

Model TMR-2A Series Telemetry Receivers Instruction Book



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Defense Electronics, Inc.

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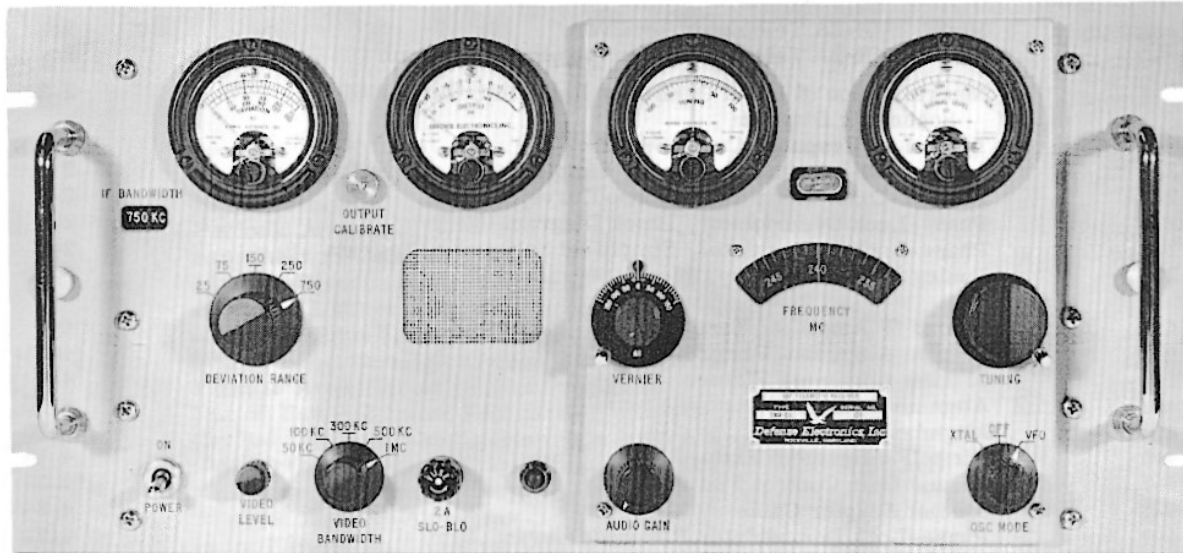
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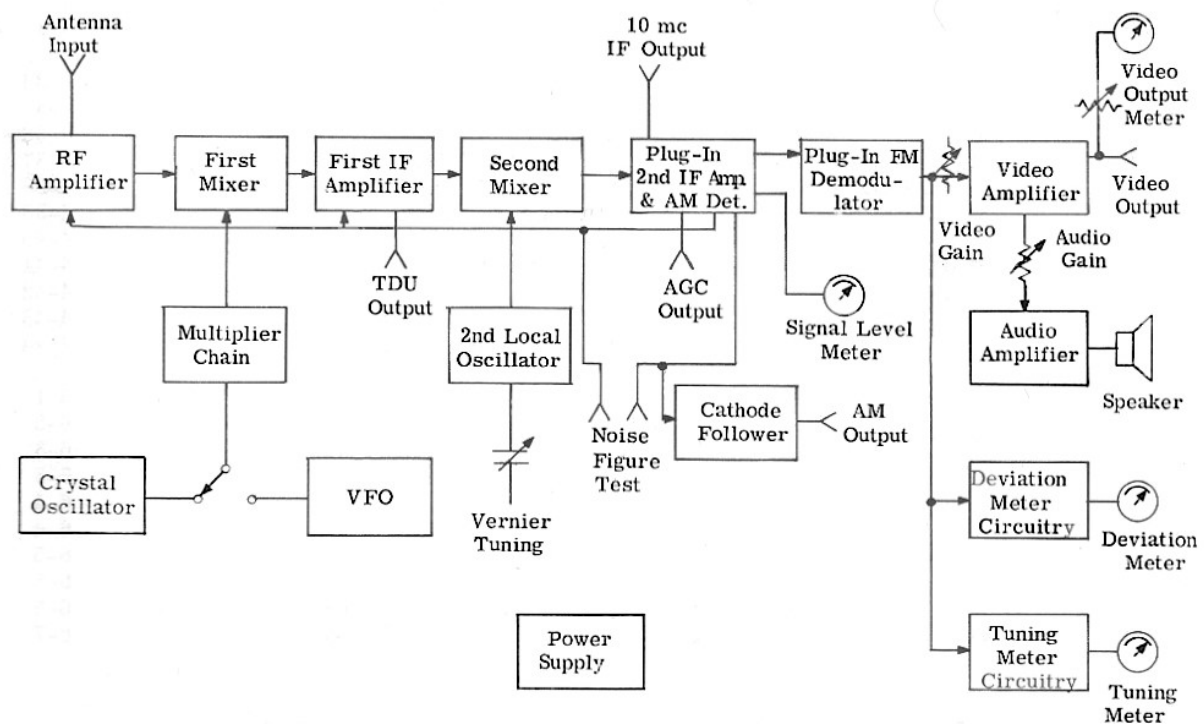
Schematic Diagrams of the Model IFA-D2 500-kc IF Amplifier, and the Model FMD-A2 Limiter-Discriminator, are included in figures 6-1 and 6-2.

Table 1-2 (cont'd)

MODEL TMR-2A SERIES RECEIVERS, TUBE COMPLEMENT		
Symbol	Tube Type	Function
2nd IF Amplifier Subchassis (Typical)		
V-701	5749/6BA6W	1st IF Amplifier
V-702	5749/6BA6W	2nd IF Amplifier
V-703	5749/6BA6W	3rd IF Amplifier
V-704	6AH6 (or 6AU6WA)	4th IF Amplifier
V-705	5726/6AL5W	AM and AGC Detector
Limiter-Discriminator Subchassis		
V-601	6BN6	First Limiter
V-602	6BN6	Second Limiter
V-603	6BN6	Second Limiter
V-604	5726/6AL5W	Discriminator
Phase-Lock Demodulator Subchassis		
V-1101	6BN6	Limiter
V-1102	5726/6AL5W	Phase Detector
V-1103	6AU6WA	Oscillator
V-1104	6CB6	Reactance Tube
Predetection Amplifier Subchassis		
V-1701	5749/6BA6W	IF Amplifier
V-1702	5749/6BA6W	IF Amplifier
V-1703	6AH6	IF Amplifier
V-1704	5726/6AL5W	AGC Detector



Model TMR-2A Telemetry Receiver



Model TMR-2A series Telemetry Receivers, Block Diagram

SECTION I GENERAL DESCRIPTION

The Model TMR-2A Series Telemetry Receiver is a double-superheterodyne designed specifically for use in FM/FM, PDM/FM, and PCM/FM telemetry systems. Noise figures of less than 8 db are obtained over the entire tuning range of 215-265 megacycles. A front panel switch allows the operator to use the receiver in either crystal-controlled or continuously tunable modes of operation. In the crystal position, the tuning dial is set to frequency and a crystal plugged into the front panel socket. In VFO operation, the receiver is tuned by using the main tuning dial. In either mode of operation a vernier frequency adjustment is provided to compensate for transmitter frequency inaccuracies or drift when the receiver is crystal controlled.

NOTE:

The Model TMR-2A Series consists of the TMR-2A and the TMR-2A(1). The only difference between the two models is in the type and frequency of the quartz crystal used in single-frequency reception, and in the frequency multiplier chain used with a particular crystal. The receivers are identical in all other respects.

IF bandwidths of 100, 200, 300, 500, and 750 kc, and 1.0 and 1.5 mc, are provided in the form of separate plug-in module subchassis which can be quickly interchanged. The TMR-2A Series Receiver is 19 inches wide for standard relay rack mounting, 8-3/4 inches high, 17-1/4 inches deep, and weighs approximately 50 pounds.

Electrical specifications, tube complements, and block diagram will be found on the following pages.

Table 1-1

TMR-2A SERIES RECEIVERS, ELECTRICAL SPECIFICATIONS

Frequency Range	215 to 265 megacycles continuously tunable or crystal controlled.
TMR-2A Crystal	MIL CR-23/U or CR-52/U, no oven.
TMR-2A(1) Crystal	MIL CR-33/U, no oven.
Receiver Stability	crystal controlled - 0.005% continuously tunable -- approx. 0.001%/C°.
Vernier Tuning	± 150 kilocycles
Type Receiver	double superheterodyne; 30 mc first IF; 10 mc second IF.
Input Impedance	50 ohms, nominal
Noise Figure	less than 8 db
Image Rejection	greater than 60 db
IF Rejection	greater than 80 db
Spurious Responses	more than 60 db below fundamental frequency response.

IF Bandwidth		plug-in IF amplifiers for bandwidths of 100, 200, 300, 500, and 750 kc, and 1.0 and 1.5 mc
Selectivity		60 to 6 db bandwidth ratio of approximately 2.5
Bandwidth Response		symmetrical (to 3 db points) within $\pm 5\%$
FM Characteristics:		
Discriminator		better than 1% linearity over a bandwidth of ± 500 kc; better than 5% linearity over a bandwidth of ± 750 kc
Video Output		0.08 volts/kc deviation, 20 volts peak-to-peak maximum
Level Adjustment		front panel control
Output Load		as low as 600 ohms shunted by 1800 pf
Source Impedance		less than 50 ohms
Frequency Response		within 3 db from 5 cps to 1 mc
Video Bandwidth		low pass filter - 50 kc, 100 kc, 300 kc, 500 kc, and 1 mc positions
AM Rejection		50% AM reference carrier deviation ± 100 kc 400 cps to 10 kc greater than 50 db 10 kc to 30 kc greater than 35 db 30 kc to 80 kc greater than 25 db
AM Characteristics:		
Output		10 uv input (50% modulation) - approximately 1 volt rms; 10 mv input (50% modulation) - approximately 2.5 volts rms.
Frequency Response		150 cps to 150 kc (within 3 db)
Output Load		as low as 10K ohms shunted by 500 pf
Metering:		
Tuning Meter		indicates proper tuning on conventional telemetry signals (FM/FM, PDM/FM, PCM/FM, FM/AM, etc.)
Signal Strength Meter		approximate indication of signal level
Frequency Deviation Meter		25, 75, 150, 250 and 750 kc full scale. Frequency response 400 cps to 500 kc
Output Meter		VU meter with adjustable reference
Aural Monitoring		Built in audio amplifier, gain control and speaker
Miscellaneous Outputs		Display Unit (DEI Type TDU-2), signal strength recording (cathode follower output)
Power Input		115 V 60 CPS 200 Watts

Table 1-2

MODEL TMR-2A SERIES RECEIVERS - TUBE COMPLEMENT			
Symbol	Tube Type	Function - TMR-2A	Function - TMR-2A(1)
V-101	5726/6AL5W	Voltage Doubler	Voltage Doubler
V-102	OA2WA	Voltage Regulator	Voltage Regulator
V-103	12AT7WA	Audio Amplifier	Audio Amplifier
V-104	12AT7WA	Video Amplifier	Video Amplifier
V-105	5814A	Tuning Meter Amplifier	Tuning Meter Amplifier
V-106	12AT7WA	AGC Amplifier	AGC Amplifier
V-107	6AU6	2nd Video Amplifier	2nd Video Amplifier
V-108	6CL6	Video Output Amplifier	Video Output Amplifier
V-109	6CL6	Video Output Amplifier	Video Output Amplifier
V-110	6AU6	Deviation Meter Amplifier	Deviation Meter Amplifier
V-111	5814A	2nd Deviation Meter Amplifier	2nd Deviation Meter Amplifier
V-201	5842/417A	1st RF Amplifier	1st RF Amplifier
V-202	5842/417A	2nd RF Amplifier	2nd RF Amplifier
V-203	5654/6AK5W	1st Mixer	1st Mixer
V-204	6AU6WA	1st Oscillator, Tunable	1st Oscillator, Tunable
V-205	6AH6	Frequency Tripler	Crystal Oscillator - Tripler
V-206	5654/6AK5W	Frequency Doubler	Frequency Doubler
V-207	5654/6AK5W	Frequency Doubler	Frequency Doubler
V-208	5749/6BA6W	30 mc IF Amplifier	30 mc IF Amplifier
V-209	5725	2nd Mixer	2nd Mixer
V-210	6AU6WA	2nd Local Oscillator	2nd Local Oscillator
V-1401	6BZ7	Crystal Oscillator	Not Used

SECTION II THEORY OF OPERATION

The Model TMR-2A is a double-superheterodyne receiver tuning the frequency range of 215-265 mc. Frequency selection is made by either a tunable oscillator or a fixed crystal oscillator as the source of the first local oscillator signal. IF amplifiers of various bandwidths are supplied in plug-in modular subchassis, and may be changed in a few minutes. Similarly, FM demodulation subchassis are supplied offering a demodulation choice of either phase-lock detection or the limiter-discriminator demodulation. Although primarily designed for the reception of any type of FM telemetry signal, an AM detector is also included in the TMR-2A. AM output is separately available at an output connector on the rear apron of the chassis.

RF Amplifier. Mallory UHF inductuners are used as tuning elements for the RF amplifier and the local oscillator-multiplier chain. A three section inductuner tunes the RF amplifier, and four section unit tunes the local oscillator and multiplier stages.

The RF amplifier is a cascode using a pair of 5842/417A low-noise, high G_m triode tubes. The cascode amplifier 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 tube. An additional advantage of the cascode is that it can be easily gain-controlled. Selectivity ahead of the first tube is particularly important because of the attenuation it provides to undesired signals outside the band. Gain control of the first stage is important because it 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 of the cascode is double-tuned. The combination of the single-tuned circuit and the double-tuned output circuit produce a response that is greater than 60 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 high enough to eliminate noise figure considerations.

First Mixer. A type 5654/6AK5W sharp cutoff pentode is used as the first mixer, V-203. Signal and injection frequency ($f + 30$ mc) voltages are both applied to the control grid. A test point is provided here to monitor the injection frequency and to facilitate alignment of the RF amplifier. An over-coupled double-tuned output circuit, T-201A and B, in the plate of the mixer couples the signal to the first (30 mc) IF amplifier. An output for display purposes is taken from a capacitance voltage divider in the secondary of the coupling circuit.

When a receiver such as the TMR-2A is operated in conjunction with an efficient antenna system, undesirable radiation is liable to occur at the oscillator frequency due to the oscillator voltage at the grid of the mixer. This voltage reaches the antenna through mixer input circuitry and the inter-electrode capacitances in the RF amplifier tubes, and is especially serious because of the possibility of interference between receivers operating in close proximity to one another. In the TMR-2A receiver, a printed circuit capacitor of special manufacture, C-299A and B, is so placed in the circuit as to apply to the output of V-202 a voltage which is equal in amplitude but opposite in phase to that reaching the same point from the grid of the mixer. See figure 2-1. Thus the possibility of spurious radiation from this source is reduced to a minimum.

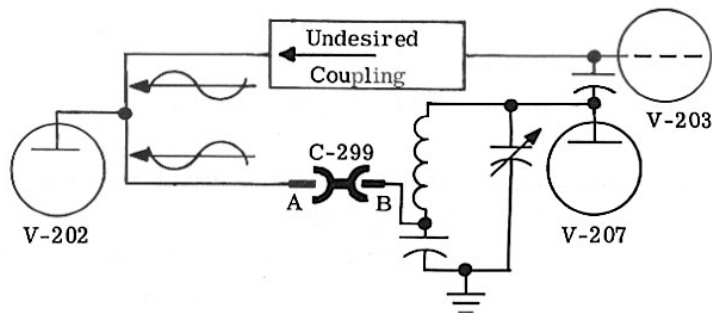


Figure 2-1. Neutralization of Local Oscillator Radiation, Simplified Schematic Diagram

Variable Frequency Oscillator. The VFO is a type 6AU6WA sharp-cutoff pentode, V-204, in a modified Colpitts circuit. The Colpitts was selected for this application because of its adaptability to inductance tuning, and its inherent stability. The circuit oscillates at one-fourth the injection frequency.

Crystal Oscillator-Multiplier Chain, Model TMR-2A Receiver. A type 6BZ7 medium-mu dual triode, V-1401, is used in a Butler oscillator circuit in conjunction with a type CR-23/U or CR-52/U series-mode quartz crystal. Oscillator output at $1/6$ the injection frequency is fed to the multiplier chain.

The Butler circuit consists of a cathode follower and a grounded-grid amplifier connected in a feedback circuit. Feedback is achieved by feeding output from the cathode-follower stage through the crystal to the cathode input of the grounded-grid stage. The crystal is thus connected directly between the two cathodes and operates in series with the feedback voltage, presenting high impedance except at the crystal frequency. The circuit is completed by coupling output from the plate of the grounded-grid stage to the grid of the cathode-follower. The plate loads are tuned to the fundamental crystal frequency, and are broadband circuits so that crystals between 40 and 50 mc will oscillate freely without circuit adjustment.

To avoid stray capacitances due to long leads, the oscillator subchassis is mounted on the rear of the front panel directly adjacent to the crystal socket.

RF output is taken from the plate of the cathode follower and fed to the grid of V-205.

Since the crystal oscillator operates at $1/6$ the injection frequency and the VFO operates at $1/4$ the injection frequency, different multiplier stages become necessary for conversion of the oscillator signal to the final injection frequency.

V-205, a type 6AH6 sharp-cutoff pentode, is used as a tripler following the crystal oscillator; V-206, a type 5654/6AK5W sharp-cutoff pentode, acts as a doubler following the VFO. Output of both multipliers is at $1/2$ the injection frequency, and is fed to the final doubler, V-207, also a type 5654/6AK5W. Output from the final doubler is applied to the mixer grid through C-222.

Selection of either oscillator-multiplier combination is made by the OSC MODE switch, S-103, on the front panel of the receiver. When in the XTAL position, S-103 applies B+ voltage to the plates of the crystal oscillator, V-1401, and the screen grid of the tripler, V-205. When in the VFO position,

S-103 applies B+ voltage to the screen grids of the VFO, V-204, and its doubler, V-206. The coupling capacitor, C-249, is connected to the outputs of both multipliers; the inactivated system remains in the circuit but has no effect.

Crystal Oscillator-Multiplier Chain, Model TMR-2A(1) Receiver. A type 6AH6 pentode, V-205, is used as the crystal oscillator in conjunction with a standard MIL type CR-33/U parallel-mode crystal. C-227 is adjusted to provide the 32-pf load capacity specified for this type of crystal. The circuit is an electron-coupled Colpitts oscillating at 1/12 the injection frequency, with output taken at the third harmonic of the crystal frequency. V-206 and V-207 are doublers, with the plate circuit of each tuned by a section of the inductuner.

Selection of either oscillator is made by the OSC MODE switch, S-103, on the front panel of the receiver. When in the XTAL position, S-103 removes the screen grid voltage from V-204. When in the VFO position, S-103 removes the screen grid voltage from the crystal oscillator, V-205. Since the plate circuits of the VFO and the crystal oscillator operate at the same frequency for any given signal frequency, they are connected in parallel and tuned by a single inductuner section.

First (30 mc) IF Amplifier. A type 5749/6BA6W remote-cutoff pentode, V-208, is used as the first IF amplifier. This stage has the response shape of two slightly over-coupled double-tuned circuits (peak to valley ratio approximately 1.03) and is centered at 30 mc. The transformers are capacitively coupled using "top" or high impedance coupling. With this configuration, the primary is in one can and the secondary in another can with coupling in the form of a capacitive "tee" using the capacity-to-ground of one of the transformer terminals as the shunt element.

The amplifier is nominally 1.8 mc wide across the top of the response so that the first IF amplifier will not affect the bandwidth of the receiver (as determined by the second IF amplifier) with any combination of second local oscillator tuning and second IF amplifier bandwidth.

AGC is applied to V-208. 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. A type 5725 sharp-cutoff pentode is used as the second mixer, V-209. This stage heterodynes the 30-mc output of the first RF amplifier with the 40-mc output of the second local oscillator to yield a resultant IF of 10 mc. The 30-mc signal is applied to grid number one which is biased for class A operation; the oscillator signal is applied to grid number three which develops self-bias. An additional input at the cathode permits introduction of an external 10-mc signal for playback purposes.

The double-tuned, over-coupled, series-capacitance coupling circuit in the output of the second mixer is actually located on the 10-mc IF subchassis which follows it.

Second Local Oscillator. The second local oscillator is an electron-coupled, Hartley-type with output taken at the fundamental frequency. The VERNIER tuning control of the receiver (C-131) tunes this oscillator plus or minus 150 kc around its normal operating frequency of 40 mc.

The oscillator coil, L-237, is a metalized glass inductance chosen for its low-temperature coefficient. The oscillator frequency is set by a powdered-iron core having a tuning range of approximately $\pm 1\%$.

The plate circuit has a high C to L ratio to minimize harmonic output and the circuit design is such that plate-circuit tuning has a minimum effect on oscillator frequency. The plate circuit is tuned

by L-234 for an indication of maximum injection at the mixer test point C-275.

Second (10 mc) Intermediate Frequency Amplifier. Seven different IF amplifiers are available for use with the TMR-2A series receivers to satisfy varying bandwidth requirements. The bandwidth of each model is listed in table 2-1.

Table 2-1
IF Amplifier Bandwidths

Model	Bandwidth
IFA-A2	100 kc
IFA-B2	200 kc
IFA-C2	300 kc
IFA-D2	500 kc
IFA-E2	750 kc
IFA-F2	1 mc
IFA-G2	1.5 mc

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. The typical response for each amplifier is shown in figure 2-2.

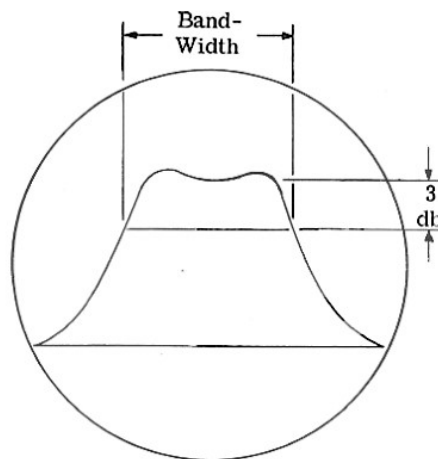


Figure 2-2. Typical IF Response Curve Shape.

AGC is applied to the first three stages. The output stage drives an AM detector, and 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, the major differences being 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.

B plus, 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-432 and R-437 are adjusted to set up the signal level meter for the 500 kc bandwidth amplifier. Corresponding adjustments are provided for each IF strip.

10 MC Predetection Amplifier. The Model PDA-A2 Predetection Amplifier is designed to boost the normal 10 mc output of the IF amplifier to a nominal 1.0 volt for external use. It is a plug-in subassembly employing three stages of RF (10 mc) amplification and an AGC detector. A complete schematic diagram of the circuitry is shown in section 6.

The response of the first stage, V-1701, a type 5749/6BA6W pentode, is that of an over-coupled double-tuned circuit. The second stage, V-1702, also a type 5749/6BA6W pentode, has the response of a critically coupled double-tuned circuit. The third stage, V-1703, a type 6AH6 pentode, has the response of a single-tuned circuit. The overall result is a response containing three peaks with a peak-to-valley ratio of approximately 5%, and a bandwidth of 1.5 mc at the 95% points. Thus the curve of the output signal is largely that of the IF amplifier in use.

An AGC detector, V-1704, a type 5726/6AL5W dual-diode, furnishes AGC voltage to the first and second stages. The AGC characteristics are designed to furnish a nominal 1-volt output with inputs between 30 and 300 millivolts. R-1723 is used to control the AGC delay voltage, and is normally set to provide a 1-volt output with 30 mv input.

When installed in the TMR-2A Receiver, the Predetection Amplifier is mounted on the side wall opposite the IF amplifier. The input cable, W-1701, (with the male connector, P-1702), is connected to J-303 (J-703, J-1003, etc.) on the IF amplifier subchassis, which formerly connected to the cable W-103. The output cable, W-1702, (with the female connector, J-1701) connects to cable W-103. The 1-volt 10 mc output is then available at J-111, the 10 MC IF OUT receptacle on the rear apron of the receiver.

Demodulator: Limiter-Discriminator. This demodulator is made in the form of a plug-in module sub-assembly 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 2.45 mc 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 2.45 mc between the points of 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 both 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 limiter-discriminator circuit is shown in figure 2-3.

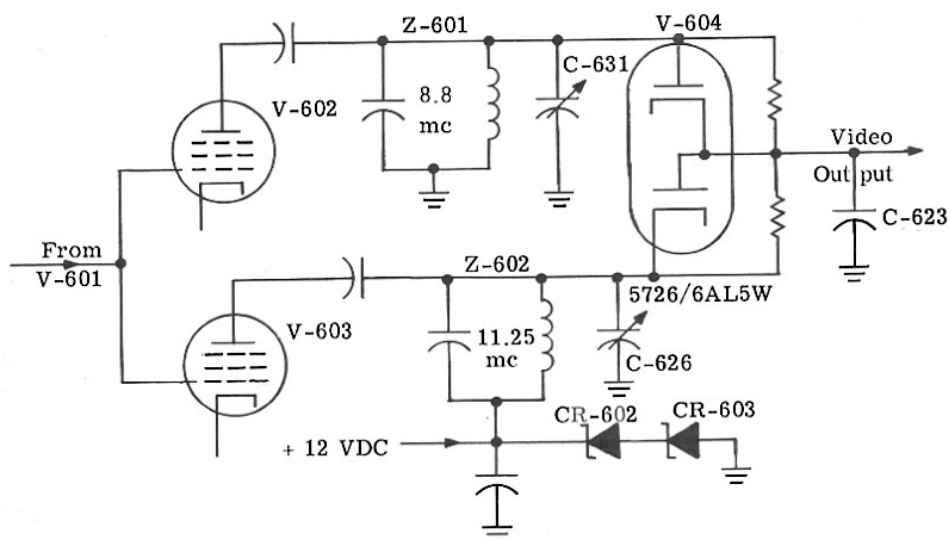


Figure 2-3. Limiter-Discriminator Circuit, Simplified Schematic Diagram.

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.

A typical response curve is shown in figure 2-4. Since the frequency deviation of any particular

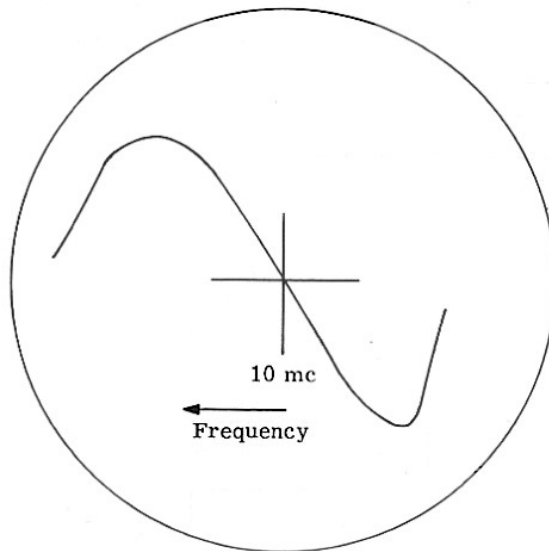


Figure 2-4. Limiter-Discriminator Response Curve, Typical.

FM signal used in this system will never be greater than ± 0.75 mc, it can be seen that the peaks will always fall outside the bandpass of the receiver.

The straight-line (linear) slope between the two peaks is the useful portion of the curve. When an unmodulated signal is tuned on center, there is no output from the discriminator. An amplitude-modulated signal will have the modulation suppressed by the limiters, and there will still be no output from the discriminator. It can also be seen that a severely mistuned signal will result in a distorted output from the discriminator.

The TUNING METER on the front panel of the receiver permits precise tuning of the receiver to a signal. A balance control, R-627, on each limiter-discriminator subchassis, is used to calibrate the TUNING METER so that when a signal is tuned exactly to the center frequency of the discriminator circuitry, the meter will read exactly (center) zero. CR-601 is a crystal detector used for alignment purposes only, and has no effect on the operation of the circuit.

Because of magnetic coupling effects within the 6BN6 limiter tubes, a certain amount of 60-cycle hum is generated which is present at the discriminator output. A small amount of AC voltage from a filament winding on the power transformer is introduced in opposite phase at the discriminator output, and is precisely controlled by the hum balance control R-625, to reduce the hum to a minimum.

Video output is taken from the discriminator and applied to the first video amplifier, V-104A, through pin 1 of P-601.

Demodulator: Phase-Lock. Phase-Lock demodulation provides an attractive means of detecting a small signal in noise. The unit available for use with Model TMR-2A series Receivers, 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 subchassis, and consists of a limiter, a phase-detector, a reactance tube, and a voltage-controlled oscillator. A block diagram of the circuit is shown in figure 2-5.

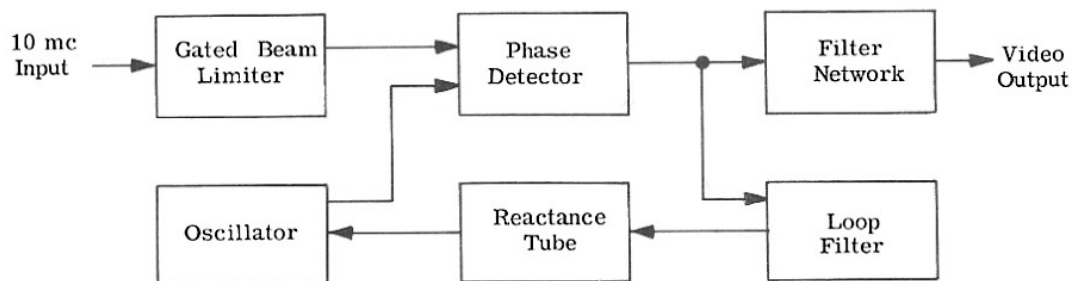


Figure 2-5. Phase-Lock Demodulator, Block Diagram.

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 limiter-discriminator 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 2-6. 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 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 and CR-1102 provide + 6 and + 12 bias voltages. The phase detector is biased at + 6

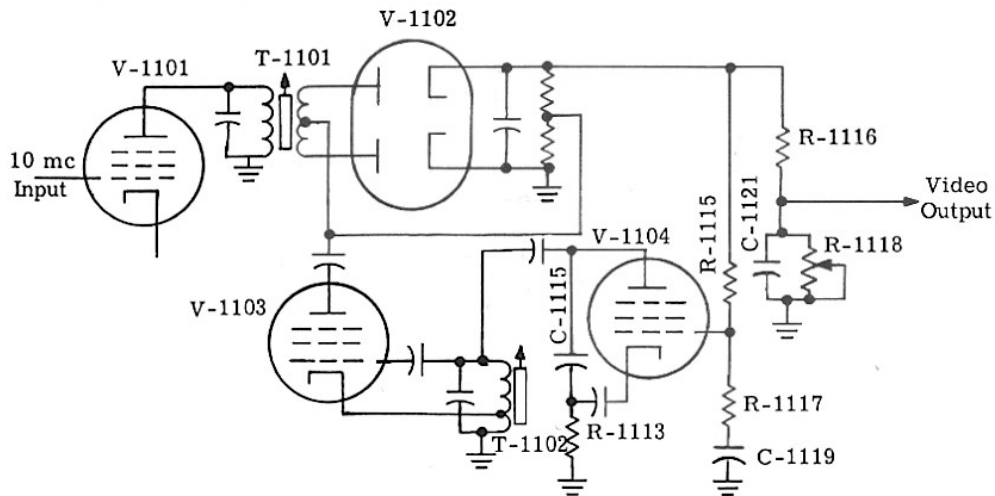


Figure 2-6. Phase-Lock Demodulator, Simplified Schematic Diagram.

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.

