GROUPE CENTRAL C135F
DOCUMENTATION
4

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

VHF NAVIGATION AND COMMUNICATIONS RECEIVER

TYPE 51X-2B

RADIO SET CONTROL

TYPE 614U-3A

MOUNTING

TYPE 390E-1

AND

MOUNTING

TYPE 349H-4

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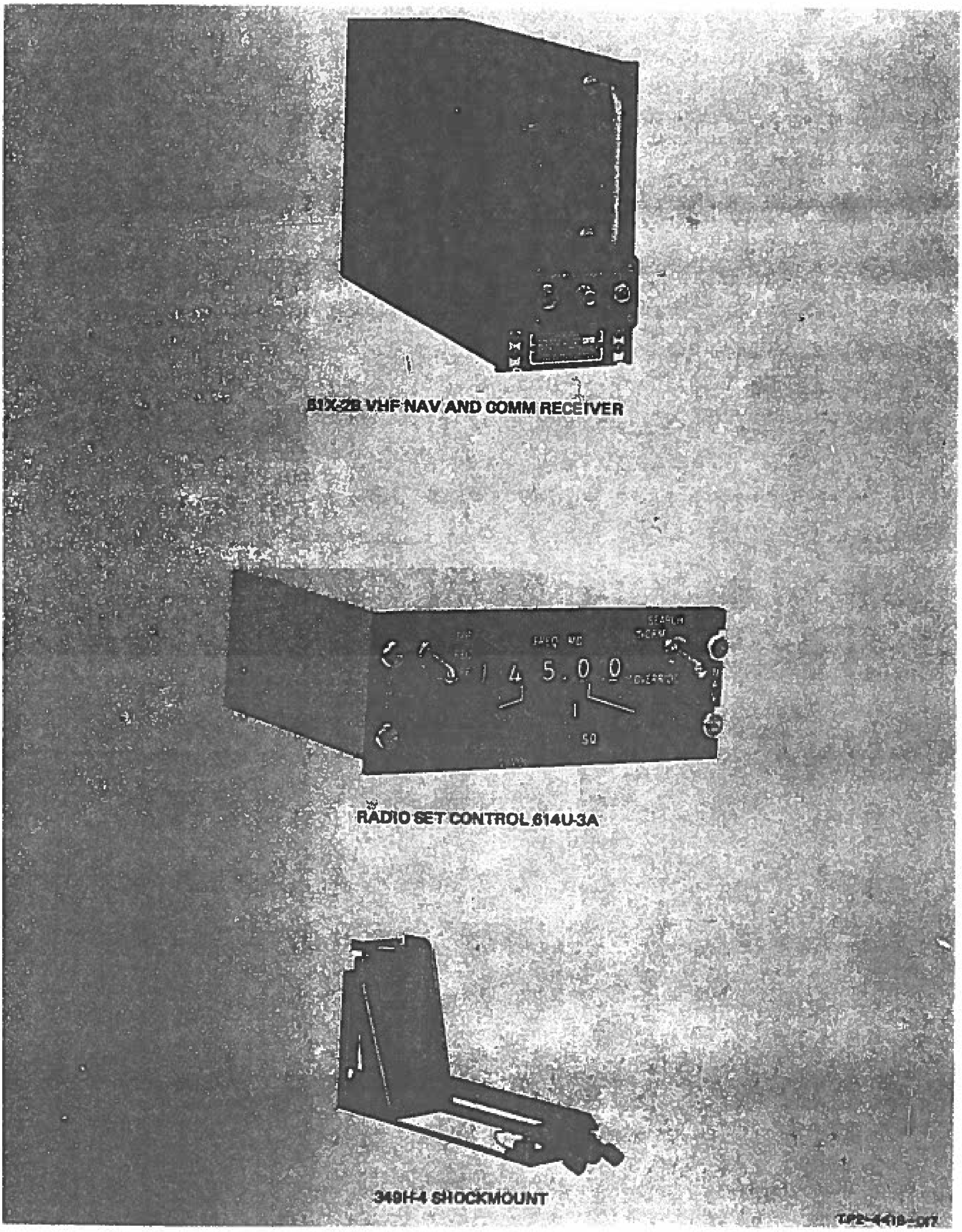


Figure 1-1. VHF Navigation and Communications Receiver 51X-2B, Radio Set Control 614U-3A, and Shockmount 349H-4

INTRODUCTION

This field maintenance manual contains maintenance instructions for VHF Navigation and Communications Receiver 51X-2B and Radio Set Control 614U-3A. The manual is compiled and printed in accordance with Specifications MIL-H-25095, MIL-N-4350 and MIL-M-4410B and conforms to applicable portions of the following specifications:

MIL-STD-15	Electrical and Electronic Symbols
MIL-STD-16B	Electrical and Electronic Reference Designations
MIL-STD-122	Color Code for Chassis Wiring for Electronic Equipment
ANA-275	Guide for the Use of Lubricants, Compounds, and Fluids in Aircraft
MIL-L-6880	General Specification for Lubrication of Aircraft
MIL-B-5005	Breakdown: Provisioning Parts and Illustrated Parts for Aeronautical Articles
MIL-M-005474B	Technical Manuals: General Requirements For Preparation of
ANA-261	Approved List of Abbreviations and Contractions

NOTE

All phrases or statements contained in this T.O. which tend to limit or restrict repair are to be disregarded. Valid Base Repair Restrictions are contained in Section VIII of the appropriate aircraft -6 Inspection Manual.

SECTION I
DESCRIPTION AND LEADING PARTICULARS

1-1. PURPOSE OF MANUAL

1-2. This publication comprises service instructions for VHF Navigation and Communications Receiver 51X-2B, Part No. 522-1439-004, and Radio Set Control 614U-3A, Part No. 522-1767-00, both manufactured by the Collins Radio Company, Cedar Rapids, Iowa. The receiver can be supplied with A-C Power Supply 516A-1, Part No. 522-0440-004, or with D-C Power Supply 516B-3, Part No. 522-1091-004. Sections I through VIII of this manual apply to the 51X-2B and the 614U-3A, contract No. AF 09(603)64991, AF 33(600)38506, AF 33(600)39926, AF 33(600)40731, AF 33(600)40877, AF 33(600)40941, AF 33(600)42208, AF 33(600)42915, AF 33(657)7058, AF 33(657)7241, AF 33(657)12356, AF 33(657)7542, AF 33(657)13210, and AF 33(657)0572.

1-3. PURPOSE OF EQUIPMENT.

1-4. VHF Navigation and Communications Receiver 51X-2B is a remotely controlled superheterodyne receiver that can be used both for communications and for VOR-LOC navigation.

1-5. DESCRIPTION OF COMPONENTS.

1-6. The equipment supplied with VHF Navigation and Communications Receiver 51X-2B and Radio Set Control 614U-3A is shown in figure 1-1 and listed in figure 1-2. Equipment required but not supplied is listed in figure 1-3.

1-7. VHF NAVIGATION AND COMMUNICATIONS RECEIVER 51X-2B.

1-8. VHF Navigation and Communications Receiver 51X-2B is an airborne, crystal-controlled, double conversion receiver that operates in the frequency range from 108.00 to 151.95 megacycles in 50 kilocycle steps. There are 880 channels available for selection by Radio Set Control 614U-3A. The 614U-3A also controls the system on-off, and the volume level

COMPONENT	WEIGHT (lb)	OVER-ALL DIMENSIONS		
		L	W	H
VHF Navigation and Communications Receiver 51X-2B Containing: D-C Power Supply 516B-3 or A-C Power Supply 516A-1	10.5	12-9/16	3-9/16	7-1/2
Radio Set Control 614U-3A	1.7	6-49/64	5-3/4	2-1/4
Shockmount 349H-4, Single	1.5	17-11/32 with sway space	4-19/32	9-5/16 with sway space

Figure 1-2. Table of Equipment Supplied

ITEM	COLLINS TYPE	FUNCTION
Shockmount	390E-1	Mounts 51X-2B and 344B-1
Shockmount	390E-2	Mounts 51X-2B and 17L-7A
Antenna	37R-2	Radiates carrier, receives transmissions
Antenna	37J-3	Receives VOR and LOC signals
Antenna Cable	RG-58A/U or RG-142/U	Couples receiver to antenna and to transmitter
Headset	HS33, HS23 or equivalent	Monitors receiver signals

Figure 1-3. Table of Equipment Required But Not Supplied

and squelch level of the receiver when the 51X-2B is used in a VOR/LOC navigation system. When the 51X-2B is used in a VHF communications system with VHF Communications Transmitter 17L-7A and Radio Set Control 614U-6, the range of frequencies controlled is 116.00 to 151.95 mc. The 51X-2B is adapted to VOR operation by inserting a jumper plug-in socket XK1 as shown in detail A of figure 5-1. This detail also shows the plug used for ADF operation and the relay used for remote selection of communications only or communications/VOR navigation operation. For communication operation only use dummy adapter plug part number 86-897 or a suitable substitute.

1-9. The 51X-2B is a complete rack-mounted equipment housed in an unpressurized ARINC standard 3/8 ATR short case which is 3-9/16 inches wide, 7-1/2 inches high, and 12-9/16 inches long. The equipment weighs 10.5 pounds. The receiver is constructed of four modules and a main frame, designated module A6, into which the other modules are plugged. The main frame contains a 3/4-inch duct to accommodate cables and plugs and the passive filter module. All modules except the passive filter are plug-in type. Connections to receiver circuitry are made through a rear connector. Cannon DPA A29C1-34P. On the front panel of the main frame are a handle, a telephone-type jack for test purposes, a control which sets the threshold operating level of a squelch circuit, and a push-button switch which disables the squelch circuit. (See figures 1-4 and 1-5.)

1-10. The r-f and variable i-f module, designated A1, contains the r-f circuits, local crystal-controlled oscillators, mixers, and variable and fixed i-f circuits used to convert incoming signals to a 500-kilocycle intermediate frequency. The Ⓡ and frequency selector mechanism are also contained in this module. The 500-kilocycle passive filter module, designated A5, contains wave shaping and filter circuits. A 500-kc mechanical filter is available as an alternate to the

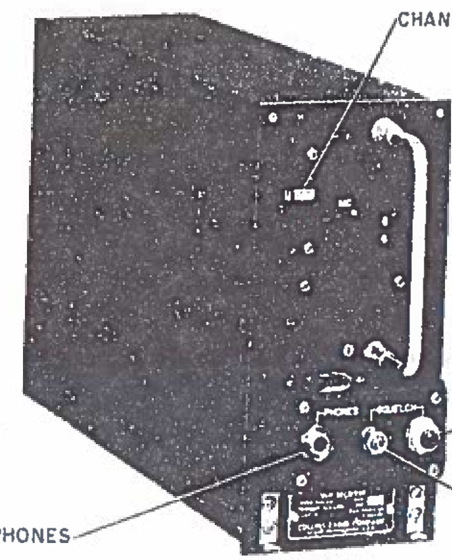


Figure 1-4. Panel Controls, VHF Navigation and Communications Receiver 51X-2B

CONTROL	FUNCTION
PHONES Jack	Connect headset for test purposes.
SQUELCH Adjustment	Establishes squelch threshold.
SQUELCH Pushbutton Switch	Disables squelch circuit.

Figure 1-5. Table of 51X-2B Controls and Functions

500-kc passive filter. The 500 kc i-f and audio module, designated A2, contains i-f amplifiers, audio detectors and amplifiers, and squelch, noise limiter, and automatic gain control circuits. The a-c power supply module, designated A4, uses an input voltage of 115 volts, 300 to 1000 cps, in a half-wave silicon rectifier circuit and a two-section resistance-capacitance filter, whose output is +130 volts. The module also contains a stepdown transformer which supplies 6.3 volts to the filaments of the receiver. The d-c power supply module, designated A3, uses a 27.5 volt d-c input to produce +130 volts for the receiver by means of a push-pull transistor oscillator which energizes a step-up transformer. A full-wave silicon diode rectifier and a resistance-capacitance filter follow the transformer. The module also contains jumpers that permit the use of the 27.5 volt input to power the receiver filaments.

1-11. RADIO SET CONTROL 614U-3A.

1-12. Radio Set Control 614U-3A is a panel-mounted assembly with all its controls mounted on the front. (See figures 1-6 and 1-7.) A coarse frequency knob and a fine frequency knob each rotate a group of wafer switches which control the Autopositioner in the receiver. The knobs also control a front-panel dial from which the set-in frequency is read off directly in megacycles. The dial is illuminated by two panel lamps. A POWER ON-OFF switch controls the input power to the receiver. Two potentiometers with coaxial shafts control the output volume and the squelch level below the levels set at the receiver.

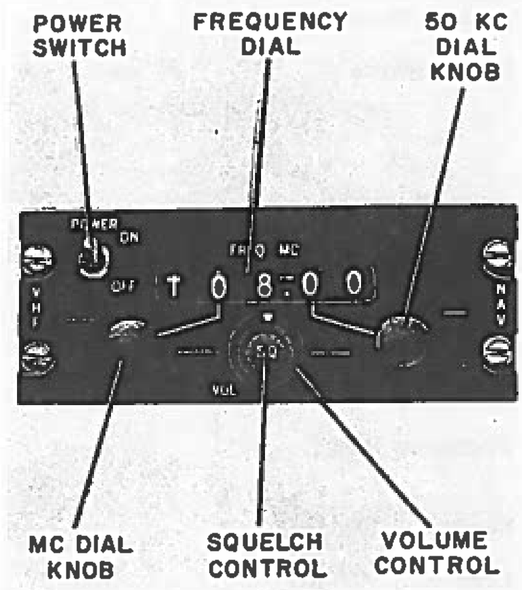


Figure 1-6. Panel Controls, Radio Set Control 614U-3A

CONTROL	FUNCTION
POWER ON-OFF Switch	Turns receiver on and off.
FREQ MC Dial	Indicates receiver channel selected.
SQ Level Control	Varies receiver squelch threshold.
VOL Level Control	Controls receiver audio level.
MC Dial Knob	Change channels in 1 mc steps.
50 KC Dial Knob	Change channels in 50 kc steps.

Figure 1-7. Table of 614U-3A Controls and Functions

1-13. OPERATING CHARACTERISTICS.

1-14. The operating characteristics of VHF Navigation and Communications Receiver 51X-2B and Radio Set Control 614U-3A are listed in figure 1-8.

1-15. VACUUM TUBE, TRANSISTOR, AND DIODE COMPLEMENT.

1-16. The vacuum tube, transistor, and diode complement is listed in figure 1-9.

Ambient Temperature Range	+10°C (+50°F) to +55°C (+131°F) performance only slightly reduced to -40°C (-40°F). Thirty minutes operation at +70°C (+158°F)
Ambient Humidity Range	0 to 95% relative. 95 to 100% at 50°C (122°F) ±3°C (37.4°F) for 48 hours.

Figure 1-8. Table of Operating Characteristics (Sheet 1 of 2)

Altitude Range	Sea level to 30,000 feet.
Power Source	With d-c power supplies: 27.5 volts dc, +10%, -20%, with negative lead grounded. With a-c power supplies: 27.5 volts dc, +10%, -20%; and 115 volts ac, +10%, -20%, 300 to 1000 cps.
Power Requirements When Using D-C Power Supply 516B-3	Normal: 1.2 amp. Channeling: 3.3 amp.
Power Requirements When Using A-C Power Supply 516A-1	Normal: 25w ac; 0.1 amp dc. Channeling: 25w ac; 2.2 amp dc.
Time Required to Change Channels	Not more than four seconds.
Frequency Range	108.00 to 151.95 mc (or 116.00 to 151.95 mc*) in 50 kc increments.
Number of Channels	880 (or 720*)
Frequency Stability	Deviation not more than 0.0035% from assigned channel frequency under the following conditions, taken singly: D-C input varied from 24 to 29 volts. A-C input varied from 105 to 125 volts. Temperature varied from +10°C (50°F) to +70°C (158°F). Humidity varied from 10% to 95% at +50°C (122°F). Altitude varied from sea level to 30,000 feet.
Selectivity	40 kc minimum at 6 db down. 77 kc maximum at 60 db down.
Sensitivity	Input for 6 db signal-plus-noise to noise ratio: 2 uv normal, 3 uv maximum.
Spurious Response	Not less than 80 db down including images.
Squelch	Carrier operated noise silences with squelch threshold control.
Noise Limiter	Series peak noise limiter.
AGC Characteristic	Maximum variation of output is 4 db over the range of 5 uv to 100,000 uv. Maximum variation of output is 4 db over the range of 100,000 uv to 400,000 uv.
AGC Time Constant	0.1 second.
Input Impedance	52 ohms, unbalanced; SWR less than 4 to 1.
Audio Output Impedance	500 ohms, balanced.
Audio Output Power	Capable of 100 mw with input of 3 uv modulated 30%.
Audio Frequency Response	Within 6 db from 300 to 3750 cps.
Harmonic Distortion	7.5% maximum at 30% modulation, 100 mw output. 20% maximum at 90% modulation, 100 mw output.
Disabling	The receiver is disabled when 27.5 volts dc is applied to pin 23 of the rear connector.

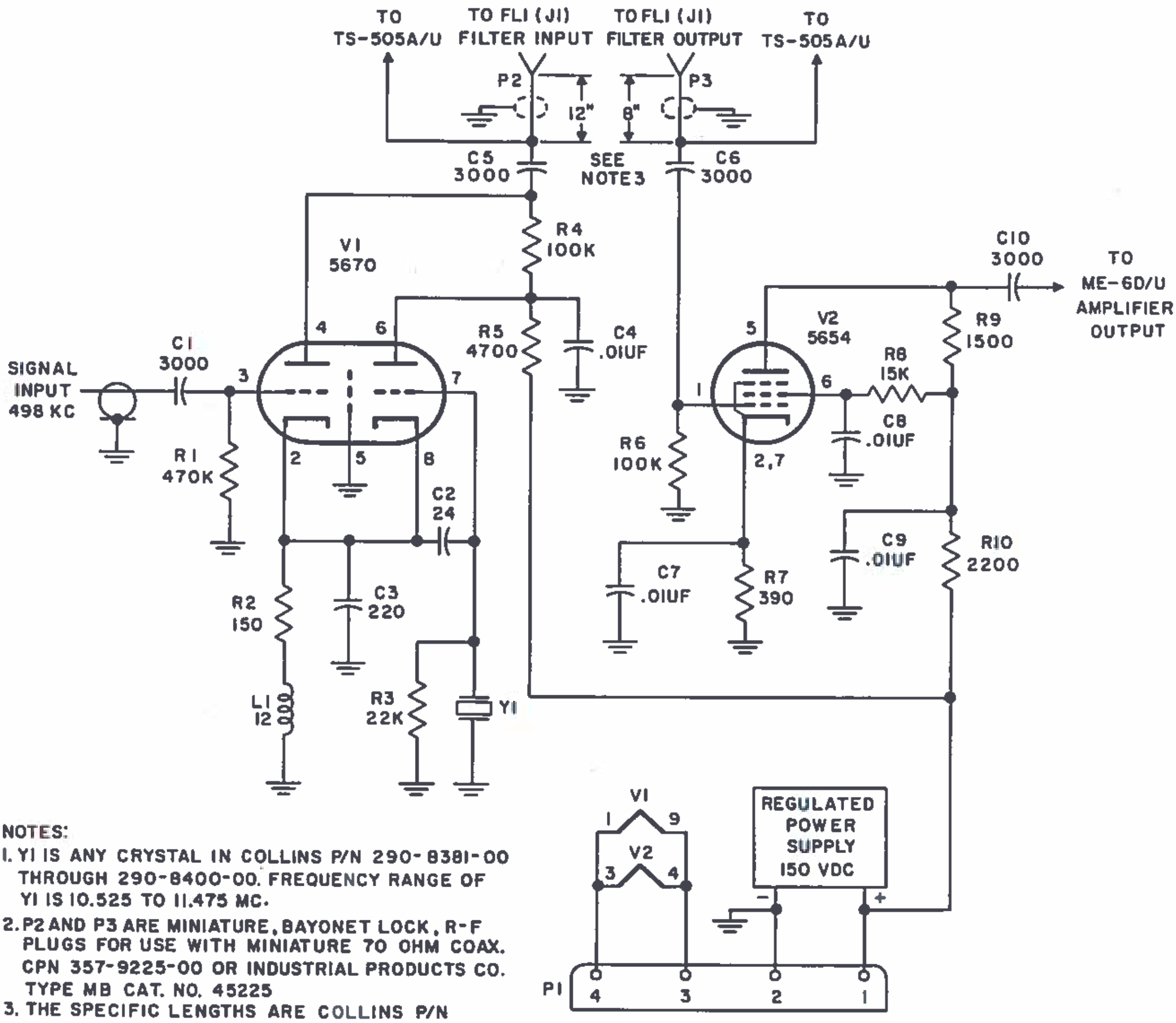
*Applies to 51X-2B used in communications service only in VHF-101 systems.

6,3 V ⇒ 2 A
130V DC ⇒ 130 mA
28V-DC ⇒ 100 mA normal
⇒ 1,5 A channeling

Figure 1-8. Table of Operating Characteristics (Sheet 2 of 2)

REFERENCE DESIGNATION	TYPE	FUNCTION
A1V1	5654	R-F Amplifier
A1V2	5654	First Mixer
A1V3	5654	Variable I-F Amplifier
A1V4	5670	Second Mixer and Oscillator
A1V5	5670	First Injection Oscillator
A1CR1		Transient Protector
A1CR2		Transient Protector
A1CR4	1N645	Transient Protector
A2CR1	601C	AGC Rectifier
A2CR2	601C	AGC Rectifier
A2CR3	HD2182	Detector
A2CR4	601C	Noise Limiter
A2CR5	601C	AGC Gate
A2CR6	601C	Squelch Bias Gate
A2CR7	Silicon 1N1320	Squelch Reference Voltage
A2Q1	DT4-17	Audio Output Amplifier
A2V1 through A2V3	5654	500 KC Amplifier
A2V4	5670	Audio Amplifier
D-C POWER SUPPLY 516B-3		
A3CR1 and A3CR2	1N1695	Full-Wave Rectifier
A3CR3	1N468	Transient Protector Bias
A3Q1	DT4-18	Oscillator
A3Q2	DT4-18	Oscillator
A3Q3	DT4-18	Transient Protector
A3Q4	2N398	Transient Protector
A-C POWER SUPPLY 516A-1		
A4CR1	1N1695	Half-Wave Rectifier

Figure 1-9. Table of Vacuum Tubes, Transistors, and Diodes



NOTES:

1. Y1 IS ANY CRYSTAL IN COLLINS P/N 290-8381-00 THROUGH 290-8400-00. FREQUENCY RANGE OF Y1 IS 10.525 TO 11.475 MC.
2. P2 AND P3 ARE MINIATURE, BAYONET LOCK, R-F PLUGS FOR USE WITH MINIATURE 70 OHM COAX. CPN 357-9225-00 OR INDUSTRIAL PRODUCTS CO. TYPE MB CAT. NO. 45225
3. THE SPECIFIC LENGTHS ARE COLLINS P/N 425-0211-00 (COAX. TYPE RG-187/U)
4. TUBE CIRCUITS TO BE MOUNTED CLOSE TO FILTER INPUT AND OUTPUT TERMINALS TO AVOID LONG LEADS.

Figure 3-3. Filter Test Jig, Schematic Diagram

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. This section describes the general theory of operation of VHF Navigation and Communications Receiver 51X-2B and operation of the 51X-2B in both a communications system and a navigation system.

4-3. VHF NAVIGATION AND COMMUNICATIONS RECEIVER 51X-2B. (See figure 4-1.)

4-4. VHF Navigation and Communications Receiver 51X-2B is a crystal controlled, double conversion, superheterodyne receiver designed to operate in the very high frequency spectrum. Frequency selection is performed by an Autopositioner system contained within the 51X-2B. The Autopositioner system is controlled by a remote radio set control. There are 720 channels available when the 51X-2B is used in a communications system with an additional 160 channels available in a navigation system. Channel separation is 50 kilocycles with either system.

4-5. The signal input to the VHF Navigation and Communications Receiver 51X-2B is amplified by A1V1 and converted at A1V2 to an intermediate frequency that is variable from 10.025 mc to 11.975 mc. The first i-f is amplified by A1V3 and converted to a 500 kc second i-f at A1V4. The passive filter provides passband shaping of the second i-f. The second i-f is amplified by A2V1, A2V2, and A2V3 and the audio demodulated by the detector circuit. The agc circuit varies the bias on the r-f and i-f stages and keeps the audio gain constant. The noise limiter circuit reduces the amplitude of impulse and shot noise. The squelch circuit renders audio amplifier A2V4 inoperative to all signals below the squelch threshold level. The audio filter limits audio response to the range of 300 cps to 3750 cps at 6 db down. Amplifier A2Q1 is the final stage of audio amplification.

4-6. The frequency selecting system operates as follows: The antenna coil, the grid and plate circuits of the r-f amplifier, and the grid circuit of the first mixer are tuned by a ganged tuning capacitor through the frequency range of 108.00 to 151.95 mc (116.00 to 151.95 mc for receivers used for communication service only). The first heterodyning oscillator, tube V5, is controlled by selectable crystals. The output of this oscillator is always on the low-frequency side of the associated reception frequency. The output starts at 97.975 mc (105.975 mc) and goes through 139.975 mc on a two-megacycle basis using a total of 22 (18) crystals. Each crystal output, when injected into the first mixer, produces a usable i-f spectrum two megacycles wide. Thus all radio signals appearing within a two-megacycle portion of the input circuit of the radio will be heterodyned to within first i-f spectrum of the receiver. The first i-f amplifier is variable tuned and tunes through the two-megacycle spectrum. The receiver is designed to receive frequencies every 50 kc. Therefore, a crystal-controlled oscillator (half of V4) with appropriate signal outputs separated by 50 kc is used to heterodyne the variable i-f signal to a fixed i-f of 500 kc. The second crystal oscillator employs but 20 crystals; thus, it would appear that on a 50-kc basis, only one megacycle would be covered. However, each crystal is used twice, once with the variable i-f 500 kc below the crystal frequency and once with the variable i-f 500 kc above the crystal frequency so that the total of 40 channels is obtained over a two-megacycle portion of the tuning range. Refer to figure 4-2 for a block diagram that shows the crystal outputs and frequencies involved in one two-megacycle portion of the tuning range of the receiver. Figure 4-3 shows the complete complement of heterodyning signal frequencies and resulting signal frequencies.

4-7. POWER SUPPLIES.

4-8. D-C Power Supply 516B-3 is a transistorized oscillator-rectifier type dc to dc converter unit which utilizes the 27.5 volt d-c aircraft power source to produce the voltages required to operate the receiver.

4-9. A-C Power Supply 516A-1 is a half wave rectifier type supply using a silicon diode. The aircraft 115 volt, 300 to 1000 cps power source is rectified directly to produce the B+ voltages required to operate the receiver. A separate step-down transformer supplies the 6.3 volt ac required by the tube filaments.

4-10. OPERATION OF VHF NAVIGATION AND COMMUNICATIONS RECEIVER 51X-2B WITHOUT JUMPER PLUG IN COMMUNICATIONS SYSTEM VHF-101.

4-11. When part of a communications system, VHF Navigation and Communications Receiver 51X-2B with VHF Communications Transmitter 17L-7A, is controlled by Radio Set Control 614U-6, it operates in the frequency range of 116.00 mc to 151.95 mc. The 51X-2B functions as a superheterodyne communications receiver and receives amplitude modulated signals and air traffic control signals.

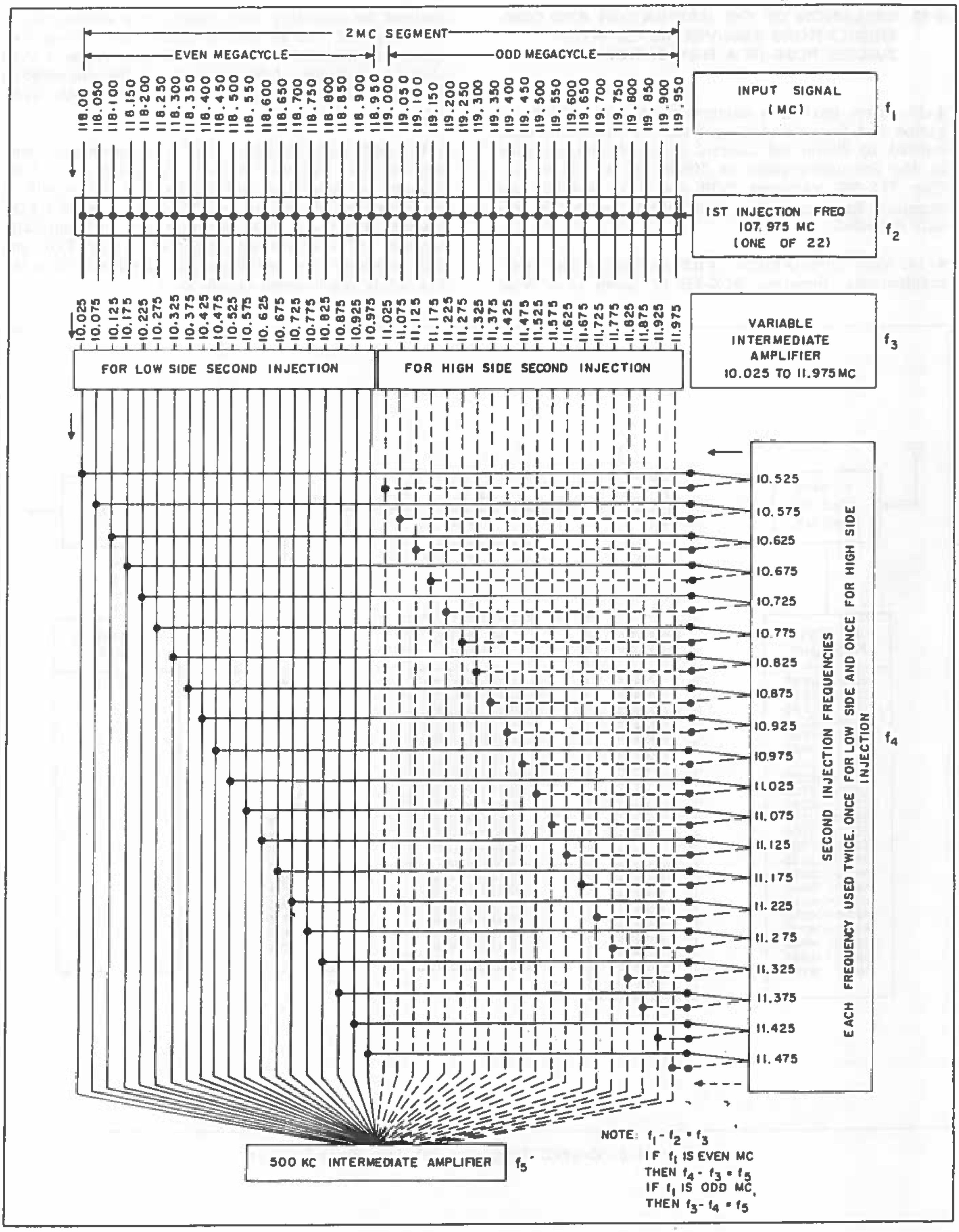


Figure 4-2. Circuit Frequencies Employed in the Reception of a 2-mc Portion of the Reception Band, Block Diagram

4-12. OPERATION OF VHF NAVIGATION AND COMMUNICATIONS RECEIVER 51X-2B WITH JUMPER PLUG IN A NAVIGATION SYSTEM.

