curve centered at 10 mc with respect to the 3 db down points on the response curve. The response curve should be flat-topped or slightly double-peaked. Disconnect the scope. Disconnect the sweep and marker generator from the termination.

Bandwidth and Symmetry Measurement.

1. Connect the signal generator (HP 606-A) to the alignment fixture at pin 1 of V-205. Connect the VTVM to the AM output of the IF amplifier between R-110 and the feed-thru. Set the generator frequency to 10 mc ± .5 kc. Adjust the generator output to produce a 10 volt VTVM reading. Vary the input frequency until the VTVM reading drops to 7.07 volts. Note the frequency to an accuracy of 0.5 kc. Tune the generator thru 10 mc to the other side of the response curve. Adjust the frequency for a VTVM reading of 7.07 volts and note the frequency to an accuracy of 0.5 kc.

> NOTE: The frequencies involved may be read to the required accuracy by shifting the generator output to the counter and increasing the generator output with the attenuator until the counter reads. Return the attenuator to the reference position before reconnecting the generator to the receiver.

2. Record the readings as + and - kc from the 10-mc reference. The difference in the absolute frequencies is the bandwidth; the difference between the -3 db points divided by the bandwidth and multiplied by 100 is symmetry.

$$\frac{f_1 - f_2}{BW} \times 100 = \%\ \text{Symmetry}$$

Disconnect the alignment fixture from pin 1 of V-205.

# MODEL IFA-J6 40-KC IF AMPLIFIER, ALIGNMENT PROCEDURE

## Recommended Equipment

VTVM RCA WV 98-B
Sweep Generator WR-59C
Oscilloscope HP 120-A
Signal Generator, Boonton 202E
Univerter, Boonton 207E
Signal Generator HP 608-D
Signal Generator HP 606-A
Audio Oscillator HP 200 CD
Alignment tool, Walsco #2541
Two 6-inch clip leads
Resistor, 10K, 1/2W
Various Coaxial Adapters
Adapter BNC to shielded double plug, GR-274-QBJ
Second IF Test Cable, figure 4-3
51-ohm Alignment Fixture, figure 4-4
47-ohm + 2.7-ohm Alignment Fixture, figure 4-5

## General Instructions.

Connect the 200 CD, tuned to 25 cps, to the external FM terminals on the Boonton 202E. Connect a .033 and a .25 meg potentiometer across the external FM terminals on the Boonton. Connect the horizontal input of the oscilloscope across the .25 meg potentiometer. See figure 4-1 for simplified diagram of connections.

Connect the Boonton 202E to the Univerter 207E. Use the QBJ adapter and a 4-foot RG-62/U coax as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Solder the 10K resistor to the test point on the second IF test cable and connect the scope input between this resistor and ground on the sidewall of the subchassis next to the feed-thru capacitor (C-551).

> CAUTION: A [illegible] limiter subchassis must be installed in the receiver before the receiver is turned on.

Alignment Procedure.

1. Set the subchassis on the top edge of the receiver side wall, dropping the studs through the holes provided. Connect the IF amplifier test cable. Connect the limiter-discriminator input cable to J-502. Short out the AGC line by connecting a short clip lead from feed-thru capacitor C-551 to ground on the subchassis sidewall. If the signal level meter was in approximate adjustment prior to alignment, do not disturb the adjustment of R-532 and R-537. If the signal level meter was not in approximate adjustment, set R-532 and R-537 to the center of their range. Remove the first local oscillator crystal from the Tuning Unit if one is installed.

2. Connect the 51-ohm alignment fixture (figure 4-4) between the grid (pin 1) of V-504 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-504B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator to maximum amplitude. Feed the marker signal as required. Adjust T-505A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped. Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-503 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-503 to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for the same response amplitude as that obtained in step 2. Feed in marker signal as required. Adjust T-504A and B as required to produce a response curve centered at 10 mc with respect to the 10% down points on the response curve. The response curve should be flat-topped

or slightly round nosed. Adjust the output of the Boonton generator for a 10-volt response amplitude. Adjust T-505B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly round nosed. Remove the alignment fixture and clip lead.

