

INSTRUCTION MANUAL

RANGE BOOSTER

RB-25



TADIRAN
ISRAEL ELECTRONICS INDUSTRIES LTD

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RB-25

TADIRAN, ISRAEL ELECTRONICS INDUSTRIES LTD.

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NOTE

The RB-25 Range Booster can also be used with Radio Sets PRC-25T and VRC-53T without changes to either equipment. These instructions remain the same, except that equipment model numbers change as follows:

AN/PRC-25	to	PRC-25T
AN/VRC-53	to	VRC-53T
AM-2060/VR	to	AM-2060T
RT-505/PRC-25	to	RT-505T
AS-1729/VRC	to	AS-1729T

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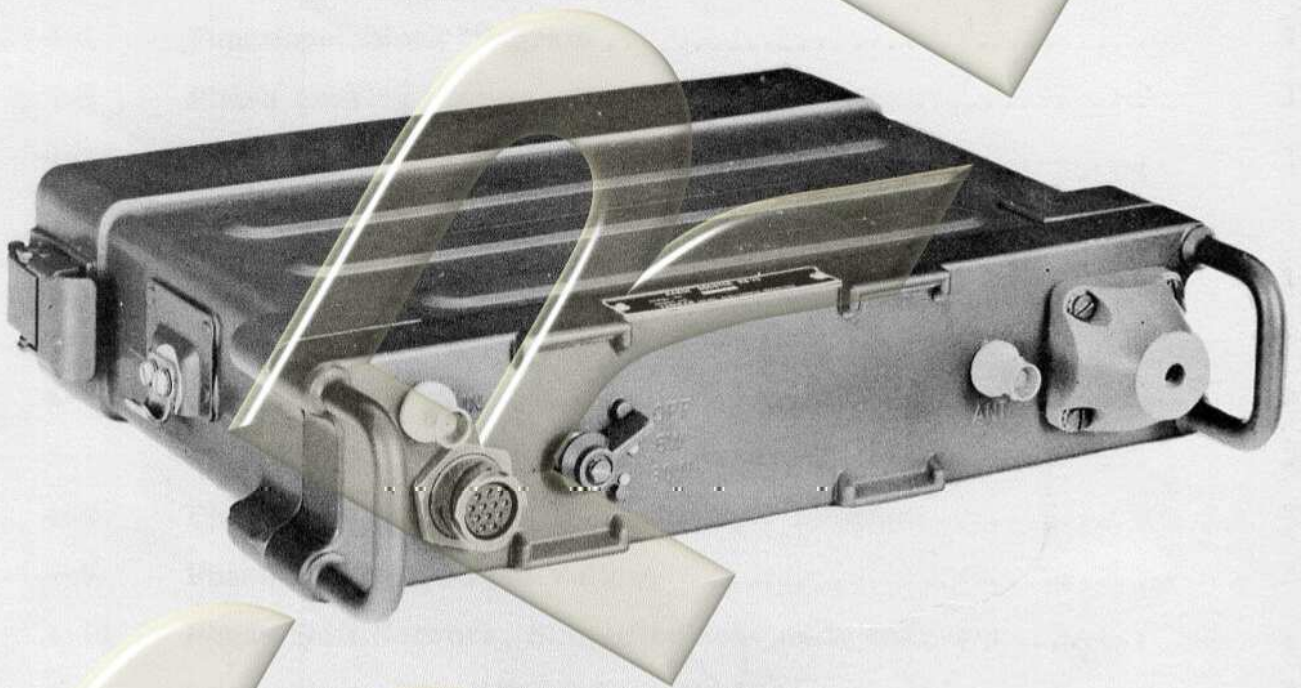


Figure 1-1. Range Booster RB-25

CHAPTER 1

GENERAL INFORMATION

1-1. INTRODUCTION .- This manual describes Range Booster RB-25; it provides operating instructions, theory and maintenance procedures for all personnel who operate and service the unit, or instruct others on the subject.

1-2. DESCRIPTION. (fig. 1-1)- The RB-25 is a solid state, military type, 30 watt r-f amplifier, designed to increase the output level of Radio Sets AN/VRC-64, AN/VRC-53, AN/PRC-77 or AN/PRC-25, to the general level of Radio Sets AN/VRC-12 series. The addition of this range booster creates an economical high power set for either vehicular (especially small military vehicles) or manpack use. The amplifier tunes automatically to driving signals from 30 to 76 MHz, and includes one manual control on the front panel. Connectors are also located at the front, except a battery plug which extends into the battery case. The unit is shock resistant, moisture proof, and is lightweight in spite of its rugged construction. In the vehicular configuration, the RB-25 offers automatic tuning of step-tuned antenna AT-912/VRC or AS-1729/VRC. In the manpack configuration, the RB-25 works into a 3-foot or a 10-foot whip antenna. An operating RB-25 consumes no power until the driving source is activated; it also displays better spurious radiation suppression than its driving signal source.

Adapter box CY-250 is provided for vehicular operation. It replaces the RB-25 battery case, and protects the amplifier from pulses above 30 volts, that may appear in a vehicular electrical system.

1-3. SPECIFICATIONS

Frequency Range.....	26 - 76 MHz
Frequency Selection.....	automatic
Worst case Tuning Interval.....	< 0.3 s
R-f Input.....	0.5 to 4 W
R-f Output.	
High.....	30 W
Low.....	6 W
Harmonic Suppression.....	60 dB
Spurious Radiation Suppression.....	90 dB
Operating Temperature Range.....	- 40 ^o C to + 65 ^o C
Weight (approximate).....	2.7 kg (6 lbs) less battery
Size.....	22.8 cm H x 27.9 cm W x 6 cm D (9" H x 11" W x 2-3/8" D)
Power Source.....	Vehicle battery or portable battery
Power Requirements	
Input Voltage.....	24 Vdc nominal
Circuit Drain.....	3.2 A @ high power 1.5 A @ low power
Portable battery	
Type.....	nickel cadmium (rechargeable)
Life.....	20 hours at high power with 9:1 receive transmit ratio

CHAPTER 2

INSTALLATION

2-1. VEHICULAR INSTALLATION. - The vehicular configuration consists of a receiver-transmitter (RT-841/PRC-77 or RT-505/PRC-25), an amplifier-power supply (AM-2060/VR), a mounting (MT-1029/VRC), an antenna (AT-912/VRC or AS-1729/VRC) and booster amplifier RB-25 (with adapter box CY-250 instead of battery case).

a. Mounting RB-25 on Receiver-Transmitter

(1) Place RB-25 on top of receiver-transmitter so that both front panels are on same plane

(2) Using flexible strap provided with RB-25, secure the two units together: wrap strap under receiver-transmitter and fasten each end to latch on either side of RB-25.

b. Installing RB-25 and Receiver-Transmitter on Amplifier-Power Supply AM-2060/VR

(1) Make sure amplifier-power supply is secured to mounting MT-1029/VRC; see Operator's Manual for Radio Set AN/VRC-53, TM11-5820-498-10.

(2) Locate and loosen the three screws on top mounting plate of AM-2060/VR; plate is at rear of area allocated to receiver-transmitter.

(3) Loosen the two mounting clamps on front of AM-2060/VR; they will drop slightly.

(4) Slide RB-25 and receiver-transmitter onto AM-2060/VR until bottom of receiver-transmitter is flush with bumper plate at rear of AM-2060/VR; make sure notches in rear lip of adapter box CY-250 fit under screws loosened in step (3).

(5) Raise mounting clamps until they engage lips on front panel of receiver-transmitter, and tighten clamps.

(6) Tighten the three screws on top mounting plate of AM-2060/VR.

c. Interconnection. (fig. 2-1)

- (1) Connect cable CX-4655/U (supplied with the AM-2060/VR) between POWER jack on receiver-transmitter and SET POWER jack on AM-2060/VR.
- (2) Connect r-f cable CG-1773/U between ANT jack on RB-25 and antenna matching unit.
- (3) Connect r-f cable CG-409G/U between IN jack on RB-25 and ANT jack on receiver-transmitter.
- (4) Connect control cable CX-4722/VRC between multi-pin jack on front panel of RB-25 and antenna matching unit.
- (5) Connect power cable between connector at rear of RB-25 and jack J23 on mounting.
- (6) Make sure mounting is connected to vehicle battery through cable connected to jack J21.

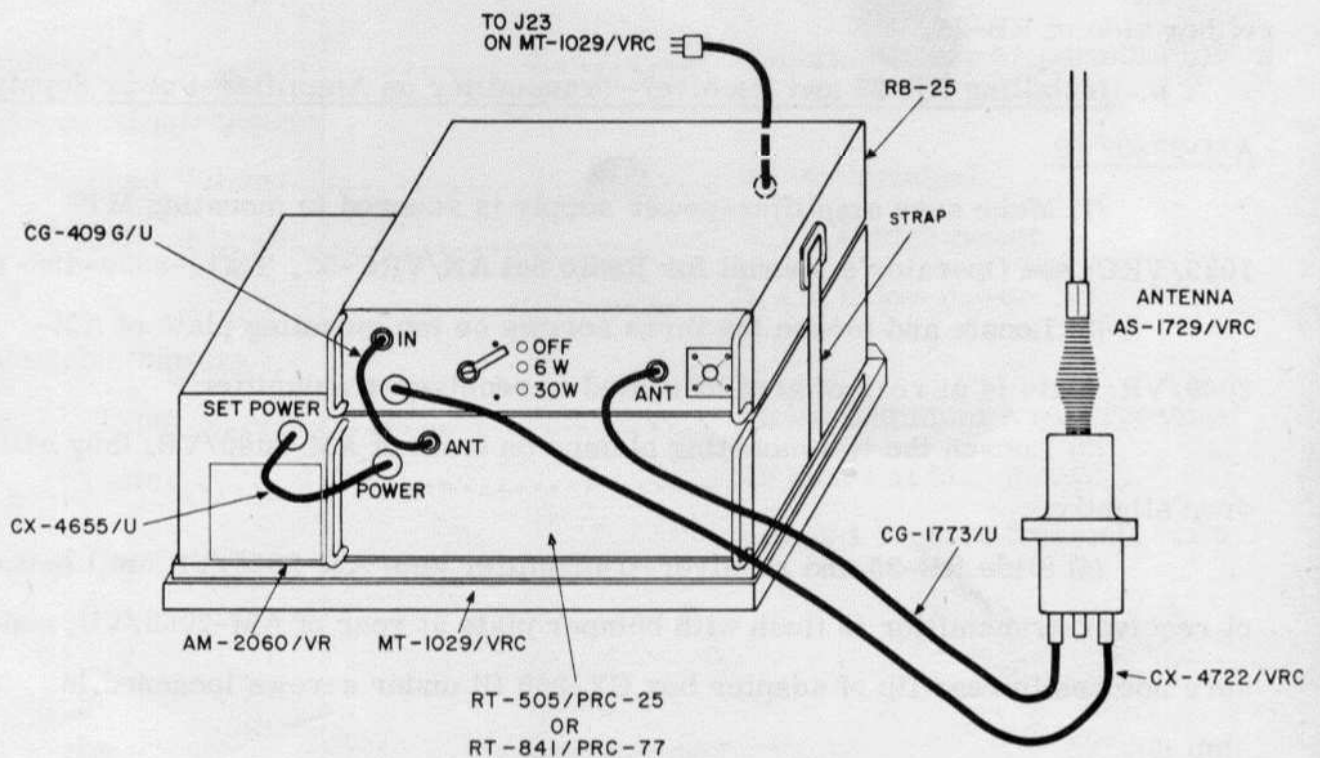


Figure 2-1. Interconnection.

2-2. MANPACK INSTALLATION.- The manpack configuration consists of a receiver-transmitter (RT-841/PRC-77 or RT-505/PRC-25), an antenna (AT-892/PRC-25 or AT-271A/PRC) and booster amplifier RB-25. To prepare the system for operation, proceed as follows:

- a. Install a battery for the RB-25 and for the receiver transmitter as required.
- b. Mount RB-25 on top of receiver-transmitter as described in paragraph 2-1a.
- c. Connect short r-f cable (CG-409 G/U) between IN jack on RB-25 and ANT jack on receiver-transmitter.
- d. Install whip antenna in RB-25 antenna mount.

CHAPTER 3

OPERATING INSTRUCTIONS

3-1. CONTROLS AND CONNECTORS. - All controls and connectors are listed on table 3-1, and are shown in figure 3-1.

Table 3-1. Controls and Connectors

Control or Connector	No. in fig. 3-1	Function
OFF-6W-30W selector	3	Turns amplifier off or selects power output level.
IN jack	5	Input connector for driving signal.
ANT jack	1	An output connector for working into a nominal 50-ohm vehicular antenna.
Multi-pin jack on front panel	4	Provides control voltages to vehicular antenna matching unit, through cable CX-4722/VRC.
Antenna mount	2	Base for 3 or 10 foot whip antenna.
Battery plug	*	Connection to 24 Vdc supply.

* Battery plug extends into battery case.

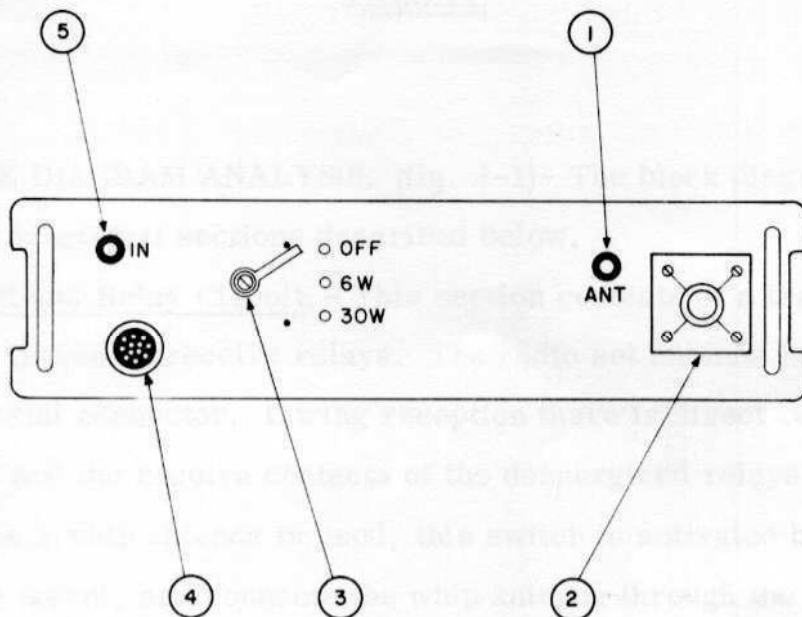


Figure 3-1. Controls and Connectors.

3-2. OPERATION. (for all configurations)

a. Receiver-Transmitter. - See Operator's Manual for Radio Set AN/VRC-53, TM11-5820-498-10.

b. Amplifier - Power Supply. (for vehicular configuration) - See Operator's Manual for Radio Set AN/VRC-53, TM11-5820-498-10; note that ANT. FREQ CONTROL has no effect on operation and is not used with RB-25.

c. Range Booster RB-25.

(1) Set front-panel selector to 6W or 30W position, depending upon desired transmitted power; RB-25 does not draw current until push-to-talk switch is operated and receiver-transmitter is in transmit condition.

(2) When front-panel selector is in OFF position, RB-25 is bypassed; r-f output of receiver-transmitter enters and leaves RB-25 without amplification. However, control cable connected to multi-pin jack on front panel of RB-25 must be transferred to ANTENNA CONTROL jack at rear of AM-2060/VR. In this case, ANT. FREQ CONTROL on AM-2060/VR must be positioned as required.



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CHAPTER 4

THEORY

4-1. BLOCK DIAGRAM ANALYSIS. (fig. 4-1)- The block diagram is divided into the four functional sections described below.

a. T/R and Relay Circuit. - This section consists of a transmit/receive unit and two transmit/receive relays. The radio set antenna jack is connected to the IN coaxial connector. During reception there is direct connection through the T/R unit and the receive contacts of the deenergized relays to the antenna switch. When a whip antenna is used, this switch is activated by a plunger in the whip antenna mount, and connects the whip antenna through the matching switch to a matching network assembly. When no whip antenna is mounted, the antenna switch connects the radio set to the ANT coaxial connector. This connector can be terminated in 50 ohms, or connected to an external antenna matching unit. During transmission the transmitter signal energizes the T/R unit and relays; as a result the radio set is connected to the Automatic Tuning Detector and Phase Locking units, while the antenna is connected to the antenna filter output. The T/R unit includes a voltage regulator that operates during transmit and supplies a stabilized +17 volts to all circuits as applicable.

b. Band Selector Circuit. - This section consists of ATD (Automatic Tuning Detector) and MD (Motor Driver) units, and the stepping motor (SM) assembly with its associated switch sections. The 26-76 MHz frequency range of the RB-25 is divided into 11 bands, and the ATD Unit includes a tuned circuit for each band. The voltages developed across these circuits are rectified and coupled to a section on the stepping motor shaft. The stepping motor is an electromagnet-activated rotary switch with 11 positions corresponding to the 11 bands. When transmission starts on a new band, the MD Unit switches on the current in the electromagnet of the stepping motor, and the rotary switch turns until it reaches the correct band position, where the output of the ATD Unit is sufficiently large to cut off the MD Unit and stop

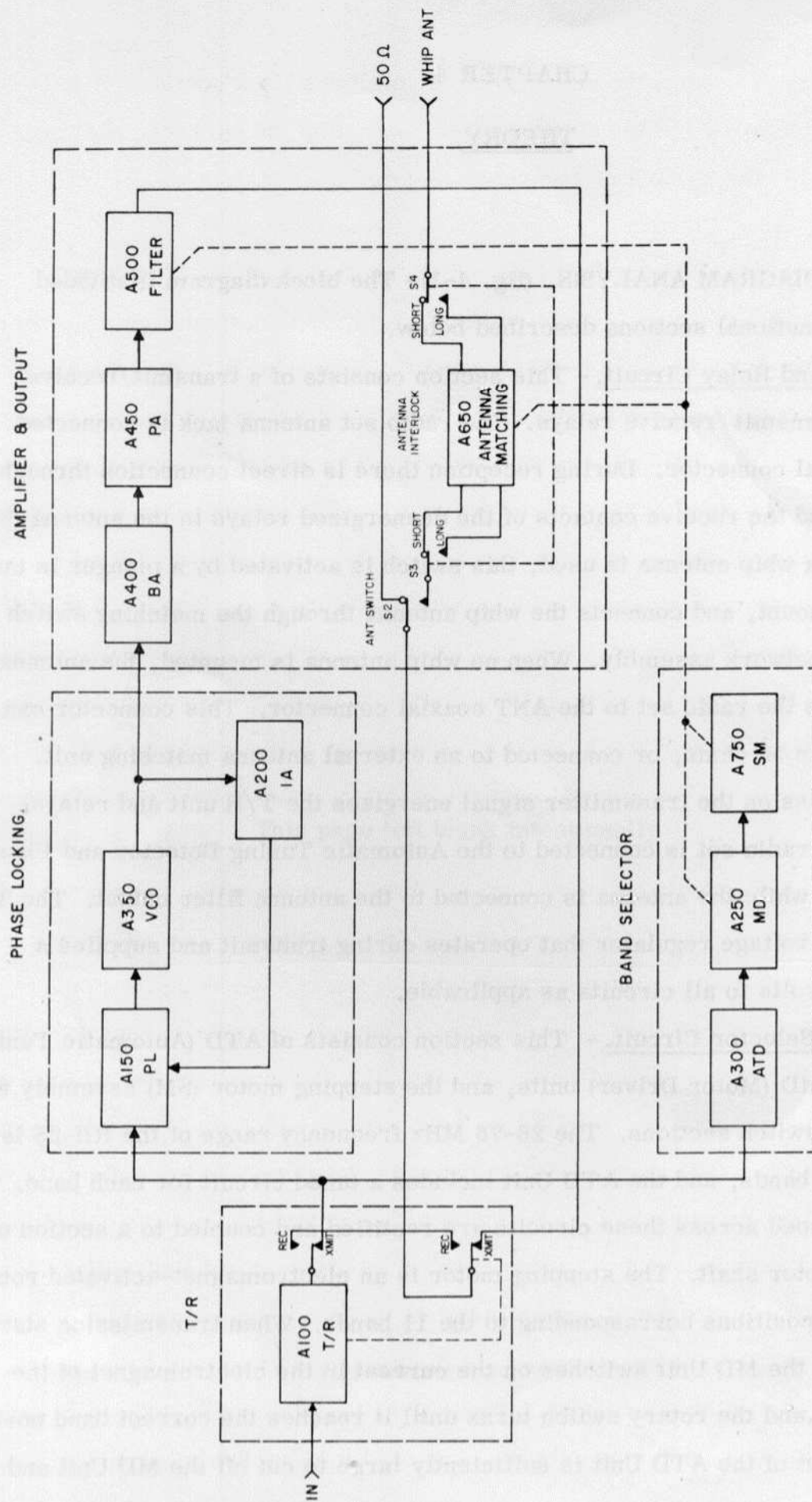


Figure 4-1. Functional Block Diagram

the stepping motor. The stepping motor also rotates the switch sections of the antenna matching network and the antenna filter, selecting the correct matching circuit and filter for the particular frequency in use.

c. Phase Locking Circuit.

