FX-30
FM EXCITER

IM NO. 597-0002
AUGUST, 1988

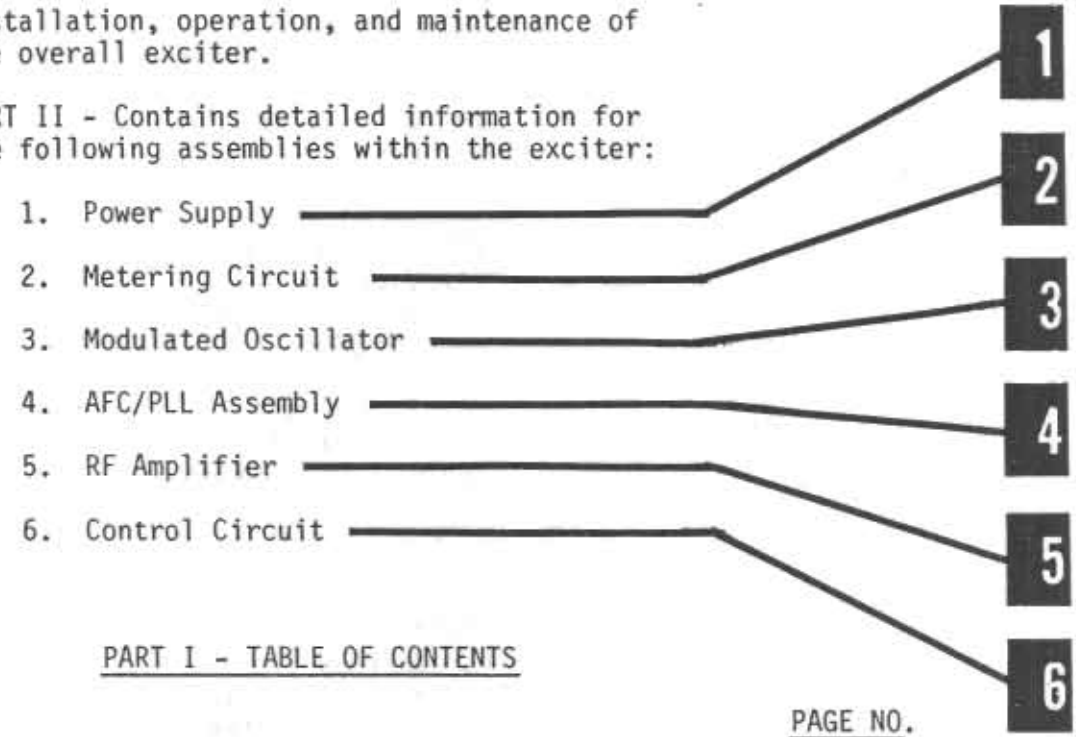
SCOPE OF MANUAL

This manual comprises two sections providing the following information for the Broadcast Electronics FX-30 FM Exciter.

A. PART I - Contains information relative to installation, operation, and maintenance of the overall exciter.

B. PART II - Contains detailed information for the following assemblies within the exciter:

1. Power Supply
2. Metering Circuit
3. Modulated Oscillator
4. AFC/PLL Assembly
5. RF Amplifier
6. Control Circuit



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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. Information presented by this section provides a general description of the FX-30 FM Exciter features and lists equipment specifications.

1-3. RELATED PUBLICATIONS.

1-4. The following list of publications provides data for equipment and options associated with the FX-30 FM Exciter.

PUBLICATION NUMBER	EQUIPMENT
597-0008	FC-30 SCA GENERATOR
597-0009	FS-30 STEREO GENERATOR

1-5. EQUIPMENT DESCRIPTION.

1-6. The FX-30 exciter is available in several configurations. Refer to the following list for the different exciter models, spares kits, and options available.

MODEL	PART NO.	DESCRIPTION
FX-30	909-0002	3-30 Watt FM exciter, solid-state with automatic power control and synthesized frequency control. 21.5 inch (54.61 cm) rack mount.
FX-30	909-0009	3-30 Watt FM exciter/transmitter, solid-state, with automatic power control, and synthesized frequency control. 19 inch (48.21 cm) rack mount with rack mounting hardware kit.
FX-30	909-0093	3-30 Watt FM exciter, solid-state with automatic power control and synthesized frequency control. 19 inch (48.21 cm) rack mount.
----	909-0114	Optional Low-Pass Filter.
----	830-0027	100% Spare Semiconductor Kit.
----	830-0028	Recommended Spare Semiconductor Kit.

1-7. PHYSICAL DESCRIPTION.

1-8. The FX-30 chassis is mounted on slides to allow easy access to all assemblies when the unit is extended from the rack (see Figure 1-1). Removal and installation of assemblies within the exciter is augmented by the semimodular mechanical construction. Each assembly is firmly mounted to the main chassis and electrically connected to the main wiring harness with plugs and jacks. Front panel test receptacles allow measurements of the composite signal without removing or opening the unit. Input and output connections are made to a terminal strip and BNC connectors mounted to the exciter rear panel.

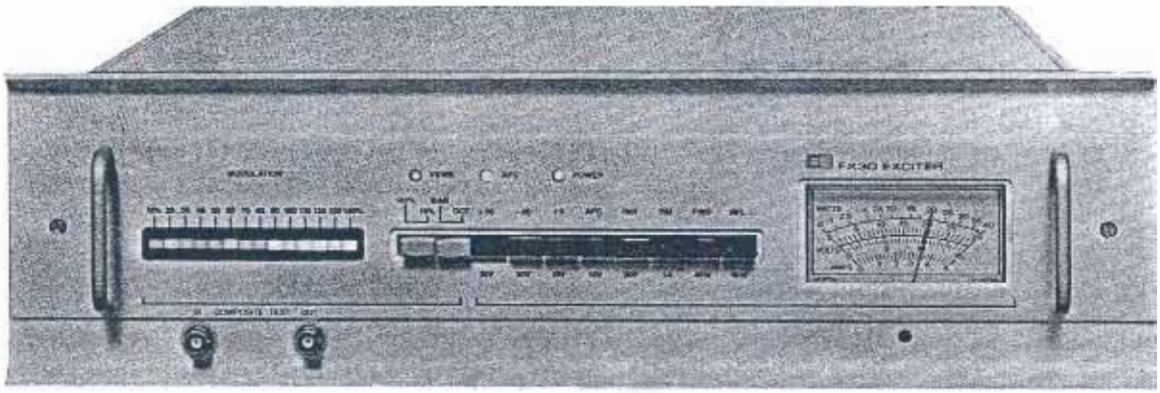

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FIGURE 1-1. FX-30 EXCITER

1-9. ELECTRICAL DESCRIPTION.

1-10. The Broadcast Electronics FX-30 is a totally solid-state wideband FM exciter providing a continuously variable RF output from 3 to 30 watts into a 50 Ohm load at any frequency within the 87 to 109 MHz FM broadcast band in 10 kHz increments (see Figure 1-2). The FX-30 accepts multiple wideband composite inputs from a stereo generator or SCA generator as well as a 600 Ohm balanced monaural input. Typical performance exhibits extremely low distortion with THD and IMD less than 0.08% and a typical signal-to-noise ratio of 78 dB. A tapped dual primary power transformer and a voltage selector allows operation from a wide range of ac input potentials.

1-11. METERING. Important exciter operation parameters are metered by an analog meter and a digital LED display. A color-coded LED display constantly monitors the composite signal applied to the modulated oscillator. Additionally, eight steady-state parameters are selected by push switches and displayed on a multimeter. The multimeter may also be used as a built-in high-impedance test meter for point-to-point voltage measurements within the exciter.

1-12. AUTOMATIC FREQUENCY CONTROL. A temperature compensated reference oscillator and a dual-speed phase-locked-loop controlling the carrier frequency locks the frequency of the modulated oscillator to the precision reference frequency oscillator allowing prompt on-frequency operation of the exciter from a cold start. Typically, the FX-30 achieves frequency lock from a cold start in less than five seconds while allowing full modulation capability from 1 Hz to 100 kHz.

1-13. CONTROL CIRCUIT. The control circuitry provides automatic control of RF output to maintain a preset power output. Additionally, the control circuitry eliminates adjustments after the initial setup, protects the RF output circuitry from excessive temperatures, high VSWR conditions, over-voltage conditions, and short circuit conditions.

1-14. RF AMPLIFIER. The RF amplifier is a broadbanded 3 to 30 watt amplifier covering the entire commercial FM broadcast band. Tuning of the amplifier is not required. An optional low-pass filter (BE P/N 979-0092) mounts inside the exciter and allows the exciter to be used as a low power transmitter connected directly to an antenna.

1-15. EQUIPMENT SPECIFICATIONS.

1-16. Refer to Table 1-1 for electrical and physical specifications of the FX-30 FM Exciter.

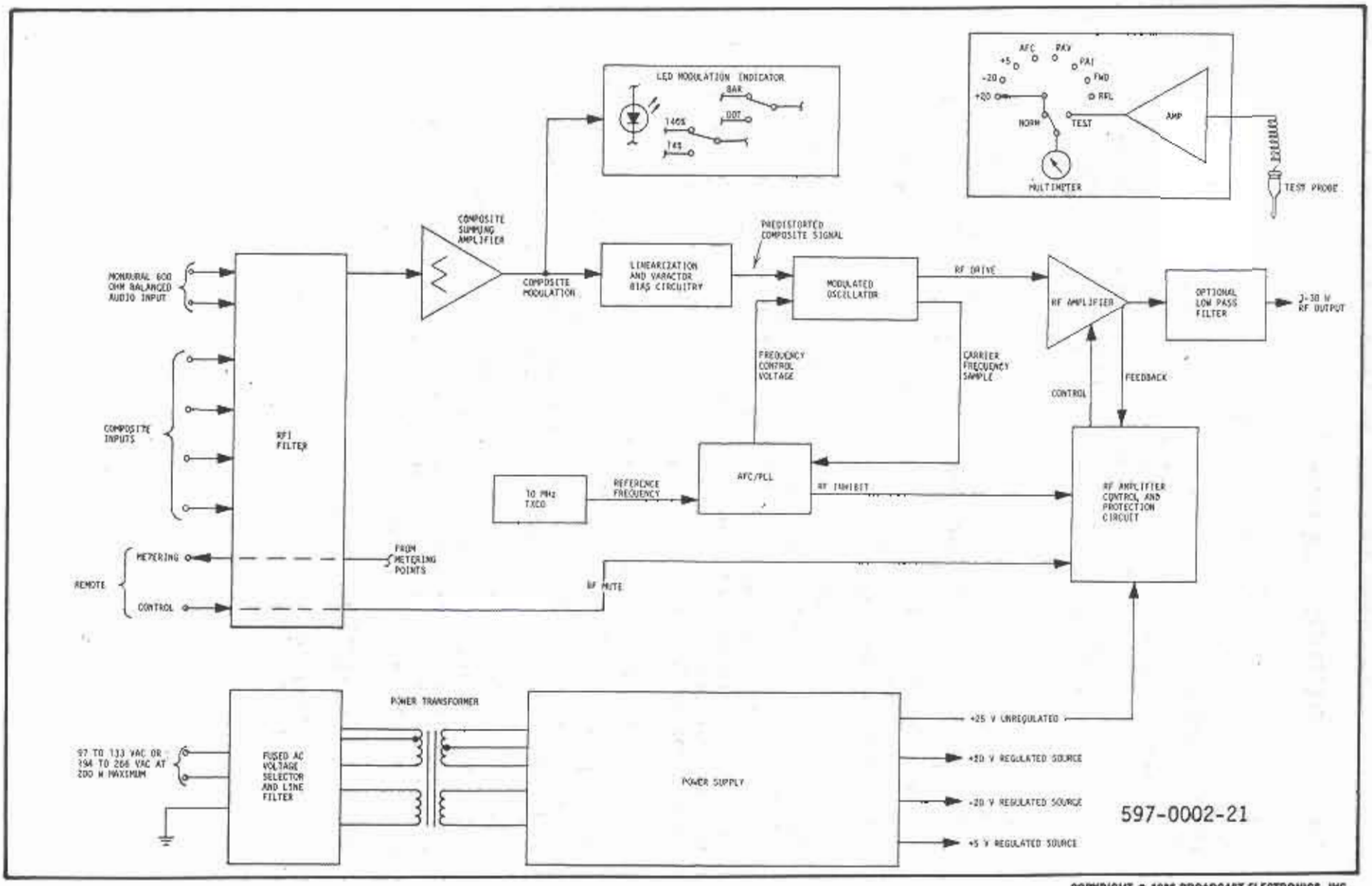


FIGURE 1-2. SIMPLIFIED BLOCK DIAGRAM

Table 1-1. FX-30 Exciter Specifications
(Sheet 1 of 3)

PARAMETER	SPECIFICATIONS
RF OUTPUT IMPEDANCE	50 Ohms
POWER OUTPUT	3 Watts to 30 Watts, Continuously Variable (BNC Connector) Open and Short Circuit Protected
R.F. HARMONIC AND SPURIOUS SUPPRESSION (CONDUCTED)	58 dB Below Rated Output, Minimum with Optional Low-Pass Filter
FREQUENCY RANGE	87 MHz to 109 MHz Digitally Programmable in 10 kHz Increments
FREQUENCY STABILITY	±300 Hz, +32°F to +122°F (0°C to +50°C)
MODULATION TYPE	Direct FM at the Carrier Frequency
MODULATION CAPABILITY	±200 kHz
MODULATION INDICATION	Peak Reading, Color Coded, LED Display with Baseband Over-Modulation Indicator
ASYNCHRONOUS AM SIGNAL-TO-NOISE RATIO	70 dB Below Reference Carrier with 100% Amplitude Modulation @ 400 Hz 75 Microsecond Deemphasis (No FM Modulation Present)
SYNCHRONOUS AM SIGNAL-TO-NOISE RATIO	60 dB Below Reference Carrier with 100% Amplitude Modulation @ 400 Hz 75 Microsecond Deemphasis (FM Modulation: ±75 kHz @ 400 Hz)
MULTIMETER	8 Function Plus Diagnostic Aid
TEST METERING	Internal High Input Impedance Multimeter with Probe for Point-to-Point Measurements
FRONT PANEL TEST JACKS	Composite Input and Composite Output
AUDIO/CONTROL CONNECTIONS	14 Terminal Barrier Strip and 4 BNC Connectors
AC INPUT POWER REQUIREMENTS	97 to 133V ac or 194 to 266V ac, 50/60 Hz, 200W Maximum

Table 1-1. FX-30 Exciter Specifications
(Sheet 2 of 3)

PARAMETER	SPECIFICATIONS
AMBIENT TEMPERATURE RANGE	+32°F to +122°F (0°C to +50°C) Operational to -4°F (-20°C)
CABINET SIZE	17.70 inches (44.96 cm) Wide X 5.25 inches (13.33 cm) High X 19.00 inches (48.26 cm) Deep. Standard 19 inch (48.26 cm) Rack Mounting with Slide Out Feature for Easy Access
NET WEIGHT	36 Pounds (16.33 kg) Unpacked 43 Pounds (19.51 kg) Packed
WIDEBAND COMPOSITE OPERATION	
COMPOSITE INPUTS	3 Total, Unbalanced (1) and Balanced (1) Plus Front Panel Test Provision (1) (BNC Connectors)
COMPOSITE INPUT IMPEDANCE	10 k Ohm, Nominal, Resistive
COMPOSITE INPUT LEVEL	3.5V p-p Nominal, for ±75 kHz Deviation
COMPOSITE FM SIGNAL-TO-NOISE RATIO	75 dB Below ±75 kHz Deviation @ 400 Hz (80 dB Typical). Measured within a 30 Hz to 100 kHz Bandwidth with 75 Microsecond Deemphasis
COMPOSITE HARMONIC DISTORTION	0.05% or Less (0.02% Typical)
COMPOSITE INTERMODULATION DISTORTION	0.03% or Less (0.015% Typical)
COMPOSITE TRANSIENT IMD	0.1% or Less (Square Wave/Sine Wave)
COMPOSITE AMPLITUDE RESPONSE	±0.1 dB, 30 Hz to 100 kHz
COMPOSITE PHASE RESPONSE	±0.5° from Linear Phase 30 Hz to 53 kHz
COMPOSITE GROUP DELAY	390 Nanoseconds ±25 Nanoseconds, 30 Hz to 53 kHz
COMPOSITE SLEW RATE	12 V/Microsecond (Symmetrical)

Table 1-1. FX-30 Exciter Specifications
(Sheet 3 of 3)

PARAMETER	SPECIFICATIONS
STEREOPHONIC SEPARATION	45 dB, 30 Hz to 15 kHz (Measured using BE FS-30 Stereo Generator)
SCA INPUTS	2 Total (1) Unbalanced and (1) Balanced, BNC Connectors
SCA INPUT IMPEDANCE	100 k Ohm, Nominal, Resistive
SCA INPUT LEVEL	3.5V p-p Nominal for ±7.5 kHz Deviation
SCA AMPLITUDE RESPONSE	±0.5 dB, 40 kHz to 100 kHz
MONAURAL OPERATION	
AUDIO INPUT IMPEDANCE	600 Ohms Balanced, Resistive, Adaptable to Other Impedances, 50 dB Common Mode Suppression
AUDIO INPUT LEVEL	+10 dBm Nominal for ±75 kHz Deviation @ 400 Hz
AUDIO FREQUENCY RESPONSE	±0.5 dB, 30 Hz to 15 kHz, Selectable Flat, 25, 50 or 75 Microsecond Preemphasis
HARMONIC DISTORTION	0.05% or Less 30 Hz to 15 kHz
INTERMODULATION DISTORTION	0.03% or Less, 60 Hz to 7 kHz, 4:1 Ratio
TRANSIENT INTERMODULATION DISTORTION	0.1% or Less (Square Wave/Sine Wave)
FM SIGNAL-TO-NOISE RATIO	75 dB Below ±75 kHz Deviation @ 400 Hz (80 dB Typical) Measured in a 30 Hz to 15 kHz Bandwidth with 75 Microsecond Deemphasis

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information required for installation and preliminary checkout of the Broadcast Electronics FX-30 FM Exciter.

2-3. UNPACKING.

2-4. The equipment becomes the property of the customer when the equipment is delivered to the carrier. Carefully unpack the exciter. Perform a visual inspection to determine that no apparent damage has been incurred during shipment. All shipping materials should be retained until it is determined that the unit has not been damaged. Claims for damaged equipment must be promptly filed with the carrier or the carrier may not accept the claim.

2-5. The contents of the shipment should be as indicated on the packing lists. If the contents are incomplete, or if the unit is damaged electrically or mechanically, notify both the carrier and Broadcast Electronics, Inc.

2-6. ENVIRONMENTAL REQUIREMENTS.

2-7. Table 2-1 provides environmental conditions which must be considered prior to exciter installation.

Table 2-1. ENVIRONMENTAL REQUIREMENTS

SPECIFICATION	REQUIREMENT
TEMPERATURE	+32°F to +122°F (0°C to +50°C) Useable to -4°F (-20°C)
ALTITUDE	Ø to 15,000 Feet (4572 m) Above Sea Level
HUMIDITY	95% Maximum, Non-Condensing
SIZE: HEIGHT	5.25 inches (13.3 cm)
WIDTH	17.70 inches (44.9 cm)
DEPTH	19.00 inches (48.3 cm)
COOLING AIR REQUIREMENTS	25 ft^3/minute (0.708 cm^3/minute)
WEIGHT	36 pounds (16.33 kg)

2-8. INSTALLATION.

2-9. Each exciter is wired, operated, tested, and inspected at the factory prior to shipment and is ready for installation when received. Prior to installation, this publication should be studied to obtain a thorough understanding of the operation, circuitry, nomenclature, and installation requirements. Installation is accomplished as follows: 1) Preliminary Installation, 2) Wiring, and 3) Exciter Checkout.

2-10. PRELIMINARY INSTALLATION.

2-11. The FX-30 exciter may be mounted in any convenient location in a 19 inch (48.3 cm) rack within reach of signal and power cables. The exciter should not be mounted directly above heat generating equipment such as power amplifier stage, otherwise no special requirements need be observed.

WARNING ENSURE ALL RACK POWER IS DEENERGIZED BEFORE ATTEMPTING EXCITER INSTALLATION.

2-12. Set the exciter on a work surface.

2-13. Remove any packing material from the outside of the exciter.

2-14. Set the exciter ON/OFF switch on the rear panel to OFF.

2-15. Remove the fuse from the AC LINE VOLTAGE SELECTOR on the exciter rear panel.

2-16. Ensure the primary ac line voltage with which the exciter will be used is visible on the AC LINE VOLTAGE SELECTOR circuit board (100V, 115/120V, 220V, or 230/240V).

2-17. If the ac line voltage must be changed, remove the AC LINE VOLTAGE SELECTOR circuit board with a small pair of needle nose pliers. Re-insert the circuit board so that the correct ac line voltage is visible when the circuit board is inserted into the receptacle.

2-18. Ensure the fuse and the spare fuse are both slow-blow types and rated at 3.0 amperes for the 100 to 120 volt range or 1.5 ampere for the 220 to 240 volt range.

2-19. If the exciter must be mounted in a rack, complete the following procedure. If the exciter was purchased as an item installed in a transmitter, proceed to paragraph 2-20.

A. Extend and remove the movable portion of each slide rail from the sides of the exciter.

B. Mount the front edge of each slide rail to its respective side of the rack cabinet with hardware supplied (see Figure 7-5).

CAUTION ENSURE THE SLIDE RAILS ARE PARALLEL TO EACH OTHER AND LEVEL BEFORE DRILLING ANY HOLES

CAUTION TO MOUNT THE REAR OF THE SLIDE RAILS.

C. The rear of each slide rail must also be supported. Hardware is supplied for this purpose.

D. After the slide rails are mounted, lift the exciter onto the rails over the slide stops and push the exciter into the rack.

2-20. Pull the exciter forward, out of the rack until the slide rail stops are encountered.

2-21. Loosen the eight turn-lock fasteners on the top of the exciter and remove the top cover.

2-22. Remove any packing material from the inside of the exciter.

2-23. Ensure the TEST/NORMAL switch on the metering assembly is set to NORMAL.

2-24. Ensure the AUTO-PWR/MAN switch on the control assembly is set to AUTO and the NORM-EXT switch is set to NORM.

2-25. Refer to the final test data sheets shipped with the exciter and ensure the AFC/PLL assembly SYNTHESIZER FREQUENCY SELECTION jumpers are correctly positioned.

2-26. Remove the two shipping screws securing the modulated oscillator assembly, and allow the unit to float on its mountings.

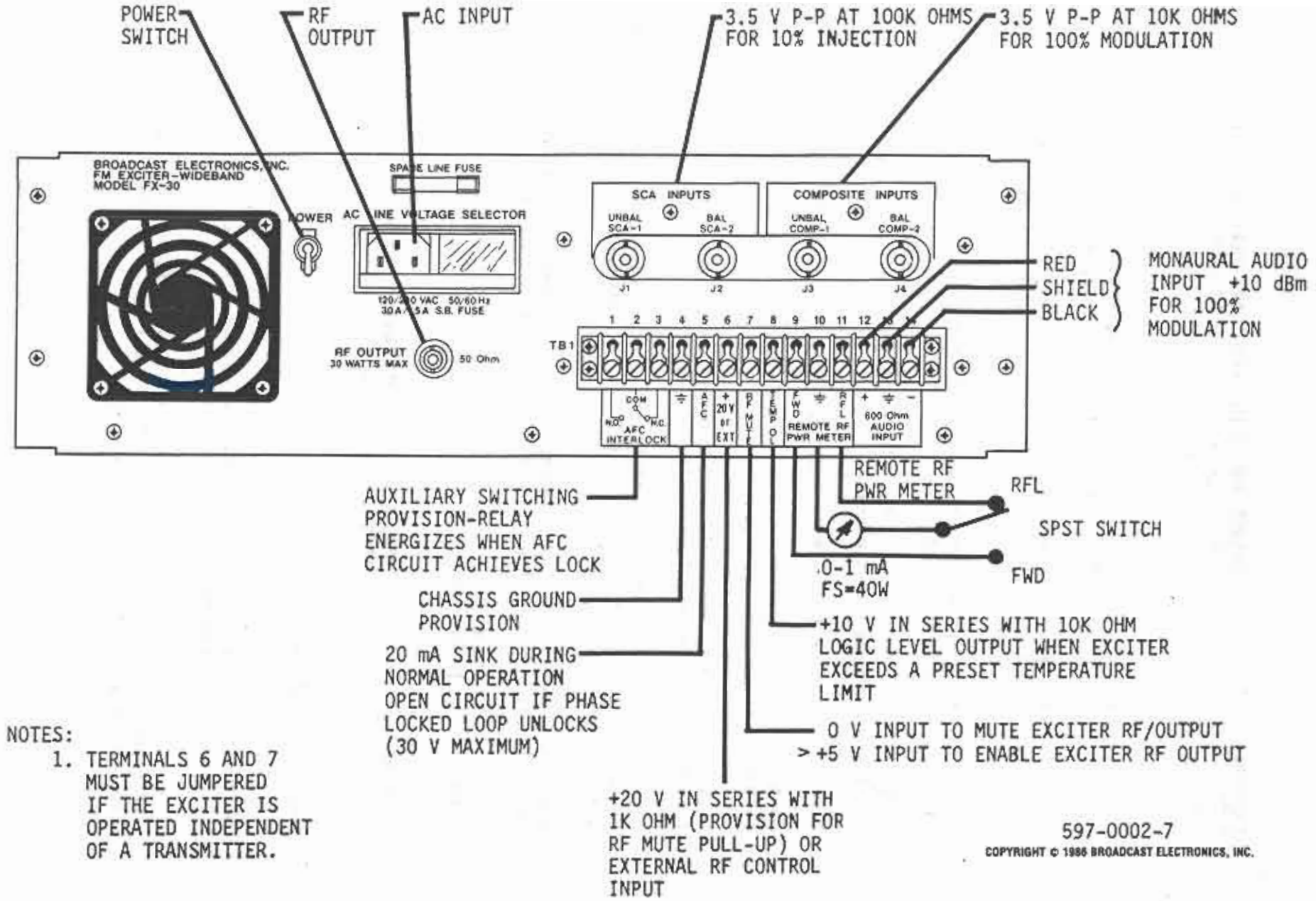
2-27. Replace the top cover on the exciter and secure the eight turn-lock fasteners on the top of the cover.

WARNING ENSURE ALL SYSTEM POWER IS DISCONNECTED BEFORE PROCEEDING.

2-28. WIRING.

2-29. Connect one of the two coaxial cables provided from the RF OUTPUT connector on the exciter rear panel to a 50 Ohm RF load capable of dissipating the output of the exciter.

2-30. Refer to Figure 2-1 and connect the external signal inputs and remote control wiring. A second coaxial cable is provided to be used to connect a SCA or composite input.



NOTES:

1. TERMINALS 6 AND 7 MUST BE JUMPERED IF THE EXCITER IS OPERATED INDEPENDENT OF A TRANSMITTER.

FIGURE 2-1. EXCITER WIRING

WARNING ENSURE THE EXCITER CASE IS CONNECTED TO EARTH GROUND.

2-31. GROUND. Ensure a ground wire is connected from terminal 4 of the exciter rear panel terminal board to earth ground.

2-32. EXCITER CHECKOUT.

2-33. Before proceeding, check the following:

A. Ensure all connections at terminal strips are secure.
B. Ensure primary power is properly programmed.
C. Ensure the chassis ground connection is secure.
D. Ensure all signal inputs are secure.
E. Ensure the RF output is properly connected.
F. Rotate the fan manually to be sure no obstructions are present.
G. All cabling should be properly dressed and secured.

2-34. Ensure the exciter POWER switch is set to OFF.

CAUTION THE PRIMARY AC POWER USED MUST BE THE SAME AS DISPLAYED ON THE AC LINE VOLTAGE SELECTOR CIRCUIT BOARD.

CAUTION

2-35. Connect the exciter to a power source with the power cord provided.

2-36. Depress the multimeter FWD switch.

2-37. Set the exciter POWER switch to ON.

A. The fan will begin to operate.
B. The front panel POWER indicator will illuminate.
C. After a time period of approximately five seconds, the front panel AFC indicator will illuminate and the multimeter will indicate the presence of RF output.

2-38. Depress the multimeter +20 switch.

A. The multimeter should indicate +20 volts ±2 volts.

2-39. Depress the multimeter -20 switch.

A. The multimeter should indicate -20 volts ±2 volts.

2-40. Depress the multimeter +5 switch.

A. The multimeter should indicate +5 volts ±0.5 volts.

2-41. Depress the multimeter AFC switch.

A. The multimeter should indicate a potential within the range of +2.5 volts to +13.5 volts, dependent upon carrier frequency. The correct voltage is noted on the final test data sheets.

2-42. Depress the multimeter PAV switch.

A. The multimeter should indicate a potential within the range of +6.5 volts to +7.5 volts (assuming an RF output power of 5 Watts).

2-43. Depress the multimeter PAI switch.

A. The multimeter should indicate approximately 1.5 amperes (assuming an RF output power of 5 Watts).

2-44. Depress the multimeter FWD switch.

A. Extend the exciter forward out of the rack on the slide rails to expose the R.F. POWER OUTPUT ADJ. control access hole in the left side of the top cover.

B. Adjust the exciter output power to the level required by the transmitter.

2-45. Check the carrier frequency of the exciter with the station frequency monitor.

2-46. Set the exciter POWER control to OFF.

2-47. Disconnect the RF load and connect the exciter output to the transmitter RF input connector.

2-48. CONNECTION OF COMPOSITE STEREO SIGNAL SOURCES.

2-49. Two composite input jacks (J3, J4) are provided on the rear panel of the FX-30 for connection to a composite stereo source such as a stereo generator or composite STL receiver.

2-50. Both inputs require a level of 3.5V P-P (1.24 VRMS) to modulate the carrier (±75 kHz). These jacks may be used entirely independent of each other and will accept frequencies from less than 1 Hz thru 100 kHz.

2-51. The UNBAL COMP-1 input (J3) is applied through a dc coupled amplifier to the modulator to provide a frequency response of 0.1 Hz to 100 kHz. The BAL COMP-2 input (J4) is ac coupled at the input and features balanced common mode rejection. Frequency response is 1 Hz to 100 kHz.

2-52. The BAL COMP-2 input (J4) should be used when a dc offset voltage is present on the composite source or when ground loops and hum are present between the exciter and composite source.

2-53. When using either composite input, the output level on the composite source must be adjusted to obtain 100% peak modulation as indicated by the FX-30 modulation display (140% range).

2-54. The front panel COMPOSITE TEST IN connector functions in the same manner as the UNBAL COMP-1 input.

2-55. CONNECTION OF SCA SIGNAL SOURCES.

2-56. Two SCA input jacks (J1, J2) are provided on the rear panel of the FX-30. J1 is unbalanced and J2 is balanced for common mode rejection. Both inputs are ac coupled and accept frequencies from 40 kHz to 100 kHz. An input of 3.5V P-P (1.24 VRMS) will modulate the FM carrier 10% (±7.5 kHz).

2-57. When using either SCA input, the output level of the source must be adjusted to obtain the desired peak modulation as indicated by the FX-30 modulation display (14% range).

2-58. Either input is compatable with any SCA generator using a dc coupled input for the transmission of video data.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section identifies all controls, and indicators associated with the FX-30 FM Exciter and provides standard operating procedures.

3-3. CONTROLS AND INDICATORS.

3-4. Refer to Figure 3-1 for the location of all controls and indicators associated with normal operation of the FX-30 Exciter. The function of each control or indicator is described by Table 3-1.

3-5. OPERATION.

NOTE THE FOLLOWING PROCEDURE IS PRESENTED UNDER THE ASSUMPTION THAT THE EXCITER IS FULLY

NOTE INSTALLED AND FREE OF ANY DISCREPANCIES.

3-6. TURN ON.

3-7. To apply power to the exciter, set the exciter rear panel ON/OFF POWER switch to ON. Normally, the POWER switch will be left in the ON position and exciter power will be energized when the transmitter filament supply is turned on.

3-8. The POWER indicator will illuminate immediately. After a delay of approximately five seconds, the AFC indicator will illuminate to indicate AFC lock and exciter RF power output will be established.

3-9. Note the MODULATION indicator to ensure programming is applied to the exciter.

3-10. Depress the FWD multimeter switch and record the multimeter indication of output power.

3-11. Depress the RFL multimeter switch and record the multimeter indication of reflected power.

3-12. The exciter forward and reflected power indications may be converted to a VSWR ratio using Table 3-2. To use the table, divide the multimeter reflected power indication by the multimeter forward power indication. Locate the quotient in the POWER RATIO column. The VSWR is listed across from the POWER RATIO entry.

3-13. TURN OFF.

3-14. If the exciter primary circuit is connected to the transmitter filament supply, the exciter deenergizes when the transmitter is turned off. If the exciter is located remotely, set the exciter rear panel ON/OFF POWER switch to OFF.

3-15. There are no circuits in the exciter which require constant power, such as a crystal oven.

Table 3-2. POWER/VSWR CONVERSION

$\frac{\text{Reflected Power in Watts}}{\text{Forward Power in Watts}}$ = POWER RATIO	VSWR
0.000	1.0:1
0.002	1.1:1
0.008	1.2:1
0.017	1.3:1
0.028	1.4:1
0.040	1.5:1
0.053	1.6:1
0.074	1.75:1
0.111	2.0:1
0.183	2.5:1
0.250	3.0:1
0.360	4.0:1

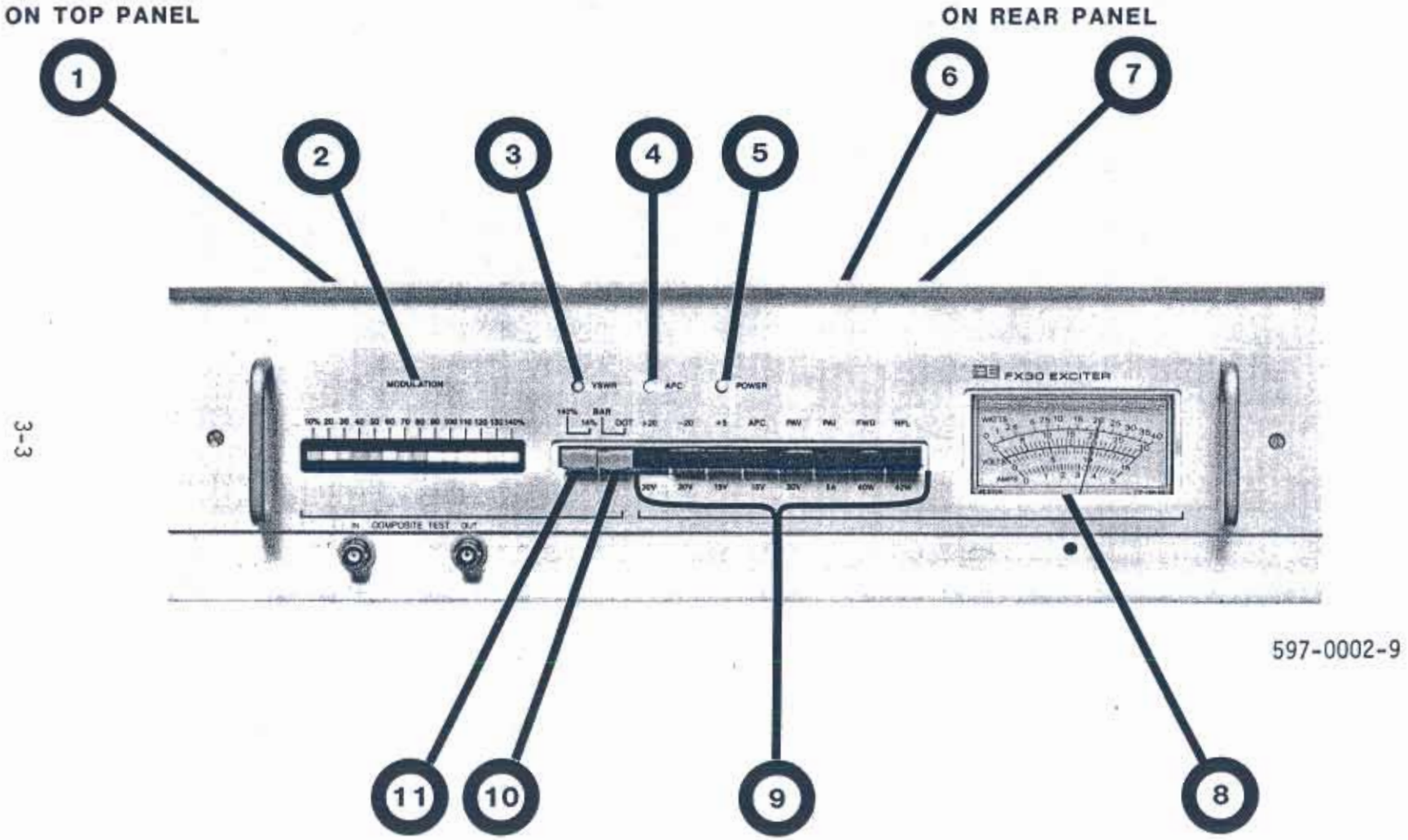


FIGURE 3-1. CONTROL AND INDICATOR LOCATIONS

Table 3-1. CONTROL AND INDICATOR FUNCTIONS

ITEM	NOMENCLATURE	FUNCTION
1	R.F. POWER OUTPUT ADJ. (R3)	Adjusts exciter RF output level. Clockwise adjustment raises power and counterclockwise adjustment lowers power.
2	MODULATION Indicator (D8 THRU D21)	Indicates peak composite baseband modulation level. 100% indication is factory calibrated to equal ±75 kHz deviation.
3	VSWR Indicator (D1)	Illuminates to indicate reflected power exceeds 3 watts.
4	AFC Indicator (D2)	Illuminates to indicate the exciter is locked on frequency and RF power output is available.
5	POWER Indicator (D3)	CONTINUOUS ILLUMINATION: Indicates AC power is applied to the exciter as in normal operation. FLASHING: Indicates RF amplifier heat sink over temperature condition.
6	AC Line Fuse	Provides overload protection for the exciter internal primary AC circuitry.
7	ON/OFF POWER Switch (S1)	Controls primary AC power application to the exciter.
8	Multimeter (M1)	Indicates voltage or current as selected by the multimeter switch.
9	Multimeter Switch (S3 THRU S10)	Determines voltage or current displayed by the multimeter.
10	BAR/DOT Switch (S2)	Change the MODULATION indicator from a sliding bar display to a moving dot display for operator preference.
11	140%/14% Switch (S1)	When depressed, expands MODULATION indicator by 10 to allow SCA and pilot injection level adjustment.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section presents overall theory of operation for the FX-30 FM Exciter.

4-3. For purposes of definition, the FX-30 Exciter is divided into functional subassemblies by the following text. A detailed description of each subassembly is presented in Part II of this manual. A block diagram of the FX-30 FM Exciter is presented as Figure 4-1.

4-4. FUNCTIONAL DESCRIPTION.

4-5. POWER SUPPLY.

4-6. AC power to the exciter is applied through an interlocked voltage selector and line filter. This device serves the additional purposes of providing overload protection for the entire exciter and allowing selection of a wide range of ac input potentials. AC power application is signified by steady illumination of the front panel POWER indicator.

4-7. All dc circuitry in the exciter operates from an unregulated potential of +25V dc and three pre-regulated potentials of +20 volts, -20 volts and +5 volts. All supplies are full-wave rectified, filtered, and electronically regulated to assure stable equipment operation.

4-8. The +20 volt, -20 volt, and +5 volt supplies are basically low-current supplies containing full protection for over-voltage, over-current, reverse-voltage, and short-circuit conditions. These potentials are distributed throughout the exciter to various subassemblies and re-regulated to lower voltages on each circuit board.

4-9. The filtered +25 volt supply associated with the RF amplifier is regulated by the circuitry on the control assembly circuit board in response to preset level controls and feedback loops. This supply contains over-voltage, over-current, reverse-voltage, short-circuit protection, and additional circuitry to protect the RF amplifier transistor load from over-voltage, over-current, and over-heating conditions.

4-10. RFI FILTER.

4-11. The RFI filter prevents interference from signals of 500 kHz and above by filtering and bypassing the audio, control, and status input and output lines. The front panel COMPOSITE TEST IN and COMPOSITE TEST OUT lines are not routed through this filter.

4-12. METERING CIRCUIT.

4-13. Metering of important exciter operating parameters is provided by a combination of an analog meter and a digital LED display. Eight steady-state parameters are selected by a push-switch and displayed on a conventional analog multimeter. Additional circuitry on the metering circuit board allows use of the analog meter as a built-in high-impedance test meter for point-to-point voltage measurements within the exciter.

4-14. A digitally controlled color-coded LED display constantly monitors, the ac composite signal applied to the modulated oscillator. A display selector provides either a bar graph or a moving dot representation of peak modulation levels from 10% to 140%. A clear indication of short transient peaks exceeding 100% modulation is provided by a one-shot multivibrator connected to the 100% digital display segment. Accuracy to 5% on signals from dc to a one-cycle burst of a 100 kHz tone is provided by a high-speed peak detector. The front panel 14%/140% switch allows expansion of the meter scale to clearly measure SCA pilot injection.

4-15. AFC/PLL CIRCUIT.

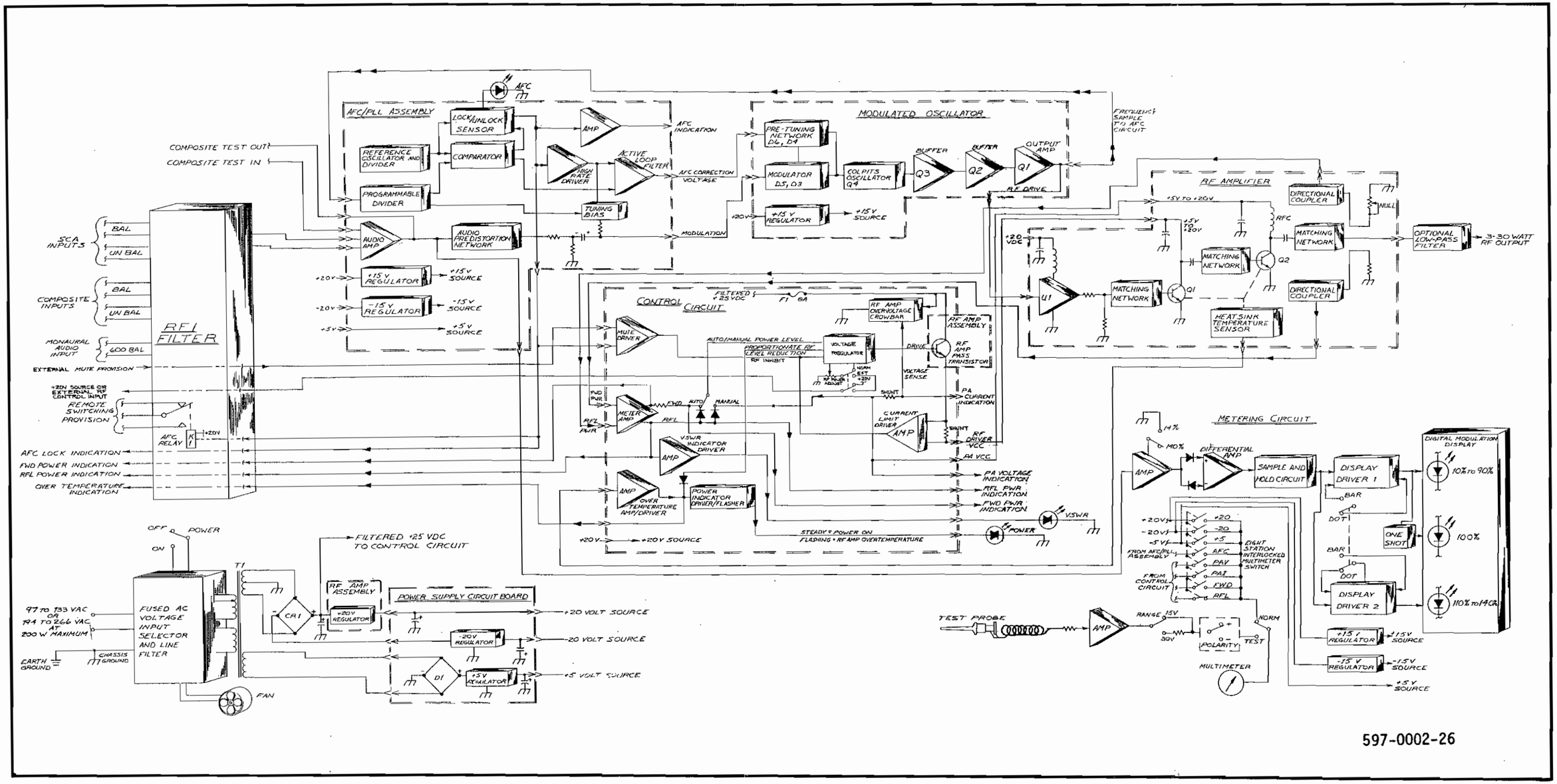
4-16. The AFC/PLL assembly synthesizes the exciter carrier frequency and maintains the phase and frequency of the carrier to a high level of precision. The FX-30 frequency synthesizer provides the ability to synthesize 2000 frequencies within the commercial FM broadcast band in 10 kHz increments.

4-17. Carrier sampled at the output of the modulated oscillator is returned to the AFC/PLL circuit as feedback. This carrier sample or feedback is divided and compared to a scaled-down reference frequency within the AFC/PLL assembly to develop an error signal.

4-18. During normal operation, the AFC/PLL assembly constantly changes the error signal applied to the modulated oscillator to maintain the stability of the carrier. If the carrier is off frequency (such as at power on), the AFC/PLL circuit will mute the RF output and deenergize the AFC relay until the carrier is again locked in phase and frequency to the reference oscillator. A dual-speed active-loop filter in the FX-30 provides rapid stabilization of the carrier while allowing full modulation from 1 Hz to 100 kHz. The condition of frequency lock is signified by illumination of the front panel AFC indicator.

4-19. As a secondary function, the assembly accepts all audio inputs, predistorts the audio, and sums the predistorted audio with AFC tuning bias which linearizes the response and adjusts the carrier frequency of the modulated oscillator.

4-20. MODULATED OSCILLATOR.



597-0002-26

FIGURE 4-1. DETAILED BLOCK DIAGRAM

4-21. The modulated oscillator assembly produces the final carrier frequency, frequency modulates the carrier, and amplifies the modulated RF carrier to a level sufficient to drive the RF amplifiers. Additional circuitry interfaced with the AFC/PLL assembly maintains the RF carrier center frequency as part of a phase-locked-loop.

4-22. RF AMPLIFIER.

4-23. The RF amplifier assembly comprises three stages of amplification designed to increase the 10 milliwatt RF input signal from the modulated oscillator to an adjustable RF power level of 3 to 30 watts as required to drive an associated transmitter.

4-24. The first stage utilizes a broadband thick-film hybrid amplifier which provides a saturated output of approximately one watt to the input of the driver stage. The driver provides 8 watts of RF to the power amplifier which outputs an adjustable RF level of 3 to 30 watts.

4-25. A microstrip directional coupler as part of the RF amplifier printed circuit board supplies information to the exciter control circuitry to automatically maintain RF power output and provide protection for operation during high VSWR conditions.

4-26. The RF amplifier transistors are mounted to a large heat sink positioned in the direct air flow from a cooling fan. Heat sink temperature is monitored by the control circuitry. If an overtemperature condition exists, the control circuit will automatically reduce RF power to maintain safe operation of the RF devices.

4-27. The broadband performance of the amplifier eliminates the need for adjustments for any particular frequency within the FM band, ensures that the exciter output is transparent to the signal generated by the modulated oscillator, and enhances amplifier stability under varying load conditions.

4-28. CONTROL CIRCUIT.

4-29. The control circuit assembly regulates operation of the RF amplifier within preset limits dependent upon several parameters such as forward RF power output, reflected power, RF amplifier heat sink temperature, dc current, dc supply voltage, an external mute control potential, and an external RF power adjust potential. The control circuit assembly also contains amplifiers for the forward and reflected power directional couplers, over temperature circuitry, and the VSWR circuitry.

4-30. The control circuit compares the sum of forward and reflected powers to a reference to accomplish automatic control of power output. If the reflected power becomes excessive, the power output will be reduced only the amount required to maintain safe operation of the RF output transistors. Excessive VSWR is signified by illumination of the front panel VSWR indicator.

4-31. The control circuit also monitors the power dissipated by each RF transistor as well as total RF amplifier assembly heat sink temperature and limits RF output accordingly. This assures operation at safe junction temperatures under the worst case conditions of high VSWR, high ambient temperatures, or failure of the cooling fan. An overtemperature condition is signified by flashing of the front panel POWER indicator.

4-32. Automatic protection of the RF devices from excessive voltage is provided by a crowbar circuit and short circuit protection is provided by foldback current limiting and a fuse.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides general maintenance information, electrical adjustment procedures, and troubleshooting information for the FX-30 FM Exciter. Maintenance is divided into two categories dependent upon the complexity of the procedure and the test equipment required to complete the maintenance.

5-3. SAFETY CONSIDERATIONS.

WARNING WHEN THE EXCITER IS OPERATED WITH THE TOP COVER REMOVED, HAZARDOUS VOLTAGES ARE ACCESSIBLE ON
WARNING THE AC LINE VOLTAGE SELECTOR AND HIGH CURRENTS ARE ACCESSIBLE ON THE EXPOSED TERMINALS OF THE
WARNING POWER SUPPLY FILTER CAPACITOR AND POWER TRANSISTORS MOUNTED TO THE RF AMPLIFIER HEAT SINK
WARNING ASSEMBLY.

WARNING USE THE INSULATED TUNING TOOL PROVIDED FOR ANY ADJUSTMENTS AND DO NOT TOUCH ANY COMPONENT
WARNING WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

5-4. Low voltages are used throughout the exciter circuitry, however maintenance with power energized is always considered hazardous and caution should be observed. It is possible to receive RF burns of a minor nature from the high impedance points of the RF power amplifier if the unit is disassembled.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING EQUIPMENT MAIN-
WARNING TENANCE.

5-5. FIRST LEVEL MAINTENANCE.

5-6. First level or preventive maintenance consists of those precautionary measures applied to equipment to forestall future failures rather than to eliminate failures after they have occurred. These procedures are performed on a regularly scheduled periodic basis, and the results recorded in a performance log.

5-7. Preventive maintenance of the FX-30 Exciter is limited to whatever cleaning may be necessary and checking performance levels using the meters and various indicators built into the equipment.

5-8. On a regular basis, the exciter should be cleaned of accumulated dust using a brush and vacuum cleaner. The concave sides of the fan impeller blades should be cleaned as these blades will collect dust. As material build up, airflow from the fan will decrease and damage to the fan will eventually result. Check for overheated components, tighten loose hardware, and lubricate mechanical surfaces (such as the slide rails) as required.

5-9. SECOND LEVEL MAINTENANCE

5-10. Second level maintenance consists of procedures required to restore the FX-30 Exciter to satisfactory operation after a fault has occurred.

5-11. The maintenance philosophy of the FX-30 FM Exciter consists of problem isolation to a specific assembly. Subsequent troubleshooting is provided by each applicable assembly publication in Part II of this manual to isolate specific components. If desired, the entire assembly may be returned to the factory for repair or exchange.

5-12. ADJUSTMENTS

5-13. Adjustment procedures for all controls on all circuit boards are provided by each applicable assembly publication in Part II of this manual.

5-14. TROUBLESHOOTING

5-15. Most troubleshooting consists of visual checks. Because of the voltages and high dc currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various exciter indicators (meters, LED's, and fuses) should be used to isolate the malfunction to a specific area as listed below. Typical meter indications are presented in Table 5-1 and exciter power demand requirements are listed in Table 5-2.

A. Exciter Input
B. Power Supply
C. Metering Circuit
D. Modulated Oscillator
E. AFC/PLL Assembly
F. RF Amplifier
G. Control Circuit
H. Exciter Output

WARNING: DISCONNECT POWER PRIOR TO SERVICING

Table 5-1. Typical Meter Indications

MULTIMETER SWITCH POSITION		MULTIMETER INDICATION		
+20 V		+18 to +22 V dc		
-20 V		-18 to -22 V dc		
+5 V		+4.8 to +5.2 V dc		
AFC		+2.5 to +13.5 V dc, dependent upon RF carrier frequency		
PAV	RF POWER	88.1 MHz	98.1 MHz	108.1 MHz
	5 Watts	+6.5 V dc	+6.7 V dc	+8.2 V dc
	10 Watts	+9.1 V dc	+9.1 V dc	+11.3 V dc
	20 Watts	+13.8 V dc	+13.5 V dc	+16.1 V dc
	30 Watts	+18.0 V dc	+17.2 V dc	+20.2 V dc
PAI	RF POWER	88.1 MHz	98.1 MHz	108.1 MHz
	5 Watts	1.5 Ampere	1.4 Ampere	1.0 Ampere
	10 Watts	2.2 Ampere	2.0 Ampere	1.4 Ampere
	20 Watts	2.95 Ampere	2.75 Ampere	2.05 Ampere
	30 Watts	3.4 Ampere	3.25 Ampere	2.6 Ampere
FWD		3 to 30 Watts		
RFL		Less than 2 Watts		

Table 5-2. AC Power Requirements

RF POWER OUTPUT MIDBAND	AC INPUT	POWER REQUIREMENTS
30 W	230 V ac	0.88 Ampere
20 W	230 V ac	0.75 Ampere
10 W	230 V ac	0.63 Ampere
30 W	115 V ac	1.75 Ampere
20 W	115 V ac	1.50 Ampere
10 W	115 V ac	1.25 Ampere

WARNING: DISCONNECT POWER PRIOR TO SERVICING

5-16. Once the trouble is isolated, refer to the applicable section discussing the theory of operation and providing troubleshooting for the respective assembly to assist in problem resolution. All internal components may be accessed through a removable top cover (see Figure 5-1).

WARNING BERYLLIUM OXIDE CERAMICS (BeO) - AVOID BREATHING DUST OR FUMES.

