INSTRUCTION MANUAL

FM-30
30 Kilowatt
FM Broadcast Transmitter

30 July 1982

IM No. 597-0003

BROADCAST ELECTRONICS INC.

a FILMWAYS company

IMPORTANT INFORMATION

EQUIPMENT LOST OR DAMAGED IN TRANSIT

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

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

TECHNICAL ASSISTANCE AND REPAIR SERVICE

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

FOR TECHNICAL ASSISTANCE
Phone (217) 224-9600 Customer Service

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 replaceme of defective merchandise will be billed to your account. This billing will be cleared by a credit issued upon return of the defective item.

RETURN, REPAIR AND EXCHANGES

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

REPLACEMENT PARTS

Replacement and Warranty Parts may be ordered from the address below. Be sure to include equipment model and serial number and part description and part number.

Broadcast Electronics, Inc.
4100 N. 24th St., P.O. Box 3606
Quincy, Illinois 62305
Tel: (217) 224-9600
Telex: 25-0142
Cable: BCST ELECT QUI

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.

BROADCAST ELECTRONICS INC

PUBLICATION CHANGE NOTICE

EQUIPMENT FM TRANSMITTER MODEL(S) FM-30 SERIAL ----

PUBLICATION NUMBER 597-0003 BASIC ISSUE/REVISION 30 JULY 1982

INSTRUCTIONS: Make the changes noted below as listed.

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

This change notice should be retained with the publication.

CHANGE NO.	DATE	DESCRIPTION
1	5 NOV 1982	1. Two optional iron vane filament meters are available: A. An iron vane meter is available which replaces the rectifier type meter normally installed in the FM-30 (P/N 909-0109). B. An additional iron vane meter is available which mounts below the filament HOURS meter (P/N 909-0092). This additional meter is wired in parallel across the PA meter panel FILAMENT VOLTAGE meter (M206). 2. Add the attached parts lists to Part I, Section 6, as tables 6-4A and 6-4B, page 6-7A. 3. Note the parts list additions to the FM-30 Parts List Index on page 6-1.
2	10 NOV 1982	1. Add the attached discussion of Operating Hazards to the front of the manual.

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

Table 6-4A. Additional Iron Vane Filament Metering Option - 909-0092

REF. DES.	DESCRIPTION	PART NO.	QTY.
M209	Meter, 3.5 inch (8.89 cm) Iron Vane Type, 0-15 Vac ±3% FS, 60 Hz	310-0017	1
----	Hole Plug, 1 1/4 inch (3.18 cm)	450-1715	1

Table 6-4B. Replacement Iron Vane Filament Metering Option - 909-0109

REF. DES.	DESCRIPTION	PART NO.	QTY.
M206	Meter, 1.5 inch (3.8 cm) Iron Vane Type, 0-12 Vac ±2% FS, 60 Hz	317-0010	1

WARNING

OPERATING HAZARDS

READ THIS SHEET AND OBSERVE ALL SAFETY PRECAUTIONS

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

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

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

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

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

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

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

HIGH VOLTAGE

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

RADIO FREQUENCY RADIATION

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

The effect of prolonged exposure to "low level" RF radiation continues to be a subject of investigation and controversy. It is generally agreed that prolonged exposure of personnel to RF radiation should be limited to an absolute minimum. It is also generally agreed that exposure should be reduced in working areas where personnel heat load is above normal. A 10 mW/cm^2 per one tenth hour average level has been adopted by several U.S. Government agencies including the Occupational Safety and Health Administration (OSHA) as the standard protection guide for employee work environments.

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

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

BeO ceramic material is used as a thermal link to carry heat from a tube or transistor to the heat sink. Do not perform any operation on any BeO ceramic which might produce dust or fumes, such as grinding, grit blasting, or acid cleaning. Beryllium oxide dust or fumes are highly toxic and breathing them can result in serious personal injury or death. BeO ceramics must be disposed of only in a manner prescribed by the device manufacturer.

HOT SURFACES

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

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PART II

SCOPE OF MANUAL

THIS MANUAL COMPRISES TWO SECTIONS PROVIDING THE FOLLOWING INFORMATION OF THE BROADCAST ELECTRONICS FM-30 KW FM BROADCAST TRANSMITTER.

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 FUNCTIONAL CIRCUITS.

   1. POWER SUPPLIES
   2. RF CIRCUITRY
   3. MICROPROCESSOR CONTROLLER

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. Information presented by this section provides a general description of the FM-30 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-30 transmitter.

PUBLICATION NUMBER	EQUIPMENT
597-0002	FM-30 FM Exciter
597-0008	FC-30 SCA Generator
597-0009	FS-30 Stereophonic Generator

1-5. EQUIPMENT DESCRIPTION

1-6. The Broadcast Electronics FM-30 is a one tube 30 kW FM Broadcast Transmitter. The transmitter incorporates a folded half wave cavity PA stage, a microprocessor control system, a solid-state IPA, and a solid-state exciter with a digital frequency synthesizer. The transmitter is available in two basic configurations as listed below.

P/N	DESCRIPTION
909-0001	FM-30 Transmitter complete with FX-30 Exciter, 208/240V ac, 3 Ø, 60 Hz or 380V ac, 3 Ø, 50 Hz. Power supply cabinet attached.

909-0001-2 Same as 909-0001 less Exciter.

909-0001-1 FM-30 Transmitter complete with FX-30 Exciter, 208/240V ac, 3 Ø, 60 Hz or 380V ac, 3 Ø, 50 Hz. Power supply separate.

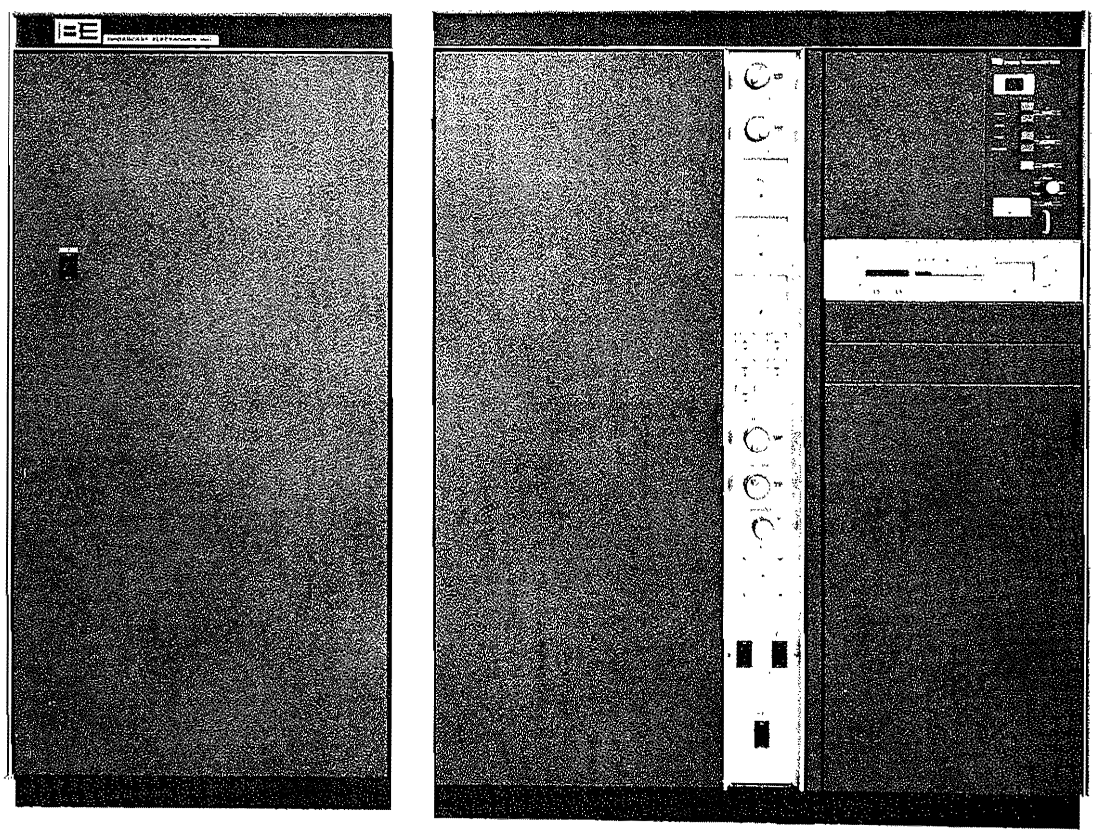
909-0001-3 Same as 909-0001-1 less Exciter.

1-7. PHYSICAL DESCRIPTION

1-8. The Broadcast Electronics FM-30 is a 30 KW FM Transmitter designed for continuous operation in the 87.5 MHz to 108 MHz FM broadcast band. The RF power amplifier, RF driver, FM exciter, and the control circuitry are housed in a single double cubicle cabinet. The high voltage power supply is housed in a separate cabinet which may be remotely located from the cabinets containing the RF circuitry if desired (see Figure 1-1).

1-9. EQUIPMENT SPECIFICATIONS

1-10. Refer to Table 1-1 for electrical specifications or Table 1-2 for physical specifications for the FM-30 FM Transmitter.



597-0003-3

FIGURE 1-1. FM-30 TRANSMITTER

Table 1-1. Electrical Characteristics

PARAMETER	SPECIFICATION
RF Power Output	15 kW to 30 kW (as ordered)
Automatic Power Control Resolution	±2%
RF Frequency Range	87.5 to 108 MHz (as ordered)
RF Output Impedance	50 Ohms Resistive
RF Output Connector	3 1/8 Inch (7.94 cm) EIA Flange
Tube Complement	8990/4CX20000A (1)
FM Noise	72 dB Below 100% Modulation at 400 Hz, ±75 kHz Deviation
AM Noise	55 dB Below a Reference Carrier AM Modulated 100% at 400 Hz, 75 us Deemphasis
RF Harmonic Suppression	Meets all FCC Requirements and CCIR Recommendations
AC Power Requirements	196 to 252 VRMS, 60 Hz or 50 Hz (as ordered). Three Phase Closed Delta or Wye. 130 Amperes per Phase Maximum at 240V
AC Power Consumption	50 kW Maximum for 30 kW RF Output (Includes Exciter)
Maximum VSWR	1.8 : 1 (Will Operate into Higher VSWR with Automatic Power Reduction)

Table 1-2. Physical Characteristics

PARAMETER	SPECIFICATION
Ambient Temperature Range	+14°F to +122°F (-10°C to +50°C)
Maximum Altitude	0 to 7,500 Feet Above Sea Level (0 to 2286 Meters)
Maximum Humidity	95%, Non-Condensing
Size: Transmitter (Excluding Power Supply)	Width: 56.6 Inches (143.5 cm) Height: 70 Inches (177.8 cm) Depth: 31.5 Inches (80.0 cm)
Maximum Head Room Required	85.5 Inches (217.17 cm)
High Voltage Power Supply	Width: 34.5 Inches (87.6 cm) Height: 70 Inches (177.8 cm) Depth: 31.5 Inches (80.0 cm)
Weight: Transmitter	1500 Pounds (682 kg) Packed: 1750 Pounds (795 kg)
High Voltage Power Supply	1200 Pounds (545 kg) Packed: 1250 Pounds (568 kg)
Cubage: Transmitter	72 Cubic Feet (2 m^3)
High Voltage Power Supply	44 Cubic Feet (1.25 m^3)
Heat Dissipation (30 kW FM Output): Driver Cabinet	1 kW Maximum
PA Cabinet	18 kW Maximum
Cooling Air Requirements: Driver Cabinet	250 Cubic Feet Per Minute (7.08 m^3/min)
PA Cabinet	1250 Cubic Feet Per Minute (35.38 m^3/min)
Exciter	25 Cubic Feet Per Minute (0.708 m^3/min)

Table 1-3. PROCESSOR DISPLAY INDICATIONS

DIGIT 1	DIGIT 2	CONTROL STATUS
Unused	1	Air Interlock Open & Filament Contactor Open
Unused	2	AFC Unlocked
Unused	3	Air Interlock Open
Unused	4	AFC & Air Interlock Open
Unused	5	Filament Contactor Open
Unused	6	Filament Contactor Open & AFC Unlocked
Unused	7	AFC Unlocked, Filament Contactor Open, Air Interlock Open
Unused	8	Interlock Open, Door or Auxiliary
Unused	9	Exciter Over-Temperature

DIGIT 1	DIGIT 2	OVERLOAD STATUS (Overload Lamp On)
0	1	Output VSWR Excessive
0	2	Plate Current Excessive
0	3	Screen Current Excessive
0	4	Bias Current Excessive
1	2	Output VSWR & Plate Current Excessive
1	3	Output VSWR & Screen Current Excessive
1	4	Output VSWR & Bias Current Excessive
2	3	Plate Current & Screen Current Excessive
2	4	Plate Current & Bias Current Excessive
3	4	Screen Current & Bias Current Excessive
5	2	Output VSWR, Plate Current & Screen Current Excessive
5	3	Output VSWR, Plate Current & Bias Current Excessive
5	4	Output VSWR, Screen Current & Bias Current Excessive
5	5	Plate Current, Screen Current & Bias Current Excessive
5	6	Output VSWR, Plate Current, Screen Current & Bias Current Excessive

DIGIT 1	DIGIT 2	DIAGNOSTIC INDICATION
0	1	PA Power Low
0	2	PA VSWR High
0	3	IPA Power Low
0	4	IPA VSWR High
0	5	IPA Hybrid Load #3 High
0	6	IPA Hybrid Load #1 High
0	7	IPA Hybrid Load #2 High
0	8	Exciter Power Low
0	9	Exciter VSWR High
1	0	HV Low
1	1	Low PA Voltage, Low PA Power
1	2	Low PA Voltage, High VSWR PA
1	3	Low PA Voltage, IPA Power Low
1	4	Low PA Voltage, IPA VSWR High
1	5	Low PA Voltage, IPA Hybrid #3 High
1	6	Low PA Voltage, IPA Hybrid #1 High
1	7	Low PA Voltage, IPA Hybrid #2 High
1	8	Low PA Voltage, Exciter Power Low
1	9	Low PA Voltage, Exciter VSWR High
2	0	Bias Voltage Low
2	1	Bias Voltage Low, PA Power Low
2	2	Bias Voltage Low, PA VSWR High
2	3	Bias Voltage Low, IPA Power Low
2	4	Bias Voltage Low, IPA VSWR High
2	5	Bias Voltage Low, Hybrid Load #3 High
2	6	Bias Voltage Low, Hybrid Load #1 High
2	7	Bias Voltage Low, Hybrid Load #2 High
2	8	Bias Voltage Low, Exciter Power Low
2	9	Bias Voltage Low, Exciter VSWR High
3	0	IPA Module 1 Voltage Low
3	1	IPA Module 1 Voltage Low, PA Power Low
3	2	IPA Module 1 Voltage Low, PA VSWR High
3	3	IPA Module 1 Voltage Low, IPA Power Low
3	4	IPA Module 1 Voltage Low, IPA VSWR High
3	5	IPA Module 1 Voltage Low, IPA Hybrid Load #3 High
3	6	IPA Module 1 Voltage Low, Hybrid Load #1 High
3	7	IPA Module 1 Voltage Low, Hybrid Load #2 High
3	8	IPA Module 1 Voltage Low, Exciter Power Low
3	9	IPA Module 1 Voltage Low, Exciter VSWR High

DIGIT 1	DIGIT 2	DIAGNOSTIC INDICATION
4	0	IPA Module 5 Voltage Low
4	1	IPA Module 5 Voltage Low, PA Power Low
4	2	IPA Module 5 Voltage Low, PA VSWR High
4	3	IPA Module 5 Voltage Low, IPA Power Low
4	4	IPA Module 5 Voltage Low, IPA VSWR High
4	5	IPA Module 5 Voltage Low, IPA Hybrid Load #3 High
4	6	IPA Module 5 Voltage Low, Hybrid Load #1 High
4	7	IPA Module 5 Voltage Low, Hybrid Load #2 High
4	8	IPA Module 5 Voltage Low, Exciter Power Low
4	9	IPA Module 5 Voltage Low, Exciter VSWR High
5	0	IPA Module 4 Voltage Low
5	1	IPA Module 4 Voltage Low, PA Power Low
5	2	IPA Module 4 Voltage Low, PA VSWR High
5	3	IPA Module 4 Voltage Low, IPA Power Low
5	4	IPA Module 4 Voltage Low, IPA VSWR High
5	5	IPA Module 4 Voltage Low, IPA Hybrid Load #3 High
5	6	IPA Module 4 Voltage Low, Hybrid Load #1 High
5	7	IPA Module 4 Voltage Low, Hybrid Load #2 High
5	8	IPA Module 4 Voltage Low, Exciter Power Low
5	9	IPA Module 4 Voltage Low, Exciter VSWR High
6	0	IPA Module 3 Voltage Low
6	1	IPA Module 3 Voltage Low, PA Power Low
6	2	IPA Module 3 Voltage Low, PA VSWR High
6	3	IPA Module 3 Voltage Low, IPA Power Low
6	4	IPA Module 3 Voltage Low, IPA VSWR High
6	5	IPA Module 3 Voltage Low, IPA Hybrid Load #3 High
6	6	IPA Module 3 Voltage Low, Hybrid Load #1 High
6	7	IPA Module 3 Voltage Low, Hybrid Load #2 High
6	8	IPA Module 3 Voltage Low, Exciter Power Low
6	9	IPA Module 3 Voltage Low, Exciter VSWR High

DIGIT 1	DIGIT 2	DIAGNOSTIC INDICATION
7	0	IPA Module 2 Voltage Low
7	1	IPA Module 2 Voltage Low, PA Power Low
7	2	IPA Module 2 Voltage Low, PA VSWR High
7	3	IPA Module 2 Voltage Low, IPA Power Low
7	4	IPA Module 2 Voltage Low, IPA VSWR High
7	5	IPA Module 2 Voltage Low, IPA Hybrid Load #3 High
7	6	IPA Module 2 Voltage Low, Hybrid Load #1 High
7	7	IPA Module 2 Voltage Low, Hybrid Load #2 High
7	8	IPA Module 2 Voltage Low, Exciter Power Low
7	9	IPA Module 2 Voltage Low, Exciter VSWR High
8	0	40 Volt Supply Low
8	1	40 Volt Supply Low, PA Power Low
8	2	40 Volt Supply Low, PA VSWR High
8	3	40 Volt Supply Low, IPA Power Low
8	4	40 Volt Supply Low, IPA VSWR High
8	5	40 Volt Supply Low, IPA Hybrid Load #3 High
8	6	40 Volt Supply Low, Hybrid Load #1 High
8	7	40 Volt Supply Low, Hybrid Load #2 High
8	8	40 Volt Supply Low, Exciter Power Low
8	9	40 Volt Supply Low, Exciter VSWR High
9	0	Screen Voltage Low
9	1	Screen Voltage Low, PA Power Low
9	2	Screen Voltage Low, PA VSWR High
9	3	Screen Voltage Low, IPA Power Low
9	4	Screen Voltage Low, IPA VSWR High
9	5	Screen Voltage Low, IPA Hybrid Load #3 High
9	6	Screen Voltage Low, Hybrid Load #1 High
9	7	Screen Voltage Low, Hybrid Load #2 High
9	8	Screen Voltage Low, Exciter Power Low
9	9	Screen Voltage Low, Exciter VSWR High

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information required for installation and preliminary checkout of the Broadcast Electronics FM-30 FM 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 (See Table 2-1). 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

2-7. 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.

2-8. INSTALLATION REQUIREMENTS

2-9. Table 1-2 provides environmental conditions which must be considered prior to transmitter installation.

2-10. COOLING AIR

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 1250 cubic feet of air per minute (35.38 m^3/min) from the PA cabinet and 250 cubic feet of air per minute (7.08 m^3/min) from the driver cabinet.

2-12. As a minimum requirement, any duct work 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-30 transmitter is designed for operation from a closed-delta or wye connected three-phase source. Operation from an unsatisfactory power source will void the warranty on this 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 FM-30 and provide degraded transmitter 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 FM-30 transmitter to a primary power source. The proper power source can readily be identified by the use of three transformers or one transformer with three windings instead of the use of two transformers as required for the unacceptable configurations.

2-17. EQUIPMENT PLACEMENT

2-18. Transmitter installation offers two options. The high voltage power supply may be located some distance from the PA and driver cabinets or the power supply can be installed along side the PA cabinet. If the cabinets are positioned apart, access holes in the top and bottom allow either overhead or under floor ducting of interconnecting wiring (see Figure 2-1). 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.

2-19. After it has been determined how the cabinets will be positioned, set the PA and driver cabinets in place as a single unit on a smooth and level location.

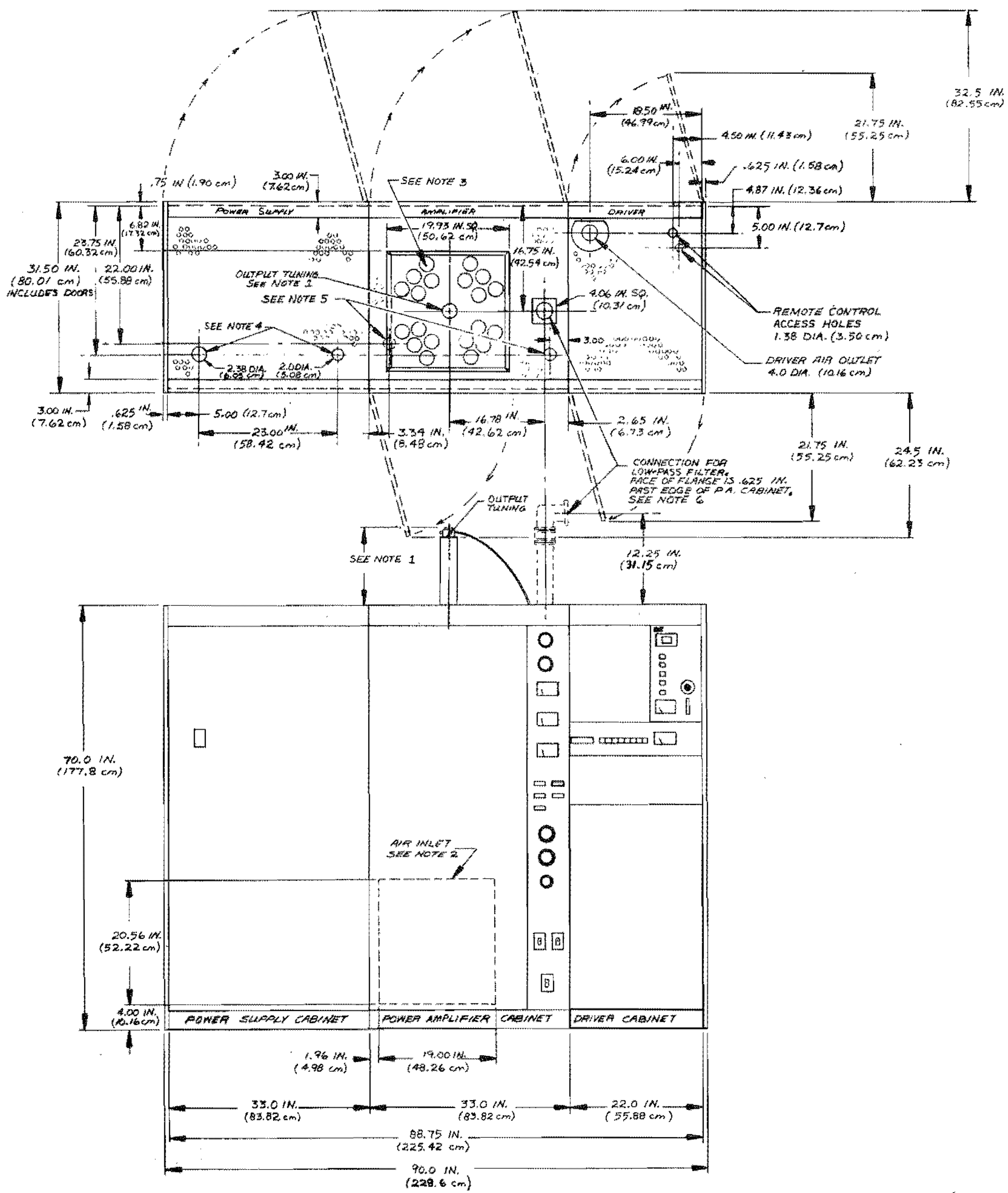
2-20. Remove the rear access door, and the left side panel from the high voltage power supply cabinet. The rear access door simply lifts off hinges. The left side panel is secured by two No. 12 Phillips head screws in the left side rear mounting rail. After the two screws are removed, the side panel lifts up and off the equipment.

TABLE 2-1. FM-30 PACKING LIST

ITEM	DESCRIPTION	PART NO.	QTY.	PACKED IN BOX NO.
1	PA CABINET AND DRIVER CABINET (ASSEMBLED)	NPN	1	1
2	HIGH VOLTAGE POWER SUPPLY CABINET (ASSEMBLED)	NPN	1	2
3	PA TUBE, 4CX20,000A/8990	243-0001	1	3
4	PA DIRECTIONAL COUPLER	950-6907	1	4
5	TRANSMISSION LINE ELBOW WITH SAMPLING PORT	427-0016	1	4
6	TRANSMISSION LINE COUPLING FLANGE WITH HARDWARE AND CLAMP	427-0001	1	4
7	TRANSMISSION LINE COUPLING SECTION WITH CLAMP	427-0005	2	4
8	TRANSMISSION LINE INSULATOR	427-0004	1	4
9	STEP START PLUG-IN MODULE (ASSEMBLED)	NPN	1	4
10	RACK CONNECTING SPACERS WITH HARDWARE	476-0006	6	4
11	STRAIN RELIEF (FOR SEPARATE EXCITER AC FEED)	401-0008	1	4
12	RELAY K103	270-1250	1	4
13	RELAY K202	270-0023	1	4
14	MICROPROCESSOR BYPASS ASSEMBLY	959-0053	1	4
15	FM-30 MANUALS	597-0003	2	4
16	SET CONTROL STATUS SHEETS	597-0004	1	4
17	SETS CABINET DOOR KEYS	NPN	3	4
18	FX-30 MANUALS	597-0002	2	4
19	SPARE FUSES AND DIP SWITCHES FOR EXCITER	961-0001	1	4
20	LOW-PASS FILTER	339-0005	1	5

NOTES - ITEM 10 NOT INCLUDED WHEN POWER SUPPLY CABINET IS TO BE POSITIONED REMOTELY FROM THE PA AND DRIVER CABINETS.

ITEMS 18 AND 19 NOT INCLUDED WHEN SHIPPED LESS EXCITER.



NOTES:

1.) HEIGHT OF OUTPUT TUNING COLUMN IS DETERMINED BY FREQUENCY OF TRANSMITTER.
MAX. = 15.5 IN. (39.37 cm) @ 108 MHz
MIN. = 4.5 IN. (11.43 cm) @ 88 MHz
APPROX. = .55 IN. PER MHz.

2.) AIR INLET AT REAR OF CABINET. 1250 CUBIC FT. OF AIR PER MINUTE.
FILTER REQUIRED – 407-1002

3.) AIR OUTLET 3.38 DIA. CENTERED IN 20.00 IN. SQ., SURROUNDED BY (20) 2.5 IN. DIA. HOLES.
SEE DWG. NO. 8471-0185 FOR FLANGE SCREW DIMENSIONS.

4.) TOP ACCESS FOR A.C. INPUTS. BOTTOM ACCESS IS AVAILABLE AROUND THE ENTIRE OUTER PERIMETER OF INSIDE CABINET.

5.) INTERCONNECT CABLE ACCESS HOLES WHEN POWER SUPPLY IS LOCATED REMOTE.

6.) LOW-PASS FILTER:

BIRD – # 339-0004
LENGTH – 60.0 (152.4 cm)
DIAMETER – 6.0 (15.24 cm)

COMARK – # 339-0005
LENGTH – 104.0 IN. (264.2 cm)
DIAMETER – 6.13 (15.57 cm)

OUTPUT ELBOW – 3 1/8 EIA UNFLANGED, 50 OHM (INCLUDES RF SAMPLE PROBE)
INPUT & OUTPUT CONNECTION OF LPF 3 1/8 EIA FLANGED, 50 OHM

7.) WEIGHT:
POWER SUPPLY – 1200 LBS. – 545 KG
POWER AMP – 1500 LBS. – 682 KG
RF DRIVER – 1500 LBS. – 682 KG

8.) POWER SUPPLY MAY BE LOCATED REMOTELY FROM P.A. & DRIVER CABINETS IF DESIRED. (MUST BE SPECIFIED ON ORIGINAL ORDER.)

9.) HEAT DISSIPATION AT 30 KW RF OUTPUT:

1 KW MAX. FROM DRIVER CABINET
18 KW MAX. FROM P.A. CABINET

10.) AIR COOLING REQUIREMENTS:

RF AMP CAVITY – 1250 FT.³/MIN. (35.38 M³/MIN.)
RF DRIVER CABINET – 250 FT.³/MIN. (7.08 M³/MIN.)

FIGURE 2-1

FM-30 TRANSMITTER INSTALLATION
D905-0002

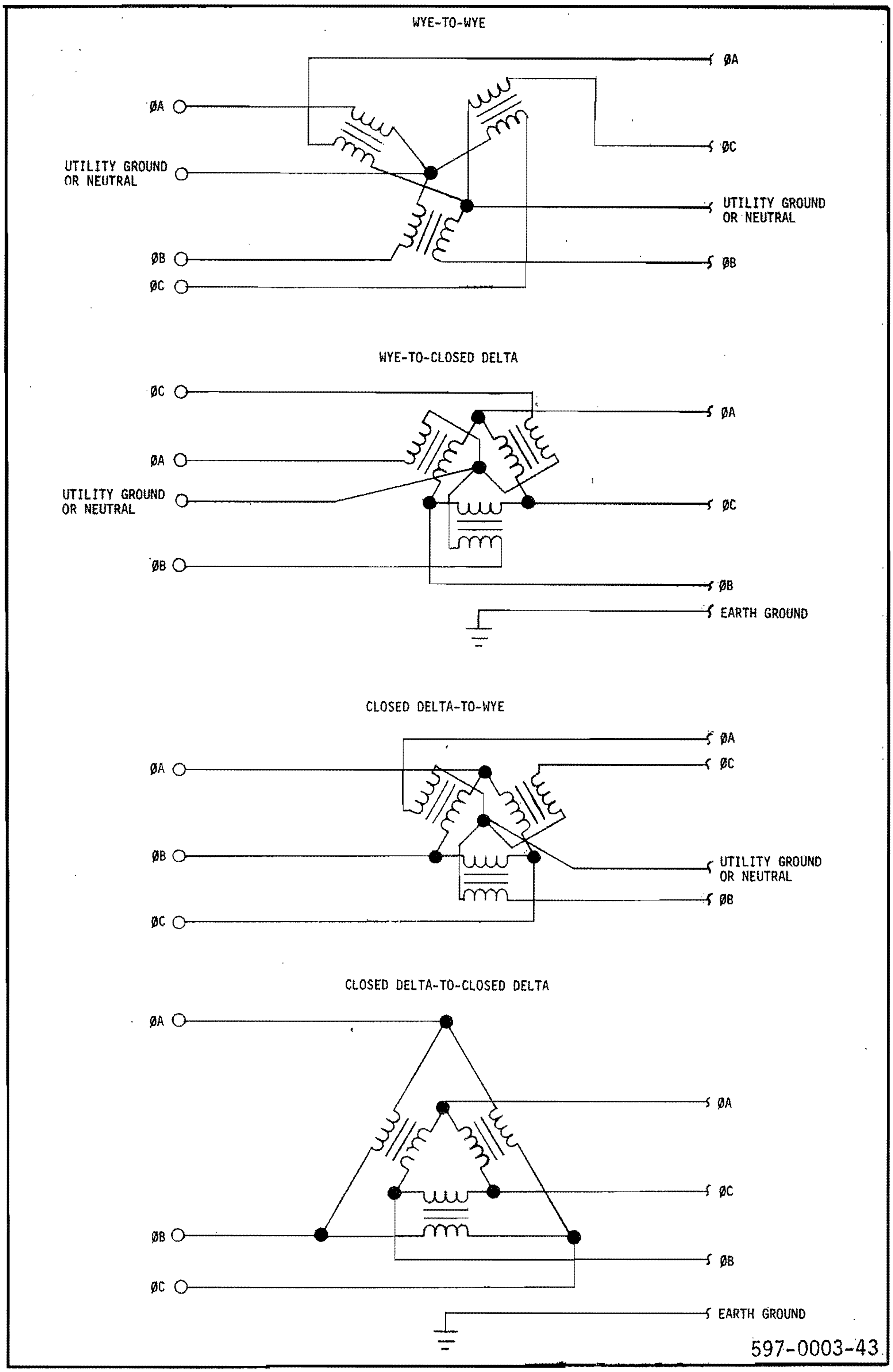


FIGURE 2-2. ACCEPTABLE AC POWER INPUT CONFIGURATIONS

2-21. After the panels are removed from the power supply cabinet, the four bolts securing the high voltage power supply cabinet to the shipping skid must be removed. To remove these bolts, a 9/16 inch (14.3 mm) box-end wrench is required. After the cabinet is unbolted from the skid, the supply may be moved to the final location with a forklift (see Figure 2-3).

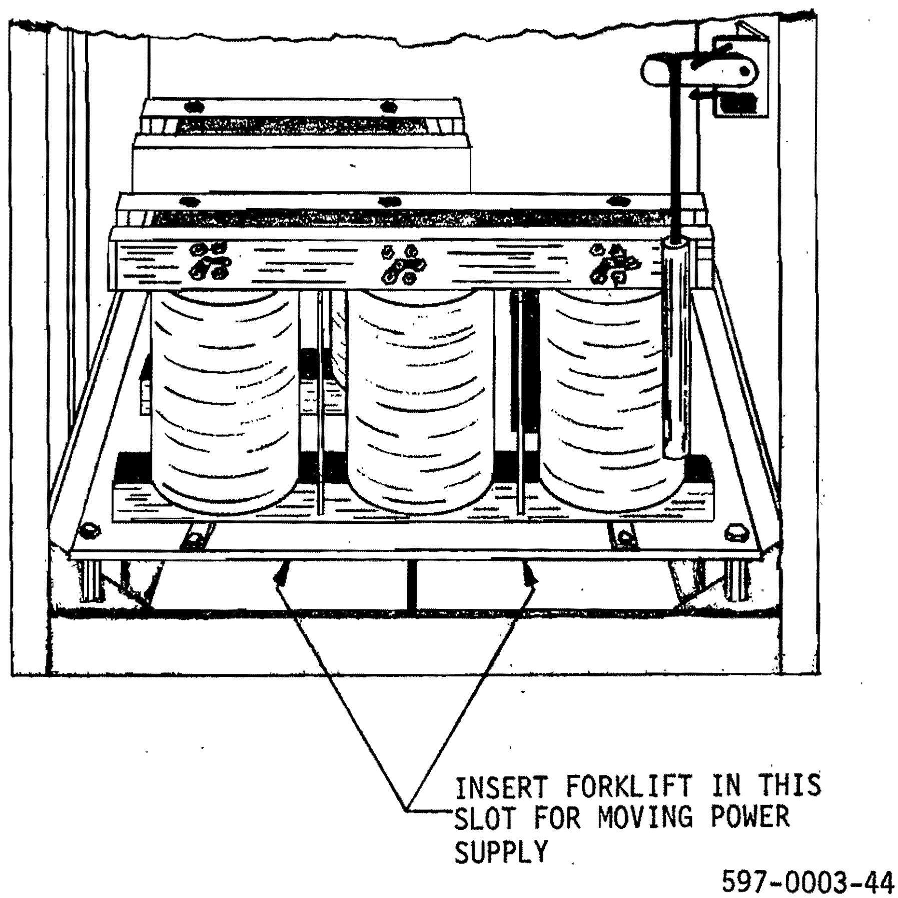


FIGURE 2-3. POWER SUPPLY CABINET MOVING PROVISIONS

2-22. Set the power supply in place. If the location chosen is next to the PA cabinet, the four bolts, one in each corner of the power supply base plate, should be adjusted to align the power supply cabinet with the PA cabinet. A 9/16 inch (14.3 mm) box-end wrench is required. Extreme care should be observed if trim alignment is a prime consideration.

2-19. COMPONENT INSTALLATION

WARNING

ENSURE NO PRIMARY POWER IS CONNECTED BEFORE PROCEEDING.

2-20. To facilitate component installation and wiring, the rear door of the driver cabinet, the front and rear doors and the lower front access panel of the PA cabinet, and the power supply cabinet rear door should be removed and left off until installation is complete.

2-21. Interconnecting wires and cables are tied in for shipment. Remove all tape, wire ties, string, and packing material used for shipment.

2-22. Cables, connectors, and miscellaneous components to be installed are shipped in separate cartons. The following text provides information concerning the installation of these items. Ensure adjustments are not moved from their factory preset positions.

2-23. HIGH VOLTAGE POWER SUPPLY. Remove the tie wraps securing the two resistors mounted in clips.

2-24. Unwrap the grounding stick and place the stick on its interlocked hanger. Store the cable on top of the plate transformer.

2-25. Locate the plug-in step-start timer (A300). Plug the device into socket XA300 on the step-start relay panel.

2-26. Unwrap the interlock connector (if the cabinets are to be positioned together) or the interlock cable (if the cabinets are to be positioned apart).

2-27. If the cabinets are to be positioned apart, route the interlock cable to the approximate position of the PA cabinet.

2-28. Route the ac power cables coiled along side the high voltage power supply cabinet to the general location of the PA cabinet. Ensure the cables are routed away from the plate transformer within the cabinet. These cables will be cut to length and connected inside the PA cabinet. Do not store extra cable by pushing the cable back within the high voltage power supply cabinet.

2-29. DRIVER CABINET. Install the 110 volt ac control relay (K103) in socket XK103. Operate the associated OVERRIDE/NORMAL switch to OVERRIDE.

2-30. Remove the retainers from the microprocessor controller and exciter slides.

2-31. Install the FM exciter on its slides and connect the transmitter wiring to the exciter. Wiring data is provided by Figure 2-4.

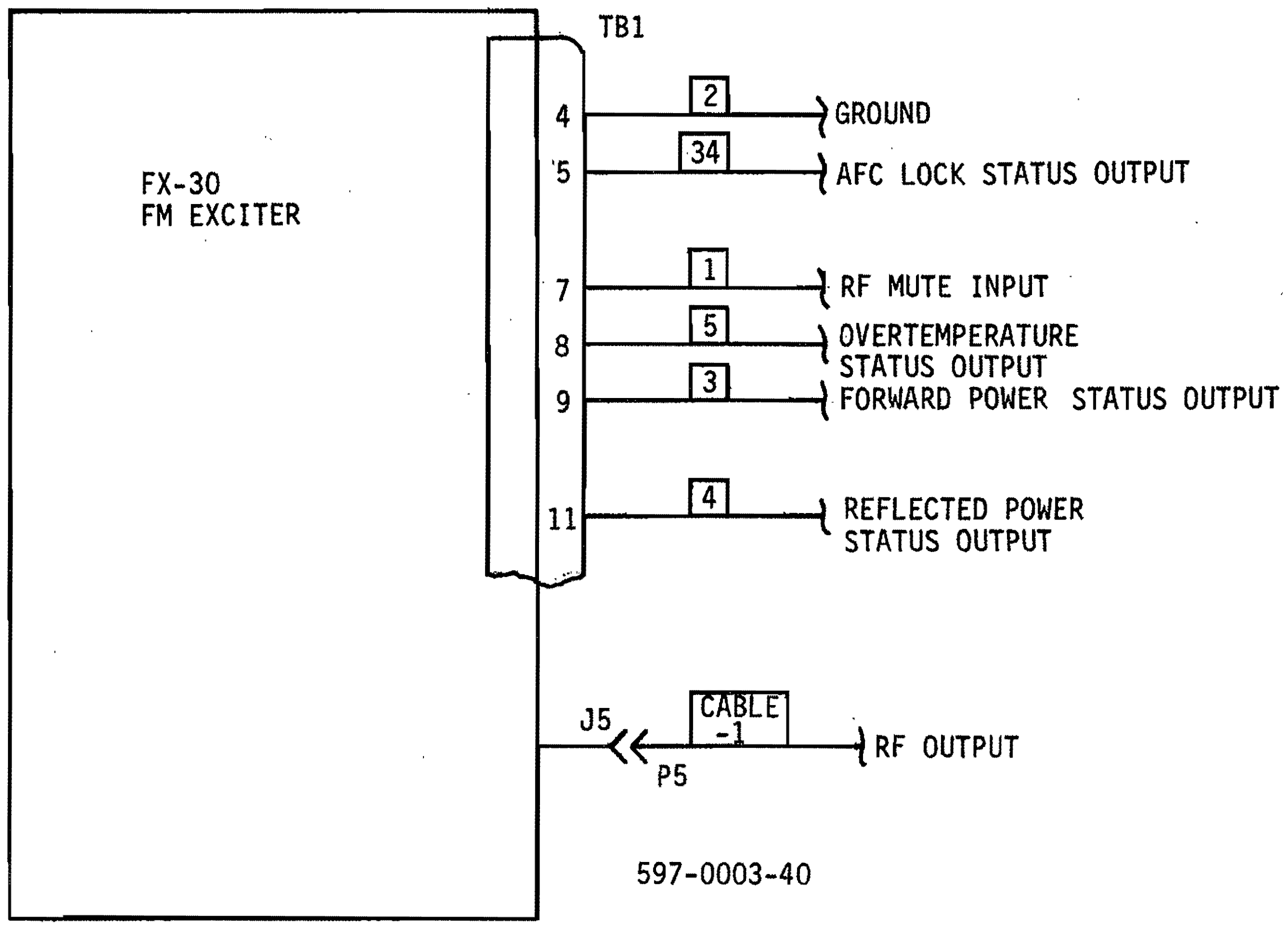


FIGURE 2-4. EXCITER WIRING

2-32. Connect P1 to J1, P2 to J2, and P3 to J3 on the rear of the microprocessor controller.

2-33. Connect the exciter, stereo generator, SCA generator and microprocessor controller power supply switched ac outlets in the cabinet rear (bottom four outlets only).

2-34. Operate the LOCAL/REMOTE switch to LOCAL, the FWD/VSWR/VSWR CAL switch to FWD, and the MAN/AUTO switch to MAN.

2-35. PA CABINET. From the top of the PA cabinet, readjust the moveable portion of plate line so that the line scribed around the tubing aligns with the top of the plate line clamping flange. A flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.635 cm) tip is required to secure the strap clamp to the transmission line clamping flange.

2-36. Remove the top from the PA cabinet. A No. 2 Phillips screwdriver is required. Retain all hardware.

2-37. Remove the hardware and semi-circular PA output line clamp. A 3/8 inch (9.53 mm) box-end wrench is required (see Figure 2-5).

2-38. Insert the transmission line inner conductor from the top, down onto the bullet connector in the transmission line coupler until the inner conductor is fully seated.

2-39. Insert the transmission line outer conductor from the top, down into the transmission line coupler until the outer conductor is seated. The FWD sampling port must be oriented downwards and towards the front. The cables associated with the directional coupler will be connected later.

2-40. Secure the top strap clamp on the transmission line coupler using a flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.635 cm) tip.

2-41. Replace the top on the transmitter. A No. 2 Phillips screwdriver is required.

2-42. Assemble the elbow with the monitor jack and the elbow inner conductor to two transmission line couplers, one on each end of the elbow. Ensure all parts of the assembly are fully seated and secure the assembly together with strap clamps using a flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.635 cm) tip.

2-43. Insert a bullet connector and insulator into the 3 1/8 inch (7.94 cm) flange.

2-44. Determine if the monitor jack will be positioned horizontally or vertically, then secure the flange into the proper end of the elbow assembly. When the elbow assembly and flange are fully seated, secure the strap clamp using a flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.635 cm) tip.

2-45. Mount the assembly on top of the transmission line. When the assembly is fully seated, orient 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 (0.635 cm) tip.

CAUTION

NEITHER THE TRANSMITTER OR THE TRANSMISSION LINE WILL SUPPORT THE WEIGHT OF THE LOW-PASS FILTER. ADDITIONAL SUPPORT MUST BE PROVIDED.

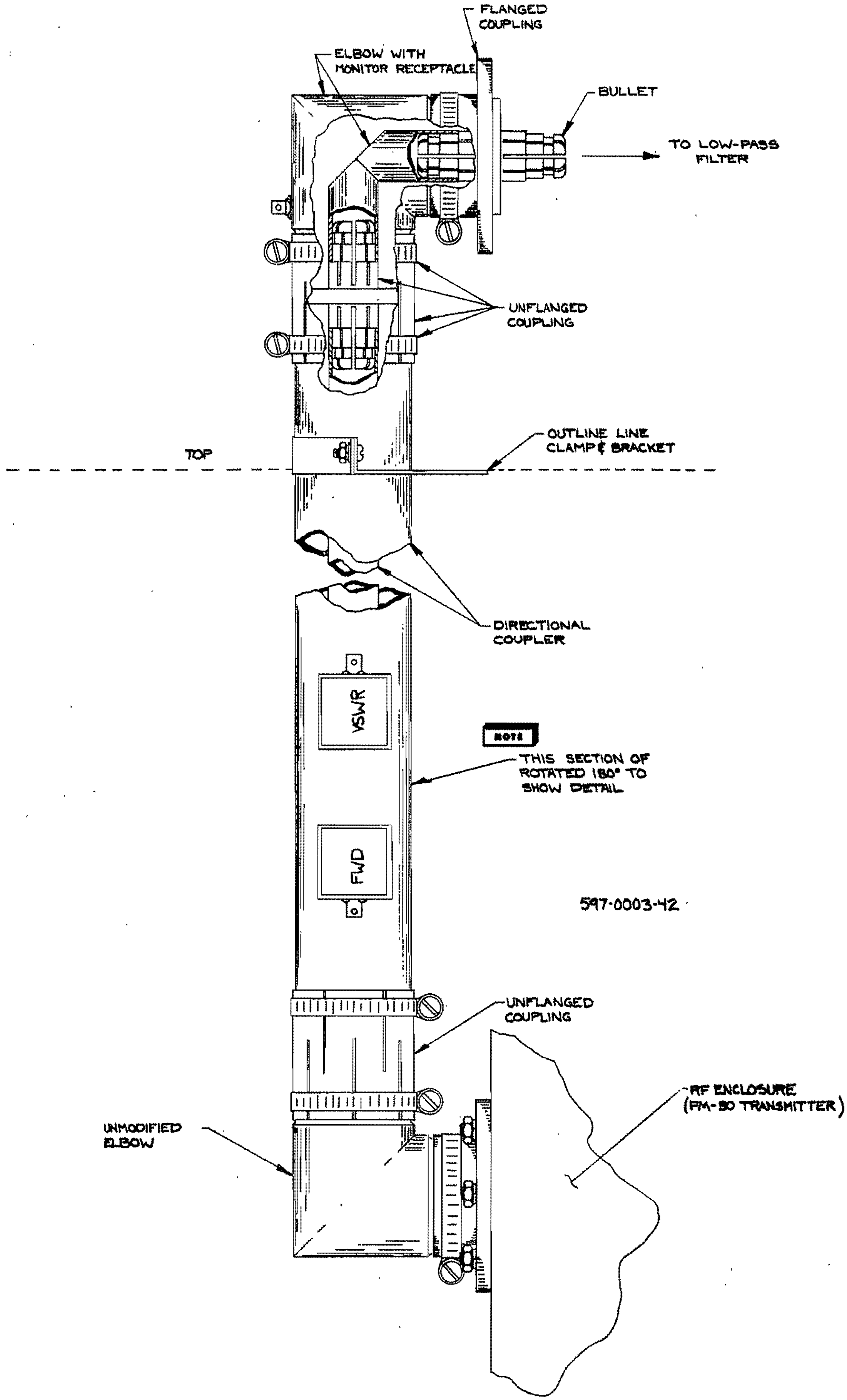


FIGURE 5-2. RF OUTPUT LINE ASSEMBLY

2-46. Connect the low-pass filter directly at the transmitter between the transmitter and the transmission line. Two 9/16 inch (14.3 cm) open/box end combination wrenches are required. Each flange secures with six bolts, six lock washers, and six nuts. Both the input and output connections are marked on the filter.

2-47. Open the PA cavity access door, raise the fixed portion of plate line, and remove all packing.

2-48. Carefully install the PA tube with a steady downward pressure. Do not rotate or rock the tube during installation or the tube socket may be damaged.

2-49. After the PA tube is fully seated, lower the fixed portion of plate line over the PA tube. Slowly squeeze the fixed portion of plate line down onto the tube using the palms of both hands and finger tips under the tube cooling fins.

2-50. Ensure the plate choke on the right side of the fixed portion of the plate line is expanded so that the coils do not touch. The choke should not be stressed but must be centered in the deck cutout.

2-51. If the transmitter will operate at 92 MHz or below, loosen the clamp on the plate line extension (see Figure 2-6). Position the extension at the scribed line and secure the strap clamp using a flat-tip screwdriver with a four-inch (10.16 cm) blade and a 1/4 inch (0.635 cm) tip.

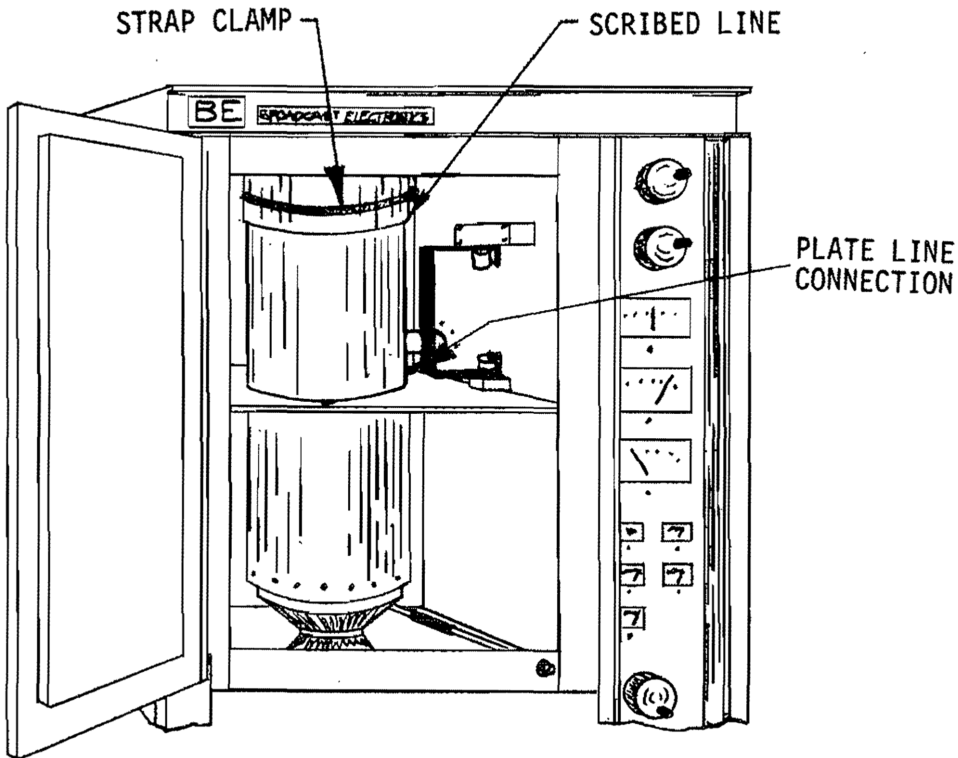


FIGURE 2-6. PLATE LINE EXTENSION

2-52. Align the plate line connections and connect the plate choke to the plate line (see Figure 2-6).

2-53. The two coaxial cables shipped with the section of transmission line mounting the directional coupler sampling ports connects to the auto power control unit adjacent to the sampling ports as follows:

CABLE NO.	FROM-OUTPUT TRANSMISSION LINE	TO-AUTO POWER CONTROL UNIT
21 (longer)	VSWR port	J1 REFL PWR INPUT
22 (shorter)	FWD port	J2 FWD PWR INPUT

2-54. Ensure the second harmonic suppressor on the rear of the PA cabinet is adjusted to the factory preset line scribed on the adjustment rod. A 5/64 inch (1.98 mm) Allen wrench is required for adjustment.

2-55. EXTENDED LOCAL CONTROL

2-56. Extended local control to the FM-30 transmitter is possible up to a maximum of 100 feet (30.48 mm) from the transmitter using the Broadcast Electronics 909-0103 master extended local control unit. A second local control unit which functions as a slave is also available (BE P/N 909-0104).

2-57. REMOTE CONTROL

2-58. Basic features including PA plate current metering, PA plate voltage metering, PA power output metering, screen voltage raise/lower control, and control of on/off functions are available as individually wired remote features when the transmitter LOCAL/REMOTE switch is set to REMOTE (see Figure 2-7). The transmitter will interface with most modern remote control units such as the Moseley Associates, Inc. Model MRC-1 remote control unit.

2-59. WIRING

WARNING

ENSURE PRIMARY POWER IS OFF BEFORE PROCEEDING

2-60. TRANSFORMER TAPS. Ensure all transmitter transformer input taps are wired for the input voltage to be used. The PA plate transformer, PA filament transformer, PA bias transformer, and the IPA power transformer must be checked and changed if required (see Figure 2-8). The PA screen transformer is also tapped, however the wiring should not be changed from the factory installed configuration. The variable transformer connected in the primary circuit allows adequate adjustment for all input potentials. The PA screen transformer wiring is shown for reference only.

2-61. CABINET INTERCONNECTIONS. Cabinet interconnecting wiring for cabinets placed adjacent to each other is shown in Figure 2-9. Connect the wires as follows. If the cabinets are positioned apart, refer to paragraph 2-62.

A. Connect wires 48, 49, 50, 51, 52, 101, and 53 to terminal board TB5 in the front of the PA cabinet.

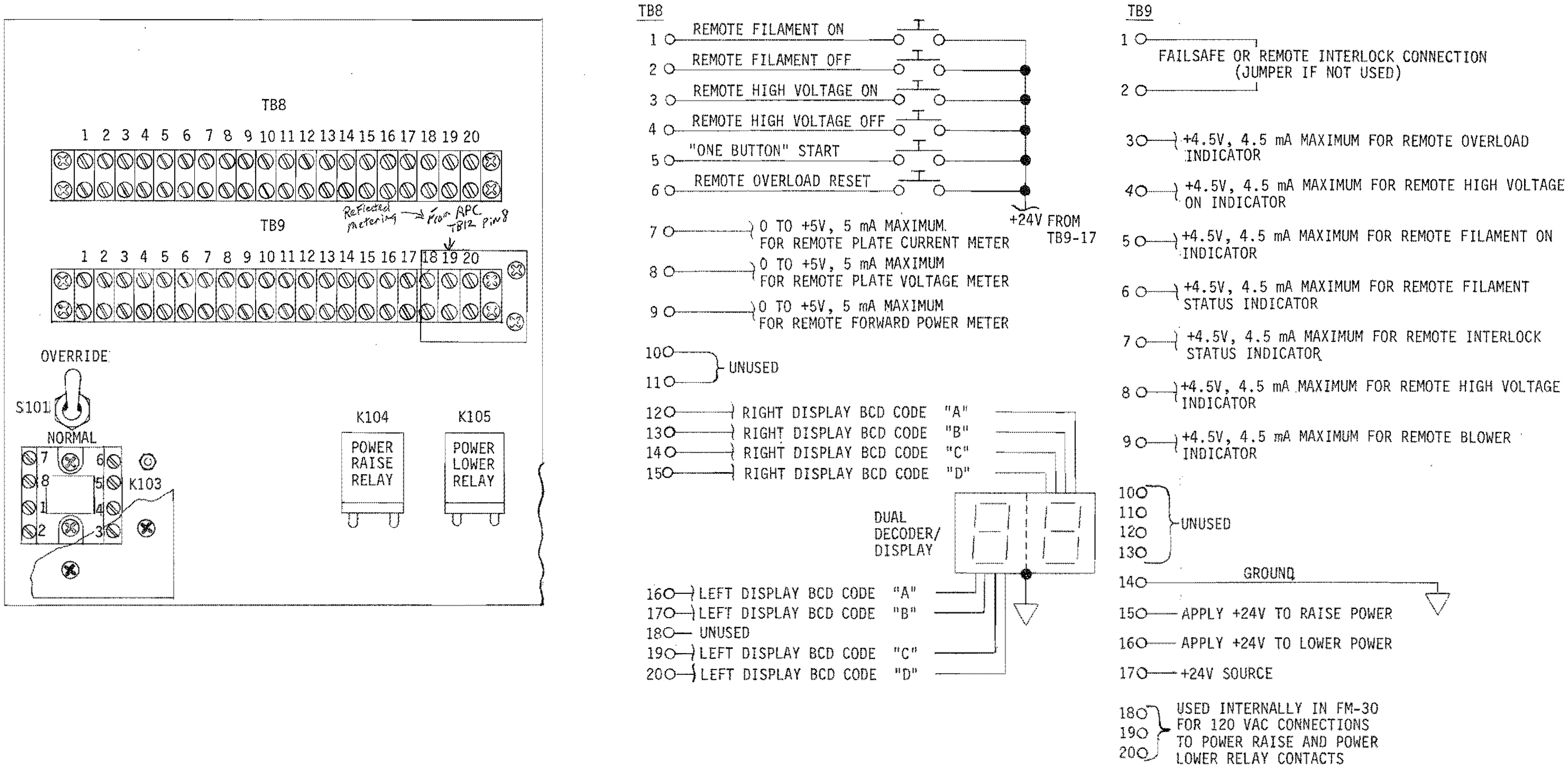


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FIGURE 2-7. REMOTE WIRING

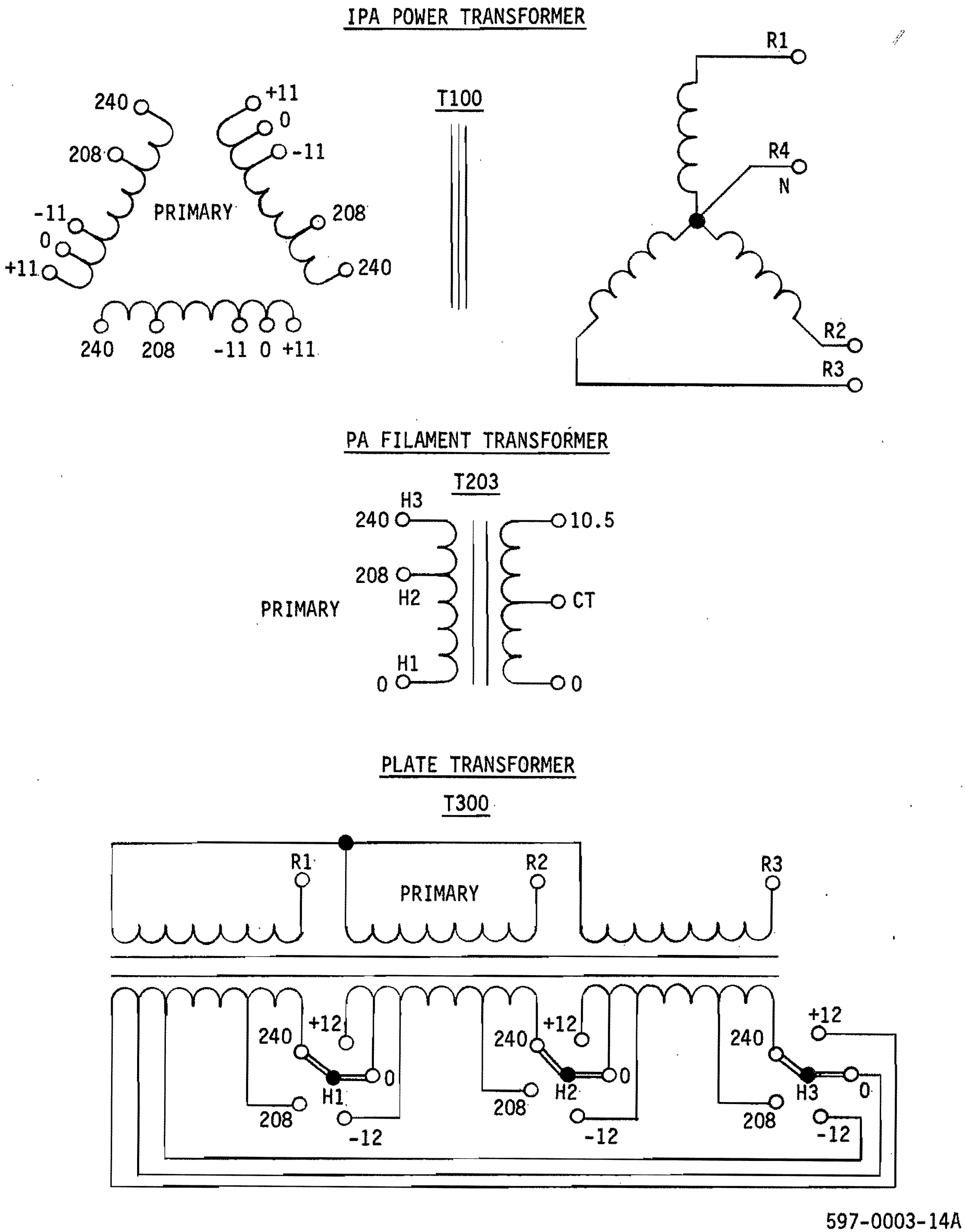
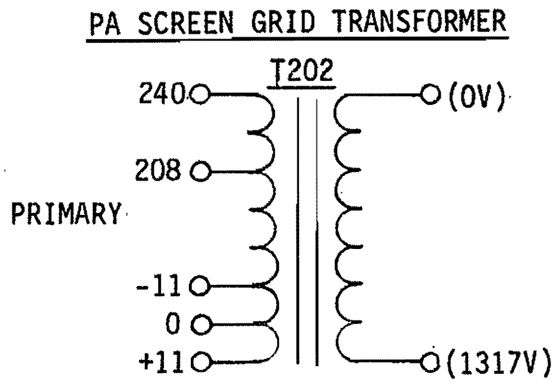
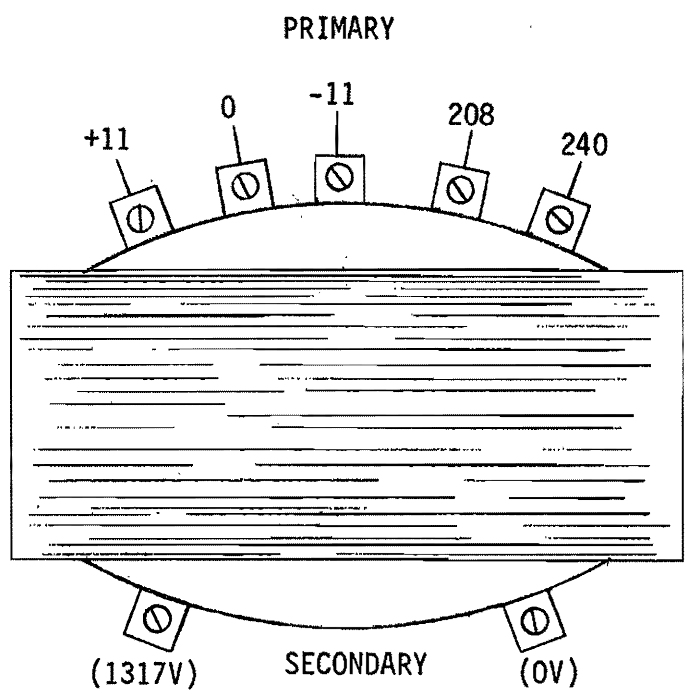
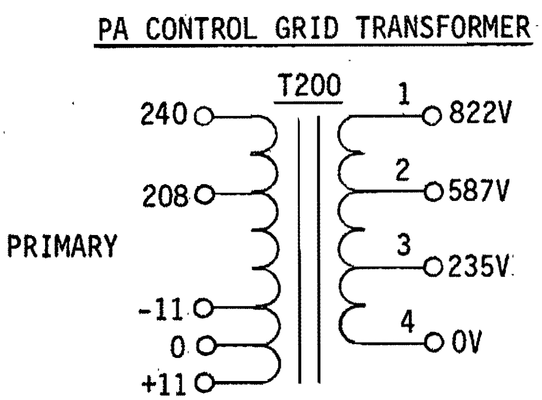


FIGURE 2-8. POWER TRANSFORMER WIRING (SHEET 1 of 2)







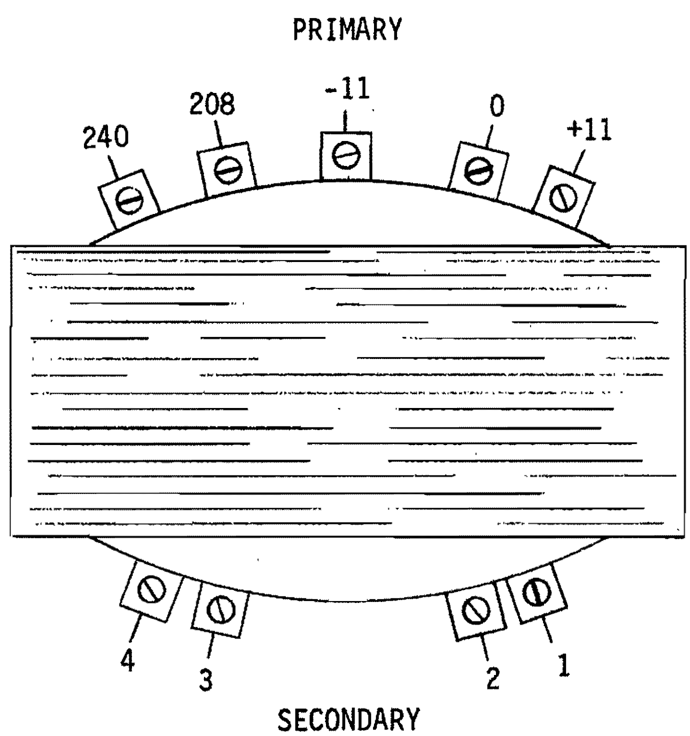


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FIGURE 2-8. POWER TRANSFORMER WIRING (SHEET 2 of 2)

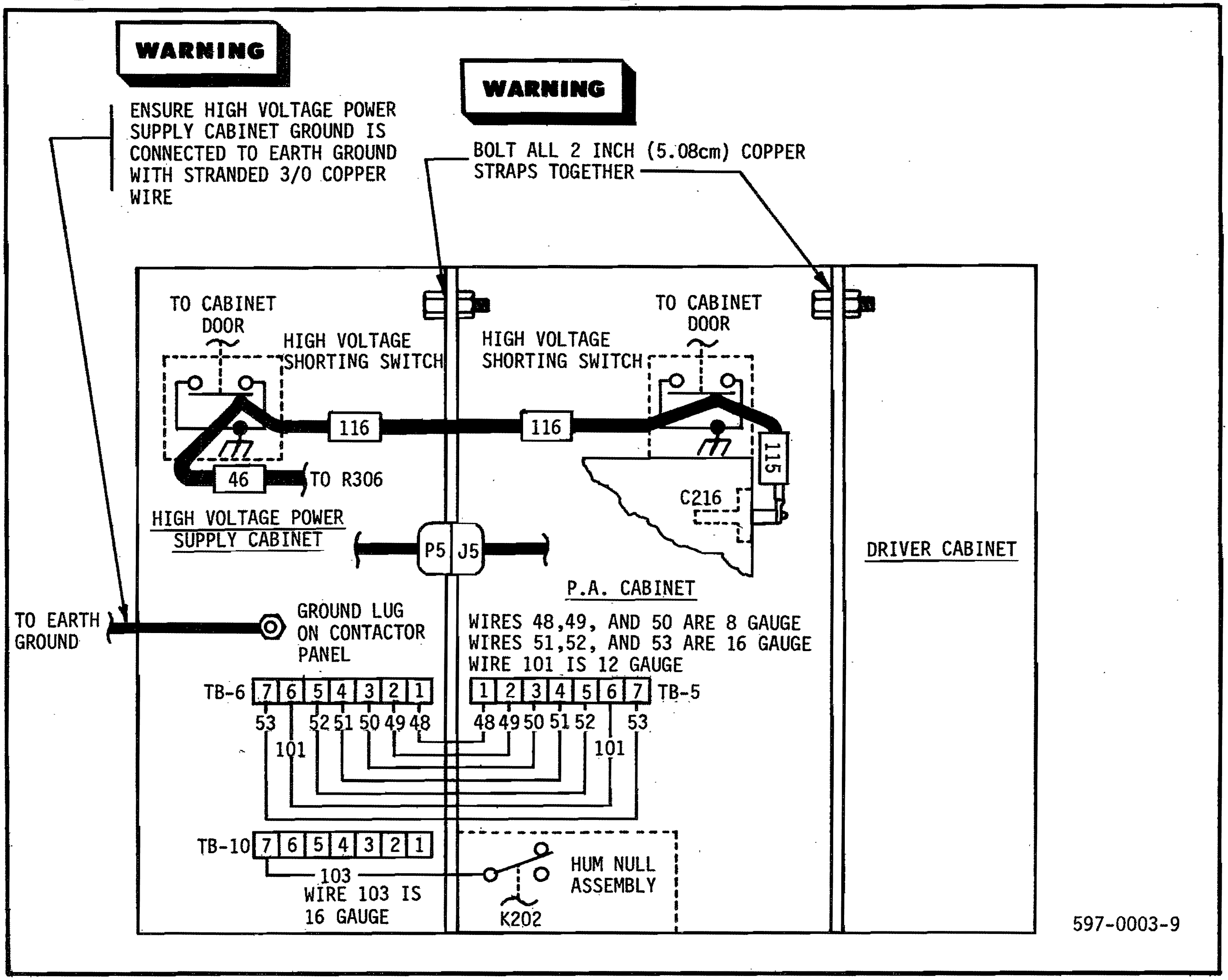

FIGURE 2-9. INTERCONNECTING WIRING, CABINETS POSITIONED TOGETHER

B. Connect wire 103 to terminal board TB10 behind the high voltage power supply cabinet front panel.

C. Connect P5 to J5 between the PA and high voltage power supply cabinets.

D. Connect high voltage wire 116 to the same point in the high voltage cabinets shorting switch assembly where wire 46 connects.

E. Connect wire 103 to terminal board TB10 on the high voltage power supply contactor panel.

WARNING

ENSURE ALL GROUNDS IN THE FOLLOWING STEP ARE SECURELY CONNECTED.

F. Bolt each copper ground strap in the top of each adjoining cabinet together securely.

2-62. If the high voltage power supply cabinet is located remotely from the PA and driver cabinets, the following wiring must be completed (see Figure 2-10). If the cabinets are positioned together, refer to paragraph 2-61.

A. Connect wires 48, 49, 50, 51, 52, 101, and 53 to terminal board TB5 in the front of the PA cabinet.

B. Connect wire 103 to terminal board TB10 on the high voltage power supply contactor panel.

C. An interlock extension cable is shipped with one end unterminated to allow the cable to be pulled through conduit. A connector shipped with the transmitter cables must be soldered onto the unterminated end as follows before connection.

WIRE NO.	COLOR	PIN NO.	SIGNAL
1	Black	1	High Voltage "E" Sample to Microprocessor Controller
2	Red	2	Door Interlock (N.O. Contact)
3	White	3	Plate Current Meter Sample
4	Green	4	Ground Stick Interlock (N.O. Contact)
5	Orange	5	High Voltage "I" Sample to Microprocessor Controller
105	Blue	6	Plate Current Meter Sample
---	Brown	7	Spare
---	Yellow	8	Spare

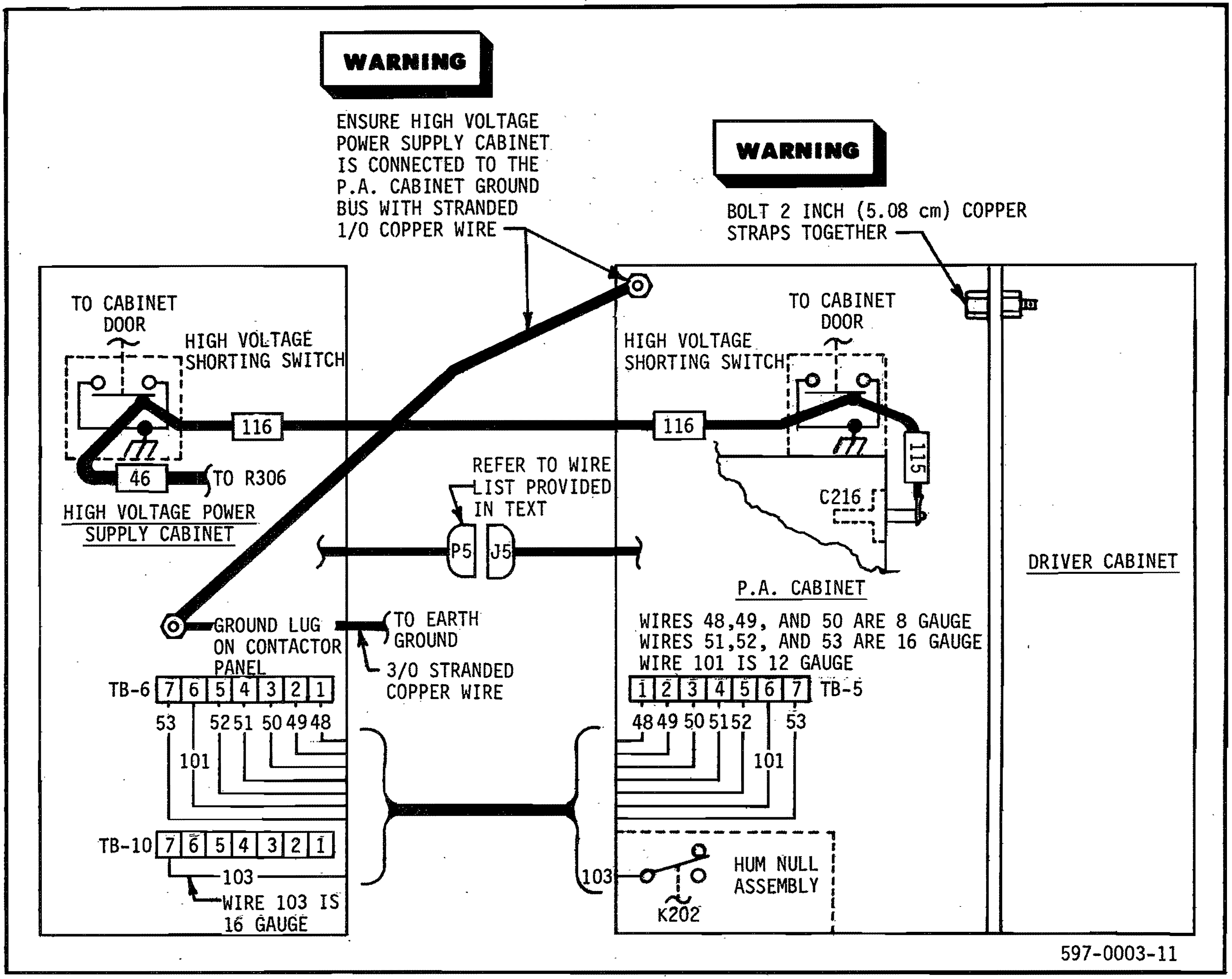

FIGURE 2-10. INTERCONNECTING WIRING, CABINETS POITIONED APART

WARNING

THE WIRE IN THE FOLLOWING STEP MUST NOT BE BROKEN OR SPLICED. THIS WIRE MUST REMAIN IN ONE UNBROKEN LENGTH, REGARDLESS OF THE DISTANCE INVOLVED.

D. Connect high voltage wire 116 to the same point in the high voltage cabinet shorting switch assembly where wire 46 connects.

WARNING

ENSURE ALL GROUNDS IN THE FOLLOWING STEPS ARE SECURELY CONNECTED.

E. Bolt the copper ground strap along the top of the PA and driver cabinets together securely.

F. Connect a No. 1 stranded bare copper wire from the copper ground strap along the top of the PA cabinet to the ground lug on the high voltage power supply contactor panel.

2-63. GROUND. A common ground conductor must connect to the ground lug on the high voltage power supply contactor panel. This ground must be securely connected to the station common earth ground by the most direct route with No. 3/0 stranded copper wire (see Figures 2-11 and 2-9 or 2-10).

2-64. 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.

2-65. EXTERNAL INTERLOCK. If an external interlock is required such as for a test load, remove the jumper between terminal TB9-1 and terminal TB9-2 in the driver cabinet. Connect a normally closed interlock switch across these terminals. This interlock must be electrically isolated from ground, any ac, or any dc potentials. The maximum potential on this circuit is 5 V dc. If a fail safe connection is required, it must be connected in series with the remote interlock.

WARNING

ENSURE PRIMARY POWER IS OFF BEFORE PROCEEDING.

2-66. AC POWER CONNECTIONS. A source of three-phase ac of 196 to 252 Vac, 60 Hz at 200 Amperes-per-phase from an approved power source is required for transmitter operation. It is strongly suggested that each power source be connected to the transmitter through a fused power disconnect (see Figure 2-11).

WARNING

ENSURE PRIMARY POWER IS OFF BEFORE PROCEEDING.

2-67. Three-Phase Power. Connect the three-phase ac power source to the ac power distribution panel behind the front panel of the high voltage power supply through a fused service disconnect as shown by Figure 2-11.

2-68. INITIAL CHECKOUT

WARNING

ENSURE PRIMARY POWER IS OFF BEFORE PROCEEDING.

2-69. Replace all panels and doors on the transmitter with the exception of the PA cabinet lower front access panel. This panel must remain off.

2-70. Ensure an RF load is connected to the transmitter.

2-71. Adjust the FILAMENT VOLTAGE and SCREEN VOLTAGE controls fully counterclockwise (minimum).

2-72. Ensure that the equipment is completely installed and the station monitors are connected to the RF sample port in the transmission line. Check the following:

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 boards are secure, especially in high current areas.

E. Ensure all ground connections and that chassis ground is properly connected to earth ground.

F. Rotate the blower by hand to ensure no obstructions are present.

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

2-73. Remove any extra hardware and wire lying within the cabinets and close all doors.

2-74. 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. Ensure all controls are preset to the positions indicated on the final test data sheets before proceeding.

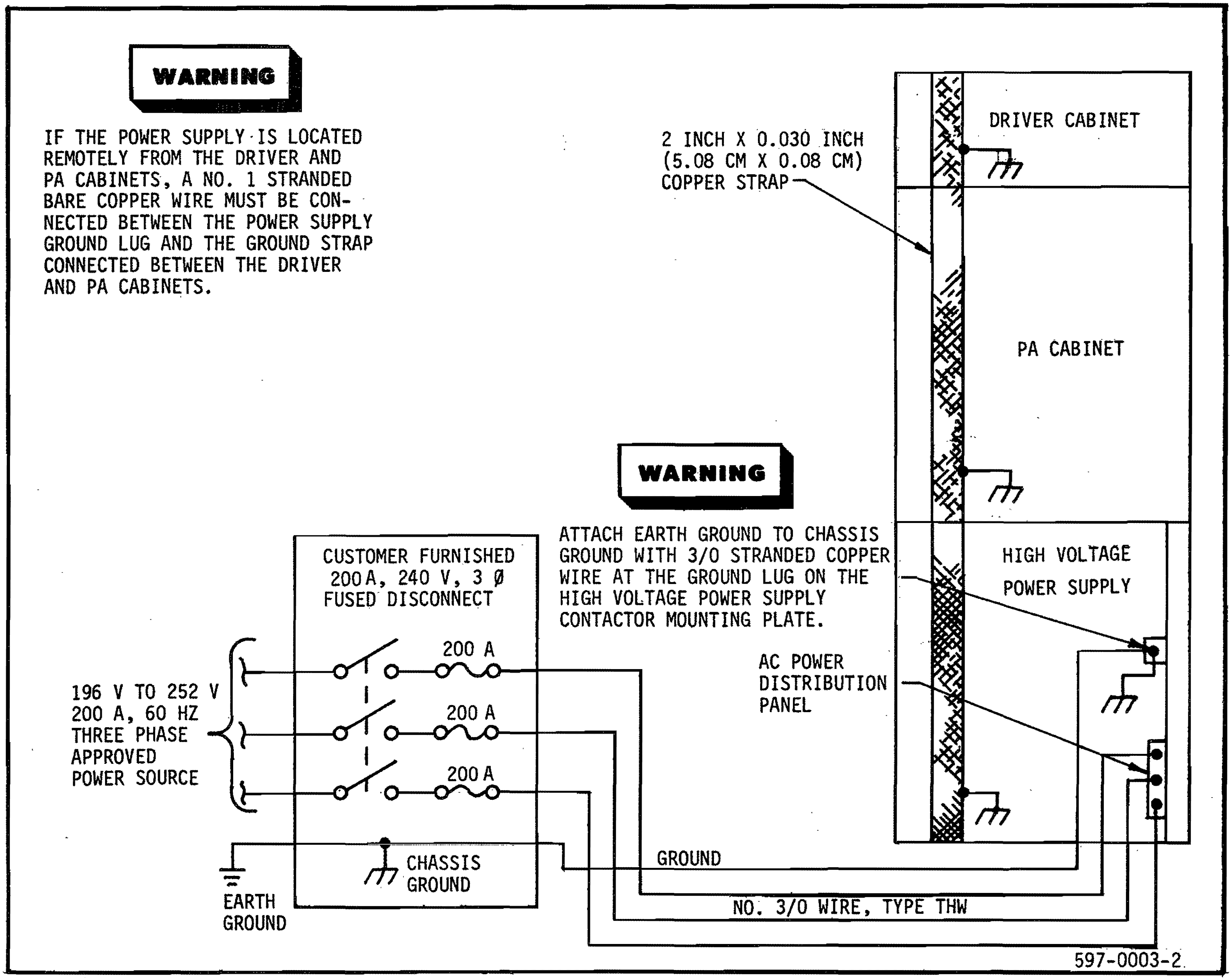

FIGURE 2-11. WIRING

2-75. Refer to Section II of the exciter publication and complete the steps under PRELIMINARY INSTALLATION.

