VERY LOW POWER
FM TRANSMITTERS

100 Watts through
300 Watts

597-0092
OCTOBER, 1987

IMPORTANT INFORMATION

EQUIPMENT LOST OR DAMAGED IN TRANSIT

When delivering the equipment to you, the truck driver or carrier's agent will present a receipt for your signature. Do not sign it until you have (a) inspected the containers for visible signs of damage and (b) counted the containers and compared with the amount shown on the shipping papers. If a shortage or evidence of damage is noted, insist that notation to that effect be made on the shipping papers before you sign them.

Further, after receiving the equipment, unpack it and inspect thoroughly for concealed damage. If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Claims for loss or damage will not be honored without proper notification of inspection by the carrier.

TECHNICAL ASSISTANCE AND REPAIR SERVICE

Technical assistance is available from Broadcast Electronics by letter or prepaid telephone or telegram. Equipment requiring repair or overhaul should be sent by common carrier, prepaid, insured and well protected. Do not mail equipment. We can assume no liability for inbound damage, and necessary repairs become the obligation of the shipper. Prior arrangement is necessary. Contact Customer Service Department for a Return Authorization.

FOR TECHNICAL ASSISTANCE DURING 8:00 AM TO 5:00 PM CENTRAL TIME

Digital Product Customer Service – Phone (217) 224–9600

RF/Studio Product Customer Service – Phone (217) 224–9617

FOR TECHNICAL ASSISTANCE DURING NON–BUSINESS HOURS

Phone (217) 224–9600 Customer Service

FOR DIGITAL PRODUCTS BULLETIN BOARD SERVICE

Phone (217) 224–1926

WARRANTY ADJUSTMENT

Broadcast Electronics, Inc. warranty is included in the Terms and Conditions of Sale. In the event of a warranty claim, replacement or repair parts will be supplied F.O.B. factory. At the discretion of Broadcast Electronics, the customer may be required to return the defective part or equipment to Broadcast Electronics, Inc. F.O.B. Quincy, Illinois. Warranty replacements of defective merchandise will be billed to your account. This billing will be cleared by a credit issued upon return of the defective item.

RETURN, REPAIR AND EXCHANGES

Do not return any merchandise without our written approval and Return Authorization. We will provide special shipping instructions and a code number that will assure proper handling and prompt issuance of credit. Please furnish complete details as to circumstances and reasons when requesting return of merchandise. All returned merchandise must be sent freight prepaid and properly insured by the customer.

REPLACEMENT PARTS

Emergency and Warranty Replacement Parts may be ordered from the address below. Be sure to include equipment model and serial number and part description and part number. Non–Emergency Replacement Parts may be ordered directly from the Broadcast Electronics stock room by Fax at the number shown below.

EMERGENCY AND WARRANTY REPLACEMENT PARTS
Broadcast Electronics, Inc.
4100 N. 24th St. P.O. BOX 3606
Quincy, Illinois 62305
Tel: (217) 224–9600 Digital Products (8 AM to 5 PM Central Time)
Tel: (217) 224–9617 RF/Studio Products (8 AM to 5 PM Central Time)
Tel: (217) 224–9600 (Non–Business Hours)
Telex: 25–0142
Fax: (217) 224–9607

NON–EMERGENCY REPLACEMENT PARTS
FAX (217) 224–9609

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MODIFICATIONS

Broadcast Electronics, Inc. reserves the right to modify the design and specifications of the equipment in this manual without notice. Any modification shall not adversely affect performance of the equipment so modified.

BROADCAST ELECTRONICS INC

PUBLICATION CHANGE NOTICE

EQUIPMENT V.L.P. FM TRANSMITTERS MODEL(S) FM-100/250/300 SERIAL N/A

PUBLICATION NUMBER 597-0092 BASIC ISSUE/REVISION OCTOBER 1987

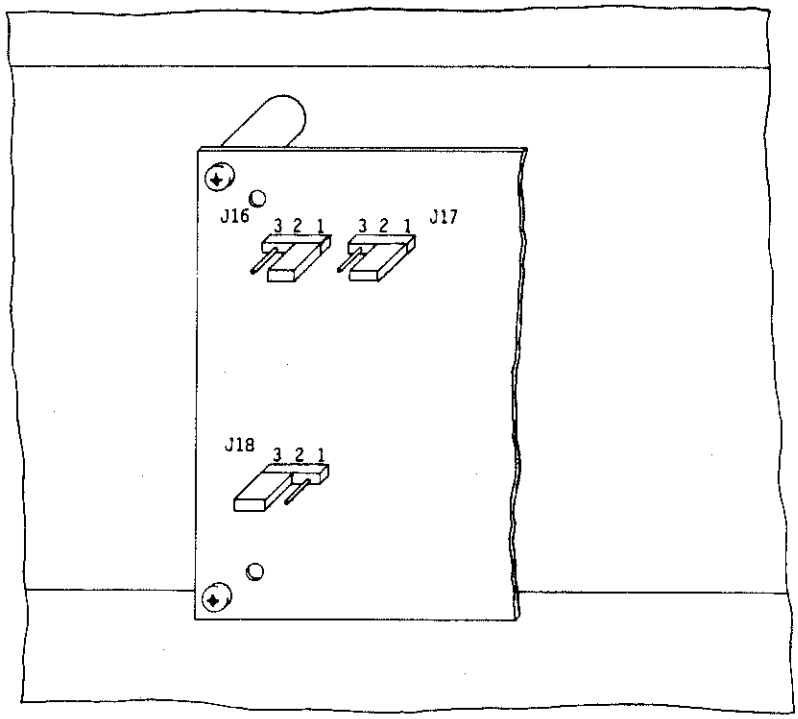
INSTRUCTIONS: Make the changes noted below as listed.

Replacement pages will be attached to this change notice as required.

This change notice should be retained with the publication.

CHANGE NO.	DATE	DESCRIPTION
1	21 MARCH 1988	Replace pages 2-7 and 2-8 with the attached revised pages.

4100 N. 24TH STREET • P.O. BOX 3606 • QUINCY, ILLINOIS 62305 • TELEX 250142 • CABLE "BCST ELECT QUI" • PHONE 217/224-9600



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597-0092-51

FIGURE 2-3. PA JUMPER PROGRAMMING

A. Extend the PA forward and remove the top-panel.

B. Refer to Figure 2-3 and ensure all circuit board jumpers are correctly positioned.

C. Replace the top-panel.

2-32. REMOTE CONTROL.

2-33. Many transmitter control and monitoring functions are available as remote control features (see Table 2-1). Also, the transmitter will interface with most modern remote control units such as the sixteen channel Moseley MRC-1600.

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-34. VOLTAGE TAPS. Ensure the transmitter is wired for the input voltage to be used. The PA's, the system controller, the transmitter controllers and the FM exciters must be checked and changed if required.

2-35. Check the PA voltage taps per Figure 2-4 and change the wiring if required.

TABLE 2-1. REMOTE INTERFACE CONNECTIONS

SYSTEM CONTROLLER (MAIN/ALTERNATE TRANSMITTERS)

TB1-	FUNCTION	STATUS
1	System On	Momentary connection to ±5V to ±24V required to activate function.
2	System Off	
3	Manual Mode	
4	Automatic Mode	
5	Transmitter No. 1 Select	
6	Transmitter No. 2 Select	
7	Control Common (Isolated)	
8	Manual Status	Current sink to ground when active.
9	Automatic Status	
10	Transmitter No. 1 Status	
11	Transmitter No. 2 Status	
12	Status Common (Chassis Ground)	

TRANSMITTER CONTROLLER (ALL TRANSMITTERS)

TB1	FUNCTION	STATUS
		POSITIVE LOGIC: ±5 TO ±24V; NEGATIVE LOGIC: ±5 TO ±24V
1	TRANSMITTER ON	
2	TRANSMITTER OFF	
3	FAILSAFE INPUT	
4	REMOTE CONTROL COMMON	
5	POWER RAISE	MOMENTARY CONNECTION TO PIN 7 REQUIRED TO RAISE OR LOWER RF POWER.
6	POWER LOWER	
7	POWER COMMON	
8	+24 VOLTS	
9	COMMON	
10	NOT USED	

TB2-	FUNCTION	STATUS
1	Forward Power	+5 VDC @ 100% forward power.
2	Reflected Power	+5 VDC @ 3:1 reflection.
3	Power Common	
4	PA No. 1 Collector Voltage	+5 VDC @ 30 VDC PA voltage.
5	PA No. 1 Collector Current	+5 VDC @ 15 A PA current.
6	PA No. 1 Meter Common	
7	* PA No. 2 Collector Voltage	+5 VDC @ 30 VDC PA voltage.
8	* PA No. 2 Collector Current	+5 VDC @ 15 A PA current.
9	* PA No. 2 Meter Common	
10	Not Used	

* FM-300 AND FM-300M/A ONLY

WARNING

OPERATING HAZARDS

READ THIS SHEET AND OBSERVE ALL SAFETY PRECAUTIONS

ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES, POWER TRANSISTORS, OR EQUIPMENT WHICH UTILIZES SUCH DEVICES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. EXERCISE EXTREME CARE AROUND SUCH PRODUCTS. UNINFORMED OR CARELESS OPERATION OF THESE DEVICES CAN RESULT IN POOR PERFORMANCE, DAMAGE TO THE DEVICE OR PROPERTY, SERIOUS BODILY INJURY, AND POSSIBLY DEATH.

DANGEROUS HAZARDS EXIST IN THE OPERATION OF POWER TUBES AND POWER TRANSISTORS

The operation of power tubes and power transistors involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel.

A. HIGH VOLTAGE - Normal operating voltages can be deadly. Additional information follows.

B. RF RADIATION - Exposure to RF radiation may cause serious bodily injury possibly resulting in blindness or death. Cardiac pacemakers may be affected. Additional information follows.

C. BERYLLIUM-OXIDE POISONING - Dust or fumes from BeO ceramics used as thermal links with conduction cooled power tubes and power transistors are highly toxic and can cause serious injury or death. Additional information follows.

D. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched. Additional information follows.

HIGH VOLTAGE

Many power tubes operate at voltages high enough to kill through electrocution. Personnel should always break the primary circuits of the power supply and discharge high voltage capacitors when direct access to the tube is required.

RADIO FREQUENCY RADIATION

Exposure of personnel to RF radiation should be minimized, personnel should not be permitted in the vicinity of open energized RF generating circuits, or RF transmission systems (waveguides, cables, connectors, etc.), or energized antennas. It is generally accepted that exposure to "high levels" of radiation can result in severe bodily injury including blindness. Cardiac pacemakers may be affected.

The effect of prolonged exposure to "low level" RF radiation continues to be a subject of investigation and controversy. It is generally agreed that prolonged exposure of personnel to RF radiation should be limited to an absolute minimum. It is also generally agreed that exposure should be reduced in working areas where personnel heat load is above normal. A 10 mW/cm^2 per one tenth hour average level has been adopted by several U.S. Government agencies including the Occupational Safety and Health Administration (OSHA) as the standard protection guide for employee work environments. An even stricter standard is recommended by the American National Standards Institute which recommends a 1.0 mW/cm^2 per one tenth hour average level exposure between 30 Hz and 300 mHz as the standard employee protection guide (ANSI C95.1-1982).

RF energy must be contained properly by shielding and transmission lines. All input and output RF connections, such as cables, flanges and gaskets must be RF leakproof. Never operate a power tube without a properly matched RF energy absorbing load attached. Never look into or expose any part of the body to an antenna or open RF generating tube or circuit or RF transmission system while energized. Monitor the tube and RF system for RF radiation leakage at regular intervals and after servicing.

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

BeO ceramic material is used as a thermal link to carry heat from a tube or transistor to the heat sink. 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.

HOT SURFACES

The anode portion of power tubes is often air-cooled or conduction-cooled. The air-cooled external surface normally operates at a high temperature (up to 200° to 300°C). Other portions of the tube may also reach high temperatures, especially the cathode insulator and the cathode/heater surfaces. All hot surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to prevent and avoid any bodily contact with these surfaces both during and for a reasonable cool-down period after tube operation.

SCOPE OF MANUAL

This manual comprises two parts, providing the following information for the Broadcast Electronics very-low-power line of FM transmitters.

A. PART I - CONTAINS INFORMATION RELATIVE TO INSTALLATION, OPERATION, AND MAINTENANCE APPLICABLE TO THE OVERALL TRANSMITTER.

B. PART II - CONTAINS DETAILED INFORMATION FOR THE TRANSMITTER POWER AMPLIFIER(S).

PART I - TABLE OF CONTENTS

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LIST OF TABLES

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PART II - TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. Information presented in this section provides a general description of the Broadcast Electronics very-low-power line of FM transmitters and lists equipment specifications.

1-3. RELATED PUBLICATIONS.

1-4. The following list of publications provides data for equipment associated with the Broadcast Electronics very-low-power line of FM transmitters.

PUBLICATION NUMBER	EQUIPMENT
597-0002-001	FX-30 FM Exciter
597-0008	FC-30 SCA Generator
597-0009	FS-30 Stereo Generator

1-5. EQUIPMENT DESCRIPTION.

1-6. The Broadcast Electronics very-low-power line of FM transmitters consists of three models available in single-transmitter configurations as well as main/alternate configurations as shown by the following list. Each transmitter is designed for continuous operation in the 87.5 to 108 MHz FM broadcast band and is completely self-contained in a single rack cabinet. The equipment design incorporates solid-state control circuitry, a solid-state power amplifier, and a solid-state exciter with digital frequency synthesization.

MODEL	PART NUMBER	DESCRIPTION
FM-100	909-0100-200	100 Watt FM transmitter including exciter, solid-state power amplifier, ac power amplifier, ac power control panel, transmitter controller, low-pass filter, and rack; for 194 to 266V, 60 Hz, 1 Ø.
FM-100	909-0100-210	Same as 909-0100-200 excluding exciter.
FM-100	909-0100-300	Same as 909-0100-200 with 50 Hz power supply.
FM-100M/A	909-2100-200	Two 909-0100-200 transmitters in automatic main/alternate configuration including system controller, test load, and RF transfer switch in single rack.
FM-100M/A	909-2100-300	Same as 909-2100-200 with 50 Hz power supply.

MODEL	PART NUMBER	DESCRIPTION
FM-250	909-0250-200	250 Watt FM transmitter including exciter, solid-state power amplifier, ac power amplifier, ac power control panel, transmitter controller, low-pass filter, and rack; for 194 to 266V, 60 Hz, 1 Ø.
FM-250	909-0250-300	Same as 909-0250-200 with 50 Hz power supply.
FM-250M/A	909-2250-200	Two 909-0250-200 transmitters in automatic main/alternate configuration including system controller, test load, and RF transfer switch in single rack.
FM-250M/A	909-2250-300	Same as 909-2250-200 with 50 Hz power supply.
FM-300	909-0300-200	300 Watt FM transmitter including exciter, solid-state power amplifier, ac power amplifier, ac power control panel, transmitter controller, low-pass filter, and rack; for 194 to 266V, 60 Hz, 1 Ø.
FM-300	909-0300-300	Same as 909-0300-200 with 50 Hz power supply.
FM-300M/A	909-2300-200	Two 909-0300-200 transmitters in automatic main/alternate configuration including system controller, test load, and RF transfer switch in single rack.
FM-300M/A	909-2300-300	Same as 909-2300-200 with 50 Hz power supply.

1-7. ELECTRICAL DESCRIPTION.

1-8. Each system consists of modular sub-assemblies to allow ease of maintenance and maximum reliability (see Figures 1-1 through 1-4). Critical units such as the exciter(s) and power amplifier(s) are constructed in drawer housings which may be pulled forward out of the cabinet for accessibility.

1-9. AC power for each transmitter is connected to the ac power control panel at the bottom of the transmitter cabinet. The ac power control panel protects the internal cabinet wiring and provides on-off control for the various assemblies within the system.

1-10. The individual heat-producing assemblies within each system such as the exciter(s) and the power amplifier(s) are individually cooled by self-contained fans. The FM-250 and FM-300 models are equipped with two fans to provide sufficient exchange of cabinet air volume several times each minute, thus assuring cool operation.

1-11. FM-100 OR FM-250 SINGLE CONFIGURATION. This transmitter consists of a transmitter controller, one power amplifier, a low-pass filter, and a directional coupler (see Figure 1-1). Each of these models function as a basic transmitter with few automatic features.

1-12. The transmitter control panel allows both local and remote on-off control and metering functions. Additionally, a battery-powered memory retains the operational configuration during power failures and will automatically restore the transmitter to operation when power returns. The battery supply for this feature is maintained at full charge during normal operation.

1-13. The RF output of the exciter is amplified by the PA stage. The output of the PA stage is routed through a low-pass filter to reduce the harmonic emissions to a sufficiently low level as required to satisfy regulatory requirements. The output of the low-pass filter is routed through a directional coupler which allows measurement of both forward and reflected power. An RF sample port is provided at the input and output of the low-pass filter for connection of a modulation monitor or other test equipment.

1-14. FM-100 OR FM-250 MAIN/ALTERNATE CONFIGURATION. This transmitter consists of one system controller, two transmitter controllers, two power amplifiers, two low-pass filters, two directional couplers, an RF transfer switch, and an RF test load (see Figure 1-2). These models function as single transmitters with automatic back-up.

1-15. The system controller allows both local and remote on-off control and automatic switching of the entire system. In the event of a failure of one transmitter, the system may be configured to automatically connect the alternate transmitter to the antenna and connect the defective transmitter to the test load in a deenergized state. Additionally, a battery-powered memory retains the operational configuration during power failures and will automatically restore the transmitter to operation when power returns. The battery supply for this feature is maintained at full charge during normal operation.

1-16. Each transmitter controller allows both local and remote control and metering of each individual transmitter.

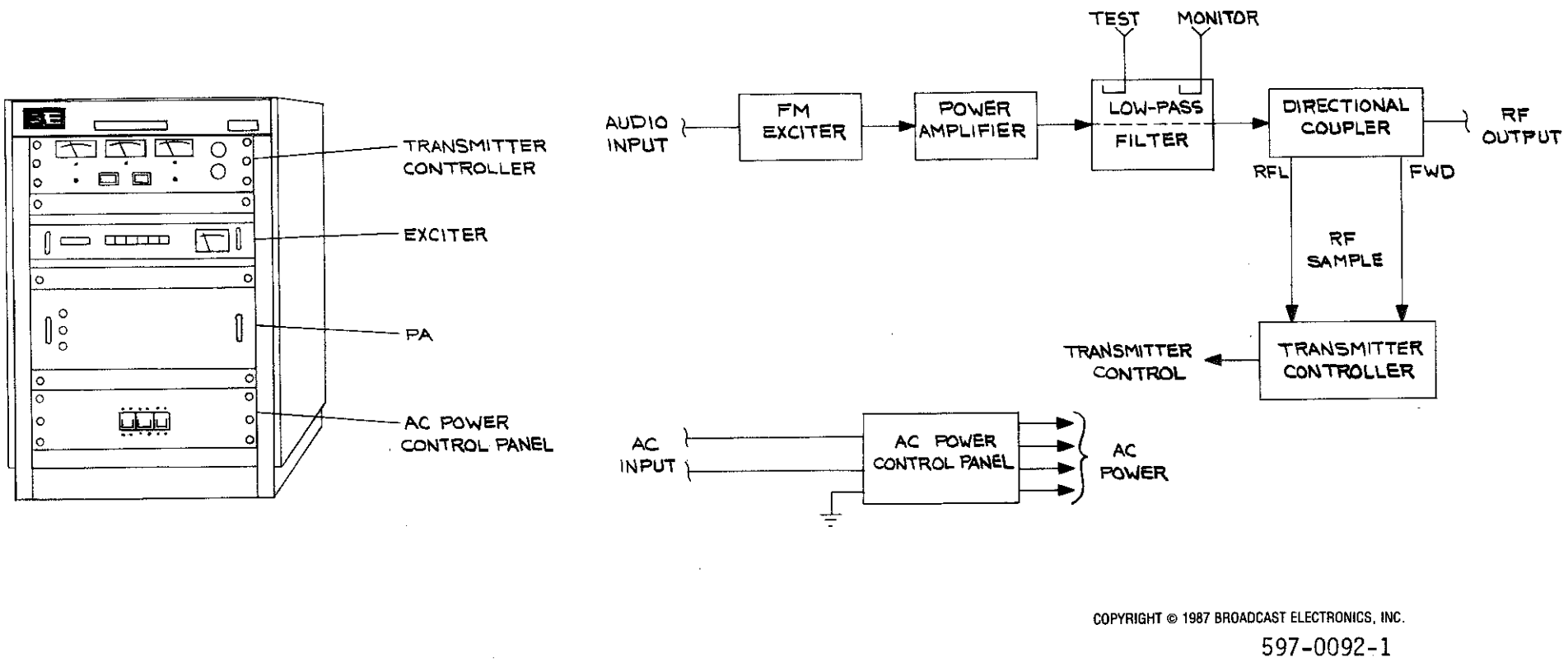

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FIGURE 1-1. FM-100 OR FM-250 SINGLE CONFIGURATION

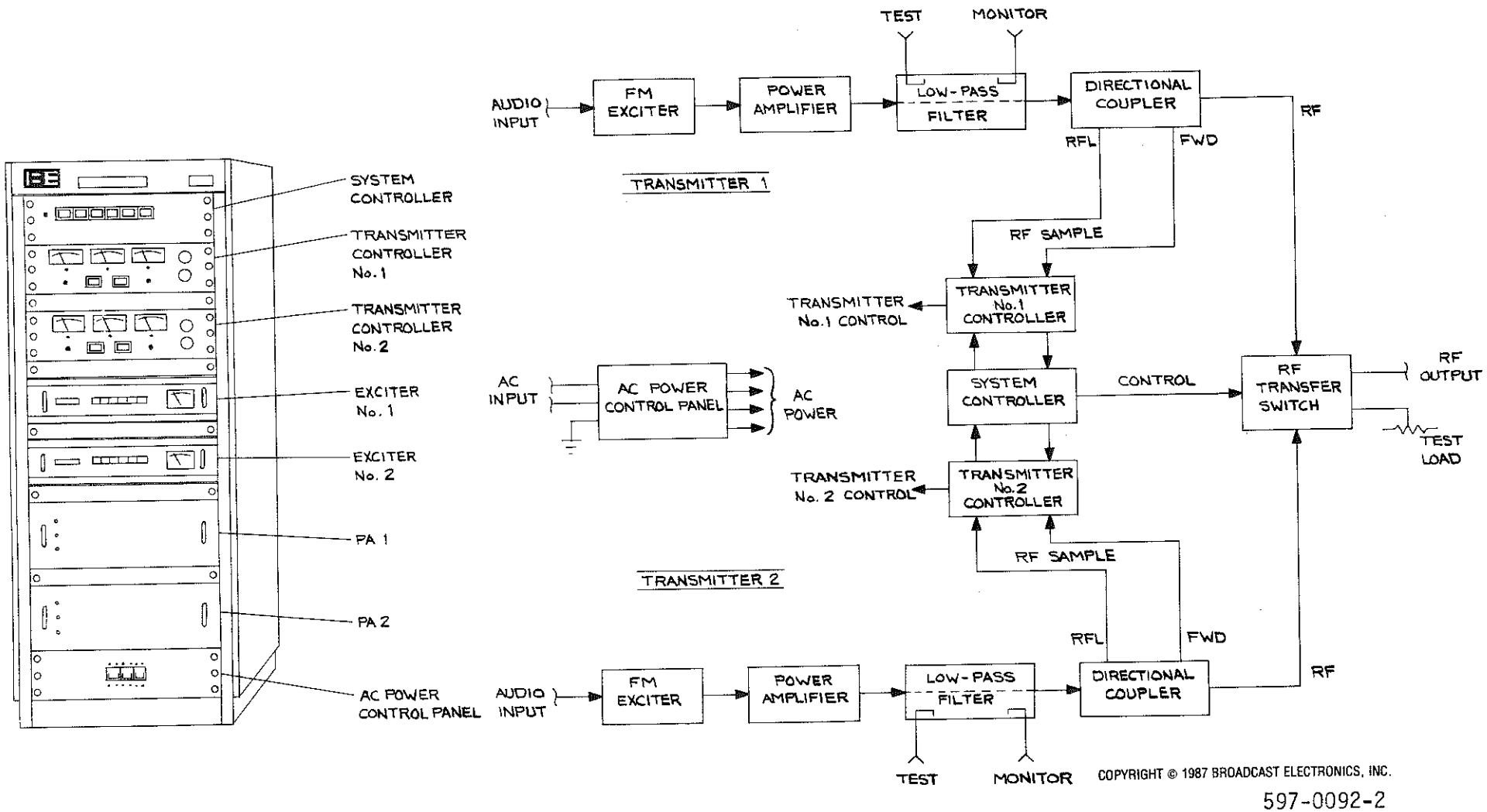


FIGURE 1-2. FM-100 OR FM-250 MAIN/ALTERNATE CONFIGURATION

1-17. The RF output of each exciter is amplified by the PA stage. The output of each PA stage is routed through a low-pass filter to reduce the harmonic emissions to a sufficiently low level as required to satisfy regulatory requirements. The output of each low-pass filter is routed through a directional coupler which allows measurement of both forward and reflected power. An RF sample port is provided at the input and output of each low-pass filter for connection of a modulation monitor or other test equipment.

1-18. FM-300 SINGLE CONFIGURATION. This transmitter consists of a transmitter controller, two power amplifiers, a hybrid splitter and a hybrid combiner, a reject load, a low-pass filter, and a directional coupler (see Figure 1-3). This model functions as a basic transmitter with few automatic features.

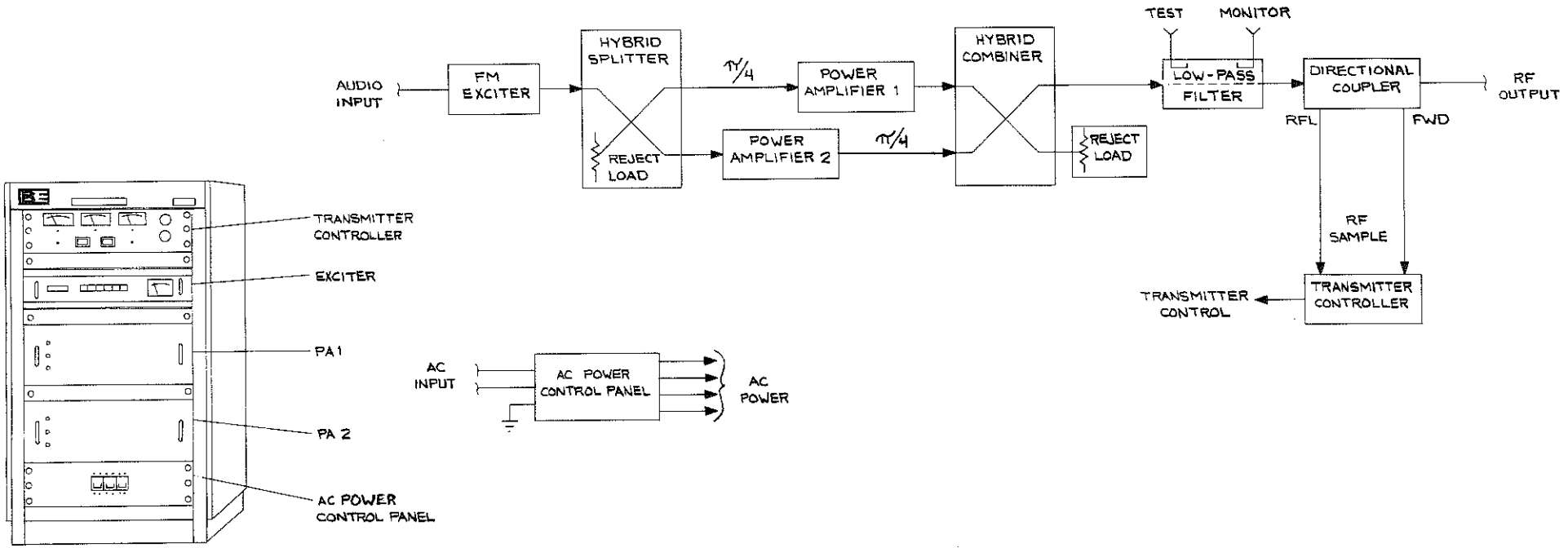
1-19. The transmitter control panel allows both local and remote on-off control and metering functions. Additionally, a battery-powered memory retains the operational configuration during power failures and will automatically restore the transmitter to operation when power returns. The battery supply for this feature is maintained at full charge during normal operation.

1-20. The RF output of the exciter is split into two equal components by a 90 degree hybrid splitter which provides two equal-amplitude signals displaced in time by 90 degrees or one-quarter cycle of the operating frequency. Each output is routed to one power amplifier. The outputs of the power amplifiers are operated in-phase with the 90 degree differential at the splitter made up by precise cable lengths at the amplifier inputs.

1-21. The outputs of the two power amplifiers are then combined through the appropriate lengths of cable and an additional 90 degree hybrid combiner. The outputs of the two amplifiers are added indirectly in the combiner to produce 300 watts at the combiner output.

1-22. As long as both amplifiers produce the proper power level and are in the proper phase relationship at the combiner inputs, there will be no power dissipated in the combining or reject load. Should an amplifier develop a fault and not produce the proper power level, the remaining power will be divided between the antenna load and the reject load.

1-23. The output of the PA stage is routed through a low-pass filter to reduce the harmonic emissions to a sufficiently low level as required to satisfy regulatory requirements. The output of the low-pass filter is routed through a directional coupler which allows measurement of both forward and reflected power. An RF sample port is provided at the input and output of the low-pass filter for connection of a modulation monitor or other test equipment.



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597-0092-3

FIGURE 1-3. FM-300 SINGLE CONFIGURATION

1-24. FM-300 MAIN/ALTERNATE CONFIGURATION. This transmitter consists of one system controller, two transmitter controllers, four power amplifiers, two reject loads, two low-pass filters, two directional couplers, an RF transfer switch, and an RF test load (see Figure 1-4). This model functions as a single transmitter with automatic back-up.

1-25. The system controller allows on-off control and automatic switching. In the event of a failure of one transmitter, the system may be configured in such a manner that the alternate transmitter will automatically be connected to the antenna and the defective transmitter will be automatically connected to the test load in a deenergized state. Additionally, a battery-powered memory retains the operational configuration during power failures and will automatically restore the transmitter to operation when power returns. The battery supply for this feature is maintained at full charge during normal operation.

1-26. Each transmitter controller allows both local and remote control and metering of each individual transmitter.

1-27. The RF output of each exciter is split into two equal components by a 90 degree hybrid splitter which provides two equal-amplitude signals displaced in time by 90 degrees or one-quarter cycle of the operating frequency. Each output is routed to a power amplifier. The outputs of the power amplifiers are operated in-phase with the 90 degree differential at the splitter made up by precise cable lengths at each amplifier input. The outputs of the two power amplifiers are then combined through the appropriate lengths of cable and an additional 90 degree hybrid combiner. The outputs of the two amplifiers are added directly in the combiner to produce 300 watts at the combiner output.

1-28. As long as both amplifiers produce the proper power level and are in the proper phase relationship at the combiner inputs, there will be no power dissipated in the combining or reject load. Should an amplifier develop a fault and not produce the proper power level, the remaining power will be divided between the antenna load and the reject load. When the system controller is operating in the automatic mode, it will sense this condition and automatically transfer operation to the alternate transmitter.

1-29. The output of each PA stage is routed through a low-pass filter to reduce the harmonic emissions to a sufficiently low level as required to satisfy regulatory requirements. The output of each low-pass filter is routed through a directional coupler which allows measurement of both forward and reflected power. An RF sample port is provided at the input and output of the low-pass filter for connection of a modulation monitor or other test equipment.

1-30. EQUIPMENT SPECIFICATIONS.

1-31. Refer to Table 1-1 for electrical specifications or Table 1-2 for physical specifications for the very-low-power line of FM Transmitters.

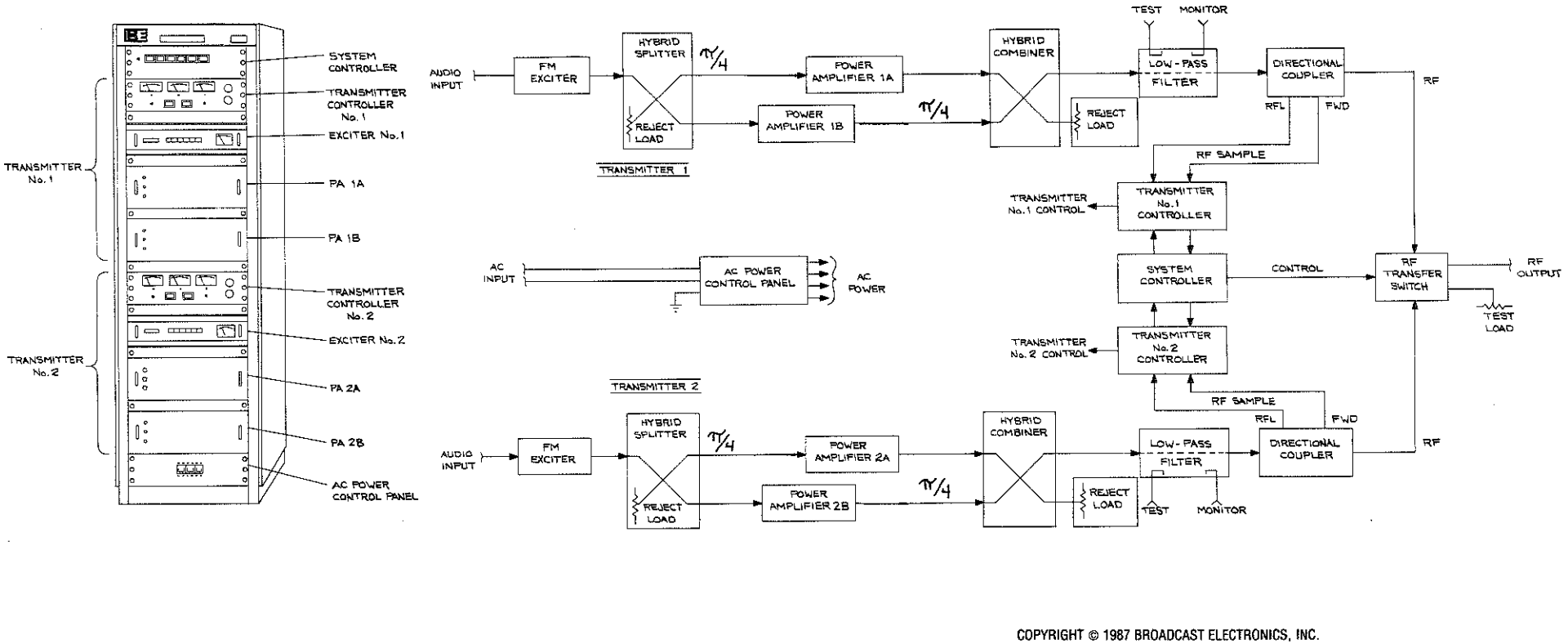

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FIGURE 1-4. FM-300 MAIN/ALTERNATE CONFIGURATION

TABLE 1-1. ELECTRICAL CHARACTERISTICS
(Sheet 1 of 2)

PARAMETER	SPECIFICATIONS
RF POWER OUTPUT	FM-100: 75 to 100 Watts. FM-250: 90 to 250 Watts. FM-300: 90 to 300 Watts.
RF FREQUENCY RANGE	87.5 to 108 MHz (as ordered).
RF OUTPUT IMPEDANCE	50 Ohms Resistive.
RF OUTPUT CONNECTOR	Type N receptacle.
MAXIMUM VSWR	1.2:1
FM S/N RATIO	72 dB below ±75 kHz Deviation @ 400 Hz, measured in a 30 Hz to 15 kHz bandwidth with 75 microsecond de-emphasis.
AM S/N RATIO	65 dB below reference carrier with 100% AM @ 400 Hz, 15 microsecond deemphasis (no FM present).
RF HARMONIC SUPPRESSION	60 dB or better.
FREQUENCY STABILITY	±300 Hz, Ø° to 50°C, temperature compensated crystal oscillator.
TYPE OF MODULATION	Direct frequency modulation at carrier frequency.
MODULATION CAPABILITY	Greater than ±200 kHz.
MONAURAL AUDIO INPUT IMPEDANCE	600 Ohms balanced, resistive.
AUDIO INPUT LEVEL	+10 dBm ±1 dB for ±75 kHz deviation @ 400 Hz.
MONAURAL AUDIO FREQUENCY	±0.5 dB, 30 Hz to 15 kHz, selectable 25, 50, or 75 microsecond pre-emphasis or flat.
MONAURAL OR COMPOSITE:	
a) HARMONIC DISTORTION	0.08% or less, 30 to 15 kHz.

TABLE 1-1. ELECTRICAL CHARACTERISTICS
(Sheet 2 of 2)

PARAMETER	SPECIFICATIONS
b) INTERMODULATION DISTORTION	0.08% or less, 60 Hz/7 kHz, 4:1 ratio.
COMPOSITE INPUTS	3 per exciter, BNC connectors.
COMPOSITE INPUT IMPEDANCE	10 k Ohm nominal, resistive.
COMPOSITE INPUT LEVEL	3.5V p-p nominal for ±75 kHz deviation.
AC INPUT POWER	194 to 266 VRMS, 50/60 Hz, single phase (0.9 power factor).
AC POWER CONSUMPTION	
FM-100	524W Maximum @ 60 Hz for 100W. 616W Maximum @ 50 Hz for 100W.
FM-100M/A *	550W Maximum @ 60 Hz for 100W. 646W Maximum @ 50 Hz for 100W.
FM-250	900W Maximum @ 60 Hz for 250W. 1068W Maximum @ 50 Hz for 250W.
FM-250M/A *	925W Maximum @ 60 Hz for 250W. 1087W Maximum @ 50 Hz for 250W.
FM-300	1100W Maximum @ 60 Hz for 300W. 1293W Maximum @ 50 Hz for 300W.
FM-300M/A *	1125W Maximum @ 60 Hz for 300W. 1322W Maximum @ 50 Hz for 300W.
* ONE TRANSMITTER OPERATING,	ONE TRANSMITTER ON STANDBY.

TABLE 1-2. PHYSICAL CHARACTERISTICS
(Sheet 1 of 2)

PARAMETER	SPECIFICATIONS
AMBIENT TEMPERATURE RANGE	+32°F to +122°F (Ø°C to +50°C).
MAXIMUM ALTITUDE	7500 feet above sea level (2286 Meters).
MAXIMUM HUMIDITY	95%, Non-condensing.
HEAT DISSIPATION	
FM-100	424 Watts @ 100 Watts output at 60 Hz. 516 Watts @ 100 Watts output at 50 Hz.
FM-100M/A	450 Watts @ 100 Watts output at 60 Hz. 546 Watts @ 100 Watts output at 50 Hz.
FM-250	650 Watts @ 250 Watts output at 60 Hz. 818 Watts @ 250 Watts output at 50 Hz.
FM-250M/A	675 Watts @ 250 Watts output at 60 Hz. 837 Watts @ 250 Watts output at 50 Hz.
FM-300	800 Watts @ 300 Watts output at 60 Hz. 993 Watts @ 300 Watts output at 50 Hz.
FM-300M/A	825 Watts @ 300 Watts output at 60 Hz. 1022 Watts @ 300 Watts output at 50 Hz.
COOLING AIR REQUIREMENT	
SINGLE CONFIGURATION	250 ft^3/min overall (7.08 m^3/min).
MAIN/ALTERNATE CONFIGURATION	500 ft^3/min overall (14.15 m^3/min).
AIR INLET SIZE (Rear Panel)	7.75 inches X 14 inches (19.69 cm X 35.56 cm).
AIR OUTLET SIZE (Top)	22 inches X 25.5 inches (55.88 cm X 64.77 cm).

TABLE 1-2. PHYSICAL CHARACTERISTICS
(Sheet 2 of 2)

PARAMETER	SPECIFICATIONS
SIZE	
FM-100 OR FM-250	23.38 inches W X 31.37 inches D X 36.56 inches H (59.39 cm X 78.68 cm X 92.86 cm).
FM-300	23.38 inches W X 31.37 inches D X 50.56 inches H (59.39 cm X 78.68 cm X 128.42 cm).
FM-100M/A OR FM-250M/A	23.38 inches W X 31.37 inches D X 69.18 inches H (59.39 cm X 78.68 cm X 175.73 cm).
FM-300M/A	23.38 inches W X 31.37 inches D X 78.56 inches H (59.39 cm X 78.68 cm X 199.54 cm).
	Anti-Tip legs extend out an additional 11.37 inches (28.88 cm) in front of transmitter.
CUBAGE	
SINGLE CONFIGURATION	15.85 ft^3 (0.45 m^3).
MAIN/ALTERNATE CONFIGURATION	33.5 ft^3 (0.95 m^3).
WEIGHT (Unpacked)	
FM-100 OR FM-250	225 pounds (102 kg).
FM-100M/A OR FM-250M/A	500 pounds (227 kg).
FM-300	275 pounds (125 kg).
FM-300M/A	550 pounds (250 kg).

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information required for installation and preliminary checkout of the Broadcast Electronics very-low-power line of FM transmitters.

2-3. UNPACKING.

2-4. The equipment becomes the property of the customer when the equipment is delivered to the carrier. Carefully unpack the transmitter. 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 list. 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 1-2 provides environmental conditions which must be considered prior to transmitter installation.

2-8. COOLING AIR REQUIREMENTS.

2-9. If the heated transmitter air is to be ducted from the room, the duct system must not introduce any back-pressure on the equipment. Proper allowances for air flow will ensure that only a limited amount of heat is dissipated into the equipment interior. The duct system must allow for the minimum air flow listed in table 1-2.

2-10. As a minimum requirement, any duct work must have a cross-sectional area equal to the exhaust area of the cabinet (refer to Figure 2-1). Sharp bends in the duct system will introduce back pressure and are not permissible. A radius bend must be used if a right angle turn is required. An exhaust fan may be used to overcome duct losses or overcome wind pressures if the duct is vented to the outside.

2-11. INSTALLATION.

2-12. Each transmitter 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 an understanding of the operation circuitry nomenclature, and installation requirements. Installation is accomplished as follows: 1) placement, 2) component installation, 3) remote control connections, 4) ac wiring, and 5) initial checkout.

2-13. EQUIPMENT PLACEMENT.

2-14. Access holes in the top and bottom of the cabinet allow ducting of interconnecting wiring from above or below. The surface must be capable of supporting the total transmitter weight as follows. The support should be more than marginal to maintain proper cabinet alignment and reduce vibration.

FM-100 OR FM-250	44 pounds per square foot
FM-100M/A OR FM-250M/A	98 pounds per square foot
FM-300	54 pounds per square foot
FM-300M/A	108 pounds per square foot

2-15. After it has been determined where and how the cabinet will be positioned, level the cabinet and bolt the base to the mounting surface.

2-16. COMPONENT INSTALLATION.

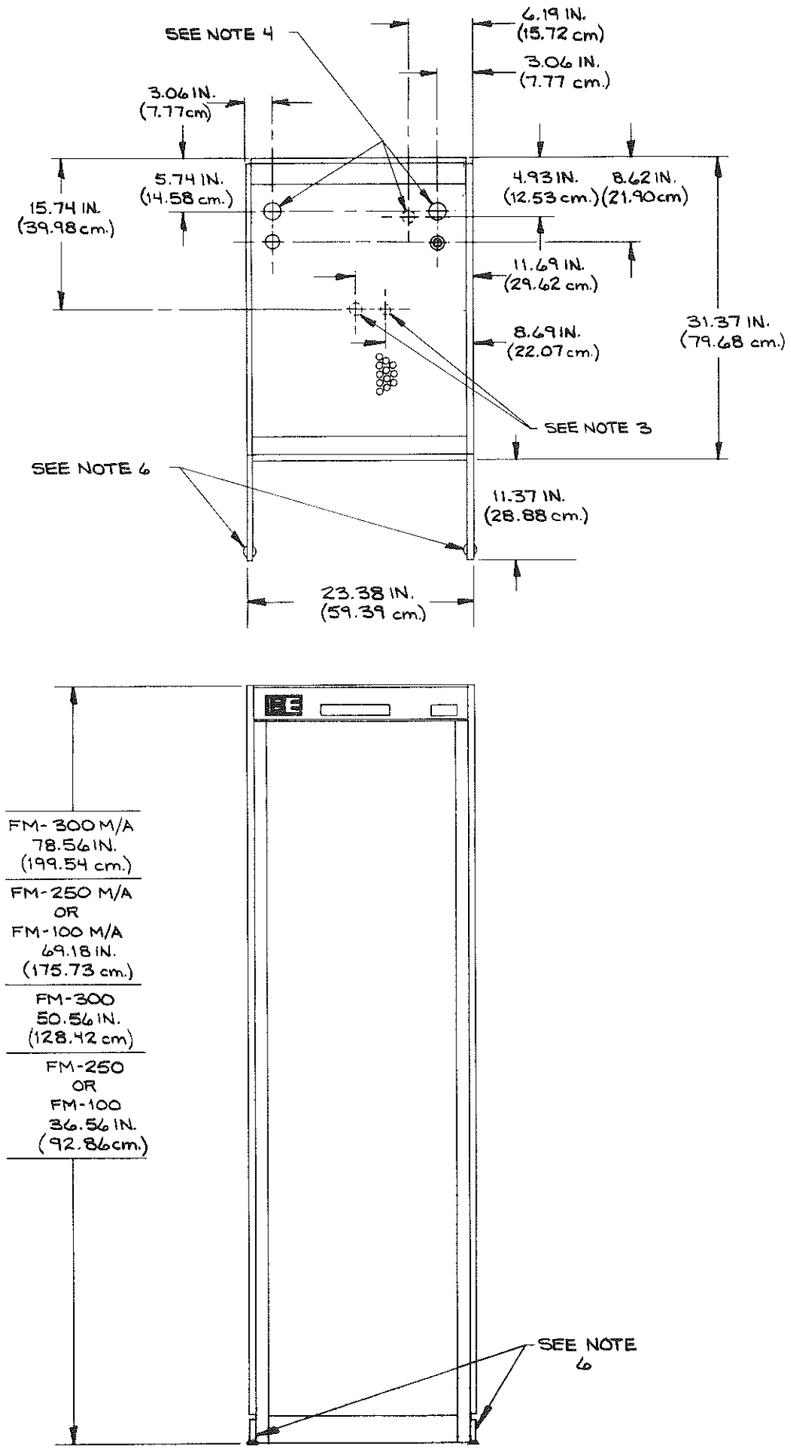
WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-17. Interconnecting wires and cables are tied in for shipment. Remove all tape, wire ties, string, and packing material used for shipment.

2-18. The exciter, the power amplifier, all cables, connectors, and miscellaneous components to be installed are shipped in separate cartons. The following text provides information concerning the installation of these items. The exact procedure may differ from the following steps due to the method and requirements for shipping.

NOTE ENSURE CONTROLS ARE NOT MOVED FROM THEIR FACTORY PRESET POSITIONS DURING INSTALLATION.

2-19. Remove the transmitter rear panel. For removal, the panel simply lifts up and off.



NOTES:

1. AIR INLET AT REAR OF CABINET, 7.75 IN. X 14 IN. (19.69 cm X 35.56 cm) P/N 407-0062 FILTER REQUIRED.
2. AIR OUTLET AT TOP OF CABINET, 21 3/4 IN. X 25 1/2 IN. (55.25 cm X 64.77 cm).
3. ACCESS FOR AC POWER THROUGH BASE PLATE. (MAY BE ACCESSED THRU TOP, REAR, OR SIDES BY ADDING ACCESS HOLE.)
4. ACCESS FOR REMOTE CONTROL AND AUDIO CONNECTIONS THROUGH TOP OR BOTTOM OF CABINET.
5. OUTPUT RF CONNECTOR IS AMPHENOL 82-66 (UG30/N) TYPE N CONNECTOR.
6. ANTI-TIP LEGS USED ON FM-300M/A TRANSMITTER ONLY.
7. IT IS RECOMMENDED THAT THIS TRANSMITTER BE BOLTED TO THE MOUNTING SURFACE.
8. WEIGHT UNPACKED:

FM-100 OR FM-250	225 lbs. (102 kg)
FM-100M/A OR FM-250M/A	500 lbs. (227 kg)
FM-300	275 lbs. (125 kg)
FM-300M/A	550 lbs. (250 kg)

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FIGURE 2-1. TRANSMITTER OUTLINE DRAWING

2-20. Remove both side panels. Each panel is secured by one bolt for the single transmitters or two bolts for the dual transmitters. A 3/8 inch (10 mm) hex nut driver is required. After the bolts are removed, each panel lifts up and off for removal.

2-21. Remove all ties from each set of slide rails.

2-22. Install the PA(s) and exciter(s) in the rack onto their slide rails.