WARNING THE WHITE CASE MATERIAL OF THE FX-30 RF AMPLIFIER TRANSISTORS IS MADE OF BeO CERAMIC
WARNING MATERIAL. DO NOT PERFORM ANY OPERATION ON ANY BeO CERAMIC WHICH MIGHT PRODUCE DUST OR
WARNING FUMES, SUCH AS GRINDING, GRIT BLASTING, OR ACID CLEANING. BERYLLIUM OXIDE DUST OR FUMES
WARNING ARE HIGHLY TOXIC AND BREATHING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. BeO
WARNING CERAMICS MUST BE DISPOSED OF ONLY IN A MANNER PRESCRIBED BY THE DEVICE MANUFACTURER. USE
WARNING CARE IN REPLACING TRANSISTORS OF THIS TYPE.

5-17. COMPONENT REPLACEMENT. The circuit boards used in the FX-30 are double-sided boards with plated through-holes. Because of the plated through-holes, solder fills the holes by capillary action. These conditions require that defective components be removed carefully to avoid damage to the board.

5-18. On all circuit boards, the adhesive securing the copper track to the board melts at almost the same temperature as solder. A circuit board track can be destroyed by excessive heat or lateral movement during soldering. Use of a small iron with steady pressure is required for circuit board repairs.

5-19. To remove a component from a board such as the type used in the FX-30 Exciter, cut the leads from the body of the defective component while the device is still soldered to the board.

5-20. Grip each component lead, one at a time, with long nose pliers. Turn the board over and touch the soldering iron to the lead at the solder connection. When the solder begins to melt, push the lead through the back side of the board and cut off the clinched end of the lead. Each lead may now be heated independently and pulled out of each hole. The holes may be cleared of solder by carefully re-heating with a low wattage iron and removing the residual solder with a soldering vacuum tool.

5-21. Install the new component and apply solder from the bottom side of the board. If no damage has been done to the plated through-holes, soldering of the top side is not required.

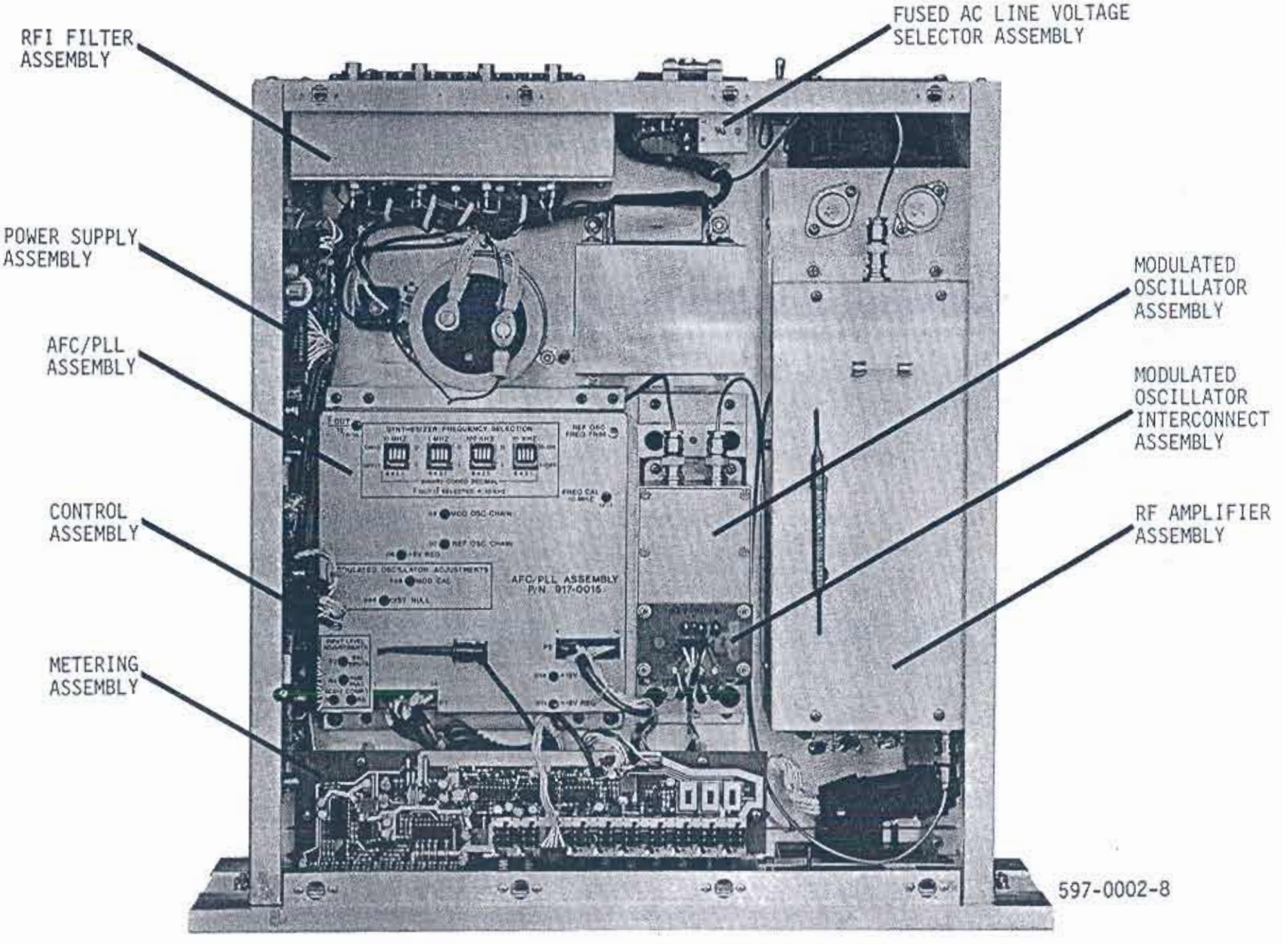


FIGURE 5-1. FX-30 ASSEMBLY

WARNING: DISCONNECT POWER PRIOR TO SERVICING

WARNING MOST SOLVENTS WHICH WILL REMOVE ROSIN FLUX ARE VOLATILE AND TOXIC BY THEIR NATURE AND SHOULD
WARNING BE USED ONLY IN SMALL AMOUNTS IN A WELL VENTILATED AREA, AWAY FROM FLAME, INCLUDING
WARNING CIGARETTES AND A HOT SOLDERING IRON.

WARNING OBSERVE THE MANUFACTURER'S CAUTIONARY INSTRUCTIONS.

5-22. After soldering, remove residual flux with a cotton swab moistened with a suitable solvent. Rubbing alcohol is highly diluted and is not effective. Solvents are available from electronic supply houses which are useful.

5-23. The board should be checked to ensure the flux has been removed and not just smeared about. Rosin flux is not normally corrosive, but it will absorb enough moisture in time to become conductive and cause problems.

5-24. EXCITER PREPARATION FOR SHIPMENT.

5-25. If the exciter is removed from service to be shipped to another location, ensure the following steps are accomplished prior to shipping:

A. Secure the modulated oscillator assembly in place with two 6-32 X 1/2 inch (1.27 cm) screws in the tapped holes provided.

B. Ensure the top cover is secured to the exciter.

C. Pack the exciter in a carton, allowing 2 inches (5.08 cm) minimum of packing material all around the exciter.

D. Provide adequate insurance coverage.

5-26. EXCITER FREQUENCY CHANGE.

5-27. If the exciter frequency is to be changed from the factory set frequency, refer to the FREQUENCY SELECTION procedure in the AFC/PLL section of this manual.

SECTION VI

PARTS LIST

6-1. INTRODUCTION.

6-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FX-30 FM Exciter. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

6-3. Parts associated with modular assemblies are listed in Part II of this manual.

TABLE 6-1. REPLACEABLE PARTS LIST INDEX

TABLE 6-2. FM EXCITER, 21.5 INCH (54.61 cm) FRONT PANEL - 909-0002

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Basic Exciter	909-0010	1
----	Accessory Kit	961-0001	1
----	Indicator Assembly	917-0022	1
----	Multimeter, 3.5 inch (8.89 cm), 1 mA dc Taut Band Movement, 15 Ohm dc Resistance	310-0005-1	1
----	Filter, Window, Gray	467-1001-1	1
----	Filter, Window, Frosted	467-1002-1	1
----	Plug, BNC	417-0016	2
----	Receptacle, Top Cover Fastener	420-0022	4

TABLE 6-3. FM EXCITER, 19 INCH (48.26 cm) FRONT PANEL - 909-0093

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Basic Exciter	909-0010	1
----	Accessory Kit	961-0001	1
----	Indicator Assembly	917-0022	1
----	Multimeter, 3.5 inch (8.89 cm), 1 mA dc Taut Band Movement, 15 Ohm dc Resistance	310-0005-1	1
----	Filter, Window, Gray	467-1001-1	1
----	Filter, Window, Frosted	467-1002-1	1
----	Plug, BNC	417-0016	2
----	Receptacle, Top Cover Fastner	420-0022	4

TABLE 6-4. FM EXCITER/TRANSMITTER, 19 INCH (48.26 cm) FRONT PANEL 909-0009/-0009-300

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Basic Exciter	909-0010	1
----	Accessory Kit	961-0001	1
----	Indicator Assembly	916-0022	1
----	Multimeter, 3.5 inch (8.89 cm) 1 mA dc Taut Band Movement, 15 Ohm dc Resistance	310-0005-1	1
----	Filter, Window, Gray	467-1001-1	1
----	Filter, Window, Frosted	467-1002-1	1
----	Plug, BNC	417-0016	2
----	Rack Mounting Hardware Kit	961-0003	1
----	Receptacle, Top Cover Fastener	420-0002	4
----	BNC Receptacle, Bulkhead, UG492A/U	417-0017	1

TABLE 6-5. ACCESSORY PACK, FX-30 - 961-0001

REF. DES.	DESCRIPTION	PART NO.	QTY.
---- *	AC Line Cord, N.E.M.A. 5-15P 3-Wire North American Plug	682-0001	1
---- *	AC Line Cord, CEE 7/7 3-Wire European Plug	682-0003	1
----	Accessory Cables, BNC Type Plugs	947-0020	2
F1,F1 * SPARE	Fuse, AGC, 240V, 1.5A, Slow-Blow (for 230 Volt Operation)	334-0150	2
F1,F1 * SPARE	Fuse, Type AGC, 120V, 3.0A, Slow-Blow (for 120 Volt Operation)	334-0300	2
S1 THRU S4	Switch, SPST, 4 Circuit, 8-Pin DIP (Alternate Switches for AFC/PLL Assembly Programmable Divider)	340-0002	4

* Applicable item included per customer specification.

TABLE 6-6. ACCESSORY CABLE - 947-0020

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Plug, BNC	417-0205	4

TABLE 6-7. RACK MOUNTING HARDWARD KIT - 961-0003

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Chassis Slides (Pair)	469-0413-002	1

TABLE 6-8. BASIC EXCITER - 909-0010
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
A1	AFC/PLL Assembly	917-0015	1
A2	Modulated Oscillator Assembly	917-0019	1
A3	RF Amplifier Assembly	955-0013	1
A4	Display/Switch Assembly	917-0018	1
A5	Power Supply Assembly	917-0023	1
A6	Control Assembly	917-0028	1
A7	RFI Assembly	955-0014	1
B1	Fan, Compact 115V ac, 50/60 Hz, 23 to 27 ft^3/min (0.65 to 0.76 cm^3/min)	380-6305	1
BR1	Bridge Rectifier, Full Wave, 200 PIV, 25 Amperes	239-0006	1

TABLE 6-8. BASIC EXCITER - 909-0010
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 22,000 uF, 50V	027-2200	1
FL1	Fused Power Connector,120/240V Voltage Selector, EMI Filter	360-6504	1
J5	Receptacle, BNC Bulkhead	417-0017	1
S1	Switch, Toggle, SPST, 250V, 3 Ampere	348-8280	1
T1	Transformer, Power, 115/230V, 50/60 Hz Dual 115V Primary: One Winding Tapped at 95V Dual Secondary: 42V CT, 5.5 A/6.4V, 1 Ampere	376-9089	1
----	Turn-Lock Fastener, Stud, Front	420-0019	4
----	Turn-Lock Fastener, Stud, Rear	420-0020	4
----	Retainers, Split Ring	420-0021	8
----	Receptacle, Top Cover Fastener	420-0022	4
----	Test Probe with Coiled Cord	449-0006	1
----	Assembly, Cable Harness	945-0007	1
----	Switch Cap, Black	343-6401	2
----	Switch Cap, Gray	343-6402	8

TABLE 6-9. WIRING HARNESS, FM EXCITER - 945-0007

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Contact Pin, Crimp AMP MOD IV	417-8766	73
----	Contact Pin, Crimp AMP MR	417-0053	36
----	AMP MR Socket Housing 4-Pin	418-0240	2
----	AMP MR Socket Housing, 6-Pin	418-0670	1
----	AMP MR Socket Housing, 12-Pin	418-1271	1
----	AMP MR Socket Housing, 15-Pin	417-2379	1
----	AMP MOD IV Socket Housing, 5-Pin	417-0501	2
----	AMP MOD IV Socket Housing, 14-Pin	417-1401	5
----	Plug, BNC	418-0011	4

TABLE 6-10. RFI FILTER - 955-0014
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C9	Capacitor, Ceramic, Feed-Thru, 1000 pF ±20%, 500V	008-1033	9
C10 THRU	Capacitor Assembly, Kapton Feed-Thru, 100 pF	--------	4
C13	Kapton Dielectric	409-1817	8
	Nylon Insulator	423-6007	4
C14 THRU C17	Capacitor, Ceramic, Feed-Thru, 1000 pF ±20%, 500V	008-1033	4
C18,C19	Capacitor, Polystyrene, 0.47 uF, 100V	038-4753	2
C20	Capacitor, Ceramic, Feed-Thru, 1000 pF ±20%, 500V	008-1033	1
CR1	Diode, Rectifier, 1N4005, Silicon, 600V, 1A	203-4005	1

TABLE 6-10. RFI FILTER - 955-0014
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1 THRU J4	Connector, BNC	417-0016	4
K1	Relay Coil: 24V dc, 450 Ohm dc Resistance Contacts: SPST, 10A @ 28V dc or 120V ac, 50/60 Hz, Resistive Load	272-0024	1
L1,L2	Choke, Ferrite, 180 MHz, 2.5 Turns, Single Section	364-0002	2
L3,L4	Inductor, 1.0 mH ±5%, 3 Section PI Winding, 160 mA Maximum	364-4662	2
L5 THRU L13	Choke, Ferrite, 180 MHz, 2.5 Turns, Single Section	364-0002	9
R1	Resistor, 620 Ohm ±5%, 1/4W	100-6233	1
R2,R3	Resistor, 8.2 k Ohm ±5%, 1/4W	100-8243	2
R4	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R5	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
R6	Resistor, 240 Ohm ±5%, 2W	130-2423	1
TB1	Barrier Strip, 14 Terminals	412-0014	1

TABLE 6-11. OPTIONAL LOW-PASS FILTER - 909-0114

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	RF Low-Pass Filter	955-0051	1

TABLE 6-12. RF LOW-PASS FILTER - 955-0051

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, 27 pF, Mica Compression, 250V dc ±5%	046-0027	1
C2	Capacitor, Ceramic, 2-8 pF Variable, 350V dc, NPO	096-0008	1
C3	Capacitor, Mica Compression, 45 pF ±5%, 250V dc	046-0045	1
C4	Capacitor, Mica Compression, 7 pF ±5%, 250V dc	046-0007	1
C5	Capacitor, Ceramic, 2-8 pF Variable, 350V dc, NPO	096-0008	1
C6	Capacitor, Mica Compression, 22 pF ±5%, 250V dc	046-0022	1
J1,J2	Receptacle, BNC	417-0203	2
L1	Coil, Airwound 7 Turns of No. 18 AWG Wire, 0.20 inches ID (0.51 cm), 0.42 inches long (1.1 cm)	601-0018	1
L2	Coil, Airwound 6 Turns of No. 18 AWG Wire, 0.20 inches ID (0.51 cm), 0.42 inches long (1.1 cm)	601-0018	1
P1,P2	Plug, BNC	418-0011	2
----	Plug, BNC, Dual Crimp	418-0034	2
----	Blank Circuit Board	517-0036	1

SECTION VII
DRAWINGS

7-1. INTRODUCTION.

7-2. This section provides assembly drawings, schematic diagrams, and wire lists as indexed below for the FX-30 FM Exciter:

FIGURE	TITLE	NUMBER
7-1	OPTIONAL RF LOW-PASS FILTER ASSEMBLY	B955-0051
7-2	OPTIONAL RF LOW-PASS FILTER SCHEMATIC DIAGRAM	A909-0036
7-3	RFI FILTER ASSEMBLY	C955-0014
7-4	RFI FILTER SCHEMATIC DIAGRAM	C909-0022
7-5	EXCITER FRONT RAIL MOUNTING APPLICATIONS	B961-0002

TABLE	TITLE	NUMBER
7-1	FX-30 WIRING HARNESS LIST (3 Sheets)	945-0007

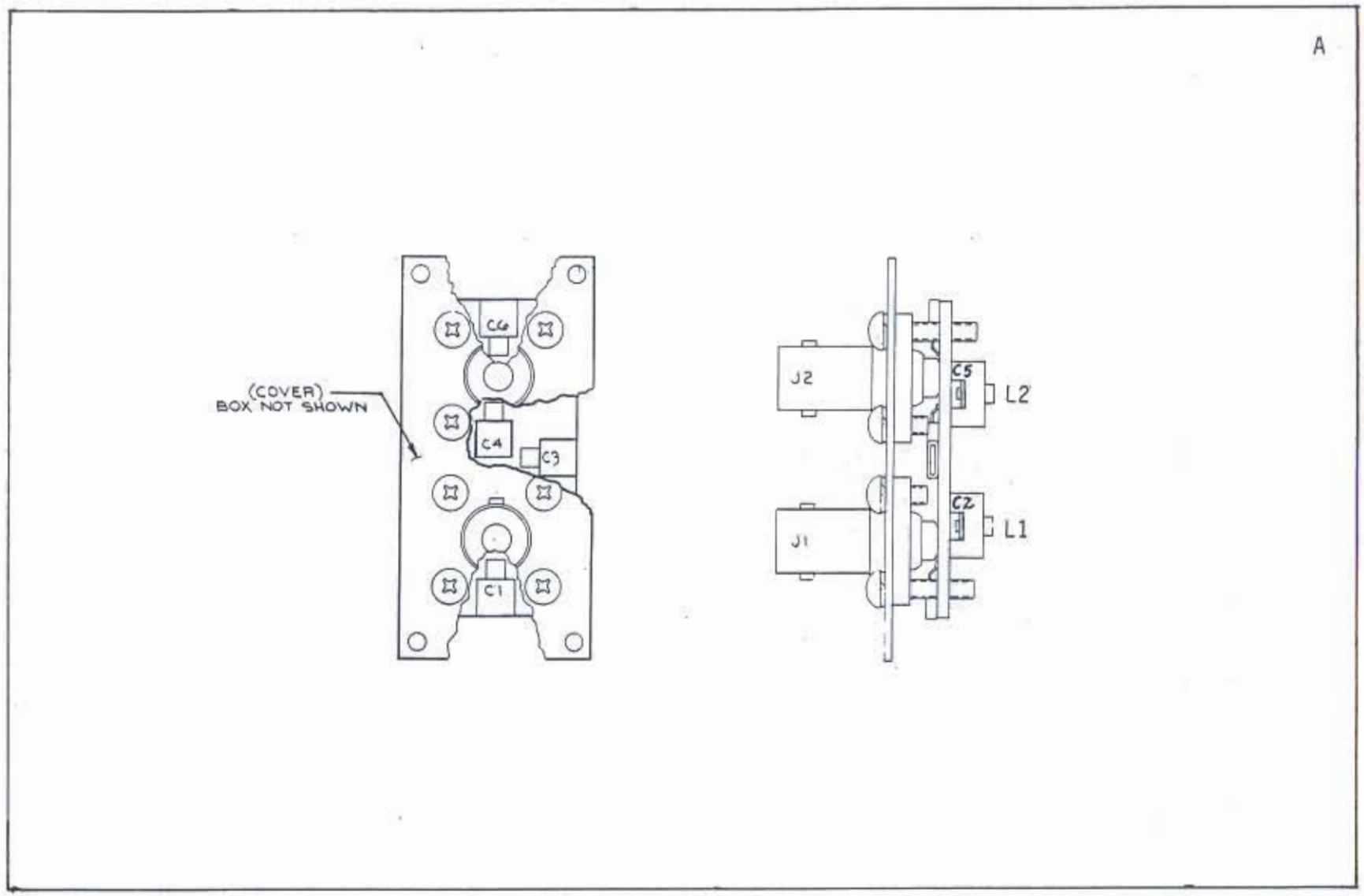


FIGURE 7-1. RF LOW-PASS FILTER ASSEMBLY - B955-0051

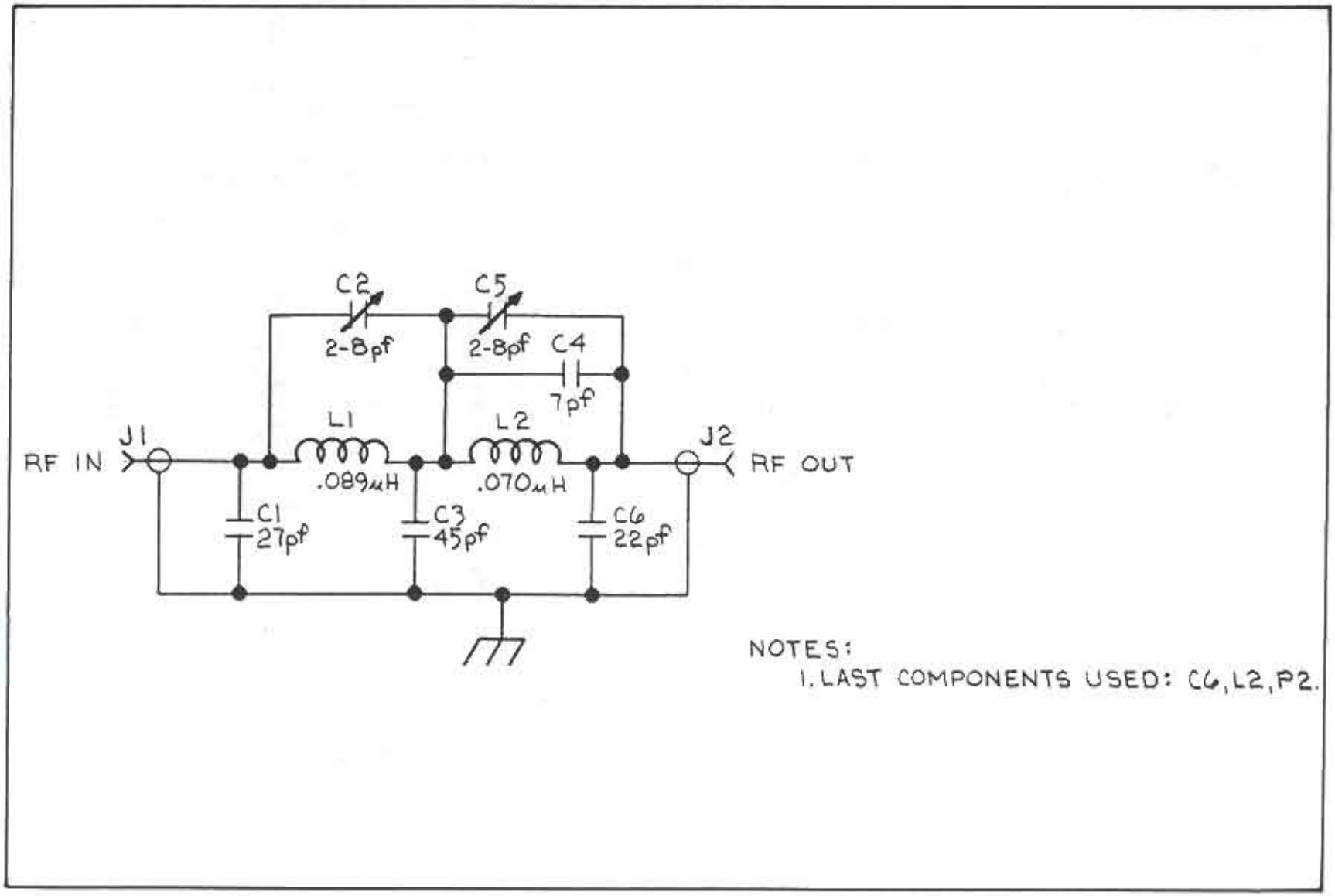


FIGURE 7-2. RF LOW-PASS FILTER SCHEMATIC DIAGRAM - A909-0036

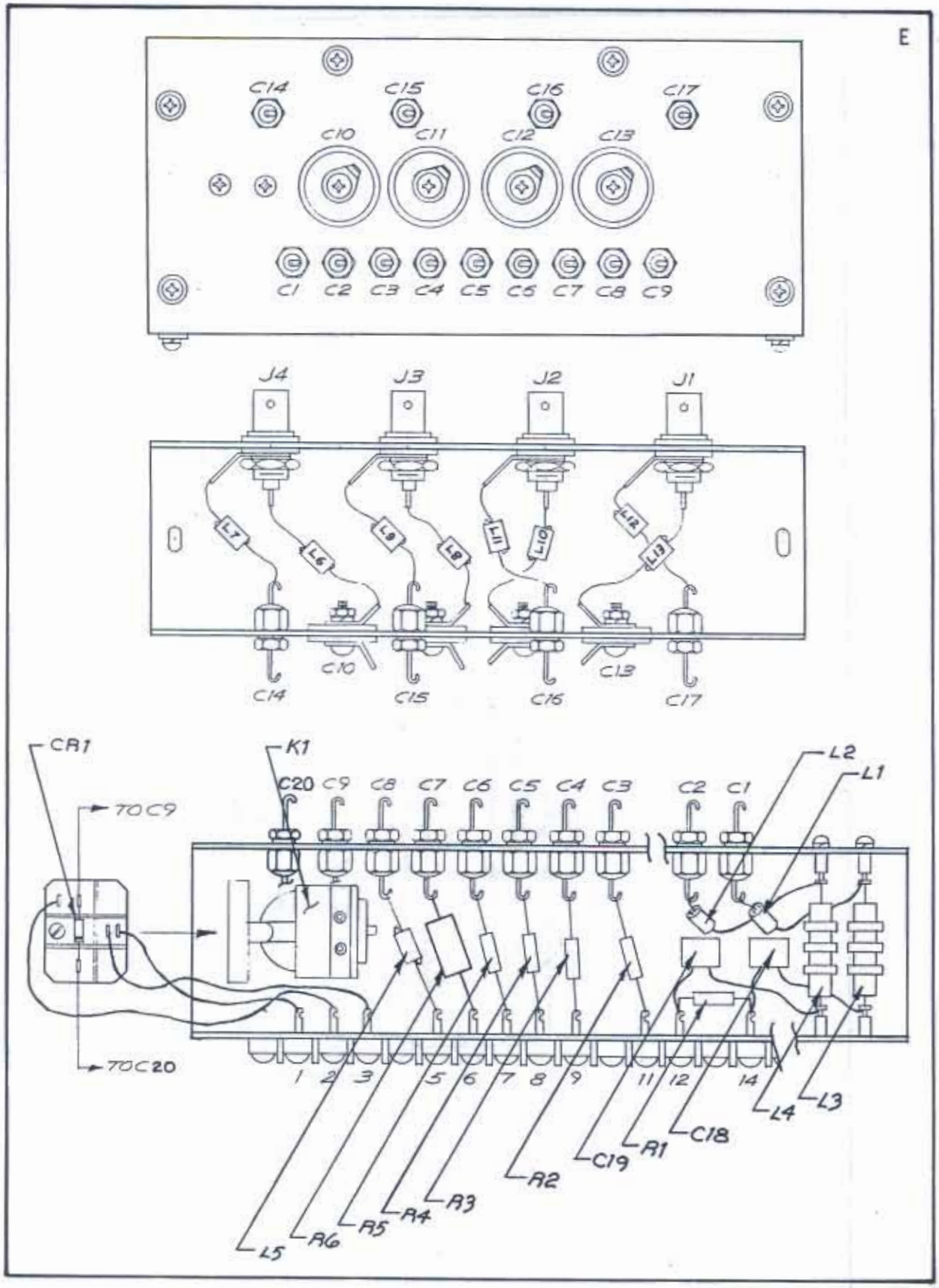


FIGURE 7-3. RFI FILTER ASSEMBLY C955-0014

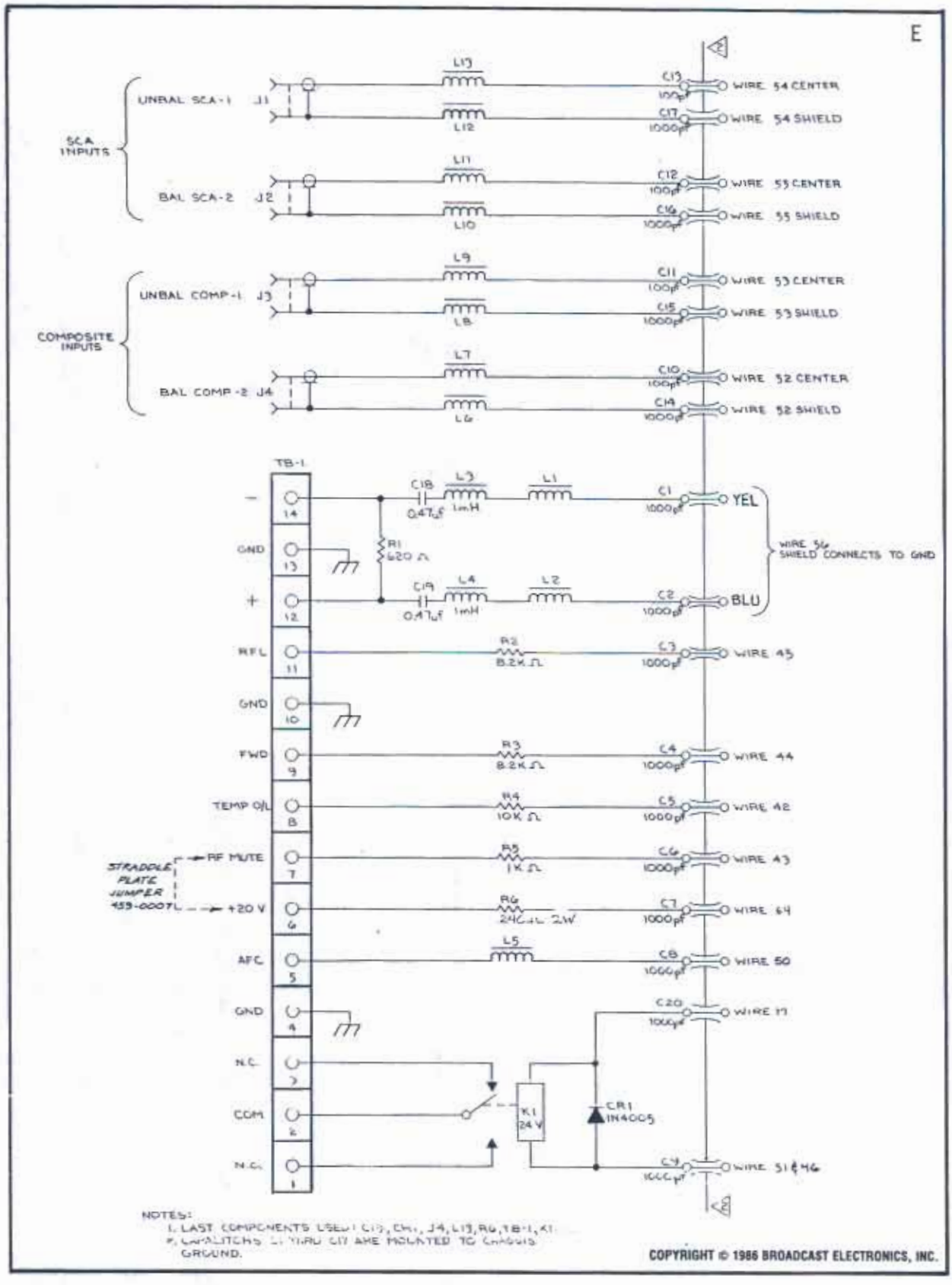


FIGURE 7-4. RFI FILTER SCHEMATIC DIAGRAM C909-0022

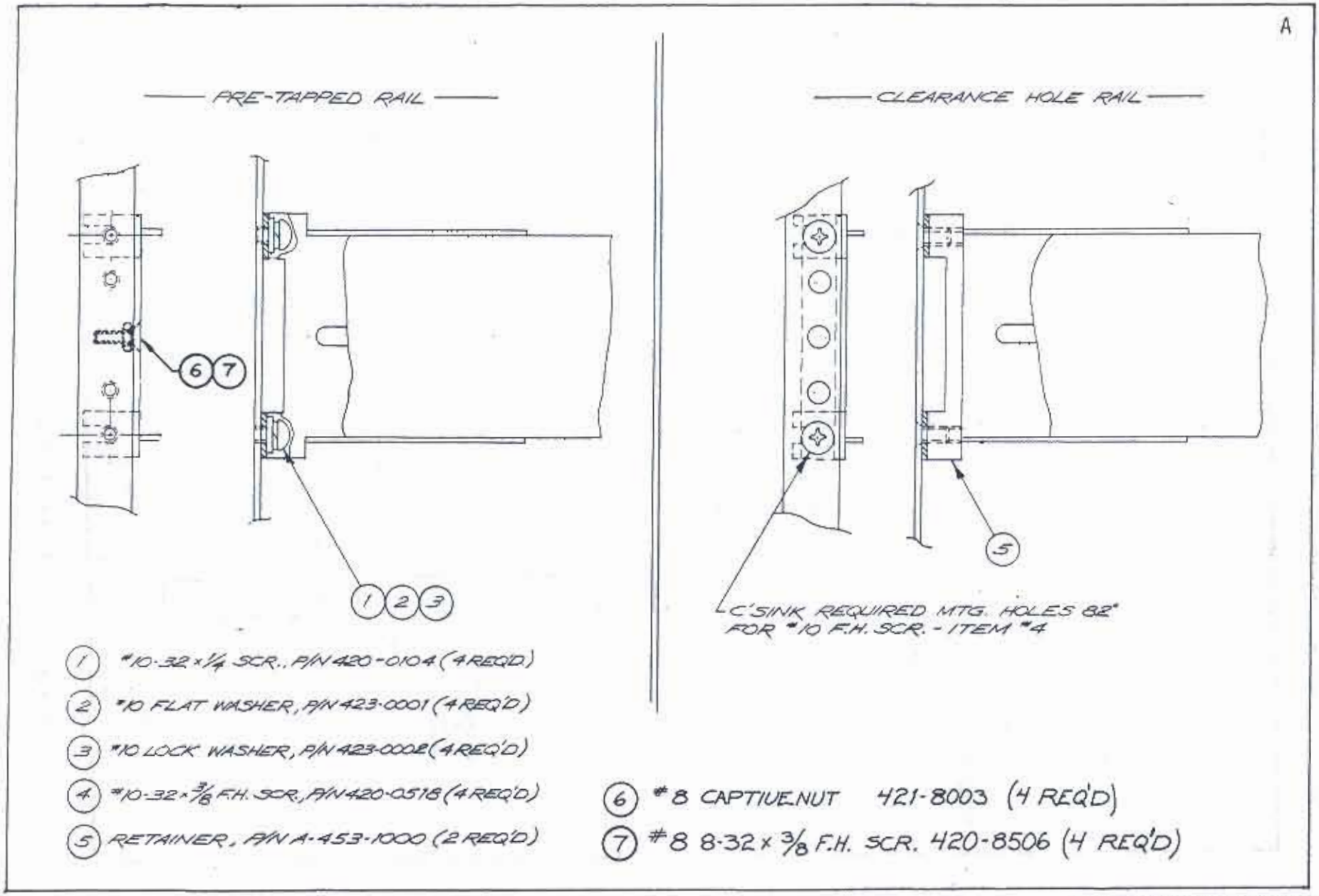


FIGURE 7-5. EXCITER FRONT RAIL MOUNTING APPLICATIONS

Table 7-1. FX-30 WIRING HARNESS LIST - 945-0007
(Sheet 1 of 3)

WIRE NO.	FROM	TO	PURPOSE
1	POWER SUPPLY 3-7	PLL/AFC 2-14	GROUND
2	POWER SUPPLY 3-11	PLL/AFC 2-11	+20 V
3	POWER SUPPLY 3-5	PLL/AFC 2-12	-20 V
4	POWER SUPPLY 3-1	PLL/AFC 2-13	+5 V
5	POWER SUPPLY 3-8	METERING BOARD 1-14	GROUND
7	POWER SUPPLY 3-12	METERING BOARD 1-11	+20 V
8	POWER SUPPLY 3-4	METERING BOARD 1-12	-20 V
10	POWER SUPPLY 3-3	METERING BOARD 1-13	+5 V
11	POWER SUPPLY 3-9	MOD OSC 1-6	GROUND
12	POWER SUPPLY 3-13	MOD OSC 1-4	+20 V
13	POWER SUPPLY 3-14	CONTROL BOARD 2-4	+20 V
14	POWER SUPPLY 2-1	RF AMP 1-4	REGULATED +20 V FROM 317 K
15	POWER SUPPLY 2-2	RF AMP 1-8	317 K ADJUST VOLTAGE
16	POWER SUPPLY 2-3	22,000 uF CAP (+)	UNREGULATED REFERENCE (+)
17	POWER SUPPLY 2-4	RFI FILTER C20	+20 VOLT RELAY CONTROL
18	POWER SUPPLY 1-3	MDA-2502 (-)	UNREGULATED SUPPLY (-)
19	POWER SUPPLY 1-4	22,000 uF CAP (-)	GROUND
20	CONTROL BOARD 2-8	22,000 uF CAP (-)	GROUND
21	CONTROL BOARD 1-3	22,000 uF CAP (+)	UNREGULATED + SUPPLY
22	CONTROL BOARD 1-1	RF AMP (MJ3000) C 1-13	UNREGULATED POSITIVE VOLTAGE (FUSED)
23	CONTROL BOARD 1-4	RF AMP (MJ3000) B 1-14	BASE CONTROL (+)
24	CONTROL BOARD 1-2	RF AMP (MJ3000) E 1-15	REGULATED RF AMP SUPPLY
25	CONTROL BOARD 2-10	RF AMP 1-1	GROUND

Table 7-1. FX-30 WIRING HARNESS LIST - 945-0007
(Sheet 2 of 3)

WIRE NO.	FROM	TO	PURPOSE
26	CONTROL BOARD 2-7	RF AMP 1-2	IPA (+)
27	CONTROL BOARD 2-1	RF AMP 1-6	PA (+)
28	CONTROL BOARD 2-12	RF AMP 1-5	DIRECTIONAL COUPLER FWD PWR
29	CONTROL BOARD 2-11	RF AMP 1-3	DIRECTIONAL COUPLER RFL PWR
30	CONTROL BOARD 2-9	RF AMP 1-7	DIRECTIONAL COUPLER GND REF
31	CONTROL BOARD 2-6	RF AMP 1-10	LM335 CATHODE
32	CONTROL BOARD 2-2	RF AMP 1-11	LM335 ANODE
33	CONTROL BOARD 2-3	RF AMP 1-12	LM335 ADJUST
34	22,000 uF CAP +	RF AMP 1-9	UNREGULATED SUPPLY TO LM317 K
35	CONTROL BOARD 3-1	LED DISPLAY 1-1	LED GROUND
36	CONTROL BOARD 3-3	LED DISPLAY 1-3	POWER LED (+)
37	CONTROL BOARD 3-6	LED DISPLAY 1-4	VSWR LED (+)
38	CONTROL BOARD 3-13	METER SWITCH 1-8	PA-V
39	CONTROL BOARD 3-12	METER SWITCH 1-7	PA-I
40	CONTROL BOARD 3-10	METER SWITCH 1-6	FWD PWR
41	CONTROL BOARD 3-7	METER SWITCH 1-5	RFL PWR
42	CONTROL BOARD 3-4	RFI ASSEMBLY C5	OVER TEMP
43	CONTROL BOARD 3-8	RFI ASSEMBLY C6	RF MUTE
44	CONTROL BOARD 3-11	RFI ASSEMBLY C4	REMOTE FWD PWR OUT
45	CONTROL BOARD 3-5	RFI ASSEMBLY C3	REMOTE RFL PWR OUT
46	CONTROL BOARD 3-9	RFI ASSEMBLY C9	AFC LOCK (RELAY CONTROL)
47	PLL/AFC 2-10	METERING BOARD 1-9	AFC VOLTAGE

Table 7-1. FX-30 WIRING HARNESS LIST - 945-0007
(Sheet 3 of 3)

WIRE NO.	FROM	TO	PURPOSE
48	PLL/AFC 2-7	LED DISPLAY 1-5	AFC LOCK LED (+)
49	PLL/AFC 2-6	LED DISPLAY 1-6	AFC LOCK LED RETURN
50	PLL/AFC 2-8	RFI FILTER C8	AFC LOCK
51	PLL/AFC 2-9	RFI FILTER C9	AFC-EXT (RELAY CONTROL)
52	PLL/AFC S/1-10, C/1-11	RFI FILTER C10, C14	COMPOSITE AC IN
53	PLL/AFC S/1-1, C/1-6	RFI FILTER C11, C15	COMPOSITE DC IN
54	PLL/AFC S/1-2, S/1-7	RFI FILTER C13, C17	SCA 1 (UNBAL) IN
55	PLL/AFC S/1-8, S/1-9	RFI FILTER C12, C16	SCA 2 (BAL) IN
56	PLL/AFC 1 1-4 BLK 2 1-3 RED	RFI FILTER C1, C2 GND	600 Ohm BAL IN
57	PLL/AFC P2-1 SHIELD 2 RED 3 BLACK	MOD OSC 1-1 SHIELD 1-2 BLACK 1-3 RED	1 SHIELD - RETURN BLACK - AFC RED - MOD
58	PLL/AFC S/1-5, C/1-12	FRONT PANEL BNC	COMPOSITE TEST - IN
59	PLL/AFC C/1-14, S/1-13	FRONT PANEL BNC	COMPOSITE TEST - OUT
60	PLL/AFC 2-5	METERING BD C/1-10 S/1-1	AUDIO
61	METERING BOARD 1-3	ANALOG METER (+)	METER + LEAD
62	METERING BOARD 1-4	ANALOG METER (-)	METER - LEAD
63	MDA2502 +	22,000 uF CAP (+)	UNREGULATED SUPPLY
64	CONTROL BOARD 2-5	RFI FILTER C7	+20V

APPENDIX A
MANUFACTURERS DATA

A-1. INTRODUCTION.

A-2. This appendix lists technical data applicable to the operation and maintenance of the FX-30 FM Exciter. Information contained in this section is listed in the following order:

1. Integrated Circuit pin identification diagrams (839-0002-28).

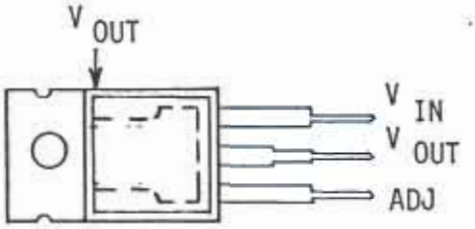
2. Data Sheet B12-28 (2N6198) RF Power Transistor and B40-28 (2N6200) RF Power Transistor.

INTEGRATED CIRCUIT CONNECTION DIAGRAMS

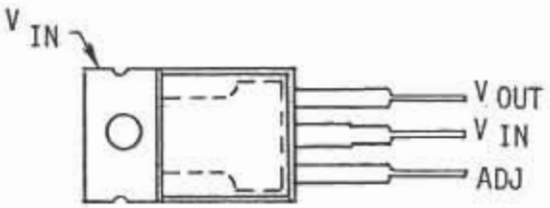
NOTE

TOP VIEW SHOWN FOR ALL DEVICES
UNLESS OTHERWISE NOTED.

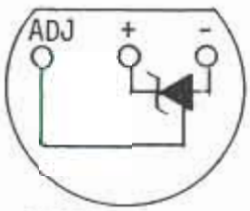
LM317 T
ADJUSTABLE POSITIVE
VOLTAGE REGULATOR



LM337T
ADJUSTABLE NEGATIVE
VOLTAGE REGULATOR

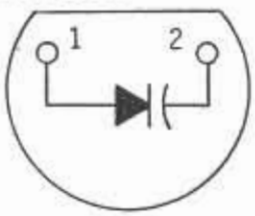


LM335Z
PRECISION TEMPERATURE
SENSOR

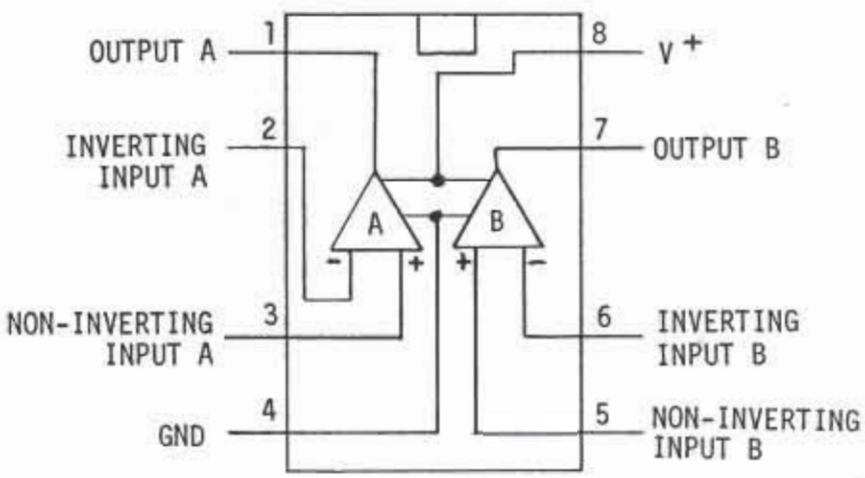


BOTTOM VIEW

MV209
VOLTAGE VARIABLE
CAPACITANCE DIODE

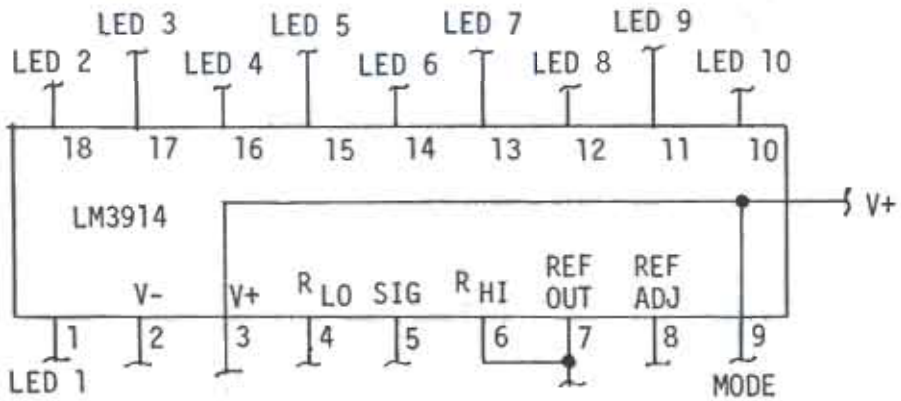


LM358N
DUAL OPERATIONAL AMPLIFIER

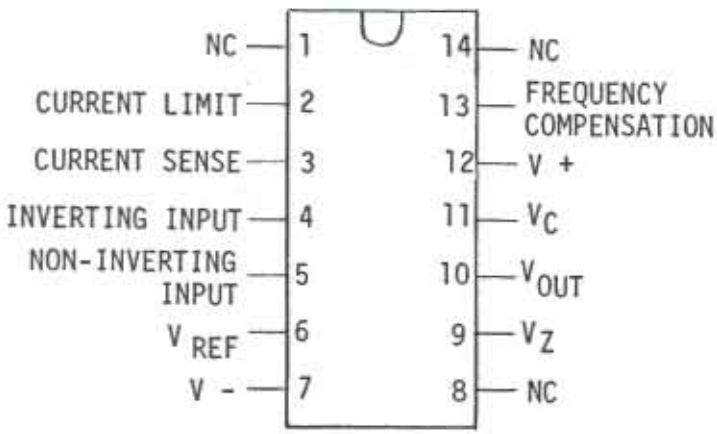


597-0002-28

LM3914N DOT/BAR DISPLAY DRIVER



MC723CL
ADJUSTABLE POSITIVE
VOLTAGE REGULATOR

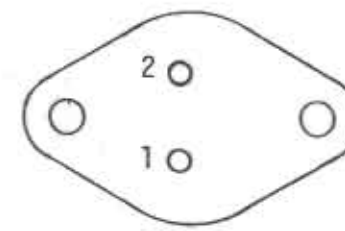


MC7805CK
+5 V REGULATOR

PIN 1 - INPUT
PIN 2 - OUTPUT
CASE - COMMON

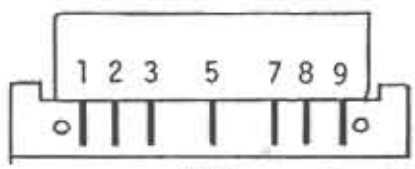
LM317K
ADJUSTABLE POSITIVE
VOLTAGE REGULATOR

PIN 1 - ADJUST
PIN 2 - INPUT
CASE - OUTPUT



BOTTOM VIEW

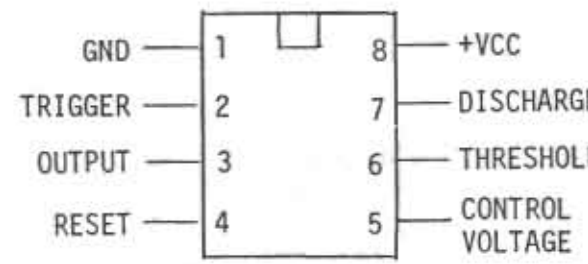
MHW592
RF HYBRID AMPLIFIER



SIDE VIEW

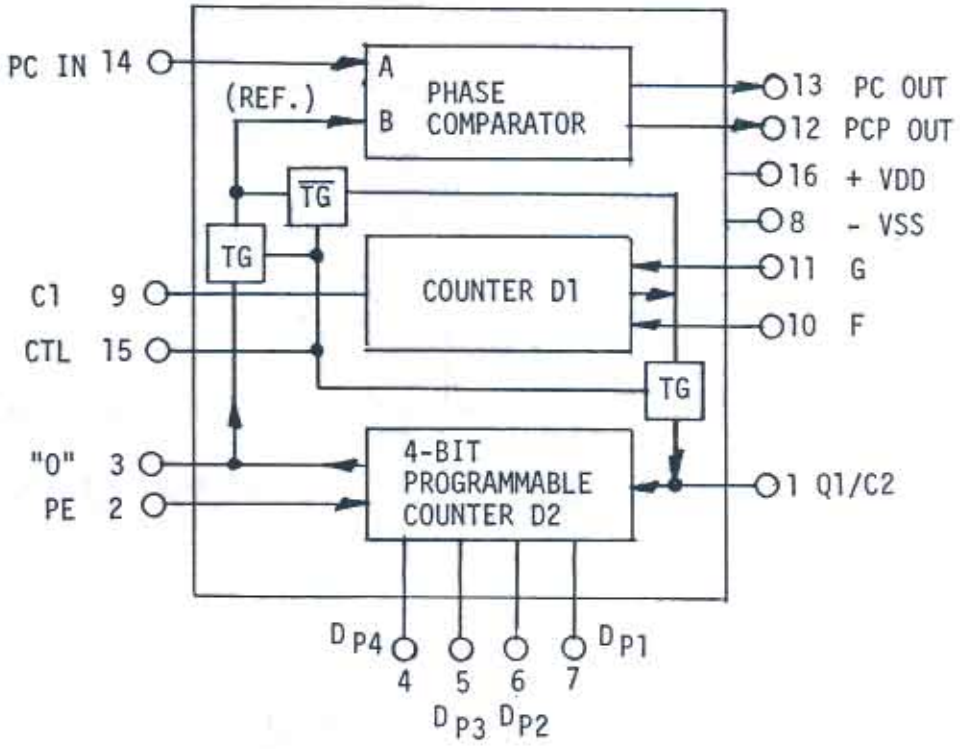
PIN	
1	RF INPUT
5	+ V DC
2,3,7,8	GROUND
9	RF OUTPUT