Tuning Meter. The tuning meter circuit is designed to operate on CW, FM/FM, PDM/FM, or PCM signals, and is essentially independent of pulse width for PDM/FM signals or of pulse coding for PCM signals. The TUNING METER will indicate zero when the signal is properly centered in the IF pass band. A block diagram of the tuning meter circuitry is shown in figure 2-7. Since amplification of DC voltages is involved here, balanced amplifiers must be used to offset the effects of drift due to voltage variations, temperature changes, etc. V-104, a type 12AT7WA dual-triode, is such a balanced amplifier, with the video signal voltage (+ 6 VDC with the video signal superimposed) applied to the grid of the first triode, and a reference DC voltage applied to the opposite grid. The reference

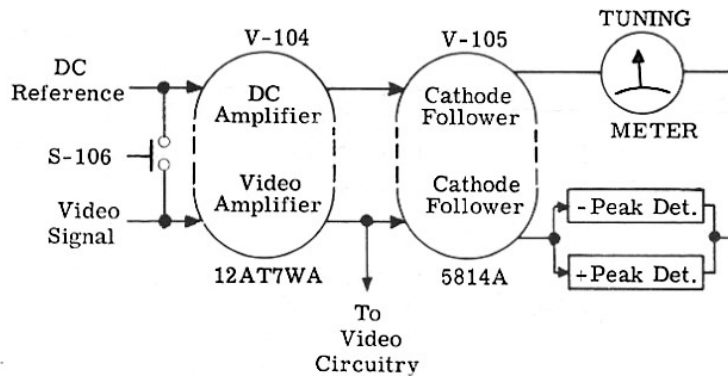


Figure 2-7. Tuning Meter Circuitry, Block Diagram.

voltage is obtained from the DISC BAL control on the demodulator subchassis, which acts as a voltage divider in the + 12 VDC discriminator bias circuit. Since B+ voltage is the same at both plates and cathode resistance values are equalized, it follows that the current through each cathode resistor is a function solely of the grid voltage. Thus any variation in plate voltage, temperature, or other extraneous factors will act equally upon both triodes, and any difference between the voltages at their cathodes will reflect a difference only in the voltages applied to their grids.

DC output is applied from the plates of V-104 to the grids of V-105, balanced cathode followers. The voltage difference between cathodes is applied to the TUNING METER through the peak detectors in the following manner:

When a video signal is present at the signal cathode of V-105, C-112 is charged through CR-105 to the peak negative signal voltage, and C-113 is charged through CR-106 to the peak positive signal voltage. As a result, there is a current flow from the reference cathode through the tuning meter and R-123 toward C-113, and there is a current flow from C-112 through R-122 and the tuning meter (in the opposite direction) toward the reference cathode. If the received signal is correctly centered in the IF pass band, the deviation is symmetrical about the center frequency of the discriminator, and the voltages on C-112 and C-113 are equal and opposite. The net current through the tuning meter therefore is zero, which is indicative of proper tuning.

S-106 is a miniature pushbutton switch located on the main chassis of the receiver. When S-106 is pushed, the DC reference voltage is applied simultaneously to the signal grid of V-104. R-114 is then adjusted for zero indication on the TUNING meter.

R-627, the discriminator calibration control on the subchassis is used to equate the reference voltage (for the reference grid of V-104) to the DC bias voltage at the output of the discriminator at 10 mc.

The signal triode of V-104 is also used as the first video amplifier. The video signal from the discriminator passes to the grid of V-104 through the first section of S-104, the VIDEO BANDWIDTH switch, which selects one position of the video bandwidth filter. This is a low-pass filter in two sections; each section is a single R-C combination which determines the upper limit of the video response curve. Output from the plate of V-104 passes through the second section of S-104 and the

filter to the grid of V-106A, a cathode-follower stage. The combined effect of the input and output sections of the filter is to determine the point on the video curve where the response is 3 db down; the asymptotic slope of the response curve is 12 db per octave.

Video Amplifier. The video amplifier circuit consists of the first video stage described in the preceding paragraph, a cathode-follower, a pentode amplifier stage, and the video output amplifier. Output is taken from the cathode of V-106A and introduced to the VIDEO LEVEL control and to the DEVIATION RANGE switch. The arm of the VIDEO LEVEL control is coupled to the grid of V-107, a type 6AU6 sharp-cutoff pentode. Output is capacitively coupled from the plate of V-107 to the grids of V-108 and V-109, two type 6CL6 power amplifier pentodes connected in a parallel cathode-follower circuit. Output is taken from the cathodes and is available at the FM OUT receptacle, J-108, on the rear apron of the main chassis, at a nominal 50 ohms. A portion of this signal is also applied to the grid of the audio monitor amplifier, V-103A.

Output is also taken from the cathodes to activate the OUTPUT level meter, M-103, on the front panel of the receiver. The gain of the video amplifier is such that a received signal with a deviation of ± 125 kc will produce a nominal peak-to-peak output of 20 volts at maximum gain.

Deviation Meter Amplifier. This is a voltage amplifier circuit with the meter, M-104, calibrated to indicate the peak frequency deviation of FM signals. The circuit consists of a type 6AU6 sharp-cutoff pentode amplifier V-110, which obtains video input from the DEVIATION RANGE switch, S-105, essentially a tapped voltage divider. V-110 is RC coupled to the triode amplifier V-111A, half of a type 5814A dual triode. The plate of V-111A, is in turn, direct-coupled to the grid of V-111B, a cathode-follower.

CR-111 and CR-112 operate in a voltage-doubler circuit to charge C-146 to a voltage essentially equal to the peak-to-peak voltage appearing at the cathode of V-111B. R-174 is used to calibrate the meter.

Flat frequency response is maintained in this circuit by partial bypass of the cathode resistors. C-143 is used for fine adjustment of the frequency response characteristics.

Audio Monitor Amplifier. A portion of the video signal is taken at the FM OUT receptacle, J-108, and applied to the grid of the audio amplifier, V-103A, half of a type 12AT7WA dual triode. The plate of the tube is transformer-coupled through T-102 to the monitor speaker, LS-101, mounted on the front panel of the receiver.

Although only a small portion of the frequencies present in a composite telemetry signal are audible, the characteristic sound of such a signal is easily recognizable and may be used for monitoring purposes.

AM Output Amplifier. The signal from the AM diode-detector incorporated in each IF amplifier subassembly is capacitively coupled to the grid of the AM cathode follower, V-103B. C-137 couples the audio output from the cathode to the AM OUT receptacle on the rear apron of the main chassis. R-158 acts as a bleeder to avoid build-up of a charge on C-137 when the output is not terminated.

AGC Amplifier. The AGC amplifier, V-106B, is a cathode-follower DC amplifier used to make the AGC voltage available externally for operation of recording apparatus. AGC voltage is applied to the grid of the triode; the cathode is biased from the negative supply which permits the signal strength output to be adjusted to zero with no signal input to the receiver, even though noise produces some AGC voltage. The stage effectively isolates externally connected apparatus from the AGC system

of the receiver, as well as providing a low source impedance. Output is taken from the AGC OUTPUT receptacle, located on the rear apron of the main chassis.

Power Supply. All voltages for operation of the TMR-2A Receiver are supplied by the power transformer, T-101. Input to the primary of T-101 is nominally 115V, 60 CPS, from an external source; connection is made at J-101 on the rear apron of the receiver main chassis. Application of power is controlled by S-101, a double-pole single-throw toggle switch. The receiver is decoupled from the power source by a line filter, and is protected against overload by F-101, a 2.0A SLO-BLO fuse.

Also connected in the primary circuit is B-101, the cooling fan mounted in the receiver dust cover. The fan is thermostatically controlled by S-102, which activates the fan at 80° F approximate chassis temperature, and deactivates the fan at 55° F.

The power supply furnishes operating voltages of + 325 VDC and + 170 VDC, both unregulated, and + 150 VDC regulated by V-102, a type OA2WA gas regulator tube. The two unregulated voltages are supplied from the center-tapped high-voltage secondary winding driving four 1N2071 diode rectifiers in a full-wave bridge circuit. The grounded pair of diodes is used with the center tap in a split-phase full-wave circuit.

Three separate filament secondary windings are provided. The first is isolated and raised above ground to minimize the heater-cathode voltage difference in the cathode-follower stages. A center-tapped filament winding provides the remaining two filament circuits; the center tap is grounded, and the filament load divided equally between the two sections.

A separate low-voltage secondary winding provides -20 VDC for bias purposes through V-101, a type 5726/6AL5W dual diode in a voltage-doubler circuit.

Filtering circuits are conventional.

SECTION III OPERATION

Make sure the desired IF amplifier subchassis is plugged in and connected. Set the TUNING control to the desired operating frequency; set the VERNIER control to zero. Set the AUDIO GAIN control about one-third clockwise. If it is desired to variably tune the receiver, set the OSC MODE switch to the VFO position; if crystal-controlled single-frequency reception is desired, set the OSC MODE switch to the XTAL position and insert a crystal of the proper type and frequency into the crystal socket on the front panel.

The Model TMR-2A Receiver is designed to operate with either a type MIL CR-23/U or CR-52/U series-mode crystal. Table 3-1 lists the proper crystal frequencies for use with the TMR-2A in single-frequency reception on telemetry frequencies. If the desired frequency is not listed in the table, the proper crystal frequency may be found from the formula given below the table.

The Model TMR-2A(1) Receiver requires the use of a type MIL CR-33/U parallel-mode crystal. Table 3-2 lists the proper crystal frequencies for use with the TMR-2A(1) for fixed-frequency operation in the telemetry band. If the desired frequency is not listed in the table, the proper crystal frequency may be derived using the formula associated with the table.

Front Panel Controls and Indicators.

The DEVIATION meter, M-104, indicates the peak deviation of FM signals including PDM/FM and PCM/FM. The DEVIATION meter will indicate accurately the deviation of a single FM/FM subcarrier, but will NOT accurately indicate the deviation of a number of simultaneous subcarriers.

The meter has a multiple scale calibrated in terms of the DEVIATION RANGE SWITCH directly below it.

The DEVIATION RANGE SWITCH, S-105, determines the full scale indication of the meter in terms of the applied voltage. S-105 selects various positions on the voltage divider consisting of R-159 through R-163.

The OUTPUT DB meter, M-103, is an output level indicator which may be calibrated arbitrarily for various conditions of operation. The OUTPUT CALIBRATE control, to the lower left of the meter, sets the operating range.

The TUNING meter, M-101, is used for precise tuning of a received signal.

M-102 is labelled APPROX SIGNAL LEVEL UV, and is known as the signal level meter. It is essentially a voltmeter, and indicates signal level in terms of AGC voltage. The meter scale is calibrated from 1 to 10K microvolts.

The TUNING control, below and to the right of the SIGNAL LEVEL meter, tunes the receiver by actuating the two ganged inductuners. The frequency to which the receiver is tuned is visible on the illuminated dial through the window labelled FREQUENCY MC. The TUNING knob is equipped with a lock to prevent it from turning when set.

The VERNIER control, directly to the left of the FREQUENCY MC window, actuates C-147, the variable capacitor in the circuit of the second local oscillator. The VERNIER knob is also equipped with a lock.

The OSC MODE switch, directly beneath the TUNING control, determines whether the receiver operates as a tunable or a fixed-frequency receiver. In the XTAL position, the switch, S-103, applies

Table 3-1
CR-23/U Crystal Frequencies for Use with the TMR-2A Receiver

Received Frequency	Crystal Frequency	Received Frequency	Crystal Frequency
216.5	41.0833	234.0	44.0000
217.0	41.1666	235.0	44.1666
217.5	41.2500	235.5	44.2500
218.0	41.3333	236.2	44.3666
218.5	41.4166	237.0	44.5000
219.0	41.5000	237.8	44.6333
219.5	41.5833	240.2	45.0333
220.0	41.6666	241.5	45.2500
220.5	41.7500	242.0	45.3333
221.0	41.8333	243.8	45.6333
221.5	41.9166	244.3	45.7166
222.0	42.0000	244.8	45.8000
222.5	42.0833	245.3	45.8633
223.0	42.1666	245.8	45.9666
223.5	42.2500	246.3	46.0500
224.0	42.3333	246.8	46.1333
224.5	42.4166	247.3	46.2166
225.0	42.5000	247.8	46.3000
225.7	42.6166	248.6	46.4333
226.2	42.7000	249.1	46.5166
226.7	42.7833	249.9	46.6500
227.2	42.8666	250.7	46.7833
227.7	42.9500	251.5	46.9166
228.2	43.0333	252.4	47.0666
229.9	43.3166	253.1	47.1833
230.4	43.4000	253.8	47.3000
230.9	43.4833	255.1	47.5166
231.4	43.5666	256.2	47.7000
231.9	43.6500	257.3	47.8833
232.4	43.7333	258.5	48.0833
232.9	43.8166	259.7	48.2833

Crystal formula for use with table 3-1:

$$f_x = \frac{f + 30}{6}$$

where: f_x = the crystal frequency in mc.

f = the desired reception frequency.

Table 3-2
CR-33/U Crystal Frequencies for Use with the TMR-2A(1) Receiver

Received Frequency	Crystal Frequency	Received Frequency	Crystal Frequency
216.5	20.5416	234.0	22.0000
217.0	20.5833	235.0	22.0833
217.5	20.6250	235.5	22.1250
218.0	20.6666	236.2	22.1833
218.5	20.7083	237.0	22.2500
219.0	20.7500	237.8	22.3166
219.5	20.7916	240.2	22.5166
220.0	20.8333	241.5	22.6250
220.5	20.8750	242.0	22.6666
221.0	20.9166	243.8	22.8166
221.5	20.9583	244.3	22.8583
222.0	21.0000	244.8	22.9000
222.5	21.0416	245.3	22.9416
223.0	21.0833	245.8	22.9833
223.5	21.1250	246.3	23.0250
224.0	21.1666	246.8	23.0666
224.5	21.2083	247.3	23.1083
225.0	21.2500	247.8	23.1500
225.7	21.3083	248.6	23.2166
226.2	21.3500	249.1	23.2583
226.7	21.3916	249.9	23.3250
227.2	21.4333	250.7	23.3916
227.7	21.4750	251.5	23.4583
228.2	21.5166	252.4	23.5333
229.9	21.6583	253.1	23.5916
230.4	21.7000	253.8	23.6500
230.9	21.7416	255.1	23.7583
231.4	21.7833	256.2	23.8500
231.9	21.8250	257.3	23.9416
232.4	21.8666	258.5	24.0416
232.9	21.9083	259.7	24.1416

Crystal formula for use with table 3-2:

$$f_x = \frac{f + 30}{12}$$

where f_x = the crystal frequency in mc.

f = the desired reception frequency.

B+ voltage to the crystal oscillator-tripler combination, V-1401 and V-205; in the VFO position, the switch applies B+ voltage to the VFO and the doubler, V-204 and V-206. In the OFF position, neither oscillator operates, and a dummy load is placed in the + 150 VDC circuit.

The AUDIO GAIN control, to the lower left of the receiver name plate, is a standard volume control, R-109. It controls the gain of the monitor amplifier, V-103A.

The red light just to the left of the AUDIO GAIN control is the power indicator. It comes on when power is applied to the receiver.

The 2A SLO-BLO fuse to the left of the power light is connected in the primary circuit of the power transformer, T-101. The fuse may be replaced from the front panel.

The VIDEO BANDWIDTH switch, S-104, determines the video response curve of the receiver.

The VIDEO LEVEL control, R-132, determines the output level at J-108, the FM OUT receptacle on the rear apron of the receiver.

The POWER switch is a double-throw single-throw toggle switch in the primary circuit of the power transformer, T-101. It applies 115V 60 CPS to the transformer.

The IF BANDWIDTH window indicates the bandwidth of the IF amplifier plug-in subchassis in use. An engraved stud on the end of each individual module becomes visible through the window when the unit is plugged in.

Rear Apron Components.

J-102, the ANTENNA INPUT connector, is mounted on the rear apron of a side panel of the receiver, and is accessible when the dust cover is in place. It is a type C female receptacle.

J-110, the TDU OUTPUT connector, makes available a 30-mc first IF signal for connection to a DEI Model TDU-2 Telemetry Display Unit. It is a type BNC female receptacle.

J-101, the POWER INPUT plug, uses the power cord for connection to the external 115V 60 CPS power source. It is a recessed male twist-lock receptacle with a center grounding post.

The J-105 TEST receptacle is for use only in maintenance procedures. Use of the receptacle will be discussed in maintenance sections.

J-107, the AM OUT connector, makes available any AM signal modulation for connection to external equipment. It is a type BNC female receptacle.

The AM voltage is the output of the cathode-follower, V-103B, which in turn is driven by the AM diode detector in the IF amplifier subassembly.

J-108, the FM OUT connector, makes available the video signal for connection to external equipment. The FM voltage is the output of the parallel cathode-follower stage, V-108 and V-109. J-108 is a type C female receptacle.

J-106, the AGC OUT connector, makes available the AGC voltage for connection to an external recorder. The AGC voltage is the output of the cathode-follower stage, V-106B. J-106 is a type BNC female receptacle.

J-111, the 10 MC IF OUT connector, makes available the 10 mc IF signal. It is a type BNC female receptacle.

Internal Adjustments.

C-143 is a 4-100 pf screwdriver-adjustable capacitor in the cathode-bypass circuit of V-111A. It is used for fine adjustment of the DEVIATION meter amplifier frequency response characteristics. C-143 is located on the deck of the main chassis.

R-114 is the TUNING METER ZERO control, a 10K-ohm screwdriver adjustable resistor in the cathode circuit of V-104B. It is used for zero-adjustment of the TUNING meter, and is located on the deck of the main chassis.

R-128 is the AGC ZERO control, a 250K-ohm screwdriver-adjustable resistor used as a voltage divider to set the bias on the grid of V-106B. It determines operating conditions for the AGC cathode-follower, and is located on the deck of the main chassis.

R-174 is the DEVIATION METER CAL. control, a 500K-ohm screwdriver-adjustable resistor used as a series resistor for the DEVIATION meter. It is located on the deck of the main chassis.

R-625 is the humbalance control, a 50K-ohm screwdriver-adjustable resistor located on one corner of the limiter-discriminator subchassis. It is used to set the amount of AC voltage introduced to counteract the hum indigenous to the circuit.

R-627, the discriminator balance control, is a 10K-ohm screwdriver-adjustable resistor located on another corner of the limiter-discriminator subchassis. It is used to determine the voltage applied to the reference grid of the balanced tuning meter amplifier.

R-332 (R-732, R-1032, etc., depending on the IF amplifier in use), is a 100K-ohm screwdriver-adjustable resistor located on the IF amplifier subchassis. It is used for calibration of the signal level meter.

R-337, (R-737, R-1037, etc., depending on the IF amplifier in use), is a 10K-ohm screwdriver-adjustable resistor located on the IF amplifier subchassis. It is the AGC delay control, and is used to vary the delay voltage from zero to approximately 15 volts.

SECTION IV MAINTENANCE

PREVENTIVE MAINTENANCE

Preventive maintenance is work performed on equipments, usually when the equipment is not in use, to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain trouble from occurring.

General Preventive Maintenance Techniques. No special tools or materials are supplied with the receiver. The common tools and materials used for the associated system equipment with suffice.

- (a) Use #0000 sandpaper to remove corrosion.
- (b) Use a clean, dry, lint-free cloth or dry brush for cleaning.
- (c) If available, dry compressed air may be used at a line pressure not exceeding 60 psi to remove dust from inaccessible places. Be careful, however, or mechanical damage from the air blast may result.

Performing Preventive Maintenance. Table 4-1, Preventive Maintenance Check List, describes the operations to be performed at the intervals indicated. Use caution to see that screws, nuts, and bolts are not tightened carelessly. Fittings tightened excessively will be damaged or broken.

Lubrication. Lubrication of the components in the TMR-2A Receiver is not required and should be avoided. Lubrication of controls may actually cause harm and lead to equipment failure. Blower motors and slide mechanisms have been lifetime lubricated at the factory and will need no further attention.

TROUBLESHOOTING.

The trouble shooting and repair work that can be performed by the range installation personnel is necessarily limited in scope by tools, test equipment and replaceable parts issued. Accordingly, trouble shooting is based on the performance of the equipment and visual inspection to determine such troubles as burned-out tubes, broken resistors, etc.

Model TMR-2A Receivers are designed to give trouble-free performance in the field with a minimum of routine maintenance. High quality components are used throughout with emphasis placed on operation well within ratings. All meters, transformers, and filter chokes are hermetically sealed.

Improperly Operating Receiver. If the receiver operates improperly it is usually possible to deduce the general area of trouble by the symptoms present. Once the area of trouble is located the circuits in question can be examined. Experience has shown that a tube is often the fault. Visual inspection may give some clue to the difficulty in the form of a burned or broken resistor, short or open in the wiring, damaged components, etc. Tables 4-2 and 4-3 are voltage charts that give the approximate voltage at the tube socket pins when the receiver is operating properly. Any significant deviation from these figures should point to the source of trouble.

PERIODIC ADJUSTMENTS.

The various components contained in the TMR-2A series Telemetry Receivers 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

Table 4-2. Tube Voltage Chart, Receiver Main Chassis

Symbol	Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V-101	5726/6AL5W	Ground	-2.2	*6.2	Ground	-11.2	Ground	-11.2	-	-
V-102	OA2 WA	150	-	-	-	150	-	Ground	-	-
V-103	12AT7 WA	292	0	2.7	*6/52	#6/52	294	96	100	#6/52
V-104	12AT7 WA	96	6	6.8	#6/52	#/52	96	6	6.8	#6/52
V-105	5814A	293	96	103	#6/52	#6/52	293	96	103	#6/52
V-106	12AT7WA	294	96	98	#6/52	#6/52	173	-2.1	-1.3	#6/52
V-107	6AU6 WA	3.6	Ground	*6.2	Ground	250	122	5.3	-	-
V-108	6CL6	93	87	293	*6/52	*6/52	292	93	293	87
V-109	6CL6	93	87	293	*6/52	*6/52	292	93	293	87
V-110	6AU6	1.8	Ground	*6.2	Ground	250	90	2.8	-	-
V-111	5814A	120	2.4	3.85	#6/52	#6/52	291	120	122	*6/52
V-201	5842/417A	130	0	*6	4.7	4.7	5.5	4.7	4.7	Ground
V-202	5842/417A	100	Ground	*6	Ground	Ground	.95	Ground	Ground	Ground
V-203	5654/6AK5 W	-1.38 ^{1/}	Ground	*6.1	Ground	170	56	Ground	-	-
V-204	6AU6 WA	-2.5 ^{2/}	Ground	*6.1	Ground	143	114	0	-	-
V-205	6AU6	-.41 ^{3/}	Ground	*6.2	Ground	141	0	Ground	-	-
V-206	5654/6AK5W	-12.2 ^{4/}	Ground	*6.1	Ground	142	112	Ground	-	-
V-207	5654/6AK5 W	-12 ^{5/}	Ground	*6.2	Ground	142	110	Ground	-	-
V-208	5749/6BA6 W	-1.44	Ground	*6.2	Ground	165	94	.83	-	-
V-209	5725	0	2	*6.2	Ground	85	127	-1.54 ^{6/}	-	-
V-210	6AU6WA	-.4	Ground	*6.1	Ground	165	145	0	-	-
XTAL Operation @ 238 mc No Signal Input										
V-203	5654/6AK5 W	-1.41 ^{1/}	Ground	*6	Ground	170	56	Ground	-	-
V-204	6AU6 WA	-.49 ^{2/}	Ground	*6.1	Ground	144	-1.1	0	-	-
V-205	6AH6	-8.8 ^{3/}	Ground	*6.1	Ground	142	106	Ground	-	-
V-206	5654/6AK5W	-.5 ^{4/}	Ground	*6.1	Ground	142	-1.1	Ground	-	-
V-207	5654/6AK5W	-9.8 ^{5/}	Ground	*6.2	Ground	142	110	Ground	-	-
V-1401	6BZ7	160	Ground	2	Ground	*5.8	160	0	2.5	Ground

NOTES: Regulated line voltage, 115 V 60 CPS. Receiver Operation VFO @ 238 mc, no signal input. Deviation switch @ 750 kc. Video bandwidth @ 1 mc. DC voltage taken with 11-megohm VTVM to ground. * AC measured to ground. # VAC measured from pins 4 & 5 to 9. 1/ taken @ C-224. 2/ taken @ TP-201. 3/ taken @ TP-202. 4/ taken @ TP-203. 5/ taken @ TP-204. 6/ taken @ C-275. All voltages + DC unless otherwise noted.

operating at peak performance. Critical circuits which should be checked regularly and which must be checked after tube replacement are as follows:

A. Tuning Meter Zero. Check the tuning meter zero indication by disconnecting the cable between the demodulator and the IF amplifier subchassis. Press S-106 and observe the reading of the tuning meter. Adjust R-114, the tuning meter zero control, if necessary.

B. Discriminator Balance. Connect an accurate 10 mc source with approximately 0.3 volt output to the input cable of the IF amplifier. With the limiter input cable connected to the IF amplifier output, observe the tuning meter indication. Adjust R-627 if necessary.

Other circuits which should be checked and adjusted after tube replacement are:

A. First Local Oscillator. Connect an accurate 30 mc source with approximately 0.3 volt output to C-224. Make sure the IF input cable is connected to the second mixer output jack on the front end subassembly. Observe the tuning meter indication. Adjust Z-201 if necessary.

B. Signal Level Meter. Connect a Boonton 202-G Signal Generator to the antenna input and tune in a 1 mv signal at 238 mc. Set the signal level meter at 2 microvolts and 10 millivolts

Table 4-3. Tube Voltage Chart, Plug-In Subchassis

Pin Number								
Symbol	Type	1	2	3	4	5	6	7
750 KC IF Amplifier Subchassis, Typical 9/								
V-701	5749/6BA6W	0 $\frac{7}{/}$	Gnd.	5.9 AC	Gnd.	152	75	1.14
V-702	5749/6BA6W	0 $\frac{7}{/}$	Gnd.	5.9 AC	Gnd.	152	73	1.14
V-703	5749/6BA6W	0 $\frac{7}{/}$	Gnd.	6 AC	Gnd.	158	78	1.16
V-704	6AH6	0 $\frac{7}{/}$	Gnd.	6 AC	Gnd.	162	150	1.85
V-705	5726/6AL5W	3.5	0	4.9 AC	Gnd.	.15	Gnd.	0 $\frac{7}{/}$ 8/
Limiter Discriminator Subchassis								
V-601	6BN6	1.45	0	6 AC	Gnd.	96	10.8	170
V-602	6BN6	1.37	0	6 AC	Gnd.	98	9.8	155
V-603	6BN6	1.39	0	6 AC	Gnd.	97	9.4	155
V-604	5726/6AL5W	6	6	5 AC	Gnd.	11.8	Gnd.	0
Phase-Lock Demodulator Subchassis								
V-1101	6BN6	+1.4V	0	6.3VAC	0	+100V	+9.5V	+170V
V-1102	5726/6AL5W	+5.9V	+2-4V	6.3VAC	0	+4-7V	0	+2-4V
V-1103	6AU6WA	-1.5V	0	6.3VAC	0	+170V	+150V	0
V-1004	6CB6	+2-4V	+7-9V	6.3VAC	0	+150V	+110V	0
TP-1101								+1-2V
TP-1102								+5.9V
Predetection Amplifier Subchassis								
V-1701	5749/6BA6W	0	Gnd.	6.3 AC	Gnd.	160	100	.54
V-1702	5749/6BA6W	0	Gnd.	6.3 AC	Gnd.	165	100	.6
V-1703	6AH6	0	Gnd.	6.3 AC	Gnd.	157	160	2.2
V-1704	5726/6AL5W	0	-.1	5.1 AC	Gnd.	65	0	0

NOTES: All voltages + DC unless otherwise noted. For measuring voltages in plug-in subchassis, adapter cables will be required, made up according to the schematic diagrams in figures 5-1 and 5-8. 7/ AGC shorted to ground @ C-742. 8/ pin B of T-704B shorted to ground. 9/ for all other IF amplifiers, read approximately the same voltages for corresponding tube and pin numbers.

generator output level, and adjust the AGC delay control, R-737, at 2 microvolts input, and signal level full scale, R-732, at 10 millivolts input until the meter reads properly at both points.

C. Deviation Meter. Set the generator output to 1 millivolt and set its deviation to ± 100 kc at the 1.7 kc rate. Adjust the Deviation Meter Cal. control for an indication of 100 kc.

D. AGC Zero. Set the output of the Signal Generator at zero and connect a VTVM to J-106. Set the AGC zero adjustment for zero indication.

ALIGNMENT PROCEDURES

The TMR-2A series Telemetry Receivers are 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 of various circuitry, and alignment may become necessary. In this case, these procedures should be followed.

LIMITER-DISCRIMINATOR ALIGNMENT PROCEDURE.

Recommended Equipment.

Boonton 202F Signal Generator

Boonton 207F Univerter

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

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

RCA WR-59C Sweep Generator.

Hewlett-Packard 120-A Oscilloscope

DEI Type IFA-G2 1.5 mc bandwidth IF Amplifier

Walsco #2541 alignment tool; two 6 inch clip leads

Special Fixtures Required for Alignment. Make the following fixtures as shown in the referenced figures:

Second IF Amplifier Test Cable (figure 4-1).

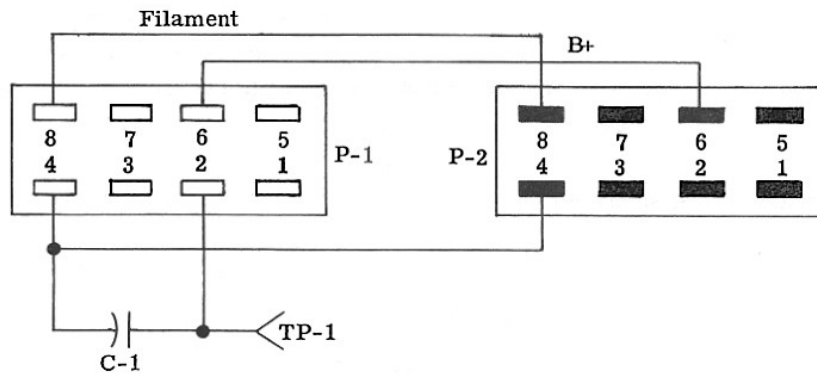
91-ohm Alignment Fixture (figure 4-2).

51-ohm Alignment Fixture (figure 4-3).

General Instructions. Z-601 and Z-602 are adjusted to set the discriminator peaks at 11.25 and 8.8 mc. C-631 and C-626 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 ± 500 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 pre-determined shape. If the slope plot has the proper shape the discriminator has the required linearity.

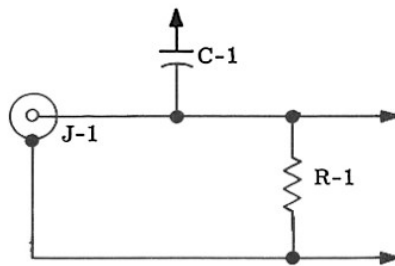
If it is desired to view the discriminator response visually the oscilloscope should be connected between pin 1 of J-103 and ground. The baseline produced by sweep blanking does not fall at center frequency but rather at a point determined by the division of R-621 and R-622. The discriminator peaks are approximately equal in amplitude about the center frequency as viewed on an oscilloscope having a direct coupled video amplifier.



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 |

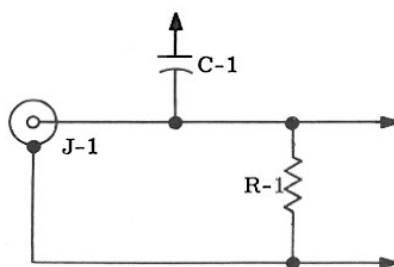
Figure 4-1. Second IF Amplifier Test Cable



Parts

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

Figure 4-2. 91-ohm Alignment Fixture



Parts

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

Figure 4-3. 51-ohm Alignment Fixture

Adjustment of T-601. 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 4-1). Connect the limiter discriminator 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 4-2) 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.

Connect the oscilloscope to feed-thru capacitor C-609 on the limiter discriminator subassembly. Adjust the tuning cores in T-601A and B to produce a response curve having equal amplitude at the 8.8 and 11.25 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. This can be checked by substituting these tubes for V-601 and noting the amplitude of the visual response with a full limiting signal applied.