4-13. When part of a navigation system, VHF Navigation and Communications Receiver 51X-2B is controlled by Radio Set Control 614U-3A and operates in the frequency range of 108.00 mc to 151.95 mc. The 51X-2B receives VOR and LOC signals and supplies Instrumentation Unit 344B-1 with the signals selected.

4-14. VOR OPERATION. VHF Navigation and Communications Receiver 51X-2B is tuned to a VOR channel by selecting even tenths of a megacycle in the range of 108.00 mc to 111.80 mc, or any frequency from 112.00 mc to 117.90 mc. When a VOR channel is tuned, LOC circuits in Instrumentation Unit 344B-1 are automatically disabled by the 51X-2B.

4-15. LOC OPERATION. VHF Navigation and Communications Receiver 51X-2B is tuned to a LOC channel by selecting odd tenths of a megacycle in the range of 108.10 mc to 111.90 mc. When a LOC channel is tuned, LOC circuits are automatically enabled and VOR circuits disabled. (Both VOR and LOC circuits are automatically disabled when the 51X-2B is tuned above 117.90 mc.)

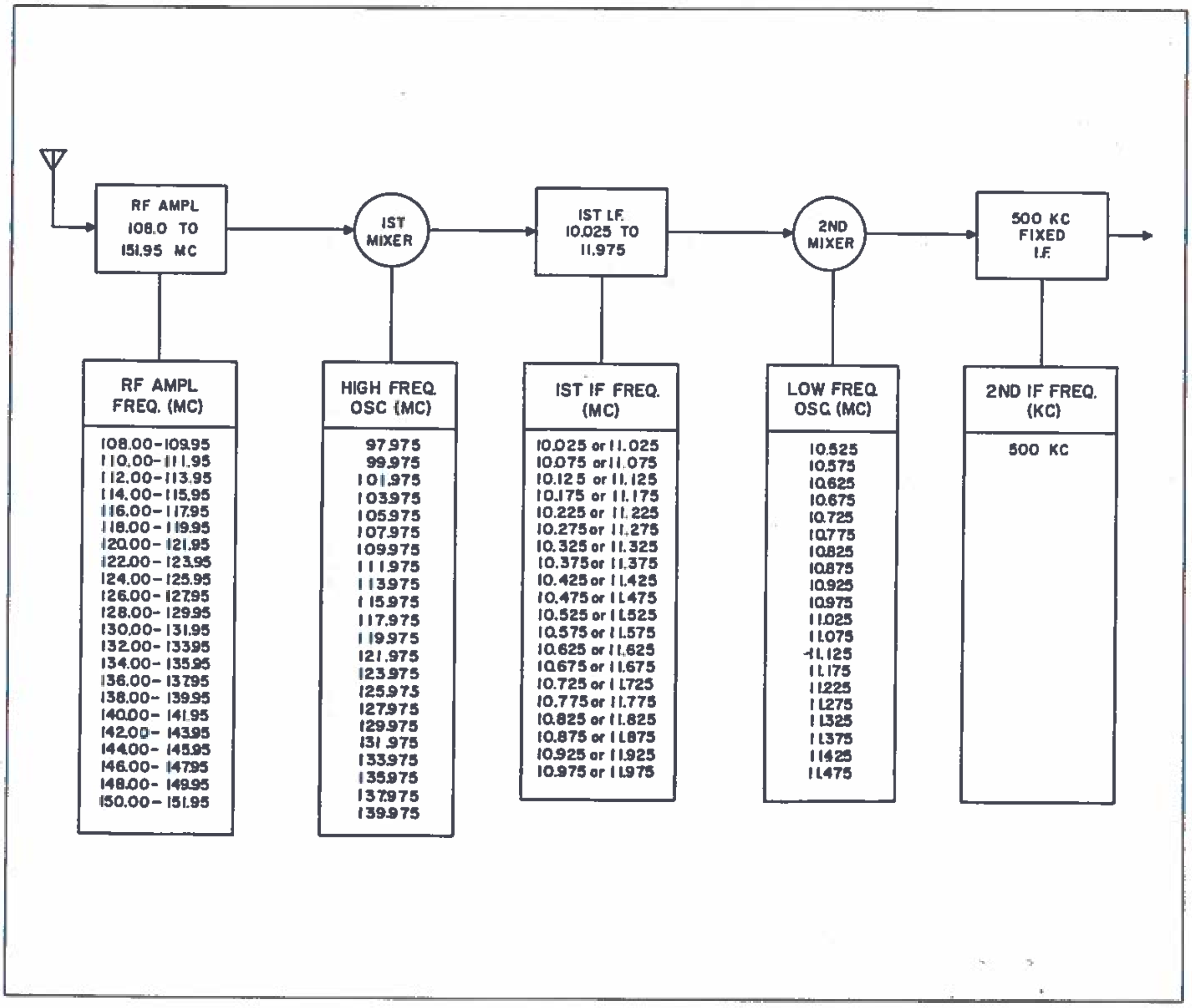


Figure 4-3. Overall Frequency Scheme, Block Diagram

SECTION V
DESCRIPTION OF SYSTEM TIE-IN OF EQUIPMENT AND ACCESSORIES

5-1. GENERAL.

5-2. This section describes the operation of VHF Navigation and Communications Receiver 51X-2B as part of a complete system using the required accessory equipment listed in figure 1-3.

5-3. REQUIRED ACCESSORY EQUIPMENT.

5-4. ADAPTERS FOR VARIOUS OPERATING REQUIREMENTS. Insertion of a plug or relay into socket XK1 (figure 7-1) provides a means of adapting the 51X-2B to various operating requirements. Dummy adapter plug part number 86-897 or suitable substitute may be used to fabricate the various plug configurations depicted in figure 5-1.

5-5. The VOR plug, shown in figure 5-1, may be fabricated and inserted in socket XK1 to convert the 51X-2B to a navigation and communications receiver.

5-6. The ADF plug, shown in figure 5-1, may be fabricated and inserted in socket XK1 to convert the 51X-2B to an ADF receiver.

5-7. Navigation/communication relay K1, shown in figure 5-1, may be fabricated and inserted in socket XK1 to provide for remote selection of the 51X-2B operation. The 51X-2B will operate as a communications receiver when K1 is energized and as a navigation/communications receiver when K1 is de-energized. Relay K1 is energized when a remote switch applies a ground to pin 3 of the 51X-2B rear connector P1.

5-8. A power supply module is required to power VHF Navigation and Communications Receiver 51X-2B. A-C Power Supply 516A-1 is used when the aircraft source power is 115 volts ac, 300 to 1000 cps. D-C Power Supply 516B-3 is used when the aircraft source power is 27.5 volts dc.

5-9. Headset HS33, HS23, or equivalent, monitors the signals tuned by VHF Navigation and Communications Receiver 51X-2B, and sidetone transmitted by VHF Communications Transmitter 17L-7A, if used.

5-10. Antenna 37R-2 receives the signals tuned by VHF Navigation and Communications Receiver 51X-2B and radiates the r-f energy transmitted by VHF Communications Transmitter 17L-7A, if used.

5-11. The VHF Navigation and Communications Receiver 51X-2B is mounted in Shockmount 349H-4 when each of the system units are mounted in separate shockmounts. Shockmount 390E-1 is the mounting for VHF Navigation and Communications Receiver 51X-2B and Instrumentation Unit 344B-1 when the 51X-2B is part of a navigation system. Shockmount 390E-2 is the mounting for the 51X-2B and VHF Communications Transmitter 17L-7A when the 51X-2B is part of a communications system. Each shockmount protects the equipment from shock damage.

5-12. Radio Set Control 614U-3A is used when VHF Navigation and Communications Receiver 51X-2B is part of a navigation system. The 614U-3A provides remote controlled channel switching, primary power switching, audio level control, and squelch threshold control to the 51X-2B. The 614U-3A frequency range is 108.00 mc to 151.95 mc.

5-13. Radio Set Control 614U-6 is used when VHF Navigation and Communications Receiver 51X-2B is part of a communications system. The 614U-6 functions are identical to the 614U-3A; however, the 614U-6 also provides SCS and DCS/DCD mode of operation for the system and controls channel switching of both the 51X-2B and VHF Communications Transmitter 17L-7A. The 614U-6 frequency range is 116.00 mc to 149.95 mc for the 17L-7A and 116.00 mc to 151.95 mc for the 51X-2B.

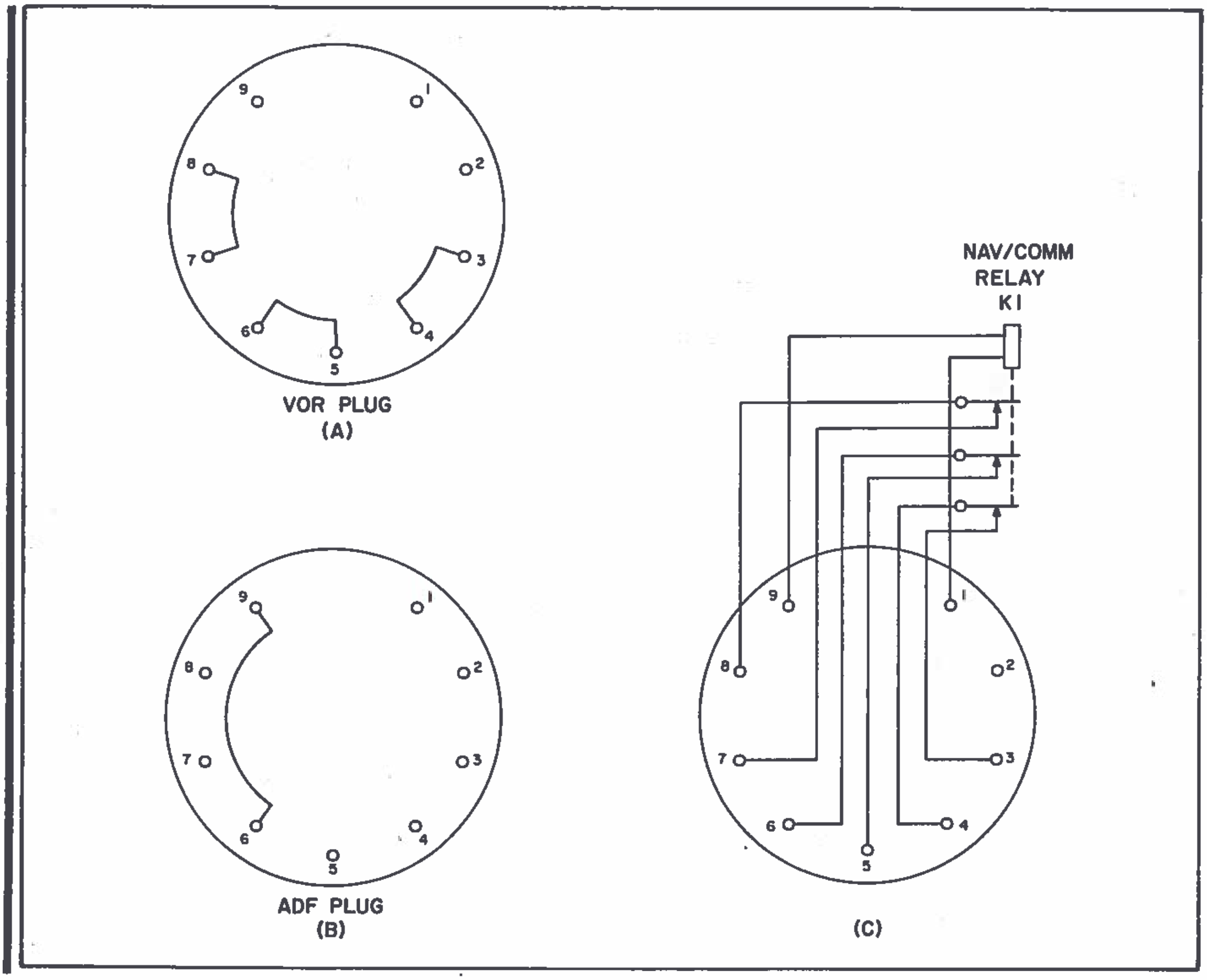


Figure 5-1. VOR-ADF Adapter Plug Fabrication Diagram

SECTION VI
PROCEDURE FOR CHECK-OUT OR ANALYSIS

6-1. GENERAL.

6-2. This section provides maintenance instructions for VHF Navigation and Communications Receiver 51X-2B and Radio Set Control 614U-3A to enable maintenance personnel to localize trouble to the defective component. Field maintenance personnel should be thoroughly familiar with the equipment and theory of operation before attempting servicing.

6-3. After the trouble is localized, refer to the servicing instructions in Section VII for VHF Navigation and Communications Receiver 51X-2B and Section VIII for Radio Set Control 614U-3A.

6-4. DIAGRAMS.

6-5. DIAGRAMS INCLUDED. Sections VII and VIII of this technical manual contain schematic diagrams of VHF Navigation and Communications Receiver 51X-2B (figure 7-43) and Radio Set Control 614U-3A (figure 8-4). Interconnections between these two components and other associated equipments are shown in figures 6-1 and 6-2. (For interconnection data between the 51X-2B and VHF Communications Transmitter 17L-7A and Radio Set Control 614U-6, refer to the applicable handbook of field maintenance instructions on the 17L-7A.) In addition, sections IV and VII contain block diagrams and simplified schematic diagrams that provide useful information to maintenance personnel.

6-6. USE OF DIAGRAMS. To trace circuits between components, refer to figures 6-1, 6-2, 7-43, and 8-4. For detailed circuit tracing within a component, refer to the diagrams of section VII for VHF Navigation and Communications Receiver 51X-2B and section VIII for Radio Set Control 614U-3A.

6-7. DRAWING SYMBOLS. Drawing symbols used in the schematic diagrams conform to military standards and are shown in figure 6-3.

6-8. TEST POINT IDENTIFICATION. Included in the component schematic diagrams are test point symbols. Major test points are identified by an Arabic number within a star and are used for test points that check the over-all performance of the equipment or permit the localization of trouble to a component or assembly. Secondary test points are identified by letters within a circle and are used for isolating the cause of trouble within an assembly or subassembly. The test point identifications appear on the illustrations only and not on the equipment itself. Certain test points are identified on the equipment by "TP".

SYSTEM INTERCONNECTION OF 51X-2B RECEIVER, 344B-1 INSTRUMENTATION UNIT AND 614U-3A CONTROL UNIT						
WIRE FUNCTION	ARINC NOTA-TION	51X-2B	614U-3A	POWER RELAY	344B-1	WIRING NOTES
4-Amp Circuit Breaker				X1 A2		From 27.5 V D-C Bus
On-Off Control			34	X2		
51X-2B, 344B-1 Power		2		A1	2	
2-Amp Circuit Breaker				B2		From 27.5 V D-C Bus
1-Amp Fuse				C2		From 115 V 380-420-Cps Line
344B-1 Instrument Power				C1	24	
Ground		22	18		25	To Rack Ground
Ground			19			
Ground			31			
Receiver Audio In		4	15			
Receiver Audio Out			16			To Interphone System
Audio Ground		5	17			Audio Ground
Remote Squelch Control		25	14			10 K CCW Log to Gnd Min. R = Max. Sens
Navigation Audio		18			29	
Nav/Com Ant. Transfer		19			30	27.5 V D-C 118.0 Mc and higher
GS and LOC ON-STBY Relay		27			27	27.5 V D-C on Glide Slope Freq.
VOR-Antenna		A-1				
Unit Mc Control	A	6	1			
Unit Mc Control	B	7	2			
Unit Mc Control	C	8	3			
Unit Mc Control	D	9	4			
Fractional Mc Control	E	10	5			
Fractional Mc Control	F	11	6			
Fractional Mc Control	G	12	7			
Fractional Mc Control	H	13	8			
Odd Mc Control	J	14	9			
Odd Fract. Mc Control	K	15	10			
Even Fract. Mc Control	L	16	11			
Even Mc Control	M	17	12			
Extended Frequency Coverage	N	20	13			
Channel 1	1		20			
Channel 2	2		21			
Channel 3	3		22			
Channel 4	4		23			
Channel 5	5		24			
Channel 6	6		25			
Channel 7	7		26			
Channel 8	8		27			
Channel 9	9		28			
Channel 10	10		29			
A-B Relay Open on A	A-B		30			
Dial Light 27.5 V Max			36			To Dimmer Circuit
Dial Light Ground			37			Panel Ground

Figure 6-1. Interconnecting Wiring Table

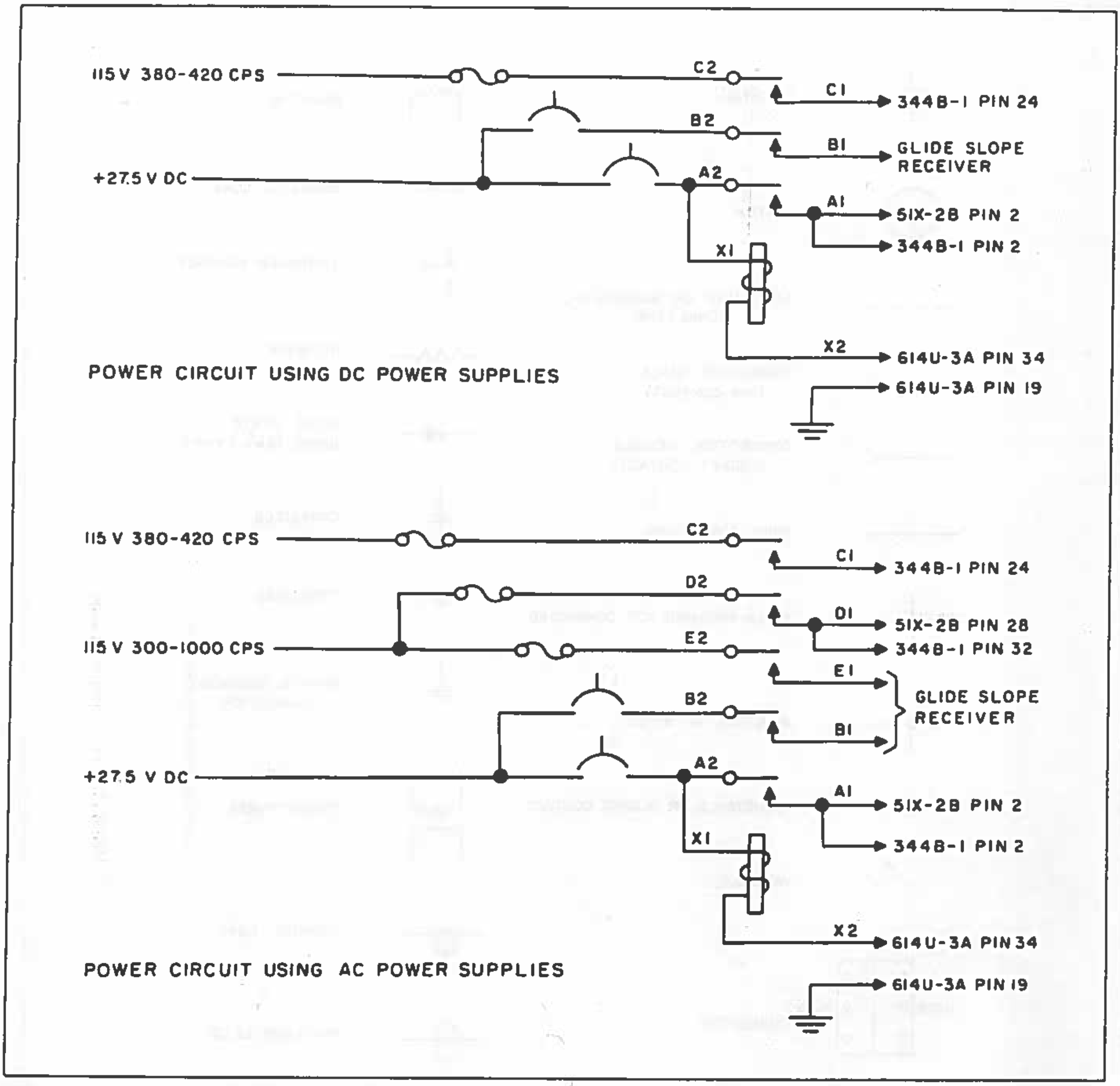


Figure 6-2. Aircraft Power Circuits and Circuit Breakers

"J", or other designations which are also shown on the illustrations. Care should be taken not to confuse these various identifications.

6-9. ANALYSIS.

6-10. INSPECTION.

6-11. Inspection is the first step in trouble analysis. Observe the nature of the malfunction for clues to the defective component. Inspect cable wiring and connectors. Listen for symptoms indicating erratic operation. For channel switching trouble, inspect both switches in Radio Set Control 614U-3A and the Autopositioner system in VHF Navigation and Communications Receiver 51X-2B.

6-12. CHECK-OUT.

6-13. The next step in trouble analysis is to conduct the checks and tests outlined in paragraphs 6-20 through 6-34 and observe the component being checked for malfunction.

6-14. WIRING CHECK.

6-15. Refer to figure 6-1. Check interconnecting wiring for continuity and grounded or shorted conductors.

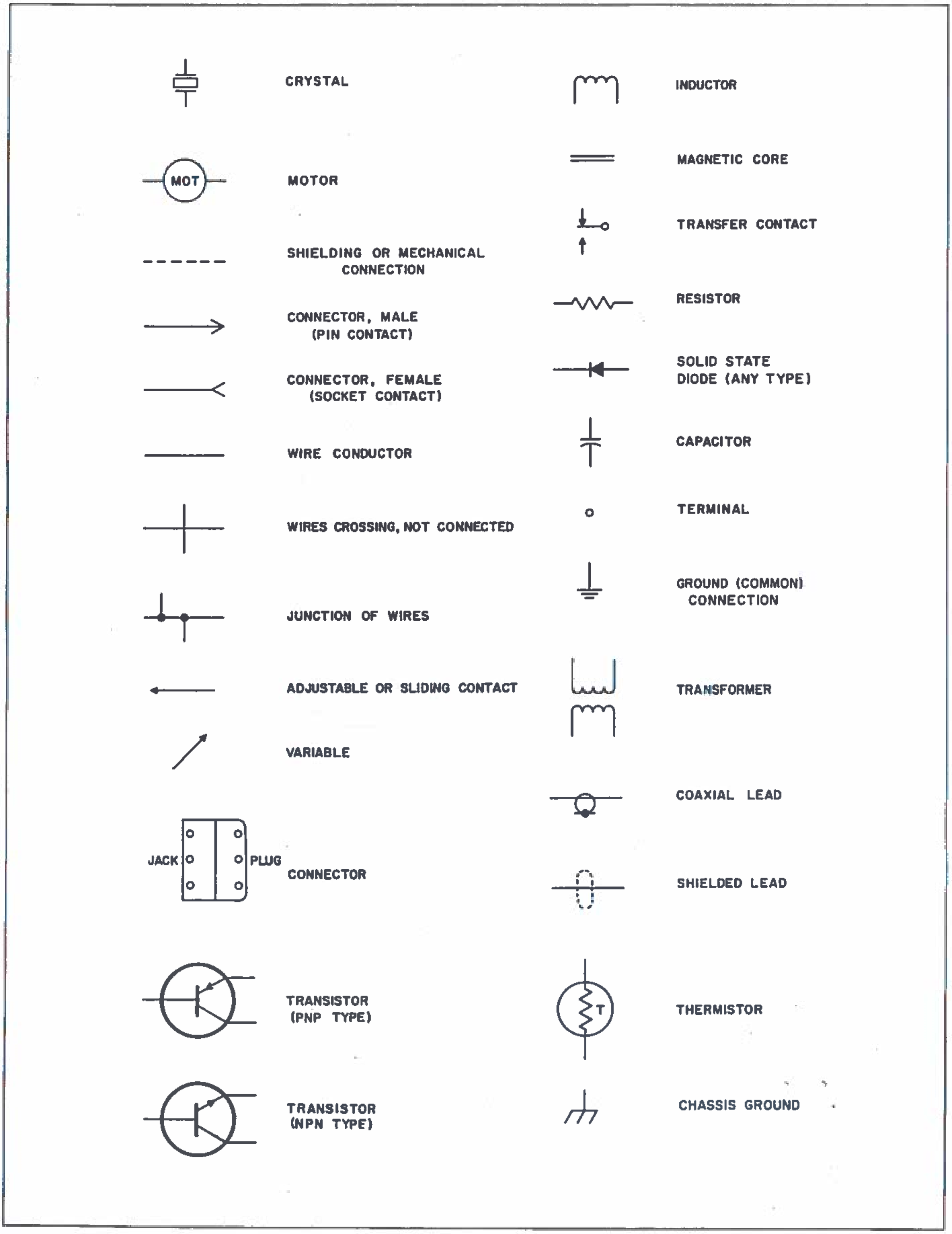


Figure 6-3. Drawing Symbols Conforming to Military Standards

6-16. SUBSTITUTION.

6-17. The final step in trouble analysis is substituting a good component for the suspect component. When the substitution eliminates the fualt proceed to Section VII or Section VIII for servicing instructions for the defective component.

6-18. Before conducting VHF Navigation and Communications Receiver 51X-2B substitution headset HS33 should be checked or substituted to eliminate the possibility of the malfunction being in the HS33.

6-19. After the defective component is serviced conduct the minimum performance check outlined in paragraphs 6-20 through 6-34.

6-20. MINIMUM PERFORMANCE CHECK.

6-21. The following checks may be used as a guide in the preparation of a maintenance check list by field maintenance personnel and to establish a maintenance history of the equipment.

NOTE

In all tests involving the AN/USM-16, a 6-db pad should be connected between the generator and load.

6-22. NON-OPERATIONAL CHECK.

a. Measure resistance from the following rear pins to ground with Multimeter TS-505A/U. Resistances should be approximately as specified below.

RESISTANCE		
PIN NO.	DC SUPPLY	AC SUPPLY
2	12 ohms	2000 ohms
28	infinite	22 ohms
23	280 ohms	280 ohms
4	infinite	infinite
5	infinite	infinite

b. Measure the resistance from the positive terminal of C2 of the main frame to ground. This resistance should be approximately 15K ohms.

6-23. OPERATIONAL CHECK.

a. Apply power to VHF Navigation and Communications Receiver 51X-2B and check for dark or overly bright filaments.

b. Note that a-c power requirement is about 25 watts, and d-c current (when using the a-c supply) is less than 0.1 ampere, except during channeling when it may rise to about 2.2 amperes.

c. Note that with d-c power supply, the d-c current drain is about 1.1 amperes, rising to approximately 3.3 amperes when channeling.

d. Check that top leads of capacitors C13 and C15 of the i-f and audio module are not grounded above 118.00 mc with jumper plug installed. Without the jumper plug they should never be grounded.

e. Check operation of Radio Set Control 614U-3A and VHF Navigation and Communications Receiver 51X-2B on each 2 megacycle and 50 kilocycle step. Observe channel display window on front panel of 51X-2B for correct frequency indication while channeling.

NOTE

Check pawl interstop wheels. Muting contacts should be open when pawl is in the stop wheel. Mute contacts should be closed when motor contacts are closed and motor is running.

f. Check that 27.5 volts d-c exists on pin 19 of P1 on the main frame from 118.0 to 151.95 mc.

g. Check audio response by plugging HS33 into J1 on front panel of 51X-2B and monitoring several stations. Check for adequate audio level by advancing VOL control on 614U-3A; audio fidelity; and signs of overloading on strong stations. Omit this step in shop when audio and frequency checks are performed (per this chapter).

h. Check operation of SQUELCH disable button on front panel of 51X-2B. Pressing button should cause background noise to reappear.

i. Check operation of squelch threshold control SQ on 614U-3A. Turning the SQ control should vary the squelch threshold setting at frequencies above 118.00 mc (disabled below 118.00 mc).

j. Check that 27.5 volts d-c exists on PIN 27 of P1 on the main frame by selecting each odd tenths of a megacycle from 108.1 to 111.9 MC on the 614U-3A Radio Set Control.

6-24. SENSITIVITY CHECK.

a. Insert Radio Set Control 614U-3A into Test Set 476V-1. Connect the 476V-1 and 51X-2B to power. Channel 614U-3A to 108.00 mc(116.00 mc for receiver in communications service only), and connect signal generator AN/USM-16 to the RECEIVER INPUT jack. Set SQUELCH control on radio set control maximum CCW and SQUELCH control on Receiver 51X-2B maximum clockwise.

b. Set Signal Generator AN/USM-16 output for 3 uv, and adjust generator frequency for maximum agc measured at secondary test point P (A2TP5) on the i-f and audio module using a TS-505A or equivalent. Adjust SQUELCH control on 51X-2B so the squelch just opens. Then set SQUELCH control on Radio Set Control 614U-3A full clockwise.

c. Adjust the AN/USM-16 for 30% modulation at 1000-cps, 1000-uv output.

d. Connect a 500-ohm audio load to the audio output major test point 1 (A6J1), and adjust the AURAL LEVEL control R18 for 100-mw output.

e. Adjust AN/USM-16 to 3-uv output. Note the audio output level. Remove the 1000-cps modulation, and again note the audio output level. Record the decibel drop in audio level as the (S+N)/N ratio (6 db minimum).

f. Reduce the USM-16 Signal Generator output to 0.1 microvolt or less and note that the squelch is open (noise in audio output). Insure that SQUELCH control on Radio Set Control will silence Receiver.

g. Repeat steps a through f for each of the following frequencies: 108.00, 111.05, 114.10, 116.1, 117.2, 118.4, 121.45, 124.5, 127.55, 130.6, 134.65, 137.7, 140.75, 143.8, 146.85, 149.9, and 151.95 mc. (Omit frequencies below 116.00 mc for receiver in communications service only.)

6-25. SELECTIVITY CHECK.

a. Correct signal generator AN/USM-16 to receiver input on Test Set 476V-1 and adjust the generator for 2 microvolts output with no modulation. Tune both receiver and signal generator to 116.00 MHZ.

b. Set the SQUELCH controls on both 51X-2B and 614U-3A fully clockwise, and connect Multimeter TS505A/U to secondary test point P (A2TP5) on the i-f and audio module.

c. Loosely couple radio receiver (Collins 51S-1) to the 500 KHZ IF (remove the tube shield from V3 on the IF and audio module). Connect a length of insulated wire to the antenna jack of the 51S-1 and loop the other end around V3.

d. Adjust the signal generator frequency to obtain an IF frequency of exactly 500 MHZ as indicated on the 51S-1. Note this output on the TS-505A/U as reference level.

e. Adjust the AN/USM-16 output level to 4 uv (6 db), and adjust the generator frequency to either side of resonance until the reference TS-505A/U indication noted in step d is again obtained.

f. Measure the + and -6 db frequencies with the 51S-1.

g. The total bandwidth (the difference between the plus and minus 6 db frequencies) should not be less than 40 kc.

h. Adjust the signal generator output level to 2000 microvolts (60 db above 2 microvolts).

i. Adjust the signal generator frequency above and below resonance until the reference level noted in step d is again obtained on the TS-505A/U.

j. Measure the + and - 60 db frequencies on the 51S-1.

k. The difference between the + and - 60 db frequencies should not be more than 77 KHZ.