2-76. Operate the exciter POWER switch to ON.

2-77. Reconnect the wire removed from the center battery in the microprocessor controller battery pack in the driver cabinet.

2-78. Depress the FILAMENT OFF and HIGH VOLTAGE OFF switches.

2-79. Operate the HIGH VOLTAGE PRIMARY circuit breaker to OFF. Operate the PRIMARY POWER, FILAMENT, SCREEN, and POWER SUPPLY circuit breakers to ON.

2-80. Open the driver cabinet rear door. Connect a temporary jumper wire from TB1 terminal 5 (AFC) of the exciter to ground. Close the driver cabinet rear door.

2-81. INTERLOCK CHECKOUT. Replace the PA cabinet lower front access panel. The microprocessor controller digital readout will indicate $\boxed{\ \ 1}$. If not, deenergize all power and ensure all interlocks are closed (including the remote interlock across TB9-1 and TB9-2 in the driver cabinet).

2-82. Complete the following steps, one at a time and note the microprocessor controller digital read-out indication. If difficulties are encountered, deenergize all power and troubleshoot the series interlock string with ohmmeter checks.

NOTE

THE MAXIMUM POTENTIAL ON THE INTERLOCK STRING IS FIVE VOLTS DC TO GROUND.

2-83. Open the driver cabinet rear door. The digital read-out will indicate $\boxed{\ \ 8}$. Close the driver cabinet rear door. The digital read-out will indicate $\boxed{\ \ 1}$.

2-84. Open the PA cavity front access door. The digital read-out will indicate $\boxed{\ \ 8}$. Close the PA cavity front access door. The digital read-out will indicate $\boxed{\ \ 1}$.

2-85. Open the PA cabinet rear door. The digital read-out will indicate $\boxed{\ \ 8}$. Depress the PA cabinet rear door interlock. The digital read-out will indicate $\boxed{\ \ 1}$.

2-86. Continue to depress the PA cabinet rear door interlock and raise the grounding hook from its hanger. The digital read-out will indicate $\boxed{\ \ 8}$. Replace the grounding hook on its hanger and close the PA cabinet rear door.

2-87. Open the high voltage power supply cabinet rear door. Depress the high voltage shorting switch actuator. The digital read-out will indicate $\boxed{\ \ 8}$.

2-88. Continue to depress the high voltage power supply cabinet high voltage shorting switch actuator and depress the door interlock. The digital read-out will indicate $\boxed{\ \ 1}$.

2-89. Depress the high voltage power supply cabinet door interlock and release the high voltage shorting switch actuator. The digital read-out will indicate $\boxed{\ 8}$.

2-90. Depress both the high voltage power supply cabinet door interlock and the high voltage shorting switch interlock and raise the grounding hook from its hanger. The digital read-out will indicate $\boxed{\ 8}$.

2-91. Release all interlocks, replace the grounding hook on its hanger, and close the high voltage power supply cabinet rear door. The digital read-out will indicate $\boxed{\ 1}$.

2-92. Open the remote interlock. The digital read-out will indicate $\boxed{\ 8}$.

2-93. Close the remote interlock. The digital read-out will indicate $\boxed{\ 1}$.

2-93A. Open the driver cabinet rear door. Disconnect the jumper wire from TB-1 terminal 5 of the exciter to ground. Close the driver cabinet rear door.

2-94. Close the three phase primary service disconnect to apply power to the transmitter. The INTERLOCK status indicator will illuminate.

2-95. EXCITER CHECKOUT. The presence of the audio programming applied to the exciter will be noted on the exciter digital MODULATION meter and the exciter front panel AFC and POWER indicators will be illuminated.

2-96. Depress the exciter multimeter +20 switch.

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

2-97. Depress the exciter multimeter -20 switch.

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

2-98. Depress the exciter multimeter +5 switch.

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

2-99. Depress the exciter multimeter AFC switch.

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

WARNING

ENSURE PRIMARY POWER IS OFF BEFORE PROCEEDING.

2-100. Open the three phase primary service disconnect.

2-101. Open the driver cabinet rear door and operate the OVERRIDE/NORMAL switch to NORMAL. Close the driver cabinet rear door. The microprocessor digital readout will indicate $\boxed{\ 2}$.

2-102. BLOWER PHASING. Blower rotation must be visually checked prior to transmitter operation and the blower motor wiring changed if blower rotation is incorrect.

NOTE

IF THE TRANSMITTER IS EQUIPPED WITH OPTIONAL UNDER-VOLTAGE AND LOSS-OF-PHASE PROTECTION, POWER WILL NOT BE APPLIED TO THE TRANSMITTER CIRCUITRY UNTIL 12 SECONDS AFTER THE MONITOR SENSES THE CORRECT PHASE SEQUENCE. THE TRIP INDICATOR WILL ILLUMINATE TO INDICATE INCORRECT PHASING AND GO OUT TO INDICATE PROPER PHASING.

2-103. Remove the blower filter from the PA cabinet rear door.

2-104. Close the three-phase fused ac disconnect.

2-105. Momentarily depress FILAMENT ON. Then depress FILAMENT OFF. The blower will begin operation. Fifteen seconds later the blower will deenergize.

2-106. As the blower slows to a near stop, the direction of rotation can be noted through the PA cabinet air filter grill. Proper rotation is shown by Figure 2-12.

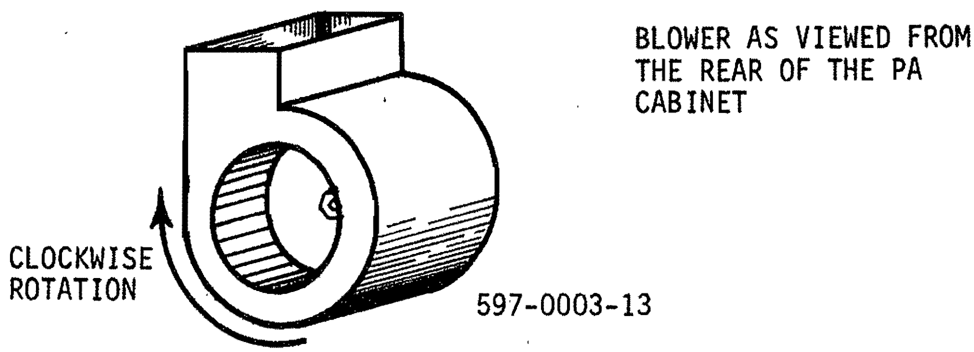

FIGURE 2-12. BLOWER ROTATION

2-107. If blower rotation is counterclockwise as viewed from the rear of the transmitter through the air filter grill, it will be necessary to change the three-phase primary ac wiring to the transmitter as follows:

WARNING

ENSURE THE THREE-PHASE AC DISCONNECT IS OPEN BEFORE ATTEMPTING THE FOLLOWING WIRING CHANGES.

A. Open the three-phase primary ac disconnect.

B. Interchange any two of the three-phase primary ac wires to the transmitter.

2-108. Replace the blower air filter.

2-109. TUNING PROCEDURE. Close the three-phase primary ac power disconnect if opened.

2-110. Operate the HIGH VOLTAGE PRIMARY circuit breaker to ON.

2-111. Pull the exciter forward on its slides out of the rack until the RF power adjustment control (R3) access hole is visible on the top left of the exciter. Adjust the control fully counterclockwise (minimum RF power output).

CAUTION

ASSURE AN RF LOAD IS CONNECTED TO THE TRANSMITTER AND THE FILAMENT VOLTAGE CONTROL IS FULLY COUNTERCLOCKWISE AND THE SCREEN VOLTAGE CONTROL FULLY COUNTERCLOCKWISE.

2-112. Depress the FILAMENT ON switch/indicator. Both the FILAMENT ON switch/indicator and the FILAMENT status indicator will illuminate and the blower will begin operation.

2-113. Adjust the FILAMENT VOLTAGE control to obtain a FILAMENT VOLTAGE meter indication of 10.0 volts ±0.5 volts or as indicated on the final test data sheets accompanying the transmitter.

2-114. Note the presence of PA stage grid bias on the GRID VOLTAGE meter (approximately -180 volts to -200 volts).

2-115. Depress all five IPA power supply circuit breakers on the driver cabinet so that the breakers latch in the "in" position.

2-116. Operate the MODULE VOLTAGE meter switch through all five positions. A potential of approximately 27.5V dc should be noted on the associated MODULE VOLTAGE meter for each switch position.

2-117. Depress the HIGH VOLTAGE ON switch/indicator. Both the HIGH VOLTAGE ON switch indicator and the HIGH VOLTAGE status indicator will illuminate.

2-118. Note the presence of PA plate voltage on the P.A. VOLTAGE meter.

2-119. Adjust the PA SCREEN control to obtain an indication of 100 volts on the SCREEN VOLTAGE meter.

2-120. Operate the DRIVER meter switch to POWER.

2-121. Adjust the exciter RF power adjustment control (R3) clockwise until an indication of approximately 100% is noted on the DRIVER meter.

NOTE

IF THE EXCITER HAS BEEN REMOTED AND ADDITIONAL RG-58 CABLE HAS BEEN ADDED BETWEEN THE EXCITER AND THE IPA STAGE INPUT, COMPLETE THE FOLLOWING STEPS:

A. DEPRESS THE EXCITER RFL SWITCH.

B. ALTERNATELY, ADJUST ONLY THE IPA STAGE MODULE 1 BASE TUNING AND INPUT LOADING CONTROLS TO MINIMIZE THE EXCITER REFLECTED POWER INDICATION. AN INSULATED ADJUSTMENT TOOL SUCH AS SHIPPED WITH THE FX-30 EXCITER (P/N 710-0001) WILL ASSIST ADJUSTMENT.

2-122. Operate the DRIVER meter switch to VSWR.

2-123. Adjust the PA INPUT TUNING stage and INPUT LOADING controls to obtain a minimum indication on the DRIVER meter. Readjust these controls until a true minimum is obtained.

2-124. Adjust the SCREEN VOLTAGE control to obtain a SCREEN VOLTAGE meter indication of 50% of the value listed on the final test data sheets.

2-125. Adjust the P.A. OUTPUT TUNING control to obtain maximum RF output as indicated by the POWER OUT meter. With 100% RF drive applied, 55% to 80% of RF power should be indicated by the POWER OUT meter.

2-126. Adjust the INPUT TUNING and INPUT LOADING controls to obtain a minimum indication on the DRIVER meter.

2-127. Adjust the SCREEN VOLTAGE control to obtain a SCREEN VOLTAGE meter indication of the value listed on the final test data sheets.

2-128. Compare the plate current, screen current, and the other PA stage metered functions against the indications recorded on the factory final test data sheets.

CAUTION

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

2-129. Adjust the PA stage for the most efficient operation with the P.A. OUTPUT TUNING and P.A. OUTPUT LOADING controls.

2-130. Check all current and voltage indications for the IPA RF modules. All voltages should indicate 27.5 volts +0.5 V, -1.0 volts. The current indication of modules 2, 3, 4, and 5 should be within one ampere of each other (refer to the factory final test data sheets). The driver module (No. 1) however, will indicate somewhat less current than the others as the power output requirement of this amplifier is lower.

2-131. Check the power present in reject loads 1, 2, and 3 to ensure the driver balance is correct (refer to the factory final test data sheets). A slightly better balance and current match may possibly be obtained by a slight readjustment of the PA stage INPUT TUNING and/or INPUT LOADING controls.

SECTION III
OPERATION

3-1. INTRODUCTION

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

3-3. CONTROLS AND INDICATORS

3-4. Refer to Figures 3-1 and 3-2, and 3-3 for the location of all controls and indicators associated with normal operation of the FM-30 transmitter. The function of each control or indicator is described by the associated table.

3-5. OPERATION

NOTE

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

3-6. TURN ON

3-7. Operate the LOCAL/REMOTE switch to LOCAL.

3-8. Operate the HIGH VOLTAGE PRIMARY circuit breaker on the high voltage power supply to ON.

3-9. Depress the FILAMENT ON switch/indicator, then depress the HIGH VOLTAGE ON switch/indicator.

3-10. If all interlocks are closed, the transmitter will be operational after ten seconds for 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. Sample log sheets are provided as Tables 3-4 and 3-5.

3-12. If remote operation is desired, operate the LOCAL/REMOTE switch to REMOTE. This will enable both local and remote operation.

3-13. When the LOCAL/REMOTE switch is set to LOCAL, transmitter power may be adjusted manually with the SCREEN VOLTAGE control or automatically with the automatic power control system. Power adjustment when the AUTO/MAN switch is set to AUTO is accomplished by operating the RAISE/LOWER switch, thereby varying the internal automatic power control set point at a slow rate.

3-14. When the LOCAL/REMOTE switch is set to REMOTE, the power can be adjusted only from the remote power control contacts (TB9-15 and 16). When the AUTO/MAN switch is set to MAN, the remote contacts directly control the variable screen transformer control motor. When the AUTO/MAN switch is set to AUTO, the remote contacts vary the internal automatic power control system set point which will also adjust power, but at a much slower rate.

3-15. TURN OFF

3-16. Depress the FILAMENT OFF switch.

3-17. After a period of blower operation to allow the PA tube to cool, the equipment will deenergize.

3-18. Operate the HIGH VOLTAGE PRIMARY circuit breaker on the high voltage power supply to OFF.

TABLE 3-1. POWER SUPPLY CABINET CONTROLS AND INDICATORS

NOMENCLATURE	FUNCTION
HIGH VOLTAGE PRIMARY Circuit Breaker	Provides overload protection and primary power control for the PA plate power supply.

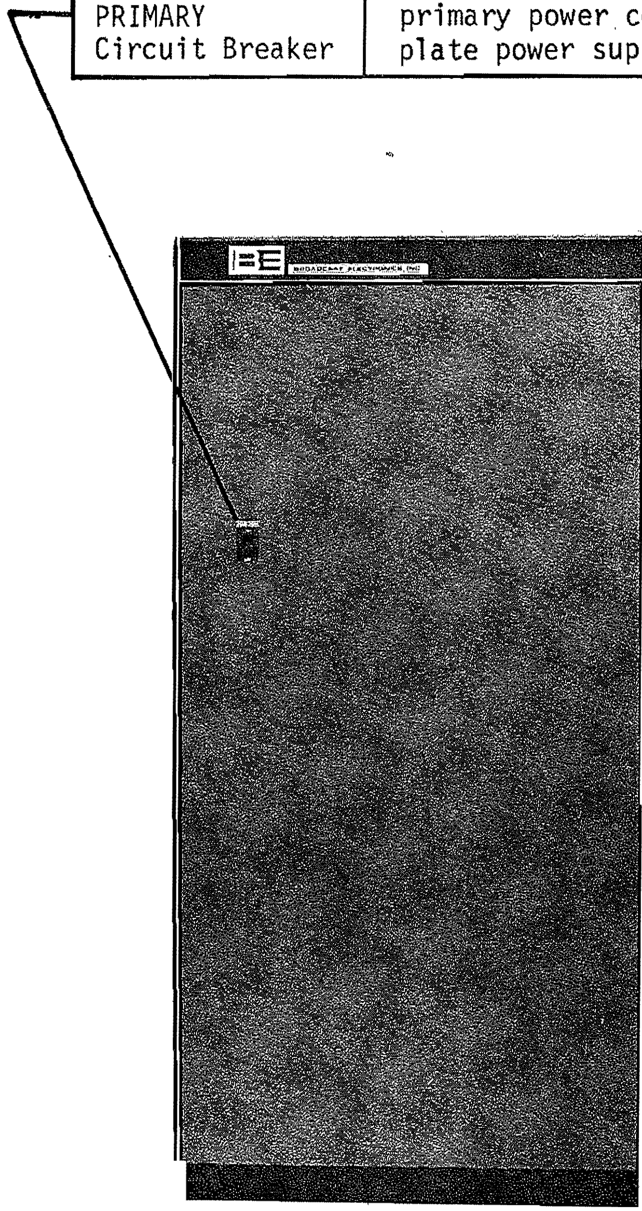

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FIGURE 3-1. POWER SUPPLY CABINET CONTROLS AND INDICATORS

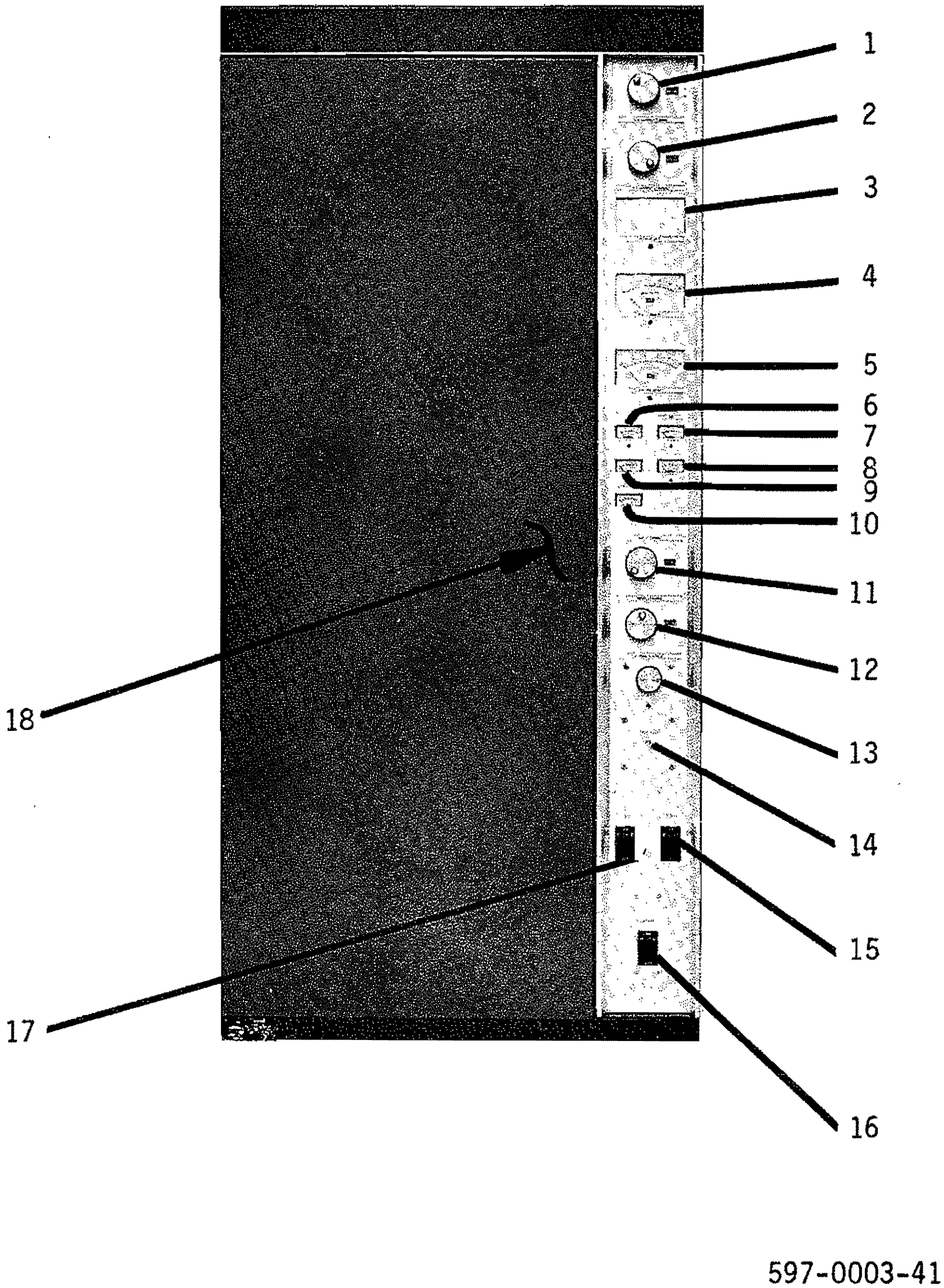

FIGURE 3-2. PA CABINET CONTROLS AND INDICATORS

Table 3-2. PA Cabinet Controls and Indicators
(Sheet 1 of 2)

INDEX NO.	NOMENCLATURE	FUNCTION
1	P.A. OUTPUT TUNING Control and Cyclometer	Tunes the PA stage output circuit to resonance.
2	P.A. OUTPUT LOADING Control and Cyclometer	Adjusts the PA stage output loading.
3	POWER OUT Meter	Displays VSWR or percentage of RF forward power output as selected by the FWD/VSWR switch.
4	P.A. CURRENT Meter	Displays PA tube plate current.
5	P.A. VOLTAGE Meter	Displays PA tube plate voltage.
6	SCREEN VOLTAGE Meter	Displays PA tube screen grid voltage.
7	GRID VOLTAGE Meter	Displays PA tube control grid voltage.
8	GRID CURRENT Meter	Displays PA tube control grid current.
9	SCREEN CURRENT Meter	Displays PA tube screen grid current.
10	FILAMENT VOLTAGE Meter	Displays the PA tube filament voltage.
11	INPUT TUNING Control and Cyclometer	Tunes the PA input circuit to resonance.
12	INPUT LOADING Control and Cyclometer	Adjusts the PA stage input loading.
13	SCREEN VOLTAGE Control	Adjusts PA tube screen grid voltage when the AUTO/MAN switch is set to MAN. Adjustment of the SCREEN VOLTAGE control should not be attempted when the AUTO/MAN switch is set to AUTO.

Table 3-2. PA Cabinet Controls and Indicators
(Sheet 2 of 2)

INDEX NO.	NOMENCLATURE	FUNCTION
14	FILAMENT VOLTAGE Control	Adjusts PA tube filament voltage.
15	SCREEN Circuit Breaker	Provides overload protection and control for the PA tube screen grid circuit.
16	PRIMARY POWER Circuit Breaker	Provides overload protection and control for the blower, the hum null assembly, and all equipment powered by the isolation transformer (FM exciter, stereo generator, etc.).
17	FILAMENT Circuit Breaker	Provides overload protection and control for the PA tube filament circuit. The HIGH VOLTAGE CONTACTOR is interlocked through the FILAMENT circuit breaker so that the plate supply will deenergize whenever the filament supply is interrupted.
18	HOURS Meter	Indicates hours of PA filament operation.

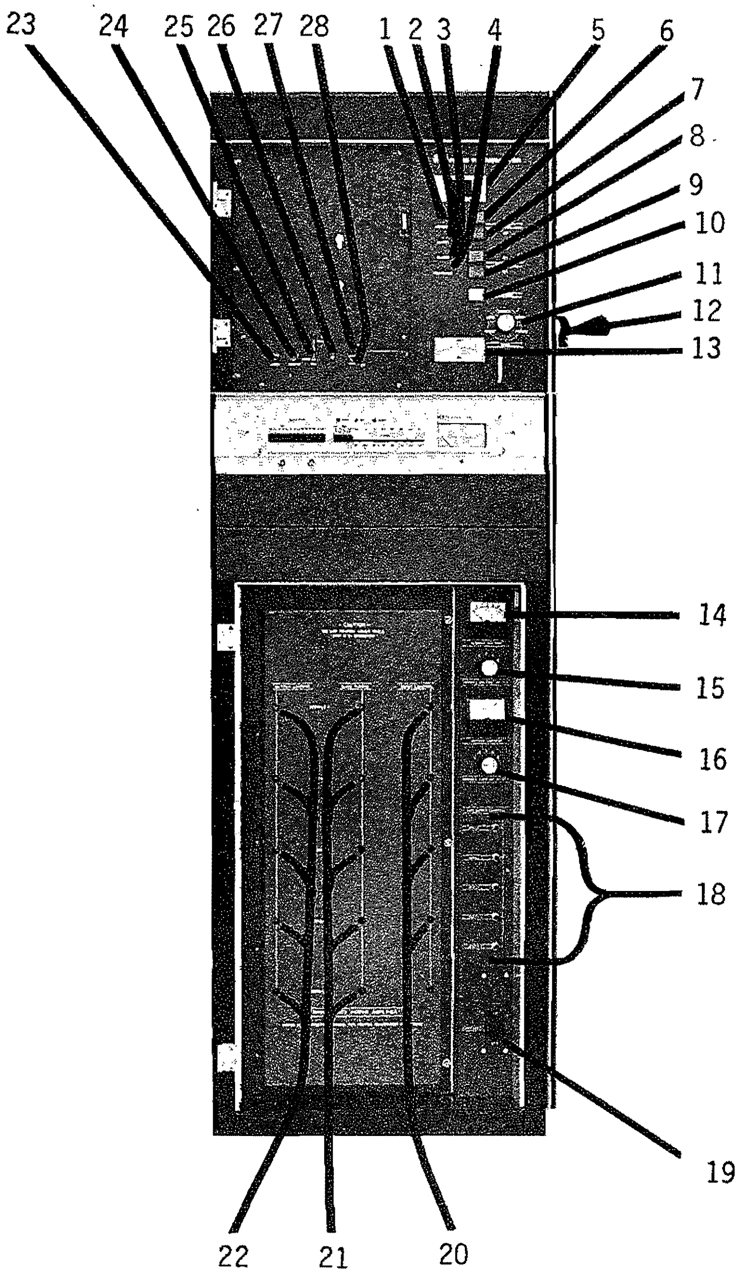

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FIGURE 3-3. DRIVER CABINET CONTROLS AND INDICATORS

Table 3-3. Driver Cabinet Control and Indicators
(Sheet 1 of 3)

INDEX NO.	NOMENCLATURE	FUNCTION
1	INTERLOCK status indicator	Illuminates to indicate all interlocks are closed.
2	BLOWER status indicator	Illuminates to indicate the blower is operational.
3	FILAMENT status indicator	Illuminates to indicate primary ac power is applied to the PA filament transformer.
4	HIGH VOLTAGE status Indicator	Illuminates to indicate the high voltage power supply is operational.
5	Microprocessor Readout	Numerically indicates the status of the transmitter control functions.
6	FILAMENT ON Switch/Indicator	SWITCH: Energizes the filament contactor to apply PA filament voltage. INDICATOR: Indicates proper operation of the filament control circuitry when illuminated.
7	FILAMENT OFF Switch	Deenergizes all transmitter functions powered by the three-phase primary ac input. The blower will run for 15 seconds after the FILAMENT OFF switch is depressed.
8	HIGH VOLTAGE ON Switch/Indicator	SWITCH: Energizes the high voltage contactor to apply PA plate potential. INDICATOR: Indicates proper operation of the high voltage control circuit when illuminated.
9	HIGH VOLTAGE OFF Switch	Deenergizes high voltage and mutes the exciter RF output.
10	OVERLOAD Switch/Indicator	SWITCH: Clears the overload circuit memory when depressed. INDICATOR: Illuminates to indicate an overload or open interlock.

Table 3-3. Driver Cabinet Control and Indicators
(Sheet 2 of 3)

INDEX NO.	NOMENCLATURE	FUNCTION
11	DRIVER Meter Switch	Selects the functions displayed by DRIVER meter.
12	RESET Switch	Initializes the microprocessor controller to start configuration.
13	DRIVER Meter	Displays IPA stage percentage of output power, IPA stage VSWR, or IPA stage combiner reject load relative power levels.
14	MODULE VOLTAGE Meter	Displays the voltage applied to each IPA module as selected by the MODULE VOLTAGE switch.
15	MODULE VOLTAGE Switch	Selects the module voltage to be displayed by the MODULE VOLTAGE meter.
16	MODULE CURRENT Meter	Displays the dc current to each IPA module as selected by the MODULE CURRENT switch.
17	MODULE CURRENT Switch	Selects the module current to be displayed by the MODULE CURRENT meter.
18	28 V MODULE ( ) Circuit Breaker	Provides overload protection and control for the associated IPA amplifier and regulator.
19	POWER SUPPLY Circuit Breaker	Provides overload protection and control for the driver power supply.
20	INTERMEDIATE POWER AMPLIFIER INPUT LOADING Controls	Adjusts the RF input loading to each IPA module.
21	INTERMEDIATE POWER AMPLIFIER BASE TUNING Controls	Tunes each IPA stage amplifier base circuit to resonance.
22	INTERMEDIATE POWER AMPLIFIER OUTPUT LOADING Controls	Adjusts the output loading of each IPA module.

Table 3-3. Driver Cabinet Control and Indicators
(Sheet 3 of 3)

INDEX NO.	NOMENCLATURE	FUNCTION
23	RAISE/LOWER Switch	Changes the automatic power control circuit operating level (operative only in local control).
24	LOCAL/REMOTE Switch	Selects between transmitter local control or both local and remote control.
25	VSWR CAL/VSWR FWD Switch	Allows calibration of the POWER OUT meter.
26	VSWR CAL Control	Allows calibration of the POWER OUT meter to 100% when the VSWR CAL/VSWR FWD switch is set to VSWR CAL.
27	AUTO Indicator	Illuminates to indicate automatic RF power output level control has been selected.
28	AUTO/MAN Switch	Allows manual control of the PA screen potential in the MAN position or enables automatic screen voltage control in the AUTO position.

TABLE 3-4. INDICATOR CHECKLIST

METER	SWITCH POSITION/INDICATOR				
POWER OUT	VSWR :	FORWARD POWER %			
P.A. CURRENT	A				
P.A. VOLTAGE	V				
SCREEN GRID VOLTAGE	V				
SCREEN GRID CURRENT	mA				
GRID VOLTAGE	V				
GRID CURRENT	mA				
FILAMENT VOLTAGE	V				
MODULE VOLTAGE	1 V	2 V	3 V	4 V	5 V
MODULE CURRENT	1 A	2 A	3 A	4 A	5 A
DRIVER	POWER %	VSWR :	HYBRID 1 %	HYBRID 2 %	HYBRID 3 %

ELAPSED TIME METER

INDICATOR	STATUS	
INTERLOCK	ON	OFF
BLOWER	ON	OFF
FILAMENT	ON	OFF
HIGH VOLTAGE	ON	OFF
MICROPROCESSOR READOUT	[]	[]
FILAMENT ON SWITCH/INDICATOR	ON	OFF
HIGH VOLTAGE ON SWITCH/INDICATOR	ON	OFF
OVERLOAD SWITCH/INDICATOR	ON	OFF

NOTE:
OPERATIONAL STATUS SHOWN BY SHADED INDICATOR

TABLE 3-5. INDICATOR CHECKLIST

METER	SWITCH POSITION/INDICATOR				
POWER OUT	VSWR :	FORWARD POWER %			
P.A. CURRENT	A			ELAPSED TIME METER	
P.A. VOLTAGE	V				
SCREEN GRID VOLTAGE	V				
SCREEN GRID CURRENT	mA				
GRID VOLTAGE	V				
GRID CURRENT	mA				
FILAMENT VOLTAGE	V				
MODULE VOLTAGE	1 V	2 V	3 V	4 V	5 V
MODULE CURRENT	1 A	2 A	3 A	4 A	5 A
DRIVER	POWER %	VSWR :	HYBRID 1 %	HYBRID 2 %	HYBRID 3 %

INDICATOR	STATUS	
INTERLOCK	ON	OFF
BLOWER	ON	OFF
FILAMENT	ON	OFF
HIGH VOLTAGE	ON	OFF
MICROPROCESSOR READOUT		
FILAMENT ON SWITCH/INDICATOR	ON	OFF
HIGH VOLTAGE ON SWITCH/INDICATOR	ON	OFF
OVERLOAD SWITCH/INDICATOR	ON	OFF

NOTE:
OPERATIONAL STATUS SHOWN BY SHADED INDICATOR

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This section presents detailed theory of operation for the FM-30 FM Transmitter.

4-3. For purposes of definition, the FM-30 Transmitter is divided into functional circuits by the following text. Refer to the detailed block diagram (Figure 4-1) and the overall schematic diagram in Section VII as required by the following explanation.

4-4. ELECTRICAL DESCRIPTION

4-5. FM EXCITER

4-6. The Broadcast Electronics FX-30 is a totally solid-state wide-band FM exciter providing a continuously variable RF output from 3 to 30 watts into a 50 Ohm load at any frequency within the 87.5 to 108 MHz FM broadcast band. The exciter may be programmed to any frequency within this band in 10 kHz increments. The FX-30 exciter is mounted in slides to allow easy access to the semi-modular exciter internal circuitry.

4-7. The FX-30 will accept multiple wideband composite inputs from a stereo generator or SCA generator as well as a 600 Ohm balanced audio input (see Figure 4-1). Refer to publication 597-0002 for a detailed explanation of the FM exciter features.

4-8. INTERMEDIATE POWER AMPLIFIER

4-9. The solid-state IPA section consists of five identical amplifier modules (one used as a driver for four) conservatively operated in a conventional quadrature hybrid combiner/splitter circuit.

4-10. Failure of any one of the four IPA output modules will typically cause only a 15 percent power reduction. In the event two modules fail, only a 35 percent reduction in transmitter power will result. Any one of the four amplifier modules can be used to replace the driver module should the need arise.

4-11. POWER AMPLIFIER

4-12. The FM-30 uses a high-gain Eimac 8990/4CX20000A tetrode to provide 30 kW of power output between 87.5 MHz to 108 MHz. The power amplifier operates in a high-gain, grid-driven class C configuration. Plate efficiency of the final amplifier approaches 80 percent at 30 kW output, resulting in comparatively low power consumption. Removal and installation of the PA tube in the FM-30 is a quick and simple procedure due to the cavity size and large access area. A large blower and an air switch arrangement ensures cool PA stage operation.

4-13. POWER AMPLIFIER CAVITY. The cavity used in the FM-30 employs a patented half wavelength folded tank circuit. This cavity design eliminates the plate blocking capacitor and all sliding contacts required by full half-wave and quarter-wave cavities. The results are high reliability, high efficiency, and low maintenance.

4-14. Output Loading. Anode voltage is applied to the lower portion of the fixed plate line at the RF voltage null point. Output loading is mechanically controlled by the position of a loop in the magnetic field generated at the RF voltage null point of the PA plate line structure. Multiple phosphor bronze leaves ground one side of the variable output loop to allow mechanical movement of the loading control without sliding contacts.

4-15. Plate Tuning. Plate tuning is provided by mechanically expanding or contracting the physical length of a beryillium copper bellows on the end of the variable or grounded portion of the PA plate line. Coarse frequency adjustment is accomplished by presetting the depth of the variable section of plate line into the tank cavity.

4-16. Second Harmonic Attenuator. A unique approach to second harmonic attenuation suppresses generation of the second harmonic in the power amplifier tank circuit. A suppressor consisting of a lumped coil and a lumped capacitor is placed inside the PA cavity at a point where the second harmonic exhibits a high impedance. This method suppresses generation of the second harmonic with minimal power loss at the fundamental frequency. When compared to a conventional second harmonic filter, the suppressor method results in increased PA efficiency.

4-17. TRANSMITTER CONTROLLER

4-18. All transmitter control and status functions in the FM-30 are performed by a built-in microprocessor controller that monitors the transmitter operating parameters in a series chain and then determines what control actions are necessary. By continuous scanning action, the microprocessor controller provides 123 different status indications, four LED displays, and three indicator lights for diagnostic purposes.

4-19. The microprocessor controller has the ability to initiate certain corrective actions concerning abnormal operating conditions without taking the transmitter off-the-air. Overload functions are retained in non-volatile memory for circuit analysis after equipment or power failure.

4-20. The control logic circuitry in the transmitter will interface directly with most modern remote control devices and ATS units. Two parallel four-bit BCD code outputs from the microprocessor controller provide remote status indications.

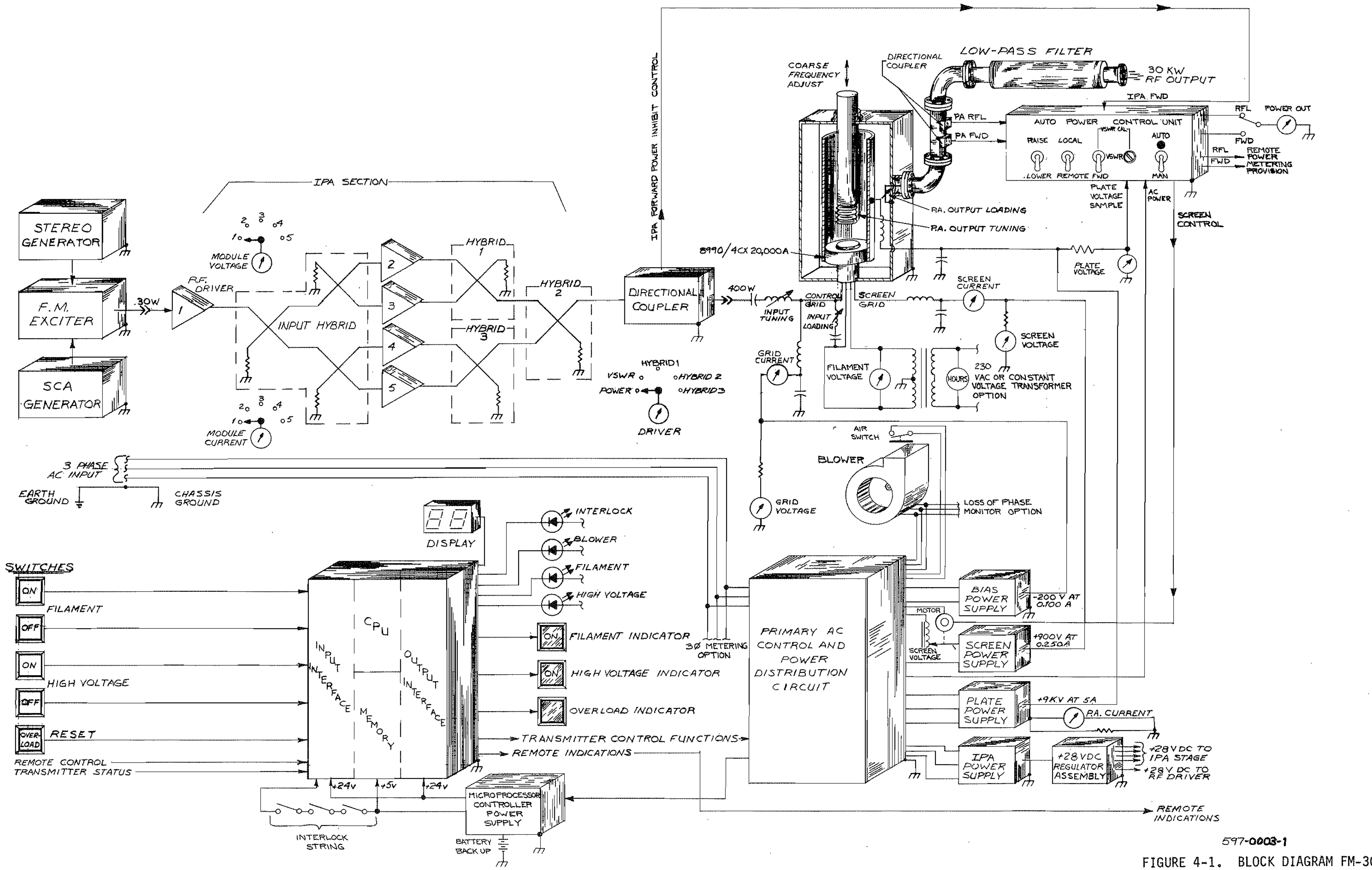

FIGURE 4-1. BLOCK DIAGRAM FM-30

4-21. AUTOMATIC RF OUTPUT LEVEL CONTROL. Part of the control circuitry monitors PA forward power, PA reflected power, and IPA forward power and adjusts the PA screen potential to maintain a constant RF output from the transmitter independent of ac line fluctuations. Manual screen control may be selected with a front-panel switch if desired.

4-22. VSWR FOLDBACK PROTECTION. PA reflected power is monitored by a circuit which automatically reduces RF power output in response to changes in the RF load such as antenna icing conditions. As the condition which caused the high VSWR condition returns to normal, RF output will proportionately increase until the full transmitter power output is restored.

4-23. SOFT START. Plate voltage is monitored by a circuit which reduces screen voltage to zero when the plate supply is turned off. When the plate supply is again turned on, the soft start circuit will gradually increase the screen supply until the rated RF output is achieved unless limited by a high VSWR or low IPA drive condition. The net effect of this circuit extends the life of the PA stage components by limiting stress.

4-24. AUTOMATIC RESTART. In event of a momentary ac power interruption, operation will resume when power returns. If ac power is lost for a prolonged period of time, the transmitter will initiate a complete start cycle to automatically return the equipment to operation.

4-25. RECYCLING. If an overload occurs, the transmitter will deenergize and allow the overload to clear. After several seconds, the transmitter will automatically return to operation. If two overloads occur in rapid succession, the equipment will deenergize and must be manually reset before operation can continue. If two or more overloads occur, spaced more than one minute apart, the transmitter will remain operational after each recycle attempt. This prevents having to manually reset the equipment after sporadic tripping due to lightning or power line surges. The microprocessor controller readout will display a code to indicate the problem whenever an overload occurs.

4-26. METERING

4-27. Twelve meters on the transmitter indicate critical parameters in addition to the microprocessor digital readout and seven status indicators. Additionally, exciter parameters are displayed by two meters and three status indicators. An elapsed time meter indicates hours of filament operation.

4-28. POWER SUPPLIES

4-29. All power supplies in the RF stage operate from a three-phase ac input. A stepdown isolation transformer operates the microprocessor controller power supply, the IPA directional coupler buffer amplifier power supply, and powers the exciter and optional stereo and SCA equipment.

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SECTION V
MAINTENANCE

5-1. INTRODUCTION

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

5-3. SAFETY CONSIDERATIONS

WARNING

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

5-4. The FM-30 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.

5-5. It is very dangerous to attempt to make measurements or replace components with power energized, therefore such actions are not recommended. The design of the equipment provides safety features such that when a door or access panel is opened, interlock switches will deenergize the plate and screen power supplies. Do not short out or bypass interlock switches as a maintenance short cut.

5-6. The power supply cabinet and the PA cabinet contain switches which discharge the PA plate potential directly to ground whenever either cabinet is opened.

5-7. Grounding sticks are provided as safety features. Each grounding stick consists of a metal rod with a phenolic handle. The metal end is connected to chassis ground. Use a grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting maintenance.

5-8. The grounding stick in the high voltage power supply cabinet and the grounding stick in the PA cabinet both rest on hook switches. When either of these grounding sticks is removed, the associated hook switch opens the transmitter interlock string and deenergizes the transmitter PA and screen potentials until each grounding stick is replaced on its respective hook switch.

5-9. FIRST LEVEL MAINTENANCE

WARNING

ENSURE THE REMOTE/LOCAL SWITCH IS SET TO LOCAL BEFORE ATTEMPTING MAINTENANCE.

5-10. First level or preventive maintenance consists of those precautionary measures applied to equipment to forestall future failures rather than to eliminate failures after they have occurred. These procedures are performed on a regularly scheduled periodic basis, and the results recorded in a performance log.

5-11. Preventive maintenance of the FM-30 transmitter falls into the category of good housekeeping and is limited to whatever cleaning may be necessary and checking the performance levels using the meters and various indicators built into the equipment.

WARNING

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

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.

5-13. AIR FILTERS

5-14. Air filter replacement is accomplished outside the transmitter without interrupting equipment operation. The filter should be checked once each week with replacement done on an as-needed basis.

5-15. The transmitter uses one disposable type air filter 1 inch X 16 inches X 20 inches (2.54 cm X 40.64 cm X 50.8 cm) mounted in the rear door of the PA cabinet. Additional filters may be ordered for replacement (P/N 407-0062) or locally purchased.

5-16. BLOWER MAINTENANCE

WARNING

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

5-17. Inspect the blower for dust accumulation and periodically clean the blower. Grease both the front and rear motor bearings at regular intervals (refer to Appendix A of the power supply portion of Part II). The blower mounting bolts should be checked for tightness.

5-18. The blower motor is cooled by the air passing through the 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 very dirty air passes over the motor, accumulated dust will impair the motor cooling unless the accumulation is wiped from and blown out of the motor.

5-19. The blower impeller blades should be inspected and cleaned periodically. If the unit is operated to move very dusty air, dust will build up on the concave side of the blower impeller. If this happens, blower performance will be reduced and unbalance will result with a possibility of damage to the blower.

5-20. SECOND LEVEL MAINTENANCE

WARNING

ENSURE THE REMOTE/LOCAL SWITCH IS SET TO LOCAL BEFORE ATTEMPTING MAINTENANCE.

5-21. Second level maintenance consists of procedures required to restore the transmitter to satisfactory operation after a fault has occurred.

5-22. The maintenance philosophy of the FM-30 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 isolation to a replaceable assembly or component. If desired, a replaceable assembly may be returned to the factory for repair or exchange.

5-23. ADJUSTMENTS

5-24. Adjustment procedures for all controls on all circuit boards are provided by each applicable assembly publication in Part II of this manual.

5-25. TROUBLESHOOTING

WARNING

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

5-26. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, fuses, and the digital read-out) should be used to isolate the malfunction to one of the specific areas listed below. Typical meter indications are presented in Table 5-1. Transmitter primary power demand requirements are listed in Table 5-2.

A. Exciter
B. Driver and IPA
C. Power Amplifier
D. Microprocessor Controller
E. Automatic Power Control Unit
F. Power Supplies
G. Transmitter Load

CAUTION

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

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.

5-27. Once the trouble is isolated, refer to the applicable assembly publication in Part II of this manual discussing the theory of operation and providing troubleshooting for the respective assembly to assist in problem resolution. Figures 5-1 through 5-8 provide drawings to assist component location. Pin-out diagrams for all integrated circuits used in the FM-30 are provided by Figure 5-9.

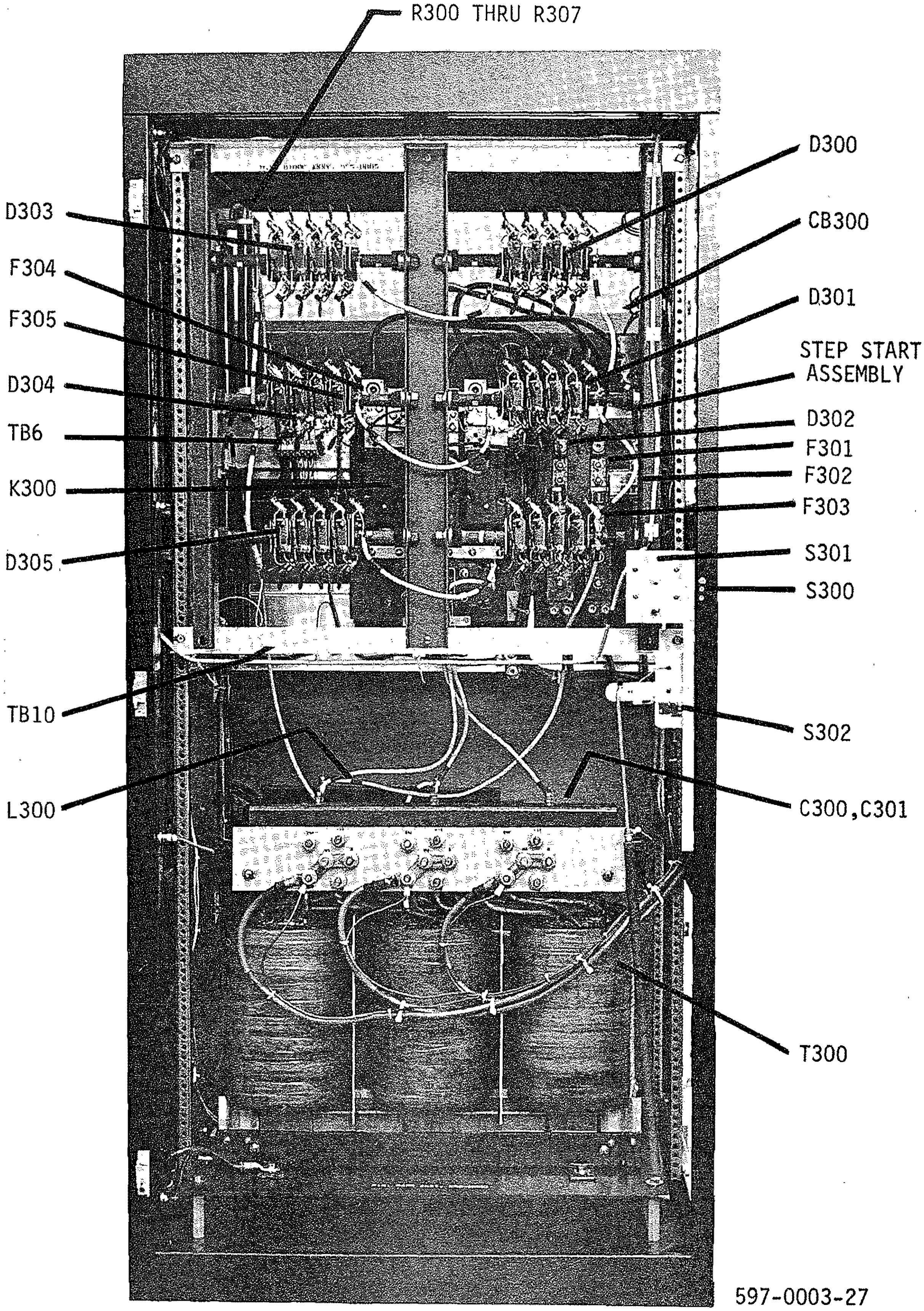

FIGURE 5-1. HIGH VOLTAGE POWER SUPPLY COMPONENT LOCATOR

WARNING: DISCONNECT POWER PRIOR TO SERVICING

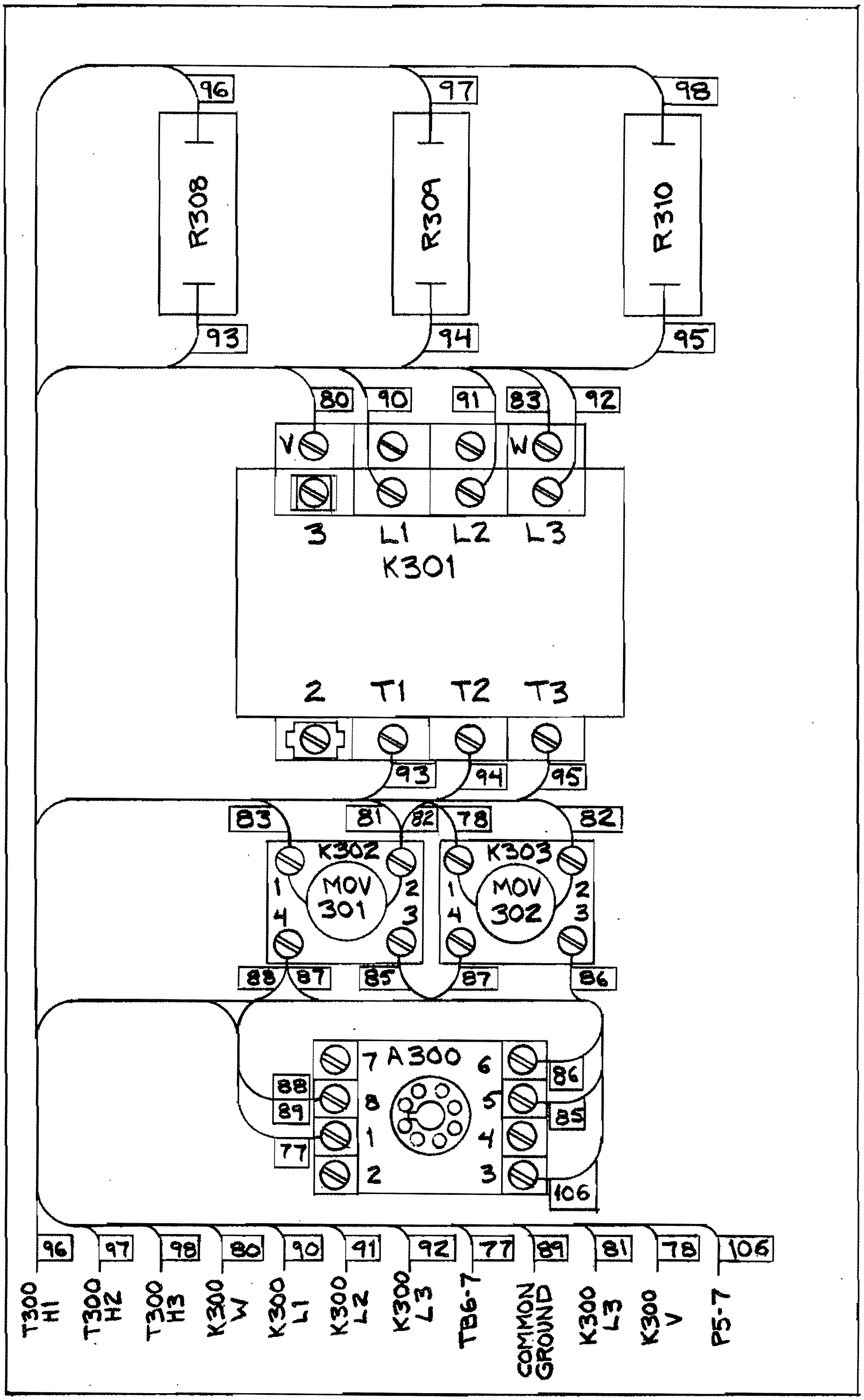

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FIGURE 5-2. STEP-START ASSEMBLY COMPONENT LOCATOR

5-28. COMPONENT REPLACEMENT ON CIRCUIT BOARDS. Many of the circuit boards used in the FM-30 are double-sided boards with plated through-holes. Because of the plated through-holes, solder fills the holes by capillary action. These conditions require that defective components be removed carefully to avoid damage to the board.

5-29. On all circuit boards, the adhesive securing the copper track to the board melts at almost the same temperature as solder melts. A circuit board track can be destroyed by excessive heat or lateral movement during soldering. Use of a small iron with steady pressure is required for circuit board repairs.

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

5-31. Grip each component lead, one at a time, with long nose pliers. Turn the board over and touch the soldering iron to the lead at the solder connection. When the solder begins to melt, push the lead through the back side of the board and cut off the bent outer end of the lead. Each lead may now be heated independently and pulled out of each hole. The holes may be cleared of solder by carefully re-heating with a low wattage iron and removing the residual solder with a soldering vacuum tool.

5-32. Install the new component and apply solder from the bottom side of the board. If no damage has been done to the plated-through holes, soldering of the top side is not required.

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.

OBSERVE THE MANUFACTURER'S CAUTIONARY INSTRUCTIONS.

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

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

Table 5-1. Typical Meter Indications (30 KW)

METER	SWITCH POSITION/INDICATION				
POWER OUT	VSWR 1:1	FORWARD POWER 100%			
P.A. CURRENT	4.2 A				
P.A. VOLTAGE	9300 V				
SCREEN GRID VOLTAGE	500 V				
SCREEN GRID CURRENT	0.240 A				
GRID VOLTAGE	-290 V				
GRID CURRENT	0.140 A				
FILA. VOTLAGE	10.0 V				
MODULE VOLTAGE	27.5 V				
MODULE CURRENT	7.5 A				
DRIVER	POWER 100%	VSWR 1.02:1	HYBRID 1 5%	HYBRID 2 5%	HYBRID 3 5%

Table 5-2. Typical Power Demand (30 KW)

AC Line Frequency		60 Hz	
3 Ø AC Line Voltage	230 V	229	235 V
3 Ø AC Line Current	140 A	139 A	136 A
AC Line Frequency		50 Hz	
3 Ø AC Line Voltage	380	380	380
3 Ø AC Line Current	93	91	91

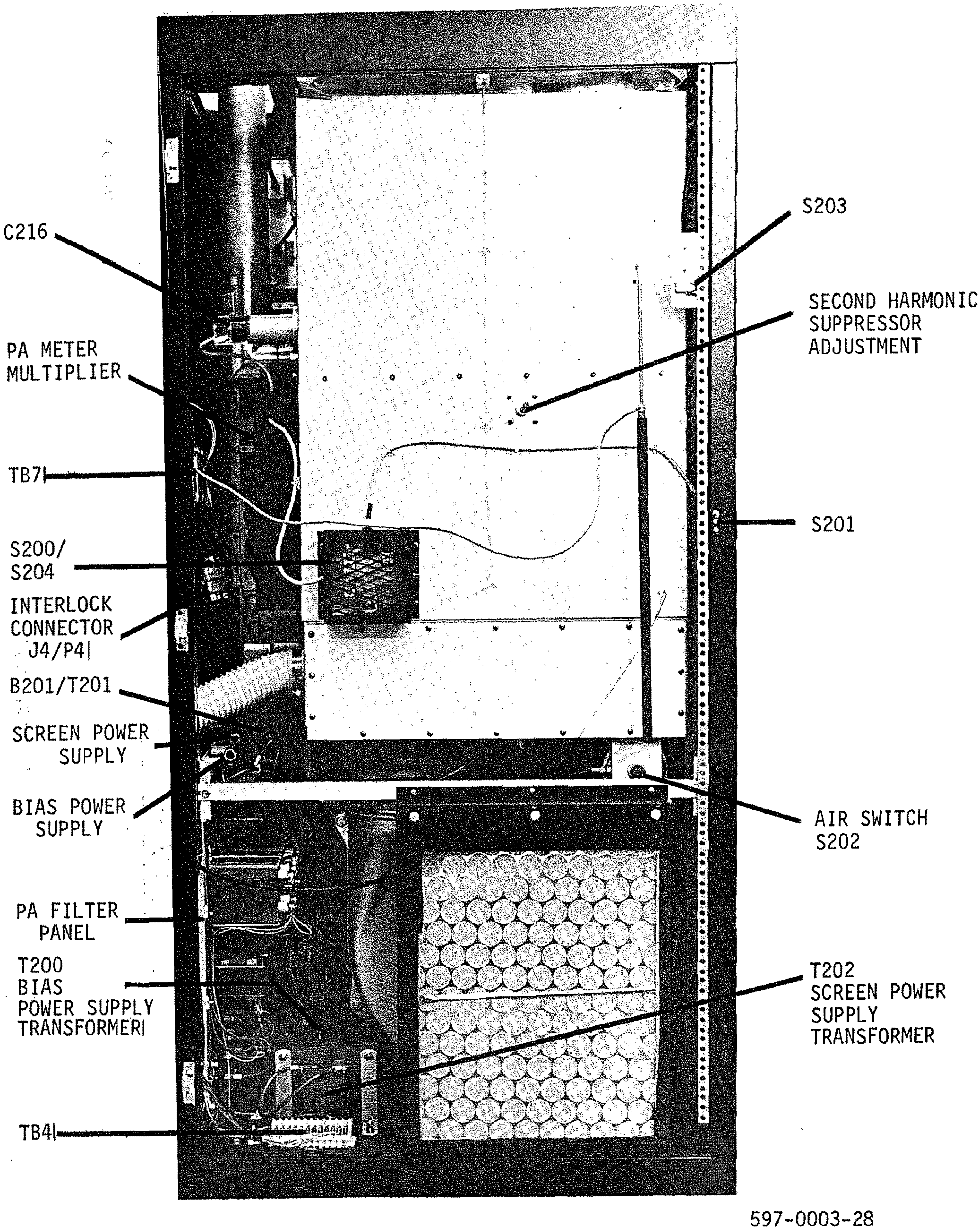


FIGURE 5-3. PA CABINET COMPONENT LOCATOR (REAR)

WARNING: DISCONNECT POWER PRIOR TO SERVICING

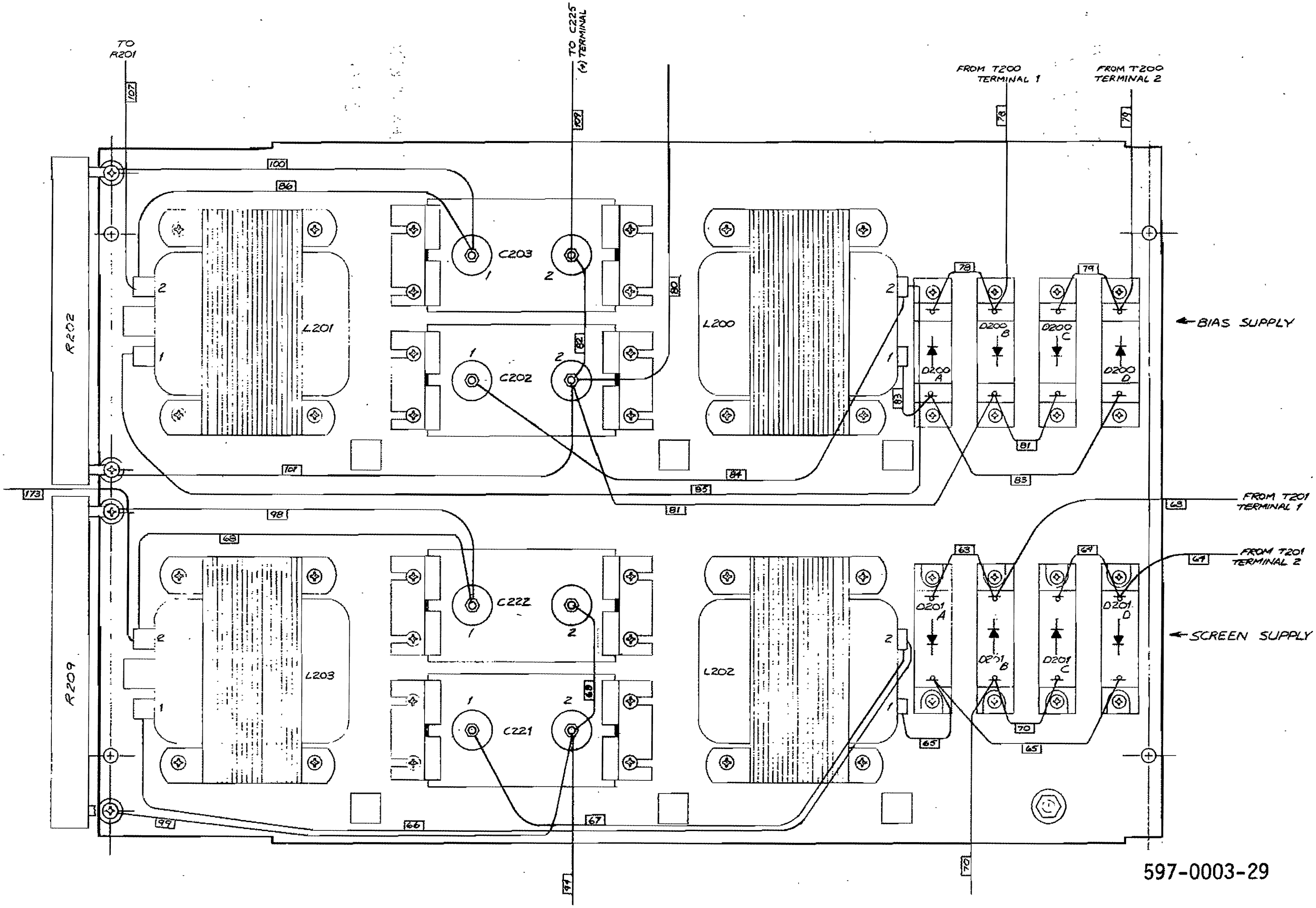
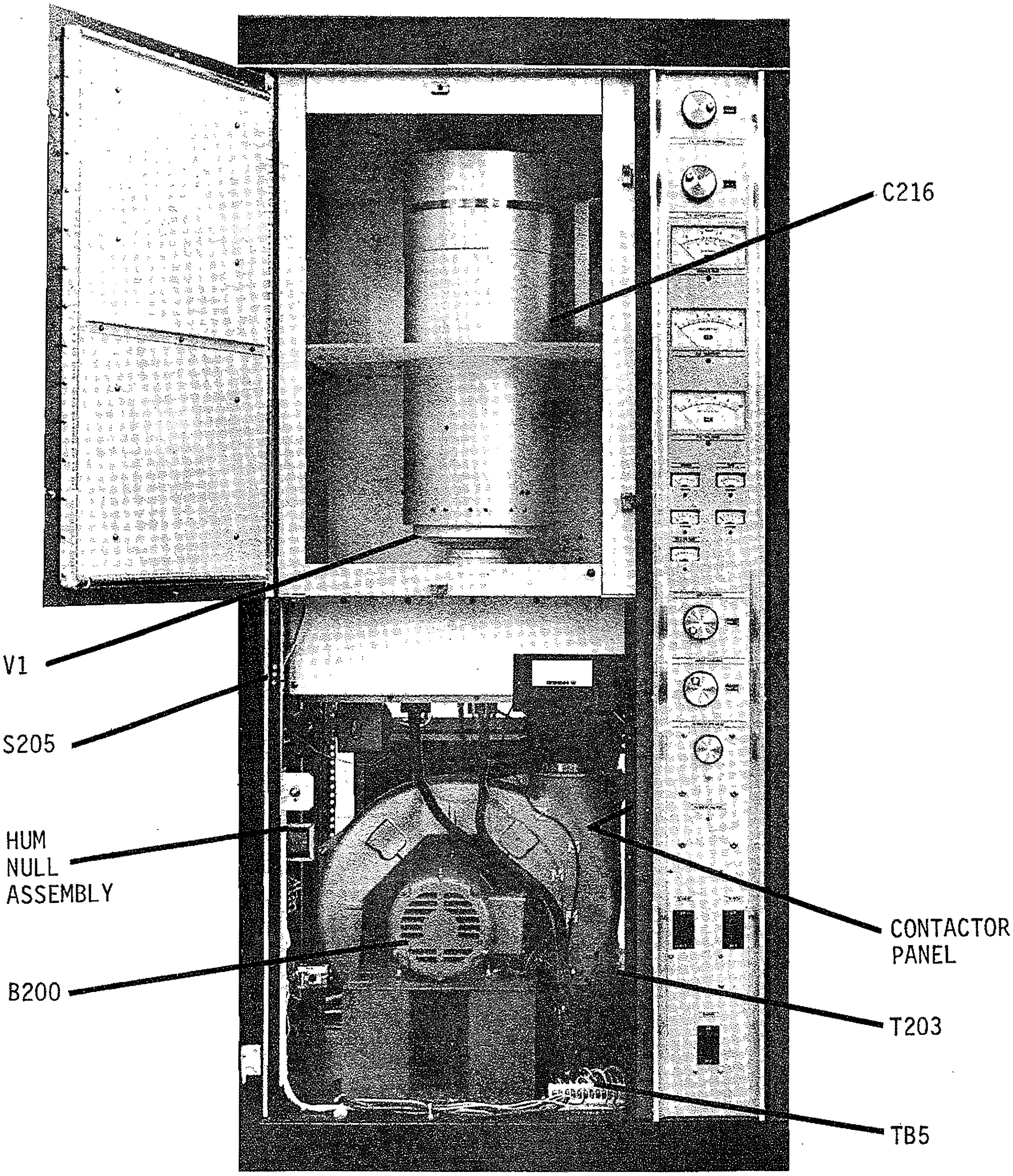
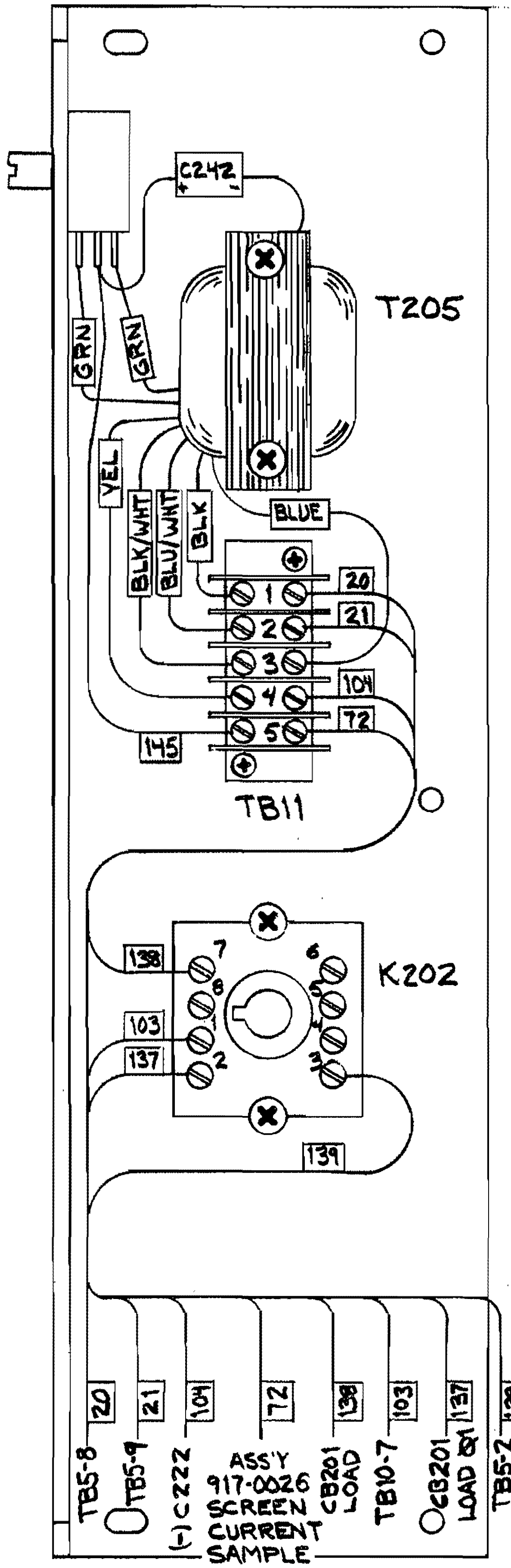


FIGURE 5-4. PA FILTER PANEL COMPONENT LOCATOR



597-0003-31

FIGURE 5-5. PA CABINET COMPONENT LOCATOR (FRONT)



597-0045

FIGURE 5-6. HUM NULL ASSEMBLY COMPONENT LOCATOR

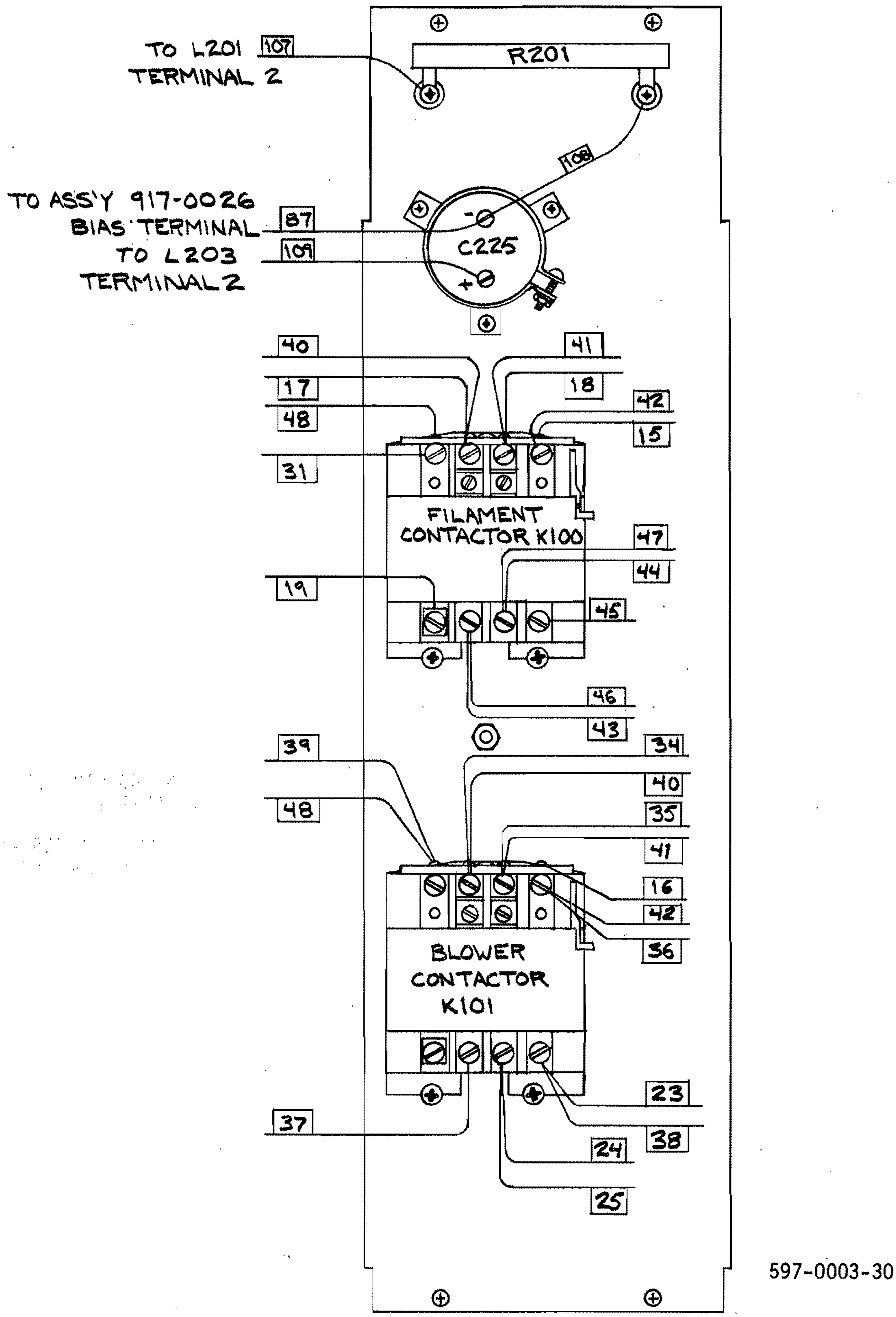


FIGURE 5-7. CONTACTOR PANEL COMPONENT LOCATOR

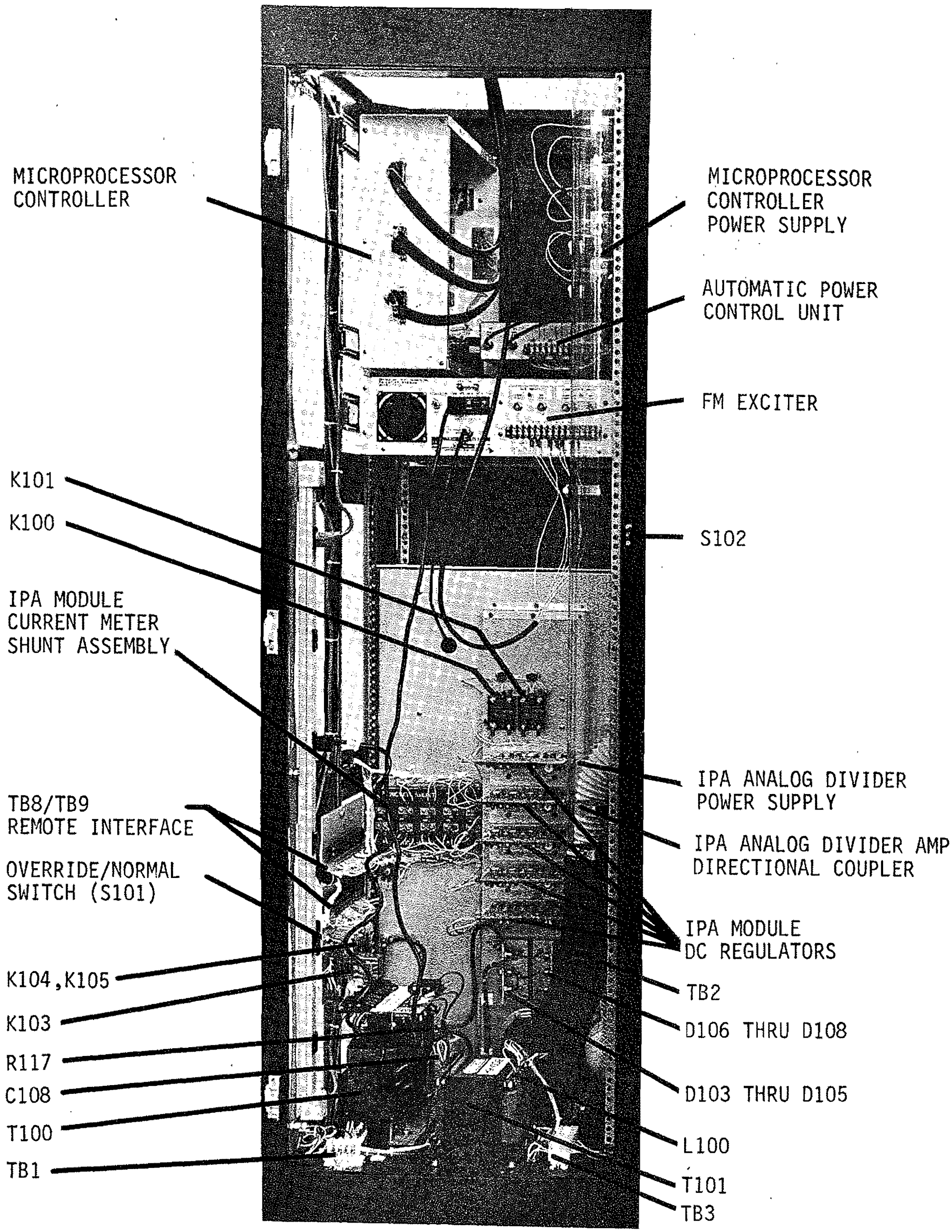


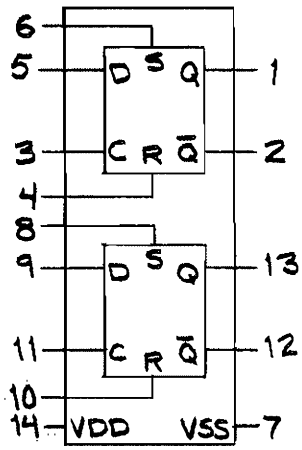
FIGURE 5-8. DRIVER CABINET COMPONENTS 597-0003-32

INTEGRATED CIRCUIT CONNECTION DIAGRAMS

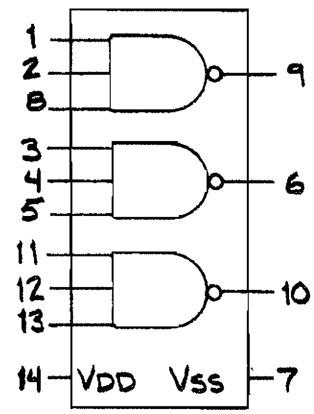
NOTE

TOP VIEW SHOWN FOR ALL DEVICES UNLESS OTHERWISE NOTED.