If the response amplitudes are not the same within 10% for V-602 and V-603 other tubes should be tried and a matched pair selected. Note: All three sockets should have tubes in them when the response amplitudes are being checked.

Alignment of Z-601 and Z-602.

1. Replace the 91-ohm alignment fixture with the 51-ohm alignment fixture (figure 4-3) and connect the Univerter. Connect the VTVM to the 10K resistor attached to the IF amplifier test cable. Connect the 415B tuned amplifier (high impedance input) to the discriminator video output pin 1 of J-103 and to ground.

2. Set the Univerter output frequency to $10\text{ mc} \pm 1\text{ kc}$ and adjust the output level for a reading of 12 volts on the VTVM. Set the selector switch on the 415B to expanded scale and adjust the gain (normally on the 40 db range) for a convenient indication (such as -.5 db) on the expanded db scale. Vary the input frequency and plot the variation in meter reading as a function of frequency over a range of $\pm 500\text{ kc}$. 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 $\pm 600\text{ kc}$.

If the slope plot shows an increase in slope on either side of center frequency reaching a maximum increase of 0.1 to 0.15 db and the slope is the same as that at center frequency at approximately ± 400 to 450 kc the discriminator is in perfect alignment and no adjustments should be made. If adjustment is indicated proceed with step 3.

3. Set the selector switch on the 415B to normal and adjust the gain (normally on the 30 db range) for a convenient meter indication. Set the input frequency to $8.8\text{ mc} \pm 1\text{ kc}$. Set the attenuator (normally on the 50 db range) of the 415B as required to produce a convenient indication and adjust Z-602 for a minimum indication.

4. Set the input frequency to $11.25\text{ mc} \pm 1\text{ kc}$. 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.

5. Recheck the adjustment of Z-602 noting the frequency at which minimum meter reading occurs. If the frequency is more than 2 kc away from 8.8 mc readjust Z-602. If Z-602 requires re-adjustment recheck Z-601 re-adjusting it if required.

6. Plot the slope of the discriminator as done in step 2. If the slope plot is not as specified make an incremental adjustment of C-626 or C-631 as required, repeat steps 3 thru 5, and recheck the slope. Repeat this procedure until the proper slope plot is obtained.

Increasing the capacity of C-631 will increase the slope on the high frequency side. Increasing the capacity of C-626 will increase the slope on the low frequency side. There is, however, some interaction between these adjustments and the discriminator peak frequencies must be readjusted (following steps 3 thru 5 of this procedure) each time an adjustment of C-626 or C-631 is made.

Note: After alignment of the discriminator is completed, the adjustment of the Tuning Meter Zero and the Discriminator Balance should be checked.

Discriminator Hum-bucking Adjustment.

1. Connect the signal generator to the antenna input of receiver. Set the generator output to 3 millivolts. Set the receiver tuning dial to 214 mc. Insert the 40.67 crystal.

2. Connect the FM OUT to oscilloscope vertical input. Switch to XTAL operation. Set R-625 for minimum hum pattern as displayed on the oscilloscope (approximately .03 V peak-to-peak).

ALTERNATE LIMITER ALIGNMENT PROCEDURE

Where a sweep generator is not available for limiter alignment, the following procedure may be used.

Recommended Equipment.

Hewlett-Packard 606-A Signal Generator

RCA WV-98A VTVM

Walsco #2541 Alignment Tool

BNC Tee Adaptor

51-ohm Alignment Fixture (figure 4-3)

Adjustment of T-601. Connect the signal generator, etc. Connect the signal generator to the Tee adaptor and the Tee adaptor to the 51-ohm fixture and to P-601 of W-601. Connect the VTVM to feed-thru capacitor C-609.

Feed in a 2-volt or greater signal at 10 mc. Push the red button of S-601 and adjust T-601B for a maximum reading on the VTVM. Release the push button and adjust T-601A for a maximum reading on the VTVM.

Vary the input frequency from 8.8 to 11.25 mc and note that the VTVM reading is approximately equal to or greater than the reading at 10 mc. T-601 is an overcoupled double-tuned circuit with a nominal bandwidth of 2.5 mc between the points on the response curve where the amplitude is equal to that at center frequency. The exact shape and symmetry of this circuit is not critical because V-602 and V-603 are considerably overdriven. If the response curve is tilted it is permissible to make an incremental adjustment of T-601B to equalize the peaks. If the amplitude response is not symmetrical about the 8.8 and 11.25 mc points it is permissible to make an incremental adjustment of T-601A to correct this.

SECOND IF AMPLIFIERS ALIGNMENT PROCEDURES.

This procedure applies to the following equipments:

Model IFA-A2 100 kc IF Amplifier (1300 series)

Model IFA-B2 200 kc IF Amplifier (800 series)

Model IFA-C2 300 kc IF Amplifier (300 series)

Model IFA-D2 500 kc IF Amplifier (400 series)

Model IFA-E2 750 kc IF Amplifier (700 series)

Model IFA-F2 1 mc IF Amplifier (1000 series)

Model IFA-G2 1.5 mc IF Amplifier (900 series)

The 700 series of numbers will be used throughout in the following paragraphs.

The last two digits of each symbol number apply equally to all models of the IF amplifiers; only the hundreds digits differ with the different models.

Recommended Equipment.

VTVM RCA WV 98-B

Sweep Generator WR-59C

Oscilloscope HP 120A

Signal Generator HP 608D

Signal Generator HP 606A

Marker Generator 10 mc + Sidebands (optional)

Coaxial cable to replace the IF-VF output cable normally supplied with the WR-59C. Cable is RG-62/U 3 feet 10 inches long with a UG-260/U coaxial connector on one end and an Amphenol 75-MCIF microphone connector on the other.

Coaxial Cable, 3 feet RG-62/U with UG-260 B/U connectors

Coaxial Cable, 4 feet RG-62/U with UG-260 B/U connectors

Coaxial Cable, 4 feet RG-55A/U with UG-88 C/U connectors

Walsco #2541 alignment tool

Two six-inch clip leads

a 10K carbon resistor

Mating connector for J-105 (Winchester M4P with hood. Pin A is brought out thru a short piece of insulated wire and terminated in a clip. Pin B is brought out thru a short piece of wire -- no clip).

Various Coaxial adapters (BNC to N and C)

Adapter BNC to shielded double plug GR 274-QBJ

*A sideband marker generator may be used in lieu of the HP 606A to furnish the markers.

If this alternative is used the response patterns are adjusted for equal peak amplitudes and equal response at the markers.

Special Fixtures Required for Alignment. Make the following fixtures as shown in the referenced figures:

Second IF Test Cable (figure 4-1).

Second IF Alignment Fixtures (figures 4-2, 4-3, 4-4, and 4-5).

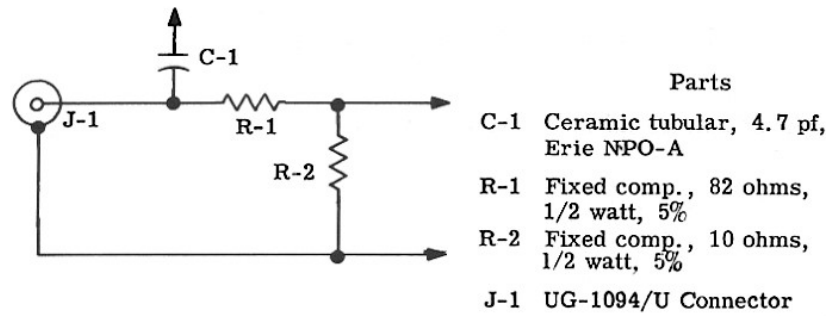


Figure 4-4. Alignment Fixture

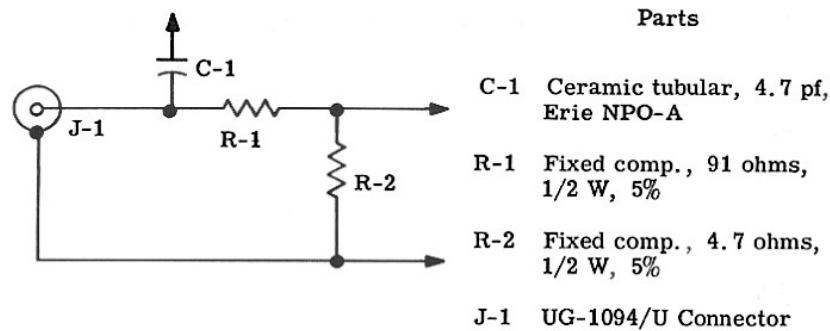


Figure 4-5. Alignment Fixture

General Instructions.

Connect the scope output of the sweep generator to the Horizontal input of the generator to the Horizontal input of the oscilloscope. Set H Gain of the scope for a base line trace that is just visible at both ends.

Use the QBJ adapter, the 4 foot RG-62/U coax and the open termination 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 feedthru capacitor (C-742).

A limiter subchassis, type FMD-A2 must be installed in the receiver before the receiver is turned on. A partial bottom cover for the 2nd local oscillator section of the front end should be installed.

Procedures.

1. Set the subchassis on the top edge of the receiver side cover dropping the studs on the subchassis sidewall through the holes in the top of the side cover provided for this purpose. Connect the IF Amplifier test cable (figure 4-1). 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 the 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. Set the OSC MODE switch to XTAL and

remove the crystal if one is installed.

2. Connect alignment fixture (91 ohm) between the grid pin 1 of V-704 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-704B to ground on the upper sidewall of the subchassis.

Adjust the output of the sweep generator for a 1-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in 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 or slightly overcoupled.

Remove the alignment fixture and clip lead.

3. Connect alignment fixture (91 ohm) 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-703B to ground on the upper sidewall of the subchassis.

Adjust the output of the sweep generator for a 1-volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in 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.

Adjust the output of the sweep generator for a 10-volt response amplitude. Adjust the tuning core in T-705B as required to remove tilt in the response curve. The response curve should be flat-topped or slightly overcoupled.

Remove the alignment fixture and clip lead.

4. Connect alignment fixture ($82 + 10$ ohm) (91 ohm on IFA-G2) between the grid (pin 1) of V-702 and ground on the strap-nut for this tube. Connect the sweep generator. Connect the marker generator. Connect a short clip lead from terminal B of T-702B to ground on the upper sidewall of the subchassis.

Adjust the output of the sweep generator for a 10-volt response amplitude. Feed in the marker signal as required. Adjust the tuning cores in 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 flat-topped or slightly overcoupled.

Remove the alignment fixture and clip lead.

5. Connect alignment fixture ($82 + 10$ ohm) between the grid (pin 1) of V-701 and ground on the strap-nut for this tube. Connect the sweep generator. Connect the marker generator. Connect a short clip lead from terminal B of T-701B to ground on the upper sidewall of the subchassis.

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-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 flat-topped or slightly overcoupled.

Remove the alignment fixture and clip lead. Install the second IF subassembly bottom cover and install the subassembly in the receiver.

6. Connect the second IF input cable to J-202. Connect the test plug to J-105 and ground the clip lead. Connect the scope between the point provided on the test plug and ground on the receiver chassis. Remove the front end subassembly cover. Connect alignment fixture ($91 + 4.7$ ohms) between the grid (pin 1) of V-209 and ground at terminal D of T-202B. Connect a short clip lead from

terminal B of T-202B to the sidewall of the front end subassembly. Connect the sweep generator. Connect the marker generator between the 4.7 pf capacitor on the test fixture and ground on the sidewall of the front end subassembly.

Adjust the output of the sweep generator for a 10-volt response amplitude. Feed in marker signal as required. Note: If a marker is present due to the second local oscillator adjust the VERNIER control of the receiver until this marker coincides with the marker due to the marker signal fed in. Adjust the tuning cores in T-701A 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 overcoupled.

Disconnect the scope. Disconnect the sweep and marker generator from the termination.

SECOND LOCAL OSCILLATOR ALIGNMENT PROCEDURE

Recommended Equipment.

Counter, HP-524C and 525A Converter

VTVM, RCA WV-98B

Alignment Procedure

1. Connect the counter input to C-275. Set the VERNIER control to zero. Connect the VTVM to C-275. Tune Z-501 and L-234 for 40 mc $\pm$ 1 KC and maximum injection respectively.

FIRST IF AMPLIFIER ALIGNMENT PROCEDURE

Recommended Equipment.

Sweep Generator - RCA WR-59C

Oscilloscope - HP 120A

Signal Generator - HP 606A

45 V Battery - RCA VS-112 or equivalent

10K Resistor 1/2W - Allen Bradley EB-1031

.001 uf Disc Capacitor - Erie CK61Y102Z or equivalent

Special Fixtures required for Alignment.

Make the following fixtures as shown in the referenced figures:

Alignment Fixture - 91 ohm (figure 4-2)

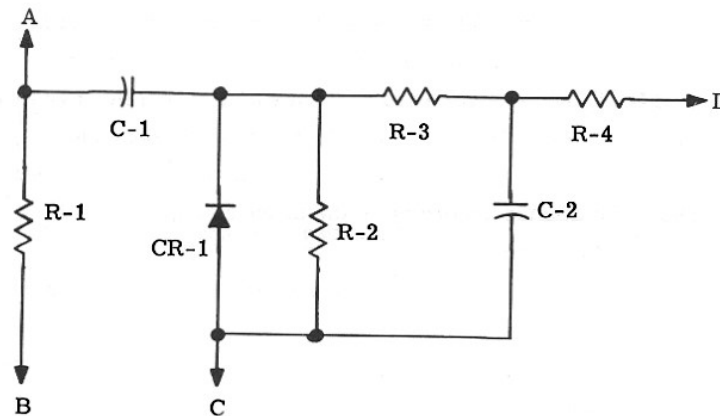
First IF Alignment Fixture (figure 4-6)

General Instructions. A low capacity cable such as RG-62/U coaxial cable should be used for connection to the oscilloscope. Cable capacity plus oscilloscope input capacity should be held to a maximum of 100 pf. The direct-coupled, vertical amplifier of the oscilloscope should be used to display the response. The marker generator signal should be coupled in (through a 4.7 pf capacitor connected to the sweep generator lead) as required to produce a suitable marker pip. If too much marker is used, the baseline of the response will be shifted. In general, a minimum of marker signal should be used.

The IF alignment fixture (figure 4-6) should be made using reasonably short leads and should be soldered in place during the alignment procedure. The sweep input and marker input cables should be dressed away from the stage being aligned or already aligned. The oscilloscope cable should be dressed away from the front end subchassis.

Alignment Procedure.

1. Disconnect the second IF input cable from J-202. Remove the front end bottom cover.



Parts

C-1	Ceramic tubular, 22 pf, 5%, Erie NPO-A
C-2	Ceramic tubular, 47 pf, 5%, Erie NPO-T
CR-1	Germanium diode, 1N198
R-1	Fixed comp., 1.5K ohms, 1/2 W, 5%
R-2	Fixed comp., 47K ohms, 1/2 W, 10%
R-3	Same as R-2
R-4	Same as R-2

Connections

A	To plate (pin 5) of V-209
B	To B+ at junction (tie point) of L-230, R-236, R-237, R-238
C	To ground on strap nut of V-209 (near pin 7)
D	To oscilloscope

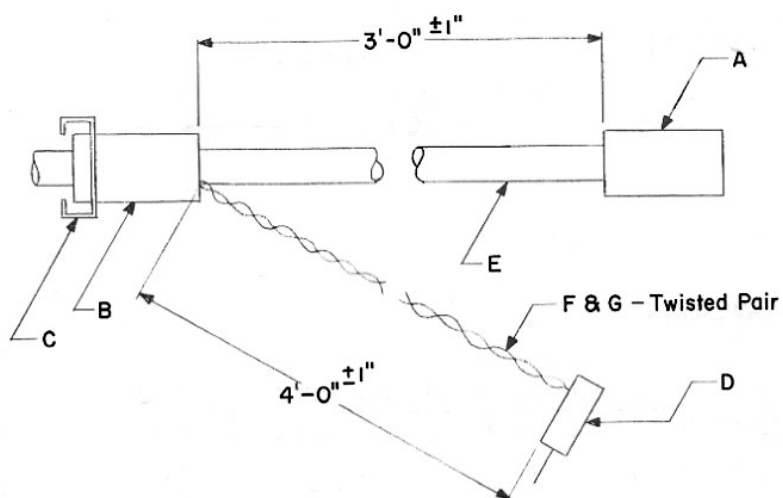
Figure 4-6. First IF Alignment Fixture

Connect the first IF alignment fixture (figure 4-6) as instructed in that figure. Connect the 45V battery negative terminal through a 10K resistor to feed-thru capacitor C-275. Ground the positive terminal of the battery. Set the OSC MODE switch to XTAL and remove the crystal from the front panel socket if one is installed. Disconnect the lead to pin 1 of V-208 at terminal A of T-201B. Connect the sweep generator termination (figure 4-2) between pin 1 of V-208 and ground on the sidewall of the front end subchassis. Connect the sweep generator to the termination and connect the signal generator between the capacitor on the termination and ground on the sidewall.

2. Adjust the sweep generator for a suitable sweep width centered at 30 mc and set the sweep generator output for a 0.5 volt response amplitude. Feed in marker signal as required. Adjust the tuning cores in T-202A and B to produce a response curve centered at 30 mc. The response curve should be flat-topped or slightly overcoupled and tuning should be adjusted for symmetry about the ± 1 mc points.

Remove the sweep and marker generator leads. Reconnect the lead to terminal D of T-201B.

3. Connect a short clip lead across C-284. Solder a .001 uf capacitor to pin 1 of V-203. Connect the sweep generator termination to this capacitor and to ground on the partial shield in the front end subchassis. Connect the marker generator between the 4.7 uuf capacitor on the termination and ground on the partial shield. Adjust the sweep generator output for a 0.5 volt response amplitude.



Manual Gain Control Cable, DEI A-15-787

KEY

- A Connector, UG-260B/U
- B Hood, Winchester H-10
- C Plug, Winchester M4PLS
- D Plug, General Radio 274MB
- E Cable, RG-62/U
- F Wire, #22 AWG, Plastic Coated, Black
- G Wire, #22 AWG, Plastic Coated, White

Feed in marker signal as required. Adjust the tuning cores in T-201A and B. The response curve should be flat-topped or slightly over-coupled and tuning should be adjusted for symmetry about the ± 1.0 MC points. NOTE: If the receiver is to be used with a type TDU-2 Display Unit an alternate method of adjustment is recommended to provide the most nearly constant response over the ± 1 MC range displayed by the TDU. The procedure up to this point should be followed and the first IF section of the display unit should be aligned according to the procedure given for that subassembly. The following adjustments are then made:

4. Connect the TDU output of the receiver to the display unit, using a cable of the same length and type as that used to connect the two units while in normal operation. Connect the oscilloscope between C-606 on the display unit and ground. Remove V-509. Adjust the sweep generator output for a response amplitude of approximately 1 volt.

5. Adjust the tuning core in Z-502 for maximum response at 30 mc center frequency. Adjust the tuning core in T-201B for equal amplitude at the ± 1 MC points on the response curve.

6. Connect the scope to the IF amplifier alignment fixture. Adjust the sweep generator output for a response amplitude of approximately .5 volt and adjust the tuning core in T-202B to remove any tilt in the response curve.

7. Remove all fixtures and the .001 capacitor. Replace V-210 and V-509. Reconnect the second IF input cable to J-202.

TUNING UNIT ALIGNMENT PROCEDURE

It is imperative that alignment and adjustment of the remainder of the receiver (including the first IF which is an integral part of the front end subassembly) be completed before this alignment is undertaken.

CRYSTAL OSCILLATOR-MULTIPLIER CHAIN-VFO ALIGNMENT, TMR-2A

Oscillator-Amplifier Alignment

Recommended Equipment

Sweep Generator, RCA WR-59C, modified to cover 210-270 mc

Oscilloscope, HP 120A

Signal Generator HP 606A

Procedure

1. Connect IF/VF output of sweep generator to TP-1401. Connect oscilloscope vertical input to TP-202. Connect sweep generator scope output to the horizontal amplifier of oscilloscope and adjust horizontal sensitivity so that a trace just visible at both ends appears on the scope. Set sweep generator channel selector to IF position. Set IF frequency to approximately 45 mc and the sweep width control at maximum.

2. Adjust L-1402 and L-212 to give the response of a double tuned circuit.

3. Loosely couple a marker from the signal generator into the sweep generator output through a small (4.7 pf or less) capacitor.

4. Set the sweep generator scope combination for a sweep calibrated on the horizontal scale from 41 to 49 mc. Disconnect marker.

5. Adjust L-1402 (primary) and L-212 (secondary) for a double-tuned response with equal amplitudes at the 41 and 49 mc points.

6. Adjust L-1402 and L-212 for a peak at 49.5 mc and about 50% amplitude at 40.5 mc by

detuning the double tuned response from the flat condition.

Crystal Oscillator Adjustment

Recommended Equipment

VTVM RCA WV-98B

Crystal, McCoy CR-23/U 40.66667 mc

Crystal, McCoy CR-23/U 49.33333 mc

Crystals at various frequencies between these two limits

Procedure

1. Connect VTVM to TP-1401. Insert the 44.67 mc crystal in the front panel crystal socket. Adjust L-1401 for maximum VTVM reading.
2. Insert the 40.67 crystal. Adjust L-1401 for a reading of about .3 volts on the VTVM.
3. Insert the 49.33 mc crystal. Adjust L-1401 for VTVM reading of about .3 volts.
4. Repeat steps 2 and 3 until VTVM readings are approximately equal for both crystals.
5. Connect another VTVM to TP-202. Adjust L-1401, L-1402 and L-212 for maximum crystal drive (at TP-1402) and maximum signal transfer to the tripler grid (TP-202) for the band limit crystals. Note: All three adjustments should be very small -- on the order of 1/4 turn.
6. Plug in assorted crystals and check for operation.

Oscillator-Multiplier Chain Alignment

Recommended Equipment

VTVM RCA WV-98B

Crystal, CR-23/U, 40.66667 mc

Crystal, CR-23/U, 49.33333 mc

Procedure

1. Connect VTVM to TP-204. Set front panel tuning dial to 214 mc. Turn the OSC MODE switch to XTAL operation. Insert the 40.67 mc crystal in the front panel crystal socket. Adjust C-251 for maximum VTVM reading (approximately -7V to -15V).
2. Set the tuning dial to 266 mc. Insert the 49.33 mc crystal. Check circuit tuning by adjusting C-251. A decrease in the capacity required to produce a peak VTVM reading indicates that the circuit has too little tuning range. To increase the tuning range, spread the coils of L-220 and/or move the coil closer to the chassis, thereby decreasing its inductance.
3. Adjust C-251 for peak VTVM reading.
4. Connect the VTVM to C-224. Adjust C-254 for maximum VTVM reading (approximately -1.5V).
5. Set the front panel tuning dial to 214 mc. Install the 40.67 mc crystal. Connect the VTVM to TP-204. Check tuning by adjusting C-251. An increase in capacity required to give a peak VTVM reading indicates too little tuning range. Reduce inductance of L-220 to increase range.
6. Adjust C-251 for peak VTVM reading.
7. Connect the VTVM to C-224. Check circuit tuning by adjusting C-254. An increase in the capacity required to give a peak VTVM reading indicates that the circuit has too little tuning range. To increase tuning range, compress the coils of L-224 and/or move the entire coil away from the chassis, thereby increasing its inductance.
8. Adjust C-254 for peak VTVM reading.

9. Repeat steps 2 and 3.
10. Connect VTVM to C-224. Check circuit tuning by adjusting C-254. A decrease in capacity required to give a peak VTVM reading indicates that the circuit has too little tuning range. To increase the tuning range, increase the inductance of L-224.
11. Repeat steps 5-10 for circuit tracking and tuning range.

VFO and Doubler Alignment

Recommended Equipment

VTVM RCA WV-98B

Signal Generator, Boonton 202G

Crystal, CR-23/U 40.66667 mc

Crystal, CR-23/U 49.33333 mc

Procedure

1. Connect the signal generator to the antenna input of receiver. Set the generator output to 3 millivolts. Set the receiver tuning dial to 214 mc. Insert the 40.67 crystal.
2. Set the OSC MODE switch for XTAL operation. Tune the generator to exactly 214 mc as indicated by the receiver tuning meter.
3. Switch to VFO operation and adjust C-235 for tuning meter zero.
4. Connect the VTVM to TP-203. Adjust C-244 for maximum VTVM reading and readjust C-235 for tuning meter zero if necessary.

NOTE: Maximum capacity in C-244 occurs when the arrow molded into the top of the capacitor points directly toward the rear apron of the receiver. Set the capacitor so that clockwise rotation increases capacity for ease in determining tracking adjustments.

5. Connect the FM OUT to oscilloscope vertical input. Switch to XTAL operation. Set R-625 for minimum hum pattern as displayed on the oscilloscope (approximately .03V peak-to-peak).

NOTE: Any 6AU6WA tube, selected at random, will operate as V-204 with no deterioration of performance. However, deliberate selection of this tube has been made at the factory, resulting in a substantial reduction in hum output. When V-204 is replaced in the field, any 6AU6WA will operate satisfactorily; however, a careful selection of this tube for optimum hum characteristics will considerably reduce hum output from this source.

6. Switch to VFO operation. If the peak-to-peak hum pattern is more than about three times as great on VFO as on crystal operation, V-204 will require changing. Select a tube which meets this hum requirement.

NOTE: The VFO must be retuned according to the procedure in Steps 2 and 3 each time the tube is changed.

7. Set the tuning dial to 266 mc. Insert the 49.33 mc crystal. Switch to XTAL operation. Tune the generator to 266 mc as indicated by the tuning meter. Switch to VFO operation. Check the oscillator tuning by adjusting C-235 for correct tuning meter reading. If a decrease in capacity is required, the circuit has too little tuning range. Reduce the inductance of L-213 to increase the range. To reduce the inductance of L-213, spread the coil slightly or move the entire coil closer to the chassis.

8. Check the oscillator plate circuit tuning by adjusting C-244. A decrease in the capacity required to produce a peak VTVM reading indicates that the circuit has too little tuning range. To increase the tuning range, spread the coil of L-217 and/or move the coil closer to the chassis, thereby decreasing its inductance.

9. Set the receiver tuning dial to 214 mc. Install the 40.67 mc crystal. Set the OSC MODE switch to XTAL. Tune the generator to 214 mc as indicated by the tuning meter. Switch to VFO operation.

10. Check the oscillator tuning by adjusting C-235 for correct tuning meter reading. If an increase in capacity is required, the circuit has too little tuning range. Reduce inductance of L-213 to increase range.

11. Check the oscillator plate circuit tuning by adjusting C-244. An increase in capacity required to give a peak VTVM reading indicates too little tuning range. Reduce inductance of L-217 to increase range.

12. Repeat steps 7 thru 11 until proper oscillator tracking is achieved. Tuning meter indications of ± 20 at both ends of the dial are satisfactory.

CRYSTAL OSCILLATOR-MULTIPLIER CHAIN-VFO ALIGNMENT, TMR-2A(1)

Recommended Equipment

Sweep Generator, RCA Model WR-59C, modified to cover 210-270 mc

Oscilloscope, Hewlett-Packard Model 120A

Signal Generator, Hewlett-Packard Model 606A

Crystal, McCoy CR-33/U, 20.3333 mc

Crystal, McCoy CR-33/U, 21.3333 mc

Crystal, McCoy CR-33/U, 22.3333 mc

Crystal, McCoy CR-33/U, 23.5000 mc

Crystal, McCoy CR-33/U, 24.6666 mc

Alignment of Oscillator Multiplier Chain

1. Connect VTVM to TP-203. Set the front panel tuning dial to 214 mc. Switch the OSC MODE switch to XTAL, and insert the 20.3 mc crystal. Adjust C-244 for maximum VTVM reading (approximately -10V to -15V).

NOTE: Maximum capacity in C-244 occurs when the arrow molded into the top of the capacitor points directly toward the rear apron of the receiver.

2. Connect VTVM to TP-204. Adjust C-251 for maximum VTVM reading (approximately -20 to -30V).

3. Connect VTVM to TP-203. Set the tuning dial to 266 mc and insert the 24.6 mc crystal. Check circuit tuning by adjusting C-244. A decrease in the capacity required to produce a peak VTVM

reading indicates that the circuit has too little tuning range. To increase the tuning range, spread the coils of L-217 and/or move the coil closer to the chassis, thereby decreasing its inductance.

4. Adjust C-244 for peak VTVM reading.

5. Connect VTVM to TP-204. Check circuit tuning by adjusting C-251. A decrease in the capacity required to produce a peak VTVM reading indicates that the circuit has too little tuning range. To increase the tuning range, spread the coils of L-220 and/or move the coil closer to the chassis, thereby decreasing its inductance.

6. Adjust C-251 for peak VTVM reading.

7. Connect VTVM to C-224. Adjust C-254 for maximum VTVM reading (approximately -1.5V).

8. Connect VTVM to TP-203. Set the dial to 214 mc. Insert the 20.3 mc crystal. Check tuning by adjusting C-244. An increase in capacity required to give a peak VTVM reading indicates too little tuning range. Reduce inductance of L-217 to increase range.

9. Adjust C-244 for peak VTVM reading.

10. Connect VTVM to TP-204. Check tuning by adjusting C-251. An increase in capacity required to give a peak VTVM reading indicates too little tuning range. Reduce inductance of L-220 to increase range.

11. Adjust C-251 for peak VTVM reading.

12. Connect VTVM to C-224. Check circuit tuning by adjusting C-254. An increase in the capacity required to give a peak VTVM reading indicates that the circuit has too little tuning range. To increase the tuning range, compress coils of L-224 and/or move the entire coil away from the chassis, thereby increasing its inductance.

13. Adjust C-254 for peak VTVM reading.

14. Repeat steps 3 thru 6.

15. Connect VTVM to C-224. Check tuning by adjusting C-254. A decrease in capacity required to give a peak VTVM reading indicates too little tuning range. Increase inductance of L-224 to increase range. Bending L-223 closer to the chassis will have the effect of increasing the tuning range.

16. Adjust C-254 for peak VTVM reading.

17. Repeat steps 8 thru 16 as required for circuit tracking and tuning range.

Alignment of VFO

1. Connect VTVM to TP-203. Set the tuning dial to 214 mc. Set the OSC MODE control to VFO. Adjust C-235 for maximum VTVM reading (approximately -10 to -15V).

2. Set tuning dial to 266 mc. Check circuit tuning by adjusting C-235. A decrease in capacity required to produce a peak VTVM reading indicates that the circuit has too little tuning range. To increase the tuning range spread coils of L-213 and/or move the entire coil closer to the chassis thereby decreasing its inductance.

3. Adjust C-235 for peak VTVM reading.

4. Set dial to 214 mc. Check tuning by adjusting C-235. An increase in capacity required to give a peak VTVM reading indicates too little tuning range. Reduce inductance of L-213 to increase range.

5. Adjust C-235 for peak VTVM reading.

6. Repeat steps 2 thru 5 as required for circuit tracking and tuning range.

7. Connect the signal generator to antenna input of receiver, using coaxial cable. Set generator output to 3 millivolts. Place partial bottom cover on front end chassis. Set receiver tuning dial to 214 mc. Insert the 20.3 mc crystal. Set the OSC MODE switch to XTAL. Tune in generator to exactly 214 mc as indicated by the receiver tuning meter. Switch to VFO operation and adjust C-235 for tuning meter zero.

8. Connect FM video output to oscilloscope vertical input. Switch to XTAL operation. Set R-163 for minimum hum pattern as displayed on the oscilloscope (approximately .03V peak-to-peak).

9. Switch to VFO operation. If the peak-to-peak hum pattern is more than about three times as great on VFO as on crystal operation, V-204 will require changing. Select a tube which meets this hum requirement.

NOTE: The VFO must be retuned according to the procedure in step 7 each time the tube is changed.

