FM–20T 20 KILOWATT FM BROADCAST TRANSMITTER

October, 1999 **IM No. 597–0220–014**

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: 1) inspected the containers for visible signs of damage and 2) 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.

RF PRODUCT TECHNICAL ASSISTANCE – REPAIR SERVICE – REPLACEMENT PARTS.

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

Emergency and warranty replacement parts may be ordered from the following address. Be sure to include the equipment model number, serial number, 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.

FACILITY CONTACTS –

Broadcast Electronics, Inc. – Quincy Facility
4100 N. 24th St. P.O. BOX 3606
Quincy, Illinois 62305
Telephone: (217) 224–9600
Fax: (217) 224–9607
E–Mail: General – bdcast@bdcast.com
Web Site: www.bdcast.com

RF PRODUCT TECHNICAL ASSISTANCE – REPAIR – EMERGENCY/WARRANTY REPLACEMENT PARTS –

Telephone: (217) 224–9600
E–Mail: rfservice@bdcast.com
Fax: (217) 224–9607

NON–EMERGENCY REPLACEMENT PARTS –

Fax: (217) 224–9609

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.

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.

PROPRIETARY NOTICE.

MODIFICATIONS.

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

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.

E. RF BURNS – Circuit boards with RF power transistors contain high RF potentials. Do not operate an RF power module with the cover removed.

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 cooling down period after tube operation.

PUBLICATION ADDENDUM
SPECIAL ASSEMBLY REQUIREMENTS
FM-20T TRANSMITTER

1-1. INTRODUCTION.

1-2. Due to special shipping requirements, selected components of the Broadcast Electronics FM-20T transmitter have been disassembled to prevent damage during shipment. This publication addendum provides information required for the re-assembly of the transmitter IN ADDITION TO the information provided in SECTION II, INSTALLATION of FM-20T instruction manual 597-0220-004. Perform the following assembly instructions prior to the procedures described in the manual.

1-3. SPECIAL ASSEMBLY.

1-4. **GENERAL.** Components removed from the transmitter contain identification tags to permit reinstallation. Items such as interconnecting wires, cables, and miscellaneous small parts are taped or tied for shipment. Remove all tape, string, and packing material used for shipping purposes as each item is installed.

1-5. Terminal blocks and wires contain identification tags with information regarding reconnection. Mounting hardware will be placed in small bags attached to each removed component or inserted in the component mounting holes.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

1-6. **HIGH VOLTAGE POWER SUPPLY CABINET.** Install the power supply cabinet base-plate in the high voltage power supply cabinet by performing the following procedure. Ensure no primary power is connected to the transmitter before attempting any component installation.

1-7. **Power Supply Cabinet Base-Plate.** Refer to Figure 1 and install the power supply cabinet base-plate as follows:

A. Using a small fork-lift, place the base-plate with all components attached in the bottom of the power supply cabinet.

B. Mount the base-plate to the cabinet with three 9/16 inch bolts, nuts, flat washers, and lockwashers. The mounting bolt at the ground strap/base-plate connection must remain off at this time.

WARNING ***ENSURE THE GROUND STRAP ON THE PLATE CHOKE BASE IS PROPERLY CONNECTED TO THE CABINET GROUND STRAP.***

WARNING

CAUTION ***ENSURE THE JUMPER WIRE BETWEEN THE TERMINALS ON CAPACITOR C301 IS REMOVED.***

CAUTION

C. Connect ground strap from the plate choke base to the power supply cabinet ground strap with the 9/16 inch base-plate mounting hardware as shown.

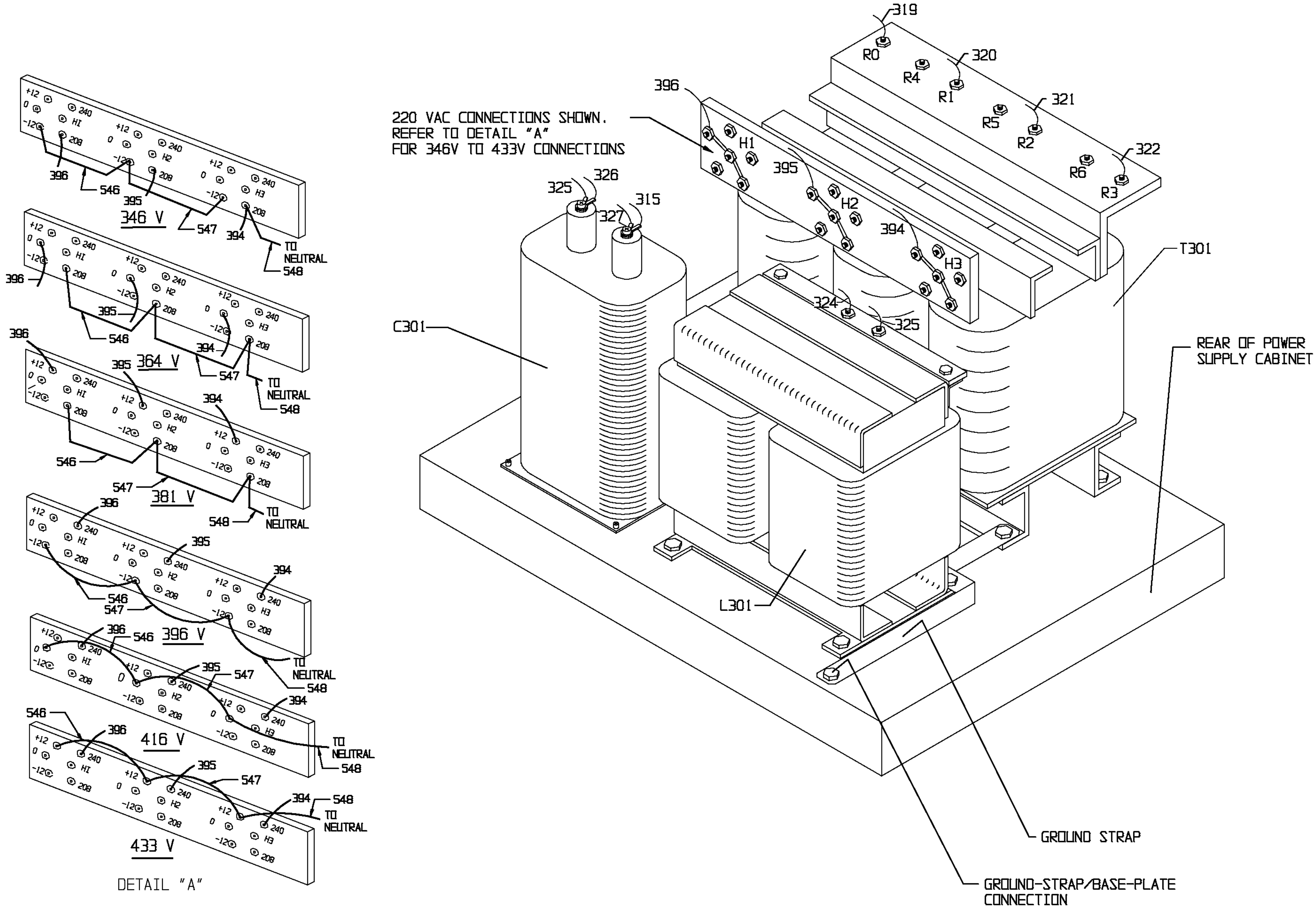

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FIGURE 1. POWER SUPPLY CABINET BASE-PLATE INSTALLATION

D. Remove the jumper wire between the terminals on capacitor C301.

E. Connect the wires to the plate supply transformer, choke, and capacitor as shown.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

1–8. **PA CABINET.** Install components in the PA cabinet as follows.

1–9. **RF Enclosure.** Refer to Figure 2 and install components in the RF enclosure as follows:

A. Insert the chimney assembly in the enclosure as shown.

B. Insert the front section of the cavity shelf into the enclosure as shown. Mount the shelf in place using the brass hardware provided.

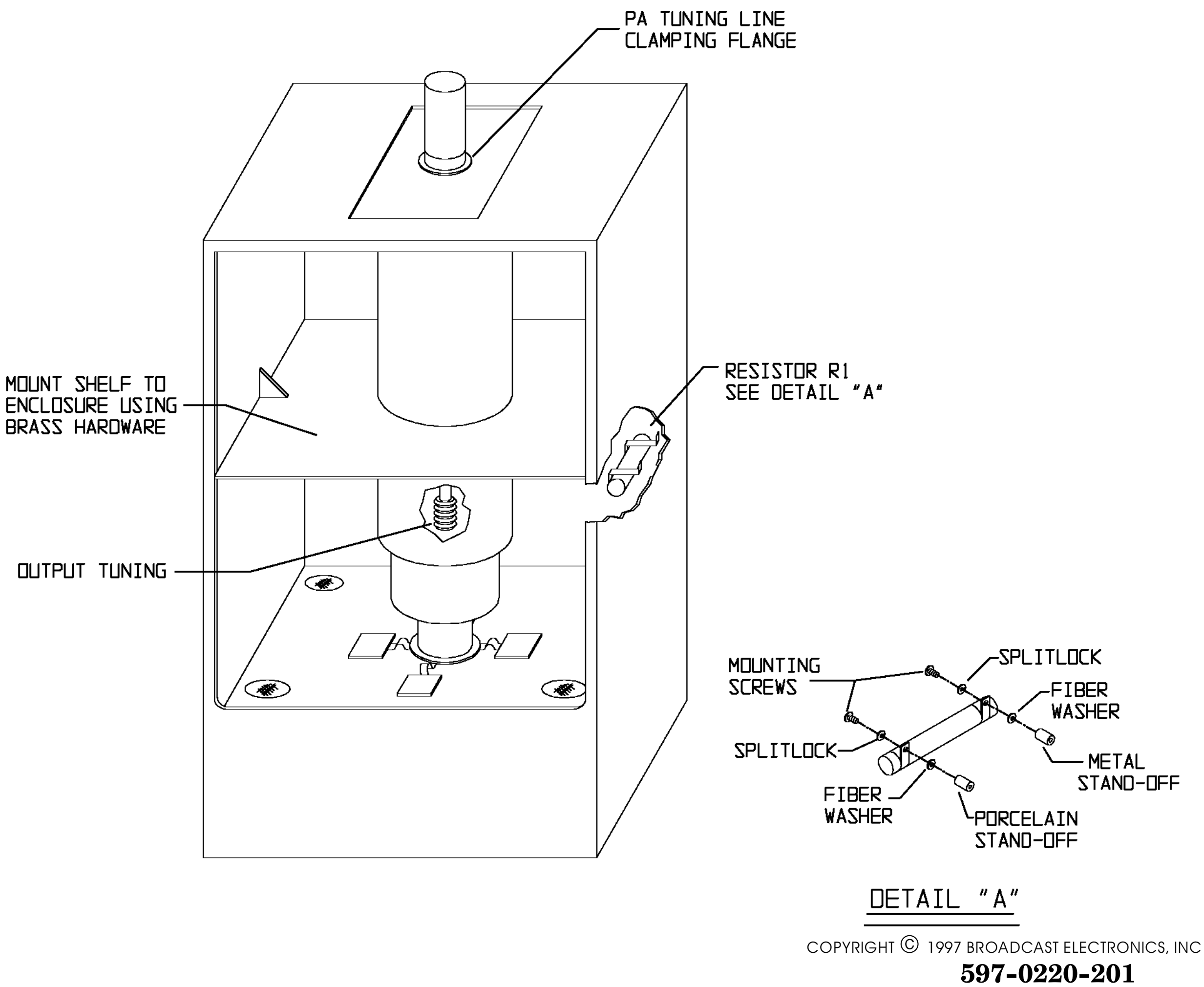

FIGURE 2. RF ENCLOSURE COMPONENT INSTALLATION

1–10. **Cavity Resistor Installation.** Locate the 100 Ohm, 150 watt suppressor resistor in the accessory kit and install R1 in the PA cavity as follows:

A. Refer to detail A in Figure 2 and install R1 using the hardware supplied in the porcelain and metal stand–offs. Ensure the resistor clamp hardware is positioned in relation to the PA cavity wall as indicated.

1–11. **Blower Assembly.** The transmitter blower assembly has been secured to the cabinet rail for shipment. Ensure all shipping materials are removed from the blower assembly.

1–12. **Tuning Line.** Insert the transmitter tuning line into the PA cabinet RF enclosure. Secure the mounting flange with the hardware provided. Attach the tuning cable to the drive assembly on the top of tuning line.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

1–13. **DRIVER CABINET.** Refer to Figure 3 and attach the following cables to the exciter rear–panel receptacles.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

WARNING ***ENSURE THE PA/DRIVER CABINET GROUND STRAPS ARE SECURELY BOLTED TOGETHER.***

WARNING

1–14. **PA/DRIVER CABINET INTERCONNECTIONS.** Refer to Figure 4 and connect the wires between the PA cabinet and the driver cabinet as shown. Ensure the cabinet ground straps are securely bolted together at the location shown.

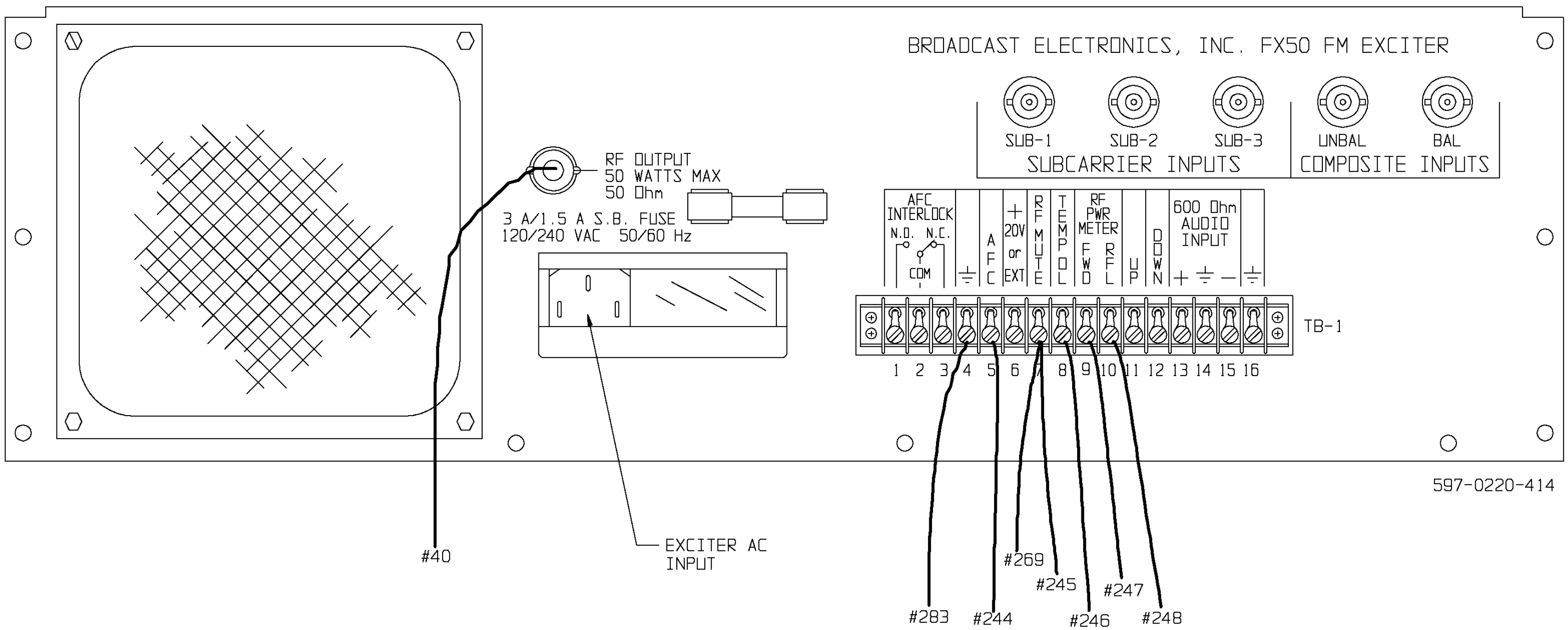

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FIGURE 3. EXCITER INSTALLATION

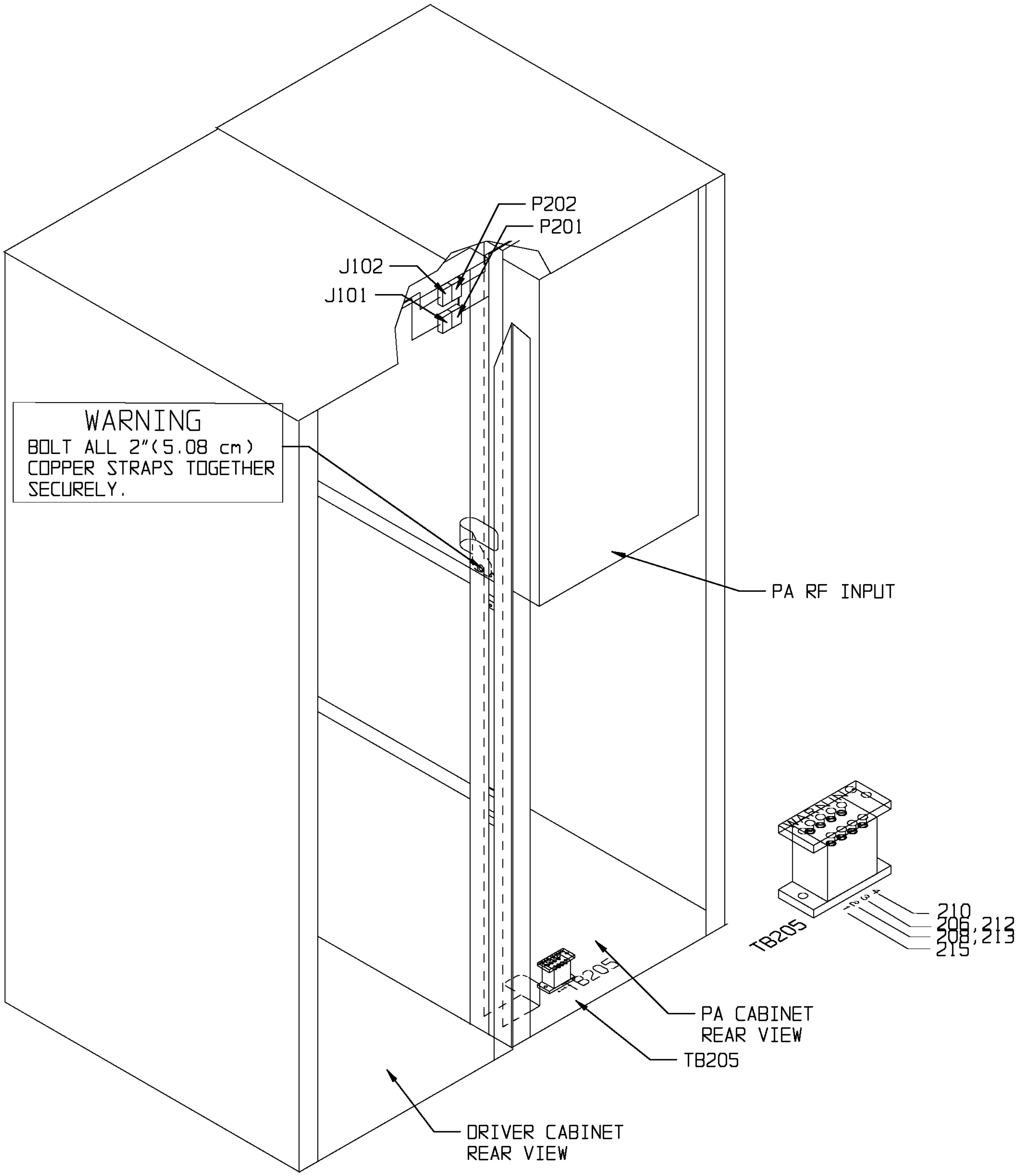

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FIGURE 4. PA/DRIVER CABINET INTERCONNECTIONS

SCOPE OF MANUAL

This manual consists of two sections which provides the following information for the Broadcast Electronics FM–20T FM Broadcast 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 following transmitter modular units.

   1. IPA

   2. TRANSMITTER CONTROLLER

PART I - TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

PART II - TABLE OF CONTENTS

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. Information presented by this section provides a general description of the Broadcast Electronics FM-20T FM transmitter and lists equipment specifications.

1-3. RELATED PUBLICATIONS.

1-4. The following list of publications provides data for equipment associated with the FM-20T and transmitters.

PUBLICATION NUMBER	EQUIPMENT
597-1050	FX-50 FM Exciter
597-0008-004	FC-30 SCA Generator
597-9900	LYNX FM Digital Stereo Generator
597-8000	PREDATOR FM Digital Exciter

1-5. EQUIPMENT DESCRIPTION.

1-6. The Broadcast Electronics FM-20T is a one-tube FM transmitter designed for continuous operation in the 87.5 MHz to 108 MHz broadcast band (refer to Figure 1-1). Specific transmitter features include: a folded half-wave cavity PA stage, a microprocessor control system, a solid-state intermediate-power-amplifier (IPA) unit, and a solid-state exciter with a digital frequency synthesizer.

1-7. The transmitter RF power amplifier, IPA unit, FM exciter, and control circuitry is housed in a single double-cubicle cabinet. The high voltage power supply is housed in a separate cabinet which may be located remotely from the PA/driver cabinet if desired. The following text provides ordering information for various transmitter configurations, optional equipment, and accessories and recommended spare parts kits.

1-8. TRANSMITTER CONFIGURATIONS.

1-9. The FM-20T may be ordered in the following configurations:

FM-20T TRANSMITTER

P/N	DESCRIPTION
909-0020-205	FM-20T Transmitter complete with FX-50 FM Exciter, 208/240V ac three-phase 60 Hz operation, high voltage power supply adjacent to PA/driver cabinet.
909-0020-215	Same as 909-0020-205 less the exciter.
909-0020-385	FM-20T Transmitter complete with FX-50 FM Exciter, 339/437V ac three-phase 50 Hz operation, high voltage power supply adjacent to PA/driver cabinet.
909-0135	Remote Power Supply Cabinet Configuration.

597-0220-1

FIGURE 1-1. FM-20T TRANSMITTER

1–10. **ACCESSORIES AND SPARE PARTS KITS.**

1–11. The following accessory products and spare parts kits are available for use with the FM–20T transmitter.

P/N	DESCRIPTION
909–9000	LYNX FM digital stereo generator.
909–0051–204	FC–30 FM SCA generator.
909–8050	PREDATOR 50 Watt FM Digital Exciter And Digital Input.
909–8051	PREDATOR 50 Watt FM Digital Exciter And Analog Input.
909–8052	PREDATOR 50 Watt FM Analog Exciter And Analog Input.
979–0123–005	Recommended spare parts kit for the FM–20T and FX–50 Exciter.
979–0123–015	Recommended spare parts kit for the FM–20T transmitter only. Does not include exciter spare parts.
979–0124–005	Recommended Semiconductor kit for the FM–20T and FX–50 Exciter.
979–0132–014	Recommended spare HV rectifier kit for the FM–20T transmitter.
907–0016–074	VMC–16 Voice Remote Control Unit, FM–20T

1–12. EQUIPMENT SPECIFICATIONS.

1–13. Refer to Table 1–1 for the electrical specifications and Table 1–2 for the physical and environmental specifications of the Broadcast Electronics FM–20T FM Transmitter.

TABLE 1-1. FM-20T ELECTRICAL CHARACTERISTICS (Sheet 1 of 3)

PARAMETER	SPECIFICATION
RF POWER OUTPUT	7.5 kW to 22 kW Maximum (as specified).
RF FREQUENCY RANGE	87.5 to 108 MHz (as ordered). Exciter programmable in 10 kHz increments.
RF OUTPUT IMPEDANCE	50 Ohms Resistive (others on special request.
RF OUTPUT CONNECTOR	3 1/8 Inch (7.94 cm) EIA Flange.
TUBE COMPLEMENT	8989/4CX12000A (1).

TABLE 1-1. FM-20T ELECTRICAL CHARACTERISTICS
(Sheet 2 of 3)

PARAMETER	SPECIFICATION
MAXIMUM VSWR	1.8 : 1 (will operate into higher VSWR with automatic power reduction).
AM SIGNAL–TO–NOISE RATIO:	
Asynchronous	55 dB below an equivalent reference carrier with 100% AM modulation @ 400 Hz, 75 microsecond deemphasis (no FM modulation present).
Synchronous	50 dB below an equivalent 20 kW reference carrier with 100% AM modulation @ 1 kHz (FM modulation ±75 kHz @ 1 kHz).
FM SIGNAL–TO–NOISE RATIO:	
Mono/Composite	85 dB below ±75 kHz deviation @ 400 Hz measured in a 20 Hz to 30 kHz bandwidth with 75 microsecond deemphasis.
Stereo	80 dB below 100% modulation @ 400 Hz measured in a 20 Hz to 30 kHz bandwidth with 75 microsecond deemphasis.
RF HARMONIC SUPPRESSION	Meets all FCC/DOC Requirements and CCIR Recommendations.
POWER SUPPLY RECTIFIERS	Silicon.
DISTORTION	
Mono/Composite	
Harmonic	0.02% or less @ 400 Hz.
SMPTE Intermodulation Distortion	0.02% or less, 60 Hz/7 kHz, Ratio: 4:1 Monophonic, 1:1 Composite.
CCIF Intermodulation Distortion	0.02% or less, 15 kHz/14 kHz, 1:1 Ratio.
Transient Intermodulation Distortion	0.02% or less, sine wave/square wave.
Stereo	
Harmonic	0.05% or less @ 400 Hz.
SMPTE Intermodulation Distortion	0.05% or less, 60 Hz/7 kHz, 4:1 Ratio.
CCIF Intermodulation Distortion	0.05% or less, 15 kHz/14 kHz, 1:1 Ratio.
Transient Intermodulation Distortion	0.05% or less, sine wave/square wave.

TABLE 1-1. FM-20T ELECTRICAL CHARACTERISTICS
(Sheet 3 of 3)

PARAMETER	SPECIFICATION
STEREO SEPARATION	50 dB or better, 30 Hz to 15 kHz.
DYNAMIC STEREO SEPARATION	50 dB or better, 30 Hz to 15 kHz (normal program content).
LINEAR CROSSTALK (Main to Sub/Sub to Main Due To Phase Matching)	45 dB minimum below 100% modulation, 30 Hz to 15 kHz.
NON-LINEAR CROSSTALK (Main to Sub/Sub to Main Due To Distortion Products)	70 dB minimum below 100% modulation.
AC POWER REQUIREMENTS	196V to 252V ac 50/60 Hz or 339V to 437V ac 50 Hz, Three-Phase Closed-Delta or Wye.
AC POWER CONSUMPTION	30 kW typical at a 20 kW RF output level, 0.97 power factor (includes Exciter).
OVERALL EFFICIENCY	67% typical (AC line input to RF output).
PA EFFICIENCY	80% typical.

TABLE 1-2. FM-20T PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS
(Sheet 1 of 2)

PARAMETER	SPECIFICATION
PHYSICAL	
DIMENSIONS:	
PA/Driver Cabinet	Width: 50.5 Inches (128.3 cm). Height: 70 Inches (177.8 cm). Depth: 31.5 Inches (80.0 cm).
High Voltage Power Supply Cabinet	Width: 28.5 Inches (72.4 cm). Height: 70 Inches (177.8 cm). Depth: 31.5 Inches (80.0 cm).
WEIGHT:	
PA/Driver Cabinet	1200 Pounds (545 kg).
High Voltage Power Supply Cabinet	1500 Pounds (681 kg).
CUBAGE:	
PA/Driver Cabinet	64 Cubic Feet (1.8 m^3).
High Voltage Power Supply Cabinet	36 Cubic Feet (1.0 m^3).

TABLE 1-2. FM-20T PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS
(Sheet 2 of 2)

PARAMETER	SPECIFICATION
LOW-PASS FILTER DIMENSIONS:	
Length	52.12 Inches (132.38 cm).
Diameter	6.13 Inches (15.57 cm).
ENVIRONMENTAL	
AMBIENT TEMPERATURE RANGE	+14°F to +122°F (-10°C to +50°C).
MAXIMUM ALTITUDE	
60 Hz Models	0 to 10,000 Feet above sea level (0 to 3048 Meters).
50 Hz Models	0 to 7,500 Feet above sea level (0 to 2286 Meters).
MAXIMUM HUMIDITY	95%, Non-Condensing.
HEAT DISSIPATION:	
Driver Cabinet	1 kW Maximum (3416 Btu/h).
PA Cabinet	13 kW Maximum (44,450 Btu/h).
Power Supply Cabinet	2 kW Maximum (6838 Btu/h).
COOLING AIR REQUIREMENTS:	
PA Cabinet	810 Cubic Feet Per Minute (23.0 m^3/min).
Driver Cabinet	500 Cubic Feet Per Minute (14.15 m^3/min).

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information required for the installation and preliminary checkout of the Broadcast Electronics FM-20T Transmitter.

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. INSTALLATION REQUIREMENTS.

2-7. ENVIRONMENTAL.

2-8. Table 1-2 provides environmental conditions which must be considered prior to transmitter installation.

2-9. COOLING AIR.

2-10. If outside air is to be used to cool the transmitter, the air inlet duct must be designed to allow adequate air flow. The air must be dry and well filtered. If intake louvers are used, operation of the louvers must be electrically interlocked with the transmitter operation.

2-11. 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 a minimum air flow of 810 cubic feet of air per minute (23.0 m^3/min) from the PA cabinet and 500 cubic feet of air per minute (14.15 m^3/min) from the driver cabinet. An exhaust fan may be used to boost the flow of heated air from the transmitter but must be capable of exhausting 1310 cubic feet of air per minute (37.15 m^3/min) as a minimum rating.

2-12. As a minimum requirement, any ducting must have a cross-sectional area equal to the exhaust area of the PA cabinet plus the exhaust area of the driver 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.

2-13. PRIMARY POWER.

2-14. The FM-20T transmitter is designed for operation from a closed-delta or wye connected three-phase power source. Operation from an unsatisfactory power source will void the warranty on the transmitter as any resultant damage is beyond the control of the manufacturer. Before attempting installation of the transmitter, assure that the proper power source is installed. Acceptable power input configurations are shown in Figure 2-2.

2–15. An open–delta, V to V, T to T, T to L, or Scott connected power source will provide unsatisfactory transmitter performance as transients and unstable power can damage components of the transmitter and provide degraded specifications. Any of these systems will develop a considerable imbalance between phases in voltage, phase angle, or both voltage and phase angle. These problems can result in premature failure of power supply and RF circuit components.

2–16. It is important that the local electric utility be consulted to ensure that the correct service is provided before connection of the transmitter to a primary power source. The proper power source can be readily identified by the use of three transformers with one winding each or one transformer with three windings instead of the use of two transformers as required for the unacceptable configurations.

2–17. INSTALLATION.

2–18. 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) wiring, and 5) initial checkout.

2–19. EQUIPMENT PLACEMENT.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

2–20. The FM–20T transmitter is designed for two types of installations: 1) adjacent high voltage power supply cabinet installation or 2) remote high voltage power supply cabinet installation. If the cabinets are positioned apart, access holes in the top of the cabinets allow overhead routing of interconnecting wiring (see Figure 2–1).

2–21. Regardless of the type of installation, the floor must be capable of supporting the total transmitter weight. Also, the floor support should be more than marginal to maintain the proper alignment of the cabinets and reduce vibration.

2–22. After determining the position of the cabinets, place the PA and driver cabinets in the desired location as a single unit on a smooth and level surface. Remove the shipping skid bolts (located under the bottom of the skid) and lift the PA/Driver cabinets from the skid.

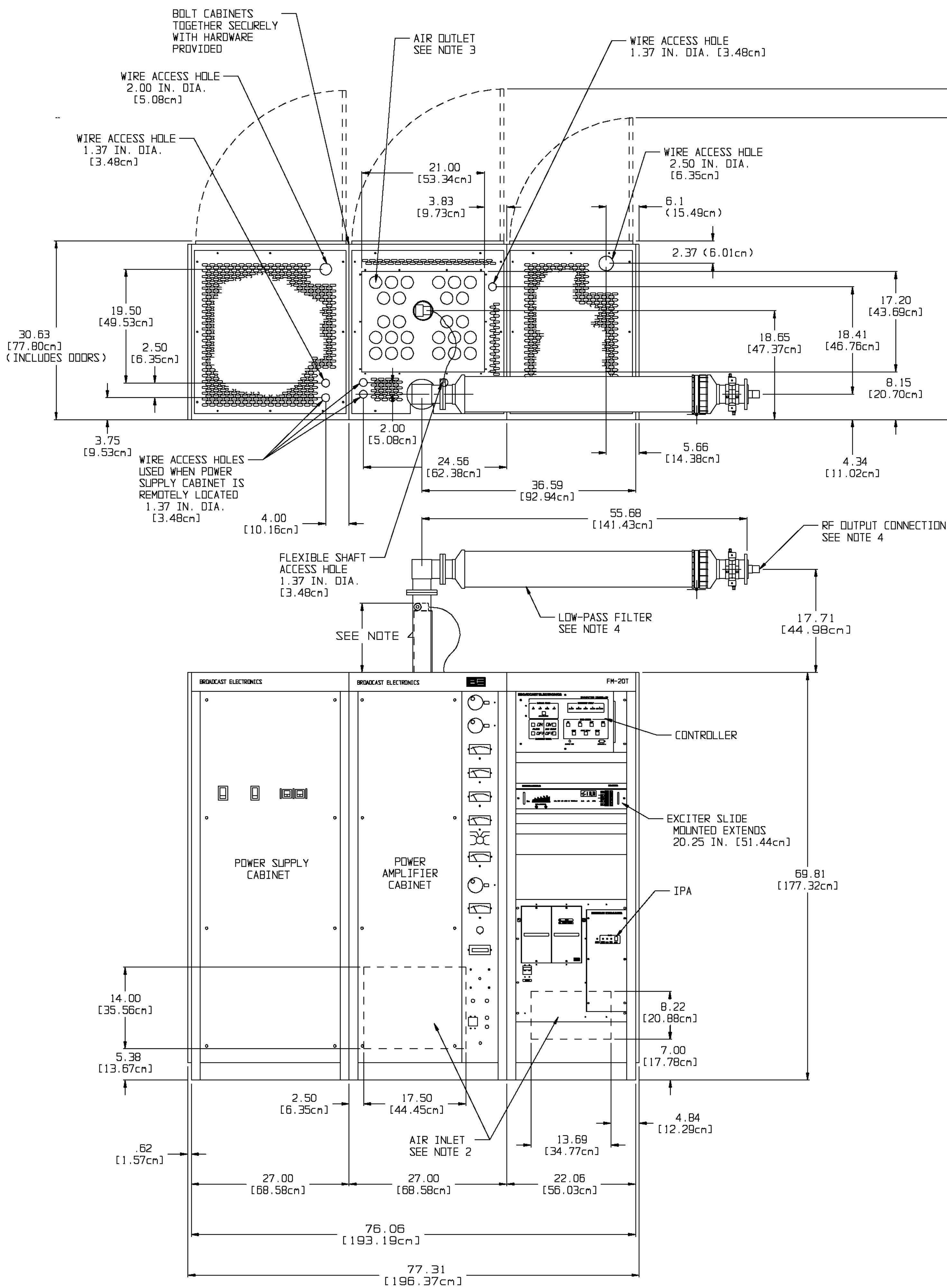
2–23. Remove the rear access door and the left side panel from the high voltage power supply cabinet. The rear access door may simply be lifted off the hinges. The left side panel is secured by two No. 2 Phillips head screws in the top mounting rail. After the two screws are removed, the side panel may be lifted up and off the rack.

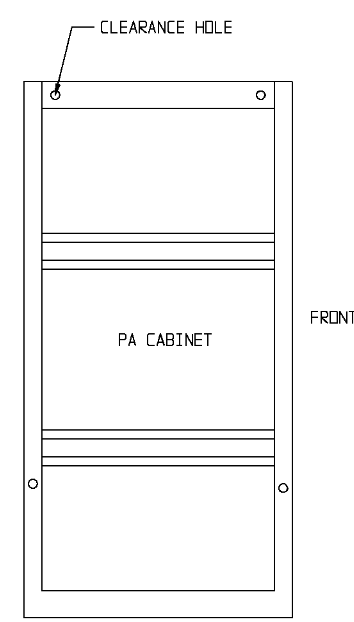
2–24. Move the power supply cabinet to the desired location using a fork–lift if one is available (refer to Figure 2–3) and remove the shipping skid. After the skid is removed from the cabinet, slide the cabinet to the final location.

2–25. If the power supply is positioned adjacent to the PA cabinet, adjust and secure the cabinets as follows:

A. Bolt the power supply cabinet to the PA cabinet through the side rails with the connecting hardware provided. A 7/16 inch open end–box end wrench and a ratchet with a 7/16 inch socket and short extension is required.

B. Check the bolts securing the PA cabinet to the driver cabinet to ensure all three cabinets are securely bolted together.





DETAIL "A"

CABINET BOLTING INSTRUCTIONS

1. REMOVE THE POWER SUPPLY CABINET FRONT PANEL.
2. REFER TO DETAIL "A" FOR THE LOCATION OF FOUR HOLES. POSITION THE PA CABINET UNTIL IDENTICAL HOLES IN THE POWER SUPPLY CABINET ARE ALIGNED.
3. USING THE 1/4-20 HARDWARE PROVIDED SECURE THE CABINETS TOGETHER. THE BOLTS SHOULD BE INSTALLED FROM THE POWER SUPPLY CABINET INTO THE PA CABINET.
4. REPLACE THE FRONT-PANEL ON THE POWER SUPPLY CABINET.

NOTES:

1. POWER SUPPLY CABINET MAY BE LOCATED REMOTELY FROM THE PA/DRIVER CABINET IF DESIRED. 30 FEET (9.14 m) STANDARD.
2. AIR INLET:
   1. LOCATION: PA CABINET REAR-PANEL
      DIMENSIONS:
      WIDTH: 17.5 INCHES (44.45 cm)
      HEIGHT: 14.0 INCHES (35.56 cm)
      FILTER: 16 INCHES X 20 INCHES X 1 INCH NOMINAL. BEI P/N 407-0062.
   2. LOCATION: DRIVER CABINET REAR-PANEL
      DIMENSIONS:
      WIDTH: 13.69 INCHES (34.77 cm)
      HEIGHT: 8.22 INCHES (20.88 cm)
      FILTER: 16 INCHES X 20 INCHES X 1 INCH NOMINAL. BEI P/N 407-0062.
3. AIR OUTLET:
   DESCRIPTION: PRIMARY - TOP OF PA CABINET
   SECONDARY - TOP OF DRIVER AND POWER SUPPLY CABINETS
4. RF OUTPUT ASSEMBLY:
   CONNECTION: 3.125 INCH EIA 50 OHM MALE FIELD FLANGE.
   LOW-PASS FILTER (BEI P/N 339-0022):
   DIMENSIONS:
   LENGTH: 52.12 INCHES (132.38cm)
   DIAMETER: 6.13 INCHES (15.57 cm)
   MOUNTING: MECHANICAL SUPPORT REQUIRED EXTERNAL TO TRANSMITTER.
   WEIGHT: 65 POUNDS (29.48 kg)
   TUNING LINE HEIGHT (DETERMINED BY TRANSMITTER FREQUENCY):
   MAXIMUM: 17.0 INCHES (43.18 cm) @ 108 MHz
   MINIMUM: 5.0 INCHES (12.7 cm) @ 88 MHz
5. CUBAGE:
   PA/DRIVER CABINET: 64 CUBIC FEET (1.8m^3)
   POWER SUPPLY CABINET: 36 CUBIC FEET (1.0m^3)
6. WEIGHT:
   PA/DRIVER CABINET: 1200 POUNDS (545 kg)
   POWER SUPPLY CABINET: 1500 POUNDS (681 kg)
7. COOLING AIR REQUIREMENTS:
   PA CABINET: 810 CUBIC FEET PER MINUTE (23 m^3/min)
   DRIVER CABINET: 500 CUBIC FEET PER MINUTE (14.2 m^3/min)
   POWER SUPPLY CABINET: NATURAL CONVECTION
8. AC INPUT REQUIRMENTS:
   196V TO 252V ac 50/60 Hz OR 339V TO 437 ac 50 Hz, THREE-PHASE CLOSED-DELTA OR WYE, 200 AMPERES PER PHASE MAXIMUM. FUSED DISCONNECT RECOMMENDED.
9. HEAT DISSIPATION:
   20 kW OUTPUT: 10 kW (34,130 BTU/H)
10. POWER CONSUMPTION:
   30.0 kW FOR A 20 kW OUTPUT, 0.97 POWER FACTOR

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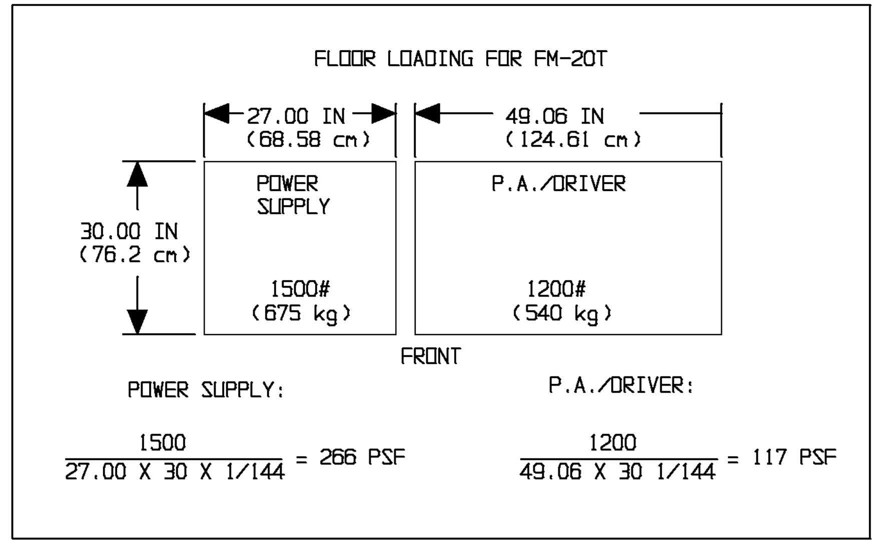
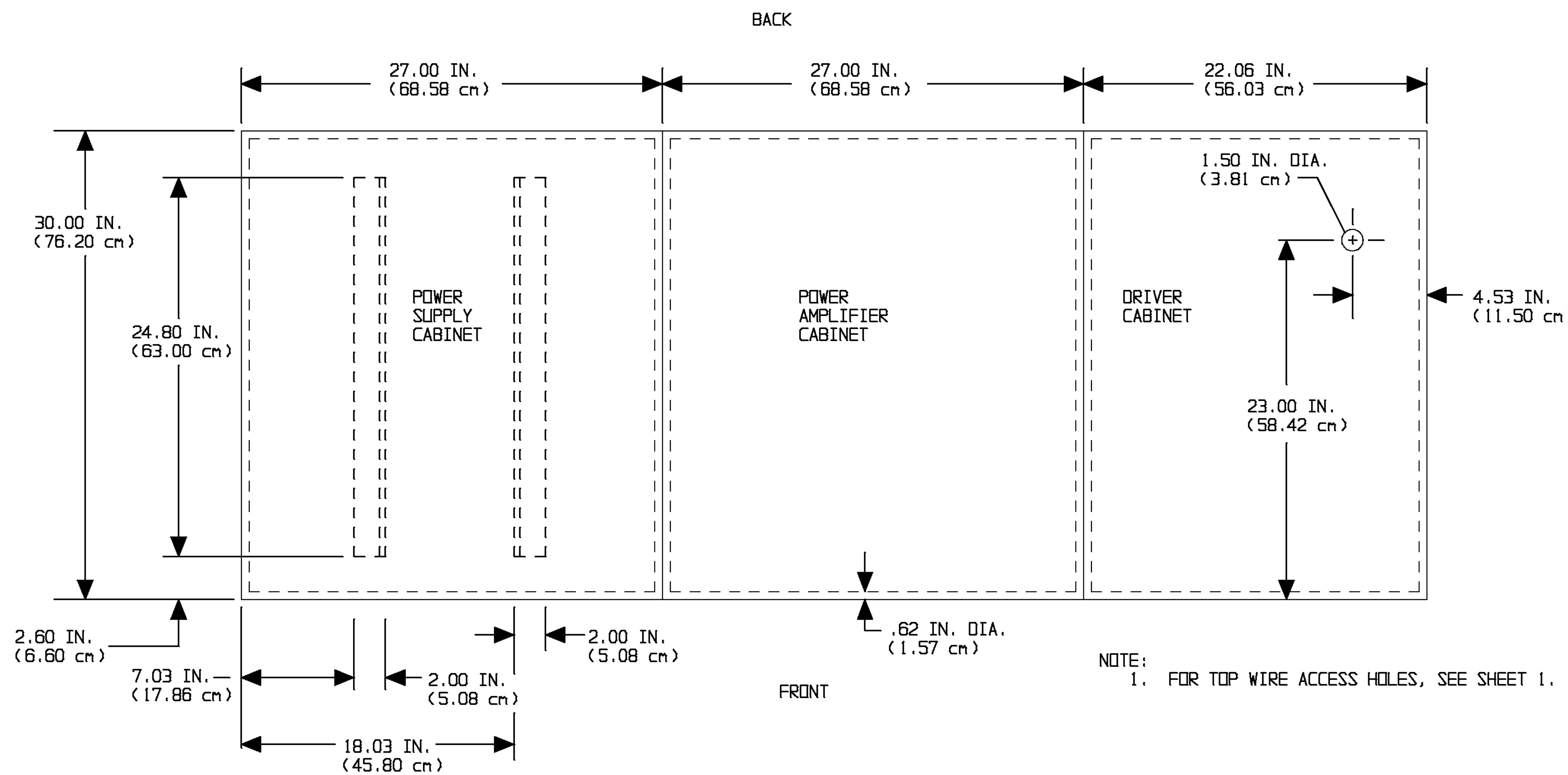
FIGURE 2-1. FM-20T/ TRANSMITTER INSTALLATION (Sheet 1 of 2)





FM-20T BASE OUTLINE

597-0220-401A

FIGURE 2-1. FM-20T/ TRANSMITTER INSTALLATION (Sheet 2 of 2)

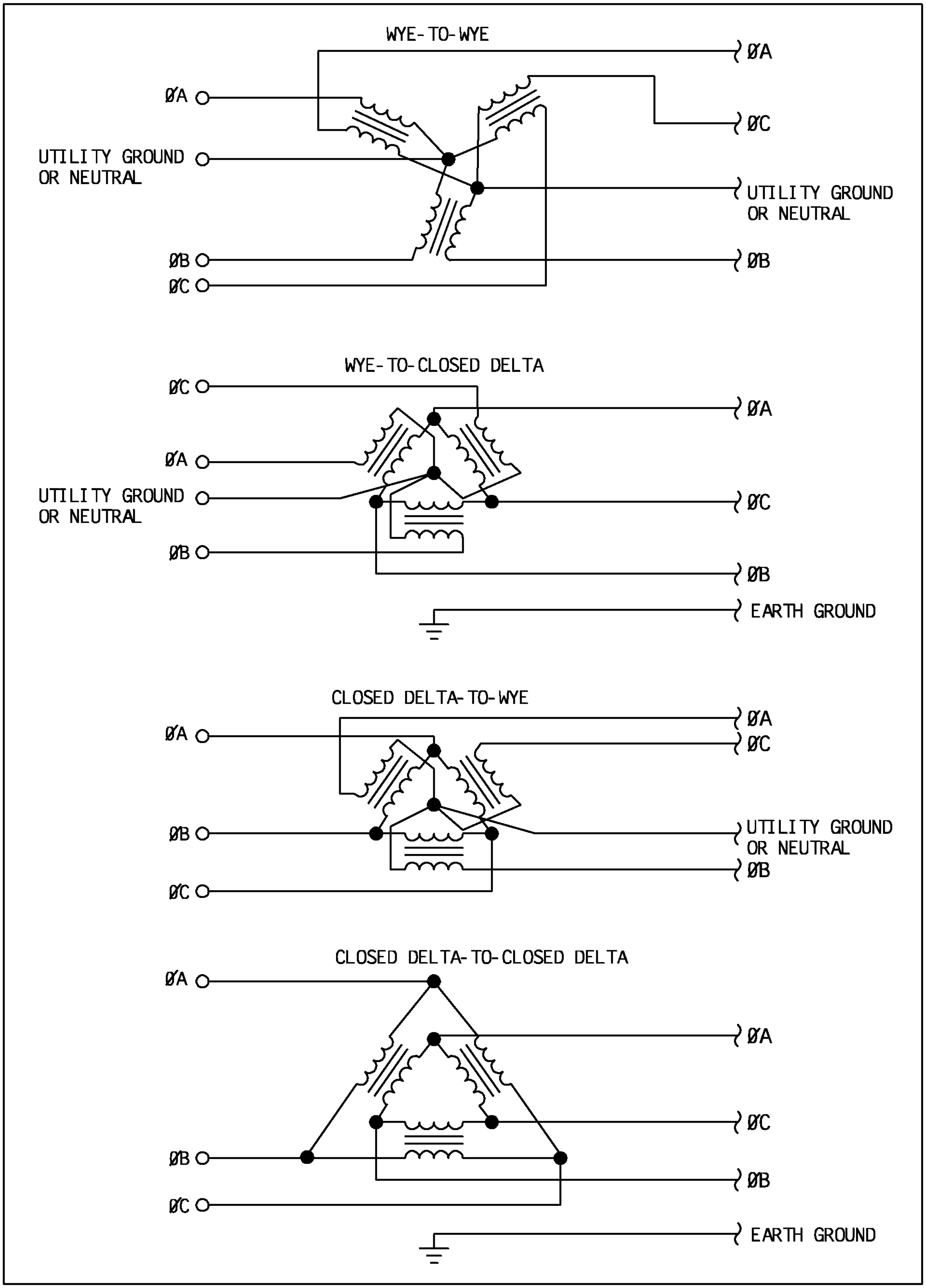


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FIGURE 2-2. ACCEPTABLE AC POWER INPUT CONFIGURATIONS

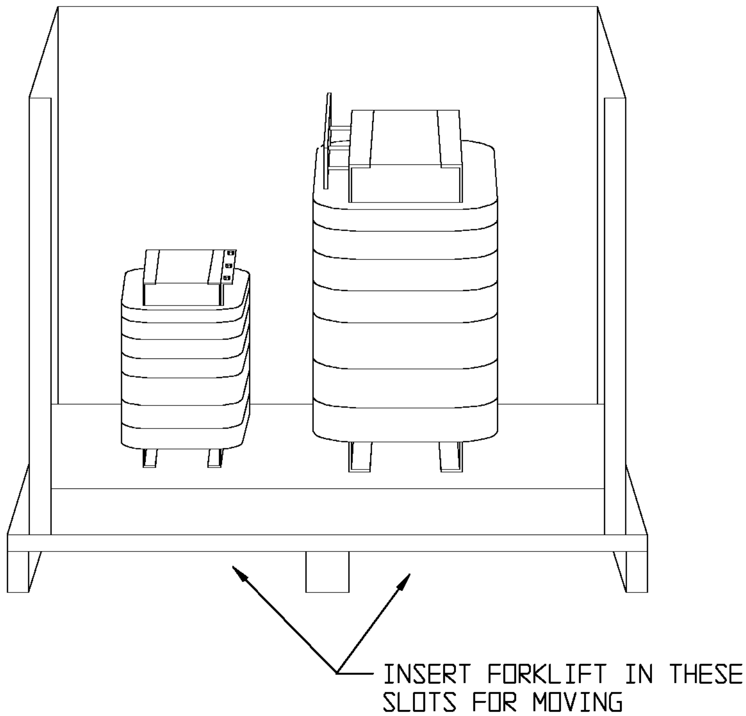

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FIGURE 2-3. POWER SUPPLY CABINET PLACEMENT

2–26. COMPONENT INSTALLATION.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

2–27. To facilitate component installation and wiring, the rear door of the driver cabinet, the rear door and the lower front access panel of the PA cabinet, and the rear door and left side panel of the power supply cabinet should be removed and remain off until installation is complete.

2–28. Interconnecting wires and cables are tied in for shipment. Remove all tape, wire ties, string, and packing material used for shipment.

2–29. Cables, connectors, and miscellaneous components to be installed are shipped in separate containers. The following text provides information concerning the installation of these items. Ensure the transmitter adjustments are not moved from the factory preset positions.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

2–30. **HIGH VOLTAGE POWER SUPPLY CABINET.** Unpack components located in the high voltage power supply cabinet as follows.

2–31. Unwrap the grounding stick and place the stick on the interlocked hanger. Ensure the wire tie securing the grounding stick interlocked hanger switch is removed.

2–32. Unwrap the interlock connector (if the cabinets are positioned together) or the interlock cable (if the cabinets are positioned apart).

2–33. Unwrap the PA/driver cabinet ac power cable harness which is coiled inside the high voltage cabinet.

2–34. Connect the high voltage power supply 9300V/4650V half–voltage jack to the 9300V receptacle.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

2–35. **DRIVER CABINET.** Unpack, check, and install components located in the driver cabinet as follows.

2–36. **Controller.** Two coaxial cables shipped inside the PA/Driver cabinet connect to the controller as follows:

	- FROM -	**- TO -**
CABLE NO.	**OUTPUT TRANSMISSION LINE DIRECTIONAL COUPLER**	**CONTROLLER**
305	VSWR port	J10 RFL PWR RF SAMPLE
304	FWD port	J9 FWD PWR RF SAMPLE

2–37. **FX-50 Exciter.** Remove the slide retainers from the FX–50 exciter.

2–38. Loosen the exciter front–panel turn–lock fasteners and pull the exciter forward.

2–39. Loosen the eight turn–lock fasteners on the top of the exciter and remove the top cover.

2–40. Remove any packing material from the inside of the exciter.

2–41. Ensure the **POS-MUTE-NEG** switch on the power supply/control circuit board is operated to POS.

2–42. Ensure the **AUTO-PWR-MAN** switch on the power supply/control assembly is operated to AUTO and the **NORM-EXT** switch is operated to NORM.

2–43. Refer to the final test data sheets shipped with the exciter and ensure the AFC/PLL assembly SYNTHESIZER FREQUENCY SELECTION switches are correctly positioned.

2–44. Remove the two shipping screws securing the modulated oscillator assembly, and allow the unit to float on its mountings.

2–45. Replace the top cover on the exciter and secure the eight turn–lock fasteners on the top of the cover.

2-46. **IPA Unit.** The RF power module is installed in RF power module location 2. To install the RF module, proceed as follows:

CAUTION *THE TRANSMITTER MAY BE DAMAGED IF THE RF POWER MODULE IS NOT SECURELY SEATED INTO THE MOTHERBOARD CONNECTORS.*

CAUTION

CAUTION *THE RF POWER MODULE IS EQUIPPED WITH REAR-PANEL MOUNTED CONNECTORS. TO PREVENT DAMAGE TO THE CONNECTORS, INSERT/REMOVE THE MODULE CAREFULLY AND DO NOT PLACE THE MODULE ON THE REAR-PANEL.*

CAUTION

1. Locate the RF power module.
2. Refer to Figure 2-4 and align the RF power module with the guides in the RF power module 2 location.
3. Insert and firmly press the RF power module into the motherboard connectors.
4. Secure the RF power module mounting hardware. The mounting hardware must be secure to ensure the RF power is properly seated in the connectors.

2-47. **Optional Equipment.** Refer to the stereo generator and SCA generator manuals and complete any applicable checks or programming included in INSTALLATION.

WARNING *ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.*

WARNING

2-48. **PA CABINET.** Unpack, check, and install components located in PA cabinet as follows.

2-49. **RF Enclosure.** Open the PA cavity access door.

2-50. Disconnect the plate-line B+ banana plug along the left side of the plate-line.

2-51. Remove all tape and packing shims from the plate-line at the cavity shelf to free the plate-line. Align the plate-line pins with the notches in the cavity shelf and raise the plate-line to allow the pins to travel up through the cavity shelf notches. Once the plate-line pins are above the cavity shelf, rotate the plate-line to lock the plate-line in the up position.

2-52. Carefully remove all packing material from over the tube socket.

2-53. Carefully install the PA tube with a steady downward pressure. Do not rotate or rock the tube during installation to prevent damage to the tube socket.

2-54. After the PA tube is fully seated, align the plate-line pins with the cavity shelf notches and lower the plate-line. Align the: 1) high-voltage plate line connection and 2) long-tapered plate-line shims with the cavity shelf notches. Once the high-voltage connection and shims are aligned, lower the plate-line over the tube until the plate-line shims engage the shelf notches.

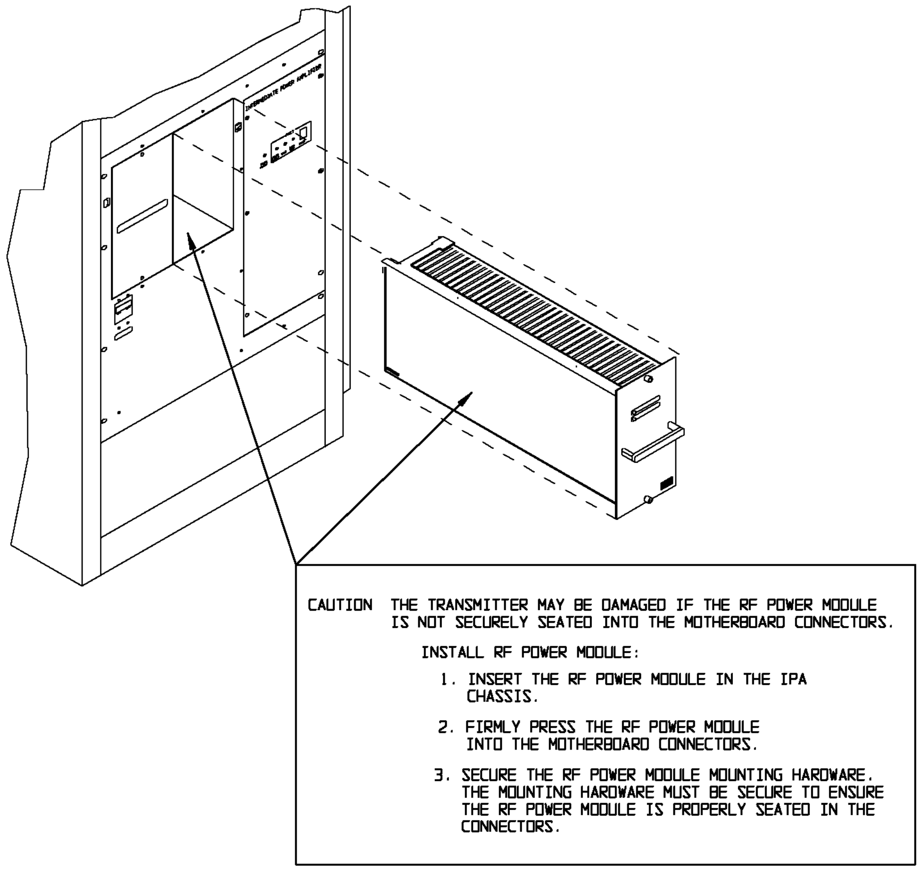

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FIGURE 2-4. IPA UNIT RF POWER MODULE INSTALLATION

2-55. Reconnect the plate RF choke banana plug to the plate-line. Ensure all connections are secure.

2-56. Secure the plate-line to the tube with the strap clamp. The plate-line must not move from the PA tube when upward pressure is applied. A flat-blade screwdriver with a 1/4 inch (0.64 cm) tip is required.

2-57. Close and secure the PA cavity access door.

2-58. Assure the second harmonic suppressor on the left side panel of the PA cavity is adjusted to the factory preset line scribed on the adjustment rod. If adjustment is required, loosen the lock screws and adjust the suppresser as required. Do not rotate the suppresser during adjustment. A 1/16 inch (1.59 mm) hex wrench is required for adjustment.

NOTE ***ENSURE THE TRANSMITTER COARSE TUNING IS ADJUSTED IN THE THE FOLLOWING STEP.***

NOTE

2-59. Adjust the transmitter coarse tuning as follows:

A. On the top of the PA cabinet, loosen the PA tuning line clamp.

B. Raise the PA tuning line until the factory scribed line is aligned with the top of the cavity clamping flange. Ensure the tuning line is perpendicular to the top surface of the cabinet. Secure the tuning line to the flange with the strap clamp.

CAUTION ***TO PREVENT INCREASED HARMONIC OUTPUT LEVELS AND EFFICIENCY DEGRADATION, ASSEMBLE THE TRANSMITTER OUTPUT LINE AS DESCRIBED IN THE FOLLOWING TEXT WITH THE COMPONENTS SUPPLIED BY THE FACTORY. DO NOT INSTALL ADDITIONAL TRANSMISSION LINE SECTIONS BETWEEN THE CAVITY OUTPUT PORT AND THE LOW-PASS FILTER.***

CAUTION

CAUTION

CAUTION

2-60. **RF Output Line Assembly.** Refer to Figure 2-5 and the following information to assemble the transmitter RF output transmission line. Assemble the RF output line as described with the components supplied by the factory. Do not install additional transmission line sections between the cavity output port and the low-pass filter. Incorrect assembly may result in increased harmonic output levels and efficiency degradation.

2-61. Locate the RF transmission line inner and outer conductors, elbow assembly, and low-pass filter assembly.

2-62. Access the PA cavity output connection by removing the PA cabinet eight front panel mounting screws.

2-63. Insert the transmission line inner conductor from the top, down onto the bullet connector in the lower transmission line elbow until the inner conductor is fully seated.

2-64. Insert the transmission line outer conductor from the top, down into the transmission line coupler until the outer conductor is fully seated. Secure the coupler strap clamps. A flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.64 cm) tip is required.

2-65. Loosen the strap clamp on the transmission line and insert the clamp into the transmission line upper support L-bracket.

2-66. Secure the transmission line strap clamp. A flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.64 cm) tip is required.

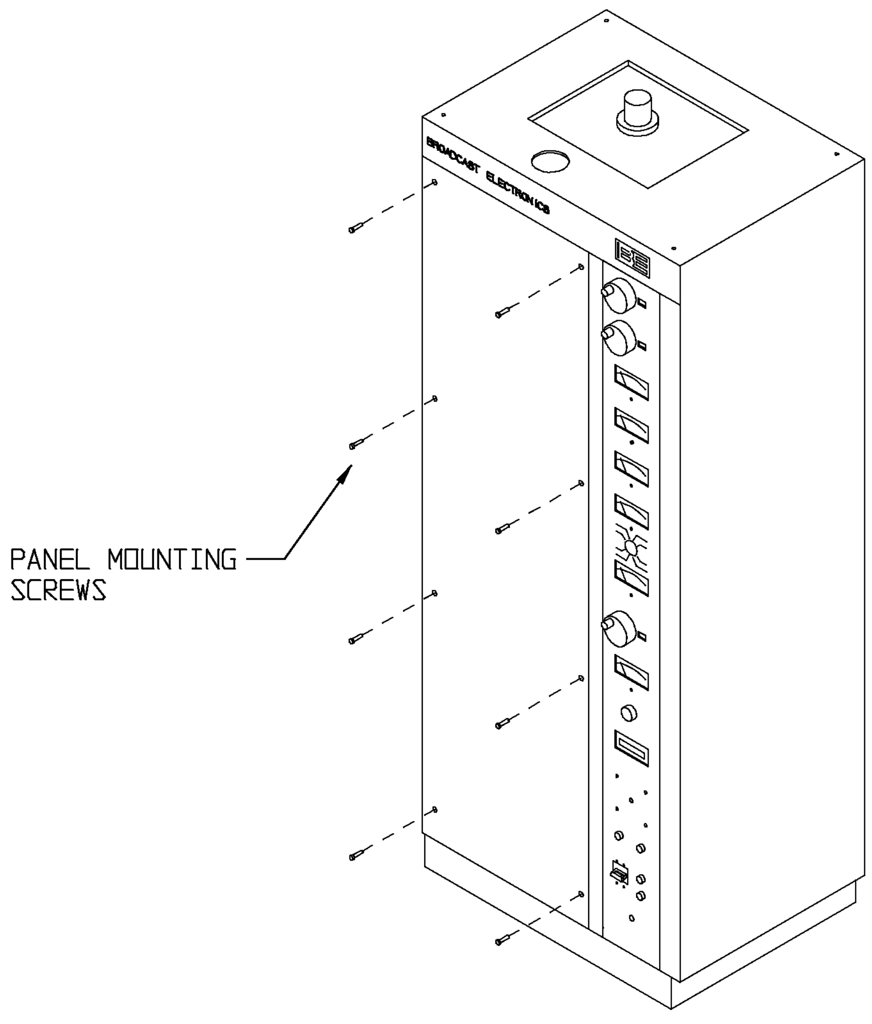
2-67. On a work surface, assemble the elbow with the monitor jack, the elbow inner conductor, a bullet conductor and insulator, and one unflanged transmission line coupling. Position the monitor receptacle either horizontally or vertically by reversing the elbow as required.

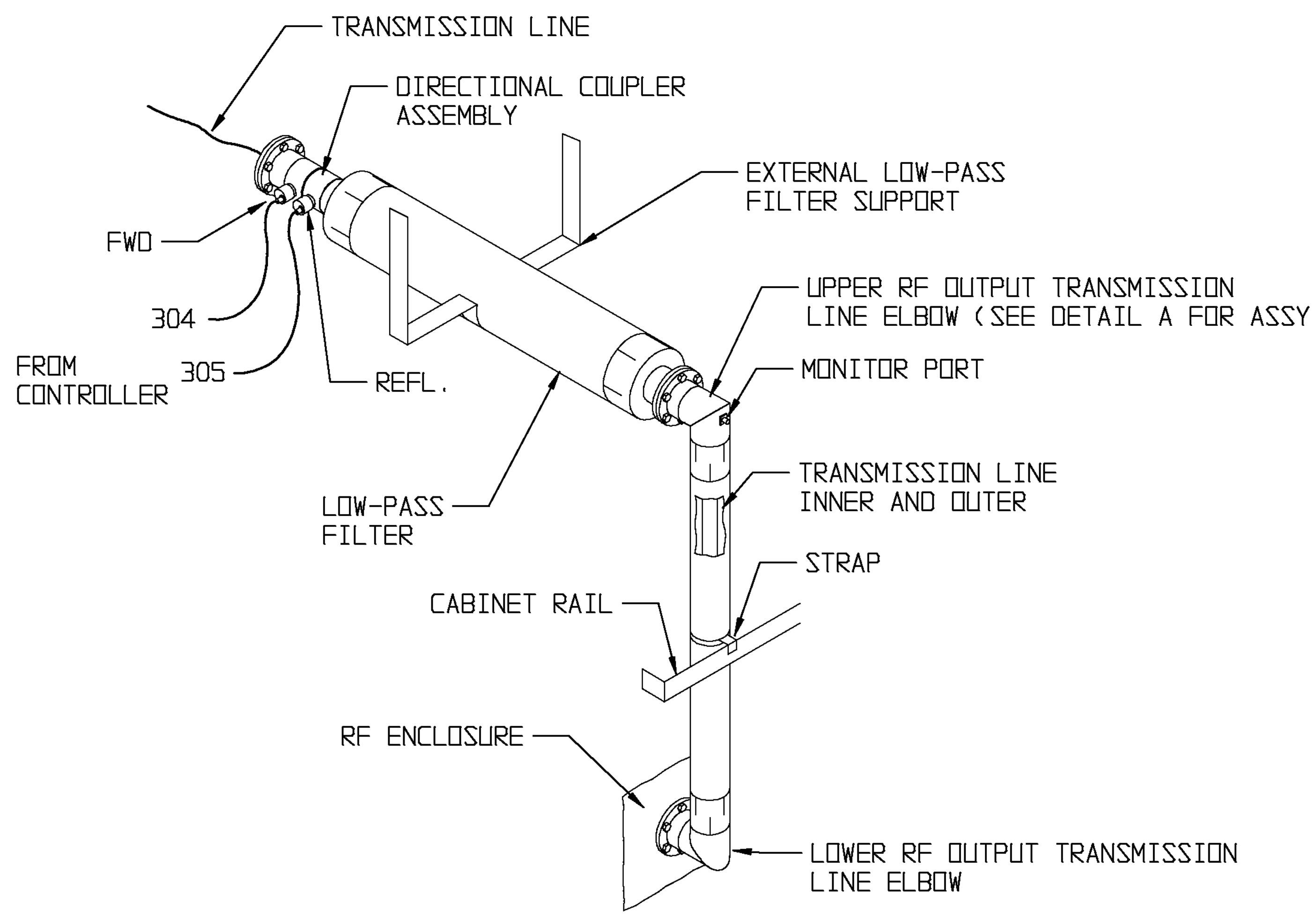
2-68. Ensure all parts of the assembly are fully seated, then secure the assembly together with a strap clamp using a flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.64 cm) tip.

2-69. Mount the entire elbow assembly on top of the transmission line. When the assembly is fully seated, position the elbow as desired and secure the elbow strap clamp using a flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.64 cm) tip.

2-70. Locate the 3 1/8 flanged coupling and bolt the coupling to the low-pass filter input as shown. The flange is secured with six bolts, six lockwashers, and six nuts.

2-71. Insert a bullet connector and insulator into the 3 1/8 inch (7.94 cm) flange.





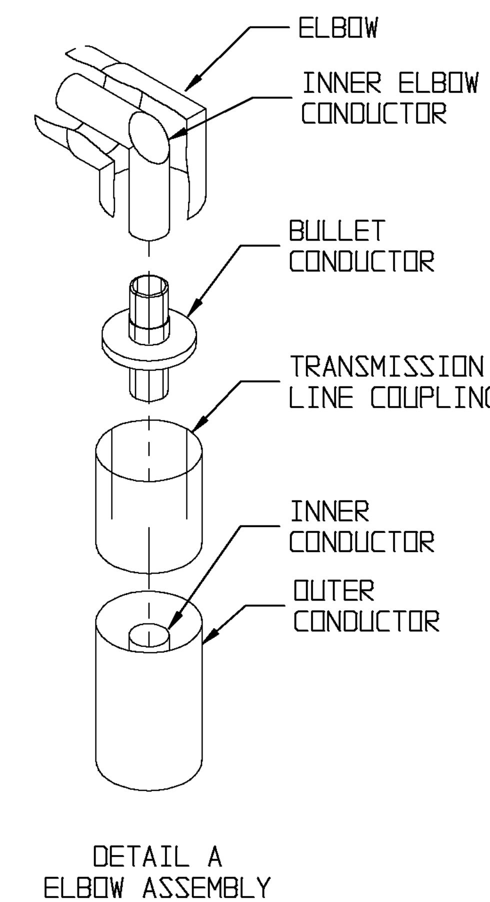


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FIGURE 2-5. FM-20T RF OUTPUT TRANSMISSION LINE ASSEMBLY

CAUTION ***THE TRANSMITTER WILL NOT SUPPORT THE WEIGHT OF THE LOW-PASS FILTER ASSEMBLY. MECHANICAL SUPPORT EXTERNAL TO THE TRANSMITTER IS REQUIRED.***

CAUTION

2-72. Using mechanical support external to the transmitter, insert the low-pass filter assembly directly into the transmission line elbow as shown. Secure the coupling to the elbow with the strap clamp.

2-73. Connect the controller and monitor coaxial cables to the assembly as follows:

A. Connect controller forward power cable 304 to the ⇒ (FWD) port on the directional coupler.

B. Connect controller VSWR cable 305 to the ⇐ (RFL) port on the directional coupler.

C. Connect the station monitor cable to the monitor port on the output line assembly.

2-74. After assembling the RF output transmission line, secure the front panel. Bolt the antenna transmission line to the low-pass filter. The flange is secured with six bolts, six lockwashers, and six nuts.

2-75. **PA Cabinet Grounding Stick.** Unpack the PA cabinet grounding stick located in the rear of the cabinet and insert the stick in the interlocked clips provided on the blower assembly.

2-76. REMOTE CONTROL.

2-77. The FM-20T transmitter is designed for complete remote control operations (refer to Figure 2-6). The transmitter will interface with almost any remote control unit such as the Broadcast Electronics VMC-16 Voice Remote Control System. The following text presents a description of the FM-20T remote control functions and indications. The remote control connections are located on the transmitter remote interface panel (refer to Figure 2-6).

2-78. The transmitter controller allows the selection of positive or negative control logic. Positive/negative control is determined by header J6 on the controller main circuit board assembly. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to activate the function. Negative control requires the use of a momentary contact to ground to activate the function. The transmitter controller is factory programmed for positive remote control operations.

2-79. The remote meter outputs can be configured for: 1) +2/+4 volt dc full-scale indications and 2) a log or linear format. +2/+4 volt dc full-scale programming is determined by headers J10 through J12 on the controller main circuit board. The log/linear control is determined by header J8 pins 15-16 on the controller main circuit board. Refer to Figure 2-6 and the following text to connect remote control equipment to the transmitter.

2-80. **Remote APC On Control.** The APC (automatic-power-control) on function is located at TB1-1. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to enable APC operation. Negative control requires the use of a momentary contact to ground to enable APC operation.

2-81. **Remote Filament On Control.** The filament on function is located at TB1-2. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to enable the filaments. Negative control requires the use of a momentary contact to ground to enable the filaments.

TB1 PIN DESCRIPTIONS

PIN	NAME	DESCRIPTION
1	APC ON COMMAND	* AUTOMATIC POWER CONTROL ON CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO OPERATE APC ON. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO OPERATE APC ON.
2	FILAMENT ON COMMAMND	* FILAMENT ON CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO ENABLE THE FILAMENTS. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO ENABLE THE FILAMENTS.
3	FILAMENT OFF COMMAND	* FILAMENT OFF CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO DISABLE THE FILAMENTS. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO DISABLE THE FILAMENTS.
4	HIGH VOLTAGE ON COMMAND	* HIGH VOLTAGE ON CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO ENABLE THE HIGH VOLTAGE. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO ENABLE THE HIGH VOLTAGE.
5	HIGH VOLTAGE OFF COMMAND	* HIGH VOLTAGE OFF CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO DISABLE THE HIGH VOLTAGE. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO DISABLE THE HIGH VOLTAGE.
6	RAISE PA PWR COMMAND	* TRANSMITTER RAISE POWER CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO RAISE TRANSMITTER POWER. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO RAISE TRANSMITTER POWER.
7	LOWER PA PWR COMMAND	* TRANSMITTER LOWER POWER CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO LOWER TRANSMITTER POWER. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO LOWER TRANSMITTER POWER.
8	PRESET PA PWR COMMAND	* PRESET POWER ON CONTROL POSITIVE CONTROL - SUSTAINED CONTACT TO +5 TO +15VDC REQUIRED TO ENABLE PRESET POWER. NEGATIVE CONTROL - SUSTAINED CONTACT TO GROUND REQUIRED TO ENABLE PRESET POWER.
9	OVERLOAD RESET COMMAND	* OVERLOAD RESET CONTROL POSITIVE CONTROL - MOMENTARY CONTACT TO +5 TO +15VDC REQUIRED TO RESET THE OVERLOAD CIRCUIT. NEGATIVE CONTROL - MOMENTARY CONTACT TO GROUND REQUIRED TO RESET THE OVERLOAD CIRCUIT.
10	NO CONNECTION	
11	NO CONNECTION	
12	NO CONNECTION	
13	NO CONNECTION	
14	NO CONNECTION	
15	APC ON STATUS	APC ON INDICATION. LOW (0 VDC) WHEN ACTIVE
16	FILAMENT ON STATUS	FILAMENT ON INDICATION. LOW (0 VDC) WHEN ACTIVE
17	REMOTE DISABLE STATUS	REMOTE DISABLE INDICATION. LOW (0 VDC) WHEN ACTIVE
18	HIGH VOLTAGE ON STATUS	HIGH VOLTAGE ON INDICATION. LOW (0 VDC) WHEN ACTIVE.
19	PLATE OVERLOAD STATUS	PLATE OVERLOAD INDICATION. LOW (0 VDC) WHEN ACTIVE.
20	SCREEN OVERLOAD STATUS	SCREEN OVERLOAD INDICATION. LOW (0 VDC) WHEN ACTIVE.
21	GRID OVERLOAD STATUS	GRID OVERLOAD INDICATION. LOW (0 VDC) WHEN ACTIVE.
22	VSWR OVERLOAD STATUS	VSWR OVERLOAD INDICATION. LOW (0 VDC) WHEN ACTIVE.
23	OVERLOAD STATUS	OVERLOAD CIRCUIT INDICATION. LOW (0 VDC) WHEN ACTIVE.
24	PRESET STATUS	PRESET POWER INDICATION. LOW (0 VDC) WHEN ACTIVE.
25	NO CONNECTION	

597-0220-418

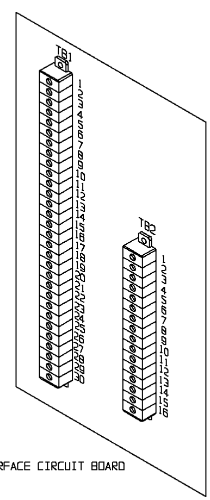
FIGURE 2-6. REMOTE CONTROL INTERFACING (Sheet 1 of 2)

TB1 PIN DESCRIPTIONS

(26)	FAILSAFE STATUS	FAILSAFE INTERLOCK INDICATION. LOW (0 VDC) WHEN ACTIVE.	0V, +V
(27)	INTERLOCK STATUS	INTERLOCK INDICATION. LOW (0 VDC) WHEN ACTIVE.	0V, +V
(28)	BLOWER STATUS	BLOWER ON INDICATION. LOW (0 VDC) WHEN ACTIVE.	0V, +V
(29)	FILAMENT STATUS	FILAMENT ON INDICATION. LOW (0 VDC) WHEN ACTIVE.	0V, +V
(30)	HIGH VOLTAGE STATUS	HIGH VOLTAGE ON INDICATION. LOW (0 VDC) WHEN ACTIVE.	0V, +V

TB2 PIN DESCRIPTIONS

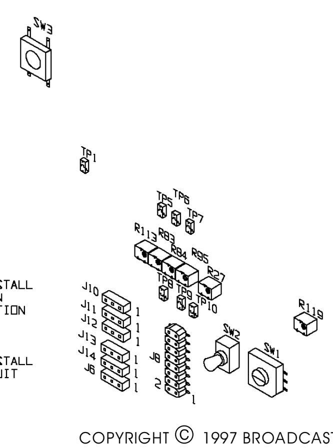
(1)	FWD PWR OUT	** TRANSMITTER FORWARD POWER METER OUTPUT. +2V OR +4 VDC FULL SCALE INDICATION +2V = INSTALL JUMPER P12 IN POSITION 2-3 +4V = INSTALL JUMPER P12 IN POSITION 1-2 LOG OR LINEAR FORMAT. LOG = INSTALL JUMPER IN J8 PINS 15-16. LINEAR = REMOVE JUMPER FROM J8 PINS 15-16. METER GROUND RECOMMENDED.	+2 OR +4 VDC
(2)	RFL PWR OUT	** TRANSMITTER REFLECTED POWER METER OUTPUT. +2V OR +4 VDC FULL SCALE INDICATION +2V = INSTALL JUMPER P13 IN POSITION 2-3 +4V = INSTALL JUMPER P13 IN POSITION 1-2 LOG OR LINEAR FORMAT. LOG = INSTALL JUMPER IN J8 PINS 15-16. LINEAR = REMOVE JUMPER FROM J8 PINS 15-16. METER GROUND RECOMMENDED.	+2 OR +4 VDC
(3)	IPA FWD PWR OUT	** IPA FORWARD POWER METER OUTPUT. +2V OR +4 VDC FULL SCALE INDICATION +2V = INSTALL JUMPER P14 IN POSITION 2-3 +4V = INSTALL JUMPER P14 IN POSITION 1-2 LOG OR LINEAR FORMAT. LOG = INSTALL JUMPER IN J8 PINS 15-16. LINEAR = REMOVE JUMPER FROM J8 PINS 15-16. METER GROUND RECOMMENDED.	+2 OR +4 VDC
(4)	PLATE VOLTAGE OUT	** PLATE VOLTAGE METER OUTPUT. +2V OR +4 VDC FULL SCALE INDICATION +2V = INSTALL JUMPER P10 IN POSITION 2-3 +4V = INSTALL JUMPER P10 IN POSITION 1-2 LOG OR LINEAR FORMAT. LOG = INSTALL JUMPER IN J8 PINS 15-16. LINEAR = REMOVE JUMPER FROM J8 PINS 15-16. METER GROUND RECOMMENDED.	+2 OR +4 VDC
(5)	PLATE CURRENT OUT	** PLATE CURRENT METER OUTPUT. +2V OR +4 VDC FULL SCALE INDICATION +2V = INSTALL JUMPER P11 IN POSITION 2-3 +4V = INSTALL JUMPER P11 IN POSITION 1-2 LOG OR LINEAR FORMAT. LOG = INSTALL JUMPER IN J8 PINS 15-16. LINEAR = REMOVE JUMPER FROM J8 PINS 15-16. METER GROUND RECOMMENDED.	+2 OR +4 VDC
(6)	METERING GROUND	METER GROUND FOR METER CONNECTIONS.	METER GROUND
(7)	METERING GROUND	METER GROUND FOR METER CONNECTIONS.	METER GROUND
(8)	METERING GROUND	METER GROUND FOR METER CONNECTIONS.	METER GROUND
(9)	NO CONNECTION		
(10)	EXT INTERLOCK OUT	CONNECTION FOR AN EXTERNAL INTERLOCK SUCH AS A TEST LOAD OR MOTORIZED COAXIAL SWITCH.	
(11)	EXT INTERLOCK IN		
(12)	NO CONNECTION		
(13)	CHASSIS GROUND	CHASSIS GROUND. CHASSIS GROUND FOR REMOTE CONTROL CONNECTIONS.	CHASSIS GROUND
(14)	CHASSIS GROUND	CHASSIS GROUND. CHASSIS GROUND FOR REMOTE CONTROL CONNECTIONS.	CHASSIS GROUND
(15)	RMT PWR +15 VDC	+15 VDC SUPPLY FROM CONTROLLER. PROVIDES A +15 VDC SUPPLY FOR REMOTE SWITCHES AND INDICATORS.	+15 VDC
(16)	RMT PWR +15 VDC	+15 VDC SUPPLY FROM CONTROLLER. PROVIDES A +15 VDC SUPPLY FOR REMOTE SWITCHES AND INDICATORS.	+15 VDC



REMOTE INTERFACE CIRCUIT BOARD

NOTES: * POSITIVE CONTROL - INSTALL P6 ON CONTROLLER MAIN CIRCUIT BOARD IN POSITION 2-3. FACTORY DEFAULT. SEE DETAIL 'A'.

NEGATIVE CONTROL - INSTALL P6 ON CONTROLLER CIRCUIT BOARD IN POSITION 1-2. SEE DETAIL 'A'.



** DETAIL 'A'

CONTROLLER MAIN CIRCUIT BOARD

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FIGURE 2-6. REMOTE INTERFACING (Sheet 2 of 2)

2–82. **Remote Filament Off Control.** The filament off function is located at TB1–3. The function: 1) provides one–button–off control by disabling the high voltage and the filaments and 2) can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to disable the: 1) filaments and 2) high voltage if not previously disabled. Negative control requires the use of a momentary contact to ground to disable the: 1) filaments and 2) high voltage if not previously disabled.

2–83. **Remote High Voltage On Control.** The high voltage on function is located at TB1–4. The function: 1) provides one–button–on control by enabling the high voltage and the filaments and 2) can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to enable the: 1) high voltage and 2) filaments if not previously enabled. Negative control requires the use of a momentary contact to ground to enable the: 1) high voltage and 2) filaments if not previously enabled.

2–84. **Remote High Voltage Off Control.** The high voltage off function is located at TB1–5. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to disable the high voltage. Negative control requires the use of a momentary contact to ground to disable the high voltage.

2–85. **Remote PA Power Level Raise Control.** The transmitter PA power level raise control is located at TB1–6. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to raise the transmitter power level. Negative control requires the use of a momentary contact to ground to raise the transmitter power level.

2–86. **Remote Power Level Lower Control.** The transmitter PA power level lower control is located at TB1–7. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to lower the transmitter power level. Negative control requires the use of a momentary contact to ground to lower the transmitter power level.

2–87. **Remote Preset Power On Control.** The preset power on function is located at TB1–8. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to enable preset power operation. Negative control requires the use of a momentary contact to ground to enable preset power operation. When a sustained remote control signal is applied, preset power will be enabled if the APC switch/indicator is illuminated and the REMOTE DISABLE switch/indicator is extinguished. The transmitter will automatically return to full power when the sustained remote control signal is removed.

2–88. **Remote Overload Reset Control.** The overload reset control is designed to reset the transmitter overload circuitry. The reset control is located at TB1–9. The function can be activated using positive or negative control. Positive control requires the use of a momentary contact to a +5 volt to +15 volt dc signal to reset the transmitter overload circuitry. Negative control requires the use of a momentary contact to ground to reset the transmitter overload circuitry.

2–89. **No Connection.** No connection at the following locations:

1) TB1–10 through TB1–14.

2) TB1–25.

3) TB2–9.

4) TB2–12.

2–90. **APC On Indicator.** The APC on indicator provides a signal to indicate when APC operation is enabled. The APC on indicator is located at TB1–15. The indicator will go LOW (0 volts dc) to indicate when APC operation is enabled.

2–91. **Filament On Indicator.** The filament on indicator provides a signal to indicate when the filaments are enabled. The filament on indicator is located at TB1–16. The indicator will go LOW (0 volts dc) to indicate when the filaments are enabled.

2–92. **Remote Disable Indicator.** The remote disable indicator provides a signal to indicate when the remote control inputs are disabled. The remote disable indicator is located at TB1–17. The indicator will go LOW (0 volts dc) to indicate when the remote control inputs are disabled.

2–93. **Remote High Voltage On Indicator.** The remote high voltage on indicator provides a signal to indicate when the high voltage is enabled. The remote high voltage on indicator is located at TB1–18. The indicator will go LOW (0 volts dc) to indicate when the high voltage is enabled.

2–94. **Remote Plate Overload Indicator.** The remote plate overload indicator provides a signal to indicate when a plate overload has occurred. The remote plate overload indicator is located at TB1–19. The indicator will go LOW (0 volts dc) to indicate when a plate overload has occurred.

2–95. **Remote Screen Overload Indicator.** The remote screen overload indicator provides a signal to indicate when a screen overload has occurred. The remote screen overload indicator is located at TB1–20. The indicator will go LOW (0 volts dc) to indicate when a screen overload has occurred.

2–96. **Remote Grid Overload Indicator.** The remote grid overload indicator provides a signal to indicate when a grid overload has occurred. The remote grid overload indicator is located at TB1–21. The indicator will go LOW (0 volts dc) to indicate when a grid overload has occurred.

2–97. **Remote VSWR Overload Indicator.** The remote VSWR overload indicator provides a signal to indicate when a VSWR overload has occurred. The remote VSWR overload indicator is located at TB1–22. The indicator will go LOW (0 volts dc) to indicate when a VSWR overload has occurred.

2–98. **Remote Overload Indicator.** The remote overload indicator provides a signal to indicate when a plate, screen, grid, or VSWR overload has occurred. The remote overload indicator is located at TB1–23. The indicator will go LOW (0 volts dc) to indicate when an overload has occurred.

2–99. **Remote Preset Power Indicator.** The preset power indicator provides a signal to indicate when preset power operation is enabled. The preset power indicator is located at TB1–24. The indicator will go LOW (0 volts dc) to indicate when preset power operation is enabled.

2–100. **Remote Failsafe Indicator.** The failsafe indicator provides a signal to indicate when the failsafe interlock is closed. The failsafe indicator is located at TB1–26. The indicator will go LOW (0 volts dc) to indicate when the failsafe interlock is closed.

2–101. **Remote Interlock Indicator.** The interlock indicator provides a signal to indicate when the internal interlocks are closed. The interlock indicator is located at TB1–27. The indicator will go LOW (0 volts dc) to indicate when the internal interlocks are closed.

2–102. **Remote Blower Indicator.** The blower indicator provides a signal to indicate when the transmitter blower is operational. The blower indicator is located at TB1–28. The indicator will go LOW (0 volts dc) to indicate when the blower is operational.

2–103. **Remote Filament Indicator.** The filament indicator provides a signal to indicate when the filament contactor is energized. The filament indicator is located at TB1–29. The indicator will go LOW (0 volts dc) to indicate when the filament contactor is energized.

2–104. **Remote High Voltage Indicator.** The high voltage indicator provides a signal to indicate when the high voltage contactor is energized. The high voltage indicator is located at TB1–30. The indicator will go LOW (0 volts dc) to indicate when the high voltage contactor is energized.

2–105. **Remote Forward Power Meter Indications.** Remote forward power meter indications are located at TB2–1. The forward power meter output can be configured for a +2 or +4 volt dc full–scale meter indication. The forward power full–scale indication is 22,000 watts. In addition, the forward power sample can be provided in a log or linear format. The transmitter is shipped with the sample programmed for a linear format. The meter ground is recommended for remote metering connections (TB2–6 through TB2–8).

2–106. **Remote Reflected Power Meter Indications.** Remote reflected power meter indications are located at TB2–2. The reflected power meter output can be configured for a +2 or +4 volt dc full–scale meter indication. The reflected power full–scale indication is 6170 watts. In addition, the reflected power sample can be provided in a log or linear format. The transmitter is shipped with the sample programmed for a linear format. The meter ground is recommended for remote metering connections (TB2–6 through TB2–8).

2–107. **Remote Plate Voltage Meter Indications.** Remote plate voltage meter indications are located at TB2–4. The plate voltage meter output can be configured for a +2 or +4 volt dc full–scale meter indication. The plate voltage full–scale indication is 10,000 volts. In addition, the plate voltage sample can be provided in a log or linear format. The transmitter is shipped with the sample programmed for a linear format. The meter ground is recommended for remote metering connections (TB2–6 through TB2–8).

2–108. **Remote Plate Current Meter Indications.** Remote plate current meter indications are located at TB2–5. The plate current meter output can be configured for a +2 or +4 volt dc full–scale meter indication. The plate current full–scale indication is 4 amps. In addition, the plate current sample can be provided in a log or linear format. The transmitter is shipped with the sample programmed for a linear format. The meter ground is recommended for remote metering connections (TB2–6 through TB2–8).

2–109. **Remote IPA Forward Power Meter Indications.** Remote IPA forward power meter indications are located at TB2–3. The meter output can be configured for a +2 or +4 volt dc full–scale meter indication. The IPA forward power full–scale indication is 500 watts. In addition, the IPA forward power sample can be provided in a log or linear format. The transmitter is shipped with the sample programmed for a linear format. The meter ground is recommended for remote metering connections (TB2–6 through TB2–8).

2–110. **Chassis Ground.** Chassis ground is designed to be used for remote control connections. Chassis ground is located at TB2–13 and TB2–14.

2–111. **+15V DC Supply.** A +15 volt dc supply is provided for the remote control switches and indicators. The +15 volt dc supply is located at TB2–15 and TB2–16.

2–112. **WIRING.**

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

2–113. **TRANSFORMER TAPS.** Ensure the transmitter is wired for the input voltage and line frequency to be used. The PA screen transformer, the PA plate transformer, the PA bias transformer, and the filament voltage regulator must be checked and changed if required (see Figure 2–7). Refer to the final test data sheets for transformer information.

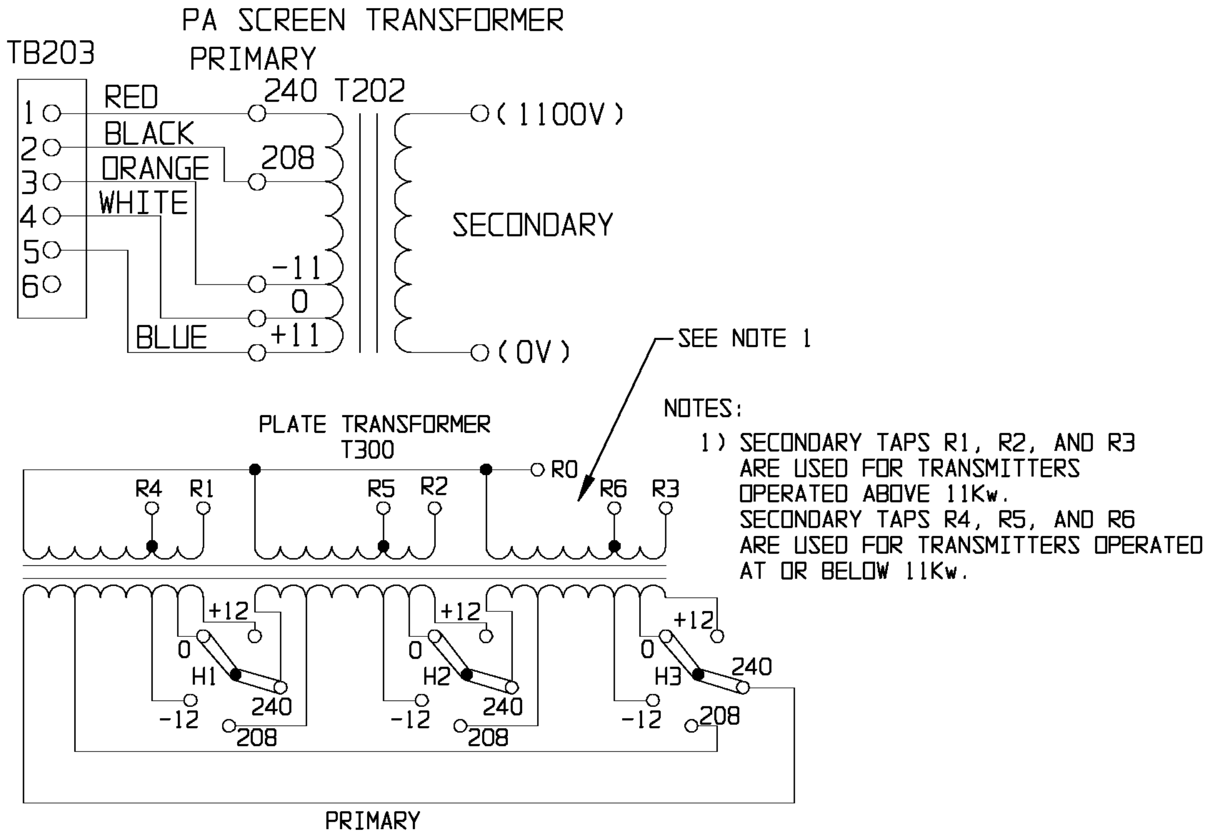

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FIGURE 2-7. POWER TRANSFORMER WIRING (Sheet 1 of 2)

2–114. **INPUT VOLTAGE CHECK.** The FM exciter, the optional stereo generator, and the optional SCA generator should be checked as follows:

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

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.

WARNING ***ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.***

WARNING

2–115. **CABINET INTERCONNECTIONS.** Refer to the following cabinet interconnection procedures for the type of transmitter installation used.

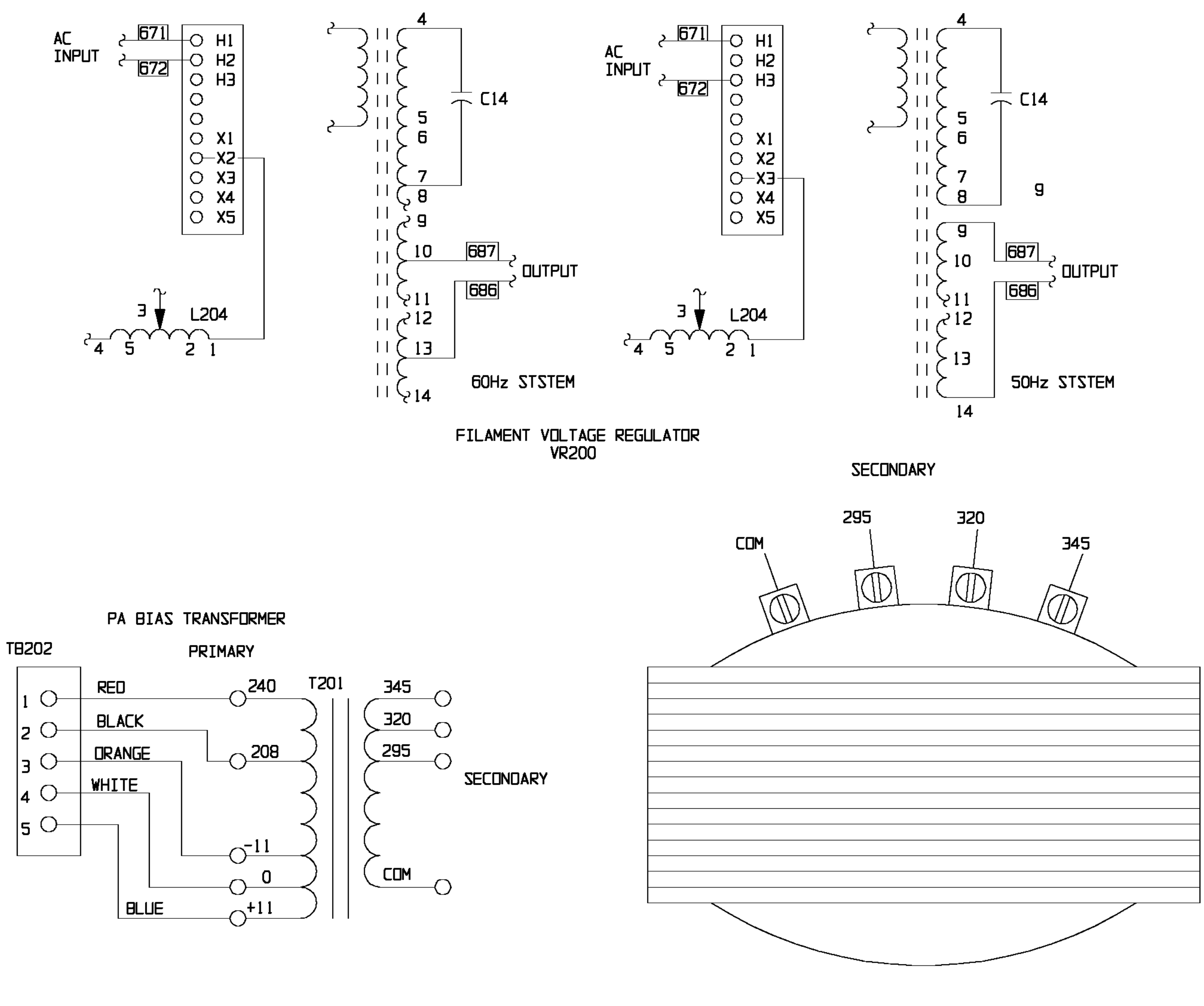

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FIGURE 2-7. POWER TRANSFORMER WIRING (Sheet 2 of 2)

2-116. **Cabinet Interconnections For Adjacent Power Supply Cabinet Installation.** For an adjacent power supply cabinet installation, refer to Figure 2-8 and perform the following cabinet interconnections.

A. Connect ac power wires 501 through 516 to TB201 in the PA cabinet.

B. Attach interlock connector P301 to J201.

CAUTION ***TO PREVENT SEVERE DAMAGE TO THE HIGH VOLTAGE POWER SUPPLY, ENSURE WIRES 450 AND 451 ARE PROPERLY INSTALLED IN THE TRANSMITTER.***

CAUTION

C. Attach high voltage wire 450 to the power supply cabinet high voltage point as shown.

D. Connect ground return wire 451 to the bottom terminal of resistor R304 as shown.

WARNING ***ENSURE ALL GROUND CONNECTIONS ARE PERFORMED IN THE FOLLOWING STEP.***

WARNING

E. Attach the ground connections in the cabinets as follows:

1. Connect a 2/0 braided copper wire from earth ground to the power supply cabinet ground terminal.

2. Bolt the copper straps in each adjoining cabinet together securely.

2-117. **Cabinet Interconnections For Remote Power Supply Installation.** For a remote power supply installation, refer to Figure 2-9 and perform the following cabinet interconnections.

WARNING ***ROUTE CABINET INTERCONNECTING HIGH VOLTAGE AND AC POWER CABLES IN 1 INCH (2.54 cm) METALLIC CONDUIT TO PREVENT EXPOSURE TO HAZARDOUS VOLTAGES.***

WARNING

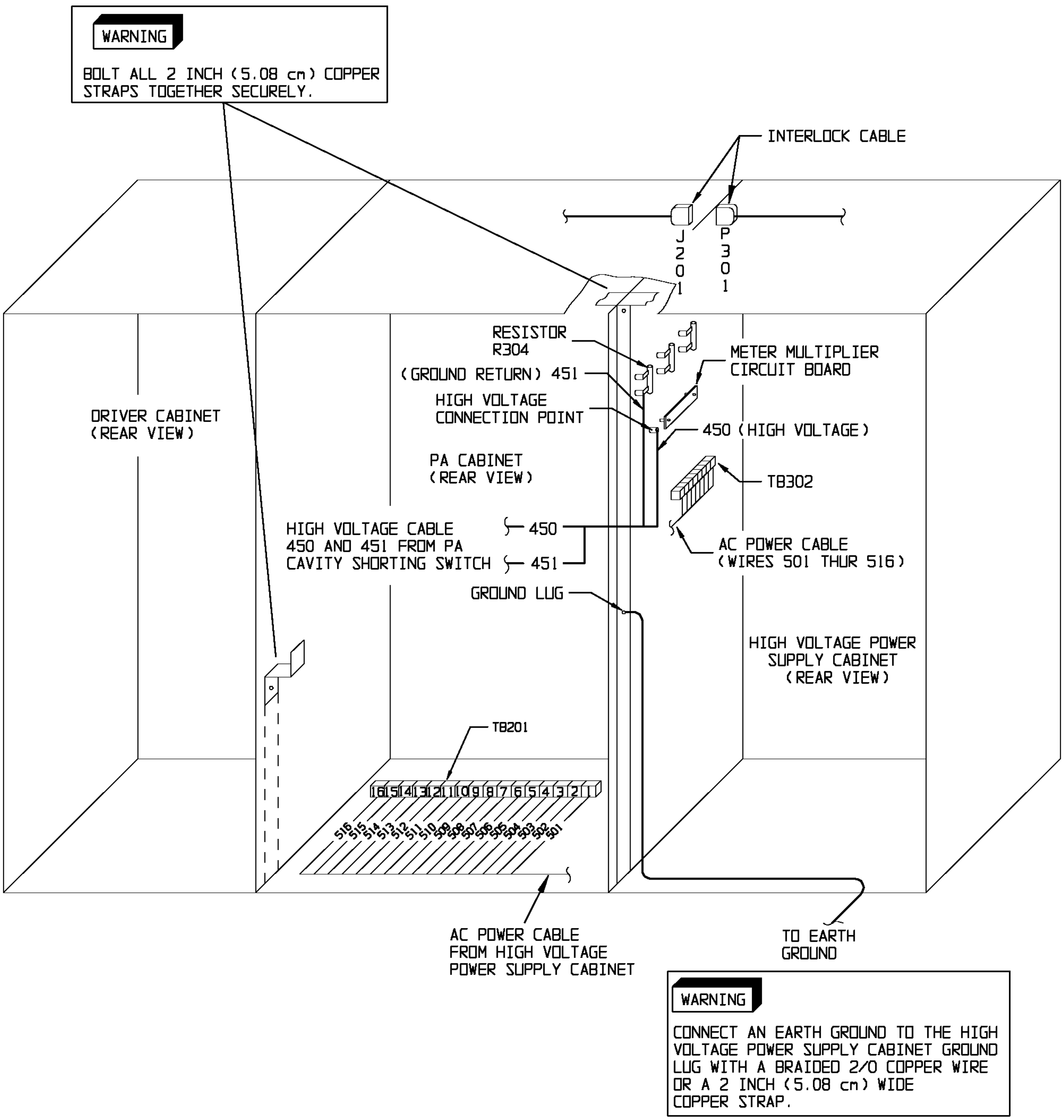
A. Using the PA cabinet and power supply cabinet overhead wiring access holes, route the high voltage and ac power cables from the power supply cabinet to the PA cabinet through 1 inch (2.54 cm) metallic conduit. Route all dc control cables in access holes separate from the ac and high voltage cables.

WARNING ***CONNECT THE CONDUIT TO THE GROUND STRAP IN EACH CABINET.***

WARNING

B. Connect the conduit to the ground strap in each cabinet.

C. Connect ac power wires 501 through 516 to TB201 in the PA cabinet.



597-0220-13

FIGURE 2-8. CABINET INTERCONNECTIONS, ADJACENT POWER SUPPLY CABINET INSTALLATION

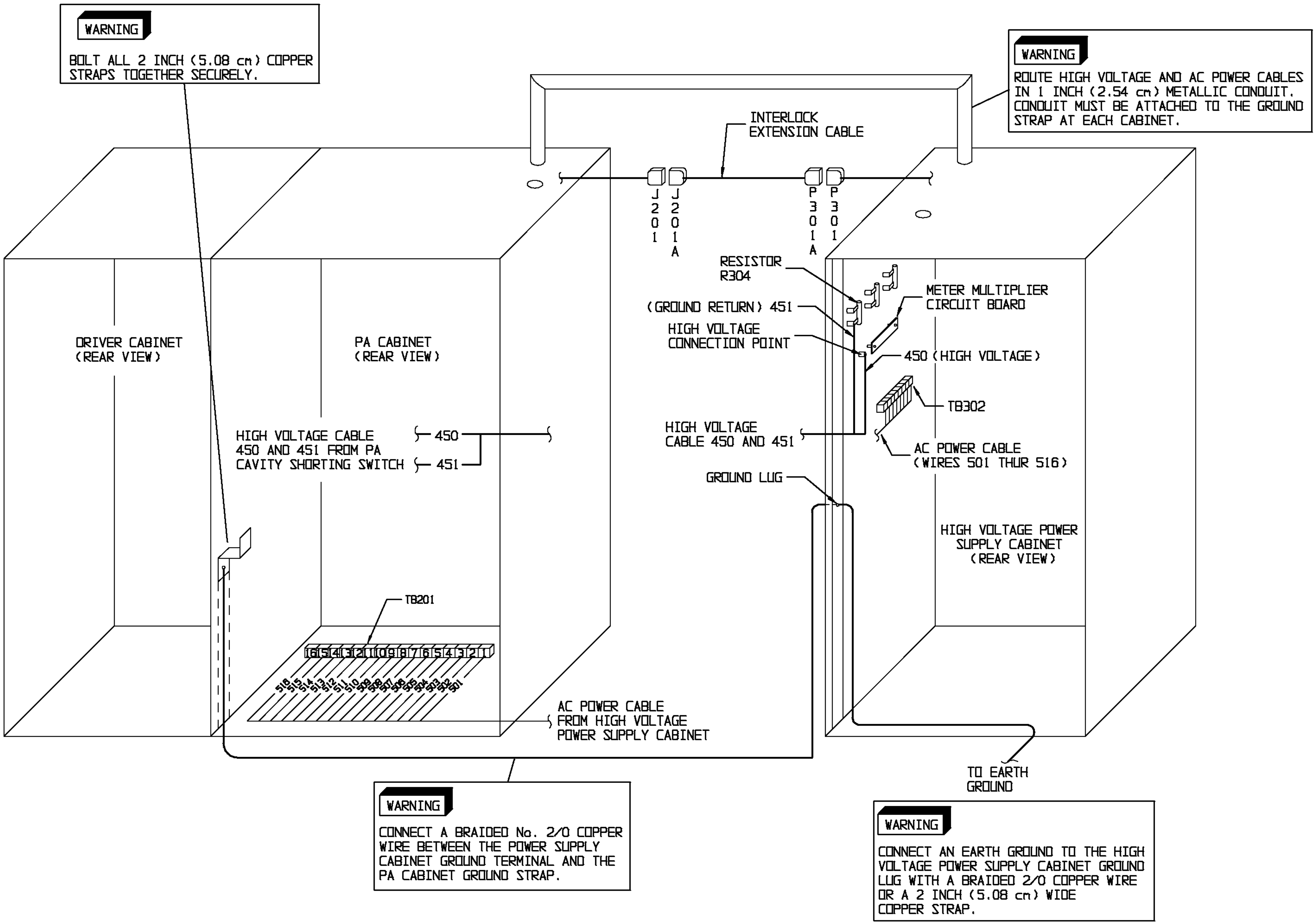


FIGURE 2-9. CABINET INTERCONNECTIONS, REMOTE POWER SUPPLY CABINET INSTALLATION 597-0220-14

CAUTION *TO PREVENT SEVERE DAMAGE TO THE HIGH VOLTAGE POWER SUPPLY, ENSURE WIRES 450 AND 451 ARE PROPERLY INSTALLED IN THE TRANSMITTER.*

CAUTION

D. Attach high voltage wire 450 to the power supply cabinet high voltage point as shown.

E. Connect ground return wire 451 to the bottom terminal of resistor R304 as shown.

F. Connect the interlock extension cable between J201 and P301.

WARNING *ENSURE ALL GROUND CONNECTIONS ARE PERFORMED IN THE FOLLOWING STEP.*

WARNING

G. Attach the ground connections in the cabinets as follows:

1. Connect a 2/0 braided copper wire from earth ground to the power supply cabinet ground terminal.
2. Connect a 2/0 braided copper wire from the power supply cabinet ground terminal to the PA cabinet ground strap.
3. Bolt the copper strap in the adjoining driver and PA cabinets together securely.

WARNING *ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.*

WARNING

CAUTION *THE AC DISTRIBUTION PANEL PROVIDES A 220V AC OPERATING SUPPLY FOR OPTIONAL EQUIPMENT. ENSURE ALL 220V AC AND 110V AC EQUIPMENT IS PROPERLY CONNECTED TO THE PANEL.*

CAUTION

2–118. **OPTIONAL EQUIPMENT WIRING.** An ac distribution panel is provided in the driver cabinet for the application of ac power to the driver cabinet modular components. Mount and wire any optional equipment not provided with the transmitter to the distribution panel (refer to Figure 2–10). The ac distribution panel provides a 220V ac operating supply for the optional equipment. Ensure all 220V ac and 110V ac equipment is properly connected to the panel.

2–119. **SIGNAL INPUTS.** Refer to the applicable technical manual for the exciter, stereo generator, and SCA generator and wire the inputs and control connections to each unit. All audio wiring should be routed in a wiring channel away from the RF circuitry.

2–120. **FAILSAFE INTERLOCK.** The FM–20T transmitter is equipped with a failsafe interlock circuit such as for a test load or remote control failsafe connection. The failsafe interlock circuit is independent of the transmitter safety interlock circuit and will disable only the high voltage plate supply when opened. The interlock is located at TB2–10 and TB2–11 on the transmitter remote interface panel. Refer to Figure 2–6 and connect the interlock wiring to TB2–10 and TB2–11 as shown. If unused, ensure the factory installed jumper is connected between the terminals.