6-26. AVC CHARACTERISTICS CHECK.

a. Adjust the AN/USM-16 to 116.00 mc at 5 uv with 30% modulation at 1000 cps.

b. With the 51X-2B set to 116.00 mc, adjust the AN/USM-16 frequency for maximum avc voltage at secondary test point P (A2TP5) on the i-f and audio module.

c. Adjust the AURAL LEVEL control R18 for 20 mw output for a zero reference.

d. Adjust the AN/USM-16 output to 100,000 microvolts, and record the decibel change in output, using the output level of 20 mw as a reference. Decibel change should not be more than 4 db.

NOTE

When avc characteristics for audio output have been checked, the avc characteristics for ATCSS output have also been checked. Other channels may be checked in the same manner.

6-27. SQUELCH PERFORMANCE CHECK.

a. Tune the 51X-2B to 116.00 MHZ and rotate both SQUELCH controls to their extreme counterclockwise position. Tuen the AN/USM-16 to 116.00 mc, and connect to 51X-2B input. (Use 118.00 mc instead of 116.00 mc for 51X-2B's with jumper plugs used in VOR systems.) Increase AN/USM-16 output until squelch just opens. Record level at which squelch opens.

b. Decrease the AN/USM-16 output 20 db, and push the SQUELCH disable button. Note that the squelch opens.

c. Repeat step a for each of the following frequencies: 120.30, 123.95, 124.30, 129.50, 134.70, 139.90, 140.90, 147.00, 151.95 mc. Limits: Minimum squelch opening point, not less than 25 uv with not more than 6 db variation between any two squelch opening levels. Gain control resistors R25 and R26 are chosen to balance the gain across the band. They may be zero resistance (bus wire).

d. Set 51X-2B frequency and the AN/USM-16 to 116.00 mv (or 118.00 mc). Adjust the AN/USM-16 output to 3 uv, and set the 51X-2B SQUELCH control so that the squelch just opens.

e. Increase AN/USM-16 output; then slowly decrease output until squelch just closes. Record AN/USM-16 output at this point.

f. Slowly increase AN/USM-16 output, and record the output where the squelch just opens. This should not be more than 3 db open-to-close.

g. Increase modulation to 90%, and measure squelch opening point.

h. Decrease modulation to 10%, and measure squelch opening point. There should not be more than 3 db variation between steps g and h.

6-28. AUDIO RESPONSE CHECK.

a. Connect an audio load and Output Meter TS-585C/U to audio output major test point 1 (A6J1). Tune the AN/USM-16 and 51X-2B to 116.00 mc.

b. Adjust the AURAL LEVEL control for 100-mw output while feeding a 1000-uv, 1000-cps, 30% modulated signal.

c. Measure the response at the following frequencies: 120, 300, 1000, 3750, and 5750 cps; then vary the modulation frequency to find the point of maximum output. Record this frequency and its level with respect to the reference level at 1000 cps. Limits: At least -20 db at 120 cps and 5750 cps; not more than 6 db variation between 300 and 3750 cps.

d. This power output may be too high for the particular installation. If so, adjust the AURAL LEVEL control (R18) in the i-f and audio module to a suitable level.

6-29. ATC OUTPUT.

a. Set the 51X-2B to 115.00 mc, and adjust the AN/USM-16 for 1000 uv output, 30% modulation at 1000 cps.

b. Connect multimeter ME-6D/U to pin 18 of P1 and the chassis of 51X-2B. Adjust potentiometer R12 on the IF and audio module for a reading of 0.5 VAC.

NOTE

If the 51X-2B is going to be used with Instrumentation Unit 344B-1, R12 should be adjusted for 0.5 volt AC into 100,000-ohm load using 1000-uv signal externally modulated 30% with 30 cps. To maintain accuracy, the signal generator and multimeter must be calibrated correctly.

6-30. AUDIO DISTORTION CHECK. Measure the distortion at the audio output with a Spectrum Analyzer TS-723/U at major test point 1 (A6J1) at 1000 cps using 30% modulation. Use a AN/USM-16 output of 1000 uv, and maintain 100-mw output. There should be not more than 7.5% distortion at 30% modulation.

6-31. DISABLING CIRCUIT CHECK.

a. Connect a variable source of d-c voltage to pin 23 of P1 of the main frame.

b. Starting from a low voltage, increase voltage until receiver becomes disabled. The voltage necessary for disabling the receiver should be not more than 20 volts.

6-32. SPURIOUS REJECTION CHECK.

a. Adjust the AN/USM-16 output to 2 uv at 116.00 mc, and set the 51X-2B to 116.00 mc.

b. Connect an Oscilloscope OS-8/U to the audio output at major test point 1 (A6J1) and Multimeter TS-505A/U to secondary test point P (A2TP5).

c. Tune the AN/USM-16 for maximum agc voltage on the TS-505A/U and note this agc reference level.

d. Adjust the AN/USM-16 output to 200,000 microvolts with 1000 cps, 30% modulation, and search the frequency range 80 to 200 mc for spurious signals which will appear on the oscilloscope.

e. When a spurious signal is located, remove the 1000-cps modulation, and adjust the AN/USM-16 output to obtain the same agc reference level noted in step c.

Be certain that the spurious response is not due to a spurious output of the AN/USM-16. With some experience, it is possible to distinguish these spurious responses from a true receiver spurious response. When in doubt, check by using a different model of signal generator.

f. Repeat steps a to e for other 51X-2B frequencies of 127.50 mc and 151.95 mc. Take particular note of those frequencies which are removed from the dial frequency by half the i-f frequency (250 kc) and i-f images. Spurious responses should be 80 db down (20,000 uv).

6-33. LOW SUPPLY VOLTAGE OPERATION CHECK.

a. Turn the 51X-2B off for a sufficient time to allow filaments to cool.

b. If using d-c supply, adjust voltage to 22 volts and turn on 51X-2B. Note that a 10 microvolt, 1000 HZ, 30% modulated signal results in at least 5 MW audio output. Operate channel selector, and note that autopositioner sets up properly.

c. If using a-c supply, additionally adjust voltage to 92 volts, and note that 10-uv signal is passed through the 51X-2B and that Autopositioner operates properly.

6-34. ALTERNATE POWER SUPPLY OPERATION CHECK.

a. Remove the power supply used in the previous tests, and substitute the alternate supply.

b. Measure sensitivity at 116.2 mc and 127.50 mc as in paragraph 6-24. The limits of the (S+N)/N ratio should be not less than 6 db.

6-35. CRYSTAL FREQUENCY CHECK.

a. Connect frequency counter to A1TP7.

b. Check frequencies of First Crystal Oscillator according to figure 7-37. Tolerance ± 0.005% (max 2.4 to 3.5 KHZ).

c. Connect frequency counter to A1TP5.

d. Check the 50 KC frequencies listed in figure 6-4. Tolerance ± 0.005% (550 HZ nominal).

6-36. TRANSIENT PROTECTOR CHECK.

a. Connect vertical input of oscilloscope to the junction of R7 and C2 on DC power supply module A3.

b. Set the transient generator On-Off switch to Off. Connect DC voltmeter to Transient Check Charge on 476V-1.

c. Set the transient generator Charge-Discharge switch to Charge and the Normal-Check switch to Check.

d. Adjust oscilloscope for a spot in the middle of the screen. Set vertical gain to about 0.5 V/CM.

e. Set the transient generator On-Off switch to On and observe the voltmeter.

f. When the DC voltmeter indicates exactly 31 volts, switch the transient generator Charge-Discharge switch to Discharge and observe the oscilloscope.

g. The spot on the scope screen should deflect upward.

h. Set the Charge-Discharge switch to Charge and again observe the voltmeter.

i. When the DC voltmeter reaches 35 volts, switch to Discharge and observe the oscilloscope.

j. The spot on the scope screen should deflect downward.

FREQUENCY (MHZ)	CRYSTAL	CRYSTAL FREQUENCY (MHZ)
0.00	A1Y1	10.525
0.05	A1Y2	10.575
0.10	A1Y3	10.625
0.15	A1Y4	10.675
0.20	A1Y5	10.725
0.25	A1Y6	10.775
0.30	A1Y7	10.825
0.35	A1Y8	10.875
0.40	A1Y9	10.925
0.45	A1Y10	10.975
0.50	A1Y11	11.025
0.55	A1Y12	11.075
0.60	A1Y13	11.125
0.65	A1Y14	11.175
0.70	A1Y15	11.225
0.75	A1Y16	11.275
0.80	A1Y17	11.325
0.85	A1Y18	11.375
0.90	A1Y19	11.425
0.95	A1Y20	11.475

Figure 6-4. 50 KC Crystal Chart.

SECTION VII

MAINTENANCE INSTRUCTIONS, VHF NAVIGATION AND COMMUNICATIONS RECEIVER 51X-2B

7-1. GENERAL.

7-2. This section provides field maintenance instructions for VHF Navigation and Communications Receiver 51X-2B. These instructions are based on the assumption that the check-out and analysis of Section VI have been previously performed. Component data in the form of a detailed circuit analysis is provided in paragraphs 7-3 through 7-61. Trouble shooting analysis procedures designed to isolate trouble to a subassembly or circuit are provided in paragraphs 7-62 through 7-65. Disassembly and alignment procedures and general instructions applicable to transistor circuits are also supplied. When reference is made to meter readings it should be remembered that unless otherwise stated the values given are approximate. It is possible that the equipment will operate normally with values slightly different from those stated.

7-3. COMPONENT DATA.

7-4. The following discussions of each circuit and mechanical system in VHF Navigation and Communications Receiver 51X-2B are detailed to the point of explaining unusual circuitry while placing less emphasis on standard applications. The descriptions of the circuits and systems are supplemented by sections on the main schematic diagram, figure 7-42. The location of the subassemblies comprising the 51X-2B are shown in figure 7-1.

7-5. RADIO-FREQUENCY AMPLIFIER, FIRST MIXER AND HIGH-FREQUENCY OSCILLATOR.

7-6. A type 5654 tube, V1, is used as the r-f amplifier. A tuned antenna coil with the antenna connected to a tap is inductively coupled to the tuned grid of the r-f amplifier. The plate coil of the r-f amplifier also is tuned and inductively coupled to the tuned grid coil of the first mixer. These four coils are tuned by a 4-section variable tuning capacitor. The complete tuning range of the receiver is covered by the one set of coils. Automatic gain control is applied to the control grid of the r-f amplifier tube through R1. Resistor R4 is a parasitic suppressor in the screen circuit of the r-f amplifier tube.

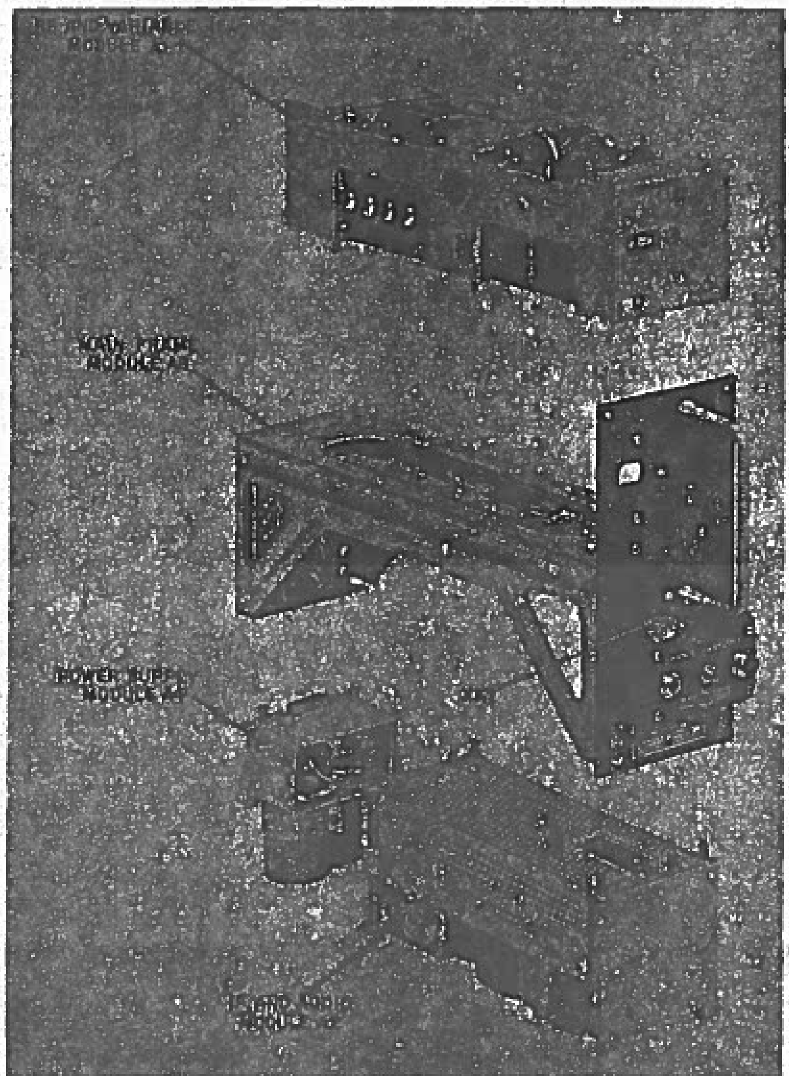


Figure 7-1. VHF Navigation and Communication Receiver, Location of Subassemblies

7-7. The first mixer, V2, is a triode-connected 5654 tube. Cathode injection of the high-frequency oscillator signal is employed. Automatic gain control is not applied to this stage. The output of the first mixer is tuned to the variable i-f by a cam-operated system of tuning slugs. The frequency range of the first mixer output is 10.025 to 11.975 mc. Three tuned circuits are used between the first mixer and the variable i-f amplifier.

7-8. A heterodyning signal is supplied to the first mixer stage by a 5670 dual-triode tube, V5, in a crystal-controlled cathode-coupled oscillator circuit. In this oscillator circuit, the crystal is connected between the cathodes of the dual triode. One section of the tube, pins 2, 3, and 4, is a frequency doubler amplifier; the other section is a grounded-grid amplifier. The crystal frequency is coupled from the plate of the right section, which contains a tank circuit resonant at the crystal frequency, to the grid of the other section. The plate circuit of this section (pin 4) is tuned to double the crystal frequency. The voltage thus obtained is injected into the cathode of the first mixer. The crystals are fifth mode crystals and are used as filters between the cathodes of the tube. The phase shift through the entire oscillator loop is zero, and oscillation takes place at the desired mode of the crystal. The tuned circuit that selects the doubled frequency of the crystals consists of L37, C53, and Z1. Inductance L37 sets the initial inductance of the circuit, and capacitor C53 trims the circuit to the highest frequency. As each lower frequency channel is selected, Z1 adds additional inductance to the circuit. Inductance L36 tunes out the capacitive reactance of the crystal electrodes and connecting wires. Inductance L35 tunes out the reactance of the crystal holder capacity to ground.

7-9. VARIABLE I-F AMPLIFIER, SECOND MIXER, AND LOW-FREQUENCY OSCILLATOR.

7-10. A type 5654 tube, V3, is used in the variable i-f amplifier stage. The variable i-f amplifier also contains six tuned circuits. The variable i-f signal of 10.025 to 11.975 mc from V2, the first mixer, is fed through three tuned circuits to the grid of variable i-f amplifier V3. The output of V3 is fed through three tuned circuits to the second mixer, V4. The six tuned circuits are ganged and tuned by powdered iron slugs by means of connection to the 50-kc autopositioner which is driven to the particular variable i-f frequency in use. Automatic gain control is shunt-fed to the grid of V3, the variable i-f amplifier, through R9. The cathode of this tube is initially biased with cathode resistor R10 which is always in the circuit. See figure 7-2. When the receiver is tuned between 108.00 and 123.95 mc, only the cathode resistor is in the cathode circuit. When the receiver is tuned between 124.00 and 139.95, switch S7, rear, connects resistor R25 in series with the cathode re-

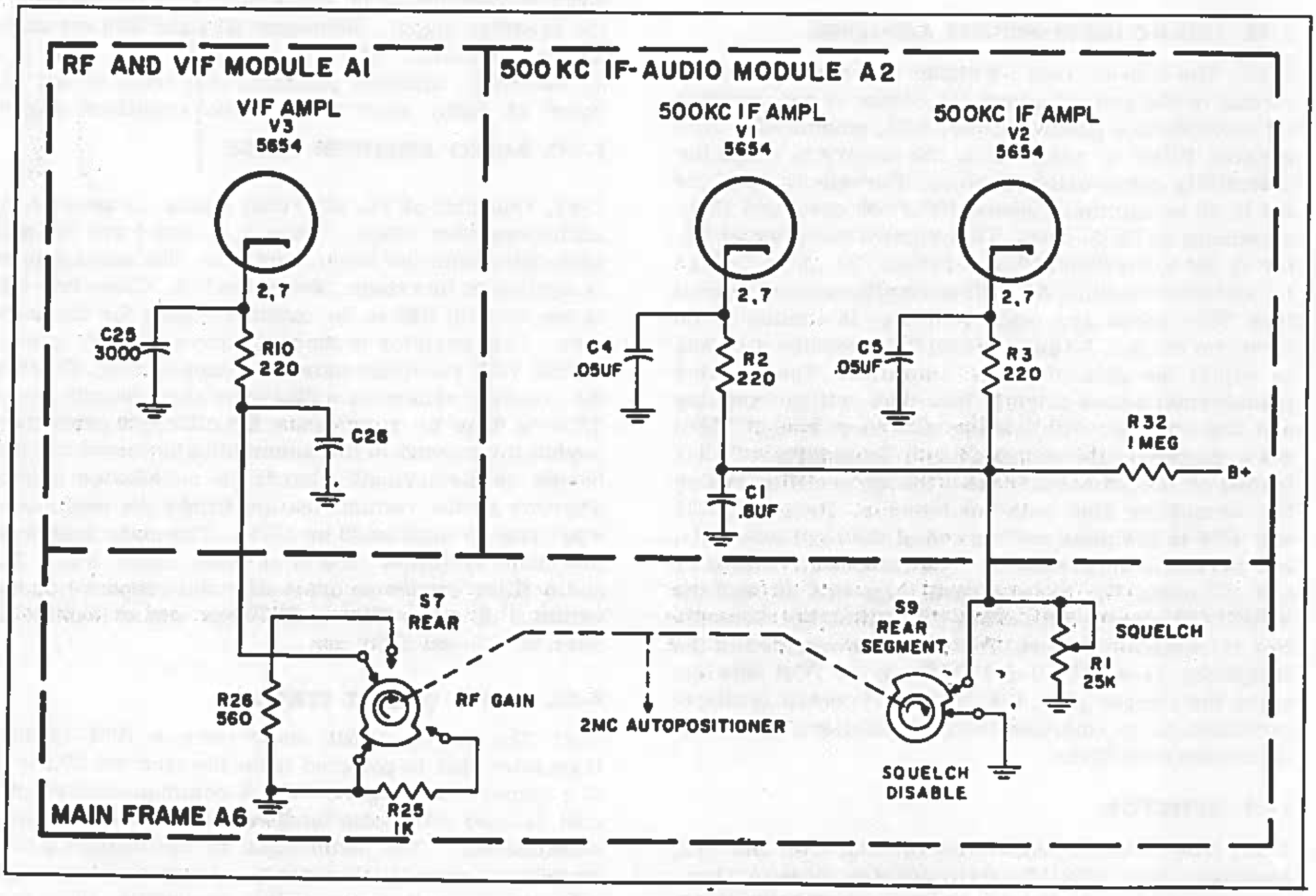


Figure 7-2. R-F Gain Control, Simplified Schematic Diagram

sistor R25 in series with the cathode resistor. When the receiver is tuned between 140.00 and 151.95, switch S7, rear, disconnects R25 and connects resistor R26 in series with the cathode resistor. This provides a more constant r-f gain over the receiver tuning range so that the squelch operates at a more constant level.

NOTE

Resistors R25 and R26 are selected in final test for optimum gain.

7-11. The second mixer utilizes one half of V4, a 5670 dual triode. The second half of the tube is used as the low frequency oscillator. The low-frequency oscillator is a crystal-controlled grid-plate type circuit in which the plate is at r-f ground and the cathode is high. Feedback is controlled by proper selection of the values of C39 and C40. The cathode circuit of the oscillator is common with the cathode circuit of the mixer, and cathode injection to the mixer takes place. The low-frequency crystals are connected between the grid of the oscillator and ground by selector switch S1. Each crystal is used once for low side injection and once for high side injection in covering the 2-mc range of the mixer grid. The sum (or difference) frequency signal is then fed to the 500-kc fixed i-f amplifier through the passive filter.

7-12. 500-KC INTERMEDIATE AMPLIFIER.

7-13. The 500-kc fixed i-f signal is fed from the plate circuit of the second mixer, V4, of the r-f and variable i-f module, to a passive filter, FL1, module A5. This passive filter is adjusted at the factory to shape the selectivity curve of the receiver. The selectivity of the set is 40 kc minimum bandwidth at 6 db down and 77 kc maximum at 60 db down. The output of the passive filter is fed to the first 500-kc i-f stage, V1 in the 500-kc i-f and audio module, A2. Three amplification stages of type 5654 tubes are employed. Agc is applied to the first two stages. I-f gain control R37 provides a means to adjust the gain of the i-f amplifier. The coupling transformers have slightly less than critical coupling and are equipped with loading resistors (except T3) to get a maximum flat-top passband. Transformer T-3 is loaded on the primary side with the agc rectifier and on the secondary side with the detector. Resistors R33 and R34 in the plate and screen of the first tube (V1), are parasitic suppressors. The cathode circuits of V1 and V2 normally are returned to ground through the SQUELCH control with which the gain of the i-f amplifier is controlled. When the receiver is operated in the frequency range 108.0 to 117.95 mc for VOR service, using the jumper plug, the SQUELCH control is short-circuited to ground, and the i-f amplifiers operate at maximum sensitivity.

7-14. DETECTOR.

7-15. The detector, consisting of CR3, C14, and R12, employs a type HD2182 semiconductor diode in a low-impedance circuit. The signal voltage is obtained from a tap on the secondary of the last i-f transformer, T3. The audio output of the detector is coupled to the noise limiter through capacitor C17. R12 is a screwdriver adjustment to set the level of the ATCSS output.

7-16. NOISE LIMITER.

7-17. Receiver 51X-2B employs a series noise limiter utilizing a type 601C semiconductor diode, CR4. The circuit is self-adjusting, with components selected to make the limiter clip impulse type noise at approximately 80% modulation.

7-18. In operation, a positive voltage proportional to the carrier is developed across C18. This voltage cannot change rapidly because C18 and R15 are relatively large. Diode CR4 acts as a conductor for the audio signal so long as the anode is positive with respect to its cathode. Positive noise peaks that exceed the maximum carrier-modulation level will drive the cathode positive instantaneously with respect to the anode, and during this instant, the diode does not conduct. The large time constant of R15 and C18 prevents any change in the reference voltage. The hole thus punched into the signal prevents the noise pulse from being reproduced, but is of such short duration that the intelligibility of the signal is not affected seriously. Negative noise peaks are clipped automatically at the detector.

7-19. Because the reference voltage is obtained from the detector load, the reference voltage is adjusted up or down automatically in accordance with the strenth of the received signal. Resistors R14 and R16 are audio voltage dividers. The noise limiter load, R18, is a screwdriver adjusted potentiometer used to set the value of audio input to the audio amplifier stages.

7-20. AUDIO AMPLIFIER STAGE.

7-21. One half of V4, 5670 dual triode, is used as the audio amplifier stage. Pins 2, 3, and 4 are the pins associated with the audio amplifier. The audio squelch is applied to this stage. See figure 7-3. Capacitor C22 in series with R26 is the cathode bypass for the audio tube. This resistor is shorted out by switch S7 (front), during VOR reception using the jumper plug. Shorting the resistor raises the audio output about four decibels. This is done to compensate for different percentage modulations found in the communication and navigation bands. In the navigation bands the modulation is 30%, whereas in the communication bands the modulation may run as high as 90 or 100%. The plate load from the audio amplifier tube is an audio filter, FL1. The audio filter causes an over-all audio response that is within 6 db from 300 to 3750 cps and at least 20 db down at 120 and 5750 cps.

7-22. AUDIO OUTPUT STAGE.

7-23. The audio output stage uses a DT4-17 PNP transistor that is powered from the aircraft 27.5-volt d-c supply. See figure 7-3. A common emitter circuit is used with audio feedback and base and emitter stabilization. The audio input to the base is a low-impedance circuit; therefore, a large coupling capacitance is necessary. This capacitor, C23, is of 25-uf value. Resistor R30 provides audio feedback to

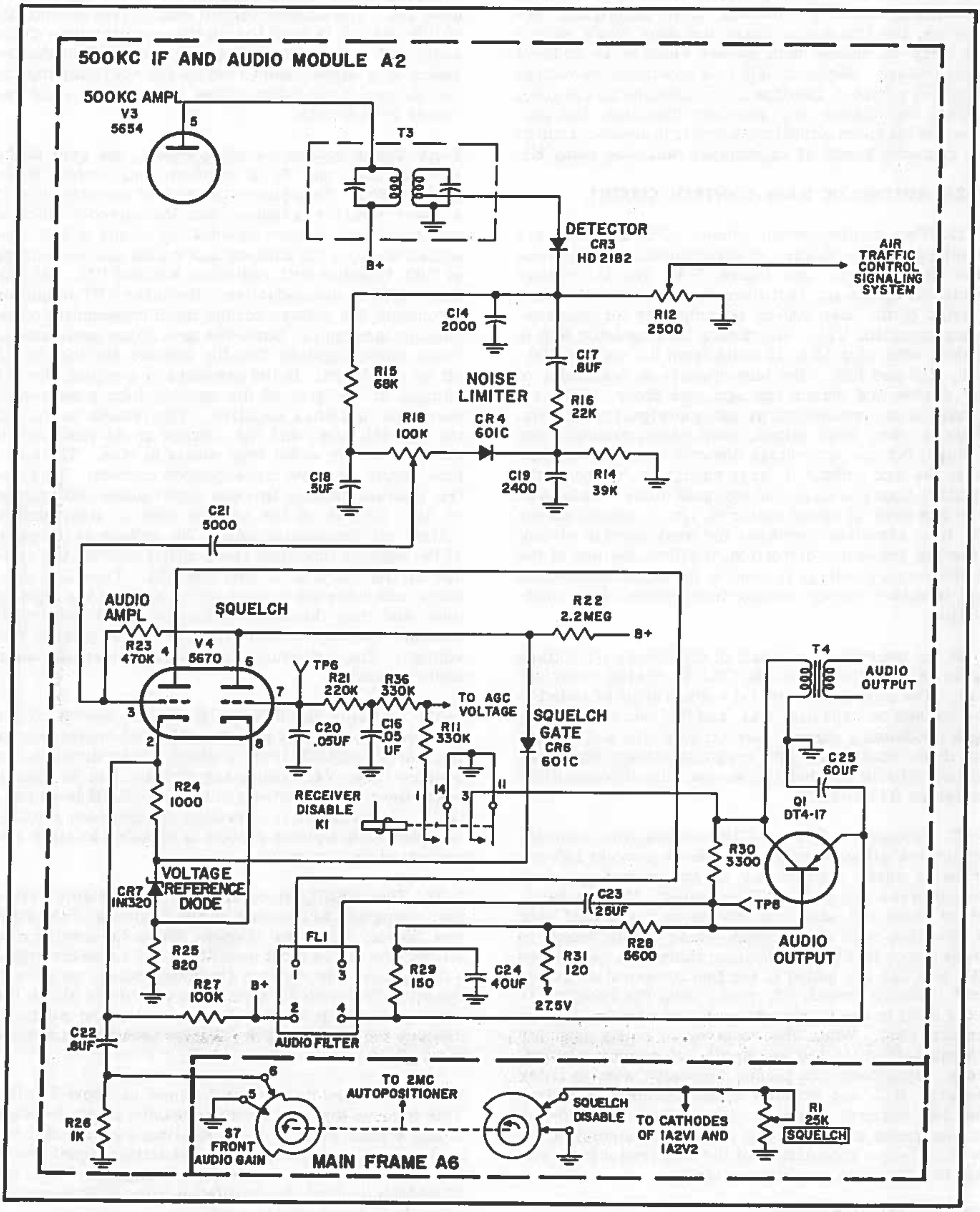


Figure 7-3. Audio and Squelch Circuits, Simplified Schematic Diagram

improve distortion characteristics. Resistor R29 is the emitter stabilizing resistor, and R28 is the base stabilizing resistor. Without these stabilizing resistors, the transistor characteristics would have a tendency to change with severe changes in ambient temperature. Resistor R31 is a power source voltage dropping resistor, and capacitors C24 and C25 are audio bypass capacitors. For receiver disabling, the primary of the audio output transformer is short-circuited by contacts 3 and 11 of receiver disabling relay K1.

7-24. AUTOMATIC GAIN CONTROL CIRCUIT.

7-25. Two semiconductor diodes, CR1 and CR2, are employed in a half-wave voltage doubler circuit to obtain agc voltage. See figure 7-4. The i-f voltage rectified by the agc rectifiers is taken from the plate circuit of the last 500-kc i-f amplifier through coupling capacitor C11. The diodes load resistor R10 is biased with plus 14 to 15 volts from the voltage divider, R17 and R20. The bias appears on both sides of the diodes and biases the agc gate diode, CR5, to a condition of nonconductivity under no signal conditions. Thus, a very weak signal, even noise, produces agc voltage; but the agc voltage does not reach the agc line until the agc voltage is large enough to overcome the positive bias placed on the agc gate diode. This system has several useful features, i.e., it maintains the set in a sensitive condition for weak signals without creating excessive distortion, it allows the use of the positive delay voltage to control the squelch tube grid, and it makes the agc voltage independent of the modulation.

7-26. In operation, one half of the 500-kc i-f voltage cycle is rectified by diode CR2 to charge capacitor C11. The next half of the i-f voltage cycle is added to the voltage on capacitor C11, and the sum of the voltages produces a current flow through CR1 and through the diode load R10. The resulting voltage appearing across R10 is applied to the agc line through filter resistors R11 and R13.

7-27. Capacitors C13 and C15 are long time constant capacitors attached to the agc line to provide 180 degrees of phase shift to any 30-cps ac that may feed back into the agc line in VOR service. If these capacitors were not used, the 30-cps ac would feed back in the line with only enough phase displacement to cause error in VOR indications; therefore, capacitors C13 and C15 are added to the line by operation of agc time constant switch S8, rear, when the receiver is being used in the VOR portion of its tuning range with jumper plug. When the receiver is being used for communication in the remainder of its tuning range, these capacitors are placed in series across filter resistor R13 and actually speed up the agc action. The 180 degrees of phase shift applied to the 30-cps ac component in the agc line has no detrimental effect on the 30-cps modulation of the received signal, except to reduce its amplitude slightly.

7-28. SQUELCH CIRCUIT.

7-29. The squelch circuit is associated with audio amplifier tube V4, pins 2, 3, and 4. See figure 7-3. In the absence of a signal in the receiver input, this audio amplifier stage is made inoperative to prevent annoying noise being reproduced in the speaker or head set. The squelch circuit employs the second half of tube V4. It is used to shift the operating bias of the audio half of the tube to plate current cutoff in the absence of a signal, and to return the operating bias to the proper level when there is a signal in the receiver r-f circuits.