10. Set dial to 266 mc. Insert the 24.6 mc crystal. Switch to XTAL operation. Tune generator to 266 mc as indicated by the tuning meter. Switch to VFO operation. Check circuit tuning by adjusting C-235 for correct tuning meter reading. If a decrease in capacity is required, the circuit has too little tuning range. Reduce inductance of L-213 to increase range.

11. Adjust C-235 for tuning meter zero.

12. Set the tuning dial to 214 mc. Insert the 20.3 mc crystal. Switch to XTAL operation. Tune the generator to 214 mc as indicated by the tuning meter. Switch to VFO operation. Check circuit tuning by adjusting C-235 for correct tuning meter reading. If an increase in capacity is required the circuit has too little tuning range. Reduce inductance of L-213 to increase range.

13. Adjust C-235 for tuning meter zero.

RF INTERSTAGE CIRCUITRY ALIGNMENT

Recommended Equipment

VTVM RCA WV-98B

Signal Generator, Boonton 202G

750 KC Bandwidth Second IF Amplifier Model IFA-E2

Crystal, McCoy CR-23/U, 42.66667 mc, or CR-33/U, 21.3333 mc

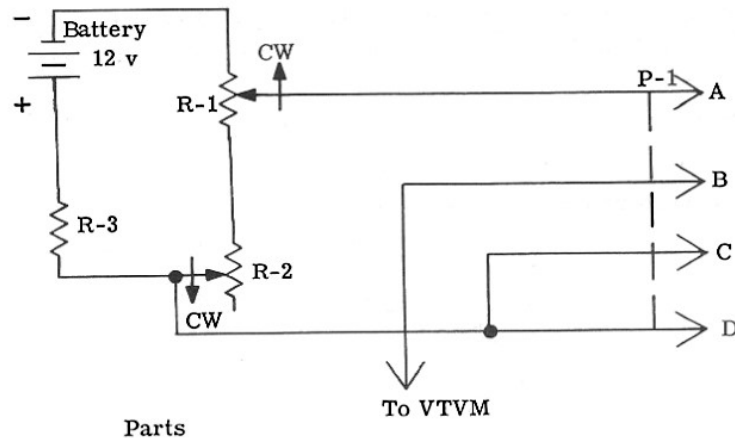
Crystal, McCoy CR-23/U, 47.0000 mc, or CR-33/U, 23.5000 mc

Special Fixtures Required for Alignment. Make the following fixture as shown in the referenced figure:

Manual Gain Control Fixture (figure 4-7).

General. The RF interstage circuit consists of a tunable double-tuned circuit with top (high-impedance) capacitive coupling. The primary circuit consists of inductances L-207, L-208, and L-235B, tuned by capacitances C-216 and various strays. The secondary circuit consists of L-209, L-210, and L-235C, tuned by C-220 and various strays. The coupling network is a capacitive "T" consisting of C-217, C-219, and a variable shunt arm, C-218, which controls bandwidth.

The tuning range of these two circuits is controlled by the value of the adjustable end inductor, L-207, or L-209. These inductors are adjusted by spreading or compressing the coils to decrease or increase, respectively, the inductance.



Parts

Battery (2) RCA VS-040S or equivalent
P-1 Winchester M4P with hood H10-C (mates with J-105)
R-1 Variable comp., 1K Ω , 2W, Ohmite CU-1021
R-2 Variable comp., 100 Ω , 2W, Ohmite CU-1011
R-3 Fixed comp., 100 Ω , 1/2W, 10%

Figure 4-7. Manual Gain Control Fixture.

Procedure

1. Install the 750 kc bandwidth IF amplifier. Connect the manual gain control fixture (figure 4-7) to J-105. Connect the VTVM to the point provided at the manual gain control plug. Set the signal generator output to 100 μ V and connect to the antenna input. Tune the generator to 226 mc (tune the generator for zero tuning meter reading on XTAL operation with the appropriate crystal). Ground C-261 with a short clip lead. Set the manual gain control fixture for a 3.5-to-5V VTVM reading.
2. Adjust C-216 and C-220 for maximum VTVM reading, resetting the manual gain control if necessary to keep the VTVM below 5V.
3. Set the receiver dial to 252 mc. Install the 47.0 (or 23.5) mc crystal and tune in the generator. Adjust C-216 and C-220 for maximum VTVM reading, noting which one has the most effect and whether capacity is added to or removed from each circuit.
4. If the change in VTVM reading is less than 5% the RF interstage may be considered aligned. If the change is more than 5% the end inductors L-207 and/or L-209 will require adjustment. L-207 will be adjusted if most of the change in step 3 was due to adjustment of C-216 and L-209 if due to C-220. Increase the inductance of the coil if capacity was removed from the circuit.
5. After adjusting the coil, set the tuning dial to 226 mc and install the 42.67 (or 21.33) mc crystal. Repeat steps 2, 3, and 4 as required for circuit tracking.

RF INPUT NETWORK ALIGNMENT

Recommended Equipment

(See next paragraph for noise figure measurements).

Procedure

1. Using VFO operation of the receiver, make noise figure measurements at 214 mc, 235 mc and 266 mc. If the noise figure is less than 7.5 db at these three points, the input circuit can be considered aligned. If this is not the case, the input circuit must be adjusted.
2. Set the receiver to 266 mc and make an incremental adjustment of C-205 (1/4 turn). Make a noise figure measurement.
3. Repeat step 2 until the capacitor setting for minimum noise figure at 266 mc is determined. Set capacitor to this point.
4. Measure the noise figure at 235 mc and 214 mc. Less than 7.5 db at these two points indicates satisfactory alignment. More than 7.5 db noise figure indicates that an adjustment of L-202 is required.
5. Set the tuning dial to 235 mc and determine setting of C-205 for minimum noise figure as in step 2. If the setting for minimum noise figure is for more capacity than the setting determined in step 3, the circuit has too little tuning range. To increase the tuning range, compress the coils of L-202 slightly.
6. Repeat steps 2 thru 5 as required.

NOISE FIGURE MEASUREMENT

Recommended Equipment

Model IFA-E2 750 kc IF amplifier, supplied

FM Signal Generator, Boonton 202G

Manual Gain Control Fixture, (figure 4-7)

VTVM, RCA WV-98B

Noise Generator, PRD 904

Cable, Coaxial, 2 feet RG-55A/U, with UG-535/U and UG-709A/U connectors.

Detector Calibration.

1. Install the model IFA-E2 750 kc bandwidth second IF amplifier in the receiver.
2. Connect the signal generator to the antenna input of the receiver.
3. Tune the generator to the receiver and set the generator output level to approximately -75 dbm.
4. Plug the manual gain control fixture (figure 4-7) into J-105.
5. Connect the VTVM to the output provided on this plug and set the gain of the receiver to produce a VTVM reading of 2.0 VDC.
6. Increase the generator output by exactly 3 db and note the VTVM reading exactly. It will be about 2.85V.
7. Disconnect the signal generator.

Detector Calibration, Alternate Method. In the event that a Noise Figure Meter with a 10 mc IF input, (Hewlett-Packard Specification H18-340B) and matching noise source (HP 343A) are available, the following procedure will be a great time-saver.

1. Connect the noise source directly to the antenna input of the receiver. Connect the IF input of the noise figure meter to J-703. Set the receiver up for normal operation in the VFO mode. The noise figure of the receiver may be read directly on the noise figure meter. Refer to meter instruction book for operating procedures for this instrument.

Noise Figure Measurement

1. Set the receiver to receive the desired frequency (either XTAL or VFO operation).
2. Connect the Noise Generator (PRD 904) output to the receiver antenna terminals using coaxial cable (2 feet RF-55A/U, UG-535A/U and UG-709A/U connectors).
3. Set the range switch on the noise generator to the 0-10 position and the output control maximum counterclockwise. Set the gain of the receiver for a 2.0 VDC reading on the VTVM.
4. Increase the output of the noise generator until the calibration voltage determined above is reached. Read the noise figure from the meter on the generator.
5. Return the output control to the maximum counterclockwise position and determine if the VTVM reading is 2.0V. If not, adjust the receiver gain and repeat the noise figure reading.

PHASE-LOCK DEMODULATOR, ALIGNMENT PROCEDURE

ALIGNMENT CHECK

This procedure is used to measure indirectly the linearity of the PLD-A2 Phase-Lock Demodulator, and is used as indication of whether or not the unit needs alignment. Any tube or other component replacement will necessitate complete realignment.

Equipment Required:

FM Signal Generator, Boonton 202E, 202G, or 202J

Univerter, Boonton 207E, or 207G

Wide-Band Oscillator (used with 202G or 202J), Hewlett Packard 200CD

Tuned Voltmeter (SWR Indicator), Hewlett Packard 415B

Receiver, DEI TMR-2A

Second IF Amplifier, DEI IFA-D2

Procedure.

1. Install the modules in the receiver and connect the output of the FM signal generator to the Univerter. If a 202E generator is used, set the modulation to FM and adjust for a 1-kc modulation rate with approximately 7.5 kc deviation. If a 202G or 202J generator is used, connect the output of the 200CD to the external modulation terminals and adjust for a 1-kc modulation rate with approximately 7.5 kc deviation.
2. Connect the output of the Univerter to the playback input of the receiver. Set the video level control to maximum and the video bandwidth control to 1 mc. Connect the FM video output to the input of the 415B.
3. Set the Univerter dial to zero and the FM generator output level to maximum. Adjust the FM generator frequency for a zero indication on the tuning meter. Adjust the modulation frequency (200CD), if necessary, for a maximum voltmeter indication.
4. Set the gain of the 415B for a meter indication of -0.5 db on the expanded scale. Check the change in slope of the Z-curve by finding the frequency excursions (read from the Univerter dial) necessary for 0.1-db changes in the 415B indication (-0.4 or -0.6 db indicated).

NOTE: These are actually 0.2-db changes in the output level, as the 415B is calibrated for a square-law detector. Hereafter, the actual change in output level will be referred to; for example, +0.2-db change in output level for a +0.1-db change in meter indication.

5. If the frequency excursions required for a +0.2-db change in output are nonsymmetrical, check the tuning-meter balance by disconnecting the demodulator input cable (the cable plugged into J-403 on the IF amplifier chassis) and pressing S-106 while observing the tuning meter. If the tuning meter does not indicate zero with the S-106 pressed, adjust R-114 as required.
6. Repeat steps three and four.
7. If the frequency excursions necessary for a +0.2-db change in output are nonsymmetrical (more than a 30-kc difference) or are not at least ± 150 kc, the demodulator will require a complete alignment.

COMPLETE ALIGNMENT

Equipment Requirements.

Commercial Equipment:

Oscilloscope, Hewlett Packard 120A or equal
Signal Generator, Hewlett Packard 606A or equal
FM Signal Generator, Boonton 202E, 202G, or 202J
Univerter, Boonton 207E or 207G
Wide-Band Oscillator, Hewlett Packard 200CD
AC VTVM, Hewlett Packard 400D or equal
Tuned Voltmeter (SWR Indicator), Hewlett Packard 415B or equal
Transistor Power Supply, Hewlett Packard 721A or equal
Sweep Generator, RCA WR-59C
Receiver, DEI TMR-2A
IF Amplifier, DEI IFA-D2
IF Amplifier, DEI IFA-G2

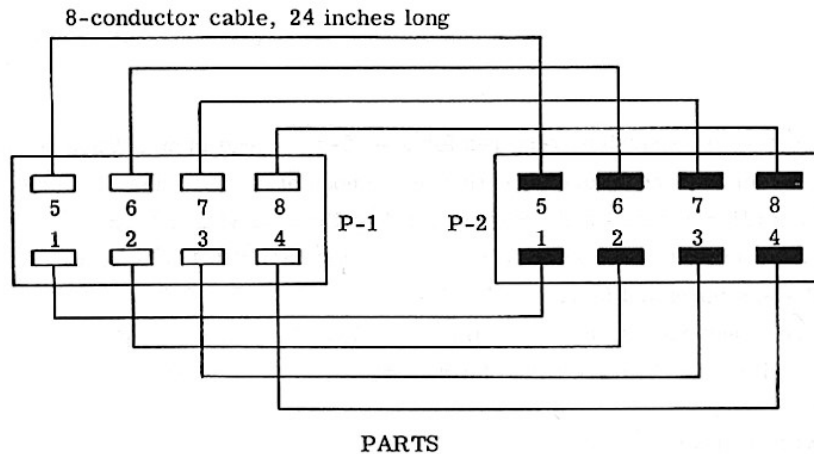
Jigs, Fixtures, and Cables (Shown starting on page 4-26 unless otherwise noted):

Coaxial Cables (various lengths and types), DEI #B13-172
Demodulator Alignment Cable, figure 4-8.
Sweep Generator Output Cable, DEI #A13-162. This fixture consists of a type RG-62 A/U coaxial cable 3 ft. 10 ± 1 in. long with an Amphenol 75MC1F connector soldered to one end and a type UG-260B/U connector soldered to the other end.
Adapter, modified (two required), DEI #A13-160
Clip Termination, DEI #A13-274. This fixture consists of a type UG-1094/U connector with an insulated alligator clip (Mueller 60-C) connected to each terminal.
Manual Gain Control Cable, DEI #A15-787
Adapter, MB to BNC, IPC 47250

General Instructions. Since the reactance-tube circuit controlling the frequency of the local oscillator in this unit has linearity adjustments, care must be exercised in making both the preliminary and the final adjustments in the alignment procedure. Unless the preliminary adjustments have been made properly, attempting the final linearity adjustment will be a useless waste of time.

In this final linearity adjustment, the effects of the controls are as follows:

1. C-1120 This capacitor controls the series-resonant frequency of the combination of L-1110 and itself. Removing capacity has the effect of flattening the slope plot curve up to a point of maximum flatness where the effect reverses. The point of maximum flatness is the desired response.



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 4-8. Special Adapter Cable

2. **L-1106** This inductor, known as a linearity coil, effectively slides the slope plot higher or lower in frequency as the inductance is decreased or increased respectively.
3. **T-1102** This is the inductance portion of the oscillator tuned circuit. As such, its adjustment controls the center frequency of the local oscillator.

This summary, necessarily short, cannot do justice to the interactions of these controls. However, if the alignment procedure is followed step by step, an intangible "feel" for their action will develop.

Receiver Setup.

1. Remove the dust cover and install the IFA-G2 1.5-Mc Bandwidth Second IF Amplifier in the receiver.
2. Place the receiver on its left side on the bench.
3. Connect the demodulator alignment cable to the demodulator receptacle in the receiver.
4. Remove the bottom cover from the demodulator and place it on the bench beside the receiver with P-1101 toward the rear of the receiver. Connect the input cable, W-1101, to the receptacle, J-902, on the IF amplifier. Connect the alignment cable to P-1101.
5. Connect the manual gain plug to J-105 on the rear apron of the receiver. Connect the positive side of the power supply to ground and the negative side to pin A of the plug.

Alignment Procedures.

1. Connect the scope output of the manual gain plug (coax) to the vertical input of the oscilloscope.
2. Connect the scope output of the sweep generator to the horizontal input of the oscilloscope. Adjust the horizontal gain of the oscilloscope for a trace length of approximately 10 cm.
3. Connect the output of the 606A to J-205 on the front-end subchassis using the MB adaptor and 50-ohm cable. Adjust the generator frequency to 10 mc using the crystal calibrator.
4. Using the sweep generator output cable, connect the IF/VF output of the sweep generator to the playback input of the receiver. Adjust the sweep generator output to maximum and adjust the bias supply voltage for a 10-volt response centered at 10 mc with a sweep of approximately 1 mc. Adjust the output level of the marker generator for a marker just visible on the response curve. Since the limiting action of the 6BN6 input tube in the demodulator will effectively remove any

marker of reasonable amplitude, it is necessary to calibrate the scope/sweep generator combination in terms of kc/cm on the horizontal axis. A convenient adjustment is 100 kc/cm with 10 mc at the center of the screen. Disconnect the marker generator from the receiver.

5. Connect the scope vertical input to TP-1101 using the clip termination and three feet of RG-62/U cable. Remove the oscillator tube V-1103 (6AU6WA). Adjust T-1101A (top slug) and T-1101B (bottom slug) for a symmetrical response centered at 10 mc. This response should be at least 600-kc wide at the 80% response points (100% at 10 mc) and should be flat to slightly-overcoupled with no more than a 5% dip at center frequency. Amplitude of the response should be 7 to 9 volts at center frequency. Disconnect the manual gain plug on the rear apron.
6. Install the bottom cover, replace the oscillator tube, and connect the scope vertical amplifier to TP-1102. Disconnect the demodulator input cable, W-1101, at the IF amplifier and adjust R-1120 on the demodulator chassis for a minimum-hum pattern on the scope. (Hum will appear as an open ellipse on the scope; a straight line with the scope gain set to 10 mv/cm indicates proper adjustment.)
7. Observe the receiver tuning-meter indication and press the switch, S-106, on the receiver main chassis. If the tuning-meter indication is not zero when S-106 is pressed, adjust R-114 (at the rear of the receiver main chassis) for a zero indication with the switch closed.
8. Reconnect the demodulator input cable to the IF amplifier. Connect the 606A (set to 10 mc $\pm$ 1 kc) to the playback input of the receiver. Set the 606A output to 200 mv. If necessary, adjust T-1102 for a zero tuning-meter indication. Disconnect the 606A.
9. Connect the output of the FM signal generator to the Univerter. If a 202E generator is used, set the modulation to FM and adjust for a 1-kc modulation rate with approximately 7.5 kc deviation. If a 202G or 202J generator is used, connect the output of the 200CD to the external modulation rate with approximately 7.5-kc deviation.
10. Connect the Univerter output to the playback input and set the Univerter dial to zero. Set the FM generator output to maximum and adjust the FM generator frequency for a zero tuning-meter reading.
11. Connect the input of the tuned voltmeter (set to 200K-input Z) to TP-1102. Apply modulation to the FM generator. Adjust the modulation frequency (200CD), if necessary, for a maximum 415B voltmeter reading.
12. Set the gain of the 415B for a meter indication of -0.5 db on the expanded scale. Check the change in slope of the Z-curve by finding the frequency excursions (read off the Univerter dial) necessary for 0.1-db changes in 415B reading (to -0.4 or -0.6 db indicated).

NOTE: These are actually 0.2-db changes in the output level, as the 415B is calibrated for a square-law detector. Hereafter, the actual change in output level will be referred to; for example, +0.2-db change in output level for a +0.1-db change in meter indication.

13. If the frequency excursions necessary for a +0.2-db change in output are symmetrical (no more than a 30-kc difference) and are at least $\pm$ 150 kc, the demodulator may be considered aligned. In this case proceed to step 17.
14. If the frequency excursions required for a +0.2-db change in output are nonsymmetrical make an incremental adjustment of L-1106 and retune T-1102 (10 mc Univerter output) for a zero tuning-

meter indication. Repeat the measurement.

15. If the frequency excursions required for a ± 0.2 -db change in output are not at least ± 150 kc, make an incremental adjustment of C-1120 and retune T-1102 for a zero tuning-meter indication.

Repeat the measurement.

16. Repeat steps 14 and 15 as required.

NOTE: When the proper adjustment is reached, the output will increase on both sides of center frequency with the ± 0.2 -db output occurring symmetrically at 155 kc to 200 kc or more on either side of center frequency.

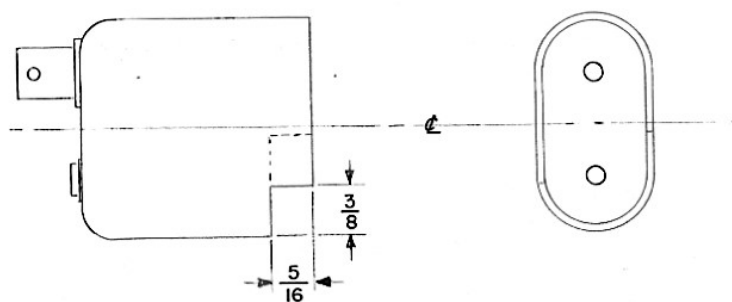
17. Connect the output of the FM generator to the RF input of the receiver. Install the demodulator and the IFA-D2 Second IF Amplifier in the receiver. Set the generator output to 1 mv and tune in a CW signal for a zero tuning-meter indication.

18. Connect the oscilloscope to the FM video output jack of the receiver. Set the video level control to maximum and adjust R-1120 on the demodulator subchassis for a minimum-hum pattern on the scope.

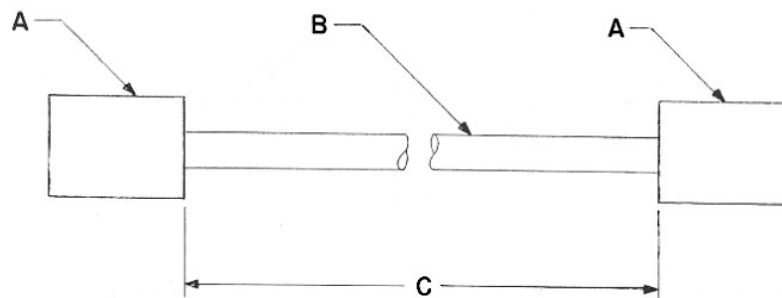
19. Set the video bandwidth control to 1 mc. Set the deviation of the FM generator to 100 kc at the 1-kc rate and adjust R-1118 on the demodulator subchassis for a 100-kc deviation-meter indication with the range switch in the 150-kc position.

20. Connect the FM video output to the 400D VTVM. Modulate the FM generator with the 200CD oscillator. Set the deviation to 100 kc at the 1-kc rate. Set the video level control for a 400D indication of 0 db on the 2V range. Vary the modulation frequency from 100 cps to above 100 kc, maintaining 100-kc deviation, and note the frequency response as read on the 400D. The response should be -3 db at approximately 100 kc.

JIGS AND FIXTURES



Modification of Adapter, General Radio 274-QBJ,
DEI Part No. A13-160



DRAWING NUMBER	A	B	C
B13-172-1	UG-88C/U	RG-58C/U	6 ± 1/4 in.
B13-172-2	UG-88C/U	RG-58C/U	1 ft. ± 1/4 in.
B13-172-3	UG-88C/U	RG-58C/U	2 ft. ± 1/2 in.
B13-172-4	UG-88C/U	RG-58C/U	3 ft. ± 1/2 in.
B13-172-5	UG-88C/U	RG-58C/U	4 ft. ± 1 in.
B13-172-6	UG-88C/U	RG-58C/U	5 ft. ± 1 in.
B13-172-7	UG-88C/U	RG-55A/U	6 ± 1/4 in.
B13-172-8	UG-88C/U	RG-55A/U	1 ft. ± 1/4 in.
B13-172-9	UG-88C/U	RG-55A/U	2 ft. ± 1/2 in.
B13-172-10	UG-88C/U	RG-55A/U	3 ft. ± 1/2 in.
B13-172-11	UG-88C/U	RG-55A/U	4 ft. ± 1 in.
B13-172-12	UG-88C/U	RG-55A/U	5 ft. ± 1 in.
B13-172-13	UG-260B/U	RG-62A/U	6 ± 1/4 in.
B13-172-14	UG-260B/U	RG-62A/U	1 ft. ± 1/4 in.
B13-172-15	UG-260B/U	RG-62A/U	2 ft. ± 1/2 in.
B13-172-16	UG-260B/U	RG-62A/U	3 ft. ± 1/2 in.
B13-172-17	UG-260B/U	RG-62A/U	4 ft. ± 1 in.
B13-172-18	UG-260B/U	RG-62A/U	5 ft. ± 1 in.

STANDARD TEST CABLES, DEI B13-172

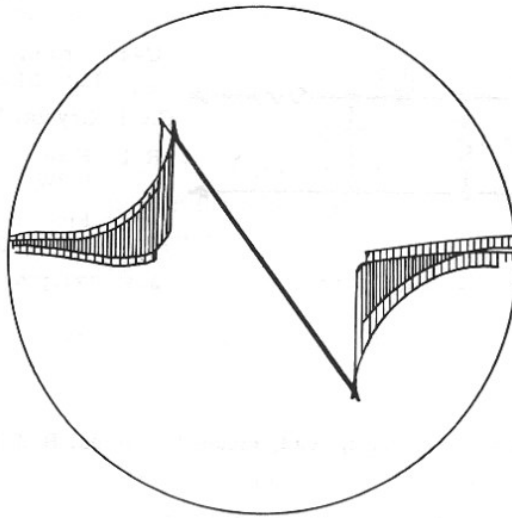


Figure 4-9. Phase-Lock Demodulator Response Curve, Typical

100 kc on the receiver Deviation Meter.

PREDETECTION AMPLIFIER, ALIGNMENT PROCEDURE

Recommended Equipment

Sweep Generator, RCA WR-59B

Signal Generator, HP 606-A

Oscilloscope, HP 120-A

VTVM, RCA WV-98B

Power Divider, Microlab DP-3F

20 db Attenuator, Microlab AF-20

Special Adapter Cable, (figure 4-8)

Two 6 inch clip leads

Special Fixtures Required for Alignment. Make the following fixtures as shown in the referenced figures:

Second IF Alignment Fixtures (figures 4-2 and 4-3)

PDA Alignment Fixture (figure 4-10)

Procedures

1. Remove the predetection amplifier from its mounted position in the receiver and place it in a convenient location on the bench. Remove the bottom cover of the subchassis. Using the special adapter cable (figure 4-8) connect the subchassis to the receiver for power.

Connect the PDA alignment fixture (figure 4-10) to the output cable, (W-1702). Using the 51-ohm alignment fixture (figure 4-3), connect the HP-606A generator to Terminal A on T-1702B and ground

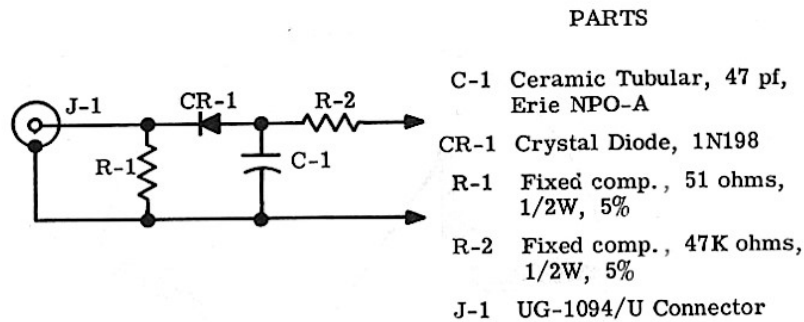


Figure 4-10. PDA Alignment Fixture

on the strapnut of V-1703. Using a short clip lead, connect terminal B of T-1702B to ground. Connect the VTVM to the output of the test fixture and set to read a positive voltage on the 1.5 VDC range. Using a short clip lead, connect TP-1 (C-1732) to ground.

Set R-1723 to the maximum counterclockwise position. Set the HP-606A generator to 10 mc and adjust the output to produce 1 volt on the VTVM. Tune L-1705 for maximum deflection on the VTVM.

As L-1705 is tuned, readjust the HP-606A generator output to maintain a nominal 1 volt on the VTVM.

Remove the clip lead from terminal B and HP-606A from terminal A of T-1702B and ground. Remove the VTVM from the output of the special test fixture.

2. Using a twisted pair, connect the WR-59B scope and ground terminals to the oscilloscope horizontal input terminals.

Connect the alignment fixture (figure 4-2) to terminal A of T-1701B and ground on the strap nut of V-1702. Using a short clip lead, connect terminal B of T-1702 to ground. Connect the WR-59B sweep generator and the HP-606A generator to the alignment fixture. Connect the output of the special test fixture to the vertical input terminals of the oscilloscope. Set the WR-59B sweep generator output to produce a 1-volt peak-to-peak response on the oscilloscope. Adjust the output of the HP-606A to produce a suitable marker on the response.

Maintaining a nominal 1 volt peak-to-peak on the oscilloscope, tune T-1702A and T-1702B for symmetry about the ± 800 kc points. The response will have a peak at 10 mc and a shelf about the ± 800 kc points.

Remove the clip lead from terminal B and the alignment fixture from terminal A of T-1701B and ground.

3. Install the bottom cover. Connect the power divider to the input cable, W-1701. Connect the WR-59B sweep generator to the power divider. Connect the HP-606A generator thru the 20 db attenuator to the power divider. Adjust the output of the WR-59B sweep generator to obtain a 1-volt peak-to-peak response on the oscilloscope. Adjust the output of the HP-606A generator to obtain a suitable marker on the response.

Maintaining a nominal 1 volt peak-to-peak on the oscilloscope, tune T-1701A and T-1701B for symmetry about the ± 800 kc points on the response. The response will have three peaks on top with

two troughs between 3% and 5% deep.

It may be necessary to retune T-1702A and T-1702B slightly to obtain the best possible symmetry.

Remove the power divider from the input cable. Remove the 20 db attenuator from the HP-606A generator. Remove the oscilloscope from the output of the special test fixture. Remove the clip lead from TP-1 and ground.

4. Connect the VTVM to the output of the special test fixture. Connect the HP-606A generator to the input cable, W-1701. Set the output of the HP-606A generator to 30 millivolts at 10 mc. Adjust R-1723 to obtain 1 volt DC on the VTVM.

The output should not change more than 40% with input signals from 30 to 300 millivolts.