4. Connect the 47 + 2.7-ohm alignment fixture (figure 4-5) between the grid (pin 1) of V-502 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-502 to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust T-503A and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be round nosed. Remove the alignment fixture and clip lead.

5. Connect the same alignment fixture between the grid (pin 1) of V-501 and ground on the strap-nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-501B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust T-502A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be round nosed. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output. Connect the same alignment fixture between the grid (pin 1) of V-205 and ground at terminal D of T-204 to the sidewall of the front end subassembly. Connect the univerter. Connect the marker generator between the 4.7 pf capacitor on the alignment fixture and ground on the sidewall of the front end subassembly. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required.

NOTE: If a marker is present remove the crystal in the front end subassembly. Adjust the T-501A and B as required to produce a response curve centered at 10 mc with respect to the 3 db down points on the response curve. The response curve should be round nosed. Disconnect the scope. Disconnect the sweep and marker generator from the termination.

## MODEL IFA-K6 10-KC IF AMPLIFIER, ALIGNMENT PROCEDURE

### Recommended Equipment

VTVM RCA WV 98-B
Oscilloscope HP 120-A
Signal Generator, Boonton 202E
Univerter, Boonton 207E
Signal Generator HP 608-D
Signal Generator HP 606-A
Audio Oscillator HP 200 CD
Alignment tool, Walsco #2541
Two 6-inch clip leads
Resistor, 10K, 1/2W
Various Coaxial Adapters (BNC to N and C)
Adapter BNC to shielded double plug, GR-274-QBJ
Second IF Test Cable, figure 4-3
51-ohm Alignment Fixture, figure 4-4
47-ohm + 2.7-ohm Alignment Fixture, figure 4-5

### General Instructions.

Connect the 200 CD, tuned to 25 cps, to the external FM terminals on the Boonton 202E. Connect a .033 and a .25 meg potentiometer across the external FM terminals on the Boonton. Connect the horizontal input of the oscilloscope across the .25 meg potentiometer. See figure 4-1 for simplified diagram of connections. Connect the Boonton 202E to the Univerter 207E. Use the QBJ adapter and a 4-foot RG-62/U coax as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Solder the 10K resistor to the test point on the second IF test cable and connect the scope input between this resistor and ground on the sidewall of the subchassis next to the feed-thru capacitor (C-742).

> CAUTION: A Model FMD-A6 limiter subchassis must be installed in the receiver before the receiver is turned on.

Alignment Procedure.

1. Set the subchassis on the top edge of the receiver sidewall, dropping the studs through the holes provided. Connect the IF amplifier test cable. Connect the limiter-discriminator input cable to J-702. Short out the AGC line by connecting a short clip lead from feed-thru capacitor C-742 to ground on the subchassis sidewall. If the signal level meter was in approximate adjustment prior to alignment, do not disturb the adjustment of R-732 and R-737. If the signal level meter was not in approximate adjustment, set R-732 and R-737 to the center of their range. Remove the first local oscillator crystal from the Tuning Unit, if one is installed.

2. Connect the 51-ohm alignment fixture (figure 4-4) between the grid (pin 1) of V-704 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-704B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for maximum amplitude. Feed the marker signal as required. Adjust T-705A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped. Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-703 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-703 to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for the same response amplitude as that obtained in step 2. Feed in marker signal as required. Adjust T-704A and B as required to

produce a response curve centered at 10 mc with respect to the 10% down points on the response curve. The response curve should be flat-topped or slightly round nosed. Adjust the output of the Boonton generator for a 10-volt response amplitude. Adjust T-705B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly round nosed. Remove the alignment fixture and clip lead.

4. Connect the 47 + 2.7-ohm alignment fixture (figure 4-5) between the grid (pin 1) of V-702 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-702 to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust T-703A and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be round nosed. Remove the alignment fixture and clip lead.