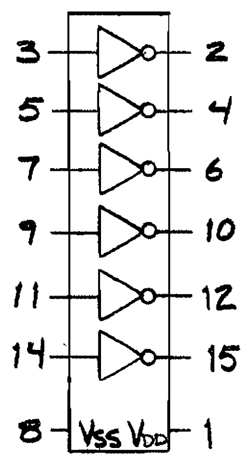
MC14013B
DUAL D
FLIP-FLOP



MC14023B
TRIPLE 3-INPUT
NAND GATE



MC14049UB
HEX-INVERTER/
BUFFER



MC14028B
BCD-TO-DECIMAL
DECODER

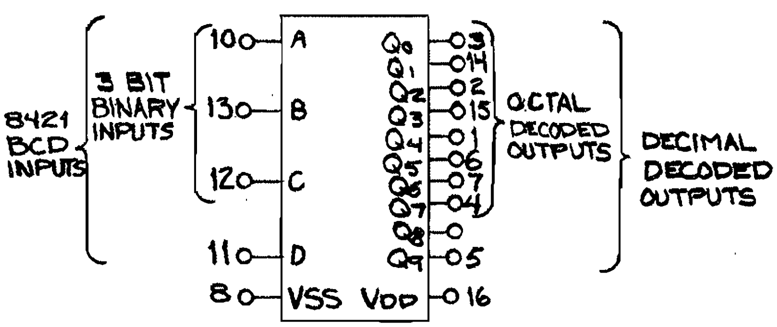
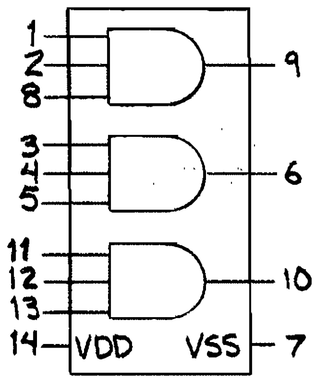


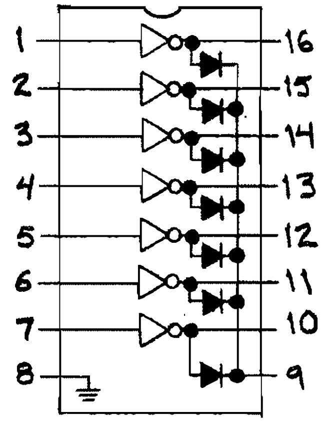
FIGURE 5-9. (Sheet 1 of 6)

597-0003-17A

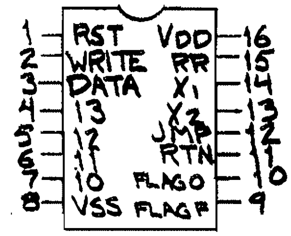
MC14073B
TRIPLE 3-INPUT
AND GATE



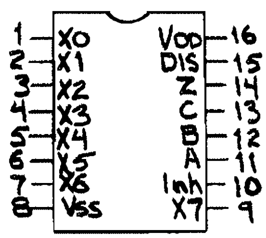
MC1413P
ULN 2003 A
7-CHANNEL
DARLINGTON DRIVER



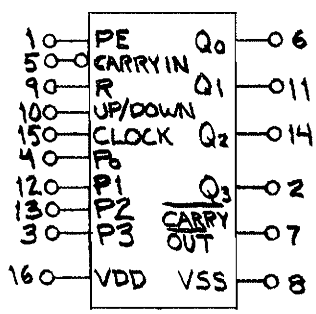
MC14500B
INDUSTRIAL
CONTROL UNIT



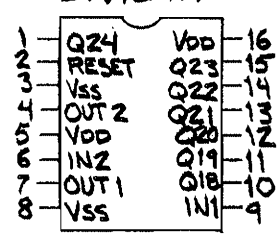
MC14512B
8-CHANNEL DATA
SELECTOR



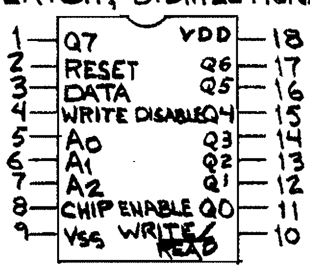
MC14516B
BINARY UP/DOWN
COUNTER



MC14521B
24-STAGE CMOS
FREQUENCY
DIVIDER



MC14599B
8-BIT ADDRESSABLE
LATCH, BIDIRECTIONAL



CD4069C
HEX INVERTER

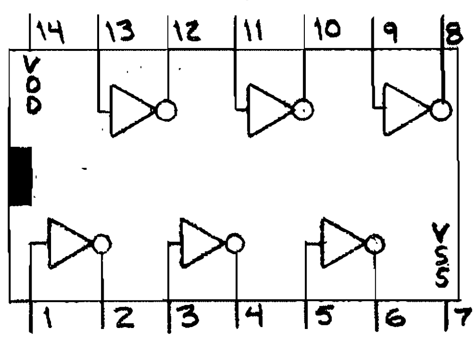
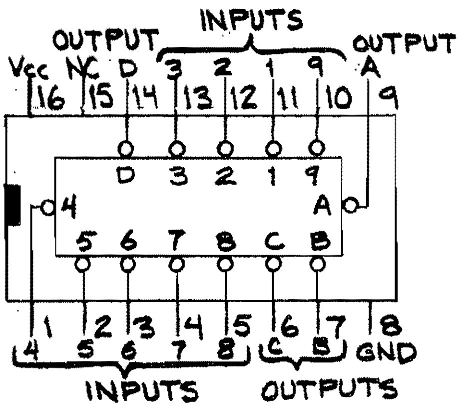


FIGURE 5-9. (Sheet 2 of 6)

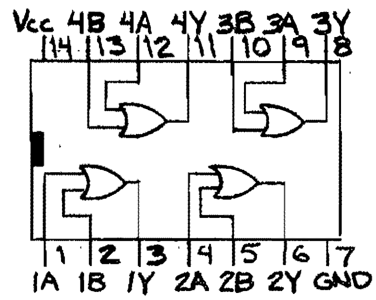
597-0003-17B

WARNING: DISCONNECT POWER PRIOR TO SERVICING

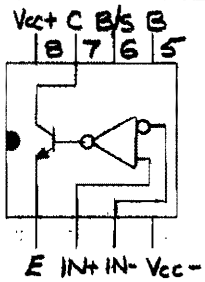
SN74147N
10-LINE-TO-4-LINE
PRIORITY ENCODER



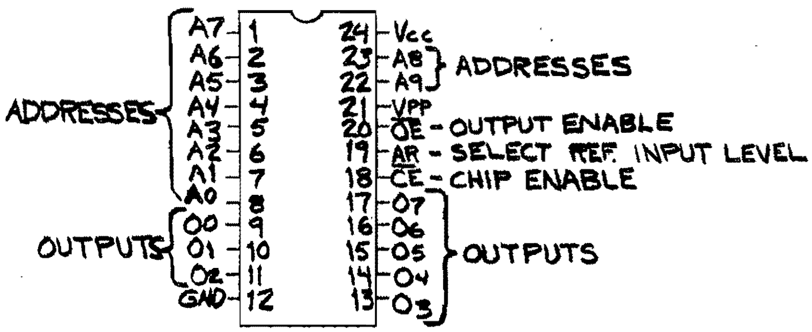
SN7432N
QUAD 2-INPUT
POSITIVE OR GATE



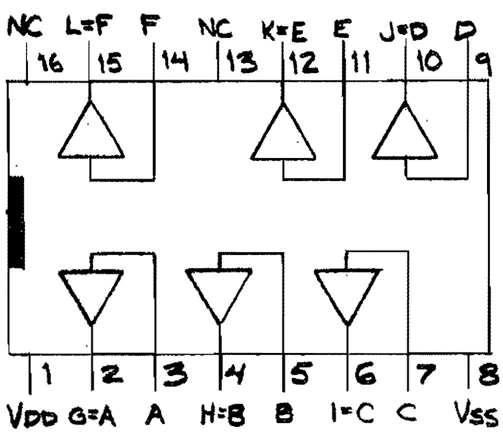
TL311P JFET INPUT
DIFFERENTAL COMPARATOR



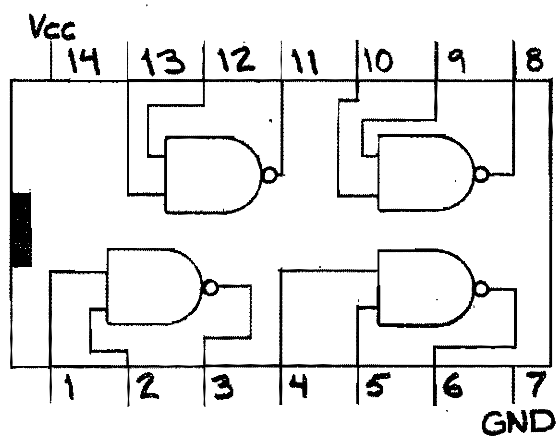
2758
UV ERASABLE 8K
READ ONLY MEMORY



CD4050 BM
HEX BUFFER



74C00N
QUAD 2 INPUT NAND GATE

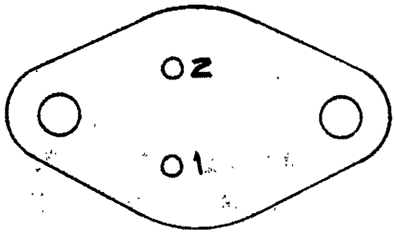


597-0003-17C

FIGURE 5-9. (Sheet 3 of 6)

WARNING: DISCONNECT POWER PRIOR TO SERVICING

2N 3054
NPN POWER TRANSISTOR

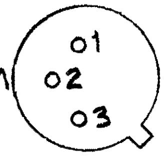


BOTTOM VIEW

1. - BASE
2.- EMITTER
CASE- COLLECTOR

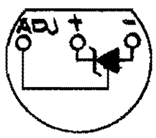
40319
PNP TRANSISTOR

BOTTOM VIEW



1.- COLLECTOR
2.- BASE
3.- EMITTER (CASE)

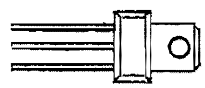
LM 3362
2.5 VOLT PRECISION
VOLTAGE REFERENCE



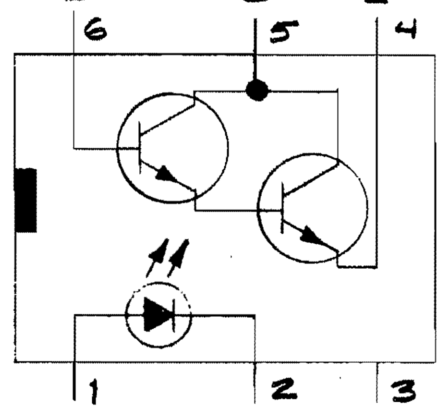
BOTTOM VIEW

MPSU05
NPN POWER TRANSISTOR

EMITTER
BASE
COLLECTOR

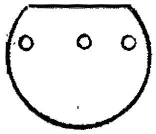


4N33
OPTICAL ISOLATOR



MPSA14 NPN DARLINGTON TRANSISTOR
2N3904 NPN TRANSISTOR
2N 3906 PNP TRANSISTOR

EMITTER
BASE
COLLECTOR



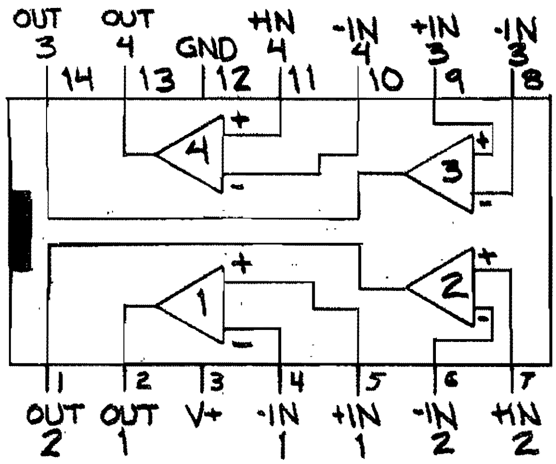
BOTTOM VIEW

597-0003-17D

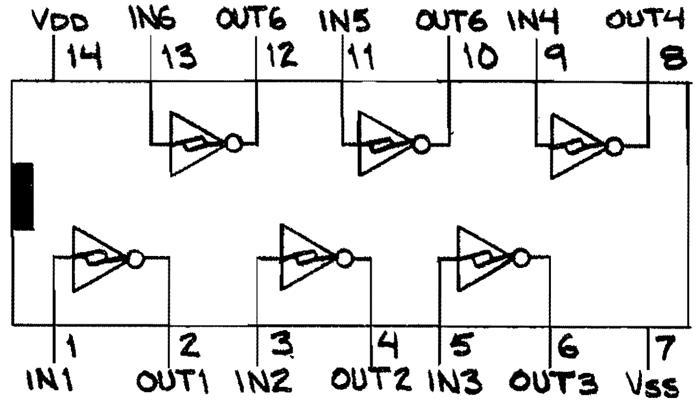
FIGURE 5-9. (Sheet 4 of 6)

WARNING: DISCONNECT POWER PRIOR TO SERVICING

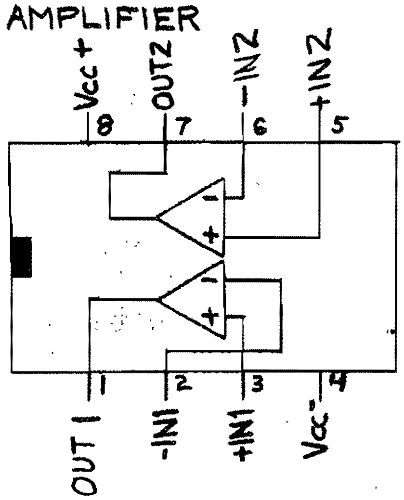
LM339AN
QUAD VOLTAGE COMPARATOR



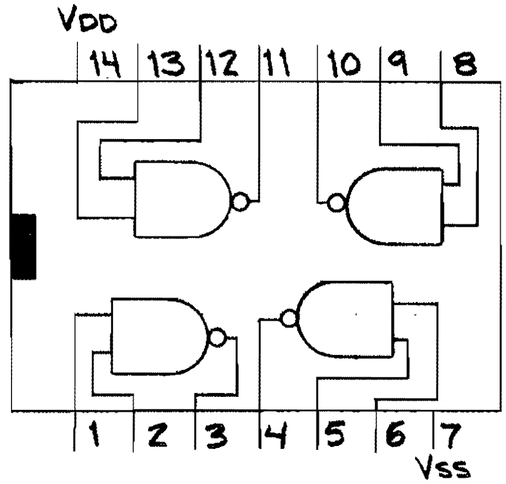
MC14584B
HEX SCHMITT TRIGGER

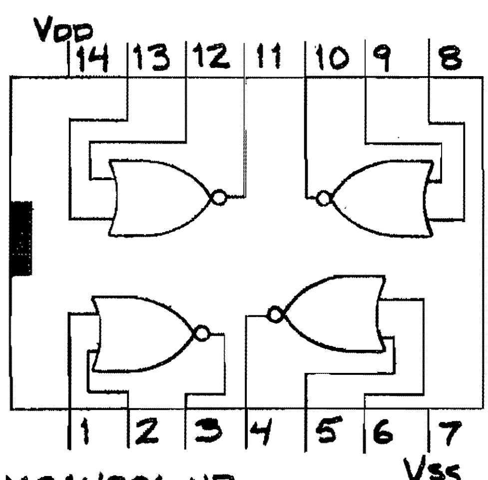


TL092CP
DUAL N CHANNEL
JFET-INPUT OPERATIONAL
AMPLIFIER



MC14011 UB
QUAD 2 INPUT NAND GATE





MC14001 UB
QUAD 2 INPUT NOR GATE

TL094C QUAD J-FET
INPUT OPERATION
AMPLIFIER

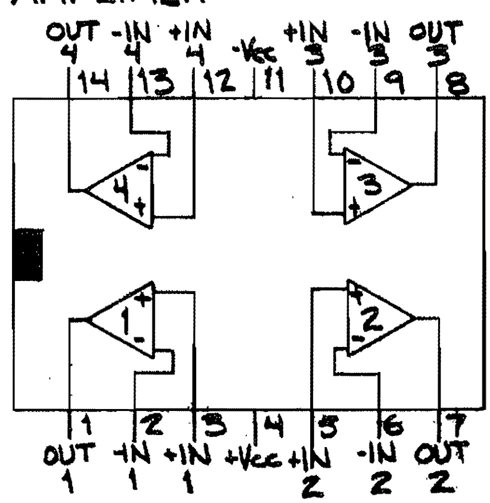
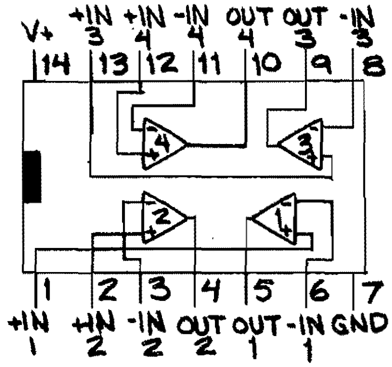


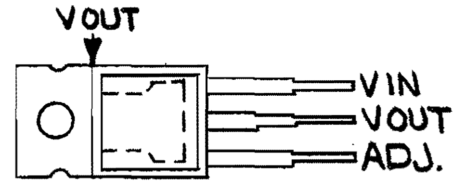
FIGURE 5-9. (Sheet 5 of 6)

WARNING: DISCONNECT POWER PRIOR TO SERVICING

LM3900
QUAD OPERATIONAL
AMPLIFIER



LM317 T
ADJUSTABLE POSITIVE
VOLTAGE REGULATOR

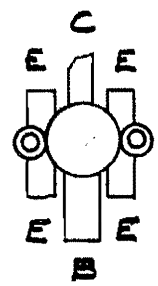


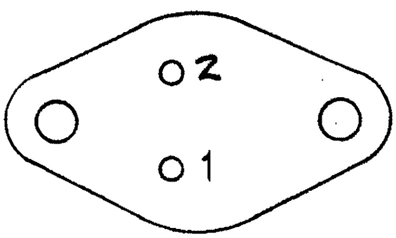
MC7824CK +24V REGULATOR
1- INPUT
2- OUTPUT
CASE- COMMON

LM317 K
ADJUSTABLE POSITIVE
VOLTAGE REGULATOR
PIN 1 - ADJUST
PIN 2 - INPUT
CASE- OUTPUT

LM 350K
ADJUSTABLE POSITIVE
VOLTAGE REGULATOR
1-ADJUST
2- INPUT
CASE- OUTPUT

BM100-28
RF OUTPUT TRANSISTOR





BOTTOM VIEW

2N3055
NPN POWER TRANSISTOR
1.- BASE
2- EMITTER
CASE- COLLECTOR

597-0003-17F

FIGURE 5-9. (Sheet 6 of 6)

WARNING: DISCONNECT POWER PRIOR TO SERVICING

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-30 FM Transmitter. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

Table 6-1. FM-30 PARTS LIST INDEX (Sheet 1 of 5)

PART NO.	TITLE	TABLE	PAGE
909-0001/-1	FM-30 TRANSMITTER	6-2	6-6
955-0043	CABLE ASSEMBLY, REMOTE HIGH VOLTAGE POWER SUPPLY INTERLOCK	6-3	6-6
909-1000	FM-30 PA CABINET	6-4	6-6
909-1001	PA CABINET SUB ASSEMBLY	6-5	6-7
950-6907	PA OUTPUT DIRECTIONAL COUPLER ASSEMBLY	6-6	6-8
950-6906	OUTPUT DIRECTIONAL COUPLER ASSEMBLY	6-7	6-8
924-0003	PA LOWER CONTROL PANEL ASSEMBLY	6-8	6-8
955-0048	VARIABLE AUTO TRANSFORMER AND MOTOR ASSEMBLY	6-9	6-9
924-0002	PA FILTER PANEL ASSEMBLY	6-10	6-9
955-0033	CAPACITOR ASSEMBLY	6-11	6-9
955-0034	CAPACITOR ASSEMBLY	6-12	6-9
924-0004	PA UPPER CONTROL ASSEMBLY	6-13	6-10
924-0005	PA METER PANEL ASSEMBLY	6-14	6-10
917-0051	FILAMENT VOLTAGE METER FILTER ASSEMBLY	6-15	6-10
924-0001	PA CONTACTOR PANEL ASSEMBLY	6-16	6-11

Table 6-1. FM-30 PARTS LIST INDEX (Sheet 2 of 5)

PART NO.	TITLE	TABLE	PAGE
959-0065	HUM NULL ASSEMBLY	6-17	6-11
939-0001	PA CABINET RF ENCLOSURE	6-18	6-11
947-0130	METER MULTIPLIER CABLE ASSEMBLY	6-19	6-12
917-0026	SCREEN AND BIAS SUPPLY METER-ING ASSEMBLY	6-20	6-12
917-0016	HIGH VOLTAGE METER MULTIPLIER ASSEMBLY	6-21	6-13
955-0015	RF ENCLOSURE CHIMNEY ASSEMBLY	6-22	6-13
955-0007	RF INPUT CIRCUIT ASSEMBLY	6-23	6-13
955-0009	OUTPUT TUNING LINE ASSEMBLY	6-24	6-13B
909-2000	FM-30 DRIVER CABINET	6-25	6-13B
947-0003,4, 5,14,15, 20,21,22	CABLE ASSEMBLY, RF DRIVER	6-26	6-14
947-0006 THRU 947-0012	CABINET ASSEMBLY, RF DRIVER	6-27	6-14
947-0013	CABLE ASSEMBLY, RF DRIVER	6-28	6-14
947-0016	CABLE ASSEMBLY, DIRECTIONAL COUPLER TO PA GRID	6-29	6-14
947-0026	CABLE ASSEMBLY, DRIVER CABINET AC POWER	6-29A	6-15
947-0030	CABLE ASSEMBLY, RF DRIVER CABINET METERING	6-30	6-16
947-0091	CABLE ASSEMBLY, MICRO-PROCESSOR POWER INPUT	6-31	6-16
924-0007	IPA ASSEMBLY	6-32	6-16
917-0004	RF AMPLIFIER MODULE, FM	6-33	6-17
955-0018	OUTPUT HYBRID NO. 1	6-34	6-17

Table 6-1. FM-30 PARTS LIST INDEX (Sheet 3 of 5)

PART NO.	TITLE	TABLE	PAGE
917-0009	DIODE DETECTOR CIRCUIT BOARD ASSEMBLY	6-35	6-18
955-0016	OUTPUT HYBRID NO. 2	6-36	6-18
955-0012	OUTPUT HYBRID NO. 3	6-37	6-18
955-0011	INPUT HYBRID ASSEMBLY	6-38	6-18
955-0003	ASSEMBLY, POWER SUPPLY, IPA ANALOG DIVIDER	6-39	6-19
917-0012	IPA ANALOG DIVIDER POWER SUPPLY ASSEMBLY	6-40	6-19
917-0021	28V REGULATOR	6-41	6-19
955-0031	METER SHUNT BOARD	6-42	6-21
955-0035	METAL OXIDE VARISTOR ASSEMBLY	6-43	6-21
924-0006	RF DRIVER CABINET CONTROL PANEL	6-44	6-21
917-0003	PROCESSOR CIRCUIT BOARD ASSEMBLY	6-45	6-22
919-0013	OUTPUT CIRCUIT BOARD ASSEMBLY	6-46	6-23
917-0006	CONTROL/TIMER CIRCUIT BOARD ASSEMBLY	6-47	6-24
919-0030	INPUT BOARD 1 CIRCUIT BOARD ASSEMBLY	6-48	6-25
919-0054	INPUT BOARD 2 CIRCUIT BOARD ASSEMBLY	6-49	6-27
919-0003	REMOTE CONTROL INTERFACE CIRCUIT BOARD ASSEMBLY	6-50	6-29
917-0020	METER CIRCUIT BOARD ASSEMBLY	6-51	6-31
917-0027	PRIMARY FUNCTION INDICATOR CIRCUIT BOARD ASSEMBLY	6-52	6-31

Table 6-1. FM-30 PARTS LIST INDEX (Sheet 4 of 5)

PART NO.	TITLE	TABLE	PAGE
917-0029	MICROPROCESSOR PATCH PANEL CIRCUIT BOARD ASSEMBLY	6-53	6-31
947-0025	MICROPROCESSOR CONTROLLER WIRING HARNESS	6-54	6-32
959-0023	AUTOMATIC POWER CONTROL ASSEMBLY	6-55	6-32
919-0031	DUAL 120 MHz LOW-PASS FILTER CIRCUIT BOARD ASSEMBLY	6-56	6-32
919-0032	POWER SUPPLY/CONTROL CIRCUIT BOARD ASSEMBLY	6-57	6-33
919-0033	ANALOG CIRCUIT BOARD ASSEMBLY	6-58	6-33
955-0037	RESISTOR AND LUGS ASSEMBLY	6-59	6-35
959-0050	IPA DIRECTIONAL COUPLER ASSEMBLY	6-60	6-36
955-0001	VSWR ASSEMBLY	6-61	6-36
951-1012	IPA DIRECTIONAL COUPLER ASSEMBLY	6-62	6-36
919-0011	BUFFER AMPLIFIER CIRCUIT BOARD	6-63	6-36
955-0020	EXCITER AC CONTROL	6-64	6-37
959-0069	MICROPROCESSOR CONTROLLER POWER SUPPLY AND BATTERY CHARGER	6-65	6-37
919-0034	MICROPROCESSOR CONTROLLER POWER SUPPLY AND BATTERY CHARGER CIRCUIT BOARD ASSEMBLY	6-66	6-38
959-0053	MICROPROCESSOR CONTROLLER BYPASS ASSEMBLY	6-67	6-39

Table 6-1. FM-30 PARTS LIST INDEX (Sheet 5 of 5)

Table 6-2. FM-30 Transmitter - 909-0001/-1-2-3

REF. DES.	DESCRIPTION	PART NO.	QTY.
V1	PA Tube, 4CX20000A/8990	243-0001	1
---	FM-30 FM Exciter (-0001 and -0001-1 configurations)	909-0002	1
---	FM-30 PA Cabinet Assembly	909-1000	1
---	FM-30 Driver Cabinet Assembly	909-2000	1
---	FM-30 High Voltage Power Supply Cabinet Assembly	909-3000	1
---	Alternate Harmonic Filter, Low-Pass, 30 kW, 88 to 108 MHz	339-0005	1
---	Transmission Line Insulator-Connector Assembly	427-0004	1
---	Adapter, Transmission Line, 3.125 inches (7.94 cm) flange to clamping ring	427-0001	1
---	Assembly, Transmission Line Coupling, 3.125 inches (7.94 cm)	427-0005	1
---	Assembly, 90° elbow, 3.125 inches (7.94 cm), modified with RF sample port	427-0016	1
---	Microprocessor readout conversion sheets	839-0004	1
---	High Voltage Cable (for -1 and -3 configurations)	610-0204	75 ft (22.86m)
---	Cable Assembly, Remote High Voltage Power Supply Interlock (for -1 and -3 configurations)	955-0043	1
---	Microprocessor Controller Bypass Assembly	959-0053	1

Table 6-3. Cable Assembly, Remote High Voltage Power Supply Interlock - 955-0043

REF. DES.	DESCRIPTION	PART NO.	QTY.
J5	Connector, 14-Pin	418-0008	1
P5	Connector, 14-Pin	417-0008	1

Table 6-4. FM-30 PA Cabinet - 909-1000 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
B200	Blower, CCW rotation, 1500 ft^3/min (42.5 m^3/min at 3450 r/min MOTOR: 230/460V, 3Ø, 60 Hz	387-5002	1
B202	HOURS Indicator, 0-99,999 Hours, 230V ac, 60 Hz	315-0002	1
C244,C245	Capacitor, Ceramic Disc, 0.01 uF, 500V	001-1044	2
----	Alternate 50 Hz Meter	315-0002-1	1
J4	Connector, 24-Pin	418-0009	1

Table 6-4. FM-30 PA Cabinet - 909-1000 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
J5	Connector, 14-Pin	418-0008	1
S201	Door Interlock Switch SPDT, 15A at 125 or 250V ac, 0.5A at 125V dc, 0.25A at 250V dc	346-3302	1
S202	Switch, Air Pressure, 1.5 to 5.0 inches Water Column (3.81 cm to 12.7 cm), 15A, 120/480V, 60 Hz Resistive, 1/8 H.P. @ 125V 60 Hz, 1/4 H.P. @ 250V 60 Hz	340-0005	1
S205	Door Interlock Switch SPDT, 15A at 125 or 250 V ac, 0.5A at 125V dc, 0.25A at 250V dc	346-3302	1
T200	Bias Transformer: PRIMARY: 208/240V ±11V, 60 Hz, 1Ø SECONDARY: 235V ac, 0.4 Amperes	376-0016	1
T202	Screen Transformer: PRIMARY: 208/240V ±11V, 60 Hz, 1Ø SECONDARY: 777V ac, 0.4 Amperes	376-0015	1
T203	Filament Transformer: PRIMARY: 208/240V, 60 Hz, 1Ø SECONDARY: 10.5V ac CT, 147 Amperes	376-0530	1
TB4,TB5	Barrier Strip, Screw Terminal	412-0724	25
TB7	Barrier Strip, 4 Terminal	412-0011	1
----	End Caps for TB4 and TB5	412-0730	2
----	PA Cabinet RF Enclosure	939-0001	1
----	Air Filter, 1 inch X 16 inches X 20 inches (2.54 cm X 40.64 cm X 50.8 cm)	407-0062	1
----	PA Cabinet Sub-Assembly	909-1001	1
----	Air Filter Grill Mounting consisting of:		
	Stud, Turn Lock	424-0008	2
	Receptacle	424-0009	2
	Stud Retainer	424-0006	2
----	Air Filter Mounting Retainer consisting of:		
	Stud, Turn Lock	424-0004	3
	Receptacle	424-0005	3
	Stud Retainer	424-0006	3

Table 6-5. PA Cabinet Subassembly - 909-1001 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	PA Output Directional Coupler Assembly	950-6907	1
----	PA Lower Control Assembly	924-0003	1
----	PA Filter Panel Assembly	924-0002	1
----	Capacitor Assembly	955-0033	1
----	Capacitor Assembly	955-0034	1
----	PA Upper Control Assembly	924-0004	1

Table 6-5. PA Cabinet Subassembly - 909-1001 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	PA Meter Panel Assembly	924-0005	1
----	PA Contactor Panel Assembly	924-0001	1
----	Hum Null Assembly	959-0065	1
----	Ground Stick Hanger Assembly	955-0038	1

Table 6-6. PA Output Directional Coupler Assembly - 950-6907

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Output Directional Coupler Assembly	950-6906	2

Table 6-7. Output Directional Coupler Assembly - 950-6906

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	BNC Connector	417-0203	1
R215	Resistor, 68 Ohm ±5%, 2W	132-6832	1

Table 6-8. PA Lower Control Panel - 924-0003

REF. DES.	DESCRIPTION	PART NO.	QTY.
CB200, CB201	Circuit Breaker, 2 Pole, 15A, 240V ac, Modified (FILAMENT and SCREEN)	341-0003-1	2
CB202	Circuit Breaker, 3 Pole, 20A, 240V ac, Modified (PRIMARY POWER)	341-0012-1	1
T204	Variable Auto Transformer, Single-Phase, 60 Hz, 0-40V, 15A, 0.6 kV A (FILAMENT VOLTAGE)	374-0001-1	1
----	Variable Auto Transformer and Motor Assembly	955-0048	1
----	Knob, Black (For INPUT TUNING and INPUT LOADING Controls)	482-0007	2
----	Knob, Black (For SCREEN VOLTAGE Control)	482-0008	1

Table 6-9. Variable Auto Transformer and Motor Assembly - 955-0048

REF. DES.	DESCRIPTION	PART NO.	QTY.
B201	Motor, Reversible, 2 RPM, 30 in/oz output Torque, 117V ac, 60 Hz, Magnetic Clutch, 5.5 vA	380-0001	1
C226	Capacitor, Mylar, 0.47 uF ±10%, 300V ac		
T201	Transformer, Variable, 240V, 0.59 kVA, 60 Hz, 2.25A output	374-0002	1
S205,S206	Micro Switch, Modified, SPDT, 125V @ 4 Amperes Inductive (Motor limit switches)	346-6100-1	2

Table 6-10. PA Filter Panel Assembly - 924-0002

REF. DES.	DESCRIPTION	PART NO.	QTY.
C202,C203, C221,C222	Capacitor, Electrolytic, oil filled, 10 uF, 2 kV	047-0002	4
D200A THRU D200D, D201A THRU D201D	Rectifier, Silicon, 4000V PIV, 2 Amperes	234-0002	8
L200 THRU L203	Choke, 10H @ 0.4 Adc dc Resistance: 92 Ohms	377-0002	4
R202	Resistor, 1 k Ohm ±5%, 100W, W/W	132-1043	1
R209	Resistor, 10 k Ohm ±5%, 100W, W/W	132-1053	1

Table 6-11. Capacitor Assembly - 955-0033

REF. DES.	DESCRIPTION	PART NO.	QTY.
C204,C205, C206,C217, C218,C223, C224	Capacitor, Disc Ceramic, 0.01 uF, 500V	001-1044	7

Table 6-12. Capacitor Assembly - 955-0034

REF. DES.	DESCRIPTION	PART NO.	QTY.
C225	Capacitor, Disc Ceramic, 0.005 uF, 500V	001-5034	1

Table 6-13. PA Upper Control Assembly - 924-0004

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Knob, Black (For PA OUTPUT TUNING and PA OUTPUT LOADING Controls)	482-0007	2

Table 6-14. PA Meter Panel Assembly - 924-0005

REF. DES.	DESCRIPTION	PART NO.	QTY.
M200	Meter, 4.5 inch (11.4 cm) Taut Band Type, FS = 200 uA dc ±2%, 208 Ohm movement (POWER OUT)	310-0004-2	1
M201	Meter, 1.5 inch (3.8 cm) Taut Band Type, FS = 1 mA ±2%, 15 Ohm movement (GRID VOLTAGE)	317-0002-1	1
M202	Meter, 1.5 inch (3.8 cm) Taut Band Type, FS = 500 mA ±2%, 15 Ohm movement (GRID CURRENT)	310-0001-1	1
M204	Meter, 1.5 inch (3.8 cm) Taut Band Type, FS = 1 mA ±2%, 15 Ohm movement (SCREEN VOLTAGE)	317-0006-1	1
M205	Meter, 1.5 inch (3.8 cm) Taut Band Type, FS = 500 mA ±2%, 15 Ohm movement (SCREEN CURRENT)	310-0001-1	1
M206	Meter, 1.5 inch (3.8 cm) Taut Band Type, FS = 15V ac ±2%, 870 Ohms/Volt sensitivity (FILAMENT VOLTAGE)	317-0003-1	1
M207	Meter, 4.5 inch (11.4 cm) Taut Band Type, FS = 1 mA ±2%, 15 Ohm movement (P.A. VOLTAGE)	317-0001-1	1
M208	Meter, 4.5 inch (11.4 cm) Taut Band Type, FS = 1V ±2%, 1000 Ohm/Volt sensitivity (P.A. CURRENT)	310-0002-1	1
----	FILAMENT VOLTAGE Meter Filter Assembly	917-0051	1

Table 6-15. FILAMENT VOLTAGE Meter Filter Assembly - 917-0051

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Polycarbonate, 0.01 uF ±5%, 50V	037-1042	2
L1	Molded Indicator, 47 uH ±10%, 700V Maximum	360-0012	1
----	Blank Circuit Board	517-0051	1

Table 6-16. PA Contactor Panel Assembly - 924-0001

REF. DES.	DESCRIPTION	PART NO.	QTY.
C225	Capacitor, Electrolytic, 300 uF, 450V	025-9086	1
K200,K201	Contactor Contacts: 3 sets SPST, 30A @ 600V Coil: 110/120V ac, 50/60 Hz	341-0006	2
R211	Resistor, 500 Ohm, 50W, W/W	132-5033	1

Table 6-17. Hum Null Assembly - 959-0065

REF. DES.	DESCRIPTION	PART NO.	QTY.
C242	Capacitor, Electrolytic, 25 uF, 100V	013-1084	1
K202	Relay, Plug-in: Coil - 240V ac Contacts - DPDT, 240V @ 5 Amperes	270-0023	1
R216	Rheostat, 50 Ohm, 25W, 0.707 Ampere	195-0149	1
T205	Transformer, Power: Primary: 230V CT, 50/60 Hz Secondary: 12.6V @ 1 Ampere	376-0232	1
TB11	Barrier Strip, 5 Terminal	412-0005-1	1
XK202	Socket, 8-Pin, Screw Terminal	417-0400	1

Table 6-18. PA Cabinet RF Enclosure - 939-0001 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C215	Capacitor, RF Feedthru, 800 pF, 3 kV	008-8024	1
C216	Capacitor, HV Feedthru, 800 pF, 30 kV (Broadcast Electronics Manufacture)	995-0049	1
C232	Capacitor plate for second harmonic suppressor	474-6440	1
L208	RF Choke, plate circuit, 26 Turns AWG 13 Nichrome wire, 0.37 inches (0.94 cm) ID, 2.75 inches (6.99 cm) long	360-0004	1
L211	High frequency strap for second harmonic suppressor	479-0053	1
----	Low frequency strap for second harmonic suppressor	479-0054	1
S200,S203	High Voltage Interlock Switch, SPDT, 11A @ 125 or 250V ac, 0.5A @ 125V dc, 0.25A @ 250V dc	346-6100	2
----	Screen and Bias Supply Metering Assembly	917-0026	1
----	High Voltage Meter Multiplier Assembly	917-0016	1
----	RF Input Circuit Assembly	955-0007	1
----	Meter Multiplier Cable Assembly	947-0130	1

Table 6-18. PA Cabinet RF Enclosure - 939-0001 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
P200	Banana Plug	418-0188	1
----	Door Fastener Stud	420-5008	4
----	Door Retainer Nut	421-0014	4
----	Door Retainer Bracket	479-6451	4
----	Door RF Gasket, Top and Bottom	469-0371	2
----	Door RF Gasket, Sides	469-0372	2
----	Transmission Line Elbow, 90°, 3.125 inches (7.94 cm)	427-0002	1
----	Transmission Line Coupling with Inner Connector, 3.125 inches (7.94 cm)	427-0005	1
----	RF Enclosure Chimney Assembly	955-0015	1
----	Output Tuning Line Assembly	955-0045	1

Table 6-19. Meter Multiplier Cable Assembly - 947-0130

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Resistor, 100 k Ohm ±5%, 2W	130-1062	1

Table 6-20. Screen and Bias Supply Metering Assembly - 917-0026

REF. DES.	DESCRIPTION	PART NO.	QTY.
C200,C201	Capacitor, Ceramic Disc, 0.001 uF, 1000V	002-1034	2
C220	Capacitor, Electrolytic, 100 uF ±10%, 20V, Dipped Tantalum	063-1083	1
R200	Resistor, 2 Meg Ohm ±5%, 1/2W	110-2073	1
R201	Resistor, 5 Ohm ±5%, 8W, W/W	132-5013	1
R203	Resistor, 0.5 Meg Ohm ±1%, 2W	140-0005	1
R206	Resistor, Copper Wire, No. 22 AWG	601-0022	0.083ft (2.53m)
R207	Resistor, 12 k Ohm ±5%, 2W	130-1253	1
R208	Resistor, 1 Meg Ohm ±1%, 2W	140-0003	1
R210	Resistor, 5 Ohm ±5%, 8W, W/W	132-5013	1
R211,R212	Resistor, 0.5 Meg Ohm ±1%, 2W	140-0005	2
----	Blank Circuit Board	517-0026	1

Table 6-21. High Voltage Meter Multiplier Assembly - 917-0016

REF. DES.	DESCRIPTION	PART NO.	QTY.
R1 THRU R10	Resistor, 1 Meg Ohm ±1%, 2W	140-0003	10
----	Blank Circuit Board	517-0016	1

Table 6-22. RF Enclosure Chimney Assembly - 955-0015

REF. DES.	DESCRIPTION	PART NO.	QTY.
J200	Banana Jack	417-0157	1
----	Plate Line Contact Fingers	469-0369-1	12

Table 6-23. RF Input Circuit Assembly - 955-0007 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C208	Capacitor, Input, Printed Circuit Board, 300 pF	917-0040	1
C209	Capacitor, Ceramic, 1000 pF ±20%, 5 kV	008-1036	1
C210	Capacitor, Ceramic, Feedthru, 800 pF ±20%, 3 kV	008-8024	1
C211	Filament Bypass Capacitor, 2.25 inch X 2.5 inch X 0.062 inch (5.715 cm X 6.35 cm X 0.158 cm), Fiberglass	467-0088	1
C212	Capacitor, Ceramic, 1000 pF ±20%, 5 kV	008-1036	1
C213	Filament Bypass Capacitor, 2.25 inch X 2.5 inch X 0.062 inch (5.715 cm X 6.35 cm X 0.158 cm), Fiberglass	467-0088	1
C215	Capacitor, Ceramic, Feedthru, 800 pF ±20%, 3 kV	008-8024	1
C227 THRU C230	Screen Bypass Capacitor, 0.005 inch (0.013 cm) Kapton	407-0953	4
C231 THRU C234, C236 THRU C241, C246	Capacitor, Ceramic, 500 pF ±20%, 5 kV	008-5024	11
J201	Receptacle, Type N, coaxial	417-0204	1
L204	Loading Coil	360-0005	1
L205	Grid Choke	360-0006	1
L212A THRU L212D	Neutralizing Slide	479-6454	4
----	Neutralizing Contact	469-0411	4
R204	Resistor, 750 Ohm ±10%, 50W, Non-Inductive	139-7532	1
R205	Resistor, 300 Ohm ±10%, 50W, Non-Inductive	139-3332	1
XU1	Socket, 8990/4CX20, Eimac SK300A, Modified	417-0007-8	1
----	Control Grid Contact Ring only for XU1	417-0007-1	1
----	Screen Grid Contact Ring only for XU1	417-0007-2	1

Table 6-23. RF Input Circuit Assembly - 955-0007 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Ceramic Post Insulator Spacer only for XU1	417-0007-9	4
----	Ceramic Sleeve Insulator Spacer only for XU1	417-0007-A	4

Table 6-24. Output Tuning Line Assembly - 955-0009

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Plate Tuning Bellows and Plate Assembly	955-0045	1

Table 6-25. FM-30 Driver Cabinet - 909-2000 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C108	Capacitor, Electrolytic, 22,000 uF, 50V	027-2200	1
J4	Connector, 24-Pin (Interlock)	417-0009	1
L100	Choke, Reactor, 0.0005 H @ 40A dc, 0.0066 Ohm	377-0001	1
S102	Door Interlock Switch, SPDT, 15A @ 125 or 250V ac, 0.5A @ 125V dc, 0.25A @ 250V dc	346-3302	1
T100	Driver Transformer: PRIMARY: 3Ø, 60 Hz, Delta connected, 208/240 ±11V SECONDARY: Wye connected, 14.8V ac, 32.6A	378-0001	1
T101	Isolation Transformer, 1000 VA PRIMARY: 115/230, Single Phase DUAL SECONDARY: 115V, 4.35A	371-0003	1
TB1,TB3	Barrier Strip, Screw Terminal	412-0724	15
----	End Caps for TB1 and TB3	412-0730	2
----	RF Driver Cabinet Control Panel	924-0006	1
----	Assembly, IPA	924-0007	1
----	Assembly, Power Supply and Battery Charger	959-0069	1
----	Assembly, Resistor and Lugs	955-0037	1
----	Exciter ac Control	955-0020	1
----	Automatic Power Control Assembly	959-0023	1
----	Assembly, IPA Directional Coupler	959-0050	1
----	Slide Rails for Microprocessor Drawer	489-0001	2
----	Cable Assembly, RF Driver	947-0003	1
----	Cable Assembly, RF Driver	947-0004	1
----	Cable Assembly, RF Driver	947-0005	1
----	Cable Assembly, RF Driver	947-0006	1
----	Cable Assembly, RF Driver	947-0007	1
----	Rack Mounting Hardware Kit for exciter	961-0003	1
----	Cable Assembly, RF Driver	947-0008	1
----	Cable Assembly, RF Driver	947-0009	1
----	Cable Assembly, RF Driver	947-0010	1
----	Cable Assembly, RF Driver	947-0011	1
----	Cable Assembly, RF Driver	947-0012	1
----	Cable Assembly, RF Driver	947-0013	1
----	Cable Assembly, RF Driver	947-0014	1
----	Cable Assembly, RF Driver	947-0015	1
----	Cable Assembly, Directional Coupler to PA Grid	947-0016	1
----	Cable Assembly, RF Driver	947-0020	1
----	Cable Assembly, RF Driver	947-0021	1

Table 6-25. FM-30 Driver Cabinet - 909-2000 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Cable Assembly, RF Driver	947-0022	1
----	Cable Assembly, RF Driver Cabinet Metering	947-0030	1
----	Cable Assembly, Microprocessor Power Input	947-0091	1
----	Cable Assembly, Driver Cabinet ac Power	947-0026	1

Table 6-26. Cable Assembly, RF Driver - 947-0003 THRU 947-0005
947-0014 THRU 947-0015
947-0020 THRU 947-0022

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	BNC Connector for RG/58 cable	917-0205	2

Table 6-27. Cable Assembly, RF Driver - 947-0006 THRU 947-0012

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	BNC Connector for RG/58 cable	417-0205	2

Table 6-28. Cable Assembly, RF Driver - 947-0013

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Type N Connector for RG/8 cable	417-0102	2
----	Adapter, BNC plug to Type N Jack, UG-349 A/U	417-0103	1
----	Adapter, Right angle Type N plug jack, UG27C/U	417-0105	1

Table 6-29. Cable Assembly, Directional Coupler to PA Grid - 947-0016

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Type N Connector for RG/8 cable	418-0102	2

Table 6-29A. Cable Assembly, Driver Cabinet ac Power - 947-0026

REF. DES.	DESCRIPTION	PART NO.	QTY.
D109,D110	Diode, 1N4005, Silicon, 1 Ampere, 600V	203-4005	2
XK104, XK105	Socket, Relay	270-0015	2

Table 6-30. Cable Assembly, RF Driver Cabinet Metering - 947-0030

REF. DES.	DESCRIPTION	PART NO.	QTY.
S100	Switch, Modified, Rotary, 1-Pole, 2-12 positions, 2.75A, 15V dc, 230 mA, 115V ac (MODULE VOLTAGE)	344-1562-1	1
S101	Switch, Modified, Rotary, 2-Pole, 2-12 positions, 2.75A, 15V dc, 230 mA, 115V ac (MODULE CURRENT)	344-1563-1	1

Table 6-31. Cable Assembly, Microprocessor Power Input - 947-0091

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	BNC Connector, RF, UG10-94/U, for RG316/U cable	417-0015	3
----	Connector, 24-Pin	417-0009	1

Table 6-32. IPA Assembly - 924-0007 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
CB100	Circuit Breaker, 3 Pole, 15 Ampere, 600V ac, modified (POWER SUPPLY circuit breaker)	341-0002-1	1
CB101 THRU CB105	Circuit Breaker, Single Pole, 10 Ampere, 28V dc (28V MODULE ( ) circuit breakers)	341-0004	5
D103 THRU D105	Diode, Silicon, S3620, 200 PIV, 70 Amperes, Stud Mount	237-0001	3
D106 THRU D108	Diode, Silicon, R3620, 200 PIV, 70 Amperes, Reverse Polarity, Stud Mount	237-0002	3
K100,K101	Relay, Solid State 120 D10, 120V ac @ 10 Amperes, 2500V Isolation, Control: 3-32V dc @ 5.0 mA	270-0002	2
M100	Meter, 2.5 inch (6.35 cm) Taut Baud Type, FS = 30V, 1000 Ohm/Volt movement (MODULE VOLTAGE meter)	317-0004	1
M101	Meter, 2.5 inch (6.35 cm) Taut Baud Type, FS = 1 mA, 150 Ohm movement (MODULE CURRENT meter)	317-0005	1
TB2	Barrier Strip, 2 Terminals	412-0002	1
----	Meter Shunt Board	955-0031	1
----	28V Regulator	917-0021	5
----	Assembly, Power Supply, IPA VSWR	955-0003	1
----	RF Amplifier Module, FM	917-0004	5
----	Input Hybrid Assembly	955-0011	1
----	Output Hybrid No. 1 Assembly	955-0018	1
----	Output Hybrid No. 2 Assembly	955-0016	1
----	Output Hybrid No. 3 Assembly	955-0012	1
----	Capacitor Tubing and Lugs Assembly	955-0033	2

Table 6-32. IPA Assembly - 924-0007 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Metal Oxide Varistor Tubing and Lugs Assembly	955-0035	3
----	Knob, Black (for MODULE VOLTAGE and MODULE CURRENT Switches)	482-0009	2
----	Diode Bracket Insulator, 0.005 inch (0.013 cm) Kapton	907-0957	1

Table 6-33. RF Amplifier Module (FM) - 917-0004

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Variable Compression, Mica, 15-115 pF, 250V	099-4006	1
C2	Capacitor, Mica, 1000 pF ±10%, 350V	046-0002	1
C3,C4	Capacitor, Mica, 80 pF ±10%, 350V	046-0003	2
C5	Capacitor, Variable Compression, Mica, 6-300 pF, 250V	099-4207	1
C6,C7	Capacitor, Mica, 1000 pF ±10%, 350V	046-0002	2
C8,C9	Capacitor, Mica, 100 pF ±10%, 350V	046-0001	2
C10,C11	Capacitor, Tantalum Dipped, 4.7 uF ±10%, 35V	064-4763	2
C12	Capacitor, Mica, 100 pF ±10%, 350V	046-0001	1
C13	Capacitor, Mica, 1000 pF ±10%, 350V	046-0002	1
C14	Capacitor, Variable Compression, Mica, 15-115 pF, 250V	099-4006	1
C15	Capacitor, Mica, 80 pF ±10%, 350V	046-0003	1
J1,J2	BNC Connector	417-0014	2
L1 THRU L4	Ferrite Choke, 50 MHz, 2.5 Turns, Single Section	364-0001	4
L5,L6	Wire, Enameled, 18 gauge, 14 Turns, 1.5 inches (3.81 cm) long, 0.375 inches (0.923 cm) ID	640-1800	2
Q1,Q2	Transistor, RF Output, Silicon, BM100-28, 100W, 175 MHz, CTC Company Case SS	213-0001	2
R1,R2	Resistor, 16 Ohm ±10%, 3W, Non-Inductive, Flashed Ends	100-1622	2
----	Blank Circuit Board	517-0004	1

Table 6-34. Output Hybrid No. 1 - 955-0018

REF. DES.	DESCRIPTION	PART NO.	QTY.
C104	Capacitor, Mica, 1 pF, 500V	042-5025	1
J9,J10,J11	BNC Connector	417-0203	3
R109	Resistor, 50 Ohm ±5%, Thin Film RF Termination, 150W, Non-Inductive	131-5027	1
----	Diode Detector Circuit Board Assembly	917-0009	1

Table 6-35. Diode Detector Assembly - 917-0009

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 0.005 uF, 50V	000-5034	1
D1	Diode, HP5082-2800, High Voltage, Schottky Barrier Type, 70V, 15 mA	201-2800	1
R1 THRU R3	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	3
----	Blank Circuit Board	517-0009	1

Table 6-36. Output Hybrid No. 2 - 955-0016

REF. DES.	DESCRIPTION	PART NO.	QTY.
C102	Capacitor, Mica, 1 pF, 500V	042-5025	1
J11A,J12, J13	BNC Connector	417-0203	3
R106	Resistor, 50 Ohm ±5%, Thin Film RF Termination, 150W, Non-Inductive	131-5027	1
----	Diode Detector Circuit Board Assembly	917-0009	1

Table 6-37. Output Hybrid No. 3 - 955-0012

REF. DES.	DESCRIPTION	PART NO.	QTY.
C100	Capacitor, Mica, 1 pF, 500V	042-5025	1
J7,J8,J12A	BNC Connector	417-0203	3
R103	Resistor, 50 Ohm ±5%, Thin Film RF Termination, 150W, Non-Inductive	131-5027	1
----	Diode Detector Circuit Board Assembly	917-0009	1

Table 6-38. Input Hybrid Assembly - 955-0011

REF. DES.	DESCRIPTION	PART NO.	QTY.
J2 THRU J6	BNC Connectors	417-0206	5
R100 THRU R102	Resistor, 50 Ohm ±5%, Thin Film RF Termination, 150W, Non-Inductive	131-5027	3

Table 6-39. Assembly, Power Supply, IPA Analog Divider - 955-0003

REF. DES.	DESCRIPTION	PART NO.	QTY.
T1	Transformer: Control/Rectifier Primary: 117V, 50/60 Hz Three Secondaries: 12V (one Center Tapped), 0.10A each	378-0002	1
----	IPA VSWR Power Supply Circuit Board Assembly	917-0012	1

Table 6-40. IPA Analog Divider Power Supply Assembly - 917-0012

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Tantalum Dipped, 33 uF, 35V	064-3373	1
C2	Capacitor, Tantalum Dipped, 100 uF, 20V	063-1083	1
D1	Bridge Rectifier, Silicon, MDA 101A, 1.0A, 100V	239-0005	1
D2 THRU D4	Diode, 1N4004, Silicon, 1.0A, 400V	203-4004	3
D5	Diode, Zener, 1N4733, 5.1V, 1W	200-4733	1
R1	Potentiometer, 2 k Ohm ±10%, 1/2W	177-2044	1
R2	Potentiometer, 500 Ohm ±10%, 1/2W	177-5032	1
R3	Resistor, 560 Ohm ±5%, 1/4W	100-5633	1
R4	Resistor, 120 Ohm ±5%, 1/4W	100-1233	1
R5	Resistor, 1.2 k Ohm ±5%, 1/2W	110-1243	1
R6	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
U1	Voltage Regulator, LM317T, Positive 3 Terminal, Adjustable, 1.2V to 37V, TO-220 Case	227-0317	1
----	Blank Circuit Board	517-0012	1

Table 6-41. 28V Regulator - 917-0021 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 0.005 uF, +80%, -20%, 50V	000-5034	1
C2,C3	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	2
C4	Capacitor, Ceramic Disc, 0.005 uF, +80%, -20%, 50V	000-5034	1
C5	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C6	Capacitor, Ceramic Disc, 0.005 uF, +80%, -20%, 50V	000-5034	1
C7	Capacitor, Electrolytic, 330 uF, 63V	015-3383	1
C8	Capacitor, Electrolytic, 100 uF, 64V	015-1084	1
C9,C10	Capacitor, Electrolytic, Tantalum Dipped, 1 uF ±10%, 35V	064-1063	2
D1 THRU D3	Diode, Silicon, 1N4148, Switching, 100V, 10 mA	203-4148	3

Table 6-41. 28V Regulator - 917-0021 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
D4	Diode, Zener, 1N4746, 18V ±10%, 1W	200-4746	1
D5	Diode, Power Rectifier, MR506, 3A, 600V	203-0506	1
L1,L2,L3	Wire, Enameled 18 gauge, 18 inches (45.72 cm) each	640-1800	3
Q1	Transistor, 40319, Silicon, PNP, TO-5 Case	211-4032	1
Q2	Transistor, 2N3054, Silicon, NPN, TO-66 Case	211-3054	1
Q3 THRU Q5	Transistor, 2N3055, Silicon, NPN, TO-3 Case	219-3055	3
R1	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	1
R2	Resistor, 30 Ohm ±5%, 1W	120-3023	1
R3	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	1
R4	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R5	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R6	Resistor, 36 k Ohm ±5%, 1/4W	100-3653	1
R7	Resistor, 68 k Ohm ±5%, 1/4W	100-6853	1
R8	Potentiometer, 1 k Ohm ±10%, 1/2W	178-1044	1
R9	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R10,R11	Resistor, 9.1 k Ohm ±5%, 1/4W	100-9143	2
R12	Resistor, 1 k Ohm ±5%, 2W	130-1043	1
R13	Potentiometer, 1 k Ohm ±10%, 1/2W	178-1044	1
R14	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R15	Potentiometer, 10 k Ohm ±10%, 1/2W	178-1054	1
R16	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R17	Resistor, 180 Ohm ±5%, 1/4W	100-1833	1
R18	Resistor, 2.7 k Ohm ±5%, 1/2W	110-2743	1
R19,R20	Resistor, 25 Ohm ±5%, 5W, W/W	132-2523	2
R21 THRU R23	Resistor, 0.2 Ohm ±5%, 5W, W/W	132-2003	3
U1	Integrated Circuit, Quad-Operational Amplifier LM3900, 14-Pin Dip	221-3900	1
U2	Integrated Circuit, LM350K, Adjustable Positive Voltage Regulator, 1.2 to 33V, 3 Ampere, TO-3 Case	227-0350	1
XQ2	Socket, TO-66	417-0012	1
XQ3 THRU XQ5	Socket, TO-3	417-0298	3
XU1	Socket, Integrated Circuit, 14-Pin	417-1400	1
XU2	Socket, TO-3	417-0298	1
----	Insulator TO-3 Case (for U1, Q3 thru Q5)	418-0010	4
----	Insulator TO-66 Case (for Q2)	407-0100	1
----	Transmitter Mounting Pad, TO-5 (for Q1)	409-0005	1
----	Blank Circuit Board	517-0021	1

Table 6-42. Meter Shunt Board - 955-0031

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Meter, Shunt, 0-50 mV	316-0003	5
----	Blank Meter Shunt Circuit Board	467-0034	1

Table 6-43. Metal Oxide Varistor Assembly - 955-0035

REF. DES.	DESCRIPTION	PART NO.	QTY.
MOV100, MOV101	Metal Oxide Varistor, V130LA10A, 130V ac RMS, 10 Joules	140-0006	2

Table 6-44. RF Driver Cabinet Control Panel - 924-0006 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C3	Capacitor, Electrolytic, 100 uF +10%, +50%, 25V	013-1084	1
DS1,DS3, DS5	Lamp, No. 327, 28V, 40 mA	321-0327	3
J1 THRU J3	Connector, 25-Pin	418-3219	3
M1	Meter, 3.5 inches (8.89 cm), Taut Baud Type, FS= 200 uA dc, 208 Ohm movement (DRIVER meter)	310-0003-2	1
S1 THRU S5	Switch, Push, SPST, N. O. contacts, 10A, 125/ 250V ac	343-0003	5
S6	Switch, Modified, Rotary, 1-Pole, 1 Section, 6 Position, 1.5A @ 28V dc, 230 mA @ 115V ac, Resistive Load (DRIVER switch)	344-1564-1	1
S7	Switch, Miniature, Push, SPST, Normally Open, 1/2A @ 125V ac (RESET switch)	340-0043	1
TB1,TB2	Barrier Strip, 3 Terminal	412-0003	2
----	Knob, Black with clear skirt (for DRIVER switch)	344-1564	1
----	Processor Circuit Board Assembly	917-0003	1
----	Output Circuit Board Assembly	919-0013	1
----	Control/Timer Circuit Board Assembly	917-0006	1
----	Input Board 1 Circuit Board Assembly	919-0030	1
----	Remote Control Interface Circuit Board Assembly	919-0003	1
----	Input Board 2 Circuit Board Assembly	919-0054	1
----	Meter Circuit Board Assembly	917-0020	1
----	Primary Function Indicator Circuit Board Assembly	917-0027	1
----	Patch Panel Circuit Board Assembly	917-0029	1
----	Decoder/Driver/Dual Seven Segment Solid State Display	323-0001	1

Table 6-44. RF Driver Cabinet Control Panel - 924-0006 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Lens, Yellow (for OVERLOAD switch)	343-0004	1
----	Lens, Green (for HIGH VOLTAGE ON and FILAMENT ON switches)	343-0006	2
----	Lens, Red (for HIGH VOLTAGE OFF and FILAMENT OFF switches)	343-0007	2
----	Microprocessor Controller Wiring Harness	947-0025	1

Table 6-45. Processor Circuit Board Assembly - 917-0003

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 0.001 uF, 1000V	002-1034	1
C2	Capacitor, Mica, 120 pF, 500V	042-1222	1
C3	Capacitor, Electrolytic, 10 uF, 16V	013-1074	1
C4	Capacitor, Ceramic Disc, 0.01 uF, 500V	001-1044	1
D1 THRU D10	Diode, Silicon, 1N4148, 75V @ 0.3 Ampere, Fast Switching	203-4148	10
J1	Connector, 12-Pin	417-1276	1
J2	Connector, 4-Pin	418-0255	1
J3	Connector, 12-Pin	417-1276	1
L1	Inductor, 0.68 uH ±10%, 700V maximum	364-0068	1
R1,R2	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R3	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R4	Resistor, 470 k Ohm ±5%, 1/4W	100-4763	1
U1	Integrated Circuit, CMOS, MC14013B, Dual D Flip-Flop, 14-Pin DIP	228-4013	1
U2	Integrated Circuit, 2758, UV Erasable 8K Read Only Memory, TTL compatable, 24-Pin DIP (programmed EPROM labeled TN2176)	228-2758-1	1
U3	Integrated Circuit, CMOS, MC14028B, BCD-to-Decimal Decoder, 16-Pin DIP	228-4028	1
U4	Integrated Circuit, CMOS, MC14049UB, Hex-inverter/Buffer, 16-Pin DIP	228-4049	1
U5	Integrated Circuit, TTL, SN7432N, Quad 2-Input Positive OR Gate, Logic, 14-Pin DIP	228-7432	1
U6	Integrated Circuit, CMOS, MC14500B, Industrial Control Unit, 16-Pin DIP	228-4500	1
U7,U8	Integrated Circuit, CMOS, MC14516B, Binary UP/DOWN Counter, 16-Pin DIP	228-4516	2
XU1	Socket, 14-Pin	417-1400	1
XU2	Socket, 24-Pin	417-2400	1
XU3,XU4	Socket, 16-Pin	417-1601	2
XU5	Socket, 14-Pin	417-1400	1
XU6 THRU XU8	Socket, 16-Pin	417-1601	3
----	Blank Circuit Board	517-0003	1

Table 6-46. Output Circuit Board Assembly - 919-0013

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
C4,C5	Capacitor, Ceramic Disc, 0.1 uF, 10V	000-1055	2
C6 THRU C8	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
C9,C10	Capacitor, Ceramic Disc, 0.1 uF, 10V	000-1055	2
C11 THRU C20	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	10
D1	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	1
D2	Diode, Silicon, 1N4005, 600V @ 1 Ampere	203-4005	1
J1 THRU J3	Connector, 12-Pin	417-1276	3
L1 THRU L7	Molded Inductor, 2.2 uH ±10%, Resistance: 0.19 Ohm, 1.1 Ampere Maximum	364-2200	7
Q1 THRU Q5	Transistor, Silicon, 2N3904, NPN, TO-92 Case	211-3904	5
Q6 THRU Q10	Transistor, Silicon, MPSA56, PNP, TO-92 Case	210-0056	5
Q11	Transistor, Silicon, 2N3904, NPN, TO-92 Case	211-3904	1
Q12	Transistor, Silicon, MPSA56, PNP, TO-92 Case	210-0056	1
R1 THRU R10	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	10
R11 THRU R24	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	14
R25 THRU R28	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	4
R29 THRU R32	Resistor, 150 Ohm ±5%, 1/4W	100-1533	4
R33	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R34	Resistor, 470 Ohm ±5%, 2W	130-4733	1
U1	Integrated Circuit, CMOS, MC14073B, Tripple 3-Input AND Gate, 14-Pin DIP	228-4073	1
U2,U3	Integrated Circuit, CMOS, MC14599B, 8-bit Addressable latch, Bidirectional Data Port, 18-Pin DIP	228-4599	2
U4	Integrated Circuit, 2758, UV Erasable 8K Read Only Memory, TTL compatable, 24-Pin DIP (Programmed EPROM labeled XMTR-3)	228-2758-2	1
XU1	Socket, 14-Pin	417-1400	1
XU2,XU3	Socket, 18-Pin	417-1804	2
XU4	Socket, 24-Pin	417-2400	1

Table 6-47. Control/Timer Circuit Board Assembly - 917-0006 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Mica, 100 pF, 50V	040-1022	3
C4,C5	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C6 THRU C10	Capacitor, Electrolytic, 10 uF, 35V	023-1076	5
C11 THRU C16	Capacitor, Ceramic Disc, 0.1 uF, 10V	000-1055	5
C17	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C18 THRU C20	Capacitor, Ceramic Disc, 0.1 uF, 10V	000-1055	3
D1 THRU D4	Diode, Silicon, 1N4148, 75V @ 0.3 Ampere Fast Switching	203-4148	4
D5	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	1
J1	Connector, 12-Pin	417-1276	1
J2	Connector, 4-Pin	418-0255	1
J3	Connector, 12-Pin	417-1276	1
L1	Molded Inductor, 2.2 uH ±10%, Resistance: 0.19 Ohm, 1.1 Ampere Maximum	364-2200	1
R1	Resistor, 180 k Ohm ±5%, 1/4W	100-1863	1
R2	Resistor, 91 k Ohm ±5%, 1/4W	100-9153	1
R3	Resistor, 68 Ohm ±5%, 1/2W	110-6823	1
R4	Resistor, 180 k Ohm ±5%, 1/4W	100-1863	1
R5	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	1
R6,R7	Resistor, 68 Ohm ±5%, 1/2W	110-6823	2
R8	Resistor, 180 k Ohm ±5%, 1/4W	100-1863	1
R9	Resistor, 91 k Ohm ±5%, 1/4W	100-9153	1
R10 THRU R12	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	3
R13,R14	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R15,R16	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R17	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R18	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R19	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R20 THRU R22	Resistor, 1.5 k Ohm ±5%, 1/2W	110-1543	3
R23,R24	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
U1 THRU U3	Integrated Circuit, CMOS, MC14521B, 24-Stage CMOS Frequency Divider, 16-Pin DIP	228-4521	3
U4	Integrated Circuit, CMOS, MC14599B, 8-bit Addressable latch, Bidirectional Data Port, 18-Pin DIP	228-4599	1
U5	Integrated Circuit, CMOS, MC14512B, 8 Channel Data Selector, 16-Pin DIP	228-4512	1
U6	Integrated Circuit, CMOS, MC14049UB, Hex Inverter, 14-Pin DIP	228-4070	1
U7,U8	Integrated Circuit, CMOS, 74COON, Quad 2-Input NAND Gate, 14-Pin DIP	221-7400	2
U9	Integrated Circuit, ULN2003A, 7-Channel Driver, CMOS/TTL Compatable, 16-Pin DIP	229-2003	1

Table 6-47. Control/Timer Circuit Board Assembly - 917-0006 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U10	Integrated Circuit, CMOS, MC14023B, Triple 3-Input NAND Gate, 14-Pin DIP	228-4023	1
XU1 THRU XU3	Socket, 16-Pin	417-1601	3
XU4	Socket, 18-Pin	417-1804	1
XU5	Socket, 16-Pin	417-1601	1
XU6 THRU XU8	Socket, 14-Pin	417-1400	3
XU9	Socket, 16-Pin	417-1601	1
XU10	Socket, 14-Pin	417-1400	1
----	Blank Circuit Board	517-0006	1

Table 6-48. Input Board 1 Circuit Board Assembly - 919-0030 (Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C2 THRU C9	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	8
C10,C11	Capacitor, Electrolytic, 100 uF, 25V	023-1084	2
C12 THRU C18	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	7
C19,C20	Capacitor, Electrolytic, 10 uF, 16V	023-1074	2
D1 THRU D3 D5 THRU D8	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	7
D9	Diode, Silicon, 1N4004, 400V @ 1 Ampere	203-4004	1
D10 THRU D15	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	6
D16	Diode, Silicon, 1N4148, 75V @ 0.3 Ampere, Fast Switching	203-4148	1
J1 THRU J3	Connector, 12-Pin	417-1276	3
R1 THRU R7	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	7
R8	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	1
R9	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R12,R13	Potentiometer, 1 k Ohm ±10%, 1/2W	177-2044	2
R14	Resistor, 27 k Ohm ±5%, 1/4W	100-2753	1
R15	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
R16	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R17	Resistor, 22 Ohm ±5%, 1/4W	100-2223	1
R18	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R19	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R20	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R21	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
R22	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R23	Resistor, 220 Ohm ±5%, 1/4W	100-2233	1
R24	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R25	Resistor, 510 Ohm ±5%, 1/4W	100-7533	1

Table 6-48. Input Board 1 Circuit Board Assembly - 919-0030 (Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R26	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R27	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
R28	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R29	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R30	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R31	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R32	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R33	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R34	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R35	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R36	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R37	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R38	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R39	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R40	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R41	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R42	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R43	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R44	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R45 THRU R51	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	7
R52 THRU R64	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	13
R65	Potentiometer, 500 Ohm ±10%, 1/2W	177-5032	1
R66	Resistor, 12 k Ohm ±5%, 1/4W	100-1253	1
R67	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R68	Resistor, 2.7 k Ohm ±5%, 1/4W	100-2743	1
R69	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R70	Resistor, 620 Ohm ±5%, 1/4W	100-6233	1
R71	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R72	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
R73	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R74	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
R75	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R76	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
R77	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R78	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R79	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R80	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R81	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R82	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R83	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R84	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R85	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R86	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R87	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R88	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R89	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1

Table 6-48. Input Board 1 Circuit Board Assembly - 919-0030 (Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R90	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R91 THRU R96	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	6
R97 THRU R102	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	6
R103	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R104 THRU R107	Resistor, 18 k Ohm ±5%, 1/4W	100-1853	4
R108	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R109	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R110	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
U1 THRU U4	Integrated Circuit, LM339AN, Quad Voltage Comparator, 14-Pin DIP	221-0339	4
U5	Integrated Circuit, MC14049UB, CMOS, Inverting Hex Buffer, 16-Pin DIP	228-4049	1
U6	Integrated Circuit, SN74147N, 10 line-to-4 line priority Encoder, 16-Pin DIP	228-4147	1
U7,U8	Integrated Circuit, CMOS, MC14013B, Dual-D Flip-Flop, 14-Pin DIP	228-4013	2
U9	Integrated Circuit, CMOS, MC14512B, 8 Channel Data Selector, 16-Pin DIP	228-4512	1
U10	Integrated Circuit, CMOS, MC14023B, 3-Input NAND Gate, 14-Pin DIP	228-4023	1
XU1 THRU XU4	Socket, 14-Pin	417-1404	4
XU5,XU6	Socket, 16-Pin	417-1604	2
XU7,XU8	Socket, 14-Pin	417-1404	2
XU9	Socket, 16-Pin	417-1604	1
XU10	Socket, 14-Pin	417-1404	1
----	Blank Circuit Board	519-0030	1

Table 6-49. Input Board 2 Circuit Board Assembly - 919-0054 (Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C2 THRU C15	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	14
D1 THRU D7	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	7
D8	Diode, Silicon, 1N4004, 400V @ 1 Ampere	203-4004	1
D9 THRU D14	Diode, Zener, 1N4733A, 5.1V ±5%, 1W	200-4733	6
D15	Diode, Silicon, 1N4148, 75V @ 0.3 Ampere Fast Switching	203-4148	1
J1 THRU J3	Connector, 12-Pin	417-1276	3

Table 6-49. Input Board 2 Circuit Board Assembly - 919-0054 (Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
J4,J5	Connector, 3-Pin	417-0003	2
J6	Connector, 12-Pin	417-0412	1
J7	Connector, 18-Pin	417-1800	1
L1	Molded Inductor, 2.2 uH ±10%, Resistance: 0.19 Ohm, 1.1 Ampere Maximum	364-2200	1
R1 THRU R7	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	7
R8	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R9 THRU R11	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R12,R13	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	2
R14	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R15	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R16	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R17	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R18	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	1
R19	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R20	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	1
R21	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R22	Resistor, 1.2 k Ohm ±5, 1/4W	100-1243	1
R23 THRU R27	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	5
R28 THRU R34	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	7
R35 THRU R41	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	7
R42 THRU R48	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	7
R49 THRU R61	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	13
R62	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R63	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R64 THRU R66	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R68	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
R69	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R70	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R71	Resistor, 1.5 k Ohm ±5%, 1/4W	100-1543	1
R72,R73	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R74	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R75	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R76	Resistor, 2.2 k Ohm ±5%, 1/4W	100-2243	1
R77,R78	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R79	Resistor, 43 Ohm ±5%, 1/4W	100-4323	1
R80,R81	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R82 THRU R87	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	6
R88 THRU R93	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	6
R94 THRU R99	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	6

Table 6-49. Input Board 2 Circuit Board Assembly - 919-0054 (Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R100 THRU R105	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	6
R106	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R107 THRU R110	Resistor, 18 k Ohm ±5%, 1/4W	100-1853	4
R111,R112	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
U1 THRU U4	Integrated Circuit, LM339AN, Quad Voltage Comparator, 14-Pin DIP	221-0339	4
U5,U6	Integrated Circuit, CMOS, MC14049UB, Inverting Hex Buffer, 16-Pin DIP	228-4049	2
U7	Integrated Circuit, SN74147N, 10 line-to-4 line priority Encoder, 16-Pin DIP	228-4147	1
U8	Integrated Circuit, CMOS, MC14013B, Dual-D Flip-Flop, 14-Pin DIP	228-4013	1
U9	Integrated Circuit, CMOS, MC14512, 8 Channel Data Selector, 16-Pin DIP	228-4512	1
U10	Integrated Circuit, CMOS, MC14023B, 3-Input NAND Gate, 14-Pin DIP	228-4023	1
W12 THRU W22	Programmable Jumper	340-0004	11
XU1 THRU XU4	Socket, 14-Pin	417-1404	4
XU5 THRU XU7	Socket, 16-Pin	417-1604	3
XU8	Socket, 14-Pin	417-1404	1
XU9	Socket, 16-Pin	417-1604	1
XU10	Socket, 14-Pin	417-1404	1
----	Blank Circuit Board	519-0054	1

Table 6-50. Remote Control Interface Circuit Board Assembly - 919-0003 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C6	Capacitor, Electrolytic, 10 uF, 16V	023-1074	6
C7	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C8 THRU C22	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	15
C23	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
D2 THRU D7	Diode, Silicon, 1N4005, 600V @ 1 Ampere	203-4005	6
D8	Diode, Zener, 1N4742A, 12V ±5%, 1W	200-4742	1
J1 THRU J5	Connector, 12-Pin	417-1276	5
L1 THRU L3	Molded Inductor, 47 uH ±10%, 700V Maximum	360-0012	3
R4,R5	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R6	Resistor, 27 k Ohm ±5%, 1/4W	100-2753	1
R7 THRU R13	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	7
R14	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1

Table 6-50. Remote Control Interface Circuit Board Assembly - 919-0003 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R16	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R17	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R18	Potentiometer, 20 k Ohm ±10%, 1/2W	177-2054	1
R19 THRU R26	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	8
R27	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R28	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R29	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R30	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R31	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	1
R32 THRU R34	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R35,R36	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	2
R37 THRU R39	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	3
R40	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
R41,R42	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	2
R43 THRU R46	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	4
R47	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	1
R48 THRU R52	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	5
R53 THRU R59	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	7
R60 THRU R62	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R63 THRU R73	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	11
U1	Integrated Circuit, TL094C, Quad JFET-Input Operational Amplifier, 14-Pin DIP	221-0094	1
U2 THRU U7	Integrated Circuit, 4N33, Optical Isolator, Infared LED-Photo, NPN, Darlington Transistor Coupled Pair, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	6
U8	Integrated Circuit, CD4050BM, CMOS, Hex Buffer, 16-Pin DIP	228-4050	1
U9	Integrated Circuit, CD4069C, CMOS, Hex Inverter, 14-Pin DIP	228-4069	1
U10	Integrated Circuit, CD4050BM, CMOS, Hex Buffer, 16-Pin DIP	228-4050	1
XU1	Socket, 14-Pin	417-1400	1
XU8	Socket, 16-Pin	417-1604	1
XU9	Socket, 14-Pin	417-1400	1
XU10	Socket, 16-Pin	417-1604	1
----	Blank Circuit Board	519-0003	1

Table 6-51. Meter Circuit Board Assembly - 917-0020

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 0.01 uF, 500V	001-1044	1
R1	Potentiometer, 50 k Ohm ±10%, 1/2W	178-5054	1
R2	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R3	Potentiometer, 2 k Ohm ±10%, 1/2W	178-2044	1
R4	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R5	Potentiometer, 2 k Ohm ±10%, 1/2W	178-2044	1
R6	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R7	Potentiometer, 2 k Ohm ±10%, 1/2W	178-2044	1
R8	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
----	Blank Circuit Board	517-0020	1

Table 6-52. Primary Function Indicator Circuit Board Assembly - 917-0027

REF. DES.	DESCRIPTION	PART NO.	QTY.
D1,D2	Indicator, LED, Yellow, 521-9176, 2.3V @ 30 mA Maximum (Interlock/BLOWER Indicators)	323-9225	2
D3	Indicator, LED, Green, 521-9175, 2.3V @ 40 mA Maximum (FILAMENT Indicator)	323-9224	1
D4	Indicator, LED, Red, 521-9212, 1.7V @ 50 mA Maximum (HIGH VOLTAGE Indicator)	323-9217	1
R1 THRU R3	Resistor, 5.1 k Ohm ±5%, 1/2W	110-5143	3
R4	Resistor, 22 k Ohm ±5%, 1/2W	110-2253	1
R5 THRU R8	Resistor, 1.5 k Ohm ±5%, 1/2W	110-1543	4
U1	Integrated Circuit, CMOS, ULN2003A, 7-Channel Driver, CMOS/TTL compatable, 16-Pin DIP	229-2003	1
XU1	Socket, 16-Pin	417-1601	1
----	Blank Circuit Board	517-0027	1

Table 6-53. Microprocessor Patch Panel Circuit Board Assembly - 917-0029

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Pin, Disconnect (PC Mount)	418-0161	99
----	Blank Circuit Board	517-0029	1

Table 6-54. Microprocessor Controller Wiring Harness - 947-0025

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Receptacle, 12-Pin	418-1271	18
----	Receptacle, 4-Pin	418-0240	2
----	Pin, Receptacle (for above receptacles)	417-0053	157
----	Receptacle, Edge Connector	417-0011	2
----	Pin, Receptacle (for Microprocessor Patch Panel Assembly)	417-0160	93

Table 6-55. Automatic Power Control Assembly - 959-0023

REF. DES.	DESCRIPTION	PART NO.	QTY.
B1	Motor, Reversible, 2 RPM, 30 in/oz Output Torque, 117V ac, 60 Hz, Magnetic Clutch, 5.5vA	380-0001	1
C1 THRU C12	Capacitor, 1000 pF, Feedthru	008-1033	12
C13,C14	Capacitor, Ceramic Disc, 0.01 uF, 500V	008-1044	2
DS1	Light Emitting Diode, Green, 521-9175, 2.3V @ 40 mA	323-9224	1
F1	Fuse, Slow-Blow, 3 AG, 1/2 Ampere	334-0050	1
J1,J2	BNC Connector	417-0206	2
R1,R2	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R3	Resistor, 4.42 k Ohm ±1%, 1/4W	103-4441	1
R4 THRU R6	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
TB12	Barrier Strip, 18 Terminal	412-0018	1
XF1	Fuseholder, 3 AG	415-2012	1
----	Dual 120 MHz Low-Pass Filter Circuit Board Assembly	919-0031	1
----	Power Supply/Control Circuit Board Assembly	919-0032	1
----	Analog Circuit Board Assembly	919-0033	1

Table 6-56. Dual 120 MHz Low-Pass Filter Circuit Board Assembly - 919-0031
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Ceramic, 10 pF ±10%, 1 kV	001-1014	2
C3,C4	Capacitor, Mica, 33 pF ±5%, 500V	042-3312	2
C5,C6	Capacitor, Ceramic, 10 pF ±10%, 1 kV	001-1014	2
D1,D2	Diode, HP5082-2800, High Voltage Schottky Barrier Type, 70V, 15 mA	201-2800	2
L1 THRU L4	Inductor, Fixed, 0.110 uH, 50 to 450 MHz, 1A dc Maximum	364-0011	4
R1,R2	Resistor, 100 Ohm ±5%, 1/2W	110-1033	2

Table 6-56. Dual 120 MHz Low-Pass Filter Circuit Board Assembly - 919-0031 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R3,R4	Resistor, 120 Ohm ±5%, 1/2W	110-1233	2
R5,R6	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
----	Blank Circuit Board	519-0031	1