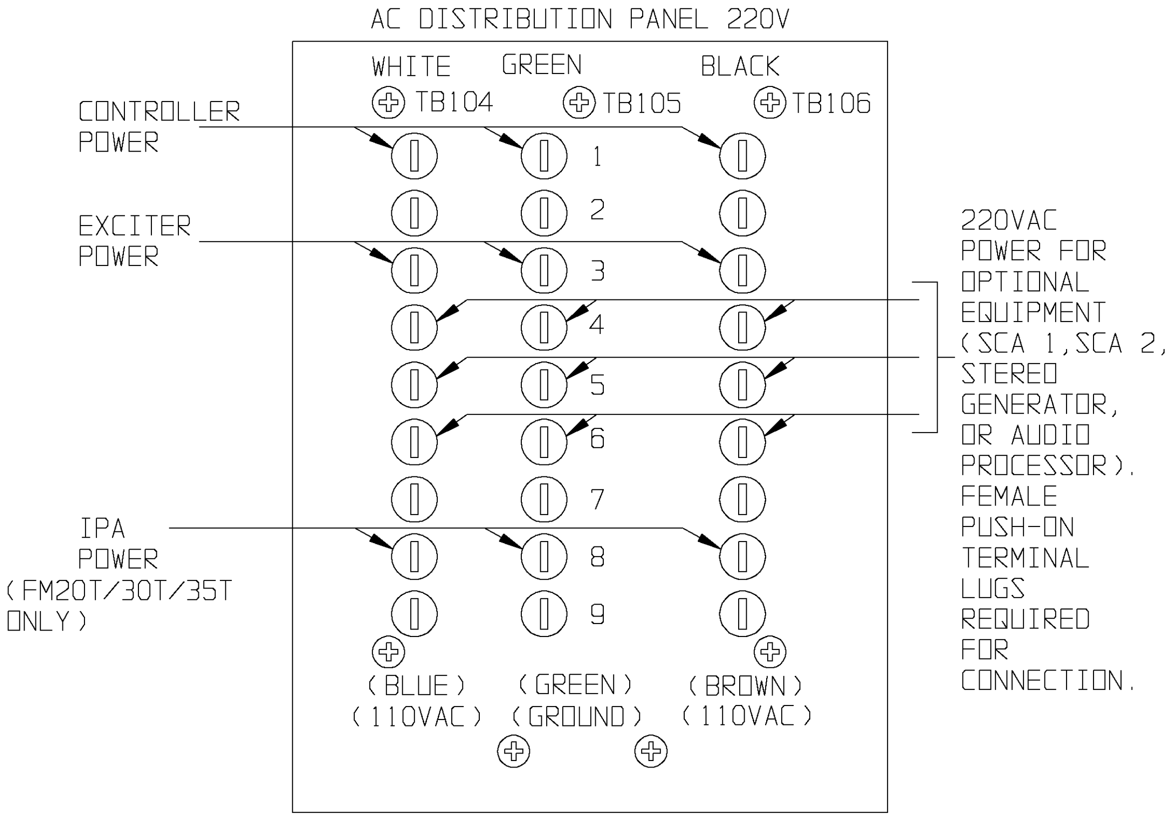


FIGURE 2-10. OPTIONAL EQUIPMENT WIRING **597-0220-403**

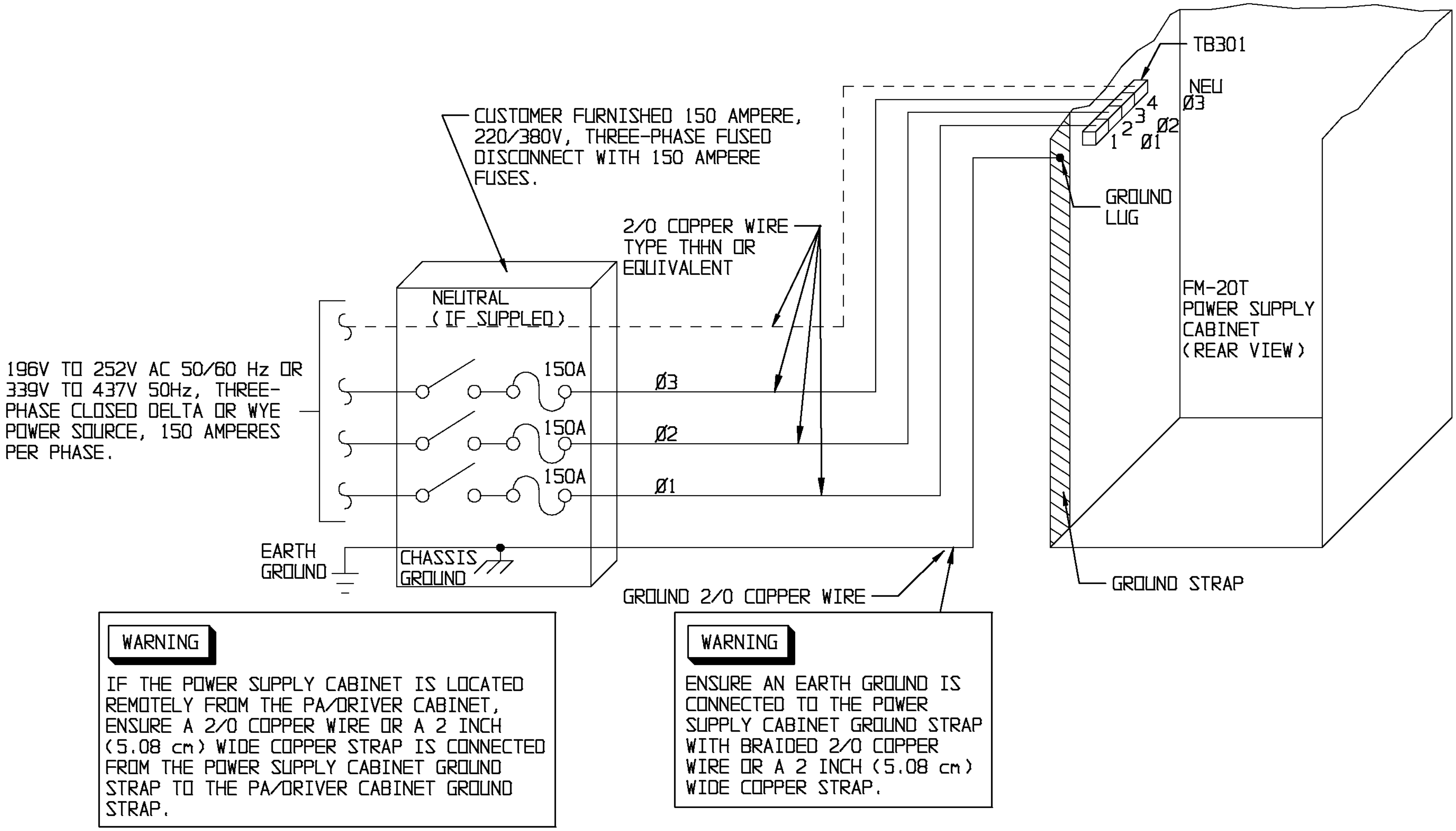
2-121. **TRANSMITTER MONITORING - MODEM CONNECTIONS.** The FM-20T transmitter is equipped with: 1) a built-in front-panel modem port and 2) a built-in rear-panel modem port. The modem ports allow modems to be connected to the transmitter for local and remote monitoring of transmitter parameters using RTDS.

2-122. **TRANSMITTER MONITORING - PRINTER CONNECTIONS.** The FM-20T transmitter is equipped with a built-in printer port. The printer port allows transmitter parameters to be printed using a local printer and RTDS.

WARNING ***ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.***

WARNING

2-123. **AC POWER CONNECTIONS.** The FM-20T requires a three-phase power source of 196V to 252V ac 50/60 Hz or 339V to 437V ac 50 Hz at 150 amperes per phase. Ensure the required power source is supplied from an acceptable ac transformer configuration (refer to PRIMARY POWER). For operating safety, the power source must be routed to the transmitter through a fused power disconnect (see Figure 2-11).



597-0220-427

FIGURE 2-11. FM-20T PRIMARY AC WIRING

WARNING ***ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.***
WARNING

WARNING ***ENSURE AN EARTH GROUND CONDUCTOR IS SECURELY CONNECTED TO THE POWER SUPPLY CABINET GROUND TERMINAL.***
WARNING

2-124. **Main ac Input.** Refer to Figure 2-11 and connect the three-phase service to the ac distribution panel in the power supply cabinet through a fused service disconnect. Ensure a utility company ground conductor is securely connected to the power supply cabinet ground lug. For a three-phase WYE service, ensure the neutral wire is connected to terminal 4.

2-125. Replace the guard over the primary ac power input terminal strip.

2-126. **INITIAL CHECKOUT.**

WARNING ***ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.***
WARNING

2-127. Replace all panels and doors on the transmitter.

2-128. Ensure that the transmitter is completely installed by checking the following items.

A. Ensure primary power is correctly wired.

B. Ensure all capacitors on the high voltage rectifier stacks are perpendicular to each respective stack.

C. Ensure all RF connections are secure.

D. Ensure all connections at terminal strips are secure, especially in high current areas.

E. Ensure all ground connections are secure.

F. Ensure the cabinet ground straps are properly connected to earth ground.

G. Rotate the blower and fans by hand to ensure no obstructions are present.

H. Using an insulator, check relay operation manually to be certain all have free movement.

I. Remove any extra hardware and wire lying within the cabinets.

J. Ensure all guards at terminal strips, transformers, etc. are replaced and secure and close all doors.

K. Using a miniature flat-blade screwdriver, mechanically zero all meters.

2-129. Operate all six front-panel circuit breakers to OFF and ensure all transmitter controls are preset to the positions indicated on the final test data sheets.

2-130. Ensure an RF load is connected to the transmitter.

2-131. Adjust the **FILAMENT VOLTAGE** control fully counterclockwise (minimum). A small flat-blade screwdriver is required.

2–132. Adjust the front panel IPA **POWER ADJUST** control fully counterclockwise (minimum).

2–133. The following procedure 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 or antenna systems.

2–134. **CONTROLLER AND INTERLOCK CHECKOUT.** Check the controller and transmitter interlock circuit operation by performing the following procedures.

2–135. **Controller Checkout.** Close the wall–mounted fused safety disconnect.

2–136. Operate the **CONTROL** circuit breaker to ON. The **HIGH VOLTAGE, SCREEN, FILAMENT,** and **BLOWER** circuit breakers must remain OFF.

2–137. Ensure the **FILAMENT ON** and **HIGH VOLTAGE ON** switch/indicators are extinguished.

2–138. Open the controller cabinet door and check the following items on the main circuit board.

A. Ensure the **–15** indicator is illuminated.

B. Ensure the **+15** indicator is illuminated.

C. Ensure the **+5** indicator is illuminated.

2–139. **Interlock Checkout.** Complete the following procedure step by step and note the controller **TRANSMITTER STATUS INTERLOCK** indicator. If problems occur, deenergize all primary power and troubleshoot the series interlock circuit with an Ohmmeter.

2–140. Ensure the **HIGH VOLTAGE, SCREEN, FILAMENT,** and **BLOWER** circuit breakers are operated to OFF.

WARNING ***DEENERGIZE PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–141. Operate the **CONTROL** circuit breaker to OFF.

2–142. Remove the PA cabinet lower front access panel.

WARNING ***DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER WITH POWER ENERGIZED.***

WARNING

2–143. Operate the **CONTROL** circuit breaker to ON. The controller **TRANSMITTER STATUS INTERLOCK** indicator will be extinguished.

WARNING ***DEENERGIZE PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–144. Operate the **CONTROL** circuit breaker to OFF.

2–145. Replace the PA cabinet lower front access panel.

2–146. Operate the **CONTROL** circuit breaker to ON. The controller **TRANSMITTER STATUS INTERLOCK** indicator will illuminate.

2–147. Open the PA cabinet rear door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will extinguish.

2–148. Close the PA cabinet rear door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will illuminate.

2–149. Open the PA cabinet rear door and perform the following:

WARNING ***PERFORM THE FOLLOWING PROCEDURES AS INDICATED. DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER WITH POWER ENERGIZED.***
WARNING

A. Depress the PA cabinet rear door interlock switch and remove the grounding stick from the mounting clips. The controller **TRANSMITTER STATUS INTERLOCK** indicator will extinguish.

B. Replace the grounding stick. The controller **TRANSMITTER STATUS INTERLOCK** indicator will illuminate.

C. Depress the PA cabinet rear door interlock switch and open the PA cavity access door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will extinguish.

D. Close the PA cavity access door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will illuminate.

E. Close the PA cabinet rear door.

2–150. Open the driver cabinet rear door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will extinguish.

2–151. Close the driver cabinet rear door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will illuminate.

2–152. Open the high voltage power supply cabinet rear door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will extinguish.

2–153. Close the high voltage power supply cabinet rear door. The controller **TRANSMITTER STATUS INTERLOCK** indicator will illuminate.

2–154. Open the high voltage power supply cabinet rear door and perform the following:

WARNING ***PERFORM THE FOLLOWING PROCEDURES AS INDICATED. DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER WITH POWER ENERGIZED.***
WARNING

A. Depress the high voltage power supply cabinet rear door interlock switch and raise the grounding stick from the hanger. The controller **TRANSMITTER INTERLOCK STATUS** indicator will extinguish.

B. Replace the grounding stick. The controller **TRANSMITTER INTERLOCK STATUS** indicator will illuminate.

C. Close the high voltage power supply cabinet rear door.

2–155. If equipment is connected to the failsafe interlock circuit, check the operation as follows:

A. Open the failsafe interlock. The controller **TRANSMITTER STATUS FAILSAFE** indicator will extinguish.

B. Close the failsafe interlock. The **TRANSMITTER STATUS FAILSAFE** indicator will illuminate.

2–156. **BLOWER CHECKOUT.** Check blower operation by performing the following procedure.

2–157. Ensure the **CONTROL** circuit breaker is operated to ON and operate the **BLOWER** circuit breaker to ON.

2–158. Depress the **FILAMENT ON** switch/indicator to illuminate the switch/indicator. The **FILAMENT ON** switch/indicator, **BLOWER STATUS**, and **FILAMENT STATUS** indicators will illuminate and the blower will begin operation.

2–159. Ensure the blower, **BLOWER STATUS** indicator, and the **FILAMENT STATUS** indicator are operating properly. At high altitudes, the **BLOWER STATUS** indicator may not illuminate. If this occurs, contact the Broadcast Electronics Customer Service Department.

2–160. **EXCITER CHECKOUT.** Check exciter operation by performing the following procedure.

2–161. Close the three–phase primary ac fused power disconnect, if opened.

2–162. Ensure the **CONTROL** and **BLOWER** circuit breakers are operated to ON. The **HIGH VOLTAGE, SCREEN,** and **FILAMENT** circuit breakers must remain OFF.

2–163. Operate the **APC ON** switch/indicator to extinguish the switch/indicator.

2–164. Depress the **HIGH VOLTAGE ON** switch/indicator.

2–165. Apply audio to the exciter. The presence of audio programming will be noted on the exciter digital **MODULATION** meter and the exciter front–panel **AFC** and **POWER** indicators will illuminate steadily.

2–166. Depress the exciter multimeter **AFC** switch.

A. The exciter multimeter will indicate a potential within the range of +2.0 volts to +9.0 volts, dependent upon carrier frequency. Refer to the final test data sheets for the correct voltage indication.

2–167. Depress the exciter multimeter **PAV** switch.

A. The multimeter will indicate a potential of approximately +12.0 volts (assuming the exciter is configured for a 20 watt RF power output).

2–168. Depress the exciter multimeter **PAI** switch.

A. The multimeter will indicate approximately 1.9 amperes (assuming the exciter is configured for a 20 watt RF power output).

2–169. Depress the **FILAMENT OFF** switch.

2–170. Remove the audio from the exciter.

2–171. **PRELIMINARY OPERATION AND TUNING.** Operate and tune the transmitter by performing the following procedure.

2–172. Check the transmitter controls. Ensure the controls are operated to the positions indicated on the factory final test data sheets.

2–173. Ensure the **CONTROL** and **BLOWER** circuit breakers are operated to ON. The **HIGH VOLTAGE** and **SCREEN** circuit breakers must be operated to OFF.

2–174. Ensure the controller **TRANSMITTER STATUS INTERLOCK** indicator is illuminated. If the **TRANSMITTER STATUS INTERLOCK** indicator is extinguished, open the wall–mounted fused disconnect and check the following:

A. All doors closed.

B. All panels installed.

C. The grounding sticks are on the hangers.

2–175. If equipment is connected to the failsafe interlock, ensure the controller **TRANSMITTER STATUS FAILSAFE** indicator is illuminated. If the indicator is extinguished, open an appropriate power source disconnect if required and check the interlock switch.

2–176. Ensure the **FILAMENT ON** and **HIGH VOLTAGE ON** switch/indicators are extinguished.

2–177. Ensure the IPA **POWER ADJUST** control is fully counterclockwise (minimum).

2–178. Depress the controller **APC ON** switch/indicator to extinguish the switch/indicator.

2–179. Depress the controller **REMOTE DISABLE** switch/indicator to illuminate the switch/indicator.

2–180. Operate the controller **FWD** switch/indicator to illuminate the switch/indicator.

CAUTION
CAUTION

ENSURE AN RF LOAD IS CONNECTED TO THE TRANSMITTER AND THE FILAMENT VOLTAGE CONTROL IS ADJUSTED TO APPROXIMATELY MID-RANGE.

2–181. Operate the **FILAMENT** circuit breaker to ON.

2–182. Depress the **FILAMENT ON** switch/indicator. Both the **FILAMENT ON** switch/indicator and the **FILAMENT TRANSMITTER STATUS** indicator will illuminate and the blower will begin operation.

2–183. Adjust the **FILAMENT VOLTAGE** control to obtain a **FILAMENT VOLTAGE** meter indication equal to the value recorded on the final test data sheets accompanying the transmitter.

2–184. Operate the **MULTIMETER** switch to **GRID VOLTAGE** and note the presence of PA stage grid bias.

2–185. Operate the **SCREEN** and the **HIGH VOLTAGE** circuit breakers to ON.

2–186. Depress the **HIGH VOLTAGE ON** switch/indicator. Both the **HIGH VOLTAGE ON** switch/indicator and the **HIGH VOLTAGE TRANSMITTER STATUS** indicator will illuminate.

2–187. Note the presence of plate voltage on the **PLATE VOLTAGE** meter.

2–188. If equipment is connected to the failsafe interlock, open the interlock. The **FAILSAFE TRANSMITTER STATUS** and **HIGH VOLTAGE** indicators will extinguish and the PA plate voltage will be removed.

2–189. Close the failsafe interlock. PA plate voltage will be restored, the transmitter will resume operation, and the **FAILSAFE TRANSMITTER STATUS** and **HIGH VOLTAGE** indicators will illuminate.

2–190. Operate the **MULTIMETER** switch to **IPA FORWARD POWER**.

2–191. Adjust the IPA unit **POWER ADJUST** control to obtain approximately 180 watts from the IPA stage.

2–192. Operate the **MULTIMETER** switch to **SCREEN VOLTAGE**.

2–193. Depress and hold the **RAISE** switch/indicator to obtain a screen voltage indication of 200 volts.

2–194. Operate the **MULTIMETER** switch to **IPA REFLECTED POWER**.

2–195. Adjust the **INPUT TUNING** control for a minimum reflected power indication.

CAUTION ***CHECK THE TRANSMITTER OUTPUT POWER INDICATION TO ENSURE TRANSMITTER OUTPUT POWER IS PRESENT.***

CAUTION

2–196. Note the presence of output power on the OUTPUT POWER meter. If no output power is indicated, perform the following:

1. Ensure the PA coarse tuning line is properly adjusted.
2. Adjust the **OUTPUT TUNING** control for a maximum indication on the **OUTPUT POWER** meter.

2–197. Depress the controller **RAISE** switch/indicator. Continue to depress the switch/indicator until the **OUTPUT POWER** meter indicates 20% power.

2–198. Depress the controller **VSWR** switch/indicator to illuminate the switch/indicator.

2–199. The **OUTPUT POWER** meter must indicate a VSWR of less than l.4:1. An excessive VSWR indicates improper load conditions.

2–200. Depress the controller **FWD** switch/indicator to illuminate the switch/indicator.

2–201. Operate the **MULTIMETER** switch to **IPA FORWARD POWER**.

2–202. Adjust the IPA unit **POWER ADJUST** control to obtain the IPA forward power value recorded on the factory test data sheets.

2–203. Operate the **MULTIMETER** switch to **IPA REFLECTED POWER**.

2–204. Adjust the **INPUT TUNING** control for a minimum reflected power indication.

2–205. Adjust the **OUTPUT TUNING** control for a maximum indication on the **OUTPUT POWER** meter.

2–206. Depress the controller **RAISE** switch/indicator. Continue to depress the switch/indicator until a 100% power indication is noted on the **OUTPUT POWER** meter. If a plate or screen current overload occurs, it may be necessary to adjust the **OUTPUT LOADING** for better efficiency before increasing power to 100%.

2–207. Operate the **MULTIMETER** switch to **IPA REFLECTED POWER.**

2–208. Adjust the **INPUT TUNING** control for a minimum reflected power indication. The IPA **REFLECTED POWER** indication will be in the NORMAL range.

2–209. Adjust the **OUTPUT LOADING** and **OUTPUT TUNING** controls to obtain the meter indications stated on the factory test data sheets.

2–210. Check the **FILAMENT VOLTAGE** meter and adjust the **FILAMENT ADJUST** control as required to obtain the level recorded on the final test data sheets.

CAUTION ***DO NOT EXCESSIVELY UNLOAD THE PA TANK CIRCUIT IN THE FOLLOWING STEP.***

CAUTION

2–211. Adjust the PA stage for the most efficient operation by adjusting the **OUTPUT TUNING** and **OUTPUT LOADING** controls for a maximum indication on the **OUTPUT POWER** meter concurrent with a minimum indication on the **PLATE CURRENT** meter.

2–212. Operate the **MULTIMETER** to **IPA REFLECTED POWER** and adjust the **INPUT TUNING** control for a minimum reflected power indication.

2–213. Depress the **RAISE** or **LOWER** switch/indicators as required to obtain a 100% OUTPUT POWER meter indication.

2–214. Compare the meter indications to those provided on the final test data sheets. All meter indications should be approximately the same as those stated on the final test data sheets.

2–215. Depress the **APC ON** switch/indicator. The switch/indicator will illuminate and the transmitter will maintain a constant 100% rated RF output.

2–216. To adjust the automatic power control unit to maintain a level other than 100%, the **APC ON** switch/indicator must be illuminated. Depress and hold either the **RAISE** or the **LOWER** switch/indicator as desired until the desired percentage of transmitter power output is indicated by the **OUTPUT POWER** meter. The automatic power control feature will then maintain this new established RF output level.

2–217. If remote operation is desired, the **REMOTE DISABLE** switch/indicator must be extinguished. TB1–17 on the remote interface circuit board provides a status signal which can be connected to a light or alarm to remind the engineer of the status of the remote disable switch. This feature will hopefully prevent inadvertent remote lockout if the engineer should leave the transmitter site and forget to enable remote operation.

SECTION III
OPERATION

3-1. **INTRODUCTION.**

3-2. This section identifies all controls and indicators associated with the FM-20T transmitter and provides standard operating procedures.

3-3. **CONTROLS AND INDICATORS.**

3-4. Refer to Figures 3-1, 3-2, and 3-3 for the location of all controls and indicators associated with normal operation of the FM-20T transmitter. The function of each control or indicator is described in Tables 3-1, 3-2, and 3-3.

3-5. **OPERATION.**

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

3-6. **TURN ON.**

3-7. Operate all circuit breakers to ON.

3-8. Depress the **REMOTE DISABLE** switch/indicator to illuminate the switch/indicator.

3-9. Depress the **FILAMENT ON** switch/indicator, then depress the **HIGH VOLTAGE ON** switch/indicator. Each switch/indicator will illuminate as it is depressed.

3-10. If all interlocks are closed, the transmitter will be operational after a short delay to allow PA tube filament warm-up.

3-11. Check and log all meter indications and the status of the various indicators to assure proper equipment operation. A sample log sheet is provided in Table 3-4.

3-12. Depress the **FWD** switch/indicator to illuminate the switch/indicator and check the forward power output.

NOTE ***NOTE*** ***THE VSWR METER IS MOST ACCURATE WHEN THE TRANSMITTER IS OPERATED AT 100% (NORMAL TPO) POWER. TRANSMITTER OPERATION AT A REDUCED POWER LEVEL WILL RESULT IN REDUCED VSWR METER ACCURACY.***

3-13. Depress the **VSWR** switch/indicator to illuminate the switch/indicator and check the VSWR.

3-14. Select the type of RF output power control:

A. If manual power control is desired, proceed as follows:

1. Depress the **APC ON** switch/indicator to extinguish the switch/indicator.
2. Depress the **RAISE** or **LOWER** switch/indicator to raise or lower the transmitter RF output power as indicated by the OUTPUT POWER meter.

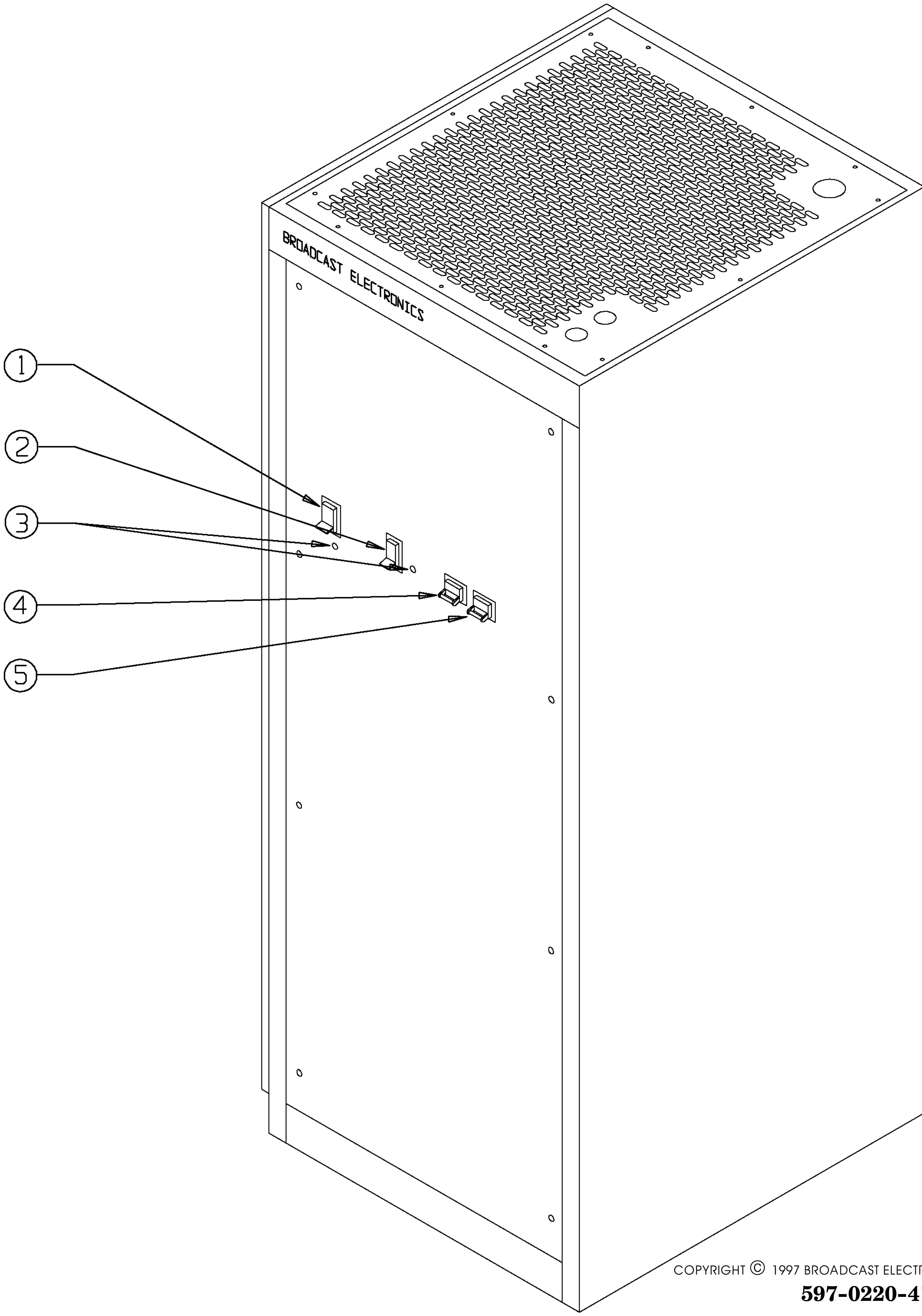


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FIGURE 3-1. FM-20T POWER SUPPLY CABINET CONTROLS AND INDICATORS

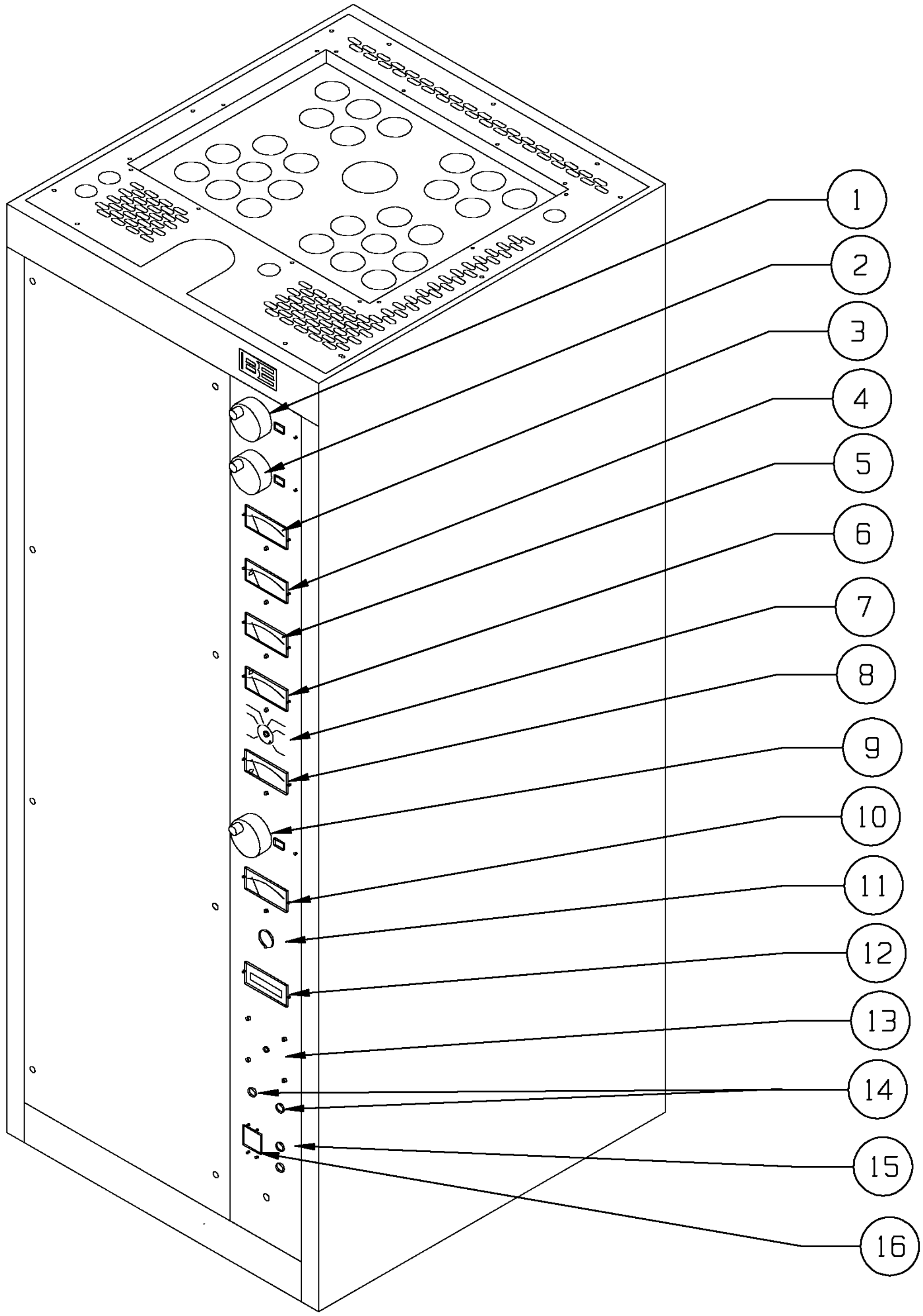

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FIGURE 3-2. FM-20T PA CABINET CONTROLS AND INDICATORS

B. If automatic power control is desired, depress the **APC ON** switch/indicator to illuminate the switch/indicator. To adjust the level at which the automatic power control circuitry will maintain, proceed as follows:

1. Depress the **APC ON** switch/indicator to illuminate the switch/indicator.
2. Depress the **RAISE** or **LOWER** switch/indicator to establish a new RF power output level as indicated by the OUTPUT POWER meter.

3–15. If remote operation is desired, depress the **REMOTE DISABLE** switch/indicator to extinguish the switch/indicator. This will enable both local and remote operation.

3–16. TURN OFF.

3–17. Depress the **FILAMENT OFF** switch/indicator. After a period of blower operation to allow the PA tube to cool, the equipment will de–energize.

3–18. OPERATING THE TRANSMITTER FOR MAXIMUM TUBE LIFE.

3–19. The FM–20T is equipped with an Eimac 4CX12000A/8989 tetrode. Maximum tube life is obtained by the implementation of a tube management program. A tube management program consists of operating and monitoring the transmitter to maintain an optimum tube filament voltage. This optimum voltage prevents premature de–carbonization of the tube filament and will result in maximum tube life. To maximize transmitter tube life, implement the procedures and operations presented in the following tube management program.

TUBE MANAGEMENT PROGRAM

1) Refer to APPENDIX A and perform the procedures presented in the Eimac publication titled "Extending Transmitter Tube Life – Eimac Application Bulletin No. 18. – March 1990".
2) Refer to APPENDIX A and the information presented in "Eimac Technical Data Sheet – 4CX12000A/8989 Tetrodes".
3) The procedures presented in any "Eimac Product Bulletins" shipped with the tube.

3–20. CONTINUOUSLY FLASHING CONTROLLER SWITCH/INDICATOR.

3–21. The FM–20T controller is equipped with an automatic remote/local control troubleshooting feature. This feature can determine if a remote control or a front–panel control is being continuously held in operation by a device such as a defective remote control unit. If a control is continuously held in operation, the front–panel switch/indicator will flash. If this condition occurs, contact the Broadcast Electronics RF Customer Service Department.

TABLE 3-1. FM-20T POWER SUPPLY CABINET CONTROLS AND INDICATORS (Sheet 1 of 2)

INDEX NO.	NOMENCLATURE	FUNCTION
1	**HIGH VOLTAGE** Circuit Breaker	Provides overload protection and primary power control of the PA high voltage plate supply.
2	**CONTROL** Circuit Breaker	Provides overload protection and primary power control for the transmitter controller, the PA RF drive components, PA screen supply, PA grid supply, PA filament supply, and the blower supply.
3	**CIRCUIT BREAKER** Test Button	Used to activate circuit breaker components to maintain reliable circuit breaker operation.

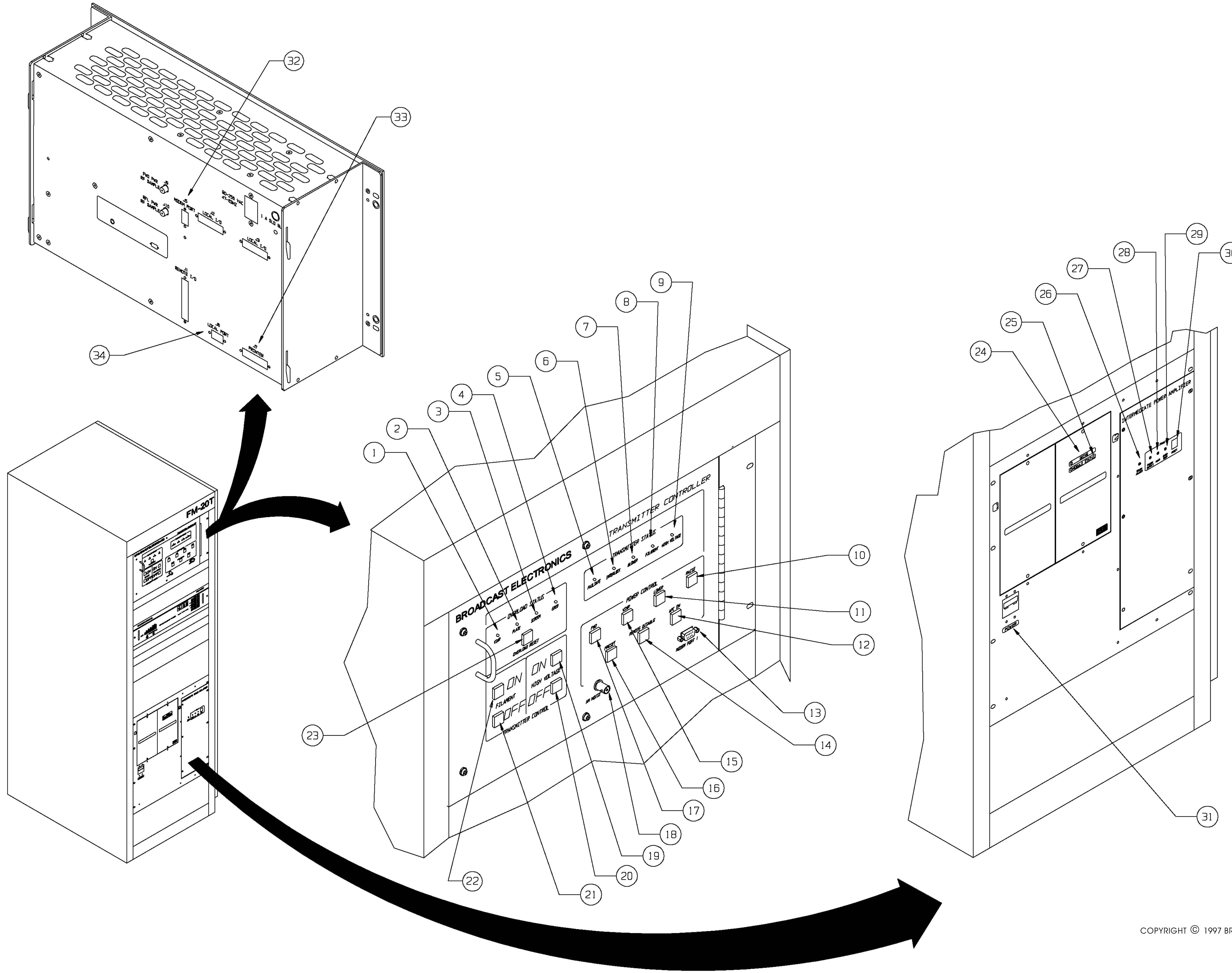

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FIGURE 3-3. FM-20T DRIVER CABINET CONTROLS AND INDICATORS

TABLE 3-1. FM-20T POWER SUPPLY CABINET CONTROLS AND INDICATORS (Sheet 2 of 2)

INDEX NO.	NOMENCLATURE	FUNCTION
4	**SCREEN** Circuit Breaker	Provides overload protection and primary power control for the PA screen power supply.
5	**FILAMENT** Circuit Breaker	Provides overload protection and primary power control for the PA filament power supply.

TABLE 3-2. FM-20T PA CABINET CONTROLS AND INDICATORS (Sheet 1 of 2)

INDEX NO.	NOMENCLATURE	FUNCTION
1	**OUTPUT TUNING** Control and Cyclometer	Tunes the PA stage output circuit to resonance.
2	**OUTPUT LOADING** Control and Cyclometer	Adjusts the PA stage output loading.
3	**OUTPUT POWER** Meter	Displays transmitter percentage of RF output power or output VSWR as selected by the **POWER CONTROL FWD** and **VSWR** switch/indicators.
4	**PLATE CURRENT** Meter	Displays the PA stage plate current.
5	**PLATE VOLTAGE** Meter	Displays the PA stage plate potential.
6	**MULTIMETER**	Displays PA **SCREEN VOLTAGE**, **SCREEN CURRENT**, **GRID CURRENT**, **GRID VOLTAGE**, **IPA FWD POWER**, or **IPA RFL POWER** as selected by the **MULTIMETER** switch.
7	**MULTIMETER** Switch	Selects PA **SCREEN VOLTAGE**, **SCREEN CURRENT**, **GRID CURRENT**, **GRID VOLTAGE**, **IPA FWD POWER**, or **IPA RFL POWER** parameters to be displayed on the **MULTIMETER**.
8	**FILAMENT VOLTAGE** Meter	Indicates the PA tube filament voltage.
9	**INPUT TUNING** Control and Cyclometer	Tunes the PA stage input circuit to resonance.

TABLE 3-2. FM-20T PA CABINET CONTROLS AND INDICATORS
(Sheet 2 of 2)

INDEX NO.	NOMENCLATURE	FUNCTION
10	**PRIMARY VOLTAGE** Meter	Displays PHASE 1-2, PHASE 2-3, or PHASE 3-1 primary ac input voltage potentials as selected by the **PRIMARY VOLTAGE** switch.
11	**PRIMARY VOLTAGE** Switch	Selects PHASE 1-2, PHASE 2-3, and PHASE 3-1 primary ac input voltage parameters to be displayed on the PRIMARY VOLTAGE meter.
12	**FILAMENT TIME** Meter	Indicates hours of filament circuit operation.
13	**FILAMENT ADJUST** Control	Adjusts the PA tube filament voltage.
14	**GRID BIAS** Circuit Breakers	Provides overload protection for the PA grid power supply.
15	**DRIVER** Circuit Breakers	Provides overload protection and primary power control for the FM exciter, optional SCA and stereo generator units, the IPA unit, and the driver cabinet flushing fans.
16	**BLOWER** Circuit Breaker	Provides overload protection and primary power control for the blower.

TABLE 3-3. FM-20T DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 1 of 5)

INDEX NO.	NOMENCLATURE	FUNCTION
1	**VSWR OVERLOAD** Indicator	Indicates a PA stage VSWR overload has occurred when illuminated.
2	**PLATE OVERLOAD** Indicator	Indicates a PA plate circuit overload has occurred when illuminated.
3	**SCREEN OVERLOAD** Indicator	Indicates a PA screen circuit overload has occurred when illuminated.
4	**GRID OVERLOAD** Indicator	Indicates a PA grid power supply overload has occurred when illuminated.
5	**FAILSAFE STATUS** Indicator	Indicates the failsafe interlock is closed when illuminated.

TABLE 3-3. FM-20T DRIVER CABINET CONTROLS AND INDICATORS (Sheet 2 of 5)

INDEX NO.	NOMENCLATURE	FUNCTION
6	**INTERLOCK STATUS** Indicator	Indicates all transmitter internal interlocks are closed when illuminated.
7	**BLOWER STATUS** Indicator	Indicates proper operation of the blower when illuminated.
8	**FILAMENT STATUS** Indicator	Indicates primary ac power is applied to the PA filament regulator when illuminated.
9	**HIGH VOLTAGE STATUS** Indicator	Indicates the plate power supply is operational when illuminated.
10	**POWER CONTROL RAISE** Switch/Indicator	SWITCH: In the automatic mode, moves the APC reference upward when depressed. In the manual mode, operates the screen control motor in a direction which will raise transmitter RF output power when depressed. INDICATOR: Illuminates to indicate the screen control motor is operating in a direction which will raise the transmitter RF power output.
11	**POWER CONTROL LOWER** Switch/Indicator	SWITCH: In the automatic mode, moves the APC reference downward when depressed. In the manual mode, operates the screen control motor in a direction which will reduce transmitter RF output power when depressed. INDICATOR: Illuminates to indicate the screen control motor is operating in a direction which will lower the transmitter RF power output.
12	**POWER CONTROL APC ON** Switch/Indicator	SWITCH: Selects APC control operation of the transmitter. INDICATOR: Indicates the transmitter is under APC control when illuminated.
13	**MODEM PORT 1**	A modem port used with RTDS.
14	**POWER CONTROL REMOTE DISABLE** Switch/Indicator	SWITCH: Inhibits or enables transmitter remote operation. INDICATOR: Indicates remote operation is inhibited when illuminated.

TABLE 3-3. FM-20T DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 3 of 5)

INDEX NO.	NOMENCLATURE	FUNCTION
15	**POWER CONTROL VSWR** Switch/Indicator	SWITCH: Configures the **OUTPUT POWER** meter to display VSWR. INDICATOR: Illuminates to indicate the **OUTPUT POWER** meter is configured to display VSWR.
16	**POWER CONTROL PRESET** Switch/Indicator	SWITCH: Selects transmitter operation at a preset RF power output level. INDICATOR: Indicates transmitter operation at a preset RF power level (such as half power) when illuminated.
17	**POWER CONTROL FWD** Switch/Indicator	SWITCH: Configures the **OUTPUT POWER** meter to display forward power. INDICATOR: Illuminates to indicate the **OUTPUT POWER** meter is configured to display forward power.
18	**AM NOISE TEST** Receptacle	Test receptacle for AM noise measurements.
19	**HIGH VOLTAGE ON** Switch/Indicator	SWITCH: Energizes the step/start contactors when depressed to activate the plate and screen power supplies and enables the RF drive. INDICATOR: Indicates a high voltage–on command has been received by the transmitter controller.
20	**HIGH VOLTAGE OFF** Switch/Indicator	SWITCH: Deenergizes the plate and screen power supplies and mutes RF drive when depressed. INDICATOR: Indicates a high voltage–off command has been received by the transmitter controller.
21	**FILAMENT OFF** Switch/Indicator	SWITCH: Deenergizes all transmitter RF circuit power. The blower and flushing fans will operate for approximately thirty–five seconds after the **FILAMENT OFF** switch has been depressed. INDICATOR: Indicates a filament–off command has been received by the transmitter controller.
22	**FILAMENT ON** Switch/Indicator	SWITCH: 1) Energizes the control contactor when depressed to apply voltage to the exciter, IPA unit, filament circuitry, and grid circuitry. 2) Energizes the blower and flushing fans. INDICATOR: Indicates a filament–on command has been received by the transmitter controller.

TABLE 3-3. FM-20T DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 4 of 5)

INDEX NO.	NOMENCLATURE	FUNCTION
23	**OVERLOAD RESET** Switch/Indicator	SWITCH: Clears the overload circuit memory when depressed. INDICATOR: Indicates an overload condition exists when illuminated.
24	**MODULE DRIVE** Indicator	Illuminates to indicate the presence of RF drive at the RF power amplifier module.
25	**MODULE STATUS** Indicator	Displays the operating status of the RF power amplifier module. **RED DISPLAY**: Indicates an RF power module fault. RF power module faults include: 1) over–current, 2) over–temperature, 3) high reflected power, and 4) high forward power demand. **YELLOW DISPLAY:** Indicates an RF power module current limit, VSWR limit, high forward power demand limit, or transmitter off condition. **GREEN DISPLAY**: Indicates normal RF power module output operation. Will illuminate if no RF drive is present.
26	**POWER ADJUST** Control	Adjusts the IPA RF power output.
27	**POWER SUPPLY FAULT** Indicator	Illuminates to indicate an IPA power supply fault.
28	**VSWR FAULT** Indicator	Illuminates to indicate a 30 watt reflected power condition is present at the IPA RF output.
29	**OVER TEMP FAULT** Indicator	Illuminates to indicate a greater than 80 Degree C condition is present at the RF power module heatsink.
30	**FAULT RESET** Switch/Indicator	SWITCH: Clears the fault circuitry if: 1) the switch is depressed and 2) the fault condition is removed. INDICATOR: Illuminates to indicate: 1) a power supply fault, 2) a VSWR fault, or 3) a module over temperature fault. During high temperature and VSWR faults, the controller will foldback IPA forward power to maintain operation.
31	**POWER** Circuit Breaker	Provides overload protection and primary power control for the IPA.
32	**MODEM PORT 2**	A modem port used with RTDS.

TABLE 3-3. FM-20T DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 5 of 5)

INDEX NO.	NOMENCLATURE	FUNCTION
33	**PRINTER PORT**	A printer port used with RTDS.
34	**LOCAL PORT**	A communication port used with RTDS.

TABLE 3-4. INDICATOR CHECKLIST

INDICATOR	STATUS		
FAILSAFE STATUS	ON	OFF	
INTERLOCK STATUS	ON	OFF	
BLOWER STATUS	ON	OFF	
FILAMENT STATUS	ON	OFF	
HIGH VOLTAGE STATUS	ON	OFF	
VSWR OVERLOAD	ON	OFF	NOTE
PLATE OVERLOAD	ON	OFF	OPERATIONAL STATUS SHOWN BY SHADED INDICATOR
SCREEN OVERLOAD	ON	OFF	
GRID OVERLOAD	ON	OFF	
OVERLOAD RESET SWITCH/INDICATOR	ON	OFF	
FILAMENT ON SWITCH/INDICATOR	ON	OFF	
HIGH VOLTAGE ON SWITCH/INDICATOR	ON	OFF	
REMOTE DISABLE SWITCH/INDICATOR	ON OR	OFF	
PRESET SWITCH/INDICATOR	ON	OFF	
APC ON SWITCH/INDICTOR	ON	OFF	
LOWER SWITCH/INDICATOR	ON	OFF	
RAISE SWITCH/INDICATOR	ON	OFF	
IPA POWER SUPPLY FAULT	ON	OFF	
IPA VSWR FAULT	ON	OFF	
IPA OVER TEMP FAULT	ON	OFF	
IPA FAULT RESET	ON	OFF	

METER	INDICATION	
	POWER	VSWR
OUTPUT POWER	%	:1
PLATE CURRENT	A	
PLATE VOLTAGE	kV	
MULTIMETER		
SCREEN VOLTAGE	V	
SCREEN CURRENT	mA	
GRID VOLTAGE	V	
GRID CURRENT	mA	
EXCITER FWD POWER	W	
EXCITER REFLECTED POWER	W	
FILAMENT VOLTAGE	V	
FILAMENT TIME	HOURS	

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SECTION IV
THEORY OF OPERATION

4–1. INTRODUCTION.

4–2. This section presents the theory of operation for the Broadcast Electronics FM–20T transmitter.

4–3. The FM–20T transmitter is divided into functional blocks which are discussed by the following text. The functional blocks consist of the FM exciter, the intermediate power amplifier (IPA), the power amplifier, the transmitter controller, metering circuitry, and the associated power supply circuitry. The power supply and RF circuitry are discussed in further detail at the end of this section. The IPA and the transmitter controller are described in detail by the modular publications in Part II of this manual. Refer to Figure 4–1 and the overall schematic diagram in SECTION VII as required for the following explanation.

4–4. ELECTRICAL DESCRIPTION.

4–5. FM EXCITER.

4–6. The Broadcast Electronics FX–50 is a totally solid–state wideband FM exciter providing a continuously variable RF output from 3 to 50 watts. The FX–50 operates into a 50 Ohm load at any frequency within the 87.5 to 108 MHz FM broadcast band. The exciter is equipped with a digital frequency synthesizer which may be programmed to any frequency within FM band in 10 kHz increments. The FX–50 exciter is mounted on slides to allow easy access to the internal semi–modular exciter circuitry.

4–7. The FX–50 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 597–1050 for detailed explanation of the FX–50 exciter features.

4–8. INTERMEDIATE POWER AMPLIFIER UNIT.

4–9. The IPA unit consists of: 1) an RF power module, 2) a switching power supply module for the amplifier circuit, 3) a switching power supply module for the controller circuitry, and 4) a controller. The IPA unit RF power module provides an overall gain of approximately 20 to output approximately 375 watts of power to drive the FM–20T PA stage. RF drive for the IPA stage is provided by the FX–50 FM exciter. The output of the exciter is routed directly to the IPA stage. The IPA unit outputs approximately 375 watts of power to drive the transmitter PA stage. The IPA stage is also equipped monitoring and metering circuitry.

4–10. The RF amplifier module consists of an RF amplifier circuit board, a logic circuit board, a combiner, and a low–pass filter circuit board, and a directional coupler circuit board assembly. The RF amplifier circuit board contains a microstrip splitter, microstrip and capacitive matching networks, and two power MOSFET transistors. The circuitry is designed to generate approximately 500 watts of RF power. The RF amplifier module logic circuit board is equipped with: 1) a power level control circuit, 2) over–voltage, over–current, over–temperature circuitry, 3) fault detection circuitry, and 4) reflected/forward power limit circuitry. The combiner circuit board contains a microstrip combiner. The directional coupler circuit board is equipped with a forward power directional coupler circuit and a reflected power directional coupler circuit. The low–pass filter circuit board is equipped with a low–pass filter circuit.

4–11. **POWER AMPLIFIER.**

4–12. The FM–20T power amplifier operates from a single high–power efficient tetrode to provide 7.5 kW to 22 kW of RF output power on a single frequency within the FM broadcast band of 87.5 MHz to 108 MHz. The power amplifier operates in a high–gain, grid–driven Class C configuration. Removal of the PA tube is simple and quick due to the cavity arrangement. A massive blower cooling system forces air through the tube socket, anode fins, and out through the main transmission line chimney. A differential air pressure sensor monitors the effectiveness of the cooling system and removes power to the tube if air flow is interrupted.

4–13. **POWER AMPLIFIER CAVITY.** The FM–20T PA stage employs a patented folded half–wave coaxial cavity constructed with aluminum sheet metal and copper tubing. The cavity design eliminates the high voltage blocking capacitors and high current sliding contacts of conventional cavities through a unique tuning and output coupling technique. A grounded concentric copper center conductor tunes the cavity by varying the length inserted into the open end of a transmission line inner conductor. The main inner conductor is insulated from ground and carries the anode dc potential. DC power is applied at the RF voltage null point, approximately one–quarter wave from the anode for effective RF decoupling. An untuned output loop is used to couple the RF energy into the transmission line.

4–14. **INPUT CIRCUIT.** The input circuit consists of a patented broadband impedance matching circuit board and a variable inductor tuning network. The impedance matching circuit board utilizes a combination of etched series inductor and shunt capacitor elements to match the 50 Ohm output of the IPA stage to the high grid impedance of the PA tube over the 88 MHz to 108 MHz FM broadcast band. The input tuning network consists of two variable inductor assemblies. Coarse input tuning is accomplished by pre–adjusting a sliding–short variable inductor assembly. Fine input tuning is accomplished by a front–panel control which adjusts a second sliding–short variable inductor assembly.

4–15. **OUTPUT COUPLING.** Energy is coupled into the transmission line by an adjustable untuned loop which functions in the electromagnetic field within the cavity. One end of the output loop is connected to ground, while the other connects to the center conductor of the output transmission line through flexible straps.

4–16. **OUTPUT TUNING.** Output tuning is accomplished by adjusting a threaded rod which mechanically expands or contracts a beryllium copper bellows on the end of the grounded transmission line center conductor which is inserted into the main line. Coarse frequency adjustment is accomplished by pre–setting the length of the center conductor into the cavity.

4–17. **NEUTRALIZATION.** Neutralization is accomplished in the PA cavity by an adjustable distributed inductance which develops a counteractive voltage swing between the screen and ground. This cancels out the voltage fed through the internal capacitances of the tube and the stray capacitances of the tube socket. This form of self–neutralization results in very stable operation and requires no adjustment when the power tube is replaced.

4–18. **SECOND HARMONIC SUPPRESSOR.** A patented second harmonic suppressor is incorporated into the PA cavity design. This consists of a capacitive disc and a series inductance to ground coupled to the main transmission line at the fundamental frequency RF voltage null point. Here, the second harmonic exhibits a high voltage and the suppressor presents a low impedance to ground which reduces the amplitude of the second harmonic. This unique method of harmonic suppression has minimal effect on the fundamental frequency and does not add losses to the PA cavity at the fundamental frequency.

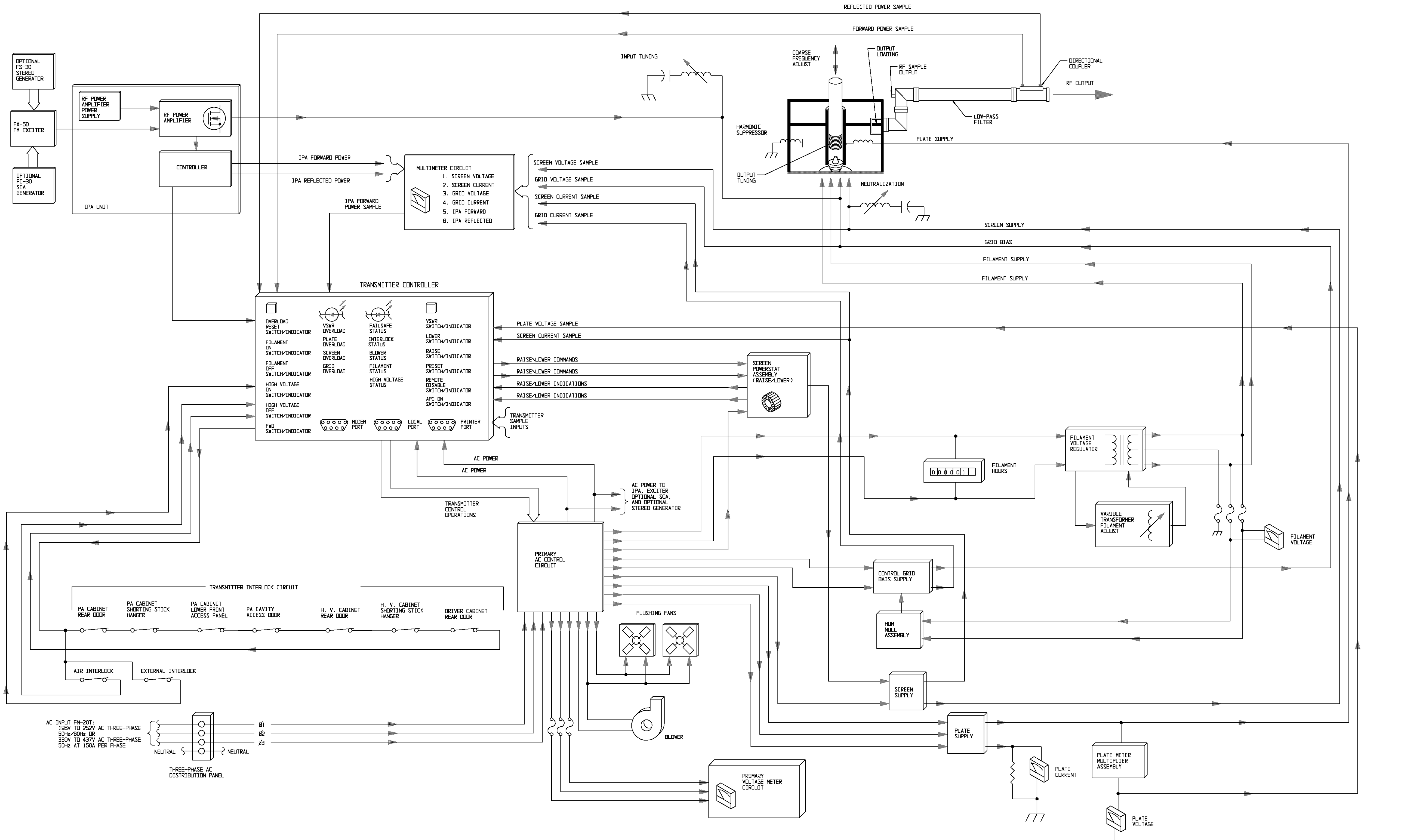

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FIGURE 4-1. FM-20T BLOCK DIAGRAM

4–19. **OUTPUT CIRCUIT.** A low–pass filter is provided with the FM–20T to attenuate all residual second and higher order harmonics. This filter functions over the entire FM broadcast band. Two RF directional couplers are mounted after the filter in the output transmission line connection to provide filtered forward and reflected power RF samples to the automatic power control unit. A third port supplies an RF sample at 40 dB below carrier at 50 Ohms for external test equipment.

4–20. **TRANSMITTER CONTROLLER.**

4–21. Transmitter control operations and parameter monitoring are performed by a built–in microprocessor based controller. The controller incorporates extensive use of RFI filtering, optical isolation, and state–of–the–art microprocessor technology to assure maximum reliability.

4–22. The controller is designed with 12 switch/indicators, 9 status indicators, 3 modem ports, and a printer port. Adjustable timers are provided to determine filament warm–up time, blower run–down time, overload–recycle time, and warm–up defeat time. In addition, the controller is equipped with adjustable plate, screen, grid, and VSWR overload limits. The timers and the overload limits are adjusted by controls on the main circuit board. The range of all controls is limited, however so that the safe operating limits of the transmitter cannot be exceeded by incorrect adjustment.

4–23. All transmitter control and monitoring operations are directed by a state–of–the–art Z–SOFT microcontroller. The microcontroller is housed on a single plug–in daughter circuit board. The circuit board plugs directly into a header on the controller main circuit board.

4–24. The controller operates from a modular switching power supply assembly. Three LEDs on the main circuit board monitor the status of the +5V, +15V, and –15V power supplies. A Lithium battery backup system has been incorporated into the circuit design. The battery is designed to maintain the controller memory during power failures and has a useful life of approximately 5 years.

4–25. The transmitter controller performs several operations. The following text presents a description of the major controller functions.

4–26. **AUTOMATIC RF OUTPUT LEVEL CONTROL.** The controller is designed to provide manual and automatic RF output power level controller. When the unit is configured for automatic power control (APC) operation, the controller monitors screen current, PA forward power, PA reflected power, and the exciter forward power and automatically adjusts the PA screen voltage via a dc servo motor–driven variable autotransformer to maintain a constant transmitter RF output. If excessive PA reflected power, excessive screen current, or low exciter power is measured, the “raise power” command will be inhibited to prevent an overload from occurring. Manual screen control is assumed by switching the APC feature to off. In the manual mode the raise and lower switches directly control the dc servo motor to vary the screen voltage supply. In the APC mode, the switches control a reference voltage stored in the microprocessor memory. This memory is maintained by the battery backup system so that the transmitter can automatically return to the desired power level whenever power is applied.

4–27. The dc servo motor control circuit uses a full–on/full–off scheme to drive the dc servo motor. This feature, combined with a deadband, eliminates hunting in this servo loop. The front panel **RAISE** and **LOWER** switches illuminate when the motor is driven by manual or automatic operation.

4–28. **VSWR FOLDBACK PROTECTION.** When the unit is in the APC mode, PA forward power is automatically reduced if output reflected power becomes excessive enough to overload the transmitter. As the condition which caused the high VSWR returns to normal, RF power will be proportionately raised until full power is again restored.

4–29. **SOFT START.** The controller monitors PA plate voltage and reduces the screen voltage to zero upon its absence. When the plate supply is energized, as during initial turn on, the controller will gradually increase the screen voltage until the stored power setting is achieved. This prevents inadvertent VSWR overloads at turn on, such as during icing of an antenna.

4–30. **MOMENTARY POWER INTERRUPTION.** In the event of a momentary power interruption, proper transmitter operation will resume immediately after power returns. If an extended power failure occurs, information maintained by the battery back–up system will enable the controller to initiate a start cycle to automatically return the transmitter to operation without assistance. If the transmitter internal interlock string opens during a power failure, the automatic restart feature will be defeated and the transmitter will enter the off condition when power is re–applied.

4–31. **OVERLOADS.** If an overload occurs, the transmitter will deenergize, allow the overload to clear, then automatically return to operation. If four overloads occur within 60 seconds, the transmitter will deenergize. The overload must be manually cleared and the transmitter **HIGH VOLTAGE ON** switch/indicator depressed before operation will resume. Single overloads of greater than 220 milliseconds duration will immediately deenergize the high voltage and filament supplies.

4–32. **INDICATORS.** Four LEDs are provided on the front panel as overload status indicators. The first overload that occurs will be latched into the controller and will illuminate the appropriate red VSWR, PLATE, SCREEN, or GRID LED and the yellow overload reset switch/indicator. All further overloads are monitored by the controller but will not be displayed by the LEDs.

4–33. Five STATUS indicators illuminate to indicate an operational condition as follows: 1) the **FAILSAFE** LED indicates the external interlock is closed, 2) the **INTERLOCK** LED indicates that the internal interlock loop is closed, 3) the **BLOWER** LED indicates that the air pressure is correct for the PA stage to operate, 4) the **FILAMENT** LED indicates primary ac power is applied to the filament transformer, and 5) the **HIGH VOLTAGE** LED indicates primary ac power is applied to the high voltage plate supply.

4–34. **METERING.**

4–35. Seven front panel meters are provided to indicate transmitter operating parameters. Output power and output VSWR indications are presented on a precision output power meter. Plate voltage and plate current information are displayed on separate meters for optimum convenience.

4–36. Additional transmitter metering features include an six function multimeter. The multimeter selects and displays information on vital transmitter operating parameters such as: 1) screen current, 2) screen voltage, 3) grid current, 4) grid voltage, 5) IPA forward power, and 6) IPA reflected power. An iron–vane voltmeter is used to measure filament voltage. A FILAMENT TIME meter is provided to indicate hours of filament circuit operation. Primary ac voltage monitoring is provided by a primary ac voltmeter. The meter selects and displays the voltage between all three phases of the ac input. All meter currents are measured on the ground side of each supply to prevent high voltages across the meters.

4–37. **EXCITER METERING.** The exciter operating parameters are displayed by two additional meters and three status indicators. For detailed information on exciter metering, refer to FX–50 exciter manual 597–1050.

4–38. **POWER SUPPLIES.**

4–39. A three–phase ac input of 196 to 252 volts or 339 to 437 volts is required to operate the transmitter internal power supplies. The plate power supply requires a three phase ac input with the remainder of the power supplies requiring conventional 220V single–phase circuits obtained from two phases of the three–phase input. Power to the plate supply is applied in two steps to reduce the inrush current at power–on to limit stress and extend component life in the plate supply.

4–40. The control grid bias and screen power supplies consist of conventional full–wave rectification circuits with choke input filter sections. A hum–null circuit consisting of a transformer and potentiometer assembly injects a small 60 Hz component in series with the ground return of the grid supply to cancel residual ripple from the tetrode amplifier.

4–41. The plate supply is a three–phase primary, six–phase secondary supply. The primary circuit is connected in a closed delta arrangement and the secondary is connected in a wye configuration. Advantages of this type of supply is good regulation and a low percentage of ripple output which requires little filtering.

4–42. The filament supply consists of a variable transformer assembly which is used to adjust a high–current low–voltage regulator assembly. A regulator assembly provides a stable input voltage environment for the supply. The device will regulate a wide range of ac input potentials to create a stable 240 ±1% volt output.

4–43. Each modular component of the transmitter is equipped with a self–contained ac power supply. In addition, a battery back–up supply in the transmitter controller maintains operational information during power outages.

4–44. DETAILED DESCRIPTION.

4–45. **POWER SUPPLIES.**

4–46. The FM–20T requires a three–phase power source of 196V to 252V ac 50/60 Hz or 339V to 437V ac 50 Hz at 150 amperes per phase maximum (refer to Figure 4–2). The following list presents approximate operating voltage and currents of the transmitter for a 20 kW RF power output.

PARAMETER	APPROXIMATE VALUES
A. PA PLATE	+9200V at 2.7 Amperes
B. PA SCREEN GRID	+700V at 0.13 Amperes
C. PA CONTROL GRID	–310V at 0.050 Amperes
D. PA FILAMENT	6.5V ac at 120 Amperes

4–47. **SEQUENCE OF OPERATION.**

4–48. When the transmitter fused disconnect is closed, three–phase ac power is distributed to the **HIGH VOLTAGE** (CB301) and **CONTROL** (CB302) circuit breakers. Closing the circuit breakers routes ac power to the following circuitry:

CIRCUIT BREAKER	CIRCUITRY
HIGH VOLTAGE	Power amplifier plate and screen supplies.
CONTROL	Transmitter controller, and a transmitter ac control circuit (grid supply, filament supply, exciter, IPA unit, and optional stereo and SCA generators).

4–49. AC power is routed to the controller when the **CONTROL** circuit breaker (CB302) is closed. A start sequence is initiated when the **FILAMENT ON** switch/indicator is depressed. Logic from the controller will enable optically–coupled–relay K306. K306 will energize control contactor K303 which applies ac power to **BLOWER** circuit breaker CB202, **FILAMENT** circuit breaker CB202, **DRIVER** circuit breaker CB201, and **SCREEN** circuit breaker CB303. When **BLOWER** circuit breaker CB202 is closed, ac power will be applied to blower B202. The blower will begin operation and the air interlock switch will close. With the air interlock and all transmitter safety interlocks closed, logic from the controller will enable filament optically–coupled–relay K307. With **FILAMENT** circuit breaker CB304 closed, K307 will apply ac power to the PA filament supply and the control grid bias supply. AC power will be applied to the driver cabinet flushing fans, exciter, optional stereo and SCA generators and IPA unit when **DRIVER** circuit breaker CB201 is closed.

4–50. Assuming the **HIGH VOLTAGE ON** switch/indicator has been depressed, and the PA filament heating delay of at least ten seconds has expired, logic from the controller will enable optically–coupled–relays K304 and K305. K304 will energize step contactor K302 which limits plate supply current inrush through resistors R301, R302, and R303. K305 will energize start contactor K301 to apply full input potential to the plate supply and screen supplies.

4–51. If during a start sequence a safety interlock opens, the entire start sequence will be cancelled and must be re–initiated manually. If a safety interlock opens during operation, the entire power supply section will deenergize. If the interlock is promptly closed, the blower and flushing fans will resume operation to cool the PA tube. To continue transmitter operation, a new manually initiated start sequence is required.

4–52. If the **HIGH VOLTAGE OFF** switch/indicator is depressed, the plate and screen power supplies will deenergize. If the **FILAMENT OFF** switch/indicator is depressed, all remaining power supplies will deenergize. The blower and flushing fans will continue operation for 30 seconds or more to cool the PA tube, then deenergize.

4–53. PA PLATE POWER SUPPLY.

4–54. Three–phase ac power for the PA plate supply is applied to transformer T301. T301 is a three–phase primary, six–phase secondary transformer. The primary winding is connected in a closed delta arrangement and protected by circuit breaker CB301. The secondary winding is connected in a wye configuration. Component stress at power on is eliminated by a step/start circuit which limits supply in–rush current.

4–55. Full–wave rectification is accomplished through high–voltage rectifier diodes D301 through D306. Filtering for the supply is accomplished by a one–section choke–input filter (L301). The choke is inserted in the negative leg of the rectified output to eliminate the dc potential between the choke and ground. Shunt capacitor C301 bypasses residual ac ripple frequencies above 360 Hz to ground. Bleeder resistors R307 through R309 increase regulation and operate in association with the high voltage discharge switch to enhance safety. A series resistance in the anode dc feedline functions to limit peak energy in case of arc–overs in the power amplifier stage. A one–half voltage supply tap is provided for transmitter troubleshooting. Plate voltage metering samples are generated by a plate meter multiplier assembly.

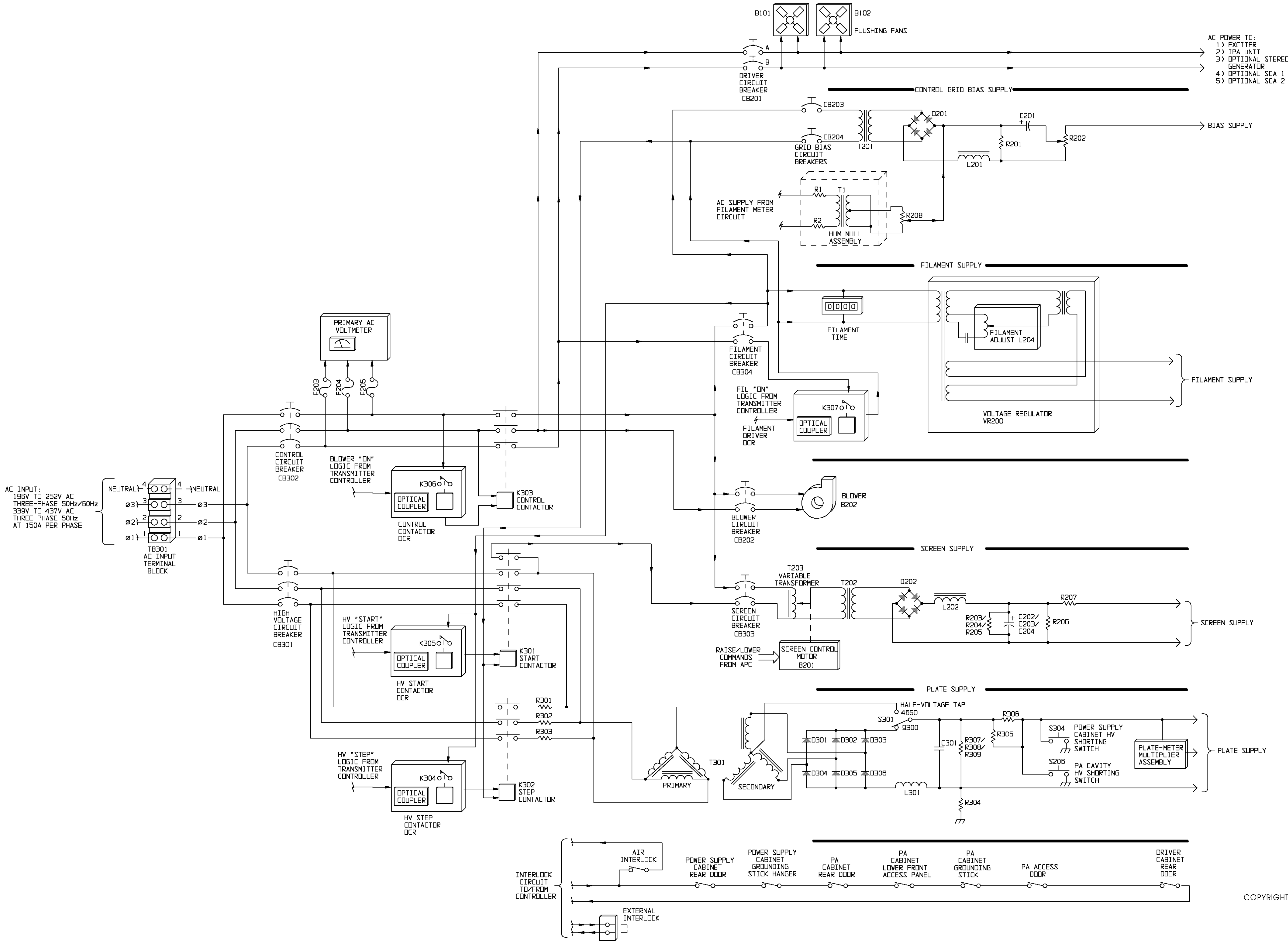

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FIGURE 4-2. FM-20T POWER SUPPLY SIMPLIFIED SCHEMATIC

4-56. Component stress at power-on is eliminated by a high voltage step/start circuit which limits the plate supply inrush current. The step/start circuit is interlocked through the control contactor and filament circuit breaker to assure the filament circuit is energized before a high-voltage-on sequence is initiated. A high-voltage-on sequence begins when the controller energizes step contactor K302 via K304. After100 milliseconds, the controller will energize start contactor K301 via K305. Next, the step contactor will deenergize after 160 milliseconds. In this manner, the current limiting resistors will only be subject to heating during a 100 millisecond interval between the step contactor and start contactor closures.

4-57. **PA SCREEN POWER SUPPLY.** The screen power supply is a full-wave bridge-rectified supply with a LC filter consisting inductor L202 and capacitors C202 through C204. Resistors R203 through R205 equalize the voltage across the capacitors. Overload protection for the circuit is provided by circuit breaker CB303. AC power transformation is performed by screen transformer T202. The primary of T202 is connected to a variable autotransformer which is used to adjust the screen supply output. A dc motor connected to the variable autotransformer allows both manual and automatic control of the screen voltage. Bleeder resistor R206 improves regulation and enhances safety. Resistor R207 is incorporated into the circuit to limit the current inrush.

4-58. **PA CONTROL GRID BIAS POWER SUPPLY.** The control grid bias supply is a full-wave bridge-rectified supply with an LC filter consisting of inductor L201 and capacitor C201. The circuit is protected from overloads by circuit breakers CB203 and CB204. Primary power transformation is provided by transformer T201. Bleeder resistor R201 improves regulation and enhances safety by discharging C201. Potentiometer R202 is provided to limit the current inrush.

4-59. **Hum-Null Circuit.** The hum-null circuit consists of a transformer and potentiometer assembly. The circuit is designed to introduce a small 60 Hz voltage into the control grid bias supply to cancel hum in the filament supply. The canceling voltage is obtained from the filament transformer secondary and is out-of-phase with the filament supply 60 Hz ripple component. The amplitude of the 60 Hz signal is adjusted by resistor R208.

4-60. **PA FILAMENT SUPPLY.** The PA filament supply is a low-voltage high-current ac supply obtained from optically-coupled-relay K307. Overload protection for the circuit is provided by circuit breaker CB304. Filament voltage regulator VR200 provides a stable ac input voltage environment. Variable transformer L204 allows accurate filament voltage adjustment. A FILAMENT TIME meter indicates hours of filament circuit operation.

4-61. **BLOWER SUPPLY.** Transmitter blower B202 operates from a conventional 220 volt single-phase supply. The supply is obtained from control contactor K303. Overload protection for the circuit is provided by circuit breaker CB202.

4-62. **DRIVER SUPPLY.** The driver supply provides ac power for the driver cabinet flushing fans, the exciter, the IPA unit, the optional stereo generator, and the optional SCA generators. Overload protection for the circuit is provided by circuit breaker CB201. The supply is obtained from control contactor K303.

4-63. **RF CIRCUITRY.**

4-64. **FM EXCITER.** The modulated FM signal for RF circuit operation is generated by the FX-50 FM exciter (refer to Figure 4-3). Approximately 20 Watts of drive is required from the exciter to operate the FM-20T IPA stage. Refer to publication 597-1050 for a complete description of the FM exciter circuitry.

4-65. **INTERMEDIATE POWER AMPLIFIER UNIT.** The FM-20T IPA unit consists of: 1) an RF power module, a switching power supply module, and a controller. The IPA unit provides an overall gain of approximately 20 to output approximately 375 watts of power to drive the FM-20T PA stage.

4-66. **RF Power Module.** The output of the exciter is applied to solid-state 500 watt RF amplifier module. The RF amplifier module consists of an RF amplifier circuit board, a logic circuit board, a combiner, and a low-pass filter circuit board, and a directional coupler circuit board assembly. The RF amplifier circuit board consists of a two-stage power MOSFET amplifier circuit with input/output matching and balun circuitry. The logic circuit board controls the operation of the RF amplifier circuit and monitors the circuit for fault conditions. A combiner circuit combines the outputs of the two stages to provide a single 500 watt output. The low-pass filter circuit board removes all frequencies above the FM broadcast band. The directional coupler circuit board provides forward and reflected power samples to the logic circuit board.

4-67. **Switching Power Supply Module.** The IPA stage is equipped with a switching power supply module. The module provides a variable +48V dc supply to the RF power amplifier module. The module is equipped with over-current, over-voltage, under-voltage, and over-temperature protection circuitry. The output of the supply is controlled by the IPA controller.

4-68. **IPA Controller.** The IPA stage is equipped with a controller. The controller is designed to monitor the operation of the RF amplifier module and the switching power supply module. The controller circuitry consists of three indicators, a power adjust control, and a reset switch. The three indicators present the status of IPA reflected power, over-temperature, and power supply fault. The power adjust control adjusts the IPA unit output power. The reset switch resets the fault circuitry after an over-temperature, VSWR, module fault, or a power supply fault condition.

4-69. **POWER AMPLIFIER.** The FM-20T PA stage contains a single tetrode operated as a class C amplifier in a folded half-wave cavity to provide the rated RF power output. The amplifier operates in a grid driven configuration and exhibits high efficiency and ease of maintenance. The following text describes the operation of components and circuits within the PA stage.

4-70. **PA Input Circuit.** The transmitter IPA stage impedance is matched to the tube grid impedance by an input matching circuit board assembly. The circuit board consists of series inductor and shunt capacitor elements which are etched into the copper-clad laminate. The multiple LC sections match the 50 Ohm IPA impedance to the higher grid circuit impedance of the PA tube. The last LC section on the circuit board is equipped with three taps. Tap B provides standard input matching characteristics. Taps A and C provide alternate input matching characteristics for special operating conditions.

4-71. The input circuit is adjusted to match the 50 Ohm IPA impedance to the higher input impedance of the grid over the 88 MHz to 108 MHz FM broadcast band by input tuning inductor networks L10/C11, L19/C19, and L9/C10. The LC networks are connected in parallel and employ sliding shorts to tune the grid capacitance to resonance. C10, C11, and C19 also function as RF bypass and dc blocking capacitors.

4-72. The L19/C19 network is configured as a frequency dependent coarse tuning component. The L10/C11 network is also configured as a coarse tuning component and is adjusted by a control at the rear of the RF enclosure. Fine tuning is accomplished by the L9/C10 network which is mechanically connected to the front panel input tuning control. Capacitors C4 and C5 are provided for dc blocking operations. Swamping network R2/C16 lowers the Q of the input circuit to increase the bandwidth. This input tuning circuit design provides a wide operating bandwidth and improves the reliability, stability, and maintainability of the transmitter.

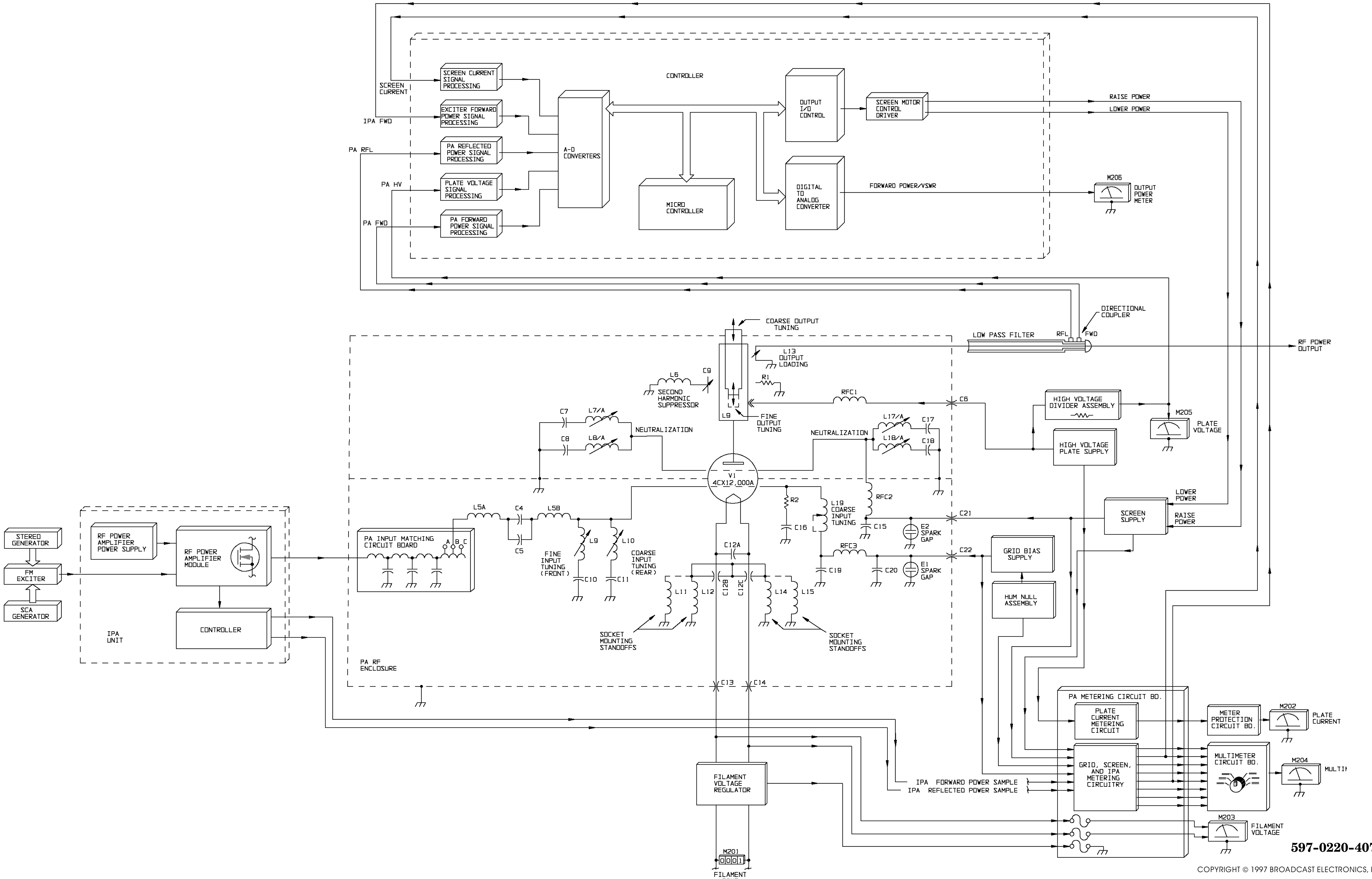

FIGURE 4-3. FM-20T RF CIRCUIT SIMPLIFIED SCHEMATIC

4–73. The PA tube screen ring is connected to dual parallel adjustable LC neutralization networks. The LC neutralization networks consist of: 1) inductor L7/A and RF bypass capacitor C7, 2) inductor L8/A and RF bypass capacitor C8, 3) inductor L17/A and RF bypass capacitor C17, and 4) inductor L18/A and RF bypass capacitor C18. The networks are configured as adjustable strap inductors which are inserted into the Kapton RF bypass capacitors (C7, C8, C17, C18). Neutralization is accomplished by adjusting the length of the straps which varies the series screen grid inductance. This introduces an out–of–phase current component causing a voltage swing across the screen to ground which cancels internal ac feedthru components. Spark–gaps E1 and E2 are provided to safely conduct energy if the tube should arc internally.

4–74. RF choke RFC2 and bypass capacitor C15 operate in conjunction to short any screen supply RF voltages to ground. RFC3 and C20 function in a similar manner by shorting any bias supply RF voltages to ground. C12A/B/C are configured as filament bypass capacitors and are incorporated into the tube socket assembly. Inductors L11, L12, L14, and L15 are tube socket mounting components and are frequency dependent.

4–75. **Power Amplifier Cavity.** The PA cavity used in the FM–20T employs a folded coaxial transmission line resonator constructed with aluminum and copper tubing (see Figure 4–4). The design eliminates the high voltage blocking capacitors and high current shorting contacts of conventional cavities. A grounded concentric center conductor tunes the cavity with a variable re–entrant length inserted into the end of a main high voltage inner conductor. The main inner conductor is insulated from ground and carries the anode dc potential. DC power is fed through RF choke RFC1 and high voltage feedthru capacitor C6 at the RF voltage null point which is approximately one–quarter wave from the anode for effective RF decoupling. An untuned loop (L13) operating in the electromagnetic field is used to couple the RF energy into the transmission line. Rather than attenuating the second harmonic after the signal has been generated and amplified, the circuitry within the cavity essentially eliminates formation of the second harmonic component.

4–76. Plate tuning is accomplished by an adjustable bellows on the grounded or center portion of the plate line (L9) which is maintained at chassis ground potential. The PA plate potential is applied to the main conductor (the fixed portion of the plate line) at the fundamental frequency RF voltage null point which is also the second harmonic peak voltage point. Second harmonic suppression is accomplished by a series LC circuit consisting of L6 and C9 which is inserted at the peak voltage point to essentially eliminate the second harmonic component. Resistor R1 is incorporated into the PA cavity design for RF suppression.

4–77. **PA Output Circuit.** Output coupling is accomplished with an untuned loop intercepting the magnetic field concentration at the voltage null point of the main line. The PA loading control varies the angular position of the plane of the loop with respect to the plate line, changing the amount of magnetic field which it intercepts. Multiple phosphor bronze leaves connect one side of the output loop to ground and the other side to the center conductor of the output transmission line connection. This allows for mechanical movement of the loop by the PA loading control without utilizing any sliding contacts. The grounded loop improves immunity to lightning and static buildup on the antenna connection.

4–78. A pair of directional couplers located in the output transmission line provide RF output voltages proportional to the PA forward and reflected power. The RF output voltages provide forward power and VSWR samples for the output power mete and the transmitter controller. An additional port in the transmission line provides a connection for a station modulation monitor.

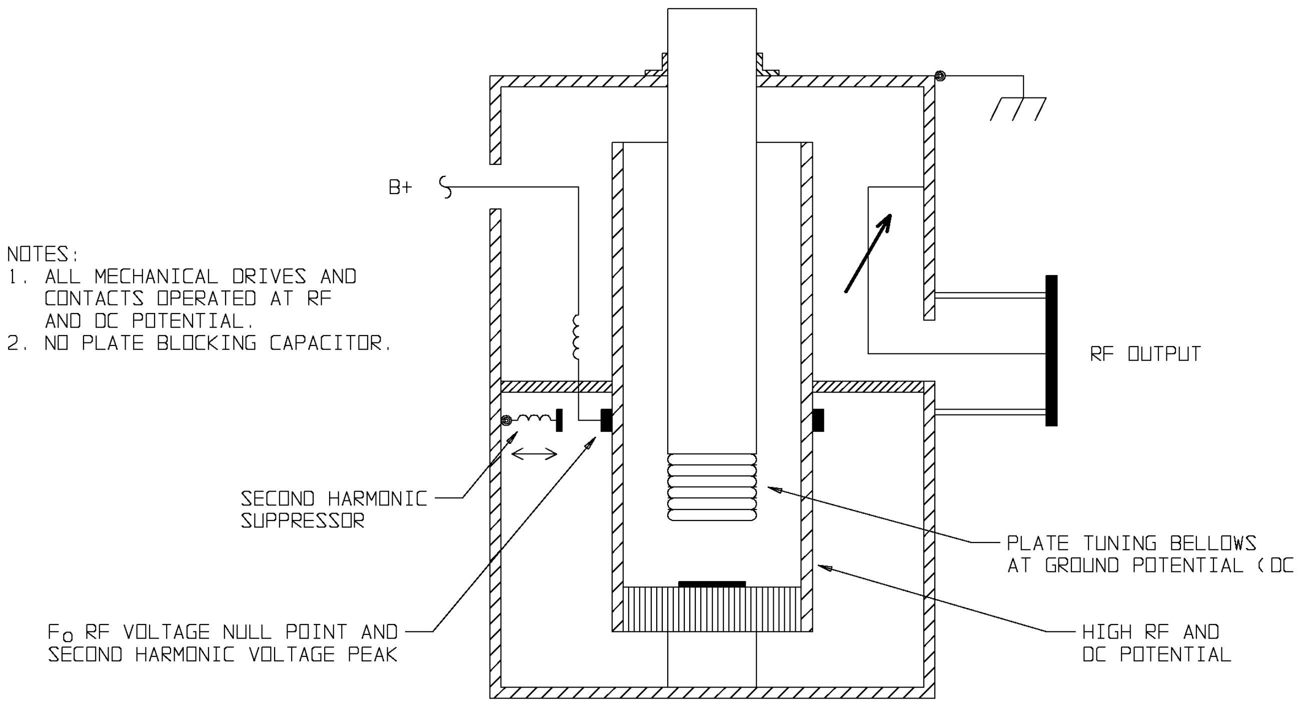

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FIGURE 4-4. PA CAVITY

4-79. **PA Metering.** Seven meters are used to indicate transmitter operating parameters. The plate current, multimeter, and the filament voltage meters measure samples from a PA metering circuit board which is mounted on the side of the RF enclosure. Additional samples from this circuit board are routed to the controller for overload and diagnostic features. The PA metering circuit board also contains fuses which protect the filament meter wiring. Plate voltage metering is obtained from a high voltage meter multiplier circuit board. Power output metering is derived from circuitry within the controller. A filament time meter indicates total elapsed time of filament circuit operation. The filament voltage meter is an iron vane type and accurately measures the filament voltage at the cavity feed-thru terminals. Monitoring of ac input potentials is provided by a primary ac voltage meter.

4-80. **AUTOMATIC POWER CONTROL.** The transmitter controller monitors a number of transmitter parameters to function as part of a closed loop which maintains a constant RF output level from the transmitter (see Figure 4-3).

4–81. PA forward and reflected power samples from the transmitter low–pass filter are applied to individual rectifier/amplifier circuits in the controller. The outputs from the rectifier/amplifier circuits are routed to analog–to–digital (A–to–D) circuitry. The A–to–D circuitry converts the signals to a digital format and routes the signals to the microprocessor. The microprocessor uses the signals: 1) to output forward power and VSWR samples to the output power meter, 2) to output forward and reflected power samples to the remote meter terminals, and 3) for automatic RF output power control operations. The controller monitors several parameters such as the forward and reflected power, screen current, and IPA forward power to determine if power control and correction is required. When automatic power control is enabled and power correction is required, the controller will use the adjustable screen supply autotransformer to obtain the desired power level.

4–82. When APC operation is enabled and as RF output power varies, the controller will act to maintain the established RF output level. If inadequate IPA drive exists for normal operation, PA reflected power increases, or if screen current is high, any power increase will be inhibited. If the PA reflected power increases to a point which may damage the RF circuitry of the transmitter, the controller will reduce the RF output to a safe level and the transmitter will continue to operate. Full power will be automatically re–established when the VSWR condition is corrected.

4–83. As an additional function, the controller will reduce the PA screen potential to minimum whenever the plate voltage is off. Whenever the plate voltage is energized, the controller will gradually increase the PA screen voltage until the rated transmitter RF output is established unless limited by low IPA drive, a high VSWR condition, or high screen current.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides general maintenance information, electrical adjustment procedures, and troubleshooting information for the Broadcast Electronics FM-20T transmitter.

5-3. SAFETY CONSIDERATIONS.

WARNING
WARNING
WARNING
WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

5-4. The FM-20T transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The transmitter has many built-in safety features, however good judgment, 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 extremely dangerous to attempt to make measurements or replace components with power energized, therefore such actions must not be performed. The design of the equipment provides safety features such that when a door is opened or an access panel is removed, interlock switches will deenergize all dc power supplies and release shorting switches to discharge the plate supply to ground. Do not bypass the interlock switches as a maintenance short-cut.

5-6. The PA cavity access door actuates an interlock switch if the door is opened during transmitter operation. All dc supplies will be deenergized and the plate supply will be shorted to ground.

5-7. Two grounding sticks are provided as safety features. One grounding stick is located in the power supply cabinet and one in the PA cabinet. Each grounding stick consists of a metal hook with an insulated rod. The metal end is connected to chassis ground. Use the grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting the maintenance.

5-8. The power supply cabinet grounding stick is stored on a hook- switch and the PA cabinet grounding stick is housed in interlocked clips. When the grounding sticks are removed, an associated switch will open the transmitter interlock string and deenergize all transmitter dc potentials until the grounding sticks are replaced.

5-9. FIRST LEVEL MAINTENANCE.

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

5-10. First level maintenance consists of procedures applied to the equipment to prevent future failures. The procedures are performed on a regular basis and the results recorded in a maintenance log. Preventive maintenance of the transmitter consists of good housekeeping, lubrication, and checking performance levels using the meters and various indicators built into the equipment.

5-11. MISCELLANEOUS.

WARNING ***NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.***
WARNING
WARNING
WARNING

5-12. On a regular basis, clean the equipment of accumulated dust. Check for overheated components, tighten loose hardware, and lubricate mechanical surfaces as required. A lubricant such as "Lubriplate" should be applied sparingly to the tuning drives, loading drives, cables, the PA tuning line right angle gear mechanism, and the cyclometer drives behind the PA cabinet front-panel. The PA output loading screw drive should be opened (four screws) and lubricated every 36 months, or more often if resistance is noted.

5-13. CONTROLLER BATTERY.

5-14. The transmitter controller is equipped with a Lithium battery. The battery has a useful life of approximately five years. After approximately five years of service, replace the controller battery using BEI part number 350-2032.

5-15. AIR FILTERS.

5-16. The FM-20T transmitter is equipped with two air filters. One filter is located in the driver cabinet rear door with the other located in the PA cabinet rear door. Air filter replacement is accomplished from outside the transmitter without interrupting equipment operation. Each filter should be checked once a week with replacement done on an as-required basis. A dirty filter could result in dust leaking into the cabinet from seams, door jambs, etc. Never reverse a dirty filter. Always replace the filter. The IPA unit also contains air filters which should be checked monthly and cleaned as necessary.

5-17. The transmitter uses disposable type air filters 1 inch X 16 inches X 20 inches (2.54 cm X 40.64 cm X 50.8 cm). Additional filters may be ordered for replacement (BE P/N 407-0062) or purchased locally. Always install the filter with the airflow arrow pointing towards the blower and flushing fans. The exciter and IPA also contain air filters. Refer to the exciter manual and the IPA section of this manual for additional information.

5–18. **BLOWER MAINTENANCE.**

WARNING

WARNING

WARNING

WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

5–19. Inspect the transmitter blower and flushing fans for dust accumulation and periodically clean the blower and flushing fans using a brush and vacuum cleaner. The blower and fan motors are cooled by air passing around each motor. 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 dirty air passes over the motors, accumulated dust will impair the motor cooling unless the accumulation is wiped from and blown out of the motor.

5–20. The blower and fan impeller blades should also 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 blower and fan impellers. If this happens, air flow will be reduced and unbalance will result with a possibility of damage to the blower or fans.

5–21. The blower motor and flushing fan are equipped with sealed element–type bearings which do not permit lubrication. Therefore, no regular motor lubrication is required. However, check the blower and flushing fan mounting hardware at regular intervals to ensure proper operation.

5–22. **SECOND LEVEL MAINTENANCE.**

WARNING

WARNING

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

5–23. Second level maintenance consists of procedures required to restore the transmitter to operation after a fault has occurred. The maintenance philosophy of the FM–20T transmitter consists of problem isolation to a specific area. Subsequent troubleshooting provided by each applicable assembly publication in Part II of this manual will assist problem isolation to a defective assembly or component. If desired, a defective assembly may be returned to the factory for repair or exchange.

5–24. **GENERAL.**

5–25. **PA STAGE.** Power amplifier tube life is a result of several circuit parameters. Usually, the first indication of the decline of a tube is a slight reduction in power output. This can normally be corrected by a small increase in filament voltage. It may be wise to order a new tube at this time. Further reductions in power output can be compensated in the same manner only a limited number of times. An Eimac application paper titled "Extending Transmitter Tube Life" is provided in APPENDIX A of this manual. Excess control grid or screen grid dissipation will shorten the life of a tube. Also, excess plate dissipation always produces trouble. Typical FM–20 PA efficiency is plotted in Figure 5–1 and should be referenced to estimate PA efficiency for a particular power level.

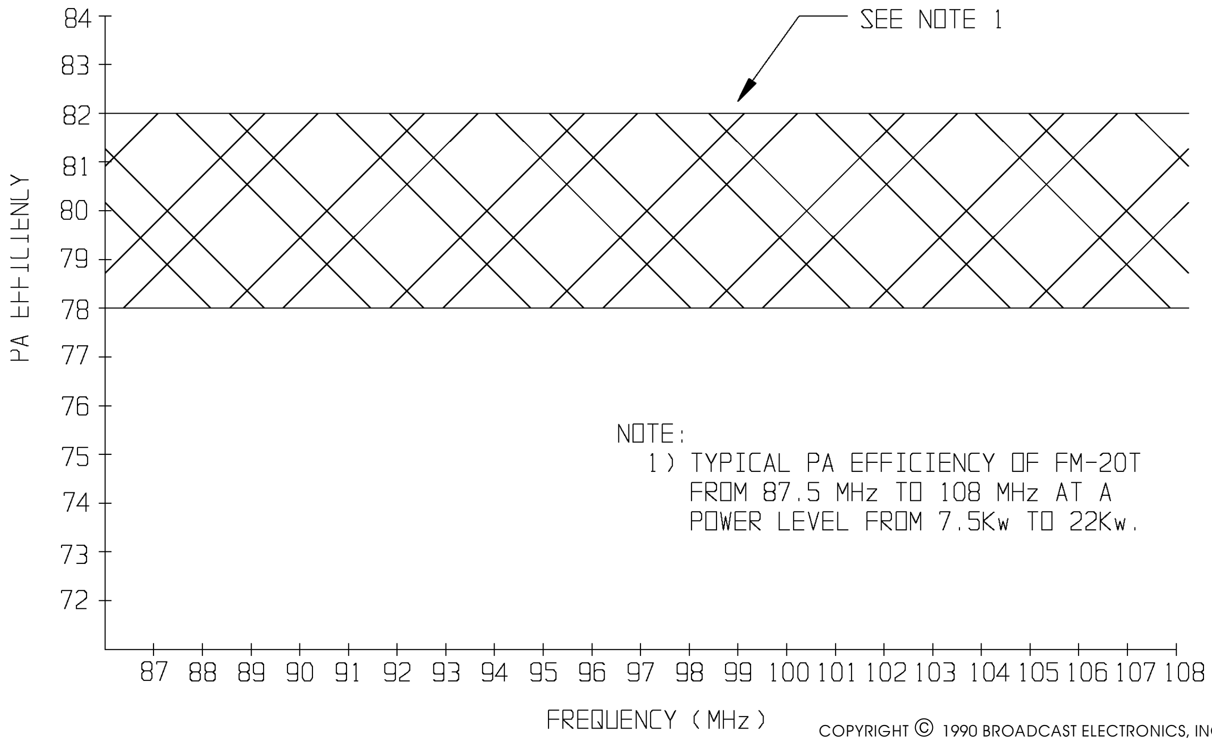

FIGURE 5-1. FM-20T TYPICAL PA EFFICIENCY 597-0220-26

5–26. **PA Tube Warranty.** The transmitter PA tube is covered by warranty from the Varian/Eimac Company, the tube manufacturer, not Broadcast Electronics, Inc. However, a tube purchased from Broadcast Electronics which is defective must be returned to Broadcast Electronics with a customer–completed warranty claim service report. A warranty claim service report form is shipped with each tube obtained from Broadcast Electronics, Inc. Following this procedure, Broadcast Electronics will expedite immediate shipment of a new tube. Contact the Broadcast Electronics, Inc. Customer Service Department for additional details as required. It is recommended that the warranty report be filled out as soon as the new tube is placed in operation while the nominal voltages are known.

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

5–27. **IPA UNIT.** The transistors in the IPA unit will normally last many times longer than the power amplifier tube unless a major fault occurs. For further maintenance information, refer to the IPA publication in Part II of this manual.

5–28. **ADJUSTMENTS.**

WARNING ***NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.***
WARNING

5–29. Adjustment procedures for controls associated with the IPA unit and the transmitter controller are presented in each applicable publication in Part II of this manual. Adjustment procedures for power supply and PA controls are presented as follows:

A. AM Noise.

B. Control Grid Bias Level Adjustment.

C. Plate Current Meter Calibration.

D. Second Harmonic Suppresser Adjustment.

E. Neutralization.

5-30. **AM NOISE.** Each FM-20T transmitter is equipped with an **AM NOISE** test receptacle. The test receptacle is located on the controller and provides a calibrated AM waveform sample for direct measurement of synchronous and asynchronous AM noise parameters. Refer to the following text for procedures to minimize AM noise parameters in the transmitter.

5-31. **Synchronous AM Noise.** Synchronous AM noise is incidental amplitude modulation of the carrier by the presence of FM modulation. The synchronous AM noise level is related to: 1) the transmitter overall bandwidth and 2) transmitter tuning. An application paper titled "TECHNIQUES FOR MEASURING SYNCHRONOUS AM NOISE IN FM TRANSMITTERS" is available from Broadcast Electronics Inc. The paper presents detailed information on AM noise measurements and procedures for tuning the transmitter to minimize the synchronous AM noise level. If adjustment of the transmitter is desired, perform the procedures in the application paper and tune the transmitter for a minimum synchronous AM noise level.

5-32. **Asynchronous AM Noise.** Asynchronous AM noise is residual amplitude modulation of the transmitter output due primarily to power supply ripple. The hum null circuit injects a small 60 Hz voltage into the grid bias supply to cancel ac components in the supply and reduce AM noise. Adjustment of the circuit will not normally be required in the field. However, if it is certain that hum null circuit adjustment is required, proceed as follows.

5-33. **Required Equipment.** The following equipment is required to adjust the hum null circuit.

A. Distortion analyzer (Tektronics Model AA501 or equivalent).

B. One locally fabricated test cable consisting of the following:

A. 10 feet (3.05 m) of Belden RG58A/U coaxial cable (BE P/N 622-0050).

B. Two BNC connectors (Pomona UG68/U-BE P/N 417-0205).

WARNING *NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE*
WARNING *THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.*

5-34. **Procedure.** To adjust the hum null circuit, proceed as follows:

5-35. Refer to Figure 5-2 and connect the distortion analyzer to the controller **AM NOISE** test receptacle using the coaxial test cable (Item B). Configure the distortion analyzer for dBm level indications.

5-36. Operate the transmitter at a normal output power level.

5-37. Refer to Figure 5-2 and adjust hum null control R208 for a minimum asynchronous AM noise indication on the distortion analyzer.

5-38. Disconnect and remove all test equipment.

5-39. **CONTROL GRID BIAS ADJUSTMENT.** A multiple tap transformer in the control grid bias supply allows adjustment of the control grid bias voltage. Adjustment of the taps will not normally be required in the field. If it is certain that adjustment of the grid bias voltage is required, contact the Broadcast Electronics Customer Service Department for maintenance information.

5-40. **PLATE CURRENT METER CALIBRATION.** The plate current meter assembly is equipped with a calibration control. Due to the special equipment required to adjust the calibration control, the control is not considered field adjustable. If it is certain that adjustment of the plate current meter calibration control is required, contact the Broadcast Electronics Customer Service Department for maintenance information on the plate current meter assembly.

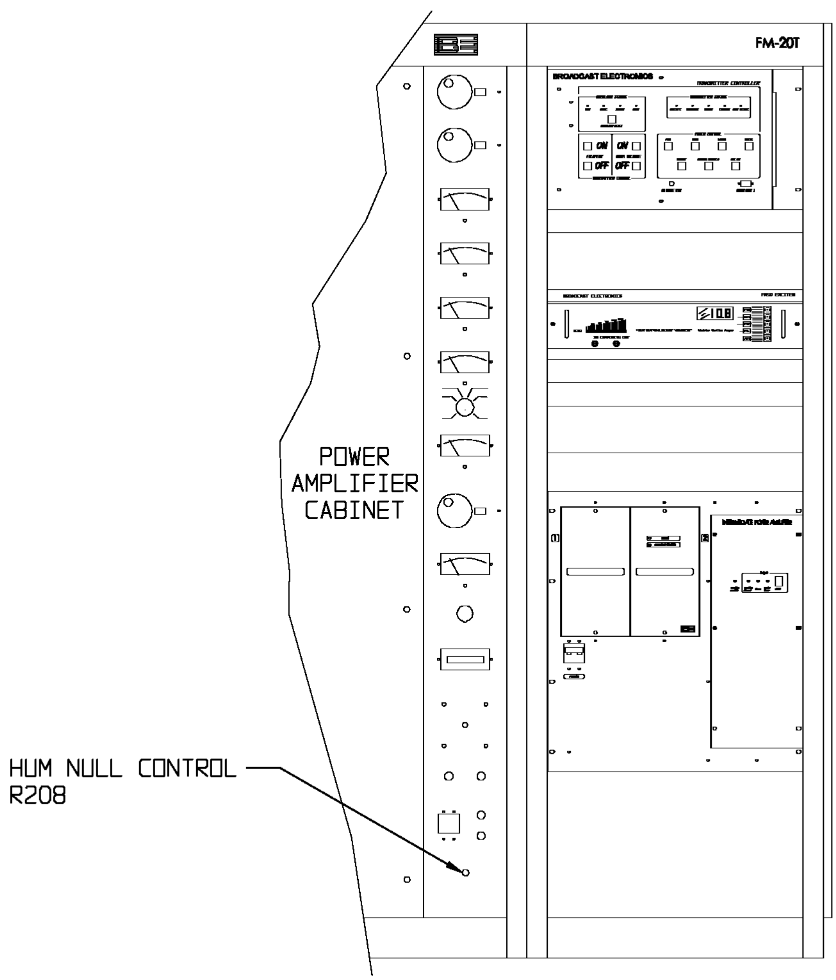

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FIGURE 5-2. HUM NULL CONTROL LOCATION

5-41. **SECOND HARMONIC SUPPRESSOR.** Adjustment of the second harmonic suppressor in the field will not normally be required, even if the PA tube is replaced. Adjustment should be attempted only when absolutely necessary. Misadjustment of the suppressor could result in sporadic operation, possibly damaging the PA tube, the cavity, or the low-pass filter. It is suggested the customer contact the Broadcast Electronics Customer Service Department before attempting this adjustment. If it is certain that adjustment of the second harmonic suppressor is required, proceed as follows.

5-42. **Required Equipment.** The following equipment is required to complete adjustment of the second harmonic suppressor.

A. 1/16 inch hex wrench.

B. Tektronix Model 492 Spectrum Analyzer or equivalent capable of displaying frequencies at twice the transmitter frequency of operation.

C. 50 Ohm 10 dB resistive attenuator pad, BNC jack to BNC plug (Texscan FP-50).

D. A test cable for the spectrum analyzer consisting of the following:

1. 10 feet (3.05 m) of Belden RG58A/U coaxial cable (BE P/N 622-0050).

2. Two BNC plugs (Pomona UG88/U--BE P/N 417-0205).

E. Six inch scale.

WARNING
WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.

5-43. **Procedure.** To adjust the second harmonic suppressor, proceed as follows:

WARNING
WARNING

DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-44. Deenergize all primary power to the transmitter.

5-45. Connect one end of the spectrum analyzer cable (Item D) to the RF sample port on the transmission line elbow near the low-pass filter.

5-46. Connect the attenuator pad (Item C) in series with the cable and attach the attenuator pad to the spectrum analyzer input.

5-47. Energize the transmitter primary ac input.

5-48. Operate the transmitter at the normal power output and ensure all PA stage tuning and loading controls are correctly adjusted.

5-49. Record the level of the second harmonic displayed on the spectrum analyzer ____________________.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

5-50. Disconnect all transmitter primary power.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

5-51. Open the PA cabinet rear door.

5-52. Loosen the two hex-head lock-screws securing the second harmonic suppressor adjustment rod very slightly--just enough to allow in and out adjustment (see Figure 5-3).

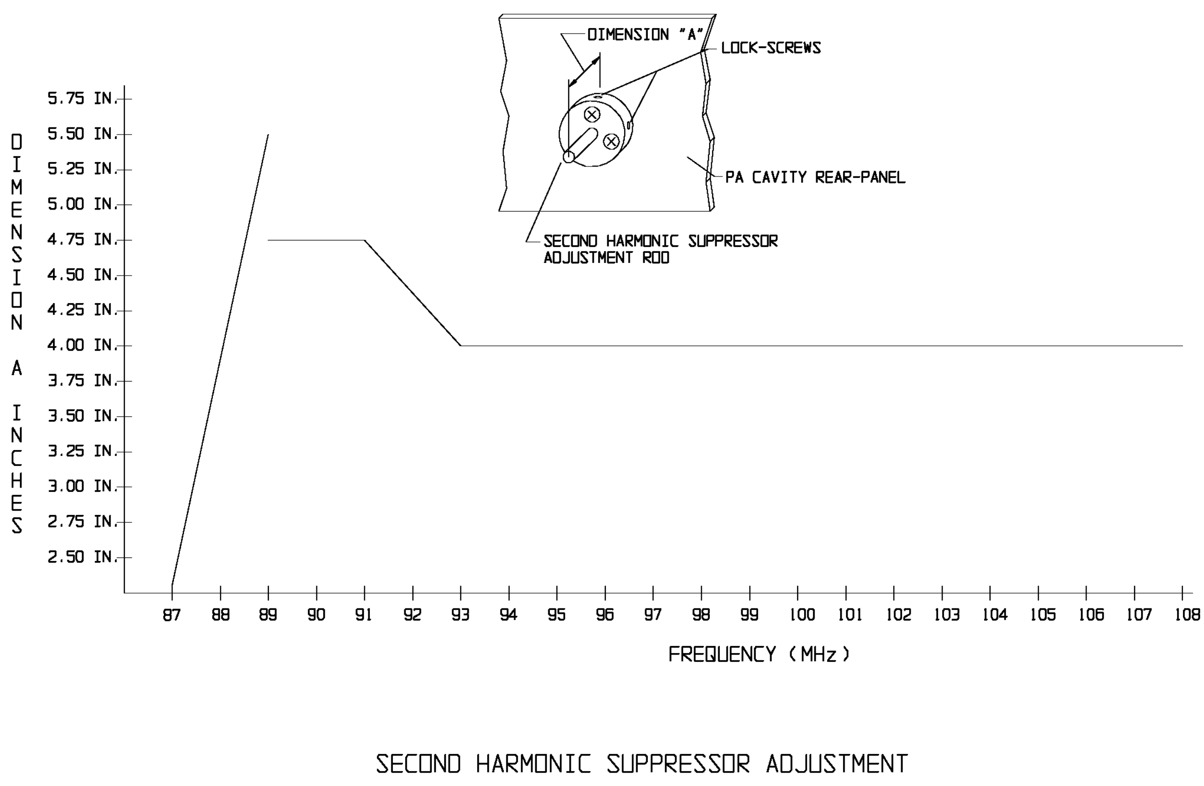

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FIGURE 5-3. SECOND HARMONIC SUPPRESSOR ADJUSTMENT

CAUTION ***THE SECOND HARMONIC SUPPRESSOR IS ADJUSTED BY SLIDING THE ADJUSTMENT ROD IN OR OUT. DO NOT ROTATE THE ROD.***

CAUTION

NOTE ***THE ORIGINAL HARMONIC SUPPRESSOR ADJUSTMENT DIMENSION IS RECORDED ON THE FACTORY FINAL TEST DATA SHEETS IF THE DIMENSION MUST BE REFERENCED.***

NOTE

5-53. Move the second harmonic suppressor adjustment rod slightly (approximately 1/16 inch). Correct adjustment will be near the original factory position (see Figure 5-3). Record the amount moved and the direction (in or out) ____________________ . Slightly tighten the two screws to secure the rod in place.

5-54. Close the PA cabinet rear door.

5-55. Operate the transmitter at the normal power output and check for a minimum second harmonic indication displayed on the spectrum analyzer.

5-56. If additional adjustment is required, repeat the procedure. Move the second harmonic suppressor adjustment rod slightly in or out as required to minimize the second harmonic indication.

5-57. After the correct placement of the second harmonic suppressor is determined, disconnect all transmitter primary power.

5-58. Open the PA cabinet rear door.

5-59. Secure the two hex-head lock-screws on the second harmonic suppressor bushing (see Figure 5-3).

5-60. Disconnect the spectrum analyzer cable from the transmission line.

