

TO 31R2-2GRT-102

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TECHNICAL MANUAL

SERVICE AND CIRCUIT DIAGRAMS

RADIO TRANSMITTER T-1108(V)/GRT-21(V) & T-1109(V)/GRT-22(V) AND RADIO FREQUENCY AMPLIFIER AM-6154/GRT-21(V) & AM-6155/GRT-22(V) (AN/GRT-21 AND AN/GRT-22)

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INTRODUCTION

NOTE

The term RADIO SET refers to a combination of both the Transmitter and the applicable Radio Frequency Amplifier. The actual Radio Set nomenclature, part number and NSN are for reference only and cannot be requisitioned. Not all locations require both Amplifier and Transmitter to accomplish their mission. The Radio Frequency Amplifier is needed only when more than 10 watts is necessary. Should a "set" be required at any location that location will have to requisition both the Radio Frequency Amplifier and Transmitter separately. When a "SET" is used the Transmitter and Amplifier will need to be listed separately on their Table Of Allowance (TA). See Table 1-1 for correct configurations.

This manual contains information to install, operate and maintain transmitter T-1108(V)/GRT-21(V), or T-1109(V)/GRT-22(V) independent of or in combination with RF Amplifier AM-6154/GRT-21 and AM-6155/GRT-22.

Both transmitters are identical in physical size as are either amplifier. Both transmitter and amplifiers are designed for mounting in a standard 19-inch rack or cabinet and can be installed either independently or in combination.

Radio Transmitter T-1108(V)/GRT-21(V) operates in the amplitude modulation (AM) mode. It is capable of transmitting on any one of 680 channels spaced 50 KHz between 116.00 KHz and 149.95 KHz (VHF). By exchanging certain of the frequency determining modules with their corresponding UHF modules, the T-1109(V)/GRT-22(V) configuration is established which provides transmission capabilities on any one of 3500 channels spaced 50 KHz between 225.00 and 399.95 MHz (UHF).

Information in this manual is presented in six chapter and one index. Chapter 1 contains a description of the equipment from a functional standpoint including the capabilities and limitations. Information is provided covering leading particulars, equipment supplied, and auxiliary equipment required but not supplied. Chapter 2 contains information for installation planning, logistics, installation procedures, and preparation for reshipment. Chapter 3 describes all operating

controls, indicators, and interlocks, and provides starting, operating, stopping, and emergency operation procedures. Chapter 4 discusses the principles of operation on a functional system basis and also to an operational or signal sequence flow. Chapter 5 includes maintenance and alignment procedures. Chapter 6 contains circuit diagrams. The alphabetical index following Chapter 6 provides references to the appropriate paragraphs according to the subject covered.

Table 1-1 is included here in the introduction as a cross-reference and indicates which modules are used in each configuration of the transmitter and which amplifier is used with each transmitter.

Changes to this manual will be indicated by a vertical line in the margin extending close to the entire area of the material affected and at the binding edge of the page. Change symbols are not used for:

- a. Introductory material, indexes, and tabular data where the change cannot be identified.
- b. Blank space resulting from the deletion of text or an illustration or a table.
- c. Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc., unless such correction changes the meaning of instructive information and procedures.

Reference is made to T.O. 00-25-234, General Shop Practice Requirements for the Repair, Maintenance and Test of Electronic Equipment for instructions concerning procedures and specific materials to be used in soldering this equipment.

The following publications are listed for reference and govern the manner of preparation, use of symbols, terms, reference designations, and abbreviations in this manual.

Military Specifications:

MIL-M-38730
(USAF)

Manuals, Technical:
General Requirement
For Preparation Of

MIL-T-9941 (USAF)

Technical Manuals:
Ground C-E Equip-
ment Facility Site and
System, Preparation
Of

T.O. 31R2-2GRT-102

Military Standards:

MIL-STD-12	Abbreviations For Use on Drawings and in Technical Type Publications
MIL-STD-15-1	Graphical Symbols For Electrical and Electronic Diagrams
ASA Y32.16-1965	Electrical and Electronics Reference Designations

Style Manual:

Library of Congress Catalog No. Z253.U58 U.S. Government Printing Office

Refer to T.O. 31R2-2GRT-512 “Addition of High Voltage Switch on AN/GRT-21/22” and T.O. 31R2-2GRT-514 “Intermodulation Distortion Modification on T-1108/GRT-21.”

Table 0-1. GRR/GRT Radio Set Configuration Matrix



Table 0-1. GRR/GRT Radio Set Configuration Matrix (Cont)



Note

The term RADIO SET refers to a combination of both the Transmitter and the applicable Radio Set nomenclature, part number and NSN are for reference only and cannot be requisitioned.

UHF

Transmitting Set, Radio AN/GRT-22

(V)1

8004200G1

5820-00-123-3952

(V)2

8004200G4

5820-01-022-3000

(V)3

8004200G7

5820-01-034-6085

(V)4

8004200G9

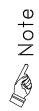
5820-01-033-0799

(V)5

SUBASSEMBLY	PART NUMBER	(V)1	(V)2	(V)3	(V)4	(V)5
Transmitter, Radio, T-1109 (V) 1/GRT-22 (V)	8004201G1	X				
Transmitter, Radio, T-1109 (V) 2/GRT-22 (V)	8004201G3	X				
Transmitter, Radio, T-1109 (V) 3/GRT-22 (V)	8004201G4		X			
Transmitter, Radio, T-1109 (V) 4/GRT-22 (V)	8004201G7		X			
Transmitter, Radio, T-1109 (V) 5/GRT-22 (V)	8004201G9			X		
Amplifier, Radio Frequency AM-6155/GRT-22 (V)	8004202G1	X	X	X	X	



Note



Note

The term RADIO SET refers to a combination of both the Transmitter and the applicable Radio Set nomenclature, part number and NSN are for reference only and cannot be requisitioned.



Note

Transmitter nomenclature, Part Number, NSN are for reference only and cannot be requisitioned.

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Table 0-2. VHF Transmitter T-1108(V)/GRT-21(V) Configuration Matrix

VHF Transmitter		Transmitter, Radio, T-1108 (V) /GRT-21 (V)									
		(V)1	(V)2	(V)3	(V)4	(V)5					
Audio Compressor	8004213G1	X	X				X				
Line Amplifier	8007655G1			X							
Amplifier Detector	8004214G1	X	X	X			X				
Regulator	8004216G1	X	X	X			X				
Control Transfer	8004217G1	X	X	X			X				
Control	8004219G1	X	X	X			X				
Buffer Modulator	8004221G1	X	X	X			X				
RF Control *	8004222G1	X	X	X			X				
RF Doubler	8004225G1	X	X	X			X				
Crystal Oscillator	8004290G2	X									
Crystal Oscillator	8004290G3		X								
Oscillator Multiplier	8009546G1				X		X				
Synthesizer	8008619G1			X							
Power Supply	8004530G1	X	X	X			X				
Heatsink Regulator	8004531G1	X	X	X			X				
Power Amplifier	8006081G1	X	X	X			X				
Inboard Monitor/Keyer	8009574G1	1	1	1			1				
Amplifier, Driver/Pwr	8136838G1	1	1	1	2		1				

* Any circuit card marked P/N 8004222G2 is improperly identified and should be marked as P/N 8004222G1.
For Air Force use P/N 8004221G2.

1 Restricted use, contact Inventory Management Specialist at managing ALC.

2 Used in S/N's 34501 and up.

Table 0-3. UHF Transmitter T-1109(V)/GRT-22(V) Configuration Matrix

		Transmitter, Radio, T-1109 (V) /GRT-22 (V)									
		(V)1	(V)2	(V)3	(V)4	(V)5					
Audio Compressor	8004213G1	X	X	X							
Line Amplifier	8007655G1			X							
Amplifier Detector	8004214G1	X	X	X							
Regulator	8004216G1	X	X	X							
Control Transer	8004217G1	X	X	X							
Control	8004219G1	X	X	X							
Buffer Modulator ‡	8004221G1	X	X	X							
RF Control *	8004222G1	X	X	X							
RF Quadrupler	8004224G1	X	X	X							
Crystal Oscillator	8004290G2	X									
Crystal Oscillator	8004290G3	X									
Oscillator Multiplier	8009546G1			X							
Synthesizer	8008619G1			X							
Power Supply	8004530G1	X	X	X							
Heatsink Regulator	8004531G1	X	X	X							
Driver Amplifier	8004890G1	X	X	X							
Inboard Monitor/Keyer	8009574G1	1	1	1	X	1					
Amplifier, Driver/Pwr	8136838G1	1	1	1	2	1					

* Any circuit card marked P/N 8004222G2 is improperly identified and should be marked as P/N 8004222G1.

‡ For Air Force use P/N 8004221G2.

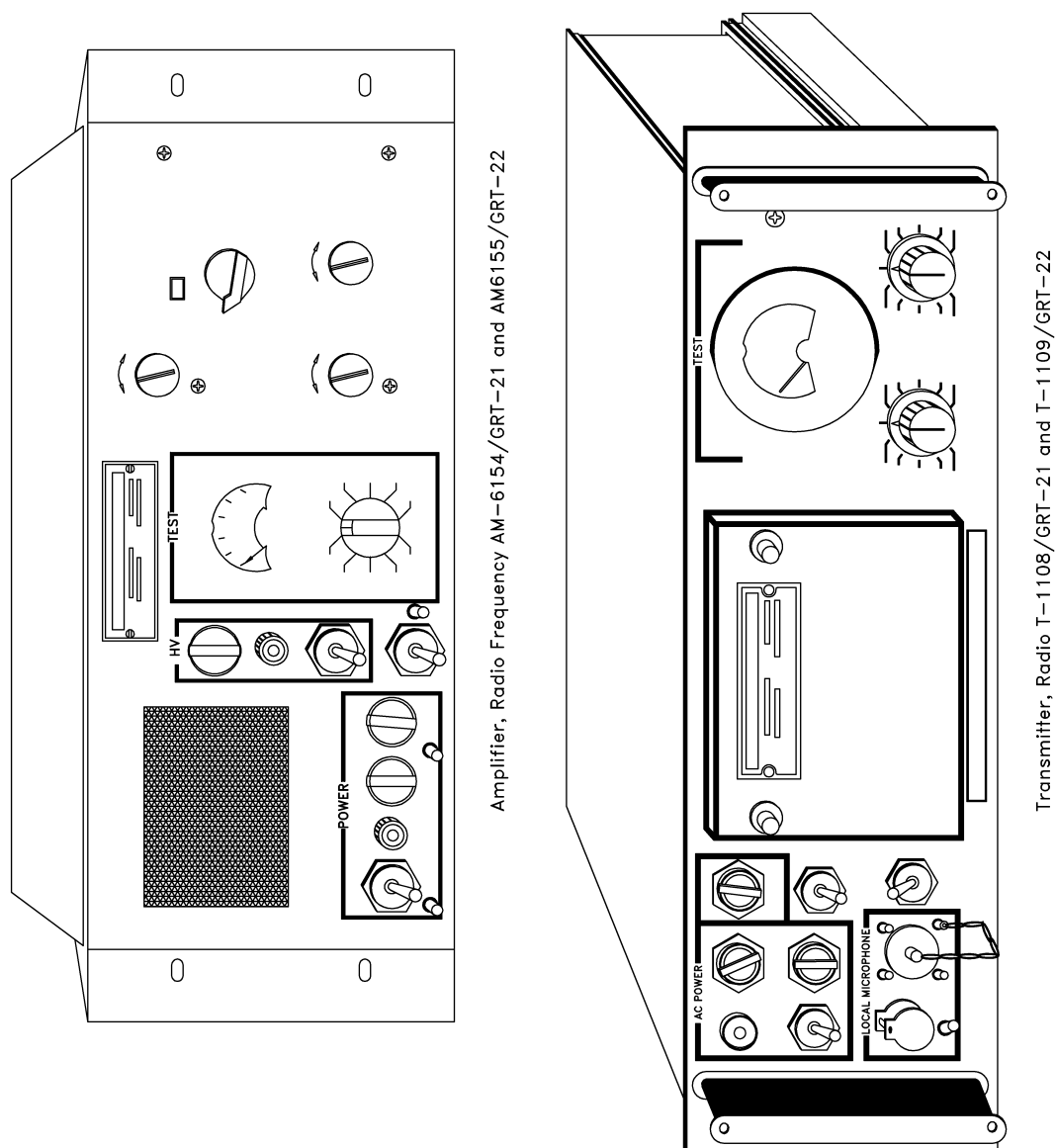
1 Restricted use, contact Inventory Management Specialist at managing ALC.

2 Used in S/N's 34501 and up.

Table 0-4. Radio Frequency Amplifier (VHF/UHF) Configuration Matrix

MODULE	PART NUMBER	Amplifier, Radio Frequency, AM-6154/GRT-21 (V) and AM-6155/GRT-22 (V)									
		VHF 5820-00-123-3965					UHF 5820-00-123-3954				
Power Supply	8004233G1	X					X				
AC/AC Converter	8004930G1	X					X				
Power Supply	8004236G1	X					X				
Buffer Amplifier	8004227G1	X					X				
Tunable Cavity	8004230G1	X									
Tunable Cavity	8004230G1						X				

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Figure 1. Transmitting Set, Radio AN/GRT-21 and AN/GRT-22

NOTE

Transmitter Nomenclature, Part number, NSN are for reference only and cannot be requisitioned.

CHAPTER 1

GENERAL INFORMATION

WARNING

With the switch off and the fuse cap removed, 115 VAC (hot side) on the exposed end of fuse holder (F1). When removing or replacing any fuse, the AN/GRT-21/22 should be disconnected from the 115 VAC source. Failure to comply with this WARNING could result in serious injury or death.

NOTE

The term RADIO SET refers to a combination of both the Transmitter and the applicable Radio Frequency Amplifier. The actual Radio Set nomenclature, part number and NSN are for reference only and cannot be requisitioned. Not all locations require both Amplifier and Transmitter to accomplish their mission. The Radio Frequency Amplifier is needed only when more than 10 watts is necessary. Should a "set" be required at any location that location will have to request both the Radio Frequency Amplifier and Transmitter separately. When a "SET" is used the Transmitter and Amplifier will need to be listed separately on the Table Of Allowance (TA). See Table 1-1 for correct configurations.

1-1. INTRODUCTION. This chapter contains information concerning Transmitting Set, Radio AN/GRT-21 (V) and Transmitting Set, Radio AN/GRT-22(V). A description of the equipment, its purpose and strategic mission, capabilities and limitations, leading particulars, and operation are discussed in the following paragraphs.

1-2. DESCRIPTION AND PURPOSE.

1-3. Transmitting Set, Radio AN/GRT-21(V), hereinafter referred to as the VHF transmitting set, is comprised of Transmitter, Radio T-1108(V)/GRT-21, hereinafter referred to as the VHF exciter, and Amplifier, Radio Frequency AM-6154/GRT-21, hereinafter referred to as the VHF power

amplifier. When only 10 watts is required, the exciter only is necessary.

1-4. Transmitting Set, Radio AN/GRT-22(V), hereinafter referred to as the UHF transmitting set, is comprised of Transmitter Radio T-1109(V)/GRT-22, hereinafter referred to as the UHF exciter, and Amplifier, Radio Frequency AM-6155/GRT-22, hereinafter referred to as the UHF power amplifier. When only 10 watts is required, the exciter only is necessary.

1-5. An oscillator-synthesizer module is available which is directly interchangeable with and replaces the crystal oscillator module

1-6. The VHF exciter, utilizing the oscillator-synthesizer is capable of transmission on any one of 2720 channels spaced 12.5 khz between 116.00 mhz and 149.9875 mhz.

1-7. The UHF exciter, utilizing the oscillator-synthesizer is capable of transmission on any one of 7000 channels spaced 25 khz between 225.00 and 399.975 mhz.

1-8. Frequency selection utilizing the oscillator synthesizer module is obtained by direct dialing the required input frequency to the doubler or quadrupler module.

1-9. An oscillator-multiplier module is available which is directly interchangeable with the crystal-oscillator module or the oscillator-synthesizer module. This oscillator-multiplier module differs from the crystal oscillator series in that it utilizes a fundamental crystal rather than a fifth overtone type and the crystal oven is eliminated. Frequency accuracy is determined by "pulling" the crystal. Tuning is accomplished to the exact frequency by monitoring the frequency with a counter.

1-10. Common to both the VHF exciter and the UHF exciter is Keyer, KY-668/GRT, hereinafter referred to as the special purpose keyer.

1-11. The VHF transmitting set and the UHF transmitting set are designed for worldwide deployment in the air-traffic control service and provide ground-to-air and point-to-point voice communication. See figure 1-1.

1-12. The VHF transmitting set and the UHF transmitting set are designed to perform reliably in an air-traffic control environment.

1-13. The VHF exciter is a crystal-controlled self-contained solid-state assembly that operates in the amplitude modulation (AM) mode. It is capable of transmission on any one of 680 channels spaced 50 khz between 116.00 mhz and 149.95 mhz as determined by the operating frequency of the crystal used. Transmitter has capability of Secure Voice Operation.

1-14. The UHF exciter is a crystal-controlled self-contained solid-state assembly that operates in the amplitude modulation (AM) mode. It is capable of transmission on any one of 3500 channels spaced 50 khz between 225.00 mhz and 399.95 mhz as determined by the operating frequency of the crystal used. The UHF exciter configuration is normally obtained by substituting UHF modules for the comparable VHF frequency determining and controlling modules.

1-15. The VHF exciter and the UHF exciter have provisions for use of an external precision oscillator in lieu of a crystal for frequency control.

1-16. The VHF exciter and the UHF exciter are capable of providing a minimum carrier power of 10 watts with 90 percent modulation capability.

1-17. When driven by their corresponding exciters the VHF power amplifier and the UHF power amplifier are capable of providing a minimum carrier power of 50 watts with 90 percent modulation capability.

1-18. The special purpose keyer provides additional keying capability when the standard keying circuit is not adequate for the special environment confronted by the exciters.

1-19. The VHF exciter and the UHF exciter and power amplifiers each have their own integral power supplies.

1-20. LEADING PARTICULARS.

1-21. The physical and electrical characteristics of the VHF exciter and the UHF exciter and power amplifiers are listed in table 1-1.

1-22. CAPABILITIES AND LIMITATIONS.

1-23. The capabilities and limitations of the VHF exciter, the UHF exciter, the VHF power amplifier, and the UHF power amplifier are listed in table 1-2.

1-24. EQUIPMENT SUPPLIED.

1-25. Equipment supplied comprising the VHF transmitting set and the UHF transmitting set is listed in table 1-3.

1-26. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

1-27. Test equipment or equivalent required for maintenance but not supplied with the VHF and UHF transmitting set is listed in table 1-4.

Table 1-1. Leading Particulars

CHARACTERISTIC	REQUIREMENT
PRIMARY INPUT POWER	105, 120, 210 and 240 volts $\pm$ 10%, single phase 47 hz to 420 hz, 140 watts maximum. If ac power fails, a 24 volt lead acid battery is automatically switched in to provide emergency power for a period dependent on the battery amp-hr (AH) capacity. A 100 AH battery will provide power for approximately 15 hours to a transmitter continuously keyed. When 210, 240 ac power operation is required and wire on PS1TB1, terminal 7 is a gray wire (this note does not apply when black with white tracer wire is on terminal 7) make certain that wire gauge size is No. 22 and that gray wire on terminal 5 of PS1TB1 is No. 20 gauge. In some equipments these wires have been inadvertently reversed.
VHF/UHF Exciter	
VHF/UHF Power Amplifier	105, 120, 210, and 240 volts $\pm$ 10%, single phase 47 hz to 420 hz 610 watts maximum. Automatic switching of antenna from power amplifier to exciter upon loss of ac power or failure of the power amplifier.

Table 1-1. Leading Particulars (Cont)

CHARACTERISTIC	REQUIREMENT
PHYSICAL DESCRIPTION	
VHF/UHF Exciter	
Dimensions	5-1/4 inches high; 17-3/4 inches wide; 16-7/8 inches deep (Standard 19-inch rack or cabinet mounting).
Weight	43 pounds
VHD/UHF Power Amplifier	
Dimensions	7 inches high; 17-3/4 inches wide; 18-1/2 inches deep (Standard 19-inch rack or cabinet mounting).
Weight	70 pounds
CABLE REQUIREMENTS	Provided by Air Traffic Control Central

Table 1-1. Leading Particulars (Cont.)

CHARACTERISTIC	REQUIREMENT
ENVIRONMENTAL	
Operating	Ambient Temperature: -29°C to $+60^{\circ}\text{C}$ Relative Humidity: 5% to 95% AC Line Voltage: 105, 120, 210, and 240 volts $\pm 10\%$, single phase AC Line Frequency: 47 hz to 420 hz DC: 22 to 30 volts Duty Cycle: Continuous unattended at rated power 90% modulated. Altitude: 0 to 10,000 Ft. MSL Warm-up Time: 30 minutes maximum with crystal oscillator module; 5 minutes maximum with oscillator-synthesizer module. Frequency Accuracy (Oscillator-Synthesizer) $\pm 0.0005\%$ after 5 minute warm-up.
Non-operating and Storage	Ambient Temperature: -62°C to $+71^{\circ}\text{C}$ Relative Humidity: 5% to 95% Barometric Pressure: 3.34 inches Hg to 31 inches Hg

Table 1-2. Capabilities and Limitations

CHARACTERISTIC	REQUIREMENT
VHF EXCITER	
Frequency Range Oscillator and Oscillator-Multiplier Module	116.00 mhz to 149.95 mhz with 680 channels spaced 50 khz within this range.
Frequency Range (Oscillator-Synthesizer Module)	116.00 mhz to 149.9875 mhz with 2720 channels spaced 12.5 khz within this range.
UHF EXCITER	
Frequency Range Oscillator and Oscillator-Multiplier Module	225.00 mhz to 399.95 mhz with 3500 channels spaced 50 khz within this range.
Frequency Range (Oscillator-Synthesizer Module)	225.00 mhz to 399.975 mhz with 7000 channels spaced 25 khz within this range.
VHF/UHF EXCITER	
Frequency Accuracy	Crystal controlled; semiconductor proportionally controlled crystal oven. No more than $\pm 0.001\%$ drift from operating frequency after 30-minute warm-up. Oscillator-synthesizer: $\pm 0.0005\%$ after 5-minute warm-up.
POWER OUTPUT	
VHF/UHF Exciter	10 to 12.5 watts into 50-ohm resistive load over entire frequency range at $90\% \pm 10\%$ modulation level. Capable of normal operation at this carrier power level when working into reactive loads producing a vswr of not greater than 3 to 1.
VHF/UHF Exciter with VHF/UHF Power Amplifier	50 to 52.5 watts into 50-ohm resistive load over entire frequency range at $90\% \pm 10\%$ modulation level. Capable of normal operation at this carrier power level when working into reactive loads producing a vswr of not greater than 3 to 1.
VHF/UHF EXCITER	
Modulation	RF carrier capable of $90\% \pm 10\%$ amplitude modulation at full power output by any sine wave frequency between 300 hz and 6000 hz.
Duty Cycle	Continuous, unattended at rated rf power output 90% amplitude modulated.
Harmonic and Spurious Output	Spurious frequencies and harmonics of the carrier frequency at all modulation levels up to 90% and frequencies up to 1000 mhz 80 db below level of carrier fundamental frequency.
Audio Frequency Response	Between 300 hz and 6000 hz modulation amplitude within +1 db and -2 db from the modulation amplitude at 1000 hz.
Wide Band Data Input	300 hz to 25 khz modulation amplitude within +1 db and -4 db from 1000 hz.
Audio Compression and Limiting	Prevents overmodulation of carrier under all conditions $90 \pm 10\%$ modulation level maintained with audio input levels from -15 dbm to +10 dbm, (or -35 dbm to -15 dbm when special strapping option is used).

Table 1-2. Capabilities and Limitations (Cont.)

CHARACTERISTICS	REQUIREMENT
Audio Distortion	At rated carrier output 90% modulated and at all frequencies between 300 hz and 6000 hz total harmonic distortion in demodulated output condition less than 10% at 0 db compression and limiting. Under same conditions with maximum compression and limiting total harmonic distortion less than 15%. When the line amplifier module is used in the exciter no compression exists. When R10 is properly adjusted distortion will be less than 10%.
Keying	Semiconductor switching devices. External and local keying provisions. Local: a. Carbon microphone b. Dynamic microphone c. Carrier test Remote: a. Simplex ground b. KY-668/GRT, (Navy Only) Special Purpose Keyer: Provides external keying in push-to-talk mode by 20 to 60 ma into 150 ohms and 50 volts or 100 volts into 47 K ohms or 300 hz to 3000 hz tone. c. Inboard Monitor/Keyer (optional): Provides external non-polarized voltage keying up to 48 Vdc.
Thermal Protection	Solid-state protective circuitry actuated at 85°C. Typically, no air flow exists into the cavity, or the detected fan voltage is low due to fan failure.
Status Monitor	With the Inboard Monitor/Keyer A3 installed (optional), signal outputs are provided for external monitoring of forward power, reverse power, audio input, and output percentage of modulation. Impedance of each output is 300 ohms.
VHF/UHF POWER AMPLIFIER	
Antenna Transfer Circuit	Automatic semiconductor control of coaxial relay switching of antenna from power amplifier to exciter upon loss of primary ac power or power amplifier failure, or vswr of greater than 3 to 1.
Thermal Protection	Solid-state protective circuitry activated when exit air from rear port exceeds 147°C typically.

Table 1-3. Equipment Supplied

OFFICIAL NOMENCLATURE	COMMON NAME
Transmitter, Radio T-1108(V)/GRT-21	VHF Exciter
Keyer KY-668/GRT (Navy only)	Special Purpose Keyer
Amplifier, Radio Frequency AM-6154/GRT-21	VHF Power Amplifier
Transmitter, Radio T-1109(V)/GRT-22	UHF Exciter
Keyer KY-668/GRT (Navy only)	Special Purpose Keyer
Slide, Drawer Extension	ITT P/N 512308-1 & 512308-2

NOTE

Slide Drawer Extensions and
Interface Cable Kit must be
Shipped with the radio set.

Table 1-3. Equipment Supplied (Cont.)

OFFICIAL NOMENCLATURE	COMMON NAME
Amplifier, Radio Frequency AM-6155/GRT-22	UHF Power Amplifier
Interface Cables, 8006149G1 (For 50 Watt Configuration). Required for AN/GRT-21(V) or AN/GRT-22(V) Transmitting Sets. Consists of:	
Cable, Special Purpose, ITT 8006147G2 (W1)	Exciter AC Input Cable
Cable, Special Purpose, ITT 8006147G3 (W2)	Power Amplifier AC Input Cable
Cable, Special Purpose, ITT 8006145G1 (W3)	Coaxial Interconnect Cable
Cable, Special Purpose, ITT 8006145G2 (W4)	Coaxial Interconnect Cable
Cable, Special Purpose, ITT 8006150G1 (W5)	Interconnecting Cable
Connector, Plug, MS3108A-24-28S	Connector
Clamp, Cable, MS3057-16A	Clamp
Interface Cables, 8006149G2 (For 10 Watt Configuration). Required for T-1108(V)GRT-21 or T-1109(V)GRT-22 Exciters only. (Required when requisitioned or returned as separate unit). Consists of:	
Cable, Special Purpose, ITT 8006147G2 (W1)	Exciter AC Input Cable
Connector, Plug MS3108A-24-28S	Connector
Clamp, Cable, MS3057-16A	Clamp
Interface Cables, 8006149G3. Required for AM- 6154/GRT-21 or AM-6155/GRT-22, Linear Power Amplifiers only. (Required when requisitioned or returned as separate unit). Consists of:	
Cable, Special Purpose, 8006147G3(W2)	Power Amplifier AC Input Cable
Cable, Special Purpose, 8006145G1(W3)	Coaxial Interconnect Cable
Cable, Special Purpose, 8006145G2(W4)	Coaxial Interconnect Cable
Cable, Special Purpose, 8006150G1(W5)	Interconnecting Cable

Table 1-4. Equipment Required (Or Equivalent) But Not Supplied

DESCRIPTION	MODEL OR TYPE DESIGNATOR	FEDERAL STOCK NUMBER
Plug-In Unit, Electronic	Tektronix 1A1	
Dummy Load, Electronic	Bird 8135	
Counter, Frequency Measuring	Hewlett Packard 5245L	
Plug-In Unit, Electronic	Hewlett Packard 5253B	
Test Set, RF Power	Bird 43	
Oscilloscope	Tektronix, RM547	6625-929-1895YA
Plug-In Unit, Electronic*	Tektronix, 1L20	6625-722-1694YA
Plug In Unit, Electronic*	Tektronix, 1S1	6625-933-2719YA
Meter, Vector Impedance*	Hewlett Packard 4815A	6625-061-0225
Distortion Analyzer*	Hewlett Packard 334A	6625-871-8012
Voltmeter, Electronic*	Fluke 801	6625-753-2114
Multimeter, Digital	Fluke 8300A	6625-00-432-5221
Crystal Unit, Quartz	CR-143/U (Holder Type HC-27/U)	
Power Supply, 19.5 V @ 10a*	New Jersey Electronics QR 36-10	
Directional Coupler*	Hewlett Packard 778D	5985-239-3215
Power Meter*	Hewlett Packard 430C	6625-560-6084
Thermistor Mount*	Hewlett Packard 477B	
Attenuator 10 dB, 5 W*	Microlab/FXR AE-10-N	
Attenuator 3 dB, 20 W*	Narda 766-3	
Attenuator 20 dB, 100 W*	Electro-Impulse AX20-100	
Attenuator 20 dB, 5 W*	Narda 765-20	
Power Supply, 0-18 V*	Power Design 3650S	
Ammeter, 0-15 Amps*	Weston Model 931	
Card Extender	ITT P/N 8004809	

Table 1-4. Equipment Required (Or Equivalent) But Not Supplied (Con't.)

DESCRIPTION	MODEL OR TYPE DESIGNATOR	FEDERAL STOCK NUMBER
Element, RF Power	Bird 25C	6625-00-980-8255
Element, RF Power	Bird 100C	6625-00-804-9671
Element, RF Power	Bird 25D	6625-00-581-5894
Element, RF Power	Bird 100D	6625-00-678-0464
Generator, RF	Hewlett Packard, 608	
Oscillator, Audio	Hewlett Packard, 200AB	6625-00-126-0196
Generator, Sweep *	Texscan, RS50	6625-00-411-0887YA
Multimeter *	Hewlett Packard, 427A	6625-00-135-0407YA
Voltmeter, RF *	Boonton, 91CA	6625-00-973-2294
Bench Top Exciter/LPA Test*	TS-3691/GRT	6625-01-038-7120
Generator	8121800G1	
Test Set, Radio AN/GRM-102*	8004801G1	6625-00-247-4713ZX
Attenuator, Variable	874-Gal	
Double Balanced Mixer	HP 10514A	
Puller, Circuit Card (optional)	1733	5210-00-409-3742
Tool Assy, Special Nut	8637112-10	5120-01-250-7244ZX

NOTE: Alternate r-f wattmeters may be used provided a d-c continuity is not required on the coaxial input.

(*) For depot use only.

CHAPTER 2

INSTALLATION

2-1. **INTRODUCTION.** Information and instructions necessary to unpack, install, make operable and prepare the VHF exciter, UHF exciter, VHF power amplifier and UHF power amplifier for reshipment are included in this chapter. Section I provides installation planning

information. Section II covers receipt and unpacking of the equipment. Section III provides installation procedures, and Section IV contains preparation for reshipment data.

SECTION I

INSTALLATION PLANNING

2-2. GENERAL.

2-3. The VHF exciter, UHF exciter, VHF power amplifier and UHF power amplifier are installed in standard relay racks in the Air Traffic Control Central.

No installation planning is required as the racks have provision to accept the chassis. Note: Slide, Drawer Extensions and Interface cable kit must be shipped with the radio set.

SECTION II

LOGISTICS

2-4. RECEIVING DATA.

2-5. The VHF exciter and the VHF power amplifier are each packed in a separate expanded polystyrene foam container. Each container is sealed in a snug fitting barrier pouch. The two units are packed in a single style A

cleated plywood box constructed of 3/8 inch plywood sheathing. The UHF exciter and the UHF power amplifier are packed identically to the VHF exciter and VHF power amplifier. Table 2-1 shows the packed and unpacked dimensions and weights of the units.

Table 2-1. Unpacking Data

QUANTITY	DESCRIPTION	UNPACKED DIMENSIONS	PACKED DIMENSIONS	UNPACKED WEIGHT	PACKED WEIGHT
1	VHF Exciter	5-1/4 in. high; 19 in. wide; 16-7/8 in. deep	21 in. high; 25 in. wide; 26 in. deep.	43 lbs.	150 lbs.
1	VHF Power Amplifier	7 in. high; 19 in. wide; 18-1/2 in. deep		70 lbs.	
1	UHF Exciter	5-1/4 in. high; 19 in. wide; 16-7/8 in. deep	21 in. high; 25 in. wide; 26 in. deep.	43 lbs	150 lbs.
1	UHF Power Amplifier	7 in. high; 19 in. wide; 18-1/2 in. deep		70 lbs.	

2-6. UNPACKING DATA.

2-7. Before unpacking the equipment, inspect the shipping containers for evidence of in-transit damage. After the equipment is unpacked, inspect for obvious damage such as bent or broken components, connectors, etc. Check particularly for any obvious damage to the connectors at the rear of the chassis.

2-8. CABLE REQUIREMENTS.

2-9. GENERAL. An interconnection cabling diagram is shown in figure 2-1. This diagram shows the cabling

interconnections required for the conventional 50 watt mode of operation with the exciter and power amplifier operating together. Interconnect cabling is also shown for exciter operation only when no power amplifier is connected. Mating connector types and cable requirements are shown in table 2-2.

CAUTION

Be sure to keep all cables clear of the air outlet above J9 at rear of power amplifier. Allow adequate clearance for exhaust air flow.

Table 2-2. Mating Connectors and Cabling to Exciter and Power Amplifier Rear Connectors

FROM	TO	CABLE	MATING CONNECTOR
Exciter J5	Remote Inputs		MS3106R24-28S
Exciter J8 (W5)	Power Amplifier J7	8006150G1	
Exciter J9 (W1)	AC Source	8006147G2	
Exciter K1J3 (W3)	Power Amplifier J8	8006145G1	
Exciter K1J4 (W4)	Power Amplifier J9	8006145G2	
Exciter K1J1	Antenna		Type N Male
Power Amplifier J1 (W2)	AC Source	8006147G3	

SECTION III

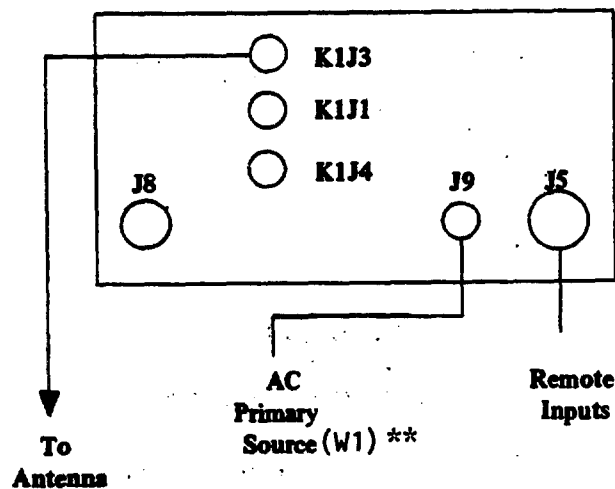
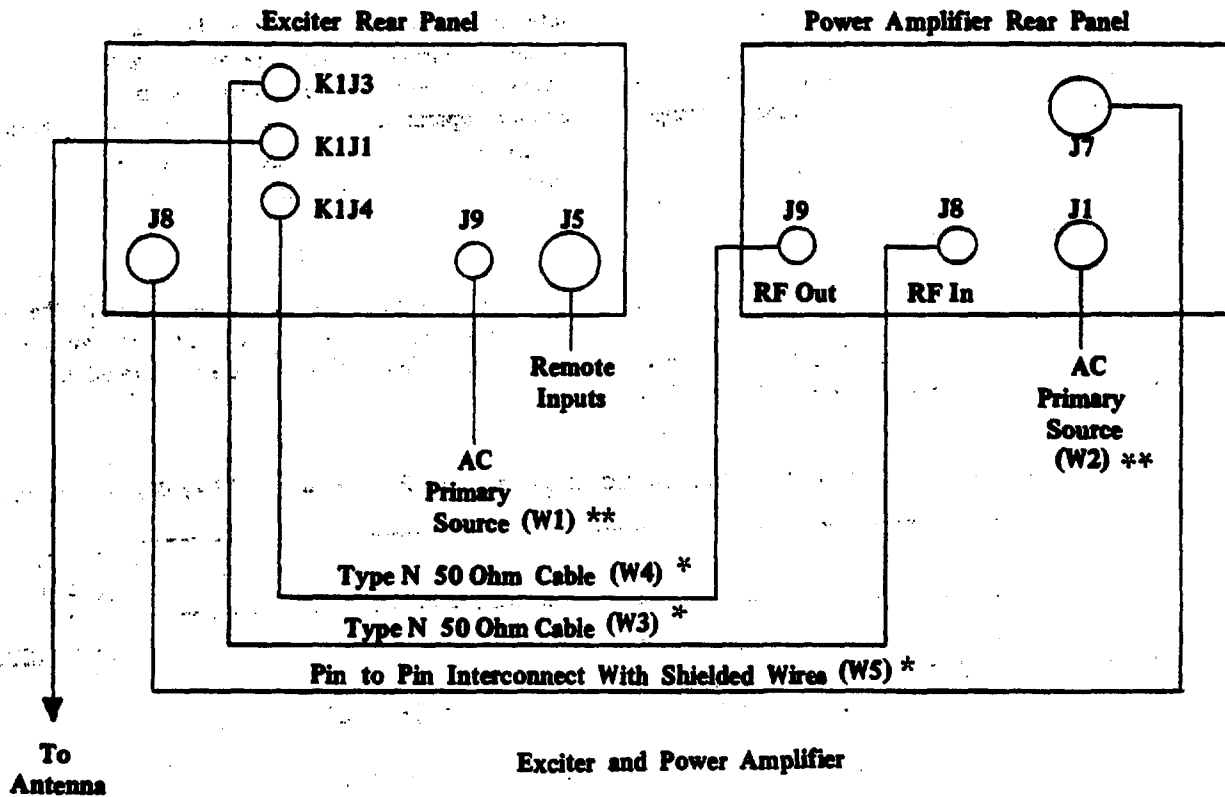
INSTALLATION PROCEDURES

2-10. INSTALLATION.

2-11. The VHF exciter, UHF exciter, VHF power amplifier and UHF power amplifier are each provided with a 3-section slide attached to each side of the chassis. The stationary member of each slide is provided with four 3/16-inch holes at one end and three 3/16-inch slots at the other end. These holes and slots are used for attaching the slides with machine screws to the corresponding rails in the rack. See figure 2-2 for a

typical view of the relay rack mounting bracket (left side).

2-12. EXCITER ONLY OPERATION. Both the VHF exciter and the UHF exciter are capable of on-the-air operation without their respective power amplifiers. See "Exciter Only" portion of figure 2-1 for cable connections.



* Approx. four (4) feet long.

** Approx. six (6) feet long with connector UP131M for connection to AC primary source power line.

Figure 2-1. Interconnecting Cabling Diagram

2-13. **EXCITER MOUNTING BRACKETS.** Figure 2-3 shows an outline drawing of a type A bracket required for a typical cabinet mounting. Four of these brackets are required for fixed installation.

2-14. Figure 2-3 also shows an outline drawing of a type B bracket required for MT-686 rack mounting. Four of these brackets are required for fixed installation.

2-15. Brackets may be fabricated for installation in other equipment enclosures by modifying the type A or type B brackets as appropriate.

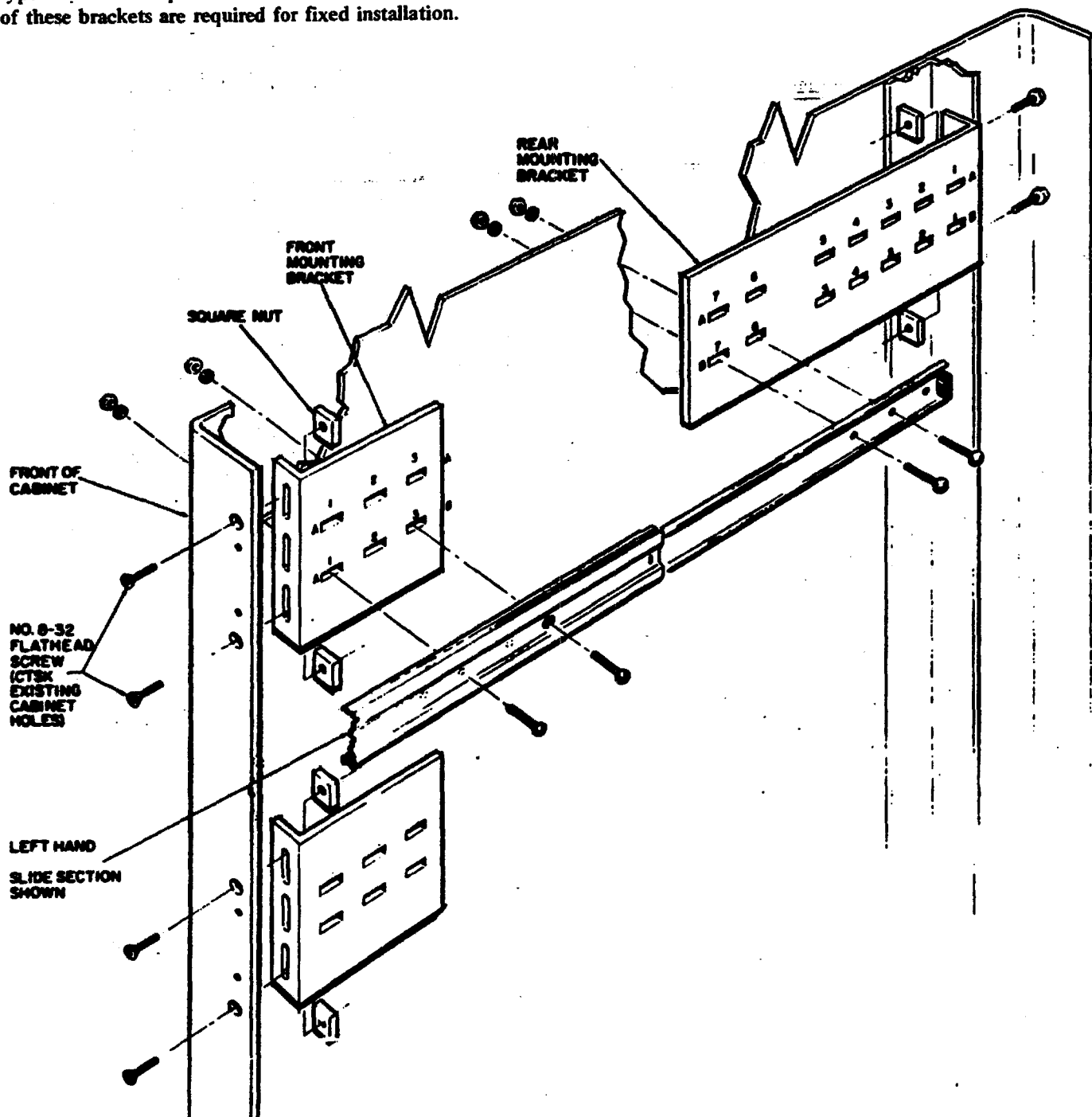
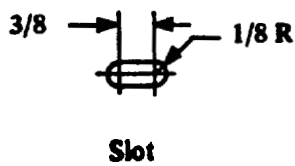
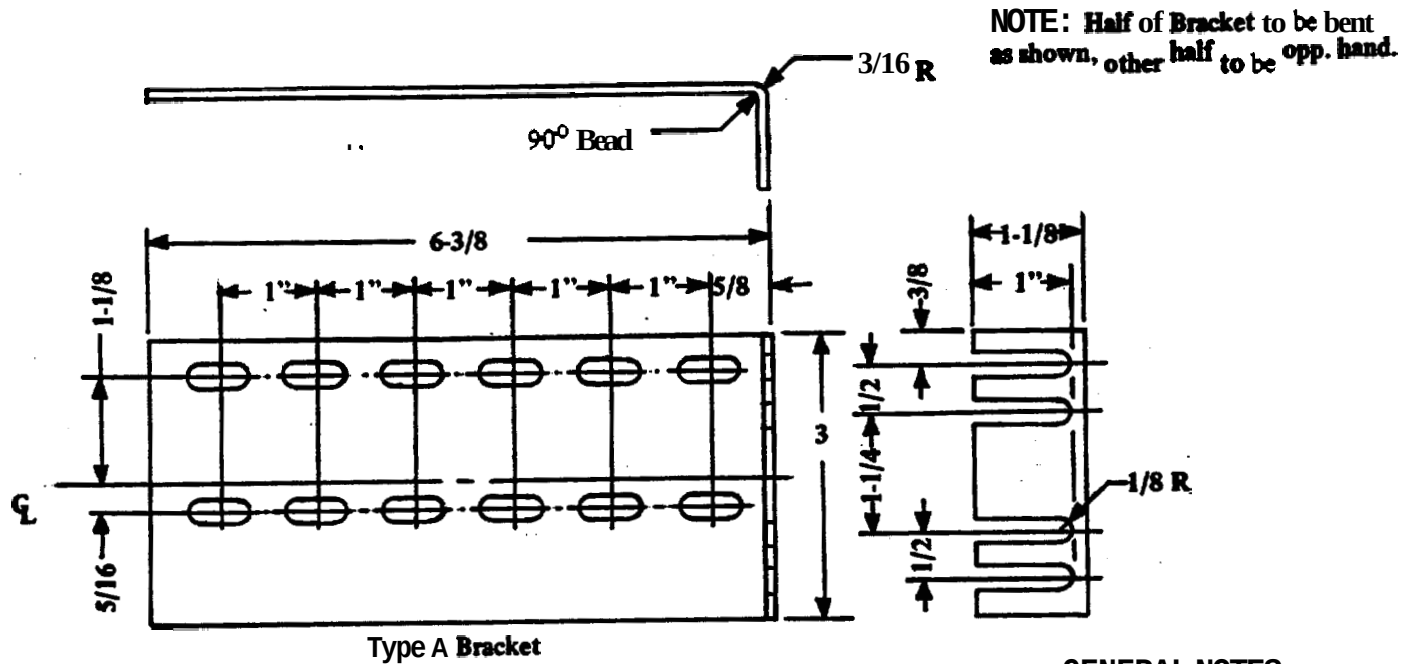


Figure 2-2. Typical View Relay Rack Mounting Bracket (Left Side)



GENERAL NOTES

1. Break all sharp edges.
2. Matl: 10 gage aluminum or 12 gage carbon sheet.
3. Finish: For steel only - primer coat zinc chromate 8010-297-0

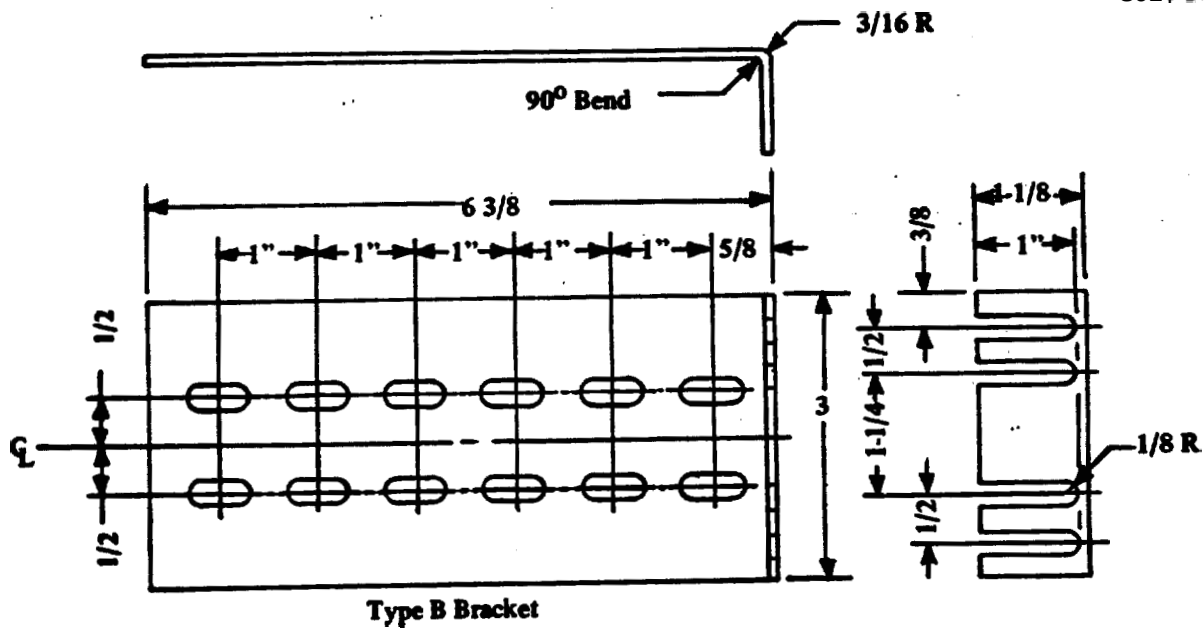


Figure 2-3. Mounting Brackets

2-16. After the slides have been firmly attached to the rack rails, connect the provided cables to their corresponding connectors at the rear of the chassis. Carefully slide the chassis into the rack observing that all cables have clearance and are not pinched or damaged. The two slots at each end of the panel on the VHF exciter and the UHF exciter allow for entry of hold-down screws into the rack.

2-17. INPUT POWER CONNECTIONS.

2-18. The transmitting sets are shipped from the factory with their input power connectors strapped for 120 vac. To utilize an input voltage of 105, 210, or 240 volts it is necessary to change the strapping arrangement on the exciter power supply, the power amplifier power supply control grid/thermal control/ac control, and the power amplifier high voltage power supply.

CAUTION

Observe strapping arrangement on back of cover and verify that input power transformers are correctly strapped for specific installation voltage. Figure 2-4 illustrates strapping arrangement. The ac line must always be connected to pins 1 and 5. This is a factory connection. DO NOT CHANGE

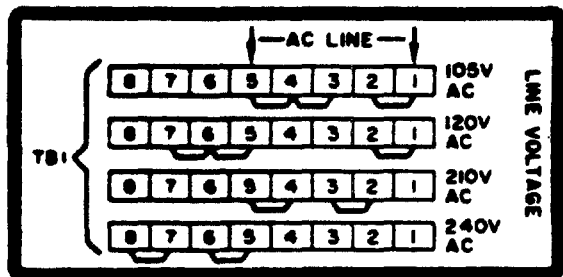


Figure 2-4. Strapping Arrangement

2-19. **EXCITER STRAPPING.** Remove top cover by loosening eleven 6-32 flat Phillips head captive screws. On the power supply module remove the four

Phillips head screws from the fiberglass cover, lift cover off providing access to the strapping arrangement terminal board. After completing strapping procedure replace fiberglass cover and print strapping voltage in space provided. Replace top cover.

2-20. **POWER AMPLIFIER STRAPPING.** Remove top cover by loosening four 6-32 flat Phillips head captive screws. On the high voltage power supply, lift up metal cover providing access to the strapping arrangement terminal board. On the power supply control grid/thermal control/ac control, lift off fiberglass cover held in place by snap fasteners providing access to the strapping arrangement terminal board. After completing strapping procedure on both power supplies replace covers and print strapping voltage in space provided. Replace top cover.

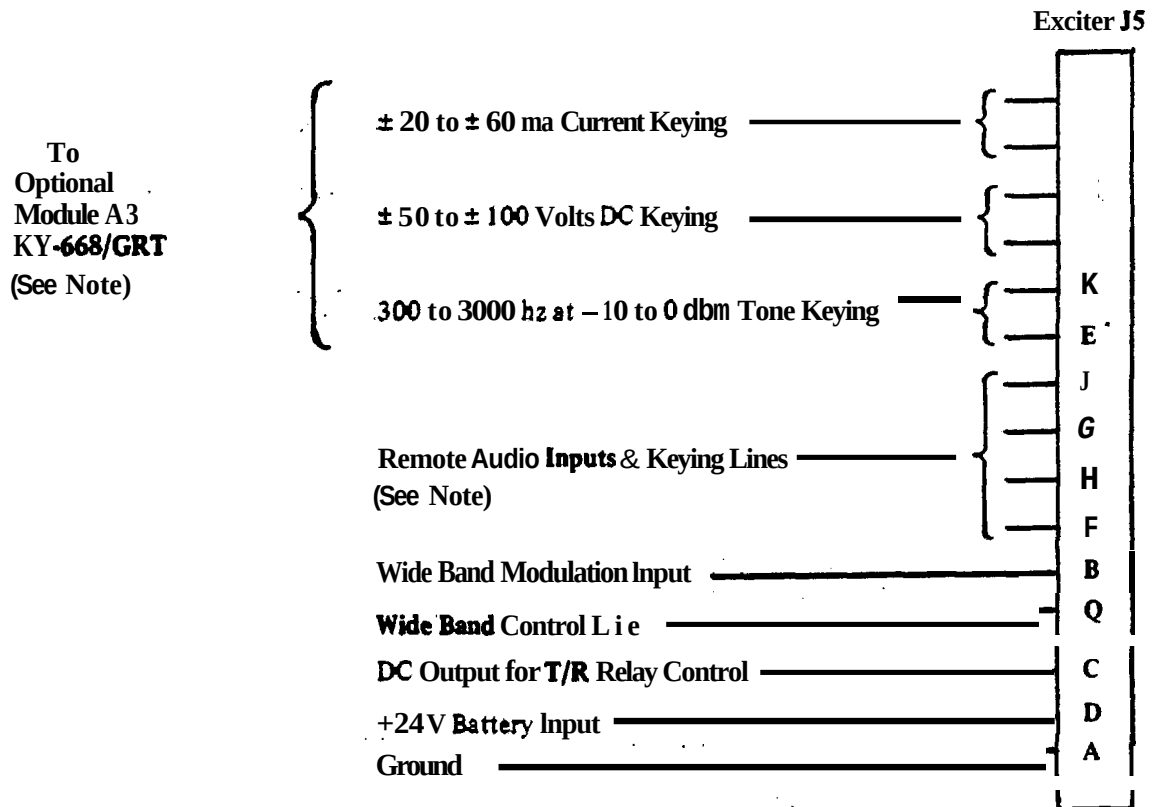
2-21. REMOTE INPUT CONNECTIONS.

2-22. Connector J5 on the rear panel of the exciter unit contains all lines for remote use, including:

- Audio input lines and remote keying using audio lines.
- Battery connections for emergency or dc operation.
- Wide band modulation input.
- Wide band modulation control line.
- Dc output for control of T/R relay or audio muting or for other desired T/R functions.
- Special keying lines when either of two optional keyers, Keyer KY-668/GRT or Inboard Monitor/Keyer, is installed in the A3 module socket. A special keying line is also available when the Line Amplifier is used in place of the Audio Compressor, A1.

g. Special status monitoring signals when the Inboard Monitor/Keyer (A3) is used.

2-23. **AUDIO INPUT AND REMOTE KEYING USING AUDIO LINES.** Refer to figures 2-8, 2-9, 2-10, and 2-11.



Note: For additional optional modules and the requirements for J5 inputs and outputs, refer to figures 2-8, 2-9, 2-10, and 2-11.

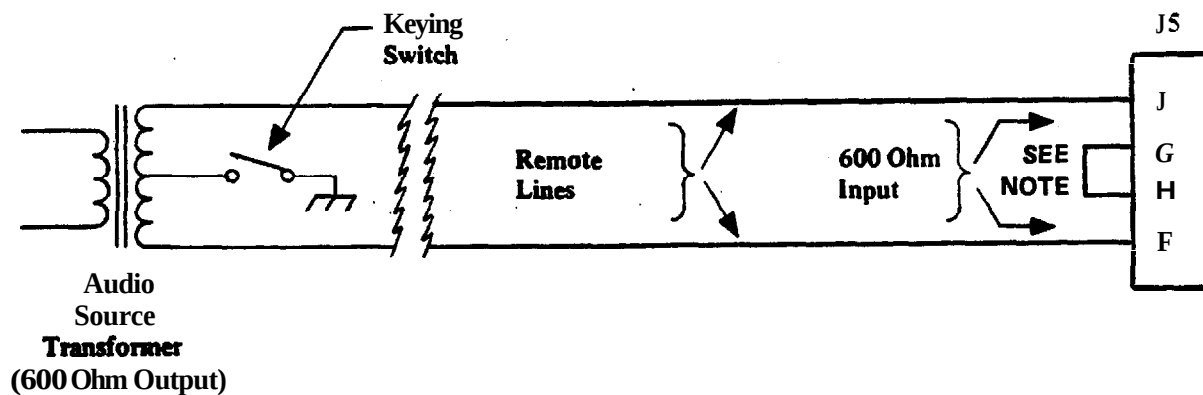


Figure 2-5. Remote Audio Input and Keying Circuit

a. The audio input and remote keying for exciters with serial numbers before approximately 28500 and not having the Inboard Monitor/Keyer (IM/K) modification are as follows. The audio input and keying lines are J5 pins J, G, H and F. Pins J and F are inputs for a 150 ohm audio line. Keying is accomplished by grounding pin G or H of the respective inputs, thus two separate 150 ohm remote audio inputs can be used, and keying can be accomplished at both sources. A 600 ohm single audio input can be obtained by jumping pins G and H, with the audio input on pins J and F. Keying is accomplished by grounding any of the audio lines; however, dc currents through the input should be kept below 5 ma to prevent distortion in the input audio transformer. Keying is best accomplished by grounding pins G or H which are the center taps of the input audio transformer when jumpered together. See figure 6-23 for details of the audio input circuit. A diagram of a recommended connection for remote audio input and keying circuit is shown in figure 2-5. Use of any of the optional module keying modes can also key the transmitter.

b. Exciters with serial numbers after approximately 28500 will have the Inboard Monitor/Keyer modification. On these units, only one 150 ohm input is available with the common input on J5-H and either J5-J or J5-F used as the other side of the 150 ohm input. The 600 ohm input is still between J5-J and J5-F. Audio line keying may be accomplished as it was before the IM/K modification if the Audio Compressor is used in place of Line Amplifier (A1). The audio input is the same when the Line Amplifier is used but the exciter cannot be keyed using the audio lines. This is discussed in the following paragraph.

2-24. AUDIO INPUT AND REMOTE KEYING USING LINE AMPLIFIER MODULE. Refer to figure 2-11. The audio input lines are J5 pins F & J for 600 ohm balanced or

unbalanced audio termination. Transmitter keying is accomplished by either ground keying or voltage keying of J5 pin H, when the appropriate interconnections are made on the printed circuit card. Ground keying is obtained when a jumper wire is soldered between terminals E3 and E5 on the line amplifier card A1. Voltage keying of +25 to +40 volts is obtained when the jumper is soldered between terminals E3 and E4 on the line amplifier card. The keying circuit is completely separate from the audio input circuit, unlike the audio compressor amplifier used alternatively with the line amplifier.

2-25. LOCAL INPUT CONNECTIONS

2-26. CARBON MICROPHONE. This front panel connector jack designated LOCAL MICROPHONE 1 mates with plug PJ068 for use with the M85/U carbon microphone.

2-27 DYNAMIC MICROPHONE. This front panel connector designated LOCAL MICROPHONE 2 mates with connector MS3106A-14S 5S which requires cable clamp MS3057-6.

2-28. EXTERNAL DC SOURCE. The exciter may be operated from an external 28-volt DC power supply or battery connected to J5, with positive output terminal to pin D and ground return to pin A. Maximum unloaded terminal voltage of the external DC source must not exceed 39 volts; minimum voltage measured from J5-D to J5-A with the transmitter under load (keyed and modulated) must not be less than 22 volts. The transmitter may be operated continuously from the DC source, or an external battery may be so connected to provide emergency power in event of failure of the AC power source. Switchover is accomplished automatically. A 100 amp-hr (AH) battery will provide power for approximately 15 hours to a transmitter continuously keyed. A battery charging circuit is built into the system which provides a nominal 300 mA charging current into the battery when the AC power is on and operating.

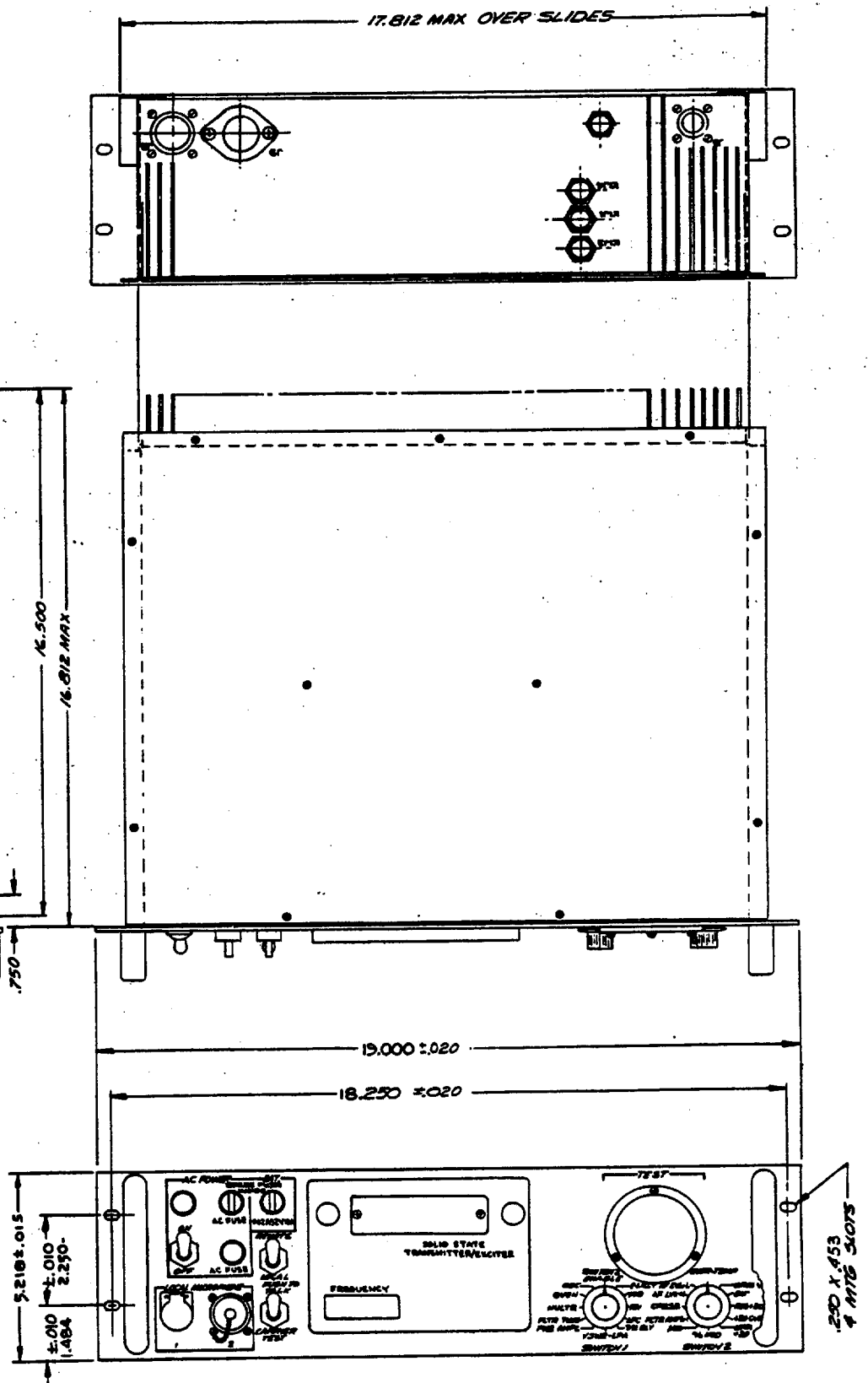


Figure 2-6. Exciter, Outline Dimension Drawing

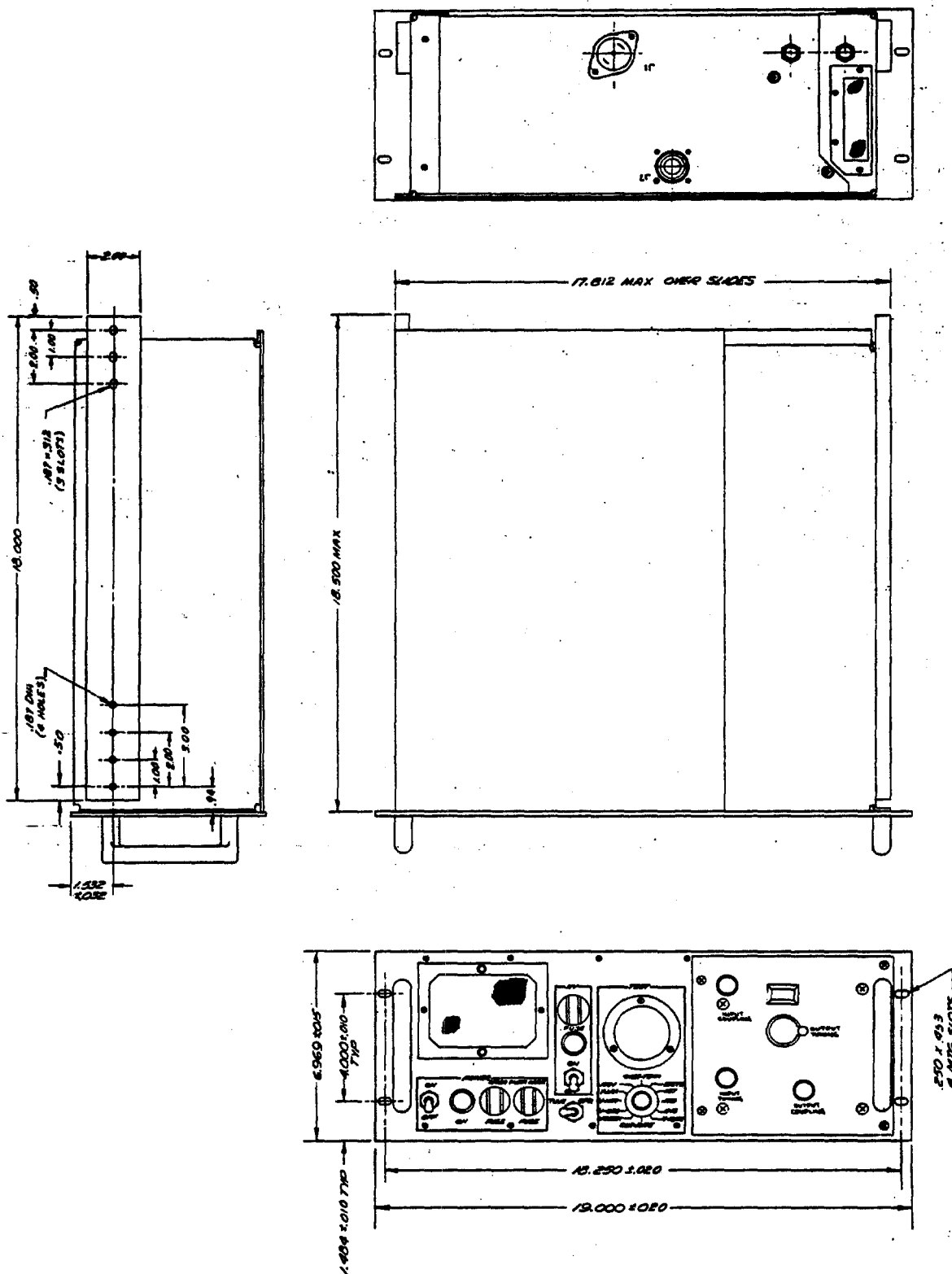


Figure 2-7. Power Amplifier, Outline Dimension Drawing

2-29. **WIDE BAND MODULATION.** A wide band modulation input signal level of 0 dBm at 600 ohms is connected into J5 pin B, and ground pin A. This input must always be unbalanced to ground. When using the wide band input, pin Q of J5 must always be grounded to switch off any audio inputs or noise coming from the audio input circuits. Keying must be accomplished by grounding either pins G or H on J5 (the same as for the audio input keying). Use of any of the optional module keying modes can also key the transmitter on wide band operation.

2-30. **T/R RELAY CONTROL LINE.** Pin C on J5 provides an output of 24 Vdc at 100 ma maximum when the transmitter is keyed on. This output can be used to drive a coaxial relay to disconnect receiver rf inputs from antenna when the transmitter is keyed on. The 24 volts can also be used to drive an audio muting relay in the output of receivers. Implementation and use of this output is to be devised by the user. The switching action of any external T/R relay used should be at least 20 milliseconds to prevent the set from switching to exciter only operation.

2-31. **SPECIAL KEYING LINES.**

2-32. **KY-668/GRT (OPTIONAL).** Pins P, N, M, L, K and E on J5 are for use with the optional module or special purpose keyer KY-668/GRT when used with this equipment. Three ungrounded keying modes, if desired, are available to key the transmitter with this module.

- a. +20 to +60 ma dc current.
- b. +50 to +100 volts dc voltage.
- c. 300 to 3000 hz tone at -10 to 0 dBm (600 ohms).

Details of the input circuits can be seen in figure 6-32.

2-33. **INBOARD MONITOR/KEYER (OPTIONAL).** Refer to figures 2-10 and 2-11. The Inboard Monitor/Keyer (A3) provides special keying lines when installed in excitors with serial numbers after approximately 28500 and those excitors

with modification kit 8004201 installed. The Inboard Monitor/Keyer can be used in either a VHF or a UHF exciter and no field adjustments are required for special keying. When the Inboard Monitor/Keyer is used as A3, pin N of J5 is available for voltage keying. Keying voltages of +6 Vdc, +24 Vdc, or +48 Vdc may be used when the appropriate connection is made on the A3 card. Pin M of J5 is the ground keying input which is separate from the ground keying using the audio lines and requires a separate remote line.

2-34. **SPECIAL STATUS MONITOR OUTPUTS WITH INBOARD MONITOR/KEYER.** To assure a minimum amount of unwanted radiation, a cable of 10 ± 0.25 inches shall be added to the existing installed cable of 8.41 ± 0.25 inches, for a total overall length of 18.41 ± 0.25 inches, and installed between the driver/power amplifier and low pass filter. The following material is required for the assembly of the additional cable length referenced above.

<u>MONITORED SIGNAL</u>	<u>J5 PIN</u>
Forward Power Level	E
Reverse Power Level	K
Percent Modulation Level	L
Audio Input Level	P
Exciter vs. LPA Operation	G

The output impedance on each line is 300 ohms except for the Exciter vs. LPA operation line which is 5.1K ohms. Detailed operational characteristics are presented in paragraph 4-111C.

2-35. **INSTALLATION OF OPTIONAL AFCS A3 KEYER CARD.** The AFCS A3 keyer card is designed to plug into socket XA3 in the exciter of either the AN/GRT-21(V) or the AN/GRT-22(V). The instructions for installation and adapting the various keying methods required at a facility are contained in Figures 2-8 and 2-9. AFCS installation standard drawing LDBW and 00133-WD000 is the engineering source document.

2-36. **LOW LEVEL AUDIO INPUT OPTIONAL STRAPPING.** If the signal level on the remote audio input lines cannot maintain a signal level of -15 dBm to +10 dBm, a jumper can be added on the audio amplifier compressor card or line

amplifier card, module A1, to increase audio sensitivity so that a -35 dBm to -15 dBm (-35 dBm = 13.8 millivolts at 600 ohms, -15 dBm = 138 mv at 600 ohms) audio input level can be utilized. Two terminals located on the lower center of of audio compressor module and on the lower left of the line amplifier module labeled E1 and E2 are the terminals to be shorted by soldering a jumper across them to obtain sensitivity to -35 dBm audio signals. When the jumper is in place, the audio signal level metering is no longer calibrated so that figure 5-6 no longer pertains to input signal level.

2-37. VHF CABLE ASSEMBLY. When the VHF exciter is used without the power amplifier there may be undesirable levels of spurious antenna radiations. On early configuration exciters, the cable length between the driver/power amplifier and the low pass filter is 8.41 ± 0.25 inches. To assure a minimum amount of unwanted radiation, a cable of 10 ± 0.25 inches shall be added to the existing installed cable of 8.41 ± 0.25 inches for a total overall length of 18.41 ± 0.25 inches, and installed between the driver/power amplifier and low pass filter. The following material is required for the assembly of the additional cable length referenced above.

<u>Item</u>	<u>Qty</u>	<u>Part Number</u>	<u>Description</u>
1	1	M39012/27-0001	Connector, coaxial receptacle
2	1	M39012/26-0001	Connector, coaxial plug
3	AR	RG142B/U	Coaxial Cable

2-38. TUNEUP AND TEST.

2-39. Refer to paragraphs 3-6 through 3-15 for starting, tuning, operating, and stopping procedures for the exciter and power amplifier.

2-40. Both the VHF exciter and power amplifier and the UHF exciter and power amplifier have been completely aligned at the factory and should require no further alignment. If performance is not satisfactory recheck the starting and tuning procedures. If performance is still not satisfactory refer to the appropriate section of Chapter 5 to locate and correct the trouble.

SECTION IV

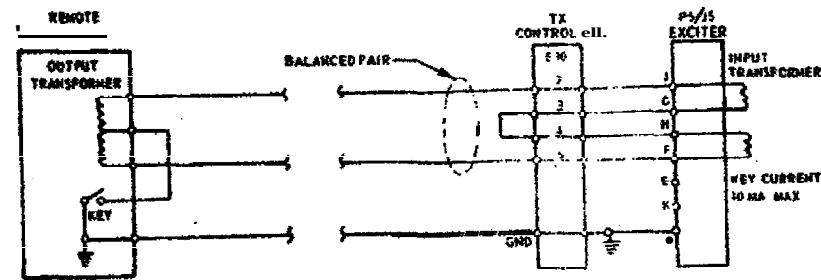
PREPARATION FOR RESHIPMENT

2-41. GENERAL

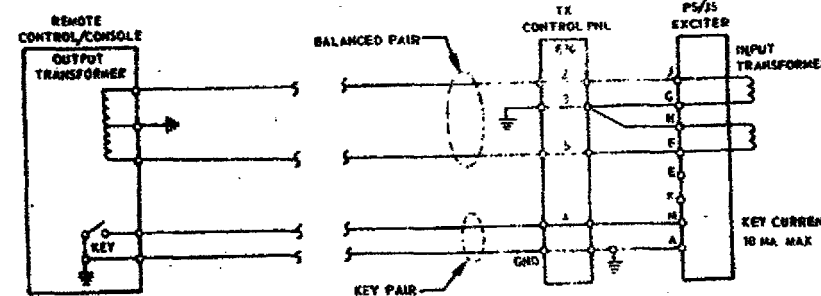
2-42. The preferred method of packing for reshipment is to use the original shipping containers, if available. If the original packing material is not available, repack the units in separate cartons using an over-wrap and suitable cushioning to protect the units.

NOTE

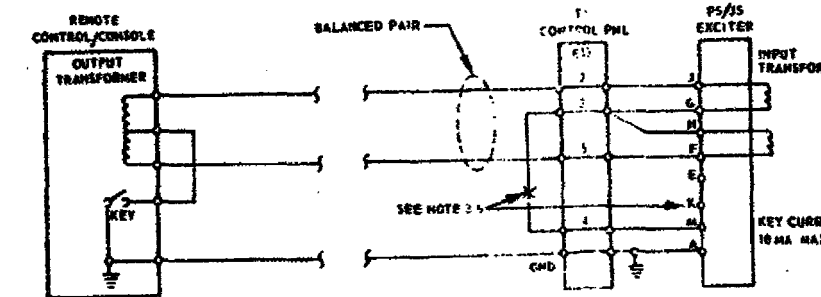
Slide, drawer extensions and interface cables must be shipped with the radio set.



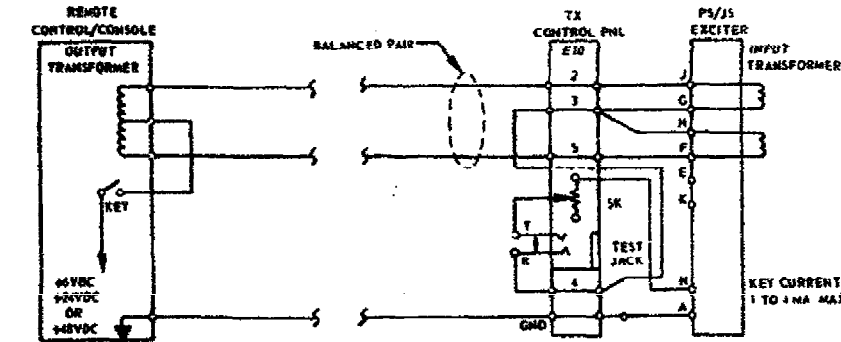
**ORIGINAL KEY CIRCUIT .
DRY-CONTACT KEYING FROM REMOTE CONTROL/CONSOLE
DETAIL A**



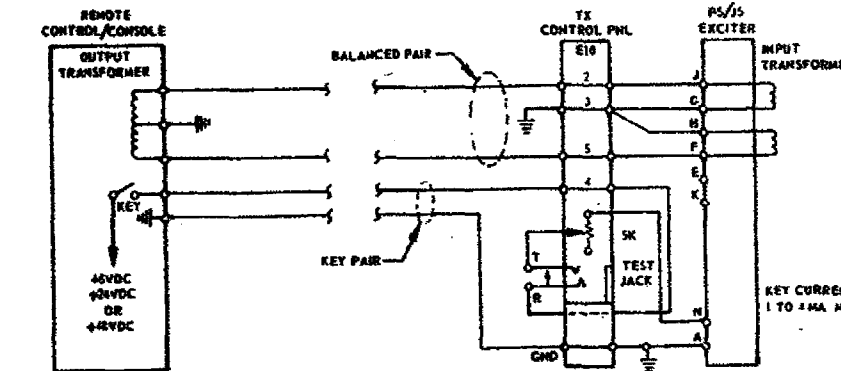
**SEPARATE LINE
DRY-CONTACT KEYING FROM REMOTE CONTROL/CONSOLE
DETAIL B**



**AUDIO LINE
DRY-CONTACT KEYING FROM REMOTE CONTROL/CONSOLE
DETAIL C**



**AUDIO LINE
VOLTAGE KEYING FROM REMOTE CONTROL/CONSOLE
DETAIL D**



**SEPARATE LINE
VOLTAGE KEYING FROM REMOTE CONTROL/CONSOLE
DETAIL E**

**REMOTE KEYING ADAPTATION
PER AFCS DWG. LDBWS00133WD000
A-3 CARO**

LABEL 1

GENERAL NOTES

- THIS DRAWING DESCRIBES THE VARIOUS BASIC METHODS OF KEYING THE AN GRT-21 AND AN GRT-22 USING THE NEW AFCS A3 KEYS CARD AND THE CIRCUIT CHANGES NECESSARY TO ATTAIN THE DESIRED CAPABILITY.
- IN ORDER TO USE THE NEW KEYS CARD "A3" IN THE AN GRT-21 OR 22 IT IS NECESSARY TO CHANGE THE TERMINATION OF ONE WIRE. THE FOLLOWING STEPS APPLY:
 - CAREFULLY REMOVE THE COVER OF THE EXCITER AND SLIDE OUT THE FOLLOWING PLUG-IN ASSEMBLIES: FUSE COVER, COMPRESSOR CARD A1, KEYS CARD A2, FILTER AMPLIFIER CARD A4, AND BUFFER MOD A5. SET THESE ASIDE SO THAT THEY WILL NOT BE DAMAGED OR THEIR ADJUSTMENTS DISTURBED.
 - POSITION THE EXCITER ON THE BENCH SO THAT IT IS SUPPORTED ON THE FRONT END BY THE TWO HANDLES.
 - LOCATE THE REAR OF THE LOCAL REMOTE SWITCH AND ITS TERMINALS. SEE SHEET 2 THIS DRAWING. ON TERMINAL 3 ARE TWO BROWN COVERED WIRES. UNSOLDER THESE FROM TERMINAL 3 AND SEPARATE. ONE OF THESE WIRES GOES TO PIN 9 OF THE A1 PLUG-IN SOCKET. THIS CAN READILY BE DETERMINED WITH AN OHM METER. THE OTHER WIRE GOES TO PIN 11 OF THE A3 PLUG-IN SOCKET. RESOLDER IT TO TERMINAL 3 OF THE LOCAL REMOTE SWITCH.
 - LOOSEN THE A3 PLUG-IN SOCKET AND CAREFULLY TURN IT OVER. LOCATE TERMINAL PIN 3 ON IT. TAKE THE BROWN WIRE GOING TO PIN 9 OF THE A1 PLUG-IN SOCKET WHICH WAS UNSOLDERED FROM THE LOCAL REMOTE SWITCH AND CAREFULLY REMOVE IT FROM THE FIRST TYP. RAY. THEN REROUTE THE WIRE AND SOLDER IT TO TERMINAL 3 OF THE A3 PLUG-IN SOCKET.
 - REMOINT THE A3 CARD SOCKET AND CAREFULLY INSTALL THE REMOVED CARDS IN THEIR SOCKETS. CAUTION: EACH CARD IS KEYS WITH SLOTS, DO NOT TRY TO FORCE IN THE WRONG LOCATION. THIS CONSTITUTES ALL INTERNAL WIRING CHANGES REQUIRED.
- INSTALL THE NEW AFCS A3 KEYS CARD IN THE A3 PLUG-IN-EL. THE EXCITER IS NOW READY TO BE KEYS BY VARIOUS METHODS WITHOUT KEYS VOLTAGE ON THE INPUT LINES WHEN UNKEYED.
- THE EXCITER CAN BE KEYS BY THE FOLLOWING METHODS USING THE NEW A3 KEYS CARD. LOCAL REMOTE SWITCH IN REMOTE:
 - GROUNDING PIN "H" OF JS WILL ENABLE KEYS CHROUT LOCALLY OR OVER A SEPARATE P. R. NO KEYS VOLTAGE WILL APPEAR ON AUDIO INPUT LINES. (SEE DETAIL B)
 - PUTTING A JUMPER ACROSS PINS "E" AND "K" OF THE PLUG JS THAT GOES INTO JS WILL ENABLE THE EXCITER TO BE KEYS THE SAME AS BEFORE THE ADDITION OF THE A3 CARD AND THE WIRING CHANGE (SEE DETAIL D). REMOVE JUMPER BETWEEN TERMINALS 3 AND 4 ON E10.
- WITHOUT A JUMPER ACROSS PINS "E" AND "K", A POSITIVE KEYS VOLTAGE APPLIED LOCALLY OR OVER A SEPARATE PAIR THROUGH THE TRANSMITTER CONTROL PANEL TO PIN "H" OF PS WILL KEY THE EXCITER. THE A3 CARD AS RECEIVED IS ACCEPTABLE FOR 24 OR 36 VDC KEYS WHEN USED WITH THE TRANSMITTER CONTROL PANEL WHICH IS EQUIPPED WITH A 5K OHM POT.
 - ADJUST RESISTANCE CHANGING (SEE BRACKETED DRAWING) TO KEYS.
 - WITH THE ADVENT OF LOW LEVEL KEYS (1.4 VDC) THE A3 CARD WILL BE USED. IT HAS BEEN PROVIDED WITH THE MEANS TO INSTALL AN OPTIONAL JUMPER THAT WILL SHORT OUT THE 10K OHM RESISTOR (SEE SHEET 2). WHEN THIS IS DONE LOOP ADJUSTMENT AT THE TRANSMITTER CONTROL PANEL IS ACCOMPLISHED AS IN "C" ABOVE (SEE DETAILS D AND E).
 - THE KEYS VOLTAGE VARIATION IN "C" AND "D" ABOVE ARE OVER SEPARATE KEYS PAIRS. ALL THREE OF THESE VOLTAGE VARIATIONS CAN BE ACCOMPLISHED OVER THE AUDIO INPUT LINES BY CONNECTION "H" OF THE EXCITER VIA THE TRANSMITTER CONTROL PANEL TO THE CENTER TAP OF THE "G" AND "H" AT THE TRANSMITTER CONTROL PANEL. (SEE DETAIL D AND E)
- AFTER THE NEW AFCS A3 CARD IS INSTALLED IN ACCORDANCE WITH THIS DRAWING, PRESSURE SENSITIVE PAPER LABEL (PSN 7530 R2 0066 OR EQUIVALENT) WILL BE TYPED IN RED WITH THE LEGENDS (SEE LABELS 1 & 2). THE FIRST WILL BE APPLIED TO THE FRONT OF THE EXCITER ACCESS DOOR DIRECTLY BELOW THE NOMENCLATURE PLATE. THE SECOND LABEL WILL BE APPLIED TO THE TX CONTROL PANEL DIRECTLY BELOW THE KEYS PAIR SPACE PROVIDED BY THE DETAIL D AND E. ETC.