2-23. Connect the wiring between the exciter(s) and PA(s) as labeled by tags attached to the wiring.

2-24. Connect the antenna load to the transmitter.

2-25. CIRCUIT BOARD PROGRAMMING.

2-26. SYSTEM CONTROLLER. The system controller is designed with programmable circuits which determine the control and operating characteristics of the unit. Figure 2-2 presents several control and operating parameters. Refer to Figure 2-2 and program the system controller circuit board as required for the following operations.

2-27. Automatic Mode Disable Control. Control circuitry is provided which will disable the automatic mode when the remote system off switch is operated. To disable the automatic mode, install jumper W1. To enable the automatic mode, remove jumper W1. The unit is shipped from the factory with jumper W1 installed.

2-28. Automatic Mode Enable Control. Control circuitry is provided which will enable the automatic mode when the XMTR ON switch/indicator is operated. To enable the automatic mode, install jumper W2. To disable the automatic mode, remove jumper W2. The unit is shipped from the factory with jumper W2 installed.

2-29. Delay Time Select Operation. The delay time prior to automatic switching is determined by programmable jumper P9. To select 0.05 second delay, install P9 in position 1-2. To select 5 second delay, install P9 in position 2-3. The unit is shipped from the factory with P9 installed in position 1-2.

2-30. Sample Voltage Reduction Operation. The maximum required sample voltage from the transmitter is selectable by programmable jumpers P7 and P8. If +5 volts is desired, remove P7 and P8. To reduce the sample voltage to +2.5 volts, install P7 and P8. The unit is shipped from the factory with P7 and P8 installed.

2-31. PA ASSEMBLY. The power amplifier assembly is designed with programmable circuits which determine the control and operating characteristics of the unit. Check the PA circuit board programming as follows:

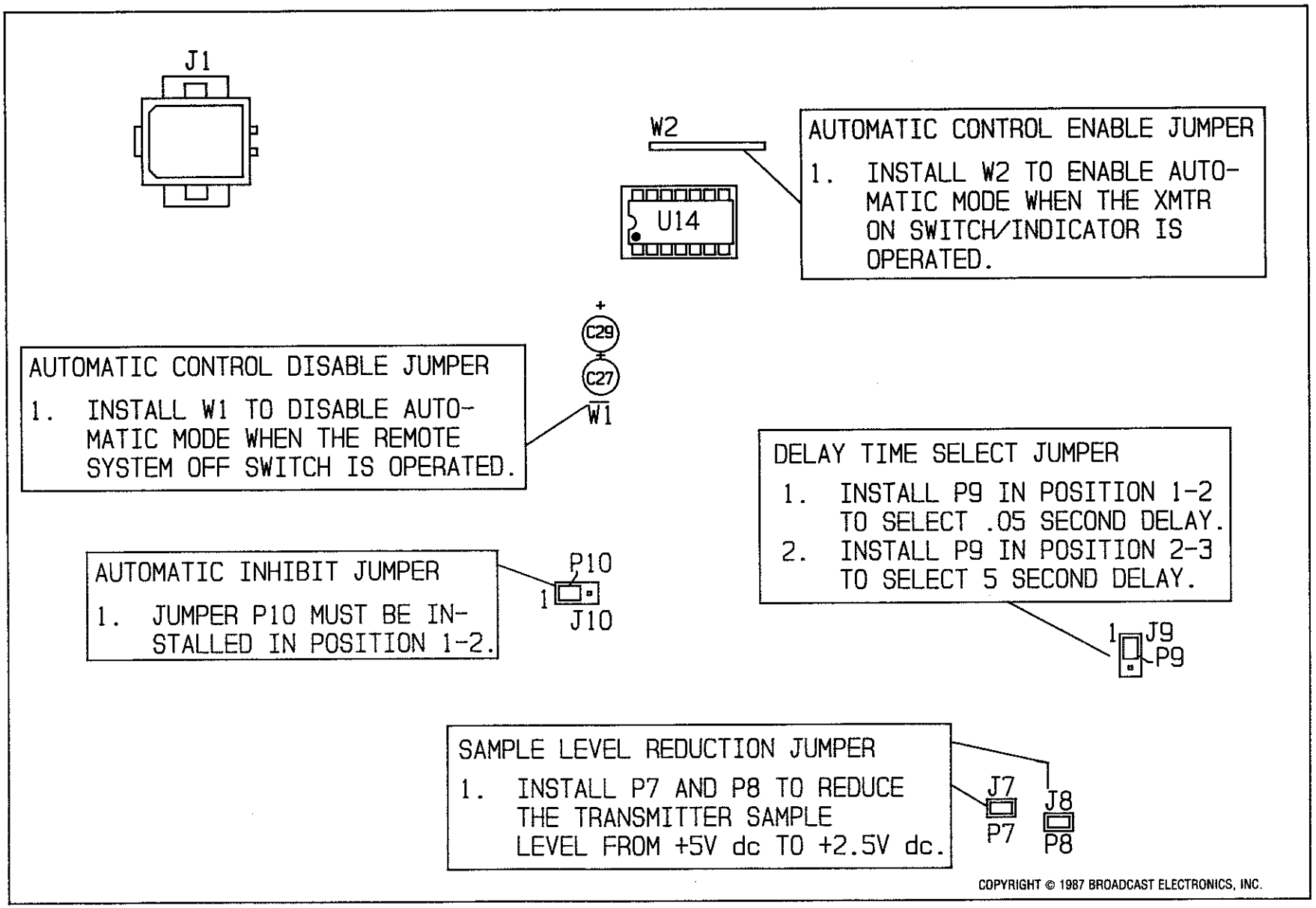

FIGURE 2-2. SYSTEM CONTROLLER CIRCUIT BOARD JUMPER PROGRAMMING 597-0092-50

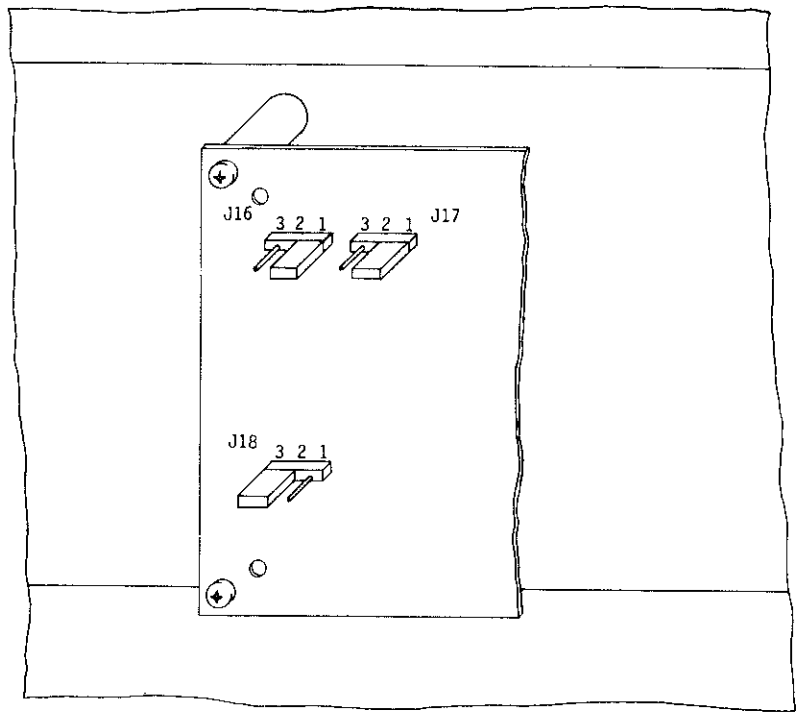

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FIGURE 2-3. PA JUMPER PROGRAMMING

A. Extend the PA forward and remove the top-panel.

B. Refer to Figure 2-3 and ensure all circuit board jumpers are correctly positioned.

C. Replace the top-panel.

2-32. REMOTE CONTROL.

2-33. Many transmitter control and monitoring functions are available as remote control features (see Table 2-1). Also, the transmitter will interface with most modern remote control units such as the sixteen channel Moseley MRC-1600.

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-34. VOLTAGE TAPS. Ensure the transmitter is wired for the input voltage to be used. The PA's, the system controller, the transmitter controllers and the FM exciters must be checked and changed if required.

2-35. Check the PA voltage taps per Figure 2-4 and change the wiring if required.

TABLE 2-1. REMOTE INTERFACE CONNECTIONS

SYSTEM CONTROLLER (MAIN/ALTERNATE TRANSMITTERS)

TB1-	FUNCTION	STATUS
1	System On	Momentary connection to ±5V to ±24V required to activate function.
2	System Off	
3	Manual Mode	
4	Automatic Mode	
5	Transmitter No. 1 Select	
6	Transmitter No. 2 Select	
7	Control Common (Isolated)	
8	Manual Status	Current sink to ground when active.
9	Automatic Status	
10	Transmitter No. 1 Status	
11	Transmitter No. 2 Status	
12	Status Common (Chassis Ground)	

TRANSMITTER CONTROLLER (ALL TRANSMITTERS)

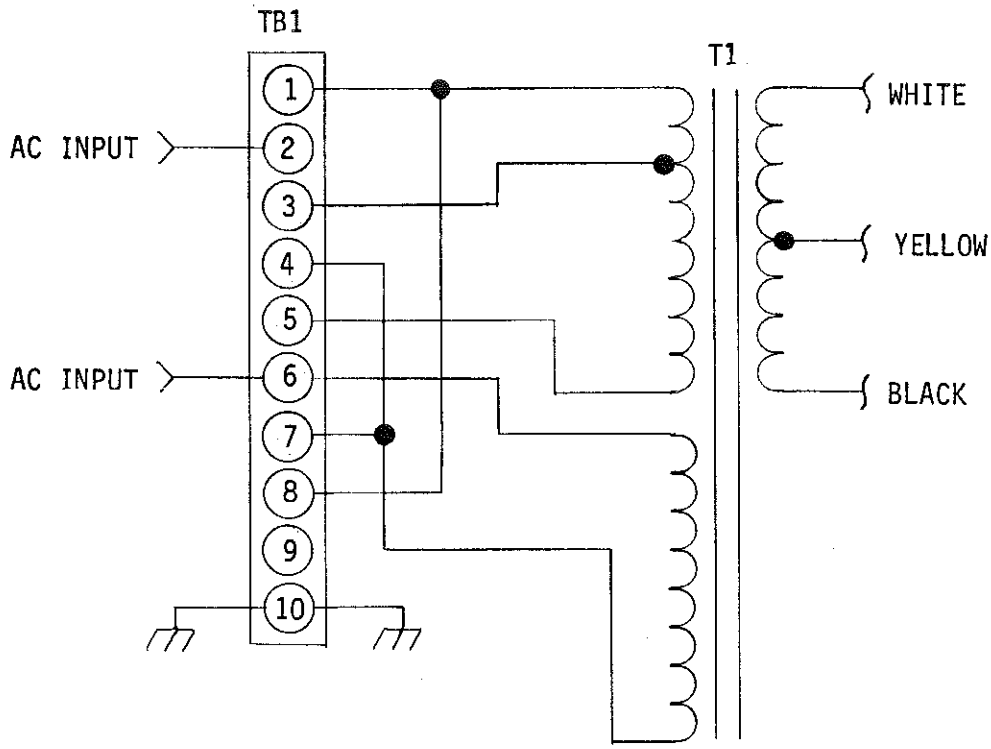
TB1-	FUNCTION	STATUS
1	Transmitter On	Momentary connection to ±5V to ±24V required to activate function.
2	Transmitter Off	
3	Failsafe Input	Constant +5V to +24V input required to enable remote control.
4	Remote Control Common	
5	Power Raise	Momentary connection to pin 7 required to raise or lower RF power.
6	Power Lower	
7	Power Common	
8	+24 Volts	
9	Common	
10	Not Used	

TB2-	FUNCTION	STATUS
1	Forward Power	+5 VDC @ 100% forward power.
2	Reflected Power	+5 VDC @ 3:1 reflection.
3	Power Common	
4	PA No. 1 Collector Voltage	+5 VDC @ 30 VDC PA voltage.
5	PA No. 1 Collector Current	+5 VDC @ 15 VDC PA current.
6	PA No. 1 Meter Common	
7	* PA No. 2 Collector Voltage	+5 VDC @ 30 VDC PA voltage.
8	* PA No. 2 Collector Current	+5 VDC @ 15 VDC PA current.
9	* PA No. 2 Meter Common	
10	Not Used	

* FM-300 AND FM-300M/A ONLY

2-36. The system controller, the transmitter controllers, and the FM exciters should be checked as follows:

A. The primary ac line voltage with which the transmitter will be used must be visible on the ac line voltage selector circuit board (220V or 230/240V).



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LINE VOLTAGE	JUMPER	SECONDARY WIRING
194-223V	2-3, 4-5, 8-9	BLACK AND WHITE
213-256V	2-3, 4-5, 8-9	BLACK AND YELLOW
208-250V	1-2, 4-5, 8-9	BLACK AND WHITE
229-275V	1-2, 4-5, 8-9	BLACK AND YELLOW

FIGURE 2-4. PA VOLTAGE TAPS

B. If an ac line voltage selector must be changed, remove the ac line voltage selector circuit board with a small pair of needle-nose pliers. Reinsert the circuit board so that the correct ac line voltage is visible when the circuit board is reinserted into the receptacle.

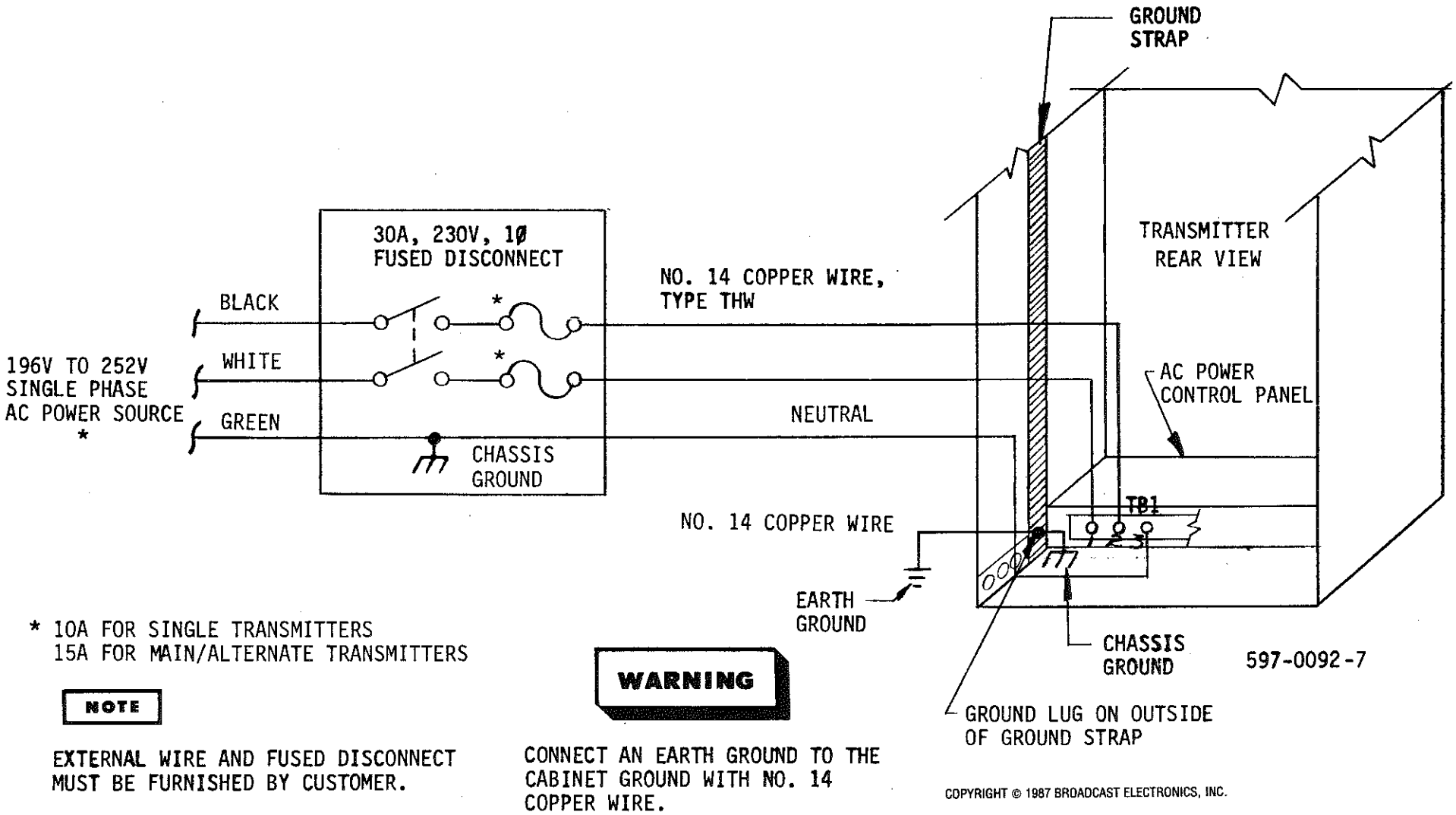


FIGURE 2-5. PRIMARY AC WIRING

2-37. GROUND. A common ground conductor must connect to the ground connection inside the cabinet (see Figure 2-5). This ground must be securely connected to the station common earth ground by the most direct route with No. 14 copper wire.

2-38. SIGNAL INPUTS. Refer to the applicable technical manual for the exciter, and wire the input connections to each unit.

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-39. AC POWER CONNECTIONS. A single-phase source of 196 to 252V ac, 60 Hz, at 15 Amperes is required for the transmitter ac input. It is strongly suggested that the power source be connected to the transmitter through a fused power disconnect for safety reasons (see Figure 2-5).

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-40. Main AC Input. Connect the ac service to TB1 on the rear of the transmitter ac power distribution panel through a fused service disconnect as shown by Figure 2-5. Ensure the neutral wire is securely connected to TB1-3.

2-41. INITIAL CHECKOUT.

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-42. Ensure that the transmitter is completely installed, the transmitter is connected to a suitable RF load, and the station monitor is connected to the RF sample port in the low-pass filter. Check the following:

A. Ensure primary power is correctly wired.

B. Ensure all ground connections are secure.

C. Ensure all RF connections are secure.

D. Ensure all connections at terminal boards are secure.

E. Rotate the fan(s) by hand to ensure no obstructions are present.

F. Earth ground is securely connected.

2-43. Remove any extra hardware and wire lying within the cabinet.

2-44. Replace the cabinet side panels and secure each side panel with one or two bolts (as applicable) through the cabinet rear support rails.

2-45. The following procedures will refer to the factory final test data sheets supplied with the transmitter. Some differences in the actual operation may be noted due to differences in primary power and/or antenna systems. Ensure any controls specified are preset to the positions indicated on the final test data sheets.

2-46. SINGLE TRANSMITTER CHECKOUT. The following checkout is presented for the single-transmitter configurations. Refer to the final test data sheets as required during the initial checkout.

2-47. Adjust the transmitter controller POWER ADJUST control fully counterclockwise and POWER METERING switch to XMTR FWD.

2-48. Operate the transmitter controller RMT/LCL switch to LCL.

2-49. Operate the exciter ON/OFF switch to ON.

2-50. Operate the transmitter controller BATTERY ON/OFF switch to ON.

2-51. Depress the exciter FWD meter switch.

2-52. Replace the cabinet rear access panel.

2-53. Operate the two circuit breakers on the ac control and distribution panel to OFF.

2-54. Close the wall-mounted fused switch.

2-55. Operate the ac power and control panel CONTROL and XMTR circuit breakers to ON. The transmitter controller OFF switch/indicator will illuminate.

2-56. Depress the transmitter controller ON switch/indicator. The transmitter controller ON switch/indicator will illuminate and the OFF switch/indicator will go out.

2-57. The transmitter will energize and PA voltage and current will be noted. The POWER meter will indicate low power output.

2-58. The exciter AFC and POWER meters will illuminate steadily and the presence of programming will be noted on the MODULATION meter.

2-59. Adjust the transmitter controller POWER ADJUST control clockwise to obtain an indication of 50% power output.

2-60. Operate the POWER METERING switch to XMTR RFL and check the reflected power. The reflected power must be less than 1.2:1.

2-61. Operate the POWER METERING switch to XMTR FWD and adjust the POWER ADJUST control to obtain a power output of 100%. The FWD POWER indicators on the PA will illuminate.

2-62. Operate the CONTROL and XMTR circuit breakers on the ac control and distribution panel to OFF.

2-63. Operate the CONTROL and XMTR circuit breakers to ON. The transmitter will automatically return to operation.

2-64. The transmitter is now ready for operation.

2-65. MAIN ALTERNATE TRANSMITTER CHECKOUT. The following checkout is presented for the main alternate transmitter configurations. Refer to the final test data sheets as required during the initial checkout.

2-66. Adjust both transmitter controller POWER ADJUST controls to half-rotation and adjust both POWER METERING switches to XMTR FWD (TOTAL FWD).

2-67. Operate the three RMT/LOCAL switches to LOCAL. There is one switch on each of the transmitter controllers and one switch on the system controller.

2-68. Open the cabinet rear access panel and operate the exciter ON/OFF switches to ON.

2-69. Operate the three BATTERY ON/OFF switches to ON. There is one switch on the rear of each of the transmitter controllers and one switch on the system controller.

2-70. Depress both exciter FWD meter switches.

2-71. Install the cabinet rear access panel.

2-72. Assure the three circuit breakers on the ac control and distribution panel are OFF.

2-73. Close the wall-mounted fused switch.

2-74. Operate the ac power and control panel CONTROL circuit breaker to ON. The system controller MAN MODE or AUTO MODE switch/indicator, the TX-1 SELECT or TX-2 SELECT switch/indicator, and the XMTR ON or XMTR OFF switch/indicator will illuminate.

2-75. Operate the ac power and control panel XMTR 1 and XMTR 2 circuit breakers to ON. The OFF switch/indicators on each of the transmitter controllers will illuminate.

2-76. Depress the system controller TX-1 SELECT switch/indicator. The TX-2 switch/indicator will go out (if illuminated) and the TX-1 switch/indicator will illuminate.

2-77. Depress the system controller XMTR ON switch/indicator. The No. 1 transmitter controller ON switch/indicator will illuminate and the OFF switch/indicator will go out.

2-78. Transmitter No. 1 will energize and PA voltage and current will be noted for the power amplifier(s). The POWER meter will indicate power output.

2-79. The exciter AFC and POWER meters will illuminate steadily and the presence of programming will be noted on the MODULATION meter.

2-80. Operate the POWER METERING switch to XMTR RFL (TOTAL RFL) and check the reflected power. The reflected power must be less than 1.5:1.

2-81. Operate the POWER METERING switch to XMTR FWD (TOTAL FWD) and adjust the POWER METERING control to obtain a power output of 100%. The FWD POWER indicator(s) for transmitter No. 1 will illuminate.

2-82. Using the No. 1 transmitter controller POWER METER switch, check the reflected and forward power. The forward power indicators should be between 90% and 110%. The reflected power indication should be less than 1.5:1.

2-83. Adjust the transmitter controller No. 1 POWER ADJUST control fully counterclockwise.

2-84. After a delay, transmitter No. 2 will energize and PA voltage and current will be noted for the power amplifier(s). The POWER meter will indicate power output. Transmitter No. 1 will deenergize.

2-85. The exciter AFC and POWER meters will illuminate steadily and the presence of programming will be noted on the MODULATION meter.

2-86. Operate the POWER METERING switch to XMTR RFL (TOTAL RFL) and check the reflected power. The reflected power must be less than 1.5:1.

2-87. Operate the POWER METERING switch to XMTR FWD (TOTAL FWD) and adjust the POWER ADJUST control to obtain a power output of 100%. The FWD POWER indicator(s) for transmitter No. 2 will illuminate.

2-88. Using the No. 2 transmitter controller POWER METER switch, check the reflected and forward power. The forward power indication should be between 90% and 110%. The reflected power indication should be less than 1.5:1.

2-89. Adjust the transmitter controller No. 1 POWER ADJUST control to half-rotation.

2-90. Adjust the transmitter controller POWER ADJUST control fully counterclockwise.

2-91. After a delay, transmitter No. 1 will energize and PA voltage and current will be noted for the power amplifier(s). The POWER meter will indicate power output. Transmitter No. 2 will deenergize.

2-92. Depress the system controller MAN MODE switch/indicator. Transmitter system No. 1 will remain operational and the MAN MODE switch/indicator will illuminate. The system controller AUTO MODE switch/indicator will go out.

2-93. Depress the system controller XMTR OFF switch/indicator. Transmitter No. 1 will deenergize, the transmitter No. 1 controller OFF switch/indicator will illuminate, and the ON indicator will go out.

2-94. Depress the system controller XMTR ON switch/indicator. The AUTO MODE switch/indicator will illuminate and the MAN MODE switch/indicator will go out. Transmitter No. 1 will energize.

2-95. Adjust the transmitter No. 1 controller POWER ADJUST control fully counterclockwise. After a delay, the system will switch to transmitter No. 2 and will not automatically switch back to transmitter No. 1, even though transmitter No. 2 is inoperative.

2-96. The transmitter is now ready for operation.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section identifies all controls and indicators associated with the Broadcast Electronics very-low-power line of FM transmitters 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. The function of each control or indicator is described in Table 3-1.

3-5. MAIN/ALTERNATE TRANSMITTER OPERATION.

NOTE

NOTE

THE FOLLOWING PROCEDURE IS PRESENTED UNDER THE ASSUMPTION THAT THE TRANSMITTER IS FULLY INSTALLED AND IS FREE OF ANY DISCREPANCIES.

3-6. TURN ON.

3-7. Operate the system controller RMT/LOCAL CONTROL switch to LOCAL and operate both transmitter controller LCL/RMT CONTROL switches to LCL.

3-8. Operate the BATTERY ON/OFF switch on the rear of the system controller to ON and operate the BATTERY ON/OFF switches on the rear of the two transmitter controllers to ON.

3-9. Close the wall-mounted fused switch.

3-10. Operate all three circuit breakers on the ac power control panel to ON.

3-11. The transmitter will energize in either the manual or automatic mode of operation; both transmitters off-the-air, transmitter No. 1 or transmitter No. 2 selected.

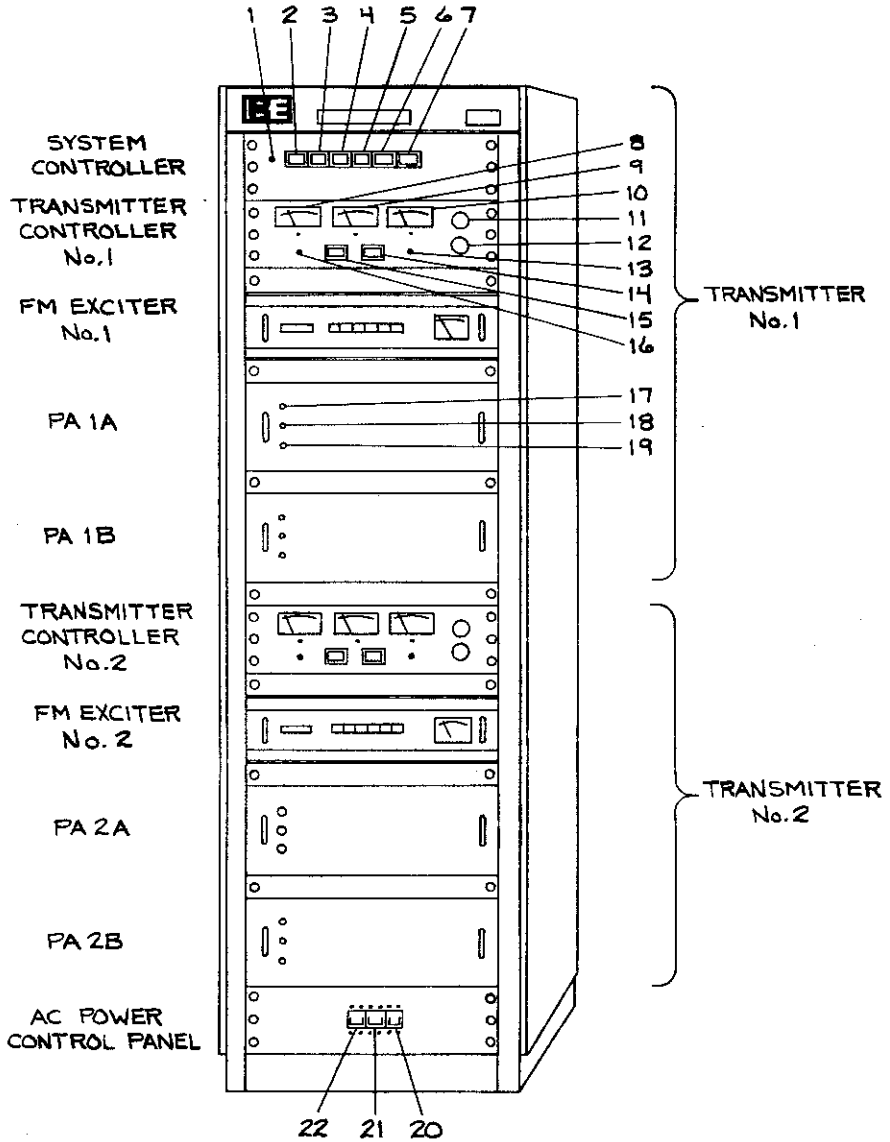
3-12. Depress the system controller AUTO MODE switch/indicator. The AUTO MODE switch/indicator will illuminate.

3-13. If operation of transmitter 1 is desired, depress the system controller TX-1 SELECT switch/indicator.

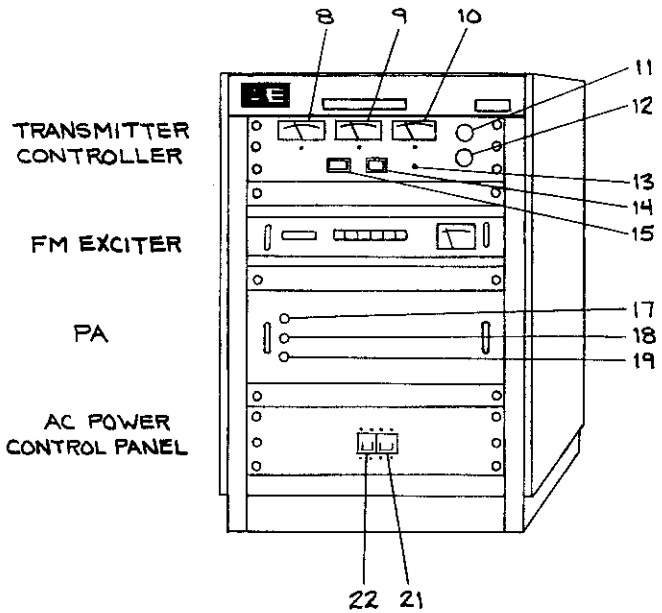
NOTE

A DELAY OF TEN SECONDS IS REQUIRED BETWEEN SELECTION OF TRANSMITTERS.

3-14. If operation of transmitter 2 is desired, depress the system controller XMTR ON switch.



TYPICAL MAIN/ALTERNATE TRANSMITTER CONFIGURATION



TYPICAL SINGLE TRANSMITTER CONFIGURATION

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FIGURE 3-1. CONTROLS AND INDICATORS

3-15. Depress the ON switch/indicator on the selected transmitter controller. The ON indicator will illuminate, the FWD POWER indicator on the selected PA stage(s) will illuminate, and the POWER and AFC indicators on the selected exciter will illuminate steadily.

3-16. Observe and record all meter indications and illuminated indicators.

3-17. TURN OFF.

3-18. Depress the system controller XMTR OFF switch.

3-19. The OFF switch/indicator on the operating transmitter will illuminate.

3-20. Operate all three circuit breakers on the ac power control panel to OFF.

3-21. Open the wall-mounted fused switch.

3-22. Operate the BATTERY ON/OFF switch on the rear of the system controller to OFF and operate the BATTERY ON/OFF switches on the rear of the two transmitter controllers to OFF.

3-23. SINGLE TRANSMITTER OPERATION.

NOTE

NOTE

THE FOLLOWING PROCEDURE IS PRESENTED UNDER THE ASSUMPTION THAT THE TRANSMITTER IS FULLY INSTALLED AND IS FREE OF ANY DISCREPANCIES.

3-24. TURN ON.

3-25. Operate the transmitter controller RMT/LCL CONTROL switch to LCL.

3-26. Operate the BATTERY ON/OFF switch on the rear of the transmitter controller to ON.

3-27. Close the wall-mounted fused switch.

3-28. Operate both circuit breakers on the ac power control panel to ON.

3-29. The transmitter controller will energize with the transmitter off-the-air and the OFF switch/indicator illuminated.

3-30. Depress the transmitter controller ON switch/indicator. The ON switch/indicator will illuminate and the OFF switch/indicator will extinguish. The POWER and AFC indicators on the exciter will illuminate steadily.

3-31. Observe and record all meter indications and illuminated indicators.

3-32. TURN OFF.

3-33. Depress the transmitter controller OFF switch/indicator.

3-34. The OFF switch/indicator will illuminate and the ON switch/indicator will extinguish.

3-35. Operate both circuit breakers on the ac power control panel to OFF.

3-36. Open the wall-mounted fused switch.

3-37. Operate the BATTERY ON/OFF switch on the rear of the transmitter controller to OFF.

TABLE 3-1. CONTROLS AND INDICATORS
(Sheet 1 of 3)

INDEX NO.	NOMENCLATURE	FUNCTION
1	RMT/LOCAL CONTROL Switch	Allows both remote and local control of the system controller when operated to RMT. Local control only is enabled when operated to LOCAL.
2	MAN MODE Switch/ Indicator	SWITCH: Configures system to allow manual control. INDICATOR: Indicates system is configured in manual mode when illuminated.
3	AUTO MODE Switch/ Indicator	SWITCH: Configures system to allow automatic control. INDICATOR: Indicates system is configured in automatic mode when illuminated.
4	TX-1 SELECT Switch/Indicator	SWITCH: Selects transmitter No. 1 for on-air operation when depressed. INDICATOR: Indicates transmitter No. 1 is operational when illuminated.

TABLE 3-1. CONTROLS AND INDICATORS
(Sheet 2 of 3)

INDEX NO.	NOMENCLATURE	FUNCTION
5	TX-2 SELECT Switch/Indicator	SWITCH: Selects transmitter No. 2 for on-air operation when depressed. INDICATOR: Indicates transmitter No. 2 is operational when illuminated.
6	XMTR OFF Switch	Deenergizes both transmitters and configures the control circuitry for manual operation.
7	XMTR ON Switch	Energizes both transmitter and configures the control circuitry for automatic operation.
8	PA VOLTAGE Meter	Indicates PA voltage for the associated amplifier.
9	PA CURRENT Meter	Indicates PA current for the associated amplifier.
10	POWER Meter	Indicates RF power output for the associated amplifier.
11	POWER METERING Switch	Selects parameter to be displayed by the POWER meter.
12	POWER ADJUST Control	Allows adjustment of transmitter output power.
13	LCL/RMT CONTROL Switch	Allows both remote and local control of the associated transmitter system.
14	ON Switch/ Indicator	SWITCH: Energizes the associated transmitter. INDICATOR: Indicates the associated transmitter is energized when illuminated.
15	OFF Switch/ Indicator	SWITCH: Deenergizes the associated transmitter. INDICATOR: Indicates the associated transmitter is deenergized when illuminated.

TABLE 3-1. CONTROLS AND INDICATORS
(Sheet 3 of 3)

INDEX NO.	NOMENCLATURE	FUNCTION
16	PA-A/PA-B METERS Switch	Selects PA-A or PA-B display of current and voltage.
17	FWD POWER Indicator	Indicates the PA stage forward output power exceeds 90 Watts in the FM-300 and FM-250 and 95 Watts in the FM-100.
18	VSWR Indicator	Indicates the PA output stage VSWR exceeds 8 Watts when illuminated.
19	OVER TEMP Indicator	Indicates a PA regulator heatsink over-temperature condition exists when illuminated.
	-----	--- MAIN/ALTERNATE TRANSMITTERS ---
20	XMTR-2 Circuit Breaker	Provides overload protection and power control for transmitter No. 2.
21	XMTR-1 Circuit Breaker	Provides overload protection and power control for transmitter No. 1.
22	CONTROL Circuit Breaker	Provides overload protection and power control for the system controller and cabinet fan(s).
	-----	--- SINGLE TRANSMITTERS ---
21	XMTR Circuit Breaker	Provides overload protection and power control for the exciter and PA.
22	CONTROL Circuit Breaker	Provides overload protection and power control for the transmitter controller and cabinet fan(s).

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section presents theory of operation for the Broadcast Electronics very-low-power line of FM transmitters.

4-3. The following text provides detailed circuit theory for all models. All theory is provided with little regard as to which model uses what circuitry. Section I of this manual should be referenced for the exact equipment compliment of each transmitter.

4-4. ELECTRICAL DESCRIPTION.

NOTE: REFER TO THE SCHEMATIC DIAGRAMS IN SECTION VII AS REQUIRED FOR THE FOLLOWING DESCRIPTIONS.

4-5. FM EXCITER.

4-6. 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 87.5 to 108 MHz FM broadcast band. The exciter may be programmed to any frequency within this band in 10 kHz increments. The FX-30 exciter is mounted with slides to allow easy access to the internal semi-modular exciter circuitry.

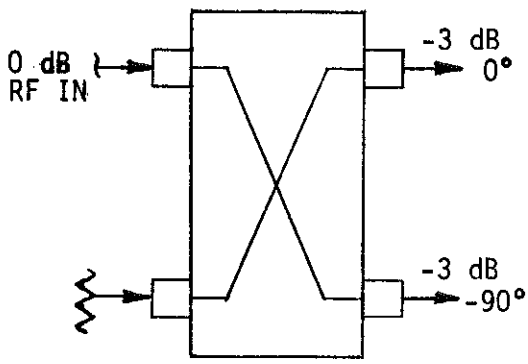
4-7. The FX-30 will accept multiple wideband composite inputs from a stereo generator or SCA generator as well as a 600 Ohm balanced audio input. Refer to publication 597-0002 for detailed explanation of the FM exciter.

4-8. HYBRID SPLITTER/COMBINER.

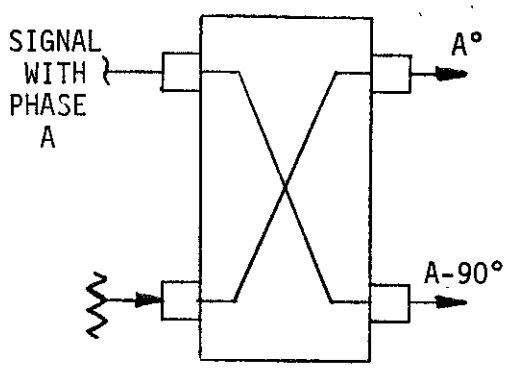
4-9. A hybrid combiner/splitter is a four-port device. When an RF source is applied to one port, the device will split the applied RF input equally between the two opposite ports (see Figure 4-1A).

4-10. Assuming the same input conditions, the phase of the two outputs will be 90 degrees out-of-phase with respect to each other. The port directly opposite the input port will be in phase with the input port (see Figure 4-1B).

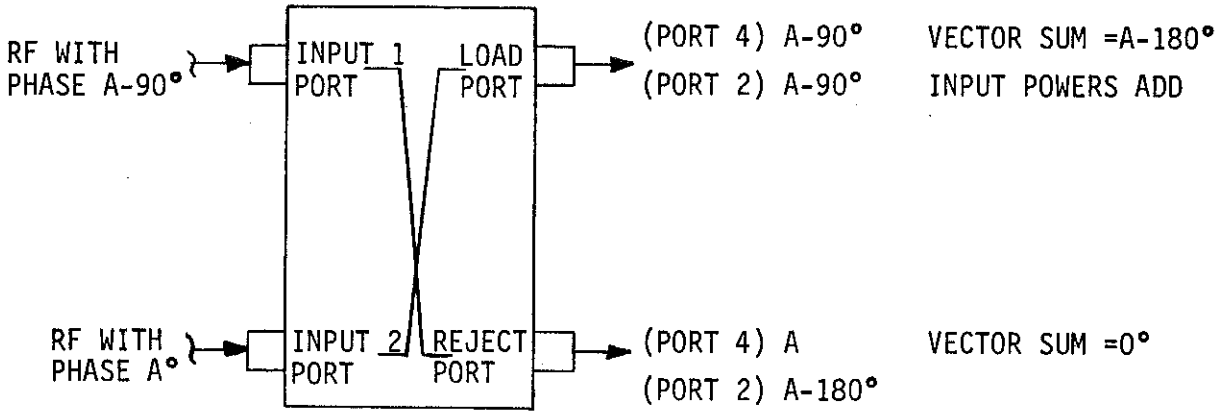
4-11. If two RF signals of the same amplitude and frequency, but 90 degrees out-of-phase are applied to two ports of a hybrid combiner, the two signals will completely combine at the output port and no power will appear at the reject port. Any difference in input phase (other than 90 degrees) or any difference in amplitude between the two inputs will appear as power at the reject port (see Figure 4-1C).



A. POWER RELATIONSHIP



B. PHASE RELATIONSHIP



C. POWER COMBINER

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FIGURE 4-1. HYBRID SPLITTER/COMBINER

4-12. The FM-300M/A employes a hybrid splitter to develop RF drive for both power amplifiers from the single exciter. Both the FM-300 and FM-300M/A employ hybrid combiners to sum the output of the two power amplifiers into a single output.

4-13. POWER AMPLIFIER.

4-14. The power amplifier consists of a broadband solid-state amplifier assembly and a regulated power supply with over-voltage and over-current protection circuitry. The PA is contained in a slide-out drawer for ease of maintenance. Both the amplifier and the regulator circuit boards are mounted on easily removable heat sinks and a fan which provides forced-air cooling.

4-15. The PA RF stage consists of two bipolar RF power transistors operated push-pull as a class C amplifier. A stripline directional coupler provides forward and reflected power samples. The PA exhibits a power gain of 10 dB to output approximately 250 Watts maximum per module.

4-16. A green FWD PWR indicator on the front panel illuminates to indicate sufficient RF output level exists for normal operation. A yellow VSWR illuminates to indicate excessive PA stage reflected power. A red OVER TEMP indicator indicates that an over-temperature condition exists within the PA. After the stage has cooled, ac power must be removed to reset the over-temperature logic and restore the PA to operation.

4-17. For additional information concerning the power amplifier, refer to Part II of this manual.

4-18. TRANSMITTER CONTROLLER.

4-19. GENERAL DESCRIPTION. The transmitter controller circuitry utilizes CMOS family logic which provides high noise immunity and reliability. Backup power is provided for the control circuits in the form of a battery supply which provides memory retention in the event of a power failure. In the single transmitter models, this battery supply is contained in the transmitter controller. In the main/alternate configurations, the battery supply is contained in the system controller.

4-20. The transmitter controller provides remote control of on-off functions along with fail-safe provisions for each single transmitter. Transmitter power output control is provided by the front-panel POWER ADJUST control in the local mode and through provisions wired to the rear panel in the remote mode.

4-21. Meters are provided on the transmitter controller to measure power amplifier collector voltage and current as well as PA power output and the total system RF output. A POWER METERING switch allows selection of forward or reflected power for either the amplifier(s) or the system output. A two-position METER switch added to the FM-300 and FM-300M/A selects between parameters of either power amplifier for display. Low-level dc outputs are provided for remote metering of power amplifier collector voltage, current, total forward power, and reflected power.

4-22. DETAILED DESCRIPTION. The on and off functions of the transmitter are controlled by flip-flop implemented with cross connected NAND gates U4B/U4C. The state of the latch is changed by applying a momentary LOW or ground to one input of the device. When one input is driven LOW, the corresponding output is forced HIGH. This action causes the input of the opposite gate to go HIGH which applies a LOW to the companion input of the first gate. This action maintains the first gate in a LOW state. The control circuit inputs are purposely delayed by input filters (R7/C5 and R10/C6) which minimize susceptibility to transients and external noise.

4-23. The front panel ON and OFF push switches provide momentary closures to ground to activate a function. The input filter minimizes the effects of contact bounce and any stray noise which may be coupled through the wiring harness. The remote on and off inputs are isolated with optical isolators U1, U2, and U3 which prevent ground loops and provide an interface system insensitive to polarity and voltage of the remote control. The remote inputs operate with any polarity or voltage from 5 to 28 volts ac or dc. Control functions may be switched in either leg of the interface as desired by the installer.

4-24. The output of U4C is inverted and compared with the fail-safe and interlock information in U4D. When a valid interlock/fail-safe command and a valid on command are received by U4D, the output will go LOW. This LOW is inverted by U5E and applied to emitter-follower Q5 which drives the ac power control panel circuitry. The ac power control panel applies ac power to the exciter and the power amplifier(s). The ON indicator is illuminated by transistor Q4 which is also driven by inverter U5E.

4-25. The fan is activated by emitter-follower Q2 connected to inverter U5D. The output of Q2 is coupled to the control circuits for cabinet fan control.

4-26. The remote fail-safe input is buffered by optical isolator U1. When the device has a voltage present at the input, the transistor output stage saturates and conducts, forcing the input of gate U4A to go HIGH. In the LCL position, the five-volt bus is directly connected to the fail-safe input of the gate. The interlock inputs (internally wired to +24V) are connected to the second gate of U4A.

4-27. The controller contains circuitry to automatically initialize the transmitter to the off state upon initial application of power. This is useful when a power failure occurs or during maintenance. Normally, the controller system operates from a battery back-up system during a power failure and the transmitter will return to operation in the state at which the power failure occurred. However, if the battery should become discharged, the automatic off circuit will still operate. This circuit consists of transistor Q1, inverters U5B and U5C, and associated circuitry. Capacitor C7 is normally charged to five volts. This forces the input to U5B to go HIGH which is repeated at the output of U5C. In this state, the circuit is isolated by diode D13. In the event of a power failure causing a loss of the five volt bus, transistor Q1 will conduct, quickly discharging capacitor C7. The capacitor will charge slowly upon re-application of power. While capacitor C7 is charging, the output of inverter U5C will go LOW and cause the system to deenergize. The time constant of this circuit is purposely made longer than that of the low-pass input filters so the circuit will over-ride the other inputs. When operation is normal, transistor Q1 is biased off and discharge of capacitor C7 cannot occur.

4-28. TRANSMITTER CONTROLLER POWER CONTROL. When the RMT/LCL switch is operated to LCL, transmitter RF power output may be adjusted with the front-panel POWER ADJUST control. When the RMT/LCL switch is operated to RMT, the front-panel POWER ADJUST control is disabled and power can be adjusted from a remote location.

4-29. When remote control is selected, the transmitter power output may be adjusted by applying a ground (TB1, pin 7) to either the power raise terminal on TB1 (pin 5) or the power lower terminal on TB1 (pin 6).

4-30. A ground applied to TB1 pin 5 or pin 6 is routed to interface relays within the transmitter controller. These relays apply a potential to a motorized potentiometer. The polarity of the potential determines the direction of motor rotation which varies the position of the potentiometer. A voltage from the potentiometer is applied to the FM exciter to adjust exciter output power and thereby adjusts the transmitter RF output.

4-31. TRANSMITTER CONTROLLER METERING CIRCUITS. The PA VOLTAGE and PA CURRENT meters indicate the collector voltage and collector current for each power amplifier. In the FM-300 and FM-300M/A these meters are switched as a group by the POWER METERING switch between PA's. The voltage dividers and current shunts for the power amplifiers are located in each amplifier assembly. Remote metering of both functions is available on terminal board TB2.

4-32. Forward and reflected power for each power amplifier and the combined output of the amplifiers is displayed by the POWER meter. The parameter to be displayed is selected by the POWER METERING switch. This switch allows metering of PA forward and reflected output before and after the low-pass filter.

4-33. The in-line directional coupler used with the transmitter provides continuous outputs for both forward and reflected power at a low level. The outputs of both couplers are amplified by dc operational amplifiers U11 and U12. The outputs of the amplifiers are buffered by identical amplifiers operating as unity gain followers to provide a low output impedance and adequate isolation for the three outputs provided. An output is provided to the front panel POWER meter and the remote power meter provision.

4-34. TRANSMITTER CONTROLLER POWER SUPPLIES. Three power supplies are provided to power the logic, the meter amplifiers, and to charge the self-contained battery back-up. The power supply potentials are derived from two full-wave bridge rectified supplies. In the single transmitter models, the battery supply is contained in the transmitter controller. In the main/alternate configurations, the battery supply is contained in the system controller.

4-35. The 24-volt power supply is used to supply power to the metering and control circuits. It is regulated by three-terminal regulator mounted to the main circuit board. The rectifier and filter components (D16 through D19, C15, and DT1) are also mounted to the main circuit board.