NE555V
TIMER

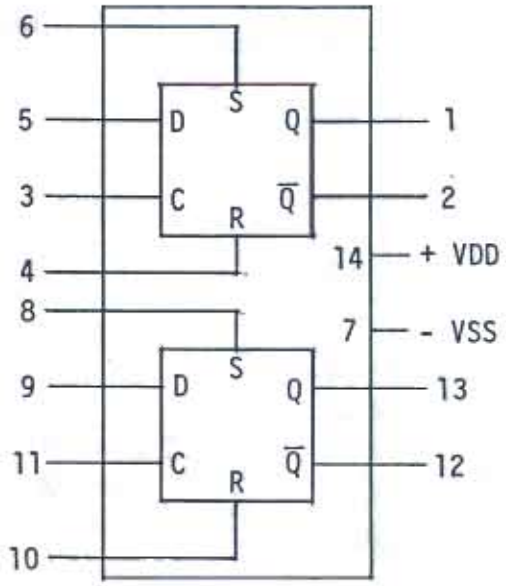


597-0002-28

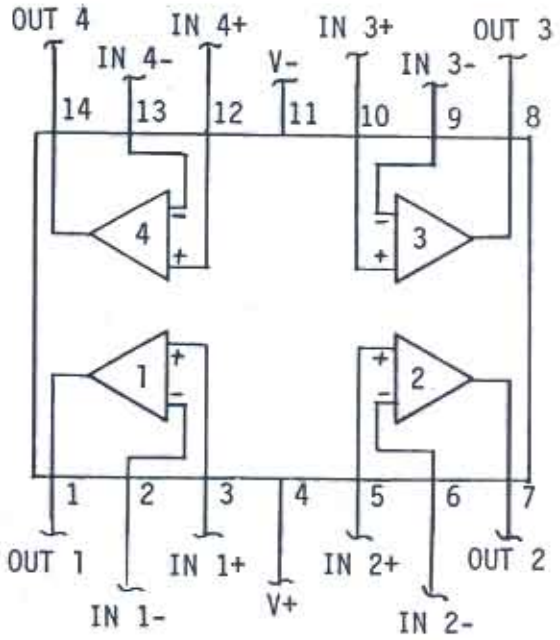
MC14568B
PROGRAMMABLE DIVIDER



MC14013B
DUAL-D FLIP-FLOP

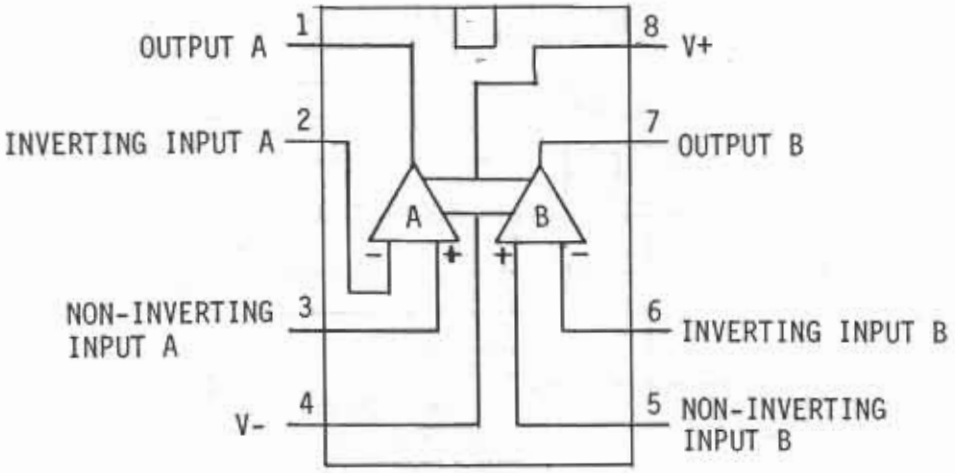


TL074CN/LF347N
QUAD INPUT JFET OPERATIONAL AMPLIFIER

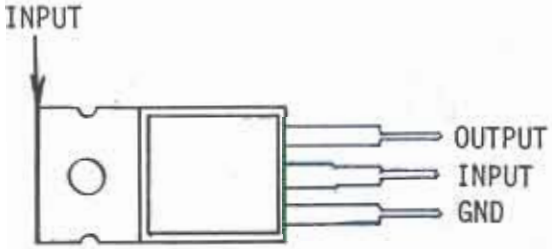


597-0002-28

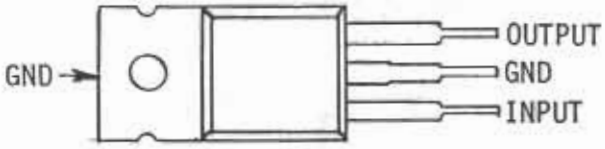
TL072/LF353N
BI-FET OPERATIONAL AMPLIFIER



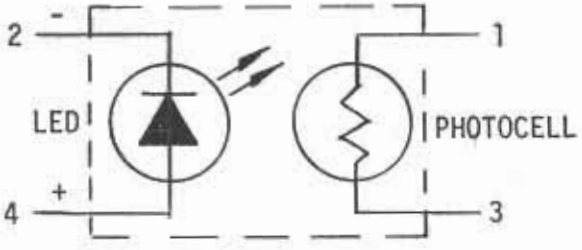
UA7915C
-15 V REGULATOR



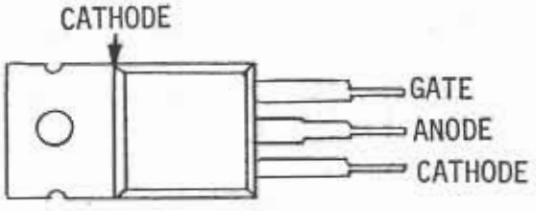
UA7815C
+15V REGULATOR



VTL5C2
OPTICAL ISOLATOR, LDR TYPE

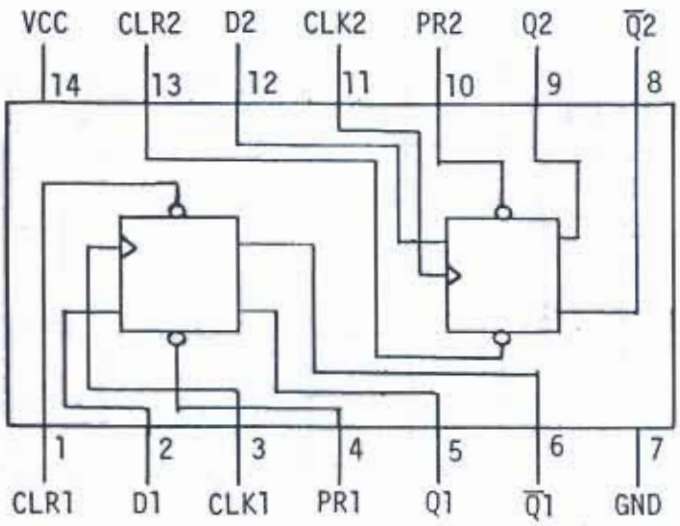


2N6395
SCR

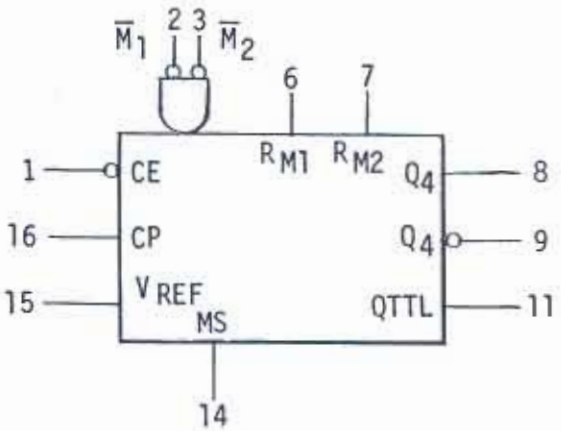


597-0002-28

74LS74N
DUAL-D FLIP-FLOP

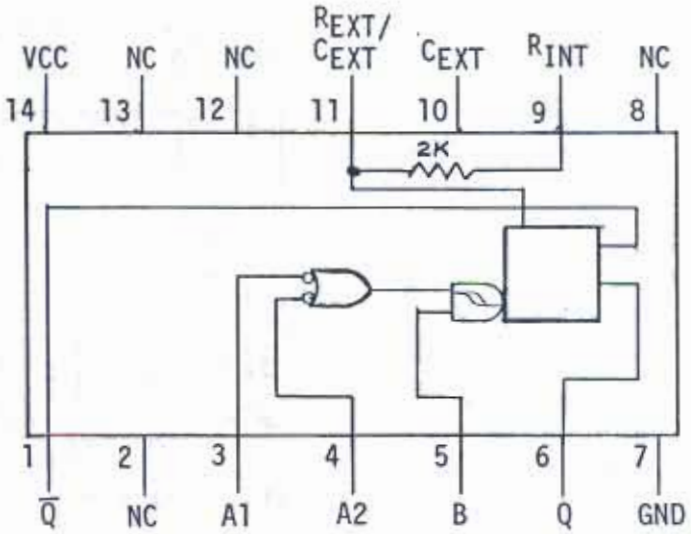


11C90
DIVIDE BY 11/10 COUNTER



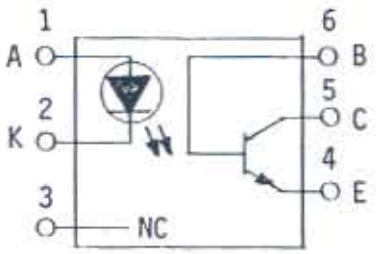
VCC = PIN 4, VCCA = PIN 5
VEE = PIN 12, VEE = PIN 13 (TTL)

74121N
MONOSTABLE MULTIVIBRATOR

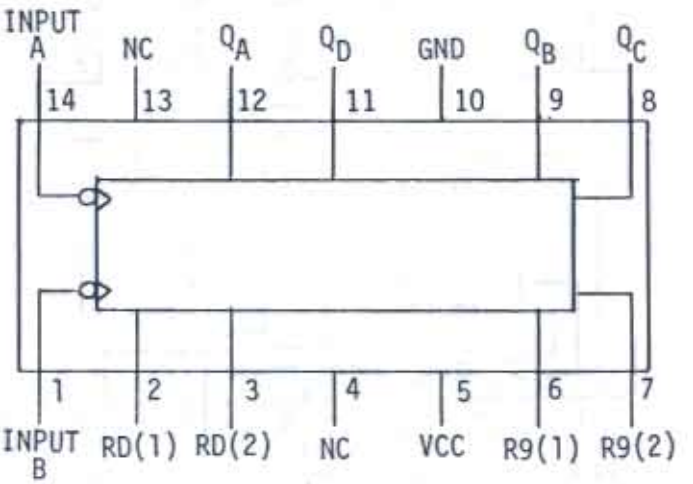


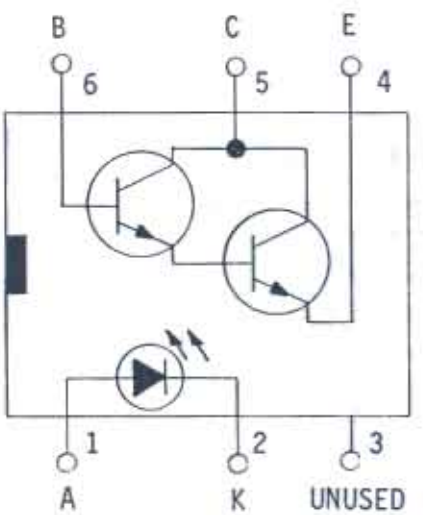
597-0002-28

4N28
OPTICAL ISOLATOR LED/
PHOTO TRANSISTOR TYPE



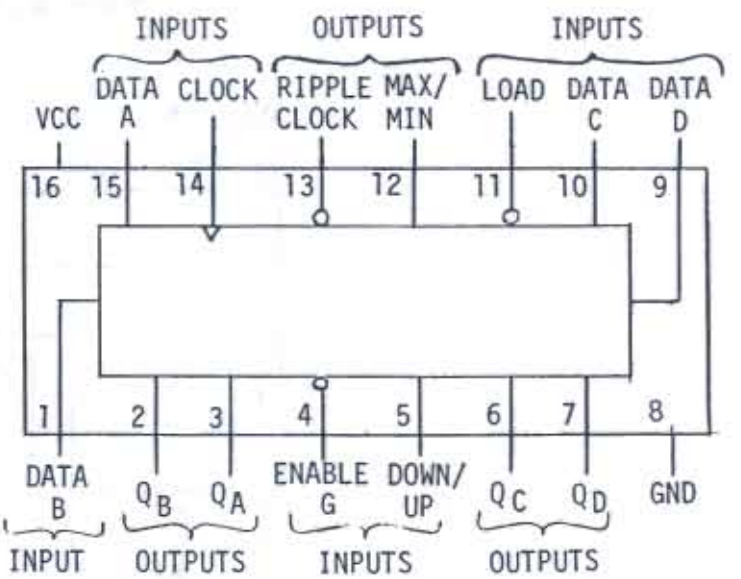
74LS90N
DECADE COUNTER





4N33
OPTICAL ISOLATOR LED/PHOTO
DARLINGTON TRANSISTOR TYPE

74LS190N
DECADE COUNTER



597-0002-28

COMMUNICATIONS TRANSISTOR CORPORATION

2N6197 ● 3 WATT
2N6198 ● 12 WATT
2N6199 ● 25 WATT
2N6200 ● 40 WATT

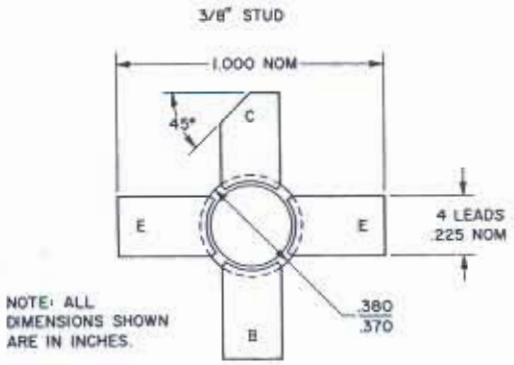
CT 175-28 Dec. 1971 2.2.8.5C

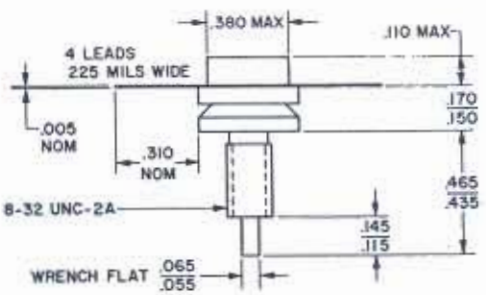
175 MHz ● 28 VOLT LINEAR RF POWER TRANSISTOR COMPLIMENT

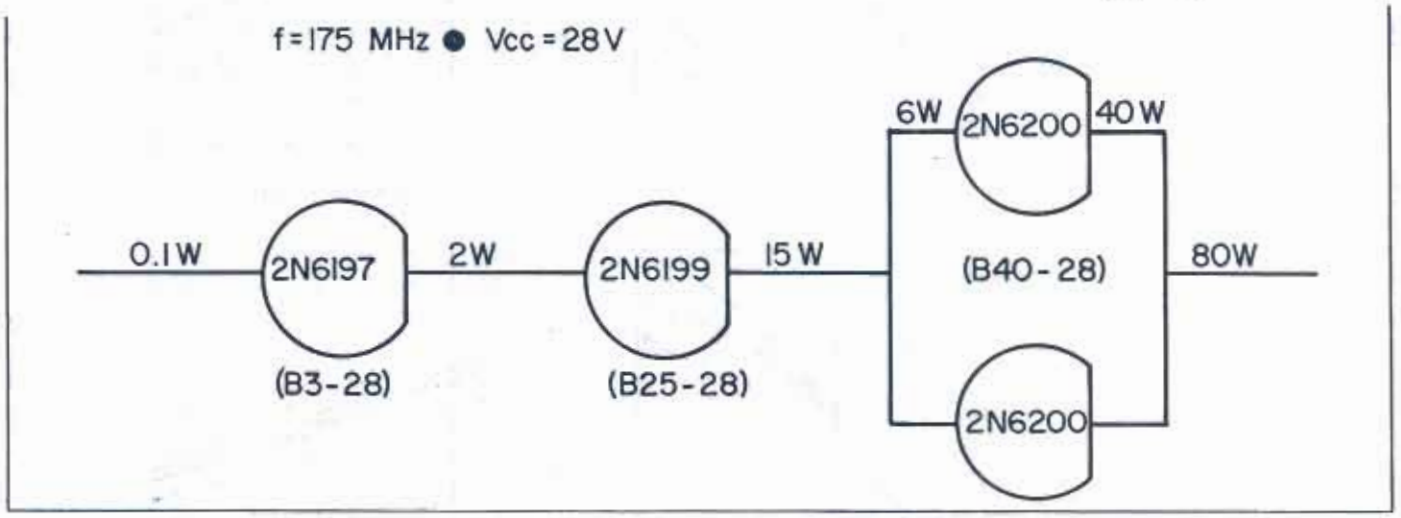
GENERAL DESCRIPTION - These devices are specifically designed for operation in VHF broadband linear power amplifier applications covering the range of 100-200 MHz. The devices are capable of operation in Class A, AB, B or C amplifiers and provide the maximum power output/power gain combination.

FEATURES

- SUPERIOR POWER PERFORMANCE FROM A 28 VOLT SUPPLY.
- MAXIMUM RELIABILITY DUE TO SINGLE CHIP CONSTRUCTION.
- GREATER HIGH FREQUENCY PERFORMANCE IN LOW INDUCTANCE CERAMIC STRIPLINE PACKAGES.
- SPECIFICALLY DESIGNED FOR 28 VOLT OPERATION COVERING THE FREQUENCY BAND OF 100-200 MHz.
- 100% TESTED AND GUARANTEED TO WITHSTAND INFINITE VSWR AT ALL PHASE ANGLES WHEN OPERATED AT RATED POWER AND SUPPLY VOLTAGE.
- IDEAL FOR USE IN LINEAR APPLICATIONS REQUIRING OPERATION IN CLASS AB DUE TO IMPROVED FORWARD BIASED SAFE AREA.
- MAXIMUM BANDWIDTH DUE TO LOWER INPUT Q.







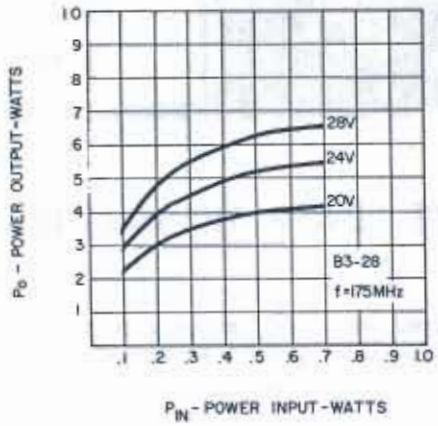
COMMUNICATIONS TRANSISTOR CORPORATION
301 Industrial Way, San Carlos, California 94070

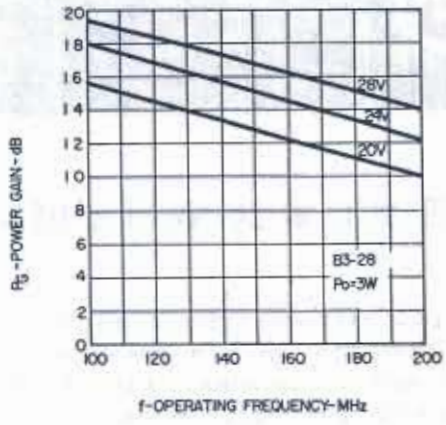
A Subsidiary of Varian Associates
(415) 592-9390 TWX 910-376-4893

COMMUNICATION TRANSISTOR 2N6197 ● 2N6198 ● 2N6199 ● 2N6200

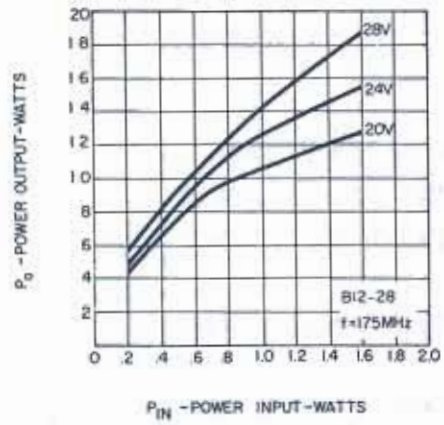
POWER OUTPUT VERSUS POWER INPUT | **POWER GAIN VERSUS FREQUENCY**

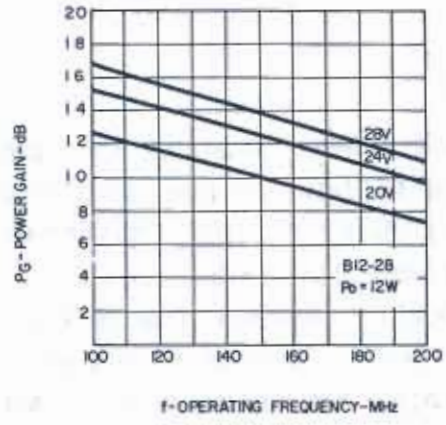
2N6197 (B3-28)



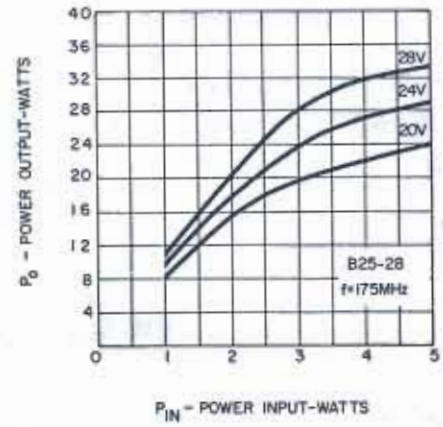


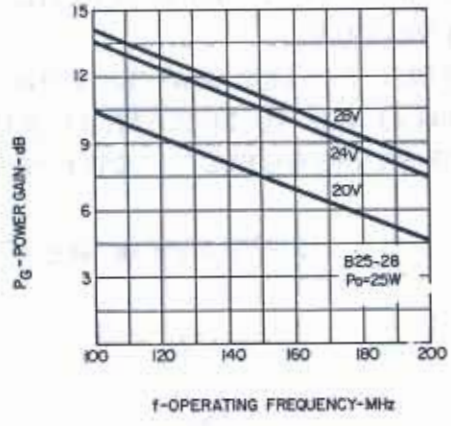
2N6198 (B12-28)



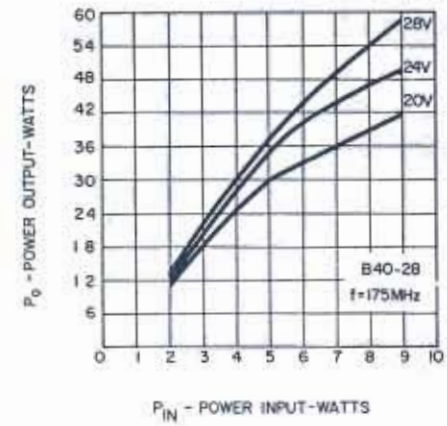


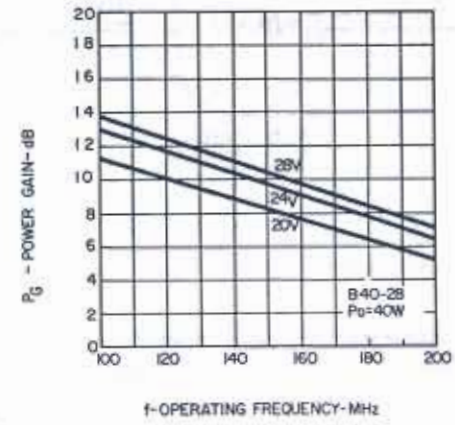
2N6199 (B25-28)





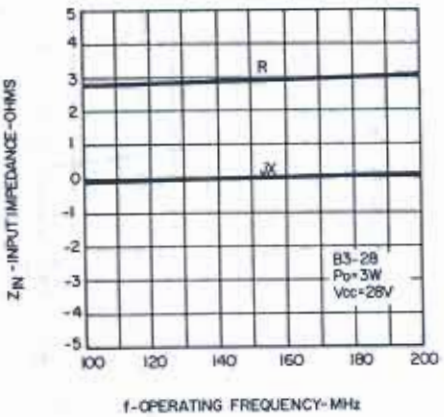
2N6200 (B40-28)

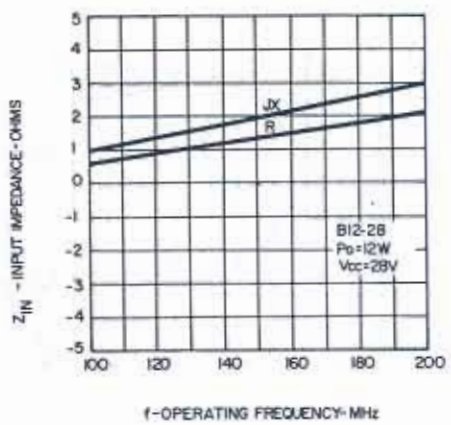


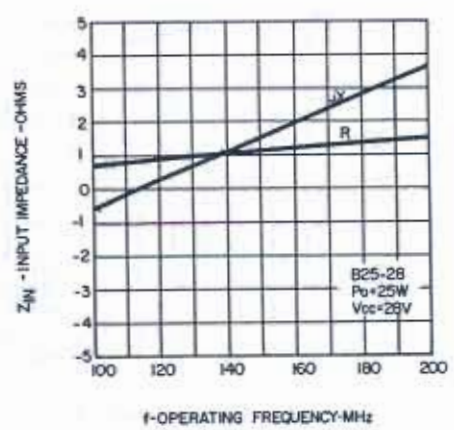


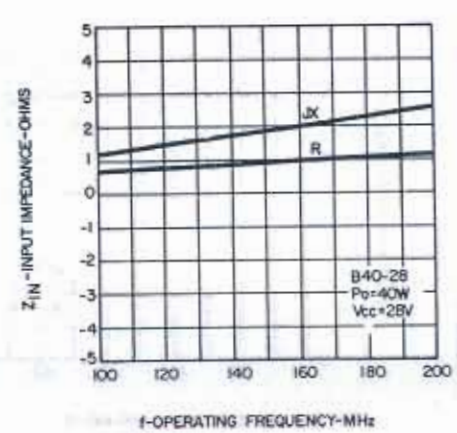
COMMUNICATION TRANSISTOR 2N6197 ● 2N6198 ● 2N6199 ● 2N6200

SERIES INPUT IMPEDANCE VERSUS FREQUENCY

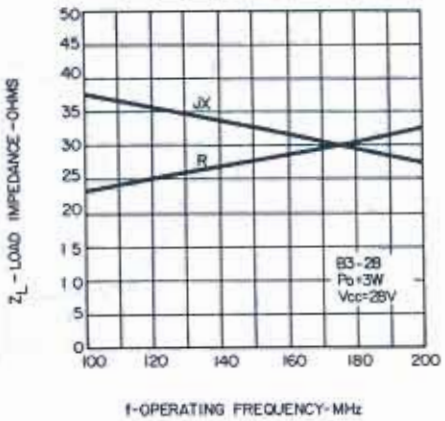


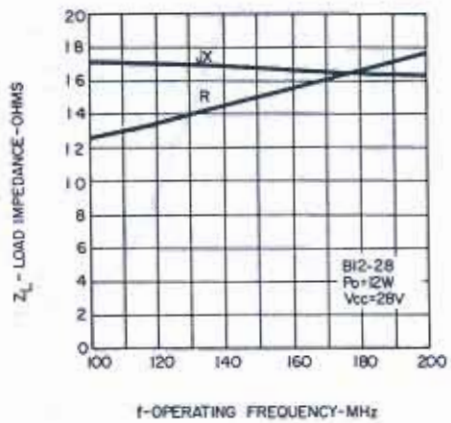


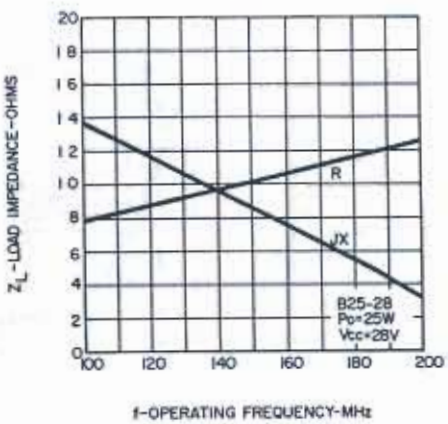


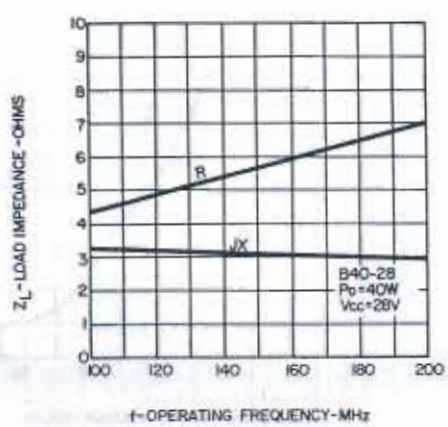


SERIES LOAD IMPEDANCE VERSUS FREQUENCY

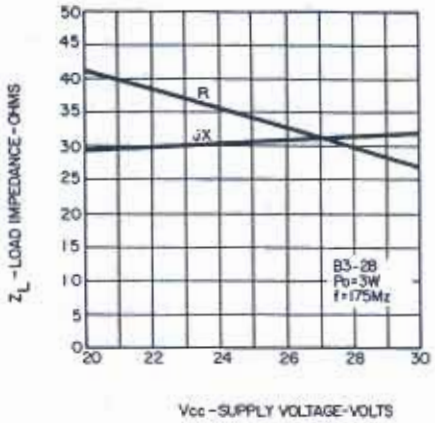


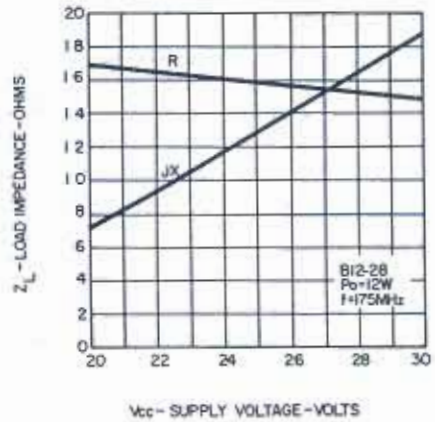


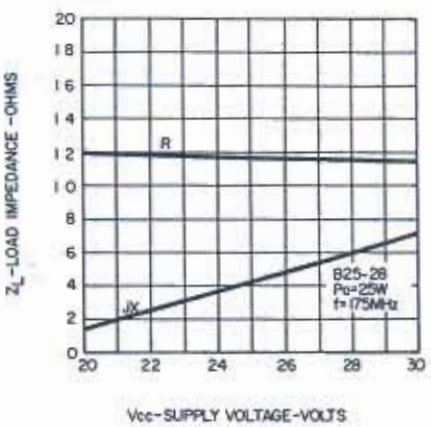


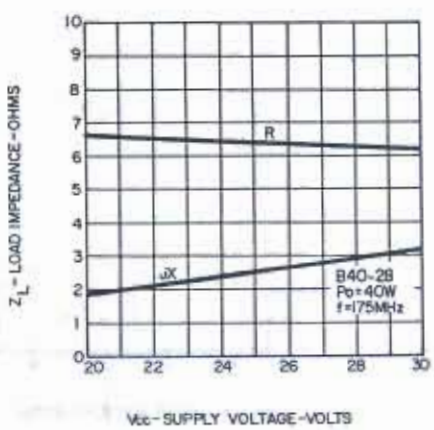


SERIES LOAD IMPEDANCE VERSUS VOLTAGE



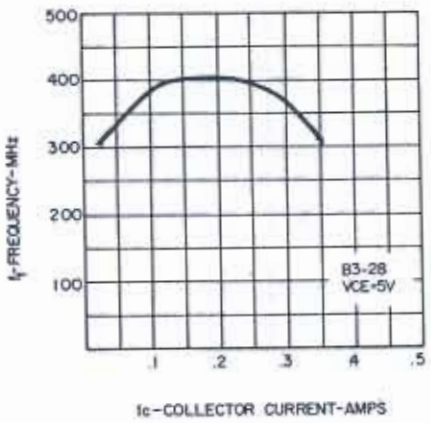


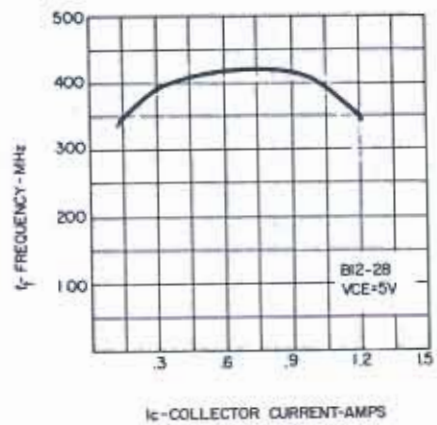


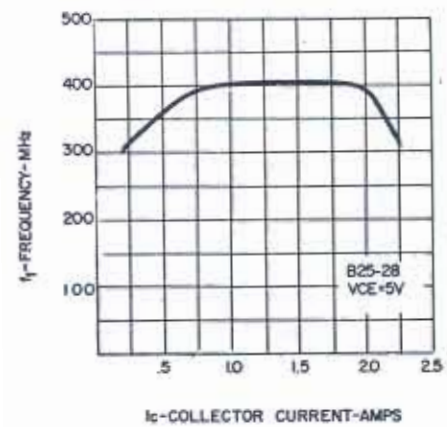


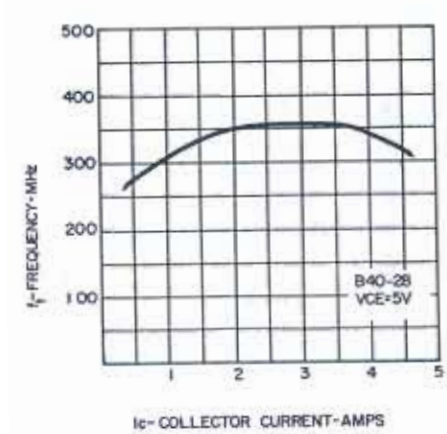
COMMUNICATION TRANSISTOR 2N6197 ● 2N6198 ● 2N6199 ● 2N6200

f_t VERSUS I_C

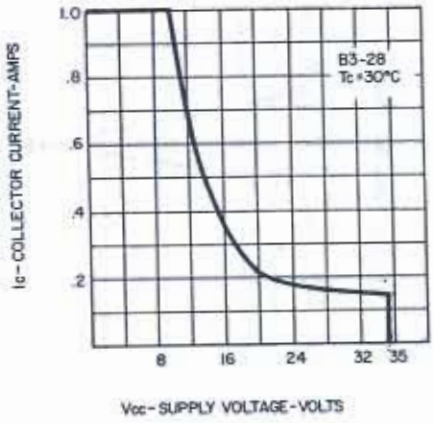


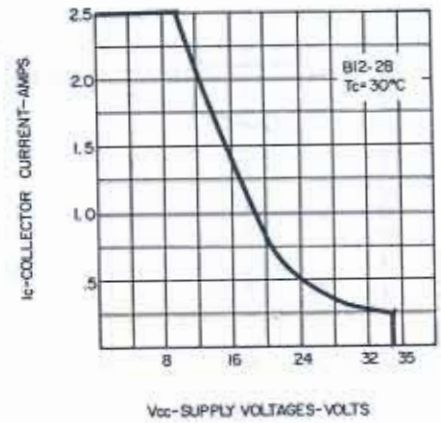


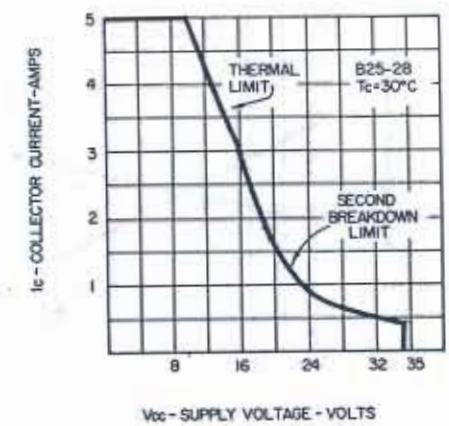


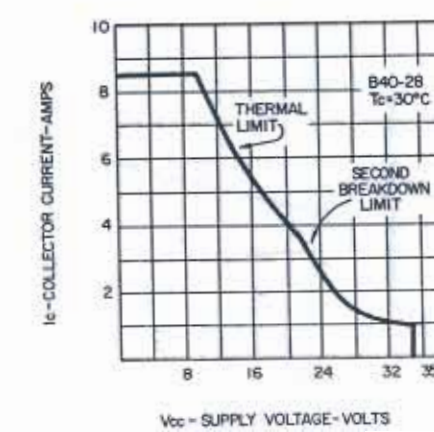


SAFE OPERATING AREA

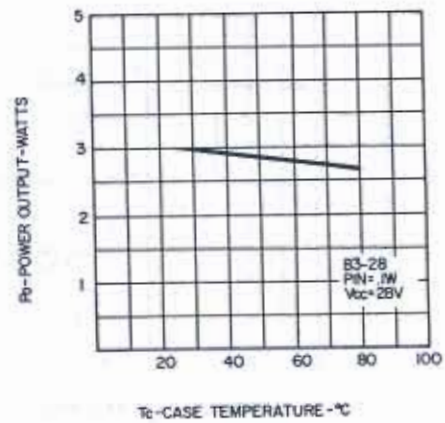


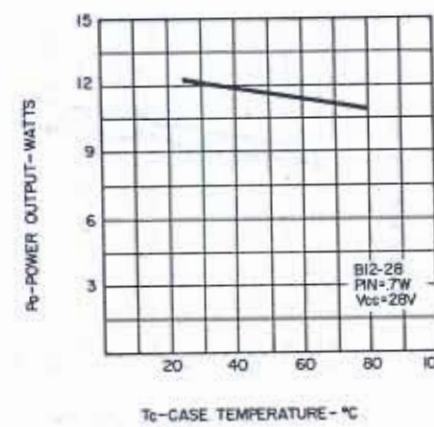


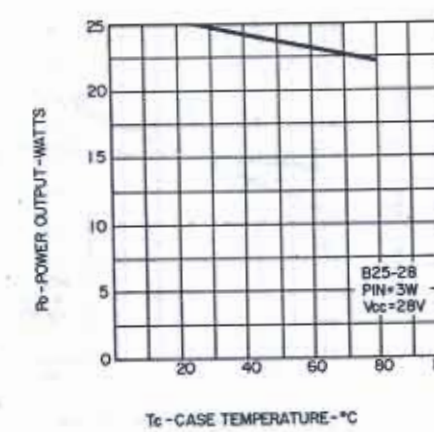


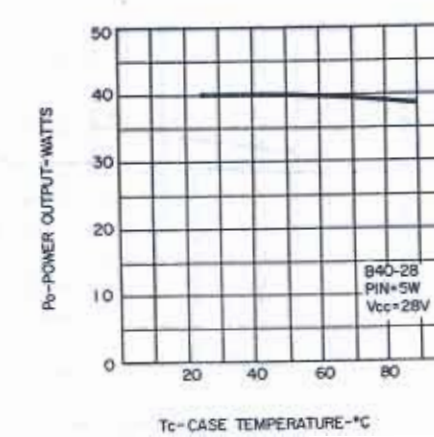


POWER OUTPUT VERSUS CASE TEMP









COMMUNICATION TRANSISTOR 2N6197 ● 2N6198 ● 2N6199 ● 2N6200

ELECTRICAL CHARACTERISTICS

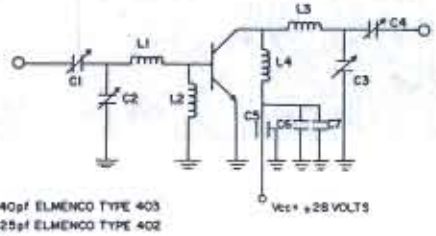
ABSOLUTE MAXIMUM RATINGS

		2N6197 (B3-28)	2N6198 (B12-28)	2N6199 (B25-28)	2N6200 (B40-28)
MAXIMUM TEMPERATURES					
Storage Temperatures		-65° C to +200° C	-65° C to +200° C	-65° C to +200° C	-65° C to +200° C
Operating Junction Temperatures		200° C	200° C	200° C	200° C
Lead Temperature (Soldering 8 seconds time limit) ≤ 1/32" from Ceramic		260° C	260° C	260° C	260° C
MAXIMUM POWER DISSIPATION (Note 1)					
Total Power Dissipation at 25° C Case Temperature		10 W	25 W	50 W	85 W
MAXIMUM VOLTAGES AND CURRENT					
BV_{CES}	Collector to Emitter Voltage	60 V	60 V	60 V	60 V
BV_{EBO}	Emitter to Base Voltage	4 V	4 V	4 V	4 V
LV_{CEO}	Collector to Emitter Voltage	35 V	35 V	35 V	35 V
I_C	Collector Current	1 A	2.5 A	5 A	8.5 A

ELECTRICAL CHARACTERISTICS (25° C unless otherwise specified)

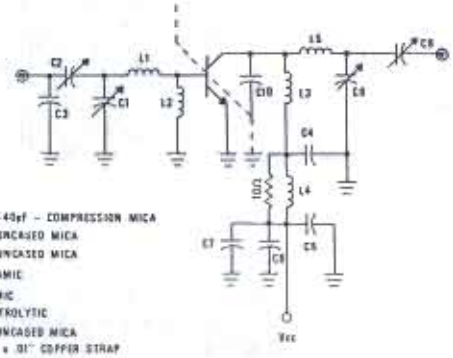
SYMBOL	CHARACTERISTIC	2N6197	2N6198	2N6199	2N6200	UNIT	LIMIT	TEST CONDITIONS
P_{OUT}	Power Output (Note 2)	3.0	12	25	40	WATTS	MIN.	f = 175 MHz, V_{CC} = 28 V
P_{IN}	Power Input (Note 2) (At Rated Power Out)	0.15	1.0	3.5	6	WATTS	MAX.	f = 175 MHz, V_{CC} = 28 V
η	Collector Efficiency (At Rated Power Out)	50	50	50	50	%	MIN.	f = 175 MHz, V_{CC} = 28 V
Z_{IN}	SERIES Input Impedance	3.0+j0	1.7+j2.4	1.3+j2.5	1.1+j2.3	OHMS	TYP.	At Rated Output Power and Frequency (Note 2)
Z_L	SERIES Load Impedance	30+j30	17+j16.5	11.5+j6	6.4+j3.0	OHMS	TYP.	At Rated Output Power and Frequency (Note 2)
C_{OB}	Collector to Base Capacitance (f = 1.0 MHz)	12	25	50	150	pF	MAX.	V_{CB} = 28 V, I_E = 0
LV_{CEO}	Collector to Emitter Voltage	35	35	35	35	VOLTS	MIN.	I_C = 50 mA, I_B = 0
BV_{EBO}	Emitter to Base Voltage	4.0	4.0	4.0	4.0	VOLTS	MIN.	I_C = 0, I_E = 5 mA
BV_{CES}	Collector to Emitter Breakdown Voltage	60	60	60	60	VOLTS VOLTS	MIN. MIN.	I_C = 5 mA I_C = 10 mA
I_{CES}	Collector to Emitter Leakage Current	2.0	5.0	10.0	20	mA	MAX.	Vcc = 30 V, T_C = 100°C

175 MHz ● TEST AMPLIFIER (FIG. 1)



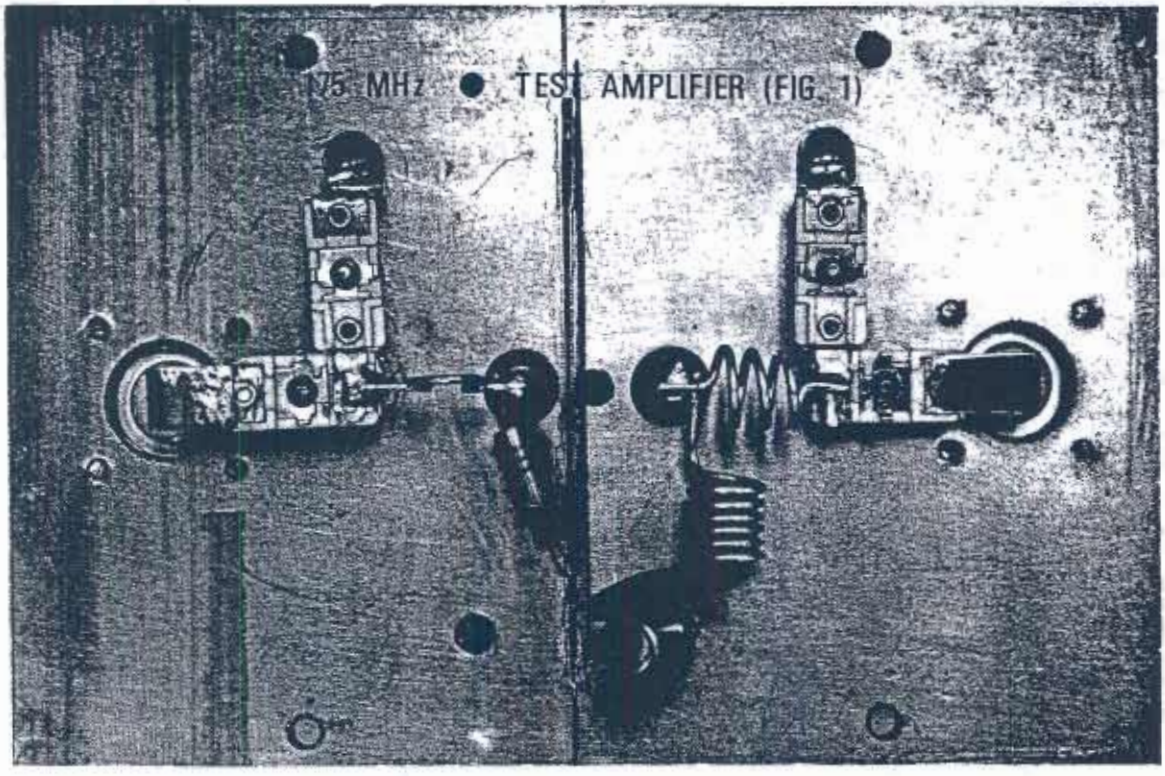
C1,C2 - 4-40pf ELMENCO TYPE 403
C3,C4 - 2-25pf ELMENCO TYPE 402
C5 - .001 uf
C6 - .1 uf
C7 - 10uf
L1 - 1/2 TURN #16, 3/8" I.D.
L2 - 1.0 uh RFC
L3 - 3 TURNS #16, 3/8" I.D.
L4 - 6 TURNS #16, 3/8" I.D.

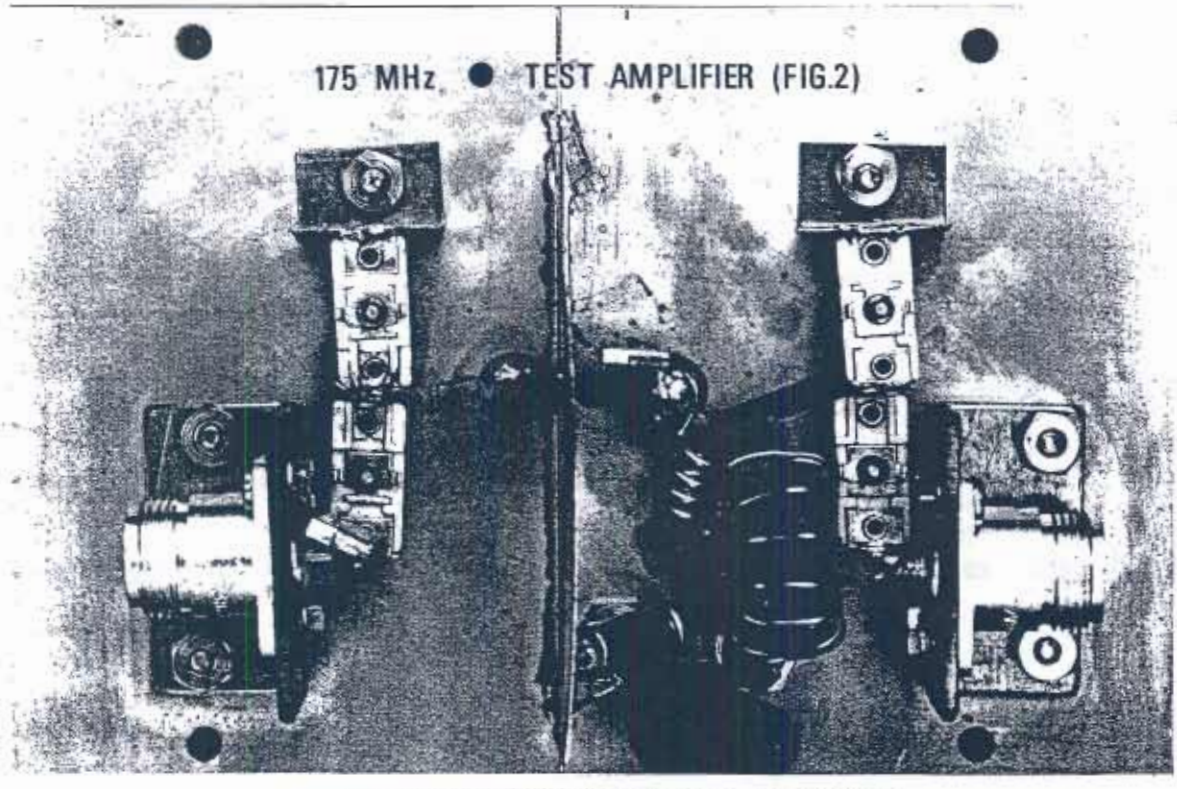
175 MHz ● TEST AMPLIFIER (FIG.2)



C1,C2,C8,C9 - 4-40pf - COMPRESSION MICA
C3 - 10pf -- UNCASED MICA
C4 - 250pf - UNCASED MICA
C5 - .01μf CERAMIC
C6 - .1μf CERAMIC
C7 - 1.0μf ELECTROLYTIC
C10 - 22 pf - UNCASED MICA
L1 - ¾" x 3/8" x .01" COPPER STRAP
L2 - 68uh RFC
L3 - 4 TURNS #18 3/16" ID - ½" LONG
L4 - 10μh RFC
L5 - 1¾" x 3/16" x .01" COPPER STRAP

COMMUNICATION TRANSISTOR 2N6197 ● 2N6198 ● 2N6199 ● 2N6200



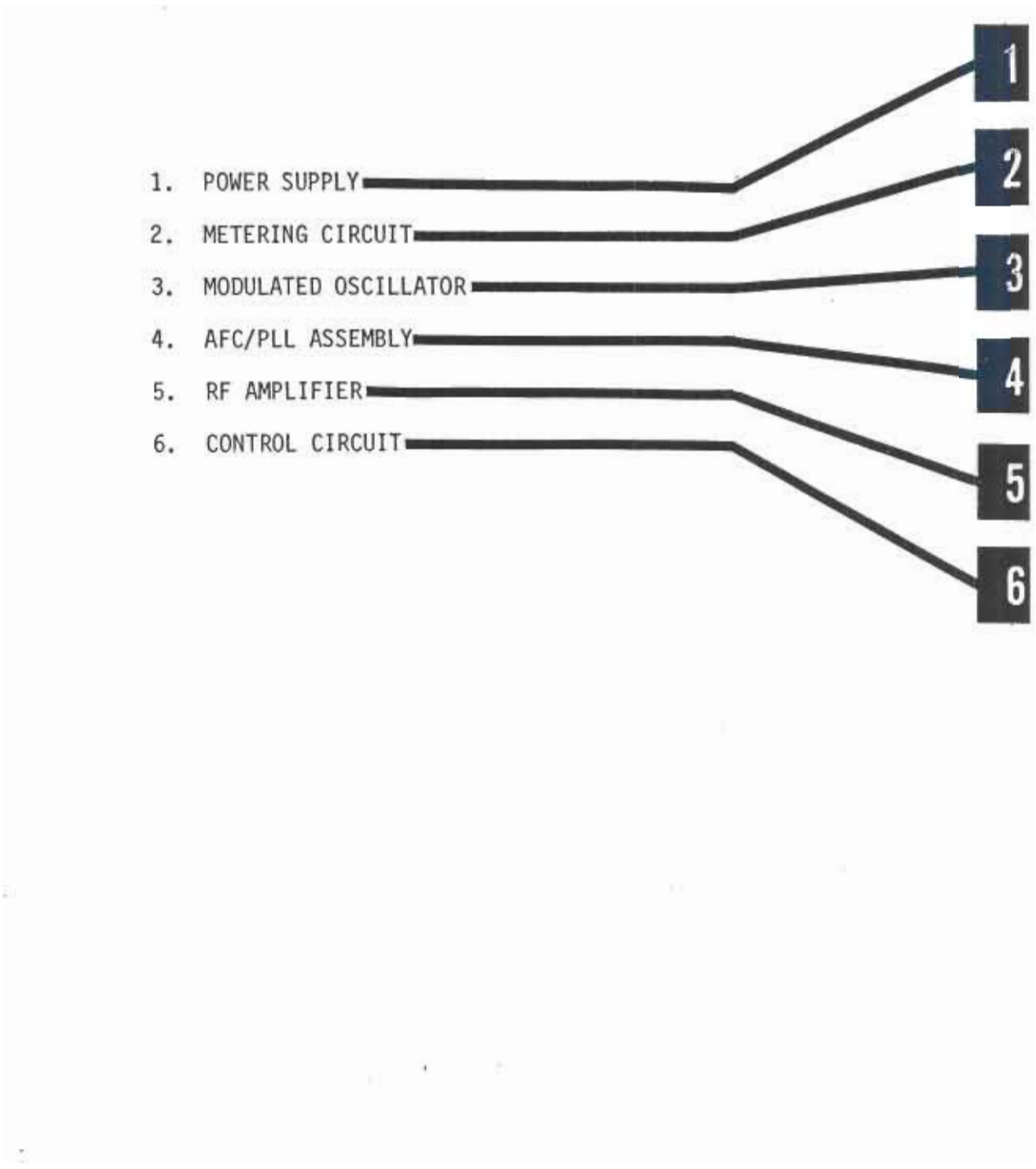


BOTTOM VIEW (See Page 5 for Schematic) ACTUAL SIZE

NOTES:

(1) These ratings give a maximum junction temperature of 200° C with junction to case thermal resistance of 17.5° C/watt for the 2N6197, 7° C/watt for the 2N6198, 3.5° C/watt for the 2N6199, and 2° C/watt for the 2N6200.

(2) Values measured in the 175 MHz test amplifier. Figure 1 used for 2N6197, 2N6198, and 2N6199. Figure 2 used for the 2N6200.