**KEYING WIRED PER AFCS
DWG LDBWS00133WD000
FIG.**

LABEL 2

Figure 2-8. Keying Methods W/AFCS A3-Card, AN/GRT-21(V) & AN/GRT-22(V)

(Sheet 1 of 2)

Change 11 2-13/(2-14 blank)

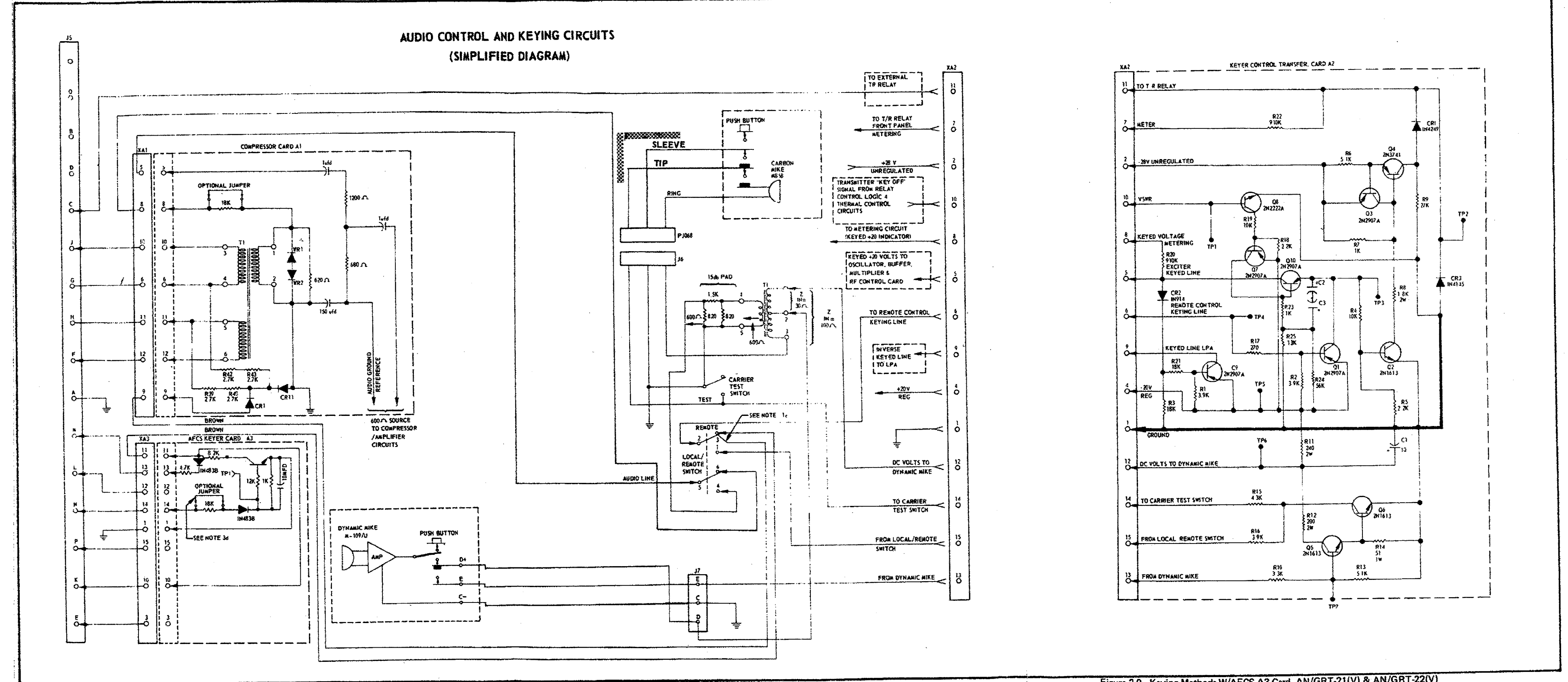
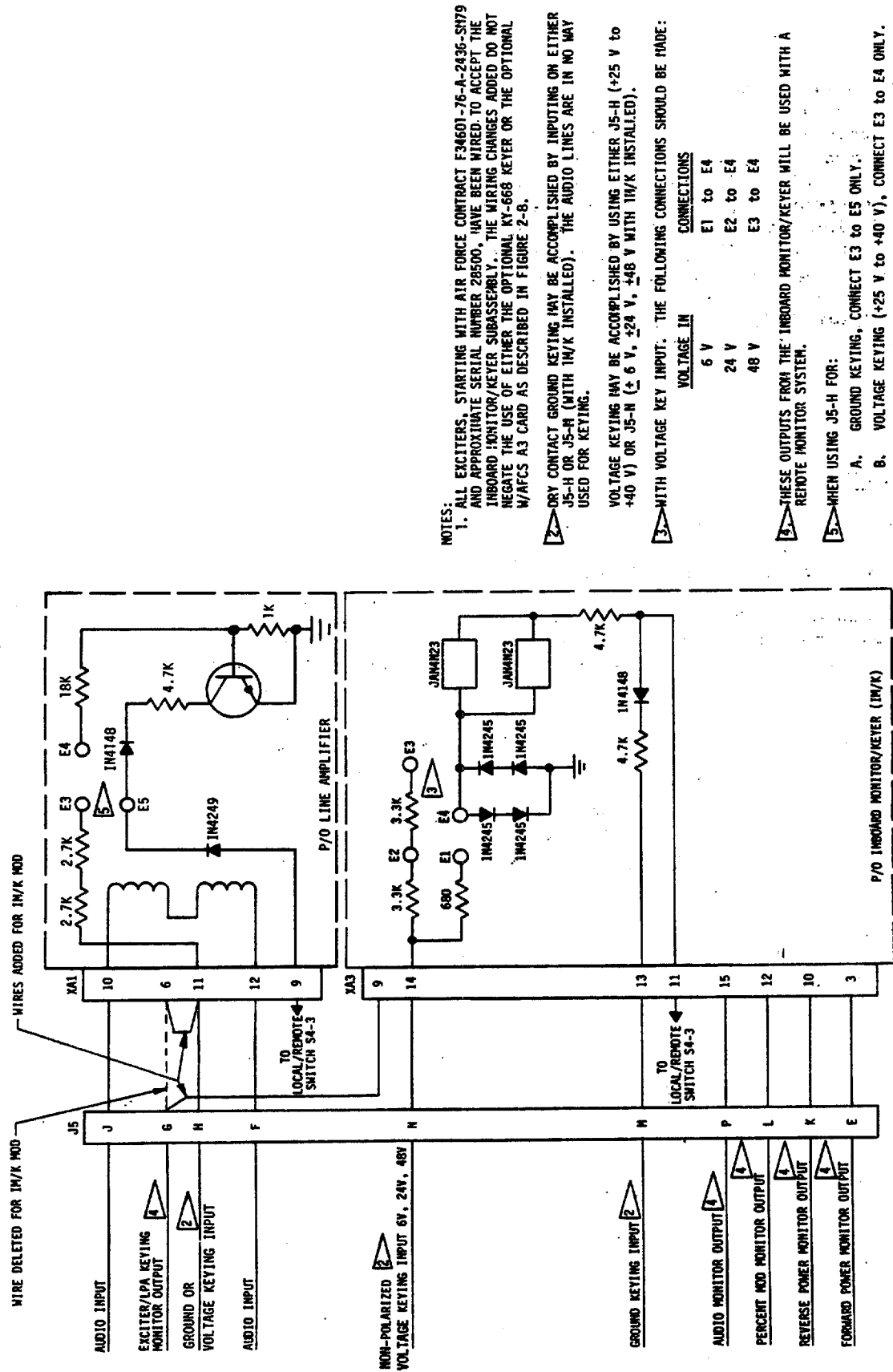


Figure 2-9. Keying Methods W/AFCS A3-Card, AN/GRT-21(V) & AN/GRT-22(V)





- NOTES:
1. ALL EXCITERS, STARTING WITH AIR FORCE CONTRACT F34601-76-A-2436-SH79 AND APPROXIMATE SERIAL NUMBER 28500, HAVE BEEN WIRED TO ACCEPT THE INBOARD MONITOR/KEYER SUBASSEMBLY. THE WIRING CHANGES ADDED DO NOT NEGATE THE USE OF EITHER THE OPTIONAL KY-668 KEYS OR THE OPTIONAL W/AFCS A3 CARD AS DESCRIBED IN FIGURE 2-8.
 2. DRY CONTACT GROUND KEYING MAY BE ACCOMPLISHED BY INPUTTING ON EITHER J5-H OR J5-N (WITH IM/K INSTALLED). THE AUDIO LINES ARE IN NO WAY USED FOR KEYING.
 3. VOLTAGE KEYING MAY BE ACCOMPLISHED BY USING EITHER J5-H (+25 V to +40 V) OR J5-N (± 6 V, ± 24 V, ± 48 V WITH IM/K INSTALLED).
 4. WITH VOLTAGE KEY INPUT, THE FOLLOWING CONNECTIONS SHOULD BE MADE:

VOLTAGE IN	CONNECTIONS
6 V	E1 to E4
24 V	E2 to E4
48 V	E3 to E4
 5. THESE OUTPUTS FROM THE INBOARD MONITOR/KEYER WILL BE USED WITH A REMOTE MONITOR SYSTEM.
 6. WHEN USING J5-H FOR:
 - A. GROUND KEYING, CONNECT E3 TO E5 ONLY.
 - B. VOLTAGE KEYING (+25 V to +40 V), CONNECT E3 TO E4 ONLY.

Figure 2-11. Keying Methods Using Inboard Monitor/Keyer (IM/K) A3 Card and Line Amplifier.

CHAPTER 3

OPERATION

3-1. **INTRODUCTION.** This chapter contains operation information and instructions for the VHF exciter, UHF exciter, VHF power amplifier, and UHF power amplifier. Basic operation information is identical for both exciters and power amplifiers. The chapter is divided into three sections. Section I illustrates and describes the functions of all controls, indicators, and interlocks. Section II provides operating instructions. Starting, operating, tuning, and stopping procedures are provided. Section III con-

trols Emergency Operation procedures.

CAUTION

Do not key the transmitter on 121.5 MHz or 243.0 MHz for over 15 seconds. A continuous key of 30 seconds will activate the International Search and Rescue Satellite (SARSAT), to be used only in an actual emergency or distress situation.

SECTION I

CONTROLS AND INDICATORS

3-2. GENERAL.

3-3. This section contains illustrations and tables to identify and describe the functions of all controls and indicators.

3-4. Controls and indicators are listed and defined in tables 3-1 and 3-2 and illustrated in figures 3-1 and 3-2.

3-5. **INTERLOCKS.** Removal of the top cover of the power amplifier disables the primary input power to its high voltage supply. This is effected by a spring-loaded switch S1 on the top of the control grid/thermal control module. This is the only mechanically activated interlock on either the exciter or power amplifier.

Table 3-1. VHF/UHF Exciter Controls and Indicators

CONTROL OR INDICATOR	REF DES	FUNCTION
AC POWER		
ON-OFF		
Toggle Switch	S5	When placed in ON position provides primary power to the exciter.
Indicator Lamp	DS1	Illuminates when POWER ON-OFF switch is in the ON position.
AC FUSE (upper)	F1*	Two 6 ampere fuses in 105-120 vac line. Two 3 ampere fuses in 210-240 vac line.
AC FUSE (lower)	F2*	Indicating fuse holders glow when fuse is blown.
BAT F02A32V10A	F3*	Single 10 ampere fuse in positive side of battery input. Indicating fuse holder glows when fuse is blown.

*NORMAL BLOW TYPE FUSES

Table 3-1. VHF/UHF Exciter Controls and Indicators (Cont.)

CONTROL OR INDICATOR	REF DES	FUNCTION
REMOTE-LOCAL Toggle Switch	S4	Provides for operation from LOCAL MICROPHONE input or remote audio.
LOCAL MICROPHONE 1	J6	Carbon microphone input (M-85/U)
2	J7	Dynamic Microphone input (M-109/U)
PUSH TO TALK - CARRIER TEST Toggle Switch	S3	Keys exciter on in CARRIER TEST position for test purposes.
The following controls are behind the front panel access door.		
Tunable Filter Module		
IN Screwdriver Adjust	C1	Tunes input section of filter for peak bandpass.
OUT Screwdriver Adjust	C2	Tunes output section of filter for peak bandpass.
Oscillator Module		
OSC Screwdriver Adjust	C13	Tunes crystal oscillator for peak output.
(Oscillator-Synthesizer) Thumbwheel Switches	S1,S2,S3,S4	Selects operating frequency of oscillator-synthesizer
Oscillator-Multiplier		
FREQ ADJ	C3	Frequency fine tune
OSC	C10	Frequency tune
BUF	C16	Frequency tune
AMPL	C21	Frequency tune
BUF Screwdriver Adjust	C3 J1	Tunes buffer stage for peak output. Provides for external oscillator input in lieu of crystal
Doubler Module (VHF) Quadrupler Module (UHF)		
	VHF	UHF
QUAD/DOUBLER Screwdriver Adjust	C5	C15 Tunes quadrupler/doubler stage for peak output.
BUFFER Screwdriver Adjust	C11	C22 Tunes buffer stage for peak output.

Table 3-1. VHF/UHF Exciter Controls and Indicators (Cont.)

CONTROL OR INDICATOR	REF DES	FUNCTION
* AMPL		
Screwdriver Adjust	C28	Tunes amplifier stage for peak output.
LEVEL ADJ		
Screwdriver Adjust	R9 R15	Sets proper output voltage level of quadrupler/doubler module.
TUNE-OPERATE Switch	S6	Reduces B+ on driver amplifier (A10) to prevent probability of arcing within filter FL2 during tuning procedure.
CARRIER LEVEL	R8	Fine adjustment of rf output power.
MOD LEVEL	R1	Adjustment of modulation percentage (AM).
* This Control Not on VHF Module.		
TEST		
Meter	M1	Indicates voltage or current as determined by SWITCH 1 or SWITCH 2 positioning.
SWITCH 1	S1	
E-L RLY		Meter reading indicates that exciter power amplifier transfer relay is energized thereby connecting exciter output to antenna. With no meter reading exciter output is fed to input of power amplifier.
FWD		Indicates forward power to antenna.
RVS		Indicates reflected power to exciter.
APC		Indicates automatic power control regulator output voltage.
T/R RLY		Indicates state of transmit/receive relay voltage. No reading indicates carrier off.
VSWR-LPA		Indicates antenna mismatch condition of power amplifier or power amplifier malfunction.
PWR AMPL		Indicates detected rf signal at driver/power amplifier output.
FLTR TUNE		Indicates driver amplifier collector current in TUNE position only (S6).

Table 3-1. VHF/UHF Exciter Controls and Indicators (Cont.)

CONTROL OR INDICATOR	REF DES	FUNCTION
MULTR		Indicates output of doubler or quadrupler.
OVEN		Indicates oven heater current.
OSC		Indicates output of oscillator stage or oscillator-synthesizer.
SWITCH 2 ENABLE		Enables SWITCH 2 to provide its position readings on meter.
SWITCH 2	S2	
UNREGLTD V		Indicates the unregulated power supply voltage.
BAT		Indicates the battery voltage when POWER ON-OFF switch is OFF.
RGLTD +20		Indicates the +20 buss voltage
+20 CUR		Indicates +20 buss current.
KEYED +20		Indicates the keyed +20 voltage.
% MOD		Indicates modulation percentage (75% to 100% modulation)
MOD		Indicates modulation output from rf control/modulator module
FLTR AMPL		Indicates output of audio filter amplifier
CPRSR		Indicates output of af compressor preamplifier or line amplifier when used.
AF LVL-H		Indicates remote audio input power level from -15 to +8 dbm
AF LVL-L		Indicates remote audio input power level from -18 to -2.5 dbm
OVER-TEMP		Monitors over-temperature sensing circuit. Indicates "go/no go"

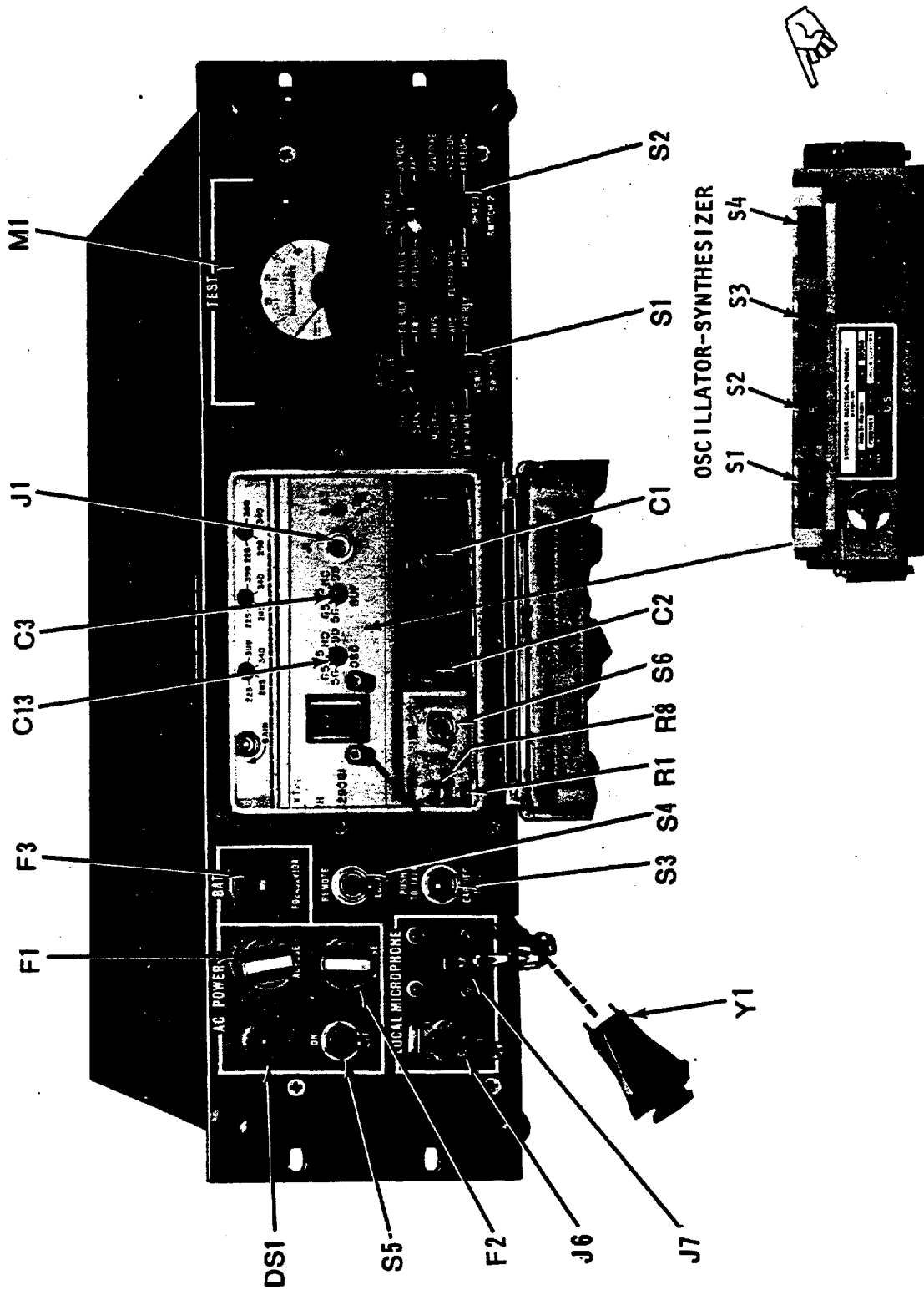


Figure 3-1. VHF Exciter and UHF Exciter Controls and Indicators (Sheet 1 of 2).

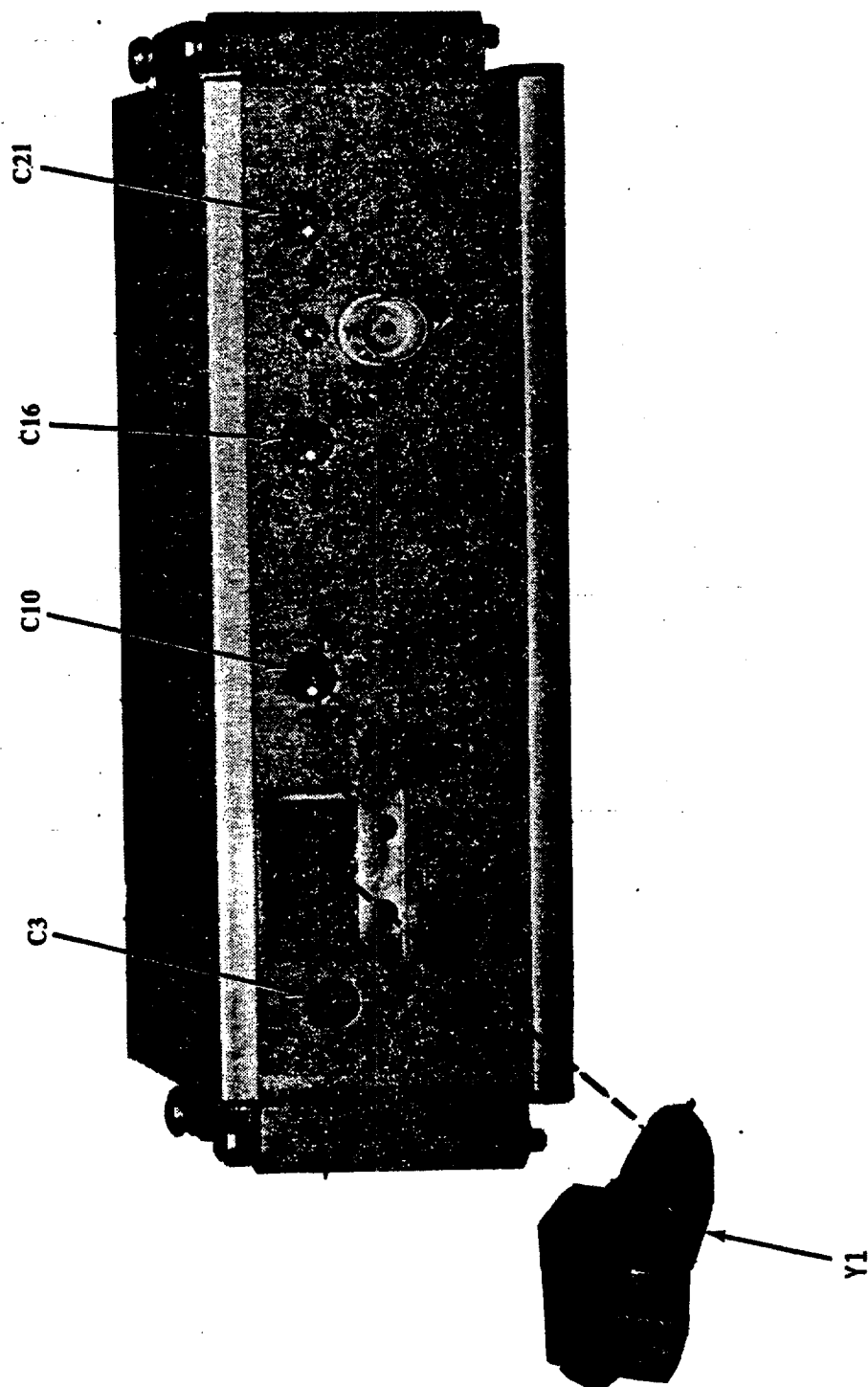


Figure 3-1. VHF Exciter and UHF Exciter Controls and Indicators (Sheet 2 of 2) (Oscillator-Multiplier Only)

Table 3-2. VHF/UHF Power Amplifier Controls and Indicators

CONTROL OR INDICATOR	REF DES	FUNCTION
POWER		
ON-OFF		
Toggle Switch	S1	When placed in ON position, provides primary power to the power amplifier.
Indicator Lamp	DS1	Illuminates when POWER ON-OFF switch is in the ON position.
Fuse (left)	F1*	One 2-Ampere Fuse in 105-120 VAC line. One 1.0-ampere fuse in 210-240 vac line. Indicating fuse holders glow when fuse is blown.
Fuse (right)	F2*	One 15-ampere fuse in 105-120 vac line. One 10-ampere fuse in 210-240 vac line.
HV		
FUSE	F3*	One 10-ampere fuse in 105-120 vac line. One 10-ampere fuse in 210-240 vac line. Indicating fuse holder glows when fuse is blown.
Indicator Lamp	DS2	Illuminates when time delay has elapsed after placing POWER ON-OFF switch to ON position allowing filament of power amplifier tube to heat and when HV ON-OFF switch is in ON position.
ON-OFF		
Toggle Switch	S4	When placed to ON position, provides primary power to high voltage power supply.
<u>WARNING</u> Prior to any fuse replacement disconnect power connections.		
TUNE-OPERATE		
Toggle Switch	S3	When in TUNE position provides reduced excitation to power amplifier for tuning purposes.
TEST		
Meter	M1	Provides indications per function switch positions.
Function Switch	A5S1	
EXCTR		Indicates exciter connected and on.

*Normal blow type fuses

Table 3-2. VHF/UHF Power Amplifier Controls and Indicators (Cont.)

CONTROL OR INDICATOR	REF DES	FUNCTION
KEY		Meter indicates 20 with exciter keyed.
FWD		Indicates forward power to antenna.
RVS		Indicates reflected power to amplifier.
V-PLATE		Indicates plate supply voltage.
CUR-PLATE		Indicates plate current.
V-SCREEN		Indicates screen supply voltage.
V-GRID		Indicates control grid voltage.
V-HTR		Indicates filament supply voltage.
V-LPA		Indicates high voltage conditions at power amplifier.
FAN		Samples cooling fan supply voltage.
OVER TEMP		Monitors over-temperature sensing circuit.
INPUT COUPLING		
Locking Dial	C2	Adjusts coupling between exciter output and power amplifier input for optimum energy transfer.
INPUT TUNING		
Locking Dial	C1	Tunes power amplifier input circuit to match exciter output.
Digital Indicator		Indicates approximate power amplifier operating frequency.
OUTPUT TUNING		
Locking Dial		Tunes power amplifier output circuit to resonate at operating frequency.
OUTPUT COUPLING		
Locking Dial	C13	Adjusts coupling between power amplifier output circuit and antenna for optimum energy transfer.

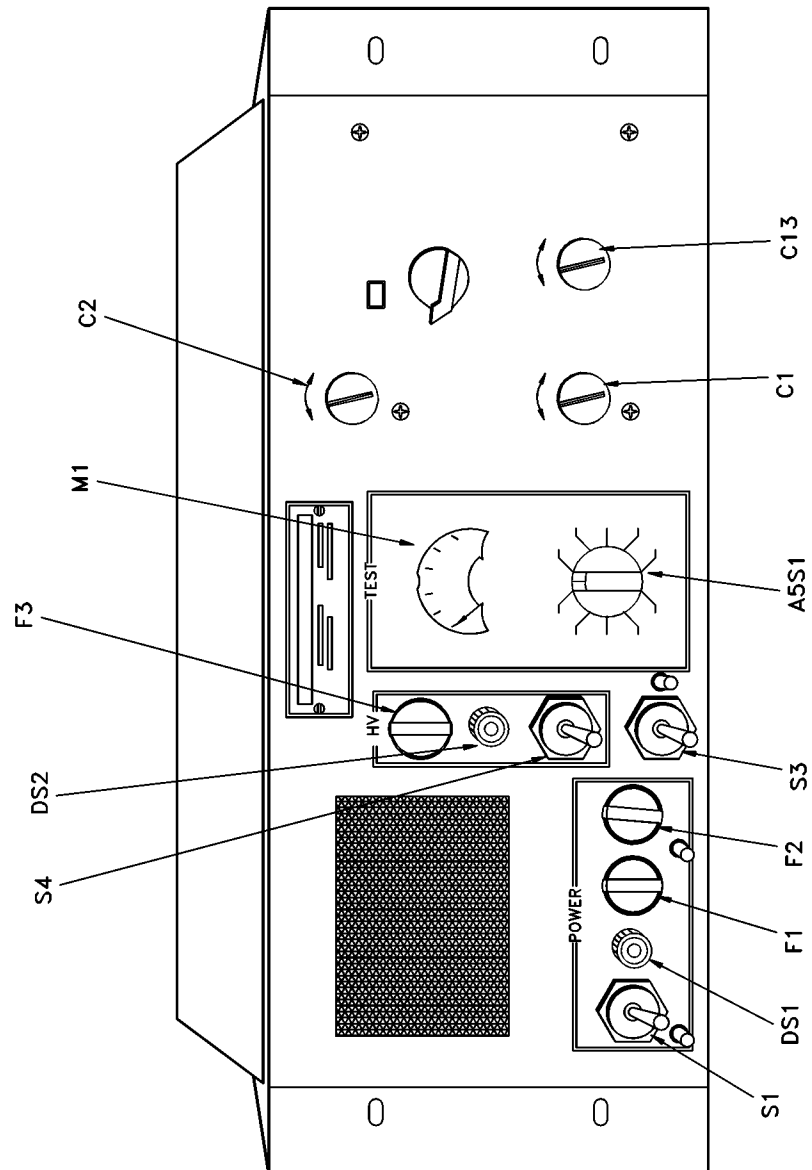


Figure 3-2. VHF Power Amplifier and UHF Power Amplifier Controls and Indicators

SECTION II

OPERATING INSTRUCTIONS

3-6. STARTING, TUNING, OPERATING, AND STOPPING PROCEDURE.



Do not key the transmitter on 121.5 MHZ or 243.0 MHZ for over 15 seconds. A continuous key of 30

seconds will activate the International Search and Rescue Satellite (SARSAT) to be used in an actual emergency or distress situation.

- a. Starting, tuning, operating, and stopping procedures of paragraphs 3-7 through 3-16 are summarized as follows:*

3-7. PRE-OPERATING CHECK.

- a. Check on equipment of unknown condition.
- b. Leave POWER OFF.
- c. Verify starting conditions.
- d. External DC power connect, if used.
- e. Connect AC power cables, if used.

3-8. INSTALL CRYSTAL. If an oscillator synthesizer is used, set thumbwheel screw to desired frequency.

3-9. EXCITER STARTING PROCEDURE.

- a. Exciter power ON.
- b. Verify OVEN, UNRGLTD V, RGLTD + 20.
- c. New units, precision verify and adjust RGLTD + 20.
- d. Rough check exciter FWD and RVS.

3-10. EXCITER TUNING PROCEDURE.

- a. Initial oscillator tune.
- b. Multiplier tune, UHF.
- c. Multiplier tune, VHF.
- d. Tunable filter tune.
- e. Oscillator final tune.
- f. RF carrier level set.
- g. Modulation set.

3-11. POWER AMPLIFIER STARTING PROCEDURE.



If the power out is below requirements, check the RF Cable Ground Shield for breaks and repair as necessary. If power is increased, damage to the power transistors may occur causing a failure.

- a. Power amplifier power ON.
- b. Verify EXCTR, V-GRID, V-HTR, FAN.
- c. Verify HV turn on time out.
- d. Verify V-PLATE, V-SCREEN.
- e. Verify exciter E-L RLY, VSWR-LPA.

3-12. POWER AMPLIFIER TUNING PROCEDURE.

- a. Verify power amplifier FWD and RVS.
- b. Verify quiescent CUR-PLATE.
- c. Verify partial forward power function.
- d. Tune INPUT TUNING and INPUT COUPLING.
- e. Tune OUTPUT TUNING and OUTPUT COUPLING.
- f. Check power amplifier FWD and RVS.

3-13. SYSTEM CHECK.

3-14. REMOTE OPERATION.

3-15. A3 KEYS CARD ADJUSTMENT.

3-16. STOPPING PROCEDURE.

- a. Power amplifier stopping procedure.
 - b. Exciter stopping procedure.
-

■ 3-7. PRE-OPERATING CHECK.

- a. This section applies to equipments whose tuned condition and/or operational status is unknown.



- Do not connect primary AC power, do not connect remote inputs, and do not attempt turn on, tuning, or operation until configuration and starting conditions have been verified per this section.
- Make sure that the strapping arrangement is correct for the primary AC input voltage to the power transformers. See sections 2-17 through 2-20.

NOTE

Make sure that UHF and VHF transmitter sets contain the following complement of replacement units, correct for the intended frequency band in correspondence with the frequency band identification provided by the equipment name plate. If the exciter top cover is removed for this configuration inspection, leave the top cover off for the steps which follow. If the power amplifier cavity module is removed for configuration inspection, make sure that it is securely replaced before proceeding.

EXCITER:	VHF	UHF
Frequency multiplier module A9	8004225G1	8004224G1
Driver/Power Amp module A10	(dbl)	(quad)
Tunable Filter FL2	8006081G1	8004890G1
Power Sensor Low Pass Filter FL1	505527-2	505527-1
POWER AMPLIFIER (IF USED):	509146-22	509146-12
Tuned cavity module A7	505516-25	505516-11
	8004230G2	8004230G1

- b. Leave exciter AC POWER ON-OFF switch in OFF position. If a power amplifier is used, leave its POWER ON-OFF switch in OFF position.

- c. Verify that starting conditions are in accord with the following.

* Specified readings are nominal. See Tables 5-2 and 5-3 for acceptable limits.

STARTING CONDITIONS

10-WATT and 50-WATT CONFIGURATIONS:

Exciter LOCAL-REMOTE switch is in LOCAL position.

Exciter PUSH TO TALK-CARRIER TEST switch is in PUSH TO TALK position.

Exciter TUNE-OPERATE switch is in TUNE position.

Remote input cable is disconnected from exciter J5.

Local modulation inputs are disconnected from exciter LOCAL MICROPHONE jacks.

10-WATT CONFIGURATION (EXCITER ONLY):

Antenna or dummy load is connected to exciter K1J3.

50-WATT CONFIGURATION (WITH POWER AMPLIFIER):

Power amplifier HV ON-OFF switch is in OFF position.

Power amplifier TUNE-OPERATE switch is in OPERATE position.

Interconnect cable W4 is connected; see Figure 2-1.

Antenna or dummy load is connected to Exciter K1J1.

Interconnect cable W3 is connected; see Figure 2-1.

Interconnect cable W5 is connected; see Figure 2-1.

3-7. PRE-OPERATING CHECK (CONT).

d. If the system consists of exciter only, and is to be operated exclusively from an external battery or DC source (without any AC power), this external DC power source should be connected at this time; see paragraph 2-28. It is preferred that all other remote functions interfacing with the transmitter through exciter J5 remain disconnected at this time. It is mandatory that wideband

modulation inputs into J5-B and J5-Q remain disconnected at this time.

e. If the system is to be operated from AC power, the external AC power source should be connected at this time. Connect AC power input cable W1 to exciter J9. If a power amplifier is used, connect AC power input cable W2 to power amplifier J1.

This completes the pre-operating check.

3-8. OSCILLATOR CRYSTAL INSTALLATION.

a. Select the proper crystal for the desired operating frequency. When the crystal oscillator is used, the crystal frequency should be one-fourth the desired carrier frequency for UHF operation and one-half the carrier frequency for VHF operation. When the oscillator-multiplier is used, the crystal frequency should be one-twentieth the carrier frequency for UHF operation and one-tenth the carrier frequency for VHF operation.

b. Place the crystal in the crystal holder and insert into the oscillator module located behind the access door on the exciter panel.

c. Secure in place with the two screwmounted crystal holder retainers.

NOTE

Crystal installation is included in the sequence at this point, before power turn-on, so that warmup of all frequency-determining elements including the crystal will begin uniformly when power is applied in the next step.

3-9. EXCITER STARTING PROCEDURE.

CAUTION

Be sure all requirements of sections 3-7 and 3-8 have been accomplished.

a. Place the AC POWER ON-OFF switch on the exciter front panel to the ON position. For systems operating with AC power connected, observe that the AC POWER indicator lamp illuminates. For exciters operating only from an external DC source, the AC POWER indicator lamp will remain OFF.

b. Using TEST SWITCH 1 and TEST SWITCH 2 as necessary, observe that the following transmitter functions are in accord with Table S-2:

1-10 OVEN
2-1 UNRGLTD V
2-3 RGLTD +20

c. IF RGLTD + 20 appears to be incorrect, check and adjust as necessary, for 19.50 VDC; in accord with paragraph S-45.c.

3-9. EXCITER STARTING PROCEDURE (CONT).

d. Using TEST SWITCH 1 as necessary, verify that FWD and RVS read ≤ 3 divisions. If necessary, adjust RF Control/Modulator Circuit Card A6, R5 for FWD zero, and R8 for RVS zero. This observation and adjustment are preliminary only, intended only for assurance that the power control circuits are functioning. Final check and adjustment of FWD and RVS zero will be provided for in connection with RF carrier level setting; see step 3-10.f.

3-10. EXCITER TUNING PROCEDURE.

STARTING CONDITIONS

be sure that all requirements of sections 3-7 through 3-9 have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

NOTE

The following tuning procedure assumes use of the crystal oscillator. If an oscillator-synthesizer is used, set the thumbwheel switches on the oscillator-synthesizer to one-fourth the desired carrier frequency for UHF and one-half the desired carrier frequency for VHF, and disregard instructions on crystal oscillator adjustment. Since the oscillator-synthesizer produces frequencies in 6.25 kHz increments, it is not possible to place all the significant digits on the frequency selection switches. Therefore, the dial numbers are rounded off with the relationship between the dial frequency and the actual frequency illustrated in the following table.

DIAL FREQUENCY	ACTUAL FREQUENCY
----------------	------------------

99.993 mhz	99.99375 mhz
99.987	99.98750
99.981	99.98125
99.975	99.97500
99.968	99.96875
99.962	99.96250
99.956	99.95625
99.950	99.95000
99.943	99.94375
99.937	99.93750
99.931	99.93125
99.925	99.92500
99.918	99.91875
99.912	99.91250
99.906	99.90625
99.900	99.90000

a. Perform initial tuning of the oscillator module in accordance with the following. For tuning the oscillator-multiplier module refer to paragraph 3-20.

NOTE

Initial tuning of the oscillator, performed during the first 30 minutes after performing step 3-10.a. during which time the frequency-determining elements are undergoing warmup stabilization, will be followed by a final oscillator tuning; see step 3-10.e.

1. Using a screwdriver, position the dots on the oscillator module to line up with the crystal frequency markings. For frequencies of 58 MHz or less, position the dots at six o'clock.

2. Using a screwdriver, position the dots on the multiplier module to line up with the operating frequency markings.

3. Place TEST SWITCH 1 to OSC position.

4. Key the transmitter by placing PUSH TO TALK-CARRIER TEST switch in CARRIER TEST position.

5. On the oscillator module carefully adjust OSC and BUF controls clockwise from the starting position, alternately between the two controls, for a maximum reading on the test meter.

NOTE

It is possible to tune the oscillator to the wrong mechanical overtone of the crystal. To verify that this has not been done, check that the final adjustment achieved for maximum output is close to the desired frequency marking.

6. Unkey the transmitter by returning the PUSH TO TALK-CARRIER TEST switch to PUSH TO TALK position.

b. Tune the UHF multiplier (quadrupler) module in accord with this section (refer to 3-10.c. for tuning VHF multiplier module).

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-10.a have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

1. The tuning controls of the multiplier module should be set to their starting positions as in Step 3-10.a.2 or Step 3-20.b.
2. On the multiplier module, adjust the LEVEL ADJ control to its full clockwise position.
3. Place TEST SWITCH 1 to MULTR position.
4. Key the transmitter as in 3-10.a.4.
5. Alternately adjust QUAD, BUFFER and AMPL controls for maximum indication on the test meter.

NOTE

If the meter reading obtained is greater than 50, re-adjust the LEVEL ADJ control for a reading of between 40 and 50, and re-peak QUAD, BUFFER and AMPL control for maximum indication.

NOTE

It is possible to tune the multiplier to the wrong harmonic of the oscillator. To verify that this has not been done, check that the adjustment achieved for maximum output is close to the desired frequency marking.

6. Recheck oscillator adjustment by repeating steps 3-10.a.3 and 3-10.a.5 and recheck multiplier adjustment by repeating steps 3-10.b.3 and 3-10.b.5.
7. Adjust LEVEL ADJ control CCW for a reading of 22 for UHF frequencies of 300 MHz and less. For UHF frequencies greater than 300 MHz, set the LEVEL ADJ control at maximum CCW position; its final setting

will be made after filter tuning has been accomplished.

8. Unkey the transmitter as in 3-10.a.6.

c. Tune the VHF multiplier (doubler) module in accord with this section (refer to 3-10.b for tuning UHF multiplier module).

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-10.a have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

1. The tuning controls of the multiplier module should be set to their starting positions as in Step 3-10.a.2 or Step 3-20.b.
2. On the multiplier module, adjust the LEVEL ADJ control to its full clockwise position.
3. Place TEST SWITCH 1 to MULTR position.
4. Key the transmitter as in 3-10.a.4.
5. Alternately adjust DOUBLER and BUFFER controls for maximum indication on the test meter.

NOTE

If the meter reading obtained is greater than 50, re-adjust the LEVEL ADJ control for a reading of between 40 and 50, and re-peak DOUBLER and BUFFER controls for maximum indication.

NOTE

It is possible to tune the multiplier to the wrong harmonic of the oscillator. To verify that this has not been done, check that the adjustment is achieved for maximum output is close to the starting position set in step 3-10.a.2.

- 6. Recheck oscillator adjustment by repeating steps 3-10.a.3 and 3-10.a.5, and recheck multiplier adjustment by repeating steps 3-10.c.3 and 3-10.c.5.
- 7. On the multiplier module, adjust the LEVEL ADJ control CCW for a reading of 22.
- 8. Unkey the transmitter as in 3-10.a.6.
- d. Tune the tunable filter per this section.

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-10.b or 3-10.c have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

WARNING

Lethal voltage is present on terminals of switch S6 to the left of capacitor C2. Use a nonmetallic alignment tool when making adjustments in this area.

- 1. Remove protective caps from the tunable filter C1 and C2.
- 2. Place TEST SWITCH 1 to FLTR TUNE position.
- 3. Key the transmitter as in 3-10.a.4. Observe that the test meter indicates a reading greater than zero in response to

keying the transmitter.

4. Adjust the tunable, filter input capacitor C1 near its correct setting by observing a sharp change in meter reading. Turn clockwise to decrease frequency, counterclockwise to increase frequency. Depending on the band and frequency, the desired point will be seen as a sharp peak, a sharp dip, or as a sharp transition between a high and a low level. For initial tuning purposes, any of these indications may be used.

- 5. Place TEST SWITCH 1 to the APC position.

6. Adjust the tunable filter output capacitor C2 to its correct setting by observing a null in the meter reading. If a null is obtained, go to-step 3-10.d.7. If a null is not obtained, place TEST SWITCH 1 to FWD position, and adjust C2, and then C1, for maximum FWD. With a reading of 30 or more obtained at maximum, place TEST SWITCH 1 to APC position and go to step 3-10.d.7. If a reading of less than 30 is obtained at maximum, momentarily unkey and rekey the transmitter as in 3-10.a.4 and 3-10.a.6, and readjust C2 and C1 for maximum, observing that the reading obtained is greater than 30 at maximum.

7. Alternately adjust C1 and C2 for minimum reading. If the filter is equipped with protective cap, proceed with step 8. If the filter is not equipped with protective cap, proceed with step 9.

8. Reinstall the protective caps on the tunable filter and observe that the minimum APC level obtained in 3-10.d.7 is not changed.

9. If multiplier module LEVEL ADJ control was set at maximum CCW in step 3-10.b.7 (UHF units above 300 MHz), place TEST SWITCH 1 to MULTR position and adjust LEVEL ADJ control for 22.

- 10. Unkey the transmitter as in 3-10.a.6.

e. Perform final tuning of the oscillator module in accord with this section. See 3-17 for G3.

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-10.d have been accomplished.

Exciter switch position

LOCAL-REMOTE	LOCAL
PUSH TO TALK- CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON

Power Amplifier switch
positions (if used):

POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

NOTE

The purpose of this section is to enable the best possible adjustment for frequency accuracy, using only the crystal itself as the criterion for frequency accuracy. The final adjustment will be made from the CCW direction, stopping at the peak.

NOTE

This procedure should be accomplished after 30 minutes (5 minutes when using oscillator-synthesizer) have elapsed from 3-9.a. allowing warmup stabilization of the frequency determining elements.

1. Repeat steps 3-10.a.3 through 3-10.a.5 of the oscillator module initial tuning procedure, using care to achieve the maximum peak observable. The test meter may be tapped for best possible observation of the peak. Record the peak reading obtained

2. Detune the OSC control in the CW direction, then carefully return it in the CCW direction to precisely the peak reading observed in step 3-10.e.1.

3. Detune the BUF control in the CW direction, then carefully retune it in the CCW direction to precisely the peak reading observed in step 3-10.e.1; then repeat step 3-10.e.2.

NOTE

If the meter reading is obtainable when returning either the OSC or BUF control is greater than or less than that reading recorded in 3-10.e.1, start over with 3-10.e.1.

NOTE

The adjustment accomplished in section 3-10.e affects the oscillator frequency very little, and does not require readjustment of the multiplier module or the tunable filter.

4. Unkey the transmitter as in 3-10.a.6.

f. Check and adjust as necessary the RF carrier level setting in accordance with this section.

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-10.e have been accomplished.

Exciter switch positions.

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON
Power Amplifier switch positions (if used):	
POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

1. In step 3-9d, a preliminary check of FWD and RVS zero set was made.

2. Using TEST SWITCH 1 as necessary, verify that FWD and RVS read 0 ± 1 division. If necessary, adjust RF Control/Modulator Circuit Card A6, R5 for FWD zero, and R8 for RVS zero.

3. Place TEST SWITCH 1 to the FWD position.

4. Key the transmitter as in 3-10.a.4. Observe that the test meter increases from the zero set condition of step 3-10f.2 to a reading of approximately 40 in response to keying the transmitter.

5. Unlock the CARRIER LEVEL control (inside the access door on front of the exciter unit) by loosening 5-16" locknut. Adjust the CARRIER LEVEL control as necessary to achieve a reading of 40 (equals approximately 10 watts; see figure 3-3). If this reading cannot be obtained, unkey exciter, turn power ON-OFF switch OFF, connect an external wattmeter and dummy load to K1J1 if operating in the 50 watt configuration or connect to K1J3 if operating in the 10 watt configuration (exciter only). After making the applicable connections, turn power ON-OFF switch to the ON position, key the transmitter as in paragraph 3.10.a.4.

(a) Set the CARRIER LEVEL control inside the access door on front of exciter unit to approximately center of its mechanical ran.

(b) On the RF Control/Modulator Circuit Card A6, adjust R19 (CARRIER-LEVEL) for a reading of 40.

(c) On the RF Control/Modulator Circuit Card A6, adjust R39 for a 10 watt reading on external wattmeter. (Alternately adjust R39 and R19 on the A6 card until a reading of 10 watts and a reading of 40 in the forward position is achieved.)

(d) Lock the RF carrier level adjust by tightening the 5-16" locking nut (inside the access door on the front of the exciter unit) while observing the level does not change.

6. Unkey the transmitter as in 3-10.a.6.

7. Place the exciter TUNE-OPERATE switch in OPERATE position for all tuning procedures steps which follow.

CAUTION

The TUNE-OPERATE switch has been in TUNE position for all previous steps following the pre-operating check, 3-7c. If necessary to return to any previous step, place the TUNE-OPERATE switch in TUNE position.

g. Check and adjust modulation employing local modulation input in accord with section. For remote modulation input, refer to 3-14.

h. If audio amplifier compressor is used perform the following procedure.

STARTING CONDITIONS	
Be sure that all requirements of section 3-7 through 3-10.f have been accomplished.	
Exciter switch positions:	
LOCAL-REMOTE	LOCAL
PUSH TO TALK	PUSH TO
-CARRIER TEST	TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON
Power Amplifier switch positions (if used):	
POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

1. Modulation input requires an audio signal generator capable of supplying a test signal at 1 KHz, continuously variable from 0.1 VRMS or less to 1.25 VRMS or more, into 600 ohm load. If, owing to excessive output level, the signal generator used is incapable of smooth adjustment or repeatable setting within this range, the output should be suitably padded. Terminate the audio signal generator output cable with a PJ068 plug per figure 3-4. If the signal generator output has one side grounded, this side must be connected to the PJ068 sleeve, while the ungrounded side is connected to the PJ068 ring. The tip contact of the PJ068 is not connected.

2. Unlock the MOD LEVEL control (inside the access door on the front of the exciter unit) by loosening 5-16" lock nut. Preset the transmitter modulation level to mid-range by turning the MOD LEVEL to approximately the middle of its mechanical range.

NOTE

With SWITCH 1 in SWITCH 2 enable do not place SWITCH 2 to % MOD unless exciter is modulated. Failure to do this will cause meter to peg negative, possibly damaging the meter.

3. Set the audio signal generator at 1KHz with its output level control turned down (0.1 VRMS or less).

4. Set TEST SWITCH 1 and 2 to read AF LVL-L. Observe the reading is 0 to 2. If necessary to adjust, on the Filter Amplifier/Detector module A4 adjust R41 (AF level zero adjust) for a reading of 0.

NOTE

For transmitters strapped for low lever audio input. Set audio signal generator to -27 dgm (0.034 vrms). Plug the audio signal generator PJ068 into the carbon microphone jack (local microphone1) on the exciter front panel. Proceed to step 3-10.h.7.

5. Set TEST SWITCH 2 to AF LVL-H. Plug the audio signal generator PJ068 into the carbon microphone jack (LOCAL MICROPHONE 1) on the exciter front panel.

6. Increase the audio signal generator output level, and observe that the AF LVL-H reading increases. Set for a reading of 18, corresponding to a 0dBm (one milliwatt) signal level. See figure 5-6.

7. Key the transmitter as in 3-10.a.4.

8. Set TEST SWITCH 2 to read % MOD.

9. Adjust the MOD LEVEL control for a reading of (30 corresponding to 90% modulation; see figure 5-5).

(a) Lock the MOD LEVEL control by tightening the 5-16" locking nut (located inside the access door on the front of the exciter unit) while insuring the meter reading does not vary.

10. Change Test Switch 2 from the % MOD setting. Unkey the transmitter as in 3-10.a.6.

NOTE

Check % MOD reading per paragraph 5-51 and 5-52 after changing power output level.

i. If line amplifier is used perform the following procedure.

1. Modulation input requires an audio signal generator capable of supplying a test signal at 1 KHz, variable from 0.1 VRMS or less to 1.25 VRMS or more, into 600 ohm load. If, owing to excessive output level, the signal generator used is incapable of smooth adjustment or repeatable setting within this range, the output should be suitably padded. Terminate the audio signal generator output cable with a PJ068 plug per figure 3-4. If the signal generator has one side grounded this side must be connected to the PJ068 sleeve, while the ungrounded side is connected to the PJ068 ring. The tip contact of the PJ068 is not connected.

2. Unlock the MOD LEVEL control (inside the access door on the front of the exciter unit) by loosening 5-16" lock nut. Preset the transmitter modulation level to zero by turning the MOD LEVEL control to the full counterclockwise position.

3. Set the audio signal generator at 1 KHz with its output level control turned down (0.1 VRMS or less).

4. Set TEST SWITCH 1 and 2 read AF LVL-L. Observe the reading is 0 to 2. If necessary to adjust, on the Filter Amplifier/Detector module A4 adjust R41 (AF level zero adjust) for a reading of 0.

6. Increase the audio signal generator output level, and observe that the AF LVL-H reading increases. Set for a reading of 18 ± 2 , corresponding to a 0 dbM (one milliwatt) signal level. See figure 5-6.

7. Connect AC voltmeter to TP1 on line amplifier PC card (A1 module). Adjust potentiometer on this card (R10) to 0.636 volts RMS or 1.8 volts peak to peak.

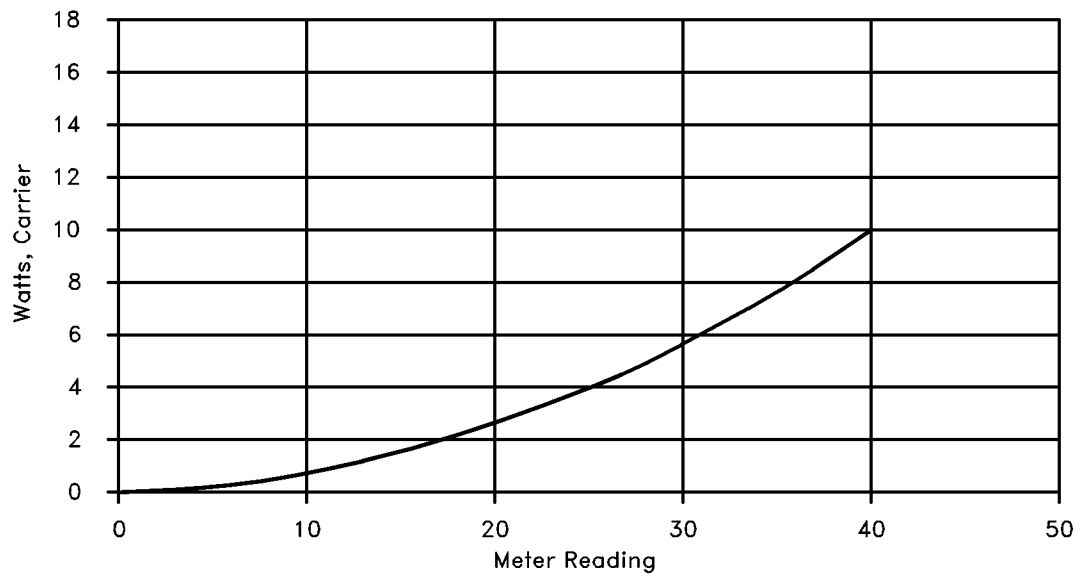
8. Key the transmitter as in 3-10.a.4.

9. Set TEST SWITCH 2 to read % MOD.

NOTE

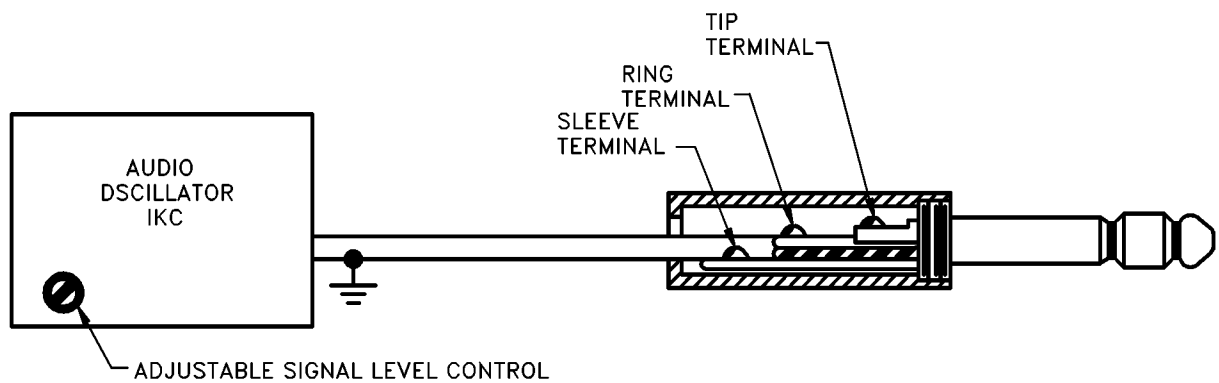
For transmitter strapped for high level audio input proceed to step 3-10h.4.

5. Set TEST SWITCH 2 to AF LVL-H. Plug the audio signal generator PJ068 into the carbon microphone jack (LOCAL MICROPHONE 1) on the exciter front panel.



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Figure 3-3. Exciter RF Carrier Power Vs. Meter Reading



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Figure 3-4. Modulation Level Test Setup

(10) Adjust the MOD LEVEL control for a reading of 30 (corresponding to 90% modulation; see figure 5-5).

(11) Change Test switch 2 from the % MOD setting. Unkey the transmitter as in 3-10.a.6.

NOTE

Check % MOD reading per paragraph 5-51 and 5-53 after changing power output level.

j. The accomplishment of all previous steps in sequence completes the tuning procedure for the exciter. If the system consists of exciter only, continue with section 3-13. If the system consists of exciter and power amplifier, continue with section 3-11.

3-11. POWER AMPLIFIER STARTING PROCEDURE.

STARTING CONDITIONS	
Be sure that all requirements of sections 3-7 through 3-10.h have been accomplished.	
Exciter switch positions:	
LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON
Power Amplifier switch positions (if used):	
POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

CAUTION

If the power out is below requirements, check the RF Cable Ground Shield for breaks and repair as necessary. If power is increased, damage to the power transistors may occur causing a failure.

a. Place the POWER ON-OFF switch on the power amplifier front panel to the ON position.

Observe that the POWER indicator lamp illuminates.

b. Using the TEST switch, observe that the following power amplifier functions are in accordance with table 5-3:

LPA 1	EXCTR
LPA 8	V-GRID
LPA 9	V-HTR
LPA 11	FAN

c. Place the HV ON-OFF switch to the ON position. Observe that, approximately one minute after step 3-11.a above, the HV ON indicator illuminates.

d. Using the TEST switch, observe that the following power amplifier functions are in accordance with table 5-3 for the unkeyed unmodulated condition:

LPA 5	V-PLATE
LPA 7	V-SCREEN

e. Using the exciter TEST SWITCH 1 as necessary, observe that the following exciter functions are in accordance with table 5-3 for the unkeyed unmodulated condition:

EXC 1-1	E-L RLY
EXC 1-6	VSWR-LPA

3-12. POWER AMPLIFIER TUNING PROCEDURE.

STARTING CONDITIONS	
Be sure that all requirements of sections 3-7 through 3-11.e have been accomplished.	
Exciter switch positions:	
LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON
Power Amplifier switch positions (if used):	
POWER ON-OFF	ON
HV ON-OFF	ON
TUNE-OPERATE	OPERATE

3-12. POWER AMPLIFIER TUNING PROCEDURE (CONT).

a. Using the TEST switch, verify that the power amplifier FWD and RVS readings are 0 ± 1 . If unnecessary to adjust, go to 3-12.b. If necessary to adjust, proceed as follows.

1. Place power amplifier HV ON-OFF switch to OFF position.
2. Remove power amplifier top cover.
3. On the Power Supply, Control Grid/Thermal Control/AC Control module A3, defeat the high voltage primary interlock switch S1 by pulling its plunger up to defeat position.
4. Place HV ON-OFF switch to ON position. Observe that the HV ON indicator illuminates.

NOTE

High voltage turn-on is not needed for the adjustment of FWD and RVS zero, but it is needed for the steps which follow; the high voltage is therefore kept turned on at this point for procedural continuity.

WARNING

Observe all HV WARNINGS inside the power amplifier unit.

5. Place TEST switch to FWD position. Adjust R7 on the Buffer Amplifier/Multiplier, Electrical Instrument circuit card A5 for 0 ± 1 reading on the test meter.

6. Place TEST switch to RVS position. Adjust R9 on the Buffer Amplifier/Multiplier, Electrical Instrument circuit card A5 for 0 ± 1 reading on the test meter.

7. Leave the power amplifier top cover off for the steps which follow.

b. Using the TEST switch, verify that the power amplifier CUR-PLATE reading is 7 ± 1 . If unnecessary to adjust, go to 3-12.c. If necessary to adjust, proceed as follows:

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-12.a have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON

3-12. POWER AMPLIFIER TUNING PROCEDURE (CONT).

Power Amplifier switch positions (if used):

POWER ON-OFF	ON
HV ON-OFF	ON
TUNE-OPERATE	OPERATE

1. If the power amplifier top cover was not removed in 3-12.a, the adjustment PLATE CURRENT ADJUST control is accessible through the top cover of the power amplifier.

2. If the power amplifier top cover was removed in 3-12.a, the plate current adjustment control on the Power Supply, Control Grid/Thermal Control/AC Control module A3 (R15, Control Grid Voltage) is directly accessible.

3. Adjust for CUR-PLATE reading of 7 ± 1 .
c. Using the TEST switch, verify that the power amplifier artificial forward power function is correctly set as follows:

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-12.b have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON
<u>Power Amplifier switch positions (if used):</u>	
POWER ON-OFF	ON
HV ON-OFF	ON
TUNE-OPERATE	OPERATE

1. Place the power amplifier TEST switch to the RVS position. Observe reading of 0 ± 1 .
2. Place the exciter TEST SWITCH 1 to the FWD position. Observe reading of 0 ± 1 .
3. Place power amplifier TUNE - OPERATE switch to TUNE position. In response to this, observe that the power amplifier RVS reading pegs below zero, and verify that the exciter FWD goes to a reading of 30 ± 1 . If necessary to adjust, proceed as follows:
 - (a) If the power amplifier top cover has not been removed in a previous step, the adjustment ARTIFICIAL FWD PWR ADJUST control is accessible through the top cover of the power amplifier.
 - (b) If the power amplifier top cover was removed in a previous step, the artificial forward power adjustment control on the Buffer Amplifier/Multiplier, Electrical Instrument circuit card A5 (R2) is directly accessible.
 - (c) Adjust for exciter FWD reading of 30 ± 1 .
4. Leave the power amplifier TUNE-OPERATE switch in TUNE position for the steps which follow.
 - d. Tune the power amplifier cavity input circuits in accord with this section.

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-12.c have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	ON
HV ON-OFF	ON
TUNE-OPERATE	TUNE

1. Unlock the OUTPUT COUPLING control on the power amplifier cavity module, and pre-set this control approximately 40 turns from the maximum CCW position (this control has a mechanical range of approximately 100 turns stop-to-stop).

2. Place the power amplifier TEST switch to CUR-PLATE position. Observe reading of 7 ± 1 .
3. Place the exciter TEST SWITCH 1 to the RVS position. Observe reading of 0 ± 1 .
4. Key the transmitter as in 3-10.a.4. In response to this, note that any increase in power amplifier CUR-PLATE reading does not exceed the reading of 18. If necessary to adjust, unkey the transmitter as in 3-10.a.6, re-set the OUTPUT COUPLING control several turns CW, re-key the transmitter as 3-10.a.4 and re-check CUR-PLATE. Repeat as necessary.
5. If the power amplifier cavity input circuits are untuned, then in response to keying the transmitter the exciter RVS reading will increase. With the transmitter keyed as in 3-10.a.4 unlock the power amplifier INPUT TUNING control, and tune this control for a minimum exciter RVS reading; then re-check power amplifier CUR-PLATE per 3-12.d.4.
6. Unlock the power amplifier INPUT COUPLING control. Alternately tune the INPUT COUPLING and INPUT TUNING controls for a minimum exciter RVS reading, until no further minimization of the exciter RVS is obtainable. A reading of less than 15 must be obtained in each case; a reading of less than 5 will be obtainable in most cases.
7. Lock the INPUT TUNING and INPUT COUPLING control knobs. Observe that knob locking does not change the exciter RVS reading.
8. Unkey the transmitter as in 3-10.a.6.
 - e. Tune the power amplifier cavity output circuits in accord with this section.

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-12.d have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	ON
HV ON-OFF	ON
TUNE-OPERATE	TUNE

CAUTION

Use extreme caution when turning OUTPUT TUNING control above 170 as read on the OUTPUT TUNING INDICATOR. Do not turn the OUTPUT TUNING control to indicate below 0 in VHF operation or below 8 in UHF operation, as read on the OUTPUT TUNING INDICATOR. Damage to the tuning mechanism will result if these maximums and minimums are exceeded.

NOTE

The OUTPUT TUNING control requires a large number of turns to cover a small range. In the following steps, care should be taken not to miss the peak or the dip in the transmitter function being monitored, where called for, when turning the OUTPUT TUNING control.

1. Place the power amplifier TEST switch to FWD position.

2. Key the transmitter as in 3-10.a.4. Tune the power amplifier OUTPUT TUNING control for a maximum FWD reading (see figure 3-5 for approximate readings on the OUTPUT TUNING INDICATOR). If at maximum the power amplifier FWD reading is between 5 and 40 (15 to 25 typical), continue with 3-12.e.3. If at maximum the FWD reading exceeds 40, or is less than 5, unkey the transmitter as in 3-10.a.6 and go to 3-12.e.6.

3. Return the power amplifier TUNE-OPERATE switch to OPERATE position. In response to this, observe that the power amplifier FWD reading remains the same as, or increases above, the reading obtained in 3-12.e.2. If ok, continue with 3-12.e.4. If the reading obtained declines below the reading obtained in 3-12.e.2, or goes to zero, unkey the transmitter as in 3-10.a.6 and go to 3-12.e.6.

4. Place the power amplifier TEST switch to CUR-PLATE position. Observe that the reading does not exceed 18. If ok, go to 3-12.e.5. If necessary to adjust, go to 3-12.e.6.

5. Optimize power amplifier output tuning in accord with this section.

(a) Place power amplifier TEST switch in FWD position, and place exciter TEST SWITCH 1 in FWD position.

(b) Re-tune the power amplifier OUTPUT TUNING for a minimum exciter FWD reading while the power amplifier FWD reading either increases or remains unchanged.

(c) Place power amplifier TEST switch in CUR-PLATE position, and re-tune OUTPUT TUNING for minimum CUR-PLATE reading.

(d) For VHF power amplifiers, the CUR-PLATE reading must always be between 12 and 16, while the exciter FWD reading is between 12 to 35; if this reading is not obtained increase or decrease as necessary, per 3-12.e.5(f).

(e) For UHF power amplifiers, the CUR-PLATE must always be between 10 and 18 (Ref. fig. 3-6) while the exciter FWD reading is between 16 and 38; If a 10 to 18 meter reading cannot be obtained, increase or decrease as necessary, per 3-12.e.5(f).

(f) To lower the CUR-PLATE reading, or to lower the exciter FWD reading, reset the OUTPUT COUPLING control several turns in the CW direction (toward MAX), then retune OUTPUT TUNING starting at 3-12.e.5.(a). To increase the CUR-PLATE reading or to increase the exciter FWD reading, reset the OUTPUT COUPLING control several turns in the CCW direction (toward MIN), then retune OUTPUT TUNING starting at 3-12.e.5.(a). Repeat as necessary. If the required reading set can not be obtained, unkey the transmitter as in 3-10.a.6 and go to 3-12.e.6.

(g) With the required reading set obtained lock the OUTPUT COUPLING and OUTPUT TUNING knobs, unkey the transmitter as in 3-10.a.6, and go to 3-12.f.

6. If incorrect responses were obtained in steps 3-12.e.2, e-3, e.4, or e.5, proceed as follows:

(a) Unkey the transmitter as in 3-10.a.6.

(b) Place power amplifier switches in positions as follow:

HV ON-OFF	OFF
POWER ON-OFF	OFF
TUNE-OPERATE	OPERATE

(c) Place exciter TUNE-OPERATE switch in TUNE position.

(d) Check exciter FWD and RVS zero and RF carrier level set per 3-10.f, and continue the tuning procedure in sequence from that point.

f. Perform final check of power amplifier performance as follows.

STARTING CONDITIONS

Be sure that all requirements of sections 3-7 through 3-12.e have been accomplished.

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	OPERATE
AC POWER ON-OFF	ON

STARTING CONDITIONS (CONT).Power Amplifier switch
positions (if used):

POWER ON-OFF	ON
HV ON-OFF	ON
TUNE-OPERATE	OPERATE

1. Re-check power amplifier FWD and RVS zero set per 3-12.a.

2. Key the transmitter as in 3-10.4.

3. Place power amplifier TEST switch in FWD position and verify the reading is correct for 50 watts in accord with figure 3-7. If reading is incorrect, make the following adjustments. If any adjustments are to be made, refer to WARNING in subparagraph 3-13(c).

(a) Adjust R26 on buffer amplifier/multiplier electrical instrument card A-5 for 50 watts on external watt meter.

(b) Adjust R22 on buffer amplifier/multiplier electrical instrument card A-5 for 40 on power amplifier front panel test meter.

(c) Repeat steps (a) and (b) until 50 watts is obtained on the external watt-meter and 40 is indicated on the power amplifier front panel test meter.

4. Place power amplifier TEST switch in RVS position and verify that the reading does not indicate excessive reverse power.

5. Unkey the transmitter as in 3-10.a.6.

3-13. SYSTEM CHECK.

a. The accomplishment of all previous steps in sequence completes the system tuning procedure.

b. Verify system functions in accordance with table 5-2 for systems consisting of exciter only, or in accord with table 5-3 for systems consisting of exciter and power amplifier.

c. Perform Frequency Check, 10 or 50 watt mode.

WARNING

Do not disconnect the coaxial output cable of the transmitter to the dummy load without first placing the remote-local switch in LOCAL position, and carrier Test/push-to-talk switch to PUSH-TO-TALK position, to assure that the transmitter will not be keyed with its load

disconnected. While the transmitter is protected from excessive high load VSWR in this condition, it is possible for maintenance personnel to sustain rf burns if handling open cable ends with the transmitter keyed.

1. Connect equipment jack K1J3 (10 watt mode) or K1J1 (50 watt mode) to the input of variable attenuator (874-GAL) or equivalent, connect output of the variable attenuator direct to the RF dummy load and the attenuated output to the Frequency Counter input. Set variable attenuator to 80 dB.

2. Set the controls as follows:

A. EXCITER

(1) Remote/Local to Local

(2) Push-To-Talk/Carrier Test to Push-To-Talk

(3) AC Power On/Off to On

B. POWER AMPLIFIER

(1) Power Off (On for 50 watt)

(2) High Voltage Off (on for 50 watt)

3. Key exciter by placing Push-To-Talk/Carrier Test switch to Carrier test and reduce variable attenuator setting until Frequency reading should read desired frequency $\pm 0.0005\%$ for synthesizer oscillator or $\pm 0.001\%$ for crystal oscillator.

4. Unkey the transmitter by placing the Push-To-Talk/Carrier Test switch to Push-To-Talk.

d. If exciter unit top cover was removed in a previous step, reinstall the top cover.

e. If power amplifier top cover was removed in a previous step, reinstall the top cover as follows:

1. Place HV ON-OFF switch to OFF position.

2. Re-install power amplifier top cover.

3. Place HV ON-OFF switch to ON position. Observe HV ON indicator illuminates.

f. If system is to be used under local control, connect and verify operation of microphone input(s) in local microphone jack(s) on the exciter front panel.

g. If system is to be used under remote control, continue with section 3-14.

3-14. REMOTE OPERATION.

- a. Remote inputs and controls are connected to the exciter through J5. Refer to sections 2-21 through 2-33.
- b. Remote keying and remote voice modulation are enabled by placing LOCAL-REMOTE switch in REMOTE position.

3-15. A3 KEYSER CARD ADJUSTMENT.

- a. After installing the A3 keyer card and connecting the exciter to the transmitter control panel for the keying method required, proceed as follows:

1. Set the REMOTE/LOCAL toggle switch on the exciter to the "REMOTE" position.
2. If the voltage keying method is used, apply the required voltage to the key terminal. With a milliammeter plugged into the channel test jack on the transmitter control panel, adjust the potentiometer for the current level shown for the keying method being used. (Refer to Fig. 2-8 and 2-9). The transmitter should key by voltage at a current of 1 to 2 milliamps.
3. If keying is accomplished by grounding the key terminal, ground the terminal with a test lead to the panel. The transmitter should then key.
4. After accomplishing either (1) or (2) above, connect the remote keying line to the key terminal and have the

remote location key the transmitter. For voltage keying, readjust the potentiometer for the current value obtained in step (2) above.

5. If keying trouble is encountered from the remote location, check to see that the current keying voltage/option has been made in accordance with Fig 2-8 and 2-9.

3-16. STOPPING PROCEDURE.

- a. To turn off the power amplifier, turn off High Voltage Switch first, then allow one (1) minute interval before the POWER ON-OFF Switch is switched to the OFF position. This greatly increases the life expectancy of the power output tube VI.

CAUTION

In systems consisting of an exciter and a power amplifier, complete de-activation of voltages within the power amplifier requires turning off both the power amplifier and the exciter. As long as the exciter remains ON, with the interconnecting cable W5 attached from exciter to power amplifier, +20 operating voltage will be present within the power amplifier, in the thermal control circuits of module A3, and on the level shift amplifiers and buffer emitter followers of circuit card A5.

- b. To turn off the exciter, place the AC POWER ON-OFF switch on the exciter front panel to the OFF

position. This completely de-activates the exciter, whether powered by AC or by an external battery or DC source. In systems consisting of an exciter and a power amplifier, this also de-activates those power amplifier functions which are powered by +20 volts supplied from the exciter through cable W5.

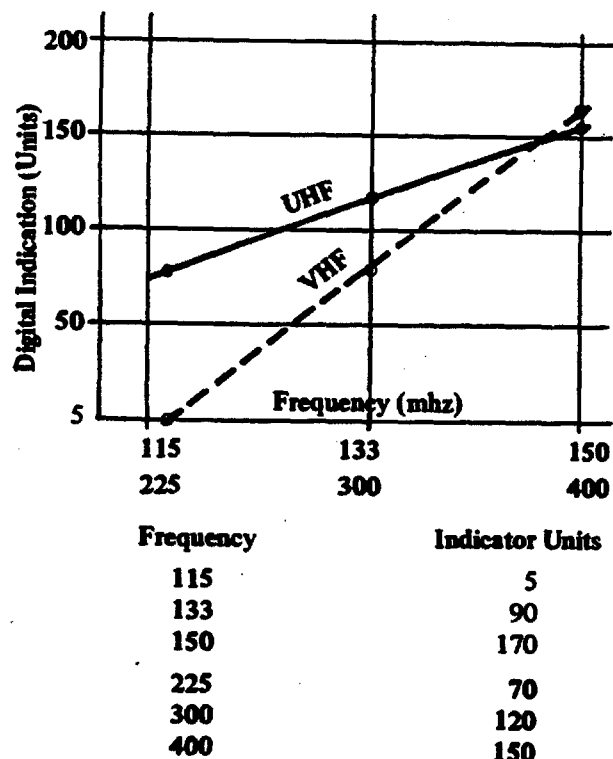


Figure 3-5. Frequency Vs. Digital Units

3-17. G3 OSCILLATOR TUNING PROCEDURE

(Substitute following for 3.10.e.)

3-18. Care must be exercised when tuning at the extremes of the band (less than 65 MHz and greater than 80 MHz crystal frequency) to assure that the proper peak is used for maximum frequency accuracy. When tuning at the band edges two peaks are observable because the tuning capacitors have an adjustment range of 360 degrees and two points exist that have the same capacitance. At the extreme low band edge the capacitance is almost at maximum and with clockwise rotation has its capacitance decreasing. The OSC and BUF adjustments are made for maximum meter indication with the tuning capacitance decreasing when tuning the VHF transmitter and for tuning the UHF transmitter for crystal frequencies equal to or greater than 75 MHz. The OSC and BUF adjustments are made for maximum meter indication with the tuning capacitance

increasing when tuning the UHF transmitter for crystal frequencies below 75 MHz. To assure proper starting position of the capacitor for frequencies less than 65 and greater than 80 MHz the OSC and BUF controls are adjusted in the CW and CCW direction to observe the presence of two peaks. The peak closest to the center scale frequency marking of 75 is the correct peak.

3-19. Perform final tuning of the G3 oscillator module in accord with this section.

STARTING CONDITIONS

Be sure that all requirements of section 3-7 through 3-10.d have been accomplished

Exciter switch positions:

LOCAL-REMOTE	LOCAL
PUSH TO TALK-CARRIER TEST	PUSH TO TALK
TUNE-OPERATE	TUNE
AC POWER ON-OFF	ON

Power Amplifier switch positions (if used):

POWER ON-OFF	OFF
HV ON-OFF	OFF
TUNE-OPERATE	OPERATE

NOTE

The purpose of this section is to enable the best possible adjustment for frequency accuracy, using only the crystal itself as the criterion for frequency accuracy.

NOTE

This procedure should be accomplished after 30-minutes have elapsed from step 3-9.a., allowing warmup stabilization of the frequency determining elements.

a. For all crystal frequencies used in VHF Transmitters and for crystal frequencies equal to or greater than 75 MHz used in UHF Transmitters.

1. Repeat steps 3-10.a.3 through 3-10.a.5 of the oscillator module initial tuning procedure, using care to achieve the maximum peak observable. The test meter may be tapped for best possible observation of the peak. Record the peak reading obtained.

2. Detune the OSC control in the CCW direction then carefully return it in the CW direction to precisely the peak reading observed in step 3-16 a.1.

3. Detune the BUF control in the CCW direction, then carefully retune it in the CW direction to precisely the peak reading observed in step 3-19 a.1, then repeat step 3-19 a.2.

NOTE

If the meter reading obtainable when returning either the OSC or BUF control is greater than or less than that reading recorded in 3-16 a.1, start over with 3-16 a.1.

NOTE

The adjustment accomplished in section 3-15C.a affects the oscillator frequency very little, and does not require readjustment of the multiplier module or the tunable filter.

4. Unkey the transmitter as in 3-10.a.6.

b. For crystal frequencies less than 75 mhz used in UHF Transmitters.

1. Repeat steps 3-10.a.3 through 3-10.a.5 of the oscillator module initial tuning procedure, using care to achieve the maximum peak observable. The test meter may be tapped for best possible observation of the peak. Record the peak reading obtained.

2. Detune the OSC control in the CW direction, then carefully return it in the CCW direction to precisely the peak reading observed in step 3-15C.b.1.

3. Detune the BUF control in the CW direction, then carefully retune it in the CCW direction to precisely the peak reading observed in step 3-16 b.1, then repeat step 3-16 b.2.

NOTE

If the meter reading obtainable when retuning either the OSC or BUF control is greater than or less than that reading recorded in 3-16 b.1, start over with 3-16 b.1.

NOTE

The adjustment accomplished in section 3-15C.b affects the oscillator frequency very little, and does not require readjustment of the multiplier module or the tunable filter.

4. Unkey the transmitter as in 3-10.a.6.

(Go to 3.10.f and continue with the procedure.)

3-20. OSCILLATOR-MULTIPLIER TUNING PROCEDURE.

a. Using a screwdriver position the dots on the OSC-MULT to line up with the frequency corresponding to five times (5X) the crystal frequency.

b. Using a screwdriver, position the dots on the multiplier module to line up with the operating frequency markings.

c. Place test SWITCH 1 to OSC position.

d. Key the transmitter by placing PUSH TO TALK-CARRIER TEST switch in CARRIER TEST position, TUNE-OPERATE in TUNE position, and LOCAL-REMOTE in LOCAL position.

e. On the oscillator-multiplier, carefully adjust OSC, BUF and AMPL controls, alternating between the controls for a maximum reading on the test meter.

NOTE

It is possible to tune the oscillator to the wrong mechanical over-tone of the crystal. To verify that this has not been done, check that the final adjustment achieved for maximum output is close to the desired frequency marking.

3-21. FREQUENCY FINE TUNE.

a. Connect a frequency counter to J1 on the front of the oscillator-multiplier unit (output signal level is approximately +13 dbm).

b. With a small screwdriver or adjustment tool, adjust the FREQ. ADJ. control to pull the oscillator to the desired frequency.

c. After the oscillator-multiplier tuning is completed, continue UHF exciter tuning with Paragraph 3-10.a.6 or VHF exciter tuning with Paragraph 3-10.b.8.

**SECTION III
EMERGENCY OPERATION**

T.O. 31R2-2GRT-102
NAVELEX 0967-LP-429-5010

3-22. GENERAL.

3-23. Emergency operation of the UHF or VHF exciter only is limited to three conditions.

- a. Crystal not available.
- b. AC power failure.
- c. Frequency synthesizer unserviceable.

Emergency operation is applicable to the power amplifiers when crystal is not available.

3-24. CRYSTAL NOT AVAILABLE. There are two configurations of the crystal-controlled oscillator (8004290G2 and 8004290G3) that require different type connections when they are used.

NOTE

RF generator must be a stable frequency source, $\pm 0.001\%$ to assure optimum transmitter performance. Continued monitoring for frequency accuracy is required.

NOTE

A type CR-75 crystal may be used for emergency operation, however, it may not meet the $\pm 0.001\%$ frequency accuracy requirements. Monitoring of the crystal frequency may be effected by using a directional coupler in the antenna output and a counter to check the frequency accuracy.

3-24.1. Crystal-Controlled Oscillator 8004290G2. If a crystal to provide the desired operating frequency is not available, perform the following:

- a. Remove crystal from holder and reinstall holder in oscillator module to maintain oven temperature.
- b. Connect output of an external rf generator set to cw (HP608 or equivalent) and to proper crystal frequency to J1 on the oscillator module. Set rf generator to one-half the operating frequency for VHF and to one-fourth the operating frequency for UHF.
- c. Adjust external rf generator for an output of from 125 to 175 mv rms when terminated with a 50-ohm ± 2 -ohms impedance.

3-24.2. Crystal-Controlled Oscillator 8004290G3. If a crystal to provide the desired operating frequency is not available, perform the following.

- a. Place AC POWER ON-OFF switch to the OFF position.
- b. Remove exciter top cover.
- c. Disconnect oscillator cable (P2) from doubler

or quadrupler module whichever is used.

d. Remove oscillator cable (P3) from its stowage clip at rear of module and connect it to the doubler (quadrupler) connector (J1).

e. Secure oscillator P2 cable in stowage clip.

f. Replace exciter top cover.

g. Remove crystal from holder and reinstall holder in oscillator module to maintain oven temperature.

h. Connect output of an external rf generator set to cw (HP608 or equivalent) and to proper crystal frequency to J1 on the oscillator module. Set rf generator to one-half the operating frequency for VHF and to one-fourth the operating frequency for UHF.

i. Adjust external rf generator for an output of from 0.5 to 1.0 v rms when terminated with a 50-ohm ± 2 -ohms impedance

j. Proceed with normal tuning procedures (paragraph 3-8) for G2 oscillator only). When using G3 oscillator proceed with normal tuning procedures, but omit tuning of oscillator controls.

NOTE

A type CR-75 crystal may be used for emergency operation, however, it may not meet the $\pm 0.001\%$ frequency accuracy requirements. Monitoring of the crystal frequency may be effected by using a directional coupler in the antenna output and a counter to check the frequency accuracy.

3-24.3. Oscillator-Multiplier 8009546G1 External Frequency Control. Provision is made to inject an externally generated frequency should a crystal of the desired frequency not be available.

- a. Remove all power from the receiver or exciter containing the oscillator-multiplier module.
- b. Remove crystal holder from oscillator-multiplier module.

CAUTION

Care must be exercised when inserting or removing the crystal holder. Be sure pins are properly aligned. Do not twist holder when inserting or removing as bent or misaligned pins may result.

c. Connect the output of an rf generator at approximately +13 dBm level to J1 on the front panel of the oscillator-multiplier module. This injected frequency must be 5 times the frequency of the crystal frequency determined by previous instructions.

d. Tuning is accomplished by peaking the AMPL control, then checking the BUF and OSC controls. A dip may appear when tuning the BUF control. The dip is not wanted and this control must be tuned to peak along with the OSC control.

3-25. AC POWER FAILURE. If a 24-volt battery is already properly connected to the exciter, and an ac power failure occurs, switchover to the battery is automatic. If a battery is not connected, proceed as follows.

- Place exciter POWER ON-OFF switch to OFF.
- Connect 24-volt battery to rear panel connector J5, positive terminal to pin D and negative terminal to pin A.
- Place exciter POWER ON-OFF switch to ON. A 100 AH battery will provide power for approximately 15 hours to a transmitter continuously keyed.7..

3-26. UNSERVICEABLE FREQUENCY SYNTHESIZER. In the event of a frequency synthesizer failure, the exciter and power amplifier can be operated using an external oscillator, proceed as follows:

- Disconnect coaxial cable A8P2 from the input to the multiplier A9J1.
- Set external oscillator (AN/USM-323 or equivalent) to the desired frequency. Set level to $+14\text{dBm} \pm 3\text{dBm}$ (REF TO 31R2-2GRT-102, paragraph 4-22) and connect to A9J1.
- Tune the exciter as prescribed in TO 31R2-2GRT-102, paragraph 3-10.