5. Connect the same alignment fixture between the grid (pin 1) of V-701 and ground on the strap-nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from L-701B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust T-702A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be round-nosed. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output. Connect the same alignment fixture between the grid (pin 1) of V-205 and ground at terminal D of T-204 to the sidewall of the front end subassembly. Connect the univerter. Connect the marker generator between the 4.7-pf capacitor on the alignment fixture and ground on the

sidewall of the front end subassembly. Adjust the output of the Boonton generator for a 10-volt response amplitude and adjust the 200 CD to 5 cps and increase the deviation as required. Feed in marker signal as required. Adjust the L-701 and Z-702 as required to produce a response curve centered at 10 mc with respect to the 3 db down points on the response curve. The response curve should be flat-topped and be 10 kc wide at the 3 db points. Disconnect the sweep and marker generator from the termination.

# MODEL IFA-[illegible] 20-KC IF AMPLIFIER ALIGNMENT PROCEDURE

## Recommended Equipment

VTVM RCA WV 98-B

Oscilloscope HP 120-A

Signal Generator, Boonton 202E

Univerter, Boonton 207E'

Signal Generator HP 608-D

Signal Generator HP 606-A

Audio Oscillator HP 200 CD

Alignment tool, Walsco #2541

Two 6-inch clip leads

Resistor, 10K, 1/2W

Various Coaxial Adapters (BNC to N and C)

Adapter BNC to shielded double plug, GR-274-QBJ

Second IF Test Cable (figure 4-3)

51-ohm Alignment Fixture (figure 4-4)

47-ohm + 2.7-ohm Alignment Fixture (figure 4-5)

## General Instructions.

Connect the 200 CD, tuned to 25 cps, to the external FM terminals on the Boonton 202E. Connect a .033 and a .25 meg potentiometer across the external FM terminals on the Boonton. Connect the horizontal input of the oscilloscope across the .25 meg potentiometer. See figure 4-1 for simplified diagram of connections. Connect the Boonton 202E to the Univerter 207E. Use the QBJ adapter and a 4-foot RG-62/U coax as the oscilloscope vertical input. Set the vertical amplifier of the oscilloscope for direct-coupled operation. Solder the 10K resistor to the test point on the second IF test cable and connect the scope input between this resistor and ground on the sidewall of the subchassis next to the feed-thru capacitor (C-742).

> CAUTION: A Model FMD-A6 limiter subchassis must be installed in the receiver before the receiver is turned on.

Alignment Procedure.

1. Set the subchassis on the top edge of the receiver sidewall, dropping the studs through the holes provided. Connect the IF amplifier test cable. Connect the limiter-discriminator input cable to J-702. Short out the AGC line by connecting a short clip lead from feed-thru capacitor C-742 to ground on the subchassis sidewall. If the signal level meter was in approximate adjustment prior to alignment, do not disturb the adjustment of R-732 and R-737. If the signal level meter was not in approximate adjustment, set R-732 and R-737 to the center of their range. Remove the first local oscillator crystal from the Tuning Unit if one is installed.

2. Connect the 51-ohm alignment fixture (figure 4-4) between the grid (pin 1) of V-704 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator between the capacitor on the alignment fixture and ground on the sidewall of the IF subchassis. Connect a short clip lead from terminal B of T-704B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a maximum amplitude. Feed the marker signal as required. Adjust T-705A and B as required to produce a response curve centered at 10 mc with respect to the 5% down points on the response curve. The response curve should be flat-topped. Remove the alignment fixture and clip lead.

3. Connect the same alignment fixture between the grid (pin 1) of V-703 and ground on the strap nut for this tube. Connect the marker generator. Connect a short clip lead from terminal B of T-703 to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for the same response amplitude as obtained in step 2. Feed in marker signal as required. Adjust T-704A and B as required to produce a

response curve centered at 10 mc with respect to the 10% down points on the response curve. The response curve should be flat-topped or slightly round nosed. Adjust the output of the Boonton generator for a 10-volt response amplitude. Adjust T-705B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly round nosed. Remove the alignment fixture and clip lead.

4. Connect the 47 + 2.7-ohm alignment fixture (figure 4-5) between the grid (pin 1) of V-702 and ground on the strap-nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from terminal B of T-702 to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust T-703A and B as required to produce a response curve centered at 10 mc with respect to the 15% down points on the response curve. The response curve should be round nosed. Remove the alignment fixture and clip lead.