4-36. The ten-volt power supply is used to charge the self-contained battery back-up and the five-volt power supply is used to power the logic. Both potentials are regulated by three-terminal regulators. The ten-volt regulator (U1) is mounted to a sub-chassis and the five-volt regulator (U10) is mounted to the main circuit board. The rectifier and filter (D1 and C1) are mounted to the main circuit board.

4-37. The input to U1 is connected through diode D25. The battery assembly is connected in parallel at the output of U1 and the five-volt regulator is connected in series at this point. The ten-volt output of U1 keeps the battery back-up charged and comparator U9 monitors the ten-volt supply. In the event of a long-term power outage sufficient to severly discharge the battery assembly, comparator U9 will deenergize relay K1 which disconnects the battery assembly from the ten-volt source. This will prevent damage to the battery assembly from excessive discharge.

4-38. SYSTEM CONTROLLER.

4-39. GENERAL. The system controller is used to activate the alternate transmitter automatically in the event of failure of the operational transmitter. The system controller provides monitoring facilities for sensing RF energy from each transmitter and contains facilities to deenergize both transmitters prior to switching action. When the RF output of each transmitter falls below a preset level, the system will initiate a transfer command and monitor the transfer switch interlocks for a valid transfer indication. Upon receipt of a valid transfer indication from the RF transfer switch, the system will automatically energize the selected transmitter. Control facilities are provided for selection of manual or automatic operation and for transmitter on/off control. Status indications are provided for manual or automatic operation and for transmitter selection. Remote control and status indication of all functions is provided through rear panel terminal strip TB1.

4-40. A battery back-up system consisting of four sealed lead-acid cells is provided for memory retention in the event of a power failure. In the single transmitter models, this battery supply is contained in the transmitter controller. In the main/alternate configurations, the battery supply is contained in the system controller.

4-41. DETAILED DESCRIPTION. Two inputs are provided for RF detection purposes. These are low level dc inputs derived from the directional couplers in the associated RF power amplifiers. Each transmitter sensor output is in the range of one to five volts dc and is applied to integrated circuit comparators U1A, B, C, and D.

4-42. Comparators U1B and U1D are supplied with a fixed dc level to allow sensing of low-level RF presence while U1A and U1C are biased to a higher adjustable level for failure-threshold sensing purposes. The threshold is normally adjusted to a level approximately three decibels below the rated output. U1A will output a HIGH with the transmitter operating normally and will switch to a LOW upon failure. When this happens, light emitting diode DS1 will go out.

4-43. If the system has been operated to the automatic mode, a pulse will be generated by timer U3 which will cause a delay of approximately five seconds before initiating a transfer pulse to be generated by timer U4. When U4 generates the transfer pulse, a transmitter off command is generated by timer U6 and is routed to both transmitters. A transfer command is also applied to flip-flop U5A forcing U5A to change states. The OFF command is indicated by DS5 for troubleshooting purposes.

When comparators U1B and U1D have switched to a LOW state indicating both transmitters are off, RF presence LED DS3 will extinguish and the RF presence line will go LOW, allowing NOR gates U13A and U13B to transfer the switching information from U5A to U5B. At this time, the transfer relay is operated to its new position and the interlock outputs are compared with the output states of U5B for correct conditions. If the transfer switch followed the commands from the flip-flop correctly, the output of NOR gate U13D will now be HIGH causing the transmitter 2 indicator to illuminate. The control input to NAND gate U15C will also go HIGH enabling an on command to be routed from timer U7 to transmitter two. The on command is generated from the interlock transition through inverter U11A. The output of U11A is ac coupled to NAND gate U8B to generate a momentary output pulse to trigger the timer U7. The on pulse momentarily illuminates DS5 to aid in troubleshooting. The on pulse generator may also be triggered by the ON push switch on the front panel or by remote control.

4-44. The system may be operated in either the manual or automatic mode as desired. The switching action for mode selection is determined by a flip-flop composed of NAND gates U15A and U15B. The inputs to the flip-flop are controlled by the front-panel MAN and AUTO push switches. A momentary pulse through the remote control inputs for these functions will also cause a switching action to occur. The flip-flop outputs are routed to local and remote status indicators as well as the inhibit bus. The on input is diode-coupled through jumper 2 to allow automatic operation when the transmitter system is turned on. Similarly, the off input is diode-coupled through jumper 1 to operate the unit to manual mode when the system is turned off. This is necessary to prevent endless switching actions when a transmitter is turned off. Switching to the manual mode blocks initiation of a fault indication.

4-45. Remote control operation is possible through momentary commands. These commands may be in the form of momentary pulses of either polarity or momentary grounds applied to the remote control terminals. The remote control equipment is interfaced to the system through optical isolators U17-U22 to minimize the opportunity for stray coupling within the system. A RMT/LOCAL switch is provided on the front panel to disable remote control for test purposes.

4-46. SYSTEM CONTROLLER POWER SUPPLIES. Three power supplies are provided to power the system controller and to charge the self-contained battery back-up. The power supply potentials are derived from two full-wave bridge rectified supplies. In the single transmitter models, the battery supply is contained in the transmitter controller. In the main/alternate configurations, the battery supply is contained in the system controller.

4-47. The 24-volt power supply provides power to the transfer relay. It is regulated by three-terminal regulator U25 mounted to the main circuit board. The rectifier and filter components assembly (D29 through D32, C35, DT1) are also mounted to the main circuit board.

4-48. The ten-volt power supply provides voltage to charge the self-contained battery back-up and the five-volt power supply provides power for the logic. Both potentials are regulated by three-terminal regulators. Both the ten-volt regulator (U2) and the five-volt regulator (U1) are mounted to the main circuit board. The rectifier and filter (D1, C1, and C2) are mounted to the main circuit board.

4-49. The input to U2 is connected through diode D37. The battery assembly is connected in parallel at the output of U2 and the five-volt regulator is connected in series at this point. The ten-volt output of U1 keeps the battery back-up charged and comparator U23 monitors the ten-volt supply. In the event of a long-term power outage sufficient to severly discharge the battery assembly, comparator U23 will deenergize relay K1 which disconnects the battery assembly from the ten-volt source. This will prevent damage to the battery assembly from excessive discharge.

4-50. AC POWER CONTROL PANEL.

4-51. The ac power control panel supplies primary power to each transmitter assembly. The control panel in the single transmitter models contains two circuit breakers. One circuit breaker protects the transmitter and the remaining circuit breaker protects the transmitter controller and the cabinet fan. The control panel in the main/alternate models contain three circuit breakers. One circuit breaker protects each transmitter and the third circuit breaker protects the system controller and the cabinet fans.

4-52. All ac power connections are made to a barrier type terminal strip on the rear of the panel. The terminal strip is provided with a protective cover for personnel safety. The control inputs are made through a multi-pin connector on the rear panel.

4-53. The ac power control panel receives power at 200 to 250 volts, 50 to 60 Hz, and distributes the power through the appropriate circuit breakers and contactors to the individual assemblies in the transmitter. The first circuit breaker, CONTROL, protects the internal wiring associated with the system controller and the cabinet air flushing fan(s). Contactor K1 is energized by a low-level dc voltage from the transmitter controller(s). A Darlington transistor pair composed of Q1 and Q2 amplifies the low-level output of the transmitter controller(s) to a current level sufficient to activate contactor K1. The 24-volt dc control voltage is supplied to contactor K1 through gating diode D3 from the transmitter controller (and through diode D2 from transmitter controller 2 in the main/alternate configuration).

4-54. The second circuit breaker, XMTR (XMTR 1 in the main/alternate configuration), protects the wiring associated with the transmitter (1) system components. The circuit breaker directly feeds the transmitter controller, and through contactor K2, feeds the exciter and the power amplifier(s). Contactor K2 is energized by a low-level dc command from the transmitter controller.

4-55. The third circuit breaker, XMTR 2, and contactor K3 are used only in the main/alternate configuration. This circuit breaker protects the wiring associated with the transmitter 2 system components. The circuit breaker directly feeds the transmitter controller, and through contactor K3, feeds the exciter and the power amplifiers. Contactor is activated by a low-level dc command from transmitter controller No. 2.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides general maintenance information, electrical adjustment procedures, and troubleshooting information for the Broadcast Electronics very-low-power line of FM transmitters. Maintenance is divided into two categories depending upon the complexity of the procedure and the test equipment required to complete the maintenance procedure.

5-3. SAFETY CONSIDERATIONS.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

5-4. All transmitters contain high voltages and currents which, if regarded carelessly, could be fatal. Each transmitter has many built-in safety features, however good judgement, care, and common sense are the best accident preventives. The maintenance information contained in this section should be performed only by trained and experienced maintenance personnel.

5-5. It is very dangerous to attempt to make measurements or replace components with power energized, therefore such actions are not recommended. AC power to the entire cabinet may be disconnected by operating the front-panel circuit breakers to off.

5-6. FIRST LEVEL MAINTENANCE.

WARNING BEFORE ATTEMPTING TRANSMITTER MAINTENANCE ASSURE THE RMT/LCL SWITCH(ES) IS OPERATED TO LCL. THERE ARE THREE SWITCHES ON THE MAIN/ALTERNATE TRANSMITTERS.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

5-7. 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.

5-8. Preventive maintenance of each transmitter falls into the category of good housekeeping and is limited to whatever cleaning may be necessary and checking the performance levels using the meters and various indicators built into the equipment.

5-9. On a regular basis, clean the equipment of accumulated dust. Check for overheated components, tighten loose hardware, and lubricate mechanical surfaces as required.

5-10. AIR FILTER.

5-11. The rear access panel must be removed to replace the air filter. As only half the filter is exposed to air flow when installed, the filter may be removed and the clean end inserted in the filter housing. A new filter should be ordered at this time. The filter should be checked once each week with replacement done on an as-needed basis. A dirty filter could result in dirt accumulation leaking into the cabinet from seams, door jambs, etc.

5-12. The transmitter uses one disposable type air filter 1 inch X 16 inches X 20 inches (2.54 cm X 40.64 cm X 50.8 cm) mounted in the rear access panel of the cabinet. Additional filters may be ordered for replacement (P/N 407-0062) or purchased locally. Always mount the filter with the air flow arrow pointing towards the fan.

5-13. FAN MAINTENANCE.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

5-14. Inspect the cabinet flushing fan for dust accumulation and periodically clean the fan. The fan bearings are sealed and do not permit lubrication. If a bearing fails, the fan must be replaced. The fan mounting bolts should be checked for tightness.

5-15. The fan motor is cooled by the air passing around the fan. If the ambient air temperature is too high or if the air flow is restricted, then the lubricant will gradually vaporize from the motor bearings and bearing failure will occur. If very dirty air passes over the fan, accumulated dust will impair the motor cooling unless the accumulation is wiped from and blown out of the motor.

5-16. The fan impeller blades should be inspected and cleaned periodically. If the transmitter is operated in a very dusty environment, dust will build up on the concave side of the fan impellers. If this happens, air flow will be reduced and unbalance will result with a possibility of damage to the fan.

5-17. SECOND LEVEL MAINTENANCE.

5-18. ADJUSTMENTS.

5-19. SYSTEM CONTROLLER. System controller adjustments are shown by Figure 5-1.

5-20. TRANSMITTER CONTROLLER. Transmitter controller adjustments are shown by Figure 5-2.

5-21. PA. Refer to Part II of this manual.

5-22. EXCITER. Refer to publication 597-0002.

5-23. TROUBLESHOOTING.

WARNING
WARNING
BEFORE ATTEMPTING TRANSMITTER MAINTENANCE ASSURE THE RMT/LCL SWITCH(ES) IS OPERATED TO LCL. THERE ARE THREE SWITCHES ON THE MAIN/ALTERNATE TRANSMITTERS.

WARNING
NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

5-24. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, fuses, and circuit breakers) should be used to isolate the malfunction to one of the specific areas listed below. Typical meter indications are presented in Table 5-1 for the FM-100 and FM-250 and Table 5-2 for the FM-300M/A.

A. Exciter
B. Power Amplifier
C. System Controller (Main/Alternate Models Only)
D. Transmitter Controller
E. Transmitter Load

CAUTION
CAUTION
MANY COMPONENTS IN THE TRANSMITTER ARE MOUNTED TO HEAT SINKS UTILIZING A FILM OF HEAT-SINK COMPOUND FOR THERMAL CONDUCTION.

CAUTION
CAUTION
IF ANY SUCH COMPONENT IS REPLACED, ENSURE A THIN FILM OF A ZINC-BASED HEAT-SINK COMPOUND IS USED (BE P/N 700-0028) TO ASSURE GOOD HEAT DISSIPATION.

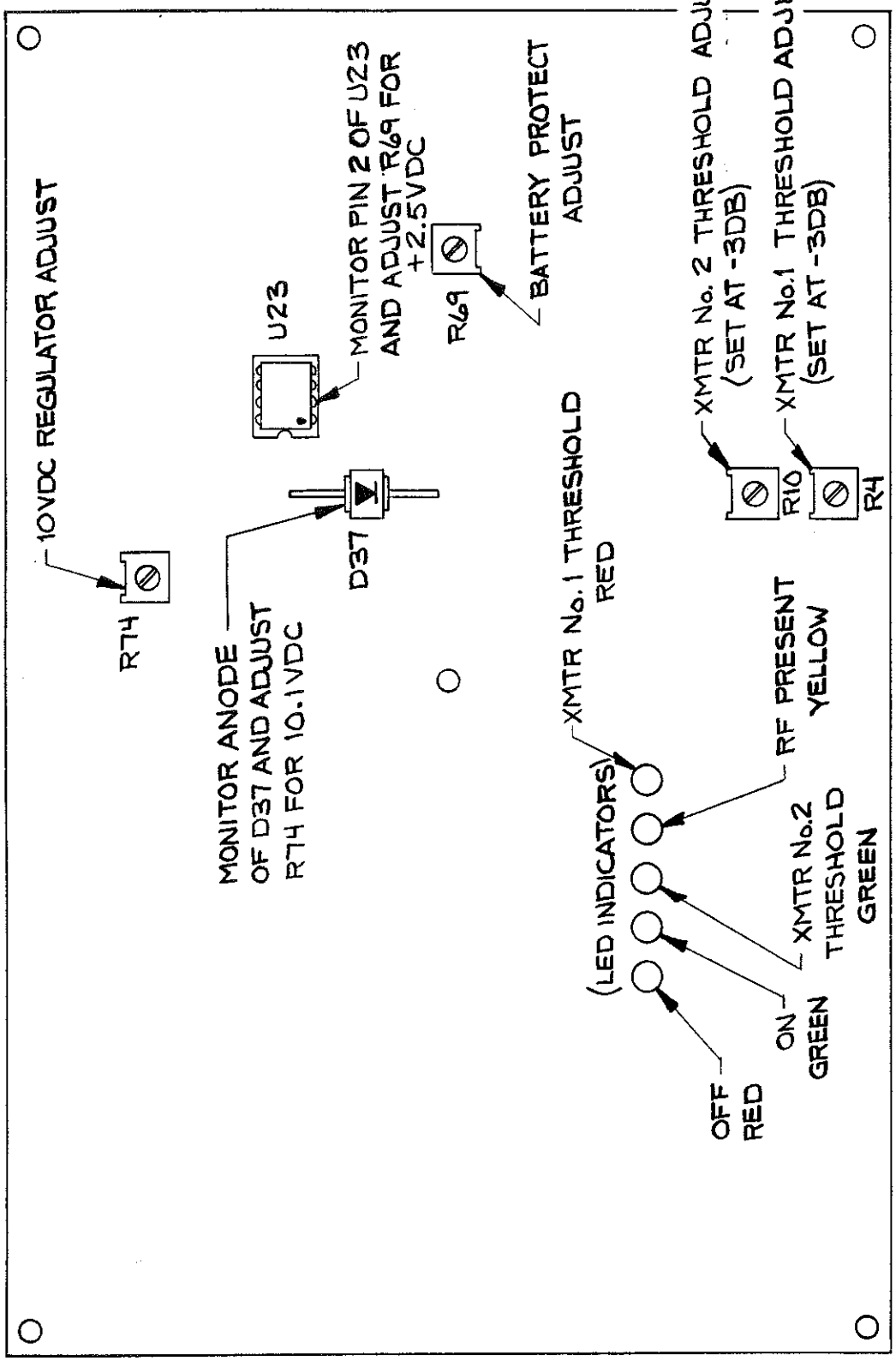

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FIGURE 5-1. SYSTEM CONTROLLER ADJUSTMENT

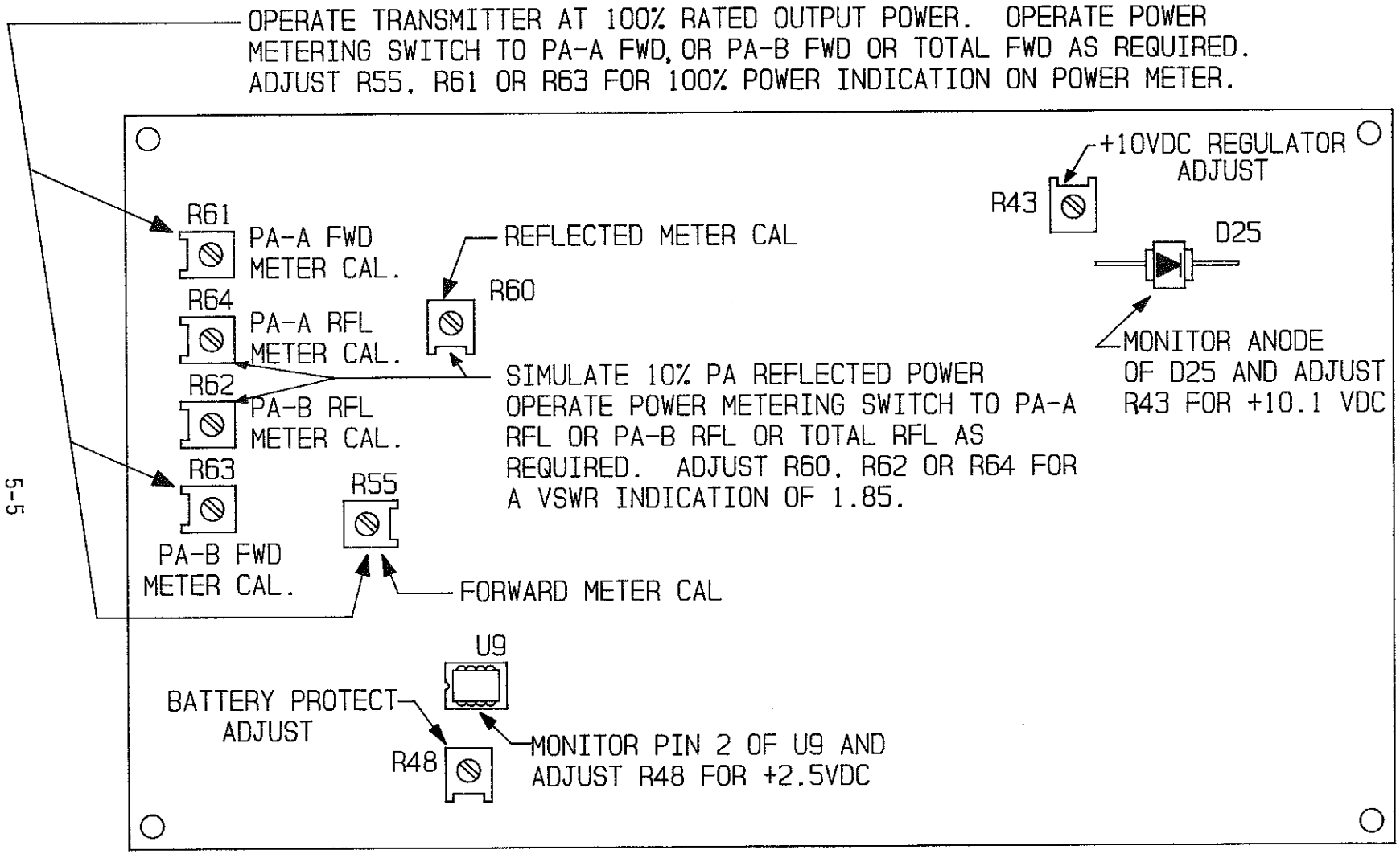

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FIGURE 5-2. TRANSMITTER CONTROLLER ADJUSTMENT

5-25. Once the trouble is isolated, refer to the portions of this manual discussing the theory of operation for the respective assembly to assist in problem resolution.

5-26. EXTENDER CABLES. A 15 foot (4.6 m) extender cable kit (BE P/N 949-0107) is provided as an extra-cost option for use with all very-low-power transmitter models. The cable kit consists of two multiple-conductor cables (logic), two coaxial cables (directional coupler), a single-conductor cable (ground), and two ac extension cords (power).

5-27. The intended use of this cable kit is to provide a method to check operation of a transmitter controller or the system controller after repair, before the repaired controller is replaced in the rack. Troubleshooting with power energized is always considered hazardous and is therefore not recommended.

5-28. COMPONENT REPLACEMENT ON CIRCUIT BOARDS. Circuit board repair requires that defective components be removed carefully to avoid damage to the board.

5-29. On all circuit boards, the adhesive securing the copper track to the board melts at almost the same temperature at which solder melts. 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.

5-30. To remove a component from a circuit board, cut the leads from the body of the defective component while the device is still soldered to the board.

5-31. Grip each component lead, one at a time, with long nose pliers. Turn the board over and touch a 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 bent-over outer 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.

5-32. Install the new component and apply solder from the bottom side of the board.

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

WARNING OBSERVE THE MANUFACTURER'S CAUTIONARY INSTRUCTIONS.

5-33. After soldering, remove flux with a cotton swab moistened with a suitable solvent. Rubbing alcohol is highly diluted and is not effective. Solvents are available in electronic supply houses which are useful.

5-34. The board should be checked to ensure the flux has been removed and not just smeared about. Rosin flux is not normally corrosive, but rosin will absorb enough moisture in time to become conductive and cause problems.

5-35. Integrated Circuits. Extra care should be exercised with integrated circuits. Each integrated circuit must be oriented so that its notch matches the notch on the socket when replaced. Do not attempt to remove an integrated circuit with fingers. Use an integrated circuit puller or a small Allen wrench to lightly pry the integrated circuit from its socket.

TABLE 5-1. TYPICAL METER INDICATIONS (FM-100 AND FM-250)

TRANSMITTER CONTROLLER				
METER	INDICATION			
	100W		250W	
PA VOLTAGE	20 V		28 V	
PA CURRENT	7.75 A		10 A	
POWER	PA		XMTR	
	FWD	RFL	FWD	RFL
	100%	LESS THAN 1.5:1	100%	LESS THAN 1.5:1

FM EXCITER		
SWITCH	INDICATION	
	100W	250W
FWD	17 W	30 W
RFL	LESS THAN 1.5 W	LESS THAN 1.5 W

TABLE 5-2. TYPICAL METER INDICATIONS (FM-300M/A, 300W OUTPUT)

TRANSMITTER CONTROLLER						
METER	INDICATION					
	PA-A		PA-B			
PA VOLTAGE	28 V		28 V			
PA CURRENT	10.5 A		10.5 A			
POWER	PA-A		PA-B		TOTAL	
	FWD	RFL	FWD	RFL	FWD	RFL
	100%	LESS THAN 1.5:1	100%	LESS THAN 1.5:1	100%	LESS THAN 1.5:1

FM EXCITER	
SWITCH	INDICATION
FWD	35 W
RFL	LESS THAN 1.5 W

WARNING: DISCONNECT POWER PRIOR TO SERVICING

SECTION VI

PARTS LISTS

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 very-low-power line of FM transmitters. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 6-1. PARTS LIST INDEX
(Sheet 1 of 2)

TABLE 6-1. PARTS LIST INDEX
(Sheet 2 of 2)

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TABLE 6-2. 100 WATT FM TRANSMITTERS, SINGLE CONFIGURATION
909-0100-200/909-0100-300

REF. DES.	DESCRIPTION	PART NO.	QTY.
DC1	Directional Coupler Assembly	959-1012-001	1
FL1	Low-Pass Filter	959-0177	1
J1A/B	Bulkhead Receptacle, Type N, Jack-to-Jack, UG30/U (Transmitter Output Connector)	418-0035	1
R3A THRU R3D	Resistor Network, PA (listed in PA Section)	959-1000-015	1
TB5	Barrier Strip, 6 Terminals	412-0008	1
----	Air Filter, 16 X 20 X 1 inch (40.64 X 50.8 X 2.54 cm)	407-0062	1
----	Power Cord, 3 Conductor, 7.5 feet (2.29 m)	682-0001	2
----	Insulator strip for TB5	407-0126	1
----	Screw, 1/4-20 X 1 inch, Button Head, Hex Socket Stainless Steel, Black (Front Panel Screws)	420-1001	12
----	Hex Wrench, 5/32 inch (For Front Panel Screws)	710-0219	1
----	FM Exciter	909-0093	1
----	Power Amplifier	959-0200	1
----	Transmitter Controller	959-0201	1
----	AC Power Control Panel	959-0174-002	1
----	Wiring Harness	949-0087	1
----	RF Cables Assembly	949-0109	1
	DIFFERENCES FOR 250 WATT FM TRANSMITTER, SINGLE CONFIGURATION, 909-0250-200/909-0250-300		
R3A THRU R3D	Resistor Network, PA (Listed in PA Section)	959-1000-015	1
----	RF Cables Assembly	949-0085	1
----	Screw, 1/4-20 X 1 inch, Button Head, Hex Socket Stainless Steel, Black (Front Panel Screws)	420-1001	14
	DIFFERENCES FOR 300 WATT FM TRANSMITTER, SINGLE CONFIGURATION, 909-0300-200/909-0300-300		
B1,B2	Fan, 6 inch (15.24 cm), 250 ft^3min, 220V ac, 50/60 Hz, 40 Watts	380-7650	2
R2	Reject Load, 50 Ohm, 150 Watts, Type N Receptacle	140-0010	1
R3A THRU R3D	Resistor Network, PA (Listed in PA Section)	959-1000-015	2
----	Right Angle Plug-Jack, Type N	417-0105	3
----	Power Cord, 3 Conductor, 7.5 feet (2.29 m)	682-0001	3
----	Screw, 1/4-20 X 1 inch, Button Head, Hex Socket Stainless Steel, Black (Front Panel Screws)	420-1001	22
----	Wiring Harness	949-0078	1
----	RF Cables Assembly	949-0081	1
----	Power Amplifier	959-0131	2
----	AC Power Control Panel	959-0174-001	1
----	Hybrid Combiner	959-0175	1
----	Hybrid Splitter	959-0176	1
----	Transmitter Controller	959-0197	1

TABLE 6-3. 100 WATT FM TRANSMITTER, MAIN/ALTERNATE CONFIGURATION
909-2100-200/909-2100-300 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
B1	Fan, 6 inch (15.24 cm), 250 ft^3min, 220V ac, 50/60 Hz, 40 Watts	380-7650	1
DC1,DC2	Directional Coupler Assembly	951-1012-001	2
FL1,FL2	Low-Pass Filter	959-0177	2
J1A/B	Bulkhead Receptacle, Type N, Jack-to-Jack, UG30/U (Transmitter Output Connector)	418-0035	1

TABLE 6-3. 100 WATT FM TRANSMITTER, MAIN/ALTERNATE CONFIGURATION
909-2100-200/909-2100-300 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
K1	Electrical RF Transfer Switch, 28V dc coil @ 0.1 Ampere RF Contacts: Type N Receptacles, 2 X SPDT, 1 kW RF @ 50 Ohms Auxiliary Contacts: Wire Terminals, 28V dc Resistive Load	340-0024	1
R1	Test Load, 50 Ohm, 150 Watt, Type N Receptacle	140-0010	1
R3A THRU R3D	Resistor Network, PA (Listed in PA Section)	959-1000-015	2
TB5	Barrier Strip, 6 Terminals	412-0008	1
----	Insulator Strip for TB5	407-0126	1
----	Screw, 1/4-20 X 1 inch, Button Head, Hex Socket Stainless Steel, Black (Front Panel Screws)	420-1001	34
----	Hex Wrench, 5/32 inch (For Front Panel Screws)	710-0219	1
----	Right Angle Plug-Jack, Type N, UG27C/U	417-0105	7
----	Power Cord, 3 Conductor, 7.5 feet (2.29 m)	628-0001	5
----	Air Filter, 16 X 20 X 1 inch (40.64 X 50.8 X 2.54 cm)	407-0062	1
----	FM Exciter	909-0093	2
----	Power Amplifier	959-0200	2
----	Transmitter Controller	959-0202	2
----	System Controller	959-0173	1
----	AC Power Control Panel	959-0199	1
----	Wiring Harness	949-0088	1
----	RF Cables Assembly	949-0108	1
	DIFFERENCES FOR 250 WATT FM TRANSMITTER, MAIN/ALTERNATE CONFIGURATION 909-2250-200/909-2250-300		
B1,B2	Fan, 6 inch (15.24 cm), 250 ft^3min, 220V ac, 50/60 Hz, 40 Watts	380-7650	2
R1	Test Load, 50 Ohm, 500 Watt, Type N Receptacle	140-0009	1
R3A THRU R3D	Resistor Network, PA (Listed in PA Section)	959-1000-015	2
----	RF Cables Assembly	949-0086	1
	DIFFERENCES FOR 300 WATT FM TRANSMITTER, MAIN/ALTERNATE CONFIGURATION 909-2300-200/909-2300-300		
B1,B2	Fan, 6 inch (15.24 cm), 250 ft^3min, 220V ac, 50/60 Hz, 40 Watts	380-7650	2
R1	Test Load, 50 Ohms, 500 Watts, Type N Receptacle	140-0009	1
R2	Reject Load, 50 Ohms, 150 Watts, Type N Receptacle	140-0010	1
R3A THRU R3D	Resistor Network, PA (Listed in PA Section)	959-1000-015	4
----	Right Angle Plug-Jack, Type N, UG27C/U	417-0105	12
----	Screw, 1/4-20 X 1 inch, Button Head, Hex Socket Stainless Steel, Black (Front Panel Screws)	420-1001	30
----	Power Cord, 3 Conductor, 7.5 feet (2.29 m)	628-0001	7
----	Wiring Harness	949-0079	1
----	RF Cables Assembly	949-0080	1
----	Power Amplifier	959-0131	4
----	Transmitter Controller	959-0172	2
----	AC Power Control Panel	959-0174	1
----	Hybrid Combiner	959-0175	2
----	Hybrid Splitter	959-0176	2

TABLE 6-4. WIRING HARNESS - 949-0078/949-0079/949-0087/949-0088

REF. DES.	DESCRIPTION	PART NO.	QTY.
	949-0078 ASSEMBLY		
----	Plug, 25-Pin	418-3219	5
----	Strain Relief/Hood	418-3223	5
	949-0079 ASSEMBLY		
----	Plug, 25-Pin	418-3219	10
----	Strain Relief/Hood	418-3223	10
	949-0087 ASSEMBLY		
----	Plug, 25-Pin	418-3219	4
----	Strain Relief/Hood	418-3223	4
	949-0088 ASSEMBLY		
----	Plug, 25-Pin	418-3219	8
----	Strain Relief/Hood	418-3223	8

TABLE 6-5. RF CABLES ASSEMBLIES - 949-0080/949-0081/949-0085/949-0086/949-0108/949-0109

REF. DES.	DESCRIPTION	PART NO.	QTY.
	949-0080 ASSEMBLY		
----	Plug, BNC, for RG58/U Cable	417-0095	6
----	Plug, Type N, for RG8/U Cable	417-0102	16
----	Plug, BNC, Right Angle for RG142/U Cable	417-0213	12
----	Plug, Type N, for RG142/U Cable	418-0031	6
----	Plug, BNC, for RG142/U Cable	417-0094	4
	949-0081 ASSEMBLY		
----	Plug, BNC, for RG58/U Cable	417-0095	3
----	Plug, Type N, for RG8/U Cable	417-0120	6
----	Plug, BNC, Right Angle for RG142/U Cable	417-0213	6
----	Plug, Type N, for RG142/U Cable	418-0031	3
----	Plug, BNC, for RG142/U Cable	417-0094	2
	949-0085 ASSEMBLY		
----	Plug, BNC, for RG58/U Cable	417-0095	2
----	Plug, Type N, for RG8/U Cable	417-0120	6
----	Plug, BNC, for RG142/U Cable	417-0094	2
	949-0086 ASSEMBLY		
----	Plug, BNC, for RG58/U Cable	417-0095	4
----	Plug, Type N, for RG8/U Cable	417-0102	16
----	Plug, BNC, for RG142/U Cable	417-0094	4
	949-0108 ASSEMBLY		
----	Plug, BNC, for RG58/U Cable	417-0095	4
----	Plug, BNC, for RG142/U Cable	417-0094	4
----	Plug, Type N, for RG142/U Cable	417-0031	16
	949-0109 ASSEMBLY		
----	Plug, BNC, for RG58/U Cable	417-0095	2
----	Plug, BNC, for RG142/U Cable	417-0094	2
----	Plug, Type N, for RG142/U Cable	417-0031	6

TABLE 6-6. DIRECTIONAL COUPLER ASSEMBLY - 951-1012-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Ceramic, 1000 pF ±20%, 500V	008-1033	2
D2,D2	Diode, HP5082-2800, High Voltage, Shottky Barrier Type, 70V, 15 mA	201-2800	2
J2,J3	Receptacle, Type N	417-0204	2
R1,R2	Resistor, 56 Ohm ±5%, 1/2W	110-5623	2

TABLE 6-7. TRANSMITTER CONTROLLER - 959-0197/959-0201/959-0202/959-0172
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
B101	Motor, Reversible, 2 RPM, 30 in/oz output torque 117V ac, 50/60 Hz, 5.5 VA, Magnetic Clutch	380-0530	1
BT1 THRU BT4	Battery, Rechargeable, X-Cell, 5 Ampere-Hour, 2 Volt	357-6900	4
C1	Capacitor, 4700 uF, 35V	014-4795	1
D1	Full-Wave Bridge Rectifier, MDA2502, Silicon, 200 PIV, 25 Amperes	239-0006	1
D2	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	1
DS2	Subminiature Lamp, No. 327, T-1 3/4 Base, 28V @ 0.04 Ampere	321-0327	2
F1, F1 SPARE	Fuse, AGC, 1.5 Ampere, 250V, Slow-Blow	334-0150	2
FL1	Fused Power Connector, 120/240V Voltage Selector, EMI Filter	360-6504	1
J3,J4	Receptacle, BNC Chassis Mount	417-0016	2
M1	PA VOLTAGE Meter, 3.5 inch (8.89 cm) Taut Band Type, FS= 1 mA ±2%, 15 Ohm Movement	310-0028	1
M2	PA CURRENT Meter, 3.5 inch (8.89 cm) Taut Band Type, FS= 1 mA ±2%, 15 Ohm Movement	310-0029	1
M3	POWER Meter, 3.5 inch (8.89 cm) Taut Band Type, FS= 200 uA ±2%, 230 Ohm Movement	310-0020-001	1
R1	Resistor, 1 k Ohm ±5%, 2W	130-1043	1
R2	Resistor, 10 k Ohm ±5%, 1/2W	110-1053	1
R3	Potentiometer, 10 k Ohm ±10%, 1W (POWER ADJUST)	192-1052	1
R4	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
R5	Resistor, 100 Ohm ±1%, 1/4W	100-1031	1
R6	Potentiometer, 10 k Ohm ±10%, 1W	192-1052	1
S1	Switch, Toggle, Miniature, DPDT, 0.4 VA Contacts at 20V Maximum, ac or dc (METERS)	348-7201	1
S2	Switch, Rotary, 6 Position non-shorting, 1 Section, 1 Pole 2.75A @ 15V dc, 0.350A @ 115V ac	340-0040-001	1
S3,S4	Switch, Push, SPST, N.O. Contacts 10A @ 125/250V ac (ON and OFF)	343-0003	2
S5	Switch, Toggle, Miniature, 3PDT, 5A @ 120V ac or 28V dc (CONTROL)	340-0062	1
S6	Switch, Toggle, Miniature, DPDT, 0.4 VA Contacts at 20V Maximum, ac or dc (POWER METERING)	348-7201	1
T1	Transformer, Power, PRIMARY: Dual 115V, One Winding Tapped at 95V, 50/60 Hz SECONDARY: 25.5V @ 1A, 13.2V @ 3A	376-0218	1
TB1,TB2	Terminal Strip, 10 Terminals	412-0010	2
U1	Integrated Circuit, LM317K, Adjustable Positive Voltage Regulator, 1.2V to 37V, 1.5 Amperes Maximum, TO-3 Case	227-0318	1
XU1	Socket, TO-3 Transistor	417-0298	1
----	Raise/Lower Motor Circuit Board Assembly	919-0089	1
----	Transmitter Controller Circuit Board Assembly	919-0072-001	1
----	Fuse Clip (for spare fuse)	415-1001	2
----	Transmitter Controller Cable Harness	949-0084	1
----	Insulator, TO-3	418-0010	1
----	Knob, (POWER METERING and POWER ADJUST)	418-0016	2
----	Standoff Terminal	413-2013	10
----	Nylon Locking Standoff (for Circuit Board)	441-9311	5
----	Switch Cap, Red (S3)	343-0007	1
----	Switch Cap, Green (S4)	343-0006	1

TABLE 6-7. TRANSMITTER CONTROLLER - 959-0197/959-0201/959-0202/959-0172
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
	DIFFERENCES FOR 959-0201 ASSEMBLY		
----	Transmitter Controller Cable Harness	949-0077	1
----	Transmitter Controller Circuit Board Assembly	919-0072	1
----	Hole Plug, Blue, 1/4 Inch	450-0650-1	1
	---DELETE THE FOLLOWING---		
S1	Switch, Toggle, Miniature, DPDT, 0.4 VA Contacts at 20V Maximum, ac or dc (METERS)	348-7201	1
	DIFFERENCES FOR 959-0202 ASSEMBLY		
----	Transmitter Controller Cable Harness	949-0077-001	1
----	Hole Plug, Blue, 1/4 Inch	450-0650-1	1
	---DELETE THE FOLLOWING---		
BT1 THRU BT4	Battery, Rechargeable, X-Cell, 5 Ampere-Hour, 2 Volt	352-6900	4
S1	Switch, Toggle, Miniature, DPDT, 0.4 VA Contacts at 20V Maximum, ac or dc (METERS)	348-7201	1
	DIFFERENCES FOR 959-0172 ASSEMBLY		
----	Transmitter Controller Circuit Board Assembly	919-0072	1
	---DELETE THE FOLLOWING---		
R5	Resistor, 100 Ohm ±1%, 1/4W	100-1031	1

TABLE 6-8. TRANSMITTER CONTROLLER CABLE HARNESS - 949-0084/949-0077/949-0077-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
P1	Plug, 12-Pin	418-1271	1
P2	Plug, 6-Pin	418-0670	1
P3 THRU P5	Plug, 12-Pin	418-1271	3
P6	Plug, 6-Pin	418-0670	1
J1,J2	Plug, 54-Pin	417-0015	2
----	Pins for P1 THRU P6	417-0053	54
	DIFFERENCES FOR 949-0077 ASSEMBLY		
----	Pins for P1 THRU P6	417-0053	59
	DIFFERENCES FOR 949-0077-001 ASSEMBLY		
----	Pins for P1 THRU P6	417-0053	50

TABLE 6-9. RAISE/LOWER MOTOR CIRCUIT BOARD ASSEMBLY - 919-0089
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Mylar, 0.47 uF, 1kV	031-4753	2
D1 THRU D4	Diode, Silicon, 1N4005, 600V, 1 Ampere	203-4005	4
K1,K2	Relay, Plug-in Coil: 24V dc, 700 Ohms Contacts: DPDT, 2A @ 28V dc or 115V ac, Resistive	270-0003	2

TABLE 6-9. RAISE/LOWER MOTOR CIRCUIT BOARD ASSEMBLY - 919-0089
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
J6	Receptacle, 6-Pin	418-0006	1
MOV1, MOV2	Metal Oxide Varistor, V130LA10A, 130V ac RMS, 10 Joules	140-0006	2
R1,R2	Resistor, 560 Ohm ±5%, 2W	130-5623	2
XK1,XK2	Relay Socket	417-1230	2
----	Pins for J6	417-0036	5
----	Blank Circuit Board	519-0017	1

TABLE 6-10. TRANSMITTER CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0072/919-0072-001
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C6	Capacitor, Electrolytic, 10 uF, 35V	023-1076	6
C7	Capacitor, Electrolytic, 47 uF, 25V	020-4773	1
C8,C9	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	2
C10	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C11	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C12,C13	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C14	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C15	Capacitor, Electrolytic, 4700 uF, 35V	014-4795	1
C16	Capacitor, Electrolytic, 33 uF, 35V, Low-Leakage	024-3335	1
C17	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C20 THRU C22	Capacitor, Electrolytic, 10 uF, 35V	023-1076	3
C23	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C24	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C25	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C26	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C27	Capacitor, Ceramic, 0.01 uF ±10%, 100V	031-1043	1
D1 THRU D15	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	15
D16 THRU D19	Diode, MR502, Silicon, 200V, 3 Amperes	202-0502	4
D20 THRU D24	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	5
D25	Diode, MR751, Silicon, 100V, 6 Amperes	202-0751	1
D26 THRU D28,D30	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	4
DT1	Transient Voltage Suppressor, 1N6284A, 36V ±1.8V, Maximum Peak Current: 30A	206-0002	1
DT2	Transient Absorber, 1N6279A, 22V ±0.1V Maximum Peak Current: 49A	206-0001	1
J1	Receptacle, 12-Pin	417-1276	1
J2	Receptacle, 6-Pin	417-0677	1
J3 THRU J5	Receptacle, 12-Pin	417-1276	3
K1	Relay, Circuit Board Mount Contacts: SPDT, 100V dc @ 8 Amperes Maximum Coil: 12V dc, 140 mA, 85 Ohms ±10 Ohms	272-0106	1
Q1	Transistor, 2N3906, Silicon, PNP, TO-92 Case	210-3906	1
Q2 THRU Q5	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	4
Q6	Transistor, MPSU05, Silicon, NPN, TO-202N Case	211-0005	1
R1 THRU R3	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R4	Resistor, 5.6 k Ohm ±5%, 1/4W	100-5643	1
R5 THRU R7	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R8,R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R10,R11	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R12	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R13	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R14	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R15 THRU R17	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	3
R18	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R19	Resistor, 270 Ohm ±5%, 1/4W	100-2733	1
R20	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	1
R21	Resistor, 90.9 k Ohm ±1%, 1/4W	103-9095	1

TABLE 6-10. TRANSMITTER CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0072/919-0072-001
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R22	Resistor, 243 Ohm ±1%, 1/4W	103-2431	1
R24,R25	Resistor, 90.9 k Ohm ±1%, 1/4W	103-9095	2
R26	Resistor, 1 k Ohm ±1%, 1/4W	103-1041	1
R28	Resistor, 130 k Ohm ±1%, 1/4W	103-1306	1
R29,R30	Resistor, 100 Ohm ±5%, 1/4W	100-1033	2
R32	Resistor, 8.66 k Ohm ±1%, 1/4W	100-8641	1
R33,R34	Resistor, 100 Ohm ±5%, 1/4W	100-1033	2
R36	Resistor, 8.66 k Ohm ±1%, 1/4W	100-8641	1
R37 THRU R40	Resistor, 470 Ohm ±5%, 1/4W	100-4733	4
R41	Resistor, 30 Ohm ±5%, 1W	120-3023	1
R42	Resistor, 820 Ohm ±5%, 1/4W	100-8233	1
R43	Potentiometer, 100 Ohm ±10%, 1/2W	177-1034	1
R44	Resistor, 121 Ohm ±1%, 1/4W	100-1231	1
R45	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R46	Resistor, 3.9 k Ohm ±5%, 1/4W	100-3943	1
R47	Resistor, 2.32 k Ohm ±1%, 1/4W	103-2341	1
R48	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R49	Resistor, 1.33 k Ohm ±1%, 1/4W	103-1331	1
R50	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	1
R51	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R52	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R53	Resistor, 365 Ohm ±1%, 1/4W	103-3631	1
R54	Resistor, 121 Ohm ±1%, 1/4W	103-1231	1
R55	Potentiometer, 1 Meg Ohm ±10%, 1/2W	177-1074	1
R56	Resistor, 68 k Ohm ±5%, 1/4W	100-6853	1
R57	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R60	Potentiometer, 100 k Ohm ±10%, 1/2W	177-1064	1
R61	Potentiometer, 5 k Ohm ±10%, 1/2W	177-5044	1
R62	Potentiometer, 20 k Ohm ±10%, 1/2W	177-2054	1
R63	Potentiometer, 5 k Ohm ±10%, 1/2W	177-5044	1
R64	Potentiometer, 20 k Ohm ±10%, 1/2W	177-2054	1
U1 THRU U3	Integrated Circuit, 4N33, Optical Isolator, NPN Photo-Transistor/Infrared Diode, 6-Pin DIP	229-0033	3
U4	Integrated Circuit, MC4011BCP, Quad 2-Input NAND Gate, CMOS, 14-Pin DIP	228-4011	1
U5	Integrated Circuit, CD4069CN, Hex Inverter, CMOS, 14-Pin DIP	228-4069	1
U7	Integrated Circuit, MC7824ACT, Fixed Positive Voltage Regulator, 24V @ 1.5A, TO-220 Case	227-7824A	1
U8	Integrated Circuit, LM3362Z-2.5, Precision Voltage Reference, 2.5V ±4%, Ø to +70°C, TO-92 Case	229-0336	1
U9	Integrated Circuit, TL311P, JFET-Input Differential Comparator, 8-Pin DIP	220-0311	1
U10	Integrated Circuit, LM317T, Adjustable Positive Voltage Regulator, 1.2 to 37V, 1.5A Maximum, TO-220 Case	227-0317	1
U11,U12	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	2
XU4,XU5	Socket, 14-Pin	417-1404	2
XU9,XU11, XU12	Socket, 8-Pin	417-0804	3
----	Blank Circuit Board	519-0072	1
	DIFFERENCES FOR 919-0072-001 ASSEMBLY		
D29	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	1

TABLE 6-11. HYBRID SPLITTER ASSEMBLY - 959-0176

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1,J2,J3	Receptacle, BNC	417-0203	3
R1	Resistor, 50 Ohm, 150W, Non-Inductive	131-5027	1

TABLE 6-12. HYBRID COMBINER ASSEMBLY - 959-0175

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1,J2,J3	Receptacle, BNC	417-0203	1
J4	Receptacle, Type N	417-0204-001	1

TABLE 6-13. SYSTEM CONTROLLER - 959-0173

REF. DES.	DESCRIPTION	PART NO.	QTY.
BT1 THRU BT4	Battery, Rechargeable, X-Cell, 5 Ampere-Hour, 2 Volt	357-6900	4
C1,C2	Capacitor, Electrolytic, 4700 uF, 35V	014-4795	2
D1	Full-Wave Bridge Rectifier, MDA2502, Silicon, 200 PIV, 25 Amperes	239-0006	1
DS1 THRU DS6	Subminiature Lamp, No. 327, T-1 3/4 Base, 28V @ 0.04 Amperes	321-0327	6
DT1	Transient Voltage Suppressor, 1N6279A, 22V ±0.1V, Maximum Peak Pulse Current: 49A	206-0001	1
F1, F1 SPARE	Fuse, AGC, 1.5 Amperes, 250V, Slow-Blow	334-0150	2
FL1	Fused Power Connector, 120/240V, Voltage Selector, EMI Filter	360-6504	1
R1	Resistor, 47 Ohm ±5%, 1/2W	110-4723	1
S1 THRU S6	Switch, Push, SPST, N.O. Contacts, 10A @ 125/250V ac (MAN/AUTO MODE, TX-1/TX-2 SELECT, XMTR OFF/XMTR ON)	343-0003	6
S7,S8	Switch, Toggle, Miniature DPDT, 0.4 VA Contacts at 20V Maximum ac or dc	348-7201	2
T1	Transformer, Power Primary: Dual 115V, One Winding Tapped at 95V, 50/60 Hz Secondary: 25.5V @ 1A, 13.2V @ 3A	376-0218	1
TB1	Barrier Strip, 14 Terminals	412-0014	1
U1,U2	Integrated Circuit, LM317K, Adjustable Positive Voltage Regulator, 1.2V to 37V, 1.5 Ampere Maximum, TO-3 Case	227-0318	2
----	Switch Cap, Green (S1,S2,S3,S5,S6)	343-0006	5
----	Switch Cap, Red (S4)	343-0007	1
----	Standoff Terminal	413-2013	7
----	Fuse Clip (for spare fuse)	415-1001	2
XU1,XU2	Socket, TO-3 Transistor	417-0298	2
----	Insulator, TO-3 (for U1,U2)	418-0010	2
----	Nylon Locking Standoff (for circuit board)	441-9311	5
----	System Controller Circuit Board Assembly	919-0073	1
----	System Controller Wiring Harness	949-0076	1