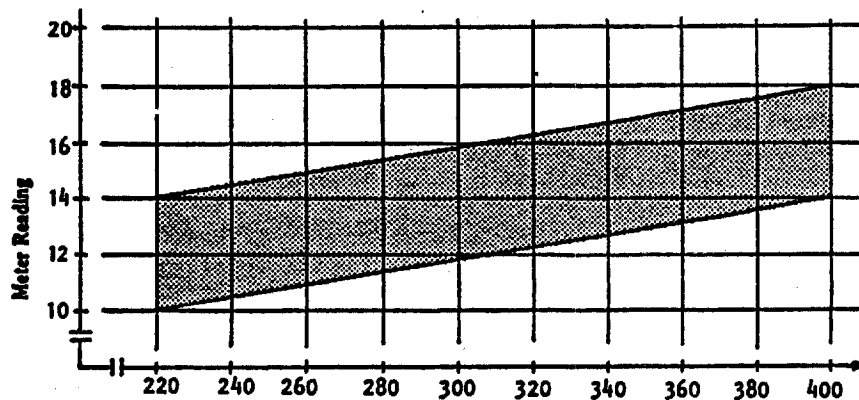


Figure 3-6. Frequency Vs. Plate Current, UHF

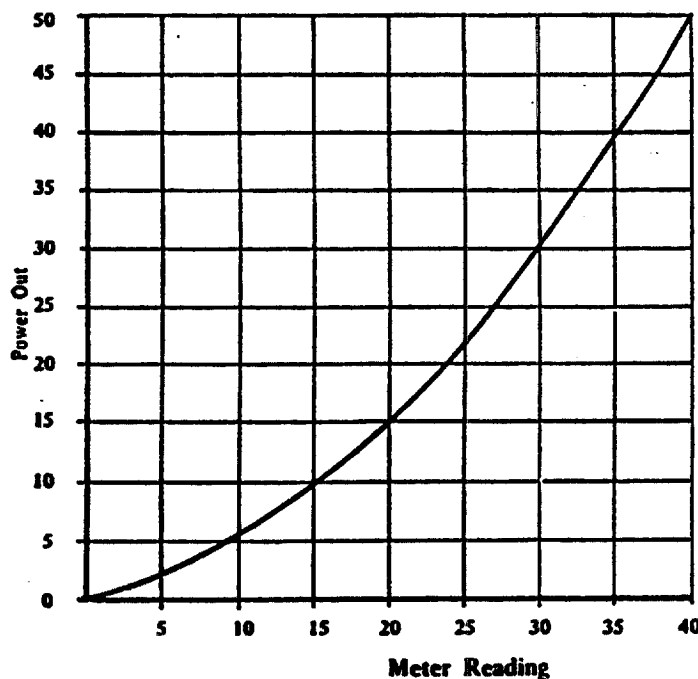


Figure 3-7 RF Power Output Vs. Meter Reading

CHAPTER 4

PRINCIPLES OF OPERATION

4-1. **INTRODUCTION.** This chapter provides information on the principles of operation of the VHF transmitting set and the UHF transmitting set. The chapter is divided into three sections. Section I describes the principles of operation of the transmitting sets to a functional block diagram level. Section II discusses the

principles of operation of the transmitting sets based on the functional operation of the electronic circuits. Section III describes the functional operation of the mechanical assemblies of the transmitting sets. For basic circuit principles of operation refer to T.O. 31-1-141.

SECTION I

FUNCTIONAL SYSTEM OPERATION

4-2. GENERAL.

4-3. The VHF transmitting set and the UHF transmitting set are identical except for their frequency determining characteristics. These functions and those functions common to both are described to a functional system block diagram level in this section. See figures 6-1 and 6-2.

4-4. FUNCTIONAL DESCRIPTION.

4-5. The VHF transmitting set and the UHF transmitting set are identical except for the radio frequency multiplier, radio frequency amplifiers, tunable filter, low pass filter, power detector, and power amplifier tuning cavity. The VHF transmitting set and the UHF transmitting set each consist of a 10-watt exciter and a 50-watt linear power amplifier.

4-6. The oscillator stage is crystal controlled in a temperature controlled oven. The oscillator output is fed into a doubler (VHF) or a quadrupler (UHF). The driver/power amplifier amplifies the radio frequency signal to a 10-watt level. The tunable filter eliminates unwanted harmonics and noise. The low pass filter following the driver/power amplifier eliminates harmonics generated in the final stages of the power amplifier. The signal then passes through the power detector to the coaxial relay. In the normal mode, the coaxial relay connects the power amplifier input to the exciter and the amplified 50-watt output to the antenna terminal. The low-pass filter in the power amplifier rejects any harmonics of the operating frequency generated in the power amplifier. The power detector supplies the control rf/modulator with detected forward and reverse signals. The control rf/modulator adjusts the driver/power amplifier output power to the level required for a 50-watt output from the power amplifier. The power sensor following the power amplifier detects the power output level and feeds back power level correction information to the control rf/modulator in the exciter unit. In the event of an antenna vswr of greater than 3 to 1, the power amplifier turns off and the exciter

power of 10 watts takes over as a backup. If the vswr becomes greater than 5 to 1, the exciter output power reduces automatically in proportion to the vswr to protect the driver/power amplifier in the exciter from excessive power dissipation.

4-7. The control, thermal/detector modulation percentage/coaxial relay control/keyer inhibit contains the logic to inhibit keying due to an excessive temperature, and it also determines the condition of the power amplifier. If the power amplifier has no output, the control, thermal/detector modulation percentage/coaxial relay control/keyer inhibit switches the coaxial relay to bypass the power amplifier. The keyer, control transfer keys the radio frequency multiplier, the crystal oscillator buffer, and the control, rf/modulator. The audio amplifier compressor contains the remote audio frequency input and remote keying input. The filter amplifier/detector receives the proper audio signal from the audio amplifier compressor. The filter amplifier/detector provides the required audio frequency response and feeds the signal to the buffer modulator. This module also contains the wide band data input, as well as a modulation limiter to prevent overmodulation.

4-8. The VHF power amplifier and the UHF power amplifier are each single-stage tetrode vacuum tube amplifiers. The amplifiers operate linearly, Class AB₁, in a common-cathode configuration. An over-temperature and airflow protection circuit is contained in the power amplifier which, when activated, removes the ac voltage input to the high voltage power supply and automatically switches the antenna output from the power amplifier to the exciter. The transmitting set power supplies convert the 47 to 420 hz primary power to regulated and unregulated dc voltages, and the ac heater voltage. When the ac power is interrupted, the exciter is automatically connected to the antenna and to a dc input from an external source, which provides a back up 10-watt level output transmission. When not in the battery mode of operation, the exciter power supply supplies the battery with 300 ma of charging current to maintain a fully charged battery.

4-9. GENERAL.

4-10. This section provides a discussion of the circuits comprising the VHF transmitting set and the UHF transmitting set. The discussion follows a logical operational or signal flow and is presented in the same functional sequence as in the preceding section.

4-11. OSCILLATOR A8.

4-12. There are three configurations of the crystal-controlled oscillator (8004290G2, 8004290G3 and 8009546G1). The oscillator module consists of a crystal controlled oscillator stage, a buffer amplifier stage, and an oven with associated heaters and temperature control circuitry. See figure 6-3 and figure 6-4. The G3 oscillator configuration is for Army use only. The oscillator-multiplier module (8009546G1) consists of a controlled oscillator and multiplier stage, a buffer amplifier stage and an output amplifier stage. No oven is required.

4-13. **CRYSTAL OSCILLATOR.** (8004290G2). The oscillator stage Q1 has its base voltage held at a constant value by a voltage divider consisting of R1 and R2. Crystal Y1 is coupled to the emitter by C4 and to a tap on L2 by C6. C6 and R5 control the drive level to Y1 and also isolate it from inductive and capacitive effects of the driving circuitry. The coupling network C4 and R4 also tends to isolate the crystal. Variable capacitor C3 is tunable for resonance at the crystal frequency.

4-14. **BUFFER AMPLIFIER.** The oscillator stage output, from a tap on L2 is coupled through C7 to the base of buffer amplifier Q2. This stage is adjusted for resonance at the crystal frequency by variable capacitor C13. The output from a tap on L4 is coupled through C10 and a matching pad consisting of R10 and R11 to coaxial connector P2. The signal at the junction of C10 and R10 is detected by CR1 and applied to the exciter front panel major Test point OSC. The signal is filtered by pi filter C11, L5, and C12 and becomes a positive voltage whose level is proportional to the oscillator output. Power supply decoupling is performed by C5, L3, C8, R23, and C14. The buffer amplifier B+ is keyed by the keyer control transfer module.

4-15. **OVEN.** A proportional temperature control system is utilized in the oven. The oven is maintained at a near constant temperature (75 degrees C $\pm$ 5 degrees) by heaters HR1 and HR2 and associated sensing and control circuitry. Power for the heaters is supplied by the unregulated output (22 to 39 volts dc) from the power supply module. The 22 to 39 volts is dropped through R12 and regulated at +6.2 volts at the cathode of zener diode VR1. Regulation is required at this point to allow the temperature sensing circuit to operate from a source voltage which has such a wide variation. The +6.2 volts is applied across a voltage divider made up of thermistors RT1, RT2, RT3 and potentiometer R16. R16 is used to control the oven temperature. The wiper of R16 is connected to the base of common emitter amplifier stage Q3. R16 and the thermistors form a temperature sensing circuit. The voltage

across R16 increases as the temperature in the crystal oven increases. At power turn-on, the crystal oven will be at room temperature. The resistance of RT1, RT2, and RT3 will be high and very little voltage will be picked off at R16. Q3 will then be in the cutoff region. The base drive of Q4 is controlled by R14, Q5 and R15. As the oven approaches the operating temperature, more and more voltage is applied to the base of Q3 which, driven into conduction, shunts a portion of the base drive current for Q4 to ground. This reduces the conduction of Q4 and current flow through heaters HR1 and HR2. Zener diode VR2 clamps the collector voltage of Q5 to a constant level as the 22 to 39 volt drive changes. Q5 and R19 through R22 hold the power dissipation in HR1 and HR2 constant as the 22 to 39 vdc level changes by controlling the base drive of Q4. The low voltage side of the heaters is brought out to the front panel major test point OVEN.

4-16. **EXTERNAL OSCILLATOR INPUT.** An external oscillator may be used in lieu of a crystal. The crystal must then be removed from the circuit and the external oscillator output connected to coaxial connector J1. The external oscillator must be adjusted to the proper frequency to serve as a local oscillator with a power level input of -5 dbm to 0 dbm. C3 and C13 are adjusted for peak output just as they were when using a crystal.

4-17. **CRYSTAL OSCILLATOR.** (8004290G3). The oscillator stage Q1 has its base voltage held at a constant value by a voltage divider consisting of R1 and R2. Crystal Y1 is coupled to the emitter by C4 and to a tap on L2 by phase network Z1. Z1 controls the phase and magnitude of the drive level to Y1. Z1 and R5 isolate Y1 from inductive and capacitive effects of the driving circuitry. The coupling network C4 and R4 also tends to isolate the crystal from the transistor. Variable capacitor C3 is tunable for resonance at the crystal frequency. Power supply decoupling is provided by C1, L1, C20, C14 and R23.

4-18. **BUFFER AMPLIFIER.** The oscillator stage output, from a tap on L2 is coupled through C7 to the base of buffer amplifier Q2. This stage is adjusted for resonance at the crystal frequency by variable capacitor C13. The output from a tap on L4 is coupled through C10 and a matching pad consisting of R10 and R11 to coaxial connector P2. The signal at the junction of C10 and R10 is detected by CR1 and applied to the exciter front panel major test point OSC. The signal is filtered by pi filter C11, L5, and C12 and becomes a positive voltage whose level is proportional to the oscillator output. Power supply decoupling is performed by C8, L3 and C5. The buffer amplifier B+ is keyed by the keyer, control transfer module.

4-19. **OVEN.** A proportional temperature control system is utilized in the oven. The oven is maintained at a near constant temperature (75 degrees C $\pm$ 5 degrees) by heaters HR1 and HR2, and associated sensing and control circuitry. Power for the heaters is supplied by the unregulated output (22 to 39 volts dc) from the power

supply module. R28 is the load resistor for the metering circuit and R25 is the multiplier resistor that furnishes the proper level for the OVEN front panel major test point. L6 and C19 furnish decoupling to the oven metering line. The regulated voltage is furnished to the resistance bridge of R13, R16, R14, R19 and RT1. Resistor R12 and R15 establish the dc operating voltage of the operational amplifier AR1. Potentiometer R16 is used to control the oven temperature and is adjusted for a temperature of 75 degrees C $\pm$ 5 degrees. With this adjustment the bridge is balanced and pin 2 and 3 of AR1 are at the same voltage. At power turn on, the oven is at room temperature. The resistance of RT1 will be high which will cause pin 3 of AR1 to be low and output of AR1 low. Transistor Q3 will be turned on by base drive through R22, R20 and VR1. With this conduction the collector current of Q3 furnishes base drive to Q4. Q4 is turned on and furnishes collector current through the heater elements HR1, HR2 from the unregulated voltage through R28. The voltage across R28 is furnished to the front panel for OVEN metering test point. R30 is to minimize thermal runaway resulting from Q4 operating at high temperature. As the oven approaches the operating temperature, the resistance of RT1 decreases to raise the voltage at Pin 3 of AR1 which raises the output voltage of AR1 to decrease drive to Q3 and Q4 which reduces heater current. At the operating temperature the output of AR1 is high so that Q3 is almost turned off which reduces base drive to Q4 and reduces the heater current to almost zero. VR1 assures that Q3 is turned off when heater current is not required as in the case when ambient temperatures exceed the oven temperature.

4-20. **EXTERNAL OSCILLATOR INPUT.** An external oscillator may be used in lieu of a crystal. Remove exciter cover. Disconnect cable P2 of the oscillator module from the double or quadrupler module. Remove oscillator cable P3 from its stowage clip at rear of oscillator module and connect it to the doubler or quadrupler connector J1. Secure cable P2 in stowage clip. The crystal must then be removed from the circuit and the external oscillator output connected to coaxial connector J1. The external oscillator must be adjusted to the proper frequency to serve as a local oscillator with a power level input between +7 to +13 dbm.

4-21. OSCILLATOR-SYNTHESIZER. (Fig 6-45)

4-22. **GENERAL.** The oscillator-synthesizer generates selectable stable frequencies by a voltage-tuned oscillator. The selected oscillator output frequency is fed to a prescaler counter which divides the frequency by 4 and feeds it to a variable counter. The variable counter further divides the frequency by a ratio of 9000 to 15,999 as determined by the settings of the frequency select thumbwheels. The division ratio of the counter is such that when the voltage-tuned oscillator is generating the correct frequency, the output of the variable counter is 1.5625 khz. This output signal is fed to a phase detector and compared with a 1.5625 khz reference signal. The 1.5625 khz reference signal is derived from a precision

crystal-controlled oscillator and a digital fixed-frequency divider counter. The phase difference between these two signals determines the d-c voltage which controls the voltage-tuned oscillator such that phase lock with the reference oscillator is maintained. The nominal output level of the oscillator is +14 dbm $\pm$ 3 dbm.

4-23. **REFERENCE GENERATOR.** The reference generator contains a temperature compensated crystal oscillator which provides a 3.2 mhz signal. Temperature stability is obtained without the use of an oven. A screwdriver trimmer adjustment is provided in the side of the crystal housing, covered by a removable, reusable sealed access cover. This cover is behind the hole plug located on the front of the synthesizer below the thumbwheel switches. The oscillator operates from the +20 vdc regulated. It is followed by an integrated circuit divider with straight-binary division by 2048, which operates from the +5 vdc regulated. The output from the reference generator is a square wave approximately 5 volts peak-to-peak, which is coupled to the phase comparator input. This is a solder sealed module and should not be serviced except by the manufacturer.

4-24. **DIVIDER/CONTROL.** This board determines the output frequency. The board contains a prescaler (divide by 4) and a variable counter with its associated frequency selection switches. The rf sample from the rf generator board is fed through attenuator R15 and R16. C5 is a d-c block which couples the rf to the base of amplifier Q4. This device places the rf at a dc level of about 3.2 volts by virtue of bias resistors R17 and R18 which is the optimum input level for U8. U8 is an emitter-coupled logic dual-D flip-flop which is hooked up to divide the input rf signal (56.25 mhz to 99.9937 mhz) by 4. The output of U8 is fed to an emitter coupled pair Q1 and Q2. This circuit amplifies the output of U8 and shifts the signal level to that of TTL (transistor-transistor logic). Q3 is used as a saturating switch which drives the first logic gate.

4-25. The variable counter number (divide by N), is essentially a chain of programmable counters constructed entirely with monolithic integrated circuits. The division ratio N ranges from 9000 to 15,999 and is programmed by generating binary logic levels with the 4-digit frequency selector thumbwheel switches. The first 3 switches are inverted 'nines' complement binary coded decimal (bcd). Switch S4 is hexadecimal code which programs U5 (divide by 16). S1, S2, and S3 program U2, U3, and U4 respectively, which are divide by 10 counters. Assuming the thumbwheels are set to 99.993 this means all switches are made placing a "low" on all the inputs, so the division ratio is 15,999. Thus the signal is coupled through the NAND gate (U7) following Q3

and into U5. This divides the input 24.9984375 M bits/sec pulse train by 16. The output of U5 drives the input of U4 which divides by 10. This signal then drives U3, which drives U2, each of which divide by 10. When the counter reaches 99.99375 (by dial), and 15,997 pulses have been counted, the inputs to the U1 AND gates (6-46) are all high, which enables a 3 input AND gate of U6 (pins 3, 4, and 5). On the 15,998th pulse, U6 changes state, which resets U2, U3, U4, and U5 and activates U7 pulse stretcher, which generates a negative 1.5625 kHz sample pulse (approximately 10 microseconds) at E3. The NAND gate of U7 (pins 1 through 6) and C4 and R14 are used to generate and shape a pulse whenever the signal at U7-1 undergoes a negative transition. The 15,999th pulse occurs at the same time the reset pulse is present at pin 1 of U2, U3, U4, and U5. Therefore, this 15,999th pulse has no effect and the counter remains in the reset condition. The next clock pulse after 15,999 starts a new count. It is important to note that the sample pulse at E3 occurs always on the 15,999th pulse and a new count always starts after the 15,999th pulse.

4-26. If the thumbwheels are set to numbers other than 99.9937, the inputs to the divider counters are made high through the switch. Z1 is a resistor network consisting of 15 each 4.7K ohm pull-up resistors with one lead common to pin 16 (B+). No change will occur until the data strobe drops to a logic zero (Q of U6 upon full count). At that time the data on the inputs will be transferred to their associated counters and the count will take up from there on the next clock pulse. Under these conditions, the count required will be shortened by the amount of the preset inputs.

4-27. **RF GENERATOR.** The rf generator provides the output signal of the synthesizer, as well as driving the divider control prescaler. The printed wiring board contains the oscillator, limit controls for the oscillator, a buffer amplifier, a final amplifier, and a voltage regulator. The oscillator is basically a voltage-tuned Hartley circuit, with L2, CR1 and CR2 the tank. CR1 and CR2 are voltage variable capacitors (varactor diodes) whose capacity is dependent on the amount of reverse voltage. This control voltage is obtained from the output of the phase comparator, and is coupled through R29 and R3, with C22 used as a bypass. Q1 is a high-frequency field-effect transistor, with R1, R2, R35, R36 and R37 providing bias and feedback. C2, C3, C7, C26 and C27 are all bypass capacitors, and C5 and C25 are blocking capacitors. L1 is an autotransformer and is used to couple the signal out to the buffer amplifier Q2, through R4, C4 and C28.

4-28. R10 is a d-c feedback resistor, and R9 is the collector load. L3, C11, L4 and C12 are low-pass filter sections to reduce the second harmonic, with C8, C9 and C23 used as bypasses. L5 is an autotransformer and couples

the signal into a signal splitter L6. R11, R12, and R13 are used to attenuate the signal which goes back to the divider control. L7, C16 and R15 match the input impedance of Q3, the final amplifier. R18 is the d-c feedback with R17 the collector load. L8, C17, L9 and C18 are two low-pass filter sections to reduce harmonics, with C10, C15 and C24 bypasses. L10 is an autotransformer which couples the signal to C19, a d-c block. R19, R20 and R21 are used to attenuate the signal to provide isolation from loading effects of the synthesizer output. R22, CR3, C20, R23, C21, and R24 form an r-f detector which indicates the presence of rf on the exciter front panel OSC test point.

4-29. U1 is a transistor array of two individual transistors and two transistors internally connected as a Darlington circuit. U1 is used as a voltage regulator, with VR1 the zener reference. Q4 and Q5 are used to limit the control line voltage to the oscillator. They are turned on by S1 on the divider control. This switch has binary coded decimal outputs and depends on the frequency selected by the first thumbwheel switch. Either or both Q4 and Q5 may be turned on. When either is turned on, a voltage limit is developed across the precision resistors which are coupled to the control line. This voltage over-rides the control voltage from the phase comparator and limits the oscillator range. This prevents the synthesizer from locking falsely on a harmonic.

4-30. **PHASE COMPARATOR.** The phase comparator converts the difference between the phase of the variable counter and the reference generator to an error voltage. Note that the frequency of these two signals is the same, but they differ in phase. Q3 is a voltage regulator of the capacitor multiplier type. C9 and R13 are filters for the regulated 18 to 20 vdc input supply. VR1 is the zener diode which provides the reference voltage. C7 and C8 are bypass capacitors for VR1, with R11 and R12 the bias for Q3. C5, C6, and R9 are filters for the regulated output of Q3. R28 is a decoupling component to further filter the input voltage to the reference generator. R27 is the current limit for VR2, which is the zener diode voltage reference for the 5 volt supply to the reference generator. Q1 is a switch for the square wave from the reference generator. R1, R2 and C1 differentiate the leading edge of the incoming square wave to cause a quick turn on of Q1. This drives the ramp generator Q2. When Q1 conducts, it discharges C2 and C3, and pulls the base and emitter of Q2 toward ground. After Q1 turns off, C2, C3, R4, and R5 are used as an RC time constant to create a ramp. Since Q2 is an emitter follower, the output is bootstrapped back to the base to increase the ramp. R7 is used to linearize the ramp. R6 and R8 are bias resistors for Q2.

4-31. Q5 is a switch for the negative pulse from the divider control circuit which is differentiated by C10 and R15. R14 and R16 are bias resistors. C11 and R17 couple the leading edge of the signal to the gate of Q6 while also providing a high impedance. The ramp generator output is applied to the source of Q6 and is a varying dc voltage. When the sample pulse from the divider control is applied,

Q6 conducts the d-c level that is on the source at that particular instant and this d-c level is stored on C12. This level is held until the next sample pulse. Thus the circuit "samples" the d-c level of the ramp, and "holds" it. This "hold" voltage is a continuous voltage that is proportional to the phase difference of the two input signals. During search mode (before phase lock occurs), CR1 or CR2 conduct because there is greater than 0.6 volt across them. After phase lock occurs, the voltage differential is low and R25 provides isolation for any noise that might be present. U1 is a high input impedance operational amplifier which is used as a d-c level shifter to provide the proper d-c level for the voltage-tuned oscillator. It has almost unity gain, with R19 and R26 providing the nominal operating level. R21, C14, R22, C15, R23, C16, R24 and C18 form a multi-section low-pass filter which is used to remove any undesired a-c signal from the control voltage to the voltage-tuned oscillator. During search mode, most of the filter is bypassed by L1 and CR3 or CR4, which conduct when the voltage differential is greater than 0.6 volt.

4-32. **SWITCHING REGULATOR.** This printed wiring board consists of an input filter, a power switch driver, and an output filter. The input filter, is C1, C2 and L3. U1 is the switch driver, with R3 used as a short circuit protector. R4, R5, and R6 is a voltage divider string. L1 is an inductor which filters the dc pulses from the power switch. Operation consists of U1 being turned on by the feedback sensor after it drops to a sufficiently low value. It is an operational amplifier with its own internal reference diode. It operates as a switch and is either on or off. It drives an integrated circuit mounted on the back of the synthesizer which is a power switch. This switch conducts the unregulated dc for short pulses, operating at 40 khz switching frequency. C4, C5, and L2 form an additional filter to smooth the 5 volts.

4-33. OSCILLATOR-MULTIPLIER A8 (G1).

4-34. **GENERAL.** The oscillator-multiplier module consists of a crystal controlled oscillator and multiplier stage, a buffer amplifier stage and an output amplifier stage that provides the necessary drive signal to the multiplier module. The oscillator-multiplier requires a fundamental mode crystal operating in the frequency range of 11.25 mhz to 99.987500 mhz. (See paragraph 3-8 for crystal frequency selection). The output frequency from the module is five times (X5) the crystal frequency. Figure 6-5 is a schematic of the oscillator-multiplier module.

4-35. **OSCILLATOR-MULTIPLIER.** The oscillator stage Q1 is a modified Colpitts type crystal oscillator circuit, with base bias voltage held constant by the voltage divider consisting of R3 and R4. Crystal Y 1 operates in an anti-resonant mode, with the parallel capacitors C25, C2 and C3 controlling the operating frequency. C3 is the frequency adjust capacitor on the front panel of the oscillator-multiplier, C25 is an internal adjustment set at the factory so that the output frequency is proper with C3 adjusted to mid range. This allows for plus or minus front panel

adjustment of frequency for crystal having an initial error up to ± 25 parts per million (ppm). Capacitor C4 and C5 provide the oscillator feedback divider, with R1 the transistor emitter resistor. The collector circuit of Q1 is tuned to the fifth harmonic of the oscillator, with the resonant circuit consisting of L2 in parallel with C10 and C11, with C10 the front panel tuned element. The dc input for Q1 consists of a 12 volt regulator circuit with zener diode VR1 providing the regulator action, and R6, R1, C6 and C7 providing the necessary filtering and decoupling to isolate the oscillator stage. Resistor R2 serves as the collector current limiting resistor, and C8 serves as the rf decoupling capacitor for the tuned collector circuit. Resistor R7 and capacitor C9 provide loose coupling to the Hi Q tuned filter consisting of L4 in parallel with C15 and front panel tuned C16. This Hi Q filter circuit aids in eliminating the unwanted harmonics, and allows the fifth oscillator harmonic to pass when properly tuned.

4-36. **BUFFER AMPLIFIER.** Transistor Q2 serves as a buffer emitter follower stage, with its high input resistance providing a minimum loading to the tuned circuit of L4, C15 and C16. Resistor R8 and capacitor C17 couple the filtered fifth harmonic to the base of emitter follower Q2. R9 and R10 are bias resistors for Q2, and R11 serves as the output emitter resistor.

4-37. **OUTPUT AMPLIFIER.** Transistor stage Q3 serves as the rf output stage from the oscillator-multiplier. The signal is coupled to the base of Q3 through parasitic suppressor resistor R14. Emitter resistors R15 and R16 provide emitter biasing, with R15 serving as an emitter degenerating resistor to protect against gain variations of this amplifier due to transistor gain variations. C22 serves as emitter bypass capacitor. The collector of the rf tuned circuit consists of L3, C20 and front panel tuned C21. This stage is likewise tuned to the 5th harmonic of the oscillator. The rf output is coupled through C19 to a 2db pad consisting of R18 and R19. The pad serves as a buffer between the output stage and the circuit to be driven, and additionally serves as a resistive drive source of approximately 50 ohms to the output coaxial cable and connector.

4-38. **METERING CIRCUIT.** A tuning detector circuit consisting of R17, rectifier diode CR1, rf filter C24, L6, C23 and meter scaling resistors R12 and R13 provide a dc tuning indication to the transmitter or receiver oscillator test point.

4-39 The dc input for Q2 and Q3 is filtered and decoupled to provide B+ isolation by components C13, C12, L1, C14 and L3. Capacitor C18 serves as the rf decoupling capacitor for the Q3 tuned collector circuit. J1, a BNC connector on the oscillator front panel, provides a frequency monitoring test point, for tuning frequency adjust capacitor C3 to the desired frequency accuracy.

4-40. **EXTERNAL INPUT.** Additionally, J1 can be used as an external signal generator input if desired. Crystal Y1 should be removed however, and it is still necessary to

adjust C16 and C21 front panel tuning adjustments and observe the oscillator test point to obtain maximum output. External drive level should be 1 to 2 volts rf rms input.

4.41. DOUBLER, RADIO FREQUENCY (VHF) A9.

4.42. The frequency doubler doubles the crystal oscillator frequency. See figure 6-6. The input signal is fed into doubler transistor Q1 through input coupling capacitor C2. R1 and R2 provide bias for Q1. The output tuned circuit from the collector of Q1 consists of L2 in parallel with C5, tuned to twice the input frequency. L3 which is wound on the same form as L2 provides the transformer-coupled output to the input of grounded-base buffer amplifier transistor Q2. The signal is coupled into Q2 through C4. The output signal from Q2 is fed from its collector through R12 to the tuned circuit consisting of C11 and L5, which is also tuned to twice the frequency of the input signal. L5 is used as an autotransformer with its output coupled from the center tap through C9 and through a 3-db pi pad attenuation network consisting of R15, R16 and R17 to coaxial output connector P2. A feedback gain control circuit is used in the frequency doubler to provide a stable output signal amplitude.

Following the output capacitor C9 is a detector consisting of CR2, and filter network C13, L6, and C14. This detector provides a dc output proportional to the signal amplitude at the output of capacitor C9. The detector dc is fed through an attenuation network consisting of potentiometer R9 and resistors R8 and R10, to the base of Q3 which operates as an amplifier. Biasing of Q3 is accomplished by the feedback dc signal to thermistor RT1, and resistor R7 in the base of Q3. Thermistor RT1 provides temperature compensation for the overall system.

4.43. The dc output level from Q3 controls the base voltage of Q2 which, in turn, operates as a gain-controlled stage in the path of the rf signal. If the output signal is too large, the dc voltage detected by CR2 provides a high positive output which, in turn, is fed through Q3 to the base of Q2 decreasing the gain of Q2. This loop action provides a constant output signal level by reducing the signal level at CR2 to the nominal level which is expected at the output. Potentiometer R9 adjusts the output signal level from the doubler. R11 serves as a current limiting resistor for the tuning meter which is located on the front panel of the exciter unit. The dc voltage to the doubler is provided by a keyed +20-volt signal. This +20-volt signal exists only when the transmitter is keyed in the transmit operation. When the transmitter is keyed off, no dc is applied to the doubler and, consequently, no doubler rf output signal is obtained. L1 and C3 provide decoupling action for the collector circuit of Q1. L4 and C7 provide decoupling action for the collector circuit of Q2. R14 and C8 provide noise decoupling on the B+ input to the

doubler from the keyed +20-volt line. The input signal level required by the doubler at J1 is approximately 10 milliwatts. The output signal level obtained at J2 is approximately 10 milliwatts.

4.44. QUADRUPLER (UHF) A9.

4.45. The frequency quadrupler provides an output frequency four times that of the crystal oscillator. See figure 6-7. The output of the quadrupler is fed to the driver/power amplifier. The input signal from the crystal oscillator at J1 is fed through coupling capacitor C2 to the base of Q3. Q3 serves as the frequency quadrupling stage with the output circuit at the collector tuned to four times the input frequency. R1 and R20 provide the bias for Q3 through rf choke L3. The tuned circuit on the collector of Q3 consists of capacitor C15 and inductance L2. The center tap on L2 provides the output to the following stage, Q1, through coupling capacitor C5. Q1 serves as a grounded-base buffer amplifier to the quadrupled frequency. L4 and C22 form the resonant circuit at the quadrupled frequency. The tap on L4 provides the output signal to be fed to Q2 through coupling capacitor C10. Q2 serves as an additional buffer and provides additional gain for the quadrupled frequency. Biasing for Q2 is obtained from voltage dividers R8 and R16, through rf choke L6. The collector output circuit of Q2 consists of C28 in parallel with L8 tuned to the quadrupled frequency. The center tap on L8 provides the output to a 3 db pad consisting of R23, R24, and R25. Output connector P2 follows the 3 db pad.

4.46. An automatic gain controlled feedback circuit provides a constant rf level output. An rf detector circuit following output capacitor C16 consisting of CR3 and filter components C29, L9, and C14 provides a dc level proportional to the output rf signal level. The dc level is fed to the base of Q4 through R15 which is the gain controlled feedback potentiometer. Q4 serves as a dc amplifier with the output from its collector coupled to emitter-follower transistor Q5. The dc output from Q5 serves as the B+ for buffer amplifier Q1 as well as the bias for the base of Q1. By either increasing or decreasing the dc voltage, the gain of Q1 can be changed to compensate for variations in rf level output. A keyed +20-volt dc fed through P1-5 serves as the B+ for Q2, Q3, and Q4. R22 and C32 provide input B+ noise decoupling. Regulated +20-volt dc serves as the B+ for Q5. The regulated B+ is introduced through P1-3 into the decoupling network consisting of R21 and C31. L1, C9, and C23 serve as a decoupling network for the collector of Q3. L5, C27, and C8 serve as the decoupling network for the collector of Q1. L7, C17, and C18 serve as the decoupling network for the collector of Q2. The meter

output is obtained from the detector circuit following capacitor C16. A current limiting resistor for metering, R9, provides the proper readings to the test meter located on the exciter front panel when the switch is in the MULTR position. Additional capacitors and resistors are used in the emitter circuits of Q2 and Q3 to serve as biasing for these stages. R5 and R4 serve as the biasing level resistors for Q1 with capacitor C24 and C6 serving to reduce any ac signals that may be present at the base of this transistor. The input power level required to drive the quadrupler module is approximately 10 milliwatts from the crystal oscillator. The output power from the quadrupler is approximately 10 milliwatts.

4-47. QUADRUPLER REVISED

4-48. Figure 6-8 shows the preferred configuration of the UHF quadrupler to assure minimum spurious antenna conducted signals. This configuration differs from the early configuration by incorporating rfi shields between the first and second stage, and second and third stage. Also an input resistor has been added and a circuit coil value change has been made to obtain a 50-ohm input impedance. Coil tap changes and circuit value changes have been made to assure stability.

4-49. DRIVER/POWER AMPLIFIER (VHF) A10.

4-50. DRIVER/POWER AMPLIFIER (VHF) A10

4-51. Different power amplifiers are required for the VHF mode and the UHF mode; each system will be described below. See figure 6-9. Filters FL1 through FL5 are rf decoupling filters to prevent rf radiation from this module into the exciter system. R1 is a resistor that is switched in or out of the system depending on the TUNE-OPERATE position of S6 on the exciter front panel. In the TUNE position, R1 is switched in to the collector of the driver transistor connected to C12. When the switch is in the OPERATE position, R1 is shorted by switching across pins 3 and 5 of P1. R2 is a current limiting resistor for front panel metering when the test switch is in the FLTR TUNE position.

4-52. The collector of Q3 is coupled through matching transformer L14 through C20 and the impedance matching network consisting of L15, L16, C21, and C22 to

P3 which is a 50-ohm output that drives the input of the tunable filter FL2. A considerable amount of decoupling and B+ line filtering is necessary to prevent spurious oscillations between the stages of this module and to prevent rf from feeding out of the driver stages to the rest of the exciter. C8, C9, C11, C12, C18, C19 and L5, L6, L9, L10 and L11 provide the decoupling necessary to prevent rf leakage and interstage oscillation. L5, L6, L9, L10 and L11 are ferrite beads with wires running through their cores. These serve as rf chokes and present a high impedance path for rf on these lines. Lead lengths on all components of this module are very critical as any additional lead length creates more inductance and, consequently could upset the impedance matching and overall operation. For proper operation, the driver requires a nominal 10 milliwatt input and with a maximum apc signal on the input to FL3, the output of the driver at P3 will be approximately 8 watts. This amplifier is broadband, amplifying all frequencies from 116 to 150 mhz. The driver output at P3 is fed to tunable filter FL2, which is a tunable narrow band pass filter which when properly tuned, returns the rf signal back to the input of the amplifier section on P4. FL1 through FL5 are rf decoupling filters to prevent rf radiation from entering other parts of the exciter. R1 is switched in or out of the system depending on the position of S6, the TUNE-OPERATE switch, on the exciter front panel. In the TUNE position, R1 is switched in to the collector of the driver transistor connected to E4. When the switch is in the OPERATE position, R1 is shorted by switching across pins 3 and 5 of P1. R2 is a current limiting resistor for front panel metering when the meter switch is in the FLTR TUNE position.

4-53. POWER AMPLIFIER (VHF) A10A2. See figure 6-11.

The rf input is at a 50-ohm level from the driver output and is fed through FL1 to P4 and proceeds through the matching network consisting of L1, C1, L2,

C2, L3, C3 and C4 to the input amplifier Q1. The matching network provides the proper impedance match from the 50-ohm input to the input impedance of Q1. R1, R2 and L4 are dc bias dividers for Q1. The amplified output of Q1 is coupled through inductor L5 through the broadband interstage matching network consisting of L5, C11, C12, L7, C16 and C17 to the input of Q2. R3 and L9 provide the dc bias return for Q2. The amplified output from the collector of Q2 is coupled through the matching network consisting of transformer L13, C26 and C27 providing the broadband output impedance of 50 ohms to the output connector P2. A detector circuit consisting of R4, R7 and CR1 with filter components R6, C23, R5, and C22 providing the proper filtering of the detected output provides a monitored rf test point output for rf power output at the PWR AMPL position of the front panel test switch. A considerable amount of decoupling is required in this module to prevent interstage oscillations and to prevent unwanted rf radiation into other areas of exciter. C5, C6, C7, C8, C9, C10, C13, C14, C25 and C28 are all decoupling capacitors which work in conjunction with decoupling inductances L6 and L8 to provide the necessary decoupling. The power amplifier is broadband amplifying signals from 116 to 150 mhz. When driven with an 8-watt signal level at P4, approximately 50 watts is obtained from the output jack P2. The input dc required for this stage from FL1 is a nominal 20 volts dc. As in the driver unit, lead lengths are extremely critical for proper operation.

4-54. **DRIVER (VHF) A10A1.** See figure 6-10. The rf output from the multiplier module enters the driver at J1 driving amplifier Q1 through an impedance matching network consisting of Z1, R1, C1 and L1 which provides a broadband 50-ohm input match to the input impedance of Q1. C2 serves as a coupling capacitor and R2 and R4 provide the proper biasing to the base of Q1. The modulation and apc changes the bias on this stage to provide modulation and proper output power. The modulation input or apc input to this stage is at E1 through FL3. C3 is for rf bypass. Resistors R5 and R6 serve as stabilizing emitter resistors for Q1 with capacitors C4 and C5 providing the rf return to ground. The output from Q1 is coupled through matching transformer L2 and the

matching network consisting of L3, L4, C6 and C7 to provide the proper interstage match between Q1 output and the base input to amplifier Q2. C10 serves as a coupling/dc blocking capacitor between these stages. R7 and L7 provide a dc return path for the base current of Q2. R3 is a swamping resistor across L2. The amplified output on the collector of Q2 is fed through matching transformer L8, through the broadband interstage matching network consisting of C13, C14, C15, C16, C17 and L12 to the base of Q3. R8 is a swamping resistor across L8 to provide proper broadband operation of the interstage network. R9 and L13 serve as a base dc return for Q3. Z2 and C23 serve as a trap at 120 mhz to reduce excessive gain.

4-55. The collector of Q3 is coupled through matching transformer L14 through C20 and the impedance matching network consisting of L15, L16, C21, and C22 to P3 which is a 50-ohm output that drives the input of the tunable filter FL2. A considerable amount of decoupling and B+ line filtering is necessary to prevent spurious oscillations between the stages of this module and to prevent rf from feeding out of the driver stages to the rest of the exciter. C8, C9, C11, C12, C18, C19 and L5, L6, L9, L10 and L11 provide the decoupling necessary to prevent rf leakage and interstage oscillation. L5, L6, L9, L10 and L11 are ferrite beads with wires running through their cores. These serve as rf chokes and present a high impedance path for rf on these lines. Lead lengths on all components of this module are very critical as an additional lead length creates more inductance and, consequently, could upset the impedance matching and overall operation. For proper operation, the driver requires a nominal 10 milliwatt input and with a maximum apc signal on the input to FL3, the output of the driver at P3 will be approximately 8 watts. This amplifier is broadband, amplifying all frequencies from 116 to 150 mhz. The driver output at P3 is fed to tunable filter FL2, which is a tunable narrow band pass filter, which when properly tuned, returns the rf signal back to the input of the amplifier section on P4. FL1 through FL5 are rf decoupling filters to prevent rf radiation from entering other parts of the exciter. R1 is switched in or out of the system depending on the position of S6, the TUNE-OPERATE switch, on the exciter front panel. In the TUNE position, R1 is switched in to the collector of the driver transistor connected to E4. When the switch is in the OPERATE position, R1 is shorted by switching across pins 3 and 5 of P1. R2 is a current limiting resistor for front panel metering when the meter switch is in the FLTR TUNE position. See figure 6-9.

4-56. **POWER AMPLIFIER (VHF) A10A2.** See figure 6-12. The rf input is at a 50-ohm level from the driver output and is fed through FL2 to P4 and proceeds through the matching network consisting of L1, C1, C2, L3, C3 and C4 to the input amplifier Q1. The matching network provides the proper impedance match from the 50-ohm input to the input impedance of Q1. R1, R2 and L4 are dc bias dividers for Q1. The amplified output of Q1 is coupled through the

broadband interstage matching network consisting of L5, C29, L16, L14, C11, L15, L7, C30, C16 and C17 to the input of Q2. R3 and L9 provide the dc bias return for Q2; R8 with R3 provides quiescent dc bias for Q2. The amplified output from the collector of Q2 is coupled through the matching network consisting of transformer L13, C26 and C27 providing the broadband output impedance of 50 ohms to the output connector P2. A detector circuit consisting of R4, R7 and CR1, with filter components R6, C23, R5, and C22 providing the proper filter of the detected output provides a monitored rf test point output for rf power output at the PWR AMPL position of the front panel test switch. A considerable amount of decoupling is required in this module to prevent interstage oscillations and to prevent unwanted rf radiation into other areas of the exciter. C5, C6, C7, C8, C9, C10, C13, C14, C25, and C28 are all decoupling capacitors which work in conjunction with decoupling inductances L6 and L8 to provide the necessary decoupling. L17, L18, L19, L20, L21, and L22 are ferrite beads placed on the dc line to provide decoupling. The power amplifier is broadband amplifying signals from 116 to 150 mhz. When driven with a 3-watt signal level at P4, approximately 10 watts is obtained from the output jack P2. The input dc required for this stage from FL1 is a nominal 20 volts dc. As in the driver unit, lead lengths are extremely critical for proper operation.

4-57. DRIVER/POWER AMPLIFIER (UHF) A10.

4-58. See figure 6-13. R1 is a current limiting resistor which is shorted in the OPERATE position of the TUNE-OPERATE switch on the exciter front panel. In the TUNE position, B+ flows through R1 and FL4 to C31 on the driver amplifier. This limits the drive current to the driver stage which drives the tunable filter FL2, preventing a possible burn-out of this filter. R2 is a series limiting resistor for the test meter in the TUNE position on the test switch of the exciter front panel. Filters FL1 through FL5 act as rf decoupling filters to prevent rf from radiating into other portions of the chassis. Two B+ lines and two ground lines carry the current for this module, two pins being required because of the current requirement. The rf input enters at J1 of the driver amplifier. Connector P3 is the output connector to the external tunable filter FL2; P4 is the return from the tunable filter, back to the driver amplifier. E2 is the output of the driver amplifier to the power amplifier, A2. The output from the power amplifier is on E3 which feeds hybrid A6 which splits the power in two directions and out of E2 and E3 to power amplifiers A3 and A4. Power amplifiers A3 and A4 are similar to power amplifier A2. The outputs from these amplifiers are on E3 and are fed to hybrid A5 through E1 and E3. The hybrid sums the two inputs and feeds the output line P2.

4-59. **DRIVER (UHF) A10A1.** See figure 6-15. The 50-ohm rf output from the multiplier enters at J1. Z2, Z1 and C6 serve as an input matching network to Q1. C5 serves as a coupling capacitor and R6 and R7 provide the dc bias and apc or modulation input to Q1. R8 is a stabilizing emitter resistor bypassed by C11, C12, and C13. The amplified output from Q1 is coupled through the broadband interstage matching network consisting of L1, C15, R10, C17 and C16 to amplifier transistor Q2. C16 is the input coupling capacitor for Q2 and R11 and R12 serving as the bias for Q2, as well as the apc and modulation input. Modulation is applied to E5 which serves as the B+ for both Q1 and Q2 and is the source of the bias for Q1 and Q2. Thus, the apc and modulation input is on the base and collector of Q1 and Q2. R13 is the stabilizing emitter resistor for Q2, with C18, C19 and C41 serving as the emitter rf bypass capacitors. The amplified output from Q2 is coupled through the broadband interstage matching network consisting of L3, Z3, R15, C22, C48, C45, L26, L25, C46 and L24. This is a special design low impedance matching network which matches the output of Q2 to the input of Q3. R19 and R18 provide the bias for the input to Q3 with C23 serving as base bypass for the input matching network. The output from amplifier transistor Q3 is coupled to the base input of Q4 through the matching network consisting of L4, Z5, R23, T2, L31, R24 and C29. This network serves as an interstage matching network. The amplified output from Q4 is fed from the collector with L11 as a load inductance with the output fed through the matching network consisting of L11, L12, C33, C32 and L13 to output E1. This is a 50-ohm output and the preceding components serve as a matching network between the output of transistor Q4 and the 50-ohm input to filter FL2, which is driven from E1.

4-60. The return signal from FL2 returns to E3 with the input entering through the matching network consisting of C40, L32, L33, R22, and T3. This is a matching network between the 50-ohm output from the filter FL2 to the base input of Q5. C38 and R17 serve as additional matching network components. The output from Q5 is obtained from the collector and from load inductance L19 and is fed through the broadband output matching network consisting of L19, L20, C37, C36 and L21 to the output at E2, the 50-ohm drive source. A considerable amount of decoupling is necessary in this circuit to prevent spurious oscillations and to prevent radiation from the driver/power amplifier to other portions of the exciter unit. C8, C14, C9, C20, C25, C26, C31, C34, C35, C51, C50 and C30 with L8, L9, L10, L28, L29 and L30 all serve as decoupling components to prevent spurious oscillations and re-radiation. R14 acts as

a decoupling resistor for C8 and C14. R9 additionally serves as a decoupling resistor for C9 and C20. L8, L9, L10, L28, L29 and L30 are ferrite beads which serve as rf chokes. Q4 is the amplifier stage which has a current limiting resistor in the collector circuit when the exciter is in the TUNE mode. The resistor is shorted and the output of the collector is returned direct to B+ when the TUNE-OPERATE switch is in the OPERATE position. This is to protect filter FL2 from excessive rf when the filter is untuned and tends to dissipate some of the power radiated out of E1.

4-61. DRIVER (UHF) A10A1.

See figure 6-14. The

50-ohm rf output from the multiplier enters at J1. Z2, Z1 and C6 serve as an input matching network to Q1. C5 serves as a coupling capacitor and R6 and R7 provide the dc bias and apc or modulation input to Q1. R8 is a stabilizing emitter resistor bypassed by C11, C12, and C13. The amplified output from Q1 is coupled through the broadband interstage matching network consisting of L1, C15, R10, C17 and C16 to amplifier transistor Q2. C16 is the input coupling capacitor for Q2 and R11 and R12 serving as the bias for Q2, as well as the apc and modulation input. Modulation is applied to E5 which serves as the B+ for both Q1 and Q2 and is the source of the bias for Q1 and Q2. Thus, the apc and modulation input is on the base and collector of Q1 and Q2. R13 is the stabilizing emitter resistor for Q2, with C18, C19 and C41 serving as the emitter rf bypass capacitors. The amplified output from Q2 is coupled through the broadband interstage matching network consisting of L3, Z3, R15, C22, C48, C45, L25, L26, C46, Z4, C57 and L24. This is a special design low impedance matching network which matches the output of Q2 to the input of Q3. R19 and R18 provide the bias for the input to Q3 with C23 and C52 serving as additional components for the input matching network. The output from amplifier transistor Q3 is coupled to the base input of Q4 through the matching network consisting of C49, L4, C27, C56 and T2. This network serves as an interstage matching network with additional matching network components consisting of C53, R16, C29, L23, R20 and C47. Inductor L23, C47 and R20 acts as a low frequency spurious suppression network to prevent oscillations at low frequencies. The amplified output from Q4 is fed from the collector with L11 as a load inductance with the output fed through the matching network consisting of L11, L12, C33, C32 and L13 to output E1. This is a 50-ohm output and the preceding components

serve as a matching network between the output of transistor Q4 and the 50-ohm input to filter FL2, which is driven from E1.

4-62. The return signal from FL2 returns to E3 with the input entering through the matching network consisting of L22, C40, R22, C55, and T3. This is a matching network between the 50-ohm output from the filter FL2 to the base input of Q5. C54, C38 and R17 serve as additional matching network components. L27, C39 and R21 act as an additional low frequency suppressor to swamp or prevent low frequency oscillations. The output from Q5 is obtained from the collector and from load inductance L19 and is fed through the broadband output matching network consisting of L19, L20, C37, C36 and L21 to the output at E2, the 50-ohm drive source. A considerable amount of decoupling is necessary in this circuit to prevent spurious oscillations and to prevent radiation from the driver/power amplifier to other portions of the exciter unit. C9, C20, C25, C26, C31, C35, C51, C50 and C30 with L8, L9, L10, L28, L29 and L30 all serve as decoupling components to prevent spurious oscillations and re-radiation. R9 additionally serves as a decoupling resistor for C9 and C20. L8, L9, L10, L28, L29 and L30 are ferrite beads which serve as rf chokes. Q4 is the amplifier stage which has a current limiting resistor in the collector circuit when the exciter is in the TUNE mode. The resistor is shorted and the output of the collector is returned direct to B+ when the TUNE-OPERATE switch is in the OPERATE position. This is to protect filter FL2 from excessive rf when the filter is untuned and tends to dissipate all the power radiated out at E1.

4-63. POWER AMPLIFIER (UHF) A10A2. See figures 6-18 and 6-19. Identical power amplifiers are used in module A10A2, A10A3 and A10A4 as shown in figure 6-13. These power amplifiers are dual channel with two high power, broadband transistor stages which operate in parallel. The input is fed into E1 to hybrid HY1. The output from HY1 is split into two equal power level outputs which are on pin 2 and pin 3 of the hybrid. Pin 4 is terminated into a 50-ohm load consisting of R2, R3, and R4 in parallel which maintains a 50-ohm input impedance at E1 with the same mismatch on both outputs. The output on pin 2 is fed to the matching network consisting of Z1, T1, C3, C4 and C22. This network serves as a matching network between the 50-ohm output of the hybrid and the input impedance of Q1. L1 and R1 serve as the base bias network for Q1. T1 is a quarter wavelength transformer made of semirigid coaxial line with a characteristic impedance of 25 ohms. The output from the collector of Q1 is coupled to HY2 on pin 3 through the matching network consisting of L2B, L2A, Z3, L4, Z5, and Z7. This network acts as a broadband matching network from the collector output impedance to the 50-ohm input impedance on the hybrid pin 3. Hybrid HY2 serves as a summing hybrid which sums the parallel output from the two channels consisting of Q1 and Q2 into a common output which is on pin 1 of HY2 which in turn

is connected to E3. The channel with amplifier Q2 is identical to the channel with amplifier Q1. Pin 4 on HY2 is terminated by 50 ohms made up of R6, R7, R8 in parallel. A B+ input decoupling network prevents rf from radiating out of the power amplifier case into the exciter chassis and also prevents spurious oscillations from occurring in this module. C7, L5, L6 and L7, C10 and C21 provide a decoupling network. L5, L6 and L7 are ferrite beads which serve as rf chokes. Lead lengths on all components of this module are critical. Additional lead lengths create more inductance and upset the impedance matching and phase relationship of the individual stages.

4-64. **POWER AMPLIFIER (UHF) A10A2.** See figures 6-16 and 6-17. Identical power amplifiers are used in module A10A2, A10A3 and A10A4 as shown in figure 6-13. These power amplifiers are dual channel with two high power, broadband transistor stages which operate in parallel. The input is fed into E1 to hybrid HY1. The output from HY1 is split into two equal power level outputs which are on pin 2 and pin 3 of the hybrid. Pin 4 is terminated into a 50-ohm load which maintains a 50-ohm input impedance. With some mismatch on both outputs. The output on pin 2 is fed to the matching network consisting of T1, C3 and C4. This network serves as a matching network between the 50-ohm output of the hybrid and the input impedance of Q1. R9 and C19 serve as the base bias network for Q1. L1, R1, and C6 serve as a low frequency spurious suppression network to prevent oscillations at low frequencies. The output from the collector of Q1 is coupled to HY2 on pin 3 through the matching network consisting of L2, L3, Z3, L4, Z5 and Z7. This network acts as a broadband matching network from the collector output impedance to the 50-ohm input impedance on the hybrid pin 3. Hybrid HY2 serves as a summing hybrid which sums the parallel output from the two channels consisting of Q1 and Q2 into a common output which is on pin 1 of HY2 which in turn is connected to E3. The channel with amplifier Q2 is identical to the channel with amplifier Q1. Pin 4 on HY2 is terminated by 50 ohms made up of R6, R7, R8 in parallel. A B+ input decoupling network prevents rf from radiating out of the power amplifier case

into the exciter chassis and also prevents spurious oscillations from occurring in this module. C7, L5, L6, L7, C10, and C21 provide a decoupling network. L5, L6 and L7 are ferrite beads which serve as rf chokes. Lead lengths on all components of this module are critical. Additional lead lengths create more inductance and upset the impedance matching and phase relationship of the individual stages.

4-65. **HYBRID A10A6.** This hybrid, see figure 6-20, splits the input from E1 into two equal level outputs on E2 and E3 when operating into 50-ohm loads. The phase between the outputs on E2 and E3 is zero degrees in relationship to each other. R1 is a load resistor between the two balanced output ports and dissipates no power when the loads are matched on pins E2 and E3.

4-66. **HYBRID/DETECTOR A10A5.** This is a summing hybrid which sums the two inputs on E1 and E3 with the summed output on E2. See figure 6-21. A fourth output is terminated in 50 ohms which is made up of resistors R1, R2, R3, R4, R5 and R6. The summing inputs must maintain a zero degree phase relationship between each other in order to get proper summing on the output line. A detector circuit consisting of R7 and CR1 is connected to E2 to detect signal presence when the transmitter is keyed "on". The detected presence signal is monitored at the test meter on the exciter front panel when the test switch is in the PWR AMPL position. C1, C2, R8, R9, and R10 serve as an output filtering network for the detected output. With no rf power present at the output, a meter reading of zero will be indicated. When the power amplifier has rf power present, the meter reading will be up-scale from 10 to 45 depending on the rf power output.

4-66A. VHF/UHF DRIVER/POWER AMPLIFIER A10

4-66B. The VHF/UHF Driver/Power Amplifier (DPA), P/N 8136838G1, operates in both the VHF and UHF bands. It can be used to replace either the VHF DPA or the UHF DPA without modification to either the exciter or the DPA.

4-66C. Refer to figure 6-53. Filters FL1-FL4 are RF decoupling filters to prevent coupling of RF interference from the DPA into the transmitter control

circuits. Connector P1 provides dc power, control, and a monitor interface with the transmitter system. The RF input is supplied to the DPA from A9 (doubler, or quadrupler) by connector P5.

4-66D. Refer to figure 6-54. The input network comprised of R1, C1, L1, and C11 provides input matching and frequency compensation to flatten the amplifier frequency response. CR2, CR3, C52, and C53 attenuate the input signal to a safe level. Transformer T1 provides an unbalanced-to-balanced transformation to permit proper push-pull operation of balanced transistor Q1. Capacitors C3 and C4 and inductors L3 and L4 provide input matching to Q1. Base bias is supplied to Q1 by R4, C36, C50, C5, R2, L5, and L18. R18, C48, and C49 help to stabilize the input to Q1. Inductor-capacitor network L7, C9, C21, L9, L10, and C23 is used to supply the collector dc bias voltage to Q1. The network of R20 and C51 protects Q1 from power supply surges.

4-66E. Transformer T2 and capacitor-inductor network C7, C8, L2, and L19 provide the interstage match between Q1-collectors and Q2-bases. Resistor R13 is used across the collectors of Q1 to achieve a flatter frequency response. Inductor L28 is used across the collectors of Q2 to attenuate some of the low frequency noise. Transformer T3 and capacitors C41, C19, and C40 provide the impedance transformation necessary to allow Q2 to deliver maximum gain and power to a 50-ohm load at E3. Control of the RF output power is achieved by varying the base bias to Q1 and Q2. Capacitors C5, C6, and C36 provide RF bypassing and diode VR1 shifts the control voltage level to limit the bias voltage applied to resistor dividers R4/R2 and R5/R14. These dividers limit the bias current to the transistors and provide a path for transistor leakage currents to ground. Inductors L5, L18, L6, and L26 function as RF chokes to keep RF off the bias lines and prevent loading of the RF signal.

4-66F. The signal at E3 goes through a 50-ohm cable to P3, through the tunable filter to P4, and 50-ohm cable to E4. Capacitor-inductor network L20, C14, R6, and R17 provide the input matching and frequency compensation to flatten the amplifier response. Transformer T4 provides an unbalanced-to-balanced transformation to permit the proper push-pull operation of balanced transistor Q3. Capacitors C15 and C16 function as coupling capacitors to the RF signal and dc block to the base bias voltage. Transformer T5, a 4:1 transformation with R15 and C17, provides a transformation to the low base impedance of Q3. RF choke L24 supplies the temperature compensated bias current from Byistor Z4 to the bases of Q3 through the center tap of T5. Capacitors C22, C44, and C12 are bypass capacitors to reduce RF on the dc lines. Resistor R7 limits the current and dissipation of Byistor Z4. Collector voltage for Q3 is provided via L11, L12, Z2, and Z3. Capacitors C18 and C43 provide RF bypassing. The load line on Q3 collectors is transformed back to 50 ohms by T6, C20, and C31.

4-66G. Transformer T7 provides an unbalanced-to-balanced transformation to permit proper push-pull operation of balanced transistor Q4. Capacitors C24 and C25 function as RF coupling capacitors to the RF signal and dc block to the base bias voltage. Transformer T8 provides a 4:1 transformation with C37, C26, and R16 to provide a transformation to the low base impedance of Q4. RF choke L25 supplies the temperature compensated bias current from Byistor Z5 to the bases of Q4 through the center tap of T8. Capacitors C27 and C46 are bypass capacitors to reduce RF on the dc lines. Resistor R8 limits the current and dissipation of Byistor Z5. Collector voltage for Q4 is provided by L21, L22, L23, and Z1 to the center tap of T9. Capacitors C47, C32, C33, C34, and C35 provide RF bypassing to prevent RF on the dc lines. The load line on Q4-collectors is transformed up to 50 ohms by T9, a 1:4 transformation with inductor L27 and capacitor C29. Capacitors

C28 and C30 function as RF coupling capacitors to the RF signal and provide a dc block to the dc voltage. Transformer T10 provides a balanced-to-unbalanced transformation to permit proper push-pull operation out to E5.

4-66H. Scaling resistors R9 and R10 couple a small amount of RF output signal to an RF detector (CR1 and C38). This detected output is proportional to the PA power level and is supplied to the front panel meter (PWR AMPL.) via filter R11, C39, and FL1.

4-66J. The first 283 DPA's built had a Tracking Diode-Resistor (TDR), P/N 500600, reference designations TDR1 and TDR2, where Z4 and Z5 (Byistors) are presently shown. It is not necessary to replace TDR's with Byistors. The Byistor does require a tailor resistor to control the quiescent collector current of the transistor the Byistor is controlling. R21 must be selected to obtain a Q3 collector quiescent current of 30 to 100 milliamps. This is measured by inserting an ammeter in line with the B+ lead attached to C22. R22 must be selected to obtain a Q4 collector quiescent current of 100 to 200 milliamps. This is measured by inserting an ammeter in line with the B+ lead attached to C34. The exciters with TDR's have serial numbers: 33364 through 33373, 34185, 34186, 34187, 34432, 34501 through 34518, 34522 through 34541, 34546 through 34554, 34556 through 34558, 34620 through 34706, 34708 through 34727, 34731 through 34832, 34843 through 34850, and 34860 through 34862.

4-67. TUNABLE FILTER FL2.

4-68. A tunable filter is required between the driver and the power amplifier stages of the driver/power amplifier. Different filters are required for the VHF and the UHF mode. The filter is a narrow band, screwdriver adjust, tuned filter with the adjustments located behind the front panel door of the exciter unit. The tunable filter serves to prevent unwanted harmonics in the transmitter power amplifier and, additionally, serves to reduce the noise generated in the broadband driver amplifier stages preceding the tunable filter.

4-69. LOW PASS FILTER FL1.

4-70. A low pass filter follows the power amplifier section of the exciter unit to reduce unwanted harmonic and spurious outputs from the driver/power amplifier.

Different low pass filters are required in the VHF and the UHF mode. No tuning of this filter is required. The filter contains a 50-ohm input and output and the insertion loss over the frequency band does not exceed 1 db.

4-71. POWER SENSOR DC1.

4-72. A power detector or power sensor is located in the rf path following the low pass filter and preceding the coaxial relay in the exciter unit. The power detector contains two diodes: one to detect forward power, and one to detect the reflected power. It is this power sensor which detects the power level output from the driver/power amplifier and provides feedback information to the control rf/modulator to maintain a constant 10 watt cw level from the exciter unit when operating in exciter mode. The power detector contains the reverse power diode to detect the vswr at the antenna terminal of the exciter unit. In the event of a vswr of greater than 5 to 1, the reverse power detector provides information to the control rf/modulator to reduce power output from the driver/power amplifier thereby protecting the output transistor stages of the power amplifier. More information concerning the operation of the power sensors is contained in the section describing the control rf/modulator.

4-73. SWITCH, COAXIAL TRANSMISSION LINE.

4-74. The coaxial relay switches the rf power from the driver/power amplifier to either the antenna or the power amplifier when it is connected to the exciter and when it is in the operating condition. The coaxial relay functions as a double-pole, double-throw relay and is controlled by all of the circuits on module A7 modulation percentage/coaxial relay control/keyer inhibit. Additional details concerning the operation of the coaxial relay are contained in the section describing the control thermal/detector, modulation percentage/coaxial relay control/keyer inhibit.

4-75. AMPLIFIER COMPRESSOR AUDIO A1.

4-76. The function of the audio amplifier compressor is to provide a constant level of audio output with varying levels of audio input from either microphone inputs or remote audio inputs. See figure 6-22. The amplifier compressor module can be modified to standardize output levels with input levels as low as -35 dbm when an optional jumper is placed across R44 near the input of the compressor module. Remote audio input lines to the exciter unit are brought into the compressor on pins 10, 11, 6 and 12 and various connections or interconnections of the remote lines can provide either 150- or 600-ohm audio inputs to this circuit. In the 600-ohm configuration, the remote audio input lines

associated with pins 11 and 6 of the compressor are shorted, thus providing a 600-ohm input. Pins 11 and 6 then serve as a center tap for the transformer input. Keying of the transmitter is accomplished by grounding the center tap. R42, R43, R39, and R40 provide the dc coupling path to the keying circuits through CR11 to pin 9. Pin 9 then provides the keying information to the keyer, control transfer module. CR11 and CR12 are impulse or transit protection diodes for impulses on the keying lines. The secondary of transformer T1 is a 600-ohm output and operates into a 620-ohm resistor, R27. Zener diodes VR1 and VR2 serve to reduce any excessive voltage spikes on the audio input lines. The signal out from transformer T1 is coupled through resistor R44 which serves as the optional attenuator for the varying signal requirements on the input signal. The signal from R44 goes from pin 8 to the LOCAL-REMOTE switch on the front panel of the exciter unit. In the REMOTE position, the signal is switched directly back to pin 5 on the amplifier compressor. In the LOCAL position, the two local microphone sources are connected into the amplifier compressor through pin 5. Pin 5 is coupled through C5 and attenuation resistors R26 and R25 into integrated circuit AR1 through resistor R7 which is in parallel with FET Q1 and coupled through capacitors C3 and C4. The FET serves as a variable resistor in parallel with R7 which, in turn, provides various attenuation levels to the input of AR1. With feedback detector information, this provides a constant output from the amplifier compressor module.

4-77. Integrated circuit AR1 amplifies the signal on pin 2 with the output appearing at pin 6. The signal from AR1 is then coupled into integrated circuit AR2, pin 2, and further amplified with the output appearing at pin 6. The output is coupled through R15 and C7 to the output of the amplifier compressor which appears on pin 13. Monitoring of the output can be accomplished at TP1. Diodes CR6, CR7, CR9 and CR10 serve as signal limiting diodes to prevent the amplitude of the output signal from exceeding a 2.4 volt peak-to-peak signal. R28 serves as a dc reference resistor for diode detector CR2. CR2 detects the positive peaks of the output signal with the dc voltage rise time controlled by the filter network consisting of R18, R19, C10, R20, and C11. The detected peak dc level is then amplified and inverted in integrated circuit AR3. With the input on pin 2, the output appears on pin 6. The output is coupled through R24, back to the gate of FET Q1. Negative dc levels appearing at the gate of Q1 serve to increase the apparent resistance of Q1 to the input signal, thus reducing the output signal appearing at pin 13 to the nominal level. It is this feedback path which controls the amplifier compressor gain and maintains a constant level output from the amplifier compressor. CR4, CR15, CR16, and R45 serve as signal limiting resistors so that the peak excursions of the dc

level from AR3 cannot exceed particular bias levels that would saturate or cut off the output signal during the instantaneous input from the signal sources. R29 controls the decay time of the amplifier compressor and provides a charge path for C10 and C11 when no signal is present. R23, R21, and R22 and potentiometer R41 provide a bias to AR3; by varying potentiometer R41, a varying output signal level can be obtained.

4-78. The amplifier compressor requires a +20-volt dc input on pin 4. R38 and C1 serve as input dc decoupling capacitors to prevent input signals from coming in on the B+ line. R1 and R2 serve as a voltage divider network to obtain a +10-volt dc level which is required for the operation of the integrated circuits. C2 serves as a decoupling capacitor for the +10-volt dc level and also filters any ac signals that may appear on the +10-volt line. CR13 peak detects the output audio. R36 is a meter multiplier resistor for the front panel TEST meter when the test switch is in the CPRSR position. TP2 serves as a monitor of the dc variations with varying signal level inputs. This test point monitors the gain voltage on FET Q1. With signals on the input of the amplifier compressor, TP2 voltage should decrease and should decrease proportionally with stronger signal inputs. The output from the amplifier compressor is fed to the filter amplifier/detector. The nominal signal level at the output of the amplifier compressor is 0.65 volt rms.

4-79. LINE AMPLIFIER A1

4-80. The line amplifier is used in place of the audio compressor amplifier (A1 module position) when audio processing and compression occurs before the transmitter input. The line amplifier consists of a fixed gain audio amplifier, with a gain control adjustment to set the audio output to the level required to maintain a high modulation percentage at the transmitter output. The gain control on the line amplifier can be set to accommodate standardized or compressed audio input signal levels of -15 dbm to +10 dbm at 600 ohms. The output from the line amplifier is set to 0.64 vrms or 1.8 volts peak-to-peak. The audio input to the line amplifier comes from J5 pins F and J on the rear of the exciter. The audio goes into the line amplifier on the printed circuit card through pins 10 and 12 to the audio transformer T1, which provides an ungrounded 600 ohm termination. The transformer provides a 1:1 turns ratio, and the output operates into the 680 ohm R5 termination resistor. VR1 and VR2 serve to limit excessive input signals or noise spikes. The audio goes through R6 to pin 8 on the PC board, and returns to pin 5 through the LOCAL-REMOTE switch on the transmitter front panel when in the REMOTE position. LOCAL position provides local microphone inputs to pin 5 on the line amplifier, and bypasses the remote input transformer T1. Remote input signal level sensitivity can be increased to -35 dbm by placing a jumper across R6 from terminal E1 to E2. The audio input to pin 5 is terminated into resistors R8, and R9 and potentiometer R10. The potentiometer is

the control for audio output signal level. The audio from the potentiometer center tap is fed to the integrated circuit amplifier U1 through coupling capacitor C1. The gain of this operational amplifier equals $R18 \div R12 = 680K \div 1K = 680$. This corresponds to 57 db gain. Resistors R16 and R17 provide the bias potential for U1 input. Capacitor C3 serves as a bypass on the non-inverting or unused signal input side of the operational amplifier. C6, R11, and C5 are frequency compensating components to control the frequency bandwidth of the amplifier. Resistor R19 serves as a current limiter in the event the output is short circuited. R20 is the output load resistor that maintains ground reference at the output. Diode CR3 and resistor R21 provide the metering current to the transmitter front panel meter in the CPRSR position, used to determine the operational status of this circuit.

4-81. KEYING CIRCUIT

4-82. Transmitter keying can be accomplished by either ground keying or positive voltage keying (+25 volts dc to +40 volts dc) by properly strapping the terminals. A jumper between terminals E3 and E5 provides ground keying. A jumper between E3 and E4 provides voltage keying. Keying is accomplished on a line separate from the audio lines (unlike the compressor, which uses only ground keying on the audio lines). Either voltage or ground keying is brought into the transmitter on J5 pin H. This ties to pin 11 on the line amplifier module. The input keying is connected through resistors R1 and R2 which provide surge current protection to the transmitter circuits due to excessive transient voltage spikes on the keying line. In the ground keying configuration, with E3 to E5 jumper, the ground reference when keyed is provided through diode CR1 to the keyer circuit on module A2 pin 6. In the voltage keying configuration, with E3 to E4 jumper, the input voltage when keyed is connected to the base of transistor Q1 through voltage divider resistors R3 and R4. Keying voltage saturates the transistor, and Q1 collector is switched low, and presents a ground through R22, diodes CR4 and CR1 to the keyer circuit on module A2. Diode CR2 prevents damage to the keying circuit in the event that keying is wired in backwards, or in the event that a negative voltage is present.

4-83. FILTER AMPLIFIER/DETECTOR A4.

4-84. The filter amplifier/detector contains dual-function circuits. See figure 6-24. This module contains an audio frequency bandpass amplifier that will pass audio frequencies from 300 hz to 6000 hz with little attenuation. Audio frequencies outside of this frequency band will not be passed without attenuation. The other circuit amplifies the remote audio input signal for detection to provide the front panel metered test points with an indication of the audio frequency signal levels. The AF LVL-L position provides output readings of -18 dbm to -2.5 dbm and the AF LVL-H position provides output signal level readings of -15 dbm to +8 dbm. Refer to Figure 5-6.

4-85. **AUDIO FILTER CIRCUIT.** The input of the audio filter circuit is derived from the output of the audio amplifier compressor and is brought in to the filter amplifier on pin 6. The input signal is coupled through C6 and through the low pass filter network consisting of R15, C7, R16, C8, R17, C9 and biasing resistors R18, and R19. Q7 and Q8 form a Darlington emitter-follower circuit, with R18 and R19 providing the proper dc bias for this circuit. R20 is the emitter resistor for this network. The output from this circuit is fed through the high-pass filter circuit consisting of C10, R21, C11, R22, C12 and biasing resistors R23 and R24. Q9 and Q10 form a second Darlington emitter follower with biasing resistors R23 and R24 providing the proper dc level for operation. R25 is the emitter resistor for this network. The output signal from this network is fed through capacitor C14 to pin 7. A detector circuit consisting of CR4, C17, R32 and R31 provides the metering indication of the output signal level that exists at this point. The metered test point for this position on the front panel is the FLTR AMPL position on the test switch.

4-86. **AUDIO LEVEL DETECTOR.** The audio level detector input on pin 8 is derived from the output of the LOCAL-REMOTE switch on the exciter front panel which can be switched to either the microphone inputs or the remote audio input lines. The input signal is fed to Q1 through coupling capacitor C1 with biasing resistors R1 and R2 providing the proper amplifier bias. The output from the collector of Q1 is fed through C2 to amplifier transistor Q3. Resistors R4, R5 and CR1 providing proper biasing for this stage. The output from the collector of Q3 is fed into amplifier transistor Q4 with the output from the collector of Q4 feeding through capacitor C18 to emitter-follower Q5. R39 and R40 provide biasing for the emitter-follower. R8 and C3 provide a feedback path to control the gains of amplifiers Q3 and Q4. The emitter-follower transistor Q5 serves as a peak-level detector with capacitor C4 providing the filtering of the dc output at the emitter. This dc level provides the signal level indication which is then metered through current limiting resistor R34 for the audio frequency low level indication and resistor R35 for the audio frequency high level indication. The metered outputs are connected to the positive side of the meter. The negative side of the meter is returned to the divider network consisting of R36, R37 and potentiometer R41. R41 provides control of the dc level for the meter return so that when no signal is present, the meter can be set to zero and the bias on the return line will match the bias on the output transistor Q5. R11 serves as the emitter resistor for Q5.

4-87. BUFFER MODULATOR A5.

4-88. The buffer modulator module contains a modulation signal amplifier with a gain setting control, a modulation limiter, and two circuits associated with metering of the control rf/modulator. See figure 6-25. On pin 12 the audio signal level comes from the filter amplifier/detector module. Pin 11 contains the wideband data input for transmitting frequencies to 25 khz. R2, R3, R1, R19 and R4 provide a resistive summing network for the two signals which are coupled into the modulation amplifier through coupling capacitor C3. The modulation amplifier consists of transistor Q1 with associated bias resistors R12 and R11, gain control R14, and bias resistors R15 and R16. The load resistor for Q1 is R13. The output signal from the collector of Q1 is coupled to the limiter circuit through C4. The modulation limiter consists of CR7, CR8 and bias resistors R17, R18 and the MOD LEV potentiometer on the front panel of the exciter. CR3, CR4, CR5, and CR6 provide impulse protection for strong pulses that might come in to the modulation input port. R5, R7, and R8 comprise a precision divider network which provides a voltage setting level for adjustment of incident power and reflected power level associated with the control/rf modulator. A monitoring amplifier provides an output to a test point on the control rf/modulator module. An audio signal present when the transmitter is modulated enters pin 10 and is coupled through C2 and R25 to the amplifier consisting of Q2 and biasing resistors R20, R21, R23 and load resistor R22. This amplified ac signal from the collector of Q2 is coupled through C5 to diode detector CR9 and biasing resistor R24. The detector detects the peak signal level of the modulation signal which is coupled to the test meter on the exciter front panel through current limiting resistor R10. The switch position on the front panel associated with this monitor output is labeled MOD.

4-89. CONTROL RF/MODULATOR A6.

4-90. The control rf/modulator contains the circuitry required to provide modulation to the driver circuit of the driver/power amplifier. See figure 6-26. In addition the rf control contains circuitry necessary to maintain a constant rf power level output with a feedback controlled circuit used to maintain modulation linearity and to compensate for any drive variation that may occur in the power amplifier circuitry. It also contains the circuitry necessary to provide power reduction in the event of a high vswr on the antenna or on the exciter rf output. This module also contains the logic circuit associated with the forward and reverse power sensing lines from the

power amplifier unit, which gives an indication when the power amplifier is used, if it is transmitting or not. This information is used in the control thermal/detector modulator circuitry to determine which mode of operation the coaxial relay is in.

4-91. The modulation input enters the control rf/modulator on pin 3. This modulated signal comes from the modulation level setting potentiometer behind the front panel of the exciter. The modulation is fed into the module through coupling capacitor C3 and R18 to pin 3 of integrated circuit AR1. AR1 is a differential high-gain amplifier which is used in the overall feedback circuit. The output from AR1 on pin 6 is coupled through amplifier transistor Q3 through zener diode VR1 and resistor R23. R25 provides the proper biasing for Q3. Q3 serves to increase the gain of the signal level from AR1, since AR1 is limited in the swing available from its output. The output of Q3 can swing from 0 to +17 volts, which, in some cases of modulation, is required. The output of Q3 is coupled from the collector and load resistor R26 to the output resistor R27. C6 is a feedback capacitor to control the frequency response of the integrated circuit and transistor Q3 operating together as an integrated amplifier circuit. The output from R27 to pin 2 of the control rf/modulator then proceeds to a chassis emitter follower and then to the apc input on the driver of the driver/power amplifier. This controls the cw level as well as the modulation level of the rf carrier. C14 and R38 form a frequency compensation network, necessary for loop frequency stability. Zener diodes VR2, VR3, and VR4 with biasing resistor R20 form a stable dc voltage for voltage dividers R21, R36, and potentiometer R19. R19 controls the dc level to pin 3 of AR1 which, in turn, controls the cw power level from the output of the driver/power amplifier section. Pin 12 connects to a potentiometer behind the front panel door of the exciter, labeled CARRIER LEV set (R8), which provides a fine tuning adjust of the carrier power level. This potentiometer is in series with the divider string R21, R19, and R36. The power detector (DC1) in the rf output from the exciter unit contains diode detectors which feed a signal to pin 15 and pin 14 of the control rf/modulator. These are the modulation feedback signals for incident and reflected power.

4-92. The signal from pin 15 is coupled to grounded base amplifier Q1 through R39 and R1 with associated biasing resistors R2 and R5. R39 is a potentiometer for adjusting the forward power meter reading on the TEST meter when in the FWD position, so that a reading of 40 on the meter corresponds to 10 watts rf output. The base of Q1 is biased by a divider network consisting of R11, CR2, and R31. The collector load resistor of amplifier Q1 consists of a resistive divider network, R3 and R4.

The output from the collector of Q1 is coupled through emitter-follower Q4 to an analog OR circuit, consisting of CR5, CR6, CR7, CR8, CR9, and R12 serving as the biasing resistor. R34 is a current limiting resistor for metering forward power and provides a path to pin 13 which is used for setting the incident power zero set on the test meter of the exciter front panel with the test switch in the FWD position. The meter return is to the voltage divider biasing network on the buffer modulator module. C13 is a filter capacitor to maintain a flat dc when modulation is present. Potentiometer R5 is adjusted to give a zero level indication on the meter when the transmitter is not keyed. The output from the analog OR circuit is coupled to pin 2 of AR1. The gains of AR1 and Q3 are such that the signal at pin 2 of AR1 must appear to be equal and opposite in phase to the modulation input signal at pin 3 of AR1. If any difference or error between these two signals exists, this error signal is amplified and fed through the apc loop or rf control loop, back through Q1 to pin 2 of AR1 providing a correction path to maintain rf carrier modulation output identical to the input modulation regardless of distortion or non-linear characteristics in any of the amplifiers of the driver or power amplifier rf circuits. Pin 14 of the control rf/modulator couples back the reflected power information from the power detector following the driver/power amplifier. This signal is amplified in grounded base amplifier Q2, with R9 and R10 serving as a dc bias and load resistor at the output. Q5 serves as an emitter-follower to provide a low impedance output from this circuit to the analog OR circuit. R8 is the dc level adjust for the reverse power sensing circuit. With the exciter front panel test switch in the RVS position, the test meter should be adjusted to zero with the transmitter keyed off. In the event of an excessive or high vswr condition, the signal level from the output of Q5 associated with the reverse detected signal, becomes a larger negative signal than that at the output of Q4. The analog OR circuit obeys the more negative signal which is coupled to AR1. Thus, in the event of a high vswr condition, this path takes control of the circuit and throttles down the driver/power amplifier cw power level, thus protecting the output stages from excessive power due to rf signals fed back from the antenna to the output of the driver/power amplifier output stages.

4-93. Pins 9 and 5 provide inputs to the analog OR circuit from the power amplifier. When the power amplifier is in operation, with normal conditions existing, the detected incident power from pin 9 is the lowest signal level of all inputs on the analog OR circuit and thus takes control of the circuit. The power sensor in the power amplifier provides the detected output which controls the output power level of the system. Pin 5

contains the reflected power information from the power amplifier and in the event of a high vswr on the antenna this line controls the throttling down of rf power output. In the event of a vswr of greater than 3 to 1 on the power amplifier output, integrated circuit AR2 detects the differential level existing and provides a digital output on pin 10 which ultimately is used to command the transmitter to cease operation in the power amplifier mode and return the coaxial relay to the exciter mode output. The output from pin 10 is fed to the relay control circuit in the control thermal/detector modulator. Pin 7 is a keyed +20-volt line which provides either 0 volts or +20 volts to R13 and the analog OR circuit diode CR9. When the transmitter is keyed off, the voltage at pin 7 is low, and the analog OR circuit, obeying whichever voltage is lowest on all five inputs, takes control. Thus at 0 volts in, voltage is very low at the input to AR1 which provides zero volts apc voltage and prevents any power from coming from the driver/power amplifier. R24 and C10 provide dc decoupling of the B+ for the circuits of AR1 and AR2 and the amplifiers consisting of transistors Q1, Q2 and emitter-followers Q4 and Q5. C11 and R37 maintain a controlled gain of amplifier Q1 to provide the same percent modulation when the system is in exciter mode as when the system is in the power amplifier mode. Pin 8 provides a power amplifier tune control input to Q1 which takes control and throttles down the rf power of the driver/power amplifier in the TUNE position for power amplifier tuning. Thus, the power amplifier can be tuned with a lower drive power level preventing damage to any of its components. When the power amplifier is tuned, the OPERATE position disables the input on pin 8 and the power amplifier power is then controlled through the loop feedback as described, through pins 9 and 5. A simplified block diagram is shown in figure 6-28 which depicts the control rf/modulator feedback loop. The power amplifier is not shown in this block diagram. Various loop frequency response controlling components are distributed throughout the circuit and have not been referred to. These include capacitor C4, resistors R22, R33, capacitors C8, C14, and resistor R38. These components control the frequency response of the loop and are required to maintain gain and phase stability to prevent oscillation of the feedback control loop.

4-94. CONTROL, THERMAL/DETECTOR
MODULATION PERCENTAGE/COAXIAL RELAY
CONTROL/KEYER INHIBIT A7.

4-95. This module contains several different circuits listed as follows: See figure 6-29.

- a. Relay control circuitry.
- b. Thermal detector protection circuit.
- c. Percent amplitude modulation analysis circuit.

d. A one-shot multivibrator associated with the relay control circuitry for key inhibit when the coaxial relay is in transition from one mode to another.

4-96. **RELAY CONTROL CIRCUITS.** The relay control circuit contains all the logic and switching functions necessary to control the output rf coaxial relay for either the power amplifier mode or the exciter mode of operation. Three logic or digital inputs control the operation of the relay driving circuit. These three inputs consist of the high voltage sample from the power amplifier on pin 3, the vswr power amplifier sample on pin 7; and the keyed +20 volts on pin 5. In the event that the power amplifier is not turned on, the high voltage sample is at 0 volts which allows base current to flow in Q2 through CR1 to the power amplifier. This base current allows Q2 to operate in a saturated mode and its output drives the coaxial relay. When the coaxial relay is driven in the mode defined or in the energized condition, the output from the driver/power amplifier in the exciter unit is fed directly to the antenna since the power amplifier is not operating. If the power amplifier is operating and a high voltage sample voltage exists on pin 3, CR1 is then back-biased and the control of Q2 is not effected through this path. When the exciter unit is keyed, +20 volts exists on pin 5 which goes through a diode OR circuit consisting of CR3 and CR5. CR2 and CR4 form a diode AND circuit. The input to pin 7, the vswr power amplifier input line, comes from AR2 on the control rf/modulator and indicates whether or not an incident power from the power amplifier is present. A P_i (incident power) will not be present until the transmitter is keyed. When the presence of a P_i is indicated from the power amplifier, pin 7 of this logic circuit is at 0 volt condition. A +20 volt on pin 7 indicates either a reverse power condition in the power amplifier or a non-keyed condition. When the keyed voltage appears on pin 5, a P_i should be detected within 30 milliseconds and pin 7 should immediately return to 0 volts. This allows the base of Q1 to remain at a low voltage potential and thus keep it in the off condition. In the off condition, the collector of Q1 is maintained at a high voltage and Q2 is thus non-conducting and the relay is in the power amplifier position. However, if a failure exists in the power amplifier and incident power is no longer detected, then pin 7 indicates a "no power amplifier" condition by rising to +20 volts. Plus 20 volts then is applied to diode CR2 and CR4 allowing the base of Q1 to rise to +20 volts. The rise time is controlled by the R2 and C1 time constant.