7-30. Under conditions of no signal, the grid of the squelch tube, pin 7, is positive, and current flows through R22. This places the grid of the audio tube at a lower positive potential than its cathode, which is maintained at a higher potential by means of R27 connected between the cathode and B plus and the voltage of CR7, together with resistors R24 and R25. At this time, CR6 is nonconductive. Rectifier CR7 maintains a constant d-c voltage across itself independent of the current through it. Since the grid of the audio tube is much more negative than the cathode, the tube is cut off or squelched. In the presence of a signal, the d-c voltage at the grid of the squelch tube goes toward zero and becomes negative. This starts to cut off the squelch tube, and the voltage at its plate and at the grid of the audio tube starts to rise. The audio tube starts to draw more cathode current. This extra current flowing through R25 causes the voltage on the cathode of the squelch tube to rise, further cutting off the squelch tube. The voltage at the plate of the squelch tube then rises until it exceeds the voltage at the junction of CR7 and R24. Then CR6 conducts and holds the voltage at the plate of the squelch tube (and thus the bias on the grid of the audio tube) constant for any further increase in the squelch grid voltage. The audio tube now functions normally as an audio amplifier.

7-31. Pressing the SQUELCH disable switch on the receiver front panel grounds CR7 and shorts across R1, the SQUELCH level control. This disables the squelch tube, V4. Thus, any channel can be opened regardless of the setting of the SQUELCH level control. The receiver is operating at maximum sensitivity when the squelch circuit is disabled to allow reception of weak signals.

7-32. The SQUELCH control R1 is a variable resistor, connected in series with the cathodes of the first two 500-kc amplifier stages. When the resistor is all out, the set is most sensitive, and a weaker signal will operate the squelch (in most cases, noise will operate the squelch); when the resistor is all in, the set is less sensitive, and it takes a stronger signal to produce the required avc voltage necessary to remove the squelch.

7-33. The squelch threshold is set at about 0 volts. This insures that no gain compression exists because of agc action, while at the same time insuring that the audio rise between threshold and strong signal levels is not excessive. As noted in paragraph 7-31, the SQUELCH control is disabled during VOR operation when the jumper plug is used.

7-34. The filaments of the tubes are connected in a series-parallel arrangement so that they can be connected in parallel for energizing from 6.3 volts or

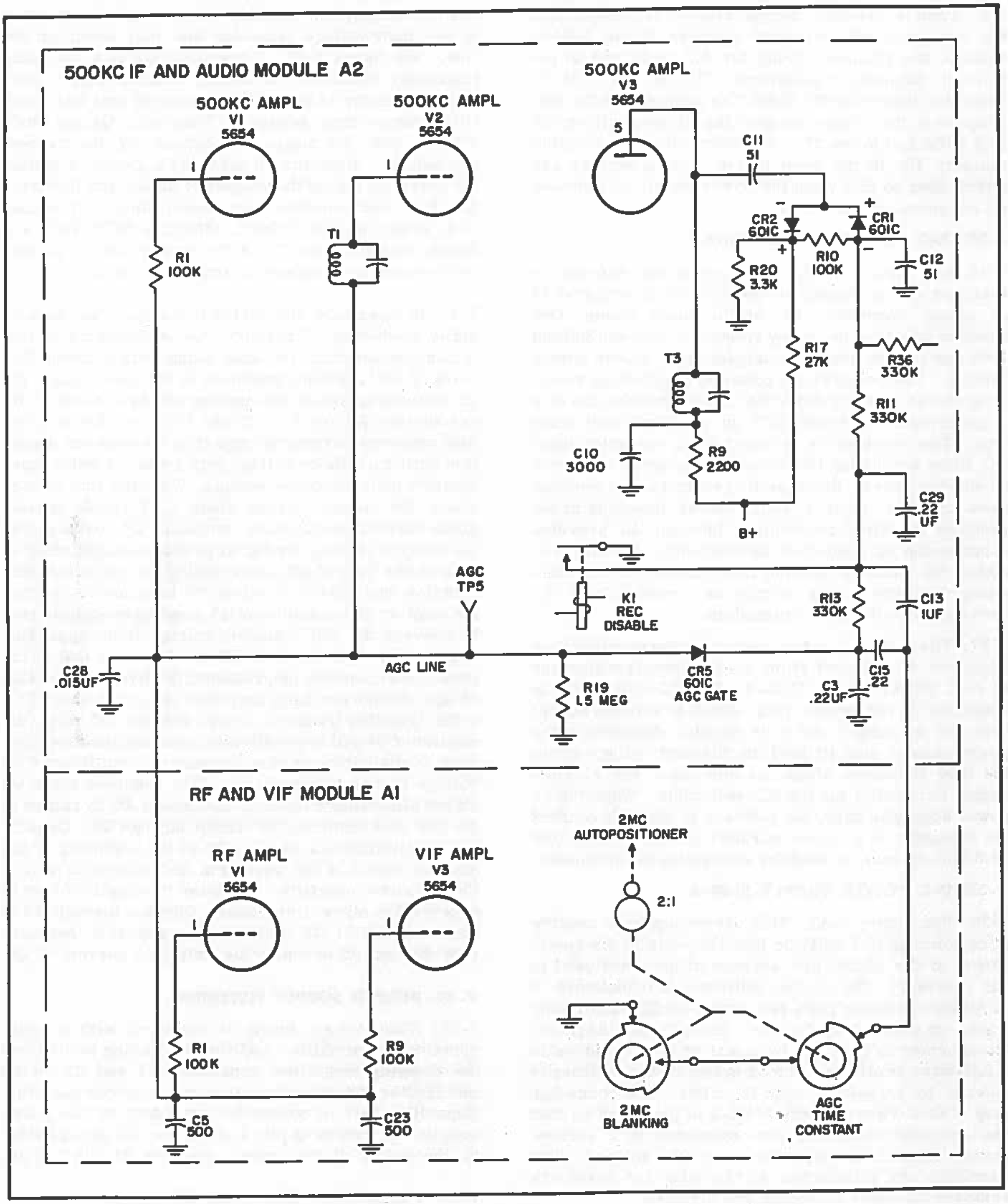


Figure 7-4. Automatic Gain Control (AGC) Circuits, Simplified Schematic Diagram

they can be connected in two series strings, each of which can be energized from 27.5 volts. See figure 7-5. When A-C Power Supply 516A-1 is plugged into the set, properly arranged jumpers in the 516A-1 connect the filament string for 6.3 volts and to the 6.3-volt filament transformer, T1, in the 516A-1. When D-C Power Supply 516B-3 is plugged into the set, jumpers in the 516B-3 connect the filament string for 25.2 volts and to the 27.5-volt source through dropping resistor R3 in the main frame. The filaments are interlocked so that when the power supply is removed all filaments are disabled.

7-35. A-C POWER SUPPLY 516A-1

7-36. See figure 7-43. The alternating current to energize the ac supply is obtained from terminal 28 of power connector P1 of the main frame. One hundred fifteen volts of any frequency between 300 and 1000 cps can be used to energize A-C Power Supply 516A-1. The receiver B+ power is obtained by rectifying the ac directly from the line without the use of a transformer. Rectifier CR1 is a silicon half-wave type. The rectifier is followed by a capacitor input RC filter employing two 120-ohm resistors and three 24-uf capacitors. Resistor R1 is a protective resistor used to open up if a short circuit develops in the rectifier or filter capacitors. Inductor L1 provides suppression of conducted interference. Bleeder resistor R4 ensures that the filter capacitors are discharged if the power supply is removed from the receiver with the power turned on.

7-37. The 6.3-volt ac for energizing the receiver tube filaments is obtained from a step-down transformer in A-C Power Supply 516A-1. The 6.3-volt output is connected to the module plug, which is wired to accept both the ac supply and a dc supply. Jumpers in the power supply plug P1 feed the filament voltage out to the tube filaments which, in this case, are all connected in parallel for the 6.3-volt value. When the dc power supply is used, the jumpers in that unit connect the filaments in a series-parallel arrangement so that 27.5 volt dc may be used for energizing the filaments.

7-38. D-C POWER SUPPLY 516B-3.

7-39. See figure 7-43. This power supply is capable of converting 27.5 volts dc into 130 volts dc for application to the plates and screens of the tubes used in the receiver. The circuit utilizes two transistors in grounded collector push-pull power oscillator, driving a step-up power transformer. The output of the power transformer is rectified by a pair of silicon diodes in a full-wave rectifier. The dc output of the rectifier is filtered by a resistor input RC filter. The connector plug of D-C Power Supply 516B-3 is jumpered so that the receiver filaments are connected in a series-parallel circuit for excitation from 27.5 volts dc. The filaments are interlocked so that when the module is removed all other filaments are disabled.

7-40. Without a protective device, the transistors Q1 and Q2 in the power supply would be subject to permanent damage from high voltage transients of the 27.5-volt line. These transients often reach peak values of 80 volts which will generally break down the transistor base material causing internal short circuits. In D-C Power Supply 516B-3, a protective circuit is used to open the supply line to the transistors for the duration of any high voltage transient that may occur on the line. See figure 7-43. Transistor Q3 is a switching transistor connected in series with the supply line. This transistor is normally conducting and has very little voltage drop across it. Transistor Q4 and diode CR3 provide the means for cutting off the current through Q3. Resistor R3 provides a means of setting the operating bias of the reference diode, and thermistor RT1 compensates for temperature variations. D-C Power Supply 516B-3, effective MCN 7100 and above, contains fuse F1 in the supply line to protect components from effects of transistor failure.

7-41. In operation, the series transistor, Q3, is normally conducting. Transistor Q4 is connected so that it is not conducting, its base being held at about 27.5 volts by RT1. When a transient in the line occurs, the transient is applied to the emitter of Q4 and to the voltage divider R3 and R6. Diode CR3 is a Zener diode that resists a current through it in the reverse direction until its cathode voltage gets about 4.5 volts more positive than its anode voltage. When the line voltage rises, the voltage across diode CR3 rises, causing diode current and Q4 base current. Q4 turns on and the current flowing through it produces slight reverse bias on the base of Q3, interrupting the collector current flow through Q3. Resistor R7 is connected across the emitter and collector of Q3, passing enough current to prevent the full transient voltage from appearing across Q3. The value of R7 is chosen so that at the peak of the transient (approximately 80 volts), the value of line voltage reaching the power supply is about 27.5 volts. When the transient decays to about +30 volts, the emitter of Q4 will be at +30 volts, also, and the base current of Q4 will drop to zero because of insufficient CR3 voltage to maintain current. This condition turns Q4 off and allows the voltage on the base of Q3 to return to normal thus restoring the circuit through Q3. Capacitor C2 eliminates a small spike at the beginning of the blanked region of the waveform and serves as part of the radiated-noise filter. Resistor R5 supplies forward bias to Q3 to allow it to conduct. Current through R5 is base current for Q3 until transient appears, then current through R5 becomes the collector current of Q4.

7-42. POWER SUPPLY FILTERING.

7-43. Each power supply is equipped with a self-contained ripple filter. Additional filtering is obtained by mounting two filter capacitors C1 and C2 on the main frame and connecting them to the power supplies. Capacitor C1B is connected internally to the power supplies by means of pin 7 of J4, and C2 is connected to the output of the power supplies at pin 1 of J4.

7-44. FREQUENCY SELECTING CIRCUITS.

7-45. GENERAL ELECTRICAL DESCRIPTION. The frequency selecting components consist of two crystal selector switches (one for megacycle selection and one for 50-kc selection), a variable capacitor to tune the r-f circuits, and a slug rack to tune the variable

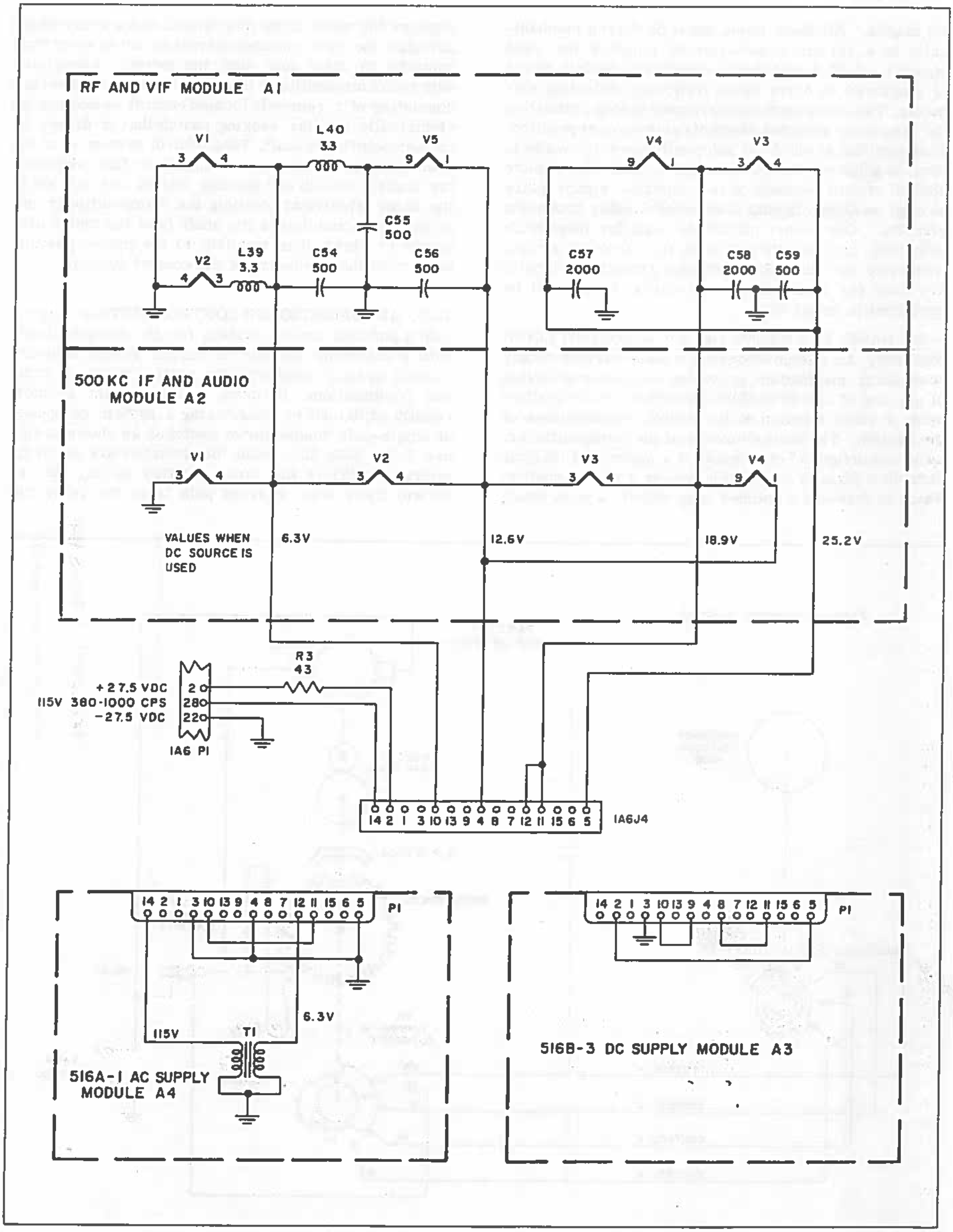


Figure 7-5. Filament Circuits, Simplified Schematic Diagram

i-f stages. All these items must be driven mechanically to a certain predetermined position for each channel. A 27.5-volt dc non-reversing electric motor is employed to drive these frequency selecting elements. Two Autopositioners are used to stop accurately the frequency selected elements at the proper position. This position, at which the autopositioners are made to stop, is selected at a remote control unit. The remote control circuit consists of two separate binary (wire saving) seeking circuits plus several other grounding circuits. One binary circuit is used for megacycle selection, and the other is used for 50-kc selection. Generally speaking, the additional grounding circuits are used for tuning range extension; these will be explained in detail later.

7-46. BASIC ELEMENTS OF AN AUTOPOSITIONER SYSTEM. An Autopositioner is a motor driven rotary positioning mechanism providing automatic selection of any one of a given number of positions, each position being a fixed function of the switch combinations of the system. The basic elements of the Autopositioner, as shown in figure 7-6, consist of a motor and its gear reduction train, a slip clutch driving a rotary shaft to which is fastened a notched stop wheel, a pawl which engages the notch of the stop wheel, and a relay which actuates the pawl and also operates a set of electrical contacts to start and stop the motor. Associated with each Autopositioner is an electrical control system consisting of a remotely located control switch and an electrically similar seeking switch that is driven by the Autopositioner shaft. This control system is of the open circuit seeking type, designed so that whenever the control switch and seeking switch are not set to the same electrical position, the Autopositioner unit is energized and drives its shaft (and the tuning elements to which it is coupled) to the proper position to restore the symmetry of the control system.

7-47. AUTOPOSITIONER CONTROL SYSTEM. To provide a position control system for the Autopositioner with a minimum number of control wires, a binary control system employing the control wires in various combinations is used. This system is most readily explained by considering a system composed of single-pole double-throw switches as shown in figure 7-7. Note that when the switches are set symmetrically (S1 in the same position as S2, etc., as shown) there is no current path from the relay coil

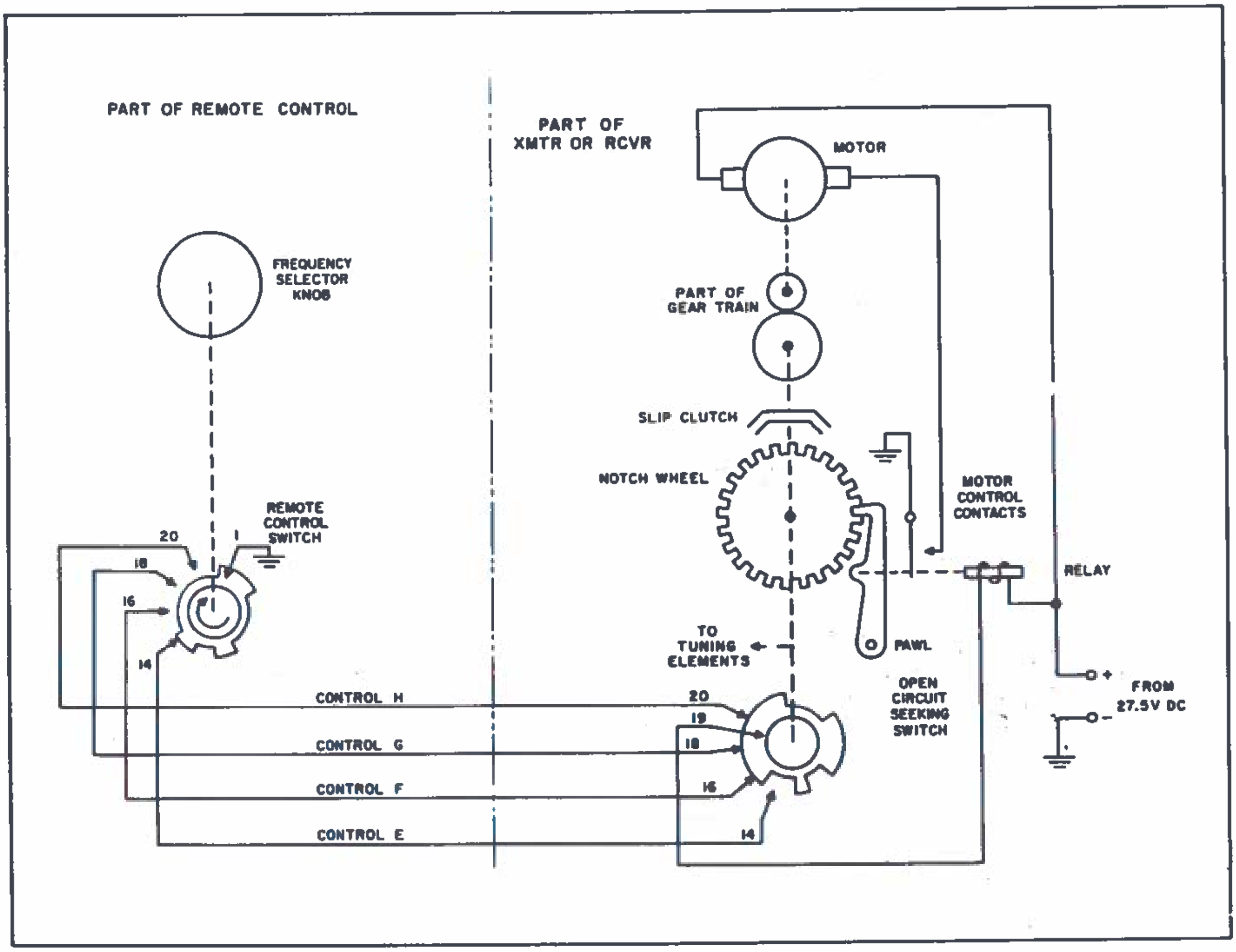


Figure 7-6. Autopositioner Basic Elements

to ground, and the relay and motor remain de-energized. If, however, any of the control switches are set to a position opposite that of a corresponding seeking switch, a path to ground will be closed, energizing the relay and motor until the seeking switches are positioned again in a symmetrical arrangement with the control switches, which will again open the relay circuit.

7-48. The total number of different combinations of switch positions in such a system is 2^n, where n is the number of control wires used. In the six-wire system shown, 2^6 of 64 different combinations exist. However, one particular combination is not usable in this application. As can be seen in figure 7-7, if all the seeking switches are set to the B position, there can be no path from the relay coil to ground no matter how remote switches are set, and the system is dead. Hence, the maximum number of usable combinations in such a system is 2^n-1. Thus, a three-wire system can control 7 positions, four-wire 15 positions, and five-wire 31 positions.

7-49. CYCLE OF OPERATION.

a. The system is at rest with the control and seeking switches in corresponding positions (open circuit), relay in the de-energized position, pawl engaging a stop-wheel notch, and the motor not energized.
b. The operator changes the setting of the remote control selector switch.
c. The control system energizes the relay, lifting the pawl out of the stop-wheel notch and closing the motor control contacts.
d. The motor starts, driving the Autopositioner shaft and the rotor of the seeking switch.
e. The seeking switch reaches the point corresponding to the new position of the remote switch, opening the relay circuit, permitting the pawl to drop into the corresponding stop-wheel notch to stop shaft rotation.

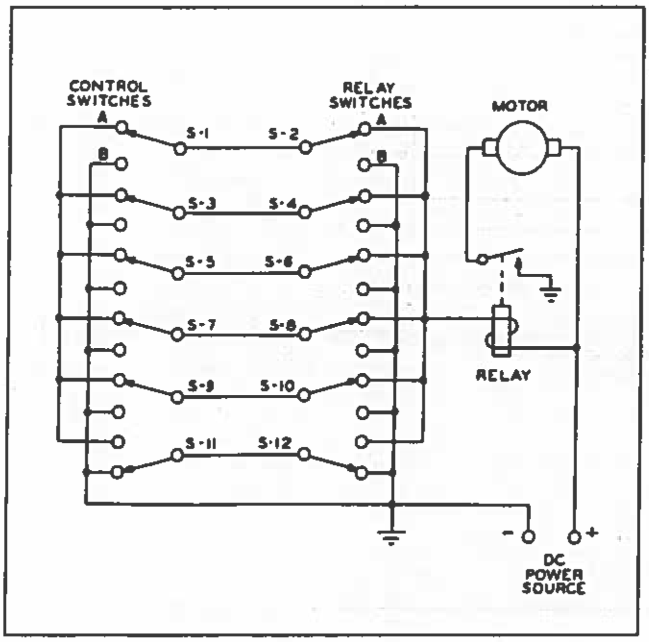


Figure 7-7. Autopositioner Function Diagram

f. The motor control contacts open, and the moto coasts to a stop, dissipating its kinetic energy in th slip clutch. The seeking switch of the control circui is adjusted to open the relay circuit before the sto wheel reaches the point where the pawl engages th proper notch. The relay contacts controlling the motor are adjusted so that they do not open until th pawl drops into the notch. The slip clutch betwee the motor and Autopositioner not only absorbs the energy of the motor as it coasts to a stop but also permits the same motor to drive more than one Autopositioner, either simultaneously or independently.

7-50. 51X-2 AUTOPOSITIONER SYSTEM. The frequency selection method employed in VHF Navigatio and Communications Receiver 51X-2B is much th same as that discussed in the preceding paragraphs The following paragraphs contain specific informatio concerning the 51X-2B Autopositioners.

7-51. MEGACYCLE SELECTION. The megacycl Autopositioner is composed of motor B1, which i common to both autopositioners, seeking switches S9 and the front section of S8. Switch S9 is electricall symmetrical to S4 in Radio Set Control 614U-3A Switch S8 is connected to the coil of the megacycl Autopositioner to rotate through the portion of th tuning cycle represented by the back of the tunin capacitor plates. Figure 7-8 is a schematic diagran of the receiver channeling circuits and figure 8-4 is schematic diagram of the Radio Set Control Uni 614U-3A.

NOTE

In the example below, the frequencies 108 and 109 mc are used. These frequencies apply only to a 51X-2B which is used in a navigation system. The 51X-2B does not operate below 116.00 mc in a communications system.

7-52. Switch S4 is shown in position for selection o 108 megacycles. The electrical information furnishe S9 by S4 for a frequency of 109 megacycles is identical to the electrical information furnished for a frequency of 108 megacycles. Therefore, the physica position of S4 is unchanged when the selected frequency is advanced from 108 megacycles to 109 megacycles. The 2:1 geneva mechanism between the frequency selector knob and S4 causes the switch S4 to advance only when the frequency is changing from ar odd megacycle to an even megacycle in the increasing frequency direction. Selection between odd and even megacycle tuning is determined by the rear section of S2, which is geared directly to the frequency selector knob. The charts at the right of figure 8-4 show that the electrical information on the four megacycle control wires ("A", "B", "C", and "D") is the same for 108 and 109 megacycles.

7-53. When the seeking switches and the control switches are set at dissimilar positions, a ground is furnished to the Autopositioner relay coil which results in the tuning motor being energized. The Autopositioner motor, B1, will continue to drive the megacycle Autopositioner until S9 is electrically similar to S4. When they are similar, the relay coil of the

Autopositioner will be de-energized and the pawl will fall onto the notched wheel. The motor will continue to run, however, because contacts 3 and 4 of the Autopositioner are being held shut by the pawl. The pawl will fall into the first notch of the notched wheel to come along causing the notched wheel to stop and contacts 3 and 4 are no longer held closed by the pawl. This results in the motor being de-energized. Notice that the 614U-3A (figure 8-4) is set for a frequency of 108.00 megacycles and the 51X-2B is set for 108.00 megacycles. In this condition the relay coil of the Autopositioner is de-energized.

7-54. If the 50-kc Autopositioner has not found its position at this time, contacts 3 and 4 of the 50-kc Autopositioner will be held closed and the motor will continue to run until the pawl drops into its proper notch. The seeking switches are synchronized with the notched wheel but are timed to open slightly ahead of the appearance of the associated notch. All tuning elements are synchronized carefully with the notches on the wheel to obtain precision positioning. The megacycle Autopositioner selects frequencies of even megacycles only. The selection of the odd megacycle is done by the variable frequency i-f amplifier and the low-frequency oscillator which are positioned by the 50-kc Autopositioner. Figure 7-9 shows the wires and switching involved in the two-megacycle seeking system.

7-55. In selecting an odd megacycle, Radio Set Control 614U-3A is set to this odd-megacycle frequency, for instance 109.00, but the position of S4 is the same as if 108.00 was the selected frequency. The megacycle Autopositioner will, therefore, set up on 108.00 as described above. Switch S2, however, has changed configuration and applies a ground to control wire "J". This ground energizes the 50-kc Autopositioner. The 50-kc Autopositioner drives the odd-even megacycle switch, S6, until the connection at clip 19 of S6 is broken and then proceeds to the frequency that is set up on the 50-kc dial of the 614U-3A. In this case, it will set up on 00. The odd-even selector switch, S6, is driven from the 50-kc shaft through a 2:1 reduction gear. While S6 was making the 1/2 revolution necessary to break the contact at clip 19, the seeking switch, S4, was making a complete revolution and the low-frequency oscillator crystal selecting switch was making one complete revolution and selecting the same crystal (because of the 2:1 step-up gear ratio). Also during the 1/2 revolution of S6, the variable i-f cam made 1/2 revolution, but because this is a 360-degree cam, the tuning slug rack was moved only approximately through 1/2 of its range. The full range of the slug rack is 2 mc; therefore, the variable i-f is set to tune 11.025 megacycles which is the difference frequency produced when a 109.00-mc signal beats against the 97.975-mc high-frequency oscillator signal (the same signal used for 108.00-mc). Beating the 11.025-mc signal against the 10.525-mc low-frequency oscillator signal produces the desired 500-kc fixed intermediate frequency.

7-56. The tuning motor, B1, always turns in the same direction, so if a frequency lower than the one previously set up is selected, the megacycle Autopositioner merely moves to the new frequency and stops; but if a higher frequency is chosen, the megacycle Autopositioner runs through almost a complete cycle before it sets up on the new frequency. A blanking switch, S8, is attached to the megacycle shaft through a 2:1 reduction gear to get the megacycle Autopositioner rotated through the portion of arc represented by the undesired sector of the tuning capacitor rotor plates. The diode-resistor combinations containing CR1 and CR2 are connected to the solenoid coils to reduce inductive transients generated when the associated seeking switch is opened due to a completed channel selection. Tuning motor B1 contains a filter network consisting of L43, L44, C61, and C62 which is used to reduce motor noise while channeling to different frequencies.

7-57. There is a limit to the number of wires that may be used to keep the system compatible with previous systems, and because of the numerous channels covered by the 51X-2B, a range extending means is employed utilizing an additional wire. This wire is designated the "N" wire and is grounded at all frequencies below 136.00 megacycles at the control unit. Refer to figure 7-9. Switch S9, front segment, is used in much the same manner as the two-megacycle blanking switch, S8 to permit the Autopositioner to rotate through the arc of rotation that represents the frequency range 108.00 to 135.95 megacycles whenever the range extension switch in the control unit grounds the "N" wire. After the tab on S9, front segment, clears the 108.00-139.95 megacycle sector of rotation, the Autopositioner is free to set up on the open circuit represented by the frequency selected by the 614U-3A. Some of the wire combinations used below 140.00 mc are again used for frequencies at and above 140.00 mc but with the addition of the "N" wire to the combinations. As soon as the tab of S9, front segment, clears clip 7, clip 7 can no longer energize the Autopositioner coil, the "N" wire is grounded by clip 21 and later by clip 17 to give the seeking circuit another multiplier with which to extend the rotation of the tuning elements.

7-58. 50-KC SELECTION. Refer to figures 7-8 and 8-4. The receiver switches are set to 108.00 mc and the control unit switches are set to 108.00 mc; therefore, there is no ground connection made to the 50-kc Autopositioner coil by seeking switch S4 or the remote control selecting switch S3A. Thus the 50-kc Autopositioner is de-energized. The remote control kilocycle selecting switch, S3A, is similar to the megacycle selecting switch, S4A.