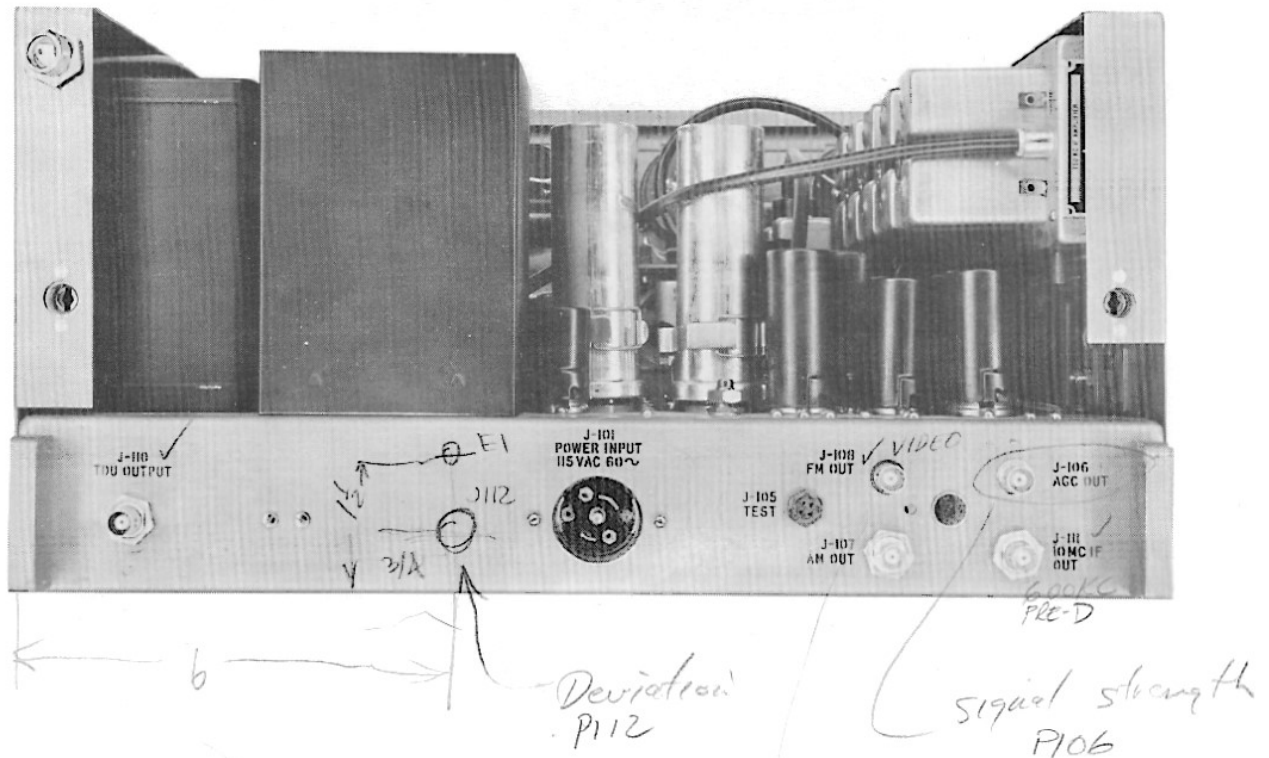


Figure 4-11. Model TMR-2A Series Receiver, Rear View

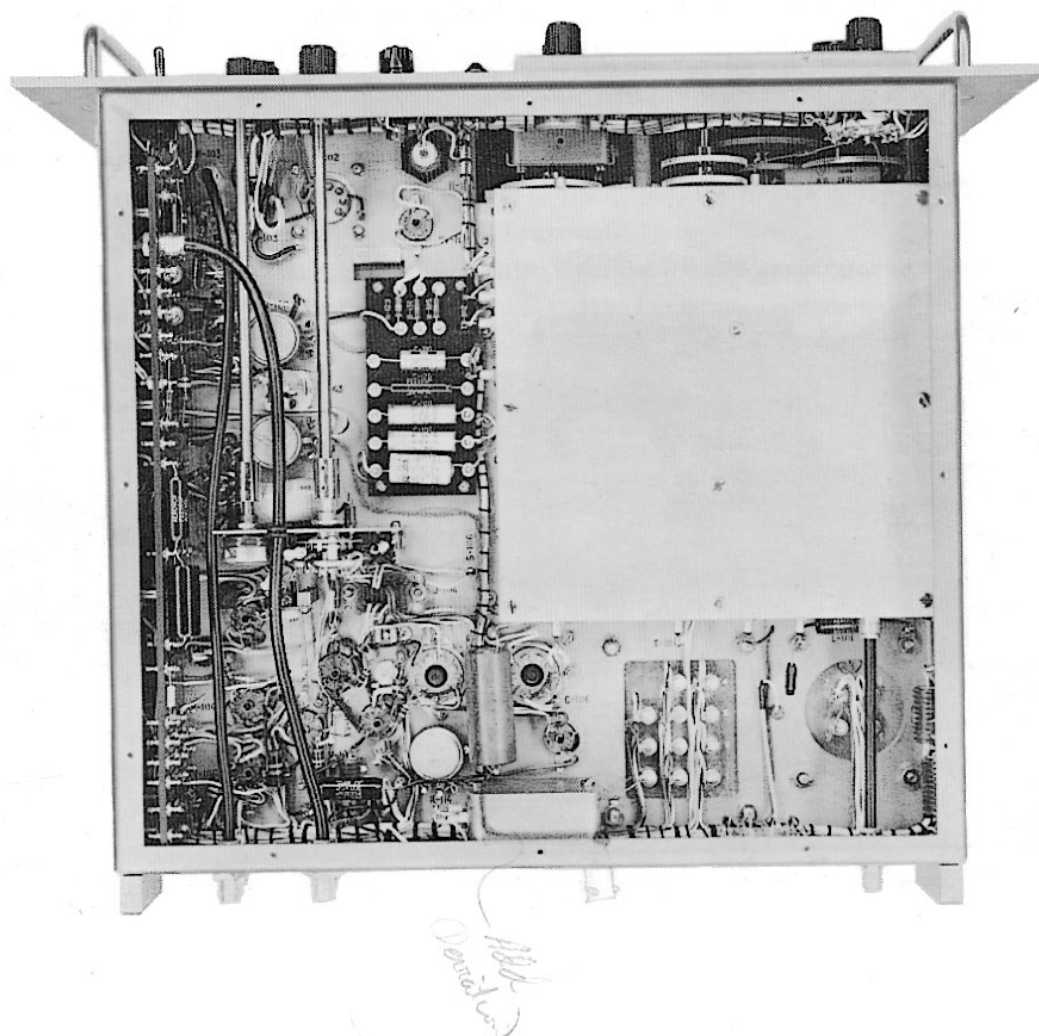


Figure 4-12. Model TMR-2A Series Receiver, Bottom View

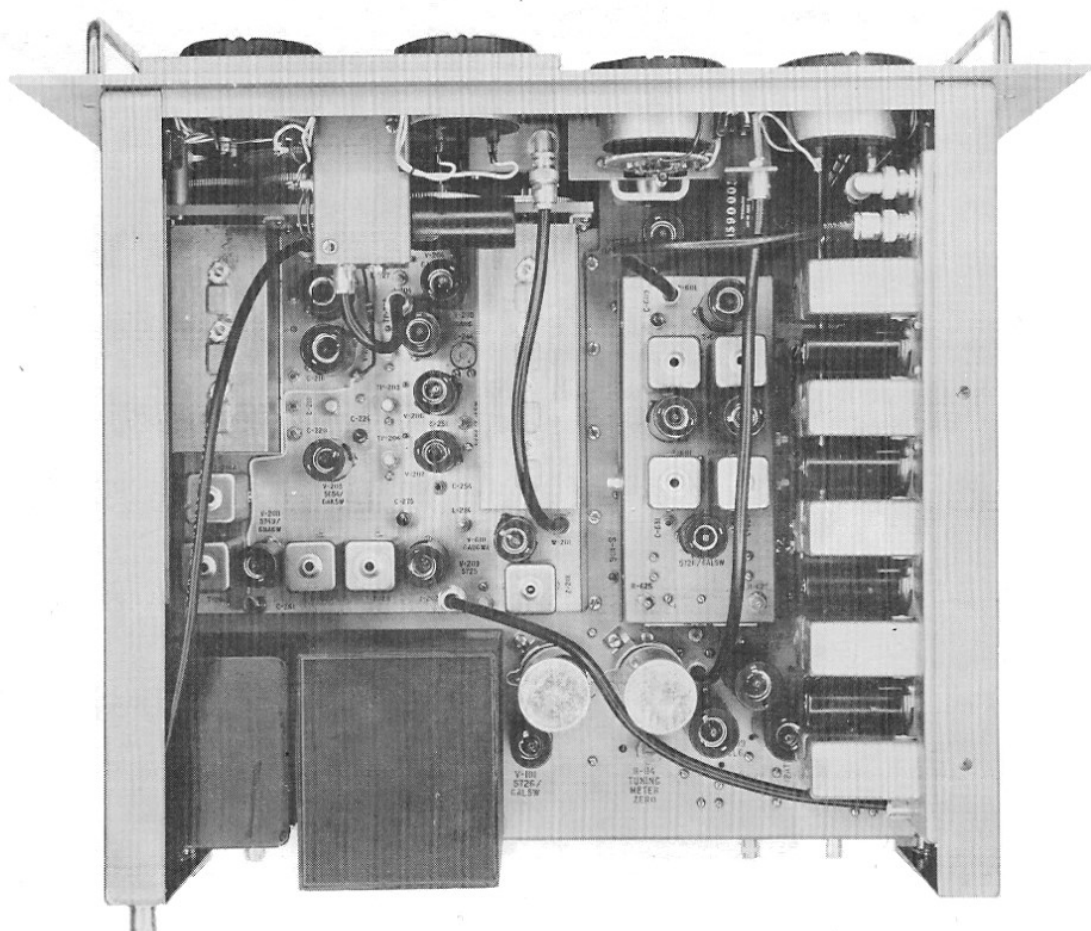


Figure 4-13. Model TMR-2A Receiver, Top View

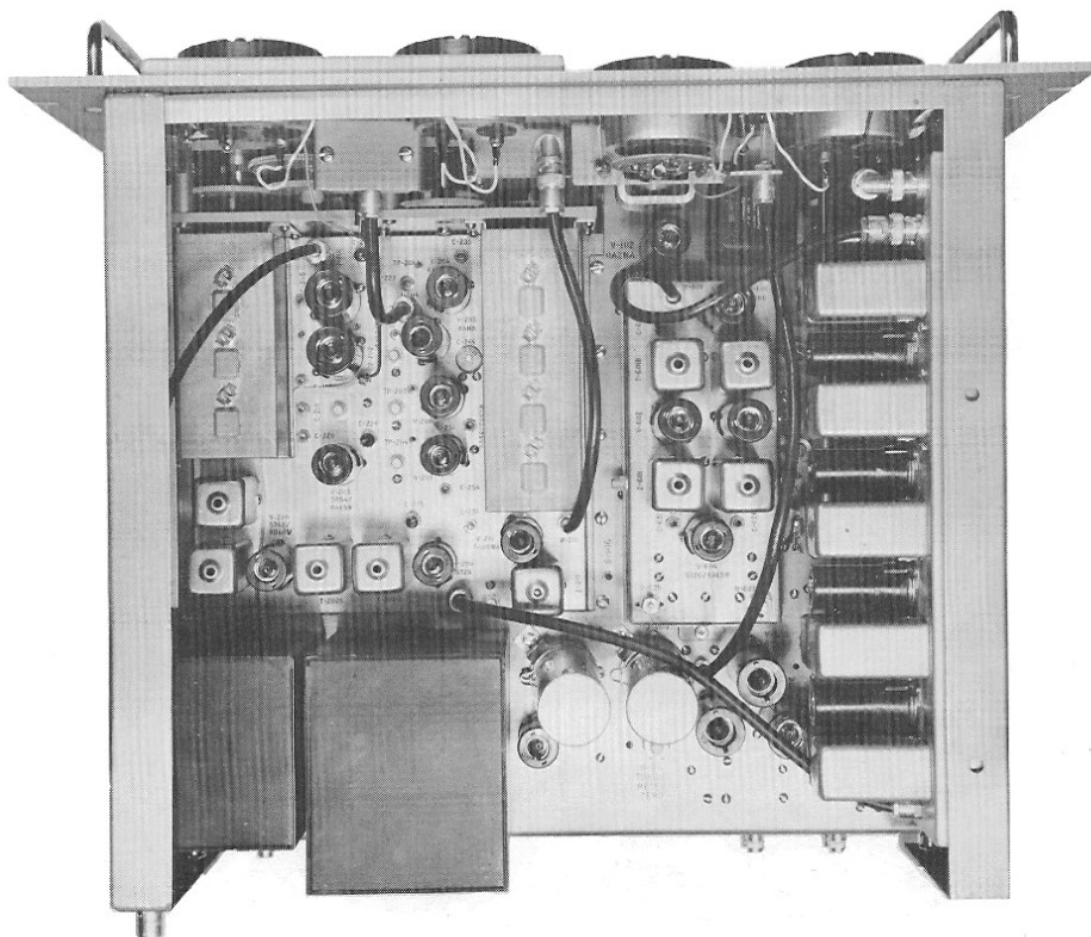


Figure 4-14. Model TMR-2A(1) Receiver, Top View

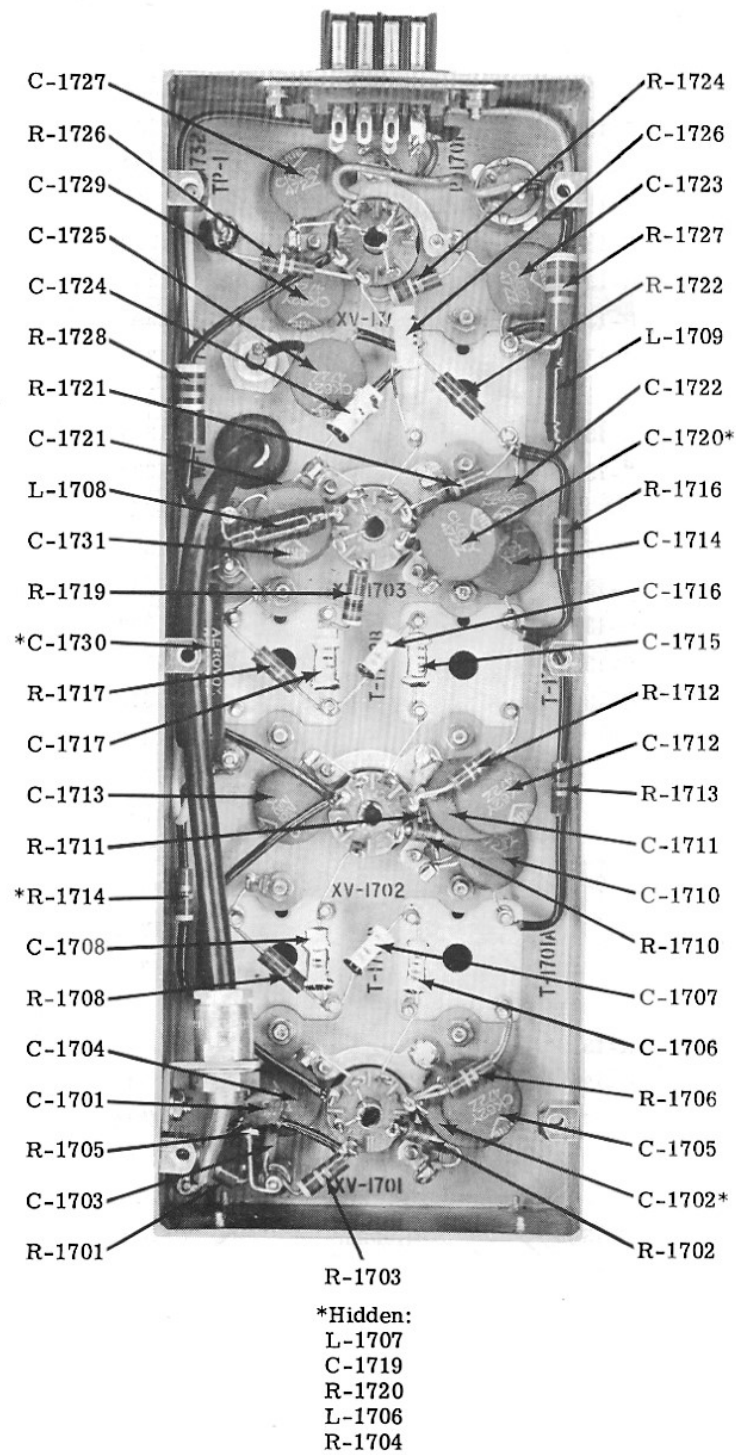


Figure 4-15. Model PDA-A2 Predetection Amplifier, Bottom View

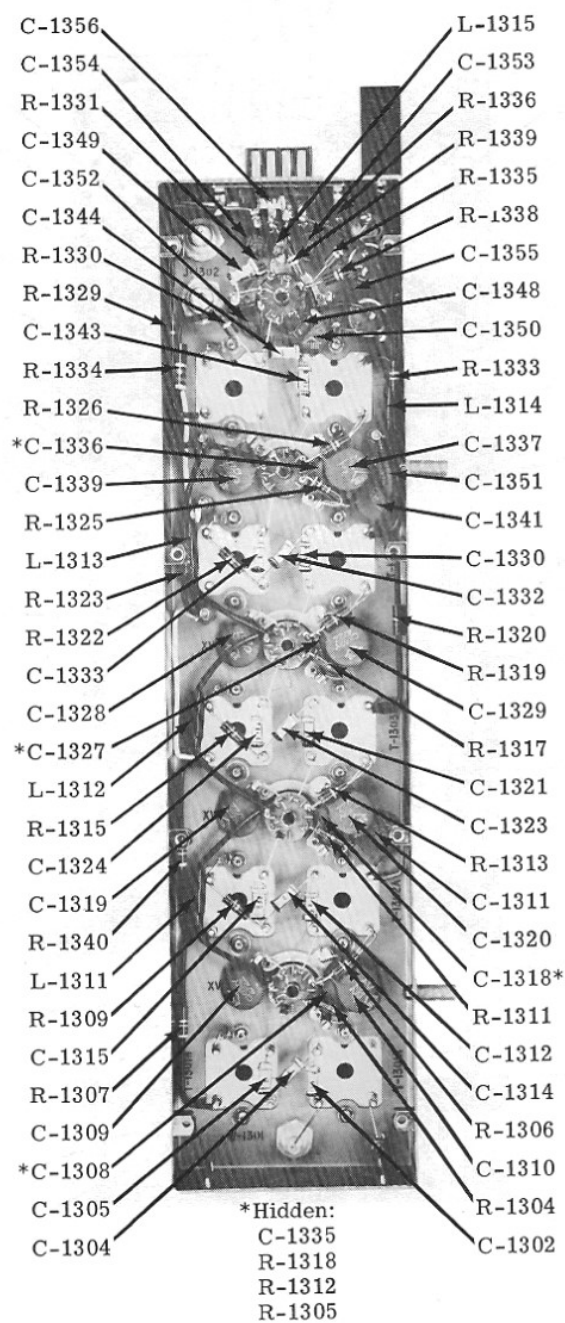


Figure 4-16. Model IFA-A2 100-kc IF Amplifier, Bottom View

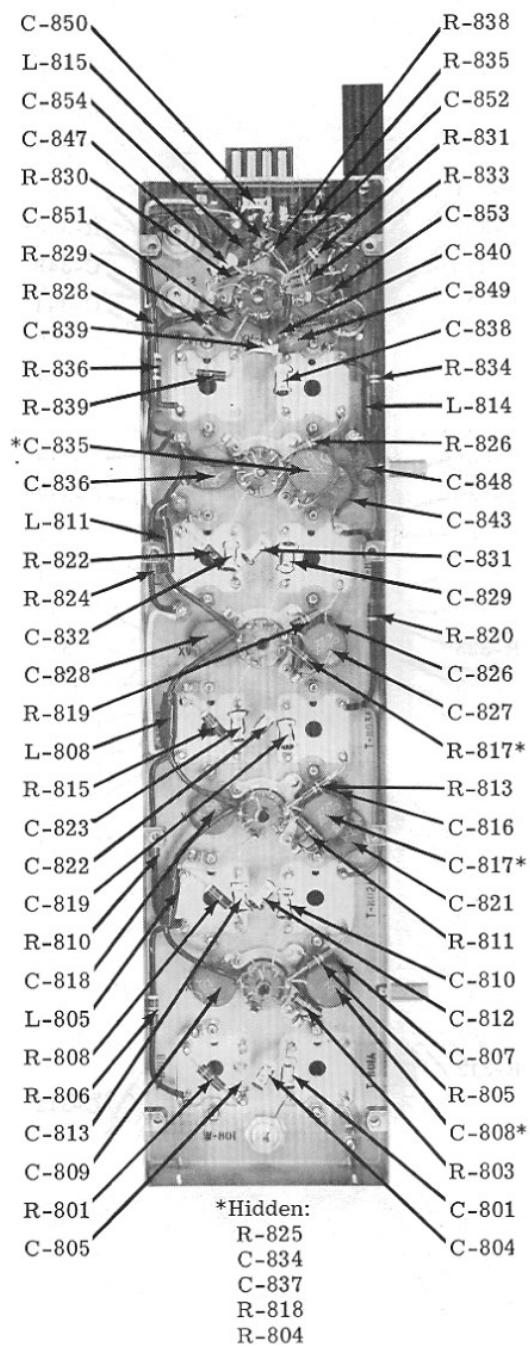


Figure 4-17. Model IFA-B2 200-kc IF Amplifier, Bottom View

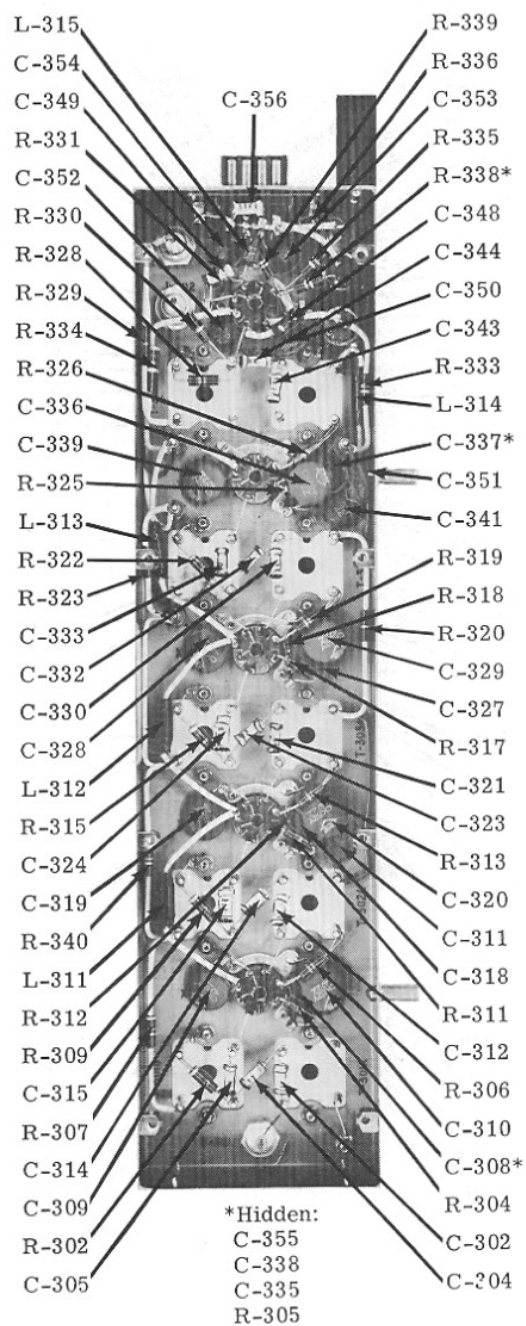


Figure 4-18. Model IFA-C2 300-kc IF Amplifier, Bottom View

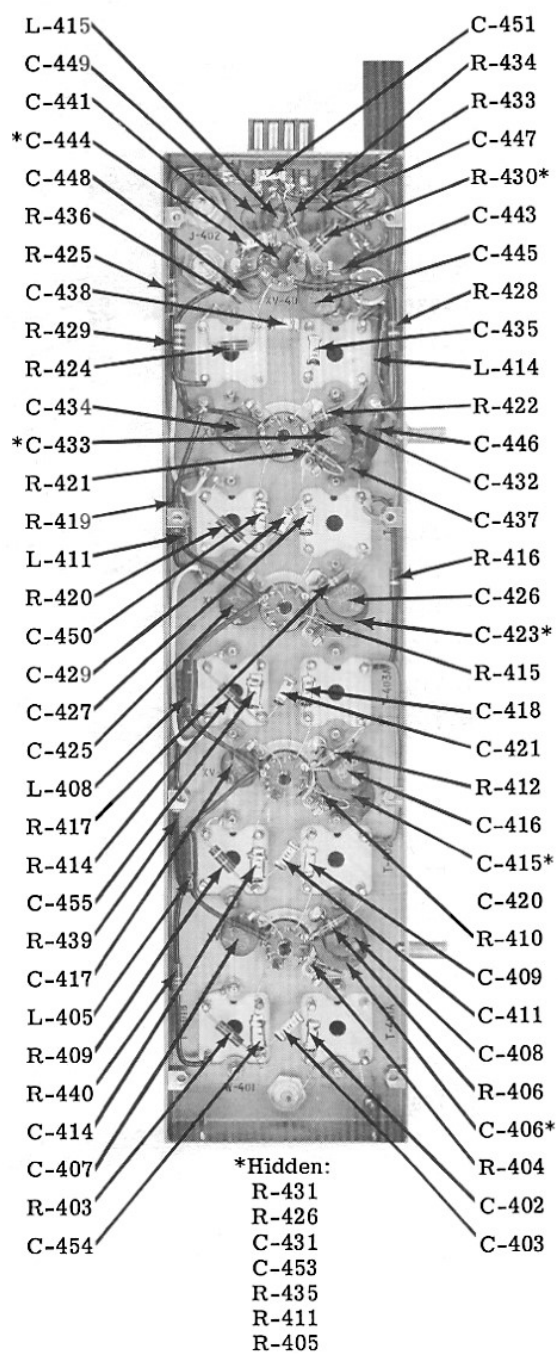


Figure 4-19. Model IFA-D2 500-kc IF Amplifier, Bottom View

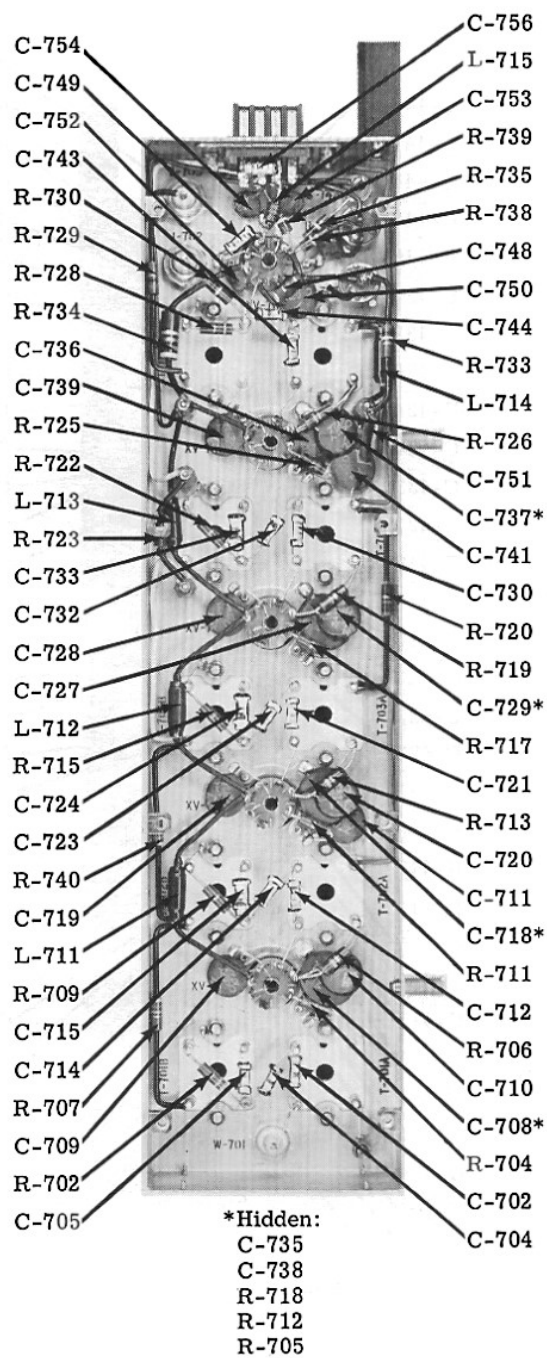


Figure 4-20. Model IFA-E2 750-kc IF Amplifier, Bottom View

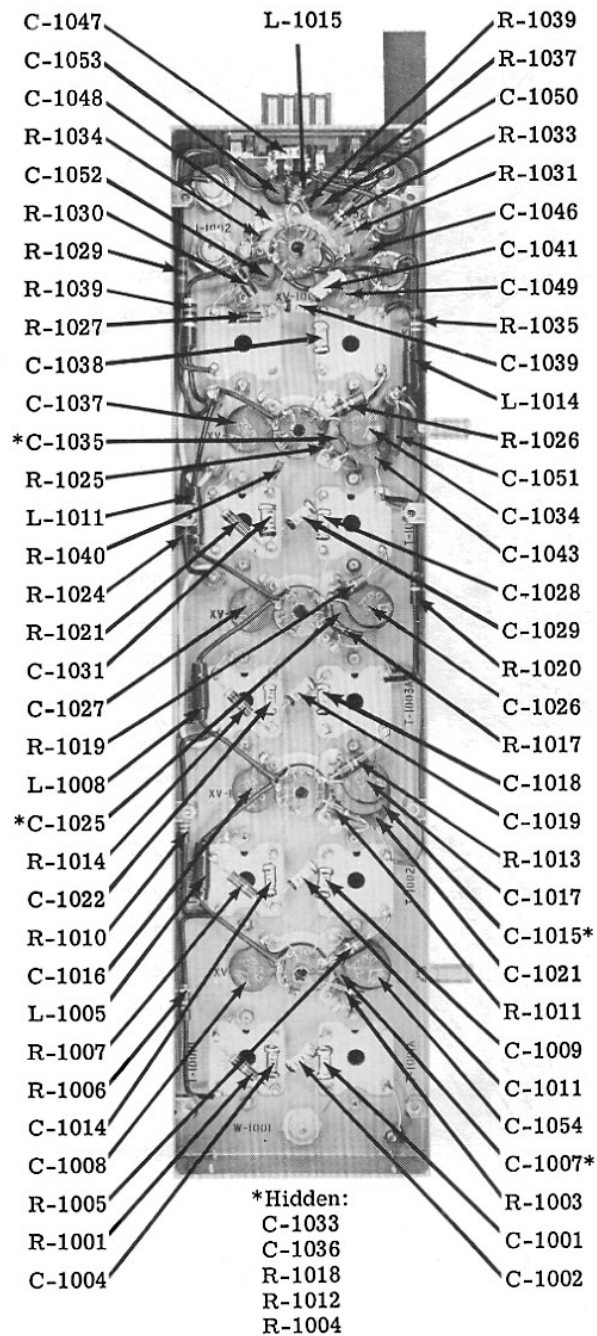