1. POWER SUPPLY
2. METERING CIRCUIT
3. MODULATED OSCILLATOR
4. AFC/PLL ASSEMBLY
5. RF AMPLIFIER
6. CONTROL CIRCUIT
1
2
3
4
5
6

POWER SUPPLY

TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

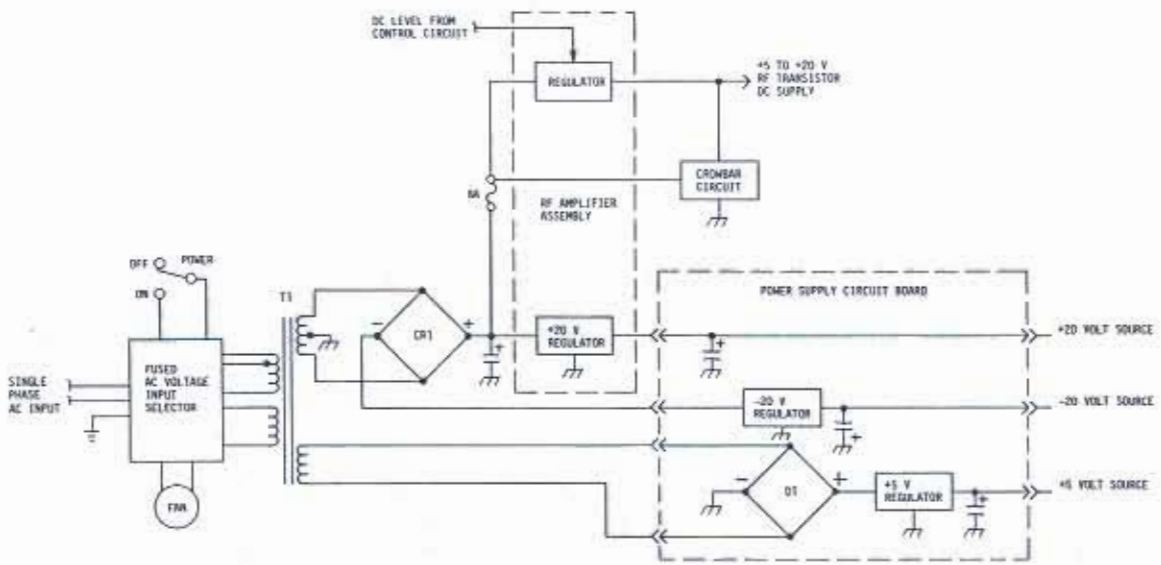
1-2. This section provides general information and specifications relative to the operation of the power supply circuitry.

1-3. EQUIPMENT PURPOSE.

1-4. All dc circuitry in the exciter operates from regulated potentials of +20V, -20V, +5V and a +5 to +20V source provided by the exciter power supply (see Figure 1-1). All supplies are full-wave rectified, filtered, and electronically regulated to assure stable equipment operation.

1-5. All supplies contain protection for over-voltage, over-current, reverse-voltage, and short-circuit conditions. The supply associated with the RF amplifier contains additional circuitry to protect the RF amplifier transistors from over-voltage, over-current, and over-heating conditions.

1-6. The fused ac voltage input selector serves the dual purpose of providing overload protection for the entire exciter and allowing selection of a wide range of ac input potentials.



597-0002-14

FIGURE 1-1. BLOCK DIAGRAM

1-7. ELECTRICAL CHARACTERISTICS.

1-8. Refer to Table 1-1 for electrical characteristics relative to the exciter power supply circuitry.

Table 1-1. ELECTRICAL CHARACTERISTICS

PARAMETER	CHARACTERISTIC
Primary AC Input	97 to 133V ac or 194 to 266V ac, 50/60 Hz, 200 W Maximum
Transformer Output	42V CT @ 5.5 Ampere 6.4V @ 1 Ampere
Unregulated DC	±26V, +9V
Regulated DC	+5 to +20V dc @ 4.2 Ampere +20V dc @ 1 Ampere -20V dc @ 100 mA +5V dc @ 1 Ampere

SECTION II
REMOVAL AND INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides removal and installation instructions for components of the exciter power supply. As the removal and installation for all the power supply components is considered evident, only general notes will be provided to assist removal and installation.

2-3. PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING REMOVAL OR INSTALLATION OF ANY POWER SUPPLY COMPONENT.
WARNING

2-4. EQUIPMENT REQUIRED.

2-5. The following equipment is required to remove and install components of the exciter power supply:

A. Flat tip screwdriver, 4 inch (10.16 cm) blade and 1/4 inch (0.635 cm) tip.

B. Number 2 Phillips screwdriver, 4 inch (10.16 cm) blade.

C. Soldering Iron, 30 watt.

2-6. PRELIMINARY PROCEDURE.

2-7. Disconnect primary ac power.

2-8. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-9. POWER TRANSFORMER.

2-10. Five ac input wires are soldered to the fused ac input voltage selector, one wire attaches to the negative terminal of the filter capacitor, one wire attaches to chassis ground, two wires plug onto the chassis mounted rectifier, and two wires connect to plug P1 on the power supply circuit board. Two screws secure the transformer shield and four screws secure the transformer to the exciter chassis.

2-11. FILTER CAPACITOR.

WARNING ENSURE THE FILTER CAPACITOR IS DISCHARGED BEFORE ATTEMPTING CAPACITOR REMOVAL.

2-12. Connect a low resistance, high wattage resistor across the filter capacitor terminals to ensure the capacitor is discharged. Two screws secure the exciter wiring. The capacitor is mounted to a clamp with one screw. Four screws secure the mounting clamp to the exciter chassis.

2-13. POWER SUPPLY CIRCUIT BOARD.

2-14. Disconnect six pin plug P1 (NOTE PIN 1). Disconnect four pin plug P2 and 14 pin plug P3. One at a time, release the latch on each nylon mounting stud and raise each corner slightly. When all four corners are free, remove the circuit board.

2-15. CHASSIS MOUNTED RECTIFIER.

2-16. Note the wire connected to the positive terminal of the rectifier and the wire connected to the negative terminal of the rectifier. Disconnect the four plug-on wires on the rectifier. One screw secures the rectifier to the exciter chassis. Ensure heat sink compound is used if the device is replaced.

2-17. RF AMPLIFIER REGULATOR AND +20V REGULATOR.

2-18. Each device mounts on a mica insulator. Ensure heat sink compound is used if a device is replaced.

SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. The following text provides detailed theory of operation with supporting diagrams for the FX-30 FM exciter power supply. For purposes of definition, the text is divided into functional circuits (see Figure 3-1).

3-3. FUNCTIONAL DESCRIPTION.

3-4. AC INPUT.

3-5. AC power is input to the exciter through a voltage range selector which additionally provides overload protection and RFI isolation for the exciter ac input. A special power transformer and a tapped dual primary allows operation from both 50 and 60 Hz and a wide range of ac voltages without component changes. The primary and secondary windings are electrostatically shielded from each other. The secondary windings of the transformer produce two ac potentials which are full-wave rectified and regulated into four dc sources which supply all operating voltages for the exciter circuitry. When the POWER switch is set to ON, the cooling fan runs continuously.

3-6. POSITIVE FIVE VOLT SUPPLY.

3-7. The 6.4 volt ac potential is routed to the power supply circuit board where it is rectified by diode bridge D1 and filtered by capacitor C6. The resultant dc potential is regulated to produce a positive five volt dc output at 1 ampere by U1. Capacitor C5 prevents oscillation of U1 and the additional capacitors on the output of the regulator filter high frequency ac components. Test point TP-3 provides a convenient point to check operation of the +5 volt supply.

3-8. Integrated circuit U1 is a three-terminal fixed positive five volt regulator containing internal thermal overload protection and short-circuit current limiting features. Further protection for U1 is provided by diode D7 which protects the regulator from a reverse polarity potential applied to the output and diode D2 which protects the regulator from a short circuit on the regualtor input.

3-9. NEGATIVE TWENTY VOLT SUPPLY.

3-10. The negative 25 volt dc potential is routed from bridge rectifier CR1 to capacitor C1 on the power supply circuit board. The input potential of -25V dc is regulated into a -20 volt source at 100 milliamperes by U2. Capacitor C6 prevents oscillation of U2 and the capacitors on the output of the regulator filter high frequency ac components from the output. Test point TP-2 provides a convenient point to check operation of the -20 volt supply.

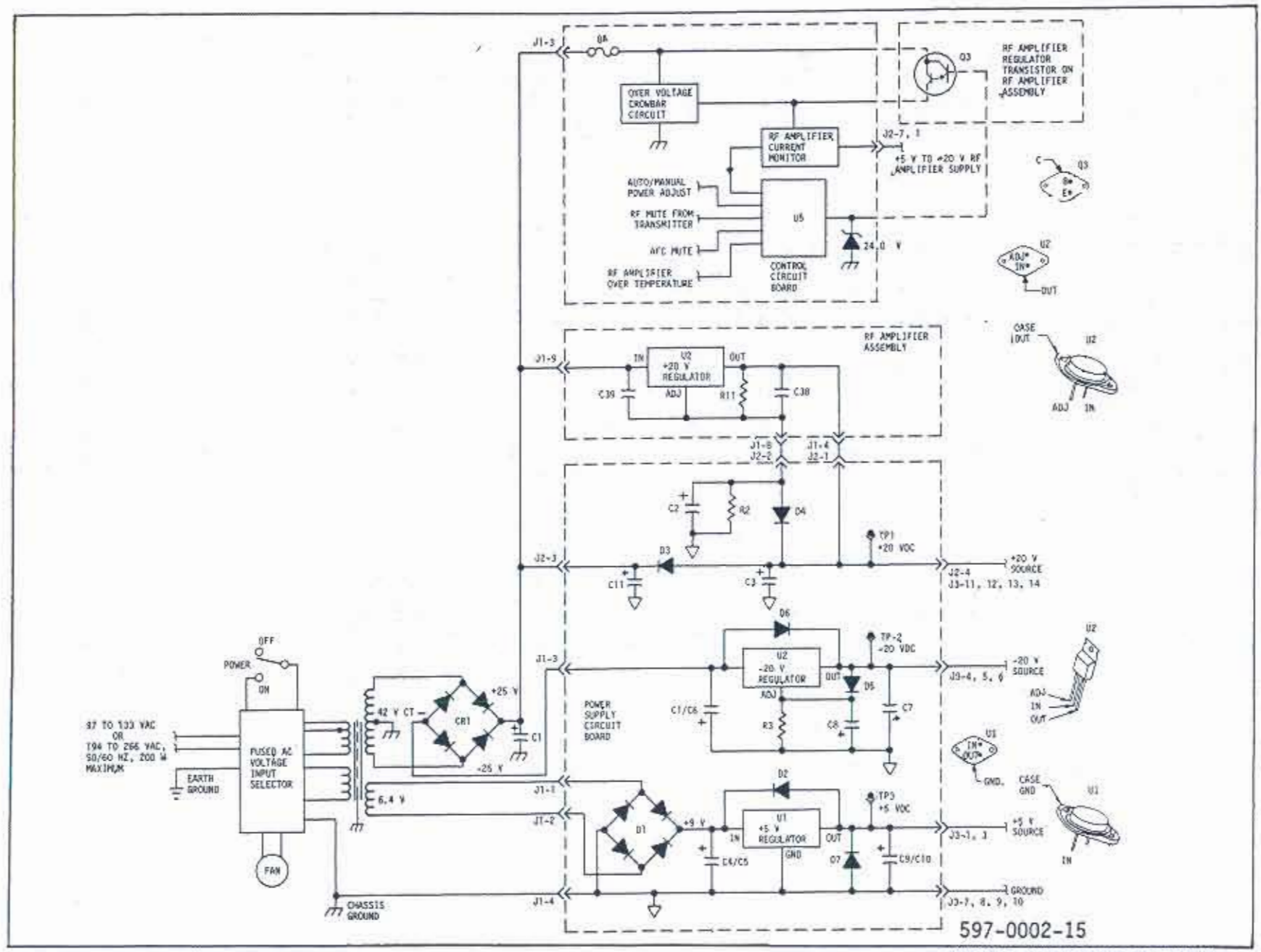


FIGURE 3-1. POWER SUPPLY SIMPLIFIED SCHEMATIC

3-11. Integrated circuit U2 is a three-terminal adjustable negative regulator containing internal thermal overload protection and short-circuit current limiting features. The output voltage is established by the value of resistors R1 and R3. Additional protection for U2 is provided by diode D5 which protects the regulator from a reverse polarity potential applied to the output and diode D6 which protects the regulator from a short circuit applied to the regulator input.

3-12. POSITIVE TWENTY VOLT SUPPLY.

3-13. The positive 25 volt dc potential is rectified by bridge rectifier CR1, filtered by capacitor C1, and routed to capacitor C11 on the power supply circuit board and regulator U2 on the RF amplifier assembly heatsink. The input potential of +25V dc is regulated into a +20 volt source at 1.0 amperes by U2. Capacitor C39 prevents oscillation of U2 and capacitors on the output of the regulator filter high frequency ac components from the output. Test point TP-1 provides a convenient point to check operation of the +20 volt supply.

3-14. Integrated circuit U2 is a three-terminal adjustable positive regulator containing internal thermal overload protection and short-circuit current limiting features. The output voltage is established by the value of resistors R11 and R1. Additional protection for U2 is provided by diode D4 which protects the regulator from a reverse polarity potential applied to the output and diode D3 which protects the regulator from a short circuit applied to the regulator input.

3-15. RF AMPLIFIER POWER SUPPLY.

3-16. The RF amplifier transistors operate from an adjustable dc potential of +5V dc to +20V dc at 4.2 amperes maximum from pass transistor Q3 mounted on the RF amplifier heat sink assembly. This adjustable potential is manually preset and automatically maintained by circuitry on the control circuit board by feedback from the directional coupler.

3-17. The control circuit monitors the RF amplifier dc current, dc voltage, temperature, and external status lines. As required, this circuit will adjust the output potential to maintain a preset exciter RF output level, lower the output potential to prevent damage to the RF output devices, or inhibit RF output as instructed by external commands.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section provides maintenance information for the exciter power supply.

4-3. MAINTENANCE.

4-4. ADJUSTMENTS.

4-5. There are no controls in the exciter power supply which require adjustment or calibration.

4-6. TROUBLESHOOTING.

WARNING TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION

WARNING SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

4-7. If difficulties are encountered and a problem is isolated to the power supply, use the fuses, the exciter metering, and the various exciter indicators to isolate the problem area. After the problem area is located, the defect may be further isolated with resistance measurements. Figure 3-1 should be referenced as an exciter power supply interconnect diagram.

4-8. DIAGRAMS.

4-9. The following diagrams are presented as aids to maintenance:

FIGURE	TITLE	NUMBER	PAGE
4-1	POWER SUPPLY CIRCUIT BOARD	839-0002-16	8
4-2	POWER SUPPLY CIRCUIT BOARD	B909-0023	9
4-3	POWER SUPPLY INPUT WIRING	B909-0016	10

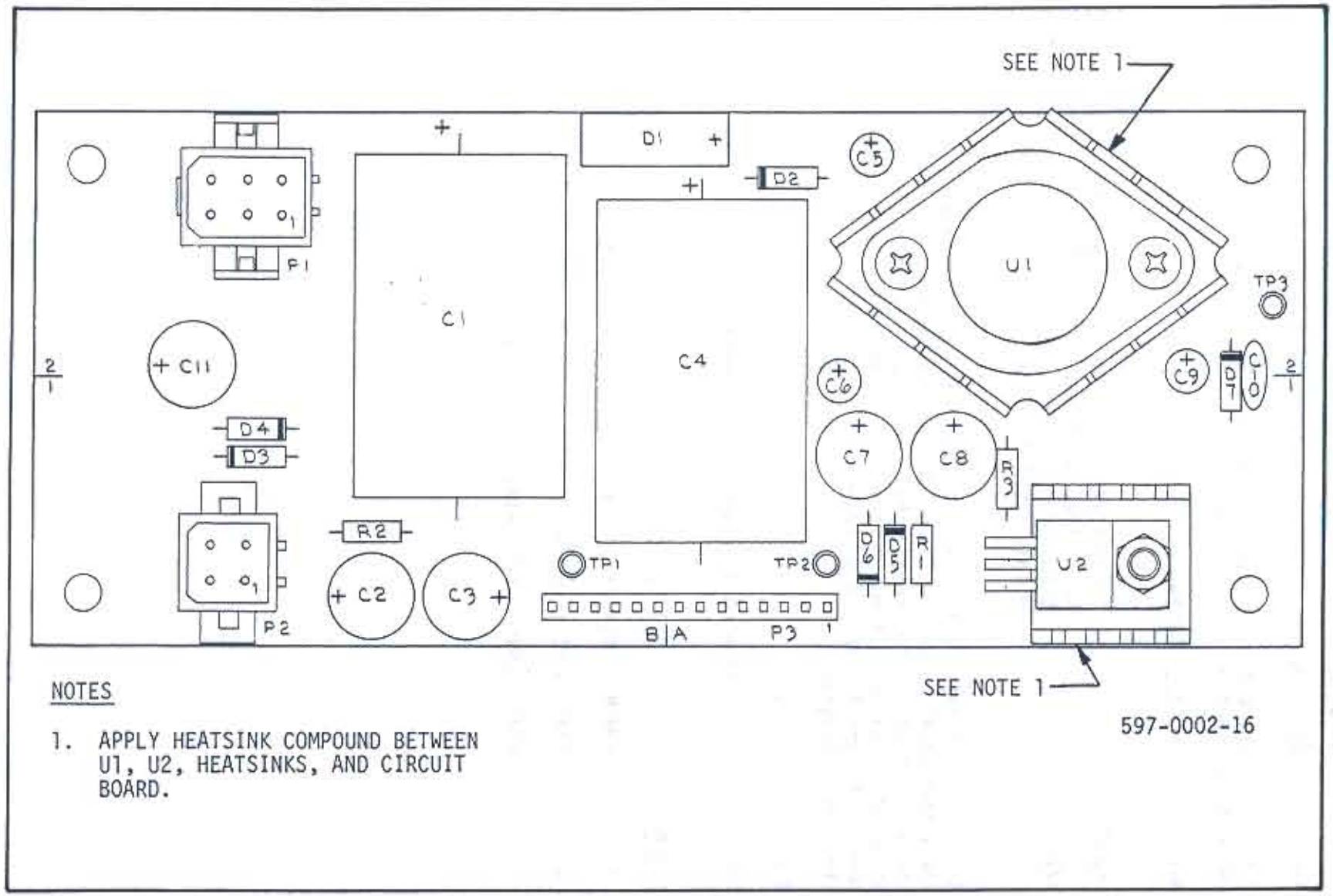
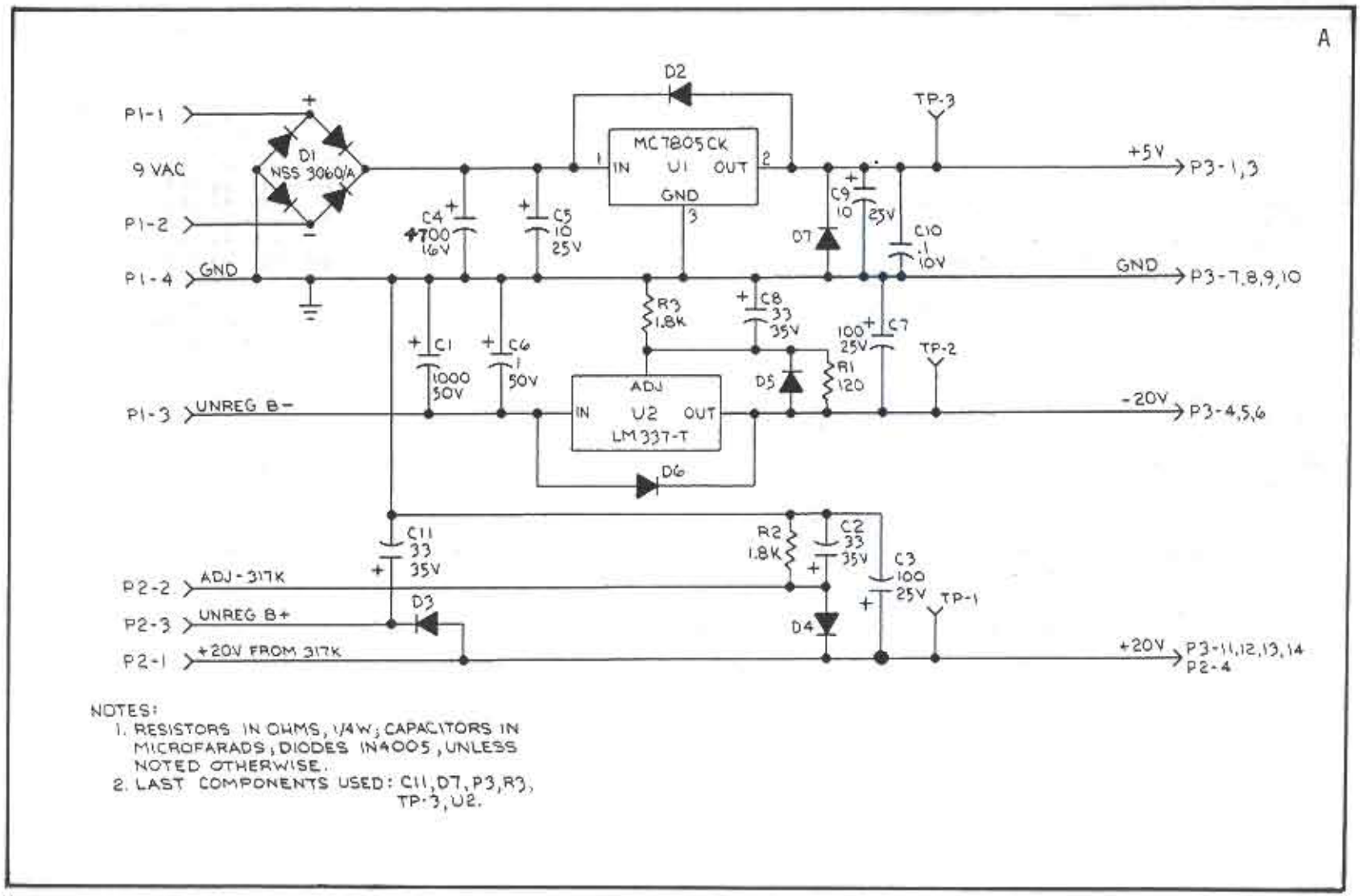


FIGURE 4-1. POWER SUPPLY CIRCUIT BOARD ASSEMBLY



NOTES:
1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS; DIODES IN4005, UNLESS NOTED OTHERWISE.
2. LAST COMPONENTS USED: C11, D7, P3, R3, TP-3, U2.

FIGURE 4-2. POWER SUPPLY CIRCUIT BOARD SCHEMATIC DIAGRAM (B909-0023)

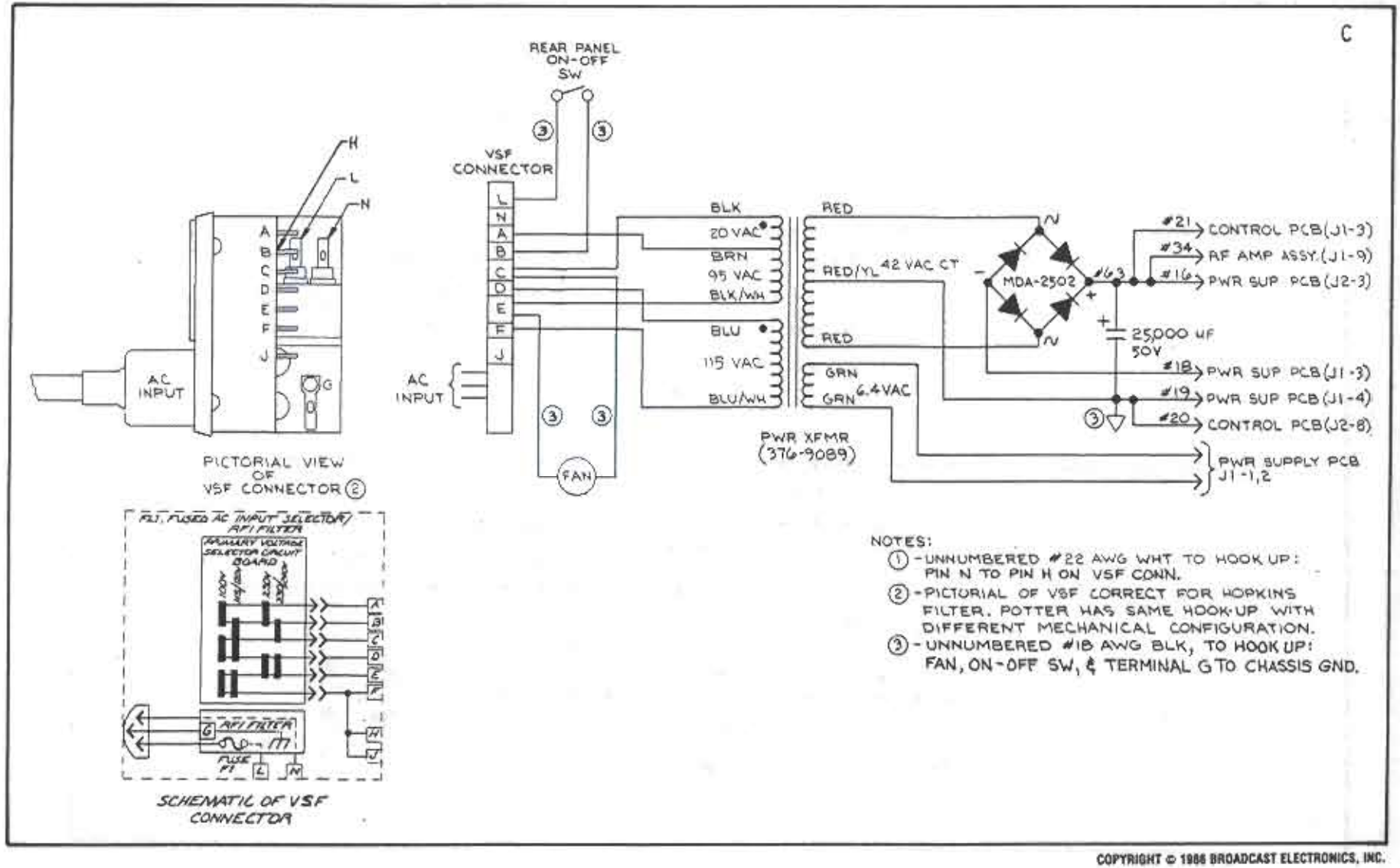


FIGURE 4-3. POWER SUPPLY AC INPUT WIRING (B909-0016)

SECTION V

REPLACEMENT PARTS

5-1. INTRODUCTION.

5-2. This section provides replacement parts lists for the FX-30 FM exciter power supply circuit board assembly as indexed below. Chassis mounted components of the power supply are listed as parts of the exciter basic assembly located in the first portion of this manual.

TABLE 5-1. POWER SUPPLY CIRCUIT BOARD ASSEMBLY
917-0023

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 1000 uF, 50V	014-1094	1
C2	Capacitor, Electrolytic, 33 uF, 35V	024-3374	1
C3	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C4	Capacitor, Electrolytic, 4700 uF, 16V	013-4794	1
C5	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C6	Capacitor, Electrolytic, 1 uF, 50V	024-1064	1
C7	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C8	Capacitor, Electrolytic, 33 uF, 35V	024-3374	1
C9	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C10	Capacitor, Ceramic Disc, 1 uF ±80% -20%, 10V	000-1055	1
C11	Capacitor, Electrolytic, 33 uF, 35V	023-3374	1
D1	Bridge Rectifier, Full Wave, 200V, 1 Ampere	239-0001	1
D2 THRU D7	Rectifier, 1N4005, Silicon, 600V, 1 Ampere	203-4005	6
P1	Connector, Male, 6-Pin	417-0677	1
P2	Connector, Male, 4-Pin	418-0255	1
P3	Connector, Header, 14-Pin	417-0140	1
R1	Resistor, 120 Ohm ±5%, 1/4W	100-1233	1
R2,R3	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	2
U1	Integrated Circuit, MC7805CK, Fixed Positive Voltage Regulator, 5V @ 1 Ampere, TO-3 Case	227-3405	1
U2	Integrated Circuit, LM337T, Adjustable Negative Voltage Regulator, 1.2V to 37V, 1.5 Amperes Maximum, TO-220 Case	227-0337	1
----	Heatsink, TO-3 (For U1)	455-6013	1
----	Heatsink, TO-220 (For U2)	455-7805	1
----	Blank Circuit Board	517-0023	1

METERING CIRCUIT

TABLE OF CONTENTS

SECTION I

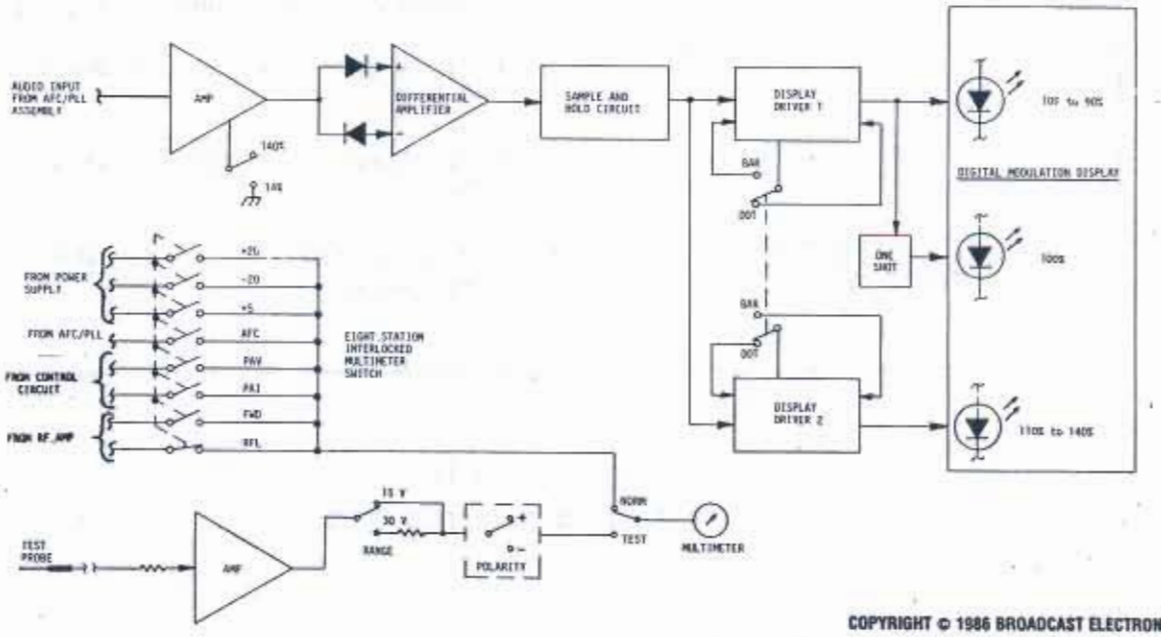
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section provides general information and specifications relative to operation of the exciter metering assembly.

1-3. EQUIPMENT PURPOSE.

1-4. The metering assembly serves three distinct purposes (see Figure 1-1). First is to meter eight different steady state exciter voltages on an analog meter. The second purpose is to continuously meter the ac composite signal as supplied to the modulated oscillator from the AFC/PLL assembly with a peak reading color-coded LED display. The third purpose is to provide a built-in high-impedance multimeter as a maintenance tool to be used for point-to-point measurements within the exciter.



597-0002-20

FIGURE 1-1. BLOCK DIAGRAM

1-5. ELECTRICAL CHARACTERISTICS.

1-6. Refer to Table 1-1 for electrical characteristics relative to the metering assembly.

TABLE 1-1. ELECTRICAL CHARACTERISTICS

PARAMETER	CHARACTERISTICS
POWER	+20V dc at 70 mA -20V dc at 25 mA +5V dc at 240 mA
LED METER	6.0V p-p Composite Audio
MULTIMETER INPUTS	+20V dc
	-20V dc
	+5V dc
	AFC Voltage: +2.5V to +13.5V dc, dependent upon RF Center Frequency
	PA Voltage: +18V for 30 W RF
	PA Current: 3.15 Ampere for 30 W RF
	FWD Voltage: 8.5V at 10 k Ohm for 30 W RF
	RFL Voltage: Less than 1V at 10 k Ohm
INTERNAL MULTIMETER TEST PROBE METER	±15V dc or ±30V dc, 15 Meg Ohm Impedance

SECTION II
REMOVAL AND INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides removal and installation for the exciter front panel LED display and the metering assembly.

2-3. REMOVAL PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING REMOVAL OF THE FRONT PANEL LED DISPLAY OR THE METERING ASSEMBLY.

WARNING

2-4. EQUIPMENT REQUIRED.

2-5. The following equipment is required to remove and install the front panel LED display and the metering assembly:

A. Flat tip screwdriver, 4 inch (10.16 cm) blade and 1/4 inch (0.635 cm) tip.

B. Number 2 Phillips screwdriver, 4 inch (10.16 cm) blade.

C. Nut Driver, 1/4 inch (0.635 cm) hex tip.

2-6. FRONT PANEL LED DISPLAY.

2-7. Disconnect primary ac power.

2-8. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-9. Disconnect J1 from P1 (NOTE PIN 1).

2-10. Remove the circuit board from the exciter.

2-11. METERING ASSEMBLY.

2-12. Disconnect primary ac power.

2-13. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-14. Disconnect J1 from P1 (NOTE PIN 1).

2-15. Remove the four Phillips head screws securing the assembly in the exciter.

2-16. Remove the metering assembly from the exciter.

2-17. INSTALLATION PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING INSTALLATION OF THE FRONT PANEL DISPLAY OR THE METERING ASSEMBLY.

WARNING

2-18. Reverse the removal procedure sequence.

SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. The following text provides detailed theory of operation with supporting diagrams for the FX-30 FM Exciter Metering Assembly. For purposes of definition, the text is divided into functional areas.

3-3. FUNCTIONAL DESCRIPTION.

3-4. All electrical inputs to the metering assembly are connected through a single 14 pin connector (P1). Refer to the simplified schematic diagram for the following discussion (see Figure 3-1).

3-5. LED DISPLAY.

3-6. AUDIO INPUT. A sample of the composite signal as applied to the modulated oscillator is derived from the AFC/PLL assembly composite audio amplifier. This signal is coupled through a 1 k Ohm resistor to pin 10 on the metering circuit board (TP-8). The level of the ac composite signal is 6 volts peak-to-peak at this point. Resistor R55 establishes a ground reference level at TP-8. Resistor R54 in conjunction with capacitor C24 comprise the first section of a low-pass filter to limit the display response to approximately 150 kHz.

3-7. VOLTAGE FOLLOWER U7A. In the normal times one non-expanded mode, the modulation indicator is calibrated from 10% to 140%. A gain of 10 is accomplished by closing switch S1 which ties the series combination of R29 and R48 to ground. This allows an expanded scale to meter low levels such as the stereophonic pilot from 1% to 14% total modulation. Amplifier U7A functions as a voltage follower with unity gain. Potentiometer allows gain adjustment to produce an amplifier gain of ten when switch S1 is closed and C23 provides high frequency compensation for U7A.

3-8. The composite signal in the non-expanded mode at the output of U7A (TP-5) is 6 volts peak-to-peak. This signal is coupled through R50 into a four way rectifier circuit built around U6A. U6A is configured as a full-wave rectifier through the use of two separate feedback loops. When a positive input is applied to the inverting input of U6A, the output will drop in level and cause diode D6 to conduct feedback to the inverting input through R45. When a negative voltage is applied to the inverting input of U6A, the output of U6A will rise, allowing diode D5 to conduct feedback to the inverting input through R46.

3-9. The output of U6A is approximately the same as the input (a sinusodial wave), but a slight amount of cross-over distortion exists near zero volts when the output is less than ±3/10 of a volt and neither diode D5 or diode D6 conducts. For this reason, the open loop gain of U6A is limited by feedback resistor R34. Capacitor C13 provides frequency compensation for the stage.

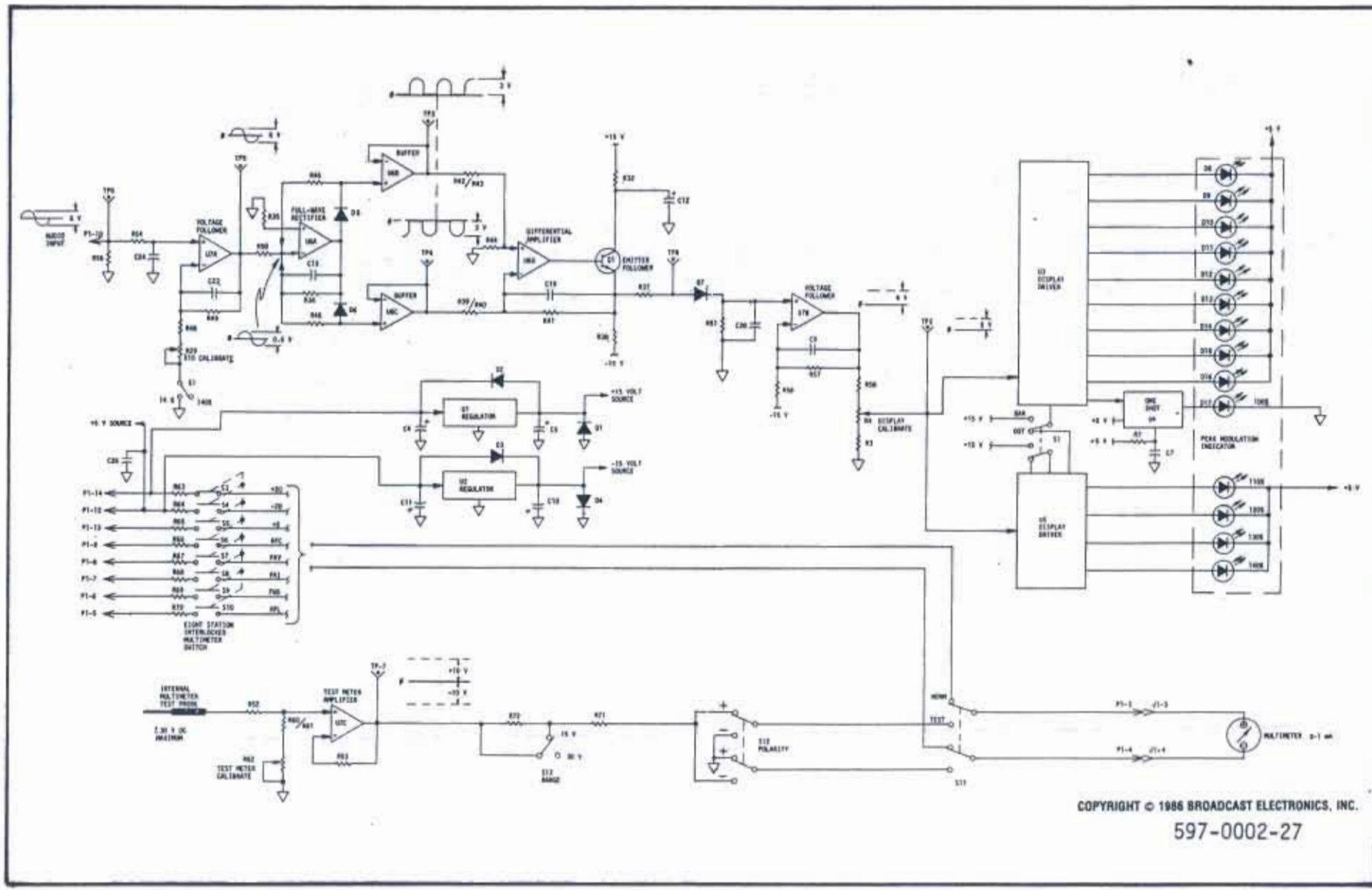


FIGURE 3-1. SIMPLIFIED SCHEMATIC

3-10. The waveform present at the junction of R46 and D5 is a positive-going half-cycle of a sinewave which starts at zero volts, extends to approximately 3 volts, and returns to zero. The waveform present at the junction of R45 and D6 is a negative-going half-cycle of a sinewave which starts at zero volts, extends to approximately 3 volts, and returns to zero. The shape of both waveforms is a half-sine function.

3-11. BUFFERS U6B AND U6C. Each respective waveform is buffered by a unity gain buffer amplifier (U6B and U6C) to provide a positive going waveform with a low source impedance at TP-3 and a complementary negative going waveform with a low source impedance at TP-4.

3-12. DIFFERENTIAL AMPLIFIER U6D. U6D differentially amplifies the waveforms input from TP-3 and TP-4, resulting in a full-wave rectified output at the emitter of Q1. Precision rectification is assured through use of a precision resistor network precisely scaling the input and feedback resistors (R39 through R44) with respect to each other.

3-13. EMITTER FOLLOWER Q1. Transistor Q1 functions as an emitter follower placed within the feedback loop of U6D to boost the full-wave rectified current output. Capacitor C19 connects from the emitter of Q1 to the inverting input to U6D to provide stage frequency compensation.

3-14. The output at TP-6 appears as a series of positive-going half-sine cycles which represents precision full-wave rectification of the input signal. This waveform causes transistor Q1 to effectively transfer the positive charge on C12 to a much smaller capacitor (C20) through diode D7. The rate at which the charge is transferred is determined by series resistor R37. Resistor R51 discharges C20 at a relatively slow rate between periods when C12 is being charged to give the display a very fast rise time with a relatively slow decay time. Component values in this circuit are selected so that the charge on C20 will be within less than 5% of the final value when one cycle of a 100 kHz signal is applied to the audio input. This allows accurate measurement of fast transient peaks.

3-15. VOLTAGE FOLLOWER U7B. Amplifier U7B is configured as a voltage follower with approximately unity gain. A FET input along with the voltage follower configuration of U7B makes the impedance at the non-inverting input of U7B extremely high which prevent loading of the RC circuit comprising C20 and R51. The output of U7B provides a low source impedance suitable for driving display drivers U3 and U5. Resistor R56 is connected between the inverting input of U7B and the negative 15 volt supply to produce a small offset in the output voltage from U7B to compensate for the offset in voltage drop across diode D7. This offset linearizes the circuit to make it possible to accurately read low level signals.

3-16. The output from U7B is applied to a voltage divider consisting of R58, R3 and R4. Potentiometer R4 allows calibration of the 100% modulation point of the LED display (positive 5 volts at TP-2).

3-17. DISPLAY DRIVERS U3, U4, AND U5. The analog input from U7B is applied to each of the identical LED driver devices. Within each driver, this input if fed in parallel to identical voltage comparators. The reference voltage for each individual comparator is derived from an internal resistive ladder network and a reference voltage of +5 volts. The first LED will illuminate at 10% of the reference voltage or 0.5 volts, while the highest LED in the series will illuminate at 100% or 5.0 volts.

3-18. Ordinarily, the tenth (100%) LED would connect between the +5 volt supply and the highest output of U3. However, this output triggers one-shot monostable multivibrator U4 which illuminates the 100% LED (D17) for approximately one second after the input to U4 has been removed. The duration of the 100% LED is established by the ratio of R7 to C7. This feature allows the user to easily identify even short duration modulation peaks that exceed the 100% threshold, corresponding to the peak indicator on a conventional modulation monitor.

3-19. Light driver U5 adds modulation indications between 110% and 140%. The bottom of the internal resistive ladder network of U5 connects to the top of the ladder network of U3. Therefore, the lowest level output of U5 will be tripped at 10% above the five volt reference on U3 allowing the light sequence to continue. Programming of the reference voltages and the current sinking capability of U3 and U5 is accomplished by appropriate resistor networks connected to each device.

3-20. Switch S2 allows selection of a bar display or a moving dot display. The LED's representing 10% through 80% are colored green to indicate safe operation. The LED representing 90% modulation is colored amber to indicate caution in approaching maximum modulation. The LED's representing 100% through 140% are colored red to indicate the undesirable condition of over-modulation.

3-21. ANALOG METER DISPLAY.

3-22. The multimeter circuit used to monitor steady state voltages comprises an eight-section front panel switch (S3 through S10) which individually selects appropriate samples to present various parameters within the exciter. All switches are interlocked, therefore, only one switch can be depressed at a time.

3-23. The +20 (S3) and the -20 (S4) switch select the positive and negative pre-regulated 20 volt supplies by sampling the inputs to the metering assembly through multiplier resistors R63 and R64. In a similar fashion, the +5 selector (S5), the AFC selector (S6), and the PAV selector (S7) use the appropriate multiplier resistor value to produce the correct indication on the Ø to 1 milliamp analog meter. With S3 through S7, one side of the meter connects to ground and the other side connects to the source through an appropriate multiplier resistor. When the PAI switch (S8) is depressed, the multimeter is floated above ground and connects across a precision shunt resistor in the control circuit. A series multiplier in conjunction with the shunt resistor allows accurate calibration to sample current through the external shunt. The FWD switch (S9) and the RFL switch (S10) again ground one side of the multiplier and connect the remaining side through an appropriate multiplier to the buffered outputs of the forward and reflected power amplifier circuits located on the control assembly.

3-24. The functions of the multimeter switch may be summarized as follows:

SWITCH	NOMENCLATURE	MULTIPLIER
S3	+20	R63
S4	-20	R64
S5	+5	R65
S6	AFC	R66
S7	PAV	R67
S8	PAI	R68
S9	FWD	R69
S10	RFL	R70

3-25. TEST FEATURE.

3-26. Test meter amplifier U7A acts as a multimeter amplifier to allow point-to-point measurements of voltage within the FX-30 FM Exciter using the front panel analog meter. The impedance of this circuit is approximately 15 Meg Ohms established by resistors R52, R60, R61, and R62. Potentiometer R62 allows accurate circuit calibration of the voltage at TP-7 which varies from -10 volts to +10 volts. The range selector switch (S13) allows selection of a full-scale reading of 30 volts or 15 volts by switching in the appropriate multiplier combination of R71 and R72. The polarity switch (S12) connects the appropriate side of the meter to ground and the remaining side to the output of the meter multipliers. The test/norm switch (S11) connects the meter to allow the normal metering function or to S12 for use as a test meter. Switches S11, S12, and S13 are maintenance tools and are located inside the exciter, inaccessible by operational personnel.

3-27. POWER SUPPLIES.

3-28. The metering assembly requires three voltage supplies for operation. The +5 volt supply enters the circuit board on P1 pin 13 and is only filtered prior to use. However, the ±20 volt inputs are re-regulated into ±15 volt potentials as follows.

3-29. POSITIVE 15 VOLT SUPPLY. Positive 20 volts enters the circuit board on P1 pin 11 and is routed to the input of fixed positive 15 volt regulator U1. Capacitors C4 and C5 serve as transient suppression capacitors and prevent oscillation of the regulator. Diodes D1 and D2 prevent input short circuit damage and reverse polarity damage to U1.

3-30. NEGATIVE 15 VOLT SUPPLY. Negative 20 volts enters the circuit board on P1 pin 12 and is routed to the input of fixed negative 15 volt regulator U2. Capacitors C10 and C11 serve as transient suppression capacitors and prevent oscillation of the regulator. Diodes D3 and D4 prevent input short circuit damage and reverse polarity damage to U2.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section provides maintenance information for the exciter metering assembly.

4-3. MAINTENANCE.

4-4. ADJUSTMENTS.

4-5. TEST METER CAL (R62). To adjust the calibration of the built-in test meter, proceed as follows.

4-6. Required Equipment. The following equipment is required to complete adjustment of the TEST METER CAL control (R62).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. (Optional) Digital voltmeter, Fluke 75 or equivalent.

4-7. Procedure. To adjust the TEST METER CAL control (R62), proceed as follows.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-8. Disconnect primary power.

4-9. Clip the internal test probe to the cathode of D1 or the anode of diode D2 on the metering board.

4-10. Set the internal RANGE switch to 15V, the internal POLARITY switch to +, and the internal TEST/NORM switch to TEST.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-11. Apply ac power and operate the exciter.

4-12. Using the insulated tuning tool (item A), adjust R62 to obtain a full scale multimeter indication of +15V dc.

4-13. For greater accuracy compare the indication to an external calibrated voltmeter (item B).

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-14. Disconnect primary ac power.

4-15. Operate the internal TEST/NORM switch to NORM.

4-16. Replace the internal test probe in its clip.

4-17. DISPLAY CALIBRATE (R4) AND X10 CALIBRATE (R29). The DISPLAY CALIBRATE control (R4) and the X10 CALIBRATE control (R29) must be adjusted together in sequence. To adjust R4 and R29, proceed as follows.

4-18. Required Equipment. The following equipment is required to complete adjustment of the DISPLAY CALIBRATE control (R4) and the X10 CALIBRATE control (R29).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Low distortion audio generator.

4-19. Procedure. To adjust the controls, proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-20. Disconnect primary power.

4-21. Apply a 400 Hz sinewave (item B) at 6 volts peak-to-peak (2.12V RMS) to TP8 (P1-10). Connect the signal ground to TP9 (P1-1).

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD
WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-22. Apply power and operate the exciter.

4-23. Using the insulated tuning tool (item A), adjust R4 fully counterclockwise, then clockwise until the 100% indicator (D17) just illuminates.

4-24. Reduce the audio input level by 20 dB to 0.6 volts peak-to-peak (0.212V RMS).

4-25. Depress the 14%/140% switch (S1).

4-26. Using the insulated tuning tool (item A), adjust R29 fully counterclockwise, then clockwise until the 100% indicator (D17) just illuminates.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-27. Disconnect primary ac power.

4-28. Disconnect the audio generator from the exciter.

4-29. TROUBLESHOOTING.

WARNING TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION
WARNING SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

4-30. If difficulties are encountered and the metering circuit is suspected as faulty, the assembly inputs and outputs should be checked to isolate the malfunction. The fuses and various exciter indicators should be noted. The defect may be further isolated with resistance measurements. Table 4-1 should be referenced as a troubleshooting guide.

TABLE 4-1. METERING CIRCUIT SYMPTOM INDEX

SYMPTOM	DEFECT
Analog Multimeter Inoperative.	Operate the Internal TEST/NORM Switch to NORM.
Analog Test Meter Inoperative, Off Scale, or Down Scale.	Operate the Internal RANGE, POLARITY, and TEST/NORM switches to the Correct Position. Defective U7C. Defective Regulator U1 or U2.
Digital Meter Inoperative - all Indicators Illuminated.	Refer to Figure 4-1.
Digital Meter Inoperative - all Indicators Out.	Defective Regulator U1 or U2. See Figure 4-1.

4-31. DIAGRAMS.

4-32. The following diagrams are presented as aids to maintenance:

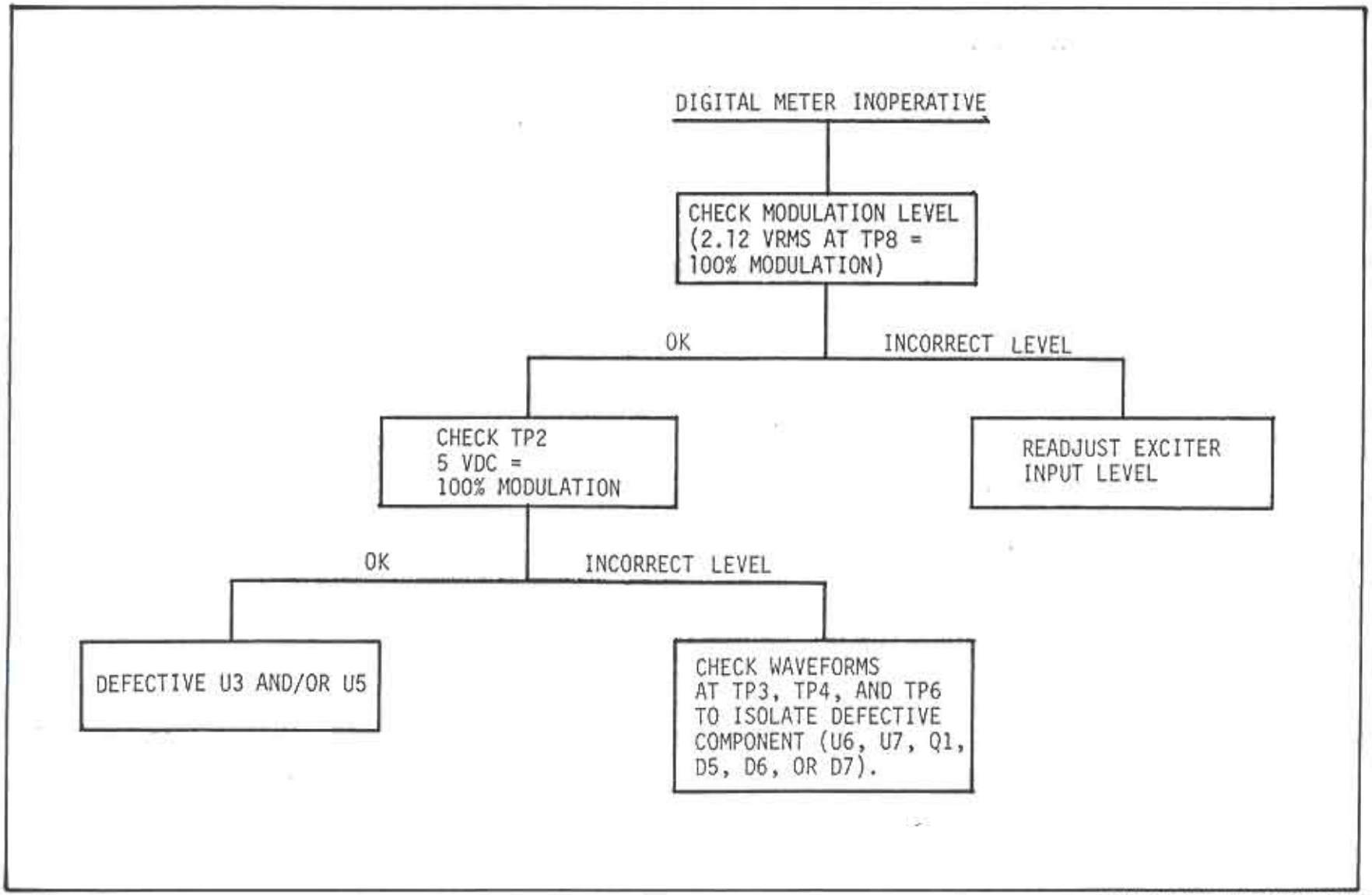


FIGURE 4-1. DIGITAL METER INOPERATIVE

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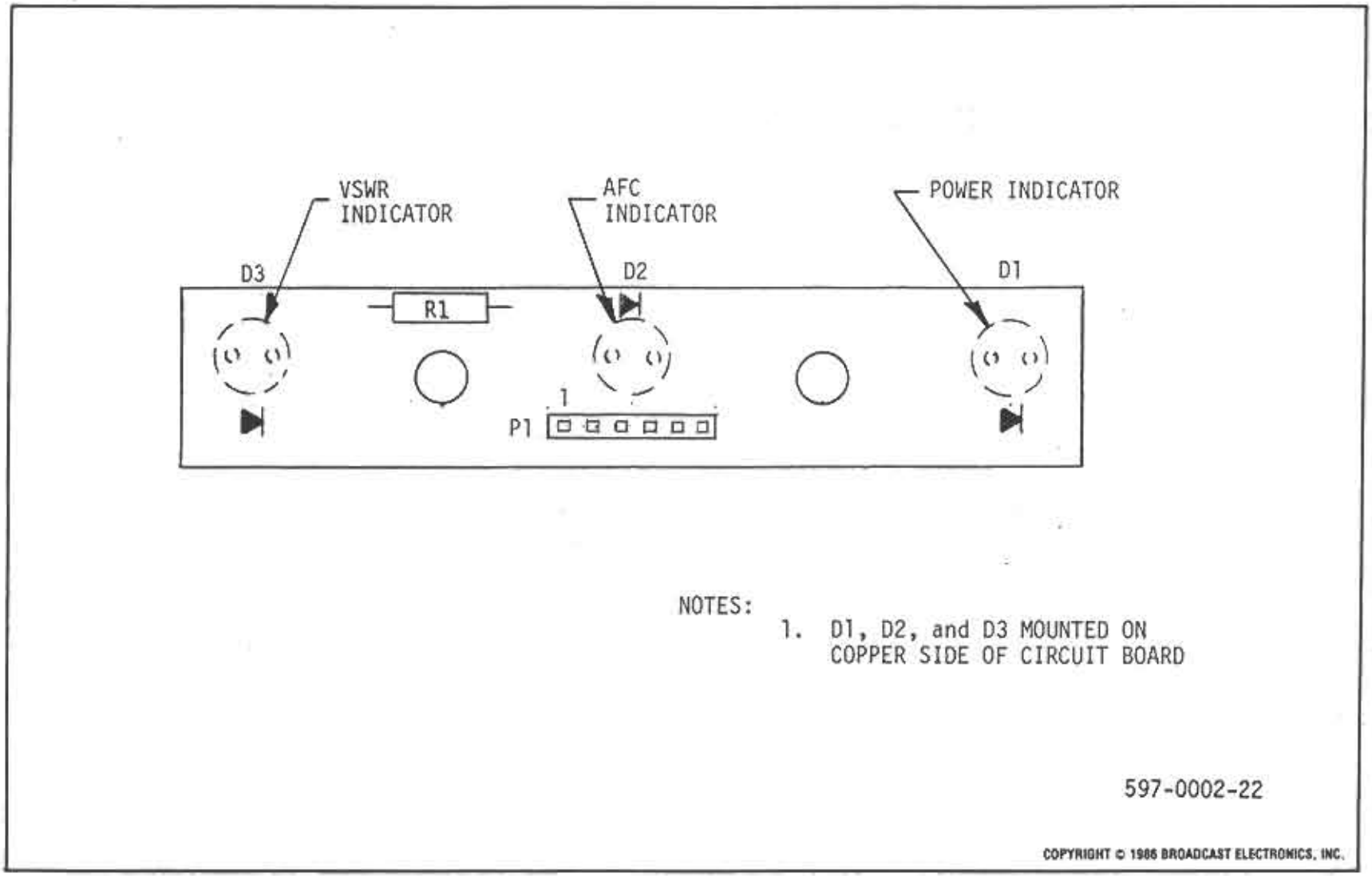


FIGURE 4-2. FRONT PANEL LED INDICATOR ASSEMBLY.