(1) General Description.(fig. 4-1) - This section consists of the PL (Phase Locking), VCO (Voltage Controlled Oscillator), and IA (Isolation Amplifier) units. The VCO operates from 26 to 76 MHz and is controlled by a d-c voltage. Phase locking is accomplished by comparing the VCO output with the driving signal, in a phase detector of the PL unit. In case of a phase deviation, a d-c correction voltage develops at the input to the VCO. The phase locking reaction is rapid enough to follow the frequency modulation of the driving signal. Consequently, the VCO output assumes the same frequency and modulation as the driving signal. Amplification of the VCO signal produces the output of the RB-25. The phase locking system eliminates spurious frequencies of the driving signal from the RB-25 output. For that reason the driving signal is not directly boosted in the broadband amplifier. The IA unit prevents spurious frequencies of the driving signal from reaching the output of the VCO through the reference line of the VCO to the PL Unit.

(2) Detailed Description. (fig. 4-2) - The signal from the radio set is fed into a 90° phase shifting network, which supplies two voltages, 90° out of phase to the phase detectors. The other r-f input signal to the two balanced type phase detectors comes from the IA unit, which amplifies the output signal of the VCO unit. If the two r-f signals applied are of the same frequency, the resultant d-c voltage varies as cosine to the phase difference (fig. 4-9). If the r-f signals are of different frequencies, the phase detectors produce an a-c voltage whose frequency represents the difference between the signals. Phase detector 1 is connected to an amplifier, whose dual output signal controls the VCO frequency. The amplifier includes RC networks that form a loop filter; this filter limits amplification over the speech frequency range, yet its phase shift is too small to cause instability of the system. The two control inputs to the VCO vary the oscillator circuit capacitance and self-inductance. The reactance of a capacitive diode is varied by one of the control voltages. The reactance of a coil

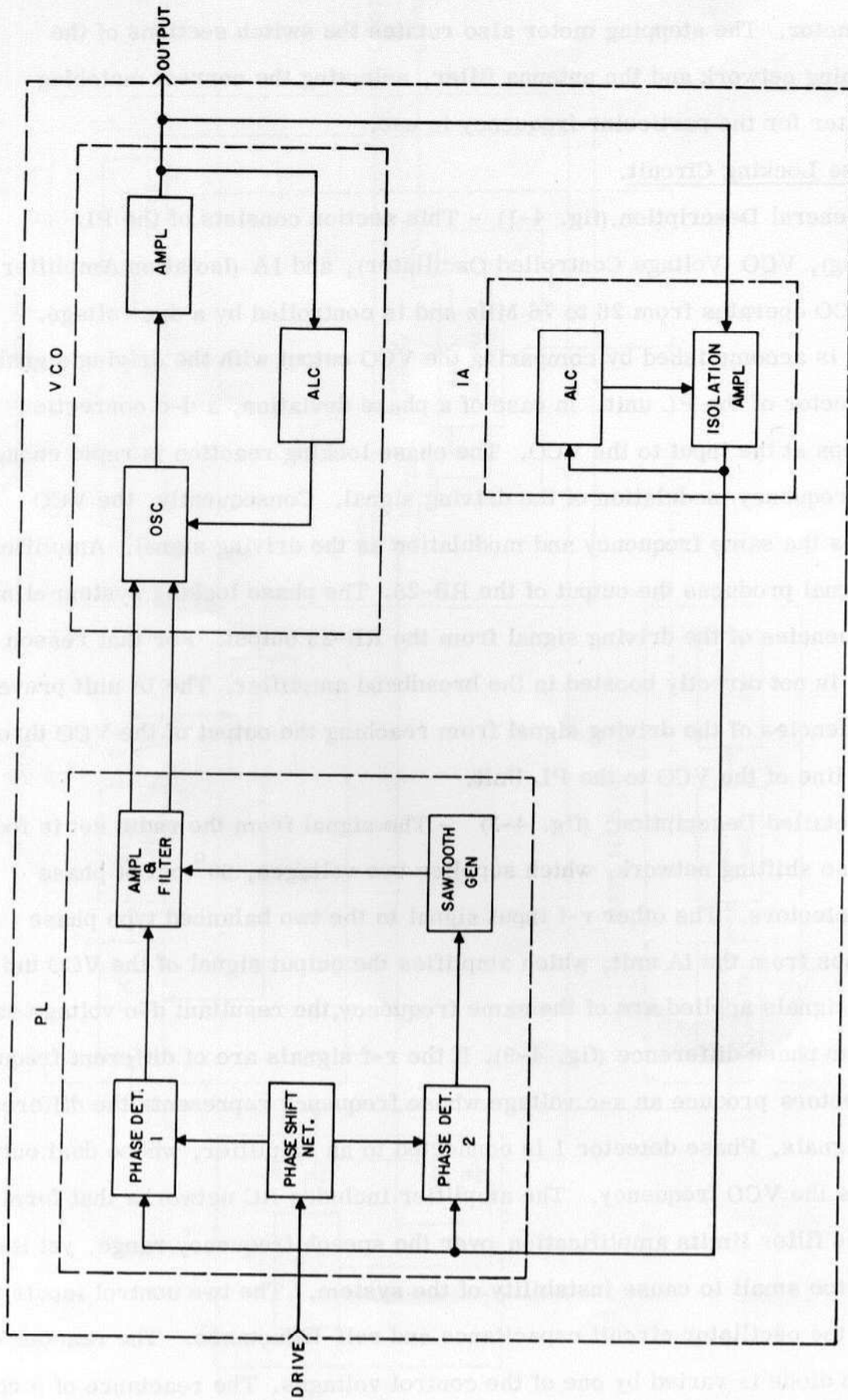


Figure 4-2. Phase Locking System, Block Diagram.

wound on a ferrite core, is varied by direct current from an amplifier stage in the VCO unit, which is driven by the second control voltage. By varying both L and C in the oscillator circuit, the range of 26 to 76 MHz can be covered without bandswitching. When transmission starts, a stabilized voltage is supplied, and a sawtooth generator in the PL unit applies a voltage to the VCO input which sweeps the VCO frequency through its entire frequency range (26 - 76 MHz). When the system is locked to the radio set frequency, the d-c output from phase detector 1 is almost zero. Due to the 90° phase-shift network, phase detector 2 produces a maximum positive voltage, which disables the sawtooth generator. The sawtooth generator is coupled to the same amplifier that receives the output of phase detector 1. However, phase detector 1 counteracts the sawtooth signal and locks the VCO frequency long enough to permit phase detector 2 to disable the sawtooth generator. The VCO and IA units contain ALC circuits which limit their outputs. This prevents overloading the output stage of the VCO and IA units, and maintains the sinusoidal shape of the voltages needed for optimal function of the phase detectors.

d. Amplifier and Output Circuit. - This section consists of the BA (Broadband Amplifier) unit, the PA (Power Amplifier) assembly, the antenna filters, the antenna matching networks, and the antenna switches. The VCO signal is amplified to the 30-watt level in the BA and the PA which consist of untuned broadband amplifiers. The signal is then applied to the antenna filter assembly, where the band selector stepping switch selects one of three low-pass filters which block harmonic frequencies. The filtered signal passes through the transmit/receive relay to the antenna selector and matching switches in the antenna mount. If a whip antenna is used, the signal is applied to the antenna matching network, in which the stepping switch selects the proper circuits for each band. If a whip antenna is not used, the signal is applied directly to the ANT connector.

4-2. CIRCUIT ANALYSIS.

a. T/R Unit. (fig. 4-3)- The T/R unit contains a circuit for energizing the transmit/receive relays, and a d-c voltage stabilizer. The circuits are incorporated in a two-module plug-in unit.

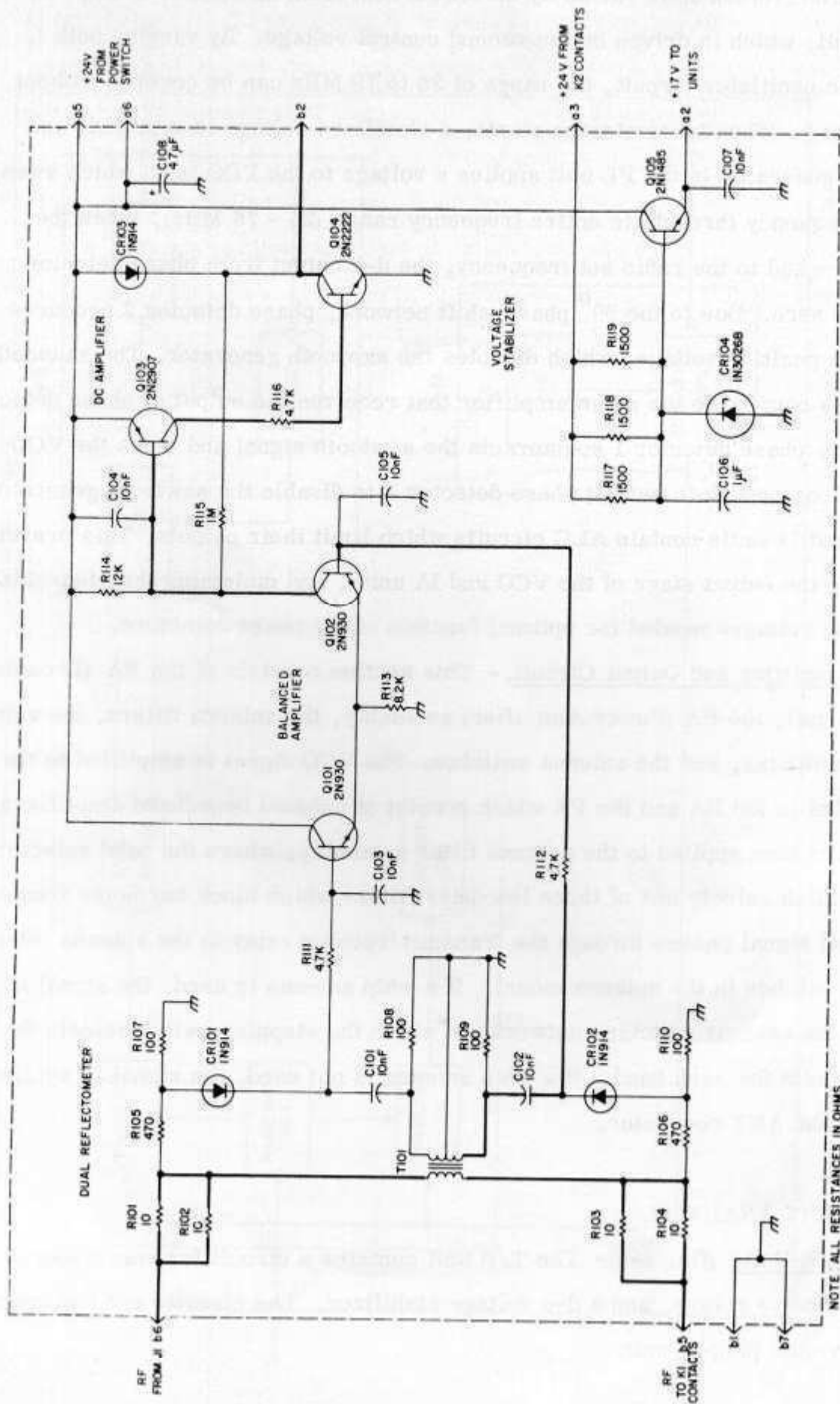


Figure 4-3. T/R Unit A100, Schematic Diagram.

(1) Relay Circuit. - The circuit consists of transistors Q101, Q102, Q103 and Q104 with associated components. The input signal from the driving radio set is applied through the IN connector to pin b6. The signal then passes through a dual reflectometer (where it is slightly attenuated) to pin b5 and to the contacts of transmit/receive relay K1. The reflectometer senses the forward and reflected power on the connection from b6 to b5. When b5 terminates in 50 ohms (voltage standing wave ratio of 1.0) the reflected power will be zero. If b5 terminates in a high impedance, the reflected power will be almost as large as the forward power, but due to circuit losses, the reflected power will always be slightly less than the forward power. This difference prevents the relay circuit from being activated by high frequency power picked up by the antenna. Power input to the IN connector develops an r-f voltage across diode CR102. The diode rectifies it to a positive voltage that appears on the base of transistor Q102. Power from the antenna will similarly develop a positive voltage on the base of Q101. Transistors Q101 and Q102 form a balanced amplifier; relays K1 and K2 are energized only when the base of Q102 is more positive than the base of Q101. Transistor Q102 draws collector current when its base becomes positive, and when the voltage drop across R114 exceeds 0.6 V, Q103 (and thereby Q104) draw current. The coils of relays K1 and K2 are connected in the collector circuit of Q104 (from b2 to +24 V), and therefore the relays energize. Resistor R115 provides positive feedback across Q103 and Q104 and prevents intermediate voltages between zero and 24 V on the collector of Q104. Diode CR103 clips voltage spikes that appear across the relay coils when the current is cut off.

(2) Reflectometer. - During transmission, pin b5 terminates in a 50-ohms load, and the transmitter output is connected to pin b6. The voltage on b6 is divided by R101, R102, R105 and R107; a fraction of the input voltage appears at the junction of R105 and R107, and is in phase with the input voltage. The load current flows through the primary of T101 which acts as current transformer. A voltage proportional to the current develops across load resistance R108 and R109 (on the secondary). The voltage across R108 is in phase with the current, whereas the voltage on R109 is 180° out of phase with the current. The values of R105 and R107, as well as the winding ratio of T101,

and the resistors across its secondary have been so chosen, that with a 50-ohm load identical voltages are obtained on R107 and R108. Since there is no phase deviation, no r-f voltage appears across diode CR101 and no rectified voltage is produced. This also applies to diode CR102, except that the voltages on R109 and R110 are 180° out of phase. As a result, the r-f voltage on CR102 is maximum, and the rectified voltage on the base of Q102 is also maximum. During reception the received signal is connected to b5 and the load (receiver-transmitter) to b6. The phase of the current through T101 is inverted, whereas the voltage divider phase is unchanged. The detector operation is reversed and the base of Q101 becomes positive.

(3) Voltage Stabilizer. - The circuit consists of transistor Q105 with its associated components. It is powered during transmission and supplies stabilized +17 V to each unit in the RB-25. The voltage stabilizer is fed by +24 V through a set of contacts on relay K2. Zener diode CR104 furnishes +18V to the base of Q105; about +17V can be obtained from the emitter of Q105. The resistance in series with CR104 consists of three parallel-connected resistors for power handling. Capacitor C106 decouples CR104 to prevent low frequency noise on the +17 V line. Transistor Q105 is thermally connected to the bottom of the module case for heat dissipation.

b. ATD Unit. (fig. 4-4)- The Automatic Tuning Detector (ATD) unit forms part of the automatic band selector system. It includes a frequency detecting system and diode logic. The circuit is incorporated in a three module plug-in unit.

The nominal frequency ranges for each band are given in the table below. Band division is the same as that used for the antenna matching unit of Antenna AS-1729/VRC or AT-912/VRC, except that a 26 to 30 MHz band has been added, changing the numbering of bands.

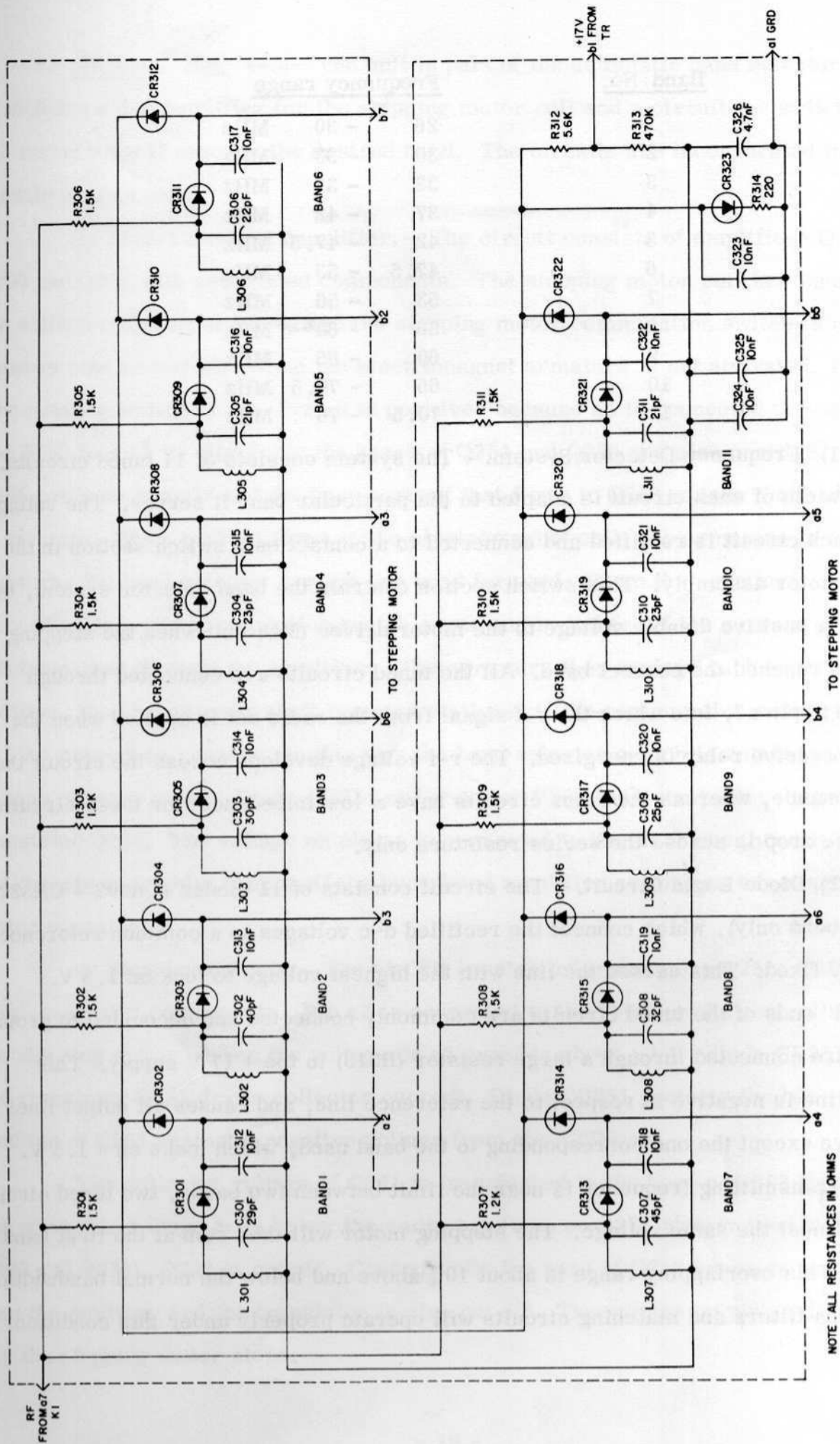


Figure 4-4. Automatic Tuning Detector (ATD) Unit A300, Schematic Diagram

<u>Band No.</u>	<u>Frequency range</u>		
1	26	- 30	MHz
2	30	- 33	MHz
3	33	- 37	MHz
4	37	- 42	MHz
5	42	- 47.5	MHz
6	47.5	- 53	MHz
7	53	- 56	MHz
8	56	- 60	MHz
9	60	- 65	MHz
10	65	- 70.5	MHz
11	70.5	- 76	MHz

(1) Frequency Detector System. - The system consists of 11 tuned circuits. The bandwidth of each circuit is adapted to the particular band it serves. The voltage across each circuit is rectified and connected to a contact on a switch section in the stepping motor assembly. This switch section controls the band selector system, by providing a positive disable voltage to the motor driver (MD) unit when the stepping motor has reached the correct band. All the tuned circuits are connected through resistors to pin a7, into which the r-f signal from the radio set is applied when the transmit/receive relay is energized. The r-f voltage develops across the circuit that is in resonance, whereas the other circuits have a low impedance; for these circuits the voltage drop is across the series resistors only.