Figure 4-21. Model IFA-F2 1-mc IF Amplifier, Bottom View

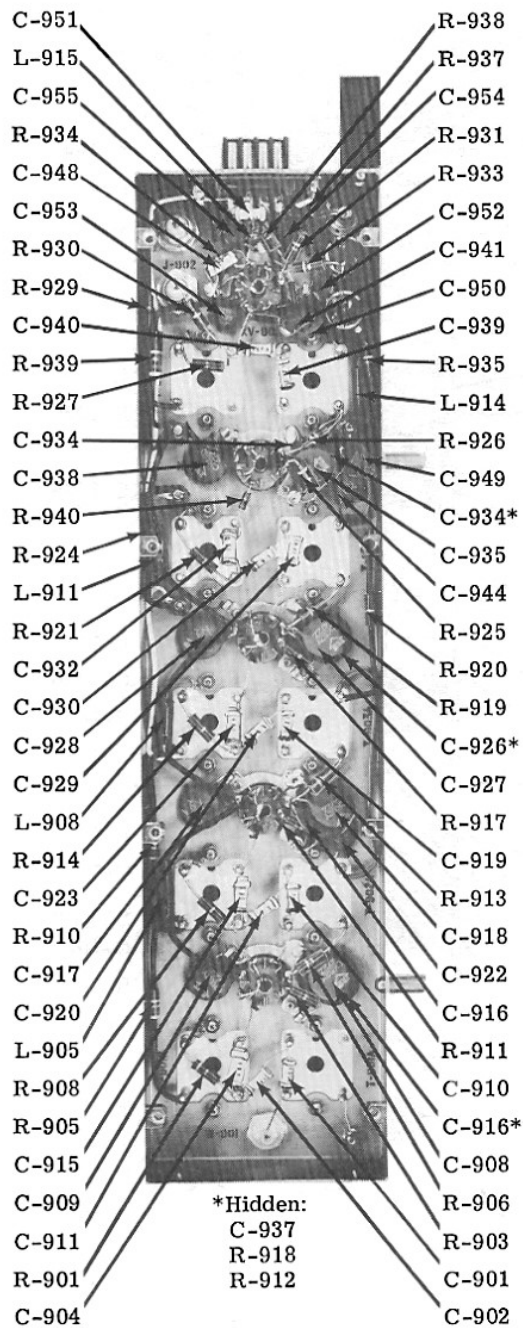


Figure 4-22. Model IFA-G2 1.5-mc IF Amplifier, Bottom View

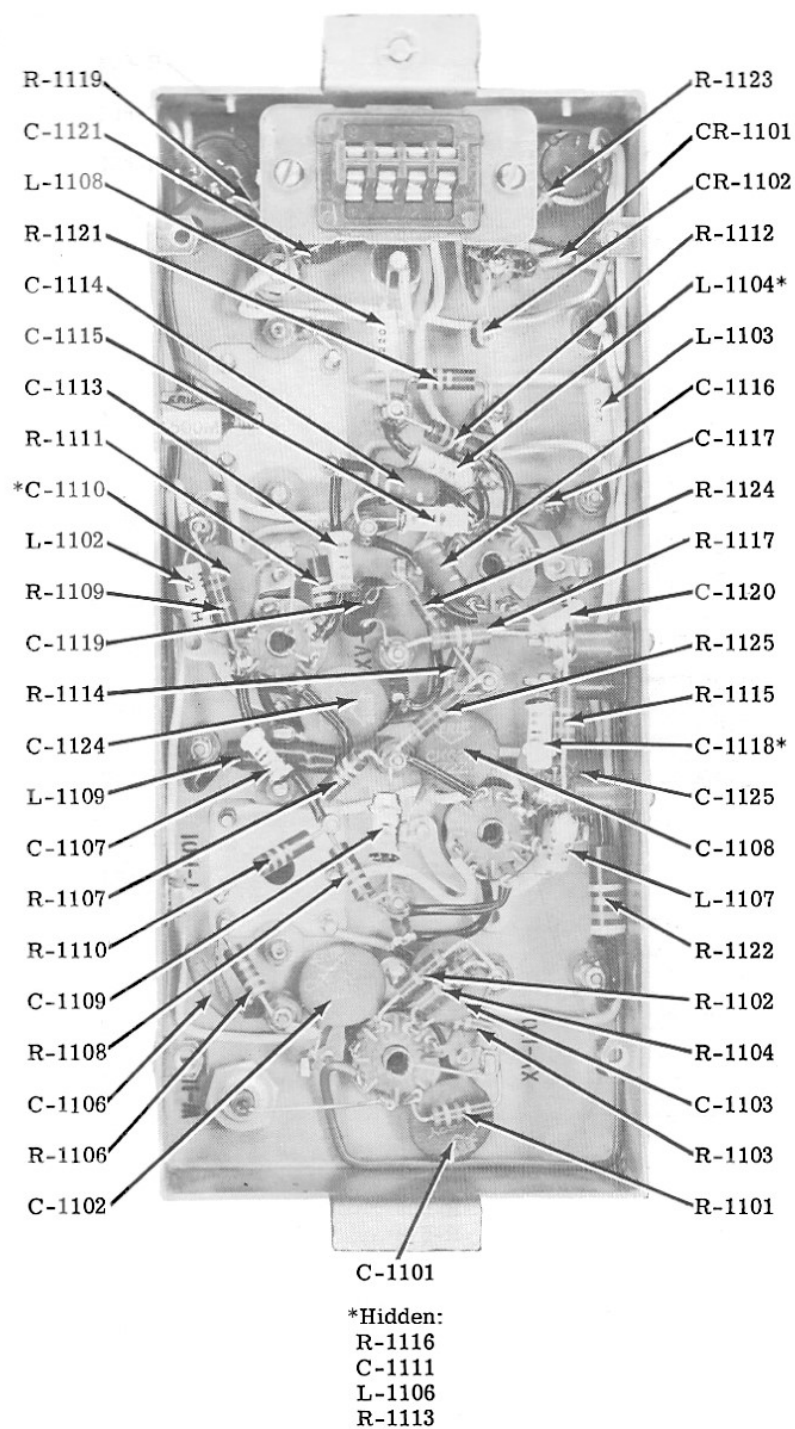


Figure 4-23. Model PLD-A2 Phase-Lock Subchassis, Bottom View

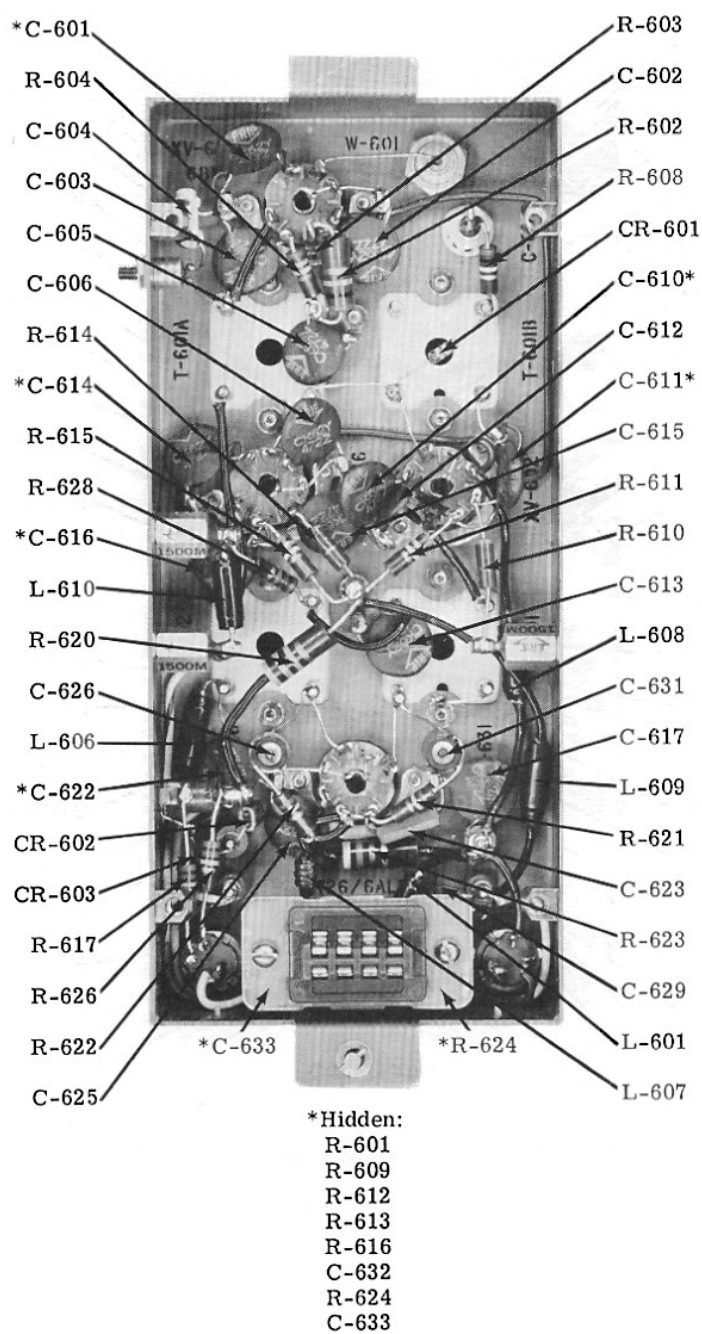


Figure 4-24. Model FMD-A2 Limiter-Discriminator Subchassis, Bottom View

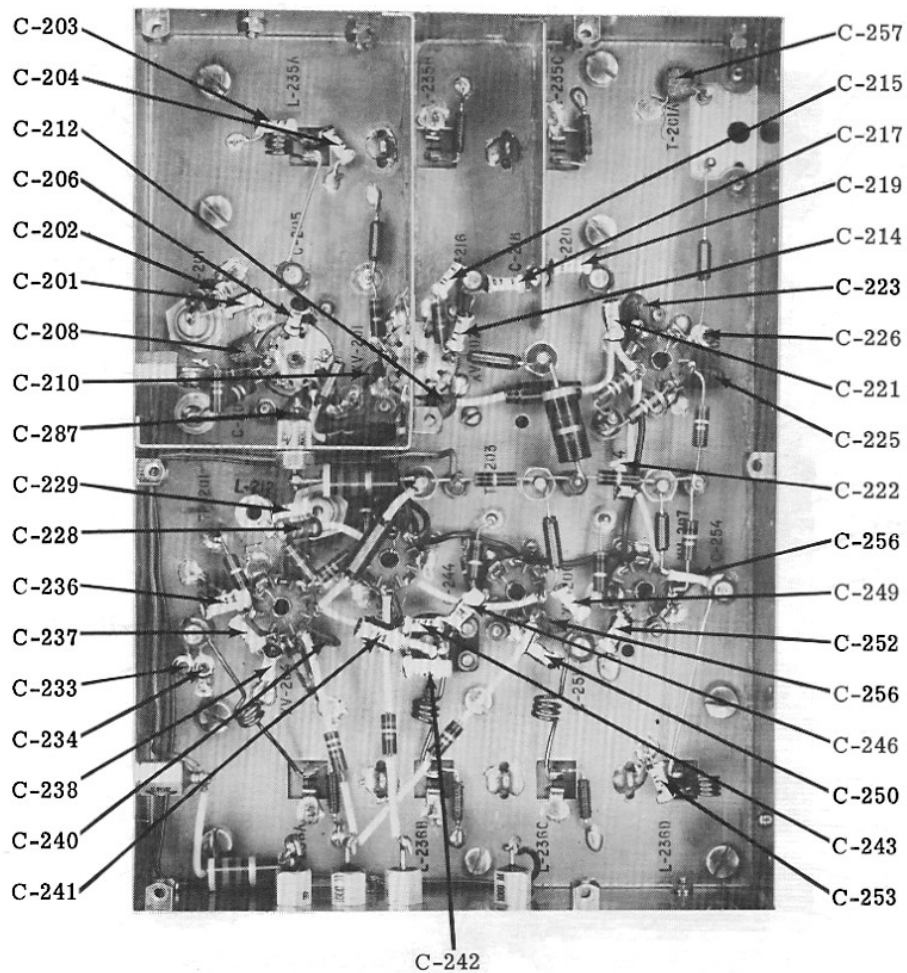


Figure 4-25. Model TMR-2A Receiver RF Section, Capacitor Location



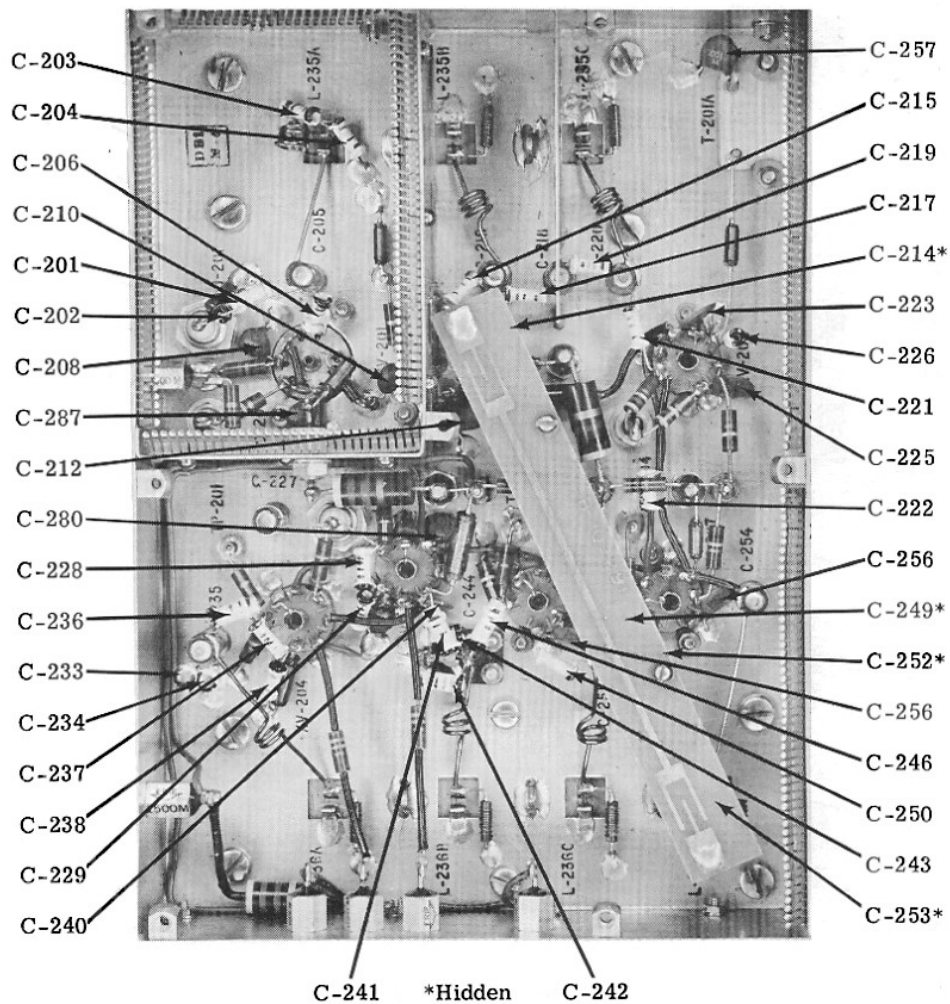
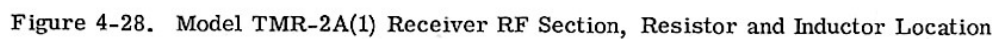


Figure 4-27. Model TMR-2A(1) Receiver RF Section, Capacitor Location



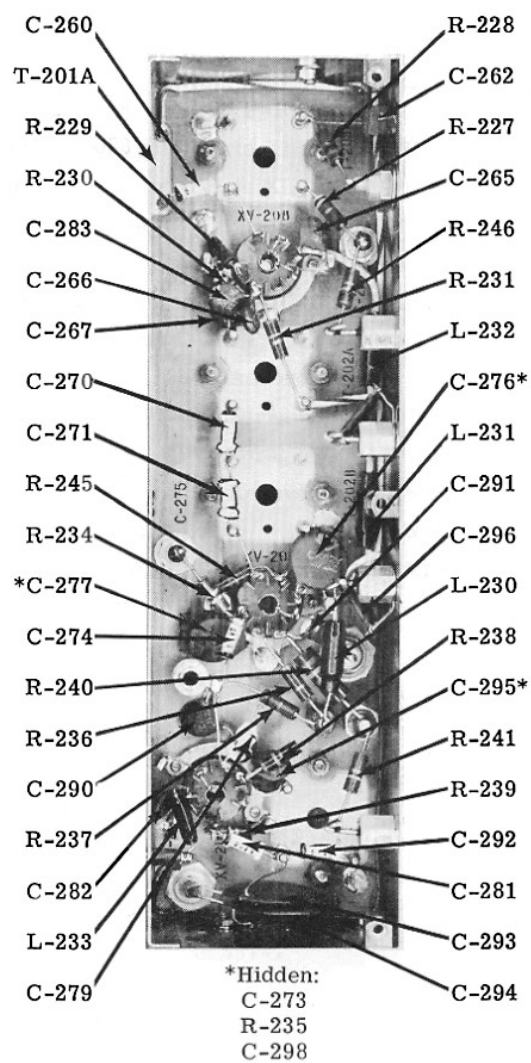
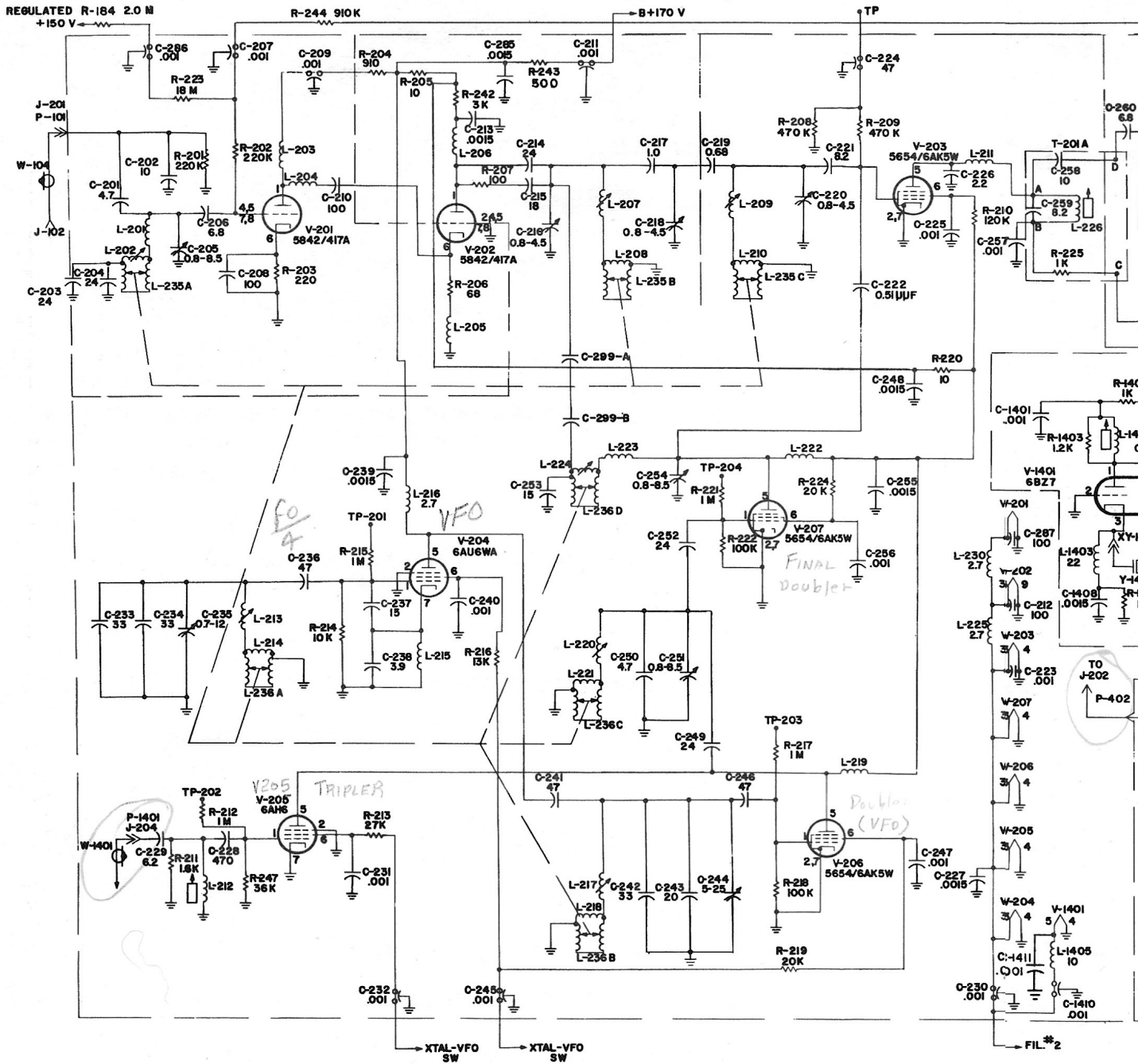
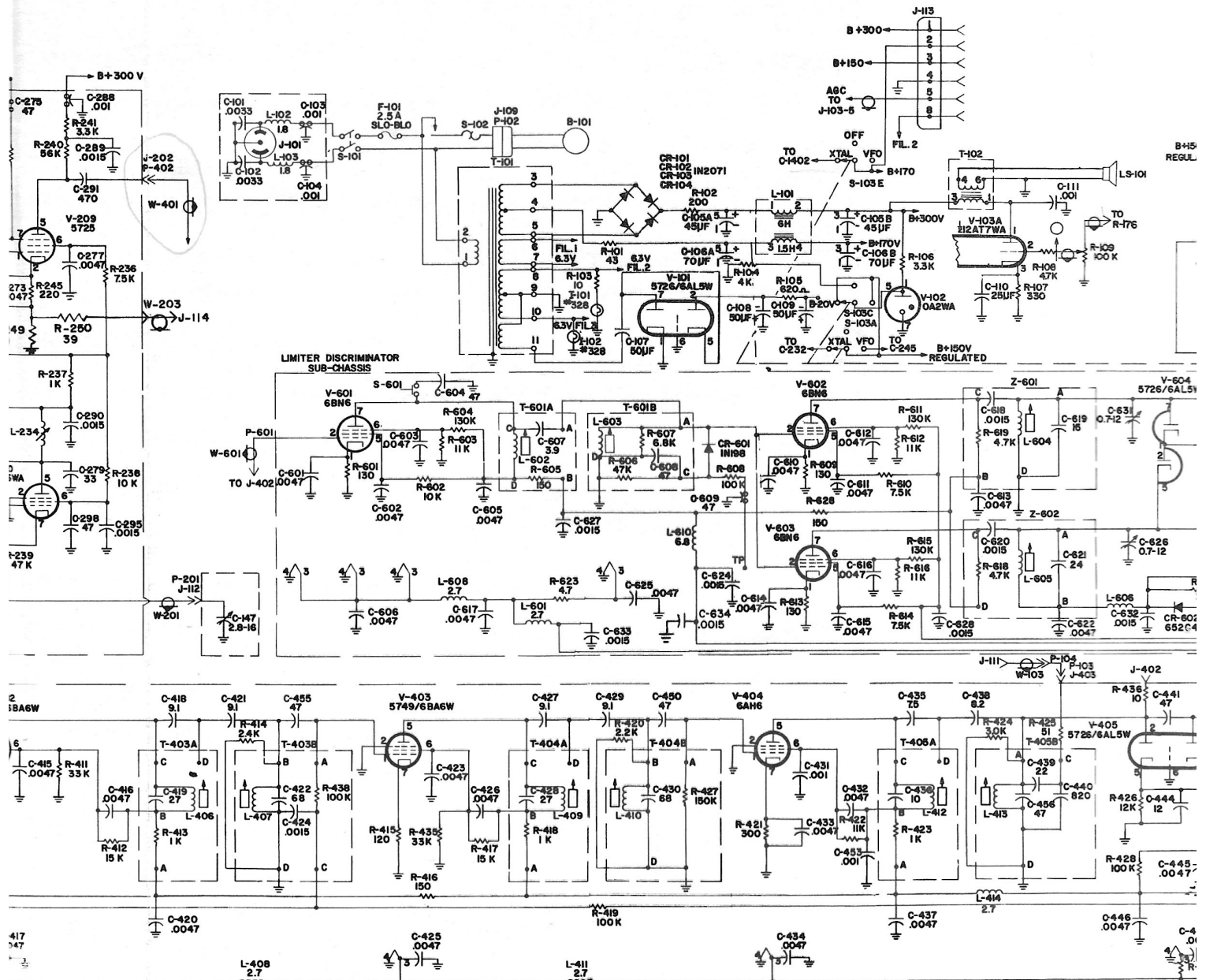
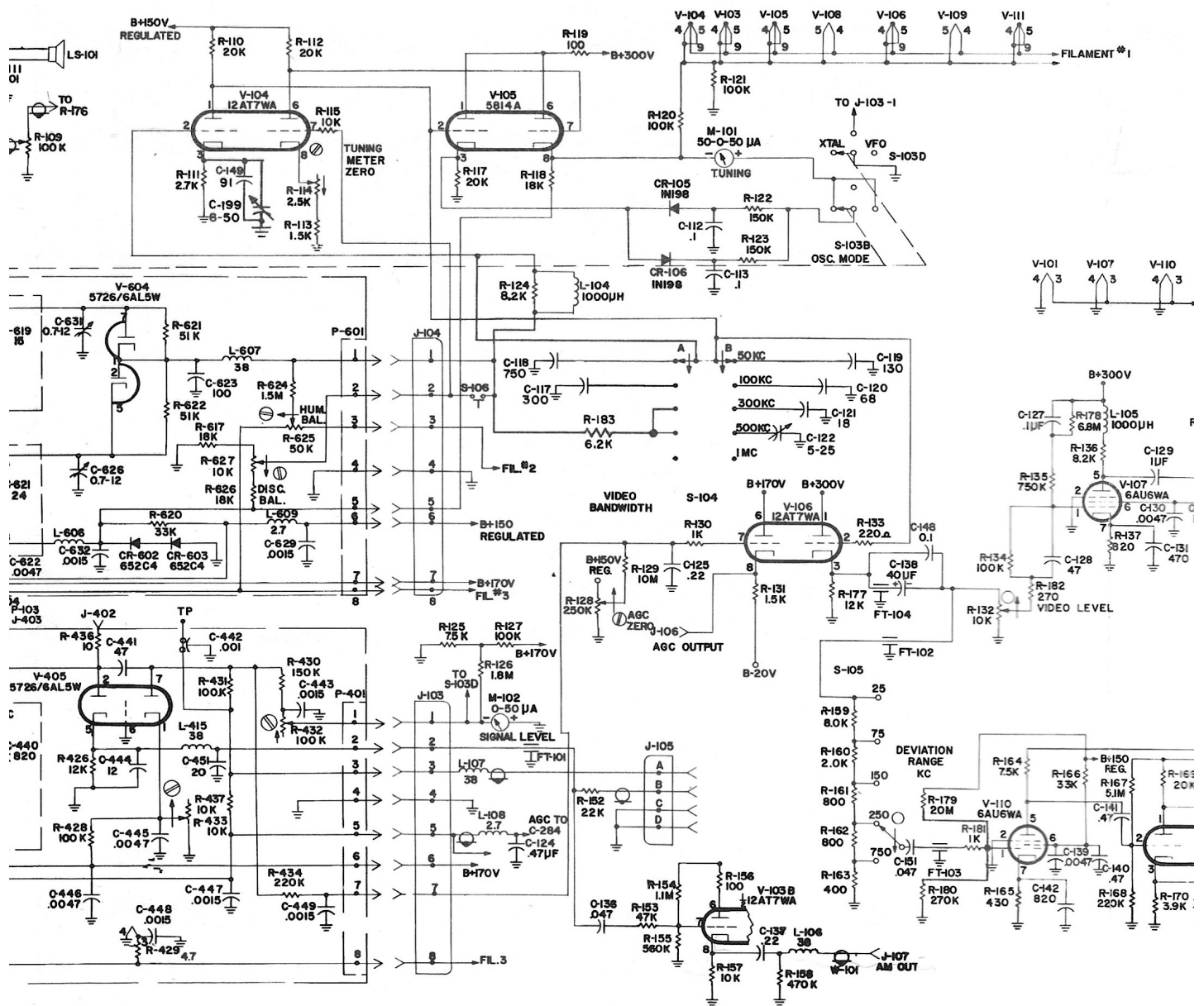
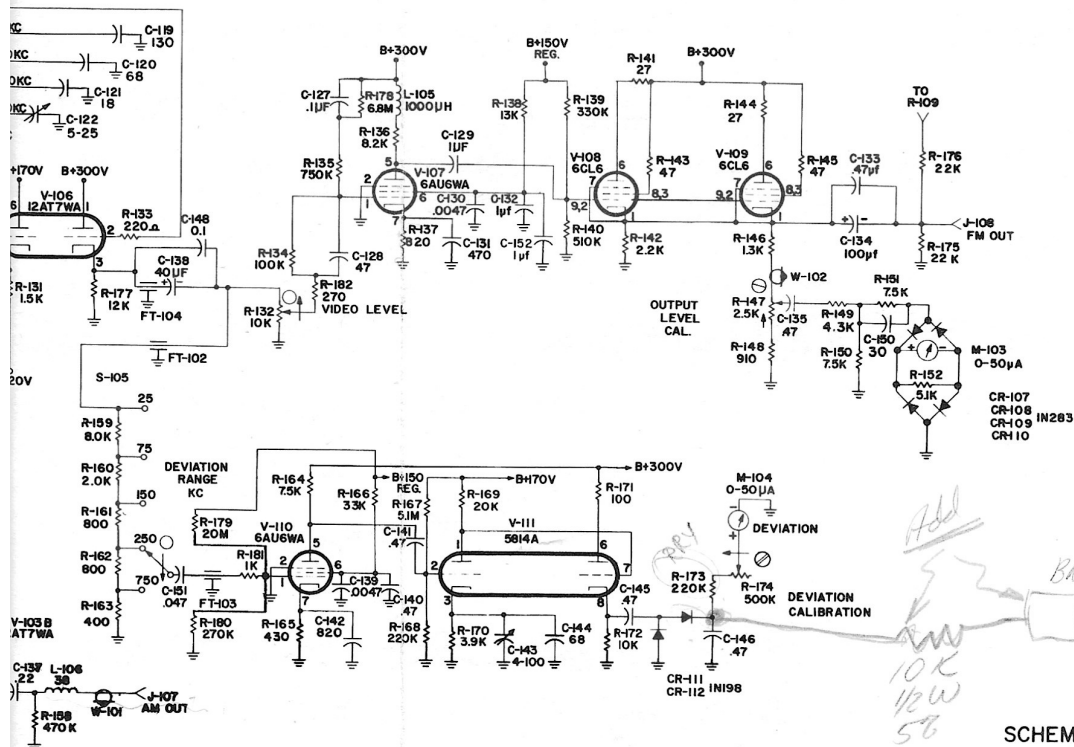
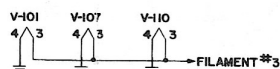
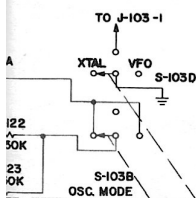


Figure 4-29. Model TMR-2A Series Receiver First IF Section, Bottom View



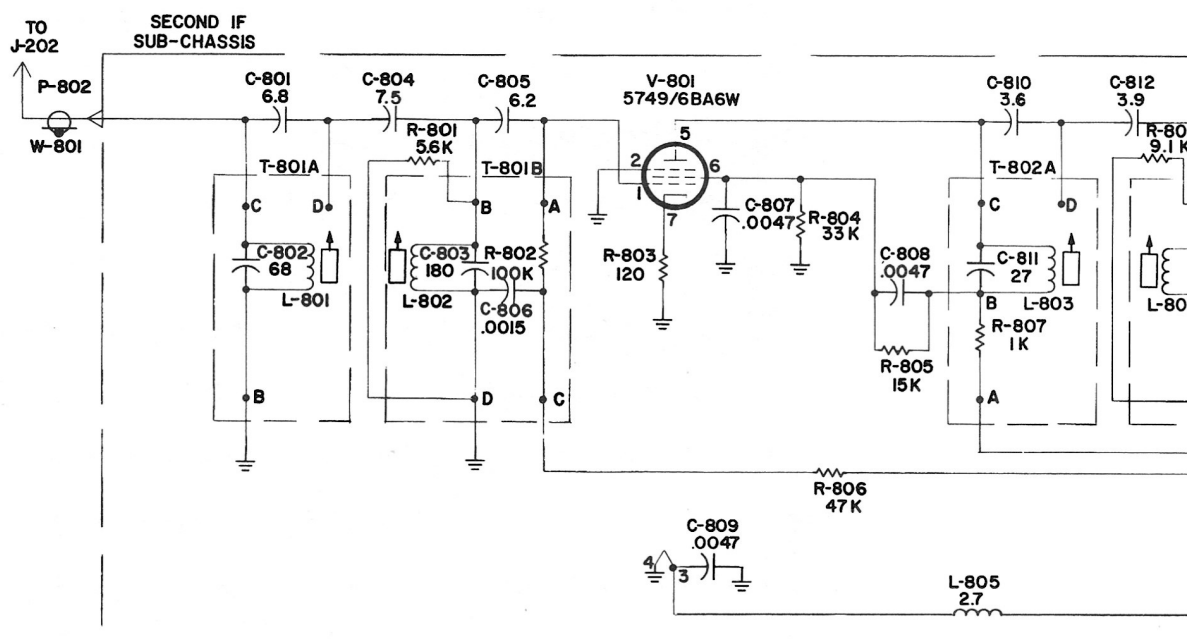
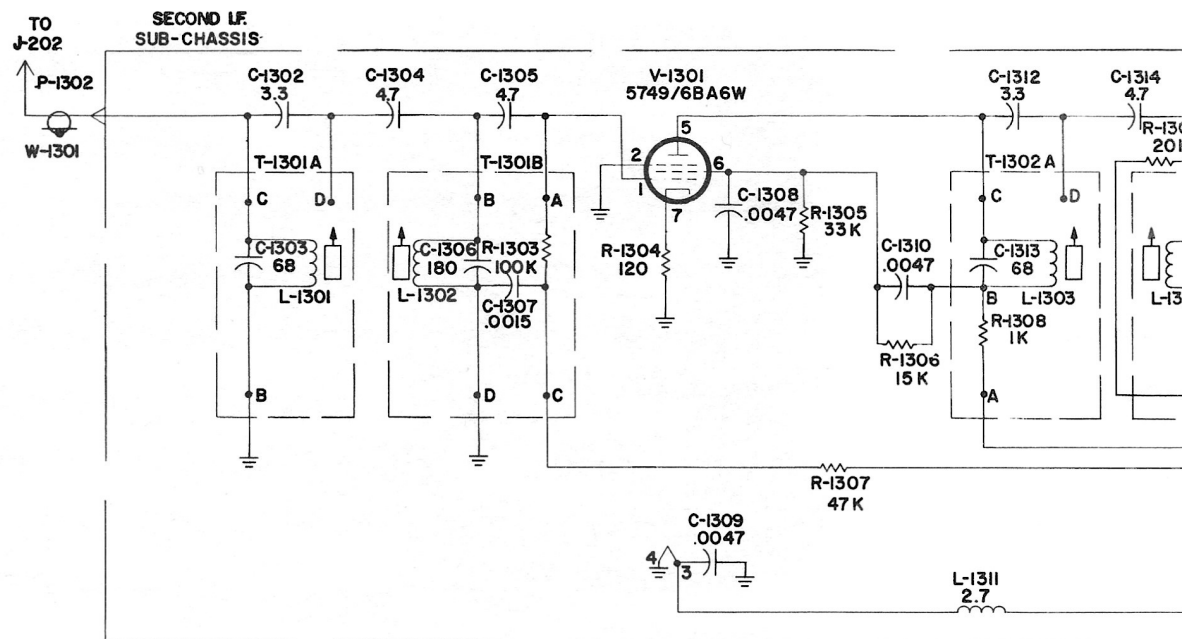