5-61. Close the PA cabinet rear door. Refer to Figure 5-3 and record the new harmonic suppressor dimension ________________.

5-62. **NEUTRALIZATION.** PA neutralization in the field will not normally be required, even if the PA tube is replaced. If it is certain that adjustment of the neutralization circuitry is required, proceed as follows.

CAUTION ***INCORRECT NEUTRALIZATION CAN RESULT IN INSTABILITY WHICH COULD DAMAGE THE PA TUBE, CAVITY, OR LOW-PASS FILTER. CONSULT THE FACTORY BEFORE ATTEMPTING NEUTRALIZATION.***

CAUTION

5-63. **Required Equipment.** The following equipment is required to complete PA neutralization.

A. Spectrum analyzer (Tektronix Model 492 or equivalent).

B. 25 Watt, 50 Ohm RF attenuator/termination with -20 dB sample output, type N receptacles (Bird Model 8340-030 or equivalent).

C. Two locally fabricated cables, each consisting of the following:

1. 36 inches (91.44 cm) of Belden RG 58A/U coaxial cable (BE P/N 622-0050).
2. Two BNC plugs (Pomona UG88/U--BE P/N 417-0205).

D. No. 2 Phillips screwdriver, 1-inch (2.54 cm) blade.

E. Flat-tip screwdriver, 8-inch (20.32 cm) blade and 3/8 inch (0.95 cm) tip.

F. Exciter line cord, (P/O exciter accessory pack--BE P/N 682-0001).

G. Fuse, AGC, 3A slow-blow, 120V (P/O exciter accessory pack--BE P/N 334-0300).

H. Electrical extension cord, 3-wire, 12 feet (3.7 m) long

I. Six-inch scale, graduated in sixty-fourths of an inch.

J. One BNC receptacle to type N plug (Pomona UG201A/U - BE P/N 417-3288).

WARNING *NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.*

WARNING

5-64. **Procedure.** To adjust PA neutralization, proceed as follows:

5-65. Operate the transmitter at the normal power output and ensure all PA stage tuning and loading controls are correctly adjusted.

5-66. Secure the INPUT TUNING, OUTPUT LOADING, and OUTPUT TUNING control knobs in position with tape. The controls must not be moved until the entire procedure has been completed.

WARNING *DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.*

WARNING

5-67. Deenergize all primary power to the transmitter.

5-68. Open the driver cabinet rear door.

5-69. Disconnect the coaxial cable from the exciter **RF OUTPUT** connector.

5-70. Disconnect the coaxial cable from the PA RF input receptacle which is located on the RF enclosure left side-panel below the PA metering circuit board assembly.

5-71. Connect one cable between the PA RF input receptacle and the RF termination -20 dB sample output.

5-72. Connect a BNC-to-type N adapter on the RF attenuator/termination input connector.

5-73. Connect one cable between the exciter **RF OUTPUT** connector and the input to the RF termination.

5-74. Disconnect wire No. 245 from TB1-7 on the exciter rear-panel and connect a temporary wire jumper from TB1-6 to TB1-7. Flag the temporary jumper with a piece of tape marked "TEMPORARY".

5-75. Disconnect the exciter line cord and remove the fuse from the AC LINE VOLTAGE SELECTOR on the rear-panel. Cover the line cord plug with a piece of tape marked "240 VOLTS".

5-76. Remove the AC LINE VOLTAGE SELECTOR circuit board with a small pair of needle-nose pliers and record the circuit board voltage indication ________V______ . Reinsert the circuit board so that "115/120V" is visible when the circuit board is inserted into the receptacle.

5-77. Replace the fuse with a slow-blow type rated at 3 Amperes.

5-78. Connect the accessory exciter line cord to the extension cord. Route the extension cord out through the top or bottom of the driver cabinet to a 110 to 120 volt ac source.

5-79. Connect the accessory exciter line cord to the exciter.

WARNING ***PRIMARY TRANSMITTER POWER MUST REMAIN OFF THROUGHOUT THE FOLLOWING PROCEDURE.***
WARNING

5-80. Assure that the exciter is operating independently of the transmitter.

5-81. Connect the spectrum analyzer to the RF sample port on the transmitter output transmission line. Adjust the analyzer to obtain a reference level display and position the analyzer so that it may be viewed from the front of the transmitter.

5-82. Open the PA cabinet rear door and observe the grounding stick.

WARNING ***USE THE GROUNDING STICK PROVIDED TO ENSURE NO PA TUBE POTENTIALS ARE PRESENT IN THE FOLLOWING STEP BY GROUNDING THE PA TUBE PLATE AND SCREEN CONNECTIONS BEFORE PROCEEDING.***
WARNING

5-83. Open the PA cavity access door and ground the PA tube plate and screen connections to ensure no potentials are present in the cavity before attempting to touch anything within the cavity.

5-84. After it has been determined that no PA tube potentials are present, mark the position of the four neutralization adjustments (refer to Figure 5-4). Correct neutralization will be found near the original factory position (refer to Figure 5-4).

WARNING ***BE CAREFUL WHEN ADJUSTING THE NEUTRALIZATION STRAPS WITH FINGERS AS THE EDGES OF THE MATERIAL ARE VERY SHARP.***
WARNING

5-85. Loosen the four screws (Figure 5-4, detail A) on top of capacitors C7, C8, C17, and C18 slightly--just enough to allow adjustment of the inductors. When the neutralization procedure is properly performed, the height of all inductors will be approximately the same, within 1/16 inch (0.16 cm).

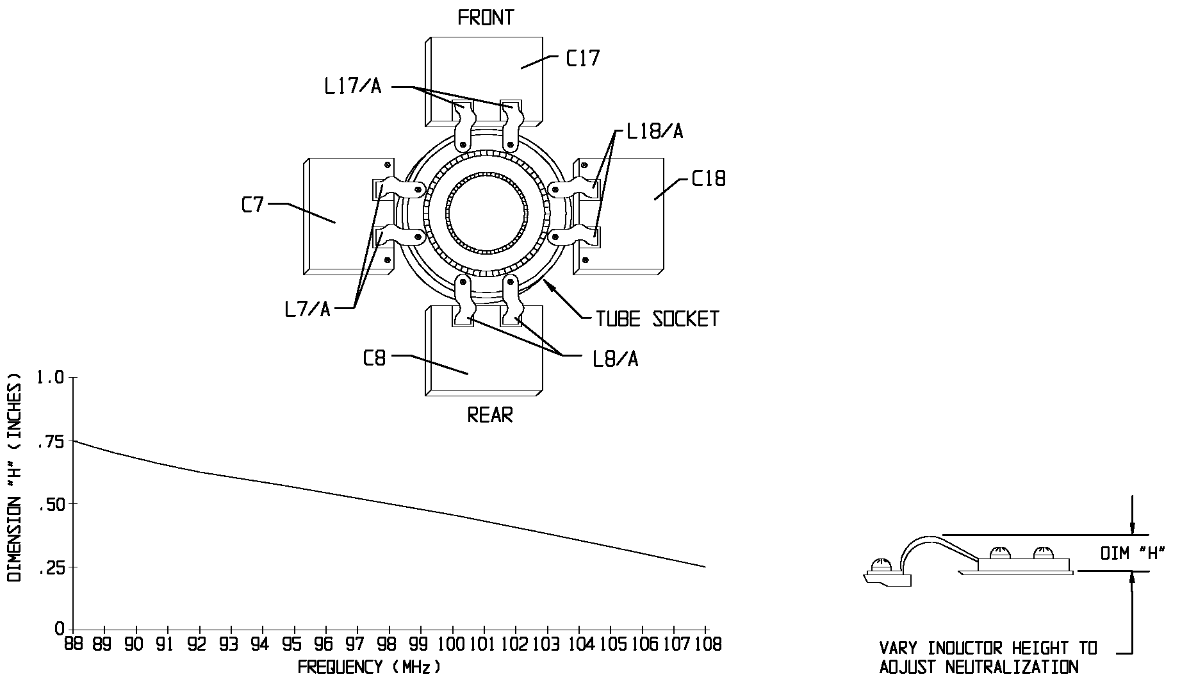

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FIGURE 5-4. COARSE NEUTRALIZATION ADJUSTMENTS

5-86. Neutralization is adjusted in the following manner:

A. Remove all foreign objects from the cavity and close the cavity access door.

B. Note the spectrum analyzer indication.

C. Open the cavity access door and adjust one inductor slightly by moving the inductor in or out of the capacitor. Lightly secure the four screws on the capacitor plate.

D. Remove all foreign objects from the cavity and close the cavity access door.

E. Note the change in the spectrum analyzer indication.

F. Repeat steps A through E until a minimum spectrum analyzer indication is noted.

G. Repeat steps A through F for the remaining inductors to minimize the spectrum analyzer indication.

H. Secure the four screws in each capacitor. When the neutralization procedure is properly performed, the height of all inductors will be approximately equal.

I. Ensure all four capacitors are secure before closing the cavity access door.

5-87. Close and latch the cavity access door. Replace the grounding stick in the interlocked clips.

5-88. Disconnect the spectrum analyzer from the transmission line RF sample output.

CAUTION *DO NOT CONNECT THE EXCITER TO THE LINE CORD WIRED INTO THE TRANSMITTER IN THE FOLLOWING STEP.*

CAUTION

WARNING *DISCONNECT ALL EXCITER PRIMARY POWER BEFORE PROCEEDING.*

WARNING

5–89. Remove the electrical extension cord and exciter line cord. Do not connect the exciter to the line cord wired into the transmitter at this time.

5–90. Remove the fuse from the exciter rear panel AC LINE VOLTAGE SELECTOR.

5–91. Remove the AC LINE VOLTAGE SELECTOR circuit board with a small pair of needle–nose pliers. Reinsert the circuit board so that the recorded voltage is visible when the circuit board is inserted into the receptacle.

5–92. Replace the fuse with a slow–blow type rated at 1.5 Amperes.

5–93. Remove the tape from the exciter line cord and connect the plug to the exciter.

5–94. Remove the temporary wire jumper from TB1 on the exciter rear panel and reconnect wire No. 245 to TB1–7.

5–95. Remove the cabling and RF attenuator/termination connected between the exciter **RF OUTPUT** connector and the **PA RF** input receptacle.

5–96. Reconnect the cabling from the exciter **RF OUTPUT** receptacle to the IPA input receptacle and the IPA output receptacle to the PA RF input receptacle.

5–97. **TRANSMITTER POWER LEVEL CHANGE.**

5–98. **GENERAL.** Each transmitter is programmed, operated, and tested at a specific power level at the factory prior to shipment. If at a future date the transmitter is to be operated at a power level other than the original factory programmed level, the following transmitter parameters must be checked and adjusted if required to assure proper transmitter operation. If problems occur during initial operation, contact the Broadcast Electronics Customer Service Department for additional service procedures.

5–99. **Procedure.** To change the transmitter power output level, proceed as follows:

WARNING *NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.*

WARNING

WARNING *DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.*

WARNING

5–100. Disconnect all transmitter primary power.

5-101. Open the power amplifier cabinet door and ground all plate supply potentials. Ensure no potentials exist before proceeding.

WARNING ***WARNING***	***USE THE GROUNDING STICK PROVIDED TO ENSURE NO PA TUBE POTENTIALS ARE PRESENT BY GROUNDING ALL PA TUBE POTENTIALS.***

WARNING ***WARNING***	***ENSURE NO POTENTIALS EXIST BEFORE PROCEEDING.***

5-102. Refer to Figure 5-5 and remove the PA cavity lower access panel. Use the grounding stick to ground all PA tube potentials and to ensure no potentials are present within the cavity or PA input circuit. Ensure no potentials exist before proceeding.

5-103. Refer to Figure 5-5 and check the PA matching circuit board programming. Install components as required by the new power level.

5-104. Refer to SECTION II, INSTALLATION and check the plate transformer secondary taps.

5-105. Refer to SECTION III, OPERATION and reset the APC operating reference.

5-106. Energize the transmitter primary ac power and operate the transmitter. Adjust the input tuning control for a minimum IPA reflected power indication on the multimeter (for high reflected power conditions, use the multimeter grid current function and maximum grid current information for indications of correct tuning operations). If input matching problems persist during initial operation, contact the Broadcast Electronics Customer Service Department for adjustment information.

5-107. Refer to CONTROLLER SECTION II, MAINTENANCE and perform the FORWARD POWER CALIBRATION and REFLECTED POWER CALIBRATION adjustment procedures.

5-108. **TRANSMITTER FREQUENCY CHANGE PROCEDURE.**

CAUTION ***CAUTION***	***CONSULT THE FACTORY BEFORE ATTEMPTING TO CHANGE THE TRANSMITTER OPERATING FREQUENCY.***

5-109. **GENERAL.** The following text presents an overall procedure to change the transmitter operating frequency. The procedure specifies operational adjustment procedures located throughout this publication and FX-50 Exciter publication 597-1050. To change the transmitter operating frequency, proceed as follows.

5-110. **Procedure.** To change the transmitter operating frequency, proceed as follows:

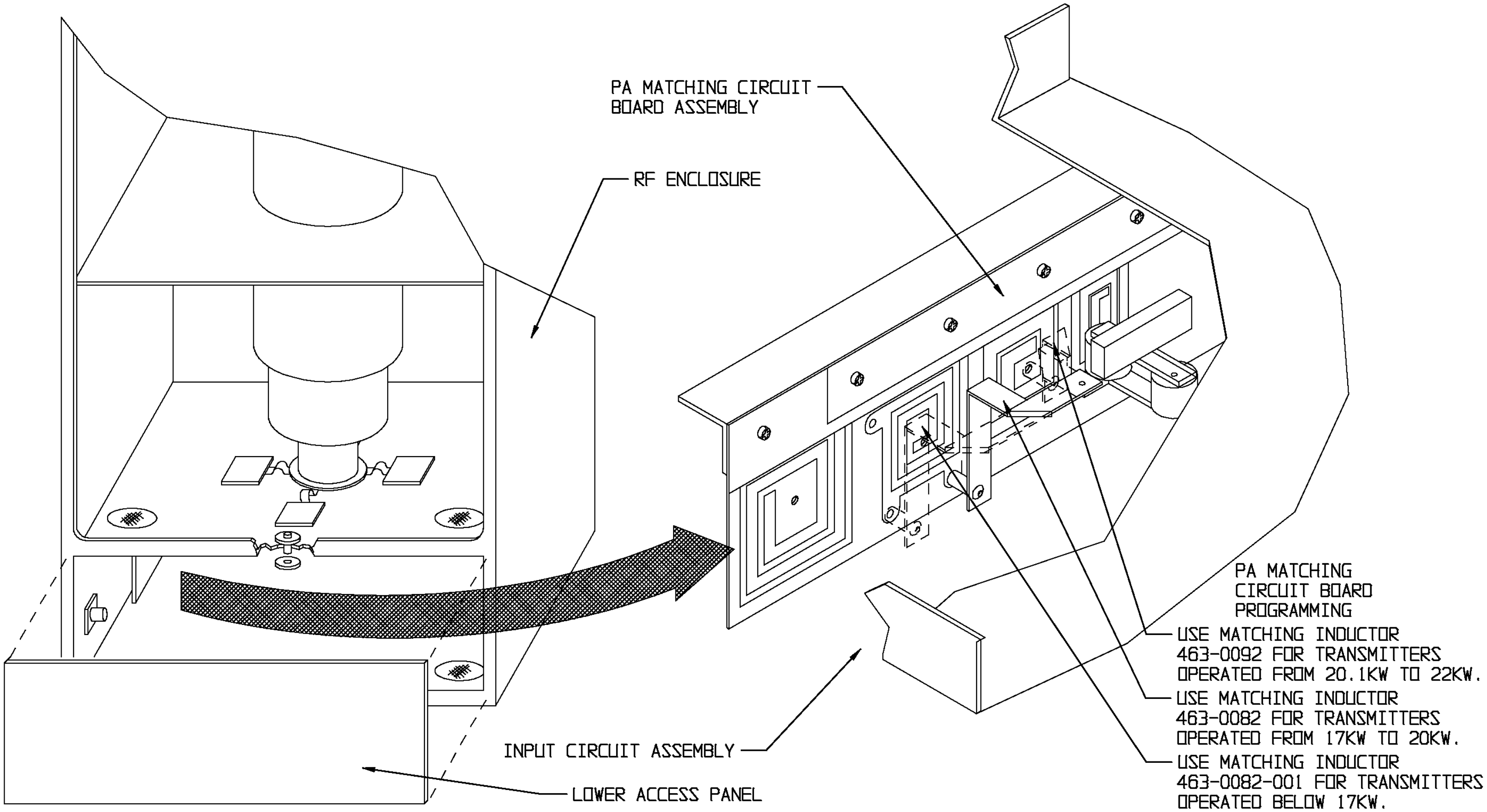

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FIGURE 5-5. COMPONENT PROGRAMMING FOR POWER LEVEL CHANGES

WARNING *WARNING*	***NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.***

WARNING *WARNING*	***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

5-111. Disconnect all transmitter primary power. The primary ac power must remain OFF unless specified by an adjustment procedure.

WARNING *WARNING*	***USE THE GROUNDING STICK PROVIDED TO ENSURE NO PA TUBE POTENTIALS ARE PRESENT BY GROUNDING ALL PA TUBE POTENTIALS.***

WARNING *WARNING*	***ENSURE NO POTENTIALS EXIST BEFORE PROCEEDING.***

5-112. Open the cavity access door and ground all PA tube potentials to ensure no potentials are present within the cavity or PA input circuit. Ensure no potentials exist before proceeding.

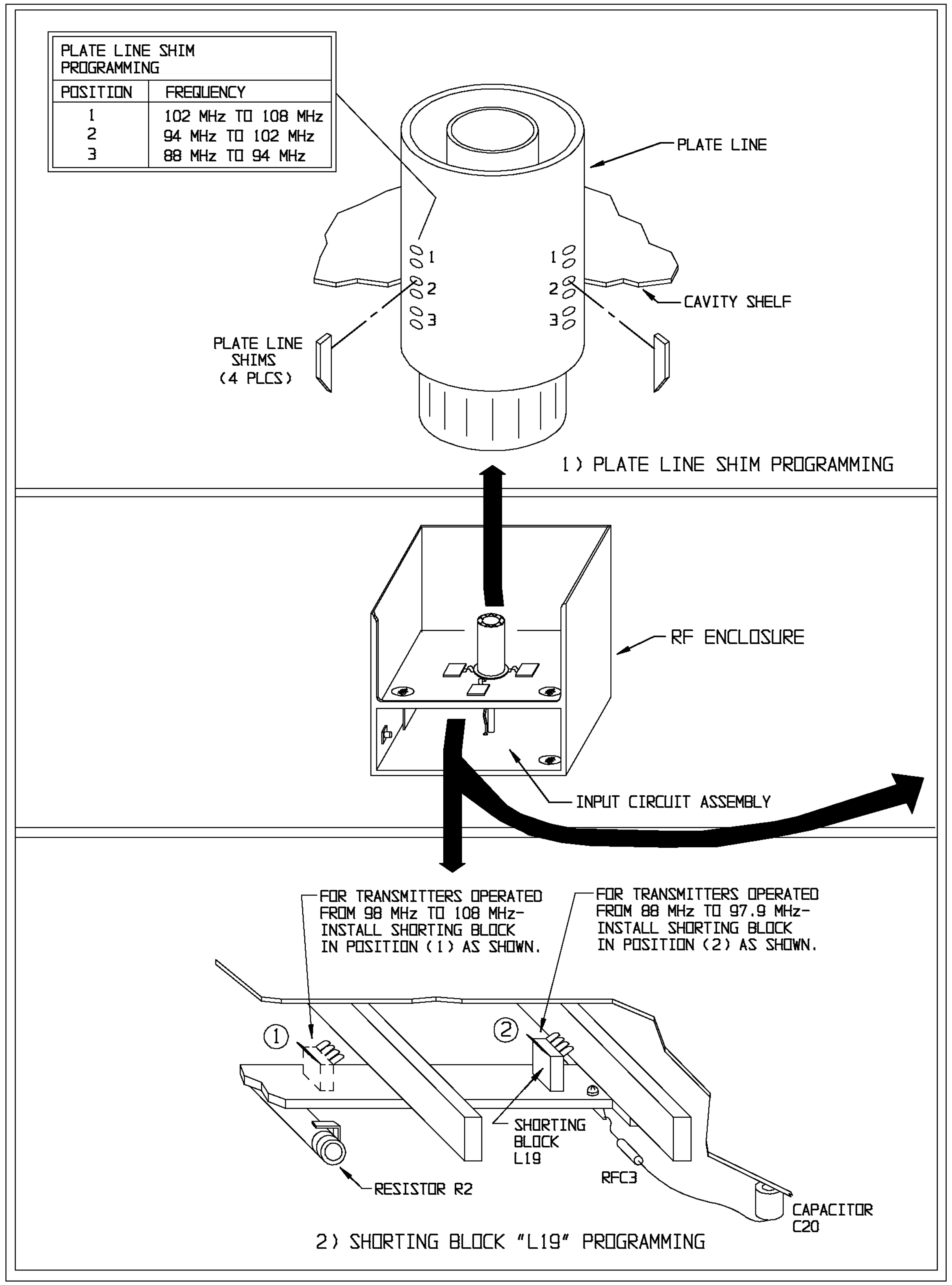
5-113. Refer to Figure 5-6 and check the programming for the: 1) tube socket mounting standoffs, 2) the shorting block, and 3) the plate line shims. Install or move components as required by the new operating frequency.

5-114. Refer to Figure 5-7A and adjust the transmitter coarse output tuning by raising or lowering the PA tuning line on top of the PA cavity. Refer to Figure 5-7B and coarse adjust the transmitter front and rear input tuning controls. The front input tuning control is adjusted by rotating the control for the specified cyclometer indication. The rear tuning control is adjusted by rotating the control fully clockwise and then adjusting the control counterclockwise for a specified number of turns.

5-115. Refer to the following text and Figure 5-10 and check second harmonic suppressor inductor L6. Replace the inductor as required by the new operating frequency.

FREQUENCY	DESCRIPTION	PART NO.
88 MHz to 89.5 MHz	Inductor, 1 1/2 turn coil	360-0075
89.5 MHz to 91.5 MHz	Inductor, 0.5 inch (1.3 cm) X 8 inch (20.3 cm)	479-0070
91.5 MHz to 108 MHz	Inductor, 0.81 inch (2.0 cm) X 6.56 inch (16.7 cm)	479-0053-001

5-116. Refer to Figure 5-3 and coarse adjust the transmitter second harmonic suppressor. The suppressor is adjusted by loosening the two hex-head lock screws and moving the adjustment rod in or out as required. Do not rotate rod during adjustment.



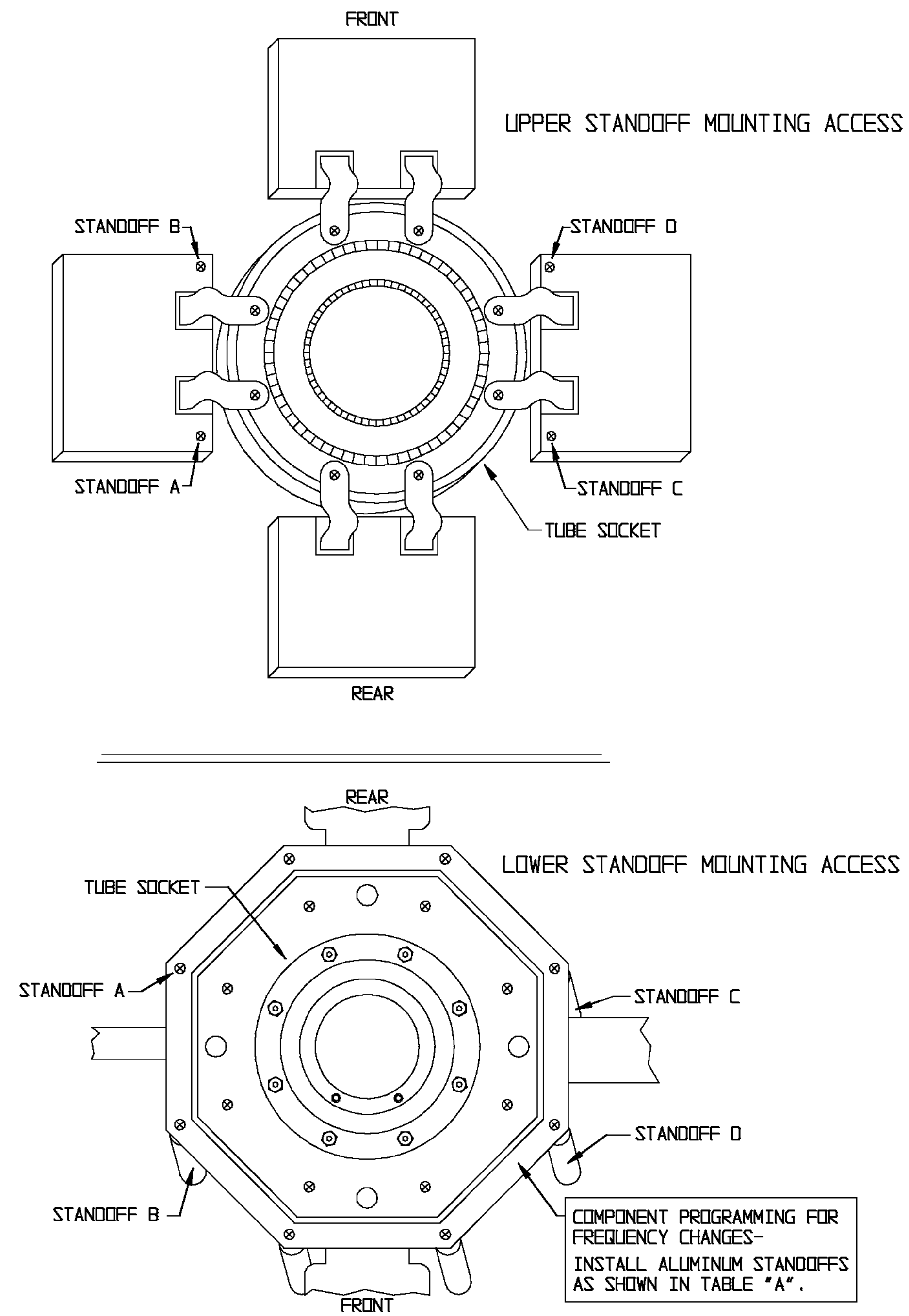


TABLE "A"

CONFIGURATION	FREQUENCY	ALUMINUM STANDOFF	BE STANDOFF-PART NUMBER	STANDOFF DIAMETER
1	88MHz-91MHz	B,C	441-0157	.375 O.D.
2	91MHz-93MHz	B,C	441-0162	.500 O.D.
3	93MHz-98MHz	A,B,C	441-0157	.375 O.D.
4	98MHz-102MHz	A,B,C	441-0157	.375 O.D.
5	102MHz-108MHz	A,B,C,D	441-0157	.375 O.D.

NOTE: ALL OTHER MOUNTING STANDOFFS ARE DELRIN.

3) TUBE SOCKET MOUNTING STANDOFF PROGRAMMING

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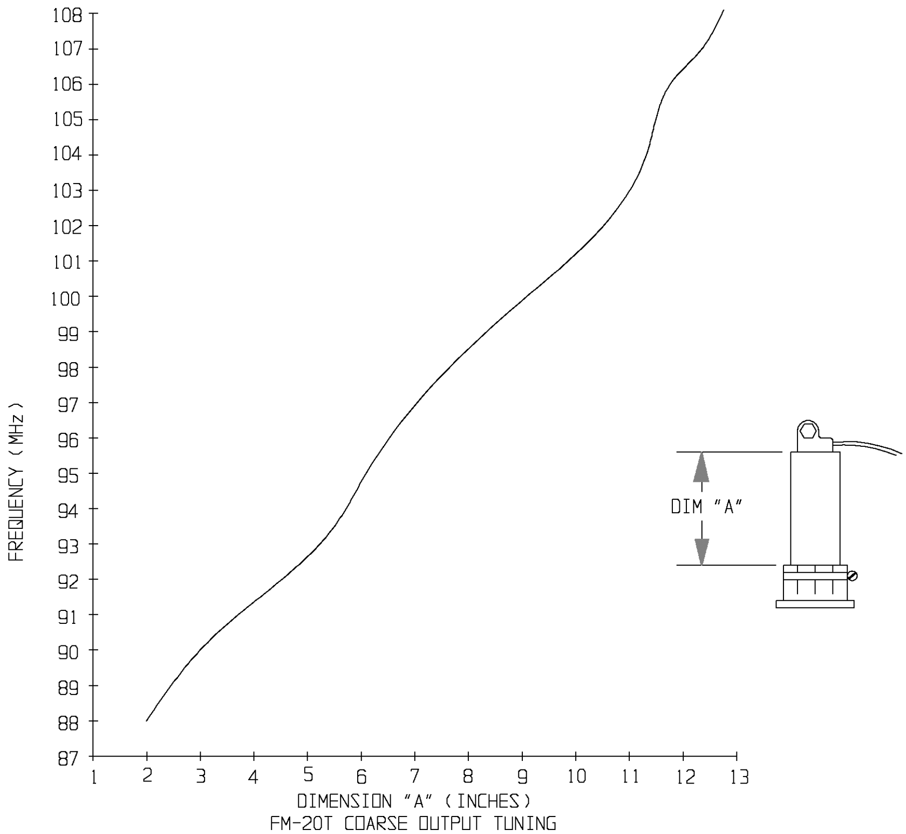
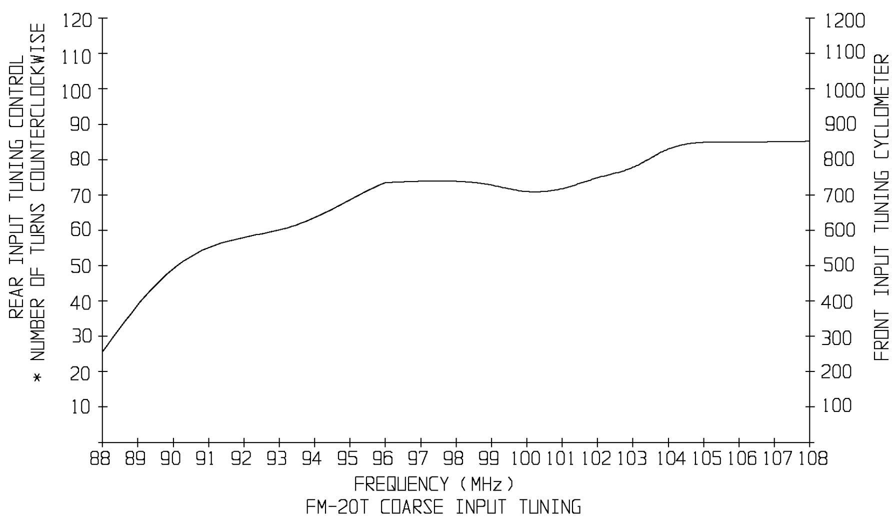
FIGURE 5-6. COMPONENT PROGRAMMING FOR FREQUENCY CHANGES





* NOTE: THE REAR INPUT TUNING CONTROL IS ADJUSTED BY ROTATING THE CONTROL FULLY CLOCKWISE AND THEN ADJUSTING THE CONTROL COUNTERCLOCKWISE FOR A SPECIFIED NUMBER OF TURNS.

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FIGURE 5-7. FM-20T COARSE TUNING ADJUSTMENTS

5–117. Refer to Figure 5–4 and coarse adjust the transmitter neutralization as follows:

A. Coarse adjust the neutralization inductors. The inductors are adjusted by loosening the screws on top of the capacitors and moving the inductors in or out of the capacitors as required. All inductors must be the same height.

B. Coarse adjust inductors L7/A, L8/A, L17/A, and L18/A. Adjust the inductors in or out as required.

5–118. Refer to FX–50 Exciter publication 597–1050, PART II SECTION 4, AFC/PLL ASSEMBLY and perform the FREQUENCY SELECTION procedure. Operate and test the exciter independently from the transmitter.

5–119. Refer to SECTION II, INSTALLATION and perform the PRELIMINARY OPERATION AND TUNING procedure to obtain a 10% power indication from the transmitter. Use a spectrum analyzer to monitor spurious activity during tuning. Also, use an in–line wattmeter connected to the transmitter output transmission line for all power output indications.

5–120. Refer to the adjustment procedures in the preceding text and perform the NEUTRALIZATION procedure.

5–121. Refer to SECTION II, INSTALLATION and complete the PRELIMINARY OPERATION AND TUNING procedure to obtain a 100% power indication from the transmitter.

5–122. Refer to the adjustment procedures in the preceding text and perform the SECOND HARMONIC SUPPRESSOR adjustment procedure.

5–123. Refer to CONTROLLER SECTION II, MAINTENANCE and perform the FORWARD POWER CALIBRATION and REFLECTED POWER CALIBRATION adjustment procedures.

5–124. **TROUBLESHOOTING.**

WARNING ***NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.***

WARNING

5–125. Most transmitter troubleshooting consists of visual checks. Due to the dangerous voltages and currents in the equipment, it is considered extremely dangerous 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 for the FM–20T transmitter are presented in Table 5–1. Transmitter primary power demand requirements are listed in Table 5–2.

TRANSMITTER TROUBLESHOOTING AREAS

A. Power Supplies
B. Exciter
C. IPA Stage
D. Power Amplifier
E. Transmitter Controller
F. Transmitter Load

TABLE 5-1. TYPICAL METER INDICATIONS, FM-20T

FREQUENCY (MHz)	88.1			98.1			107.9		
POWER OUTPUT (kW)	7.5	15	20	7.5	15	20	7.5	15	20
PLATE VOLTAGE (V)	7150	9300	9150	7150	9300	9200	7150	9350	9220
PLATE CURRENT (A)	1.28	2.00	2.72	1.28	1.96	2.64	1.30	1.98	2.70
SCREEN VOLTAGE (V)	400	450	600	390	480	700	390	445	640
SCREEN CURRENT (mA)	45	100	130	55	115	130	60	120	140
GRID VOLTAGE (V)	–300	–310	–310	–300	–300	–310	–310	–315	–315
GRID CURRENT (mA)	40	50	50	40	50	45	40	48	42
FILAMENT VOLTAGE (V)	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
IPA FORWARD POWER (W)	230	350	380	220	330	370	210	300	375
IPA REFLECTED POWER	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
PA EFFICIENCY (%)	82	81	80	82	82	82	81	81	80

TABLE 5-2. TYPICAL POWER CONSUMPTION, FM-20T

FREQUENCY (MHz)	88.1			98.1			107.9		
POWER OUTPUT (kW)	7.5	15	20	7.5	15	20	7.5	15	20
AVERAGE AC LINE VOLTAGE (V)	215.5	215	215.5	215.5	215.5	215	215	215.5	215.8
AC LINE CURRENT (A)									
PHASE 1	34.7	62.4	84.7	35.1	61.6	81.3	36.1	63.5	83.5
PHASE 2	37.6	66.1	88.3	38.4	65.6	85.0	39.8	67.0	86.6
PHASE 3	37.2	65.6	87.8	38.0	64.7	84.7	39.1	66.5	86.3
POWER FACTOR	.95	.97	.97	.96	.97	.97	.96	.97	.97
AC POWER CONSUMPTION (kW)	12.7	22.8	30.6	13.0	22.6	29.5	13.4	23.2	30.3

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.***

5-126. Once the trouble is isolated, refer to the applicable assembly of this manual which presents the theory of operation and troubleshooting for the respective assembly to assist in problem resolution. Figures 5-8 through 5-13 provide drawings to assist component location.

5-127. **COMPONENT REPLACEMENT ON CIRCUIT BOARDS.** Component replacement on printed circuit boards requires extreme care to avoid damage to the board traces.

5-128. On all circuit boards, the adhesive securing the copper trace to the board melts at almost the same temperature at which solder melts. A circuit board trace 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.

5-129. 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.

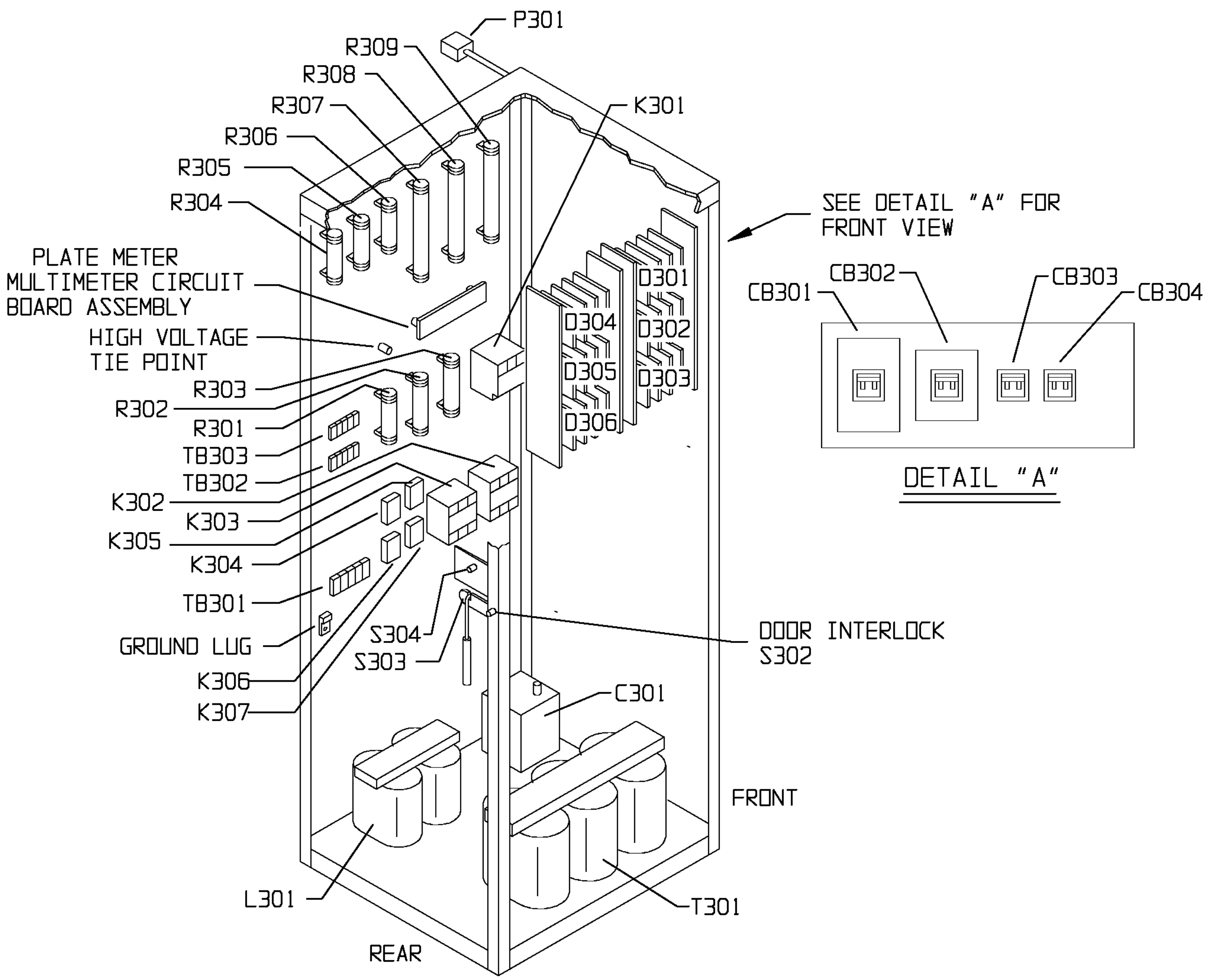
5-130. Grip each component lead, one at a time, with long nose pliers. Turn the board over and touch a soldering iron to the lead at the solder connection. When the solder begins to melt, push the lead through the back side of the board and cut off the bent-over outer end of the lead. Each lead may now 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.

5-131. Install the new component and apply solder from the bottom side of the board.

WARNING *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 *WARNING*	***OBSERVE THE MANUFACTURER'S CAUTIONARY INSTRUCTIONS.***

5-132. After soldering, remove flux with a cotton swab moistened with a suitable solvent. Rubbing alcohol is highly diluted and is not effective.

5-133. The board should be checked to ensure the flux has been removed and not just smeared. Rosin flux is not normally corrosive, but rosin will absorb enough moisture in time to become conductive and cause problems.



597-0220-30

FIGURE 5-8. FM-20T POWER SUPPLY CABINET COMPONENT LOCATOR

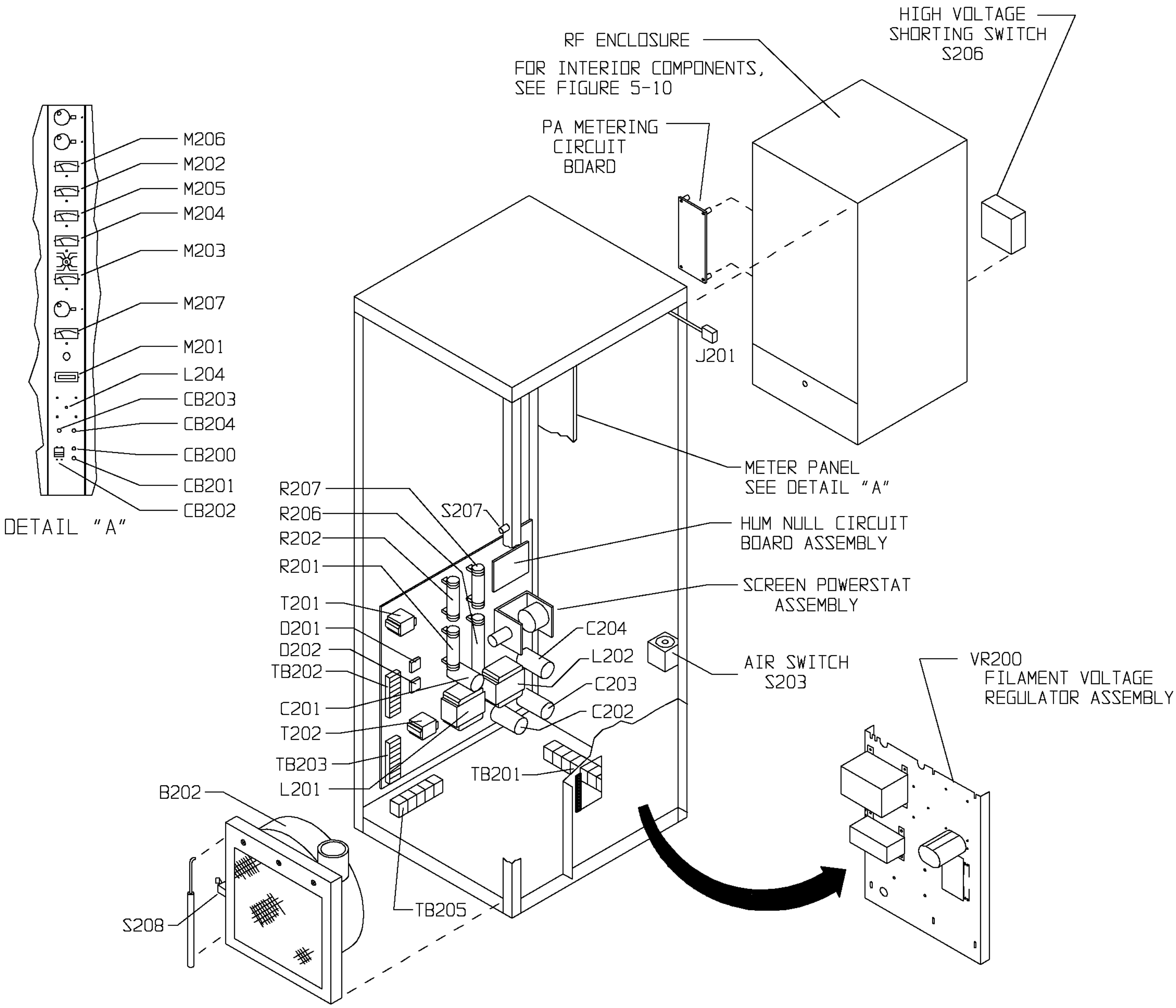


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FIGURE 5-9. FM-20T PA CABINET COMPONENT LOCATOR

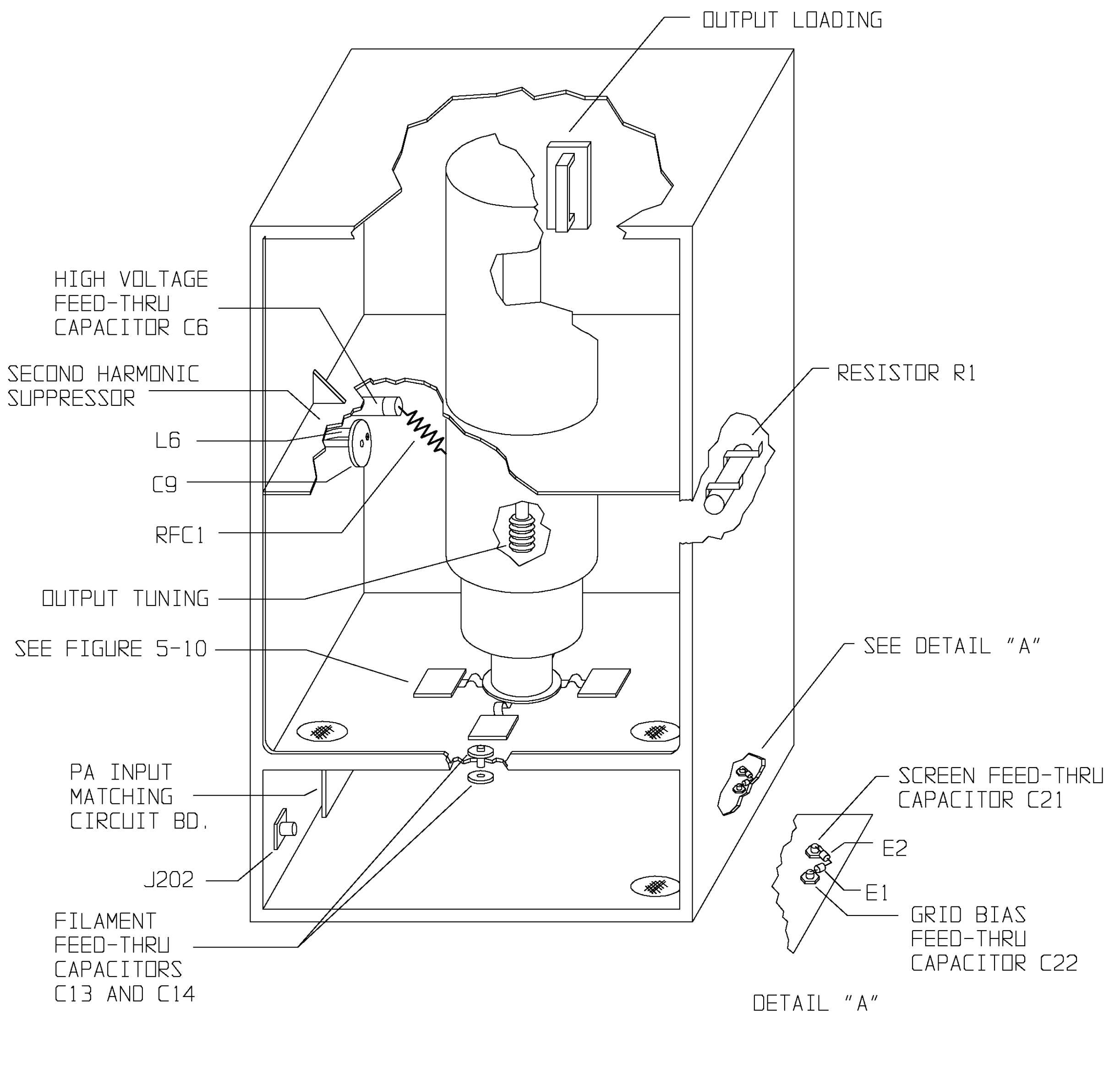

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FIGURE 5-10. RF ENCLOSURE COMPONENT LOCATOR

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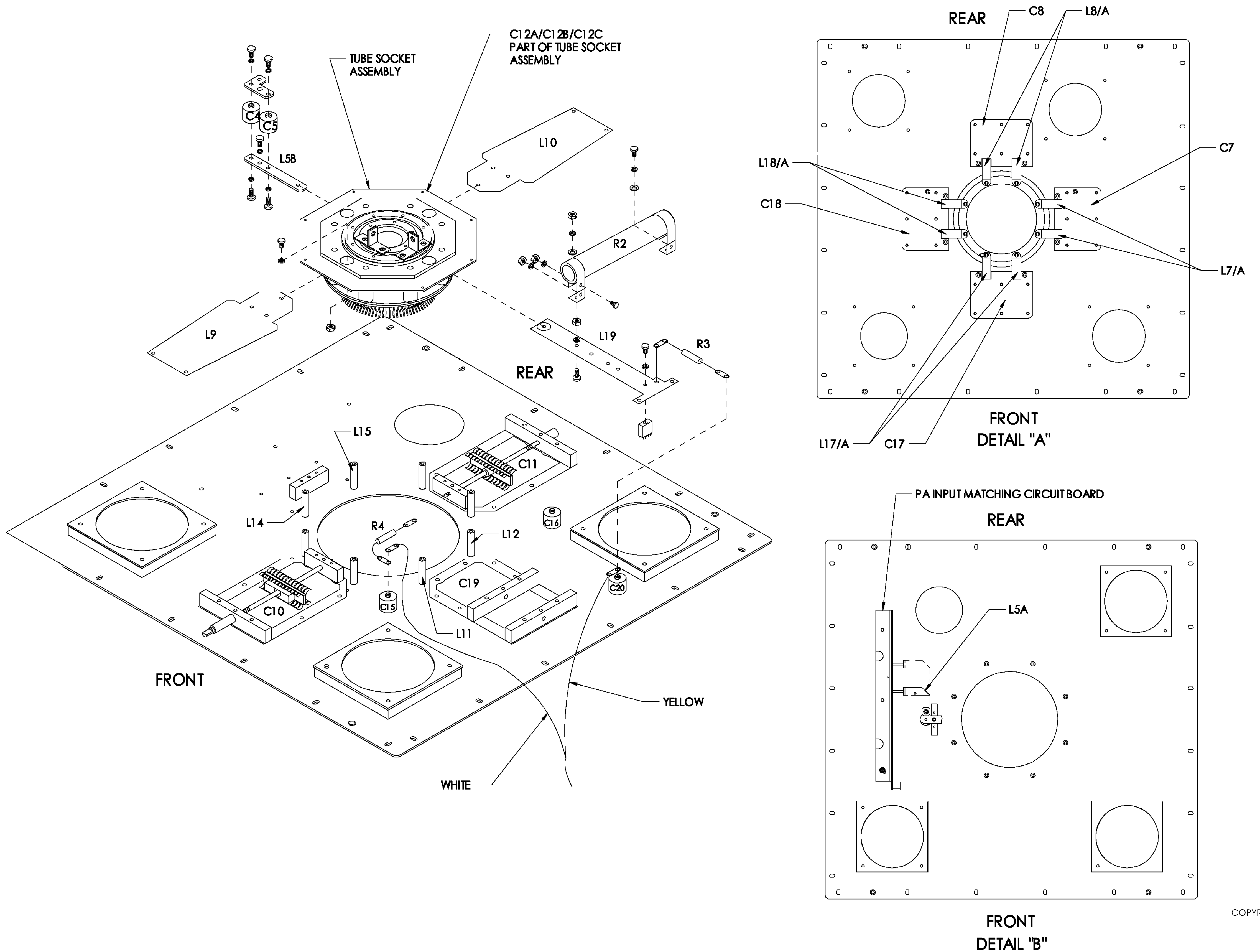

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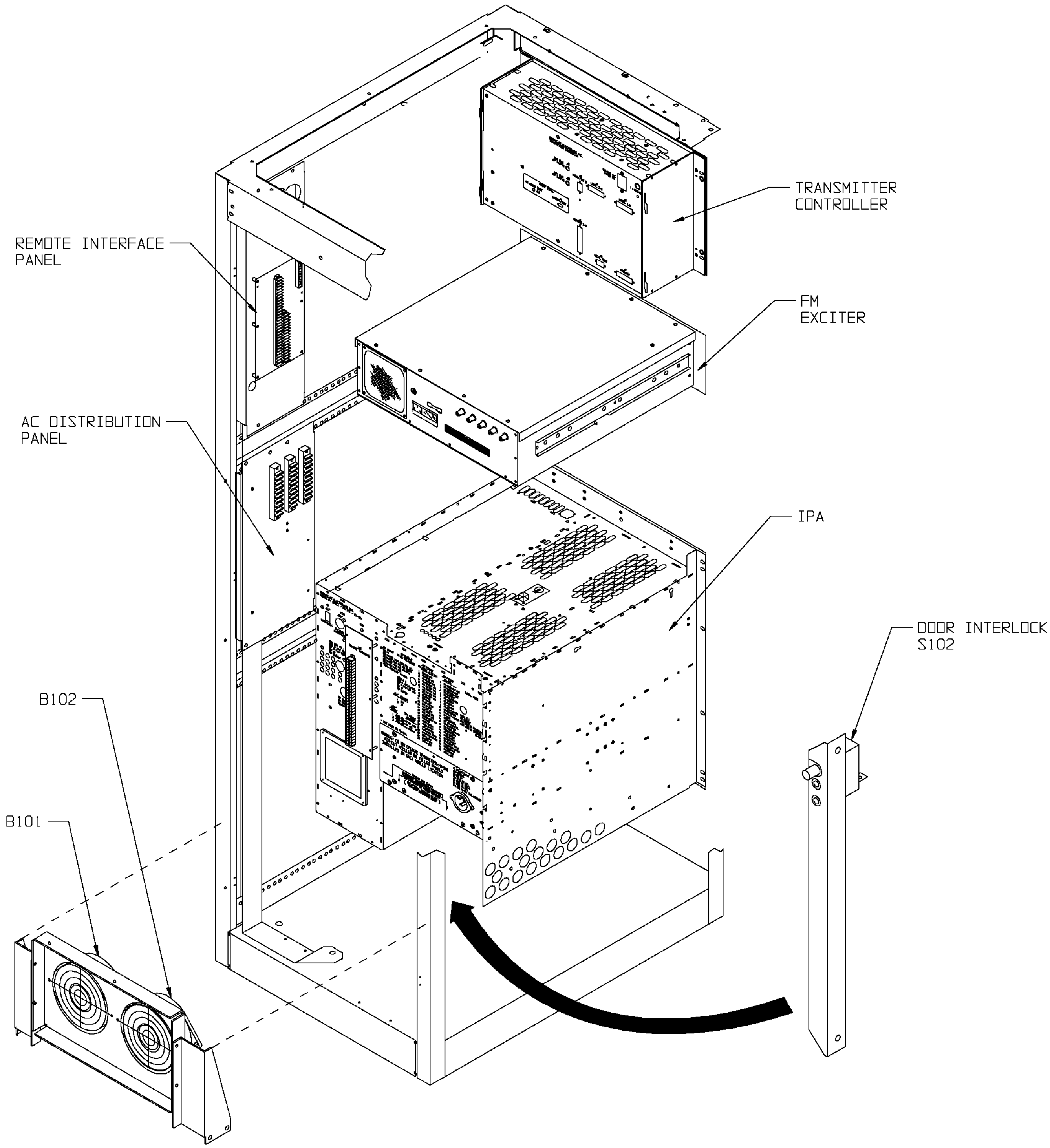
FIGURE 5-11. PA INPUT CIRCUIT COMPONENT LOCATOR



597-0096-34

FIGURE 5-12. FM-20T DRIVER CABINET COMPONENT LOCATOR

SECTION VI
PARTS LIST

6-1. INTRODUCTION.

6-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FM-20T transmitter. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram. Parts for the transmitter controller and IPA unit are listed in the CONTROLLER and IPA sections of this manual.

TABLE 6-1. FM-20T REPLACEABLE PARTS LIST INDEX
(Sheet 1 of 2)

TABLE 6-1. FM-20T REPLACEABLE PARTS LIST INDEX
(Sheet 2 of 2)

TABLE 6-2. FM-20T TRANSMITTER - 909-0020-205/-385

REF. DES.	DESCRIPTION	PART NO.	QTY.
V1	Tube, Eimac, 4CX12000A/8989	240-0012	1
----	Low Pass Filter, 45 kW	339-0022	1
----	FX-50 Exciter, 220V ac 50/60 Hz Operation	909-1050-325	1
----	Driver Cabinet Assembly	959-0297-100	1
----	Power Amplifier Cabinet Assembly	959-0296-100	1
----	Power Supply Cabinet Assembly	959-0295-100	1
----	Accessory Parts Kit	969-0015	1
	FOR 50 Hz MODELS 909-0020-385		
M207	Meter, 3.5 Inch (8.89 cm), Iron Vane Type, 0V to 500V ac Range, 150 k Ohm Resistance (PRIMARY VOLTAGE)	310-0060	1
M201	Meter, Elapsed Time, 0-99,999.9 Hour, Non-Resettable, 50 Hz, 230V, 3.5 Inch (8.89 cm) (FILAMENT TIME Meter)	310-0000-003	1

TABLE 6-3. POWER AMPLIFIER CABINET ASSEMBLY - 959-0296-100 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
	FOR 60 Hz MODELS		
B202	Blower, Centrifugal, 500 ft/min at 4.2 inches H20 Motor: 110/220V ac, 3450 R/M, 2 hp	380-0010	1
F203 thru F205	Fuse, 3AG, 1/2 Ampere, 250V	330-0050	3
S203	Switch, Pressure, 0.15 to 0.5 Inches W.C., 2% Repetitive Accuracy	340-0117	1
S205, S207	Interlock Switch, SPDT, 15A @ 125V ac, 0.5A @ 125V dc, 0.25A @ 250V dc	346-3302	2
TB201	Barrier Strip, Single Section, 600V	412-0725	16
TB205	Barrier Strip, Single Section, 600V	412-0725	4
XF203 thru XF205	Fuseholder, Panel Mount	415-2012	3
----	Barrier Strip, End Cap (for 412-0725)	412-0730	2
----	Transformer Regulator, Filament FM-10T/FM-20T	370-0053	1
----	Connector, BNC Flanged Modified	417-0203-1	1
----	Flange, 3 1/8 inch	427-0001	1
----	Elbow, 90 Degree, 3 1/8 inch	427-0002	1
----	Elbow, 90 Degree, 3 1/8 inch, Modified	427-0002-1	1
----	Pushnut Fast, PALNUT PH094	454-5200	2
----	Coupling, Un-Flanged , 3 1/8 inch	427-0005	1
----	R.F. Enclosure Assembly	959-0244-100	1
----	Door, R.F. Enclosure Assembly	959-0244-001	1
----	Chimney Assembly, FM-20B	959-0244-005	1
----	Top Cover, R.F. Enclosure Assembly	959-0244-104	1
----	Transmitter Ground Stick Assembly	955-0032-001	1
----	PA Metering Circuit Board Assembly	919-0048-006	1
----	PA Cable Assembly	949-0171-100	1

TABLE 6-3. POWER AMPLIFIER CABINET ASSEMBLY - 959-0296-100
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Tube Socket Assembly	959-0245	1
----	PA Screen & Bias Panel Assembly	959-0296-101	1
----	Fan/Blower Assembly	959-0296-004	1
----	PA Meter Panel Assembly	959-0296-105	1
----	Tuning Line Assembly, RF Enclosure	959-0246-003	1

TABLE 6-4. PA METERING CIRCUIT BOARD ASSEMBLY - 919-0048-006
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
C4, C5	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	2
C6, C7	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C8, C9	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	2
C10	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C11 THRU C13	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	3
C14	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C15, C16	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	2
C17	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C18	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C19	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C20	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C21	Capacitor, Electrolytic, 470 uF, 50V	024-4783	1
D1 THRU D7	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	7
E1 THRU E10	Terminal, Male Disconnect	410-0025	10
E11, E12	Terminal Turret, Two Shoulder	413-1597	2
E13	Terminal, Male Disconnect	410-0025	1
F1, F2	Fuse, AGC, 1 Ampere, Fast-Blow	330-0100	2
F3	Fuseable Link, 0.028 in (0.528 cm) of 28 AWG Silver-plated Copper Wire	630-2806	.208
J1	Connector, Housing, 10-Pin Dual In-line	418-1003	1
J2	Connector, Housing, 10-Pin	417-0169	1
J3	Receptacle, 6-Pin	417-0677	1
L1	RF Choke, 2.2 uH ±10%, 0.4 Ohms DC Resistance, 550 mA Maximum	360-2200	1
R1	Resistor, 100 Ohm ±5%, 1/2W	110-1033	1
R2 ,R3	Resistor, 0.5 Ohm ±1%, 5W, W/W	130-5001	2
R4, R5	Resistor, 0.5 Meg Ohm ±1%, 2W	140-0005	2
R6	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R7	Resistor, 5.11 k Ohm ±1%, 1/4W	103-5141	1
R8	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R9	Resistor, 0.5 Meg Ohm ±1%, 2W	140-0005	1
R10	Resistor, 5.62 k Ohm ±1%, 1/4W	103-5624	1
R11	Resistor, 49.9 k Ohm ±1%, 1/4W	103-4951	1
R12	Resistor, 26.7 k Ohm ±1%, 1/4W	103-2675	1
R13	Resistor, 49.9 k Ohm ±1%, 1/4W	103-4951	1
R14	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R15	Resistor, 100 Ohm ±5%, 1/4W	110-1033	1
R16	Resistor, 16 Ohm ±1%, 3W	130-1621	1
R17	Resistor, 18 Ohm ±1%, 3W	130-1821	1

TABLE 6-4. PA METERING CIRCUIT BOARD ASSEMBLY - 919-0048-006 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R18	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R19	Resistor, 41.2 k Ohm ±1%, 1/4W	103-4125	1
R20	Resistor, 22.1 k Ohm ±1%, 1/4W	103-2211	1
R21	Resistor, 49.9 k Ohm ±1%, 1/4W	103-4951	1
R22	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R23	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R24	Resistor, 16 Ohm ±1%, 3W	130-1621	1
R25	Resistor, 18 Ohm ±1%, 3W	130-1821	1
R26	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R27	Resistor, 24.3 k Ohm ±1%, 1/4W	103-2435	1
R28	Resistor, 18.2 k Ohm ±1%, 1/4W	103-1825	1
R29	Resistor, 59 k Ohm ±1%, 1/4W	103-5905	1
R30	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R33, R34	Resistor, 2.49 k Ohm ±1%, 1/4W	103-2494	2
R37	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R39	Resistor, 3.74 k Ohm ±1%, 1/4W	103-3744	1
R41	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
TP1	Terminal Turret, Two Shoulder	413-1597	1
U1,U2	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	2
XF1, XF2	Fuse Clip	415-2068	4
XU1, XU2	Socket, 8-Pin DIP	417-0804	2
----	Blank PA Metering Circuit Board	519-0048-002	1

TABLE 6-5. PA CABINET CABLE HARNESS ASSEMBLY - 949-0171-100

REF. DES.	DESCRIPTION	PART NO.	QTY.
J201	Receptacle, 15-Pin	417-1504	1
P1	Plug, Housing, 4-Pin (Temperature Sensor Circuit Board)	418-0240	1
P1, P1	Connector, Ribbon Cable, 10-Pin (PA Metering Circuit Board to Multimeter)	417-1003	2
P2	Connector, Housing, 15-Pin (PA Metering Circuit Board)	417-2379	1
P3	Connector, Housing, 6-Pin (PA Metering Circuit Board)	418-0670	1
P201	Connector, 25-Pin D-Type	417-0251	1
P202	Connector, 9-Pin D-Type	417-0900	1
----	Connector, BNC (J1)	417-0095	1
----	Connector, Straight Type-N	417-0120	1
----	Connector, Type N (J202)	417-0076	1
----	Pins, Connector	417-0053	22
----	Pins, Socket	417-0143	11
----	Pins, Connector	417-0142	32

TABLE 6-6. RF ENCLOSURE ASSEMBLY 959-0244-100

REF. DES.	DESCRIPTION	PART NO.	QTY.
C6	High Voltage Feed–Thru Capacitor Assembly	955–0049–002	1
C9	Capacitor Plate for Second Harmonic Suppressor	474–0319–001	1
C13, C14	Capacitor, Filament Feed–Thru	519–0039	4
E1	Spark Gap, 1000V dc ±20% Breakdown, 5000A Discharge Maximum	140–0015	1
E2	Spark Gap, 2500V dc ±20% Breakdown, 2500A Discharge Maximum	140–0016	1
L6	Inductor, Second Harmonic Suppressor		
	87.5 MHz to 89.5 MHz	360–0075	1
	89.5 MHz to 91.5 MHz	479–0070	1
	91.5 MHz to 108 MHz	479–0053–001	1
R1	Resistor, 100 Ohm ±1%, 150W	139–0006	1
RFC1	Inductor, RF Choke (Plate Circuit)	360–0073	1
S206	Interlock Switch, SPDT, 11A @ 125V or 250V ac, 0.5A @ 125V dc, 0.25A @ 250V dc (PA Cavity Access)	346–6100	1
----	Connector, Banana	418–0188	1
----	Connector, Output Coupling Loop	419–0034	1

TABLE 6-7. TUBE SOCKET ASSEMBLY - 959-0245

REF. DES.	DESCRIPTION	PART NO.	QTY.
C4, C5	Capacitor, Ceramic, 500 pF ±20%, 5 kV	008–5024	2
C7, C8	Capacitor, Screen Bypass, Printed Circuit Board	519–0037	2
C10, C11	Capacitor, Grid Tuning, Printed Circuit Board	519–0208	2
C15	Capacitor, Ceramic, 500 pF ±20%, 5 kV	008–5024	1
C16	Capacitor, Ceramic, 1000 pF ±20%, 5 kV	008–1036	1
C17, C18	Capacitor, Screen Bypass, Printed Circuit Board	519–0037	2
C19	Capacitor, Grid Tuning, Printed Circuit Board	519–0208	1
C20	Capacitor, Ceramic, 500 pF ±20%, 5 kV	008–5024	1
L5A	Inductor, Input Matching		
	20.1 KW to 22 KW	463–0092	1
	17 KW to 20 KW	463–0082	1
	Below 17 KW	463–0082–001	1
L5B	Inductor, Input	474–0313	1
L7/A, L8/A	Inductor, Neutralization	463–0083	4
L9, L10	Inductor, Input Tuning	474–0321	2
L11, L12,	Inductor, Tube Socket Mounting		
L14, L15	88 MHz to 91 MHz	441–0157	2
	91 MHz to 93 MHz	441–0162	2
	93 MHz to 98 MHz	441–0157	3
	98 MHz to 102 MHz	441–0157	3
	102 MHz to 108 MHz	441–0157	4
L17/A, L18/A	Inductor, Neutralization	463–0083	4
L19	Inductor, Input Tuning	474–0320	1
R1	Resistor, 750 Ohm ±10%, 50W	139–7532	1
R3, R4	Resistor, 1.5 Ohm ±5%, 10W	132–0114	2
XV1	Assembly, Tube Socket	417–0360	1
----	Input Matching Circuit Board Assembly	919–0064–002	1

TABLE 6-8. INPUT MATCHING CIRCUIT BOARD ASSEMBLY - 919-0064-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
E1 THRU E5, E8	Terminal, Turret, Double Shoulder	413-0025	6
J2	Connector, BNC	417-0014	1
----	Blank PA Input Matching Circuit Board	519-0064	1
----	Matching Capacitor Circuit Board	519-0064-001	1

TABLE 6-9. PA SCREEN & BIAS PANEL ASSEMBLY - 959-0296-101

REF. DES.	DESCRIPTION	PART NO.	QTY.
C201 thru C204	Capacitor, Electrolytic, 300 uF ±10%, 450WV	025-9086	4
D201, D202	Bridge Rectifier, H440: Peak Reverse Voltage: 4000V DC Forward Current: 750 mA Forward Voltage @ 150 mA dc: 6.0 Volts	239-0440	2
L201, L202	Choke, 10 Henrys, 0.4 Amperes, 2500 Volt Insulation, 92 Ohm dc Resistance	377-0002	2
R201	Resistor, 2 k Ohm ±5%, 100W, W/W	132-2043	1
R202	Resistor, 500 Ohm, Variable, 50W	130-5033	1
R203 thru R205	Resistor, 220 k Ohm ±5%, 2W	130-2263	3
R207	Resistor, 250 Ohm, 25W, W/W	130-2503	1
R206	Resistor, 10 k Ohm ±5%, 175W, W/W	132-1054	1
T201	Transformer, Primary: 208/240V ±11V RMS, 50/60 Hz Secondary: 295/320/345V @ 200 mA, Continuous	370-0036	1
T202	Transformer, Power Primary: 208/240V ±11V RMS, 50/60 Hz, Single Phase Secondary: 1100V ac @ 385 mA, Continuous	376-0043	1
TB202	Barrier Strip, Insulated, 5 Terminals	407-0125	1
TB203	Barrier Strip, Insulated, 6 Terminals	407-0126	1
----	Barrier Strip, 5 Terminals	412-0005-1	1
----	Barrier Strip, 6 Terminals	412-0008	1
----	Screen and Bias Supply Panel	471-0653	1
----	Hum Null Circuit Board Assembly	919-0112	1
----	PA Powerstat Panel Assembly	959-0296-103	1

TABLE 6-10. HUM NULL CIRCUIT BOARD ASSEMBLY - 919-0112

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 470 uF, 50V	024-4783	1
E1 THRU E3	Terminal, Turret, Double Shoulder	413-1597	3
R1, R2	Resistor, 22 Ohm ±5%, 2W, W/W	130-2223	2
T1	Transformer, Audio Output Primary: 7.5V Secondary: 7.5V Frequency Response: 6.21V @ 0.3A	371-0010	1
TB1	Terminal Strip, 4-Position	411-0815	1
----	Blank Hum Null Circuit Board	519-0112	1

TABLE 6-11. PA POWERSTAT PANEL ASSEMBLY - 959-0296-103

REF. DES.	DESCRIPTION	PART NO.	QTY.
B201	Motor and Gearhead Assembly, 24V dc @ 235 mA, 9.1 r/min, Torque: 300 oz/in.	381-0001	1
D203, D204	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	2
S201, S202	Microswitch, Modified, SPDT, 125V @ 4 Amperes Inductive	346-6100-1	2
T203	Powerstat Variable Transformer Input: 240V, 50/60 Hz Output: 280V @ 2.25A, 0.63 kVA Continuous	370-0007	1
TB204	Barrier Strip, 4 Terminal	412-0011	1

TABLE 6-12. FAN/BLOWER ASSEMBLY - 959-0296-004

REF. DES.	DESCRIPTION	PART NO.	QTY.
B202	Blower , Plenum & Flushing Fan	380-0011	1
S203	Interlock Switch, SPDT, 11A @ 125V or 250V ac, 0.5A @ 125V dc, 0.25A @ 250V dc	346-6100	1
----	Fuse Clip	415-1009	2

TABLE 6-13. PA METER PANEL ASSEMBLY - 959-0296-105
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C205 thru C208	Capacitor, Ceramic, 0.001 uF, 1 kV	002-1034	5
CB200, CB201	Circuit Breaker, KD1-15, 15 Amps, 250V ac, Push-On (Driver Circuit Breaker)	341-0059	2
CB202	Circuit Breaker, W92X112-30, 2-Pole, 250V, 30 Amperes (Blower Circuit Breaker)	341-0047	1
CB203, CB204	Circuit Breaker, KD1-0.5 ,Heinemann, 0.5 Amps (Grid Bias Circuit Breaker)	341-0057	2
M201	Meter, Elapsed Time, 230V ac/60 Hz, 3.5” Window Mount	310-0000-002	1
M203	Meter, 3.5 Inch (8.89 cm), Iron Vane Type, FS= 0-10V ac Movement ±3%	310-0024	1
M204	Multimeter, 3.5” Window Mount, Taut Band	310-0057	1
M205	Meter, 0-10kV dc, 3.5” Window Mount, Taut Band	310-0051	1
M206	Meter, 0-105% Power, 3.5” Window Mount, Taut Band, 0-200 Microamps	310-0058	1
M207	Meter, 3.5 Inch (8.89 cm), Iron Vane Type, 0V to 300V ac Range, 60 k Ohm Resistance	310-0032	1
S1	Selector Switch Assembly, KS-46B, Black, 3-Position	341-0021	1
----	Contact Assembly, KA-1	341-0020	4
----	Potentiometer, 50 Ohm ±10%, 25W, W/W	195-0149-001	1
----	Cyclometer	290-0001	3

TABLE 6-13. PA METER PANEL ASSEMBLY - 959-0296-105
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Transformer, Variable, Modified	370-1790-001	1
----	446-0047V Transmitter Counter Drive	446-0016	3
----	Meter Panel	471-0816-004	1
----	Knob, RB-67-5-CT-M, Black Matte	482-0027	3
----	Knob, RB-67-3-MD, Black Matte	482-0029	1
----	Multi-Meter Circuit Board Assembly	919-0049	1
----	Meter Assembly, Plate Current	959-0292	1

TABLE 6-14. MULTIMETER CIRCUIT BOARD ASSEMBLY - 919-0049

REF. DES.	DESCRIPTION	PART NO.	QTY.
E1, E2	Terminal, Male Disconnect	410-0025	2
J1	Connector, 10-Pin	418-1003	1
S1	Switch, Rotary, 8 Position, 15A @ 1000V ac	340-0110	1
----	Blank PA Multimeter Circuit Board	519-0049	1

TABLE 6-15. METER ASSEMBLY, PLATE CURRENT - 959-0292

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Meter, 3.5 Inch (8.89 cm), Taut Band Type, FS= 1 mA dc ±2%, Scale: 0-4A, 35 Ohm Movement	310-0055	1
----	Meter Protection Circuit Board Assembly	919-0109-002	1

TABLE 6-16. METER PROTECTION CIRCUIT BOARD ASSEMBLY - 919-0109-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1, C2	Capacitor, Ceramic Disc, 0.001 uF, 1000V	002-1034	2
D1	Diode, Zener, 1N4728, 3.3V ±5%, 1W	201-4728	1
E1, E2	Terminal, Male Disconnect	410-0025	2
R1	Resistor, 680 Ohm ±5%, 1W	120-6833	1
R2	Resistor, 182 Ohm ±1%, 1/4W	103-1823	1
R3	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
----	Blank Meter Protection Circuit Board	519-0109	1

TABLE 6-17. TOP COVER, RF ENCLOSURE ASSEMBLY - 959-0244-104

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Flange, Adaptor, Modified	427-0001-1	1
----	Exhaust Air Temperature Circuit Board Assembly	919-0082	1

TABLE 6-18. ASSEMBLY, EXHAUST AIR TEMPERATURE SENSOR - 919-0082

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C3,C4	Capacitor, Ceramic, 0.001 uF ±10%, 1 kV	002-1034	2
J1	Socket, 4-Pin	418-0255	1
R1	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R2	Resistor, 2.21 k Ohm ±1%, 1/4W	103-2241	1
U1	Integrated Circuit, LM35DZ, Celsius Temperature Sensor, TO-92 Case	220-0035	1
----	Blank Circuit Board	519-0082	1

TABLE 6-19. POWER SUPPLY CABINET ASSEMBLY - 959-0295-100

REF. DES.	DESCRIPTION	PART NO.	QTY.
C301	Capacitor, Plastic, 4 uF, 15 kV DC	030-0001	1
	FOR 60 Hz MODELS		
L301	Choke, 4.0 H @ 3.75 Amperes	360-0070-001	1
S302	Microswitch, Door Interlock, SPST, 0.5A @ 125V dc	346-3302	1
S303	Assembly, Ground Stick Hanger	955-0038	1
	FOR 60 Hz MODELS ONLY		
T301	Transformer, Plate Primary: Three-Phase, 196-252V or 339-437V ac, Delta Configuration Secondary: Three-Phase, 6923V ac @ 3.1 Amperes, Wye Configuration	370-0096-001	1
CB301	Circuit Breaker, KAL36150, 150 Amps, 600V ac, 3 Pole (High Voltage Circuit Breaker)	341-0051	1
CB302	Circuit Breaker, FAL34030, 30 Amps, 480V ac, 3 Pole (Control Circuit Breaker)	341-0052	1
CB303	Circuit Breaker, AM2-A8-A-3-20, 2 Pole, 3 Amps, 50/60 Hz	341-0055	1
CB304	Circuit Breaker, W92X1110-20, 20 Amps, 250V ac, 2 Pole	341-0078	1
---	Assembly, Ground Stick, Short	959-0145	1
----	Assembly, Power Supply Adjacent Interconnect Jumpers	949-0155	1
----	Rectifier Panel Assembly	959-0295-001	1
----	Contactor Panel Assembly	959-0295-002	1

TABLE 6-20. GROUND STICK HANGER ASSEMBLY - 955-0038

REF. DES.	DESCRIPTION	PART NO.	QTY.
S302	Microswitch, SPDT, 11A @ 125V or 250V ac, 0.5A @ 125V dc, 0.25A @ 250V dc	346-6100	1

TABLE 6-21. RECTIFIER PANEL ASSEMBLY - 959-0295-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	High Voltage Rectifier Assembly, 28 kV PRV @ 8 Amperes	230-0004	6
----	Jack, Banana, 1 kV, Capacitance: 7.0 uF	417-0109	2

TABLE 6-22. CONTACTOR PANEL ASSEMBLY - 959-0295-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
K301	Contactor (Start Contactor) Coil: 120/208/240V 60 Hz or 110/190/220V ac 50 Hz Contacts: 3-Pole, 550V ac, 120 Amperes	341-0054	1
K302	Contactor (Step Contactor) Coil: 208/240V ac 60 Hz or 190/220V ac 50 Hz Contacts: 3-Pole, 600V ac, 40 Amperes	341-0053	2
R301 thru R303	Resistor, 2 Ohm ±5%, 50W, W/W	132-1004	3
R304 thru R306	Resistor, 22 Ohm ±20%, 150W, Non-Inductive	139-0220	3
R307 thru R309	Resistor, 100 k Ohm ±5%, 225W, W/W	133-1064	3
TB301	Barrier Strip, 4-Position	412-0040	1
----	Barrier Strip, Single Section, 600V	412-0725	32
----	Barrier Strip, End Cap	412-0730	2
----	Switch, Interlock, 600V ac Maximum, Normally Open	340-0051	1
----	Contactor Mounting Panel	471-0619	1
----	Meter Multiplier Circuit Board Assembly	919-0079	1
----	Optically-Coupled-Relay OCR Assembly	919-0096	4
----	Power Supply Cabinet Cables Assembly	949-0141	1

TABLE 6-23. METER MULTIPLIER ASSEMBLY - 919-0079

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	1
R1 THRU R10	Resistor, 1 Meg Ohm ±1%, 2W	140-0003	10
R11	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
----	Blank Meter Multiplier Circuit Board	519-0079	1

TABLE 6-24. OPTICALLY-COUPLED-RELAY (OCR) ASSEMBLY - 919-0096 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 0.001 uF, 1 kV	002-1034	1
C2	Capacitor, Electrolytic, 47 uF, 35V	020-4773	1
C3	Capacitor, Ceramic Disc, 0.03 uF, 300V	000-1051	1
C4	Capacitor, Ceramic Disc, 0.001 uF, 1 kV	002-1034	1
D1	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	1
D2	Diode, Zener, 1N5359, 24V, 5W	200-5359	1
D4	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	1
D5	Bridge Rectifier, MDA970A3, 4 Amps, 50-200V	239-0003	1
E1 THRU E5	Terminal, Male, 0.25 Tab	410-0025	5
F1, F2	Fuse, PCB Mount, 250V, 3 Amperes	330-0055	2
K1	Relay, Coil: 24V dc, 30A, 660 Ohms ±10% dc Resistance Contacts: SPST, 0.5 to 15A @ 12 to 240V dc	270-0054	1
MOV1	Metal Oxide Varistor, V272A60, 27V AC RMS, 120 Joules	140-0023	1
R1	Resistor, 2 k Ohm ±3%, 10W	130-2032	1

TABLE 6-24. OPTICALLY-COUPLED-RELAY (OCR) ASSEMBLY - 919-0096 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R2	Resistor, 560 Ohm ±5%, 1/2W	110-5633	1
R3	Resistor, 820 Ohm ±5%, 1/2W	110-8233	1
R4	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	1
R5	Resistor, 2 k Ohm ±3%, 10W	130-2032	1
U1	Integrated Circuit, 4N33, Optical Isolator, Infared LED-Photo NPN Darlington Transistor Coupled Pair, 1500V Isolation	229-0033	1
XU1	Socket, 6-Pin DIP	417-0600	1
----	Relay Dust Cover	270-0054-001	1
----	Blank Circuit Board	519-0096	1

TABLE 6-25. POWER SUPPLY CABINET CABLES ASSEMBLY - 949-0141

REF. DES.	DESCRIPTION	PART NO.	QTY.
P301	Connector, 15-Pin, D-Type	417-1500	1
S301	Plug, Banana, 25 Amperes ac	418-0039	1
----	Pins, Connector	417-0142	11

TABLE 6-26. DRIVER CABINET ASSEMBLY - 959-0297-100

REF. DES.	DESCRIPTION	PART NO.	QTY.
S102	Interlock Switch, SPDT, 15A @ 125V ac, 0.5A @ 125V dc, 0.25A @ 250V dc	346-3302	1
----	Filter, Air 16X20X1	407-0062	1
----	Driver Cabinet Wiring Harness Assembly	949-0142-100	1
----	Transmitter Controller Assembly	959-0430	1
----	IPA Assembly	959-0421	1
----	AC Distribution Panel	959-0297-002	1
----	Driver Fan Assembly	959-0297-005	1
----	Assembly, Remote Interface Panel	959-0297-103	1

TABLE 6-27. DRIVER CABINET WIRING HARNESS ASSEMBLY - 949-0142-100

REF. DES.	DESCRIPTION	PART NO.	QTY.
J101	Receptacle, 25-Pin D-Type	417-0252	1
J102	Receptacle, 9-Pin D-Type	417-0901	1
P2, P3, P8	Connector, 25-Pin D-Type	417-0251	3
----	AC Line Cord With Ears, 220V	682-0004	2
----	Pins, Socket	417-0143	27
----	Connector, BNC, Crimp Type, RG58U Cable	417-0094	4
----	Connector, 9-Pin	417-0059	1
----	Pins, Connector	417-0053	2
----	Pins, Connector	417-0142	53
----	Connector, 2 Pole 3 Wire, 15A, 250V	417-0320	1
----	Connector, 37-Pin Male	417-2819	1

TABLE 6-28. AC DISTRIBUTION PANEL ASSEMBLY - 959-0297-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
TB104, TB105 TB106	Terminal Block, 9-Position	412-0090	1

TABLE 6-29. DRIVER FAN ASSEMBLY - 959-0297-005

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Fan, 6 inch (15.24 cm), 250 ft3/min 220V ac, 50/60 Hz, 40 Watt	380-7650	2
----	Pin Connector	417-0036	6
----	Housing, 9-Pin Connector	418-0055	1

TABLE 6-30. REMOTE INTERFACE PANEL ASSEMBLY - 959-0297-103

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Remote Interface Circuit Board Assembly	919-0439	1

TABLE 6-31. REMOTE INTERFACE CIRCUIT BOARD ASSEMBLY - 919-0439

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Connector, 40-Pin RibbonCable	417-0173	1
TB1	Barrier Strip, 30-Position	412-3000	1
TB2	Barrier Strip, 16-Position	412-1600	1
----	Blank Remote Interface Circuit Board	519-0439	1

TABLE 6-32. LOW-PASS FILTER ASSEMBLY - 339-0022

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Transmission Line Insulator-Connector Assembly	427-0004	1
----	Output Directional Coupler Assembly	959-0082-050	1

TABLE 6-33. OUTPUT DIRECTIONAL COUPLER ASSEMBLY - 959-0082-050

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Receptacle, BNC	417-0016	1
----	Resistor, 150 Ohm ±5%, 2W	130-1533	1
----	Choke, 1.5 uH ±10%, 580 mA Maximum	360-0032	1

TABLE 6-34. ACCESSORY PARTS KIT - 969-0015

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Battery, Cell, 3V, 190M	350-2032	1
----	FM-20T, FX-50 Exciter, Binder and Manual	979-0221-014	1

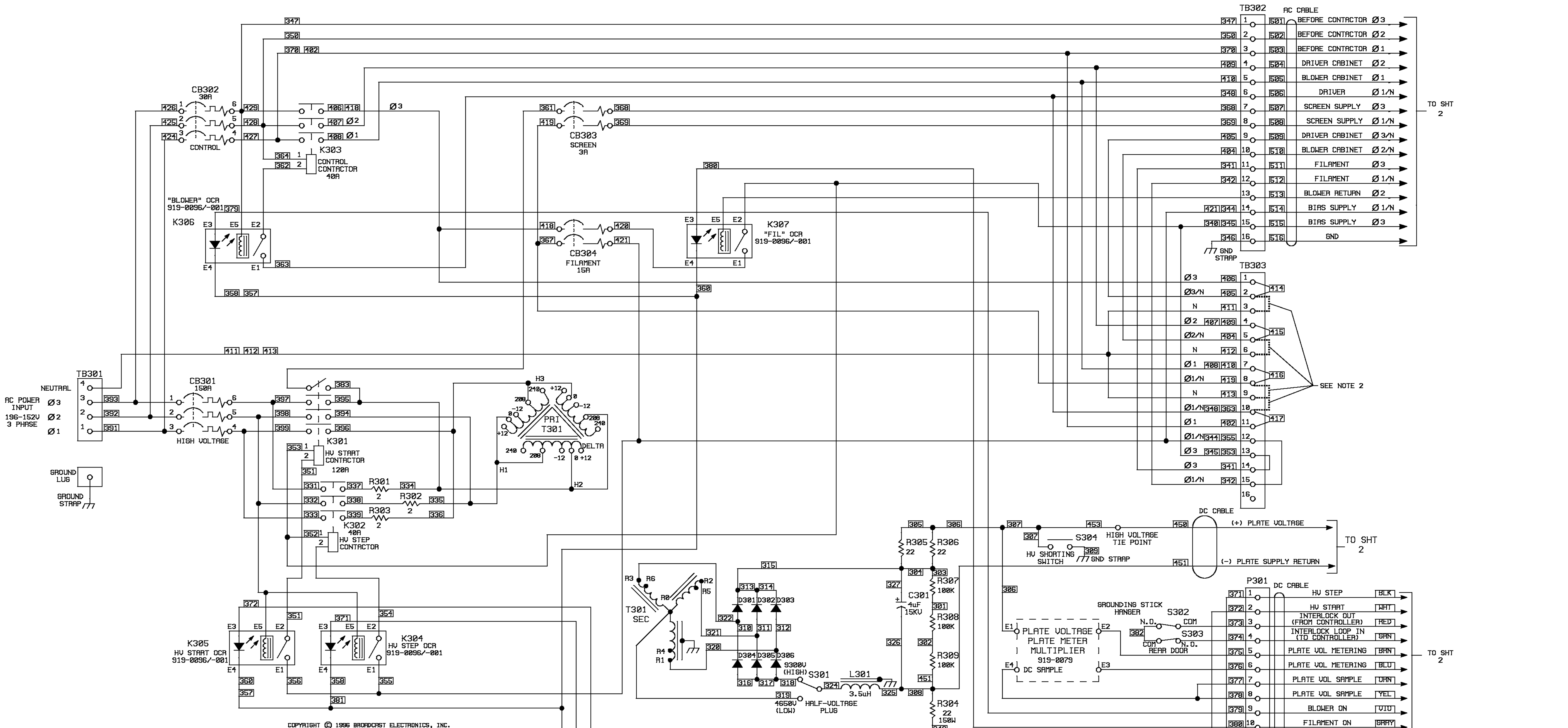
TABLE 6-35. KIT, REMOTE HIGH VOLTAGE POWER SUPPLY - 909-0135

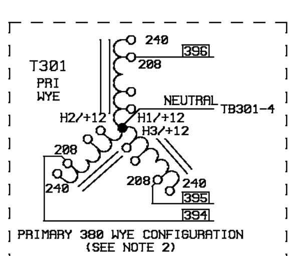
REF. DES.	DESCRIPTION	PART NO.	QTY.
	DELETE FROM ASSEMBLY 959-0295		
----	Assembly, Power Supply Adjacent Interconnect Jumpers	949-0155	1
	ADD TO ASSEMBLY 959-0295		
----	Assembly, Power Supply Remote Interconnect Jumpers	949-0156	1

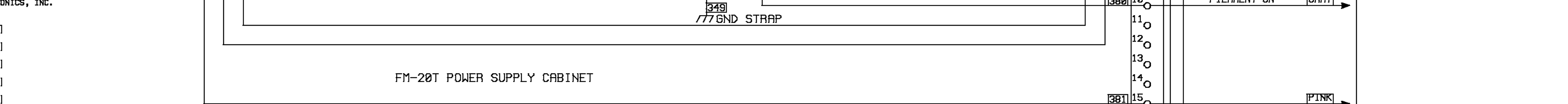
SECTION VII
DRAWINGS

7-1. INTRODUCTION.

7-2. This section provides schematic diagrams and assembly diagrams as indexed below for the FM-20T transmitter.







NOTES:

1. FOR 50 HZ INSTALLION, CONNECT WIRE 672 TO REGULATOR TERMINAL H3. WIRE 658 TO REGULATOR TERMINAL X3. CONNECT WIRE 687 TO REGULATOR TRANSFORMER TERMINAL 9. CONNECT WIRE 686 TO REGULATOR TRANSFORMER TERMINAL 14. MOVE THE CONNECTION FROM THE CAPACITOR FROM REGULATOR TRANSFORMER TERMINAL 7 TO TERMINAL 8.
2. JUMPERS SHOWN IN 208/240 PRIMARY DELTA CONFIGURATION ON TB303-1 THRU 11 FOR PRIMARY 380 WYE CONFIGURATION MOVE TO POSITIONS INDICATED BY DOTTED LINES.
3. FOR PRIMARY 380 WYE CONFIGURATION STRAP TAPS OF T301 AS FOLLOWS:
   H1 +12 TO H2 +12 WIRE No. 546
   H2 +12 TO H3 +12 WIRE No. 547
   H3 +12 TO TB301-4 WIRE No. 548
4. USING SECONDARY TAPS R4,R5,& R6 OF TB301 HIGH = 7100V, LOW = 3500V.

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

DWN. BY MSE 11-7-96	MATERIAL SEE B/M 909-0020-205,-385		
DESIGNER(S)	FINISH		
PROJ. LEADER MBS			
MFG.	NEXT ASSY.		

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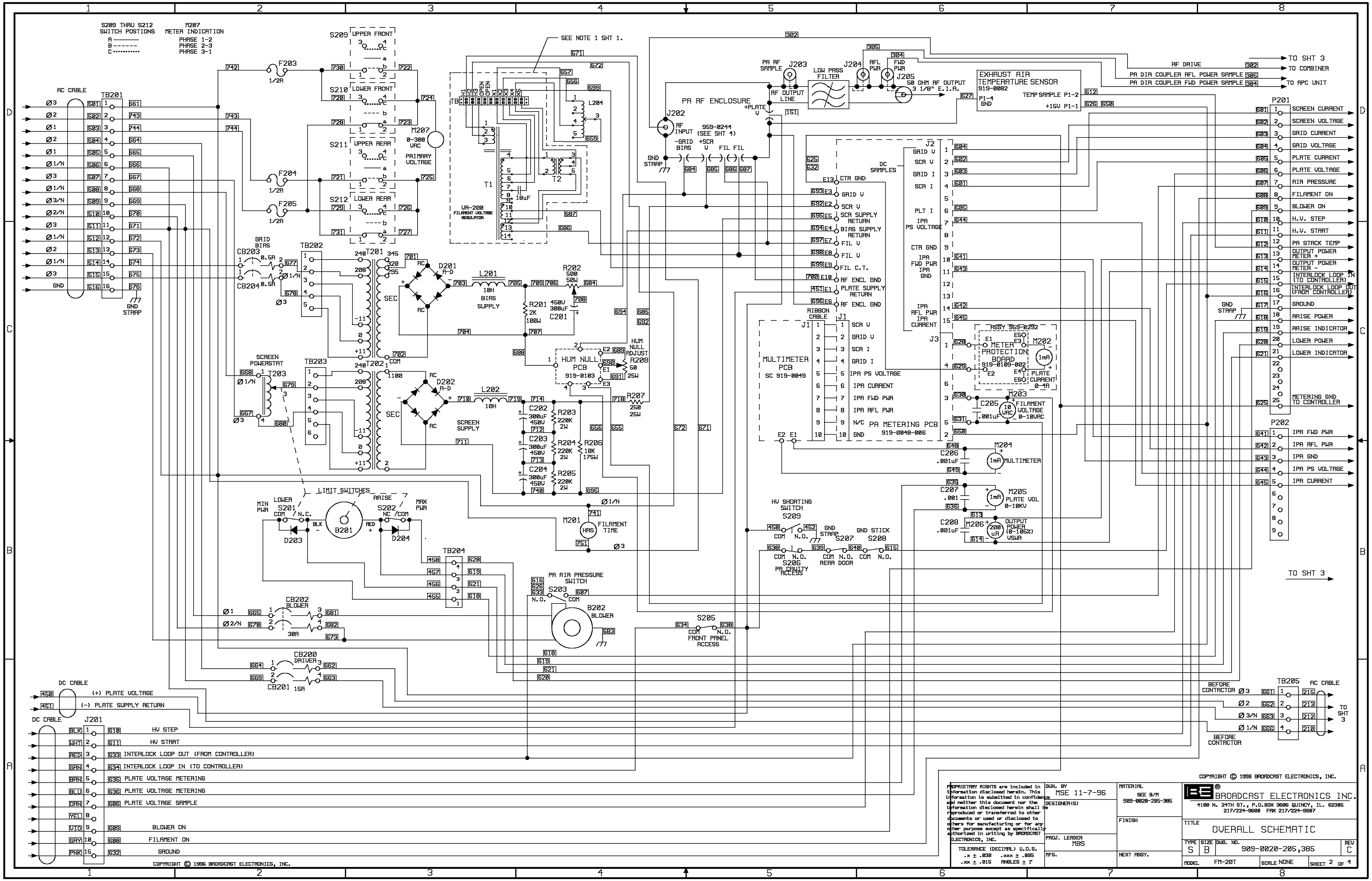
217/224-9600 FAX 217/224-9607

TITLE: OVERALL SCHEMATIC

TYPE	SIZE	DWG. NO.	REV
S	B	909-0020-205,-385	C

MODEL FM-20T SCALE NONE SHEET 1 OF 4



OVERALL SCHEMATIC
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4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305
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DWN. BY MSE 11-7-96
PROJ. LEADER MBS
MATERIAL SEE B/M 909-0020-205-385
DWG. NO. 909-0020-205,385
REV C
MODEL FM-20T
SCALE NONE
SHEET 2 OF 4
TOLERANCE (DECIMAL) U.O.S.
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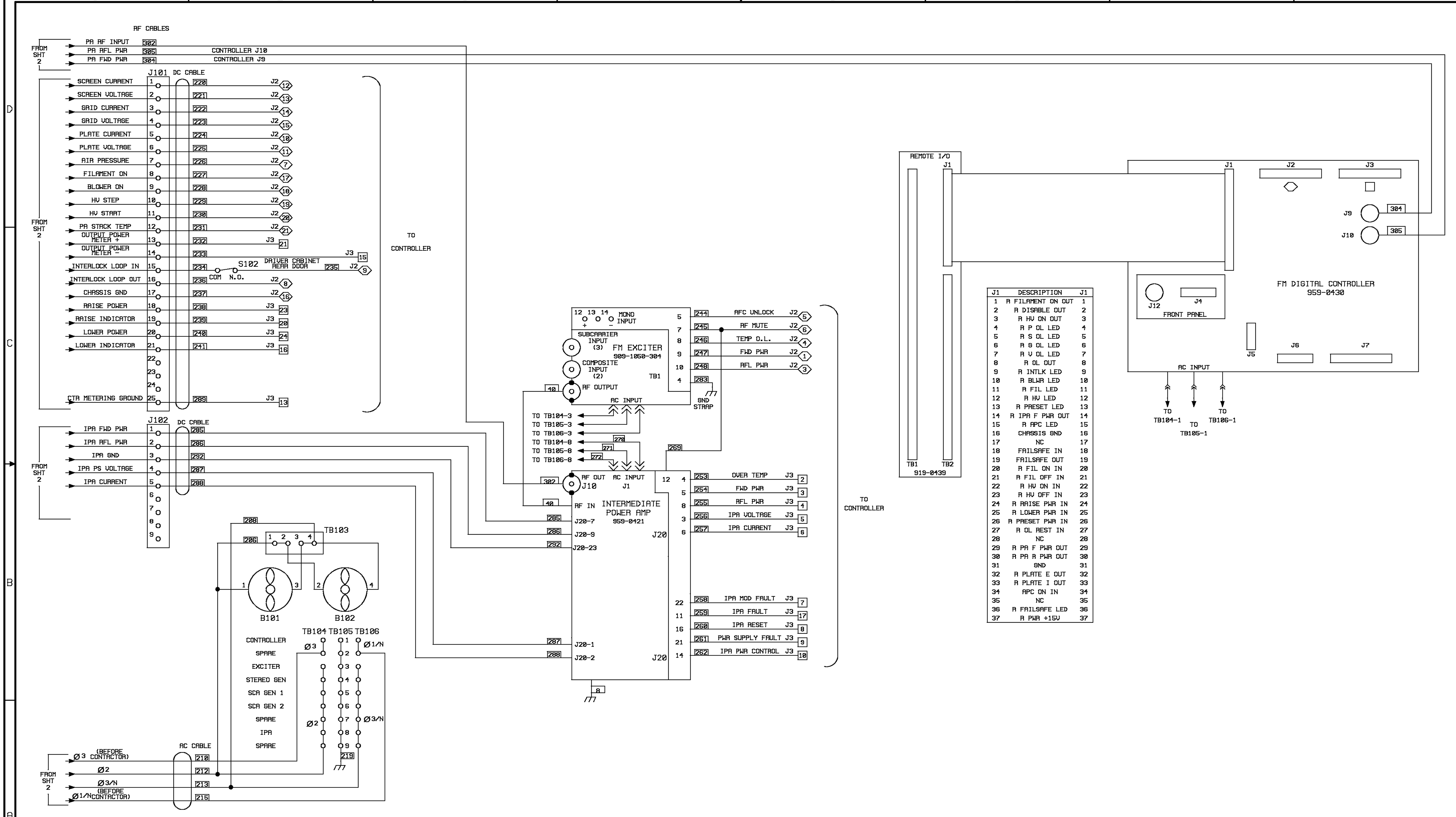
PA RF ENCLOSURE
EXHAUST AIR TEMPERATURE SENSOR 919-0082
MULTIMETER PCB SC 919-0049
PA METERING PCB 919-0040-006
HUM NULL PCB 919-0103
METER PROTECTION BOARD 919-0109-002
LOW PASS FILTER
TO SHT 3
TO COMBINER
TO APC UNIT



J1	DESCRIPTION	J1
1	R FILAMENT ON OUT	1
2	R DISABLE OUT	2
3	R HV ON OUT	3
4	R P OL LED	4
5	R S OL LED	5
6	R G OL LED	6
7	R V OL LED	7
8	R OL OUT	8
9	R INTLK LED	9
10	R BLWR LED	10
11	R FIL LED	11
12	R HV LED	12
13	R PRESET LED	13
14	R IPA F PWR OUT	14
15	R APC LED	15
16	CHASSIS GND	16
17	NC	17
18	FAILSAFE IN	18
19	FAILSAFE OUT	19
20	R FIL ON IN	20
21	R FIL OFF IN	21
22	R HV ON IN	22
23	R HV OFF IN	23
24	R RAISE PWR IN	24
25	R LOWER PWR IN	25
26	R PRESET PWR IN	26
27	R OL REST IN	27
28	NC	28
29	R PA F PWR OUT	29
30	R PA R PWR OUT	30
31	GND	31
32	R PLATE E OUT	32
33	R PLATE I OUT	33
34	APC ON IN	34
35	NC	35
36	R FAILSAFE LED	36
37	R PWR +15V	37

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

DWN. BY MSE 11-7-96
DESIGNER(S)
PROJ. LEADER MBS
MFG.
MATERIAL SEE B/M 909-0020-205,-305
FINISH
NEXT ASSY.

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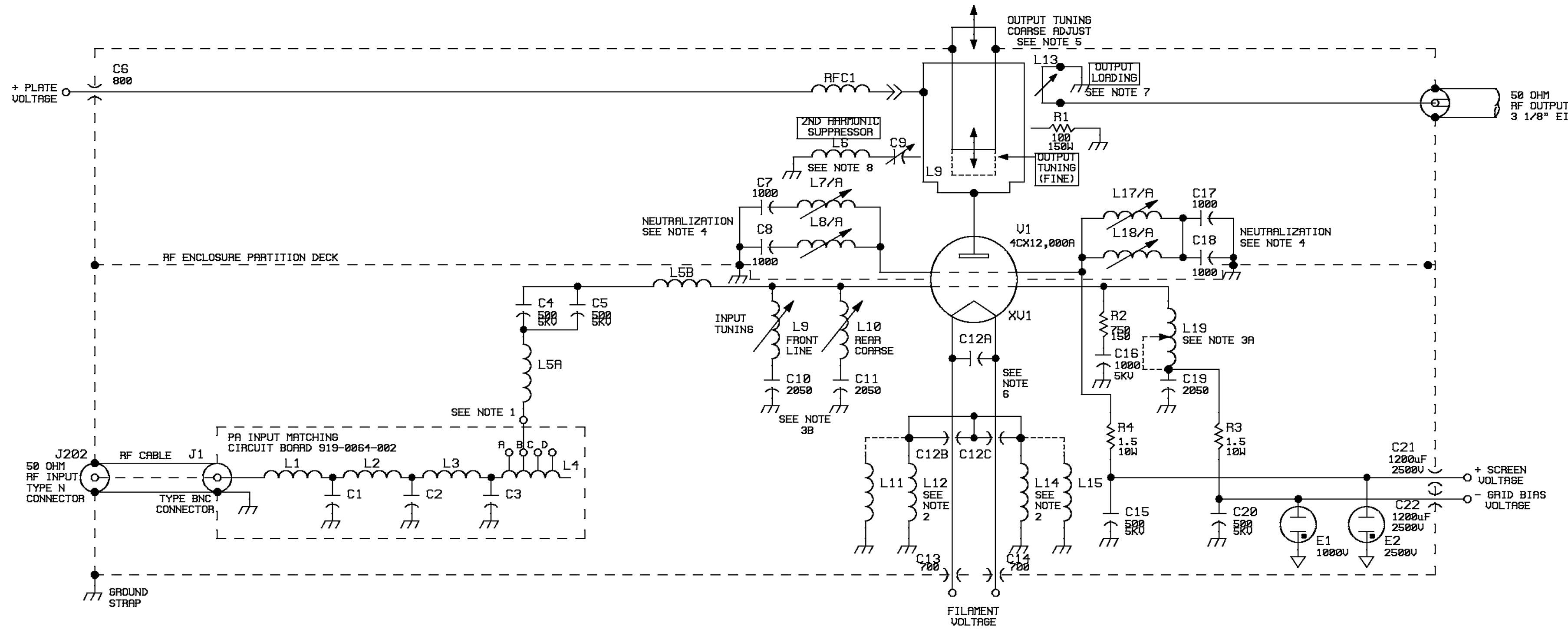
TITLE OVERALL SCHEMATIC

TYPE S SIZE B DWG. NO. 909-0020-205,-305 REV C
MODEL FM-20T SCALE NONE SHEET 3 OF 4



NOTES:

CONSULT INSTRUCTION MANUAL FOR THE FOLLOWING:

1. SCHEMATIC SHOWS PA INPUT MATCHING STRAP (L5A) CONNECTED TO STANDARD TAP (POSITION B) OF INDUCTOR (L4) ON THE PA INPUT MATCHING PCB.
2. TUBE SOCKET MOUNTING STANDOFF (L11-L15) FREQUENCY DEPENDENT PART.
3. A) INPUT TUNING PLATE "SIDE" (L19) FREQUENCY DEPENDENT ADJUSTMENT.
   B) INPUT TUNING PLATES "FRONT & REAR" (L9,L10). FREQUENCY DEPENDENT ADJUSTMENT.
4. NEUTRALIZATION STRAPS (L7,L8,L17,L18) FREQUENCY DEPENDENT ADJUSTMENT.
5. OUTPUT TUNING HALF-WAVE FOLDED TRANSMISSION LINE (L9), COARSE AND FINE ADJUSTMENT, FREQUENCY DEPENDENT.
6. CAPACITORS C12A,B, & C ARE PART OF TUBE SOCKET XV1.
7. OUTPUT LOADING LOOP (L13) FREQUENCY AND OUTPUT POWER DEPENDENT ADJUSTMENT.
8. SECOND HARMONIC SUPPRESSOR (L6&C9) FREQUENCY DEPENDENT PARTS AND ADJUSTMENT.
9. ALL CAPACITORS IN pF: ALL RESISTORS IN OHMS, UNLESS OTHERWISE SPECIFIED.

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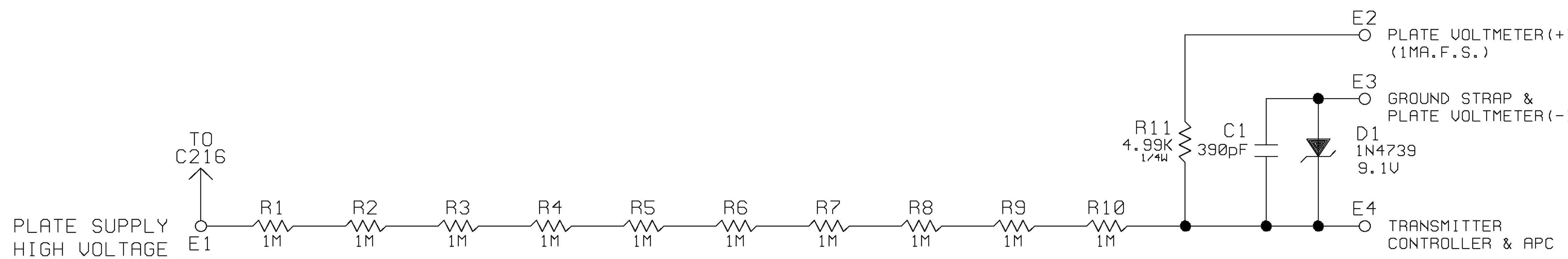
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY MSE 11-11-96	MATERIAL SEE B/M 909-0020-205,-385	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 FAX 217/224-9607
DESIGNER(S)	FINISH	TITLE OVERALL SCHEMATIC
PROJ. LEADER MBS		TYPE S / SIZE B / DWG. NO. 909-0020-205,-385 / REV C
MFG.	NEXT ASSY.	MODEL FM-20T / SCALE NONE / SHEET 4 OF 4



NOTES:

1. ALL RESISTORS IN OHMS; 2W, 1%, UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C1, D1, E4, R11
3. SEE PCB ASSEMBLY AB919-0079

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

DWN. BY KT 6-16-97	MATERIAL SEE BOM 919-0079	BROADCAST ELECTRONICS INC.	
DESIGNER(S)	FINISH	TITLE PCB SCHEMATIC METER MULTIPLIER	
PROJ. LEADER W.L.HARNESS		TYPE S / SIZE B / DWG. NO. 919-0079	REV B
MFG.	NEXT ASSY.	MODEL XMTRS / SCALE NONE	SHEET 1 OF 1

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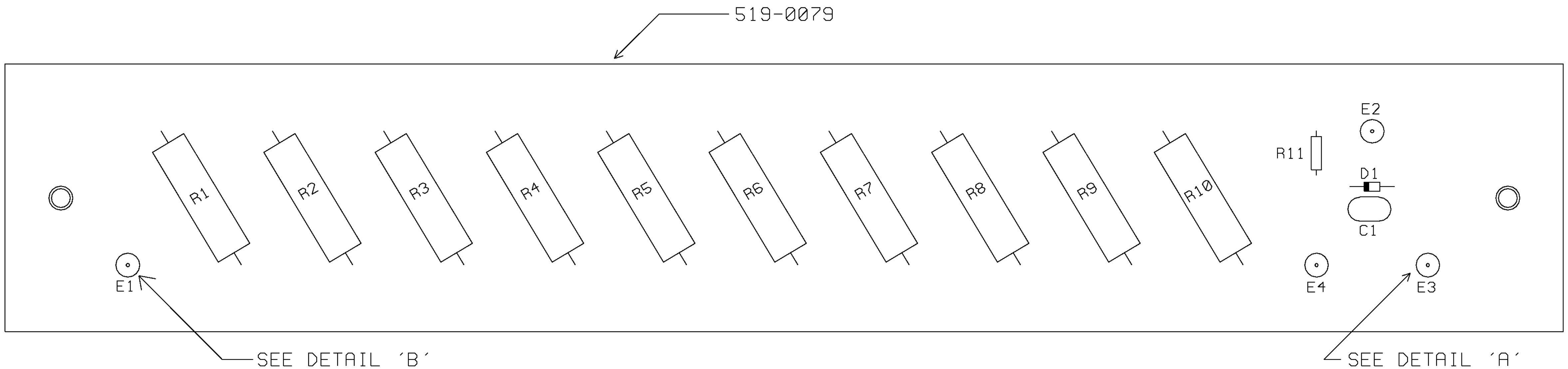
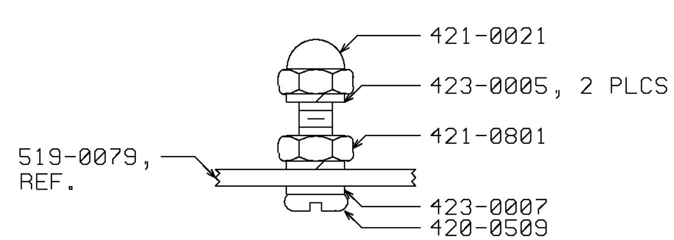
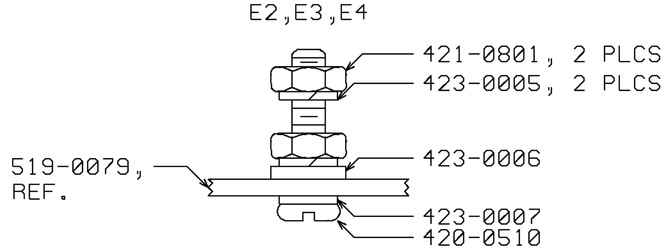
217/224-9600 FAX 217/224-9607



DETAIL 'B'



DETAIL 'A'
3 PLCS
E2,E3,E4



NOTES:
1. LAST COMPONENTS USED: C1, D1, E4, R11.
2. SEE PCB SCHEMATIC: SB919-0079

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

DWN. BY: KT 6-17-97
DESIGNER(S):
PROJ. LEADER: W.L.HARNESS
MFG.:

MATERIAL: SEE B/M NO. 919-0079
FINISH:
NEXT ASSY.:

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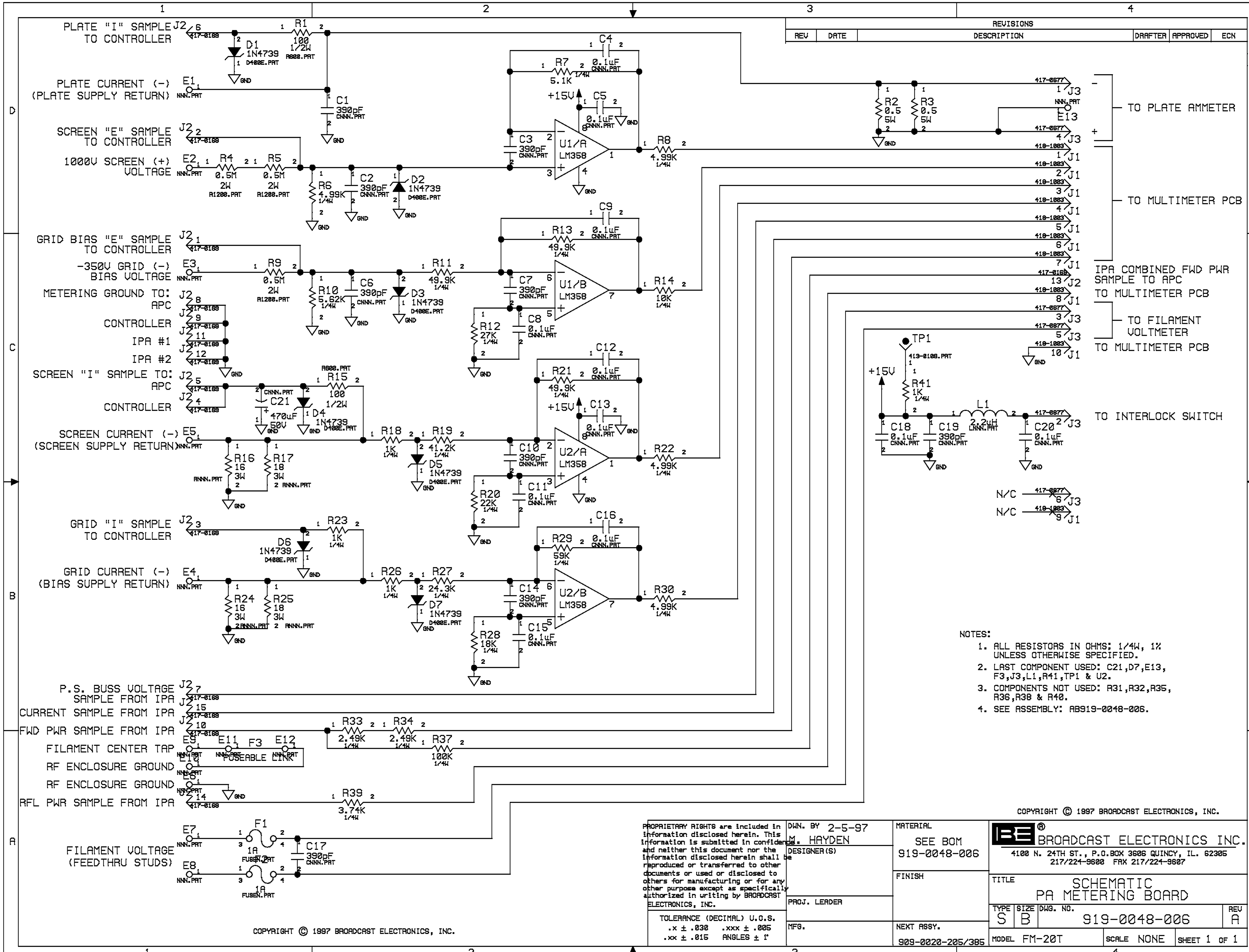
217/224-9600 FAX 217/224-9607

TITLE: PCB ASSEMBLY- METER PROTECTION BD.