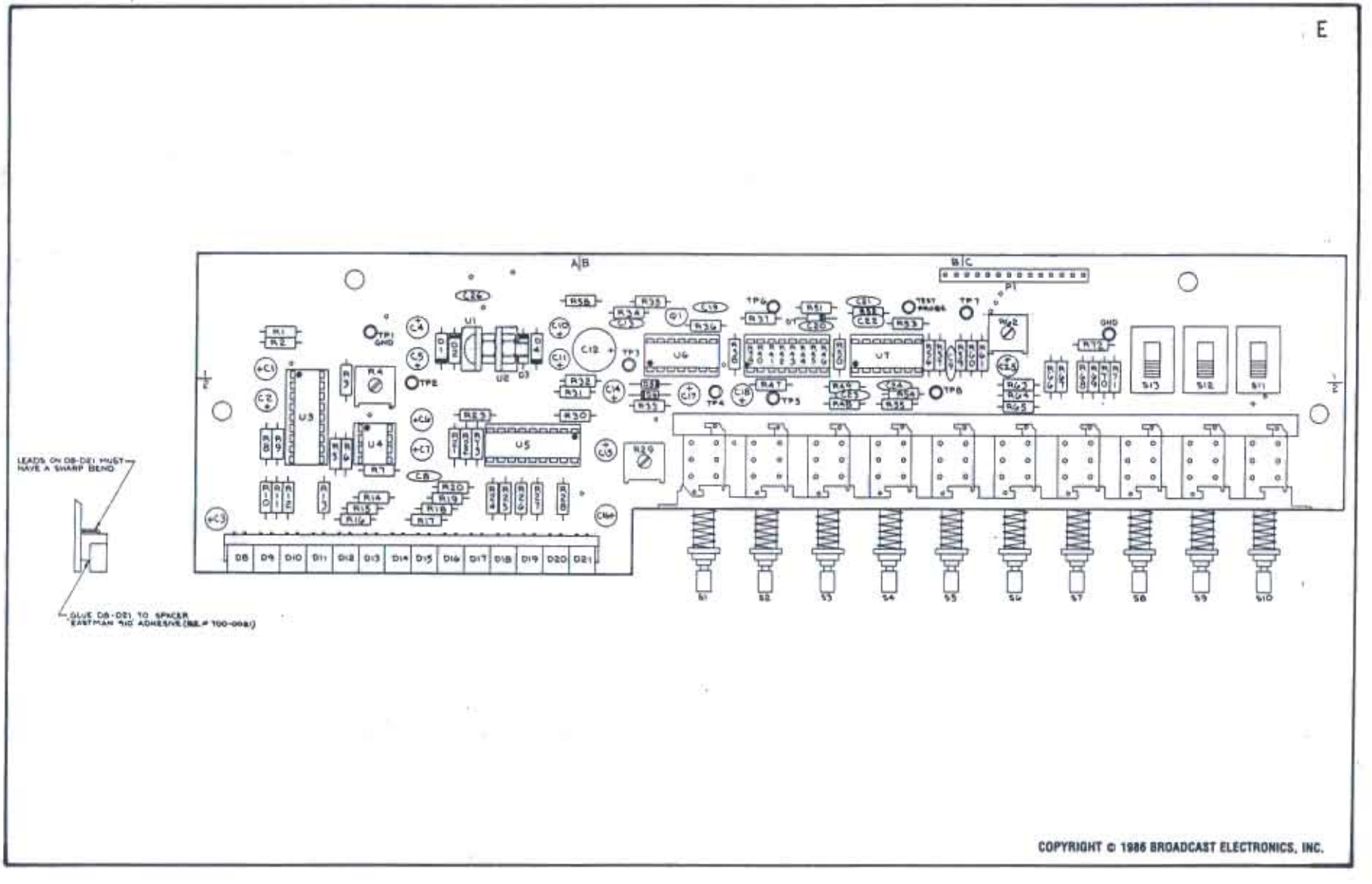


FIGURE 4-3. METERING CIRCUIT BOARD ASSEMBLY - D917-0018

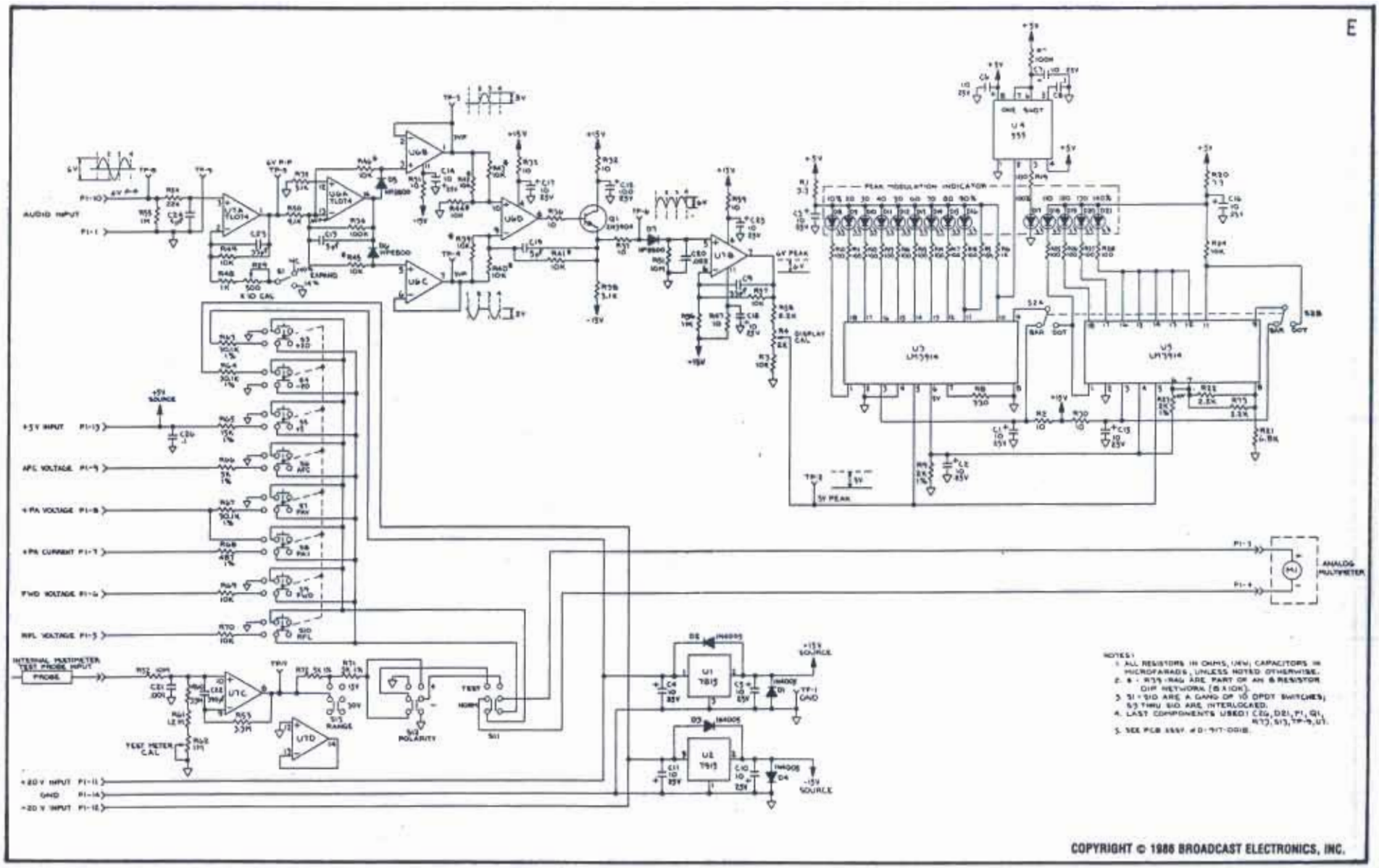


FIGURE 4-4. METERING CIRCUIT SCHEMATIC DIAGRAM D909-0011

SECTION V

REPLACEMENT PARTS

5-1. INTRODUCTION.

5-2. This section provides replacement parts lists for the FX-30 FM Exciter Metering Assembly as indexed below.

TABLE 5-1. METERING CIRCUIT BOARD ASSEMBLY - 917-0018
(Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C7	Capacitor, Electrolytic, 10 uF, 25V	023-1076	7
C8	Capacitor, Ceramic Disc, 0.1 uF -20 +80%, 10V	000-1055	1
C9	Capacitor, Mica, 33 pF ±5%, 500V	042-3312	1
C10,C11	Capacitor, Electrolytic, 10 uF, 25V	023-1076	2
C12	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C13	Capacitor, Ceramic Disc, 5 pF, 500V, NPO	001-5004	1
C14 THRU C18	Capacitor, Electrolytic, 10 uF, 25V	023-1076	5
C19	Capacitor, Ceramic Disc, 5 pF, 500V, NPO	001-5004	1
C20	Capacitor, Mylar Film, 0.022 uF, 200V	031-2243	1
C21	Capacitor, Ceramic Disc, 0.001 uF, 1000V	002-1034	1
C22	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C23	Capacitor, Mica, 33 pF ±5%, 500V	042-3312	1
C24	Capacitor, Ceramic Disc, 5 pF, 500V NPO	001-5004	1
C25	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C26	Capacitor, Ceramic Disc, 0.1 uF -20 +80%, 10V	000-1055	1
D1 THRU D4	Diode, 1N4005, Silicon, Rectifier, 600V, 1 Ampere	203-4005	4
D5 THRU D7	Diode, HP5082-2800, High Voltage Schottky Barrier Type, 70V, 15 mA	201-2800	3
D8 THRU D15	Indicator, LED, Green, MV52124, 2V @ 20 mA	323-2124	8
D16	Indicator, LED, Yellow, MV53124, 2V @ 20 mA	323-3124	1
D17 THRU D21	Indicator, LED, Red, MV57124, 2V @ 20 mA	323-7124	5
P1	Connector, 14-Pin	417-0140	1
Q1	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	1

TABLE 5-1. METERING CIRCUIT BOARD ASSEMBLY - 917-0018
(Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R1	Resistor, 3.3 Ohm ±5%, 1/4W	100-3313	1
R2	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R3	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R4	Potentiometer, 2 k Ohm ±10%, 1/2W	177-2044	1
R5	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R6	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R7	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R8	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R9	Resistor, 2 k Ohm ±1%, 1/4W	100-2041	1
R10 THRU R19	Resistor, 100 Ohm ±5%, 1/4W	100-1033	10
R20	Resistor, 3.3 Ohm ±5%, 1/4W	100-3313	1
R21	Resistor, 6.8 k Ohm ±5%, 1/4W	100-6843	1
R22	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R23	Resistor, 2 k Ohm ±1%, 1/4W	100-2041	1
R24	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R25 THRU R28	Resistor, 100 Ohm ±5%, 1/4W	100-1033	4
R29	Potentiometer, 500 Ohm ±10%, 1/2W	177-5032	1
R30 THRU R33	Resistor, 10 Ohm ±5%, 1/4W	100-1023	4
R34	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R35	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R36,R37	Resistor, 10 Ohm ±5%, 1/4W	100-1023	2
R38	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R39 THRU R46	Resistor Network, 8-10 k Ohm ±2%, 1/4W, 16-Pin DIP	226-1055	1
R47	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R48	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R49	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R50	Resistor, 9.1 k Ohm ±5%, 1/4W	100-9143	1
R51,R52	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	2
R53	Resistor, 3.3 Meg Ohm ±5%, 1/4W	100-3373	1
R54	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R55,R56	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	2
R57	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R58	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R59	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R60	Resistor, 3.3 Meg Ohm ±5%, 1/4W	100-3373	1
R61	Resistor, 1.2 Meg Ohm ±5%, 1/4W	100-1273	1
R62	Potentiometer, 1 Meg Ohm ±10%, 1/2W	177-1074	1
R63,R64	Resistor, 30 k Ohm ±1%, 1/4W	100-3051	2
R65	Resistor, 15 k Ohm ±1%, 1/4W	100-1551	1
R66	Resistor, 5 k Ohm ±1%, 1/4W	100-5041	1
R67	Resistor, 30 k Ohm ±1%, 1/4W	100-3051	1
R68	Resistor, 487 Ohm ±1%, 1/4W	100-4831	1
R69,R70	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R71,R72	Resistor, 5 k Ohm ±1%, 1/4W	100-5041	2
R73	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1

TABLE 5-1. METERING CIRCUIT BOARD ASSEMBLY - 917-0018
(Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
S1 THRU S10	Switch, Push-Push, 10 Station DPDT, Positions 1 & 2 Interlocked; Positions 3 thru 10 Interlocked, 0.45A @ 115V ac or 1A @ 28V dc	343-1008	1
S11 THRU S13	Switch, DPDT, 125V, 0.5A dc or ac	345-0863	3
TP1 THRU TP9	Test Point	413-0315	9
U1	Integrated Circuit, uA7815C, Fixed Positive Voltage Regulator, 15V, 1.5A, TO-220 Case	227-7815-C	1
U2	Integrated Circuit, uA7915C, Fixed Negative Voltage Regulator, 15V, 1.5A, TO-220 Case	227-7915-C	1
U3	Integrated Circuit, LM3914N, Dot/Bar Display Driver, 18-Pin DIP	229-3914	1
U4	Integrated Circuit, NE555V, Timer, 8-Pin DIP	229-0555	1
U5	Integrated Circuit, LM3914N, Dot/Bar Display Driver, 18-Pin DIP	229-3914	1
U6,U7	Integrated Circuit, TL074CN, Quad-Input Operational Amplifier, Bipolar JFET Type, 14-Pin DIP	221-0074	2
XU3	Socket, 18-Pin DIP	417-1804	1
XU4	Socket, 8-Pin DIP	417-0804	1
XU5	Socket, 18-Pin DIP	417-1804	1
XU6,XU7	Socket, 14-Pin DIP	417-1404	2
XR39 THRU XR46	Socket, 16-Pin DIP	417-1604	1
----	Blank Circuit Board	517-0018	1

TABLE 5-2. CIRCUIT BOARD ASSEMBLY, FRONT PANEL LED INDICATOR 917-0022

REF. DES.	DESCRIPTION	PART NO.	QTY.
D1	Indicator, LED, Red, 521-9212, 1.7V, 50 mA Maximum	323-9217	1
D2	Indicator, LED, Yellow, 521-9175, 2.3V, 40 mA Maximum	323-9225	1
D3	Indicator, LED, Green, 521-9176, 2.3V, 40 mA Maximum	323-9224	1
P1	Connector, 6-Pin	417-0006-1	1
R1	Resistor, 470 Ohm ±5%, 1/4W 100-4733	1	
----	Blank Circuit Board	517-0022	1

MODULATED OSCILLATOR

TABLE OF CONTENTS

SECTION I

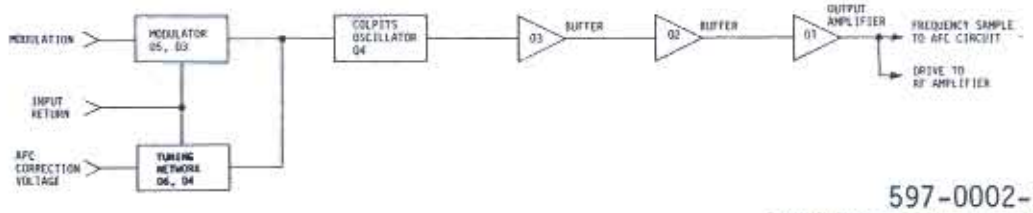
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section provides general information and specifications relative to the operation of the Modulated Oscillator or Voltage Controlled Oscillator (VCO) Assembly.

1-3. EQUIPMENT PURPOSE.

1-4. The VCO assembly produces the carrier frequency, frequency modulates the carrier, and amplifies the modulated RF carrier to a level sufficient to drive the RF amplifiers. Additional circuitry interfaced with the AFC/PLL assembly maintains the RF carrier center frequency as part of a phase-locked-loop (see Figure 1-1).



597-0002-1

FIGURE 1-1. BLOCK DIAGRAM

1-5. ELECTRICAL CHARACTERISTICS.

1-6. Refer to Table 1-1 for electrical characteristics relative to the modulated oscillator assembly.

TABLE 1-1. ELECTRICAL CHARACTERISTICS

PARAMETER	CHARACTERISTIC
Power Requirements	+20V dc at 0.100 Ampere
Signal Inputs:	
Modulation	60 mV, p-p Nominal on a Quiescent Level of +5.0V dc to +11.0V dc, Dependent upon RF Frequency.
AFC	+2.5V dc to +13.5V dc, Dependent upon RF Center Frequency.
Signal Outputs:	
RF	1.0V, RMS at 50 Ohms
AFC Feedback	1.0V, RMS at 50 Ohms

SECTION II
REMOVAL AND INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides removal and installation instructions for the VCO assembly.

2-3. REMOVAL PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING VCO ASSEMBLY
WARNING REMOVAL.

2-4. EQUIPMENT REQUIRED.

2-5. The following equipment is required to remove the VCO assembly:

A. Flat tip screwdriver, 4 inch (10.16 cm) blade and 1/4 inch (0.635 cm) tip.

B. Number 2 Phillips screwdriver, 4 inch (10.16 cm) blade.

2-6. PROCEDURE.

2-7. Disconnect primary ac power.

2-8. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-9. Unplug connector J1 from P1 on the top of the VCO assembly (NOTE PIN 1).

2-10. Unplug the two connectors from the rear of the VCO assembly.

2-11. Remove the four Phillips head screws securing the VCO assembly and steel mounting plate to the shock mount.

2-12. Remove the VCO assembly from the exciter.

2-13. INSTALLATION PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING VCO ASSEMBLY
WARNING INSTALLATION.

2-14. Reverse the removal procedure sequence.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. The following text provides detailed theory of operation with supporting diagrams for the FX-30 FM exciter VCO assembly. For purposes of definition, the text is divided into functional areas.

3-3. FUNCTIONAL DESCRIPTION.

3-4. MECHANICAL ASSEMBLY.

3-5. The modulated oscillator circuit board is enclosed in a cast aluminum box. The housing is fastened to a heavy steel plate which is supported off the exciter main chassis by rubber shock mounts. These precautions mechanically insulate the assembly from vibrations. The increased mass of the VCO assembly lowers the mechanical resonance below the frequency of vibrations caused by fans and blowers of associated equipment such as the transmitter.

3-6. To further reduce the likelihood of mechanically introduced noise modulation and increase frequency stability of the oscillator, the circuit is potted with a clear compound which remains elastic (Dow-Corning SLYGARD 184). The material may be cut away from the components if repairs become necessary and repoured after repairs are complete.

3-7. Inputs to the shielded assembly are connected through feedthrough capacitors to reduce the effect of any interference from RF fields. The outputs are connected through BNC connectors.

3-8. ELECTRICAL DESCRIPTION.

3-9. The VCO assembly consists of the: 1) modulator and oscillator circuit, 2) a two-stage buffer, low-pass filter, and output amplifier, and 3) a power supply. Refer to Figure 3-1 for the following discussion.

3-10. MODULATOR AND OSCILLATOR. The oscillator is a modified Colpits type using an N-channel junction FET as the active device. The oscillator operates directly on the carrier frequency within the commercial FM band of 87 to 109 MHz. Primary tuning is accomplished by a bias voltage of +5.0 to +11.0V dc (dependent upon carrier frequency) which is applied to varactor diodes D4 and D6. Minor corrections to the carrier center frequency are accomplished by a +2.5 to +13.5V dc potential applied to modulator diodes D3 and D5 from the phase-locked-loop circuit.

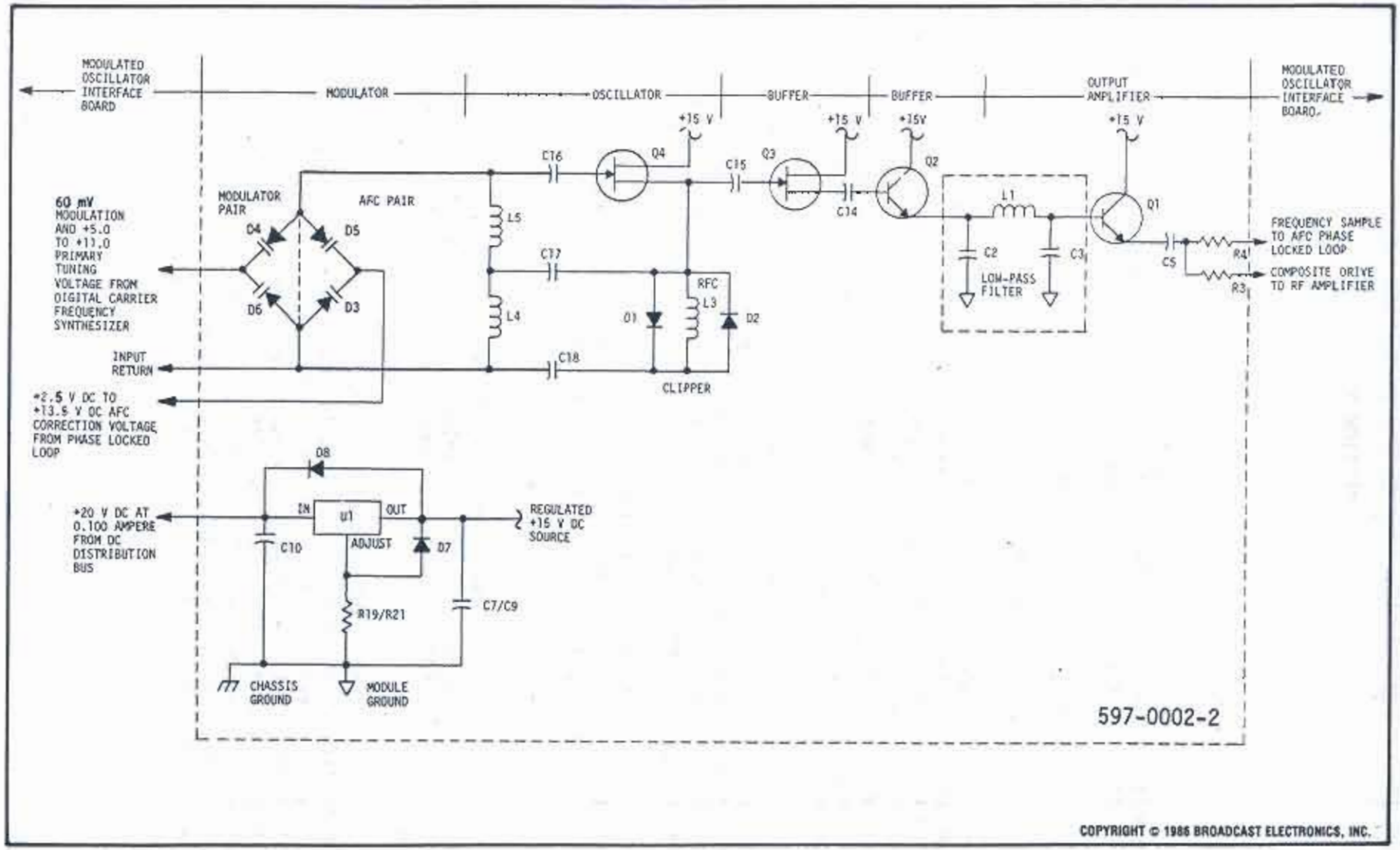


FIGURE 3-1. SIMPLIFIED SCHEMATIC

3-11. Pre-distorted audio from the AFC/PLL circuit is applied to varactor diodes D3 and D5. The modulation voltage applied varies the capacitance of the diodes across the oscillator tank circuit to accomplish direct FM modulation. Ground loops between the AFC/PLL circuit board and the VCO assembly are prevented by coupling capacitors C16, C17, and C18 which isolate the two dc ground circuits.

3-12. The oscillator output amplitude is maintained at a constant level by clipper diodes D1 and D2. RF choke L3 provides a dc return path while preventing the flow of RF current.

3-13. BUFFERS AND OUTPUT AMPLIFIER. Three stages serve to isolate the oscillator from the output load, provide harmonic suppression, and provide a low impedance output.

3-14. Source follower Q3 functions as a high input impedance buffer-amplifier which feeds buffer Q2. The output of Q2 is applied to the base of the output amplifier emitter follower (Q1) through a low-pass filter comprising C2, C3, and L1. Resistors R3 and R4 establish a 50 Ohm output impedance.

3-15. Two identical signals are output from the VCO assembly. One output provides drive to the RF amplifier and the second output provides a frequency sample output to the phase-locked-loop.

3-16. POWER SUPPLY. Regulator U1 provides a stable source of +15V dc from a module input of +20V dc from the exciter pre-regulated bus. U1 is a three terminal regulator whose output voltage is established by R19 and R21. Diodes D7 and D8 provide reverse voltage and input short circuit protection for the regulator.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section provides maintenance information for the VCO assembly.

4-3. MAINTENANCE.

4-4. ADJUSTMENTS.

4-5. The VCO assembly contains no controls which require adjustment or calibration.

4-6. TROUBLESHOOTING.

WARNING TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION

WARNING SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

4-7. If difficulties are encountered and the VCO assembly is suspected as faulty, the assembly input and output voltage and waveforms should be checked to isolate the malfunction. If the unit is faulty, it should be returned to Broadcast Electronics, Inc. for repair or exchange as the unit is not normally considered field serviceable.

4-8. To ensure mechanical stability of the oscillator, the circuit is potted with a clear compound which remains elastic (Dow-Corning SLYGARD 184). In the event that field servicing is mandatory, the potting compound can be cut away from the components and repoured after repairs are complete.

4-9. DIAGRAMS.

4-10. The following diagrams are presented as aids to maintenance:

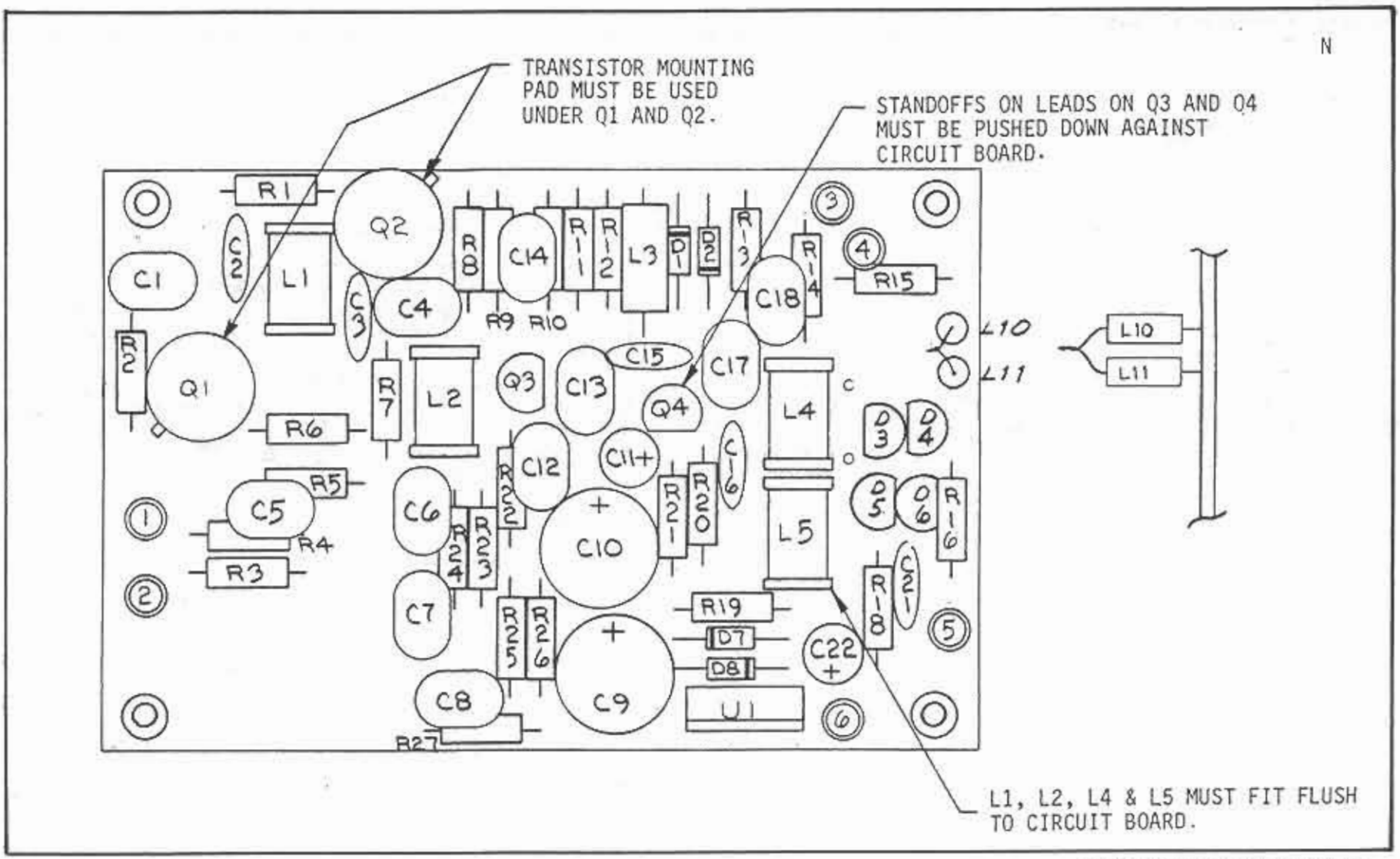


FIGURE 4-1. MODULATED OSCILLATOR ASSEMBLY - B917-0019

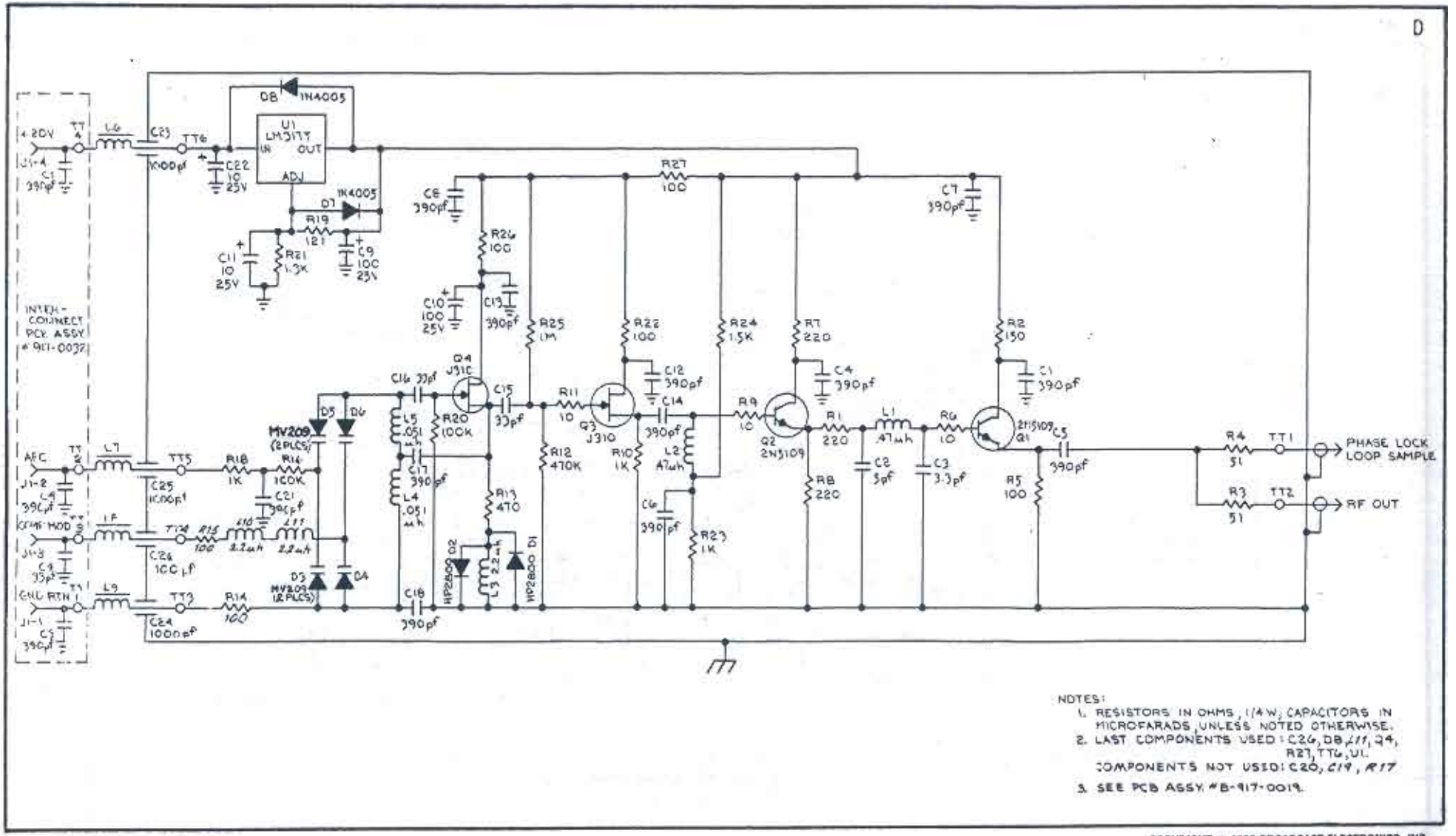
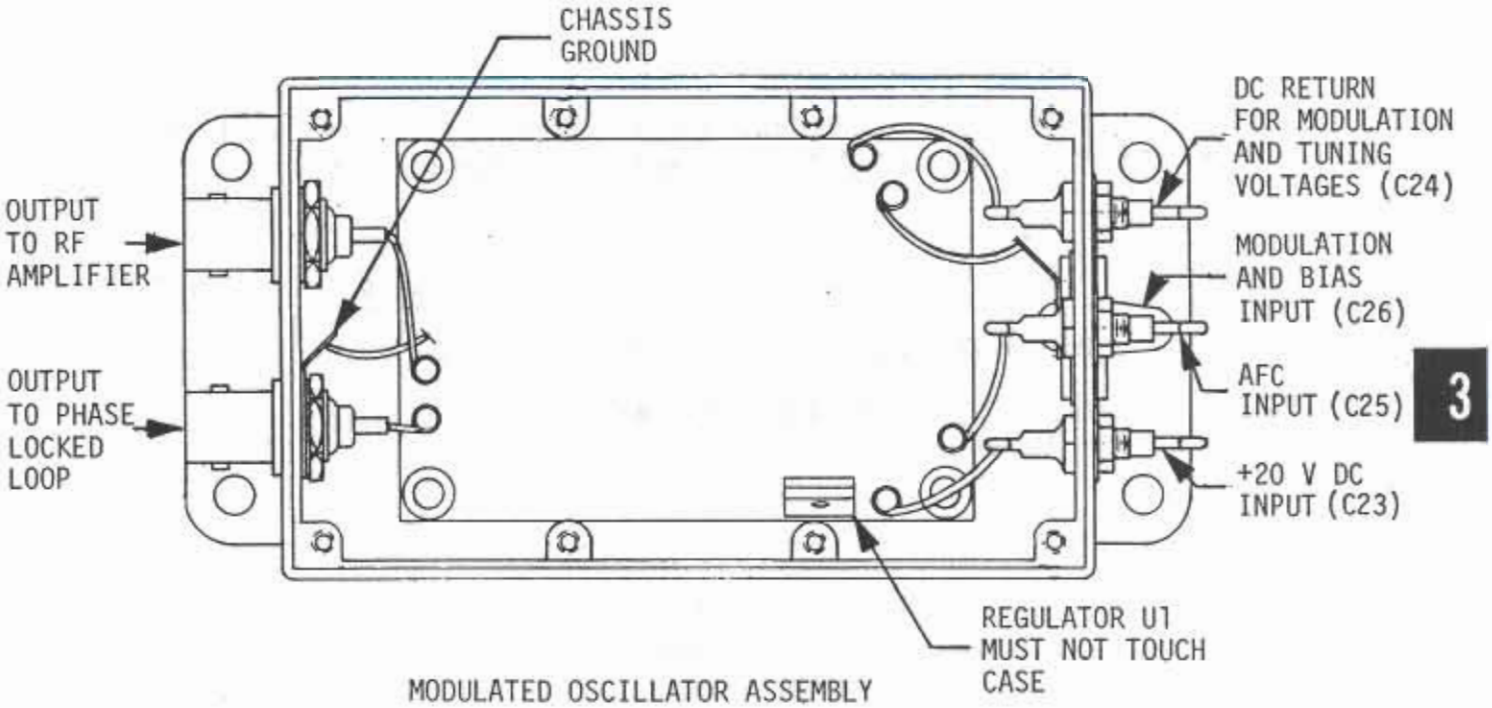


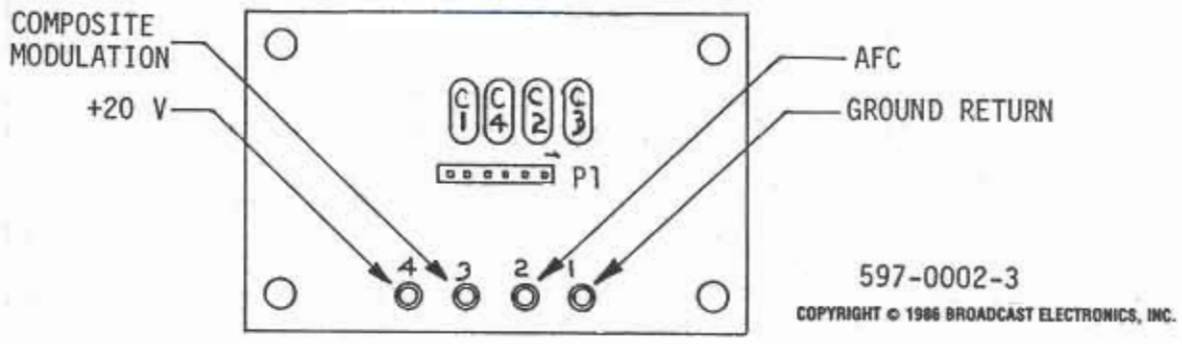
FIGURE 4-2. MODULATED OSCILLATOR SCHEMATIC DIAGRAM - C909-0019



MODULATED OSCILLATOR ASSEMBLY

NOTES

1. TOP NOT SHOWN
2. TORQUE 3/32 INCH (0.24 cm) HEX HEAD SCREWS SECURING TOP COVER TO 20 INCH POUNDS (0.23 kg-m).



MODULATED OSCILLATOR INTERCONNECT ASSEMBLY

FIGURE 4-3. VCO ASSEMBLY

SECTION V

REPLACEMENT PARTS

5-1. INTRODUCTION.

5-2. This section provides replacement parts lists for the FX-30 FM Exciter Modulated Oscillator Assembly as indexed below:

Table 5-1. Modulated Oscillator Assembly - 917-0019
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Mica, 390 pF, 500V	042-3922	1
C2	Capacitor, Ceramic Disc, 5 pF, 500V, NPO	001-5004	1
C3	Capacitor, Ceramic Disc, 3.3 pF, 1000V, NPO	000-3302	1
C4 THRU C8	Capacitor, Mica, 390 pF, 500V	042-3922	5
C9,C10	Capacitor, Electrolytic, 100 uF, 25V	023-1084	2
C11	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C12 THRU C14	Capacitor, Mica, 390 pF, 500V	042-3922	3
C15,C16	Capacitor, Mica, 33 pF, 500V	042-3312	2
C17,C18, C21	Capacitor, Mica, 390 pF, 500V	042-3922	3
C22	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C23 THRU C25	Capacitor, Ceramic, Feed-Thru, 1000 pF, 500V	008-1033	3
C26	Capacitor Assembly, Kapton, Feed-Thru, 100 pF	------	1
	Kapton Dielectric	409-1817	2
	Nylon Insulator	423-6007	1
D1,D2	Diode, HP5082-2800, High Voltage Schottky Barrier Type, 70V @ 15 mA	201-2800	2
D3 THRU D6	Diode, Varactor, MV209, 26-32 pF, 30V @ 200 mA Maximum	205-0109	4
D7,D8	Diode, Silicon, 1N4005, 600V, 1 Ampere	203-4005	2
J2,J3	Connector, BNC Type, UG1094 A/U	417-0016	2
L1,L2	Coil, 0.47 uH	364-0047	2
L3	Coil, 2.2 uH	364-2200	1
L4,L5	Coil, 0.051 uH	364-0051	2

TABLE 5-1. MODULATED OSCILLATOR ASSEMBLY - 917-0019
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
L6 THRU L9	Ferrite Choke, 180 MHz, 2.5 Turn, Single Section	364-0002	4
L10,L11	Coil, Molded, 2.2 uH	364-2200	2
Q1,Q2	Transistor, Silicon, 2N5109, NPN	211-5109	2
Q3,Q4	Field Effect Transistor, Silicon, J310, N-Channel, Junction Type	212-0310	2
R1	Resistor, 220 Ohm ±5%, 1/4W	100-2233	1
R2	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R3,R4	Resistor, 51 Ohm ±5%, 1/4W	100-5123	2
R5	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R6	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R7,R8	Resistor, 220 Ohm ±5%, 1/4W	100-2233	2
R9	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R10	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R11	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R12	Resistor, 470 k Ohm ±5%, 1/4W	100-4763	1
R13	Resistor, 470 Ohm ±5%, 1/4W	100-4733	1
R14,R15	Resistor, 100 Ohm ±5%, 1/4W	100-1033	2
R16	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R18	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R19	Resistor, 121 Ohm ±5%, 1/4W	100-1231	1
R20	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R21	Resistor, 1.3 k Ohm ±5%, 1/4W	100-1343	1
R22	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R23	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R24	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R25	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R26,R27	Resistor, 100 Ohm ±5%, 1/4W	100-1033	2
U1	Voltage Regulator, LM317T, 3 Terminal Adjustable, Positive 1.2 to 37V dc, 1.5 Ampere, TO-220 Case	227-0317	1
----	Pad, Transistor Mount (Q1 and Q2)	409-0012	2
----	Modulated Oscillator Interconnect Assembly	917-0032	1
----	Potting Compound	700-0027	--
----	Modulated Oscillator Shock Mounts	400-0001	4
----	Blank Circuit Board	517-0019	1

TABLE 5-2. MODULATED OSCILLATOR INTERCONNECT ASSEMBLY
917-0032

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Mica, 390 pF, 100V	042-3922	3
C4	Capacitor, Mica, 33 pF, 500V	042-3312	1
P1/J1	Connector, Header, 6-Pin	417-0006-1	1
----	Blank Circuit Board	517-0032	1

AFC/PLL ASSEMBLY

TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section provides general information and specifications relative to the operation of the automatic frequency control/phase-locked-loop (AFC/PLL) assembly.

1-3. EQUIPMENT PURPOSE.

1-4. The AFC/PLL assembly synthesizes the desired carrier and maintains the carrier frequency to a high level of precision (see Figure 1-1).

1-5. The carrier is sampled at the output of the modulated oscillator and compared to a precision reference within the AFC/PLL assembly. The AFC/PLL assembly constantly changes the error signal applied to the modulated oscillator to maintain the stability of the carrier frequency. If the carrier is off frequency (such as at power on), the AFC/PLL circuit will mute the RF output until the carrier frequency is again locked in phase to the reference frequency. A dual speed PLL loop filter ensures rapid stabilization of the carrier frequency.

4

1-6. As a secondary function, the assembly accepts audio inputs, predistorts the audio inputs, and sums the predistorted audio with AFC tuning bias to linearize the response and adjust the carrier frequency of the modulated oscillator.

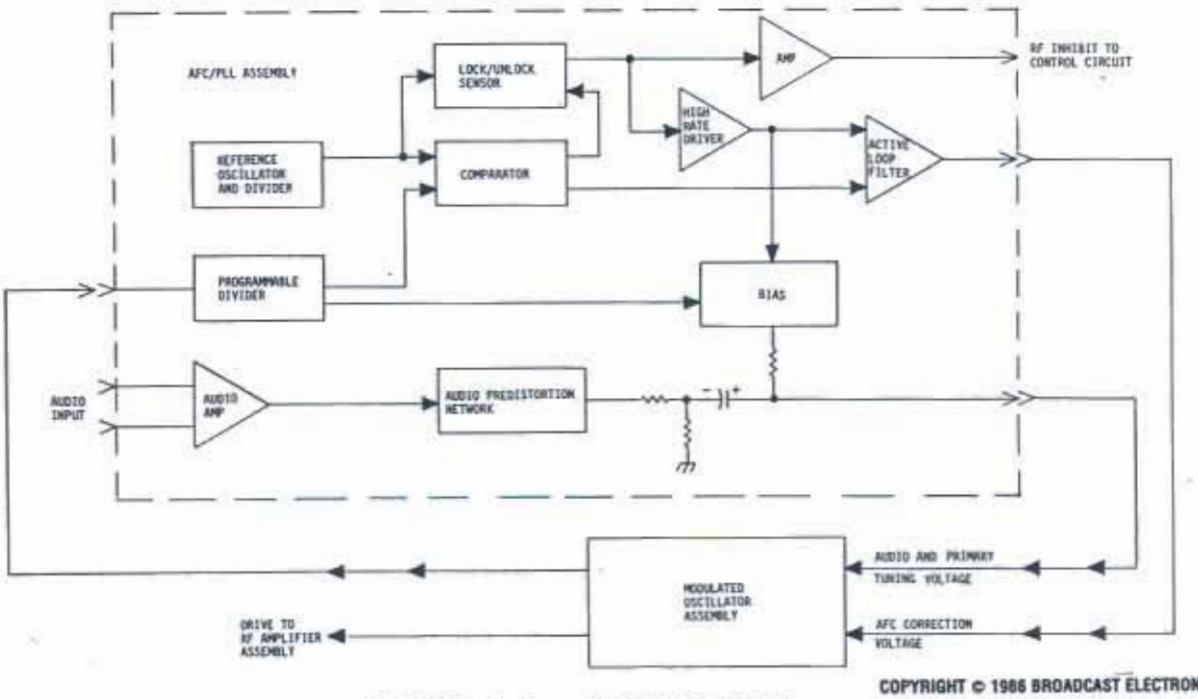


FIGURE 1-1. BLOCK DIAGRAM 597-0002-24

1-7. ELECTRICAL CHARACTERISTICS.

1-8. Refer to Table 1-1 for electrical characteristics relative to the AFC/PLL assembly.

TABLE 1-1. ELECTRICAL CHARACTERISTICS

PARAMETER	CHARACTERISTICS
INPUTS	
Power	+20V dc at 60 mA -20V dc at 35 mA +5V dc at 300 mA
RF Sample	1.0V RMS at 50 Ohms
Balanced Audio Input	+10 dBm at 600 Ohm for 100% Modulation
Composite Inputs	3.5V p-p (1.237V RMS) for 100% Modulation
SCA Input	3.5V p-p (1.237V RMS) for 10% Injection
OUTPUTS	
Modulation	60 mV p-p, Nominal on a Quiescent Level of +5V dc to +11.0V dc, Dependent upon RF Frequency
AFC	+2.5V dc to +13.5V dc, Dependent Upon RF Center Frequency
AFC (Metering)	+2.5V to +13.5V dc, Dependent Upon RF Center Frequency
AFC Interlock	Open Collector Output
External Lock Indicator Provision	Open Collector Output
Composite Audio (Metering)	6.0V p-p at 1 k Ohm
Composite Test	6.0V p-p at 1 k Ohm

SECTION II

REMOVAL AND INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides removal and installation instructions for the exciter AFC/PLL Assembly.

2-3. REMOVAL PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING REMOVAL OF THE AFC/PLL ASSEMBLY.
WARNING

2-4. EQUIPMENT REQUIRED.

2-5. The following equipment is required to remove and install the exciter AFC/PLL assembly:

A. Flat tip screwdriver, 4 inch (10.16 cm) blade and 1/4 inch (0.635 cm) tip.

B. Number 2 Phillips screwdriver, 4 inch (10.16 cm) blade.

2-6. PROCEDURE.

2-7. Disconnect primary ac power.

2-8. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-9. Disconnect 14 pin plug P1 and 14 pin plug P2. (Note Pin 1).

2-10. Remove the four Phillips head screw securing the cover to the AFC/PLL Assembly and remove the cover.

2-11. Disconnect the RF sample input from the output of the Modulated Oscillator Assembly.

2-12. Remove the four Phillips head screws securing the AFC/PLL Assembly Circuit Board to the chassis and remove the circuit board.

2-13. INSTALLATION PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING INSTALLATION OF THE AFC/PLL ASSEMBLY.
WARNING

2-14. Reverse the removal procedure sequence.

SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. The following text provides detailed theory of operation with supporting diagrams for the FX-30 FM Exciter AFC/PLL Assembly. For purposes of definition, the text is divided into functional circuits.

3-3. FUNCTIONAL DESCRIPTION.

3-4. RF SAMPLE DIVIDER.

3-5. INPUT CIRCUIT. RF sampled from the modulated oscillator output is coupled into the 50 Ohm input of transformer T1 (see Figure 3-1). Both the inner conductor and the outer conductor of the coaxial cable remain isolated from the ground plane of this board. The primary circuit of T1 ensures common mode interference does not enter the prescaler section.

3-6. The secondary of transformer T1 matches the 200 Ohm impedance of a third-order Butterworth low-pass filter comprising L1, C15, and C16. This low-pass filter removes harmonics from the modulated oscillator input signal and provides a sinusodial input to prescaler U3. An RF load for the output of the low-pass filter is provided by R55. Capacitors C17 and C18 provide dc blocking at both high and low frequencies.

3-7. The signal is input to U3 at ECL levels, divided by 10, and output as TTL levels. The output from U3 is applied to divide-by-two counter U4A which outputs a 5 MHz square wave with a 50% duty cycle. Test point TP15 at the input of U4 allows the user to measure the carrier frequency prescaled by a factor of 10 using only a low-frequency counter.

3-8. PROGRAMMABLE DIVIDER. The programmable divider establishes a divide ratio between 8,700 and 10,900 in 2,200 steps to allow the carrier frequency of the exciter to be programmed from 87 MHz to 109 MHz in 10 kHz increments.

3-9. The $\overline{Q}$ output from U4A at approximately 5 MHz is simultaneously applied in parallel to the clock inputs of decade counters U5, U6, U7, and U8. Each counter is set to count down with a particular binary coded decimal (BCD) number preset on the input to each counter.