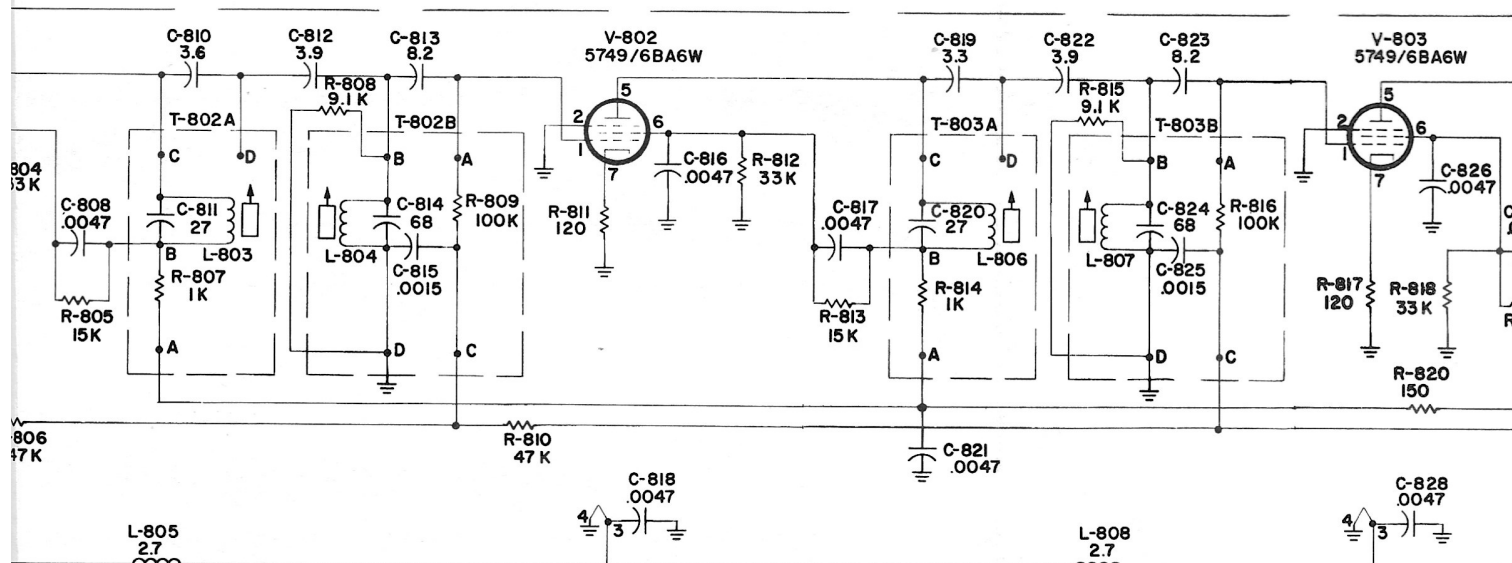


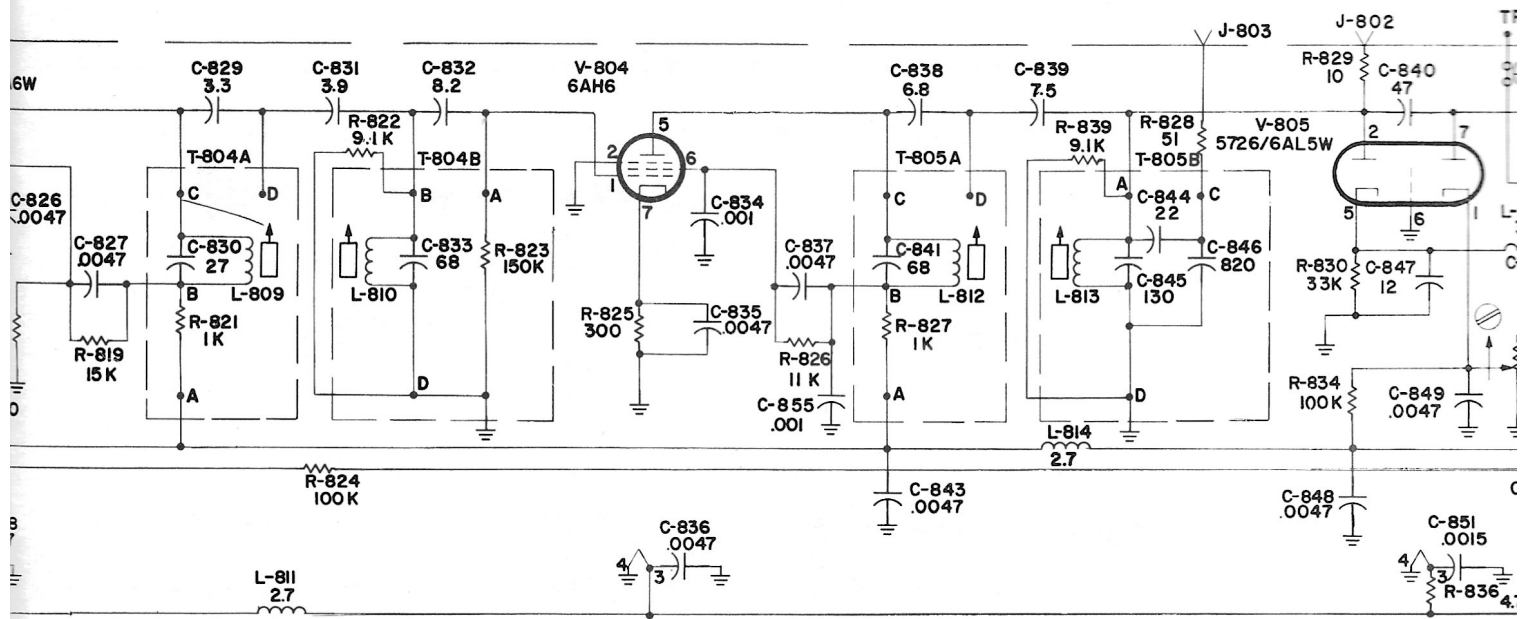
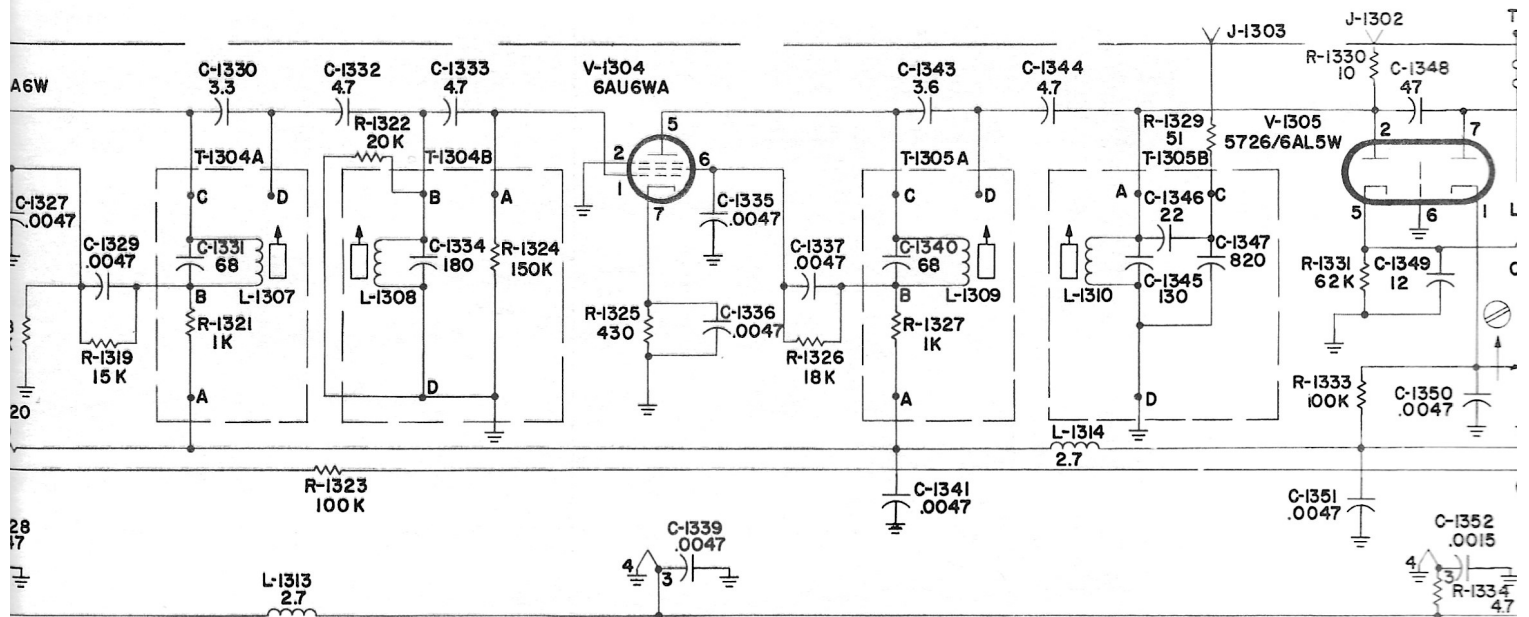


⊘ LOCKED ADJUSTMENT AVAILABLE
ON FRONT PANEL.

R-10-771







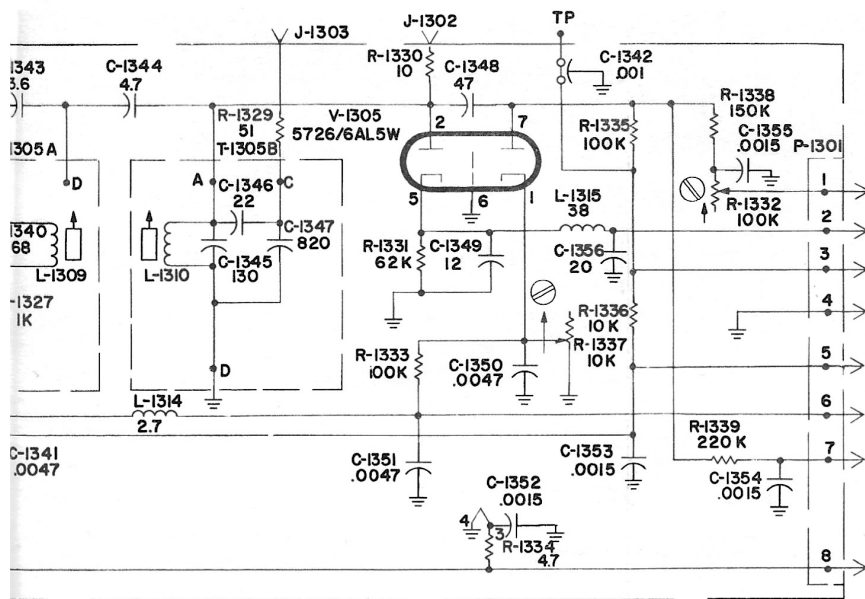


Figure 6-3. Model IFA-A2 100-kc IF Amplifier, Schematic Diagram

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.

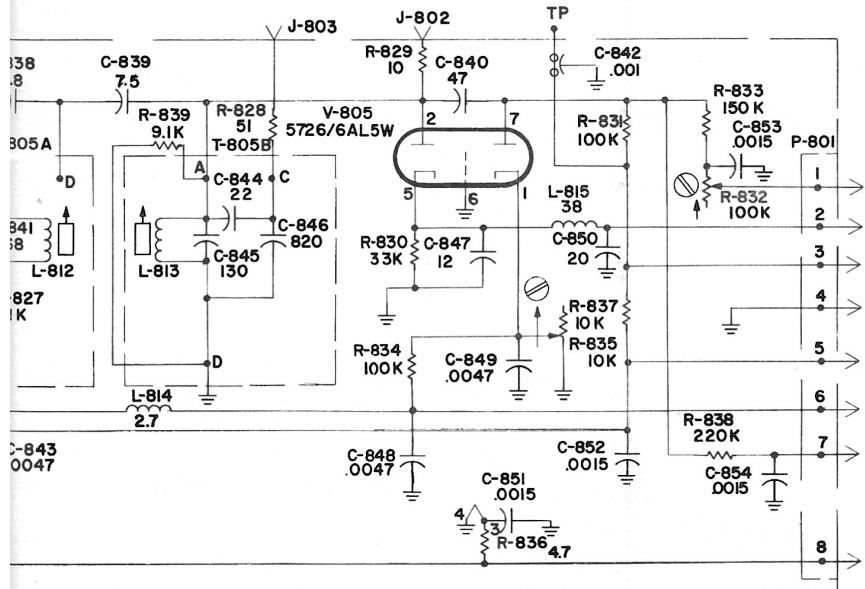
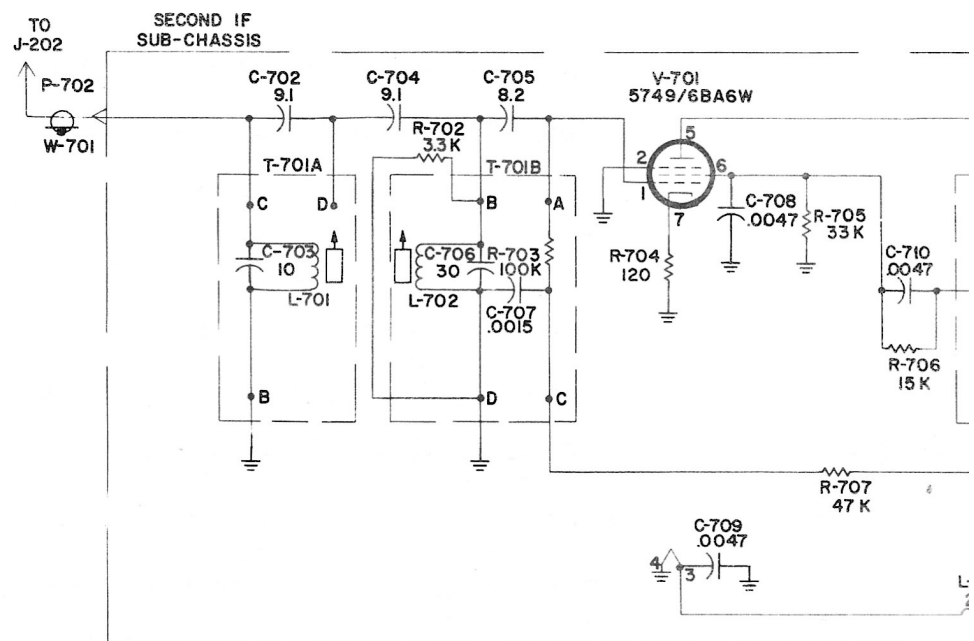
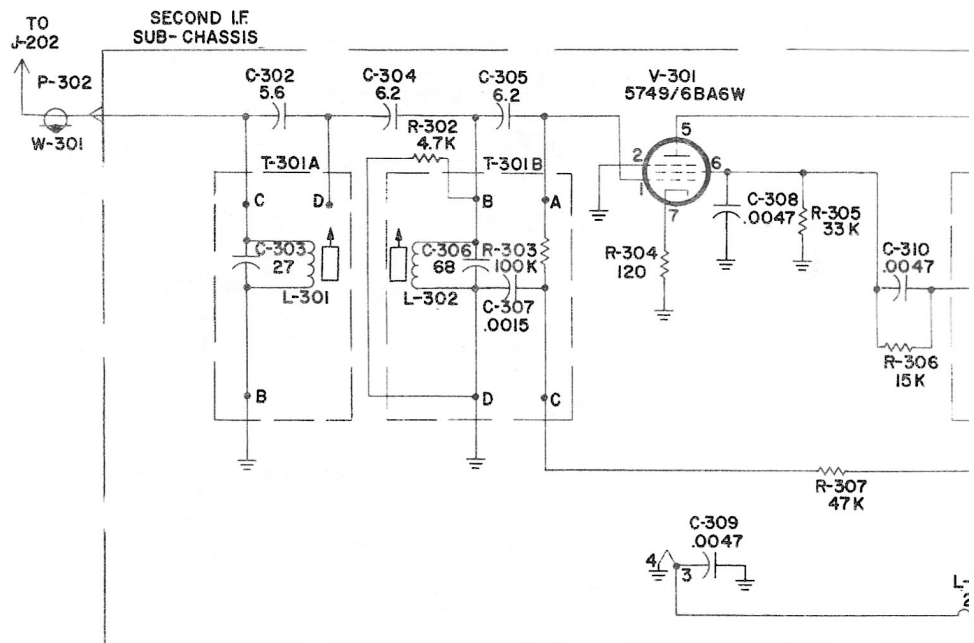
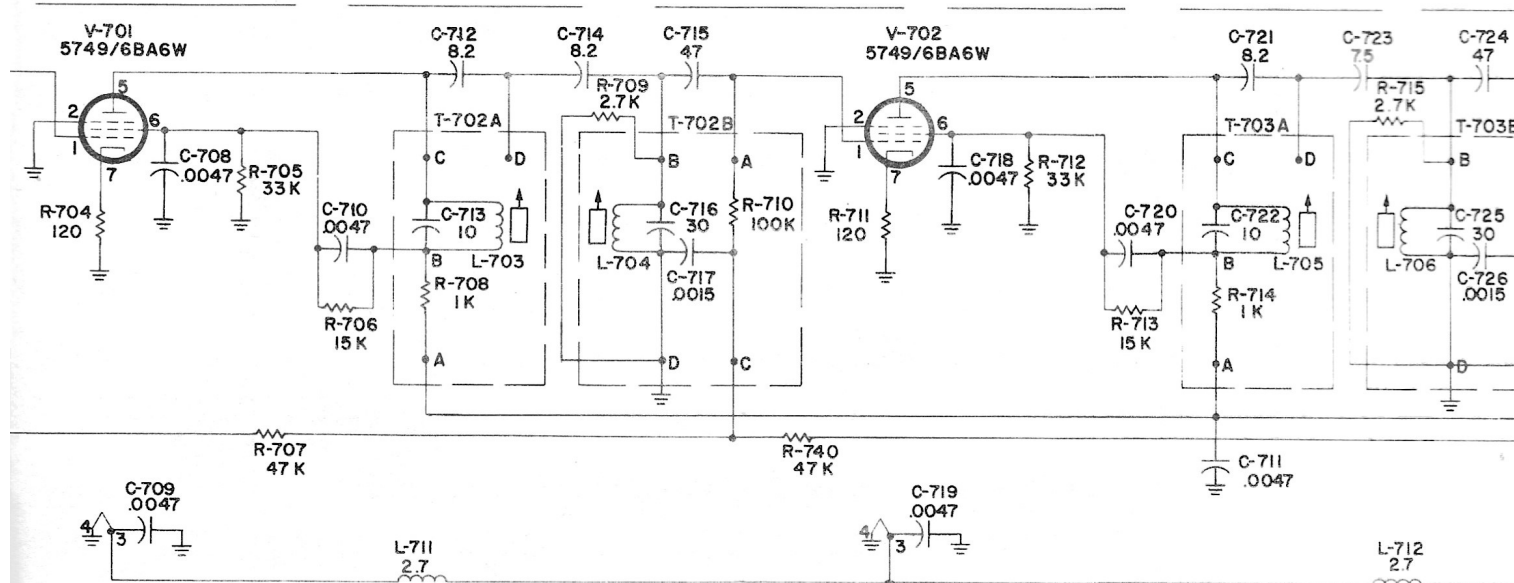
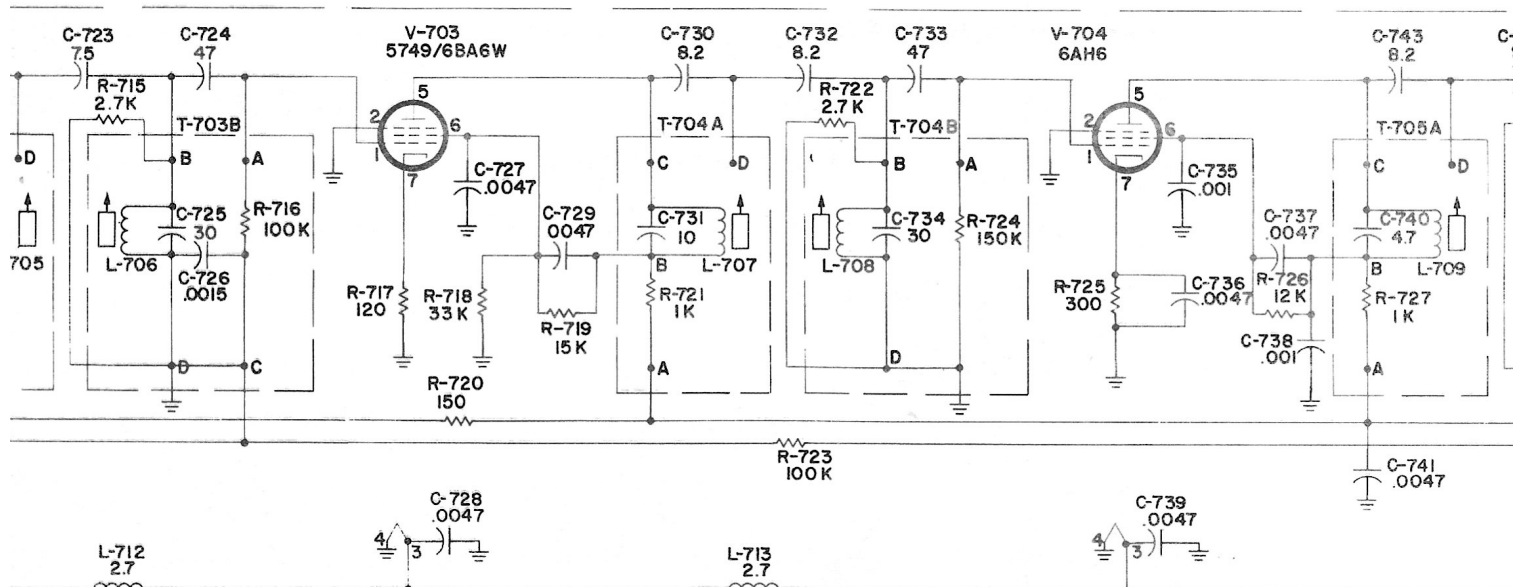
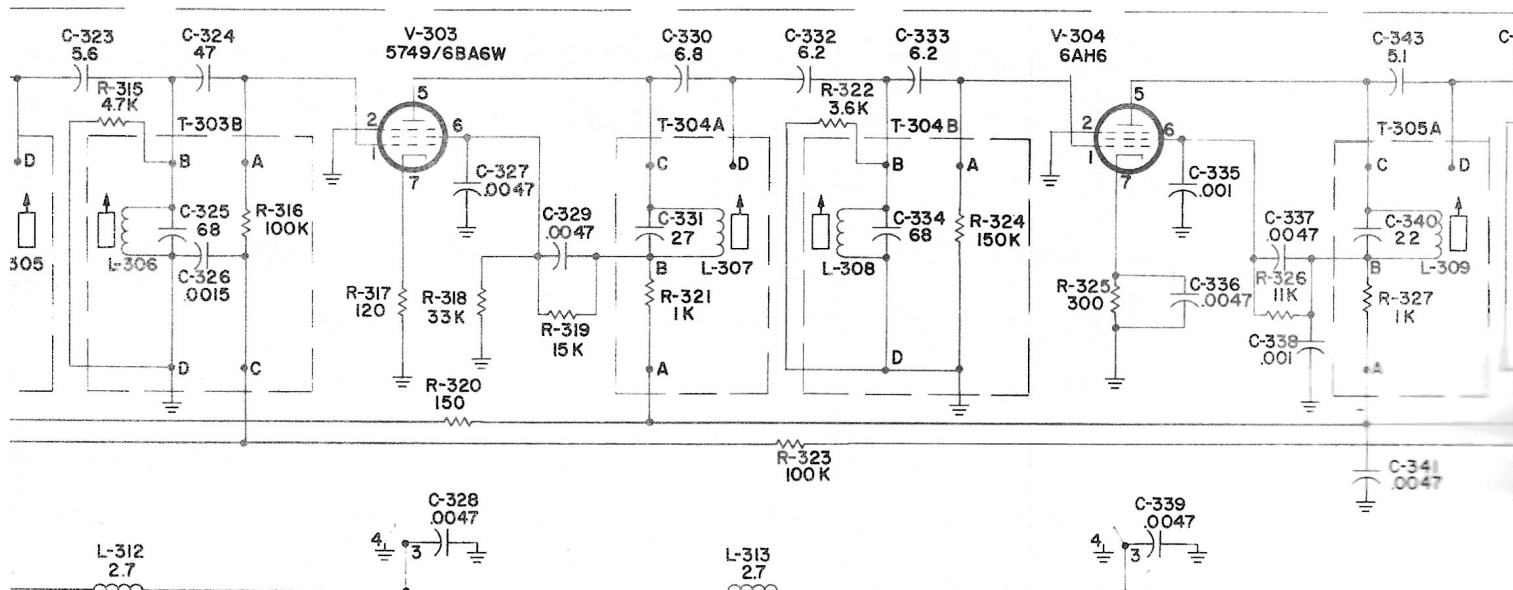


Figure 6-4. Model IFA-B2 200-kc IF Amplifier, Schematic Diagram







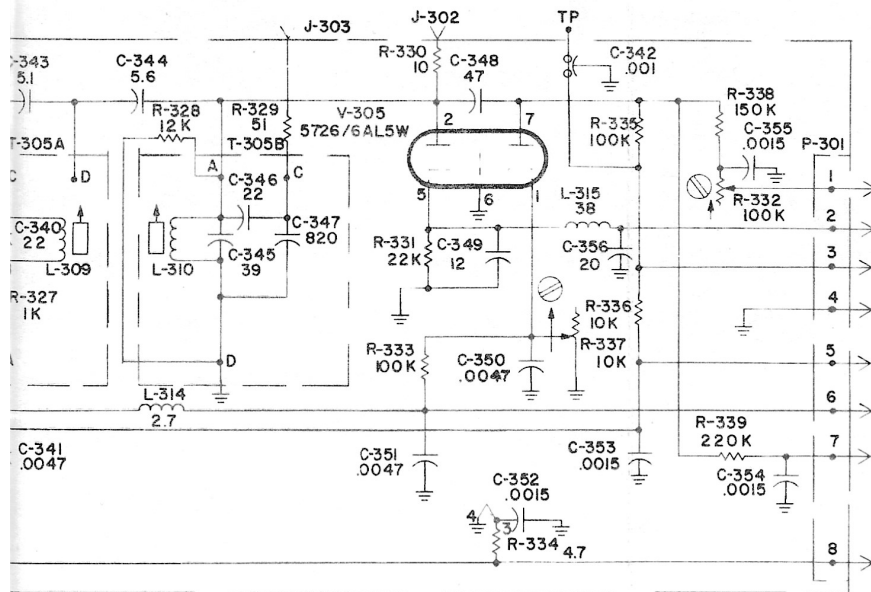
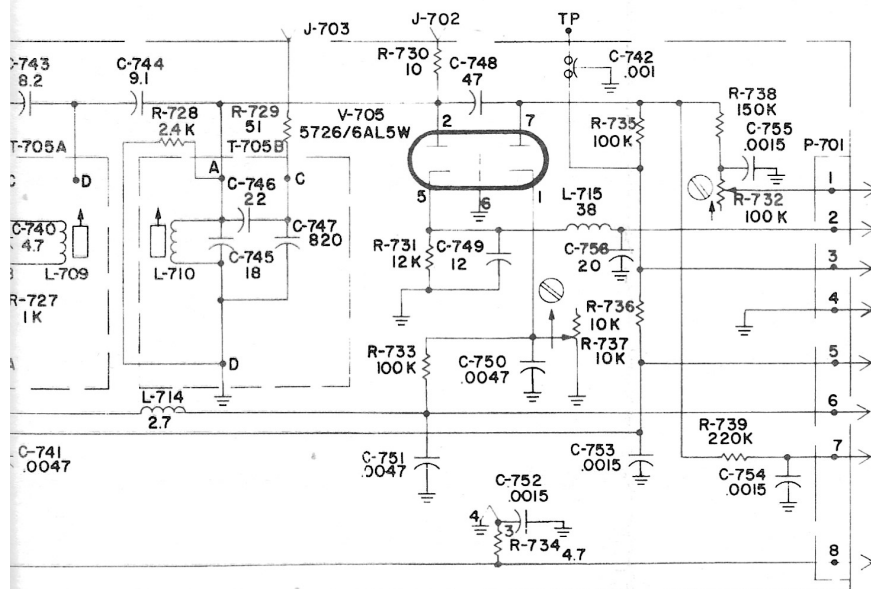


Figure 6-5. Model IFA-C2 300-kc IF Amplifier, Schematic Diagram



NOTE:

UNLESS OTHERWISE NOTED:

1. CAPACITOR VALUES LESS THAN ONE ARE IN MICROFARADS.

CAPACITOR VALUES GREATER THAN ONE ARE IN MICROMICROFARADS.

2. INDUCTANCE VALUES ARE IN MICROHENRYS.

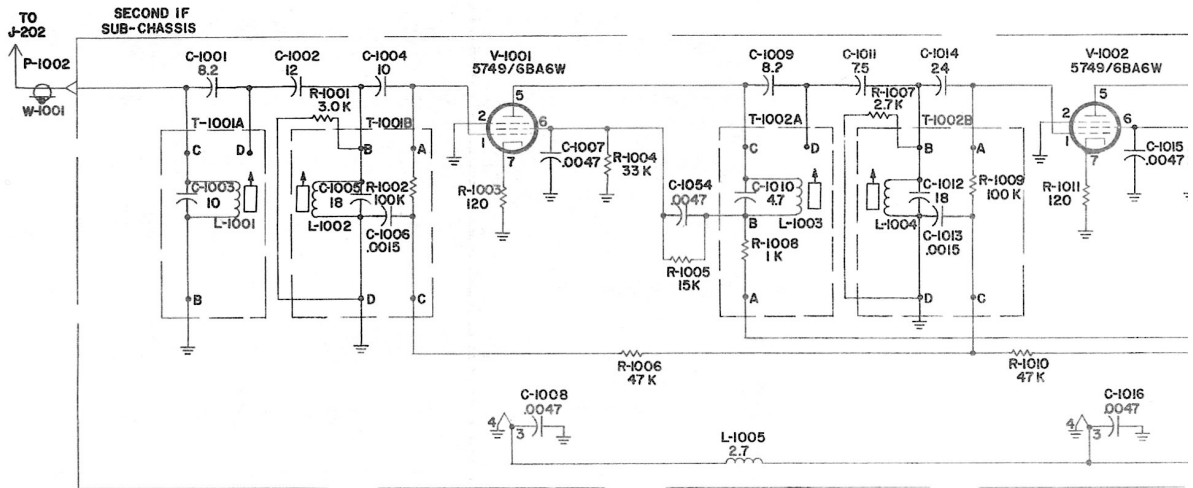
3. RESISTOR VALUES ARE IN OHMS, K=1000, M=1,000,000

⊗ INTERNAL ADJUSTMENT

↻ ARROW DENOTES CLOCKWISE ROTATION.