(2) Diode Logic Circuit. - The circuit consists of 11 diodes (CR302 - CR322, even numbers only), which connect the rectified d-c voltages to a common reference line of 1 V fixed. This causes the line with the highest voltage to lock on 1.5 V. The "cold" ends of the tuned circuits are commonly connected and decoupled to ground, but they are connected through a large resistor (R313) to the +17 V supply. This common line is negative in respect to the reference line, and causes all output lines to be negative except the one corresponding to the band used, which locks on +1.5 V. When the transmitting frequency is near the limit between two bands, two tuned circuits develop almost the same voltage. The stepping motor will then stop at the first band reached. This overlapping range is about 10% above and below the normal bandwidth. The antenna filters and matching circuits will operate properly under this condition.

c. MD Unit. (fig. 4-5)- The unit is part of the automatic band selector system. It includes a d-c amplifier for the stepping motor coil and a circuit for switching off the motor when it reaches the desired band. The circuits are incorporated in a two module plug-in unit.

(1) Direct Current Amplifier. - The circuit consists of amplifiers Q254, Q255 and Q256 with associated components. The stepping motor coil is connected to the collector circuit of Q256, and the stepping motor commutation switch is connected between pins a4 and a3. When the electromagnet armature is not activated, the commutation switch is on. Pin a3 is positive, because a4 is connected through Q253 and R253 to +17 V. Similarly the bases of Q254 and Q255 are also positive. Transistor Q255 conducts heavily and the base current that flows in Q256 causes the transistor to saturate. When current flows in the electromagnet coil, the armature is activated and turns the band selector system one band forward. When the armature is almost fully attracted, the commutation switch opens and switches off the current in the electromagnet through the amplifier. The armature then springs back to its initial position, the change-over shaft remains stationary, the commutation switch reconnects, and the procedure repeats. In this way the band selector switch is rotated until no voltage appears on a4. Diode CR254 and resistor R266 limit the peak voltage on transistor Q256. The voltage on pin a4 is connected to the ALC line through R604 in the chassis assembly; it cuts off the broadband amplifier as long as the stepping motor operates.

(2) Stopping Circuit. - The circuit consists of transistors Q251, Q252 and Q253 with associated components. Pin a2 is connected to the rotor on the control section of the stepping motor. When the voltage on a2 exceeds about +1 V, diode CR251 conducts and transistor Q251 draws collector current. Diode CR251 protects the base-emitter junction of Q251 against a negative voltage from the ATD unit.

The collector voltage of Q251 is transferred to the base of Q252 through R258, and when this voltage falls below the emitter voltage on Q252 (determined by R259, R260 and R253), Q252 is cut off. Consequently the base of Q253 becomes more positive than the emitter, and the transistor is also cut off. The voltage on pin a4 disappears and the stepping motor stops.

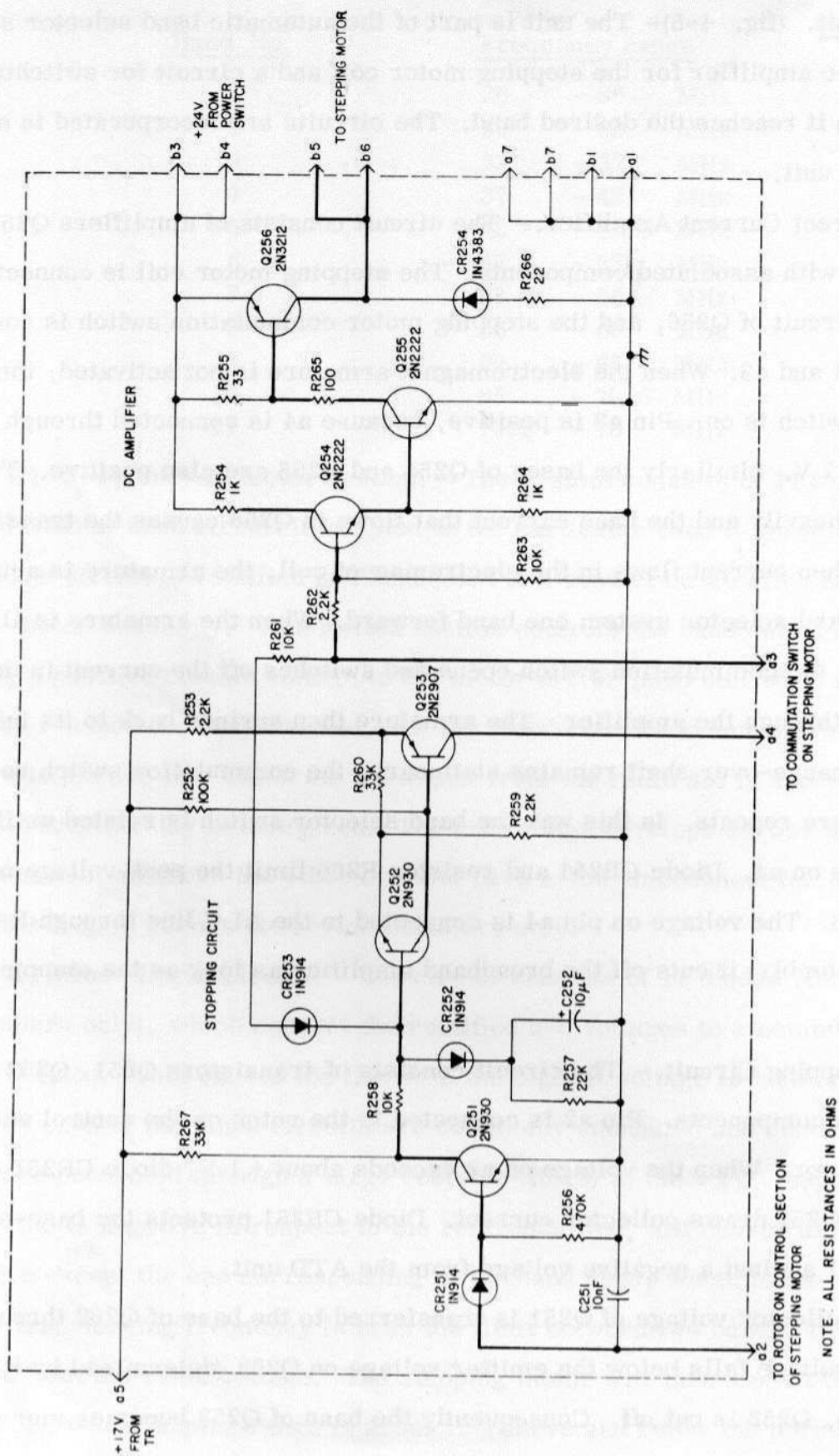


Figure 4-5. Motor Driver (MD) Unit A250, Schematic Diagram

A positive feed-back across transistors Q252 and Q253 through R260 ensures that the current will fall from full value to zero, at a particular base voltage on Q252. The network consisting of CR253 and R261 provides a voltage that prevents premature stopping of the motor. This positive voltage at the base of Q252 keeps the transistor cut off as long as the commutation switch is closed, regardless of whether there is a disable voltage on a2. Only when the switch opens, does the disable voltage - if any - become effective. Consequently, the last step of the adjustment sequence is normal even if the moving contact of the driving switch section touches the fixed contact of the desired band before the commutator opens.

The network consisting of CR252, R257 and C252 delays the start of the stepping motor when the disable voltage disappears, by causing the voltage at the base of Q252 to rise. This way the motor is prevented from advancing one step when transmission is momentarily interrupted. In addition, capacitors C324, C325 and C326 in the ATD unit retain their negative voltage until they are charged by R313. The delay is not effective when the motor stops, because diode CR252 does not conduct.

d. Stepping Motor Assembly. (fig. 4-6)- This assembly is part of the automatic band selector system. It contains a stepping motor, control section S1 sect 2 for the band selector system, and an additional control section S1 sect 1 for an external antenna matching unit. The assembly is mounted between the front panel and the chassis. All electrical connections are made through a 28 terminal connector.

(1) Stepping Motor. - The circuit contains an electromagnet whose armature - through a pawl mechanism - activates a switch shaft and turns the sections of switch S1 one position forward each time the current is switched on in the coil. When the current is switched off, the armature is returned to the start position by a spring; while the pawl mechanism with a detent keeps the switch shaft stationary. A commutation switch mounted on the stepping motor is normally closed, but opens when the armature is almost fully attracted. The electromagnetic coil and commutation switch must be series-connected to + 24 volts so that the motor can be self-stepping; however, the transistor amplifier (Q254-Q256, as described in paragraph 4-2c (1) above) is inserted to reduce the current through the commutation switch.

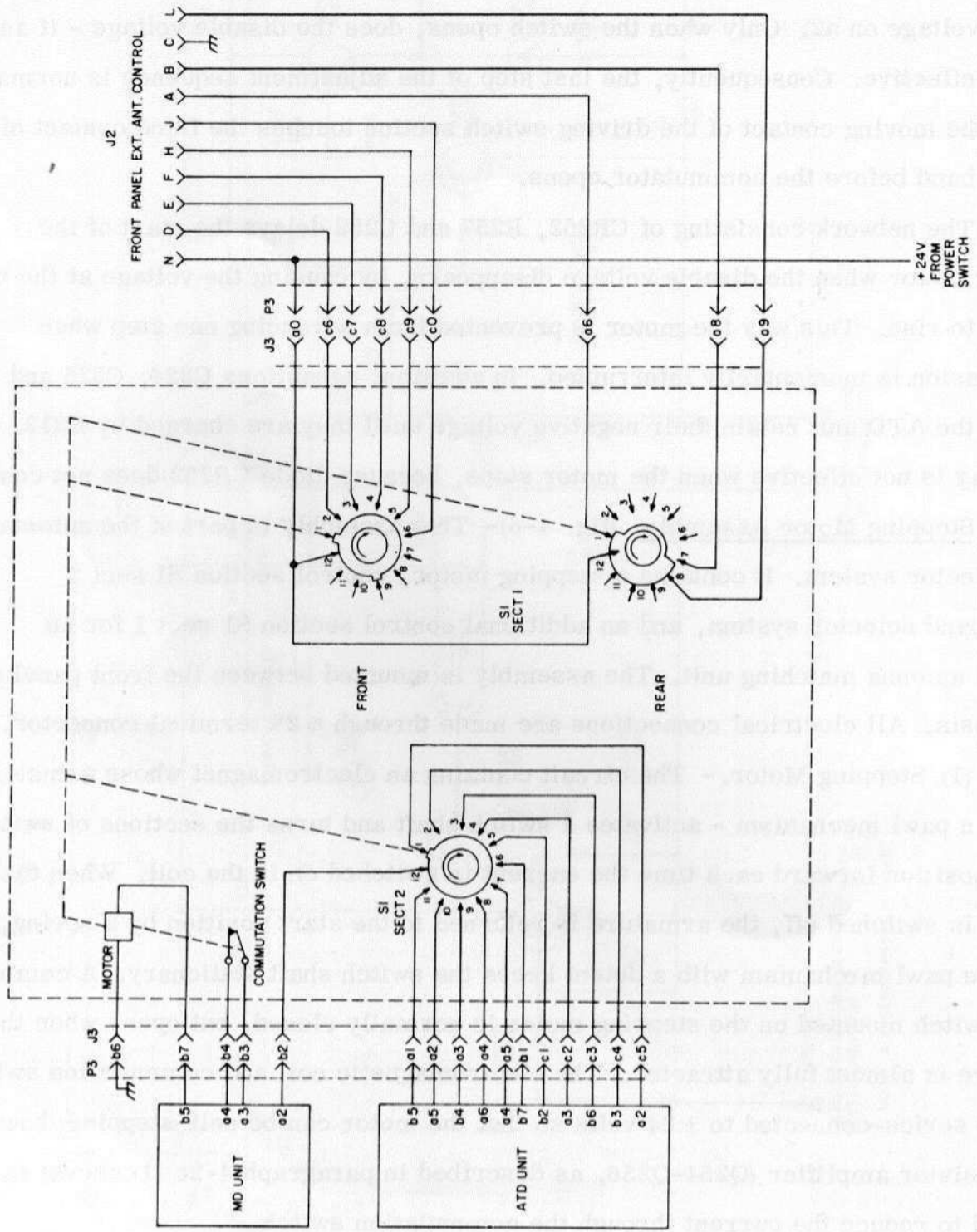


Figure 4-6. Stepping Motor Assembly A750, Schematic Diagram

(2) Control Sections. - Control section S1, sect 2 serves the automatic band selector system. The 11 fixed contacts are connected to the 11 band detectors of the ATD unit, whereas the moving contact is connected to pin a2 on the MD unit.

Control section S1, sect 1 (front and rear), which is connected to a multi-pin plug on the front panel, can control an external antenna matching unit. Several pins are connected to + 24 volts, whereas the others are free. The code for the 26-76 MHz range is as listed below:

<u>Band No.</u>	<u>Frequency MHz</u>	<u>Pins with + 24 V</u>
1	26 - 30	N, A, L
2	30 - 33	N, A, D
3	33 - 37	N, A, E
4	37 - 42	N, A, F
5	42 - 47.5	N, A, H
6	47.5 - 53	N, A, J
7	53 - 56	N, B, D
8	56 - 60	N, B, E, L
9	60 - 65	N, B, F, L
10	65 - 70.5	N, B, H, L
11	70.5 - 76	N, B, J, L

e. PL Unit. (fig. 4-7)- The unit forms a part of the phase locking system. It contains two phase detectors with associated phase shifting networks, a d-c amplifier with an audio filter, and a sawtooth generator. The circuits are incorporated in a three module plug-in unit.

(1) Phase Detectors. - The phase detectors consist of transformer T151 with associated components. Phase detector 1 includes diodes CR152-CR155 and phase detector 2 includes diodes CR156-CR159. The two detectors are driven commonly by transformer T151, whose primary is connected through pin b6 to the Isolation Amplifier (IA) unit. The signal from the radio set is connected to pin a3 through a voltage divider in the chassis assembly (R601 and R602). This voltage is supplied to the center taps of the transformer windings through a phase shift network consisting of C160, R167, L151 and R176. If the phase difference between generator voltages (fig. 4-8) E1 and E2 is 90° , the vector diagram is as shown. The voltage at point A in the schematic is the vector sum of E1 and E2a and is shown by vector A. Similarly, the voltage at point B is the vector sum of E1 and E2b, except that E2 has been shifted

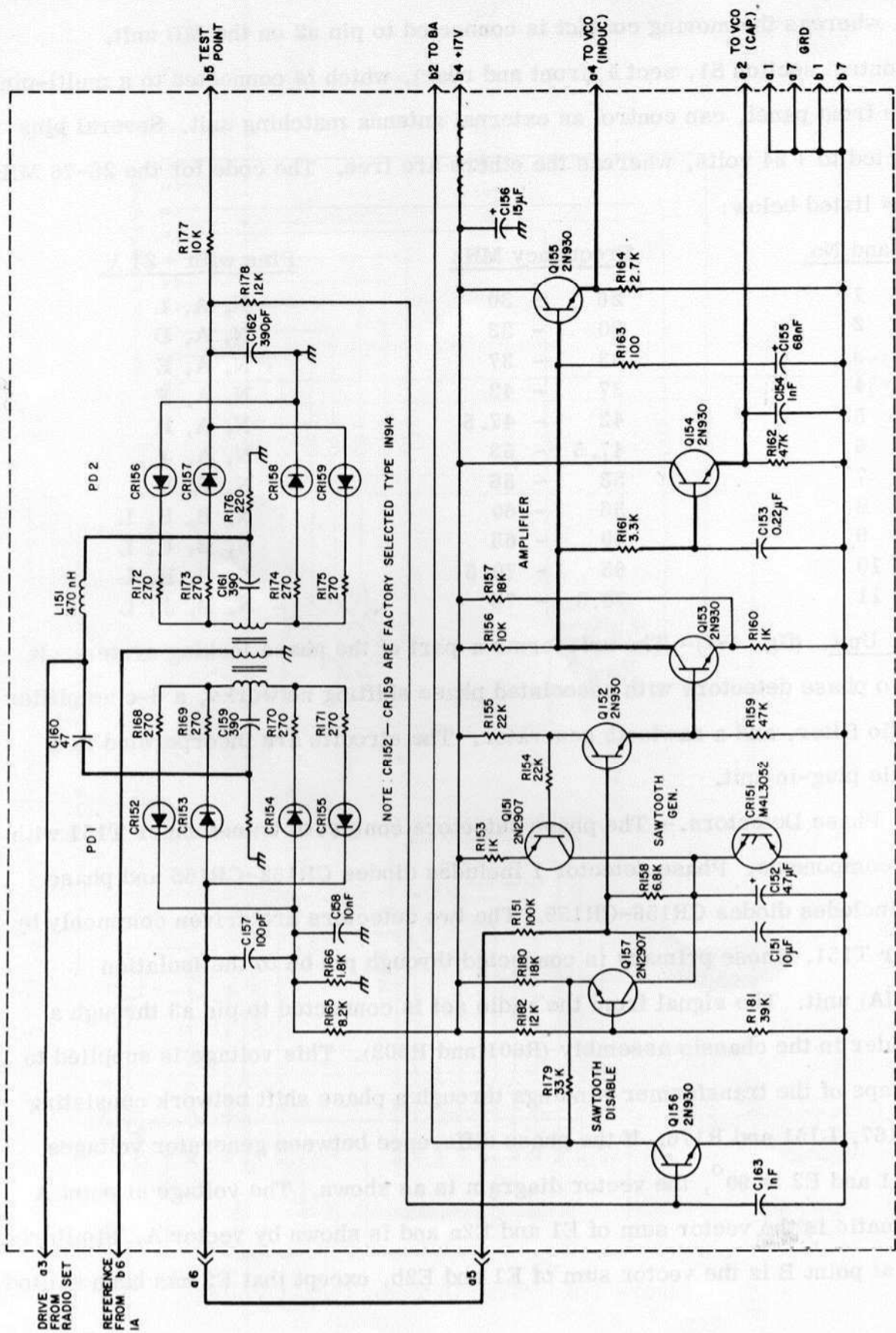
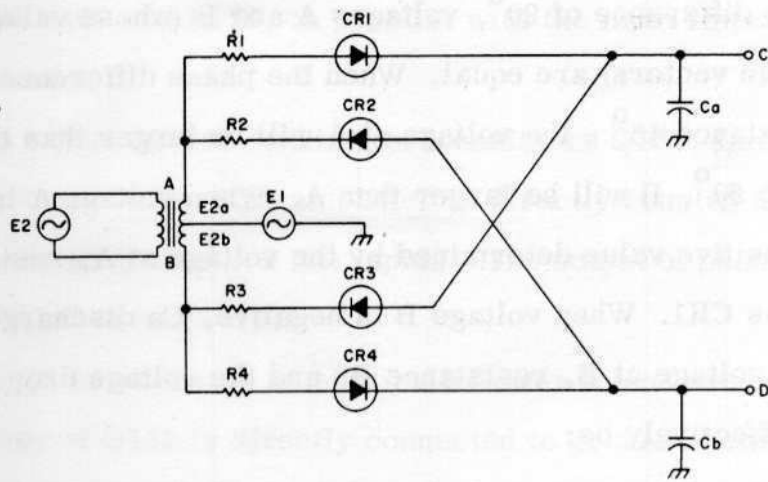


Figure 4-7. Phase Locking (PL) Unit A150, Schematic Diagram



PHASE DIFFERENCE BETWEEN E1 AND E2

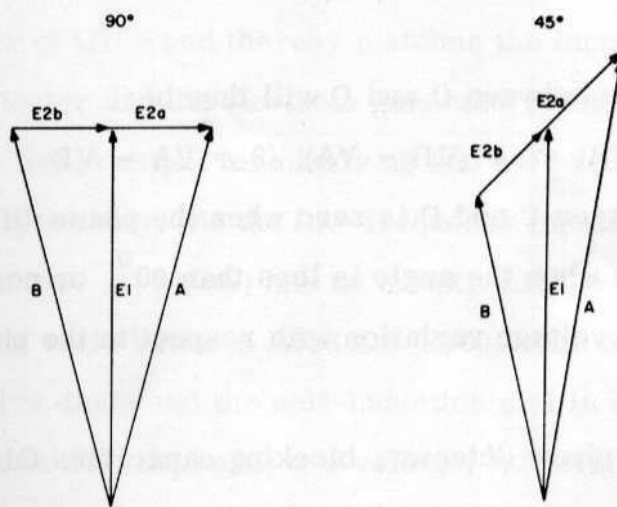


Figure 4-8. Phase Detector, Simplified Schematic Diagram.