TYPE	SIZE	DWG No.	REV
A	B	919-0079	C

MODEL: XMTRS | SCALE: 1/1 | SHEET 1 OF 1



NOTES:

1. ALL RESISTORS IN OHMS; 1/4W, 1% UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C21,D7,E13, F3,J3,L1,R41,TP1 & U2.
3. COMPONENTS NOT USED: R31,R32,R35, R36,R38 & R40.
4. SEE ASSEMBLY: AB919-0048-006.

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

DWN. BY 2-5-97 M. HAYDEN
DESIGNER(S)
PROJ. LEADER
MFG.

MATERIAL SEE BOM 919-0048-006
FINISH
NEXT ASSY. 909-0020-205/305

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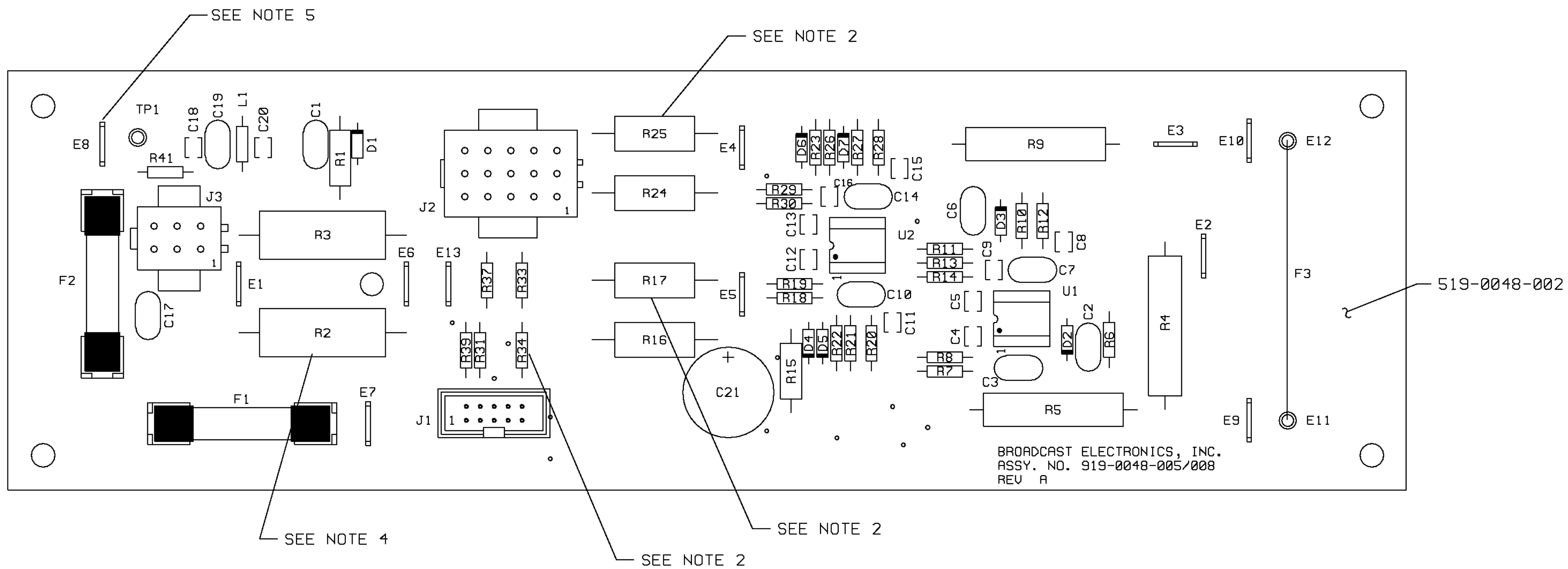
217/224-9600 FAX 217/224-9607

TITLE SCHEMATIC PA METERING BOARD

TYPE S | SIZE B | DWG. NO. 919-0048-006 | REV A
MODEL FM-20T | SCALE NONE | SHEET 1 OF 1



NOTES:

1. LAST COMPONENT USED: C21,D7,E13,F3,J3,L1,R41,TP1 & U2.
2. R17,R25,R32-R36,R38 & R40 NOT USED ON FM-5T & FM-10T.
   R31,R32,R35,R36,R38 & R40 NOT USED ON FM-20T,FM-30T & FM-35T.
3. SEE B/M AND SCHEMATIC SB919-0048-005 FOR FM-30T & FM-35T
   SEE B/M AND SCHEMATIC SB919-0048-006 FOR FM-20T
   SEE B/M AND SCHEMATIC SB919-0048-007 FOR FM-10T
   SEE B/M AND SCHEMATIC SB919-0048-008 FOR FM-5T
4. R2,R3 BODY SIZE IS LARGER THAN SHOWN ON
   MODELS: FM-30T & FM-35T.
5. E1-E13 (410-0025) MUST BE STRAIGHT UP ON BOARD.

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

DWN. BY 2-6-97
M. HAYDEN
DESIGNER(S)
PROJ. LEADER
MFG.

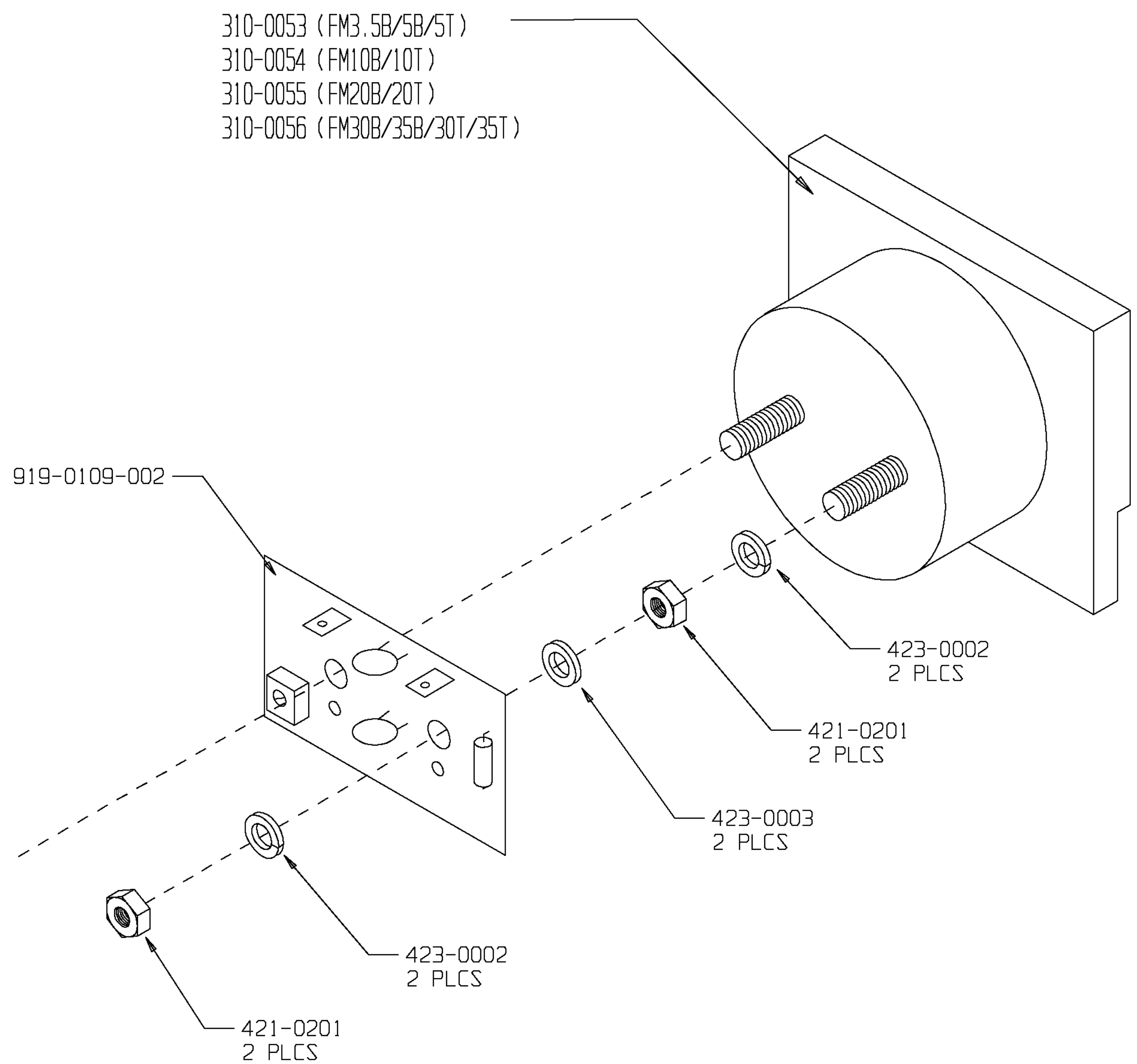
MATERIAL
SEE BOM
919-0048-005
919-0048-006
919-0048-007
919-0048-008
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305
217/224-9600 FAX 217/224-9607

TITLE
PCB ASSEMBLY
PA METERING BOARD

TYPE	SIZE	DWG No.	REV
A	B	919-0048-005/006/007/008	A

MODEL FM-5T/10T/20T FM-30T/35T | SCALE 1/1 | SHEET 1 OF 1



ASSY. NO.	CALIBRATION VOLTAGE	XMTR MODEL
959-0300	1.00 VDC	FM3.5B/5B/5BS/5T
959-0291	0.985 VDC	FM10B/10T
959-0292	0.99 VDC	FM20B/20T
959-0293	1.01 VDC	FM30B/35B/30T/35T

NOTES:

1) ASSEMBLED UNIT TO BE GIVEN TO INCOMING INSPECTION FOR SET-UP AND CALIBRATION AND DELIVERY TO STOCK.

2) INCOMING- SET CALIBRATOR AS PER TABLE 50 OHM DIVIDER OFF - ADJUST POTENTIOMETER FOR FULL SCALE READING ON METER, SEAL POTENTIOMETER WITH ANTI-TAMPER LACQUER (B.E. 700-0130)

3) PCB 919-0109-002 USED IN FM3.5B,5B,5T FM10B,10T,20B,20T,30B,30T,35B,35T.

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

DWN. BY KT 6-10-97

DESIGNER(S)

PROJ. LEADER MUKUNDA B. SHRESTHA

MFG. JAS 6-2-88

MATERIAL SEE B/M

FINISH

SEE DWG RA592-0000

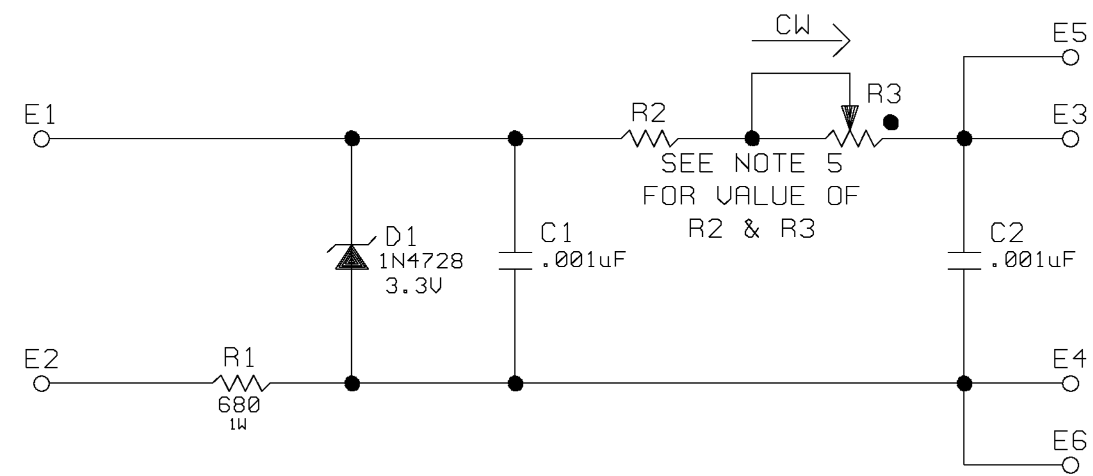
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N.24TH ST.,P.O.BOX 3606 QUINCY,IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE
ASSY, PLATE METER

TYPE A | SIZE B | DWG. NO. 959-0291(FM10B),959-0292(FM20B) 959-0293(FM30/35B) 959-0300(FM3.5B,5B,5BS) | REV C

MODEL FM3.5B,5B,5T,5BS,5TBS,10B,10T 20B,20T,30B,30T,35B,35T | SCALE NTS | SHEET 1 OF 1



NOTES:

1. ALL RESISTORS IN OHMS; 1/4W, 5%, UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C2, D1, E6, R3
3. SEE PCB ASSEMBLY AB919-0109, 919-0109-001, 919-0109-002.
4. 919-0109 USED IN FM-35A, FM-30A, FM-20A.
   919-0109-001 USED IN FM-10A.
   919-0109-002 USED IN FM-3.5B, FM-5B, FM-5BS, FM-10B, FM-20B, FM-30B, FM-35B.
5. R2: 103-2493 USED IN 919-0109.
   100-4713 USED IN 919-0109-001.
   103-1823 USED IN 919-0109-002.

   R3: 177-1034 USED IN 919-0109, 919-0109-001.
   177-2034 USED IN 919-0109-002.

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

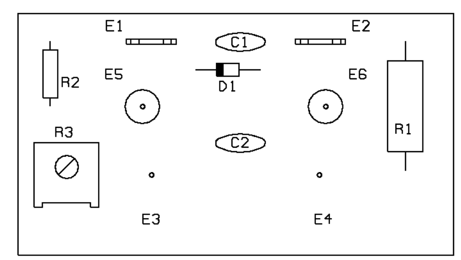
DWN. BY KT 6-10-97	MATERIAL SEE BOM 919-0109	
DESIGNER(S)	FINISH	
PROJ. LEADER 6-13-88 M. SHRESTHA		
MFG.	NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305
217/224-9600 FAX 217/224-9607

TITLE PCB SCHEMATIC METER PROTECTION BD

TYPE	SIZE	DWG. NO.	REV
S	B	919-0109/-001/-002	E

MODEL SEE NOTE 4 | SCALE NONE | SHEET 1 OF 1



NOTES:

1. LAST COMPONENTS USED: C2, D1, E6, R3.
2. SEE PCB SCHEMATIC: SB919-0109, 919-0109-001, 919-0109-002.

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

DWN. BY	KT 6-11-97
DESIGNER(S)	
PROJ. LEADER	6-13-88 M.SHRESTHA
MFG.	
MATERIAL	SEE B/M NO. 919-0109
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305
217/224-9600 FAX 217/224-9607

TITLE
PCB ASSEMBLY-
METER PROTECTION BD.

TYPE	SIZE	DWG No.	REV
A	B	919-0109/-001/-002	E

MODEL SEE SB919-0109 | SCALE 1/1 | SHEET 1 OF 1

NOTES:

1. LAST COMPONENT USED: E2, J1, S1
2. SEE PCB ASSEMBLY AB919-0049.

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

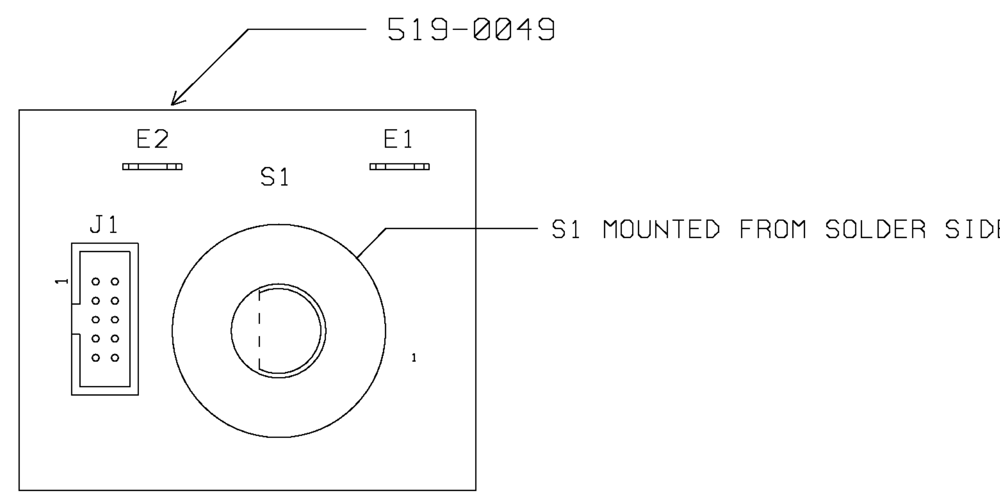
DWN. BY	MERK 9-8-87
DESIGNER(S)	
PROJ. LEADER	11-2-88 M.SHRESTHA
MFG.	11-2-88 P.R.BROSE
MATERIAL	SEE BOM 919-0049
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305
217/224-9600 FAX 217/224-9607

TITLE: PCB SCHEMATIC MULTIMETER BOARD

TYPE	SIZE	DWG. NO.	REV
S	B	919-0049	A

MODEL XMTRS | SCALE NONE | SHEET 1 OF 1



NOTES:
1. LAST COMPONENTS USED: E2, J1, S1.
2. SEE PCB SCHEMATIC: SB919-0049.

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

DWN. BY	MERK	9-8-87
DESIGNER(S)	J.STEINKAMP	11-2-88
PROJ. LEADER	M.SHRESTHA	11-2-88
MFG.	P.R.BROSE	11-2-88

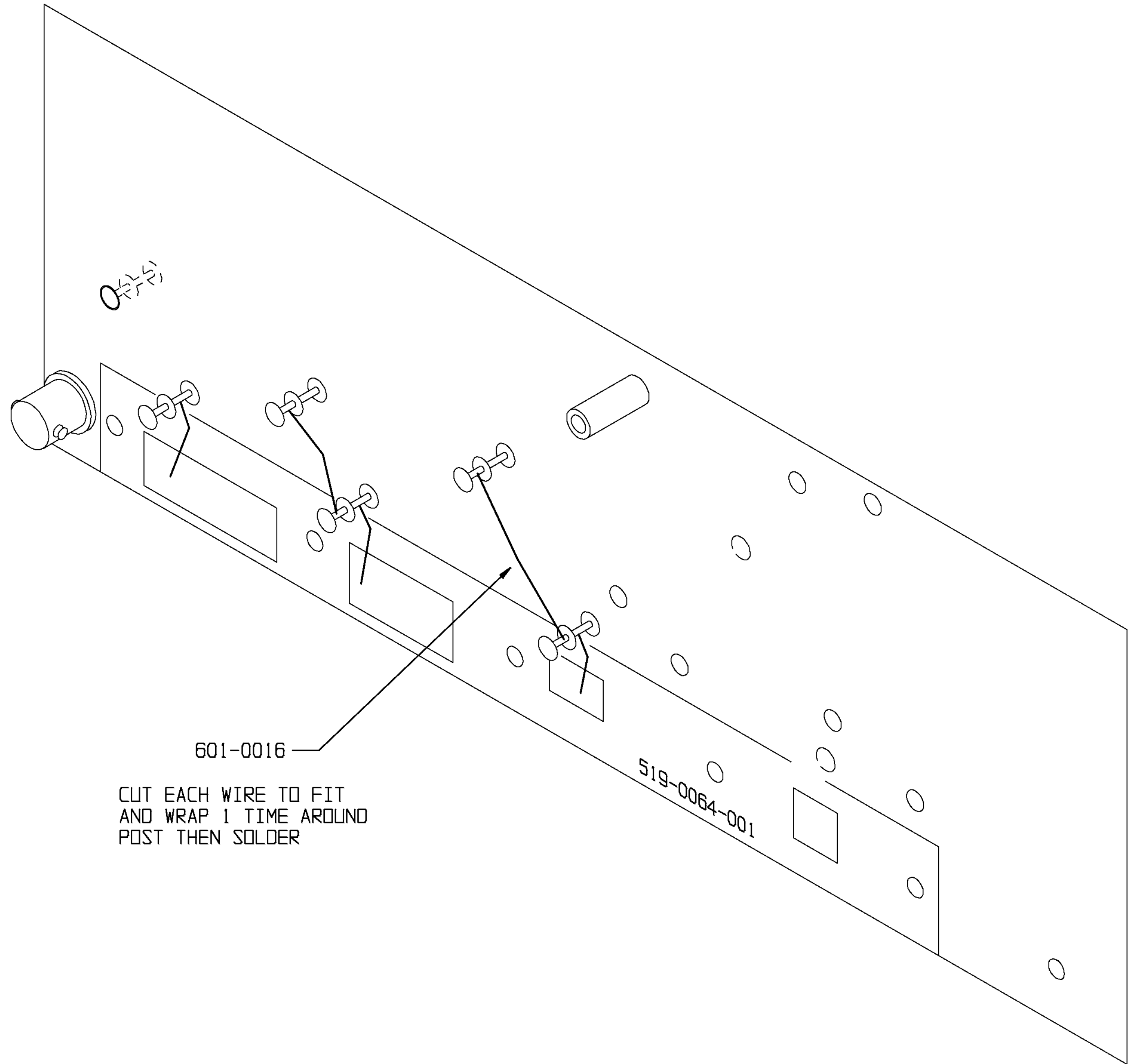
MATERIAL: SEE B/M NO. 919-0049
FINISH:
NEXT ASSY.:

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305
217/224-9600 FAX 217/224-9607

TITLE: PCB ASSEMBLY- MULTIMETER BOARD

TYPE	SIZE	DWG No.	REV
A	B	919-0049	A

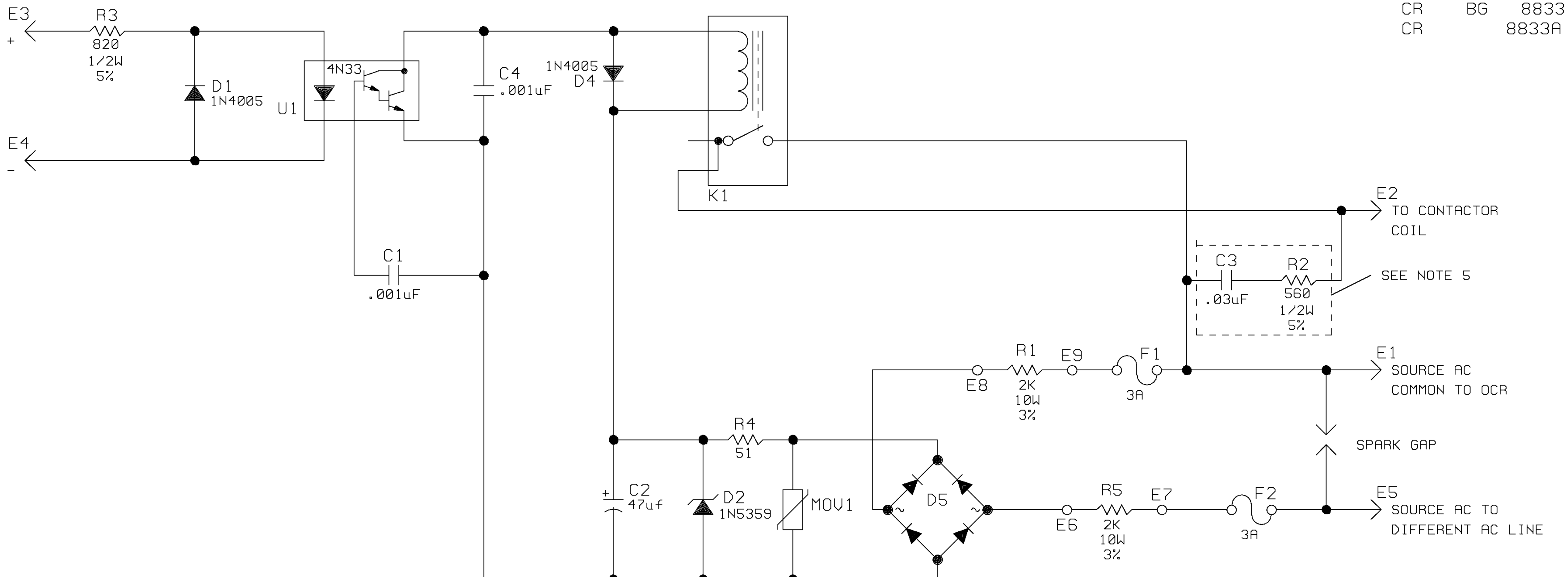
MODEL XMTRS | SCALE 1/1 | SHEET 1 OF 1



597-0220-428

FIGURE 7-11. INPUT MATCHING CIRCUIT BOARD ASSEMBLY DIAGRAM

JAH	TJL	7419
CR	BG	8833
CR		8833A



NOTES:

1. ALL RESISTORS IN OHMS; 1/4W, 1% UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED:R5,F2,MOV1,C4, D4,U1,K1,E9
3. COMPONENTS NOT USED:D3
4. SEE ASSEMBLY:AB 919-0096
5. THESE COMPONENTS NOT USED ON 919-0096-001 C3,R2

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

DWN. BY JAH 11-26-91
CHKD BG 11-92
ME
PROJ. ENGR. BG 11-92
MFG.

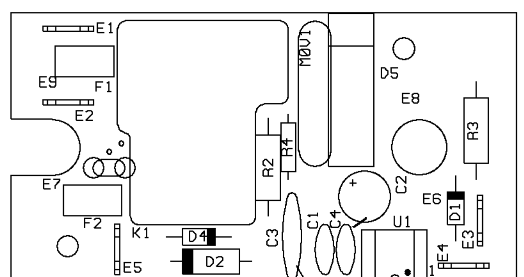
MATERIAL SEE B/M 919-0096 919-0096-001
FINISH
SEE DWG RA592-0000
NEXT ASSY.

BE® BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE OPTICALLY COUPLED RELAY

TYPE	SIZE	DWG. NO.	REV
S	B	919-0096,-001	J

MODEL FM XMTR'S | SCALE NONE | SHEET 1 OF



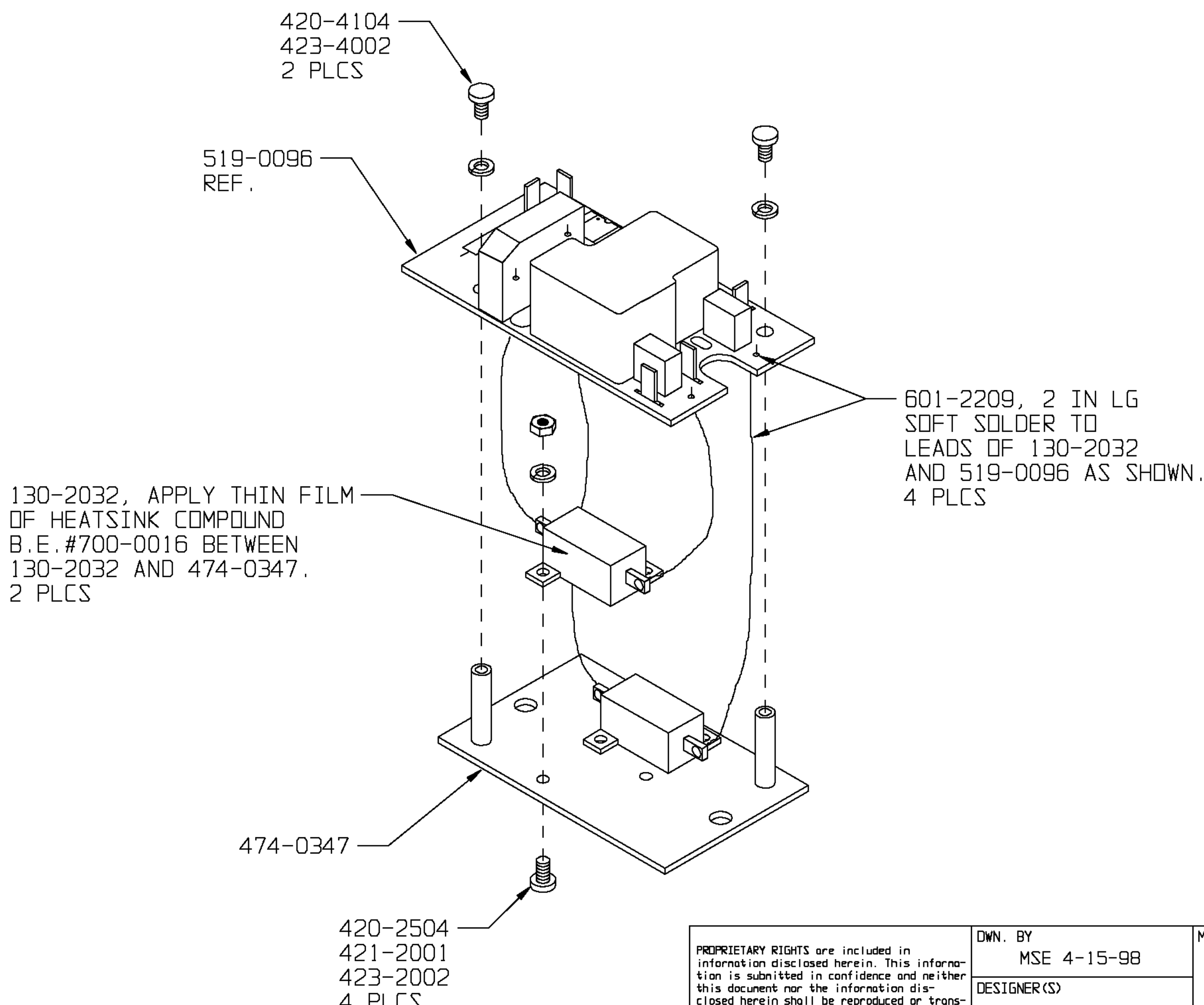
REMOVE R2 AND C3 FROM 919-0096
TO MAKE 919-0096-001

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

DWN. BY	JAH 12-13-91
DESIGNER(S)	
PROJ. LEADER	J.TUCKER 7-14-86
MFG.	J.STEINKAMP 7-14-86
MATERIAL	SEE B/M 919-0096 919-0096-001
FINISH	~~SEE DWG AA592-0000~~
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N.24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 PH. 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE	PCB ASSEMBLY OPTICALLY COUPLED RELAY BD.
TYPE	A
SIZE	B
DWG No.	919-0096, 919-0096-001
REV	N
MODEL	TRANSMITTERS
SCALE	1=1
SHEET	1 OF 2



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

DWN. BY	MSE 4-15-98
DESIGNER(S)	
PROJ. LEADER	
MFG.	
MATERIAL	SEE BOM 919-0096, -001
FINISH	SEE DWG RA592-0000
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N.24TH ST.,P.O.BOX 3606 QUINCY,IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE: ASSY, PCB OPTICALLY COUPLED RELAY (OCR)

TYPE	SIZE	DWG. NO.	REV
A	B	919-0096, -001	N

MODEL XMTRS | SCALE 1/1 | SHEET 2 OF 2

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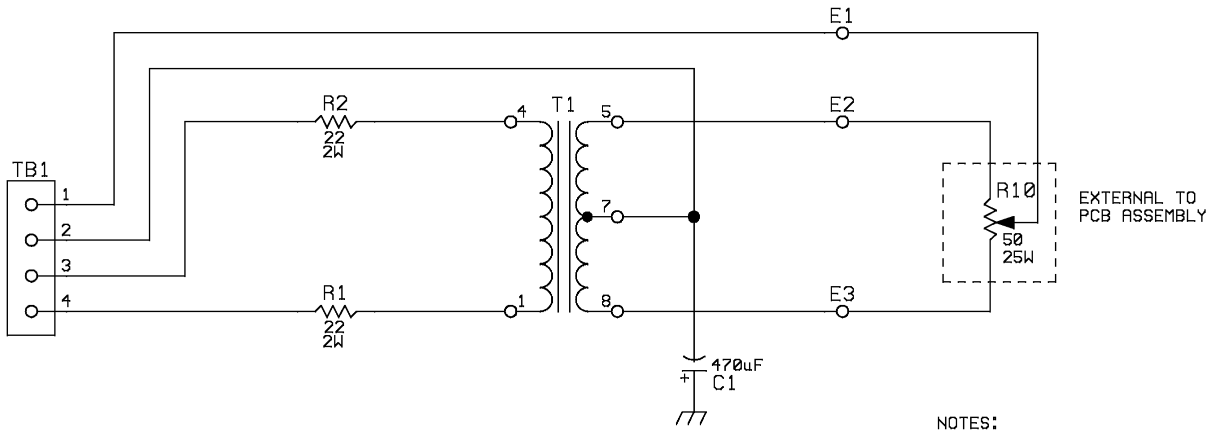
REVISIONS					
REV	DATE	DESCRIPTION	DFTSMN	ENGR	ECN



NOTES:

1. RESISTORS ARE IN OHMS;1/4, 5% UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED:T1,TB1,E3,C1,& R2.
3. COMPONENTS NOT USED:
4. SEE PCB ASSEMBLY: AB 919-0112

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

DWN. BY JAH 8-17-89
CHKD
ME
PROJ. ENGR.
MFG.

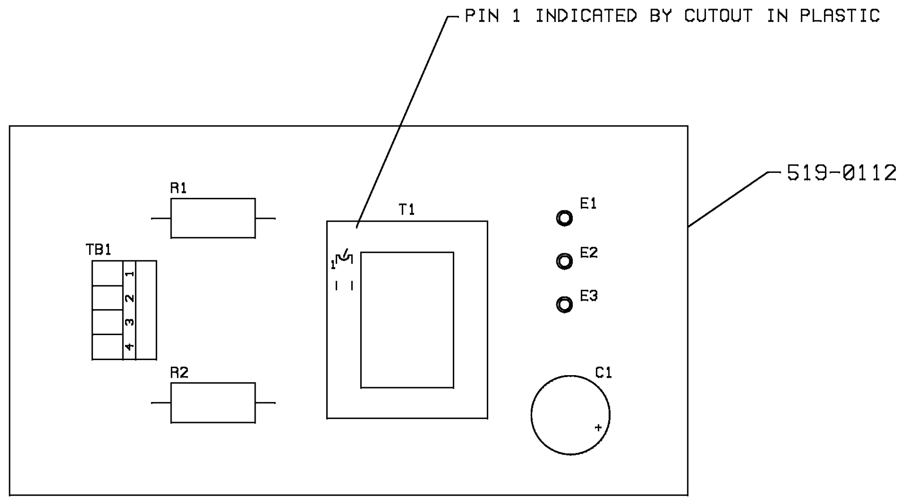
MATERIAL SEE B/M 919-0112
FINISH
SEE DWG AA592-0000
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE HUM NULL BD

TYPE	SIZE	DWG. NO.	REV
S	B	919-0112	A

MODEL XMTR'S | SCALE NONE | SHEET 1 OF 1



REVISIONS					
REV	DATE	DESCRIPTION	DFTSMN	ENGR	ECN

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

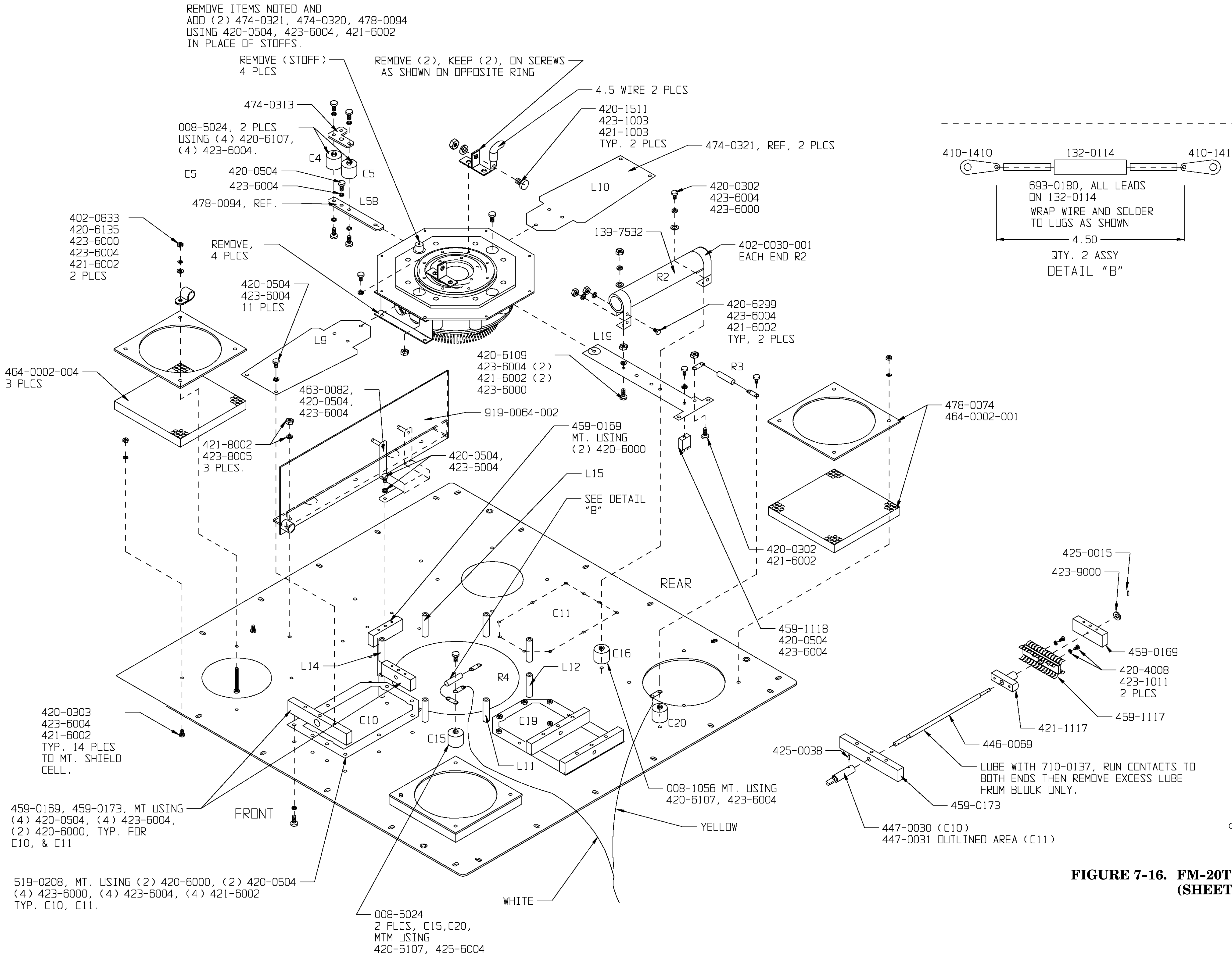
DWN. BY	JAH 10-24-89
CHKD	
ME	
PROJ. ENGR.	
MFG.	
MATERIAL	SEE B/M 919-0112
FINISH	SEE DWG RA592-0000
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY, IL. 62305 PH. 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE PCB ASSEMBLY
HUM NULL

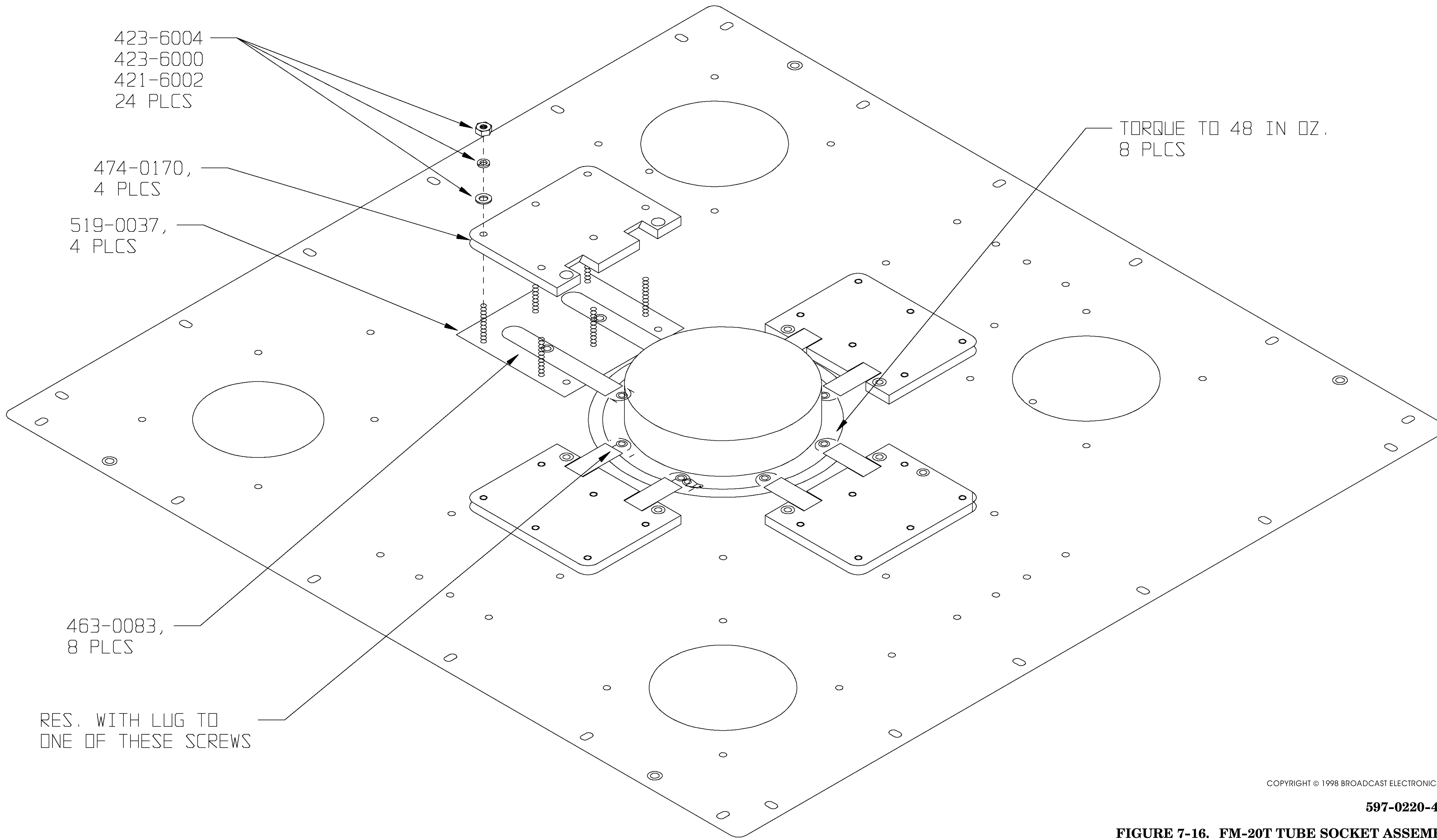
TYPE	SIZE	DWG.No.	REV
A	B	919-0112	A

MODEL XMTR´S SCALE 1/1 SHEET 1 OF 1



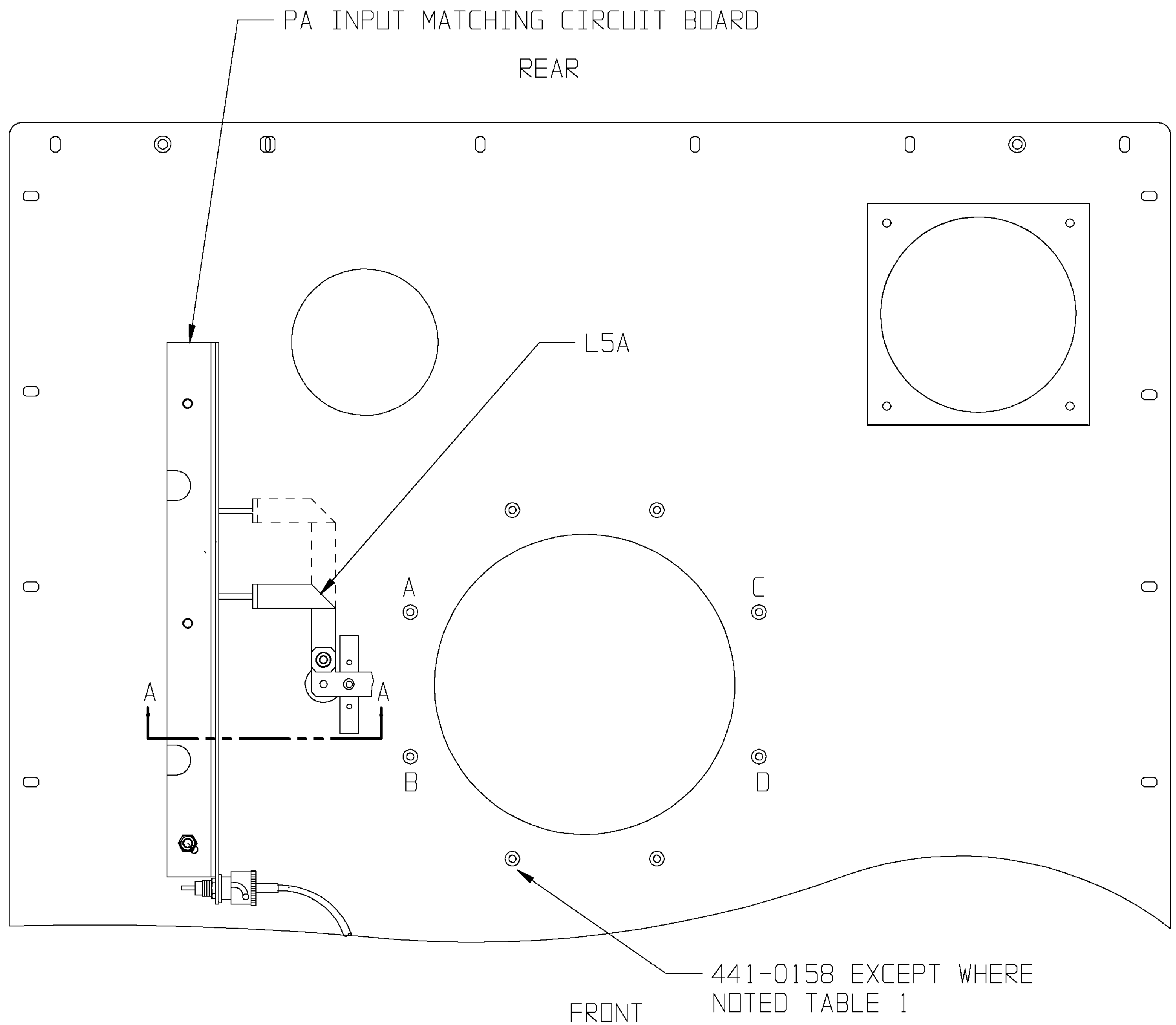
597-0220-433A

FIGURE 7-16. FM-20T TUBE SOCKET ASSEMBLY (SHEET 1 OF 3)



597-0220-433B

FIGURE 7-16. FM-20T TUBE SOCKET ASSEMBLY (SHEET 2 OF 3)



VIEW
"A-A"

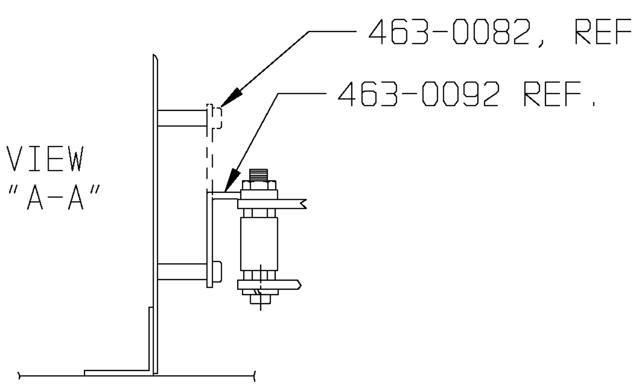


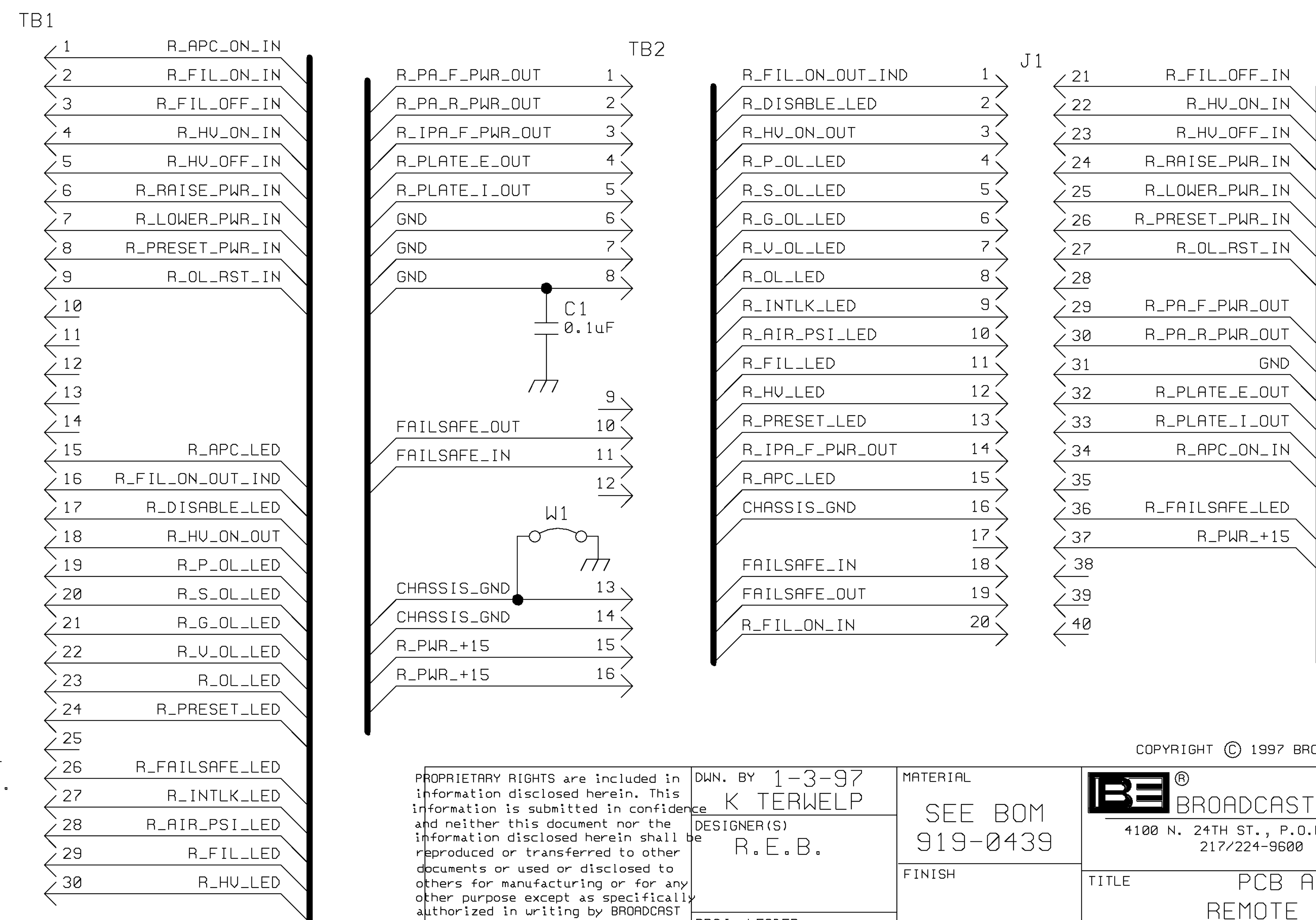
TABLE 1			
FREQUENCY	STANDOFF	PART No.	STANDOFF
87.5 - 91 mhZ	B + C	441-0157	.375 O.D..AL.
91.1 - 95 mhZ	B + C	441-0162	.50 O.D. AL.
93.1 - 98 mhZ	A,B + C	441-0157	.375 O.D..AL.
98.1 - 102 mhZ	A,B + C	441-0157	.375 O.D..AL.
102.1 - 108 mhZ	A,B,C + D	441-0157	.375 O.D..AL.

597-0220-433C

FIGURE 7-16. FM-20T TUBE SOCKET ASSEMBLY (SHEET 3 OF 3)

597-0096-506

FIGURE 7-17. DIRECTIONAL COUPLER ASSEMBLY DIAGRAM



NOTES:
1) LAST COMPONENT C1,J1,TB2 & W1.
2) SEE ASSEMBLY AC919-0439.

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

DWN. BY 1-3-97 K TERWELP
DESIGNER(S) R.E.B.
PROJ. LEADER
MFG.

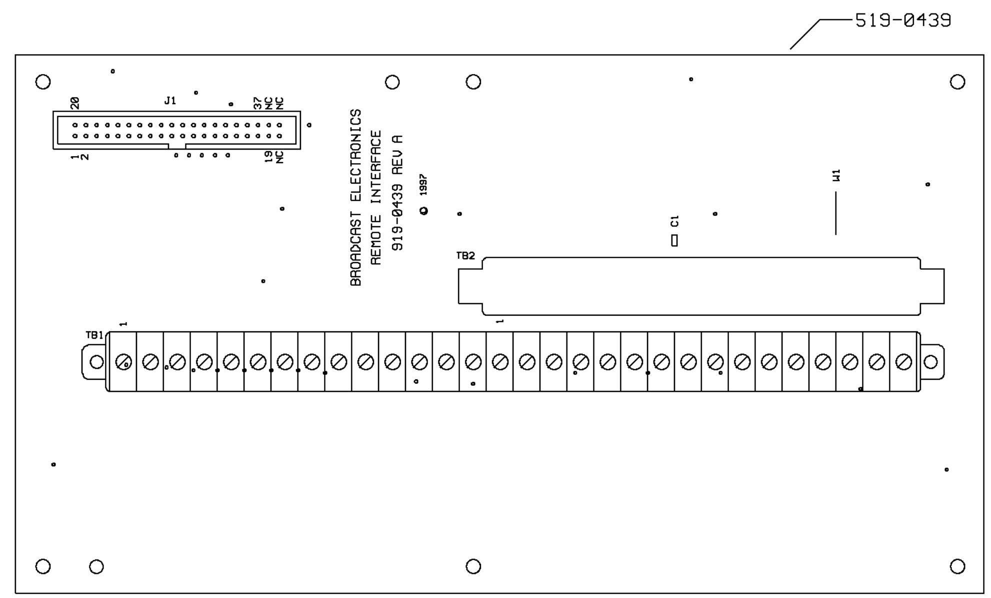
MATERIAL SEE BOM 919-0439
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305
217/224-9600 FAX 217/224-9607

TITLE PCB ASSEMBLY REMOTE INTERFACE

TYPE	SIZE	DWG. NO.	REV
S	B	919-0439	A

MODEL FM-35T/30T/20T/10T/5T | SCALE NONE | SHEET 1 OF 1



NOTES:
1) LAST COMPONENTS USED:
C1, J1, TB2 & W1.
2) SEE SCHEMATIC SB919-0439.
3) W1 IS NOT STUFFED DURING ASSEMBLY.,

DWN. BY 1-29-97 K. TERWELP	MATERIAL SEE BOM 919-0439	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 217/224-9600 FAX 217/224-9607
DESIGNER(S) R.E.B.	FINISH	TITLE PCB ASSEMBLY REMOTE INTERFACE
PROJ. LEADER		TYPE A / SIZE C / DWG No. 919-0439 / REV A
MFG.	NEXT ASSY.	MODEL FM-35T/30T/20T/10T/5T / SCALE 1/1 / SHEET 1 OF 1

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

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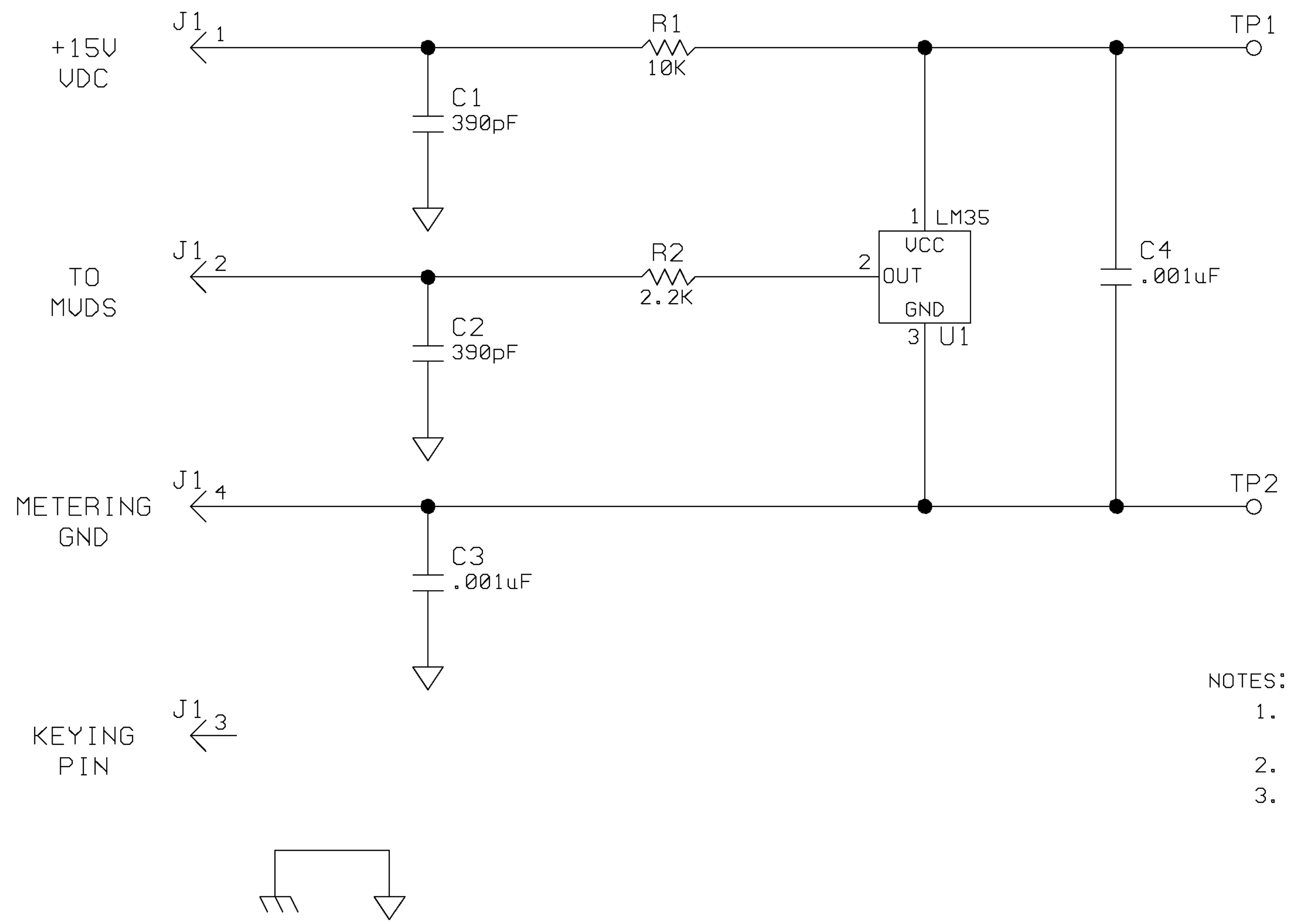


NOTES:

1. ALL RESISTORS IN OHMS; 1/4W, 5%, UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C4, J1, R2, TP2, U1
3. SEE PCB ASSEMBLY AB919-0082

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

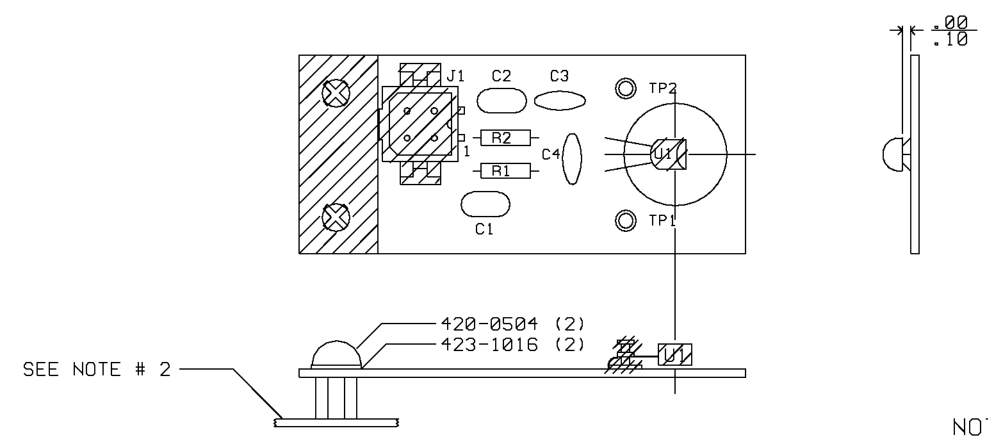
DWN. BY	KT 7-1-97
DESIGNER(S)	
PROJ. LEADER	JML 5-22-84
MFG.	
MATERIAL	SEE BOM 919-0082
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305
217/224-9600 FAX 217/224-9607

TITLE SCHEMATIC, EXHAUST AIR TEMPERATURE SENSOR, PCB

TYPE	SIZE	DWG. NO.	REV
S	B	919-0082	B

MODEL	SCALE	SHEET
FM3.5A/5A MVDS OPTION	NONE	1 OF 1



NOTES:

1. U1 CENTERED IN .625 HOLE.
2. BOARD SHOWN MOUNTED TO 959-0048 SHIELD CELL ASM.
3. SEE PCB SCHEMATIC: SB919-0082.
4. COVER WITH URETHANE CONFORMAL COATING (700-0126) AFTER COMPONENTS ARE SOLDERED. SEE COATING INSTRUCTIONS.
5. LAST COMPONENTS USED: C4, J1, R2, TP2, U1.

COATING INSTRUCTIONS:

1) MASK BODY OF DEVICE U1 COMPLETLY, MASK TURRETS TP1 & TP2, INSERT 418-0240 DUMMY PLUG IN J1, AND MASK BOTH SIDES OF PCB AT MOUNTING HOLE END AS SHADED.
2) APPLY ONE COAT OF 700-0126, SPRAY ON BOTH SIDES, PER VENDOR INSTRUCTIONS, THEN REMOVE MASKING.
3) ALLOW 15 MINS. DRYING TIME.

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

DWN. BY	KT 7-1-97
DESIGNER(S)	
PROJ. LEADER	JML 5-31-84
MFG.	
MATERIAL	SEE B/M NO. 919-0082
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305
217/224-9600 FAX 217/224-9607

TITLE ASM., PCB EXHAUST AIR TEMPERATURE SENSOR

TYPE	SIZE	DWG No.	REV
A	B	919-0082	C

MODEL FM-3.5A/5A MVDS OPTION | SCALE 1/1 | SHEET 1 OF 1

APPENDIX A
MANUFACTURERS DATA

A-1. INTRODUCTION.

A-2. This appendix provides technical data associated with the operation and maintenance of the FM-20T transmitter. The information contained in this appendix is presented in the following order.

A. Service Bulletin, Furnas Contactor, Size 120/150 Amp.

B. Service Bulletin, Furnas Contactor, Size 40 Amp.

C. Operating Instructions and Parts List, Cincinnati Fan Company, LM-6C Volume Blower.

D. Technical Data Sheet, Eimac, 4CX12,000A Tetrode.

E. Application Paper, Eimac, Extending Transmitter Tube Life.

F. Troubleshooting Guide, Pioneer Magnetics PM3329BP-5 Power Supply.

G. Schematic Diagram, Power Supply, Computer Products, NPN40-7610

Furnas

Replacement Parts

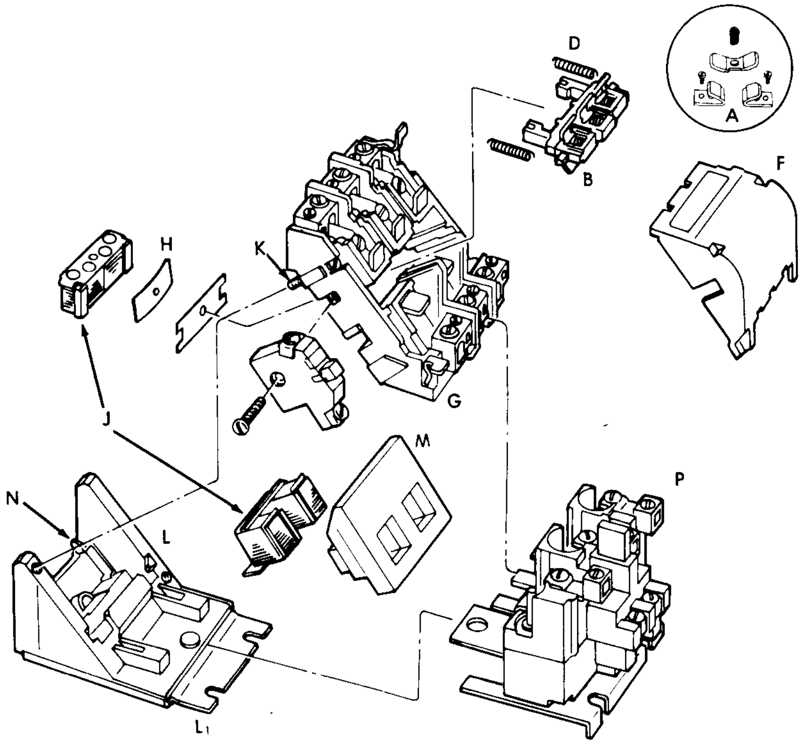
16-GHF

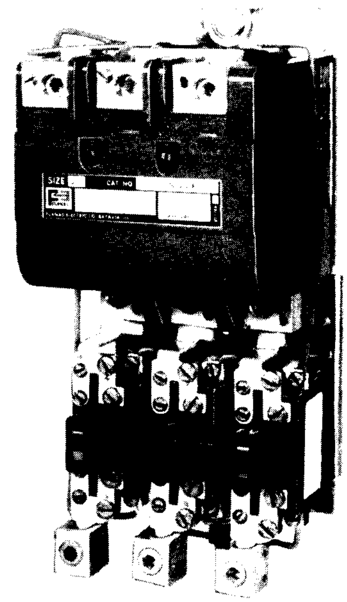
June, 1986
Supersedes Issue of
February 1983

Magnetic Controls
120 & 150 Amp
42HF & 42IF

Class 16 & 42
16HF, 16IF, 42HF & 42IF

FOR PROTECTION OF INTERNAL CONTROL CIRCUIT CONDUCTORS IN ACCORDANCE WITH THE N.E.C., USE FUSE KIT 49D55046002





ITEM	PART NAME		PART NUMBER
A	Contacts & Spring, One Complete Pole	Size 3	75HF14
		Size 3½	75IF14
B	Cross Arm (less contacts)		75P1002
D	Cross Arm Springs		75P1002
F	Contact Board Cover		D55040001
G	Contact Board with Terminals (less contacts)		D73458001
H	Armature Spring Clip		D25842001
J	Magnet and Armature		D27222001
K	Contact Board Screw		D24827001
L	Base		D26080001
L_1	Mounting Panel		D55043001
M	Coil 60 Hz. 110-120/220-240 V. 50 Hz. 110/190-220 V.		75D73251A
	220-240/440-480 V. 190-220/380-440 V.		75D73251C
	550-600 V. 550 V.		75D73251E
N	Coil Spring Clip		D25821001
P	Overload Relays — 3 Pole Standard Bimetal	120 Amp	48HC37AA2
		150 Amp	48IC37AA6
	Amb. Compensated Bimetal	120 Amp	48HC38AA2
		150 Amp	48IC38AA6

NOTE: When ordering replacement parts, give catalog number of control and part name and number.

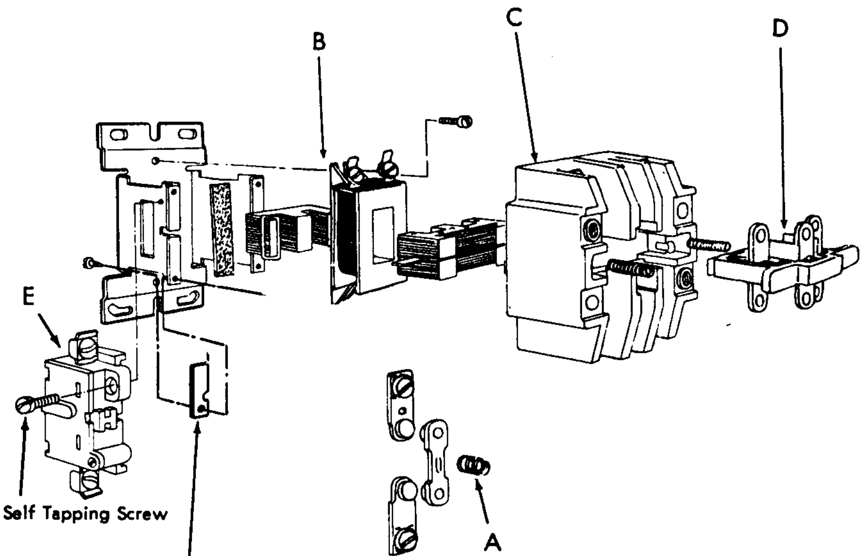
Furnas

Replacement Parts

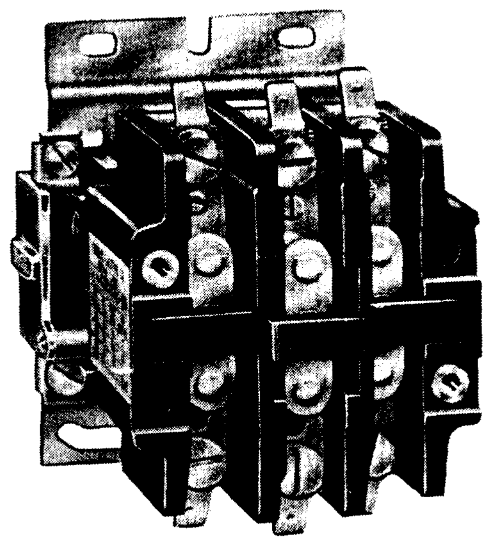
October, 1982
Supersedes Issue of
May, 1978

Contactors
30-40 Amp.

Class 42
42BE & 42CE



① CAUTION — Spacers (1 each side) are required when 24 volt coil is used.



ITEM	PART NAME		PART NUMBER	
			42BE	42CE
A	Contacts and Spring One (1) Complete Pole — Specify No. Required.		75BE42	75CE42
B	Coil, *60 Hertz	24 Volts ①	75D54822J	75D54822J
		120 Volts	75D54822F	75D54822F
		240 Volts	75D54822G	75D54822G
	*Other voltages and frequencies available on request	480 Volts	75D54822H	75D54822H
C	Contact Board (less hardware)	3 Pole	D73342001	D73342001
		4 Pole	D73142001	D73142001
D	Cross Arm (less hardware)	3 Pole	D55138001	D55138001
		4 Pole	D53753001	D53753001
E	Auxiliary interlock (normally open)		49D22125001	49D22125001
	Auxiliary interlock (normally closed)		49D22125002	49D22125002

① 2 spacers included with 24 Volt 60 Hertz coil.

NOTE: When ordering replacement parts, give catalog number of control and part name and number.

OPERATING & MAINTENANCE INSTRUCTIONS AND PARTS LIST

for
"PB" & "SPB" Pressure Blowers
"LM" Volume Blowers

CONTENTS

⚠ DANGER

ALL FANS AND BLOWERS SHOWN HAVE ROTATING PARTS AND PINCH POINTS. SEVERE PERSONAL INJURY CAN RESULT IF OPERATED WITHOUT GUARDS. STAY AWAY FROM ROTATING EQUIPMENT UNLESS IT IS DISCONNECTED FROM ITS POWER SOURCE AND ALL ROTATING PARTS HAVE STOPPED MOVING.

READ ALL OPERATING INSTRUCTIONS CONTAINED HEREIN BEFORE INSTALLING EQUIPMENT.

⚠ DANGER

NO GUARANTEE OF ANY LEVEL OF SPARK RESISTANCE IS IMPLIED BY SPARK RESISTANT CONSTRUCTION. IT HAS BEEN DEMONSTRATED THAT ALUMINUM IMPELLERS RUBBING ON RUSTY STEEL MAY CAUSE HIGH INTENSITY SPARKS. AIR STREAM MATERIAL AND DEBRIS OR OTHER SYSTEM FACTORS MAY ALSO CAUSE SPARKS.

cincinnati fan and ventilator company, inc.

CATALOG # PMA-289
SUPERSEDES: PMA-177

3/

I GENERAL SAFETY NOTES

1. Rotating parts including shaft and V-belt drives must be properly guarded to prevent personal injury.

2. Electrical wiring must be accomplished by a qualified electrician in accordance with all applicable codes.

3. Care should be taken:
   - Not to run fan above its safe speed (See Performance Tables in Sales Catalog or call CFV sales office).
   - Not to operate in excessive temperatures (See Limitations in Sales Catalog or call CFV sales office).
   - Not to operate in dangerous environments.
   - Read all instructions carefully.

II RECEIVING

Receiving Inspection

When unit is received, inspect immediately for damaged or missing parts. Even though all units are carefully inspected and prepared for shipment at the factory, rough handling enroute may cause concealed damage or cause nuts, set screws, bolts or locking collars to work loose. Be certain all fasteners are tightened securely. Rotate wheel by hand to verify that it rotates freely and that there are no obstructions.

If concealed damage is found, call the freight carrier and ask for their Inspection Department. Fill out a concealed damage inspection report.

III GENERAL INSTALLATION INSTRUCTIONS

Foundations

Fan foundation must be flat, level and rigid. Where foundation is not completely flat, shims must be placed under fan support at each anchor bolt as required. Bolting fan to an uneven foundation distorts alignment and causes vibration.

Structural steel foundations should be heavily cross-braced for load support.

OPERATION

Before Connecting Power

1. Inspect all fasteners and retighten if necessary:
   a. Foundation bolts.
   b. Set screws in fan and wheel and V-belt drive (See Table #1 & #2).
   c. Housing, bearing and motor mounting.

2. Access Doors should be tight and sealed.

3. Bearings should be checked for alignment and lubrication (See Bearing Maintenance).

4. Turn rotating assembly by hand to insure that it does not strike housing. If the wheel strikes the housing, the wheel may have moved on the shaft or the bearings may have shifted in transit. Correction must be made prior to start up.

5. Check motor to insure proper speed and electrical characteristics.

6. Check V-belt drive for alignment and correct belt tension.

7. After wiring, energize motor for 1 second to check for proper rotation.

Table #1

TORQUE VALUES FOR TAPERED BUSHINGS		
	MINIMUM RECOMMENDED TORQUE (INCH-LBS)	
Bushing Size	Steel Parts	Alum. Parts
H	95	60
P	192	80
Q	350	155
R	350	155

Table #2

SET SCREW TORQUE VALUES			
SET SCREW SIZE		MINIMUM REQUIRED TORQUE (INCH-LBS)	
Diameter & No. of Threads/Inch	Hex Size Across Flats (Allen Wrench)	Steel Set Screw Into Steel Threads	Steel Set Screw Into Alum. Threads or Stainless Steel Set Into Stainless Steel Threads
1/4-20	1/8"	65	65
5/16-18	5/32"	165	100
3/8-16	3/16"	228	155
7/16-14	7/32"	348	230
1/2-13	1/4"	504	330
5/8-11	5/16"	1104	700

NOTE: If wheel set screws are loosened and/or wheel is removed from shaft, set screws must be replaced. Set screws cannot be used more than once. Use knurled, cup point set screws with a locking patch.

IV GENERAL MAINTENANCE

CAUTION

Before any maintenance or service is performed, assure that unit is disconnected from power source to prevent accidental starting.

The key to good fan maintenance is a regular and systematic inspection of all fan parts. Severity of the application should determine frequency of inspection. The components requiring service are generally the moving parts which include bearings, fan propeller, belts, sheaves and motor.

Cast Aluminum & Metal Parts

Cast aluminum and steel parts usually do not require maintenance during the life of the unit except painted metal surfaces that may require periodic repainting. In a severe, dirty operation, the wheel should be cleaned with a wire brush to prevent an accumulation of foreign matter that could result in fan unbalance. After cleaning wheel, inspect for possible cracks or excessive wear, which can cause unbalance. DO NOT operate a wheel that is cracked, chipped, has broken blades or excessive wear. NOTE: If wheel set screws are loosened and/or wheel is removed from shaft, set screws must be replaced. Set screws cannot be used more than once. Belts on V-belt drive units require periodic inspection and replacement when worn. For multiple belt drives, belts should be replaced with matched sets.

Motor Maintenance

1. Disconnect power to motor.

2. Removing dust and dirt: Blow out open type motor windings with low pressure air to remove dust or dirt. Air pressure above 50 P.S.I. should not be used as high pressure may damage insulation and blow dirt under loosened tape. Dust accumulation can cause excessive insulation temperatures.

3. Lubrication: Consult the motor manufacturer for recommendations.

4. Motors must be stored under cover in a clean, dry, vibration-free location. Remove sufficient packaging material to allow circulation of air around motor. Maintain the temperature of the windings a few degrees above that of the surrounding air to protect against condensation. This may be accomplished by using space heaters, if supplied, or by any other safe, reliable method of heating. Measure and record monthly the ambient air temperature and winding temperature.

To prevent rusting of bearing parts, the rotor must be rotated at regular intervals (30 days) to assure these parts are will covered with oil or grease.

V V-BELT DRIVES

Care should be taken not to over tighten V-belt drive. Excessive belt tension overloads fan and motor bearings. It is much less expensive to replace belts worn from slippage than to replace bearings damaged from excessive loading.

Fans shipped completely assembled have had V-belt drive aligned at the factory. Alignment should be rechecked before operation as a precaution due to handling during shipment.

1. Be sure sheaves are locked in position.

2. Key should be seated firmly in keyway.

3. Place straight edge or taut cord across faces of driving and driven sheaves to check alignment. The motor and fan shafts must be parallel with V-belts and at right angles to the shafts.

4. Start the fan. Check for proper rotation. Run fan at full speed. A slight bow should appear on slack side of belt. Disconnect power and adjust belt tension by adjusting motor on its sliding base. All belts must have some slack on one side.

A WORD OF CAUTION ABOUT MOTORS

Using your hand to test the running temperature of a motor can be a very painful experience:

Normal body temperature	98.6° F
Threshold of pain caused by heat	120.0° F
Average temperature of hot tap water	140.0° F
Average temperature of hot coffee	180.0° F
Normal operating temperature of a fully loaded electric motor, open type, 70° F ambient temperature	174.0° F

You cannot wash your hands in 140° F water!

You cannot stir a fresh cup of coffee with your finger!

You cannot place your hand on a motor that is operating properly without burning your hand!

5. If belts squeal at start up, they may be too loose.

6. When belts have had time to seat in the sheave grooves, then readjust belt tension.

V-belt drive assembly can be mounted as follows:

1. Clean motor and fan shafts. Be sure they are free from corrosive material. Clean bore of sheaves and coat with heavy oil for ease of shaft entry. Remove oil, grease, rust or burrs from sheaves.

2. Place fan sheave on fan shaft and motor sheave on its shaft. **Do not pound sheaves on** as this may damage bearings. Tighten sheaves in place per Table # 1.

3. Move motor on slide base so belts can be placed in grooves of both sheaves without forcing. Do not roll belts or use a tool to force belts over the grooves.

4. Align fan and motor shafts so they are parallel. The belts should be at right angles to the shafts. A straight edge or taut cord placed across the face of the sheaves will aid in alignment.

5. Tighten belts by adjusting motor base. Correct tension gives the best drive efficiency. Excessive tension causes undue bearing pressure.

6. Start the fan and run it at full speed. Adjust belt tension until only a slight bow appears on the slack side of the belts. If slippage occurs, a squeal will be heard at start-up. Eliminate this squeal by **disconnecting power** and tightening up the belts.

7. Give belts a few days running time to become seated in sheave grooves, then readjust belt tension.

If the shafts become scratched or marked, carefully remove sharp edges and high spots such as burrs with fine emery cloth or honing stone. Avoid getting emery dust in the bearings.

Do not apply any belt dressing unless it is recommended by the drive manufacturer. V-belts are designed for frictional contact between the grooves and sides of the belts. Dressing will reduce this friction.

Belt tension on an adjustable pitch drive is obtained by moving the motor, not by changing the pitch diameter of the adjustable sheave.

VI FAN BEARING MAINTENANCE

Sealed Bearings

Sealed for life bearings are pre-lubricated with the correct amount of manufacturer-approved ball bearing grease, and are designed for application where relubrication is not required.

Arrangement #2 units feature two single-row deep groove bearings in a cast iron bearing bracket. Dirt and grease guard seals are an integral part of the assembly. For high temperature applications the bearings are pre-lubricated with a high temperature grease.

Relubricatable Bearings

Relubricatable Type Bearings must be relubricated periodically to assure long life. The length of interval between greasing is dependent on the running speed and ambient conditions. The following table covers most situations and can be used as a guide.

Generally Recommended
Relubrication Frequency In MONTHS

Operating Speed (RPM)	Bore in Inches			
	1/2 to 1	1-1/8 to 1-1/2	1-5/8 to 1-15/16	2 to 2-1/2
To 500	6	6	6	6
501-1000	6	6	6	5
1001-1500	6	5	5	4
1501-2000	5	5	4	3
2001-2500	5	5	3	2
2501-3000	5	4	2	2
3001-3500	4	3	2	1
3501-4000	3	3	1	–
4001-4500	2	2	1	–
4501-5000	2	1	–	–

For normal operating conditions the grease should be lithium base and conform to the NLGI grade #2 or #3 consistency and be free of any chemical impurities such as free acid or free alkali, dust, rust, metal particles or abrasives.

If bearings are in a hostile environment such as temperatures above 120° F, high moisture areas or contaminated areas, more frequent lubrication is required. Consult bearing manufacturer for recommendations.

For best results, bearings should be relubricated while in operation. **NOTE**: Due caution for personal safety must be observed when servicing rotating equipment. The grease should be pumped in slowly until a slight bead forms around the seals. This bead, in addition to acting as an indicator of adequate relubrication, provides additional protection against the entry of foreign matter.

By the time the slight-grease bead is formed, it will be noted that the temperature rise is in the neighborhood of 30° F. If necessary to relubricate while the bearing is idle, contact bearing manufacturer for the maximum grease capacity for the various sizes of bearings.

VII WARRANTY

Cincinnati Fan & Ventilator Company warrants products of its own manufacture against defects of material and workmanship under normal use and service for a period of eighteen (18) months from date of shipment or twelve (12) months from date of installation, whichever occurs first. This warranty does not cover ordinary wear and tear, abuse, misuse, overloading, negligence, alteration or systems and/or materials not of Seller's manufacture. Expenses incurred by Buyer(s) in repairing or replacing any defective product will not be allowed except where authorized in writing and signed by an officer of the Seller.

The obligation of Seller under this warranty shall be limited to repairing or replacing F.O.B. Seller's plant, or allowing credit at Seller's option. This warranty is expressly in lieu of all other warranties expressed or implied including the warranties of merchantability and fitness for use and of all other obligations and liabilities of the Seller. The Buyer acknowledges that no other representations were made to him or relied upon him with respect to the quality or function of the products herein sold.

On equipment furnished by the Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller receives from the manufacturer thereof. Repairs for motors should be obtained from nearest authorized motor service station for the make of motor furnished. All motors used are products of well-known manufacturers with nationwide service facilities. Check the yellow pages of your telephone directory for the location of the nearest service shop.

Cincinnati Fan & Ventilator Company assumes no responsibility for material returned to our plant without our prior written permission.

VIII ORDERING REPLACEMENT PARTS

Replacement or spare parts may be ordered through your local Cincinnati Fan representative. (Refer to drawings that begin on Page 6.) The following information should accompany parts orders:

1. Motor horsepower, frame size, motor speed, voltage, phase, cycle and enclosure. Motor manufacturer's model number from motor nameplate.
2. Fan Speed (if V-belt driven).
3. Fan arrangement number.
4. Fan serial AND model numbers from the FAN nameplate and a complete description of the part.

An adequate stock of repair parts is maintained where possible. If your fan is vital to production or to plant operation, it may be advisable to have all spare parts on hand to minimize the possibility of downtime.

IX FAN TROUBLE SHOOTING

In the event that trouble is experienced in the field, the following are the most common fan difficulties. These points should be checked in order to prevent needless delay and expense.

1. CAPACITY OR PRESSURE BELOW RATING

a. Incorrect direction of wheel rotation.
b. Speed too slow.
c. Dampers or variable inlet vanes not properly adjusted.
d. Poor fan inlet or outlet conditions (elbows, restrictions).
e. Air leaks in system.
f. Damaged wheel.
g. Total resistance of system higher than anticipated.
h. Wheel mounted backwards on shaft.
i. Fan not properly selected for a high temperature and/or high altitude application.

2. VIBRATION AND NOISE

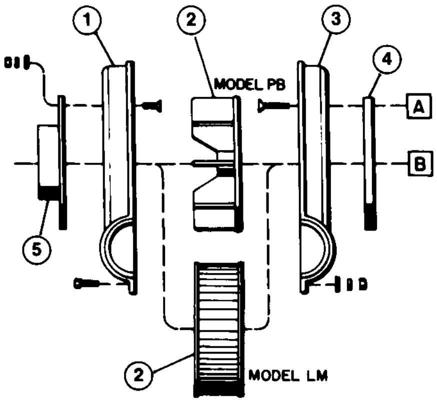
a. Misalignment of bearings, coupling, wheel or V-belt drive.
b. Unstable foundation.
c. Foreign material in fan causing unbalance.
d. Worn bearings.
e. Damaged wheel or motor.
f. Broken or loose bolts and set screws.
g. Bent shaft.
h. Worn coupling.
i. Fan wheel or drive unbalanced.
j. 120 cycle magnetic hum due to electrical input. Check for high or unbalanced voltage.
k. Fan delivering more than rated capacity.
l. Loose dampers.
m. Speed too high or fan rotating in wrong direction.
n. Vibration transmitted to fan from some other source.

3. OVERHEATED BEARINGS

a. Check bearing lubrication.
b. Poor alignment.
c. Damaged wheel or drive.
d. Bent shaft.
e. Abnormal end thrust.
f. Dirt in bearings.
g. Excessive belt tension.

4. OVERLOAD ON MOTOR

a. Speed too high.
b. Blower over capacity due to existing system resistance being lower than original rating.
c. Specific gravity or density of gas above design value.
d. Packing too tight or defective (on fans with stuffing box).
e. Wrong direction of wheel rotation.
f. Shaft bent.
g. Poor alignment.
h. Wheel wedging or binding on inlet bell.
i. Bearings improperly lubricated.
j. Motor improperly wired.
k. Defective motor. Motor must be tested by motor manufacturer's authorized repair shop.



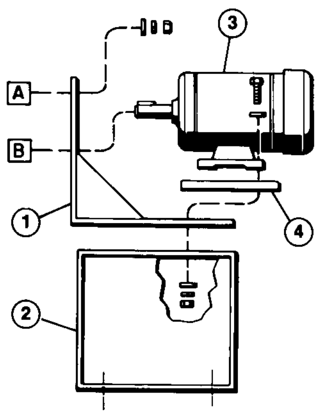
HOUSING WHEEL COMPONENTS

All arrangements

* 1. Housing, inlet side.
* 2. Wheel (PB or LM type).
* 3. Housing, drive side.
4. Drive side plate (if required).
5. Inlet side plate (if required).

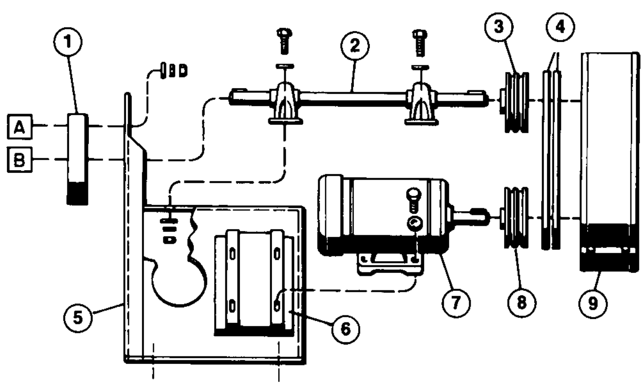
* NOTE: Rotation determined by viewing blower from drive side, **not** looking into inlet.

BASE ARRANGEMENT COMPONENTS



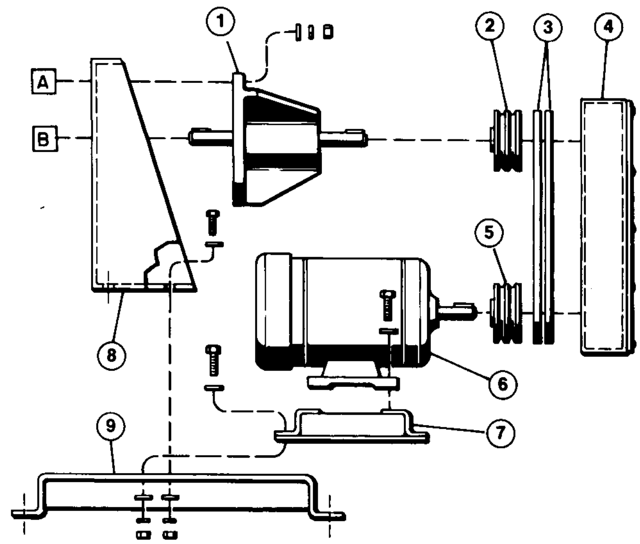
Arrangement 4

1. Angle bracket (if required).
2. Bottom base.
3. Motor.
4. Riser pad (if required).



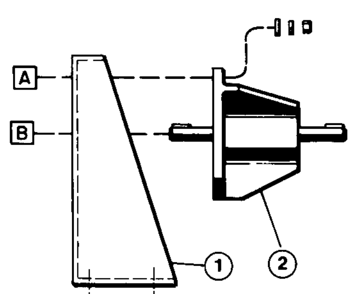
Arrangement 9-1

1. Spacer ring.
2. Shaft/bearing assembly.
3. Fan sheave.
4. Belt(s).
5. Bearing base.
6. Motor slide base.
7. Motor.
8. Motor sheave.
9. Belt guard.



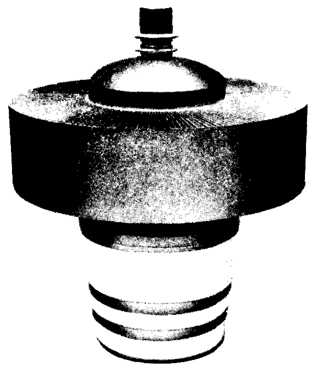
Arrangement 9-2

1. Shaft/bearing assembly.
2. Fan sheave
3. Belt(s).
4. Belt guard.
5. Motor sheave.
6. Motor.
7. Motor slide base.
8. Upright base.
9. Sub base.



Arrangement 2

1. Upright base.
2. Shaft/bearing assembly.



TECHNICAL DATA

8989/4CX12,000A VHF POWER TETRODE

The EIMAC 8989/4CX12,000A is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings up to 250 MHz.

The 8989/4CX12,000A has a gain of over 18 dB in FM broadcast service, and is also recommended for rf linear amplifier service, and for VHF television linear amplifier service. The anode is rated for 12 kilowatts of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	6.5 V nominal[2]	
Current @ 6.5 volts	105 A nominal	
Amplification Factor (average) Grid to Screen	6.7	
Direct Interelectrode Capacitance (grounded cathode)[3]		
Cin	160	pF
Cout	18.5	pF
Cgp	1.0	pF
Direct Interelectrode Capacitance (grid & screen grounded)[3]		
Cin	70	pF
Cout	18.6	pF
Cpk	0.1	pF
Maximum Frequency for Full Ratings (CW)	250	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian should be consulted before using this information for final equipment design.
2. See ELECTRICAL, FILAMENT OPERATION on page 3.
3. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length (height)	9.84 In; 25.0 cm
Diameter	7.76 In; 19.7 cm
Net Weight (approximate)	14 lbs; 6.4 kg
Operating Position	Vertical Only
Cooling	Forced Air
Maximum Operating Temperature, Ceramic/Metal Seals & Anode Core	250°C
Base	Special Concentric
Recommended Air System Socket (for dc, LF, HF applications)	EIMAC SK-300A
Recommended Air System Socket (for VHF applications)	EIMAC SK-360
Recommended Air Chimney	EIMAC SK-336
Available Screen Bypass Capacitor Kit for SK-360 (8000 pF @ DCWV = 5000)	EIMAC SK-355
Available Anode Connector Clip	EIMAC ACC-3

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varian
power grid & x-ray tube products
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8989/4CX12,000A

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM - Key Down Conditions

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.5	AMPERES
PLATE DISSIPATION	12.0	KILOWATTS
SCREEN DISSIPATION	300	WATTS
GRID DISSIPATION	150	WATTS

*Approximate Value #Calculated Data

Typical Operation (Frequencies to 30 MHz)#

Plate Voltage	9.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-250	Vdc
Plate Current	2.83	Adc
Screen Current*	135	mAdc
Grid Current*	63	mAdc
Peak rf Grid Voltage*	335	v
Driving Power*	23	W
Plate Dissipation*	5470	W
Plate Output Power*	20	kW
Load Impedance	1590	Ohms

RADIO FREQUENCY POWER AMPLIFIER
Commercial FM Service

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.5	AMPERES
PLATE DISSIPATION	12.0	KILOWATTS
SCREEN DISSIPATION	300	WATTS
GRID DISSIPATION	150	WATTS

*Approximate #Delivered to the Load

Measured Operation, Commercial FM Service
Operation in EIMAC CV-2210 Cavity at 108.1 MHz

Plate Voltage	8.0	8.0	10.0	kVdc
Screen Voltage	750	800	800	Vdc
Grid Voltage	-300	-400	-300	Vdc
Plate Current	1.6	2.58	2.81	Adc
Screen Current*	115	120	130	mAdc
Grid Current*	51	38	32	mAdc
Driving Power*	165	250	275	W
Useful Power Output#	11.0	15.8	22.5	kW
Efficiency	84	77	80.2	%
Gain	18.4	18.0	19.1	dB

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

MOUNTING - The 4CX12,000A must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the designer.

SOCKET & CHIMNEY - The EIMAC air-system sockets SK-300A and SK-360, and air chimney SK-336 are designed especially for use with the 4CX12,000A. The SK-300A may be used for dc, LF or HF applications, while for VHF service the SK-360 should be used. The SK-355 screen bypass capacitor kit is available for use with the SK-360. The recommended air flow through either socket, in a base-to-anode direction, provides effective cooling of the base, with air then guided through the anode cooling fins by the air chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below this rated maximum.

It is considered good engineering practice to design for a maximum anode core temperature of 225°C and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available on request.

It is also good practice to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special attention is required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Minimum air flow requirements for a maximum anode temperature of 250°C for various altitudes and dissipation levels are listed. The pressure drop values shown are approximate and are for the tube mounted in an SK-300A socket with an SK-336 air chimney, with air passing through the socket in a base-to-anode direction and then on to the anode cooler.

Pressure drop in a typical installation will be higher because of system loss.

Inlet Air Temperature = 25°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	120	0.27
	10000	170	0.55
	12500	260	1.12

5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	140	0.40
	10000	210	0.56
	12500	310	1.14

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	170	0.40
	10000	250	0.70
	12500	380	1.29

Inlet Air Temperature = 35°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	130	0.30
	10000	190	0.69
	12500	300	1.28

5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	160	0.45
	10000	240	0.70
	12500	360	1.43

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	190	0.45
	10000	290	0.85
	12500	430	1.59

Inlet Air Temperature = 50°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	160	0.41
	10000	240	0.84
	12500	360	1.58

5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	190	0.45
	10000	290	0.85
	12500	440	1.74

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	7500	230	0.56
	10000	350	1.00
	12500	530	2.05

When long life and consistent performance are factors cooling in excess of minimum requirements is normally beneficial.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cooldown.

ELECTRICAL

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 300 amperes. At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase tube life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased two or three tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life. EIMAC Application Bulletin #18 titled EXTENDING TRANSMITTER TUBE LIFE is available on request.

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. <u>It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.</u>

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CX12,000A must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods (10 seconds maximum) such as may occur during tuning.

GRID OPERATION - The maximum control grid dissipation is 150 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 300 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The tube may exhibit reversed (negative) screen current under some operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, to assure that net screen supply current is always positive. This is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and air-flow interlock, the tube must be protected from damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power supply stored energy if an internal arc should occur. If power supply stored energy is high an electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The test for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch section of #30 AWG copper wire. The wire will remain intact if the test is met.

EIMAC's Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground." The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the application. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian Power Grid & X-Ray Tube Products, Attn: Applications Engineering, 301 Industrial Way, San Carlos, CA 94070 U.S.A.

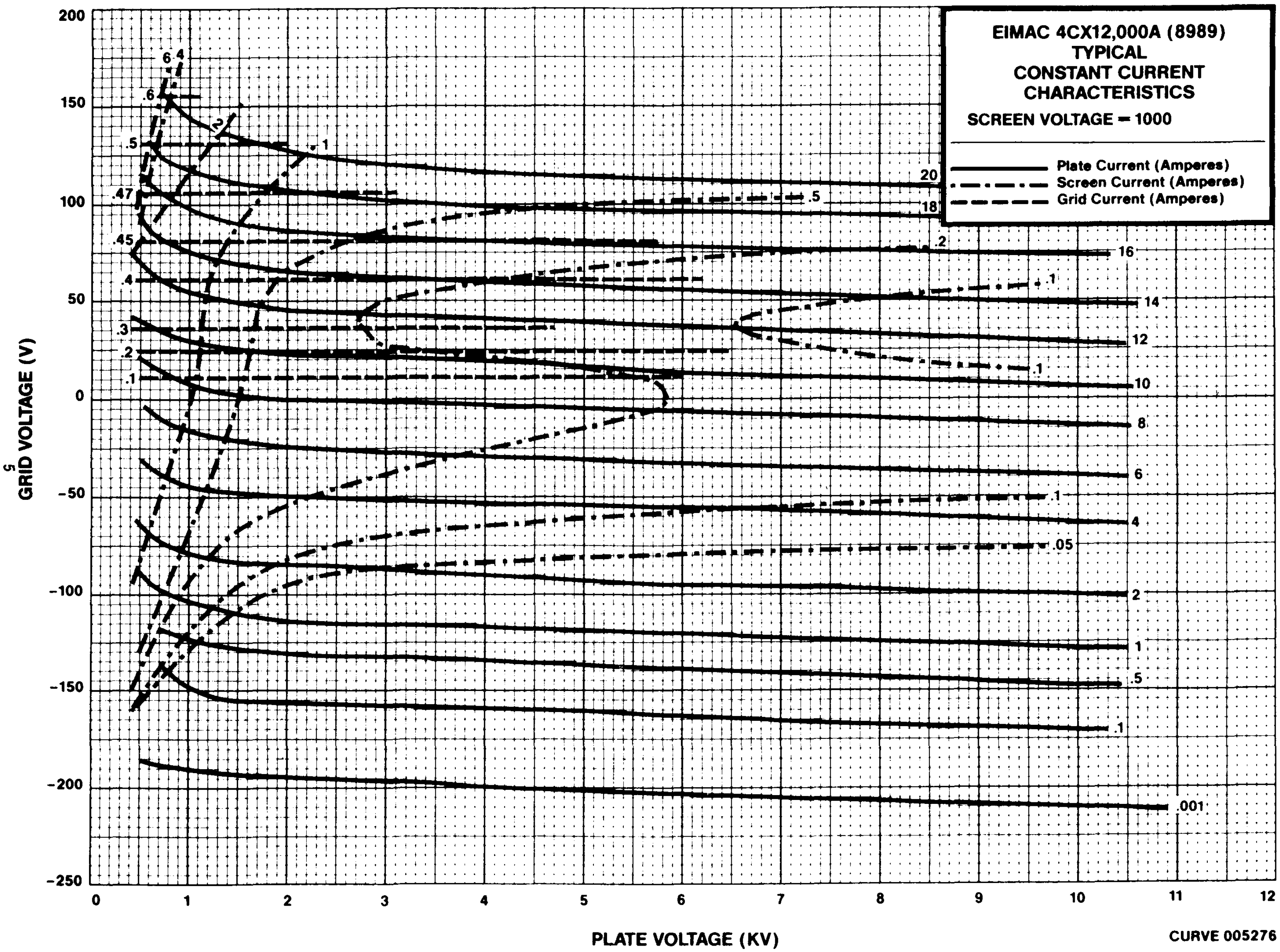
OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

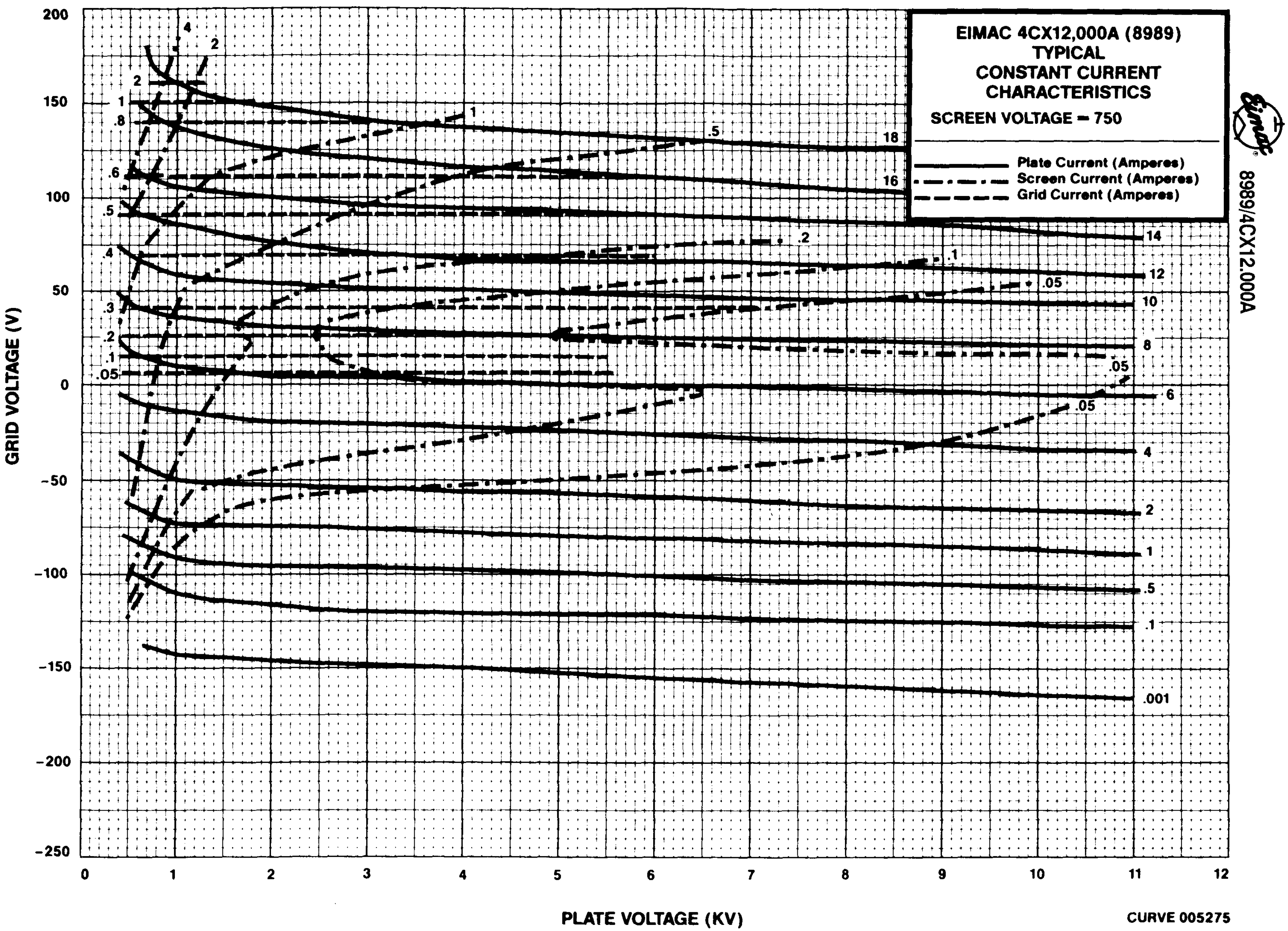
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.
c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.
d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian Power Grid & X-Ray Tube Products, Power Grid Application Engineering, 301 Industrial Way, San Carlos, CA 94070.

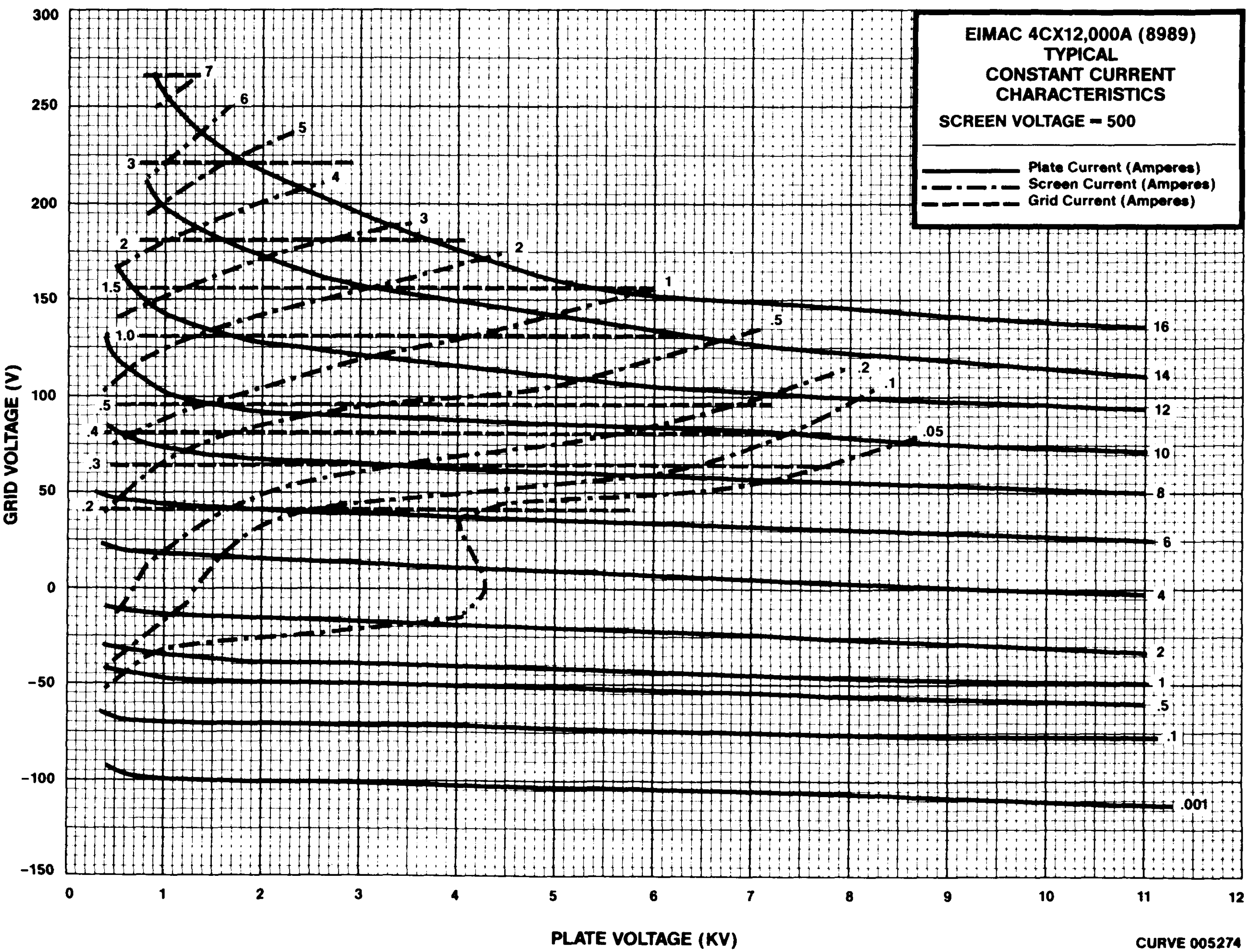


CURVE 005276

8989/4CX12,000A



EIMAC 4CX12,000A (8989)
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE 005275
8989/4CX12.000A

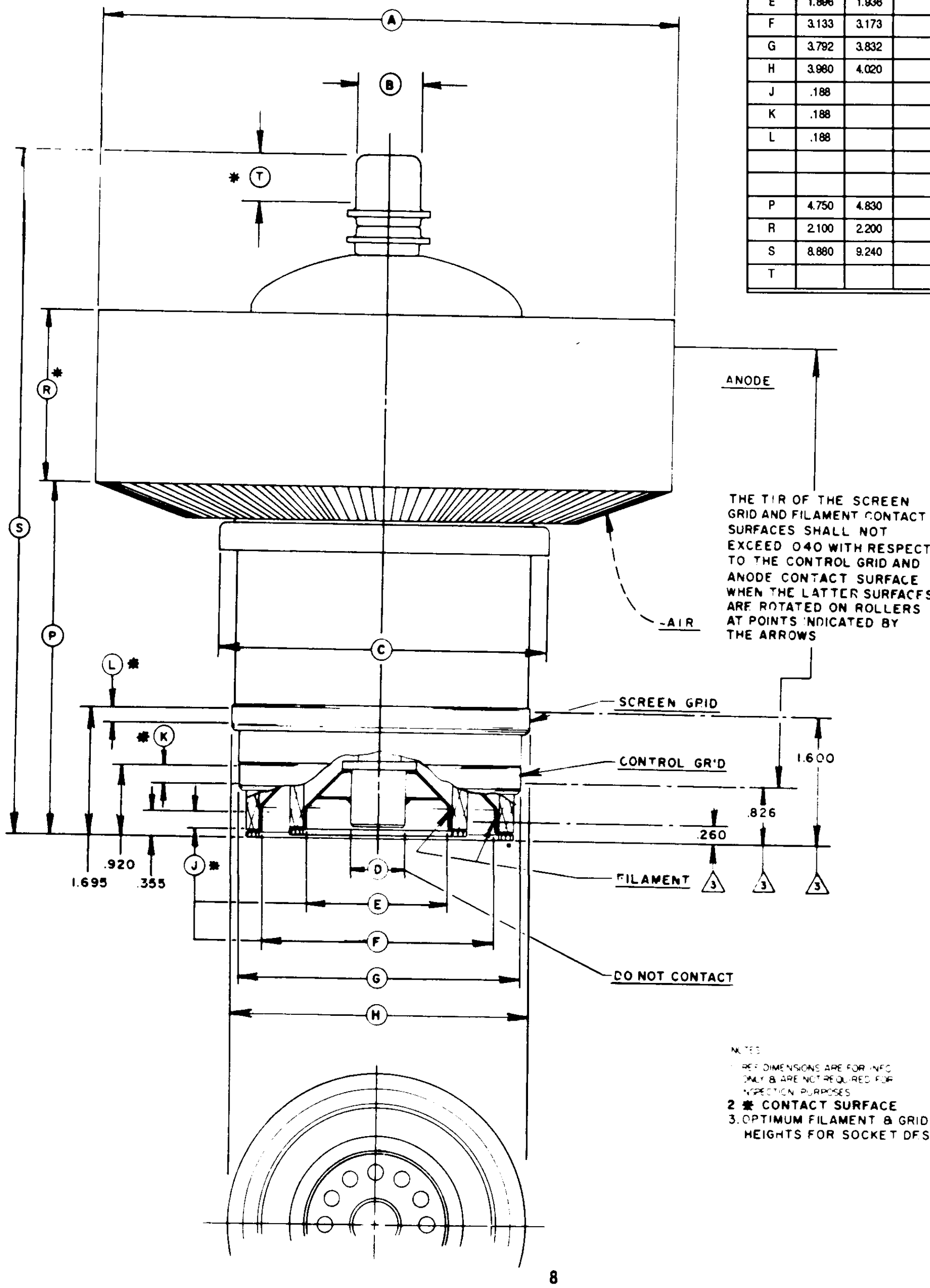


CURVE 005274

8989/4CX12,000A

8989/4CX12,000A

DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	7.700	7.760		195.58	197.10	
B	.855	.895		21.72	22.73	
C	4.300	4.362		109.22	110.79	
D	600	.760		15.24	19.30	
E	1.896	1.936		48.16	49.17	
F	3.133	3.173		79.58	80.59	
G	3.792	3.832		96.32	97.33	
H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
P	4.750	4.830		120.65	122.68	
R	2.100	2.200		53.34	55.88	
S	8.880	9.240		225.55	234.69	
T				12.70		



NOTES:
1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. * CONTACT SURFACE
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES

EXTENDING TRANSMITTER TUBE LIFE

EIMAC APPLICATION BULLETIN NO. 18

A carefully followed program of filament voltage management can substantially increase the life expectancy of transmitter power grid tubes. With today's rising operating costs, such a program makes good financial sense.