4-97. This time constant provides a small amount of delay time before Q1 conducts in a saturation mode, allowing a small amount of time for detection of incident power from the power amplifier when the transmitter is keyed on. When the base of Q1 rises to +20 volts, its

collector voltage decreases. The base current at Q2 flows through Q1 allowing relay control by transistor Q2 to operate in a saturated condition energizing the relay thereby returning to the exciter backup condition. This is the auxiliary or emergency condition that occurs when a failure exists in the power amplifier. Zener diode VR1, with bias resistor R4, provides a +10 volt dc operating condition for the emitter of Q1. VR3 maintains the emitter of Q2 at about 5 volts below the unregulated B+ input voltage level. CR7 provides a transient or inductive protect for Q2 so that in the event of a surge current generated by the relay, CR7 will protect Q2. When Q1 is in a saturation mode due to a power amplifier failure, a negative voltage or spike is coupled through C2 to the one-shot multivibrator consisting of Q3, Q4 and associated circuitry. This one-shot multivibrator allows a time delay of approximately 200 milliseconds applied back to CR5 and through R14 to the keyer inhibit circuit.

4-98. The keyer inhibit turns transmitter keying off for the duration of the one-shot multivibrator time, which keeps RF off of the coaxial relay while it is switching from power amplifier mode to the exciter mode. This protects both the coaxial relay and the power amplifier output transistors from too high a reflected signal. The timing for the one-shot multivibrator circuit is controlled by R11 and C4. The logic input associated with CR5 from the one-shot multivibrator serves as a memory to the logic circuit indicating that the transmitter was in a keyed condition and will return to the keyed condition as soon as the one-shot multivibrator time duration has elapsed. A metered output of the relay control circuit is coupled through current limiting resistor R7 to the test position on the exciter front panel, which is labeled E-L RLY. A zero indication on this meter indicates operation in the power amplifier mode. Note: A zero indication will also be obtained if the power amplifier is not connected to the exciter. An up-scale reading, mid-scale, or above, indicates operation in the exciter mode or backup mode of operation of the system. Another metering position is coupled through current limiting resistor R31 to the meter front panel for the test position labeled VSWR-LPA which indicates the level of the logic input on pin 7. R30 and C7 serve as decoupling resistors for the B+ from the unregulated 28 volts for Q1. A considerable amount of B+ ripple exists on the unregulated voltage source and it is necessary to eliminate this for proper operation of Q1.

4-99. **THERMAL DETECTOR CIRCUIT.** The thermal detector circuit works in conjunction with a heat sensing thermistor mounted on the power supply regulator heat sink. The thermistor at the heat sink is connected to ground on one end and to pin 11 forming a voltage divider with resistor R17. The voltage divider connects to the base of Q5. The emitter of Q5 is biased by VR2 and R29. When the thermistor is heated to an excessive amount, its resistance is decreased, causing the voltage at

the base of Q5 to drop permitting transistor Q5 to conduct with a positive output appearing at the collector on load resistors R15 and R16. When the collector of Q5 goes positive, the positive gate is coupled out through pin 12 to the keyer inhibit circuit which prevents transmitter keying so that a further excessive temperature condition can not exist due to a keyed carrier or keyed modulation signal. R18 is a current limiting resistor providing a metered indication of the temperature sensing to the exciter front panel switch position labeled OVER TEMP. In the normal condition the meter should read zero. If an over temperature condition exists, the meter will read up-scale, approximately mid-scale or above.

4-100. **PERCENT MODULATION CIRCUIT.** An audio signal from the control rf/modulator to pin 6 is connected to the input of the percent modulation circuit at pin 15. It is coupled in through C5 with diode CR11 and CR10, and C6, forming a voltage doubler detector circuit, which, in turn is connected to the gate input of FET Q6. R22, R23 and potentiometer R27 serve as source biasing resistors for Q6 with the output from the drain fed through potentiometer R25 to the percent modulation meter negative terminal. A positive return comes into pin 14 and proceeds to a voltage divider consisting of R26 and R28. The amplitude of the audio signal is compared to a dc level corresponding to the 10 watt carrier level.

4-101. KEYER, CONTROL TRANSFER A2.

4-102. The keyer, control transfer contains the circuit required for keying various modules in the exciter and furnishing an inverted signal that may be used (currently not used) for keying the power amplifier rf output. See figure 6-30. This module provides the keyed voltage to the crystal oscillator buffer, the multiplier in the exciter, and the control, rf modulator. The keyed voltage is +20 volts for the exciter module, and inverted +20 for the power amplifier. The keying input is pin 6. Grounding of pin 6 through resistance as high as 3 K ohms provides adequate keying for this circuit. Grounding pin 6 causes Q1 to conduct which in turn causes Q10 to conduct thus applying +20 volts to pin 5. Pin 4 is the +20 volt regulated dc input to the emitter of Q1. Turning on of Q1 causes the +20 volts to be applied to the RC timing network of R25, C2, C3 at the emitter of Q10. This timing network delays the exciter keying voltage at pin 5 for about 25 milliseconds, while the external T/R relay control voltage of pin 11 is available within 1 millisecond. Thus keying of the transmitter will result in an immediate T/R relay signal and a delayed transmitter rf output. This feature permits operation of an external T/R relay prior to rf transmission by the transmitter. There are several modes of keying Q1: one being through the remote audio line; the others being by the local microphones or by the local carrier test switch. Figure 6-31 shows the connections to the keyer, control transfer and shows the inputs for the two

microphones as well as the connections to the LOCAL-REMOTE switch. Pins 14 and 15 are connected to the proper biasing and keying circuits associated with the M85/U carbon microphone and M109/U dynamic microphone. When the carbon microphone is keyed, the tip is grounded to the sleeve which provides a ground return to pin 14, when the LOCAL-REMOTE switch is in the LOCAL position. Pin 14 is tied to pin 15 through R15 and R16 to pin 6 (the keying line). This provides the ground path to pin 6 allowing Q1 to conduct. In addition, the carbon microphone output is coupled through the ring to the 100-ohm input impedance point on transformer T1 on the exciter chassis. The secondary of T1 is fed through a 18 db pad to the local audio line input on the amplifier compressor as shown on figure 6-22.

4-103. Pin 12 of the keyer, control transfer supplies dc to the primary of the transformer T1 which is the bias for the carbon microphone. The bias is obtained from the +20 volts regulated (pin 4) through R11 with decoupling capacitor C1 providing the ac ground for the T1 input. When the dynamic microphone, M109/U, is keyed, a dc potential is necessary to operate an amplifier enclosed in the microphone case. The dc bias is obtained from pin 12 through T1 to the microphone connector or pin D of J7. This supplies the required B+ voltage for the amplifier, the return path being through pin C to ground. Pin E of J7 is returned to pin 13 which applies a positive voltage on Q5, operating as an emitter-follower. The positive voltage into Q5 allows an output voltage from R14 to saturate Q6 thus grounding the collector. This, in turn, provides keying voltage through pin 15 to pin 6 and to Q1. In addition, keying Q5 into conduction provides a lower voltage at pin 12 due to the divider action of R11, R12, and R14. This lower voltage is necessary to operate the dynamic microphone which requires 10 volts for operation. The audio output from the dynamic microphone is coupled through pin D to the 30-ohm input to T1. The output is coupled through the 18-db pad via the local microphone switch to the input of the amplifier compressor.

4-104. In the event of a high vswr condition, a positive voltage is applied to pin 10 of the keyer, control transfer from the control/thermal detector module. A positive voltage (+1 volt or more) at pin 10 allows transistor Q8 to conduct which, in turn, causes transistor Q7 to conduct. This places Q10 in a non-conducting state and turns off the output keying voltage. Though the keying voltage is off, Q1 is still in the on condition with +20 volts at pin 11. When keying transistor Q1 is in the "on" condition with +20 volts at pin 5, Q2 saturates, allowing Q4 to conduct. The current from Q4 flows through CR1 to pin 11; labeled TO T/R RELAY. This is a supplemental relay to be supplied by the user as an external transmit/receive relay. CR1 and CR3 are transient protect diodes for impulses that may exist on the T/R relay line. The output voltage on this line is a nominal 24 volts dc and can provide 100 ma current. The occurrence of a high vswr condition or non-operating LPA will not cause the T/R relay voltage to switch off during the transition period from LPA to exciter. Q3 serves as a short-circuit protect transistor to

prevent an excessive current from flowing in the T/R relay output in the event of a short circuit. R22 serves as a meter current limiting resistor to meter the T/R relay line on the exciter front panel when the test switch is in the T/R RLY position. The meter should read 20 when the transmitter is in the keyed "on" condition. CR3 also serves as a negative transient suppression diode in the event of a back emf from the T/R relay coil inductance. Keying of this module can also be accomplished by KEYER KY-668/GRT. The output from the module shown on figure 6-21 is tied to pin 2 of the LOCAL-REMOTE switch which connects to pin 6 (the keying line) for keying transistor Q1.

4-105. Remote keying lines tie to the keyer through the input transformer on the amplifier compressor module. Keying the remote line is accomplished by grounding either of the center tapped terminals on the audio input transformer. This allows current to flow to ground from pin 6 of the keyer, control transfer through the LOCAL-REMOTE switch to pin 9 on the amplifier compressor either through CR11 and R42, R43, or through R39 and R40 on the amplifier compressor at the transformer input. The CARRIER TEST switch shown on figure 6-21 grounds pin 14 of the keyer control transfer which, in turn, provides a ground return for pin 6 through pin 15 and R15 and R16. The carbon microphone operates into a 100-ohm impedance on T1 and the dynamic microphone operates into a 30-ohm tap on T1. These taps provide the proper impedance load for these two microphones. The output of T1 is coupled through the 18 db pad to the amplifier compressor input circuits. Q9 provides an inverted keyed output to pin 9. This output is at +20 volts in a non-keyed condition and is at 0 volts in a keyed "on" condition. Keying potentials for Q9 base are obtained from the output of keying transistor Q10.

4-106. KEYER KY-668/GRT A3.

4-107. Keyer KY-668/GRT provides transmitter keying with three modes of input: See figure 6-32.

- a. Tone keying 300 hz to 3 khz: -10 to 0 dbm signal level.
- b. Voltage keying, either polarity, 50 to 100 vdc into 47 K ohms.
- c. Current keying, either polarity, 20 to 60 ma dc into 150 ohms.

4-108. TONE KEYING. The tone inputs enter at pin 3 and pin 10 through R14 and R15 to T1. CR1 and CR2 provide impulse protection from external transients that exist on the keying line. R14 and R15 are current limiters for any input transients. T1 serves as an isolation transformer with a 1-to-1 turns ratio. The transformer output signal is the same level as the input signal. The output from T1 is coupled through C1 to amplifier Q1 with its bias network consisting of R2 and R3 and CR4 with load resistor R6 and emitter resistors R5 and R16. The amplified output of Q1 is dc coupled through zener

diode VR1 to the base of amplifier Q2. The load resistor of Q2 is R11 with emitter resistor R10 controlling the gain of this stage. The amplified output is peak detected by CR3 with filter capacitor C4 providing smoothing of the rectified output. R13 couples the detected dc to the base of Q3 causing Q3 to saturate providing a zero volt output at the collector causing a ground return to the keying transistor in the control transfer keyer. The keying output is on pin 11 via R12.

4-109. VOLTAGE KEYING. The voltage keying input enters at pin 12 and pin 13 through R17 and R1 to one of the two input coils of relay K1. A voltage of from ± 50 to ± 100 vdc will energize this relay. R1 and R17 are current limiting resistors for any input transients that may exist. When the relay contacts close, a bias of +20 volts is applied through the resistor-divider network consisting of R4 and R7 to the base of Q3 with R9 serving as a gain controlling resistor and resistive summing network input for Q3. The positive voltage applied at the base of Q3 saturates it and provides an apparent ground at its collector which provides the keying ground through R12. C2 is a filter capacitor to prevent relay chatter.

4-110. CURRENT KEYING. The current keying inputs enter on pin 14 and pin 15 and are connected to the other input coil on relay K1. A current of ± 20 to ± 60 ma energizes the relay providing the same output keying as that of the voltage input keying.

4-111. AFCS A3 KEYS CARD.

4-111A. DC Power from the exciter keying circuit is applied to the AFCS A3 keyer card through contact 11 of plug-in socket XA3. See Figures 2-8 and 6-52. This voltage (approximately +20 VDC) is applied to the switch transistor collector through a 8.2K resistor. When the transistor is switched on, or contact 13 of XA3 is grounded, the voltage on contact 11 of XA3 drops to approximately 18 volts and the Exciter keys on. If it is desired that the original method of keying be used, this can be provided by connecting an external jumper between connector pins K and E of the connector that mates with J5. This jumper restores the exciter internal keying voltage that is on contact 11 of XA3 to contact 9 of XA1 through the A3 keyer card contacts 11 and 10 which are connected together on the new AFCS A3 keyer card.

4-111B. The transistor on the A3 keyer card is switched on by an external DC current applied to contact 14 of XA3 to the 18K current limiting resistor, to the 1N483B diode gate and then to the base input network composed of a 12K, a 1K resistors, and a 10 mfd capacitor. The diode prevents conduction to the base network by other than a positive voltage. The 12K and 1K resistors provide a test point isolation junction TP-1 for test of the VDC at

TP-1 for satisfactory operation. If it does not turn on at +1 VDC, the transistor may be defective.

4-111C. INBOARD MONITOR/KEYER A3.

4-111D. GENERAL INFORMATION. The Inboard Monitor/Keyer card A3 is a combination keyer and exciter monitor sensor interface card. The keying circuit was revised from the AFCS input and their requirement for low level voltage keying and the addition of the conventional ground keying capability. To incorporate the new A3 card into existing systems requires the addition of eight wires in the Exciter card nest and removal of one interconnection. This modification does not invalidate the original keyer KY-668/GRT A3 card. Should it be desirable, a jumper can be removed which will eliminate the presence of a positive DC voltage on the primary winding of the input audio transformers. Ground keying control is provided in the A3 card.

4-111E. KEYS CONTROL. (See Figure 6-51.) The AFCS keyer card is a single transistor circuit for positive low level (6,24,48 Vdc) keying and a control for grounded keying. (See Paragraph 4-111.) To increase the operational flexibility, this was changed (AFCS) to provide the same levels of dc voltage keying with either polarity being applied. The grounded key control remains the same. The low level key voltage is applied through pin 14 (XA3) to R63, R64, or R65. A jumper connection is used to select the resistor associated with a +6 Vdc, +24 Vdc or +48 Vdc keying input level. Pin 14 of XA3 is wired directly to J5-N. CR6, CR7, CR8, and CR9 in combination with the selected resistor provide the voltage/current source for the input diodes of U3 and U4. U3 and U4 are optically coupled isolators with the outputs connected in parallel to R66. U3 controls when a positive voltage is applied to pin 5 and U4 controls when a negative voltage is applied to pin 7. The reverse polarity applied to either unit is approximately one-third the maximum allowable level. The level of the input keying voltage using the specified resistor, is not critical. Variations up

to 50 percent can still provide the required keying without circuit damage. Pin 11 (XA3) provides the normal interface with LOCAL/REMOTE keying control, CR5 and R67 connected to pin 11 and pin 13 provide the grounded keying control. Pin 13 is wired directly to J5-M.

4-111F. MONITOR SENSOR INTERFACE. The monitor sensor interface consists of four active circuits and one passive circuit. Active devices Q1, U1B, and Q6 form the forward power sensor interface and Q2, U1A, and Q5 form the reverse power sensor interface for performance assessment/monitor system. These two circuits function in the same manner, differing only in the input level set-up alignment. The circuit description is the same. Q1 is an N-channel monolithic dual J-FET used as a differential amplifier. The amplifier is a selected device in that the pinch off voltage must be greater than -3.0 Vdc to allow control below that point. The forward power from the power sensor is applied to pin 7 of Q1. R9, R10, and R11 form the gain network for U1B with R11 as a gain control and R10 used to ensure that R11 will be within the proper adjustment range with any voltage level. This adjustment is used to compensate for power sensor differences. R8 provides the offset adjust control set in the no input signal (RF) state. R70 is used for amplifier output slope adjustment. R69 is the feedback resistor and the circuit gain is approximately 2. Q6 is the output buffer amplifier. The forward power sensor is aligned for $+1.000 \pm 0.005$ Vdc at the 10 watt RF level. The monitor output level will track the input level over a 10 ± 5 watt range with a maximum output of only 30 mV or less from the nominal. When the forward power monitor output is adjusted to 1.000 ± 0.005 Vdc for 10 W input, the maximum monitor variance that might be expected from actual power is ± 0.55 watt over the above input power range.

4-111G. The reverse power sensor is aligned for $+0.295 \pm 0.005$ Vdc for VHF

and 0.305 ± 0.005 V dc for UHF at a 2:1 mismatch load. One percent film resistors provide the desired stability over the operating temperature range of the prime equipment.

4-111H. U1 and U2 are quad operational amplifiers. Two sections of U2 are used for percentage of modulation and two sections are used for audio input sensor interface. Q3 and Q4 are the respective buffer amplifiers provided for load isolation. The percentage of modulation input is through C1 to U2B. The output of U2B is detected and applied to U2A. U2B functions as an audio amplifier and U2A as a dc amplifier isolated from the load by Q3. The percentage of modulation gain control (R32) is set for an output of $+4.00 \pm 0.01$ V dc with a 10-watt rf carrier modulated 90 percent at 1 kHz. R35 is adjusted at a low level input and sets the operating point of the amplifier. R41 is selected to give the proper output voltage slope over the output voltage range. The input to the percentage modulation sensor is from the RF/Modulator Control Card (A6).

4-111J. The input to the audio sensor interface is through C6 to U2C. The detected output is applied to U2D and isolated by buffer amplifier Q4. This circuit is functionally the same as the percentage of modulation sensor, except for a higher gain.

4-111K. The status of the exciter coax relay control is sensed by R68 and VR5. The coax relay is only energized when the LPA is connected to the exciter and the system is transmitting 10 watts. Therefore, with the LPA connected, and operating only 10 watts, The exciter/LPA monitor will indicate a logic high (about 3 volts). When operating at 50 watts, the exciter/LPA monitor will indicate a logic low (0 volts). When the LPA is not connected to the exciter, the exciter/LPA monitor will always indicate a logic low (0 volts).

4-112. POWER SUPPLY PS1A3.

4-113. The ac input is connected to pins 1 and 5 of TB1. See figure 6-33. TB1 requires jumper straps connected according to the input voltage; the strapping arrangement is shown on the module cover. Transformer T1 converts the primary input voltage to a nominal 25 volts rms output on the secondary. This voltage is rectified in a bridge rectifier consisting of diodes CR1, CR2, CR3, and CR4. C1 provides smoothing of the ripple content of the output of the bridge rectifier. CR5 serves

as the input diode from the battery for backup operation in the event of loss of the primary ac power. The output from this module is approximately 28 volts dc.

4-114. REGULATOR PS1A1 and PS1A2.

4-115. The regulator circuitry is contained on two modules: PS1A1 and PS1A2. PS1A1 contains the primary regulator transistor which dissipates a considerable amount of heat and thus is mounted on the rear of the chassis, which serves as a heat sink. Thermistor RT1, associated with the overcurrent protect circuit is also mounted on this module. RT1 is associated with the thermal detector circuit (A7). The unregulated dc enters PS1A1 on pin 6 of TB2, feeds through R24 to the main regulator transistor Q6. The output from the emitter of Q6 is on pin 5 of TB2 as a +20-volt regulated output. The feedback regulator circuit on PS1A2 samples the +20 volt dc output through the divider resistor network consisting of R14, R26 and potentiometer R25. The wiper of R25 is connected to pin 2 of AR1, which is a high gain differential operational amplifier. A reference voltage of approximately 10.1 volts is derived from bias

resistor R13 and zener diodes VR2 and VR3 and fed to the input (pin 3) of AR1. The output of AR1 is on pin 6, which is connected to amplifier Q7 through the resistor divider network consisting of R22, R28 and R21. B+ voltage for Q7 is obtained from the unregulated voltage which is derived from pin 7. Load resistors for this amplifier consist of R19 and R20. The sampled signal output from Q7 is connected to the base of amplifier Q5 on module PS1A1, which provides amplification at the collector of Q5; this drives Q6 through resistor divider network R12 and R8. The voltage at the base of Q6 is approximately 0.6 volt greater than the +20 volt output required. Q6, being the series regulator transistor, operates as an emitter-follower with the +20 volt output from the emitter serving as the regulated voltage for the rest of the exciter system. The feedback at pin 2 of AR1 compares with the reference input on pin 3 and if any variation of the dc level exist on pin 2, the feedback loop serves to correct the error returning pin 2 to near the reference voltage input derived at pin 3. Potentiometer R25 serves as a dc regulated output adjustment. The dc input to AR1 is brought in to pin 7 which is connected to the

unregulated source voltage through resistor R29, as well as being connected to the regulated source voltage through diode CR10. R29 is the source for the unregulated B+ voltage for starting the operation of this feedback loop. This starts regulator action and when 20 volts exists at the output of the regulator, the 20-volt regulated voltage takes over as the B+ voltage for AR1 and provides a regulated dc through CR10. This provides a smoother operating voltage for operation of AR1. However, operation of AR1 could not exist without the starting voltage required through R29 from the unregulated source. C7 serves as a decoupling capacitor for the input dc voltage to AR1. C4, R23, and C5 serve as frequency response controlling components to maintain proper loop frequency response action and, additionally, to prevent oscillation in the feedback loop.

4-116. OVERCURRENT PROTECT CIRCUIT. The overcurrent protect circuit senses a dc voltage drop across resistor R24 on PS1A1. The output from PS1A1 is connected to the overcurrent protect circuit from pin 4 of TB2 to pin 8 on PS1A2. Pin 8 connects through R11 to the base of Q3. The divider network consisting of R10 and R18 with transistor Q4 divides down voltage from the pin 7 unregulated input voltage which is the source for this circuit. If an overcurrent condition exists, the voltage at the output of R24 decreases, lowering the voltage at the base of Q3. Lowering the base voltage increases the current through Q3 and R17 thereby increasing the base current drive to Q4. Increasing the base current drive of Q4 further increases collector current required through Q4 thus reducing the input to Q3 even further. This loop action provides saturation of Q4 thus bringing the collector near ground potential. CR11, connected to the regulated circuit at the divider point between resistor R22 and R28 serves as a ground for the feedback correction circuit and thus reduces the +20 volt regulated output voltage to 0 volts. The only way to reset this circuit is to turn off the ac input power and allow the voltage to restore itself to normal condition, then turn it back on again. If the overcurrent is sensed again, the circuit will turn off the regulated B+ output. C9 serves as a ripple filter for the base of Q3. R9 and R16 serve as current limiting resistors for monitoring the unregulated dc input at the exciter front panel when the test switch on the front panel is in the UNRGLTD position.

4-117. BATTERY CHARGING CIRCUIT. The battery charging circuit consists of a constant current drive source which is Q1 on PS1A1, and its associated drive circuitry on PS1A2. The unregulated dc voltage is applied to R3 and R4 and is coupled out through pin 12 of PS1A2 to pin 2 of TB2 on PS1A1. This connects the input to the emitter of Q1. The collector of Q1 is connected to pin 3 of TB2, with the base connected to pin 1 of TB2. R3 and R4 on PS1A2 serve as constant current source resistors when a fixed base

voltage is applied to regulating transistor Q1. The fixed base voltage is derived from the network consisting of CR7, CR8 and CR9 in series with resistor R5 to ground. The voltage at the cathode of CR7 is approximately 2.1 volts less than the unregulated input voltage which is applied to the emitter of Q1. This causes Q1 to conduct allowing diode CR6 to be forward biased and allows voltage to be applied through pin 14 to the battery circuit. Diode CR6 serves as a reverse protection for Q1 with the battery connected properly. Q2, with bias resistors R1 and R2, serves as a transistor protect circuit in the event of connecting the battery in the reverse mode or in the event of a short circuit at a battery charging terminal. In either case, Q2 conducts heavily, which shorts the potential derived from CR7, CR8 and CR9 and returns the base voltage of Q1 to the same potential as the unregulated input, which turns off current flow through Q1 and protects the battery charging circuit.

4-118. On PS1A2, R15 serves as a multiplier resistor for a monitor test point on the exciter front panel associated with the regulated voltage output. When the test switch is in the REG +20 position, a reading of 20 on the meter should be obtained when the regulated output voltage is +20 volts. A battery monitoring point provides a dc input from the external battery to pin 10 of PS1A2, which is divided through R6 and R7 which serve as current limiting resistors for the metering test point associated with the battery monitoring position on the front panel of the exciter. When the test switch is in the BAT position, the battery voltage will be monitored and should be read directly in volts on the test meter. The battery voltage should be monitored with the ac power ON-OFF switch OFF, so that a monitor of the battery charging voltage is not read on this position. C6 serves as an output ripple filter capacitor on the +20 volt line.

4-119. POWER AMPLIFIER

4-120. GENERAL. The power amplifier is a self-contained unit which amplifies the 10-watt exciter output to 50 watts. See figure 6-34. The power amplifier utilizes a 350 watt plate dissipation beam power tetrode vacuum tube in a tuned cavity configuration. The amplifier operates Class AB₁ linear. The 50-watt output is maintained by means of a closed-loop automatic power control action which is coupled back into the exciter. A TEST meter and meter function switches provide metering indications of the various modules' performance under operating conditions. The tetrode vacuum tube amplifier is cooled by forced air. The power supplies required for filament grid, and plate voltages for the power amplifier vacuum tube are contained within the unit.

4-121. TUNED CAVITY A7.

4-122. **GENERAL.** The tuned cavity is a separate self-contained module that plugs into the power amplifier chassis through the front panel. It is held in place by four screws. The tuned cavity module contains input and output tuning circuitry, a low pass filter and a power sensor. To change the VHF tuned cavity to UHF operation it is necessary to change the input tuning cavity, the plate high voltage cable assembly, the vacuum tube socket, the low pass filter and the power sensor. A plunger located in the front of the cavity and behind the front panel changes the output tuning cavity from VHF to UHF depending on its position. For VHF operation the plunger should be out. For UHF operation the plunger should be in. A snap lock holds the plunger in place when all the way in or all the way out.

4-123. **TUNED CAVITY (VHF).** The rf output from the exciter is fed through a coax line to P4 on the cavity module. See figure 6-35. From P4 the rf is fed to J1 on the input cavity and to the impedance matching network consisting of C2, C1, R1, and coupling capacitor C3. This network serves as a 50-ohm matching network to the grid of V1. Grid bias enters at P1E from the control grid power supply through L1 and L2 serving as rf chokes, with C22 and C4 serving as decoupling capacitors to remove any rf that might be on the grid input lead. Filament voltage enters at P1B from the filament supply and is connected to the tube filaments through filter decoupling capacitors C10 and C11. The filament return is ground. The cathode of V1 is grounded through R2, R3, R4 and R5 in parallel which maintains a constant rf gain at V1. Screen grid voltage for V1 is brought in at P1K with C12 serving as a feedthrough and decoupling capacitor along with C17, C18, C19 and C20. The screen grid operating voltage is a nominal +390 volts dc. An additional decoupling capacitor is built into the tube socket. The arc suppressor E1 prevents damage to screen grid circuitry when short duration flash over or internal shorts exist within the vacuum tube.

4-124. The rf output from V1 is taken from its plate and coupled to the output tuning cavity through coupling capacitors C15 and C21. This cavity is plunger-tuned. The rf output is coupled through C13 at the output of the cavity. The B+ voltage for the plate of V1 is supplied from P2 through feedthrough filter FL1. The proper operating voltage for the plate of V1 is a nominal +2000 volts dc. The rf output from J2 of the cavity is coupled through P9 to low pass filter FL2. FL2 passes the frequencies of 116 to 149.95 mhz and suppresses unwanted harmonics above the desired frequency. The output from FL2 is on P8 which connects to P7 of power sensor DC1. The power sensor detects forward and reverse power and is used in closed-loop operation similar to

power detector DC1 in the exciter unit; however, when the exciter is driving the power amplifier, power sensor DC1 takes control of loop operation and output power reference is controlled from this power sensor. In the event of a vswr greater than 3 to 1, the system switches from power amplifier operation to exciter operation to protect the output of the cavity amplifier. The rf output from the power sensor is on P6 which connects to P3 on the rear of the cavity module. This output couples through the rear panel of the power amplifier chassis and is connected back to the exciter coaxial relay. Pins F and H of P1 provide an interlock to prevent the high voltage power supply from turning on in the event that the cavity is not plugged into the unit. Amplifier tube V1 requires forced air cooling to remove the heat, and an air flow path exists through the mechanical structure of this cavity with a thermal sensing element in the exhaust air flow duct. The thermal sensor unit provides the detection action required to determine if an over-temperature condition exists. The blower must always be operating whenever the power amplifier is operating.

4-125. **TUNED CAVITY (UHF).** The UHF tuned cavity operates essentially the same as the VHF tuned cavity. To properly tune the higher frequencies the cavity sizes are different from the UHF; filter frequency requirements are different and component values are changed. The plunger behind the front panel must be locked in the "in" position for UHF operation. The rf output from the exciter is fed through a coax line to P4 on the cavity module. See figure 6-36. From P4 the rf is fed to J1 on the input cavity and to the impedance matching network consisting of C2, C1 and coupling capacitor C3. This network serves as a 50-ohm matching network to the grid of V1. Grid bias enters at P1E from the control grid power supply through L1 and L2 serving as rf chokes, with C4 serving as a decoupling capacitor to remove any rf that might be on the grid input lead. Filament voltage enters at P1B from the filament supply and is connected to the tube filaments through filter decoupling capacitor C10 and C11. The filament return is grounded. The cathode of V1 is grounded. Screen grid voltage for V1 is brought in at P1-K and C12 serving as a feedthrough and decoupling capacitor and rf choke L3 to the screen grid of V1. The screen grid operating voltage is a nominal +390 volts dc. An additional decoupling capacitor is built into the tube socket. The arc suppressor E1 prevents damage to screen grid circuitry when short duration flash over or internal shorts exist within the vacuum tube.

4-126. The rf output from V1 is taken from the plate and coupled to the output tuning cavity through coupling capacitor C15. This cavity is plunger-tuned. The rf output is coupled through C13 at the output of the cavity. The B+ voltage for the plate of V1 is supplied from P2 through feedthrough filter FL1. The proper operating voltage for the plate of V1 is a nominal +2000 volts dc.

The rf output from J2 of the cavity is coupled through P9 to low pass filter FL2. FL2 passes the frequencies of 225 to 399.95 mhz and suppresses unwanted harmonics above the desired frequency. To prevent the second harmonic of 399.95 MHz from getting out of the LPA onto the exciter to LPA RF signal line, a low pass filter, FL3 is installed in series with the tube control grid input line. The power sensor detects forward and reverse power and is used in closed-loop operation similar to power detector DC1 in the exciter unit; however, when the exciter is driving the power amplifier, power sensor DC1 takes control of loop operation and output power reference is controlled from this power sensor. In the event of a vswr greater than 3 to 1, the system switches from power amplifier operation to exciter operation to protect the output of the cavity amplifier. The rf output from the power sensor is on P5 which connects to P3 on the rear of the cavity module. This output couples through the rear panel of the power amplifier chassis and is connected back to the exciter coaxial relay. Pins F and H of P1 provide an interlock to prevent the high voltage power supply from turning on in the event that the cavity is not plugged into the unit. Amplifier tube V1 requires forced air cooling to remove the heat, and an air flow path exists through the mechanical structure of this cavity with a thermal sensing element in the exhaust air flow duct. The thermal sensor unit provides the detection action required to determine if an over-temperature condition exists. The blower must always be operating whenever the power amplifier is operating.

4-127. **POWER SUPPLY CONTROL GRID/THERMAL CONTROL/AC CONTROL A3.** This module contains the filament supply, the grid voltage supply, the thermal control detector circuits, the blower failure sensor circuits and the ac control circuits. See figure 6-37. The operation of each of these will be described separately.

4-128. **AC CONTROL.** Figure 6-38 shows the ac control circuits. Included are the power supply control grid/thermal control, the high voltage power supply, the cavity interlocks, and the interlock on top of the chassis, as well as the chassis wiring, switches and lamps on the front panel. S1 is the POWER ON-OFF switch on the front panel of the power amplifier. The ac line goes in to module A3, the power supply control grid/thermal control through fuses F1 and F2 and into pins 15 and 16 of P1. These pins tie to TB1 which requires strapping for various primary source voltages. The strapping arrangement for this terminal board is shown on the insulated cover of the module. When the straps are inserted properly for the source voltage, pins 1 and 7 will maintain a 120 volts ac and the POWER ON lamp is across pins 14 and 15 of P1 and DS1 illuminates, giving an indication of ac power to this chassis. The ac input also goes through F3 on one side of the line to the high voltage power supply module A4 to TB1 which, in

addition, requires the proper strapping for the various primary source voltages. The strapping arrangement for this terminal board is identical to the strapping arrangement for TB1 in module A3. The ac return comes through the relay logic circuits and ac control circuits which will be defined as follows: When the ac is turned on, pin 1 and 7 of TB1 in module A3 will provide 120 volts to relay K3, a 60-second time delay relay. In 60 seconds the contact associated with the relay coil is closed allowing current to flow through the printed circuit board containing relay K1 through pins E6 and E7 to relay K2 through pin 11 of P1 through chassis wiring to the cavity interlock wire shown on the drawing as C7 and C8 and returns to pin 14 of module A3 providing an energizing path for K2. When K2 energizes the switch contact A2 contacts A1 which provides a continuous or holding input into K2 from P1 pin 15 side of the ac line, thus holding K2 energized.

4-129. Time delay relay K3 returns to the normal position and is unused until turn-on of the ac input again. Relay K2 current path is through K1 in module A2 and through the cavity interlock. In the event that the cavity is not plugged into the power amplifier chassis, no current can flow through K2 and thus K2 will not be energized. In addition, K1 shown above K2 and associated with the thermal sensing circuits and blower failure sensing circuits when energized also breaks the line to de-energizing it. Energizing K2 closes contact B2 to B1, which applies the ac line associated with pin 15 P1 through the cover interlock out through P1, pin 10 through the high voltage switch S4 to the high voltage power supply, to pin 1 TB1 thus completing the ac to the high voltage power supply transformer input energizing the high voltage power supply. Thus, the high voltage power supply is not turned on until the time delay relay period of 60 seconds has elapsed or in the event of any of the interlocks being opened to relay K2. If the cover interlock is open, or the HV ON-OFF switch on the front panel is OFF no high voltage will be available from the high voltage power supply. The latter two switches, however, can be turned on and high voltage will be regained immediately. In the case of the interlocks associated with relay K2, the elapsed time of 60 seconds must complete before the high voltage power supply will be energized. Lamp DS2 on the front panel will turn on by 120 volts ac rms applied from pins 1 and 7 of TB1, the terminal board in the high voltage power supply. This lamp indicates the presence of high voltage.

4-130. **FILAMENT SUPPLY.** Transformer T1 supplies the filament voltage on pins 8 and 7 with pin 7 being the ground for the system. See figure 6-37. It is necessary to have the proper straps in place on TB1 in order to obtain the proper output voltages from T1.

4-131. **GRID SUPPLY.** The grid supply provides a negative dc voltage to the control grid of the cavity amplifier tube. The voltage is obtained from the rectifier circuit shown in figure 6-37. The output of T1, pins 9 and 10 is applied to the bridge rectifier consisting of diode CR5, CR6, CR7 and CR8 with the positive side of this bridge connected to ground. The negative side feeds through a filter consisting of C1, R12 and zener diode VR1 which provides a -100 volt dc output to the resistive divider network consisting of R14, R16 and potentiometer R15. This dc output is further filtered by C2. The output can be adjusted from 66 to 95 volts. R17 and R18 provide current limiting and divider action for metering the output voltage through E11 to pin 4 of P1 which is connected to the front panel TEST meter V-GRD position.

4-132. **THERMAL CONTROL CIRCUITS.** The thermal control circuits shut down the LPA when the tuned cavity overheats, the airflow is insufficient, or when the blower fails. Two thermal sensing circuits operate in the voltage divider network consisting of R8, R9, and either thermistor RT1 (in cavity exhaust port) or Q2 of the SSVS (fan intake port). Operation of either the thermistor (high temperature condition) or the SSVS (loss of airflow) provides a low resistance to the divider network, thereby decreasing the voltage to the base of Q3 and increasing Q3 collector voltage. The thermal sensing circuit has a thermistor in the airflow exhaust which operates in a voltage divider line consisting of R8, R9, and the thermistor. Operation of these circuits requires +19.5V which is obtained from the exciter 20-volt power supply. In the event of an excessive temperature at the thermistor, its resistance decreases and the voltage at the base of Q3 decreases, increasing the voltage of Q3. The voltage increased at the collector of Q3 is applied through R6 to the base of Q2. The increase of voltage on the base of Q2 decreases the collector voltage energizing relay K1. This disables the primary voltage energizing relay K2 in the high voltage a.c. line. A detected d.c. voltage from the blower is brought into the input connector through R1 to the base of Q1. If this voltage decreases due to a failure of the fan voltage, the voltage on the collector of Q1 increases, coupling the voltage increase through R4 to the base of Q2. An increase at this point decreases the output on the collector of Q2, thus energizing relay K1 which disables the high voltage power supply. CR2, CR3, and CR4 provide a fixed emitter voltage of approximately +2V for the emitters of Q1, Q2, and Q3. CR1 serves as a transient protector across K1 to protect the transistor from coil inductance of K1. R4 and R6 are summing resistors to the base of transistor Q2. R11 limits current of the OVER TEMP signal for monitoring.

4-133. **AC TO AC CONVERTER SOURCE VOLTAGE.** In addition pins 11 and 12 of the transformer provide 13.5 volts rms to the AC-AC converter, which drives the blower motor.

4-134. POWER SUPPLY PLATE/SCREEN GRID A4.

4-135. See figure 6-39. The ac input to this module comes in to connector P1, pins B and C, to terminal board TB1 which requires the proper straps for the proper line voltage input. T1 is the power supply transformer. The secondary output is fed to pins E2 and E4 to a bridge rectifier consisting of CR1, CR2, CR3 and CR4. The dc output from the bridge rectifier connects to E3 to a pi section filter consisting of C1A, C1B and L1. The dc output is connected to E1 on the printed circuit board and is a nominal +2000 v. Terminal E1 is the tie point for the high voltage output wire feeding the plate of the cavity amplifier tube. R4, R5, R6, R7 and R8 serve as a resistor-divider to divide down the voltage for metering at the front panel of the power amplifier TEST meter V-PLATE position. The negative side of the bridge is tied to ground through R1 and R2 in parallel and the voltage drop across these resistors provides the monitor of the current required by the high voltage power supply. R3 is a current limiting resistor to the TEST meter on the power amplifier front panel which is coupled out on connector P1, pin L, to the meter position CUR-PLATE. The screen voltage is derived from the 2 kv power supply by dropping dc voltage across R12 and R15 to a zener regulated output consisting of VR1, VR2 and VR3 in series. C3 serves as a ripple filter for the screen voltage. The output voltage available from pin E22 is +390 volts dc.

4-136. The screen voltage is at the operating +390 volt condition at all times. R24 is a current limiting resistor to the TEST meter on the front of the power amplifier and is coupled out through P1, pin E, to the test switch KEY position, which gives a direct reading of the keying voltage. The screen voltage is fed to the power amplifier vacuum tube V1, through R22 to P1, pin F. R19, R20 and R21 serve as a voltage divider and as a current limiting resistor network for monitoring the screen grid voltage on the power amplifier front panel when the test switch is in the V-SCREEN position. A voltage divider network consisting of R16, R17, R18 and R26 provides a voltage at P1, Pin H, which is a sample of the screen voltage for the logic circuit in the exciter unit. When the screen voltage is at +390 volts, the output voltage on pin H of connector P1 is a nominal +35 volts dc. R23 is a current limiting resistor for

monitoring the V-LPA test voltage point on the power amplifier front panel when the test switch is in the V-LPA position.

4-137. CONVERTER AC TO AC A2.

4-138 The ac to ac converter converts the input line frequency to a 400 hz output to drive the blower for cooling the tuned cavity. See figure 6-41. The ac input is a nominal 13.5 volts rms at a frequency of from 47 hz to 420 hz. The output ac to drive the blower is a nominal 115 volts rms at 400 hz. The ac to ac conversion is obtained by rectifying the ac input and using the dc to drive a 400 hz oscillator. The output from the 400 hz oscillator is amplified and drives the blower through an output step-up transformer. The 13.5 volts rms input comes to connector P1, pins 2 and 3. The ac input is rectified by a bridge rectifier consisting of CR5, CR6, CR7 and CR8. The negative side is grounded and the positive output is a nominal +15 volts dc. C9 serves as a filter capacitor for the dc output of the rectifier circuit. Q2 is a basic RC phase-shift oscillator with the output from its collector shifted in phase by the phase shifting network consisting of R4, R5, R6, C2, C3 and C4. The output from the phase shifting network is connected to the base of transistor Q1 which is an emitter-follower presenting a high impedance load to the phase shifting network. R1 is the emitter-follower output resistor. C1 serves as the ac coupling capacitor of the phase shifted signal to the base of Q2. The phase shifted feedback is of such a phase as to support oscillations in Q2. R2 serves as a dc biasing resistor for Q2. This phase-shift oscillator circuit provides a 400 hz output to the base of Q3 and can be observed at TP1. Q3 is an emitter follower acting as an isolation stage to prevent loading of the oscillator circuit. The output is taken from the emitter of Q3, with R7 serving as the emitter resistor.

4-139. The output signal is coupled to the base of Q4 through coupling capacitor C5, with resistors R9 and R10 serving as bias resistors for Q4. Q4 is an amplifier stage with the output from its collector driving the base of emitter follower Q5. R11 serves as a load resistor for Q4 and R15 serves as a gain controlling resistor to stabilize the output level from Q4. Q5 operates as an emitter follower, driving the primary of T1. The emitter of Q5 drives pin 3 of T1 with pin 4 grounded. The output from the secondary of T1 is a nominal 115 volts, 400 hz. One side of the output is grounded, the other side drives the blower through J1, pin 6, with the blower return on J1, pin 4, to ground through resistor R14. C6 across the secondary of T1, serves as a resonating capacitor at 400 hz and maintains a sinusoidal 400-hz output from the secondary. CR3 rectifies a sample of T1 secondary output with R12 and R13 serving as a voltage divider network

and current limiting resistors to provide the proper dc level output to the front panel TEST meter. When the meter test switch is in the FAN position, a reading of the detected secondary voltage is indicated on the meter. CR4, in conjunction with filter capacitor C8 rectifies a sampling of the return ac from the blower to ground across R14. This sampled voltage is indicative of blower operation and in the event that no voltage is detected at this point, an indication of a blower failure results. The nominal sensing voltage from the output of CR4 on pin E7 is +3 volts dc and is connected to the blower current sensing circuit through connector P1, pin 7. In the event of a blower failure, the thermal control blower sensing circuit senses the fault and disables the high voltage power supply.

4-140. BLOWER B1.

4-141. The blower is a centrifugal type which cools the vacuum tube and associated circuitry in the power amplifier. See figure 6-34. The blower has long life bearings and low acoustical noise output. It operates from 115 volts, 400 hz, single phase, with an external phasing capacitor for a split phase winding. The external starting capacitor is mounted on the blower frame. The ac input to the blower comes from J1, pins 4 and 6, of the ac to ac converter.

4-142. BUFFER AMPLIFIER/MULTIPLIER, ELECTRICAL INSTRUMENT A5.

4-143. The buffer amplifier/multiplier, electrical instrument module contains circuits for a buffer amplifier between the detectors from the power sensor and the rf control unit in the exciter chassis. See figure 6-42. These circuits are similar to the circuits for the forward and reverse power lines in the rf control/modulator in the exciter unit. In addition, this module contains various metering multiplier resistors, current limiting resistors, and a meter-protect circuit for controlling the metering functions on the front panel of the power amplifier. The meter selector switch is wired to this module.

4-144. BUFFER AMPLIFIER. The inputs to the buffer amplifiers come from power sensor forward and reverse detector outputs, with the forward power detected output coming to connector P1, pin 2 and the reverse power detected output coming to connector P1, pin 3. In the forward power line, the input is connected through terminating resistor R3 and R26 to the emitter of Q1. R26 is a potentiometer for adjusting the forward power output to 50 watts cw when the LPA OPERATE-TUNE switch is in the OPERATE position. R22 is a potentiometer for adjusting the forward power meter reading on the test meter when in the FWD position.

that a reading of 40 on the meter corresponds to 50 watts rf output. This transistor operates as a grounded-base amplifier, with the output from the collector. The nominal gain of this amplifier is approximately 0.6. R6 and R7 serve as biasing resistors to set the output dc level to the proper starting dc voltage. The collector load of Q1 consists of R12 and R13, and frequency compensation network R27 and C3. The output from Q1 collector is coupled to the base of Q3, which is an emitter follower. The output from the emitter of Q3 is connected through E12 on P1, pin 6 and from there to the rf control in the exciter unit and serves the same function as the forward power line in the exciter unit; however, when the power amplifier unit is operating, this line takes control of the rf control loop. The detected reverse power line is connected into terminating resistor R4 to the emitter of Q2, R8 and R9 serve as biasing resistors for this stage. The output from Q2 is coupled from its collector to the base of emitter follower Q4. The output from the emitter of Q4 is connected through pin E13 to connector P1, pin 7 and from there to the rf control in the exciter unit. The rf control in the exciter unit determines and acts on any vswr present in the power amplifier unit. A vswr greater than 3 to 1 returns control to the exciter unit. R22, associated with the forward power output, serves as a meter multiplying resistor and connects to the front panel test switch and TEST meter. When the test switch on the front panel of the power amplifier is in the FWD position and the transmitter is unkeyed, the meter should be zeroed by adjusting potentiometer R7 at the emitter circuit of Q1. The return path of the meter is to E2 and to divider resistors R19 and R20. The division voltage at the junction of these divider resistors serves as the reference voltage for both the forward and reverse power returns when in the unkeyed condition. The reverse power line is zeroed in the same way when the test switch on the front panel is in the RVS position and the dc return from the meter connects to pin E-3 through R21 to the divider network of R19 and R20. R9 is adjusted such that a zero meter reading is obtained when the transmitter is in an unkeyed condition.

4-145. The front panel TEST meter is connected to P1, pins 9 and 19. R17 serves as a multiplier resistor for the meter with all test functions to the meter coupled through this resistor. CR4 serves as an overcurrent protect diode for the meter in the forward direction and in the event of an excessive current, damage to the meter will not occur since current will then flow through CR4. CR6 serves to protect the meter from negative voltages or transients. Both sides of the meter input circuit are connected to switch S1A and S1B, which serve as the switch arms for the two-layer

multi-position test switch on the front panel below the meter. Various monitored voltages associated with the switch are connected into P1 and are seen as grid voltage on pin 14, plate current on pin 12, fan voltage on pin 15, V-LPA, or sample voltage, on pin 16, screen voltage on pin 13, plate voltage on pin 10, transmitter keyed +20 volts to pin 17, over-temperature indication on pin 18, and the heater voltage on pin 8. These inputs are all connected to the switch and the various switch positions indicate the operation of each of these functions. A +20 volts dc is required for operation of the circuits in this module and the +20 volts is obtained from the exciter unit. Thus, the buffer circuits will not operate when the exciter is not turned on. C2 serves as a B+ filtering capacitor in this module for the +20-volt input. R11 and potentiometer R2 serve as power amplifier tune-function controls with adjustment of R2 controlling the power output obtainable from the power amplifier when in the TUNE position. R2 should be adjusted such that the power output does not exceed approximately 30 watts when tuned to a maximum rf output in the TUNE position. The dc output from this network is connected through P1 pin 5 to the TUNE-OPERATE function switch. Shielding on several of the wires coming from the cavity amplifier sections is required since a strong rf field exists in this module and shielding is required to prevent radiation of the rf to other circuits associated with the buffer amplifier and metered functions.

4-146. TUNE-OPERATE CONTROL.

4-147. The TUNE-OPERATE switch in the power amplifier provides an artificial tune voltage to the logic circuit in the exciter so that the exciter will continue to drive the power amplifier when no forward power is being sensed at the power amplifier output. See figure 6-34. Otherwise, the rf control relay circuit would switch back to exciter output, indicating a fault in the power amplifier. A +20 volts is applied from the dc input through TUNE-OPERATE switch S3 through R1 to the inter-chassis connector, J7, pin G, which is the reverse power line to the exciter. The reverse power is raised to a high positive voltage indicating to the logic circuit in the exciter unit that a power amplifier forward power exists at the differential amplifier input. The other half of the double-pole, double-throw switch S3 delivers the voltage and current associated with potentiometer R2 in the buffer amplifier to the rf control forward power detector circuit which cuts down the rf power in the exciter loop to a nominal 2.5 to 3.0 watts so that a maximum 30-watt output can be obtained from the power amplifier in the TUNE position. When operating in the TUNE position, the loop through the power amplifier is not used and the

basic forward power loop in the exciter only is used and the power amplifier is merely serving as a final amplifier with no relation to controlling the rf loop. When switched to the OPERATE position, the forward power functions return to normal and must be delivered from the power amplifier power sensor or a power amplifier fault will be detected and rf control returned to the exciter 10-watt output.

4-148. HIGH VOLTAGE SWITCH.

4-149. A high voltage switch on the front panel of the power amplifier allows disabling of the high voltage. It allows enabling of the high voltage without having to wait for the time delay relay to enable. High voltage will not come on until time delay has completed after initial ac turn-on. This switch is used when tuning the exciter and the power amplifier is to be disabled.

■ 4-150. SOLID-STATE VANE SWITCH (SSVS).

4-151. The SSVS derives its power (19.5V dc) and the circuit ground from E1 and E12 of the A3 module via the chassis wiring harness and the A2 module. Diode VR1 provides a 7V dc bias voltage to RT2 during normal operation of the fan motor, while R1, R2, R3, RT3, RT1, and Q1 provide the proper bias current to RT2 for varying temperature conditions of -29°C to 60°C. The SSCS pc board is mounted across the intake port of the blower. During normal operating conditions, airflow across the board maintains the body temperature of the thermistor RT2 (See Figure 114-41A) below its switching point of $120^{\circ}\text{C} \pm 7^{\circ}\text{C}$. However, if the airflow stops or is reduced, RT2 self-heats. As the temperature of the thermistor increases above 120°C , the resistance increases drastically, thereby increasing the voltage drop to a point where zenerdiode VR2 conducts to supply current to the base of Q2 transistor. When Q2 turns on the collector-emitter, resistance goes from a very high value to a very low value, enabling the thermal sensing circuit A3 module (TP3). (It should be noted that if the airflow problem corrects itself, the cooling of RT2 resets the SSVS and restores the high voltage to the LPA.)

SECTION III

FUNCTIONAL OPERATION OF MECHANICAL ASSEMBLIES

(Not Applicable)

CHAPTER 5 MAINTENANCE

5-1. INTRODUCTION. This chapter contains information and instructions for maintenance personnel to accomplish satisfactory operation of the VHF transmitting set and the UHF transmitting set. This chapter also contains organizational/field maintenance and includes fault isolation corrective maintenance, and alignment procedures.

CAUTION

Transmitting Set, Radio AN/GRT-21(V) and AN/GRT-22(V) contains electrostatic discharge sensitive (ESDS) devices. Special handling methods and materials must be used to prevent damage to the devices both before and after installation in a subassembly. Refer to TO 00-25-234, section VII, for handling ESDS devices. The ESDS devices and the subassemblies in which they are installed are identified in TO 31R2-2GRT-104

ORGANIZATIONAL/FIELD MAINTENANCE

5-2. GENERAL.

5-3. This section contains information necessary for maintenance of the VHF transmitting set and the UHF transmitting set at the organizational field level.

5-4. Table 5-1 contains a listing of maintenance test equipment for maintenance of the transmitting set.

Table 5-1. Maintenance Test Equipment and Special Tools

TEST EQUIPMENT	CHARACTERISTIC
Dummy Load, Electronic, Bird 8135	Power Rating 150 watts continuous duty VSWR 1.1 max dc to 1000 mhz Ambient Air Temperature Range -40° to +145°C Input Connector "QC" Type (Female "N" normally supplied)
Frequency Counter, (HP5245L and HP5253B)	Measures frequencies and repetition rates from 0 to 50 million pps. Converter subtracts multiples of 10, 50, or 200 mhz from cw frequency to be measured providing the difference to be measured to the counter.
Multimeter, Simpson Model 260	Dc voltage 0 to 5000 in 7 ranges Ac voltage 0 to 5000 in 6 ranges Dc current 0 to 10 amperes in 6 ranges Dc resistance 0 to 20 megohms in 3 ranges -20 to +50 db in 4 ranges Accuracy $\pm 3\%$ full scale dc $\pm 5\%$ full scale ac

Table 5-1. Maintenance Test Equipment and Special Tools (Cont.)

TEST EQUIPMENT	CHARACTERISTIC
Test Set, RF Power Bird 43	Insertion type; measures forward or reflected CW power in coax transmission lines utilizing various load elements
Card Extender ITT P/N 8004809	
Element, RF Power, Bird 25C	100 - 250 Mhz at 250 watts
Element, RF Power, Bird 100C	100 - 250 Mhz at 100 watts
Element, RF Power, Bird 25D	200 - 500 Mhz at 25 watts
Element, RF Power, Bird 100D	200 - 500 Mhz at 100 watts
Oscillator, Audio Hewlett Packard 200AB	Frequency Range: 20 hz to 40 khz; 4 bands. $\pm 2\%$ calibration accuracy; 1 watt output, 60 ohms at 24 volts. Maximum distortion 1% from 20 hz to 20 khz; 2% from 20 khz to 40 khz.
Oscilloscope Tektronix Model 515A	Vertical: Frequency response: dc to 15 mhz ac: 2 hz to 15 mhz Input impedance: 1 megohm, 30 μ f; With P410 probe: 10 megohm, 10.5 μ f Horizontal: Time base: from 0.2 sec/cm to 2 sec/cm. Frequency response dc to 50 khz, 3 db

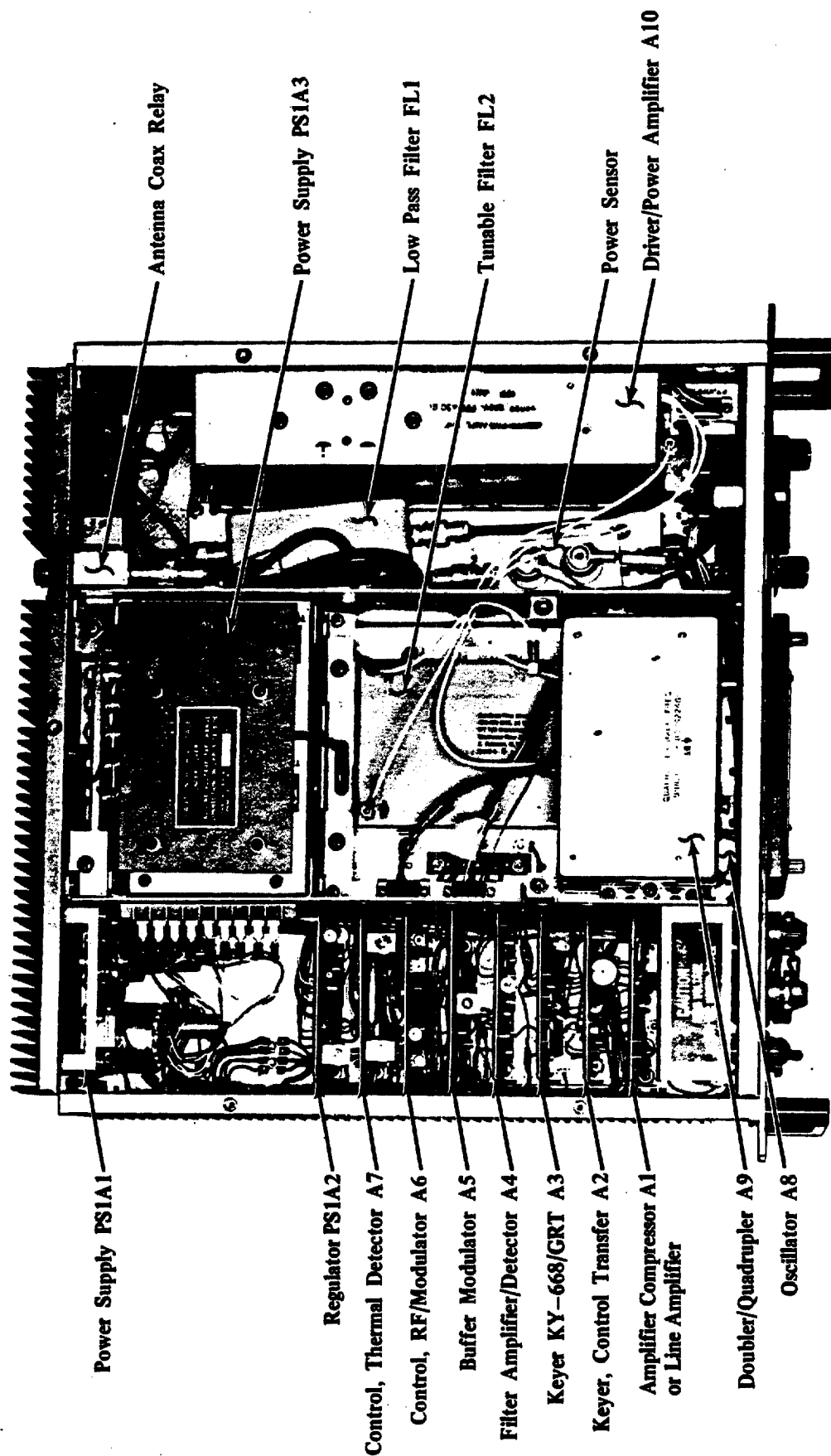


Figure 5-1. Exciter Module Location and Identification

Table 5-1. Maintenance Test Equipment
and Special Tools (Cont.)

TEST EQUIPMENT	CHARACTERISTIC
Multimeter, Digital Fluke 8300A	DC Voltage Ranges $\pm 10V$, $\pm 100V$ and $\pm 1000V$. AC Voltage Ranges 1V, 10V, 100V and 1000V. DC Millivolt Ranges $\pm 100mv$ and $\pm 100 mv$. Ohms Ranges 1, 10, 100 and 1000 kilohms.

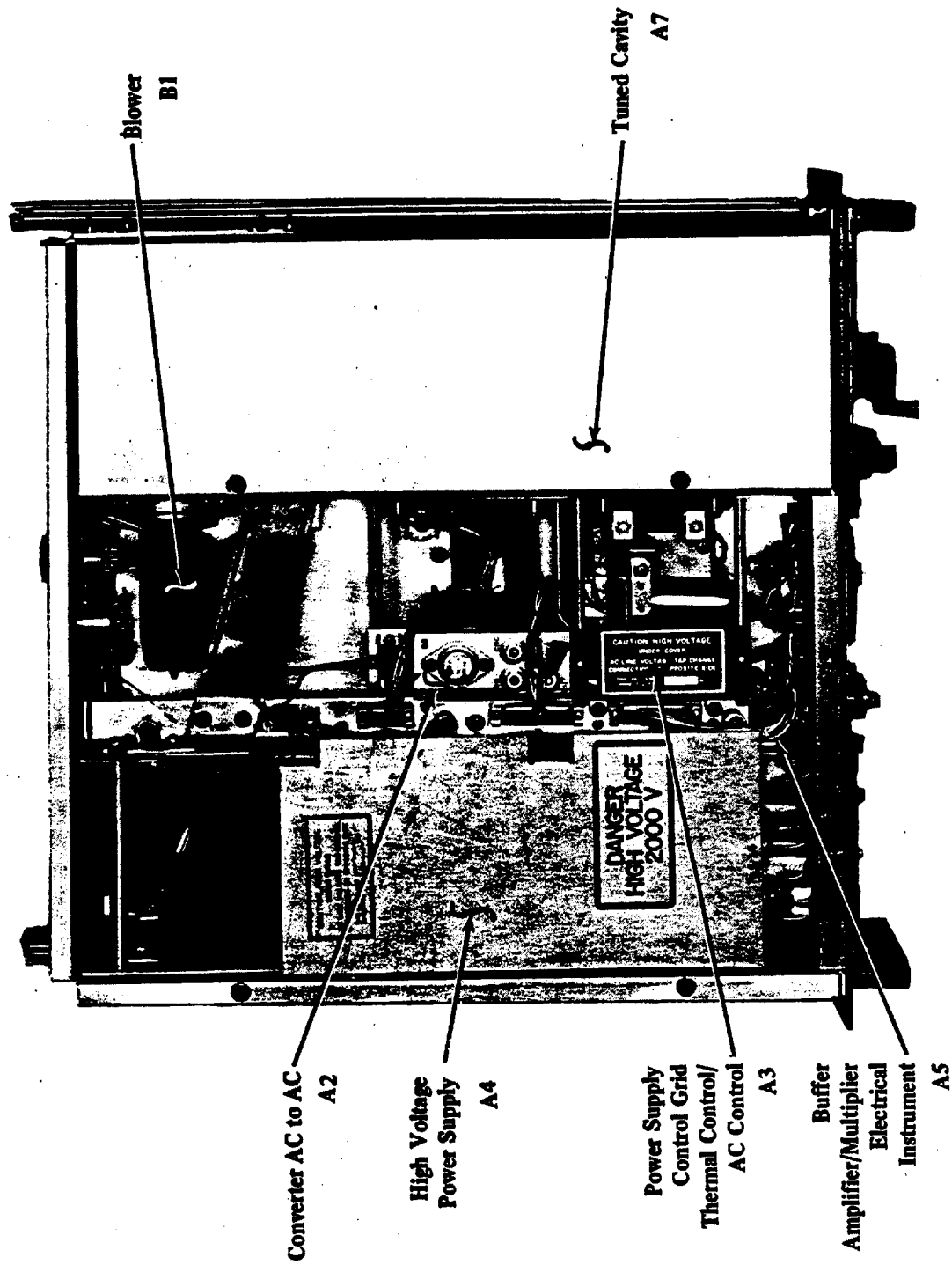


Figure 5-2. Power Amplifier Module Location and Identification

5-5. FAULT DIAGNOSIS AND CORRECTIVE MAINTENANCE.

5-6. GENERAL.

5-7. Fault diagnosis and isolation to the module level for both the exciter and power amplifier is accomplished by observing readings on the TEST meters as programmed by the meter function switches and by monitoring the carrier and audio on a receiver tuned to the exciter frequency.

5-8. The procedures contained in this section are based on the assumption that the exciter and power amplifier has been properly installed, and that now some type of operational deficiency has been reported or observed requiring corrective maintenance.

5-9. Fault diagnosis and corrective maintenance is divided into three basic groups.

- a. Normal meter indication and a description of each of the metered functions.
- b. Fault diagnosis using a group of tables organized such that maintenance personnel can start from the basic indicated fault, and proceed on a step-by-step basis to isolate the faulty module.
- c. Module adjustment and alignment after replacement.
- d. If correct readings are not obtained when using fault diagnosis tables, adjustments should be made in accordance with the module alignment procedures.

NOTE

Check the TEST meter needle on exciter and power amplifier for zero when all power is off. If needle does not zero, adjust by means of screwdriver slot zero adjust in meter front.

5-10. **NORMAL METER INDICATIONS.** Tables 5-2, 5-3, 5-4, and 5-5 contain the normal ranges for the front panel metered test positions when the equipment is modulated from either local or remote locations as defined in the tuning procedures. An explanation of each test position is contained in paragraph 5-11. Tables 5-4 and 5-5 contain detailed information for the various modes and conditions relating to a typical system operation.

5-11. **TEST POSITION DESCRIPTIONS.** The following paragraphs contain explanations of the various test positions relative to tables 5-2 and 5-3. The normal test readings presented in the respective tables are intended to provide criteria for evaluation of test readings taken during analysis of faults. When reference, in the

fault diagnosis section, is made to a test position reading being high or low, it means, in comparison with the expected value given in tables 5-2 and 5-3 under the specific operating mode and condition involved. If the readings do not conform to the normal readings in these tables, the particular module referred to in the table should be suspected of misalignment or fault.

5-12. The following explanations relate to test position readings in the exciter only (10-watt) mode of operation, and the standard test point readings given for that condition of operation in table 5-2.

EXC 1-1 E-L RLY: In exciter-only mode, there being no umbilical cable connecting the exciter to a power amplifier, there is no ground return for the EL relay and the EL relay can not pull in. The EL relay is thus inhibited from transferring. Under this condition of operation the coaxial antenna connection to the exciter is made at K1J3 rather than at K1J1; and K1J1 and K1J4 are left open.

EXC 1-2 FWD: The correspondence between forward (FWD) rf power meter readings and rf power in watts is given in figure 5-3.

EXC 1-3 RVS: The correspondence between reverse (RVS) rf power meter readings and reflected rf power in watts is given in figure 5-4.

EXC 1-4 APC: The APC (automatic power control) meter reading of the APC voltage is analytic only and should read near mid scale. The value shown is subject to variations over the frequency range.

EXC 1-5 T/R RLY: Indicates the voltage on the T/R relay line to control an external relay if desired. This line supplies +24 volts at 100 ma from pin C of J5 to ground. Meter indicates upscale when transmitter is keyed.

- EXC 1-6 VSWR-LPA:** Indicates the condition when the LPA has a reflected VSWR of greater than 3:1. Normal or good reading at this test point is an upscale reading. A high VSWR reading is 0.
- EXC 1-7 PWR AMPL:** The value shown is approximate and is subject to variation over the range of 10 to 45.
- EXC 1-8 FLTR TUNE:** Used only during tuning operations, this test position has an output only with the TUNE-OPERATE switch in TUNE position.
- EXC 1-9 MULTR:** Metered tuning position for the multiplier module. Tuning controls should be peaked, and gain level output should be set for a nominal meter reading of 22.
- EXC 1-10 OVEN:** In normal continuous operation the OVEN test position slowly swings over the range of 0 to 10 with unvarying ambient temperature and ac line input, it tends toward a steady-state value of 3 to 6 on the meter. At first turn-on with a cold unit the OVEN reading may be as high as 40 for a few minutes.
- EXC 1-11 OSC:** Values shown, and variations with operating frequency, are typical, subject to further variations from unit to unit. Generally, oscillator test position readings above 25 are normal, and provide sufficient drive to the multiplier to enable the multiplier unit to maintain the closed-loop automatic-level-controlled normal output giving a value of 22 for the MULTR test position.
- EXC 2-1 UNRGLTD V:** The rise in unregulated B+ voltage with the transmitter unkeyed is in part a function of the source impedance of the ac lines to the transmitter. In the case shown for ac line was measured at 120v with the transmitter keyed; unkeyed, the unregulated voltage rises from 32 to 36 (approximate) on the meter due to line and load change.
- EXC 2-2 BAT:** With a battery connected, this test position reads the battery terminal voltage when the ac switch is OFF or ON. Without battery connected will read UNRGLTD V.
- EXC 2-3 RGLTD +20:** Indicates regulated +20 volt dc output. Good reading is 17.5 to 21.5.
- EXC 2-4 +20 CUR:** Multiply meter reading by 0.2 to obtain actual current in amps drawn by the +20 volt load. Variations with operating band and frequency are typical and subject to some further variation from unit to unit.
- EXC 2-5 KEYED +20:** Indicates approximately 20 on meter when exciter is keyed. Meter should read approximately 0 when unkeyed.
- EXC 2-6 % MOD:** The correspondence between meter readings and actual modulation percent is given in figure 5-5.
- EXC 2-7 MOD:** This test point gives analytic indication only of the ac (audio) component of the composite modulation APC voltage at the base of the Mod-APC driver transistor. This test point is used to determine any existing malfunction in the rf control/modulator card.

EXC 2-8 FLTR AMPL: Indicates upscale reading when the system is modulated on the audio input lines or local microphone lines, and indicates the signal is present at the output of the filter amplifier.

**EXC 2-9 CPRSR:
or LINE AMPL** Indicates upscale reading when the system is modulated on the audio input lines or local microphone lines; indicates the signal is present at the output of the audio compressor amplifier.

**EXC 2-10 AF LVL-H
and
2-11 AF LVL-L** The correspondence between meter readings and actual audio line levels, for high and low audio frequency level test positions, is given in figure 5-6.

**EXC 2-12 OVER
TEMP:** Normally indicates 0. In over temp condition at 75°C to 80°C, meter indicates midscale, transmitter will not key.

5-13. The following explanations relate to test position readings in 50-watt operating mode with a power amplifier in use with the exciter, as given in table 5-3.

EXC 1-1 E-L RLY: With normal interconnections between exciter and power amplifier unit, and the antenna connected to K1J1 of the exciter, the power amplifier unit is in operation with the EL relay de-energized. In event of loss of ac line power and with a battery connected, the transmitter automatically reverts to Exciter-Only operating mode, with the EL relay energized.

EXC 1-2 FWD: See figure 5-7 for interpretation of meter reading in watts. Note that the forward rf power out of the exciter unit to drive the

power amplifier in 50-watt mode is less than the normal forward rf power out of the exciter in 10-watt mode only. The required drive power for the power amplifier is 3 watts to 8 watts, depending on operating band and frequency. Also, see EXC 1-4.

EXC 1-3 RVS: See figure 5-8 for interpretation of meter reading in watts of reflected power and equivalent load VSWR.

EXC 1-4 APC: Gives an approximate APC dc voltage meter reading in volts. The APC level in an exciter unit driving a power amplifier is lower than in an exciter unit alone. With the power amplifier TUNE-OPERATE switch in TUNE position the exciter forward rf power sense circuit is artificially offset to a high value, simulating an excess-power condition and causing the apc voltage, under this condition, to operate at a lower level resulting in the application of reduced rf drive to the power amplifier.

EXC 1-7 PWR AMPL: The variations in the test point reading shown correspond to the varying rf drive conditions associated with exciter-only mode and 50-watt mode, and the power amplifier tune-operate condition, as discussed in connection with Exciter 1-2 FWD and 1-4 APC.

EXC 2-4 +20 CUR: The variations in current drawn by the +20 volt system under exciter-only and under power amplifier 50-watt modes correspond to the varying system conditions discussed under

	Exciter 1-2 FWD, 1-4 APC, and 1-7 PWR AMPL.		
EXC 2-6 % MOD:	See figure 5-5 for interpretation of meter reading in percent.	LPA 7 V-SCREEN:	Power amplifier tube screen voltage may be directly read by multiplying the meter reading by 10; i.e., a reading of 39 equals 390 volts dc.
LPA 1 EXCTR:	Indicates that exciter is connected and on. Will indicate in both keyed and unkeyed condition.	LPA 8 V-GRID:	Power amplifier tube control grid bias may be directly read by multiplying the meter reading by -2; i.e., a reading of 42 equals a control grid bias voltage of -84 volts dc.
LPA 2 KEY:	Indicates only when exciter is keyed.	LPA 9 V-HTR:	Power amplifier tube heater voltage may be directly read by dividing the meter reading by 4; i.e., a reading of 24 equals 6.0 volts ac.
LPA 3 FWD:	Power amplifier driver power is decreased with the power amplifier TUNE-OPERATE switch in TUNE position (see EXC 1-4, APC). See figure 5-7 for interpretation of meter reading in watts.	LPA 10 V-LPA:	A voltage level generated within the power amplifier, derived from the high voltage and screen dc voltage supply, when this voltage is less than 26 volts it signals the existence of an abnormal power amplifier voltage condition and causes the exciter to energize the EL relay, putting the transmitter in 10-watt mode. With the EL relay energized in a normal exciter the V-LPA function reads 20 on the meter.
LPA 4 RVS:	Reverse power meter readings are interpreted in watts reflected power in figure 5-8.	LPA 11 FAN:	Derived from unregulated voltage, the fan voltage test point varies as shown with changing line and load conditions.
LPA 5 V-PLATE:	Unregulated plate voltage for the power amplifier tube varies with input AC line typically as shown, and with the transmitter unkeyed and unloaded, supply rises to the high value shown. Readings may be interpreted directly in volts by multiplying by 100; i.e., a meter reading of 19 equals 1900 volts dc.	LPA 12 OVER TEMP:	Meter normally reads zero. In over temp mode, meter reads midscale, disables the high voltage and transfers to exciter mode output.
LPA 6 CUR-PLATE:	Power amplifier tube plate current may be directly interpreted from the meter readings by multiplying by 10; i.e., a reading of 15 equals 150 milliamperes.		

Table 5-2. Normal Test Position Readings, 10-Watt Mode of Operation Power Amplifier Not Connected

SWITCH POSITION	MODULE	METER READINGS (12)	
		UNKEYED AND UNMODULATED	KEYED AND MODULATED (10)
1-1	E-L RLY	A7	0 to 2
1-2	FWD	A6	≤3 (16)
1-3	RVS	A6	≤3 (76)
1-4	APC	A6	0
1-5	T/R RLY	A2	0
1-6	VSWR-LPA	A6	0 to 3
1-7	PWR AMPL	A10	0
1-8	FLTR TUNE	FL2	0 (18)
1-9	MULTR	A9	0
1-10	OVEN	A8	0 to 40 (2)
1-11	OSC	A8	0
2-1	UNRGLTD V	PS1A-3	20 to 40
2-2	BAT		20 to 40 (4)
2-3	RGLTD + 20	PS1A1, PS1A2	17.5 to 21.5
2-4	+20 CUR		0 to 3 (11)
2-5	KEYED +20	A2	0 to 3
2-6	% MOD	A7	Negative indication (17)
2-7	MOD	A6, A5	0
2-8	FLTR AMPL	A4	0
2-9	CPRSR	A1	0
2-10	AF LVL-H	A4	0
2-11	AF LVL-L	A4	0 to 2
2-12	OVER-TEMP	A7	0 to 7 (7)

NOTES:

- (1) Reading applies when TUNE-OPERATE switch is in TUNE position. Reading should be greater than 0.
- (2) At initial turn-on meter may peg for several minutes. Within 10 minutes reading will be less than 40 μ a.
- (3) Meter indication is dependent on oscillator frequency setting, will be at low end of range at highest frequency. With external generator input (crystal removed) meter may be as low as 3, with G2 oscillator. With external generator input (crystal removed) meter reading will be 0 with G3 oscillator.
- (4) When operating with battery, these readings will indicate battery voltage. Without battery, readings will be the same as UNREG V.
- (5) A reading of 30 indicates 90% modulation.
- (6) See curves, figure 5-3 through 5-6.
- (7) Any indication of greater than 7 on this position indicates that the over temperature protection circuits will prevent keying transmitter.
- (8) Multiply meter reading by 0.2 to obtain true current in amperes.
- (9) With typical voice signal inputs, the AF LVL-L and AF LVL-H readings will vary instantaneously. Steady state readings on these test positions can be obtained only with continuous sine-wave inputs. The normal ranges for these readings depend on the characteristics of modulation signal sources peculiar to each installation.
- (10) "Modulated" means continuous modulation inputs are present within the required range for frequency and level.

Table 5-2. Normal Test Position Readings, 10-Watt Mode of Operation Power Amplifier Not Connected (Cont)

- (11) Meter reading is usually very slightly up-scale from zero but never higher than 3. A reading of 0 to 10 is typical on exciters equipped with the VHF/UHF Driver/Power Amplifier (P/N 8136838G1).
- (12) Whenever 0 appears in the table, the tolerance on the 0 condition is ± 1 .
- (13) With high level AF line inputs, the AF LVL-L reading may peg at greater than 60, input line level may be read out on the A F LVL-H test position.
- (14) When G3 Crystal Oscillator is used acceptable limits are 15 to 24.
- (15) When G3 Crystal Oscillator is used acceptable limits are 5 to 24.
- (16) Meter readings below zero are permissible.
- (17) With SWITCH 1 in SWITCH 2 ENABLE do not place SWITCH 2 to % MOD unless exciter is modulated. Failure to do this will cause meter to peg negative possibly damaging meter.
- (18) A reading of 0 to 5 is typical on exciters equipped with the VHF/UHF Driver/Power Amplifier (P/N 8136838G1).
- (19) A reading of 0 to 15 is typical on exciters equipped with the VHF/UHF Driver/Power Amplifier (P/N 8136838G1).

Table 5-3. Normal Test Position Readings, Exciter and Power Amplifier, 50-Watt Mode of Operation (Exciter reading below will differ from the Exciter Only readings Table 5-2. Refer to Table 5-2 for all other Exciter readings.)

				METER READINGS (16)	
SWITCH POSITION		MODULE		UNKEYED AND UNMODULATED	KEYED AND MODULATED (15)
EXC	1-1	E-L RLY	EXC A7	0 to 2 (1)	0 to 2 (1)
EXC	1-2	FWD	EXC A6	≤ 3 (17)	12 to 35 (VHF) (2) 16 to 38 (UHF) (2)
EXC	1-3	RVS	EXC A6	≤ 3 (17)	0 to 15 (3)
EXC	1-4	APC	EXC A6	0	5 to 32
EXC	1-6	VSWR-LPA	EXC A6, A7	16 to 24	1 to 4 (14)
EXC	1-7	PWR AMPL	EXC A 10	0	3 to 45 (UHF) 3 to 45 (VHF)
EXC	2-4	+20 CUR		0 to 3 (12)	5 to 30 (UHF) 5 to 25 (VHF)
EXC	2-6	% MOD	EXC A7	Negative Indication (18)	15 to 40 (4) (13)
EXC	2-7	MOD	EXC A5, A6	0	5 to 40
LPA	1	EXCTR		17 to 24	17 to 24
LPA	2	KEY	EXC A2	0	17 to 24
LPA	3	FWD	LPA A5	≤ 3 (17)	40 to 45 (5)
LPA	4	RVS	LPA A5	≤ 3 (17)	0 to 25 (5) (11)
LPA	5	V-PLATE	LPA A4	18 to 28 (6)	15 to 26 (6)
LPA	6	CUR-PLATE	LPA A4	6 to 8	10 to 18 (UHF) (7) 12 to 16 (VHF) (7)
LPA	7	V-SCREEN	LPA A4	33 to 45 (8)	33 to 45 (8)
LPA	8	V-GRID	LPA A3	30 to 50 (9)	30 to 50 (9)
LPA	9	V-HTR	LPA A3	21 to 31	21 to 31
LPA	10	V-LPA	LPA A4	30 to 45	30 to 45
LPA	11	FAN	LPA A2	20 to 32	20 to 32
LPA	12	OVER-TEMP	LPA A3	0 to 7 (10)	0 to 7 (10)

Table 5-3. Normal TEST Position Readings, Exciter and Power Amplifier, 50-Watt Mode of Operation (Exciter reading below will differ from the Exciter Only readings Table 5-2. Refer to Table 5-2 for all other Exciter readings.) (Cont)

NOTES:

- (1) When power amp is not operating, reading will be 15 to 40 indicating exciter mode of operation.
- (2) See Curve Figure 5-3.
- (3) Power amplifier cavity input tuned for minimum reading on exciter reverse. See Curve Figure 5-4.
- (4) See Curve Figure 5-5.
- (5) See Curves Figures 5-7 and 5-8.
- (6) Multiply meter reading by 100 to obtain true plate voltage.
- (7) Multiply meter reading by 10 to obtain current in milliamperes. A meter reading of 16 or less (VHF) or 18 or less (UHF) greatly increases the life expectancy of the tube.
- (8) Multiply meter reading by 10 to obtain true screen voltage.
- (9) Multiply meter reading by -2 to obtain true grid voltage.
- (10) Meter reading greater than 7 indicates an over temperature condition, and system will switch to exciter operation only.
- (11) Negative indication exists when power amplifier is in the tune mode.
- (12) Meter reading is usually very slightly up scale from 0 but never greater than 3. A reading of 0 to 10 is typical on exciters equipped with the VHF/UHF Driver/Power Amplifier (P/N 8136838G1).
- (13) A reading of 30 indicates 90% modulation.
- (14) When power amp is not operating, reading will be 16 to 24 indicating exciter mode of operation.
- (15) "Modulated" means continuous modulation inputs are present within the required range for frequency and level.
- (16) Whenever 0 appears in the table, the tolerance on the 0 condition is ± 1 .
- (17) Meter readings below zero are permissible.
- (18) With SWITCH 1 in SWITCH 2 ENABLE do not place SWITCH 2 to % MOD unless exciter is modulated. Failure to do this will cause meter to peg negative possibly damaging meter.

Table 5-4. Typical Test Position Readings, Exciter Only, 10-watt Mode of Operation

STANDARD CONDITIONS:		SAME AS STANDARD CONDITIONS, EXCEPT AS NOTED:																	
UHF transmitter at band center; AC operation at nominal (120V); TUNE-OPERATE in OPERATE position; Key down; normal remote voice modulation input at 0 dbm.		Low AC Line 108V	High AC Line 132V	Bat- tery only 24V	Low Band Edge 225	High Band Edge 400	VHF Low Band 116	VHF High Band 150	TUNE Sw. in	Mod In +10 Dbm	Mod In -10 Dbm	Un- mod. key							
EXC	1-1	2	2	2	2	2	2	2	2	2	2	0							
EXC	1-2	42	42	42	42	42	42	42	42	42	42	0							
EXC	1-3	5	5	5	5	5	5	5	5	5	5	0							
EXC	1-4	18	18	18	24	22	18	18	18	18	18	0							
EXC	1-5	31	39	23	35	35	35	35	35	35	35	0							
EXC	1-6	3	3	3	3	3	3	3	3	3	3	0							
EXC	1-7	40	40	40	40	40	40	40	40	40	40	0							
EXC	1-8	0	0	0	0	0	0	0	0	0	0	0							
EXC*	1-9	20	20	20	20	20	20	20	20	20	20	0							
EXC	1-10	5	5	5	5	5	5	5	5	5	5	5							
EXC	1-11	33	33	33	40	28	40	33	33	33	33	0							
EXC	2-1	28	36	23	32	32	32	32	32	32	32	36							
EXC	2-2	26	31	24	29	29	29	29	29	29	29	30							
EXC	2-3	20	20	20	20	20	20	20	20	20	20	20							
EXC	2-4	20	20	20	24	22	16	18	20	20	20	1							
EXC	2-5	20	20	20	20	20	20	20	20	20	20	1							
EXC	2-6	30	30	30	30	30	30	30	30	30	30	0							
EXC	2-7	25	25	25	25	25	25	25	25	25	25	0							
EXC	2-8	16	16	16	16	16	16	16	16	16	16	0							
EXC	2-9	6	6	6	6	6	6	6	6	6	6	0							
EXC	2-10	16	16	16	16	16	16	16	16	50	6	0							
EXC	2-11	50	50	50	50	50	50	50	50	50	16	0							
EXC	2-12	0	0	0	0	0	0	0	0	0	0	0							

* When G3 Oscillator used with quadrupler average reading will be 10, with doubler average reading will be 15.

(1) Max neg meter.

Table 5-5. Typical Test Position Readings, with Power Amplifier, 50-watt Mode of Operation

STANDARD CONDITIONS: UHF transmitter at a band center; AC operation at nominal (120V); Exciter in OPERATE mode; LPA TUNE-OPERATE in OPERATE position; Key down; normal remote voice modulation input at 0 dbm.		SAME AS STANDARD CONDITIONS, EXCEPT AS NOTED:												Key Off	
EXC	1-1	E-L RLY	0	Low AC Line 108V	High AC Line 132V	Bat- tery Only 24V	Low Band Edge 225	High Band Edge 400	VHF Low Band 116	VHF High Band 150	Un- Mod LPA TUNE	Un- key	EXC Off	Hv Off	Key Off
EXC	1-2	FWD	24	24	24	42	24	24	24	24	33	0	4	0	36
EXC	1-3	RVS	5	5	5	5	5	5	5	5	5	0	4	0	0
EXC	1-4	APC	14	14	14	18	14	14	14	14	12	0	0	0	0
EXC	1-6	VSWR-LPA	3	3	3	20	3	3	3	3	3	20	0	20	0
EXC	1-7	PWR AMPL	30	30	30	40	30	30	30	30	25	0	0	0	0
EXC	2-4	+20 CUR	14	14	14	20	14	14	14	14	12	1	0	1	1
EXC	2-6	% MOD	30	30	30	40	30	30	30	30	0	0	4	0	0
LPA	1	EXCTR	20	20	20	20	20	20	20	20	20	20	0	20	20
LPA	2	KEY	20	20	20	20	20	20	20	20	20	0	0	0	0
LPA	3	FWD	40	40	40	0	40	40	40	40	20	0	6	0	0
LPA	4	RVS	5	5	5	0	5	5	5	5	5	0	4	0	0
LPA	5	V-PLATE	19	17	21	0	19	19	19	19	22	26	23	0	0
LPA	6	CUR-PLATE	15	15	15	0	14	16	14	15	11	7	7	0	0
LPA	7	V-SCREEN	39	39	39	2	39	39	39	39	39	39	39	0	0
LPA	8	V-GRID	42	42	42	0	42	42	42	42	42	42	42	42	42
LPA	9	V-HTR	24	23	25	0	24	24	24	24	24	24	24	24	24
LPA	10	V-LPA	32	32	32	20	32	32	32	32	32	26	37	20	20
LPA	11	FAN	25	23	27	0	25	25	25	25	25	25	25	26	26
LPA	12	OVER-TEMP	0	0	0	20	0	0	0	0	0	0	0	0	20

NOTE: For exciter test position conditions not shown on this sheet, refer to table 5-2 covering exciter only test position readings. Exciter test points 1-5, and 1-8 thru 1-11, and 2-1 thru 2-3, and 2-5 and 2-7 thru 2-12 are the same in 50-watt mode as in 10-watt mode.