7-59. The physical position of the two switches is the same for two positions of the kilocycle dial knob, i.e., for any 100-kc segment, the electrical configuration of the switches is the same for the even 50-kc setting as it is for the odd 50-kc setting. This is also true of the seeking switch, S4, in the receiver. To make the 50-kc Autopositioner choose between even or odd 50-kc positions, a section is added to the 50-kc seeking switch (S4, front segment) that operates in conjunction with switch section S3A (rear outside) in the 614U-3A to place a ground on the

MEGACYCLE POSITION	S9				S6		S9
	A	B	C	D	J	M	N
108	X	O	X	O		X	X
109	X	O	X	O	X		X
110	X	X	O	X		X	X
111	X	X	O	X	X		X
112	X	X	X	O		X	X
113	X	X	X	O	X		X
114	O	X	X	X		X	X
115	O	X	X	X	X		X
116	O	O	X	X		X	X
117	O	O	X	X	X		X
118	X	O	O	X		X	X
119	X	O	O	X	X		X
120	O	X	O	O		X	X
121	O	X	O	O	X		X
122	O	O	X	O		X	X
123	O	O	X	O	X		X
124	O	O	O	X		X	X
125	O	O	O	X	X		X
126	X	O	O	O		X	X
127	X	O	O	O	X		X
128	X	X	O	O		X	X
129	X	X	O	O	X		X
130	O	X	X	O		X	X
131	O	X	X	O	X		X
132	X	O	X	X		X	X
133	X	O	X	X	X		X
134	O	X	O	X		X	X
135	O	X	O	X	X		X
136	X	O	X	O		X	O
137	X	O	X	O	X		O
138	X	X	O	X		X	O
139	X	X	O	X	X		O
140	O	X	X	O		X	O
141	O	X	X	O	X		O
142	O	O	X	X		X	O
143	O	O	X	X	X		O
144	X	O	O	X		X	O
145	X	O	O	X	X		O
146	X	X	O	O		X	O
147	X	X	O	O	X		O
148	X	X	X	O		X	O
149	X	X	X	O	X		O
150	O	X	X	X		X	O
151	O	X	X	X	X		O

THE WIRES OF THE 2-MC SWITCHES ARE GROUNDED OR CONNECTED AS SHOWN ABOVE WHEN THE INDICATED POSITIONS ARE SELECTED. AN X INDICATES THAT A WIRE IS CONNECTED TO GROUND. AN O INDICATES WIRES CONNECTED TOGETHER AND NOT GROUNDED.

THIS TABLE APPLIES TO THE REMOTE SELECTOR SWITCHES ONLY. AT THE RECEIVER, AN O INDICATES WIRES CONNECTED TOGETHER THAT GO TO THE 2-MC AP RELAY. ALSO, THE CODE OF THE J AND M WIRES IS INTERCHANGED TO INDICATE GROUNDING OF THE J WIRES AT EVEN-NUMBERED MC AND GROUNDING OF THE M WIRES AT ODD-NUMBERED MC.

Figure 7-9. 2-mc Seeking Switch Wire Table

50 KILOCYCLE POSITION	S4					
	E	F	G	H	K	L
00	X	O	O	O		X
05	X	O	O	O	X	
10	O	X	O	O		X
15	O	X	O	O	X	
20	X	O	X	O		X
25	X	O	X	O	X	
30	O	X	O	X		X
35	O	X	O	X	X	
40	O	O	X	O		X
45	O	O	X	O	X	
50	X	O	O	X		X
55	X	O	O	X	X	
60	X	X	O	O		X
65	X	X	O	O	X	
70	O	X	X	O		X
75	O	X	X	O	X	
80	O	O	X	X		X
85	O	O	X	X	X	
90	O	O	O	X		X
95	O	O	O	X	X	

THE WIRES OF THE 50-KC SWITCHES ARE GROUNDED OR CONNECTED AS SHOWN WHEN THE INDICATED POSITIONS ARE SELECTED. AN X INDICATES THAT THE WIRE IS CONNECTED TO GROUND. AN O INDICATES WIRES CONNECTED TOGETHER AND NOT GROUNDED.

THIS TABLE APPLIES TO THE REMOTE SELECTOR SWITCHES ONLY. AT THE RECEIVER, AN O INDICATES WIRES CONNECTED TOGETHER THAT GO TO THE .05-KC AP RELAY. ALSO, THE CODE OF THE K AND L WIRES IS INTERCHANGED TO INDICATE GROUNDING OF THE K WIRE AT EVEN-NUMBERED .05 KC AND GROUNDING OF THE L WIRE AT ODD-NUMBERED .05 KC.

Figure 7-10. 50-kc Seeking Switch Wire Table

Autopositioner long enough to permit it to rotate to the desired 50-kc position. If the action is from a low frequency to a higher frequency, the Autopositioner merely moves to the new channel. If the action is from a high frequency to a lower frequency, the Autopositioner moves the switches through the remaining high-frequency positions and through the necessary low-frequency positions required to arrived at the correct channel. This is necessary because the motor is non-reversing. Figure 7-10 shows the wires and switching involved in the 50-kc seeking system.

7-60. Assume that the system is set up on 118.00 megacycles. The tuning capacitor is positioned to tune 118.00 megacycles, the high-frequency crystal selector switch has selected the crystal that produces a 107.975-mc heterodyning signal, the variable i-f is tuned to 10.025 megacycles, and the low-frequency oscillator switch, S1, has selected the 10.525-mc crystal. High side injection is used, and a fixed i-f frequency is produced. Now if the megacycle selector knob on the 614U-3A is turned to the 119.00-mc position, the following will happen: the megacycle selector switch, S4, does not move as was explained above, seeking switch S9 does not move because it is still symmetrical with S4, and the high frequency oscillator retains the same crystal. Switch S2, however, has advanced one position, and has placed a ground on control wire "J." This ground is connected to the 50-kc Autopositioner coil through clips 19 and 2 of S6 (rear segment). The 50-kc Autopositioner will cycle the seeking switches through a complete revolution then find its open circuit and stop. The odd-even megacycle selector switch, S6, has advanced to where the J wire is open and the M wire is closed at switch S6 but is open at switch S2 rear section. In completing this one complete revolution the low-frequency oscillator crystal selector switch has made one complete revolution and has selected the same crystal, but the variation i-f cam has been operated to the position where the variable i-f is tuned to 11.025 megacycles. Under these conditions, low side injection can be employed using the same crystal that was used for 118.00 megacycles. Rotation of the 50-kc shaft operates the cam that drives the 50-kc input to the differential so that the tuning capacitor is advanced to the correct position for 119.00 megacycles.

7-61. Assume that the system is set up on 119.00 megacycles, and it is desired to tune to 119.05 megacycles. The 50-kc dial on the 614U-3A is positioned to 05 which causes the 50-kc selector switch to advance one position. The 50-kc selector switch, S3A (front and rear inside wafers), is constructed to present the same electrical information on the even and 50-kc positions in any 100-kc segment. Thus the receiver seeking switches would not cause the Autopositioner to function. Switch S3B (rear outside wafer), however, grounds control wire "K" which causes the Autopositioner coil to energize through clips 1 and 20 of S4, front segment. The 50-kc autopositioner would then turn the seeking switches until the "K" wire is broken at S4. This movement is sufficient to rotate the low-frequency oscillator crystal selector switch, S1, to the next crystal at 10.575. The variable i-f cam is advanced to a position equal to 50-kc, and the tuning capacitor is advanced to a position equal to 50-kc by the differential.

7-62. TROUBLE ANALYSIS, VHF NAVIGATION AND COMMUNICATIONS RECEIVER 51X-2B.

CAUTION

The Autopositioner motor and relays A1K1 and A1K2 have a continuous duty cycle of 4 seconds on, 26 seconds off. The cyclic duty cycle, as would occur if the 51X-2B were channeled to different frequencies in rapid succession, is much longer.

7-63. GENERAL. The procedures outlined in the following paragraphs are intended for use after the check-out or analysis of Section VI has been com-

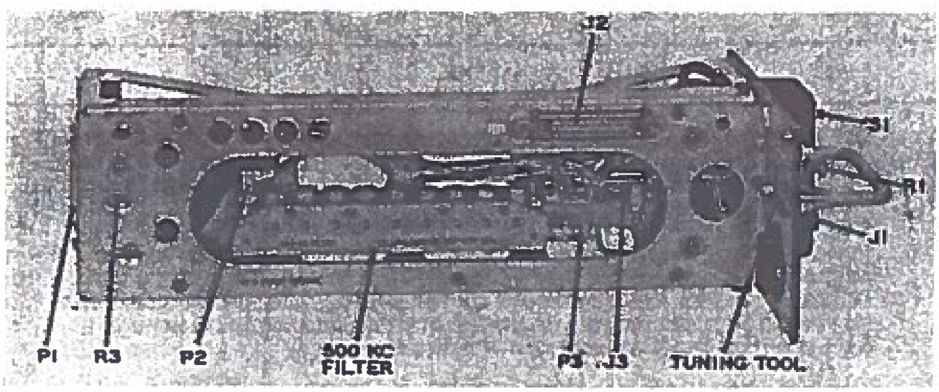


Figure 7-11. VHF Navigation and Communications Receiver 51X-2B, Main Frame, Top View

pleted. The equipment makes use of a frequency control unit, which can be Radio Set Control 614U-3A, and test cables for electrically connecting modules that must be removed to facilitate maintenance. Location of controls is shown in figures 1-4 and 1-6. Location of test points and adjustable controls is shown in figures 7-11 through 7-31.

7-64. AUTOPOSITIONER TROUBLE SHOOTING PROCEDURE. Figure 7-32 is a trouble shooting chart for the Autopositioner. When the procedure calls for adjusting Autopositioner contacts A1K1 and A1K2, use a tool or pliers with smooth jaws. Adjust in the middle at the straight contact arms.

7-65. ELECTRONIC CIRCUITS TROUBLE SHOOTING PROCEDURE. Figure 7-33 is a trouble shooting chart for the electronic circuits. If the procedures in figure 7-33 do not clearly indicate the part that is causing trouble, make voltage and resistance measurements in accordance with figures 7-34, 7-35, and 7-36.

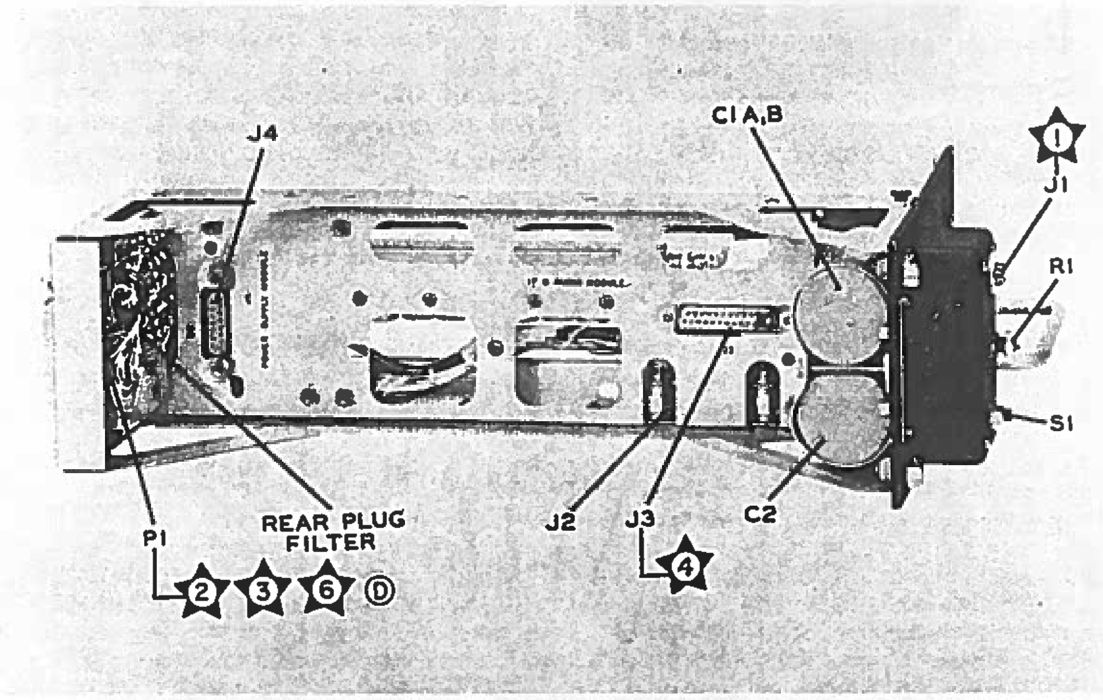


Figure 7-12. VHF Navigation and Communications Receiver 51X-2B, Main Frame, Bottom View

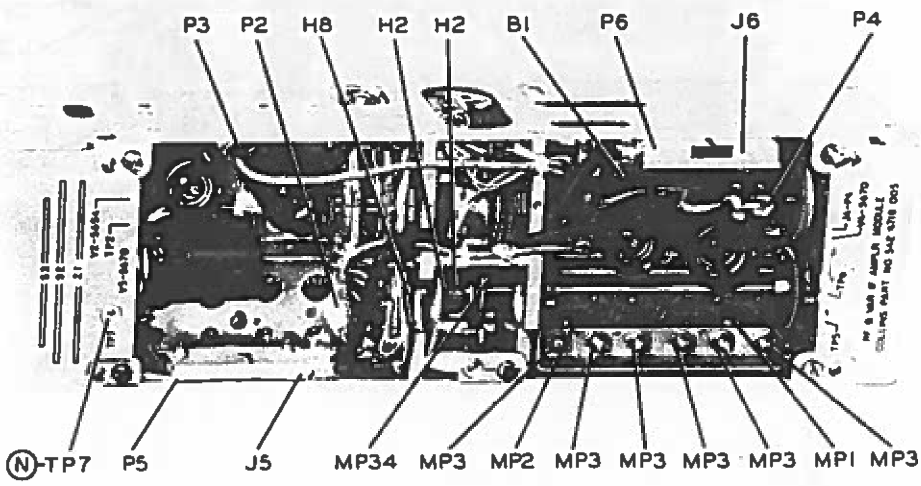


Figure 7-13. VHF Navigation and Communications Receiver 51X-2B R-F and Variable I-F Module A1, Top View

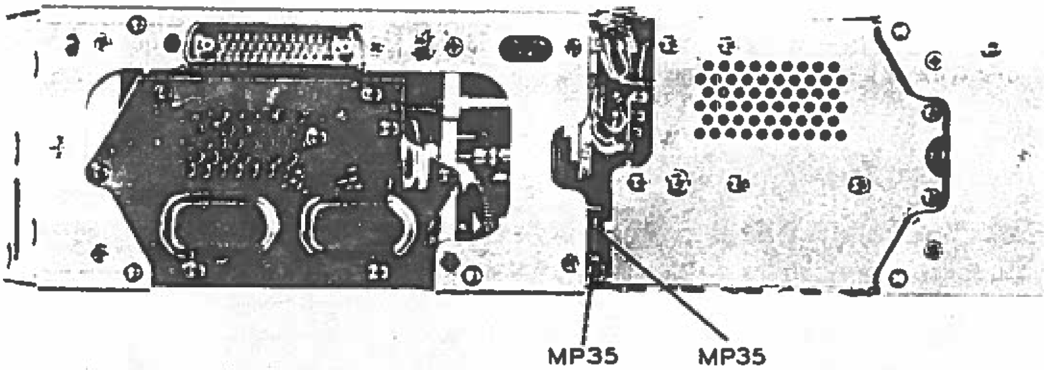


Figure 7-14. VHF Navigation and Communications Receiver 51X-2B, R-F and Variable I-F Module A1, Bottom View

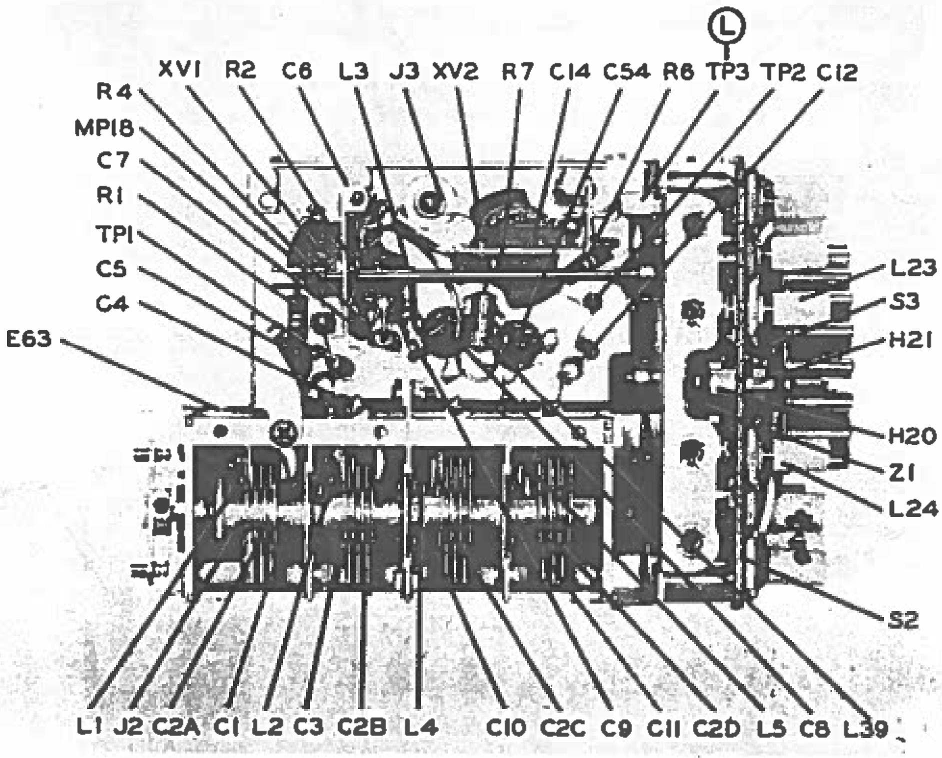


Figure 7-15. VHF Navigation and Communications Receiver 51X-2B, R-F Module, Top View

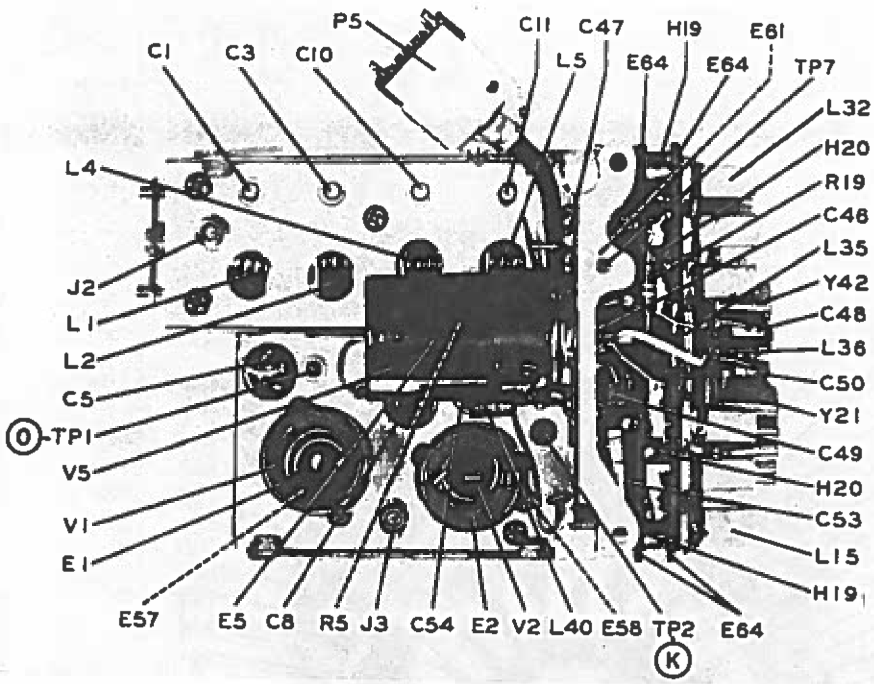


Figure 7-16. VHF Navigation and Communications Receiver 51X-2B, R-F Module, Side View

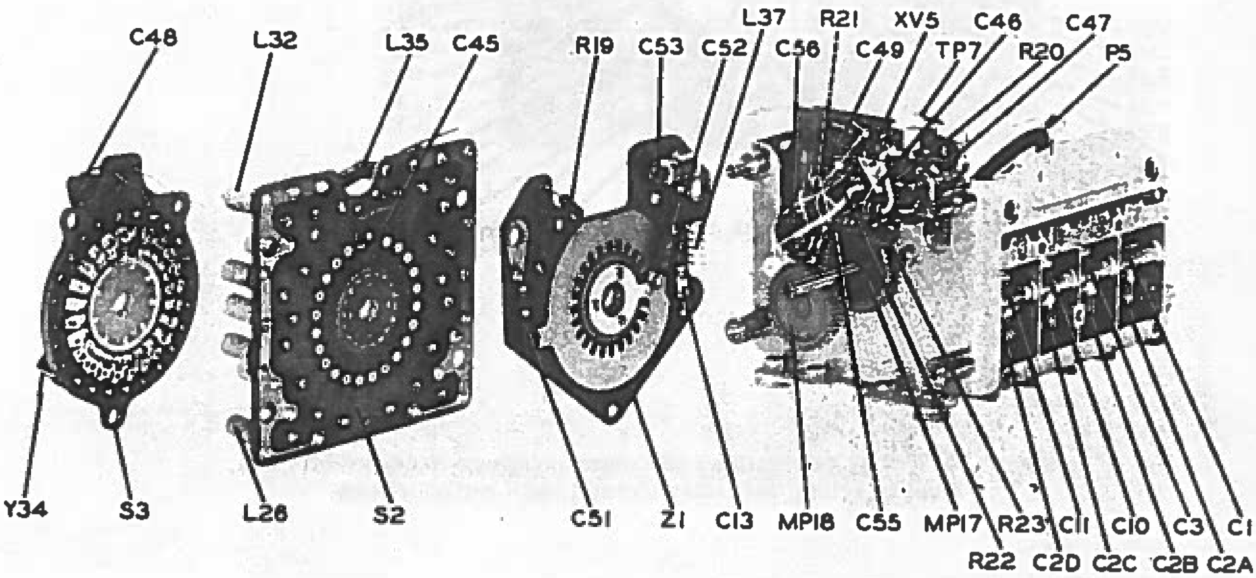


Figure 7-17. VHF Navigation and Communications Receiver 51X-2B, R-F Module, Partially Exploded View

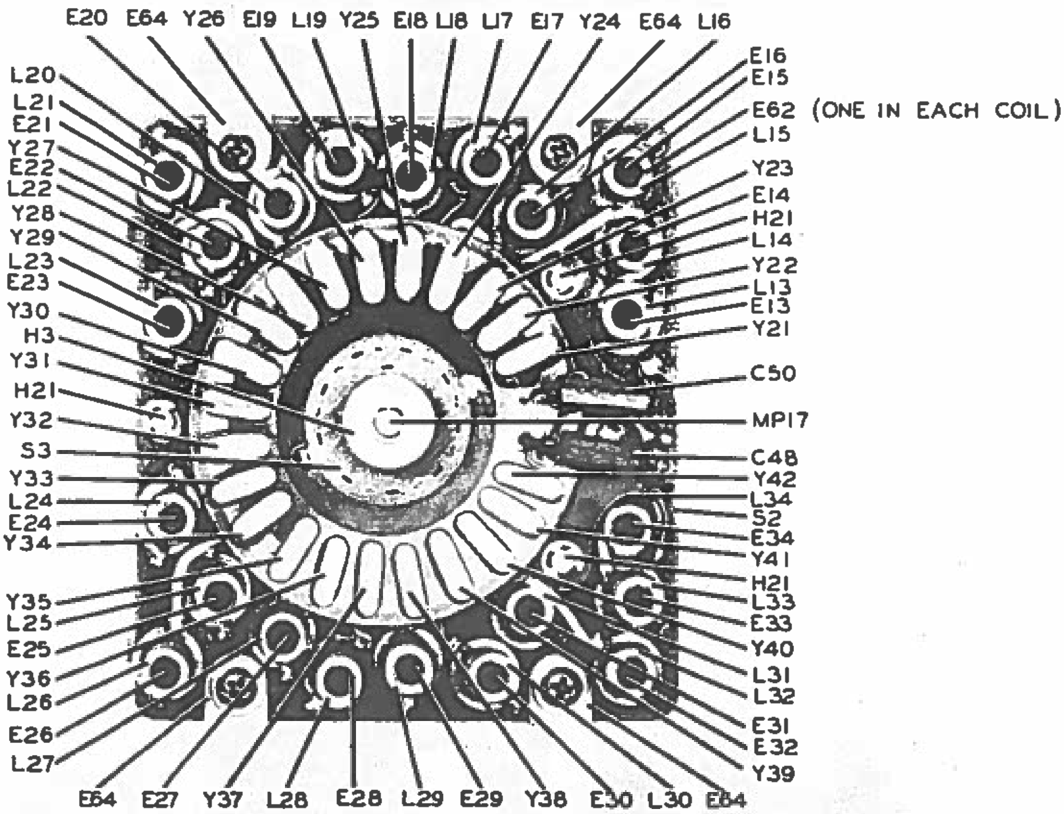


Figure 7-18. VHF Navigation and Communications Receiver 51X-2B, First Injection Oscillator Crystal and Coil Locations

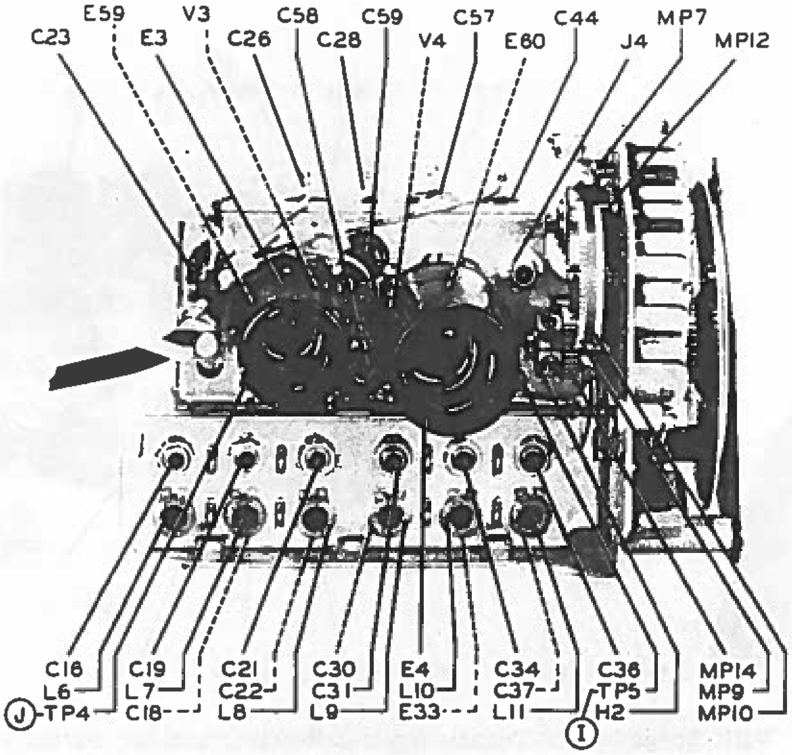


Figure 7-19. VHF Navigation and Communications Receiver 51X-2B, Variable I-F Module, Top View

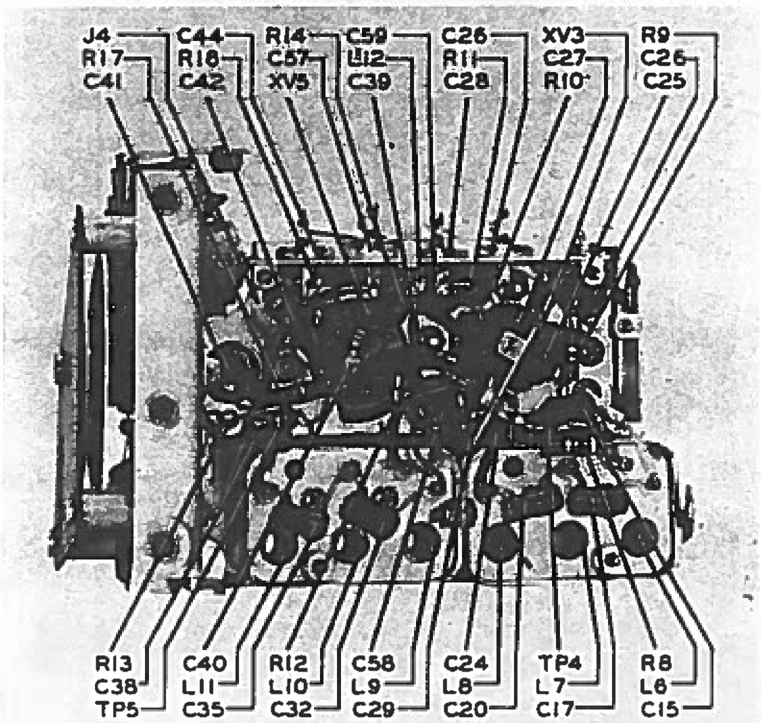


Figure 7-20. VHF Navigation and Communications Receiver 51X-2B, Variable I-F Module, Bottom View

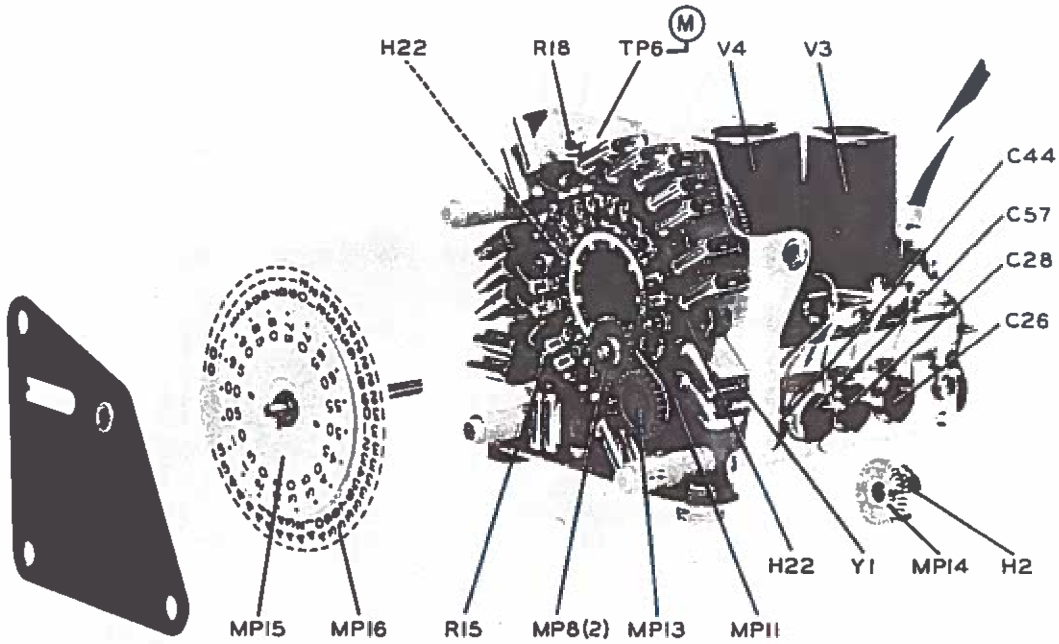


Figure 7-21. VHF Navigation and Communications Receiver 51X-2B, Partially Exploded View