IN RECENT YEARS station managers have seen a substantial increase in replacement costs for power grid tubes. The blame can be placed on higher manufacturing costs due to inflation, volatile precious metal prices, and an uncertain supply of some exotic metals. The current outlook for the future holds little promise for a reversal in this trend toward higher prices.

One way to offset higher operating costs is to prolong tube life. For years station engineers have used various tricks to get longer operating life, with greater and lesser degrees of success. Success can be maximized, however, by understanding the various

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EIMAC Application Bulletin AB-18
Revised March, 1990

factors that affect tube life and implementing a program of filament voltage management.

A number of factors can aid maximum tube life in your transmitter. For example, are the maximum ratings given on the tube manufacturer's data sheet being exceeded? Data sheets are available upon request from most companies. Most tube manufacturers have an application engineering department to assist in evaluating tube performance for a given application. Make use of these services!

Headroom

Is the final power tube of the transmitter capable of delivering power in excess of the desired operating level? Or is the demand for performance so great that minimum output power levels can only be met at rated nominal filament voltage?

Figure 1 can be used as a basic guide to determine if a given transmitter and tube combination has a good probability of giving extended life service. Extended life service is defined as useful operating life beyond that normally achieved by operating at rated nominal filament voltage. The amperes/watt ratio is obtained by dividing average plate current by the product of filament voltage and filament current. If the amperes/watt ratio falls in the "good" to "excellent" range, excess emission is sufficient to permit filament voltage derating. At a lower filament voltage, the filament temperature is lowered, thus extending life. A typical FM transmitter on the market today may have an amperes/watt filament ratio of 0.002 to 0.003. This equipment would be considered an excellent choice to achieve extended tube life. On the other hand, if the amperes/watt ratio falls in the "poor" range, it is unlikely that filament derating is possible due to limited emission. Note that this guideline should be used for thoriated tungsten emitters only, and does not apply to oxide cathode-type tubes.

Instrumentation

Are all tube elements metered in the transmitter? Elements should be metered for both voltage and current, and meters should be redlined to define operation within safe limits. More modern transmitters may incorporate a microprocessor-controlled circuit to monitor all pertinent parameters.

In addition, the following controls are necessary if an effective filament voltage management program is to be undertaken: power output metering for an FM transmitter or a distortion level meter for AM equipment; *accurate* filament voltage metering (an iron-vane instrument is preferred over the more common average responding RMS calibrated type; the filament voltage measurement must be made at the tube socket terminals); filament voltage control, capable of being adjusted to 0.1 V secondary voltage change; and a filament current meter—desirable but optional.

A means must be provided to hold filament voltage constant. If the filament voltage is permitted to vary in accordance with primary line voltage fluctuation, the effect on tube life can be devastating. An acceptable solution is the use of a ferroresonant transformer or line regulator. This accessory is offered by some transmitter manufacturers as an option and should be seriously considered if a tube life extension program is planned.

Transmitter housekeeping

Once the transmitter has been place in operation, tube life is in the hands of the chief engineer. The first action to prolong tube life falls into the category of routine maintenance. Most transmitter manufac-

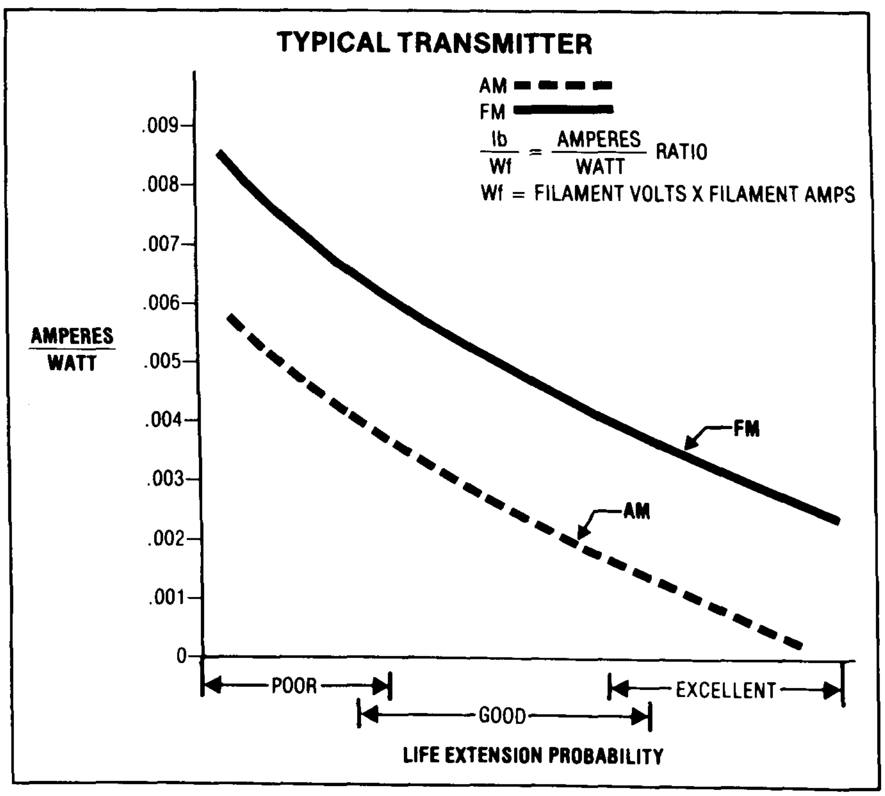


Fig. 1. *Probability of extended life service can be determined from this graph. Divide the average p.a. plate current in amperes by the product of filament voltage and current. The resulting amperes/watt ratio (Y-axis) is projected horizontally to the appropriate curve. The vertical projection to the X-axis indicate the life extension probability.*

Extending Transmitter Tube Life

Figure 2

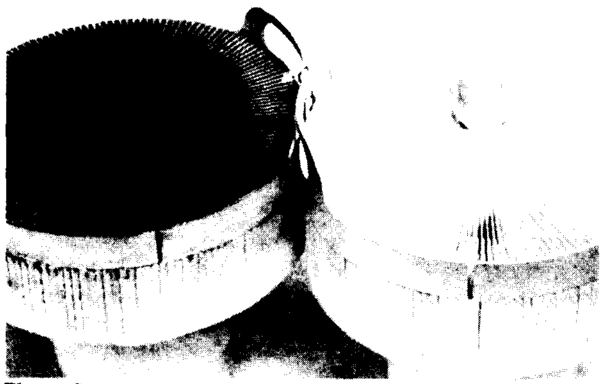


Figure 3

Figure 4

Figure 5

turers have a routine maintenance schedule established in the equipment manual. This procedure must be followed carefully if operating costs are to be held to a minimum. During routine maintenance it is very important to look for tube and socket discoloration, either of which can indicate overheating.

Look for discoloration around the top of the cooler near the anode core and at the bottom of the tube stem where the filament contacts are made. Review Figures 2 and 3 for examples of a tube operating with inadequate cooling. It is possible for discoloration to appear in the areas mentioned if the transmitter has to operate in a dirty environment. If this is the case, the tube should be removed and cleaned with a mild detergent. After cleaning, the tube should be rinsed thoroughly to remove any detergent residue and blown dry with compressed air. If the discoloration remains, this is an indication that the tube has operated at too high a temperature. Check inlet and outlet air ducting and filters for possible air restriction. It may also be necessary to verify that the air blower is large enough to do the job in the present environment and that it is operating at rated capacity.

With the tube removed, the socket should be blown or wiped clean and carefully inspected. Any discoloration in the socket finger stock caused by overheating could contribute to early tube failure. A finger stock that loses its temper through prolonged operation at high temperature will no longer make contact to the tube elements (Figure 4). A well-maintained socket will score the tube contacts when the tube is inserted. If all fingers are not making contact, more currect flows through fewer contacting fingers, causing additional overheating and possible burnout (Figure 5).

Filament voltage management

The useful operating life of a thoriated tungsten emitter can vary widely with filament voltage. Figure 6 describes the relative life expectancy with various filament voltage levels. Obviously, a well-managed filament voltage program will result in longer life expectancy. Improper management, on the other hand, can be very costly.

For a better understanding of this sensitive aging mechanism, the filament itself must be understood. Most filaments in high-power, gridded tubes are a mixture of tungsten and thoria with a chemical com-

Fig. 2. *Improper cooling means short tube life (left). Discoloration of metal around inner filament stem and anode fins indicates poor cooling or improper operation of tube. Properly cooled and operated tube (right) shows no discoloration after many hours of use. In both cases, good socketing is indicated by scoring on circular connector rings.*

Fig. 3. *Dirty and discolored cooler of amplifier tube at left indicates combination of discoloration due to heating and lack of cleaning. Tube has operated too hot and dust has collected in anode louvres.*

Fig. 4. *Minute scoring in base contact rings indicates that socket finger stock has made good, low-resistance contact to tube elements. Well-maintained socket will score the tube contacts when tube is inserted. If all fingers do not make contact, more current will flow through fewer contact fingers, causing additional overheating and burning, as shown in Fig. 5.*

Fig. 5. *High resistance socket contacts has caused severe burning of contact area in the base. Overheated base caused early demise of tube.*

position of W + THO_2. A filament made of this wire is not a suitable electron emitter for extended life applications until it is processed. Once the filament is formed into the desired shape and mounted, it is heated to approximately 2100°C in the presence of a hydrocarbon. The resulting thermochemical reaction forms di-tungsten carbide on the filament's surface. Life is proportional to the degree of carburization. If the filament is overcarburized, however, it will be brittle and easily broken during handling and transporting. Therefore, only approximately 25% of the cross-sectional area of the wire is converted to di-tungsten carbide. Di-tungsten carbide has a higher resistance than tungsten; thus, the reaction can be carefully monitored by observing the reduction in filament current as the carburizing process proceeds.

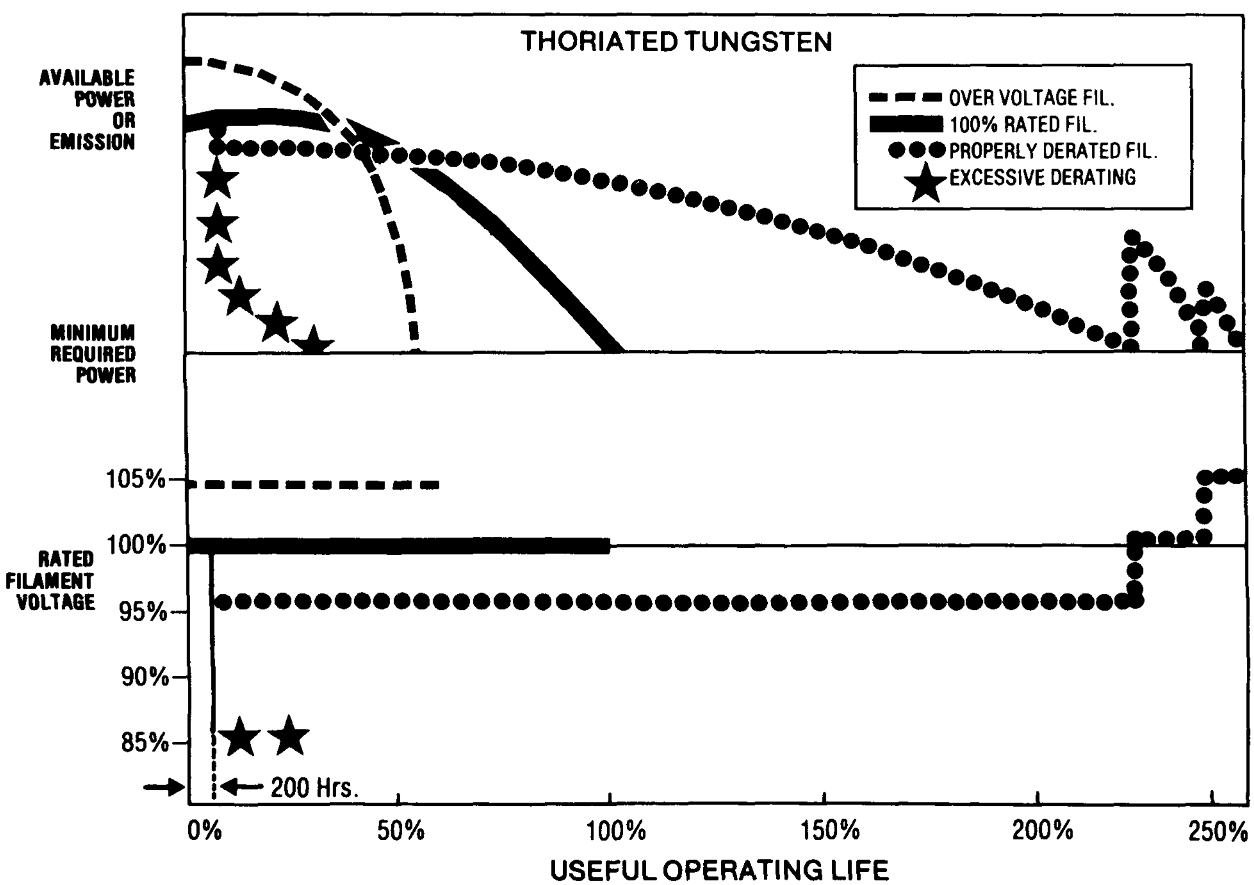
As the tube is used the filament slowly decarburizes. At some point in life, all of the di-tungsten carbide layer is depleted and the reduction of thoria to free thorium stops. The filament is now decarburized and is no longer an effective electron emitter.

The key to extending the life of a thoriated tungsten filament emitter is to control operating temperature. Emitter temperature is a function of the total RMS power applied to the filament. Thus, filament voltage control is temperature control. Temperature varies directly with voltage. As the emitter temperature rises the de-carburizing process is accelerated and tube life shortened. Figure 6 shows that useful tube life can vary significantly with only a 5% change in filament voltage.

FILAMENT VOLTAGE MANAGEMENT (Figure 6)

Filament voltage management allows extended tube life when accompanied by a continuing housekeeping program. When filament voltage is too high (dashes), power tube looses emission rapidly and normal operating life is not achieved. When filament is operated at rated voltage (black curve) normal tube life is achieved in a majority of cases. With a filament voltage management program (bullets), extended tube life may be achieved. When the minimum required output power level is finally reached (right-hand portion of curve), the filament voltage may be raised to rated value, or above, to achieve additional useful operating life. If filament is run "cool" (stars), extremely short life will result. Note that filament voltage management program does not take effect until about 200 hours of operating time have passed.

If voltage management program is not undertaken, tube should be run at rated filament voltage.



Extending Transmitter Tube Life

Of great importance to long tube life is the temperature of the elements and the ceramic-to-metal seals. Element temperature can be held within proper limits by observing the maximum dissipation ratings listed in the data sheet. Seal temperature should be limited to 200°C at the lower anode seal under worst-case conditions. As element temperature rises beyond 200°C, the release of contaminants locked in the materials used in tube manufacturing increases rapidly. These contaminants cause a rapid depletion of the di-tungsten carbide layer of the filament.

When a new power tube is installed in a transmitter, it must be operated at rated nominal filament voltage for the first 200 hours. This procedure is very important for two reasons. First, operation at normal temperature allows the getter to be more effective during the early period of tube life when contaminants are more prevalent. This break-in period conditions the tube for operation at lower filament voltage to obtain longer filament life. Secondly, during the first 200 hours of operation filament emission increases. It is necessary for the life extension program to start at the peak emission point.

A chart recorder or other device should be used to monitor variations in primary line voltage for several days of transmitter operation. The history of line voltage variations during on-air time must be reviewed prior to derating filament voltage. Plan to establish the derated voltage during the time period of historically low line voltage, as this is the worst-case condition. If line variation is greater that ±3%, filament voltage must be regulated.

Record output power (FM) or distortion level (AM) with the tube operating at rated nominal filament voltage. Next, reduce filament voltage in increments of 0.1 V and record power or distortion levels at each increment. Allow one minute between each increment for the filament emission to stabilize.

When a noticeable change occurs in output power or the distortion level changes, the derating procedure must stop. Obviously, operation at this point is unwise since there is no margin for a drop in line voltage. It is safer to raise the voltage 0.2 V above the critical voltage at which changes are observed to occur. Finally, recheck power output or distortion to see if they are acceptable at the chosen filament voltage level. Recheck again after 24 hours to determine if emission is stable and that the desired performance is maintained. If performance is not repeatable, the derating procedure must be repeated.

Continuing the program

The filament voltage should be held at the properly derated level as long as minimum power or maximum distortion requirements are met. Filament voltage can be raised to reestablish minimum requirements as necessary. This procedure will yield results similar to those shown in the illustration, to achieve as much as 10% to 15% additional life extension. When it becomes necessary to increase filament voltage, it is a good time to order a new tube. Filament voltage can be increased as long as the increase results in maintaining minimum level requirements.

When an increase fails to result in meeting a level requirement, filament emission must be considered inadequate and the tube should be replaced. Don't discard it or sell it for scrap! Put it on the shelf and save it. It will serve as a good emergency spare and may come in very handy some day. Also, in AM transmitters, a low-emission RF amplifier tube can be shifted to modulator use where the peak filament emission requirement is not as severe.

Start planning for longer tube life now! Review the following steps you can take:

- Investigate the manufacturer's ratings on the power tubes in your present equipment, or the transmitter you plan to buy.
- Check that your transmitter has sufficient headroom. Is there a margin of safety in tube operation?
- Look for important instrumentation in the next transmitter you buy. Are all tube elements monitored for voltage and current in the transmitter?
- Whether your transmitter is new or old, start a filament life extension program.

Remember that each time you replace a power tube, the recommended derating procedure must be rerun. Voltage levels required with one tube do not apply to a replacement tube.

When purchasing a tube, insist on a new tube that carries the full, original manufacturer's warranty. Only tubes manufactured by the company of origin have to perform to published data. This is the important reason that transmitter manufacturers buy new, warranted tubes from the original manufacturer.

Thanks to William Barkley, William Orr, William Sain, and Bob Tornoe, all of Varian EIMAC, for their help and suggestions in preparing this paper.

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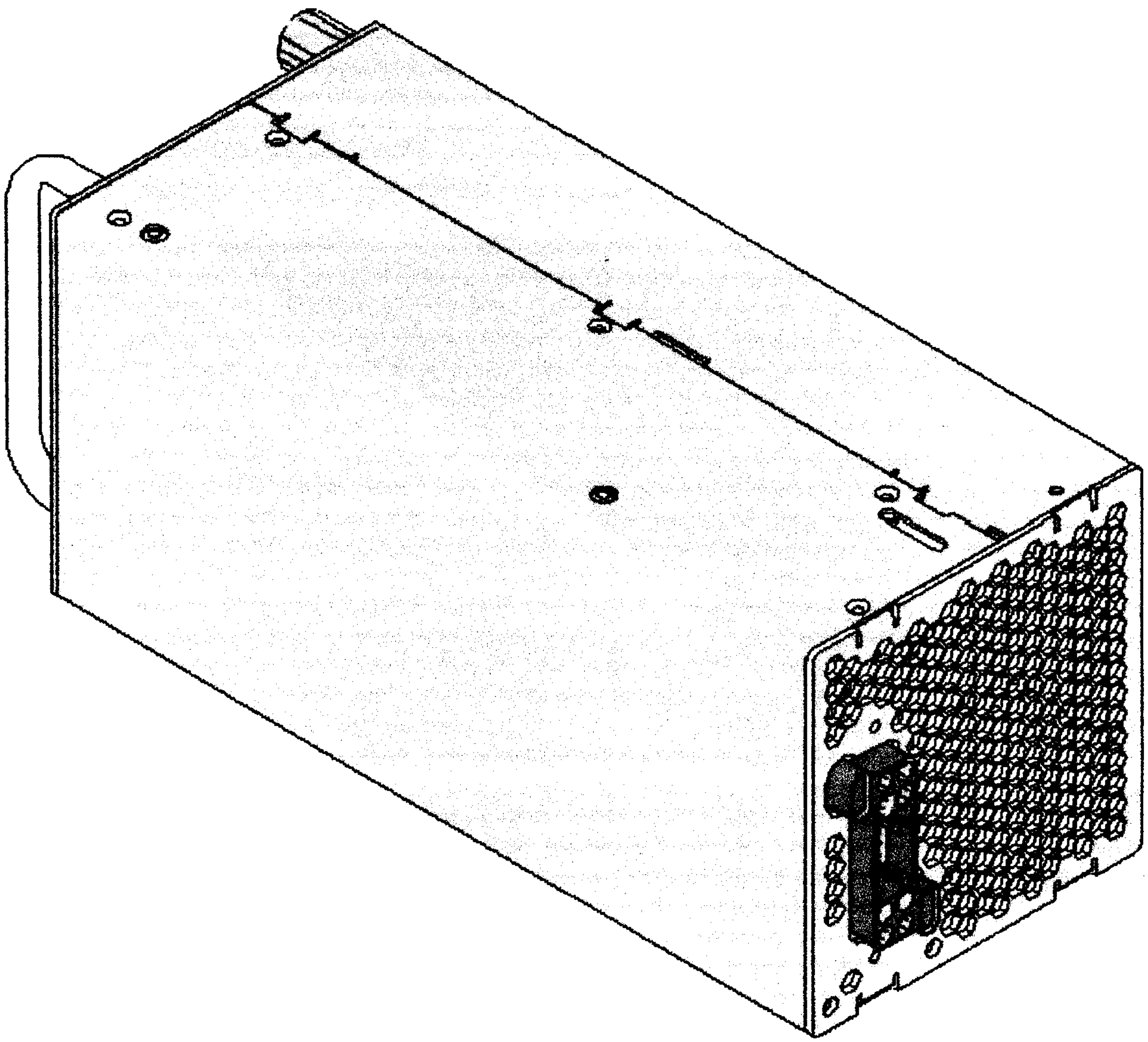
Troubleshooting Guide for the PM3329BP-5



Pioneer Magnetics

Troubleshooting Guide for the PM3329BP-5

PM3329BP-5 Troubleshooting Guide

Pioneer Magnetics Inc.
1745 Berkeley Street
Santa Monica, California 90404

Telephone: (800) 233-1745
(310) 829-6751
Fax: (310) 4533929

Troubleshooting Guide for the PM3329BP-5

Table of Contents

Pioneer Magnetics

Troubleshooting Guide for the PM3329BP-5

List of Illustrations

List of Illustrations (continued)

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Troubleshooting Guide for the PM3329BP-5

INSTALLATION INSTRUCTIONS

MOUNTING CONSIDERATIONS

The power supply is intended for use in commercial and industrial, controlled environment applications.

A reasonably dust-proof enclosure must be provided in the end use system, machine or equipment.

Ambient temperature less than 50°C, relative humidity less than 95%.

At installation, do not block the airflow generated by its internal ventilator fan.

Maximum mounting screw penetration is 3/32 inches (2.28mm), care should be exercised not to reduce internal creepage and clearance distances, nor to cause internal damages due to excessive penetration.

CAUTION:

The available energy at the secondary output studs exceeds 240 VA. Consideration is required for added operator accessibility.

INPUT VOLTAGE SELECTOR

The power supply is provided with dedicated input voltage as marked. The power supply has no on-off switch provision and is activated by the application of input power as rated, make sure that all output connections are properly made before application of input power.

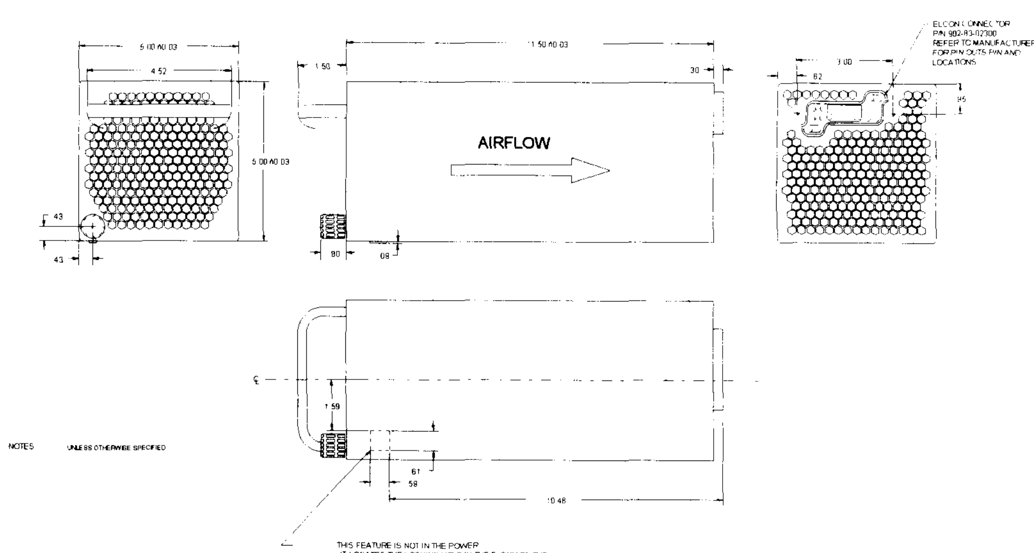
INPUTS AND OUTPUTS

After the supply has been installed mechanically, the connections to the input and output terminals are made by connecting cables of suitable gauge to the input and output terminals.

Note that main output terminals are connected internally to voltage sense circuitry and provide automatic local sense when no connection is made to the remote sense terminals provided at the Elcon connector.

VOLTAGE ADJUSTMENT

To verify output voltage, place a digital voltmeter across the output terminals. Do not install a load. Energize unit. When voltage appears, correct level by turning the voltage adjust pot to specified output voltage (clockwise to increase).



Pioneer Magnetics

Troubleshooting Guide for the PM3329BP-5

SPECIFICATIONS

OPTIONS

RANGE: 180 to 264 VAC. Frequency: 47 to 63 Hertz.
INPUT CURRENT: FULL LOAD: 12 Amps RMS.
INRUSH CURRENT: 25 Amps averaged over ½ cycle.
INPUT LEAKAGE: Input leakage current to ground 25 ma.
POWER FACTOR: 0.99 @ full power.
HARMONIC CURRENT: <5%.
Efficiency: Typically 80% at 185 VAC.
HOLD UP TIME: Minimum of 86 watt-seconds are available upon loss of input.
FUSING: Internal fuse located in input line.

OUTPUT

VOLTAGE: 48 VDC.
OUTPUT VOLTAGE ADJUSTMENT RANGE: ±10% of nominal output voltage.
POLARITY: Output is fully isolated and regulated. It may be referenced plus or minus as required.
CURRENT: 0 to 42 Amps.
REMOTE SENSING: Provides correct voltage at load with up to 0.5 volt total loop drop in the output line.
STATIC REGULATION: Line: ±0.25% over full line range. Load: See droop curve.
VOLTAGE STABILITY: ±0.1% after 30 minutes warm-up for a 24 hour period.
TEMPERATURE COEFFICIENT: ±0.2% ° FROM 0°C TO 50°C, P-P.
RIPPLE AND NOISE: Differential: 1% of 500 mV; (20 Hz to 20 MHz bandwidth) Common mode: 1.5 V p-p.
MINIMUM LOAD: No minimum load is required.
TURN ON DELAY: 1sec, maximum from application of AC line (when greater than or equal to 220 VAC.
OVERVOLTAGE PROTECTION: The standard OVP setting is 125% ±5% of nominal. OVP sensing is done at the output terminals.
OVERCURRENT PROTECTION: Constant current limiting set at 105% of rated output current.

ENVIRONMENTAL

OVERTEMPERATURE PROTECTION: Automatically shuts down and latches the unit the event of an over temperature condition.
AUDIBLE NOISE: 60 dBA maximum at 1 meter.
TEMPERATURE: Operating: 0°C to 50 °C at full load. Storage: -55°C to + 85°C.
HUMIDITY: 20% TO 95% non-condensing.
ALTITUDE: Operating: To 8,000 feet. Non-operating: To 30,000 feet.
VIBRATION: Operating: From 5 to 27Hz, 0.02 in double amplitude; from 27 to 500Hz, 0.75 G, 3 axes, 5 min per octave sweep, dwell 1 min at resonance. Non-operating: From 5 to 17Hz, 0.01 in double amplitude, from 17 to 500Hz, 1.5G peak; 3 axes, 5 min per octave sweep; dwell 0 min at resonance.
SHOCK: Operating: 5G, half sine, 11 mSec, 3 axes. Non-operating: 15G, half sine, 11 mSec, 3 axes.
COOLING: Forced air, internal fan. Airflow enters at the connector end.
EMI: Conducted: VDE071, Level A, 150KHz to 30MHz. Radiated: VDE0871, Level A.
SAFETY: UL 1950, CSA22.2 No. 950, TUV to EN60-950.

MECHANICAL

DIMENSIONS: Case 5" x 5" x 11.5" plus 0.30" for I/O connectors and 1.5" for handle.
WEIGHT: 9 lb.
MOUNTING: Designed to lock into matching rack.
I/O CONNECTORS: Elcon Lower Drawer Connector™ provides hot plug operation.

OPTIONS

POWER FAIL - TTL signal goes low at least 5 mSec before loss of regulation.
LOGIC INHIBIT and enable system can be turned on or off with a TTL compatible signal low switch contact.
CURRENT SHARING: Single wire current sharing.
UNDERVOLTAGE DETECTION: Monitors the output voltage when it drops below a specified level.

Pioneer Magnetics

Troubleshooting Guide for the PM3329BP-5

Introduction to the PM3329BP-5 Power Supply

Reference Schematics: PFC Board - 122220 Main Converter - 122217

The input board is called the PFC (Power Factor Corrector) module, and the main converter board is called the Main module. The PFC module, utilizing a boost converter provides the 380 volt DC bus for the main module through connectors J9 and J8. The PFC module also provides the operating voltages for the fan and for the option circuits. The power supply uses a DC fan, so that the wide range of the (PFC) Power Factor Corrected AC input voltage does not affect the fan speed or air flow intensity.

Let's begin with the PFC board, since everything starts with the AC input voltage.

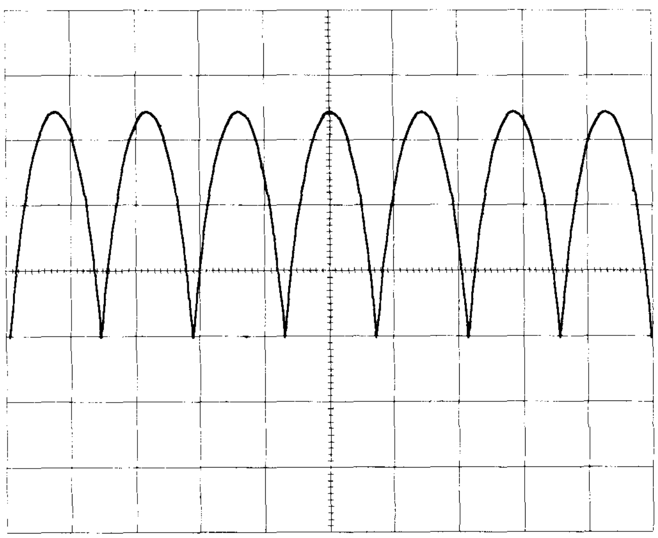


Figure 2-1

V(humps)

Scope probe to L3, pin 1
Scope Ground to 380 volt bus return

Time = 5 uSec/div
Amplitude = 50 v/div

This is the rectified unfiltered signal from the bridge rectifier BR!

The turn-on sequence begins with the charging up of the input capacitors, C11, C112, and C113, through the input bridge rectifier, BR1. The initial charging current of the input capacitors is limited by the inrush resistors, R7 and R21. When the voltage on the input caps reaches approximately 100 Volts, or the voltage across the inrush resistors reaches 30 volts, the Relay K1, closes, forcing the charging current through the relay contacts to prevent the inrush resistors from overheating and burning. During this time, the auxiliary circuit of the PFC provides an isolated 24 volts DC to the DC fan which begins turning. It also provides 15 volts DC for the control circuit of the main converter.

Introduction to the PM3329BP-5 Power Supply (continued)

The main converter does not turn on until the low line inhibit /enable sees about 300 volts on the 380 volt DC bus. The enable circuit senses the DC bus, and when the bus reaches 300 volts, an enable signal is sent from the PFC controller hybrid Z1, pin 17 (CE+) through the opto-coupler (U1) through J3, pin 1, turning on the main converter. Note that the returns of the PFC and the main converter are isolated by use of the opto-coupler. At this time the power supply will have regulated output.

To facilitate troubleshooting the PFC module, several critical waveforms are illustrated. The first four illustrations show the waveforms of the boost converter. The rest show the signals of the aux circuits.

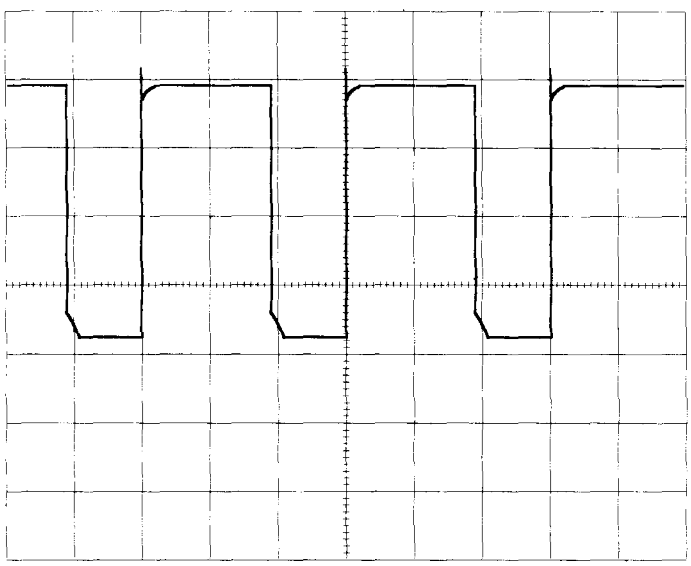


Figure 2-2

FET GATE DRIVE SIGNAL

Scope probe to base of Q2 & Q3
Scope ground to 380V bus return

- 0 volts

Time = 5uSec/div
Amplitude = 5 v/div

The FET gate drive signal is generated by the PFC controller hybrid, Z1-14 (GD). This signal uses the negative swing to -4 volts or so to ensure that the FET Q4, fully dumps the FET charge on turn off. This enhances the operation of the boost converter and protects the FET from excessive stress, which in turn means more reliability. If the FET gate drive signal is distorted or looks much different than pictured, the hybrid Z1 would be suspect.

Introduction to the PM3329BP-5 Power Supply (continued)

Speaking of the "hybrid" circuits, there are two on each module. They provide all of the controlling signals for the entire power supply. Special care must used when replacing them. Only recommended soldering procedures are to be used, especially in putting a new one in place. Excessive heat can kill many of the miniature components embedded on the hybrids. At this moment, note that it is extremely important that all of the components that are in this power supply be obtained from Pioneer Magnetics; see replacement part recommendations at the end of this document. Each component has been selected carefully for optimum performance and reliability. Z1 is the PFC controller. Z2 is the controller for the auxiliary circuit. Also a sync signal is generated at the clock, pin 10 of Z1 which is used both on the PFC board and the main converter. This sync signal keeps everything between different commons and levels throughout the entire power supply including the option circuits. The clock signal is illustrated in Figure 2-4 on the next page.

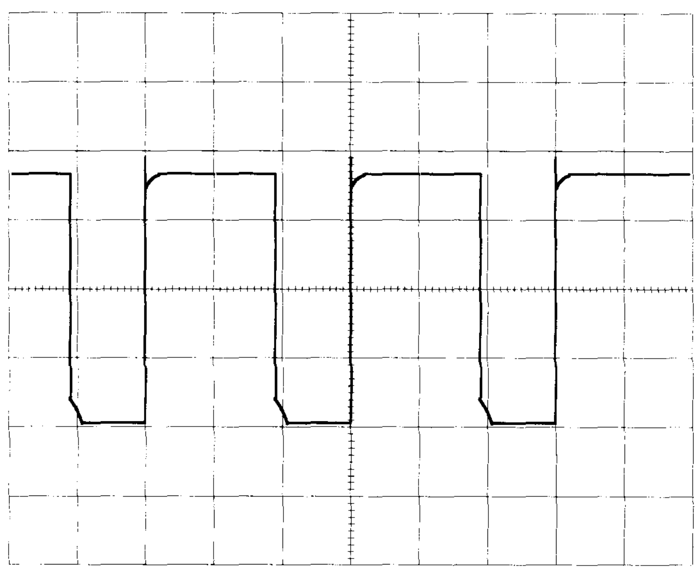


Figure 2-3

FET DRIVE SIGNAL

Scope probe to emitter of Q3
Scope ground to C15 negative

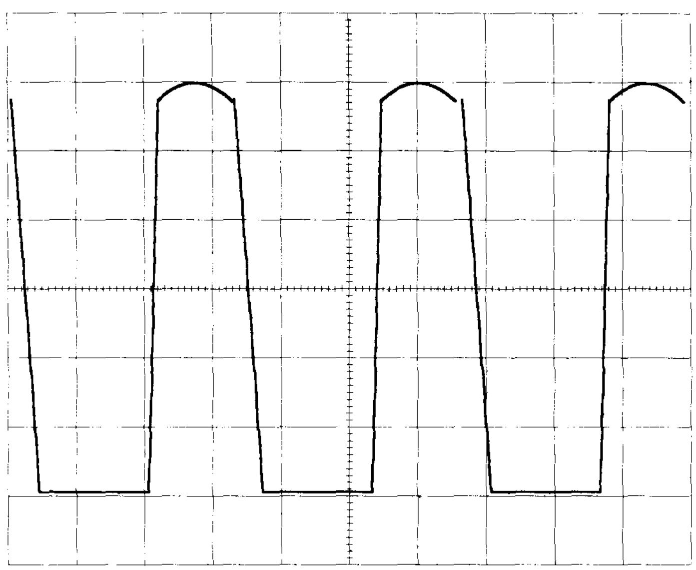
Time = 5uSec/div
Amplitude = 0.5v/div

← 0 volts

Even though every component on the PFC board is important ,and the failure of any one of them would jeopardize the functionality of the whole power supply, some of these components are extremely critical. Of course, the PFC controller hybrid must be functioning properly in order for anything else to respond accordingly. In troubleshooting the PFC board, as it is in any electronic device, it is sometimes very difficult to verify which is the cause of the failure because most electronic circuits are just a bunch of loops.

Introduction to the PM3329BP-5 Power Supply (continued)

We therefore have to look first at the component that is supposed to be the controlling device. In this case, it is definitely the PFC controller hybrid. I am not suggesting that you replace Z1 automatically, however it is a good starting point. The telltale distortion of the (V(humps) see figure 2-1) would probably indicate a defective bridge rectifier (BR1) or possibly one of the components of the EMI filter circuit. Also, if the fuse (F3) is open or if the inrush resistors (R21 & R7) are burned, then we would suspect the relay (K1) or again, the PFC controller hybrid. The critical components on the PFC board are: (*not necessarily in order of importance*) the PFC controller hybrid (Z1), the bridge rectifier (BR1), the FET (Q4), the FET (Q1), the aux supply hybrid (Z2), and the opto-coupler (U1). Also we need to include the diodes D1, D4, D5, and especially D9.



CLOCK SIGNAL

Figure 2-4

Scope probe to pin 10 of Z1
Scope ground to 380 V bus return

Time = 5uSec/div
Amplitude = 0.5v/div

← 0 volts

Another waveform which should be monitored is the FET switching signal at Q4. See Figure 2-5 on next page.

Another item to check is the + 5 volt DC reference from the PFC controller hybrid, Z1, at pin 16. This is directly connected to the auxiliary supply hybrid, Z2, at pin 9.

Introduction to the PM3329BP-5 Power Supply (continued)

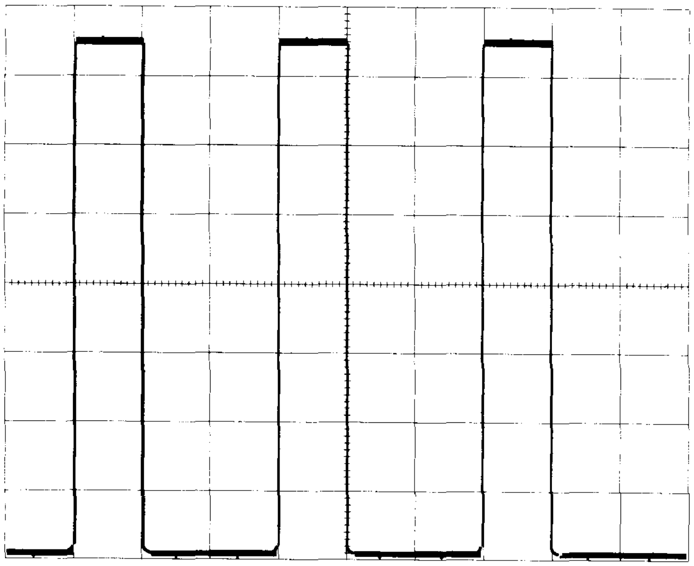


Figure 2-5

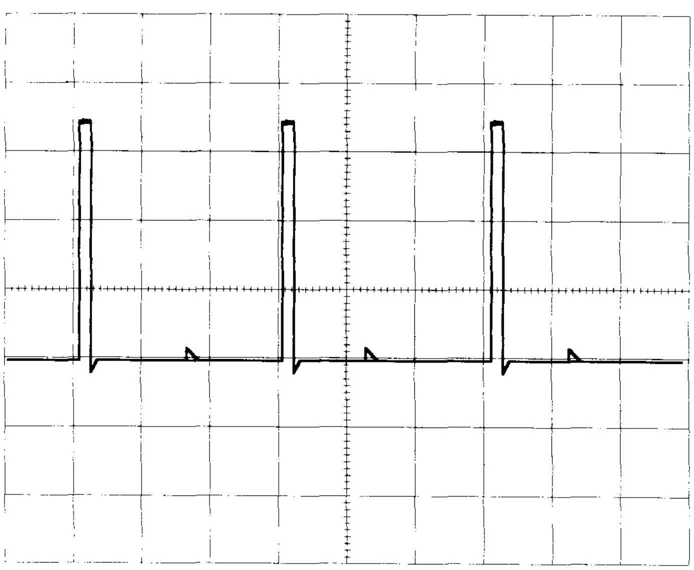
FET Switching Signal

Scope probe to the drain of Q4
Scope ground to the source of Q4

Time = 5 uSec/div
Amplitude = 50 v/div

← 0 volts

The auxiliary supply hybrid "aux", is responsible for the generation of the auxiliary voltages for the main converter board. Initially a 5 volt reference is provided by Z1 at startup; before the main converter can be turned on, it must have a 7 ½ volt enable level.



AUXILIARY DRIVE SIGNAL

Figure 2-6

Scope probe to pin 4 of Z2
Scope ground to the 380 V bus return

← 0 volts

Time = 5 uSec/div
Amplitude = 5 v/div

Troubleshooting Guide for the PM3329BP-5

Introduction to the PM3329BP-5 Power Supply (continued)

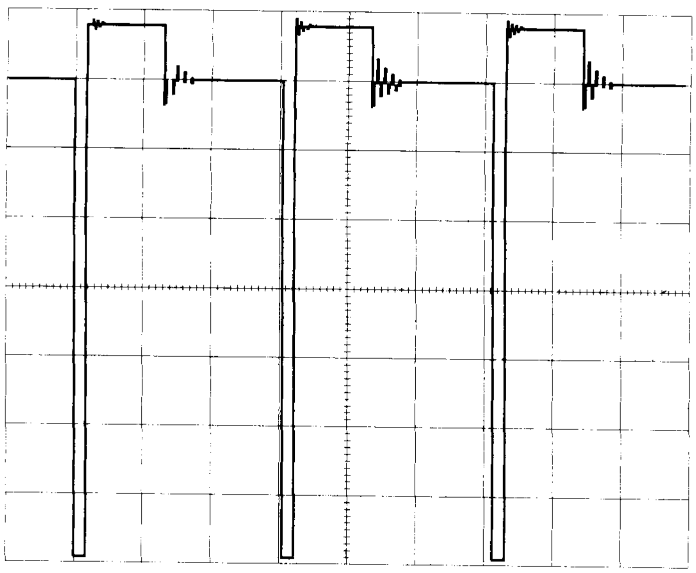


Figure 2-7

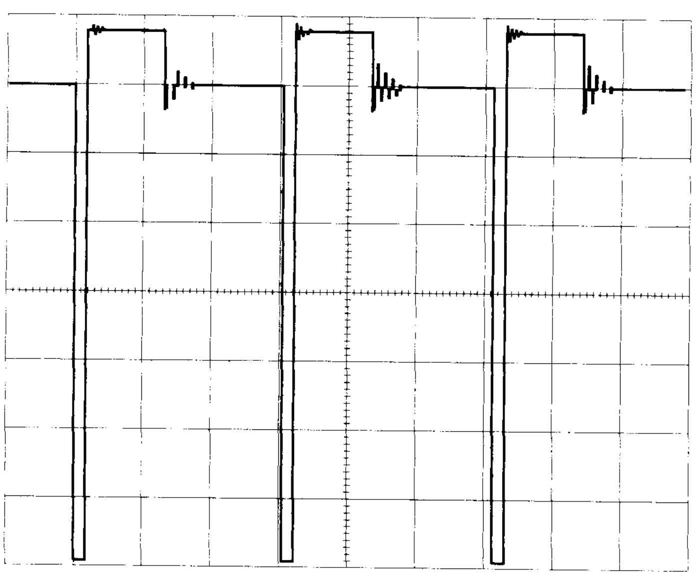
← 0 volts

AUXILIARY (AC) SUPPLY

Scope probe to the anode of D6
Scope ground to the cathode of D6

Time = 5 uSec/div

Amplitude = 20 v/div



AUXILIARY SUPPLY

Figure 2-8

Scope probe to the drain of Q1
Scope ground to the source of Q1

Time = 5 uSec/div
Amplitude = 50 v/div

← 0 volts

Introduction to the PM3329BP-5 Power Supply (continued)

The main converter module uses the 380 volt DC bus from the PFC module for primary power. The 380 volt DC bus connects via the connectors P9 [+] and P8 [-] to the sources of the power FETs, Q101 through Q104. These FETs are connected as two sets of switches. One set of FETs is turned on which causes current flow in the power transformer (T101) in one direction, then after some dead time, the other FETs are turned on causing current flow in the power transformer in the reverse direction. Note the waveform in Figure 2-9. The "dead time" between the sets of FETs is deliberate to prevent the situation in which both sets of FETs will be conducting at the same time. If this happens, something will be sure to fail, causing a small catastrophe in other parts of the main converter board and even on the PFC board.

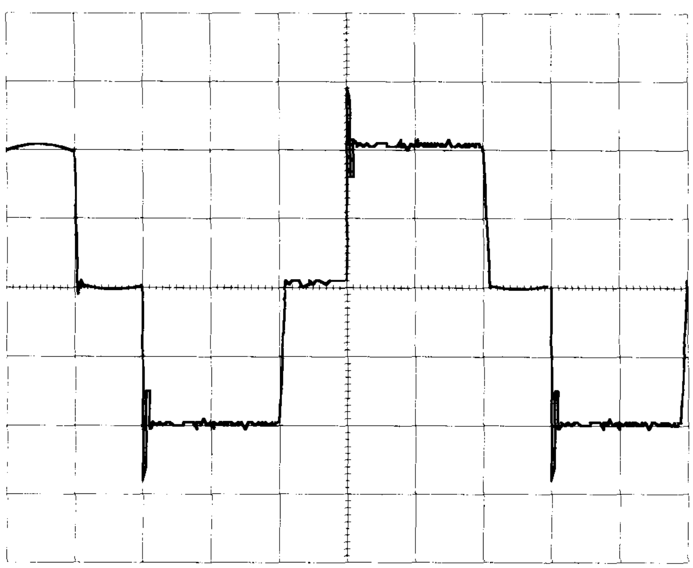


Figure 2-9

POWER TRANSFORMER OUTPUT

Scope probe to T101-5
Scope ground to T101-6

← 0 volts

Time = 5 uSec/div
Amplitude = 50 v/div

The power FETs (Q101 through Q104) are being driven by the flip-flop (U101); actually the drive signal is developed by the pulse width modulator which is one of the functions of the hybrid Z101. The flip-flop only acts basically as a steering circuit for the drive signal. See the power FET drive signals in Figure 2-11. The waveforms in this troubleshooting guide are close approximations of the way the waveforms that actually appear. They are mostly to show some semblance of the time and amplitude. You may find that if and when you look at these waveforms on your scope, that you think the power supply is not functioning properly.

Introduction to the PM3329BP-5 Power Supply (continued)

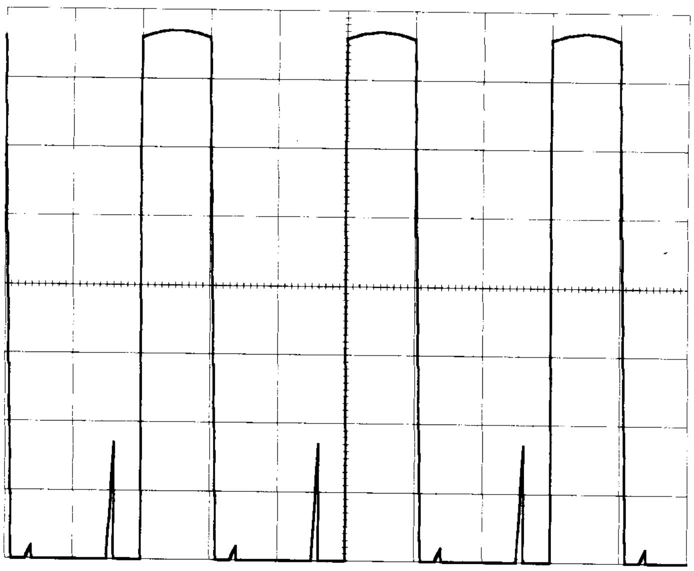


Figure 2-10

FET Switching Signal

Scope probe to the drain of Q101
Scope ground to the source of Q101

Time = 10 uSec/div
Amplitude = 50 v/div

← 0 volts

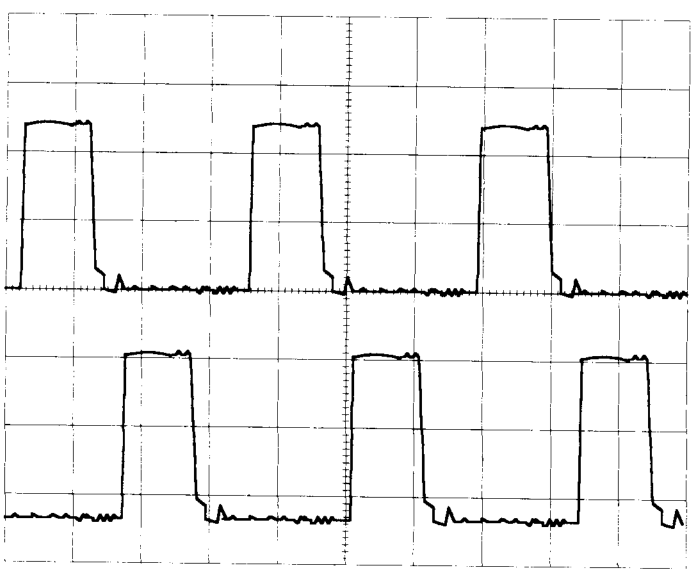


Figure 2-11

Power FET Drive Signals

Scope probe to pin 6 of U101
Scope ground to aux return

← 0 volts

Scope probe to pin 11 of U101

← 0 volts

Introduction to the PM3329BP-5 Power Supply (continued)

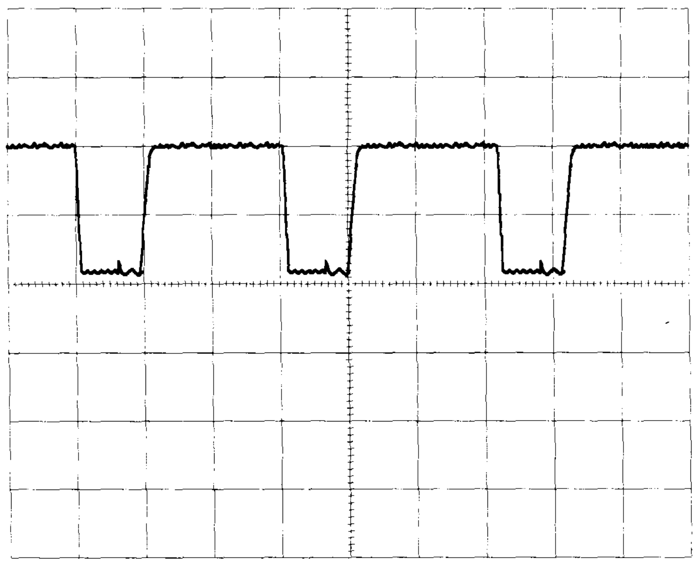


Figure 2-12

Power Pulses

Scope probe to pin 3 of U101
Scope ground to aux return

← 0 volts

Time = 5 uSec/div
Amplitude = 2 v/div

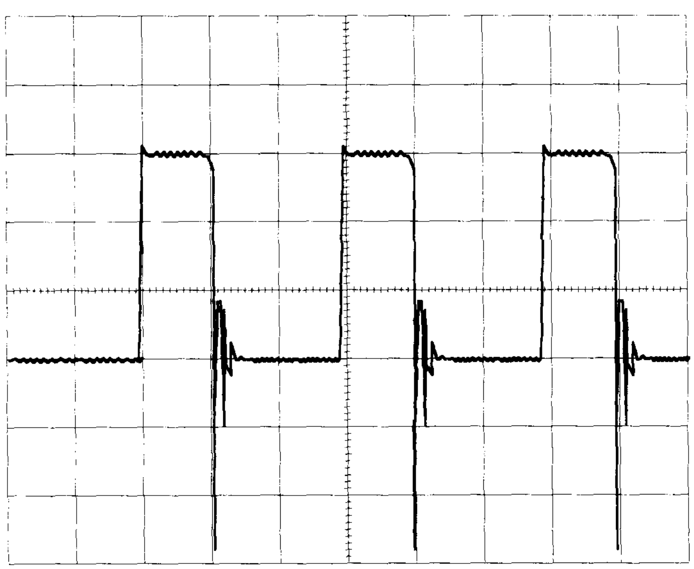


Figure 2-13

Output Choke Signal

← 0 volts

Scope probe to pin 1 of L101
Scope ground to aux return

Time = 5 uSec/div
Amplitude = 20 v/div

Introduction to the PM3329BP-5 Power Supply (continued)

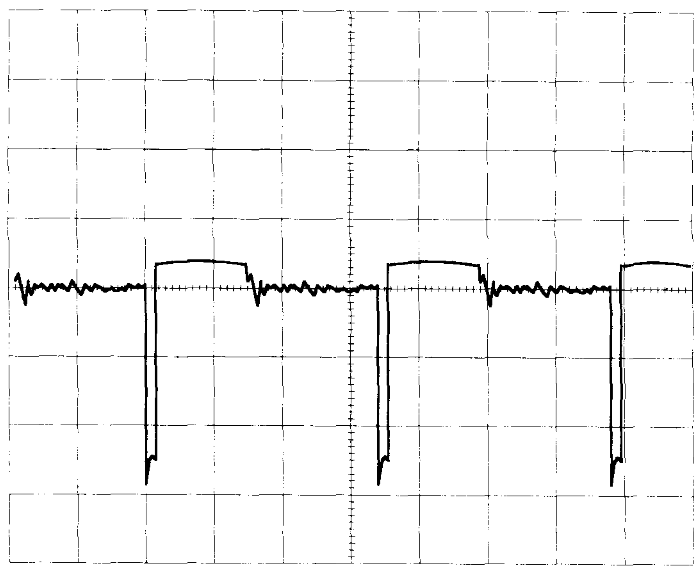


Figure 2-14

Auxiliary (aux) Flyback

← 0 volts

Scope probe to the anode of D110
Scope ground to aux return

Time = 5 uSec/div
Amplitude = 50 v/div

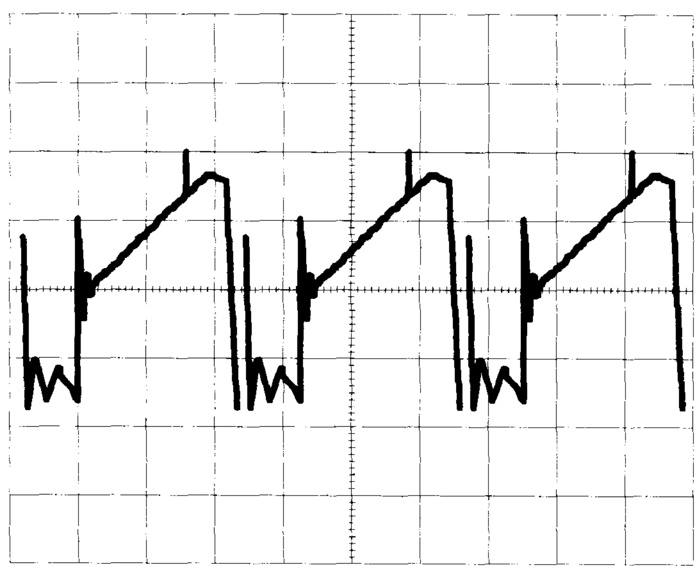


Figure 2-15

Burden Resistor Waveform
(used as a ramp)

Scope probe to pin 23 of Z101 (R106)
Scope ground to aux return

Time = 5 uSec/div
Amplitude = 0.2 v/div
← 0 volts

Introduction to the PM3329BP-5 Power Supply (continued)

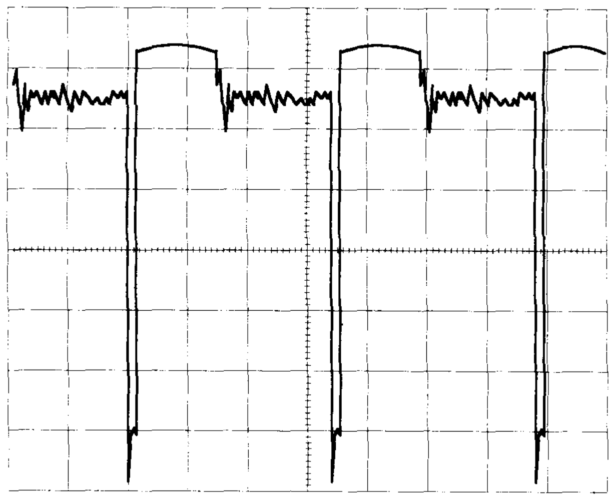


Figure 2-16

← 0 volts

Option (AC) Supply

Scope probe to Cathode of D112
Scope ground to logic return

Time = 5 uSec/div
Amplitude = 50 v/div

The options circuit which includes undervoltage detection, and logic inhibit, is not referenced to the return of the output bus because it requires a floating return for isolation for external connections.

The control for the functions on the main converter board are handled by the two hybrids, Z101 and Z102. The following functions for each hybrid are shown below.

Z101	Z102
current mode pulse modulator	undervoltage detection -128
current ramp signal	5 volt reference for the option
remote sense amplifier	logic inhibit
current sharing -6B disconnect	special voltage adjust -127
voltage ratio amplifier	
low line inhibit control	
current amplifier	
sync circuit	
current limiting	
overvoltage protection	

Bring-up Procedures for the PFC Board

1. Visual Inspection

   1.1 Check the PFC board closely for any evidence of physical damage: such as, broken connections, broken or damaged wires, damaged or burned pcb traces, loose or damaged connectors, poor solder joints or solder bridges. Ensure that the board is mechanically sound before testing. This board should be tested after any failure or repair on either the main (base board) or the PFC board.

2. Isolation Tests

   2.1 Measure the resistance between INPUT and OUTPUT, between INPUT and CHASSIS, and between OUTPUT and CHASSIS. Each resistance measurement must exceed 2 megohms. These tests should be performed again when the power supply has been reassembled with the case. To ensure compliance with universal safety standards, a High-Pot test should be performed on the complete power supply before placing the power supply into the rack.

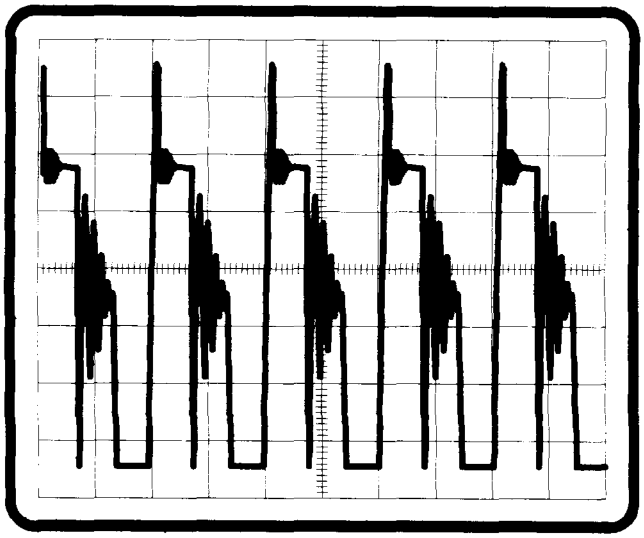
3. PFC Test

   3.1 Apply 60 volts DC from a "CURRENT LIMITED" DC power supply to the PFC input; the positive lead to E3 and the negative lead to E5.

   3.2 Connect the scope probe to the heatsink (drain) of Q1, with the ground clip to pin 1 of J8 (380 volt bus return). Check waveform for frequency and amplitude. See Figure 2-17.

   3.3 If the waveform is distorted, and the DC power supply is drawing excessive current, check the auxiliary drive signal at Z2, pin 4. If there is no signal or if the signal is very low, replace the hybrid module Z2. If the problem persists, replace the FET, Q1.

   3.4 If the waveform checks out approximately like the one in Figure 2-17, go to Part 2 on the next page.



Waveform at the drain of the FET, Q4

5 uSec/div

20 volts/div

The time should be approximately 11 ms

The amplitude should be approximately 150 volts

Figure 2-17

Bring-up Procedures for the PFC Board Part 2

4. Connect the DC fan to the connector at J3.

    4.1 If possible, use the DC fan that is connected to the power supply case.

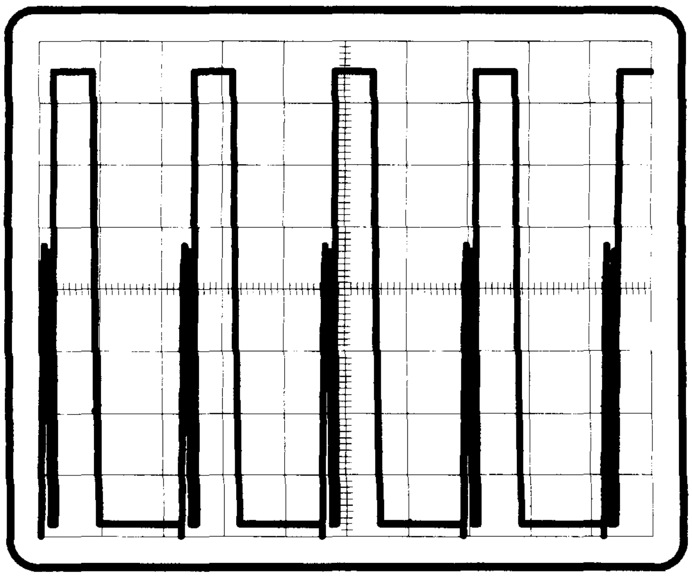
5. Solder connector at pins 1, 6, and 20 of Z1.

6. Apply 60 volts DC to the PFC input at E3 & #5.

7. Check the wave form at the FET Q4 (on screw #3). See Figure 2-18 on next page.

    7.1 Measure the PFC output at C11; should be approximately 375 volts DC.

    7.2 The waveform shown is only an approximation of the actual signal.



Waveform at Q4

5uSecs/div

50volts/div

The time is approximately 13 milliseconds. The amplitude approximately 375 VDC.

Figure 2-18

If the PFC board performs according to the prior tests, the next step is to connect the PFC board to the base board. It is extremely important that the PFC board function properly before connecting to the base board.

Comments

Troubleshooting Guide for the PM3329BP-5

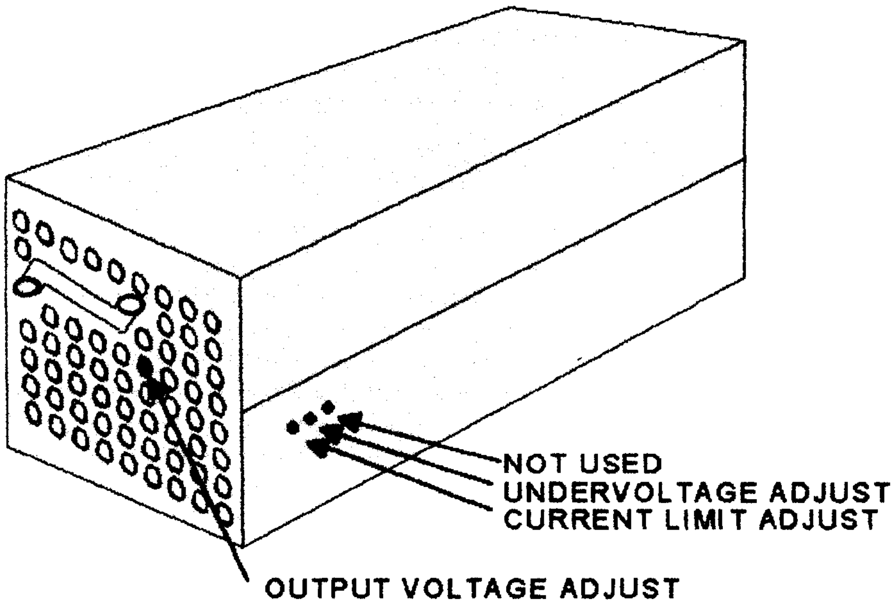


Figure 3-1

Incoming Test Procedures

1. Test Equipment Requirements

1.1 Variable AC source 0 to 270 VAC 3 KVA - typical - ®Powerstat
1.2 True RMS Digital AC Ammeter
1.3 True RMS Digital AC Voltmeter
1.4 Dual Trace Oscilloscope with 1 times 10 scope probe
1.5 Times ripple probe to be connected to the Elcon connector ... see number 1.11
1.6 Current probe to monitor input current waveform
1.7 Variable DC power supplies 0 to 60 VDC 0 to 2 amps with series diode
1.8 Digital DC Voltmeter
1.9 Digital DC Ammeter
1.10 Multimeter - typical - Tripplett
1.11 Elcon connector (female) model 298-08-01100
1.12 Dynamic Active Load Bank - 2500 Watt - typical - Transistor Devices

Incoming Test Procedures continued

2. Isolation Resistance Test - *This test must be done before any connections are made.*

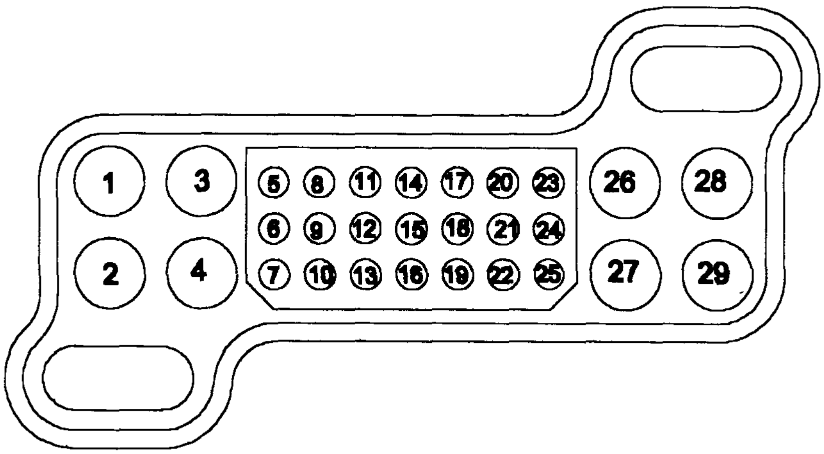
2.1 Using an ohmmeter set to the times 10 ohms scale:
2.1.1 Measure for continuity between Chassis Pins 3 and 4 to any exposed part of the chassis, such as the handle.
2.1.2 Measure across the AC input pins 1 and 2 to verify that the input is not shorted.
2.1.3 Measure across the output pins 26/28 and 27/29 to verify that the output is not shorted.

2.2 Using an ohmmeter set to the times 100K scale:
2.21 Measure from any part of the chassis to either input pin; must measure greater than 200K.
2.22 Measure from either input pin to either output pin; must measure greater than 200K
2.23 Measure from either output pin to the chassis; must measure greater than 200K.

Check to see that none of the pins on the Elcon connector are bent or damaged.

If you already have an incoming inspection procedure set up, you have the option to use either method.

Incoming Test Procedures continued



Connector Pinouts:

48D42-2f-4d-6b-127-128-R

Elcon Lower Drawer Part No.
297-08-01100

Figure 3-2

Pinouts

Pin 1:	Input AC (Neutral)
Pin 2:	Input AC
Pin 3:	Chassis Ground
Pin 4:	Chassis Ground
Pin 6:	Unit Present Indication
Pin 7:	Unit Present Indication
Pin 17:	-6B, Current Sharing
Pin 18:	Not Used
Pin 19:	Logic Return
Pin 20:	-2F, Logic Inhibit

Pin 21:	Dummy Pin
Pin 22:	-128, Undervoltage Signal
Pin 23:	Remote Sense, Positive
Pin 24:	-127, Voltage Adjust
Pin 25:	Remote Sense, Negative
Pin 26:	Output Positive
Pin 27:	Output Negative
Pin 28:	Output Positive
Pin 29:	Output Negative

Options List

-2F	Logic Inhibit
-4D	Overtemperature Thermal Switch
-6B	Single Wire Current Sharing
-127	Special Voltage Adjust
-128	Undervoltage Detection Signal
-R	Reverse Airflow

Incoming Test Procedures continued

Connect the test equipment to the power supply under test. A test adapter for connecting to the Elcon connector will have to made, including scope probe connection. A current probe for the input current waveform is not shown, however, a "clamp-on" type of current probe may be used.

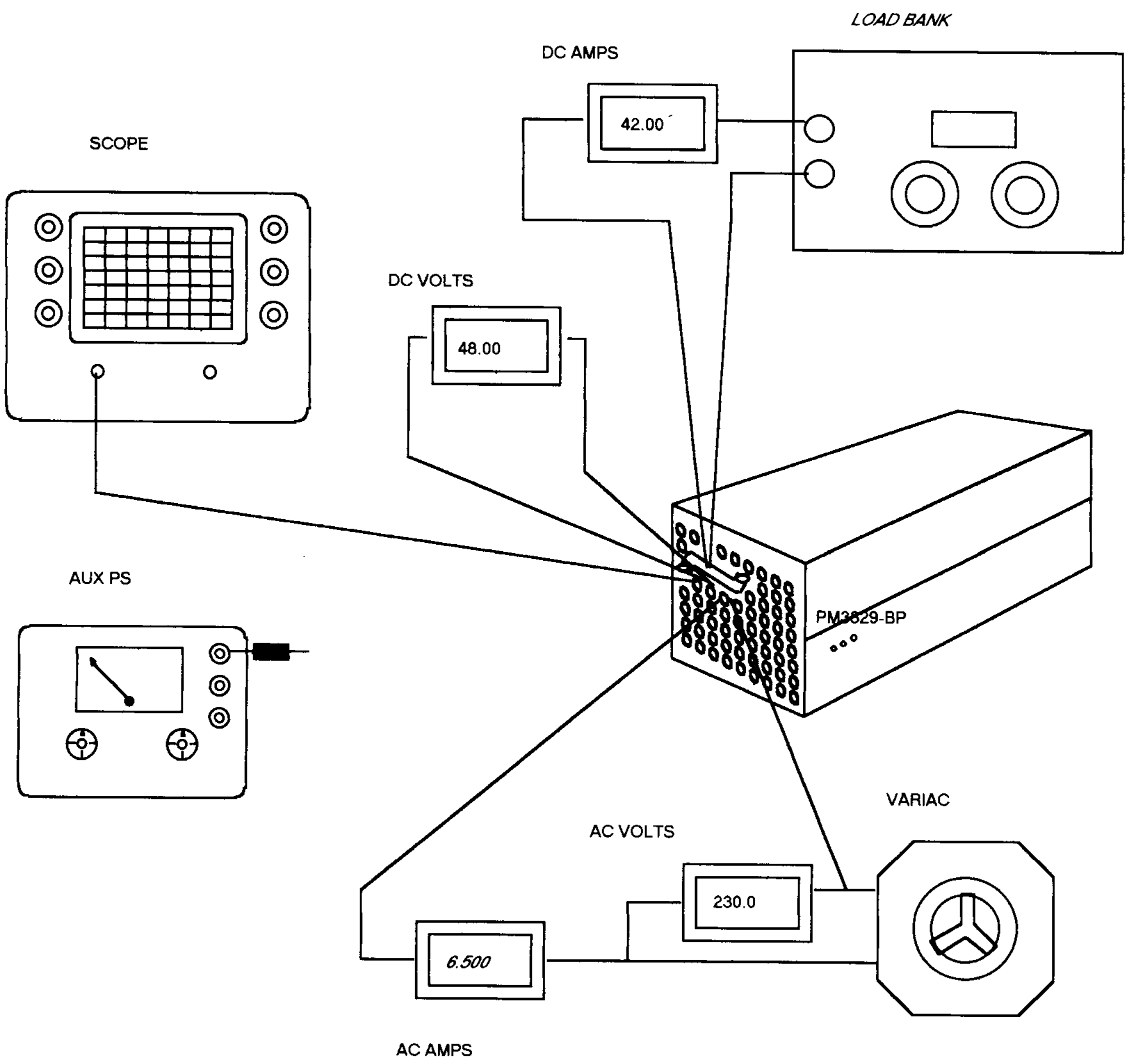


Figure 3-3

Incoming Test Procedures continued

3.1 Once all of the connections have been made on the unit under test , verify that all connections are secure and of the correct polarities.

3.2 Adjust the output load to 0 amps.

3.3 While monitoring the AC input current, turn on the switch of the variable AC source and gradually increase the input voltage ... the fan should start turning at about 100 volts AC in ... if the input current is normal, continue adjusting the input voltage ... the output should come on at approximately 170 volts .... continue increasing the input AC voltage to nominal, 230 volts AC.

3.4 Apply a small load and verify and adjust the output voltage to nominal value, always observing the AC input current. This is a good indicator if anything is drastically wrong.

3.5 Increase the load current to the rated level (42 amps). Check each meter and the scope waveform for anything out of the ordinary .... the input current should not exceed 10 amps. Once the AC input voltage is at nominal, verify that the output voltage does not change significantly with changes in load or line.

3.6 Test 1: Overload Test - Set the AC input to 230 volts.

3.6.1 Adjust the load current to maximum and verify that the output current does not exceed 48.3 amps.

3.7 Test 2: Low Line Test - Set the load current to 42.0 amps.

3.7.1 Lower the AC input to 175 volts and verify that the output voltage does not drop below 47.0 volts.

3.8 Test 3: Voltage Adjust Range - Set the AC input to 230 volts - adjust the load current to 30 amps.

3.8.1 Verify that the output voltage will adjust to 47.0 volts and to 49.0 volts. Set the output voltage back to 48.0 volts after the voltage adjust range test.

Incoming Test Procedures continued

3.9 Test 4: Regulation and Ripple.

3.9.1 Adjust the load current to minimum load (0.3 amps).

3.9.2 Set the AC input to 180 volts; measure and record the output voltage and output ripple and spikes.

3.9.3 Set the AC input to 264 volts; measure and record the output voltage and output ripple and spikes

3.9.4 Adjust the load current to nominal (42.0 amps).

3.9.5 Set the AC input to 180 volts; measure and record the output voltage and output ripple and spikes.

3.9.6 Set the AC input to 264 volts; measure and record the output voltage and output ripple and spikes.

3.9.7 The output ripple spikes should not exceed 480 millivolts peak to peak under all of the above conditions.

3.9.8 Subtract the lowest output voltage measurement from the highest output voltage measurement. The maximum output deviation should not exceed 250 millivolts.

3.10 Test 5: Dynamic Test: Set the AC input to 230 volts.

3.10.1 Set the static load to 31.5 amps - Step load to 10.5 amps.

3.10.2 Switch between the static load and full load (42.0 amps) and verify that neither the positive or negative overshoot exceeds 960 millivolts.

3.11 Test 6: Overvoltage Protection - Set AC input to 230 volts - set the load current to 0.3 amps.

Incoming Test Procedures continued

3.11.1 Monitor closely while increasing the output voltage until it reaches the overvoltage trip point and drops to 0 volts. The output should trip between 52.0 and 54.0 volts. It may be necessary to connect a current limited DC power supply across the Elcon pins 24 and 27. Note the special voltage adjust (-127 option). After the overvoltage trips, the power supply will have to recycled; turn off the AC input, remove the overvoltage condition, wait 30 seconds and turn the power supply back on. Verify that the output comes up normal.

3.12 Test 7: Logic Inhibit.

3.12.1 Apply + 2.0 volts to the inhibit, Elcon pin 20, the return to logic return, pin 19, and verify that the output is disabled.

3.12.2 Remove the voltage to the inhibit, Elcon pin 20, and verify that the output is disabled.

3.12.3 Short Elcon pin 20 to pin 19, and verify that the output is enabled.

3.13 Test 8: Current Sharing Check (-6B).

3.13.1 <u>Open circuit voltage test</u> - Adjust the AC input to 230 volts and adjust the load current to 0.3 amps.

3.13.2 Measure the voltage between the -6B output on Elcon pin 17, and the output negative remote sense on Elcon pin 25. Verify that the -6B output is between 2.57 and 2.67 volts.

3.13.3 Adjust the load current to 42.0 amps and verify that the -6B output is between 4.95 and 5.05 volts.

3.13.4 <u>Quick disconnect test</u> - connect a 7.5K, 1% resistor between the -6B output, with the load current at 42.0 amps and the AC input at 230 volts, turn of the input power and measure the resistance between pin 17 and pin 25 of the Elcon connector. The resistance should read 7.5K, ± 5%.

Incoming Test Procedures continued

3.14 Test 9: Special Voltage Adjust (-127).

3.14.1 Connect the external current limited DC power supply positive lead to pin 24 of the Elcon connector, with the negative lead to the negative output pin 27 or 29.

3.14.2 Adjust the external DC power supply to 0 volts and verify that the output of the unit under test measures between 11.85 and 12.15 volts.

3.14.3 Adjust the external DC power supply to 2.5 volts and verify that the output of the unit under test measures between 29.90 and 30.10 volts.

3.14.4 Adjust the external DC power supply to 5.0 volts and verify that the output of the unit under test measures between 47.90 and 48.10 volts.

3.15 Test 10: Undervoltage Warning Signal (-128).

315.1 Adjust the load current to 1 amp, set the AC input to 230 volts.

315.2 Apply 2.0 volts to pin 20 of the Elcon connector with the return to pin 19.

315.3 Monitor pin 22 of the Elcon connector and verify that the signal goes from "logic high" to "logic low" when the unit is disabled.

3.16 Test 11: Power Factor Corrector Operational Test.

3.16.1 Set the AC input to 230 volts, adjust the load current to 42.0 amps.

3.16.2 Using a current probe on one lead of the AC input line measure and observe the input current waveform. The input current waveform should be a smooth waveform. See examples in figure 3-4 on the next page.

This concludes the incoming test. Remember to set the output voltage to 48.0 volts.

Incoming Test Procedures continued

Input Current Waveform

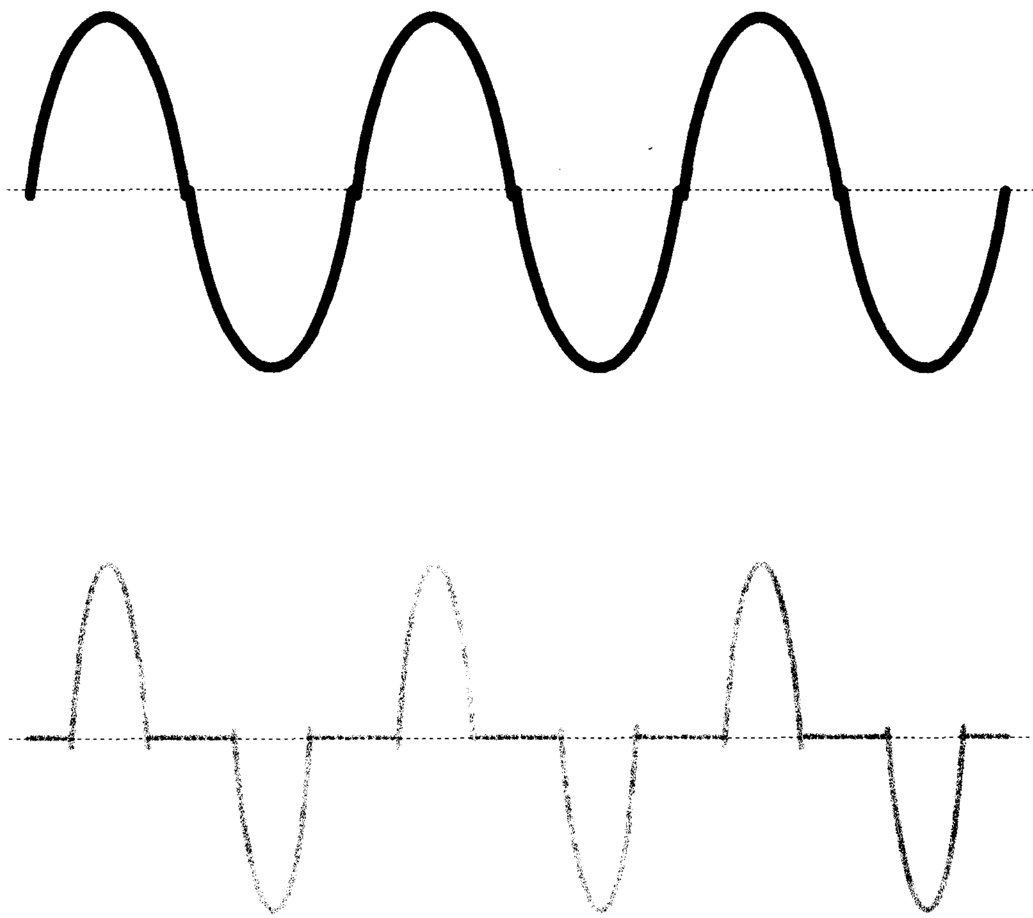


Figure 3-4

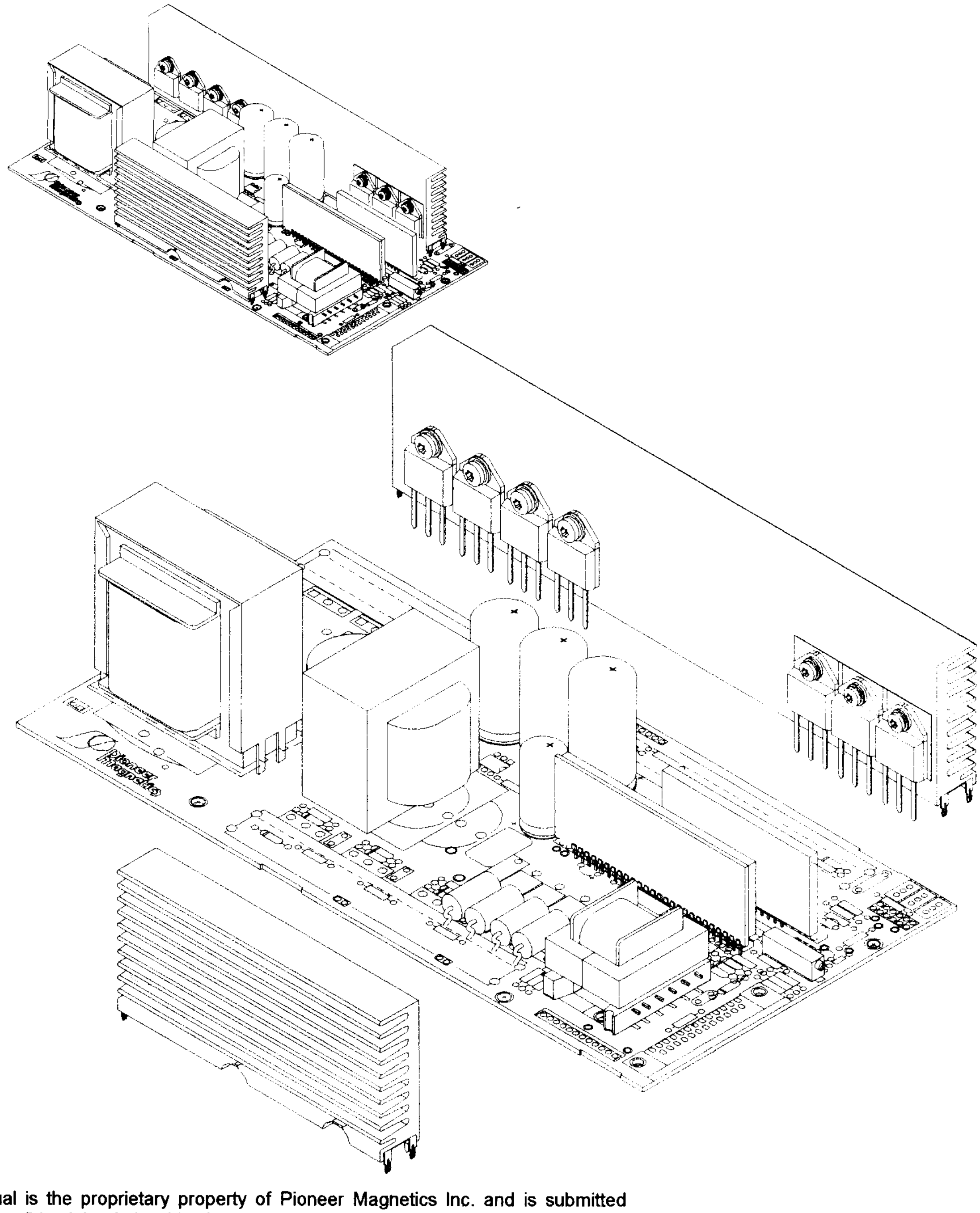
GOOD

BAD

Troubleshooting Tips

"Let's look inside this power supply" Figure 4-1

Main Converter



Troubleshooting Tips (continued)

Figure 4-2 Main Converter PCB

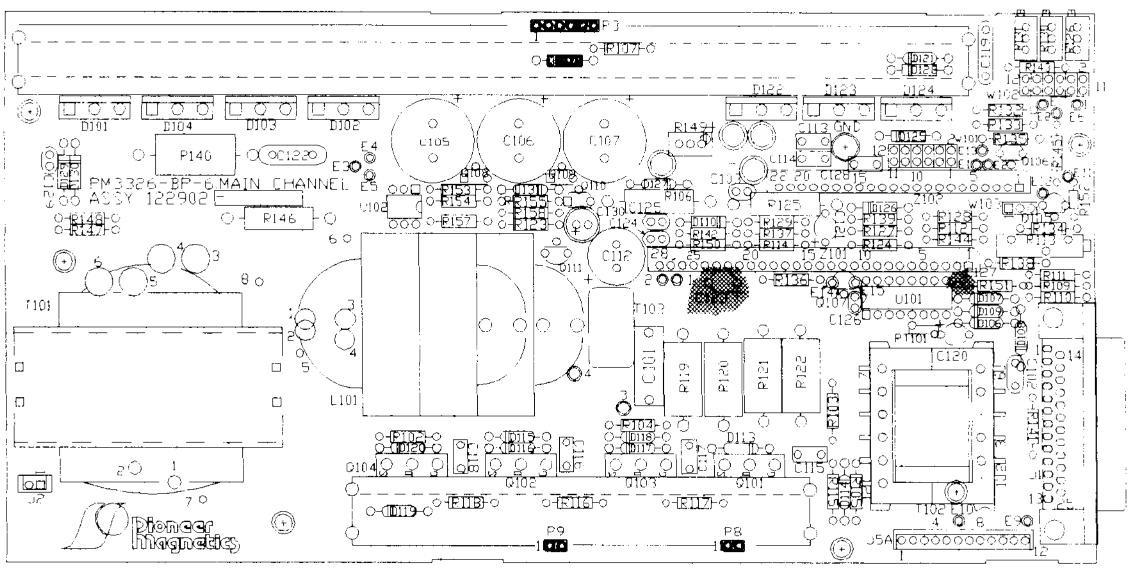
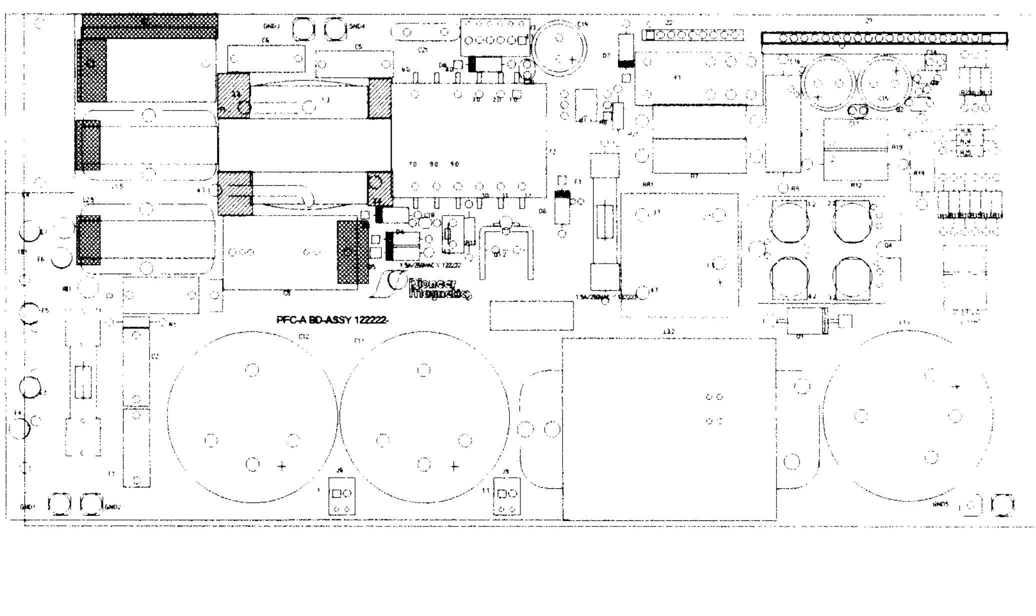


Figure 4-3 PFC PCB



Troubleshooting Tips (continued)

Reference Schematics: Base -122217 PFC - 122220

It has been said, that successful troubleshooting is a special talent. I know some technicians who can't tell the difference between forward drop and leakage current, but can "smell out" the problem in an amazingly short time. The point here is that good troubleshooter utilizes all of his senses The sound, the smell, the feel of the air flow, or the sight of watching a meter needle pinned against the manufacturer's label, all of the senses that a person possesses can be used in troubleshooting.

In the power supply, the PM3329BP-5, the failures though few, usually are something mechanical; something loose, a piece of foreign material inside the unit, a broken terminal or an installation problem. These are the first things that are noticed, long before a defective diode or IC. However, the purpose of this troubleshooting guide is not to show how to troubleshoot, but to point out some of the most likely failures based on the symptoms.

Looking a some of the mechanical considerations;

First of all, all of the screws that are used on this power supply are torx screws. When they are removed for troubleshooting or inspection, a new torx screw of the same size and length shall be used. Do not under any circumstances, reuse any of the torx screws or replace it with another type of screw.

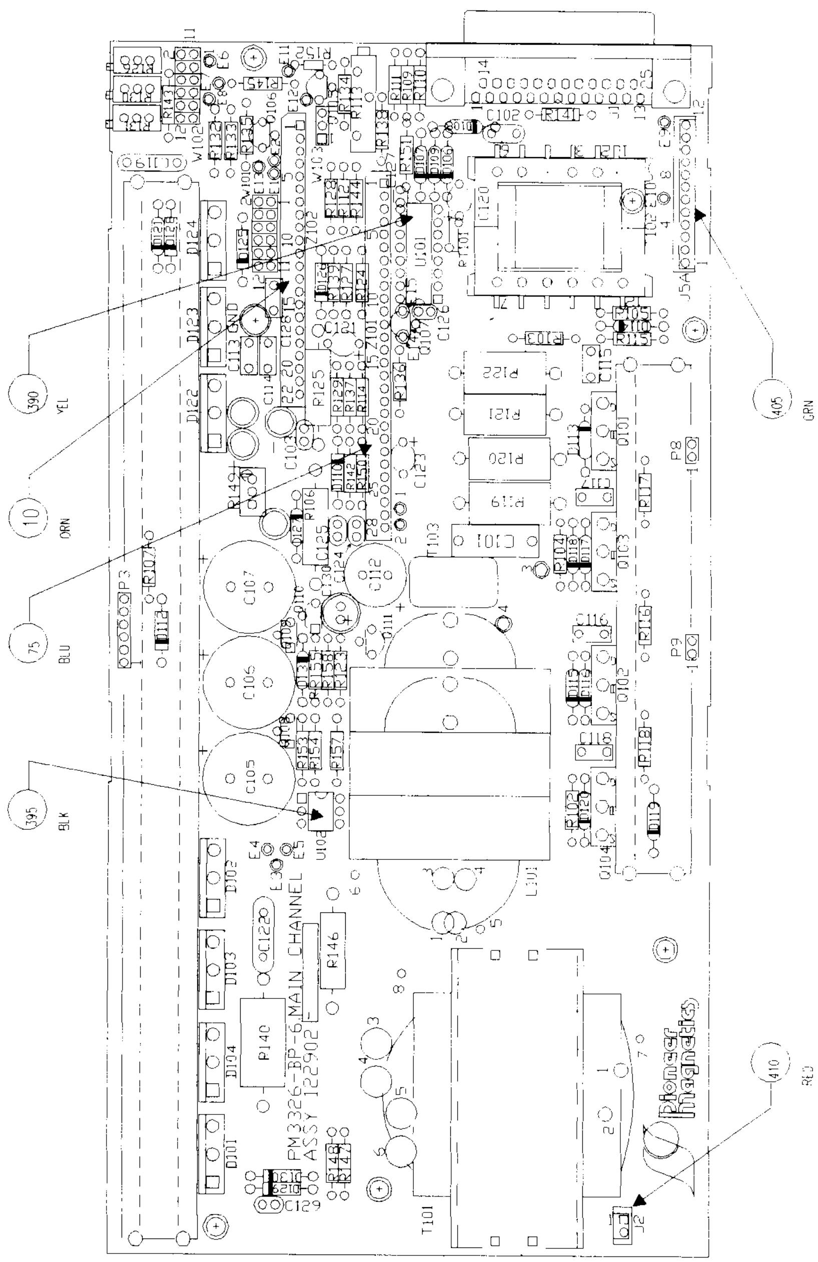
Screw Size and Description	Where used
FLAT HEAD TORX M4-0.7 X 8 MM	FOR Q4 ON THE PFC BOARD
FLAT HEAD TORX 4-40 X 3/16	FOR THE POWER SUPPLY COVER
FLAT HEAD TORX 4-40 X 5/32	USED ON THE PFC BOARD
PAN HEAD TORX 4-40 X ¼	USED ON THE MAIN CONVERTER BOARD

The case contains a number of special insulators. If one of these insulators has to be removed, make sure that the insulator does not get torn or distorted. It is extremely important that the insulators as well as any other materials that were installed in the power supply be replaced in a good condition and properly located.

See figure 4-4, and figure 4-5 on the following pages for some of the mechanical layouts.

Troubleshooting Tips (continued)

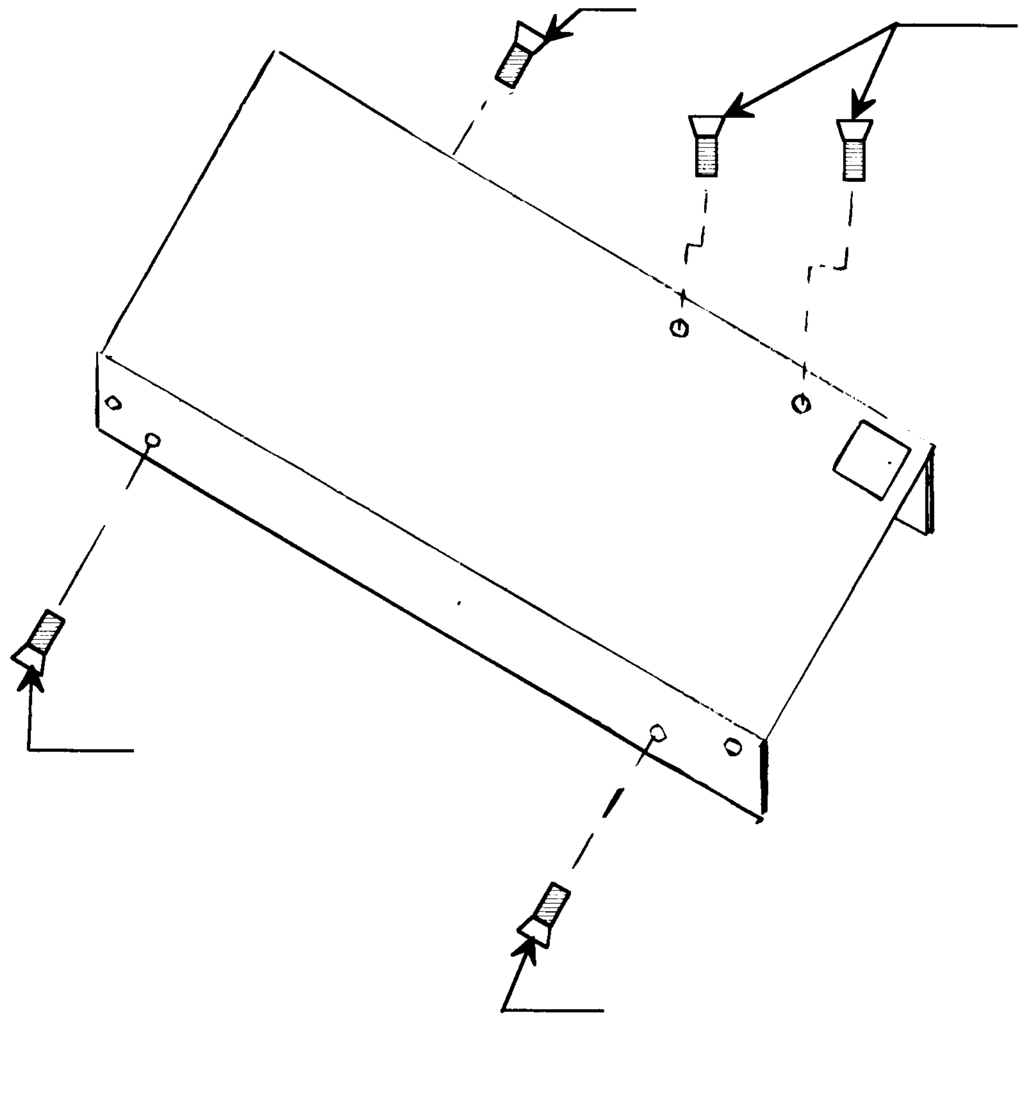
Figure 4-4



Troubleshooting Tips (continued)

Figure 4-5

1. INSTALL SCREWS TO SECURE PFC ASSY TO CHASSIS AS SHOWN.
2. TORQUE ALL SCREWS TO 6 INCH POUNDS.



Troubleshooting Tips (continued)

Power Supply With the Cover on

Failure	Suggestions	Board
Output Regulation	Loose connection on the output busbar, check for bent pins at the remote sense pins on the Elcon connector, check that there is solid contact between the unit and the receptacle. Make sure that the fan is turning and the airflow is normal. Check the input voltage and the input current. If all of these are OK, the unit should be moved to an area where the cover can be removed.	Elcon
Draws High Input Current, more than 10 amps.	Check to see that the input voltage is at the proper level, this power supply requires 230 volts AC. Check for burning smell. Check for strange noises. Is the current pulsing?	
Fan noisy	Fan blade possibly hitting the insulator or the fan wires. This will have to be opened to verify.	Main Board
Output won't come up or comes on briefly, then shuts off.	Check the output voltage adjustment pot. Turn the pot all the way counter-clock-wise and recycle the unit. Also check the remote sense connections at pins 23 and 25 of the Elcon connector.	Main Board
The power supply shuts off after being on for some period of time	Check the fan, this is a sign that the unit is overheating. If the fan seems to be OK, something inside the power supply is probably overheating or the thermal switch is faulty. This unit will have to be opened to verify	Unit
Fan not turning	Check for fan blade being hindered by something like the insulator or fan wires	
Audible noise	Check for loose connections	Unit

Troubleshooting Guide for the PM3329BP-5

Troubleshooting Tips (continued)

Power Supply With the Cover Off

Failure	Suggestions	Board
Output regulation	Check for loose connection at the output busbar. Check for loose screws on the output capacitors. Loosen the output cap screws, then secure. Check the FET switching signal at the drain of the FET, Q101, while varying the output load current. See the waveform example in figure 2-5 on page 5. If the signal is low or distorted, check the power FET drive signals at U101, pins 6 and 11. If this looks OK, replace Q101.	Main Board
Draws high input current	Check D110, D106, D109, and U101. Also check Q101-Q104.	Main Board
High output	Check U102, replace Z101	Main Board
Current limit out of range	Replace Z101	Main Board
High output ripple	Check connections on output caps, C105-C107	Main Board
Fan not turning	Loose connection at J2 and P2. Check voltage across C19 at D8. Check the signals at Q1 and the anode of D6	PFC
Fan noisy	Check to see if the fan blade is touching the fan wires or the insulator.	Main Board
Power section failure	Check the power FETs, Q101-Q104, diodes D113-D120. Check D1, D11, D14, Q4 and Q5 on the PFC board	Main Board

Troubleshooting Tips (continued)

Power Supply With the Cover Off

Failure	Suggestions	Board
Audible noise	Check for loose connections, especially the output caps.	Main Board
Output won't come up or comes on briefly, then shuts off	This is more than likely an overvoltage problem. If the voltage pot did not fix the problem This is sometimes called output runaway. Check the thermal switch. Replace Z101.	Main Board
The power supply shuts off after being on for some period of time	Check the thermal switch. Replace Z101	Main Board
No output, burning smell	Usually an inrush problem, check for burned resistors R21 and R7. Check to see if F3 is open. If the resistors are burned, it means that the relay (K1) is not operating or if the relay is OK, then replace Z1. Also check BR1, the input bridge rectifier.	PFC
380 volt Bus low	Check the bridge rectifier, BR1, check Q2 and Q3, Check Q4, and D9. Also check the diode D1. Disconnect the PFC from the main converter see if the bus is still low, if not, check Q101-Q104 on the main board	PFC or Main Board
Logic inhibit does not work	If connections are OK, replace Z102.	Main Board

Troubleshooting Tips (continued)

Please note that most of the failures are caused by mechanical problems as opposed to component failures. Many times the components that fail are usually being subjected to unnecessary stresses due to blocking of air flow, dirty environments and just plain bad handling. Following is a quick reference guide of places and parts on this power supply that will be the most likely cause of the failure.

Where is the problem?

Current limit	hybrid Z101
Undervoltage Detection	hybrid Z102
Overvoltage Detection	hybrid Z101
Overheating	Thermal switch
Regulation	hybrid Z101
Logic Inhibit	hybrid Z102
Output ripple and noise	output capacitors
Current sharing	hybrid Z101
Special voltage adjust -127	hybrid Z102
Power section failures	Q101-Q104, D113-D120

Telephone Support during business hours 8:00 A.M. to 4:00 P.M. PCT

Doug Hansen	Telephone: (310) 828-0390	Fax: (310) 453-3929
Spare Parts	Telephone: (310) 829-6751	Fax: (310) 453-3929

Pioneer Magnetics

Troubleshooting Guide for the PM3329BP-5

Recommended Spare Part List Part 1 PFC Board

Note: *Quantities are listed per 50 power supplies*

Component	Designator	PMI Part No	Quantity
PFC Control Hybrid	Z1	122104-3	5
PFC Aux Supply Hybrid	Z2	122105	5
Capacitor 470uF 450V	C11, C12, C13	512108	6
Capacitor 120pf 1000V	C18	515064-104	5
Capacitor 0.1uF 1000V	C21	515064-121	5
Diode 1A 600V	D3,D4,D6,D7,D8	500177	10
Diode 3A 600V	D1	522044	5
Diode Heatsink Assy	D9 & BR1	122391	5
Zener Diode 75V 35W	D5	525095	5
Fuse 20A 250V	F1	533033	5
Fuse 1.5A	F3	533047	10
Relay 20A 12V Coil	K1	537010	5
FET Heatsink Assy	Q4	122425	5
Transistor NPN	Q2	547066	5
Transistor PNP	Q3	547067	5
Resistor 5W 10% 7.5 ohms	R7, R21	542001	10
IC (H11AV1A)	U1	528149	5

Note 2: *All screws used on the PM3329BP-5 must be torx screws; these screws are not to be reused under any circumstances, if any screws are removed, throw them away.*

Pioneer Magnetics

Troubleshooting Guide for the PM3329BP-5

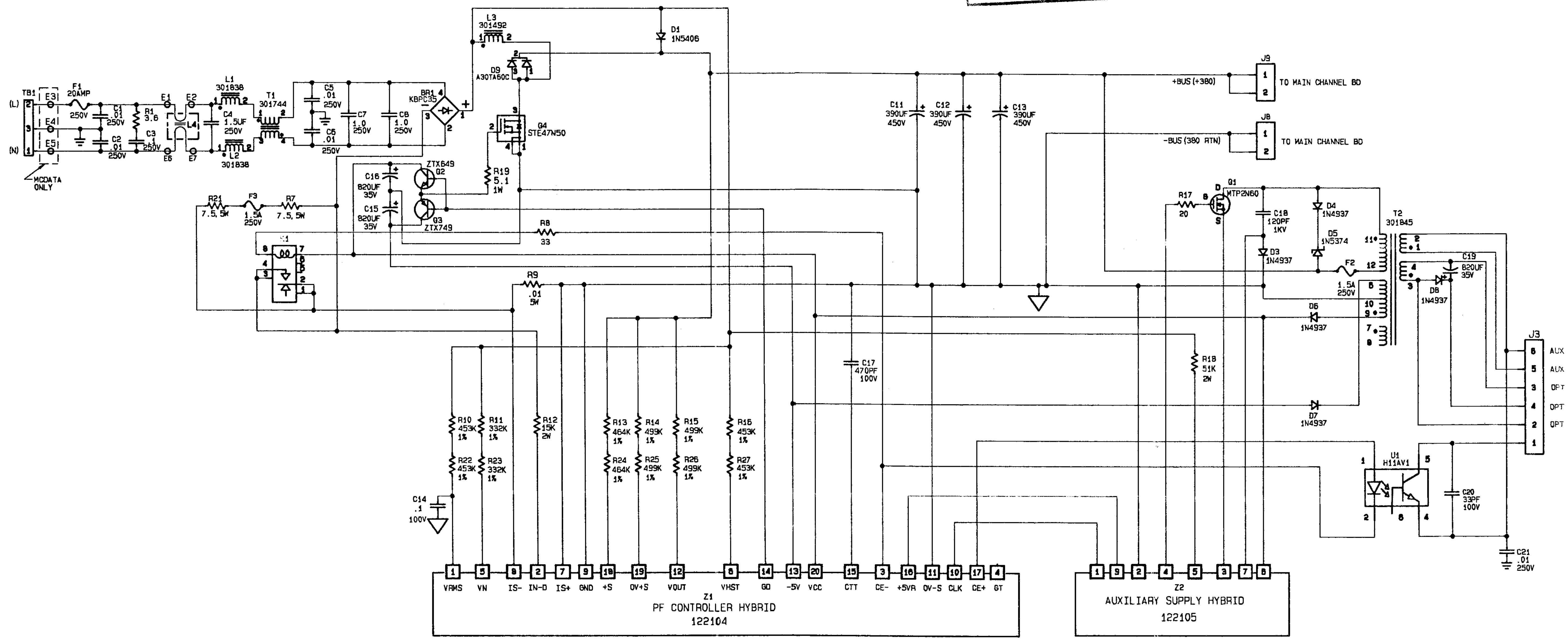
Recommended Spare Part List Part 2 Main Converter

Note: *Quantities are listed per 50 power supplies*

Component	Designator	PMI Part No	Quantity
Control Hybrid	Z101	122160	5
Option Hybrid	Z102	122161	5
Capacitor 1000 uF63V	C105, C106, C107	514079-108	6
Capacitor 680 pF 500V	C101	515070-681	5
Diode Heatsink Assy	D101-D104	122537	5
FET Heatsink Assy	Q101-Q104	123023	5
Diode 1A 20V	D106-D109, D127	522048	6
Diode 1A 600V	D110, D129, D130	500177	6
Diode/Resistor Assy	D112	117627	5
Zener Diode 15V 1W	D113-D120	525075	20
Thermistor PTC 33 ohms	RT101	545012	5
IC (UC3706N)	U101	528386	5
IC (4N28)	U102	528112	5

REVISIONS

REV	ECO		DATE	APPR
A		PRODUCTION RELEASE	9-15-93	J.S.
B	19218	SEE ECO	1-10-94	C.L.
C	19305	SEE ECO	3-15-94	C.L.
D	19389	SEE ECO	5-31-94	C.L.



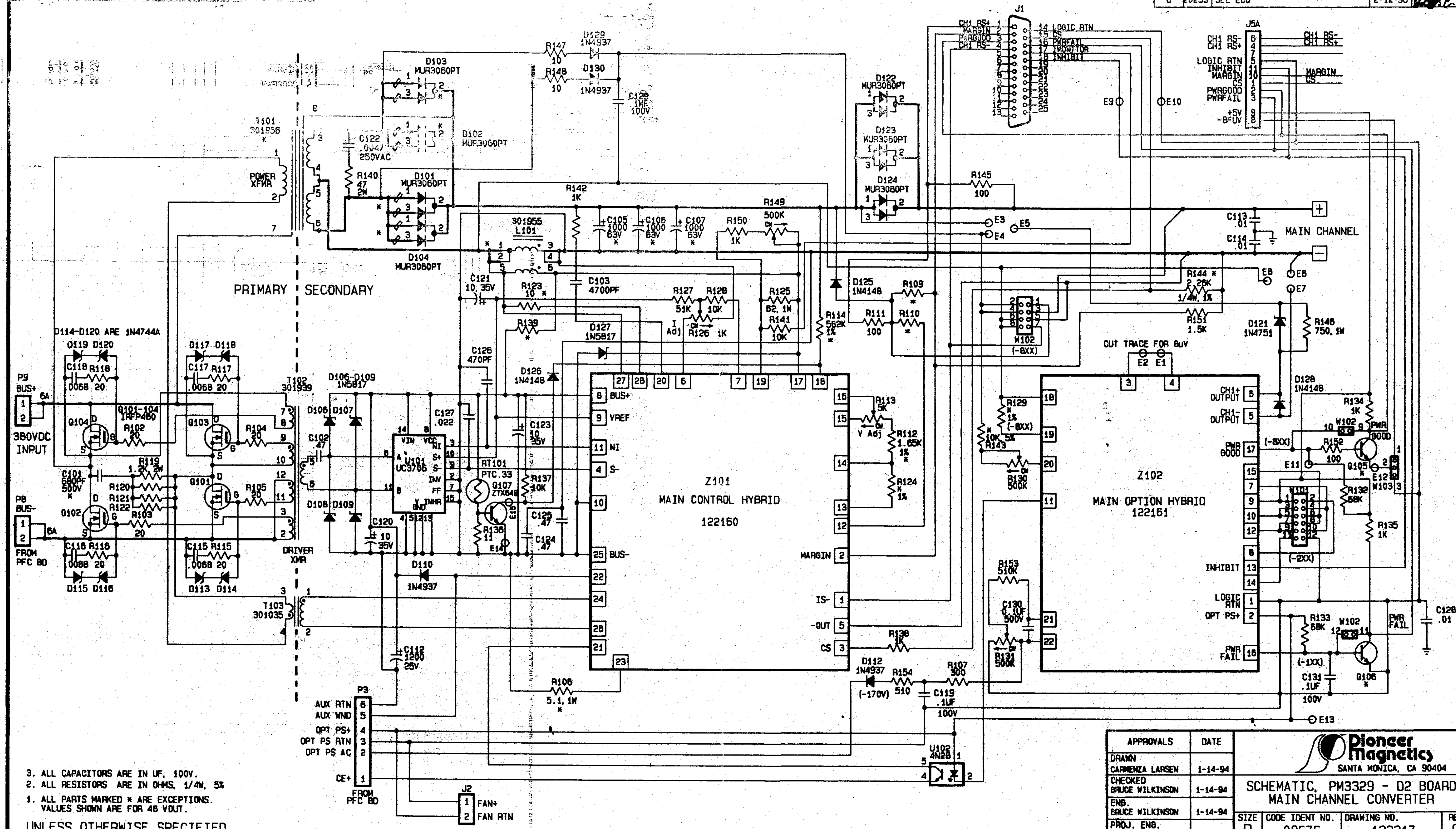
NOTES: UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS.
2. RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.