TABLE 6-14. SYSTEM CONTROLLER CABLE HARNESS - 949-0076

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Receptacle, 25-Pin	417-0015	1
P1,P2	Plug, 12-Pin	418-1271	2
P3	Plug, 6-Pin	418-0670	1
P4,P5	Plug, 12-Pin	418-1271	2
----	Pins for P1 thru P5	417-0053	51

TABLE 6-15. SYSTEM CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0073
(Sheet 1 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C5	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	5
C6	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C7	Capacitor, Ceramic, 0.01 uF ±10%, 200V	030-1043	1
C8	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C9	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1

TABLE 6-15. SYSTEM CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0073
(Sheet 2 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C10	Capacitor, Ceramic, 0.01 uF ±10%, 200V	030-1043	1
C11 THRU C13	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	3
C14,C15	Capacitor, Electrolytic, 10 uF, 35V	023-1076	2
C16	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C17	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C18	Capacitor, Ceramic, 0.01 uF ±10%, 200V	030-1043	1
C19,C20	Capacitor, Electrolytic, 10 uF, 35V	023-1076	2
C21 THRU C24	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	4
C25	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C26	Capacitor, Ceramic, 0.01 uF ±10%, 200V	030-1043	1
C27 THRU C34	Capacitor, Electrolytic, 10 uF, 35V	023-1076	8
C35	Capacitor, Electrolytic, 4700 uF, 35V	014-4795	1
C36	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	1
C37	Capacitor, Electrolytic, 33 uF, 35V, Low Leakage	024-3335	1
C38,C39	Capacitor, Electrolytic, 10 uF, 35V	023-1076	2
C40	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C41	Capacitor, Electrolytic, 1 uF, 50V, Non- Polarized	020-1064	1
D1 THRU D28	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	28
D29 THRU D36	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	8
D37	Diode, MR751, Silicon, 100V @ 6 Amperes	202-0751	1
D38 THRU D40	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	3
D41 THRU D46	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	6
D47 THRU D50	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	4
DS1	Indicator, LED, Red, CM6-86B, 2.2V @ 0.1 Ampere Maximum, T-1 3/4 Size	323-0023	1
DS2	Indicator, LED, Green, 521-9175, 3V @ 40 mA Maximum, T-1 3/4 Size	323-9224	1
DS3	Indicator, LED, Yellow, 521-9176, 3V @ 30 mA Maximum, T-1 3/4 Size	323-9225	1
DS4	Indicator, LED, Red, CM6-86B, 2.2V @ 0.1 Ampere Maximum, T-1 3/4 Size	323-0023	1
DS5	Indicator, LED, Green, 521-9175, 3V @ 40 mA Maximum, T-1 3/4 Size	323-9224	1
DT1	Transient Voltage Suppressor, 1N6284A, 36V ±1.8V, Maximum Peak Pulse Current: 30A	206-0002	1
J1,J2	Receptacle, 12-Pin	417-1276	2
J3	Receptacle, 6-Pin	417-0677	1
J4,J5,J6	Receptacle, 12-Pin	417-1276	3
J7,J8	Receptacle, Male, 2-Pin	417-4004	2
J9,J10	Receptacle, Male, 3-Pin In-line	417-0003	2
K1	Relay, Circuit Board Mount Contacts: SPDT, 100V dc @ 8 Amperes Maximum Coil: 12V dc, 140 mA, 85 Ohms ±10 Ohms	272-0106	1
P7 THRU P10	Jumper, Programmable, 2-Pin	340-0004	4
Q1	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	1
Q2,Q3	Transistor, MPSU05, Silicon, NPN, TO-202N Case	211-0005	2
Q4	Transistor, 2N3053, Silicon, NPN, TO-39 Case	211-3053	1
Q5	Transistor, 2N4036, Silicon, PNP, TO-39 Case	210-4036	1
R1	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R2,R3	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R4	Potentiometer, 5 k Ohm ±10%, 1/2W	177-5044	1
R5 THRU R7	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R8	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R9	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R10	Potentiometer, 5 k Ohm ±10%, 1/2W	177-5044	1
R11,R12	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R13 THRU R16	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	4
R17	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R18,R19	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2

TABLE 6-15. SYSTEM CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0073
(Sheet 3 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R20	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R21,R22	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R23	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R24	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R25	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R26	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R27,R28	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R29,R30	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	2
R31	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R32	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R33,R34	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R35,R36	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	2
R37,R38	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	2
R39,R40	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R41	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R42	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R43	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R44	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R45,R46	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	2
R47 THRU R49	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	3
R50	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R51	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R52	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R53,R54	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	2
R55	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R56	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R57	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R58	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R59	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R60 THRU R64	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	5
R65	Resistor, 3.9 k Ohm ±5%, 1/4W	100-3943	1
R66	Resistor, 2.32 k Ohm ±1%, 1/4W	103-2341	1
R67	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R68	Resistor, 30 Ohm ±5%, 1W	120-3023	1
R69	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R70	Resistor, 1.33 k Ohm ±1%, 1/4W	103-1331	1
R71	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	1
R72	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R73	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R74	Potentiometer, 100 Ohm ±10%, 1/2W	177-1034	1
R75	Resistor, 820 Ohm ±5%, 1/4W	100-8233	1
R76	Resistor, 121 Ohm ±1%, 1/4W	100-1231	1
R77	Resistor, 365 Ohm ±1%, 1/4W	103-3631	1
R79	Resistor, 121 Ohm ±1%, 1/4W	100-1231	1
R80 THRU R83	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	4
R84	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R85 THRU R87	Resistor, 680 Ohm ±5%, 1/4W	100-6833	3
R88	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
R89	Resistor, 10 k Ohm ±5%, 1/2W	110-1053	1
R90	Resistor, 47 Ohm ±5%, 1/2W	110-4723	1
R91	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
R92,R93	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R94,R95	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R96,R97	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
U1	Integrated Circuit, LM339AN, Quad Comparator, 14-Pin DIP	221-0339	1
U2	Integrated Circuit, ULN2003, 7 NPN Darlington Driver Pack, 16-Pin DIP	229-2003	1
U3,U4	Integrated Circuit, NE555V, Timer, 8-Pin DIP	229-0555	2
U5	Integrated Circuit, CD4027BE, Dual JK Master-Slave Flip-Flop, 16-Pin DIP	225-0003	1
U6,U7	Integrated Circuit, NE555V, Timer, 8-Pin DIP	229-0555	2
U8,U9	Integrated Circuit, MC4011BCP, Quad 2-Input NAND Gate, CMOS, 14-Pin DIP	228-4011	2
U10,U11	Integrated Circuit, CD4069CN, Hex Inverter, CMOS, 14-Pin DIP	228-4069	2

TABLE 6-15. SYSTEM CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0073
(Sheet 4 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U12,U13	Integrated Circuit, MC14001BCP, Quad 2-Input NOR Gate, CMOS, 14-Pin DIP	228-4001	2
U14	Integrated Circuit, CD4069CN, Hex Inverter, CMOS, 14-Pin DIP	228-4069	1
U15	Integrated Circuit, MC4011BCP, Quad 2-Input NAND Gate, CMOS, 14-Pin DIP	228-4011	1
U16	Integrated Circuit, ULN2003, 7 NPN Darlington Driver Pack, 16-Pin DIP	229-2003	1
U17 THRU U22	Integrated Circuit, 4N33, Optical Isolator, NPN Photo-Transistor/Infrared Diode, 6-Pin DIP	229-0033	6
U23	Integrated Circuit, TL311P, JFET-Input Differential Comparator, 8-Pin DIP	220-0311	1
U24	Integrated Circuit, LM3362Z-2.5, Precision Voltage Reference, 2.5V ±4%, -0 to +70°C, TO-92 Case	229-0336	1
U25	Integrated Circuit, MC7824ACT, Fixed Positive Voltage Regulator, 24V @ 1.5A, TO-220 Case	227-7824A	1
U26 THRU U29	Integrated Circuit, 4N33, Optical Isolator, NPN Photo-Transistor/Infrared Diode, 6-Pin DIP	229-0033	4
XU1	Socket, 14-Pin DIP	417-1404	1
XU2	Socket, 16-Pin DIP	417-1604	1
XU3,XU4	Socket, 8-Pin DIP	417-0804	2
XU5	Socket, 16-Pin DIP	417-1604	1
XU6,XU7	Socket, 8-Pin DIP	417-0804	2
XU8 THRU XU15	Socket, 14-Pin DIP	417-1404	8
XU16	Socket, 16-Pin DIP	417-1604	1
XU23	Socket, 8-Pin DIP	417-0804	1
----	Nylon Washer (for Q2,Q3)	423-6015	2
----	Transistor Pad, TO-5	409-0005	1
----	Blank Circuit Board	519-0073	1

TABLE 6-16. AC POWER CONTROL PANEL - 959-0174/959-0174-001/959-0174-002/959-0199

REF. DES.	DESCRIPTION	PART NO.	QTY.
CB1	Circuit Breaker, 2 Pole, 2 Amperes, 250V ac (CONTROL)	341-0009	1
CB2,CB3	Circuit Breaker, 2 Pole, 10 Amperes, 250V ac (XMTR-1, XMTR-2)	341-0030	2
J1	Receptacle, 25-Pin	417-0015	1
K1 THRU K3	Relay Coil: 24V dc @ 0.08 Ampere, Resistance = 290 Ohms Contacts: DPST, 750 Watts, 1 hP Maximum	270-0040	3
MOV1	Metal-Oxide Varistor, V250LA40A, 250V, 40 Joules	140-0012	1
TB1	Terminal Strip, 15 Terminals	412-0015-001	1
----	AC Power Control Panel Circuit Board	919-0074	1
	DIFFERENCES FOR 959-0174-001 ASSEMBLY		
CB3	Circuit Breaker, Deleted (XMTR-2)	341-0030	0
	DIFFERENCES FOR 959-0199 ASSEMBLY		
CB2	Circuit Breaker, 2 Pole, 7 Amperes, 250V ac (XMTR-1)	341-0025	1
CB3	Circuit Breaker, Deleted (XMTR-2)	341-0030	0

TABLE 6-17. AC POWER CONTROL PANEL CIRCUIT BOARD ASSEMBLY - 919-0074

REF. DES.	DESCRIPTION	PART NO.	QTY.
D1 THRU D5	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	5
Q1	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	1
Q2 THRU Q4	Transistor, 2N3054, Silicon, NPN, TO-66 Case	211-3504	3
R1,R2	Resistor, 100 Ohm ±5%, 1/2W	110-1033	2
R3	Resistor, 10 k Ohm ±5%, 1/2W	110-1053	1
R4	Resistor, 100 Ohm ±5%, 1/2W	110-1033	1
R5	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
R6	Resistor, 100 Ohm ±5%, 1/2W	110-1033	1
R7	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
XQ2 THRU XQ4	Socket, TO-66 Transistor	417-0012	3
----	Insulator, TO-66	407-0100	3
----	Blank Circuit Board	519-0074	1

SECTION VII

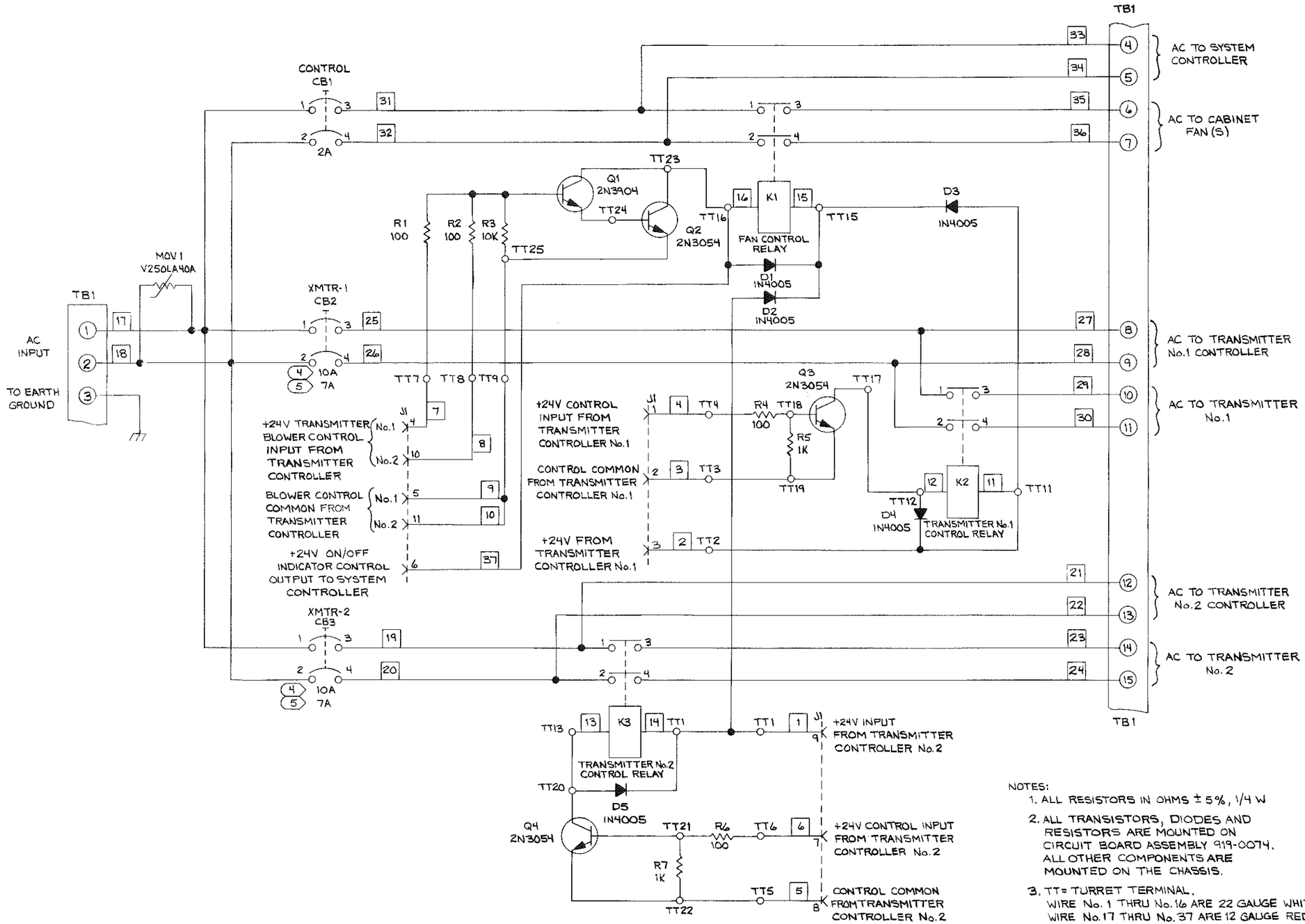
DRAWINGS

7-1. INTRODUCTION.

7-2. This section provides assembly drawings, wiring diagrams, and schematic diagrams as listed below for the Broadcast Electronics very-low-power line of FM transmitters.

FIGURE	TITLE	NUMBER
7-1	SCHEMATIC, AC POWER CONTROL PANEL, MAIN/ ALTERNATE TRANSMITTERS	597-0092-19
7-2	SCHEMATIC, AC POWER CONTROL PANEL, SINGLE CONFIGURATION TRANSMITTERS	597-0092-20
7-3	ASSEMBLY, AC POWER CONTROL PANEL	597-0092-21
7-4	SCHEMATIC, TRANSMITTER CONTROLLER CHASSIS, FM-100, FM-250	SD959-0201/ -0202
7-5	SCHEMATIC, TRANSMITTER CONTROLLER CHASSIS, FM-300	SD959-0172/ -0197
7-6	WIRING DIAGRAM, TRANSMITTER CONTROLLER CHASSIS	597-0092-25
7-7	SCHEMATIC, TRANSMITTER CONTROLLER CIRCUIT BOARD	SD919-0072/ -0072-001
7-8	ASSEMBLY, TRANSMITTER CONTROLLER CIRCUIT BOARD	AD919-0072/ -0072-001
7-9	SCHEMATIC, REMOTE RAISE/LOWER MOTOR CONTROL	SC919-0089
7-10	ASSEMBLY, REMOTE RAISE/LOWER MOTOR CONTROL	AB919-0089
7-11	SCHEMATIC, SYSTEM CONTROLLER CHASSIS	SD959-0173
7-12	WIRING DIAGRAM, SYSTEM CONTROLLER CHASSIS	597-0092-24
7-13	SCHEMATIC, SYSTEM CONTROLLER CIRCUIT BOARD	SD919-0073
7-14	ASSEMBLY, SYSTEM CONTROLLER CIRCUIT BOARD	597-0092-23
7-15	WIRING DIAGRAM, RF CABLES, FM-100/FM-250	WD909-0100-200/ -300 WD909-0250-200/ -300

FIGURE	TITLE	NUMBER
7-16	WIRING DIAGRAM, SYSTEM INTERCONNECT, FM-100/FM-250	WD909-0100-200/ -300 WD909-0250-200/ -300
7-17	WIRING DIAGRAM, RF CABLES, FM-100M/A & FM-250M/A	WD909-2100-200/ -300 WD909-2250-200/ -300
7-18	WIRING DIAGRAM, SYSTEM INTERCONNECT, FM-100M/A & FM-250M/A	WD909-2100-200/ -300 WD909-2250-200/ -300
7-19	WIRING DIAGRAM, RF CABLES, FM-300A	WD909-0300-200/ -300
7-20	WIRING DIAGRAM, SYSTEM INTERCONNECT, FM-300A	WD909-0300-200/ -300
7-21	WIRING DIAGRAM, RF CABLES, FM-300M/A	WD909-2300-200/ -300
7-22	WIRING DIAGRAM, SYSTEM INTERCONNECT, FM-300M/A	WD909-2300-200/ -300



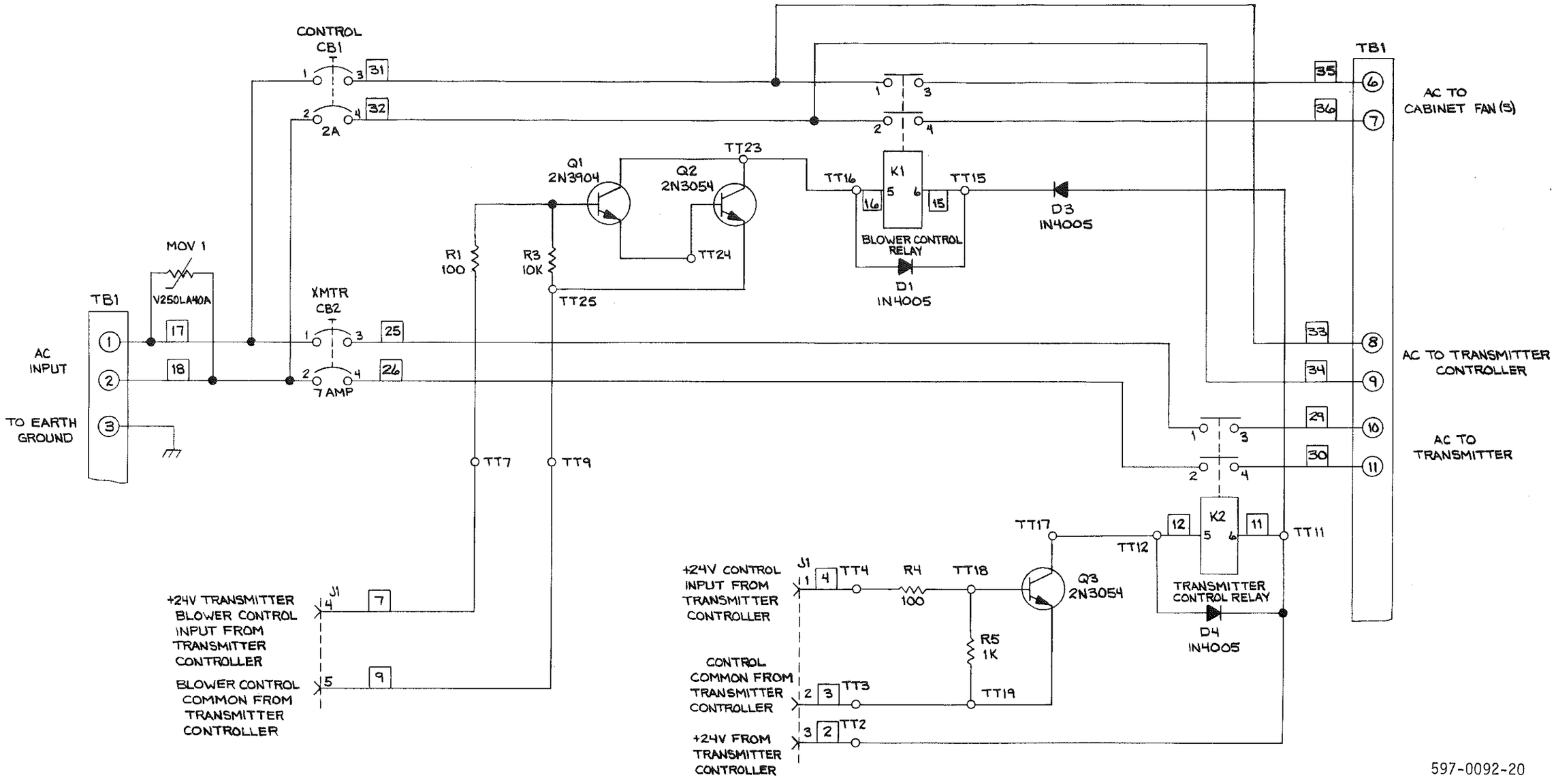
597-0092-19

NOTES:

1. ALL RESISTORS IN OHMS ± 5%, 1/4 W
2. ALL TRANSISTORS, DIODES AND RESISTORS ARE MOUNTED ON CIRCUIT BOARD ASSEMBLY 919-0074. ALL OTHER COMPONENTS ARE MOUNTED ON THE CHASSIS.
3. TT= TURRET TERMINAL. WIRE No. 1 THRU No. 16 ARE 22 GAUGE WHITE. WIRE No. 17 THRU No. 37 ARE 12 GAUGE RED. [XX] INDICATES WIRE NUMBER
4. FM-250 M/A AND FM-300 M/A
5. FM-100 M/A

FIGURE 7-1.

SCHEMATIC, AC POWER CONTROL PANEL, MAIN/ALTERNATE TRANSMITTERS



597-0092-20

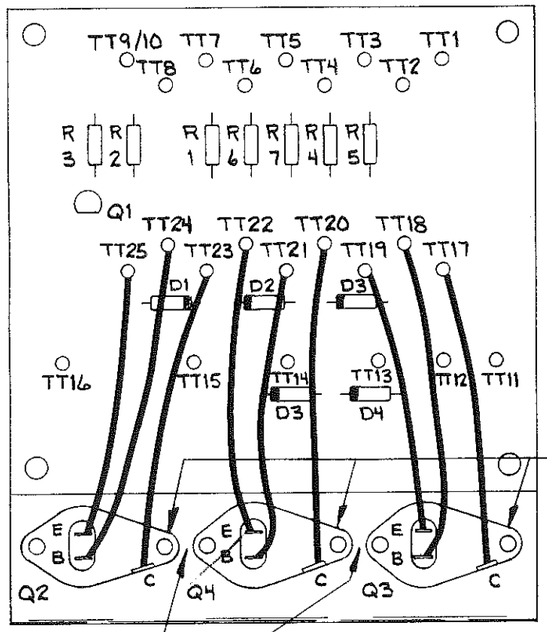
NOTES:

1. ALL RESISTORS IN OHMS ± 5%, 1/4 WATT
2. ALL TRANSISTORS, DIODES AND RESISTORS ARE MOUNTED ON CIRCUIT BOARD ASSEMBLY 919-0074, ALL OTHER COMPONENTS ARE MOUNTED ON THE CHASSIS. COMPONENTS MOUNTED ON ASSEMBLY 919-0074 AND NOT ILLUSTRATED ON THIS SCHEMATIC ARE NOT USED.
3. TT = TURRET TERMINAL
   WIRES No. 1 THRU No. 16 ARE 22 GAUGE WHITE,
   WIRES No. 17 THRU No. 37 ARE 12 GAUGE RED.
   [XX] INDICATES WIRE NUMBER
4. SEE ASSY DRAWING 597-0092-21

FIGURE 7-2.

SCHEMATIC AC POWER CONTROL PANEL, SINGLE CONFIGURATION TRANSMITTERS

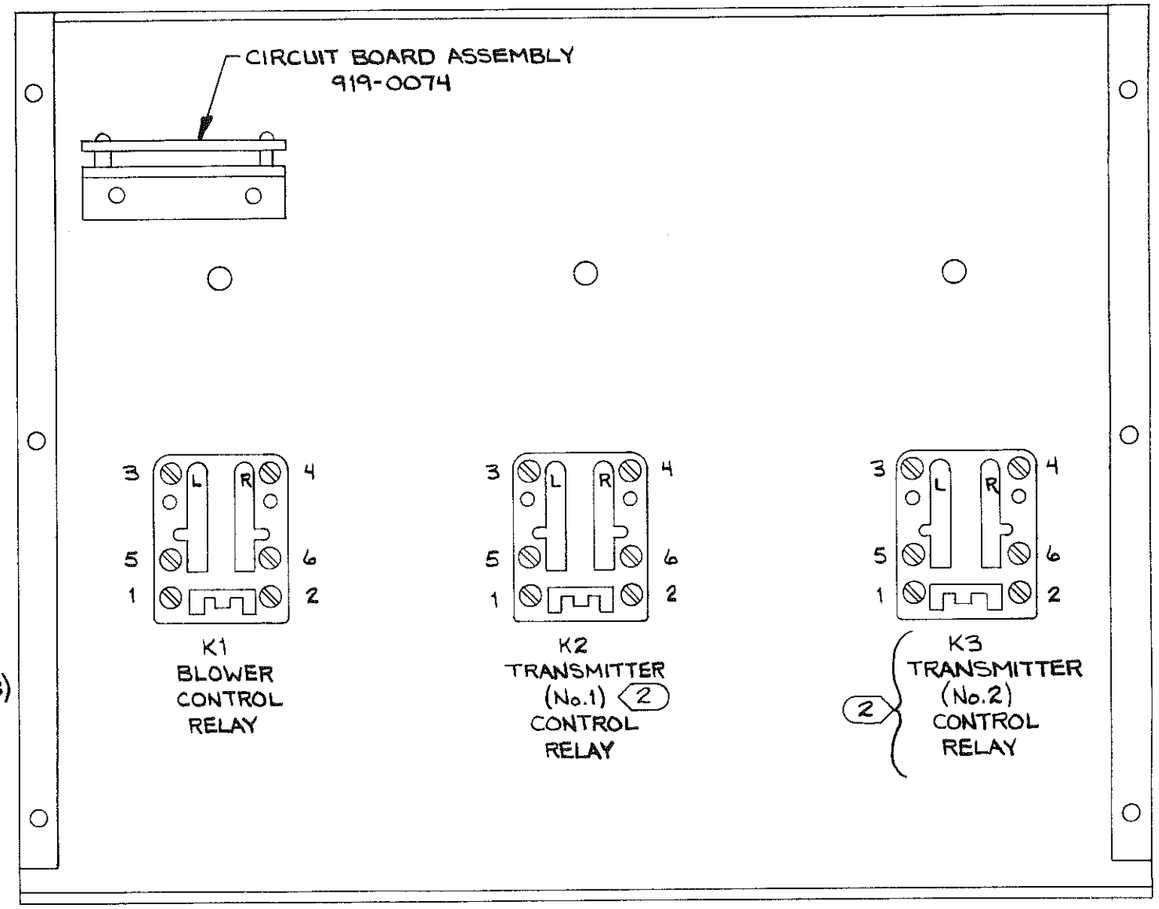
CIRCUIT BOARD ASSEMBLY 919-0074



CAUTION
USE HEATSINK THERMAL COMPOUND (B·E P/N 700-0028) ON BOTH SIDES OF INSULATOR (B·E P/N 407-0100). INSULATOR MUST BE USED.

CAUTION
DO NOT ALLOW TRANSISTORS TO TOUCH.

WIRE FROM	WIRE TO
Q2-E	TT-25
Q2-B	TT-24
Q2-C	TT-23
Q4-E	TT-22
Q4-B	TT-21
Q4-C	TT-20
Q3-E	TT-19
Q3-B	TT-18
Q3-C	TT-17

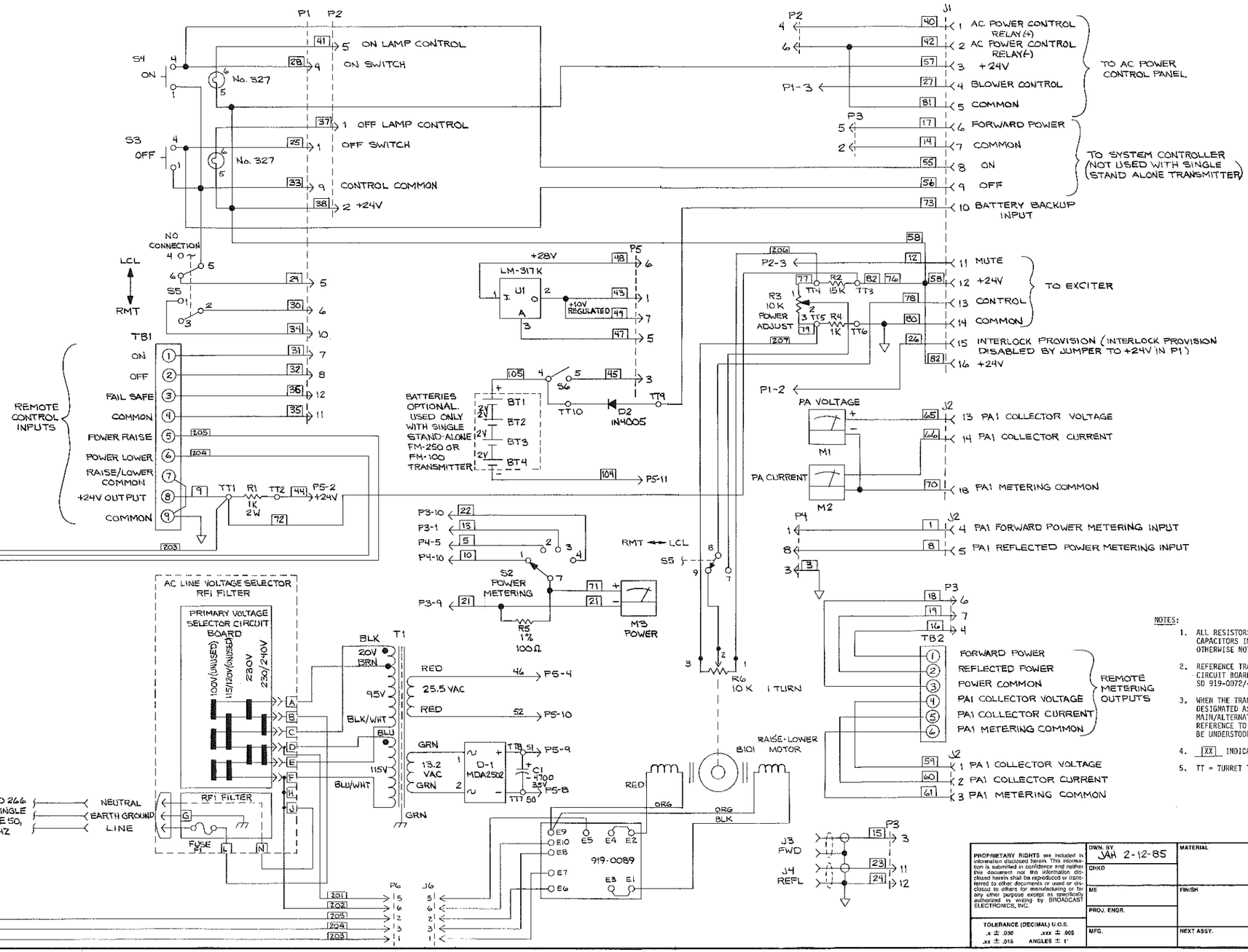


CHASSIS ASSEMBLY

597-0092-21

NOTES:
1. SEE SCHEMATIC DRAWINGS 597-0092-19 & 597-0092-20
2. MAIN/ALTERNATE TRANSMITTERS ONLY

FIGURE 7-3. POWER PANEL ASSEMBLY



NOTES:

1. ALL RESISTORS IN OHMS, 1/4 WATT; ALL CAPACITORS IN MICROFARADS, UNLESS OTHERWISE NOTED.
2. REFERENCE TRANSMITTER CONTROLLER CIRCUIT BOARD SCHEMATIC DIAGRAM NO. SD 919-0072/-001.
3. WHEN THE TRANSMITTER CONTROLLER IS DESIGNATED AS CONTROLLER NO. 2 IN A MAIN/ALTERNATE CONFIGURATION, ALL REFERENCE TO PA1-A AND PA1-B SHALL BE UNDERSTOOD TO BE PA2-A AND PA2-B.
4. [XX] INDICATES WIRE NUMBER.
5. TT = TURRET TERMINAL.

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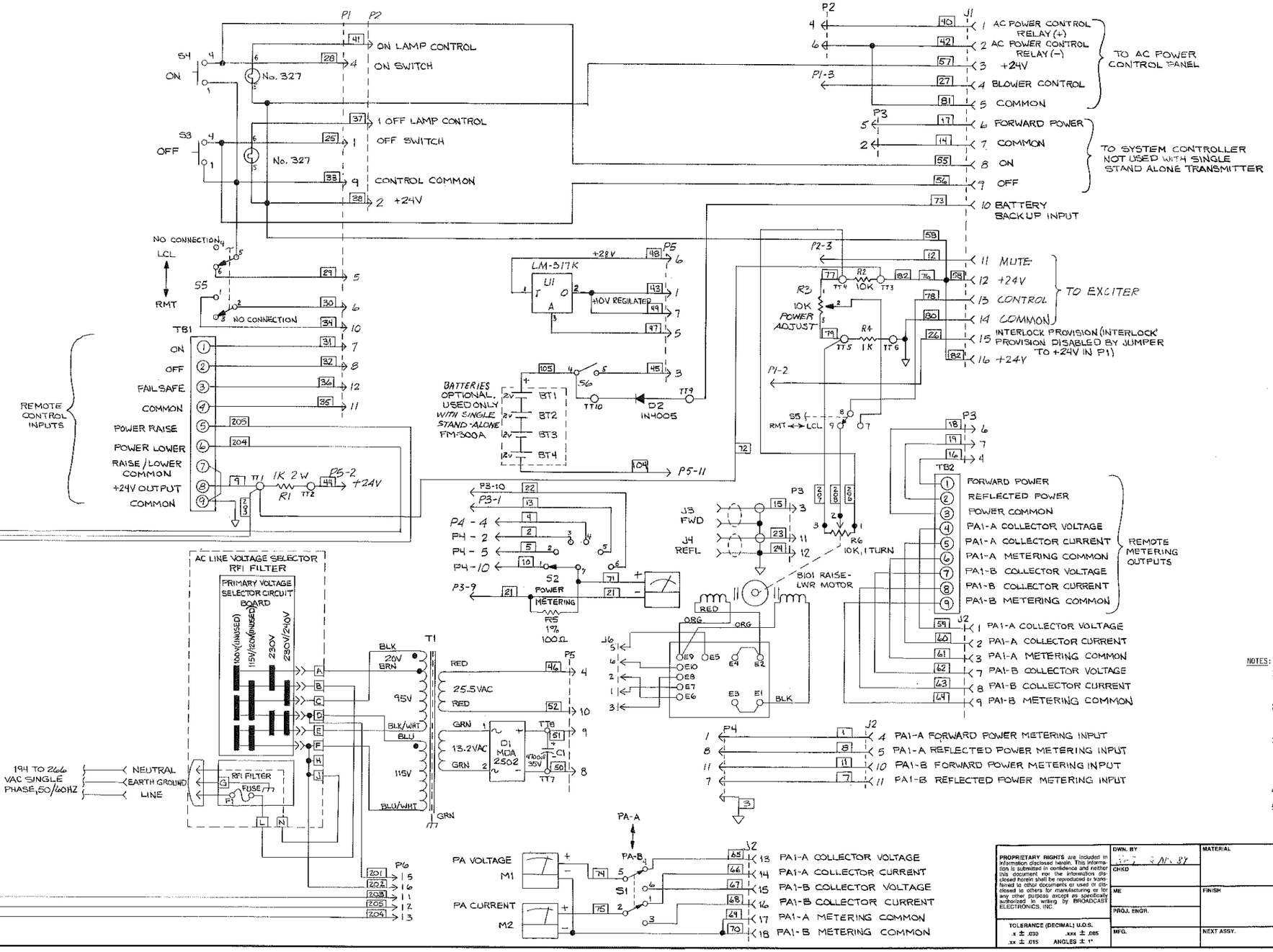
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY JAH 2-12-85
CHKD
ME
PROJ. ENGR.
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CASLE BROADCAST

TITLE SCHEMATIC TRANSMITTER CONTROLLER CHASSIS

TYPE S SIZE D DWG. NO. 959-0201/-0202 REV D
MODEL FM 250 MA, 250 FM 100 MA, 100 SCALE — SHEET 1 OF 1



NOTES:

1. ALL RESISTORS IN OHMS, 1/4 WATT; ALL CAPACITORS IN MICROFARADS, UNLESS OTHERWISE NOTED.
2. REFERENCE TRANSMITTER CONTROLLER CIRCUIT BOARD SCHEMATIC DIAGRAM NO. SD 919-0072/-001.
3. WHEN THE TRANSMITTER CONTROLLER IS DESIGNATED AS CONTROLLER NO. 2 IN A MAIN/ALTERNATE CONFIGURATION, ALL REFERENCE TO PA1 SHALL BE UNDERSTOOD TO BE PA2.
4. [XX] INDICATES WIRE NUMBER.
5. TT = TURRET TERMINAL.

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TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°

DWN. BY — CHKD — ME — PROJ. ENGR. — MFG.

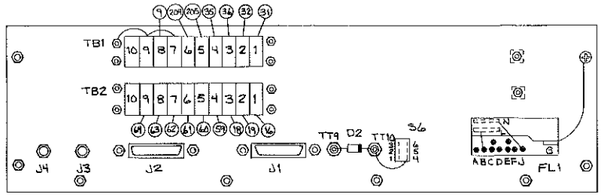
MATERIAL — FINISH — NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

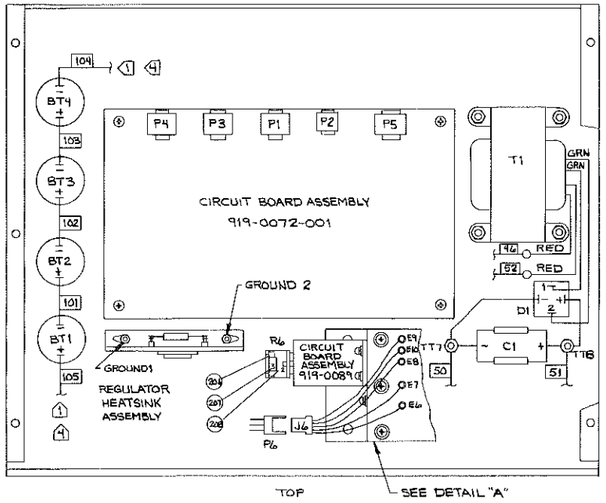
TITLE SCHEMATIC TRANSMITTER CONTROLLER C.B.

TYPE S SIZE D DWG. NO. 959-0172/959-0191 REV E

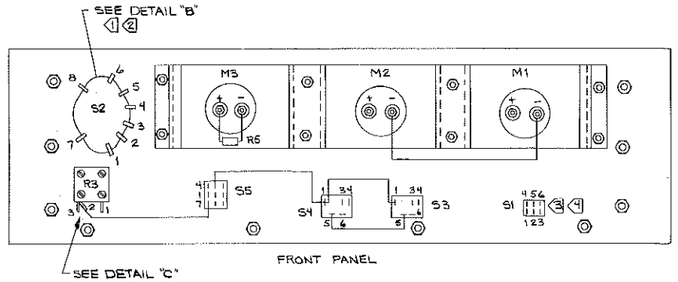
MODEL FM300MA SCALE SHEET 1 OF 1



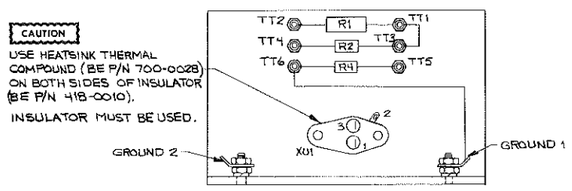
REAR PANEL



TOP



FRONT PANEL



REGULATOR HEAKSINK ASSEMBLY

TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.
TB1-1	31	J2-1	59	J1-1	40	J1-16	82
TB1-2	32	J2-2	60	J1-2	42	S6-5	45
TB1-3	36	J2-3	61	J1-3	57	J3	15
TB1-4	35	J2-4	1	J1-4	27	J4	23
TB1-5	205	J2-5	8	J1-5	81	TT9	73
TB1-6	204	3 4 J2-7	62	J1-6	17	FL1-A	BRN OF T1
TB1-8	9	3 4 J2-8	63	J1-7	14	FL1-C	BLK OF T1
TB2-1	16	3 4 J2-9	64	J1-8	55	FL1-D	201 BLU OF T1
TB2-2	19	3 4 J2-10	11	J1-9	56	FL1-E	BLK/WHT OF T1
TB2-3	18	3 4 J2-11	7	J1-10	73	FL1-F	202 BLU/WHT OF T1
TB2-4	59	J2-13	65	J1-11	12	FL1-G	CHASSIS
TB2-5	60	J2-14	66	J1-12	58	TT10	1 4 105
TB2-6	61	3 4 J2-15	67	J1-13	78		
3 4 TB2-7	62	3 4 J2-16	68	J1-14	80		
3 4 TB2-8	63	3 4 J2-17	69	J1-15	26		
3 4 TB2-9	64	J2-18	70				

TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.
P4-1	1	P3-1	13	P1-1	25	P2-1	37
3 4 P4-2	2	P3-2	14	P1-2	26	P2-2	38
P4-3	3	P3-3	15	P1-3	27	P2-3	12
3 4 P4-4	4	P3-4	16	P1-4	28	P2-4	40
P4-5	5	P3-5	17	P1-5	29	P2-5	41
3 4 P4-7	7	P3-6	18	P1-6	30	P2-6	42
P4-8	8	P3-7	19	P1-7	31		
P4-10	10	P3-9	21	P1-8	32		
3 4 P4-11	11	P3-10	22	P1-9	33		
		P3-11	23	P1-10	34		
		P3-12	24	P1-11	35		
				P1-12	36		

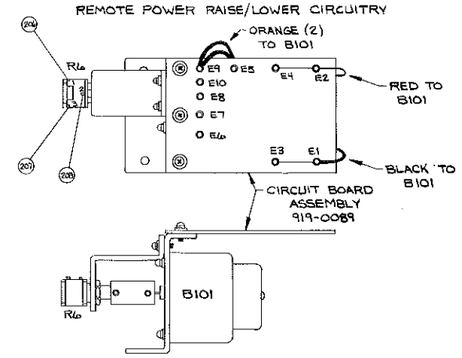
TERMINAL	WIRE No.
R6-1	206
R6-2	208
R6-3	207

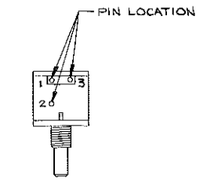
TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.
P5-1	43	P6-1	203				
P5-3	45	P6-2	205				
P5-4	46	P6-3	204				
P5-5	47	P6-5	201				
P5-6	48	P6-6	202				
P5-7	49						
P5-8	50						
P5-9	51						
P5-10	52						
P5-11	1 4 104						

TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.
S2-1	10	M3+	71	S4-4	28 & 55	S1-1	3 4 46
S2-2	5	M3-	21	S4-5	58 & 76	S1-2	3 4 75
S2-3	13	M2+	1 2 66	S4-6	41	S1-3	3 4 48
S2-4	22	M2+	3 4 75	S3-1	33	S1-4	3 4 65
S2-5	13	M2-	70	S3-4	25 & 56	S1-5	3 4 74
3 4 S2-6	22	M1+	1 2 65	S3-5	38 & 57	S1-6	3 4 67
3 4 S2-7	71	M1+	3 4 74	S3-6	37		
R3-1	77	M1-	3 4 69				
R3-3	79	S5-1	34				
		S5-2	30				
		S5-6	29				
		S5-8	78				
		S5-9	208				

TERMINAL	WIRE No.
TT1	9 & 203
TT2	44
TT3	76 & 82
TT4	77 & 206
TT5	79 & 207
TT6	80
XU1-1	48
XU1-2	43 & 49
XU1-3	47
GROUND 1	3 JUMPER
GROUND 2	24 & 81

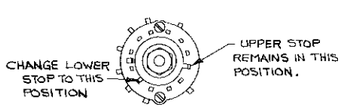
DETAIL "A"
REMOTE POWER RAISE/LOWER CIRCUITRY





DETAIL "C" (R3)

DETAIL "B" (S2) 1 2



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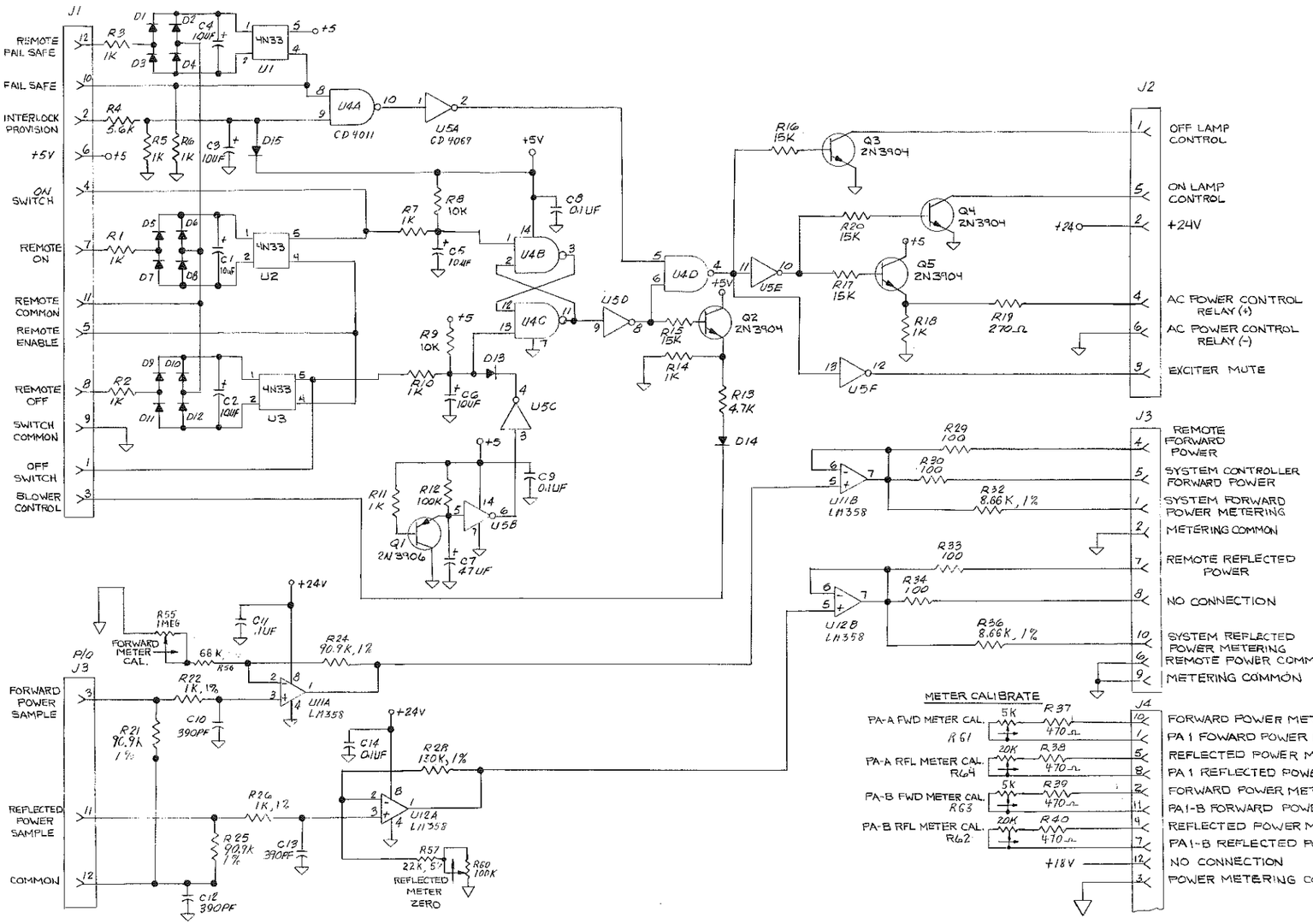
597-0092-25

1 959-0201 ASSEMBLY ONLY
2 959-0202 ASSEMBLY ONLY
3 959-0172 ASSEMBLY ONLY
4 959-0197 ASSEMBLY ONLY

FIGURE 7-6. WIRING DIAGRAM, TRANSMITTER CONTROLLER CHASSIS



NOTES:

1. ALL RESISTORS IN OHMS, 1/4 WATT; ALL CAPACITORS ARE IN MICROFARADS, 0.01 UF; ALL DIODES ARE 1N4148, UNLESS OTHERWISE NOTED.
2. REFERENCE TRANSMITTER CONTROLLER CHASSIS SCHEMATIC DIAGRAM NO. SD 959-0172/SD 959-0197 AND SD 959-0201/959-0202.
3. WHEN A TRANSMITTER CONTROLLER IS DESIGNATED AS CONTROLLER NO. 2 IN A MAIN/ALTERNATE CONFIGURATION, ALL REFERENCE TO PA1-A AND PA1-B SHALL BE UNDERSTOOD TO BE PA2-A AND PA2-B.
4. (#) INDICATES WIRE NUMBER.
5. TT = TURRET TERMINAL.
6. DIODE D29 IS INSTALLED WHEN BATTERIES ARE NOT USED IN THE TRANSMITTER CONTROLLER (P/N 919-0072-001). REMOVE DIODE D29 IN TRANSMITTER CONTROLLER P/N 919-0072.