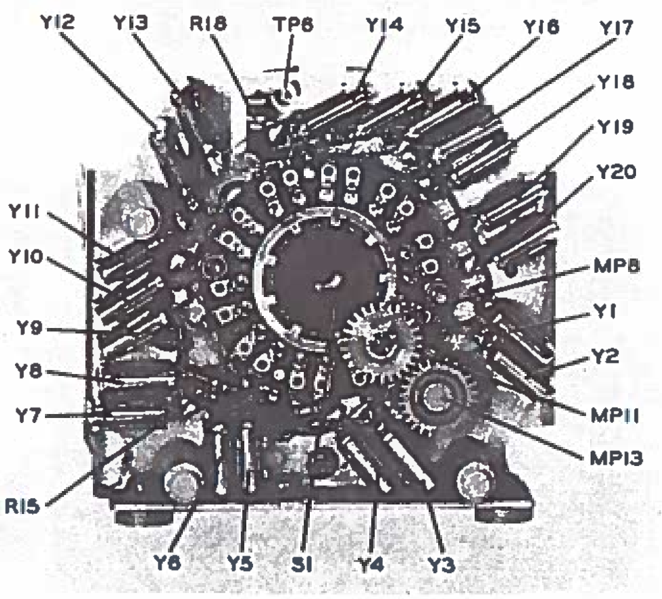


Figure 7-22. VHF Navigation and Communications Receiver 51X-2B, Second Injection Oscillator Crystal Locations

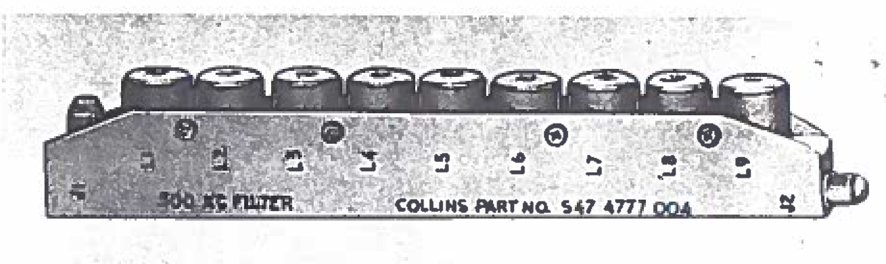


Figure 7-23. VHF Navigation and Communications Receiver 51X-2B, 500-kc Filter A5, Side View

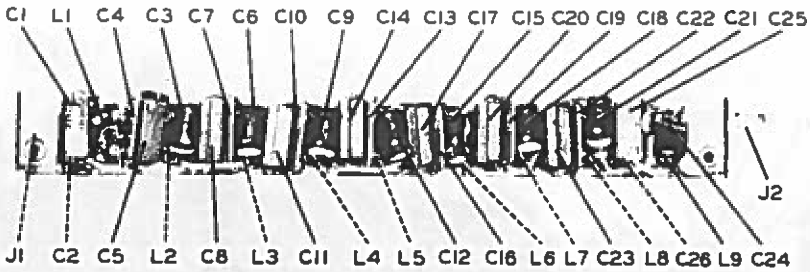


Figure 7-24. VHF Navigation and Communications Receiver 51X-2B, 500-kc Filter A5, Bottom View

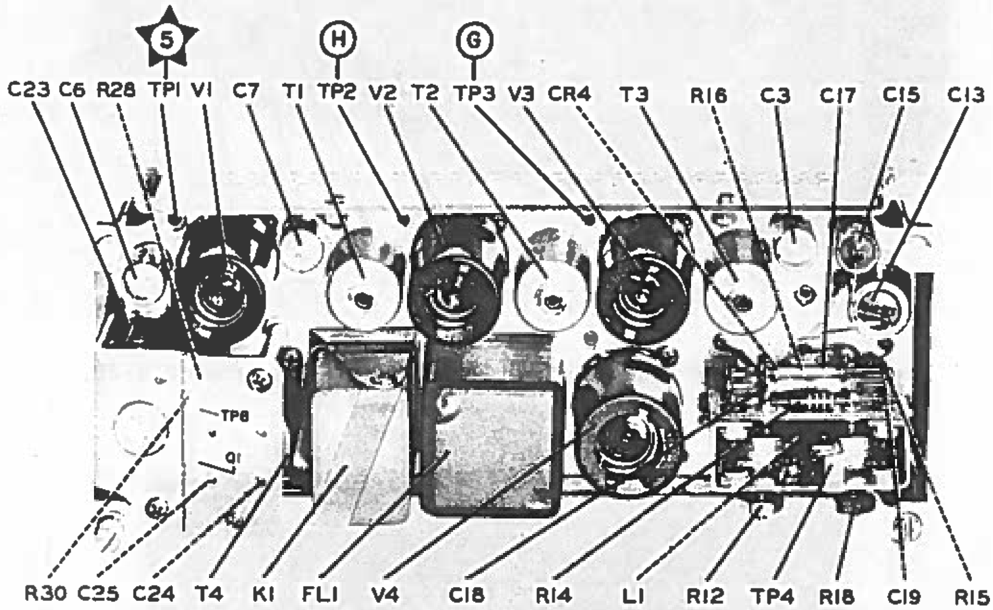


Figure 7-25. VHF Navigation and Communications Receiver 51X-2B, I-F and Audio Module A2, Top View

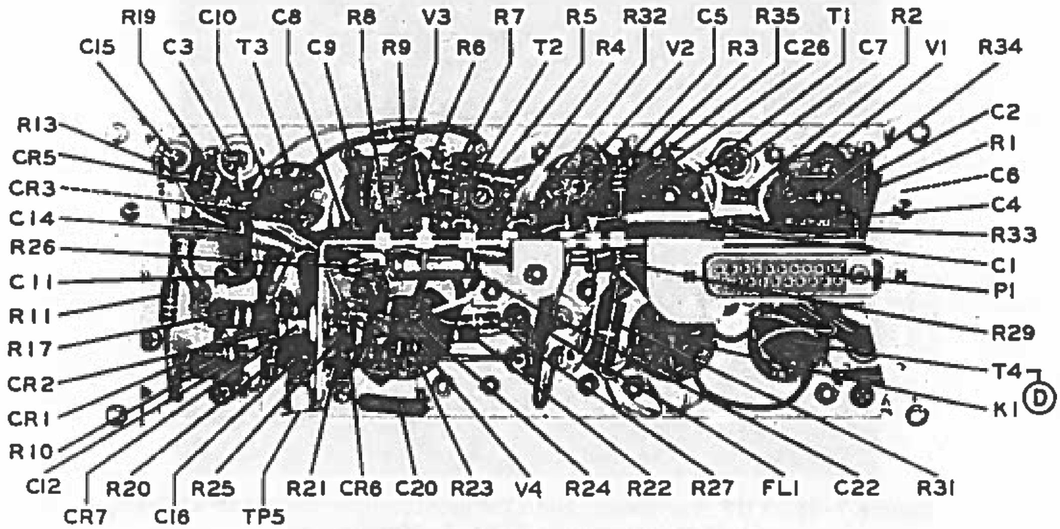


Figure 7-26. VHF Navigation and Communications Receiver 51X-2B, I-F and Audio Module A2, Bottom View

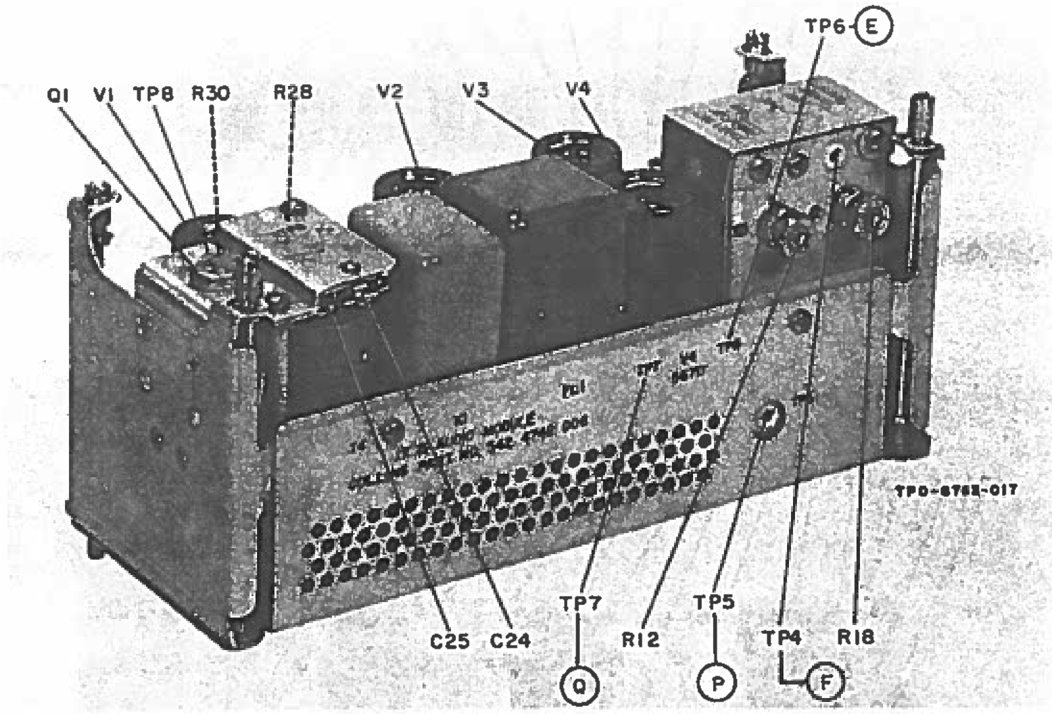


Figure 7-27. VHF Navigation and Communications Receiver 51X-2B, I-F and Audio Module A2, Side View

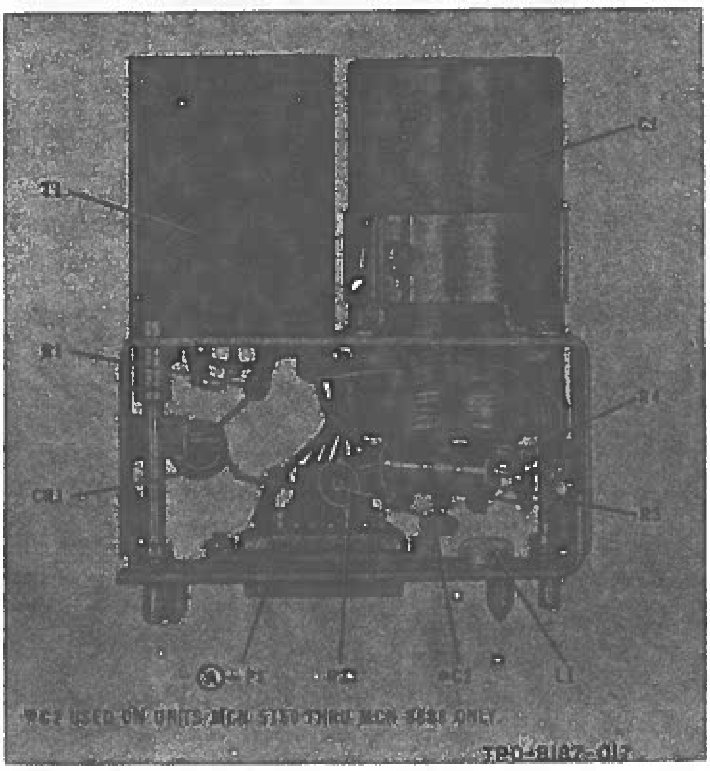


Figure 7-28. VHF Navigation and Communications Receiver 51X-2B, A-C Power Supply 516A-1, Module A4

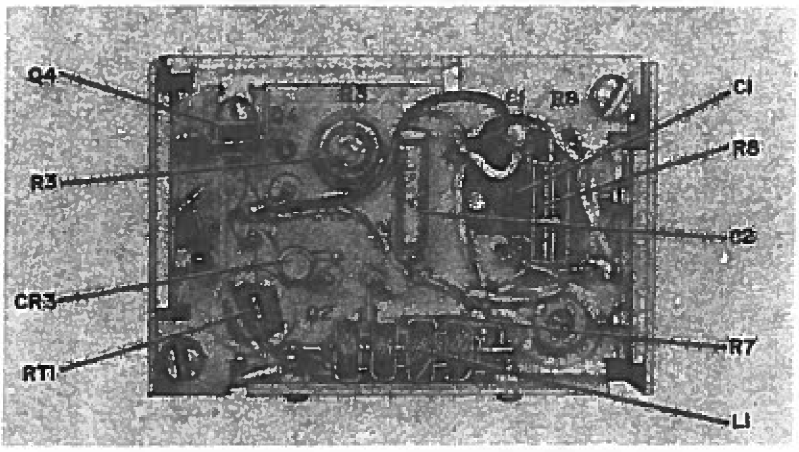


Figure 7-29. VHF Navigation and Communications Receiver 51X-2B, D-C Power Supply 516B-3, Module A3, Top View

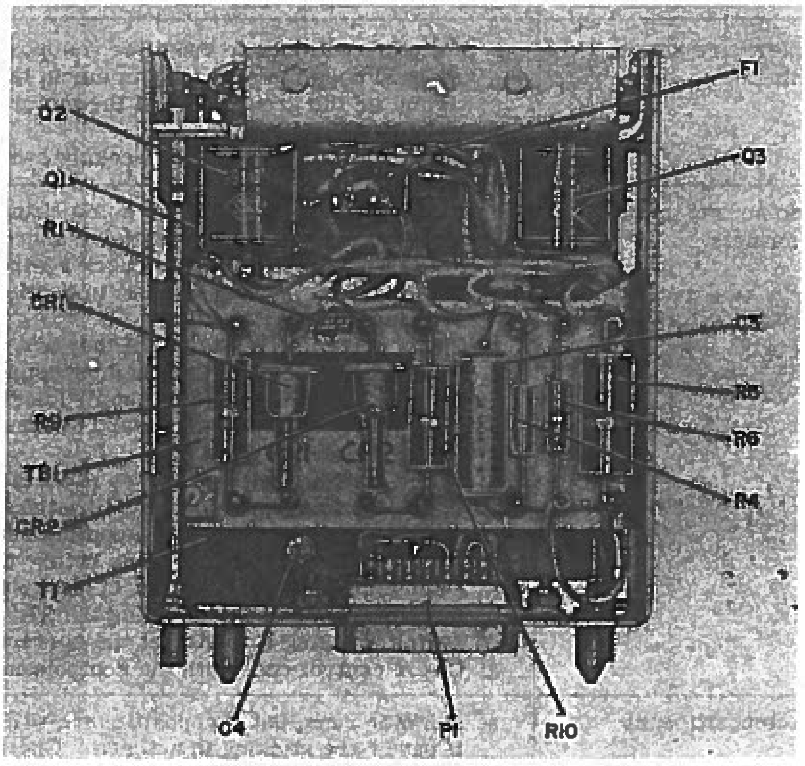


Figure 7-30. VHF Navigation and Communications Receiver 51X-2B, D-C Power Supply 516B-3, Module A3, Side View

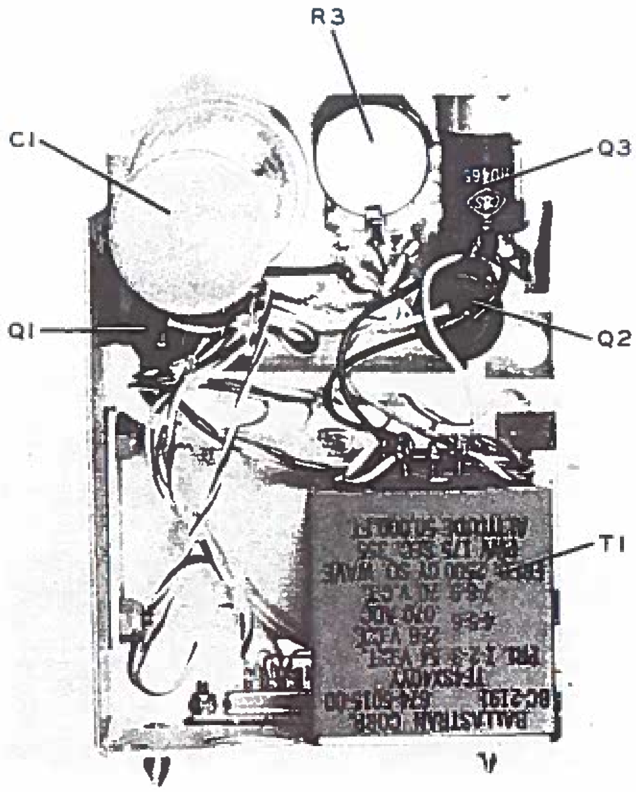


Figure 7-31. VHF Navigation and Communications Receiver 51X-2B, D-C Power Supply 516B-3, Module A3, Side View with Cover Removed

MALFUNCTION	PROBABLE CAUSES
1. After Autopositioners are set up, motor keeps running.	a. If motor continues to run after Autopositioners are set up, pawl does not seat fully in notch, there is a short circuit on the ground side of the motor, or contacts 3 and 4 have not opened. b. Check for bent contacts on seeking switches.
2. Autopositioners do not set up properly on all channels.	a. If Autopositioners set up on some channels but not on others, check control wires for a short to ground. Note channels affected and check control code on frequency control unit schematic in Section VII to locate wire involved. b. Check control wires to see if they are shorted together. c. From frequency control unit schematic, determine if two wires normally are to supply identical information on properly set up channels and different information on channels giving trouble. d. Check seeking switches to see if contacts are bent. e. Check for improperly adjusted switch, which may have been rotated too far on its mounting screws so that some contacts are being made before they should. f. Determine correct position of seeking switch for a defective channel by controlling the 27.5 volt supply to the switch, causing it to stop at the correct position. g. Check control code with the contacts in this position.
3. Motor runs but Autopositioners do not move.	a. If motor runs, but Autopositioners will not turn, check if pawls are sticking in notches. Check for obstruction in lifting path of pawl.

Figure 7-32. Autopositioner Trouble Shooting Chart (Sheet 1 of 2)

MALFUNCTION	PROBABLE CAUSES
3. (Cont)	b. If there is insufficient clutch torque, check torque setting. Check for slippage, glazed or contaminated clutch face, or broken or worn clutch cup spring.
4. Motor does not run when Autopositioner relay closes.	a. If Autopositioner relay closes but motor does not run, check for a bent relay contact and adjust contact spacing. b. Check for broken ground wire on motor or relay. c. Check wiring path from motor through relay. d. Check for power to the motor. If there is power, check brushes, magnets and armature to see if motor is defective. e. Check if gear train is jammed by manually turning gear train.
5. Autopositioners do not stop at proper point.	a. If Autopositioners do not stop at proper point but continue to run, check to see if pawl is entering or holding in notch wheel. b. Look for bent or broken pawl tip, rounded or chipped notch shoulder, or pawl travel out of adjustment. c. Seeking switch out of synchronization with marginal operation. Reposition seeking switch slightly. Intermittent short or open in seeking switch wires.

Figure 7-32. Autopositioner Trouble Shooting Chart (Sheet 2 of 2)

STEP	TEST POINT	TEST EQUIPMENT	CONTROL SETTINGS AND INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
1.	(1) J1	Headset HS-33A	Set up receiver for normal reception.	Normal signal at headset.		If receiver is dead, proceed to step 2. If tubes light but there is no audio, proceed to step 3. If audio is poor or distorted, proceed to alignment procedure paragraph 7-78.
2.	(2) P1, pin 2 or P1, pin 28	51X-2B Module Cable Power Cable Multimeter TS-505A/U	Set up receiver for normal reception.	Power supply voltage 27.5V dc at pin 2 or 115V 300-1500 cps ac at pin 28 and 27.5V dc at pin 2.	Check continuity of power supply leads at (A) or (B). Check connectors. Check power supply. Check filament string continuity.	Check power switch and switch leads.
3.	(C) P1, pin 18	51X-2B Module Cable IF and Audio Multimeter TS-505A/U	Set up receiver for normal reception.	Open circuit between (C) and ground	Check headphones, K1, 5, 12, continuity. Check tubes and Q1. Check continuity from (J1) to (J4, 3 & 4) (P1, 4, 5) to (J1). If some filaments are not lit, check filament continuity. If OK, proceed to step 4.	If K1 is defective, replace. Check for presence of 27.5V dc at P1, pin 23. Check Autopositioner.

Figure 7-33. Electronic Circuits Trouble Shooting Chart (Sheet 1 of 4)

STEP	TEST POINT	TEST EQUIPMENT	CONTROL SETTINGS AND INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
4.	(4) J3, pin 6	51X-2B Module Cable Power Cable 51X-2B Module Cable IF and Audio Multimeter TS-505A/U	Set up receiver for normal reception.	135 v dc	Check continuity of (J4, 1) B+ lead. Check module connectors. If OK, proceed to step 5.	Check R1. Check power supply. Recheck P1, pin 2, or 28 for source power.
5.	(D) T4, pin 1	51X-2B Module Cable IF and Audio Oscillator TS-382F/U	Connect TS-382F/U to headphones and adjust output level for normal audio level. Connect TS-382F/U to T4, pin 1. Turn 51X-2B on.	Audio signal in headset.	Proceed to step 6.	Check T4. Repeat step 3.
6.	(E) A2TP6	51X-2B Module Cable IF and Audio Oscillator TS-382F/U	Connect TS-382F/U to (E). Turn 51X-2B on.	Audio signal in headset.	Proceed to step 7.	Check A2U4, Q1 TV5, Audio output stage, Audio amplifier stage, Squelch circuit.
7.	(F) A2TP4	RF Signal generator AN/URM-25F set at 500 kc, 30% modulated. Adjust AN/URM-25F output for normal audio level. 51X-2B Module Cable IF and Audio	Connect AN/URM-25F to (F). Receiver on.	Audio signal in headset.	Proceed to step 8.	Check K1. Check C17, C21, R18, CR4. Check rest of detector output circuit.
8.	(G) A2TP3	RF Signal generator AN/URM-25F set at 500 kc, 30% modulated. Adjust AN/URM-25F output for normal audio level. 51X-2B Module Cable IF and Audio	Connect AN/URM-25F to TP3. Receiver on.	Audio signal in headset.	Proceed to step 9.	Check A2V3, C11, CR3, T3, R6, R8. Check rest of A2V3 amplifier.
9.	(H) A2TP2	RF Signal generator AN/URM-25F set at 500 kc, 30% modulated. Adjust AN/URM-25F output for normal audio level. 51X-2B Module Cable IF and Audio	Connect AN/URM-25F to TP2.	Audio signal in headset.	Proceed to step 10.	Check A2V2, T2, R4. Check rest of A2V2 amplifier.

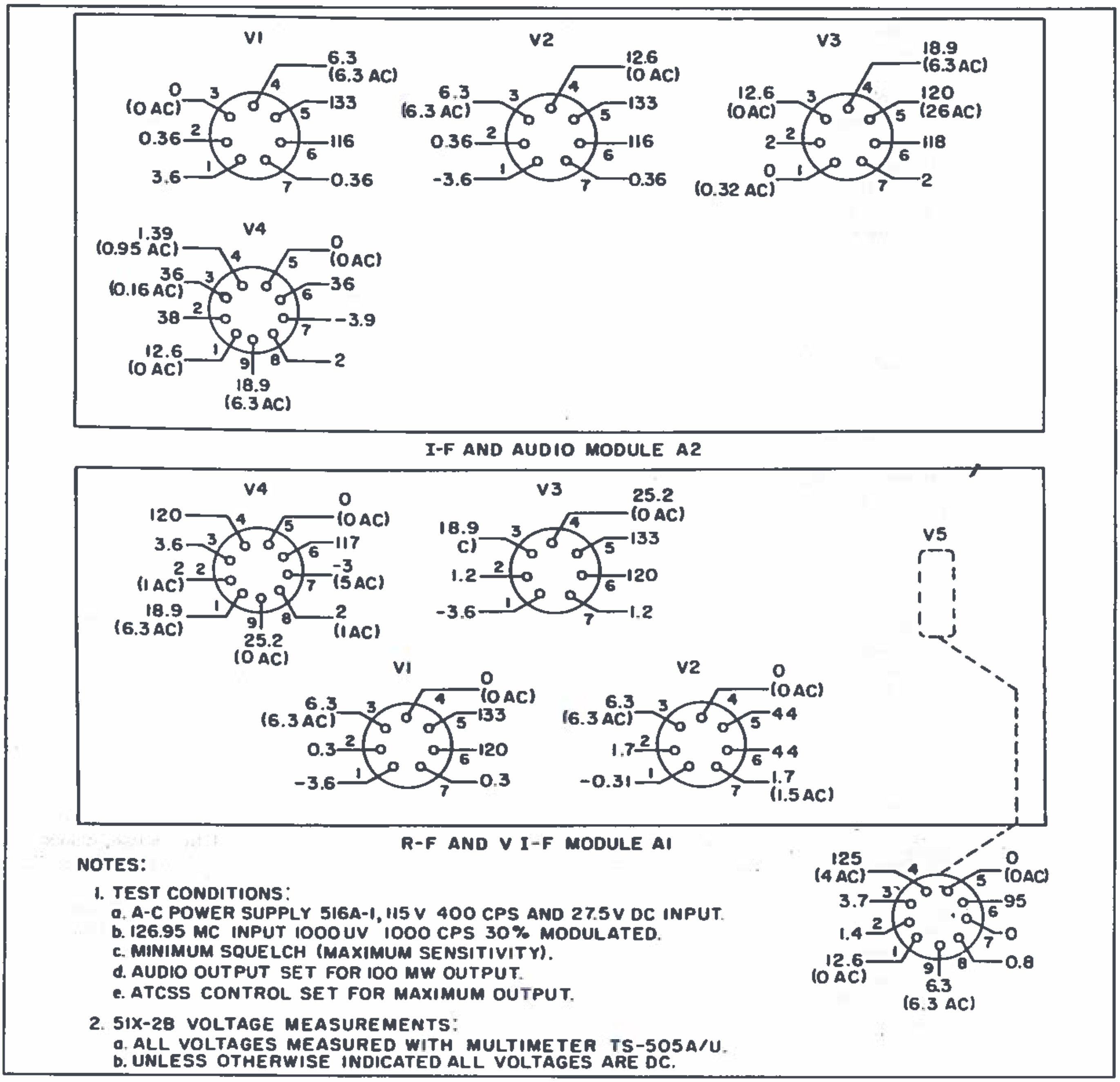
Figure 7-33. Electronic Circuits Trouble Shooting Chart (Sheet 2 of 4)

STEP	TEST POINT	TEST EQUIPMENT	CONTROL SETTINGS AND INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
10.	(5) A2TP1	RF Signal generator AN/URM-25F set at 500 kc, 30% modulated. Adjust AN/URM-25F output for normal audio level. 51X-2B Module Cable IF and Audio	Connect AN/URM-25F 51X-2B on.	Audio signal in headset.	Proceed to step 11.	Check A2V1, R33, R34, R33, R2. Check rest of A2V1 amplifier.
11.	(I) A1TP5	RF Signal generator AN/URM-25F 30% modulated. Set AN/URM-25F for correct 1st IF frequency indicated in frequency table figure 4-3. 51X-2B Module Cable RF and VIF	Connect AN/URM-25F to (I).	Audio Signal in headset.	Proceed to step 12.	Check A1V4, C42, R13, crystal being used, switch S1, ground connection on crystal holder. Substitute a good A5 filter module. Check rest of A1V4 circuit. Check J4, P4.
12.	(J) A1TP4	RF Signal generator AN/URM-25F 30% modulated. Set AN/URM-25F for correct 1st IF frequency indicated in frequency table figure 4-3. 51X-2B Module Cable RF and VIF.	Connect AN/URM-25F to (J).	Audio signal in headset.	Proceed to step 13.	Check A1V3, C32, C35, C38, P6, J6, R9, C23, R11, C28. Check rest of A1V3 circuit.
13.	(K) A1TP2	RF Signal generator AN/URM-25F 30% modulated. Same frequency as tuned by 51X-2B	Connect AN/URM-25F to (K).	Audio signal in headset.	Proceed to step 14.	Check A1V2, J3, P3, C17, C20, C24, C14, R6, R7. Check A1V2 plate circuit. Proceed to step 14.
14.	(L) A1TP3	RF Signal generator AN/URM-25F 30% modulated. Same frequency as tuned by 51X-2B Module Cable RF and VIF Multimeter TS-505A/U a-c scale 0-5 volts	Connect AN/URM-25F to (L). Connect probe of TS-505A/U to TP3, A1	1.5 volts ac	Proceed to step 15.	Check A1V5, C13, C49. Check crystal in use, check crystal switch, S3, check indicator switch S2 and associated inductors. Check rest of oscillator circuit.

Figure 7-33. Electronic Circuits Trouble Shooting Chart (Sheet 3 of 4)

STEP	TEST POINT	TEST EQUIPMENT	CONTROL SETTINGS AND INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
15.	(O) A1TP1	RF Signal generator AN/URM-25F 30% modulated. Same frequency as tuned by 51X-2B. 51X-2B Module Cable RF and VIF.	Connect AN/URM-25F to (6)	Audio signal in headset.	Proceed to Autopositioner Trouble Shooting Table figure 7-32 Check L1, L2, J1, J2. Check antenna.	Check A1V1, C19, L4, L5, R4, C7, P5, J5. Check AGC line. Check rest of r-f circuit.

Figure 7-33. Electronic Circuits Trouble Shooting Chart (Sheet 4 of 4)



NOTES:

1. TEST CONDITIONS:
   a. A-C POWER SUPPLY 516A-1, 115 V 400 CPS AND 27.5 V DC INPUT.
   b. 126.95 MC INPUT 1000 UV 1000 CPS 30% MODULATED.
   c. MINIMUM SQUELCH (MAXIMUM SENSITIVITY).
   d. AUDIO OUTPUT SET FOR 100 MW OUTPUT.
   e. ATCSS CONTROL SET FOR MAXIMUM OUTPUT.
2. 51X-2B VOLTAGE MEASUREMENTS:
   a. ALL VOLTAGES MEASURED WITH MULTIMETER TS-505A/U.
   b. UNLESS OTHERWISE INDICATED ALL VOLTAGES ARE DC.