SIGNATURES	DATE	
DRAWN CARMENZA LARSEN	9-15-93	Pioneer Magnetics SANTA MONICA, CA 90404
CHECKED		TITTLE SCHEMATIC, PM3386 PFC, A BOARD
ENGR BRUCE WILKINSON	9-15-93	
ENGR		SIZE B · CODE IDENT NO. 08676 · DRAWING NO. 122220 D
PROJ ENG		
OTHER		SCALE —— SH

REVISIONS

REV	ECO	DESCRIPTION	DATE	APPROVED
A		PRODUCTION RELEASE	1-14-94	
B	19386	SEE ECO	6-15-94	C.L.
C	20233	SEE ECO	2-12-96	C.L.



3. ALL CAPACITORS ARE IN UF, 100V.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
1. ALL PARTS MARKED * ARE EXCEPTIONS. VALUES SHOWN ARE FOR 48 VOUT.

UNLESS OTHERWISE SPECIFIED.

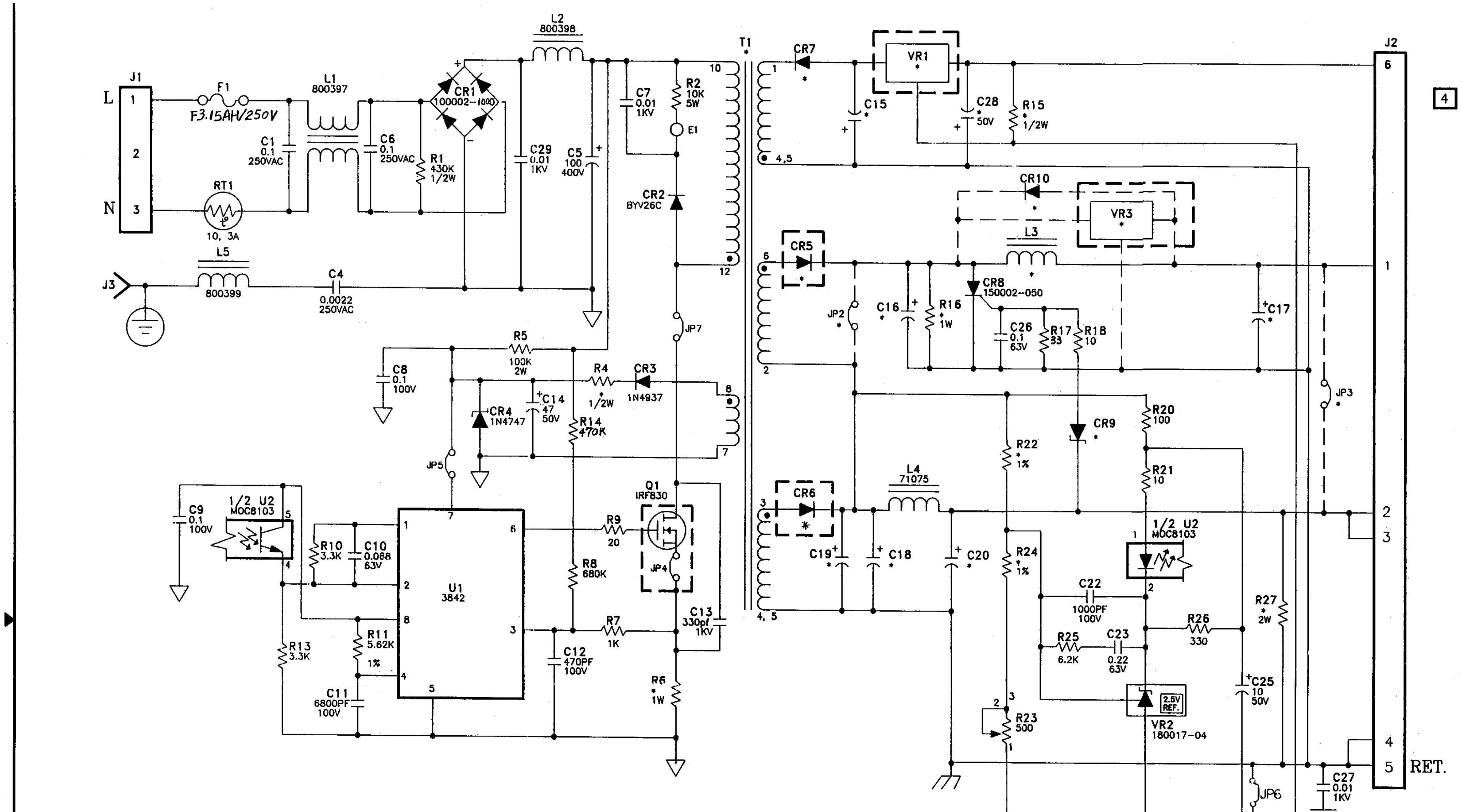
APPROVALS	DATE
DRAWN CARMENZA LARSEN	1-14-94
CHECKED BRUCE WILKINSON	1-14-94
ENG. BRUCE WILKINSON	1-14-94
PROJ. ENG.	
OTHER	

Pioneer Magnetics
SANTA MONICA, CA 90404

SCHEMATIC, PM3329 - D2 BOARD MAIN CHANNEL CONVERTER

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	08676	122217	C

SCALE : NONE SHEET 1 OF 1



720184-008 NFN40-7628	100UF, 50V	10UF	100UF, 50V	10uF,50V	1800uf, 10V	100020-400 3A,400V	100020-400 3A,400V	100049-045 16A,45V	IN4733A	IN4007	N/A	N/A	N/A	24	0.24	680	220	47	2.15K, 1%	1.82K, 1%	800396	160010 NVR -12V	160017 PVR +12V
720184-007 NFN40-7624	N/A	N/A	N/A	N/A	330uf, 35V	N/A	N/A	BYW29-200	IN4750A	N/A	JUMPER	JUMPER	N/A	15	0.30	JUMPER	N/A	620	35.7K, 1%	3.92K, 1%	800395	N/A	N/A
720184-006 NFN40-7615	N/A	N/A	N/A	N/A	330uf, 35V	N/A	N/A	BYW29-200	IN4746A	N/A	JUMPER	JUMPER	N/A	15	0.30	JUMPER	N/A	220	17.8K, 1%	3.24K, 1%	800394	N/A	N/A
720184-005 NFN40-7612	N/A	N/A	N/A	N/A	330uf, 35V	N/A	N/A	BYW29-200	IN4743A	N/A	JUMPER	JUMPER	N/A	15	0.27	JUMPER	N/A	180	15.8K, 1%	3.92K, 1%	800393	N/A	N/A
720184-004 NFN40-7610	330UF, 35V	47UF	680UF 35V	680uf, 35V	1800uf, 10V	100020-400 3A,400V	BYW29-200	100049-045 16A,45V	IN4733A	N/A	N/A	N/A	H1565	24	0.30	680	470	47	2.15K, 1%	1.82K, 1%	800392	160035 NVR -15V	N/A
720184-003 NFN40-7607	330UF, 35V	47UF	680UF 35V	680uf, 35V	1800uf, 10V	100020-400 3A,400V	BYW29-200	100049-045 16A,45V	IN4733A	N/A	N/A	N/A	H1565	24	0.27	100	220	47	2.15K, 1%	1.82K, 1%	800391	160034 NVR -5V	N/A
720184-002 NFN40-7605	N/A	N/A	100UF 50V	N/A	2200uF, 16V	N/A	100020-400 3A,400V	100049-045 16A,45V	IN4733A	N/A	470 1W	JUMPER	N/A	20	0.27	JUMPER	750	47	2.15K, 1%	1.82K, 1%	800390	N/A	N/A
720184-001/ 700184-252 NFN40-7608/B	330UF, 35V	47UF	680UF 35V	680uf, 35V	1800uf, 10V	100020-400 3A,400V	BYW29-200	100049-045 16A,45V	IN4733A	N/A	N/A	N/A	H1565	24	0.30	680	220	47	2.15K, 1%	1.82K, 1%	800389	160010 NVR -12V	N/A
PART NO. MODEL NO.	C15	C28	C16	C17	C18,C19,C20	CR7	CR5	CR6	CR9	CR10	JP2	JP3	L3	R4	R6	R15	R16	R27	R22	R24	T1	VR1	VR3

COMPONENTS VALUE TABLE

NOT A CONTROLLED ISSUE WILL NOT BE KEPT UP TO DATE

MAY 16 1997

	F1
	RTI
JP1,(2,3 OPTION)	JP7
RT1 (OPTION)	RT1
	J3
	T1
	U2
	Q1
	L4
VR3 (OPTION)	VR3
CR10 (OPTION)	CR10
C2,3,21,24	C29
R3,R12,R19	R27
NOT USED	LAST USED

ENVIRONMENTAL TESTS COMPLETE
DATE 2-28-92 BY

CHECKED APR. 17. 97.

4. SEE J2 OUTPUT CHART.
3. * SEE COMPONENTS VALUES TABLE.
2. ALL CAPACITANCE VALUES ARE IN MICROFARADS, VOLTAGES ARE IN D.C..
1. ALL RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%.
NOTES: UNLESS OTHERWISE SPECIFIED.

PIN No.	J2 OUTPUT TABLE 720184-001 NFN40-7608	720184-002 NFN40-7605	720184-003 NFN40-7607	720184-004 NFN40-7610	720184-005 NFN40-7612	720184-006 NFN40-7615	720184-007 NFN40-7624	720184-008 NFN40-7628
1	+12V	+5V	+12V	+15V	+12V	+15V	+24V	+12V
2,3	+5V		+5V	+5V				+5V
4,5	RET	RET	RET	RET	RET	RET	RET	RET
6	-12V		-5V	-15V				-12V

720184-008	NFN40-7628
720184-007	NFN40-7624
720184-006	NFN40-7615
720184-005	NFN40-7612
720184-004	NFN40-7610
720184-003	NFN40-7607
720184-002	NFN40-7605
720184-001	NFN40-7608
USED ON	MODEL NO.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
.X=± .XX=± .XXX=± ANGLE=±

DO NOT SCALE DRAWING

APPROVALS DATE
DRAWN J.MICHALSKI 6-28-91
CHECKED
ENG.
ENG. MGR.
MFG. ENG.
Q.A. ENG.
RELEASED

COMPUTER PRODUCTS
POWER CONVERSION AMERICA

SCHEMATIC
POWER SUPPLY
NFN40-76XX

SIZE D DRAWING NO. 730184-001 THRU -008
SCALE NONE SHEET 1 OF 1

COMPUTER PRODUCTS

8 7 6 5 3 2 1

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I
IPA THEORY OF OPERATION

1-1. INTRODUCTION.

1-2. The following text provides detailed theory of operation with supporting diagrams for the IPA unit.

1-3. GENERAL DESCRIPTION.

1-4. The IPA unit consists of: 1) an RF power module, 2) two switching power supply modules, and 3) a controller (refer to Figure 1-1). The IPA unit RF power module provides an overall gain of approximately 20 to output approximately 375 watts of power to drive the PA stage. RF drive for the IPA stage is provided by the FX-50 FM exciter.

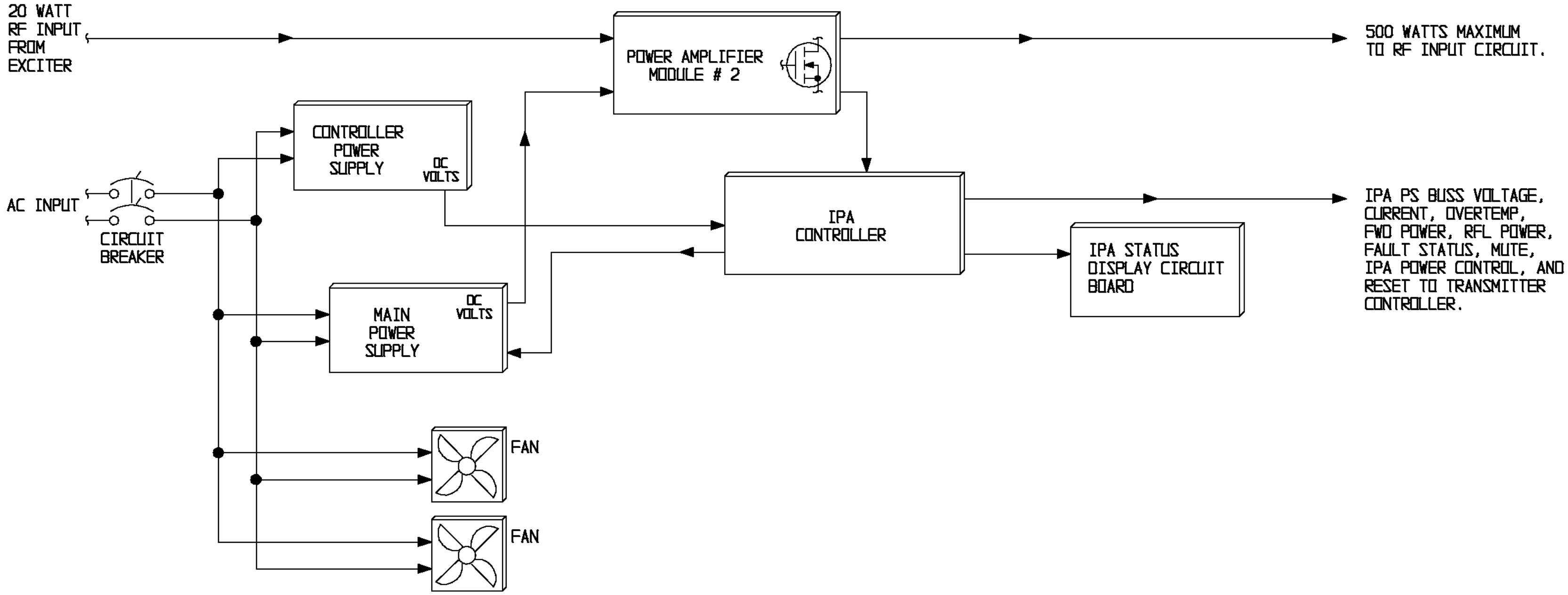
1-5. The IPA is equipped monitoring and metering circuitry. The monitoring and control functions are performed by a CMOS digital controller. The controller circuitry is implemented on two circuit boards: 1) a status indicator circuit board and 2) a controller circuit board. The controller is designed to: 1) monitor the RF power module and power supply for fault conditions, 2) provide automatic power control operation in response to IPA VSWR and RF power module temperature conditions, 3) provide indications of power supply, VSWR, over-temperature, and fault conditions, and 4) provide fault reset and manual RF output power control.

1-6. The RF amplifier module consists of an RF amplifier circuit board, a logic circuit board, a combiner, and a low-pass filter circuit board, and a directional coupler circuit board assembly. The RF amplifier circuit board contains a microstrip splitter, microstrip and capacitive matching networks, and two power MOSFET transistors. The circuitry is designed to generate approximately 500 watts of RF power. The RF amplifier module logic circuit board is equipped with: 1) a power level control circuit, 2) over-voltage, over-current, over-temperature circuitry, 3) fault detection circuitry, and 4) reflected/forward power limit circuitry. The combiner circuit board contains a microstrip combiner. The directional coupler circuit board is equipped with forward power and reflected power directional coupler circuits. The low-pass filter circuit board is equipped with a low-pass filter circuit.

1-7. IPA STATUS INDICATOR CIRCUIT BOARD.

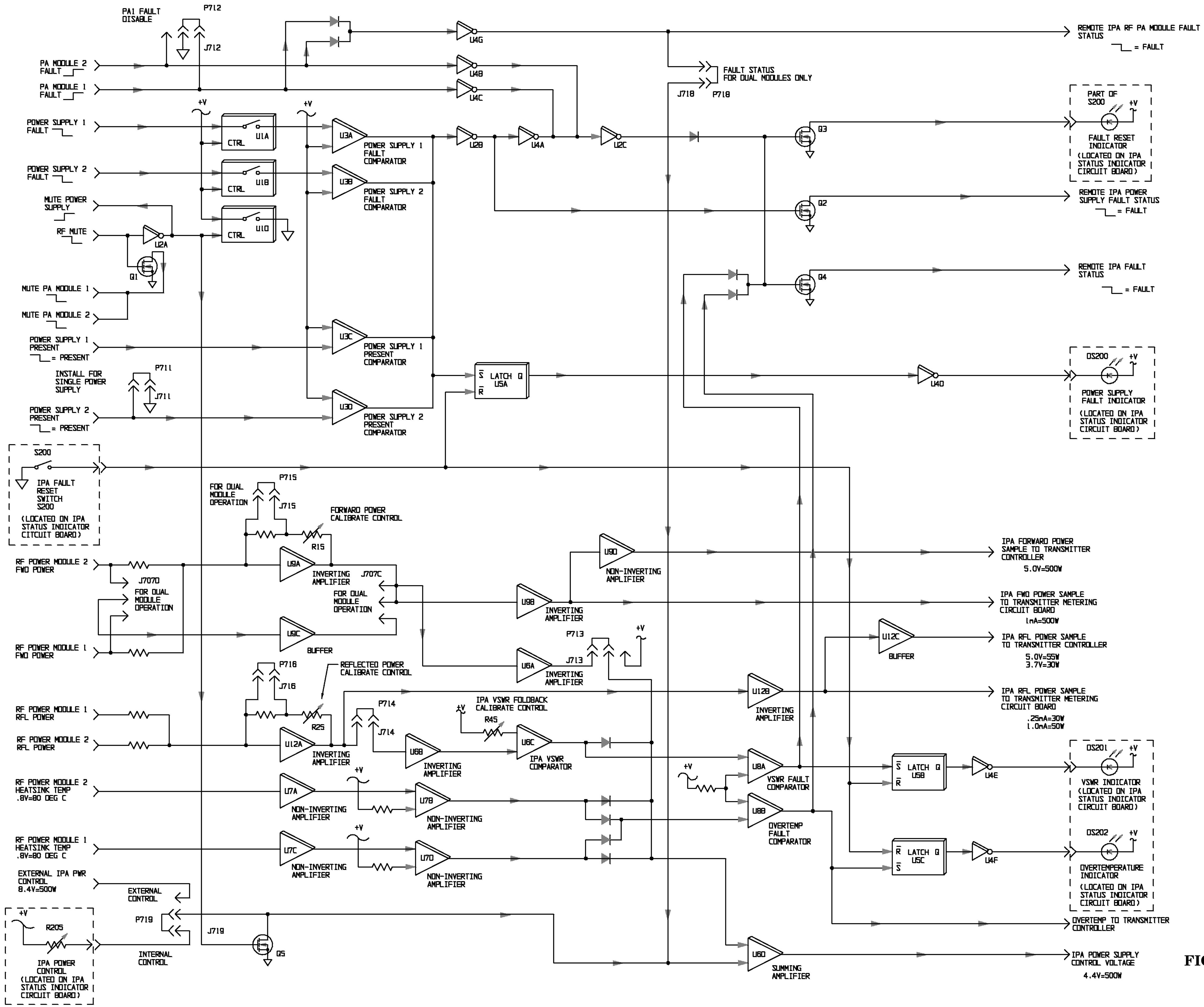
1-8. The IPA status indicator circuit board is equipped with an IPA fault reset switch, an IPA power control potentiometer, and four LEDs (refer to Figure 1-2). IPA fault reset switch S200 is designed to reset the IPA controller fault circuitry in the event of an IPA power supply, VSWR, or over-temperature condition. Once the power supply, VSWR, or over-temperature condition has cleared, S200 can be depressed to reset the fault circuitry. When S200 is depressed, a LOW is output to the reset input of latches U5A, U5B, and U5C on the controller circuit board to reset the fault circuitry. IPA power control potentiometer R205 is designed to output a 3.6 volt to 3.8 volt dc supply to U6D on the controller circuit board. The voltage is used to control the IPA RF power output.

1-9. LEDs DS200, DS201, DS202, and the LED associated with S200 present the status of the following IPA conditions: 1) fault/fault reset, 2) power supply fault, 3) VSWR, and 4) over-temperature. In the event of a power supply fault, VSWR, or over-temperature condition, a LOW is routed from the controller circuit board to the IPA status indicator circuit board to illuminate the appropriate indicator. In addition to the illumination of the appropriate fault indicator, a LOW from the controller circuit board is applied to the FAULT RESET switch/indicator LED when a power supply, VSWR, or over-temperature condition occurs.



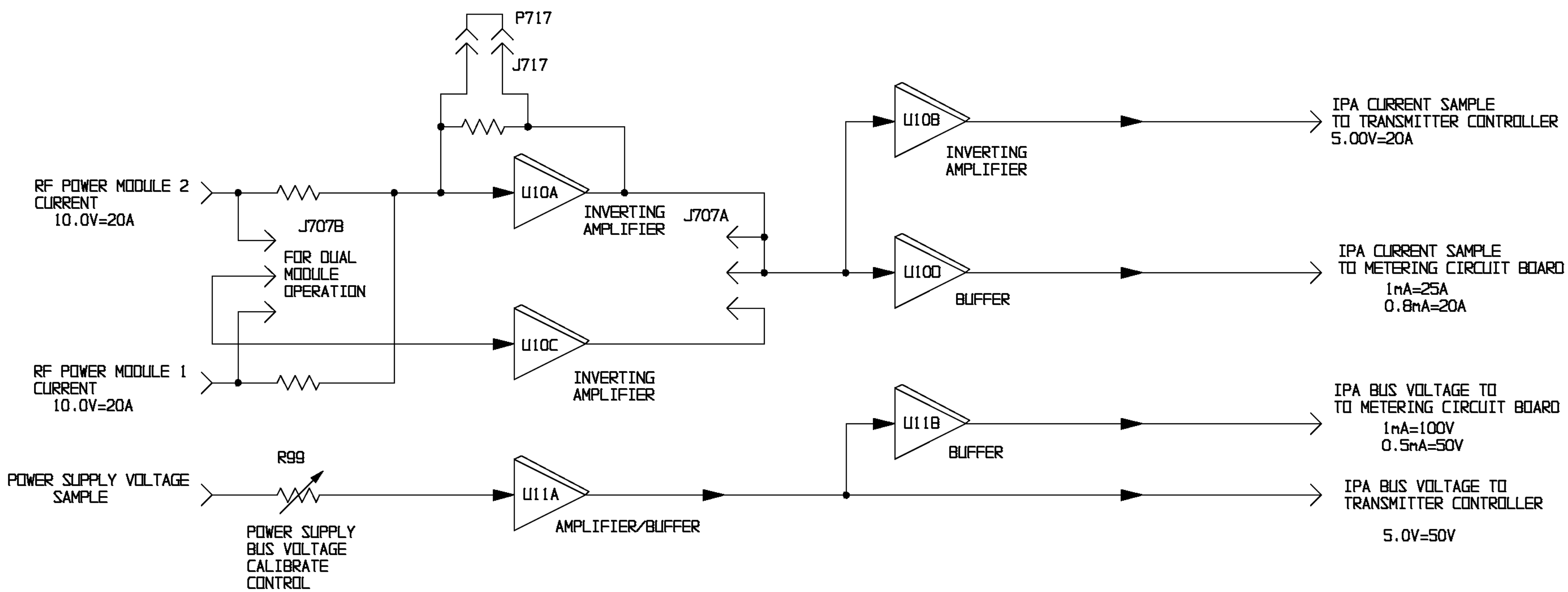
597-0220-411

FIGURE 1-1. IPA BLOCK DIAGRAM



597-0220-413

FIGURE 1-2. IPA CONTROLLER SIMPLIFIED SCHEMATIC (Sheet 1 of 2)



597-0220-413A

FIGURE 1-2. IPA CONTROLLER SIMPLIFIED SCHEMATIC (Sheet 2 of 2)

1–10. **IPA CONTROLLER CIRCUIT BOARD.**

1–11. The controller is designed to monitor the operation of the RF amplifier module and the PA power supply module. The controller circuit board is equipped with power supply and RF power amplifier fault detector circuits. A power control circuit automatically foldsback the RF output power during high VSWR and temperature conditions. The circuit board is also equipped with metering circuits. The metering circuits process forward power, reflected power, and power supply voltage samples for application to the transmitter metering circuit board.

1–12. **POWER SUPPLY FAULT CIRCUIT.** The power supply fault circuit monitors the PA power supply 1 and optional PA power supply module 2 for fault conditions. In the event of a power supply 1 fault, a LOW is applied through switch U1A to power supply 1 fault comparator U3A. U3A will output a LOW to inverter U2B and the set input of latch U5A. U2B will output a HIGH to: 1) inverter U4A and 2) field–effect transistor Q2. With a HIGH at the gate of Q2, Q2 will output a LOW remote IPA power supply fault status signal. U4A will respond by routing a LOW to U2C. U2C will output a HIGH to bias field–effect transistors Q3 and Q4 on. Q3 will output a LOW to illuminate the fault reset indicator on the IPA status indicator circuit board. Q4 will output a LOW remote IPA fault status signal. U5A will output a HIGH to inverter U4D. U4D will output a LOW to illuminate the power supply fault indicator on the IPA status indicator circuit board.

1–13. The circuit also monitors the power supply present status signal. In the event the power supply present signal goes LOW to indicate a fault or RF mute condition, comparator U3C will output a HIGH to latch U5A. U5A will respond by routing a HIGH to U4D. U4D will output a LOW to illuminate the power supply fault indicator on the IPA status indicator circuit board.

1–14. **RF POWER AMPLIFIER MODULE FAULT CIRCUIT.** The RF power amplifier module fault circuit monitors module 2 for fault conditions and optional module 1 for fault conditions. In the event of an RF power amplifier module 2 fault, a HIGH is applied to inverters U4B and U4G. U4B will output a LOW to U2C. U2C will output a HIGH to bias transistors Q3 and Q4 on. Q3 will output a LOW to illuminate the fault reset indicator on the IPA status indicator circuit board. Q4 will output a LOW remote IPA fault status signal. U4G will output LOW remote IPA RF power amplifier fault signal.

1–15. **RF POWER AMPLIFIER MODULE FORWARD POWER CIRCUIT.** A sample of RF power amplifier module 2 forward power is applied to inverting amplifier U9A. Forward power calibrate control R15 is provided to calibrate the forward power sample. The output from U9A is applied to: 1) inverting amplifiers U9B and U6A. The output of U9B provides a 1 mA = 500 watt sample to the metering circuit board and to non–inverting amplifier U9D. The output of U9D provides a +5.0 volt = 500 watt sample to the transmitter controller. The output of U6A is applied to a voltage summing line used to control the IPA output power.

1–16. **RF POWER AMPLIFIER MODULE REFLECTED POWER CIRCUIT.** A sample of the RF power amplifier module 2 reflected power is applied to inverting amplifier U12A. Reflected power calibrate control R25 is provided to calibrate the reflected power sample. The output from U12A is applied to: 1) inverting amplifiers U12B and U6B. The output of U12B provides a 1 mA = 50 watt sample to the metering circuit board and to non–inverting amplifier U12C. The output of U12C provides a +5.0 volt = 55 watt sample to the transmitter controller.

1–17. The output of U6B is applied to IPA VSWR comparator U6C. IPA VSWR control R45 adjusts the VSWR level at which the IPA will begin power foldback operation. The output of U6C is applied to: 1) a voltage summing line used to control the IPA output power and 2) VSWR fault comparator U8A.

1–18. VSWR fault comparator U8A is designed to monitor the IPA VSWR level. When the VSWR signal from U6C rises above the threshold, the output of U8A will go LOW. The LOW is applied to: 1) the set input of latch U5B and 2) transistors Q3 and Q4. Q3 will output a LOW to illuminate the fault reset indicator on the IPA status indicator circuit board. Q4 will output a LOW remote IPA fault status signal. U5B will output a HIGH to inverter U4E. The output of U4E will go LOW to illuminate the VSWR indicator on the IPA status indicator circuit board.

1–19. **RF POWER AMPLIFIER MODULE OVER-TEMPERATURE CIRCUIT.** A temperature sample from the RF power amplifier module 2 temperature circuit is applied to non–inverting amplifier U7A. The output of U7A is applied to non–inverting amplifier U7B. The output of U7B is applied to: 1) a voltage summing line used to control the IPA output power and 2) over–temperature fault comparator U8B.

1–20. Over–temperature fault comparator U8B is designed to monitor the RF power amplifier module temperature. When the over–temperature signal from U7B rises above the threshold, the output of U8B will go LOW. The LOW is applied to: 1) the set input of latch U5C and 2) transistors Q3 and Q4. Q3 will output a LOW to illuminate the fault reset indicator on the IPA status indicator circuit board. Q4 will output a LOW remote IPA fault status signal. U5C will output a HIGH to inverter U4F. The output of U4F will go LOW to illuminate the over–temperature indicator on the IPA status indicator circuit board.

1–21. **RF POWER AMPLIFIER MODULE CURRENT CIRCUIT.** A current sample from RF power amplifier module 2 is applied to inverting amplifier U10A. The output of U10A is applied to buffer U10D and inverting amplifier U10B. U10D will output a 1 mA module current signal when the module current is equal to 25A. U10B will output a 5.0 volt signal to the transmitter controller when the module current is equal to 20A.

1–22. **POWER CONTROL CIRCUIT.** The IPA output power is controlled by IPA power control potentiometer R205 on the IPA status indicator circuit board. The dc control voltage is applied to summing amplifier U6D. With no fault conditions, U6D will output a 4.4 volt signal to the IPA power supply. The supply will output the required dc voltage to produce 500 watts of RF output power.

1–23. Automatic power control operation is provided by summing amplifier U6D, the RF power module over–temperature circuit, the RF power module forward power circuit, and the RF power module reflected power circuit. U6D sums the outputs from the individual circuits and outputs a 3.8 volt signal to the IPA power supply for a 375 watt RF output. In the event of a module over–temperature or high VSWR condition, the output of U6D will automatically decrease in proportion to the condition. As a result, the IPA power supply voltage will be reduced and result in a lower output power. When the over–temperature or high VSWR condition clears, the IPA output power will automatically return to the original power level.

1–24. **FAULT RESET CIRCUIT.** The IPA controller circuit board is equipped with a reset circuit in the event of a fault in the IPA circuitry. The reset circuit is activated using IPA fault reset switch S200 on the IPA status indicator circuit board.

1–25. Once an IPA fault has cleared, the fault circuitry can be reset using S200. S200 will output a LOW to the reset inputs of latches U5A, U5B, and U5C. As a result, the output of each latch will go LOW. The LOW from each latch will be routed through an inverter to reset the IPA fault, VSWR fault, and over–temperature fault indicators.

1–26. **MUTE CIRCUIT.** Under certain conditions, the transmitter controller will output a LOW RF mute command to the IPA controller circuit board. The LOW is applied to inverter U2A and field–effect transistor Q1. U2A will output a HIGH to mute the power supply and disable the power supply fault circuitry. Q1 will be disabled to mute the RF power amplifier module and bias transistor Q5 on. Q5 will output a LOW to disable the IPA power control circuit.

1–27. **POWER SUPPLY VOLTAGE METERING CIRCUIT.** A voltage sample from the power supply circuit is applied through power supply bus voltage calibrate control R99 to amplifier/buffer U11A. Potentiometer R99 allows the power supply voltage to be calibrated. The output of U11A: 1) is applied to buffer U11B and 2) provides a 5.0 = 50V sample for the transmitter controller circuit board. Buffer U11B provides a 1 mA = 100V sample to the transmitter metering circuit board.

1–28. **RF AMPLIFIER MODULE.**

1–29. The output of the exciter is applied to solid–state 500 watt RF amplifier module (refer to Figure 1–3). The RF amplifier module consists of an RF amplifier circuit board, a logic circuit board, a combiner, and a low–pass filter circuit board, and a directional coupler circuit board assembly. The RF amplifier circuit board consists of a two–stage power MOSFET amplifier circuit with input/output matching and balun circuitry. The logic circuit board controls the operation of the RF amplifier circuit and monitors the circuit for fault conditions. A combiner circuit combines the outputs of the two stages to provide a single 500 watt output. The low–pass filter circuit board removes all frequencies above the FM broadcast band. The directional coupler circuit board provides forward and reflected power samples to the logic circuit board.

1–30. **RF AMPLIFIER AND CONTROLLER POWER SUPPLIES.**

1–31. The IPA stage RF amplifier is equipped with a switching power supply module. The module provides a variable +48V dc supply for application to the RF power amplifier module. The module is equipped with over–current, over–voltage, under–voltage, and over–temperature protection circuitry. The output of the supply is controlled by the IPA controller. The supply is not manufactured by Broadcast Electronics; however, a troubleshooting guide in APPENDIX A provides information on power supply operation. Refer to the Pioneer Magnetics troubleshooting guide in APPENDIX A for operation and troubleshooting information on the RF amplifier power supply module.

1–32. The IPA is also equipped with a modular switching controller power supply assembly. The assembly is not manufactured by Broadcast Electronics. Therefore, no theory of operation is provided.

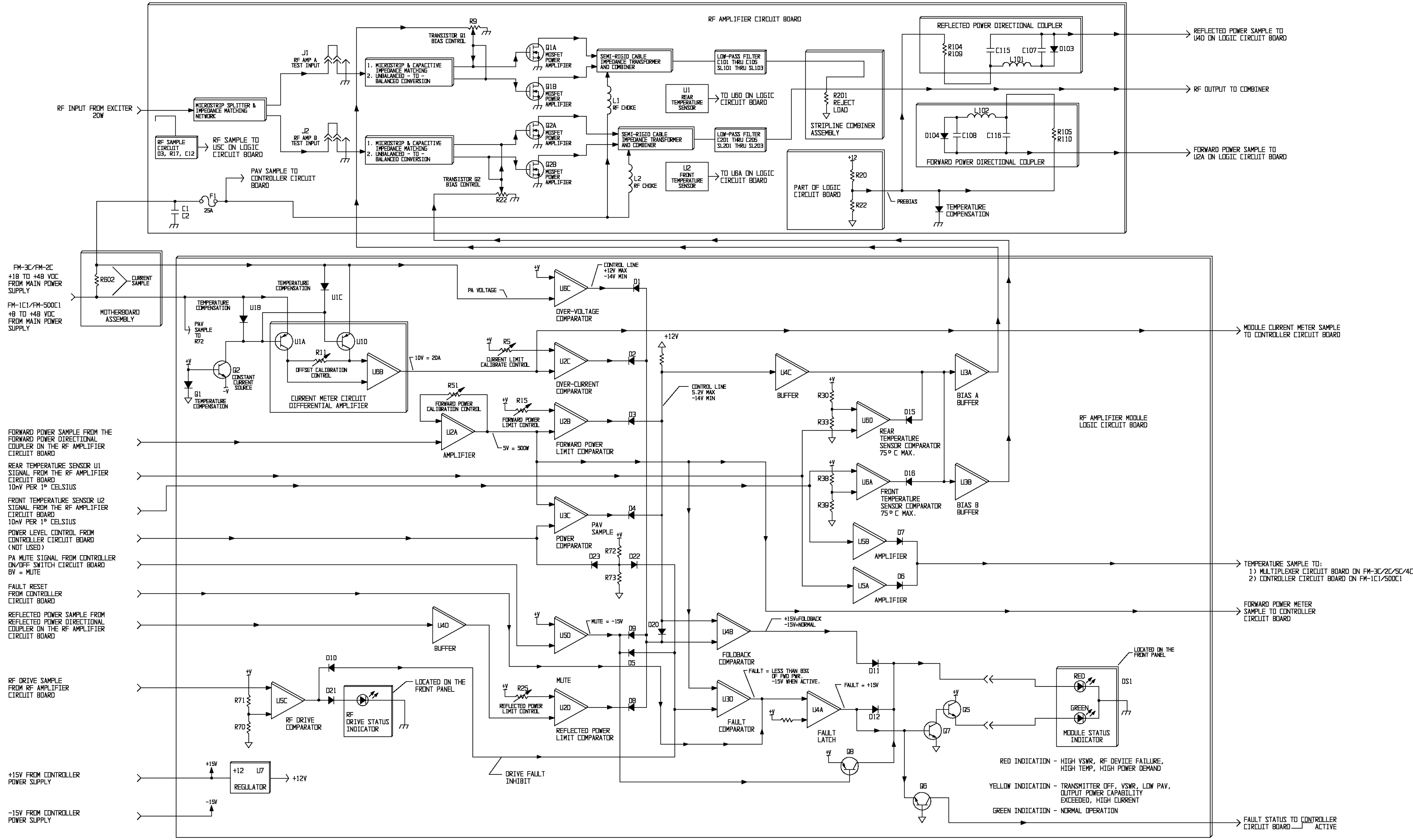


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FIGURE 1-3. RF AMPLIFIER MODULE SIMPLIFIED SCHEMATIC

SECTION II
IPA MAINTENANCE

2–1. **INTRODUCTION.**

2–2. This section provides maintenance information for the IPA unit.

2–3. **SAFETY CONSIDERATIONS.**

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

WARNING

2–4. The transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The 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. **MAINTENANCE.**

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

WARNING

2–6. The maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to prevent future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault. Perform the following maintenance procedures as required.

WARNING ***NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. ENSURE ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.***

WARNING

2–7. **INSPECTION AND CLEANING.**

2–8. On a regular basis, clean the equipment of accumulated dust using a brush and vacuum cleaner. Inspect the RF amplifier module and the power supplies for damage caused by component overheating. Overheated components are identified by circuit board discoloration near the component leads. Inspect the circuit boards for loose hardware as required.

2–9. **AIR FILTERS.**

2–10. The IPA is equipped with two air filters. One filter is a disposable type filter located in a housing under the power amplifier module. The second filter is a screen type filter located on the IPA unit rear–panel.

2–11. **DISPOSABLE FILTER.** The disposable filter should be checked approximately once a month with replacement performed on an as–required basis. Never reverse a dirty air filter. Always replace the filter. A dirty filter results in restricted air flow and increased operating temperatures for the transmitter solid–state components.

2–12. The IPA uses a disposable type air filter 1 in. X 10 in. X 20 in. (2.54 cm X 25.4 cm X 50.8 cm). Additional filters may be ordered from Broadcast Electronics (BE P/N 407–0162) or purchased locally. Install the blue side of the filter pointing towards the flushing fans. If a filter from a different manufacturer is purchased, install the filter air flow indicator pointing towards the flushing fans. Air filter replacement is accomplished by: 1) sliding the filter out of the housing and 2) inserting the new air filter into the panel with the airflow arrow pointing towards the flushing fans.

2–13. **SCREEN FILTER.** The screen filter is designed to be removed and cleaned using a brush and vacuum. Check the filter approximately once a month. Remove dirt from the filter on an as–required basis by: 1) removing the filter from the chassis and 2) cleaning the filter using a brush and vacuum.

2–14. **FLUSHING FANS.**

2–15. Inspect the IPA unit flushing fans for dust accumulation and periodically clean the fans using a brush and vacuum cleaner. The fans are cooled by air passing around each motor. If dust is allowed to accumulate on the motors, the ambient air temperature will increase due to restricted air flow. When the ambient air temperature increases, the fan motor bearing lubricant will gradually vaporize and bearing failure will occur.

2–16. It is recommended the flushing fan mounting hardware be periodically checked. The flushing fans are equipped with sealed bearings which do not permit lubrication. If a bearing fails, the motor must be replaced.

2–17. **IPA CONTROLLER FRONT PANEL REMOVAL.**

2–18. During maintenance of the IPA, the controller front panel will be required to be removed. The panel is equipped with a special bracket which allows the panel to be suspended from the chassis for maintenance procedures. To remove the IPA controller front panel, proceed as follows:

1. Refer to Figure 2–1 and remove the IPA controller front–panel mounting hardware.
2. Remove the IPA controller front panel and rotate the front panel hanger bracket 90° as shown (refer to Figure 2–1).
3. Refer to Figure 2–1 and install the IPA controller front panel in the maintenance position by inserting the hanger bracket into the slots in the chassis as shown.

2–19. **ADJUSTMENTS.**

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

WARNING

2–20. The following procedures present information required to adjust all the controls in the IPA unit. These adjustments are factory preset and therefore will require re–adjustment only if components on the circuit board have been replaced.

2–21. **RF POWER AMPLIFIER MODULE ADJUSTMENTS.**

2–22. The RF power amplifier module amplifier circuit board and the logic circuit board contain calibration controls. The power amplifier circuit board is equipped with bias level controls R9 and R22. The RF amplifier logic circuit board contains current offset control R11, current limit control R5, forward power calibration control R51, forward power limit control R15, and reflected power limit control R25. Due to the critical nature and specialized test equipment required to adjust the controls, the controls are not considered field adjustable. If the controls are to be adjusted, contact the Broadcast Electronics Customer Service Department.

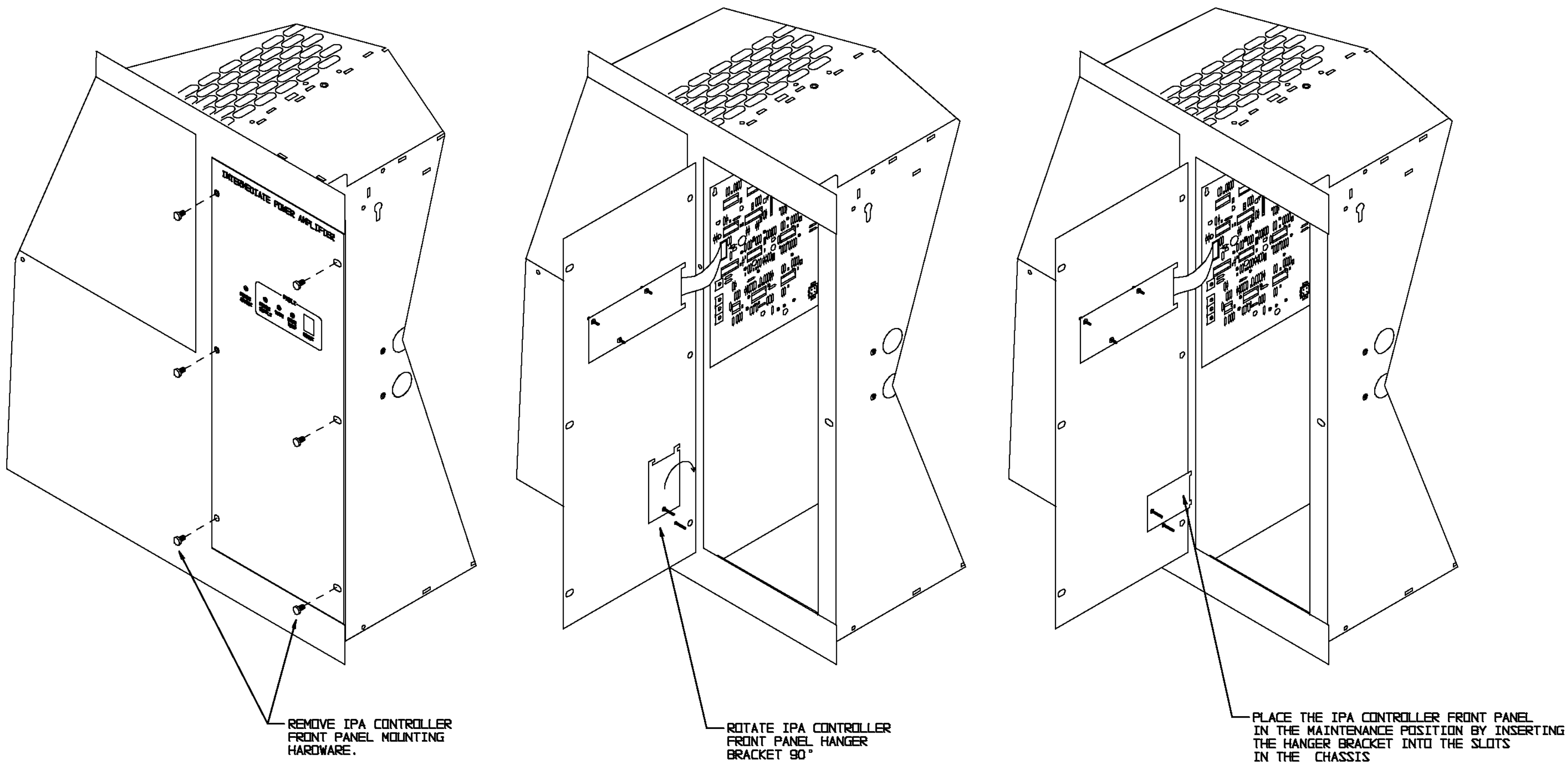

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FIGURE 2-1. IPA CONTROLLER FRONT PANEL REMOVAL

2–23. **IPA CONTROLLER ADJUSTMENTS.**

2–24. **REFLECTED POWER AND VSWR FOLDBACK CALIBRATION.** Potentiometer R25 calibrates the reflected power circuit. Potentiometer R45 determines the VSWR level for foldback operations. The following text presents the procedure to adjust the reflected power meter and VSWR foldback controls.

2–25. **Required Equipment.** The following equipment is required to adjust the reflected power and VSWR foldback calibration controls.

1. Insulated adjustment tool.
2. Test cable.
3. Digital multimeter (Fluke 77 or equivalent).

2–26. **Procedure.** To adjust the reflected power calibration control, proceed as follows:

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–27. Disconnect all transmitter primary power before proceeding.

2–28. Refer to IPA CONTROLLER FRONT PANEL REMOVAL in the preceding text and perform the procedure to remove the IPA controller front panel.

2–29. Connect a test cable from the exciter RF output to the IPA RF output connector.

2–30. Remove the exciter top cover and operate the MUTE switch to NEG.

2–31. Operate the exciter to on and depress the FWD switch/indicator. Record the exciter forward power output displayed on the multimeter ____________________.

2–32. Adjust the exciter POWER SET control for a 30 watt forward power indication on the exciter multimeter.

2–33. Refer to Figure 2–2 and connect a digital multimeter between test point TP–9 and ground.

2–34. Refer to Figure 2–2 and adjust reflected power calibrate control R25 for a –1.48 volt dc indication on the multimeter.

2–35. Refer to Figure 2–2 and connect a digital multimeter between test point TP–1 and ground.

2–36. Refer to Figure 2–2 and adjust IPA VSWR foldback calibrate control R45 for a 4.3 volt dc indication on the multimeter. The **VSWR** indicator and the **RESET** switch/indicator will illuminate.

2–37. Remove the test equipment, replace the controller front panel, re–adjust the exciter output power to the level recorded in the previous text, operate the exciter MUTE switch to POS, and re–connect the exciter to the IPA input.

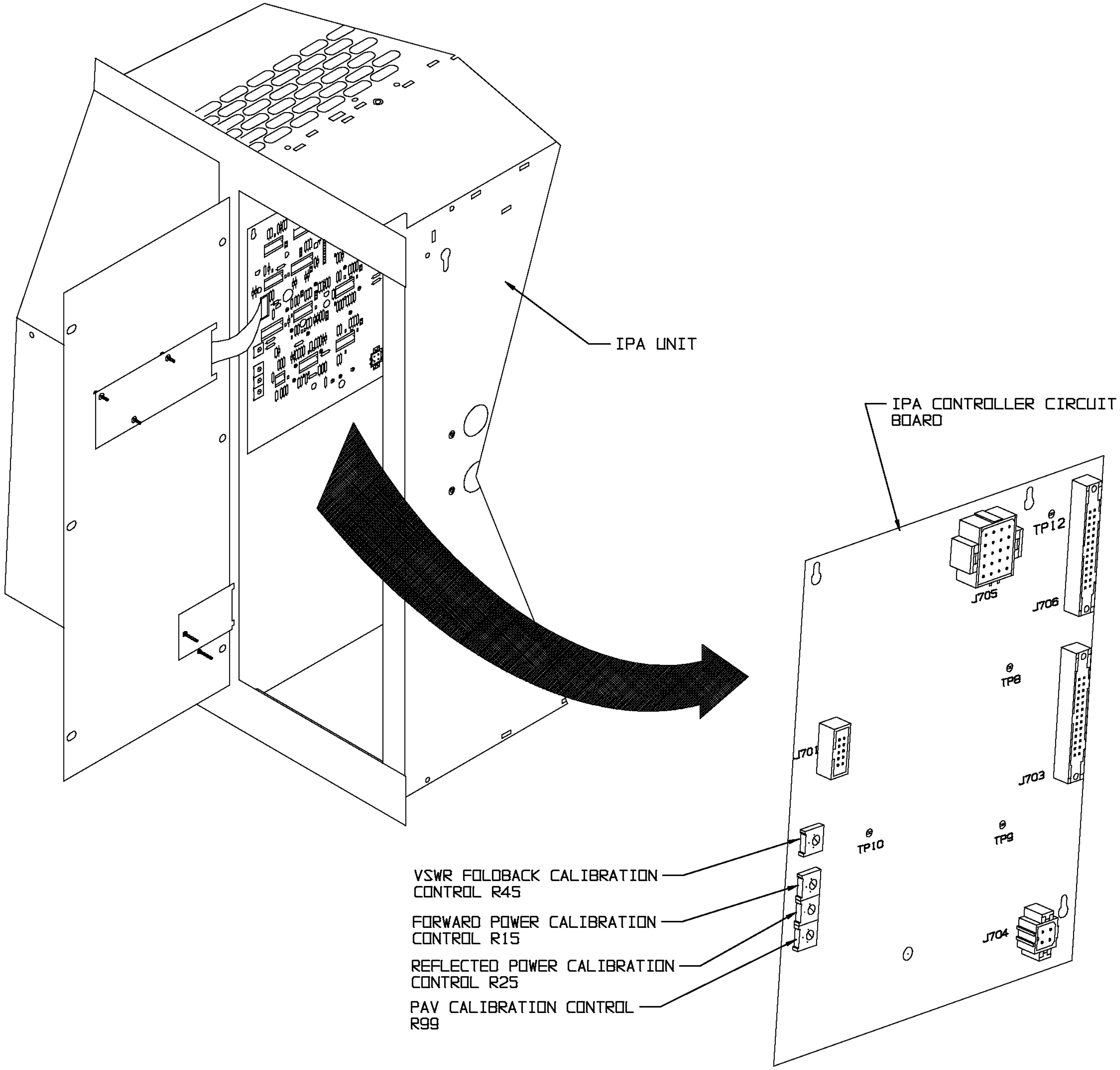

FIGURE 2-2. CONTROLLER CIRCUIT BOARD CONTROLS

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2–38. **FORWARD POWER CALIBRATION.** Potentiometer R15 calibrates the forward power detector circuitry. The following text presents the procedure to calibrate the forward power detector circuitry.

2–39. **Required Equipment.** The following equipment is required to adjust the forward power calibration control.

1. Insulated adjustment tool.
2. Calibrated in–line wattmeter with 500 Watt element (Bird 43 or equivalent).
3. Test load and cable (50 Ohm Non–Inductive, Type N connector, 500 Watt minimum).
4. Digital multimeter (Fluke 77 or equivalent).

2–40. **Procedure.** To adjust the forward power calibration control, proceed as follows:

2–41. Operate the transmitter at a normal RF output power.

2–42. Operate the transmitter **MULTIMETER** switch to **IPA FWD POWER** and record the forward power indication ______________________.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–43. Disconnect all transmitter primary power before proceeding.

2–44. Refer to IPA CONTROLLER FRONT PANEL REMOVAL in the preceding text and perform the procedure to remove the IPA controller front panel.

2–45. Refer to Figure 2–2 and connect a digital multimeter between test point TP–8 and ground.

2–46. Energize the transmitter primary ac power and operate the transmitter at the desired output power level.

2–47. Adjust the front–panel POWER ADJUST control for a 500 watt indication on the wattmeter.

2–48. Refer to Figure 2–2 and adjust FWD PWR calibration control R15 for a –5.0 volt dc indication on the digital multimeter.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–49. Disconnect all transmitter primary power.

2–50. Remove the test equipment, re–adjust the IPA forward power output to the level recorded in the preceding text, and replace the IPA controller front panel.

2–51. **POWER SUPPLY BUSS VOLTAGE CALIBRATION.** Potentiometer R99 on the controller circuit board calibrates the PA module power supply voltage detector circuitry. The following text presents the procedure to calibrate the PA module power supply voltage detector circuitry.

2–52. **Required Equipment.** The following equipment is required to adjust the PA module power supply voltage calibration control.

1. Insulated adjustment tool.
2. Digital multimeter (Fluke 77 or equivalent).

2–53. **Procedure.** To adjust the PA voltage calibration control, proceed as follows:

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–54. Disconnect all transmitter primary power before proceeding.

2–55. Refer to IPA CONTROLLER FRONT PANEL REMOVAL in the preceding text and perform the procedure to remove the IPA controller front panel.

2–56. Remove the RF power module and connect a digital multimeter between J603–A2 on the motherboard assembly and ground.

2–57. Energize the transmitter primary ac power.

2–58. Record the multimeter indication ____________________.

2–59. Refer to Figure 2–2 and connect a digital multimeter between test point TP–12 and ground.

2–60. Refer to Figure 2–2 and adjust PWR SUPPLY BUSS VOLTAGE calibrate control R99 for 10% of the multimeter indication recorded in the preceding text. For example, the multimeter indication at J603–A2 = 40.6 volt dc. Therefore, adjust the voltage at test point TP–12 for a 4.06 volt dc indication.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–61. Disconnect all transmitter primary power.

2–62. Remove the test equipment, replace the IPA controller front panel, and replace the RF power module.

2–63. **TROUBLESHOOTING.**

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

WARNING

2–64. 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.

2–65. **PRELIMINARY TROUBLESHOOTING.** If difficulties are encountered and the IPA is suspected as faulty, the first step in troubleshooting should determine whether the exciter, the IPA unit, or the load is at fault. A high VSWR or an over–heating condition will cause the controller to limit RF output to prevent damage. The observable symptom would be loss of RF power. However, as the controller and the RF amplifier module are both components of a closed loop, either circuit could cause this symptom. Complete loss of RF output would indicate a power supply module problem. The following text presents a list of preliminary troubleshooting operations.

1. The RF input level to the IPA stage should be checked and adjusted as required.
2. Adjust the **INPUT TUNING** control to obtain a minimum **IPA REFLECTED POWER** indication on the transmitter multimeter.
3. If RF input level adjustment or input tuning adjustment does not correct the fault, refer to TABLE 2-1, RF AMPLIFIER POWER SUPPLY TROUBLESHOOTING, POWER AMPLIFIER POWER SUPPLY MODULE TROUBLESHOOTING, and POWER AMPLIFIER MODULE TROUBLESHOOTING/REPAIR in the following text and troubleshoot the IPA unit. 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 or replacement.

CAUTION ***CAUTION*** ***REMOVING OR INSTALLING THE POWER AMPLIFIER POWER SUPPLY WITH THE TRANSMITTER ENERGIZED MAY RESULT IN DAMAGE TO THE SUPPLY. DO NOT REMOVE/INSERT THE POWER AMPLIFIER POWER SUPPLY WITH THE TRANSMITTER ENERGIZED.***

2-66. **POWER SUPPLY MODULES.** The IPA is equipped with two modular switching power supply modules. One module provides dc potentials for the controller circuitry. A second power supply module provides dc potentials for the PA circuitry. Each power supply module is equipped with an ac line fuse. The following text presents the procedures to remove the power supply modules.

2-67. **Controller Power Supply Removal.** To remove the controller power supply, perform the following procedure. IPA component locations are presented in Figure 2-4 at the end of this section.

WARNING ***WARNING*** ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

2-68. Disconnect all transmitter primary power.

2-69. Remove all the rear access panel Phillips-Head screws.

2-70. Remove the access panel.

2-71. Remove the two Knurled nuts securing fan B2 to the interior panel.

2-72. Remove the fan.

2-73. Remove the two stand-offs securing the controller power supply module to the side panel.

2-74. Disconnect the wiring and remove the controller power supply module.

2-75. Check the power supply fuse. If the power supply fuse has not blown, contact the Broadcast Electronics Customer Service Department. If desired, refer to appendix A and the computer products power supply schematic diagram for additional power supply troubleshooting information.

2-76. Once power supply troubleshooting is complete, re-install the supply by reversing the preceding procedure.

2-77. **Main Power Supply Assembly Removal.** The main power supply assembly (PA RF power amplifier power supply module) can be easily removed from the IPA chassis in the event of a failure. The power supply is a modular assembly designed to be removed from the front of the IPA (refer to Figure 2-3). To remove the main power supply assembly, refer to Figure 2-3 and proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

WARNING

2–78. Disconnect all transmitter primary power before proceeding.

2–79. Refer to IPA CONTROLLER FRONT PANEL REMOVAL in the preceding text and perform the procedure to remove the IPA controller front panel.

2–80. Rotate the power supply lock knob fully counterclockwise.

2–81. Using the power supply handle, pull the supply from the transmitter chassis.

2–82. Check the power supply fuse. If the fuse has not blown, refer to APPENDIX A and locate the Pioneer Magnetics Troubleshooting Guide For The PM3329BP–5 power supply. Use the guide to troubleshoot the power supply.

2–83. Once power supply troubleshooting is complete, re–install the supply by reversing the preceding procedure.

2–84. **IPA TROUBLESHOOTING PROCEDURES.** Table 2–1 presents troubleshooting information for the IPA unit. Refer to Table 2–1 to isolate the problem to a specific assembly. Once the trouble is isolated, refer to the theory of operation and schematic diagrams to assist in problem resolution.

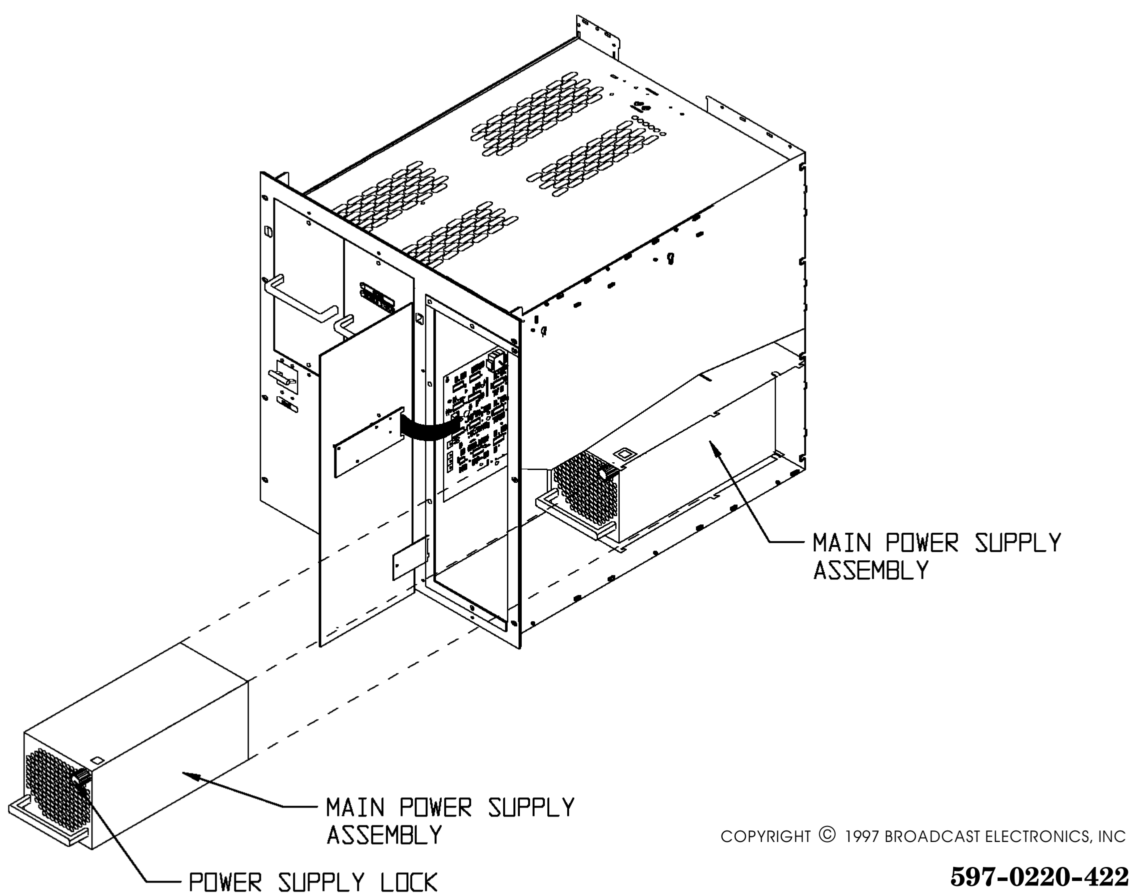

FIGURE 2-3. MAIN POWER SUPPLY REMOVAL

2-85. **IPA COMPONENT LOCATIONS.** Figure 2-4 presents the IPA component locations. Refer to Figure 2-4 as required during the troubleshooting procedures to locate components within the IPA.

2-86. **POWER AMPLIFIER POWER SUPPLY MODULE TROUBLESHOOTING.** The IPA is equipped with a modular switching power supply unit. The unit is constructed with a fuse and cooling fan. When a power supply module fault indicator illuminates, check the following:

1. The PA power supply module is equipped with temperature overload protection. If the power supply module temperature overload occurs, the modules must be reset. To reset the power supply module, proceed as follows:

   A. Depress the IPA **RESET** switch/indicator.

   B. Wait approximately 1 minute.

   C. Depress the **FILAMENT ON** switch/indicator. The module will return to operation if the problem was associated with a temperature overload.

2. If the power supply module does not return to operation, check the rotation of the fan. Ensure the fan is operating.

3. If the fan is not operating, proceed as follows:

CAUTION

CAUTION

THE POWER AMPLIFIER POWER SUPPLY MODULE WILL BE DAMAGED IF THE MODULE IS REMOVED OR INSTALLED WITH POWER ENERGIZED. DISCONNECT ALL TRANSMITTER POWER PRIOR TO REMOVING OR INSTALLING THE POWER AMPLIFIER MODULE.

   A. De-energize all transmitter primary power.

   B. Refer to IPA CONTROLLER FRONT PANEL REMOVAL in the preceding text and perform the procedure to remove the IPA controller front panel.

   C. Loosen the power supply module lock knob on the front panel.

   D. Remove and re-insert the power supply module and secure the lock knob.

   E. Energize the transmitter primary power and operate the transmitter. The module will return to operation if the problem is associated with improper module seating.

4. If the power supply module problem remains, refer to APPENDIX A and locate the Pioneer Magnetics Troubleshooting Guide For The PM3329BP-5 power supply. Use the guide to troubleshoot the power supply.

CAUTION

CAUTION

REMOVING OR INSTALLING THE POWER AMPLIFIER MODULE WITH THE TRANSMITTER ENERGIZED MAY RESULT IN DAMAGE TO THE MODULE. DO NOT REMOVE/INSERT THE POWER AMPLIFIER MODULE WITH THE TRANSMITTER ENERGIZED.

2-87. **POWER AMPLIFIER MODULE TROUBLESHOOTING/REPAIR.** The IPA RF power amplifier module requires specialized equipment for troubleshooting and repair operations. Therefore, almost all power amplifier module troubleshooting and repair can not be performed in the field. If a power amplifier module is determined to be defective, contact the Broadcast Electronics Customer Service department for: 1) troubleshooting information and 2) information on a power amplifier module exchange program (refer to the following text).

2-88. **Power Amplifier Module Exchange Program.** If the power amplifier module is determined to be defective, Broadcast Electronics has established a power amplifier module exchange program. The program allows the customer to: 1) exchange a defective module for a reconditioned module or 2) obtain a module on loan during the repair of the defective module. Terms of the program are available from the Broadcast Electronics Customer Service Department.

TABLE 2-1. IPA TROUBLESHOOTING
(Sheet 1 of 2)

SYMPTOM	CIRCUITRY TO CHECK
1. LOW OUTPUT POWER 2. MODULE DRIVE INDICATOR EXTINGUISHED 3. MODULE STATUS INDICATOR ILLUMINATES YELLOW 4. RESET INDICATOR ILLUMINATED	1. Depress the reset switch. 2. Check the exciter forward power. The forward power must be 20W. The power supply will present a fault with low RF drive. 3. If the exciter forward power is low, refer to the FX-50 exciter manual and troubleshoot the exciter. 4. If the correct exciter forward power is present, check the voltage at TP-12 on the IPA controller circuit board. The voltage at TP-12 is 10% of the power supply voltage. The voltage must be equal to the normal operating voltage. 5. If the PA voltage is normal, defective RF power amplifier module. 6. If the PA voltage is low, adjust the front-panel IPA POWER ADJUST control to increase the PA voltage until the MODULE STATUS indicators illuminate green.
1. RESET INDICATOR ILLUMINATED 2. POWER SUPPLY INDICATOR ILLUMINATED 3. RED MODULE STATUS INDICATOR	1. Depress the reset switch. 2. If the reset indicator does not display normal indications, check the power supply.

TABLE 2-1. IPA TROUBLESHOOTING
(Sheet 2 of 2)

SYMPTOM	CIRCUITRY TO CHECK
1. RESET INDICATOR ILLUMINATED 2. OVER TEMP INDICATOR ILLUMINATED 3. RED MODULE STATUS INDICATOR	1. Depress the reset switch. 2. If the reset indicator does not display normal indications, check the flushing fans and the filter.
1. RESET INDICATOR ILLUMINATED 2. VSWR INDICATOR ILLUMINATED 3. RED MODULE STATUS ILLUMINATED	1. Depress the reset switch. 2. If the reset indicator does not display normal indications, use the transmitter **MULITMETER** to check the IPA reflected power. The reflected power must be less than 30 watts. 3. If the reflected power is greater than 30 watts, adjust the transmitter INPUT TUNING control for a reflected power indication of less than 30 watts. 4. If the reflected power is less than 30 watts, check the RF power module logic circuit board.
1. IPA OFF WITH NO FRONT PANEL INDICATIONS	1. Ensure primary ac power is applied to the unit and ensure the POWER switch is operated to on. 2. If the primary ac power is on, defective controller power supply.
1. IPA OFF 2. NO INDICATORS 3. NO MODULE STATUS INDICATORS	1. Defective controller power supply +15V output.
1. IPA OFF WITH FRONT PANEL INDICATIONS 2. MODULE STATUS INDICATORS ILLUMINATE YELLOW	1. Defective controller power supply +5V output.
1. IPA OFF WITH FRONT PANEL INDICATIONS 2. MODULE STATUS INDICATORS ILLUMINATE YELLOW	1. Defective controller power supply –15V output.
1. MODULE STATUS INDICATOR ILLUMINATES YELLOW	1. Defective module. Troubleshoot the module.
1. CIRCUIT BREAKER OPERATION	1. Check the MOVs, main power supply, controller power supply, and the circuit breaker.

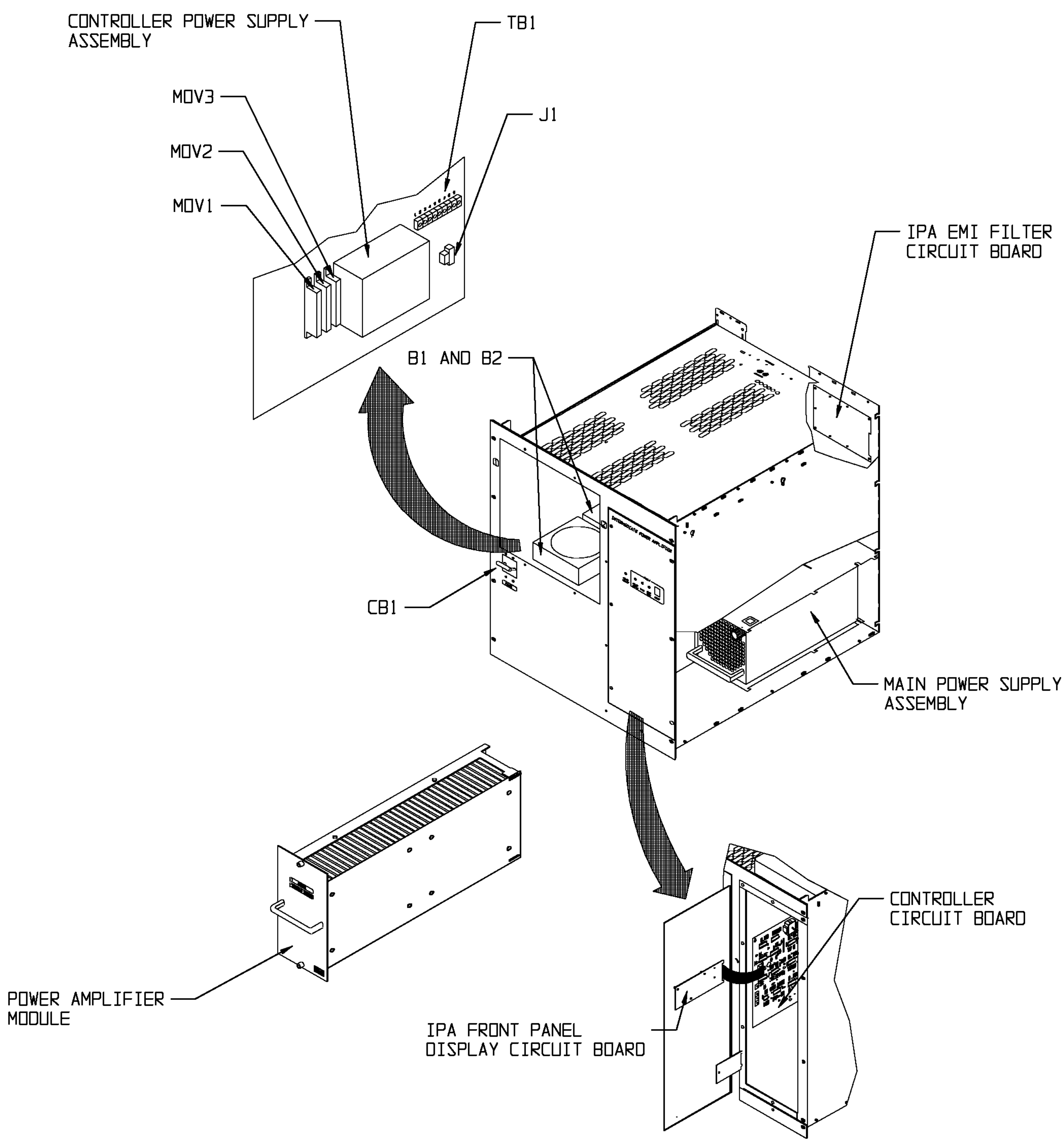

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FIGURE 2-4. IPA COMPONENT LOCATOR (Sheet 1 of 2)

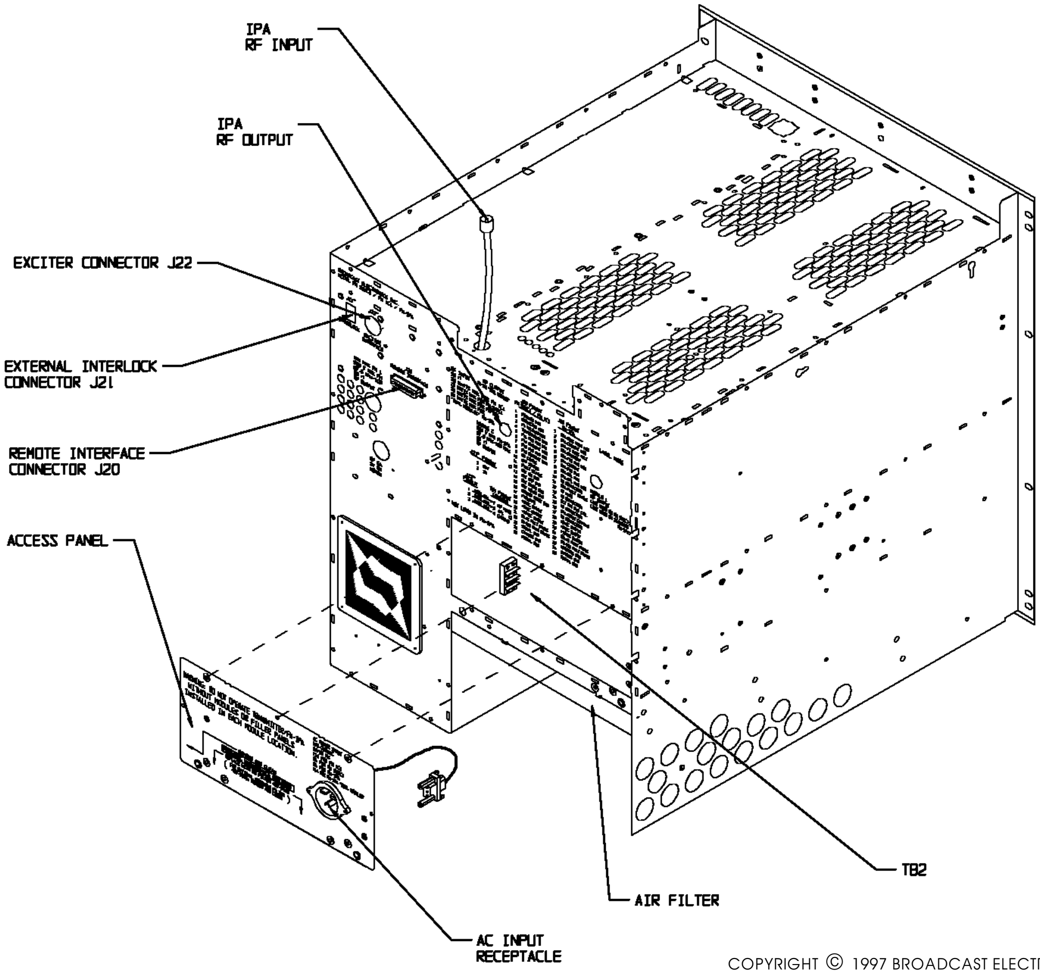

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FIGURE 2-4. IPA COMPONENT LOCATOR (Sheet 2 of 2)

SECTION III
IPA PARTS LIST

3-1. INTRODUCTION.

3-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics IPA unit. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 3-1. IPA PARTS LIST INDEX

TABLE	DESCRIPTION	PART NO.	PAGE
3-2	INTERMEDIATE POWER AMPLIFIER ASSEMBLY	959-0421	3-2
3-3	MOTHERBOARD CIRCUIT BOARD ASSEMBLY	919-0400-001	3-2
3-4	POWER SUPPLY MOTHERBOARD CIRCUIT BOARD ASSEMBLY	919-0423	3-2
3-5	IPA CONTROL BOARD CIRCUIT BOARD ASSEMBLY	919-0434-001	3-3
3-6	IPA STATUS INDICATOR BOARD CIRCUIT BOARD ASSEMBLY	919-0434-002	3-6
3-7	RFI FILTER CIRCUIT BOARD ASSEMBLY	919-0435	3-6
3-8	FM-IPA HARNESS ASSEMBLY	949-0400-003	3-7
3-9	RF AMPLIFIER MODULE ASSEMBLY	959-0412	3-8
3-10	RF AMPLIFIER CIRCUIT BOARD ASSEMBLY	919-0416	3-8
3-11	RF AMPLIFIER CABLES ASSEMBLY	949-0405	3-9
3-12	RF AMPLIFIER LOGIC CIRCUIT BOARD ASSEMBLY	919-0417	3-9
3-13	RF AMPLIFIER MODULE DIRECTIONAL COUPLER CIRCUIT BOARD ASSEMBLY	919-0418-001	3-12
3-14	RF AMPLIFIER MODULE LOW-PASS FILTER CIRCUIT CIRCUIT BOARD ASSEMBLY	919-0418-002	3-12

TABLE 3-2. INTERMEDIATE POWER AMPLIFIER ASSEMBLY - 959-0421

REF. DES.	DESCRIPTION	PART NO.	QTY.
B1, B2	Fan, 6 inch (15.24 cm), 250 ft3/min 220V ac, 50/60 Hz, 40 Watt	380-7650	2
CB1	Circuit Breaker, W92X11-2-10, 240V, 10 Amperes, 2-Pole	341-0030	1
J4, J5	Connector Housing, 2-Pin, Male	418-0702	2
J10	Bulkhead Receptacle, Type N. Jack-to-Jack, UG30/U	418-0035	1
MOV1 thru MOV3	Metal-Oxide Varistor, B40K275, 275V, 1680 Joules	140-0021	3
TB1	Barrier Strip, 9 Terminal	412-0090	1
----	Filter, Fan, Pamotor 5502	380-5502	1
----	Barrier Strip, 2 Terminal	412-0002	1
----	Air Filter, 9 3/4 X19 3/4 X 3/4 Inches (24.77 X 50.17 X 1.91 cm)	407-0162	2
----	Pin Connector	417-0036	4
----	Power Supply, Computer Products, NFN40-7610, -15V ±5%, +5 ± 2%, +15V +10%/-3%, 85V to 264V Operation, 40W	540-0006	1
----	Power Supply, Pioneer Magnetics, PM3329BP-5 48D42-2F-4D-6B-127-128-R, 48 Adjustable, 2 kW, Power Factor Corrected	540-0016-001	1
----	Motherboard Circuit Board Assembly, FM-500C	919-0400-001	1
----	Power Supply Mother Board Circuit Board Assembly, FM-1C	919-0423	1
----	IPA Control Board Circuit Board Assembly .	919-0434-001	1
----	IPA Status Indicator Circuit Board Assembly	919-0434-002	1
----	RFI Filter, FMSS Circuit Board Assembly	919-0435	1
----	FM-IPA Harness Assembly	949-0400-003	1
----	RF Amplifier Module Assembly, FM-3C	959-0412	1

TABLE 3-3. MOTHERBOARD CIRCUIT BOARD ASSEMBLY - 919-0400-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
C5	Capacitor, Electrolytic, 47 uF, 35V	020-4770	1
C7	Capacitor, Mylar, 0.1 uF ±10%, 100V	030-1053	1
J601	Receptacle, 26-Pin Dual In-line	418-2602	1
J603	Connector, Female	417-0322	1
R3	Resistor, .005 Ohm ±3%, 5W, WW	139-0007	1
R5	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
----	Assembly, Motherboard RF Cable	949-0417	1
----	Blank, Motherboard Circuit Board	519-0400	1

TABLE 3-4. POWER SUPPLY MOTHERBOARD CIRCUIT BOARD ASSEMBLY- 919-0423

REF. DES.	DESCRIPTION	PART NO.	QTY.
J24	Connector, Housing, 6-Pin, PCB Mount	417-0677	1
J25	Connector, For Pioneer Power Supplies, 29-Pin	417-2900	1
----	Blank, Power Supply Motherboard Circuit Board	519-0423	1

TABLE 3-5. IPA CONTROL BOARD CIRCUIT BOARD ASSEMBLY- 919-0434-001
(Sheet 1 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 thru C6	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	6
C7	Capacitor, Electrolytic, 10 uF, 50V	023-1076	1
C8 thru C16	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	9
C8, C9	Capacitor, Electrolytic, 1 uF, 50V	024-1064	2
C17	Capacitor, Electrolytic, 100 uF ±10%, 25V, Low-Leakage	023-1085	1
C20 thru C34	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	15
C35, C36	Capacitor, Ceramic, 47 pF ±5%, 50V	003-4712	2
D1 thru D15	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	15
D16	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	1
D17, D18	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	2
D19	Diode, Zener, 1N4732A, 4.7V ±1%, 1W	200-4732	1
D20 thru D22	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	3
D23	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	1
D24	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	1
J701	Connector, Printed Circuit Board Mounting, 10-Pin (Dual 5)	418-1003	1
J703	Receptacle, 26-Pin Dual In-line	418-2602	1
J704	Socket, 4-Pin	418-0255	1
J705	Connector, Male, 20-Pin PCB Mount	417-0230	1
J706	Receptacle, 26-Pin Dual In-line	418-2602	1
J707	Receptacle, Male, 20-Pin In-Line	417-0200	1
J711	Receptacle, Male, 2-Pin In-line	417-4004	1
J712, J713	Receptacle, Male, 3-Pin In-line	417-0003	2
J714 thru J718	Receptacle, Male, 2-Pin In-line	417-4004	5
J720	Receptacle, Male, 3-Pin In-line	417-0003	1
P711 thru P719	Jumper, Programmable, 2-Pin	340-0004	9
Q1 thru Q5	Transistor, 2N27000, FET, N-Channel, TO-92 Case	210-7000	5
Q6	Field-Effect-Transistor, J270, P-Channel JFET, TO-92 Case	210-0270	1
R1, R2	Resistor, 100 Ohm ±1%, 1/4W	100-1031	2
R3 thru R5	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	3
R6	Resistor, 12.4 k Ohm ±1%, 1/4W	103-1245	1
R7	Resistor, 2.49 k Ohm ±1%, 1/4W	103-2494	1
R8	Resistor, 100 Ohm ±1%, 1/4W	100-1031	1
R9 thru R11	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	3
R12, R13	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R14	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R15	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R16, R17	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	2
R18	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R19, R20	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	2
R21	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R22	Resistor, 11.0 k Ohm ±1%, 1/4W	103-1105	1
R23	Resistor, 4.02 k Ohm ±1%, 1/4W	103-4024	1
R24	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R25	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R26	Resistor, 49.9 k Ohm ±1%, 1/4W	103-4951	1
R27	Resistor, 40.2 k Ohm ±1%, 1/4W	103-4025	1
R28	Resistor, 11.3 k Ohm ±1%, 1/4W	103-1135	1

TABLE 3-5. IPA CONTROL BOARD CIRCUIT BOARD ASSEMBLY- 919-0434-001
(Sheet 2 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R29	Resistor, 3.83 k Ohm ±1%, 1/4W	103-3841	1
R30	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R31	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R33 thru R36	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	4
R37	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R38	Resistor, 40.2 k Ohm ±1%, 1/4W	103-4025	1
R39	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R40	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R41	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R43	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R44	Resistor, 6.04 k Ohm ±1%, 1/4W	103-6044	1
R45	Potentiometer, 2 k Ohm ±10%, 1/2W	177-2044	1
R46	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R47	Resistor, 7.50 k Ohm ±1%, 1/4W	103-7541	1
R48, R49	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	2
R50	Resistor, 102 k Ohm ±1%, 1/4W	103-1026	1
R51	Resistor, 33.2 k Ohm ±1%, 1/4W	103-3325	1
R52	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R53	Resistor, 619 Ohm ±1%, 1/4W	103-6193	1
R54	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R55	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R56	Resistor, 34 k Ohm ±1%, 1/4W	103-3405	1
R57, R58	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	2
R59	Resistor, 8.06 k Ohm ±1%, 1/4W	103-8064	1
R60	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R61	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R62	Resistor, 102 k Ohm ±1%, 1/4W	103-1026	1
R63	Resistor, 33.2 k Ohm ±1%, 1/4W	103-3325	1
R64	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R65	Resistor, 619 Ohm ±1%, 1/4W	103-6193	1
R66	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R67	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R68	Resistor, 34 k Ohm ±1%, 1/4W	103-3405	1
R69	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R70	Resistor, 10 Ohm ±5%, 1/4W	100-1024	1
R71, R72	Resistor, 33.2 k Ohm ±1%, 1/4W	103-3325	2
R73	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R74	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R75	Resistor, 19.1 k Ohm ±1%, 1/4W	103-1915	1
R76	Resistor, 33.2 k Ohm ±1%, 1/4W	103-3325	1
R77, R78	Resistor, 40.2 k Ohm ±1%, 1/4W	103-4025	2
R79	Resistor, 9.76 k Ohm ±1%, 1/4W	103-9764	1
R80	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R81, R82	Resistor, 14.3 k Ohm ±1%, 1/4W	103-1435	2
R83	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R84	Resistor, 24.3 k Ohm ±1%, 1/4W	103-2435	1
R85	Resistor, 19.1 k Ohm ±1%, 1/4W	103-1915	1

TABLE 3-5. IPA CONTROL BOARD CIRCUIT BOARD ASSEMBLY- 919-0434-001 (Sheet 3 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R86	Resistor, 20.0 k Ohm ±1%, 1/4W	103-2051	1
R87	Resistor, 49.9 k Ohm ±1%, 1/4W	103-4951	1
R88	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R89	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
R90	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R91, R92	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	2
R93	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R94	Resistor, 20.0 k Ohm ±1%, 1/4W	103-2051	1
R95	Resistor, 20.5 k Ohm ±1%, 1/4W	103-2055	1
R96	Resistor, 20.0 k Ohm ±1%, 1/4W	103-2051	1
R97	Resistor, 24.9 k Ohm ±1%, 1/4W	103-2495	1
R98	Resistor, 75 k Ohm ±1%, 1/4W	103-7505	1
R99	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R100, R101	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R102	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R103	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R104, R105	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	2
R106	Resistor, 1 Meg Ohm ±1%, 1/4W	103-1007	1
R107	Resistor, 40.2 k Ohm ±1%, 1/4W	103-4025	1
R108, R109	Resistor, 20.0 k Ohm ±1%, 1/4W	103-2051	2
R110	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R110	Resistor, 4.87 k Ohm ±1%, 1/4W	103-4874	1
R111, R112	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R113	Resistor, 49.9 k Ohm ±1%, 1/4W	103-4951	1
R114	Resistor, 100 k Ohm ±1%, 1/4W	103-1062	1
R115	Resistor, 200 k Ohm ±1%, 1/4W	103-2061	1
R116	Resistor, 2.49 k Ohm ±1%, 1/4W	103-2494	1
R117, R118	Resistor, 88.7 k Ohm ±1%, 1/4W	103-8875	2
TP1 thru TP16	Terminal, Test Point, Oval, Red	413-0106	16
U1	Integrated Circuit, CD4066BE, Quad Bilateral Switch, CMOS, 14-Pin DIP	225-0004	1
U2	Integrated Circuit, MC14106BCP, Hex Schmitt Trigger, 14-Pin	228-4106	1
U3	Integrated Circuit, LM339AN, Quad Comparator, 14-Pin DIP	221-0339	1
U4	Integrated Circuit, ULN2004, 7 NPN Darlington Driver Pack, 16-Pin DIP	226-2004	1
U5	Integrated Circuit, MC14044BP, Quad NAND R-S Latch, CMOS, 16-Pin DIP	228-4044	1
U6, U7	Integrated Circuit, TLO74CN, Quad JFET-Input Operational Amplifier, 14-Pin DIP	221-0074	2
U8	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	1
U9, U10	Integrated Circuit, TLO74CN, Quad JFET-Input Operational Amplifier, 14-Pin DIP	221-0074	2
U11	Integrated Circuit, TL072CP, Dual JFET-Input Operational Amplifier, 8-Pin DIP	221-0072	1

TABLE 3-5. IPA CONTROL BOARD CIRCUIT BOARD ASSEMBLY- 919-0434-001 (Sheet 4 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U12	Integrated Circuit, TLO74CN, Quad JFET-Input Operational Amplifier, 14-Pin DIP	221-0074	1
XU1 thru XU3	Socket, 14-Pin DIP	417-1404	3
XU4, XU5	Socket, 16-Pin DIP	417-1604	2
XU6, XU7	Socket, 14-Pin DIP	417-1404	2
XU8	Socket, 8-Pin DIP	417-0804	1
XU9, XU10	Socket, 14-Pin DIP	417-1404	2
XU11	Socket, 8-Pin DIP	417-0804	1
XU12	Socket, 14-Pin DIP	417-1404	1
----	Blank, IPA Control Board Circuit Board	519-0434-001	1

TABLE 3-6. IPA STATUS INDICATOR BOARD CIRCUIT BOARD ASSEMBLY - 919-0434-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
C200	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
DS200 thru DS202	Indicator, LED, Red, 521-9212, 1.7V @ 50 mA Maximum	323-9217	3
J201	Connector Header, 10-Pin Right Angle, PCB Male Header	417-1023	1
R200 thru R203	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	4
R204	Resistor, 6650 Ohm ±1%, 1/4W	103-6641	1
R205	Potentiometer, 10 k Ohm, 12 Turn, Vertical Adjust	177-1058	1
R206	Resistor, 1 Ohm ±5%, 1/4W	100-1013	1
S200	Switch, SPDT, MOM MP Series, 1 Red, C&K	340-0030	1
----	Blank, IPA Status Indicator Circuit Board	519-0434-002	1

TABLE 3-7. RFI FILTER CIRCUIT BOARD ASSEMBLY - 919-0435 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C201 thru C218	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	18
C221 thru C228	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	8
D1 thru D8	Bidirectional Zener Transient Voltage Suppressor, Motorola SA13CA, +/-13V	201-0039	8
D9 thru D17	Bidirectional Zener Transient Voltage Suppressor, Motorola SA18C, Or SA18CA, +/-18V	201-0040	9
D18	Bidirectional Zener Transient Voltage Suppressor, Motorola SA13CA, +/-13V	201-0039	1

TABLE 3-7. RFI FILTER CIRCUIT BOARD ASSEMBLY - 919-0435
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
D19 thru D25	Bidirectional Zener Transient Voltage Suppressor, Motorola SA18C Or SA18CA, +/-18V	201-0040	7
FL1 thru FL25	EMI Suppression Filter, 10,000 pF ±30%, 3-Pin	411-0001	25
J19	Connector, PC 26 Positions, ANSLEY 609-2624	418-2602	1
J20	Receptacle, 25-Pin	417-2500	1
J21	Connector, 2-Pin	417-0700	1
J22	Socket, 4-Pin	418-0255	1
R201 thru R211	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	11
R212 thru R217	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	6
R218 thru R220	Resistor, 100 Ohm ±5%, 1/2W	110-1033	3
R221 thru R223	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	3
R224, R225	Resistor, Power, 47 Ohm ±5%, 3 1/4W, W/W	132-4721	2
R226, R227	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	2
R228	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	1
----	Blank, RFI Filter Board Circuit Board	519-0435	1

TABLE 3-8. FM-IPA HARNESS ASSEMBLY - 949-0400-003
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Connector, 2 Pole 3 Wire, 15 Amperes, 250V	418-0320	1
J2	Connector, Male, PLA03M1B00	417-0380	1
P2	Connector, Female, PLA03F1000-135.0	417-0379	1
P4, P5	Connector Housing, 2-Pin, Female	418-0701	2
P6	Housing, SL-156, 3 Position	417-0306	1
P7	Housing, SL-156, 6 Position	417-0606	1
P19	Plug, Ribbon Cable, 26-Pin Dual In-line	418-2600	1
P24	Connector Housing, 6-Pin	418-0670	1
P201	Socket, Connector, 10-Pin	417-1003	1
P601	Plug, Ribbon Cable, 26-Pin Dual In-line	418-2600	1
P701	Socket, Connector, 10-Pin	417-1003	1
P703	Plug, Ribbon Cable, 26-Pin Dual In-line	418-2600	1
P705	Receptacle, 20-Pin	417-0176	1
P706	Plug, Ribbon Cable, 26-Pin Dual In-line	418-2600	1
----	Crimp Terminal, AMP 640707-1	410-2478	6
----	Pins, Connector	417-0053	18
----	Contact Housing, 4-Pin In-line	417-0138	1

TABLE 3-8. FM-IPA HARNESS ASSEMBLY - 949-0400-003
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Keying Plug MOD IV 87077 AMP	417-0224	1
----	Connector, FC112N2, Crimp Contact	417-0372	3
----	Connector, MC112N, Crimp Contact	417-0381	3
----	Pins, Crimp Type	417-8766	3

TABLE 3-9. RF AMPLIFIER MODULE ASSEMBLY - 959-0412

REF. DES.	DESCRIPTION	PART NO.	QTY.
C13 thru C16, C27 thru C30	Capacitor, Ceramic Chip, 470 pF ±5%, 200V	009-4723	8
C39, C40	Capacitor, Ceramic Chip, 15 pF ±5%, 500V	009-1513	2
Q1, Q2	Transistor, RF Power Mosfet, MRF-151G, 175 MHz, 50V, 300W	210-0151	2
R1	Resistor, 50 Ohm ±1%, 20W	132-5002	1
R201	Resistor, 50 Ohm, 250W	131-5030	1
T1, T2	Transformer, RF Amplifier Output	370-0052	2
----	RF Amplifier Module Logic Circuit Board Assembly	919-0417	1
----	RF Amplifier Module Directional Coupler Circuit Board Assembly	919-0418-001	1
----	RF Amplifier Circuit Board Assembly	919-0416	1
----	RF Amplifier Module Low-Pass Filter Circuit Board Assembly	919-0418-002	1
----	Blank, Module Combiner Shield Circuit Board	519-0419	1
----	Blank, Module Combiner Circuit Board	519-0420	2

TABLE 3-10. RF AMPLIFIER CIRCUIT BOARD ASSEMBLY - 919-0416
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1, C2	Capacitor, Electrolytic, 47 uF, 63V	020-4770	2
C6, C7	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	2
C9	Capacitor, Ceramic Chip, 1000 pF ±5%, 500V	009-5613	1
C10	Capacitor, Ceramic, Variable, 4 to 25 pF, 100V	090-0004	1
C11, C12	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	2
C17	Capacitor, Mica, Feedthru, 1000 pF ±10%, 350V	046-1030	1
C20, C21	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	2
C23	Capacitor, Ceramic Chip, 1000 pF ±5%, 500V	009-5613	1
C24	Capacitor, Ceramic, Variable, 4 to 25 pF, 100V	090-0004	1
C25	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	1
C31	Capacitor, Mica, Feedthru, 1000 pF ±10%, 350V	046-1030	1
C34	Capacitor, Ceramic Chip, 1000 pF ±5%, 500V	009-1033	1
C35, C36	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	2
C38	Capacitor, Ceramic Chip, 1000 pF ±5%, 500V	009-1033	1

TABLE 3-10. RF AMPLIFIER CIRCUIT BOARD ASSEMBLY - 919-0416 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C43	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	1
D1, D2	Diode, Switching, MMBD914LT1, TO-236AB	204-0914	2
D3	Diode, MMBD701LT1, High Voltage, Schottky Barrier Type, 70V, Surface Mount	201-2801	1
DS1, DS2	LED, 521-9450, Tri-Color, Common Cathode	320-0031	2
F1	Fuse, ATC-25, 25A	334-2500	1
L1, L2	Choke, RF Amplifier Decoupling, FM-1C1	360-0146	2
J1, J2	Receptacle, Male, 3-Pin In-Line	408-0300	1
J801	Connector, Header, 40-Pin Dual-In-Line	417-4040	1
P1, P2	Jumper, Programmable, 2-Pin	340-0004	2
P803	Connector, Type N, Angle, PCB Mount	417-0235	1
R2	Resistor, Chip, 2.2 k Ohm ±5%, 1/4W	101-2243	1
R4	Resistor, Chip, 267 k Ohm ±1%, 1/4W	101-2670	1
R5 thru R8	Resistor, Chip, 22 Ohm ±5%, 1/2W	111-2223	4
R9	Potentiometer, 10 k Ohm ±10%	198-1054	1
R10	Resistor, Chip, 2.2 k Ohm ±5%, 1/4W	101-2243	1
R11	Resistor, Chip, 47.5 k Ohm ±1%, 1/4W	101-0475	1
R13	Resistor, Chip, 2.2 k Ohm ±5%, 1/4W	101-2243	1
R14	Resistor, Chip, 499 k Ohm ±1%, 1/4W	101-4990	1
R15	Resistor, Chip, 2.2 k Ohm ±5%, 1/4W	101-2243	1
R18 thru R21	Resistor, Chip, 22 Ohm ±5%, 1/2W	111-2223	4
R22	Potentiometer, 10 k Ohm ±10%	198-1054	1
R23, R26	Resistor, Chip, 2.2 k Ohm ±5%, 1/4W	101-2243	2
R27, R28	Resistor, 22 Ohm ±5%, 4W	130-2243	2
U1, U2	Integrated Circuit, LM35DZ, Celsius Temperature Sensor, TO-92 Case	220-0035	2
----	Input Transformer	370-0721	2
----	RF Amplifier Circuit Board Wire Harness	949-0405	1
----	Fuse Holder, ATC Type, PCB Mount	415-0015	2
----	Blank RF Amplifier Circuit Board	519-0416	1

TABLE 3-11. RF AMPLIFIER CABLES ASSEMBLY - 949-0405

REF. DES.	DESCRIPTION	PART NO.	QTY.
P802	Connector, Male, Circuit Board Right Angle D	418-0322	1
W1	Coaxial Cable, RG316/U, Teflon, Impedance: 50 Ohm Capacitance: 29.3 pF/ft. Nominal	621-1359	1.5

TABLE 3-12. RF AMPLIFIER LOGIC CIRCUIT BOARD ASSEMBLY - 919-0417 (Sheet 1 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 20 pF ±10%, 1kV	002-2013	1

TABLE 3-12. RF AMPLIFIER LOGIC CIRCUIT BOARD ASSEMBLY - 919-0417 (Sheet 2 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C2	Capacitor, Monolythic Ceramic, .047 uF ±5% 50V	003-4733	1
C3, C4	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	2
C5, C6	Capacitor, Monolythic Ceramic, .047 uF ±5% 50V	003-4733	2
C7 thru C10	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	4
C11	Capacitor, Monolythic Ceramic, .047 uF ±5% 50V	003-4733	1
C12 thru C14	Capacitor, Ceramic Disc, 20 pF ±10%, 1kV	002-2013	3
C15	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C16 thru C18	Capacitor, Electrolytic, 10 uF, 35V	023-1076	3
C19	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C20	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C21	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C22	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C23, C24	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	2
C25, C26	Capacitor, Ceramic Disc, 20 pF ±10%, 1kV	002-2013	2
D1 thru D16	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	16
D17	Diode, Zener, 1N4742A, 12V ±5%, 1W	200-4742	1
D19 thru D21	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	3
D22, D23	Diode, HP5082-2800, High Voltage, Schottky Barrier Type, 70V, 15 mA	201-2800	2
D24, D25	Diode, 1N4148, Silicon, 75V @ 0.3 Amperes	203-4148	2
P801	Receptacle, 40-Pin Dual In-line	417-4041	1
Q1, Q2, Q5 thru Q7	Transistor, MPSA06, NPN, TO-92 Case	211-0006	5
Q8	Transistor, 2N3906, PNP, Silicon, TO-92 Case	210-3906	1
R1	Resistor Network, 5 k Ohm ±1%, 1/4W, 16-Pin DIP	226-0500	1
R2	Resistor, 499 k Ohm, ±1%, 1/4W	103-4996	1
R3	Resistor, 2.74 k Ohm ±1%, 1/4W	103-2744	1
R4	Resistor, 499 k Ohm, ±1%, 1/4W	103-4996	1
R5	Potentiometer, 10 k Ohm ±10% 1/2W	178-1054	1
R6 thru R8	Resistor, 22.1 k Ohm ±1%, 1/4W	103-2211	3
R9	Resistor, 182 k Ohm ±1%, 1/4W	103-1826	1
R10	Resistor, 22.1 k Ohm ±1%, 1/4W	103-2211	1
R11	Potentiometer, 200 Ohm ±10%, 1/2W	177-2035	1
R12	Resistor, 499 k Ohm, ±1%, 1/4W	103-4996	1
R13	Resistor, 2.74 k Ohm ±1%, 1/4W	103-2744	1
R14	Resistor, 8.25 k Ohm ±1%, 1/4W	103-8254	1
R15	Potentiometer, 10 k Ohm ±10% 1/2W	178-1054	1
R12	Resistor, 499 k Ohm, ±1%, 1/4W	103-4996	1
R16	Resistor, 499 k Ohm ±1%, 1/4W	103-4996	1
R17	Resistor, 2.74 k Ohm ±1%, 1/4W	103-2744	1
R18	Resistor, 499 k Ohm, ±1%, 1/4W	103-4996	1
R19	Resistor, 240 Ohm ±1%, 1/4W	103-2431	1
R20	Resistor, 499 k Ohm, ±1%, 1/4W	103-4996	1

TABLE 3-12. RF AMPLIFIER LOGIC CIRCUIT BOARD ASSEMBLY - 919-0417
(Sheet 3 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R21	Resistor, 22.1 k Ohm ±1%, 1/4W	103–2211	1
R22	Resistor, 162 k Ohm ±1%, 1/4W	103–1626	1
R23	Resistor, 499 k Ohm, ±1%, 1/4W	103–4996	1
R24	Resistor, 22.1 k Ohm ±1%, 1/4W	103–2211	1
R25	Potentiometer, 10 k Ohm ±10% 1/2W	178–1054	1
R26	Resistor, 2.74 k Ohm ±1%, 1/4W	103–2744	1
R27	Resistor, 499 k Ohm, ±1%, 1/4W	103–4996	1
R28, R29	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	2
R30	Resistor, 15.8 k Ohm ±1%, 1/4W	103–1585	1
R31, R32	Resistor, 499 k Ohm, ±1%, 1/4W	103–4996	2
R33	Resistor, 1.33 k Ohm ±1%, 1/4W	103–1331	1
R34	Resistor, 5.11 k Ohm ±1%, 1/4W	103–5141	1
R35	Resistor Network, 8–22 k Ohm 1/4W Resistors, 16–Pin DIP	226–2250	1
R36	Resistor, 22.1 k Ohm ±1%, 1/4W	103–2211	1
R37	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	1
R38	Resistor, 15.8 k Ohm ±1%, 1/4W	103–1585	1
R39	Resistor, 1.33 k Ohm ±1%, 1/4W	103–1331	1
R40	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	1
R41	Resistor, 9.09 k Ohm ±1%, 1/4W	103–9041	1
R42	Resistor, 499 k Ohm, ±1%, 1/4W	103–4996	1
R43	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	1
R44, R45	Resistor, 22.1 k Ohm ±1%, 1/4W	103–2211	2
R46, R47	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	2
R48	Resistor, 7.68 k Ohm, ±1%, 1/4W	103–7684	1
R49, R50	Resistor, 22.1 k Ohm ±1%, 1/4W	103–2211	2
R51	Potentiometer, 20 k Ohm ±10%, 1/2W	178–2054	1
R52	Resistor, 162 k Ohm ±1%, 1/4W	103–1626	1
R53	Resistor, 5.11 k Ohm ±1%, 1/4W	103–5141	1
R54	Resistor, 47.5 k Ohm ±1%, 1/4W	103–4755	1
R55	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	1
R56	Resistor, 10 k Ohm ±1%, 1/4W	100–1051	1
R57, R58	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	2
R59, R60	Resistor, 51.1 Ohm ±1%, 1/4W	103–5112	2
R61	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	1
R62	Resistor, 5.11 k Ohm ±1%, 1/4W	103–5141	1
R63	Resistor, 1 k Ohm ±1%, 1/4W	100–1041	1
R64	Resistor, 5.11 k Ohm ±1%, 1/4W	103–5141	1
R65	Resistor, 499 k Ohm, ±1%, 1/4W	103–4996	1
R66	Resistor, 47.5 k Ohm, ±1%, 1/4W	103–4755	1
R67	Resistor, 100 k Ohm ±1%, 1/4W	103–1062	1
R68	Resistor, 16.9 k Ohm ±1%, 1/4W	103–1695	1
R69	Resistor, 22.1 k Ohm ±1%, 1/4W	103–2211	1
R70	Resistor, 8.25 k Ohm ±1%, 1/4W	103–8254	1
R71	Resistor, 15.8 k Ohm ±1%, 1/4W	103–1585	1
R72	Resistor, 499 k Ohm, ±1%, 1/4W	103–4996	1
R73	Resistor, 78.7 k Ohm ±1%, 1/4W	103–7875	1
R74	Resistor, 2.05 k Ohm ±1%, 1/4W	103–2054	1

TABLE 3-12. RF AMPLIFIER LOGIC CIRCUIT BOARD ASSEMBLY - 919-0417 (Sheet 4 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R75, R76	Resistor, 5.11 k Ohm ±1%, 1/4W	103-5141	2
R77	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
TP1 thru	Terminal, Test Point, Oval Red	413-0106	3
U1	Integrated Circuit, MPQ3799, Quad Amplifier, PNP, 14-Pin DIP	220-3799	1
U2 thru U6	Integrated Circuit, TLO74CN, Quad JFET-Input Operational Amplifier, 14-Pin DIP	221-0074	5
U7	Integrated Circuit, LM317LZ, Adjustable Positive Voltage Regulator, 1.2 to 37V @ 0.1 Ampere, TO-92 Case	220-0317	1
----	Blank RF Amplifier Logic Circuit Board	519-0417	1

TABLE 3-13. RF AMPLIFIER MODULE DIRECTIONAL COUPLER CIRCUIT BOARD ASSEMBLY -919-0418-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
C101	Capacitor, Ceramic Chip, 10 pF ±5%, 500V	009-1013	1
C102	Capacitor, Ceramic Chip, 15 pF ±5%, 500V	009-1513	1
C103	Capacitor, Ceramic Chip, 6.8 pF, 500V	009-6810	1
C104, C105	Capacitor, Ceramic Chip, 10 pF ±5%, 500V	009-1013	2
C106	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	1
C107, C108	Capacitor, Ceramic, 47 pF ±5%, 50V	003-4712	2
C109, C112 thru C114	Capacitor, Ceramic Chip, 1000 pF ±5%, 100V	009-1032	1
C115, C116	Capacitor, Ceramic Chip, 15 pF ±5%, 500V	009-1513	2
D103 thru D105	Diode, HP5082-2800, High Voltage, Schottky Barrier Type, 70V, 15 mA	201-2800	3
L101, L102	Coil, Molded, .11 uH, 1A	364-0011	2
L103, L104	Inductor, Molded, 68 uH	360-0106	2
R104, R105	Resistor, 66.5 Ohm ±1%, 1/4W	103-6652	2
R109, R110	Resistor, 1 k Ohm ±1%, 1/4W	100-1041	2
----	Blank RF Amplifier Directional Coupler Circuit Board	519-0418-001	1

TABLE 3-14. RF AMPLIFIER MODULE LOW-PASS FILTER CIRCUIT BOARD ASSEMBLY -919-0418-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
C201	Capacitor, Ceramic Chip, 10 pF ±5% 500V	009-1013	1
C202	Capacitor, Ceramic Chip, 15 pF ±5%, 500V	009-1513	1
C203	Capacitor, Ceramic Chip, 6.8 pF, 500V	009-6810	1
C204, C205	Capacitor, Ceramic Chip, 15 pF ±5%, 500V	009-1013	1
----	Blank RF Amplifier Module Low-Pass Filter Circuit Board	519-0418-002	1

SECTION IV
IPA DRAWINGS

4-1. INTRODUCTION.

4-2. This section provides assembly drawings and schematic diagrams as listed below for the IPA unit.

FIGURE	TITLE	NUMBER
4-1	SCHEMATIC DIAGRAM, IPA OVERALL	SB959-0421
4-2	SCHEMATIC DIAGRAM, FILTER CIRCUIT BOARD	SB919-0435
4-3	ASSEMBLY DIAGRAM, FILTER CIRCUIT BOARD	AB919-0435
4-4	SCHEMATIC DIAGRAM, MOTHERBOARD ASSEMBLY	SB919-0400/-001
4-5	ASSEMBLY DIAGRAM, MOTHERBOARD ASSEMBLY	AC919-0400/-001
4-6	SCHEMATIC DIAGRAM, IPA CONTROLLER CIRCUIT BOARD ASSEMBLY	SB919-0434-001
4-7	SCHEMATIC DIAGRAM, IPA STATUS CIRCUIT BOARD ASSEMBLY	SB919-0434-002
4-8	ASSEMBLY DIAGRAM, IPA CONTROLLER CIRCUIT BOARD ASSEMBLY	AC919-0434-001 /-002
4-9	SCHEMATIC DIAGRAM, IPA POWER SUPPLY MOTHERBOARD ASSEMBLY	SA919-0423
4-10	ASSEMBLY DIAGRAM, IPA POWER SUPPLY MOTHERBOARD ASSEMBLY	AB919-0423
4-11	SCHEMATIC DIAGRAM, RF POWER MODULE	SB959-0412
4-12	SCHEMATIC DIAGRAM, RF AMPLIFIER LOGIC CIRCUIT BOARD	SB919-0417
4-13	ASSEMBLY DIAGRAM, RF AMPLIFIER LOGIC CIRCUIT BOARD	AB919-0417
4-14	ASSEMBLY DIAGRAM, RF AMPLIFIER CIRCUIT BOARD BOARD	AD919-0416
4-15	ASSEMBLY DIAGRAM, RF AMPLIFIER MODULE LOW-PASS FILTER/DIRECTIONAL COUPLER CIRCUIT BOARDS	AC919-0418-001 /-002

J703/P703 <---------------> J601/P601

1	GND	1
2	GND	14
3	PA2 REFLECTED POWER SAMPLE	2
4	PA2 MODULE TEMPERATURE	15
5	PA2 MUTE	3
6	PA2 FAULT STATUS	16
7	PA2 -15V	4
8	PA2 MODULE CURRENT	17
9	PA2 LOGIC GROUND	5
10		18
11	PA2 +15V	6
12	PA2 FORWARD POWER SAMPLE	19
13	PA2 FAULT RESET	7
14	PA VOLTAGE SAMPLE	20
15	PA1 -15V	8
16	PA1 MODULE CURRENT	21
17	PA1 LOGIC GROUND	9
18		22
19	PA1 +15V	10
20	PA1 FORWARD POWER SAMPLE	23
21	PA1 FAULT RESET	11
22	PA1 FAULT STATUS	24
23	PA1 MUTE	12
24	PA1 MODULE TEMPERATURE	25
25	PA1 REFLECTED POWER SAMPLE	13
26	GND	26

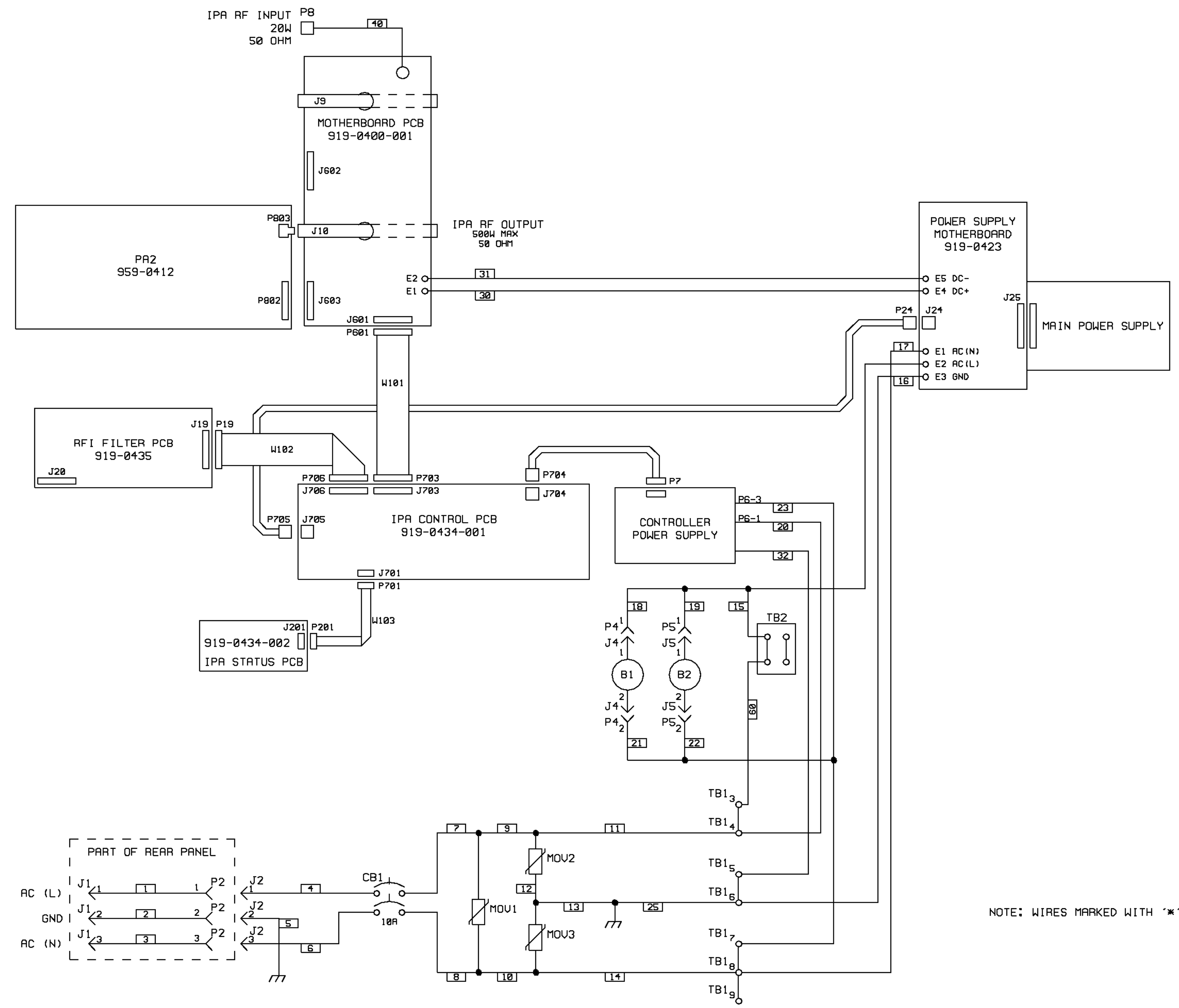
J706/P706 <--> P19/J19 <------------> J20/P20

1	IPA BUSS VOLTAGE TO XMTR METERING BD	1
2	IPA CURRENT TO XMTR METERING BD	2
3	IPA BUSS VOLTAGE TO XMTR CONTROLLER	3
4	IPA OVERTEMP TO XMTR CONTROLLER	4
5	IPA FORWARD POWER TO XMTR CONTROLLER	5
6	IPA CURRENT TO XMTR CONTROLLER	6
7	IPA FORWARD POWER TO XMTR METERING BD	7
8	IPA REFLECTED POWER TO XMTR CONTROLLER	8
9	IPA REFLECTED POWER TO XMTR METERING BD	9
10	NO CONNECTION	10
11	IPA FAULT STATUS (REMOTE)	11
12	RF MUTE FROM XMTR CONTROLLER	12
13	NO CONNECTION	13
14	EXTERNAL IPA POWER CONTROL	14
15	NO CONNECTION	15
16	IPA RESET COMMAND (REMOTE)	16
17	NO CONNECTION	17
18	NO CONNECTION	
19	NO CONNECTION	
20	+5V	18
21	+15V	20
22	IPA PWR SUP FAULT STATUS (REMOTE)	21
23	IPA MOD FAULT STATUS (REMOTE)	22
24	GND TO XMTR METERING BD	23
25	NO CONNECTION	
26	GND	25

J701/P701 <--> P201/J201

1	GND
2	P.S. FAULT
3	VSWR
4	OVERTEMP
5	GND
6	IPA FAULT RESET
7	GND
8	FAULT RESET INDICATOR
9	IPA POWER ADJUST
10	+15V

FROM	SIGNAL	TO	WIRE
P7 - 1	+15V	J704 - 1	26
P7 - 2	+5V	J704 - 3	27
P7 - 4	GND	J704 - 2	28
P7 - 6	-15V	J704 - 4	29
J705-1			33 *
J705-2			34 *
J705-3			35 *
J705-4			62 *
J705-8			63 *
J705-9	MUTE P.S.	P24 - 6	65
J705-12	P.S. VOLTAGE CNTL	P24 - 5	67
J705-13	P.S. FAULT	P24 - 3	66
J705-16	GND (LOGIC)	P24 - 1	64
J705-18	P.S. PRESENT	P24 - 2	73



NOTE: WIRES MARKED WITH '*' NOT USED.