OUTPUT VOLTAGE BETWEEN C AND D (fig. 4-8)

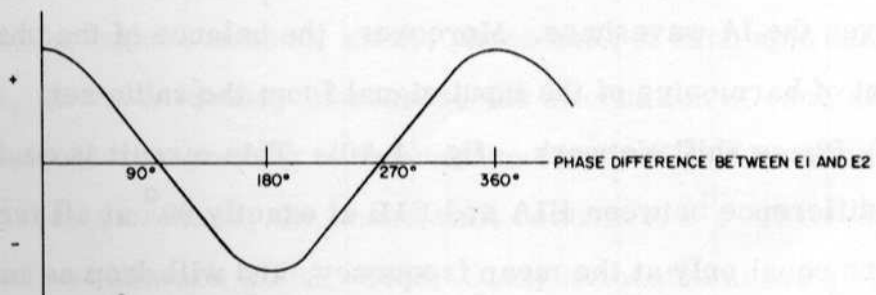


Figure 4-9. Phase Detector Output Voltage.

180°. For a phase difference of 90°, voltages A and B (whose values are represented by the lengths of the vectors) are equal. When the phase difference between E1 and E2 is not 90° - for instance 45° - the voltage at A will be larger than that at B; if the phase difference is above 90°, B will be larger than A. When voltage A is positive, capacitor Ca charges to a positive value determined by the voltage at A, resistance R1, and the voltage drop across CR1. When voltage B is negative, Ca discharges at a rate determined by the voltage at B, resistance R3 and the voltage drop across CR3. The voltage at C will effectively be:

$$\bar{V}_C = (\bar{V}_A - \bar{V}_B) / 2$$

The voltage at D will effectively be:

$$\bar{V}_D = (\bar{V}_B - \bar{V}_A) / 2$$

The voltage difference between C and D will thus be:

$$\bar{V}_C - \bar{V}_D = (\bar{V}_A - \bar{V}_B) / 2 - (\bar{V}_B - \bar{V}_A) / 2 = \bar{V}_A - \bar{V}_B$$

Thus the voltage between C and D is zero when the phase difference between E1 and E2 is 90° and is positive when the angle is less than 90°, or negative when it is greater than 90°. The output voltage variation with respect to the phase difference is shown in figure 4-9.

In the actual phase detector, blocking capacitors C159 and C161 are in series with the transformer center tap to make the circuit floating. In phase detector 2, one output terminal is grounded and one is decoupled by C162. One output terminal of phase detector 1 is connected to voltage divider R165 and R166, providing 3 V, whereas the other output terminal is connected to the amplifier through pins a6 and a5. The series resistors connected to all diodes cause the diodes to function as mean value rectifiers and not as peak voltage rectifiers. As a result, the load on the IA unit is more constant and improves the IA waveshape. Moreover, the balance of the phase detectors is independent of harmonics of the input signal from the radio set.

(2) Phase Shift Network. (fig. 4-10)- This circuit is designed to maintain the phase difference between E1A and E1B at exactly 90° at all frequencies. The voltages are equal only at the mean frequency, and will drop as much as half this value at the extreme frequencies, but this does not affect circuit operation. The impedance of the circuit is ohmic and equal to R at all frequencies. In the actual circuit, R is

75 ohms, consisting of R167 and R176, in parallel with the input impedances of the respective phase detectors.

(3) Amplifier. - The circuit consists of transistors Q152, Q153, Q154 and Q155 with associated components. The amplifier is directly coupled and thus amplifies the dc and low-frequency ac (below 0.2 Hz) inputs. The output of phase detector 1 is applied to the base of Q152 through R151.

Transistor Q152 functions as an emitter follower to ensure a high input impedance. The emitter of Q152 is directly connected to grounded emitter amplifier Q153. Resistor R160 in the emitter circuit is unbypassed to produce negative feedback and stabilize the amplifier. Resistors R157 and R160 form a voltage divider that maintains +1 V at the emitter of Q153 and thereby matches the input characteristic of the amplifier to the phase detector and the sawtooth generator. The amplified signal from the collector of Q153 is fed to output terminals a2 and a4 through the emitter followers Q155 and Q154, respectively. At the low-frequency inputs, the shunting effect of the three loop filters (see (4) below) has no effect, and the amplification of Q153 is determined by the 10:1 ratio between R156 and R160. The output voltages at a2 and a4 control the capacitive diode and the self-induction coil in the VCO circuit, respectively. Two control lines with the same d-c voltage, but with different low frequency filtering, are needed because a phase shift occurs in the VCO self-induction coil at the high frequencies. Therefore, frequencies above 200 Hz cannot vary the self-induction coil and are only applied to the capacitive diode.

(4) Loop Filter. - The filter provides a frequency cutoff in the amplifier. Spurious components of the radio set signal are prevented from modulating the VCO frequency. The cutoff must be achieved without a phase shift causing circuit instability. Ordinary low-pass networks cannot be used, as the phase shift of each approaches 90° . As shown in figure 4-11, as the frequency increases, the attenuation of each network approaches a constant value corresponding to the voltage output of divider R1 and R2. In addition, as the frequency increases, the phase shift returns to 0° . Three such networks are used. The first network (R151, R158, C152) is located at the amplifier input. While the VCO synchronizes to the radio set frequency, C152 becomes part of the sawtooth generator as described in paragraph (5) below.

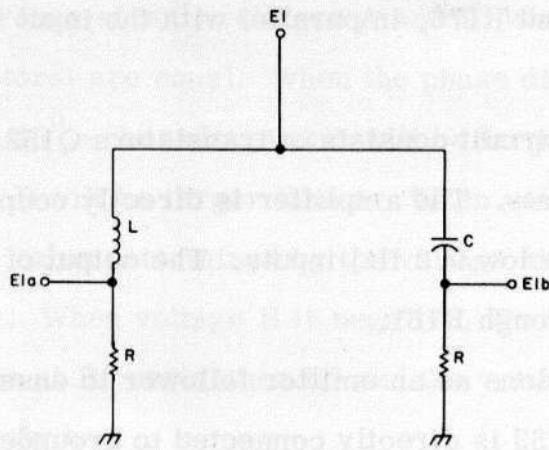


Figure 4-10. Phase Shift Network, Simplified Schematic Diagram

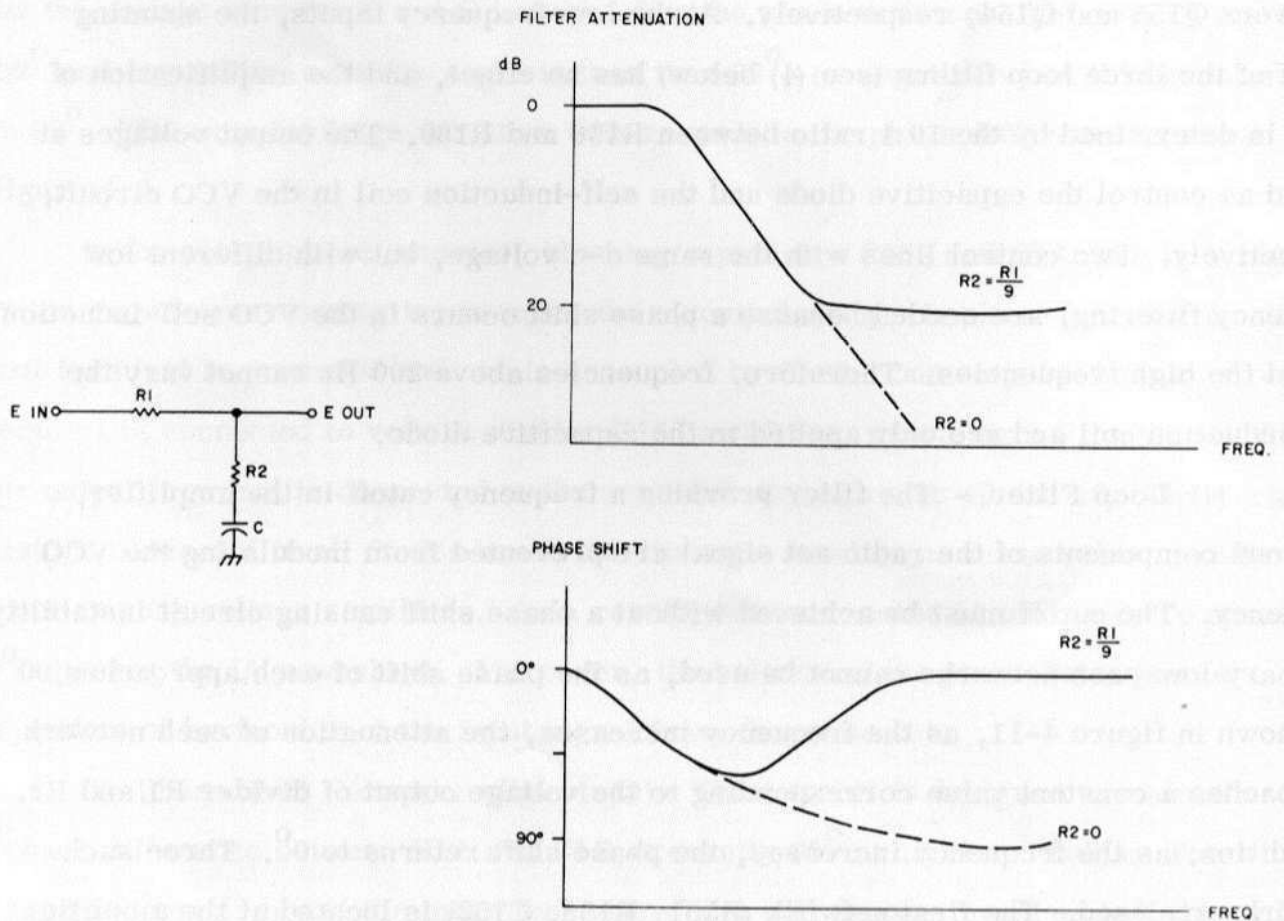


Figure 4-11. Loop Filter, Simplified Schematic Diagram and Curves.

The second network in the collector of Q153 consists of R156, R161 and C153. The voltage for pin a4 at the output of emitter follower Q154, is developed across C154, thereby achieving the sharp cutoff of an ordinary RC network. The third network consists of R156, R163 and C155; it affects only the control voltage of the capacitive diode in the VCO unit.

These filter networks markedly attenuate the speech frequency range, but the modulation frequency response of the total phase locking system is still flat, and the amplification is sufficiently great to cause the VCO frequency to follow the radio set signal accurately.

(5) The Sawtooth Generator. - The circuit consists of transistors Q151, Q156, Q157 and four-layer diode CR151 with associated components. The sawtooth voltage is generated when capacitor C152 is charged by a constant current from current generator Q157. When the capacitor voltage reaches the trigger voltage of CR151 (about 9 volts) the diode conducts, and instantly discharges the capacitor. When the current in the diode drops to a low value, the diode again cuts off and the sequence repeats. The sawtooth voltage is applied to the amplifier input through R158, and the amplified sawtooth voltage sweeps the VCO frequency through its entire frequency range.

Transistor Q157 functions as current generator since the base is at +13 V. The emitter current flows through R180 which permits a current of about 200 μ A through the transistor. Transistor Q156 disables the sawtooth generator by cutting off the current generator. When the phase locking system locks, phase detector 2 furnishes a positive voltage through R178 to the base of Q156. The transistor saturates, a voltage division occurs between R179 and R180, and the emitter voltage on Q157 drops and cuts off Q157. The charging of C152 stops, and the system synchronizes. Pin b5 is a test point for the output of phase detector 2 of the PL unit. The voltage on pin b2 is connected through resistor R603 in the chassis assembly and the ALC line to the broadband amplifier; it cuts off the amplifier when the system is not synchronised.

Transistor Q151 draws current when the current flow in emitter follower Q152 rises heavily. This happens when Q153 becomes saturated, at which time R160 is effectively in parallel with R159. The collector current in Q151 charges capacitor C152 quickly until the trigger voltage of CR151 is reached. The transistor shortens the fall time of the sawtooth. During normal phase locked operation the voltage drop across

R155 is less than the voltage across R153, and Q151 is cut off.

f. VCO Unit. (fig. 4-12)- The unit forms part of the phase locking system, as shown in figure 4-2. The unit contains a voltage-controlled oscillator, a buffer amplifier, an ALC circuit, and a d-c amplifier for a current-controlled inductor. The circuit is incorporated in a three module plug-in unit.

(1) Oscillator.- The circuit consists of transistor Q353 with associated components. It is an LC-oscillator in which one of the windings of transformer T351 provides the inductance, and series-connected capacitors C355, C362 and C354, and diode CR351, provide the capacitance. The capacitors form a voltage divider which furnishes positive feedback to the emitter of Q353 through capacitor C367.

The capacity of capacitive diode CR351 varies with the d-c voltage on control terminal a2, which is de-coupled for high frequencies. The other end of CR351 is raised to + 3 V for the greatest possible capacity variation with the voltage available from the PL unit. The VCO frequency varies from 26 MHz to 76 MHz when the d-c voltage at a2 and a4 varies from + 3 V to + 9 V.

(2) Buffer Amplifier.- This circuit consists of transistors Q354 and Q355 with associated components. It is a two-stage, untuned, transformer-coupled amplifier. Both stages are class A grounded-emitter amplifiers, with unbypassed feedback resistor in the emitters. The driving signal for the amplifier is taken from the oscillator emitter and coupled through capacitor C364 to the base of Q354. Broadband transformer T352 is wound on a ferrite core and transfers the signal to the base of Q355. The d-c voltage to the base of Q355 is obtained from the emitter of Q354. Two output signals are obtained from the two secondary windings on transformer T353. One, about 1.2 V, is applied to the BA unit through pins b6 and b7; the other is applied to the IA unit through pins b2 and b5.

(3) ALC circuit.- This circuit consists of transistor Q352 with associated components. The high frequency voltage on the collector of Q355 is rectified in a voltage doubler which includes diodes CR352 and CR353. The rectified voltage is coupled through zener diode CR355 and resistor R360 to the base of regulating transistor Q352. When the rectified d-c voltage exceeds the zener voltage (8.2 V), Q352 begins to draw collector current through resistor R351. This reduces the base

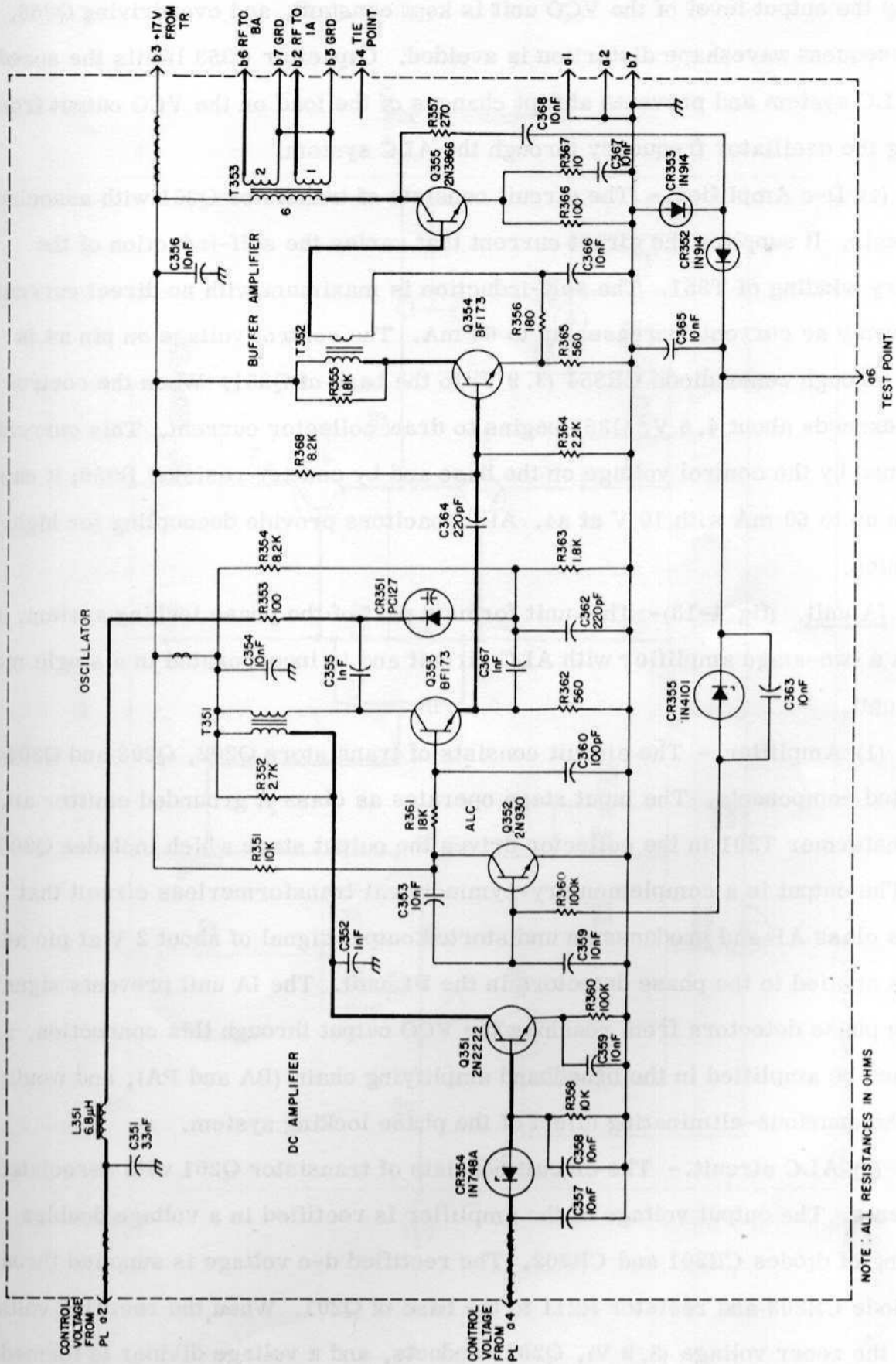


Figure 4-12. Voltage Controlled Oscillator (VCO) Unit A350, Schematic Diagram

voltage on oscillator transistor Q353, causing the oscillator output voltage to drop. This way the output level of the VCO unit is kept constant, and overdriving Q355, with consequent waveshape distortion is avoided. Capacitor C353 limits the speed of the ALC system and prevents abrupt changes of the load on the VCO output from affecting the oscillator frequency through the ALC system.

(4) D-c Amplifier.- The circuit consists of transistor Q351 with associated components. It supplies the direct current that varies the self-induction of the secondary winding of T351. The self-induction is maximum with no direct current and drops evenly as current increases up to 60 mA. The control voltage on pin a4 is coupled through zener diode CR354 (3.9 V) to the base of Q351. When the control voltage exceeds about 4.5 V, Q351 begins to draw collector current. This current is determined by the control voltage on the base and by emitter resistor R359; it can increase up to 60 mA with 10 V at a4. All capacitors provide decoupling for high frequencies.

g. IA unit. (fig. 4-13)- This unit forms a part of the phase locking system. It contains a two-stage amplifier with ALC circuit and is incorporated in a single module plug-in unit.

(1) Amplifier.- The circuit consists of transistors Q202, Q203 and Q204 with associated components. The input stage operates as class A grounded emitter amplifier. Autotransformer T201 in the collector drives the output stage which includes Q203 and Q204. The output is a complementary-symmetrical transformerless circuit that operates class AB and produces an undistorted output signal of about 2 V at pin a6. The signal is applied to the phase detectors in the PL unit. The IA unit prevents signals from the phase detectors from reaching the VCO output through this connection, as they would then be amplified in the broadband amplifying chain (BA and PA), and would cancel the spurious-eliminating effect of the phase locking system.