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

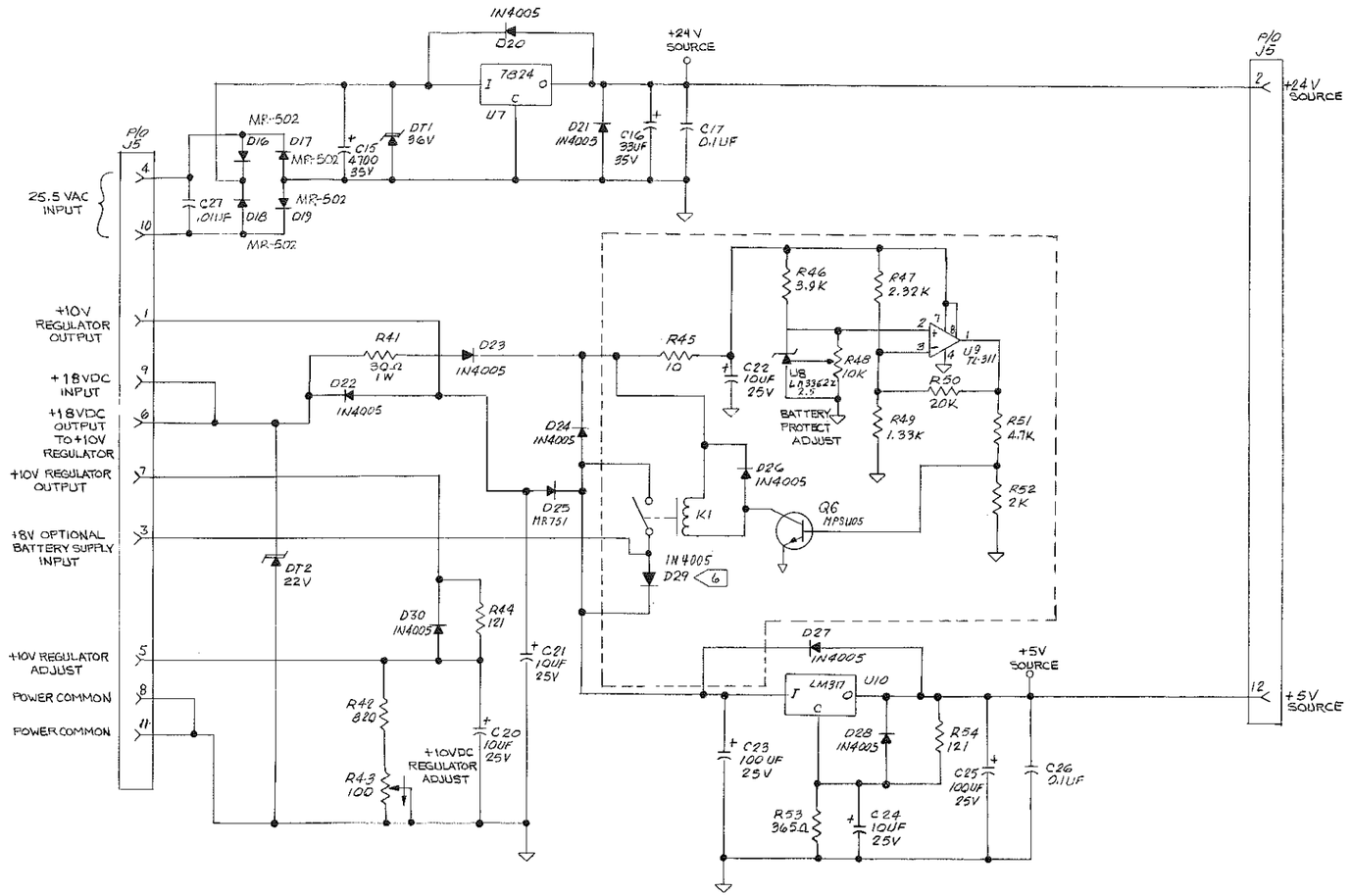
DWN. BY RHF 12 DEC '94
CHKD
ME
PROJ. ENGR. JS
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3605 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SCHEMATIC TRANSMITTER CONTROLLER P.C.B.

TYPE S SIZE D DWG. NO. 919-0072 919-0072-001 REV H

MODEL FM-300A/FM-5U SCALE — SHEET 1 OF 2



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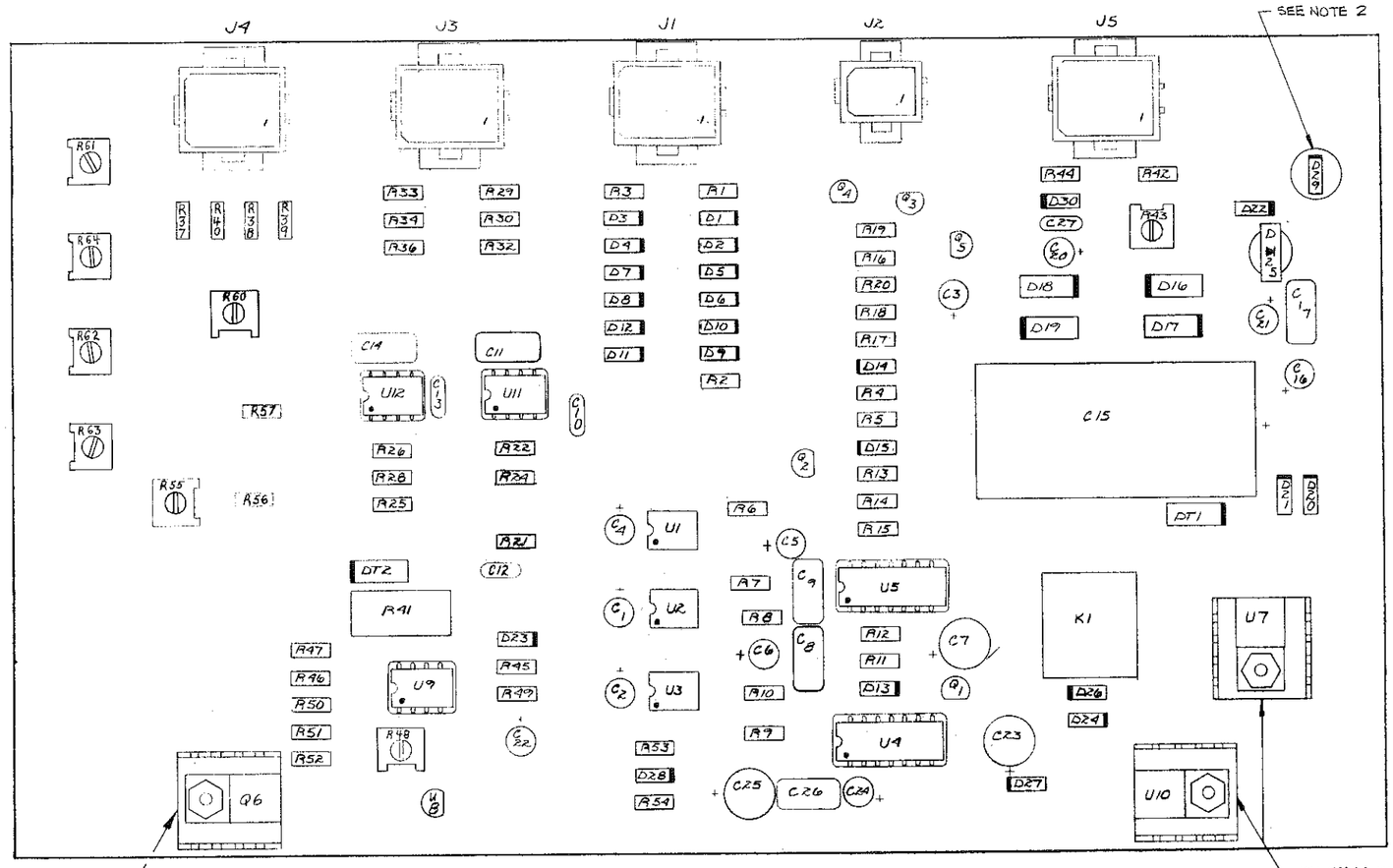
	CHKD		TITLE SCHEMATIC TRANSMITTER CONTROL PCB
	ME	FINISH	
TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°	PROJ. ENGR.		TYPE S SIZE D DWG. NO. 919-0072 919-0072-001 REV H
	MFG.	NEXT ASSY.	MODEL FM25U, FM25UHP SCALE - SHEET 2 OF 2

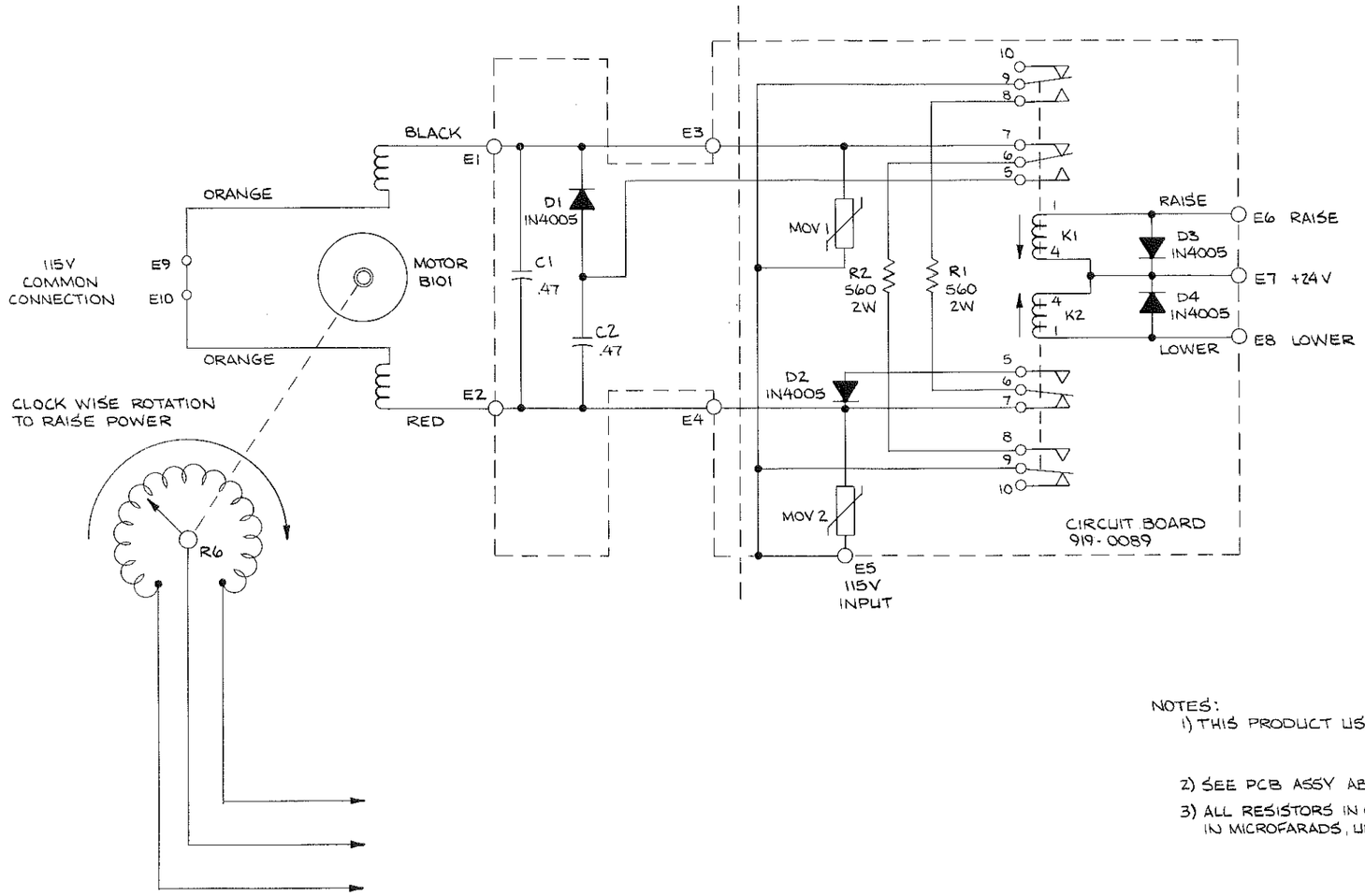


USE HEAT SINK COMPOUND
420-4106
421-4001
423-4002
423-0001 SPACER UNDER TAB OF Q6

NOTES:

1. REFERENCE TRANSMITTER CONTROLLER CIRCUIT BOARD SCHEMATIC DIAGRAM No. SD 919-0072/-001.
2. DIODE D29 IS INSTALLED WHEN BATTERIES ARE NOT USED IN THE TRANSMITTER CONTROLLER (P/N 919-0072-001). REMOVE DIODE D29 IN TRANSMITTER CONTROLLER P/N 919-0072.

PROPRIETARY NOTICE	DWN BY FHS 12 MAY 94	MATERIAL	BROADCAST ELECTRONICS INC.
	CHKD		4100 N. 24TH ST. P.O. BOX 3606 QUINCY IL 62305 217 224-9600 TELEX 250147 CABLE BROADCAST
	ME	FINISH	TITLE ASSY, PCB TRANSMITTER CONTROLLER
	PROJ ENG J5		TYPE A SIZE D DWG NO 919-0072 919-0072-001 REV K
	MFG	NEXT ASSY	MODEL FM250/FM250HA SCALE 2/1 SHEET 1 OF 1



NOTES:

1) THIS PRODUCT USED ON FM100/100 MA
FM250/250 MA
FM300/300 MA

2) SEE PCB ASSY AB 919-0089

3) ALL RESISTORS IN OHMS, 1/4 W, 5%; ALL CAPACITORS IN MICROFARADS, UNLESS OTHERWISE NOTED.

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY MSE 8-6-85
CHKD MH 8-28-85
ME
PROJ. ENGR. JHS
MFG.

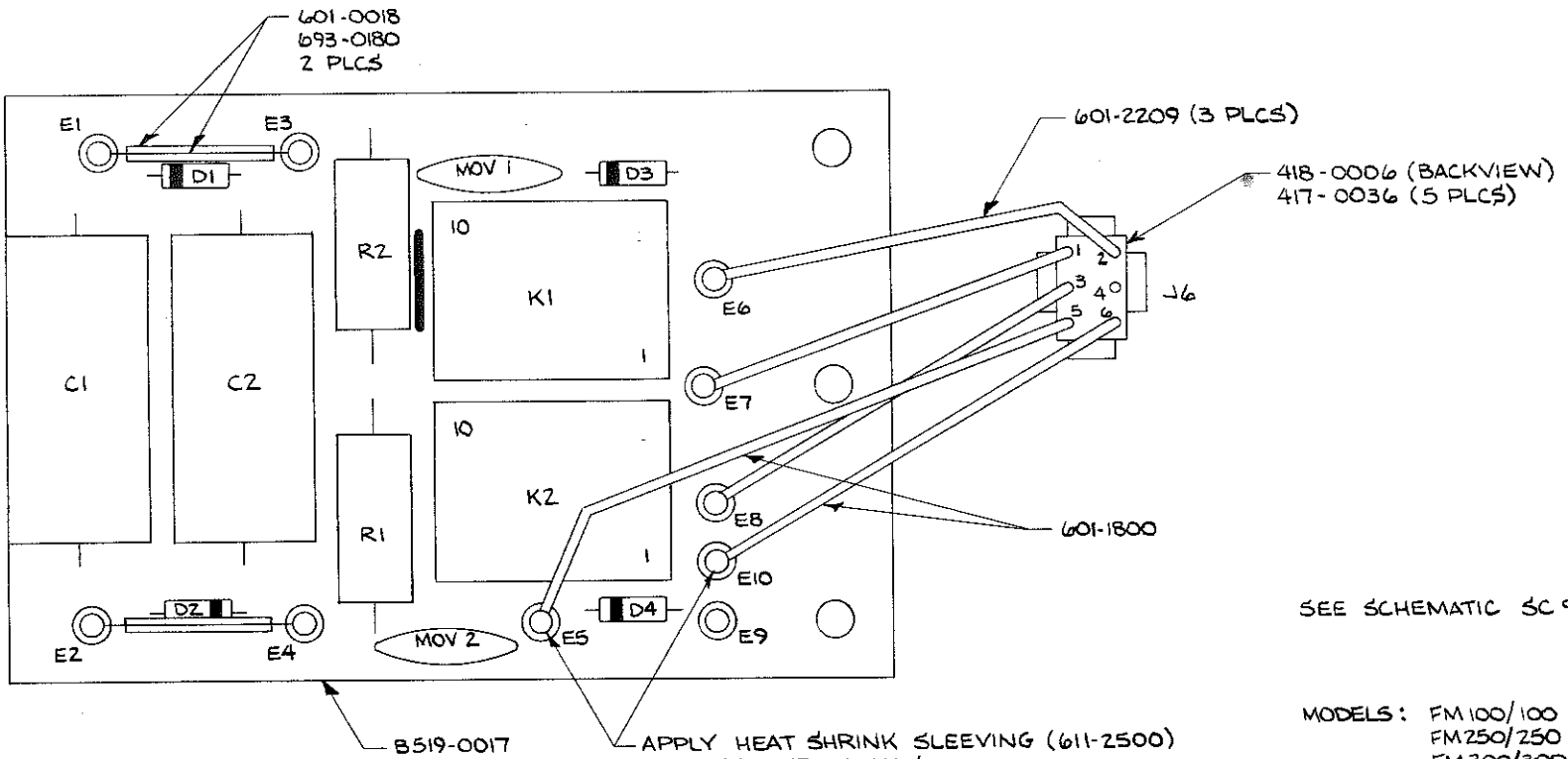
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SCHEMATIC, REMOTE RAISE-LOWER MOTOR CONTROL

TYPE S | SIZE C | DWG. NO. 919-0089 | REV A

MODEL SEE NOTE #1 | SCALE ~ | SHEET 1 OF 1



SEE SCHEMATIC SC 919-0089

MODELS: FM 100/100 MA
FM 250/250 MA
FM 300/300 MA

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

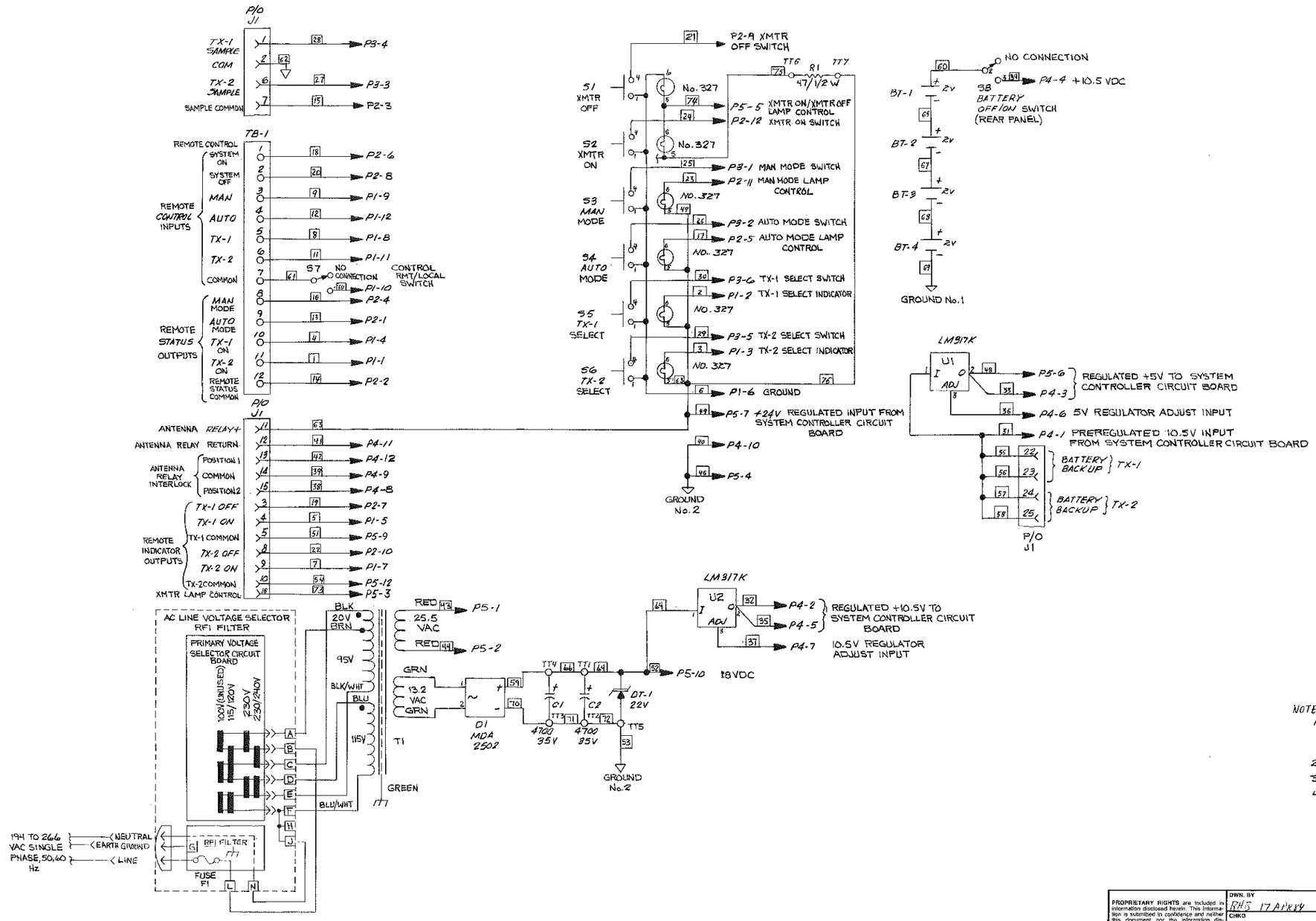
DWN. BY	MSE 8-6-85
CHKD	MH 8-28-85
ME	
PROJ. ENGR.	
MFG.	
MATERIAL	SEE B/M 919-0089
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE ASSY, RAISE-LOWER MOTOR CONTROL

TYPE	SIZE	DWG. NO.	REV
A	B	919-0089	A

MODEL | SCALE 2/1 | SHEET 1 OF 1



NOTES:

1. TT= TURRET TERMINAL
   XX INDICATES WIRE NUMBER
2. SEE SCHEMATIC D919-0073
3. SEE ASSEMBLY D919-0073
4. CAPACITORS IN UF, RESISTORS IN OHMS.

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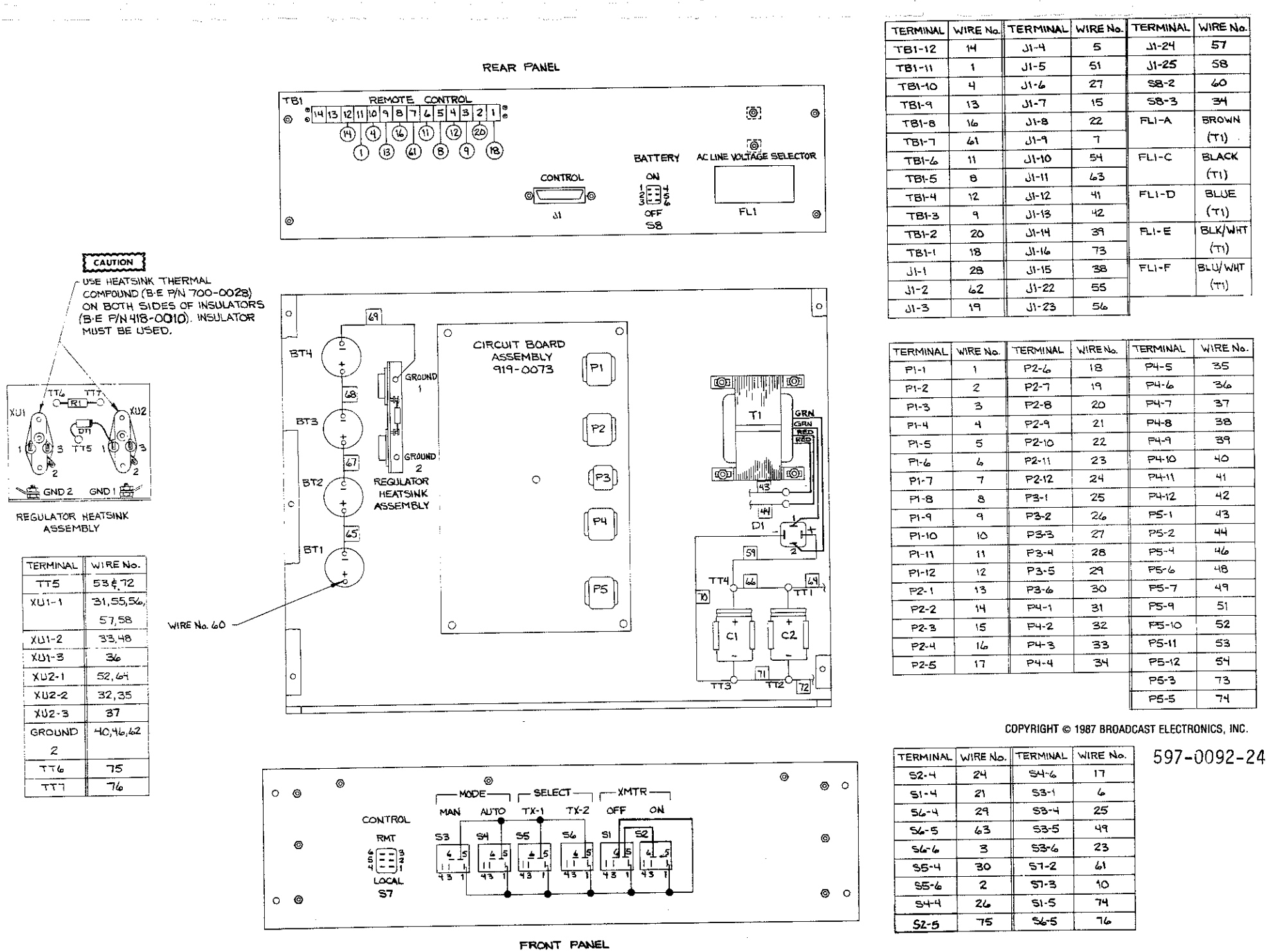
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY RHS 17 APR 84
CHK'D
ME
PROJ. ENGR. JS
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 350142 CABLE BROADCAST

TITLE SCHEMATIC, SYSTEM CONTROLLER CHASIS
TYPE S SIZE D DWG. NO. 959-0173 REV C
MODEL FM300MA FM250MA SCALE — SHEET 1 OF 1



TERMINAL	WIRE No.
TT5	53 & 72
XU1-1	31,55,56, 57,58
XU1-2	33,48
XU1-3	36
XU2-1	52,64
XU2-2	32,35
XU2-3	37
GROUND 2	40,46,62
TT6	75
TT7	76

TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.
TB1-12	14	J1-4	5	J1-24	57
TB1-11	1	J1-5	51	J1-25	58
TB1-10	4	J1-6	27	S8-2	60
TB1-9	13	J1-7	15	S8-3	34
TB1-8	16	J1-8	22	FL1-A	BROWN (T1)
TB1-7	61	J1-9	7		
TB1-6	11	J1-10	54	FL1-C	BLACK (T1)
TB1-5	8	J1-11	63		
TB1-4	12	J1-12	41	FL1-D	BLUE (T1)
TB1-3	9	J1-13	42		
TB1-2	20	J1-14	39	FL1-E	BLK/WHT (T1)
TB1-1	18	J1-16	73		
J1-1	28	J1-15	38	FL1-F	BLU/WHT (T1)
J1-2	62	J1-22	55		
J1-3	19	J1-23	56		

TERMINAL	WIRE No.	TERMINAL	WIRE No.	TERMINAL	WIRE No.
P1-1	1	P2-6	18	P4-5	35
P1-2	2	P2-7	19	P4-6	36
P1-3	3	P2-8	20	P4-7	37
P1-4	4	P2-9	21	P4-8	38
P1-5	5	P2-10	22	P4-9	39
P1-6	6	P2-11	23	P4-10	40
P1-7	7	P2-12	24	P4-11	41
P1-8	8	P3-1	25	P4-12	42
P1-9	9	P3-2	26	P5-1	43
P1-10	10	P3-3	27	P5-2	44
P1-11	11	P3-4	28	P5-4	46
P1-12	12	P3-5	29	P5-6	48
P2-1	13	P3-6	30	P5-7	49
P2-2	14	P4-1	31	P5-9	51
P2-3	15	P4-2	32	P5-10	52
P2-4	16	P4-3	33	P5-11	53
P2-5	17	P4-4	34	P5-12	54
				P5-3	73
				P5-5	74

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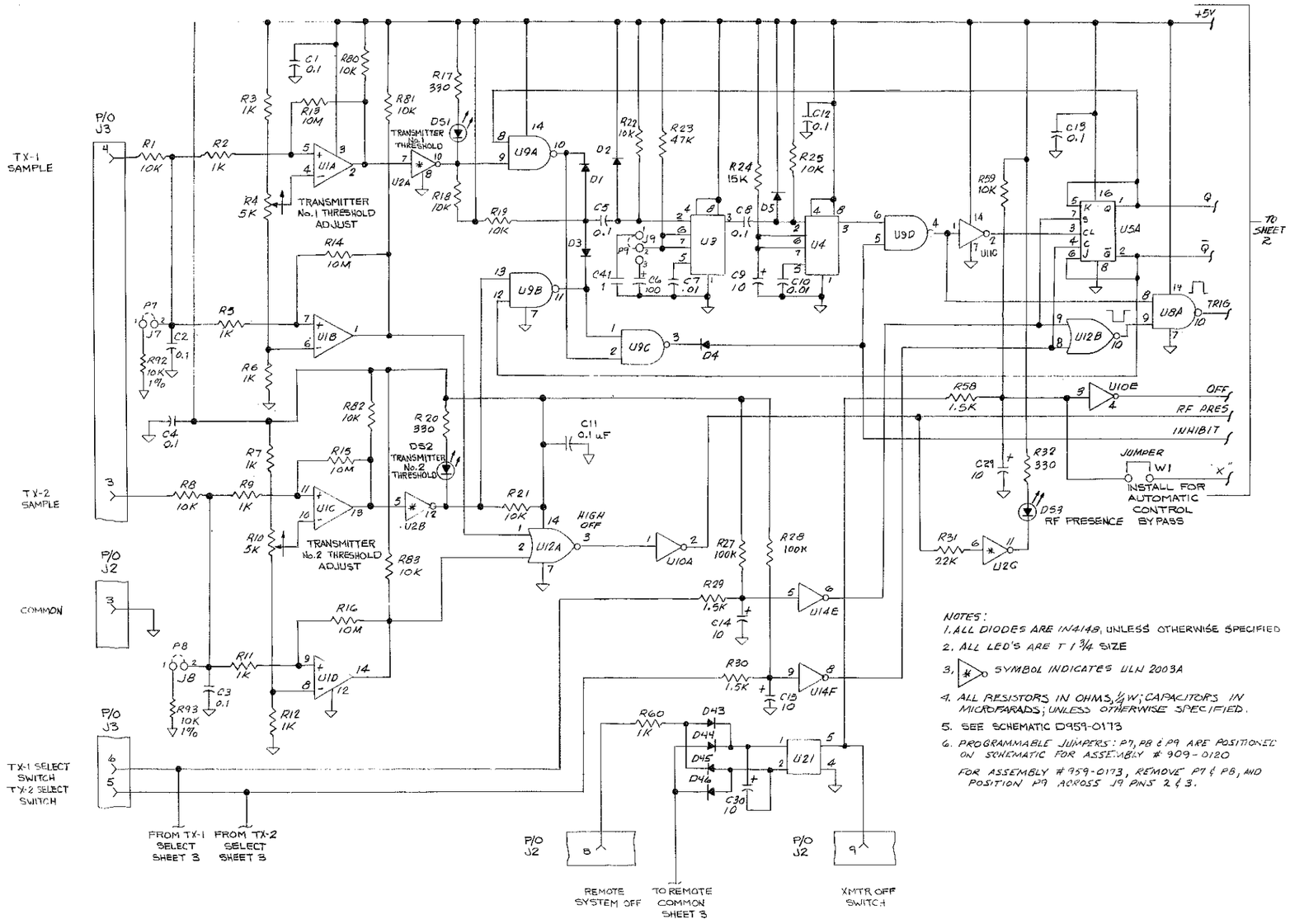
TERMINAL	WIRE No.	TERMINAL	WIRE No.
S2-4	24	S4-6	17
S1-4	21	S3-1	6
S6-4	29	S3-4	25
S6-5	63	S3-5	49
S6-6	3	S3-6	23
S5-4	30	S7-2	61
S5-6	2	S7-3	10
S4-4	26	S1-5	74
S2-5	75	S6-5	76

FIGURE 7-12. SYSTEM CONTROLLER CHASSIS WIRING DIAGRAM



NOTES:
1. ALL DIODES ARE IN4148, UNLESS OTHERWISE SPECIFIED
2. ALL LED'S ARE T 1 3/4 SIZE
3. ▷* SYMBOL INDICATES ULN 2003A
4. ALL RESISTORS IN OHMS, ¼ W; CAPACITORS IN MICROFARADS; UNLESS OTHERWISE SPECIFIED.
5. SEE SCHEMATIC D959-0173
6. PROGRAMMABLE JUMPERS: P7, P8 & P9 ARE POSITIONED ON SCHEMATIC FOR ASSEMBLY # 909-0120
   FOR ASSEMBLY # 959-0173, REMOVE P7 & P8, AND POSITION P9 ACROSS J9 PINS 2 & 3.

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

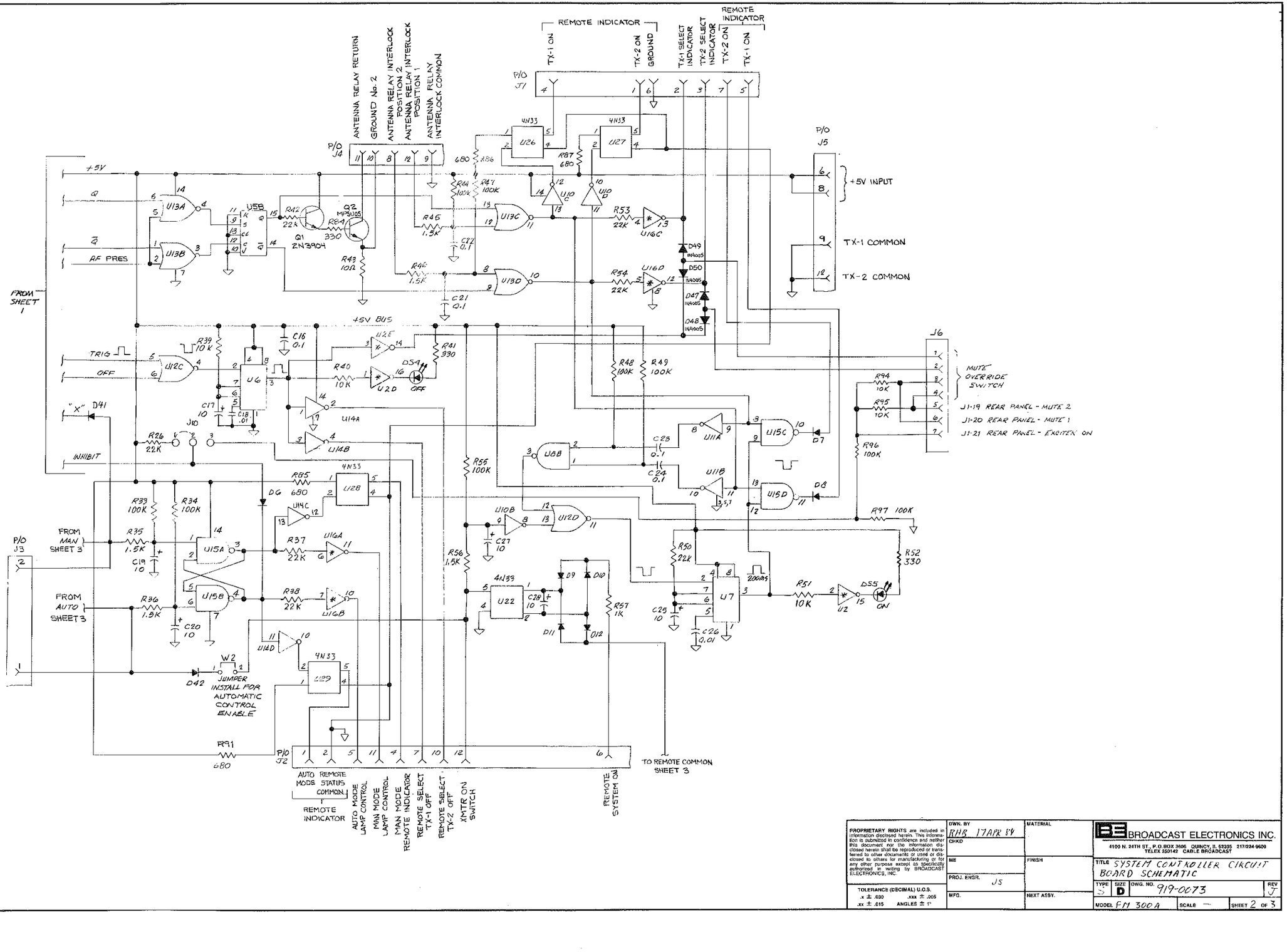
DWN. BY	RHF 17APR 84
CHKD	
ME	
PROJ. ENGR.	JS
MFG.	
MATERIAL	
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SYSTEM CONTROLLER CIRCUIT BOARD SCHEMATIC

TYPE	SIZE	DWG. NO.	REV
S	D	919-0073	J

MODEL FM 300A SCALE — SHEET 1 OF 3



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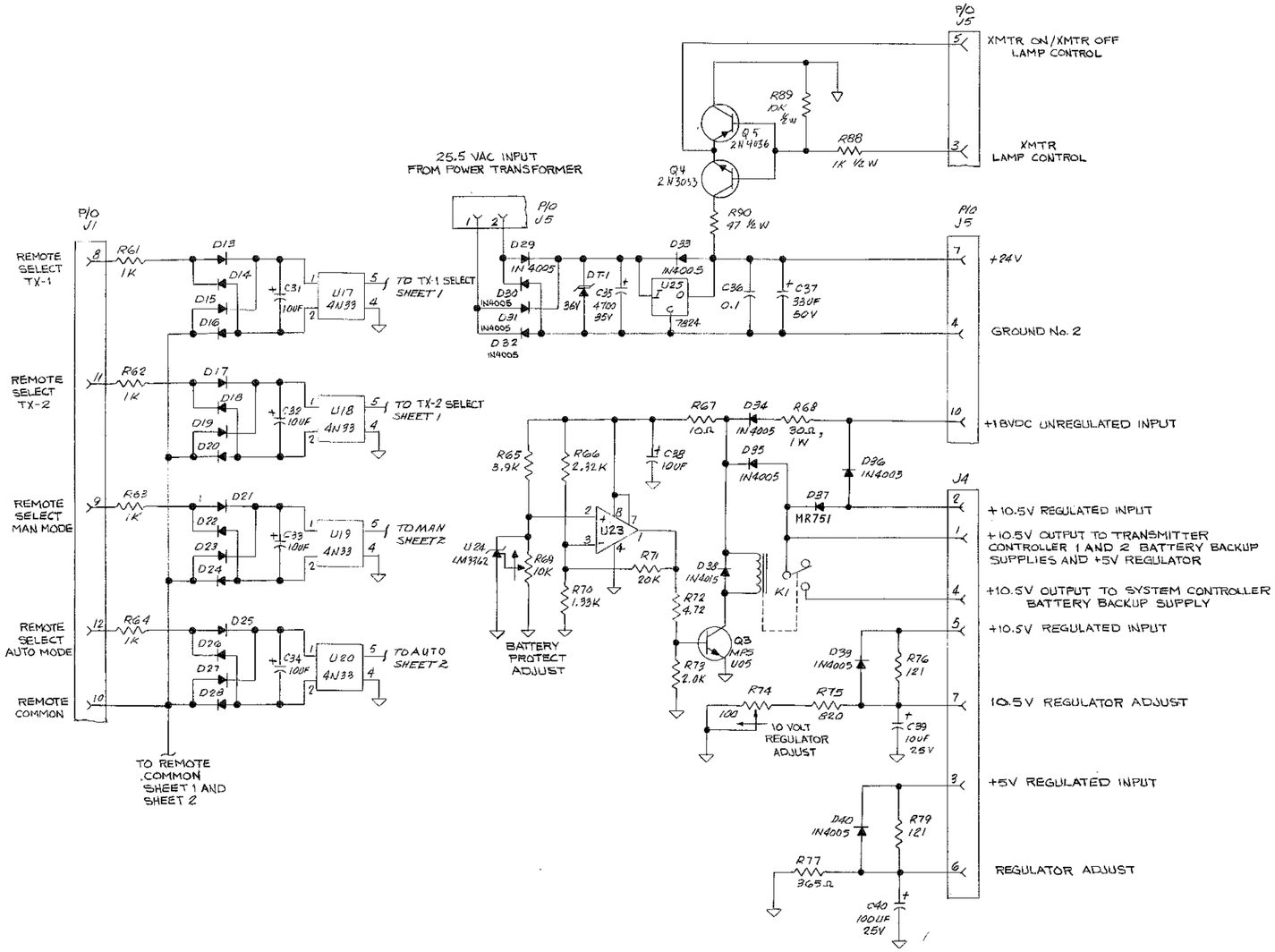
TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°	CHKD	FINISH	TITLE SYSTEM CONTROLLER CIRCUIT BOARD SCHEMATIC
	ME		TYPE 3 SIZE D DWG. NO. 919-0073 REV J
	PROJ. ENGR. JS	NEXT ASSY.	MODEL FM 300A SCALE — SHEET 2 OF 3
	MFG.		



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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY RHB 17 APR.84
CHKD
ME
PROJ. ENGR. JS
MFG.

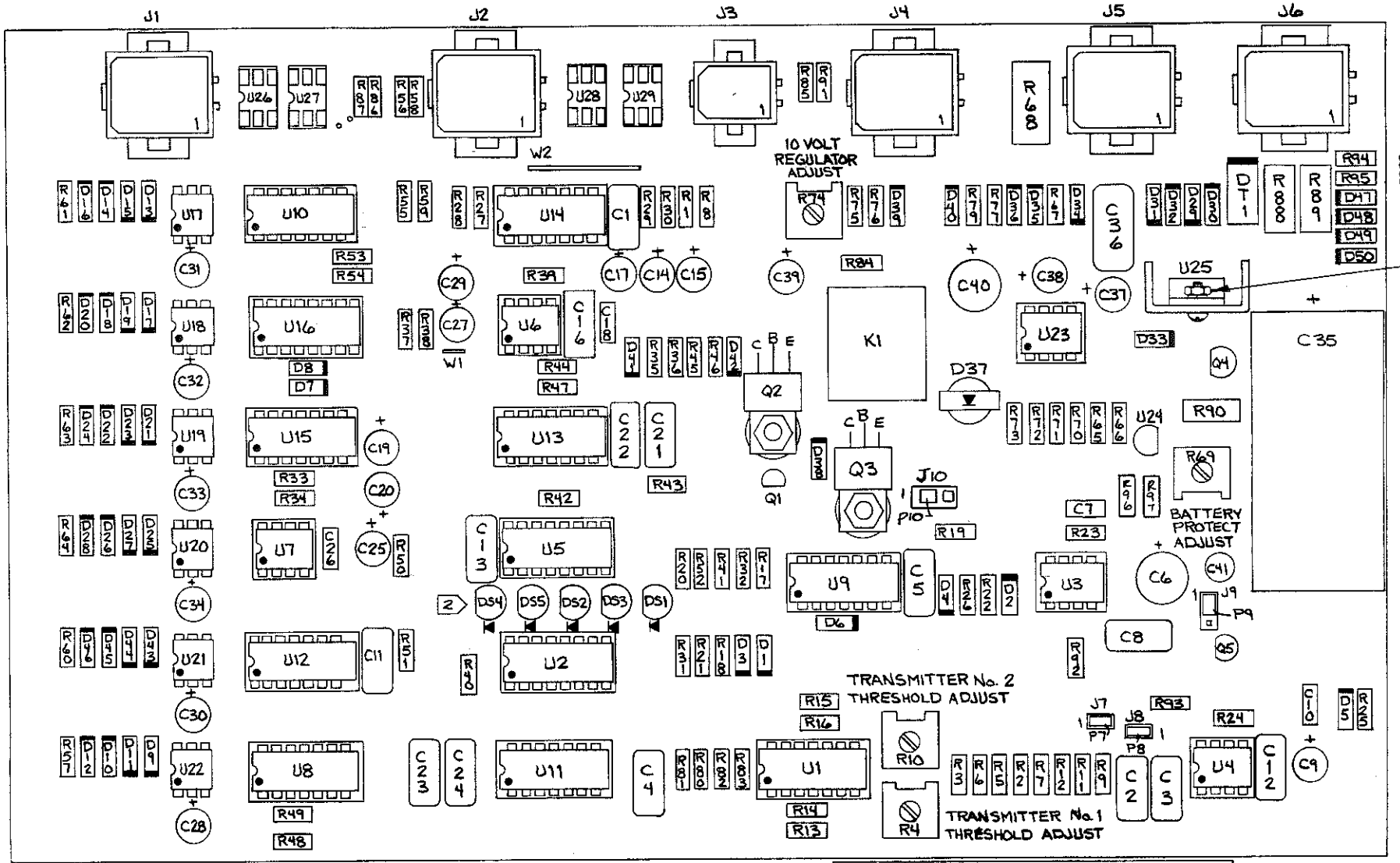
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SYSTEM CONTROL CIRCUIT BOARD SCHEMATIC

TYPE S | SIZE D | DWG. NO. 719-0073 | REV J

MODEL FM 300 MA | SCALE — | SHEET 3 OF 3



NOTES:

1. SEE SCHEMATIC D919-0073
2.

LED	INDICATION
DS4	OFF
DS5	ON
DS2	TRANSMITTER No. 2 THRESHOLD
DS3	RF PRESENCE
DS1	TRANSMITTER No. 1 THRESHOLD

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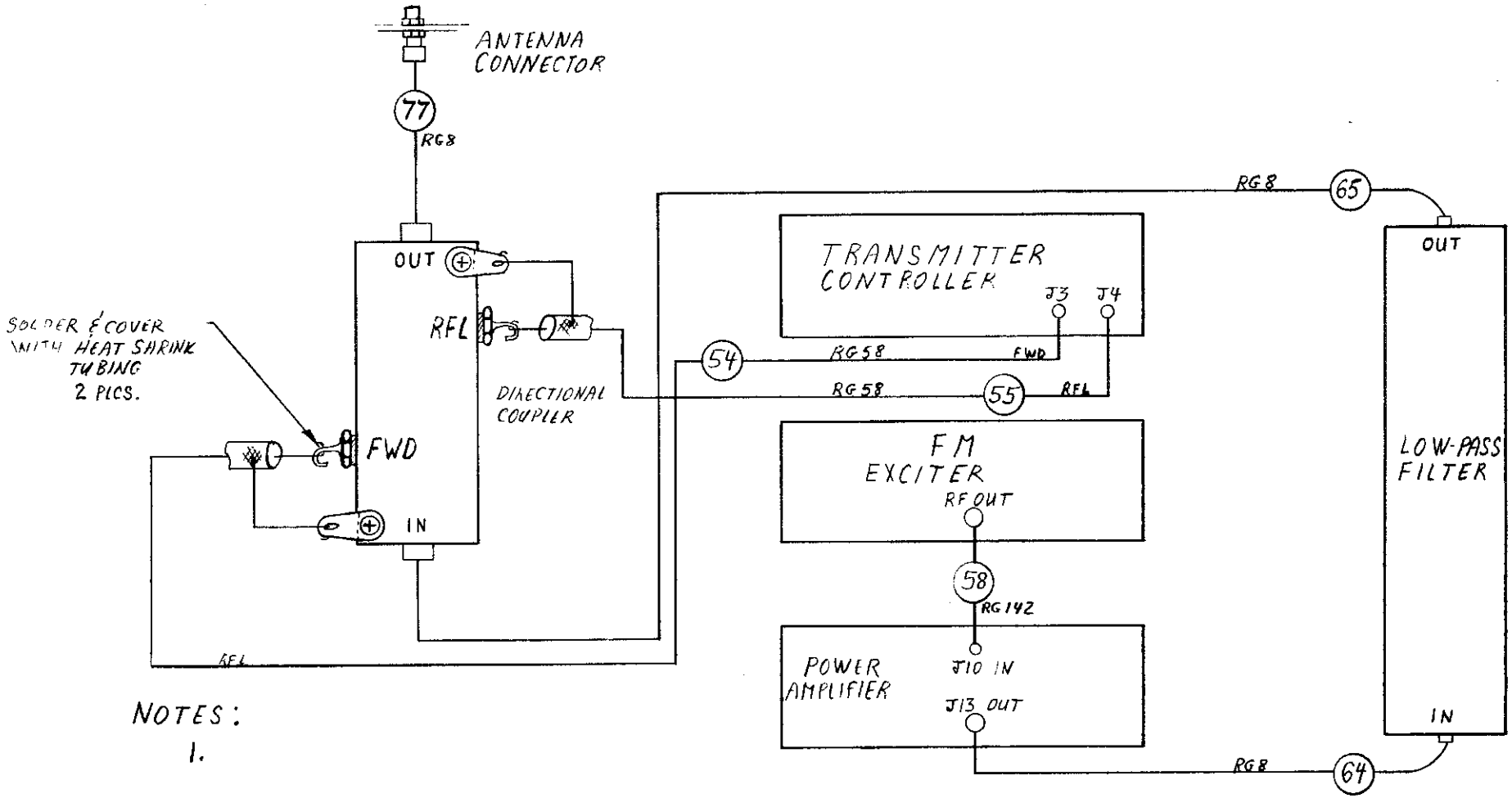
597-0092-23

FIGURE 7-14. SYSTEM CONTROLLER CIRCUIT BOARD ASSEMBLY



NOTES:

1.