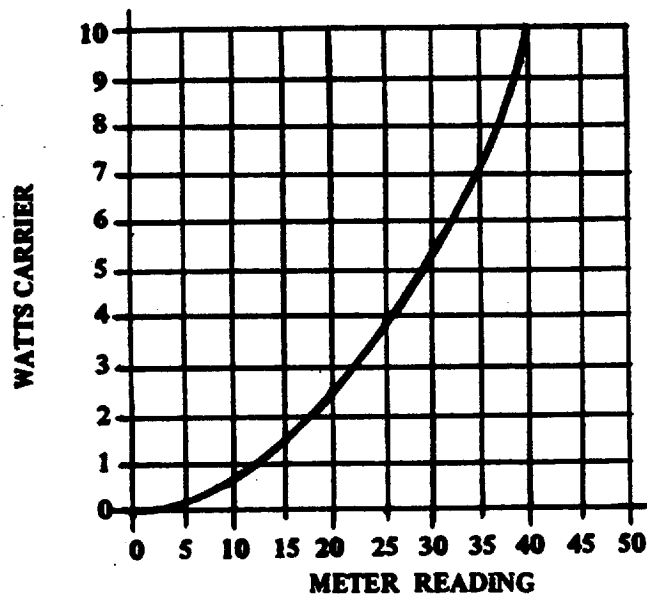


Figure 5-3. Exciter RF Carrier Power Vs Meter Reading

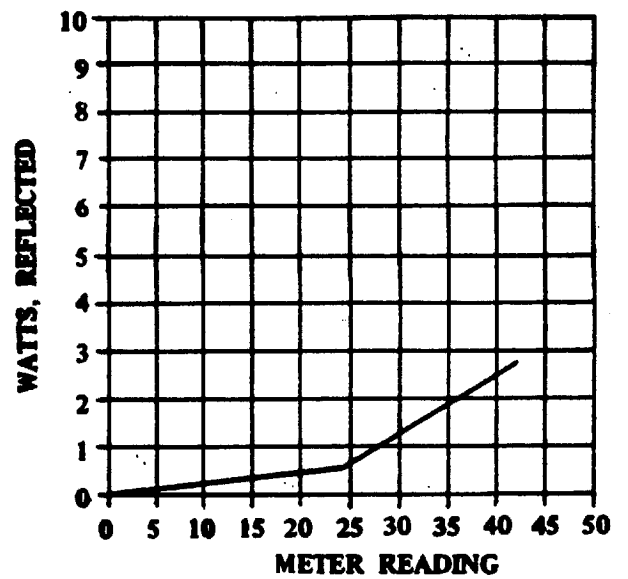


Figure 5-4. Exciter Reverse (Reflected) RF Power Vs Meter Reading

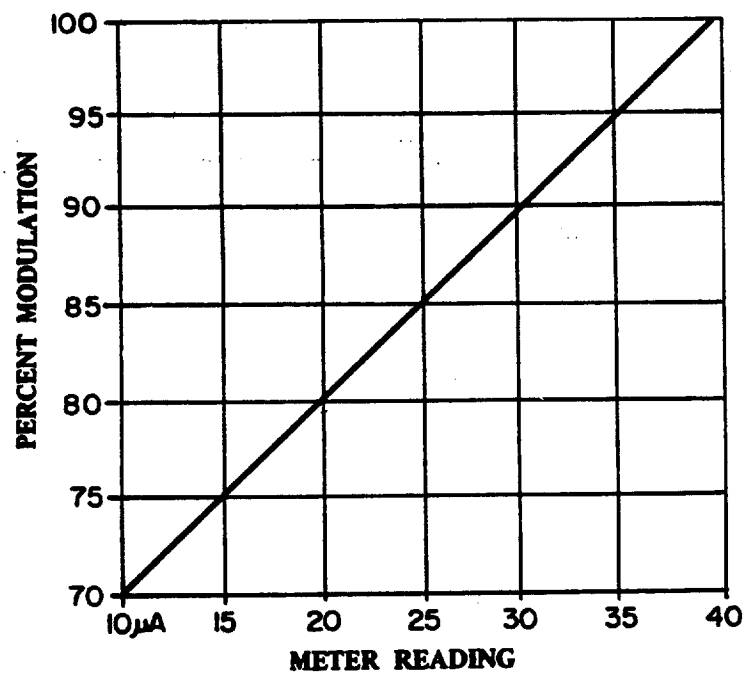


Figure 5-5. Percent Modulation Vs Meter Reading

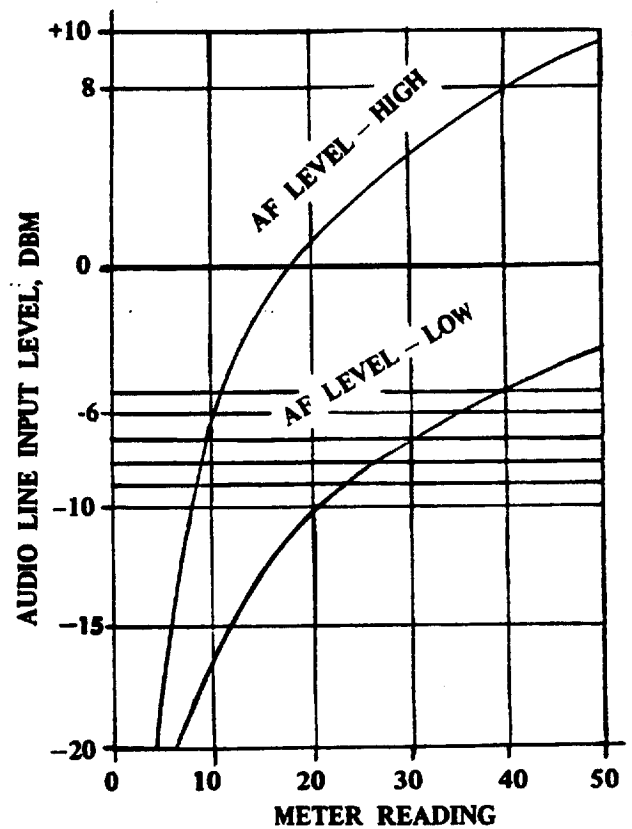


Figure 5-6. Audio Input Line Levels Vs Meter Reading

5-14. FAULT DIAGNOSIS. The following paragraphs and tables contain fault diagnosis, removal and replacement, or repair-in-place maintenance, and readjustment required for restoration of service. Prior to performing actual diagnosis of faults perform the following:

a. Always verify that transmitter operating mode and operating voltages are correct, in accord with table 5-6 for transmitters operating in 10-watt mode (exciter only) and table 5-7 (for transmitters operating in 50-watt mode with exciter and power amplifier).

b. When it is desired to monitor the output of the transmitter, tune a receiver on the known transmitter frequency (if none is already on that frequency) and use the receiver output as a transmitter monitor. Plug headphones into the AUDIO OUTPUT jack of the receiver, if necessary. Place transmitter REMOTE-LOCAL switch in LOCAL. If carrier only is desired, key the transmitter by use of the CARRIER TEST switch; or if it is desired to check both carrier and modulation, plug in either a carbon microphone or a dynamic microphone in the jacks provided, and key and voice modulate as desired. Compare the output observed from the monitor receiver with the expected result. Confirm, if possible, that the reported fault actually exists.

NOTE

If keying the transmitter in maintenance mode would cause interference with operations on that frequency channel, disconnect the transmitter from its antenna and connect it to a dummy load. If this is done, it may be desirable to employ a coupler to the input of the monitor receiver. Not less than 40 db of isolation between the transmitter output and the receiver input must be used.

WARNING

Do not disconnect the coaxial output cable of the transmitter to the antenna without first placing the REMOTE-LOCAL switch in LOCAL position, with the CARRIER TEST switch in normal position, to assure that the transmitter will not be remotely keyed with its load disconnected. While the transmitter is protected from excessive high load VSWR in this condition, it is possible for maintenance personnel to sustain rf burns if handling open cable ends with the transmitter keyed.

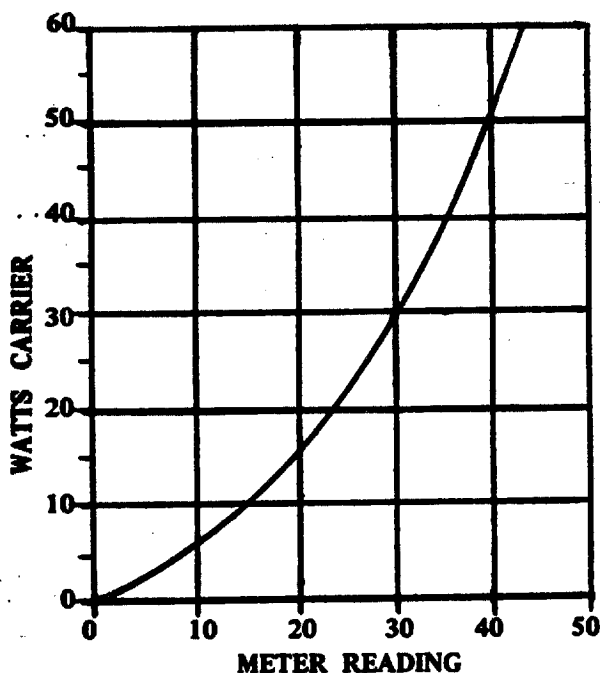


Figure 5-7. LPA RF Carrier Power Vs Meter Reading

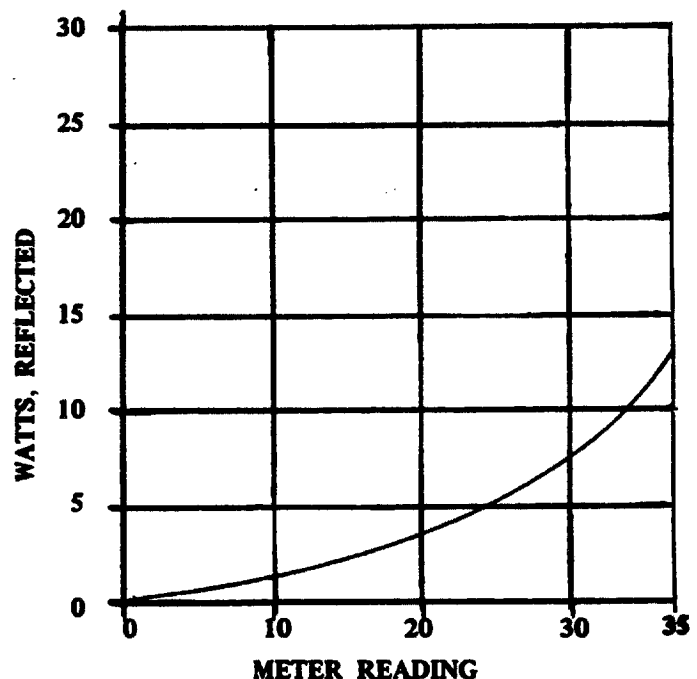


Figure 5-8. LPA Reverse (Reflected) RF Power Vs Meter Reading

c. When a fault is apparent with only the transmitter connected and operating in normal operational mode, and disappears when used in maintenance mode, the fault may be peculiar to operational mode only. Refer to table 5-8 as a guide to diagnosis.

d. When the reported fault is apparent in maintenance mode, based on the observations made in step c. perform further diagnosis with table 5-9 as a guide.

e. When the reported fault is in the tuning mode, perform further diagnosis using table 5-18 as a guide.

NOTE

Before proceeding with further diagnosis, be sure that the procedures of tables 5-6, 5-7 and 5-8 as applicable, and steps a, b, and c have been performed sufficient to establish at this point that a fault actually exists in the transmitter and, in a general way, a description of the faulty condition, such as low carrier power, distorted modulation, etc. In the performance of further diagnosis, the following checks should be adhered to:

1. When a test position appears to have an incorrect indication, verify that operating mode switching, keying, and input modulation signal conditions are as expected.

2. When a test position reading leads to some conclusion regarding the module

which is faulty, verify all other related test position readings which would support this conclusion.

3. Do not make adjustments to the transmitter with undiagnosed faults present in the transmitter.

4. When rf power or modulation show a significant degradation, do not attempt to restore normal conditions through adjustment. While such adjustments might seem to correct or improve a condition noted, it will only mask the original symptoms and make further diagnosis difficult.

5. Do not swing tuning controls through their range in an attempt to see if they respond, or to see if they have been improperly set. Perform only those retuning and alignment adjustments indicated, following replacement of a faulty module.

NOTE

In exciter/power amplifier configuration, if it is desired to check exciter on antenna without going through EL relay, disconnect antenna cable from K1J1 on back of exciter and reconnect to K1J3 cable must be disconnected from J8 for proper operation.

Table 5-6. Transmitter Normal Operating Mode Conditions and Voltages
10 Watt Mode (Exciter Only)

SWITCH OR INDICATOR	CONDITION OR VOLTAGE
ON-OFF switch	ON
AC POWER indicator	Illuminated
Fuse Indicator	Extinguished
REMOTE-LOCAL switch	REMOTE
PUSH TO TALK-CARRIER TEST switch	PUSH TO TALK (up)

Operating voltage: Verify that +20 voltage is correct placing TEST SWITCH 1 to SWITCH 2 ENABLE, SWITCH 2 to RGLTD +20 position. The front panel meter should indicate 17.5 to 21.5 (20 vdc).

5-15. MODULE REMOVAL AND REPLACEMENT
(See Figures 5-1 and 5-2).

CAUTION

Electrostatic Sensitive Devices observe precautions for handling. Refer to page 5-1, para 5-3.

5-16. EXCITER.

NOTE

When any reference is made to the oscillator module in the module removal and replacement procedures, the same information applies to the oscillator-synthesizer and oscillator-multiplier as these three modules are mechanically and electrically interchangeable.

NOTE

When removing coaxial cables from modules requiring use of 1/4-inch open-end wrenches, be sure to use two wrenches. When replacing coaxial cables first tighten finger tight, then only snug up connector with wrench (threads may still show).

5-17. TOP COVER. To remove the top cover, loosen the eleven 6-32 flat Phillips head captive screws. Replacement is the reverse of removal.

NOTE

Make certain all 11 screws are tightened to assure positive RFI shielding effectiveness.

**Table 5-7. Transmitter Normal Operating Mode Conditions and Voltages
50 Watt Mode (Exciter and Power Amplifier)**

SWITCH OR INDICATOR	CONDITION OR VOLTAGE
NOTE The conditions of table 5-6 apply for the exciter, and in addition, the following for the power amplifier.	
POWER ON-OFF switch	ON
POWER ON indicator	Illuminated
POWER fuse indicators	Extinguished
HV ON-OFF switch	ON
HV indicator	Illuminated
HV fuse indicator	Extinguished
TUNE-OPERATE switch	OPERATE
Interlock under top cover	Cover shall be securely closed, holding the interlock closed.
Interlock, cavity module drawer	Drawer must be securely closed, holding the interlock closed.
Observe and verify the following:	
Plate voltage: TEST switch to V-PLATE	Transmitter unkeyed, meter reads 18 to 28. Transmitter keyed, meter reads 15 to 26.
Screen voltage: TEST switch to V-SCREEN	Transmitter keyed, meter reads 33 to 45
Control grid voltage: TEST switch to V-GRID	Meter reads 30 to 50 (-60 to -100 volts)
Heater voltage: TEST switch to V-HTR	Meter reads 21 to 31

5-18. MULTIPLIER AND/OR OSCILLATOR-SYNTHESIZER.

a. **Multiplier Module:** To remove the multiplier module, disconnect A9P1 from J2 (A9P1). Disconnect A9P2 from A10J1. Disconnect A8P2 from A9J1. Remove the multiplier module from the oscillator/synthesizer module by loosening the 8-32 Phillips head screws, one at each end of the module. Lift out the multiplier module. Replacement is the reverse of the removal.

b. **Oscillator/synthesizer:** To remove the oscillator/synthesizer module, first remove the multiplier module as above. Disconnect A8P1 from J1(A8P1). Loosen the 8-32 Phillips head captive screws, two at each end, holding the module to the chassis. Lift out the oscillator/synthesizer module. Replacement is the reverse of removal.

5-19. TUNABLE FILTER. To remove the tunable filter it is first necessary to remove the oscillator and multiplier modules (see paragraph 5-18). Remove the coaxial connectors from J1 and J2. The UHF filter is held to the bottom of the chassis by four 8-32 Phillips head

screws. The VHF filter is held to the bottom of the chassis by two 8-32 Phillips head screws. Replacement is the reverse of removal.

5-20. DRIVER/POWER AMPLIFIER. To remove the driver/power amplifier module, disconnect the input coaxial cable coming from the multiplier module. Remove both the coaxial cables from the tunable filter. Remove the input power connector J3. Remove the output coaxial cable to the low pass filter. Position right side chassis slide rails so that the two 10-32 Phillips head captive screws holding module to chassis side wall may be loosened. These two screws are located approximately 7-5/16 inches and 12-1/8 inches back from the front panel and pass through clearance holes in the slide rail. Loosen the five 10-32 Phillips head captive screws holding the module to the chassis base. Carefully remove module from chassis. Replacement is the reverse of removal.

Table 5-8. Fault Diagnosis, Normal Operating Mode

**NORMAL OPERATING MODE INDICATION
(REMOTE CONTROL)**

PROBABLE CAUSE

NOTE

The following faults are apparent in normal operating mode, but are not apparent in maintenance mode (operating the transmitter locally).

Transmitter keyed continuously

a. External remote audio line is grounded

b. Fault in optional keyer module

Transmitter will not key in main keying mode

a. External remote audio lines open

b. Remote microphone defective

Transmitter will not key in operational mode (tone, current, or voltage)

a. Fault in optional keyed module

b. Fault in external keying line, or in external keying signal generator

Transmitter keys, but will not modulate; or modulates with hum and noise, some audio

One external remote audio line open

Transmitter keys and modulates, but excessive background noise between speech syllables

a. Fault in compressor-preamplifier module

b. Gain set link incorrectly connected on compressor-preamplifier module

c. Excessive audio gain in external audio compression equipment, on external audio line

CAUTION

Before replacing the driver/power amplifier module, brush on a thin coating of Thermal Joint Compound (ITT part no. 502371-1) to all surfaces of the module that contact the chassis. This is necessary to provide maximum thermal conduction from the module to the chassis.

5-21. **REGULATOR.** To remove the regulator first disconnect the nine leads from TB2. Remove four 1/4

inch hex head screws holding regulator to the rear of the chassis. Replacement is the reverse of removal.

CAUTION

Before replacing the regulator, brush on a thin coating of Thermal Joint Compound (ITT part no. 502371-1) to all surfaces of the module that contact the chassis. This is necessary to provide maximum thermal conduction from the module to the chassis.

Table 5-9. General Fault Indications, and Recommended Action For Further Fault Diagnosis

INDICATION	PROBABLE CAUSE AND RECOMMENDED ACTION
Transmitter will not key; when transmitter is keyed, there is no evidence of a carrier; and exciter RGLTD +20 reads zero. Otherwise normal per tables 5-6 and 5-7.	Exciter power supply is in over-current protection mode; or is faulty. Continue diagnosis per table 5-10.
Transmitter will not key; when transmitter is keyed there is no evidence of a carrier; and exciter RGLTD +20 reads normal. Other conditions normal per tables 5-6 and 5-7.	Fault exists in rf circuits of exciter. Probably in low level stages (oscillator or multiplier); or in keying control circuits; or in rf driver-power amplifier; or control rf/modulator circuit; or over temperature protect circuit or in optional line amplifier if used. Continue diagnosis per table 5-11.
Transmitter keys; some evidence of carrier is present when keyed, but output rf power is low; modulation either normal or distorted. Otherwise normal per tables 5-6 and 5-7.	Either exciter or power amplifier and may involve either rf circuits or automatic rf power leveling control circuits. Proceed with diagnosis per table 5-12.
Transmitter keys; output power is excessive; modulation is either normal or distorted. Otherwise normal per tables 5-6 and 5-7.	Automatic rf power leveling control circuits in exciter. Proceed with diagnosis per table 5-13.
Transmitter keys; output power normal; modulation weak, distorted, or missing, otherwise normal per tables 5-6 and 5-7.	Low-level modulation circuits. Refer to table 5-14.
Transmitter keyed continuously but normal per tables 5-6 and 5-7.	Fault in keying module.
Power amplifier voltages not in accordance with table 5-3; transmitter operates only in 10-watt mode.	Fault in power amplifier. Proceed with diagnosis per table 5-17.
Exciter indications are not in accordance with table 5-6.	Fault in exciter or in exciter voltage supply. Diagnose per table 5-15.

Table 5-10. No Carrier - RGLTD +20 Position on Exciter Reads Zero

STEP	PROCEDURE	OBSERVED RESULT	FURTHER DIAGNOSIS REQUIRED	PROBABLE CAUSE
1	Check UNRGLTD +20	a. Low or zero b. Normal	Proceed to table 5-15 Proceed to Step 2	Primary power, or power supply
2	With transmitter unkeyed, set POWER ON-OFF switch to OFF for 20 seconds, then to ON, and check RGLTD +20	a. Still zero b. Normal	Proceed to table 5-15 Proceed to step 3	Power supply, or short on +20 distribution box
3	Key transmitter, and observe RGLTD +20	a. Normal b. Goes to zero	Proceed to step 4 Proceed to step 5	
4	Leaving transmitter keyed, observe RGLTD +20 for several minutes	a. Goes to zero b. Remains on	Repeat step 2 An undiagnosed condition has caused non-repeating loss of +20. Perform complete rf and system check in accord with table 5-9, 5-10, 5-11, and 5-12, as applicable	
5	Open top access cover; disconnect multi-pin connector for driver-power amplifier module. Disconnect A/C power, inspect for corrosion and clean (if necessary) terminals on PS1A3 (28 volt power supply) and terminals on TB2 (main chassis). Reconnect A/C power. Repeat procedure of Steps 2 and 3.	a. RGLTD +20 remains ON b. RGLTD +20 disappears		Driver power amplifier module has a fault which causes overload of +20 system with transmitter keyed. Replace driver power amplifier module. Short exists on keyed +20 line. Disconnect oscillator and multiplier modules one at a time, repeating procedure of steps 2 and 3, and/or replace keyed module and repeat steps 2 and 3, until short is cleared. Replace indicated module.

Table 5-11. No Carrier - RGLTD +20 in Exciter Reads Normal

STEP	PROCEDURE	OBSERVED RESULT	FURTHER DIAGNOSIS REQUIRED	PROBABLE CAUSE
1	Key transmitter; check keyed +20	a. Normal	Proceed to step 4	Faulty keyer module
		b. Low, or zero	Proceed to step 2	
2	Check OVER-TEMP	a. High	Proceed to step 3	Faulty keyer module
		b. Normal		
3	Observe OVER-TEMP test position indication on meter for several minutes.	Decreases from high to normal after several minutes	Proceed to table 5-16	An over temperature condition exists causing automatic shutdown of the exciter
4	With transmitter keyed, check exciter APC test position	a. High	Proceed to step 7	
		b. Low, or zero	Proceed to step 5	
5	With transmitter keyed, check power amplifier FWD and power amplifier RVS test positions	a. Either, or both, very high	None	Faulty buffer amplifier module in power amplifier has created an indication which looks like excessive forward or excessive reverse rf power, and has cut off APC control.
		b. Both essentially zero	Proceed to step 6	
6	With transmitter keyed, check exciter FWD and RVS test position	a. Either, or both, very high	None	Faulty rf control module in exciter has created situation noted in step 5
		b. Both essentially zero	None	Faulty rf control module in exciter will not drive APC bus, resulting in no carrier. (May also be caused by MOD/APC drive transistor on output of the rf control module.)

Table 5-11. No Carrier - RGLTD +20 in Exciter Reads Normal (Cont)

STEP	PROCEDURE	OBSERVED RESULT	FURTHER DIAGNOSIS REQUIRED		PROBABLE CAUSE
7	With transmitter keyed, check exciter OSC test position	Zero	None		Faulty oscillator module or oscillator-synthesizer module
		Normal	Step 8		
8	With transmitter keyed, check MULTR test position	Zero	None		Faulty multiplier module
		Normal	Step 9		
9	Bypass tunable filter with attenuator, fixed, rf, 3.0 dB, 20-watt, PN500436-1	Zero	None		Faulty driver power amplifier module
	Key transmitter and observe FWD position on exciter	Normal	None		Faulty tunable filter

Table 5-12. Low RF Power-Modulation OK or Not (50-Watt Configuration) (Transmitter OK Per Table 5-6, 5-7 and 5-8)

EL- RLY	Exciter Test Positions				Power Amplifier Test Positions					V- PLATE		PROBABLE CAUSE
	FWD	RVS	APC	PWR AMPL	MULTR	OSC	CUR +20	FWD	RVS	Low	High	
OK	High	OK	High	High			High	Low	OK	Low	(LPA) cavity amplifier module (amplifier tube)	
OK	OK	High						Low	OK	Low	(LPA) cavity amplifier module (input circuit)	
OK	Low	Low	Low				Low	Low	High	High	(LPA) output circuit (antenna or line, high VSWR)	
OK	High		High				High	Low		High	(LPA) cavity amplifier module (output circuit filter or sensor) Note 1	
High								Low	Low	Low	Transmitter has transferred automatically to 10-watt mode (exciter only); check further indication as follows: compare with normal readings for 10-watt mode.	

Table 5-12. Low RF Power-Modulation OK or Not (50-Watt Configuration) (Transmitter OK Per Table 5-6; 5-7 and 5-8) (Cont.)

EL- RLY	Exciter Test Positions			Power Amplifier Test Positions					V- PLATE	PROBABLE CAUSE
	FWD	RVS	APC	PWR AMPL	MULTR	OSC	CUR +20	FWD	RVS	
Low	Low	High	Low							High load VSWR, antenna of transmission line. Note 1
	OK	OK	OK	OK	OK	OK	OK			(LPA) cavity amplifier module; or (LPA) buffer-amplifier. Notes 2, 3, 4, 5, 6
	Low	OK	High	Low	Low	Low				Oscillator; oscillator synthesizer
	Low	OK	High	Low	Low	OK				Multiplier module
	Low	OK	High	Low	OK	OK	OK	Low		Driver-power amplifier module or tunable filter
	OK	High	Low	OK	OK	High				Driver-power amplifier module
	Very High	OK	Low	Low	OK	OK	Low			Rf control module Note 7
	Low	Very High	Low	Low	OK	OK	Low			Rf control module Note 8
	Low	OK	Low	Low	OK	OK	Low			Rf control module

NOTES:

- (1) Effect noted can also be caused by defective coaxial relay in exciter.
- (2) Automatic transfer from 50-watt to 10-watt mode occurs if normal forward power in power amplifier is not sensed within 35 milliseconds following keying, or if forward power falls below set threshold level during keying cycle, or if excessive reverse power is sensed by reverse sensor.

NOTES (Cont.)

- (3) Transfer from 50-watt to 10-watt mode may occur due to fault in power amplifier buffer-amplifier, falsely simulating high VSWR (high reflected power) condition. To check this unkey transmitter while observing power amplifier RVS. If it maintains high reading, replace power amplifier buffer amplifier.
- (4) Transfer may also occur if power amplifier forward power sensor or buffer amplifier are unable to sense forward power, due to some fault in the power sensor or buffer amplifier. To check this, place power amplifier TUNE-OPERATE switch in TUNE mode; if power amplifier FWD reads zero, replace cavity amplifier module (with defective power sensor; or, if required, replace the power amplifier buffer amplifier module.
- (5) Transmitter may be held in 10-watt mode permanently because of defect in VSWR detector circuit in exciter rf control card; check VSWR-LPA test position. Replace rf control module if required.
- (6) Transmitter may go into 10-watt mode on each keying cycle because EL relay is permanently energized due to fault in keyer module. To check this (after verifying that all power amplifier voltages are normal, including the V-LPA test position), unkey transmitter. If EL-RLY test position stays high replace keyer module.
- (7) This effect is caused by fault in rf control module, falsely simulating an excessive FWD power. Replace module.
- (8) This effect is caused by fault in rf control module, falsely simulating an excessive reflected power. Replace rf control module.

Table 5-13. High RF Power-Modulation OK or Not (50-Watt Configuration) (Transmitter OK per Table 5-6, 5-7 and 5-8)

EL- RLY	Exciter Test Positions				Power Amplifier Positions				V-		PROBABLE CAUSE
	FWD	RVS	APC	PWR AMPL	MULTR	OSC	CUR	FWD	RVS	PLATE	
OK	High		High	High			High	High	High	High	rf power reference on rf control module. Replace module.
OK	High		High	High			High	Low	High	High	(LPA) buffer-amplifier, or (LPA) cavity amplifier (Power sensor) Note 1.
	High		High	High			High				Rf power reference on rf control module. Replace module.

(10-Watt Configuration) (Transmitter OK per Table 5-6, 5-7 and 5-8)

Table 5-13. High RF Power-Modulation OK or Not (50-Watt Configuration) (Transmitter OK per Table 5-6, 5-7 and 5-8) (Cont.)

EL- RLY	Exciter Test Positions				Power Amplifier Positions				V- PLATE	PROBABLE CAUSE	
	FWD	RVS	APC	AMPL	MULTR	OSC	CUR	FWD			RVS
				FWR			+20				
	Low		High	High			High				Forward power buffer on rf control module. Replace module or forward power sensor (Note 2).

NOTES:

- (1) This condition is caused by fault in power amplifier buffer amplifier or forward power sensor, which falsely indicates that forward rf power is deficient, causing actual rf power to rise.
- (2) This condition is caused by fault in exciter rf control module forward power buffer, or in forward power sensor, which falsely indicates that forward rf power is deficient, causing actual rf power to rise.
- (3) High rf power faults described in table presuppose that an actual condition of excessive rf power is known to exist by some external means. Without such evidence actual forward power readings obtained on major test points are taken to indicate exact rf output power conditions (LPA FWD when in 50-watt mode, Exciter FWD when in 10-watt mode). For normal purpose these forward power indicators can be taken as reliable indications of actual rf power level. However, if APC, PWR, AMPL, +20 CUR, and V-PLATE test position readings show consistent tendency to be high, as shown above, check actual forward power with an rf power meter in transmitter rf output.

Table S-14. Modulation Weak, Distorted or None, Carrier Power OK, 10-Watt or 50-Watt Mode
(Transmitter OK per Tables S-6, S-7, and S-8)

GENERAL DESCRIPTION	Exciter Test Positions						PROBABLE CAUSE
	AF LVL-L	AF LVL-H	CPRSR	FLTR AMPL	MOD	% MOD	
Weak, or none	Low	Low	Low	Low	Low	Low	REMOTE-LOCAL switch, or Compression preamplifier module Note 1.
Weak, or none	OK	OK	Low	Low	Low	Low	Compression-Preamplifier module. Line amplifier (if used) not adjusted for proper output signal level.
Weak, or none	OK	OK	OK	Low	Low	Low	Filter amplifier module
Weak, or none	OK	OK	OK	OK	Low	Low	Modulator module % Mod potentiometer or buffer mod board
Excessive, distorted, on high level input audio; OK on low level inputs	OK	OK	High	High	OK	OK	Compression preamplifier module. Line amplifier (if used) improperly adjusted.
Distorted on modulation input signals at all levels	OK	OK	OK	OK	Low	Low	Rf control module (Note 2)
	OK	OK	OK	Low	Low	Low	Filter amplifier module
	OK	OK	Low	Low	Low	Low	Compression preamp module. Line amplifier (if used) improperly adjusted.

NOTES:

- (1) Only faults at LOCAL-REMOTE switch or immediately at input to compression preamplifier module are capable of indicating low AF monitor readings in both remote and local operating modes.
- (2) Certain unlikely effects are capable of occurring in rf control module resulting in normal rf carrier power together with inability to up-modulate, causing modulation distortion.
- (3) Do not attempt to diagnose apparent modulation problems unless rf power conditions are normal. If both rf carrier and modulation problems are apparent, first correct rf power condition. Apparent modulation problem may only be result of rf problem.
- (4) Ensure that operating mode switches are in condition assumed. For example, if LPA TUNE-OPERATE switch is in TUNE position, it will cause gross distortion of modulation, together with other effect which could be falsely diagnosed as fault in rf control module. Also exciter TUNE-OPERATE switch in TUNE position can cause modulation distortion.

Table 5-15. Power Supply Fault Analysis Exciter

TYPE OPERATION	REG B+	UNREG B+	AC ON LIGHT	BLOWN FUSE LIGHT	AC VOLTAGE AT FUSES	AC LINE VOLTAGE ON INPUT CABLE	BATTERY VOLTAGE	BATTERY TERMINAL VOLTAGE	PROBABLE CAUSE
AC Operation Only	Low	Low	On	Off	Low				Low AC line voltage
AC Operation Only	Low	Low	Off	Off	Low				Low AC line voltage
AC Operation Only	Zero	Zero	Off	On					AC line fuse (2)
AC Operation Only	Zero	Zero	off	Off	OK (1)				Power On-Off Switch
AC Operation Only	Zero	Zero	Off	Off	Zero	OK (3)			AC line filter
AC Operation Only	OK	OK					Low (5)		Power Supply (7)
Battery Operation Only	Zero	Zero					OK (4)		Power On-Off Switch
Battery Operation Only	Zero	Zero					Zero	OK (5)	DC line filter
Battery Operation Only	Low	Low					Low		Low battery voltage
AC and Battery	Low	Low			Low		Low		Both inputs low (7)
AC or Battery	Zero	OK							Short on Reg B+ distribution bus, in some module (6)

NOTES:

- (1) AC line voltage may be measured at the fuseholders with caps and fuses removed however if other equipments in the installation are served by the same AC line and the basic line voltage is known to be correct, a quick check for the presence of AC voltage may be made by removing one of the fuses and reinstalling the fuse cap. Its indicating light will illuminate if AC voltage is present and the other fuse is intact.
- (2) If a fuse is blown it is likely that the power supply module which was in use has an internal fault.
- (3) Measured on AC input cable disconnected from rear of chassis.

NOTES (Cont.)

- (4) Measured on battery input filter at inside rear of chassis.
- (5) Measured on battery terminals of main cable disconnected from rear of chassis.
- (6) With short on Reg B+ distribution line in some external module, power supply goes into "Overcurrent protection" mode and will remain there indefinitely until short is cleared and regulator is reset by turning power off for approximately 20 seconds, then turning power on. Disconnect modules, one at a time, with power off at least 20 seconds, until the short is cleared and Reg B+ returns to normal. Replace the indicated module.
- (7) The exciter normally supplies a nominal 300 ma trickle charge to a low battery. If a good, but discharged battery is not recharged a fault probably exists in the power supply.

Table 5-16. Analysis of Automatic Shutdown for Over Temperature Conditions in Exciter

STEP	PROCEDURE	OBSERVED RESULT	FURTHER DIAGNOSIS REQUIRED	PROBABLE CAUSE

Table 5-16. Analysis of Automatic Shutdown for Over Temperature Conditions in Exciter (Cont.)

STEP	PROCEDURE	OBSERVED RESULT	FURTHER DIAGNOSIS REQUIRED	PROBABLE CAUSE
2	Assuming external ambient air temperature is close to 70°F (25°C) feel top of exciter with hand	Very hot Moderately warm	None Proceed to step 3.	Insufficient ventilation in equipment rack; combined thermal output of exciter and power amplifier being stored inside the rack.
3	Feel left rear heat sink on exciter	Very hot Moderately warm	Proceed to step 4 None	Excessive current drawn through +20 regulator, probably by driver-power amplifier module. Incorrect set point on over-temperature protection. Replace thermal control module.
4	Check exciter FWD, RVS, APC and PWR AMPL test positions	Any abnormal	Proceed to table 5-9, 5-10, 5-11 or 5-12 as applicable	Excessive +20 current drawn by the Driver-Power Amplifier Module

Table 5-17. Power Amplifier Fault Analysis

POWER ON INDICATOR	HV INDICATOR	POWER FUSE INDICATOR	HV FUSE INDICATOR	V PLATE	CUR- PLATE	V- SCREEN	V- GRID	V- HTR	PROBABLE CAUSE
Off	Off	Off	0	0	0	0	0	0	Ac power failure exciter operating on battery, or power ON-OFF switch not ON.
Off	Off	On	Off	0	0	0	0	0	Blown POWER fuse
On	Off	Off	On	0	0	0	OK	OK	Blown HV fuse
ON	ON		Low or 0	Low or 0	Low or 0	Low or 0	OK	OK	High voltage power supply
On	On		Low	High	Normal or Low	Low or 0	Low or 0	OK	Control Grid Power Supply
On	On		OK	Low	Low or 0	Low or 0	OK	OK	Screen power supply section of high voltage power supply
On	On		OK	Low	OK	OK	OK	OK	Cavity amplifier - possibly tube.
On	Off		0	0	0	0	OK	OK	Wait for time delay relay. If still not working, check following: a. Top cover interlock b. Cavity plug-in secure c. Front panel HV ON-OFF switch to ON If still not working check a. OVER TEMP - If high, a cooling problem exists. b. FAN - If low, a blower or ac-ac converter problem exists. If above checks are ok, fault in ac control circuits in control grid power supply.

Table 5-18. Exciter Tuning Fault Diagnosis Table and Recommended Action For Further Fault Diagnosis

INDICATION	PROBABLE CAUSE AND RECOMMENDED ACTION
Oscillator output as observed on OSC test position of switch 1, will not peak when tuning OSC or BUF controls on oscillator unit.	Keying circuits not operational, continue diagnosis per table 5-11 or Bad crystal - replace crystal with another crystal, or insert signal on external input jack with crystal removed, or Faulty oscillator module - Replace module, making certain to remove crystal from faulty module and replacing in new module. Oscillator; oscillator-synthesizer
Multiplier will not tune or give adequate output indication (22 on meter). (Refer to table 5-2 for nominal readings.)	Possibly tuned to wrong harmonic - preset all frequency controls on multiplier to the desired output frequency, and repeak for maximum meter indication or Keying line to oscillator not operating - check KEYED +20 for keying indication or Faulty multiplier module. Replace module and tune new module per tuning procedure in Ch 3 or Output line from oscillator unit not properly connected to multiplier input.
Bandpass filter input will not tune properly on FLTR TUNE position of test switch.	Check for proper connections of input and output RF cables to filter or Make certain exciter TUNE-OPERATE switch is in the TUNE position or Filter may be tuned to an erroneous null. Look for another more pronounced null. - If no null can be found; observe +20 CUR metering position and see if input tuning capacitor will find a dip in current reading. or Multiplier module may be tuned to the wrong harmonics.
Bandpass filter output will not tune on APC position of test switch.	Improper tuning of the input capacitor on the bandpass filter. Retune the input to the most pronounced change in meter with test switch in FLTR TUNE position or APC drive level not high enough - Observe meter on APC position with filter untuned. Meter should read 20 minimum. If not, adjust carrier level adjust potentiometer on rf control for a reading of 20, then retune filter output for APC dip. When found, readjust CARRIER LEVEL pot for output meter reading of 40 on FWD position of test meter. or Replace filter module

5-22. **POWER SENSOR AND LOW PASS FILTER.** To remove the power sensor, unscrew the two connectors from the top of power sensor noting their marking. Remove coaxial cable from LOAD end of module. Remove coaxial cable from input of low pass filter. Remove four 8-32 Phillips head screws from front portion of mounting plate. Loosen the two 8-32 Phillips head screws at rear of the mounting plate. Lift the mounting plate and slide forward to remove. (Use caution when sliding forward or damage may be done to switch contacts.) The power sensor and the low pass filter are each attached to the mounting plate by four 6-32 pan head screws.

CAUTION

Cards are keyed to prevent complete insertion into wrong slot; do not force, check to see if card is in right location.

5-23. **PRINTED CIRCUIT CARDS.** To remove any of the printed circuit cards from the nest, grasp the top of the board at each side with a thumb and forefinger or circuit card puller and lift straight upwards. Replacement is the reverse of removal.

CAUTION

Electrostatic Sensitive Devices. Observe precautions for handling. Refer to page 5-1, paragraph 5-3.

5-24. **POWER SUPPLY.** To remove the power supply make sure the ac input connector at rear of chassis is disconnected. Remove two 10-32 Phillips head screws from tuner front rail, two 10-32 Phillips head screws from rear of power supply, and two 1/4 inch hex head screws from fiberglass cover. Remove leads from terminal board noting the strapping arrangement for replacement. The power supply may now be lifted from the chassis. Replacement is the reverse of removal.

CAUTION

Before replacing the power supply brush on a thin coating of Thermal Joint Compound (TTT part no. 502371-1) to all surfaces of the module that contact the chassis. This is necessary to provide maximum thermal conduction from the module to the chassis.

5-25. POWER AMPLIFIER.

NOTE

Procedures outlined in operations chapter 3, paragraph 3-12, power amplifier tuning procedures, must be observed when working on the power amplifier.

5-26. **TOP COVER.** To remove the top cover loosen the four 6-32 flat head Phillips head captive screws. Replacement is the reverse of removal.

NOTE

Make certain all four screws are tightened to assure positive RFI shielding effectiveness.

5-27. **POWER SUPPLY CONTROL GRID/THERMAL CONTROL/AC CONTROL.** Before attempting to remove this module make sure that the exciter AC POWER ON-OFF switch is OFF and that the power amplifier POWER ON-OFF switch is OFF. Loosen four 8-32 Phillips head captive screws at top of module. Using a long shank Phillips screwdriver loosen the single 8-32 Phillips head captive screw at bottom right center of module. Remove P1 from J4 and remove cable clamp. Lift out module. Replacement is the reverse of removal. (Potentiometer R15 must be turned fully clockwise.)

5-28. **BUFFER AMPLIFIER/MULTIPLIER, ELECTRICAL INSTRUMENT.** Before attempting to remove this module the power supply control grid/thermal control/ac control module must be removed as detailed in paragraph 5-27. Remove knob from TEST meter function switch using an Allen wrench to loosen the two 4-40 set screws. Observe indexing of knob to shaft for reassembly in the same position. Remove lock nut from switch shaft using a 17/32 inch open end wrench, allowing switch to be removed. Remove five 6-32 Phillips head screws holding printed circuit card to front panel. Remove P1 from J6. Lift out module and meter function switch. Replacement is the reverse of removal.

5-29. **BLOWER.** Remove ac connector from rear of chassis. Loosen the four 8-32 Phillips head captive screws holding blower bracket. Remove P1 on blower from J1 on converter, ac to ac. Tilt and lift assembly upwards to remove.

5-30. HIGH VOLTAGE POWER SUPPLY.

CAUTION

Before attempting any removal procedures on the high voltage power supply make sure the ac input connector at rear of chassis is disconnected.

WARNING

To gain access to the high voltage power supply, carefully lift off high voltage cover. Do not let fingers get under cover during removal. Follow instructions printed on top of the high voltage safety switch. This will ensure the discharging of high voltage capacitor C1.

Loosen six 8-32 Phillips head captive screws from left outer side of chassis. Loosen three 10-32 Phillips head captive screws from center rail. Remove P1 from J5 using flat blade

screwdriver. Loosen screws together to avoid bind. Remove wire from capacitor C1A. Lift module up using front and rear rails. Replacement is the reverse of removal.

5-31. TUNED CAVITY. Prior to removal make sure ac power switch is off on power amplifier. To remove the tuned cavity loosen the four 8-32 Phillips head captive screws at the front panel and pull the cavity straight out. Replacement is the reverse of removal.

NOTE

To prevent tube damage, R-15 on the 2A3 Power Supply must be turned fully clockwise.

5-32. TUNED CAVITY VACUUM TUBE. To remove the tuned cavity vacuum tube, proceed as follows:

- a. Remove tuned cavity from chassis (paragraph 5-31).
- b. Loosen four captive screwdriver head screws at corners of air duct housing at rear right side of cavity and lift off housing.
- c. Lift off plastic ring noting recess in ring fitting over tube.
- d. Remove tube by lifting straight up.

NOTE

It may be necessary to assist tube out of socket by pushing against ring at base of tube using a screwdriver through bottom of socket.

- e. Replacement is the reverse of removal.
- f. The following steps should be taken to properly install air duct P/N 8004679-1:
 1. Place the air duct, P/N 8004679-1 over the tube cooling fins, taking care to properly seat the lower lip on the air duct inside the plate contact ring.
 2. Carefully place the air duct housing, P/N 8004753-1, in place and tighten the four screws in a clockwise pattern. Tighten each screw only 1/2 turn at a time to assure the air duct housing does not distort the air duct.
 3. Insert a small mirror through the opening in the air duct housing and inspect the air duct for proper alignment.

CAUTION

After replacing the vacuum tube, care should be exercised when replacing the white teflon air duct (Part No. 8004679-1 or -3) around the tube for proper seating. This is necessary to prevent all air leakage and thereby insure proper cooling of the vacuum tube.

5-33. CHASSIS MAINTENANCE.

5-34. EXCITER CHASSIS. The following chassis components are replaceable at field level in accordance with the following instructions:

Switch, Coaxial.

APC drive transistor.

Audio input transformer.

CARRIER LEVEL potentiometer.

MOD LEVEL potentiometer.

TUNE-OPR switch.

All front panel switches, indicators, and jacks.

CAUTION

Before proceeding with any of the following maintenance procedures make sure primary power is disconnected from chassis.

5-35. SWITCH, COAXIAL. The coaxial switch is mounted on the rear apron of the chassis on the right hand side. It is removed by removing the upper and lower hex nuts on the threaded output connectors on back of chassis. Carefully unsolder + (green) and - (blue) leads.

5-36. APC DRIVE TRANSISTOR Q1. The apc drive transistor is located on a U shaped bracket mounted on the right side wall at the front of the chassis adjacent to the rear of the front panel meter. The U bracket must be removed from the chassis to replace transistor Q1. Remove the three meter mounting screws from the front panel releasing meter. Pull meter out from front panel. This allows access to both Phillips head screws holding U shaped bracket. Remove Phillips head transistor retaining screws releasing transistor. Observe placement of insulator bushings, insulator plate and color coding of leads.

5-37. AUDIO INPUT TRANSFORMER. The audio input transformer is mounted on the chassis bottom at the left front directly behind the LOCAL MICROPHONE input jacks. It is removed by removing the high voltage safety cover and printed circuit boards XA1 and XA2 then removing the Phillips head screws and hex nuts at each end of the transformer. Observe color coding of leads.

5-38. CARRIER LEVEL AND MOD LEVEL POTENTIOMETERS. These two potentiometers are located behind the front panel access door on the left side. It is necessary to remove the oscillator and doubler/quadrupler modules to gain access to these items. Remove shaft lock nut then remove hex nut holding potentiometer to its panel. Observe color coding of leads.

5-39. **TUNE-OPR SWITCH.** This switch is located to the right of the CARRIER LEVEL and MOD LEVEL potentiometers and on the same panel. It is necessary to remove the oscillator and doubler/quadrupler modules to gain access to the switch. Remove hex nut holding switch to panel. Observe color coding of leads.

5-40. **FRONT PANEL SWITCHES, INDICATORS, AND JACKS.** These items are all standard hardware and normally accepted removal and replacement procedures apply.

CAUTION

The indicator knobs on TEST meter switches 1 and 2 each have two setscrews holding the knob to the switch shaft. Make sure when replacing either knob that the same setscrew is on the flat of the shaft as when it was removed. There is no end-of-travel stop on the switches. Seating the wrong setscrew on the shaft will cause an incorrect pointer indication.

5-41. **POWER AMPLIFIER CHASSIS.** Only the front panel switches and indicators are recommended as being replaceable at field level. These items are all standard hardware and normally accepted removal and replacement procedures apply.

5-42. ALIGNMENT

5-43. After installation of any one of the following modules in either the exciter or power amplifier perform the applicable alignment procedure.

- a. Audio Amplifier Compressor (A1) (Exciter)
- b. Filter Amplifier/Detector (A4) (Exciter)
- c. Buffer Modulator (A5) (Exciter)
- d. Control RF/Modulator (A6) (Exciter)
- e. Control Thermal/Detector Modulation Percentage/Coaxial/Relay Control/Keyer Inhibit (A7) (Exciter)
- f. Power Supply Regulator (PS1A2) (Exciter)
- g. Buffer Amplifier/Multiplier, Electrical Instrument (A5) (Power Amplifier)

5-44. All other modules in the exciter and power amplifier are prealigned at the factory. If it is necessary to replace any of the following modules, perform the tuning procedures defined in paragraphs 3-9, 3-10, or 3-12 as applicable.

- a. Crystal Oscillator (A8) (Exciter)
- b. Doubler or Quadrupler (A9) (Exciter)
- c. Tunable Filter (F1,2) (Exciter)

d. Power Supply, Control Gird/Thermal Control (A3) (Power Amplifier).

5-45. **POWER SUPPLY REGULATOR.** (Schematic Diagram, Figure 6-33) PS1A1 and PS1A2.

a. Before inserting the printed card ensure that the exciter power is off and in the unkeyed condition. Turn exciter power on.

b. Place SWITCH 1 on the exciter front panel in the SWITCH 2 ENABLE position.

c. Place SWITCH 2 in the RGLTD +20 position.

d. Deleted.

e. Connect digital voltmeter to TP1 on printed circuit card. Adjust R25 on the printed circuit card for a meter reading of 19.5 ± 0.10 VDC on the digital voltmeter. Verify that front panel meter is between 17.5 to 21.5.

f. This completes the alignment.

5-46. **AMPLIFIER COMPRESSOR** (Schematic Diagram, Figure 6-22) A1.

a. Place REMOTE-LOCAL switch to LOCAL. Place PUSH TO TALK-CARRIER TEST switch to PUSH TO TALK. Insert the printed circuit card into the exciter chassis.

b. Connect an audio input to the remote input lines at a frequency of 1000 hz, and at a signal level of 0 dBm (0.775 volt rms) or -27 dBm (0.034 Vrms) for low level option.

c. Place REMOTE-LOCAL switch to REMOTE.

d. Connect oscilloscope on ac position to TP1.

e. Adjust R41 for 1.8 volts peak-to-peak output.

f. This completes the alignment.

5-47. **LINE AMPLIFIER.** (Schematic Diagram, Figure 6-23)

a. Place REMOTE-LOCAL switch to REMOTE. Place PUSH TO TALK-CARRIER TEST switch to PUSH TO TALK. Insert the printed circuit card into the exciter chassis.

b. Connect an audio input to the remote input lines at a frequency of 1000 hz, and at a signal level from -15 to +10 dBm (.137 volts to 2.45 volts rms at 600 ohms)

c. Connect ac voltmeter or oscilloscope to TP3 on line amplifier (A1 module).

d. Adjust R10 for 0.636 volts rms or 1.8 volts peak to peak.

e. This completes the alignment.

5-48. FILTER AMPLIFIER/DETECTOR (Schematic Diagram, Figure 6-24) A4.

- a. Insert the printed circuit card into the exciter chassis.
- b. Turn off any audio input to the exciter.
- c. On the front panel of the exciter, place SWITCH 1 in the SWITCH 2 ENABLE position and SWITCH 2 in the AF LVL-L position.
- d. Adjust R41 on the printed circuit card for a zero reading on the front panel meter.
- e. This completes the alignment.

NOTE

Do not connect an audio signal of zero DB to remove input lines with SWITCH in the SWITCH 2 ENABLE position and SWITCH 2 in the AF LVL position. Failure to change one of these switch settings will cause the meter to peg upon the required input.

5-49. BUFFER MODULATOR (Schematic Diagram, Figure 6-25) A5.

- a. Insert the printed circuit card in the exciter chassis.
- b. Connect an audio input to the remote input lines at a frequency of 1000 hz, and at a signal level of 0 dBm (0.775 volt rms) or -27 dBm (0.034 Vrms) for low level option.
- c. Place Remote-Local switch to Remote.
- d. Connect an oscilloscope to TP1.
- e. Adjust R14 until a flat characteristic appears on the top and bottom of the audio waveforms; back off R14 until the flattening just disappears.
- f. This completes the alignment. Remove the audio input source for the following procedure.

5-50. CONTROL RF/MODULATOR (Schematic Diagram, Figure 6-26) A6.

- a. Place TUNE-OPERATE switch on the power amplifier to the OPERATE position.
- b. Before inserting printed circuit card, unkey the transmitter, and turn the Carrier Level potentiometer R19 (on printed circuit card) full counterclockwise.
- c. Connect external wattmeter and dummy load in antenna output line.

d. On the exciter front panel, adjust the CARRIER LEVEL potentiometer, R8 to mid range.

e. On the exciter front panel set SWITCH 2 to APC position.

f. Insert printed circuit card into system observing the test meter on the exciter front panel. Meter should not indicate reading upon insertion of card. If the meter does indicate reading, remove the card quickly as some damage may occur to the power transistor in the driver/power amplifier. Some problem exists in the control rf/modulator printed circuit card just inserted.

g. If meter does not indicate reading set exciter SWITCH 1 to FWD positions, and adjust R5 on printed circuit card for a zero meter reading. (Make sure power amplifier TUNE-OPERATE switch is in the OPERATE position while making this adjustment).

h. Set exciter SWITCH 1 to RVS position, and adjust R8 on printed circuit card for a zero meter reading.

i. Set exciter SWITCH 1 to FWD position.

j. Key transmitter on.

k. Adjust Carrier Level potentiometer R19 on printed circuit card for a reading of 40 on exciter TEST meter (FWD).

l. Adjust potentiometer R39 for a 10-watt reading on external wattmeter. Prior to making any adjustments of the control make positively sure the rf power measuring meter is accurately calibrated for frequency under test.

m. Readjust R19 for a reading of 40 on exciter test meter (FWD).

n. Readjust R39 for a 10-watt reading on external wattmeter.

o. Continue steps g through l, until an exciter meter reading of 40 and an external watt meter reading of 10 watts is achieved.

p. This completes alignment.

q. Place PUSH TO TALK-CARRIER TEST switch to PUSH TO TALK

5-51. CONTROL THERMAL/DETECTOR MODULATION PERCENTAGE/COAXIAL RELAY CONTROL/KEYER INHIBIT (Schematic Diagram, Figure 6-29) A7.

NOTE

The two adjustment potentiometers on this printed circuit card are associated with the percent modulation detection circuit. If it was previously known that no difficulty existed in this particular circuit with the printed circuit card being reinserted, no adjustment will probably be necessary. However, if a new card or a card with changed components in the percent modulation circuit is to be inserted, it will be necessary to realign these controls.

a. Set up test equipment per figure 5-9, for remote modulation. For high level strapping use 1 KHz audio tone at 0 dbm, (low level 1 KHz audio tone at -27 dbm). Set signal generator 2 MHz above or below operating frequency at 0 dbm.

b. Modulate exciter by placing PUSH TO TALK/CARRIER TEST SWITCH to PUSH TO TALK and REMOTE/LOCAL SWITCH to REMOTE. Verify pin G and H on A3 cord are grounded. Exciter should key.

c. Place exciter front panel SWITCH 1 to SWITCH 2
■ ENABLE and SWITCH 2 to % MOD.

NOTE

With SWITCH 1 in SWITCH 2 ENABLE do not place SWITCH 2 to % MOD unless exciter is modulated. Failure to do this will cause meter to peg negative possibly damaging meter.

d. Using para 5-52, adjust R1 on exciter front panel for 80% modulation. Adjust R27 for meter reading of 20. (Refer to Figure 5-5 for percentage of modulation versus FRONT PANEL METER reading.)

e. Change exciter modulation to 90% by readjusting R1 on front panel. Adjust R25 on printed circuit card A7 for a meter reading of 30.

f. Continue rocking back and forth between 80% (20) and 90% (30) using steps D and E until no further adjustments on A7 card are necessary, as a considerable amount of interaction exists between the two potentiometers.

NOTE

Final Adjustment will be made at 90% with meter reading at 30.

g. This completes the alignment.

5-52. The modulation percentage can be determined in the following manner. Connect equipment per figure 5-9. Key exciter and adjust 874 GAL Attenuator for a modulated envelope presentation on the oscilloscope. Adjust Mod Level Potentiometer R1 on the exciter front panel for a modulated envelope on the oscilloscope whose valves, when substituted in the formula:

$$\frac{E_{\text{Max}} - E_{\text{Min}}}{E_{\text{Max}} + E_{\text{Min}}} \times 100$$

Equals 80% modulation. Readjust R1 for a modulation envelope to 90% per the above formula.

5-53. BUFFER AMPLIFIER/MULTIPLIER, ELECTRICAL INSTRUMENT. (Schematic Diagram, Figure 6-42) A5.

a. Before turning on ac to power amplifier to be sure that the system is unkeyed and the TUNE-OPERATE switch is in the OPERATE position.

b. Remove top cover of power amplifier and disable the HV interlock.

c. Place power amplifier HV ON-OFF switch to ON.

d. On the power, amplifier, place TEST SWITCH to the FWD position.

e. Adjust R7 on the buffer amplifier/multiplier electrical instrument circuit card (A5) for 0 ± 1 reading on the meter.

f. On the power amplifier, place TEST SWITCH to the RVS position.

g. Adjust R9 on the buffer amplifier/multiplier electrical instrument circuit card (A5) for 0 ± 1 reading on the meter.

h. On the exciter, place TEST SWITCH 1 to the FWD position.

i. On the power amplifier, place the TUNE-OPERATE switch to the TUNE position. Observe that the power amplifier RVS meter reading pegs below zero. Adjust the artificial forward power/adjustment control, R2, on the buffer amplifier/multiplier electrical instrument circuit card (A5) for an exciter FWD meter reading of 30 ± 1 .

NOTE

Do not leave the power amplifier TEST SWITCH IN THE RVS position for an extended period of time as this causes the meter to peg negative.

j. On the power amplifier, place the TUNE-OPERATE switch to the OPERATE Position.

k. On the power amplifier, place the TEST SWITCH to the FWD position.

l. Key the exciter.

m. Adjust R26 on the buffer amplifier/multiplier electrical instrument circuit card (A5) for 50 watts on the external wattmeter.

n. Adjust R22 on the buffer amplifier/multiplier electrical instrument circuit card (A5) for 40 on the power amplifier front panel TEST Meter.

o. Repeat steps m. and n. until 50 watts is obtained on the external wattmeter and 40 is indicated on the power amplifier front panel TEST Meter.

p. Unkey the exciter, place the power amplifier HV ON-OFF switch to OFF and replace the power amplifier top cover.

q. This completes the A5 alignment.

5-54. OSCILLATOR SYNTHESIZER. The only adjustment which may be required in the reference oscillator. The adjustment is necessary when the frequency is not within $\pm 0.0005\%$ of the desired frequency. This module is a self-contained and sealed unit located below the phase comparator board. A frequency trimming capacitor is accessible through the sealed case by removal of a sealed screw cover. This is located directly behind the snap-out hole plug which is on the left front of the synthesizer. Turn power off with the front

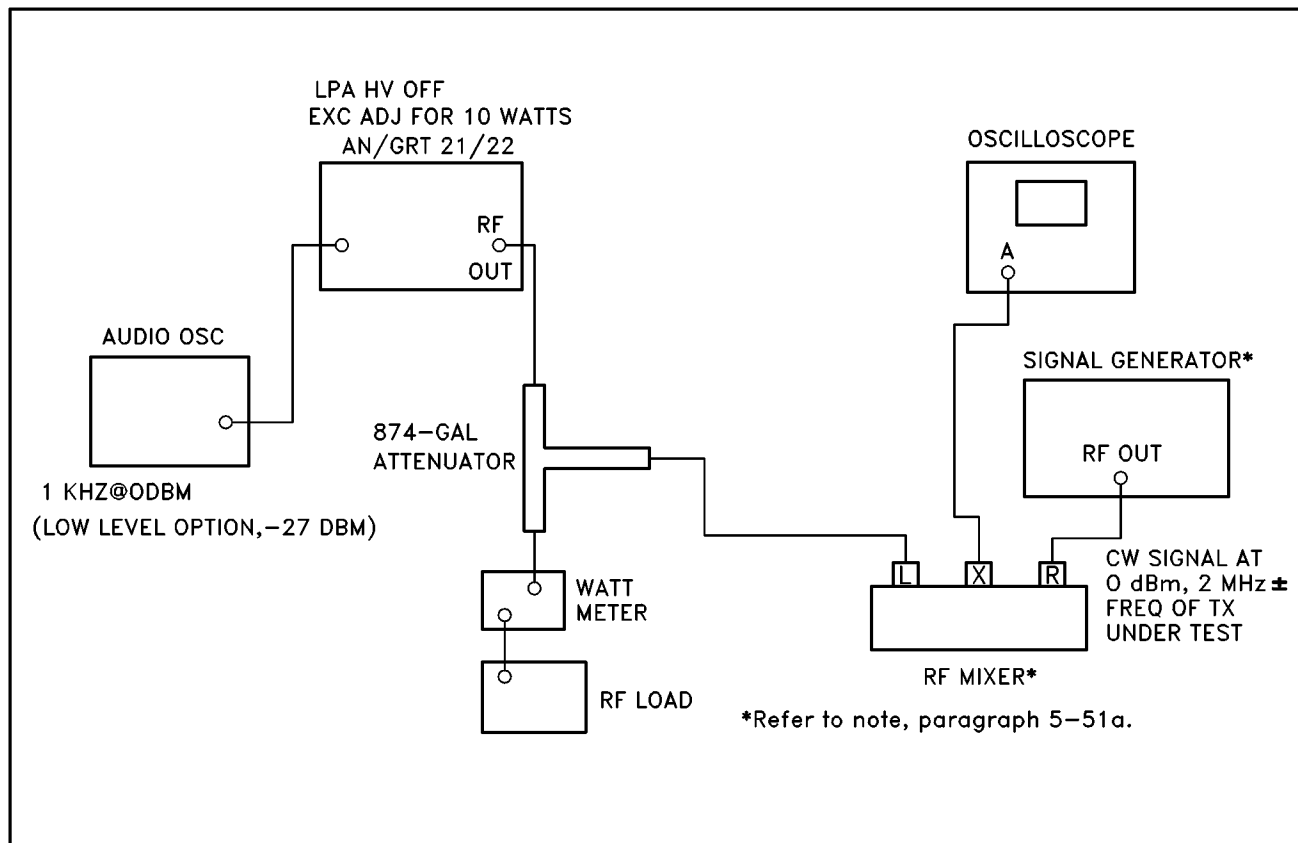
panel switch. Remove exciter top cover. Disconnect oscillator synthesizer output connector at P2, connect frequency counter to P2 using a sub-miniature RF connector adapter P/N 50-075-6801. Then open the front panel door of the parent equipment. Snap out the hole plug on the left front of the DIGI CHANNEL. Use a standard screw, launcher type (split blade) screwdriver to remove the screw cover. With the unit near room ambient temperature, reapply power and wait at least 10 minutes before adjusting. Key the transmitter to get an output from the oscillator synthesizer if necessary. Using a small tuning tool or small blade screwdriver, adjust the trimming capacitor for the actual frequency.

NOTE

Be sure to refer to page 3-12, paragraph 3-10 for actual frequency vs dialed frequency. Notice that a small portion of a turn may shift the frequency sufficiently. When adjustment is complete, remove power and reinstall the screw cover and then the hole plug. Reconnect the oscillator synthesizer for normal operation.

5-55. After connecting a HP5305B frequency counter (or equivalent) (using subminiature RF connector adapter P/N 50-075-6801), between the output and ground, determine if the output is adequate to trigger the counter. If the counter is not triggered properly, the following troubleshooting procedures should be followed:

1. Check the voltage inputs to the oscillator synthesizer using a voltmeter.
2. Connect an oscilloscope to P2 and check for approximately 5V P-P sine wave signal



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Figure 5-9. Test Set Up for Percent of Modulation.

5-56. SPECIAL MAINTENANCE INSTRUCTIONS

5-57. SYNTHESIZER SWITCHING REGULATOR.

Voltage regulator U1 in the synthesizer switching regulator (A8A5) is no longer manufactured in the 14-pin dual-inline package (dip). The circuit cards installed in synthesizers with serial numbers 24052 and higher have two places to install U1. U1 may be replaced with either the 14-pin dip or with the 8-pin TO-5 or TO-99 package that are electrically equivalent. Use one or the other, do not install both on the same circuit card. On earlier circuit cards, the 8-pin TO-5 or TO-99 package can be used to replace the 14-pin dip if it is installed as shown in figure 5-10.

5-58. The frequency determination formula decal located on the oscillator synthesizer module contains erroneous information, while performing routine inspections/maintenance, remove this decal. Refer to paragraph 3-10, page 3-12 for the correct procedure to determine the proper frequency.

5-59. INSTALLATION INSTRUCTIONS FOR A SOLIDSTATE VANE SWITCH IN THE AM-6154/GRT-21 OR AM-6155/GRT-22 AMPLIFIERS. (Use of the SSVS is optional).

a. Turn off power and remove ac power cords to the LPA and exciter assemblies.

b. Remove the cover assembly to the LPA (four screws).

c. Remove the following subassemblies:

(1) Ac to ac converter, A2 module (8004930G1).

(2) Power supply, control grid/thermal control ac, A3 module (8004236G1).

(3) Blower assembly, B1 module (8004959G1).

d. Modify the blower assembly, B1:

(1) Remove the two flange screws on the inlet port of fan.

(2) With the same two screws, mount the SSVS (8009571G1) to the inlet port of the fan. Reinstall the blower assembly.

NOTE

The SSVS is properly mounted when the component side of the board faces away from the exit port of the blower assembly as shown in Figure 11.

(3) Terminate the three wires from the SSVS to the fan assembly plug, P1, as follows. (See Figure 12)

Blue to P1-7

Red to P1-8

Black to P1-9

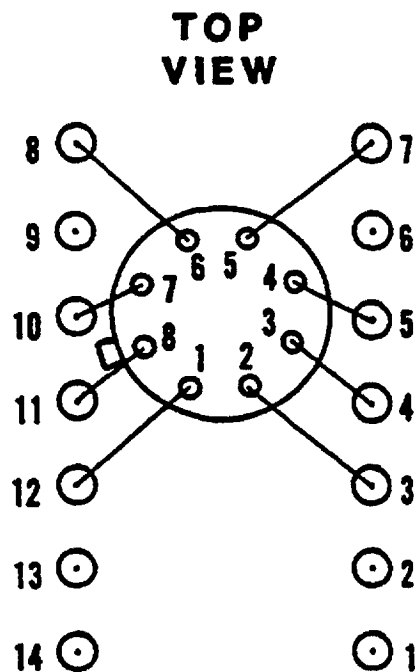
(4) Visually examine the SSVS to ascertain that thermistor RT2 on SSVS pc board is properly orientated as shown in Figure 13. This completes the blower assembly portion of the modification.

e. Modify the ac to ac converter, A2:

(1) Using 9 1/2-inch wire group (female and male connector on each wire) connect A2 jack J1 to A2 plug P1 as shown below and in Figure 12.

Wire	A2 Jack J1	A2 Plug P1
Blue	Female to pin 7	Male to pin 5
Red	Female to pin 8	Male to pin 4
Black	Female to pin 9	Male to pin 6

(2) This completes the modification to the ac to ac converter.



F9124697

Figure 5-10. Installation Drawing for A8A5U1 (Early Configuration)

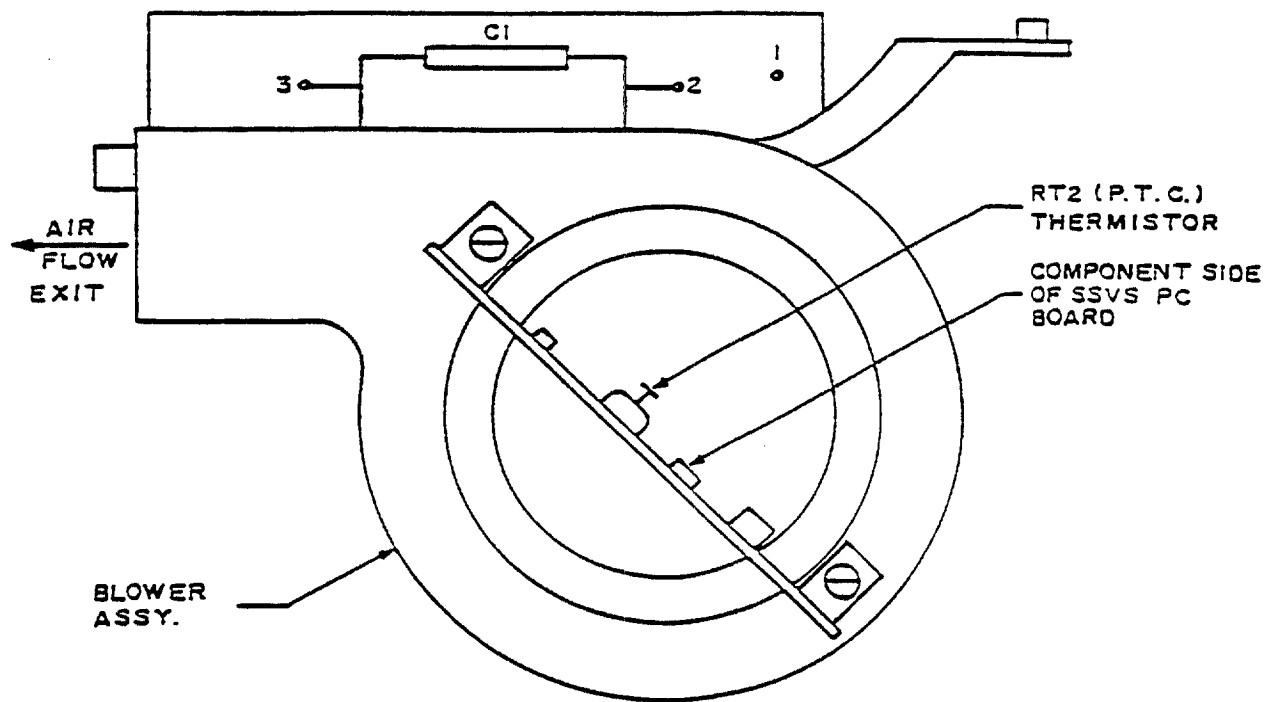


Figure 5-11. SSVS Printed-Circuit Board Mounting

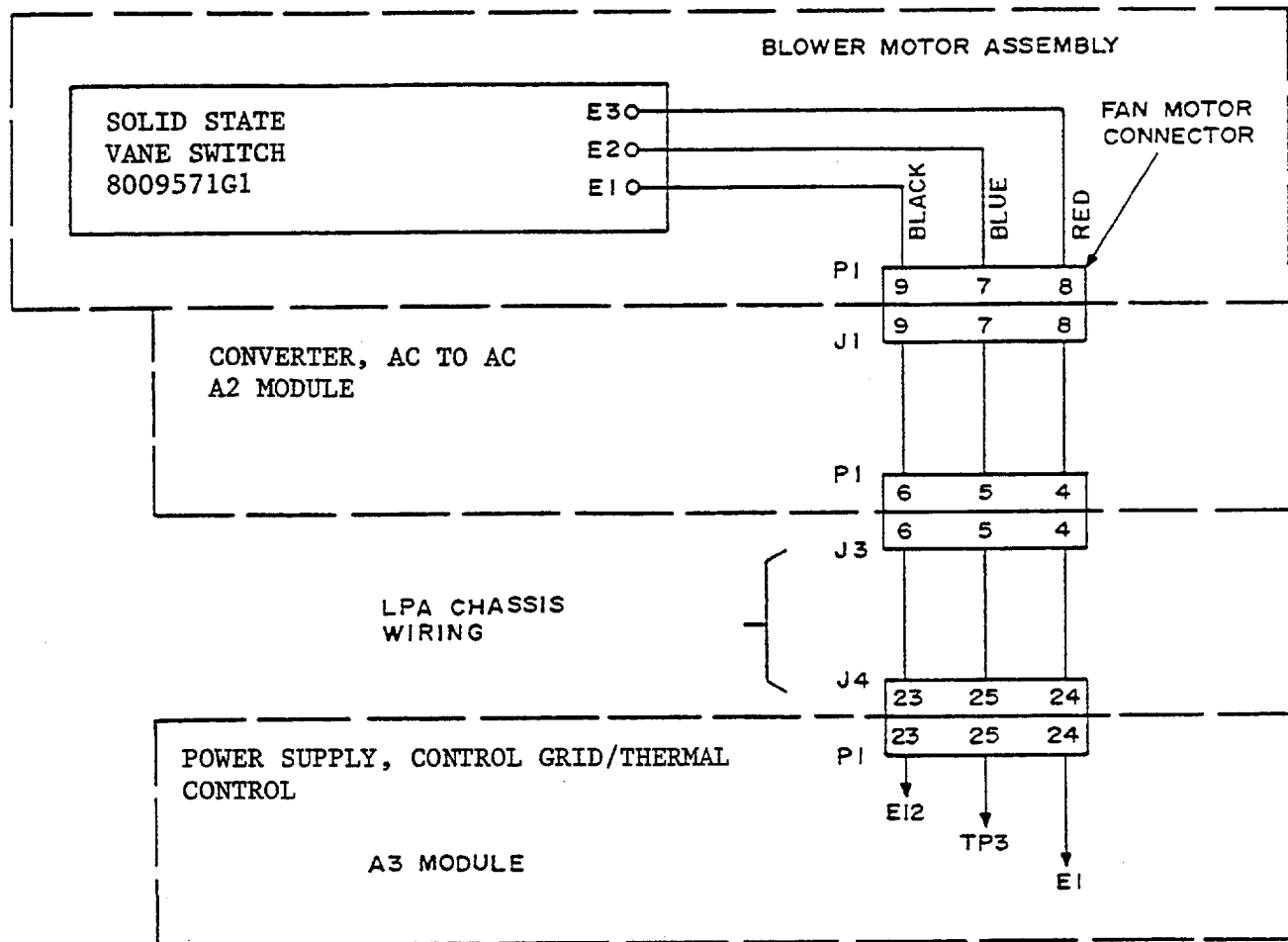


Figure 5-12. SSVS Inter-Module, Inter-Chassis Wiring

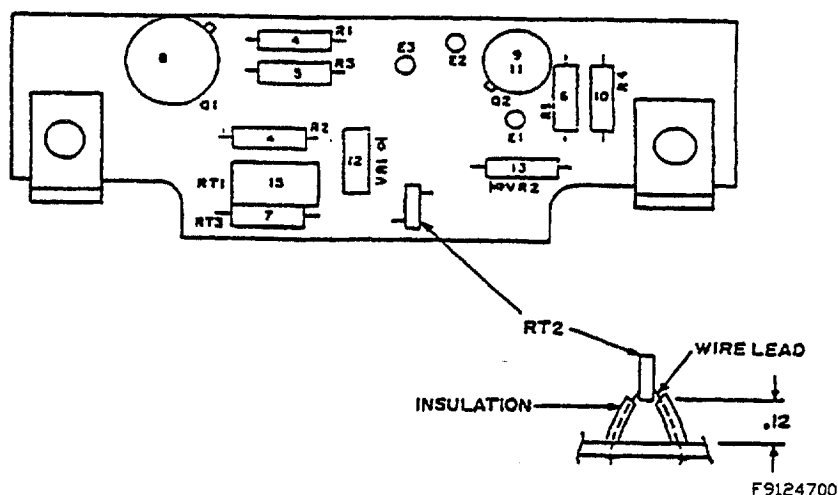


Figure 5-13. Proper Orientation of RT2

f. Modify power supply, control grid/thermal control, A3:

(1) Select the 14-inch wire group (male connector and stripped end), and connect between A3 plug P1 and the indicated A3 locations as shown below. Solder terminal locations on A3. (See Figure 12)

Wire	A3 Plug P1	A3 Terminals
Blue	Pin 25	TP3
Red	Pin 24	E1
Black	Pin 23	E12

(2) This completes the modification of the power supply, control grid/thermal control.

g. Modify the LPA chassis:

(1) Select the 8-inch wire group (female connector on both ends), and connect between LPA chassis jacks J3 and J4 as shown below. It may be necessary to detach chassis connectors from the LPA to insert contacts. (See Figure 12)

Wire	Chassis Jack J3	Chassis Jack J4
Blue	Pin 5	Pin 25
Red	Pin 4	Pin 24
Black	Pin 6	Pin 23

(2) This completes the modification of the LPA chassis.

h. Reinstall the modified modules A2 and A3 into the LPA chassis. Check for continuity between these points: (See Figure 12)

- (1) E3 of SSVS and E1 of A3 module.
- (2) E2 of SSVS and TP3 of A3 module.
- (3) E1 of SSVS and E12 of A3 module

i. Replace cover on LPA.

5-60. Solid state vane switch (SSVS) operation check AM-6154/GRT-21, AM-6155/GRT-22 amplifiers.

CAUTION

The LPA high voltage is not required and should remain off during test.

a. Turn off LPA high voltage. Turn on exciter and LPA power.

b. Place the LPA test switch on the "over-temp" position. Verify that the meter reading is 0-3.

c. Turn LPA power off. Verify that the meter immediately rise to mid-scale. If there is a 3-5 second delay for mid-scale indication, there is a malfunction in the blower sensing circuitry (LPA-A3Q1).

d. Wait for 15-30 seconds to allow the SSVS to enter OVER-TEMP condition. The point in time at which this happens can be seen by an extremely slight increase in the meter reading (approximately the width of the meter needle).

e. Turn the LPA power on. Verify that after 3-5 seconds, the meter returns to 0.

f. If the meter falls immediately to 0 after step "e", either the SSVS did not have enough time to enter OVER-TEMP condition (try a longer wait), or the SSVS and/or LPA-A3 Q3 has failed.

g. If the meter does not rise to mid-scale after LPA power has been turned off or falls to 0 immediately after the power is restored, this test has failed.

NOTE

The 3-5 second delay after LPA power has been restored O's the key to this test. If the 15-30 second wait is not used, the SSVS will not have sufficient time to go into OVER-TEMP condition. The delay in returning to 0 indicates that all thermal control components from LPA-A3 K1 to the SSVS are working properly.

Table 5-20. Performance Test of VHF and UHF Transmitter

STEP	TEST EQUIPMENT	POINT OF TEST	OPERATION OF EQUIPMENT	PERFORMANCE STANDARD
1 EXCITER			Place LOCAL-REMOTE switch to LOCAL. Place PUSH TO TALK CARRIER TEST switch to PUSH TO TALK. Place AC POWER ON-OFF switch to ON.	
			NOTE Ensure that power amplifier, if connected, is off and TUNE-OPERATE switch is in OPERATE position.	
2	NOTE With 0-1701/GR electrical synthesizer installed oven position on switch 1 should read 0 (zero) at all times.		Place SWITCH 1 to the following positions and observe performance standard for normal unkeyed indications. OVEN APC FWD RVS E-L RLY	Test meter indications: $\left\{ \begin{array}{l} 0 \text{ to } 10 \text{ (after approximately 15 minutes warmup)} \\ 0 \\ \leq 3 \\ \leq 3 \end{array} \right.$ 0 to 2 (Exciter Only) 15 to 40 (Power Amplifier) Connected but not operating). NOTE: With oscillator synthesizer installed the oven position on SWITCH 1 will indicate 0 (zero). 20 to 40 17.5 to 21.5 0 to 3
3	Connect dummy load (50 ohms) or antenna, if not already connected.		Place SWITCH 1 to "SWITCH 2 Enable" and proceed using SWITCH 2. UNRGLTD RGLTD +20 KEYED +20	

Table 5-20. Performance Test of VHF and UHF Transmitter (Cont.)

STEP	TEST EQUIPMENT	POINT OF TEST	OPERATION OF EQUIPMENT	PERFORMANCE STANDARD
4	Connect to K1J1, if power amplifier is connected to exciter.		Power amplifier shall be Off.	
	Connect to K1J3 if power amplifier is not connected.		Key transmitter in CW mode by setting PUSH TO TALK-CARRIER TEST switch to CARRIER TEST Place SWITCH 1 to the following positions and observe performance standard for normal keyed indications.	Test meter indications: 5 to 45 (See Note) 10 to 45 20 to 40 5 to 32 0 to 10 (LOW VSWR antenna) 40 to 45 (Indicates 10 watt CW) 15 to 40 (If power amplifier connected but not operating).
5	MULTR 20 to 24 (VHF with G2 Oscillator) 15 to 24 (VHF with G3 Oscillator) 15 to 24 (UHF with G2 Oscillator) 5 to 24 (UHF with G3 Oscillator) 15 to 24 (Oscillator Synthesizer) With 0-1701/GR electrical synthesizer installed, over position on SWITCH 1 should read ZERO (0) at all times.		OSC MULTR PWR AMPL T/R RLY APC RVS FWD E-L RLY	

5 MODULATION

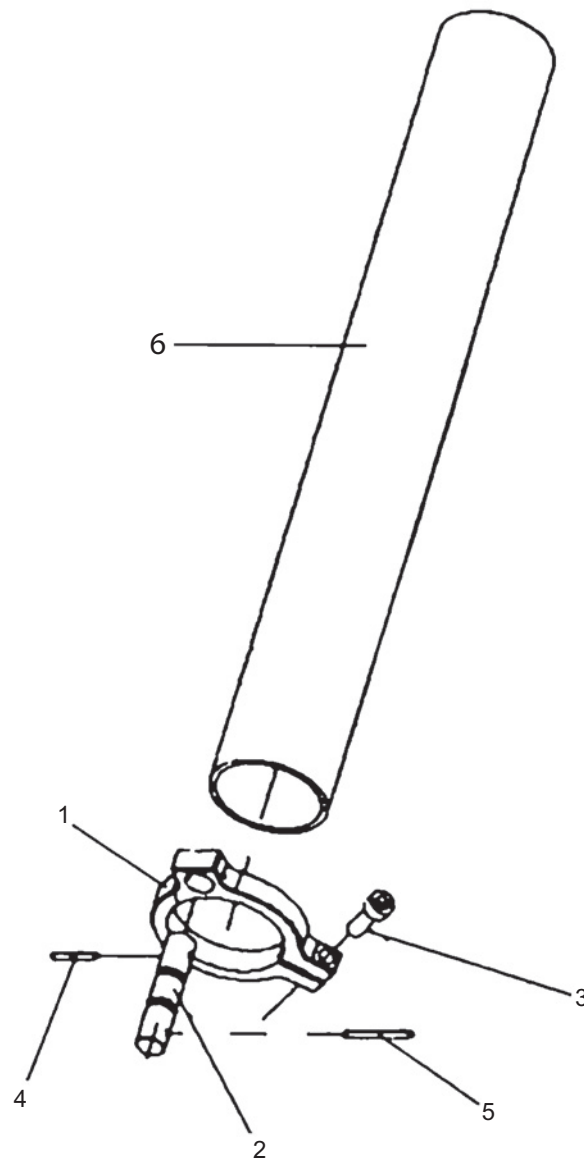
Place PUSH TO TALK -CARRIER TEST switch to PUSH TO TALK.
Connect 1000 hz audio input on remote input lines at 0 dbm signal level (-13 dbm low level option) signal level.
Key exciter from remote input.

Table 5-20. Performance Test of VHF and UHF Transmitter (Cont.)