Table 6-57. Power Supply/Control Circuit Board Assembly - 919-0032

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 1000 uF, 35V	024-1000	1
C2	Capacitor, Mylar, 0.47 uF, 1 kV	031-4753	1
D1 THRU D6	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	6
K1 THRU K4	Relay, Plug-In Contacts: 4 Sets SPDT, 2 Amperes, 28V dc or 115V ac Coil: 12V dc, 185 Ohm ±10%	270-1253	4
RV1,RV2	Metal Oxide Varistor, V130LA10A, 130V ac RMS, 10 Joules	140-0006	2
S1	Switch, SPDT Center Off, Miniature Toggle, 2A, 250V ac, 5A, 125V ac (RAISE/LOWER Switch)	348-0002	1
S2	Switch, Toggle, DPDT, 2A 250V ac, 5A 125V ac (LOCAL/REMOTE Switch)	348-0005	1
T1	Transformer, Power, Circuit Board Mount Primary: 115/230V, 50/60 Hz Secondary: Dual 12V @ 1 Ampere	376-0524	1
XK1 THRU XK4	Relay Socket, PC Board Mount	270-0008	4
----	Blank Circuit Board	519-0032	1

Table 6-58. Analog Circuit Board Assembly - 919-0033 (Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Electrolytic, 4.7 uF, 35V	024-4764	2
C3	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C4,C5	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C6 THRU C11	Capacitor, Electrolytic, 4.7 uF, 35V	024-4764	6
C12 THRU C16	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	5
C17 THRU C19	Capacitor, Electrolytic, 100 uF, 25V	023-1084	3
D1	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	1

Table 6-58. Analog Circuit Board Assembly - 919-0033 (Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
D2	Diode, 1N4148, Silicon, Fast-Switching, 100V, 10 mA	203-4148	1
L1,L2	Inductor, Molded, 2.20 mH ±10%, 100 MHz, 0.19 Ohm dc Resistance, 1100 mA Maximum	364-2200	2
Q1 THRU Q3	Transistor, 2N3906, Silicon, PNP, TO-92 Case	210-3906	3
R1	Resistor, 115 Ohm ±1%, 1/4W	100-1131	1
R2	Resistor, 909 Ohm ±1%, 1/4W	103-9031	1
R3,R4	Resistor, 15 k Ohm ±5%, 1/4W	100-1553	2
R5	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R6	Potentiometer, 50 k Ohm ±10%, 1/2W (RFL CAL Control)	178-5054	1
R7	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R8	Potentiometer, 50 k Ohm ±10%, 1/2W (FWD CAL Control)	178-5054	1
R9	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R10	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R11	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	1
R12,R13	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	2
R14	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R15	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R16,R17	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R18	Potentiometer, 1 k Ohm, 2W, W/W, 10 Turn	190-0051	1
R19	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R20	Potentiometer, 50 k Ohm ±10%, 1/2W (LOW DRIVE TRIP Control)	178-5054	1
R21,R22	Resistor, 18 k Ohm ±5%, 1/4W	100-1853	2
R23 THRU R25	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	3
R26 THRU R28	Resistor, 10 Ohm ±5%, 1/4W	100-1023	3
R29 THRU R31	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R32 THRU R35	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	3
R36	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R37	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R38	Resistor, 4.3 k Ohm ±5%, 1/4W	100-4343	1
R39	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R40	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R41	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R42	Resistor, 4.75 k Ohm ±1%, 1/4W	103-4741	1
R43	Resistor, 5.11 k Ohm ±1%, 1/4W	103-5141	1
R44	Resistor, 7.50 k Ohm ±1%, 1/4W	103-7541	1
R45	Resistor, 3.65 k Ohm ±1%, 1/4W	103-3641	1
R46 THRU R52	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	7
R53,R54	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	2
R55 THRU R57	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	3

Table 6-58. Analog Circuit Board Assembly - 919-0033 (Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R58,R59	Resistor, 470 k Ohm ±5%, 1/4W	100-4763	2
R60	Potentiometer, 10 k Ohm ±10%, 1W, Linear Taper, Modified (VSWR CAL Control)	192-1052	1
R61	Resistor, 25.5 k Ohm ±1%, 1/4W	103-2551	1
R62 THRU R69	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	8
R70	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	1
R71	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R72	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R73	Resistor, 820 Ohm ±5%, 1/4W	100-8233	1
R74	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
S1	Switch, DPDT, Miniature Toggle, 3A 250V ac, 5A 125V ac, (FWD/VSWR/VSWR CAL Switch)	348-0003	1
S2	Switch, SPDT Center Off, Miniature Toggle, 3A 250V ac, 5A 125V ac (AUTO/MAN Switch)	348-0004	1
U1	Integrated Circuit, LM317T, Adjustable Positive Voltage Regulator, 1.2 to 37V, 1.5 Ampere, TO-220 Case	227-0317	1
U2 THRU U4	Integrated Circuit, TL092CP, Dual N-Channel JFET Input Operational Amplifier, 8-Pin DIP	221-0092	3
U5,U6	Integrated Circuit, LM339AN, Quad Voltage Comparator, 14-Pin DIP	221-0339	2
U7,U8	Integrated Circuit, MC14001B, CMOS, Quad Input Nor Gate, 14-Pin DIP	228-4001	2
U9	Integrated Circuit, MC1413P, CMOS, Seven Circuit NPN Darlington Driver, 16-Pin DIP	229-2003	1
XU2 THRU XU4	Socket, 8-Pin	417-0804	3
XU5 THRU XU8	Socket, 14-Pin	417-1404	4
XU9	Socket, 16-Pin	417-1604	1
----	Insulator, TO-220 Case	409-7403	1
----	Screw, Nylon, 6-32 Thread	420-6998	1
----	Blank Circuit Board	519-0033	1

Table 6-59. Resistor and Lugs Assembly - 955-0037

REF. DES.	DESCRIPTION	PART NO.	QTY.
R117	Resistor, 400 Ohm ±10%, 25W, W/W	132-4032	1

Table 6-60. IPA Directional Coupler Assembly - 959-0050

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	VSWR Assembly	955-0001	1
----	IPA Directional Coupler Assembly	951-1012	1

Table 6-61. VSWR Assembly - 955-0001

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2,C6 THRU C10	Capacitor, Ceramic Feed-Thru, 1000 pF ±20%, 500V	008-1033	7
----	Buffer Amplifier Circuit Board	919-0011	1

Table 6-62. IPA Directional Coupler Assembly - 951-1012

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Ceramic Feed-Thru, 1000 pF ±20%, 500V	008-1033	2
D1,D2	Diode, HP5082-2800, High Voltage Schottky Barrier Type, 70V, 15 mA	201-2800	2
J2,J3	Type N Coaxial Connector	417-0204	2
R1,R2	Resistor, 56 Ohm ±5%, 1/2W	110-5623	2

Table 6-63. Buffer Amplifier Circuit Board - 919-0011 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C3,C4	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C5	Capacitor, Electrolytic, 10 uF, 16V	023-1074	1
R1,R2	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	2
R3	Potentiometer, 50 k Ohm ±10%, 1/2W	177-5054	1
R4	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R5	Potentiometer, 50 k Ohm ±10%, 1/2W	177-5054	1
R6	Resistor, 33 k Ohm ±5%, 1/4W	100-3353	1
R7 THRU R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R11,R12	Resistor, 3.3 k Ohm ±5%, 1/4W	100-3343	2
R13	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R14 THRU R16	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R17	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1

Table 6-63. Buffer Amplifier Circuit Board - 919-0011 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U1	Integrated Circuit, TL092CP, Dual N-Channel JFET Operational Amplifier, 8-Pin DIP	221-0092	1
XU1	Socket, 8-Pin	417-0804	1
----	Blank Circuit Board	519-0011	1

Table 6-64. Exciter ac Control - 955-0020

REF. DES.	DESCRIPTION	PART NO.	QTY.
K103	Relay, Plug-In Coil: 120V ac Contacts: 2 Sets DPDT, 10A/240V ac Resistive	270-1250	1
K104,K105	Relay, Plug-In Coil: 2500 Ohm ±10%, Nominal 24-48V dc Contacts: 2 Sets DPDT, 2A/28V or 115V Resistive	271-0154	2
S101	Switch, Toggle, DPST, 125V, 15A; 250V, 10A Screw Terminals	348-7360	1
TB8,TB9	Terminal Strip, 20 Terminals	418-0019	2
XK103	Socket, 8-Pin, Screw Terminals (for K103)	417-0400	1
----	AC Outlet Strip, 6 Receptacles	840-4007	1

Table 6-65. Microprocessor Controller Power Supply and Battery Charger - 959-0069 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
BT1 THRU BT4	Battery, X Cell, 2V, 5 AH, Rechargeable Lead-Acid	357-6900	4
D15	Bridge Rectifier, Full Wave, MDA2502, 200 PIV, 25 Amperes	239-0006	1
F1	Fuse, MDL, 240V, 1.5 A, Slow-Blow	334-0150	1
L1 THRU L11	Ferrite Beads	360-0003	11
P1	Plug, 12-Pin	418-1271	1
P2	Plug, 6-Pin	418-0670	1
T1	Transformer, Power Primary: 95/115/210/230V, 50/60 Hz Dual Secondary: 25.5V @ 1A 13.2V @ 3A	376-0218	1
TB1	Terminal Board, 7 Terminal	412-0007	1

Table 6-65. Microprocessor Controller Power Supply and Battery Charger - 959-0069 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U3	Integrated Circuit, LM317K, 3 Terminal Adjustable Voltage Regulator, 1.2 to 37V @ 1.5 Ampere, TO-3 Case	227-0318	1
U4	Integrated Circuit, MC7824CK, Fixed Positive Voltage Regulator, +24V, 1.5 Ampere, TO-3 Case	227-7824	1
U5	Integrated Circuit, LM317K, 3 Terminal Adjustable Voltage Regulator, 1.2 to 37V @ 1.5 Ampere, TO-3 Case	227-0318	1
XF1	Fuse Holder, In-Line, 3 AG	415-0145	1
XU3,XU4, XU5	Transistor Socket, TO-3	417-0298	3
----	Mica Insulator, TO-3 (for U3,U4,U5)	418-0010	3
----	Connector Pins (for P1 and P2)	417-0053	17
----	Microprocessor Power Supply and Battery Charger Circuit Board Assembly	919-0034	1

Table 6-66. Microprocessor Controller Power Supply and Battery Charger Circuit Board Assembly - 919-0034 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Mylar, 0.01 uF, 100V	031-1043	1
C2 THRU C4	Capacitor, Electrolytic, 4700 uF, 35V	014-4795	3
C5,C6	Capacitor, Electrolytic, 10 uF, 35V	023-1076	2
C7	Capacitor, Electrolytic, 33 uF, 35V	024-3374	1
C8	Capacitor, Mylar, 0.1 uF, 100V	030-1053	1
C9	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C10	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C11	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C12	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C13	Capacitor, Mylar, 0.1 uF, 100V	030-1053	1
D1 THRU D4	Diode, MR502, Silicon, 200V, 3 Ampere	202-0502	4
D5 THRU D8	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	4
D9	Diode, MR751, Silicon, 100V, 6 Ampere	202-0751	1
D10 THRU D14	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	5
DT1	Diode, 1N6279A, Silicon Transient Voltage Suppressor, 22V ±5%	206-0001	1
DT2	Diode, 1N6284A, Silicon Transient Voltage Suppressor, 36V ±5%	206-0002	1
J1	Connector, 12-Pin	417-1276	1
J2	Connector, 6-Pin	417-0677	1
K1	Relay, Circuit Board Mount Contacts: SPDT, 100V dc @ 8 Amperes Coil: 12V dc, 140 mA, 85 Ohms ±10 Ohms	272-0106	1
Q1	Transistor, MPS-U05, Silicon, NPN, Motorola Case 152-02	211-0005	1

Table 6-66. Microprocessor Controller Power Supply and Battery Charger Circuit Board Assembly - 919-0034 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R1	Resistor, 820 Ohm ±5%, 1/4W	100-8233	1
R2	Potentiometer, 100 Ohm ±10%, 1/2W	177-1034	1
R3	Resistor, 30 Ohm ±5%, 1W	120-3023	1
R4	Resistor, 121 Ohm ±1%, 1/4W	100-1231	1
R5	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R6	Resistor, 3.9 k Ohm ±5%, 1/4W	100-3943	1
R7	Resistor, 365 Ohm ±1%, 1/4W	103-3631	1
R8	Potentiometer, 10 k Ohm ±10%, 1/2W	177-1054	1
R9	Resistor, 2.32 k Ohm ±1%, 1/4W	103-2341	1
R10	Resistor, 1.33 k Ohm ±1%, 1/4W	103-1331	1
R11	Resistor, 20 k Ohm ±5%, 1/4W	100-2051	1
R12	Resistor, 121 Ohm ±1%, 1/4W	100-1231	1
R13	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R14	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
TB2	Barrier Strip, 4 Terminal	412-0004	1
U1	Integrated Circuit, LM336Z-2.5, Precision Voltage Reference, 2.5V ±4%-0 to 70°C, TO-92 Case	229-0336	1
U2	Integrated Circuit, TL311P, JFET Input Differential Comparator, 8-Pin DIP	220-0311	1
XU2	Socket, 8-Pin	417-0804	1
----	Blank Circuit Board	519-0034	1

Table 6-67. Microprocessor Controller Bypass Assembly - 959-0053

REF. DES.	DESCRIPTION	PART NO.	QTY.
DS1	Light Emitting Diode, Red, CM4-86B, 5V @ 20 mA	323-0023	1
DS2	Light Emitting Diode, Green, 521-9175, 2.3V @ 40 mA	323-9224	1
DS3,DS4	Incandescent Lamp, No. 345, 6V, 0.04 Ampere (for START Switch/Indicators)	321-0328	2
P2	Plug, 25-Pin	418-3219	1
S1 THRU S4	Switch/Indicator, SPST Push, Normally open 12V @ 100 mA Maximum Resistive Load	343-0012	4
----	Switch Cap, Red (STOP)	343-0016	2
----	Switch Cap, Green (START)	343-0015	2
----	Microprocessor Controller Bypass Circuit Board Assembly	919-0009	1
----	Microprocessor Controller Bypass Assembly 24 Volt Control Circuit Board	919-0014	1

Table 6-68. Microprocessor Controller Bypass Circuit Board Assembly - 919-0009
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C2,C3	Capacitor, Electrolytic, Dipped Tantalum, 2.2 uF ±20%, 35V	064-2263	2
C4	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C5	Capacitor, Electrolytic, Dipped Tantalum, 100 uF ±20%, 20V	063-1083	1
C6 THRU C12	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	7
C13,C14	Capacitor, Electrolytic, 100 uF, 25V	023-1084	2
C15	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C16	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C18	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
D1 THRU D7	Diode, Silicon, 1N4148, 75V @ 0.3 Ampere Fast Switching	203-4148	7
L1	Molded Inductor, 47 mH ±10%, 700V Maximum	360-0012	1
Q1 THRU Q3	Transistor, Silicon, MPSA14, NPN, TO-92 Case	211-0014	3
R1	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R2	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R3 THRU R7	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	5
R8,R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R10	Resistor, 150 Ohm ±5%, 1/4W	100-1533	1
R11	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R12	Resistor, 180 Ohm ±5%, 1/4W	100-1833	1
R13,R14	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R15 THRU R18	Potentiometer, 100 k Ohm ±10%, 1/2W	177-1064	4
R19	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R20	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R21	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R22	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R23	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R24	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R25	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R26	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R27	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R28	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R29	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	1
R30	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R31	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R32	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R33	Resistor, 330 Ohm ±5%, 1/4W	100-3333	1
R34	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R35,R36	Resistor, 330 Ohm ±5%, 1/4W	100-3333	2
R37,R38	Resistor, 470 Ohm ±5%, 1/4W	100-4733	2
U1	Integrated Circuit, MC14011UB, CMOS, Quad 2-Input NAND Gate, 14-Pin DIP	228-4011	1
U2	Integrated Circuit, TL094C, Quad JFET-Input Operational Amplifier, 14-Pin DIP	221-0094	1

Table 6-68. Microprocessor Controller Bypass Circuit Board Assembly - 919-0009 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U3	Integrated Circuit, MC14049UB, CMOS, Inverting Hex Buffer, 16-Pin DIP	228-4049	1
U4	Integrated Circuit, 4N33, Optical Isolator, Infared LED-Photo NPN Darlington Transistor Coupled Pair, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	1
XU1,XU2	Socket, 14-Pin	417-1404	2
XU3	Socket, 16-Pin	417-1604	1
----	Blank Circuit Board	519-0009	1
----	Bypass Assembly, 24 Volt Control Circuit Board	919-0014	1

Table 6-69. Microprocessor Controller Bypass Assembly 24 Volt Control Circuit Board - 919-0014

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
R1	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R2	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R3	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R4	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
U1	Integrated Circuit, 4N33, Optical Isolator, Infared LED-Photo NPN Darlington Transistor Coupled Pair, 1500V Isolation, Response: 30 kHz Maximum, Current: 50 mA Maximum, 6-Pin DIP	229-0033	1
----	Blank Circuit Board	519-0014	1

Table 6-70. High Voltage Power Supply Cabinet Assembly - 909-3000 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
CB300	Circuit Breaker, 3 Pole, 200 Ampere, 600V ac (HIGH VOLTAGE PRIMARY)	341-0001	1
K300	Contactor Coil: 110/120V ac, 50/60 Hz Contacts: 3 sets SPST, 270 Amperes, 600V ac	341-0005	1
R300	Resistor, Ceramic, clip mounting, 5 Ohm ±10%, 275W, Non-Inductive	140-0002	1
R301 THRU R304	Resistor, 50 k Ohm ±5%, 225W, W/W	132-0001	4
R305	Resistor, 100 Ohm ±5%, 25W, W/W	132-1011	1
R306	Resistor, Ceramic, clip mounting, 5 Ohm ±10%, 275W, Non-Inductive	140-0002	1

Table 6-70. High Voltage Power Supply Cabinet Assembly - 909-3000 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R307	Ammeter Shunt, 1 Volt, 6 Amperes, 0.1667 Ohm	316-0001	1
S300	Door Interlock Switch, SPDT, 15A at 125 or 250V ac, 0.5A at 125V dc, 0.25A at 250V dc	346-3302	1
S301	High Voltage Shorting and Interlock Switch Assembly	955-0030	1
TB6,TB10	Barrier Strip, Screw Terminal (7 per Strip)	412-0724	14
XR300, XR306	Clip, Fuse Mounting, Type FRS	415-1003	4
----	End Cap for TB6 and TB10	412-0730	2
----	Power Supply Diode Assembly	955-0005	1
----	Power Supply Base Assembly	955-0006	1
----	Wiring Harness, Power Supply Interlock	947-0090	1
----	AC Power Distribution Panel	959-0067	1
----	High Voltage Step Start Assembly	959-0064	1

Table 6-71. High Voltage Shorting and Interlock Switch Assembly - 955-0030

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Ground Stick Hanger	955-0038	1

Table 6-72. Ground Stick Hanger - 955-0038

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

Table 6-73. Power Supply Diode Assembly - 955-0005

REF. DES.	DESCRIPTION	PART NO.	QTY.
D300 THRU D305	Half Wave Silicon Rectifier Stack with transient compensation, 28 kV, 6 Ampere	234-0001	6

Table 6-74. Power Supply Base Assembly - 955-0006

REF. DES.	DESCRIPTION	PART NO.	QTY.
C300,C301	Capacitor, Oil Filled, 2 uF, 15 kV	047-0001	2
L300	Choke, Filter, 6H, 5A dc	376-0014	1
T300	Plate Transformer: Primary: 3Ø, 60 Hz, Delta connected, 208/240V ±12V Secondary: Wye connected, 6780V ac, 4.08A	376-0013	1

Table 6-75. Wiring Harness, High Voltage Power Supply Interlock - 947-0090

REF. DES.	DESCRIPTION	PART NO.	QTY.
P5	Plug, 14-Pin	417-0008	1

Table 6-76. AC Power Distribution Panel - 959-0067

REF. DES.	DESCRIPTION	PART NO.	QTY.
F301 THRU F303	Fuse, Clip Mounting, 40 Ampere, 250V, Dual	330-0601	3
F304,F305	Fuse, 3 AG, 20 Amperes, 250V	334-0020	2
XF301 THRU XF303	Clip, Fuse Mounting, Type S2 (2 per fuse)	415-0001	6
XF304, XF305	Fuse Holder, In-Line, 3 AG	330-0300	2

Table 6-77. High Voltage Step Start Assembly - 959-0064 (Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
A300	Step Start Circuit Board Assembly	919-0199	1
K301	Contactor Coil: 110/230V, 50/60 Hz Contacts: 3 Sets SPST, 40 Amperes, 600V	341-0023	1
K302,K303	Relay, Solid State, 240D10, 240V @ 10 Amperes, 2500V Isolation, Control: 3-32V dc @ 5.0 mA	273-0002	2
MOV301, MOV302	Metal Oxide Varistor, V250LA15A, 250V ac RMS	140-0008	2
R308 THRU R310	Resistor, 2 Ohm ±5%, 50W, W/W	132-1004	3

Table 6-77. High Voltage Step Start Assembly - 959-0064 (Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
XA300	Socket, 8-Pin	417-0400	1
----	Housing with 8-Pin Plug (for A300)	418-0650	1

Table 6-78. Step Start Circuit Board Assembly - 919-0199

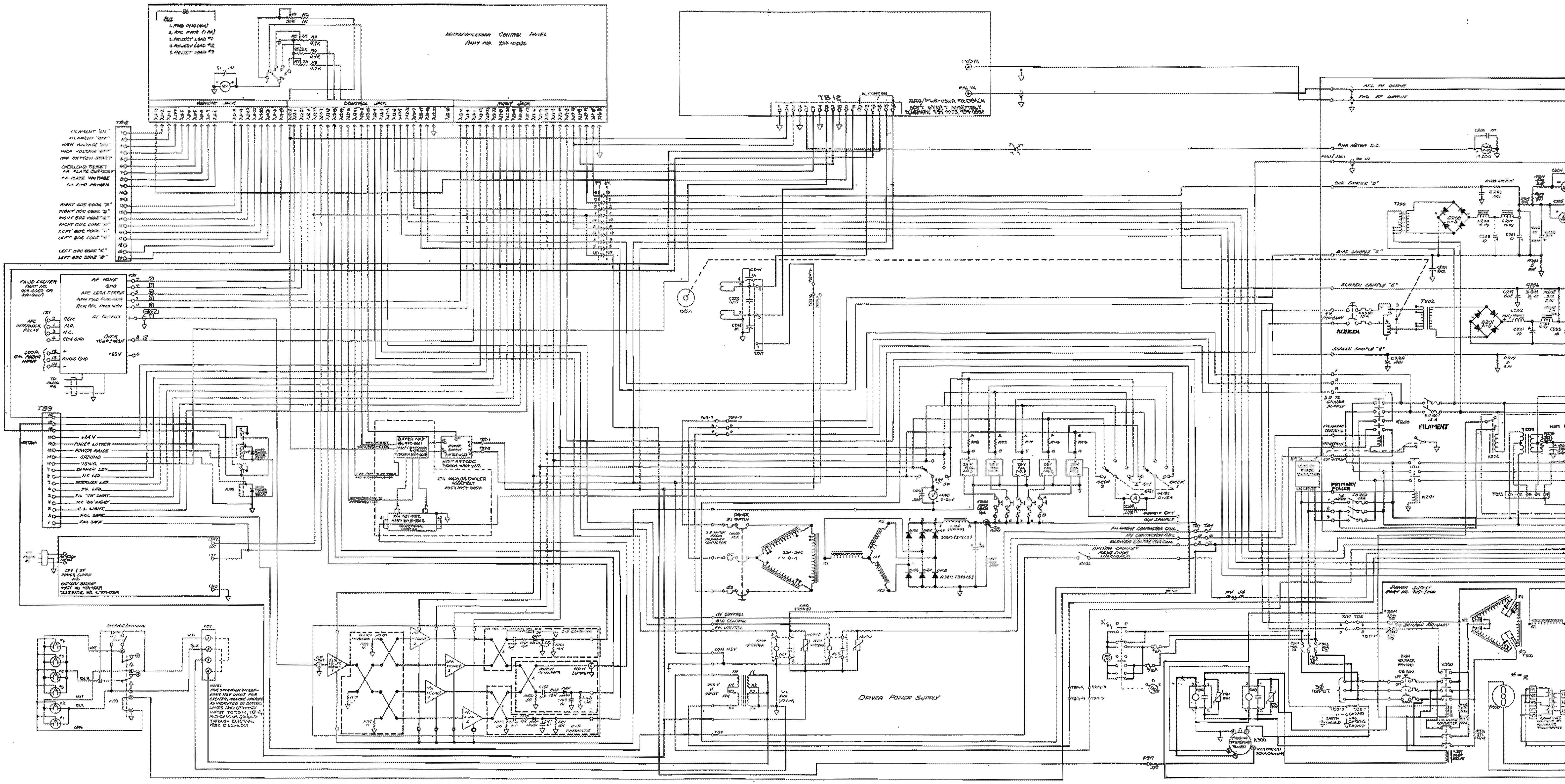
REF. DES.	DESCRIPTION	PART NO.	QTY.
C1,C2	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C3,C4	Capacitor, Polystyrene, 0.47 uF, 100V	038-4753	2
C5,C6	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C7	Capacitor, Electrolytic, 1 uF, 50V	024-1064	1
C8	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C9,C10	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
D1,D2	Diode, 1N4148, Silicon, Fast-Switching, 100V, 10 mA	203-4148	2
D3,D4	Diode, 1N4742A, Zener, 12V ±5%, 1W	200-4742	2
D5	Diode, 1N4004, Silicon, 400V, 1 Ampere	203-4004	1
L1,L2	Inductor, Molded, 2.20 mH ±10%, 100 MHz, 0.19 Ohm dc Resistance: 1100 mA Maximum	364-2200	2
Q1,Q2	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	2
R1,R2	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R3	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R4	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R5	Resistor, 820 k Ohm ±5%, 1/4W	100-8263	1
R6,R7	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R8,R9	Resistor, 560 Ohm ±5%, 1/4W	100-5633	2
R10	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	1
R11	Resistor, 680 Ohm ±5%, 1/4W	100-6833	1
U1	Integrated Circuit, MC14584B, CMOS, Hex Schmitt Trigger, 14-Pin DIP	228-4584	1
XU1	Socket, 14-Pin	417-1400	1
----	Blank Circuit Board	519-0199	1

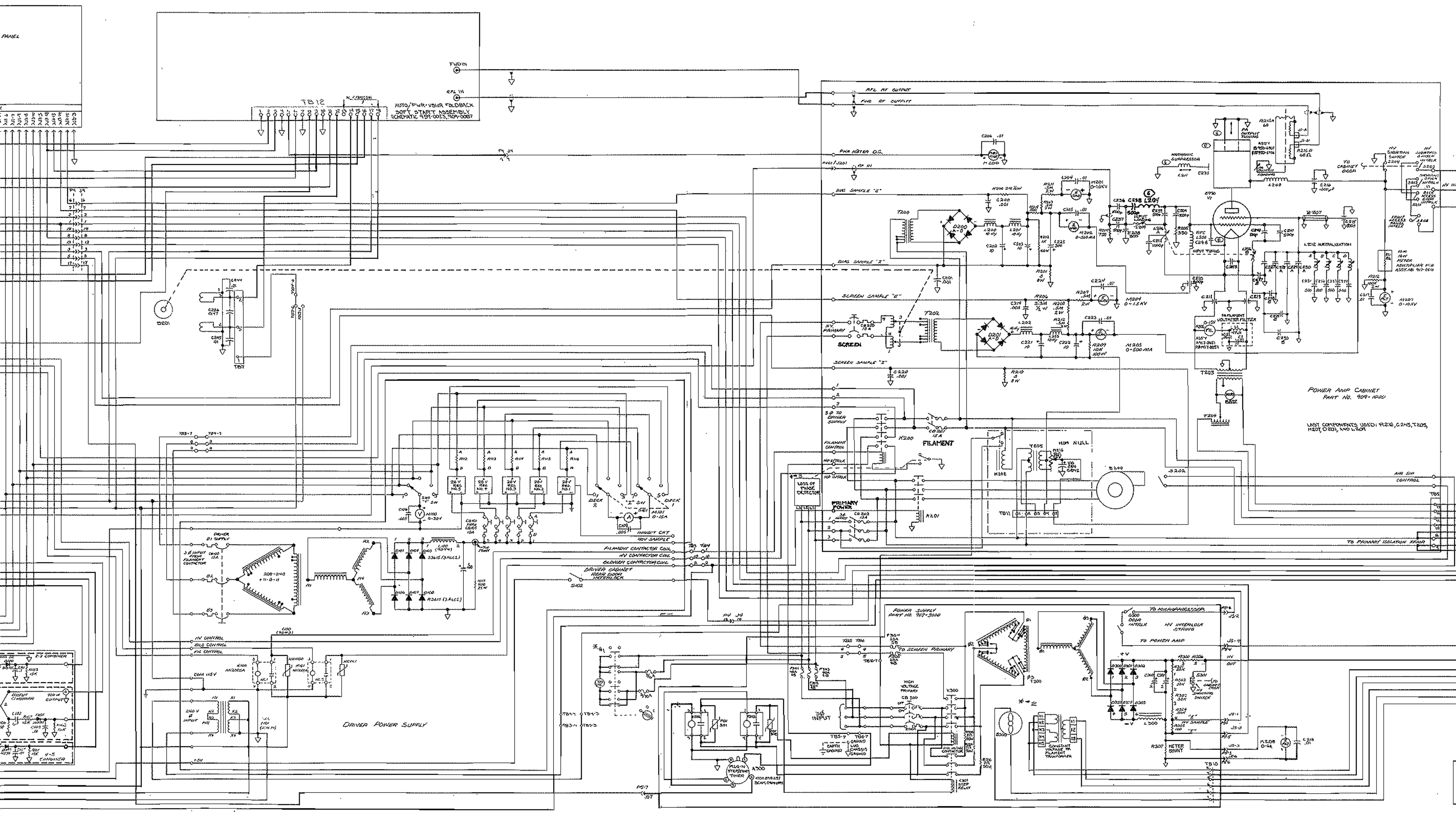
SECTION VII
DRAWINGS

7-1. INTRODUCTION

7-2. This section provides assembly drawings, schematic diagrams, and wire lists as indexed below applicable to the overall FM-30 Transmitter.

FIGURE	TITLE	NUMBER
7-1	Overall Schematic, 30 kW Transmitter	D909-0300





REV.	DESCRIPTION	DATE	APP.
G	REDRAWN & REVISED	7-8-81	DHP
H	PER ECN 3114	12-2-81	JAH.
I	SEE ECN 3164	12-29-81	MT
J	PER ECN 3189	1-8-82	AMM
K	PER ECN # 3342	3-16-82	JAH
L	PER ECN # 3301	3-25-82	JAH
M	ADDED WIRE FROM TB4-10 TO TB12-4 (PER ECN 3380)	3-29-82	MRR

NOTES:

1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS U.O.S.
2. TB3 IS THE DRIVER CABINET WIRING INTERCONNECTION TERMINAL STRIP. TB4 & TB5 ARE THE P.A. CABINET WIRING INTERCONNECTION TERMINAL STRIPS. TB6 IS THE POWER SUPPLY CABINET WIRING INTERCONNECTION TERMINAL STRIP.
3. ALL INTERLOCKS ARE SHOWN OPEN.
4. — REFERS TO WIRE OR CABLE NUMBER.
5. * OPTIONS
   1) 909-0072 PHASE VOLTAGE METERING
   2) 909-0073 PA FILAMENT CONSTANT VOLTAGE TRANSFORMER
   3) 909-0071 LOSS OF PHASE DETECTOR
6. (6) FREQUENCY DEPENDENT.

BROADCAST ELECTRONICS, INC.
— A FILMWAYS COMPANY —

TITLE: OVERALL SCHEMATIC 30KW TRANSMITTER

DRAWN BY: JAH DATE: 7-9-81

SIZE: E DWG. NO. 909-0300 REV. M

SCALE: NTS SHEET 1 OF 1

PART II

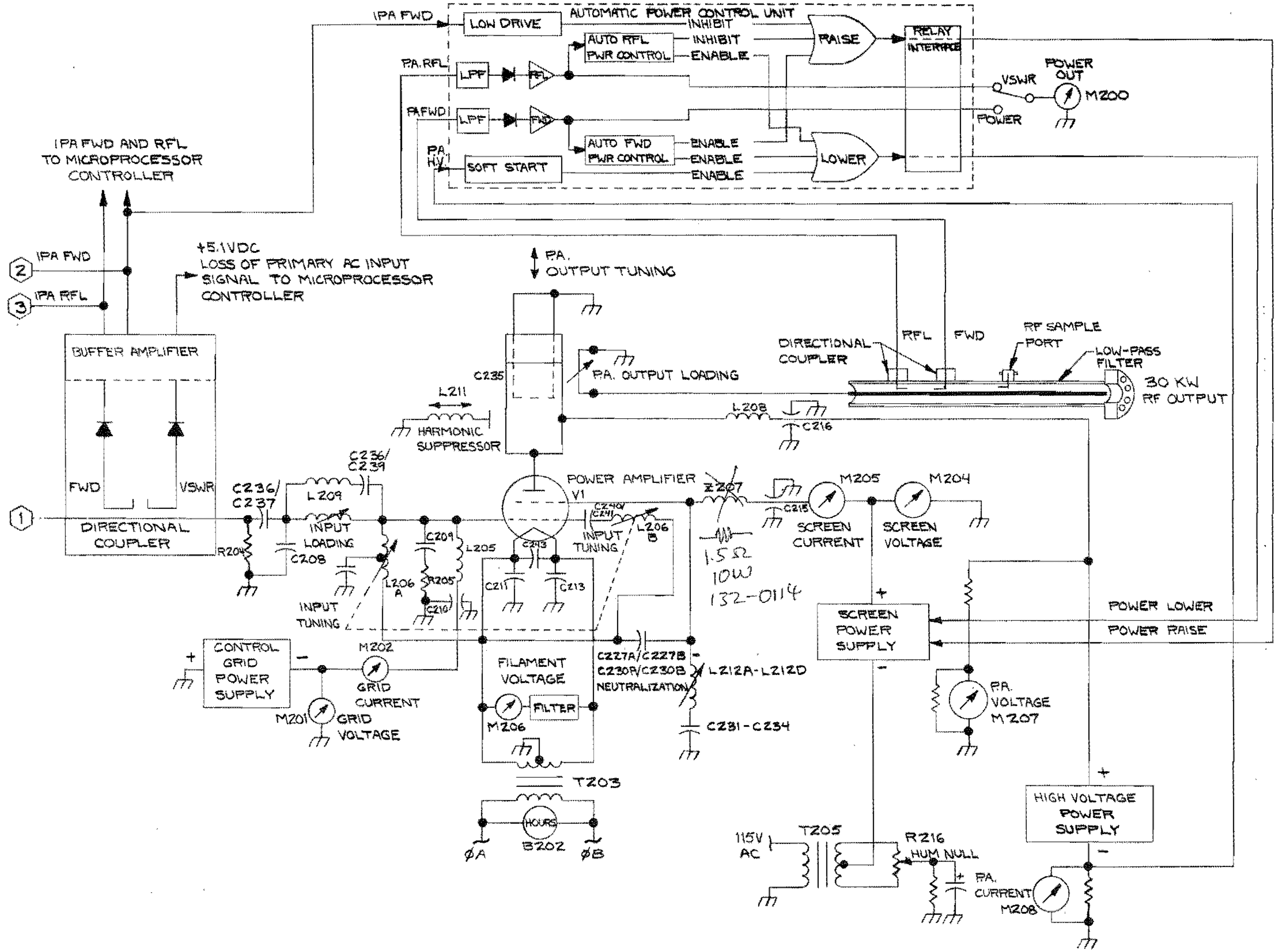


FIGURE 1-1. RF CIRCUIT SIMPLIFIED SCHEMATIC (SHEET 2 OF 2)

1-13. After amplification, the four IPA section outputs are combined in phase by three separate output combiners. First the output of amplifiers 2 and 3 are combined in hybrid 3 and the output of amplfiers 4 and 5 are combined in hybrid 1. Finally the output from hybrid 1 and hybrid 3 are combined in hybrid 2 to furnish full power output from the IPA stage. The reject load voltage on the three output combiners are monitored by the microprocessor controller for operational status. A metered display of this information is available on the DRIVER meter located on the front of the microprocessor controller. The dc voltage to each amplifier module is also monitored by the microprocessor controller as an indication of amplifier status.

1-13A. The FM-30 uses four separate IPA amplifiers and sums the output of the IPA amplifiers in two separate combiners. As all IPA amplifiers share any mismatch equally, increased isolation to high VSWR conditions is evident when compared to single combiner approaches. Evidence of the IPA stage sharing mismatches equally may be noted during tuning as a mismatch in grid tuning will cause all IPA amplifier currents to rise or fall together, indicating equal load sharing between output amplifiers. Correct phasing between amplifiers and at each hybrid coupler port is established by coaxial cables cut to the proper length (see Figure 1-2A).

1-14. A directional coupler located in the cable feeding the PA grid circuit provides dc output voltages proportional to the IPA stage forward and reflected power. The voltages are used as samples for the microprocessor controller and provide forward and reflected DRIVER meter indications.

1-15. PA STAGE. The PA stage contains a single 4CX20,000A/8990 tetrode operated class C in a folded half-wave cavity to output 30 kW of RF power with approximately 400 Watts of RF drive. The grid circuit is adjusted for proper operation with two inductors. The INPUT LOADING controls changes inductance with a sliding short in a hairpin configuration to match the 50 Ohm output of the IPA stage to the higher grid circuit impedance. The INPUT TUNING control is a double hairpin configuration adjusting parallel circuit inductance with two sliding shorts.

1-16. The PA tank circuit is a half-wave circuit electrically folded back on itself with no wiping or sliding contacts, blocking capacitors, or output loading capacitor (see Figure 1-3). Incorporated into the tank design is a second harmonic suppressor. Rather than attenuating the second harmonic after the signal has been generated and amplified, the circuitry in the FM-30 essentially eliminates formation of this signal.

2

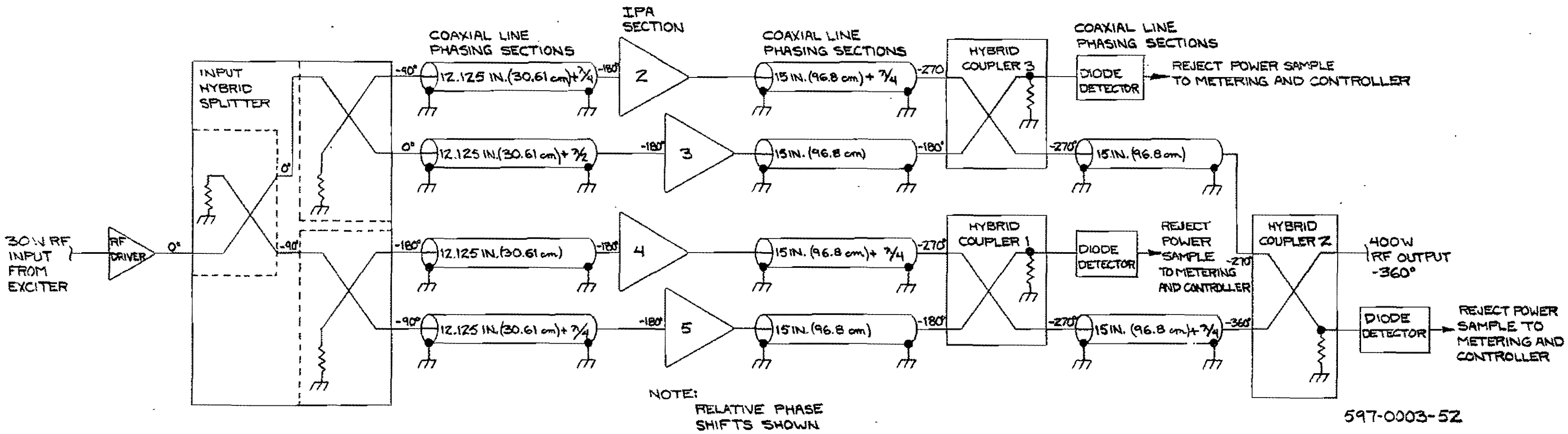


FIGURE 1-2A. FM-30 HYBRID SPLITTER/COMBINER PHASING

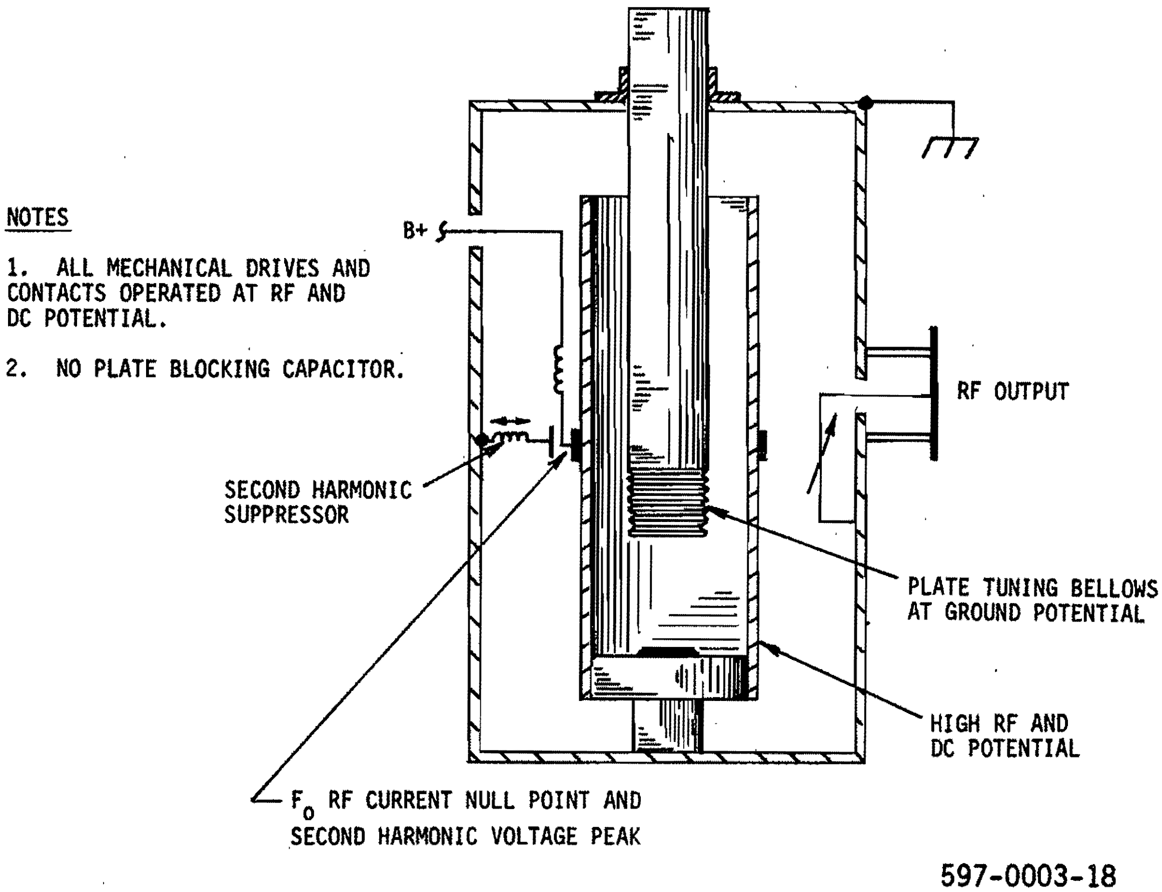


FIGURE 1-3. FM-30 PA CAVITY

1-17. Plate tuning is accomplished by adjustable bellows on the grounded or center portion of the plate line which is maintained at chassis ground potential. The PA plate potential is applied to the outer or fixed portion of plate line at the fundamental frequency RF circuit null point. As this point is also the point at which the second harmonic will peak in voltage, a basic resonant L-C circuit at this point will essentially eliminate the second harmonic.

1-18. Energy is coupled into the transmission line by an adjustable untuned link which functions in the electromagnetic field within the cavity. One end of the output link is connected to ground, while the other connects to the center conductor of the output transmission line.

1-19. A directional coupler located in the output transmission line provides RF output voltages proportional to the PA forward and reflected power. The RF output voltages are rectified and amplified to provide power and VSWR indications on the POWER OUT meter, samples for the microprocessor controller, and inputs to the automatic power control unit.

1-20. AUTOMATIC POWER CONTROL UNIT. The automatic power control unit 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 1-4). As an additional function, a soft start circuit slowly increases RF power output at start to limit stress on the PA and power supply components.

1-21. PA forward and reflected power samples are input through individual low-pass filters which assure the samples will be sensed at the frequency of operation only. These samples are amplified and applied to the POWER OUT meter to provide indications of transmitter operation. The amplified power samples are also applied to the forward and reflected automatic power control circuits which control the adjustable autotransformer when the AUTO/MAN switch is set to AUTO. As RF power varies, the forward automatic power control circuit will act to maintain the established RF output level. If inadequate IPA drive exists for normal operation or if PA reflected power increases, any power increase will be inhibited. The microprocessor controller will display either of these conditions on the readout. If the PA reflected power increases to a point which may damage the external low-pass filter on the transmitter, the circuit will reduce the RF output to a safe level and the transmitter will continue to operate. Full power will be automatically reestablished when the IPA defect or VSWR condition is corrected.

1-22. As an additional function, a soft start circuit monitors PA plate voltage. This circuit reduces the PA screen potential to minimum whenever plate voltage is off. Whenever the plate voltage is energized, the circuit will gradually increase the PA screen voltage until the rated transmitter RF output is established unless limited by low IPA drive or a high VSWR condition.

1-23. <u>IPA Forward Power Sense Circuit</u>. A sample of forward power from the IPA directional coupler is input to dc amplifier U2A. The signal is amplified and applied to the inverting inputs of comparators U5A and U5B.

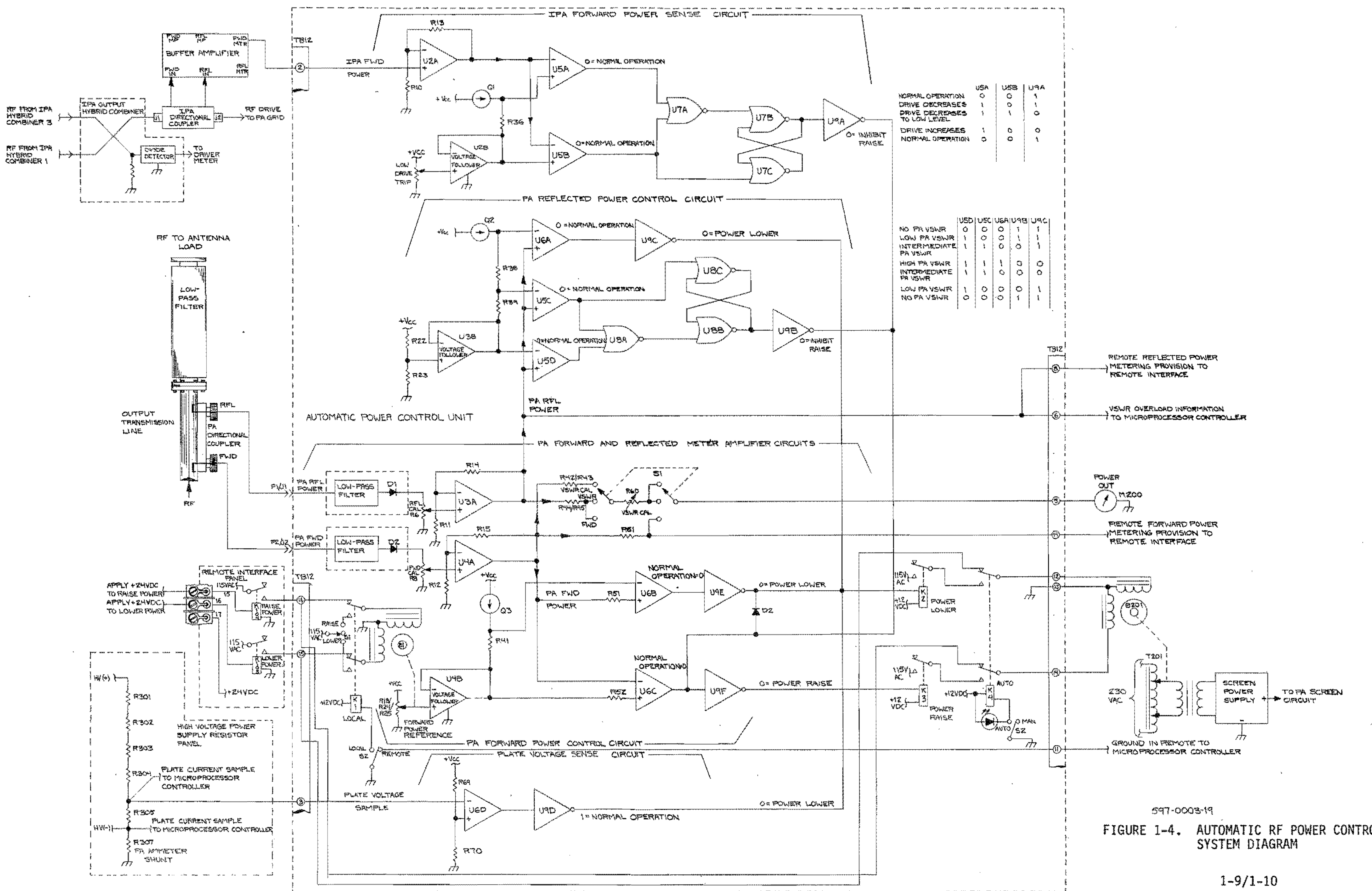


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FIGURE 1-4. AUTOMATIC RF POWER CONTROL SYSTEM DIAGRAM

1-24. Voltage follower U2B in combination with constant current source Q1 establishes a precise voltage drop across R36. This voltage drop creates a dead-band or window which determines how the IPA reflected power control circuit will react when IPA power falls below a level preset with R20. The circuit configuration used assures that system operation will not become erratic with minor drive power fluctuations.

1-25. The circuit remains idle when the IPA stage RF power level remains constant. If the IPA power falls and the level applied to the inverting input of U5A falls below the potential on the non-inverting input of U5A, the output of voltage comparator U5A will change states and output a HIGH. This may be considered a preset as no further action will be taken by the circuit at this time.

1-26. If IPA RF power continues to fall, the level on the inverting input of U5B will fall below the fixed reference on the non-inverting input and U5B will change states to output a HIGH. With two HIGH states input to U7A, U7A will output a LOW causing the bistable flip-flop comprising U7B and U7C to change states and input a HIGH to inverter U9A. The resultant LOW from U9A holds the output of inverter U9F HIGH which inhibits raise functions. This prevents the forward power control circuit from attempting to increase screen voltage when IPA RF power falls below a nominal range.

2

1-27. When IPA stage output power increases and the level on the inverting input of U5B rises above the fixed reference on the non-inverting input, U5B will output a LOW. With one LOW and one HIGH input to U7A, no further action will occur.

1-28. If IPA drive power continues to rise, the level on the inverting input of U5A will increase above the fixed reference on the non-inverting input and U5A will output a LOW. With two LOW states input to U7A, U7A will output a HIGH causing the bistable flip-flop comprising U7B and U7C to change states and input a LOW to inverter U9A. The resultant HIGH from U9A will enable inverter U9F to allow raise functions as required by the forward power control circuit.

1-29. PA Reflected Power Control Circuit. A dc sample of reflected power from the PA meter amplifier circuit is applied to the non-inverting inputs of comparators U5D, U5C, and U6A.

1-30. Voltage follower U3B in combination with constant current source Q2 establishes three precise voltages across the series string of resistors R38 and R39. These voltages create dead-bands or windows which determine how the PA reflected power control circuit will react when PA reflected power increases beyond the level established with R22 and R23.

1-31. The circuit remains idle when the PA reflected power is within acceptable limits. If the PA reflected power increases and the level applied to the non-inverting input of U5D rises above the fixed reference on the inverting input of U5D, the output of voltage comparator U5D will change states and output a HIGH. This may be considered a preset as no further action will be taken by the circuit at this time.

1-32. If the PA reflected power continues to rise, the level on the non-inverting input of U5C will rise above the fixed reference on the inverting input and U5C will change states to output a HIGH. With two HIGH states input to U8A, U8A will output a HIGH and U5C will output a HIGH causing the bistable flip-flop comprising U8C and U8B to change states and input a HIGH to inverter U9B. The resultant LOW from U9A holds the output of inverter U9F HIGH which inhibits raise functions.

1-33. If the PA reflected power should continue to rise to the point which could cause equipment damage, the level on the non-inverting input of U6A will rise above the fixed reference on the inverting input and U6A will change states to output a HIGH to U9C. The resultant LOW from inverter U9C will energize the power lower relay to decrease the transmitter RF power output. This LOW is steered through diode D2 to hold the output of inverter U9F HIGH to assure any attempt to raise power is inhibited.

1-34. When the PA reflected power falls to a safe level and the level on the non-inverting input of U6A falls below the fixed reference on the inverting input, U6A will output a LOW. This LOW will halt the power reduction and remove the inhibit on U9F through Diode D2.

1-35. If the PA reflected power continues to fall, the level on the non-inverting input of U5C will fall below the fixed reference on the inverting input and U5C will change states to output a LOW. With one HIGH and one LOW input to U8A, the bistable flip-flop comprising U8C and U8B will be held in its present state and no further action will occur.

1-36. As the PA reflected power returns to a minimal level, the level on the non-inverting input of U5D will decrease below the fixed reference on the inverting input and U5D will output a LOW. With two LOW states input to U8A, U8A will output a HIGH causing the bistable flip-flop comprising U8C and U8B to change states and input a LOW to inverter U9B. The resultant HIGH from U9B will enable inverter U9F to allow raise functions as required by the forward power control circuit.

1-37. <u>Forward and Reflected Meter Amplifiers</u>. The directional coupler located in the output transmission line provides ac voltages proportional to the PA forward and reflected power. These voltages are coupled through low-pass filters which assure that harmonics do not affect the samples. The reflected power sample is rectified by diode D1, calibrated by R6, and amplified by U3A. The forward power sample is rectified by diode D2, calibrated by R8, and amplified by U4A. Five volts output by U3A represents an approximate 2:1 VSWR and five volts output from U4A represents 100% forward power (preset at factory for customer specified power level).

1-38. The reflected power is applied to the PA reflected power control circuit, the processor for VSWR overload information, and the metering circuit. The forward power sample is applied to the forward PA power control circuit and the metering circuit. All metering information is applied to the VSWR CAL/VSWR/FWD switch and displayed by the POWER OUT meter.

1-39. PA Forward Power Control Circuit. A sample of forward power from the PA meter amplifier circuit is applied to the non-invering input of U6B and the inverting input of U6C.

1-40. Voltage follower U4B in combination with constant current source Q3 establishes a precise voltage drop across R41. This voltage drop creates a dead-band or window which determines how the PA forward control circuit will react when PA output power differs from the level preset with B1/R18. The circuit configuration used assures that system operation will not become erratic with minor power fluctuations.

1-41. The circuit is idle when the transmitter output power remains established at the correct level. If the PA forward input falls below the fixed reference on the bottom of R41, comparator U6C will change states and output a HIGH. The resultant LOW from inverter U9F will energize the power raise relay until the correct transmitter RF output power is sensed by the PA directional coupler and input to U6C.

2

1-42. If the PA forward input rises above the fixed reference on the top of R41, comparator U6B will change states and output a HIGH. The resultant LOW from inverter U9E will energize the power lower relay until the correct transmitter RF output power is sensed by the PA directional coupler and input to U6B. This LOW is coupled through diode D2 to hold the output of inverter U9F HIGH to assure any attempt to raise power is inhibited.

1-43. Remote control of the forward power control circuit is permitted through +24 volt inputs to the remote interface panel when the AUTO/MAN switch is set to AUTO and the LOCAL/REMOTE switch is set to REMOTE. The level set by R18 is varied by remote control of motor B1. If the AUTO/MAN switch is switched to MAN, control of the screen transformer motor control circuit is removed from the PA forward power control circuit and is routed directly to the remote interface power control relays to allow remote power control. When the LOCAL/REMOTE switch is set to LOCAL, screen control may be accomplished with the transmitter front panel RAISE/LOWER switch. Whenever the AUTO/MAN switch is set to MAN, screen control must be accomplished with the transmitter front panel SCREEN control.

1-44. Plate Voltage Monitor Circuit. A plate voltage sample derived from the high voltage bleeder resistor chain is applied to the inverting input of voltage comparator U6D in the plate voltage monitor circuit. When the plate voltage sample decreases below the fixed level on the non-inverting input of U6D (such as when PLATE OFF is depressed), U6D will output a HIGH. The resultant LOW from inverter U9D will energize the power lower relay to minimize the transmitter RF power output. This LOW is coupled through diode D2 to hold the output of inverter U9F HIGH to assure any attempt to raise power is inhibited. Consequently, whenever the transmitter is deenergized, the automatic power control system will hold U9D LOW to maintain zero screen voltage.

1-45. When the PLATE ON swtich/indicator is depressed and the high voltage sample on the inverting input of U6D rises above the fixed reference on the non-inverting input, U6D will output a LOW. This LOW will remove the inhibit on U9F through diode D2 and allow the PA forward power control unit to reestablish RF power output unless limited by low IPA drive or a high VSWR condition.

SECTION II
RF CIRCUIT MAINTENANCE

2-1. INTRODUCTION

2-2. This section provides maintenance information for the FM-30 FM transmitter RF circuitry.

2-3. SAFETY CONSIDERATIONS

WARNING

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

2-4. The FM-30 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. It is very dangerous to attempt to make measurements or replace components with power energized, therefore such actions are not recommended. The design of the equipment provides safety features such that when a door or access panel is opened, interlock switches will deenergize the plate and screen power supplies. Do not short out or bypass interlock switches as a maintenance short cut.

2-6. The power supply cabinet and the PA cabinet contain switches which discharge the PA plate potential directly to ground whenever either cabinet is opened.

2-7. Grounding sticks are provided as safety features. Each grounding stick consists of a metal rod with a phenolic handle. The metal end is connected to chassis ground. Use a grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting maintenance.

2-8. The grounding stick in the high voltage power supply cabinet and the grounding stick in the PA cabinet both rest on hook switches. When either of these grounding sticks is removed, the associated hook switch opens the transmitter interlock string and deenergizes the transmitter PA and screen potentials until each grounding stick is replaced on its respective hook switch.

2-9. MAINTENANCE

WARNING

ENSURE THE REMOTE/LOCAL SWITCH IS SET TO LOCAL BEFORE ATTEMPTING MAINTENANCE.

WARNING

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

2-10. GENERAL

2-11. The FM-30 maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-12. 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. Excess grid or screen dissipation is detrimental to the life expectancy of a tube. Also, excess plate dissipation signals nothing but trouble.

2-13. Occasionally a bit of heavy lubricant should be applied sparingly to the drives and tuning mechanism, especially the right angle gear drives.

2-14. IPA STAGE. The transistors in the IPA RF modules will normally last many times longer than the power amplifier tube unless some major problem occurs. An open circuit on the output, an extreme output VSWR, or an over voltage condition due to a regulator malfunction can shorten the life of the transistors. One indication of a transistor fault will be that IPA amplifier module RF output power will slowly decline while the dc input power remains constant. Under no circumstances should the RF input from the exciter be increased over 10% above that indicated by the factory test data sheets. When the driver output power declines with a fixed power input, the fault will usually be traced to mistuning, a high VSWR condition, or a faulty transistor and/or regulator.

2-15. ADJUSTMENTS

WARNING

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

2-16. Adjustment of many controls is considered obvious and may be accomplished with the information provided on the applicable schematic diagram. The following information is provided to assist adjustment of the more complex adjustments. However, it is never suggested that maintenance be performed on any circuitry within the transmitter with power applied to any portion of the transmitter.

2

2-17. SECOND HARMONIC TRAP. Adjustment of the second harmonic trap in the field will not normally be required, even if the PA tube is replaced. Adjustment should be attempted only when absolutely necessary. If it is certain that adjustment of the second harmonic trap is required, proceed as follows.

2-18. Required Equipment. The following equipment is required to complete adjustment of the second harmonic trap.

A. 5.64 inch (0.2 cm) hex wrench.

B. Tektronix 7613 Oscilloscope with 7L12 Spectrum Analyzer plug-in accessory or the equivalent capable of displaying frequencies at twice the frequency of operation.

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

D. A cable for the spectrum analyzer comprising the following:

   1. 10 feet (3.05 m) of Belden RG 58A/U coaxial cable (BE P/N 622-0050).

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

2-19. Procedure. To adjust the second harmonic trap, proceed as follows:

WARNING

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

2-20. Deenergize all primary power to the transmitter.

2-21. Open the PA cabinet rear door.

2-22. Loosen the hex-head lock-screw securing the second harmonic trap adjustment rod very slightly--just enough to allow in and out adjustment.

2-23. Close and lock the PA cabinet rear door.

2-24. Connect one end of the spectrum analyzer cable (Item D) to the RF sample port (J1) on the elbow just before the low-pass filter.

2-25. Connect the attenuator pad (Item C) in series with the cable and attach the attenuator pad to the spectrum analyzer input.

2-26. Energize the transmitter primary ac input.

2-27. Operate the transmitter at the normal power output and ensure all PA stage turning and loading controls are correctly adjusted.

2-28. Record the level of the second harmonic displayed on the spectrum analyzer ________________.

WARNING

DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-29. Disconnect all transmitter primary power.

2-30. Open the PA cabinet rear door.

CAUTION

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

2-31. Move the second harmonic trap adjustment rod slightly. Record the amount moved and the direction (in or out) __________________.

2-32. Close and lock the PA cabinet rear door.

2-33. Energize the transmitter primary ac input and operate the transmitter at the normal power output.

2-34. Repeat paragraphs 2-28 through 2-88, moving the second harmonic trap adjustment rod slightly in or out as required to minimize the second harmonic indication.

WARNING

DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-35. After the correct setting of the second harmonic suppressor is determined, disconnect all transmitter primary power.

2-36. Open the PA cabinet rear door.

2-37. Secure the hex-head lock-screw on the second harmonic trap adjustment rod.

2-38. Close and lock the PA cabinet rear door.

2-39. Disconnect the spectrum analyzer cable from J1 on the elbow just before the low-pass filter.

2-40. 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.

2-41. Required Equipment. The following equipment is required to complete PA neutralization.

A. RF microvoltmeter, 100 MHz, 1 millivolt scale (Boonton Electronics Corporation Model 92 B or equivalent with the following items):

1. RF probe (Boonton Model 91-12F).
2. 50 Ohm probe adapter (Boonton Model 91-88).
3. Adapter, BNC plug-to-plug (Pomona UG 491 A/U).

B. Locally fabricated adapter cable comprising 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).

C. Adapter, BNC receptacle to type N plug (Pomona UG 201A/U--BE P/N 417-3288).

D. No. 1 Phillips offset screwdriver.

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

F. AC extension cord, 3-wire, 12 feet (3.7 mm) long.

2-42. Procedure. To adjust PA neutralization, proceed as follows:

2-43. Operate the transmitter at the normal power output and ensure all PA stage tuning and loading controls are correctly adjusted.

2-44. Secure the INPUT LOADING, P.A. OUTPUT TUNING, and P.A. OUTPUT LOADING control knobs in position with tape. The controls must not be moved until the entire procedure has been completed.

2-45. Record the INPUT TUNING cyclometer indication, | | | | | |.

WARNING

ENSURE ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED BEFORE OPENING THE EQUIPMENT.

2-46. Deenergize all primary power to the transmitter.

2-47. Open the IPA cabinet rear door.

2-48. Disconnect the coaxial cable from the exciter RF OUTPUT connector.

2-49. Disconnect the cable from the input to the IPA directional coupler (front connector) mounted to the cabinet right side rail.

2-50. Connect the BNC receptacle-to-type N plug adapter to the IPA directional coupler input.

2-51. Connect the adapter cable between the adapter on the IPA directional coupler input and the exciter RF OUTPUT connector.

2-52. Disconnect wire No. 1 from TB1 terminal 7 on the rear of the exciter and connect a temporary wire jumper from TB1 terminal 6 to TB1 terminal 7.

2-53. Connect the exciter to an external power source with an electrical extension cord.

2-54. Route the extension cord along the cabinet base. Close and lock the IPA cabinet rear door.

2-55. Connect the RF microvoltmeter (item A) to the RF sample port in the output transmission line. Adjust the meter to the 1 microvolt scale and position the meter so that the scale may be viewed from the front of the FM-30.

WARNING

THREE-PHASE PRIMARY AC POWER MUST REMAIN OFF THROUGHOUT THE FOLLOWING PROCEDURE.

2-56. Energize the exciter ac input only. The three phase primary ac input must remain deenergized as the following procedure is completed without power applied.

2-57. Ensure the exciter is operating.

2-58. Depress the exciter RFL switch.

2-59. Adjust the INPUT TUNING control to minimize the exciter VSWR indication.

2-60. Secure the INPUT TUNING control in position with tape. The control must not be moved until the entire procedure has been completed.

2-61. Open the PA cabinet front door and note 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.

2-62. Open the PA cabinet 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.

2-63. After it has been determined that no PA tube potentials are present, mark the position of the four neutralization adjustments. Correct neutralization will be found very close to the present position of the neutralization adjustments.

2-64. Loosen the retaining screws in the bottom of each capacitor mounting bracket very slightly--just enough to allow adjustment. The capacitors can be swung in an arc, restricted only by the ends of the neutralizing segments.

2-65. When the neutralization procedure is properly completed, the four capacitors will be positioned approximately in the same relative location and direction relevant to the axis of the tube socket. Each capacitor fingerstock contact must rest on its respective neutralizing segment entirely, without exception (see Figure 2-1).

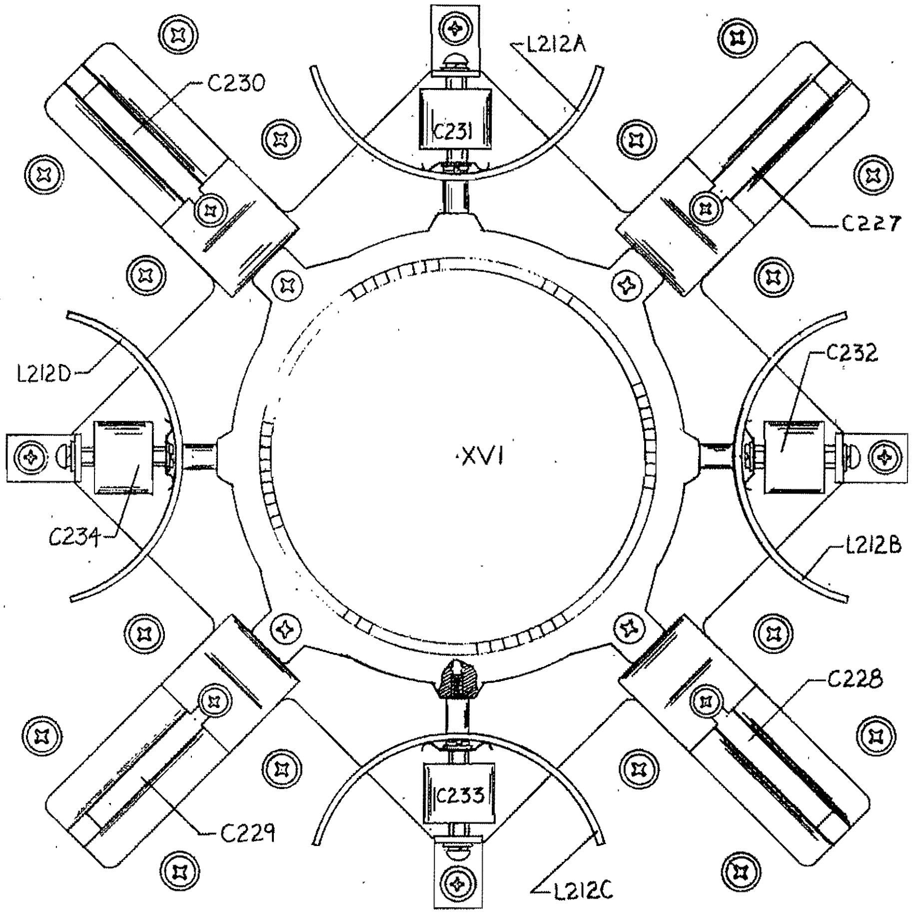

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FIGURE 2-1. PA NEUTRALIZATION

2-66. Neutralization is adjusted in the following manner.

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

B. Note the millivoltmeter indication.

C. Open the cavity access door and adjust one capacitor very slightly.

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

E. Note the change in the millivoltmeter indication.

F. Repeat steps A through E until a minimum millivoltmeter indication is noted and secure the capacitor.

G. Repeat steps A through F for the remaining segments.

H. Ensure the following conditions exist before closing the cavity access door:

1. Each capacitor contact plate rests completely against its respective neutralizing segment entirely.

2. All four capacitors are secured.

2-67. Close the cavity access door and replace the grounding stick in its hanger.

2-68. Disconnect the millivoltmeter from the output transmitter line.

WARNING

ENSURE ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED BEFORE OPENING THE EQUIPMENT.

2-69. Deenergize all primary power to the transmitter.

2-70. Open the IPA cabinet rear door.

2-71. Remove the electrical extension cord and reconnect the exciter power cord to the driver cabinet ac outlet strip.

2-72. Remove the test cable and adapter between the exciter and IPA directional coupler input.

2-73. Replace the IPA input cable on the exciter RF OUTPUT connector.

2-74. Replace the IPA output cable on the IPA directional coupler input.

2-75. Remove the temporary wire jumper from TB1 on the exciter rear panel and reconnect wire No. 1 to TB1-7.

2-76. Close and lock the IPA cabinet rear door.

2-77. Readjust the INPUT TUNING control to the indication recorded in paragraph 2-30.

2-78. IPA MODULE TUNING. Due to the complexity of the procedure, field adjustment of the entire IPA section is not recommended. If it is certain that total adjustment of the entire IPA section is required, contact the Broadcast Electronics, Inc. Customer Service Department for a recommended procedure. The following procedure provides information required to adjust the IPA Section MODULE 1 BASE TUNING and INPUT LOADING controls to maximize the match between the exciter and IPA section.

2-79. Required Equipment. The following equipment is required to adjust the IPA section MODULE 1 BASE TUNING and INPUT LOADING controls.

A. Insulated adjustment tool, flat screwdriver tip (BE P/N 710-0001).

2-80. Procedure. To adjust the IPA section MODULE 1 BASE TUNING and INPUT LOADING controls, proceed as follows:

2-81. With the transmitter operational, depress the exciter RFL switch.

2-82. Alternately, adjust the IPA stage MODULE 1 INPUT LOADING and BASE TUNING controls to minimize the exciter reflected power indication.

2-83. AUTOMATIC POWER CONTROL UNIT. To adjust the automatic power control unit, remove the panel adjacent to the AUTO/MAN switch. Adjustment data is provided by Figure 2-2.

2-84. TROUBLESHOOTING

WARNING

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

2-85. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indications (meters, LEDs, fuses, and the digital read-out) should be used to isolate the malfunction to one specific area.

CAUTION

THE IPA STAGE RF AMPLIFIER TRANSISTORS ARE ATTACHED TO A LARGE HEAT SINK. ENSURE A THIN FILM OF A ZINC-BASED HEAT-SINK COMPOUND IS USED (BE P/N 700-0028) WHENEVER AN AMPLIFIER DEVICE IS INSTALLED.

2-86. 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. IPA stage RF cabling is shown in Figure 2-3.

2-87. 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.

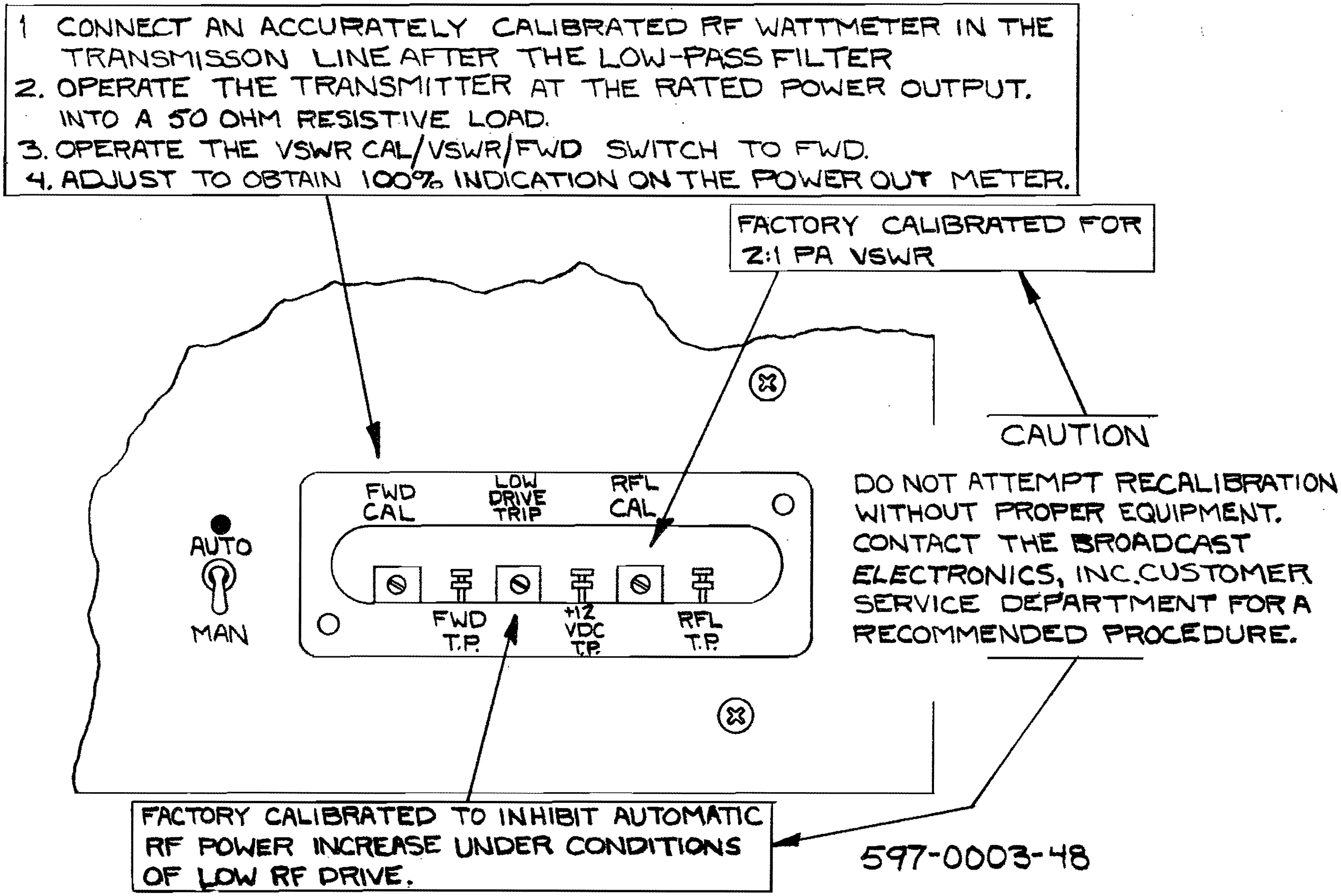
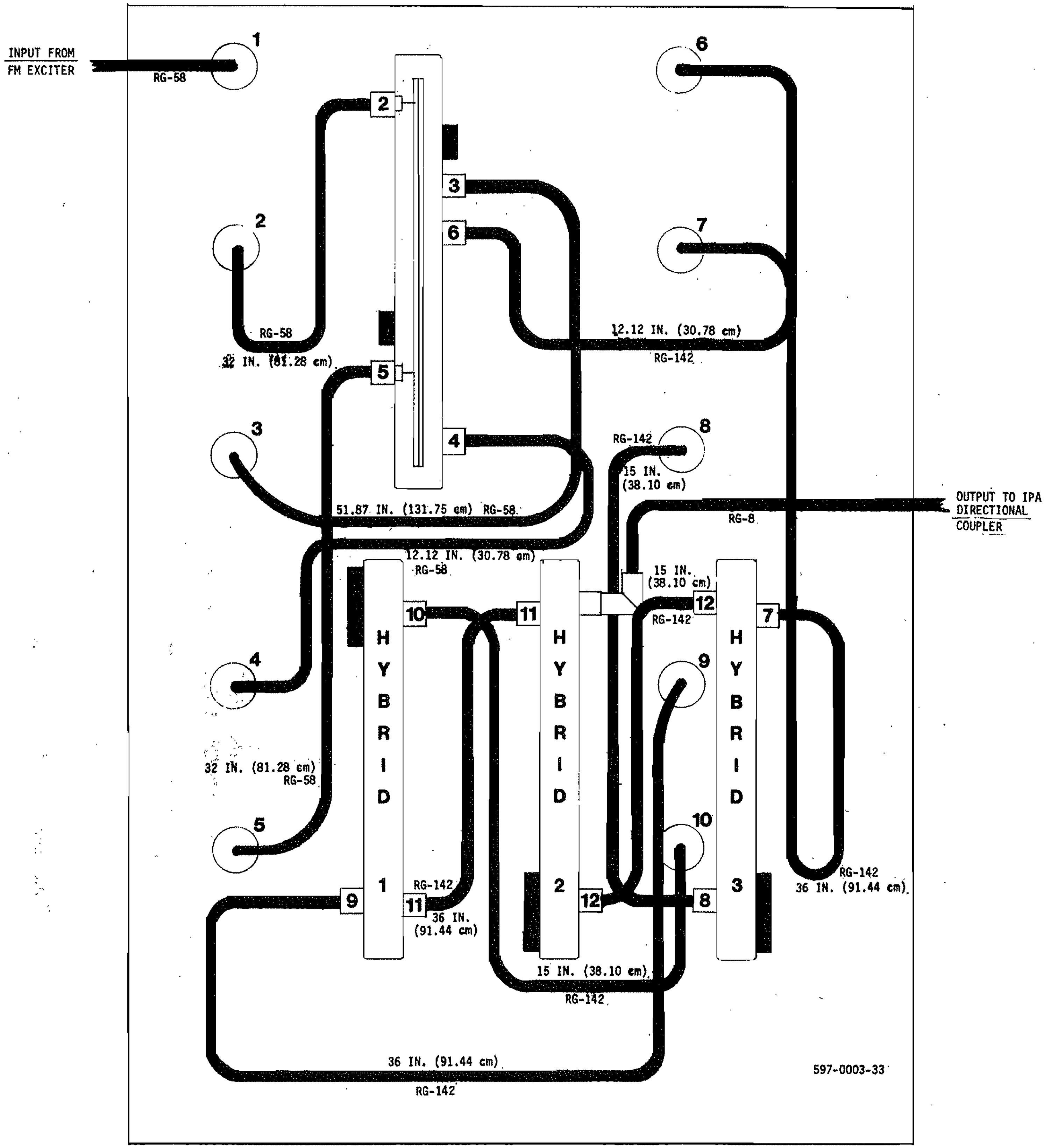


FIGURE 2-2. AUTOMATIC POWER CONTROL UNIT ADJUSTMENTS



CABLE INFORMATION			
CABLE	MANUFACTURER	MANUFACTURERS TYPE	BE P/N
RG-58 C/U	BELDEN	8262	622-0050
RG-8 A/U	BELDEN	9251	622-9251
RG-142 B/U	BELDEN	83242	621-0001

FIGURE 2-3. IPA STAGE RF AMPLIFIER CABLING

SECTION III
RF CIRCUIT DRAWINGS

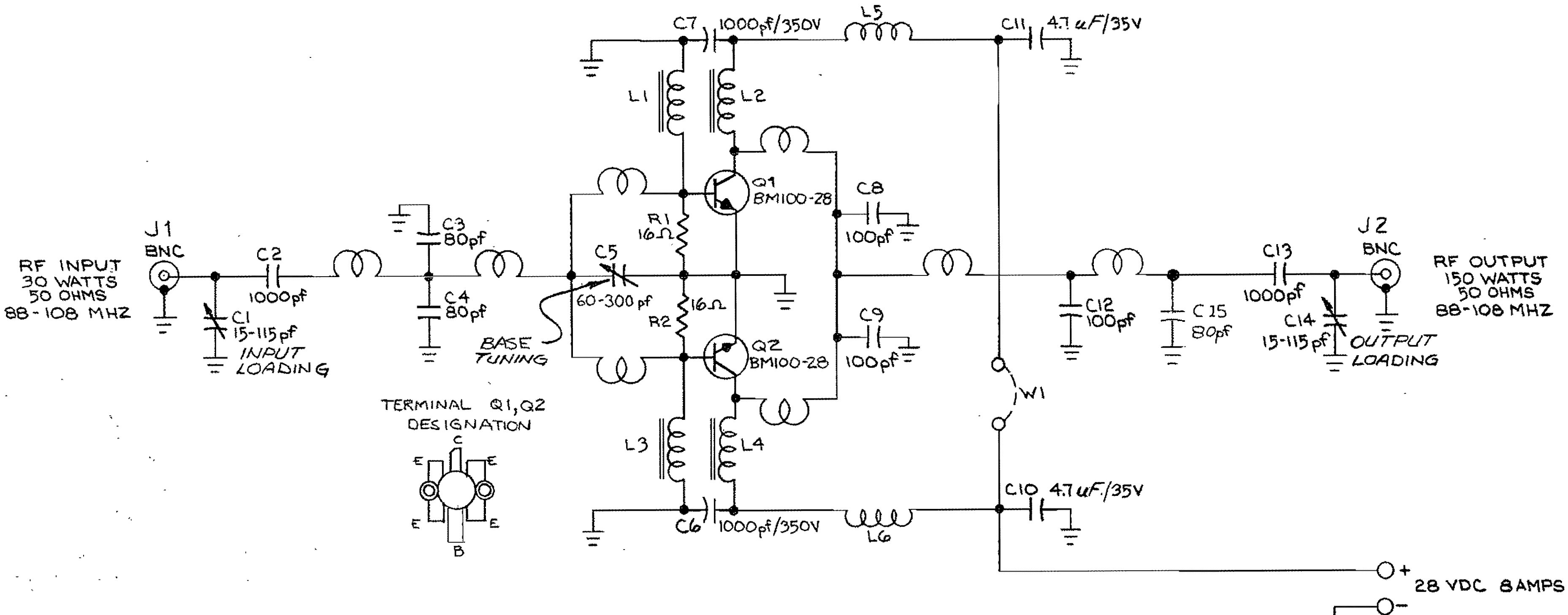
3-1. INTRODUCTION

3-2. This section provides assembly drawings, schematic diagrams, and wire lists as indexed below for the FM-30 Transmitter RF circuitry.