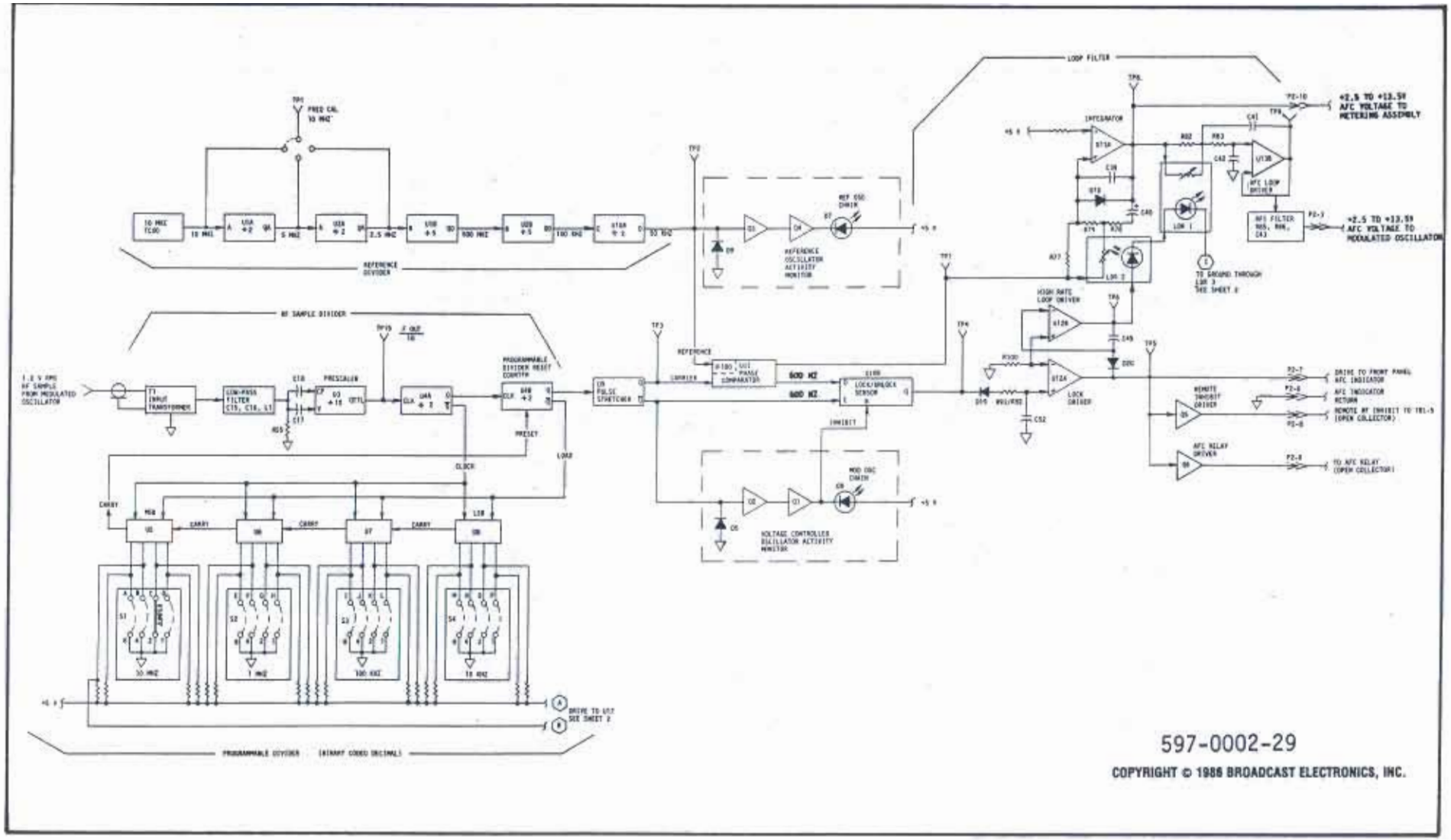


FIGURE 3-1. AFC/PLL ASSEMBLY SIMPLIFIED DIGITAL CIRCUIT

3-10. At the beginning of a counting cycle, the load line will momentarily go LOW to preset the BCD number selected into each counter. Countdown begins with U8 at the least significant bit (LSB). U8 will count down the 5 MHz clock frequency until the preset BCD number entered into U8 is attained. At that time, a carry or overflow output will be generated and fed to the next counter (U7). After U7's preset number is reached, a carry will be generated to enable U6. When U6 reaches its preset BCD number, another overflow condition exists and a carry signal will enable U5 to begin the final count as the most significant bit (MSB) in the sequence. When the preset BCD number in U5 is reached, a carry is generated and applied as a LOW to the preset input of U4B.

3-11. RESET COUNTER. The clock input of the reset counter (U4B) is connected to the opposite phase of the clock feeding the four decade counters (Q of U4A). One-half clock period after the preset occurs to U4B, the reset counter will change states and initiate another load command, presetting the counters back to the orignial state and beginning an entirely new counting sequence. Initiation of each new counting sequence with a reset counter in this manner eliminates the possibility of false counts and racing conditions between the inputs and the outputs of the decade counter. The reset counter also ensures that one count will be missed during each counting cycle, therefore the output frequency of the modulated oscillator will be 10 kHz higher than the frequency selected by the BCD switches of the synthesizer (frequency output = frequency selected + 10 kHz).

3-12. PULSE STRETCHER. The Q line of the reset counter is applied to one-shot monostable multivibrator U9 which expands the pulse width from half of a clock period at 5 MHz to approximately a 50% duty cycle at 500 Hz. Both outputs from U9 are fed to the phase comparator circuit.

3-13. VCO ACTIVITY MONITOR. The RF sample divider chain is monitored for activity by a circuit consisting of D5, D8, Q1, and Q2. Diode D5 rectifies a portion of the signal from the $\overline{Q}$ output of U9. This dc potential maintains a bias on Q1 and Q2 which illuminates the MOD OSC CHAIN indicator (D8) and enables the phase-locked-loop. If any component within the frequency synthesizer should fail or if the input to the AFC/PLL assembly is removed, the indicator will go out to indicate a failure within the RF sample divider chain and inhibit RF output.

3-14. REFERENCE DIVIDER.

3-15. A second chain divides the output of the 10 MHz temperature-compensated precision reference oscillator (TXCO) down to an appropriate frequency for comparison with the RF sample after division by the programmable divider.

3-16. The 10 MHz frequency is divided by 2 in U1A to produce a 5 MHz square wave. This signal is then divided again by 2 to produce a frequency of 2.5 MHz. This manner of frequency division provides that all the multiples and sub-multiples of the 10 MHz reference frequency will be available at test point TP1 which allows the user to directly calibrate the TXCO against any worldwide frequency standard using an inexpensive portable receiver.

3-17. The 2.5 MHz signal is then divided by 5 in U1B to output a frequency of 500 kHz, divided by 5 in U2B to output a 100 kHz signal, and divided by 2 in U10A to produce the 50 kHz signal which is applied to the divide-by-100 prescaler input of phase comparator U11 for comparison at 500 Hz with the signal from the RF sample divider chain.

3-18. REFERENCE OSCILLATOR ACTIVITY MONITOR. The reference oscillator divider chain is monitored for activity by a circuit consisting of D7, D9, Q3, and Q4. Diode D9 rectifies a portion of the signal from the Q output of U10A. This dc potential maintains a bias on Q3 and Q4 which illuminates the REF OSC CHAIN indicator (D7). If any component within the referenced divider fails, the indicator will go out to indicate a failure within the reference oscillator divider chain.

3-19. PHASE COMPARATOR.

3-20. The prescaler input of U11 is programmed to divide the 50 kHz input from the reference oscillator divider chain by 100 for direct comparisons with the 500 Hz Q output from U9.

3-21. If the carrier frequency from U9 is higher than the reference frequency from U10A, the phase comparator will output a continuous HIGH. If the carrier frequency is LOWER than the reference frequency, the output of U11 will be continuously LOW. If the inputs to U11 are equal but the carrier frequency leads the reference frequency in phase, the output of U11 will be HIGH a portion of the time and the pulse width output will be proportionate to the phase difference existing between the carrier frequency and the reference frequency. If the carrier frequency and the reference frequency are the same but the carrier frequency lags the reference frequency, then the output of U11 will be LOW a portion of the time and the pulse width of this signal will be proportionate to the phase error existing between the carrier frequency and the reference frequency. When the carrier frequency and reference are equal and in phase, U11 will output half the supply voltage of 5 volts (2.5V dc). The 5 volt supply for U11 is stabilized by zener diode D22.

3-22. LOOP FILTER.

3-23. The output from U11 (TP7) is connected to the input of the loop filter. Within the loop filter, U10B, U12A, and U12B provide phase lock protection. Phase lock means that the reference frequency and the carrier frequency are identical but not necessarily exactly in phase such as during modulation. The phase lock circuit indicates when the carrier and the reference frequency are the same and when the phase shift between the two frequencies is within a ±90° limit.

3-24. PHASE LOCK CIRCUIT. The line from U11 to the D input of U10B is normally HIGH when the frequency and phase between the inputs is identical. If the frequency is identical but the phase is not, negative going pulse will be output by U11; the pulse wideth directly proportional to the phase error existing between the reference and the carrier. The clock input of U10B is clocked opposite in phase to U11. Therefore, if both the set line and the reset inputs to U10B are LOW and the D line is HIGH when the clock edge rises, a constant HIGH will be generated at the Q output of U10B. However, if the phase difference between the reference and the carrier frequency exceeds +90°, the pulse width of the negative going pulse on the D input to U10B will exceed the half-clock frequency time limit and a LOW will be preset on the D input at the instant that the clock edge rises. This will clock a LOW from the Q output of U10B. If the clock output from U9 should disappear as if a failure occurred in the carrier divide chain, a HIGH will be present on the reset line causing the Q output of U10B to remain LOW, regardless of activity on the other inputs.

3-25. Lock Driver. The lock driver (U12A) is activated by a slow charge/quick discharge circuit comprising D19, R91, and R92. As long as the Q output of U10B is held continuously HIGH, the voltage on C52 will trip U12A after a delay of approximately three seconds. The output of U12A illuminates the front panel AFC indicator, activates the open collector output of Q5 to remove the remote RF inhibit from the rear panel terminal strip, and activates the open collector output of Q6 which energizes the AFC relay.

3-26. If the Q output of U10B goes LOW, even momentarily, capacitor C52 will discharge through D19 and R92. If this occurs, U12A will return to the original state and the loads connected to U12A will be deactivated.

3-27. High Rate Loop Driver. Another output from U12A connects to a second slow charge/quick discharge circuit comprising D20, R92, and R109. After a period of several seconds following the activation of U12A, this circuit will force the output of U12B LOW. U12B controls the light dependent resistors (LDR's) within the active filter section which control the loop response.

3-28. ACTIVE FILTER.

3-29. The active filter for the phase-locked-loop comprises U13A and U13B. The loop filter smooths out pulses from the phase comparator into an average dc error voltage to maintain the modulated oscillator frequency and phase.

3-30. INTEGRATOR. A potential of slightly less than +2.5 volts is applied to the non-inverting input of U13A as a reference voltage. A deliberate offset is applied to the inverting input of U13A to eliminate possible problems of "dead-band instability" from the phase comparator.

3-31. In the unlocked state, the output of U12B will be HIGH and current will be supplied to LDR 1, LDR 2, and LDR 3. All these devices will be activated, exhibiting a low resistance of approximately several hundred Ohms which increases the loop response approximately 100 to 1. The series of narrow positive pulses output by U11 will be applied to U13A through LDR 2 to increase the loop response for minimum lockup time. After lock is achieved, the output level of U12B returns to a LOW, LDR 2 is turned off, and the integrator cut off frequency is reduced to 0.03 Hz. After lock is achieved, the series of narrow positive pulses output by U11 are applied to U13A through a relatively high resistance (R77).

3-32. AFC LOOP DRIVER. The filtering action of integrator U13A alone is not sufficient to completely remove the residual 500 Hz comparison frequency from the error voltage. Further filtering is provided by an active 8 Hz second-order Butterworth filter comprising C41, C42, R82, R83, and U13B. This circuit outputs a dc potential between +2.5 volts and +13.5 volts dc, dependent on the exact frequency of operation to maintain the modulated oscillator frequency. An RFI filter prevents RF from affecting the AFC voltage.

3-33. In order to accomplish lockup in a short time period, the cut-off frequency of filter U13B is increased by LDR 1 at the same time that the response of U13A is increased by LDR 2.

3-34. AUDIO CIRCUIT.

3-35. BALANCED INPUTS. A total of six balanced and unbalanced audio inputs are provided in the FX-30 exciter (see Figure 3-2). The 600 Ohm balanced monaural audio input load resistance along with ac coupling capacitors and RF filtering is contained within the RFI filter assembly. Pre-emphasis is accomplished by two indentical networks, one on each side of the balanced line. The networks are normally set for 75 microsecond pre-emphasis which is determined by a parallel resistor-capacitor combination. Pre-emphasis of 50 or 25 microseconds can be selected by removing the appropriate components as noted on the schematic diagram.

3-36. Two additional balanced inputs are provided. One is an ac coupled balanced composite input which has a frequency response of 1 Hz to 100 kHz. The remaining balanced input is an ac coupled high frequency input with a response of 40 kHz to 100 kHz. All of the balanced inputs are coupled to the inverting inputs of two operational amplifiers operated in a balanced configuration.

3-37. Audio Amplifiers. Amplifiers U14B and U14D operate differentially and their outputs are combined in unity gain amplifier U14C. R4 matches the gain between U14B and U14D to cancel hum and maximize common mode rejection. The output of U14C is coupled through potentiometer R2 which calibrates the balanced audio signal applied to U14A. Frequency compensation is provided for U14B by C2 and for U14D by C10. Amplifier U14C is frequency compensated by capacitor C6.

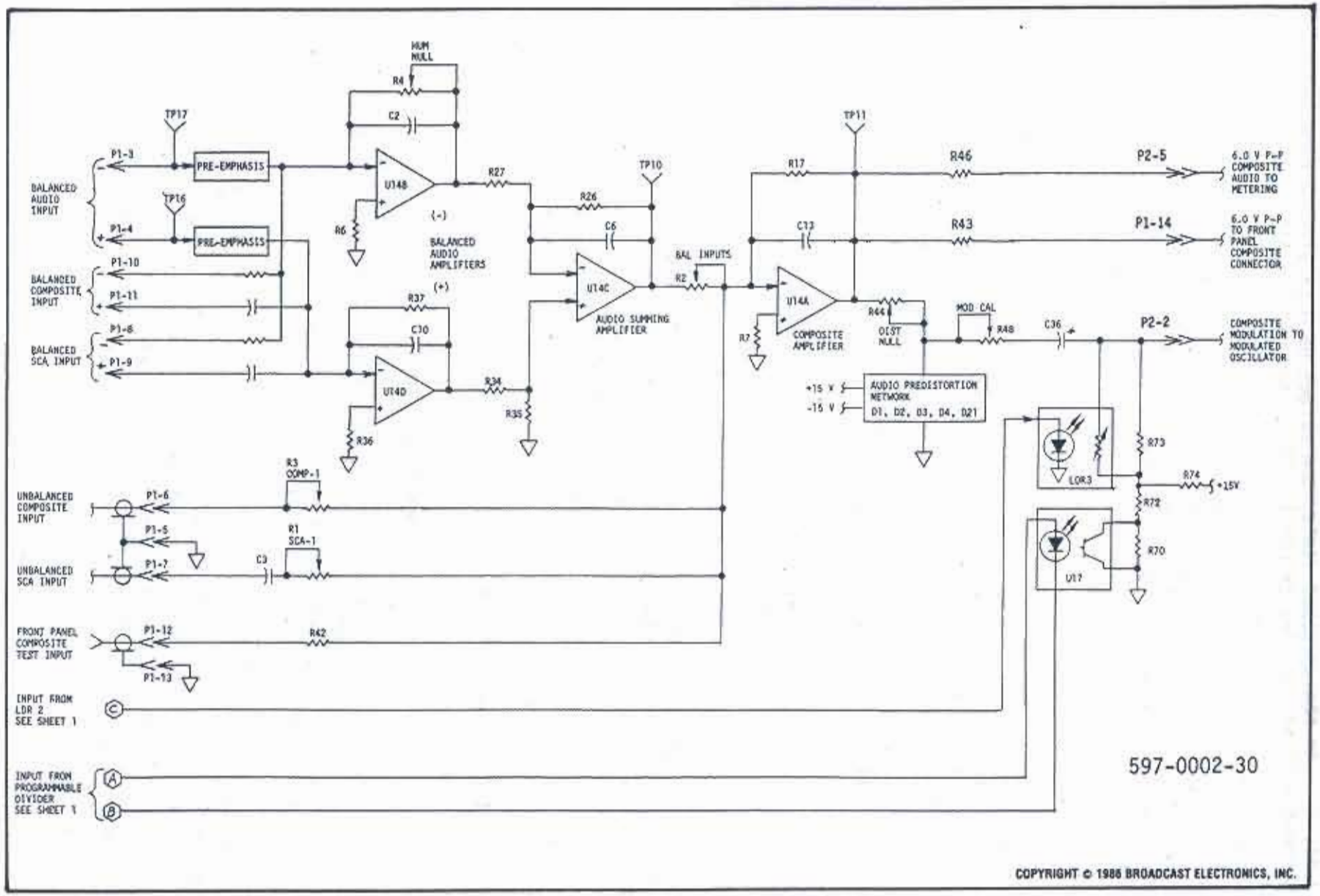


FIGURE 3-2. AFC/PLL ASSEMBLY SIMPLIFIED AUDIO CIRCUIT

3-38. UNBALANCED INPUTS. A dc coupled composite input, and unbalanced ac coupled SCA input, and unbalanced dc coupled composite test input are also summed at the inverting input to U14A. One unbalanced composite input and the unbalanced SCA input are both routed through the RFI filter from rear panel connectors. The second unbalanced composite signal is input from a front panel test connector which allows the operator to easily inject a test signal into the exciter without removing the equipment from operation. Potentiometers R1 and R3 calibrate the unbalanced composite and SCA rear panel input levels.

3-39. COMPOSITE AMPLIFIER. All audio inputs are independently summed at the inverting input of U14A. The gain of this amplifier is 1.7, therefore the output for 100% modulation will be 6 volts peak-to-peak (2.12V RMS). Nominal input levels for all of the coaxial inputs (balanced and unbalanced) to obtain the correct level from U14A is 3.5 volts peak-to-peak (1.24V RMS). The input level required by the balanced monaural audio input is +10 dBm for 100% modulation. Frequency compensation for U14A is provided by capacitor C13.

3-40. AUDIO PRE-DISTORTION NETWORK. The output of U14A is applied to a modulation linearization network through potentiometer R44. As the output from U14A swings positive, the attenuation through R44 will decrease while the attenuation through R44 will increase as the output of U14A swings negative. The resultant waveform will be slightly stretched on the positive half cycle and slightly compressed on the negative half cycle. Approximately 0.2% distortion or less is added by this network to correct for non-linearity in the varactor diodes.

3-41. In order to maintain a frequency response of less than 1 Hz through capacitor C36, a dc biasing resistor with a high resistance is required (R73). To charge capacitor C36 rapidly, LDR 3 in the dual-speed-loop momentarily bypasses R73 with a low resistance whenever the loop is unlocked. After lock is achieved, LDR 3 is disabled to allow tuning bias to be superimposed on the audio through C36.

3-42. TUNING BIAS. Tuning bias is applied through R73 and automatically varies with the particular frequency range within the FM band.

3-43. Optical coupler U17 connects to the frequency program switches on U5 in the RF sample divider. This arrangement determines the tuning bias when the carrier frequency is selected without having to make any type of adjustment to the modulated oscillator. Below 100 MHz, U17 is enabled, bypassing R70 to ground and lowering the bias voltage to 5 volts. Above 100 MHz, U17 is turned off, allowing full bias voltage to be summed with the audio signal output.

3-44. POWER SUPPLIES.

3-45. The AFC/PLL assembly requires three voltage supplies for operation (see Figure 3-3). The +5 volt supply enters the circuit board on P2 pin 13 and is only filtered prior to use. The +5V REG indicator signifies the potential is active when illuminated.

3-46. POSITIVE 15 VOLT SUPPLY. Positive 20 volts enters the circuit board on P2 pin 11 and is routed to the input of fixed positive 15 volt regulator U15. Capacitors C48 and C47 serve as transient suppression capacitors and prevent oscillation of the regulator. Diodes D18 and D15 prevent input short circuit damage and reverse polarity damage to U15. The +15V REG indicator signifies the potential is active when illuminated. Capacitors C45 and C46 serve as transient suppression capacitors and prevent oscillation of the regulator. Diodes D17 and D12 prevent input short circuit damage and reverse polarity damage to U16. The -15V REG indicator signifies the potential is active when illuminated.

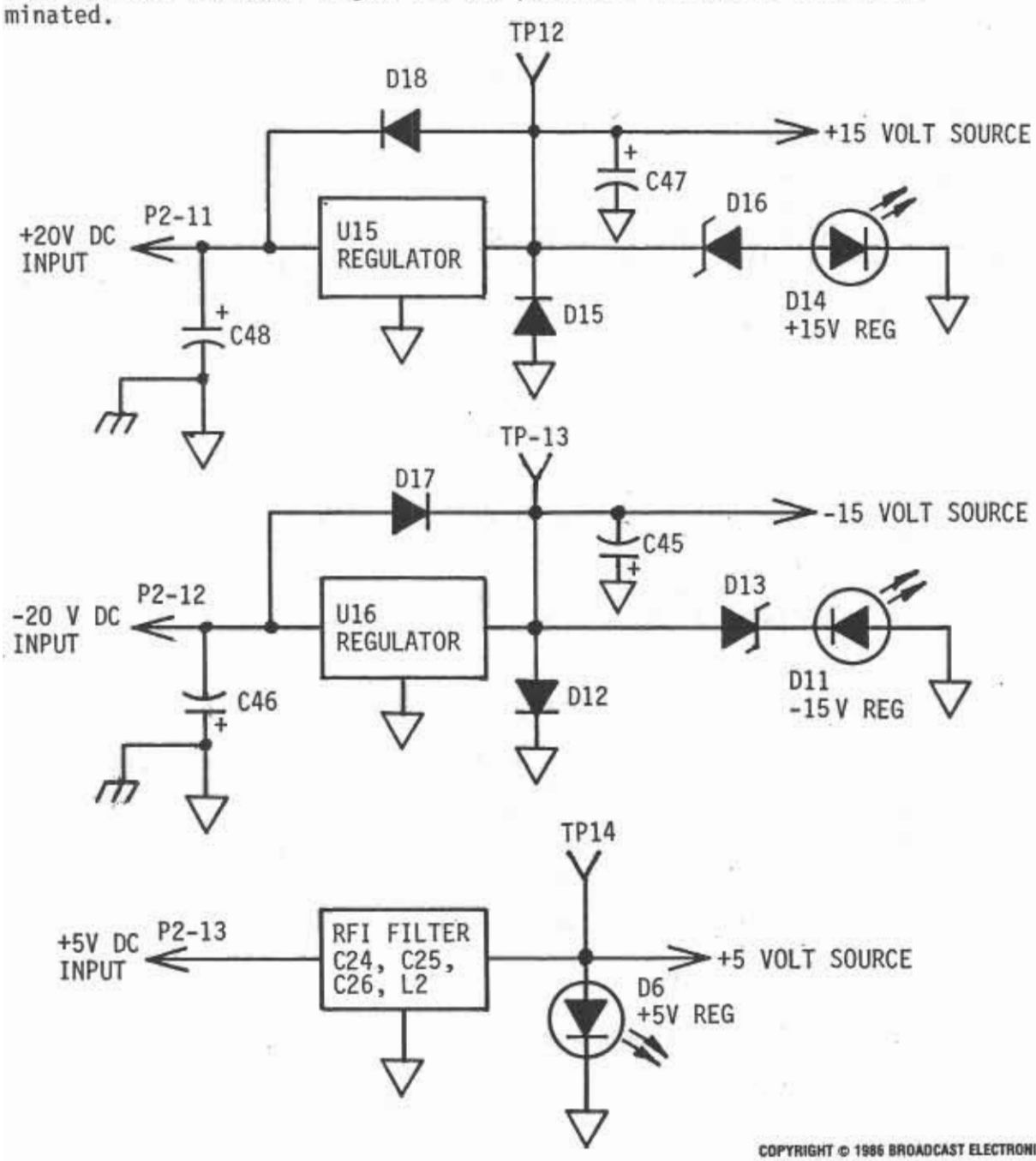


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FIGURE 3-3. AFC/PLL ASSEMBLY POWER SUPPLY

SECTION IV

MAINTENANCE

4-1. INTRODUCTION.

4-2. This section provides information for the exciter AFC/PLL assembly.

4-3. MAINTENANCE.

4-4. ADJUSTMENTS.

4-5. SCA-1 (R1). To adjust the SCA-1 control, (R1), proceed as follows.

4-6. Required Equipment. The following equipment is required to complete adjustment of the SCA-1 control (R1).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Low distortion audio generator.

4-7. Procedure. To adjust the SCA-1 control, (R1), proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-8. Disconnect primary power.

4-9. Depress the front panel 140%/14% switch.

4-10. Connect the audio generator (Item B) to the UNBAL SCA-1 connector (J1).

4-11. Adjust the audio generator output to 3.5V p-p (1.24V RMS) at 67 kHz.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-12. Apply power and operate the exciter.

4-13. Using the insulated tuning tool (Item A), adjust R1 to obtain an indication of 10% on the exciter modulation monitor.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-14. Disconnect primary ac power.

4-15. Disconnect the test equipment.

4-16. BAL INPUTS (R2). To adjust the BAL INPUTS control (R2), proceed as follows.

4-17. Required Equipment. The following equipment is required to complete adjustment of the BAL INPUTS control (R2).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Digital voltmeter, Fluke 75 or equivalent.

C. Low distortion audio generator.

4-18. Procedure. To adjust the BAL INPUTS control (R2) proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-19. Disconnect primary power.

4-20. Connect the voltmeter (Item B) between TP11 and ground.

4-21. Connect the audio generator (Item C) to the BAL COMP-2 connector (J4).

4-22. Adjust the audio generator output to 3.5V p-p (1.24V RMS) at 400 Hz.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-23. Apply power and operate the exciter.

4-24. Using the insulated tuning tool (Item A), adjust R2 to obtain an indication of 6V p-p (2.12V RMS) on the voltmeter.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-25. Disconnect primary ac power.

4-26. Disconnect the test equipment.

4-27. COMP-1 (R3). To adjust the COMP-1 control (R3), proceed as follows.

4-28. Required Equipment. The following equipment is required to complete adjustment of the COMP-1 control (R3).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Digital voltmeter, Fluke 75 or equivalent.

C. Low distortion audio generator.

4-29. Procedure. To adjust the COMP-1 control (R3) proceed as follows:

4

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-30. Disconnect primary power.

4-31. Connect the voltmeter (Item B) between TP11 and ground.

4-32. Connect the audio generator (Item C) to the UNBAL COMP-1 connector (J3).

4-33. Adjust the audio generator output to 3.5V p-p (1.24V RMS) at 400 Hz.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-34. Apply power and operate the exciter.

4-35. Using the insulated tuning tool (Item A), adjust R3 to obtain an indication of 6V p-p (2.12V RMS) on the voltmeter.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-36. Disconnect primary ac power.

4-37. Disconnect the test equipment.

4-38. HUM NULL (R4). To adjust the HUM NULL control (R4), proceed as follows.

4-39. Required Equipment. The following equipment is required to complete adjustment of the HUM NULL control (R4).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Digital voltmeter, Fluke 75 or equivalent.

C. Low distortion audio generator.

4-40. Procedure. To adjust the HUM NULL control (R4), proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-41. Disconnect primary power.

4-42. Connect the voltmeter (Item B) between TP11 and ground.

4-43. Connect TB1, terminal 12 and TB1, terminal 14 together with a jumper.

4-44. Connect the audio generator (Item C) between the jumper on TB1 and chassis ground at TB1, terminal 13.

4-45. Adjust the audio generator output to 6.93V p-p (2.45V RMS) at 100 Hz.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-46. Apply power and operate the exciter.

4-47. Using the insulated tuning tool (Item A), adjust R4 to obtain the best null in voltage as indicated by the voltmeter.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-48. Disconnect primary ac power.

4-49. Disconnect the jumper from TB1 and remove the test equipment.

4-50. DIST NULL (R44). To adjust the DIST NULL control (R44), proceed as follows.

4-51. Required Equipment. The following equipment is required to complete adjustment of the DIST NULL control (R44).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Audio distortion analyzer, Sound Technology 1710A with IMD option or equivalent.

C. High Linearity FM Demodulator, Boonton 82AD or equivalent.

D. 20 dB power attenuator, Bird 8343-200.

4

4-52. Procedure. To adjust the DIST NULL control (R44), proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-53. Disconnect primary power.

4-54. Connect the FM Demodulator (Item C), to the exciter RF output through the 20 dB power attenuator (Item D).

4-55. Connect the generator portion of the audio distortion analyzer (Item B) to the UNBAL COMP-1 (J3) connector.

4-56. Adjust the audio distortion analyzer to output a 1:1 (60 Hz/7 kHz) SMPTE Intermodulation Distortion test signal at 3.5V p-p (1.24V RMS).

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-57. Apply power and operate the exciter.

4-58. Using the insulated tuning tool (Item A), adjust R44 to obtain an indication of minimum IMD as demodulated from the de-emphasized modulation monitor output (0.015% to 0.025%, typical).

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-59. Disconnect primary ac power.

4-60. Disconnect the test equipment and reconnect the exciter output.

4-61. MOD CAL (R48). To adjust the MOD CAL control (R48), proceed as follows: Correct adjustment which requires that R1, R2, and R3 first be adjusted.

4-62. Required Equipment. The following equipment is required to complete adjustment of the MOD CAL control (R48).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Low distortion audio generator.

C. High Linearity FM Demodulator, Boonton 82AD or equivalent.

D. 20 dB power attenuator, Bird 8343-200 or equivalent.

4-63. Procedure. To adjust the MOD CAL control (R48) proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-64. Disconnect primary power.

4-65. Connect the FM demodulator (Item C) to the exciter RF output through the 20 dB power attenuator (Item D).

4-66. Connect the audio generator (Item B) to the UNBAL COMP-1 connector (J3).

4-67. Adjust the audio generator output to 3.5V p-p (1.24V RMS) at 400 Hz.

WARNING TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD ALWAYS BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-68. Apply power and operate the exciter.

4-69. Using the insulated adjustment tool (Item A), adjust R48 to obtain an indication of 100% modulation on the modulation monitor.

4-70. The front panel 100% indicator should have reached its operating threshold and should be illuminated. If the indicator is not illuminated, refer to the metering assembly portion of this manual and adjust the DISPLAY CALIBRATE control (R4).

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-71. Disconnect primary ac power.

4-72. Disconnect the test equipment and reconnect the exciter output.

4-73. TUNING BIAS (R74). To adjust the TUNING BIAS control (R74), proceed as follows.

4-74. Required Equipment. The following equipment is required to complete adjustment of the TUNING BIAS control (R74).

A. Insulated adjustment tool, shipped with the exciter (P/N 407-0083).

B. Four DIP switches for AFC/PLL assembly programmable divider, shipped with the exciter (P/N 340-0002).

C. Needle-nose pliers with 1.5 inch (3.8 cm) jaws.

4-75. Procedure. To adjust the TUNING BIAS control (R74), proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-76. Disconnect primary power.

CAUTION

CAUTION

IN THE FOLLOWING STEP, SKETCH HOW EACH PROGRAMMABLE HEADER IS ORIENTED AND POSITIONED IN THE AFC/PLL CIRCUIT BOARD BEFORE REMOVING THE HEADERS.

4-77. After it is noted how each programmable header is oriented and positioned in the AFC/PLL circuit board, remove the headers from the circuit board with the needle-nose pliers and insert the four DIP switches in their place. It is not required to remove the metal cover from the circuit board to replace the headers.

4-78. Using the insulated adjustment tool, adjust each DIP switch to 1001.

4-79. Depress the exciter front-panel AFC switch.

WARNING

WARNING

WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING

USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-80. Apply power and operate the exciter.

4-81. Using the insulated tuning tool, adjust R74 to obtain a front-panel multimeter indication of 12.5 volts. The control is a multi-turn potentiometer and the AFC voltage will track quite slowly.

WARNING

ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-82. Disconnect primary ac power.

4-83. Using the needle-nose pliers, remove the four DIP switches from the AFC/PLL circuit board and insert the four programmable headers in their place. Ensure the programmable headers are properly oriented and positioned.

4-84. The MOD CAL control (R48) and the DIST NULL control (R44) must both be adjusted before the exciter is returned to operation.

4-85. REF OSC FREQ TRIM. To adjust the frequency of the AFC/PLL assembly reference oscillator, proceed as follows.

4-86. Required Equipment. The following equipment is required to complete adjustment of the REF OSC FREQ TRIM control.

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Communications receiver.

4-87. Procedure. To adjust the frequency of the AFC/PLL assembly reference oscillator, proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-88. Disconnect primary power.

4-89. Connect a short piece of wire to be used as an antenna to the AFC/PLL assembly FREQ CAL 10 MHz test point (TP-1).

4-90. Operate the communications receiver (Item B) to receive a broadcast frequency standard on one of the following frequencies:

2.5 MHz	15.0 MHz
5.0 MHz	20.0 MHz
10.0 MHz	25.0 MHz

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-91. Apply power and operate the exciter.

4-92. Bring the wire from TP-1 close to the receiver to obtain a beat note.

4-93. Using the insulated adjustment tool (Item A), adjust the AFC/PLL assembly REF OSC FREQ TRIM control to obtain a zero beat.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-94. Disconnect primary ac power.

4-95. Disconnect the wire from the AFC/PLL assembly.

4-96. PRE-EMPHASIS. The exciter is normally shipped with 75 microsecond pre-emphasis (see Figure 4-5). To select other pre-emphasis configurations, proceed as follows.

4-97. Required Equipment. The following equipment is required to change the exciter pre-emphasis characteristics.

A. Soldering Iron, 30 watt.

4-98. Procedure. To change the exciter pre-emphasis characteristics, proceed as follows.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-99. Exciter pre-emphasis is determined by a parallel resistor-capacitor combination connected to the exciter balanced audio inputs (see Figure 4-5). Remove or add the following components to select the desired pre-emphasis characteristics.

Ø us	Remove C4, C5, C7, C8
25 us	Remove C4, C7
50 us	Remove C5, C8
75 us	Install C4, C5, C7, C8

4-100. FREQUENCY SELECTION. The carrier frequency of the exciter is established by the frequency synthesizer section of the AFC/PLL assembly (see Figure 4-1). The synthesizer is programmed with four groups of switches. The position of each group of switches corresponds to a binary coded decimal (BCD) number. To change the exciter frequency, proceed as follows.

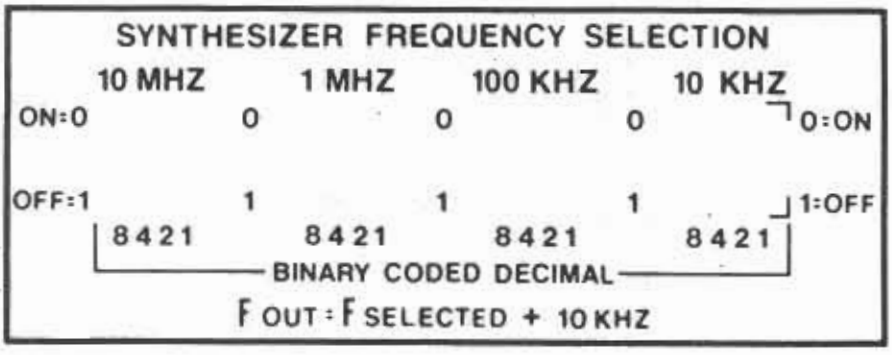

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FIGURE 4-1. FREQUENCY PROGRAMMING

4-101. Required Equipment. The following equipment is required to change the exciter carrier frequency.

A. Insulated adjustment tool, shipped with the exciter (P/N 407-0083).

B. Four DIP switches for the AFC/PLL assembly programmable divider, shipped with the exciter (P/N 340-0002).

C. Needle-nose pliers with 1.5 inch (3.8 cm) jaws.

4-102. Procedure. To change the exciter carrier frequency, proceed as follows.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

A. Disconnect primary power.

NOTE IN THE FOLLOWING STEP, IT IS NOT REQUIRED TO REMOVE THE METAL COVER FROM THE CIRCUIT BOARD

NOTE TO REPLACE THE PROGRAMMABLE HEADERS.

B. Using the needle-nose pliers, remove the four programmable headers from the AFC/PLL circuit board and insert the four DIP switches in their place.

C. Determine the frequency synthesizer code using the following formula:

CARRIER FREQUENCY - 10 kHz = FREQUENCY SYNTHESIZER CODE

Example: 98.10 MHz - 10 kHz =
98.09 MHz = 9809 FREQUENCY SYNTHESIZER CODE

D. Select the binary numbers for the frequency selection switches from the following list. Switch selections in the ON position correspond to a "Ø" in the code and switch selections in the OFF position correspond to a "1" in the code.

DECIMAL NUMBER	BINARY CODE
Ø	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010

E. Operate the switches to the correct positions using the insulated adjustment tool.

4-103. To determine the carrier frequency from the frequency synthesizer code, refer to the following formula:

N + 10 kHz = CARRIER FREQUENCY
N = CARRIER FREQUENCY CODE converted to a decimal number (see the list in step D) in MHz.

Example: 9809 FREQUENCY SYNTHESIZER CODE = 98.09 MHz
98.09 MHz + 10 kHz = 98.10 MHz CARRIER FREQUENCY

4-104. If the exciter is equipped with the optional low-pass filter, adjust the filter as follows:

A. Refer to SECTION 6, CONTROL CIRCUIT and perform the FWD CAL (R3) and RFL CAL (R2) adjustment procedure.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

B. Ensure all primary power is disconnected from the exciter.

C. Refer to Figure 4-2 and remove the two low-pass filter mounting screws.

D. Connect a spectrum analyzer (Tektronix 7603 oscilloscope main frame and 7L12 plug-in spectrum analyzer with L3 module or equivalent) to the low-pass filter output through a 20 dB power attenuator (Bird 8343-200 or equivalent).

E. Depress the exciter RFL switch.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND CAUTION SHOULD BE OBSERVED. USE THE INSULATED TUNING TOOL FOR ADJUSTMENTS.

WARNING

F. Apply ac power and operate the exciter.

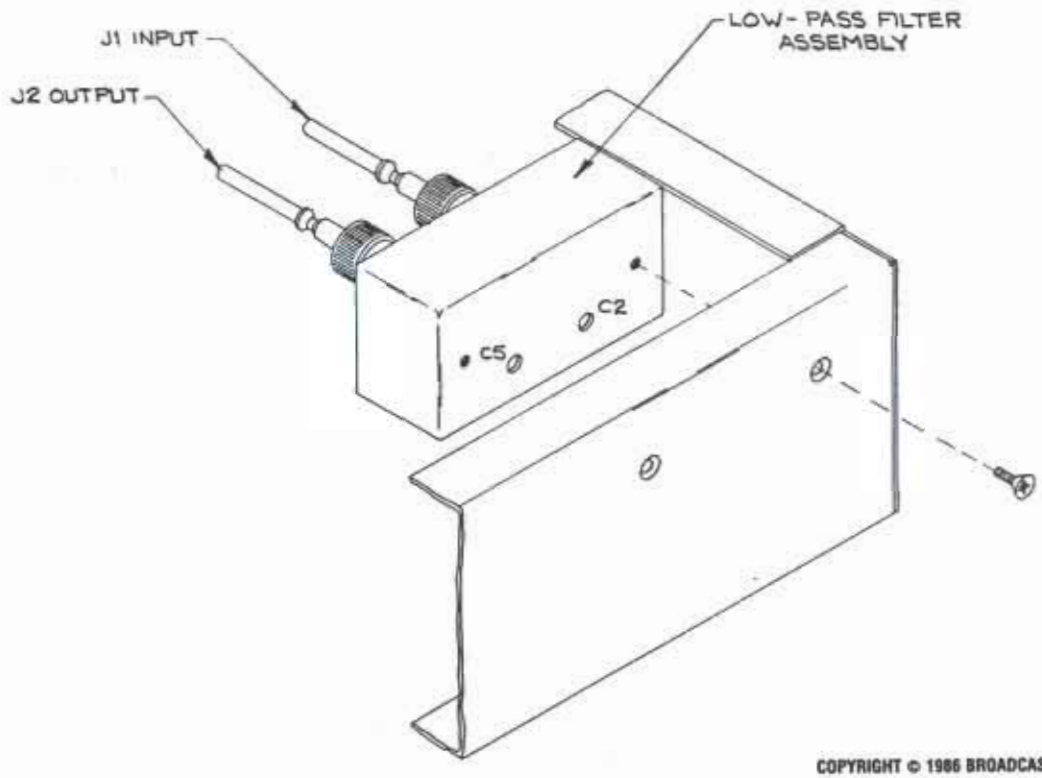
G. Refer to Figure 4-2 and adjust capacitor C2 for a minimum reflected power indication on the exciter multimeter.

H. Refer to Figure 4-2 and adjust capacitor C5 for a minimum reflected power indication on the exciter multimeter and a minimum harmonic display on the spectrum analyzer.

I. Repeat steps G and H.

J. Refer to SECTION 5, RF AMPLIFIER and perform the DIRECTIONAL COUPLER REFLECTED POWER NULL (R10) adjustment procedure.

K. Refer to SECTION 6, CONTROL CIRCUIT and perform the FWD CAL (R3) and RFL CAL (R2) adjustment procedure.



597-0002-50

FIGURE 4-2. LOW-PASS FILTER ASSEMBLY ADJUSTMENTS

WARNING: DISCONNECT POWER PRIOR TO SERVICING

L. Refer to the adjustment procedures in the preceeding text and perform the MOD CAL (48) adjustment procedure.

M. Refer to the adjustment procedures in the preceeding text and perform the DIST NULL (R44) adjustment procedure.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

N. Ensure all primary power is disconnected from the exciter.

O. Disconnect all test equipment and replace the low-pass filter assembly.

4-105. TROUBLESHOOTING.

WARNING TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION

WARNING SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

4-106. If difficulties are encountered and the AFC/PLL circuit is suspected as faulty, the assembly inputs and outputs should be checked to isolate the malfunction. The fuses and various exciter indicators and the assembly power indicators should be noted. The defect may be further isolated with resistance measurements. Table 4-1 should be referenced as a troubleshooting guide.

TABLE 4-1. SYMPTOM INDEX

SYMPTOM	REMEDY
No RF Output, AFC indicator out.	Refer to Figure 4-3.
AFC Indicator illuminated, no modulation.	Refer to Figure 4-4.

4-107. The forward signal path through the AFC/PLL assembly and the feedback signal path from the modulated oscillator assembly form a closed loop. The simplest method to isolate problems in the loop is to modify the feedback portion of the loop and note the effect on the output of the loop.

4-108. If there is an output and if the output does not change when the feedback path is altered, then a fault exists within the feedback path. If the output changes when the feedback path is changed, then both the forward and feedback portions of the loop are operating properly, or at least partially operative, providing the change is relative to the purpose of the loop. For example, the purpose of the feedback loop in the FX-30 exciter is frequency control, therefore a change in the feedback path will change the output frequency if the feedback path is operating properly.

4-109. DIAGRAMS.

4-110. The following diagrams are presented as aids to maintenance:

FIGURE	TITLE	NUMBER	PAGE
4-5	AFC/PLL ASSEMBLY	D917-0015	30
4-6	AFC/PLL ASSEMBLY SCHEMATIC DIAGRAM	D909-0015	31

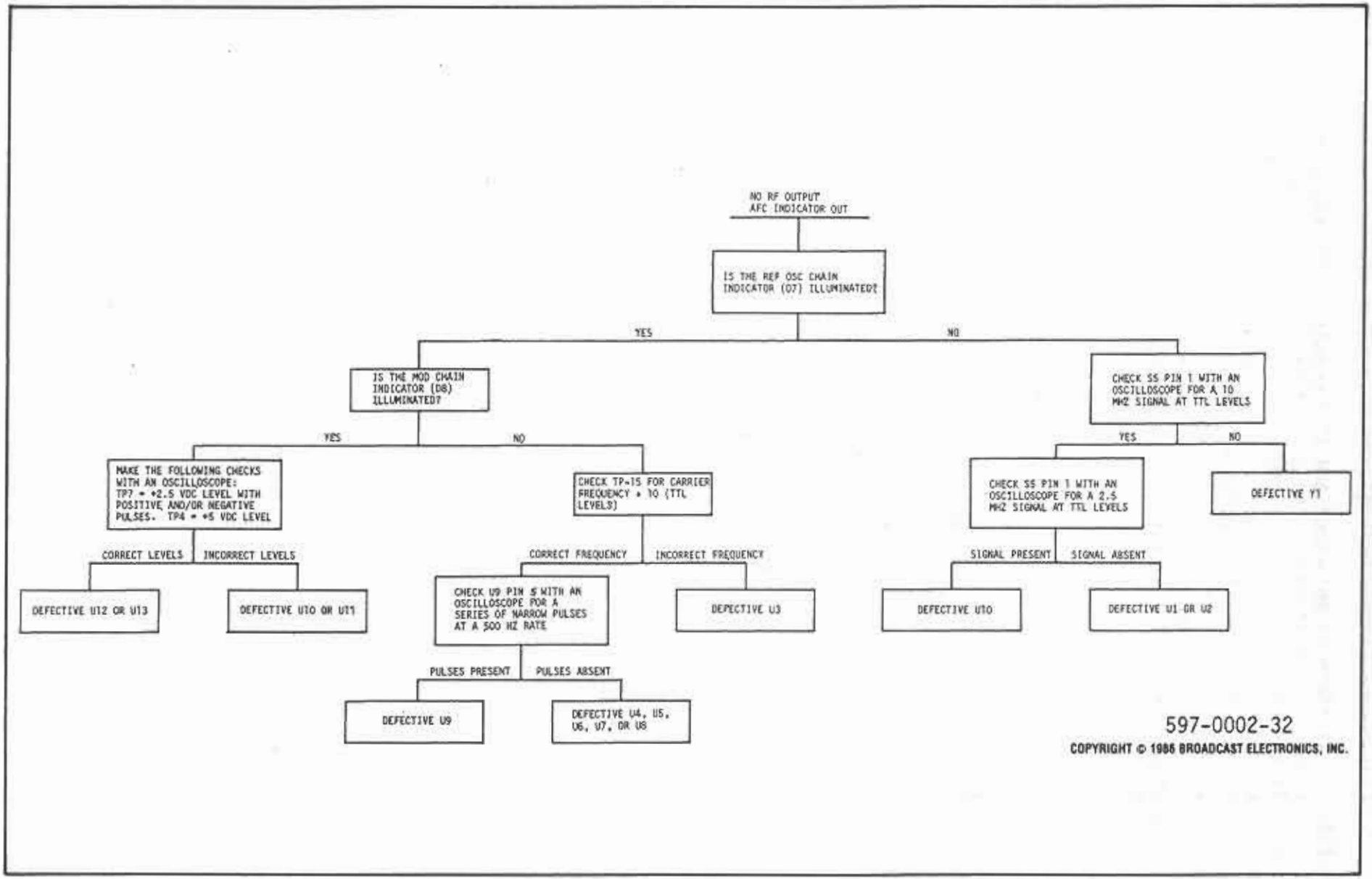


FIGURE 4-3. NO RF OUTPUT - AFC INDICATOR OUT

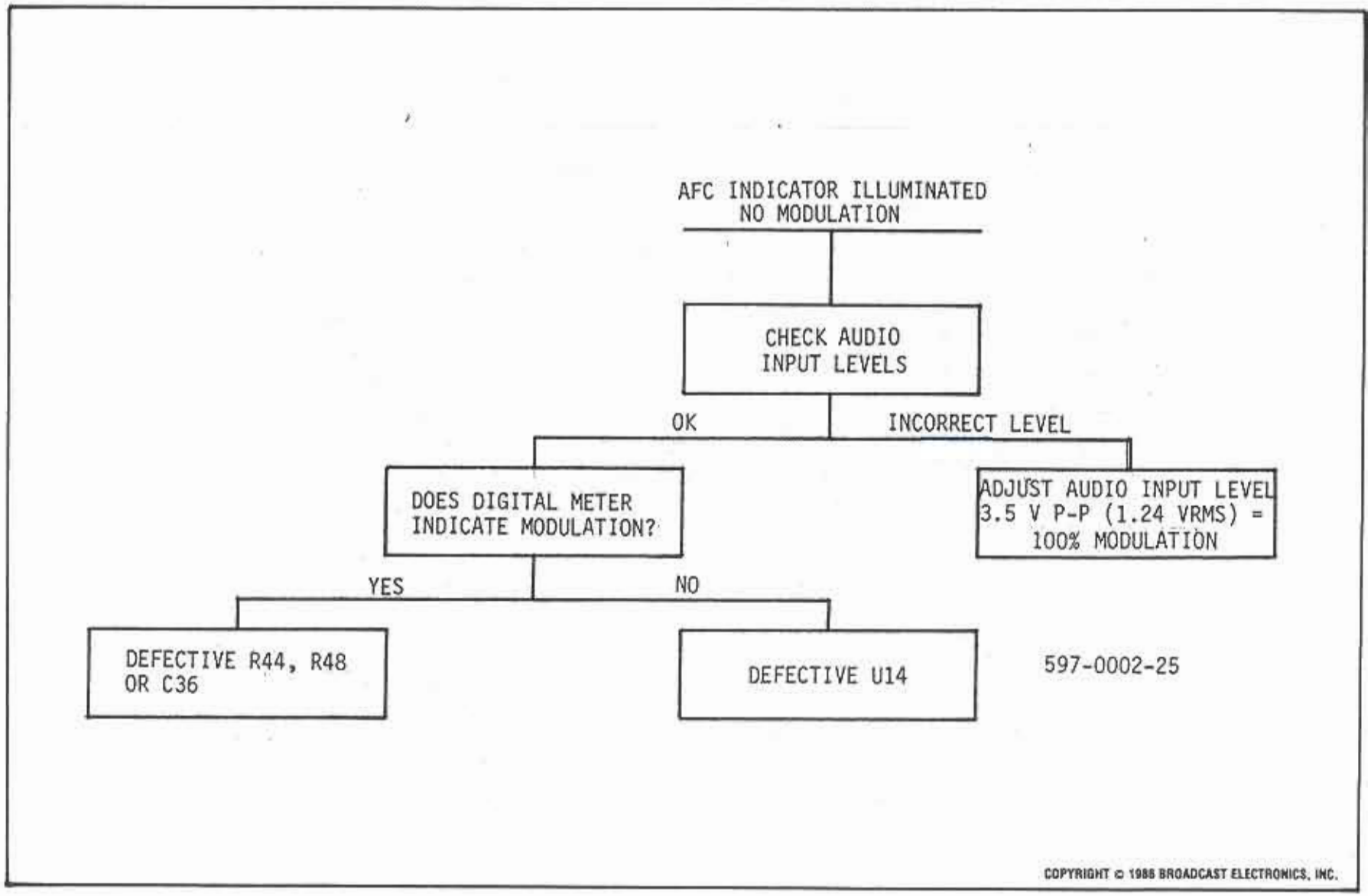


FIGURE 4-4. AFC INDICATOR ILLUMINATED - NO MODULATION

5-8. On a regular basis, the exciter should be cleaned of accumulated dust using a brush and vacuum cleaner. The concave sides of the fan impeller blades should be cleaned as these blades will collect dust. As material build up, airflow from the fan will decrease and damage to the fan will eventually result. Check for overheated components, tighten loose hardware, and lubricate mechanical surfaces (such as the slide rails) as required.

5-9. SECOND LEVEL MAINTENANCE.

5-10. Second level maintenance consists of procedures required to restore the FX-30 Exciter to satisfactory operation after a fault has occurred.

5-11. The maintenance philosophy of the FX-30 FM Exciter consists of problem isolation to a specific assembly. Subsequent troubleshooting is provided by each applicable assembly publication in Part II of this manual to isolate specific components. If desired, the entire assembly may be returned to the factory for repair or exchange.

5-12. ADJUSTMENTS.

5-13. Adjustment procedures for all controls on all circuit boards are provided by each applicable assembly publication in Part II of this manual.

5-14. TROUBLESHOOTING.

5-15. Most troubleshooting consists of visual checks. Because of the voltages and high dc currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various exciter indicators (meters, LED's, and fuses) should be used to isolate the malfunction to a specific area as listed below. Typical meter indications are presented in Table 5-1 and exciter power demand requirements are listed in Table 5-2.