Figure 6-6. Model IFA-E2 750-kc IF Amplifier, Schematic Diagram

(Series F)



NOTE:

UNLESS OTHERWISE NOTED:

1. CAPACITOR VALUES LESS THAN ONE
ARE IN MICROFARADS

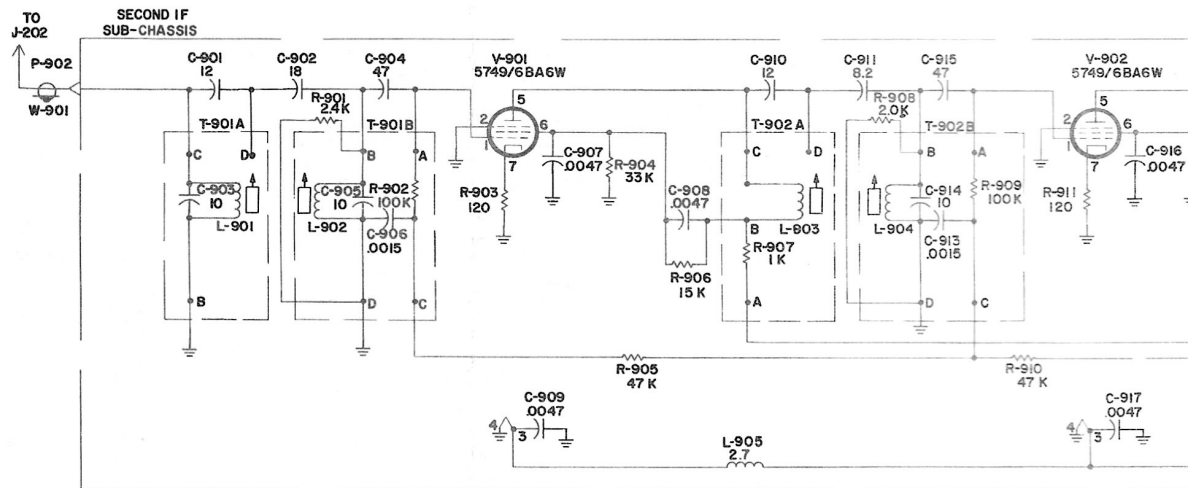
CAPACITOR VALUES GREATER THAN ONE
ARE IN MICROMICROFARADS

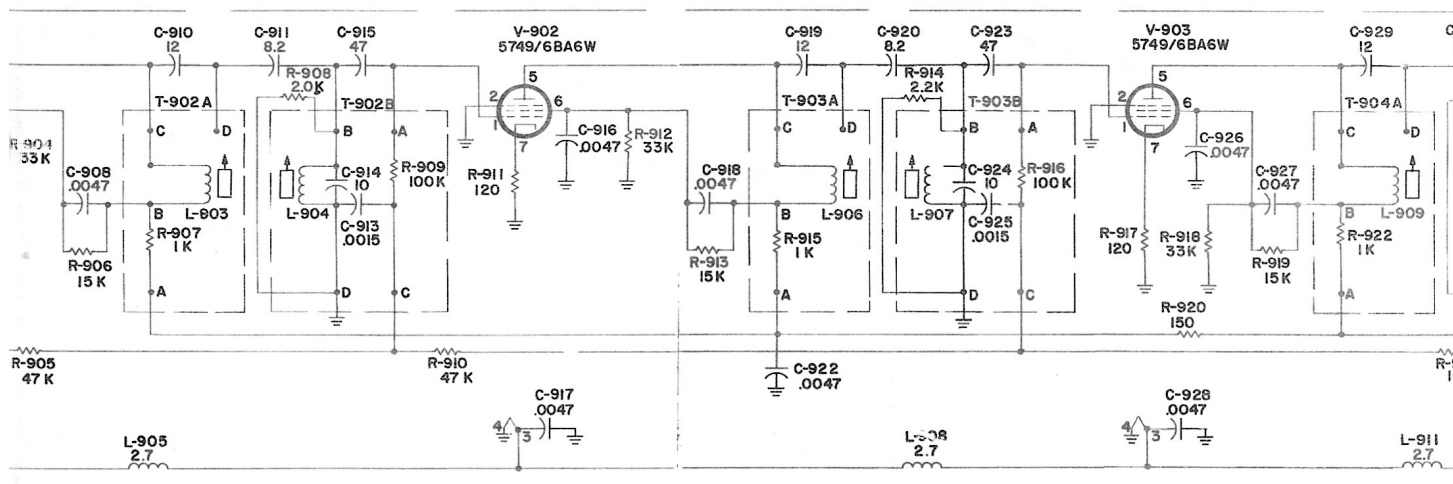
2. INDUCTANCE VALUES ARE IN MICROHENRYS

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

INTERNAL ADJUSTMENT

ARROW DENOTES CLOCKWISE ROTATION





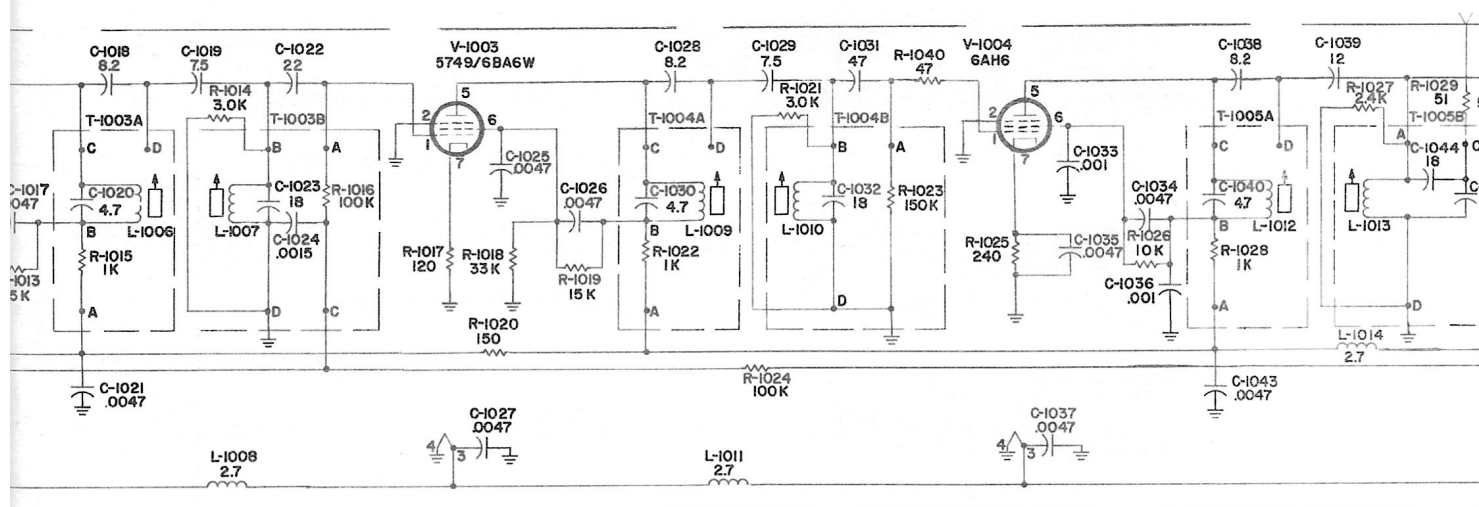


Figure 6-7.

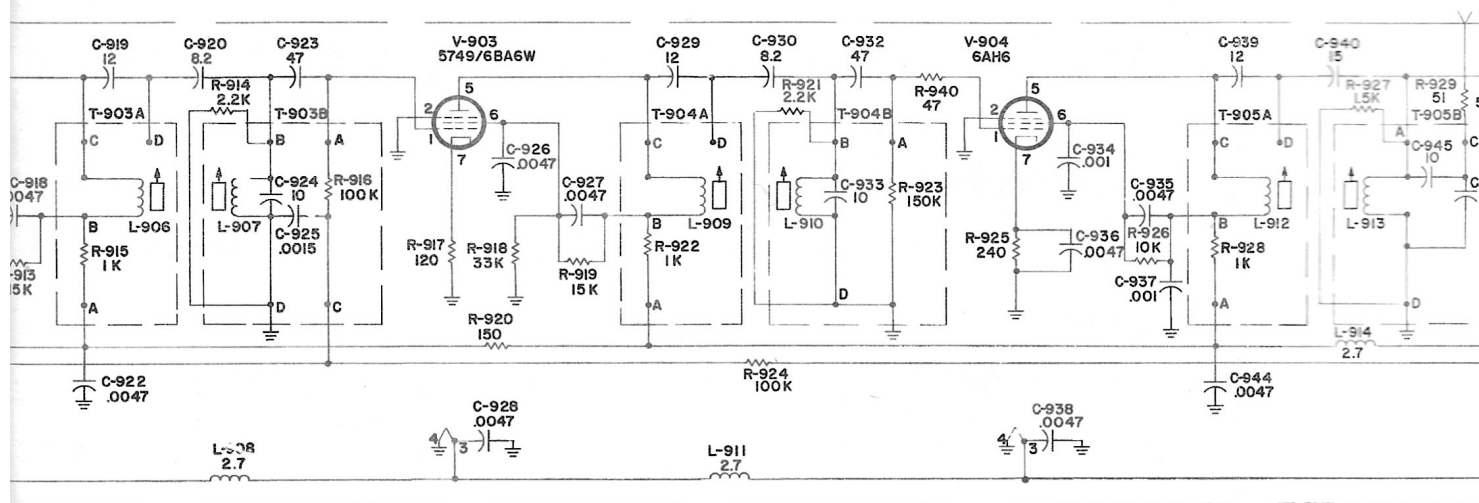


Figure 6-8. A

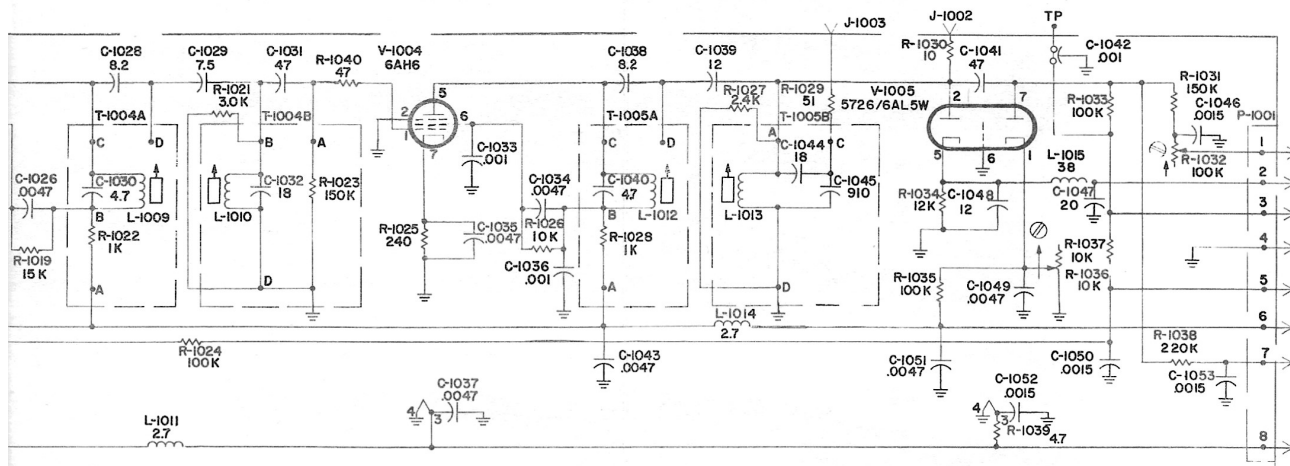


Figure 6-7. Model IFA-Fa 1-mc IF Amplifier, Schematic Diagram

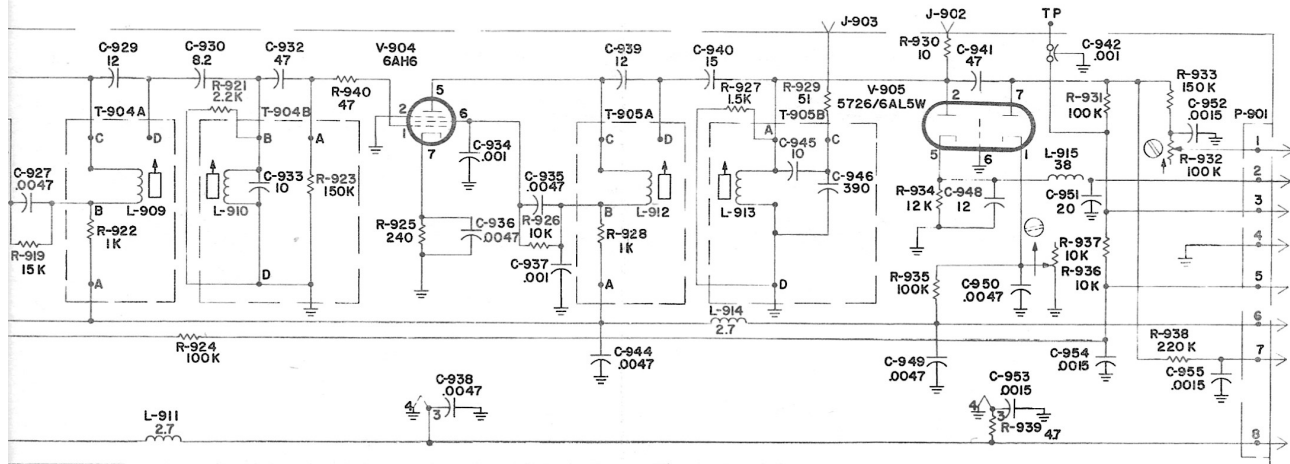
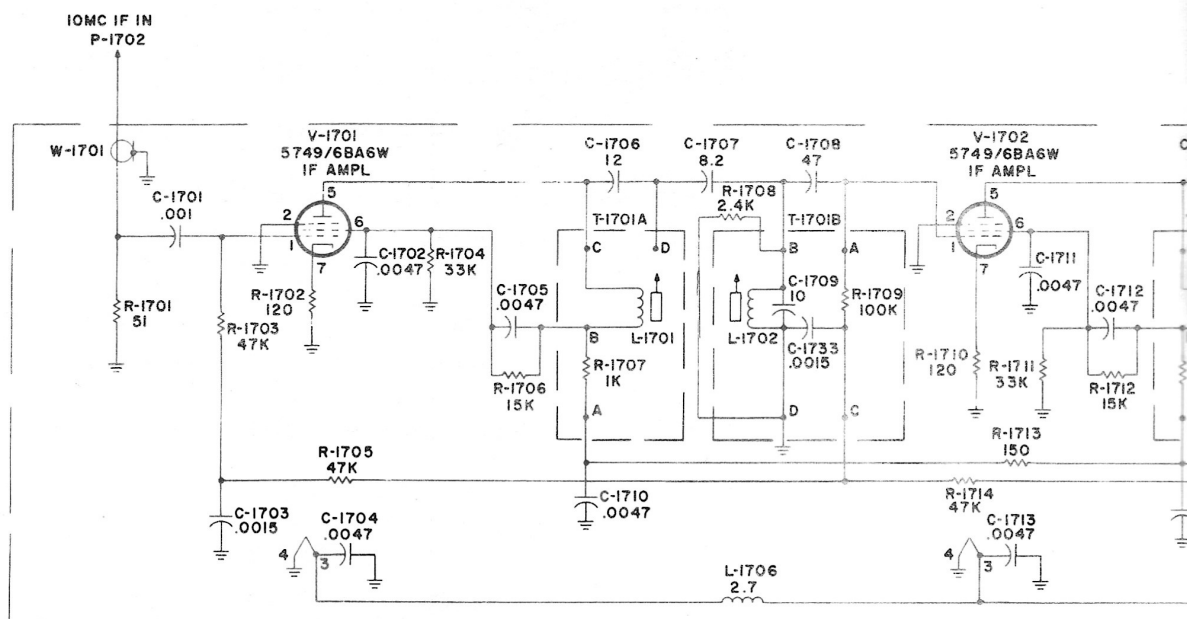
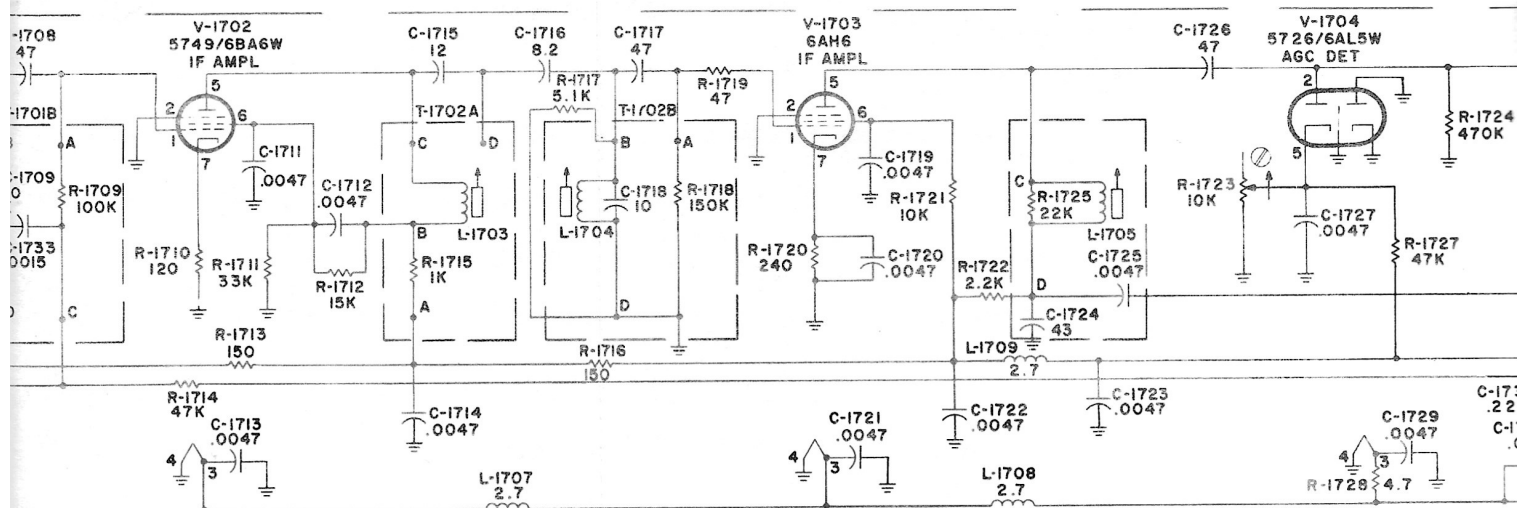


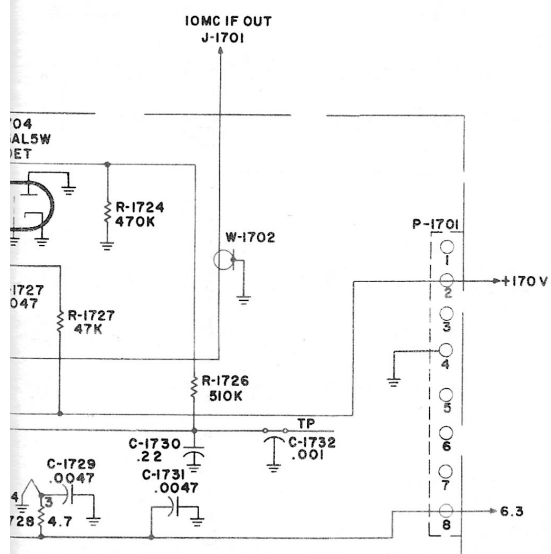
Figure 6-8. Model IFA-G2 1.5-mc IF Amplifier, Schematic Diagram





SCHEMATIC PRI

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NOTE:

UNLESS OTHERWISE NOTED:

I. CAPACITOR VALUES LESS THAN ONE
ARE IN MICROFARADS

CAPACITOR VALUES GREATER THAN ONE
ARE IN MICROMICROFARADS

2. INDUCTANCE VALUES ARE IN MICROHENRYS

3. RESISTOR VALUES ARE IN OHMS,
K=1,000, M=1,000,000

 INTERNAL ADJUSTMENT


 ARROW DENOTES CLOCKWISE ROTATION

HEMATIC PREDETECTION AMPLIFIER

(SERIES B)

Figure 6-10. Model PDA-A2 Predetection Amplifier, Schematic Diagram

NOTE:

UNLESS OTHERWISE NOTED:

CAPACITOR VALUES LESS THAN ONE
ARE IN MICROFARADS.

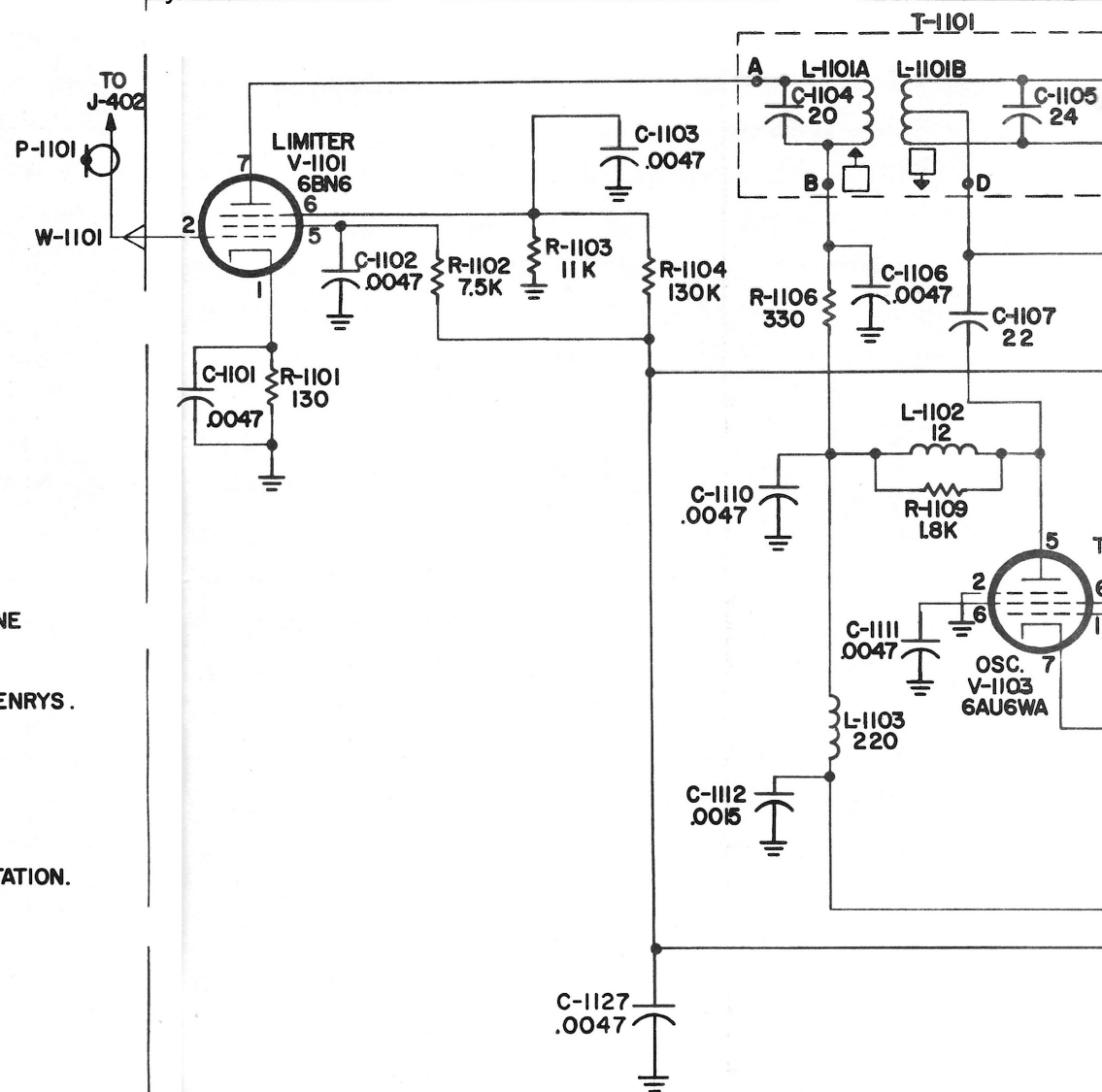
CAPACITOR VALUES GREATER THAN ONE
ARE IN MICROMICROFARADS.

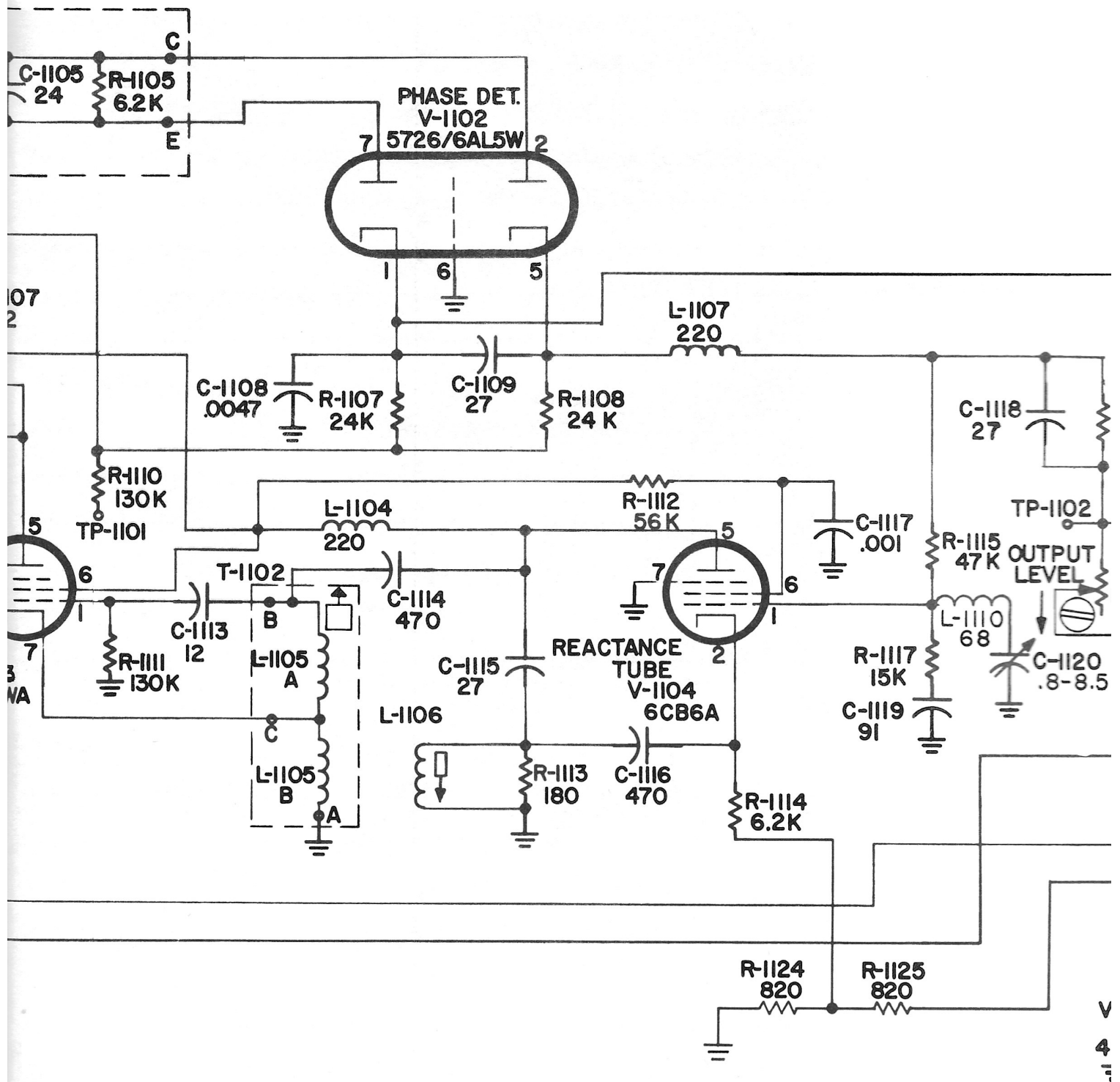
INDUCTANCE VALUES ARE IN MICROHENRYS.

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

 INTERNAL ADJUSTMENT

 ARROW DENOTES CLOCKWISE ROTATION.





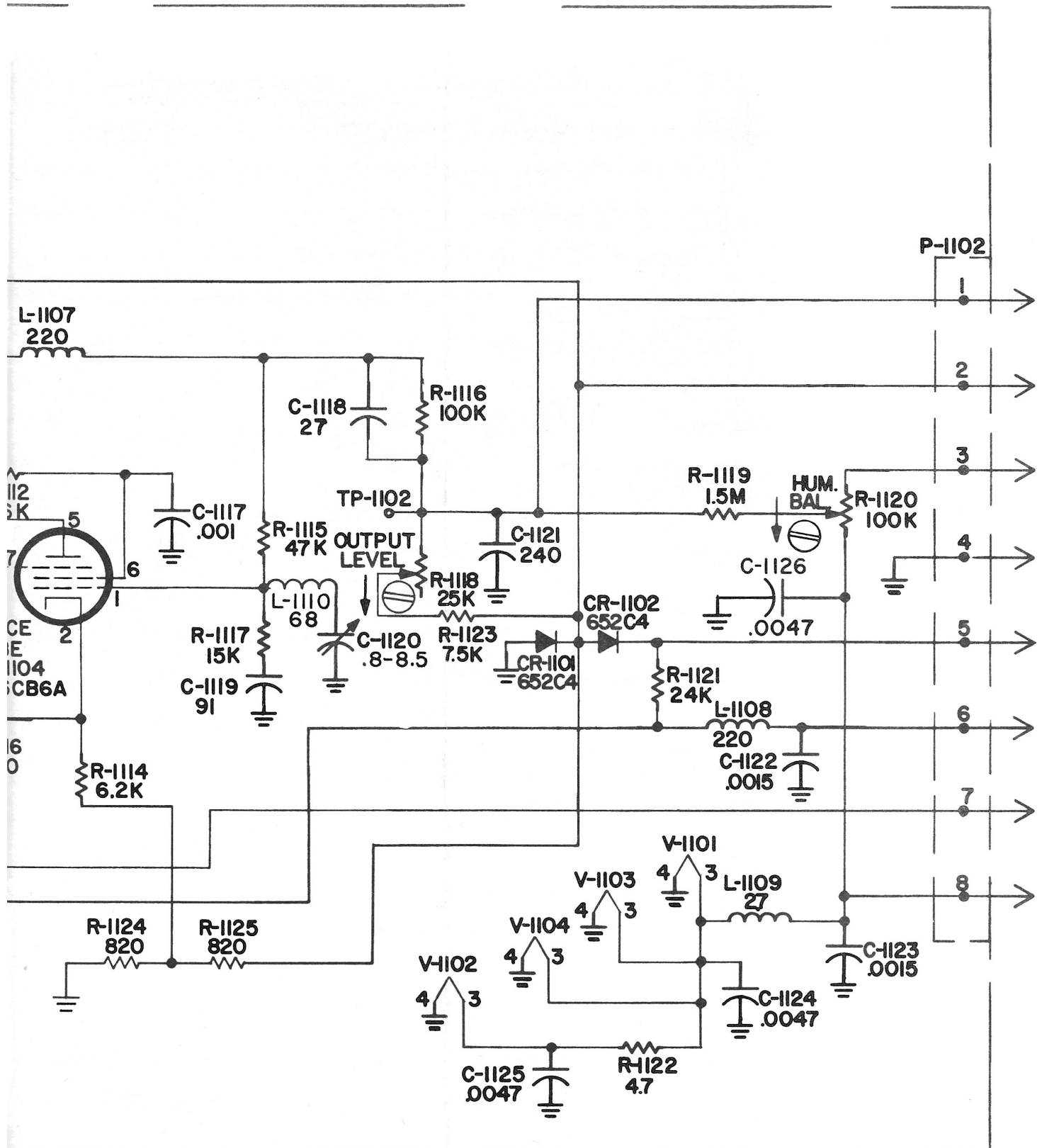


Figure 6-9. Model PLD-A2 Demodulator: Phase-Lock, Schematic Diagram