FIGURE	TITLE	NUMBER
3-1	Schematic, IPA RF Amplifier	B909-0004
3-2	Assembly, IPA RF Amplifier	B917-0004
3-3	Assembly, IPA Directional Coupler	B951-1012
3-4	Assembly, IPA Directional Coupler Buffer Amplifier	B955-0001
3-5	Schematic, IPA Directional Coupler Buffer Amplifier	B979-0058
3-6	Assembly, IPA Directional Coupler Buffer Amplifier Circuit Board	B919-0011
3-7	Assembly, IPA Hybrid Combiner Diode Detector	A917-0009
3-8	Assembly, PA Cabinet Input Circuit	597-0003-37A,B
3-9	Assembly, IPA Ammeter Meter Shunt Board	B955-0031
3-10	Schematic, IPA Multimeter	B909-0020
3-11	Assembly, IPA Multimeter	A917-0020
3-12	Schematic, Automatic Power Control Unit Assembly	D979-0032
3-13	Assembly, Automatic Power Control Unit Power Supply and Control Assembly	C919-0032
3-14	Assembly, Automatic Power Control Unit Low-Pass Filter	B919-0031
3-15	Schematic, Automatic Power Control Unit Circuit Board	D979-0033
3-16	Assembly, Automatic Power Control Unit Circuit Board	C919-0033
3-17	Schematic, Screen and Bias Supply Metering Board	B909-0026
3-18	Assembly, Screen and Bias Supply Metering Board	B917-0026
3-19	Assembly, Hours Meter Filter Circuit Board	A917-0051
3-20	Assembly, PA Meter Multiplier	B917-0016
3-21	Final Assembly, PA Directional Coupler	B950-6907
3-22	Sub-Assembly, PA Directional Coupler	B950-6906

2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 2712	6-2-81	GED
B	PER ECN NO. 2948	10-5-81	JDS



NOTES:

1. Q1 & Q2 ARE EXTERNAL TO PCB ASS'Y.
2. LAST COMPONENTS USED: C15, L16, Q2, R2, W1.
3. SEE PCB ASSY DWG. # B-917-0004
   SEE B/M # 917-0004
4. ⌒⌒ INDICATES SECTION OF ETCHED MICROSTRIP LINE.

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

MATERIAL

DRAWN BY M. HAYDEN	DATE 7-2-79
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE RF AMPLIFIER MODULE (FM)

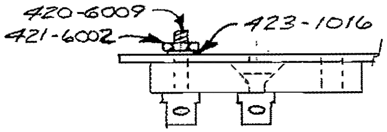
B DWG. NO. 909-0004 REV. B.

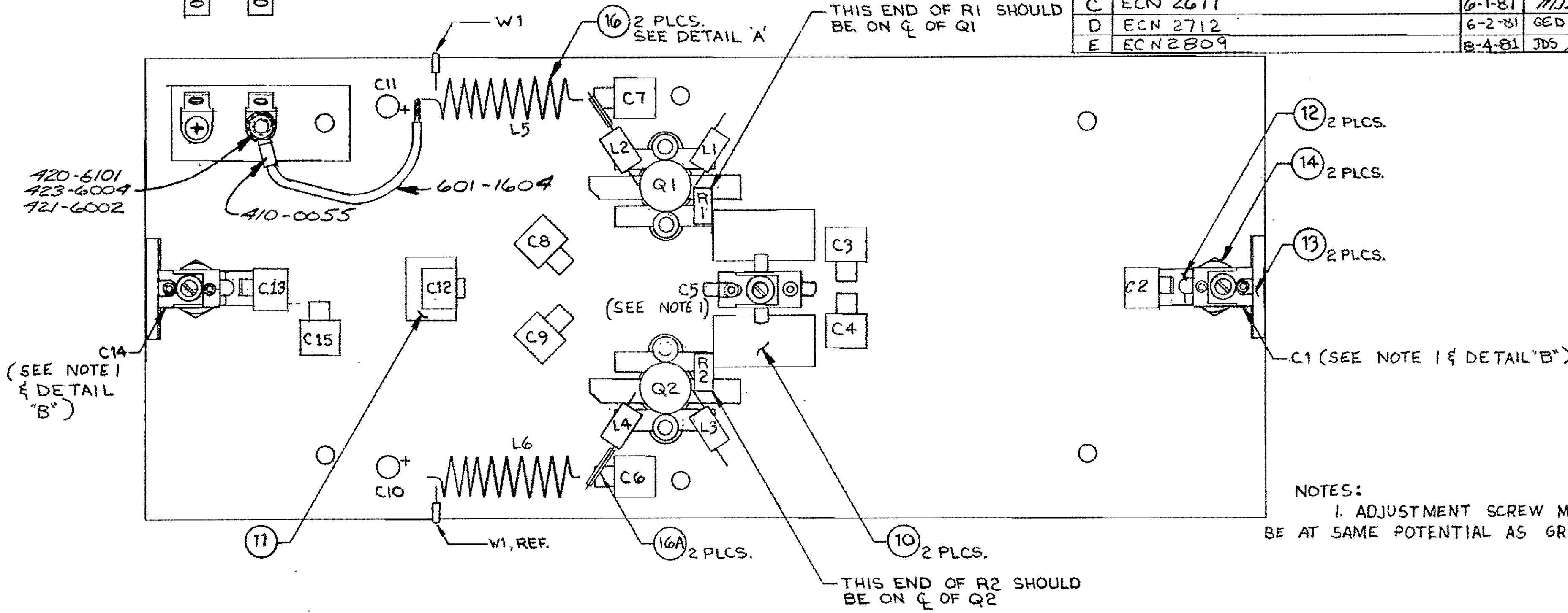
30KW TRANSMITTER | SCALE — | SHEET 1 OF 1

F	PER. ECN NO. 2946 SHT. 1	10-5-81	JDS
G	PER ECN 2978 SHT 1	10-13-81	MH

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN 2009	4-23-80	JH
B	PER ECN 2248	8-13-80	mm
C	ECN 2677	6-1-81	MJS
D	ECN 2712	6-2-81	GED
E	ECN 2809	8-4-81	JDS



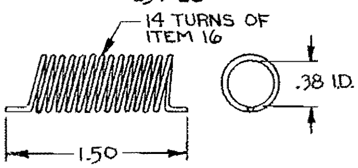


NOTES:

1. ADJUSTMENT SCREW MUST BE AT SAME POTENTIAL AS GROUND.

DETAIL "A"

L5 & L6



SEE B/M # 917-0004

SEE SCHEMATIC # B-909-0004

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

MATERIAL

DRAWN BY M. HAYDEN	DATE 6-5-79
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

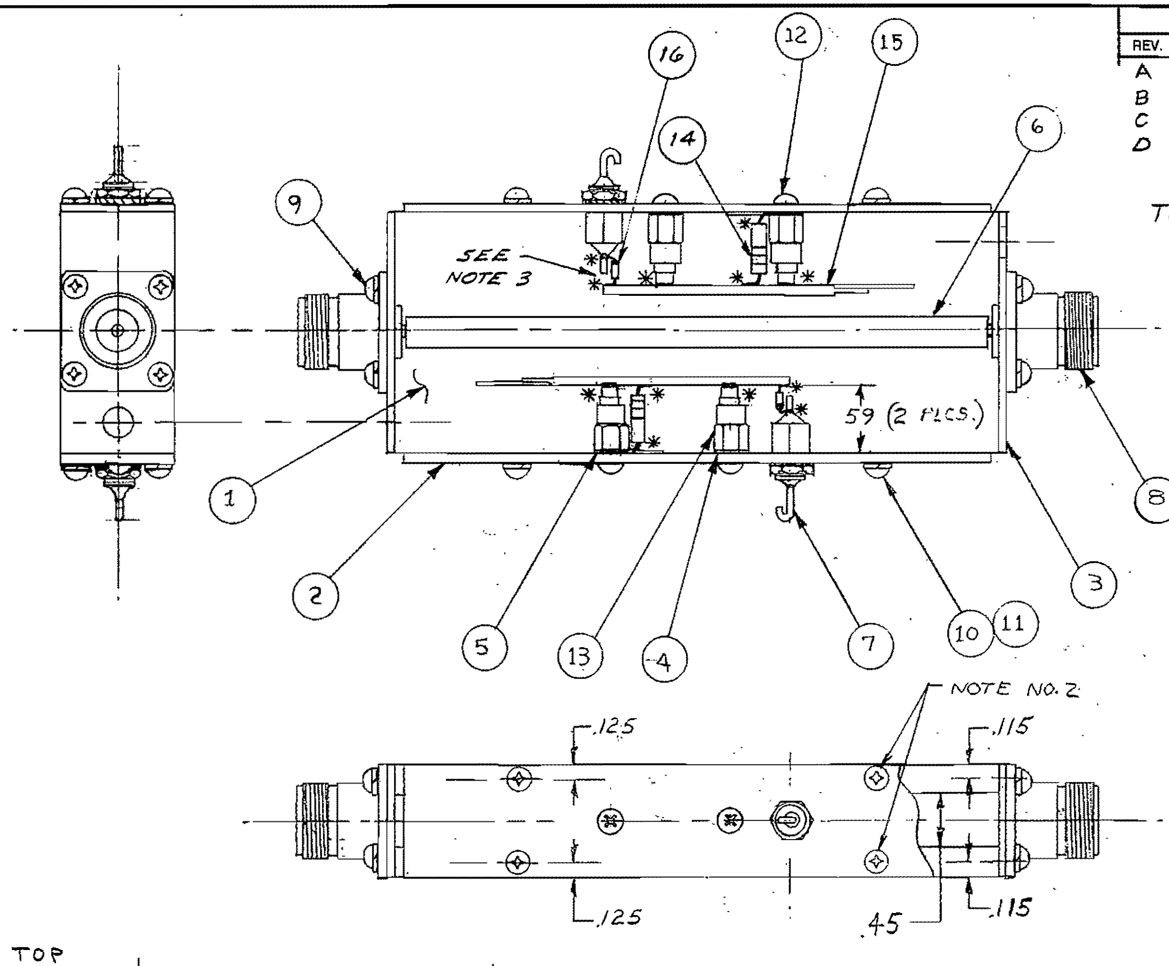
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE: RF AMPLIFIER MODULE (FM)

B | DWG. NO. 917-0004 | REV. G

30KW TRANSMITTER | SCALE 1/1 | SHEET 1 OF 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN #1997	4-21-80	MH
B	PER ECN NO. 2886	9-8-81	J.D.S.
C	PER ECN NO.2977	10-12-81	J.D.S.
D	PER ECN #3410	4-13-82	MERK

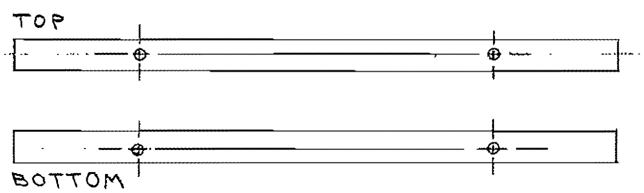


TOP PLATE OMITTED FOR CLARITY.

NOTES:

1. SOLDER AT MARK ✳ (12 PLC'S)
2. WHEN PUTTING SIDE PLATE ON TOP & BOTTOM BARS, ALIGN SCREW HOLES SO THAT HOLES ARE CLOSER TO TOP & BOTTOM; SEE DETAIL "A".
3. NOTE THAT END OF TRIM TAP IS CENTERED ABOVE FEED-THRU CAPACITOR & LEADS ON DIODES & RESISTORS ARE AS SHORT AS POSSIBLE. CAPACITOR HOOK IS CUT OFF.

SEE SCHEMATIC #D-909-0300
SEE B/M 951-1012



DETAIL "A"

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

MATERIAL

DRAWN BY CRM	DATE 12-12-78
CHECKED BY B.L.	DATE 12-18-78
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

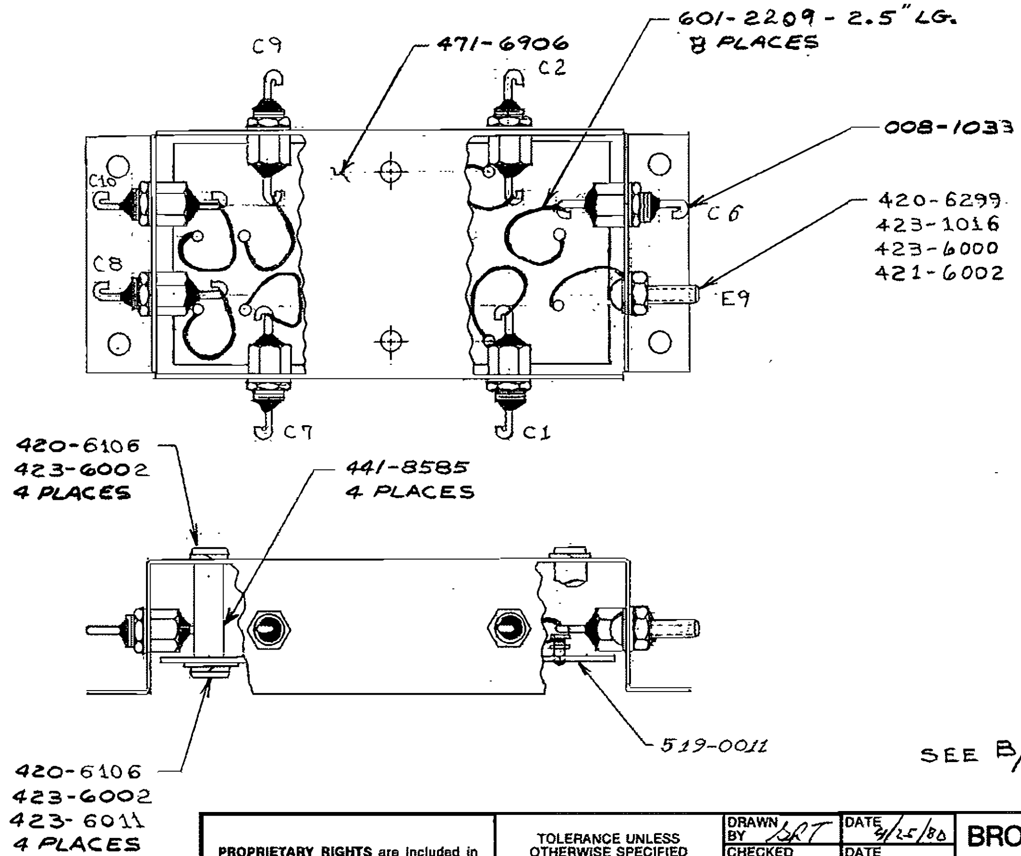
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY - IPA DIRECTIONAL COUPLER

B DWG. NO. 951-1012 REV. D

FM TRANSMITTER SCALE 1/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 2233	8-11-80	mm
B	PER ECN # 2337	9-25-80	mm
C	PER ECN # 2616	4-14-81	DK
D	PER ECN NO. 2886	9-10-81	JDS



SEE B/M 955-0001

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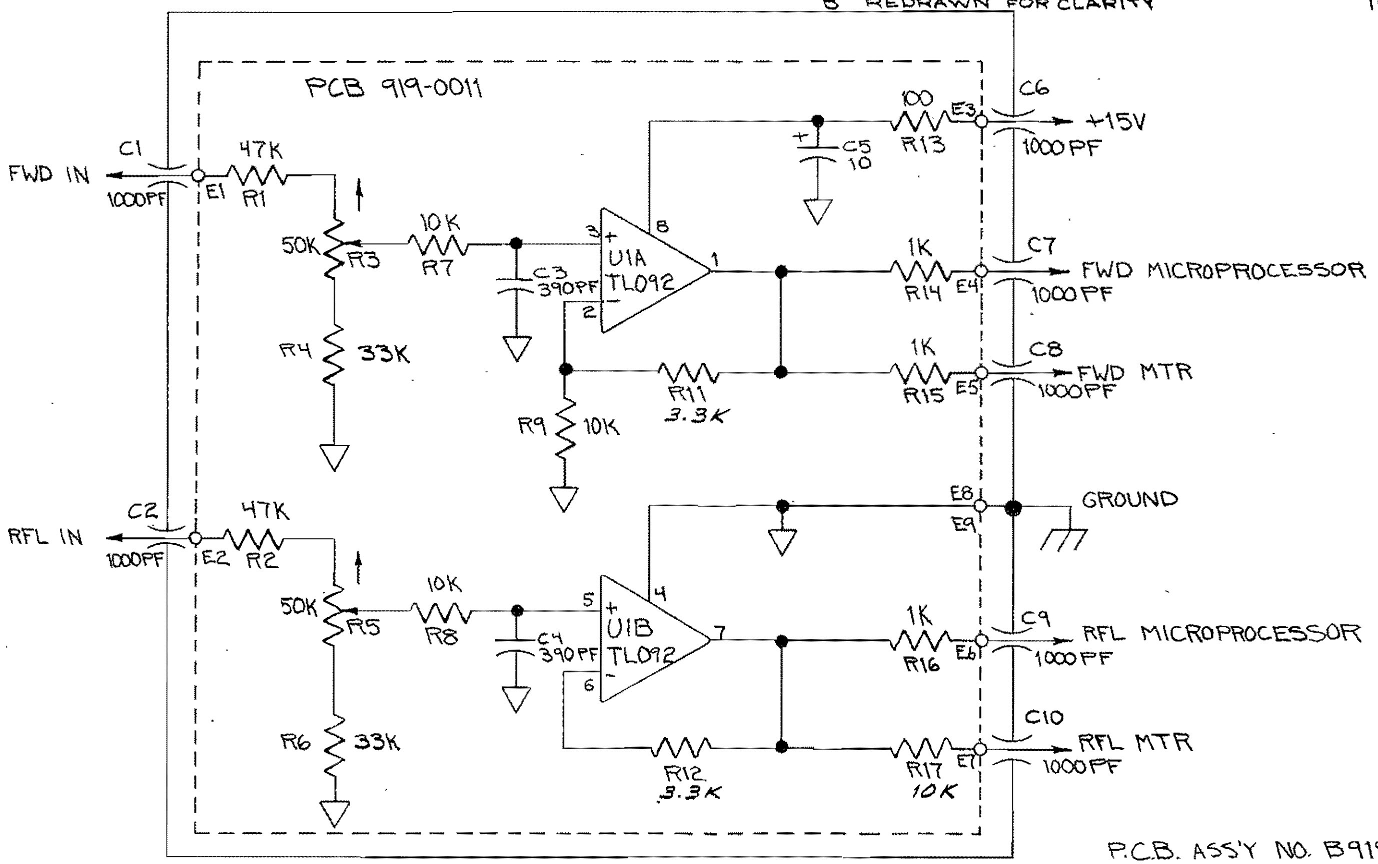
	MATERIAL NOTED	TREATMENT OR FINISH	B DWG. NO. 955-0001 REV. D FM30 SCALE 1/1 SHEET 1 OF 1

C	PER ECN #3131	12-9-81	JAH
D	PER ECN 3377	4-8-82	MERK

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	PER TCN 909-2000-1		
B	REDRAWN FOR CLARITY	11-9-81	JAH



P.C.B. ASS'Y NO. B919-0011

B/M NO. 919-0011

NOTES:

1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS, U.O.S
2. LAST COMPONENTS USED: C10, R17, U1, & E9
3. COMPONENTS NOT USED: R10

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

MATERIAL

TREATMENT OR FINISH

DRAWN BY	J.A.H.	DATE	11-9-81
CHECKED BY		DATE	
PROJECT ENGR.	JAML	DATE	11-9-81
APPROVED BY	MH		11-9-81

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC IPA FWD/RFL BUFFER AMPLIFIER

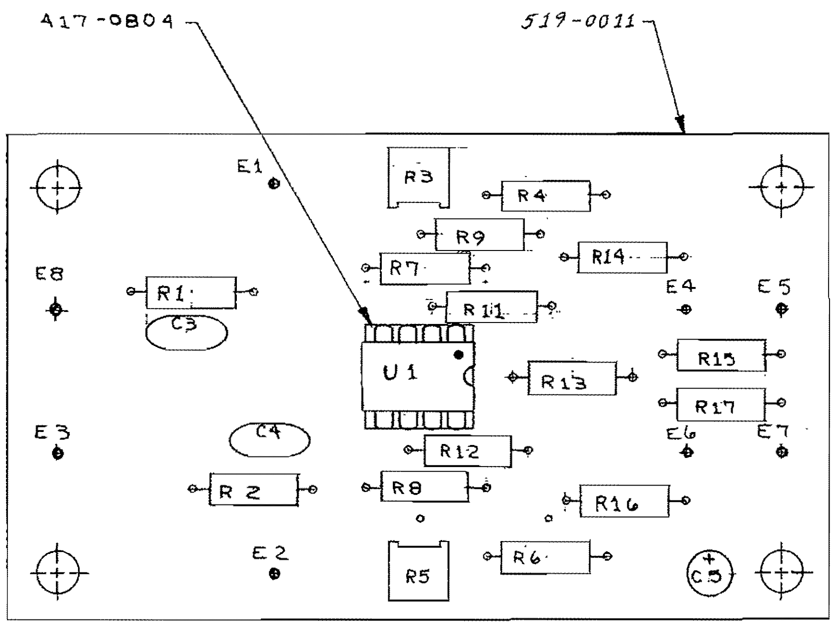
B DWG. NO. 979-0058 REV. D

FM 30-FM5 DRIVER CABINET

SCALE —

SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN #3131	12-10-81	JAH
B	PER ECN 3377	4-8-82	MERK



SEE TCN NO. 909-2000-1, SKETCH NO. 5
SEE B/M 919-0011
SEE SCHEMATIC NO. B979-0058

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

MATERIAL

DRAWN BY J.D.SAWYER	DATE 9-1-81
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY MH	9-15-81

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

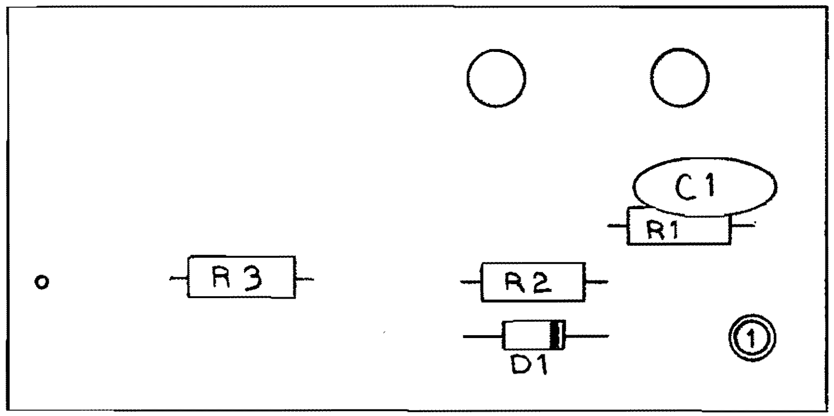
TITLE ASS'Y PCB - FWD/VSWR BUFFER AMPLIFIER

B DWG. NO. 919-0011 REV. B

FM 30-FM5 DRIVER CABINET

SCALE 2/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



SEE B/M #917-0009
SEE SCHEMATIC #D909-0300

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

MATERIAL

DRAWN BY M.HAYDEN	DATE 6-25-79
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY, IPA
HYBRID COMBINER DIODE DETECTOR

A DWG. NO. 917-0009 REV.

TRANSMITTER SCALE 2/1 SHEET 1 OF 1

POWER SUPPLIES

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1

SECTION I

POWER SUPPLY THEORY OF OPERATION

1-1. INTRODUCTION

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

1-3. SEQUENCE OF OPERATION

1-4. Three-phase power is distributed throughout the transmitter circuitry whenever primary power is applied to the transmitter.

1-5. When the high voltage power supply HIGH VOLTAGE PRIMARY circuit breaker is closed, power is applied to the start contactor and the step relay. When the PA cabinet PRIMARY POWER circuit breaker is closed, power is applied to the hum null circuit, the filament relay, the blower contactor, and the primary isolation transformer. The primary isolation transformer applies 115 Vac power to the IPA directional coupler buffer power supply, the microprocessor controller power supply, and the accessory control relay and accessory outlets in the driver cabinet.

1-6. When the FILAMENT ON switch is depressed, the blower relay will close. At the same time, the accessory control relay in the driver cabinet will energize and apply power to the exciter and optional equipment. After the blower comes up to speed and closes the air switch, the filament relay will close and apply power to the control grid power supply, the PA filament circuit, and the IPA power supply.

1-7. Assuming the HIGH VOLTAGE ON switch has been depressed, the start sequence will continue after a 15 second delay to allow PA tube heating. When the PA tube heating delay expires, the step/start timer will energize the step relay, then energize the start contactor, then deenergize the step relay to apply full power to the plate and screen supplies.

1-8. If the power to the filament supply should open during operation, the high voltage filament interlock relay will open the start contactor and deenergize the plate and screen supplies.

1-9. When the HIGH VOLTAGE OFF switch is depressed, the start contactor will open immediately and deenergize the plate and screen supplies. When the FILAMENT OFF switch is depressed, the remainder of the transmitter supplies will deenergize. The blower will continue to operate for 15 seconds to allow the PA stage to cool.

1-10. FUNCTIONAL DESCRIPTION

1-11. A 196 to 252 volt, 60 Hz, three-phase ac input from a closed delta or wye power source is required for proper operation of the FM-30 transmitter. The following supplies operate from the three-phase input. All values shown are typical for 30 kW operation.

A. PA PLATE	+9300V at 4.2 Amperes
B. PA SCREEN GRID	+500V at 0.240 Amperes
C. PA CONTROL GRID	-290V at 0.140 Amperes
D. PA FILAMENT	10 Vac at 140 Amperes
E. IPA	+36V at 37.5 Amperes
1. IPA RF MODULE	+27.5V at 7.5 Amperes
F. IPA DIRECTIONAL COUPLER BUFFER	+15V at 0.1 Amperes +5.1V at 0.01 Amperes
G. AUTOMATIC POWER CONTROL UNIT	+12V at 0.1 Amperes
H. CONTROLLER	+24V at 2 Amperes +5V at 0.3 Amperes
I. AUXILIARY AC	AC input to exciter, stereo generator, SCA generator, etc.

1-12. PA PLATE POWER SUPPLY

1-13. The high voltage power supply is a three-phase primary, six-phase secondary supply. The primary circuit is connected in a closed delta arrangement and protected by circuit breaker CB300. Component stress at power on is eliminated by a step/start circuit which limits supply inrush current.

1-14. A +18 volt "high voltage on" signal from the controller is applied to a circuit containing two dual schmitt-trigger drivers. The input is interlocked through contacts of the filament relay to assure that the filament circuit is energized before a high voltage on sequence is initiated. The step driver energizes the step relay to energize the primary of T300 through three limiting resistors. After a short delay, the second schmitt-trigger driver will energize the start contactor and apply the full primary potential to T300. The step relay will deenergize after the relay has been energized for 160 milliseconds. In this manner the current limiting resistors will only be subject to heating during the short interval between step and start closures.

1-15. The secondary of the high voltage transformer is connected in a wye configuration. Due to the physical construction of the transformer, each phase appearing in the secondary will lead and lag a respective phase appearing in the primary by 60 degrees. The secondary phase separation of 60 degrees divided into one primary phase of 360 degrees equals six secondary phases.

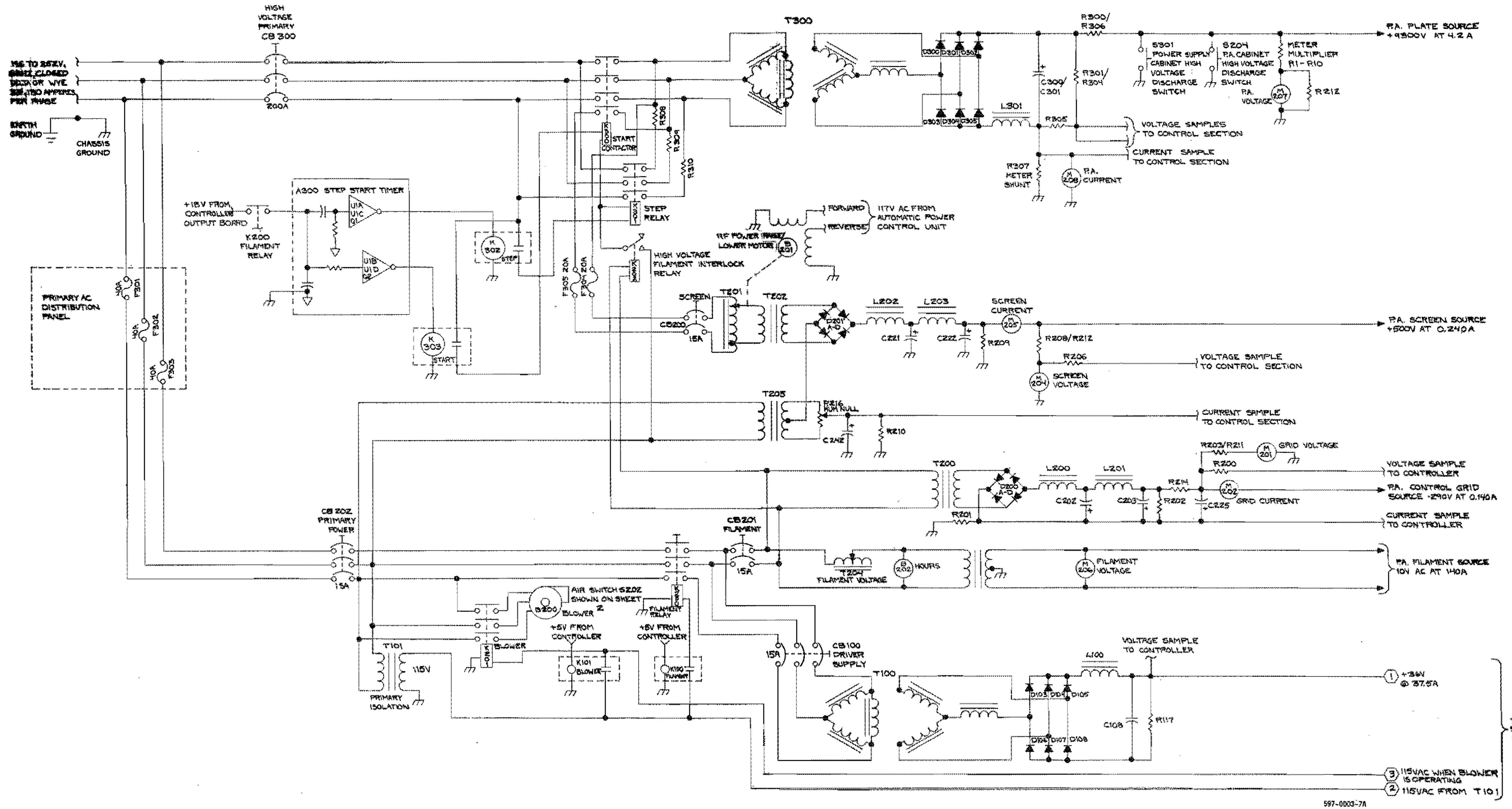


FIGURE 1-1. POWER SUPPLY SIMPLIFIED SCHEMATIC DIAGRAM
(SHEET 1 OF 2)

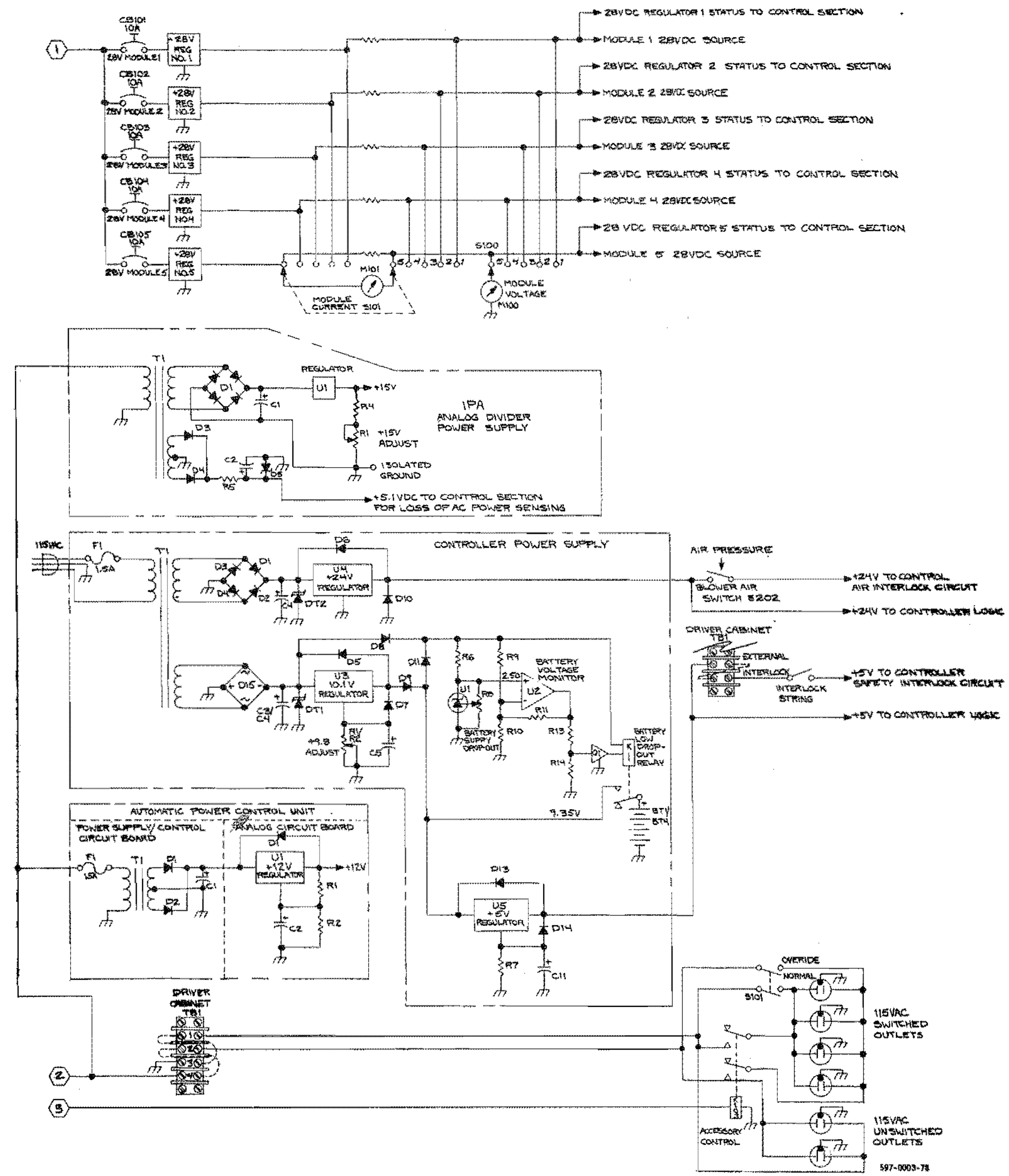


FIGURE 1-1. POWER SUPPLY SIMPLIFIED SCHEMATIC DIAGRAM (SHEET 2 OF 2)

1-16. Little filtering is required as only 4.2 percent ripple is output from the rectifiers. One requirement of the multiphase supply, however is that the primary ac input must be balanced to within the percentage of ripple voltage which is to be obtained from the supply. Constant primary ac line unbalance can be corrected by the use of primary taps or a tapped three-phase autotransformer.

1-17. Filtering for the supply is accomplished by a one-section choke-input filter. The choke is inserted in the negative leg of the rectifier output to eliminate the dc potential between the choke and ground. The negative leg of the supply is referenced to ground through the PA stage current meter shunt. Bleeder resistors connected across the supply increase regulation and in conjunction with interlocked high voltage discharge switches, enhance safety. A series resistance in the anode dc feedline limits peak energy in case of arc-overs in the power amplifier stage or grounding switch operations.

1-18. Status outputs from this supply provide voltage and current samples to the microprocessor controller and a voltage sample to the automatic power control unit.

1-19. PA SCREEN GRID POWER SUPPLY

1-20. The screen power supply is a full-wave bridge rectified supply with a two section filter. The primary of the screen transformer is connected through CB200 to two phases of the three-phase ac input to the high voltage power supply transformer. The output of the screen supply is manually adjustable with a variable autotransformer connected in the primary of the screen transformer. A motor connected to the variable autotransformer allows remote adjustment. The ground return path for the screen supply is routed through the hum null circuit which introduces a small 60 Hz component into the screen supply to cancel hum. The amount of voltage added to the negative side of the screen supply is adjusted by R216.

1-21. Status outputs from the screen supply provide voltage and current samples to the microprocessor controller.

1-22. PA CONTROL GRID POWER SUPPLY

1-23. The control grid bias supply is a full-wave bridge rectified supply with a two section filter. The primary of the supply is connected across two phases of the three-phase ac input at the filament relay. Circuit breaker CB201 provides overload protection for the supply. Voltage and current samples from the supply are applied to the microprocessor controller as status indications.

1-24. IPA POWER SUPPLY

1-25. The IPA stage power supply is a three-phase primary six-phase secondary supply similiar to the PA plate power supply. All the general considerations listed for the PA plate power supply also apply to the IPA supply. The output of the supply is sampled by the microprocessor controller as a status indication.

1-26. The secondary of the IPA transformer is connected in a wye configuration. After rectification, the output is applied to a single section choke input filter and bleeder. The output of the supply terminates in five 10 Ampere circuit breakers which provide overlaod protection for the following five regulators. Each circuit breaker can be used as a switch for troubleshooting purposes.

1-27. IPA MODULE SUPPLY. Each plug-in regulator module is a 28 volt, 10 ampere current limiting unit providing safe area dissipation protection and remote shutdown (see Figure 1-2).

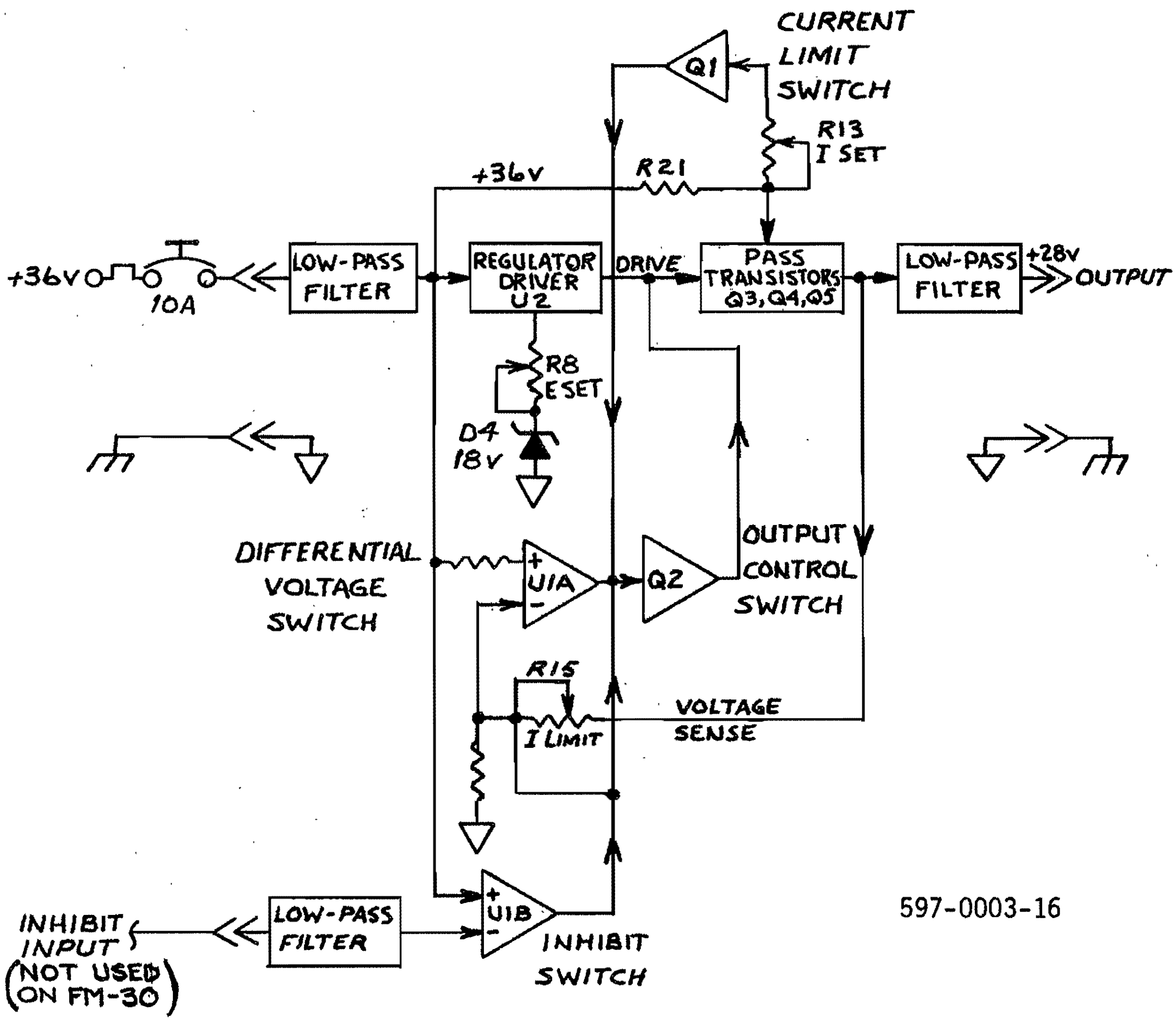


FIGURE 1-2. REGULATOR BLOCK DIAGRAM

1-28. Regulator Circuit. The input and output from each supply is routed through a low-pass filter to prevent RF interference with the supply operation. The input potential is applied to three-terminal regulator U2 which drives the output stage pass transistors (Q3, Q4, and Q5). The drive level is adjusted by the E SET control (R8) and stabilized by zener diode D14. An additional output from each regulator is applied to the microprocessor controller as a status indication.

1-29. Current Limiting. Current flow in the output stage is sensed by a voltage drop across resistor R21. When a preset limit established by the I SET control (R13) is exceeded, the current limit switch (Q1) will operate and trigger the output control switch (Q2) which decreases the drive applied to the pass transistors.

1-30. Safe Area Protection. Output voltage from the pass transistors is monitored by differential voltage switch U1A and compared to the module input potential. When a drop in output voltage is sensed, U1A will trigger the output control switch (Q2) which will decrease the drive applied to the pass transistors. The sense line to U1A is calibrated by the I LIMIT control (R15).

1-31. Remote Shutdown. As an optional feature used in some transmitters, circuitry exists which allows interruption of the output of the IPA section RF amplifiers. Inhibit switch U1B accommodates this feature by triggering the output control switch (Q2) which removes drive from the pass transistors.

1-32. IPA DIRECTIONAL COUPLER BUFFER POWER SUPPLY

1-33. The IPA directional coupler buffer power supply contains two supplies. Both supplies are operated from a common transformer powered by 115 Vac from primary isolation transformer T101.

1-34. The +15 volt supply is a full-wave bridge rectified supply with a one section filter. The rectifier is followed by a three-terminal voltage regulator which is adjustable with control R1.

1-35. The +5.1 volt supply is full-wave rectified and followed by a one section filter. A zener diode stabilizes the output of the supply which is applied to the microprocessor controller to signal loss of ac power.

1-36. AUTOMATIC POWER CONTROL UNIT POWER SUPPLY

1-37. The automatic power control unit power supply operates from a primary potential of 115 Vac obtained from primary isolation transformer T101. Fuse F1 provides overload protection.

1-38. The supply is full-wave rectified and followed by a one section filter. The filter section is followed by a three-terminal adjustable voltage regulator which provides a stable +12 Vdc source from the +18 Vdc input.

1-39. MICROPROCESSOR CONTROLLER POWER SUPPLY

1-40. The power supply for the microprocessor controller provides +24 and +5 volt outputs to operate the controller and its interface. The supply operates from a 115 volt ac input obtained from primary isolation transformer T101. Fuse F1 provides overload protection.

1-41. The 24 volt supply is full-wave bridge-rectified and followed by a single section filter. The supply is regulated by fixed three-terminal regulator U4 which outputs a +24 volt dc potential.

1-42. The second supply functions as a voltage source for the five volt regulated supply and acts as a charger source for the built-in battery back-up supply. The batteries are on charge whenever the primary input is energized. In event ac power fails, enough energy is contained in the batteries to operate the microprocessor controller display for a period of approximately three hours to assist troubleshooting.

1-43. This supply is full-wave bridge rectified and followed by a single section filter. The supply is preregulated to 10.1 Vdc by U3. U5 re-regulates this potential to output +5 Vdc.

1-44. The preregulated 10.1 volt potential is also applied to a circuit comprising U1, U2, and Q1 which monitors the battery voltage in case the power fails and disconnects the battery stack when the output falls low to prevent damage to the batteries.

1-45. The battery disconnect circuit operates as follows: Precision voltage reference U1 is adjusted with control R8 to establish a threshold of 2.50 volts on the non-inverting input of comparator U2. When the inverting input of U2 (battery supply line) falls below this 2.50 volt threshold, the output of U2 will enable Q1 which deenergizes relay K1 and disconnects the battery supply output.

SECTION II
POWER SUPPLY MAINTENANCE

2-1. INTRODUCTION

2-2. This section provides maintenance information for the FM-30 FM transmitter power supplies.

2-3. SAFETY CONSIDERATIONS

WARNING

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

2-4. The FM-30 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. It is very dangerous to attempt to make measurements or replace components with power energized, therefore such actions are not recommended. The design of the equipment provides safety features such that when a door or access panel is opened, interlock switches will deenergize the plate and screen power supplies. Do not short out or bypass interlock switches as a maintenance short cut.

2-6. The power supply cabinet and the PA cabinet contain switches which discharge the PA plate potential directly to ground whenever either cabinet is opened.

2-7. Grounding sticks are provided as safety features. Each grounding stick consists of a metal rod with a phenolic handle. The metal end is connected to chassis ground. Use a grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting maintenance.

2-8. The grounding stick in the high voltage power supply cabinet and the grounding stick in the PA cabinet both rest on hook switches. When either of these grounding sticks is removed, the associated hook switch opens the transmitter interlock string and deenergizes the transmitter PA and screen potentials until each grounding stick is replaced on its respective hook switch.

2-9. MAINTENANCE

WARNING

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

WARNING

ENSURE THE REMOTE/LOCAL SWITCH IS SET TO LOCAL BEFORE ATTEMPTING ANY MAINTENANCE.

2-10. The FM-30 maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-11. ADJUSTMENTS

WARNING

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

2-12. Adjustment of many controls is considered obvious and may be accomplished with the information provided on the applicable schematic diagram. The following information is provided to assist adjustment of the more complex controls. However, it is never suggested that maintenance be performed on any circuitry within the transmitter with power applied to any portion of the transmitter.

2-13. IPA MODULE REGULATORS. To adjust the IPA module regulators, proceed as follows.

2-14. Required Equipment. The following equipment is required to complete adjustment of the IPA module regulators.

A. External 36 volt, low current dc power supply.

B. Calibrated dc voltmeter (Simpson 260 or equivalent).

C. Number 1 Phillips screwdriver, 4 inch (10.16 cm) blade.

D. Insulated adjustment tool, Flat screwdriver tip (BE P/N 710-0001).

E. Soldering Iron, 60 Watt.

F. Solder Removal Tool.

2-15. Procedure. To adjust the IPA module regulators, proceed as follows:

WARNING

DISCONNECT PRIMARY POWER BEFORE PROCEEDING.

2-16. Disconnect all primary power.

2-17. Open the IPA cabinet rear access door.

2-18. Four wires are soldered to each regulator. Unsolder the wires from each circuit board to be removed.

2-19. Each circuit board assembly is mounted to the main heat sink assembly with two Phillips head screws. Remove the screws from each regulator to be removed.

2-20. Adjust the following controls as indicated (see Figure 2-1).

A. E Set control (R8) to center of its range.

B. I Set control (R13) fully counterclockwise (the I Set control remains fully counterclockwise).

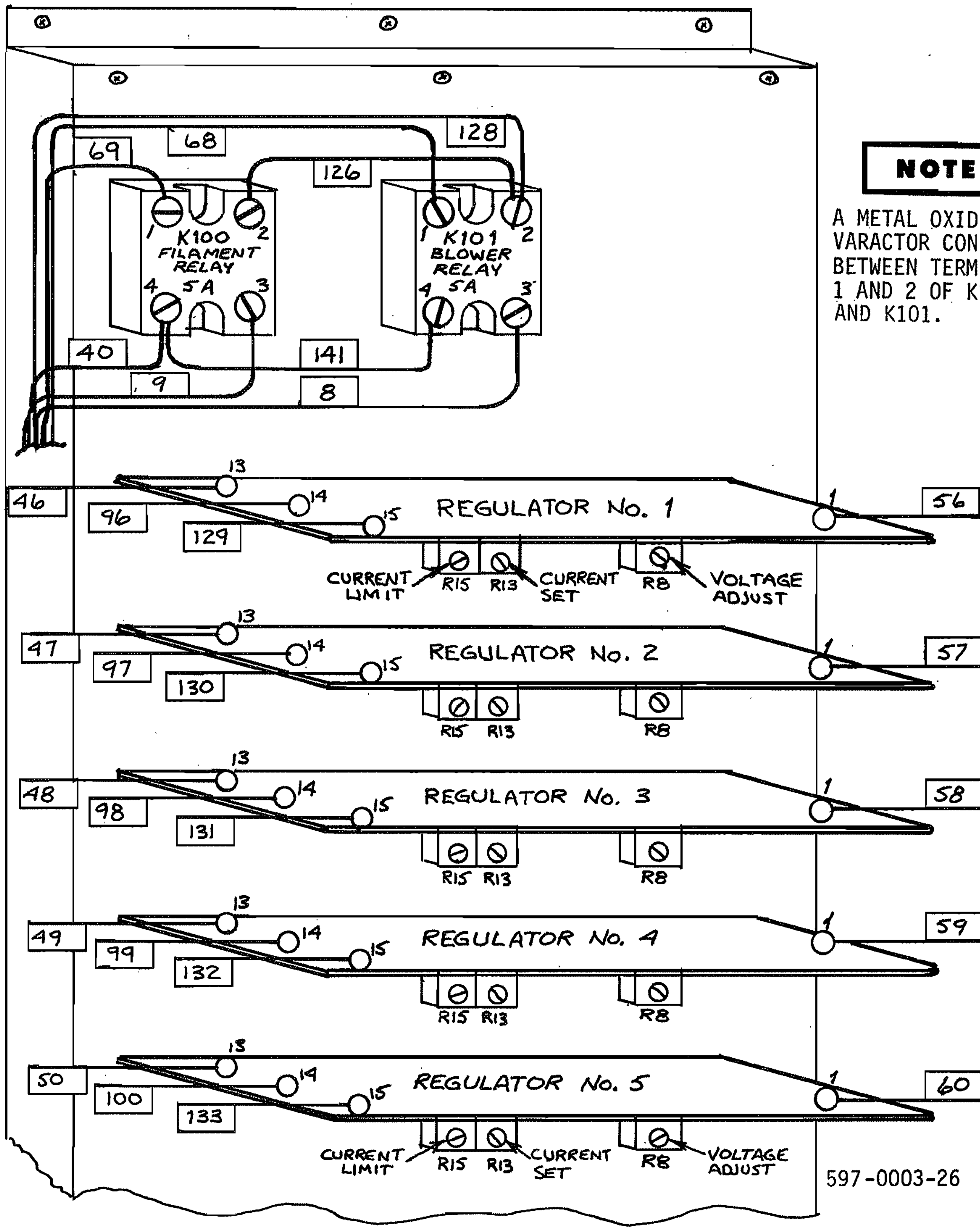
2-21. Connect the voltmeter positive lead to terminal 13 and the negative lead to terminal 1.

2-22. Connect the external 36 volt dc power supply positive to terminal 14 and the negative to terminal 15.

2-23. Energize the power supply and adjust R8 to obtain a voltmeter indication of 27.5 volts.

CAUTION

THE IPA STAGE REGULATORS ATTACH TO A LARGE HEAT SINK. ENSURE A THIN FILM OF A ZINC-BASED HEAT-SINK COMPOUND IS USED (BE P/N 700-0028) WHENEVER A REGULATOR IS INSTALLED.



NOTE

A METAL OXIDE VARACTOR CONNECTS BETWEEN TERMINALS 1 AND 2 OF K100, AND K101.

FIGURE 2-1. IPA MODULE REGULATOR WIRING DIAGRAM

2-24. Replace the module(s) in the equipment. Wiring information is shown in Figure 2-1.

2-25. TROUBLESHOOTING

WARNING

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

2-26. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indications (meters, LEDs, fuses, and the digital read-out) should be used to isolate the malfunction to one specific area.

2-27. 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.

2-28. 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.

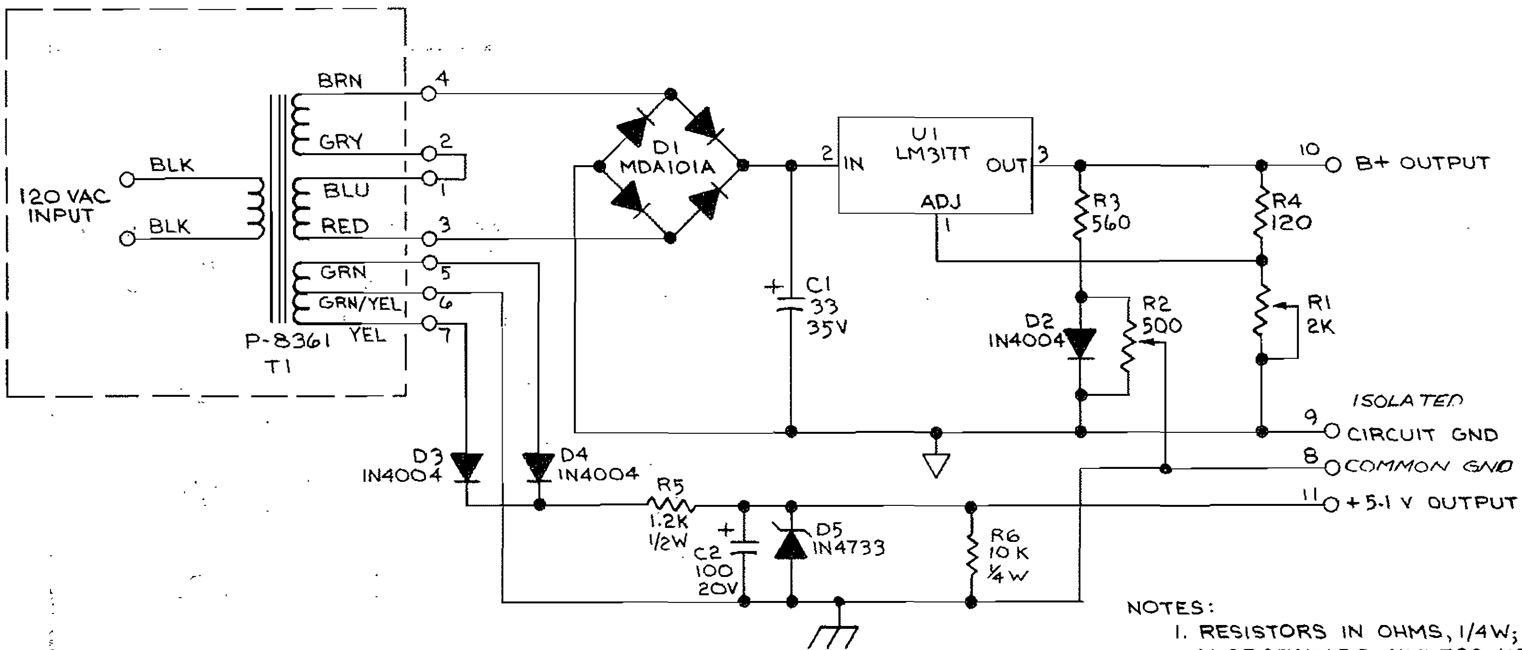
SECTION III
POWER SUPPLY DRAWINGS

3-1. INTRODUCTION

3-2. This section provides assembly drawings, schematic diagrams, and wire lists as indexed below for the FM-30 Transmitter power supplies.

FIGURE	TITLE	NUMBER
3-1	Schematic, IPA Analog Divider Power Supply	B909-0012
3-2	Assembly, IPA Analog Divider Power Supply	A917-0012
3-3	Schematic, IPA Voltage Regulator	B909-0021
3-4	Assembly, IPA Voltage Regulator	C917-0021
3-5	Schematic, Microprocessor Controller Power Supply	C909-0059
3-6	Assembly, Microprocessor Controller Power Supply	C919-0034
3-7	Schematic, Step-Start Circuit	C909-0199
3-8	Assembly, Step-Start Circuit	B919-0199

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 2272	9-15-80	mm
B	PER ECN # 2637	4-9-81	LA



NOTES:
1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS, UNLESS NOTED OTHERWISE.
2. LAST COMPONENTS USED: C2, D5, R5, T1, U1.
3. SEE B/M # 917-0012
SEE PCB ASSY # A-917-0012.

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

MATERIAL

DRAWN BY M. HAYDEN	DATE 3-5-80	
CHECKED BY	DATE	
PROJECT ENGR.	DATE	
APPROVED BY		

TREATMENT OR FINISH

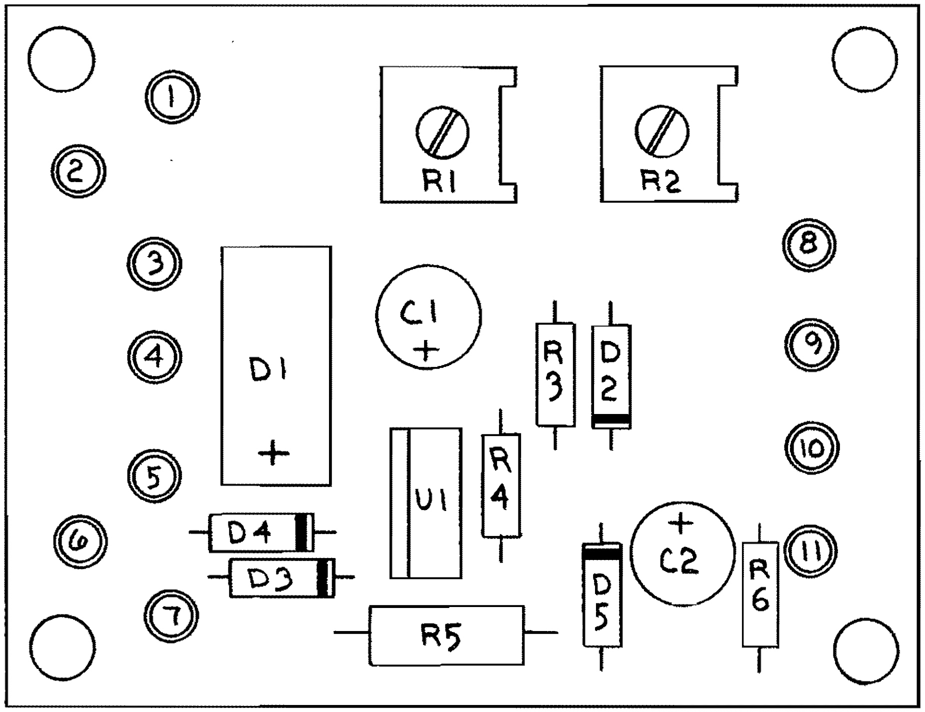
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC
ANALOG DIVIDER POWER SUPPLY

B DWG. NO. 909-0012 REV. B

FM30 XMTR SCALE — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 2637	4-16-81	LA CWK



SEE B/M # 917-0012
SEE SCHEMATIC # B-909-0012

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

MATERIAL

DRAWN BY M.HAYDEN	DATE 3-5-80
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

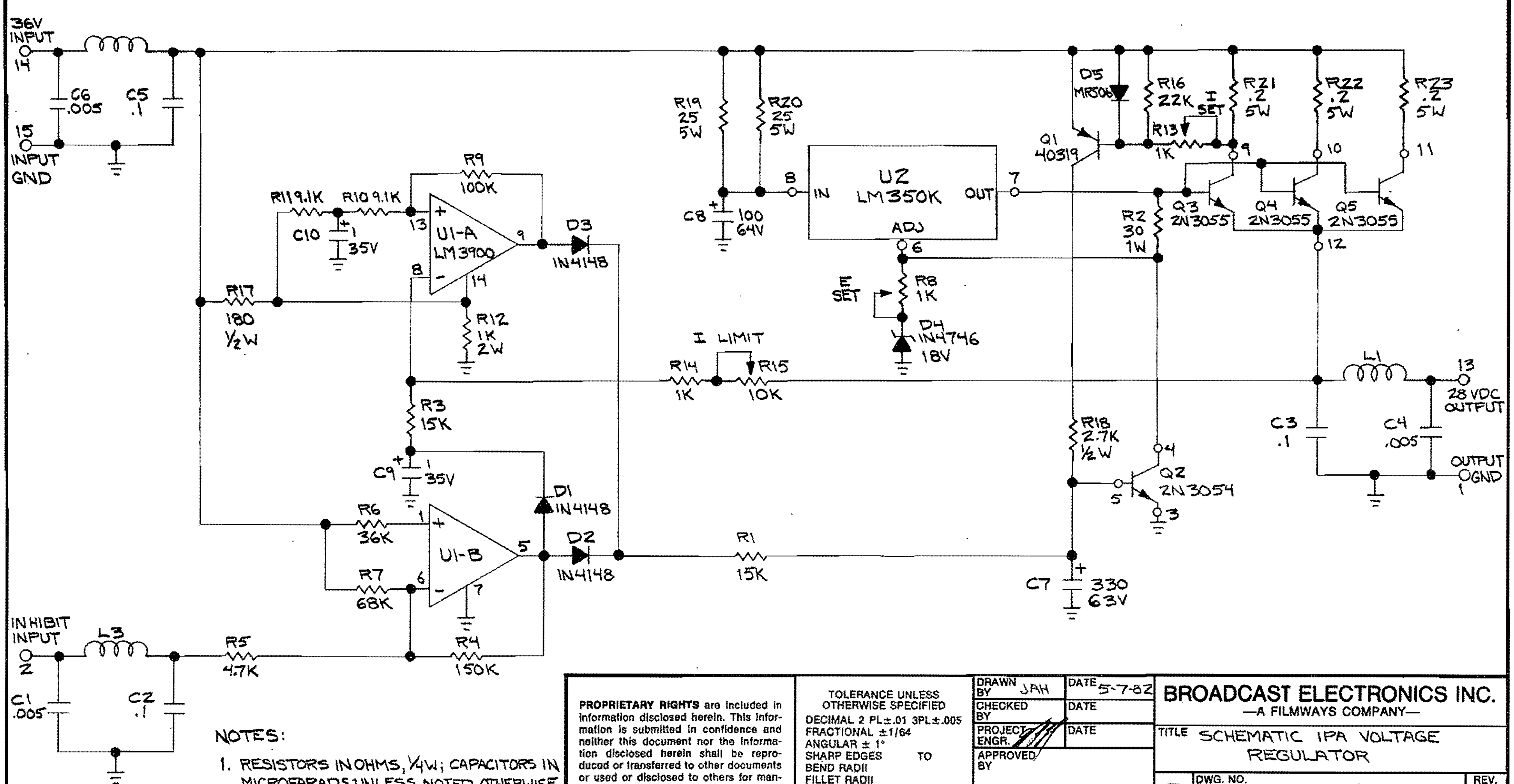
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY
ANALOG DIVIDER POWER SUPPLY

A DWG. NO. 917-0012 REV. A

FM30 XMTR SCALE 2/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	ECN# 2210	7-23-80	BLAWS



NOTES:

1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS, UNLESS NOTED OTHERWISE.
2. LAST COMPONENTS USED; C10, D5, L3, Q5, R23, U2.
3. SEE PCB ASS'Y # C-917-0021

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

MATERIAL

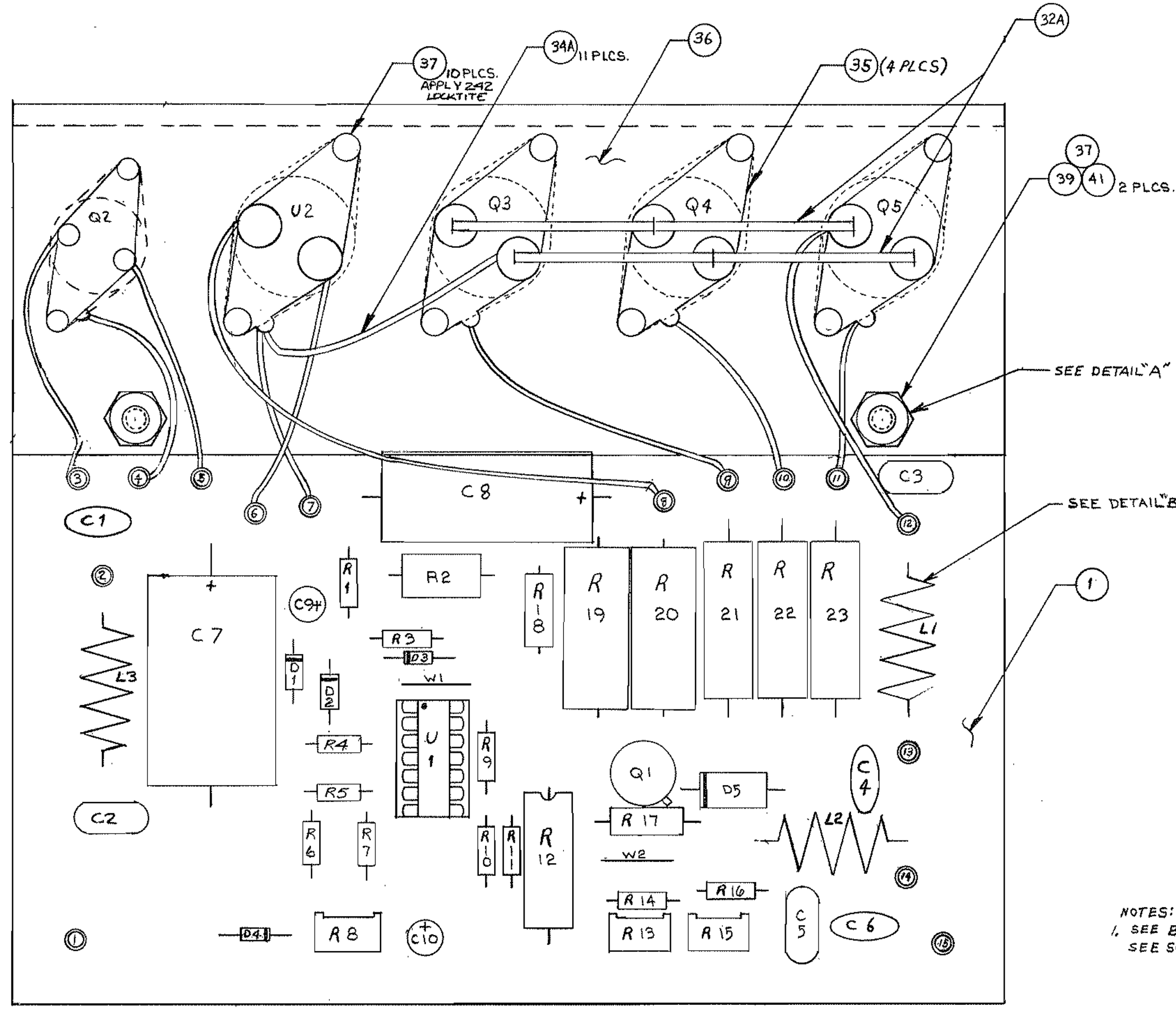
DRAWN BY JAH	DATE 5-7-82
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	
TREATMENT OR FINISH	

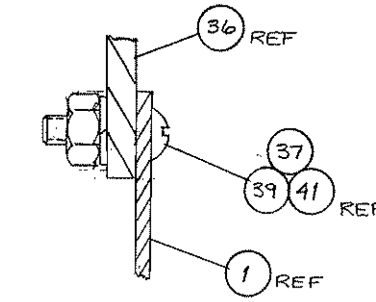
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC IPA VOLTAGE REGULATOR

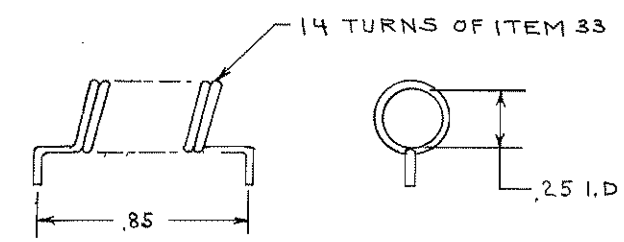
B	DWG. NO. 909-0021	REV. A
30KW XMTR	SCALE —	SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN #2279	9-19-80	





DETAIL "A"



DETAIL "B"
L1 - L2 & L3

NOTES:
1. SEE B/M# 917-0021
SEE SCHEMATIC # B-909-0021

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

MATERIAL

TREATMENT OR FINISH

DRAWN BY G H DATE 8-14-79
CHECKED BY DATE
PROJECT ENGR. DATE
APPROVED BY

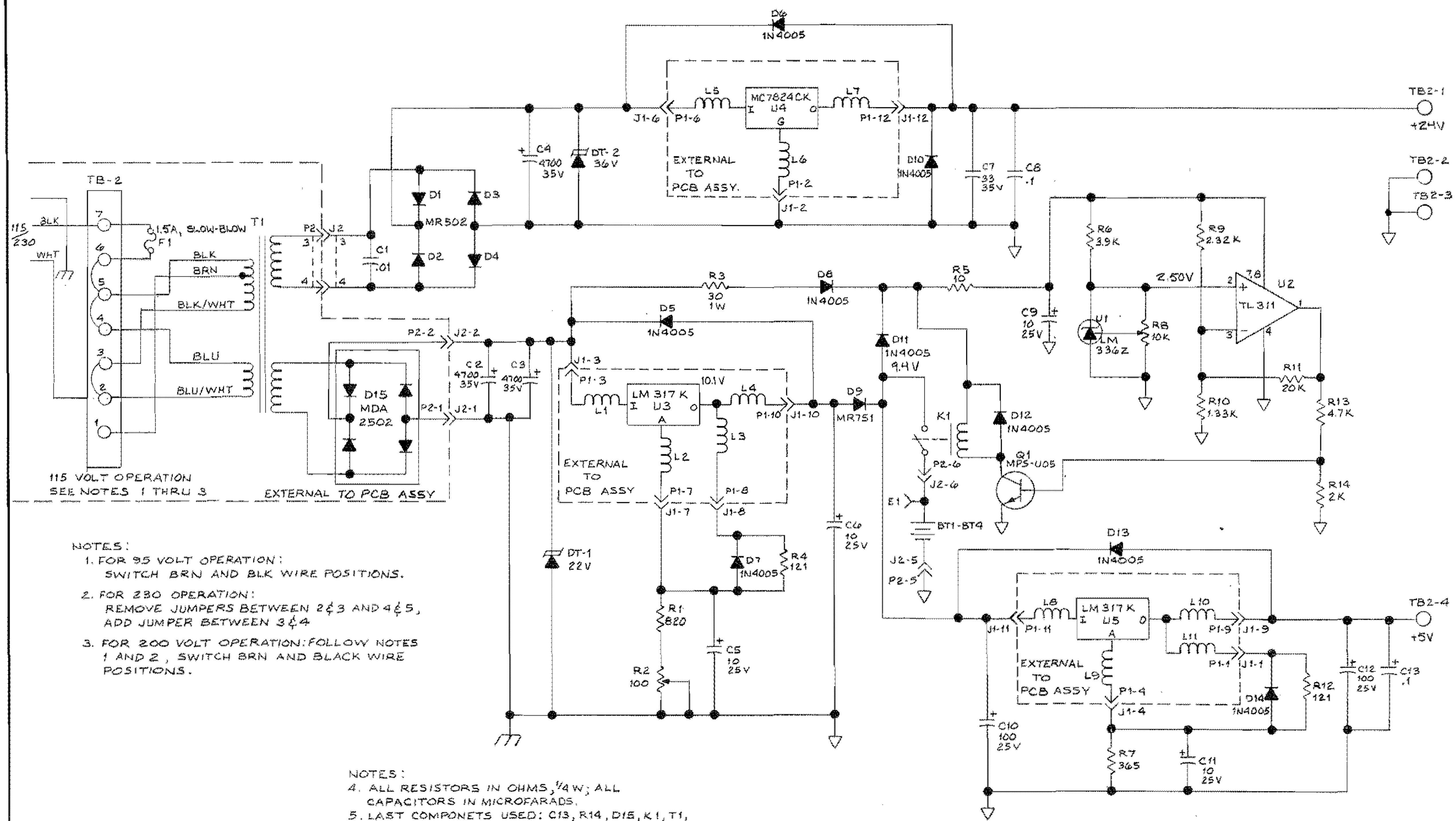
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY IPA VOLTAGE REGULATOR

C DWG. NO. 917-0021 REV. A

XMTR SCALE 2/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 3372	3-24-82	JAH



NOTES:
1. FOR 95 VOLT OPERATION: SWITCH BRN AND BLK WIRE POSITIONS.
2. FOR 230 OPERATION: REMOVE JUMPERS BETWEEN 2&3 AND 4&5, ADD JUMPER BETWEEN 3&4
3. FOR 200 VOLT OPERATION: FOLLOW NOTES 1 AND 2, SWITCH BRN AND BLACK WIRE POSITIONS.

NOTES:
4. ALL RESISTORS IN OHMS, 1/4 W; ALL CAPACITORS IN MICROFARADS.
5. LAST COMPONETS USED: C13, R14, D15, K1, T1, E1, Q1, TB2, L11, J2, DT2, U5, BT4, P2.