(2) ALC circuit.- The circuit consists of transistor Q201 with associated components. The output voltage of the amplifier is rectified in a voltage doubler consisting of diodes CR201 and CR202. The rectified d-c voltage is supplied through zener diode CR203 and resistor R211 to the base of Q201. When the rectified voltage exceeds the zener voltage (3.9 V), Q201 conducts, and a voltage divider is formed by

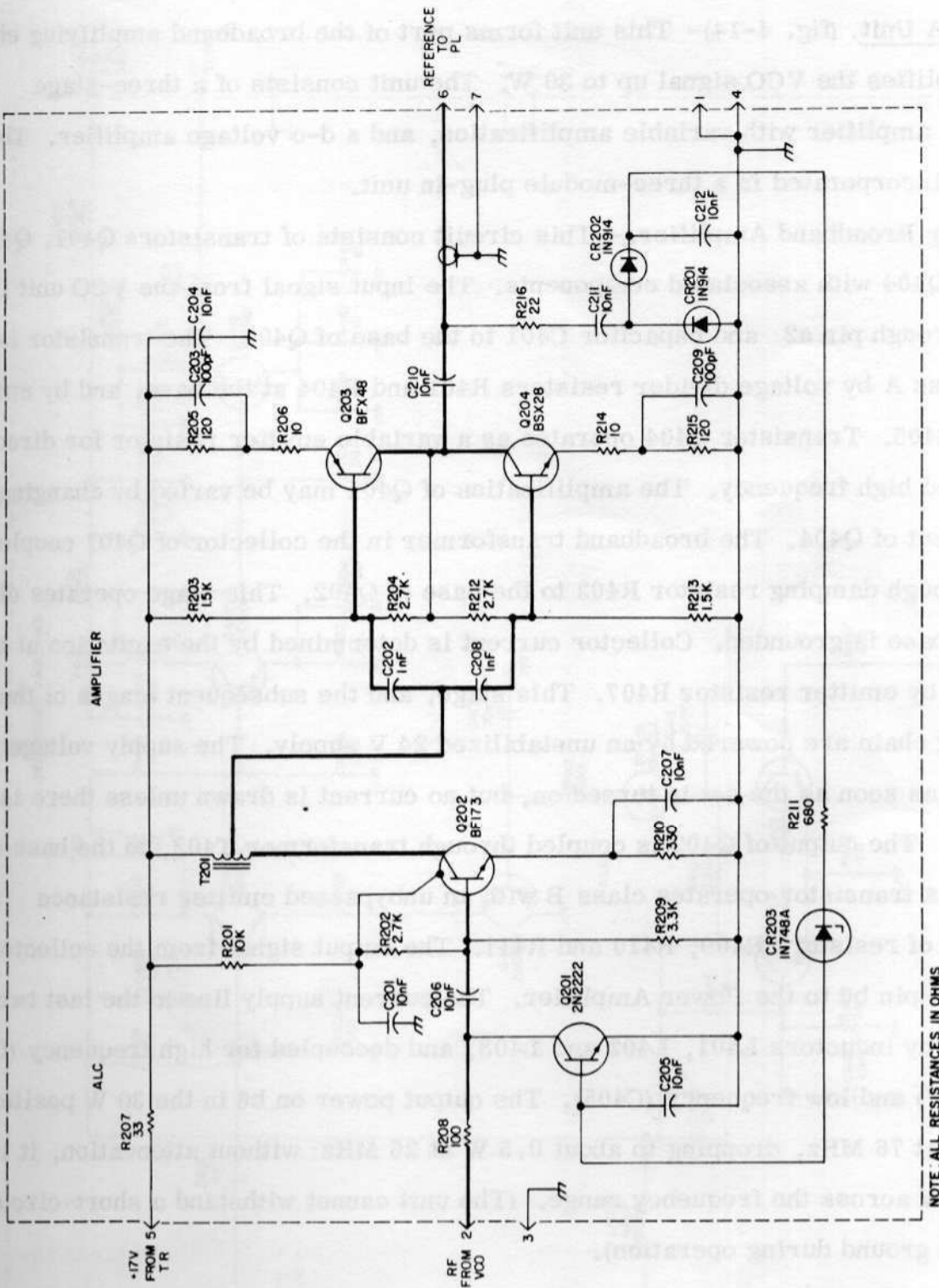


Figure 4-13. Isolation Amplifier (IA) Unit A200, Schematic Diagram

the transistor collector impedance and resistor R208, thereby reducing the input signal to the amplifier. This way the output signal is kept constant, and no overdrive of the IA output stages occurs.

h. BA Unit. (fig. 4-14)- This unit forms part of the broadband amplifying chain which amplifies the VCO signal up to 30 W. The unit consists of a three-stage broadband amplifier with variable amplification, and a d-c voltage amplifier. The circuit is incorporated in a three-module plug-in unit.

(1) Broadband Amplifier. - This circuit consists of transistors Q401, Q402, Q403 and Q404 with associated components. The input signal from the VCO unit is applied through pin a2 and capacitor C401 to the base of Q401. The transistor is biased class A by voltage divider resistors R401 and R404 at the base, and by emitter resistor R405. Transistor Q404 operates as a variable emitter resistor for direct current and high frequency. The amplification of Q401 may be varied by changing the base current of Q404. The broadband transformer in the collector of Q401 couples the signal through damping resistor R403 to the base of Q402. This stage operates class B since the base is grounded. Collector current is determined by the excitation at the base, and by emitter resistor R407. This stage, and the subsequent stages of the amplifying chain are powered by an unstabilized 24 V supply. The supply voltage is connected as soon as the set is turned on, but no current is drawn unless there is excitation. The output of Q402 is coupled through transformer T402, to the base of Q403. This transistor operates class B with an unbypassed emitter resistance consisting of resistors R409, R410 and R411. The output signal from the collector is fed through pin b6 to the Power Amplifier. The current supply line to the last two stages is filtered by inductors L401, L402 and L403, and decoupled for high frequency (C403, C406, C407) and low frequency (C405). The output power on b6 in the 30 W position is about 2 W at 76 MHz, dropping to about 0.5 W at 26 MHz; without attenuation, it is about 3-6 W across the frequency range. (The unit cannot withstand a short-circuit from b6 to ground during operation).

(2) D-c Voltage Amplifier. - The circuit consists of transistors Q405 and Q406, with associated components, that form a balanced d-c voltage amplifier. Input terminal a5 is connected from the current limiting circuit in the PA assembly through R417 to

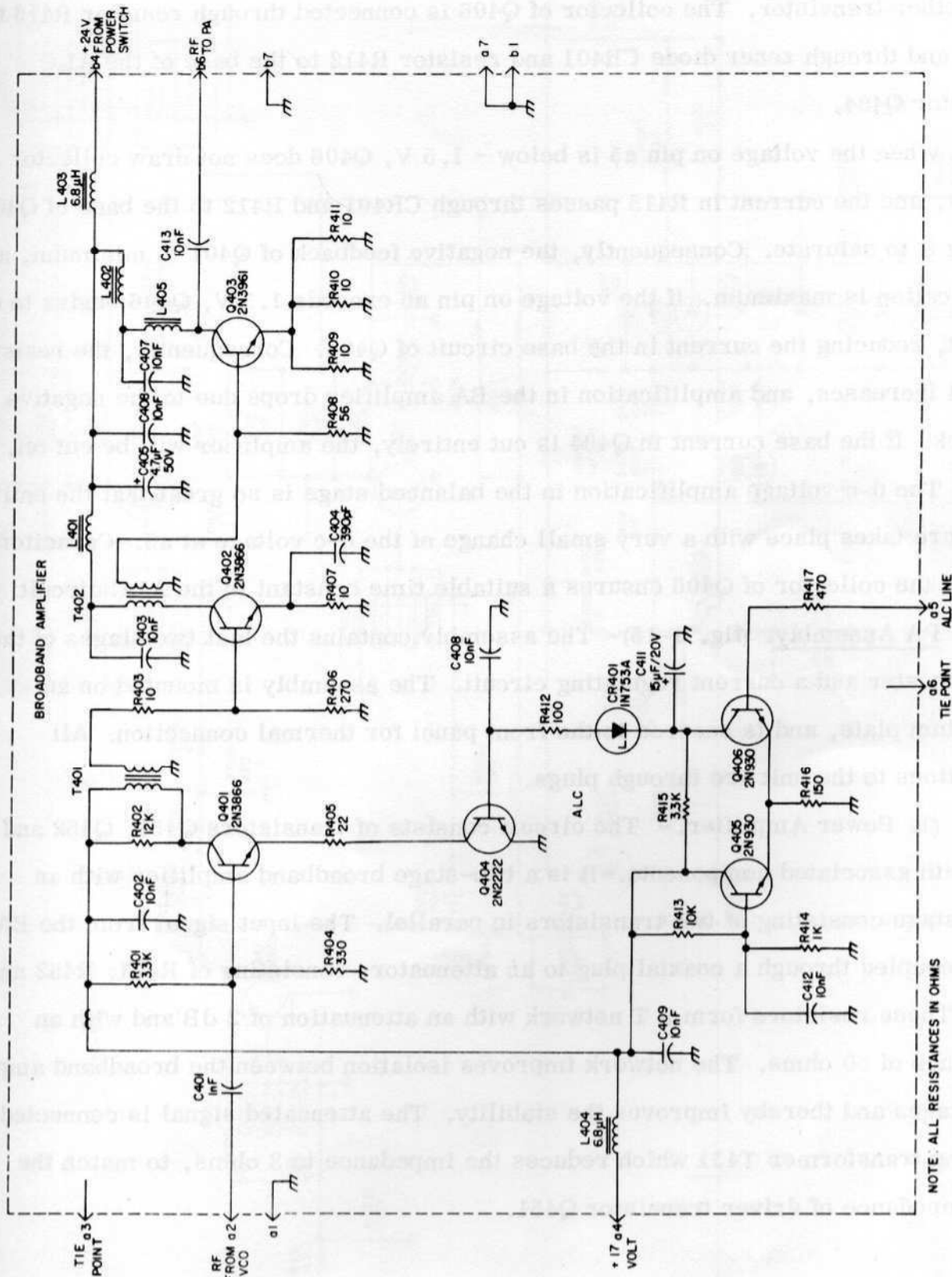


Figure 4-14. Broadband Amplifier (BA) Unit A400, Schematic Diagram

the base of Q406. The base of Q405 is connected to a voltage divider which maintains + 1.5 V. Both transistors have a common emitter resistor (R416); a current increase in one transistor raises the common emitter voltage and thereby decreases the current in the other transistor. The collector of Q406 is connected through resistor R415 to + 17 V and through zener diode CR401 and resistor R412 to the base of the ALC transistor Q404.

When the voltage on pin a5 is below + 1.5 V, Q406 does not draw collector current, and the current in R415 passes through CR401 and R412 to the base of Q404, causing it to saturate. Consequently, the negative feedback of Q401 is minimum, and amplification is maximum. If the voltage on pin a5 exceeds 1.5 V, Q406 begins to draw current, reducing the current in the base circuit of Q404. Consequently, the resistance of Q404 increases, and amplification in the BA amplifier drops due to the negative feedback. If the base current in Q404 is cut entirely, the amplifier will be cut off.

The d-c voltage amplification in the balanced stage is so great that the entire procedure takes place with a very small change of the d-c voltage at a5. Capacitor C411 on the collector of Q406 ensures a suitable time constant in the ALC circuit.

i. PA Assembly. (fig. 4-15)- The assembly contains the last two stages of the range booster and a current regulating circuit. The assembly is mounted on an aluminium plate, and is secured to the front panel for thermal connection. All connections to the unit are through plugs.

(1) Power Amplifier.- The circuit consists of transistors Q451, Q452 and Q453 with associated components. It is a two-stage broadband amplifier with an output stage consisting of two transistors in parallel. The input signal from the BA unit is coupled through a coaxial plug to an attenuator, consisting of R451, R452 and R453. These resistors form a T network with an attenuation of 2 dB and with an impedance of 50 ohms. The network improves isolation between the broadband amplifying stages and thereby improves the stability. The attenuated signal is connected to matching transformer T451 which reduces the impedance to 3 ohms, to match the input impedance of driver transistor Q451.

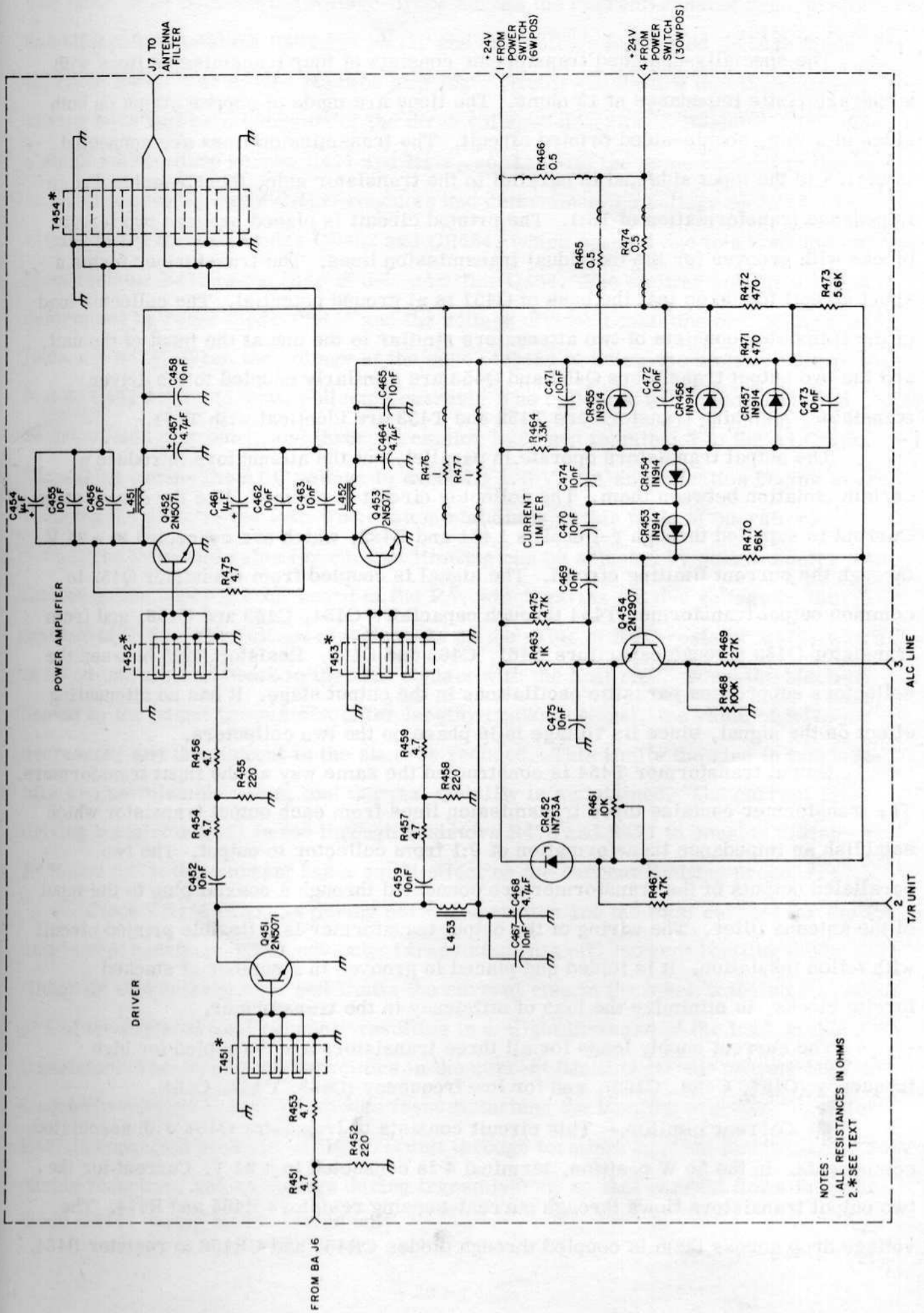


Figure 4-15. Power Amplifier (PA) Assembly A450, Schematic Diagram

The specially-designed transformer consists of four transmission lines with a characteristic impedance of 12 ohms. The lines are made of copper strips on both sides of a thin, double-sided printed circuit. The transmission lines are connected in series to the input side and in parallel to the transistor side, thereby achieving an impedance transformation of 16:1. The printed circuit is placed between two ferrite blocks with grooves for the individual transmission lines. The transformer forms a short circuit for dc so that the base of Q451 is at ground potential. The collector load of the transistor consists of two attenuators similar to the one at the input of the unit, and the two output transistors Q452 and Q453 are similarly coupled to the driver transistor. Matching transformers T452 and T453 are identical with T451.

The output transistors operate in parallel, but the attenuators introduce a certain isolation between them. The collector circuit is untuned, like the driver stage. Current is supplied through r-f chokes L451 and L452, which are connected to + 24 V through the current limiting circuit. The signal is coupled from transistor Q452 to common output transformer T454 through capacitors C454, C455 and C456, and from transistor Q453 through capacitors C461, C462 and C463. Resistor R475 between the collectors suppresses parasitic oscillations in the output stage. It has no attenuating effect on the signal, since its voltage is in phase on the two collectors.

Output transformer T454 is constructed the same way as the input transformers. The transformer contains three transmission lines from each output transistor which establish an impedance transformation of 9:1 from collector to output. The two paralleled outputs of the transformer are connected through a coaxial plug to the input of the antenna filter. The wiring of the output transformer is a flexible printed circuit with teflon insulation. It is folded and placed in grooves in a number of stacked ferrite blocks, to minimize the loss of efficiency in the transformer.

The current supply leads for all three transistors are decoupled for high frequency (C467, C458, C465), and for low frequency (C468, C457, C464).

(2) Current Limiter.- This circuit consists of transistor Q454 with associated components. In the 30 W position, terminal 4 is connected to + 24 V. Current for the two output transistors flows through current-sensing resistors R465 and R474. The voltage drop across them is coupled through diodes CR455 and CR456 to resistor R464.

The mean value between the voltage-drops across the current-sensing resistors is established by resistors R471 and R472, and this voltage is coupled through diode CR457 to R464. The diodes function as a logic circuit and ensure that the voltage across R464 will be the largest of the three voltages described. Resistor R473 adds a small voltage drop across R471 and R472, so that with the same current in the two output transistors, diode CR457 conducts and determines the voltage on R464. The voltage is fed through diodes CR453 and CR454, which conduct due to a constant current from resistor R470 to the base of d-c amplifier Q454. The emitter voltage of Q454 is determined by zener diode CR452 and the voltage divider consisting of resistors R461, R463 and R475. When the voltage at the base of Q454 is below the emitter voltage less 0.6 V, Q454 begins to draw collector current. The collector is connected through resistor R468 to ground, and through resistor R269 and terminal 3 to the ALC line. When Q454 causes the ALC voltage to exceed + 1.5 V, BA amplification begins to drop, reducing the drive to the PA. The system stabilizes at this point of operation.

The threshold value for current limiting can be adjusted by potentiometer R461, located on the upper circuit board of the PA, which varies the d-c voltage on the emitter of Q454. The voltage also depends on the value of NTC resistor R475, which is fitted into a metal block in thermal contact with the heat sink. When the block is heated by the output transistors (after lengthy transmissions), the value of R475 decreases, and the current in the stage is reduced. This limits the rise in temperature to a permissible value, and thermal stability is maintained. The current in driving transistor Q451 is fed through resistors R476 and R477 to sensing resistors R465 and R474; this current has a small effect on the current limiting process.

Diode CR456 conducts during normal operation and the total current for the PA unit is kept constant. When one output transistor cuts off, current limiting diode CR455 or CR456 takes over and limits the current rise in the other transistor to about 65% of the adjusted total current, resulting in a slight increase of the load on this transistor. The decoupling capacitors in the current limiting circuit prevent high frequency voltages across the diodes from disturbing the limiting process. Resistor R467 is connected to pin b2 of the T/R unit through terminal 2. This junction has + 24 V during reception, and no voltage during transmission, so that current flows in zener diode CR452 during transmission only.

j. Antenna Filter. (fig. 4-16)- The unit includes three low-pass filters with switch sections and a reflectometer. The unit is mounted between the front panel and the chassis. Connections to the unit are through two coaxial plugs and a soldered terminal.