Figure 7-34. Tube Socket Voltage Measurements

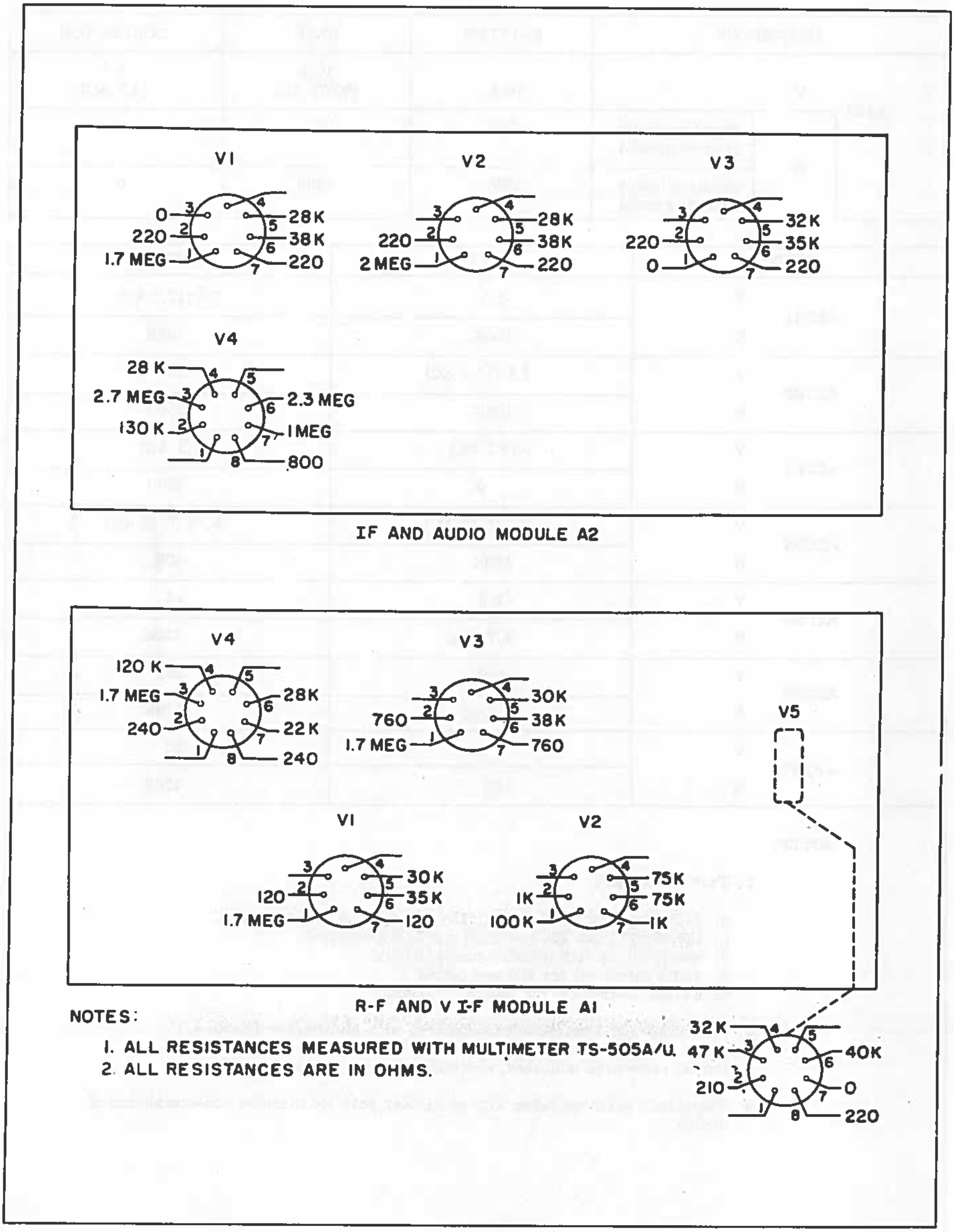


Figure 7-35. Tube Socket Resistance Measurements

TRANSISTOR			EMITTER	BASE	COLLECTOR
A2Q1	V		10.6	10.4 (0.075 AC)	1.3 (5.5 AC)
	R	Negative meter lead on ground	1700	30	0
		Positive meter lead on ground	2600	2600	0

DIODE		ANODE	CATHODE
A2CR1	V	-5.7	3.8 (12.5 AC)
	R	100K	105K
A2CR2	V	3.8 (12.5 AC)	16
	R	105K	3300
A2CR3	V	0 (4.7 AC)	4.5 (1 AC)
	R	0	2500
A2CR4	V	1.3 (0.47 AC)	0.75 (0.48 AC)
	R	150K	40K
A2CR5	V	-3.6	-4
	R	1.7 meg	720K
A2CR6	V	-3.9	35
	R	1 meg	130K
A2CR7	V	2	35
	R	800	130K

NOTES:

1. Test Conditions:

   a. A-C Power Supply 516A-1, 115v 400 cps and 27.5 vdc input.
   b. 126.95 mc input 1000 uv 1000 cps 30% modulated.
   c. Minimum squelch (maximum sensitivity).
   d. Audio output set for 100 mw output.
   e. ATCSS control set for maximum output.

2. All voltages and resistances measured with Multimeter TS-505A/U.

3. Unless otherwise indicated, resistances are in ohms and voltages dc.

4. Resistance readings taken with ohmmeter polarity to cause non-conduction of diodes.

Figure 7-36. Transistor and Diode Voltage and Resistance Measurements

7-66. REMOVAL AND REPLACEMENT PROCEDURES.

7-67. GENERAL. The following procedures cover partial disassembly of VHF Navigation and Communications Receiver 51X-2B for maintenance and adjustment purposes. Disassembly of the frequency selector unit is beyond the scope of this handbook; for instructions refer to the applicable handbook of overhaul instructions. Perform the applicable adjustments and alignments of paragraphs 7-78 through 7-106 before completing reassembly of the 51X-2B.

7-68. REMOVAL OF RECEIVER FROM SHOCKMOUNT AND EXTERIOR CASE.

a. Loosen two hold-down nuts on the front of the shockmount allowing the nuts to be disengaged, and drop the front panel down.
b. Turn the center extractor nut counterclockwise to disengage receiver from rear connector.
c. Lift receiver up and out of shockmount.
d. Loosen locking screw in the center of the rear of the dust cover case.
e. Hold case, and pull receiver out of the case with the front handle.

7-69. REMOVAL OF MODULES. The r-f and variable i-f module on top and the i-f and audio and power supply modules on the bottom of the main chassis may be removed by loosening the captive-type hold-down screws on each module and lifting the modules straight up. Do not twist or pry on the module to disengage mating connectors, or damage to the connectors may result. To remove the 500-kc passive filter module, the other three modules must be removed first, then the two coaxial connectors must be unfastened. Remove four flathead screws, and lift filter out.

7-70. REMOVAL OF MODULE COVERS. To gain access to the components in the r-f and variable i-f section of the r-f and variable i-f module, remove the screws and lock washers of the two covers on the bottom of the module. To gain access to the components in the i-f and audio module, remove the wrap-around cover. See figure 7-27. To gain access to 500-kc filter components, remove wrap-around cover. See figure 7-23.

7-71. REPLACEMENT OF CRYSTALS IN LOW-FREQUENCY OSCILLATOR. This operation may be done with the r-f and variable i-f module removed from the main frame and no further disassembly. Remove four flathead and two Phillips-head screws mounting the end cover (see figure 7-13) enclosing dial and crystal switch. Lift out on the bottom edge of the cover and remove. Remove three Truarc rings securing escutcheon plate to the stand-offs. Remove dials by loosening collar H2 on MP14 (see figure 7-21) and sliding dial out of module. Replace crystals as desired using care not to overheat crystals. Reassemble in reverse order seeing that proper switch position is picked on dial shaft insertion and that proper dial synchronization is maintained.

7-72. REPLACEMENT OF CRYSTALS IN VHF OSCILLATOR. See figure 7-18. Channel the 51X-2B to 108.00 mc. This operation can be done with the module removed from the main frame and with no further disassembly. Remove four flathead and two Phillips-head screws mounting the cover enclosing vhf oscillator. See figure 7-13. Remove cover, top side first, and slide off. Loosen two setscrews on the switch drive collar, and remove drive collar. Remove three Truarc rings on parts supporting the crystal switch. Unsolder the two wires connected to the crystal board. Lift the crystal unit out. Crystals may be replaced as desired using care not to overheat crystals. Check to see that switch clips have not been misaligned in the replacement procedure. Replace the crystal board making sure that its rotor is aligned correctly with the other switches. When the correct alignment is achieved the rotor contact will be visible through the hole by 721. Reassemble in reverse order. If it is desired to complete the crystal complement to obtain use of the frequencies in the range of 135.0 to 151.95 mc, eight crystals must be added. Remove the crystal unit as explained above. Remove the two bus wire hold-downs and add the crystals in the correct order. Trim the ends of the crystal leads as required, and make solder connections equivalent to factory-installed units.

7-73. REMOVAL OF TUNING MOTOR B1. See figure 7-13. Disengage J6 and P6 by removing two mounting screws and cover clamp. Disengage coaxial connector P4. Remove three motor mounting screws on motor mounting flange. Tip motor up and out. The motor terminal cap may have to be removed before motor can be completely lifted out. Replace in reverse order making sure that motor drive gear is not forced into two clutch drive gears in Autopositioner mechanism.

7-74. REMOVAL OF VARIABLE I-F COIL ASSEMBLY. (May be removed from complete module.) See figures 7-13 and 7-14. The coils may be removed in banks of three each as follows: Unsolder all leads connecting to each bank of coils. Remove respective loading spring MP1 or MP2 (see figure 7-13). Remove three coil securing Truarc rings from each bank of coils. Remove three trimmer capacitor mounting nuts and lock washers. Remove screw fastening the banks of coils together to interstage shield. Remove coil bank assembly. Remove two screws, and pull out assembly from shield cam. Reassemble in reverse order.

7-75. REMOVAL OF VHF OSCILLATOR SWITCH ASSEMBLY TO GAIN ACCESS TO OSCILLATOR TUBE SOCKET COMPONENTS. (Can be done in module form.) Remove cover as explained in paragraph 7-70. Remove drive shaft collar as before. Unsolder four wires going from XV5 to the three switchboards. Unsolder the wires from tuner Z1 to the feedthrough capacitor, C47. Unsolder the wire from the tuner Z1 feeding through TP3 (TP3 access hole). Remove four Phillips-head mounting screws and flatwashers. Lift out assembly of three boards, S2, S3, and Z3, making sure not to lose the ground clips, E64. The three switchboards may be further disassembled if required and, if done, should be reassembled with care to keep proper alignment between rotors and doubled "D" drive shaft holes in order to insure proper torque-free assembly. Replace all spacers H24, 19, 21 and grounding clips E64 (see figures 7-15 and 7-18) in same manner as removed, reassemble switch package in reverse order to removal, and resolder wires. Make sure rotors line up at correct alignment point.

7-76. REMOVAL OF R-F SUBASSEMBLY FROM VARIABLE I-F MODULE. See figures 7-13 and 7-15. Remove endplate enclosing vhf oscillator. Remove cover enclosing r-f components. Disengage P5 and J5 by removing the screws and cover clamp. Remove two module mounting screws by slipping off the Truarc rings. Disengage two coaxial connectors. P3 and P2. Remove two loading springs MP35 on coupler driving four-gang capacitor by lifting off one end of each. Remove seven flathead mounting screws securing r-f subassembly to frame. Slide r-f subassembly out of the frame. Reassemble in reverse order, but prior to reassembly, pinch split drive shaft MP18 slightly (figure 7-15) to insure backlash free drive to vhf oscillators, and check rotor alignment of vhf oscillator stack for conformance to frequency indicated by dials, and check four-gang capacitor position to insure that it is the same as when disassembled.

7-77. REMOVAL OF VARIABLE I-F SUBASSEMBLY. See figures 7-13 and 7-14. Remove endplate enclosing i-f oscillator. Disengage J6 and P6 by removing two mounting screws and clamp. Disengage coaxial connector P4. Remove frequency selector cover by removing three mounting screws. Disconnect coaxial connector P3 in r-f subassembly. Remove two module mounting screws by removing Truarc rings, and lift out. Loosen setscrews on 50-kc differential cam collar H2, 50-kc drive shaft gear collar H2, and S6 drive shaft collar H8 (see figure 7-13). Remove bottom cover of variable i-f subunit. Remove six flathead screws securing variable i-f subunit to frame. Remove one Phillips-head screw securing variable i-f subunit to gear plate. Slide the variable i-f subunit out of the frame along with the slug rack drive shaft, MP6. Previous to reassembly, pinch split shaft MP13 slightly (figure 7-22) to insure minimum backlash. Reassemble in reverse fashion, and check for proper end play in 50-kc drive shaft MP6, switch alignment, cam alignment, and dial indication before tightening setscrews in collar. Make sure setscrews do not fall in slots of hubs, the differential cam spring MP34 is in location, and the collar does not limit end play.

7-78. ALIGNMENT.

7-79. GENERAL. Alignment procedures for the electronic circuits of VHF Navigation and Communications Receiver 51X-2B is facilitated with the use of test cables. Refer to Section III for test cable information. A frequency channeling device, which may be Radio Set Control 614U-3A or 614U-6, is also required. Allow a 15 minute warmup period before proceeding with alignment. All alignment procedures and tests shall be conducted under normal ambient conditions. The aircraft power source will determine whether A-C Power Supply 516A-1 or D-C Power Supply 516B-3 is used.

NOTE

In all tests involving the AN/USM-16, a 6-db pad should be connected between generator and load.

7-80. ALIGNMENT OF FIRST CRYSTAL OSCILLATOR.

a. Set the 614U-3A (or 614U-6) to 150 mc (134 mc if not equipped for extended coverage).

b. Connect the TS-505A/U to secondary test point N (A1TP7). Adjust the slug of L34 (marked "150") or L26 (marked "134") for maximum indication on the meter (sharp peak).

c. Channel the 614U-3A (or 614U-6) to each even megacycle and adjust the slug marked with the appropriate channel frequency for maximum d-c voltage at A1TP7.

d. Remove A1P3 from A1J3 and connect the TS-505A/U to secondary test point K (A1TP2). Channel the 614U-3A (or 614U-6) to each even megacycle. The indication of A1TP2 should be at least 1.0 volt d-c for each frequency. A sudden appreciable drop in d-c voltage on a channel may indicate a defective crystal or improper synchronization of the Z1 tuner. Reconnect A1P3 to A1J3.

NOTE

Do not detune the slug so far that the voltage at A1TP2 drops more than 10%.

e. Channel the 614U-3A (or 614U-6) to 116 mc. Adjust C53 for maximum voltage at A1TP2.

f. Channel the 614U-3A (or 614U-6) to 146 mc. Using the insulated tuning tool, adjust L37 for maximum voltage at A1TP2.

g. Repeat steps e and f until no further improvement is obtained. If necessary, touch up the tuning of C53 at 146 mc after completion of the alignment procedure.

h. Loosely couple the output of a frequency rack of an accuracy of better than 0.0025% for frequency check. Channel the 614U-3A (or 614U-6) to each even megacycle and check the frequency of each crystal according to figure 7-37. If a frequency is off more than 1000 cps, slightly readjust the appropriate slug of L17 through L34 to put the frequency within this range.

CHANNEL FREQUENCY	CRYSTAL FREQUENCY (mc)
*108	48.9875
*110	49.9875
*112	50.9875
*114	51.9875
116	52.9875
118	53.9875
120	54.9875
122	55.9875
124	56.9875
126	57.9875
128	58.9875
130	59.9875
132	60.9875
134	61.9875
136	62.9875
138	63.9875
140	64.9875
142	65.9875
144	66.9875
146	67.9875
148	68.9875
150	69.9875

*Not applicable to receivers used in communication service only.

Figure 7-37. Table of Channel Frequency vs First Crystal Oscillator Frequency

7-81. VARIABLE I-F ALIGNMENT.

a. Insert Radio Set Control 614U-3A or 614U-6 into VHF-101 Test Set 476V-1. Connect the 476V-1 to the 51X-2B and to power sources.

CAUTION

Ensure the power circuits to the 51X-2B are appropriate for the power supply in it.

b. Connect the RF and VIF MODULE, A1, to its mating connector in the 51X-2B using the appropriate extension cable.

c. Connect a d-c voltmeter to secondary test point M (A1TP6). Channel the 50-kc Autopositioner and check the output voltage of each crystal in the second oscillator circuit and for approximate frequency with a 51J receiver. The voltmeter should indicate at least -1.0 volt d-c for each crystal.

d. Channel the 51X-2B to the low end of the variable i-f (even +.00 mc). Adjust R-F Signal Generator AN/USM-16 to 10.025 mc and connect it to secondary test point K (A1TP2). Set the output of the AN/USM-16 to obtain a reading at secondary test point P (A2TP5) using Multimeter TS-505A/U. Adjust the slugs of coils L6 through L11 for maximum output of A2TP5.

e. Channel the high end of variable i-f (odd mc +.95 mc). Adjust the AN/USM-16 for 11.975-mc output and tune capacitors C16, C19, C21, C31, and C36 for maximum output at A2TP5.

f. Repeat steps d and e until no further improvement can be made. Always end with step e. If maximum flatness of gain is desired, recheck slug adjustment at 10.975 mc.

7-82. R-F ALIGNMENT.

a. With the RF and VIF Module, A1, still connected to the 51X-2B with the extension cable, channel the 614U-3A (or 614U-6) to 151.95 mc.

b. Supply a 151.95 mc signal from the AN/USM-16 to the RECEIVER INPUT jack on the 476V-1. Connect the TS-505A/U to secondary test point P (A2TP5) on the 500 kc I-F and Audio Module, A2.

c. Adjust C1, C3, C10, and C11 of the RF and VIF Module, A1, for maximum agc voltage as indicated by the meter at A2TP5.

CAUTION

Keep input from the AN/USM-16 at a level that does not allow the agc voltage to exceed 3 volts.

d. Channel the 614U-3A (or 614U-6) to 116.00 mc (108.00 mc for a 51X-2B that is used in VOR operation only) and adjust the AN/USM-16 for 116.00 mc (or 108.00 mc).

e. Using the insulated tool, adjust inductors L1, L2, L4, and L5 of the RF and VIF Module, A1, for maximum agc voltage as indicated by the meter at A2TP5. Adjust L1 at the grounded end of the coil, L2 at the hot end, L4 at the grounded end, and L5 at the hot end. Adjust the coils by spreading or squeezing the turns while maintaining about 1/4 inch spacing between L1 and L2 and about 5/16 inch between L4 and L5.

f. Repeat steps a through e until no further improvement can be made. Always end at 151.95 mc (135.95 mc).

NOTE

The following procedures are for tracking the four-gang tuning capacitor. These procedures are not required, and should not be attempted, unless the tuning capacitor has been damaged or replaced, or extended range crystals have been added.

g. Channel module to 151.95 mc (135.95 mc) and remove the r-f bottom cover. Tune the AN/USM-16 to the 51X-2B frequency and feed a signal into the antenna input. Adjust C1, C3, C10, and C11 for maximum agc voltage as indicated by a TS-505A/U connected at A2TP5.

h. Channel module to 148 mc (133 mc). Using an insulated tool, bend the segment of the outer capacitor plate which has just become fully meshed, on C2 sections A, B, C, and D, for maximum agc.

i. Repeat step h at the following frequencies, in each case adjusting the plate which has just become fully meshed: 148, 144, 138, 127, 122, 116, 111, and 108 mc.

j. Return to 151.95 mc (135.95 mc) and repeat steps b through e.

k. Recheck tracking at each of the specified frequencies in step i, rebending the plates slightly if necessary.

l. Replace r-f bottom cover and repeat steps b through e.

7-83. ALIGNMENT TESTS OF THE R-F AND VARIABLE I-F AMPLIFIER MODULE A1.

The test setup is the same as in paragraph 7-82 except that the r-f and variable i-f module should be mounted in the frame. These tests require that the i-f and audio module and the passive filter module are working satisfactorily. Reference to the stage gain chart, figure 7-38, will aid in making these tests.

7-84. FIRST CRYSTAL OSCILLATOR OUTPUT.

a. Adjust Control Unit 614U-3A (or 614U-6) to each even megacycle and check that the frequency output of the first crystal oscillator is accurate to within ±1000 cps.

b. Disconnect plug P3. The d-c voltage at secondary test point K (A1TP2) should be not less than 1 volt for each frequency obtained as in step a. Reconnect plug P3.

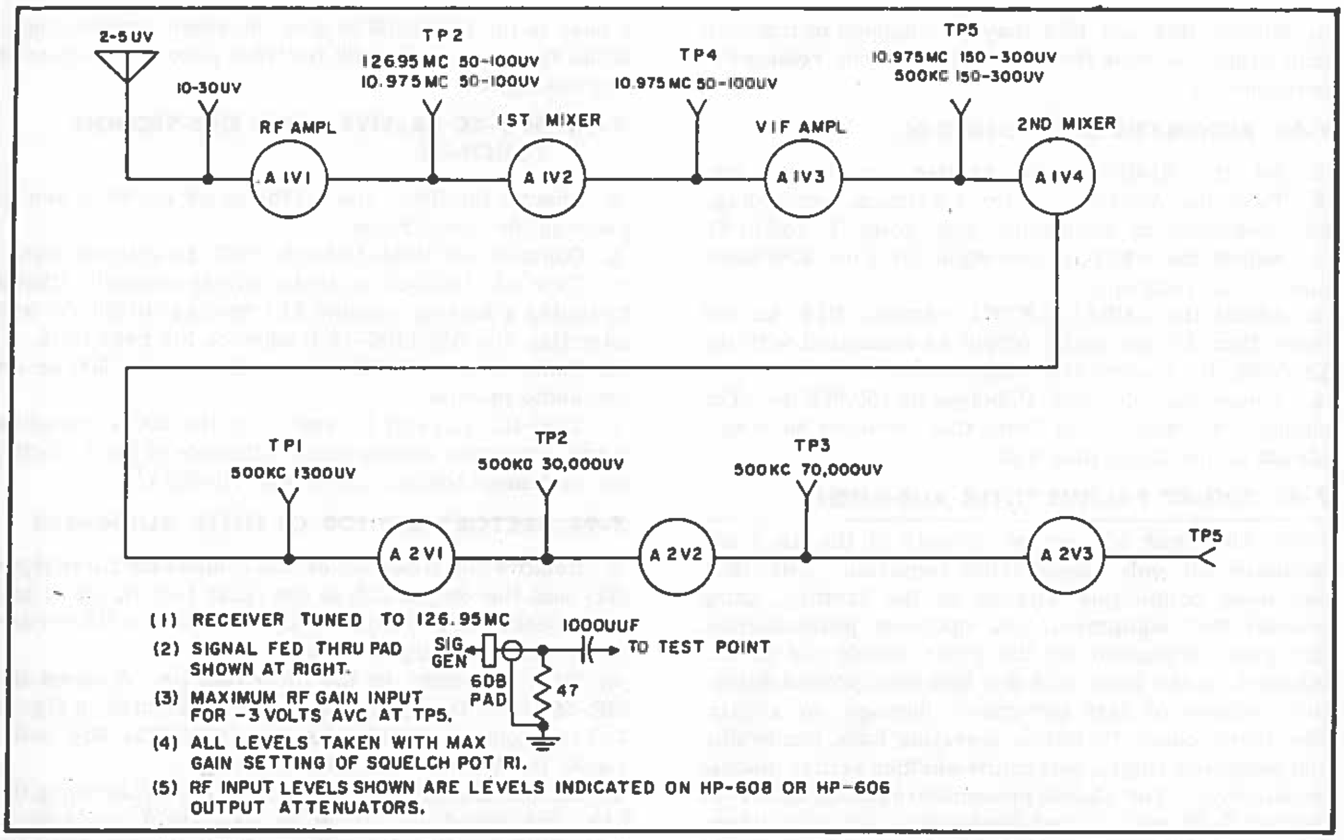


Figure 7-38. Stage Gain Chart

7-85. SENSITIVITY.

a. Connect the AN/USM-16 to the RECEIVER INPUT jack and channel the 614U-3A (or 614U-6) to 116.00 mc (108.00 mc for a 51X-2B that is used in VOR operation only). Set the SQUELCH control fully clockwise to obtain maximum gain.

b. Adjust the AN/USM-16 for 3 uv output. Vary the generator frequency to obtain maximum agc voltage at secondary test point P (A2TP5). Set the AN/USM-16 for output signal that is modulated 30% with 1000 cps.

c. Adjust the VOL control on the 614U-3A (or 614U-6) until the audio output as indicated on the OP182, connected to the RECEIVER AUDIO terminals of the 476V-1, is less than 100 mw. Record this output value.

d. Do not change the VOL control or input level. Remove the modulation from the input signal and note the audio output level. The drop in the audio output level, the (S+N)/N ratio, should be more than 6 db.

e. Repeat steps a through d for each of the following frequencies: 108.00, 111.05, 114.10, 116.00, 117.15, 120.20, 123.25, 126.30, 129.35, 132.40, 135.45, 138.50, 141.55, 144.60, 147.65, 150.70, and 151.95 mc. (Omit frequencies below 116.00 mc for receivers in communications service only.)

7-86. SQUELCH.

a. Channel the 614U-3A (or 614U-6) to 120.0 megacycles.

b. Set the AN/USM-16 to provide a 120.0-mc output modulated 30 percent with 1000 cycles.

c. Set the signal generator output level to 25 microvolts (If a 10K-ohm load is connected to pin 25 of B1 to simulate the squelch potentiometer in a remote box, set the output level to 10 microvolts.)

d. Set the squelch control on the 614U-3A completely counterclockwise and the sensitivity control on the receiver front panel counterclockwise.

e. Adjust i-f gain control R37 to open the squelch circuit (if tubes have normal gain, this control will be set fully clockwise). R37 (250K) variable resistor used effective MCN 7298.

f. Channel the 614U-3A (or 614U-6) to 116.00 MHZ and adjust the AN/USM-16 for 5 uv output.

NOTE

Channel the 614U-3A (or 614U-6) to 118.00 MHZ instead of 116.00 MHZ for 51X-2B receivers with jumper plugs used in VOR systems.

g. Adjust the squelch threshold control so that the squelch circuit in the 51X-2B just opens.

h. Channel the 614U-3A (or 614U-6) to each of the following frequencies: 118.00, 120.30, 123.95, 124.30, 131.00, 139.90, 140.90, 147.00, 151.95. The AN/USM-16 output level required to open the squelch circuit should not vary by more than a 2-to-1 ratio.

(Resistors R25 and R26 may be changed to improve gain balance across the band. They may be reduced to zero ohms.)

7-87. AUTOMATIC GAIN CONTROL.

a. Set the 614U-3A (or 614U-6) to 116.00 mc.
b. Tune the AN/USM-16 for maximum agc voltage as measured at secondary test point P (A2TP5).
c. Adjust the AN/USM-16 output for 5 uv, 30% modulated with 1000 cps.
d. Adjust the AURAL LEVEL control, R18, for not more than 25 mw audio output as measured with the TS-585C/U. Record this output level.
e. Adjust the AN/USM-16 output to 100,000 uv. The change in output level from that obtained in step d should be not more than 4 db.

7-88. 500-KC PASSIVE FILTER ALIGNMENT.

7-89. The input and output circuits of the filter are normally the only adjustments required. The filter has been completely aligned at the factory, using special test equipment, for optimum performance. Complete alignment of the filter should not be attempted in the field unless it has been proved defective because of part movement, damage, or repair. The three characteristics, insertion loss, bandwidth, and passband ripple, determine whether a filter module is defective. The checks presented in paragraphs 7-90 through 7-92, with all modules in place, will help determine if the filter module requires repair. Paragraphs 7-94 and 7-95 present information on aligning the filter, and paragraphs 7-96 and 7-97 describe filter evaluation tests that should be performed on a filter module that has been repaired.

7-90. INSERTION LOSS CHECK.

a. Check end section tuning as directed in paragraph 7-93.
b. Make stage gain checks per figure 7-38 and compare with those for a good 51X-2B.
c. Replace suspected filter with a good one, and after tuning the end sections per paragraph 7-93, repeat stage gain tests. If the suspected filter exhibits a loss 3 db or more greater than that for the good filter, the alignment of the suspected filter should be rechecked.

7-91. BANDWIDTH CHECK.

a. Perform the selectivity test as directed in paragraph 6-25. If the 6 db bandwidth is too wide, the filter may be defective.
b. Substitute a good filter, and after tuning the end sections per paragraph 7-93, recheck the selectivity. If the selectivity has been corrected it can be assumed that the filter is defective. Repair and realign the defective filter.

7-92. PASSBAND RIPPLE CHECK.

a. Check end section tuning as directed in paragraph 7-93.
b. Note the agc voltage variation, as measured at TP5 on the i-f and audio module, as the frequency of the AN/URM-25F signal applied to the antenna input is varied from 482 to 518 kc. The passband ripple is the ratio of the signal inputs required at a dip and at a peak in the passband to give the same agc readings. If the ripple exceeds 3 db the filter should be repaired and realigned.

7-93. 500-KC PASSIVE FILTER END-SECTION TOUCH-UP.

a. Ensure the filter and all the other modules are in place in the main frame.
b. Connect AN/USM-16 to the 51X-2B antenna input.
c. Tune AN/USM-16 to center of any channel. Check by tuning a loosely coupled 51J receiver to 500-kc and adjusting the AN/USM-16 frequency for zero beat.
d. Connect the TS-505A/U to TP5 on the 500 kc i-f and audio module.
e. Tune the slugs of L1 and L9 of the 500-kc passive filter, using the access holes in the side of the 51X-2B, for maximum indications on the TS-505A/U.

7-94. FACTORY METHOD OF FILTER ALIGNMENT.

a. Remove the filter cover and connect the filter input (J1) and the output (J2) to the filter test jig input and output connectors respectively. Ground the filter case to the filter test jig chassis.
b. Turn on power to the filter test jig. Connect the ME-6D/U to the filter test jig as indicated in figure 3-3 and connect Signal Generator AN/URM-25F to the signal input jack of the filter test jig.
c. Set the AN/URM-25F frequency to 498 kc using the 51J, and adjust its output to give about a 3/4 scale indication on the 0.1 volt scale of the TS-505A/U.
d. Short coil L2 of the filter module to ground by shorting the exposed coil terminal to the filter base with a small screwdriver.
e. Adjust coil L1 for a maximum indication on the TS-505A/U using position of core nearest base of coil.
f. Remove screwdriver short at L2 and place at L3.
g. Adjust coil L2 for a minimum indication on the TS-505A/U using position of core nearest base of coil.
h. Repeat steps d through g according to figure 7-39.
i. Repeat steps d through h.
j. Evaluate the filter as directed in paragraph 7-96.

COIL SHORTED	COIL TUNED	TS-505A/U INDICATION
L2	L1	Max
L3	L2	Min
L4	L3	Max
L5	L4	Min
L6	L5	Max
L7	L6	Min
L8	L7	Max
L9	L8	Min
	L9	Max

Figure 7-39. Alignment Sequence

7-95. FILTER ALIGNMENT USING 51X-2B MODULES.

NOTE

Do not perform this procedure if the filter has been aligned as directed in paragraph 7-94.

a. Remove the r-f and variable i-f module, A1, and the 500 kc i-f and audio module, A2, from the 51X-2B main frame. Connect the removed modules to the main frame using the appropriate module extension cables.

b. Remove the 500 kc passive filter module, A5, by removing the four screws that secure it to the main frame and disconnecting A1P2 and A1P3.

c. Remove the cover from the filter.

d. Reconnect P2 and P3 and place the filter module on the frame so that all the coil slug adjustments are accessible.

e. Channel the 51X-2B to a frequency higher than 118.00 mc and inject a 498-kc signal, from Signal Generator AN/URM-25F, into the grid of the second mixer (secondary test point I(A1TP5)). Adjust SQUELCH control fully counterclockwise for minimum gain.

f. Connect Multimeter ME-6D/U to major test point 1(A6J1).

g. Turn on power and adjust the output level of the AN/URM-25F until a meter indication is obtained.

h. Short coil L2 of the 500-kc filter module to ground by shorting the exposed coil terminal to the filter base with a small screwdriver.

i. Adjust coil L1 for maximum indication on the ME-6D/U. This maximum should occur with the core nearest the base of the coil.

j. Remove the screwdriver short at L2 and place it at L3.

k. Adjust coil L2 for minimum indication on the ME-6D/U. This minimum should occur with the core nearest the base of the coil.

l. Repeat steps h through k according to figure 7-39.

m. Repeat steps h through l.

n. Evaluate the filter as directed in paragraph 7-97.