A. Exciter Input
B. Power Supply
C. Metering Circuit
D. Modulated Oscillator
E. AFC/PLL Assembly
F. RF Amplifier
G. Control Circuit
H. Exciter Output

WARNING: DISCONNECT POWER PRIOR TO SERVICING

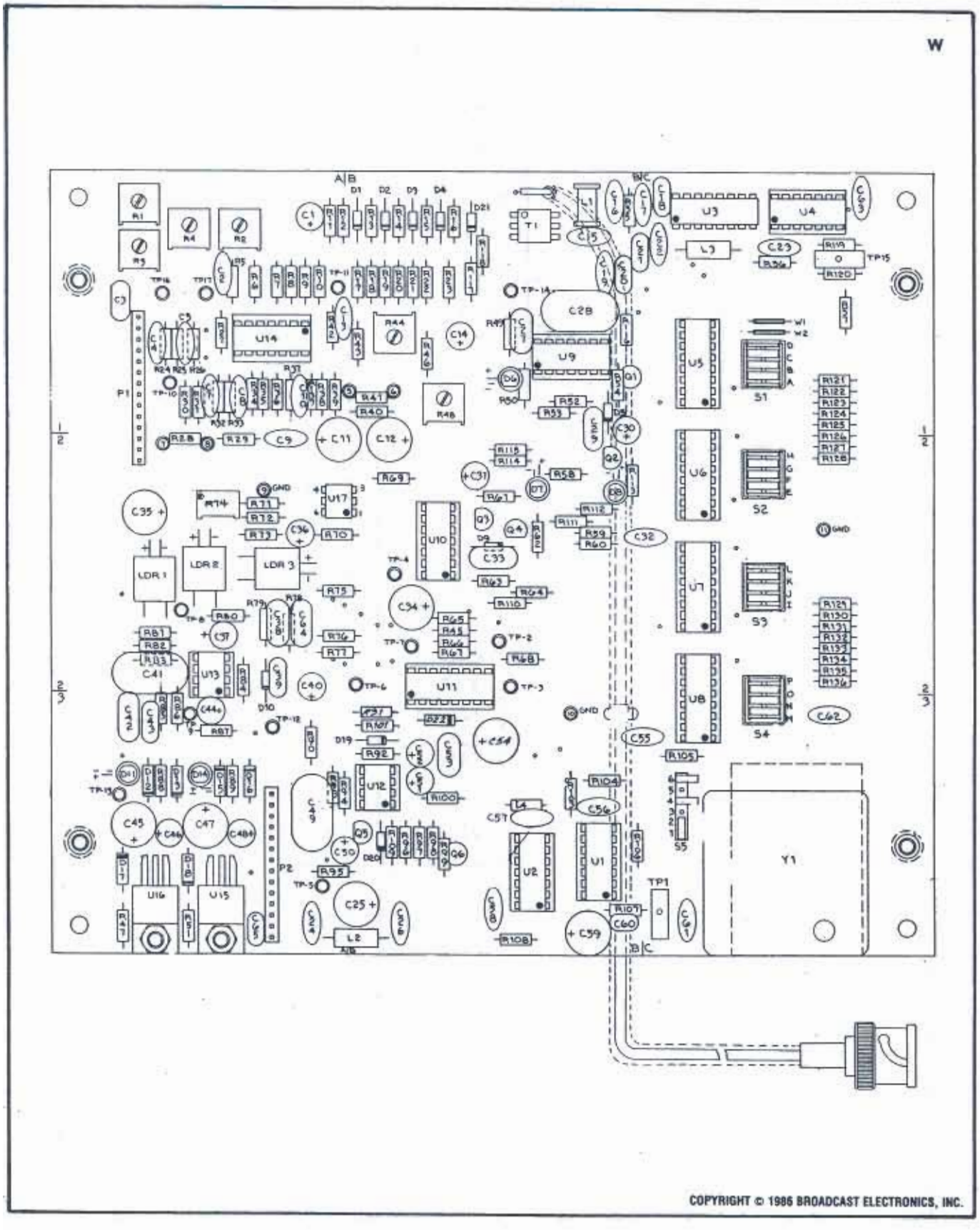
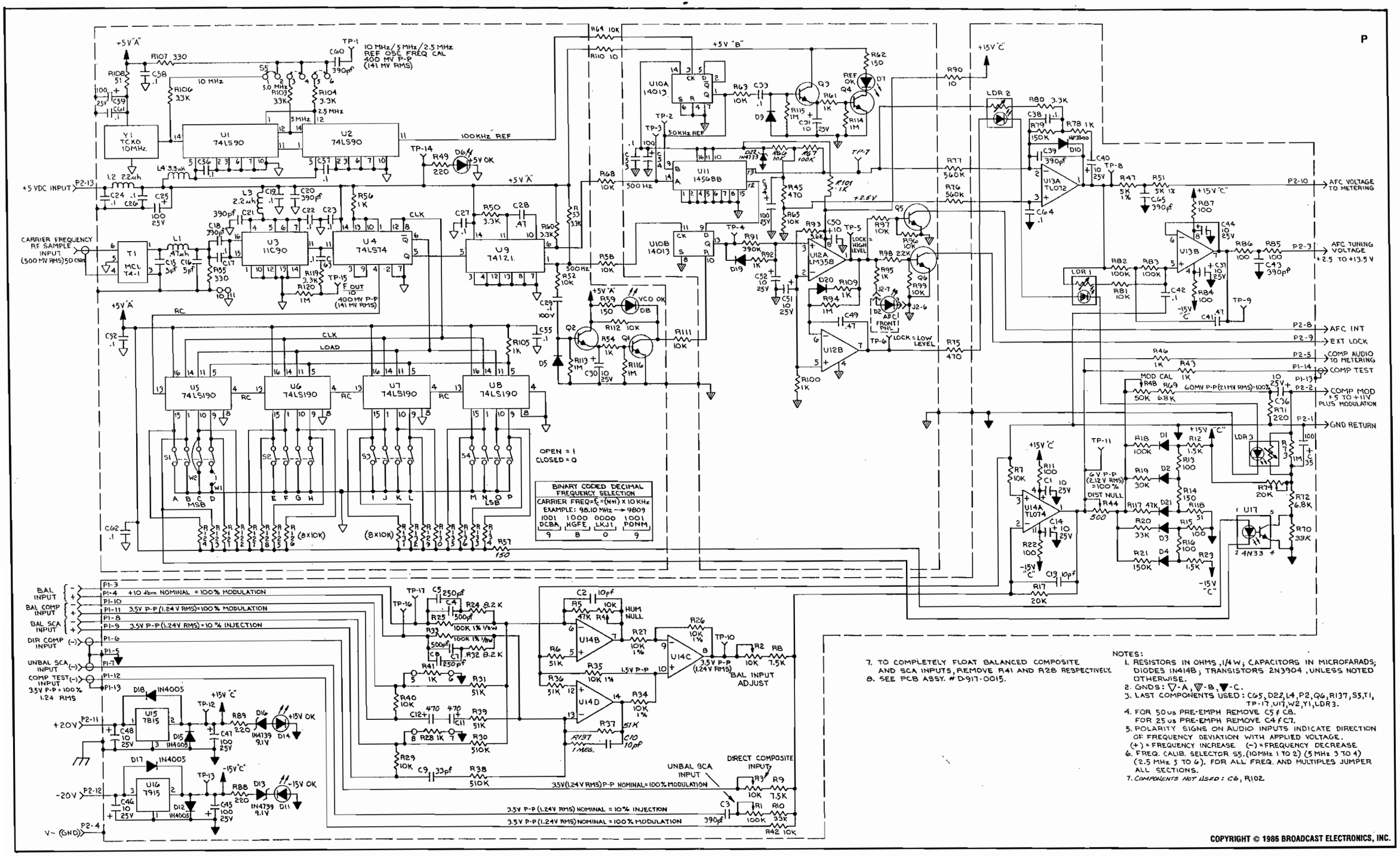


FIGURE 4-5. AFC/PLL ASSEMBLY D917-0015



7. TO COMPLETELY FLOAT BALANCED COMPOSITE AND SCA INPUTS, REMOVE R41 AND R28 RESPECTIVELY.
8. SEE PCB ASSY. # D-917-0015.

NOTES:
1. RESISTORS IN OHMS, 1/4 W; CAPACITORS IN MICROFARADS; DIODES IN4148; TRANSISTORS 2N3904, UNLESS NOTED OTHERWISE.
2. GNDS: ▽-A, ▽-B, ▼-C.
3. LAST COMPONENTS USED: C65, D22, L4, P2, Q6, R137, S5, T1, TP-17, U17, W2, Y1, LDR3.
4. FOR 50 us PRE-EMPH REMOVE C5 & C8. FOR 25 us PRE-EMPH REMOVE C4 & C7.
5. POLARITY SIGNS ON AUDIO INPUTS INDICATE DIRECTION OF FREQUENCY DEVIATION WITH APPLIED VOLTAGE. (+) = FREQUENCY INCREASE. (-) = FREQUENCY DECREASE.
6. FREQ. CALIB. SELECTOR S5. (10MHz 1 TO 2) (5 MHz 3 TO 4) (2.5 MHz 5 TO 6). FOR ALL FREQ. AND MULTIPLES JUMPER ALL SECTIONS.
7. COMPONENTS NOT USED: C6, R102.

FIGURE 4-6.
AFC/PLL ASSEMBLY SCHEMATIC DIAGRAM
D909-0015

SECTION V

REPLACEMENT PARTS

5-1. INTRODUCTION.

5-2. This section provides replacement parts list for the FX-30 FM Exciter AFC/PLL Assembly as indexed below.

TABLE	TITLE	NUMBER	PAGE
5-1	AFC/PLL ASSEMBLY	917-0015	33
5-2	CABLE ASSEMBLY, AFC/PLL CIRCUIT BOARD	949-0133	38

TABLE 5-1. AFC/PLL CIRCUIT BOARD ASSEMBLY - 917-0015
(Sheet 1 of 6)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C2	Capacitor, Ceramic Disc, 10 pF ±10%, 1 kV, NPO	001-1014	1
C3	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C4	Capacitor, Mica, 500 pF ±1%, 500V	042-5021	1
C5	Capacitor, Mica, 250 pF ±1%, 500V	042-2521	1
C6	Capacitor, Ceramic Disc, 10 pF ±10%, 1 kV, NPO	001-1014	1
C7	Capacitor, Mica, 500 pF ±1%, 500V	042-5021	1
C8	Capacitor, Mica, 250 pF ±1%, 500V	042-2521	1
C9	Capacitor, Mica, 33 pF ±5%, 500V	042-3312	1
C10	Capacitor, Ceramic Disc, 10 pF ±10%, 1 kV, NPO	001-1014	1
C11,C12	Capacitor, Electrolytic, 470 uF, 6.3V	021-0002	2
C13	Capacitor, Ceramic Disc, 10 pF ±10%, 1 kV, NPO	001-1014	1
C14	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C15,C16	Capacitor, Ceramic Disc, 5 pF, 500V	001-5004	2
C17	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	1
C18	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C19	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	1
C20,C21	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C22 THRU C24	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	3
C25	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C26	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	1
C27	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C28	Capacitor, Polyester, 0.47 uF, 100V	038-4753	1
C29	Capacitor, Ceramic Disc, 0.1 uF, 100V	030-1053	1
C30,C31	Capacitor, Electrolytic, 10 uF, 25V	023-1076	2

TABLE 5-1. AFC/PLL CIRCUIT BOARD ASSEMBLY - 917-0015
(Sheet 2 of 6)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C32	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	1
C33	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C34,C35	Capacitor, Electrolytic, 100 uF, 25V	023-1084	2
C36,C37	Capacitor, Electrolytic, 10 uF, 25V	023-1076	2
C38	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C39	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C40	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C41	Capacitor, Polyester, 0.47 uF, 100V	038-4753	1
C42	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C43	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C44	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C45	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C46	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C47	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C48	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C49	Capacitor, Polyester, 0.47 uF, 100V	038-4753	1
C50 THRU C52	Capacitor, Electrolytic, 10 uF, 25V	023-1076	3
C53	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C54	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C55 THRU C58	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	4
C59	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C60	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C61 THRU C63	Capacitor, Ceramic Disc, 0.1 uF +80% -20%, 10V	000-1055	3
C64	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C65	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1 THRU D5	Diode, Silicon, Switching, 1N4148, 100V, 10 mA	203-4148	5
D6 THRU D8	Indicator, LED, Green, 521-9176, 3V, 20 mA	323-9224	3
D9	Diode, Silicon, Switching, 1N4148, 100V, 10 mA	203-4148	2
D10	Diode, HP5082-2800, High Voltage, Schottky Barrier Type, 70V, 15 mA	201-2800	1
D11	Indicator, LED, Green, 521-9176, 3V, 20 mA	323-9224	1
D12	Diode, Silicon, Rectifier, 1N4005, 600V, 1A	203-4005	1
D13	Diode, Zener, 1N4739A, 9.1V ±10%, 1W	200-0009	1
D14	Indicator, LED, Green, 521-9176, 3V, 20 mA	323-9224	1
D15	Diode, Silicon, Rectifier, 1N4005, 600V, 1A	203-4005	1
D16	Diode, Zener, 1N4739A, 9.1V ±10%, 1W	200-0009	1
D17,D18	Diode, Silicon, Rectifier, 1N4005, 600V, 1A	203-4005	2
D19 THRU D21	Diode, Silicon, Switching, 1N4148, 100V, 10 mA	203-4148	3
D22	Diode, Zener, 1N4733A, 5.1V ±10%, 1W	200-4733	1
L1	Coil, 0.47 uH, Molded	364-0047	1
L2,L3	Coil, 2.2 uH, Molded	364-2200	2
L4	RF Choke, 3.3 uH ±10%, 0.85 Ohms DC Resistance,	360-3300	1
LDR1 THRU	Optical Isolator, VTL5C2, LDR/LED Type	323-7345	3

TABLE 5-1. AFC/PLL CIRCUIT BOARD ASSEMBLY - 917-0015
(Sheet 3 of 6)

REF. DES.	DESCRIPTION	PART NO.	QTY.
LDR3	On Resistance: 500 Ohms Off Resistance: 1 Meg Ohm Cell Voltage: 200V Maximum Cell Current: 10 to 40 mA		
P1,P2	Connector, Header, 14-Pin	417-0140	2
Q1 THRU Q6	Transistor, Silicon, 2N3904, NPN, TO-92 Case	211-3904	6
R1	Potentiometer, 100 k Ohm ±10%, 1/2W	177-1064	1
R2 THRU R4	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	3
R5	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R6	Resistor, 51 k Ohm ±5%, 1/4W	100-5152	1
R7	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R8,R9	Resistor, 7.5 k Ohm ±5%, 1/4W	100-7543	2
R10	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R11	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R12	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R13	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R14	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R15,R16	Resistor, 100 Ohm ±5%, 1/4W	100-1033	2
R17	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	1
R18	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R19	Resistor, 30 k Ohm ±5%, 1/4W	100-3053	1
R20	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R21	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R22	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R23	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R24	Resistor, 8.2 k Ohm ±5%, 1/4W	100-8243	1
R25	Resistor, 100 k Ohm ±1%, 1/8W	103-1061	1
R26,R27	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R28	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R29	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R30	Resistor, 510 k Ohm ±5%, 1/4W	100-5163	1
R31	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R32	Resistor, 8.2 k Ohm ±5%, 1/4W	100-8243	1
R33	Resistor, 100 k Ohm ±1%, 1/8W	103-1061	1
R34,R35	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R36,R37	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	2
R38	Resistor, 510 k Ohm ±5%, 1/4W	100-5163	1
R39	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R40	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R41	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R42	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R43	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R44	Potentiometer, 500 Ohm ±10%, 1/2W	177-5032	1
R45	Resistor, 470 Ohm ±5%, 1/4W	100-4733	1
R46	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R47	Resistor, 5 k Ohm ±1%, 1/4W	100-5041	1
R48	Potentiometer, 50 k Ohm ±20%, 1/2W	177-5054	1
R49	Resistor, 220 Ohm ±5%, 1/4W	100-2233	1

TABLE 5-1. AFC/PLL CIRCUIT BOARD ASSEMBLY - 917-0015
(Sheet 4 of 6)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R50	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R51	Resistor, 5 k Ohm ±1%, 1/4W	100-5041	1
R52	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R53	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R54	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R55	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R56	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R57	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R58	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R59	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R60	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R61	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R62	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R63 THRU R66	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	4
R67	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R68	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R69	Resistor, 6.8 k Ohm ±5%, 1/4W	100-6843	1
R70	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R71	Resistor, 220 Ohm ±5%, 1/4W	100-2233	1
R72	Resistor, 6.8 k Ohm ±5%, 1/4W	100-6843	1
R73	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R74	Potentiometer, 20 k Ohm ±10%, 1/2W	178-2055	1
R75	Resistor, 470 Ohm ±5%, 1/4W	100-4733	1
R76,R77	Resistor, 560 k Ohm ±5%, 1/4W	100-5663	2
R78	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R79	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R80	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R81	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R82,R83	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R84 THRU R87	Resistor, 100 Ohm ±5%, 1/4W	100-1033	4
R88,R89	Resistor, 220 Ohm ±5%, 1/4Q	100-2233	2
R90	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R91	Resistor, 390 k Ohm ±5%, 1/4W	100-3963	1
R92	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R93	Resistor, 5.6 k Ohm ±5%, 1/4W	100-5643	1
R94	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R95	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R96,R97	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R98	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R99	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R100,R101	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R103,R104	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	2
R105	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R106	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R107	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1

TABLE 5-1. AFC/PLL CIRCUIT BOARD ASSEMBLY - 917-0015
(Sheet 5 of 6)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R108	Resistor, 51 Ohm ±5%, 1/4W	100-5123	1
R109	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R110	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R111,R112	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R113 THRU R116	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	4
R117	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R118	Resistor, 51 Ohm ±5%, 1/4W	100-5123	1
R119	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R120	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R121 THRU R136	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	16
S1 THRU S4	Header, Programmable, 8-Pin DIP	340-0006	4
S5	Connector, Header, 6-Pin	417-0006-1	1
T1	RF Transformer, 0.2 to 350 MHz, 50/75 Ohm to 200/300 Ohm CT Winding	370-0002	1
TP1,TP15	Test Point, Plastic	417-0004	2
U1,U2	Integrated Circuit, 74LS90N, Decade Counter, TTL Type, 14-Pin DIP	228-0290	2
U3	Integrated Circuit, 11C90, ECL Type, Divide by 10/11 Counter, 16-Pin DIP	228-1190	1
U4	Integrated Circuit, 74LS74N, Dual-D Type Flip-Flop, 14-Pin DIP	228-0074	1
U5 THRU U8	Integrated Circuit, 74LS190N, Decade Counter, TTL Type, 14-Pin DIP	228-2190	4
U9	Integrated Circuit, 74121N, Mono-Stable Multivibrator, Schmitt Trigger Input, TTL Type, 14-Pin DIP	228-2121	1
U10	Integrated Circuit, MC14013B, Dual-D Type, Flip-Flop, 14-Pin DIP	228-4013	1
U11	Integrated Circuit, MC14568B, Programmable Divider, 14-Pin DIP	228-4568	1
U12	Integrated Circuit, LM358N, Low-Power Dual Operational Amplifier, 8-Pin DIP	221-0358	1
U13	Integrated Circuit, TL072, Dual Bifet Operational Amplifier, 8-Pin DIP	221-0072	1
U14	Integrated Circuit, TL074CN, Bipolar JFET Type, Quad-Input Operational Amplifier, 14-Pin DIP	221-0074	1
U15	Integrated Circuit, uA7815C, Fixed Positive, Voltage Regulator, 15V, 1.5A, TO-220 Case	227-7815C	1
U16	Integrated Circuit, uA7915C, Fixed Negative, Voltage Regulator, 15V, 1.5A, TO-220 Case	227-7915C	1
U17	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, 6-Pin DIP	229-0033	1
XS1 THRU XS4	Socket, 8-Pin DIP	417-0804	4

TABLE 5-1. AFC/PLL CIRCUIT BOARD ASSEMBLY - 917-0015
(Sheet 6 of 6)

REF. DES.	DESCRIPTION	PART NO.	QTY.
XU1,XU2, XU4	Socket, 14-Pin DIP	417-1404	3
XU5 THRU XU8	Socket, 16-Pin DIP	417-1604	4
XU9,XU10	Socket, 14-Pin DIP	417-1404	2
XU11	Socekt, 16-Pin DIP	417-1604	1
XU12,XU13	Socket, 8-Pin DIP	417-0804	2
XU14	Socket, 14-Pin DIP	417-1404	1
Y1	Oscillator, Crystal, TCXO, 10 MHz ±3 PPM, Ø°C to 50°C, Input: +5V dc, Output: TTL Compatible	390-0001	1
----	Test Probe	415-1011	1
----	Cable Assembly, AFC/PLL Circuit Board	949-0133	1
----	Programmable Jumpers (for S5)	340-0004	3
----	Blank Circuit Board	517-0015	1

TABLE 5-2. CABLE ASSEMBLY, AFC/PLL CIRCUIT BOARD - 949-0133

REF. DES.	DESCRIPTION	PART NO.	QTY.
P3	Plug, BNC	418-0034	1

RF AMPLIFIER

TABLE OF CONTENTS

SECTION I

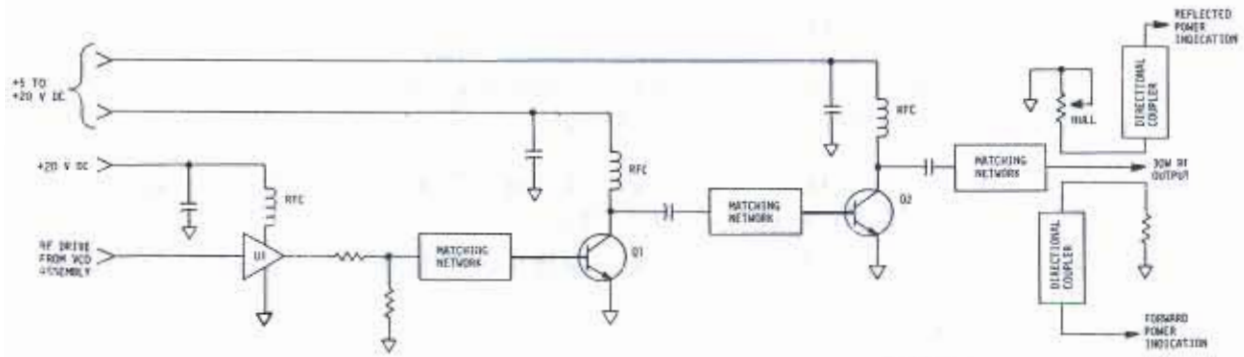
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section provides general information and specifications relative to the operation of the RF amplifier assembly.

1-3. EQUIPMENT PURPOSE.

1-4. The RF amplifier assembly comprises three stages of amplification designed to increase the low-level RF signal input from the modulated oscillator to an adjustable level of 3 to 30 watts as required to drive an associated transmitter. Directional coupler sensing lines on the printed circuit board allow both forward and reflected power outputs to monitor and control amplifier operation.



597-0002-4

FIGURE 1-1. BLOCK DIAGRAM

1-5. ELECTRICAL CHARACTERISTICS.

1-6. Refer to Table 1-1 for electrical characteristics relative to the RF amplifier assembly.

TABLE 1-1. ELECTRICAL CHARACTERISTICS

PARAMETER	CHARACTERISTIC
POWER REQUIREMENTS: U1	+20V dc at 0.275 Amperes
Q1	+5 to +20V dc at 0.8 Amperes
Q2	+5 to +20V dc at 3.15 Amperes
SIGNAL INPUT	1.0V p-p RF at 50 Ohms
SIGNAL OUTPUT	3 to 30 Watts RF at 50 Ohms (adjustable)
DIRECTIONAL COUPLER OUTPUTS (30 Watts RF): FORWARD	1.5V dc, approximate
REFLECTED	Less than 1V dc

SECTION II
REMOVAL AND INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides removal and installation instructions for the RF amplifier assembly.

2-3. REMOVAL PROCEDURE.

WARNING — ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING RF AMPLIFIER ASSEMBLY REMOVAL. WARNING

2-4. EQUIPMENT REQUIRED.

2-5. The following equipment is required to remove the RF amplifier assembly from the exciter chassis:

A. Flat tip screwdriver, 4 inch (10.16 cm) blade and 1/4 inch (0.635 cm) tip.

B. Number 2 Phillips screwdriver, 4 inch (10.16 cm) blade.

2-6. PROCEDURE.

2-7. Disconnect primary ac power.

2-8. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-9. Unplug connector P1 from J1 on the top of the RF amplifier assembly power and control cable.

2-10. Unplug connector P2 from J2 on the top front of the RF amplifier assembly (RF input).

2-11. Unplug connector P3 from J4 on the rear of the RF amplifier assembly (RF output).

2-12. Remove the six Phillips head screws beneath the exciter securing the RF amplifier assembly to the chassis.

2-13. Remove the RF amplifier assembly from the exciter.

2-14. INSTALLATION PROCEDURE.

WARNING — ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING RF AMPLIFIER ASSEMBLY INSTALLATION. WARNING

2-15. Reverse the removal procedure sequence.

SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. The following text provides detailed theory of operation with supporting diagrams for the FX-30 FM exciter RF amplifier assembly. For purposes of definition, the text is divided into functional circuits.

3-3. RF AMPLIFIER ASSEMBLY.

3-4. The RF amplifier assembly mounts the RF amplifier circuit board as a sub-assembly, the RF amplifier regulator transistor and the exciter +20 volt dc bus regulator. All wiring to the assembly connects to the exciter wiring through plugs and jacks to simplify removal and installation. A fan ensures cool amplifier operation for long life.

3-5. RF AMPLIFIER CIRCUIT BOARD.

5

3-6. The RF amplifier is a broadband micro-stripline amplifier covering the FM broadcast band with a nominal output power of 30 watts. By adjusting the controller voltages of the RF transistors, the RF power is variable over a range of 3 to 30 watts. Tuning of the three-stage amplifier is not required.

3-7. The dc power and directional coupler outputs are connected from the circuit board through the chassis with feed through capacitors to prevent RF interference. All circuit board wiring connects from the circuit board to the amplifier assembly through plugs to aid in maintenance.

3-8. INPUT AMPLIFIER. The voltage controlled oscillator assembly inputs 10 mW of drive to the 50 Ohm input of hybrid amplifier U1 (refer to Figure 3-1). This device provides a typical gain of 34 dB to output approximately 1 watt of RF drive which is applied across a resistive pad consisting of R1 and R2. The output of the pad provides approximately 800 mW of RF drive to the following stage.

3-9. Power. Amplifier U1 operates from a dc potential of +20 volts at 275 milliamperes. Power supply isolation is provided by C1, C3, C6, and L1.

3-10. DRIVER AMPLIFIER. The matching network between U1 and Q1 converts the 50 Ohm output of U1 to the low input impedance required by the base circuit of Q1. The output of Q1 provides approximately 8 watts of RF drive to power amplifier stage Q2. A dc return path for Q1 is provided by L3. Resistor R3 ensures stable driver amplifier operation.

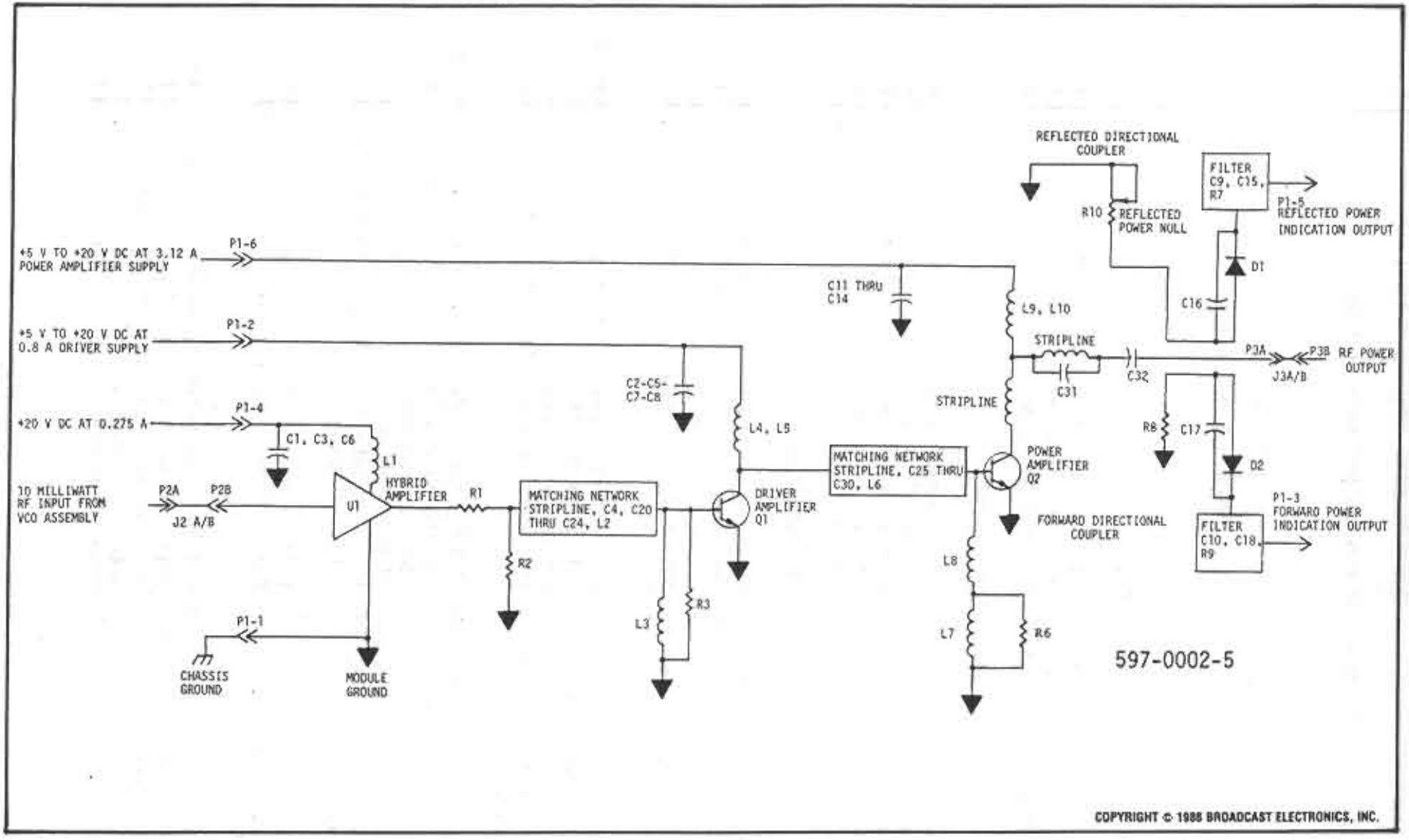


FIGURE 3-1. SIMPLIFIED SCHEMATIC

3-11. Power. Driver amplifier Q1 operates from an adjustable dc potential of +5 to +20 volts at 800 mA maximum from pass transistor Q3 on the RF amplifier heat sink assembly. This adjustable potential is preset by circuitry on the control circuit assembly and is automatically maintained by feedback from the forward power directional coupler. Power supply isolation is provided by C2, C5, C7, L4, and L5.

3-12. POWER AMPLIFIER. The matching network between Q1 and Q2 converts the 25 Ohm output impedance of Q1 to the low input impedance required by the base circuit of Q2. A dc return path for Q2 is provided by L7 and L8. Resistor R6 ensures stable power amplifier stage operation.

3-13. The collector of Q2 feeds a stripline section which acts as a broadband impedance step-up transformer to establish a stage output impedance of 50 Ohms. Capacitor C31 shunts a portion of the predominately inductive stripline in the RF output circuit to create a second harmonic notch filter near the center of the FM broadcast band. Capacitor C32 functions as a dc blocking capacitor.

3-14. Power. Power amplifier Q2 is fed in parallel from the same adjustable dc potential as driver amplifier Q1 at a current of 3.4 amperes, maximum. The collector voltage is automatically maintained at a preset level to ensure RF output remains constant. Power supply isolation is provided by C11 through C14, L9, and L10.

3-15. DIRECTIONAL COUPLER. The directional coupler provides two dc signals, each signal obtained by rectifying a portion of the RF output signal, inductively coupled from a transmission line section etched onto the circuit board. Due to the polarity of the two samples, one signal will be proportionate to the forward traveling RF wave and the other signal will be proportionate to the reflected traveling RF wave.

3-16. Forward Port. The forward port of the directional coupler is broadbanded across the entire FM broadcast band by capacitor C17. The voltage sample obtained is rectified by diode D2 and filtered by a PI section filter. This output is routed to the control circuit to maintain the exciter RF power output level and the metering circuit for display.

3-17. Reflected Port. The reflected port of the directional coupler is broadbanded across the entire FM broadcast band by capacitors C16 and C19. The voltage sample obtained is rectified by diode D1 and filtered by a PI section filter. This output is routed to the control circuit to prevent damage to the RF amplifier stage from a high VSWR condition and is routed to the metering circuit for display.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section provides maintenance information for the RF amplifier assembly.

4-3. MAINTENANCE.

4-4. ADJUSTMENTS.

4-5. The following controls affect operation of the RF amplifier but are located remotely from the actual RF amplifier assembly. The adjustment procedure for each control is presented in the control assembly portion of this manual.

A. TEMP TRIP (R1)
B. RFL CAL (R2)
C. FWD CAL (R3)
D. TEMP CAL (R5)

4-6. DIRECTIONAL COUPLER REFLECTED POWER NULL (R10). This control is factory calibrated and sealed during final test. Adjustment in the field is not normally required unless repairs have been made to the directional coupler circuitry. If adjustment is required, proceed as follows.

4-7. Required Equipment. The following equipment is required to complete the directional coupler reflected power null control adjustment procedure:

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).
B. Non-inductive, 25 watt, 50 Ohm test load (P/N 829-8080).
C. Adapter, BNC jack to type N plug, for test load (P/N 417-3288).
D. Adapter, type N jack to jack, for test load (P/N 417-3841).
E. Coaxial Accessory Cable, BNC connectors, shipped with exciter (P/N 947-0017-2).

4-8. Procedure. To adjust the directional coupler reflected power null control (R10), proceed as follows.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

A. Disconnect primary ac power.

B. Remove the hole plug from the right rear top of the RF amplifier assembly.

C. Disconnect the transmitter load and connect a non-inductive, 25 watt, 50 Ohm test load to the exciter RF OUTPUT connector (items B, C, D, and E).

D. Depress the exciter RFL switch.

WARNING
WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

WARNING
WARNING
WARNING

DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED. EVEN THOUGH LOW VOLTAGES ARE USED THROUGHOUT THE EXCITER, IT IS POSSIBLE TO RECEIVE PAINFUL RF BURNS FROM THE RF AMPLIFIER.

CAUTION

ENSURE THE EXCITER IS OPERATED BELOW THE 25 WATT RATING OF THE TEST LOAD.

5

E. Connect ac power and operate the exciter.

F. Using the insulated tuning tool (item A) adjust R10 to obtain a minimum indication on the exciter multimeter.

WARNING

ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

G. Disconnect primary ac power.

H. Replace the hole plug in the top of the RF amplifier assembly.

I. Disconnect the test load and reconnect the exciter to the transmitter.

J. Check exciter operation.

4-9. TROUBLESHOOTING.

WARNING — TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING — USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-10. If difficulties are encountered and the RF amplifier assembly is suspected as faulty, the assembly inputs and outputs should be checked to isolate the malfunction (refer to Figure 4-1). If the unit is faulty, the fault may be isolated and repaired or the assembly may be returned to Broadcast Electronics, Inc. for repair or exchange.

4-11. The first step in troubleshooting should determine if the RF amplifier is actually at fault. A high VSWR condition or an over heating condition will cause the control circuit to limit RF output to prevent damage to the RF amplifier transistors; both conditions signaled by front panel indications. If the AFC circuit phase-locked-loop becomes unlocked (front panel indication) or an inhibit signal is received from the transmitter, RF output will be totally inhibited. Again, Figure 4-1 should be referenced as a troubleshooting guide.

4-12. The second step in troubleshooting should be to determine which stage of the amplifier is actually defective, and then to isolate the fault to a single component. Shorts or excessive current requirements may be localized with resistance measurements.

WARNING — BERYLLIUM OXIDE CERAMICS (BeO) - AVOID BREATHING DUST OR FUMES.

WARNING — THE WHITE CASE MATERIAL OF THE FX-30 RF AMPLIFIER TRANSISTORS IS MADE OF BeO CERAMIC MATERIAL. DO NOT PERFORM ANY OPERATION ON ANY BeO CERAMIC WHICH MIGHT PRODUCE DUST OR FUMES, SUCH AS GRINDING , GRIT BLASTING, OR ACID CLEANING. BERYLLIUM OXIDE DUST OR FUMES ARE HIGHLY TOXIC AND BREATHING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. BeO CERAMICS MUST BE DISPOSED OF ONLY IN A MANNER PRESCRIBED BY THE DEVICE MANUFACTURER. USE CARE IN REPLACING TRANSISTORS OF THIS TYPE.

4-13. Characteristically, the type of RF transistors used in the exciter can fail partially, but still operate to some extent. If the RF driver or RF power amplifier transistors are suspected as having inadequate gain, they must be replaced with new devices of the same identical type and manufacture as the original device. Figure 4-2 contains information relative to replacement of the exciter RF transistors.

4-14. DIAGRAMS.

4-15. The following diagrams are presented as aids to maintenance:

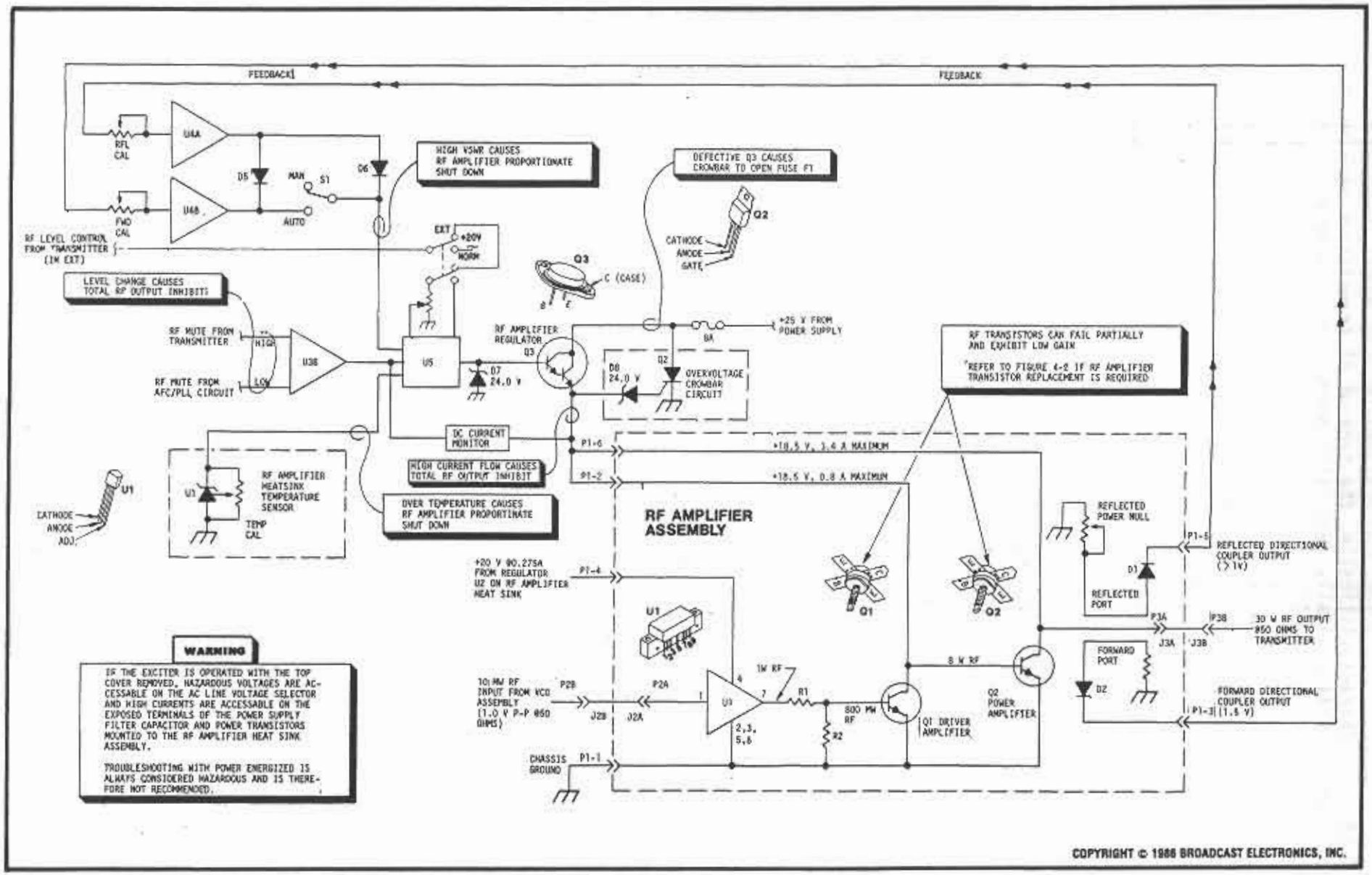
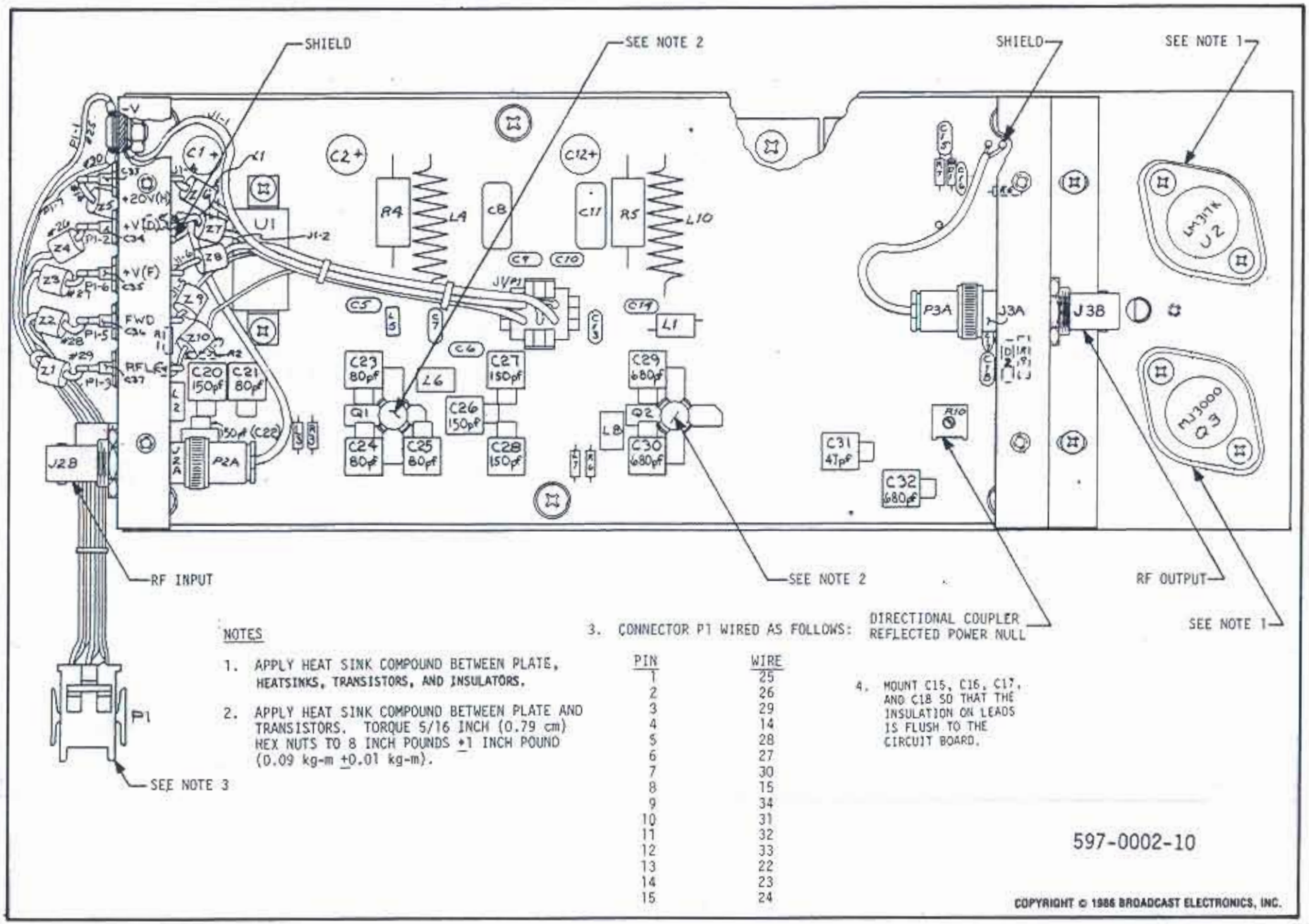


FIGURE 4-1. RF AMPLIFIER TROUBLESHOOTING



NOTES

1. APPLY HEAT SINK COMPOUND BETWEEN PLATE, HEATSINKS, TRANSISTORS, AND INSULATORS.
2. APPLY HEAT SINK COMPOUND BETWEEN PLATE AND TRANSISTORS. TORQUE 5/16 INCH (0.79 cm) HEX NUTS TO 8 INCH POUNDS ±1 INCH POUND (0.09 kg-m ±0.01 kg-m).
3. CONNECTOR P1 WIRED AS FOLLOWS:

PIN	WIRE
1	25
2	26
3	29
4	14
5	28
6	27
7	30
8	15
9	34
10	31
11	32
12	33
13	22
14	23
15	24

DIRECTIONAL COUPLER REFLECTED POWER NULL

4. MOUNT C15, C16, C17, AND C18 SO THAT THE INSULATION ON LEADS IS FLUSH TO THE CIRCUIT BOARD.

597-0002-10

FIGURE 4-2. RF AMPLIFIER ASSEMBLY, TOP VIEW

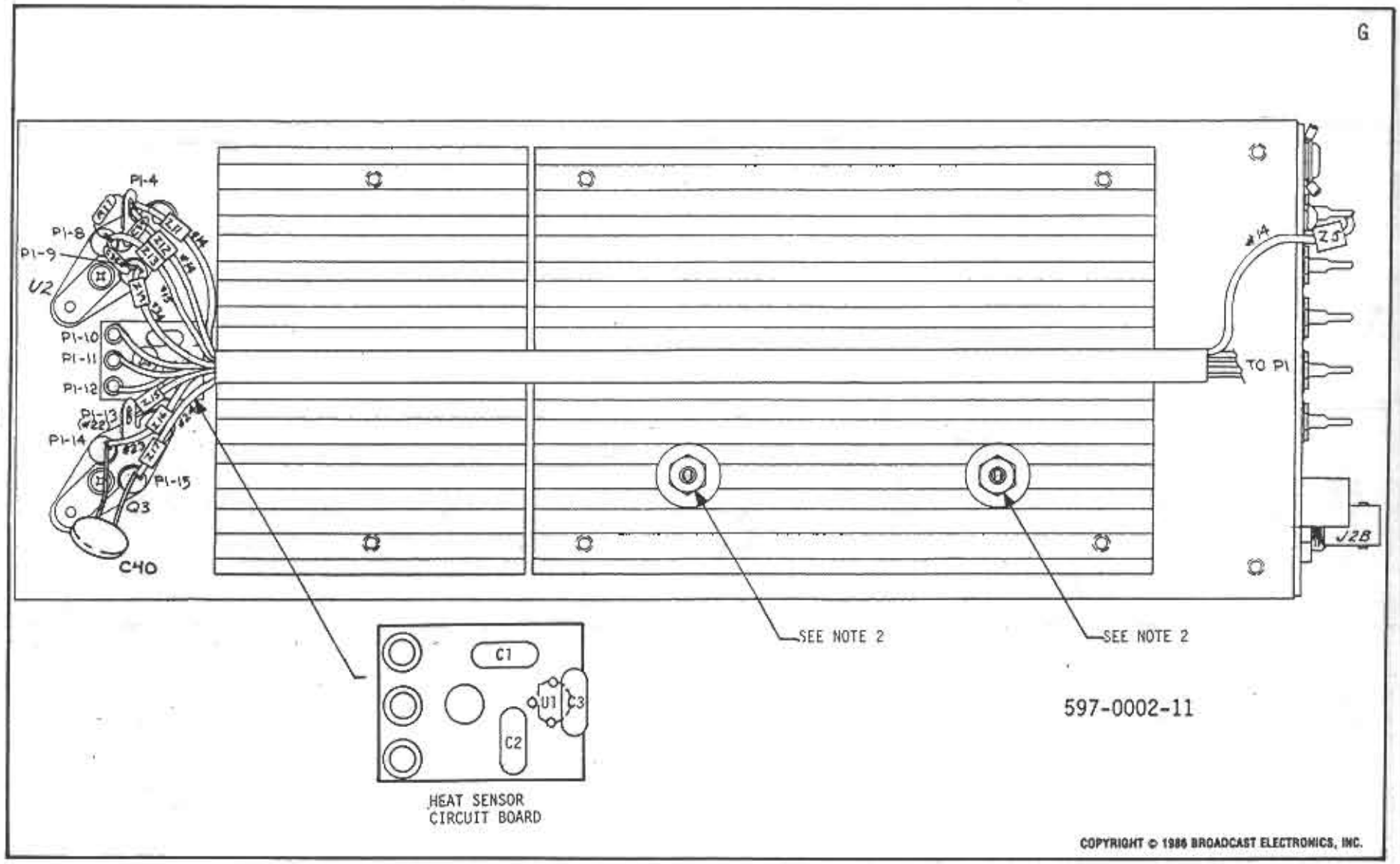


FIGURE 4-3. RF AMPLIFIER ASSEMBLY, BOTTOM VIEW

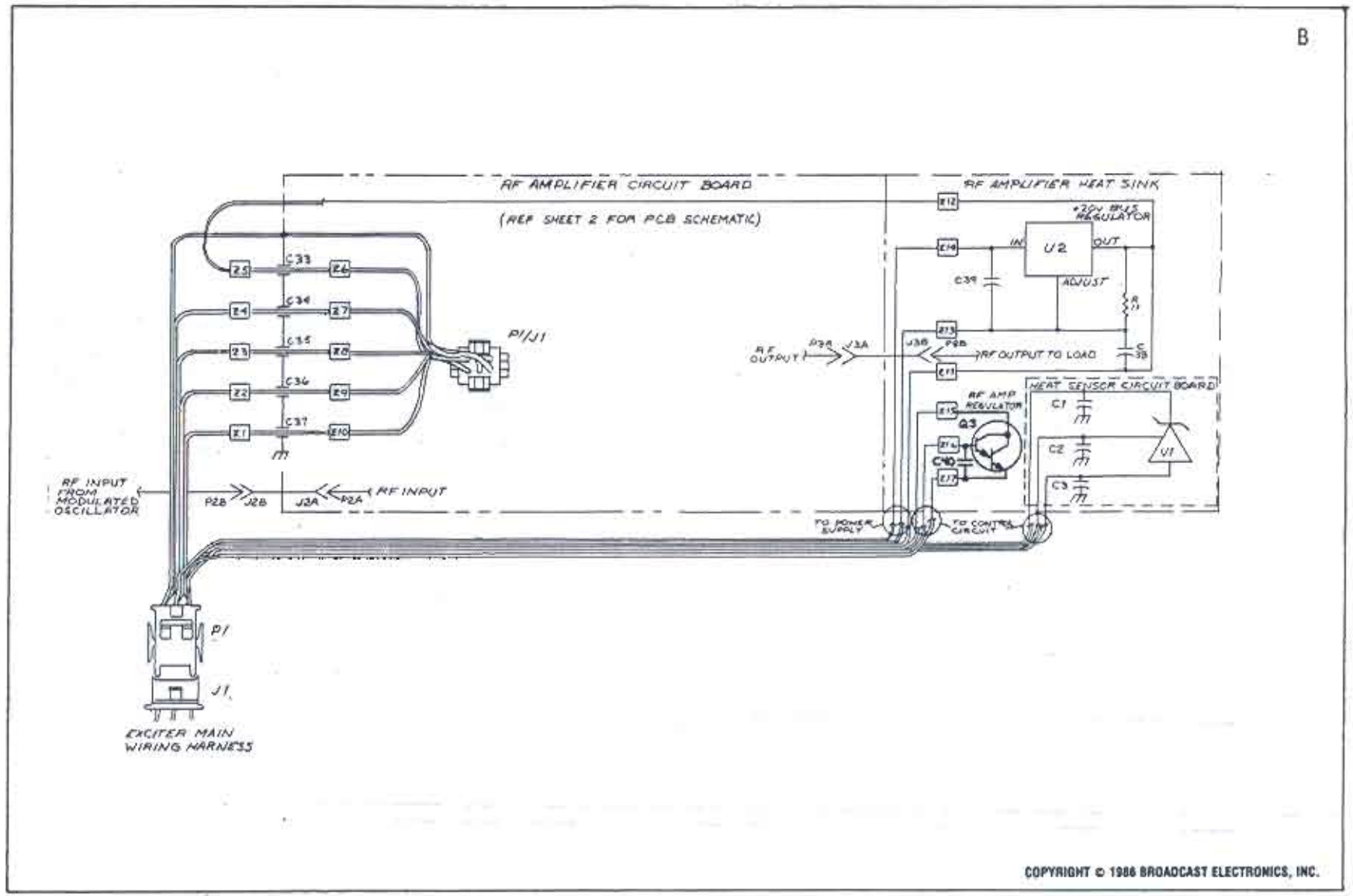


FIGURE 4-4. RF AMPLIFIER SCHEMATIC DIAGRAM C909-0025 (Sheet 1 of 2)

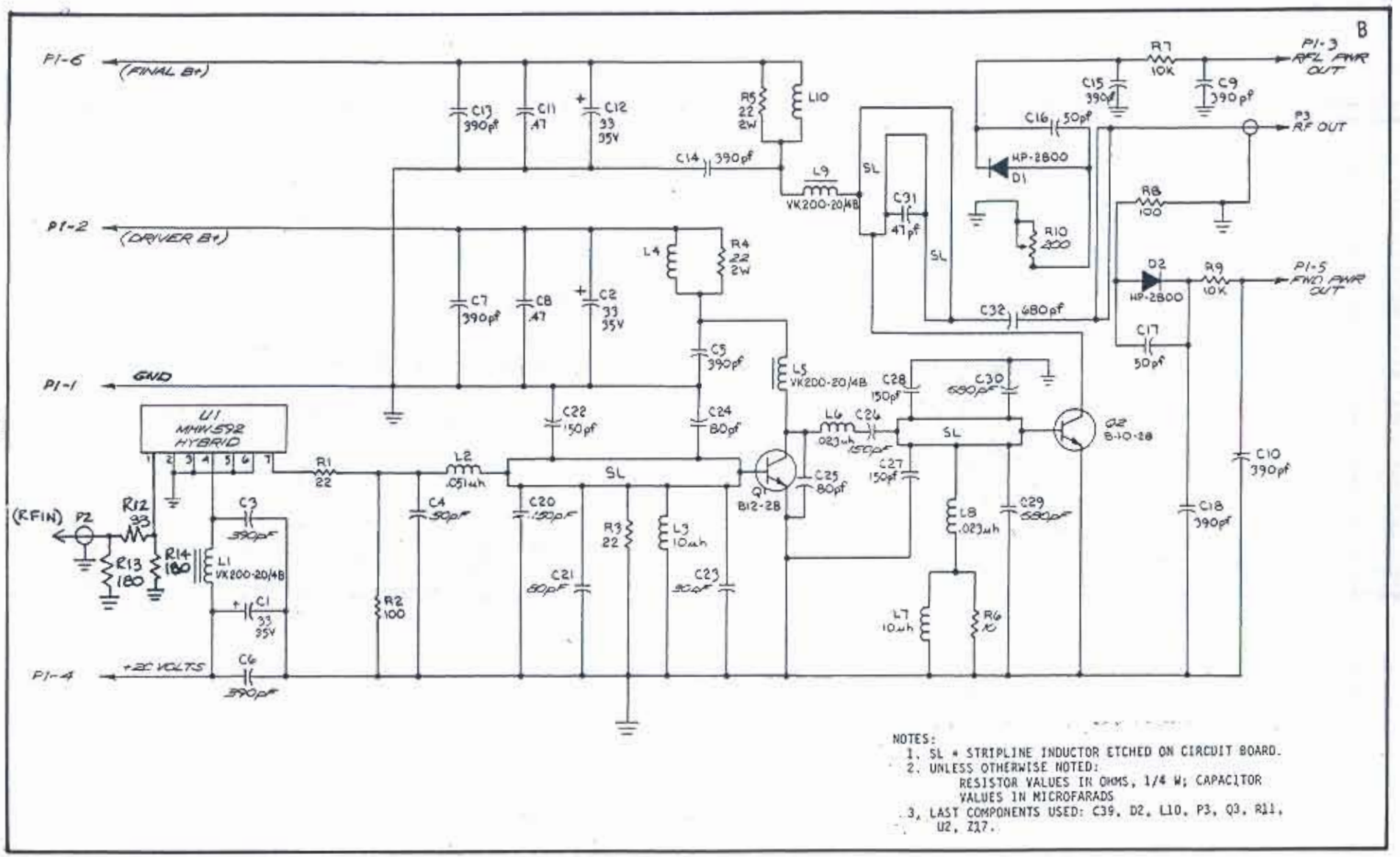


FIGURE 4-4. RF AMPLIFIER SCHEMATIC DIAGRAM - C909-0025 (Sheet 2 of 2)

SECTION V

REPLACEMENT PARTS

5-1. INTRODUCTION.