(1) Low-Pass Filters.- These three filters are similarly constructed, but have different cutoff frequencies. The passbands and cutoff frequencies are as follows:

<u>Filter</u>	<u>Passband</u>	<u>Band No.</u>	<u>Cutoff Frequency</u>
1	26-37 MHz	1, 2, 3	42 MHz
2	37-53 MHz	4, 5, 6	61 MHz
3	53-76 MHz	7, 8, 9, 10, 11	87 MHz

The basic diagram of the filters is shown in figure 4-17. The filter assembly can be divided into a transformer section, a constant R-section, and three low-pass filter sections.

The transformer section matches the output impedance of the amplifier to that of the filter. The complete transformer is used only in filter No. 1. In filter No. 2 only a coil (L507) is used, whereas no transformer is used in filter No. 3.

The constant R-section consists of a series-tuned circuit (L2, C2) and a parallel-tuned circuit (L3, C3) that are tuned to the center frequency in the passband of the filter. At this frequency the series circuit acts as a short-circuit and the parallel circuit has a high impedance. There is maximum coupling of the center frequency, but the LC ratios of the circuits cause little attenuation over the entire passband. At frequencies much above or much below the passband, the series circuit has a high impedance, so that the 47 ohms resistor is coupled into the circuit, while the parallel circuit acts as a short-circuit. Consequently, the filter has a resistive input impedance of 47 ohms, independent of the antenna impedance. This load on the output amplifier improves amplifier stability, particularly at low frequencies. The low-pass filter consists of three pi-sections: the last two have parallel capacitors across the coils, and function as wavetraps for two frequencies above the cutoff frequency. These traps, and the ratio between the other components, give the filter a sharp cutoff characteristic, which attenuates harmonics of the transmitting frequency by at least 50 dB.

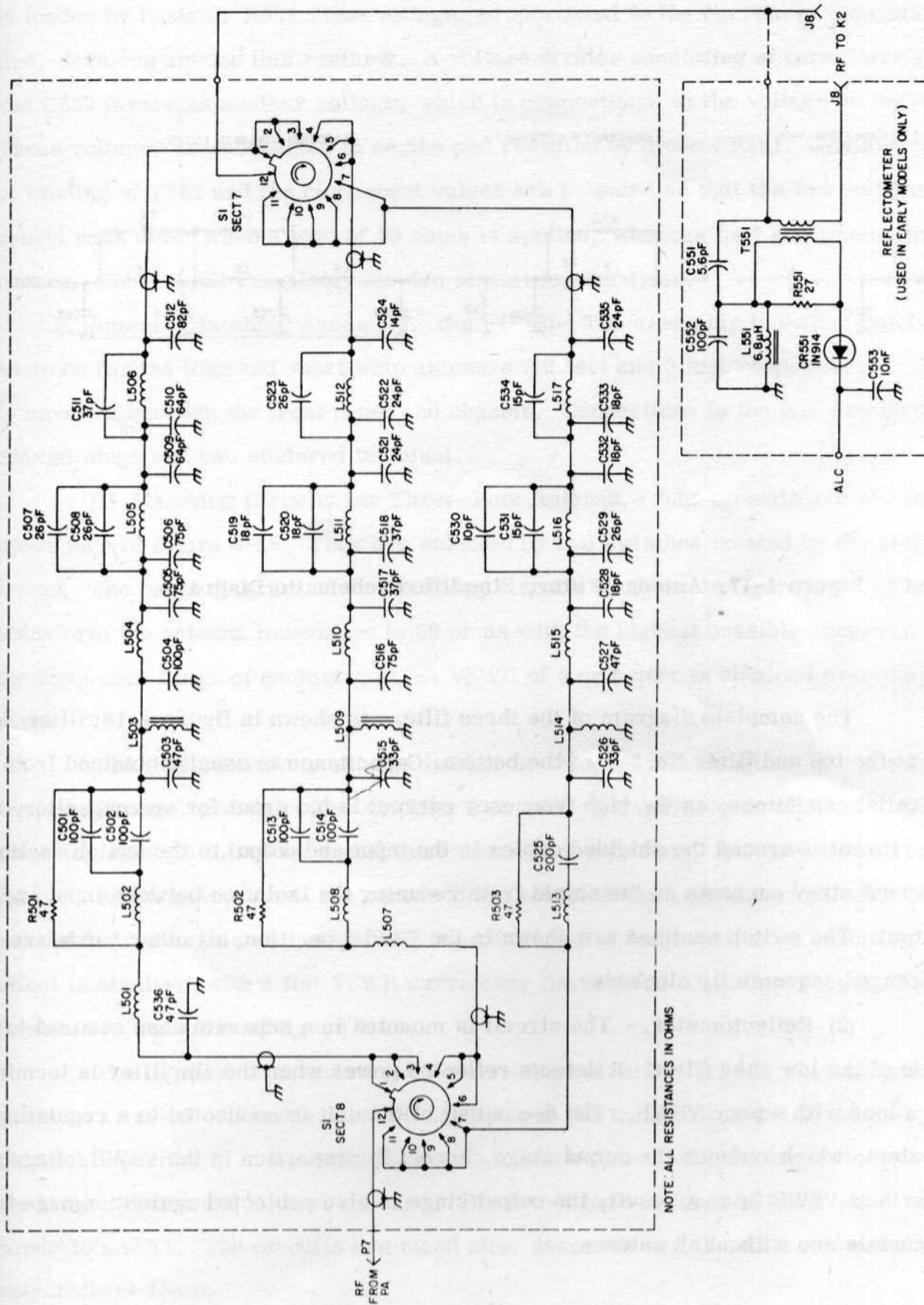


Figure 4-16. Antenna Filter Assembly A500, Schematic Diagram

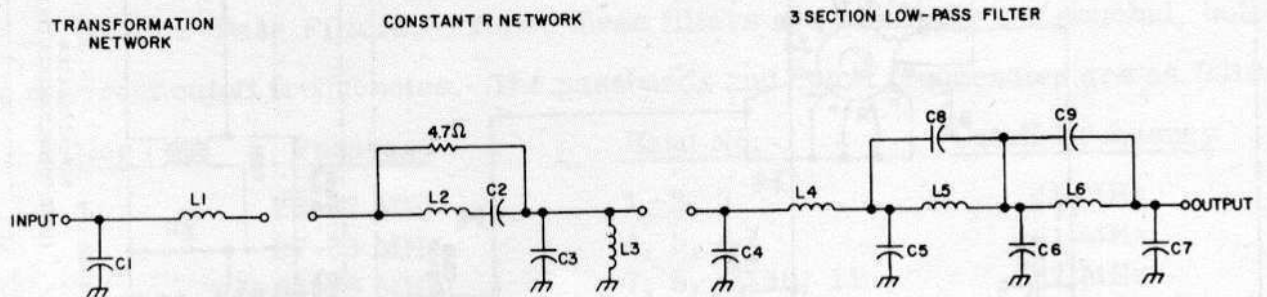


Figure 4-17. Antenna Filter, Simplified Schematic Diagram

The complete diagram of the three filters is shown in figure 4-16; filter No. 1 is at the top and filter No. 3 is at the bottom. Capacitance is usually obtained from two parallel capacitors, as the high frequency current is too great for one capacitor. Ferrite cores around the shielded cables in the input and output to the switch sections prevent stray currents on the shield from reducing the isolation between input and output. The switch sections are shown in the Band 1 position; all other bands are arranged sequentially clockwise.

(2) Reflectometer. - The circuit is mounted in a separate case secured to one side of the low pass filter. It detects reflected power when the amplifier is terminated in a load with a poor VSWR. The d-c output of the unit is connected to a regulating system, which reduces the output stage current in proportion to the VSWR. Regulation starts at VSWR 3; as a result, the output stage is also protected against damage from transmission without an antenna.

The reflectometer contains a current transformer (T551), whose secondary is loaded by resistor R551. One voltage, proportional to the current in the coaxial line, develops across this resistor. A voltage divider consisting of capacitors C551 and C552 furnishes another voltage, which is proportional to the voltage on the cable. These voltages are connected in series and rectified by diode CR551. The direction of winding of T551 and the component values are selected so that the two voltages cancel each other when a load of 50 ohms is applied, whereas they add when a mismatch occurs. Choke L551 completes the d-c circuit for the diode.

k. Antenna Matching Assembly. (fig. 4-18)- The assembly includes matching sections for the long and short whip antennas (10 feet and 3 feet respectively). The unit is mounted between the front panel and chassis. Connections to the unit are through two coaxial plugs and two soldered terminal.

(1) Matching Circuits for Three-Foot Antenna. - The circuits are shown at upper part of figure 4-18. They are selected by two switches rotated by the stepping motor. The basic diagram of the matching circuits is shown in figure 4-19. The circuits transform the antenna impedance to 50 ohms with the highest possible accuracy within the frequency range of each circuit. A VSWR of 3 or better is obtained over the entire range.

The three-foot whip antenna is shorter than $1/4$ wavelength over the entire frequency range, and therefore displays a capacitive impedance on all bands. The matching circuits introduce a coil in series with the antenna. A series circuit is then formed, which resonates at the center of the selected band. A tapped parallel circuit across the input maintains a low VSWR over a band of frequencies. A bandpass filter effect is obtained, with a flat VSWR curve over the desired frequency range. The effect is shown in the curve of figure 4-19.

The parallel compensating circuits are used on bands 1-6, whereas bands 7-11 only use a series coil and a parallel capacitor at the transmitter end of the circuit. This parallel capacitor is composed of several parallel-connected mica capacitors to withstand the large r-f current in these circuits. Bands 7-9 have a common shunt capacitor, as do bands 10 and 11. The circuits are tuned after assembly and the coils are embedded in polyurethane foam.

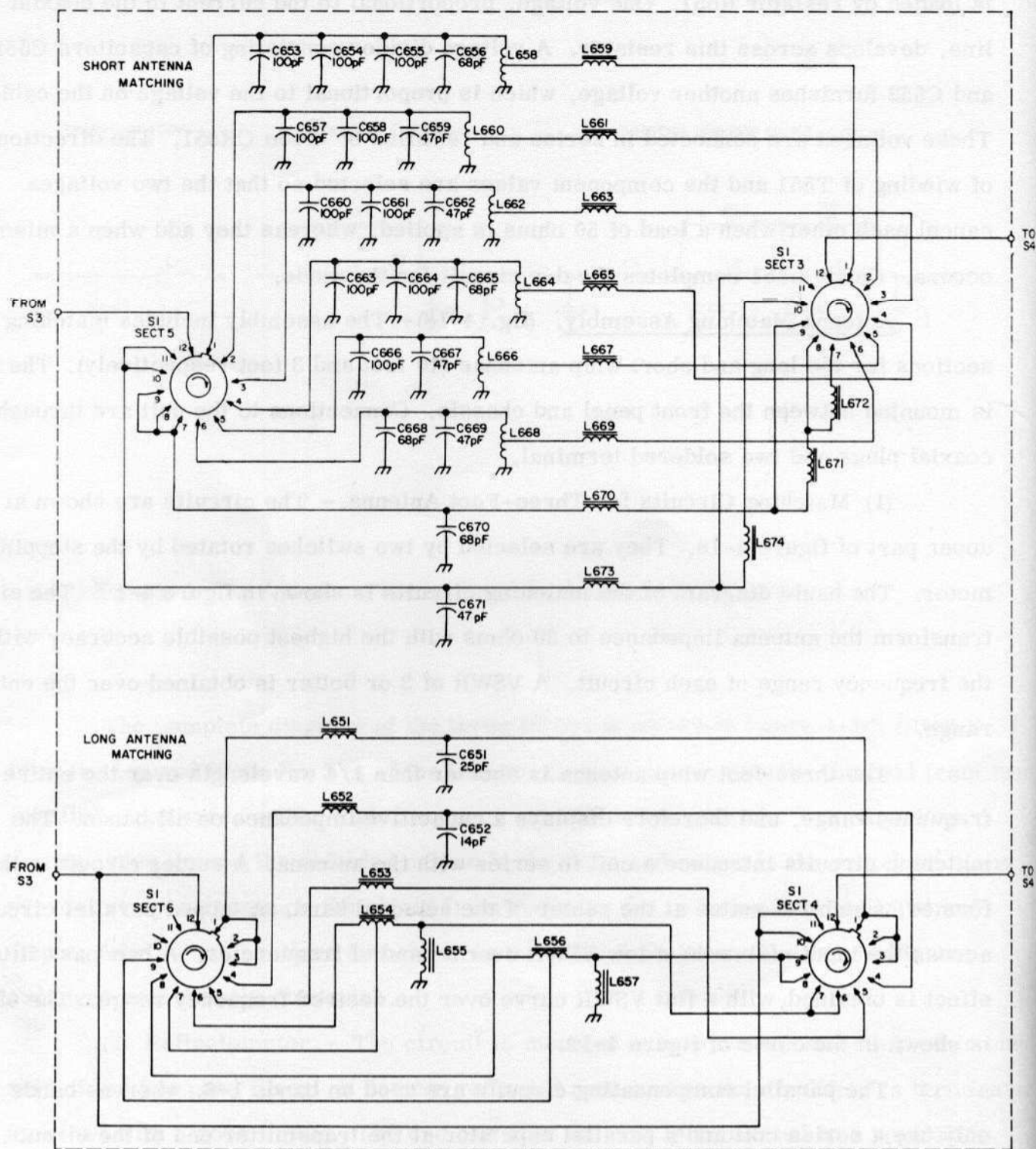


Figure 4-18. Antenna Matching Network A650, Schematic Diagram

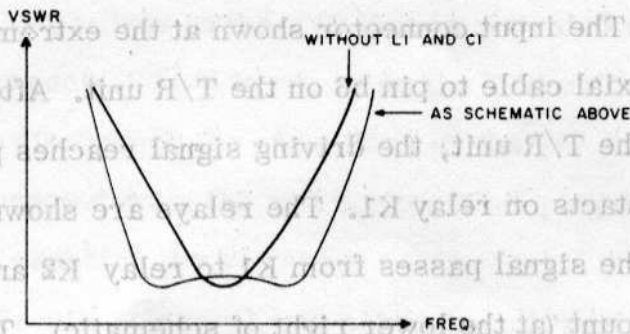
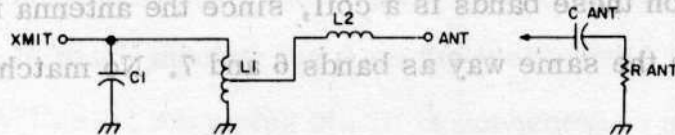


Figure 4-19. Antenna Matching Network, Simplified Schematic Diagram, and VSWSR Curve.

(2) Matching Sections for Ten-Foot Antenna. - The circuits are shown at the bottom of figure 4-18. Both input and output circuits are selected by two switch sections rotated by the stepping motor. The ten-foot antenna is $1/4$ wavelength at 26 MHz, $1/2$ wavelength at 45 MHz, and $3/4$ wavelength at 70 MHz. It is therefore inductive from 26 to 45 MHz and capacitive from 45 to 70 MHz. A VSWSR of 3 or better is obtained over the entire band.

All matching circuits are L-sections. Bands 1-3 have a common L-section, consisting of coil L651 and capacitor C651, which reduces the antenna impedance. The capacitor also provides a parallel tuning of the inductive impedance of the antenna. Band 4 also uses an L-section consisting of L652 and C652. On band 5, only series coil L653 is connected, as the necessary parallel capacity is inherent in the antenna mount and the wiring.

Bands 6 and 7 are combined on the output side, while the series coil is tapped. The parallel reactance on these bands is a coil, since the antenna is capacitive. Bands 8 and 9 are connected in the same way as bands 6 and 7. No matching circuit is used on bands 10 and 11.

1. Complete Schematic Diagram. - A complete schematic diagram of the RB-25 is found at the end of chapter 5 , and shows all electronic components of the unit. The description in this paragraph covers those components mounted on the chassis or front panel which have not been described previously.

(1) Signal Path. - The input connector shown at the extreme left of the diagram, is connected through a coaxial cable to pin b6 on the T/R unit. After passage through the dual reflectometer in the T/R unit, the driving signal reaches pin b5 which is connected to one of the contacts on relay K1. The relays are shown in the static receive position. In this position the signal passes from K1 to relay K2 and then to the microswitch S2 at the antenna mount (at the lower right of schematic). The microswitch is activated like the other two described, by a plunger in the antenna mount, when the antenna is installed. Switch S2 selects the coaxial output connector (ANT socket) or the antenna matching circuits, and is activated by the short or the long antenna. Microswitches S3 and S4 are activated by the long antenna only; the two switches select the matching circuits for the short or for the long antenna. In the transmit condition, relays K1 and K2 are energized. The driving signal is coupled through one set of contacts on K1 and through C601 to the ATD unit. Coupling to the PL unit is made through voltage divider R601 and R602. The other set of relay contacts grounds the line between the two relays and thereby increases the isolation between the input and output circuits of the booster. During transmission, K2 connects the antenna switch assembly to the output of the antenna filter reflectometer.

(2) Power Distribution Circuits. - The power supply is connected through the battery plug at the bottom of the case. The lead connections are as follows:

Pin A	Ground
Pin B	+ 24 V
Pin C	Control Line

The set is not protected against reverse polarity connection.

The battery plug is connected through an r-f filter to a plug which is inserted in the test socket on the chassis, when the lid that holds the plug-in units is fitted. The ground connection is made through pin A on the test socket.

The + 24 V line (battery plug pin B) is connected to test socket pins B and D. Pin B is connected through the power switch to the PA assembly. In the 6 W position, connection is made to point 1 on the PA assembly, and in the 30 W position to point 4. Test socket pin D supplies + 24 V through the power switch to the plug-in units in both the 6 W and 30 W positions. Pin D also connects + 24 V to the antenna control socket.

The + 17 V stabilizer in the T/R unit is activated through a set of contacts on relay K2, which connects + 24 V to pin a3 on the T/R unit. The same set of contacts in receive position discharges the capacitors on the +17 volt line through diode CR601. This voltage is connected from the test socket to all plug-in units, but is filtered additionally before reaching the VCO unit.

(3) Test Circuit. - Several test points permit rapid localizing of defective plug-in units. The test socket is used with standard test equipment. Details of the voltages measured are given in chapter 5. The following list identifies the circuits connected to the individual pins of the test socket:

<u>Test socket pin</u>	<u>Connection</u>
A	Ground
B	+ 24 V to PA assembly
C	EXT. ANT socket pin M
D	+ 24 V to plug-in units
E	+ 17 V from T/R unit
F	+ 17 V to plug-in units
H	VCO control voltage to self-inductance coil
J	VCO control voltage to capacitive diode
K	VCO voltage regulation
L	IA voltage regulation
M	BA voltage regulation
N	BA output voltage
P	ATD stop voltage

m. Adapter Box CY-250.- This box is required when the RB-25 is fed from a vehicular electrical system. It replaces the normal battery box, and includes a rear connector to allow connection to the power source by a cable assembly. The box protects the RB-25 against pulses above 30 V. The electrical circuit includes a 5A fuse at the input; the output is obtained from the emitter of transistor Q1, which conducts due to the bias supplied by R1. However, any pulse above 30 V which appears at the input is grounded by zener diode CR1.

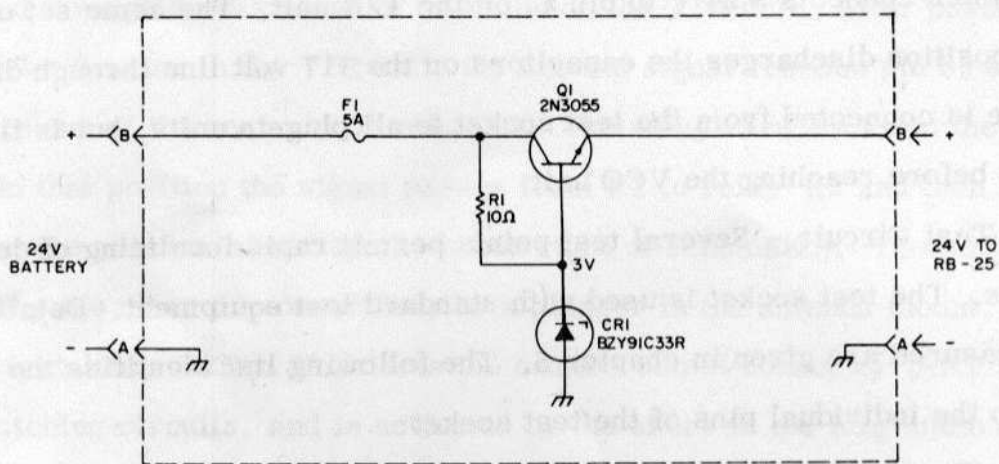


Figure 4-20. Adapter Box CY-250.