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

DWN. BY 9-8-96 M. HAYDEN
DESIGNER(S)
PROJ. LEADER MBS 1/17/97
MFG.
MATERIAL
FINISH
SEE DWG AA592-0000
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE IPA OVERALL SCHEMATIC

TYPE S | SIZE B | DWG. NO. 959-0421 | REV A

MODEL IPA | SCALE NONE | SHEET 1 OF 1

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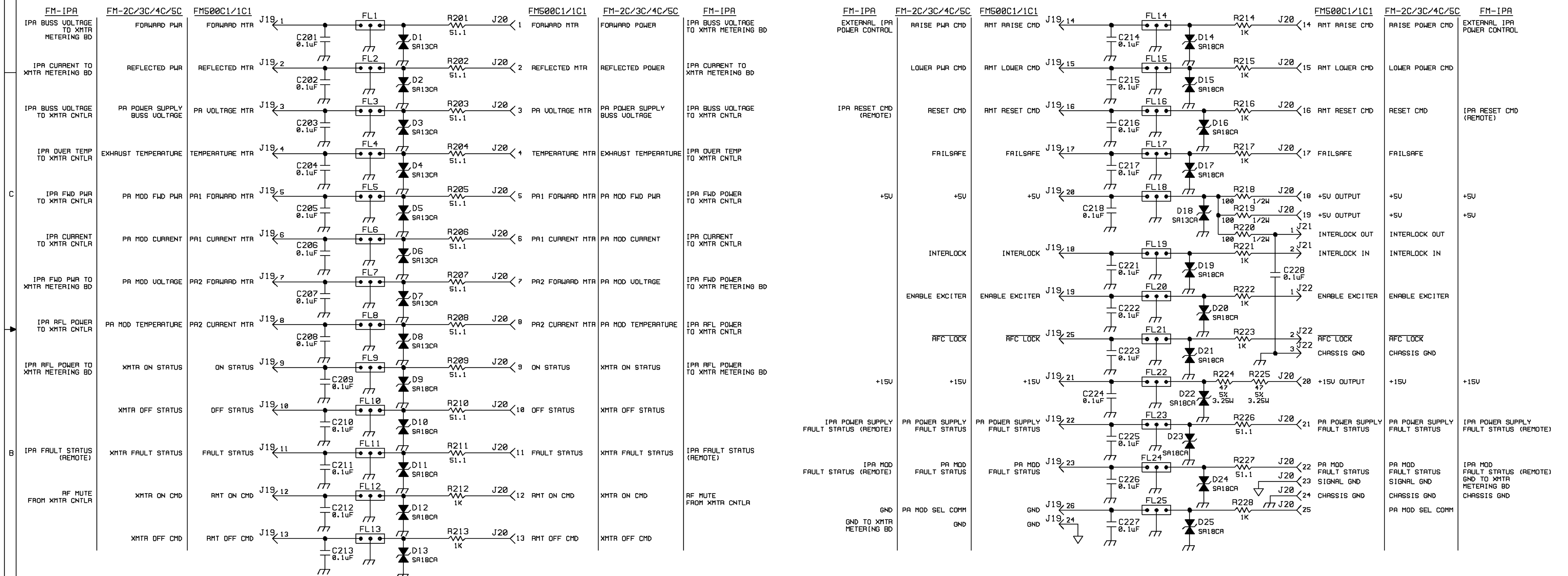


NOTES:

1. ALL RESISTORS IN OHMS; 1/4W, 1%, UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C228, D25, FL25, J22, R228.
3. COMPONENTS NOT USED: C219, C220, J1-J18
4. SEE ASSEMBLY: AB919-0435.

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

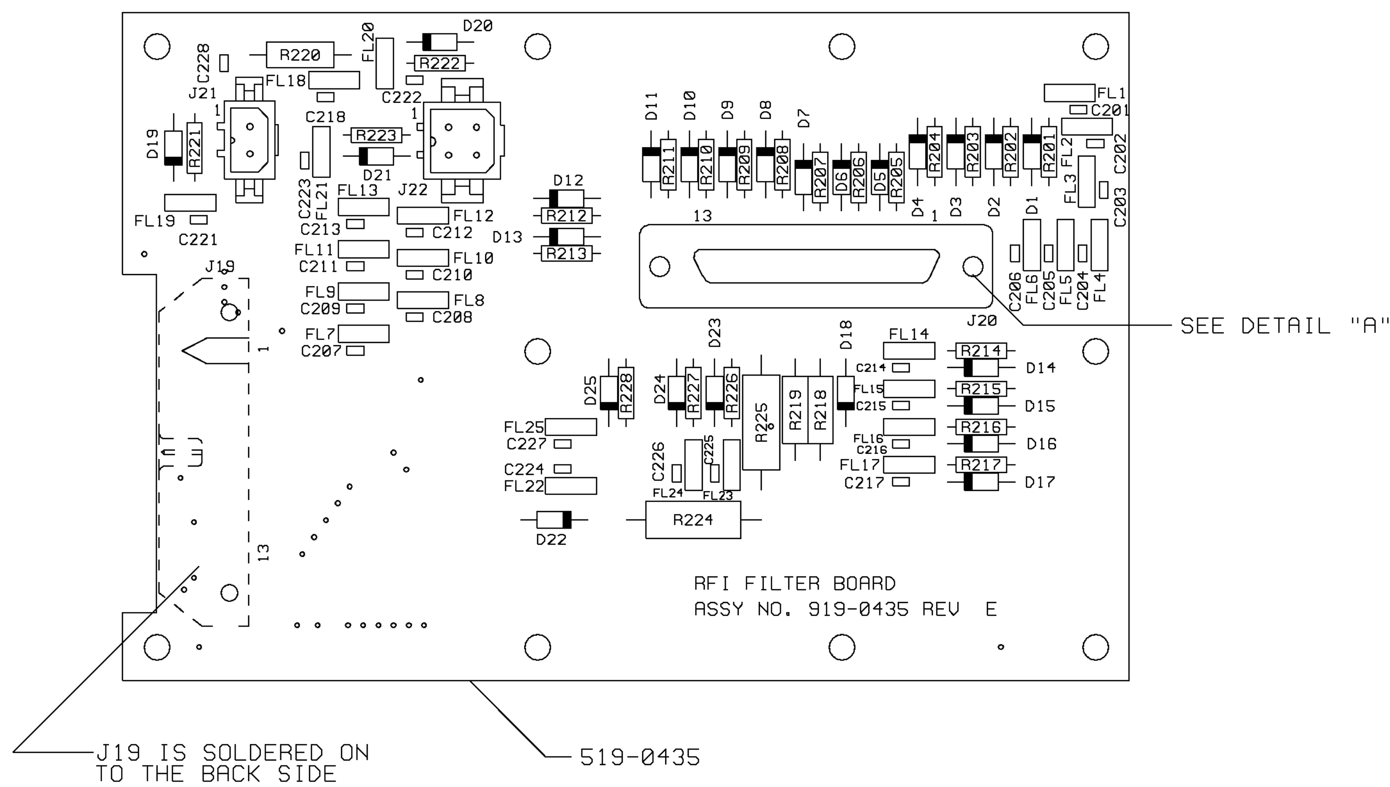
DWN. BY	5-14-96 M. HAYDEN
DESIGNER(S)	
PROJ. LEADER	MBS 1-24-97
MFG.	
MATERIAL	SEE BOM 919-0435
FINISH	
NEXT ASSY.	~~SEE DWG AA592-0000~~

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE: SCHEMATIC RFI FILTER BOARD

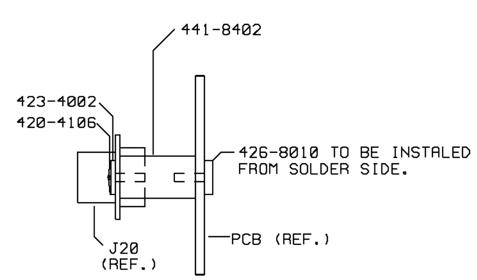
TYPE	SIZE	DWG. NO.	REV
S	B	919-0435	B

MODEL FM-IPA | SCALE NONE | SHEET 1 OF 1



NOTES:

1. SEE SCHEMATIC SB919-0435.



DETAIL "A"
TYPICAL 2 PLCS.

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

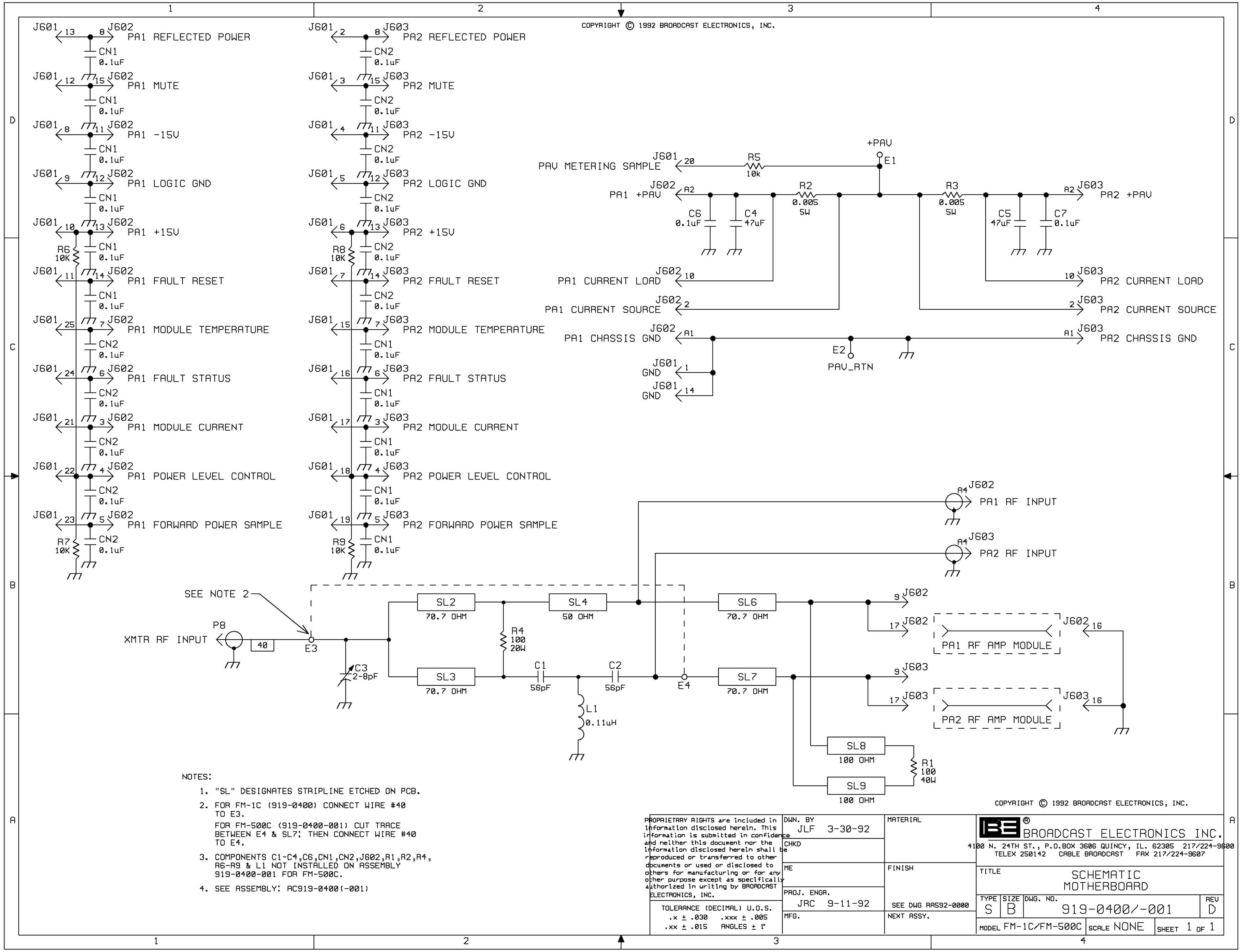
DWN. BY	6-12-96 M. HAYDEN
DESIGNER(S)	
PROJ. LEADER	
MFG.	
MATERIAL	SEE BOM'S 919-0435
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305
217/224-9600 FAX 217/224-9607

TITLE PCB ASSEMBLY
RFI FILTER BOARD

TYPE	SIZE	DWG No.	REV
A	B	919-0435	E

MODEL FM-IPA | SCALE 1/1 | SHEET 1 OF 1



COPYRIGHT © 1992 BROADCAST ELECTRONICS, INC.
PA1 REFLECTED POWER
PA1 MUTE
PA1 -15V
PA1 LOGIC GND
PA1 +15V
PA1 FAULT RESET
PA1 MODULE TEMPERATURE
PA1 FAULT STATUS
PA1 MODULE CURRENT
PA1 POWER LEVEL CONTROL
PA1 FORWARD POWER SAMPLE
PA2 REFLECTED POWER
PA2 MUTE
PA2 -15V
PA2 LOGIC GND
PA2 +15V
PA2 FAULT RESET
PA2 MODULE TEMPERATURE
PA2 FAULT STATUS
PA2 MODULE CURRENT
PA2 POWER LEVEL CONTROL
PA2 FORWARD POWER SAMPLE
CN1 0.1uF
CN2 0.1uF
R6 10K
R7 10K
R8 10K
R9 10K
+PAV
E1
PAV METERING SAMPLE
R5 10k
PA1 +PAV
R2 0.005 5W
R3 0.005 5W
PA2 +PAV
C6 0.1uF
C4 47uF
C5 47uF
C7 0.1uF
PA1 CURRENT LOAD
PA2 CURRENT LOAD
PA1 CURRENT SOURCE
PA2 CURRENT SOURCE
PA1 CHASSIS GND
PA2 CHASSIS GND
E2
PAV_RTN
GND
PA1 RF INPUT
PA2 RF INPUT
SEE NOTE 2
XMTR RF INPUT
P8
40
E3
C3 2-8pF
SL2 70.7 OHM
SL3 70.7 OHM
R4 100 20W
SL4 50 OHM
C1 56pF
C2 56pF
L1 0.11uH
E4
SL6 70.7 OHM
SL7 70.7 OHM
PA1 RF AMP MODULE
PA2 RF AMP MODULE
SL8 100 OHM
SL9 100 OHM
R1 100 40W
NOTES:
1. "SL" DESIGNATES STRIPLINE ETCHED ON PCB.
2. FOR FM-1C (919-0400) CONNECT WIRE #40 TO E3.
FOR FM-500C (919-0400-001) CUT TRACE BETWEEN E4 & SL7; THEN CONNECT WIRE #40 TO E4.
3. COMPONENTS C1-C4,C6,CN1,CN2,J602,R1,R2,R4, R6-R9 & L1 NOT INSTALLED ON ASSEMBLY 919-0400-001 FOR FM-500C.
4. SEE ASSEMBLY: AC919-0400(-001)
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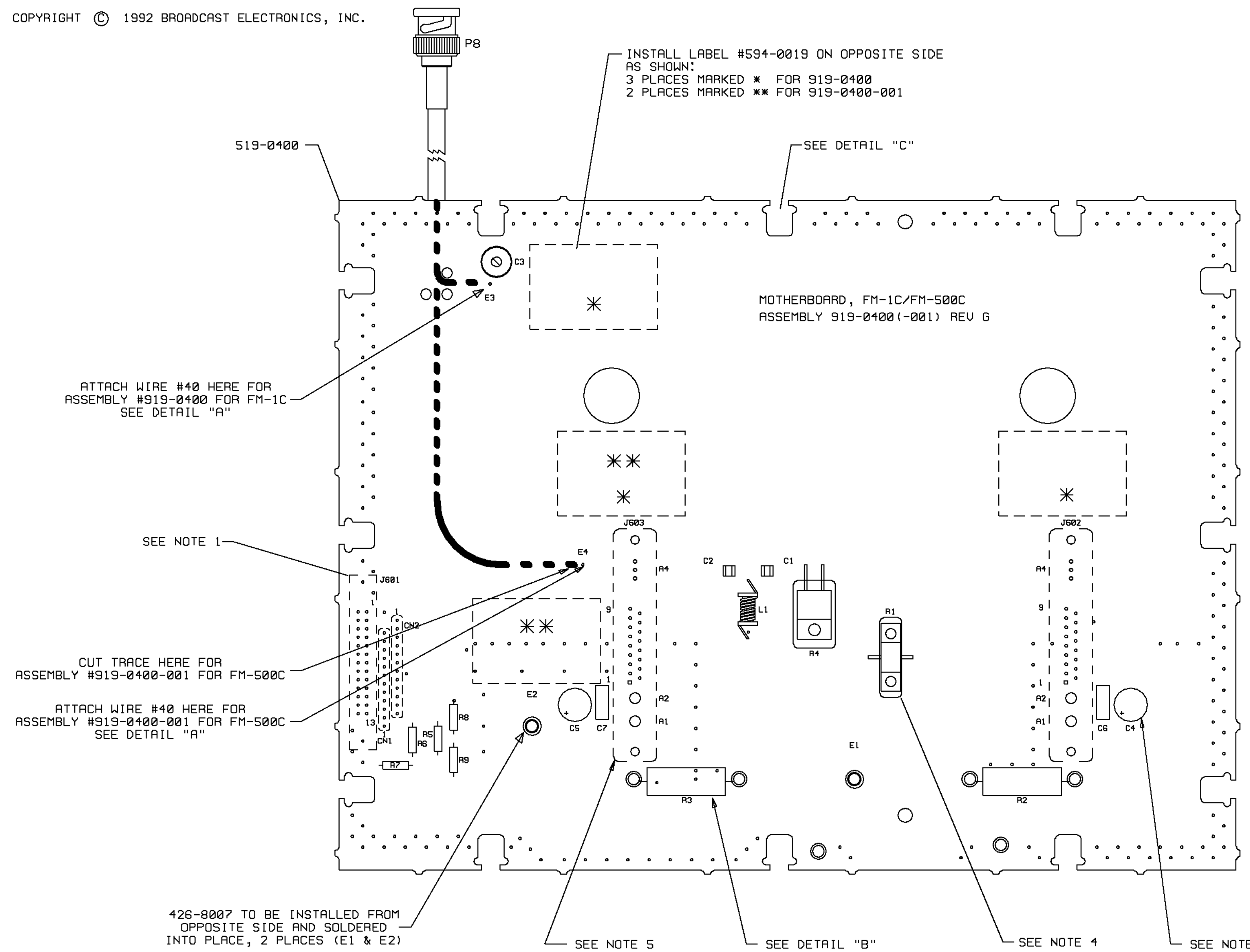
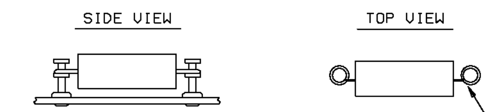
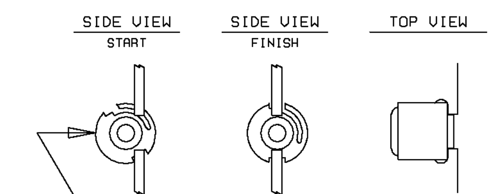
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°
DWN. BY JLF 3-30-92
CHKD
ME
PROJ. ENGR. JRC 9-11-92
MFG.
MATERIAL
FINISH
SEE DWG AA592-0000
NEXT ASSY.
BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607
TITLE
SCHEMATIC
MOTHERBOARD
TYPE S
SIZE B
DWG. NO. 919-0400/-001
REV D
MODEL FM-1C/FM-500C
SCALE NONE
SHEET 1 OF 1





INSTALL (2) TURRETS #413-0025 AND SOLDER INTO PLACE TOP & BOTTOM. MOUNT RESISTOR #139-0007 TO TURRETS AS SHOWN - NOTE THAT RESISTOR MOUNTS TO LOWER SIDE OF TURRETS AS SHOWN IN TOP VIEW. RESISTOR LEADS SHOULD BE AS SHORT AND STRAIGHT AS POSSIBLE WITHOUT BENDING TURRETS.

DETAIL "B"
2 PLCS (R2, R3)

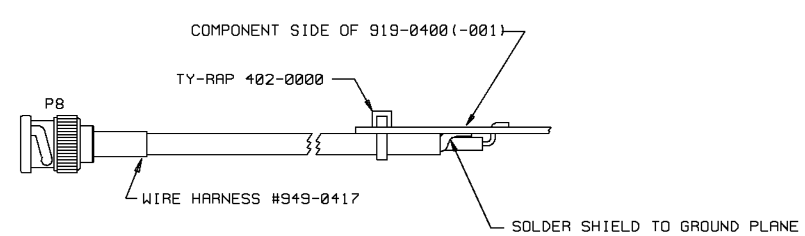


PRESS #421-6908 SHEETEDGE FASTENER INTO CUTOUT UNTIL SNAPPED INTO PLACE AS SHOWN

DETAIL "C"
12 PLCS

NOTES:

1. COMPONENTS SHOWN WITH DASHED LINES TO BE INSTALLED ON OPPOSITE SIDE.
2. COMPONENTS C1-C4,C6,CN1,CN2,J602,R1,R2, R4,R6-R9 & L1 NOT INSTALLED ON ASSEMBLY # 919-0400-001 FOR FM-500C.
3. SEE SCHEMATIC: SC919-0400(-001)
4. R1 & R4 TO BE INSTALLED DURING TRANSMITTER FINAL ASSEMBLY.
5. MOUNT J602/J603 TO PCB WITH :
   QTY (2) EACH #423-4002 SPLIT
   QTY (2) EACH #441-0187 STOFF
   BEFORE SOLDERING INTO PLACE.



DETAIL "A"

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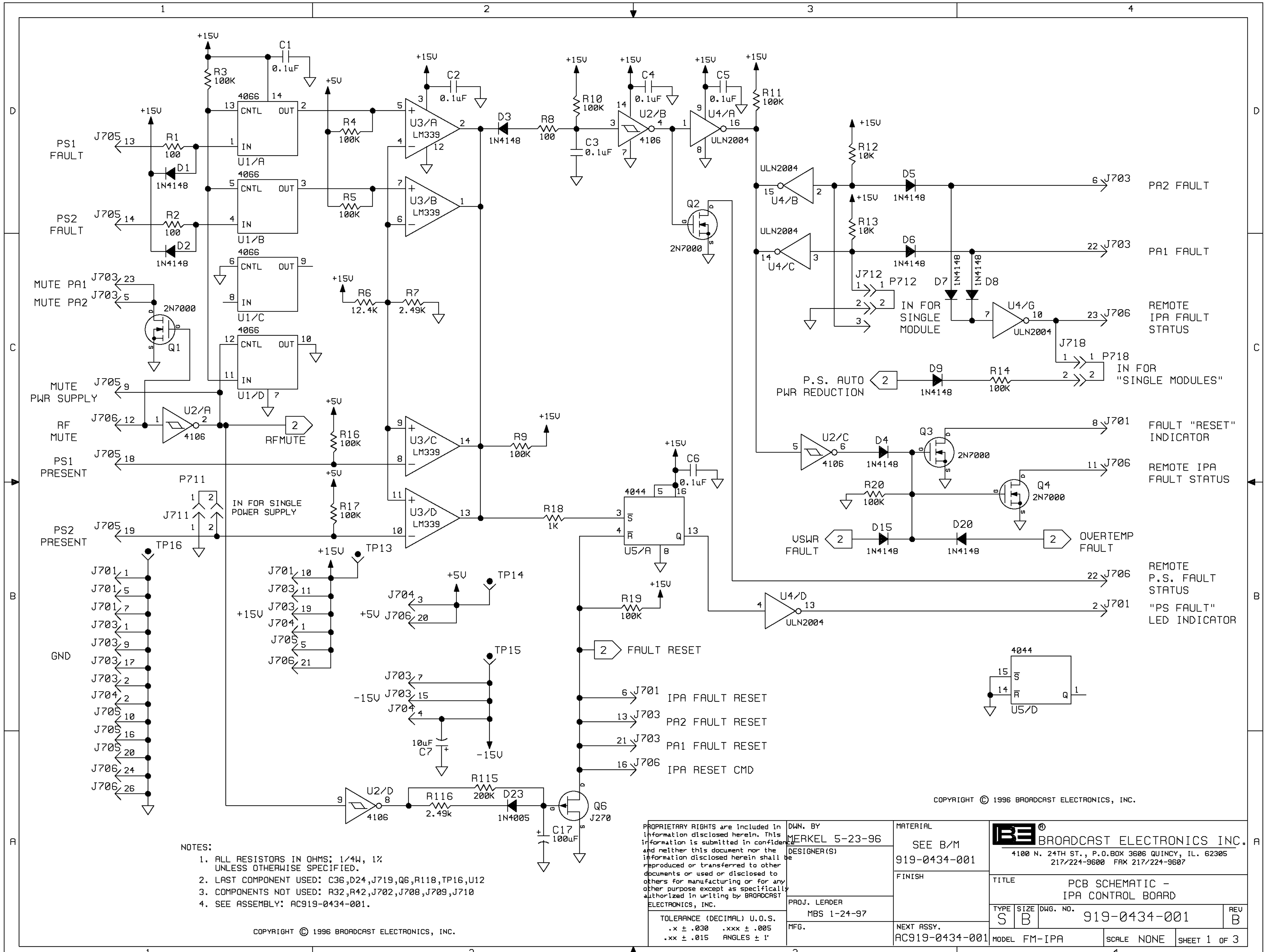
TOLERANCE (DECIMAL) U.O.S. .X ± .030 .XXX ± .005 .XX ± .015 ANGLES + 1°	DWN. BY JLF 2-12-92	MATERIAL SEE BOM 919-0400 919-0400-001	BROADCAST ELECTRONICS INC. 4100 N.24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 PH. 217/224-9600 TELEX 250142 CABLE BROADCAST FAX 217/224-9607
	CHKD		TITLE PCB ASSEMBLY MOTHERBOARD
	ME	FINISH ----	TYPE A · SIZE C · DWG No. 919-0400 919-0400-001 · REV G
	PROJ. ENGR. JRC 9-11-92	SEE DWG RA592-0000	MODEL FM-1C FM-500C · SCALE 1:1 · SHEET 1 OF 1
	MFG.	NEXT ASSY.	



NOTES:
1. ALL RESISTORS IN OHMS; 1/4W, 1%
UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C36,D24,J719,Q6,R118,TP16,U12
3. COMPONENTS NOT USED: R32,R42,J702,J708,J709,J710
4. SEE ASSEMBLY: AC919-0434-001.

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

DWN. BY: MERKEL 5-23-96
DESIGNER(S)
PROJ. LEADER: MBS 1-24-97
MFG.
MATERIAL: SEE B/M 919-0434-001
FINISH
NEXT ASSY.: AC919-0434-001

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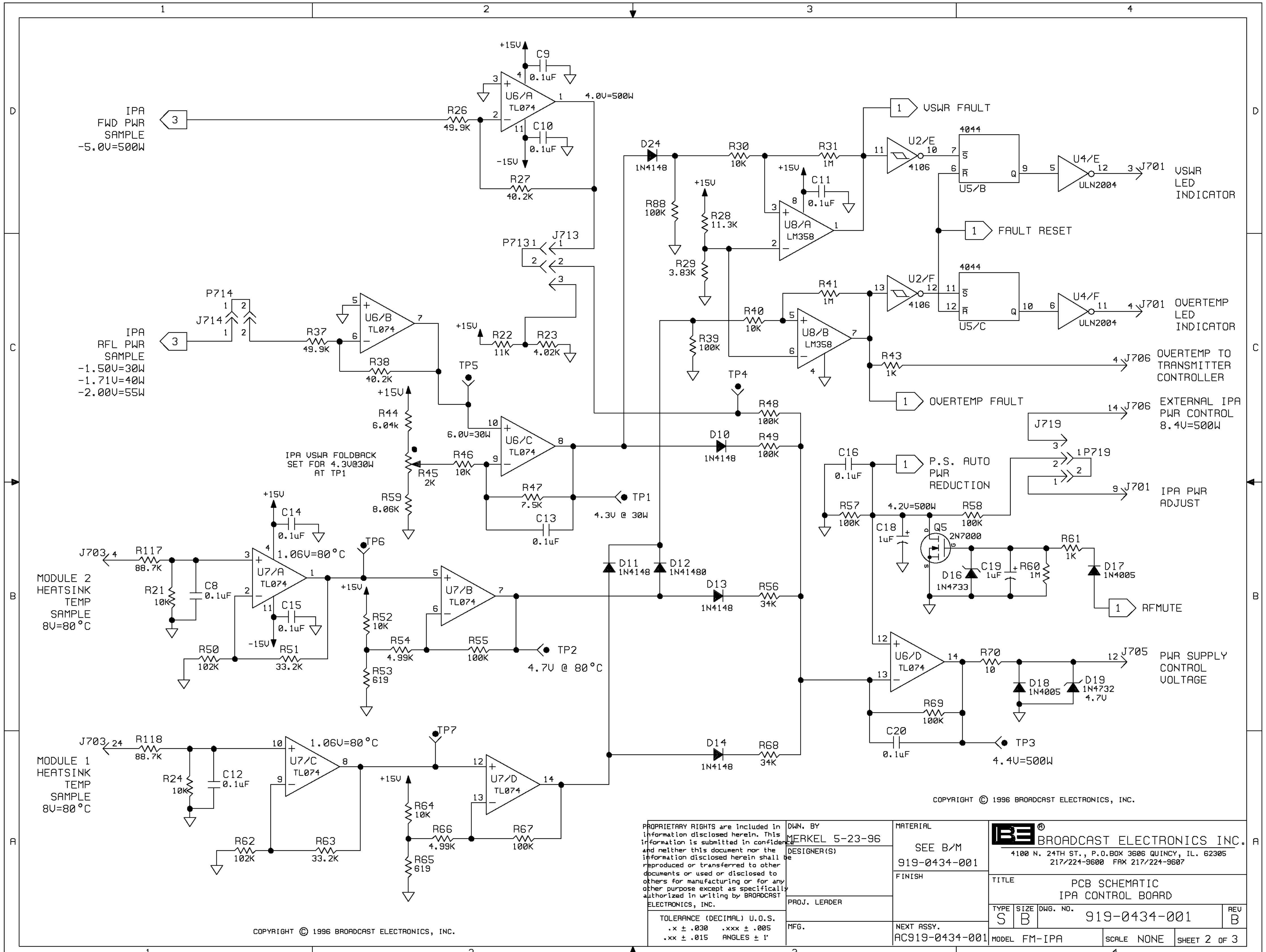
217/224-9600 FAX 217/224-9607

TITLE: PCB SCHEMATIC - IPA CONTROL BOARD

TYPE S | SIZE B | DWG. NO. 919-0434-001 | REV B

MODEL FM-IPA | SCALE NONE | SHEET 1 OF 3



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

DWN. BY MERKEL 5-23-96	MATERIAL SEE B/M 919-0434-001		
DESIGNER(S)	FINISH	TITLE	PCB SCHEMATIC IPA CONTROL BOARD
PROJ. LEADER			
MFG.	NEXT ASSY. AC919-0434-001	TYPE S SIZE B DWG. NO. 919-0434-001	REV B
		MODEL FM-IPA SCALE NONE	SHEET 2 OF 3

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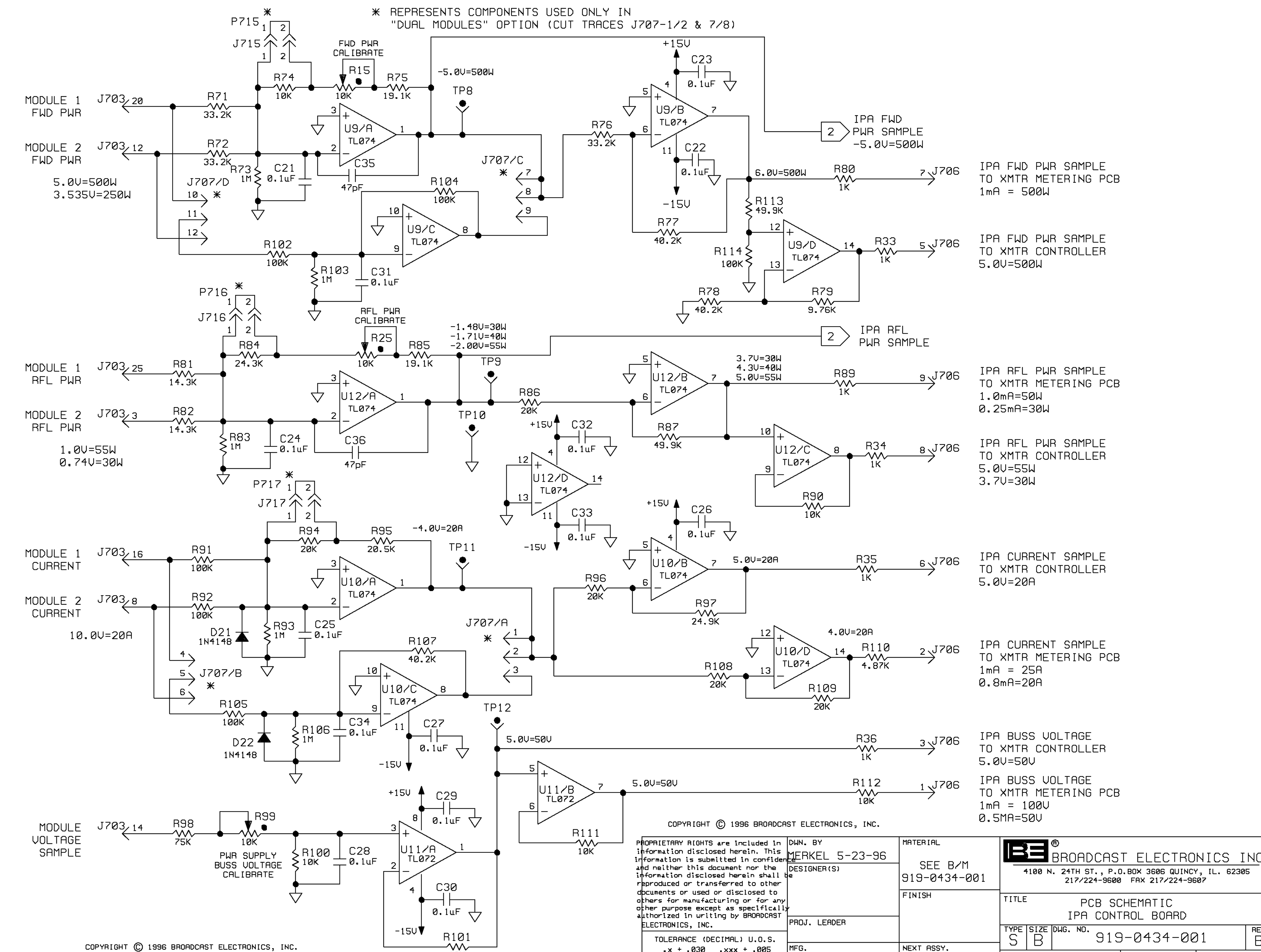
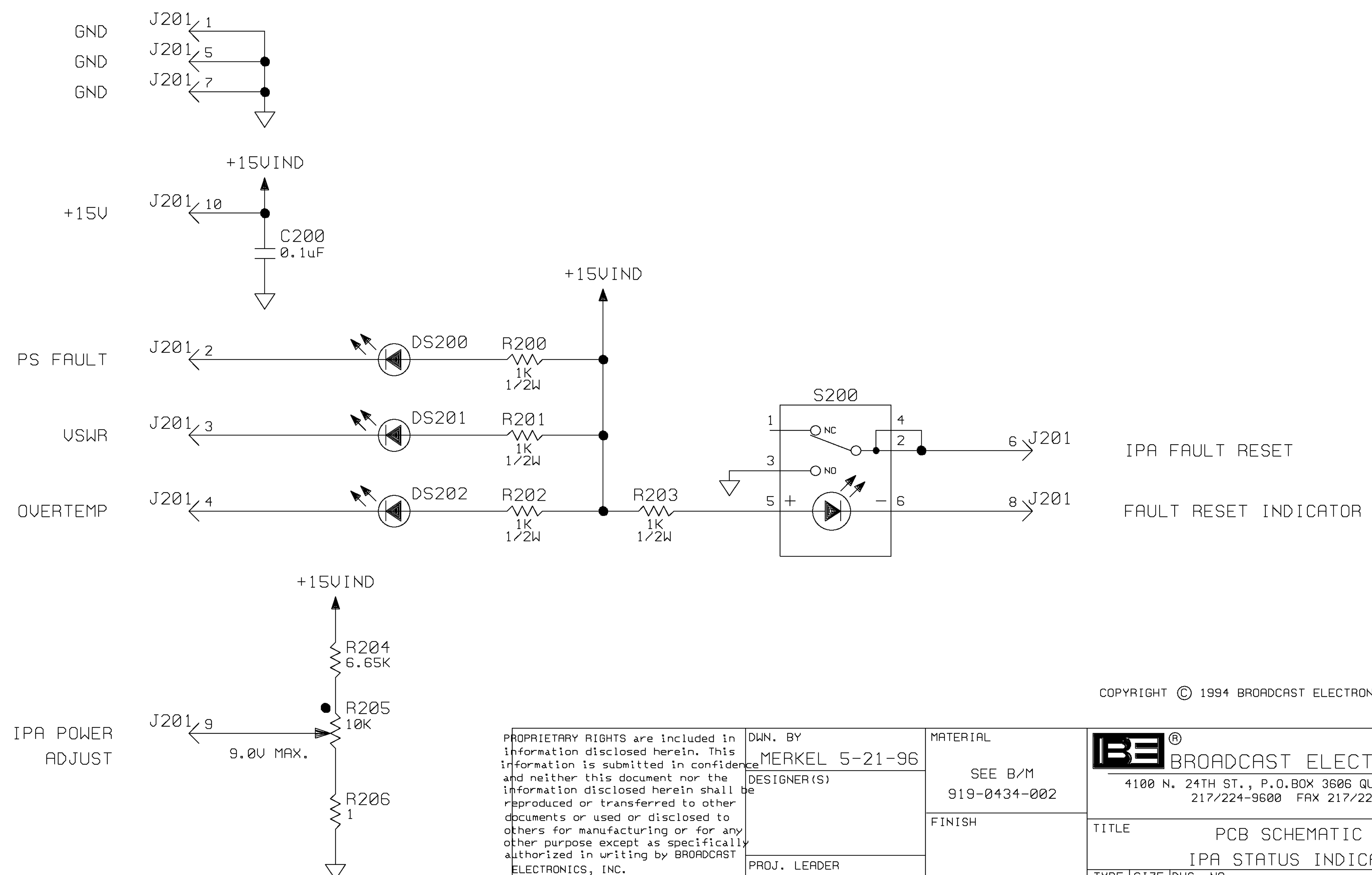
217/224-9600 FAX 217/224-9607



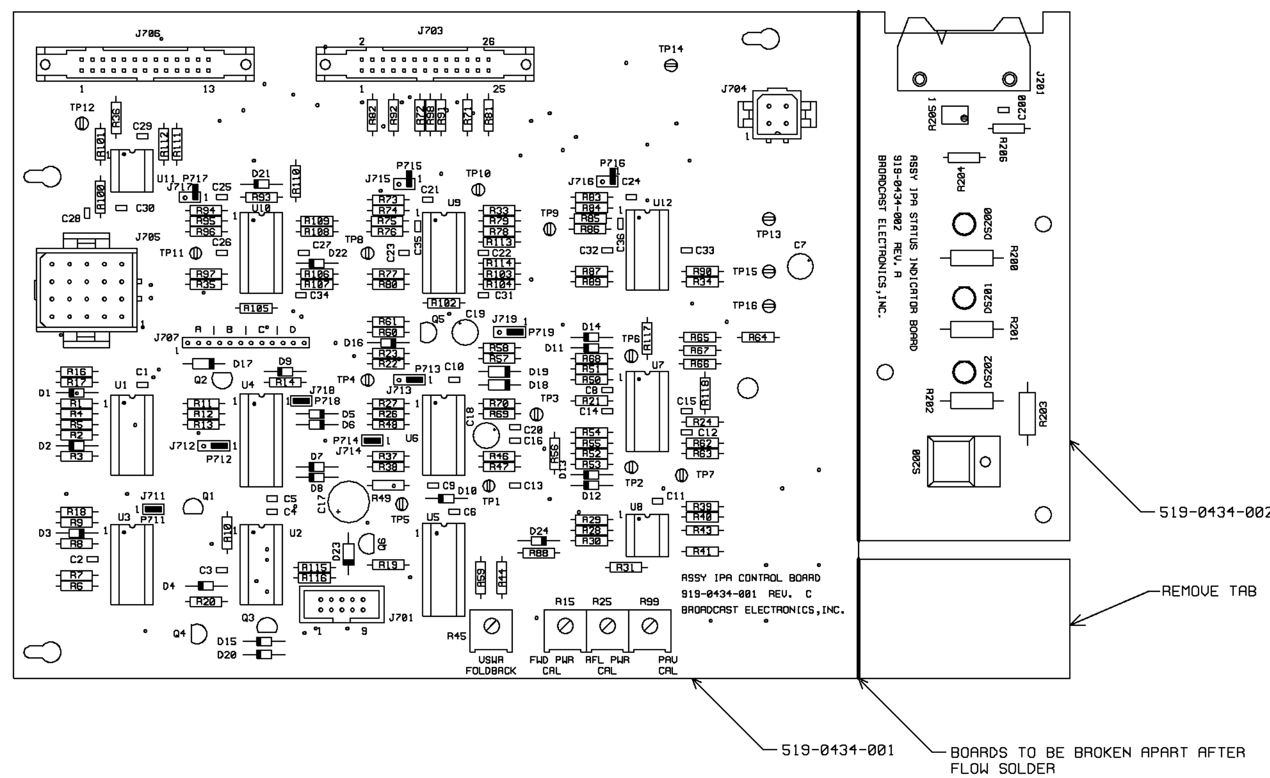
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY MERKEL 5-23-96	MATERIAL SEE B/M 919-0434-001	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 FAX 217/224-9607	
DESIGNER(S)	FINISH	TITLE PCB SCHEMATIC IPA CONTROL BOARD	
PROJ. LEADER		TYPE S SIZE B DWG. NO. 919-0434-001	REV B
MFG.	NEXT ASSY. AC919-0434-001	MODEL FM-IPA SCALE NONE	SHEET 3 OF 3



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

DWN. BY MERKEL 5-21-96	MATERIAL SEE B/M 919-0434-002	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 FAX 217/224-9607
DESIGNER(S)	FINISH	TITLE PCB SCHEMATIC - IPA STATUS INDICATOR
PROJ. LEADER		TYPE S / SIZE B / DWG. NO. 919-0434-002 / REV A
MFG.	NEXT ASSY.	MODEL FM-IPA / SCALE NONE / SHEET 1 OF 1



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

DWN. BY	MERKEL 5-29-96
DESIGNER(S)	
PROJ. LEADER	
MFG.	
MATERIAL	SEE B/M 919-0434-001 919-0434-002
FINISH	
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305
217/224-9600 FAX 217/224-9607

TITLE PCB ASSEMBLY - IPA CONTROL & STATUS INDICATOR BOARDS

TYPE	SIZE	DWG No.	REV
A	C	919-0434-001 919-0434-002	C

MODEL FM-IPA SCALE 1/1 SHEET 1 OF 1

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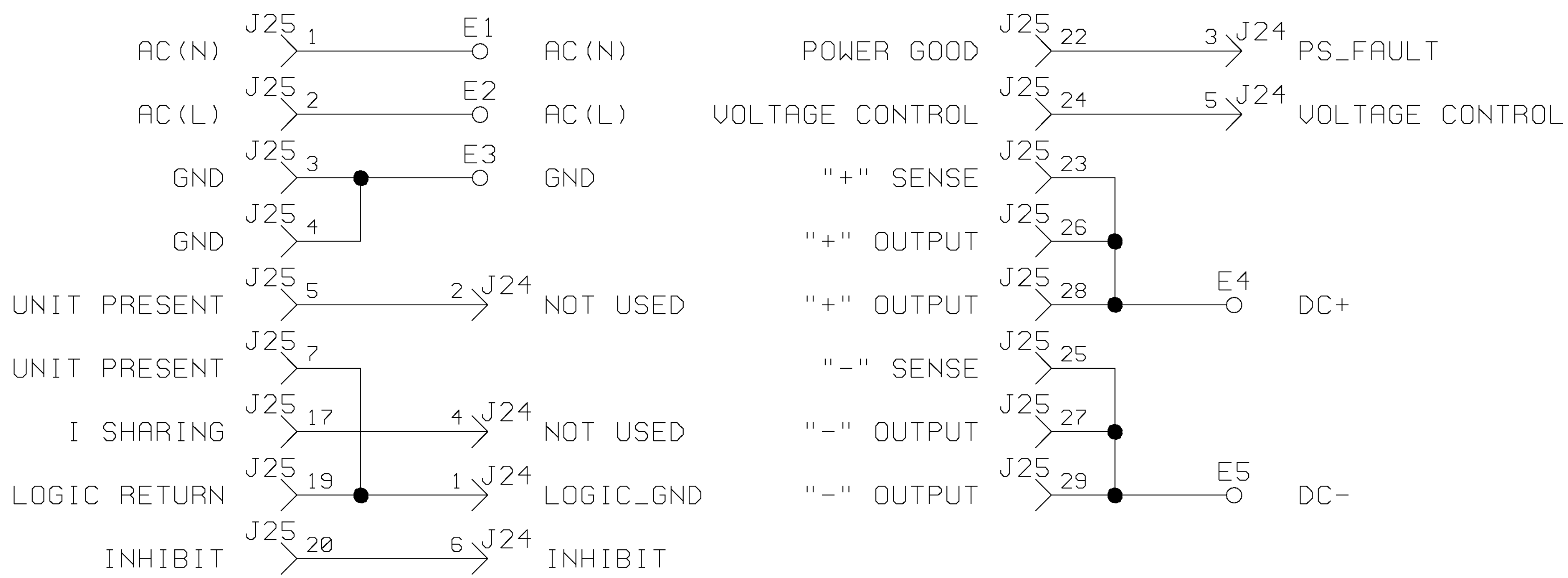

TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY	JLF 5-2-94
DESIGNER(S)	JRC 6-23-94
PROJ. LEADER	
MFG.	
MATERIAL	SEE BOM 919-0423
FINISH	SEE DWG RA592-0000
NEXT ASSY.	

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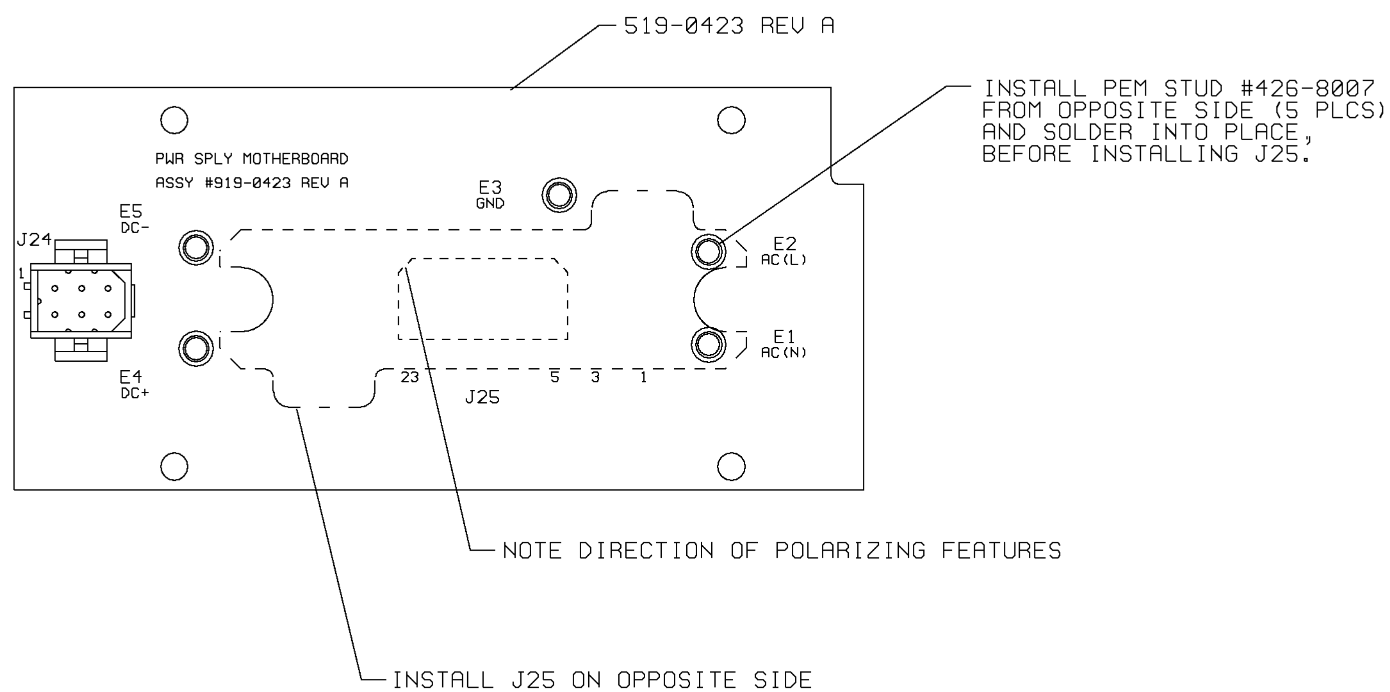
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE SCHEMATIC
POWER SUPPLY MOTHERBOARD

TYPE	SIZE	DWG. NO.	REV
S	A	919-0423	A

MODEL	SCALE	SHEET
FM-1C1	NONE	1 OF 1



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

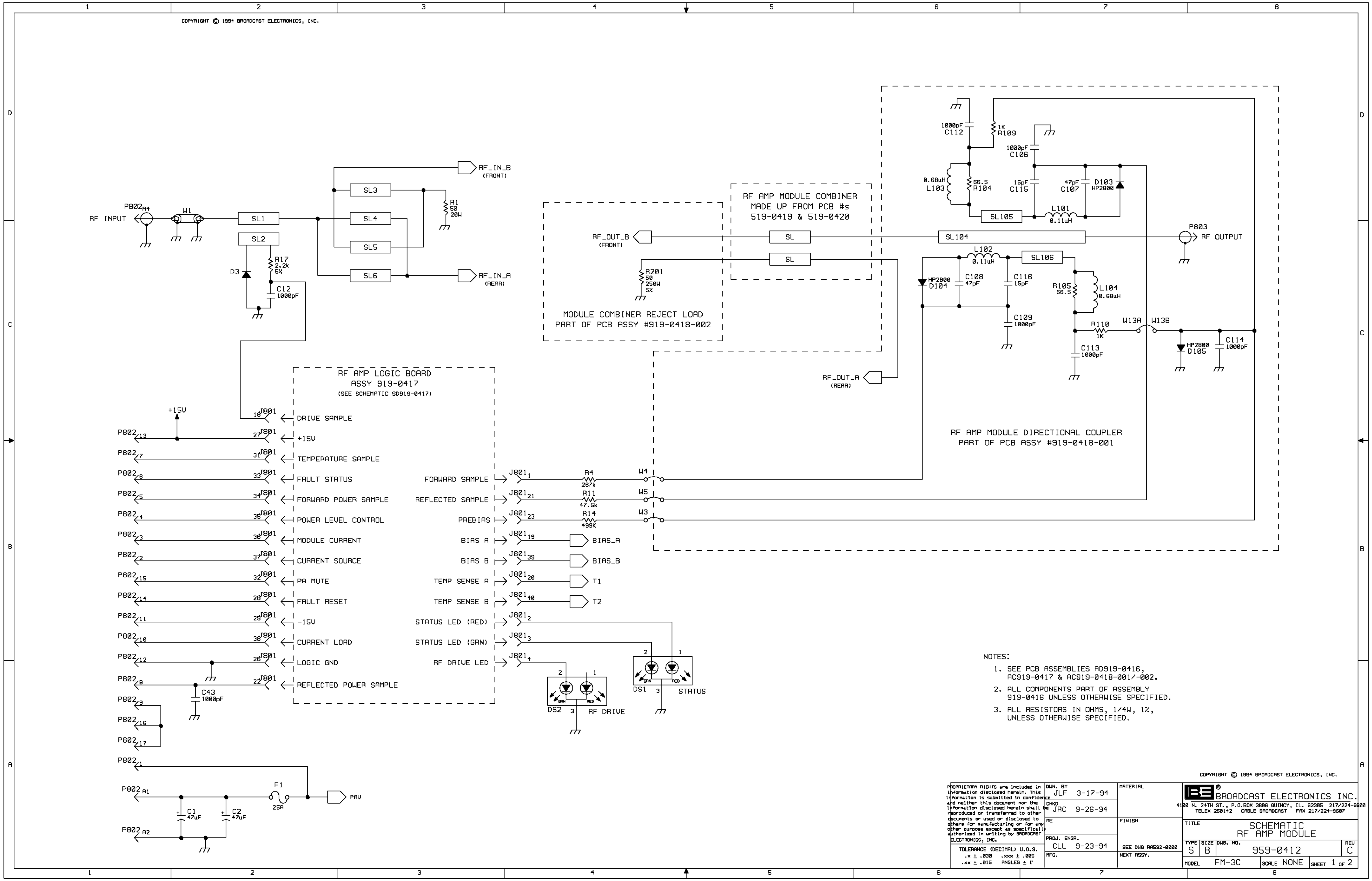
DWN. BY	JLF 6-16-94
DESIGNER(S)	JRC 6-23-94
PROJ. LEADER	
MFG.	
MATERIAL	SEE BOM 919-0423
FINISH	SEE DWG RA592-0000
NEXT ASSY.	

BROADCAST ELECTRONICS INC.
4100 N.24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 PH. 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE: PCB ASSEMBLY PWR SPLY MOTHERBOARD

TYPE	SIZE	DWG No.	REV
A	B	919-0423	A

MODEL FM-1C1 | SCALE 1/1 | SHEET 1 OF 1



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RF INPUT
P802 A4
W1
SL1
SL2
SL3
SL4
SL5
SL6
R1 50 20W
R17 2.2k 5%
D3
C12 1000pF
RF_IN_B (FRONT)
RF_IN_A (REAR)
RF_OUT_B (FRONT)
R201 50 250W 5%
MODULE COMBINER REJECT LOAD
PART OF PCB ASSY #919-0418-002
RF AMP MODULE COMBINER
MADE UP FROM PCB #s
519-0419 & 519-0420
SL
SL
RF_OUT_A (REAR)
1000pF C112
1K R109
1000pF C106
0.68uH L103
66.5 R104
15pF C115
47pF C107
D103 HP2800
SL105
L101 0.11uH
SL104
P803
RF OUTPUT
L102 0.11uH
SL106
HP2800 D104
C108 47pF
C116 15pF
R105 66.5
L104 0.68uH
C109 1000pF
R110 1K
W13A
W13B
C113 1000pF
HP2800 D105
C114 1000pF
RF AMP MODULE DIRECTIONAL COUPLER
PART OF PCB ASSY #919-0418-001
RF AMP LOGIC BOARD
ASSY 919-0417
(SEE SCHEMATIC SD919-0417)
+15V
J801 18 DRIVE SAMPLE
P802 13 J801 27 +15V
P802 7 J801 31 TEMPERATURE SAMPLE
P802 6 J801 33 FAULT STATUS
P802 5 J801 34 FORWARD POWER SAMPLE
P802 4 J801 35 POWER LEVEL CONTROL
P802 3 J801 36 MODULE CURRENT
P802 2 J801 37 CURRENT SOURCE
P802 15 J801 32 PA MUTE
P802 14 J801 28 FAULT RESET
P802 11 J801 29 -15V
P802 10 J801 30 CURRENT LOAD
P802 12 J801 26 LOGIC GND
P802 8 J801 22 REFLECTED POWER SAMPLE
C43 1000pF
P802 9
P802 16
P802 17
P802 1
FORWARD SAMPLE J801 1
REFLECTED SAMPLE J801 21
PREBIAS J801 23
BIAS A J801 19 BIAS_A
BIAS B J801 39 BIAS_B
TEMP SENSE A J801 20 T1
TEMP SENSE B J801 40 T2
STATUS LED (RED) J801 2
STATUS LED (GRN) J801 3
RF DRIVE LED J801 4
R4 267k
R11 47.5k
R14 499K
W4
W5
W3
DS1 STATUS
DS2 RF DRIVE
GRN
RED
P802 A1
P802 A2
C1 47uF
C2 47uF
F1 25A
PAV
NOTES:
1. SEE PCB ASSEMBLIES AD919-0416, AC919-0417 & AC919-0418-001/-002.
2. ALL COMPONENTS PART OF ASSEMBLY 919-0416 UNLESS OTHERWISE SPECIFIED.
3. ALL RESISTORS IN OHMS, 1/4W, 1%, UNLESS OTHERWISE SPECIFIED.
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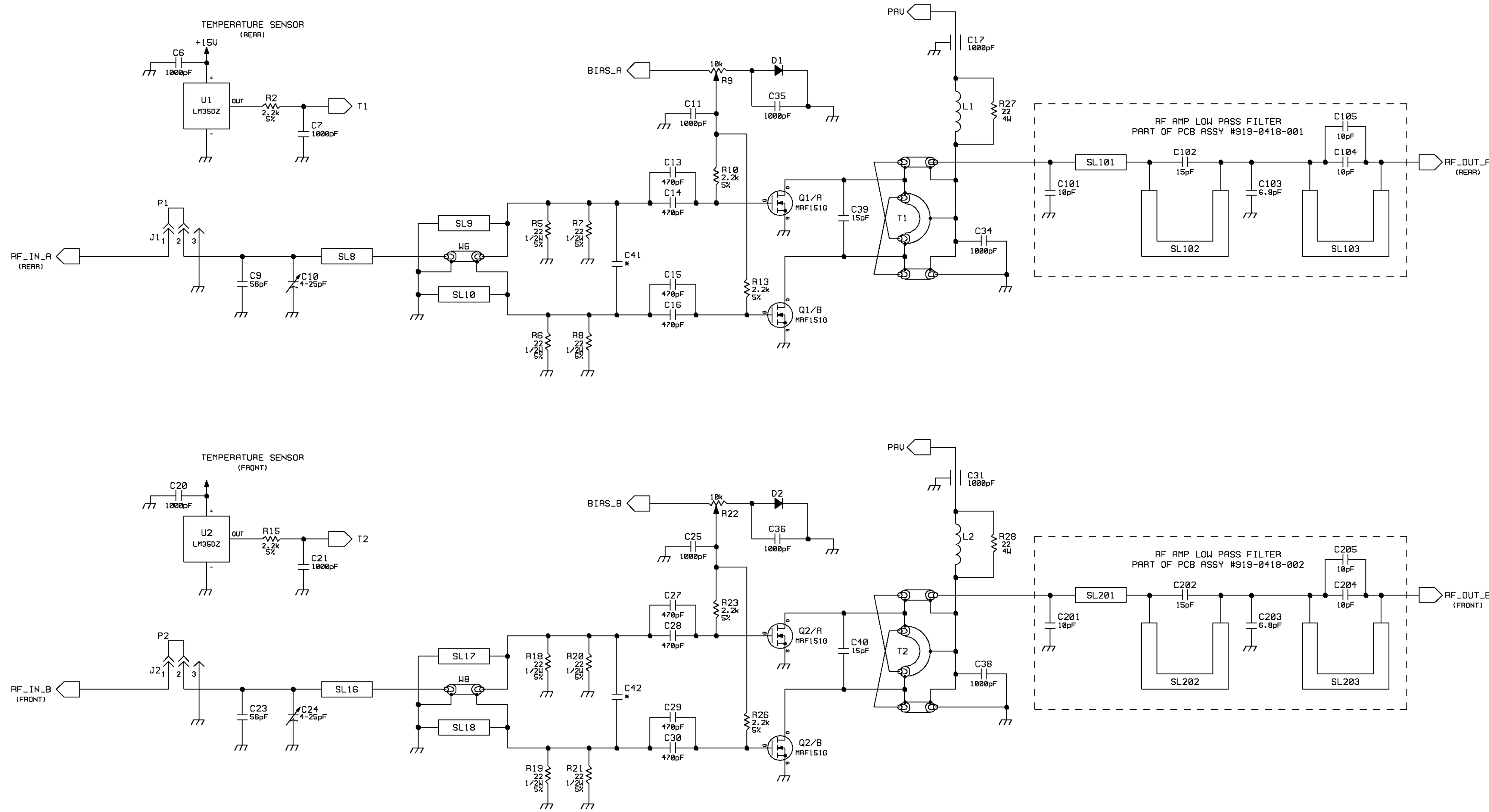
TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°
DWN. BY JLF 3-17-94
CHKD JRC 9-26-94
ME
PROJ. ENGR. CLL 9-23-94
MFG.
MATERIAL
FINISH
SEE DWG RA592-0000
NEXT ASSY.
BE BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607
TITLE SCHEMATIC RF AMP MODULE
TYPE S SIZE B DWG. NO. 959-0412 REV C
MODEL FM-3C SCALE NONE SHEET 1 OF 2



* VALUE FOR C41 AND C42 TO BE FACTORY SELECTED DURING MODULE TEST.

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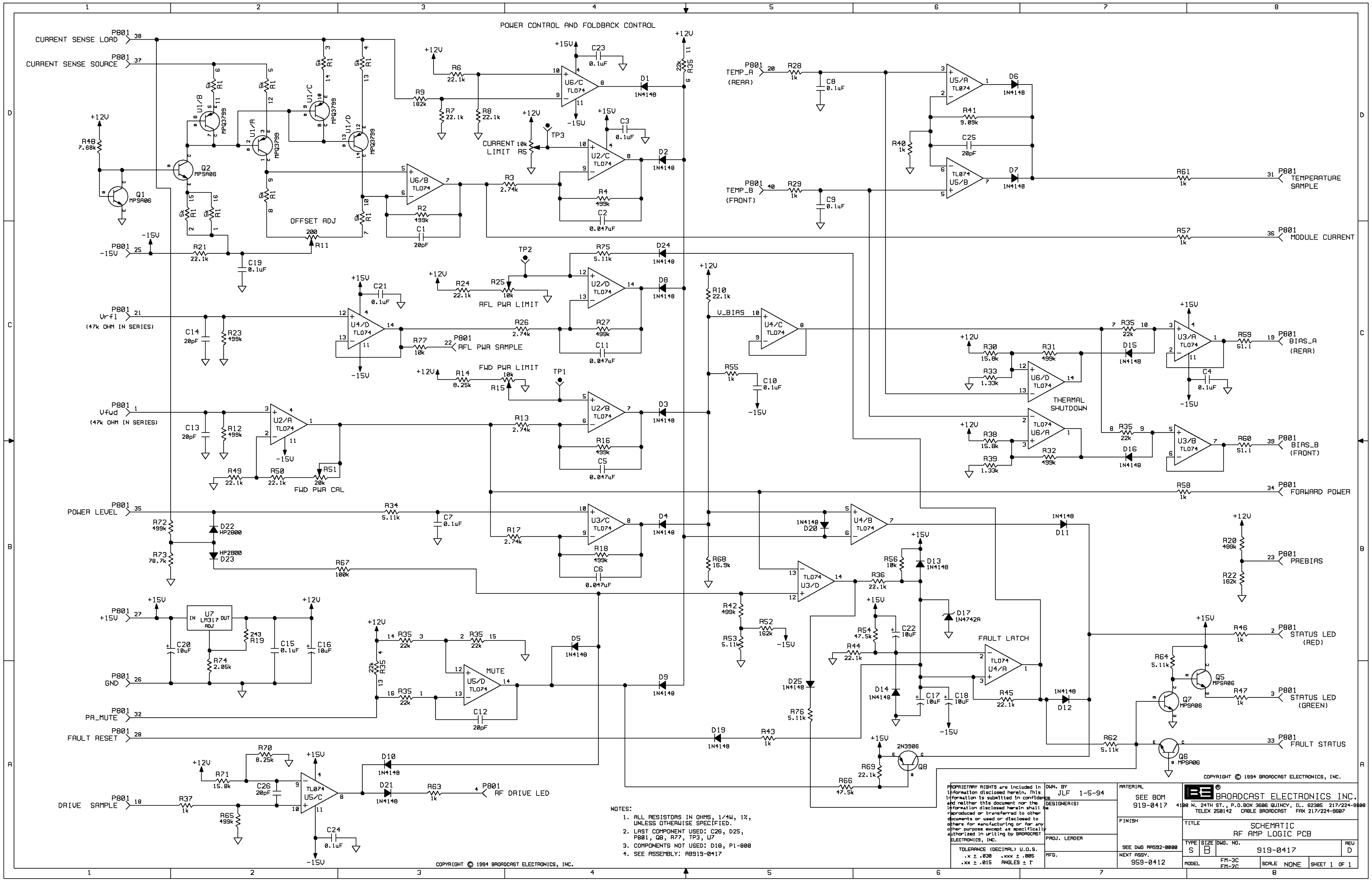
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY JLF 3-17-94	MATERIAL	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 TELEX 250142 CABLE BROADCAST FAX 217/224-9607	
CHKD JRC 9-26-94			
ME	FINISH	TITLE SCHEMATIC RF AMP MODULE	
PROJ. ENGR. CLL 9-23-94	SEE DWG AA592-0000	TYPE S SIZE B DWG. NO. 959-0412	REV C
MFG.	NEXT ASSY.	MODEL FM-3C SCALE NONE	SHEET 2 OF 2


POWER CONTROL AND FOLDBACK CONTROL
CURRENT SENSE LOAD
CURRENT SENSE SOURCE
OFFSET ADJ
CURRENT LIMIT R5
RFL PWR LIMIT
FWD PWR LIMIT
FWD PWR CAL
RFL PWR SAMPLE
Vrfl
(47k OHM IN SERIES)
Vfwd
(47k OHM IN SERIES)
POWER LEVEL
+15V
GND
PA_MUTE
FAULT RESET
DRIVE SAMPLE
RF DRIVE LED
MUTE
TEMP_A
(REAR)
TEMP_B
(FRONT)
TEMPERATURE SAMPLE
MODULE CURRENT
V_BIAS
BIAS_A
(REAR)
BIAS_B
(FRONT)
THERMAL SHUTDOWN
FORWARD POWER
PREBIAS
FAULT LATCH
STATUS LED
(RED)
STATUS LED
(GREEN)
FAULT STATUS
NOTES:
1. ALL RESISTORS IN OHMS, 1/4W, 1%, UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C26, D25, P801, Q8, R77, TP3, U7
3. COMPONENTS NOT USED: D18, P1-800
4. SEE ASSEMBLY: A8919-0417
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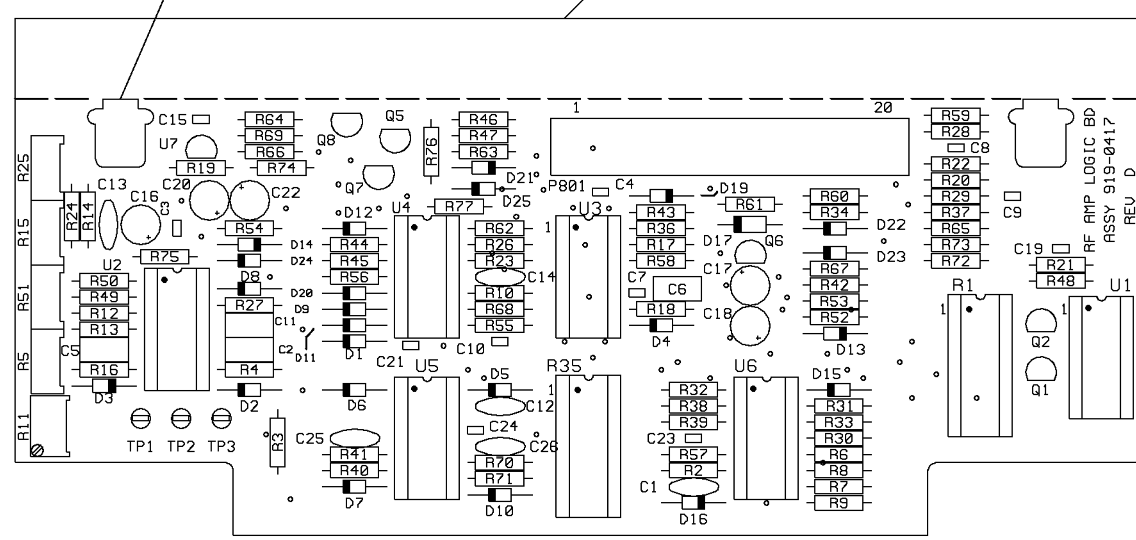
DWN. BY JLF 1-5-94
MATERIAL SEE BOM 919-0417
BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607
TITLE SCHEMATIC RF AMP LOGIC PCB
DWG. NO. 919-0417
REV D
SEE DWG A8592-0000
NEXT ASSY. 959-0412
MODEL FM-3C FM-2C
SCALE NONE
SHEET 1 OF 1

SEE DETAIL "A"

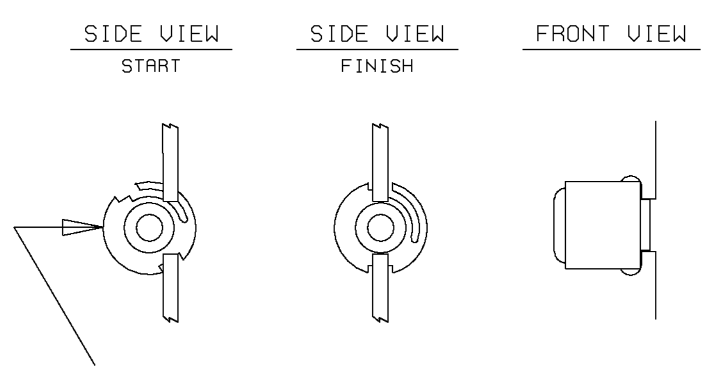
519-0417



THIS TAB TO BE BROKEN OFF ALONG DASHED LINE AFTER BOARD IS FLOW SOLDERED.

NOTES:

1. SEE SCHEMATIC SB919-0417



PRESS #421-6908 SHEETEDGE FASTENER INTO CUTOUT UNTIL SNAPPED INTO PLACE AS SHOWN

DETAIL "A"

2 PLCS

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

DWN. BY	JLF 1-5-94
DESIGNER(S)	C.LANGNER 9-23-94
PROJ. LEADER	R.CARPENTER 9-26-94
MFG.	
MATERIAL	SEE BOM 919-0417
FINISH	SEE DWG AA592-0000
NEXT ASSY.	959-0412

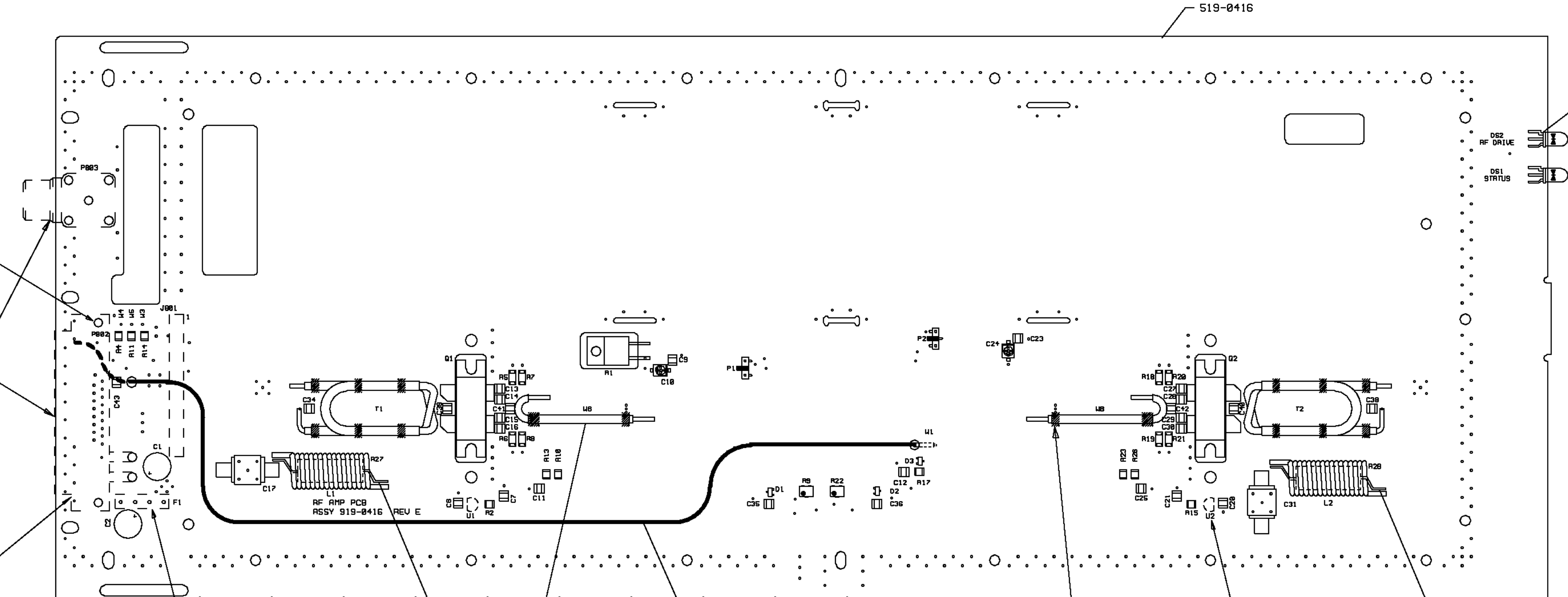
BROADCAST ELECTRONICS INC.
4100 N.24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 PH. 217/224-9600
TELEX 250142 CABLE BROADCAST FAX 217/224-9607

TITLE: PCB ASSEMBLY RF AMP LOGIC BOARD

TYPE	SIZE	DWG No.	REV
A	B	919-0417	D

MODEL	SCALE	SHEET
FM-3C	1/1	1 OF 1

919-0416



INSTALL PEM NUT #426-4003 THIS SIDE (2) PLACES;
MOUNT P802 TO OPPOSITE SIDE SHOWN USING QTY (2)
#420-4106 SCREW, & (2) #423-4002 SPLIT LOCK.
(P802 IS PART OF RF CABLE ASSY #949-0405)

P802 & P803 TO BE INSTALLED TO OPPOSITE SIDE
AS SHOWN USING FIXTURE FOR PROPER ALIGNMENT.
SOLDER SHELL OF P803 TO GROUND PLANE ON REAR
OF BOARD ONLY. DO NOT SOLDER PINS YET.

SEE NOTE 2

BACK EDGE OF DS1 & DS2 TO BE ALIGNED
WITH EDGE OF GROUND PLANE; MOUNT WITH
BOTTOM EDGE RESTING ON PCB.

INSTALL QTY (2) #415-0015
FUSE CLIPS ON OPPOSITE SIDE
(SOLDER ON TOP & BOTTOM).
INSTALL FUSE F1 IN CLIPS.

SEE NOTE 5

370-0721
2 PLCS (W6 & W8)

TYPICAL ROUTING FOR CABLE W1.

SEE NOTE 3

SEE NOTE 4

SEE NOTE 5

NOTES:

1. FOLLOWING COMPONENTS TO BE INSTALLED DURING RF AMP MODULE FINAL ASSEMBLY; AND ARE SHOWN HERE FOR REFERENCE ONLY: C13-16, C27-30, C39-42, Q1-2, R1, T1-2, W3-5
2. COMPONENTS SHOWN WITH DASHED LINES TO BE INSTALLED ON OPPOSITE SIDE.
3. OUTER CONDUCTOR OF T1, T2, W6, & W8 TO BE SOLDERED TO PCB WHERE INDICATED BY SHADING.
4. COMPONENTS U1 & U2 TO BE MOUNTED ON OPPOSITE SIDE OF PCB WITH A MAXIMUM COMPONENT HEIGHT OF 0.28".
5. R27 & R28 TO BE INSERTED INSIDE OF L1 & L2 RESPECTIVELY AND SOLDERED AS SHOWN.

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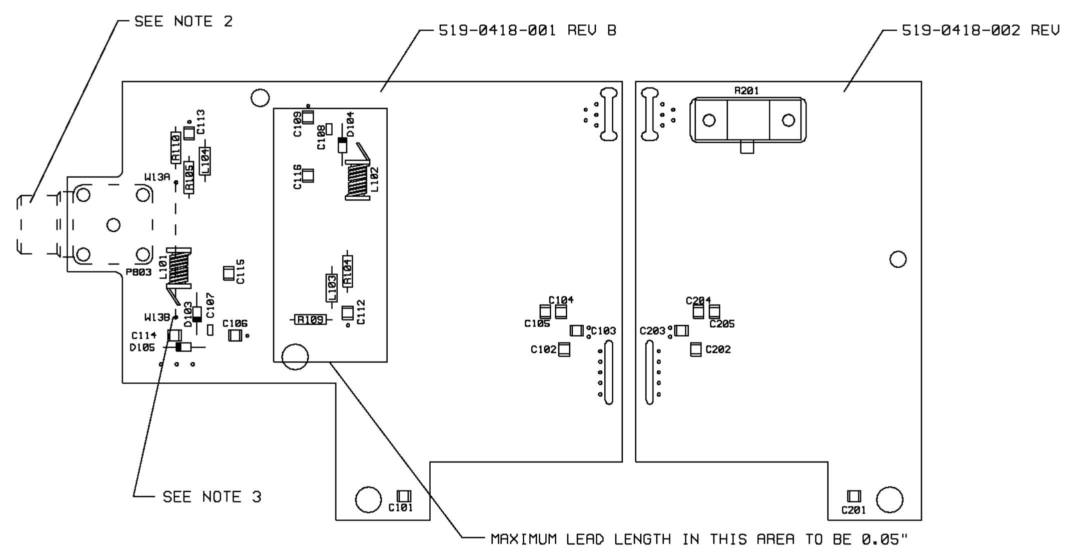
TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES + 1°

DWN. BY: JLF 3-17-94	MATERIAL: SEE BOM 919-0416	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 217/224-9600 FAX 217/224-9607	
DESIGNER(S): CLL 6-23-94	FINISH: ----	TITLE: PCB ASSEMBLY RF AMP, MAIN BD	
PROJ. LEADER:		TYPE: A / SIZE: D / DWG No. 919-0416	REV: E
MFG.:	NEXT ASSY. 959-0412	MODEL: FM-3C / SCALE: 1/1	SHEET 1 OF 1



NOTES:

1. SEE SCHEMATIC SB959-0412.
2. P803 & R201 SHOWN FOR REFERENCE ONLY; TO BE INSTALLED DURING RF AMP MODULE FINAL ASSEMBLY.
3. JUMPER WIRE W13 TO BE INSTALLED ON SOLDER SIDE USING WIRE 601-0022 INSULATED WITH TEFLON TUBING 693-0220.

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TOLERANCE (DECIMAL) U.O.S. .X ± .030 .XXX ± .005 .XX ± .015 ANGLES + 1°	DWN. BY 1-9-94 M. HAYDEN	MATERIAL SEE BOM 919-0418-001/002	BE® BROADCAST ELECTRONICS INC. 4100 N.24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 PH. 217/224-9600 TELEX 250142 CABLE BROADCAST FAX 217/224-9607
	CHKD	FINISH	TITLE PCB ASSEMBLY AMP LPF / DIRECTIONAL COUPLER
	ME	~~SEE DWG RA592-0000~~	TYPE A / SIZE C / DWG No. 919-0418-001/002 / REV A
	PROJ. ENGR. 1-10-94 CL LANGNER	NEXT ASSY. 959-0412	MODEL FM-3C / SCALE 1/1 / SHEET 1 OF 1
	MFG.		

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I
TRANSMITTER CONTROLLER THEORY OF OPERATION

1–1. INTRODUCTION.

1–2. The following text provides theory of operation with supporting diagrams for the FM–20T transmitter controller.

1–3. GENERAL DESCRIPTION.

1–4. All transmitter control and monitoring functions are performed by a microprocessor based controller (refer to Figure 1–1). The controller is designed to monitor the status of several transmitter parameters and perform control actions when required. The controller will interface with almost any remote control device such as the Broadcast Electronics VMC–16 remote control system.

1–5. The controller is equipped with 12 switch/indicators, 4 overload indicators, and 5 status indicators. Controller processing power is provided by a Z–Soft microcontroller. The microcontroller is housed on a small plug–in circuit board. The microcontroller circuit board is designed to plug directly into a header on the controller main circuit board.

1–6. The controller circuitry includes a front–panel modem port, one rear–panel modem port, one rear–panel local port, and a printer port. The modem ports and the printer port are designed to be used with a future remote monitoring and diagnostic system. The rear–panel local port is for interfacing to a future dual/main/alternate transmitter control system.

1–7. A Lithium battery back–up system is included in the controller design. The battery back–up system will maintain the controller memory and other parameters during a power failure. This system allows the transmitter to return to operation after the power failure in the exact same operating conditions.

1–8. A modular switching power supply provides operating potentials for the controller circuitry. Power supply status indications are provided by +15V, –15V, and +5 V indicators.

1–9. FUNCTIONAL DESCRIPTION.

1–10. The following text presents a description of the major functions performed by the transmitter controller. The text describes controller operations during major transmitter functions such as turn–on and automatic power control.

1–11. TRANSMITTER TURN–ON.

1–12. Commands such as filament on and high voltage on are initiated by the front–panel **FILAMENT ON** and **HIGH VOLTAGE ON** switch/indicators. A one–button–start may be selected by depressing only the **HIGH VOLTAGE ON** switch/indicator. As each switch is depressed, the associated switch/indicator will illuminate to indicate that the selected command has been received and stored.

1–13. Assuming the **FILAMENT ON** and/or **HIGH VOLTAGE ON** switch/indicators have been depressed and all internal interlocks are closed, the blower will start. The internal interlock closed condition is identified by the illumination of the front–panel **INTERLOCK** indicator.

1–14. When the air pressure switch closes: 1) the **BLOWER** indicator will illuminate, 2) the filament warm–up timer will start, 3) filament voltage will be applied to the PA tube, and 4) the **FILAMENT** indicator will illuminate. A high–voltage on signal will be output to the high voltage step–start circuitry and the mute command will be removed from the FM exciter: 1) after the filament warm–up delay expires, 2) no overloads exist, 3) all internal interlocks remain closed, 4) the failsafe interlock is closed, 5) the air switch remains closed, and 6) the exciter AFC signal lock status is obtained. The failsafe interlock closed condition is identified by the illumination of the front–panel **FAILSAFE** indicator. The **HIGH VOLTAGE** indicator will illuminate to indicate that a high voltage on command has been output from the controller.

1–15. The high voltage on signal is applied to the step driver. The driver will energize the plate supply step relay to apply primary voltage to the plate supply transformer through three limiting resistors. After a 100 millisecond delay, the controller will enable the start driver. The start driver will energize the start contactor and apply the full primary potential to the plate supply transformer. The step circuit will deenergize after being energized for 160 milliseconds. In this manner, the plate supply inrush is limited and the current limiting resistors are subject to heating only during a 100 millisecond interval before start contactor closure. For added reliability, the limiting resistors are disconnected after 160 milliseconds.

1–16. Simultaneous with generation of the high voltage on start signal, the exciter will be enabled and the **HIGH VOLTAGE** status indicator will illuminate to indicate that the plate supply control signal has been output. The high voltage supply is prevented from step–starting under full load in this manner.

1–17. TRANSMITTER TURN-OFF.

1–18. When the **HIGH VOLTAGE OFF** switch/indicator is depressed, the controller will: 1) deenergize the high voltage supply, 2) extinguish the **HIGH VOLTAGE ON** switch/indicator, and 3) extinguish the **HIGH VOLTAGE STATUS** indicator. A one–button–stop feature is provided when the **FILAMENT OFF** switch/indicator is depressed. When the switch/indicator is depressed, the controller will perform the following operations:

1. Mutes the exciter.
2. De–energize the high voltage supply.
3. De–energize the filament supply.
4. Extinguish the **FILAMENT ON** switch/indicator and the **FILAMENT STATUS** indicator.
5. Initiate a filament cool–down interval.
6. When the filament cool–down timer delay expires, the blower will de–energize and the **BLOWER STATUS** indicator will extinguish.

1–19. REMOTE CONTROL OPERATION.

1–20. Transmitter remote control operation is enabled whenever the **REMOTE DISABLE** switch/indicator is extinguished. Local control of the transmitter is enabled at all times. Remote control inputs are routed: 1) through the controller EMI I/O filter circuit board, 2) through optical isolators, and 3) connected in parallel with the local inputs. The remote control inputs can be enabled by a HIGH or a ground with proper circuit board programming of header J6 on the main circuit board. Remote metering and status outputs are active at all times.

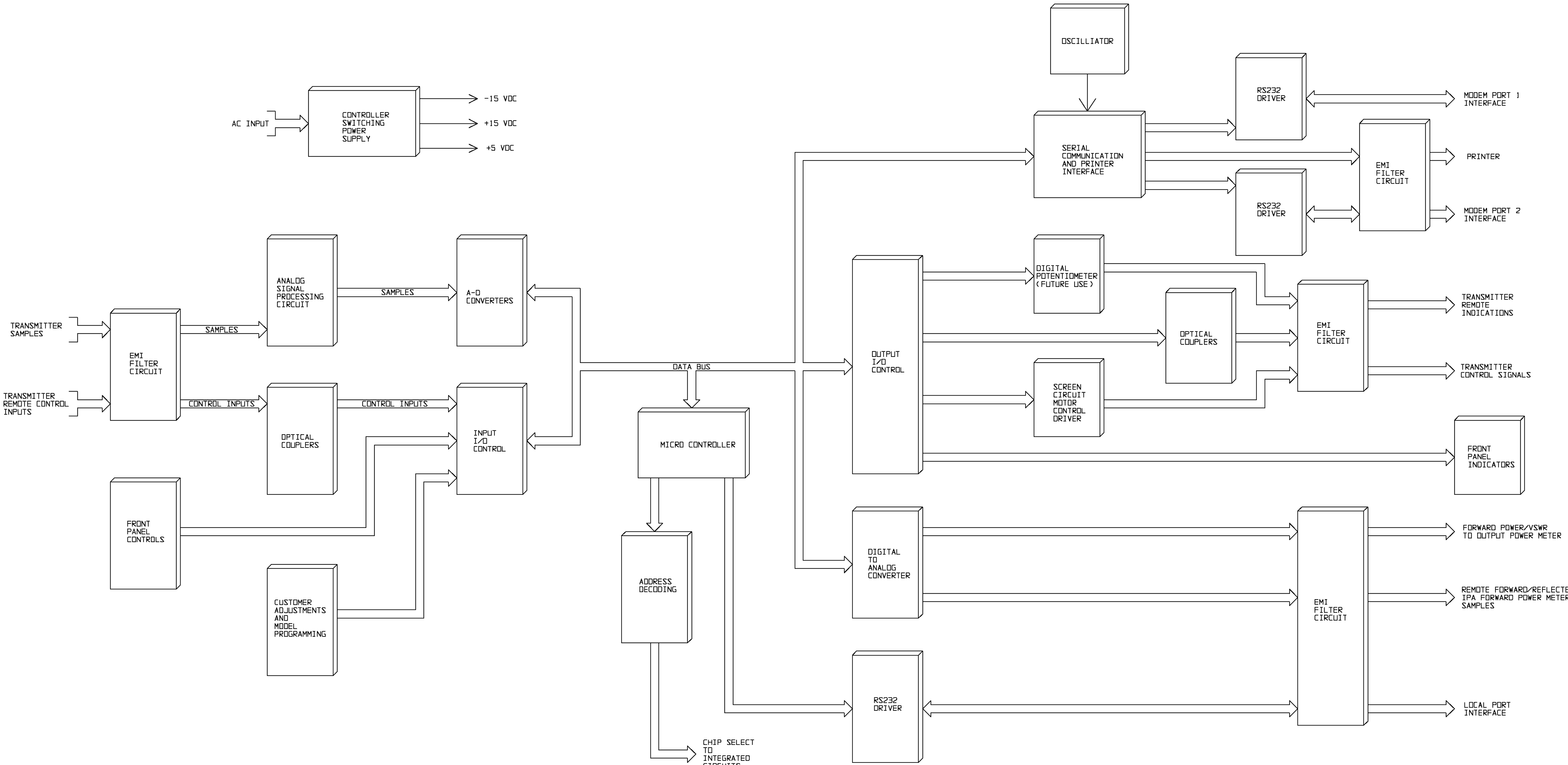

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FIGURE 1-1. TRANSMITTER CONTROLLER BLOCK DIAGRAM

1-21. **INTERLOCKS.**

1-22. The internal interlock circuitry consists of a series string of normally closed switches mounted in areas which contain electrical or mechanical hazards. Each switch is mechanically activated by a door or panel to deenergize the entire transmitter when opened. If an internal interlock opens, the transmitter will deenergize immediately. The transmitter must be manually restored to operation after the open interlock is closed. The controller front-panel **INTERLOCK** indicator will extinguish to indicate an open interlock. If the opened internal interlock is closed before the filament cool-down timer interval expires, the blower will re-energize for the remaining duration of the cool-down cycle and then de-energize. If the air pressure interlock opens, the power supplies will de-energize immediately. When the interlock closes, the transmitter will return to operation automatically.

1-23. The failsafe interlock circuitry consists of an external switch such as from a test load or remote control failsafe circuit connected to the failsafe interlock terminals on the remote interface circuit board. If the failsafe interlock is opened, only the high voltage plate supply will be deenergized. The controller **FAILSAFE** and **HIGH VOLTAGE** indicators will extinguish to indicate an open interlock. When the failsafe interlock is closed, the transmitter will return to operation automatically.

1-24. **OVERLOAD OPERATION.**

1-25. Plate current, screen current, control grid bias supply current, and PA reflected power are monitored for overload conditions. If an overload occurs, the overload initiate an overload control sequence.

1-26. Any overload will illuminate the **OVERLOAD** indicator and initiate two timed intervals. A timer and counter monitors the number of times an overload occurs during a 60 second interval. A second overload recycle timer delays restoration of the transmitter to operation to allow the condition that prompted the overload to dissipate.

1-27. When the timed interval delaying restoration of the transmitter to operation has expired, the transmitter will recycle back into operation. If no further overloads occur during the 60 second interval following the first overload, the 60 second timer will clear the overload counter. If four overload recycles occur during the 60 second counter/timer interval, the transmitter will deenergize and must be manually reset. This can be done by depressing the **OVERLOAD** switch/indicator, the **FILAMENT ON** switch/indicator, and the **HIGH VOLTAGE ON** switch/indicator. The overload can also be cleared by remote control if remote control is enabled.

1-28. If an overload persists in duration for longer than 0.22 seconds, the controller will consider the overload a short circuit and immediately deenergize the transmitter. The transmitter must then be manually restored to operation after the fault is repaired.

1-29. The overload reset sequence is initiated when the **OVERLOAD RESET** switch/indicator is depressed. When the switch/indicator is depressed, the following actions will occur.

1. The **OVERLOAD RESET** switch/indicator and the overload diagnostic indicator (**PLATE, SCREEN, GRID,** or **VSWR**) indicator will extinguish.
2. The overload timer/counter will be reset.
3. The overload recycle timer will be reset.

1-30. **EMI I/O CIRCUIT BOARD.**

1-31. All controller inputs and outputs are routed through connectors J1, J2, and J3 mounted to the EMI I/O circuit board. The circuitry consists of PI-section low-pass LC filters effective to 108 MHz and connected in series with each input and output to prevent RF leakage into the controller. Each input/output also contains a transzorb. The transzorb limits the input/output signal to ±15 volts.

1–32. AC POWER FAILURE.

1–33. The controller is equipped with a battery back–up system. When ac power is lost, the following actions will occur:

1. The filament restart delay timer is set as soon as ac power is lost. If ac power is removed long enough for the filament restart delay timer interval to expire, the filament timer will reset. When power returns, a new filament heating delay will be initiated before the plate supply is energized. If the ac power outage is momentary and the timer does not expire, high voltage will energize immediately upon restoration of ac power.

2. The overload feature will be inhibited.

3. The battery back–up system will maintain the controller memory. This system allows the transmitter to return to operation after the power failure in the exact same operating conditions.

1–34. POWER CONTROL OPERATION.

1–35. The controller is designed with two power control modes: 1) manual and 2) automatic. Manual/automatic power control operation is controlled by the **APC ON** switch/indicator. The controller is configured for manual power control when the **APC ON** switch/indicator is extinguished. The controller is configured for automatic power control when the **APC ON** switch/indicator is illuminated.

1–36. The controller manipulates the RF output power using the screen supply. The primary of the screen power transformer is controlled by variable autotransformer which is driven by dc servo motor B4. The controller manipulates the RF output power by routing raise/lower commands B4. A raise command rotates the motor in a manner which increases the screen voltage. As a result of the increase in screen voltage, the RF output power will increase. A lower command rotates the motor in a manner which decreases the screen voltage. Limit switches on the motor prevent possible damage to the autotransformer by disconnecting the drive signal at the end of travel for each direction.

1–37. MANUAL POWER CONTROL OPERATION.

1–38. Manual operation refers to operation of the transmitter with the APC feature off. In this mode, RF power output is not automatically controlled, but responds only to manual raise and lower commands. In the manual mode, the **RAISE** and **LOWER** switch/indicators directly control the dc servo motor which varies the screen voltage supply.

1–39. AUTOMATIC POWER CONTROL (APC) OPERATION.

1–40. When the controller is in the automatic mode, the **RAISE** and **LOWER** switch/indicators control a power control reference point. When the **RAISE** switch/indicator is depressed, the power control reference point is raised and the transmitter output power level will increase. When the **LOWER** switch/indicator is depressed, the power control reference point is lowered and the transmitter output power level will decrease.

1–41. The transmitter output power level will respond to the changes in the power control reference point. The controller manipulates the RF output power using the screen supply dc servo motor. Once the desired output level is established using the RAISE/LOWER switch/indicators, the controller will automatically maintain the established RF output power level.

1-42. The controller is equipped with circuitry which rectifies and calibrates the PA directional coupler forward and reflected power signals. These signals serve as control inputs. In addition to the forward and reflected power signals, PA screen current, and IPA forward power allow automatic control of the PA screen voltage using a dc servo motor. If excessive PA reflected power, excessive screen current, or low IPA power is measured, the “raise power” function will be inhibited to prevent an overload condition. The absence of plate voltage will inhibit the raise function and signal the controller to adjust the screen voltage to minimum. Excessive transmitter RF output or a high PA reflection will first inhibit the raise function. If the condition exceeds the limits, the circuit will initiate a sequence which lowers power proportionately in response to the condition.

1-43. **VSWR FOLDBACK.**

1-44. In the automatic power control mode, PA power will be automatically reduced if PA reflected power becomes excessive enough to overload the transmitter. As the condition which caused the high VSWR returns to normal, RF power will be proportionally raised until full output is restored. A similar circuit for PA forward power will reduce power if the output is excessive.

1-45. A dead-band window is used to prevent the controller from hunting. If reflected power is below the lower limit of the dead-band, the controller will perform no correction. If reflected power increases beyond the lower limit, the raise feature will be inhibited to prevent the forward power control function from raising power and avoid a transmitter overload. If the PA reflected power continues to rise and is within the dead-band, no lowering of power will occur. If the upper limit of the dead-band is reached, a lower command will be applied.

1-46. **SOFT START.**

1-47. Soft start operation is when APC is enabled, the controller monitors the plate voltage and reduces the screen voltage to zero upon the absence of plate voltage. When the plate supply is energized such as during power-on, the controller will perform the following:

1. Gradually increase the screen voltage until the APC power level reference is achieved unless limited by low IPA drive, excessive screen current, or a high VSWR condition. This prevents inadvertent cycling of the VSWR overload at turn-on if the load is not optimal such as during an ice storm.

2. When the plate voltage sample decreases below the fixed level, the following events will occur:

   A. The raise function will be inhibited.

   B. The controller will output a lower command to: 1) lower the screen voltage and 2) stop lowering the screen voltage at a minimum level. Once the minimum level is achieved, the lower command will remain.

   C. When the HIGH VOLTAGE ON switch/indicator is depressed, the plate voltage sample from the plate meter multiplier circuit board will rise above the fixed reference. The raise inhibit will be removed along with the power lower signal and the APC mode will be allowed to re-establish the transmitter RF power.

1-48. OUTPUT POWER CONTROL.

1-49. The controller uses a dead-band to determine how the PA forward power control circuit will react when PA forward power increases or decreases beyond the established level. When power is within the dead-band, the controller will take no control action. If the PA forward power decreases by 2% or more from 100%, the controller will start corrective action by applying the raise power command. If PA forward power then increases by 2% or more from 100%, the raise function is to be inhibited. This is the upper edge of the deadband. If PA power should continue to increase to a point which is 2% above the desired power level reference, the controller will lower the power. As the PA power is lowered to the normal level, the controller will remove the power lower command. The power will remain at this point within the power level reference point deadband. If the power should drop below the lower limit, the unit will again apply the raise command. The circuit will now function normally to control power and maintain operation within the deadband.

NOTE ***PRESET POWER IS ONLY USED FOR EMERGENCY OPERATION AT LESS THAN LICENSED POWER OPERATION.***

NOTE

1-50. PRESET POWER.

1-51. Preset power is normally used to automatically switch the transmitter to a predetermined power output level such as half-power for periods of auxiliary generator operation. The following events are to occur during preset power operation.

1. The APC functions as before, only the preset power reference is used to determine the APC power level reference. The transmitter power output will now be determined by the preset power level reference.
2. If ac power is momentarily removed from the controller, the preset power command will be automatically maintained.
3. When the APC ON and PRESET switch/indicators are illuminated, any adjustment of the RAISE and LOWER switch/indicators will adjust the preset power level reference.

1-52. CONTROLLER POWER SUPPLY MODULE.

1-53. The transmitter controller is equipped with a modular switching power supply assembly. The assembly is not manufactured by Broadcast Electronics. Therefore, no theory of operation can be provided.

SECTION II
TRANSMITTER CONTROLLER MAINTENANCE

2–1. INTRODUCTION.

2–2. This section provides maintenance information for the FM–20T transmitter controller.

2–3. SAFETY CONSIDERATIONS.

2–4. The FM–20T transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The transmitter has many built–in safety features, however; good judgment, 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. MAINTENANCE.

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

WARNING

2–6. The maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment of forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault. The following text presents the controller adjustments.

2–7. MAIN CIRCUIT BOARD CONTROL ADJUSTMENTS.

2–8. **OVERLOAD CONTROLS.** The following text presents the overload adjustment procedures. If more than one control is adjusted, adjust the controls as follows: 1) VSWR, 2) PLATE, 3) SCREEN, and 4) GRID.

2–9. **VSWR OVERLOAD THRESHOLD ADJUST.** To adjust the VSWR overload threshold, proceed as follows.

2–10. **Required Equipment.** The following equipment is required to adjust the VSWR overload threshold.

A. 7 dB attenuator, BNC connections.

B. 5/16 inch nut–driver.

CAUTION ***THE OVERLOAD THRESHOLD LEVEL ADJUSTMENTS DETERMINE WHEN THE TRANSMITTER INITIATES ACTION. IF A CONTROL IS INCORRECTLY ADJUSTED THE CONTROLLER MAY NOT SENSE THE FAULT AND DAMAGE TO THE TRANSMITTER MAY RESULT.***

CAUTION

2–11. **Procedure.** To adjust the control, proceed as follows.

2–12. Check and adjust reflected power meter calibration control R84 before proceeding (refer to REFLECTED POWER CALIBRATION in the following text).

2–13. Apply power to the transmitter.

2–14. Refer to Figure 2–1 and select VSWR OVERLOAD as follows:

1. Operate customer adjustment function switch SW1 to position 6.
2. Depress and hold customer adjustment up/down switch S2 in the up position to raise the threshold.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–15. Disconnect the transmitter primary power.

2–16. Disconnect cable 305 from the reflected power directional coupler (← port) on the transmitter low–pass filter.

2–17. Using the nut–driver, loosen the clamps securing the reflected power directional coupler to to the low–pass filter.

2–18. Rotate the reflected power directional coupler 180 degrees so the arrow on the coupler is pointing away from the transmitter (→). Secure the clamps.

2–19. Connect the 7 dB attenuator to the reflected power directional coupler and connect cable 305 to the attenuator.

2–20. Apply power and operate the transmitter at the normal RF power output as indicated by the front panel **OUTPUT POWER** meter.

2–21. Depress the **VSWR** switch/indicator to illuminate the switch/indicator.

2–22. Refer to Figure 2–1 and use up/down switch S2 to lower the VSWR overload threshold until the **VSWR OVERLOAD** indicator and the **OVERLOAD RESET** switch/indicator illuminate and the transmitter cycles off.

2–23. Depress the **HIGH VOLTAGE OFF** switch then depress the **LOWER** switch/indicator for approximately 4 seconds to lower the transmitter power.

2–24. Depress the **OVERLOAD RESET** and the **HIGH VOLTAGE ON** switch/indicators.

2–25. Depress the **RAISE** switch/indicator to raise power. The transmitter will cycle off at a VSWR indication of 2.8 : 1. If not, repeat the adjustment.

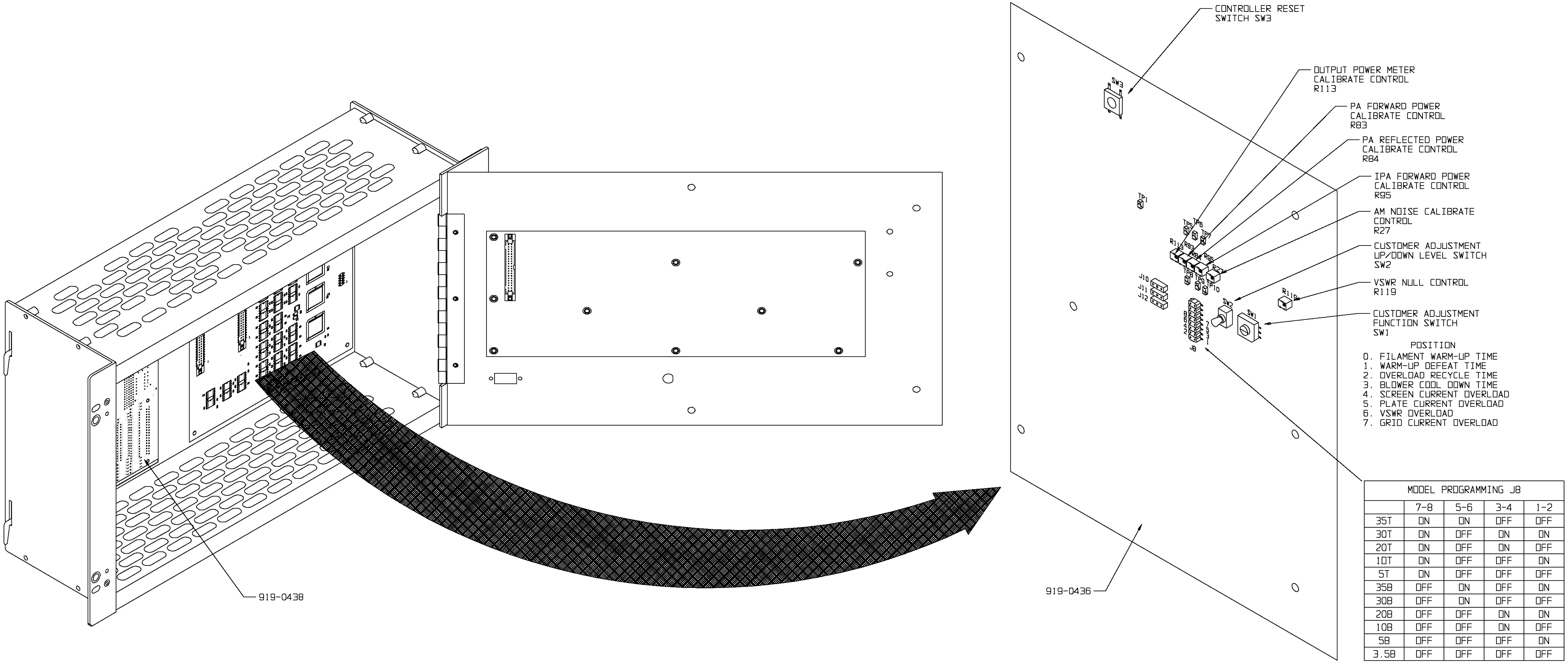
WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–26. Disconnect all transmitter primary power.

2–27. Remove the test equipment and replace the reflected power directional coupler. Ensure the reflected power directional coupler arrow is pointing towards the transmitter (←). Ensure cable 305 is re–connected to the reflected power directional coupler port.

2–28. **PLATE OVERLOAD ADJUSTMENT.** The plate overload control can be adjusted from 0.1 A to 0.75 A above a normal plate current level. The factory default is 0.5 A. To adjust the PLATE overload threshold, proceed as follows.



MODEL PROGRAMMING J8

	7-8	5-6	3-4	1-2
35T	ON	ON	OFF	OFF
30T	ON	OFF	ON	ON
20T	ON	OFF	ON	OFF
10T	ON	OFF	OFF	ON
5T	ON	OFF	OFF	OFF
35B	OFF	ON	OFF	ON
30B	OFF	ON	OFF	OFF
20B	OFF	OFF	ON	ON
10B	OFF	OFF	ON	OFF
5B	OFF	OFF	OFF	ON
3.5B	OFF	OFF	OFF	OFF

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FIGURE 2-1. CONTROLLER MAIN CIRCUIT BOARD CONTROLS

CAUTION ***THE OVERLOAD THRESHOLD LEVEL ADJUSTMENTS DETERMINE WHEN THE TRANSMITTER INITIATES ACTION. IF A CONTROL IS INCORRECTLY ADJUSTED THE CONTROLLER MAY NOT SENSE THE FAULT AND DAMAGE TO THE TRANSMITTER MAY RESULT.***

CAUTION

2-29. **Procedure.** To adjust the threshold level of the plate overload circuit, proceed as follows:

2-30. Apply power and operate the transmitter within specifications at the rated RF output into a proper 50 Ohm load. Record the **OUTPUT LOADING** control cyclometer indication __________.

2-31. Refer to Figure 2-1 and select PLATE OVERLOAD as follows:

1. Operate customer adjustment function switch SW1 to position 5.
2. Depress and hold customer adjustment up/down switch S2 in the up position to raise the threshold.

2-32. Operate the **APC ON** switch/indicator to extinguish the switch/indicator.

2-33. Operate the **OUTPUT LOADING** control clockwise and the **RAISE** switch/indicator to detune the transmitter until plate current is increased by 0.5 Amperes as indicated on the **PLATE CURRENT** meter.

2-34. Refer to Figure 2-1 and use up/down switch S2 to lower the plate overload threshold until the **PLATE OVERLOAD** indicator and the **OVERLOAD RESET** switch/indicator illuminate and the transmitter cycles off.

2-35. Depress the **HIGH VOLTAGE OFF** switch then depress and hold the **LOWER** switch/indicator for approximately four seconds.

2-36. Depress the **OVERLOAD RESET** and the **HIGH VOLTAGE ON** switch/indicators.

2-37. Observe the **PLATE CURRENT** meter and operate the **RAISE** switch/indicator until the transmitter deenergizes. Correct adjustment is obtained when the transmitter deenergizes and plate current is 0.5 amperes above normal. Repeat the procedure if required.

2-38. Depress the **HIGH VOLTAGE OFF** switch and **OVERLOAD RESET** switch/indicator.

2-39. Restore the **OUTPUT LOADING** control to the cyclometer indication recorded in the preceding text and operate the **APC ON** switch/indicator to illuminate the switch/indicator.

2-40. **SCREEN OVERLOAD ADJUSTMENT.** The screen overload control can be adjusted from 230 mA to 330 mA. The factory default is 280 mA. To adjust the SCREEN overload threshold, proceed as follows.

2-41. **Required Equipment.** The following equipment is required to adjust the screen overload threshold.

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

CAUTION ***THE OVERLOAD THRESHOLD LEVEL ADJUSTMENTS DETERMINE WHEN THE TRANSMITTER INITIATES ACTION. IF A CONTROL IS INCORRECTLY ADJUSTED THE CONTROLLER MAY NOT SENSE THE FAULT AND DAMAGE TO THE TRANSMITTER MAY RESULT.***

CAUTION

2-42. **Procedure.** To adjust the threshold level of the screen overload circuit, proceed as follows:

2–43. Apply power and operate the transmitter within specifications at the rated RF output into a proper 50 Ohm load. Record the **OUTPUT LOADING** control cyclometer indication ____________.

2–44. Refer to Figure 2–1 and select SCREEN OVERLOAD as follows:

1. Operate customer adjustment function switch SW1 to position 4.
2. Depress and hold customer adjustment up/down switch S2 in the up position to raise the threshold.

2–45. Operate the **APC ON** switch/indicator to extinguish the switch/indicator.

2–46. Operate the **MULTIMETER** to the **SCREEN CURRENT** position.

2–47. Operate the **OUTPUT LOADING** control counterclockwise and the **RAISE** switch/indicator to detune the transmitter for a screen current of 280 milliamperes as indicated on the **MULTIMETER**. If 280 milliamperes can not be obtained, increase the IPA power as follows:

1. Operate the **MULTIMETER** switch to **IPA FWD POWER** and record the forward power indication ________.
2. Adjust the front–panel IPA **POWER ADJUST** control until the **MULTIMETER** indicates approximately 500 watts.

2–48. Refer to Figure 2–1 and use up/down switch S2 to lower the screen overload threshold until the **SCREEN OVERLOAD** indicator and the **OVERLOAD RESET** switch/indicator illuminate and the transmitter cycles off.