5. Connect the same alignment fixture between the grid (pin 1) of V-701 and ground on the strap nut for this tube. Connect the univerter. Connect the marker generator. Connect a short clip lead from L-701B to ground on the upper sidewall of the subchassis. Adjust the output of the Boonton generator for a 10-volt response amplitude. Feed in marker signal as required. Adjust T-702A and B as required to produce a response curve centered at 10 mc with respect to the 25% down points on the response curve. The response curve should be round nosed. Remove the alignment fixture and clip lead. Install the second IF subchassis bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable. Connect the scope to the AM output. Connect the same alignment fixture between the grid (pin 1) of V-205 and ground at terminal D of T-204 to the sidewall of the front end subassembly. Connect the univerter. Connect the marker generator between the 4.7 pf capacitor on the alignment fixture and ground on the sidewall of the front end subassembly. Adjust the output of the Boonton

generator for a 10-volt response amplitude and adjust the 200 CD to 5 cps and increase the deviation as required. Feed in marker signal as required. Adjust the L-901 and Z-902 as required to produce a response curve centered at 10 mc with respect to the 3 db down points on the response curve. The response curve should be flat-topped and be approximately 20 kc wide at the 3 db points. Disconnect the sweep and marker generator from the termination.

# MODEL TMH-A6 136-MC TUNING UNIT, ALIGNMENT PROCEDURE

## Recommended Equipment

Sweep Generator, RCA WR-59B (Modified)

30-mc amplifier

Signal Generator, Hewlett-Packard 608-D

Oscilloscope, Hewlett-Packard 120-A

Frequency Counter, Hewlett-Packard 524-C

Noise Meter, Hewlett-Packard H 18-340-C

VTVM, RCA WR-98

## Second Local Oscillator Alignment.

Connect the VTVM to TP-202 and set the VTVM to read a negative voltage on the 1.5-volt range. Adjust L-225 for maximum output on the VTVM.

## First IF Alignment.

Connect the sweep generator (terminated in 91-ohms) through a 1000 pf capacitor to pin 1 of the first mixer V-203. Connect the ground lead to the partitition wall. Remove the second local oscillator crystal. Connect the 30-mc test amplifier 50-ohm input to the receiver TDU output J-104 using RG-55A/U cable. (The 30-mc test amplifier should be checked for flatness of response at 2-volt peak-to-peak output just prior to use). Connect a signal generator to the marker input on the test amplifier. Connect the oscilloscope to the detector output on the test amplifier. The IF Gain Control should be in the manual position at maximum gain. Adjust T-201 and T-202 for a symmetrical response about the ± 500 kc points, maintaining a two-volt peak-to-peak response on the oscilloscope. Connett the 91-ohm input of the test amplifier to J-114, second mixer output, using RG-62/U cable approximately 18 inches long. Adjust T-203 and T-204 for a symmetrical response at the ± 500 kc points maintaining a two-volt peak-to-peak response.

Oscillator and Multiplier Section Alignment.

Connect a VTVM to TP-203, set the VTVM to read a negative voltage on the 15-volt range, and plug in a crystal. Adjust L-212 for maximum output on the VTVM. Adjust L-215 for maximum output on the 50-volt range of the VTVM. Connect the VTVM to TP-201 and set the VTVM to the 1.5-volt range. Adjust L-216 for maximum output on the VTVM. Connect the counter to the local oscillator output on the receiver J-102 and set the counter to approximately 166 mc, depending on the crystal frequency. Set the vernier tuning control C-243 to the center of its range. Adjust L-213 and L-214 to obtain a ± 5 kc or greater shift in the local oscillator output frequency when C-243 is rotated ± 90 degrees. When L-213 and L-214 are properly adjusted, the change in frequency of the local oscillator will be on the order of ± 7 or 8 kc.

RF Amplifier Alignment.

Connect the oscilloscope to TP-201. Connect the sweep generator to the antenna input J-101 and set the sweep generator to approximately 136 mc. Connect the marker generator. Adjust L-205 and L-206 for maximum response amplitude on the oscilloscope maintaining a 100-mv peak-to-peak amplitude. Adjust C-203 for maximum amplitude. The coupling between L-205 and L-206 is controlled by C-215. Adjust C-215 and readjust L-205 and L-206 to obtain a symmetrical response and to have a 3-mc bandwidth ± 10% at the 3 db points.