2.

3. ◯ = WIRE NUMBER

4. REF. AD 949-0085 FOR CABLE ASSY'S.

5. RG 142/U CABLE USED ON FM-100

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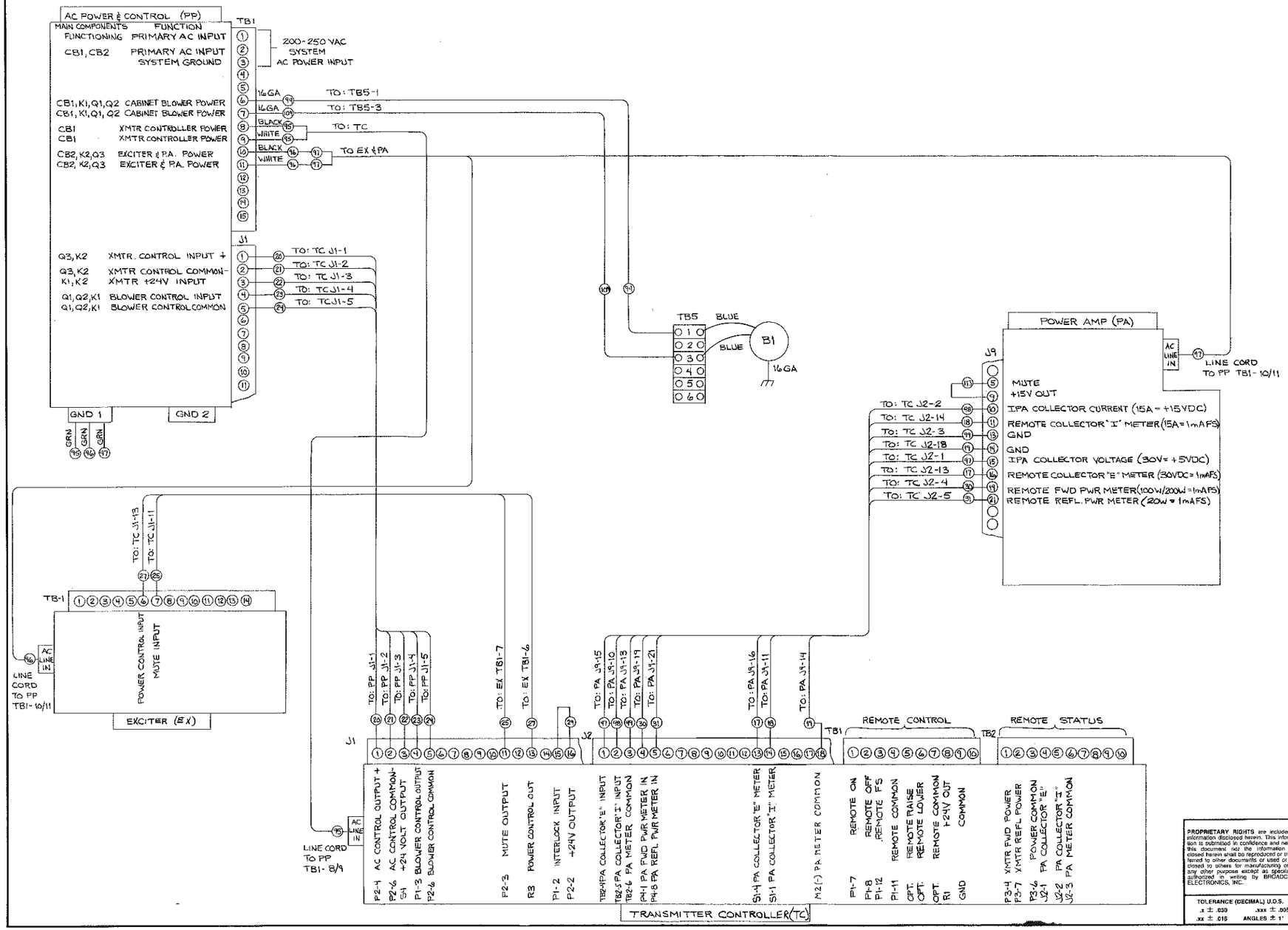
RF WIRING DIAGRAM, FM-100/FM-250

WD 909-0100-200/-300

WD 909-0250-200/-300



NOTES:

1. ALL WIRE IS 22 GAUGE WHITE NUMBERED EXCEPT WHERE OHTERWISE NOTED.
2. REF SHEET 2 FOR RF WIRING
3. BLOWER B1 IS REMOVED FOR FM-100 CONFIGURATION.

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

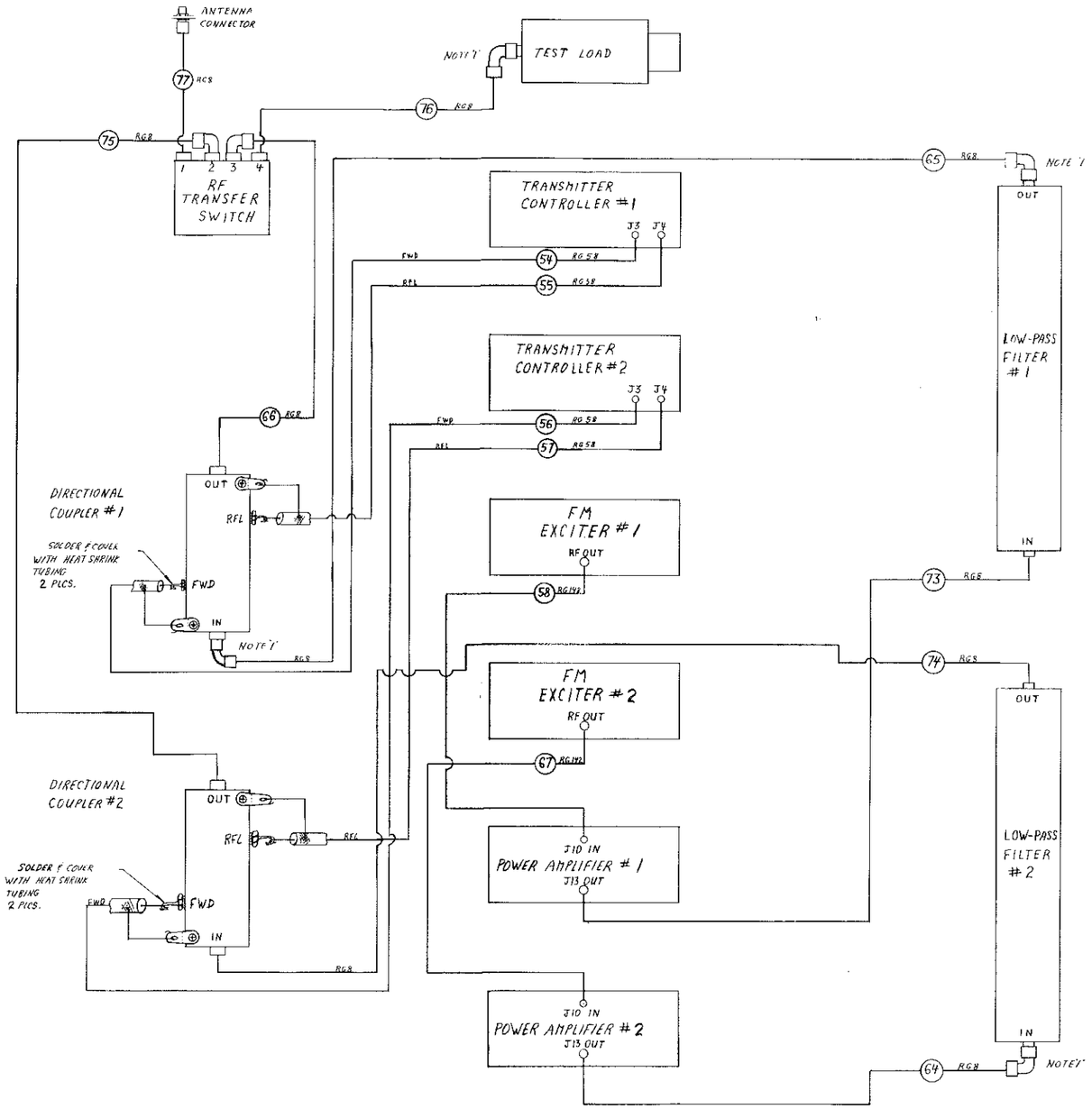
DWN. BY JAH 2-14-85
CHKD
ENG
PROJ. ENGR.
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SYSTEM INTERCONNECT FUNCTIONAL WIRING DIAGRAM

TYPE W | SIZE D | DWG. NO. 909-0100-200/-300 909-0250-200/-300 | REV H

MODEL FM100/-250 SCALE —— SHEET 3 OF 3



NOTES:

1. ◻ = 90° "N" TYPE ADAPTER P/N. 417-0105 (7 REQ.)
2.
3. ◯ = WIRE #
4. REF. AD949-0086 FOR CABLE ASSY'S.
5. RG 142/U CABLE USED ON FM-100 M/A

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY RHE 30 MAR 84
CHKD
ME
PROJ. ENGR.
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3905 QUINCY, IL 62305 217/224-9660
TELEX 250142 CABLE BROADCAST

TITLE RF WIRING DIAGRAM

TYPE W | SIZE D | DWG. NO. 909-2100-200/-300, 909-2250-200/-300 | REV D

MODEL FM 100MA/250MA | SCALE — | SHEET 2 OF 3

TRANSMITTER CONTROLLER #1 (TC1)

EXCITER #1 (EX1)

AC POWER & CONTROL (PP)

SYSTEM CONTROLLER (SC)

POWER AMP. (PA1)

POWER AMP. (PA2)

TRANSMITTER CONTROLLER #2 (TC2)

EXCITER #2 (EX2)

REMOTE CONTROL

REMOTE STATUS

NOTES:
1. ALL WIRE IS 22 GAUGE WHITE NUMBERED EXCEPT WHERE OTHERWISE INDICATED.
2. REF: SHEET 2 OF 3 FOR R.F. WIRING.
3. B1, B2, TB-5, WIRES 94 AND 109 ARE NOT USED IN FM100-MA APPLICATION.

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TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xx ± .005 .xx ± .015 ANGLES ± 1°

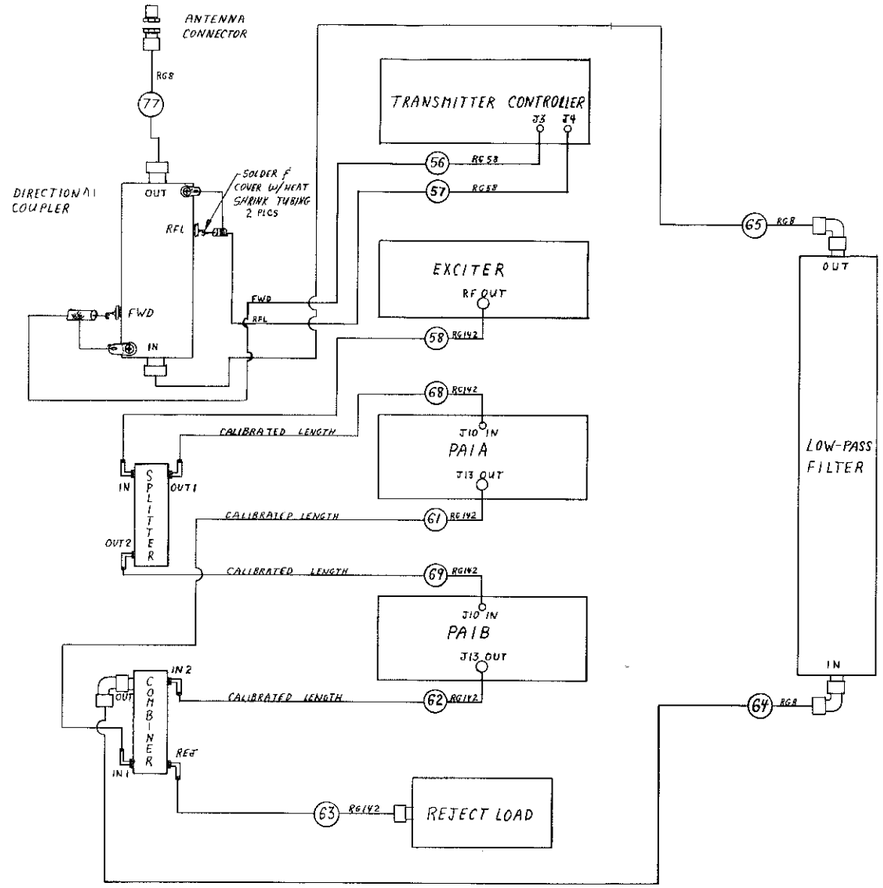
DWN. BY RHB 19 APR 84 | CHKD | ME | PROJ. ENGR. | MFG. | MATERIAL | FINISH | NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 220142 CABLE BROADCAST

TITLE SYSTEM INTERCONNECT FUNCTIONAL WIRING DIAGRAM

TYPE W | SIZE D | DWG. NO. 909-2100-200/-300, 909-2650-200/-300 | REV F

MODEL FM100MA/250MA | SCALE — | SHEET 3 OF 3



CRITICAL CABLE LENGTHS		
WIRE NO.	LENGTH IN INCHES WITHOUT CONNECTOR	MATERIAL
61	37.00	BELDEN NO. 33242 TEFLON COAXIAL CABLE RG142 B/U-- MIL-C-17D
62	58.00	
68	58.00	
69	37.00	

NOTES:

1. = 90° 'N' TYPE ADAPTER (3 REQ.) P.N. 417-0105
2.
3. ◯ = WIRE NUMBER
4. = 90° BNC TYPE CONNECTOR (PART OF CABLE ASSY.)
5. REF. AD 949-0081 FOR CABLE ASSYS.

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.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY RHB
CHKD
ME
PROJ. ENGR. JS
MFG.

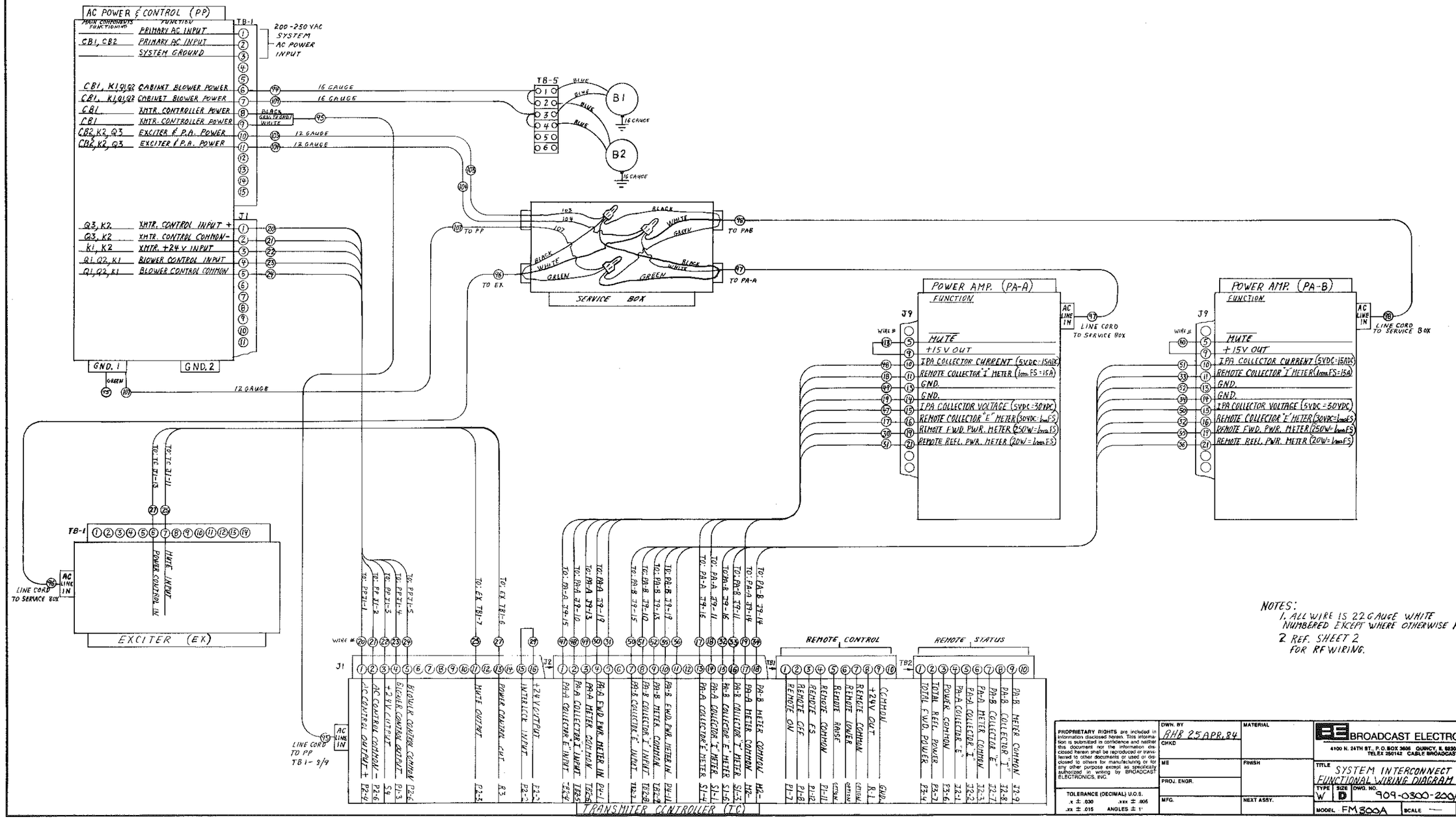
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE RF WIRING DIAGRAM

TYPE W | SIZE D | DWG. NO. 949-0300-200/-300 | REV B

MODEL FM300A | SCALE ~ | SHEET 2 OF 3



NOTES:
1. ALL WIRE IS 22 GAUGE WHITE NUMBERED EXCEPT WHERE OTHERWISE NOTED.
2. REF. SHEET 2 FOR RF WIRING.

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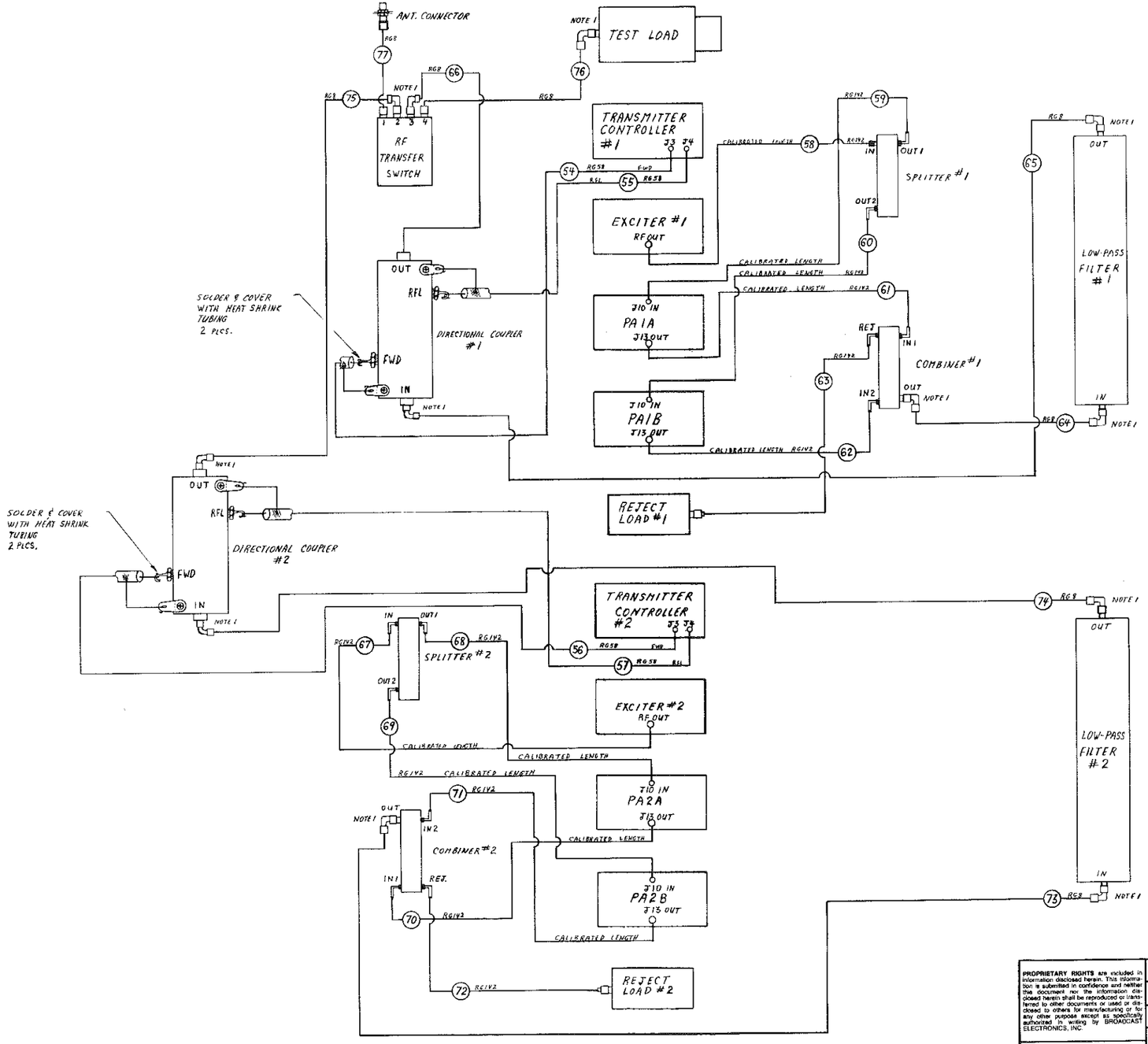
TOLERANCE (DECIMAL) U.O.S.
x ± .030 xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY RHB 25 APR. 84	MATERIAL	BROADCAST ELECTRONICS INC.
CHKD		4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600 TELEX 250143 CABLE BROADCAST
ME	FINISH	TITLE: SYSTEM INTERCONNECT FUNCTIONAL WIRING DIAGRAM
PROJ. ENGR.		TYPE W SIZE D DWG. NO. 909-0300-200/-300 REV D
MFG.	NEXT ASSY.	MODEL FM300A SCALE — SHEET 3 OF 3



CRITICAL CABLE LENGTHS		
WIRE NO.	LENGTH IN INCHES WITHOUT CONNECTOR	MATERIAL
58	30.00	
59	58.00	
60	37.00	
61	37.00	BELDEN NO. 83242 TEFLON COAXIAL CABLE
62	58.00	
67	30.00	RG142 B/U-- MIL-C-17D
68	58.00	
69	37.00	
70	37.00	
71	58.00	

NOTES:
1. = 90° 'N' TYPE ADAPTER P.N. 417-0105 (12 REQ.)
2.
3. ◯ = WIRE #
4. = 90° BNC TYPE CONNECTOR, PART OF CABLE ASSY.
5. REF. AD 949-0080 FOR CABLE ASSEMBLIES.

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TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

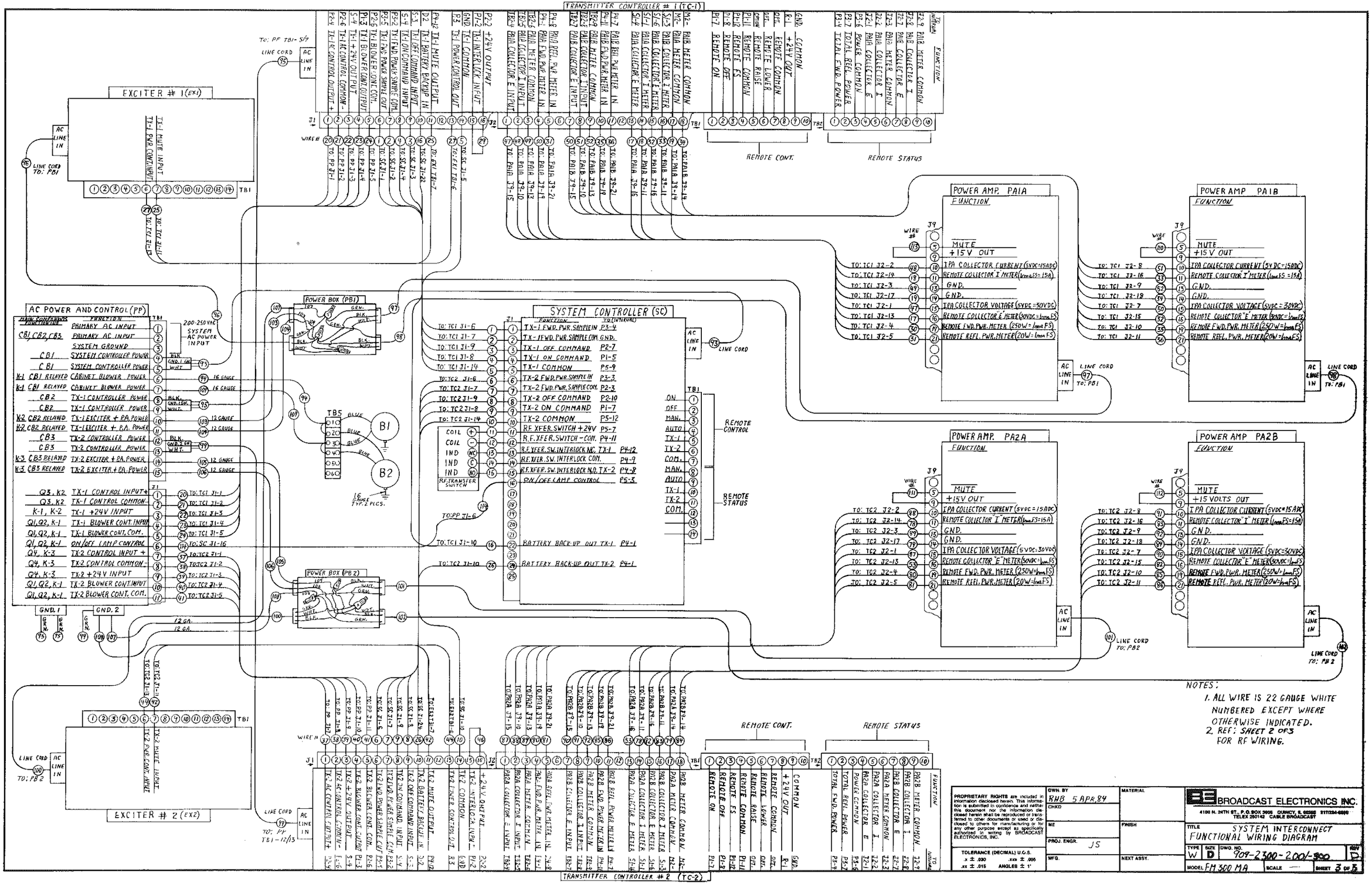
DWN. BY RHB 30 MAR 84
CHKD
ME
PROJ. ENGR.
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE RF WIRING DIAGRAM

TYPE W | SIZE D | DWG. NO. 949-2300-2004-300 | REV D

MODEL FM 30C MA | SCALE — | SHEET 2 OF 3


TRANSMITTER CONTROLLER # 1 (TC-1)
EXCITER # 1 (EX1)
POWER BOX (PB1)
POWER BOX (PB2)
SYSTEM CONTROLLER (SC)
AC POWER AND CONTROL (PP)
EXCITER # 2 (EX2)
TRANSMITTER CONTROLLER # 2 (TC-2)
POWER AMP PA1A
POWER AMP PA1B
POWER AMP PA2A
POWER AMP PA2B
REMOTE CONT.
REMOTE STATUS
REMOTE CONTROL
REMOTE STATUS
NOTES:
1. ALL WIRE IS 22 GAUGE WHITE NUMBERED EXCEPT WHERE OTHERWISE INDICATED.
2. REF: SHEET 2 OF 3 FOR RF WIRING.
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TOLERANCE (DECIMAL) U.O.S.
BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3905 QUINCY, IL 62302 217/224-9600
TELEX 250142 CABLE BROADCAST
SYSTEM INTERCONNECT FUNCTIONAL WIRING DIAGRAM
DWG. NO. 909-2300-2001-300
MODEL FM 300 MA
SHEET 3 OF 5

TABLE OF CONTENTS

LISI OF TABLES

LIST OF ILLUSTRATIONS

SECTION I

PA THEORY OF OPERATION

1-1. INTRODUCTION.

1-2. The following text provides detailed theory of operation with supporting diagrams for the power amplifier (PA) stage used in the Broadcast Electronics very-low-power line of FM transmitters. For purposes of definition, the text is divided into functional circuits.

1-3. GENERAL DESCRIPTION.

1-4. The PA stage is a totally self-contained solid-state wideband FM amplifier providing a 50 to 250 Watt output. Frequency coverage is 87.5 MHz to 108 MHz. The unit is mounted on slide rails for ease of maintenance.

1-5. The PA stage consists of an RF amplifier circuit board and a control regulator circuit board mounted side-by-side on easily removed heat sinks. An interconnection filter circuit board, an unregulated dc power supply, and a status indicator circuit board are also mounted within the PA stage (see Figure 1-1).

1-6. POWER SUPPLY.

1-7. The PA power supply consists of a conventional full-wave bridge-rectified supply, a capacitor filter and bleeder, and a series regulator. The transformer primary has multiple taps which must be preset to minimize over-voltage and consequent over-dissipation of the regulator devices. This allows optimum efficiency to be obtained through the supply.

1-8. The power supply operates from an input of 194 to 275V ac at 2 Amperes and produces the following potentials:

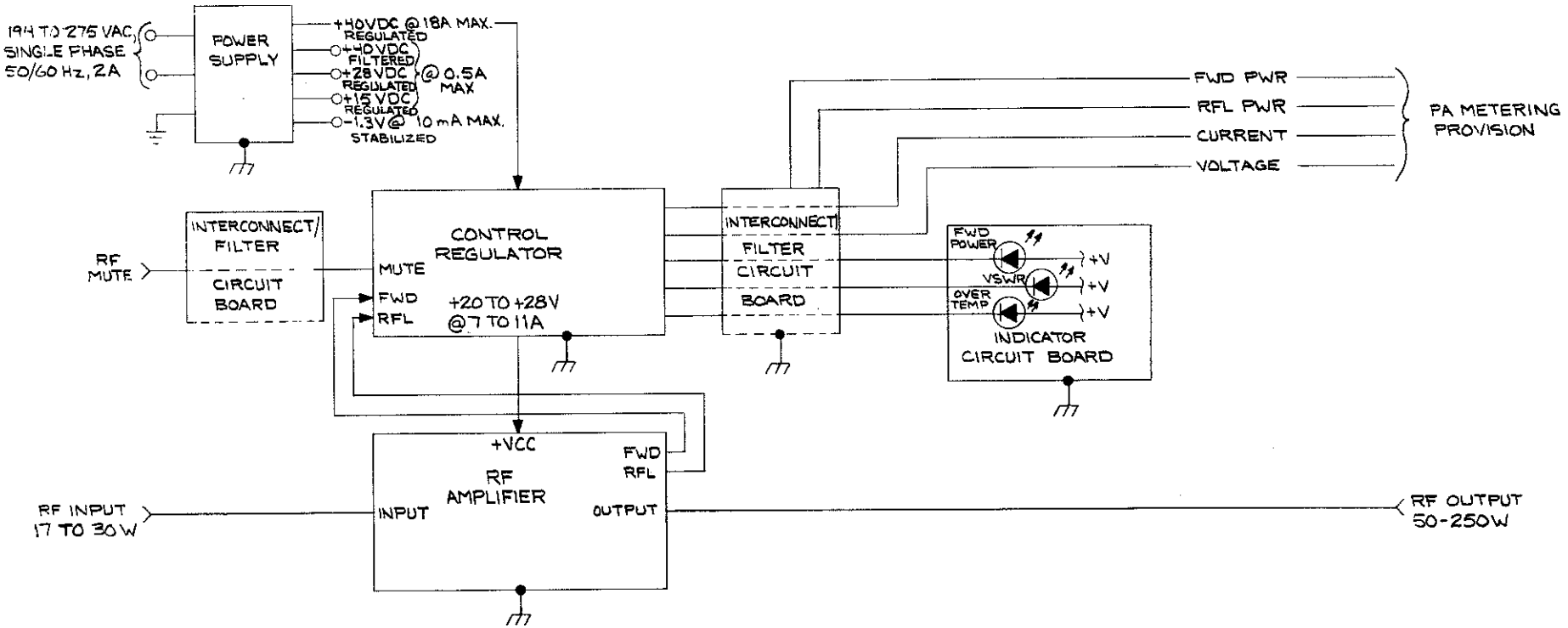
+40 Vdc, filtered @ 18 Amperes

+40 Vdc, filtered)
+28 Vdc, regulated) @ 0.5 Amperes
+15 Vdc, regulated)

-1.3 Vdc @ 10 mA Stabilized

1-9. INTERCONNECT/FILTER CIRCUIT BOARD.

1-10. The interconnection filter circuit board provides internal connections between circuit boards, provides RFI filtering for the PA status outputs, and provides some interface for control inputs.



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597-0092-11

FIGURE 1-1. PA BLOCK DIAGRAM

1-11. CONTROL CIRCUIT BOARD.

1-12. The control circuit board regulates the operation of the RF amplifier within preset limits dependent upon several parameters such as reflected power and forward power or dc voltage, control regulator heat-sink temperature, dc current, and an external mute input. The control circuit board also contains amplifiers for the forward and the reflected directional couplers, the over-temperature circuit, and the PA metering circuitry.

1-13. The regulator and control circuitry is contained on a printed circuit board with the output pass transistors mounted on an attached heatsink. Multiple paralleled devices are used to enhance reliability. The regulator is capable of supplying 28 volts dc at 15 Amperes maximum. Voltage foldback will occur when excessive current is drawn or a high reflected power sample is evident. This protects the RF power transistors against output mismatch-induced damage. The drive signal or ac power must be momentarily removed to restore normal voltage from the regulator after foldback has occurred. A yellow front-panel mounted VSWR indicator indicates excessive reflected power into the output of the PA with possible voltage foldback occurring when illuminated.

1-14. TEMPERATURE SENSOR. A temperature sensor is bonded to the regulator heatsink. This protects the output pass transistors from over-dissipation in the event of a fault by latching off the regulator driver circuit upon excessive temperature. A red front-panel mounted OVER TEMP indicator indicates this condition when illuminated. Removal of dc power is required to reset the operation of the regulator after an over-temperature condition has occurred.

1-15. RF AMPLIFIER.

1-16. The RF circuitry consists of two bipolar RF power transistors conservatively operated as a push-pull class C amplifier. Wide-band transmission-line matching sections transform impedances on the printed circuit board while providing for balanced push-pull operation of the transistors. Stripline networks along with chip capacitors match the base and collector elements of both transistors to the transmission line sections. A stripline directional coupler provides forward and reflected power samples. The PA exhibits a minimum power gain of 10 dB.

1-17. Normal PA stage operation is signaled by illumination of the green front-panel FWD POWER indicator which signals approximately 50 Watts of forward power. A high reflection is indicated by illumination of the yellow front-panel VSWR which signals 10 Watts of reflected power with possible foldback of the control regulator. Removal of the dc or RF input to the PA stage is required to reset a foldback condition.

1-18. DETAILED DESCRIPTION.

1-19. POWER SUPPLY.

1-20. PRIMARY CIRCUIT. The PA power supply operates from an input of 194 to 275 volts ac at a maximum of 2 Amperes (see Figure 1-2). AC power is input through RFI filter FL1 which provides 55 dB of attenuation to frequencies of 10 MHz and above. A special power transformer with a tapped dual primary allows operation from both 50 and 60 Hz as well as a wide range of ac input voltages without component changes. Compensation for different input voltages is accomplished by wiring changes to terminal strip TS1 and a power transformer secondary tap. If the supply is ever operated from a single-line input such as 120 volts ac, the fuse in the common side of the ac input must be jumpered out of the circuit for safety reasons. Refer to schematic diagram D959-0151 for input potentials and required wiring changes.

1-21. The cooling fan is connected across one primary of transformer T1 and runs continuously whenever ac power is applied. Fuses F1 and F2 provide overload protection for the primary circuit and metal-oxide varistor MOV1 provides suppression of voltage surges in excess of 250 volts.

1-22. SECONDARY CIRCUIT. The tapped secondary of T1 produces two ac voltages which are full-wave rectified into two dc supplies (39V and 35.5V average). C1 provides filtering, R1 acts as a bleeder, and fuse F3 provides overload protection for the secondary circuit. The +40 volt dc output is routed to the control regulator assembly where it is distributed and re-regulated into several different potentials.

1-23. Regulators. The 40 volt dc potential is fed directly to the pass transistor network mounted on the control regulator heat sink and to the regulators on the control regulator circuit board through fuse F1. The pass transistor network outputs a regulated potential to the RF amplifier to maintain a constant RF output in response to control parameters measured by the control regulator circuit board.

1-24. The 40 volt input to U1 is regulated into a +28 volt source. The +28 volt source is re-regulated by U2 into a +15 volt source. Regulators U1 and U2 are both three-terminal adjustable positive regulators containing internal thermal-overload protection and short-circuit current limiting features. Further protection for the regulators is provided by diodes D3 and D4, each which protects its respective regulator from a reverse polarity potential applied to the output and diodes D1 and D2, each which protects its respective regulator from a short circuit applied to the input.

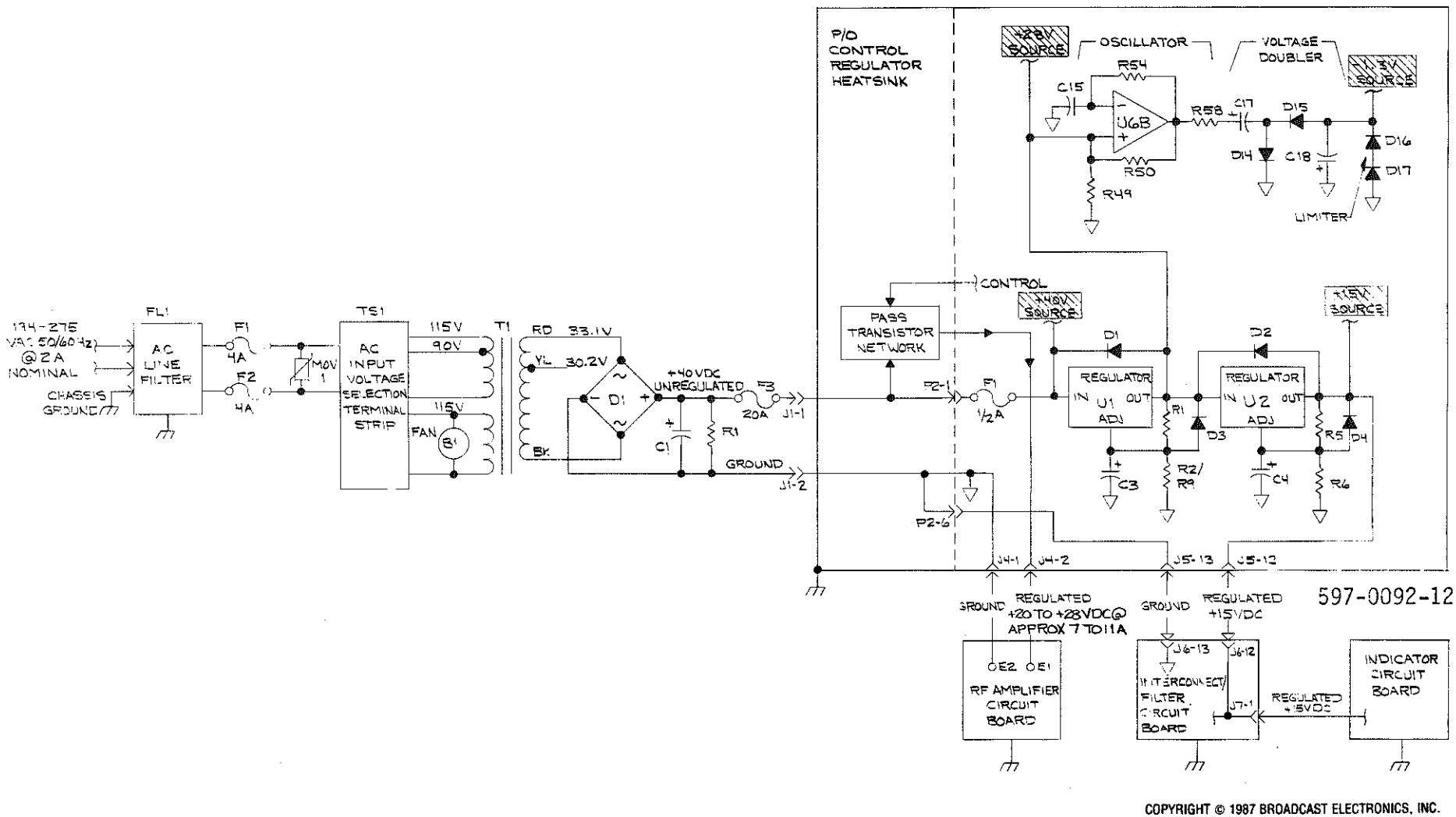

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FIGURE 1-2. PA POWER DISTRIBUTION

1-25. Negative 1.3 Volt Supply. A negative 1.3 volt potential required for the metering circuit is developed from the output of U6B which is configured as an oscillator. The sinusodial output of U6B is rectified by a voltage doubler consisting of C17, D14, and D15. The output of this supply is stabilized by diodes D16 and D17, each which provides a constant 0.65 volt drop to maintain the output at a constant -1.3 volts.

1-26. CONTROL REGULATOR.

1-27. The control regulator consists of a circuit board and a heatsink assembly which forms part of a closed loop with the RF amplifier. Jumper-plug programming allows feedback selection of either dc voltage and VSWR or forward RF power and VSWR for feedback (see Figure 1-3).

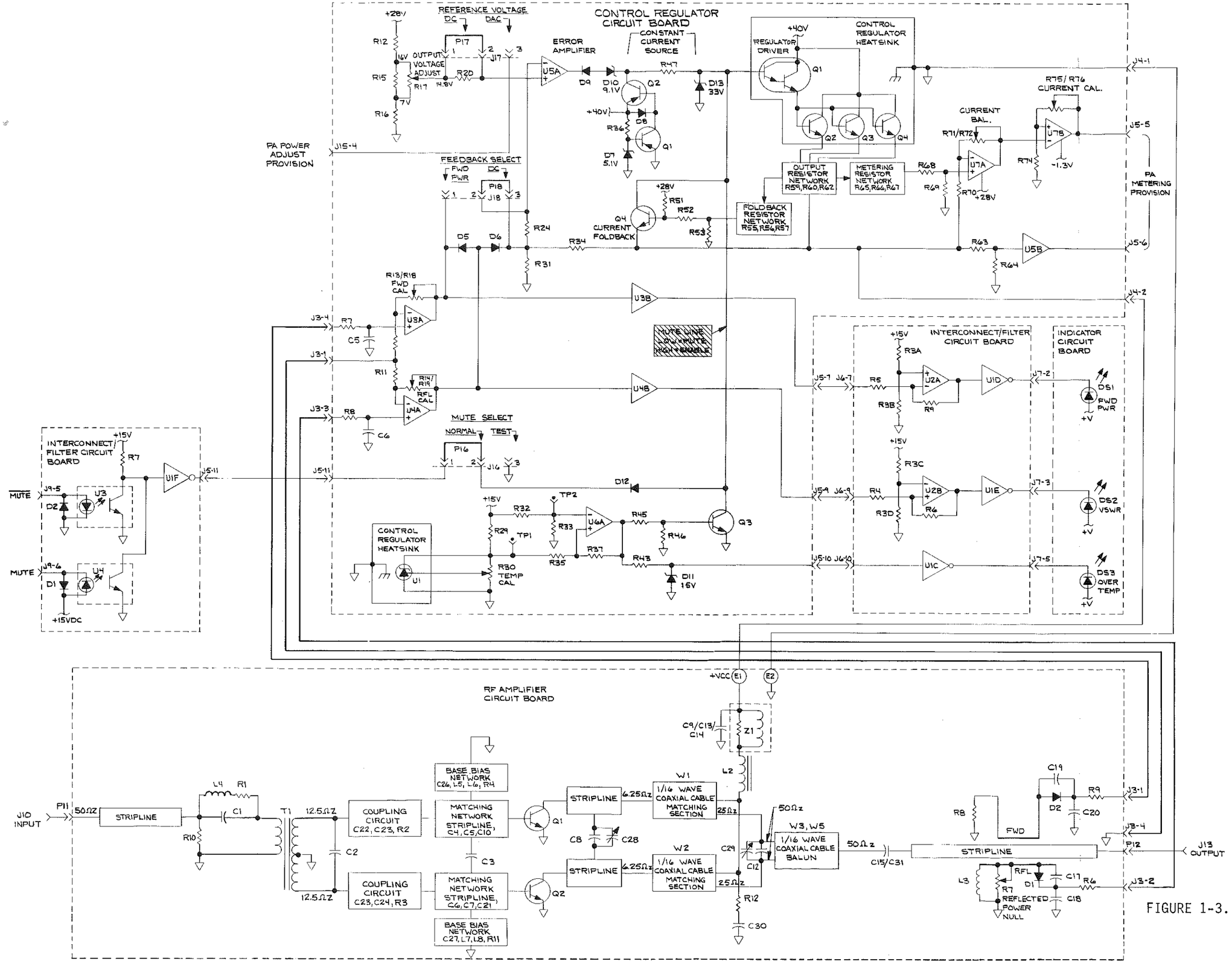
1-28. The regulator output voltage is established by a precision voltage drop, a series string of resistors, and the output voltage adjust control (R17). For a regulator output voltage of 28 volts, R17 must be adjusted to 14.8 volts on the wiper.

1-29. P17 allows selection of a dc voltage as a regulator reference or an external reference. Resistor R20 provides an input to error amplifier U5A if P17 is inadvertently left out. The potential from P17 is applied to the non-inverting input to error amplifier U5A. Error amplifier U5A compares this input to the regulator output which is applied through a voltage divider to the inverting input. If the regulator output goes down, the output of U5A will increase. If the regulator output increases, the output of U5A will decrease. This control voltage is routed through steering diode D9 and level-shift diode D10 to a constant-current source.

1-30. Q1 and Q2 form a constant-current source which produces a stable current independent of the 40 volt regulator supply. The constant-current generator assures that the current through R47 remains constant and independent of the foldback, mute, or over temperature circuits connected in parallel to the mute line. Diode D13 prevents an excessive voltage applied to the mute line from exceeding a limit which might damage Q1.