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

MATERIAL

DRAWN BY MDM	DATE 10-14-81
CHECKED BY	DATE
PROJECT ENGR.	DATE 2-24-82
APPROVED BY	12-16-81

TREATMENT OR FINISH

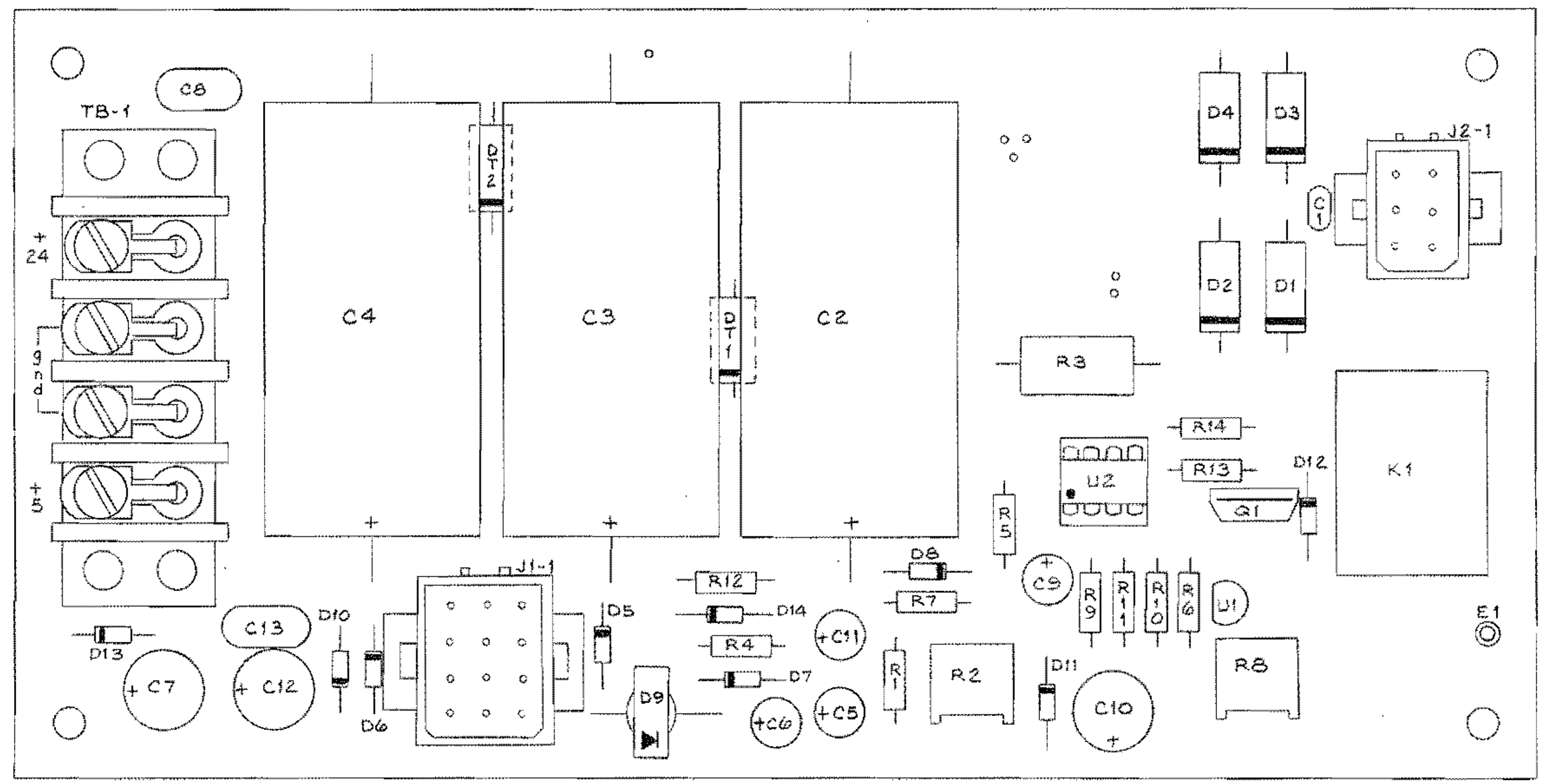
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE MICRO. POWER SUPPLY & BATTERY CHARGER SCHEMATIC

C DWG. NO. 909-0059 REV. A

FM TRANSMITTERS SCALE NA SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



SEE B/M # 919-0034
SEE SCHEMATIC # C-909-0059

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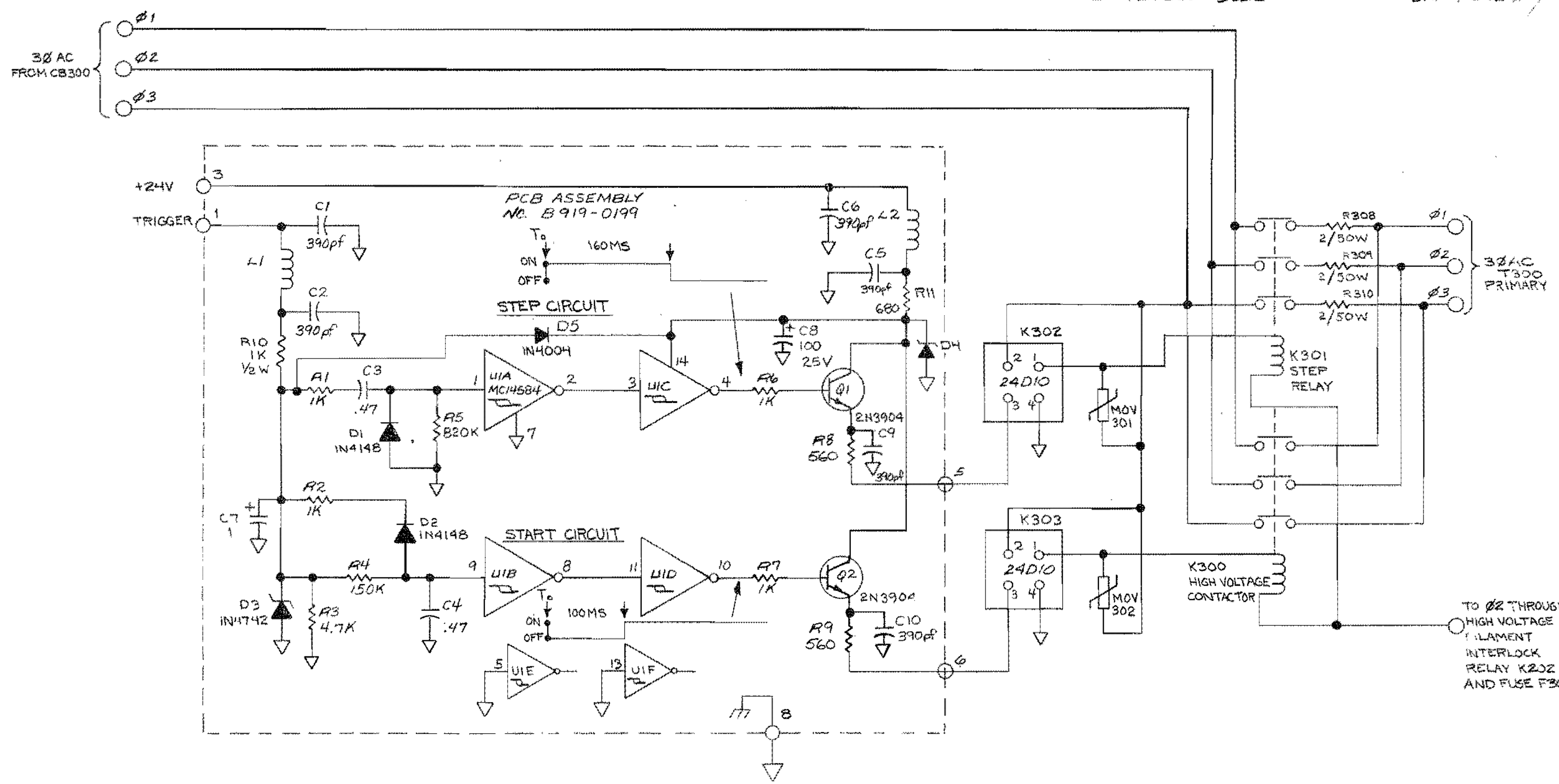
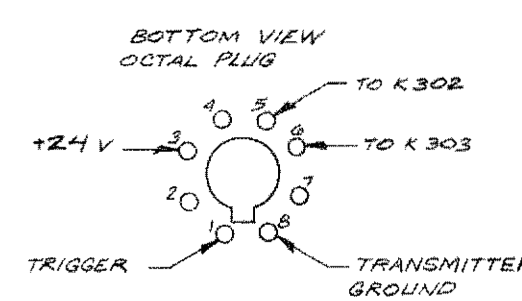
	MATERIAL	TREATMENT OR FINISH		C DWG. NO. 919-0034 REV.
				FM TRANSMITTERS SCALE 2/1 SHEET 1 OF 1

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	UPDATED	12-5-81	MH
B	SEE ECN 2887	12-29-81	
C	PER ECN 3365	3-24-82	JAH
D	PER ECN # 3626	JAH 7-8-82	





NOTES:
1. CAPACITORS IN MICROFARADS; RESISTORS IN OHMS, 1/4 W, ± 5% UNLESS NOTED OTHERWISE.

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

MATERIAL

TREATMENT OR FINISH

DRAWN BY CAF DATE 10-16-81
CHECKED BY DATE
PROJECT ENGR. DATE 7-12-82
APPROVED BY MH 1-14-82

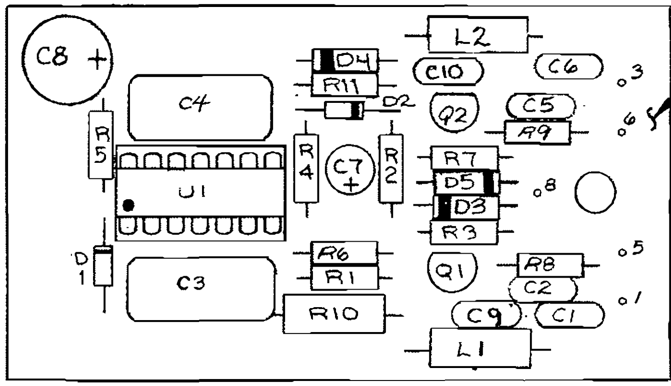
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC STEP-START CIRCUIT

C DWG. NO. 909-0199 REV D

FM30-XMTR SCALE — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	ADD D3, C7 & R10. CHGD. CONTACTS 2 TO 3; 3 TO 5; 4 TO 6; AND 5 TO 8.	12-4-81	MH
B	PER ECN #3365 ORF	4-8-82	
C	DIODE SYMBOL CORRECTED ORF	6-2-82	
D	PER ECN # 3626 JAH	7-8-82	



SEE SCHEMATIC NO. C909-0199
SEE B/M NO. 919-0199

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY ORF	DATE 10-15-81	BROADCAST ELECTRONICS INC. —A FILMWAYS COMPANY—
	CHECKED BY	DATE	TITLE ASSEMBLY STEP-START CIRCUIT
	PROJECT ENGR.	DATE 7-12-82	B DWG. NO. 919-0199 REV. D
	APPROVED BY MH	1-14-82	
MATERIAL	TREATMENT OR FINISH		FM30-XMTR SCALE 2/1 SHEET 1 OF 1

APPENDIX A
POWER SUPPLY MANUFACTURERS DATA

A-1. INTRODUCTION

A-2. This appendix provides the following technical data relative to the operation and maintenance of the FM-30 FM transmitter power supplies. Information in the appendix is provided in the following order.

A. Service Bulletin, Furnas Contactor, Size 1 & 1 3/4

B. Service Bulletin, Furnas Contactor, Size 4 1/2

C. Operation and Maintenance Bulletin, Powerstat 21-40 Variable Transformer

D. Operation and Maintenance Bulletin, Powerstat 10B-12 Variable Transformer

E. Technical Data Sheet, Opto 22 Solid State Relay

F. Operating Instructions and Parts List, Cincinnati Fan Company Type PB-14 Pressure Blower

G. Instructions, Furnas 3 Phase Voltage Monitor, P/N 947PB10AD/AG/AH

1

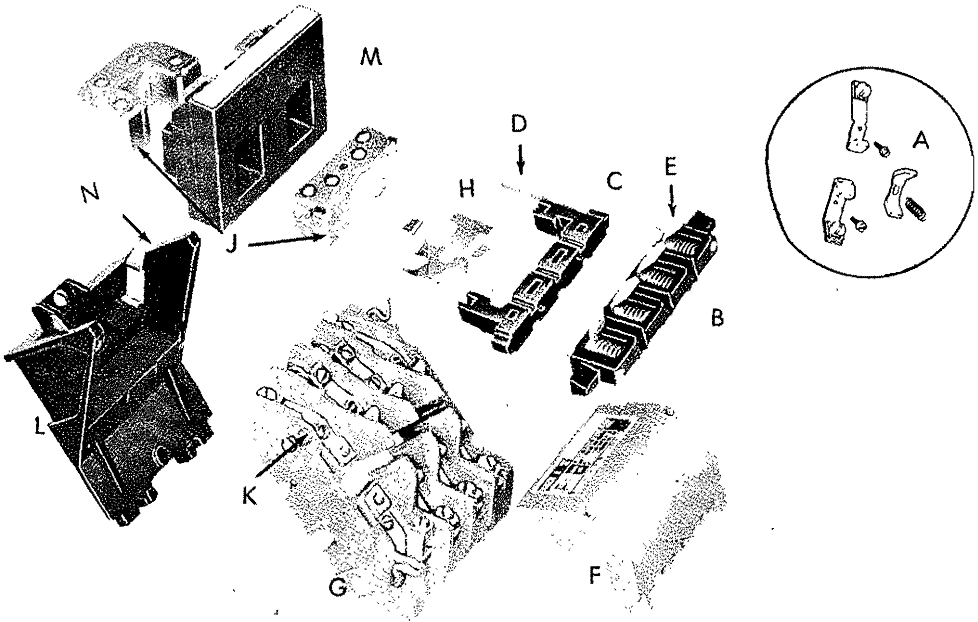
Innova/45

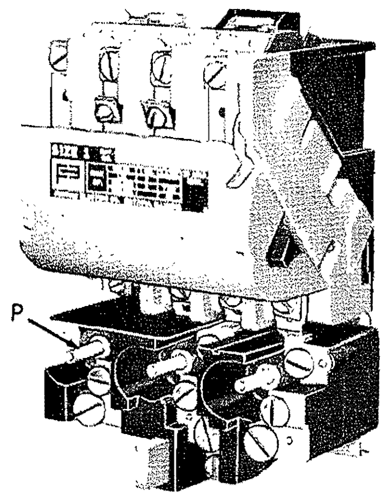
Supersedes Issue of January, 1975

REPLACEMENT PARTS

MAGNETIC CONTROLS

File No.	14-GCF
Cat. No. or Class Series	14BF, 14CF, 14DF, 14EF 40BF, 40CF, 40DF, 40EF
Size	00, 0, 1, 1P, & 1¾
	SEPTEMBER 1975





ITEM	PART NAME		PART NUMBER 14BF Size 00	14CF Size 0	14DF Size 1	14EF Size 1P & 1¾
A	Contacts & Spring, One complete pole —	Power Pole	75BF14	75CF14	75DF14	75EF14
		Interlock Pole	75AF14	75AF14	75AF14	75AF14
B	Cross Arm (less contacts)		D54670-001	D54670-001	D54670-001	D54670-001
C	Cross Arm Base		D54873-001	D54873-001	D54873-001	D54873-001
D	Cross Arm Springs		D24826-001	D24826-001	D24826-001	D24826-001
E	Cross Arm Screw		D25013-001	D25013-001	D25013-001	D25013-001
F	Contact Board Cover		D73062-001	D73062-001	D73062-001	D73062-001
G	Contact Board (less contacts)		D73116-022	D73116-021	D73116-021	D73116-021
H	Armature Spring Clip		D24817-001	D24817-001	D24817-001	D24817-001
J	Magnet and Armature		D25551-001	D25551-001	D25551-001	D25551-001
K	Contact Board Screw		D24827-001	D24827-001	D24827-001	D24827-001
L	Base		D73060-001	D73060-001	D73060-001	D73060-001
M	Coil 60 Hz. 110-120/208-240 Volts	50 Hz. 110 Volts	75D73070A	75D73070A	75D73070A	75D73070A
	208-240/440-480 Volts	220 Volts	75D73070C	75D73070C	75D73070C	75D73070C
	550-600 Volts	550 Volts	75D73070E	75D73070E	75D73070E	75D73070E
N	Coil Spring Clip					
P	Overload Relays — Melting alloy (std.)	1 Pole	48DC11A2	48DC11A2	48DC11A2	48EC11A2
		3 Pole	48DC31A2	48DC31A2	48DC31A2	48EC31A2
	Overload Relays — Standard Bimetal	1 Pole	48DC17AA2	48DC17AA2	48DC17AA2	48EC17AA2
		3 Pole	48DC37A2	48DC37A2	48DC37A2	48EC37A2
	Overload Relays — Amb. Compensated Bimetal	1 Pole	48DC18AA2	48DC18AA2	48DC18AA2	48EC18AA2
		3 Pole	48DC38A2	48DC38A2	48DC38A2	48EC38A2

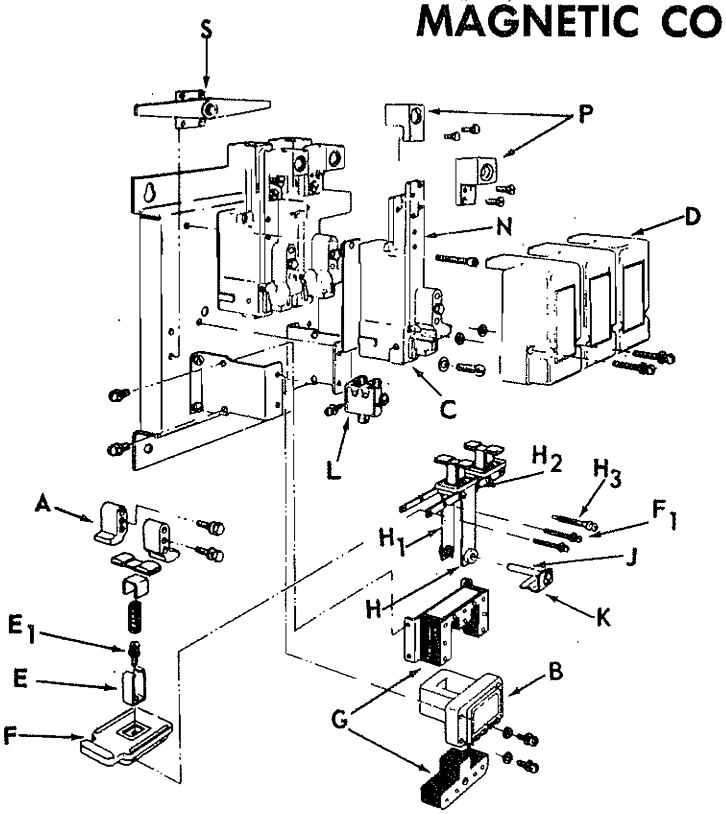
NOTE: When ordering replacement parts, give catalog number of control and part name and number.

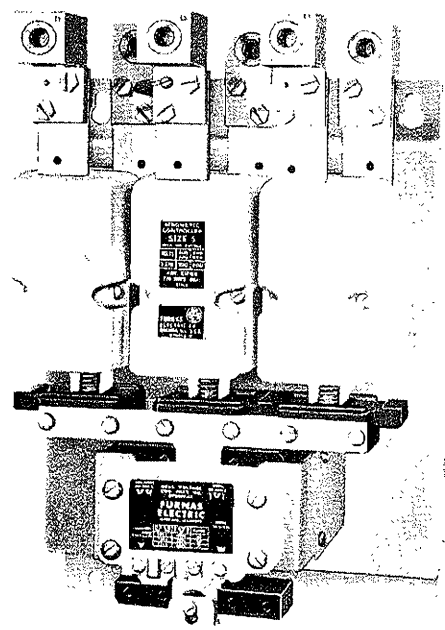
Supersedes issue of September, 1963

REPLACEMENT PARTS

MAGNETIC CONTACTORS

FILE NO.	40-GKB
CAT. NO. OR CLASS SERIES	40RB & 40KB
SIZE	4½ & 5
	JANUARY, 1966





ITEM	PART NAME	PARTS NUMBER 40RB SIZE 4½	PARTS NUMBER 40KB SIZE 5
A	Contacts and Spring		
	One (1) Complete Pole — Specify No. Required	75RB14	75KB14
B	Coil* (50/60 Cycle)		
	110-220 Volts	D72069-31	D72069-31
	220-440 Volts	D72069-32	D72069-32
	*Other voltages and frequencies available on request. 550 Volts	D72069-33	D72069-33
C	Contact Board (Less Hardware) One (1) Pole	D20746-2	D20746-1
D	Contact Board Cover with Screws One (1) Pole	D52087-2	D52087-1
E	Contact Guide	D12101-1	D12101-1
E_1	Contact Guide Screw — Size ¼ — 20 x ½ Fil. Hd. Sems	S-227-8	S-227-8
F	Cross Arm (Less Hardware)	D52051-3	D52051-3
F_1	Cross Arm Screw — Size ¼ — 28 x 2 Rd. Hd.	S-114-32	S-114-32
G	Magnet and Armature	D18826-1	D18826-1
H	Front Pusher Assembly	D17066-3	D17066-3
H_1	Rear Pusher Assembly	D17066-4	D17066-4
H_2	Pusher Screw — Size ¼ — 28 x 2¼	S-114-36	S-114-36
H_3	Pusher Screw for Reversing	D18945-1	D18945-1
	Split Locker Washer for F_1, H_1, H_2	S-122-6	S-122-6
J	Armature Pin	D18742-1	D18742-1
K	Armature Pin Retaining Clip	D18760-1	D18760-1
L	Switchlets — Interlock — Kit (Max. 2 each side) Left	49L100103	49L100103
	Right	49L100102	49L100102
N	Terminal Front	D52118-2	D52118-1
	Rear	D18756-2	D18756-1
P	Terminal Lug Front	D18748-2	D18748-2
	Rear	D18749-2	D18749-2
S	Mech. Interlock for Reversing	D18951-1	D18951-1

NOTE: When ordering replacement parts, give catalog number of control and part number.

FURNAS ELECTRIC COMPANY ▪ BATAVIA, ILLINOIS

FURNAS

INSTRUCTIONS

for

These Devices Manufactured Under One Or More Of The Following U.S. Patents: 3,366,878; 3,466,585, 3,529,340. Patented Canada 1968.

OPERATION and MAINTENANCE

POWERSTAT®

Variable Transformers

21, 21-40 SERIES with POWERKOTE® COILS and 22 SERIES

CONNECTIONS AND RATINGS

Connections and ratings given in these instructions are those most commonly used. The individual units in ganged 21-40 Series assemblies are usually wired as electrically independent units according to the single unit connection chart. Ganged 21 and 22 Series assemblies may be wired as independent units, if desired.

Connections are made to the 8-32 screws on the terminal board. Terminal adapters are furnished in the mounting hardware pack to accommodate AMP250 series (or equivalent) female connectors or for soldered connections.

Coil-to-terminal connections for 21, 21-40 and 22 Series POWERSTAT Variable Transformers are shown in Figure A.

MOTOR-DRIVEN UNITS are wired in the same manner as manually-operated units using the connections for CW ROTATION, KNOB ON RADIATOR END. Motor-drive wiring is shown in Figure B.

DERATING OF OUTPUT CURRENT AT AMBIENT TEMPERATURES ABOVE 50°C is shown in Figure C. At ambient temperatures between −20°C and +50°C use the current ratings given in the charts.

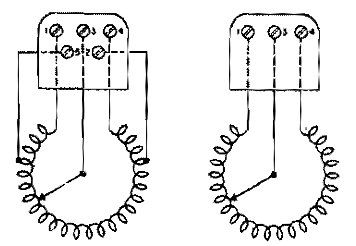


FIGURE A

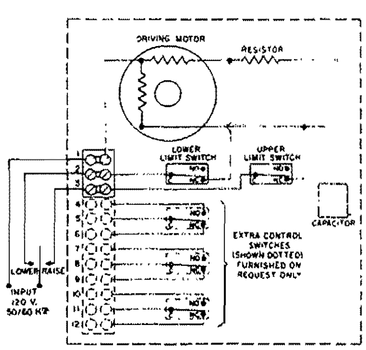


FIGURE B — MOTOR DRIVE WIRING

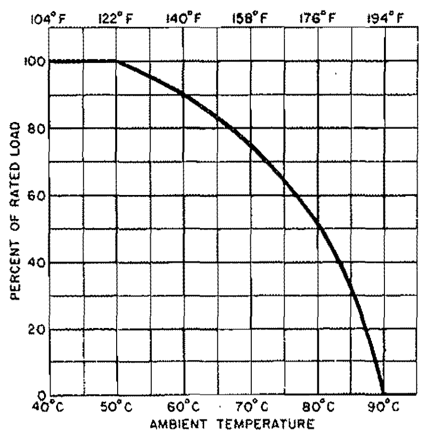
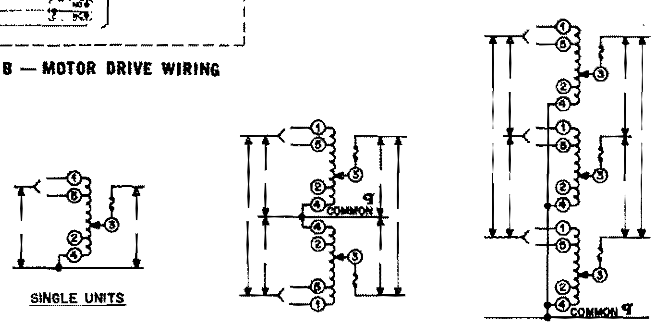


FIGURE C



SINGLE UNITS

2-GANG ASSEMBLIES

3-GANG ASSEMBLIES

TYPE	INPUT		OUTPUT					KNOB ROTATION	TERMINALS					
				CONSTANT CURRENT LOAD		CONSTANT IMPEDANCE LOAD*			KNOB ON BASE END			KNOB ON RADIATOR END		
	VOLTS	HERTZ	VOLTS	MAX. AMPS.	MAX. KVA	MAX. AMPS.	MAX. KVA		INPUT	JUMPER	OUTPUT	INPUT	JUMPER	OUTPUT
SINGLE UNITS — SINGLE PHASE														
21-40 M21-40‡	40	60	0-40	18 #	0.72	22**	0.88	CW	1-4	—	3-4	1-4	—	1-3
								CCW	1-4	—	1-3	1-4	—	3-4
21 M21‡	120	50/60	0-120	5†	0.54	6.5§	0.78	CW	1-4	—	3-4	1-4	—	1-3
								CCW	1-4	—	1-3	1-4	—	3-4
			0-140	5†	0.63	—	—	CW	4-5	—	3-4	1-2	—	1-3
								CCW	1-2	—	1-3	4-5	—	3-4
22 M22‡	240	50/60	0-240	2.25‡‡	0.54	3.25††	0.78	CW	1-4	—	3-4	1-4	—	1-3
								CCW	1-4	—	1-3	1-4	—	3-4
			0-280	2.25‡‡	0.63	—	—	CW	4-5	—	3-4	1-2	—	1-3
								CCW	1-2	—	1-3	4-5	—	3-4
2-GANG ASSEMBLIES — SINGLE PHASE														
21-2 M21-2‡	240	50/60	0-240	5†	1.1	6.5§	1.6	CW	1-1	4-4	3-3	4-4	1-1	3-3
								CCW	4-4	1-1	3-3	1-1	4-4	3-3
			0-280	5†	1.3	—	—	CW	5-5	4-4	3-3	2-2	1-1	3-3
								CCW	2-2	1-1	3-3	5-5	4-4	3-3
22-2 M22-2‡	480	50/60	0-480	2.25‡‡	1.1	3.25††	1.6	CW	1-1	4-4	3-3	4-4	1-1	3-3
								CCW	4-4	1-1	3-3	1-1	4-4	3-3
			0-560	2.25‡‡	1.3	—	—	CW	5-5	4-4	3-3	2-2	1-1	3-3
								CCW	2-2	1-1	3-3	5-5	4-4	3-3
2-GANG ASSEMBLIES — THREE PHASE														
21-2 M21-2‡	120	50/60	0-120	5†	0.94	6.5§	1.4	CW	1-4-1	4-4	3-4-3	4-1-4	1-1	3-1-3
								CCW	4-1-4	1-1	3-1-3	1-4-1	4-4	3-4-3
			0-140	5†	1.1	—	—	CW	5-4-5	4-4	3-4-3	2-1-2	1-1	3-1-3
								CCW	2-1-2	1-1	3-1-3	5-4-5	4-4	3-4-3
22-2 M22-2‡	240	50/60	0-240	2.25‡‡	0.94	3.25††	1.4	CW	1-4-1	4-4	3-4-3	4-1-4	1-1	3-1-3
								CCW	4-1-4	1-1	3-1-3	1-4-1	4-4	3-4-3
			0-280	2.25‡‡	1.1	—	—	CW	5-4-5	4-4	3-4-3	2-1-2	1-1	3-1-3
								CCW	2-1-2	1-1	3-1-3	5-4-5	4-4	3-4-3
3-GANG ASSEMBLIES — THREE PHASE														
21-3 M21-3‡	240	50/60	0-240	5†	1.9	6.5§	2.7	CW	1-1-1	4-4-4	3-3-3	4-4-4	1-1-1	3-3-3
								CCW	4-4-4	1-1-1	3-3-3	1-1-1	4-4-4	3-3-3
		60	0-280	5†	2.2	—	—	CW	5-5-5	4-4-4	3-3-3	2-2-2	1-1-1	3-3-3
								CCW	2-2-2	1-1-1	3-3-3	5-5-5	4-4-4	3-3-3
22-3 M22-3‡	480	50/60	0-480	2.25‡‡	1.9	3.25††	2.7	CW	1-1-1	4-4-4	3-3-3	4-4-4	1-1-1	3-3-3
								CCW	4-4-4	1-1-1	3-3-3	1-1-1	4-4-4	3-3-3
		60	0-560	2.25‡‡	2.2	—	—	CW	5-5-5	4-4-4	3-3-3	2-2-2	1-1-1	3-3-3
								CCW	2-2-2	1-1-1	3-3-3	5-5-5	4-4-4	3-3-3

¶Common used as third leg in 3-phase open delta or neutral in 3-wire single-phase and 4-wire 3-phase wye connections; not used in 2-wire series or 3-wire wye connections.
‡For motor-driven units use terminals for CW rotation, KNOB ON RADIATOR END.
*Loads such as incandescent lamps or resistance heaters in which current drawn is approximately proportional to applied voltage.
#18 ampere fuses recommended, not supplied.
†5 ampere fuses recommended, not supplied.
§8 ampere fuses recommended, not supplied.
‡‡3 ampere fuses recommended, not supplied.
††4 ampere fuses recommended, not supplied.
**25 ampere fuses recommended, not supplied.

MAINTENANCE

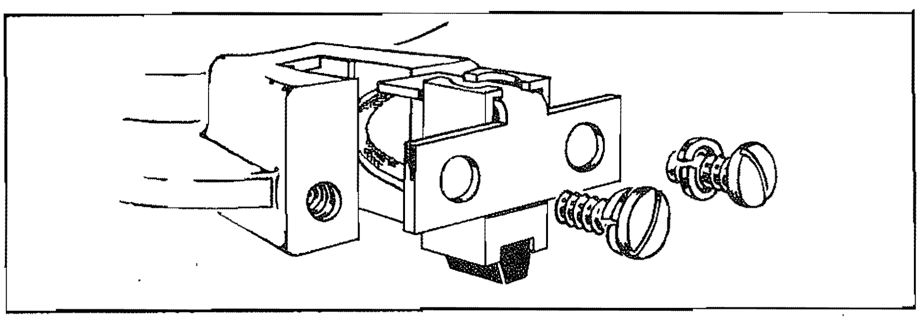
With ordinary care, a POWERSTAT Variable Transformer should require no servicing except possible replacement of the brush assembly. The brush should be inspected periodically and replaced if arcing takes place or if it is badly worn. Because the brush must be of a special material, replace only with the Superior Electric brush assembly listed below. The assembly is designed to assure perfect contact of the brush to the radiator regardless of brush position and length of time in use.

Follow these steps to install a new brush assembly.

1. Unfasten the brush assembly anchor screws, remove and discard the old brush assembly.
2. Insert the new brush assembly in the radiator slot, replace the anchor screws and tighten to the radiator. Be sure the back end of the brush strap is under the projection at the rear of the radiator brush slot.
3. Raise the brush and place a piece of crocus cloth or very fine sandpaper between the brush and the commutator so the smooth side is against the commutator and the abrasive side is toward the brush.
4. While holding the cloth or sandpaper in place, rotate the radiator through a short arc. Blow out the excess carbon particles.
5. Remove the cloth or sandpaper and rotate the radiator over the full range several times to check for smooth travel of the brush over the commutator surface. The brush should fit flat over the entire commutator range. No space should be visible between the brush and the surface.

REPLACEMENT BRUSH ASSEMBLIES

TYPE	BRUSH ASSEMBLY NO.
21	RB21
21-40	RB21-40
22	RB22



POWERSTAT® VARIABLE TRANSFORMER INSTRUCTIONS

10B, 10B-40 AND 12 SERIES

The right to make engineering refinements on all products is reserved. Dimensions and other details are subject to change.

These Devices Manufactured Under One or More Of The Following U.S. Patents: 2,947,959; 3,087,132; 3,128,442; 3,136,967; 3,466,585; 3,529,348. Patented Canada 1963, 1968.

INSPECTION

Your new POWERSTAT Variable Transformer has been carefully packed for shipment. However, damage may occur in transit. After receiving unit, check all components (brush contact primarily) to satisfy yourself that there is no damage. Also make sure that the dial, knob, lockwasher and mounting nuts are in the package. The "Damage and Shortage" Instructions packed with the unit outline the proper procedure to follow if any parts are damaged or missing.

INSTALLATION

POWERSTAT Variable Transformers of the 10B, 10B-40 and 12 Series are designed for mounting in the back-of-panel position only.

SINGLE UNITS

The single hole mounting of single units is fast and simple. For keying to the panel, a 1/16 inch projection is provided. To facilitate mounting, a drilling template is supplied as part of these instructions. Actually, the drilling template must be used only when the hole for the 1/16 inch projection is required.

To mount, proceed as follows:

1. Using the drilling template, locate the panel holes. In order that the terminals should be on top, the template should be upright. Drill the holes.
2. Mount the POWERSTAT variable transformer as shown. Mount the unit flush to the back of the panel and the dial flush to the front. A single nut and lockwasher hold the unit and dial in place. The knob, mounted on the shaft, covers the nut and lockwasher.
3. If the unit is not to be keyed to the panel, only the hole for the 3/8 inch center shaft should be drilled. The extra nut provided is placed on the shaft between the unit and the back of the panel. Otherwise the mounting is as explained above.

GANGED UNITS

Ganged units require four panel holes for mounting. Three are needed for the mounting bolts and a clearance hole is necessary for the center shaft.

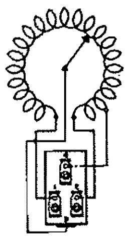
To mount, proceed as follows:

1. Using the drilling template locate the four panel holes. If the template is upright, the terminals will not be directly on top. When terminals are required at the top, line marked "T" should be vertical. Drill the holes.
2. Mount the unit behind the panel as shown using the three 1/4" 20 mounting bolts provided. Mount the dial on the front of the panel, securing it in place with the 3/8"-32 nut and lockwasher provided. The knob, when mounted on the shaft covers the nut and lockwasher.

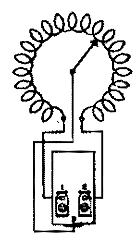
CONNECTION AND RATING *

POWERSTAT Variable Transformers of the 10B, 10B-40 and 12 Series may be connected to suit various requirements as shown in the chart. The individual units in types 10B-40-2 and 10B-40-3 are not electrically interconnected but are independently wired following the type 10B-40 connections. Under "KNOB ROTATION," rotating the knob in the direction indicated will INCREASE the output voltage. The dial is marked for clockwise rotation only.

VIEWED FROM PANEL END



TYPES 10B, 12



TYPE 10B-40

TYPE	INPUT VOLTAGE	FREQUENCY (hertz)	OUTPUT VOLTS	CONSTANT CURRENT LOAD MAX. AMP.	CONSTANT CURRENT LOAD MAX. KVA	CONSTANT IMPEDANCE LOAD MAX. AMP.	CONSTANT IMPEDANCE LOAD MAX. KVA	KNOB ROTATION	TERMINALS INPUT	TERMINALS JUMPER*	TERMINALS OUTPUT
SINGLE UNITS — SINGLE PHASE											
10B-40	40	60	0-40	7	0.28	9	0.36	CW	1-2		1-3
								CCW	1-2		2-3
10B	120	50/60	0-120	2.25†	0.27	3‡	0.36	CW	1-2		1-3
								CCW	1-2		2-3
		60	0-132	2.25†	0.30			CW	1-4		1-3
12	240	50/60	0-240	0.7††	0.17	0.9**	0.22	CW	1-2		1-3
								CCW	1-2		2-3
			0-264	0.5‡‡	0.13			CW	1-4		1-3
TWO GANG ASSEMBLIES — SINGLE PHASE, SERIES CONNECTED											
10B-2	240	50/60	0-240	2.25†	0.54	3‡	0.72	CW	2-2	1-1	3-3
								CCW	1-1	2-2	3-3
		60	0-264	2.25†	0.59			CW	4-4	1-1	3-3
12-2	480	50/60	0-480	0.7††	0.34	0.9**	0.43	CW	2-2	1-1	3-3
								CCW	1-1	2-2	3-3
			0-528	0.5‡‡	0.26			CW	4-4	1-1	3-3
TWO GANG ASSEMBLIES — THREE PHASE, OPEN DELTA CONNECTED											
10B-2	120	50/60	0-120	2.25†	0.47	3‡	0.62	CW	2-1-2	1-1	3-1-3
								CCW	1-2-1	2-2	3-2-3
		60	0-132	2.25†	0.51			CW	4-1-4	1-1	3-1-3
12-2	240	50/60	0-240	0.7††	0.29	0.9**	0.37	CW	2-1-2	1-1	3-1-3
								CCW	1-2-1	2-2	3-2-3
			0-264	0.5‡‡	0.23			CW	4-1-4	1-1	3-1-3
THREE GANG ASSEMBLIES — THREE PHASE, WYE CONNECTED											
10B-3	240	60	0-240	2.25†	0.94	3‡	1.2	CW	2-2-2	1-1-1	3-3-3
								CCW	1-1-1	2-2-2	3-3-3
12-3	480	50/60	0-480	0.7††	0.58	0.9**	0.75	CW	2-2-2	1-1-1	3-3-3
								CCW	1-1-1	2-2-2	3-3-3
		60	0-528	0.5‡‡	0.46			CW	4-4-4	1-1-1	3-3-3

*Jumper provided in standard common position should be moved or removed as required.
†Rating when mounted on a metal panel. When mounted on a bracket or nonmetallic panel, derate to 1.75 amperes.
‡Rating when mounted on a metal panel. When mounted on a bracket or nonmetallic panel, derate to 2.5 amperes.
††Rating when mounted on a metal panel. When mounted on a bracket or nonmetallic panel, derate to 0.5 ampere.
**Rating when mounted on a metal panel. When mounted on a bracket or nonmetallic panel, derate to 0.75 ampere.
‡‡0.7 ampere maximum in range from zero to line voltage when mounted on a metal panel.

PRECAUTIONS

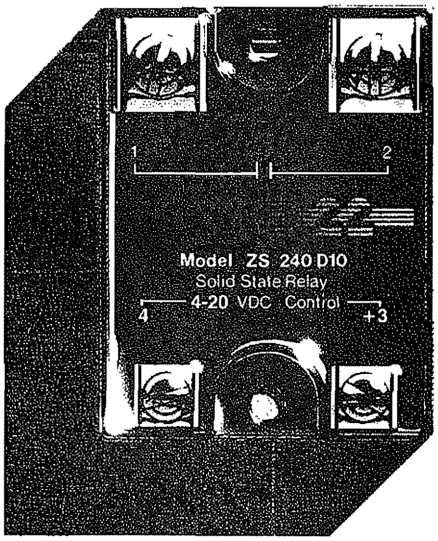
Be absolutely certain that the line voltage, phase and frequency are as noted on the nameplate. Install a fuse in the brush output lead.

MAINTENANCE

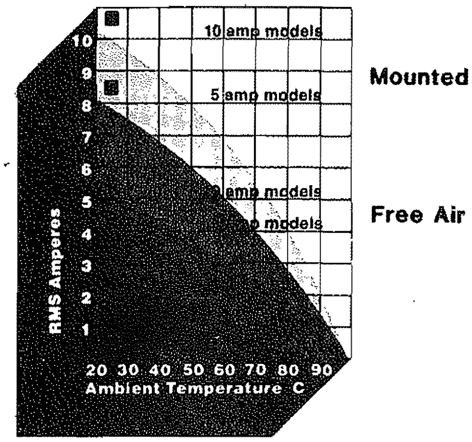
With ordinary care and attention to the precautions outlined above, the POWERSTAT Variable Transformer should require no servicing except possible replacement of the brush. The brush should be inspected periodically and replaced if arcing takes place or if it is badly worn. The correct replacement brush is RB10B for 10B Series units, RB10B-40 for 10B-40 Series units and RB12 for 12 Series units. Because the brushes must be of a special material, only the specified replacement should be used.

Whenever electrical or mechanical difficulties arise in installing or operating the POWERSTAT Variable Transformer, contact the factory or the nearest Superior Electric field office.

THE SUPERIOR ELECTRIC COMPANY, Bristol, Connecticut, U.S.A.

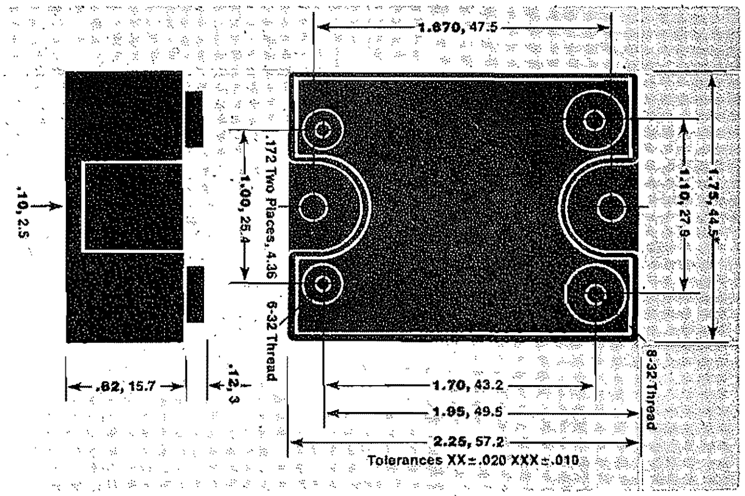


Current vs Ambient



Surge Current Data

TIME SECONDS	TIME (CYCLES)	MODELS 5 AMP PEAK AMPS	MODELS 10 AMP PEAK AMPS
.017	1	85	110
.050	3	70	85
.100	6	65	70
.200	12	55	60
.500	30	48	50
1	60	40	40
2	120	33	36
3	180	32	33
4	240	31	32
5	300	30	31
10	600	28	30



Detail Electrical Specifications

Model Number	Nominal AC Line Voltage	Nominal Current Rating Amps	1 Cycle Surge (Amps) Peak	Nominal Signal Input Resistance Ohms	Signal Pick-up Voltage	Signal Drop-out Voltage	Peak Repetitive Voltage Minimum	Maximum Contact Voltage Drop	Off State Leakage ma Maximum	Operating Voltage Range Volts AC	I²t Rating t=8.3 Milli-Seconds	Standard Isolation Voltage	Θjc °C/Watt	Dissipation Watts/Amp
Z 120 D5 or ZS 120 D5	120	5	85	500	4 VDC (20 V allowed)	1 VDC	250	1.6 V	8 ma	12-140	30	2500 V RMS	5	1.3
Z 120 D10 or ZS120 D10		10	110						15 ma	12-140	30		4	1
Z 240 D5 or ZS 240 D5	240	5	85				500		8 ma	24-280	50		5	1.3
Z240 D10 or ZS240 D10		10	110						15 ma	24-280	50		4	1

Additional Specifications (All Models)

Isolation: Input-to-output and input-to-base: 2500 VAC 10^{10} ohms DC. Coupling capacitance input to output 8 PF max.

Operating temp: −40°C to 100°C

Operating Freq: 25-65 HZ

Θjc = Thermal resistance junction to base. Maximum junction temperature = 110°C

Turn-On-Time: ½ cycle maximum zero voltage

Turn-Off-Time: ½ cycle maximum zero current

DV/DT-Off State: 200 V/microsecond

DV/DT-Commutating: Snubbed for rated current at .5 power factor

Note: —4 to Part No. for 4000 V. isolation. 600 volt PRV available any model. Add -6 to Part No.

OPERATING INSTRUCTIONS
AND
PARTS LIST

For
"PB" Pressure Blowers
"HP" Pressure Blowers
"LM" Volume Blowers
"ORB" Industrial Exhausters
Series FC and BI Utility Sets

WARNING

Rotating Equipment must be properly guarded to prevent personal injury.

By acceptance of this merchandise, the purchaser and user assume complete responsibility for the safe operation of this equipment. The manufacturer disclaims any and all responsibility unless this unit is operated in compliance with all federal and local laws and regulations.

CONTENTS

cincinnati fan and ventilator company, inc.

5345 Creek Road, Cincinnati, Ohio 45242, Area Code 513-984-0600

RECEIVING & START-UP

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,bolts or locking collars to work loose. Check wheel to see that it rotates freely and that there are no obstructions. Be certain all bolts and locking collars are tightened securley.

If concealed damage is found, call the carrier and ask for their Inspection Department. Then fill out a concealed damage inspection report.

Operation

Before Start Up

1. Inspect all fasteners to make sure they are secure.
   a. Foundation bolts
   b. Set screws in fan wheel and V-belt drive
   c. Housing, bearing and motor mounting bolts
2. Access Doors should be tight and sealed.
3. Bearings should be checked for alignment and lubrication.
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.

GENERAL MAINTENANCE

CAUTION –*Before any maintenance or service is performed, be sure that unit is disconnected from power source to prevent accidental starting.*

Cast Aluminum & Metal Parts

The cast aluminum bearing housings and impellers, as well as all metal parts, are maintenance free and should not require any maintenance during the life of the unit.* 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 impeller, inspect for possible cracks or excessive wear, which can cause unbalance. Belts on V-belt drive units require periodic inspection and replacement when worn.

*Painted metal surfaces may require periodic repainting.

Motor Maintenance

1. 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 can cause excessive insulation temperatures.
2. Lubrication: Under normal conditions, ball bearing motors will operate for five years without re-lubrication. Under continuous operation at higher temperatures (exceeding 104 degrees F. ambient) or dusty atmosphere re-lubricate after one year. To re-lubricate motor bearings, disassemble motor and housings thoroughly. Bearings are located in the end shields of the motor. Repack each bearing and fill cavity in back of bearings 1/3 full with Alvania Grease No. 2 (Shell Oil Company) or equivalent.

V-BELT DRIVES

CAUTION–*Care should be taken not to over tighten V-belt drives. 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 Cincinnati Fan. Alignment should be re-checked 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 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. Adjust belt tension by adjusting motor on its sliding base. All belts must have slack on one side.
5. If belts squeal at start-up, they are too loose and should be tightened.
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 white lead or 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.

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 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 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.

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 re-lubrication is not required.

Units feature two single row deep groove bearings in a rugged cast aluminum or 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 Bearing

For grease lubricated ball or roller bearings, or pillow blocks, a good grade of soda soap grease free from chemically or mechanically active material should be used.

This grease is a mixture of lubricating oil and a soap base to keep the oil in suspension. They have an upper temperature limit where the oil and soap base oxidize and thermally decompose into a gummy sludge.

Grease listed (or equivalents) are satisfactory for normal operating conditions. Regreasing will vary from 3 months to a year depending upon hours of operation, temperature and surrounding conditions. Special grease may be required for dirty or wet atmospheres (consult your lubricant supplier).

The pillow block should be filled with a low pressure gun until 1/3 full as excess grease may cause over heating.

Recommended grease for temperatures ranging from -40 degrees F to 250 degrees F are: Sinclair Refining Co.–AF No. 2, Scony Mobile Oil Co.–Mobilplex EP No. 1, Sun Oil Co.–Sun 72XMP grease, Esso Standard Oil Co.–ANDOK "C", Texas Co.–Texaco Regal Starfak No. 2.

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, altered products, systems 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.

On equipment furnished by Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller receives from the manufacturer thereof.

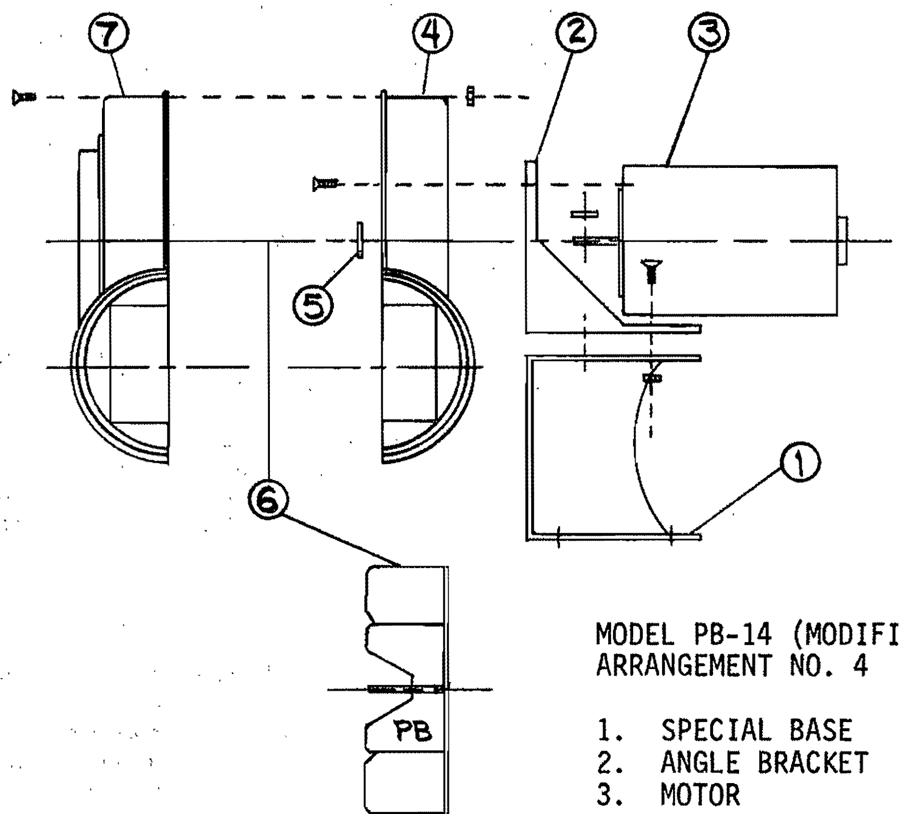
Cincinnati Fan & Ventilator Company assumes no responsibility for material returned to our plant without our written permission.

ORDERING REPLACEMENT PARTS

Replacement or spare parts may be ordered through your local Cincinnati representative.

The following information should accompany parts orders.

1. Motor horsepower, frame size and motor speed.
2. Fan Speed (if V-belt driven).
3. Fan arrangement and model number.
4. Serial number, model number and a complete description of the part.



MODEL PB-14 (MODIFIED BASE)
ARRANGEMENT NO. 4

1. SPECIAL BASE
2. ANGLE BRACKET
3. MOTOR
4. HOUSING, MOTOR SIDE
5. FELT SEAL
6. WHEEL
7. HOUSING, INLET SIDE

CLASS 947

INSTRUCTIONS

File No.
947-HPB
Cat. No. or Class Series 947PBIOAD, AG & AH
Size
Date JUNE, 1977

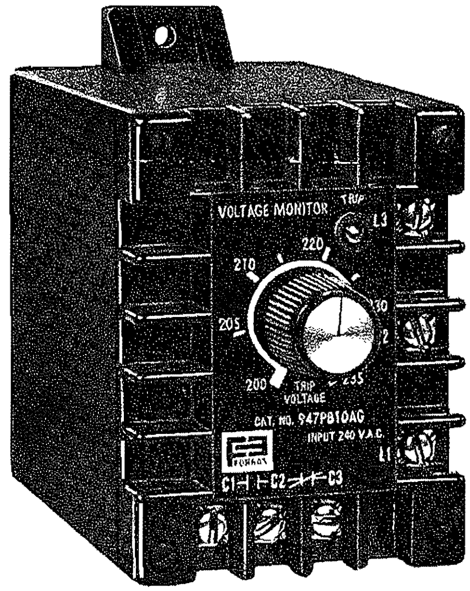
3 PHASE VOLTAGE MONITORS

UNDER VOLTAGE — PHASE PROTECTION RELAY

THREE PHASE RATING

Specification	208V	240V	480V
Operating Voltage 60 Hz. (Neutral Not Required)	190-225V	215-265V	430-520V
Trip Voltage Range	175-208V	200-235V	400-470V
Pick Up Sequence L1 - L2 - L3	A - B - C	A - B - C	A - B - C
Pick Up - Trip Out Differential	15V	15V	30V
Pick Up Delay (Typ.)	12 sec.	12 sec.	12 sec.
Trip Out Delay (Typ.)	6.5 sec.	6.5 sec.	6.5 sec.
Set Point Repeatability @ 25°C	2%	2%	2%
Dial Calibration	5%	5%	5%
Transient Protection	10,000V	10,000V	10,000V
Operating Temperature	0 to +70C	0 to +70C	0 to +70C
Trip Indicator Light (Solid State)	L.E.D.	L.E.D.	L.E.D.
Relay Output Contact	SPDT	SPDT	SPDT

Contact Rating	Max. Amps		Max. Volt Amps	
	Make	Break	Make	Break
120 Volts	15	1.5	1800	180
240 Volts	7.5	0.75	1800	180
480 Volts	3.75	0.375	1800	180



GENERAL OPERATION

The voltage monitor is a voltage and phase sensing relay which helps protect machinery and equipment against low voltage, voltage unbalance, loss of phase, and phase reversal. The voltage monitor will not pick up if any of the above fault conditions exists or if they occur during operation, the voltage monitor will trip out. It will automatically pick up (reset) after it has tripped out provided the fault condition is corrected and all other requirements for pick up are met.

LOW VOLTAGE

The voltage monitor will pick up after a time delay if all three phase voltages are at least 15 volts higher than the dial set trip voltage for either the 208 V or 240 V unit and 30 volts higher for the 480 V unit. The voltage monitor will trip out after a time delay when all three phase voltages drop below the dial set trip voltage.

The voltage monitor will trip out in the same manner as previously described if all three phase voltages drop just below the dial set trip voltage for longer than 4 seconds and then return to their original value. The unit will trip out instantaneously if all three phase voltages are momentarily interrupted or turned off.

The pick up-trip out voltage differential and time delays have been designed into the voltage monitor to prevent chattering, rapid recycling, and nuisance trip outs caused by momentary transient voltage drops that can occur during motor starting. (See increased protection adjustment.)

VOLTAGE UNBALANCE

The voltage monitor will trip out in cases where the voltage unbalance is created by a phase voltage drop. The voltage monitor will trip out after a time delay when the system operating voltage is the same as the just pick up voltage and any one of the phase voltages drops 9% below the system operating voltage. (See increased protection adjustment.)

LOSS OF PHASE

The voltage monitor will not pick up if all three phases are not present or it will trip out after a time delay if a phase loss occurs during operation. The voltage monitor senses a lost phase by monitoring the voltage drop on the lost phase. In some applications a lightly loaded motor may regenerate the voltage drop on the lost phase enough to keep the voltage monitor from tripping out. (See increased protection adjustment.)

PHASE REVERSAL

The voltage monitor will pick up after a time delay only if it senses the proper phase sequence: A-B-C to L1-L2-L3. The voltage monitor will trip out after a time delay if a phase reversal occurs during operation.

INCREASED PROTECTION ADJUSTMENT

To increase the amount of protection afforded by the voltage monitor the dial set trip voltage can be adjusted closer to the system operating voltage once the unit has picked

3 PHASE VOLTAGE MONITORS

UNDER VOLTAGE — PHASE PROTECTION RELAY

up. This in effect reduces the amount of voltage drop required to trip out the voltage monitor due to low voltage, voltage unbalance and loss of phase during operation. The amount of the reduction is governed by the system voltage fluctuation. This adjustment may require that the voltage monitor be reset manually for pick-up if the system voltage-trip out voltage differential is less than the pick up - trip out voltage differential.

The voltage monitor can be manually reset for pick up by turning the dial set trip voltage to the minimum trip voltage value and then after the unit has picked up, returning it to its original dial set trip voltage.

TRIP INDICATOR

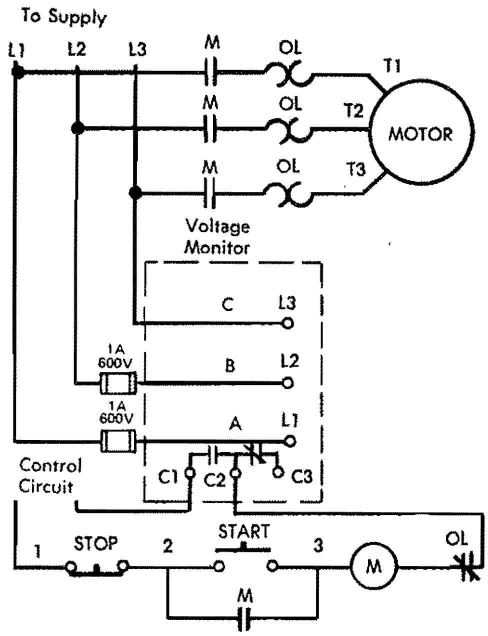
The voltage monitor incorporates in its design a light emitting diode to indicate the operational status of the unit and is operational only when the applied voltage is at least 25% of the system voltage. LED on, unit has tripped out; LED off, unit has picked up.

OUTPUT

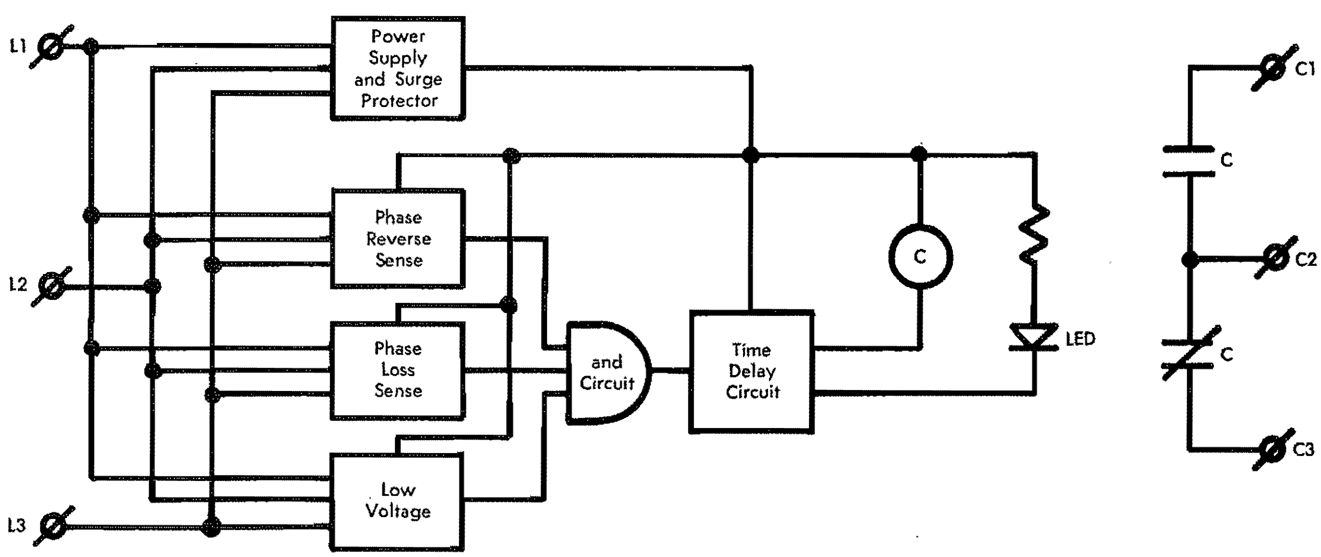
The voltage monitor incorporates in its design a set of single pole double throw relay contacts for the output circuit. The normally closed portion of this contact arrangement can be used to initiate an alarm to warn of improper conditions when the unit is tripped out.

CAUTION: Automatic resetting of the voltage monitor can occur on two wire control. When not desired, three wire control should be used.

TYPICAL DIAGRAM



BLOCK DIAGRAM



RF CIRCUITRY

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

2

SECTION I

RF CIRCUIT THEORY OF OPERATION

1-1. INTRODUCTION

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

1-3. FUNCTIONAL DESCRIPTION

1-4. FM EXCITER

1-5. A complete technical description of the FM exciter circuitry is contained in publication 597-0002, FX-30 FM Exciter.

2

1-6. RF AMPLIFIER

1-7. IPA STAGE. The RF output from the FM exciter is applied to the FM-30 driver amplifier. Five identical amplifiers comprise the IPA section of the FM-30 transmitter. One amplifier is used as a driver for the remaining four. The RF driver may be interchanged with any of four other RF amplifiers in the IPA stage, its only distinction being the physical placement of the amplifier in the MODULE 1 position within the configuration.

1-8. Each amplifier module employs two RF transistors conservatively operated class C in parallel with tuned input and output circuits. The amplifiers employ micro-stripline tuned sections etched into the circuit board. When combined with associated capacitors in the circuit, the micro-stripline sections offer the required impedance transformation from RF input to base circuit impedance and collector circuit impedance to RF output. Normally, amplifier tuning will not be required unless a component fails on an amplifier circuit board and requires replacement. Bandwidth of each amplifier is approximately 6 MHz at 3 dB points.

1-9. Hybrid Combiner/Splitter Operation. A hybrid combiner/splitter is a four-port device. When fed by an RF source into one port, the device will split the applied input equally between the two opposite ports (see Figure 1-2).

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

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

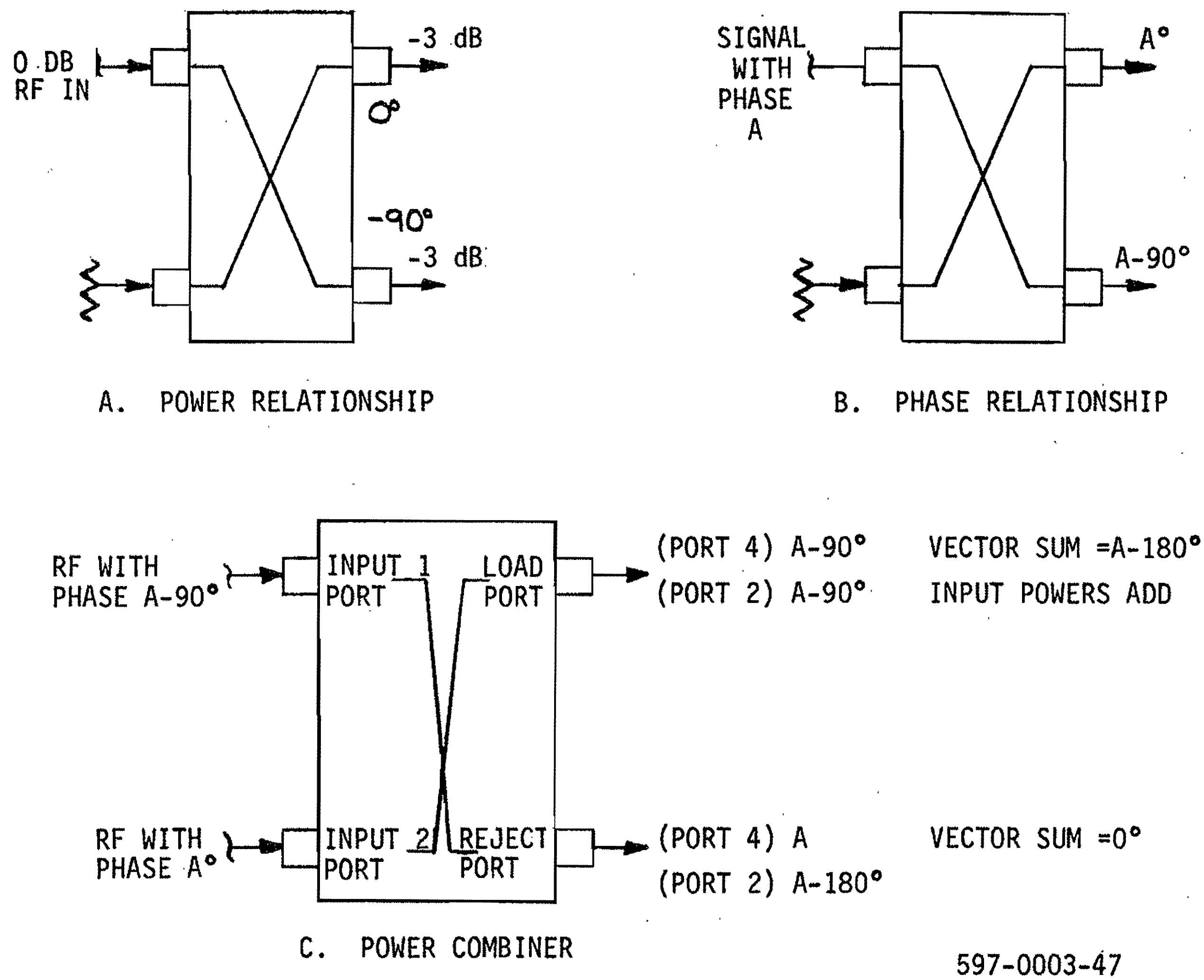


FIGURE 1-2. HYBRID COMBINER

1-12. FM-30 Hybrid RF Circuit. The output of the RF driver is connected to the input of a triple section hybrid splitter which offers four outputs, each output 90° shifted in phase from one output to each adjacent output. The outputs from this hybrid splitter feed the inputs of the four IPA amplifiers. Each amplifier is identical and may be interchanged.

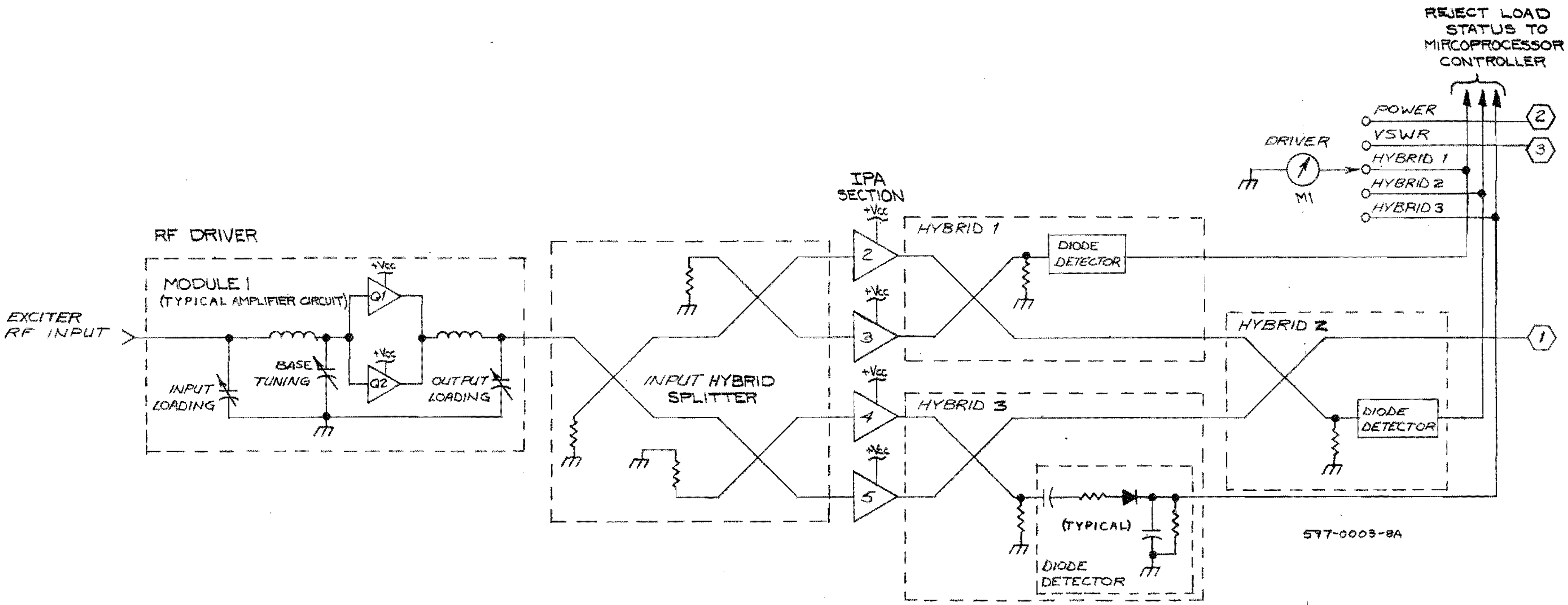
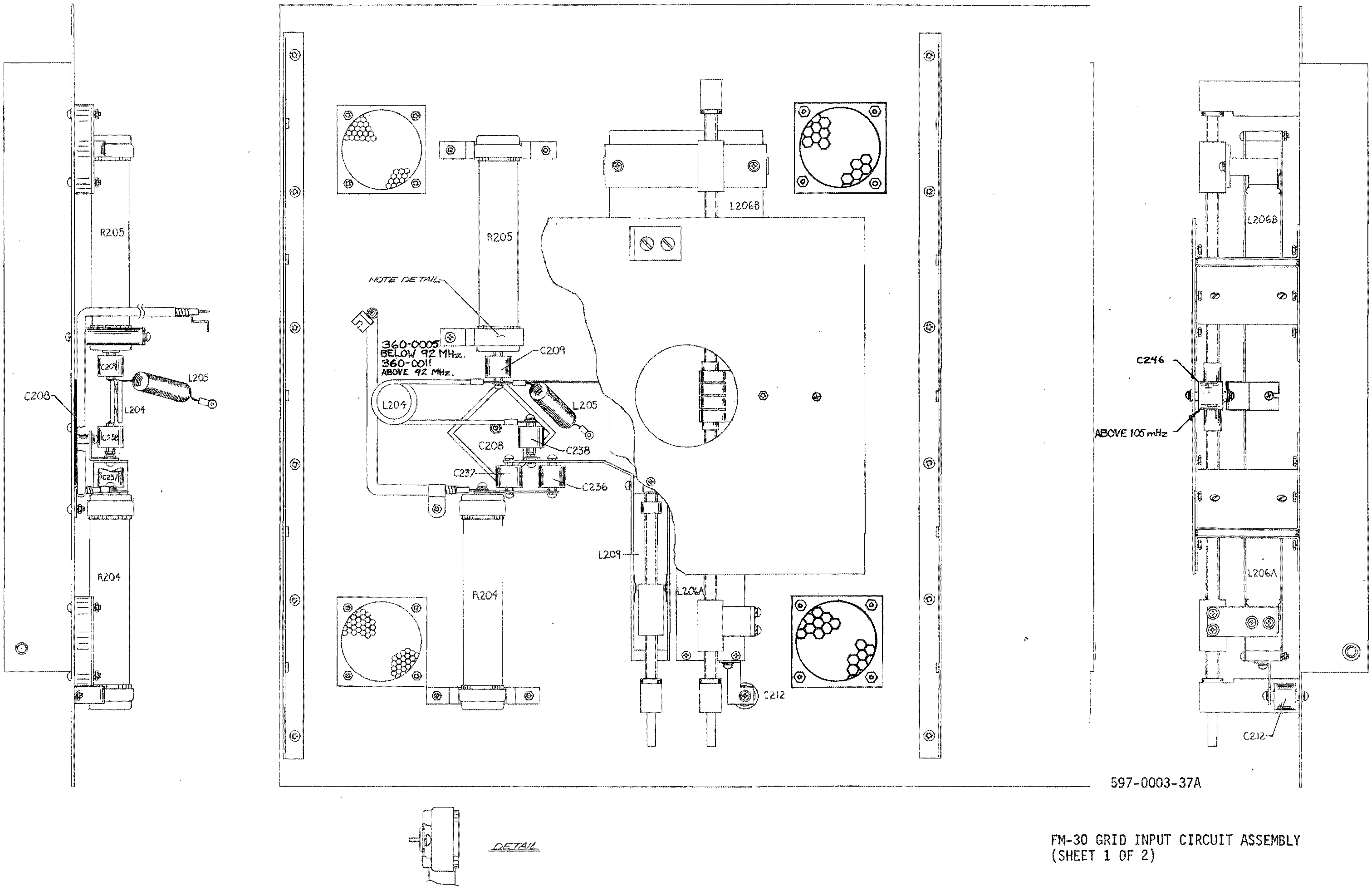
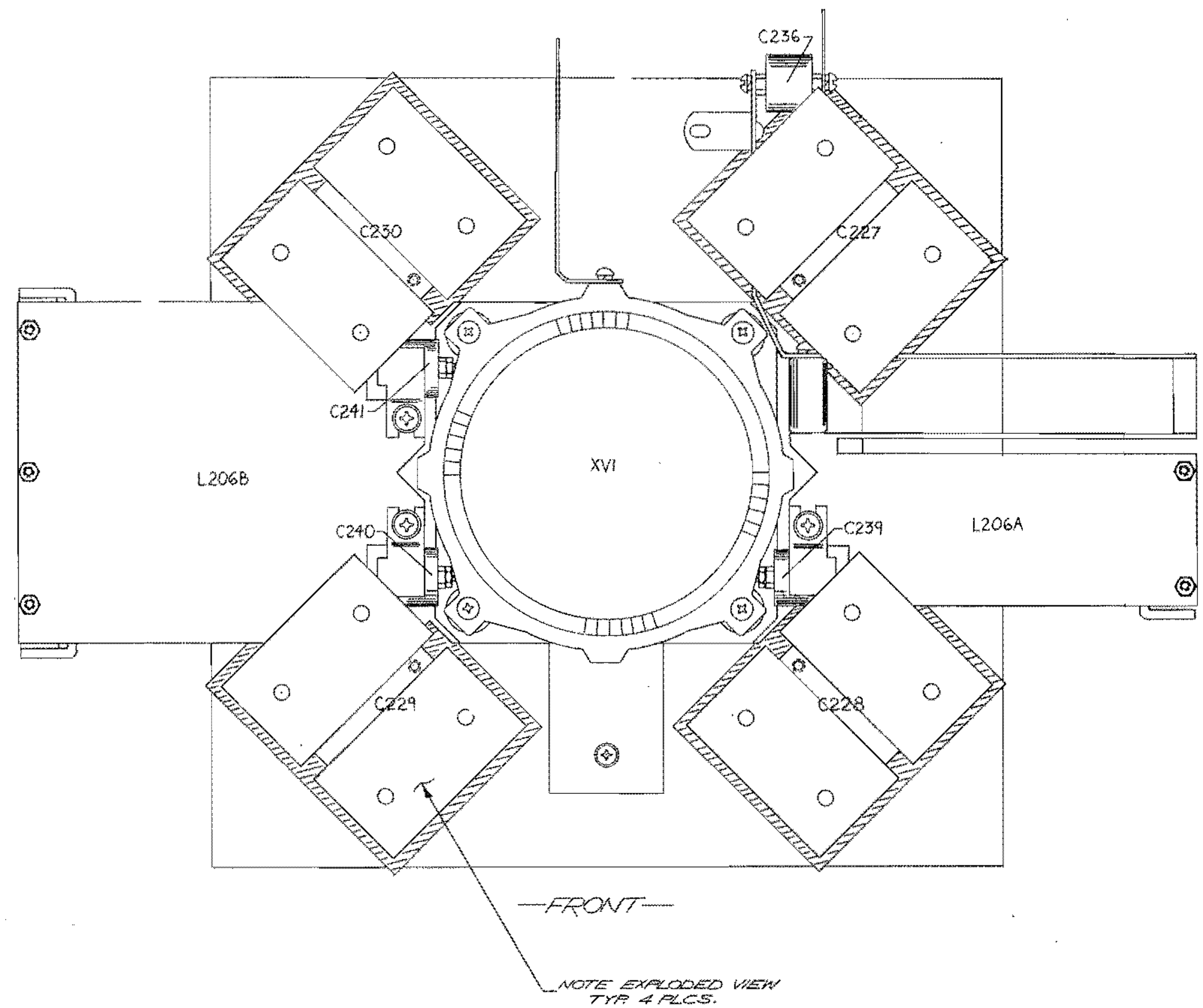


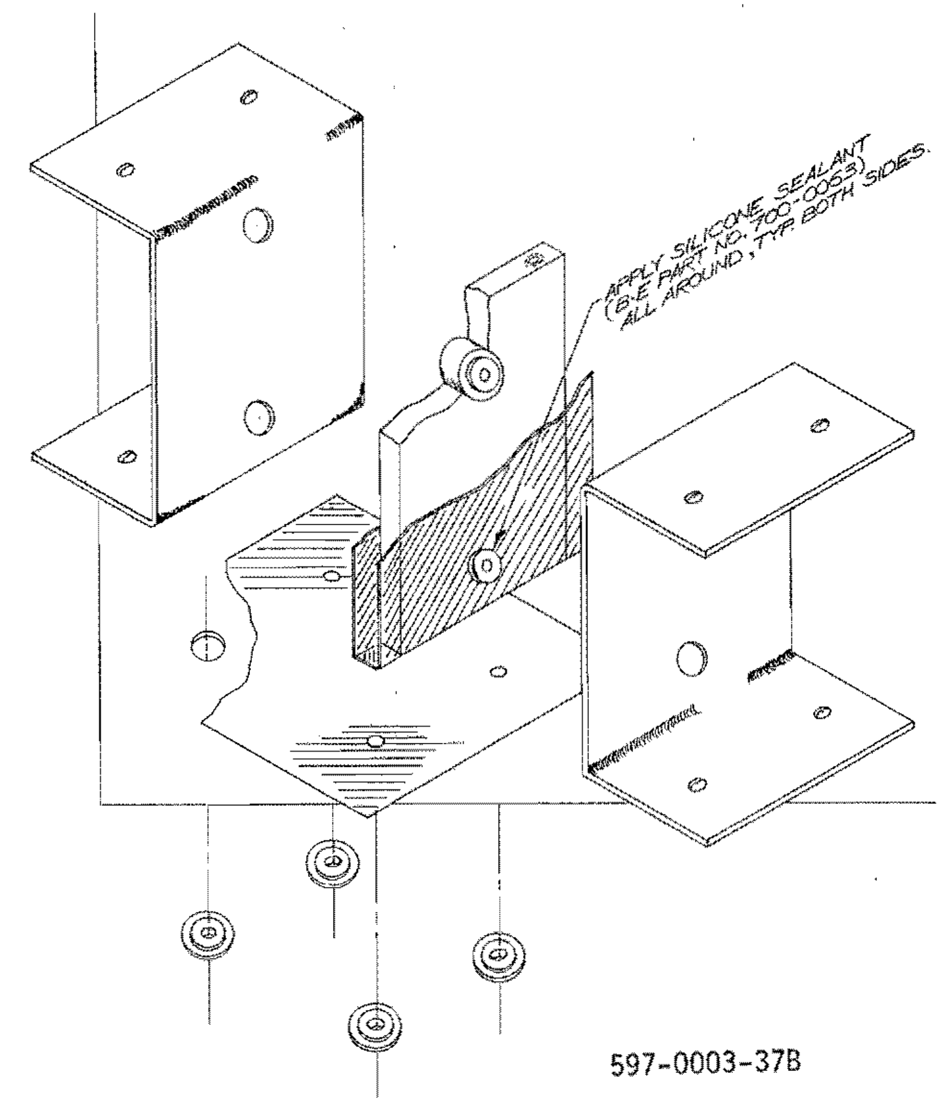
FIGURE 1-1. RF CIRCUIT SIMPLIFIED SCHEMATIC
(SHEET 1 OF 2)



597-0003-37A

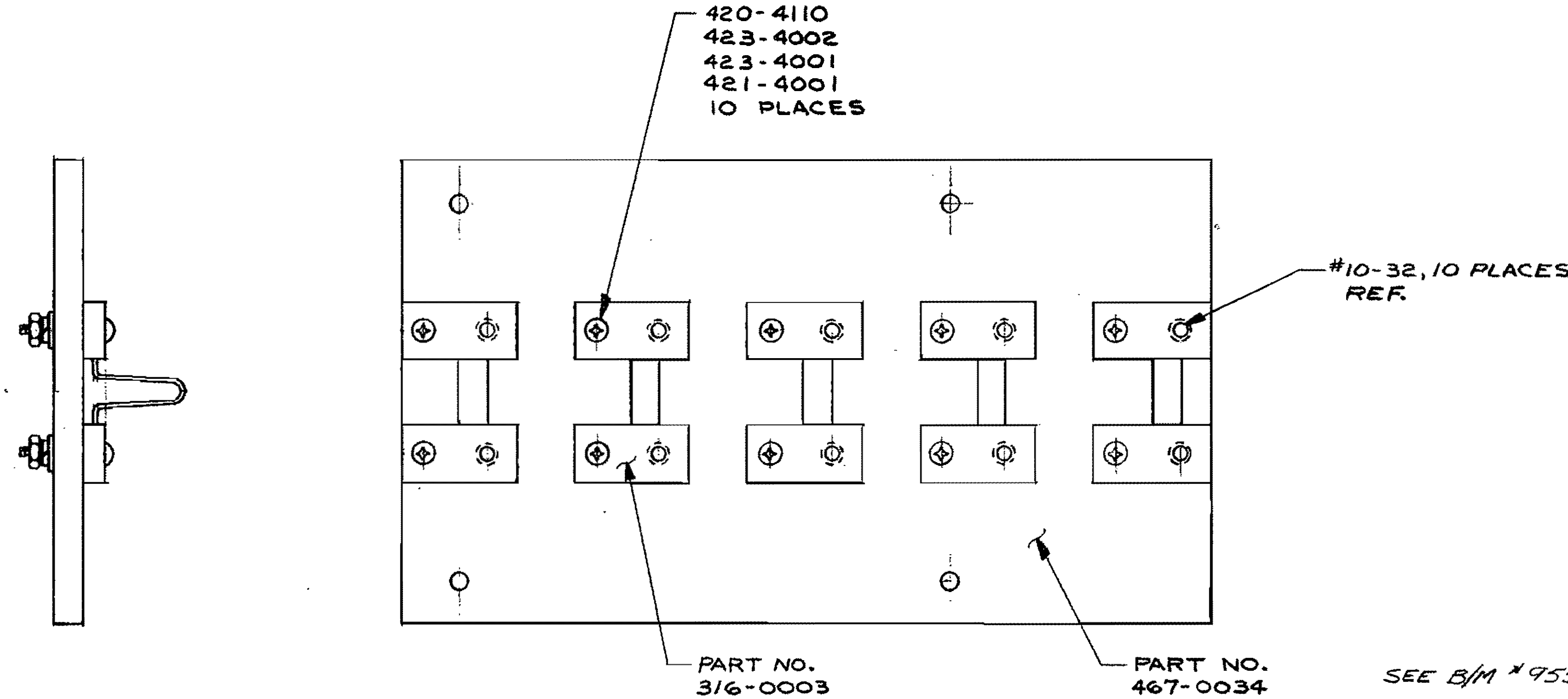
FM-30 GRID INPUT CIRCUIT ASSEMBLY
(SHEET 1 OF 2)





597-0003-37B

FM-30 GRID INPUT CIRCUIT ASSEMBLY
(SHEET 2 OF 2)



SEE B/M #955-0031

SEE SCHEMATIC #D909-0300

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED

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

MATERIAL: NOTED

DRAWN BY: MIKE MT. DATE: 10-14-80
CHECKED BY: DATE:
PROJECT ENGR.: DATE:
APPROVED BY:
TREATMENT OR FINISH:

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE: ASSEMBLY-IPA AMMETER-METER SHUNT BOARD

B DWG. NO. 955-0031 REV.