Noise Figure Measurement.

With the IFA-C6 (300-kc) IF amplifier installed in the receiver, connect IF output to the Hewlett-Packard Noise Meter, 10-mc IF input. Connect the noise diode to the antenna input jack J-101. Set the receiver IF Gain Control to the manual position with maximum gain. Adjust L-202 and C-203 for the best noise figure.

## OVERALL RECEIVER CHECKS

Make sure the proper IF amplifier is installed and connected, and the FMD-A6 demodulator is in place. Connect a 100-ohm load to the video output jack J-112.

Recommended Equipment.

Hewlett-Packard 400-D AC VTVM

Hewlett-Packard 608-A Signal Generator

Boonton 202F Signal Generator

RCA VTVM WV-98

Tuning Meter Zero.

Check the tuning meter zero by disconnecting the input cable to the FM demodulator. Press S-105 and adjust R-127 for zero indication.

Discriminator Balance.

Connect the input cable from the FM demodulator to J-502. Connect a signal generator, tuned to 10-mc, to P-501, the input to the second IF amplifier. Feed in approximately a 200-millivolt signal and adjust R-627 for zero on the tuning meter.

Signal Level Meter.

The signal level meter should indicate -105 dbm with 1.3 microvolt input, and -15 dbm with 40 millivolts input signal. If the meter does not indicate correctly, adjust R-532 to make the meter read -105 dbm with the 1.3 microvolt input and -15 dbm with 40 millivolts input. These two adjustments interact and the meter should be rechecked at both ends of the scale.

Deviation Meter.

Feed in an FM signal of 1 millivolt with 24 kc deviation at 1 kc. The IF Gain Control should be in the AGC position, the video cutoff switch in the 10 cps position, and the deviation range switch in the 25 kc position. Set R-138 for 24 kc reading on the deviation meter. Switch the deviation range switch to the 75 kc position and the meter should read approximately 24 kc deviation.

FM Hum Bucking.

Connect the 400-D to the 100-ohm resistor on the video output jack, J-112. Rotate the video level control to the maximum clockwise position. Feed in an FM signal of 1 millivolt with 24 kc deviation at 1 kc and observe the indication on the 400D. Remove the FM modulation and adjust R-625, on the FM demodulator, for a null as indicated on the 400-D.

AM Hum Bucking.

Set the signal generator to AM 50% modulation at 1 kc. Set the deviation range switch to the AM position and with 1-millivolt input adjust R-113 for minimum output as indicated on the 400-D.

FM Output Stability.