5-2. This section provides replacements parts lists for the FX-30 FM Exciter RF Amplifier Assembly as indexed below:

TABLE 5-1. RF AMPLIFIER ASSEMBLY - 955-0013
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C20	Capacitor, Mica, 150 pF ±10%, 350V	046-0005	1
C21	Capacitor, Mica, 80 pF ±10%, 350V	046-0003	1
C22	Capacitor, Mica, 150 pF ±10%, 350V	046-0005	1
C23 THRU C25	Capacitor, Mica, 80 pF ±10%, 350V	046-0003	3
C26 THRU C28	Capacitor, Mica, 150 pF ±10%, 350V	046-0005	3
C29,C30	Capacitor, Mica, 680 pF ±10%, 350V	046-0006	2
C31	Capacitor, Mica, 47 pF ±10%, 350V	046-0004	1
C32	Capacitor, Mica, 680 pF ±10%, 350V	046-0006	1
C33 THRU C37	Capacitor, Ceramic Feed Thru, 100 pF ±20%, 500V	008-1033	5
C38,C39	Capacitor, Ceramic, 0.01 uF, 25V	000-1044	2
C40	Capacitor, Mylar, 0.1 uF, 100V	030-1053	1
F1 Spare	Fuse, AGC, 250V, Fast Acting, 8 Ampere	330-0800	1
J2B,J3A	Receptacle, BNC	418-0011	2
P2,P3	Plug, BNC Bulkhead Disconnect	417-0017	2
Q1	RF Driver Transistor, CTC B12-28, Silicon, NPN	213-6198	1
Q2	RF Output Transistor, CTC B40-28, Silicon, NPN	213-6200	1
Q3	Transistor, NJ3000, Silicon, NPN, TO-3 Case	219-3000	1
R11	Resistor, 120 Ohm ±1%, 1/4W	100-1231	1

TABLE 5-1. RF AMPLIFIER ASSEMBLY - 955-0013
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U1	Amplifier, RF Hybrid, MHW592 or CA2830, 250 MHz, 35 dB gain @ 24V supply	229-2830	1
U2	Integrated Circuit, LM317K, Adjustable Positive Voltage Regulator, 1.2 to 37V, 1.5 Ampere Maximum, TO-3 Case	227-0318	1
XF1	Fuse Clip, AGC	415-1010	4
XQ2,XQ3	Socket, TO-3 Transistor	417-0298	2
Z1 THRU Z17	Ferrite Beads	360-0003	17
----	Adjustment Tool	407-0083	1
----	RF Amplifier Circuit Board Assembly	917-0025	1
----	Heat Sensor Circuit Board Assembly	917-0030	1

TABLE 5-2. RF AMPLIFIER CIRCUIT BOARD ASSEMBLY - 917-0025
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Electrolytic, 33 uF, 35V	023-3374	2
C3	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C4	Capacitor, Mica, 50 pF, 50V 040-5013	1	
C5 THRU C7	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
C8	Capacitor, Polystyrene, 0.47 uF, 100V	038-4753	1
C9,C10	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C11	Capacitor, Polystyrene, 0.47 uF, 100V	038-4753	1
C12	Capacitor, Electrolytic, 33 uF, 35V	024-3374	1
C13 THRU C15	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
C16,C17	Capacitor, Mica, 50 pF, 50V	040-5013	2
C18	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1,D2	Diode, HP5082-2800, High Voltage, Schottky Barrier Type, 70V, 15 mA	201-2800	2
L1	Choke, Ferrite, 180 MHz, 2.5 Turns Single Section	364-0002	1
L2	Coil, Molded, 0.051 uH (Yellow)	364-0051	1
L3	Choke, Molded RF, 10 uH ±10%	364-0010	1
L4	Enameled Wire, 18 inches (45.72 cm) of No. 18 Gauge, 28 Turns, 1.5 inches (3.81 cm) long, 0.38 inches (0.97 cm) ID	640-1800	1
L5	Choke, Ferrite, 180 MHz, 2.5 Turns Single Section	364-0002	1
L6	Coil, Molded, 0.023 uH (Red)	364-0023	1
L7	Choke, Molded RF, 10 uH ±10%	364-0010	1
L8	Coil, Molded, 0.023 uH (Red)	364-0023	1

TABLE 5-2. RF AMPLIFIER CIRCUIT BOARD ASSEMBLY - 917-0025
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
L9	Choke, Ferrite, 180 MHz, 2.5 Turns Single Section	364-0002	1
L10	Enameled Wire, 18 inches (45.72 cm) No. 18 Gauge, 28 Turns, 1.5 inches (3.81 cm) long, 0.38 inches (0.97 cm) ID	640-1800	1
P1	Connector, 6-Pin	417-0677	1
R1	Resistor, 47 Ohm ±5%, 1/2W	110-4723	1
R2	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R3	Resistor, 22 Ohm ±5%, 1/4W	100-2223	1
R4,R5	Resistor, 22 Ohm ±5%, 2W	130-2223	2
R6	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R7	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R8	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R10	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
R12	Resistor, 33 Ohm ±5%, 1/4W	100-3323	1
R13,R14	Resistor, 180 Ohm ±5%, 1/4W	100-1833	2
----	Socket Pins (for Hybrid Amplifier)	417-5022	1
----	Blank Circuit Board	517-0025	1

5

TABLE 5-3. HEAT SENSOR CIRCUIT BOARD ASSEMBLY - 917-0030

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
U1	Integrated Circuit, LM335Z, Precision Temperature Sensor, TO-92 Case	229-0335	1
----	Blank Circuit Board	517-0030	1

TABLE 5-4. CABLE ASSEMBLY, RF AMPLIFIER - 949-0134

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Housing, Connector, 6-Pin	418-0670	1
P1	Plug, 15-Pin	418-2379	1
----	Pins for P1	417-0036	15
----	Pins for J1	417-0053	6

CONTROL CIRCUIT

TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section provides general information and specifications relative to the operation of the control circuit board.

1-3. EQUIPMENT PURPOSE.

1-4. The control circuit board regulates the operation of the RF amplifier within preset limits dependent upon several parameters such as forward power output, reflected power, RF amplifier heat sink temperature, dc current, dc voltage, and external control potentials. The control circuit board also contains amplifiers for the forward and reflected directional couplers, over temperature circuit, and the VSWR circuit (see Figure 1-1).

1-5. Outputs from the control circuit board include forward and reflected power, and PA current and voltage to the metering board, drive to the POWER and VSWR indicators, and an over temperature status signal to the associated system transmitter.

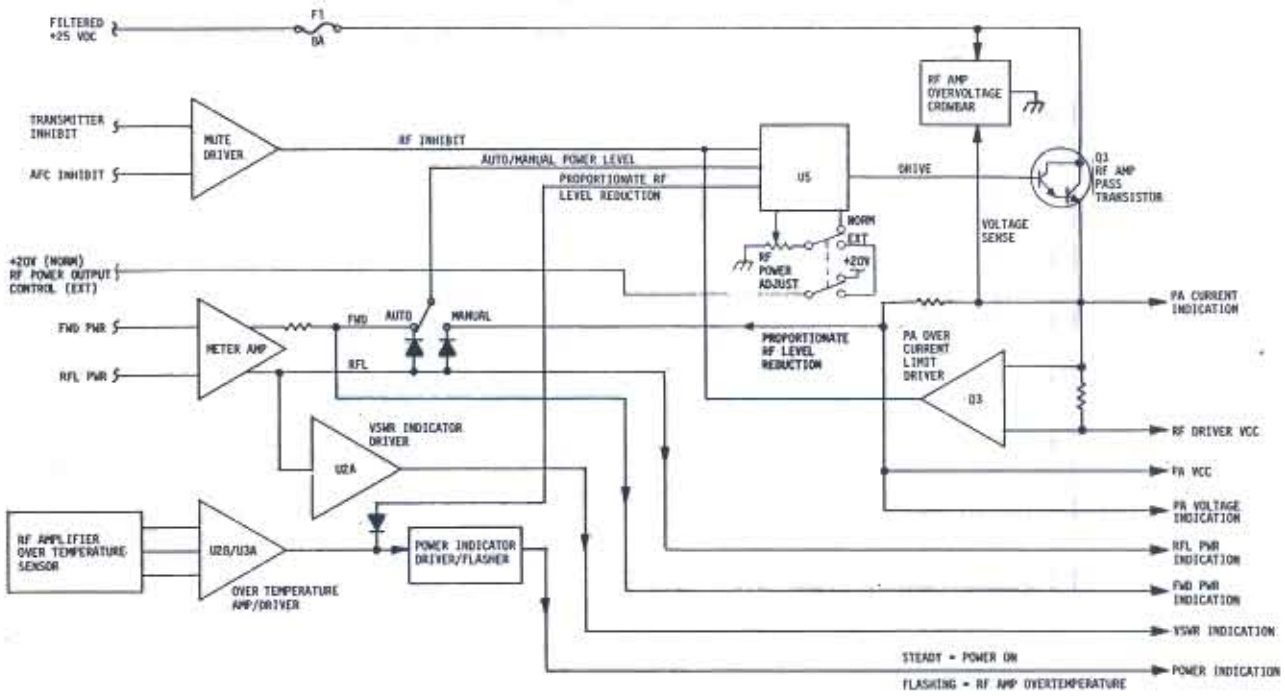


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FIGURE 1-1. BLOCK DIAGRAM

TABLE 1-1. ELECTRICAL CHARACTERISTICS

PARAMETER	SPECIFICATIONS
INPUTS	
Power	+20V dc at 50 mA +20V dc at 8 Amperes, Maximum
Transmitter Inhibit	Low 1V = RF OFF High 12V = RF ON
AFC Inhibit	Low 1V = AFC Locked High 10V From Open Collector = AFC Unlocked
FWD PWR	1.5V dc, Approximate (30W RF)
RFC PWR	Less than 1V dc (30W RF)
OT Sensor	3.5V or Proportionately Less, Dependent Upon RF Amplifier Heat Sink Assembly Temperature (+2.73V at 0°C Plus 10 mV/°C)
RF Power Output Control	Positive potential, varies with setting of PWR SET control.
OUTPUTS	
PA Current	3.15 Amperes for 30W RF
PA Voltage	+18V for 30W RF
RFL PWR	Less than 1V at 10 k Ohm
FWD PWR	8.6V at 10 k Ohm for 30W RF
VSWR Indicator Drive	1.7V at 15 mA
Power Indicator Drive	1.7V at 15 mA Constant Illumination: Power On Flashing: Over Temperature Indication
Over Temperature Status	+10V at 5 mA, Maximum
VCC to RF Driver	+18V at 0.8A for 30W RF
VCC to PA	+18V at 3.15A for 30W RF
+20V	+20V @ 0.002 Ampere

SECTION II

REMOVAL AND INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides removal and installation instructions for the exciter control circuit board.

2-3. REMOVAL PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING REMOVAL OF THE
WARNING CONTROL CIRCUIT BOARD.

2-4. EQUIPMENT REQUIRED.

2-5. The following equipment is required to remove and install the exciter control circuit board:

A. Flat tip screwdriver, 4 inch (10.16 cm) blade and 1/4 inch (0.635 cm) tip.

B. Number 2 Phillips screwdriver, 4 inch (10.16 cm) blade.

2-6. PROCEDURE.

2-7. Disconnect primary ac power.

2-8. Loosen the eight turn-lock fasteners and remove the exciter cover.

2-9. Disconnect 12 pin plug P2 and 4 pin plug P1.

2-10. Disconnect 14 pin P1 (NOTE PIN 1).

2-11. One at a time, release the latch on each nylon mounting stud and raise each corner slightly. When all four corners are free, remove the circuit board.

2-12. INSTALLATION PROCEDURE.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE ATTEMPTING INSTALLATION OF
WARNING THE CONTROL CIRCUIT BOARD.

2-13. Reverse the removal procedure sequence.

2-14. Ensure a fuse is inserted in the fuse holder.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. The following text provides detailed theory of operation with supporting diagrams for the FX-30 FM exciter control circuit assembly. For purposes of definition, the text is divided into functional circuits (see Figure 3-1).

3-3. FUNCTIONAL DESCRIPTION.

3-4. METER AMPLIFIERS.

3-5. FORWARD AMPLIFIER. The output of the forward port of the directional coupler is applied to the forward meter amplifier of the control circuit board. An input impedance of 100 k Ohm is established by resistor R31. RF is filtered from the signal before entering the forward power meter amplifier (U4A) by R34 and C6.

3-6. Amplifier U4A has a high input impedance and is configured as a voltage follower with gain established by the ratio of feedback resistor R43 to ground return resistors R3 and R35. Capacitor C7 compensates the amplifier for high frequencies. The exact gain of the amplifier is adjusted by potentiometer R3 to produce +10 volts at the output of U4A with 40 watts of RF power.

3-7. REFLECTED AMPLIFIER. The reflected meter amplifier (U4B) works in a manner similar to the forward amplifier section except that the voltage gain of this amplifier is less than the forward amplifier which compensates for differences in the lengths of the directional coupler sampling lines. U4B is calibrated by potentiometer R2 so that 40 watts of reflected power would produce +10 volts at the output of U4B.

3-8. Forward and Reflected Outputs. The outputs of U4A and U4B are routed to the metering circuit board as well as to terminals on the rear of the exciter. This allows external metering of forward and reflected power as well as when the exciter is used with a Broadcast Electronics, Inc. transmitter, these terminals convey information to the transmitter microprocessor controller monitoring the exciter output power.

3-9. REGULATOR U5.

3-10. When switch S1 is set to AUTO, the forward power output by U4A is scaled by a voltage divider and applied to the inverting input of voltage regulator U5. Reflected power is added to the forward power input of U5 in the automatic mode through diode D5 when there is sufficient reflected power for the voltage at the output of U4B to exceed the output of U4A.

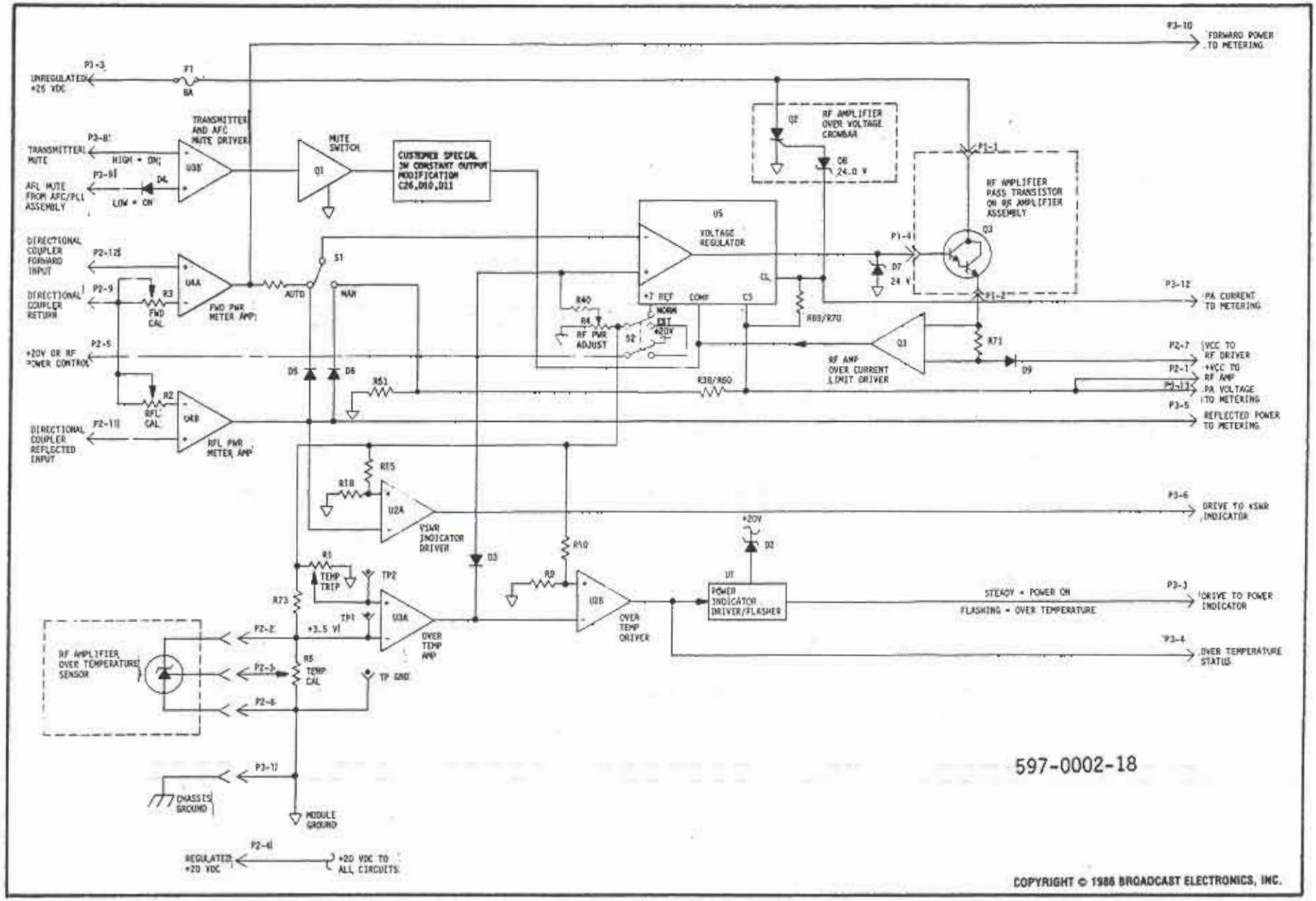

FIGURE 3-1. SIMPLIFIED SCHEMATIC

3-11. In the automatic mode, the sum of the forward and reflected power beyond the threshold established by diode D5 controls the feedback to U5. This means that if the reflected power is negligible, the power output of the amplifier is controlled only by the forward power sampled by the directional coupler. This keeps the power output of the RF amplifier very constant with variations in load and temperature. If, however, the reflected power to the amplifier becomes excessive, the sum of the forward and reflected power will become the controlling reference and the power output will be reduced only the amount required to maintain safe operation of the RF output devices. Typically, power reduction will not begin until the VSWR has exceeded 2 to 1. At low power levels of less than 10 watts, full output can be maintained at a very high VSWR while at higher output levels such as 30 watts, power reductions of up to 50% may occur if the VSWR is high enough.

3-12. If the gain control switch (S1) is operated to MAN, the reflected power will be added to a sample of the output control voltage through R60. This will reference the output of U5 to the output voltage compared to a reference voltage established by R4.

3-13. An internal +7 volt reference established by precision zener diodes within U5 is adjusted with the PWR SET control (R4) and applied to the non-inverting input of U5. As R4 is adjusted, the output of U5 must proportionately increase or decrease the output of the RF amplifier circuit to balance the inputs to U5. Potentiometer R4 is the exciter RF power output adjustment. This is a normal user adjustment and is accessible through a hole in the top cover of the exciter without removing the top cover.

3-14. In the manual mode, U5 operates essentially as a conventional voltage regulator. If, however, the reflected power exceeds the threshold across diode D6, the output of U5 will be reduced accordingly to prevent damage to the RF output devices. In a fashion similar to operation in automatic power control, the power output will be reduced as much as required to maintain safe operation of the RF output devices.

3-15. Whenever the VSWR is sufficiently high to require a power reduction via D5 or D6, U2A illuminates the front panel VSWR indicator. U2 acts as a voltage comparator biased to a reference voltage. When the output of U4B exceeds this reference voltage, then the output of U2A switches from Ø volts to near +12 volts to illuminate the VSWR indicator.

3-16. As U5 does not have sufficient current capability to drive the RF amplifier circuit, an external Darlington pass transistor is used as an emitter follower with the output following the output of U5. Zener diode D7 and the associated resistors prevent the output of the pass transistor from exceeding a 23 volt potential if U5 should fail.

3-17. RF DRIVER SUPPLY. The output of the pass transistor is applied to the RF driver through resistor R71 and to the RF power amplifier through resistors R69 and R70. The current supplied to the driver is sampled as a voltage drop across R71. Transistor Q3 and the associated resistors provide foldback current limiting for the RF driver to prevent damage from a short circuit or current overload. Diode D9 prevents rectified RF drive from affecting the current overload circuit during foldback limiting.

3-18. PA SUPPLY. Current to the RF power amplifier flows through R69 and R70. The voltage across these resistors is sensed by a transistor internal to U5 and resistors R61, R62, and R64. This circuit provides short circuit and foldback current limiting for the RF power amplifier. Voltage sampled across a current shunt consisting of R69 and R70 is used for monitoring current to the final RF amplifier.

3-19. CROWBAR. Fuse F1 provides a means to disconnect the power supply from the RF amplifier circuit if an over-voltage condition occurs. Diode D8 in conjunction with SCR Q2 comprise an over-voltage crowbar circuit. In the event the pass transistor short-circuits or loss of control by U5 occurs, an over-voltage condition could exist at the emitter of the pass transistor. If the voltage at this point should rise above 25 volts, Q2 will fire and cause fuse F1 to open.

3-20. Normally, short circuits in the RF amplifier will cause foldback current limiting without opening fuse F1. If the fuse does open, it is unlikely that the exciter can be returned to operation by simply replacing the fuse. A blown fuse indicates replacement of the pass transistor is probably required.

3-21. In the event that fuse F1 is opened by the crowbar circuit, the VSWR indicator will remain on continuously and the power indicator will flash with no RF power output from the exciter.

3-22. EXCITER MUTING. Exciter RF output is automatically muted whenever the AFC circuit is unlocked or whenever the transmitter is not ready to accept RF drive. This function is provided by a circuit consisting of U3B and Q1. The non-inverting input to U3B accepts the AFC mute input and the inverting input to U3B accepts the transmitter mute input.

3-23. To enable RF output, the inverting input to U3B from the transmitter must be greater than +2 volts. Simultaneously, the input to the non-inverting input from Q5 on the AFC/PLL circuit board after phase lock must be less than +2 volts. If these conditions are not met, U3B will output a high and enable Q1 which grounds the compensation input to voltage regulator U5 to turn off RF output.

3-24. Diode D4 connected to the non-inverting input of U3B makes the input a current sinking line only and prevents the voltage input to the non-inverting input of U3B from rising beyond the value established by the supply resistors. Additional capacitors on the input to U3B provide RFI filtering.

3-25. Additional circuitry including C26, D10, and D11 are added as a customer special configuration to the control circuit board when used with the Continental Exciter Switcher. Zener diode D11 maintains a constant three-watt output so that the Continental Exciter Switcher will recognize the second exciter as operational. Capacitor C26 provides mute line filtering and diode D10 functions as a steering diode for isolation.

3-26. Remote Mute Provision. The transmitter RF mute line is connected through the RFI filter to terminals on the exciter rear panel. When the exciter is used with Broadcast Electronics transmitters, this input allows the transmitter controller to disable exciter RF output as required. If the exciter is used in other types of transmitters, the RF mute line on the rear panel of the exciter can be permanently strapped to the +24 volt supply terminal to disable the transmitter mute function circuitry.

3-27. TEMPERATURE SENSOR.

3-28. An electronic temperature sensing circuit consisting of U3A, U2B, and U1 senses the RF amplifier heat sink temperature. If an overtemperature condition occurs, RF output will automatically be reduced proportionately to prevent damage to the RF output transistors. Under normal conditions, the POWER indicator on the exciter front panel remains continuously illuminated to indicate power is applied to the exciter. As a visual indication that an overtemperature condition exists, the POWER indicator on the exciter front panel will flash.

3-29. Temperature sensor U1 is mounted on and thermally coupled to the RF output heat sink assembly. U1 functions much as if it were a zener diode with a calibrated positive temperature coefficient. The sensor is calibrated by the TEMP CAL control (R5) so that the voltage between test point TP1 at the inverting input to U3A and ground is set to +2.98 volts when the heat sink temperature is +25 degrees Centigrade and +2.73 volts at Ø degree Centigrade. Overtemperature amplifier U3A operates as an inverting amplifier with a voltage offset established by the TEMP TRIP control (R1) of +3.5 volts at test point TP2.

3-30. As the voltage from U1 increases at the rate of 10 millivolts per degree Centigrade, the voltage at the output of U3A will decrease at the rate of 150 millivolts per degree Centigrade. At normal heat sink temperatures, the voltage output of U3A is greater than the voltage at the non-inverting input of U5, therefore, diode D3 will not conduct.

3-31. If, however, the heat sink temperature is high enough, the voltage output of U3A will fall lower than the voltage at the non-inverting input to U5 and diode D3 will conduct. This will cause the power set reference voltage applied to U5 to decrease as the temperature of the heat sink continues to increase. The result is that the output of the RF power amplifier is reduced and the amount of heat dissipated into the heat sink is correspondingly reduced.

3-32. In this manner, safe junction temperatures of the RF devices are maintained without shutting the RF amplifier down completely. In a fashion somewhat similar to operation of the VSWR protection circuitry, the RF output is proportionately reduced only the amount required to maintain safe operation of the RF output devices.

3-33. LIGHT DRIVER. Comparator U2B is configurated to operate at the point at which diode D3 begins to conduct. Under normal conditions, the voltage at the inverting input to U2B is higher than the voltage at the non-inverting input to U2B. If the output of U2B is low, diode D1 will conduct and hold bistable multivibrator U1 continuously on. As the output of U2B rises to output a high state, diode D1 will no longer conduct and U1 will begin to operate as a flasher.

3-34. The output of U1 drives the POWER indicator on the exciter front panel. Under normal conditions, the indicator will remain continuously illuminated whenever power is applied to the exciter. Under overtemperature conditions, the indicator will flash at a rate of approximately two flashes per second.

3-35. Capacitor C1 in conjunction with R17 determines the flashing rate and diode D2 and resistor R27 derives the supply voltage for U1 from the +20 volt pre-regulated bus.

SECTION IV
MAINTENANCE

6

4-1. INTRODUCTION.

4-2. This section provides maintenance information for the exciter control circuit board.

4-3. MAINTENANCE.

4-4. ADJUSTMENTS.

4-5. FWD CAL (R3) and RFL CAL (R2). The FWD CAL control (R3) and the RFL CAL control (R2) must be adjusted together in sequence. To adjust R3 and R2, proceed as follows.

4-6. Required Equipment. The following equipment is required to complete adjustment of the FWD CAL control (R3) and the RFL CAL control (R2).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Non-inductive, 25 watt, 50 Ohm test load (P/N 829-8080).

C. Adapter, BNC jack-to-type N plug, for test load (P/N 417-3288).

WARNING: DISCONNECT POWER PRIOR TO SERVICING

D. Adapter, type N jack-to-jack, for test load (P/N 417-3841).

E. Coaxial Accessory Cable, BNC connectors, shipped with exciter (P/N 947-0017-2).

F. Calibrated 50 Ohm in-line wattmeter.

4-7. Procedure. To adjust the FWD CAL (R3) control and the RFL CAL control (R2) proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-8. Disconnect primary power.

4-9. Disconnect the transmitter load and connect a non-inductive, 25 watt, 50 Ohm test load to the exciter RF OUTPUT connector through the wattmeter (items B, C, D, E, and F).

4-10. Operate the internal AUTO/MAN switch (S1) to MAN.

4-11. Depress the FWD PWR meter switch.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-12. Apply power and operate the exciter.

4-13. Using the insulated tuning tool (item A), adjust the PWR SET control (R4) to establish an exciter RF output power of 20 watts as indicated by the external wattmeter.

4-14. Using the insulated tuning tool (item A), adjust R3 to obtain an indication of 20 watts forward power on the red colored multimeter scale.

4-15. Using the insulated tuning tool (item A), adjust the PWR SET control (R4) to establish an exciter RF output power of 5 watts.

4-16. Disconnect the RF output connector from the exciter.

4-17. Using the insulated adjustment tool (item A), readjust the FWD PWR control (R4) to maintain a forward RF output power of 5 watts.

4-18. Depress the RFL multimeter switch.

4-19. Using the insulated tuning tool (item A), adjust the RFL CAL control (R2) to obtain an indication of 5 watts reflected power (the front panel VSWR indicator will illuminate).

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-20. Disconnect primary ac power.

4-21. Disconnect the test equipment and reconnect the exciter load.

4-22. TEMP TRIP (R1). To adjust the TEMP TRIP control (R1) proceed as follows.

4-23. Required Equipment. The following equipment is required to complete adjustment of the TEMP TRIP control (R1).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Digital voltmeter, Fluke 75 or equivalent.

4-24. Procedure. To adjust the TEMP TRIP control (R1) proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

6

4-25. Disconnect primary power.

4-26. Connect the digital voltmeter (item B) between TP2 and TP GND.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-27. Apply power and operate the exciter.

4-28. Using the insulated tuning tool (item A), adjust R1 to obtain an indication of +3.5V dc on the external meter.

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-29. Disconnect primary ac power.

4-30. Remove the test equipment.

4-31. TEMP CAL (R5). To adjust the TEMP CAL control (R5) proceed as follows.

4-32. Required Equipment. The following equipment is required to complete adjustment of the TEMP CAL (R5).

A. Insulated adjustment tool, shipped with exciter (P/N 407-0083).

B. Digital voltmeter, Fluke 75 or equivalent.

C. Fluke 80T-150 temperature probe or equivalent.

4-33. Procedure. To adjust the TEMP CAL control (R5) proceed as follows:

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-34. Disconnect primary power.

4-35. Attach the temperature probe (item C) to the RF amplifier heatsink assembly near U6.

4-36. Connect the voltmeter (item B) and record the temperature indication, add +273, and divide by 100 ($\frac{°C + 273}{100}$ = VOLTAGE).

4-37. Connect the voltmeter (item B) between TP1 and TP GND.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD

WARNING BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

WARNING USE THE INSULATED TUNING TOOL FOR ADJUSTMENT.

4-38. Apply power and operate the exciter.

4-39. Using the insulated tuning tool (item A), adjust R5 to obtain an indication equal to the result obtained in paragraph 4-36.

EXAMPLE: $\frac{25°C + 273}{100} = \frac{298}{100} = 2.98V$

WARNING ENSURE ALL PRIMARY POWER IS DISCONNECTED FROM THE EXCITER BEFORE PROCEEDING.

4-40. Disconnect primary ac power.

4-41. Remove the test equipment.

4-42. TROUBLESHOOTING.

WARNING TROUBLESHOOTING WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION

WARNING SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENT WITHIN THE EXCITER WHEN POWER IS ENERGIZED.

4-43. If difficulties are encountered and the control circuit is suspected as faulty, the assembly inputs and outputs should be checked to isolate the malfunction. The fuses, exciter metering, and the various exciter indicators should be noted. The defect may be further isolated with resistance measurements. Table 4-1 should be referenced as a troubleshooting guide.

TABLE 4-1. CONTROL CIRCUIT SYMPTOM INDEX

SYMPTOM	DEFECT
Incorrect forward power indication or incorrect reflected power indication.	Defective U4.
Power indicator does not flash to indicate an over temperature condition.	Defective U1 or D2.
Incorrect VSWR indication.	Defective U4B or U2A.
Power indication flashes when exciter is cold.	Refer to Figure 4-1.
No DC voltage to RF Amplifier.	Refer to Figure 4-2.

6

4-44. DIAGRAMS.

4-45. The following diagrams are presented as aids to maintenance:

FIGURE	TITLE	NUMBER	PAGE
4-3	CONTROL CIRCUIT BOARD ASSEMBLY	C917-0028	16
4-4	CONTROL CIRCUIT BOARD SCHEMATIC DIAGRAM	D909-0028	17

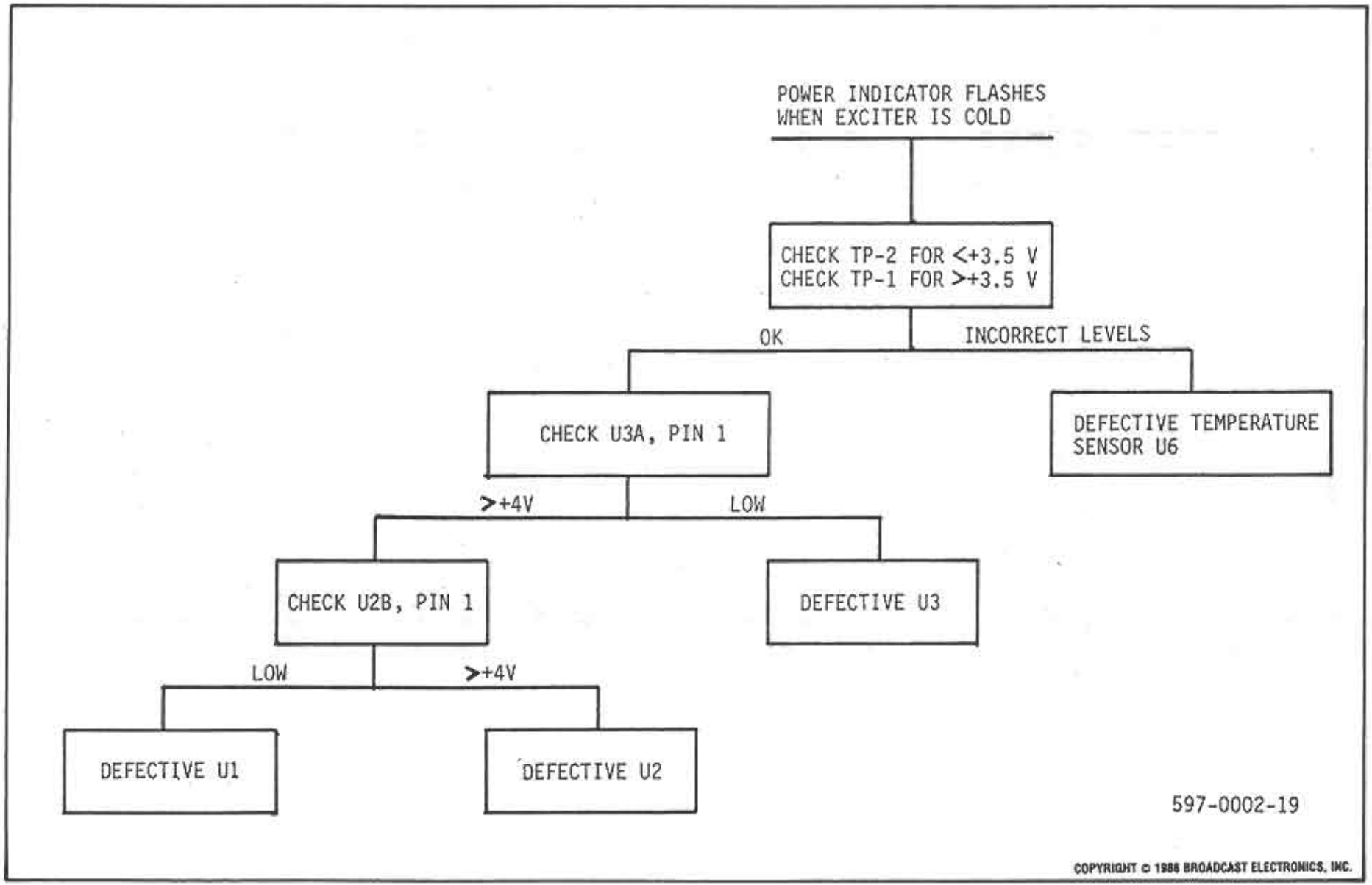

FIGURE 4-1. POWER INDICATOR FLASHES WHEN EXCITER IS COLD

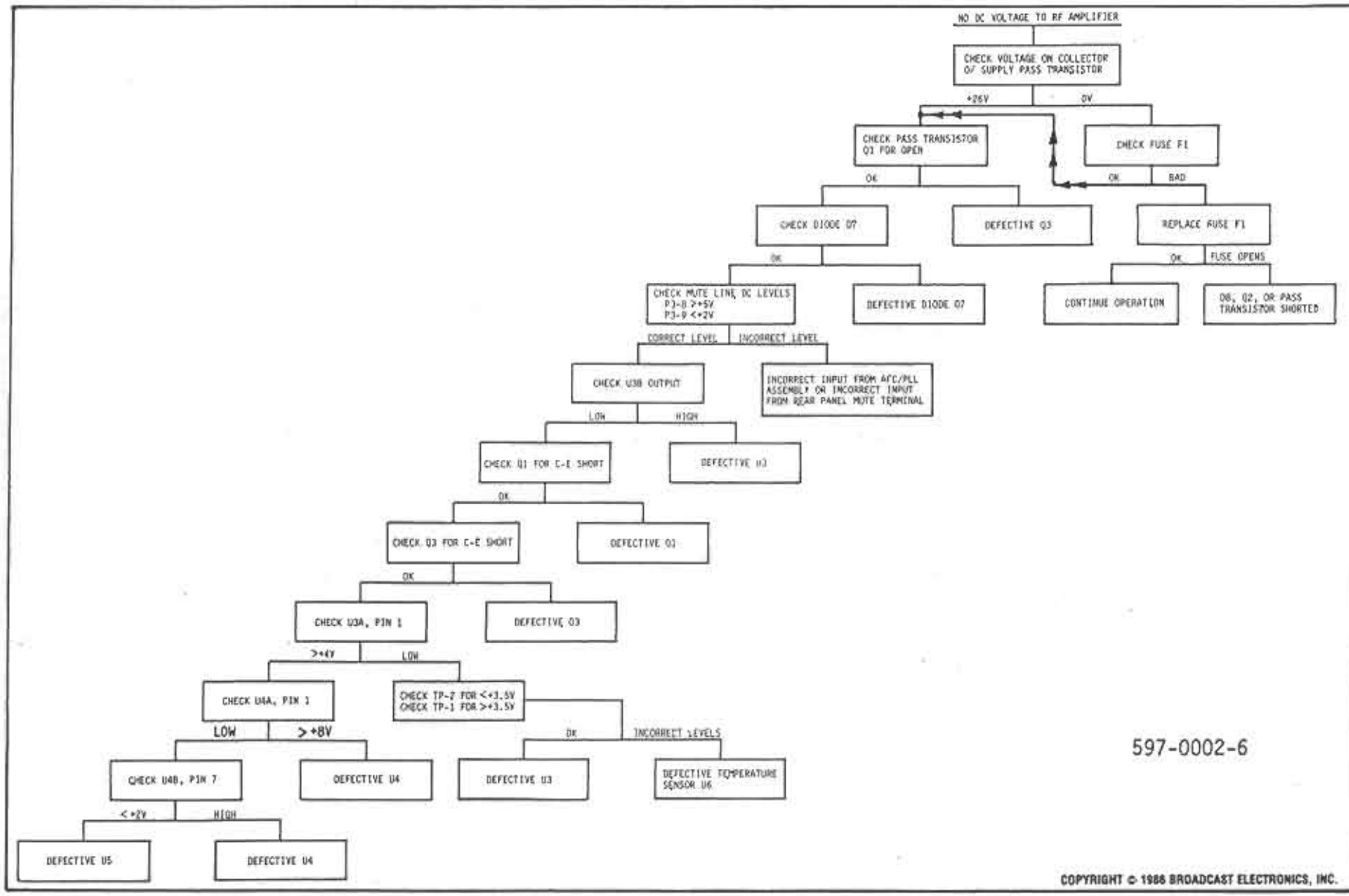

FIGURE 4-2. NO DC VOLTAGE TO RF AMPLIFIER.

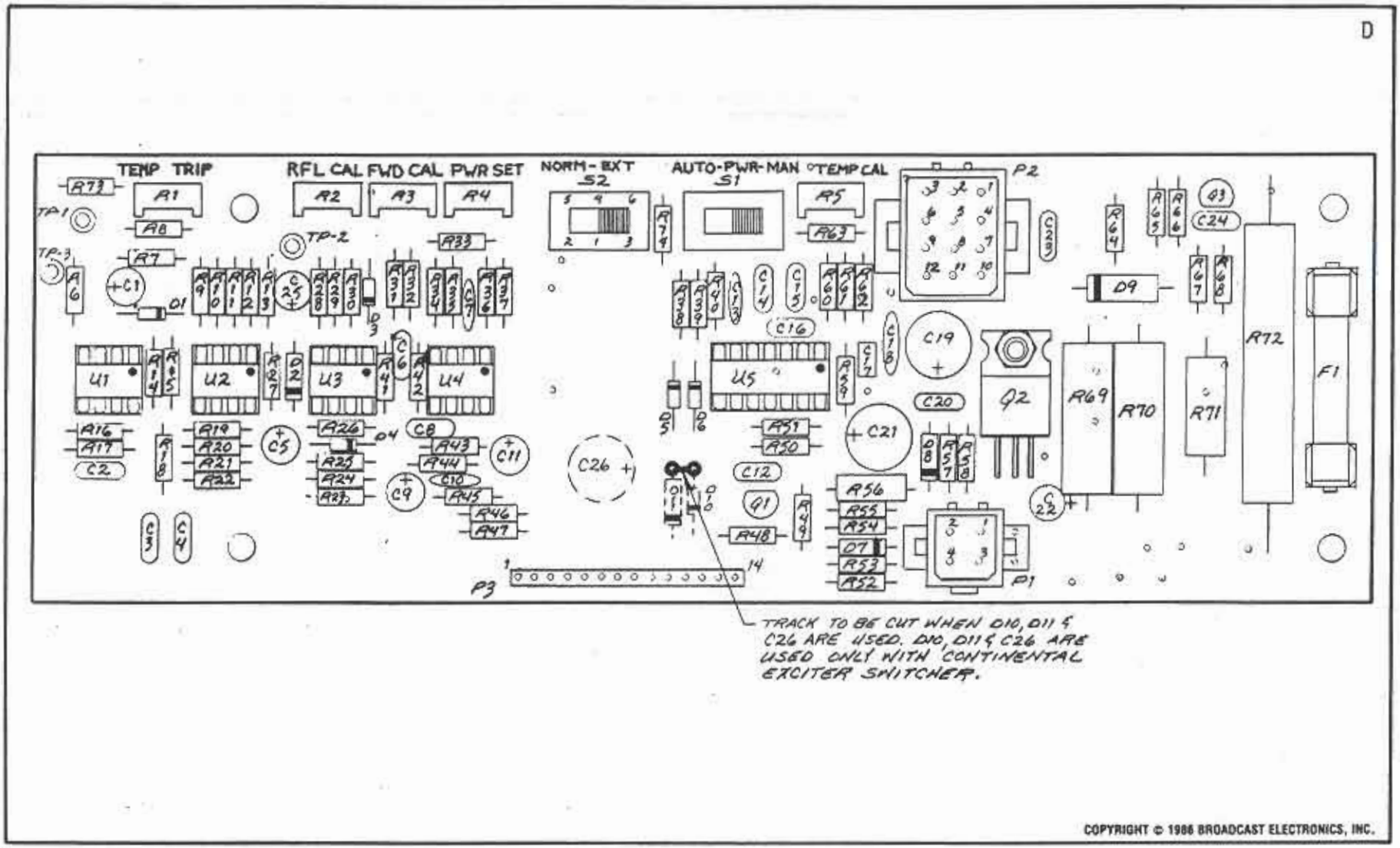

FIGURE 4-3. CONTROL CIRCUIT BOARD ASSEMBLY C917-0028

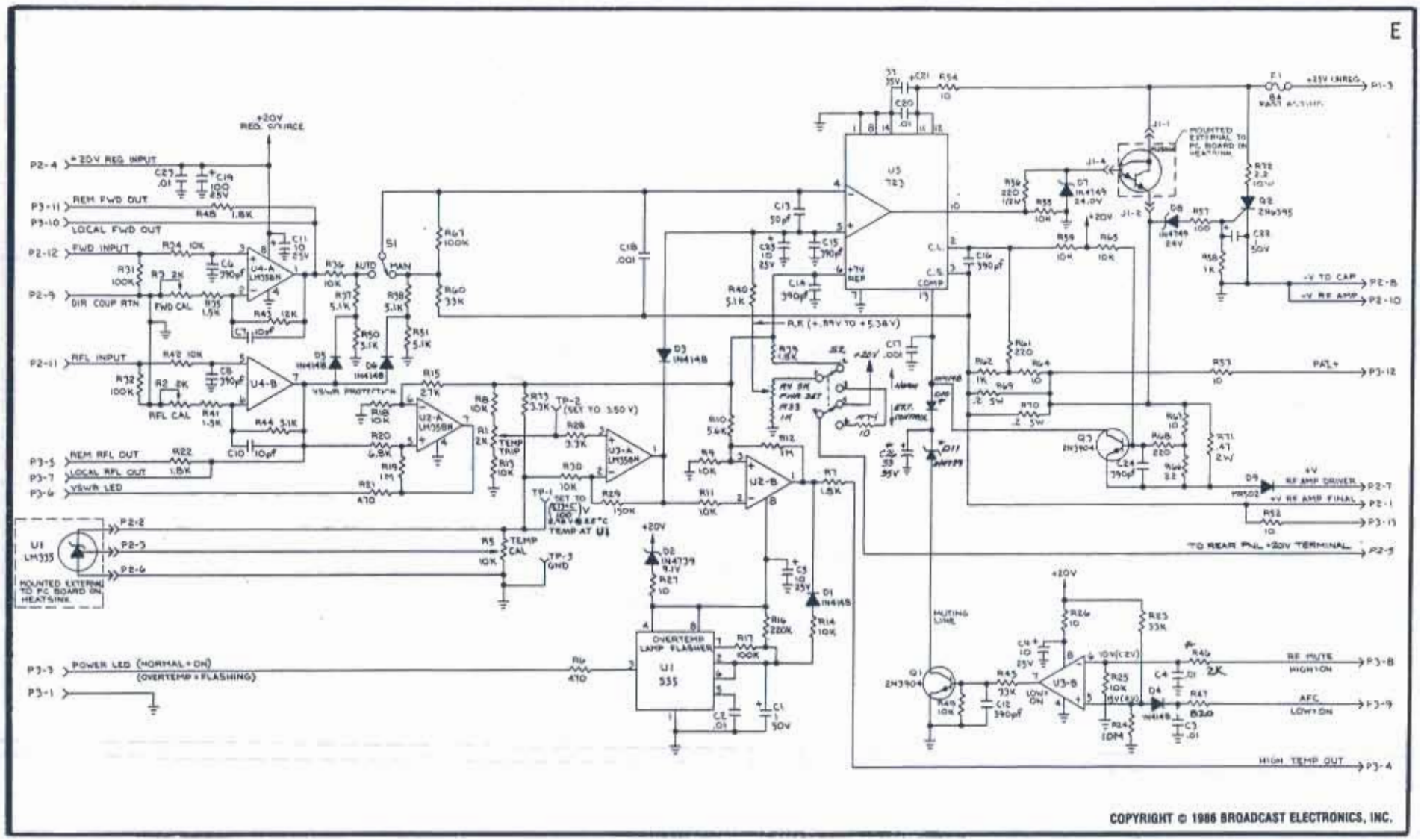

FIGURE 4-4. CONTROL CIRCUIT SCHEMATIC DIAGRAM D909-0028

SECTION V
REPLACEMENT PARTS

5-1. INTRODUCTION.

5-2. This section provides replacement parts lists for the FX-30 FM exciter control assembly circuit board as indexed below. Associated components mounted to the RF amplifier heatsink assembly are listed as parts of the RF amplifier.

TABLE 5-1. CONTROL ASSEMBLY CIRCUIT BOARD - 917-0028
(Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 1 uF, 50V	024-1064	1
C2 THRU C4	Capacitor, Polycarbonate, 0.01 uF ±10%, 50V	030-1042	3
C5	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C6	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C7	Capacitor, Ceramic Disc, 10 pF ±10%, 1 kV, NPO	001-1014	1
C8	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C9	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C10	Capacitor, Ceramic Disc, 10 pF ±10%, 1 kV, NPO	001-1014	1
C11	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
C12	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C13	Capacitor, Ceramic Disc, 50 pF, 500V	001-5014	1
C14 THRU C16	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
C17	Capacitor, Mylar Film, 0.001 uF ±10%, 100V	030-1033	1
C18	Capacitor, Ceramic Disc, 0.001 uF, 1000V	002-1034	1
C19	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C20	Capacitor, Polycarbonate, 0.01 uF ±10%, 50V	030-1042	1
C21	Capacitor, Electrolytic, 33 uF, 35V	024-3374	1
C22	Capacitor, Electrolytic, 1 uF, 50V	024-1064	1
C23	Capacitor, Polycarbonate, 0.01 uF ±10%, 50V	030-1042	1
C24	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C25	Capacitor, Electrolytic, 10 uF, 25V	023-1076	1
D1	Diode, 1N4148, Silicon, Switching, 100V, 10 mA	203-4148	1
D2	Diode, Zener, 1N4739A, 9.1V ±10%, 1W	200-0009	1
D3 THRU D6	Diode, 1N4148, Silicon, Switching, 100V, 10 mA	203-4148	4
D7,D8	Diode, Zener, 1N4749A, 24V ±5%, 1W	200-0024	2
D9	Rectifier, 200 PIV, 3A	202-0502	1

TABLE 5-1. CONTROL ASSEMBLY CIRCUIT BOARD - 917-0028
(Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
F1	Fuse, 3AG, Fast Acting, 250V, 8 Ampere	330-0800	1
P1	Connector, 4-Pin	418-0255	1
P2	Connector, 12-Pin	417-1276	1
P3	Connector, 14-Pin	417-0140	1
Q1	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	1
Q2	Rectifier, 2N6395, Silicon Controlled, 100V, 12 Ampere, TO-220 Case	237-6395	1
Q3	Transistor, 2N3904, Silicon, NPN	211-3904	1
R1 THRU R3	Potentiometer, 12 k Ohm ±10%, 1/2W	178-2044	3
R4	Potentiometer, 5 k Ohm ±10%, 1/2W	178-5044	1
R5	Potentiometer, 10 k Ohm ±10%, 1/2W	178-1054	1
R6	Resistor, 470 Ohm ±5%, 1/4W	100-4733	1
R7	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R8,R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R10	Resistor, 5.6 k Ohm ±5%, 1/4W	100-5643	1
R11	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R12	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R13,R14	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R15	Resistor, 27 k Ohm ±5%, 1/4W	100-2753	1
R16	Resistor, 220 k Ohm ±5%, 1/4W	100-2263	1
R17	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R18	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R19	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R20	Resistor, 6.8 k Ohm ±5%, 1/4W	100-6843	1
R21	Resistor, 470 Ohm ±5%, 1/4W	100-4733	1
R22	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R23	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R24	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R25	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R26,R27	Resistor, 10 Ohm ±5%, 1/4W	100-1023	2
R28	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R29	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R30	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R31,R32	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R33	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R34	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R35	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R36	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R37,R38	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	2
R39	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R40	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R41	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R42	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R43	Resistor, 12 k Ohm ±5%, 1/4W	100-1253	1
R44	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R45	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R46	Resistor, 2 k Ohm ±1%, 1/4W	100-2041	1
R47	Resistor, 820 Ohm ±5%, 1/4W	100-8233	1
R48	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1

TABLE 5-1. CONTROL ASSEMBLY CIRCUIT BOARD - 917-0028
(Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R49	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R50,R51	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	2
R52 THRU R54	Resistor, 10 Ohm ±5%, 1/4W	100-1023	3
R55	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R56	Resistor, 220 Ohm ±5%, 1/2W	110-2233	1
R57	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R58	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R59	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R60	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R61	Resistor, 220 Ohm ±5%, 1/4W	100-2233	1
R62	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R63	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R64	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R65	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R66	Resistor, 22 Ohm ±5%, 1/4W	100-2223	1
R67	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R68	Resistor, 220 Ohm ±5%, 1/4W	100-2233	1
R69,R70	Resistor, 0.2 Ohm ±5%, 5W, W/W	132-2003	2
R71	Resistor, 0.47 Ohm ±5%, 2W	132-4703	1
R72	Resistor, 2.2 Ohm ±5%, 10W	132-2213	1
R73	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R74	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
S1,S2	Switch, Slide, DPDT, 125V, 0.5 Ampere ac or dc	345-0863	2
TP1 THRU TP3	Test Point	413-0315	3
U1	Integrated Circuit, NE555V, Timer, 8-Pin DIP	229-0555	1
U2 THRU U4	Integrated Circuit, LM358N, Low-Power Dual Operational Amplifier, 8-Pin DIP	221-0358	3
U5	Integrated Circuit, MC723CL, Adjustable Positive Voltage Regulator, 37V to 2V at 150 mA, 14-Pin DIP	227-0723	1
XF1	Clip, Fuse	415-2068	2
XU1 THRU XU4	Socket, 8-Pin DIP	417-0804	4
XU5	Socket, 14-Pin DIP	417-1404	1
----	Blank Circuit Board	517-0028	1