1-31. Regulator drive is applied to the base of Q1 which in turn drives regulator pass transistors Q2, Q3, and Q4. The dc supply for the regulator drive and the pass transistors is routed directly from the power supply high current 40 volt source. A current balancing network for the pass transistors is provided by the output resistor network. The output of the output resistor network is applied to the RF amplifier load.

1-32. Either forward and reflected power feedback or dc voltage and reflected power feedback may be selected with jumper P18. When P18 is set to dc, a dc sample of the output voltage will be applied to the inverting input of U5A through R31 and R34. Resistor R24 provides an input to error amplifier U5A if P17 is inadvertently left out. A reflected power control signal will be added through diode D6 when the reflection is great enough to exceed the 0.7 volt drop across D6, approximately 15 volts at R22.



597-0092-13

FIGURE 1-3. PA SIMPLIFIED SCHEMATIC

1-33. When P18 is set to FWD PWR, a dc potential representative of the PA forward power level will be applied to the inverting input of U5A. Reflected power control will be added through Diode D5 when the reflection is great enough to exceed the 0.7 volt drop across D5.

1-34. CURRENT FOLDBACK. The output resistor network and the foldback resistor network work together to provide the current foldback action when the output current reaches 18 Amperes. If the regulator output is at the correct level, R51 will be essentially out of the circuit as there will be practically no current flow through the resistor. As the voltage across R59, R60, and R62 increases due to current increase, the voltage summed at the junction of R52 and R53 will increase with respect to the emitter of Q4. As Q4 is biased on, current will begin to flow through R51 which saturates Q4. This action grounds the mute line which removes the dc output. DC power must be interrupted to reset the foldback condition or removal of RF drive is required.

1-35. METERING. Current through the pass transistor output resistor network is used to generate the voltage used to meter output current. The transistor emitter connections are summed into the non-inverting input of U7A and the output side of the emitter resistor is connected to the inverting input of differential amplifier U7A. The current bal control (R72) adjusts the offset on U7A so that with zero current, the output will be zero. The output of U7A is applied to U7B which acts as a meter driver. R76 allows adjustment of the stage calibration. The -1.3 volt supply is connected to the -Vcc connection of U7B so that a meter connected to U7B will properly register zero with no input. This below-ground reference is required with zero volt operation of the operational amplifier.

1-36. Forward Amplifier. The rectified output of the forward port of the directional coupler is applied to the forward meter amplifier of the control regulator circuit board. Non-inverting amplifier U3A has a high input impedance and high gain. The exact gain of the amplifier is adjusted by potentiometer R18. RF is filtered from the signal before entering the forward power meter amplifier by R7 and C5.

1-37. Reflected Amplifier. The reflected meter amplifier (U4A) works in a manner similar to the forward amplifier section except that the voltage gain of this amplifier is higher than the forward amplifier which compensates for the differences in the coupling factor of the directional coupler sampling lines. RF is filtered from the signal before entering the reflected amplifier by R8 and C6. U4A is calibrated by potentiometer R19.

1-38. The 15 volt full-scale output of U3A and U4A are routed through 3:1 dividers and voltage follower stages U3B and U4B to amplifiers U2A and U2B on the interconnect filter circuit board. The forward power signal is routed through comparator U1D and the reflected power output is routed through comparator U1E and applied to the front panel VSWR indicator. This indicator illuminates when 10 Watts of power is reflected back into the PA from the load. The FWD PWR indicator illuminates when the forward power is 50 Watts or greater.

1-39. REMOTE PA MUTE. Provisions exist which allow the PA stage RF output to externally muted using either a positive voltage or ground connection for control.

1-40. The mute input is applied to J9-5 if a positive voltage is used for muting or J9-6 if a ground is used for muting. When an input is applied, the optical coupler (U3 or U4) will pull the input to inverter U1F which inhibits the drive applied to regulator driver Q1 and mutes the PA RF output. The mute select jumper (P16) must be in the normal position to allow external muting. Diode D12 steers the input to prevent external devices from loading the mute line.

1-41. TEMPERATURE SENSOR. An electronic temperature sensing circuit consisting of U1 and U6A senses the control regulator heatsink temperature. If an over-temperature condition occurs, dc output will automatically be removed to prevent damage to the RF output transistors. Under normal conditions, the OVER TEMP indicator (DS3) on the front panel will remain off. As a visual indication that an over-temperature condition exists, the OVER TEMP indicator will illuminate.

1-42. Temperature sensor U1 is mounted on and is thermally coupled to the control regulator heatsink. 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 (R30) so that the voltage between test point TP1 at the non-inverting input to U6A and ground is set to +2.98 volts when the heatsink temperature is +25 degrees Celsius and +2.73 volts at Ø degrees Celsius. U6A operates as a voltage comparator with +3.61 volts at test point TP2. This corresponds to an 88 degree Celsius comparison threshold.

1-43. At normal heatsink temperatures, the voltage output of U6A will hold Q3 biased off. As the voltage from U1 increases with heat rise at the rate of 10 millivolts per degree Celsius, U6A will trigger at the point preset by R30 and bias Q3 into conduction. Q3 will inhibit the drive applied to the regulator driver (Q1) and inhibit RF output.

1-44. In this manner, PA is allowed to operate until a predetermined temperature is reached, then the RF output will be inhibited. An over-temperature condition is signaled by illumination of the OVER TEMP indicator (DS3) through inverter U1C. Zener diode D11 limits the input to U1C to a safe operating level if U6A should internally short. The PA can be restored to operation after the temperature cools by interrupting the dc supply.

1-45. RF AMPLIFIER.

1-46. The RF amplifier is a broadband stripline-matched amplifier covering the FM broadcast band (see Figure 1-3). By adjusting the RF drive and/or the dc supply voltage, the RF power is variable over a range of 50 to 250 Watts. Tuning of the single-stage push-pull amplifier is not required.

1-47. The dc power input and the directional coupler outputs are connected to the circuit board through the chassis with feed-through capacitors to prevent RF interference. All wiring connects to the PA assembly with plugs to aid in maintenance.

1-48. POWER AMPLIFIER. Approximately 17 to 30 Watts of drive is input to the 50 Ohm primary of transformer T1 through a section of stripline. R10 acts as a swamping resistor to improve the input match and capacitor C1 tunes out the series reactance in the primary circuit of transformer T1. The series combination of L4 and R1 effectively lowers the Q of the input circuit to allow a broadband match.

1-49. Transformer T1 provides a 4:1 step-down in impedance from 50 Ohms to two 12.5 Ohm sources, each source 180° out-of-phase. The output of T1 is capacitive coupled by a low-Q circuit to a matching network which further reduces the 12.5 Ohm impedance to approximately 1.5 Ohms to match the base impedance of Q1 and Q2. Base bias networks stabilize gain while C2 and C3 function as lumped matching elements in the impedance transformation. Capacitors C4/C5 and C6/C7 cancel out the inductive base reactance of Q1 and Q2.

1-50. Q1 and Q2 are NPN RF power transistors operated as a class C push-pull stage. The collector of each transistor feeds a stripline section which acts as a broadband impedance step-up transformer to convert the 0.5 Ohm collector impedance of each transistor to 6.25 Ohms. Capacitors C8 and C28 assist in the impedance transformation. Parallel connected inputs and series connected outputs of 25 Ohm coaxial cable raise the 6.25-6.25 Ohm push-pull outputs up to the 25-25 Ohm level. The series combination of R12 and C30 assure stable amplifier operation.

1-51. A coaxial cable balance-to-unbalance (balun) transformer converts the two 25 Ohm impedances to a single 50 Ohm unbalanced RF output. Capacitors C12 and C29 provide balanced transistor operation and paralleled capacitors C15/C31 block dc in the RF output line.

1-52. DIRECTIONAL COUPLER. The directional coupler provides two dc signals, each signal obtained by rectifying a portion of the RF output signal, coupled from a transmission line section etched into the circuit board. Due to the polarity of the two samples, one signal will be proportional to the forward traveling RF wave and the other signal will be proportional to the reflected traveling RF wave.

1-53. Forward Directional Coupler Port. The forward port of the directional coupler is broadbanded across the FM broadcast band. The voltage sample obtained is rectified by diode D2 and filtered by a PI-section filter. C19 improves the match due to the presence of D2. This output is routed to the control regulator for use in the control and metering circuits.

1-54. Reflected Directional Coupler Port. The reflected port of the directional coupler is broadbanded across the FM broadcast band. The voltage sample obtained is rectified by diode D1 and filtered by a PI-section filter. C27 improves the match due to the presence of D1. Inductor L3 in parallel with variable resistor R7 improves the linearity of the coupler across the band. R7 is adjusted to maximize directivity at the frequency of operation. This output is routed to the control regulator for use in the control and metering circuits.

SECTION II

PA MAINTENANCE

2-1. INTRODUCTION.

2-2. This section provides PA maintenance information for the Broadcast Electronics very-low-power line of FM transmitters.

2-3. SAFETY CONSIDERATIONS.

2-4. All transmitters contain high voltages and currents which, if regarded carelessly, could be fatal. Each transmitter has many built-in safety features, however good judgement, care, and common sense are the best accident preventives. The maintenance information contained in this section should be performed only by trained and experienced maintenance personnel.

2-5. It is very dangerous to attempt to make measurements or replace components with power energized, therefore such actions are not recommended. AC power to the entire cabinet may be disconnected by operating the transmitter front-panel circuit breakers to off.

2-6. MAINTENANCE.

WARNING BEFORE ATTEMPTING TRANSMITTER MAINTENANCE ASSURE THE RMT/LCL SWITCH(ES) IS OPERATED
WARNING TO LCL. THERE ARE THREE SWITCHES ON THE MAIN/ALTERNATE TRANSMITTERS.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

2-7. The power amplifier maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-8. ADJUSTMENTS.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

2-9. The following procedures present information required to adjust all controls in the PA stage. These adjustments are factory preset and therefore will require readjustment only if components on the individual circuit boards have been replaced. Adjustments for the control regulator circuit board (R17, R18, R19, R72, and R76) are presented first, followed by an adjustment procedure for R7 on the RF amplifier circuit board. The adjustments may be accessed by extending the PA chassis forward on its slide rails out of the rack and removing the top cover.

2-10. OUTPUT VOLTAGE ADJUST (R17). To adjust the output voltage control (R17) on the control regulator circuit board, proceed as follows.

2-11. Required Equipment. The following equipment is required to adjust the output voltage adjust control (R17).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

2-12. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-13. Disconnect primary power.

2-14. Connect the voltmeter between J4 pin 1 and chassis ground.

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

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-15. Apply power and operate the PA.

2-16. Using the insulated adjustment tool, adjust V OUT control R17 to obtain a voltmeter indication per the following list.

MODEL	VOLTAGE
FM-100	+20V DC
FM-250/FM-300	+28V DC

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-17. Disconnect primary ac power.

2-18. Remove the test equipment.

2-19. FWD CAL (R18). To adjust FWD CAL control R18 on the control regulator circuit board, proceed as follows: This adjustment is required if the FWD POWER indicator threshold is incorrect or if either the RF amplifier or control regulator assemblies are replaced.

2-20. Required Equipment. The following equipment is required to adjust the fwd cal control (R18).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Test load and connecting cable (50 Ohm non-inductive, 300 Watt minimum).

E. Calibrated in-line wattmeter and connecting cable (Bird 43 or equivalent with 250 Watt element).

2-21. Procedure. To adjust the control, proceed as follows:

2-22. Refer to the preceding text and perform the OUTPUT VOLTAGE ADJUST (R17) procedure.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-23. Disconnect primary power.

2-24. Disconnect the transmitter load and connect the non-inductive 250 Watt, 50 Ohm test load to the PA OUTPUT connector (J13) through the in-line wattmeter. Adjust the wattmeter to measure forward power.

2-25. Connect the voltmeter between J9-17 on the PA interconnect filter circuit board and chassis ground.

2-26. Remove the exciter top-panel.

2-27. Operate the exciter NORM-EXT switch on the control assembly to NORM.

2-28. Replace the exciter top-panel and remove the PA top-panel.

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

WARNING BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE PA WHEN POWER IS ENERGIZED.

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-29. Apply power and operate the PA.

2-30. Depress the exciter FWD switch and record the exciter RF output power:_____ Watts.

2-31. Using the exciter R.F. POWER OUTPUT ADJ control, obtain a wattmeter indication per the following list.

MODEL	WATTS
FM-100	100W
FM-250	250W
FM-300	250W

2-32. Using the insulated adjustment tool, adjust R18 to obtain a voltmeter indication of +5 volts dc.

2-33. Readjust the exciter RF output power to the level recorded in the preceding text.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-34. Disconnect primary ac power.

2-35. Remove the test equipment, operate the exciter NORM-EXT switch on the control assembly to EXT, and reconnect the transmitter load.

2-36. RFL CAL (R19). To adjust RFL CAL control R19 on the control regulator circuit board, proceed as follows. This adjustment is required if the VSWR indicator threshold is incorrect, the VSWR foldback limit is incorrect, or if either the RF amplifier or the control regulator assemblies are replaced.

2-37. Required Equipment. The following equipment is required to adjust the RFL calibration control.

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter (Fluke model 75 or equivalent).

D. Two 150 watt, non-inductive, 50 Ohm test loads and connecting cables.

E. BNC Tee (Pomona 3285).

F. Calibrated in-line wattmeter and connecting cable (Bird 43 or equivalent with 100 watt element).

2-38. Procedure. To adjust the control, proceed as follows:

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

NOTE — REFLECTED POWER NULL CONTROL R7 ON THE RF AMPLIFIER CIRCUIT BOARD MUST BE ADJUSTED

NOTE — BEFORE PERFORMING THE FOLLOWING PROCEDURE (SEE REFLECTED POWER NULL).

2-39. Disconnect primary ac power.

2-40. Remove the exciter top-panel.

2-41. Operate the NORM-EXT switch on the control assembly to NORM.

2-42. Replace the exciter top-panel and remove the PA top-panel.

2-43. Disconnect the cable from the RF amplifier output receptacle and connect the BNC tee to the receptacle.

2-44. Attach one test load to the BNC tee. Attach the second test load to the BNC tee through the in-line wattmeter. Adjust the wattmeter to measure forward power.

2-45. Connect the voltmeter between J9-20 on the PA interconnect filter circuit board and chassis ground.

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

WARNING — BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE PA WHEN POWER IS ENERGIZED.

WARNING — USE AN INSULATED TOOL FOR ADJUSTMENT.

2-46. Apply power and operate the transmitter.

2-47. Depress the exciter FWD switch and record the RF output power _____ Watts.

2-48. Using the insulated adjustment tool, adjust the exciter R.F. POWER OUTPUT ADJ control clockwise to obtain the output power listed below and adjust R19 to obtain the voltmeter indication per the following list.

	FM-100	FM-250/FM-300
OUTPUT POWER	50 WATTS	75 WATTS
VOLTAGE	3.6 VDC	4.75 VDC

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-49. Adjust the exciter R.F. POWER OUTPUT ADJ control to obtain the meter indication recorded in the preceding step.

2-50. Disconnect primary ac power.

2-51. Remove the test equipment, operate the NORM-EXT switch on the control assembly to EXT, and reconnect the PA output cable.

2-52. TEMP CAL (R30). To adjust the temp cal control (R30) on the control regulator circuit board, proceed as follows. This adjustment is required only if the temperature sensor (U1) is replaced.

2-53. Required Equipment. The following equipment is required to adjust the temp cal control (R30).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Fluke 80T-150 temperature probe or equivalent Celcius indicating probe.

2-54. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-55. Disconnect primary ac power.

2-56. Attach the temperature probe to the control regulator heat-sink assembly near U1.

2-57. Connect the probe to the voltmeter. Record the temperature indication _____°C, add 273, and divide by 100:

FORMULA: $\left(\frac{°C + 273}{100} = \text{VOLTAGE}\right)$.

2-58. Connect the voltmeter between TP1 and ground on the control regulator circuit board.

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

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-59. Apply power and operate the transmitter.

2-60. Using the insulated adjustment tool, adjust R30 to obtain an indication equal to the result obtained in the preceding text.

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

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-61. Disconnect primary ac power.

2-62. Remove the test equipment.

2-63. CURRENT BAL (R72). To adjust the current bal control (R72) on the control regulator circuit board, proceed as follows.

2-64. Required Equipment. The following equipment is required to adjust the current bal control (R72).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

2-65. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-66. Disconnect primary ac power.

2-67. Connect the voltmeter between pin 7 of U7 and chassis ground.

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

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-68. Apply power and operate the transmitter.

2-69. Using the insulated adjustment tool, adjust R72 to obtain a voltmeter indication of Ø.ØØ volts dc.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-70. Disconnect primary ac power.

2-71. Remove the test equipment.

2-72. The current cal control (R76) must now be adjusted. Refer to the following text.

2-73. CURRENT CAL (R76). To adjust the current cal control (R76) on the control regulator circuit board, proceed as follows. This adjustment is required if either the RF amplifier or control regulator circuit board is replaced.

NOTE R72 ON THE CONTROL REGULATOR CIRCUIT BOARD MUST BE ADJUSTED BEFORE R76 IS ADJUSTED (SEE PARAGRAPH 2-63).

2-74. Required Equipment. The following equipment is required to adjust the current cal control (R76).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Resistor, 5 Ohm ±5%, 160 Watt, Wire Wound (BE P/N 130-0005).

2-75. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-76. Disconnect primary ac power.

2-77. Unplug P4-1 and P4-2 from J4-1 and J4-2.

2-78. Temporarily connect the 5 Ohm, 160 Watt resistor from J4-1 to J4-2.

2-79. Connect the voltmeter between pin 7 of U7 and chassis ground.

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

WARNING BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE PA WHEN POWER IS ENERGIZED.

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-80. Apply power and operate the transmitter.

2-81. Using the insulated adjustment tool, adjust R76 to obtain a voltmeter indication of +1.96 volts dc.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-82. Disconnect primary ac power.

2-83. Remove the test equipment and reconnect P4-1 and P4-2 to J4-1 and J4-2.

2-84. REFLECTED POWER NULL (R7). 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 PA directional coupler circuitry, the RF amplifier circuit board has been replaced, or the transmitter operating frequency has been changed. If it is certain adjustment is necessary, proceed as follows.

2-85. Required Equipment. The following equipment is required to adjust the reflected power null control (R7).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Test load and connecting cable (50 Ohm non-inductive, 250 Watt minimum).

E. Calibrated in-line wattmeter and connecting cable (Bird 43 with 250 Watt element or equivalent).

2-86. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-87. Disconnect primary ac power.

2-88. Disconnect the transmitter load and connect the test load to the PA OUTPUT connector (J13) through the wattmeter. Adjust the wattmeter to indicate forward power.

NOTE IF A HOLE TO ACCESS R7 IS NOT PRESENT IN THE COVER OF THE RF AMPLIFIER MODULE, CONTACT THE

NOTE BROADCAST ELECTRONICS CUSTOMER SERVICE DEPARTMENT BEFORE PROCEEDING.

2-89. Carefully prop the RF amplifier module in the cooling air path with R7 accessible through the hole provided in the module cover.

2-90. Connect the voltmeter between J9-20 on the PA interconnect filter circuit board and chassis ground.

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

WARNING BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE PA WHEN POWER IS ENERGIZED. EVEN THOUGH LOW

WARNING VOLTAGES ARE USED THROUGHOUT THE PA, IT IS POSSIBLE TO RECEIVE PAINFUL RF BURNS FROM THE RF

WARNING AMPLIFIER.

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-91. Apply power and operate the transmitter.

2-92. Depress the exciter front-panel FWD switch and record the exciter RF power output:_____Watts.

2-93. Adjust the exciter R.F. POWER OUTPUT ADJ control to obtain a wattmeter indication per the following list.

MODEL	WATTS
FM-100	100W
FM-250	250W
FM-300	300W

CAUTION AN INSULATED TOOL MUST BE USED IN THE FOLLOWING STEP OR THE AMPLIFIER MAY BE DAMAGED.

2-94. Using the insulated adjustment tool, adjust R7 located on the RF amplifier circuit board to obtain a minimum voltmeter indication.

2-95. Readjust the exciter RF power output to the level recorded in the preceding step.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-96. Disconnect primary ac power.

2-97. Remove the test equipment and reconnect the transmitter load.

2-98. TROUBLESHOOTING.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

2-99. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the transmitter, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, fuses, and circuit breakers) should be used to isolate the malfunction to one specific area.

2-100. If difficulties are encountered and the PA is suspected as faulty, the first step in troubleshooting should determine whether the exciter, the RF amplifier, the control regulator, the power supply, or the load is at fault. A high VSWR condition or an over-heating condition will cause the control regulator to limit RF output to prevent damage to the PA stage. The observable symptom would be loss of RF power. However, as the control regulator and the RF amplifier are both components of a closed loop, either circuit could cause this symptom. Complete loss of RF output would indicate power supply problems.

2-101. As a first check, the RF input level to the PA stage should be checked and adjusted as required. Next the PA load should be checked. If neither the input level or the output load is at fault, subsequent troubleshooting should determine which circuit is at fault.

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

WARNING THE WHITE CASE MATERIAL OF THE PA RF AMPLIFIER TRANSISTORS IS MADE OF BeO CERAMIC MATERIAL.

WARNING DO NOT PERFORM ANY OPERATION ON ANY BeO CERAMIC WHICH MIGHT PRODUCE DUST OR FUMES, SUCH AS GRIND-

WARNING ING, GRIT BLASTING, OR ACID CLEANING. BERYLLIUM OXIDE DUST OR FUMES ARE HIGHLY TOXIC AND BREATH-

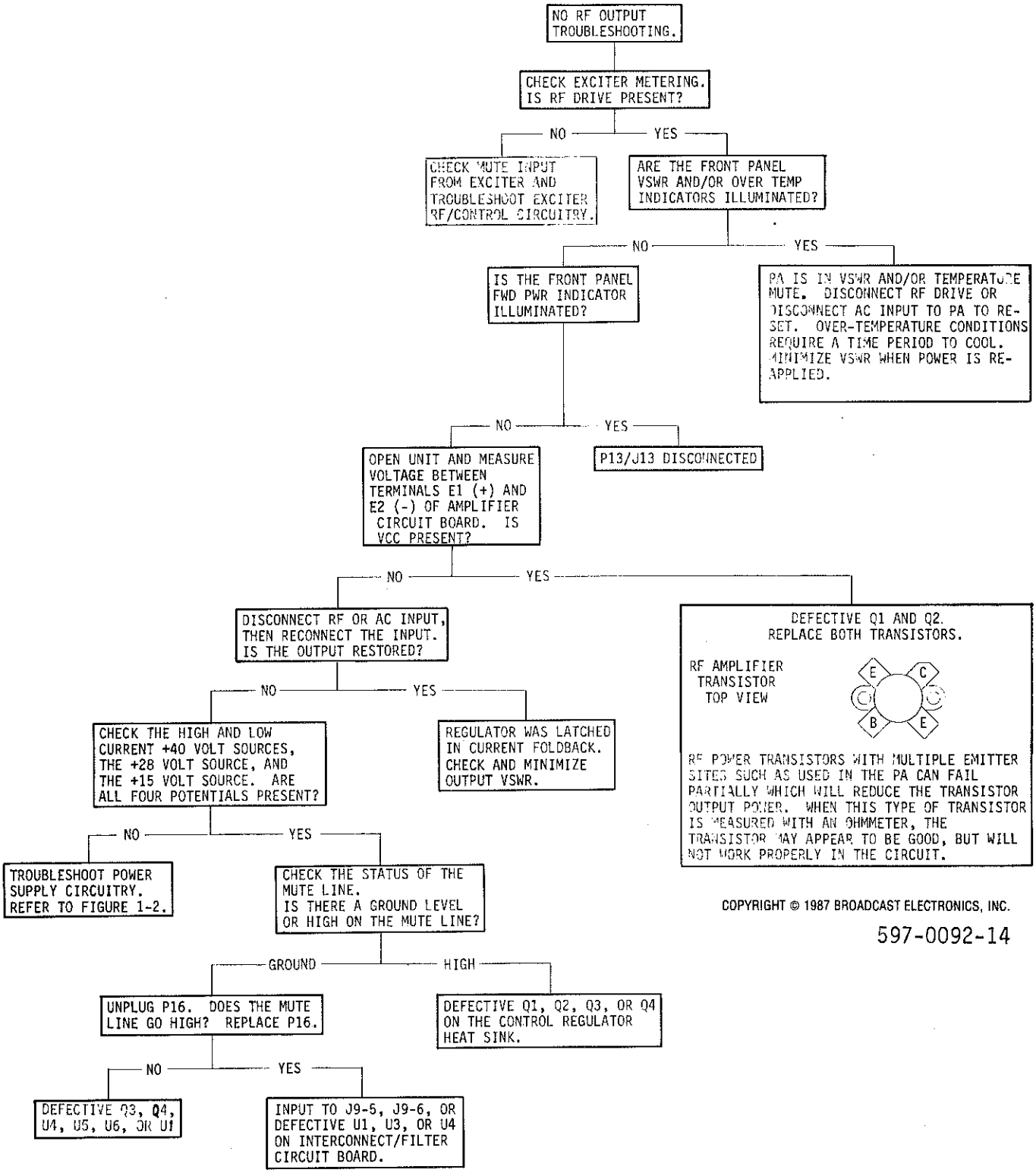
WARNING ING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. BeO CERAMICS MUST BE DISPOSED OF ONLY IN

WARNING A MANNER PRESCRIBED BY THE DEVICE MANUFACTURER. USE CARE IN REPLACING TRANSISTORS OF THIS TYPE.

2-102. Characteristically, the type of RF transistors used in the PA stage can fail partially, but still operate to some extent. If the 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 2-1 contains information relative to replacement of the RF transistors. The transistors should be replaced in pairs to maintain matched gain for optimum push-pull operation. Due to the difficulty of replacing Q1 and Q2 in the field, it is recommended to return the RF amplifier module to Broadcast Electronics, Inc. for repair as chip capacitors C4 through C7 may have to be removed with Q1 and Q2.

2-103. Once the trouble is isolated and power is totally deenergized, it is suggested that the exact problem be located with resistance checks using the schematic diagrams and theory of operation presented throughout the text. Figures 2-1 and 2-2 should be referenced as troubleshooting aids.

2-104. If a circuit is diagnosed as faulty, the circuit fault may be isolated and repaired locally or the entire device may be returned to Broadcast Electronics, Inc. for exchange, alignment, or replacement. The modular approach used in the construction of the PA allows spare control regulator or RF amplifier modules to be substituted in the system with minimal down time.



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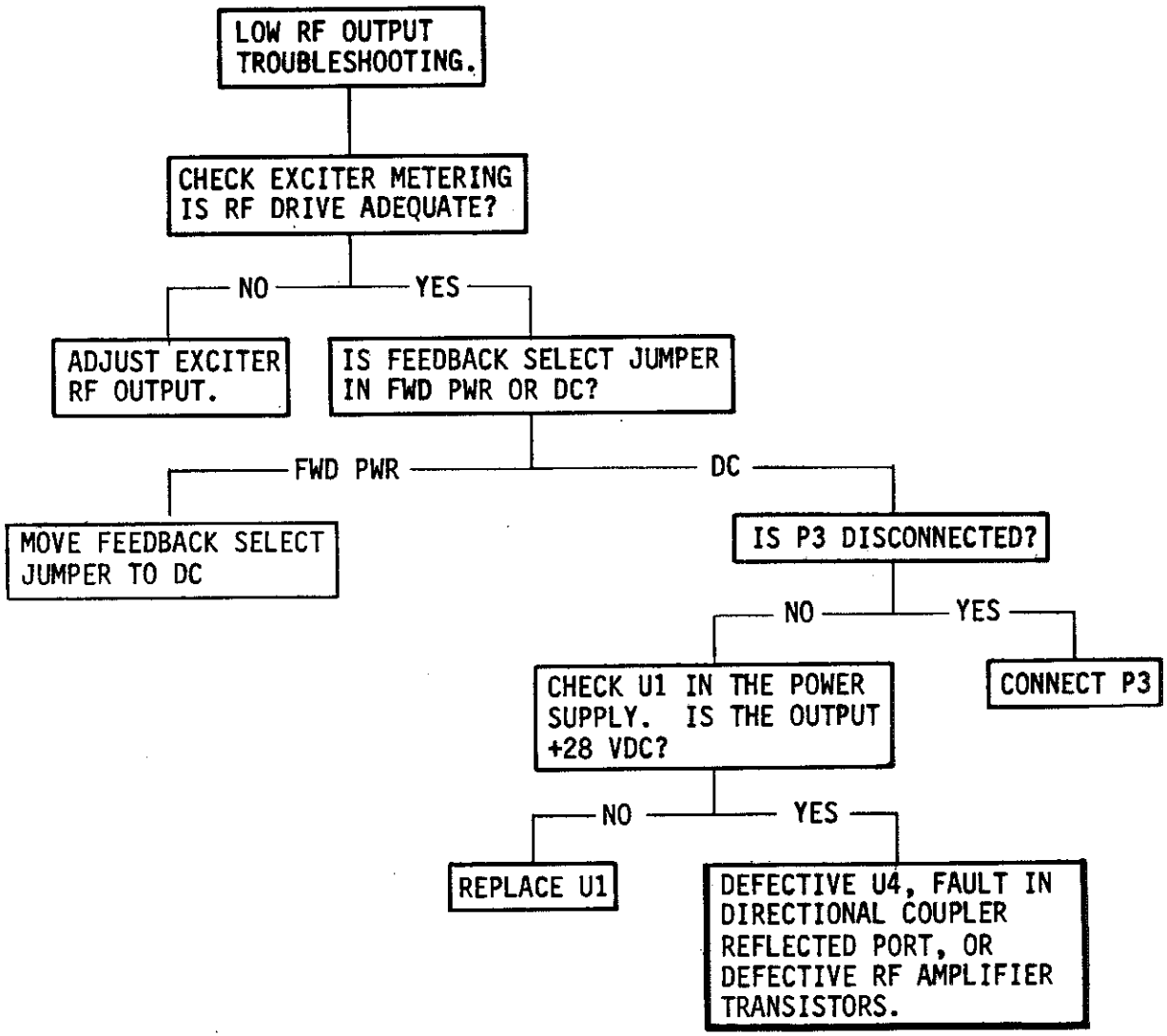
597-0092-14

FIGURE 2-1. NO RF OUTPUT TROUBLESHOOTING

WARNING: DISCONNECT POWER PRIOR TO SERVICING



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597-0092-15

FIGURE 2-2. LOW RF OUTPUT TROUBLESHOOTING

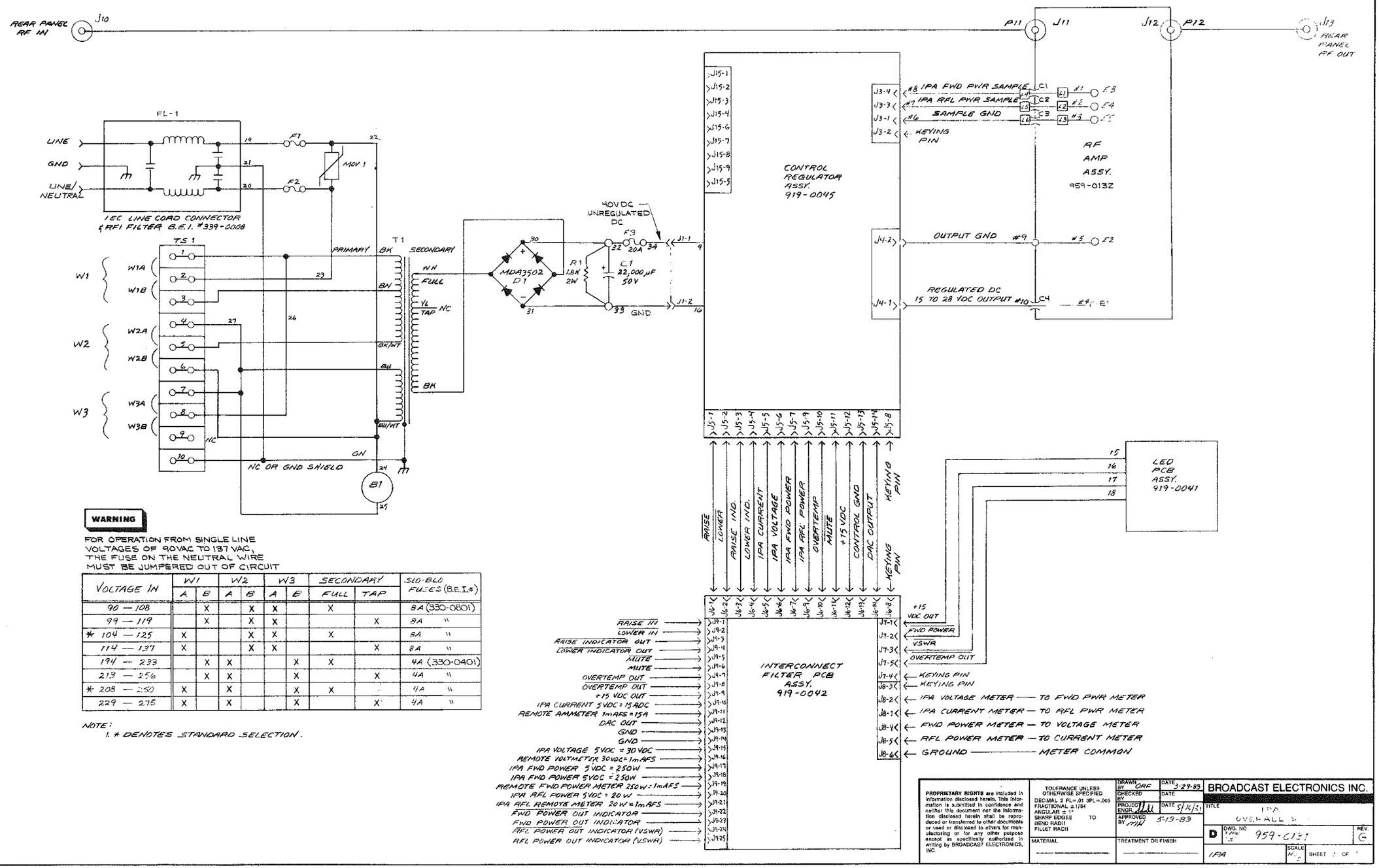
SECTION III

PA DRAWINGS

3-1. INTRODUCTION.

3-2. This section provides assembly drawings and schematic diagrams, as listed below for the PA used in the Broadcast Electronics very-low-power line of FM transmitters.

FIGURE	TITLE	NUMBER
3-1	SCHEMATIC, PA OVERALL	SD959-0131
3-2	ASSEMBLY, PA OVERALL	597-0092-16
3-3	SCHEMATIC, INTERCONNECT/FILTER CIRCUIT BOARD	SD919-0042
3-4	ASSEMBLY, INTERCONNECT/FILTER CIRCUIT BOARD	AC919-0042
3-5	SCHEMATIC, CONTROL REGULATOR OVERALL	SD919-0045
3-6	ASSEMBLY, CONTROL REGULATOR CIRCUIT BOARD	AD919-0045
3-7	COMPONENT LOCATOR, CONTROL REGULATOR CIRCUIT BOARD	597-0092-17
3-8	SCHEMATIC, RF AMPLIFIER OVERALL	SC919-0065
3-9	ASSEMBLY, RF AMPLIFIER CIRCUIT BOARD	AD959-0132
3-10	ASSEMBLY, RESISTOR NETWORK	597-0092-22



WARNING

FOR OPERATION FROM SINGLE LINE VOLTAGES OF 90VAC TO 137 VAC, THE FUSE ON THE NEUTRAL WIRE MUST BE JUMPERED OUT OF CIRCUIT

VOLTAGE IN	W1		W2		W3		SECONDARY		3AG-BLO FUSES (B.E.I.#)
	A	B	A	B	A	B	FULL	TAP	
90 — 108		X		X	X		X		8A (330-0801)
99 — 119		X		X	X			X	8A "
* 104 — 125	X			X	X		X		8A "
114 — 137	X			X	X			X	8A "
194 — 233		X	X			X	X		4A (330-0401)
213 — 256		X	X			X		X	4A "
* 208 — 250	X		X			X	X		4A "
229 — 275	X		X			X		X	4A "

NOTE:
1. * DENOTES STANDARD SELECTION.

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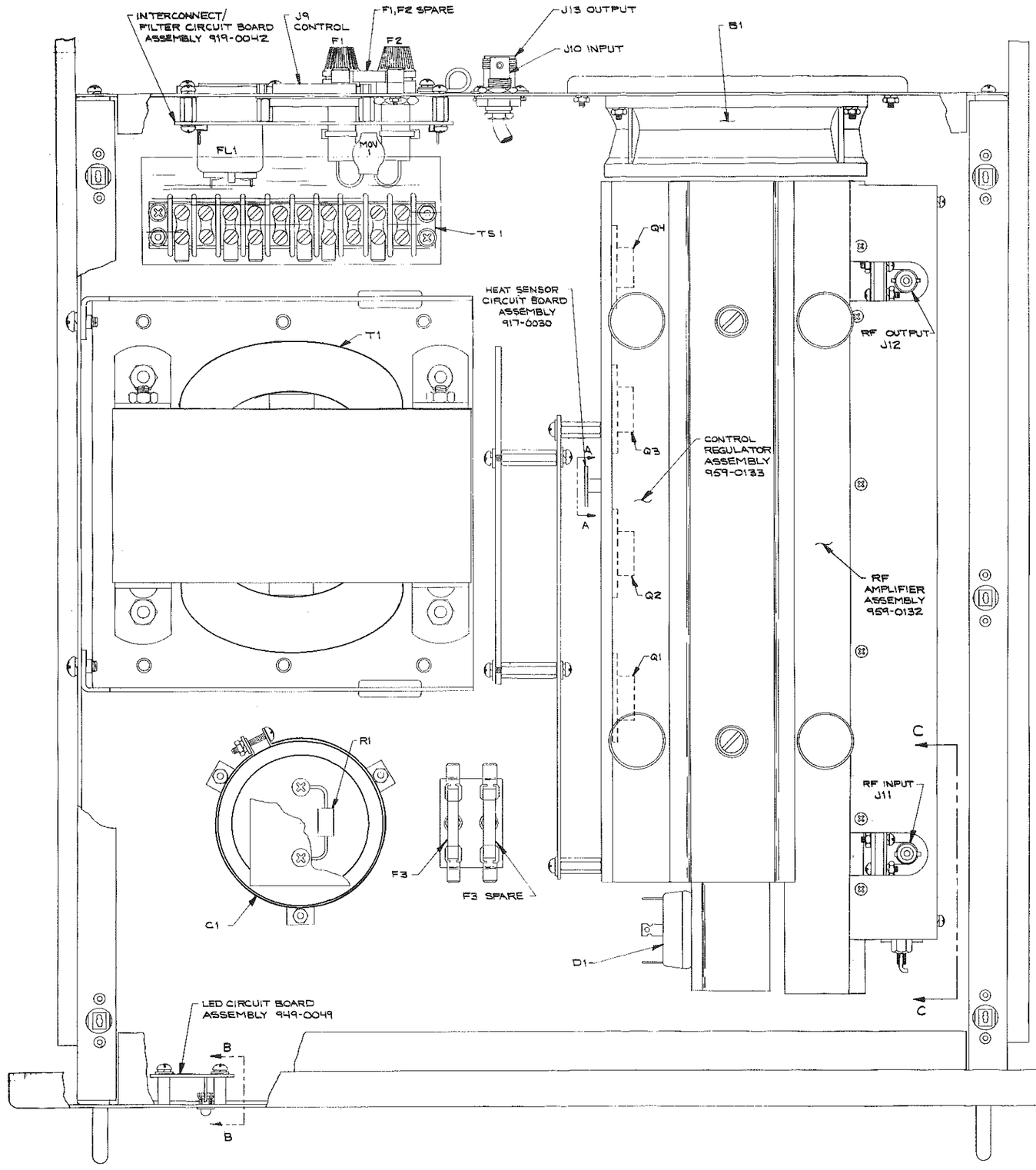
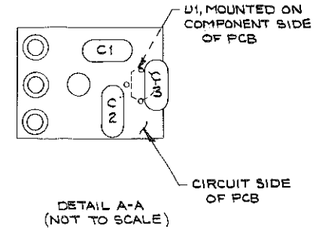
TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL = 1/64
ANGULAR = 1°
SHARP EDGES TO BEND RADII
FILLET RADII

MATERIAL

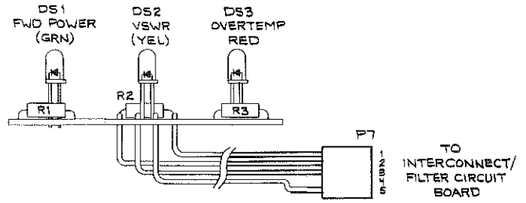
TREATMENT OR FINISH

DRAWN BY ORF	DATE 3-29-83	BROADCAST ELECTRONICS INC.
CHECKED BY	DATE	
PROJECT ENGR.	DATE 5/4/83	TITLE IPA OVERALL S
APPROVED BY PJW	5-19-83	
D	DWG. NO 959-0131	REV G
IPA	SCALE N.S.	SHEET 1 OF 1

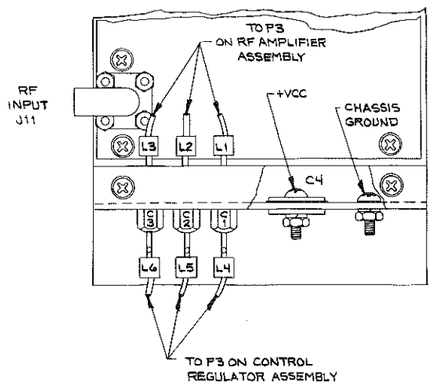




DETAIL A-A
(NOT TO SCALE)



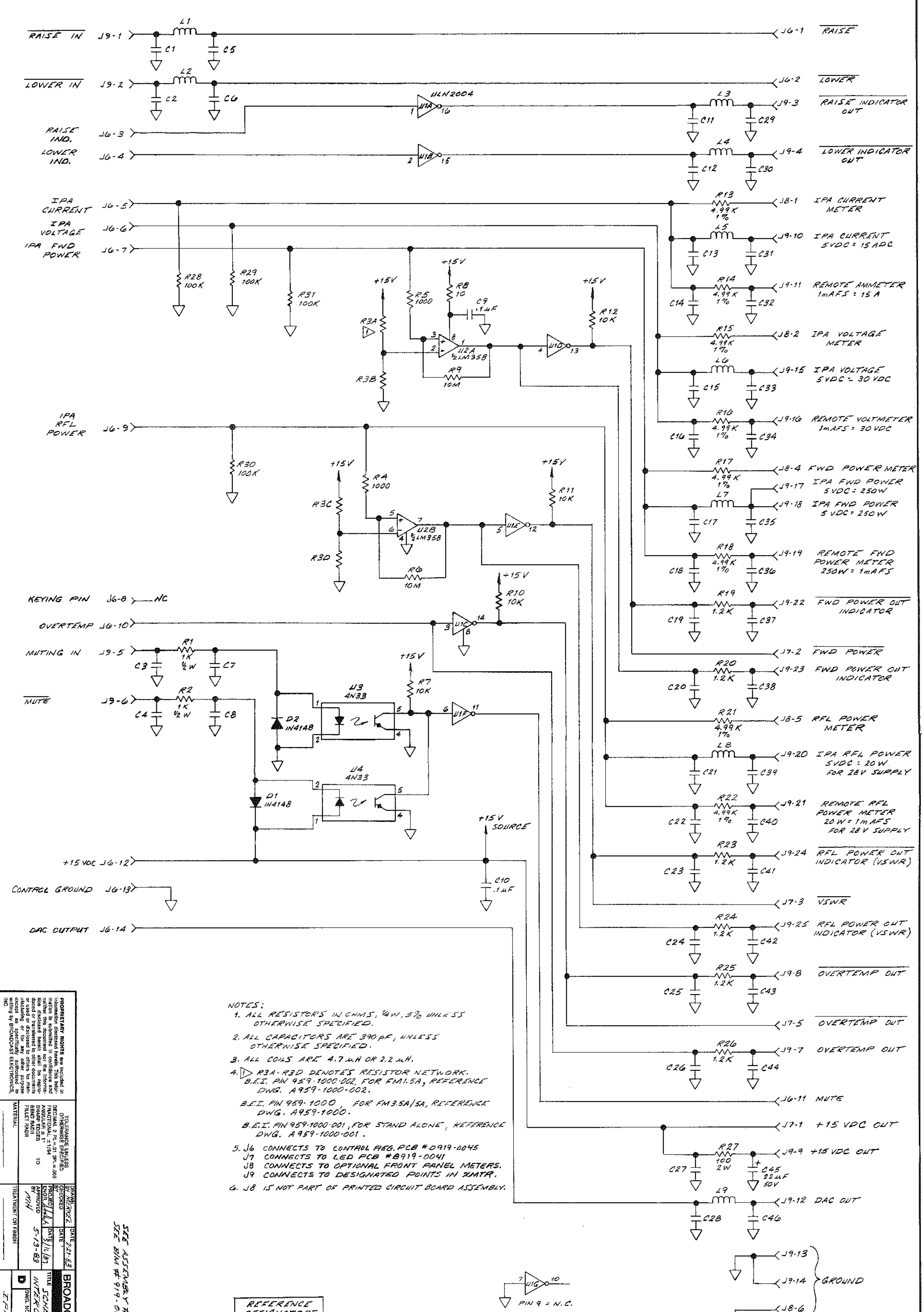
DETAIL B-B
(NOT TO SCALE)



DETAIL C-C
(NOT TO SCALE)

597-0092-16

FIGURE 3-2. INTERMEDIATE POWER AMPLIFIER OVERALL ASSEMBLY


RAISE IN J9-1
LOWER IN J9-2
RAISE IND. J6-3
LOWER IND. J6-4
IPA CURRENT J6-5
IPA VOLTAGE J6-6
IPA FWD POWER J6-7
IPA RFL POWER J6-9
KEYING PIN J6-8 NC
OVERTEMP J6-10
MUTING IN J9-5
MUTE J9-6
+15 VDC J6-12
CONTROL GROUND J6-13
DAC OUTPUT J6-14
J6-1 RAISE
J6-2 LOWER
J9-3 RAISE INDICATOR OUT
J9-4 LOWER INDICATOR OUT
J8-1 IPA CURRENT METER
J9-10 IPA CURRENT 5VDC = 15 ADC
J9-11 REMOTE AMMETER 1mAFS = 15 A
J8-2 IPA VOLTAGE METER
J9-15 IPA VOLTAGE 5VDC = 30 VDC
J9-16 REMOTE VOLTMETER 1mAFS = 30 VDC
J8-4 FWD POWER METER
J9-17 IPA FWD POWER 5VDC = 250W
J9-18 IPA FWD POWER 5 VDC = 250W
J9-19 REMOTE FWD POWER METER 250W = 1mAFS
J9-22 FWD POWER OUT INDICATOR
J7-2 FWD POWER
J9-23 FWD POWER OUT INDICATOR
J8-5 RFL POWER METER
J9-20 IPA RFL POWER 5VDC = 20W FOR 28V SUPPLY
J9-21 REMOTE RFL POWER METER 20W = 1mAFS FOR 28V SUPPLY
J9-24 RFL POWER OUT INDICATOR (VSWR)
J7-3 VSWR
J9-25 RFL POWER OUT INDICATOR (VSWR)
J9-8 OVERTEMP OUT
J7-5 OVERTEMP OUT
J9-7 OVERTEMP OUT
J6-11 MUTE
J7-1 +15 VDC OUT
J9-9 +15 VDC OUT
J9-12 DAC OUT
J9-13
J9-14 GROUND
J8-6
NC J7-4 KEYING PIN
NC J8-3 KEYING PIN
ULN2004
U1A
U1B
U1C
U1D
U1E
U1F
U1G
PIN 9 = N.C.
U2A ½LM358
U2B ½LM358
U3 4N33
U4 4N33
D1 IN4148
D2 IN4148
+15V
+15V SOURCE
R1 1K ½W
R2 1K ½W
R3A
R3B
R3C
R3D
R4 1000
R5 1000
R6 10M
R7 10K
R8 10
R9 10M
R10 10K
R11 10K
R12 10K
R13 4.99K 1%
R14 4.99K 1%
R15 4.99K 1%
R16 4.99K 1%
R17 4.99K 1%
R18 4.99K 1%
R19 1.2K
R20 1.2K
R21 4.99K 1%
R22 4.99K 1%
R23 1.2K
R24 1.2K
R25 1.2K
R26 1.2K
R27 100 2W
R28 100K
R29 100K
R30 100K
R31 100K
C9 .1uF
C10 .1uF
C45 22uF 50V

NOTES:

1. ALL RESISTORS IN OHMS, ¼W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE 390 pF, UNLESS OTHERWISE SPECIFIED.
3. ALL COILS ARE 4.7 µH OR 2.2 µH.
4. R3A-R3D DENOTES RESISTOR NETWORK. B.E.I. P/N 959-1000-002, FOR FM1.5A, REFERENCE DWG. A959-1000-002.
   B.E.I. P/N 959-1000, FOR FM3.5A/5A, REFERENCE DWG. A959-1000.
   B.E.I. P/N 959-1000-001, FOR STAND ALONE, REFERENCE DWG. A959-1000-001.
5. J6 CONNECTS TO CONTROL REG. PCB #0919-0045
   J7 CONNECTS TO LED PCB #B919-0041
   J8 CONNECTS TO OPTIONAL FRONT PANEL METERS.
   J9 CONNECTS TO DESIGNATED POINTS IN XMTR.
6. J8 IS NOT PART OF PRINTED CIRCUIT BOARD ASSEMBLY.