STEP	TEST EQUIPMENT	POINT OF TEST	OPERATION OF EQUIPMENT	PERFORMANCE STANDARD
6 POWER AMPLIFIER			Place SWITCH 2 to the following positions and observe per performance standard for normal keyed and modulated indications.	TEST meter indications: (All indications in step 4.)
			AF LVL-H 3 MOD	16-20 (0 dBm) See figure 5-6. 28-32 (90% mod)
			Unkey exciter Off. Place exciter REMOTE - LOCAL exciter to LOCAL. Place exciter PUSH TO TALK - CARRIER TEST switch to PUSH TO TALK. Place power amplifier POWER ON-OFF switch to ON. Place TUNE - OPERATE switch to OPERATE. Wait 1 minute for time delay relay. Place power amplifier HV ON-OFF switch to ON.	Note AF LVL meter readings obtained in low level strapping option are for reference use only and will not correlate with figure 5-6.
7			Place power amplifier TEST selector switch to the following positions and observe performance standard for normal conditions before keying exciter.	High voltage comes on. HV indicator lamp illuminates.
			FWD RVS EXCTR V-GRID V-SCREEN V-PLATE KEY	Power Amplifier TEST meter indications: ≤ 3 ≤ 3 17 to 24 30 to 50 33 to 45 18 to 28 0

Table 5-20. Performance Test of VHF and UHF Transmitter (Cont.)

STEP	TEST EQUIPMENT	POINT OF TEST	OPERATION OF EQUIPMENT	PERFORMANCE STANDARD
8			Key exciter ON by either placing PUSH TO TALK-CARRIER TEST switch to CARRIER TEST or by keying from the remote line. Place power amplifier TEST selector switch to the following positions and observe performance standard for normal power amplifier keyed conditions. FWD RVS KEY CUR-PLATE	Power Amplifier Test meter indications: 40 to 45 0 to 10 (Low VSWR antenna) 17 to 24 10 to 20 (Refer to section 3 tuning procedure.)



INDEX	NOUN	QTY	P/N
1	MOUNTING BRACKET	1	0-2217-134-D503
2	ROD. FREQUENCY RANGE SHIFTING	1	0-2217-134-D504
3	8-32 X 0.5 SOCKET HEAD SCREW	1	MS16997-32
4	1/16 X 0.5 SPRING PIN	1	MS16562-194
5	5/64 X 0.75 SPRING PIN	1	MS16562-206
6	INTERMEDIATE TUBE	1	0-2217-134-D502

Figure 5-14. Intermediate Tube Subassembly (P/N 8004256G1)

NOTE

These procedures are for Depot use only.

5-61 INSPECTION, REPAIR AND REPLACEMENT OF THE INTERMEDIATE TUBE, P/N 8004256G1, A PART OF THE AN/GRT-22/22 TUNED CAVITY ASSEMBLY, P/N 8004230G1/G2. Refer to Figure 5-14 for component identification.

- a. Inspection. Following disassembly of the Tuned Cavity, and removal of the Intermediate Tube perform a visual inspection of the Tube. The inspection should include the following:

- (1) Examine the dip weld at the attachment of the Frequency Range Shift Rod Mounting Bracket (index 1), referred to as the Bracket for rest of the procedures.
- (2) Examine the exterior and inter of the Intermediate Tube (index 6), referred to as the Tube for the rest of procedures for damage.

NOTE

If the Bracket weld is cracked or broke, but the Tube is serviceable, proceed to step b. If the Tube surface is damaged, proceed to step c. If no visible damage is found, proceed to step d.

- b. Replacement/Repair of the Frequency Range Shift Rod and Mounting Bracket.

- (1) Detach and discard the Frequency Range Shift Rod, referred to as the Rod (index 6) by removing the socket head screw (index 3) and pressing out the

attaching Spring Pins (index 4 and 5).

- (2) Carefully remove and discard the Bracket from the Tube.
- (3) Using a hand file or grinder, remove any remaining weld material and smooth the tube exterior surface to the original contour.
- (4) Install the replacement Bracket by inserting the Tube through the Bracket and securing with the socket head screw. Tighten to 10 inch/pounds of torque. Apply MIL-S-22473E, locking compound.
- (5) Install the Rod (index 2) by inserting the Rod into the Bracket and secure using the spring pins (index 4 and 5).

- c. Replacement of the Intermediate Tube

- (1) Detach and discard the Frequency Range Shift Rod, referred to as the Rod, by removing the socket head screw and pressing out the attaching Spring Pins.
- (2) Remove and discard the Tube.
- (3) Install the replacement Tube through the Bracket and secure with the socket head screw (index 3).
- (4) Tighten to 10 inch/pounds of torques and apply MIL-S-22473E locking compound.
- (5) Install the Rod by inserting the Rod into the Bracket and secure using the spring pins (index 4 and 5).

- d. Reinstall the Intermediate Tube Assembly.

CHAPTER 6

CIRCUIT DIAGRAMS

6-1. INTRODUCTION. This chapter contains block diagrams, schematic diagrams, logic diagrams, wiring diagrams and a wire list necessary to support the theory and maintenance of Transmitting Set, Radio AN/GRT-21 and Transmitting Set Radio AN/GRT-22. The schematic

diagrams contain MP (measurement point), TP (test point), and E (terminal) locations which are referenced in the performance and diagnostic tests of the depot special maintenance and testing technical order utilizing Test Set Radio AN/GRM-102.

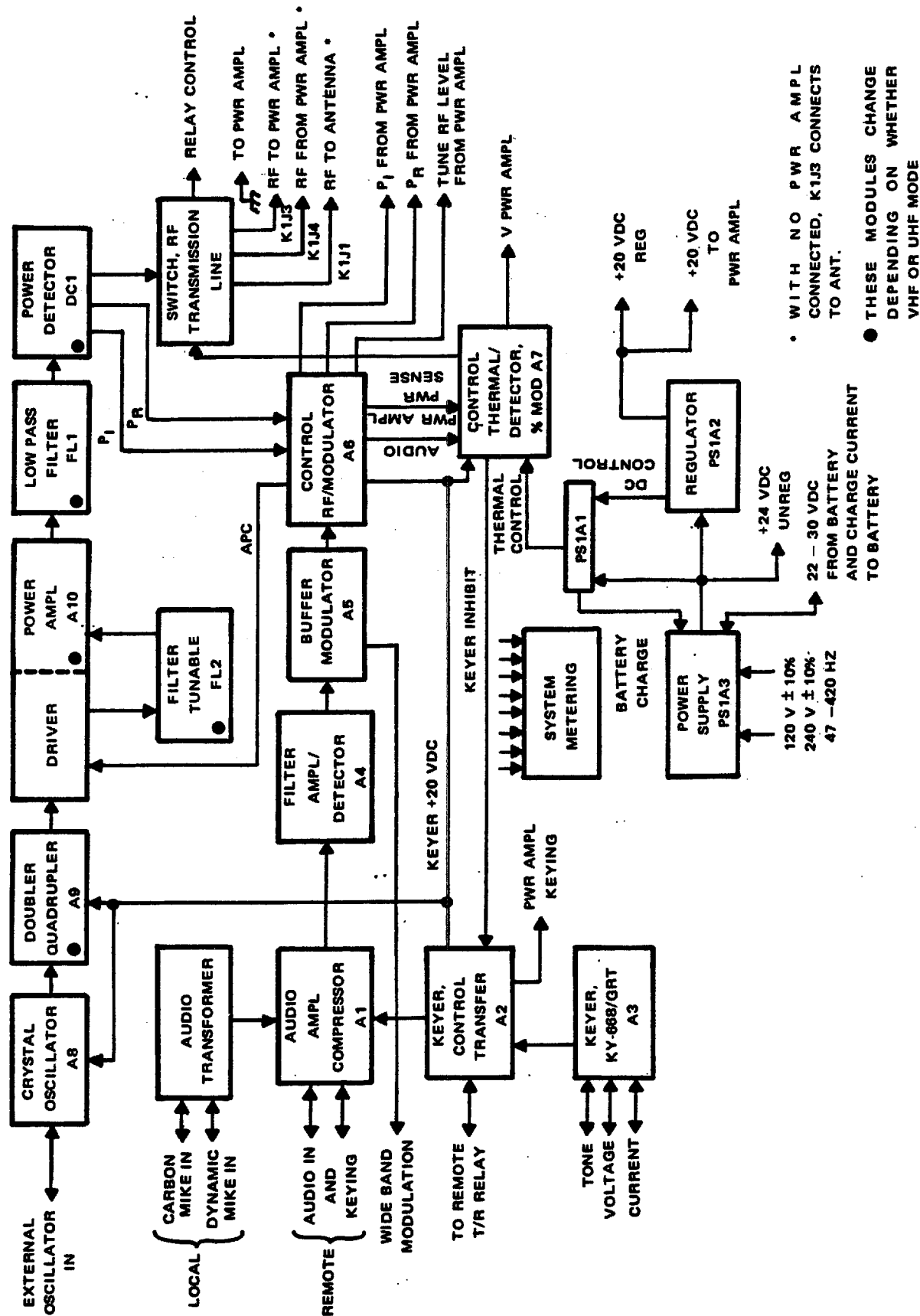


Figure 6-1. VHF/UHF Exciter (Unit 1) Block Diagram

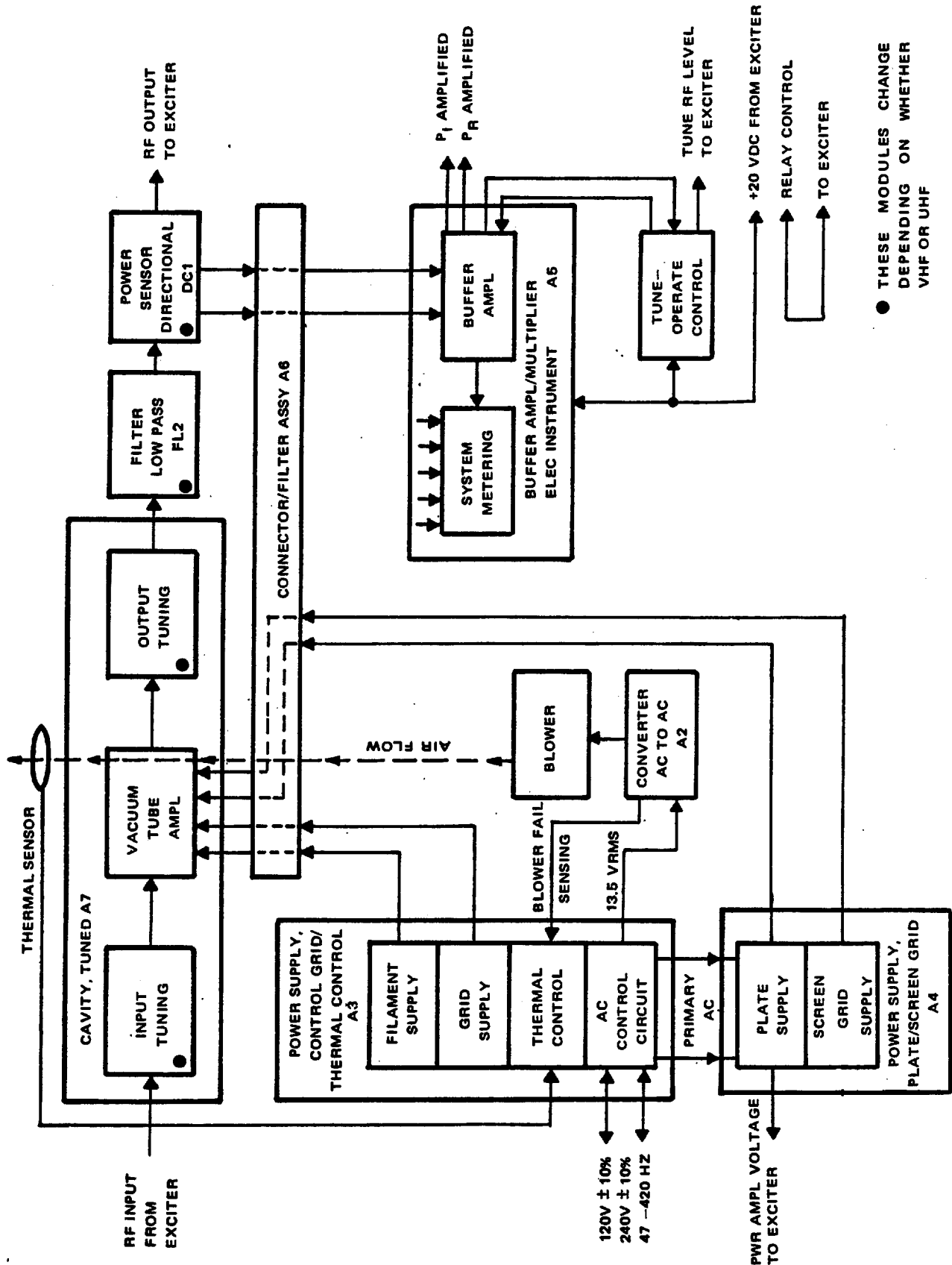


Figure 6-2. VHF/UHF Power Amplifier (Unit 2) Block Diagram

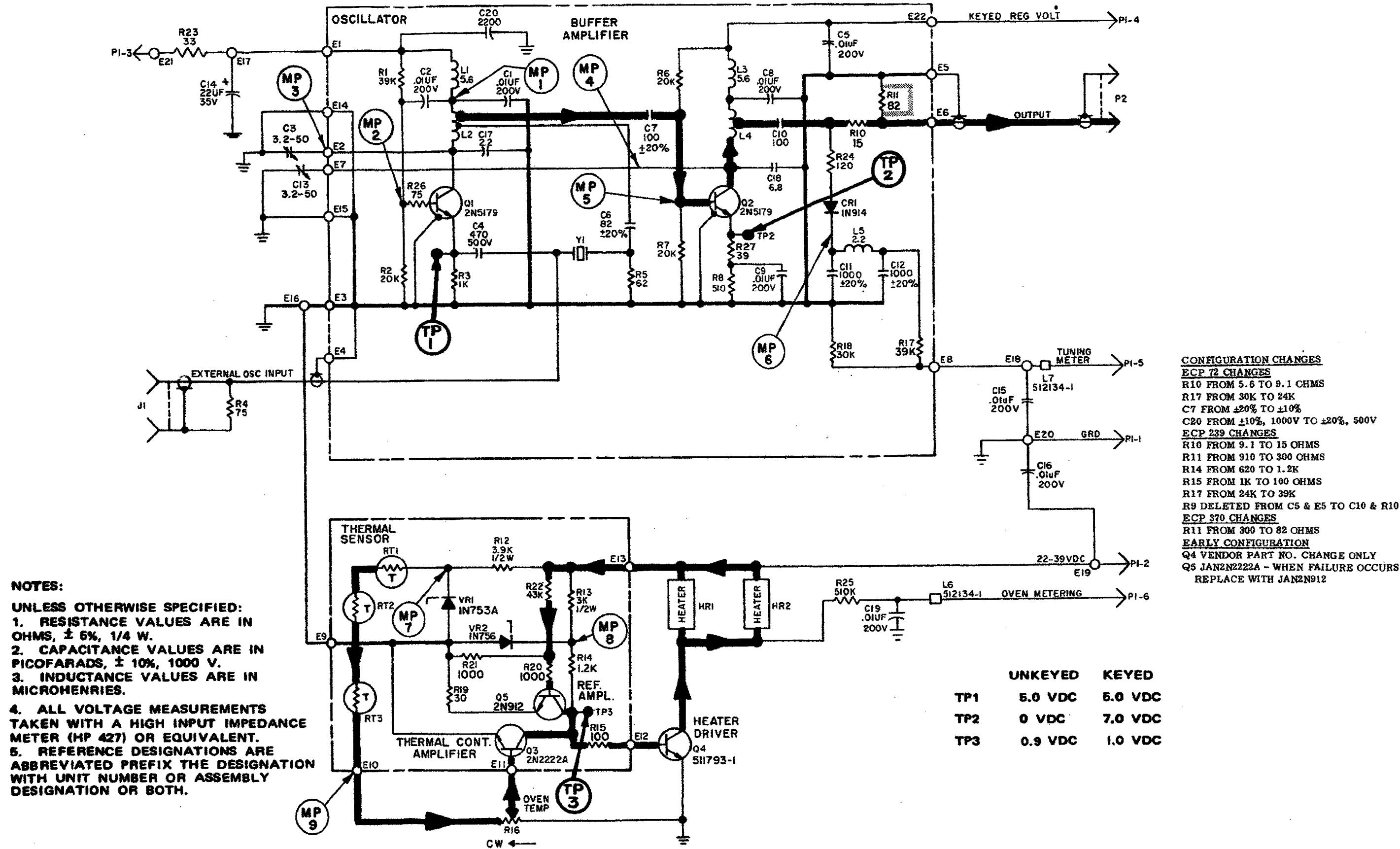


Figure 6-3. Crystal Controlled Oscillator A8, Schematic Diagram
6-5/(6-6 blank)

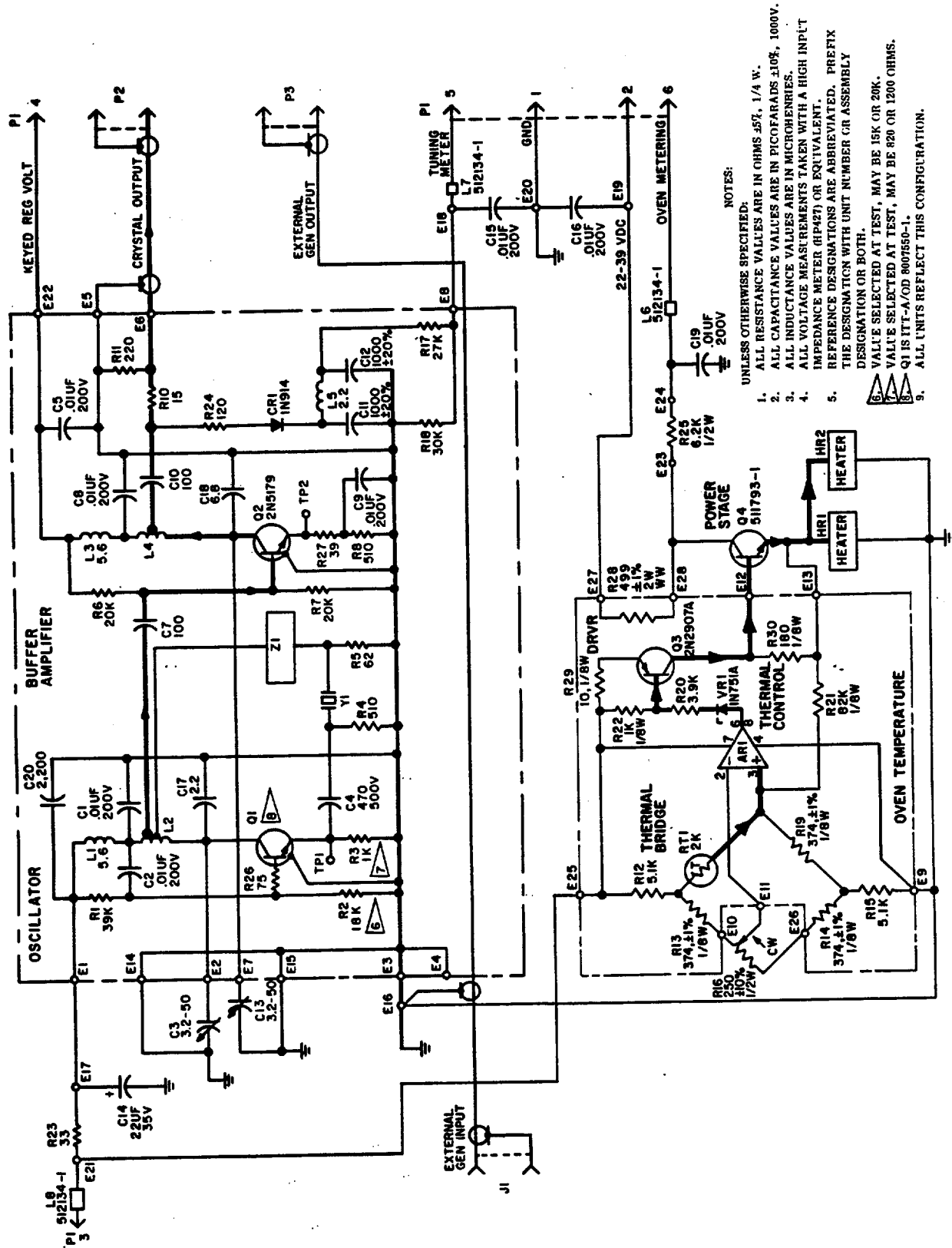
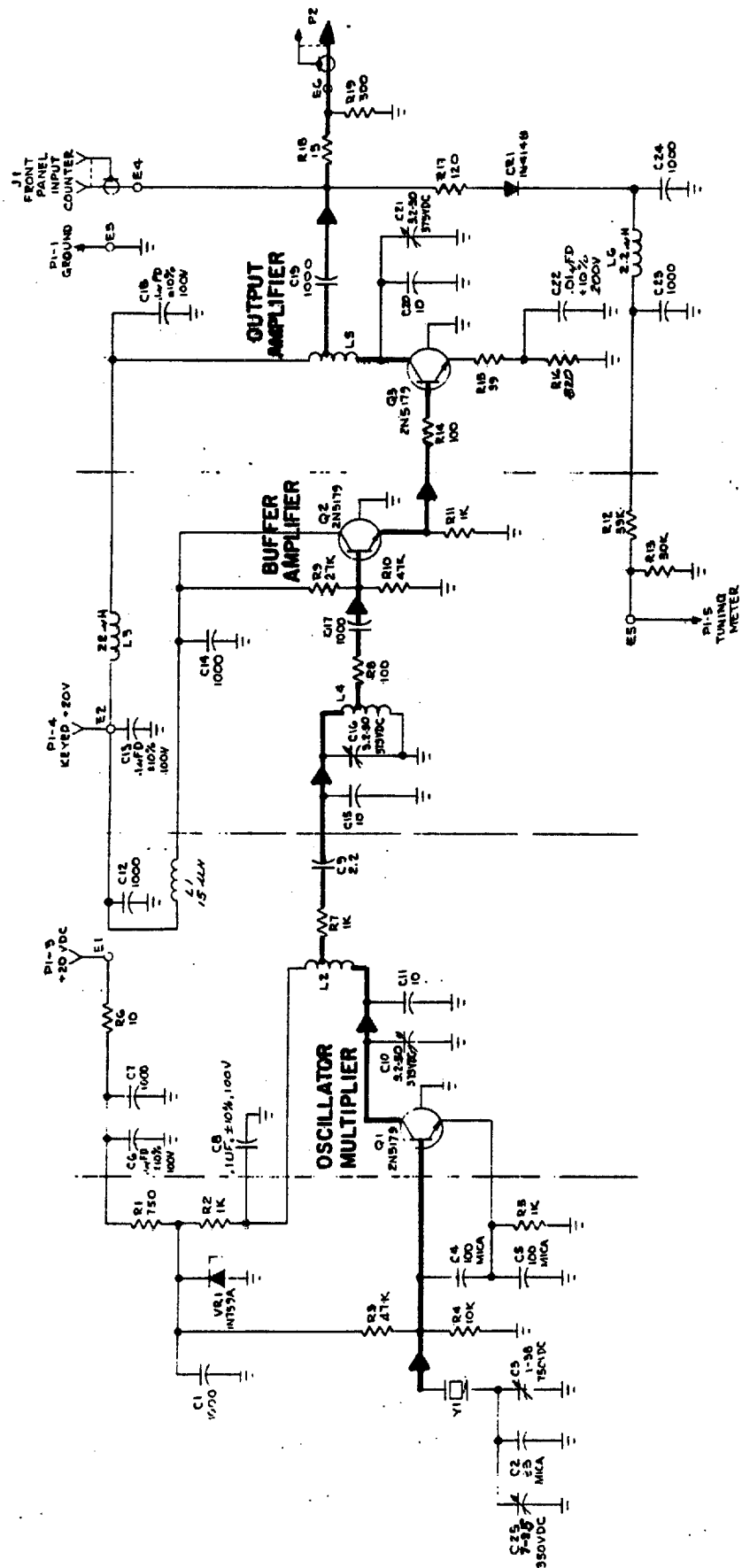


Figure 6-4. Crystal Controlled Oscillator A8, Schematic Diagram



CONFIGURATION CHANGES
ECP 571 CHANGE
C25 FROM 5.5-18 TO 7-25 pF

LAST NUMBER USED

C25	LG	Y1
C21	P2	Y1
J1	R19	

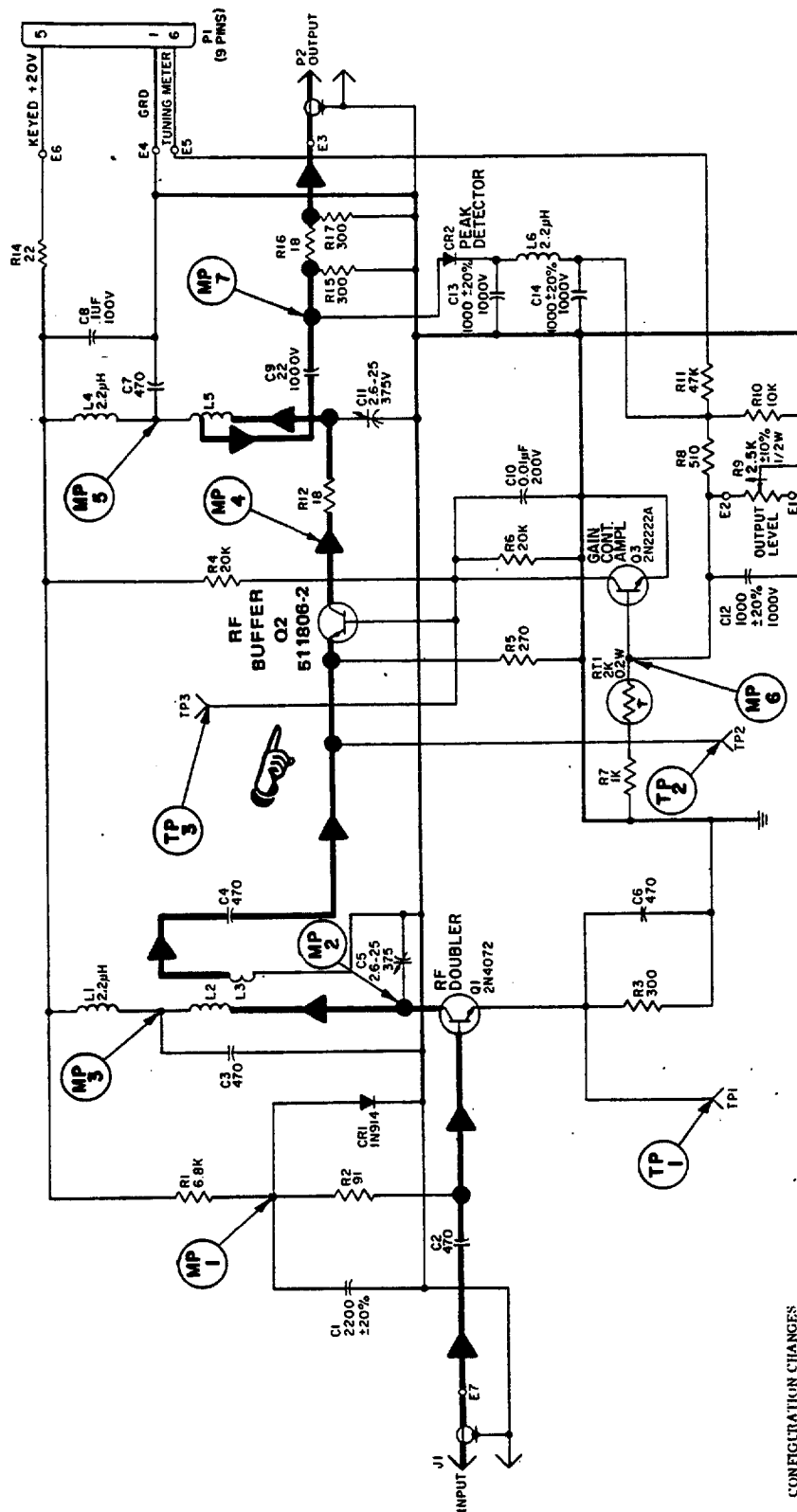
REFERENCE DESIGNATIONS ARE ASSUMED
PREFIX THE DESIGNATIONS WITH UNIT NUMBER
OR ASSEMBLY DESIGNATION FOR BOTH

NOTES:

UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE VALUES ARE IN OHMS $\pm 5\%$, 1/4W.
2. CAPACITANCE VALUES ARE IN PICOFARADS $\pm 10\%$, 1000V.
3. INDUCTANCE VALUES ARE IN MICROHENRIES.
4. ALL VOLTAGE MEASUREMENTS TAKEN WITH A HIGH INPUT IMPEDANCE METER (HP427 OR EQUIVALENT).

Figure 6-5. Oscillator-Multiplier A8, Schematic Diagram

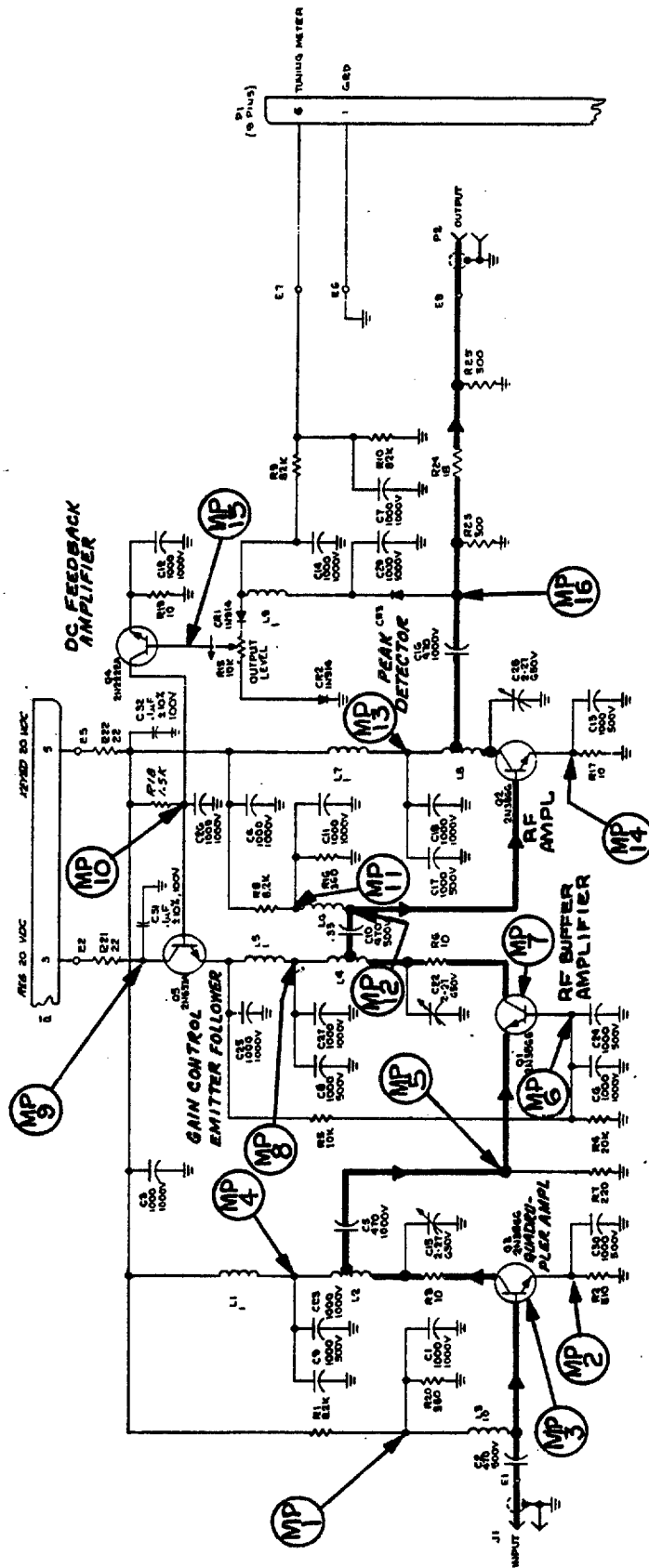


CONFIGURATION CHANGES
ECP 287 CHANGES
R9 FROM 28K TO 2.5K
EARLY CONFIGURATION
CONNECTION REMOVED FROM C3 GROUND SIDE
TO THE POINTS OF L2 AND L3.

- NOTES:
- UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, ± 5%, 1/4 W.
2. CAPACITANCE VALUES ARE IN PICO FARADS, ± 10%, 500 V.
 - ALL VOLTAGE MEASUREMENTS TAKEN WITH A HIGH INPUT IMPEDANCE METER (HP 427) OR EQUIVALENT.
 - REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.

UNKEYED	KEYED
TP1 0 VDC	3.0 VDC
TP2 0 VDC	2.5 VDC
TP3 0.2 VDC	3.0 VDC

Figure 6-6. Doubler, Radio Frequency (VHF) A9, Schematic Diagram

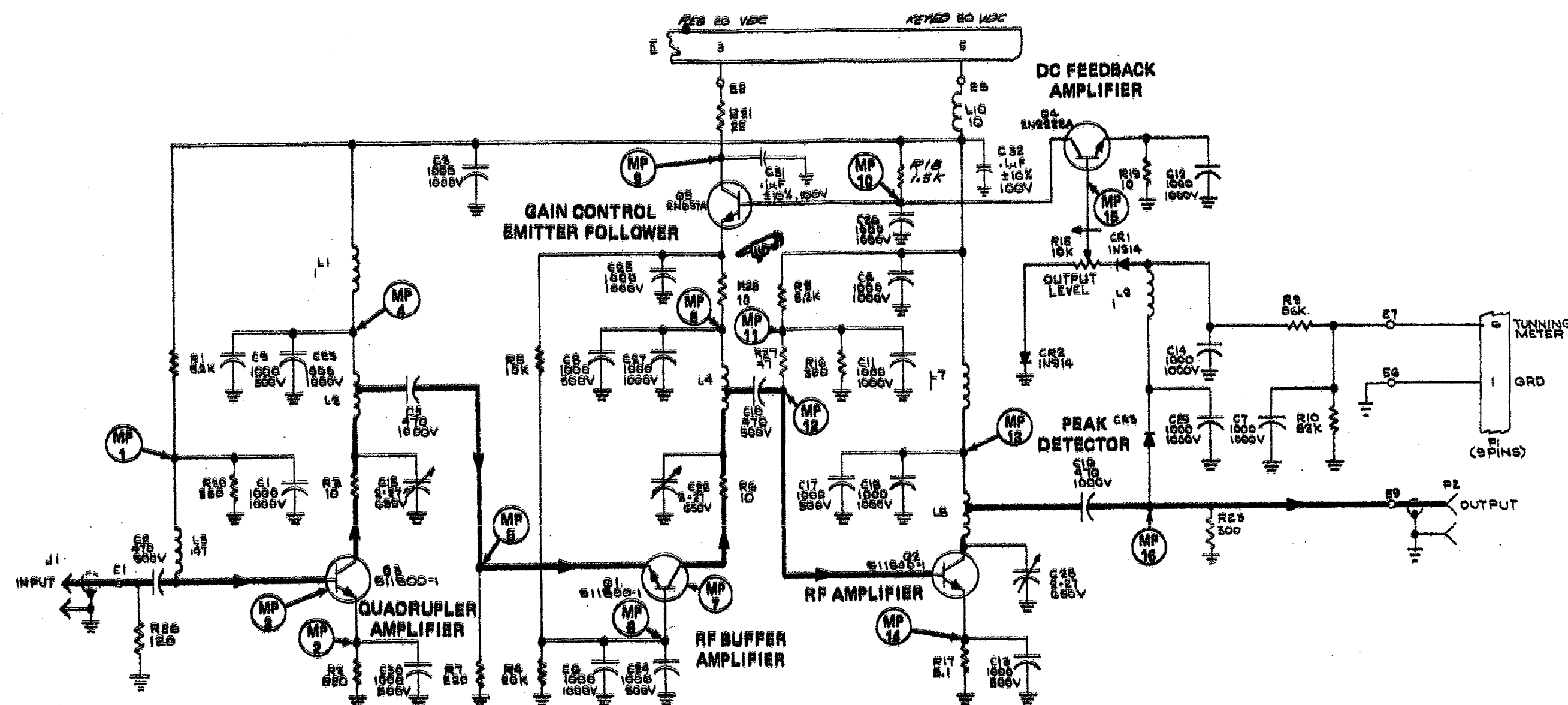


NOTES:

UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE VALUES ARE IN OHMS, $\pm 10\%$, 1/4 W.
2. CAPACITANCE VALUES ARE IN PICOFARADS, $\pm 20\%$.
3. INDUCTANCE VALUES ARE IN MICROHENRIES.
4. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.

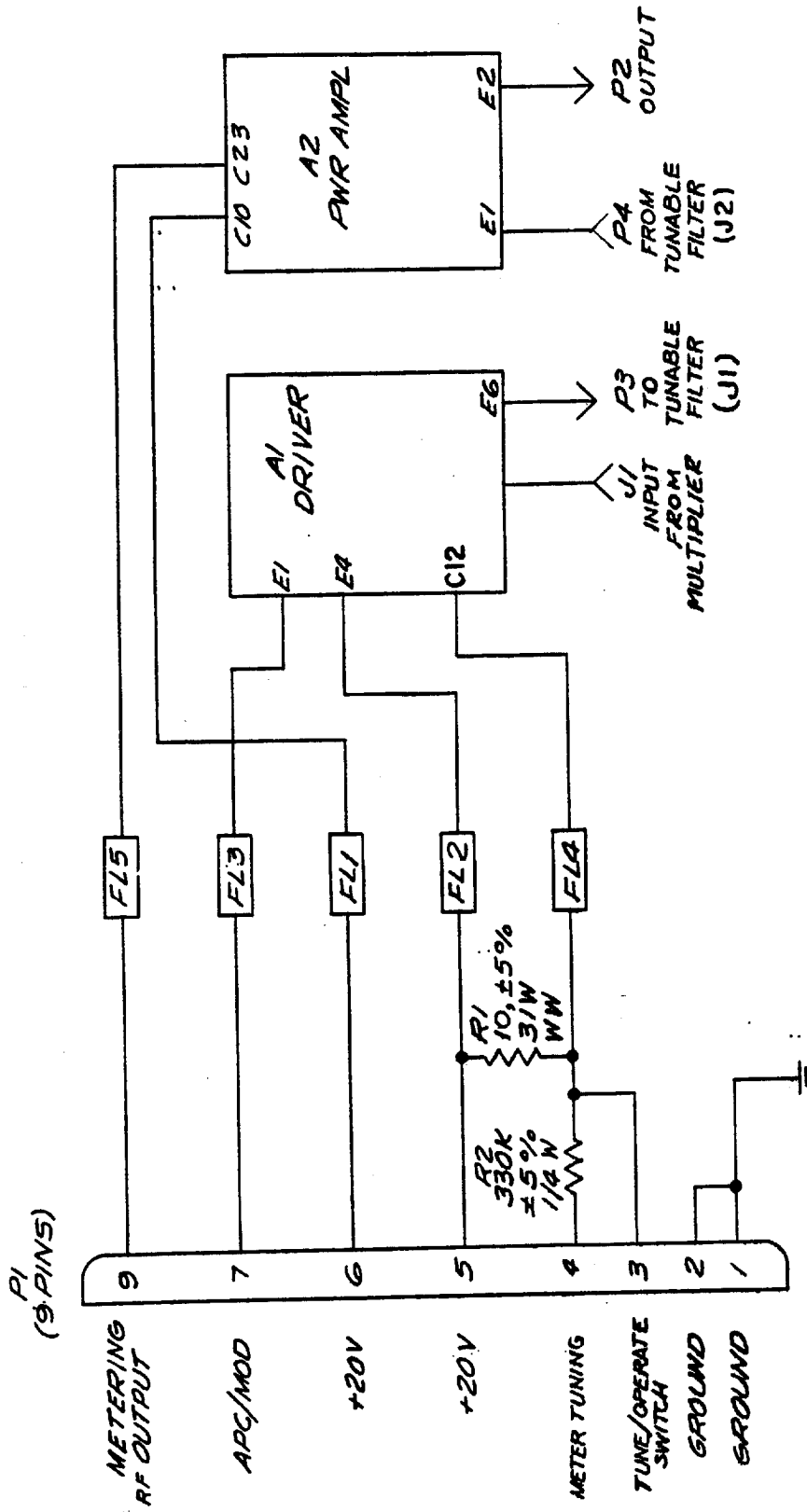
Figure 6-7. Quadrupler (UHF) A9, Schematic Diagram (Early Configuration)



CONFIGURATION CHANGES
THIS SCHEMATIC REFLECTS ALL CHANGES IN EOP 810
EOP 628 CHANGES
L8 DELETED
R27 ADDED
EOP 658 CHANGES
R8 FROM 88K TO 88K
R26 FROM 88 OHMS TO 120 OHMS
EOP 678 CHANGES
L8 DELETED
R26 ADDED

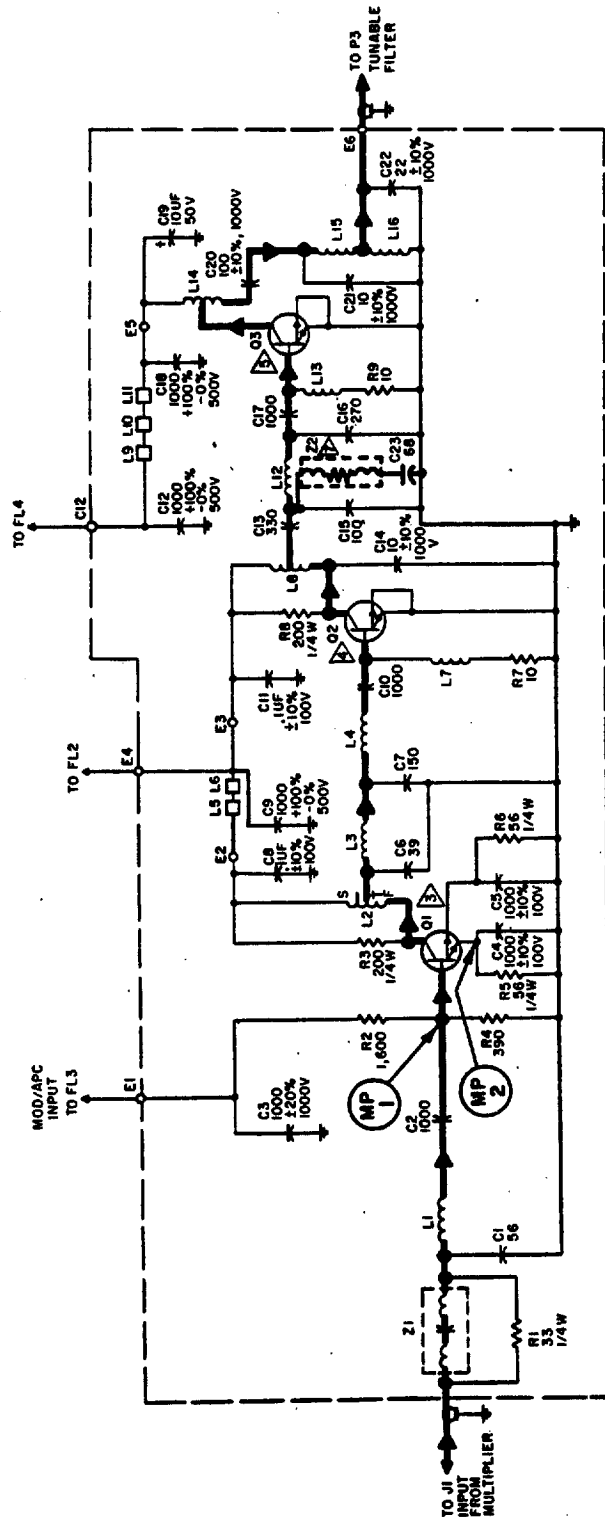
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4W
2. ALL CAPACITANCE VALUES ARE IN PICOFARADS, $\pm 20\%$
3. ALL INDUCTANCE VALUES ARE IN MICROHENRIES
4. REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.

Figure 6-8. Quadrupler (UHF) A9, Schematic Diagram
(Latest Configuration)



REFERENCE DESIGNATIONS ARE
ABBREVIATED PREFIX THE DESIG-
NATION WITH UNIT NUMBER OR
ASSEMBLY DESIGNATION OR BOTH

Figure 6-9. Driver/Power Amplifier (VHF) A10, Schematic Diagram



NOTES:

UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 12 V.
2. CAPACITANCE VALUES ARE IN PICOFARADS, $\pm 5\%$, 50 V.
3. 515337-1.
4. 511810-1.
5. 511824-2.
6. TRANSISTORS ARE RF AMPLIFIERS.
7. TAILOR POINT. IF USED, VALUE TO BE DETERMINED AT TEST.

8. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.
9. Z2, Q1 AND Q2 ADDED TO DRIVER BOARD (A1) AFTER ASSEMBLY INTO NEXT HIGHER ASSEMBLY (A10); THEREFORE PARTS LIST INFORMATION IS CONTAINED IN A10 SECTION OF ILLUSTRATED PARTS BREAKDOWN MANUAL.

CONFIGURATION CHANGES

ECP 48 CHANGES

- Z2 ADDED
- C23 ADDED

Figure 6-10. Driver (VHF) A10A1, Schematic Diagram

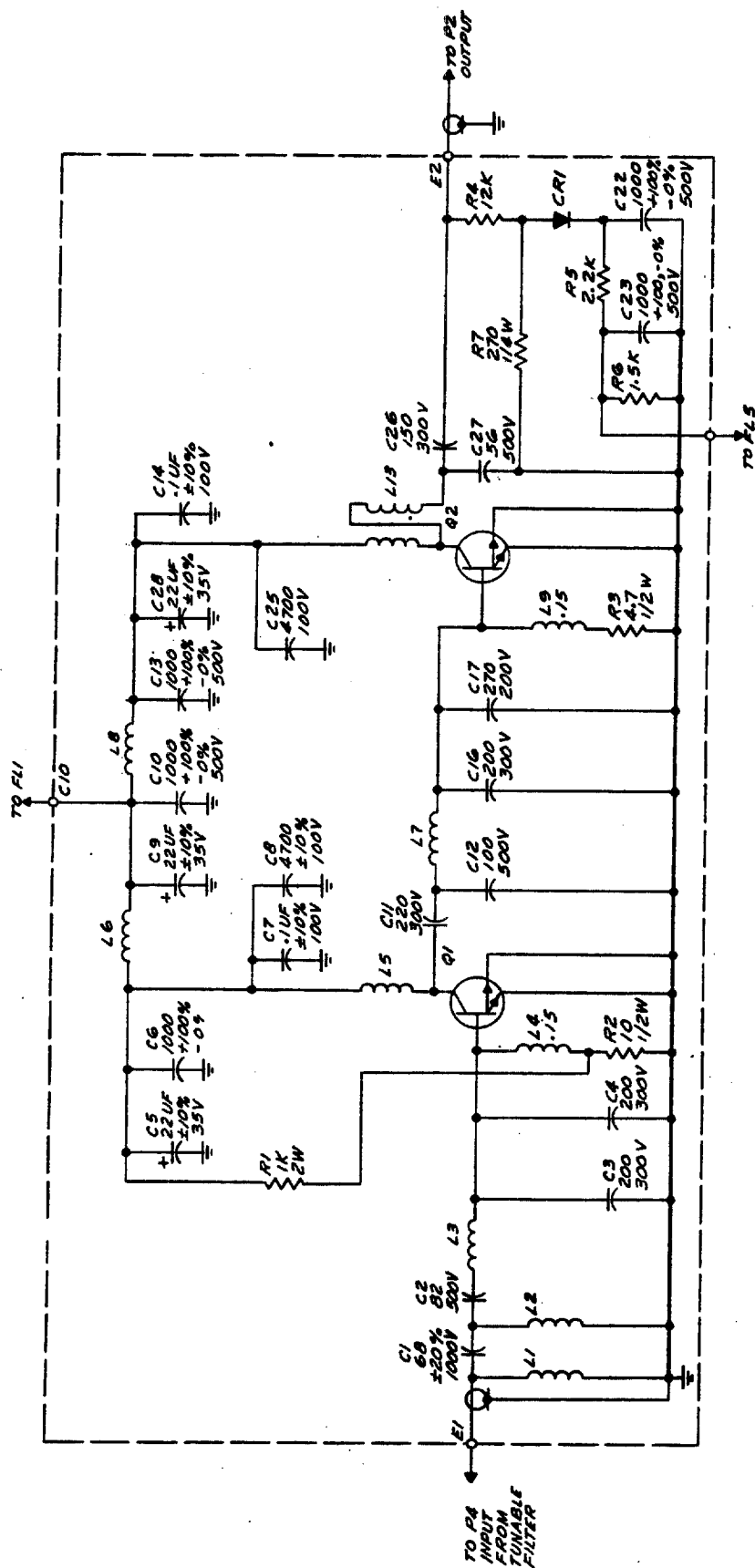
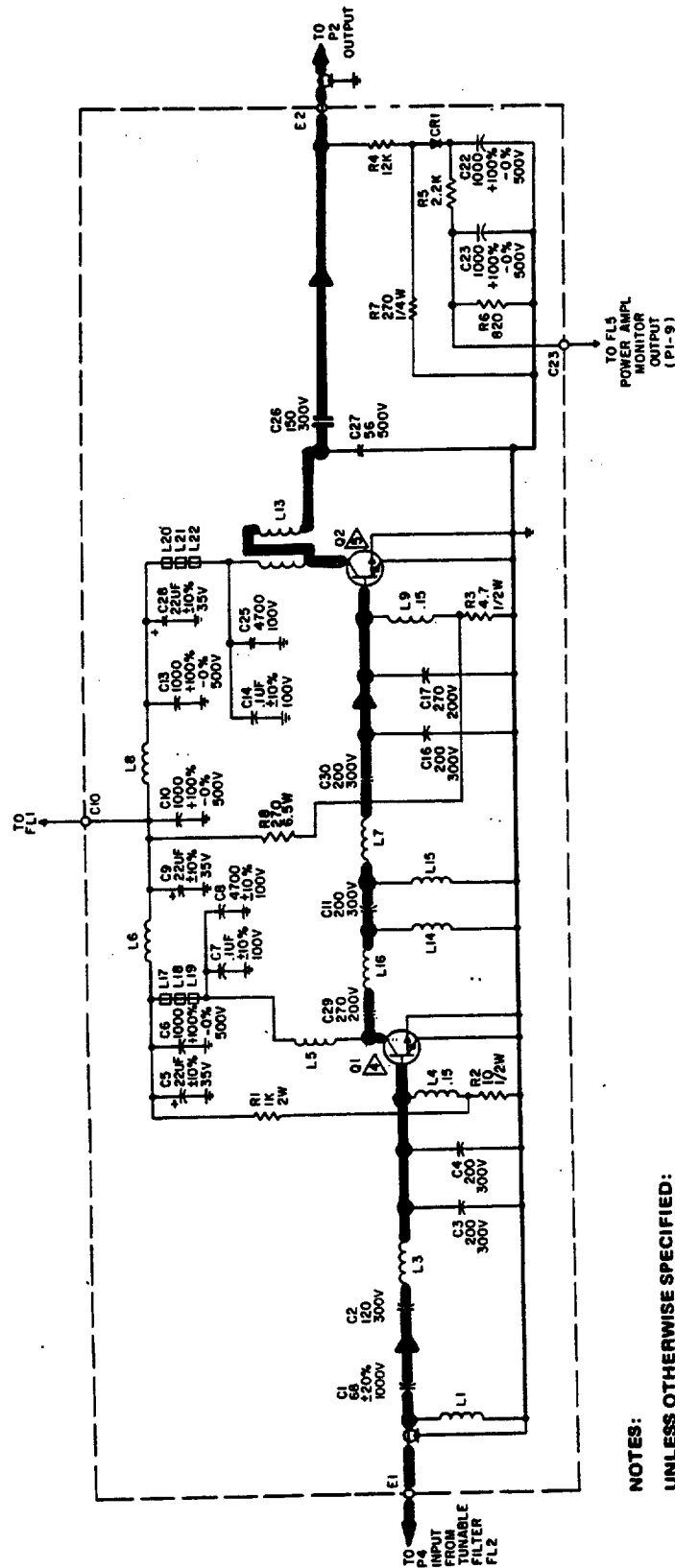


Figure 6-11. Power Amplifier (VHF) A10A2, Schematic Diagram
(Early Configuration)



NOTES:

UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4 W.
2. CAPACITANCE VALUES ARE IN PICO FARADS, $\pm 5\%$.
3. INDUCTANCE VALUES ARE IN MICROHENRIES.

515342-1.

515343-1.

6. TRANSISTORS ARE RF AMPLIFIERS.

7. REFERENCE DESIGNATIONS ARE

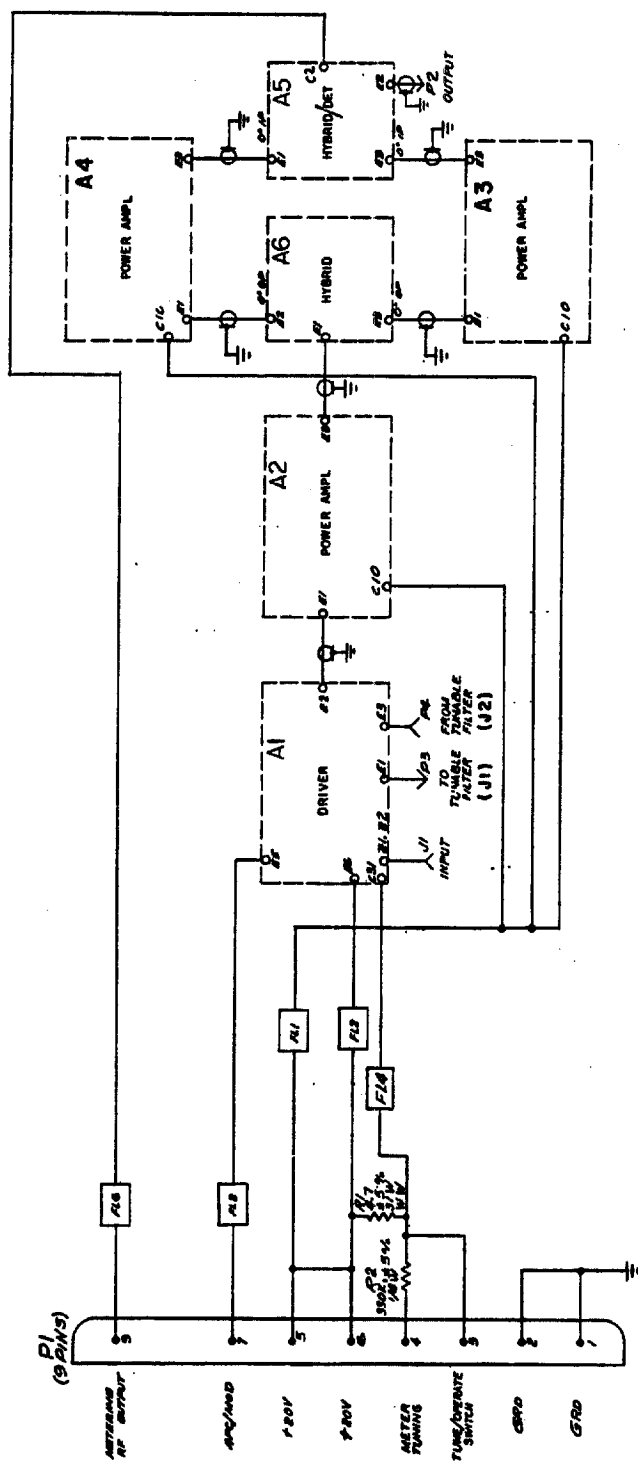
ABBREVIATED. PREFIX THE DESIGNATION WITH UNIT NUMBER OR

ASSEMBLY DESIGNATION OR BOTH

8. R8, 270 OHM, 6.5W ADDED BY T.C.10

31R2-2GRT-514

Figure 6-12. Power Amplifier (VHF) A10A2, Schematic Diagram
(Latest Configuration)



REFERENCE DESIGNATIONS ARE
ABBREVIATED PREFIX THE DESIG-
NATION WITH UNIT NUMBER OR
ASSEMBLY DESIGNATION OR BOTH

CONFIGURATION CHANGE
REVERSED REF DESIGNATIONS A3 & A4

Figure 6-13. Driver/Power Amplifier (UHF) A10, Schematic Diagram

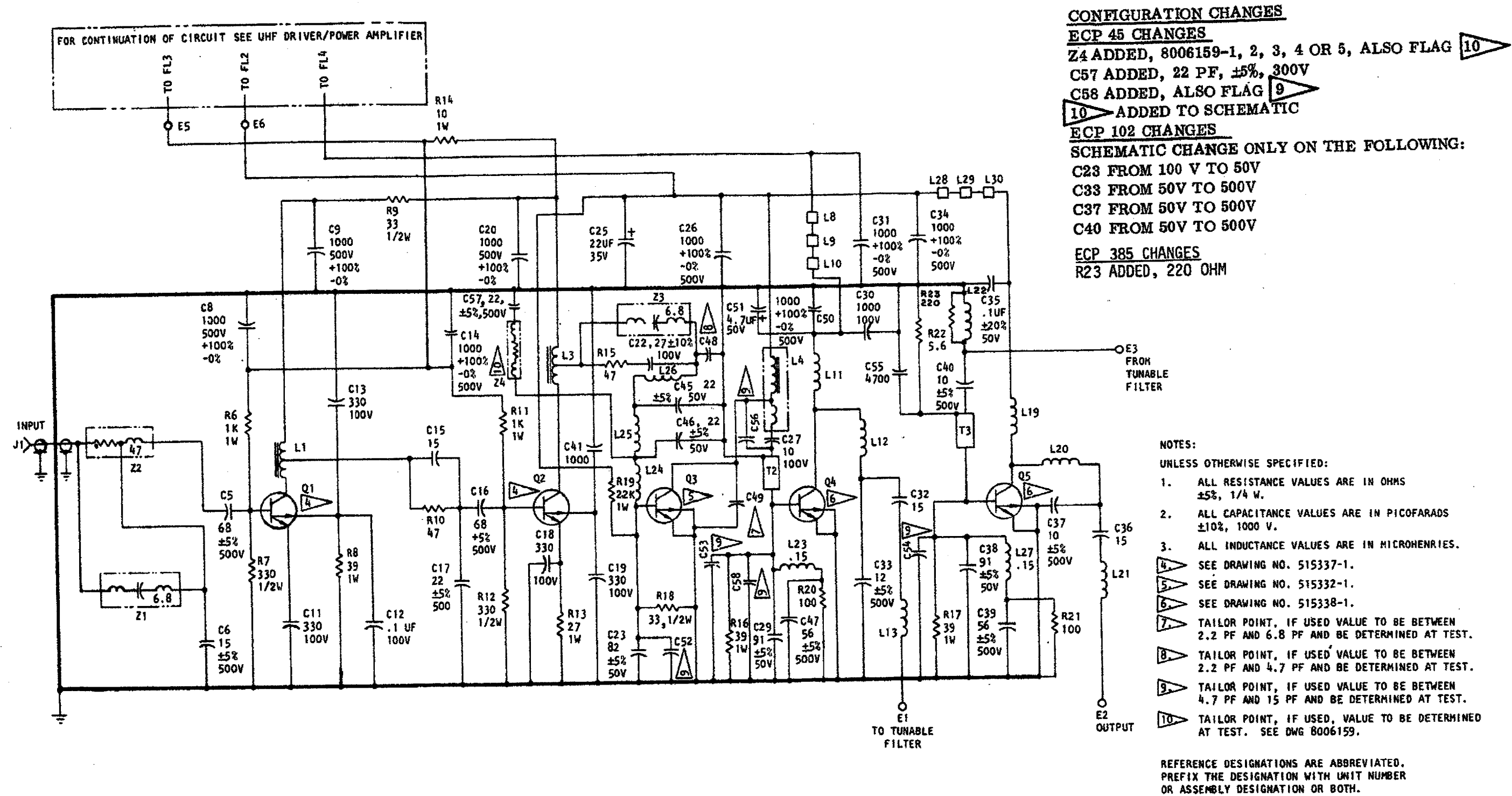


Figure 6-14. Driver (UHF) A10A1, Schematic Diagram
(Early Configuration)

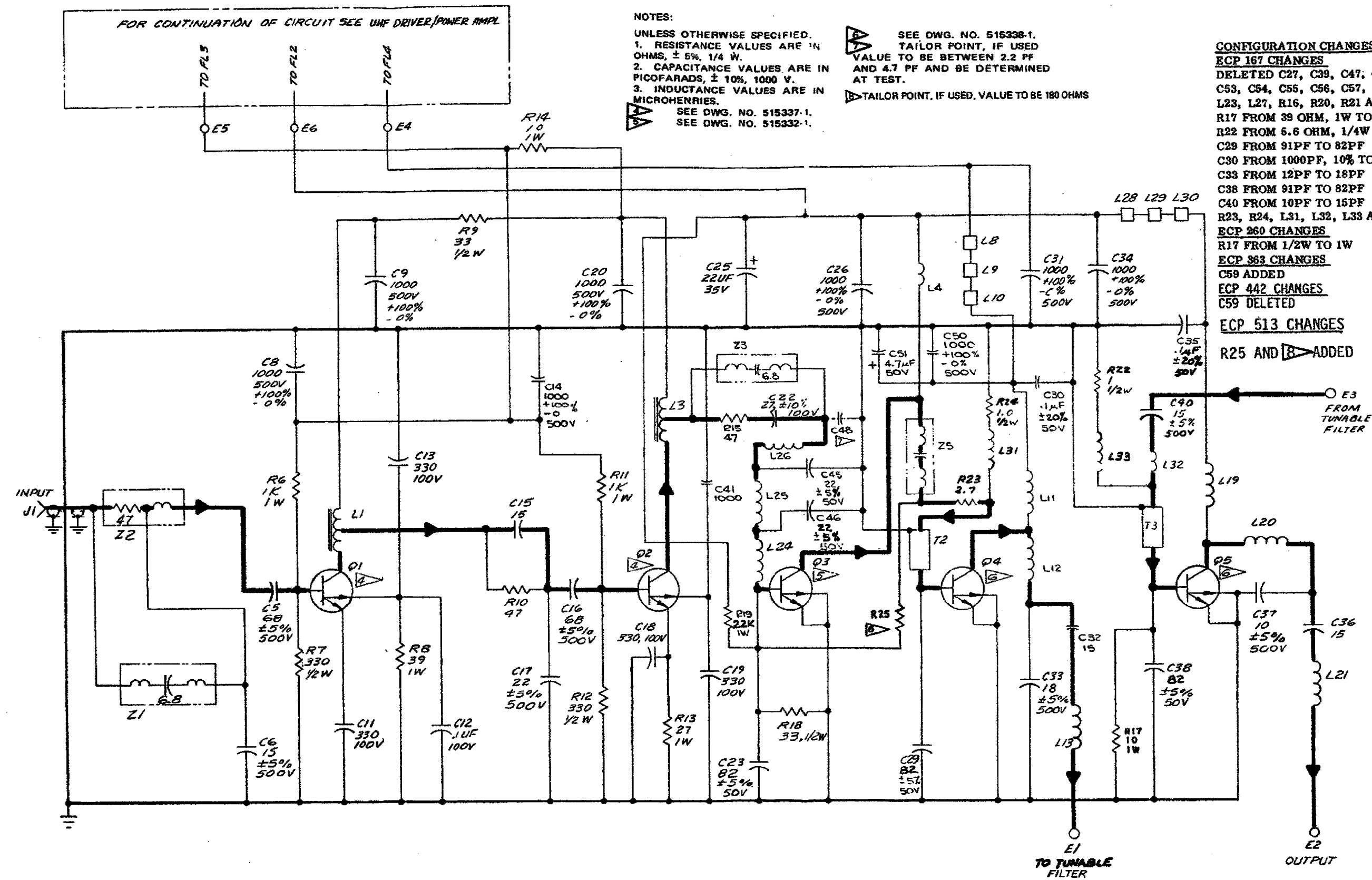
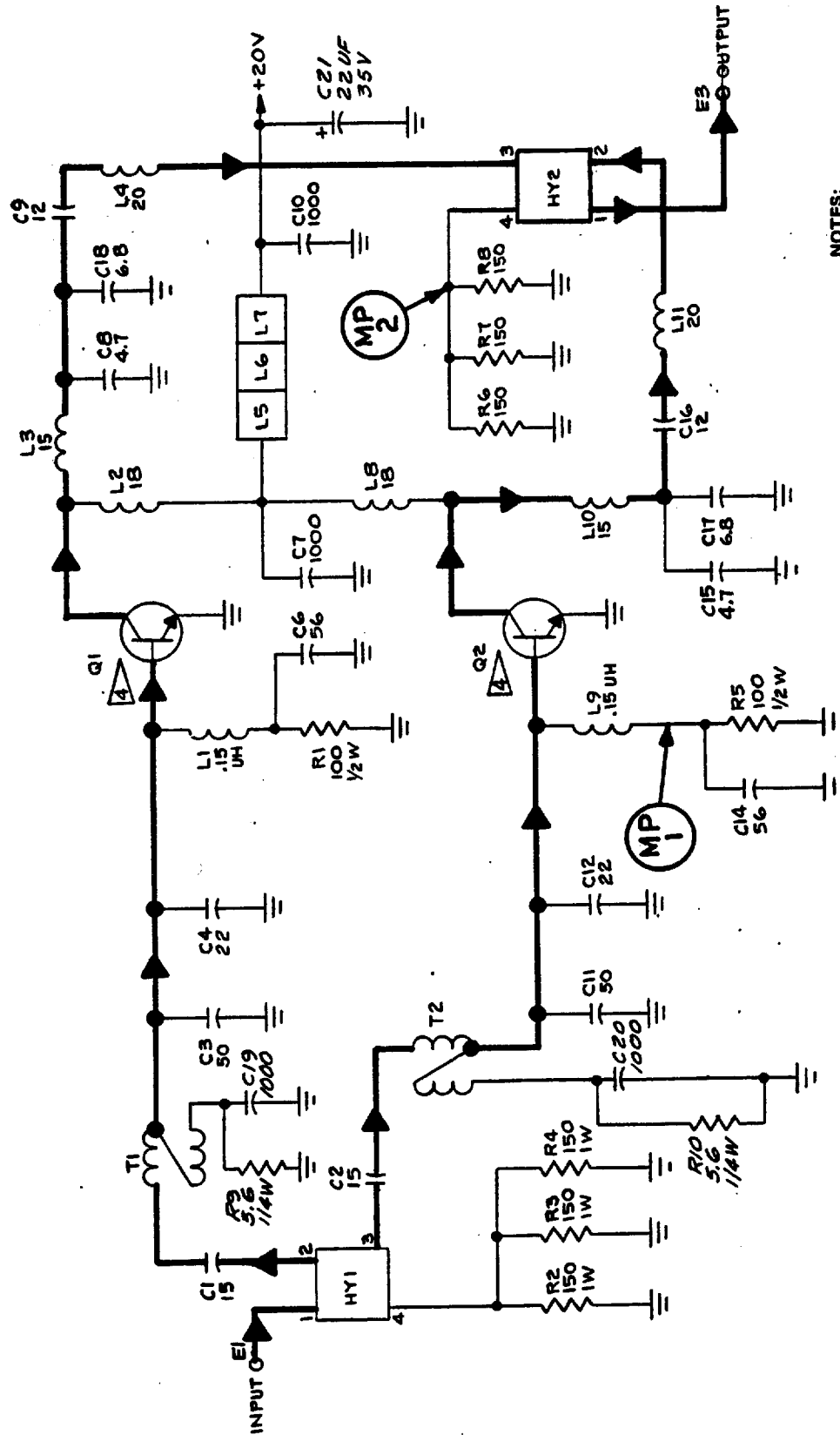


Figure 6-15. Driver (UHF) A10A1, Schematic Diagram
(Latest Configuration)



NOTES:

- UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 2 WATT.
2. CAPACITANCE VALUES ARE IN PICOFARADS.
3. INDUCTANCE VALUES ARE NANOHENRIES.
PART NO. FOR Q1 AND Q2 IS 615338-1 RF AMPLIFIERS.

Figure 6-16. Power Amplifier (UHF) A10A2, A3, A4, Schematic Diagram (First Configuration)

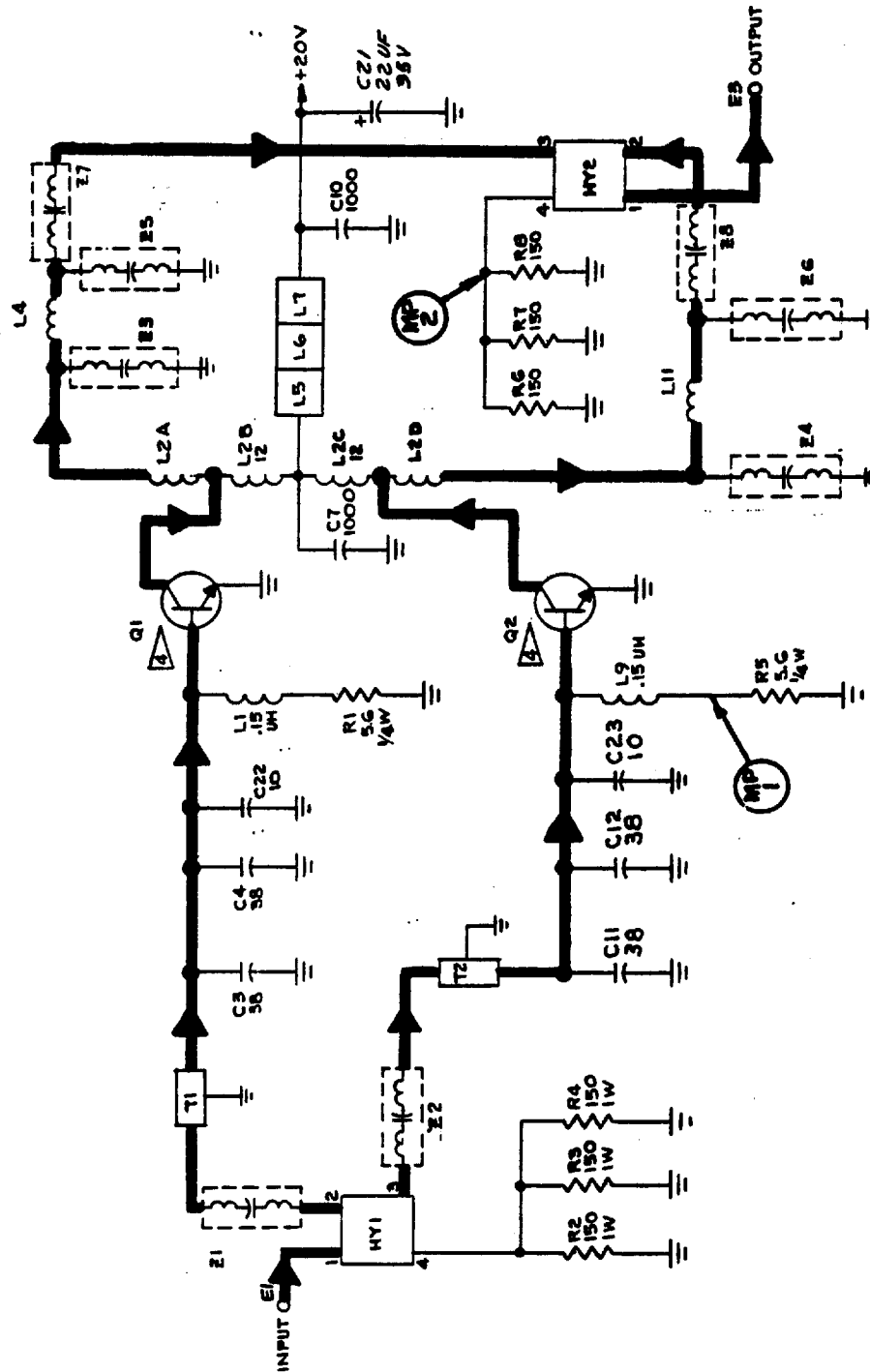
**UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 2 WATT.
2. CAPACITANCE VALUES ARE IN PICOFARADS.**

3. INDUCTANCE VALUES ARE NANOHENRIES.

**▲ PART NO. FOR Q1 AND Q2
IS 515338-1 RF AMPLIFIERS.**

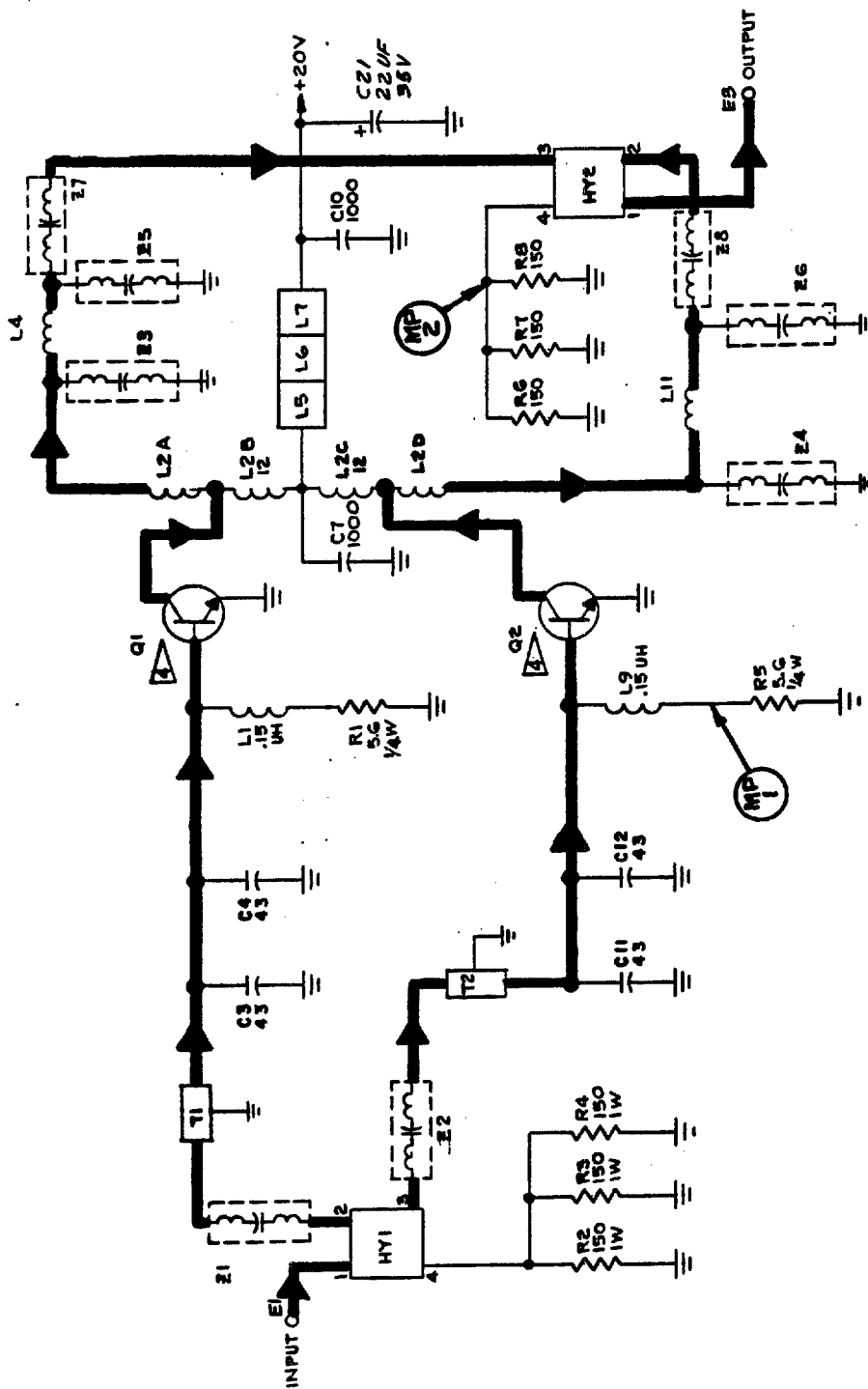


Figure 6-17. Power Amplifier (UHF) A10A2, A3, A4, Schematic Diagram (Second Configuration)



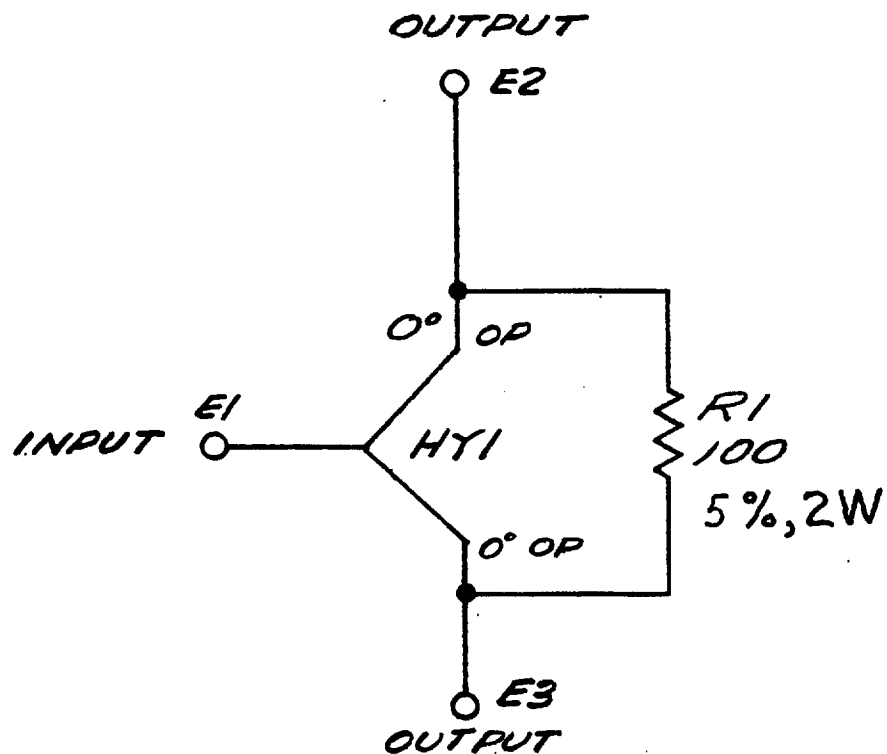
- NOTES:
- UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 2 WATT.
 2. CAPACITANCE VALUES ARE IN PICOFARADS.
 3. INDUCTANCE VALUES ARE NANOHENRIES.
- PART NO. FOR Q1 AND Q2 IS 615338-1 RF AMPLIFIERS.
5. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

Figure 6-18.: Power Amplifier (UHF) A10A2, A3, A4, Schematic Diagram
(Third Configuration)



- NOTES:
- UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 2 WATT.
 2. CAPACITANCE VALUES ARE IN PICOFARADS.
 3. INDUCTANCE VALUES ARE NANOHENRIES.
- PART NO. FOR Q1 AND Q2 IS 615338-1 RF AMPLIFIERS.
5. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

Figure 6-19. Power Amplifier (UHF) A10A2, A3, A4, Schematic Diagram
(Fourth and Latest Configuration)



REFERENCE DESIGNATIONS ARE
ABBREVIATED PREFIX THE DESIG-
NATION WITH UNIT NUMBER OR
ASSEMBLY DESIGNATION OR BOTH

Figure 6-20. Hybrid A10A6, Schematic Diagram

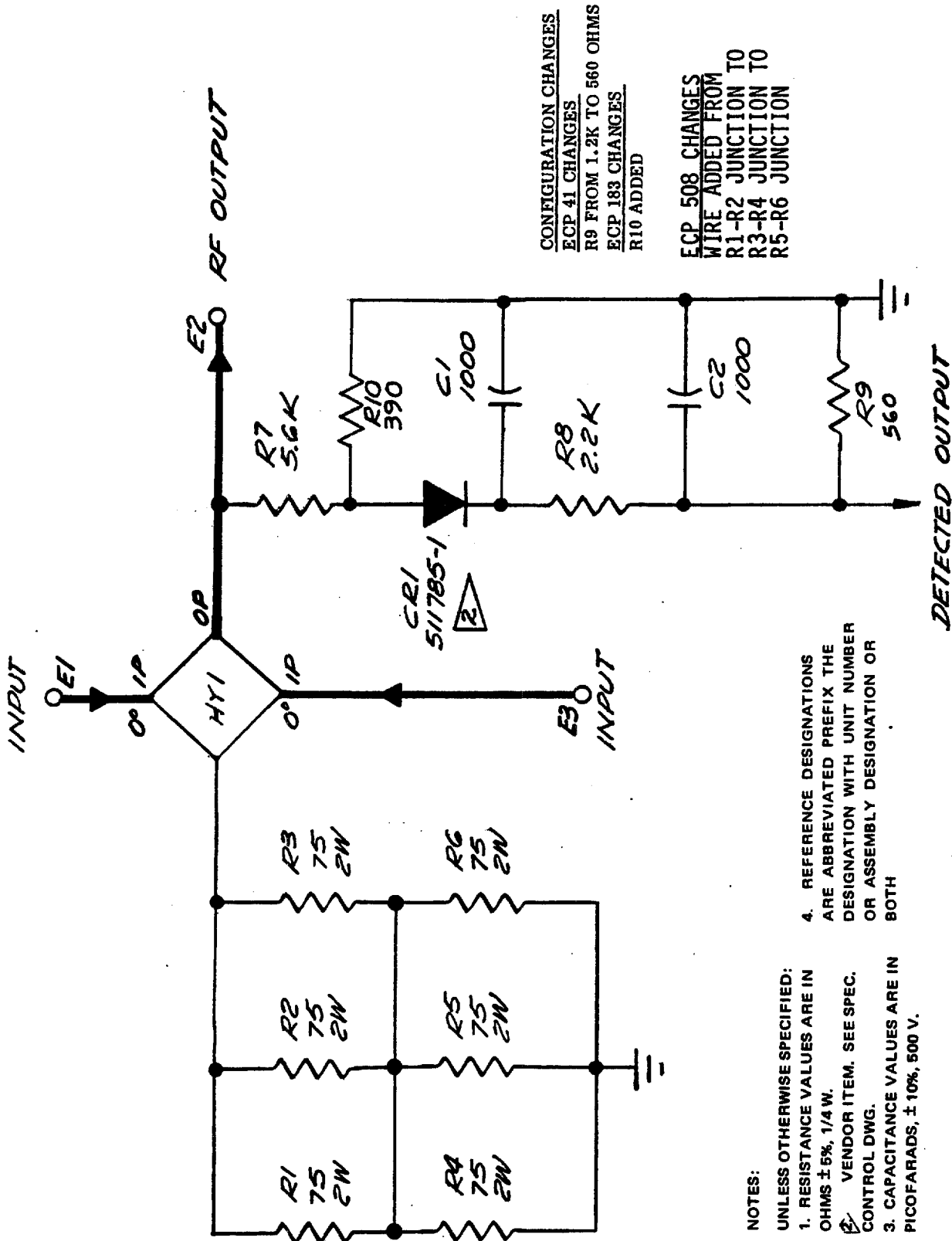
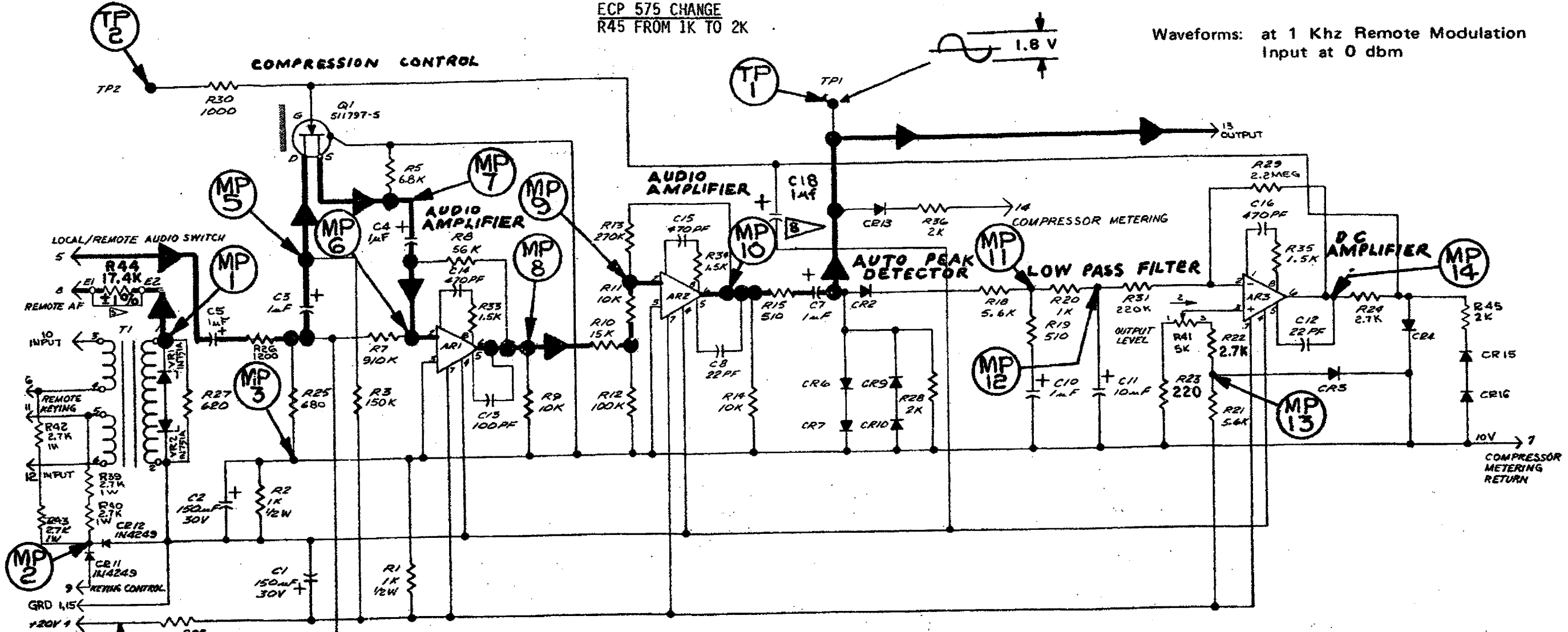


Figure 6-21. Hybrid/Detector A10A5, Schematic Diagram

CONFIGURATION CHANGES
ECP 282 CHANGES
R44 FROM 18K, 5% TO 17.4K, 1%
ECP 284 CHANGES
C18 FROM 0.1μF, 100V TO 1μF, 50V
ECP 575 CHANGE
R45 FROM 1K TO 2K



NOTES:

- UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, ± 5%, 1/4 W.
2. CAPACITANCE VALUES ARE IN PICO FARADS, ± 10%, 50V.
3. INDUCTANCE VALUES ARE IN MICROHENRIES.
4. DIODES ARE JAN1N914.