2–49. Depress the **HIGH VOLTAGE OFF** switch/indicator then depress and hold the **LOWER** switch/indicator for approximately four seconds.

2–50. Depress the **OVERLOAD RESET** and the **HIGH VOLTAGE ON** switch/indicators.

2–51. Observe the **MULTIMETER** and operate the **RAISE** switch/indicator until the transmitter deenergizes. Correct adjustment is obtained when the transmitter deenergizes and the **MULTIMETER** indicates 280 milliamperes. Repeat the procedure if required.

2–52. Depress the **HIGH VOLTAGE OFF** and **OVERLOAD RESET** switch/indicators.

2–53. Restore the **OUTPUT LOADING** control to the cyclometer indication recorded in the preceding text, re–adjust the IPA if required, and operate the **APC ON** switch/indicator to illuminate the switch/indicator.

2–54. **GRID OVERLOAD ADJUSTMENT.** Position 7 on customer adjustment function switch SW1 adjusts the grid overload threshold. The control is adjusted at the factory and will not require re–adjustment. The control is designed in a manner which does not permit mis–adjustment in the field.

2–55. **FILAMENT WARM-UP ADJUSTMENT.** The warm–up adjustment controls the filament heating delay prior to high voltage on. The warm–up time can be adjusted from 10 seconds to 4.5 minutes. A minimum interval is preset so that incorrect adjustment cannot damage the PA tube. To adjust the warm–up time, proceed as follows.

2–56. **Required Equipment.** The following equipment is required to adjust warm–up time.

A. Wristwatch with seconds hand or stopwatch function.

2–57. **Procedure.** To adjust the warm–up time, proceed as follows.

2–58. Depress the **FILAMENT OFF** switch/indicator to illuminate the switch/indicator.

2–59. Wait approximately 15 seconds. Note the time and depress the **HIGH VOLTAGE ON** switch/indicator.

2-60. Again note the time when the plate contactor energizes.

2-61. Refer to Figure 2-1 and select the warm-up feature by operating customer adjustment function switch SW1 to position 0.

2-62. Refer to Figure 2-1 and use up/down switch S2 to increase or decrease the time delay. Check the adjustment by repeating the procedure. The control is factory set for 10 seconds.

2-63. **COOL-DOWN ADJUSTMENT.** The cool-down adjustment controls the blower run-down interval after the filament voltage is off. The cool-down time can be adjusted from 30 seconds to 4.5 minutes. A minimum interval is preset so that incorrect adjustment cannot damage the PA tube. To adjust the cool down time, proceed as follows.

2-64. **Required Equipment.** The following equipment is required to adjust cool down time.

A. Wristwatch with seconds hand or stopwatch function.

2-65. **Procedure.** To adjust the cool-down time, proceed as follows.

2-66. Apply power and operate the transmitter.

2-67. Simultaneously depress the **FILAMENT OFF** switch and note the time.

2-68. Again note the time when the blower halts operation.

2-69. Refer to Figure 2-1 and select the cool-down feature by operating customer adjustment function switch SW1 to position 3.

2-70. Refer to Figure 2-1 and use up/down switch S2 to increase or decrease the blower run-down interval. Check the adjustment by repeating the procedure. The control is factory set for 30 seconds. Each click of S2 is equal to 1 second.

2-71. **RECYCLE ADJUSTMENT.** The recycle adjustment controls the amount of time the transmitter will remain deenergized to allow an overload to dissipate. The recycle time can be adjusted from 100 milliseconds to 15 seconds. The factory default is 2 seconds. To adjust the recycle time, proceed as follows.

2-72. **Required Equipment.** The following equipment is required to adjust the recycle time.

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

2-73. **Procedure.** To adjust the recycle time, proceed as follows.

2-74. Apply power and operate the transmitter.

2-75. Simulate a screen or plate overload using the **OUTPUT LOADING** control and note the time when the transmitter attempts to return to operation.

2-76. Refer to Figure 2-1 and select the recycle feature by operating customer adjustment function switch SW1 to position 2.

2-77. Refer to Figure 2-1 and use up/down switch S2 to increase or decrease the recycle time. Check the adjustment by repeating the procedure. The control is factory set for 2 seconds. Each click of S2 is equal to 1 second.

2-78. **WARM-UP DEFEAT ADJUSTMENT.** The warm-up defeat adjustment controls the length of the interval the filaments can be off before initiating a new filament warm-up cycle. The warm-up defeat time can be adjusted from 1 second to 15 seconds. A 3 second delay is preset so that momentary power fluctuations will not initiate a new filament warm-up cycle. To adjust the warm-up defeat time, proceed as follows.

2-79. **Required Equipment.** The following equipment is required to adjust the warm-up defeat time.

A. Wristwatch with seconds hand or stopwatch function.

2–80. **Procedure.** To adjust the warm–up defeat time, proceed as follows.

2–81. Apply power and operate the transmitter.

2–82. Check the current warm–up defeat time as follows:

1. Depress the **FILAMENT OFF** switch/indicator to illuminate the switch/indicator.
2. Wait approximately 3 seconds and depress the **HIGH VOLTAGE ON** switch/indicator to illuminate the switch/indicator. With the warm–up defeat time configured at 3 seconds, the filaments will automatically re–energize.

2–83. Refer to Figure 2–1 and select the warm–up defeat feature by operating customer adjustment function switch SW1 to position 1.

2–84. Refer to Figure 2–1 and use up/down switch S2 to increase or decrease the warm–up time. Check the adjustment by repeating the procedure. The control is factory set for 3 seconds. Each click of S2 is equal to 1 second.

2–85. **FORWARD POWER CALIBRATION.** Potentiometer R83 calibrates the forward power sample circuit. Adjustment is required only if repairs have been made to the directional coupler forward port, controller main circuit board, or low–pass filter. To adjust the control, proceed as follows.

2–86. **Required Equipment.** The following equipment is required to adjust the forward power calibration control.

A. 1/16 inch jewelers screw–driver, flat–tip.

B. Digital multimeter (Fluke 77 or equivalent).

C. Test load and connecting line (50 Ohm non–inductive, 3 1/8 inch line input, 20 kW minimum).

D. Calibrated in–line wattmeter with 3 1/8 inch sampling section and cables (Bird 4720 Thruline with 20 kW element or equivalent).

2–87. **Procedure.** To adjust the control, proceed as follows.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–88. Disconnect the transmitter primary power.

2–89. Connect the test load and wattmeter to the transmitter output.

2–90. Connect the multimeter between TP–5 (signal) and TP–1 (ground) or to the chassis.

2–91. Apply power and operate the transmitter in the local manual mode (REMOTE DISABLE illuminated, APC ON extinguished) at the desired 100% RF power output as indicated by the in–line wattmeter.

2–92. Depress the **FWD** switch/indicator to illuminate the switch/indicator.

2–93. Refer to Figure 2–1 and adjust forward power calibrate control R83 until the multimeter indicates +4.25 volts dc.

2–94. Refer to OUTPUT POWER METER CALIBRATION in the following text and perform the procedure to calibrate the output power meter.

2–95. Remove the test equipment and return the transmitter to service.

2–96. **OUTPUT POWER METER CALIBRATION.** This adjustment will be required only if the **OUTPUT POWER** meter or potentiometer R113 is replaced. To adjust output meter calibrate control R113, proceed as follows.

2–97. **Required Equipment.** The following equipment is required to adjust the output meter calibrate control.

A. 1/16 inch jewelers screw–driver, flat–tip.

B. Test load and connecting line (50 Ohm non–inductive, 3 1/8 inch line input, 20 kW minimum).

C. Calibrated in–line wattmeter with 3 1/8 inch sampling section and cables (Bird 4720 Thruline with 20 kW element or equivalent).

2–98. **Procedure.** To adjust the control, proceed as follows:

2–99. Check and adjust forward power calibration control R83 before proceeding (refer to FORWARD POWER CALIBRATION in the preceding text).

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–100. Disconnect the transmitter primary power.

2–101. Connect the test load and wattmeter to the transmitter output.

2–102. Apply power and operate the transmitter in the local manual mode (REMOTE DISABLE illuminated, APC ON extinguished) at the desired 100% RF power output as indicated by the in–line wattmeter.

2–103. Refer to Figure 2–1 and adjust meter calibration control R113 to obtain a 100% **OUTPUT POWER** meter indication.

WARNING ***ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.***

WARNING

2–104. Disconnect primary power.

2–105. Remove the test equipment and reconnect the transmitter output to the antenna load.

2–106. **REFLECTED POWER CALIBRATION.** Potentiometer R84 calibrates the reflected power sample circuit. Adjustment is required only if repairs have been made to the directional coupler reflected port, controller main circuit board, or low–pass filter. To adjust the control, proceed as follows.

2–107. **Required Equipment.** The following equipment is required to adjust the reflected power calibration control.

A. 1/16 inch jewelers screw–driver, flat–tip.

B. 10 dB attenuator, BNC connections.

C. 5/16 inch nut–driver.

2–108. **Procedure.** To adjust the control, proceed as follows.

2–109. Check and adjust output power meter calibration control R113 before proceeding (refer to OUTPUT POWER METER CALIBRATION in the preceding text).

2–110. Adjust the VSWR null control as follows:

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***
WARNING

1. Disconnect the transmitter primary power.
2. Ensure the test load and wattmeter are connected to the transmitter output.
3. Refer to Figure 2–1 and connect the multimeter between TP–6 (signal) and TP–1 (ground) or to the chassis.
4. Apply power and operate the transmitter in the local manual mode (**REMOTE DISABLE** illuminated, **APC ON** extinguished) at the desired 100% RF power output as indicated by the in–line wattmeter.
5. Refer to Figure 2–1 and adjust VSWR null control R119 for a 0.0 volt dc indication on the multimeter.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***
WARNING

2–111. Disconnect the transmitter primary power.

2–112. Disconnect cable 305 from the reflected power directional coupler (← port) on the transmitter low–pass filter.

2–113. Using the nut–driver, loosen the clamps securing the reflected power directional coupler to to the low–pass filter.

2–114. Rotate the reflected power directional coupler 180 degrees so the arrow on the coupler is pointing away from the transmitter (→). Secure the clamps.

2–115. Connect the 10 dB attenuator to the reflected power directional coupler and connect cable 305 to the attenuator.

2–116. Apply power and operate the transmitter at the normal RF power output as indicated by the front panel **OUTPUT POWER** meter.

2–117. Depress the **VSWR** switch/indicator to illuminate the switch/indicator.

2–118. Refer to Figure 2–1 and adjust reflected power calibrate control R84 until the **OUTPUT POWER** meter indicates a VSWR condition of 1.9 : 1.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***
WARNING

2–119. Disconnect the transmitter primary power.

2–120. Remove the test equipment and replace the reflected power directional coupler. Ensure the reflected power directional coupler arrow is pointing towards the transmitter (←). Ensure cable 305 is re–connected to the reflected power directional coupler port.

2–121. **AM NOISE TEST RECEPTACLE CALIBRATION.** Potentiometer R27 calibrates the signal at the AM noise test receptacle. Adjustment is required only if repairs have been made to the AM noise circuitry. To adjust the control, proceed as follows.

2–122. **Required Equipment.** The following equipment is required to adjust the AM noise calibration control.

A. 1/16 inch jewelers screw–driver, flat–tip.

B. Digital multimeter (Fluke 77 or equivalent).

2–123. **Procedure.** To adjust the control, proceed as follows.

2–124. Check and adjust output power meter calibration control R113 before proceeding (refer to OUTPUT POWER METER CALIBRATION in the preceding text).

2–125. Disconnect the transmitter primary power.

2–126. Connect the multimeter between the center conductor of the AM noise test receptacle and chassis ground.

2–127. Apply power and operate the transmitter in the local manual mode (**REMOTE DISABLE** illuminated, **APC ON** extinguished) at the desired 100% RF power output as indicated by the front panel **OUTPUT POWER** meter.

2–128. Refer to Figure 2–1 and adjust AM noise calibration control R27 for a 1.09 volt dc indication on the multimeter.

2–129. Disconnect the transmitter primary power.

2–130. Remove the test equipment and return the transmitter to service.

2–131. **IPA FORWARD POWER CALIBRATION.** Potentiometer R95 calibrates the IPA forward power sample circuit.

2–132. **Required Equipment.** The following equipment is required to adjust the IPA forward power calibration control.

A. Flat–tip insulated adjustment tool and flat–tip 1/16 inch jewelers screw–driver.

B. Digital multimeter (Fluke 77 or equivalent).

2–133. **Procedure.** To adjust the control, proceed as follows.

WARNING ***DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.***

WARNING

2–134. Disconnect the transmitter primary power.

2–135. Connect the multimeter between TP–7 (signal) and TP–1 (ground).

2–136. Apply power and operate the transmitter in the local automatic mode (**REMOTE DISABLE** illuminated, **APC ON** illuminated) at the desired 100% RF power output as indicated by the in–line wattmeter.

2–137. Operate the **MULTIMETER** switch to IPA **FWD POWER**. Ensure the IPA forward power output is 400 watts. If the IPA forward power must be changed, adjust the IPA **POWER ADJUST** potentiometer to obtain a 400 watt indication on the mulitmeter.

2–138. Refer to Figure 2–1 and adjust IPA forward power calibrate control R95 until the multimeter indicates +4.4 volts dc.

2–139. Remove the test equipment, re–adjust the IPA forward power if required, and return the transmitter to service.

2–140. **CONTROLLER RESET.** The controller is equipped with reset switch SW3. However, the microcontroller is equipped with a circuit to automatically reset the processor in the event of a lock–up condition. As a result, the switch will typically not be used.

2–141. **CUSTOMER ADJUSTMENTS - RESET.** The customer adjustments and the 100% power programming can be reset to the factory defaults if required. The reset operation is required only if the customer adjustments have been mis–adjusted. To reset the controller programming to the factory defaults, proceed as follows:

1. Depress the **HIGH VOLTAGE OFF** switch/indicator.
2. Refer to Figure 2–1 and remove the model programming jumpers from model programming header J8.
3. Refer to Figure 2–1 and re–install the model programming jumpers. Ensure the jumpers are correctly programmed for the transmitter model.
4. Depress the **HIGH VOLTAGE ON** switch/indicator and return the transmitter to service.

2–142. **TROUBLESHOOTING.**

WARNING ***NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.***

WARNING

2–143. Most troubleshooting consists of visual checks. Because of the high voltages and currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, and fuses) should be used to isolate the malfunction to one specific area.

2–144. Troubleshooting within the controller circuit board enclosure is not considered hazardous due to the low potentials and currents involved. 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.

2–145. 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.

2–146. **CONTROLLER COMPONENT LOCATIONS.** Figure 2–2 presents the controller component locations. Refer to Figure 2–2 as required during the troubleshooting procedures to locate components within the controller.

CAUTION ***TO PREVENT DAMAGE TO THE MAIN CIRCUIT BOARD, DO NOT REMOVE POWER SUPPLY CONNECTOR P5 WITH POWER ENERGIZED.***

CAUTION

2–147. **MAIN CIRCUIT BOARD POWER SUPPLY CONNECTOR P5.** The controller main circuit board is equipped with power supply connector P5. The main circuit board may be destroyed if the connector is removed with power energized. Therefore, disconnect the transmitter ac power before removing the connector.

2–148. **MICROPROCESSOR MODULE.** The transmitter controller is equipped with a microprocessor module. Figure 2–2 presents the location of the module. The module is designed to plug directly into header J1 on the main circuit board. In the event of a microprocessor failure, the module can be replaced by performing the following procedure.

CAUTION
CAUTION

DO NOT REMOVE THE MICROPROCESSOR MODULE WITH THE TRANSMITTER PRIMARY AC POWER ENERGIZED.

2–149. Disconnect the transmitter primary power.

2–150. Open the controller door and locate the microprocessor module.

2–151. Using a Phillips screwdriver, remove the microprocessor mounting screw.

2–152. Using your hands, gently pull the module from the header.

2–153. Orient the new microprocessor module as shown and insert the module in header J1.

2–154. Re–install the mounting screw, close the controller door, and return the transmitter to service.

2–155. **POWER SUPPLY INDICATORS.** The controller main circuit board is equipped with three LEDs. The LEDs present the status of the power supply +15V, –15V, and +5V power supplies. Use the indicators to check the status of the power supply module.

2–156. **CONTROLLER POWER SUPPLY MODULE.** The transmitter controller is equipped with a modular switching power supply assembly. The power supply module is equipped with an ac line fuse and is not manufactured by Broadcast Electronics.

2–157. If the power supply is suspected as being faulty, check the power supply fuse. If the power supply fuse has not blown, contact the Broadcast Electronics Customer Service Department. If desired, refer to Appendix A and the computer products power supply schematic diagram for additional power supply troubleshooting information.

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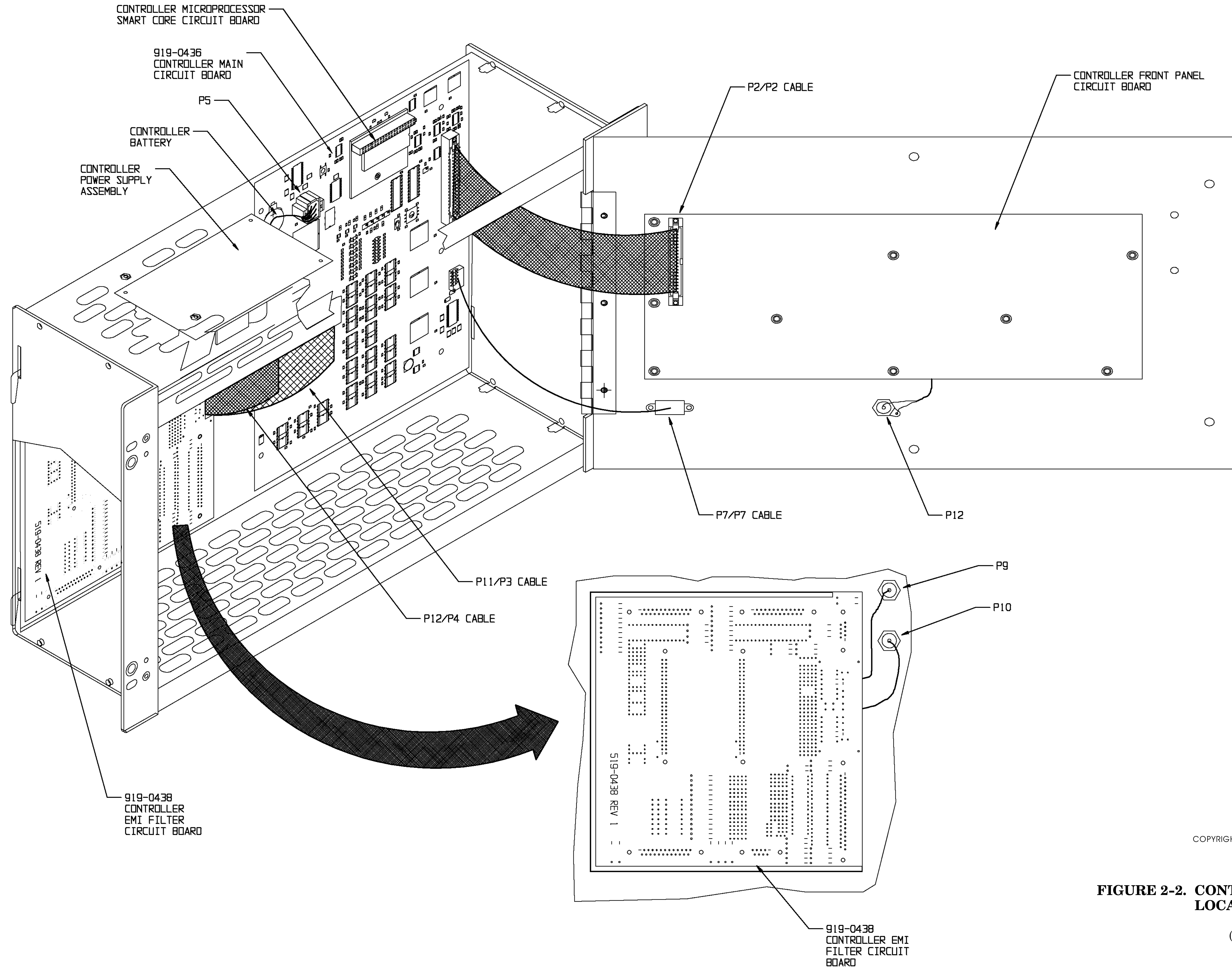

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FIGURE 2-2. CONTROLLER COMPONENT LOCATIONS

SECTION III
PARTS LIST

3-1. INTRODUCTION.

3-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FM-20T transmitter controller. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 3-1. TRANSMITTER CONTROLLER PARTS LIST INDEX

TABLE	DESCRIPTION	PART NO.	PAGE
3-2	FM TRANSMITTER DIGITAL CONTROLLER ASSEMBLY	959-0430	3-2
3-3	MAIN BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY	919-0436	3-2
3-4	FRONT PANEL CONTROLLER CIRCUIT BOARD ASSEMBLY	919-0437	3-5
3-5	I/O BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY	919-0438	3-6
3-6	HARNESS, FM DIGITAL CONTROLLER ASSEMBLY	949-0423	3-7

TABLE 3-2. FM TRANSMITTER DIGITAL CONTROLLER ASSEMBLY - 959-0430

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Power Input Connector/RFI Filter, 3 Amperes, 250V ac, 50/60 Hz	339-0008	1
----	Fuse, 313001, 3AG, 1 Amp, Slow-Blow, 250V	334-0100	1
----	Fuse Holder, AGC	415-2012	1
----	Connector, BNC	417-0016	1
----	Receptacle, BNC	417-0017	2
----	Power Supply, NFN40-7610, SMPS, 3 Output 40W	540-0006	1
----	Main Board, Controller Circuit Board Assembly	919-0436	1
----	Front Panel, Controller Circuit Board Assembly	919-0437	1
----	I/O Board, Controller Circuit Board Assembly	919-0438	1
----	Smartcore Z1B Circuit Board Assembly	544-0006	1
----	Harness, FM Digital Controller Assembly	949-0423	1
----	Software Kit, T-Series Controller	979-0443-003	1

TABLE 3-3. MAIN BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0436 (Sheet 1 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
BT1	Battery, 3 Volts, 190 mAh, Lithium	350-2032	1
C1, C2	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	2
C3	Capacitor, Tantalum, 15 uF ±10%, 35V, SMD	070-1564	1
C4 thru C8	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	5
C9	Capacitor, Tantalum, 15 uF ±10%, 35V, SMD	070-1564	1
C10, C11	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	2
C12 thru C15	Capacitor, Ceramic, 390 pF ±5%, 100V, SMD	007-3923	4
C16 thru C30	Capacitor, Ceramic, 1 uF ±10%, 50V, SMD	007-1054	15
C31, C32	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	2
C33	Capacitor, Ceramic, 1 uF ±10%, 50V, SMD	007-1054	1
C34	Capacitor, Electrolytic, 330 uF ±20%, 25V, SMD	007-0331	1
C35, C36	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	2
C37 thru C52	Capacitor, Ceramic, 390 pF ± 5%, 100V, SMD	007-3923	16
C53	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	1
C54, C55	Capacitor, Tantalum, 15 uF ±10%, 35V, SMD	070-1564	2
C56, C57, C59 thru C63	Capacitor, Ceramic, 0.1 uF ±10%, 50V, SMD	007-1044	7
D1	Transzorb, P6SMB27CAT3, Case 403A-03, 27V, SMD	204-0027	1
D2	Transzorb, P6SMB15CAT3, Case 403A-03, 15V, SMD	204-0015	1
D3	Diode, MMBD914LT1, Case 318-07, Switching, SMD	204-0914	1
DS1 thru DS3	LED, HSMF-C655, Dual Red/Green, Low Profile, SMD	325-0250	3
J1	Receptacle, 40-Position, Two Row, PCB	417-4042	1
J2	Header, 40-Pin, .100 Centers, SMD	408-0040	1
J3, J4	Header, 50-Pin, .100 Centers, SMD	408-0050	2
J5	Receptacle, 6-Pin	417-0677	1
J6	Header, 3-Pin, .100 Centers, SIP	408-0300	1
J7	Header, 10-Pin, .100 Centers, DIP	408-1000	1
J8	Header, 16-Pin, .100 Centers, DIP	408-1600	1
J9 thru J14	Header, 3-Pin, .100 Centers	408-0300	6
OSC1	Oscillator, Crystal, 1.8432 Mhz, SMD	390-0054	1
P8A thru P8H P6, P9 thru P14	Switch, Jumper Programmable	340-0004	15
Q1, Q2	Transistor, MMBT3904LT1, NPN, SMD	216-3904	2
R1, R2	Resistor, Chip, 1.00 k Ohm ±1%, 1/10W, SMD	102-1001	2
R3 thru R19	Resistor, Chip, 471 Ohm ±1%, 1/10W, SMD	102-4711	17
R20 thru R25	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	6
R26	Resistor, Chip 2.00 k Ohm, 1/10W, SMD	102-2001	1
R27	Potentiometer, 100 k Ohm, Top Adjust, SMD	198-0104	1

TABLE 3-3. MAIN BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0436
(Sheet 2 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R31, R32, R34 thru R45	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	12
R46	Resistor, Chip 1.00 k Ohm ±1%, 1/10W, SMD	102-1001	1
R47 thru R59	Resistor, Chip, 1.00 k Ohm ±1%, 1/10W, SMD	102-1001	13
R60	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R61	Resistor, Chip 1.00 k Ohm ±1%, 1/10W, SMD	102-1001	1
R62	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R63	Resistor, Chip, 1.00 k Ohm ±1%, 1/10W, SMD	102-1001	1
R64	Resistor, Chip, 471 Ohm ±1%,1/10W, SMD	102-4711	1
R65 thru R73	Resistor, Chip, 471 Ohm ±1%, 1/10W, SMD	102-4711	9
R74	Resistor, Chip, 471 Ohm ±1%, 1/10W, SMD	102-4711	1
R75	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R76	Resistor, Chip, 41.2 k Ohm ±1%, 1/10W, SMD	102-4122	1
R77, R78	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	2
R79	Resistor, Chip, 100 k Ohm ±1%, 1/10W	102-1003	1
R80	Resistor, Chip, 20.0 k Ohm ±1%,1/10W, SMD	102-2002	1
R81, R82	Resistor, Chip, 10.0 k Ohm ±1%,1/10W, SMD	102-1002	2
R83, R84	Potentiometer, 100 k, Top Adjust, SMD	198-0104	2
R85	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R86	Resistor, Chip, 100 k Ohm ±1%, 1/10W	102-1003	1
R87	Resistor, Chip, 2.00 k Ohm ±1%, 1/10W, SMD	102-2001	1
R88, R89	Resistor, Chip, 10.0 k Ohm ±1%,1/10W, SMD	102-1002	2
R90, R91	Resistor, Chip, 2.00 k Ohm ±1%, 1/10W, SMD	102-2001	2
R92	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R94	Resistor, Chip, 2.00 k Ohm, 1/10W, SMD	102-2001	1
R95	Potentiometer, 100 k, Top Adjust, SMD	198-0104	1
R96	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R99	Resistor, Chip, 768 Ohm ±1%,1/10W, SMD	102-7680	1
R100	Resistor, Chip, 1.00 k Ohm ±1%,1/10W, SMD	102-1001	1
R101, R103	Resistor, Chip, 332 k Ohm ±1%,1/10W, SMD	102-3323	2
R104	Resistor, Chip, 10.0 k Ohm ±1%,1/10W, SMD	102-1002	1
R106	Resistor, Chip, 20.0 k Ohm ±1%,1/10W, SMD	102-2002	1
R107	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R109	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R110	Resistor, Chip, 10.0 k Ohm ±1%,1/10W, SMD	102-1002	1
R112	Resistor, Chip, 33 k Ohm ±1%, 1/10W, SMD	102-3353	1
R113	Potentiometer, 100 k, Top Adjust, SMD	198-0104	1
R114	Resistor, Chip, 2.00 k Ohm, 1/10W, SMD	102-2001	1
R115, R116	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	2
R117	Resistor, Chip, 2.00 k Ohm, 1/10W, SMD	102-2001	1
R118	Resistor, Chip, 100 k Ohm ±1%, 1/10W	102-1003	1
R119	Potentiometer, 50k Ohm, Top Adjust, SMD	198-0503	1
R120	Resistor, Chip, 100 k Ohm ±1%, 1/10W	102-1003	1
R125 thru R131	Resistor, Chip, 10.0 k Ohm ±1%,1/10W, SMD	102-1002	7
R133 thru R140	Resistor, Chip, 10.0 k Ohm ±1%,1/10W, SMD	102-1002	8
R141 thru R143	Resistor, Chip, 49.9 Ohm ±1%, 1/10W	102-4991	3
R144	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R145	Resistor, Chip, 20.0 k Ohm ±1%, 1/10W, SMD	102-2002	1
R146, R147	Resistor, Chip, 2.00 k Ohm, 1/10W, SMD	102-2001	2
R148	Resistor, Chip, 49.9 Ohm ±1%,1/10W	102-4991	1
R149, R150	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	2
R151 thru R156	Resistor, Chip, 49.9 Ohm ±1%, 1/10W	102-4991	6
R159	Resistor, Chip, 2.00 k Ohm, 1/10W, SMD	102-2001	1
R160	Resistor, Chip, 10.0 k Ohm ±1%, 1/10W, SMD	102-1002	1
R162	Resistor, Chip, 49.9 Ohm ±1%, 1/10W	102-4991	1

TABLE 3-3. MAIN BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0436
(Sheet 3 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R165	Resistor, Chip, 49.9 Ohm ±1%, 1/10W	102-4991	1
R168	Resistor, Chip, 49.9 Ohm ±1%, 1/10W	102-4991	1
SW1	Switch, 94HCB08W, Rotary, BCD, 8 Position, SMD	342-9410	1
SW2	Switch, ETO5SD1CBE, Toggle, SPDT, MOM/OFF/MOM	340-0510	1
SW3	Switch, TL3304F160, TACT, SPST, N.O., SMD, Recessed	342-3304	1
TP1 thru TP10	Chip, Test Point, 1206, SMD	413-1206	10
U1, U2,	Integrated Circuit, 82C55A, Peripheral Interface, 44-Pin PLCC Package	229-8255-001	2
U3	Varistor, LM79L05AC, Negative Voltage, 100 mA, SMD	231-7905	1
U4	Integrated Circuit, 82C55A, Peripheral Interface, 44-Pin PLCC Package	229-8255-001	1
U7, U8	Integrated Circuit, ADC0808CCV, A/D Converter, 8-BIT, 8-Channel Multiplexer, 28-Pin Molded Chip Carrier Package	224-0808	2
U9	Integrated Circuit, MAX351CSE, Quad Analog Switch, 16-Pin, SO Package, SMD	224-0351	1
U18	Integrated Circuit, ST16C552CJ68, PLCC Package, 68-Pin, Dual Universal Asynchronous Receiver/Transmitter with FIFO and Parallel Printer Port With Power Down Capability, SMD	224-0552	1
U29, U31	Integrated Circuit, LT1491CS, OP Amp, Quad Micropower Rail-To-Rail Input and Output, 14-Pin, SO Package, SMD	224-1491	2
U32 thru U34	Integrated Circuit, SP241ACT, RS-232 Multi-Transceiver, +5V, 28-Pin SOIC Package, SMD	224-2410	3
U35	Integrated Circuit, X9312WS, Nonvolatile Trimmer Pot, 10 k, 0-15V dc, 8-Pin SOIC Package, SMD	198-9312	1
U36	Integrated Circuit, Si9986CY, 1 Amp, Buffered Full-Bridge, 8-Pin SOIC Package, SMD	224-9986	1
U37	Integrated Circuit, LT1491CS, OP Amp, Quad Micropower Rail-To-Rail Input and Output, 14-Pin SO Package, SMD	224-1491	1
U38	Integrated Circuit, MAX505ACWG, QUAD, 8-BIT DAC, Volt Out, +5V, 24-Pin Wide SO Package, SMD	224-0505	1
U39	Integrated Circuit, N74F74D, Dual Positive Edge Triggered D-Type Flip-Flop, 14-Pin SO, SMD	224-0074	1
U40, U41	Integrated Circuit, LT1491CS, Op Amp, Quad Micropower Rail-To-Rail Input and Output, 14-Pin, SO Package, SMD	224-1491	2
U10A thru U17A	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	8
U10B thru U17B	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	8
U19A thru U22A	Integrated Circuit, H11AA1, AC Input Opto-Isolator, 6-Pin DIP	229-0111	4
U19B thru U22B, U25B	Integrated Circuit, H11AA1, AC Input Opto-Isolator, 6-Pin DIP	229-0111	5
U24A	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	1
U25A	Integrated Circuit, H11AA1, AC Input Opto-Isolator, 6-Pin DIP	229-0111	1
U26A thru U28A	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	4
U24B, U26B thru U28B	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	4
XBT1	Holder, Battery For CR-2032, SMD	415-2032	1
XU5, XU6	Socket, 20-Pin, DIP, SMD	431-2000	2
XU5	Software, FM Control Programmed Kit	979-0436-005	1
XU6	Software, FM Control Programmed Kit	979-0436-006	1

TABLE 3-3. MAIN BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0436
(Sheet 4 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
XU10 thru XU17	Socket, 14-Pin, DIP, SMD	431-1400	8
XU18	Socket, 68-Pin, PLCC, SMD	431-6800	1
XU19 thru XU22	Socket, 14-Pin, DIP, SMD	431-1400	4
XU24 thru XU28	Socket, 14-Pin, DIP, SMD	431-1400	5
----	Blank, Main Board, Controller Circuit Board	519-0436	1

TABLE 3-4. FRONT PANEL CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0437
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C2	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C3	Capacitor, Ceramic, Monolythic, .1 uF ±20%, 50V	003-1054	1
DS1 thru DS4	LED, LN322GP, Green, Diffused Chimney	320-0322	4
DS5 thru DS8	LED, LN222RP, Red Diffused Chimney, P424, 70 mW, 20 mA, 4V	320-0037	4
DS9	LED, LN322GP, Green, Diffused Chimney	320-0322	1
J2	Connector Header, 40-Pin	417-0173	1
J12	Receptacle, Male, 8-Pin In-Line, Right Angle	417-0080-001	1
L1	RF Choke, 4.7 uH ±10%, 430 mA, DC Resistance: 0.55 Ohms, 0.43 Amperes Maximum, Resonant at 115 MHz	360-0022	1
R1, R2	Resistor, 10 Ohm ±1%, 1/4W	103-1021	2
R3	Resistor, 17.8 Ohm ±1%, 1/4W	103-1782	1
R4	Resistor, 10 Ohm ±1%, 1/4W	103-1021	1
R5	Resistor, 17.8 Ohm ±1%, 1/4W	103-1782	1
R6	Resistor, 10 Ohm ±1%, 1/4W	103-1021	1
R7	Resistor, 17.8 Ohm ±1%, 1/4W	103-1782	1
R8	Resistor, 10 Ohm ±1%, 1/4W	103-1021	1
R9	Resistor, 267 Ohm ±1%, 1/4W	103-2673	1
R10	Resistor, 10 Ohm ±1%, 1/4W	100-1051	1
R11 thru R14	Resistor, 536 Ohm ±1%, 1/4W	103-5363	4
R15 thru R18	Resistor, 150 Ohm ±1%, 1/4W	100-1531	4
R19 thru R27	Resistor, 10 Ohm ±1%, 1/4W	100-1051	9
R28	Resistor, 267 Ohm ±1%, 1/4W	103-2673	1
R29	Resistor, 10 Ohm ±1%, 1/4W	103-1021	1
R30	Resistor, 10 Ohm ±1%, 1/4W	100-1051	1
R31	Resistor, 10 Ohm ±1%, 1/4W	103-1021	1
R32	Resistor, 10 Ohm ±1%, 1/4W	100-1051	1
R33	Resistor, 536 Ohm ±1%, 1/4W	103-5363	1
R34	Resistor, 150 Ohm ±1%, 1/4W	100-1531	1
R35	Resistor, 442 Ohm ±1%, 1/4W	103-4423	1
SW1	Switch, TL-1251-G, Pushbutton, Momentary, LED Illuminated, Green	340-0140	1
SW2	Switch, TL-1251-Y, Pushbutton, Momentary, LED Illuminated, Yellow	340-0139	1
SW3	Switch, TL-1251-R, Pushbutton, Momentary, LED Illuminated, Red	340-0143	1
SW4	Switch, TL-1251-G, Pushbutton, Momentary, LED Illuminated, Green	340-0140	1
SW5, SW6	Switch, TL-1251-Y, Pushbutton, Momentary, LED Illuminated, Yellow	340-0139	2
SW7	Switch, TL-1251-G, Pushbutton, Momentary, LED Illuminated, Green	340-0140	1
SW8	Switch, TL-1251-R, Pushbutton, Momentary, LED Illuminated, Red	340-0143	1
SW9	Switch, TL-1251-Y, Pushbutton, Momentary, LED Illuminated, Yellow	340-0139	1

TABLE 3-4. FRONT PANEL CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0437
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
SW10	Switch, TL-1251-R, Pushbutton, Momentary, LED Illuminated, Red	340-0143	1
SW11, SW12	Switch, TL-1251-Y, Pushbutton, Momentary, LED Illuminated, Yellow	340-0139	2
----	Blank, Front Panel Controller Circuit Board	519-0437	1

TABLE 3-5. I/O BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0438
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C2 thru C12	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	11
C13	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C14 thru C33	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	20
C34, C35	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	2
C36	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C37	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C38 thru C45	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	8
C46, C47	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	2
C48 thru C52	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	5
C53 thru C57	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	5
C58	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C59	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C60	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C61 thru C69	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	9
C70	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C71, C72, C75 thru C83	Capacitor, Monolythic Ceramic, 0.1 uF ±20%, 50V	003-1054	11
D1 thru D4 70V, 15 mA	Diode, HP5082-2800, High Voltage, Schottky Barrier Type,	201-2800	4
D5 thru D48	Bidirectional Zener Transient Voltage Suppressor, P6KE15CA-RL, +/-15V	201-0015	44
D51 thru D73	Bidirectional Zener Transient Voltage Suppressor, P6KE15CA-RL, +/-15V	201-0015	23
D74, D75	Bidirectional Zener Transient Voltage Suppressor, P6KE27CA-RL, +/-27V	201-0027	2
D76, D77	Bidirectional Zener Transient Voltage Suppressor, P6KE15CA-RL, +/-15V	201-0015	2
FL1 thru FL44 FL47 thru FL69	Filter, EMI, 10,000 pF, 3-Pin	411-0001	65
J1	Connector, DB37F, Vertical, PCB	417-3703	1
J2, J3	Receptacle, 25-Pin	417-2500	2
J5, J6	Connector, DB9M, Vertical, PCB	417-9001	2
J7	Receptacle, 25-Pin	417-2500	1
J11, J12	Header, 50-Pin, Right Angle, .100 Centers	417-5017	2
L1 thru L6	RF Choke, 4.7 uH ±10%, 430 mA, DC Resistance: 0.55 Ohms, 0.43 Amperes Maximum, Resonant at 115 MHz	360-0022	6
R1	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R2 thru R6	Resistor, 100 Ohm ±1%, 1/4W	100-1031	5
R7	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	1
R8, R9	Resistor, 100 Ohm ±1%, 1/4W	100-1031	2
R10, R11	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	2
R12	Resistor, 100 Ohm ±1%, 1/4W	100-1031	1
R14 thru R21	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	8

TABLE 3-5. I/O BOARD CONTROLLER CIRCUIT BOARD ASSEMBLY - 919-0438
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R24 thru R31	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	8
R34	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R37 thru R39	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	3
R45	Resistor, 56 Ohm ±5%, 2W	130-5621	1
R46 thru R48	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	3
R54	Resistor, 475 Ohm ±1%, 1/4W	103-4753	1
R55, R56	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R57	Resistor, 475 Ohm ±1%, 1/4W	103-4753	1
R58	Resistor, 56 Ohm ±5%, 2W	130-5621	1
R60	Resistor, 21 k Ohm ±1%, 1/4W	103-2105	1
R64 thru R66	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	3
R67	Resistor, 8.66 k Ohm ±1%, 1/4W	100-8641	1
R68	Resistor, 4.32 k Ohm ±1%, 1/4W	103-4324	1
R73, R75,	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	2
R76, R77	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	2
R79	Resistor, 4.32 k Ohm ±1%, 1/4W	103-4324	1
R82	Resistor, 8.66 k Ohm ±1%, 1/4W	100-8641	1
R90 thru R92	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	3
R94 thru R98	Resistor, 51.1 Ohm ±1%, 1/4W	103-5112	5
----	Blank, I/O Board Controller Circuit Board	519-0438	1

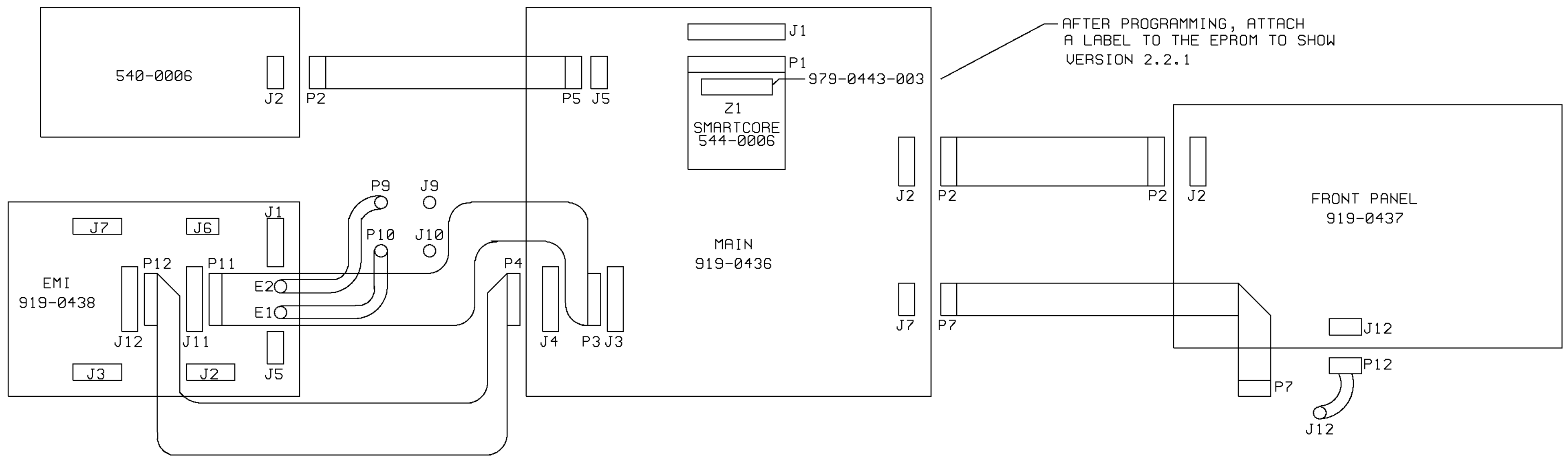
TABLE 3-6. HARNESS, FM DIGITAL CONTROLLER ASSEMBLY - 949-0423

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Connector, Male, 9-Pin	417-0181	1
----	Socket, Connector, 50-Pin	417-0228	4
----	Housing, SL-156, 3 Position	417-0306	1
----	Plug, Housing, 2-Pin	417-0499	3
----	Housing, SL-156, 6 Position	417-0606	1
----	Pins, Crimp Type	417-8766	6
----	Connector Housing, 6-Pin	418-0670	1
----	Plug, 40-Pin Dual In-Line	418-4001	2
----	Varistor, V250LA20A GE, Model Size 14	140-0008	2
----	Socket, Connector, 641294-1 Amp	417-0053	6
----	Socket, Connector, 10-Pin	417-1003	1

SECTION IV
DRAWINGS

4-1. INTRODUCTION.

4-2. This section provides assembly drawings, schematic diagrams, and wiring diagrams as indexed below for the FM-20T transmitter controller.



919-0438

REMOTE I/O J1	
1	R_FIL_ON_OUT
2	R_DISABLR_LED
3	R_HV_ON_OUT
4	R_PLATE_OL_LED
5	R_SCREEN_OL_LED
6	R_GRID_OL_LED
7	R_VSWR_OL_LED
8	R_OL_LED
9	R_INTLK_LED
10	R_AIR_PSI_LED
11	R_FIL_LED
12	R_HV_LED
13	R_PRESET_LED
14	R_IPA_F_PWR_OUT
15	R_APC_LED
16	CHASIS_GND
17	NO CONNECTION
18	FAILSAFE_IN
19	FAILSAFE_OUT
20	R_FIL_ON_IN
21	R_FIL_OFF_IN
22	R_HV_ON_IN
23	R_HV_OFF_IN
24	R_RAISE_PWR_IN
25	R_LOWER_PWR_IN
26	R_PRESET_PWR_IN
27	R_OL_RST_IN
28	NO CONNECTION
29	P_PA_F_PWR_OUT
30	R_PA_R_PWR_OUT
31	GND
32	R_PLATE_E_OUT
33	R_PLATE_I_OUT
34	R_APC_ON_IN
35	NO CONNECTION
36	R_FAILSAFE_LED
37	R_PWR_+15V

TRANSMITTER J2	
1	EXCTR_F_PWR_IN
2	KEY
3	EXCTR_R_PWR_IN
4	EXCTR_TEMP_IN
5	AFC_UNLOCK_IN
6	EXCTR_MUTE_OUT
7	AIR_PSI_IN
8	INTERLOCK_OUT
9	INTERLOCK_IN
10	PLATE_I_IN
11	PLATE_E_IN
12	SCREEN_I_IN
13	SCREEN_E_IN
14	GRID_I_IN
15	GRID_E_IN
16	CHASIS_GND
17	FIL_ON_SSR
18	BLWR_ON_SSR
19	S/S_ON_SSR
20	HV_ON_SSR
21	PA_TEMP_IN
22	GND
23	GND
24	NO CONNECTION
25	PA_TEMP_OUT

TRANSMITTER J3	
1	KEY
2	IPA_TEMP_IN
3	IPA_F_PWR_IN
4	IPA_R_PWR_IN
5	IPA_E_IN
6	IPA_I_IN
7	IPA_MOD_FAULT_IN
8	IPA_RESET_OUT
9	IPA_PWR_FALT_IN
10	IPA_PWR_CNTRL_OUT
11	NO CONNECTION
12	NO CONNECTION
13	GND
14	NO CONNECTION
15	GND
16	LOWER_PWR_IND_IN
17	IPA_FALT_STAT_IN
18	NO CONNECTION
19	NO CONNECTION
20	RAISE_PWR_IND_IN
21	FWD/VSWR_OUT
22	NO CONNECTION
23	RAISE_PA_PWR_OUT
24	LOWER_PA_PWR_OUT
25	NO CONNECTION

LOCAL PORT J6		
1	NO CONNECTION	
2	RECIEVE DATA	(RX)
3	TRANSMIT DATA	(TX)
4	NO CONNECTION	
5	SIGNAL GROUND	(GND)
6-9	NO CONNECTION	

MODEM PORT 2 J5		
1	DATA CARRIER DETECT	(DCD)
2	RECIEVE DATA	(RX)
3	TRANSMIT DATA	(TX)
4	DATA TERMINAL READY	(DTR)
5	SIGNAL GROUND	(GND)
6	DATA SET READY	(DSR)
7	REQUEST TO SEND	(RTS)
8	CLEAR TO SEND	(CTS)
9	RING INDICATOR	(RI)

PRINTER PORT J7	
1	STROBE
2	DATA BIT 0
3	DATA BIT 1
4	DATA BIT 2
5	DATA BIT 3
6	DATA BIT 4
7	DATA BIT 5
8	DATA BIT 6
9	DATA BIT 7
10	ACKNOWLEDGE
11	BUSY
12	OUT OF PAPER
13	SELECT
14	AUTO FEED
15	I/O ERROR
16	INITIALIZE PRINTER
17	SELECT IN
18-25	GROUND

J11/P11 ◄──► P3/J3		
1	+15V	1
2	R_HV_ON_OPT	2
3	R_FIL_ON_OPT	3
4	R_OL_OPT	4
5	R_PLATE_OL_OPT	5
6	R_SCREEN_OL_OPT	6
7	R_GRID_OL_OPT	7
8	R_VSWR_OL_OPT	8
9	R_INTLK_OPT	9
10	R_AIR_PSI_OPT	10
11	R_FIL_OPT	11
12	R_HV_OPT	12
13	R_FIL_ON_IN_OPT	13
14	R_FIL_OFF_OPT	14
15	R_HV_ON_IN_OPT	15
16	R_HV_OFF_OPT	16
17	R_OL_RST_OPT	17
18	R_RAISE_PWR_OPT	18
19	R_LOWER_PWR_OPT	19
20	R_PRESET_PWR_OPT	20
21	R_DISABLE_OPT	21
22	R_PA_F_PWR_MTR	22
23	R_PA_R_PWR_MTR	23
24	R_PLATE_E_MTR	24
25	R_PLATE_I_MTR	25
26	FWD/VSWR_MTR	26
27	EXCTR_F_PWR_SMP	27
28	EXCTR_R_PWR_SMP	28
29	EXCTR_TEMP	29
30	AFC_UNLOCK	30
31	EXCTR_MUTE_OPT	31
32	FIL_ON_OPT	32
33	BLWR_ON_OPT	33
34	S/S_ON_OPT	34
35	HV_ON_OPT	35
36	PLATE_I_SMP	36
37	PLATE_E_SMP	37
38	SCREEN_I_SMP	38
39	SCREEN_E_SMP	39
40	GRID_I_SMP	40
41	GRID_E_SMP	41
42	PA_TEMP_SMP	42
43	GND	43
44	RAISE_PA_PWR	44
45	RAISE_PWR_LED	45
46	LOWER_PA_PWR	46
47	LOWER_PWR_LED	47
48	PA_F_PWR_SMP	48
49	PA_R_PWR_SMP	49
50	R_PRESET_LED_OPT	50

J12/P12 ◄──► P4/J4		
1	+5V	1
2	IPA_FALT_STAT	2
3	IPA_F_PWR_SMP	3
4	IPA_R_PWR_SMP	4
5	IPA_E_SMP	5
6	IPA_I_SMP	6
7	IPA_PWR_CNTL	7
8	IPA_PWR_FALT	8
9	IPA_RESET_OPT	9
10	IPA_MOD_FALT	10
11	IPA_TEMP	11
12	FAILSAFE_OPT	12
13	INTERLOCK_OPT	13
14	AIR_PSI_OPT	14
15	NO CONNECTION	15
16	SLCT	16
17	ERROR	17
18	PE	18
19	/SLCTIN	19
20	INIT	20
21	/AUTOFDXT	21
22	/STROBE	22
23	ACK	23
24	/BUSY	24
25	PD_0	25
26	PD_1	26
27	PD_2	27
28	PD_3	28
29	PD_4	29
30	PD_5	30
31	PD_6	31
32	PD_7	32
33	TXCO	33
34	RXCI	34
35	TXBO	35
36	RXBI	36
37	/RIBI	37
38	/CDBI	38
39	/DSRBO	39
40	/DTRBO	40
41	/RTSBO	41
42	/CTSBI	42
43	GND	43
44	R_FAILSAFE_OPT	44
45	NO CONNECTION	45
46	R_APC_ON_IN_OPT	46
47	R_APC_LED_OPT	47
48	R_IPA_F_PWR_MTR	48
49	NO CONNECTION	49
50	CHASIS_GND	50

FWD POWER E2 ◄──► P9/J9		
1	CONDUCTOR	1
2	SHIELD	2

RFL POWER E1 ◄──► P10/J10		
1	CONDUCTOR	1
2	SHIELD	2

J1 ◄──► P1		
1	GND	1
2	+5	2
3	VBAT	3
4	PFI	4
5	D1	5
6	/RESET	6
7	D2	7
8	NO CONNECTION	8
9	D3	9
10	NO CONNECTION	10
11	D4	11
12	/CS1	12
13	D5	13
14	NO CONNECTION	14
15	D6	15
16	D0	16
17	NO CONNECTION	17
18	A0	18
19	A1	19
20	NO CONNECTION	20
21	/INT1	21
22	/INT0	22
23	A3	23
24	A2	24
25	NO CONNECTION	25
26	A4	26
27	D7	27
28	A5	28
29	/WR	29
30	/IORQ	30
31	NO CONNECTION	31
32	/RD	32
33	NO CONNECTION	33
34	TX1	34
35	NO CONNECTION	35
36	RX0	36
37	TX0	37
38	RX1	38
39	E	39
40	GND	40

J2/P2 ◄──► P5/J5	
1	+15
2	+5
3	+5
4	GND
5	GND
6	-15

J2/P2 ◄──► P2/J2		
1	+15V	1
2	+5V	2
3	APC_ON_LED	3
4	APC_ON_SW	4
5	FIL_ON_LED	5
6	FIL_ON_SW	6
7	PRESET_LED	7
8	PRESET_SW	8
9	FIL_OFF_LED	9
10	FIL_OFF_SW	10
11	RM_DIS_LED	11
12	RM_DIS_SW	12
13	OL_RST_LED	13
14	OL_RST_SW	14
15	HV_ON_LED	15
16	HV_ON_SW	16
17	HV_OFF_LED	17
18	HV_OFF_SW	18
19	LOWER_PWR_LED	19
20	LOWER_PWR_SW	20
21	RAISE_PWR_LED	21
22	RAISE_PWR_SW	22
23	FWD_PWR_LED	23
24	FWD_PWR_SW	24
25	VSWR_LED	25
26	VSWR_SW	26
27	INTERLOCK_OPT	27
28	AIR_PSI_OPT	28
29	FIL_ON_OPT_A	29
30	HV_ON_OPT_A	30
31	V_OVRLD	31
32	P_OVRLD	32
33	S_OVRLD	33
34	G_OVRLD	34
35	GND	35
36	FAILSAFE_OPT	36
37	PA_F_PWR	37
38	NO CONNECTION	38
39	GND	39
40	NO CONNECTION	40

MODEM PORT 1 J7/P7 ◄──► P7			
1	DATA CARRIER DETECT	(DCD)	1
2	RECIEVE DATA	(RX)	2
3	TRANSMIT DATA	(TX)	3
4	DATA TERMINAL READY	(DTR)	4
5	SIGNAL GROUND	(GND)	5
6	DATA SET READY	(DSR)	6
7	REQUEST TO SEND	(RTS)	7
8	CLEAR TO SEND	(CTS)	8
9	RING INDICATOR	(RI)	9
10	NO CONNECTION		10

AM NOISE TEST J12/P12 ◄──► J12		
1	CONDUCTOR	1
2	SHIELD	2

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

DWN. BY 4-24-97 K.TERWELP
DESIGNER(S)
PROJ. LEADER
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
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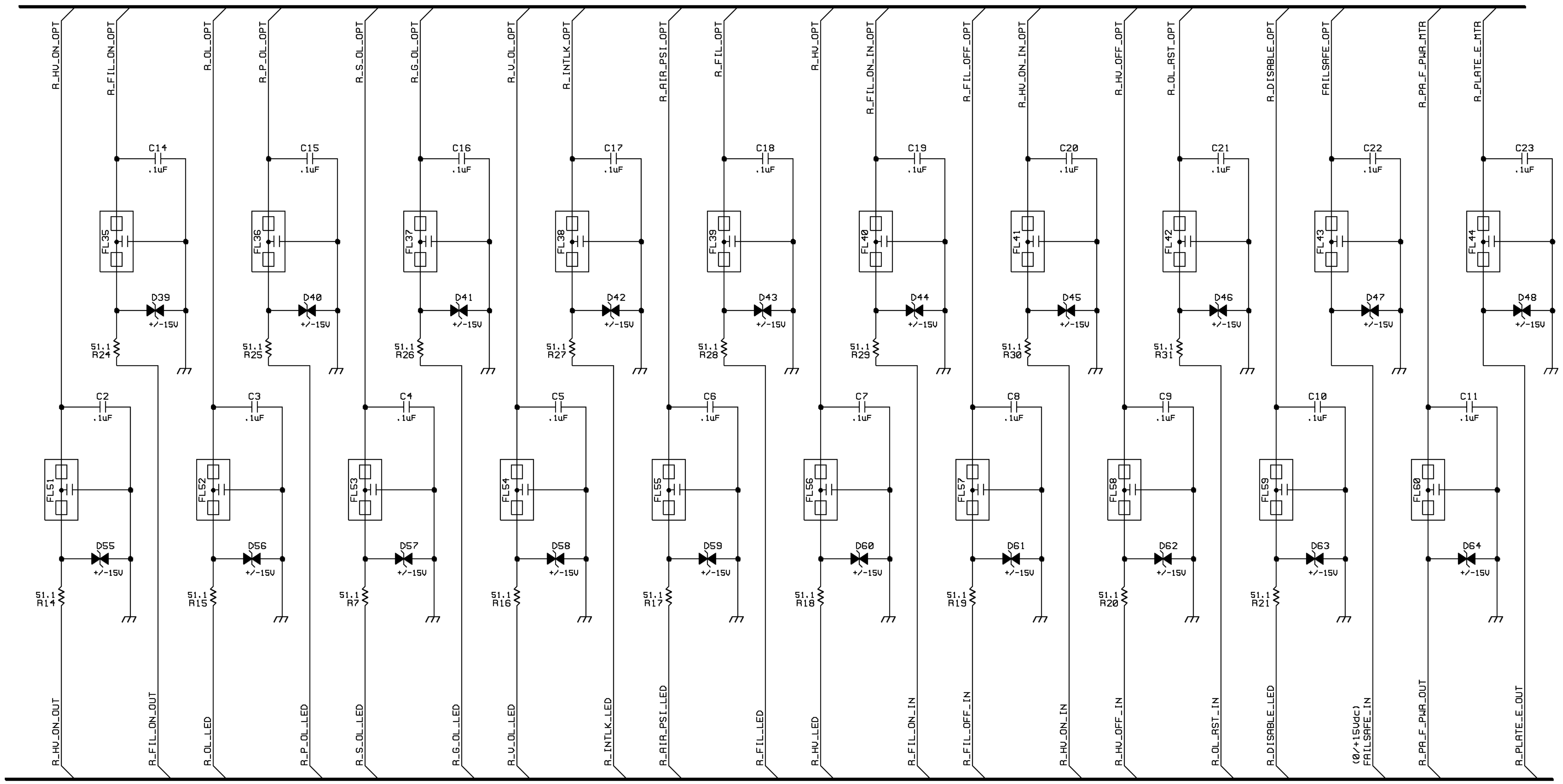
217/224-9600 FAX 217/224-9607

TITLE T-SERIES CONTROLLER OVERALL SCHEMATIC

TYPE S | SIZE B | DWG. NO. 959-0430 | REV C
MODEL | SCALE NONE | SHEET 1 OF 1



NOTES:

1. ALL RESISTORS IN OHMS: 1/4W, 1% UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C87,D81,E2,FL71,J12,L8 & R98.
3. COMPONENTS NOT USED: J4,J8-J10,R22,R23,R32,R33,R35,R36, R49-R52,R59,R61-R63,R69-R72,R74,R78,R80,R81, R83-R89 & R93.
4. SEE ASSEMBLY: AC919-0438.

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

DWN. BY 1-8-97 K.TERWELP
DESIGNER(S)
PROJ. LEADER R.E.BROWN
MFG.

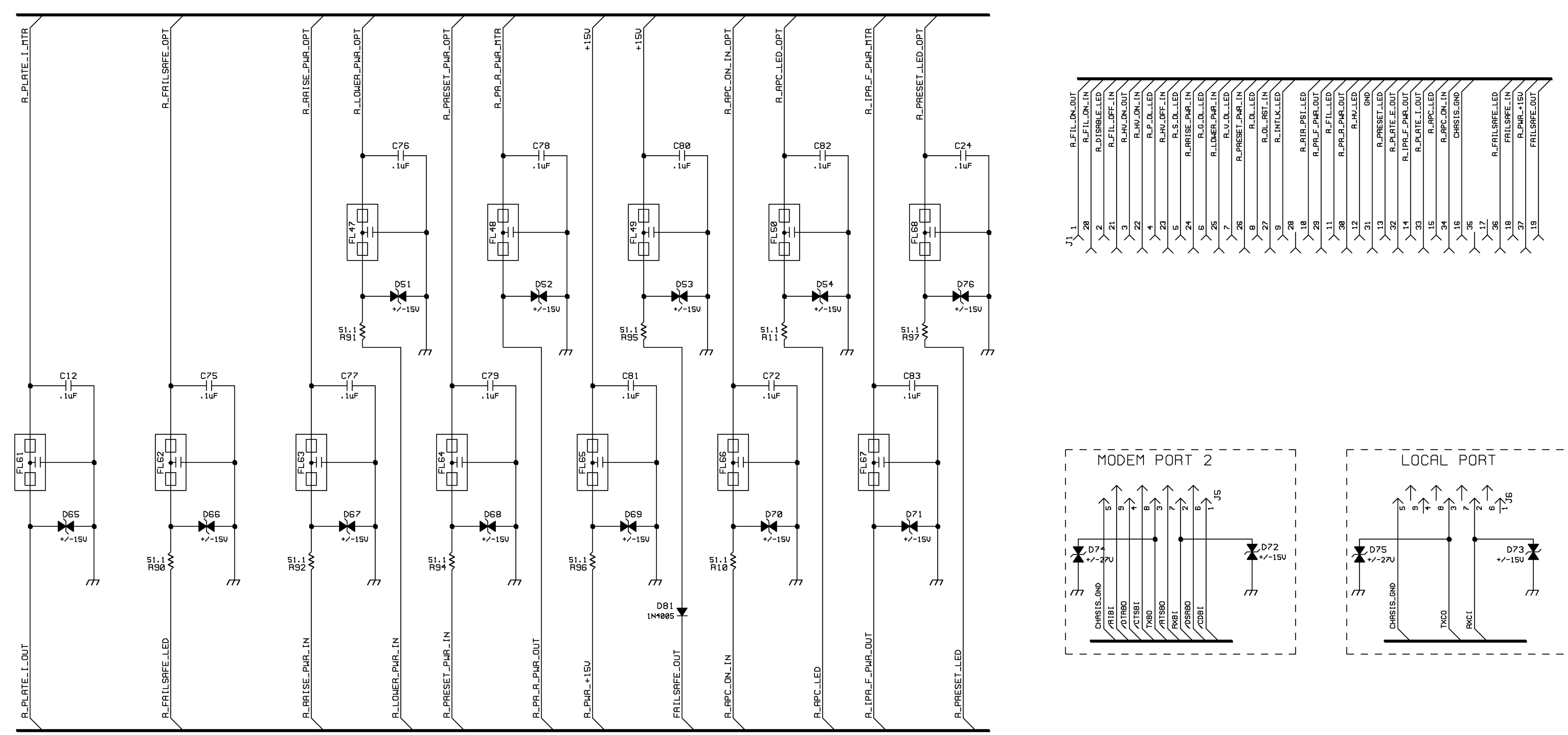
MATERIAL SEE BOM 919-0438
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305
217/224-9600 FAX 217/224-9607

TITLE EMI BOARD

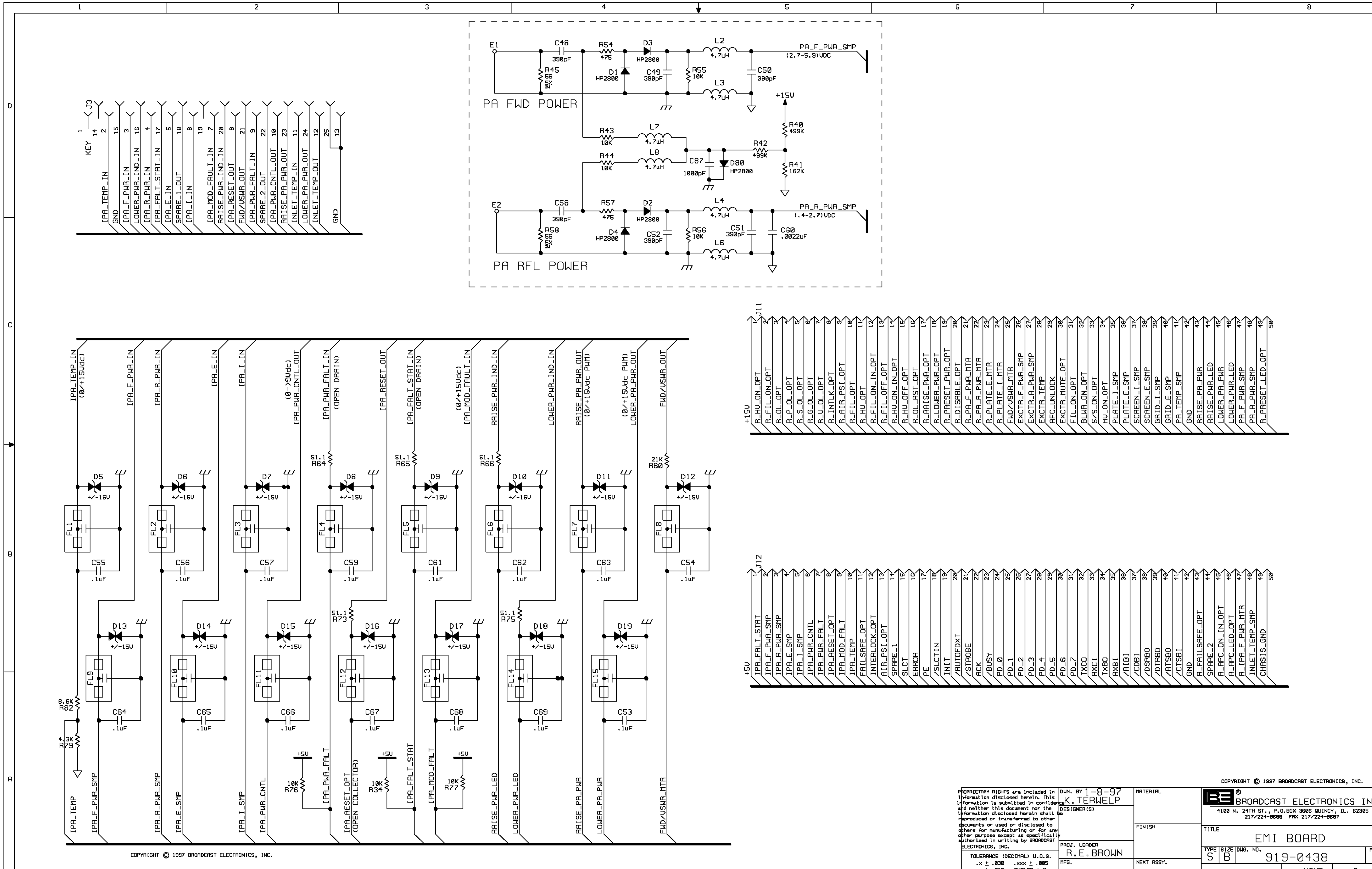
TYPE S | SIZE B | DWG. NO. 919-0438 | REV C

MODEL T-SERIES XMTR | SCALE NONE | SHEET 1 OF 4



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

DWN. BY 1-8-97 K.TERWELP	MATERIAL	BE® BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 FAX 217/224-9607
DESIGNER(S)	FINISH	TITLE EMI BOARD
PROJ. LEADER R.E.BROWN		TYPE S SIZE B DWG. NO. 919-0438 REV C
MFG.	NEXT ASSY.	MODEL SCALE NONE SHEET 2 OF 4



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

DWN. BY 1-8-97 K.TERWELP
DESIGNER(S)
PROJ. LEADER R.E.BROWN
MFG.
MATERIAL
FINISH
NEXT ASSY.

BROADCAST ELECTRONICS INC.
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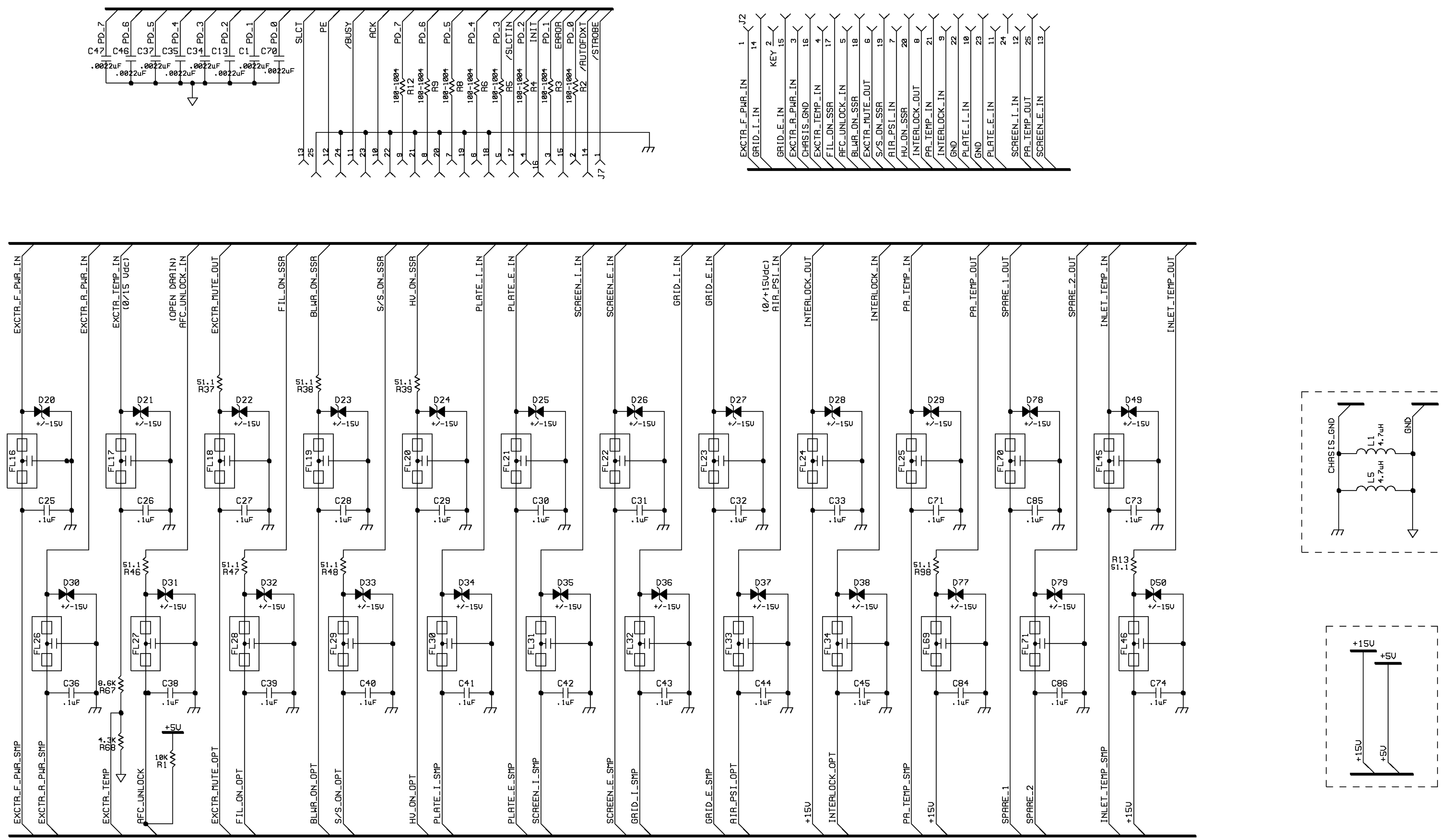
217/224-9600 FAX 217/224-9607

TITLE EMI BOARD

TYPE S SIZE B DWG. NO. 919-0438 REV C
MODEL SCALE NONE SHEET 3 OF 4



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

DWN. BY 1-8-97 K.TERWELP	MATERIAL		
DESIGNER(S)	FINISH		
PROJ. LEADER R.E.BROWN		TITLE EMI BOARD	
MFG.	NEXT ASSY.	TYPE S SIZE B DWG. NO. 919-0438	REV C
		MODEL	SCALE NONE SHEET 4 OF 4

BROADCAST ELECTRONICS INC.
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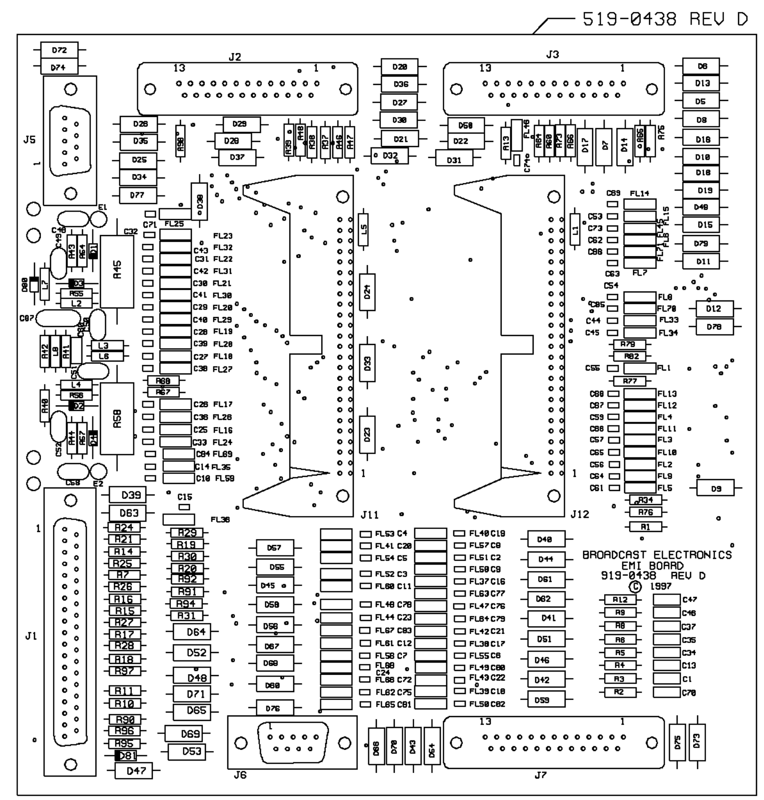
217/224-9600 FAX 217/224-9607



NOTES:

1) LAST COMPONENTS USED: C87,D81,E2,FL71,J12, L8, & R98.
2) COMPONENTS NOT USED: J4,J8-J10, R22,R23,R32,R33,R35,R36,R49,R50-R53, R59,R61-R63,R69-R72,R74,R78,R80,R81, R83-R89,R93.
3) SEE SCHEMATIC: SB919-0438.

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

DWN. BY	2-18-97 K. TERWELP
DESIGNER(S)	
PROJ. LEADER	R. E. BROWN
MFG.	
MATERIAL	SEE BOM 919-0438
FINISH	
NEXT ASSY.	

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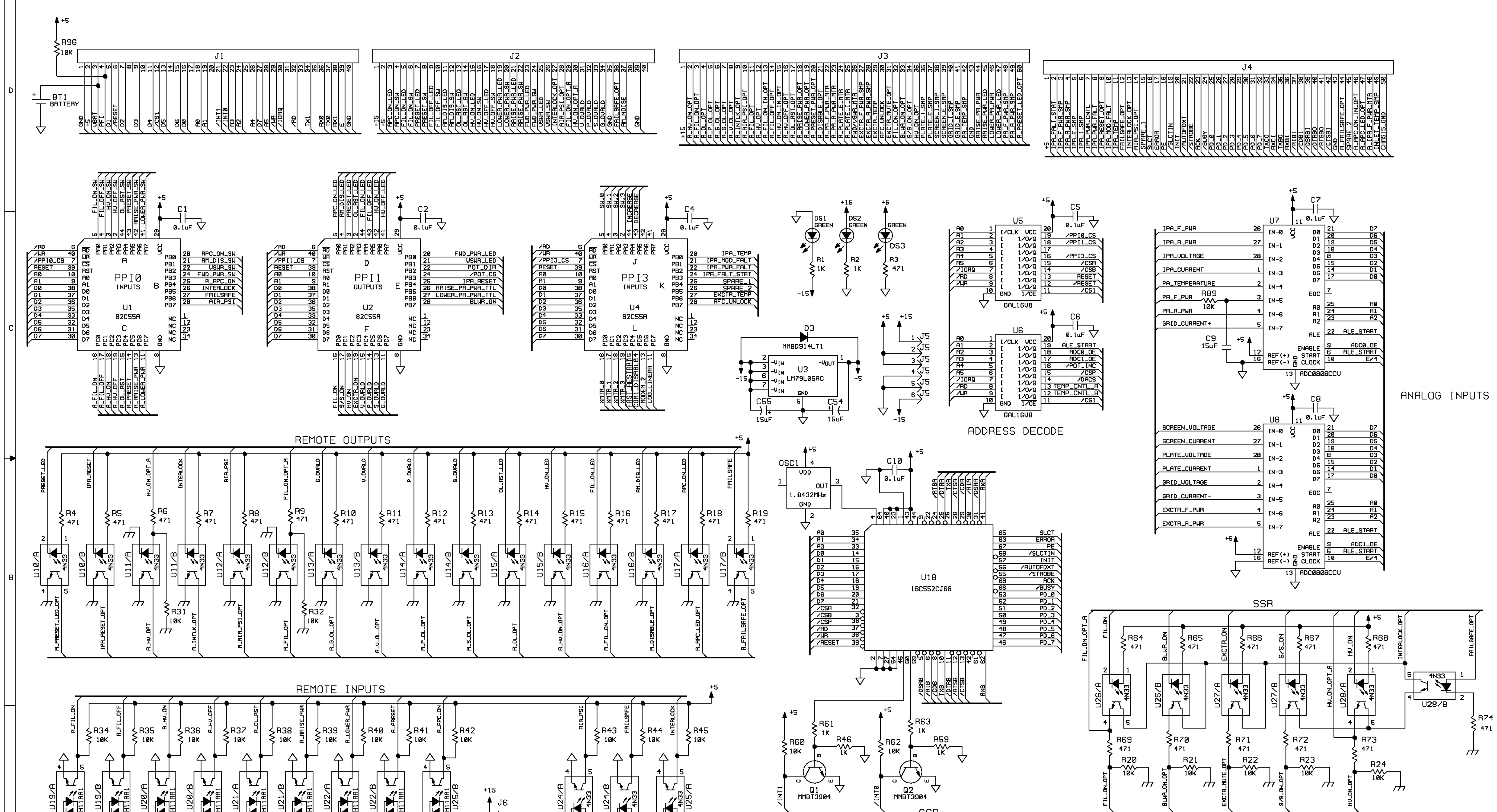
TITLE: PCB ASSEMBLY EMI BOARD

TYPE	SIZE	DWG No.	REV
A	C	919-0438	D

MODEL T-SERIES XMTR | SCALE 1/1 | SHEET 1 OF 1



NOTES:

1. ALL RESISTORS IN OHMS; 1/10W, 1% UNLESS OTHERWISE SPECIFIED.
2. LAST COMPONENT USED: C63,D7,J14,R168, SW4,TP10,U40
3. COMPONENTS NOT USED: C58,R28,R29,R30,R33, R93,R102,R105,R108,R111,R121-R124, R157,R158,R160,R161,R163,R164,R166,R167, U3,U9,U30.
4. SEE ASSEMBLY: AC919-0436
5. U3 USED ON 544-0006

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

DWN. BY	MERKEL 11-14-96
DESIGNER(S)	RICHARD BROWN 2-13-97
PROJ. LEADER	
MFG.	
MATERIAL	SEE B/M 919-0436
FINISH	
NEXT ASSY.	AC919-0436

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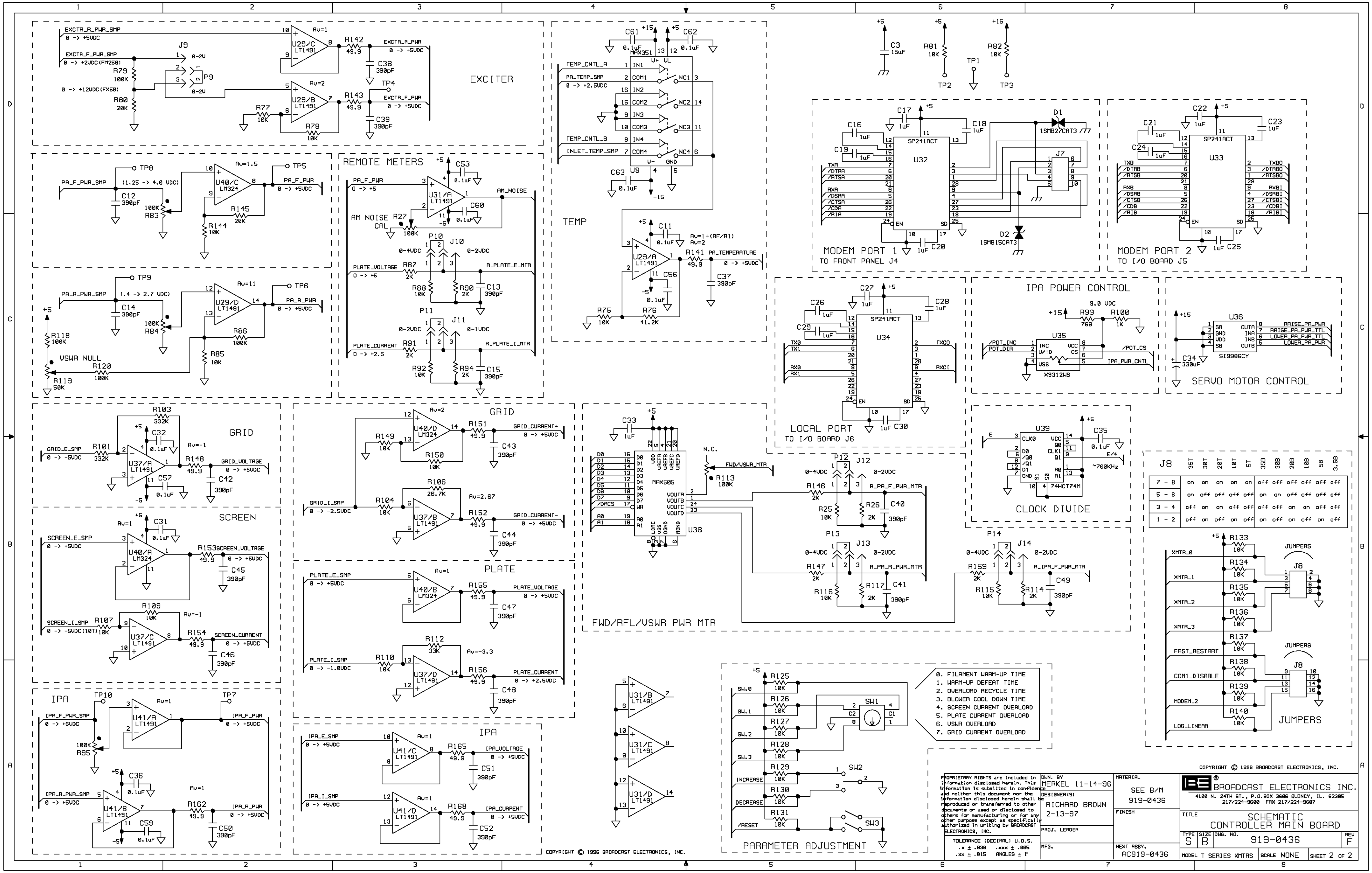
TITLE: SCHEMATIC CONTROLLER MAIN BOARD

TYPE	SIZE	DWG. NO.	REV
S	B	919-0436	F

MODEL T SERIES XMTRS | SCALE NONE | SHEET 1 OF 2


EXCITER
REMOTE METERS
TEMP
MODEM PORT 1
TO FRONT PANEL J4
MODEM PORT 2
TO I/O BOARD J5
LOCAL PORT
TO I/O BOARD J6
IPA POWER CONTROL
SERVO MOTOR CONTROL
CLOCK DIVIDE
GRID
SCREEN
PLATE
IPA
FWD/RFL/VSWR PWR MTR
PARAMETER ADJUSTMENT
JUMPERS
0. FILAMENT WARM-UP TIME
1. WARM-UP DEFEAT TIME
2. OVERLOAD RECYCLE TIME
3. BLOWER COOL DOWN TIME
4. SCREEN CURRENT OVERLOAD
5. PLATE CURRENT OVERLOAD
6. VSWR OVERLOAD
7. GRID CURRENT OVERLOAD
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217/224-9600 FAX 217/224-9607
SCHEMATIC
CONTROLLER MAIN BOARD
919-0436
DWN. BY MERKEL 11-14-96
DESIGNER(S) RICHARD BROWN 2-13-97
SEE B/M 919-0436
NEXT ASSY. AC919-0436
MODEL T SERIES XMTRS
SCALE NONE
SHEET 2 OF 2
REV F

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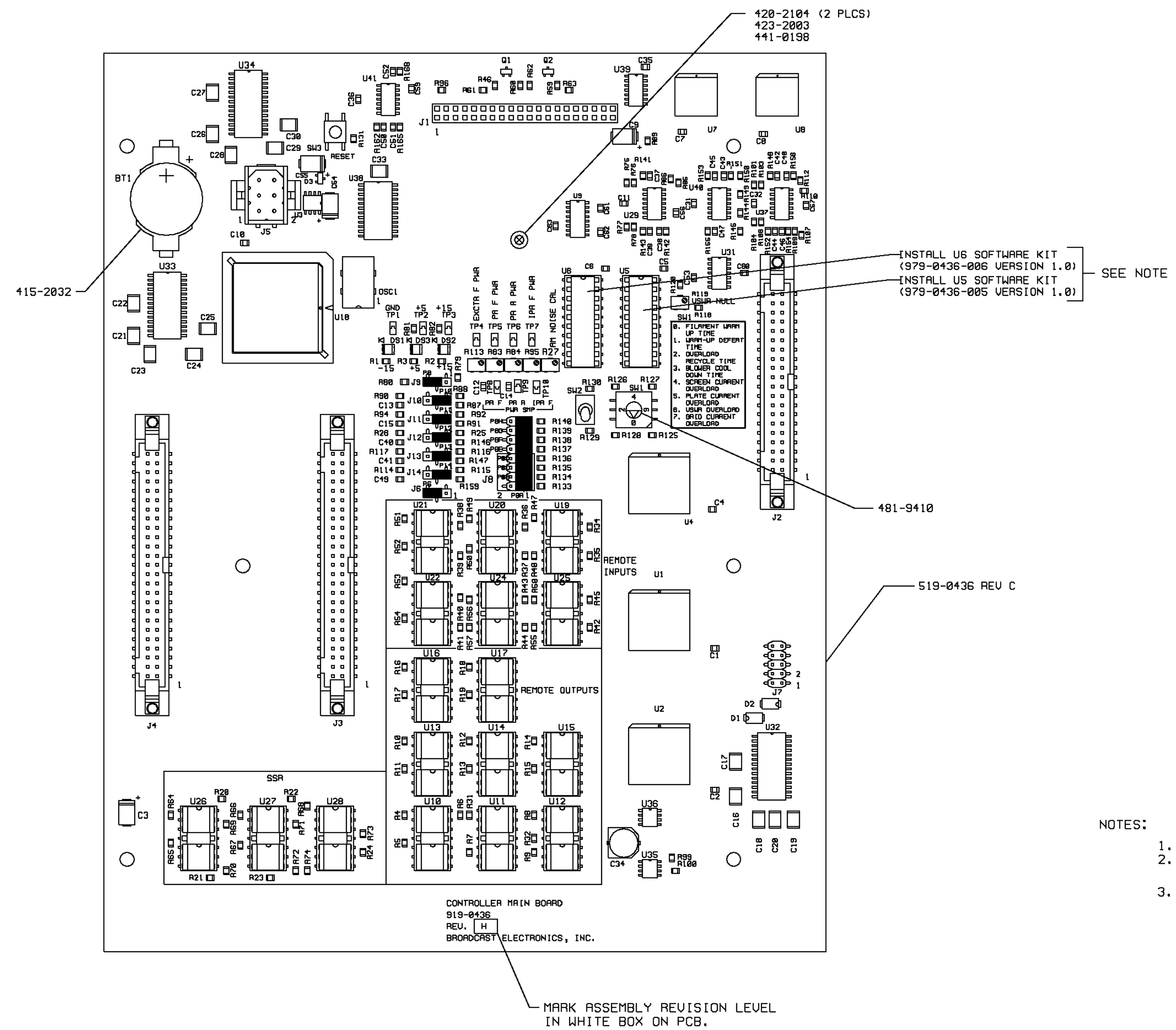
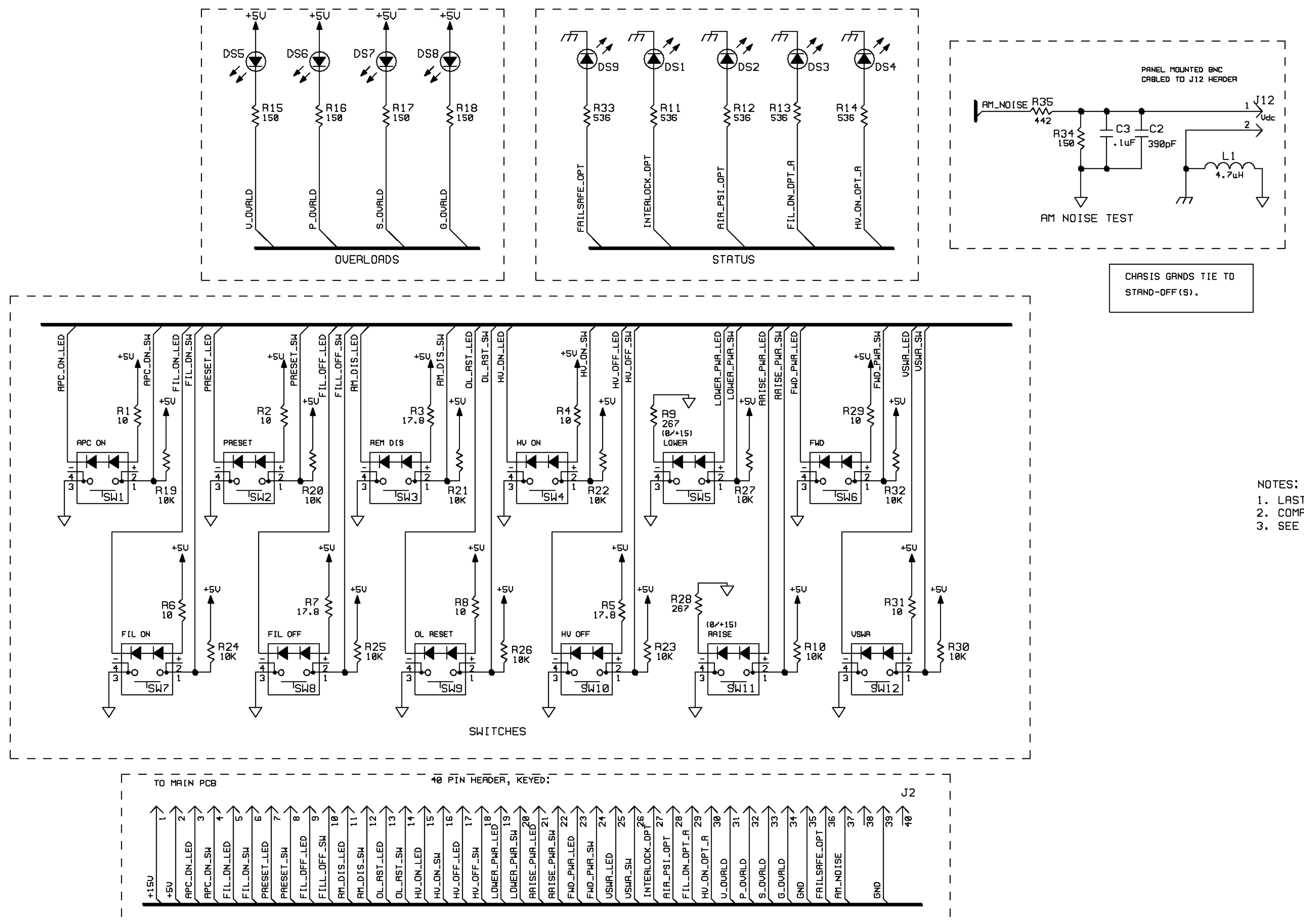


NOTES:

1. SEE SCHEMATIC SB919-0436.
2. MARK EPROM SOFTWARE REVISION LEVEL WITH A LABEL ON EACH PROGRAMMABLE IC.
3. BOARDS ARE TO BE FUNCTIONALLY TESTED USING A 544-0006 MODULE, AND THE MODULE REMOVED BEFORE SHIPMENT TO BEI OR TURNED INTO STOCK AT BEI.

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

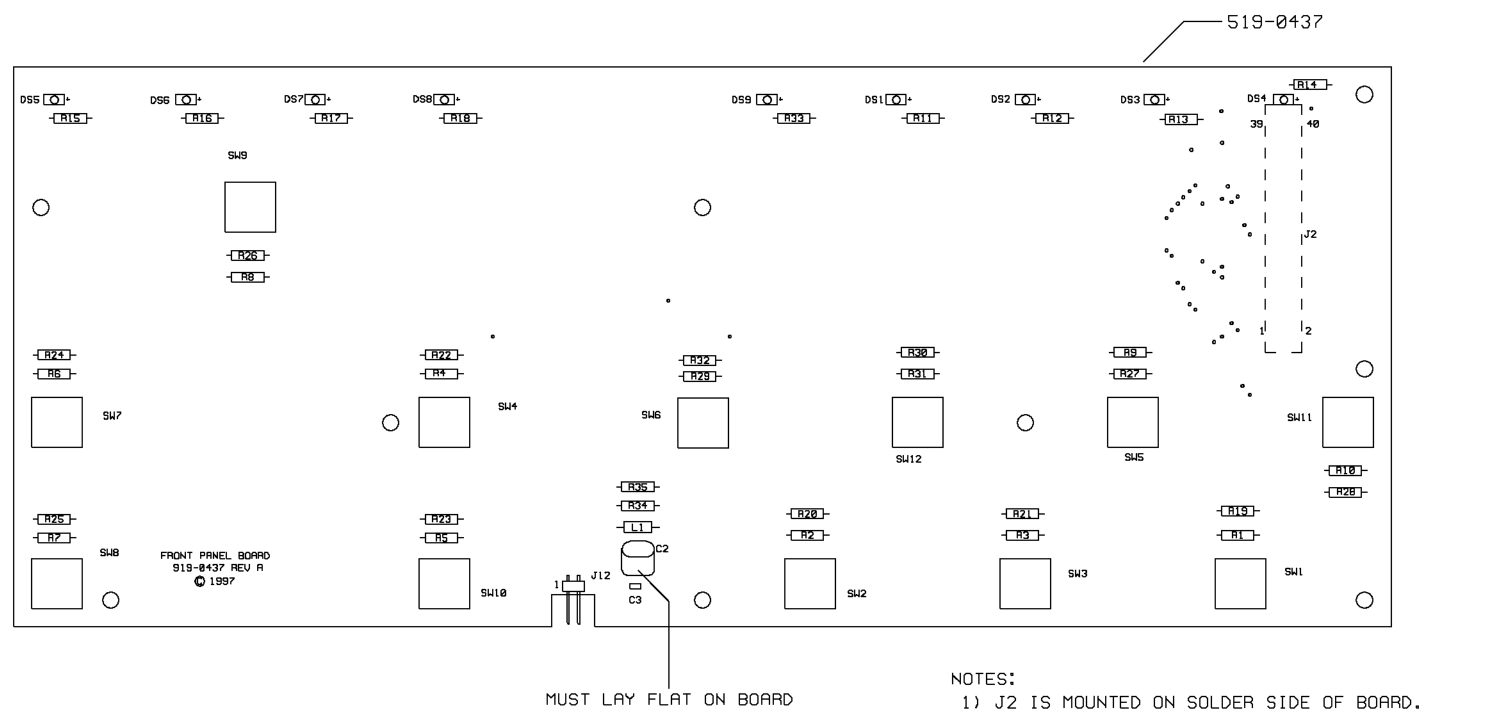
DWN. BY MERKEL 12-3-96	MATERIAL SEE B/M 919-0436	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 FAX 217/224-9607
DESIGNER(S)	FINISH	TITLE PCB ASSEMBLY CONTROLLER MAIN BOARD
PROJ. LEADER 12-3-96 RICHARD BROWN		TYPE A · SIZE C · DWG No. 919-0436 · REV H
MFG.	NEXT ASSY.	MODEL T SERIES XMTRS · SCALE 1/1 · SHEET 1 OF 1



NOTES:
1. LAST COMPONETS USED C3,DS,J12,L1,R35 & SW12.
2. COMPONETS NOT USEDC1,J1, & J3-J11.
3. SEE ASSEMBLY AC919-0437.

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

DWN. BY 12-17-96 K. TERWELP	MATERIAL SEE BOM 919-0437	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL. 62305 217/224-9600 FAX 217/224-9607	
DESIGNER(S)	FINISH	TITLE SCHEMATIC FRONT PANEL BOARD	
PROJ. LEADER		TYPE S SIZE B DWG. NO. 919-0437	REV B
MFG.	NEXT ASSY.	MODEL DIGITAL CNTRL SCALE NONE	SHEET 1 OF 1



NOTES:
1) J2 IS MOUNTED ON SOLDER SIDE OF BOARD.
2) LAST COMPONET USED;C3,D9,J12,L1,R36 & SW12.
3) COMPONETS NOT USED; C1,J1 & J3-J11.
4) LED´S (DS1-DS9) FIT FLUSH ON PCB.
5) SEE SCHEMATIC SB919-0437.

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

DWN. BY 2-4-97 K. TERWELP	MATERIAL SEE BOM 919-0437	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. P.O.BOX 3606 QUINCY,IL. 62305 217/224-9600 FAX 217/224-9607
DESIGNER(S)	FINISH	TITLE PCB ASSEMBLY DIGITAL CONTROLLER FRONT BOARD
PROJ. LEADER R. E. BROWN		TYPE A · SIZE C · DWG No. 919-0437 · REV B
MFG.	NEXT ASSY.	MODEL DIGITAL CNTRL · SCALE 1/1 · SHEET 1 OF 1

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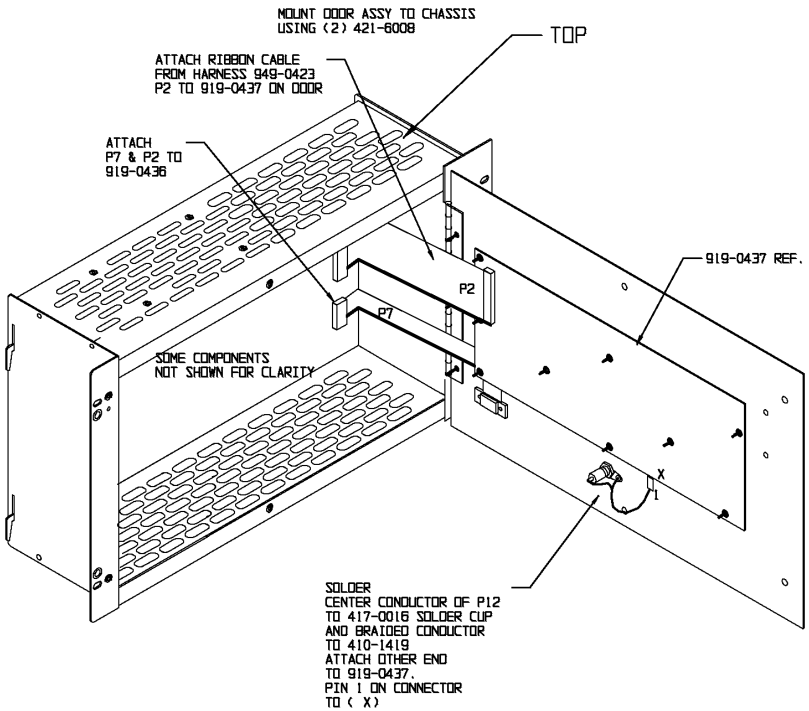
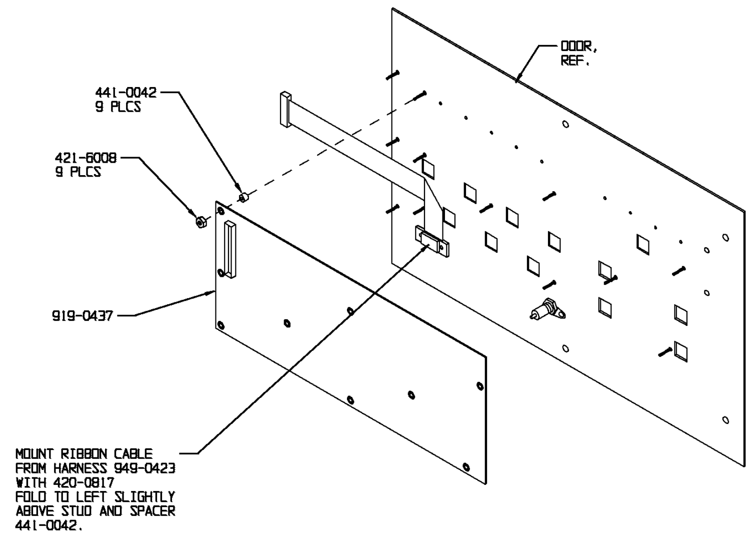
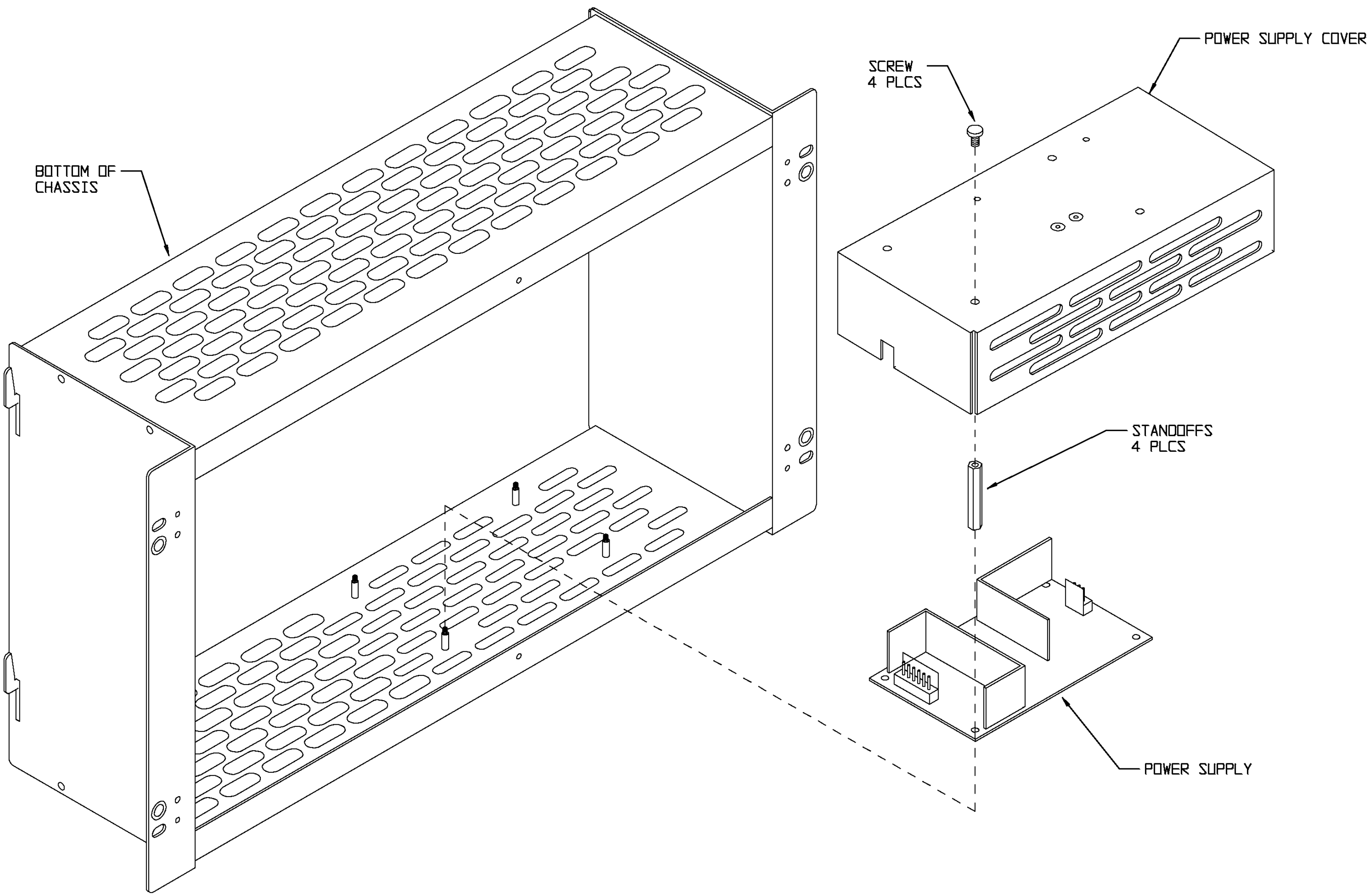




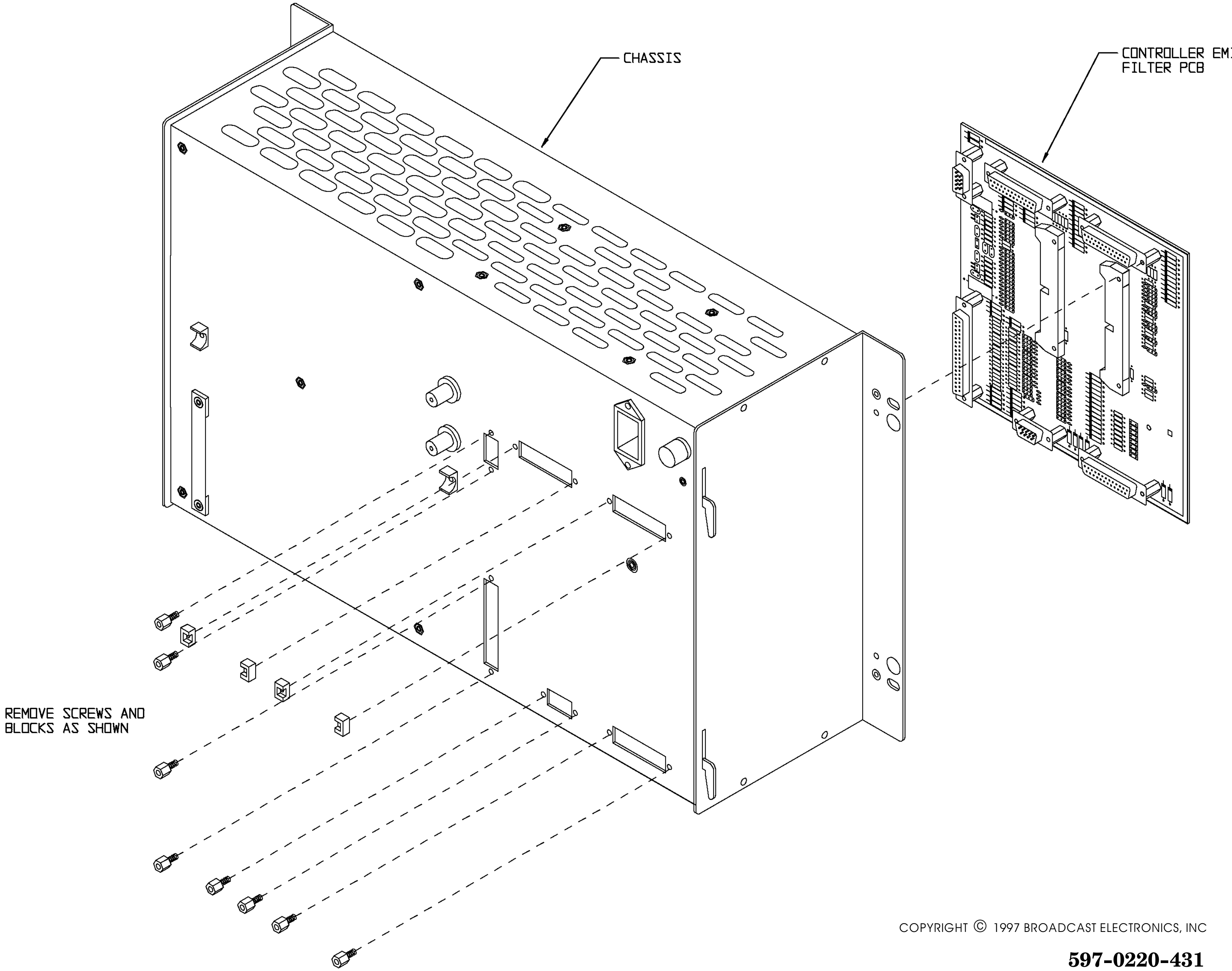
597-0220-429

FIGURE 4-8. ASSEMBLY DIAGRAM, TRANSMITTER CONTROLLER (Sheet 1 of 4)



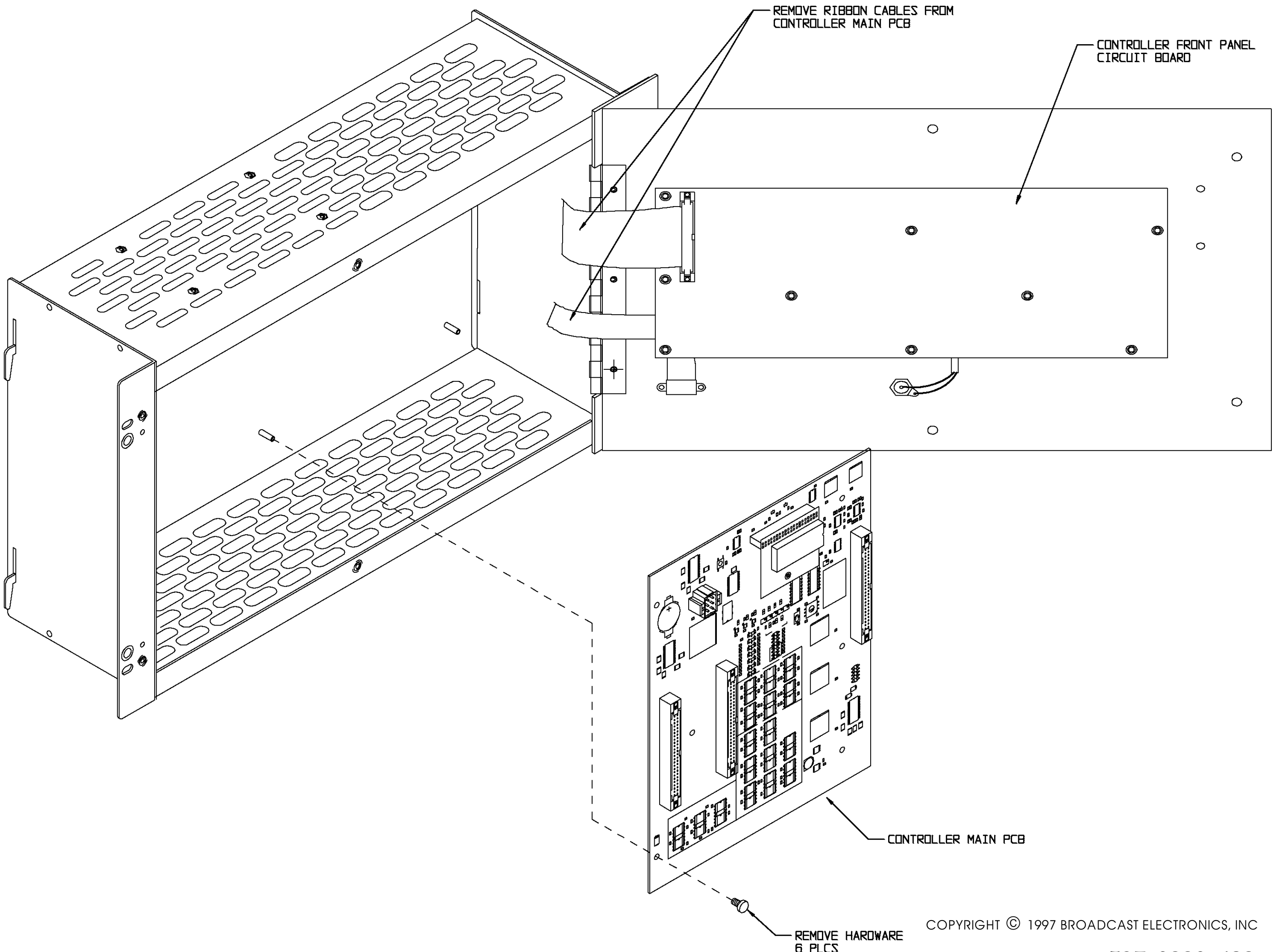
597-0220-430

FIGURE 4-8. ASSEMBLY DIAGRAM, TRANSMITTER CONTROLLER (Sheet 2 of 4)



597-0220-431

FIGURE 4-8. ASSEMBLY DIAGRAM, TRANSMITTER CONTROLLER (Sheet 3 of 4)



597-0220-432

FIGURE 4-8. ASSEMBLY DIAGRAM, TRANSMITTER CONTROLLER (Sheet 4 of 4)