SEE ASSEMBLY # C919-0042
SEE B/M # 919-0042

REFERENCE DESIGNATORS	
LAST USED	NOT USED
C46	U1G
D2	
J9	
L9	
R31	
U4	

REFERENCE DESIGNATORS	U1	U2	U3, U4
B.E. PART NO.	226-2004	221-0358	229-0033
VENDOR PART NO.	ULN2004	LM358	4N33
VOLTAGE PIN NO.	——	8	——
GROUND PIN NO.	8	4	——

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TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL ±.01 3PL ±.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES
BEND RADII
FILLET RADII
TO
MATERIAL
TREATMENT OR FINISH

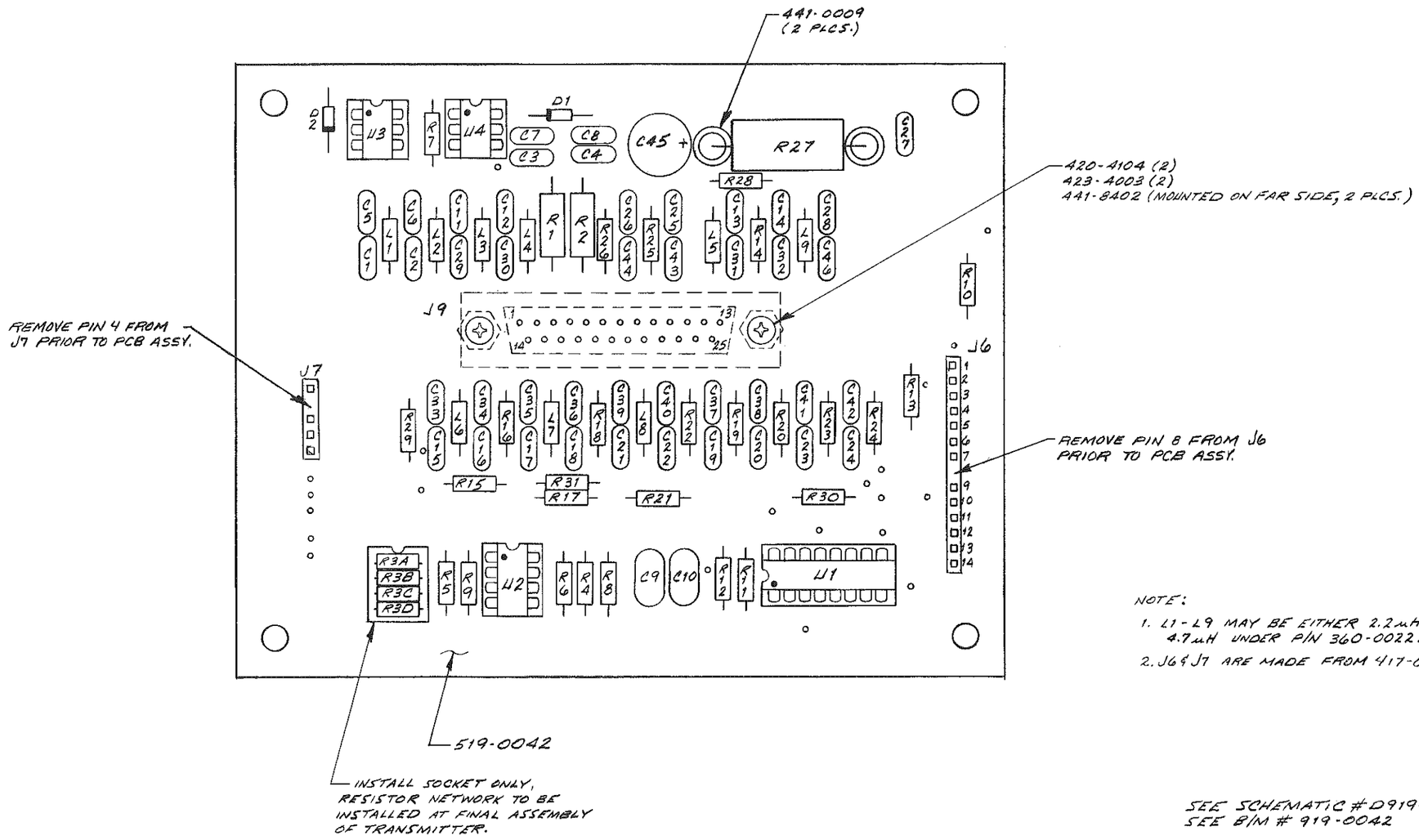
DRAWN BY MERKEL DATE 2-21-83
CHECKED BY DATE
PROJECT ENGR DATE 3/16/83
APPROVED BY MH 5-13-83

BROADCAST ELECTRONICS INC.

TITLE SCHEMATIC - IPA INTERCONNECT/FILTER PCB

D DWG. NO. 919-0042 REV. D

IPA SCALE NA SHEET 1 OF 1



NOTE:

1. L1 - L9 MAY BE EITHER 2.2μH OR 4.7μH UNDER P/N 360-0022.
2. J6 & J7 ARE MADE FROM 417-0200.

SEE SCHEMATIC #0919-0042
SEE B/M # 919-0042

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TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

DWN. BY MERKEL 2-26-83	NEXT ASSY.
CHKD.	
ME	PRODUCT USED ON IPA
EE	
PROJ. ENGR. S.S. 5/16/83	FINISH
DFTG. SUPVR. MH 5-13-83	
MFG.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BCST ELECT QUI

TITLE PCB ASSEMBLY - IPA INTERCONNECT/ FILTER BOARD

SHEET 1 OF 1 | SCALE 2/1 | REV D

TYPE A | SIZE C | DWG. NO. 919-0042

PART OF IPA CONTROL REGULATOR HEATSINK ASSY. #0959-0133

STUD ON HEATSINK

40VDC INPUT

GND

40 VDC

J1-2 #16

J1-1 #9

#6

#15

E7

E1

BOMB TAIL SPLICE

#1

KEYING PIN

E2

E3

F1

½ A, FAST-BLO

#11 MJ3000

#12

#13

#14

Q1

#2

Q2 * #3 2N3055A

Q3 * #4 2N3055A

Q4 * #5 2N3055A

E4

E5

E6

D13 1N4752A 33V

D18 1N4005

R55 22

R56 22

R57 22

R59 .1 5W 1%

R60 .1 5W 1%

R62 .1 5W 1%

R65 22

R66 22

R67 22

+28V

R51 6.2K

R52 120

C14 390pF

R53 100K

MPSA06 Q4

C16 22 50V

E11

E12

D19 1N5364

J4-1 15 TO 29 VDC REGULATED DC OUTPUT

J5-14 DAC OUTPUT

+28V SOURCE

D1 1N4005

U1 LM317K ADJ.

R1 169 1%

D3 1N4005

C1 22 50V

C3 22 50V

R2 7.32K 1%

R9 7.32K 1%

C7 22 50V

R12 1.40K 1%

R15 1.13K 1%

R16 787 1%

R17 10K

15.99V

28.32V

14.83V

6.96V OUTPUT VOLTAGE ADJUST

REFERENCE VOLTAGE SELECT TRIMPOT DAC CIRCUIT

P17 J17

R20 100K

+28V

R23 10

C11 22 50V

C12 2.2 N.P.

U5A LM358

R36 12K

D8 1N4148

R38 390

R44 100

C13 .01

Q2 MPSA56

D10 1N4739A 9.1V

R47 100

D9 1N4148

Q1 MPSA06

D7 5.1V

R39 4.7K

FEEDBACK SELECT IPA FWD PWR DC VOLTAGE

P18 J18

R24 100K

14.83V

R34 2.21K 1%

28.0V

R21 1.1K

D5 1N4148

D6 1N4148

R22 10

R31 2.49K 1%

DAC INPUT J15-4

KEYING PIN J3-2 NC

+28V

C8 .1

R13 16K

R18 100K FWD CAL

R25 10.0K 1%

U3B

R26 4.99K 1%

R40 10

IPA FWD PWR SAMPLE J3-4

R7 10K

R3 100K

C5 390pF

U3A LM358

R10 24K

+28V

C9 .1

R19 50K RFL CAL

R14 10K

R27 10.0K 1%

U4B

R28 4.99K 1%

R41 10

IPA RFL PWR SAMPLE J3-3

R8 10K

R4 100K

C6 390pF

U4A LM358

R11 2.4K

SAMPLE GND J3-1

C21 390pF

MUTING SELECT NORMAL TEST

P16 J16

MUTE J5-11

NOTE: REMOVE P16 TO DEFEAT MUTING FUNCTION

+28V

D12 1N4148

R42 10

+15V

R32 11.0K 1%

TP2

C20 22 50V

3.61V

U6A LF353

R45 10K

R46 1.8K

Q3 MPSA06

R29 10K

TP1

R33 3.57K 1%

R35 10K

R37 5.6M

R43 1.2K

R30 10K TEMP CAL

D11 1N4744A 15V

E8

E9

E10

PART OF IPA CONTROL REGULATOR HEATSINK ASSY. ASSY. NO. 917-0030B

U1 LM335

C2 390pF

C3 390pF

C1 390pF

#7

#8

#10

+28V

+15 V SOURCE

D2 1N4005 +14.73V

U2 LM317T ADJ.

D4 1N4005

C2 22 50V

C4 22 50V

R5 115 1%

R6 1.24K 1%

C10 22 50V

+15V

+28V

+15V

+ 28V

RAISE IND J15-8 J5-3 RAISE IND.

LOWER IND J15-9 J5-4 LOWER IND.

RAISE J5-1 J15-6 RAISE

LOWER J5-2 J15-7 LOWER

J15-1 +28VDC

J15-2 +15VDC

NC J15-5 KEYING PIN

J15-3 GND

J5-13 CONTROL GND

J4-2 OUTPUT GND

NC J5-8 KEYING PIN

+28V

R70 10.0K 1%

R71 9.76K 1%

CURRENT BAL R72 500

C19 .1

R68 10.0K 1%

R69 10.0K 1%

U7A LM358

-1.3V

R75 1% 9.53K

R76 CURRENT CAL 1K

R74 1.10K 1%

U7B

R77 10

J5-5 IPA CURRENT 5.0 VDC @ 15A DC OUTPUT

R73 10

J5-6 IPA VOLTAGE 5.0 VDC @ 30 VDC OUTPUT

+28V

C15 .0022

R54 10K

R48 20K

R50 10K

R49 20K

U6B

R58 1K

C17 22 50V

D15 1N4148

D14 1N4148

C18 22 50V

R61 1K

D16 1N4148

D17 1N4148

R63 4.99K 1%

R64 7.00K 1%

U5B

J5-7 IPA FWD POWER 5.0VDC @ 250W FWD PWR

J5-9 IPA RFL POWER 5.0 VDC @ 20W RFL FOR 28V SUPPLY 3.5VDC @ 10 W RFL FOR 20 V SUPPLY

J5-10 OVERTEMP

NOTE:
1. ALL RESISTORS IN OHMS, ¼W; ALL CAPACITORS IN MICROFARADS, U.O.S.
2. COMPONENTS LAST USED: C21, D19, F1, Q4, R77, TP2 & U7, E12
3. J15 IS NOT PRESENTLY INSTALLED IN PCB. J2 IS NOT USED.
   SEE ASSY. NO. 0919-0045
   SEE B/M NO. 919-0045
4. * COMPONENTS INDICATED MUST BE FROM THE SAME MANUFACTURER

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TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO BEND RADII FILLET RADII
MATERIAL

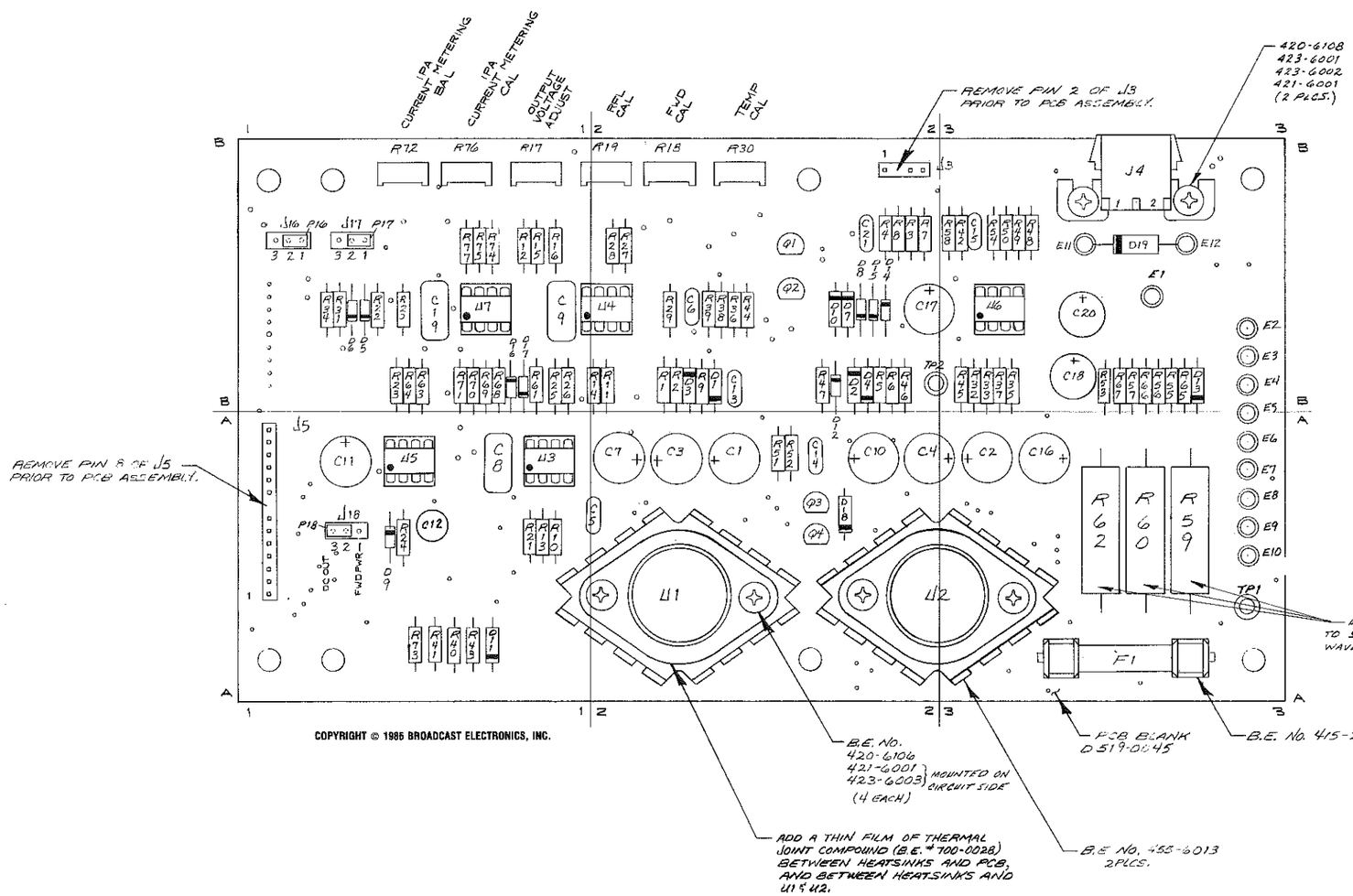
DRAWN BY ORF DATE 5-23-83
CHECKED BY DATE
PROJECT ENGR. DATE
APPROVED BY MH 5-13-83
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE SCHEMATIC IPA CONTROL REGULATOR PCB

D DWG. NO. 919-0045 REV. G

SCALE NTS SHEET 1 OF 1



SEE SCHEMATIC #D919-0045
SEE B/M #919-0045

NOTE:
1. J3 & J5 ARE MADE FROM 417-0200.

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TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO BEND RADII
FILLET RADII

MATERIAL

TREATMENT OR FINISH

DRAWN BY	DFF	DATE 5-7-83
CHECKED BY		DATE
PROJECT ENGR.		DATE 5/16/83
APPROVED BY	MH	5-13-83

BROADCAST ELECTRONICS INC.

TITLE PCB ASSEMBLY IPA CONTROL REGULATOR PCB

D | DWG. NO. TYPE A 917-0045 | REV. F

FINISH | SCALE 2/1 | SHEET 1 OF 1

REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE
C1	A2	D16	B1	R19	B2	R55	B3
C2	A3	D17	B1	R20	B1	R56	B3
C3	A2	F1	A3	R21	A1	R57	B3
C4	A2	---	--	R22	B1	R58	B3
C5	A2	J3	B2	R23	B1	R59	A3
C6	B2	J4	B3	R24	A1	R60	A3
C7	A2	J5	A1	R25	B1	R61	B1
C8	A1	---	--	R26	B1	R62	A3
C9	B1	J16	B1	R27	B2	R63	B1
C10	A2	J17	B1	R28	B2	R64	B1
C11	A1	J18	A1	R29	B2	R65	B3
C12	A1	P16	B1	R30	B2	R66	B3
C13	B2	P17	B1	R31	B1	R67	B3
C14	A2	P18	A1	R32	B3	R68	B1
C15	B3	Q1	B2	R33	B3	R69	B1
C16	A3	Q2	B2	R34	B1	R70	B1
C17	B2	Q3	A2	R35	B3	R71	B1
C18	B3	Q4	A2	R36	B2	R72	B1
C19	B1	R1	B2	R37	B3	R73	A1
C20	B3	R2	B2	R38	B2	R74	B1
C21	B2	R3	B2	R39	B2	R75	B1
D1	B2	R4	B2	R40	A1	R76	B1
D2	B2	R5	B2	R41	A1	R77	B1
D3	B2	R6	B2	R42	B3	TP1	A3
D4	B2	R7	B2	R43	A1	TP2	B2-B3
D5	B1	R8	B2	R44	B2	U1	A2
D6	B1	R9	B2	R45	B3	U2	A2-A3
D7	B2	R10	A1	R46	B2	U3	A1
D8	B2	R11	B2	R47	B2	U4	B2
D9	A1	R12	B1	R48	B3	U5	A1
D10	B2	R13	A1	R49	B3	U6	B3
D11	A1	R14	B2	R50	B3	U7	B1
D12	B2	R15	B1	R51	A2		
D13	B3	R16	B1	R52	A2		
D14	B2	R17	B1	R53	B3		
D15	B2	R18	B2	R54	B3		

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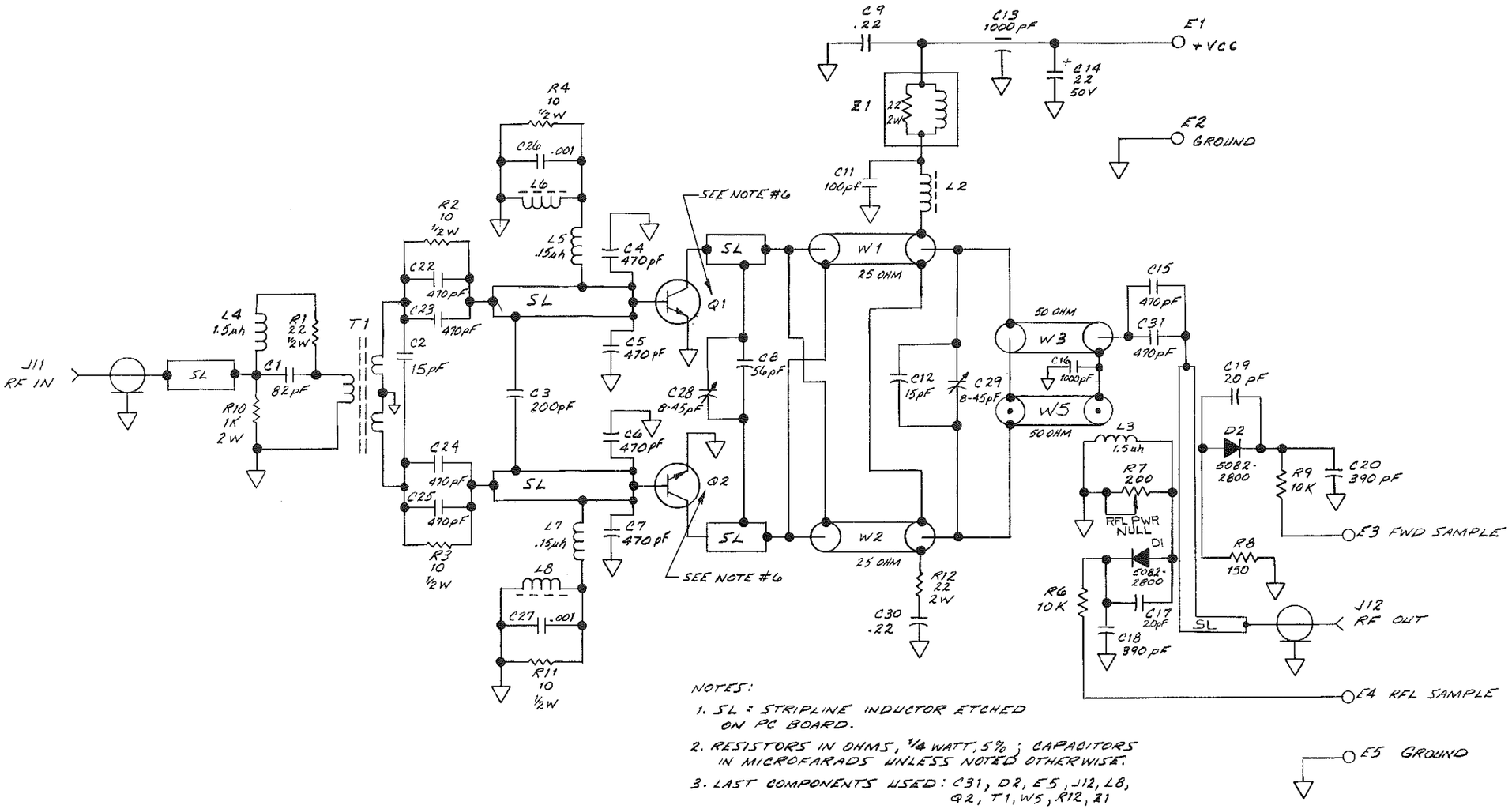
597-0092-17

FIGURE 3-7. CONTROL REGULATOR CIRCUIT BOARD COMPONENT LOCATOR



NOTES:

1. SL = STRIPLINE INDUCTOR ETCHED ON PC BOARD.
2. RESISTORS IN OHMS, 1/4 WATT, 5%; CAPACITORS IN MICROFARADS UNLESS NOTED OTHERWISE.
3. LAST COMPONENTS USED: C31, D2, E5, J12, L8, Q2, T1, W5, R12, Z1
4. SEE PCB ASSY. # 0959-0132, SHEET 1 OF 2.
5. COMPONENTS NOT USED: R5, C10, J1-J10
6. Q1 AND Q2 MATCHED PAIR OF B.E. PART NO. 210-1460-001. MUST HAVE SAME COLOR DOT.

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TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

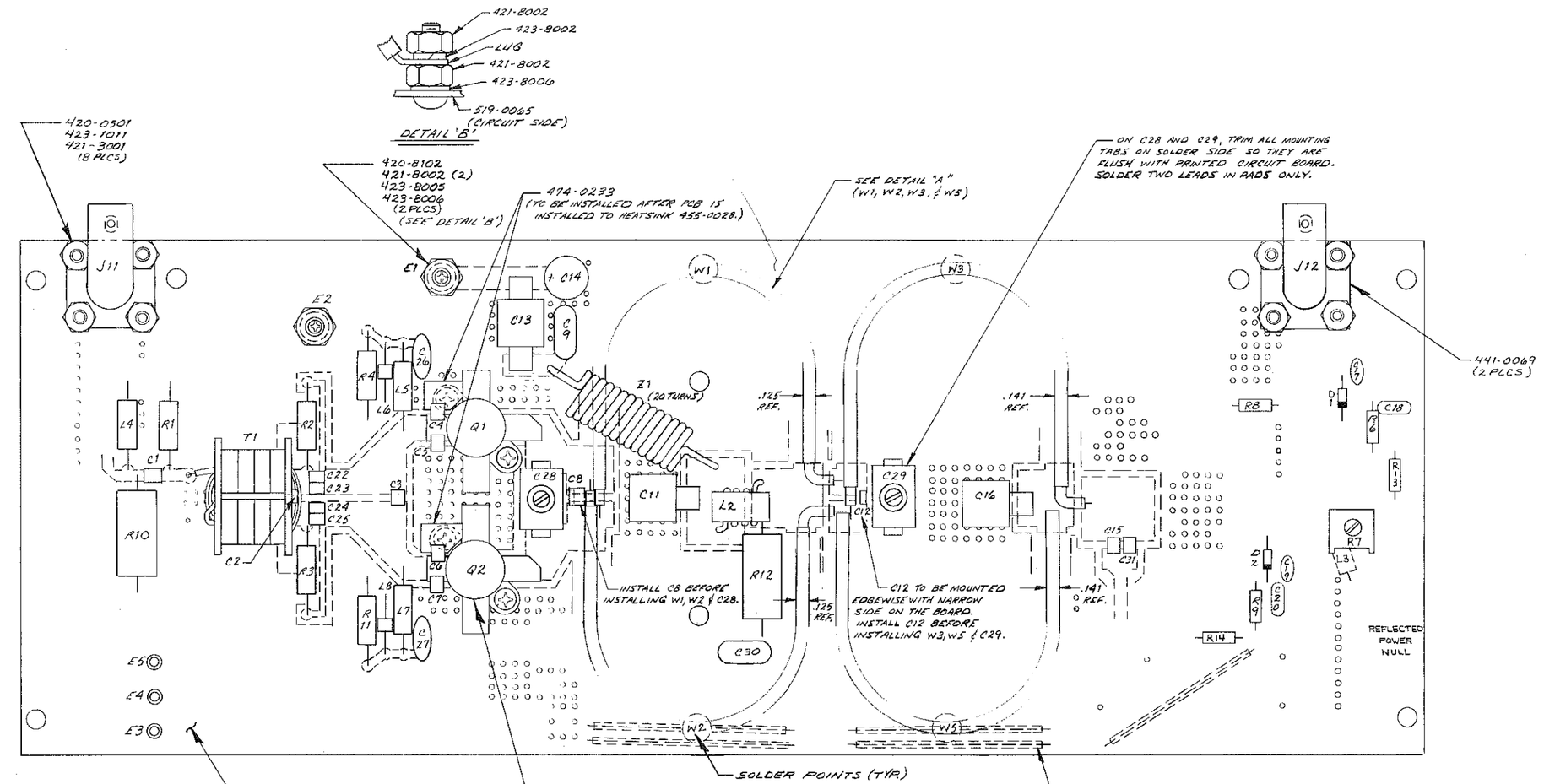
DWN. BY	MERKEL 3-10-83
CHKD.	
ME	
EE	
PROJ. ENGR.	S.S. 5/16/83
DFTG. SUPVR.	MH 5-13-83
MFG.	
NEXT ASSY.	
PRODUCT USED ON	IPA
FINISH	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BCST ELECT QUI

TITLE PCB SCHEMATIC - IPA RF AMP PCB

SHEET 1 OF 1
SCALE FL
REV F

TYPE 5 SIZE C DWG. NO. 919-0065



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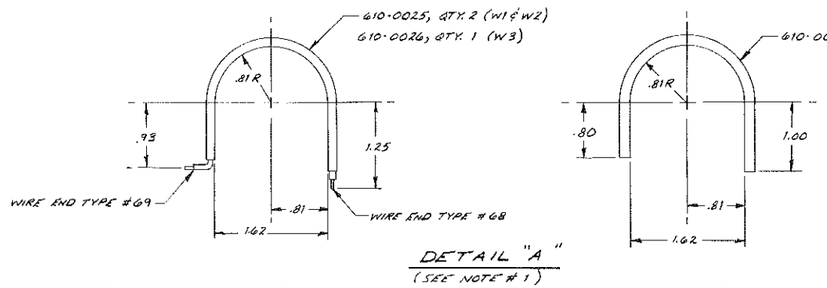

DETAIL "A"
(SEE NOTE #1)

NOTES:
1. USE FIXTURE TO FORM W1, W2, W3, & W5.
2. REFERENCE SCHEMATIC #D959-0131
3. REFERENCE B/M 919-0065.
4. REFERENCE RF AMP PCB SCHEMATIC #C919-0065.
5. TRANSISTORS Q1 & Q2 ARE MATCHED PAIRS.

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TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO BEND RADII
FILLET RADII

MATERIAL

DRAWN BY DAF DATE 9-12-88
CHECKED BY DATE
PROJECT ENGR. R.W DATE 9-16-88
APPROVED BY

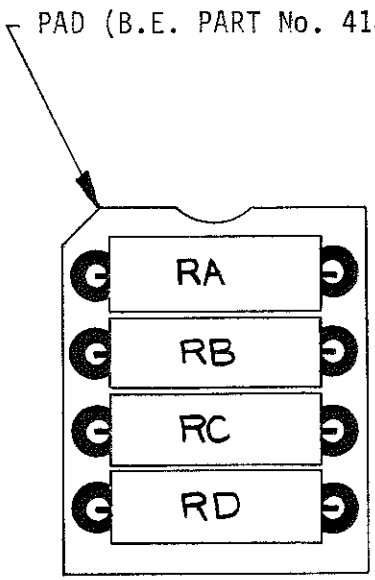
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE: IPA RF AMP ASSEMBLY

D | DWG. NO. TYPE A 959-0132 | REV. M

IPA | SCALE 2/1 | SHEET 1 OF 2



P/N 959-1000-015			
R3A	R3B	R3C	R3D
10K OHM	1.5K OHM	10K OHM	2.7K OHM

USED ON: ALL MODELS OF FM-100,FM-250, AND FM-300 AS R3

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597-0092-22

FIGURE 3-10. ASSEMBLY, PA RESISTOR NETWORK

SECTION IV

PA PARTS LISTS

4-1. INTRODUCTION.

4-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the PA used in the Broadcast Electronics very-low-power line of FM transmitters. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 4-1. PA PARTS LIST INDEX

TABLE 4-2. OVERALL PA - 959-0131

REF. DES.	DESCRIPTION	PART NO.	QTY.
B1	Fan, 115V, 50/60 Hz, 18W, 120 ft^3/min, 3100 r/min, 4.5 inch (11.43 cm)	380-4600	1
C1	Capacitor, Electrolytic, 22,000 uF, 50V	027-2200	1
D1	Bridge Rectifier, MDA3502, 200V, 35 Amperes, Silicon	230-3502	1
F1,F2, SPARE	Fuse, MDA, 250V, Slow-Blow, Ceramic Element, 4 Amperes	330-0401	3
F3,SPARE	Fuse, 3AB, 250V, 20 Amperes	330-2000	2
FL1	Power Input Connector/RFI Filter, 3 Amperes, 250V ac, 50/60 Hz	339-0008	1
MOV1	Metal Oxide Varistor, V2506A15A, 250V ac RMS, 15 Joules	140-0008	1
----	Transformer and Bracket Assembly	959-0195	1
T1	Transformer, Power, Single Phase, 50/60 Hz Primary: Dual 115 volt windings, one winding tapped at 90V Secondary: 33.1V @ 15 Amperes Continuous, tapped at 30.2V	376-0040-001	1
TS1	Barrier Strip, 10 Terminal	412-0100	1
XF1,XF2	Fuse Holder, AGC	415-2012	2
XF3	Fuse Holder, Dual, 3AB	415-0003	1
----	Fuse Clips for Spare fuse, AGC	415-1001	2
----	Chassis Slides, Pair	469-0413-002	1
----	Receptacle, Top Cover Fastener	420-0022	8
----	Turn-Lock Fastener, Long	420-0019	6
----	Turn-Lock Fastener, Short	420-0027	2
----	Retainer, Turn-Lock Fastener	420-0021	8
----	LED Circuit Board Assembly	919-0041	1
----	Interconnect/Filter Circuit Board	919-0042	1
----	RF Amplifier Assembly	959-0132	1
----	Control Regulator Assembly	939-0133	1
----	IPA Wiring Assembly	949-0029	1

TABLE 4-3. PA WIRING ASSEMBLY - 949-0029

REF. DES.	DESCRIPTION	PART NO.	QTY.
J10	Receptacle, BNC, Bulkhead UG-909	417-0106	1
J13	Receptacle, Type N	417-0076	1
P1,P2	Plug, BNC, Right Angle	417-0213	2
P1	Plug Assembly:		
	Contact, Male	418-0036	1
	Contact, Female	417-0100	1
	Housing	417-0099	1
P5,P6	Plug Assembly, 14-Pin	417-1401	2
P7	Plug Assembly, 5-Pin	417-0165	1
R1	Resistor, 1.8 k Ohm ±5%, 2W	130-1843	1
----	Contacts for P5, P6, and P7	417-8766	30

TABLE 4-4. LED CIRCUIT BOARD ASSEMBLY - 919-0041

REF. DES.	DESCRIPTION	PART NO.	QTY.
DS1	FWD PWR Indicator, LED, Green, 521-9175, 2.3V @ 40 mA Maximum	323-9224	1
DS2	VSWR Indicator, LED, Yellow, 521-9176, 2.3V @ 40 mA Maximum	323-9225	1
DS3	OVER TEMP Indicator, LED, Red, 521-9212, 1.7V @ 50 mA Maximum	323-9217	1
R1	Resistor, 680 Ohm ±5%, 1/2W	110-6833	1
R2,R3	Resistor, 820 Ohm ±5%, 1/2W	110-8233	2
----	Blank Circuit Board	519-0041	1

TABLE 4-5. INTERCONNECT/FILTER CIRCUIT BOARD - 919-0042

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C8	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	8
C9,C10	Capacitor, Mylar Film, 0.1 uF ±5%, 100V	030-1053	2
C11 THRU C44	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	34
C45	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C46	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1,D2	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	2
J6	Receptacle, Header, 14-Pin In-line (.7 Portion of Connector)	417-0200	1
J7	Receptacle, Header, 5-Pin In-Line (.25 Portion of Connector)	417-0200	1
J9	Receptacle, 25-Pin	417-2500	1
L1 THRU L9	Molded Choke, 4.7 uH ±10%, DC Resistance: 0.55 Ohms, 0.43 Amperes Maximum, Resonant at 130 MHz	360-0022	9
R1,R2	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	2
R3	Resistor Network Assembly	959-1000-002	1
R4,R5	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R6	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R7	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R8	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R9	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R10 THRU R12	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R13 THRU R18	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	6
R19,R20	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	2
R21,R22	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	2
R23 THRU R26	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	4
R27	Resistor, 100 Ohm ±5%, 2W	132-1033	1
R28 THRU R31	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	4
U1	Integrated Circuit, ULN2003A, 7-Channel Driver, CMOS/TTL Compatable, 16-Pin DIP	229-2003	1
U2	Integrated Circuit, 4N33, Optical Isolator NPN Photo-Transistor/Infrared Emitting Diode Type, 1500V Isolation, 6-Pin DIP	229-0033	1
U3,U4	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	2
XR3	Rectptacle, 8-Pin DIP	417-0088	1
XU1	Receptacle, 16-Pin DIP	417-1604	1
XU2	Receptacle, 8-Pin DIP	417-0804	1
XU3,XU4	Receptacle, 6-Pin DIP	417-0600	2
----	Blank Circuit Board	519-0042	1

TABLE 4-6. RF AMPLIFIER ASSEMBLY - 959-0132

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Ceramic, Feed-Thru, 1000 pF ±20%, 500V	008-1033	3
C4	Capacitor Assembly, Kapton, Feed-Thru, 100 pF		
	Kapton Dielectric	409-1817	2
	Nylon Insulator	423-6007	2
L1 THRU L6	Ferrite Bead	360-0003	6
----	RF Amplifier Wiring Assembly	949-0040	1
----	RF Amplifier Circuit Board	919-0065	1

TABLE 4-7. RF AMPLIFIER WIRING ASSEMBLY - 949-0040

REF. DES.	DESCRIPTION	PART NO.	QTY.
J3,J3	Receptacle, 4-Pin		
	Receptacle	417-6002-004	2
	Top Cover	417-6001-004	2
P4	Plug Assembly:		
	Contact, Female	417-0100	2
	Housing	418-0078	1

TABLE 4-8. RF AMPLIFIER CIRCUIT BOARD - 919-0065
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic, Chip, 82 pF ±5%, 500V	009-8013	1
C2	Capacitor, Ceramic, Chip, 15 pF ±5%, 500V	009-1513	1
C3	Capacitor, Ceramic, Chip, 200 pF ±5%, 300V	009-2023	1
C4 THRU C7	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	4
C8	Capacitor, Ceramic, Chip, 56 pF ±5%, 500V	009-5613	1
C9	Capacitor, Mylar, 0.22 uF ±10%, 100V	030-2253	1
C11	Capacitor, Mica, 100 pF ±10%, 350V	046-0001	1
C12	Capacitor, Ceramic, Chip, 15 pF ±5%, 500V	009-1513	1
C13	Capacitor, Mica, Feedthru, 1000 pF ±10%, 350V	046-1030	1
C14	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C15	Capacitor, Ceramic Chip, 470 pF ±5%, 200V	009-4723	1
C16	Capacitor, Mica, 1000 pF ±10%, 350V	046-0002	1
C17	Capacitor, Ceramic, 20 pF ±10%, 1kV	002-2013	1
C18	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C19	Capacitor, Ceramic, 20 pF ±10%, 1kV	002-2013	1
C20	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C22 THRU C25	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	4
C26,C27	Capacitor, Ceramic, 0.001 uF ±10%, 1kV	002-1034	2
C28,C29	Capacitor, Mica, Adjustable Compression, 4 to 45 pF, 175V	090-0403	2
C30	Capacitor, Mylar, 0.22 uF ±10%, 100V	030-2253	1
C31	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	1
D1,D2	Diode, HP5082-2800, High Voltage Schottky Barrier Type, 70V, 15 mA	201-2800	2
J3	Receptacle, 4-Pin	417-0138	1
----	Pins for J3	417-8766	4
J11,J12	Receptacle, Right Angle BNC, UG535/U	417-0049	2
L2	RF Choke: 4 Turns of enameled 16 AWG wire on a 1/2 inch OD ferrite torroid form.	360-0025	1
L3,L4	RF Choke, 1.5 uH ±10%, 580 mA Maximum, DC Resistance = 0.30 Ohms	360-0032	2
L5	RF Choke, 0.15 uH, 1.47A dc Maximum DC Resistance = 0.037 Ohms	360-0151	1
L6	RF Choke, Consists of BE P/N 360-0041 ferrite bead, OD = 0.13 inch, ID = 0.047 inch, L = 0.11 inch	360-0042	1
L7	RF Choke, 0.15 uH, 1.47A dc Maximum DC Resistance = 0.037 Ohms	360-0151	1
L8	RF Choke, Consists of BE P/N 360-0041 ferrite bead, OD = 0.13 inch, ID = 0.047 inch, L = 0.11 inch	360-0042	1
Q1,Q2	Transistor, SD1460-5, Matched Pair, NPN, Silicon, CB-290 Case	210-1460-001	1
R1	Resistor, 22 Ohm ±5%, 1/2W	110-2223	1
R2 THRU R4	Resistor, 10 Ohm ±5%, 1/2W	110-1023	3
R6	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R7	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
R8	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R10	Resistor, 1 k Ohm ±5%, 2W	130-1043	1
R11	Resistor, 10 Ohm ±5%,, 1/2W	110-1023	1
R12	Resistor, 22 Ohm ±2%, 2W	130-2223	1
T1	RF Input Transformer, Broadcast Electronics Manufacture Primary: 50 Ohms Impedance Secondary: 25 Ohms Impedance, CT	370-0008	1

TABLE 4-8. RF AMPLIFIER CIRCUIT BOARD - 919-0065
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
W1,W2	Coaxial Cable Sections: 25 Ohm rigid coaxial cable matching section	610-0025	2
W3,W5	Coaxial Cable Sections: 50 Ohm rigid coaxial cable matching section	610-0026	2
Z1	Parasitic Suppressor: 20 Turns of enameled 16 AWG wire close wound on a 22 Ohm ±5%, 2W carbon resistor (BE P/N 130-2223)	360-0024	1
----	Blank Circuit Board	519-0065	1

TABLE 4-9. CONTROL REGULATOR ASSEMBLY - 959-0133

REF. DES.	DESCRIPTION	PART NO.	QTY.
Q1	Transistor, MJ3000, Silicon, NPN Darlington, TO-3 Case	219-3000	1
Q2 THRU Q4	Transistor, 2N3055A, Silicon, NPN, TO-3 Case	218-3055	3
XQ1 THRU XQ4	Socket, TO-3 Transistor	417-0298	4
----	Insulator, Mica, TO-3 Transistor	418-0010	4
----	Control Regulator Wiring Assembly	949-0039	1
----	Control Regulator Circuit Board	919-0045	1
----	Temperature Sensor Circuit Board	917-0030	1

TABLE 4-10. CONTROL REGULATOR WIRING ASSEMBLY - 949-0039

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Jack Assembly:		
	Contact, Male	418-0036	1
	Contact, Female	417-0100	1
	Housing	417-0098	1

TABLE 4-11. CONTROL REGULATOR CIRCUIT BOARD - 919-0045
(Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C4	Capacitor, Electrolytic, 22 uF, 50V	024-2274	4
C5,C6	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C7	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C8,C9	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	2
C10,C11	Capacitor, Electrolytic, 22 uF, 50V	024-2274	2
C12	Capacitor, Electrolytic, 2.2 uF, 50V	020-2264	1
C13	Capacitor, Mylar Film, 0.01 uF, 100V	031-1043	1
C14	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C15	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C16 THRU C18	Capacitor, Electrolytic, 22 uF, 50V	024-2274	3
C19	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C20	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C21	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1 THRU D4	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	4
D5,D6	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	1
D7	Diode, Zener, 1N4733A, 5.1V, 1W	200-4733	1
D8,D9	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	2
D10	Diode, Zener, 1N4739A, 9.1V, 1W	200-0009	1
D11	Diode, Zener, 1N4744A, 15V, 1W	200-0015	1
D12	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	1
D13	Diode, Zener, 1N4752A, 33V, 1W	200-4752	1
D14 THRU D17	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	4

TABLE 4-11. CONTROL REGULATOR CIRCUIT BOARD - 919-0045
(Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
D18	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	1
D19	Diode, Zener, 1N5363, 30V, 5W	200-5363	1
F1	Fuse, AGC, 250V, 1/2 Ampere	330-0050	1
J3	Receptacle, Header, 4-Pin In-line (.2 Portion of Connector)	417-0200	1
J4	Receptacle, Header, 2-Pin	417-0097	1
J5	Receptacle, Header, 14-Pin In-line (.7 Portion of Connector)	417-0200	1
J16 THRU J18	Receptacle, Header, 3-Pin	418-0003	3
P16 THRU P18	Plug, Shorting, 2-Pin	340-0004	3
Q1	Transistor, MPSA06, NPN, TO-92 Case	211-0006	1
Q2	Transistor, MPSA56, PNP, TO-92 Case	210-0056	1
Q3,Q4	Transistor, MPSA06, NPN, TO-92 Case	211-0006	2
R1	Resistor, 169 Ohms ±1%, 1/4W	103-1693	1
R2	Resistor, 7.32 k Ohm ±1%, 1/4W	103-7324	1
R3,R4	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R5	Resistor, 115 Ohm ±1%, 1/4W	100-1131	1
R6	Resistor, 1.24 k Ohm ±1%, 1/4W	103-1244	1
R7,R8	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R9	Resistor, 7.32 k Ohm ±1%, 1/4W	103-7324	1
R10	Resistor, 36 k Ohm ±5%, 1/4W	100-3653	1
R11	Resistor, 4.3 k Ohm ±5%, 1/4W	100-4343	1
R12	Resistor, 1.40 k Ohm ±1%, 1/4W	103-1404	1
R13	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	1
R14	Resistor, 18 k Ohm ±5%, 1/4W	100-1853	1
R15	Resistor, 1.13 k Ohm ±1%, 1/4W	103-1134	1
R16	Resistor, 787 Ohm ±1%, 1/4W	103-7873	1
R17	Potentiometer, 10 k Ohm ±10%, 1/2W	178-1053	1
R18	Potentiometer, 100 k Ohm ±10%, 1/2W	178-1064	1
R19	Potentiometer, 50 k Ohm ±10%, 1/2W	178-5053	1
R20	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R21	Resistor, 1.1 k Ohm ±5%, 1/4W	100-1143	1
R22,R23	Resistor, 10 Ohm ±5%, 1/4W	100-1023	2
R24	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R25	Resistor, 10.0 k Ohm ±1%, 1/4W	100-1051	1
R26	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R27	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R28	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R29	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R30	Potentiometer, 10 k Ohm ±10%, 1/2W	178-1053	1
R31	Resistor, 2.49 k Ohm ±1%, 1/4W	103-2494	1
R32	Resistor, 11.0 k Ohm ±1%, 1/4W	103-1105	1
R33	Resistor, 3.57 k Ohm ±1%, 1/4W	103-3574	1
R34	Resistor, 2.21 k Ohm ±1%, 1/4W	103-2241	1
R35	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R36	Resistor, 12 k Ohm ±5%, 1/4W	100-1253	1
R37	Resistor, 5.6 Meg Ohm ±5%, 1/4W	100-5673	1
R38	Resistor, 390 Ohm ±5%, 1/4W	100-3933	1
R39	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R40 THRU R42	Resistor, 10 Ohm ±5%, 1/4W	100-1023	3
R43	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	1
R44	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R45	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R46	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R47	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R48,R49	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	2
R50	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R51	Resistor, 6.2 k Ohm ±5%, 1/4W	100-6243	1
R52	Resistor, 120 Ohm ±5%, 1/4W	100-1233	1
R53	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R54	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R55 THRU R57	Resistor, 22 Ohm ±5%, 1/4W	100-2223	3
R58	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1

TABLE 4-11. CONTROL REGULATOR CIRCUIT BOARD - 919-0045
(Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R59,R60	Resistor, 0.1 Ohm ±1%, 5W, W/W	130-1000	2
R61	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R62	Resistor, 0.1 Ohm ±1%, 5W, W/W	130-1000	1
R63	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R64	Resistor, 1.00 k Ohm ±1%, 1/4W	103-1041	1
R65 THRU R67	Resistor, 22 Ohm ±5%, 1/4W	100-2223	3
R68 THRU R70	Resistor, 10.0 k Ohm ±1%, 1/4W	100-1051	3
R71	Resistor, 9.76 k Ohm ±1%, 1/4W	103-9764	1
R72	Potentiometer, 500 Ohm ±10%, 1/2W	178-5000	1
R73	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R74	Resistor, 1.10 k Ohm ±1%, 1/4W	103-1104	1
R75	Resistor, 9.53 k Ohm ±1%, 1/4W	103-9534	1
R76	Potentiometer, 1 k Ohm ±10%, 1/2W	178-1043	1
R77	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
U1,U2	Integrated Circuit, LM317K, Three-Terminal Adjustable Positive Voltage Regulator, 1.2 to 37V, 1.5 Ampere Maximum, TO-3 Case	227-0318	1
U3 THRU U5	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	3
U6	Integrated Circuit, LF353N, Dual JFET Input Operational Amplifier, 8-Pin DIP	221-0353	1
U7	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	1
XF1	Fuse Clips, AGC	415-2068	2
XU3 THRU XU7	Socket, 8-Pin DIP	417-0804	5

TABLE 4-12. TEMPERATURE SENSOR CIRCUIT BOARD - 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 4-13. RESISTOR ASSEMBLY NETWORK - 959-1000-015

REF. DES.	DESCRIPTION	PART NO.	QTY.
R3A	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R3B	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R3C	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R3D	Resistor, 2.7 k Ohm ±5%, 1/4W	100-2743	1

APPENDIX A

PA MANUFACTURERS DATA

A-1. INTRODUCTION.

A-2. This appendix provides the following technical data relative to the operation and maintenance of the PA used in the Broadcast Electronics very-low-power line of FM transmitters. Information contained in this appendix is provided in the following order:

A. SD1460 VHF NPN Power Transistor Data Sheet