5. JUMPER OPTIONAL PART.
6. ALL VOLTAGE MEASUREMENTS TAKEN WITH A HIGH INPUT IMPEDANCE METER (HP 427) OR EQUIVALENT.
7. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.
8. VALUE OF C18 IS .1 μF ON SOME UNITS IN THE FIELD

	UNKEYED	KEYED
TP1	10 VDC	10 VDC
TP2	10 VDC	10 VDC
TP3	10 VDC	10 VDC

Figure 6-22. Amplifier Compressor Audio A1, Schematic Diagram

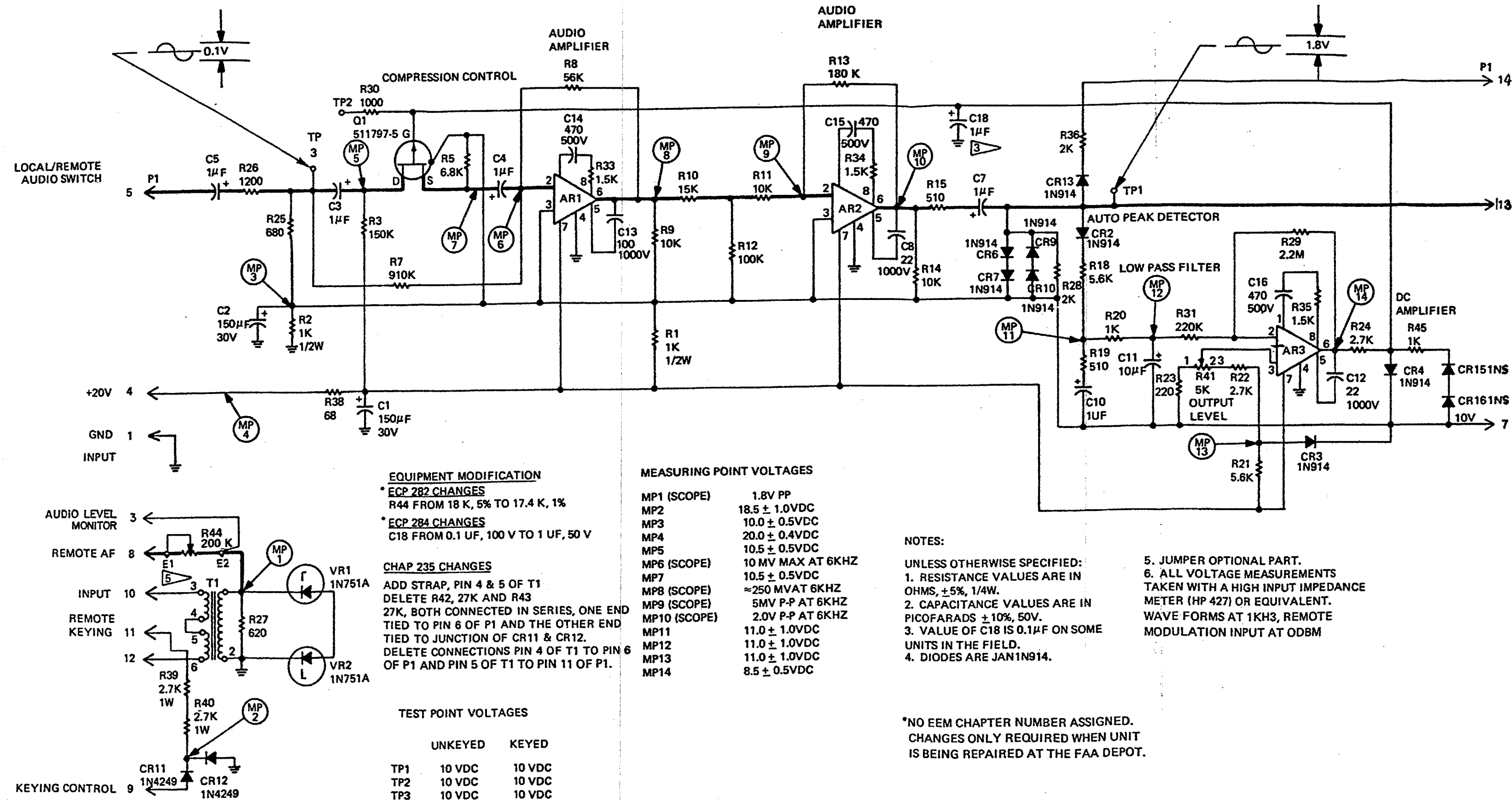


Figure 6-22A. Audio Amplifier Compressor A1 Schematic
Diagram

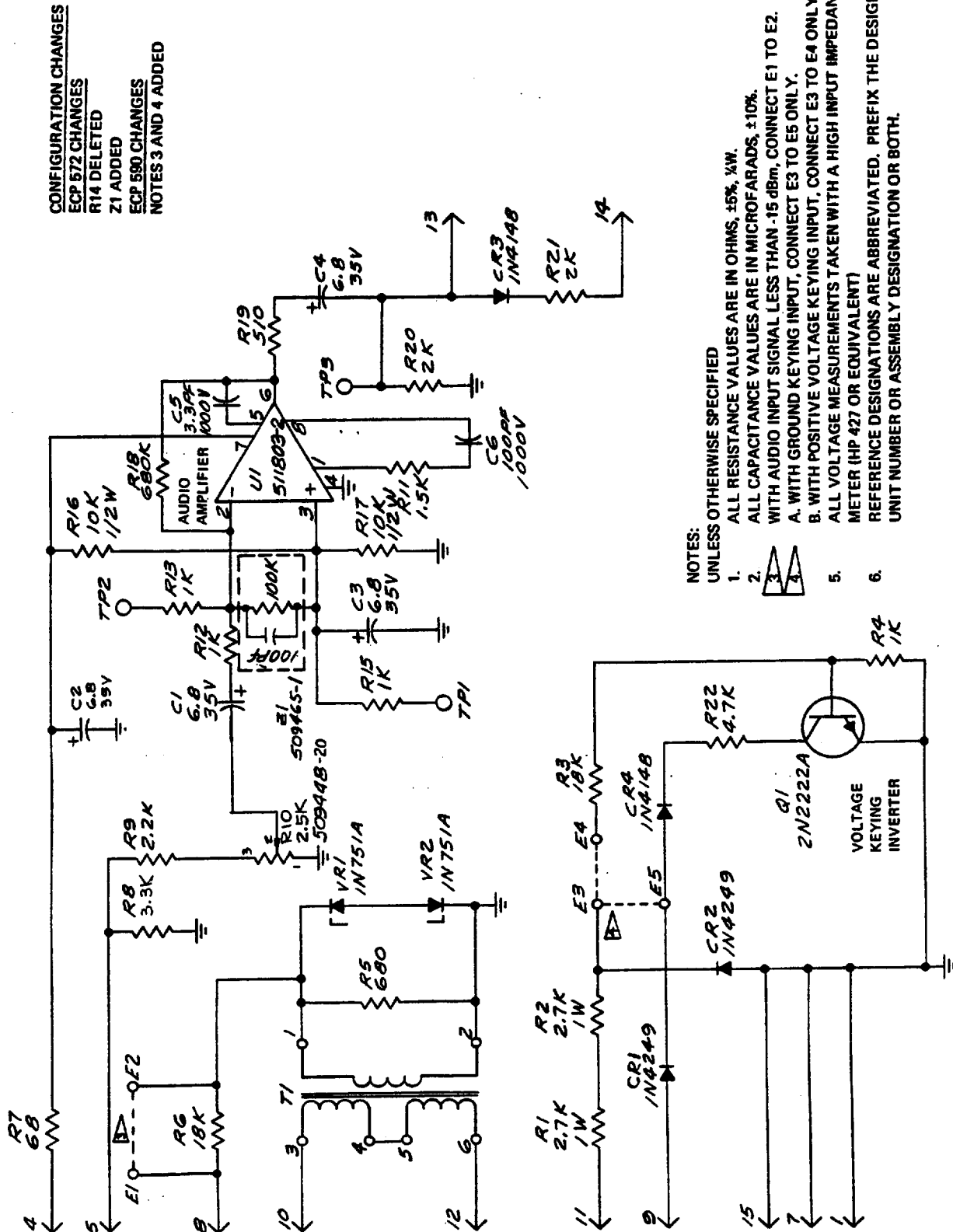
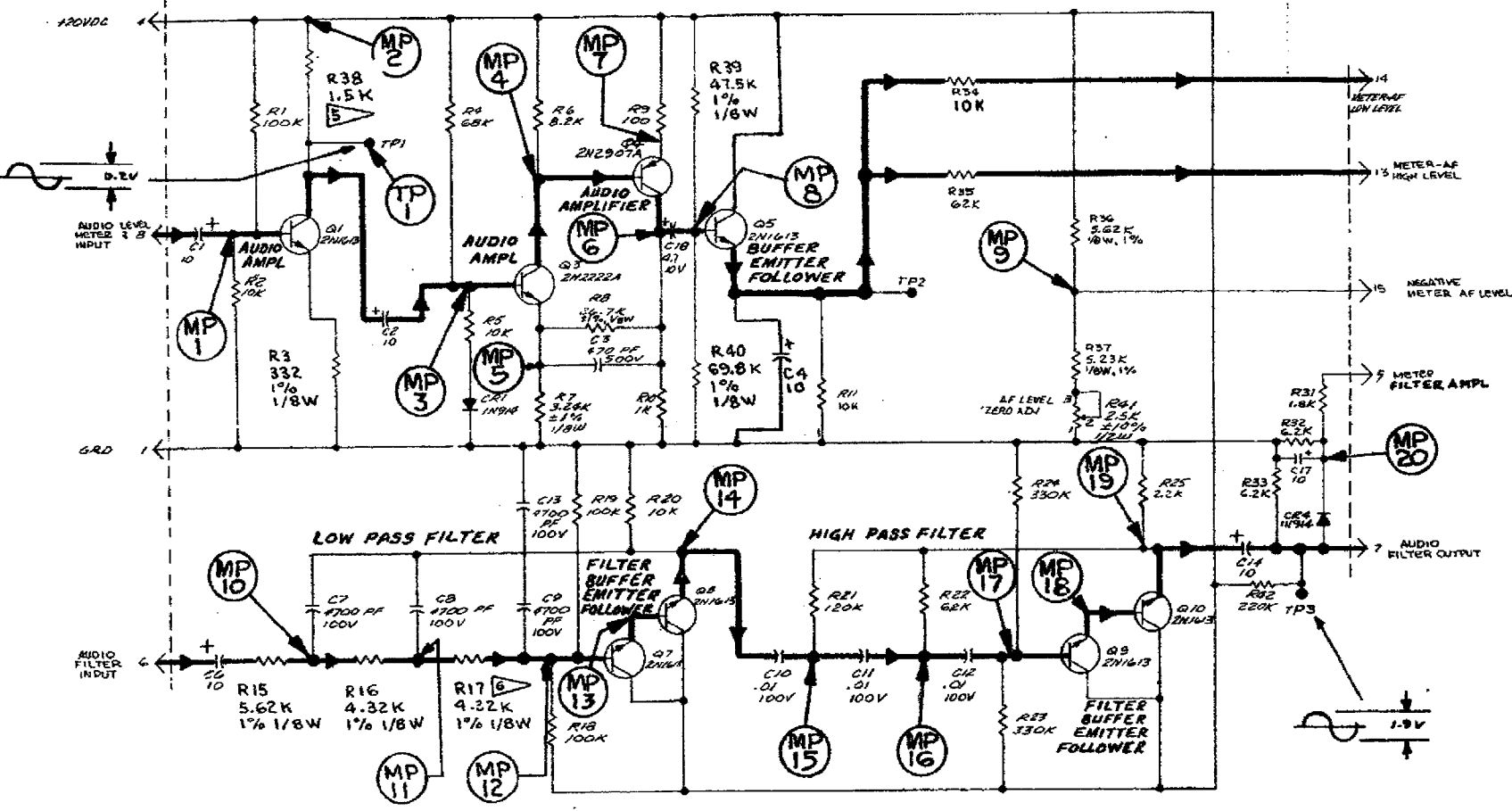


Figure 6-23. Line Amplifier A1, Schematic Diagram



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4 W.
2. CAPACITANCE VALUES ARE IN MICROFARADS, $\pm 10\%$, 20 V.
3. ALL VOLTAGE MEASUREMENTS TAKEN WITH A HIGH INPUT IMPEDANCE METER (HP 427) OR EQUIVALENT
4. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH
5. R38 VALUE SELECTED MAY BE 1.3K, 1.6K, 1.8K OR 2.0K
6. R17 VALUE SELECTED MAY BE 5.62K OR 6.04K

	UNKEYED	KEYED
TP1	16 VDC	16 VDC
TP2	10 VDC	10 VDC
TP3	0.2 VDC	0.2 VDC

Waveforms: at 1 KHz Remote Modulation input at 0 dbm

CONFIGURATION CHANGES

ECP 178 CHANGES

R15 FROM 4.7K TO 5.6K

ECP 303 CHANGES

R3 FROM 330 OHM, 15%, 1/4W TO 322 OHM, 1%, 1/8W

R15 FROM 5.6K, 5%, 1/4W TO 5.62K, 1%, 1/8W

R16 FROM 4.7K, 5% TO 4.32K, 1%

R17 FROM 4.7K, 5% TO 4.32K, 1%

R38 FROM 1.5K, 5%, 1/4W TO 1.5K, 1%, 1/8W

R39 FROM 47K, 5%, 1/4W TO 47.5K, 1%, 1/8W

R40 FROM 68K, 5%, 1/4W TO 69.8K, 1%, 1/8W

ECP 354A CHANGES

R38 FROM 1.5K, 1%, 1/8W TO TAILOR POINT, SEE FLAG NOTE 5

ECP 373 CHANGES

R17 FROM FIXED TO TAILOR POINT, SEE FLAG NOTE 6

Figure 6-24. Filter Amplifier/Detector A4, Schematic Diagram

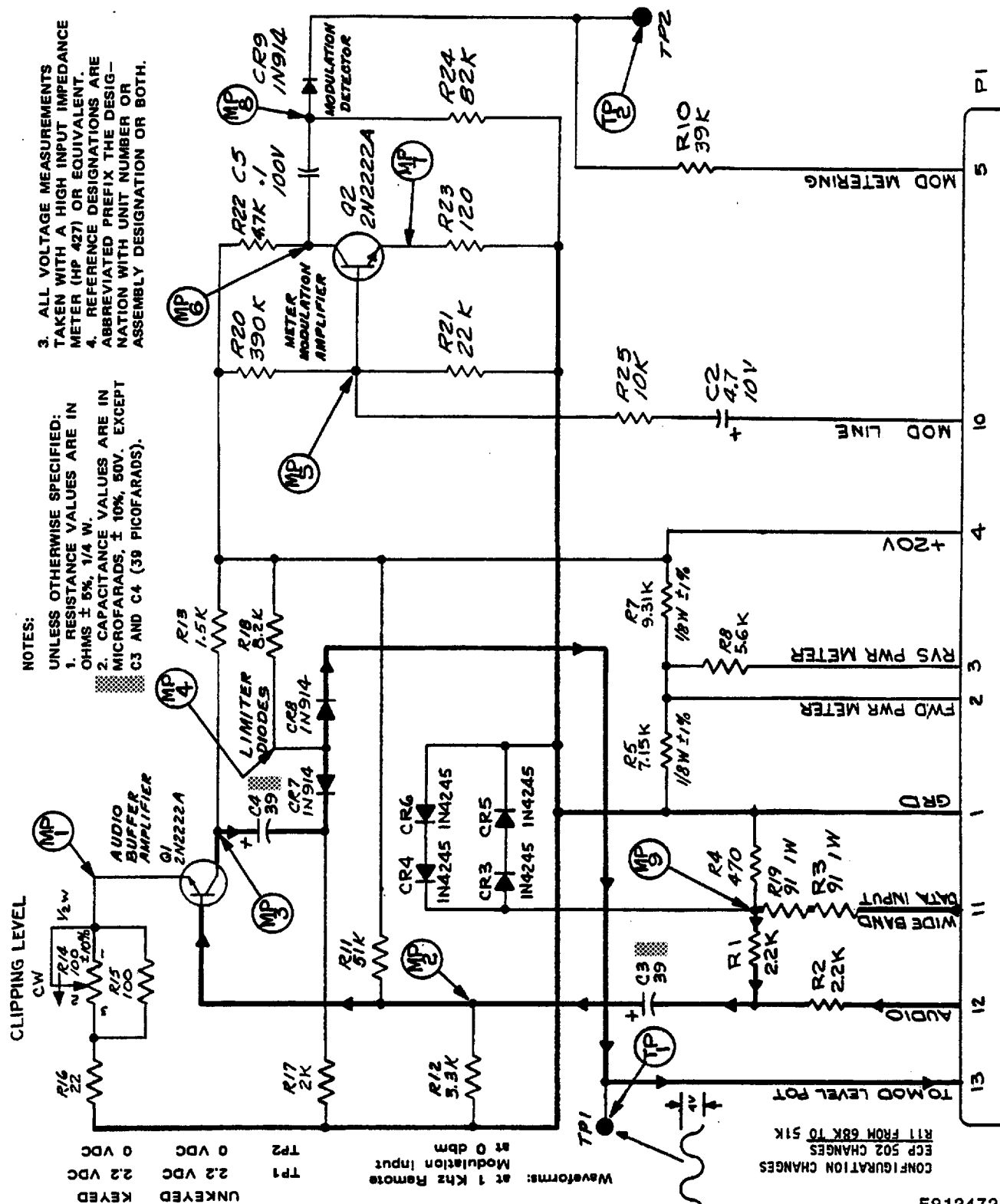


Figure 6-25. Buffer Modulator A5, Schematic Diagram

F9124726

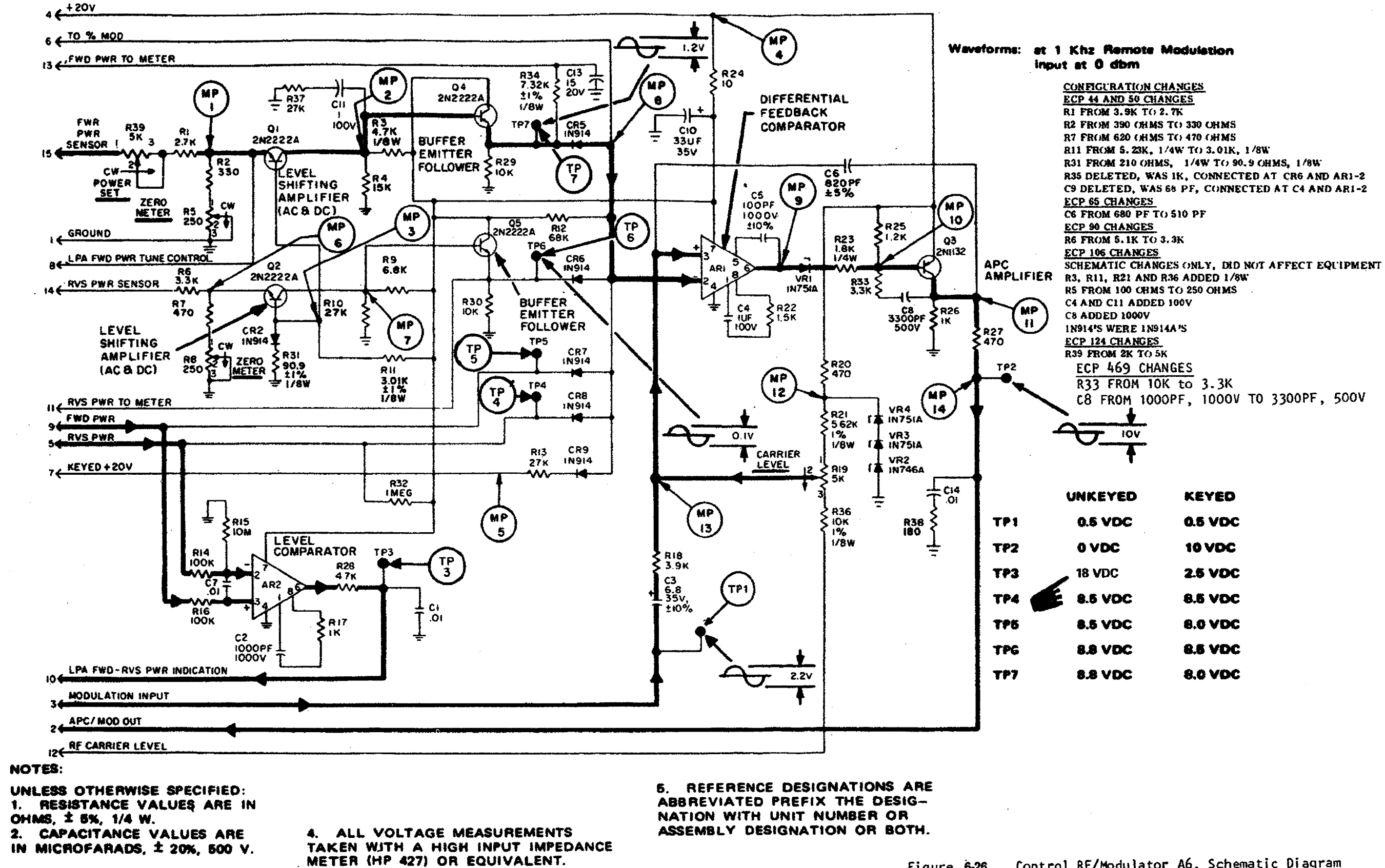
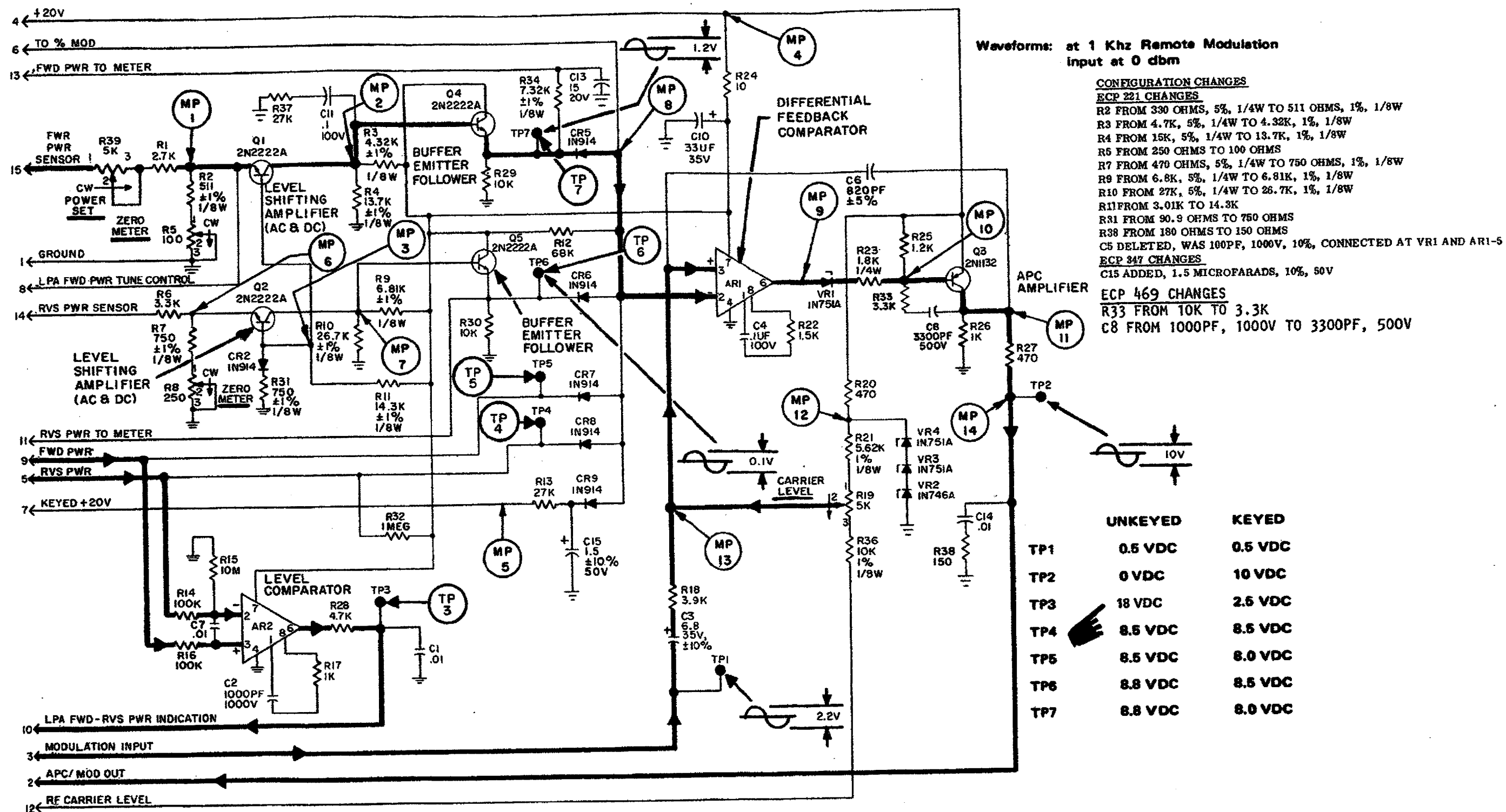


Figure 6-26. Control RF/Modulator A6, Schematic Diagram (Early Configuration)



NOTES:

- UNLESS OTHERWISE SPECIFIED:
 1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4 W.
 2. CAPACITANCE VALUES ARE IN MICROFARADS, $\pm 20\%$, 500 V.

4. ALL VOLTAGE MEASUREMENTS TAKEN WITH A HIGH INPUT IMPEDANCE METER (HP 427) OR EQUIVALENT.

5. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.

Figure 6-27. Control, RF/Modulator A6, Schematic Diagram (Latest Configuration)

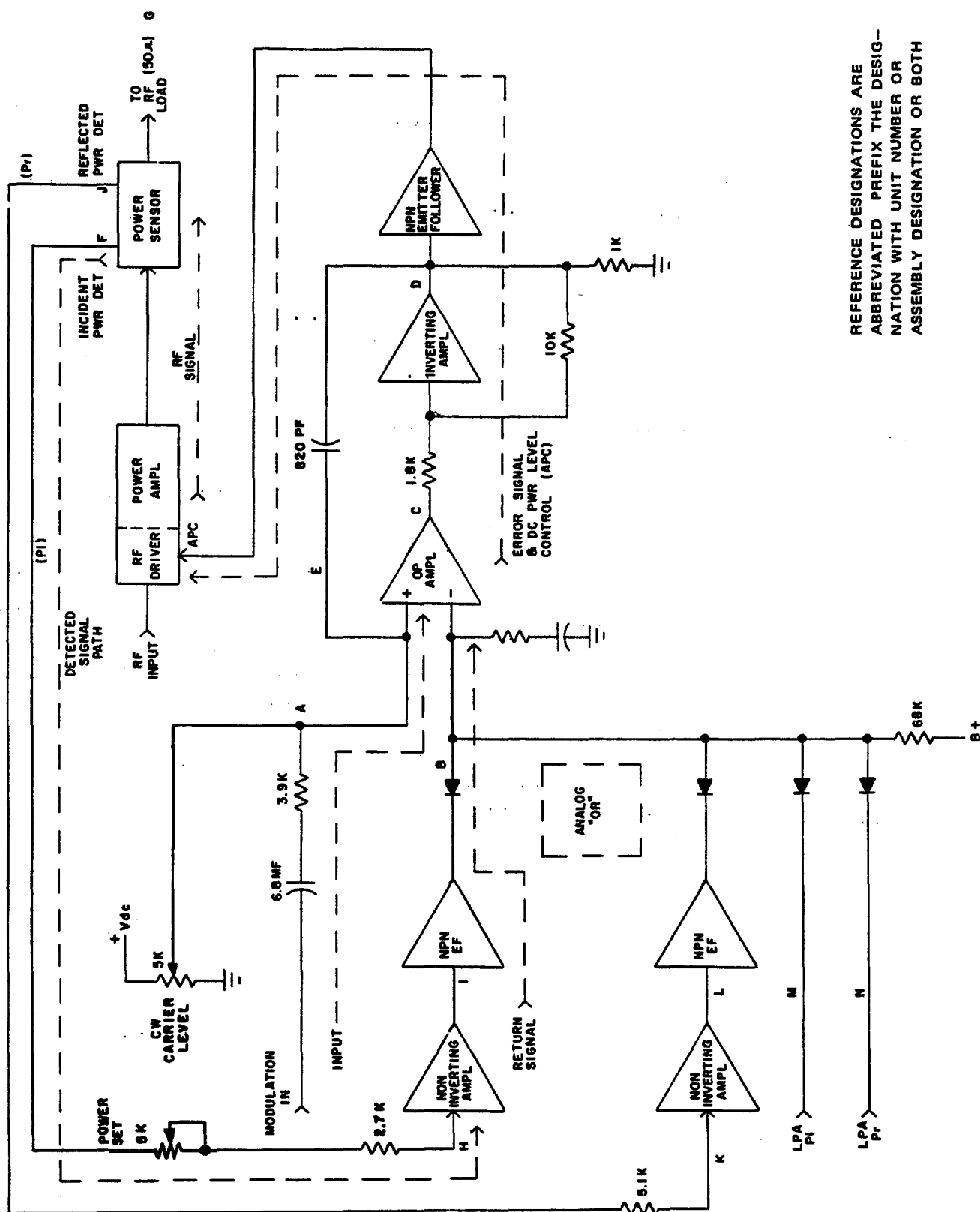


Figure 6-28. Control RF/Modulator Feedback Loop, Block Diagram

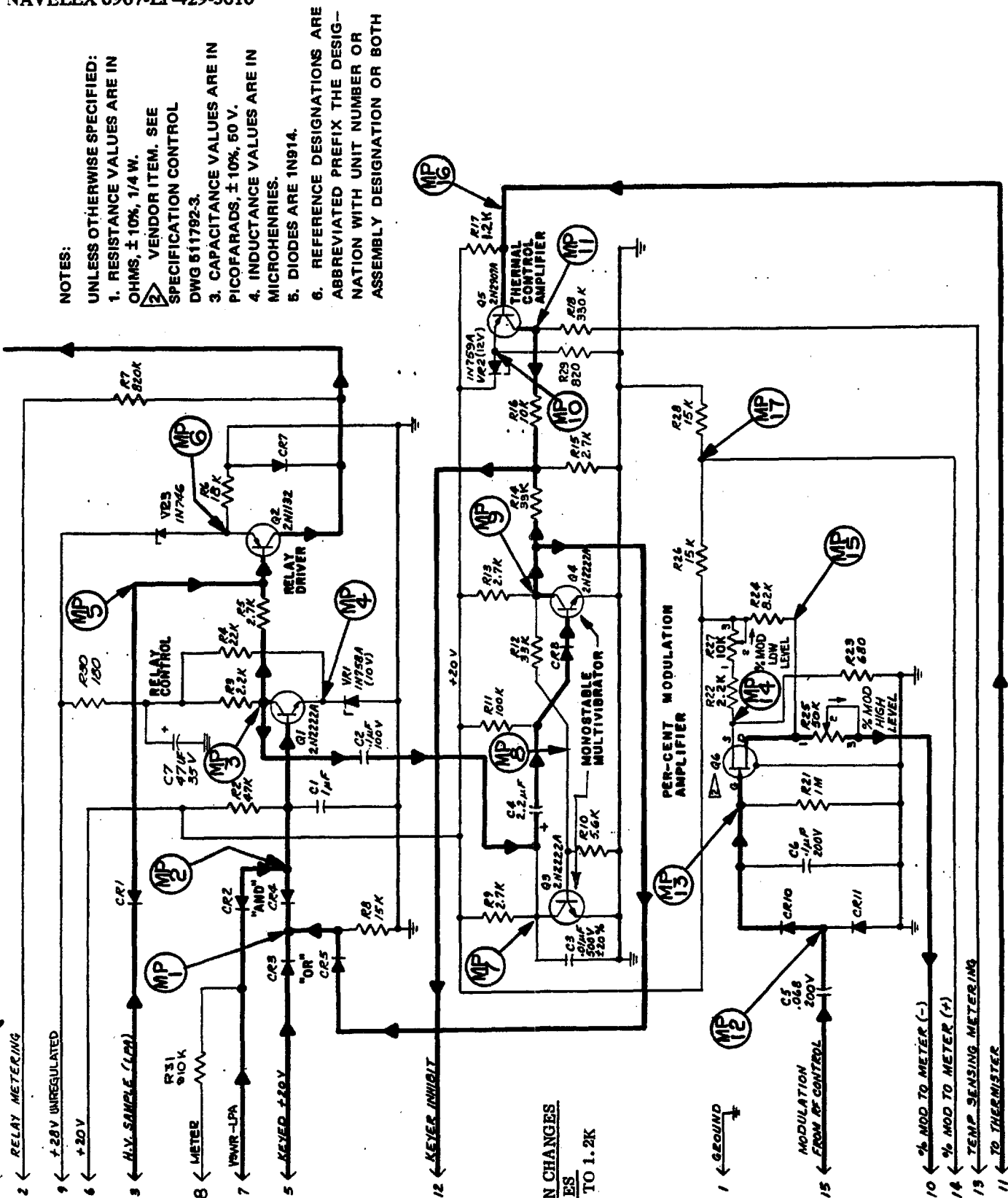


Figure 6-29. Control, Thermal/Detector Modulation Percentage/Coaxial Relay/Control Keyer Inhibit A7, Schematic Diagram

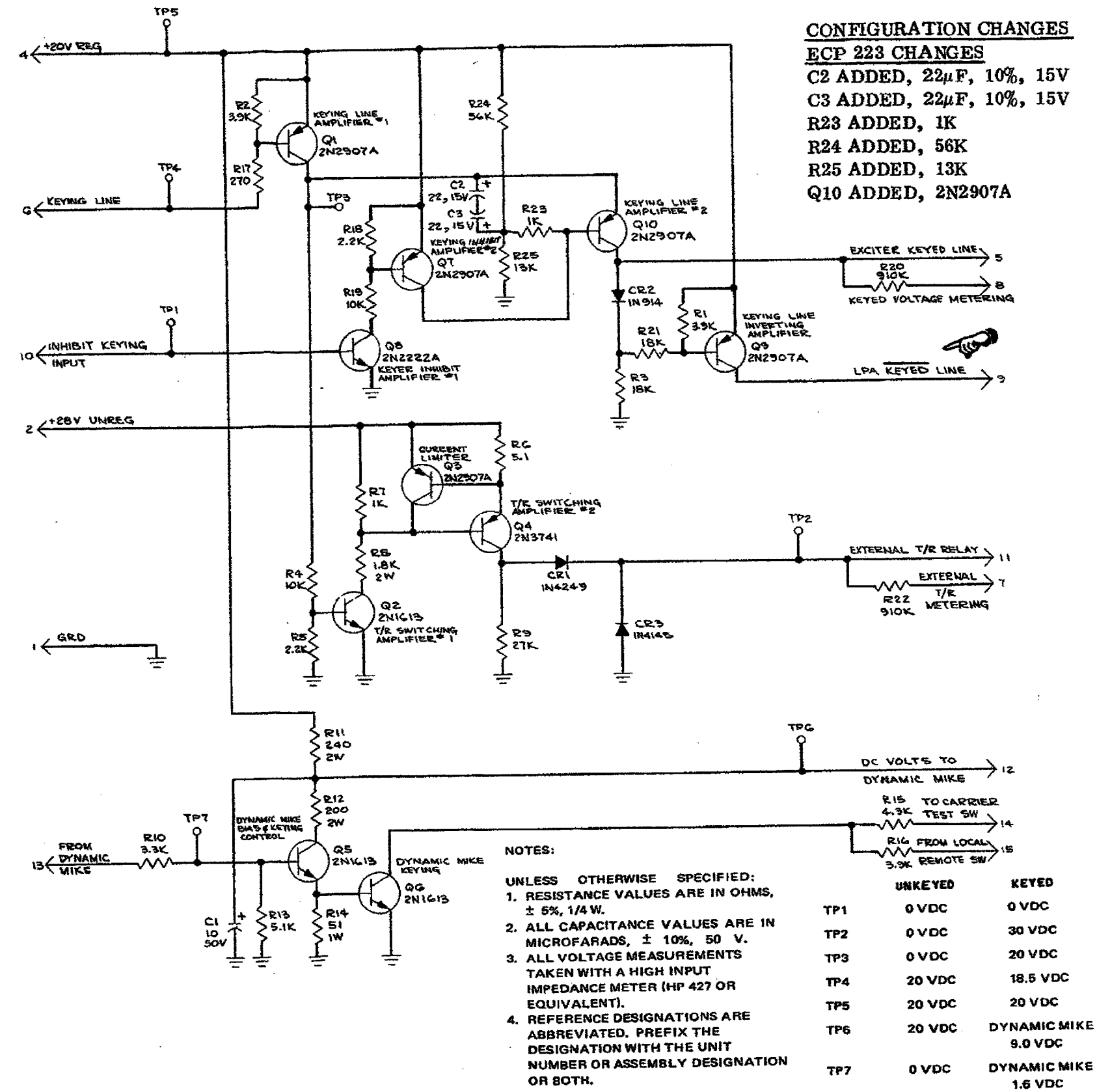


Figure 6-30. Keyer, Control Transfer A2, Schematic Diagram

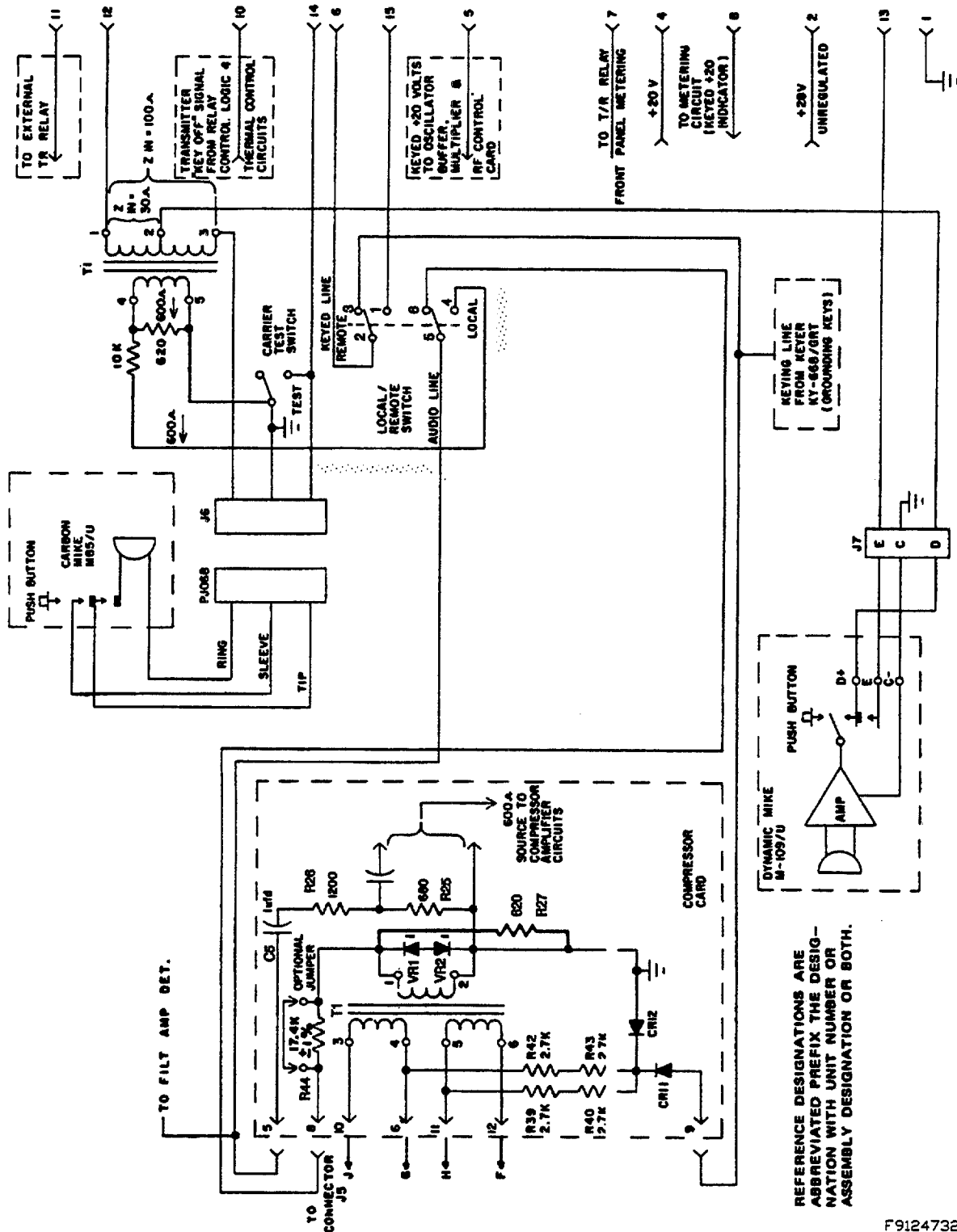


Figure 6-31. Audio Control Circuits, Schematic Diagram

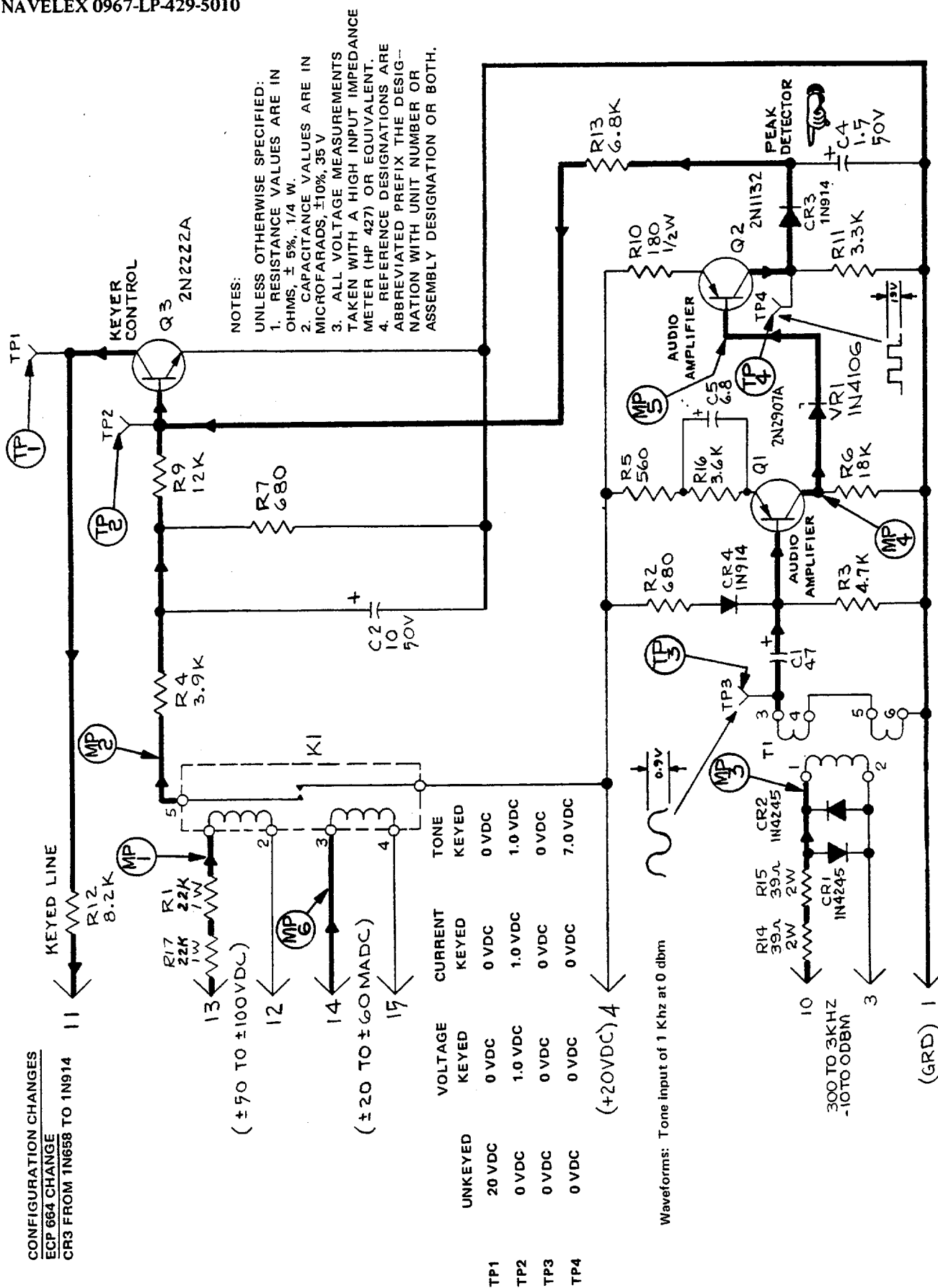


Figure 6-32. Keyer KY-688/GRT A3, Schematic Diagram

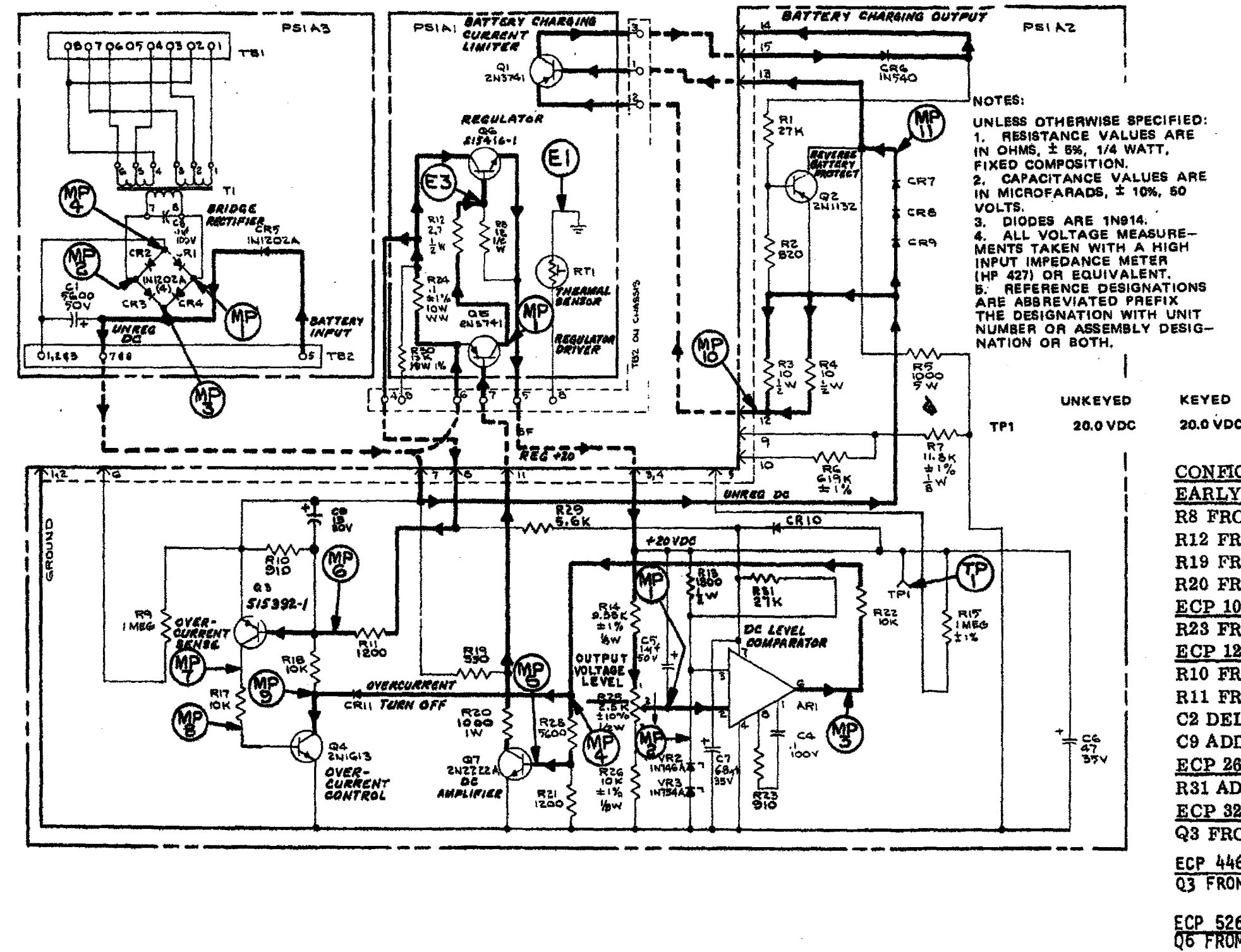


Figure 6-33. Power Supply PS1A3, Regulator PS1A1 and PS1A2, Schematic Diagram

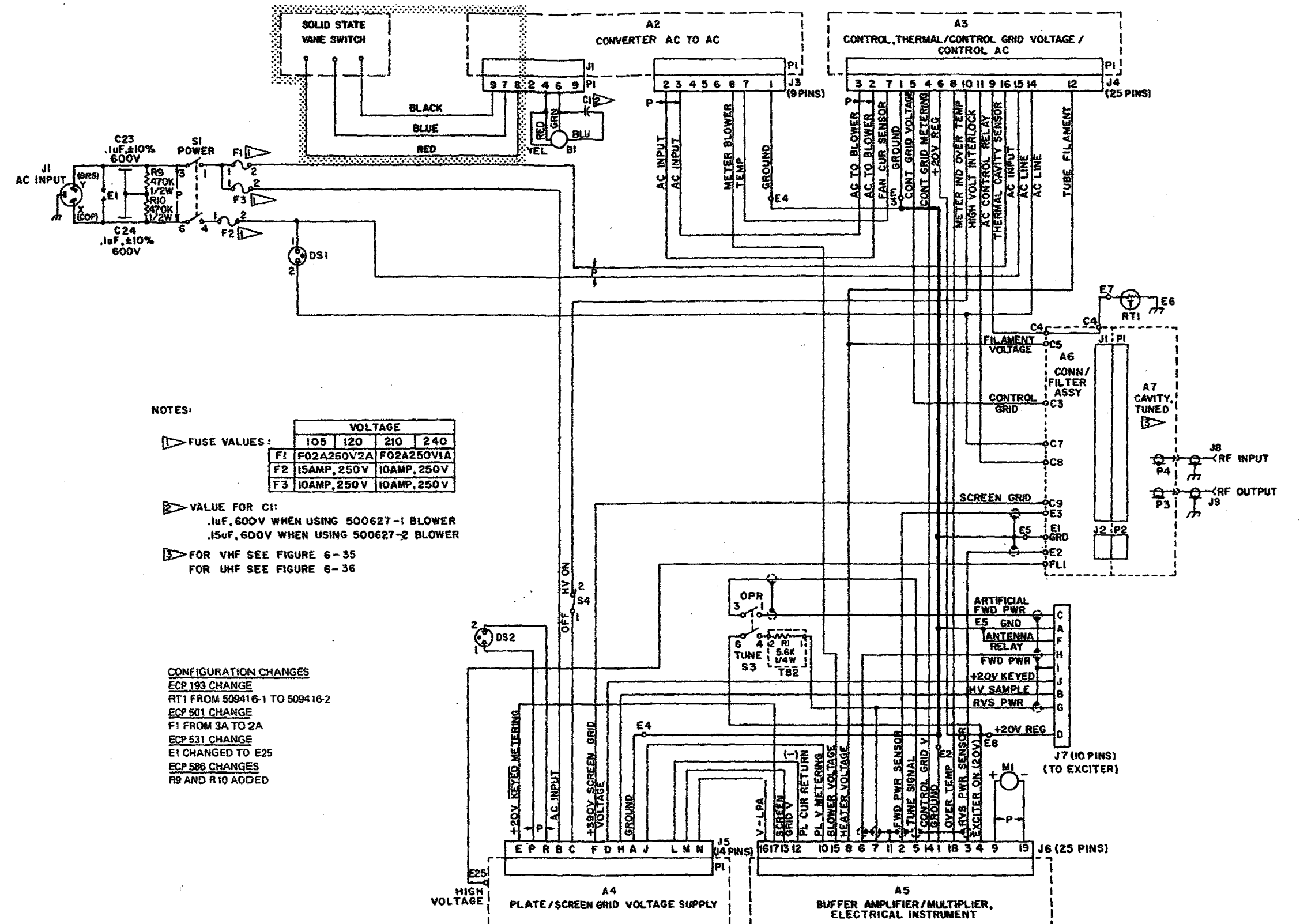
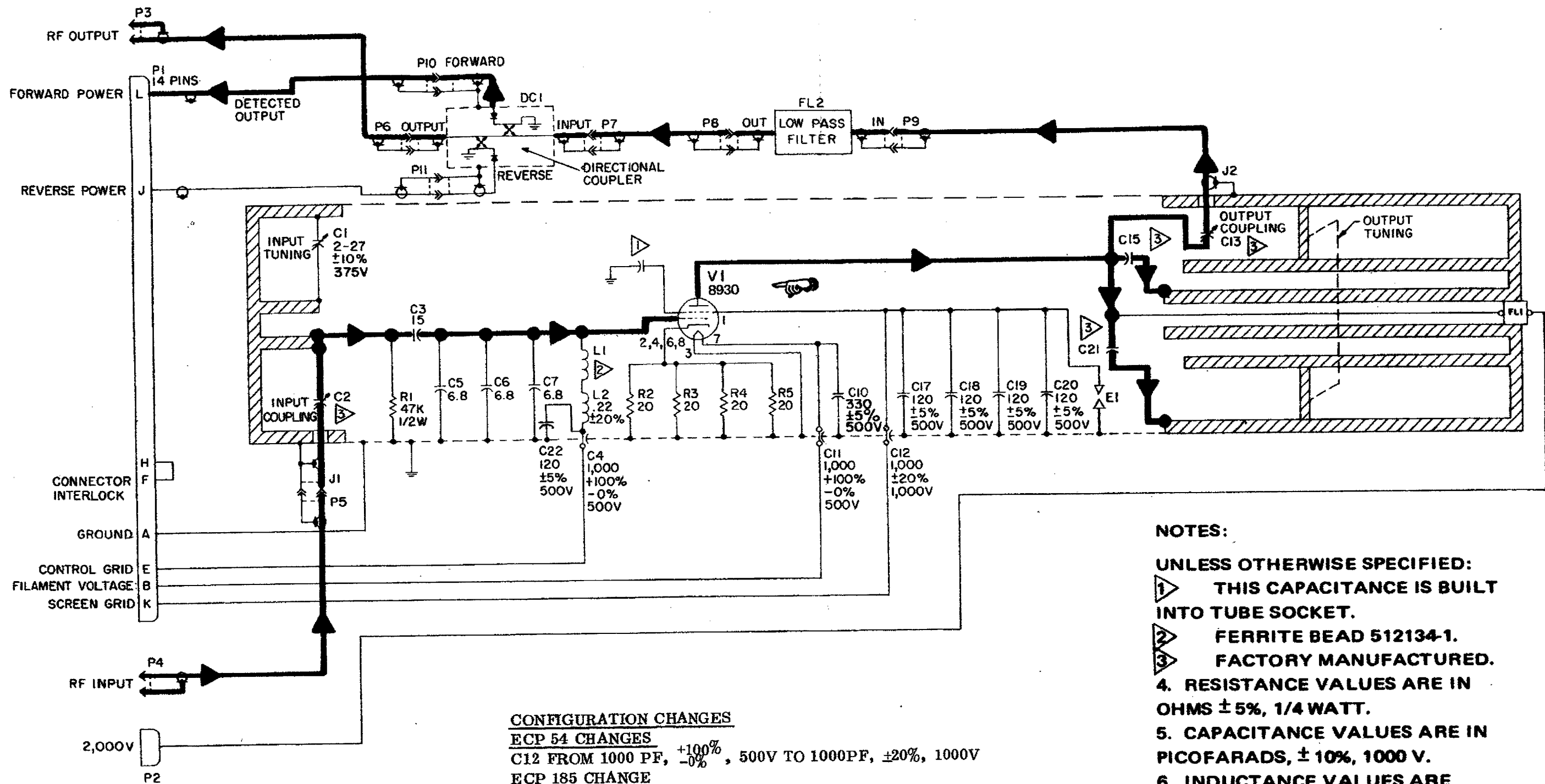


Figure 6-34. Power Amplifier, Schematic Diagram.



CONFIGURATION CHANGES

ECP 54 CHANGES

C12 FROM 1000 PF, $\pm 100\%$, 500V TO 1000PF, $\pm 20\%$, 1000V

ECP 185 CHANGE

C10 FROM 470 PF, 100V, $\pm 10\%$ TO 330PF, $\pm 5\%$, 500V

ECP 236 CHANGE

E1 ADDED

ECP 441 CHANGE

E1 FROM 501204-2 TO 501204-3

ECP 608 CHANGE

V1 FROM 504809-1 TO 8930

NOTES:

UNLESS OTHERWISE SPECIFIED:

1 THIS CAPACITANCE IS BUILT INTO TUBE SOCKET.

2 FERRITE BEAD 512134-1.

3 FACTORY MANUFACTURED.

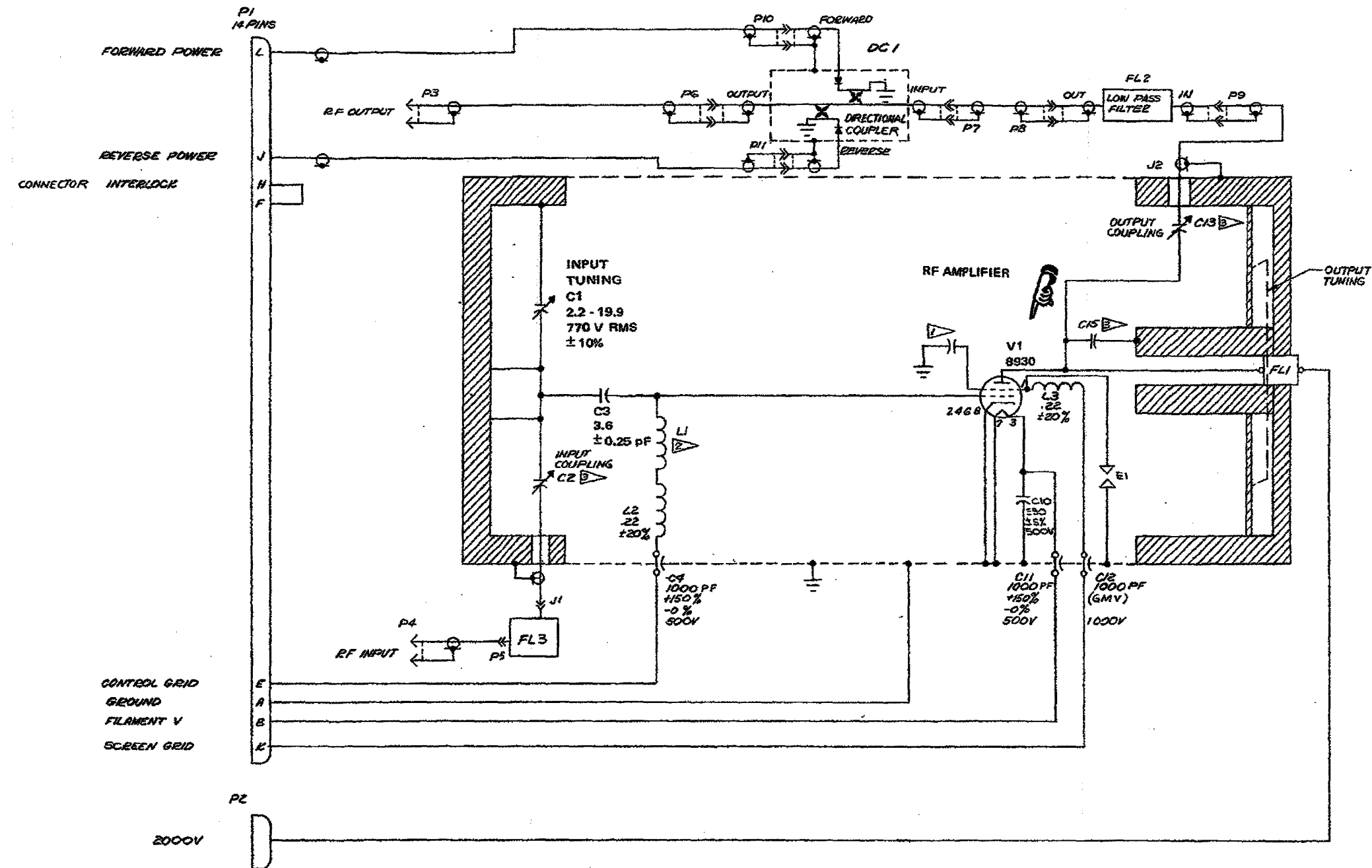
4. RESISTANCE VALUES ARE IN OHMS $\pm 5\%$, 1/4 WATT.

5. CAPACITANCE VALUES ARE IN PICO FARADS, $\pm 10\%$, 1000 V.

6. INDUCTANCE VALUES ARE 1.0 MICROHENRIES $\pm 10\%$.

7. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH

Figure 6-35. Tuned Cavity (VHF) A7, Schematic Diagram



EARLY CONFIGURATION
C3, C5, C6 FROM $\pm 10\%$ TO ± 0.1 pF

CONFIGURATION CHANGES

C3, C5, C6 FROM ± 0.1 pF TO ± 0.25 pF

ECP 38 CHANGE

C5, C6 DELETED

ECP 64 CHANGE
G12 FROM 1992 -

C12 FROM 1000 pF, (+100% - 0%), 500V TO GMV, 1000 V
ECR 185 CHANGE

ECP 185 CHANGE
C10 FROM 470 pF

C10 FROM 470 pF, $\pm 10\%$, 100V TO 330 pF, $\pm 5\%$, 500 V
ECP 236 CHANGE

ELF 236 CHANGE
E1 ADDED

ECP 281 CHA

C3 FROM 1000V TO 500V

ECP 346 CHANGES

C1 FROM 1.2 - 20, 375V TO 2.2 - 19.9 pF

C3 FROM 3.3 pF, ± 0.5

ECP 441 CHANGE
E1 FROM E0022-0

E1 FROM 509204-2 TO 509204-3
ECR 611 CHANGE

ECP 611 CHANGE
EL 3 ADDED

**FL3 ADDED
FOR \$20 CHARGE**

ECP 608 CHANGE

NOTES:
UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IS BUILT INTO TUBE SOCKET.
2. FERRITE BEAD 512134-1.
3. FACTORY MANUFACTURED.
4. ALL CAPACITANCE VALUES ARE IN PICO FARADS, $\pm 10\%$, 1000V.
5. ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
6. REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.

Figure 6-36. Tuned Cavity (UHF) A7, Schematic Diagram

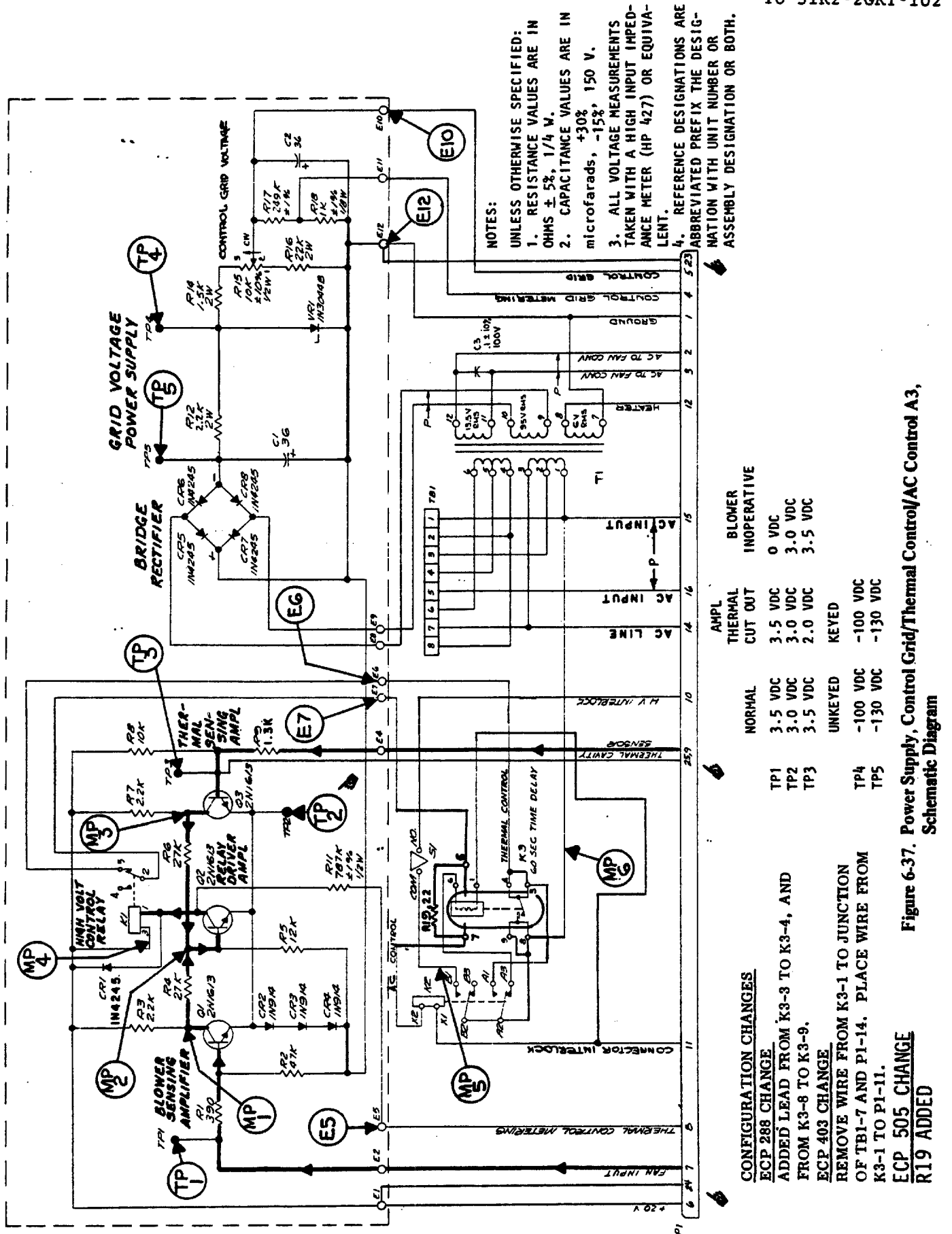


Figure 6-37. Power Supply, Control Grid/Thermal Control/AC Control A3, Schematic Diagram

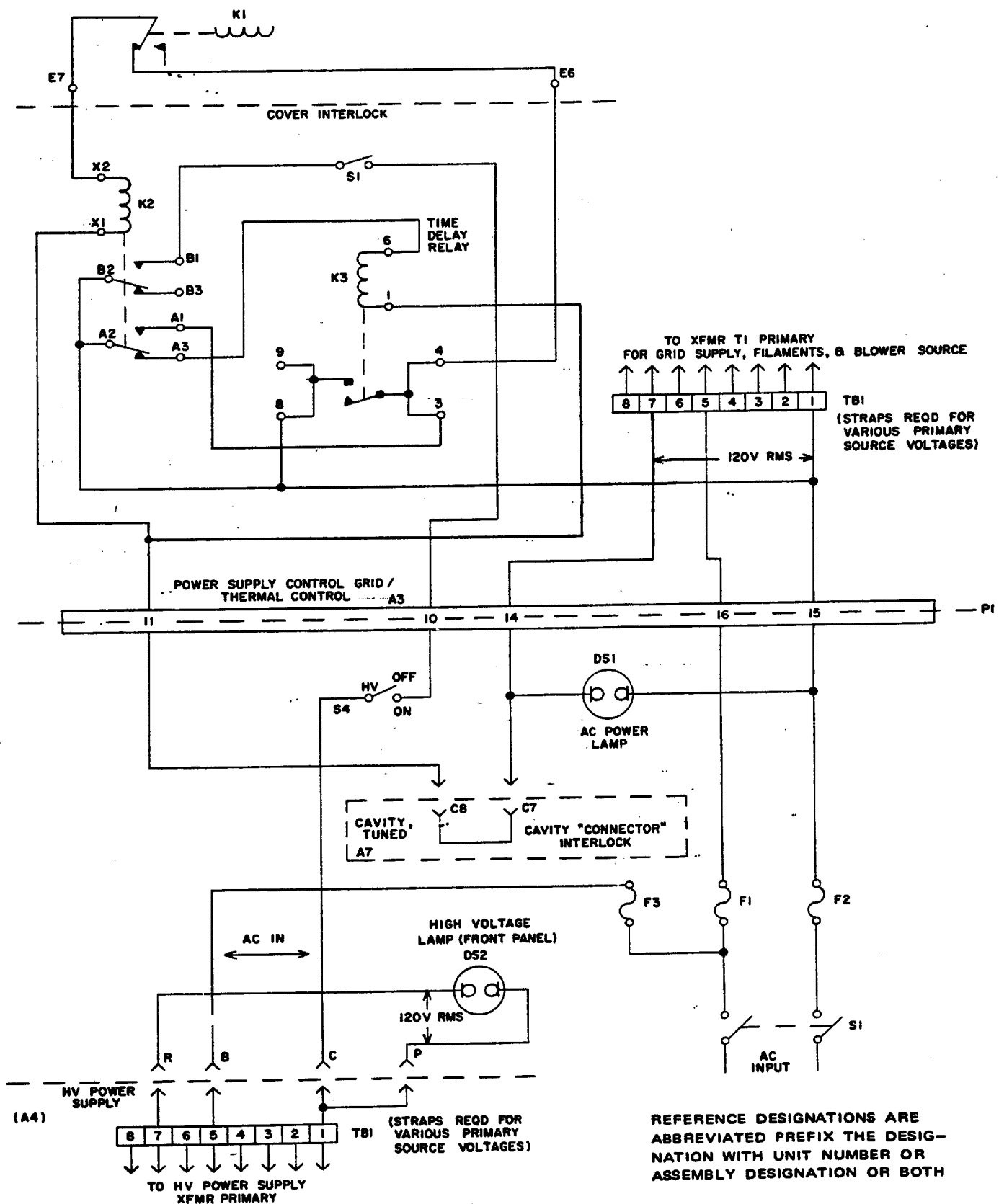


Figure 6-38. AC Control Circuits, Schematic Diagram

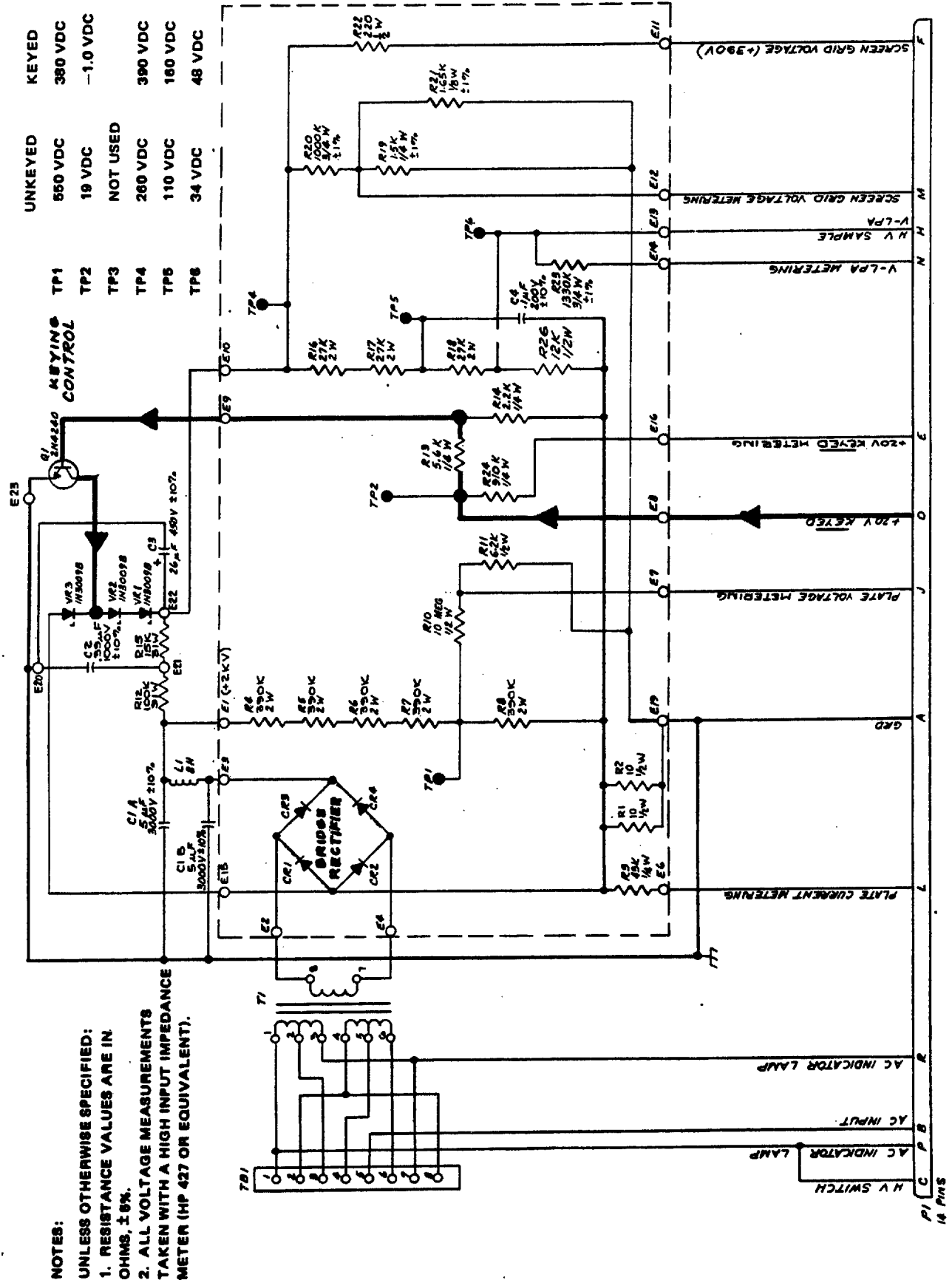


Figure 6-39. Power Supply, Plate/Screen Grid A4, Schematic Diagram (Early Configuration)

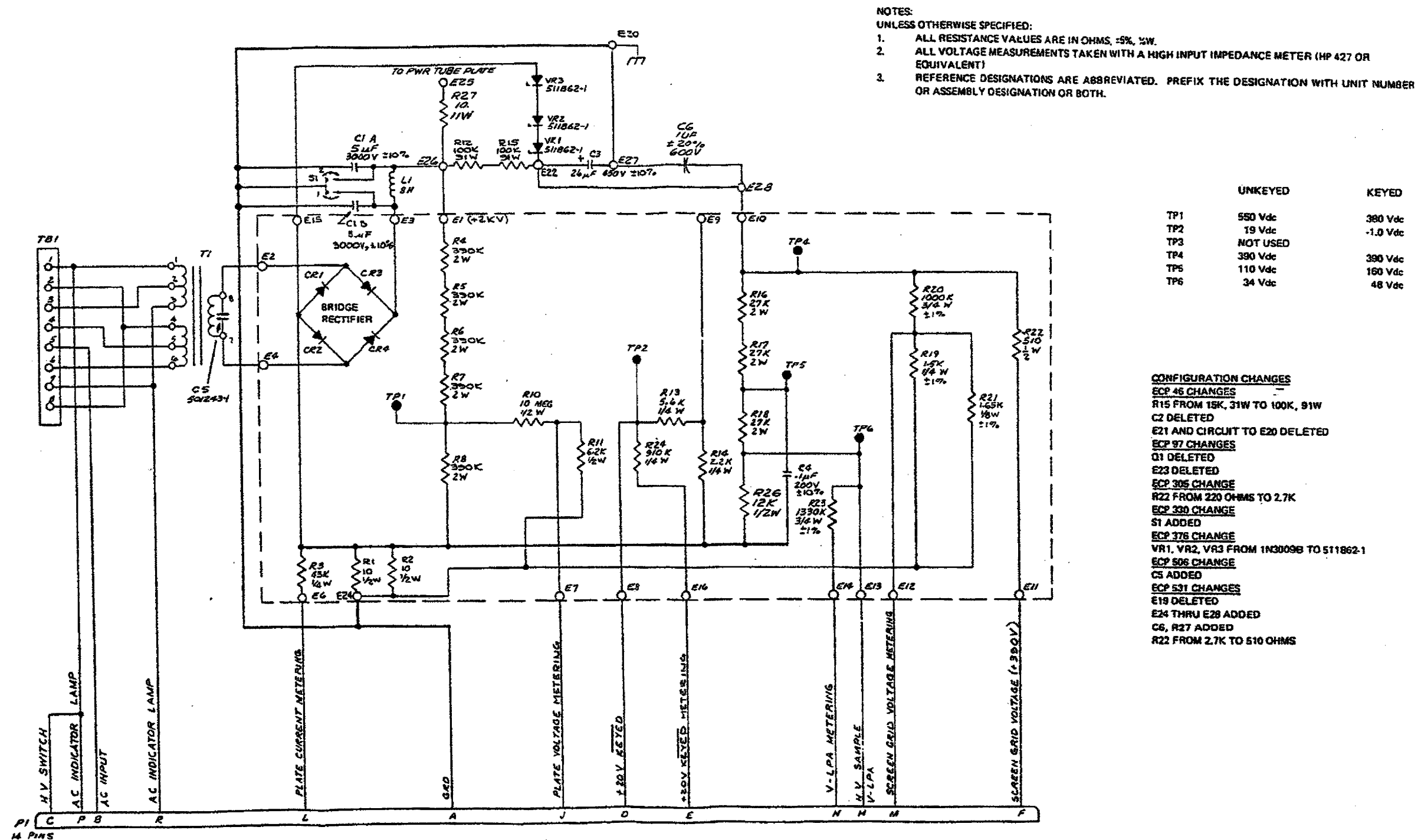
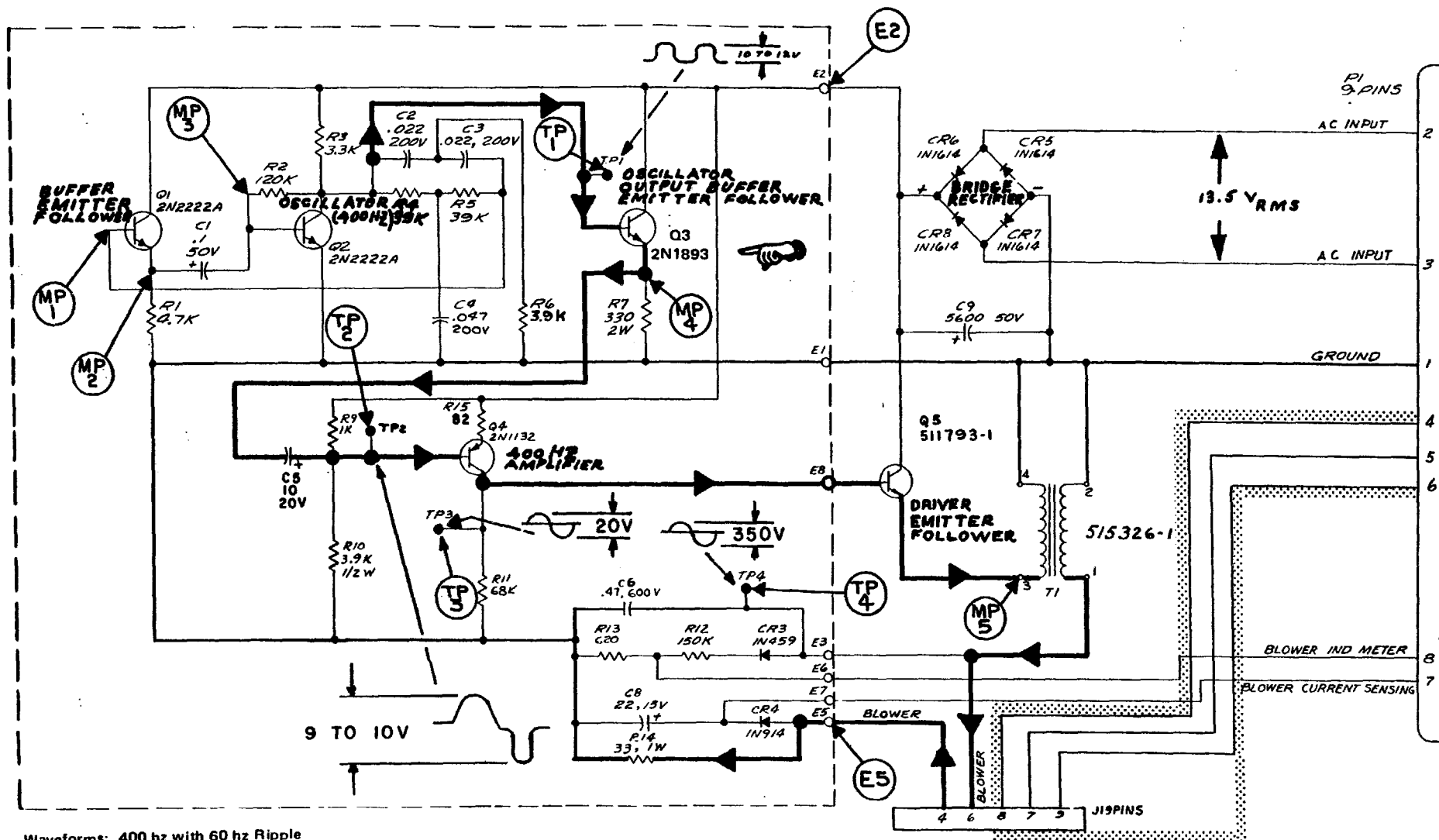


Figure 6-40. Power Supply, Plate/Screen Grid A4, Schematic Diagram
(Latest Configuration)



EARLY CONFIGURATION
Q5 FROM 2N3771 TO 511793-1
ECP 87 CHANGE
R6 FROM 2.7K TO 3.9K
ECP 356 CHANGE
R11 FROM 68K TO 3.9K
ECP 588 CHANGE
R11 FROM 3.9 TO 68K
ECP 619 CHANGE
Q3 FROM 2N1613 TO 2N1893

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4 WATT.
2. CAPACITANCE VALUES ARE IN MICROFARADS, $\pm 10\%$.

3. ALL VOLTAGE MEASUREMENTS TAKEN WITH A HIGH INPUT IMPEDANCE METER (HP 427 OR EQUIVALENT).
4. REFERENCE DESIGNATIONS ARE ABBREVIATED PREFIX THE DESIGNATION WITH UNIT NUMBER OR ASSEMBLY DESIGNATION OR BOTH.