FM30 SCALE 1/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
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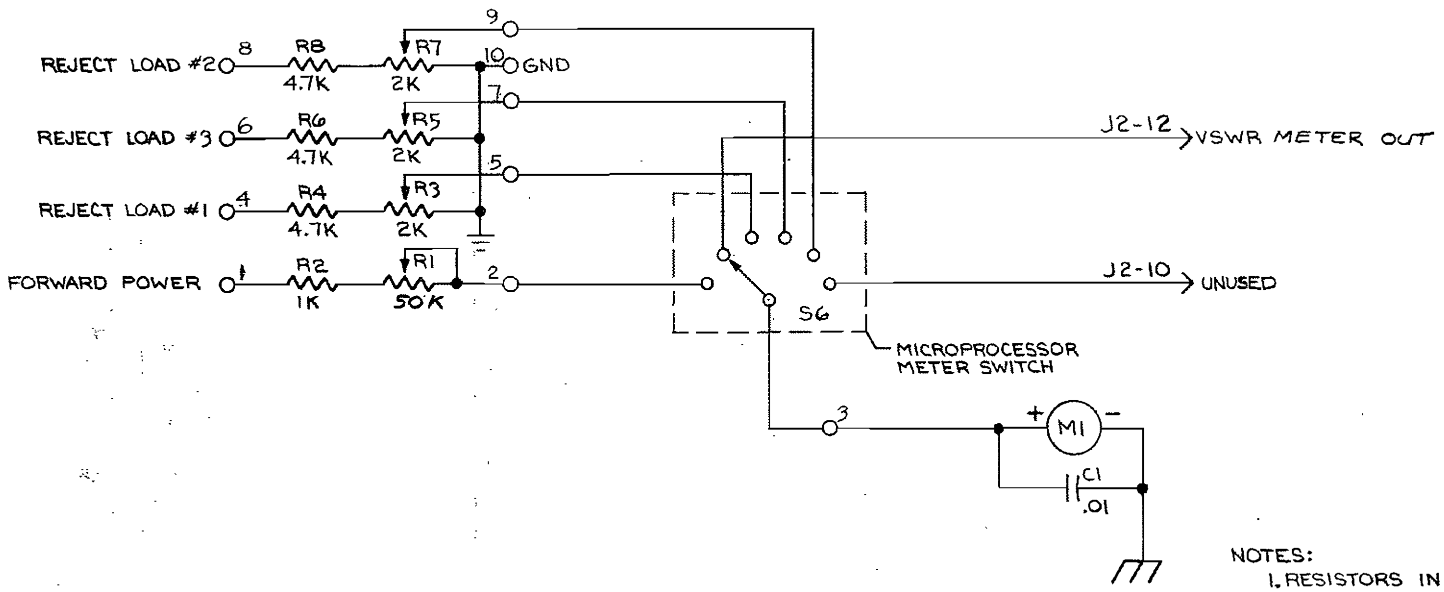
B	PER ECN #1965	3-19-80	MH
C	PER ECN 2542	2-5-81	mm



NOTES:

1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS, UNLESS NOTED OTHERWISE.
2. LAST COMPONENTS USED: C1, M1, R8.
3. SEE PCB ASSY # A-917-0020.

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

MATERIAL

DRAWN BY M. HAYDEN	DATE 3-3-80	
CHECKED BY	DATE	
PROJECT ENGR.	DATE	
APPROVED BY		

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC
1PA MULTIMETER BOARD

B DWG. NO. 909-0020 REV. C

FM 30 XMTR SCALE — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
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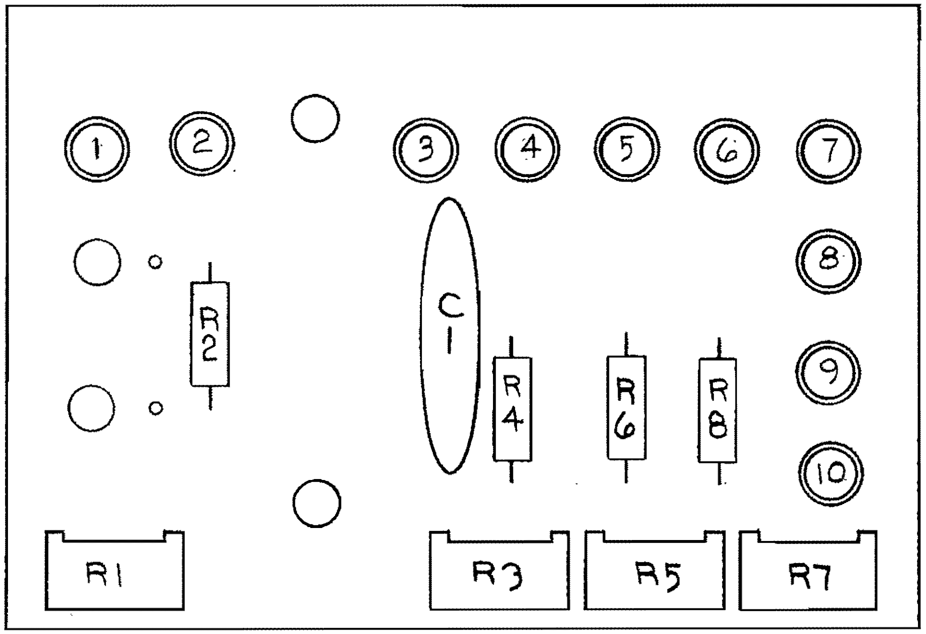
B	PER ECN #1965	3-19-80	MH
C	PER ECN # 2542	2-3-81	mm



SEE B/M # 917-0020
SEE SCHEMATIC # B-909-0020

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

MATERIAL

DRAWN BY M.HAYDEN	DATE 3-3-80
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

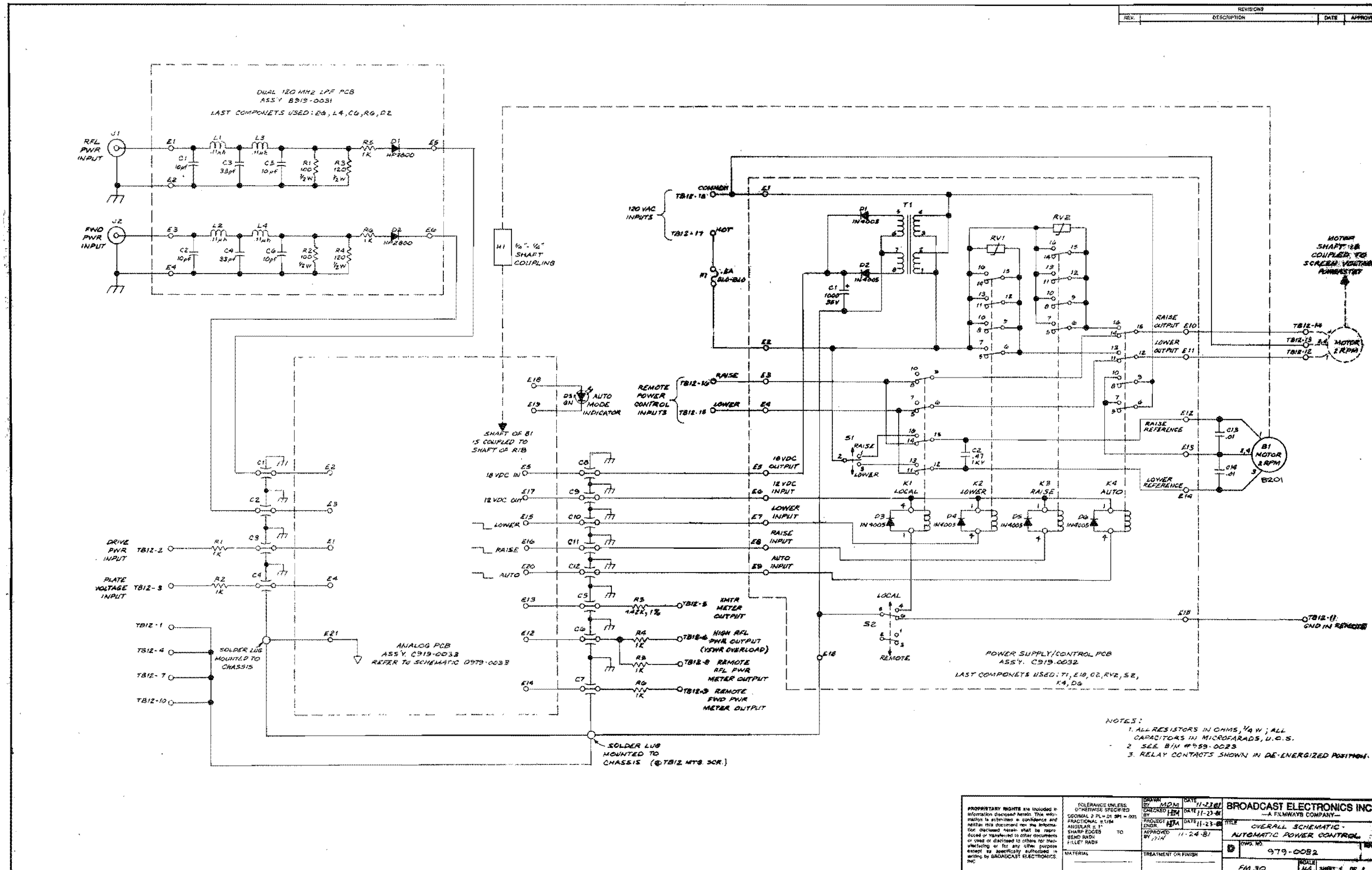
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

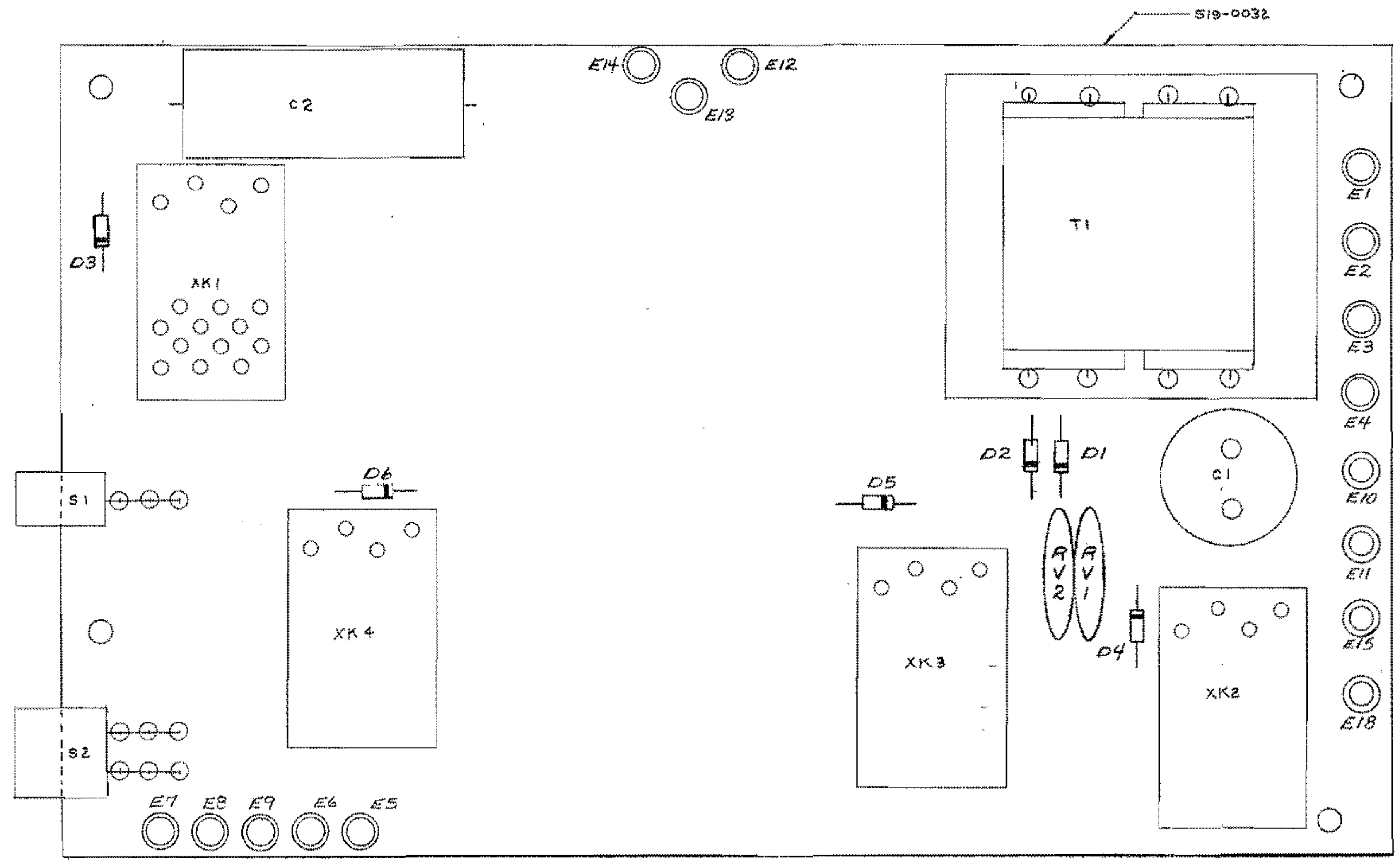
TITLE PCB ASSY.
IPA MULTIMETER BOARD

A DWG. NO. 917-0020 REV. C

FM30 XMTR SCALE 2/1 SHEET 1 OF 1


REVISIONS
REV. DESCRIPTION DATE APPROVED
DUAL 120 MHz LPF PCB
ASS'Y B919-0031
LAST COMPONETS USED: E6, L4, C6, R6, D2
RFL PWR INPUT
FWD PWR INPUT
H1 1/4"-1/4" SHAFT COUPLING
SHAFT OF B1 IS COUPLED TO SHAFT OF R18
DRIVE PWR INPUT TB12-2
PLATE VOLTAGE INPUT TB12-3
SOLDER LUG MOUNTED TO CHASSIS
ANALOG PCB
ASS'Y C919-0033
REFER TO SCHEMATIC D979-0033
DS1 GN AUTO MODE INDICATOR
18 VDC IN
12 VDC OUT
LOWER
RAISE
AUTO
XMTR METER OUTPUT
HIGH RFL PWR OUTPUT (VSWR OVERLOAD)
REMOTE RFL PWR METER OUTPUT
REMOTE FWD PWR METER OUTPUT
SOLDER LUG MOUNTED TO CHASSIS (@TB12 MTG. SCR.)
120 VAC INPUTS
COMMON
HOT
REMOTE POWER CONTROL INPUTS
18 VDC OUTPUT
12 VDC INPUT
LOWER INPUT
RAISE INPUT
AUTO INPUT
K1 LOCAL
K2 LOWER
K3 RAISE
K4 AUTO
LOCAL
REMOTE
RAISE OUTPUT
LOWER OUTPUT
RAISE REFERENCE
LOWER REFERENCE
MOTOR SHAFT IS COUPLED TO SCREEN VOLTAGE POWERSTAT
MOTOR 2 RPM
B1 MOTOR 2 RPM
B201
GND IN REMOTE
POWER SUPPLY/CONTROL PCB
ASS'Y C919-0032
LAST COMPONENTS USED: T1, E18, C2, RV2, S2, K4, D6
NOTES:
1. ALL RESISTORS IN OHMS, 1/4 W; ALL CAPACITORS IN MICROFARADS, U.O.S.
2. SEE B/M #959-0023
3. RELAY CONTACTS SHOWN IN DE-ENERGIZED POSITION.
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—
OVERALL SCHEMATIC - AUTOMATIC POWER CONTROL
979-0082
FM 30

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	UPDATED OFF	11-12-81	



SEE B/M # 919-0032
SEE SCHEMATIC # 979-0032

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

MATERIAL —

DRAWN BY T. GREENE	DATE 9-8-81
CHECKED BY HDM	DATE 1-12-82
PROJECT ENGR. HDM	DATE 1-12-82
APPROVED BY	

TREATMENT OR FINISH —

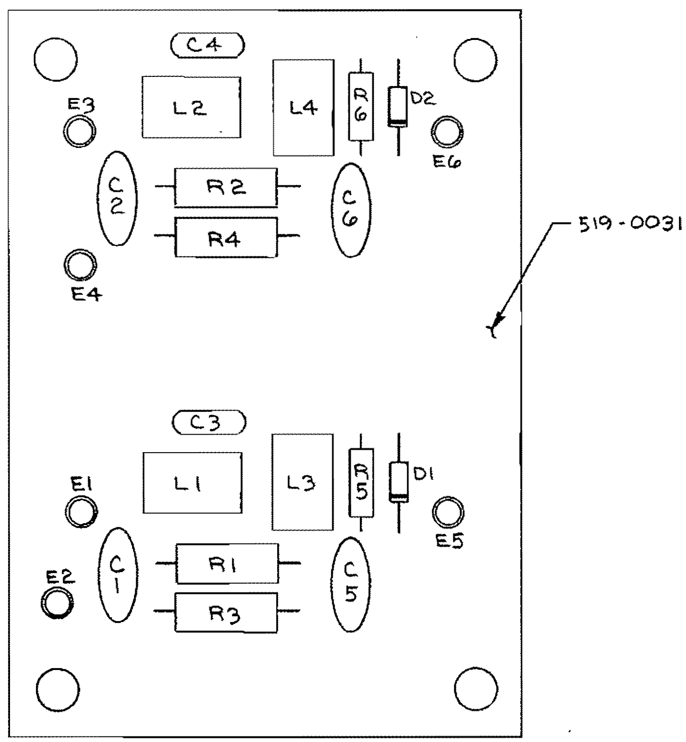
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE P.C.B. ASSEMBLY, POWER SUPPLY AND CONTROL

C DWG. NO. 919-0032 REV. A

FM-30 AUTO POWER CONTROL | SCALE 2/1 | SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



SEE B/M # 919-0031
SEE SCHEMATIC #D-979-0033

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

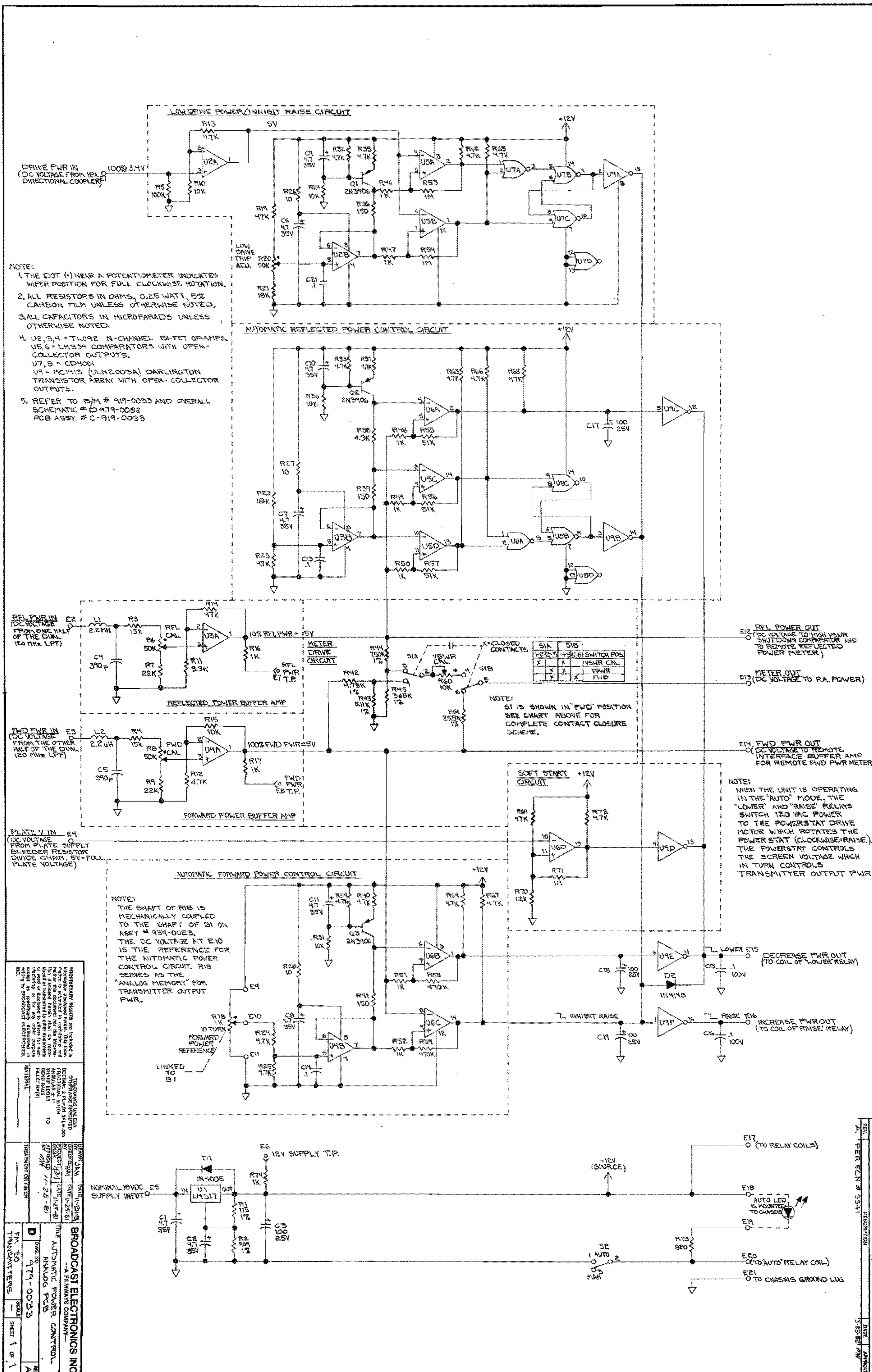
MATERIAL

DRAWN BY M. HAYDEN	DATE 10-21-81
CHECKED BY HJM	DATE 1-12-82
PROJECT ENGR. HJM	DATE 1-12-82
APPROVED BY	
TREATMENT OR FINISH	

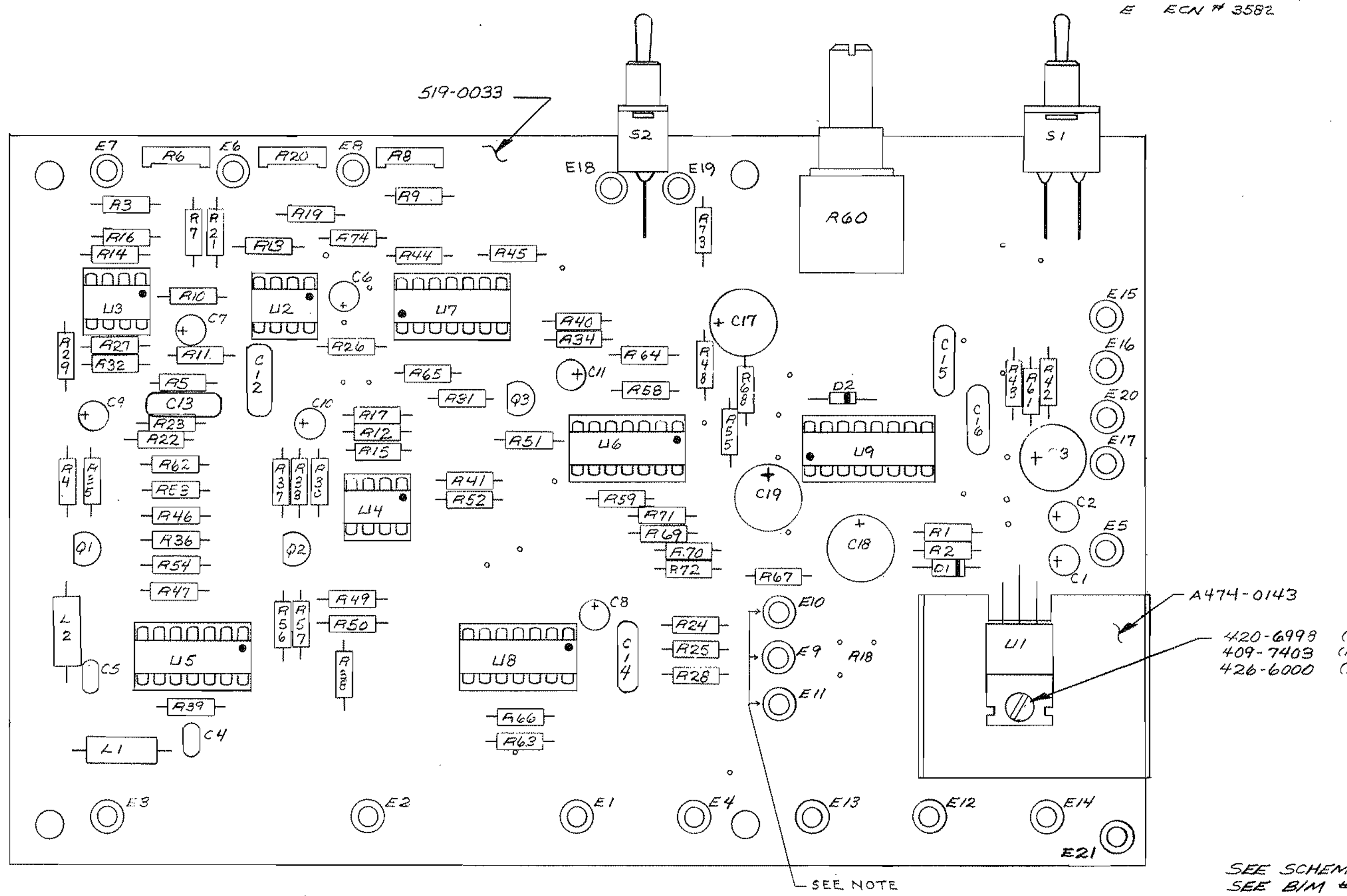
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY, DUAL 120 MHz LOW PASS FILTER

B	DWG. NO. 919-0031	REV.
FM 30 AUTO POWER CONTROL	SCALE 2/1	SHEET 1 OF 1


LOW DRIVE POWER/INHIBIT RAISE CIRCUIT
DRIVE PWR IN (DC VOLTAGE FROM IPA DIRECTIONAL COUPLER)
100% 3.4V
LOW DRIVE TRIP ADJ.
AUTOMATIC REFLECTED POWER CONTROL CIRCUIT
NOTE:
1. THE DOT (•) NEAR A POTENTIOMETER INDICATES WIPER POSITION FOR FULL CLOCKWISE ROTATION.
2. ALL RESISTORS IN OHMS, 0.25 WATT, 5% CARBON FILM UNLESS OTHERWISE NOTED.
3. ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE NOTED.
4. U2,3,4 = TL092 N-CHANNEL BI-FET OP-AMPS. U5,6 = LM339 COMPARATORS WITH OPEN-COLLECTOR OUTPUTS. U7,8 = CD4001 U9 = MC1413 (ULN2003A) DARLINGTON TRANSISTOR ARRAY WITH OPEN-COLLECTOR OUTPUTS.
5. REFER TO B/M # 919-0033 AND OVERALL SCHEMATIC # D 979-0082 PCB ASSY. # C-919-0033
RFL PWR IN (DC VOLTAGE FROM ONE HALF OF THE DUAL 120 MHz LPF)
REFLECTED POWER BUFFER AMP
RFL PWR E7 T.P.
METER DRIVE CIRCUIT
x = CLOSED CONTACTS
VSWR CAL
NOTE: S1 IS SHOWN IN "FWD" POSITION. SEE CHART ABOVE FOR COMPLETE CONTACT CLOSURE SCHEME.
RFL POWER OUT (DC VOLTAGE TO HIGH VSWR SHUTDOWN COMPARATOR AND TO REMOTE REFLECTED POWER METER)
METER OUT (DC VOLTAGE TO P.A. POWER)
FWD PWR IN (DC VOLTAGE FROM THE OTHER HALF OF THE DUAL 120 MHz LPF)
FORWARD POWER BUFFER AMP
FWD PWR E8 T.P.
100% FWD PWR = 5V
FWD PWR OUT (DC VOLTAGE TO REMOTE INTERFACE BUFFER AMP FOR REMOTE FWD PWR METER)
SOFT START CIRCUIT
NOTE: WHEN THE UNIT IS OPERATING IN THE "AUTO" MODE, THE "LOWER" AND "RAISE" RELAYS SWITCH 120 VAC POWER TO THE POWERSTAT DRIVE MOTOR WHICH ROTATES THE POWERSTAT (CLOCKWISE=RAISE). THE POWERSTAT CONTROLS THE SCREEN VOLTAGE WHICH IN TURN CONTROLS TRANSMITTER OUTPUT PWR.
PLATE V IN (DC VOLTAGE FROM PLATE SUPPLY BLEEDER RESISTOR DIVIDE CHAIN, 5V = FULL PLATE VOLTAGE)
AUTOMATIC FORWARD POWER CONTROL CIRCUIT
NOTE: THE SHAFT OF R18 IS MECHANICALLY COUPLED TO THE SHAFT OF S1 ON ASSY # 959-0023. THE DC VOLTAGE AT E10 IS THE REFERENCE FOR THE AUTOMATIC POWER CONTROL CIRCUIT. R18 SERVES AS THE "ANALOG MEMORY" FOR TRANSMITTER OUTPUT PWR.
FORWARD POWER REFERENCE
LINKED TO S1
LOWER E15
DECREASE PWR OUT (TO COIL OF "LOWER" RELAY)
INHIBIT RAISE
RAISE E16
INCREASE PWR OUT (TO COIL OF "RAISE" RELAY)
12V SUPPLY T.P.
NOMINAL 18VDC E5 SUPPLY INPUT
+12V (SOURCE)
(TO RELAY COILS)
AUTO LED IS MOUNTED TO CHASSIS
AUTO
MAN
(TO "AUTO" RELAY COIL)
TO CHASSIS GROUND LUG
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—
AUTOMATIC POWER CONTROL ANALOG PCB
FM 30 TRANSMITTERS
D 919-0033
SHEET 1 OF 1
A PER ECN # 3341

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	UPDATED	10-7-81	CRF
B	UPDATED	11-9-81	CRF
C	PER ECN # 3341	3-23-82	MH
D	SEE ECN 3549	6/10/82	RRT
E	ECN # 3582 CRF	6-25-82	



SEE SCHEMATIC # D 979-0033
SEE B/M # 919-0033

NOTE:
HOOKUP TO THE 10 TURN POT (R18) IS WITH #22 WIRE-WHITE-(601-2209) - 3 LENGTHS - 4" LG.

TABLE	
PCB	TO POT
E10	SL
E9	CW
E11	CCW

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

MATERIAL

DRAWN BY CRF	DATE 9-25-81	
CHECKED BY HM	DATE 1-12-82	
PROJECT ENGR. HM	DATE 1-12-82	
APPROVED BY		

TREATMENT OR FINISH

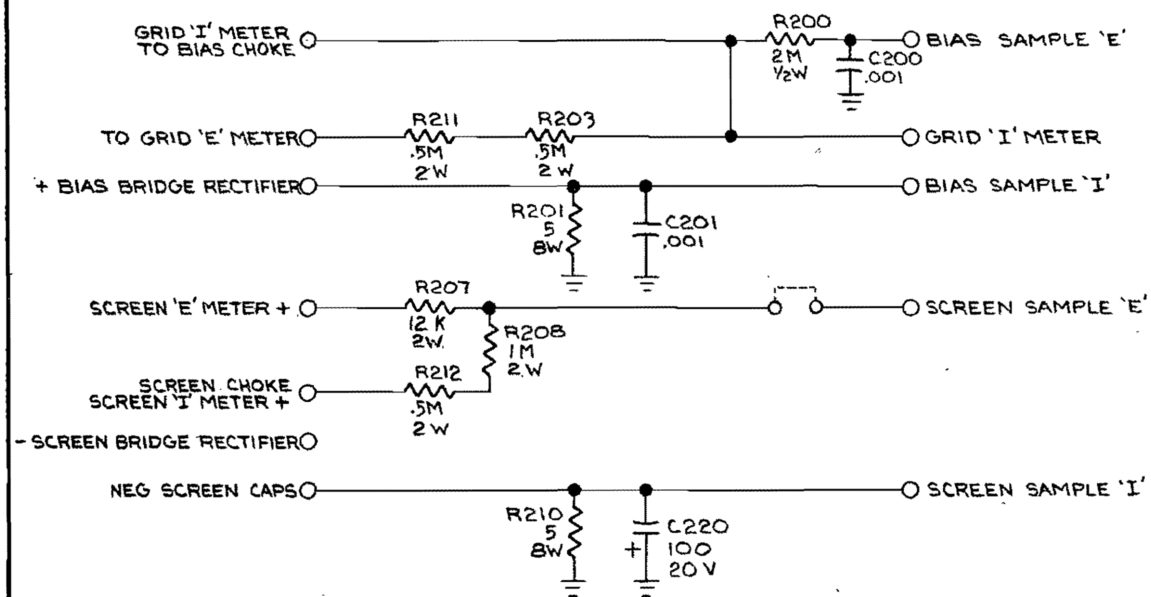
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY, ANALOG

C DWG. NO. 919-0033 REV. E

FM-30 AUTO POWER CONTROL SCALE 2/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN #2065	5-23-80	MH
B	PER ECN # 2561	3-16-81	Wsh



NOTES:
1. ALL RESISTORS IN OHMS; ALL CAPACITORS IN MICROFARADS, UNLESS NOTED OTHERWISE.
2. SEE PCB ASSY. DWG. NO. B-917-0026.

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

MATERIAL

DRAWN BY M. HAYDEN — DATE 10-17-79
CHECKED BY — DATE
PROJECT ENGR. — DATE
APPROVED BY

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE: SCHEMATIC SCREEN/BIAS SUPPLY METERING BOARD

B — DWG. NO. 909-0026 — REV. B

30KW TRANSMITTER — SCALE ___ — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
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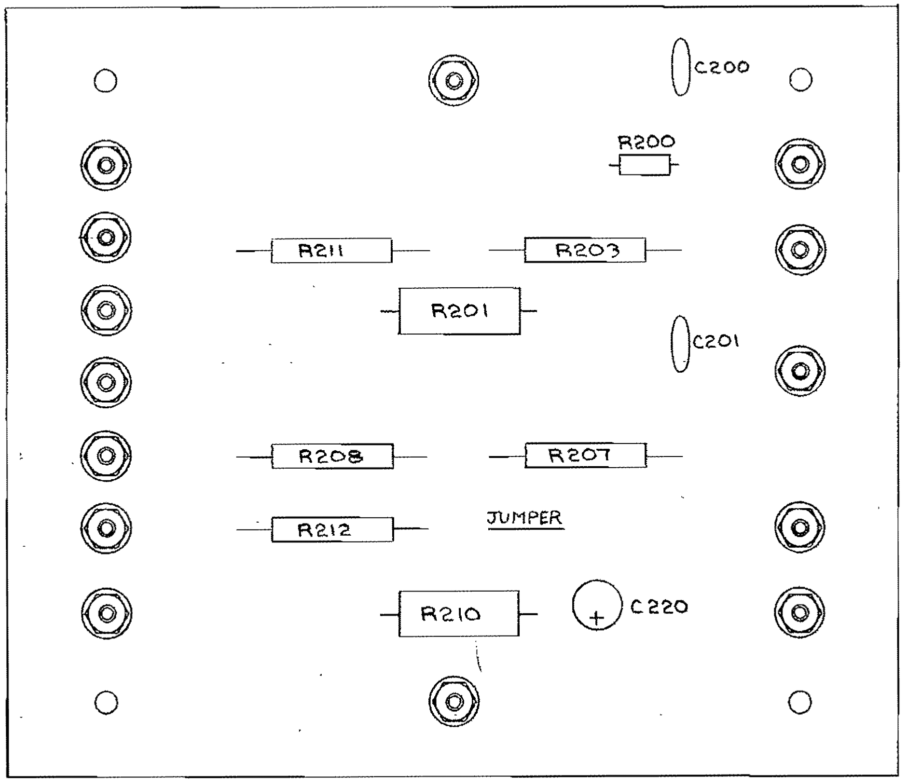
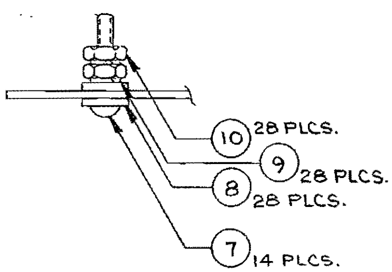
B	PER ECN # 2561	3-16-81	LAsh





SEE B/M NO. 917-0026
SEE SCHEMATIC NO. B-909-0026

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

MATERIAL

DRAWN BY M.HAYDEN — DATE 10-17-79
CHECKED BY — DATE
PROJECT ENGR. — DATE
APPROVED BY

TREATMENT OR FINISH

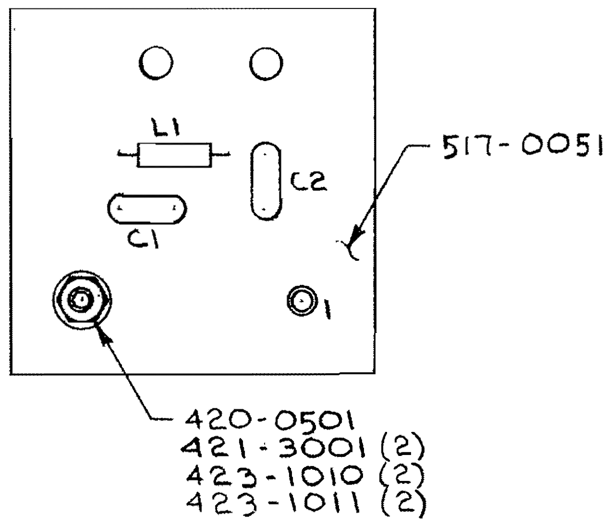
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY- SCREEN/BIAS SUPPLY METERING BOARD

B — DWG. NO. 917-0026 — REV. B

30KW TRANSMITTER — SCALE 1/1 — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



SEE B/M NO. 917-0051

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

MATERIAL

DRAWN BY M.HAYDEN	DATE 3-18-81
CHECKED BY [illegible]	DATE 4-2-81
PROJECT ENGR. [illegible]	DATE 4-2-81
APPROVED BY	

TREATMENT OR FINISH

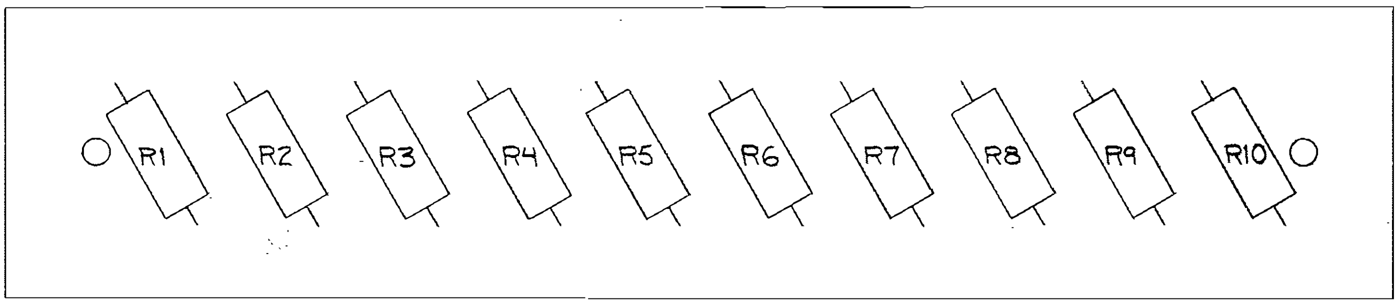
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY AC METER FILTER

A DWG. NO. 917-0051 REV.

FM30 PA CAB SCALE 1/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED



SEE B/M #917-0016
SEE SCHEMATIC # D909-0300

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

MATERIAL

DRAWN BY	JAH	DATE	7-15-82
CHECKED BY		DATE	
PROJECT ENGR.		DATE	
APPROVED BY			

TREATMENT OR FINISH

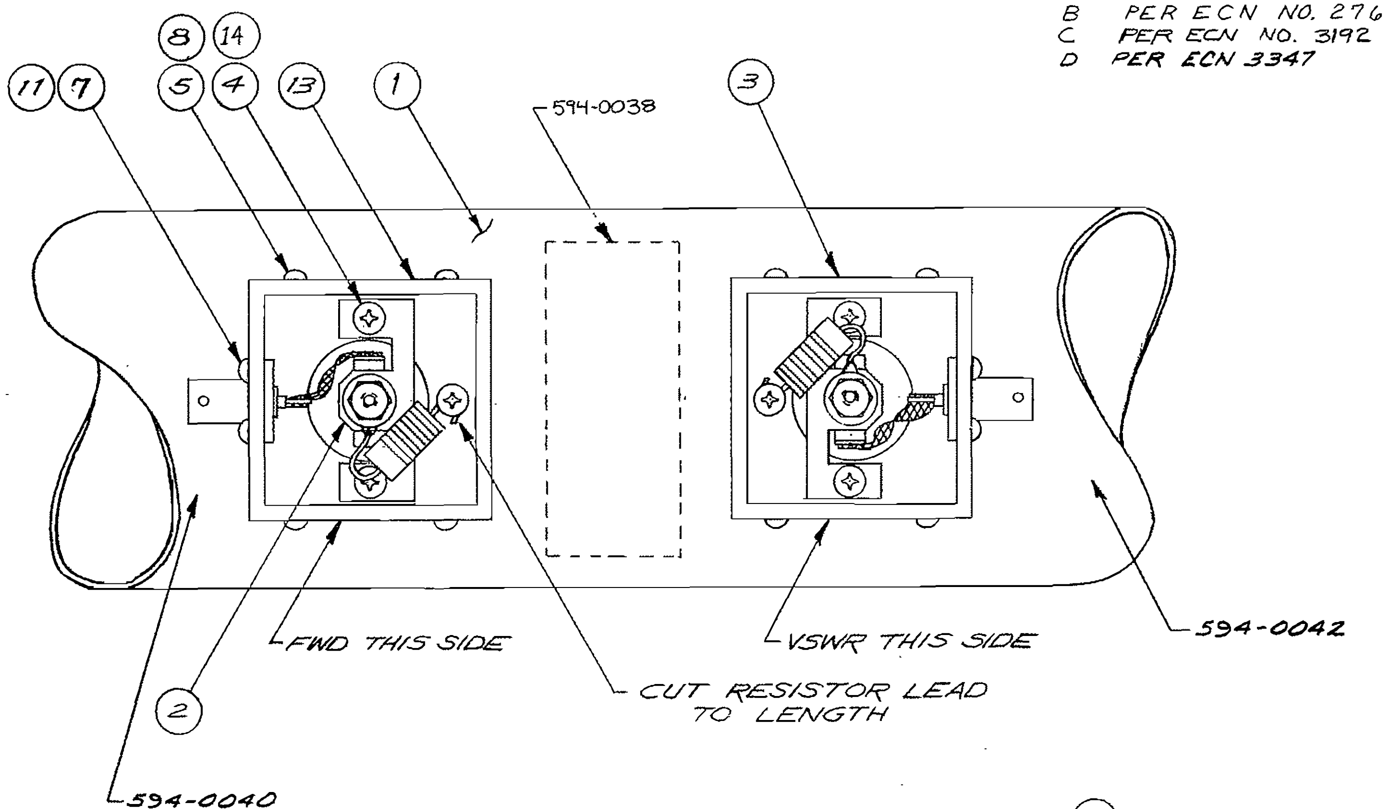
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY, PA METER MULTIPLIER

B DWG. NO. 917-0016 REV.

TRANSMITTER RF ENCLOSURE | SCALE 1/1 | SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN 2115	6-12-80	CLO
B	PER ECN NO. 2764	8-10-81	JDS
C	PER ECN NO. 3192	1-14-82	JAH/
D	PER ECN 3347	3-29-82	MRK



PART NO. 6 END PLATE, OMITTED FOR CLARITY.

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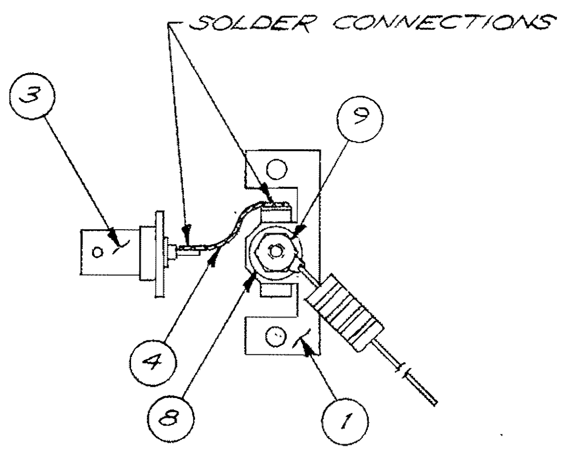
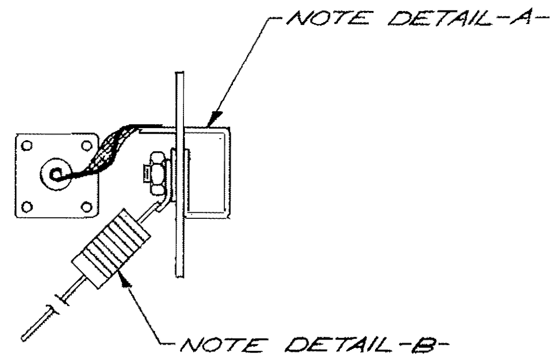
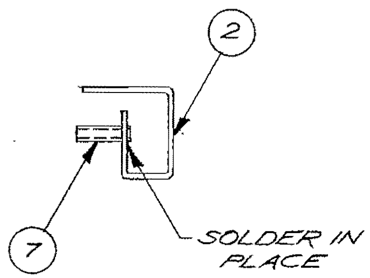
	MATERIAL	TREATMENT OR FINISH	B — DWG. NO. 950-6907 — REV. D XMTR — SCALE 1/1 — SHEET 1 OF 1

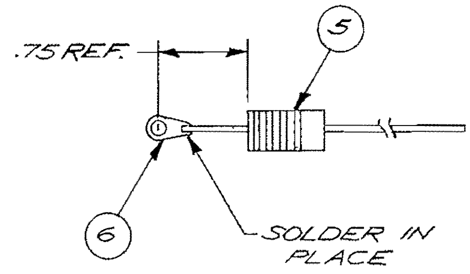
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED







DETAIL-A-



DETAIL-B-

ITEM	PART NO.	DESCRIPTION	QTY
1	A-479-6437	INSULATOR	1
2	A-479-6438	LOOP	1
3	417-0203	BNC CONNECTOR	1
4	614-8474	BRAID - 1.00 LONG	1
5	132-6832	RESISTOR, 68Ω, 2W	1
6	410-1416	SOLDER LUG W/#6 HOLE	1
7	420-0068	#6-32 × ½ STUD (BRASS)	1
8	423-6000	#6 FLAT WASHER (BRASS)	1
9	421-6002	#6 HEX NUT (BRASS)	1

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

MATERIAL

DRAWN BY C. ORR	DATE 6-15-79
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SUB-ASSEMBLY- PA DIRECTIONAL COUPLER

B DWG. NO. 950-6906 REV.

XMTR SCALE 1/1 SHEET 1 OF 1

APPENDIX A

RF CIRCUIT MANUFACTURERS DATA

A-1. <u>INTRODUCTION</u>

A-2. This appendix provides the following technical data relative to the operation and maintenance of the FM-30 FM Transmitter RF circuitry. Information in the appendix is provided in the following order.

A. Technical Data Sheet, Communications Transistor Corporation BM100-28 Transistor.

B. Technical Data Sheet, Eimac 8990 (4CX20000A Tetrode).

C. Engineering News Letter, Eimac, Life VS Filament Voltage.

2

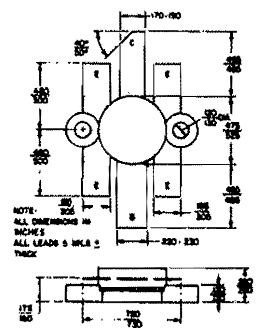
CT BM100-28 July, 1976 (2.2.8.5L)

COMMUNICATIONS TRANSISTOR CORPORATION

BM100-28

100 WATTS ● 175 MHz

PACKAGE



GENERAL DESCRIPTION The BM100-28 is a matched, 100 watt VHF device. The single matching section allows improved performance for operation to 220 MHz. The BM100-28 offers improved saturated power and ruggedness at the same gain as the 2N6369 (BM80-28). Input match has been designed to be similar to that of the BM80-28.

Maximum Power Dissipation (Note 1)

	Total Power Dissipation at 25°C Case Temperature	270

Maximum Voltage and Current

BV_{CES}	Collector to Emitter Voltage	70
BV_{EBO}	Emitter to Base Voltage	4
I_C	Collector Current	20

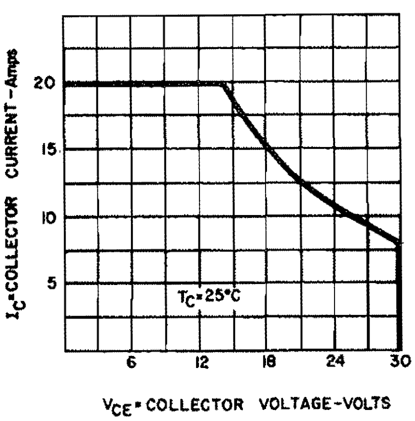
ELECTRICAL CHARACTERISTICS (25°C unless otherwise specified)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
P_{OUT}	Power Output	100			WATTS	f = 175 MHz, Vcc = 28 Volts
P_{IN}	Power Input (At rated Power Out)			20	WATTS	f = 175 MHz, Vcc = 28 Volts
η	Collector Efficiency (At rated Power Out)		60		%	f = 175 MHz, Vcc = 28 Volts
Z_{IN}	Series Input Impedance		1 + j 2.2		OHMS	At rated output power and frequency
C_{CB}	Collector to Base Capacitance(f = 1.0 MHz)		250		pF	V_{CB} = 28 V, I_E = 0
BV_{EBO}	Emitter to Base Voltage	4			VOLTS	I_E = 5 mA
BV_{CES}	Collector to Emitter Voltage	70			VOLTS	I_C = 100 mA
BV_{CEO}	Collector to Emitter Voltage	33			VOLTS	I_C = 50 mA
H_{FE}	DC Current Gain	20		100		I_C = 1A, Vce = 5 Volts
VSWR	Output VSWR Capability	∞				P_{OUT} = 100W, Vcc = 28 V f = 175MHz

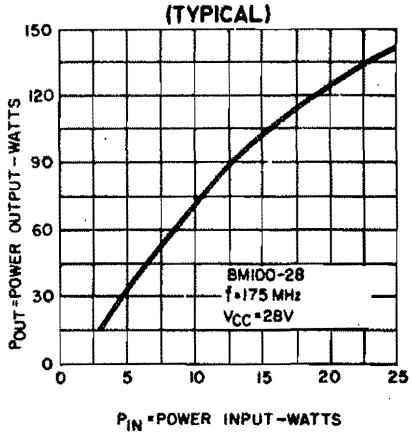
NOTES:

1. This rating gives a maximum junction temperature of 200°C with junction to case thermal resistance of .65 °C/watt.

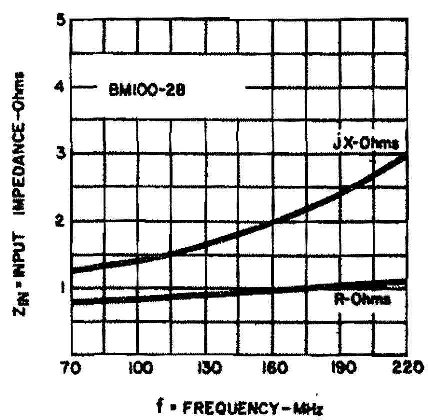
D.C. SAFE OPERATING AREA



POWER OUTPUT VS POWER INPUT (TYPICAL)

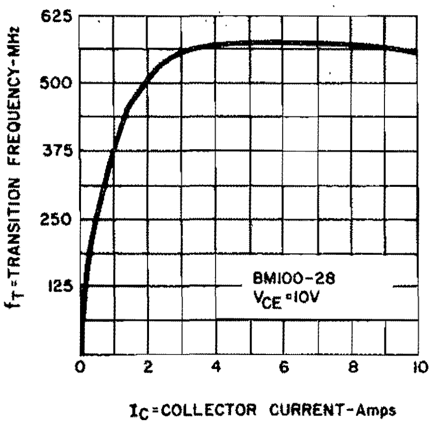


SERIES INPUT IMPEDANCE VS FREQUENCY

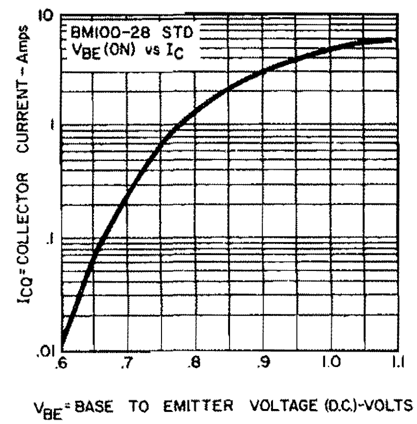


COMMUNICATIONS TRANSISTOR CORPORATION
301 Industrial Way, San Carlos, California 94070
A Subsidiary of Varian Associates
(415) 592-9390 TWX 910-376-4893

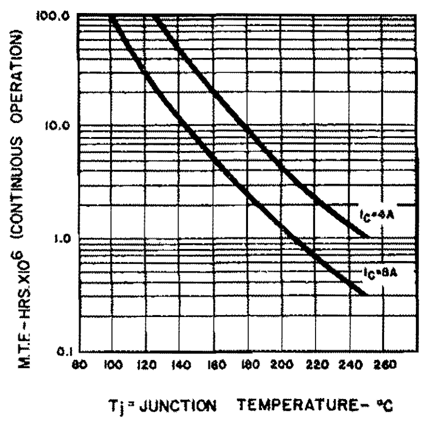
TRANSITION FREQUENCY VS COLLECTOR CURRENT



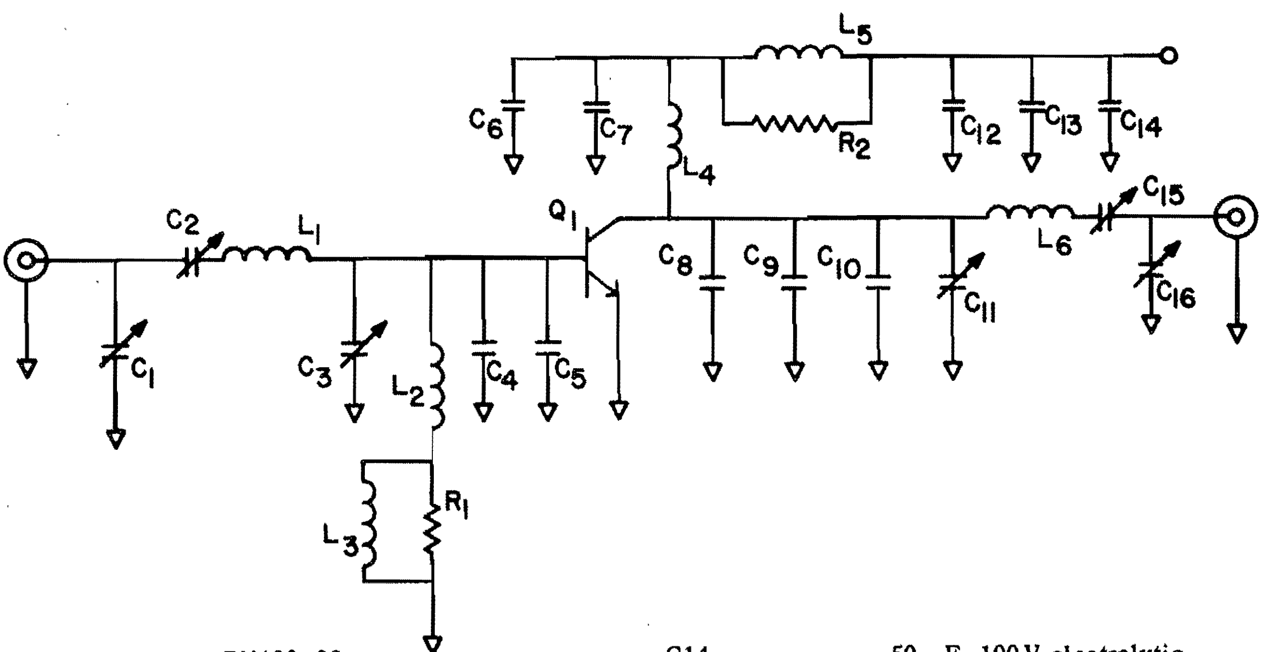
D.C. COLLECTOR CURRENT VS V_{BE} (ON)



MEAN TIME TO FAILURE VS TEMPERATURE



175 MHz TEST CIRCUIT



Q1	BM100-28	C14	50 μF, 100V electrolytic
C1, C2, C3	ARCO 5-70pF	L1	2 turns #16 wire, ½" I.D.
C11, C16	ARCO 5-70pF	L2	.33 μH, molded inductor
C4, C5	100pF UNDERWOOD	L3	5.6 μH, molded inductor
C6, C12	300pF UNDERWOOD	L4	3 turns #16 wire, ½" I.D.
C7	.01 μF disc ceramic	L5	6 turns #18 wire, wound on Indiana General F627-8, H material
C8, C9	15pF UNDERWOOD		
C10,	4 ea, 33pF ATC .10" cube	L6	2 turns #16 wire, ½" I.D.
C13	100pF UNDERWOOD	R1	15 Ω ½ watt carbon comp.
		R2	15 Ω ½ watt carbon comp.

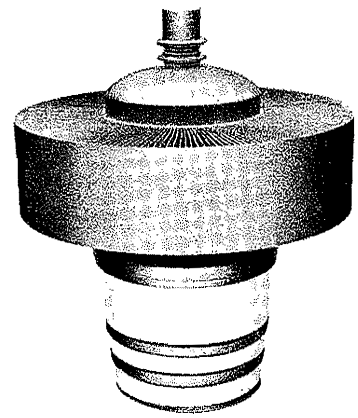
5K Printed in U.S.A.

TECHNICAL DATA

8990
4CX20,000A
8990A

VHF
RADIAL BEAM
POWER TETRODES

The EIMAC 8990/4CX20,000A 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 110 MHz.



The 8990/4CX20,000A has a gain of over 18 dB in FM broadcast service, and is also recommended for radio-frequency linear power amplifier service, and for VHF television linear amplifier service. The anode is rated for 20 kW of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.

The 8990A is recommended for high-level, plate modulated amplifier service.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage:	10.0 ± 0.5 V
Current, at 10.0 volts	140 A
Amplification Factor, average	
Grid to Screen	6.7
Direct Interelectrode Capacitances (cathode grounded):[2]	
Cin	190 pF
Cout	23.5 pF
Cgp	1.5 pF
Direct Interelectrode Capacitances (grid and screen grounded):[2]	
Cin	83 pF
Cout	24.5 pF
Cpk	0.2 pF
Frequency of Maximum Ratings (CW)	110 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. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. 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	9.840 in; 24.99 cm
Diameter	8.800 in; 22.35 cm
Net Weight (Approximate)	14.0 lbs; 6.35 kg
Operating Position	Axis vertical, base up or down
Cooling	Forced air
Operating Temperature, maximum	
Ceramic/Metal Seals and Anode Core	250°C
Base	Special, concentric
Recommended Air System Socket	SK-320
Recommended Air Chimney	SK-326

4402 (Effective 20 October 1980)

Printed in U.S.A.

Varian / EIMAC Division / 301 Industrial Way / San Carlos / California 94070
Telephone: (415) 592-1221 Twx: 910 376-4893

8990/4CX20,000A,8990A

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (frequencies to 30 MHz)

Plate Voltage	7.5	9.0	kVdc
Screen Voltage	750	900	Vdc
Grid Voltage	–200	–250	Vdc
Plate Current	3.68	4.01	Adc
Screen Current[1]	208	222	mAdc
Grid Current[1]	91	88	mAdc
Peak rf Grid Voltage[1]	265	300	v
Calculated Drive Power	24.1	26.4	W
Plate Dissipation[1]	5.84	7.93	kW
Plate Output Power[1]	21.8	28.2	kW
Load Impedance	1062	1136	Ω

[1] Approximate value

TYPICAL OPERATION, COMMERCIAL FM SERVICE
(measured values at frequency shown, in
EIMAC CV-2200 cavity amplifier)

Frequency of Operation	88.3	107.7	MHz
Plate Voltage	9.0	9.0	kVdc
Screen Voltage	800	800	Vdc
Grid Voltage	–400	–300	Vdc
Plate Current	4.08	4.15	Adc
Screen Current	200	200	mAdc
Grid Current	40	38	mAdc
Drive Power	325	360	W
Useful Power Output[1]	28.75	28.9	kW
Efficiency	80.5	77.4	%
Gain	19.5	19.0	dB

[1] Delivered to the load

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER
8990A RECOMMENDED

GRID DRIVEN Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC GRID VOLTAGE	–1,000	VOLTS
DC PLATE CURRENT	5	AMPERES
PLATE DISSIPATION	13.5	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	7,800	Vdc
Screen Voltage	750	Vdc
Grid Voltage	–300	Vdc
Peak af screen voltage (100% modulation)	750	v
Plate Current	4.6	Adc
Screen Current[1]	220	mAdc
Grid Current[1]	108	mAdc
Calculated Driving Power	35	W
Plate Impedance	845	Ω
Plate Output Power	29	kW
Plate Dissipation	6880	W

[1] Approximate

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

GRID DRIVEN, Class AB1
(sinusoidal wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	6	AMPERES
PLATE DISSIPATION	20	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (2 tubes)

Plate Voltage	7,800	7,800	7800	Vdc
Screen Voltage	500	750	1500	Vdc
Grid Voltage[1]	–70	–125	-250	Vdc
Zero Signal Plate Current	0.75	0.75	1.0	Adc
Max. Signal Plate Current	3.4	5.2	9.2	Adc
Max. Signal Screen Current[2]	90	220	600	mAdc
Peak Grid Voltage[2]	65	115	200	v
Max. Signal Plate Dissipation[3]	6	7	13.5	kW
Plate Output Power	14.5	26	44	kW
Load Impedance p/p	6,300	3,500	1600	Ω

[1] Adjust for specified zero-signal plate current.
[2] Approximate value
[3] Per tube

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the 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. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

APPLICATION

MOUNTING – The 8990 must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET & CHIMNEY – The EIMAC air-system socket SK-320 and air chimney SK-326 are designed especially for use with the 8990. The use of the recommended air flow through this socket provides effective forced-air 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 the rated maximum.

The cooling characteristics of the anode are shown in the attached graph, for power levels from 7.5 kW to 20 kW dissipation. The designer is cautioned to keep in mind that is ABSOLUTE data, with pure dc power, with no safety factors added, and the pressure drop figures make no allowance for losses in filters, ducting, and the like.

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. It is also considered good practice to add a 15% safety factor to the indicated airflow, and allow for variables such as dirty air filters, rf seal heating at VHF, and the fact that the anode coolings 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 into the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

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 allowed for tube cooldown.

FILAMENT OPERATION – The rated nominal filament voltage for the 8990 is 10.0 volts, as measured at the socket or tube base. Variation in voltage should be maintained within plus or minus five percent. During application of filament voltage the inrush current should be limited to no more than twice normal current.

The peak emission capability at nominal filament voltage is normally more than that required for communication service. A small decrease in filament temperature due to reduction in filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance (such as plate current, power output, or distortion) while filament voltage is reduced. At some point in filament voltage there will be a noticeable change in the operating parameter being monitored, and the operating filament voltage must be slightly higher than the level at which deterioration was noted. When filament voltage is to be reduced in this manner it should be regulated and held to plus or minus one percent, and the actual operating value should be checked periodically to maintain proper operation.

ELECTRODE DISSIPATION RATINGS – The maximum dissipation ratings for the 8990 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 8990 control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should normally be kept near the values shown in the TYPICAL OPERATION section of the data sheet whenever possible.

SCREEN OPERATION – The power dissipated by the screen of the 8990 must not exceed 450 watts. Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with the filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure. 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 8990 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 normal plate overcurrent interlock and screen current interlock it is good practice to protect the tube from internal damage which could result from a plate arc at high voltage. In all cases some protective resistance, 10 to 50 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a tube arc should occur. If power supply stored energy is high some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a tube arc is recommended.

HIGH VOLTAGE – Normal operating voltages used with the 8990 are deadly and the equipment must be designed properly and operating precautions must be followed. All equipment must be designed so that no one can come into 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.

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 specially constructed test fixtures which effectively shield all external tube leads from each other and eliminate 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, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally 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 any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS – If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070 for recommendations.

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 power tubes 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.

b. 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.

c. X-RAY RADIATION – High voltage tubes can produce dangerous and possibly fatal x-rays.

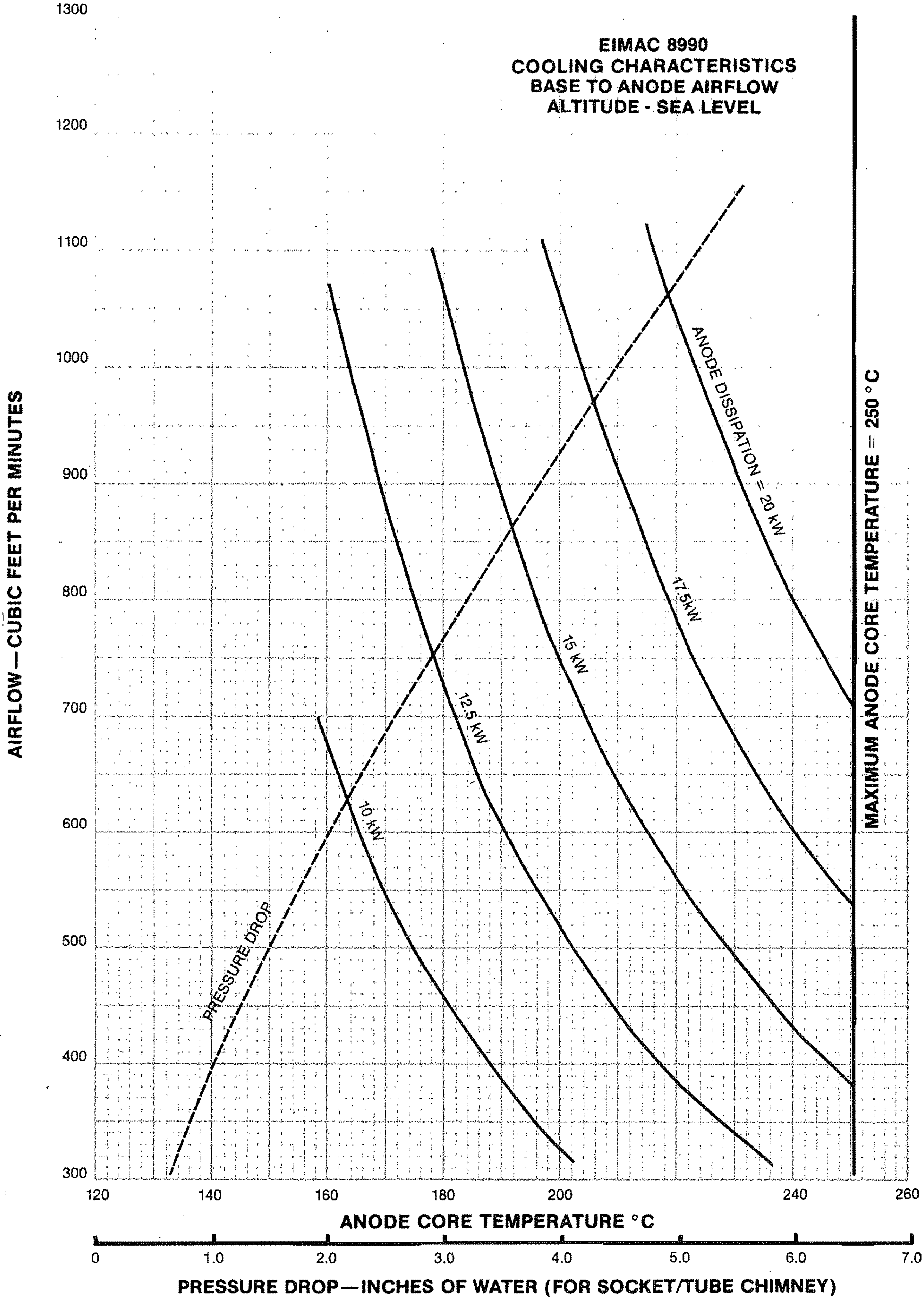
d. BERYLLIUM OXIDE POISONING – Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

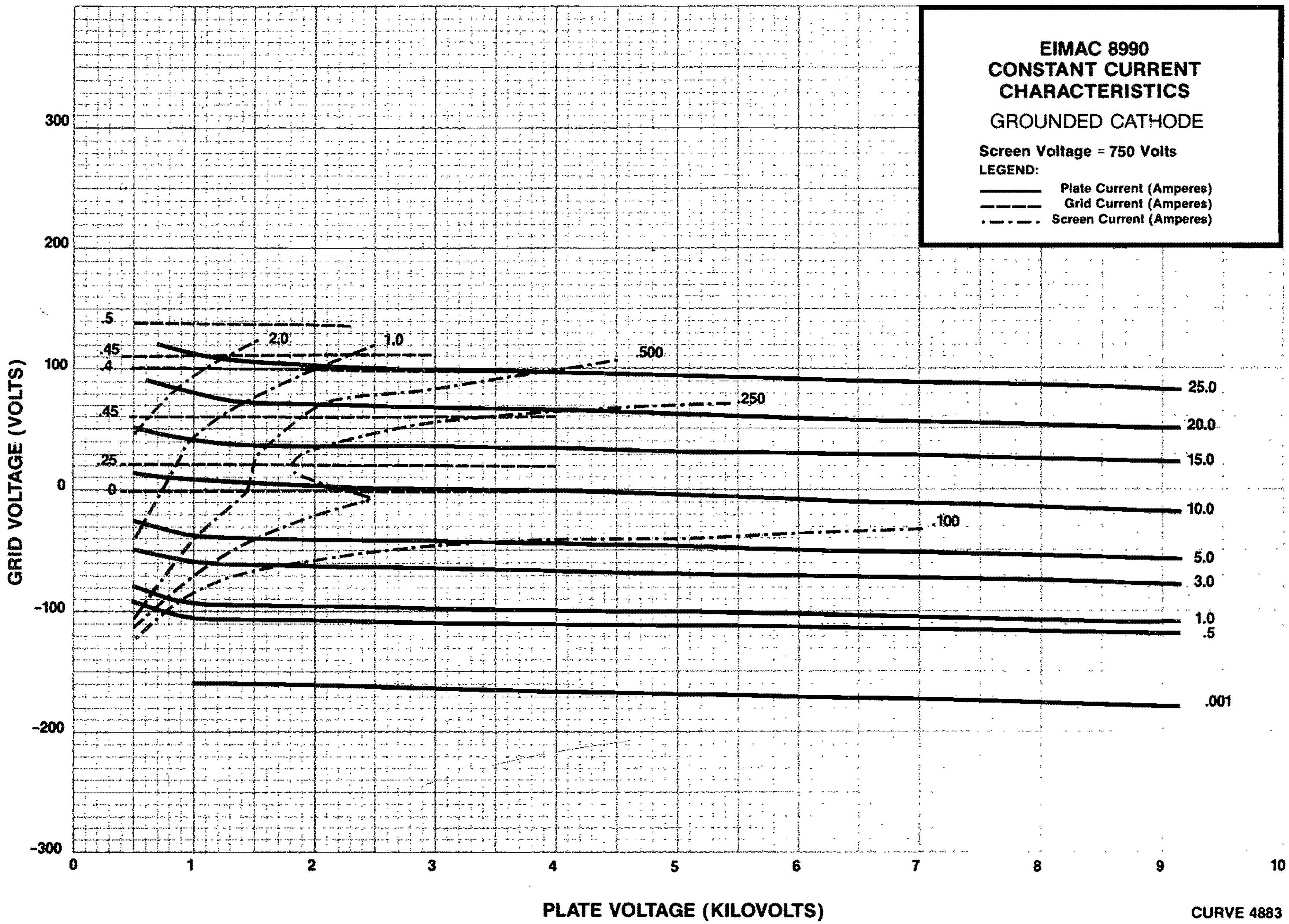
e. GLASS EXPLOSION – Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

f. HOT WATER – Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

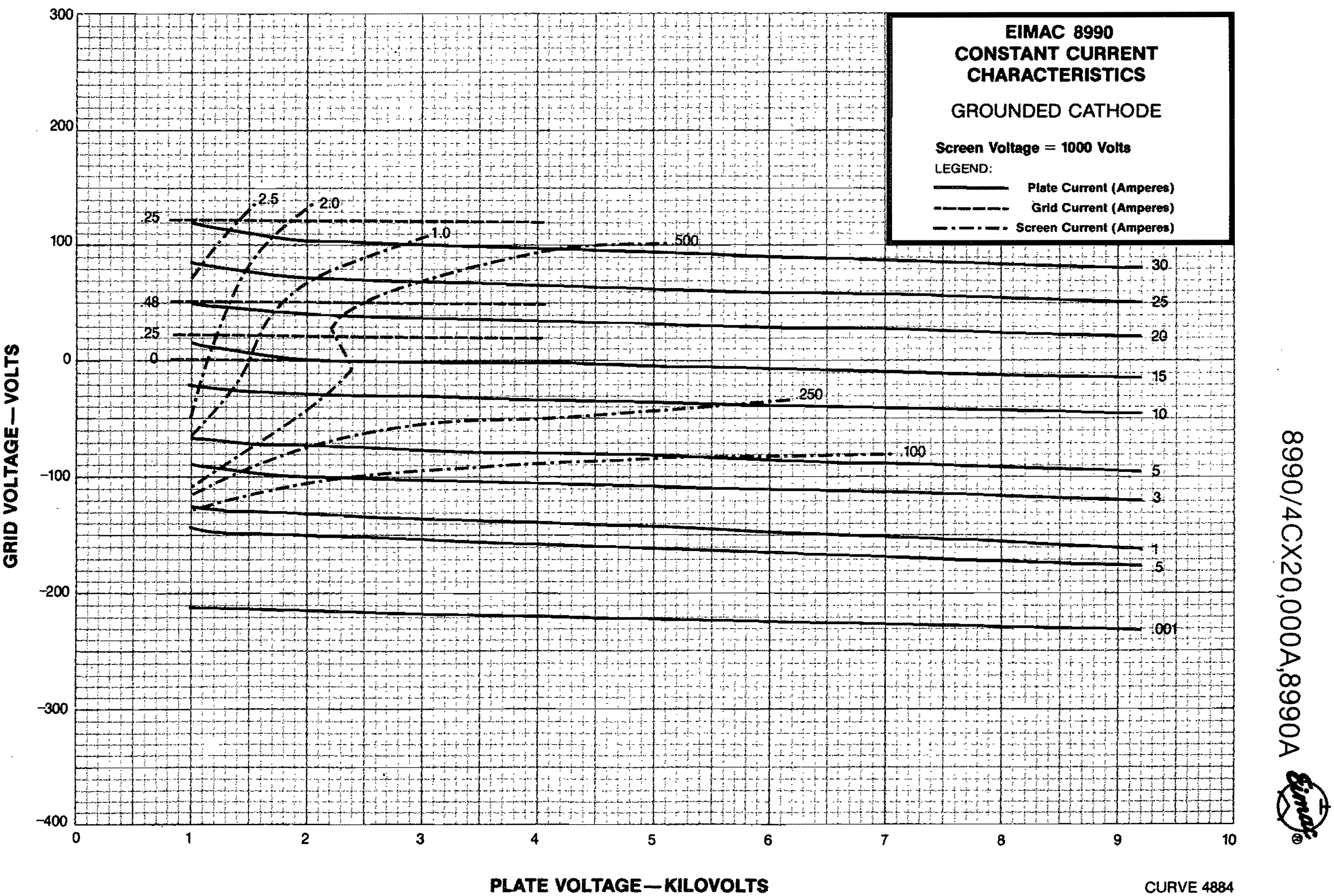
g. HOT SURFACES – Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, Varian, EIMAC division, 301 Industrial Way, San Carlos, California 94070.