CHAPTER 5
MAINTENANCE

5-1. TROUBLESHOOTING

a. Introduction. - The purpose of troubleshooting is to localise a failure to a replaceable unit; the unit is then replaced, and the RB-25 is subsequently checked to ensure that the failure has been eliminated. Most common failures can be corrected by this procedure. The check list in table 5-1 also serves as a simple final test for the RB-25 when a complete final test, demanding complicated measuring equipment, cannot be made.

b. Operational Check. - Troubleshooting should always start with this procedure. The checks are made without removing the RB-25 from its case. The following equipment is necessary: Radio Set AN/PRC-25 or AN/PRC-77, or signal generator with 2 W output; coaxial cable CG-409G/U; and r-f wattmeter, Bird type 611 or equivalent.

- (1) Connect radio set to IN jack on RB -25 using coaxial cable.
- (2) Connect wattmeter to RB-25 ANT jack.
- (3) Switch wattmeter to its lowest scale.
- (4) Perform procedure listed in table 5-1 in the order given. When a normal indication is not obtained, stop test and proceed to paragraph 5-1(c).

Table 5-1. Operational Checklist

Action	Normal Indication	Probable Cause for Abnormal Indication
RB-25 in OFF position; radio set keyed on 31 MHz	2 W	1. Defective interconnecting cable 2. Defective radio set 3. Fault in RB-25
RB-25 in 6 W position; radio set keyed on 31 MHz	6 W	1. Defective RB-25 battery 2. Fault in RB-25
RB-25 in 30 W position; radio set keyed on 31 MHz	30 W	1. Weak RB-25 battery 2. Faulty RB-25
Radio set keyed on 35 MHz	30 W	Faulty RB-25
40 MHz	30 W	Faulty RB-25
45 MHz	30 W	Faulty RB-25

Table 5-1. (cont)

Action	Normal Indication	Probable Cause for Abnormal Indication
Radio set keyed on 50 MHz	30 W	Faulty RB-25
55 MHz	30 W	Faulty RB-25
58 MHz	30 W	Faulty RB-25
63 MHz	30 W	Faulty RB-25
68 MHz	30 W	Faulty RB-25
75 MHz	30 W	Faulty RB-25

The RB-25 is tested under 50-ohm load as in a vehicular installation. The whip antenna matching sections can only be tested by communicating with another radio set at a distance of at least 100 meters. If the matching sections do not function properly, repair the unit at a high echelon.

c. Preparation for Troubleshooting. - When the operational check indicates that the RB-25 is defective, prepare the unit for troubleshooting: withdraw the RB-25 from its case and remove the cover which holds the plug-in units, as well as the silicone-rubber insert. It is now possible to replace plug-in units without further disassembly. The following equipment is required for troubleshooting:

- (1) Radio set AN/PRC-25 or AN/PRC-77 with battery (a signal generator with 2 W output may be used).
- (2) Coaxial cable CG-409G/U
- (3) R-f wattmeter, Bird type 611 or equivalent
- (4) VTVM, Hewlett-Packard type HP410C or equivalent
- (5) Multimeter, Simpson type 270 or equivalent (current measurements)
- (6) RB-25 battery, or a 24 V, 4A power supply (a stabilized power supply or a large 24 volt battery are recommended).

d. Procedure. -

- (1) Connect radio set to IN jack on RB-25 using coaxial cable.
- (2) Connect wattmeter to RB-25 ANT jack.
- (3) Follow the sequence in table 5-2; when a normal indication is not obtained, replace the unit mentioned first in the replace column. If this does not remedy the fault return the original part or unit and replace the next item listed as a possible cause for this trouble. After the fault is corrected, continue to perform the remaining steps to ensure that no other faults have resulted.

Table 5-2. Troubleshooting Procedure

RB-25 Setting	Radio Set Output Frequency (MHz)	Test Point	Normal Indication	Trouble	Faulty Item	Replace
Off	75	ANT jack	1.5 W	No output	Antenna switch Relay K1 or K2 Coaxial cable	* Relay K1 or K2 Cable
6 W	75	ANT jack	6 W	Short circuit No output Output too high	Plug-in unit or chassis wiring Motor jammed AGC circuit	* BA
30 W	75	ANT jack	30 W	Output too low No output	Plug-in unit Continue tests	BA -
30 W	75	E	17.0 V	Incorrect reading	Booster doesn't key	T/R
30 W	75	E-F	180 mA	Incorrect reading	Plug-in unit	PL; IA; VCO; BA
30 W	75	D	450 mA	Incorrect reading	Plug-in unit	MD; BA
30 W	75	D-B	3.2 A	Incorrect reading	Continue tests	-
6 W	75	H	8 -8.5 V	Incorrect reading	Plug-in unit	PL; VCO; IA
6 W	75	J	8 -8.5 V	Incorrect reading	Plug-in unit	PL; VCO
6 W	75	K	9.3 -9.5 V	Incorrect reading	Plug-in unit	VCO
6 W	75	L	0.05 V	Incorrect reading	Plug-in unit	IA; VCO
6 W	75, 68, 63, 58, 55, 50, 45, 40, and 31	P	1.1 V	Motor doesn't step Motor doesn't stop Short circuit	Plug-in unit Motor jammed Wiring between motor and ATD	MD; ATD * *
30 W	75	N	4.0 -4.25 V	Incorrect reading	Plug-in unit	BA
30 W	75	M	0.75-0.79 V	Incorrect reading	Plug-in unit AGC-wire to PA	BA; MD; PL *

* High echelon repair

Note: The PA assembly, antenna filter assembly, antenna matching network, and stepping motor unit are replaced by high echelon personnel.

e. Troubleshooting Chassis Wiring. - This procedure localizes trouble in the wiring and components of the chassis assembly, by resistance measurement with a multimeter. Trouble can also be localised in the multiconductor cables and to a limited extent in the front panel assembly. Before measuring resistances, remove all external connections to the RB-25 as well as the seven plug-in units. The normal resistance values and the connecting leads are shown in figure 5-1. If an incorrect reading results, the RB-25 must be disassembled further for repair; this includes opening the hinged chassis, removing the coaxial plug under the printed board of the PA assembly, and removing the chassis bottom plate. Disassembly and assembly of these parts must be performed carefully and according to the instructions in paragraph 5-2; otherwise the RB-25 may be damaged and high echelon repair will be necessary.

5-2. REPAIRS.

a. Introduction.

(1) Range booster RB-25 may be repaired only by qualified personnel provided with suitable tools and test equipment. An inexperienced operator who tries to repair the RB-25 may damage the set such that it may need overhaul.

(2) Sometimes components or wiring may have to be removed for access to the faulty part; if so, draw a sketch of the wires to be removed and their location in the RB-25.

(3) Avoid dropping solder into the RB-25; the tiniest bit of solder may cause short circuits. When soldering diodes, use long-nose pliers, held around the wire between the point of solder and the diode, as a heat sink.

(4) Never change the location of components or wiring, as this may affect circuit operation.

(5) Take special care when disassembling and assembling mechanical parts; tighten screws well, but not until the thread is stripped.

b. Disassembly. - To troubleshoot and repair the RB-25, the set must be partially disassembled. Never disassemble the RB-25 more than necessary for repair.

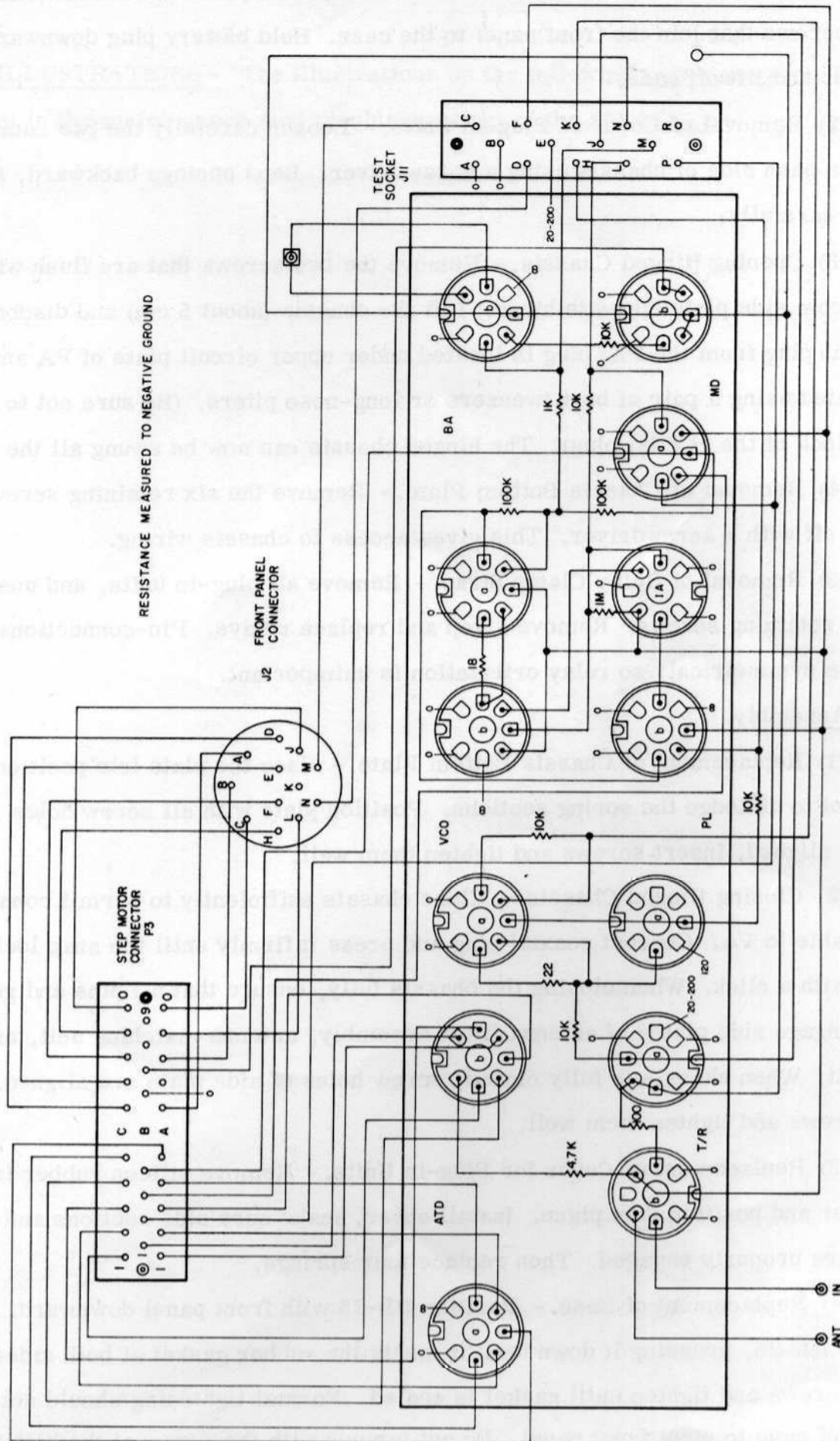


Figure 5-1. Resistance Measurements

(1) Removal of Case. - Position RB-25 with front panel downward. Remove the four screws that join the front panel to the case. Hold battery plug downward with the thumb, and lift off case.

(2) Removal of Cover of Plug-in Units. - Loosen carefully the two retaining springs on each side of chassis using a screwdriver. Bend springs backward, and lift off cover carefully.

(3) Opening Hinged Chassis. - Remove the two screws that are flush with the chassis from side plate opposite hinge. Lift the chassis (about 5 cm) and disconnect the coaxial plug from the PA; plug is located under upper circuit plate of PA and should be separated using a pair of bent tweezers or long-nose pliers. (Be sure not to damage the snap lock of the coaxial plug). The hinged chassis can now be swung all the way up.

(4) Removal of Chassis Bottom Plate. - Remove the six retaining screws, and pry plate off with a screwdriver. This gives access to chassis wiring.

(5) Removal of Relay Clamp Strap. - Remove all plug-in units, and unscrew the strap retaining screws. Remove strap and replace relays. Pin-connections of the relays are symmetrical, so relay orientation is unimportant.

c. Assembly.

(1) Replacement of Chassis Bottom Plate. - Ease the plate into position, being careful not to dislodge the spring sections. Position plate with all screw holes correctly aligned, insert screws and tighten them well.

(2) Closing Hinged Chassis. - Close chassis sufficiently to permit connection of coaxial cable to PA. Connect coaxial plug and press it firmly until the snap lock engages with a click. When closing the chassis fully, ensure that all pins and guide springs engage side plates of antenna filter assembly, antenna matching unit, and step motor unit. When chassis is fully closed, screw holes of side plate are aligned. Then insert screws and tighten them well.

(3) Replacement of Cover for Plug-in Units. - Remove silicon rubber insert from cover and position it in place. Install cover, make sure side sections and multi-pin plug are properly engaged. Then replace four springs.

(4) Replacement of Case. - Position RB-25 with front panel downward. Slide case over RB-25, pressing it down until it meets the rubber gasket at both sides. Insert the four screws and tighten until gasket is sealed. Normal tightening should not cause side lugs of case to meet front panel. Do not tamper with the screw at the bottom of the case; it is used for vacuum-testing a sealed RB-25.

5-3. ILLUSTRATIONS - The illustrations on the following pages are provided to assist in the maintenance (and troubleshooting) of the RB-25.