Figure 6-41. Converter, AC to AC A2, Schematic Diagram

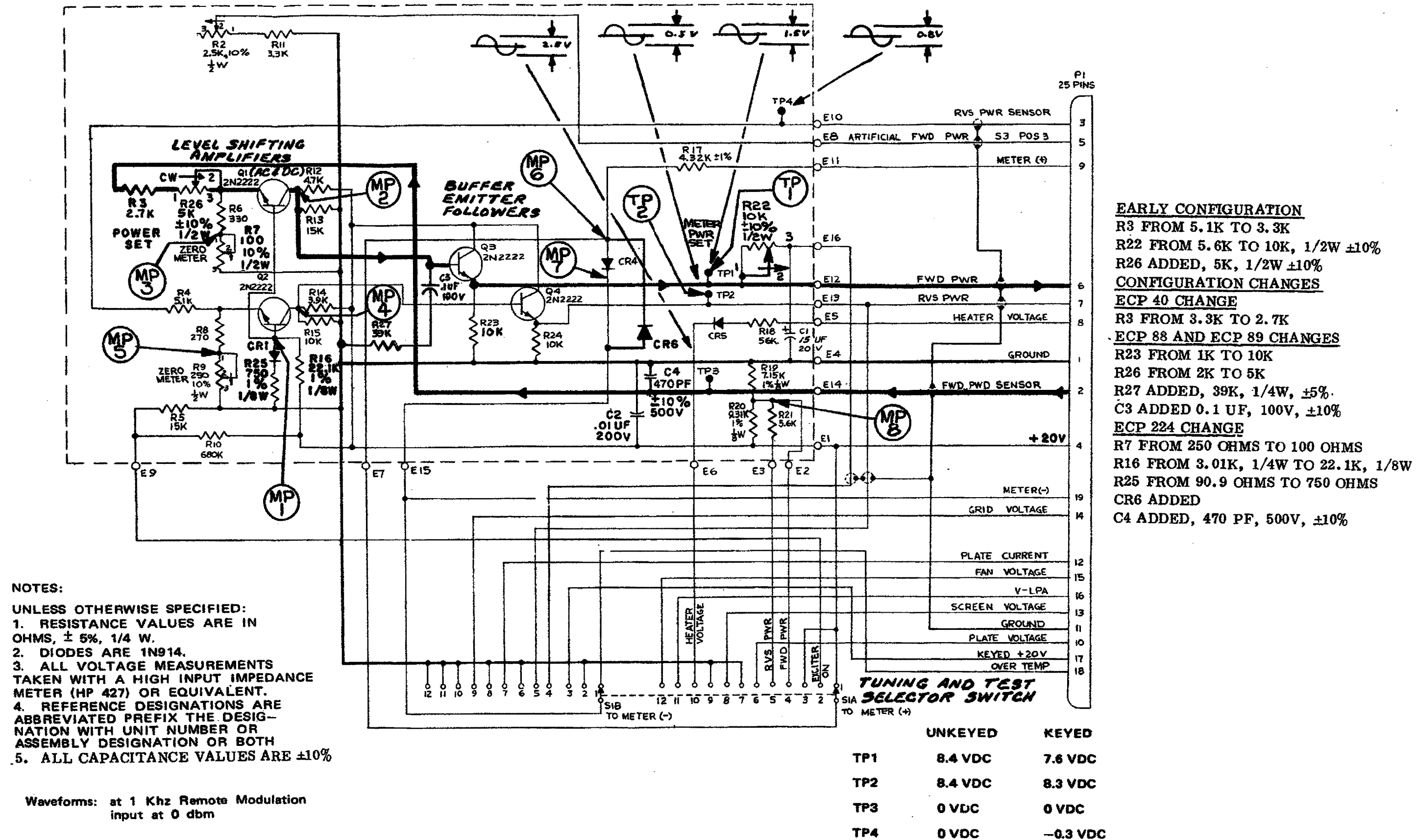


Figure 6-42. Buffer Amplifier/Multiplier, Electrical Instrument A5, Schematic Diagram

NOTES:

WARNING

With the switch off and the fuse cap removed, 115 VAC (hot side) is present on the exposed end of fuse holder (F1). When removing or replacing any fuse, the AN/GRT-21/22 should be disconnected from the 115 VAC source. Failure to comply with this WARNING could result in serious injury or death.

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4 W.
2. CAPACITORS C1 THRU C6, C25, C26, AND C27 VALUES IN PICO FARADS, $\pm 20\%$, 500 V.
3. CAPACITORS C8 THRU C17 AND C19 THRU C22 ARE 1000 PICO FARADS (+150, -0%), 500 V.
4. DELETED.
5. FOR UHF SEE FIGURE 6-7 OR 6-8 FOR VHF SEE FIGURE 6-6
6. FOR UHF SEE FIGURE 6-13 FOR VHF SEE FIGURE 6-9 FOR VHF/UHF SEE FIGURE 6-53
7. FOR CRYSTAL CONTROLLED OSCILLATOR (8004290G2) SEE FIGURE 6-3 FOR CRYSTAL CONTROLLED OSCILLATOR (8004290G3) SEE FIGURE 6-4 FOR SYNTHESIZER SEE FIGURE 6-45 FOR OSCILLATOR-MULTIPLIER SEE FIGURE 6-5
8. FOR AMPLIFIER-COMPRESSOR, AUDIO SEE FIGURE 6-22 FOR LINE AMPLIFIER SEE FIGURE 6-23
9. ADDED WIRING FOR INBOARD MONITORING AND LOW LEVEL NONPOLARIZED KEYING. KEYS, KY-668GRT IS STILL FUNCTIONAL AS OPTIONAL ASSEMBLY WITH ADDED WIRING.
10. FOR KEYS, KY-668GRT SEE FIGURE 6-32 FOR INBOARD MONITOR/KEYER SEE FIGURE 6-51 FOR AFCS KEYS CARD SEE FIGURE 6-52

CONFIGURATION CHANGES

ECP 369 CHANGE
CR2 ADDED
ECP 512 CHANGE
FLAG NOTES 7 AND 8 ADDED
ECP 578 CHANGES
NOTE 9 AND ASSOCIATED WIRING CHANGES
ECP 586 CHANGES
R9 AND R10 ADDED
ECP 643 CHANGES
VHF/UHF DPA ADDED IN NOTE 6

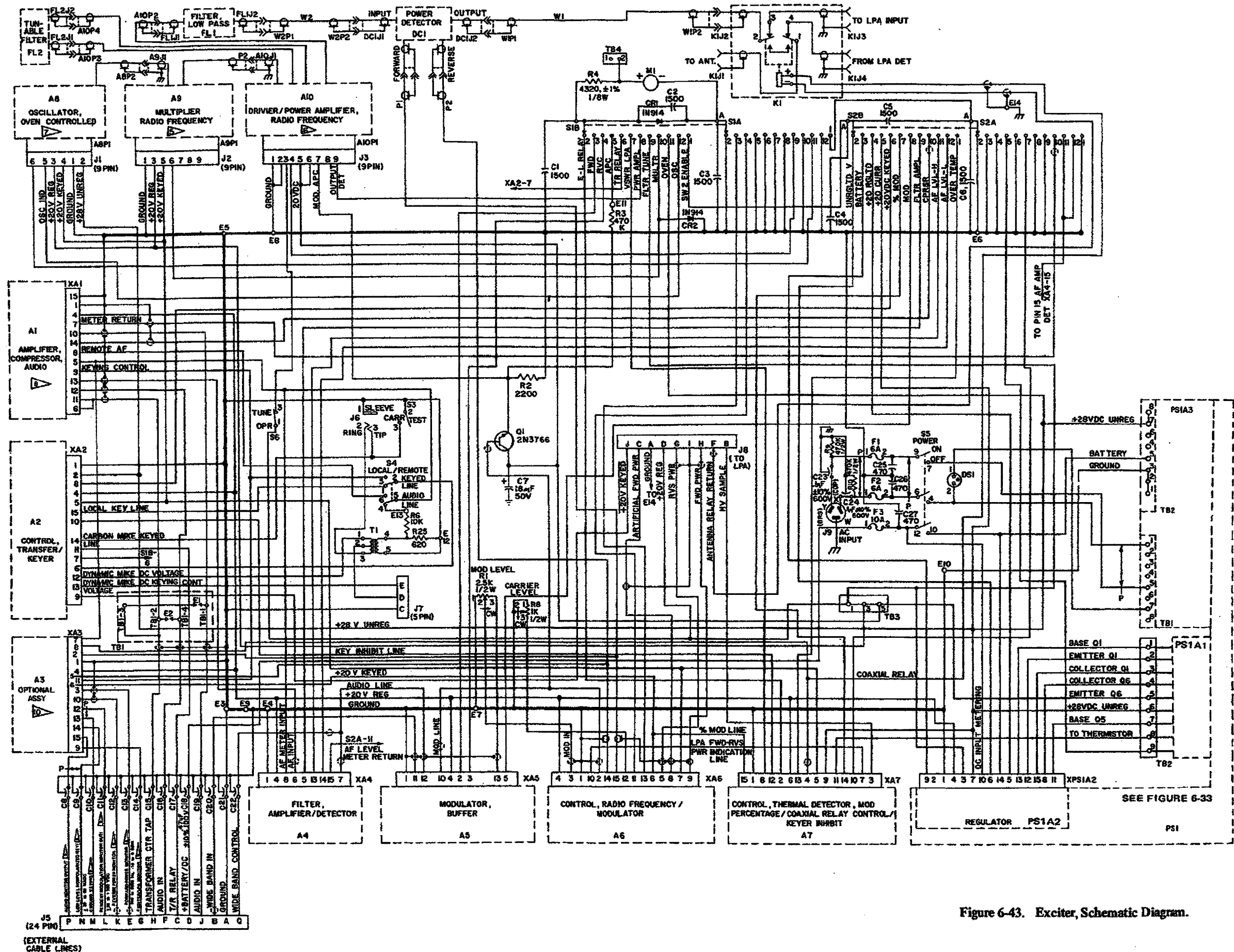


Figure 6-43. Exciter, Schematic Diagram.

NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL CAPACITANCE VALUES
ARE 1000 PF $\pm 100\%$ -0%, 500 VDC

2. REFERENCE DESIGNATIONS ARE
ABBREVIATED PREFIX THE DESIG-
NATION WITH UNIT NUMBER OR
ASSEMBLY DESIGNATION OR BOTH

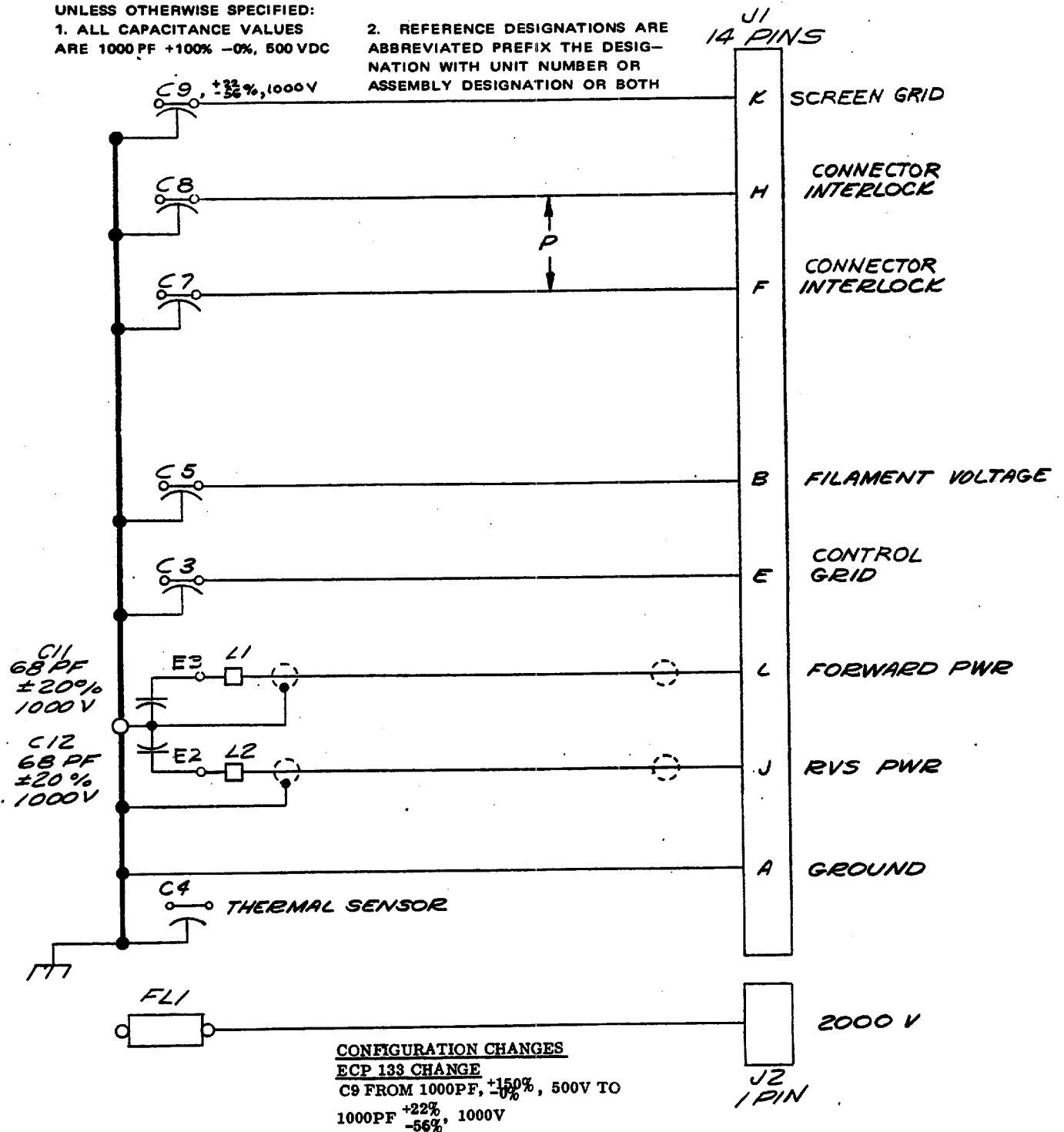


Figure 6-44. Connector/Filter, Cavity Input, Schematic Diagram

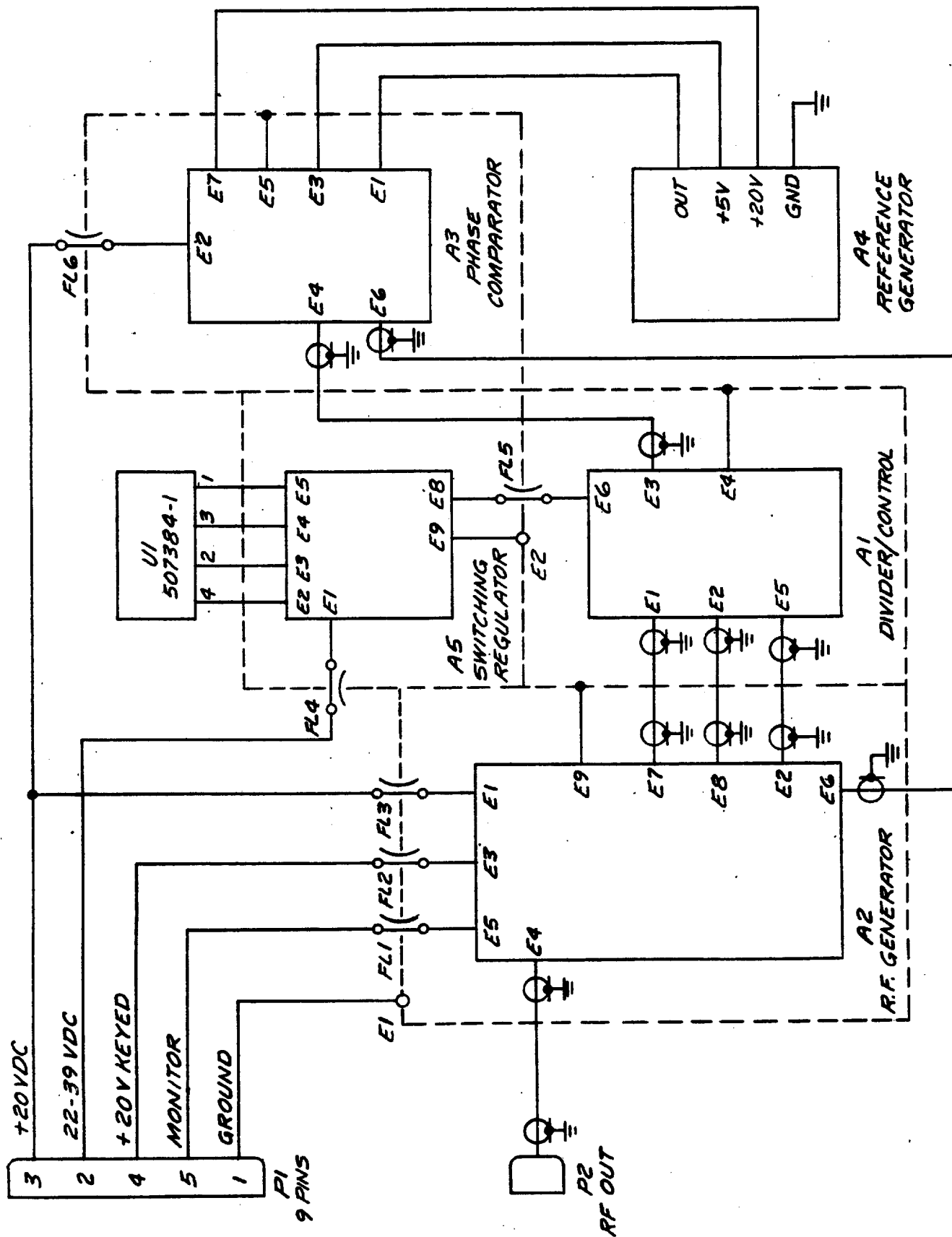
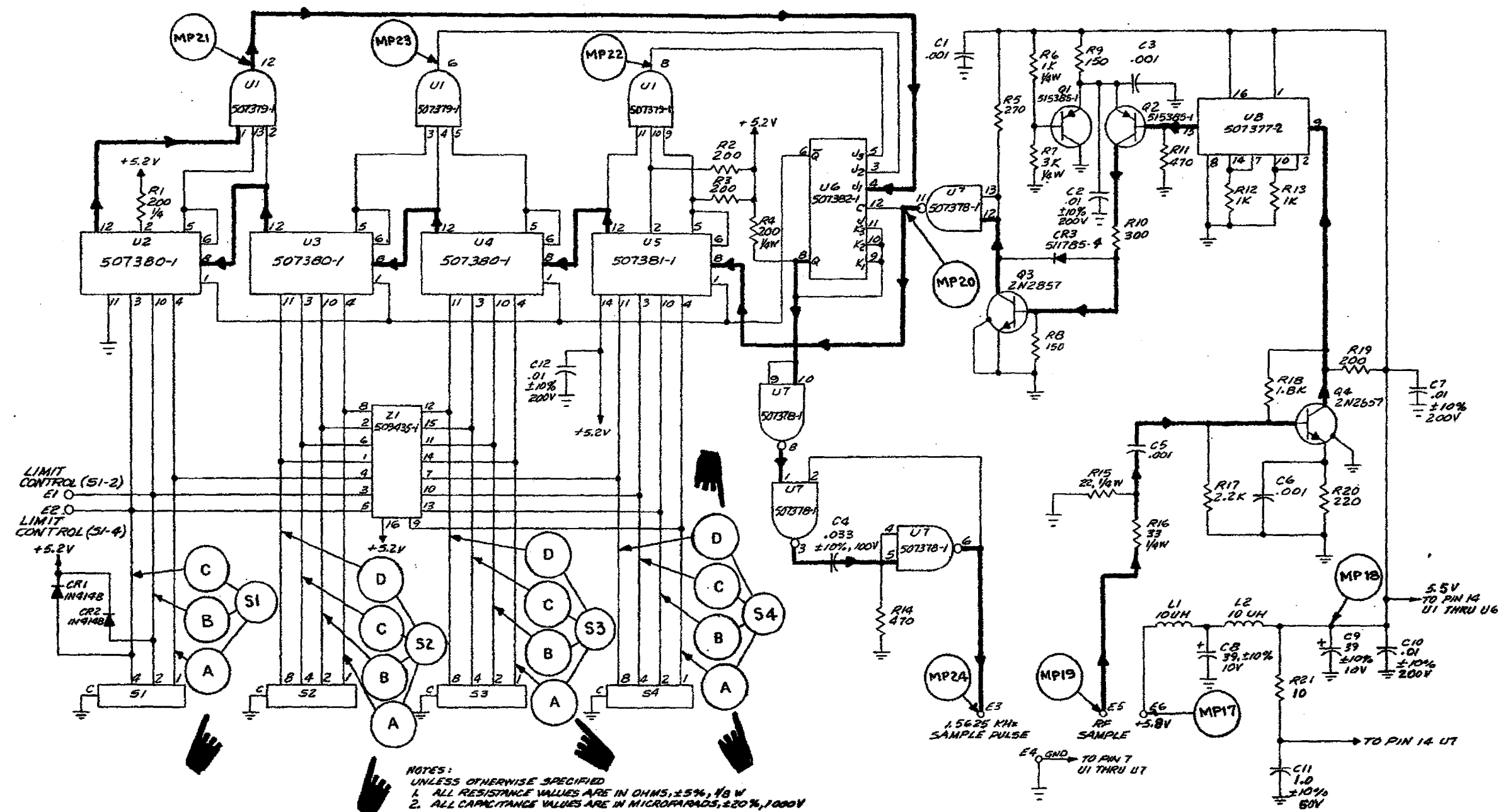


Figure 645. Synthesizer A8, Schematic Diagram



CONFIGURATION CHANGES

ECP 476 CHANGE
CR3 FROM 511785-1 TO 511785-4

ECP 520 CHANGES
R21 WAS 47
C11 WAS 0.01, 200V
VOLTAGE AT E6 WAS 5.5 Vdc

Figure 6-46. Divider/Control A8A1, Schematic Diagram

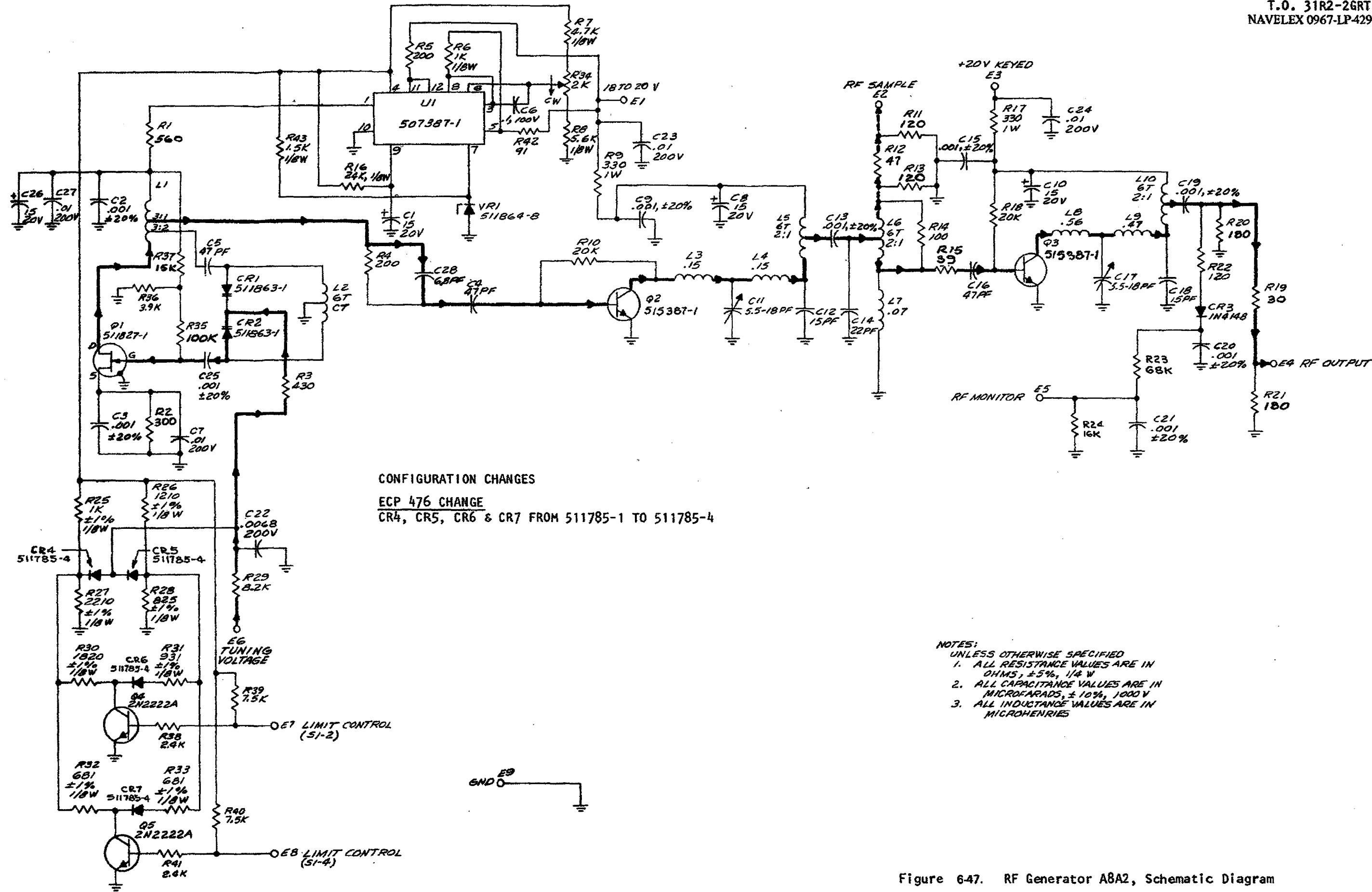
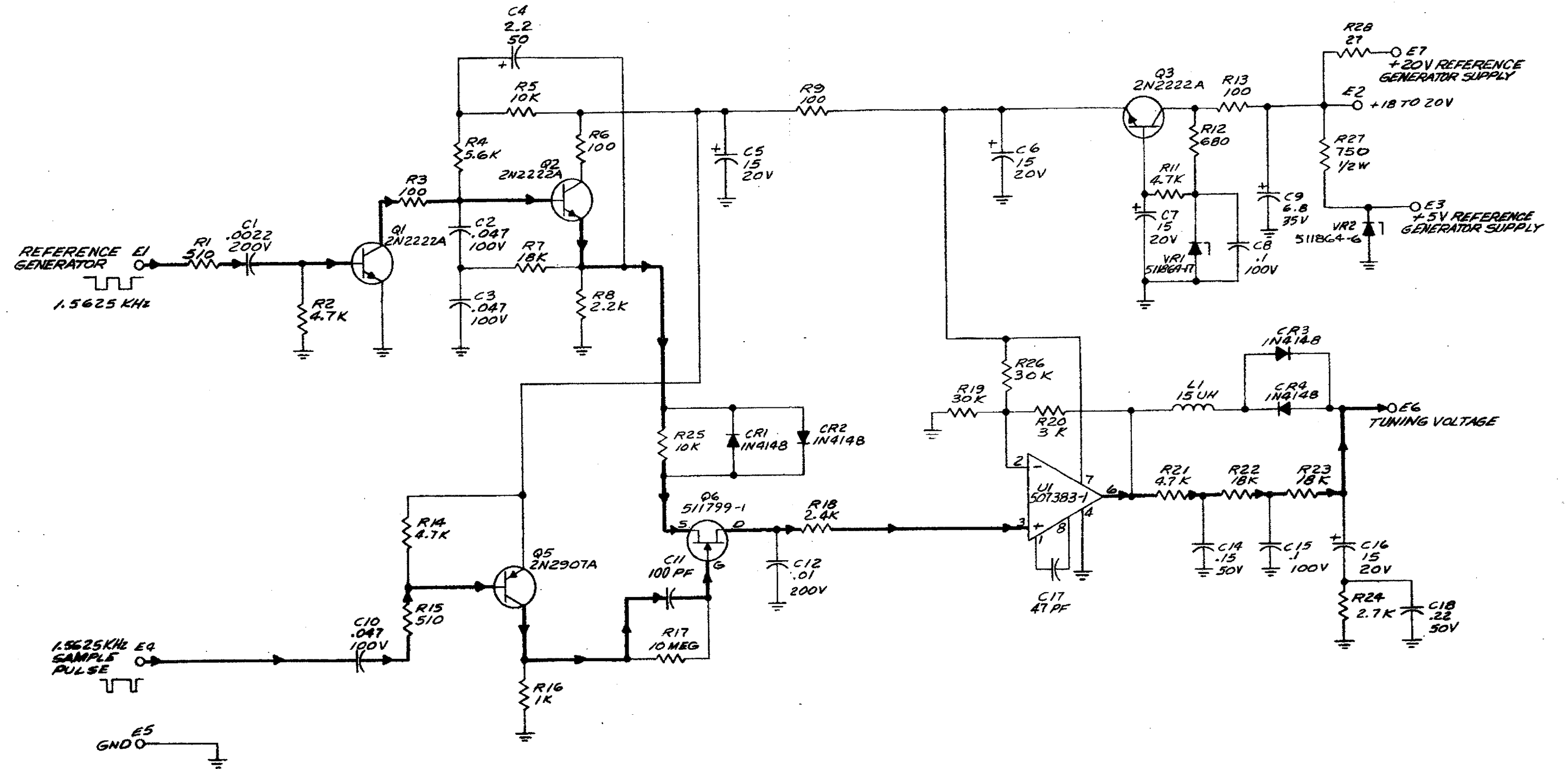
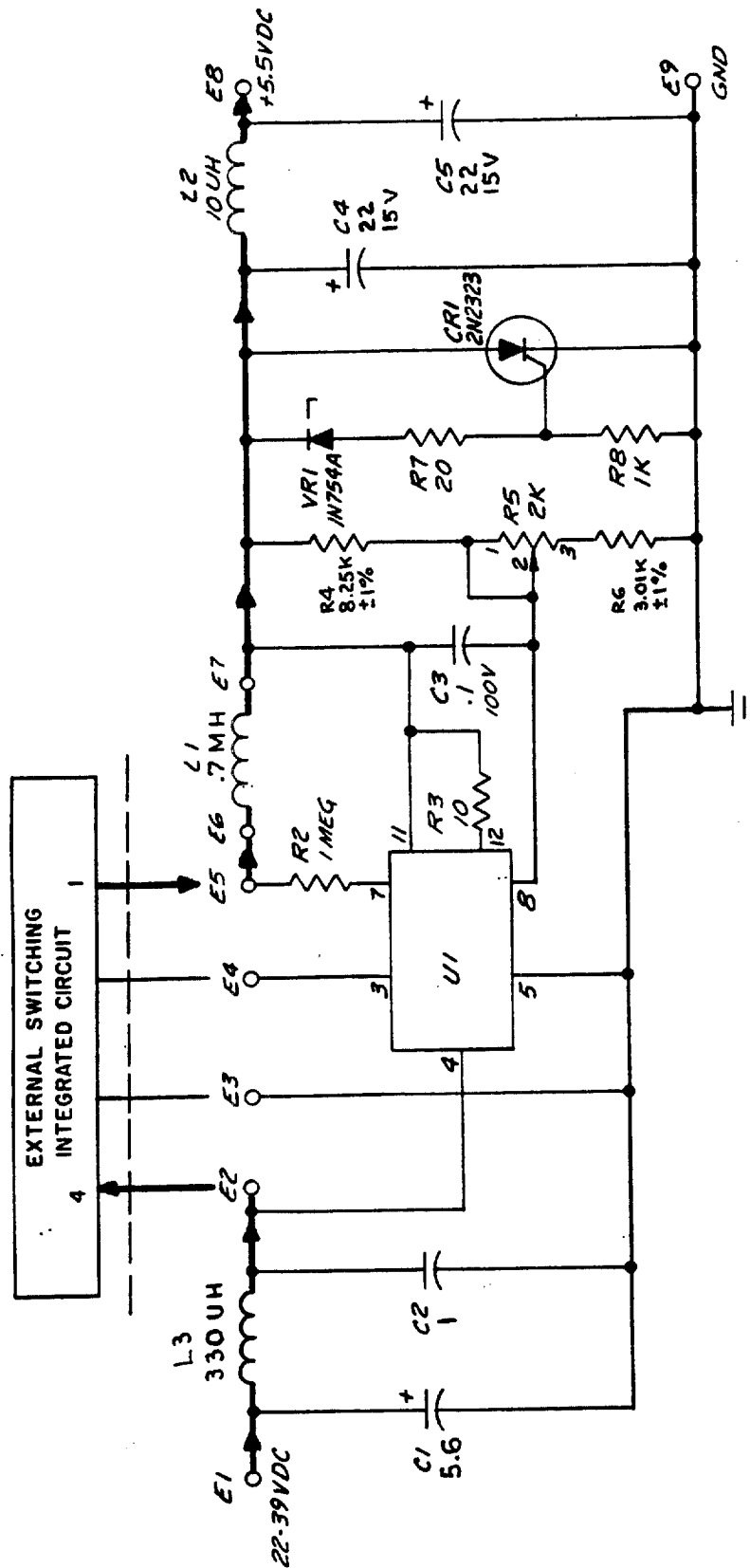


Figure 6-47. RF Generator A8A2, Schematic Diagram



- NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, 1/4 W
 2. ALL CAPACITANCE VALUES ARE IN MICROFARADS, $\pm 10\%$, 100 V

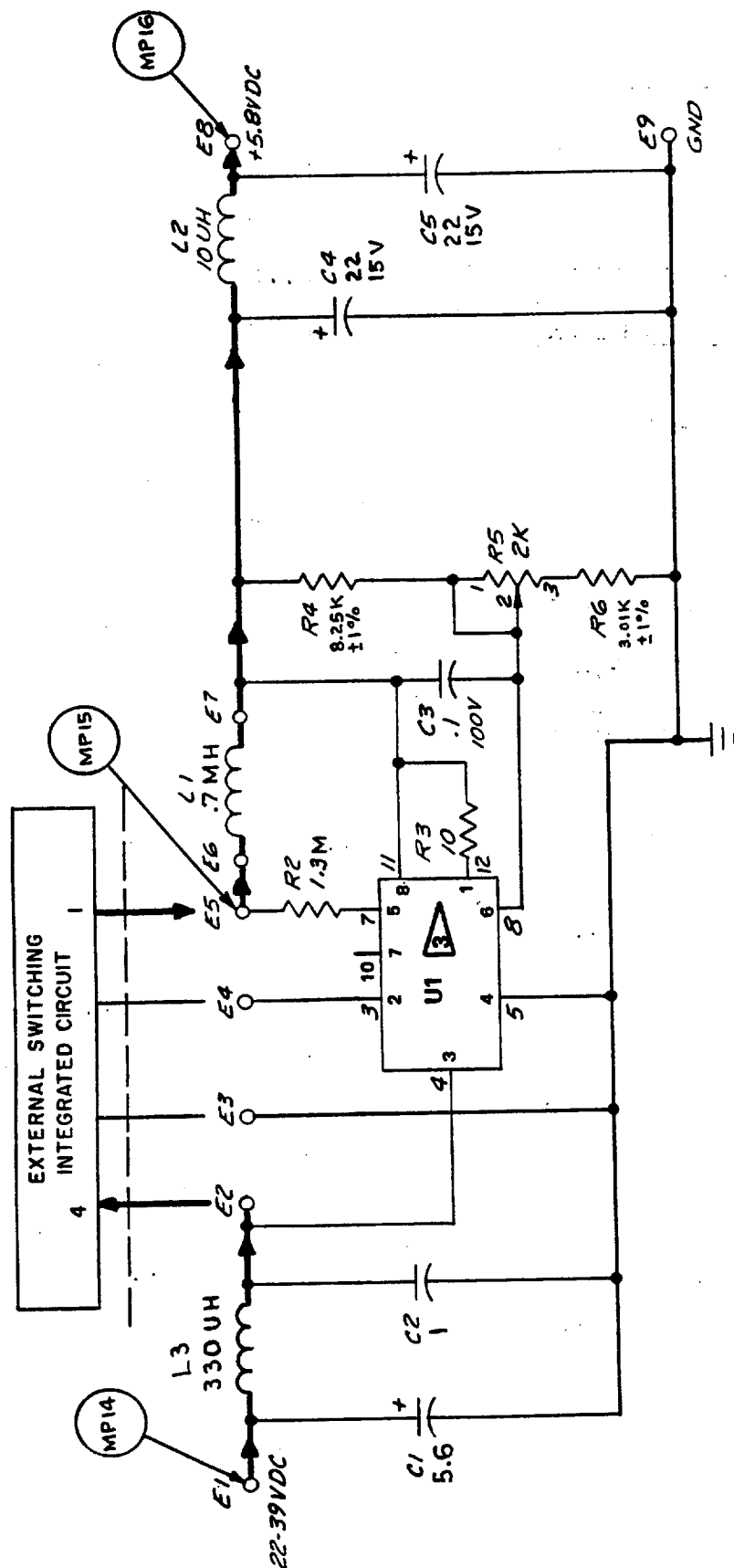
Figure 648. Phase Comparator A8A3, Schematic Diagram



NOTES:

- UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, $\frac{1}{8}$ W.
2. ALL CAPACITANCE VALUES ARE IN MICROFARADS
 $\pm 10\%$, 50V

Figure 6-49. Switching Regulator A8A5, Schematic Diagram
(Early Configuration)



NOTES:

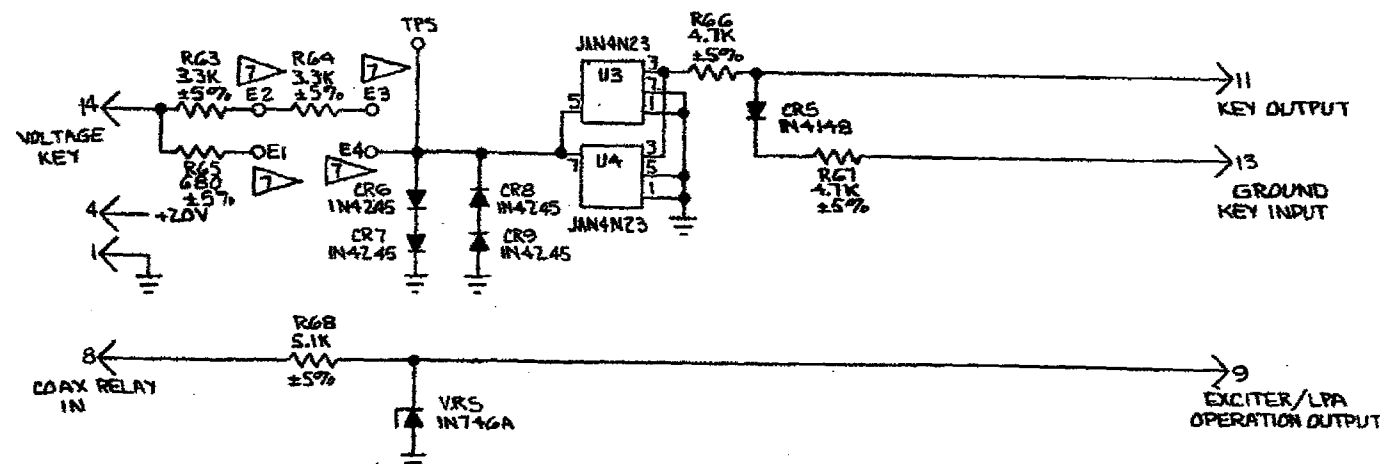
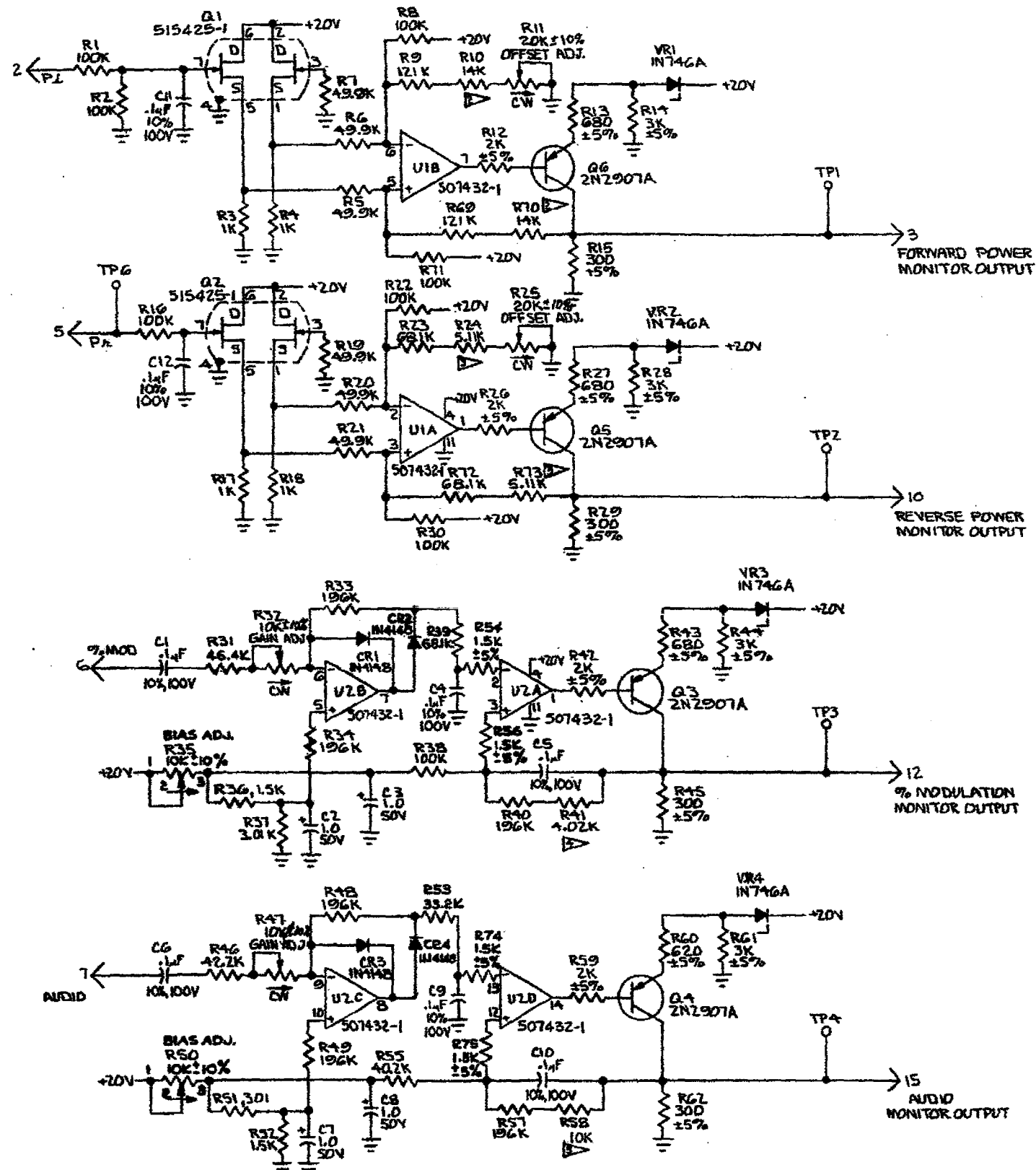
UNLESS OTHER SPECIFIED

1. ALL RESISTANCE VALUES ARE IN OHMS, $\pm 5\%$, $1/8$ W.
2. ALL CAPACITANCE VALUES ARE IN MICROFARADS $\pm 10\%$, 50 V.

INTERNAL PIN NO.S ARE FOR 8-PIN U1
EXTERNAL PIN NO.S ARE FOR 14-PIN U1

ECP 470 CHANGES
DELETE VR1 (IN754A)
DELETE R7 (20 OHMS) AND R8 (1K)
DELETE CR1 (2N2323)
ECP 520 CHANGES
R2 WAS 1.0 M
VOLTAGE AT E8 WAS +5.5 Vdc
ECP 648 CHANGES
NOTE 3 ADDED

Figure 6-50. Switching Regulator A8A5, Schematic Diagram (Later Configuration).



NOTES:

1. ALL RESISTORS ARE IN OHMS + 1%, 1/4W UNLESS OTHERWISE SPECIFIED.
2. GAIN ADJUSTMENT TAILOR POINT FOR R10 + R70 (10K TO 18.2K) NOMINAL 14K.
3. GAIN ADJUSTMENT TAILOR POINT FOR R24 + R73 (3K TO 7.15K) NOMINAL 5.11K.
4. GAIN ADJUSTMENT TAILOR POINT FOR R41 (2K TO 10K) NOMINAL 4.02K.
5. GAIN ADJUSTMENT TAILOR POINT FOR R58 (2K TO 14K) NOMINAL 10K.
6. NOTE 6 DELETED.
7. WITH VOLTAGE KEY INPUT, THE FOLLOWING CONNECTIONS SHOULD BE MADE:

VOLTAGE IN	CONNECTIONS
6 V	E1 TO E4
24 V	E2 TO E4
48 V	E3 TO E4

Figure 6-51. Inboard Monitor/Keyer Card A3, Schematic Diagram

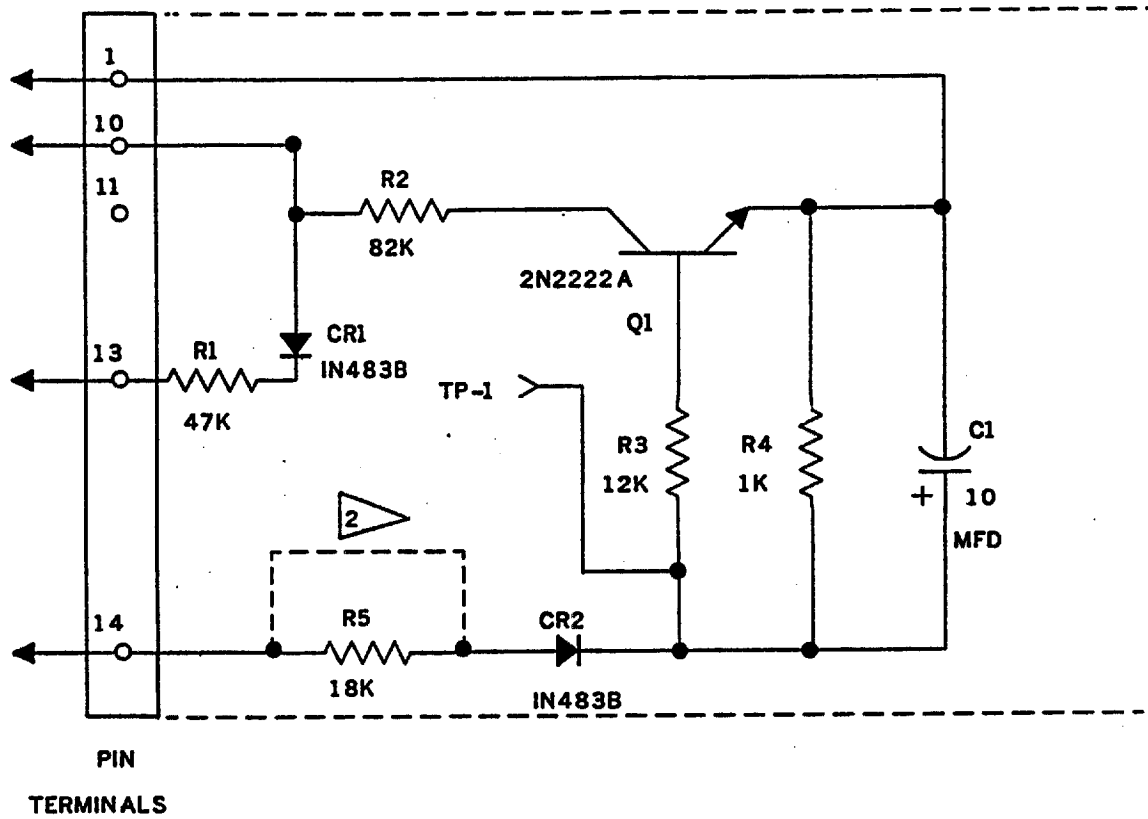


Figure 6-52. AFCS Keyer Card A3, Schematic Diagram

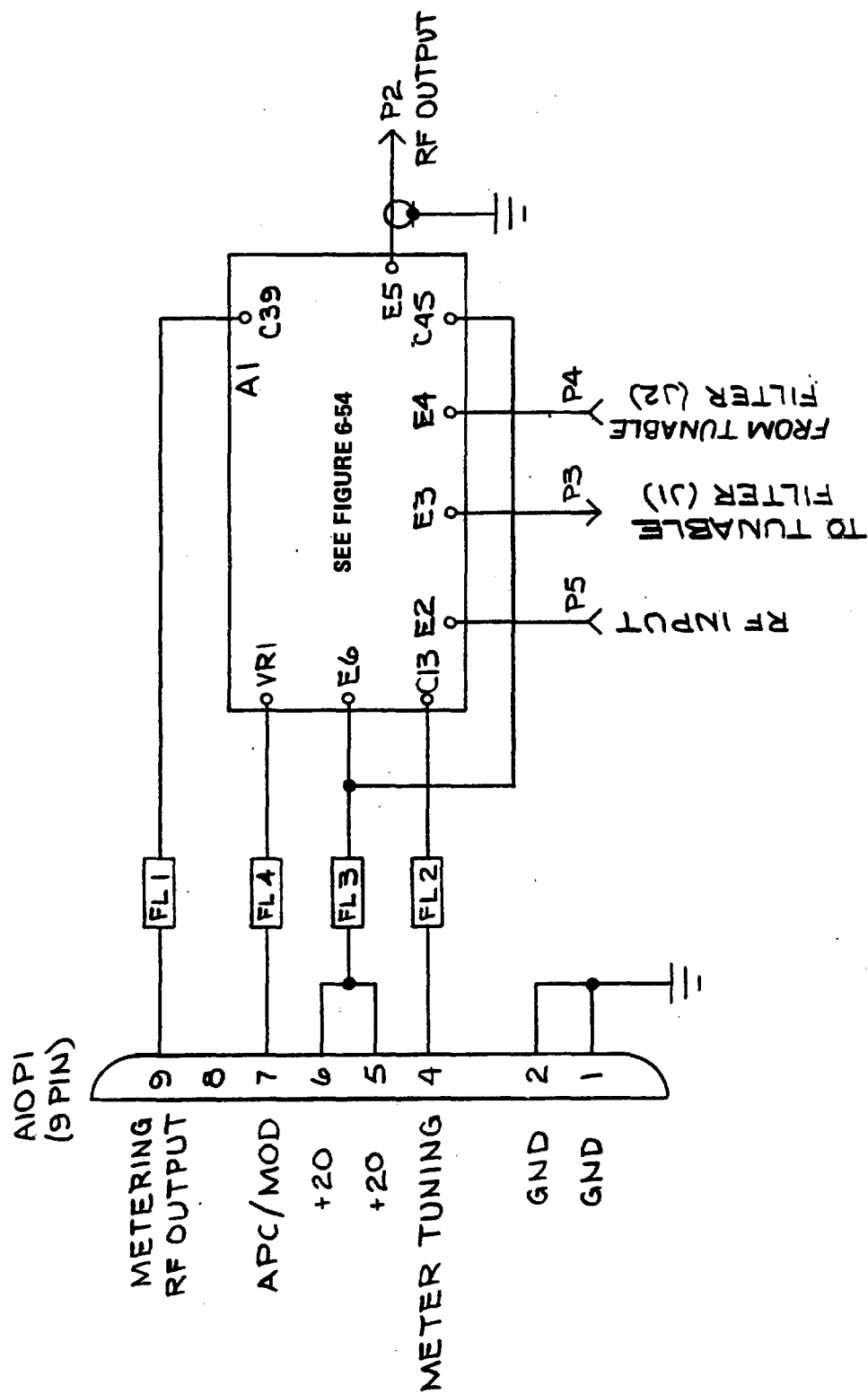


Figure 6-53. VHF/UHF Driver/Power Amplifier A10, Wiring Diagram (8136838G1)

NOTES

1. UNLESS OTHERWISE SPECIFIED:
Q1 - 515538-1
Q2 - 515538-2
Q3 - 515538-3
Q4 - 515538-5
2. ALL RESISTORS ARE IN OHMS, 1/4 W, $\pm 5\%$
3. ALL CAPACITORS ARE IN PICOFARADS, 500 V, $\pm 5\%$
4. Q3 QUIESCENT COLLECTOR CURRENT TAILOR POINT (3.3 TO 8.2) NOMINAL 4.7
5. Q4 QUIESCENT COLLECTOR CURRENT TAILOR POINT (3.3 TO 8.2) NOMINAL 4.7

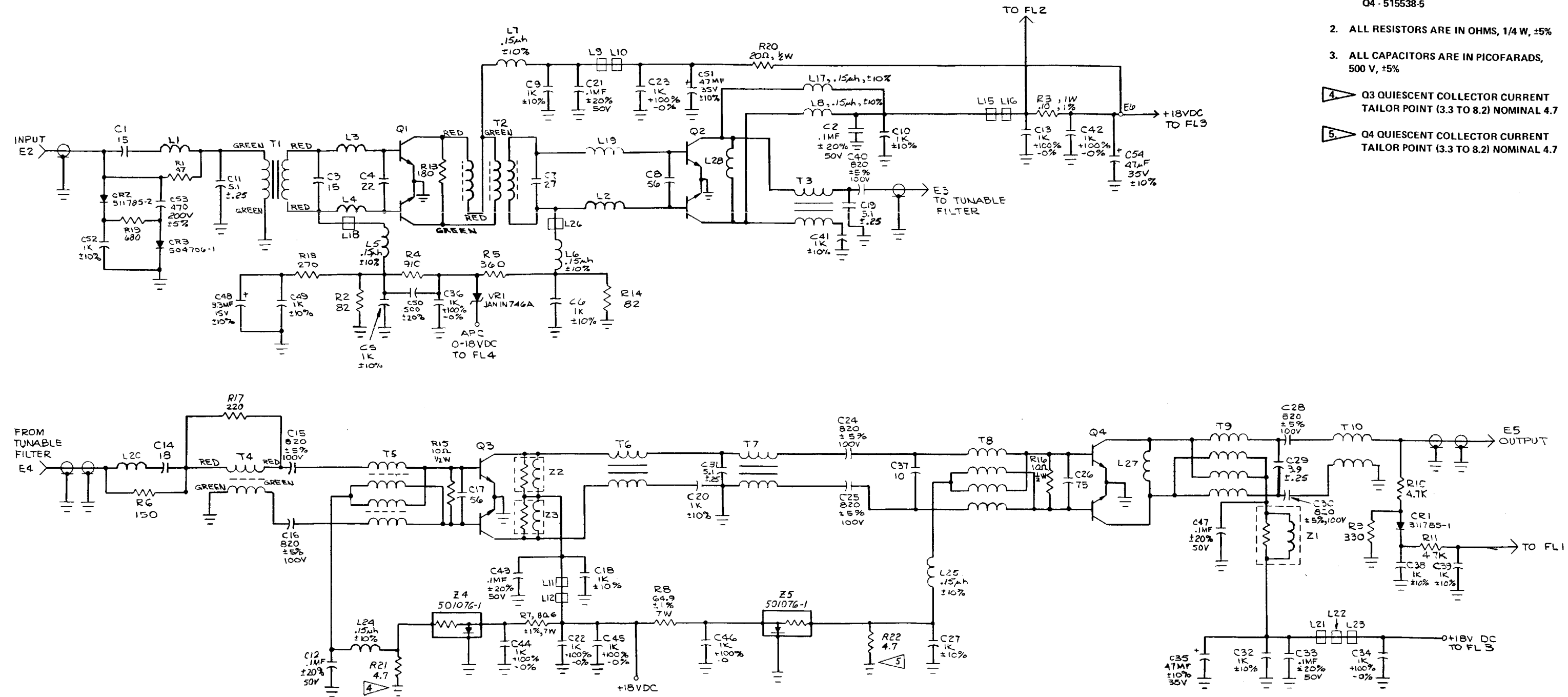
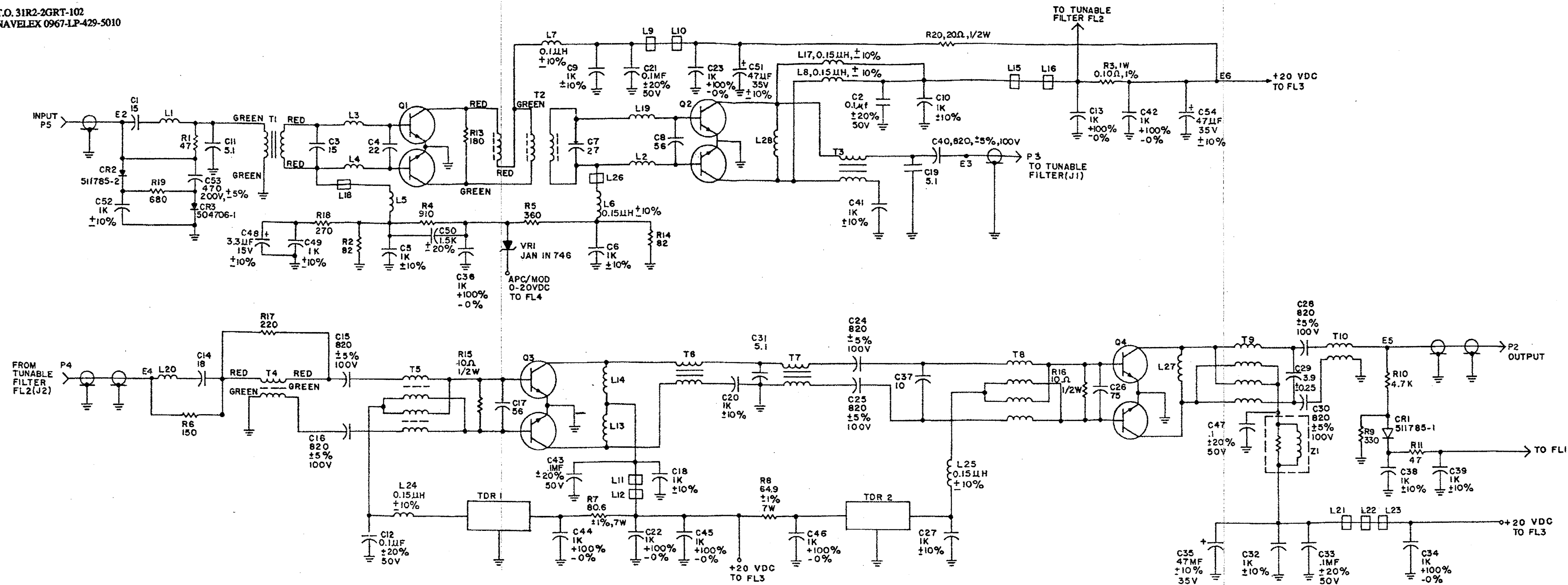
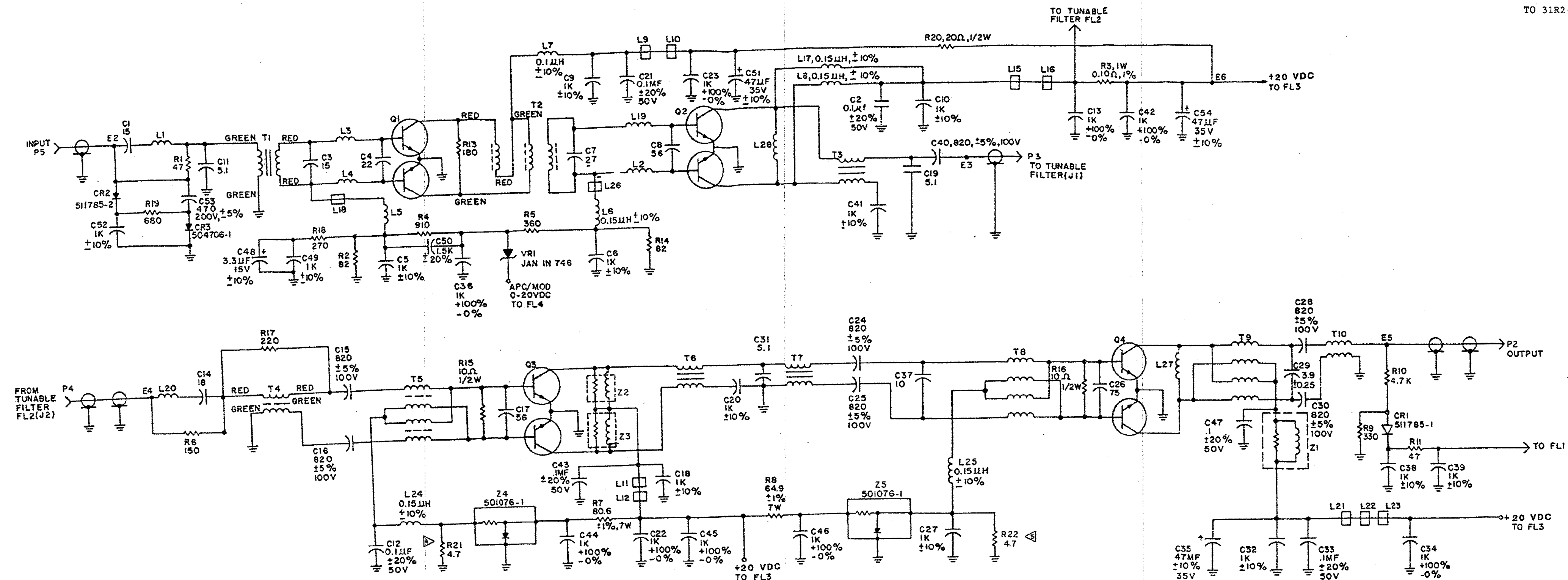


Figure 6-54. VHF/UHF Driver/Power Amplifier A10A1, Schematic Diagram



- NOTES:
UNLESS OTHERWISE SPECIFIED:
1. Q1 - 515538-1
Q2 - 515538-2
Q3 - 515538-3
Q4 - 515538-5
2. ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
3. ALL CAPACITORS ARE IN PICOFARADS, 500V, ±5%

Figure 6-54A. VHF/UHF Broadband Driver/Power Amplifier (TDR Version) 1/2A10 Schematic Diagram



NOTES:

UNLESS OTHERWISE SPECIFIED:

- Q1 - 515538-1
Q2 - 515538-2
Q3 - 515538-3
Q4 - 515538-5
- ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
- ALL CAPACITORS ARE IN PICOFARADS, 500V, ±5%.
- Q3 QUIESCENT COLLECTOR CURRENT
TAILOR POINT (3.3 TO 8.2) NOMINAL 4.7 OHMS.
- Q4 QUIESCENT COLLECTOR CURRENT
TAILOR POINT (3.3 TO 8.2) NOMINAL 4.7 OHMS.

Figure 6-54B. VHF/UHF Broadband Driver/Power
Amplifier (Bistort Version)
1/2A10 Schematic Diagram

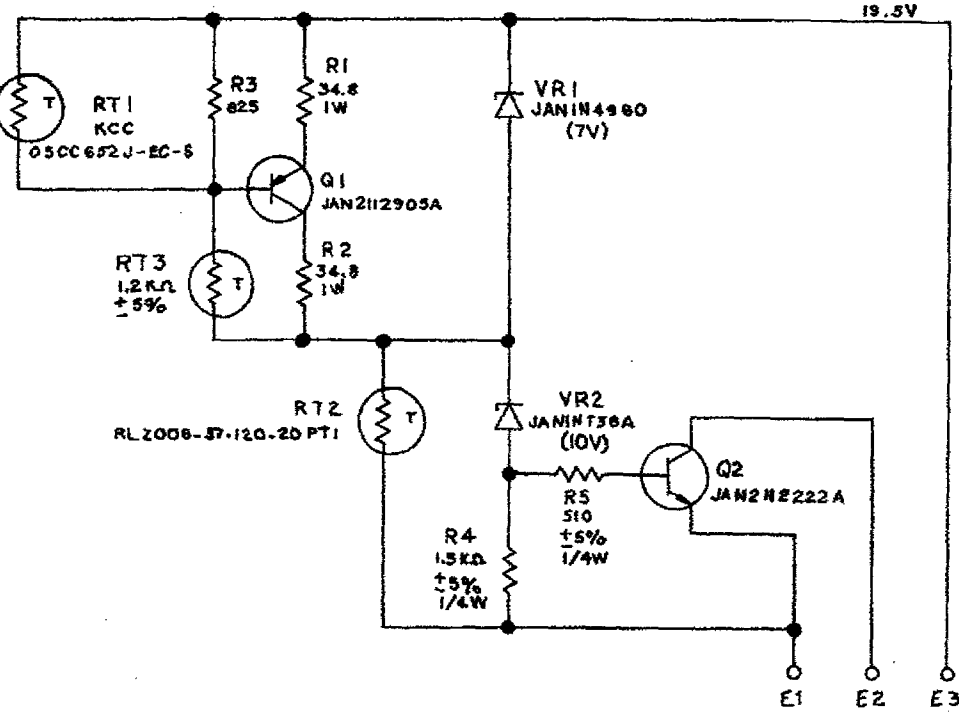


Figure 6-55. Solid-State Vane Switch Schematic Diagram

Table 6-1. Exciter Wire List

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
1	C21	2	E3		E	16	0	6	0		
2	E3		SHLD		E	22	0			4	
3	C17	2	XA2	2	E	22	91	20	0		
4	C18	2	XF3	4	E	16	6	25	4		
5	ABJ1	4	XA2	2	E	22	92	15	2		
7	A10J3	3	S6	2	E	22	92	20	4		
8	E3		SHLD		E	22	0			11	
10	C11	2	XA3	2	R	22	2	18	4		Twisted Pair
11	C10	2	XA3	2	R	22	9	18	4		Twisted Pair
12	C9	2	XA3	2	R	22	6	18	0		Twisted Pair
13	C8	2	XA3	2	R	22	9	17	4		
14	XA3	4	S4	4	E	22	1	13	0		
15	A2XPS1	7	XA7	2	E	20	7	17	0		
16	XA2	2	XA6	2	E	22	92	11	4		
17	XA2	2	S4	4	E	22	9	12	6		
18	XA2	2	J8	2S	E	22	90	36	0	1	
19	XA2	2	XA7	2	E	22	93	11	6		
20	XA2	2	T1	2	E	22	5	12	4		
21	XA2	2	J7	2S	E	22	6	11	0	1	
22	XA2	2	S3	4	E	22	4	11	2		
23	XA2	2	S4	4	E	22	96	11	2		
24	XA1	5	S4	4	E	22	3	12	0		
25	XA1	8	S4	4	E	22	7	11	0		
26	S4	5	XA4	2	E	22	3	14	6		
27	XA1	9	S4	4	E	22	1	12	0		
28	XA2	8	S2B	2	E	24	3	19	4		
29	XA1	14	S2B	2S	E	22	8	19	0	13	1,14,15
30	XA1	7	S2A	2S	Y	22	4	24	0	13	1,14,15
31	XA4	5	S2B	2	Y	22	7	23	2		
32	XA4	13	S2B	2	E	24	94	21	4		
33	XA4	14	S2B	2	E	24	1	21	6		
34	XA5	2	S1B	2	E	24	93	24	0		
35	XA5	3	S1B	2	E	24	96	25	4		

Table 6-1. Exciter Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
36	XA2	2	XA7	9	E	22	7	2	0		
37	XA6	2	XA7	6	E	22	2	27	0		
38	XA6	2S	J8	2S	Y	22	5	40	0	1,14	
39	XA6	2	S1A	3	E	24	90	23	4		
40	XA6	2	XA7	15	E	22	97	9	0		
41	XA6	2	S1A	4	E	24	95	23	4		
42	XA6	2S	Q1	8	Y	22	7	28	0	1,14,15	
43	XA6	2	XA7	7	E	22	9	7	0		
44	XA6	2S	J8	2S	Y	22	9	39	0	1,14	
45	XA6	2	XA7	5	E	22	92	8	0		
46	XA6	2S	J8	2S	Y	22	3	40	0	1,14	
47	XA5	2S	XA6	2	Y	22	7	7	0	1,14,15	
48	XA5	2	S2B	8	E	24	5	23	4		
49	XA7	2	TB2	8	E	22	96	16	0		
50	XA7	2	S2B	7	E	24	6	26	0		
51	XA7	2	S2A	7	E	24	98	25	4		
52	XA7	2	S2B	1	E	24	95	21	4		
53	XA7	2	S1B	2	E	24	91	24	0		
54	XA7	2	J8	2S	E	22	1	39	4	1	
55	A2XPS1	3	TB3	1	E	20	2	12	0		
57	A2XPS1	5	S2B	4	E	24	92	26	2		
58	A2XPS1	6	S2B	2	E	24	91	26	6		
60	A2XPS1	8	TB2	4	E	22	1	16	4		
61	A2XPS1	9	S2B	3	E	24	9	25	6		
62	A2XPS1	10	S5	12	E	22	96	20	4		
63	A2XPS1	11	TB2	7	E	22	95	15	0		
64	A2XPS1	12	TB2	2	E	22	4	16	6		
65	A2XPS1	13	TB2	1	E	22	5	16	4		
66	A2XPS1	14	S5	10	E	22	6	20	4		
67	A8J1	1	E5	A	E	20	0	8	0		
68	A8J1	3	TB3	3	E	22	2	31	0		
69	A8J1	5	S1B	12	E	22	6	23	4		
70	A9J2	1	E5	4	E	20	0	8	0		

Table 6-1. Exciter Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
71	A9J2	3	TB3	3	E	22	2	8	0		
72	A9J2	5	XA2	5	E	22	92	24	0		
73	A9J2	6	S1B	10	E	22	8	23	4		
74	XA2	2	S1B	11	E	24	7	23	4		
75	S6	1	S1B	9	E	24	2	23	4		
76	A10J3	9	S1B	8	E	22	3	23	4		
77	A10J3	1	E8	4	E	20	0	4	0		
78	A10J3	2	E8	4	E	20	0	4	0		
79	A10J3	5	Q1	2	E	20	2	6	0		
80	A10J3	6	Q1	2	E	20	2	6	0		
81	A10J3	7	Q1	2	E	22	4	18	0		
83	XA7	8	S1B	7	E	24	5	11	0		
84	XA2	7	S1B	6	E	24	1	16	4		
89	TB2	6	PS1TB2	7	E	16	7	34	6		
91	S1B	11	S2B	5	E	24	7	23	0		
93	J6	1	E12	2	E	20	0	6	0		
94	J6	2	T1	4	E	22	3	9	2		
95	J6	3	S3	2	E	22	4	9	0		
96	J7	D	T1	2	E	22	2	9	4	1	
97	J7	D	J6	1	E	22	0	3	0	1	
98	J8	A	E14	4	E	20	0	18	0	1	
99	J8	D	S1B	9	E	24	2	46	0	1	
100	J8	F	K1	2	Y	22	6	8	0	1,10,14,15	
101	J8	I	SHLD	2	E	22	0		0	3	
102	K1	+	XA7	4	Y	22	5	23	0	10,14,15	
103	Q1	C	TB2	5	E	16	2	26	0		
104	S4	4	E13	2	E	22	6	10	6		
106	S6	2	J6	1	E	20	0	7	0		
107	R1	1	E7	4	E	20	0	2	0		
108	TB4	2	M1	2	E	22	92	10	0		
109	S1A	A	M1	2	E	24	98	10	0		
110	S1B	1	S2B	2	E	24	0	8	4		
111	S1A	2	S1A	5	J	24				2	

Table 6-1. Exciter Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
112	S1A	5	S1A	6	J	24					
113	S1A	6	S1A	7	J	24					
114	S1A	7	S1A	8	J	24					
115	S1A	8	S1A	10	J	24					
116	S1A	9	A10J3	4	E	22	94	10	4		
117	S1A	10	S1A	12	J	24					
118	S1A	11	J1	6	E		9	17	4		
119	S1A	10	E6	4	E	24	0	7	0		
120	S1A	1	S2A	A	E	24	97	12	0		
121	S2A	2	S2A	3	J	24					
122	S2A	3	S2A	4	J	24					
123	S2A	5	TB2	9	E	22	93				
124	S2A	4	S2A	6	J	24				2	
125	S2A	6	S2A	8	J	24					
126	S2A	8	S2A	9	J	24				2	
127	S2A	9	S2A	1	J	24					
128	S2A	11	S2A	12	J	24					
129	S2A	11	XA4	15	E	24	90	21	0	2	
130	S2A	2	E6		E	24	0	7	0		
131	XF3	2	S5	12	E	16	6	16	0		
132	S5	10	PS1TB2	5	E	16	6	28	0		
133	TB2	5	TB3	5	E	16	2	19	0		
134	XA2	2	ABJ1	2	E	22	7	14	0		
136	PS1TB2	8	A2XPS1	7	E	20	7	8	0		
138	PS1TB2	3	E10		E	14	0	6	0		
139	A2XPS1	15	TB2	3	E	22	3	16	0		
140	E3		E9		E	16	0	3	4		
141	TB3	1	TB3	3	J	20					
142	TB3	3	TB3	5	J	20					
144	XA1	15	E4	4	E	20	0	15	0		
145	XA1	1	E4	4	E	20	0	15	0		
146	XA2	1	E4	4	E	20	0	14	0		
147	XA3	1	E4	4	E	20	0	13	0		

Table 6-1. Exciter Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
148	XA4	2	E4	4	E	20	0	12	0		
149	XA5	2	E4	4	E	20	0	11	0		
150	XA6	2	E4	4	E	20	0	10	0		
151	XA7	2	E4	4	E	20	0	9	0		
152	A2XPS1	2	E4	4	E	20	0	2	0		
154	C23	2	XF1	1	R	20	8	27	0		Twisted Pair
155	C24	2	XF2	1	R	20	98	27	0		
156	XF1	4	S5	4	R	20	8	12	0		Twisted Pair
157	XF2	4	S5	4	R	20	98	12	0		
158	S5	4	PS1TB1	5	R	20	8	38	0		Twisted Pair
159	S5	4	PS1TB1	1	R	20	98	38	0		
160	PS1TB1	7	XDS1	1	E	22	90	30	0		
161	S5	4	XDS1	2	E	22	98	4	4		
162	C22	2S	XA4	7	Y	22	3	16	0	1,14,15	
163	C20	2S	XA5	11	Y	22	6	15	0	1,14	
164	C19	2S	TB1	1	Y	22	7	8	0	1,14,15	
165	C16	2S	TB1	4	Y	22	9	6	0	1,14,15	
166	C15	2S	TB1	2	Y	22	5	7	0	1,14,15	
167	C13	2S	XA3	3	Y	22	8	17	0	1,14	
168	C12	2S	XA3	10	Y	22	4	19	0	1,14	
169	TB1	4S	XA1	10	Y	22	7	15	0	1,14,15	
170	TB1	4S	XA1	11	Y	22	5	16	0	1,14,15	
171	TB1	4S	XA1	12	Y	22	9	17	0	1,14,15	
172	XA1	2S	XA4	6	Y	22	6	12	0	1,14,15	
173	XA4	2S	XA5	12	Y	22	3	10	0	1,14,15	
174	XA5	2S	R1	3	Y	22	9	17	0	1,14,15	
175	XA6	2S	R1	2	Y	22	6	18	0	1,14,15	
176	XA1	2	XA2	4	E	22	2	2	0		
177	XA2	2	XA3	4	E	22	2	2	0		
178	XA3	2	XA4	4	E	22	2	2	0		
179	XA4	2	XA5	4	E	22	2	2	0		
180	XA5	2	XA6	4	E	22	2	3	0		
181	XA6	2	R8	3	E	22	2	15	0		

Table 6-1. Exciter Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
182	XA7	2	A2XPS1	4	E	22	2	3	0		
183	T83	2	S6	1	E	20	2	9	4		
185	XA1	2	SHLD		E	22	0	3	6	5	
186	XA3	2	SHLD		E	22	0	2	4	6	
187	XA5	2	SHLD		E	22	0	2	2	7	
188	XA6	2	SHLD		E	22	0	2	0	8	
190	E7	2	R8	2	E	20	0	3	0		
191	T81	2	T81	3	J	22		1	0		
192	C14	2	XA3	2	E	22	1	15	0		
193	E12	2	T1	2	E	20	0	1	4		
194	XA7	2	SHLD		E	22	0	2	4	9	
195	R8	2	R8	2	J	22			4		
196	S1B	2	E11	2	E	24	4	8			
197	XA6	2	SHLD		E	22	0	11	0	12	
198	XA6	14	P2		WC			24	0	14	
199	XA6	15	P1		WC			24	0	14	
200	XA3	25	XA6	15	Y	22	9	9	0	1,14,15	
201	XA3	25	XA6	14	Y	22	9	9	0	1,14,15	
202	XA3	2	XA6	6	E	22	97	8	0		
203	XA3	2	XA1	5	E	22	3	8	0		
204	XA3	2	XA7	4	E	22	5	11	0		
205	XA1	2	XA1	11	E	22	5	3	0		
206	E4	2	SHLD		E	22	0	11	0	16	

Table 6-1. Exciter Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
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NOTES:

1. S-DENOTES SLEEVING.
2. SLEEVE WIRE.
3. WIRE CONNECTS AS INDICATED TO SHIELDS OF WIRES 38, 44, and 46.
4. CONNECT SHIELDS OF W162, 163, 164 AND 165 TOGETHER AT J5.
5. CONNECT SHIELDS OF W169, 170, 171 AND 172 TOGETHER AT XA1.
6. CONNECT SHIELDS OF W167 AND 168 AT XA3.
7. CONNECT SHIELDS OF W163, 173 AND 174 AT XA5.
8. CONNECT SHIELDS OF W38, 44 AND 46 AT XA6.
9. CONNECT SHIELDS OF W42, 47 AND 175 AT XA7.
10. CONNECT SHIELDS OF W100 AND 102 AT E14.
11. CONNECT SHIELDS OF W166, 167 AND 168 AT J5.
12. CONNECT SHIELDS OF WIRES 198 AND 199 AT XA6.
13. CONNECT SHIELDS OF WIRES 29 AND 30 AT XA1-15.
14. USE SLEEVING OVER SHIELD TERMINATION WITH PIGTAIL.
15. USE SLEEVING OVER SHIELD TERMINATION WITHOUT PIGTAIL.
16. CONNECT SHIELDS OF W200 AND 201 AT XA6.

CODES:

- | | |
|----|---------------------------|
| E | WIRE |
| R | WIRE, TWISTED PAIR |
| Y | WIRE, SHIELDED & JACKETED |
| J | WIRE, COPPER BARE |
| WC | WIRE, COAX |
| DF | CONTACT, FEMALE |
| DL | TERMINAL, TAB |
| DM | TERMINAL, TAB |
| HT | TERMINAL LUG, CRIMP |
| 2 | 2/8 STRIP LENGTH |
| 4 | 4/8 STRIP LENGTH |

Table 6-2. Power Amplifier Wire List

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
1	C23	2	S1	3	R	20	8	32	0		Twisted Pair
2	C24	2	S1	6	R	20	98	31	0		Twisted Pair
3	S1	4	XF1	1	R	20	97	16	0		Twist with W14
6	XF3	4	A4J5	8	E	20	98	22	0		
7	XF2	4	XDS1	1	E	20	1	8	0		
9	XDS1	4	A3J4	14	E	20	9	16	0		
10	XDS1	4	A6C7	2	E	20	8	37	0		
12	A3J4	DF	A6C8	2	E	22	7	24	0		
13	S1	4	XF3	1	E	20	1	10	0		
14	S1	4	XF2	1	R	20	95	10	0		Twist with W3
16	A3J4	DF	S4	1	E	20	95	12	0		
17	XDS2	4	A4J5	P	R	22	7	25	0		Twisted Pair
18	XDS2	4	A4J5	R	R	22	8	25	0		Twisted Pair
19	XF1	4	A3J4	16	R	20	8	15	0		Twisted Pair
20	XF2	4	A3J4	15	R	20	98	18	0		Twisted Pair
21	A2J3	1	E4	4	E	20	0	24	0		Twisted Pair
22	A2J3	DF	A3J4	2	R	20	95	12	0		
23	A2J3	DF	A3J4	3	R	20	97	9	0		
27	A2J3	DF	A3J4	7	E	22	92	12	0		
28	A2J3	DF	A5J6	15	E	22	9	14	0		
29	A3J4	DF	E3	4	E	20	0	27	0		
30	A3J4	DF	A5J6	14	E	22	94	11	0		
31	A3J4	DF	A6C3	2	E	22	3	28	0		
32	A3J4	DF	E8	2	E	22	2	27	0		
33	A3J4	DF	A5J6	18	E	22	4	11	0		
34	A3J4	DF	A6C4	2	E	22	6	28	0		
35	A3J4	DF	A6C5	2	E	20	95	28	0		
36	A6C5	2	A5J6	8	E	20	1	31	0		
37	A4J5	DJ	E4	4	E	20	0	22	0		
38	A4J5	DJ	J7	J	E	22	92	22	0	1	

Table 6-2. Power Amplifier Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR	TO TERMINAL CONNECTOR	CONN LUG	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
39	A4J5	A5J6	E	DJ	E	22	93	16	0		
40	A4J5	C9	F	DJ	E	22	2	22	0		
41	A4J5	J7	H	DJ	E	22	1	22	0	1	
42	A4J5	A5J6	J	DJ	E	22	6	16	0		
43	A4J5	A5J6	L	DJ	E	22	96	16	0		
44	A4J5	A5J6	M	DJ	E	22	3	16	0		
45	A4J5	A5J6	N	DJ	E	22	7	16	0		
46	A4E25	A6FL1		HW	WA	22	2	15	0	6	
47	A5J6	A6E3	2	DF	Y	22	5	31	0		
48	A5J6	A6E2	3	DF	Y	22	9	31	0		
49	A5J6	S3	4	DF	E	22	2	31	0		
50	A5J6	S3	5	DF	Y	22	7	12	0		
51	A5J6	J7	6	DF	Y	22	3	12	0	1	
52	A5J6	TB2	7	DF	Y	22	6	30	0		Twist with W55
53	A5J6	M1	9	DF	R	22	2	16	0		
54	A5J6	E2	1	DF	E	20	0	29	0		
55	A5J6	M1	19	DF	R	22	9	16	0		Twist with W53
56	J7	E5	A	2S	E	20	0	10	0	1	
57	J7	E5	F	2S	E	22	0	10	0	1	
58	J7	SHLD	I	2S	E	22	0	5	0	1 & 3	
59	J7	E8	D	2S	E	22	2	6	0	1	
60	J7	S3	C	2S	Y	22	9	35	0	1	
61	A6E1	E5		4	E	20	0	13	0		At S3 At TB2
62	SHLD	SHLD	W50		J	22					
63	SHLD	SHLD	W52		J	22					
64	A6E1	SHLD	G	2S	E	22	0	13	0	4	
65	J7	TB2	6	4	Y	22	6	36	0	1	
66	S3	E8	11	DF	E	22	0	16	0		
67	A5J6	SHLD			E	22	96	6	0	5	
68	S3	TB2	4		E	22	95	5	0		
69	A4J5	S4	C	DJ	E	20	0	18	0		
70	J3	J4	6	DF	E	22	0	8	0		
71	J3	J4	5	DF	E	22	6	8	0		
72	J3	J4	4	DF	E	22	2	8	0		

Table 6-2. Power Amplifier Wire List (Cont.)

WIRE NUMBER	FROM TERMINAL CONNECTOR PIN	CONN LUG	TO TERMINAL CONNECTOR PIN	CONN LUG	TYPE	GAUGE	COLOR	INCHES	EIGHTH	NOTES	REMARKS
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NOTES:

- 1. S DENOTES SLEEVING.
- 2. DELETED
- 3. WIRE CONNECTS AS INDICATED TO SHIELDS OF WIRES 51, 60 AND 65.
- 4. WIRE CONNECTS AS INDICATED TO SHIELDS OF WIRES 47 AND 48.
- 5. WIRE CONNECTS AS INDICATED TO SHIELDS OF WIRES 47, 48, 50, 51 AND 52.
- 6. ASSEMBLE INSIDE SLEEVING, HEAT SHRINKABLE TO W46 AT FLL.

CODES:

- HW TERMINAL LUG
- DJ CONTACT, FEMALE
- DF CONTACT, FEMALE
- E WIRE
- R WIRE, TWISTED PAIR
- Y WIRE, SHIELDED AND JACKETED
- WA WIRE, HIGH VOLTAGE
- J WIRE, COPPER, BARE
- 1 1/8 STRIP LENGTH
- 2 2/8 STRIP LENGTH
- 4 4/8 STRIP LENGTH

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