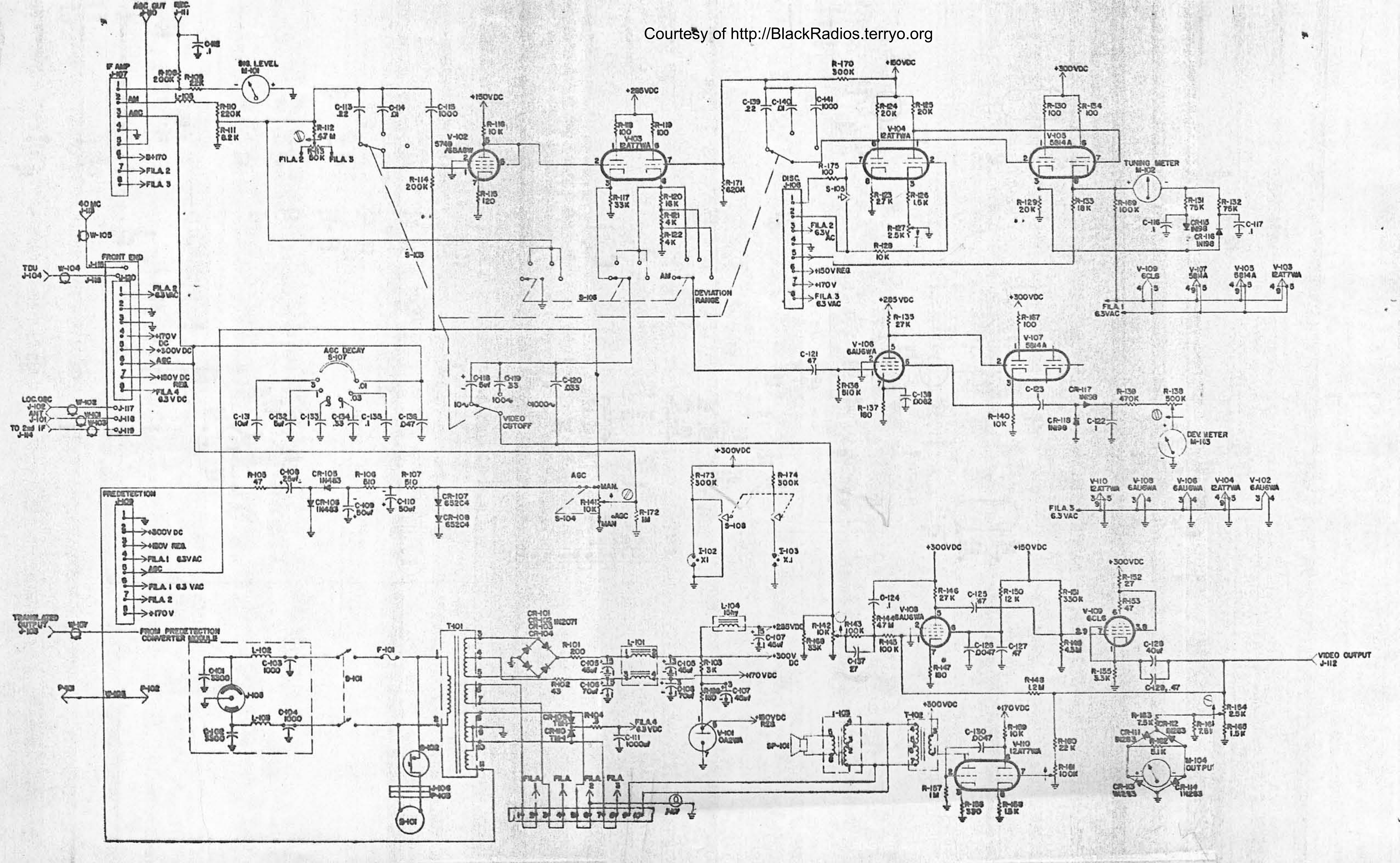
Connect the 400-D to the 100-ohm load on J-112, the video output jack. Set the signal generator to 24 kc deviation at 1 kc and 1 millivolt input. Set the deviation range switch to the 25 kc position. Set the video level control to read zero db on the 1-volt range of the 400-D. Vary the input signal between 1 microvolt and 40 millivolts and observe the change in db on the 400-D.

AM Output Stability.

Set the signal generator to AM 50% modulation at 1 kc and 1 millivolt input. Set the deviation range switch to the AM position. Set the video level control to read zero db on the 1-volt range of the 400-D. Vary the input between 1 microvolt and 40 millivolts and observe the total change in db on the 400-D.

The Model TMR-6 Telemetry Receiver is designed to give trouble-free performance with a minimum of field maintenance. High-quality components are used throughout with emphasis placed on operation well within ratings. All meters, transformers, and filter chokes are hermetically sealed.

Familiarity with the theory of operation and the schematic diagrams in the back of this book is invaluable in successful troubleshooting. If the receiver operates improperly, experience has shown that a tube is often at fault. Visual inspection may give some clue to the difficulty in the form of a burned or broken resistor, short or open wiring circuit, damaged component, etc. Table 4-1 is a voltage chart that gives the approximate voltage at all tube socket pins during proper operation of the receiver. Any significant deviation from these figures should point to the source of trouble.




NOTE:

UNLESS OTHERWISE NOTED:

CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS.

CAPACITOR VALUES GREATER THAN ONE ARE IN MICROMICROFARADS.