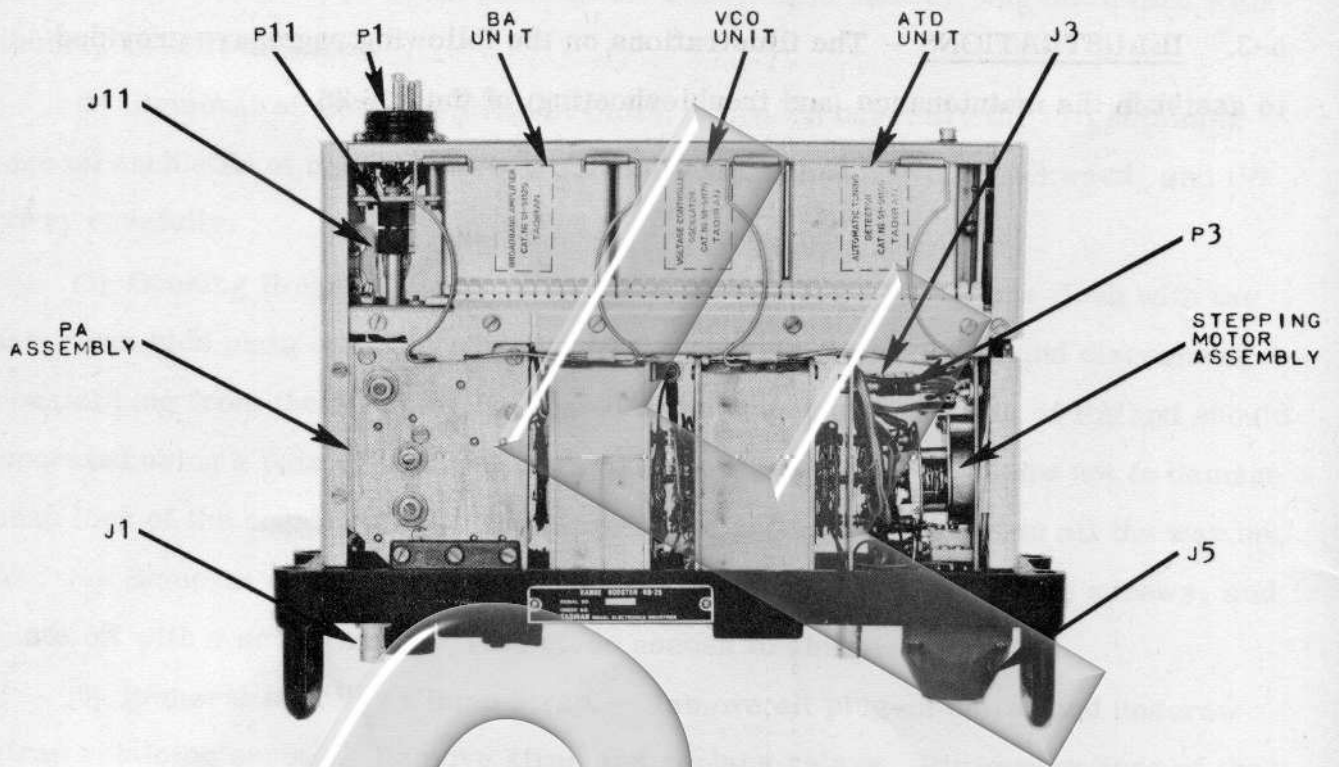


Figure 5-2. RB-25 Removed from Case, Top View

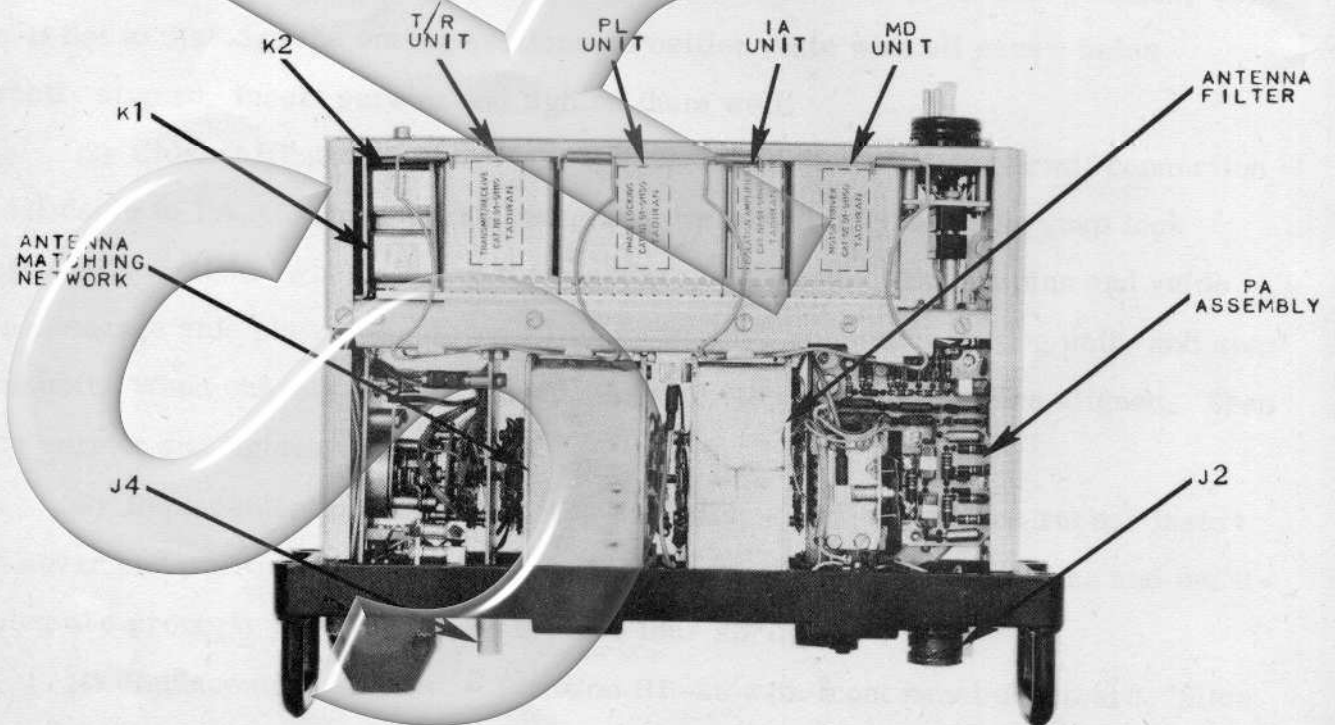


Figure 5-3. RB-25 Removed from Case, Bottom View

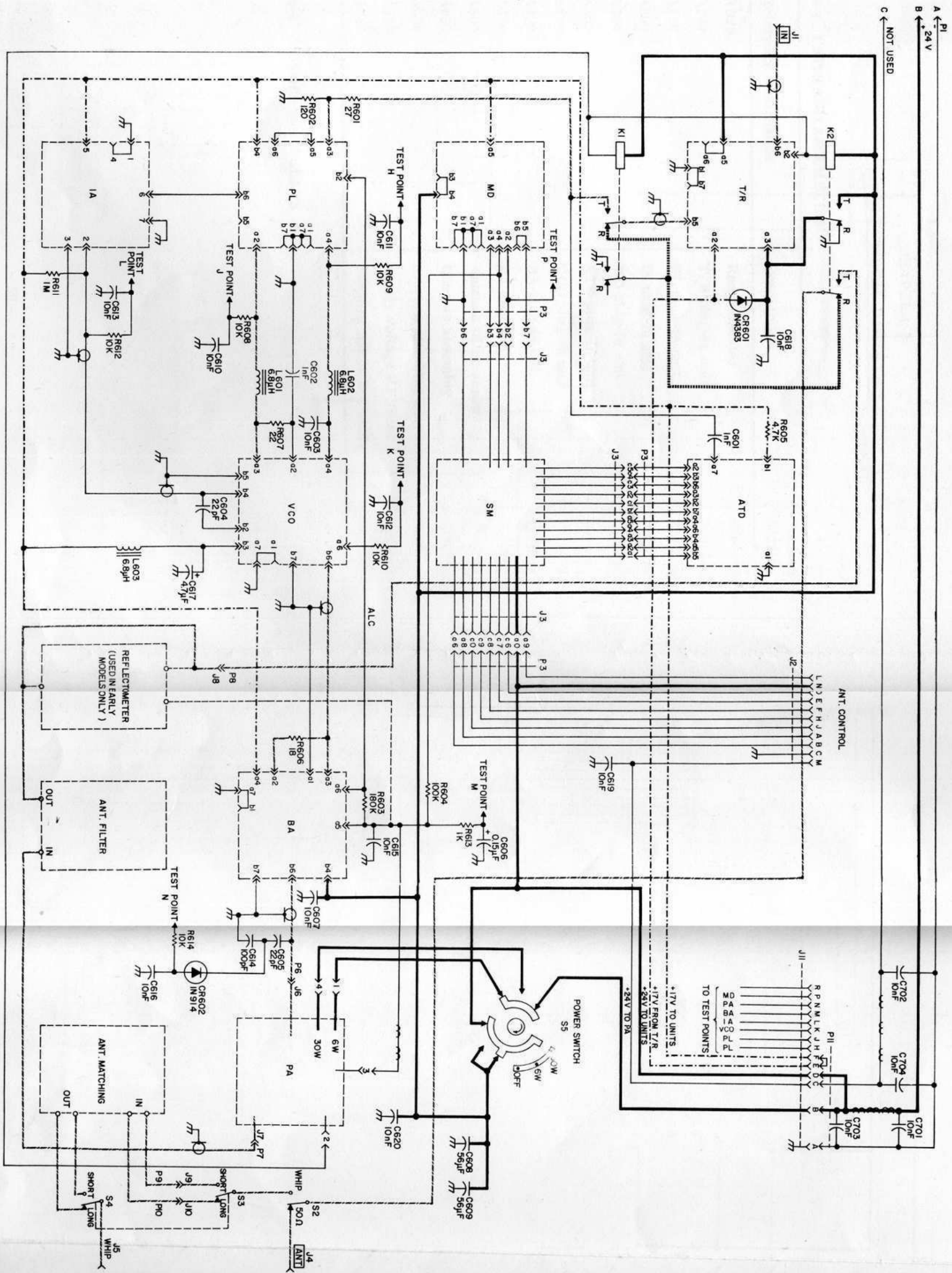


Figure 5-4, Complete Schematic Diagram

LEGEND:

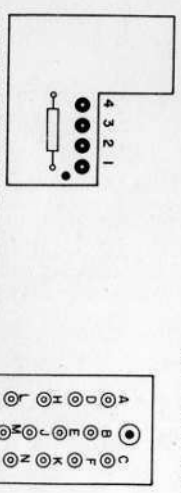
— + 24 V

— + 17 V REGULATED

— MAIN TRANSMIT SIGNAL (AND RECEIVE AS REQUIRED)

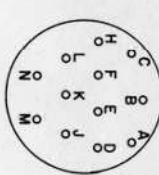
— MAIN RECEIVE SIGNAL ONLY

(FOR PARTS REPLACEMENT, JACKS ARE NUMBERED: J401, J402, J403, J404)

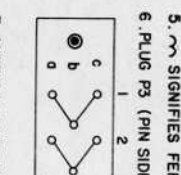


9. POWER AMPLIFIER JACKS

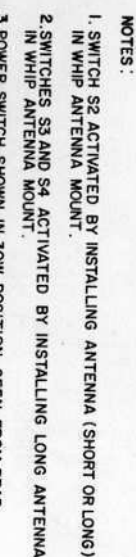
10. TEST SOCKET J9 (RECEPTACLE SIDE)



7. ANTENNA CONTROL CONNECTOR J2 (RECEPTACLE SIDE)



8. BATTERY CONNECTOR P1 (PIN SIDE)



NOTES:

1. SWITCH S2 ACTIVATED BY INSTALLING ANTENNA (SHORT OR LONG) IN WHIP ANTENNA MOUNT.
2. SWITCHES S3 AND S4 ACTIVATED BY INSTALLING LONG ANTENNA IN WHIP ANTENNA MOUNT.
3. POWER SWITCH SHOWN IN 30W POSITION SEEN FROM REAR.
4. ALL RESISTANCES IN OHMS
5. ~ SIGNIFIES FERRITE BEAD
6. PLUG P3 (PIN SIDE)

CHAPTER 6

ELECTRICAL PARTS LIST

6-1. UNITS AND ASSEMBLIES

Reference Designation	Description	Tadiran Catalog No.
RB25	Range booster	919101000
A100	T/R plug-in unit	919111000
A150	PL plug-in unit	919115000
A200	IA plug-in unit	919114000
A250	MD plug-in unit	919116000
A300	ATD plug-in unit	919110000
A350	VCO plug-in unit	919117000
A400	BA plug-in unit	919112000
A450	PA assembly	919113000
A500	Antenna filter assembly	919105000
A600	Chassis assembly	919107000
A650	Antenna matching network	919106000
A700	Supply voltage RF filter	919237000
A750	Stepping motor assembly	919108000

6-2. MOTORS (see RELAYS, 6-6)

6-3. CAPACITORS (all capacitors are fixed)

Reference Designation	Description	Tadiran Catalog No.
C101, C102, C103, C104, C105, C107, C158, C201, C204, C205, C206, C207, C210, C211, C212, C251, C312, C313, C314, C315, C316, C317, C318, C319, C320, C321, C322, C323, C324, C325, C354, C356, C357, C358, C359, C363, C365, C366, C367, C368, C402, C403, C406, C407, C408, C409, C412, C413, C452, C453, C455, C456, C458, C459, C462, C463, C465, C467, C469, C470, C471, C472, C473, C474, C475, C603, C607, C610, C611, C612, C613, C615, C616, C701, C702, C703, C704	Ceramic, 10nF, 50V	911200103
C106, C353, C454, C461	Tantalum, 1 μ F, 50V	911201101
C108, C405, C457, C464, C468, C617	Tantalum, 4.7 μ F, 50V	911201102
C151	Ceramic, 10pF, 400V	911200301
C152	Tantalum, 10 μ F, 50V	911201103
C153	Tantalum, 0.22 μ F, 100V	911201203
C154, C163, C352, C355	Ceramic, 1nF, 50V	911200101
C155	Tantalum, 68 μ F, 100V	911201201
C156, C411	Tantalum, 15 μ F, 20V	911201002
C157, C203, C209, C360, C614	Ceramic, 100pF, 25V	911200401
C159, C404, C661, C662	Ceramic, 390pF, 400V	911200800
C160	Ceramic, 47pF, 400V	911200200
C252	Tantalum, 10 μ F, 20V	911201001
C301	Ceramic, 29pF, 400V	911200605
C302	Ceramic, 40pF, 400V	911200608
C303	Ceramic, 30pF, 400V	911200606

Reference Designation	Description	Tadiran Catalog No.
C304, C310	Ceramic, 23pF, 400V	911200603
C305, C311	Ceramic, 21pF, 400V	911200601
C306	Ceramic, 22pF, 400V	911200602
C307	Ceramic, 45pF, 400V	911200609
C308	Ceramic, 32pF, 400V	911200607
C309	Ceramic, 25pF, 400V	911200604
C326	Ceramic, 4.7nF, 25V	911200700
C351	Ceramic, 3nF, 50V	911200102
C362, C364	Ceramic, 220pF, 25V	911200402
C501, C502, C504, C513, C514	Ceramic, 100pF, 400V	911200513
C505, C506, C516	Ceramic, 75pF, 400V	911200511
C507, C508, C523, C529	Ceramic, 26pF, 400V	911200506
C509, C510	Ceramic, 64pF, 400V	911200510
C511, C517, C518	Ceramic, 37pF, 400V	911200508
C512	Ceramic, 82pF, 400V	911200512
C515, C526	Ceramic, 33pF, 400V	911200507
C519, C520, C528, C532, C533	Ceramic, 18pF, 400V	911200504
C521, C522, C535	Ceramic, 24pF, 400V	911201603
C524	Ceramic, 14pF, 400V	911201602
C525	Mica, 200pF, 500V	911201304
C527, C536	Ceramic, 47pF, 400V	911200509
C530	Ceramic, 10pF, 400V	911200501
C531, C534	Ceramic, 15pF, 400V	911200503
C604, C605	Ceramic, 22pF, 400V	911200302
C606	Tantalum, 0.15 μ F, 100V	911201202
C608, C609	Tantalum, 56 μ F, 75V	911201400
C651	Ceramic, 12pF, 400V	911200505

Reference Designation	Description	Tadiran Catalog No.
C652	Ceramic, 3.3pF, 400V	911201501
C653, C654, C655, C660, C661, C663, C664, C666	Mica, 100pF, 500V	911201303
C656, C665, C668	Mica, 68pF, 500V	911201302
C662, C667, C671	Mica, 47pF, 500V	911201301
C670	Ceramic, 68pF, 400V	911200514

6-4. DIODES

Reference Designation	Description	Tadiran Catalog No.
CR101, CR102, CR103, CR152, CR153, CR154, CR155, CR156, CR157, CR158, CR159, CR201, CR202, CR251, CR252, CR253, CR301, CR302, CR303, CR304, CR305, CR306, CR307, CR308, CR309, CR310, CR311, CR312, CR313, CR314, CR315, CR316, CR317, CR318, CR319, CR320, CR321, CR322, CR323, CR352, CR353, CR453, CR454, CR455, CR456, CR457, CR602	Rectifier, 1N914	912100200
CR104	Zener, 1N3026B	912100800
CR151	PNPN, M4L3052	912100600
CR203, CR354	Zener, 1N748A	912100500
CR254, CR601	Rectifier, 1N4383	912100300
CR351	Capacitive, PC127	912100400
CR355	Zener, 1N4101	912100700
CR401, CR452	Zener, 1N753A	912100100

6-5. CONNECTORS (receptacles)

Reference Designation	Description	Tadiran Catalog No.
J1, J4	Coaxial, BNC	913300300
J2	12 contacts; U-291/U	913302100
J3	28 contacts, female	913301900
J5	Whip antenna mount	919206000
J6	Coaxial, miniature, male	913300600
J7, J8, J9, J10	Coaxial, miniature, male	913300400
J11	14 contacts, female	913302500
J401, J402, J403, J404	Jack, tip	913302200

6-6. RELAYS

Reference Designation	Description	Tadiran Catalog No.
K1, K2	Relay, miniature	913100500
Motor	Solenoid, stepping	913100600

6-7. COILS

Reference Designation	Description	Tadiran Catalog No.
L151	RF choke, 470nH	911300100
L301	RF coil	911300400
L302	RF coil	911300500
L303	RF coil	911300600
L304	RF coil	911300700
L305	RF coil	911300800
L306	RF coil	911300900
L307	RF coil	911301000

Reference Designation	Description	Tadiran Catalog No.
L308	RF coil	911301100
L309	RF coil	911301200
L310	RF coil	911301300
L311	RF coil	911301400
L351, L403, L404, L601, L602, L603	RF choke, 6.8 μ H	911300200
L401, L402	RF choke	911303700
L405, L451, L452, L453	RF choke	911301600
L501, L510	RF coil	911301700
L502, L505, L506	RF coil	911302000
L503	RF coil	911304100
L504	RF coil	911301900
L507	RF coil	911302100
L508	RF coil	911302200
L509	RF coil	911304200
L511, L515	RF coil	911302300
L512, L514	RF coil	911305600
L513	RF coil	911302400
L516, L517	RF coil	911301800
L651	RF coil	911304300
L652, L655	RF coil	911304700
L653	RF coil	911304500
L654A, L654B	RF coil	911304600
L656A, L656B	RF coil	911304800
L657	RF coil	911304900
L658A	RF coil	911302600
L658B	RF coil	911305700
L659	RF coil	911305000

Reference Designation	Description	Tadiran Catalog No.
L660A, L668A, L668B	RF coil	911302800
L660B, L671	RF coil	911302700
L661	RF coil	911305100
L662A, L662B, L666B	RF coil	911302900
L663	RF coil	911305500
L664A	RF coil	911303000
L664B	RF coil	911302500
L665	RF coil	911304400
L666A, L674	RF coil	911303100
L667	RF coil	911305200
L669	RF coil	911305300
L670	RF coil	911305400
L672	RF coil	911303900
L673	RF coil	911304000
None (31 pieces)	Ferrite beads	911500100

6-8. CONNECTORS (plugs)

Reference Designation	Description	Tadiran Catalog No.
P1	3 pin, male	913301800
P3	28 pin, male	913302000
P6, P7, P8, P9, P10	Coaxial, miniature, female	913300500
P11	14 pin, male	913302400
P601, P602, P603, P604	Pin connector	913302300

6-9. TRANSISTORS

Reference Designation	Description	Tadiran Catalog No.
Q101, Q102, Q152, Q153, Q154, Q155, Q156, Q251, Q252, Q352, Q405, Q406	Silicon, NPN, 2N930	912100900
Q103, Q151, Q157, Q253, Q454	Silicon, PNP, 2N2907	912101000
Q104, Q201, Q254, Q255, Q351, Q404	Silicon, NPN, 2N2222	912101100
Q105	Silicon, NPN, 2N1485	912101900
Q202, Q353, Q354	Silicon, NPN, BF173	912101600
Q203	Silicon, PNP, BFX48	912101500
Q204	Silicon, NPN, BSX28	912101400
Q256	Silicon, PNP, 2N3791	912101800
Q355, Q401, Q402	Silicon, NPN, 2N3866	912101200
Q403	Silicon, NPN, 2N3961	912101300
Q451, Q452, Q453	Silicon, NPN, 2N5071	912101700

6-10. RESISTORS (all values in ohms)

Reference Designation	Description	Tadiran Catalog No.
R101, R102, R103, R104, R206, R214, R367, R403, R407, R409, R410, R411	Composition, $10 \pm 10\%$, 1/10W	911100300
R105, R106, R417, R471, R472	Composition, $470 \pm 10\%$, 1/10W	911100313
R107, R110, R356	Composition, $180 \pm 10\%$, 1/10W	911100309
R108, R109, R416	Composition, $150 \pm 10\%$, 1/10W	911100308
R111, R112, R116, R467, R605	Composition, $4.7k \pm 10\%$, 1/10W	911100323
R113, R354, R368	Composition, $8.2k \pm 10\%$, 1/10W	911100326
R114, R178, R182	Composition, $12k \pm 10\%$, 1/10W	911100328
R115, R611	Composition, $1M \pm 10\%$, 1/10W	911100340

Reference Designation	Description	Tadiran Catalog No.
R117, R118, R119, R203, R213, R301, R302, R304, R305, R306, R309, R310, R311	Composition, 1.5k±10%, 1/10W	911100318
R120, R121	Composition, 270k±10%, 1/10W	911100338
R151, R252, R360, R468, R604	Composition, 100k±10%, 1/10W	911100336
R152, R156, R177, R201, R258, R261, R263, R351, R358, R413, R608, R609, R610, R612, R614	Composition, 10k±10%, 1/10W	911100327
R153, R160	Composition, 1k±5%, 1/10W	911101201
R154, R155, R257	Composition, 22k±10%, 1/10W	911100330
R157, R180	Composition, 18k±5%, 1/10W	911101204
R158	Composition, 6.8k±10%, 1/10W	911100325
R159, R162	Composition, 47k±10%, 1/10W	911100334
R161, R209, R401, R415, R464	Composition, 3.3k±10%, 1/10W	911100322
R163, R208, R353, R366, R412	Composition, 100±10%, 1/10W	911100306
R164, R202, R204, R212, R352	Composition, 2.7k±10%, 1/10W	911100321
R165	Composition, 8.2k±5%, 1/10W	911101203
R166	Composition, 1.8k±5%, 1/10W	911101202
R167, R176	Film, 220±5%, 1/2W	911100500
R168, R169, R170, R171, R172, R173, R174, R175	Film, 270±1%, 0.062W	911100600
R179, R260, R267	Composition, 33k±10%, 1/10W	911100332
R181	Composition, 39k±10%, 1/10W	911100333
R205, R215	Composition, 120±10%, 1/10W	911100307
R207, R255	Composition, 33±10%, 1/10W	911100304
R210, R404	Composition, 330±10%, 1/10W	911100312
R211	Composition, 680±10%, 1/10W	911100315
R216, R266, R405, R607	Composition, 22±10%, 1/10W	911100303
R253, R259, R262, R364	Composition, 2.2k±10%, 1/10W	911100320

Reference Designation	Description	Tadiran Catalog No.
R254, R264, R414, R463, R613	Composition, 1k±10%, 1/10W	911100316
R256, R313	Composition, 470k±10%, 1/10W	911100339
R265	Composition, 100±10%, 1W	911100402
R303, R307, R308, R402	Composition, 1.2k±10%, 1/10W	911100317
R312, R473	Composition, 5.6k±10%, 1/10W	911100324
R314	Composition, 220±10%, 1/10W	911100310
R355, R363	Composition, 1.8k±10%, 1/10W	911100319
R357, R406	Composition, 270±10%, 1/10W	911100311
R359	Composition, 100±10%, 1/2W	911100802
R361	Composition, 18k±10%, 1/10W	911100329
R362, R365	Composition, 560±10%, 1/10W	911100314
R408	Composition, 56±10%, 1/10W	911100305
R451, R453, R456	Composition, 4.7±10%, 1/2W	911101100
R452, R455, R458	Composition, 220±10%, 1/2W	911100804
R461	Variable, 10k±5%, 1W	911100900
R465, R466, R474	Wirewound, 0.5±2%, 2W	911101000
R469	Composition, 27k±10%, 1/10W	911100331
R470	Composition, 56k±10%, 1/10W	911100335
R475	NTC, 47k±20% @ 25 ^o	911100200
R476, R477	Wirewound, 1±2%, 1W	911100700
R501, R502, R503	Composition, 47±10%, 1W	911100401
R601	Composition, 27±10%, 1/2W	911100801
R602	Composition, 120±10%, 1/2W	911100803
R603	Composition, 180k±10%, 1/10W	911100337
R606	Composition, 18±10%, 1/10W	911100302

6-11. SWITCHES

Reference Designation	Description	Tadiran Catalog No.
S1, sect 1, front and rear	Wafer	913302700
S1, sect 2 through sect 8	Wafer	913100400
S2, S3, S4	Microswitch	913100200
S5	Wafer	913100300

6-12. TRANSFORMERS

Reference Designation	Description	Tadiran Catalog No.
T101	RF transformer	911303800
T151	RF transformer	911303300
T201	RF transformer	911301500
T351	RF, variable inductance coil	911300300
T352	RF transformer	911303400
T353	RF transformer	911303500
T401, T402	RF transformer	911303600
T451, T452, T453	RF transformer	913201500
T454	RF transformer	913201600

6-13. SOCKETS, HOLDERS

Reference Designation	Description	Tadiran Catalog No.
XK1, XK2	Relay socket, 8 pins	913302800
XA100a, XA100b, XA150a, XA150b, XA200, XA250a, XA250b, XA300a, XA300b, XA350a, XA350b, XA400a, XA400b	Module socket, 7 pins, miniature	913302900