7-96. FILTER EVALUATION USING THE FILTER TEST JIG.

a. Connect and adjust the equipment per steps a through c of paragraph 7-94.

b. Adjust the AN/URM-25F to obtain a convenient reading on the ME-6D/U decibel scale. Note this reading.

c. Reconnect the ME-6D/U to the filter output connection and note the decrease in the reading. If the decrease is less than 2.5 db, the insertion loss of the filter module is acceptable.

d. Decrease the AN/URM-25F output attenuator to the X100 scale and connect the ME-6D/U to the amplifier output. Set the ME-6D/U to the 0.1 volt scale.

e. Sweep the passband and locate the point of peak response. Adjust the AN/URM-25F output for a 10 db indication on the ME-6D/U.

f. Vary the frequency of the AN/URM-25F above and below 500 kc and, using the 51S-1, determine the frequencies at which the ME-6D/U indicates 4 db down. The plus and minus 4-db frequencies should be at least 20 kc removed from the center frequency and the total 4-db bandwidth should be at least 40 kc.

NOTE

If the total bandwidth meets requirements, but plus and minus deviations are not met, realign filter at slightly different frequency in order to make passband more symmetrical about 500 kc.

g. Reduce the AN/URM-25F output attenuator to X10 and set the ME-6D/U to the 0.01-volt range. Locate the frequency of maximum response and adjust the AN/URM-25F level for a 10-db indication on the ME-6D/U. Note this indication.

h. Increase the frequency of the AN/URM-25F at least 40 kc and set the output attenuator to X10K. Adjust the AN/URM-25F frequency above and below 500 kc until the indication noted in step g is obtained on the ME-6D/U. Measure the frequencies using the 51S-1 set to the second harmonic. These plus and minus 60-db half bandwidths should each be less than 46 kc and the sum should be less than 82 kc. If all the above conditions are met, the filter module bandwidth is acceptable.

i. Set the AN/URM-25F output attenuator to X100 and the ME-6D/U to the 0.1-volt range. The ME-6D/U should still be connected to the amplifier output.

j. Sweep the frequency range of 482 to 518 kc and note the maximum variation of output in db. If it is less than 3 db, the passband ripple is acceptable.

7-97. FILTER EVALUATION USING 51X-2B MODULES.

NOTE

Do not perform this procedure if the filter has been evaluated as directed in paragraph 7-96.

a. Connect the equipment per paragraph 7-95 steps a through f. Adjust Signal Generator AN/URM-25F for a convenient reading on the ME-6D/U decibel scale. Note this reading.

b. Connect the ME-6D/U to the output of the 500-kc filter output, A2J2. If the indication obtained on the decibel scale is not more than 2.5 db below that noted in step a, the filter insertion loss is acceptable.

c. Connect the ME-6D/U to A5J2 and adjust the AN/URM-25F step attenuator to obtain a convenient indication on the multimeter.

d. Vary the frequency of the AN/URM-25F over the passband and locate the point of peak response as indicated on the ME-6D/U. Note the db level.

e. Vary the frequency of the AN/URM-25F above and below 500 kc and record the frequencies at which the ME-6D/U indicates 4 db less than the level noted in step b. The deviation from 500 kc should be not less than 20 kc, and the total bandwidth between the 4 db points should be not less than 40 kc. If the total bandwidth exceeds 40 kc, but either the plus or minus deviations are less than 20 kc, realign the filter at a slightly different frequency in order to make the passband more symmetrical about 500 kc.

f. Locate the frequency of maximum response, and adjust the AN/URM-25F input for a convenient indication on the ME-6D/U. Note this indication and the step attenuator setting.

g. Increase the frequency of the AN/URM-25F by 40 to 50 kc and adjust the step attenuator to provide an output that is 1000 times that notes in step d. Adjust the frequency of the AN/URM-25F until the reading of the previous step is obtained. Determine, and record, the frequency of this 60-db point. It should not differ from 500 kc by more than 46 kc.

h. Decrease the frequency of the AN/URM-25F and determine the low-side 60-db point. Record this frequency. It should not differ from 500 kc by more than 45 kc. The total bandwidth between the 60-db points should not be more than 82 kc. If all the above conditions are met, the filter module bandwidth is acceptable.

i. Reduce the AN/URM-25F output to the level noted in step f.

j. Vary the frequency of the AN/URM-25F from 482 to 518 kc. Note the maximum variation of output, in decibels, as indicated by the ME-6D/U (still connected to A6J1). If the peak-to-valley ratio is not more than 3 db, the passband ripple is acceptable.

7-97A. 500-KC MECHANICAL FILTER ALIGNMENT.

a. Apply a 515-kc signal at the second mixer grid (A1TP5) at a level to obtain minus 3.5 volts at TP5 of the i-f and audio module.

b. Adjust A5C1 and A5C2 of the mechanical filter to obtain maximum negative voltage on the vtvm connected to TP5 of the i-f and audio module.

NOTE

Recent types of mechanical filters have fixed resonating capacitors (see figure 7-43). These filters require no alignment.

7-97B. 500-KC MECHANICAL FILTER EVALUATION.

NOTE

This filter is an alternate for the 500-kc passive filter.

a. Make the stage gain checks, as given in figure 7-38, on the suspected filter.

b. Replace suspected filter module with a good module, and repeat the stage gain checks. If the suspected filter module exhibits a loss of 3 db or more than the good filter, the suspected filter is defective.

c. Perform the selectivity check given in paragraph 6-25. If the 6-db bandwidth points are out of symmetry by 10 kc or more, or the 6-db bandwidth is not correct, the filter may be defective.

d. Substitute a good filter module and recheck the selectivity. If the receiver selectivity has been corrected, the suspected filter module is defective.

e. Measure the agc voltage variation at TP5 on the i-f and audio module as the frequency of the AN/USM-16 is varied across the passband of the filter module.

f. Record the input signal level and the agc voltage when a peak voltage is read as the frequency is varied.

g. Vary the frequency to obtain a dip in the agc voltage, and then increase the input signal level to obtain the same voltage as in step f. Record signal level.

h. The ratio of the input signal level recorded in step g to that recorded in step f, which is the passband ripple should be less than 3-db.

7-98. I-F AND AUDIO MODULE ALIGNMENT.

a. Remove power from the 51X-2B.

b. Remove the i-f and audio module, A2. Measure the resistance from pin 15 of P1 to the chassis of the module. (See note 10, figure 7-43.) This resistance should be about 20 ohms.

c. Measure the resistance from pin 6 of P1 to the chassis of the module. This resistance should be about 30,000 ohms.

d. Repeat step c. from pin 14 at P1. (See note 10, figure 7-43.) This resistance should be about 30,000 ohms.

e. Reassemble the module into the 51X-2B. Apply power to the 51X-2B and check that all tubes light. Set the 614U-3A (or 614U-6) to any convenient channel.

f. Inject a 500-kc signal at major test point 5 (A2TP1), using the AN/URM-25F. Connect the TS-505A/U or equivalent to secondary test point P (A2TP5). Adjust the top and bottom cores of T1 and T2 of the i-f and audio module, A2, for maximum indication on the TS-505A/U or equivalent. Use the tuning tool supplied with the 51X-2B.

CAUTION

Adjust input to keep meter on 3-volt scale.

g. Tune top core (primary) of the T3 for maximum output as indicated on the TS-505A/U or equivalent.

h. Tune the bottom core (secondary) of T3 for minimum output as indicated on the TS-505A/U or equivalent.

CAUTION

In adjusting T1, T2, and T3, tune to first resonance encountered as slugs move into coil.

7-99. ALIGNMENT TEST OF I-F AND AUDIO MODULE A2.

7-100. SELECTIVITY.

a. Connect AN/URM-25F to major test point 5 (A2TP1). Accurately set the frequency to 500kc.

b. Adjust input level to 300 uv and note output level indication on TS-505A/U or equivalent connected at secondary test point P (A2TP5).

c. Adjust the AN/URM-25F to provide 380 uv and vary the frequency to either side of resonance until the indication noted in step b is obtained. The total bandwidth between these plus and minus 2 db frequencies should be not less than 40 kc.

d. Adjust the AN/URM-25F output level to 30,000 uv, and repeat step c for the 40-db points. The bandwidth should be not more than 210 kc.

NOTE

If the 2 db half bandwidths differ appreciably, repeat paragraph 7-98 steps f through h using a frequency slightly removed from 500 kc in the direction of the smaller 2-db half bandwidth.

7-101. GAIN.

a. Adjust the AN/URM-25F output to provide 300 uv at 500 kc.

b. Measure the agc voltage at secondary test point P(A2TP5) using TS-505A/U or equivalent. Indication should be about 2 volts.

7-102. SQUELCH.

a. Adjust the AN/URM-25F to provide a 500 kc signal modulated 30%. Set the squelch control on receiver fully clockwise to obtain maximum gain.

b. Vary the input voltage supplied to the 51X-2B from the signal generator until the squelch circuit just opens. The input required should be not more than 150 uv.

c. Turn the squelch control fully counterclockwise and adjust the signal generator for 30% modulation. The input required to just open the squelch should be not less than 4500 uv.

d. With the SQUELCH control set about 1/8 turn from the full clockwise position, note the input required to just open squelch and to just close squelch. The ratio should be not more than three decibels.

7-103. NOISE LIMITER.

a. Set the AN/URM-25F for 1000 uv output and connect an Oscilloscope OS-8/U to secondary test point Q(A2TP7).

b. Modulate the input signal 10% with 1000 cps. Increase the percentage modulation until clipping occurs as indicated on the oscilloscope. Record this percentage modulation. It should be not less than 70%.

7-104. AUTOMATIC VOLUME CONTROL.

a. Adjust the AN/URM-25F to provide a 250 uv signal, modulated 30% with 1000 cps.

b. Adjust the AURAL LEVEL control (R18) for 25 mw output into 500 ohms as measured with Output Meter TS-585C/U at the PHONES jack, or test point 1 (A6J1).

c. Adjust the AN/URM-25F to 50,000 uv. The change in output from the indication obtained in step b should be not more than 4 db.

7-105. ATCSS OUTPUT LEVEL AND FREQUENCY RESPONSE.

a. Connect AC probe on Multimeter TS-505A/U or equivalent to the ATCSS output of i-f and audio module, secondary test point C (pin 18 of P1).

b. Connect the AN/URM-25F to the input of the i-f and audio module, major test point 5 (A2TP1). Adjust the AN/URM-25F to supply a 1000 uv, 500 kc signal, 30% modulated with 1000 cps. (The 51X-2B should be set at 116.00 mc and VOR plug installed in XK1.)

NOTE

If the 51X-2B is going to be used with Instrumentation Unit 344B-1, the AN/URM-25F or equivalent should be adjusted to supply a 1000 uv, 500 kc signal, 30% modulated with 30 cps.

c. Adjust the ATCSS level potentiometer (R12) for 0.5 volt ac output indicated on the TS-505A/U or equivalent.

d. Measure the voltage output for each of the following modulation frequencies: 30, 100, 300, 1000, 3000, 10,000, 15,000, and 22,000 cps. Ensure the percentage modulations remain at 30%. The difference in response at any two frequencies should be not more than 6 db.

7-106. AUDIO OUTPUT LEVEL AND FREQUENCY RESPONSE.

a. With Output Meter TS-585C/U still connected as in step b., paragraph 7-104, inject a 1000 uv signal, externally modulated 30% with 1000 cps from a TS-382F/U.

b. Adjust the AURAL LEVEL control, R18, for 100 mw audio output.

c. Measure the audio output for each of the following modulation frequencies: 120, 300, 1000, 3750, and 5750 cps. The output should be not less than -20 db at 120 and 5750 cps. From 300 to 3750 cps, the output should not vary more than 6 db from 100 mw reference.

7-107. AUDIO DISTORTION.

a. Connect Spectrum Analyzer TS-723/U to the RECEIVER AUDIO jacks on the 476V-1 or 476U-1, and measure the distortion, using a 1000 uv signal input modulated 30 percent with 1000 cps. Distortion should be not more than 7.5 percent.

b. Repeat measurements at 400 and 3000 cps, using an r-f input of 1000 uv. The distortion should be not more than 7.5 percent.

NOTE

The 51X-2B is set at the factory for 100-mw output with a 1000-uv signal modulated 30 percent with 1000-cps at a frequency below 118.00 mc. This setting gives a power output of approximately 40 mw in the communication band. This power output may be too high for the particular installation. If it is, adjust the AURAL LEVEL control, R18, in the i-f and audio module to a level suitable for the particular installation.

7-108. RECEIVER DISABLE

a. Using Signal Generator AN/URM-25F, inject a 1000 uv, 500 kc signal, modulated 30% with 1000 cps, to the i-f input, test point 5 (A2TP1).

b. Disable the 51X-2B by applying 27.5 volts d-c to pin 23 of the rear connector, P1. The receiver audio should disappear; agc voltage should drop; 27.5 volts on pin 19 of the rear connector, P1, should disappear (above 118 mc) and 27.5 volts on pin 27 of the rear connector, P1, should disappear (on odd tenths, 108 - 111.9 mc).

7-109. MECHANICAL ALIGNMENT.

a. Refer to figure 7-40 for preliminary mechanical adjustment. The final adjustment is done as follows after first connecting the r-f and variable i-f module to the remainder of the receiver with a 51X-2B Module Cable RF and VIF.

b. Check the preliminary module synchronization by channeling the 51X-2B to 108.00 megacycles and comparing with figure 7-40. (To channel the 51X-2B to 108.00 megacycles, if using a 614U-6, set the 614U-6 to 136.00 megacycles and ground pin 20 on the receiver connector. Remove the ground from pin 20 on the receiver connector after the synchronization has been checked.)

c. Cycle each Autopositioner in turn, and note that the front switch on each Autopositioner switch stack closes first. If these switch sections do not operate properly, check contact adjustment as outlined in figure 7-40.

d. Cycle each Autopositioner through all of its positions, and note that it sets up properly on each channel.

e. If Autopositioner appears to be synchronized improperly, break the primary power input at the point where the dials indicate 108.00 mc and the pawls have engaged the stop wheels. Check S4, S5, S6, S7, S8, and S9 switch stators and rotors for orientation in accordance with figure 7-40. If adjustment is required, make sure on retightening clamping collars that end play is not limited by the collars.

f. Cycle the 50-kc Autopositioner so that the setscrew of the 50-kc drive gear clamping collar can be reached and tightened.

g. Cycle the two-megacycle Autopositioner so that the setscrew of the 2 mc drive shaft collar can be reached and tightened.

h. Cycle receiver to 151.95 mc. Loosen top screw on differential clamp (see figure 7-40) and readjust position of tuning capacitor shaft so that the index on the coupler lines up with the index on the capacitor. Connect the module in a test setup similar to that in paragraph 7-82 and inject a 151.95-mc signal into the set. Obtain an agc reading of 3 volts at secondary test point P(A2TP5). Rock the tuning capacitor C2 back and forth until a peak reading is obtained. Keep the agc level below 3 volts by reducing the input to the receiver while making adjustments. Adjust lateral position of differential output shaft to allow 0.010 to 0.015 inch end play in the differential frame. Tighten both setscrews on the differential clamp. Make sure clamp is not limiting end play.

7-110. ADJUSTMENT PROCEDURES FOR D-C POWER SUPPLY 516B-3.

7-111. The following procedure will properly adjust the transient blanker trip out level for the 516B-3. The potentiometer, R3, is adjusted with the 516B-3 installed in the 51X-2B.

a. Connect the 51X-2B and the 614U-6 to the 476V-1 using the interconnecting cables.

b. Connect the 476V-1 to primary power.

c. Place the 476V-1 POWER ON-OFF switch in the ON position and note that the power indicator lamp lights.

d. Place the TRANSIENT TEST ON-OFF switch of the 476V-1 in the ON position.

e. Place the TRANSIENT TEST CHECK-NORMAL switch of the 476V-1 in the CHECK position.

f. Remove the dust cover of the 51X-2B and connect the vertical input of the OS-8/U between the junction of R7 and C2 and ground on Power Supply 516B-3.

g. Adjust the OS-8/U for a spot in the middle of the screen.

h. Loosen the locking nut on R3 in Power Supply 516B-3 and turn the control fully counterclockwise.

i. Adjust R3 on the 476V-1 for an indication of 35 volts d-c at the TRANSIENT CHECK CHARGE -35 VDC jack of the 476V-1.

j. When the capacitors have charged to 35 volts d-c, depress the TRANSIENT TEST CHARGE-DISCHARGE switch of the 476V-1 to the DISCHARGE position and note the upward deflection of the spot on the OS-8/U. Adjust the vertical gain if necessary.

k. Turn R3 of Power Supply 516B-3 clockwise a few degrees at a time while applying transients. When the spot first deflects downward, lock R3 in that position. This is the point where the transient protector circuit is protecting the power supply from transients of 33 volts or more.

CAUTION

Always be sure that the transient generator has charged to 35 volts before discharging and that R3 is locked at the point where the spot first deflected downward. This ensures that the transient protector circuit is not set too high or too low.

l. Return the 476V-1 TRANSIENT TEST CHECK-NORMAL switch to NORMAL and the TRANSIENT TEST ON-OFF switch to OFF.

7-112. SERVICING TRANSISTOR CIRCUITS.

7-113. GENERAL. Servicing procedures and test equipments that have been used in the past with other types of electronics equipment, for the most part, may be used with transistor circuits. Some special precautions which must be used are listed below. If the equipment under test contains transistors, even though they may not be in the circuits under test, the precautions should be observed because of the possibility of accidentally contacting a transistor circuit.

7-114. TEST EQUIPMENT. Damage to transistors by test equipment usually is the result of accidentally applying too much current or voltage to the transistor elements. Common causes of damage from test equipment are as follows:

7-115. TRANSFORMERLESS POWER SUPPLIES. Test equipment with transformerless power supply is one source of such current. This type of test equipment can be used by employing an isolation transformer in the power line.

7-116. LINE FILTER. It is still possible to damage transistors from line current, even though the test equipment has a power transformer in the power supply, if the test equipment is equipped with a line filter. This filter may act like a voltage divider and apply 55 volts a-c to the transistor. To eliminate trouble from this situation, connect ground wire from the chassis of the test equipment to the chassis of the equipment under test before making any other connections.

7-117. LOW SENSITIVITY MULTIMETERS. Another cause of transistor damage is a multimeter that requires excessive current for adequate indications. Multimeters that have sensitivities of less than 5000 ohms per volt should not be used. A multimeter with lower sensitivity will draw too much current through many types of transistors and damage them. Use of 20,000-ohm-per-volt meters or vacuum-tube voltmeters is recommended. Check the ohmmeter circuits (even those in vtvms) on all scales with an external, low resistance milliammeter in series with the ohmmeter leads. If the ohmmeter draws more than one milliampere on any range, this range cannot be used safely on small transistors.

7-118. POWER SUPPLY. Always use fresh batteries of the proper value for the equipment under test in test power supplies. Never use battery eliminators because the regulation of these devices is poor at the current values drawn by transistor circuits. Be certain about identification of polarity before attaching the battery to the equipment under test; polarity reversal may damage the transistor.

7-119. ELECTRIC SOLDERING IRONS. The possible causes of transistor damage from soldering irons are given in paragraphs 7-115 and 7-116.

7-120. LEAKAGE CURRENT. Electric soldering irons may damage transistors through leakage current. To check a soldering iron for leakage current, connect an a-c voltmeter between the tip of the iron and a ground connection (water pipe or line ground), allow the iron to heat, then check for a-c voltage with the meter. Reverse the plug in the a-c receptacle, and again check for voltage. If there is any indication on the meter, isolate the iron from the a-c line with a transformer. The iron may be used without the isolation transformer if the iron is plugged in and brought to temperature then unplugged for the soldering operation. It also is possible to use a ground wire between the tip of the iron and the chassis of the equipment being repaired to prevent damage from leakage current.

7-121. IRON SIZE. Light duty soldering irons of 20 to 25 watts capacity are adequate for transistor work and should be used. If it is necessary to use a heavier duty iron, wrap a piece of number 10 copper wire around the tip of the iron, and make it extend beyond the tip of the iron. Tin the end of the piece of copper wire, and use it as the soldering tip.

7-122. SERVICING PRACTICES.

7-123. HEAT SINK WHEN SOLDERING. When installing or removing a soldered-in transistor, grasp the lead to which heat is being applied, between the solder joint and the transistor, with long-nosed pliers to bleed off some of the heat that conducts into the transistor from the soldering iron. Make sure that the wires that are being soldered to transistor terminals are pretinned properly so that the

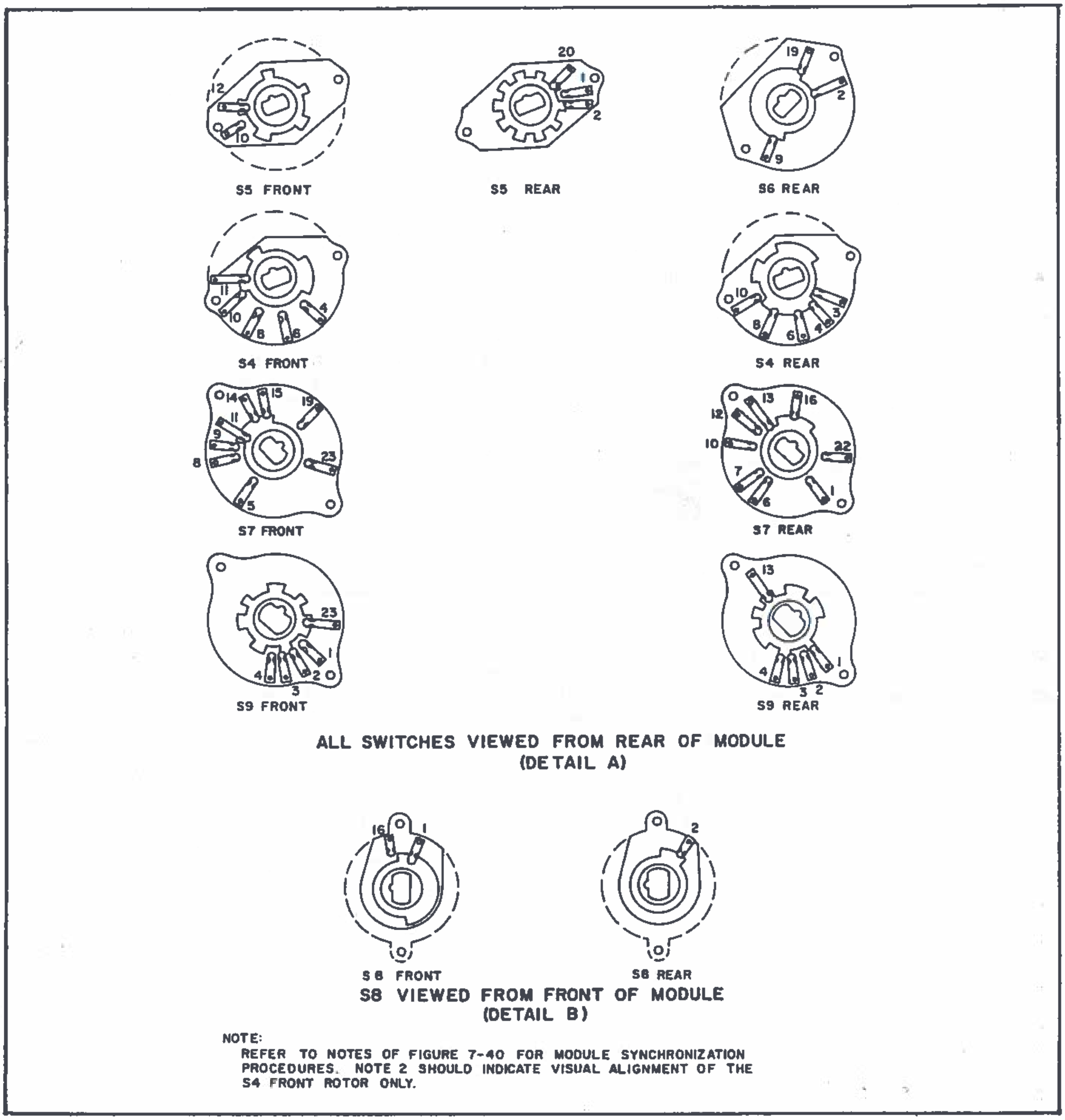


Figure 7-40A. Mechanical Alignment Procedure for 51X-2B Units 7868 and Above connection can be made quickly. Excessive heat will damage a transistor permanently.

7-124. REMOVAL OF TRANSISTORS FROM OPERATING CIRCUITS. Never remove or replace a plug-in transistor when the supply voltage is turned on. Transients thus produced may damage the transistor or others remaining in the circuit. If a transistor is to be evaluated in an external test circuit, be sure that no more voltage is applied to the transistor than normally is used in the circuit from which it came.

7-125. PLUG-IN TRANSISTORS. When servicing equipment that used plug-in transistors, it is good practice to remove the transistors from their sockets and reinsert them to break down any film of corrosion or dirt that may have formed.

7-126. RESISTANCE MEASUREMENTS IN TRANSISTOR CIRCUITS. When measuring resistances of circuits containing transistors or mineral diodes, remember that these components are polarity and voltage conscious; therefore, follow the directions of the notes that are given on the resistance tables or drawings to be sure that the correct polarity and range is applied to the circuit from the ohmmeter. Any capacitors used in transistor circuits usually are of large values (especially in audio, servo, or power circuits), and it takes time to charge these capacitors when an ohmmeter is connected to a circuit in which they appear. Thus, any reading obtained is subject to error if the capacitor is not allowed time to charge fully. In some cases, it may be best to isolate the components in question and measure them individually.

7-127. POWER TRANSISTOR HEAT SINKS. In some cases, power transistors are mounted on heat sinks that are designed to carry heat away from them. In some power circuits, the transistor also must be insulated from ground. This insulating is done by means of insulating washers made of fiber and mica. When replacing transistors mounted in this manner, be sure that the insulating washers are replaced in proper order. Before installing the mica washers, treat them with a film of silicone fluid, Collins part number 005 0273 00, or equivalent. This treatment helps in the transfer of heat. After the transistor is mounted and before making any connections to it, check from the case to ground with an ohmmeter to see that the insulation is effective.

7-128. TEST PRODS. Test prods should be clean and sharp. Because many of the resistors used in transistorized equipments have low values, any additional resistance produced by a dirty test prod will make a good resistor appear to be out of tolerance. In miniaturized equipment, the clearance between socket terminals, wires, and other components usually is very small. It is a good practice to cover all of the exposed tip of the test prod, except about one-eighth inch, with plastic tape or other insulation.

7-129. TROUBLE SHOOTING. The usual trouble shooting practices apply to transistors. Be sure the test equipment and tools meet the requirements outlined in the above paragraphs. It is recommended that transistor testers be used to evaluate the transistor.

7-130. OHMMETER TEST OF TRANSISTORS. If a transistor tester is not available, a good ohmmeter may be used for testing. Be sure the ohmmeter meets the requirements as set forth in the above paragraph on test equipment. To check a PNP transistor, connect the positive lead of the ohmmeter to the base and the negative lead to the emitter. (The red lead is not necessarily the positive lead on all ohmmeters.) Generally, a resistance reading of 50,000 ohms or more should be obtained. Connect the negative lead to the collector; again a reading of 50,000 ohms or more should be obtained. Reconnect the circuit with the negative lead of the ohmmeter to the base. With the positive lead connected to the emitter, a value of resistance in the order of 500 ohms or less should be obtained. Likewise, with the positive lead connect to the collector, a value of 500 ohms or less should be obtained.

7-131. Similar tests made on an NPN transistor produces results as follows: With the negative ohmmeter lead connected to the base, the value of resistance between the base and the emitter and between the base and the collector should be high. With the positive leads on the ohmmeter connected to the base, the value of resistance between the base and the emitter and between the base and collector should be low. If the readings do not check out as indicated, the transistor probably is defective and should be replaced.

CAUTION

If a defective transistor is found, make sure that the circuit is in good operating order before inserting the replacement transistor. If a short circuit exists in the circuit, plugging in another transistor most likely will result in another burned out transistor. Do not depend upon fuses to protect transistors.

7-132. Make sure that the value of the bias resistors in series with the various transistor elements are as shown on the schematic diagram. The transistor is very sensitive to improper bias voltages; therefore, a short or open circuit in the bias resistors may damage the transistor. For this reason, do not trouble shoot by shorting various points in the circuit to ground and listening for clicks.

7-133. LUBRICATION.

7-134. Only the r-f module requires lubrication. Lubrication points are accessible when covers are removed. Remove dirt and old lubricant before proceeding with lubrication. Lubrication procedures should be in accordance with Specification MIL-L-6880 and ANA-275.

7-135. Refer to figures 7-41 and 7-42 for lubrication data.

7-136. The following parts should never be lubricated: (Items a, b, and c, below, are self-lubricating; items d and e should be kept free of grease, oil, and other contaminants at all times.)

a. Tuning motor.
b. Tuning capacitor.
c. Bore of the clutch gears.
d. All gear teeth.
e. Autopositioner clutch working surfaces.

7-137. MAINTENANCE AND INSPECTION SCHEDULE.

7-138. The following inspection and maintenance procedures should be performed at intervals of 3 months.

a. Inspect entire equipment for accumulations of dust, dirt, lint, and foreign matter. Blow out all accumulations with a jet of clean, dry air.
b. Examine ventilation perforations and remove any obstructions.
c. Examine all structural screws and nuts for tightness and freedom from burrs. Tighten all loose fittings and remove burrs with a file.
d. Examine switch contacts and pin on all tube sockets, plugs and connectors for corrosion. Clean corroded parts with alcohol, Federal Specification MIL-A-6091A.
e. Test all potentiometers for smooth operation when rotated during alignment and adjustment procedures. Do not disturb adjustments at other times.

LUB.	COLLINS PART NO.	A/N NO.	TYPE
A	005-0116-00	AN-06	Oil
B	005-0613-00	---	Mixture of: (parts by volume) 5.0 Aeroshell Fluid No. 12; 2.5 butyl alcohol; 2.5 xylene
C	005-0334-00	---	Lubricant-dry

Figure 7-41. Table of Approved Lubricants

7-139. 100 HOUR INSPECTION.

a. Check equipment mountings and make sure they are secure.
b. Check cable connections for poor connections, frayed wiring, poor insulation, and corrosion.
c. Check primary voltage.
d. Inspect for loose components, loose wires, and overheating.
e. Check all vacuum tubes and transistors. (See paragraphs 7-112 to 7-132 for data on checking transistors.)
f. Check for proper frequency selection by channeling through each megacycle and each 50 kilocycle position with switches S2 and S3 of Radio Set Control 614U-3A.
g. Check VHF Navigation and Communications Receiver 51X-2B for adequate audio response by monitoring several stations.
h. Check the 51X-2B for proper squelch threshold.
i. Check SQUELCH disable button on front panel of 51X-2B. Background noise should appear when button is pressed.

PARTS LUBRICATED AT INTERVALS OF 10,000 TUNING CYCLES	LUBRICANT	QUANTITY
Working surfaces of the cams	C	Thin film
Tuning table guide slots	C	Thin film
Bores of gears that idle on shafts (except those mentioned in par. 7-126)	A	One drop
Porous bronze bearings	A	One drop
PARTS LUBRICATED AT INTERVALS OF 25,000 TUNING CYCLES		
S1 through S9	B	Thin film on rotor contact paths. Avoid excess.

NOTES

Access to lubrication points may be gained by the removal of covers; further disassembly is unnecessary.

If any item requiring lubrication is disassembled, it should be relubricated upon reassembly into the set.

Figure 7-42. Lubrication Chart