INDUCTANCE VALUES ARE IN MICROHENRYS

RESISTOR VALUES ARE IN OHMS, K=1000, M=1,000,000

INTERNAL ADJUSTMENT

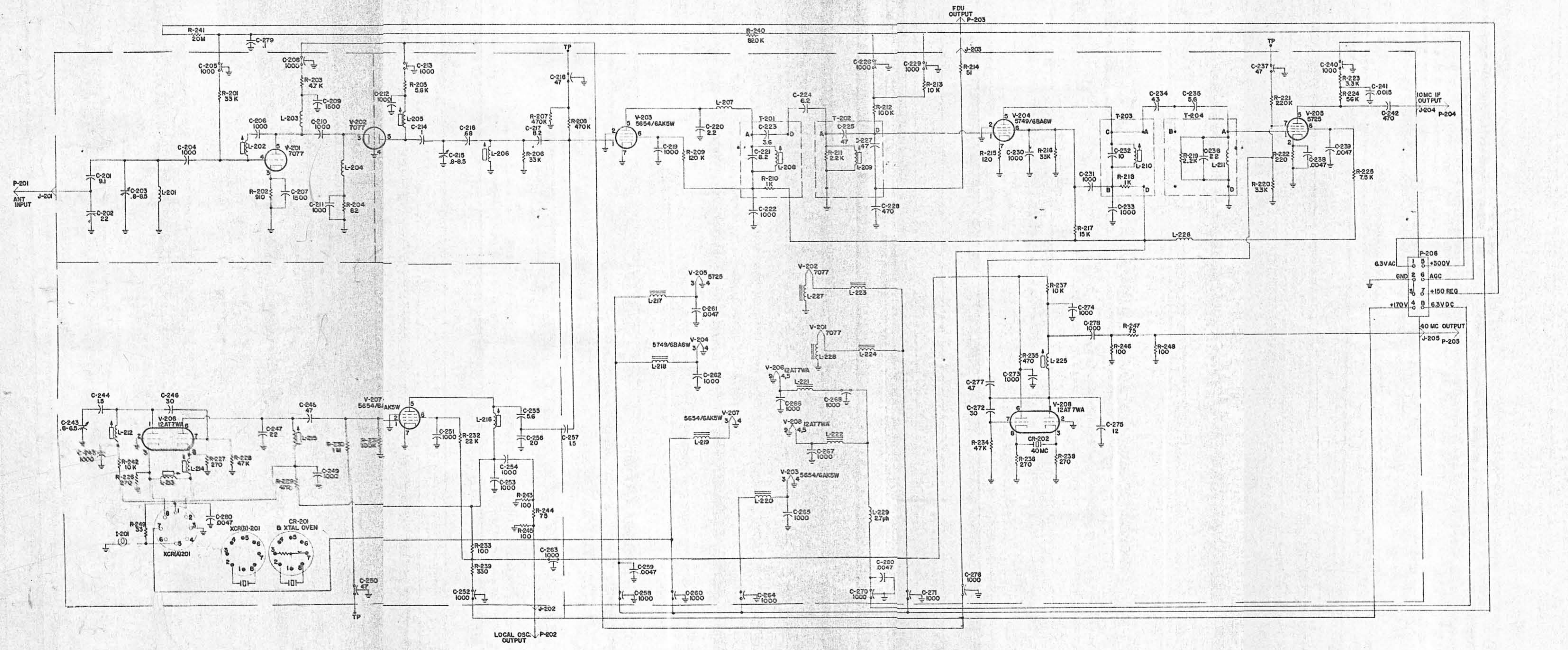
OPERATING CONTROL

LOCKED ADJUSTMENT AVAILABLE ON FRONT PANEL.

ARROW DENOTES CLOCKWISE ROTATION.

Model TMR-6 Telemetry Receiver, Schem

R-11-258
Series M



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Model TMH-A6 136-Mc Tuning Unit, Schematic Diagram

R-11-238
Series G


NOTE:
UNLESS OTHERWISE NOTED:
CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS.
CAPACITOR VALUES GREATER THAN ONE ARE IN MICROMICROFARADS.
INDUCTANCE VALUES ARE IN MICROHENRYS.
RESISTOR VALUES ARE IN OHMS, K=1000, M=1,000,000
INTERNAL ADJUSTMENT
ARROW DENOTES CLOCKWISE ROTATION

MODEL IFA-L6 20KC IF STRIP

R-11-578

Model IFA-L6 20KC IF Strip, Schematic Diagram

R-11-578