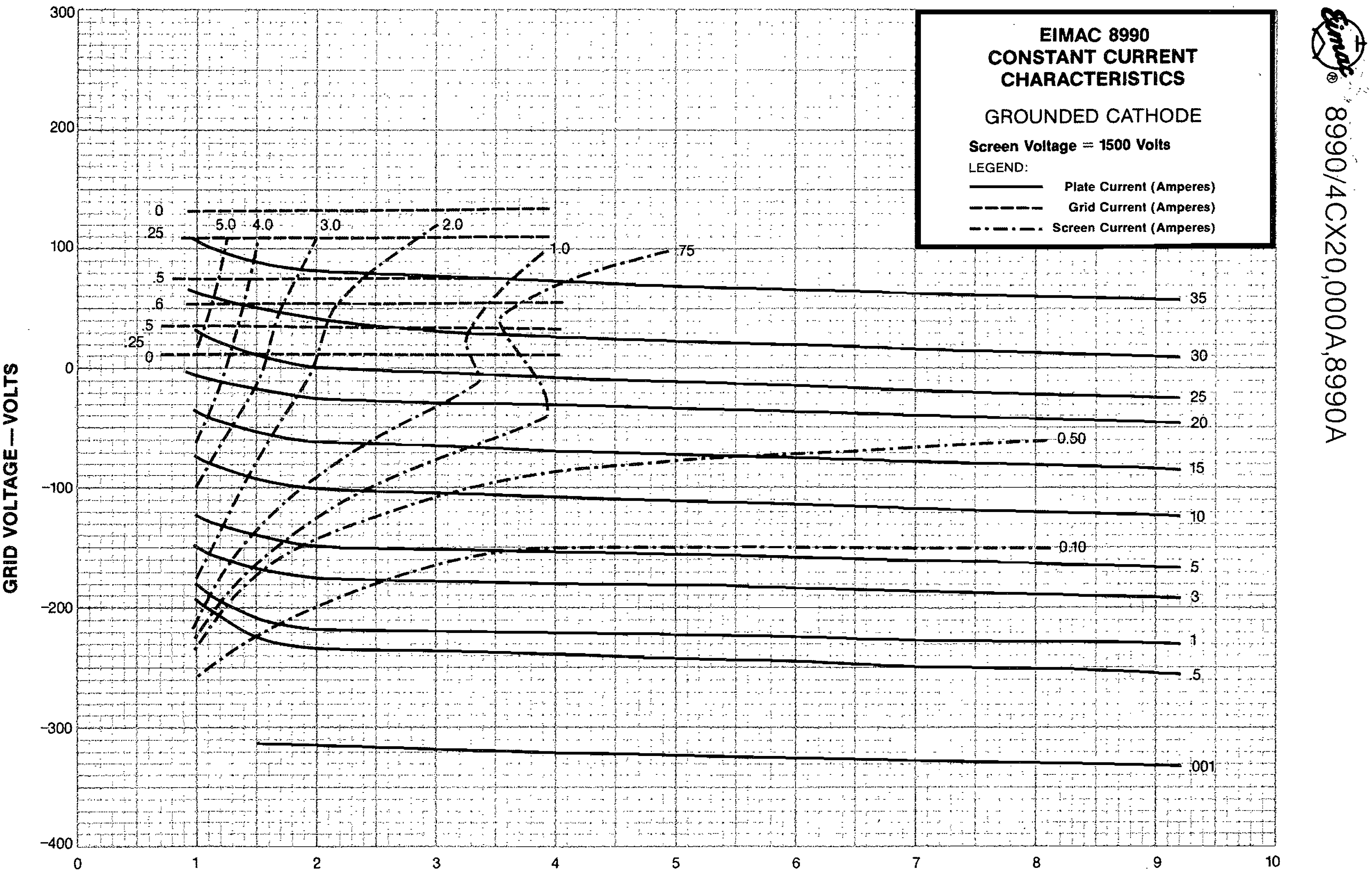

EIMAC 8990
COOLING CHARACTERISTICS
BASE TO ANODE AIRFLOW
ALTITUDE - SEA LEVEL
AIRFLOW — CUBIC FEET PER MINUTES
1300
1200
1100
1000
900
800
700
600
500
400
300
ANODE DISSIPATION = 20 kW
17.5kW
15 kW
12.5 kW
10 kW
PRESSURE DROP
MAXIMUM ANODE CORE TEMPERATURE = 250 °C
120
140
160
180
200
240
260
ANODE CORE TEMPERATURE °C
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
PRESSURE DROP—INCHES OF WATER (FOR SOCKET/TUBE CHIMNEY)


EIMAC 8990
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage = 750 Volts
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
Screen Current (Amperes)
GRID VOLTAGE (VOLTS)
PLATE VOLTAGE (KILOVOLTS)
300
200
100
0
-100
-200
-300
0
1
2
3
4
5
6
7
8
9
10
.5
.45
.4
.45
.25
0
2.0
1.0
.500
.250
.100
25.0
20.0
15.0
10.0
5.0
3.0
1.0
.5
.001

CURVE 4883

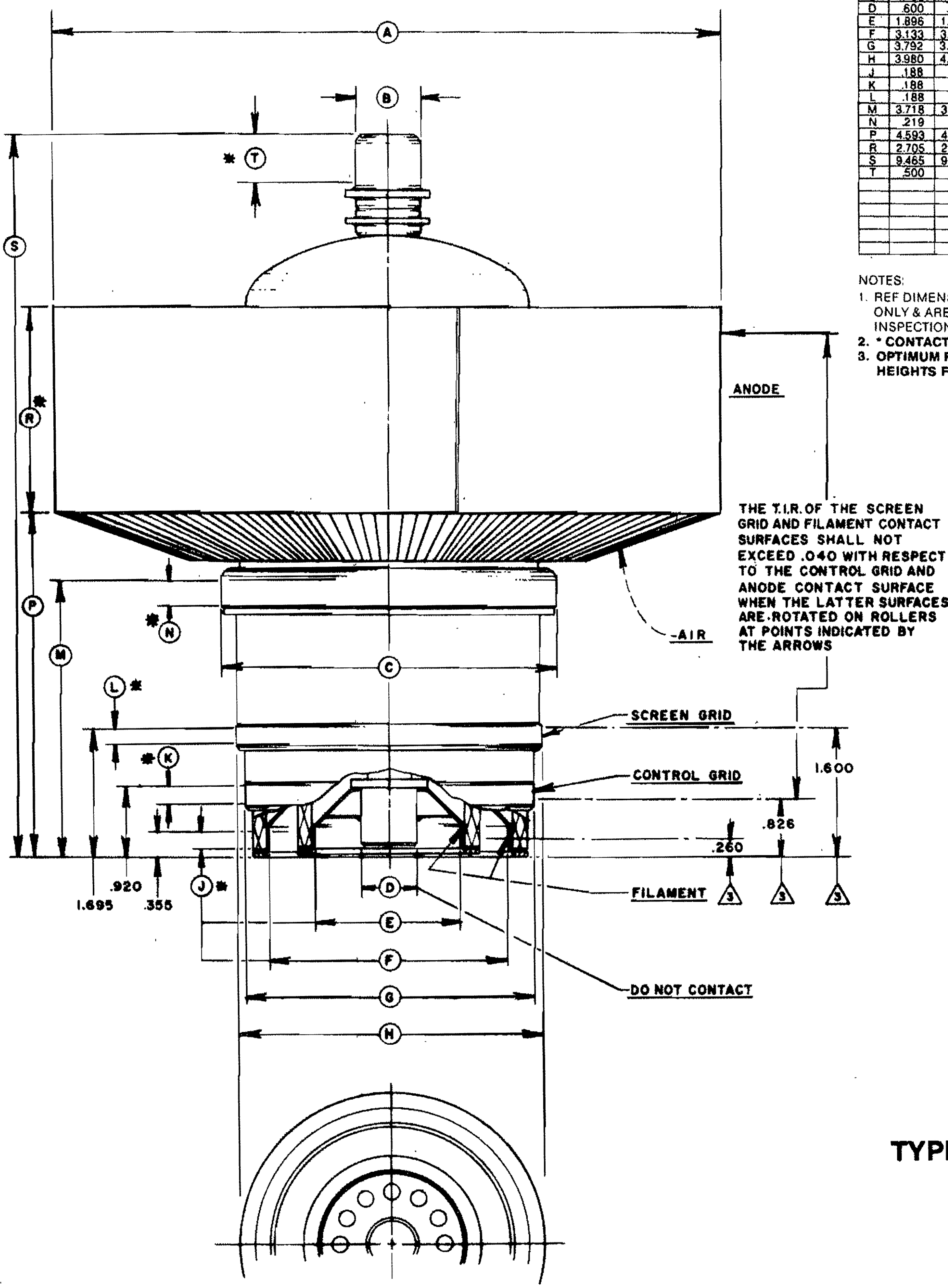


EIMAC 8990
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage = 1000 Volts
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
Screen Current (Amperes)
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
300
200
100
0
-100
-200
-300
-400
0
1
2
3
4
5
6
7
8
9
10
2.5
2.0
1.0
.500
.250
.100
.25
.48
.25
0
30
25
20
15
10
5
3
1
.5
.001
8990/4CX20,000A,8990A
CURVE 4884


EIMAC 8990
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage = 1500 Volts
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
Screen Current (Amperes)
8990/4CX20,000A,8990A
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — KILOVOLTS
CURVE 4886

	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN	MAX.	REF.
A	8.670	8.800		220.22	223.52	
B	.855	.895		21.72	22.73	
C	4.406	4.468		111.91	113.49	
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		
M	3.718	3.781		94.44	96.04	
N	.219			5.56		
P	4.593	4.656		116.66	118.26	
R	2.705	2.825		68.71	71.76	
S	9.465	9.840		240.41	249.94	
T	.500			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.



TYPE 8990

	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
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H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
M						
N						
P	4.593	4.656		116.66	118.26	
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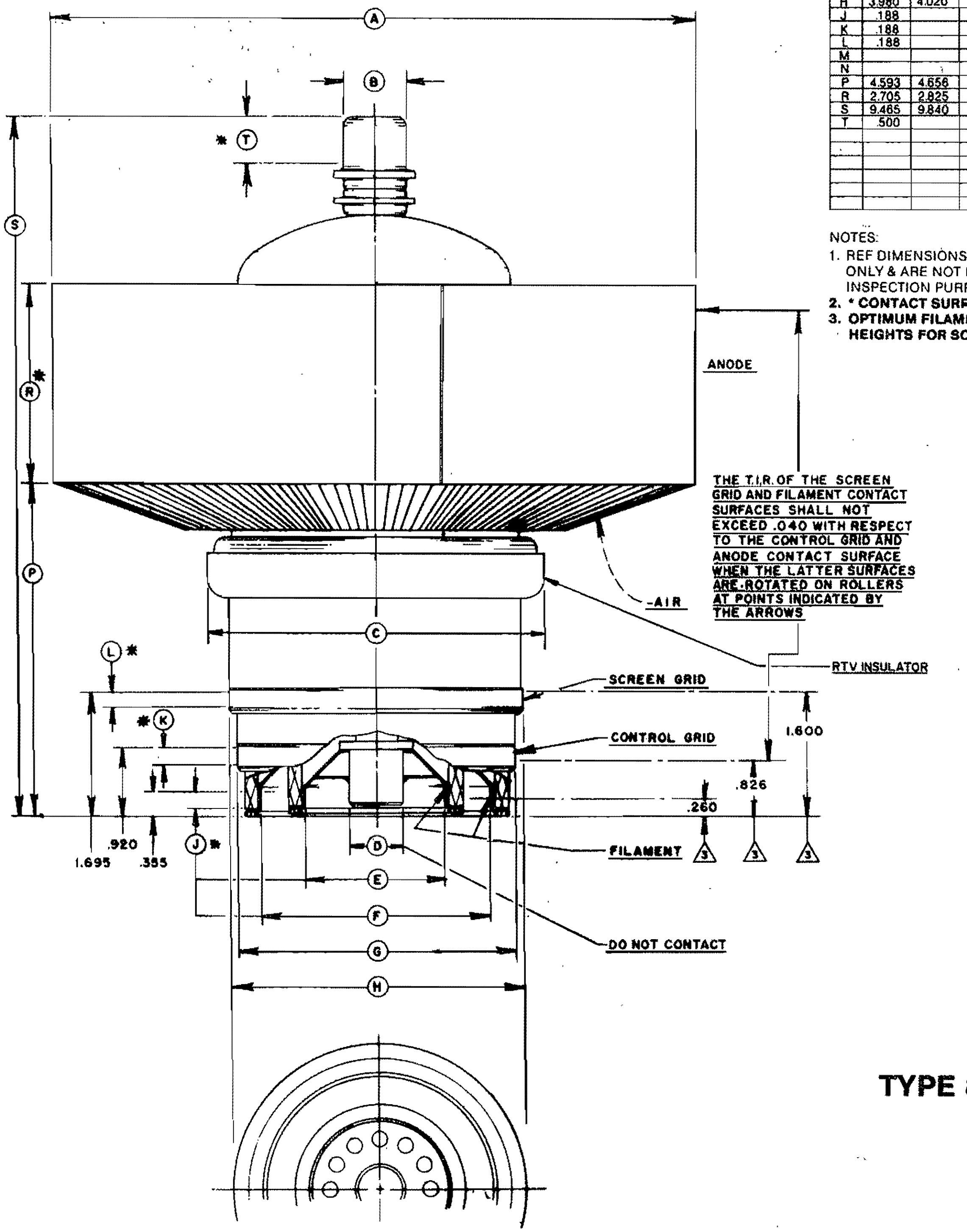
3. **OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.**



TYPE 8990A

Eimac engineering newsletter

LIFE VS. FILAMENT VOLTAGE

TUBE TYPES WITH THORIATED-TUNGSTEN FILAMENTS OR CATHODES.

Power tube users and equipment manufacturers are naturally interested in extending the life of these tubes. A very large factor in tube life is the temperature of the thoriated-tungsten cathode.

The equipment manufacturer and the end user of the equipment have more control over tube life through proper adjustment of filament voltage (filament power) than is generally realized. This is true because tube ratings and most equipment designs are conservative in peak cathode emission required of the tube compared with peak cathode emission available at nominal rated filament voltage.

It is good practice to determine in the field for each particular combination of equipment and operating power level, the nominal filament voltage for best life. This is best done in the field by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage on the power tube is reduced. At some point in filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may safely be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. A recheck should be made in 12 to 24 hours to make certain that emission is stable.

The thoriated-tungsten filament or cathode is processed in a hydrocarbon atmosphere to form a deep layer of di-tungsten carbide on the surface. Stable emission is not possible without the carbide. If the carbide layer is too deep the filament becomes too brittle to withstand shipping and handling. The end of useful life for this type of filament occurs when most of the carbon has evaporated or combined with residual gas, depleting the carbide surface layer.

Theoretically it is estimated that a 3% increase in filament voltage will result in a 20°K increase in temperature, a 20% increase in peak emission, and a 50% decrease in life due to carbon loss. This, of course, works the other way, too. For a small decrease in temperature and peak emission, life of the carbide layer and hence tube life can be increased by a substantial percentage. Peak emission as meant here is the emission obtained in the test for emission described in the Test Specification. This is normally many times the peak emission required in communication service.

Continued.......

Obviously, if small percentage variations in filament voltage are to have a large percentage effect on tube life, it is important to be able to measure and adjust filament voltage measured at the tube terminals with accuracy of about 1%.

The common rectifier type of multimeter which is used for almost every measurement in electronic gear, should not be relied on for AC filament voltage measurement. A simple iron-vane AC meter which has recently been checked against a reliable standard is the best inexpensive instrument for this measurement because it responds to the RMS, or heating value, of the voltage wave form.

As a guide for use with most communications, and broadcast equipment, to get the best life service from your EIMAC power tubes, the following table has been prepared. It is not meant to imply that lower filament voltage will not be satisfactory in some instances.

SUGGESTED NOMINAL FILAMENT VOLTAGE

FOR

EXTENDED LIFE IN BROADCAST AND COMMUNICATION SERVICE

TUBE TYPE	
3X2500A3 and F3	7.2 volts
3X3000A1 and A7	7.2
3CX2500A3 and F3	7.2
3CX3000A1 and A7	7.2
3CX10,000A3, A1 and A7	7.2
3CX15,000A3	6.0
6697A	12.3
4-125A	4.8
4-400A	4.8
4-1000A	7.2
4W20,000A	(2300 watts cathode heating power)
4CX3000A	8.6 volts
4CX5000A	7.2
4CX10,000D	7.2
4CX15,000A	6.0
4CX35,000C	9.0
4CV100,000C	9.0
4E27A	4.8
5-500A	9.5
5CX1500A	4.8
5CX3000A	8.6

Credit is due the paper, High Power Transmitting Valves ---, by Walker, Aldous, Roach, Webb and Goodchild, IEE Paper No. 3200E March, 1960, also the paper Life Expectancy Tubes ---, Eitel-McCullough, October 6, 1963, by Paul Williams.

MICROPROCESSOR CONTROL CIRCUIT

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LIST OF ILLUSTRATIONS

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SECTION I

MICROPROCESSOR CONTROLLER THEORY OF OPERATION

1-1. INTRODUCTION

1-2. The following text provides theory of operation with supporting diagrams for the FM-30 transmitter microprocessor controller.

1-3. FUNCTIONAL DESCRIPTION

1-4. Two levels of discussion are provided. A general discussion of microprocessor controller principles at block diagram level is followed by a detailed discussion of circuit operation for each circuit board.

1-5. GENERAL DESCRIPTION

1-6. All status functions and most control functions in the FM-30 transmitter are implemented through use of a microprocessor controller that monitors transmitter operation (see Figure 1-1). Using information collected throughout the transmitter, the microprocessor controller will determine what control actions are required. Some control actions such as timed functions, overloads, or interlocks will be accomplished without delay by the controller. Information concerning faults, overloads, or a power outage will be stored by a non-volatile memory for analysis after the problem has occurred to aid in problem resolution.

1-7. In the case of out-of-tolerance status samples, the controller will advise the operator of the status of each sample according to a preset priority. The controller provides 123 status indications on a two-segment digital readout, four LED indicators, and three incandescent lights for diagnostic purposes.

1-8. The transmitter control logic will interface with most modern remote control devices and ATS units. Two parallel four bit binary coded decimal outputs from the microprocessor controller allow remote indications of the two transmitter status display digits.

1-9. OPERATION. The microprocessor controller is implemented using a Motorola MC14500B Industrial Control Unit integrated circuit. Throughout the following discussions, this integrated circuit will be referred to as "the processor".

1-10. A system reset generated at power application starts the program counter incrementing from zero. Once started, this program loops continuously. At the maximum count, the program counter "rolls over" to zero and continues incrementing. Processor instructions and I/O addresses are stored in a programmable read only memory addressed by the program counter. Interlaced clock is used to differentiate between these instructions and the I/O addresses as the system scans through the read only memory. Data from the various input and output locations is carried to and from the processor by a single one-bit bidirectional data bus.

1-11. Eight bit addressable latches with tri-state data ports are used on each circuit board to prevent loading of the data bus. Unless a specific chip is addressed, all data bus connections exhibit a high impedance. Whenever a chip is addressed, the chip output can be HIGH or LOW, depending upon the inputs to the chip.

1-12. Commands such as "filament on" and "high voltage on" are initiated by a momentary ground applied to the control/timer board input circuitry. When the switches are depressed, the associated switch/indicators will illuminate to indicate that the selected commands have been received and stored.

1-13. As directed by the program, the processor will address each addressable chip on each circuit board to determine all status inputs. When the processor addresses the correct chip on the control/timer board, the "filament on command" will be output over the data bus to the processor board. The "filament on command" is assigned a higher priority than the "high voltage on command" by the program and will therefore be output first.

1-14. The processor board will momentarily raise the write line, address the output board, and output an instruction on the data bus to apply drive to the blower control relay. The associated BLOWER indicator on the primary function indicator board will illuminate to indicate that a "blower on command" has been output from the microprocessor controller.

1-15. After the PA air switch closes, this information will be applied as a status input to input board 1. When the processor addresses the correct chip on input board 1, the "air switch closed" information will be output to the processor over the data bus.

1-16. After the "air switch closed" information has been received by the processor, the processor board will momentarily raise the write bus, address the output board, and output a command on the data bus to apply drive to the filament control relay. The associated FILAMENT indicator on the primary function indicator board will illuminate to indicate that a "filament on command" has been output from the microprocessor controller. At the same time, the processor will initiate a filament timing sequence by addressing the correct circuitry on the control/timer board.

1-17. After the filament heating delay has expired, the processor board will accept the "high voltage on command" from the control/timer board via the data bus. If no overloads exist, all interlocks remain closed, the air switch remains closed, and the FM exciter is operational, the processor board will momentarily raise the write bus, address the output board, and output commands on the data bus to apply drive to the high voltage step-start circuitry and remove the mute from the FM exciter. The associated HIGH VOLTAGE indicator on the primary function indicator board will illuminate to indicate that a "high voltage command" has been output from the microprocessor controller.

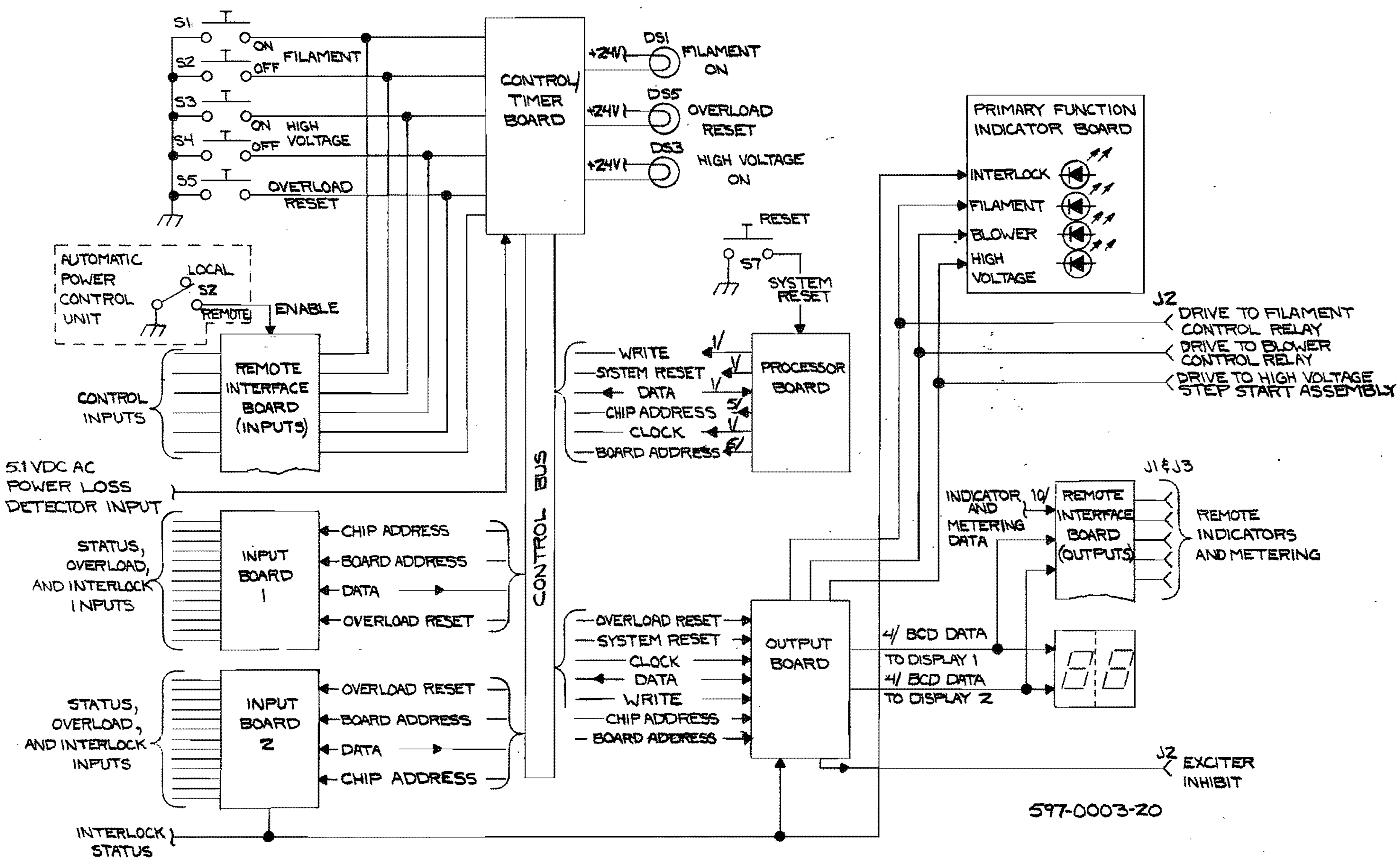


FIGURE 1-1. MICROPROCESSOR CONTROLLER BLOCK DIAGRAM

1-18. If the FILAMENT OFF switch is depressed, a momentary ground applied to the control/timer board input circuitry will initiate a control sequence similar to the preceeding examples. The processor will receive the command via the data bus, deenergize the high voltage and filament supplies, and start a filament cool-down interval timer on the control/timer board. When the timed interval expires, the processor will command the output board to deenergize the blower.

1-19. Remote Control. Remote interface is accomplished by circuitry on the remote interface board. The remote control inputs are enabled by a ground applied to the remote interface board by the LOCAL/REMOTE switch. However, outputs to the remote indicators and metering are active at all times. When a high is input to the interface, a ground is output to simulate the transmitter switch-selectable commands. A "one button start" provision is incorporated as a remote control feature.

1-20. Interlocks. Interlocks and overloads are treated to the same priority. If an interlock opens, the transmitter will deenergize immediately. The INTERLOCK indicator on the primary function indicator board will go out to indicate an open interlock. The transmitter must then be manually restored to operation with a new start sequence initiated by depressing the FILAMENT ON and HIGH VOLTAGE ON switch/indicators.

1-21. Overloads. If an overload occurs, this information will be output to the processor board via the data bus when the proper chip is addressed. The processor board will then enable the write bus, initiate two timed intervals on the control/timer board, and illuminate the OVERLOAD indicator. One timer monitors the number of times an overload occurs during a timed interval and the second timer delays restoration of the equipment to operation to allow the condition that produced the overload to dissipate.

1-22. When the timed interval delaying restoration of the equipment has expired, the processor will recycle the equipment back into operation. If no further overloads occur during the recycle timed interval, the recycle timer interval will expire to await another overload. If two overloads occur during the period of the recycle interval timer, the equipment will deenergize and must be manually reset. This can be done from the front panel OVERLOAD reset switch or from remote control, if enabled by the LOCAL/REMOTE switch.

1-23. The manual overload reset sequence after overload lock-out is initiated by a ground applied to the control/timer board input circuitry. The OVERLOAD indicator will go out to indicate that the overload reset command has been received and stored. When the processor addresses the correct chip on the control/timer board, the overload reset command will be output over the data bus to the processor board. The processor will momentarily raise the write bus, address the output board, and output a command on the data bus to generate an overload reset pulse. The overload reset pulse is simultaneously applied to both input boards to reset the overload latches.

1-24. DETAILED DESCRIPTION

1-25. INPUT BOARDS. All status information to the microprocessor controller is input through input boards 1 and 2 (see Figures 1-2 and 1-3). The first nine inputs to each board provide the controller with diagnostic information. These inputs are priority encoded with hardware before they are scanned by the processor. The remaining four inputs are used to signal critical parameters out-of-tolerance which will result in immediate transmitter shut-down.

1-26. All inputs are isolated through series resistors and amplitude protected by shunt zener diodes. The zener diodes are returned to ground through a bus which is slightly positive. This limits negative over voltage excursions so that the forward biased zener voltage drop is compensated by the positive return bus voltage which results in zero voltage at the level detector input.

1-27. Each input has resistive strapping options to divide the input down to a nominal level. Negative polarity inputs are connected to the end of a positive polarity voltage divider to convert the signal into a positive sample. A reference voltage divider establishes the comparison level for each level detector, which outputs a binary state according to the comparison of its inputs. The level detector may be followed by an inverter, depending upon the normal state of the input signal.

3

1-28. Some inputs have adjustments which depend upon the transmitter operating power level and therefore contain potentiometers in the reference voltage dividers. These more critical adjustments are preset at the factory during actual operation and should not be readjusted in the field unless absolutely necessary.

1-29. Overloads and interlocks are processed by the input circuitry identical to the diagnostic inputs. However, the outputs from the overload level detectors are applied to bistable flip-flops which function as storage devices. These flip-flops can only be reset by a +5 volt pulse from the output board which is generated by the processor responding to the OVERLOAD reset switch.

1-30. Diagnostic information from each level detector is applied to a priority encoder which reduces the information to a single BCD word for the highest priority input which as an abnormal level. This code is applied to an eight channel data selector. Outputs from the overload and interlock circuits are applied directly to the same eight-channel data selector. These inputs share equal priority in the controller.

1-31. As a matter of routine, the controller will address each input board through a three-input NAND gate. After a board has been addressed, activity on the chip input select lines will determine what information will be output on the bidirectional data line to the processor board. All information is output in serial binary form. Whenever an input board is not addressed, the respective eight-channel data selector remains disconnected from the data bus.

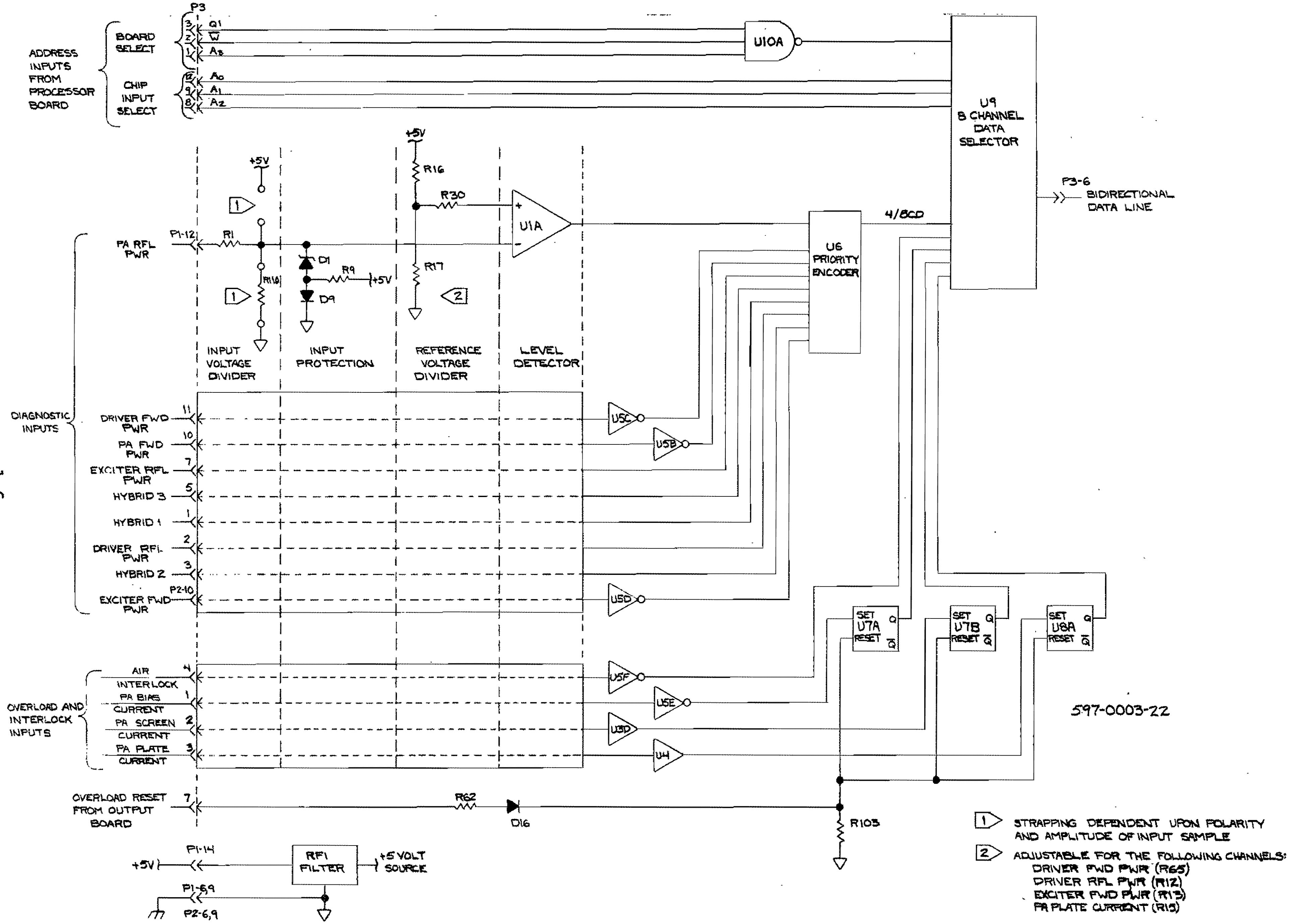


FIGURE 1-2. INPUT BOARD 1 SIMPLIFIED SCHEMATIC

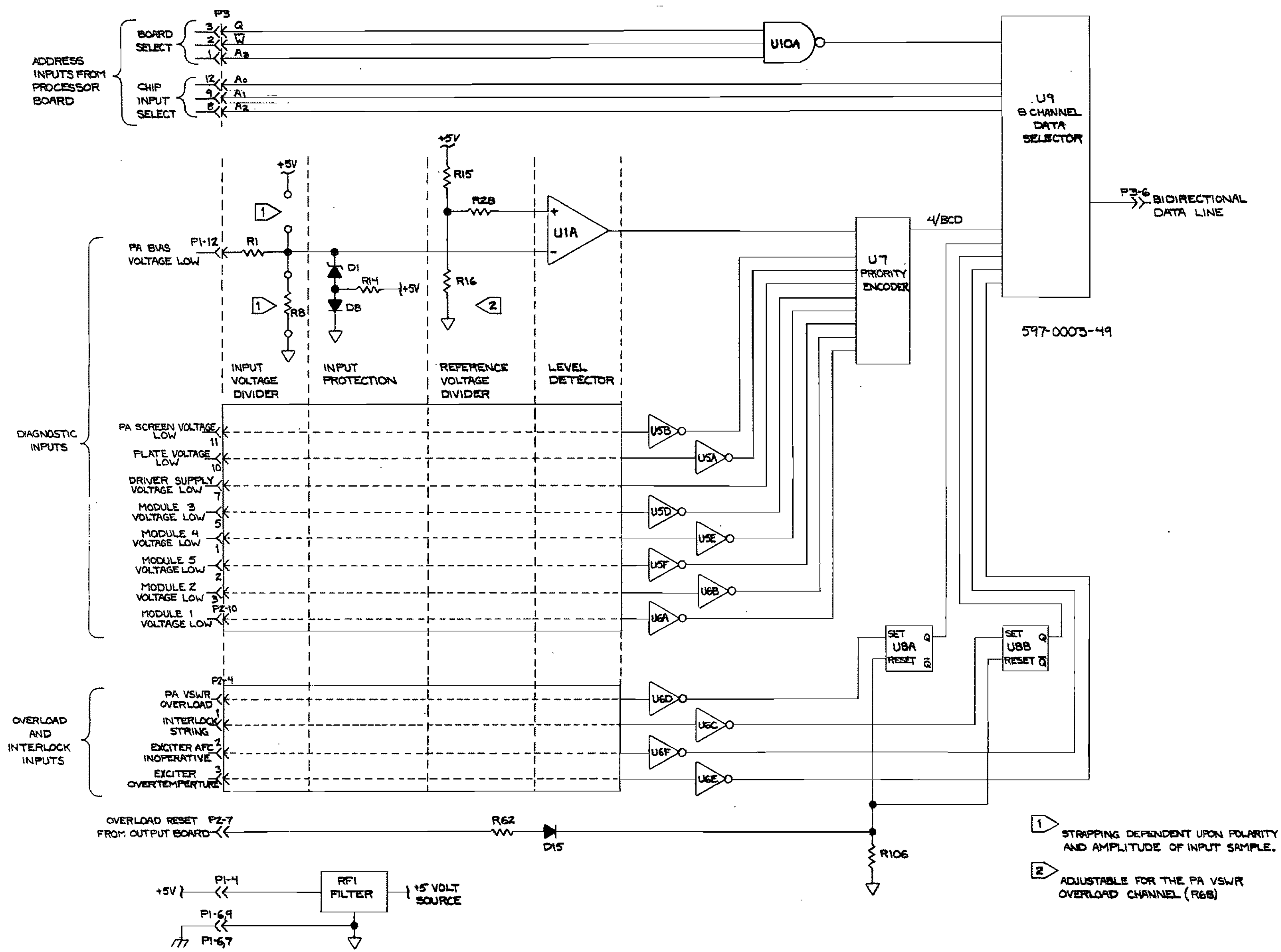


FIGURE 1-3. INPUT BOARD 2 SIMPLIFIED SCHEMATIC

1-32. CONTROL/TIMER BOARD. The control/timer board interfaces control commands and provides turn-on, turn-off, time-up and time-down functions to operate the transmitter. One status input allows the processor to monitor the 230 volt ac power status (+5.1V dc sample) and one status input allows the processor to check the contents of the processor result register (RR) (see Figure 1-4). This is a temporary storage register for one-bit data.

1-33. The input latches store contact closures for commands. When the FILAMENT ON and HIGH VOLTAGE ON switches are depressed, grounds applied to U7 A/B and U8 A/B will force each latch to the HIGH state. Line driver U9 will illuminate the FILAMENT ON and HIGH VOLTAGE ON indicators to signify that the commands have been received and stored. Resistors R20, R21, and R22 allow the lamp bulbs to draw standby current to keep the filaments warm and thereby reduce inrush current when illuminated, prolonging lamp life. An RC circuit connected to the input of each latch provides noise immunity.

1-34. The transmitter can be controlled by positive dc inputs to the remote interface board. Inverters on the remote interface board provide a ground output to simulate the switch selectable commands. Additionally, a one-button start provision is available as a remote control feature by diodes connected to the FILAMENT ON and HIGH VOLTAGE ON switches.

1-35. As directed by the program, the processor will address the control/timer board. When the processor addresses eight-channel data selector U5, the "filament on command" will be output over the data bus to the processor board. The "filament on command" is assigned a higher priority than the "high voltage on command" by the program and will therefore be output first.

1-36. First a "blower on" control action will be initiated and when complete, the "filament on" sequence will be initiated. The processor will again address the control/timer board, address latch U4, raise the write enable bus, and output a command on the bidirectional data bus to initiate a "filament on" timing sequence by timer U1 via U6F.

1-37. After a filament heating delay has expired and this information has been received by the processor, the processor will accept the "high voltage on command". If all parameters are within tolerance, the processor will complete the "high voltage on" sequence and the transmitter will be operational.

1-38. When the FILAMENT OFF switch is depressed, a momentary ground applied to the control/timer board will reset latch U7 A/B. The FILAMENT ON indicator will extinguish to signify that the "filament off command" has been received and stored. The processor will receive the "filament off command" via the data bus and deenergize high voltage. The controller will address the control/timer board, raise the write bus, address latch U4 via the data bus, and reset the "high voltage on" latch (U8 A/B) and deenergize the HIGH VOLTAGE ON indicator via U6B. Instructions will also initiate a "blower off" timing sequence by U1 via U6F. When the timed interval expires, the processor will output a command to open the blower relay and the transmitter will be deenergized.

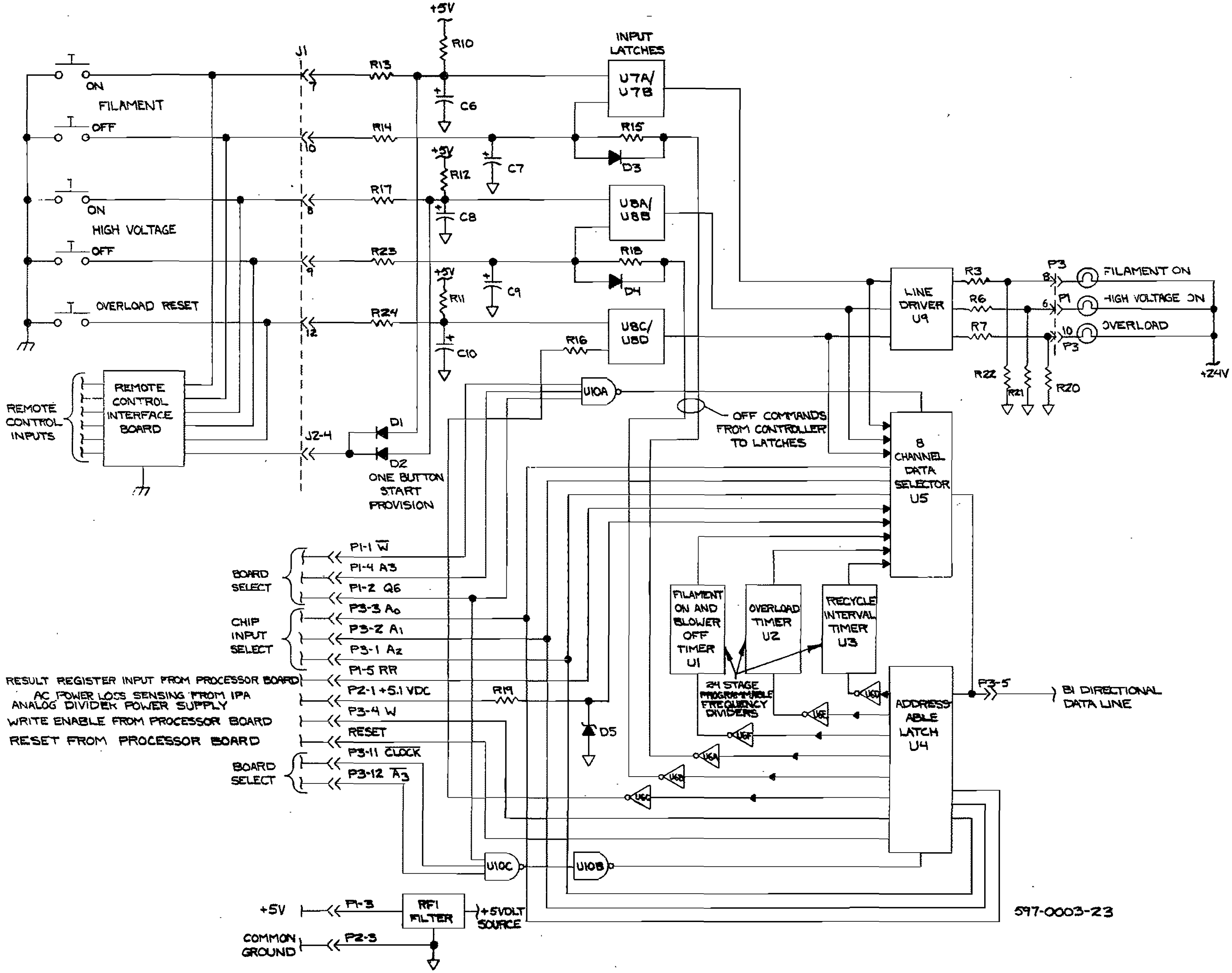


FIGURE 1-4. CONTROL/TIMER BOARD SIMPLIFIED SCHEMATIC DIAGRAM

1-39. After an overload has occured and the overload information has been received by the processor, the processor will address the control/timer board, raise the write bus, address latch U4, and output commands via the data bus to simultaneously start timers U2 via U6E and timer U3 via U6D. Additional instructions will set latch U8 C/D by way of U6C to illuminate the OVERLOAD indicator.

1-40. Timer U2 determines the length of time the transmitter remains off-the-air after an overload to allow the conditions that prompted the overload to dissipate. Timer U3 determines the time interval between overload recycle attempts.

1-41. When the interval timed by U2 expires, the processor will cycle the high voltage relay back into operation. If no further overloads occur during the timing cycle of U3, the interval timed by U3 will expire to await another overload. If two overloads occur during the timing cycle of U3, the transmitter will deenergize and must be manually reset.

1-42. The overload reset sequence is initiated by a ground applied to the control/timer board input circuitry that resets latch U8 C/D. The OVERLOAD indicator will go out to indicate that the overload reset command has been received and stored. The "reset" command will be output to the processor via the data bus to initiate a reset pulse sequence. The processor will then output an overload reset pulse from the output board to reset the overload latches on the input boards.

1-43. PROCESSOR BOARD. The entire transmitter system is synchronized and controlled by logic circuitry along with the program stored on the processor board (see Figure 1-5). The program begins cycling when power is applied to the processor and a reset is initiated by R2 and C3 or manually with switch S7. Control actions will begin only when a command such as "filament on" is received by the processor as it scans the inputs on the control/timer board.

1-44. Processor Chip. The MC14500B Industrial Control Unit is the microprocessor integrated circuit used in the FM-30 system. The chip controls the flow of data between its internal register and the one-bit bidirectional data bus, performs logical operations between data in its result register and data on the one-bit bidirectional data bus, and controls all system components with the write line, reset line, and the clock line (which assures synchronized system operation). The system clock is generated internally to the processor chip. The clock frequency is determined by the value of R4 and is approximately 55 kHz ±15 kHz.

1-45. The MC14500B operates synchronously with single phase clock which divides the processor machine cycle into two phases. The first phase (CLOCK HIGH) is the "fetch" phase when the processor fetches an instruction from memory. When the clock signal falls low, the instruction is latched into the processor's instruction register. During the second phase (CLOCK LOW) the instruction is executed.

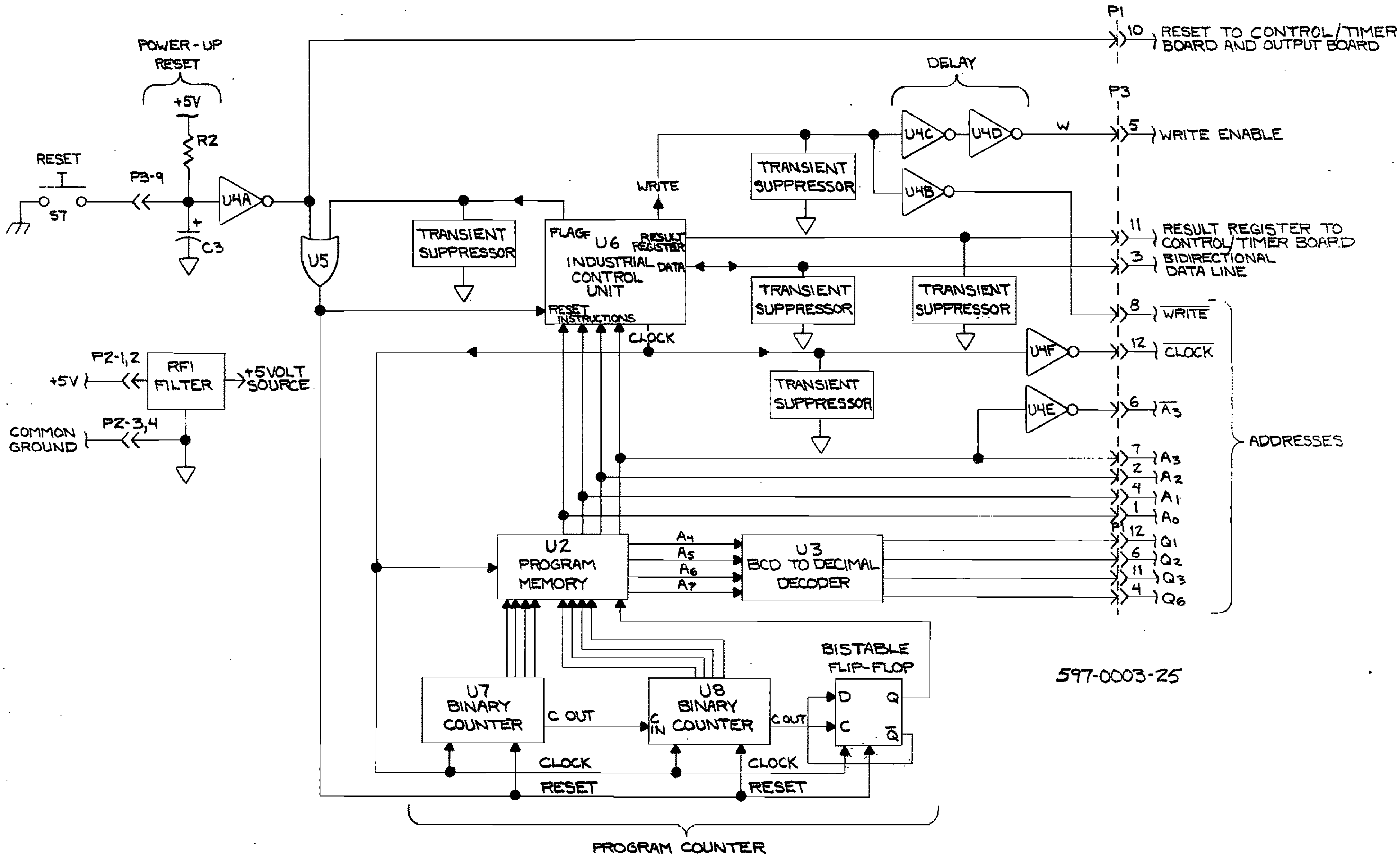


FIGURE 1-5. PROCESSOR SIMPLIFIED SCHEMATIC DIAGRAM

1-46. Three types of I/O related instructions are used: logical, input, and output. During the execution phase of input or logical instructions, the operand of the instruction is demultiplexed onto the processor's data bus by the input data selectors. The memory supplies the input selectors with the address of the bit to be used in the operation. During the execution phase of an output instruction, the processor puts the data (or the data complement) in the result register on its data bus and raises the write control line. The data bit is then multiplexed to an output line where the data is read into an output latch on the rising edge of the clock signal. The memory supplies the address of the output latch to which the data is to be routed.

1-47. Program Memory. The processor chip data output is wired to the one-bit bidirectional data bus. To prevent loading of this bus, tri-state logic is used on all circuit boards connected to this bus. Unless a specific chip on a board is addressed, all data connections to the bus exhibit a high impedance. When a chip is addressed, the chip output can be high or low, depending upon the inputs to the chip.

1-48. The controller program is contained in programmable read-only memory U2 which is factory programmed. The program consists of 4-bit processor instruction codes interlaced with 8-bit I/O addresses. The low order bits contain the instruction codes and are output from the program memory when the clock is high (the clock forms the least significant bit of the memory address). When the clock is low, the program memory sends out four high order bits, which are further decoded to generate board address signals by U3, and four low order bits which are routed directly to all input selectors and output latches in the system. These signals (called chip selects) are decoded by each data selector or addressable latch to select the appropriate input or output line to be connected to the bidirectional data bus.

1-49. Program Counter. The 8-bit program counter formed by U7 and U8 supplies the processor system memory with the address of the command to be executed. Stepped by clock obtained from the processor chip, the counter counts up sequentially in binary to its highest value. After an entire program has cycled, U6 will output a $FLAG_F$ pulse that resets the program counter and the processor chip to initiate a new program cycle. This is a looping control structure.

1-50. OUTPUT BOARD. Controller actions are interfaced with all external devices through the output board. Discrete drivers on the output board drive solid-state relays which control operation of the transmitter contactors. The board also mutes the exciter whenever the transmitter is not fully operational, provides a +5 volt pulse to reset the overload circuitry on the input boards in response to a command input from the processor, and supplies information to operate the transmitter front-panel digital display (see Figure 1-6).

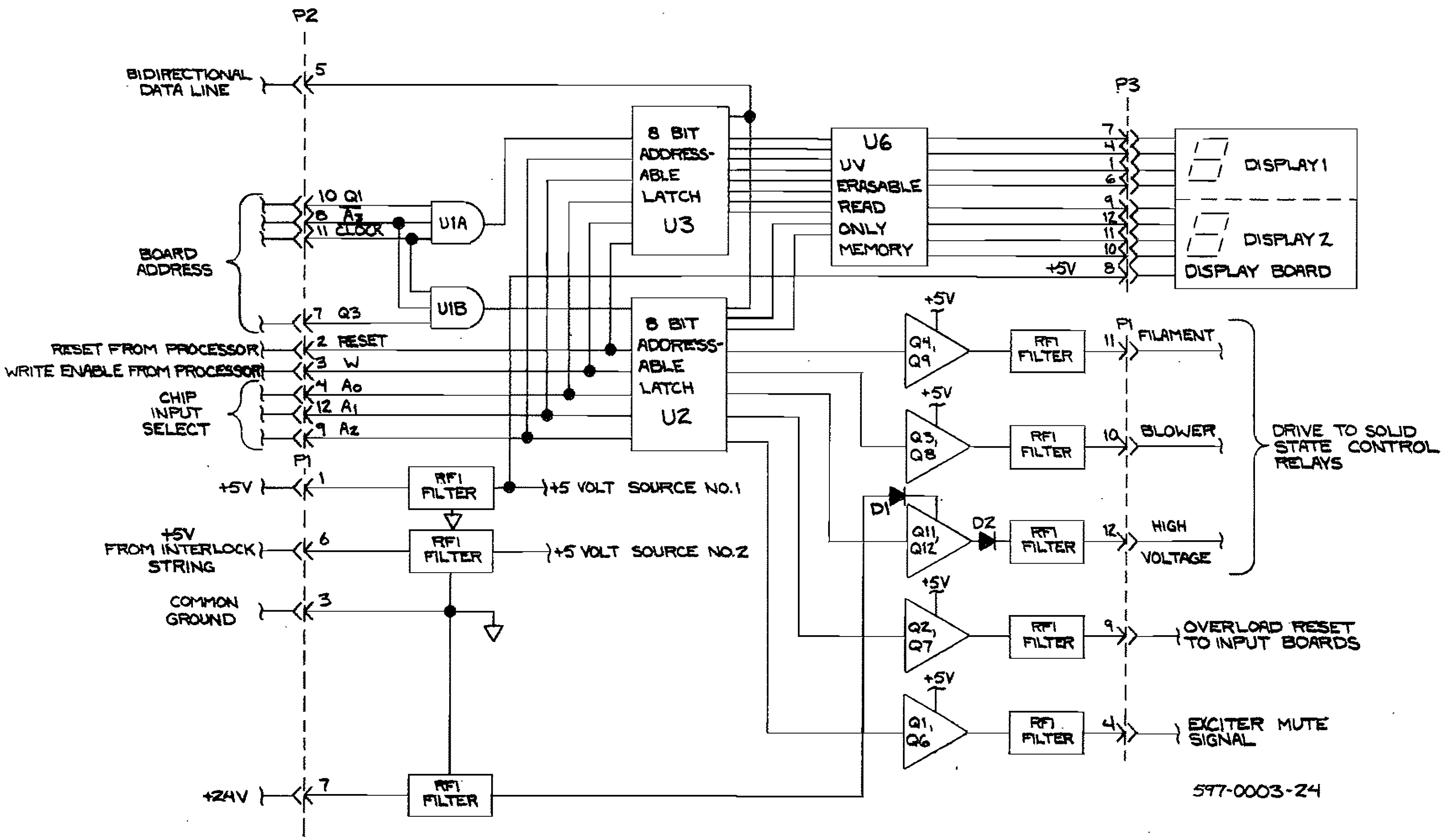


FIGURE 1-6. OUTPUT BOARD SIMPLIFIED SCHEMATIC DIAGRAM

1-51. After a command sequence such as "filament on" is initiated, the processor will address the output board as directed by the program. The first interface action required in the "filament on" sequence is the "blower on" action. After the board has been addressed, the processor will address U2, raise the write bus, and output a command on the data bus to switch Q8 via Q3 to output a +5 volt pulse to activate the blower control relay. The remaining interface provisions function in the same manner in sequence as directed by the program. The high voltage driver operates at +18 volts to provide noise immunity for the control line to the step start assembly in the high voltage power supply cabinet.

1-52. The two digit numeric display provides three types of information.

A. During turn on or turn off sequences, it displays a single digit control status code. This code changes to indicate each step in the sequence.

B. PA current overloads and output reflected power overloads will cause a two digit code to be displayed along with illumination of the yellow OVERLOAD indicator. Up to four overloads can be displayed simultaneously.

C. Minor faults which are not serious enough to warrant shutdown are displayed with a two digit code. Two faults can be displayed simultaneously. The priority system is structured so that a fault can be diagnosed to the lowest component or subsystem.

1-53. When information displayed is to be changed, the processor will address the output board, address U3, raise the write bus, and output a command on the data bus containing information to be displayed. Factory programmed read only memory U4 is programmed with a table to convert information bits from U3 into BCD to drive the decoders in the transmitter front panel display.

1-54. If an overload occurs, the display will change to indicate the overload. This information will be retained by the indicator until the overload sensing circuitry on the input boards is reset by depressing the OVERLOAD switch/indicator. If a safety interlock is opened, the display will indicate the open interlock information until the interlock is closed.

1-55. Safety interlocks have the highest priority in the transmitter controller system. Overloads have a secondary priority followed by the remaining parameters. The display will change from a lower priority display to indicate a higher priority parameter, but will not switch between parameters sharing the same priority.

1-56. REMOTE CONTROL INTERFACE BOARD. The FM-30 remote control interface permits remote control of transmitter basic control functions and allows remote indications of critical displays when associated with the correct extended control panel or remote control unit (see Figure 1-7). The amplifiers on the remote control interface board are intended as signal buffers to prevent external devices from interferring with local transmitter operation and should not be considered as line amplifiers. All circuits may be accessed on the remote interface terminal strips in the driver cabinet (TB8 and TB9).

1-57. Display Drivers. Drive obtained from the output board is applied to buffers which provide isolation to operate a remote digital display. Each buffer output TTL levels. The remote display outputs are enabled whenever the transmitter front panel display is operational.

1-58. Remote Metering. Plate current, Plate voltage, and PA forward power are available as remote metering outputs from the FM-30. All three outputs are active whenever the transmitter is operational.

A. Plate current is sampled across the negative return resistor in the high voltage power supply. U1A is configured as an inverting amplifier to provide +5 volts at nominal plate current. R14 adjusts the sample level to U1A.

B. Plate voltage is sampled across the low voltage end of the bleeder resistor chain in the high voltage power supply. This resistor is not connected to ground, but to the negative return resistor. Therefore a differential amplifier (U1C) is used to negate common mode voltage from the plate current sample. R17 adjusts the sample level to U1C.

C. PA forward power is derived from the rectifier and buffer amplifier in the automatic power control unit and is buffered by U1B. The level is adjusted by R18.

3

1-59. Remote Indicators. Signals representative of the three transmitter front panel incandescent indicators and the four LED indicators are applied to buffers and available as +5 volt outputs on the remote interface terminal strips. These indicators are enabled whenever the associated transmitter front panel indicators are illuminated.

1-60. Remote Control. Remote control of the five basic transmitter control functions is provided by optical isolators. A one button start feature is provided as a remote provision. A low voltage positive dc input to each photo diode will enable the associated photo darlington transistor to simulate one of the basic switch selectable commands. Remote control is enabled by a ground from the REMOTE/LOCAL switch in the automatic power control unit. Removing the ground connection "floats" the darlington transistor emitters in the optical couplers which prevents their collectors from pulling down the command lines.

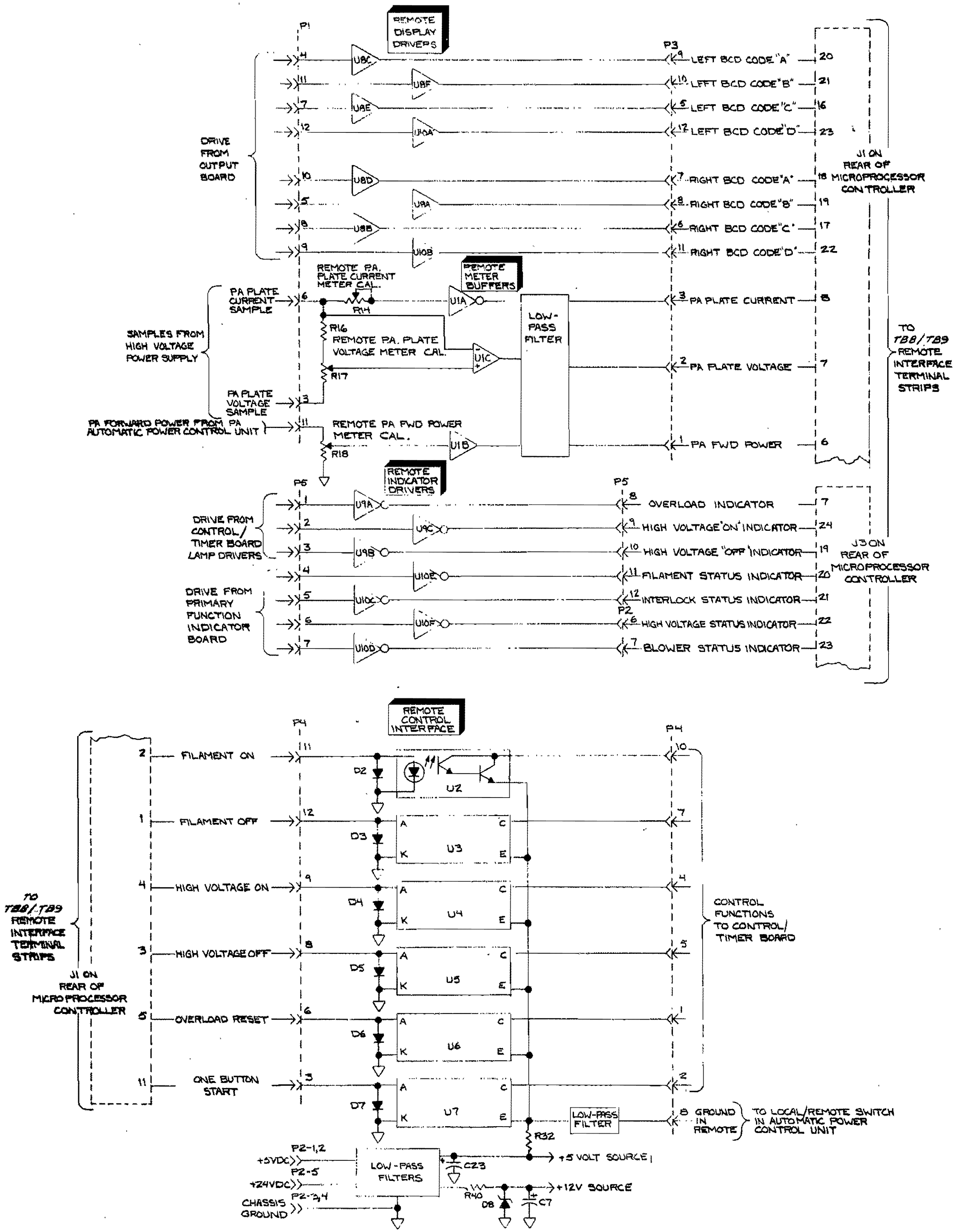


FIGURE 1-7. REMOTE CONTROL INTERFACE SIMPLIFIED SCHEMATIC

1-61. MICROPROCESSOR CONTROLLER BYPASS ASSEMBLY

1-62. The microprocessor controller bypass assembly is a maintenance tool which allows basic control of the transmitter in event of a microprocessor controller failure. The assembly is interfaced to in-line receptacle J2 which connects to plug P2 attached to the transmitter wiring harness. The microprocessor controller may then be removed from maintenance. No timed intervals, remote features, or automatic power control features are provided, only on/off functions and PA stage overloads (see Figure 1-8).

1-63. The bypass assembly is powered by a five volt input from the safety interlock circuit. Presence of the +5 volt input is signified by illumination of the INT/LCK indicator. If a safety interlock is opened, all power to the bypass assembly will be lost and the transmitter will completely shut down.

1-64. The five volt "blower air switch closed" potential is applied to transistor switch Q1. This potential turns on Q1 which illuminates the BLO indicator and provides drive to the filament control relay to signify that the air flow in the transmitter has reached adequate levels for PA stage operation.

1-65. The basic on and off functions are implemented with NAND gates configured as two bistable flip-flops.

1-66. If the FIL START switch is depressed, a ground applied to the filament control flip-flop causes the output of U1A to go HIGH which illuminates the FILL START indicator and provides drive to the blower control relay through transistor switch Q2.

1-67. If the H.V. START switch is depressed, a ground applied to the high voltage control flip-flop causes the output of U1C to go HIGH. This HIGH will enable the exciter. Additionally, drive from transistor switch Q3 will enable U4 which illuminates the H.V. START indicator and provides drive to the plate control relay.

1-68. If the H.V. STOP switch is depressed, U1C will output a LOW which inhibits exciter operation, turns off the H.V. START indicator, and removes drive from the plate control relay.

1-69. If the FIL STOP switch is depressed, U1A will output a LOW which turns off the FIL START indicator and removes drive from the blower control relay. In this configuration, the HIGH output by U1B is inverted by U3B and applied to U1D assures the plate potential is deenergized.

1-70. PA stage plate current, screen grid current, control grid current, and PA output VSWR are monitored as overloads by four level detectors (U2A through U2D). The threshold of each level detector is preset by a potentiometer to a level relative to the parameter being sensed. The output of each level detector is applied to an inverter and is used to deenergize the plate supply automatically if an overload is sensed. Steering diodes connected to each inverter prevents interaction between overload detectors.

3

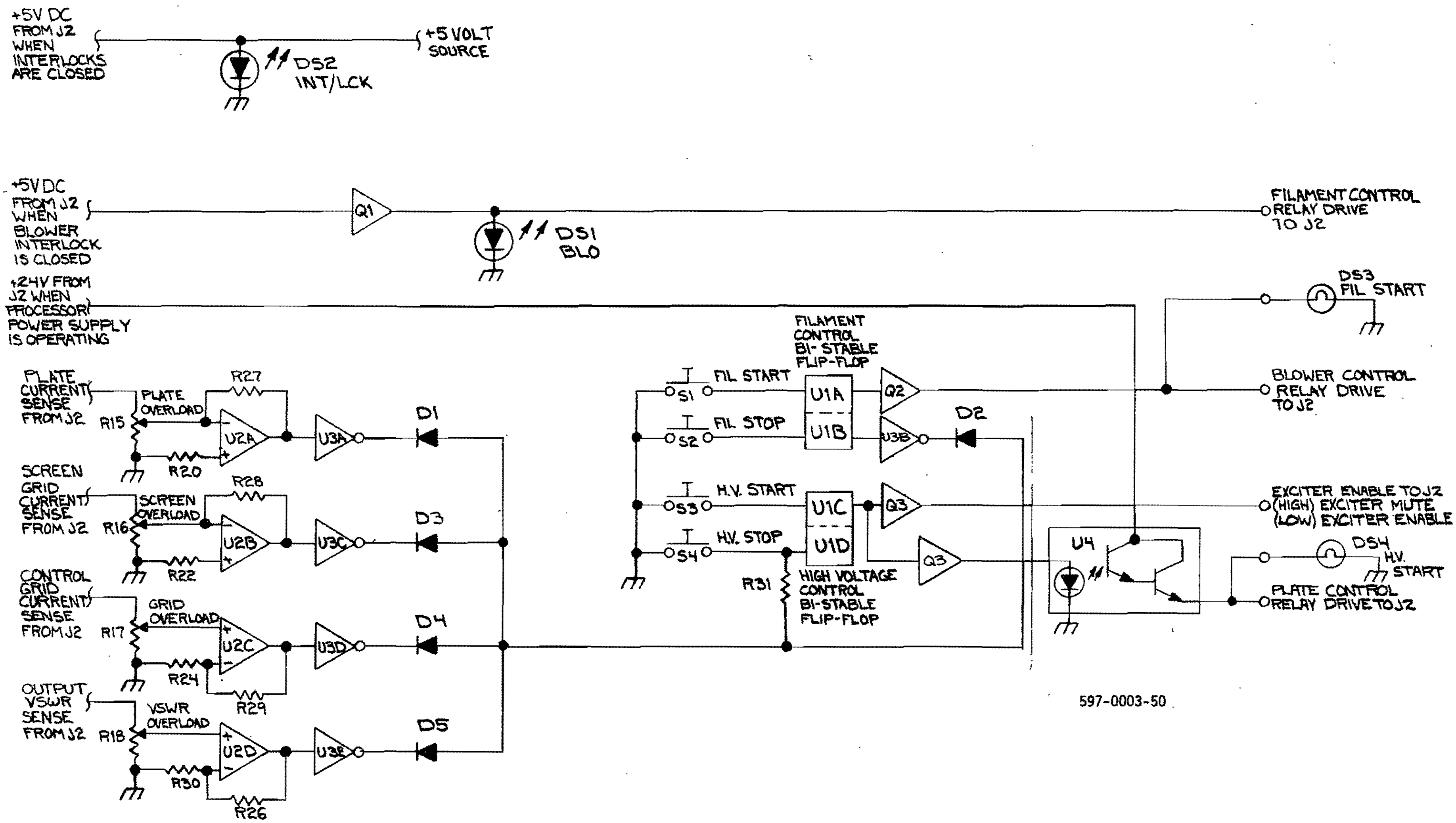


FIGURE 1-8. MICROPROCESSOR CONTROLLER BYPASS ASSEMBLY SIMPLIFIED SCHEMATIC DIAGRAM

SECTION II

MICROPROCESSOR CONTROLLER MAINTENANCE

2-1. INTRODUCTION

2-2. This section provides maintenance information for the FM-30 FM transmitter microprocessor controller.

2-3. SAFETY CONSIDERATIONS

WARNING

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

3

2-4. The FM-30 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. It is very dangerous to attempt to make measurements or replace components with power energized, therefore such actions are not recommended. The design of the equipment provides safety features such that when a door or access panel is opened, interlock switches will deenergize the plate and screen power supplies. Do not short out or bypass interlock switches as a maintenance short cut.

2-6. The power supply cabinet and the PA cabinet contain switches which discharge the PA plate potential directly to ground whenever either cabinet is opened.

2-7. Grounding sticks are provided as safety features. Each grounding stick consists of a metal rod with a phenolic handle. The metal end is connected to chassis ground. Use a grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting maintenance.

2-8. The grounding stick in the high voltage power supply cabinet and the grounding stick in the PA cabinet both rest on hook switches. When either of these grounding sticks is removed, the associated hook switch opens the transmitter interlock string and deenergizes the transmitter PA and screen potentials until each grounding stick is replaced on its respective hook switch.

2-9. MAINTENANCE

WARNING

ENSURE THE REMOTE/LOCAL SWITCH IS SET TO LOCAL BEFORE ATTEMPTING ANY MAINTENANCE.

WARNING

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

2-10. The FM-30 maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-11. ADJUSTMENTS

WARNING

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

2-12. INPUT BOARD AND MICROPROCESSOR BYPASS ASSEMBLY LEVEL CONTROLS. The input level controls are all preset during factory final test and will not normally require readjustment in the field. Replacement of an associated level detector will not require control readjustment. Adjustment will only be required if a control is replaced or the PA power output level is changed. The microprocessor bypass assembly level controls are adjusted in a manner similar to the procedure stated in Paragraph 2-16 except that the transmitter must be restored to operation by depressing the H.V. START switch/indicator. To adjust the input level controls, proceed as follows.

2-13. Required Equipment. The following equipment is required to complete adjustment of the input board level controls.

A. Insulated adjustment tool, flat screwdriver tip (BE P/N 710-0001).

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

2-14. Procedure. To adjust the input board level controls, proceed as follows:

2-15. Operate the transmitter within specifications at the rated RF output power into a proper 50 Ohm load in the manual power control mode.

2-16. If a control associated with an overload is to be adjusted, complete the following steps:

A. Refer to Figure 2-1 and locate the control to be adjusted.

NOTE

THE MAXIMUM POTENTIAL AT ANY POINT WITHIN THE MICROPROCESSOR DRAWER IS 24V DC TO GROUND.

B. Open the microprocessor controller drawer.

CAUTION

ADJUSTMENT OF THE INPUT BOARD OVERLOAD LEVEL CONTROLS DETERMINES AT WHAT POINT THE PROCESSOR WILL INITIATE ACTION. IF A CONTROL IS INCORRECTLY ADJUSTED, THE PROCESSOR MAY NOT SENSE A FAULT AND DAMAGE TO THE EQUIPMENT MAY RESULT.

C. Adjust the control until the transmitter deenergizes, then back the control off slightly, noting the direction of rotation.

D. Wait approximately three seconds and depress the OVERLOAD RESET and the HIGH VOLTAGE ON switch/indicators.

E. If the equipment does not return to operation, adjust the control a bit more in the direction of rotation noted in step C.

F. Wait approximately three seconds and depress the OVERLOAD RESET and the HIGH VOLTAGE ON switch/indicators.

G. If the equipment does not return to operation, repeat steps E and F until the control is adjusted to the point where the transmitter will just return to operation.

2-17. If a control associated with a diagnostic input is to be adjusted, complete the following steps:

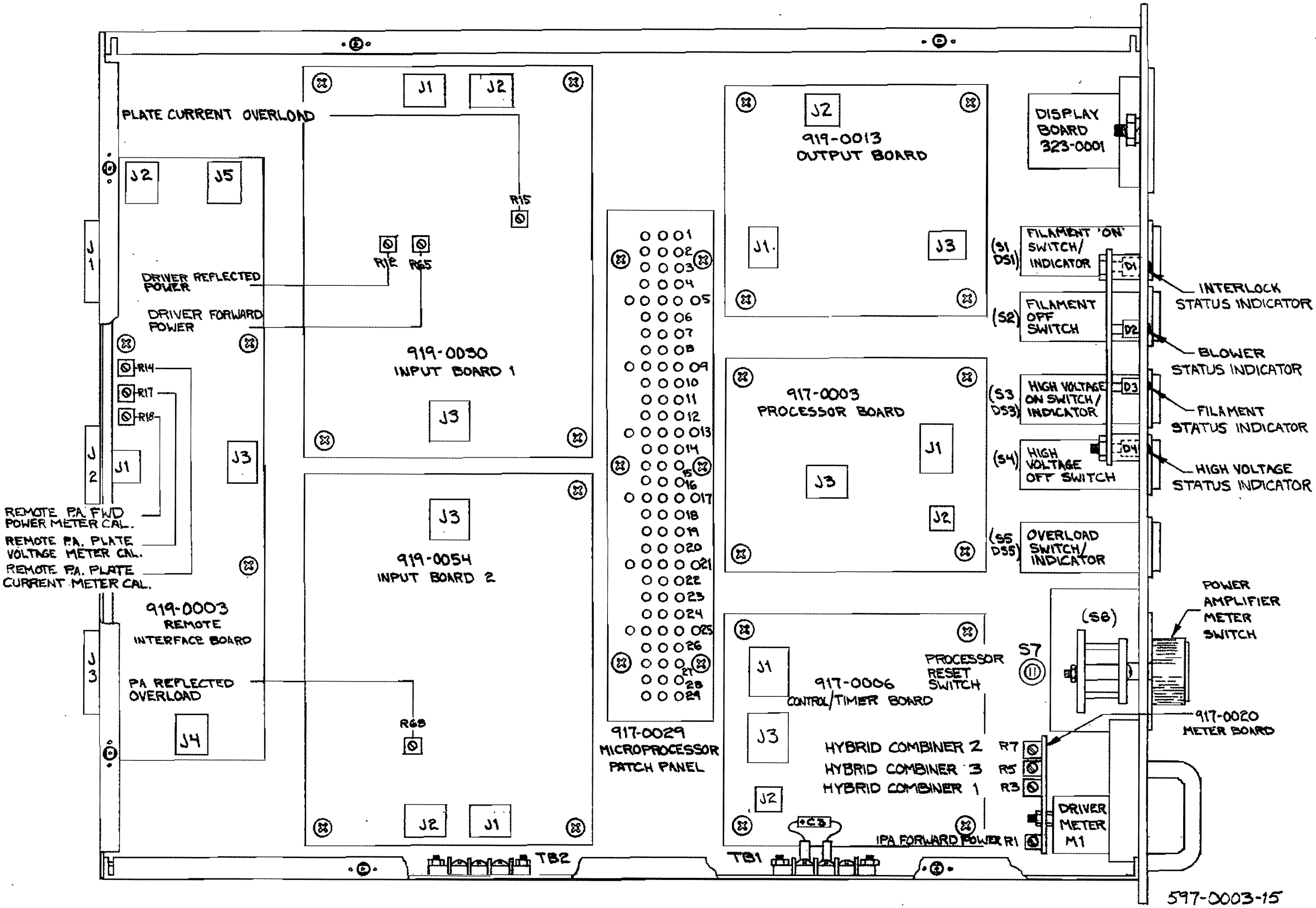


FIGURE 2-1. MICROPROCESSOR CONTROLLER ASSEMBLY

A. Refer to Figure 2-1 and locate the control to be adjusted.

NOTE

THE MAXIMUM POTENTIAL AT ANY POINT WITHIN THE MICROPROCESSOR DRAWER IS 24V DC TO GROUND.

B. Open the microprocessor controller drawer.

NOTE

ADJUSTMENT OF THE INPUT BOARD DIAGNOSTIC LEVEL CONTROLS DETERMINES WHAT DIAGNOSTIC INFORMATION WILL BE DISPLAYED. IF A CONTROL IS INCORRECTLY ADJUSTED, THE PROCESSOR MAY NOT SENSE AN OUT-OF-TOLERANCE PARAMETER AND THEREFORE THAT PARAMETER MAY NOT BE DISPLAYED.

C. Adjust the control until the display indicates $\boxed{0}\boxed{0}$.

3

2-18. TROUBLESHOOTING

WARNING

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

2-19. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indications (meters, LEDs, fuses, and the digital read-out) should be used to isolate the malfunction to one specific area.

NOTE

THE MAXIMUM POTENTIAL AT ANY POINT WITHIN THE MICROPROCESSOR DRAWER IS 24V DC TO GROUND.

2-20. Troubleshooting within the controller drawer is not considered hazardous due to the low potentials and currents involved. If troubleshooting in the controller drawer is required to isolate problems, an oscilloscope with a 5 MHz bandwidth and 1 volt per centimeter sensitivity and a 20 k Ohm/volt multimeter is required. Microprocessor controller waveform patterns are presented in Figure 2-2 as aids to maintenance.

2-21. 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.

2-22. 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.

2-23. MICROPROCESSOR BYPASS ASSEMBLY USE. Basic on and off functions and PA stage overloads may be controlled with the bypass assembly which derives its power from the five volt interlock circuit. As the unit is intended as a temporary maintenance back-up device, no timed intervals, remote features, or automatic power control features are provided.

WARNING

DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-24. Disconnect all transmitter primary power, then extend the microprocessor controller forward, out of the rack on its slides.

2-25. Unplug P2 from J2 on the rear of the microprocessor controller.

2-26. Plug P2 into J2 of the microprocessor controller bypass assembly and latch the two connectors together.

2-27. The microprocessor controller may now be removed from the transmitter for maintenance if the remaining connectors are unplugged. Ensure all plugs and wiring are taped or tied securely in a safe area within the transmitter.

WARNING

DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER IF THE TRANSMITTER IS OPERATED WITH THE MICROPROCESSOR CONTROLLER REMOVED. IT IS SUGGESTED THAT A TEMPORARY GUARD BE LOCALLY FABRICATED TO COVER THE AREA IN WHICH THE MICROPROCESSOR CONTROLLER IS NORMALLY MOUNTED.

2-28. Turn On. Assure the INT/LCK indicator is illuminated. If not, the open safety interlock must be located and closed.

2-29. Depress the FIL START switch/indicator. The FIL START indicator will illuminate.

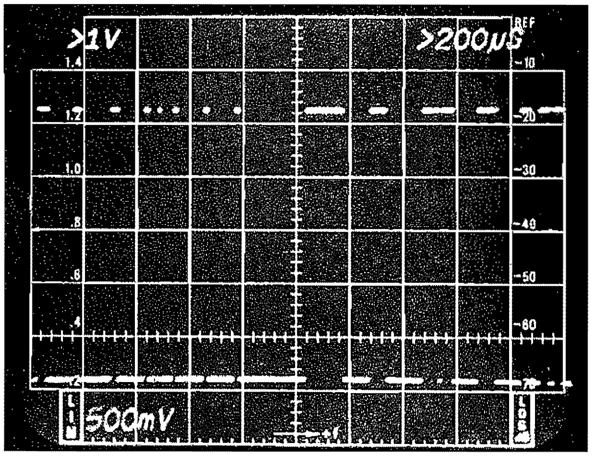
2-30. At least ten seconds after the BLO indicator illuminates to indicate the blower is up to speed, the H.V. START switch/indicator may be depressed. The H.V. START indicator will illuminate.

2-31. A PA stage overload will deenergize the PA plate supply. The transmitter may be restored to operation by depressing the H.V. START switch/indicator.

2-32. Turn Off. Depress the H.V. STOP switch.

2-33. After a ten second minimum delay to allow the PA tube filament to cool, depress the FIL STOP switch.

3



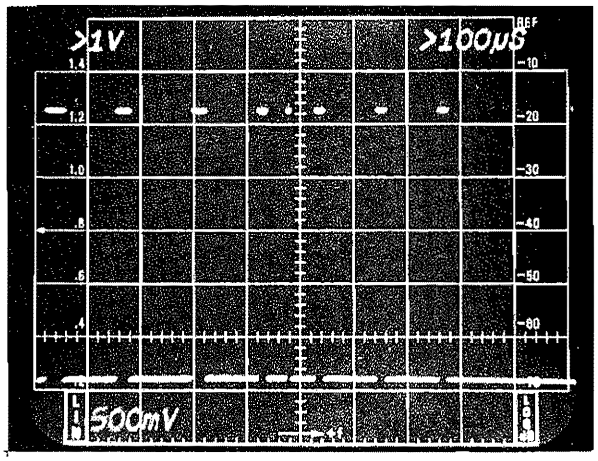
CHANNEL A: TYPICAL PROGRAM PATTERN (3.3 ms Long)

CHANNEL B: FLAG$_0$ PULSE (Signals Program Start)

MICROPROCESSOR INDICATOR: $\boxed{\ }\boxed{1}$

TEST POINT: A PATCH PANEL PIN 4
B U6 PIN 10 ON PROCESSOR BOARD

SYNC: U6 PIN 10 ON PROCESSOR BOARD



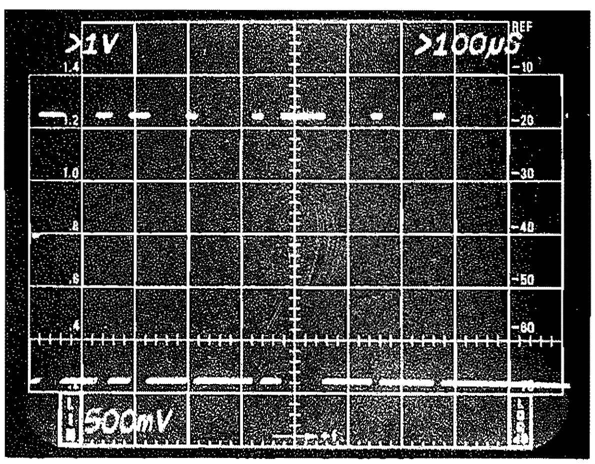
CHANNEL A: TYPICAL PROGRAM PATTERN, FIRST HALF (Control Pulse Portion)

CHANNEL B: FLAG$_0$ PULSE (Signals Program Start)

MICROPROCESSOR INDICATOR: $\boxed{\ }\boxed{1}$

TEST POINT: A PATCH PANEL PIN 4
B U6 PIN 10 ON PROCESSOR BOARD

SYNC: U6 PIN 10 ON PROCESSOR BOARD



CHANNEL A: TYPICAL PROGRAM PATTERN, FIRST HALF (Control Pulse Portion)

CHANNEL B: FLAG$_0$ PULSE (Signals Program Start)

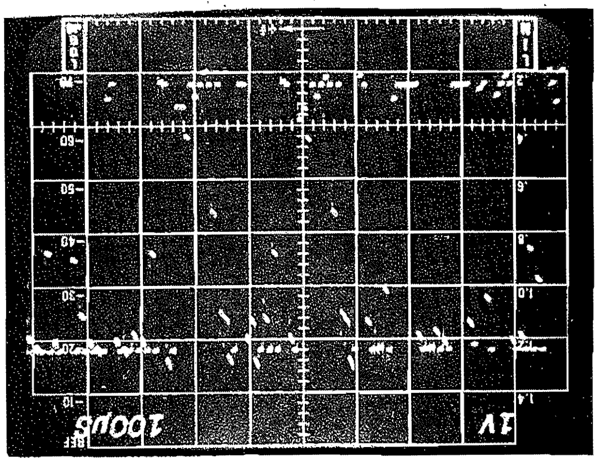
MICROPROCESSOR INDICATOR: $\boxed{9}\boxed{8}$

TEST POINT: A PATCH PANEL PIN 4
B U6 PIN 10 ON PROCESSOR BOARD

SYNC: U6 PIN 10 ON PROCESSOR BOARD

597-0003-35A

FIGURE 2-2. MICROPROCESSOR CONTROLLER TYPICAL WAVEFORMS (Sheet 1 of 3)



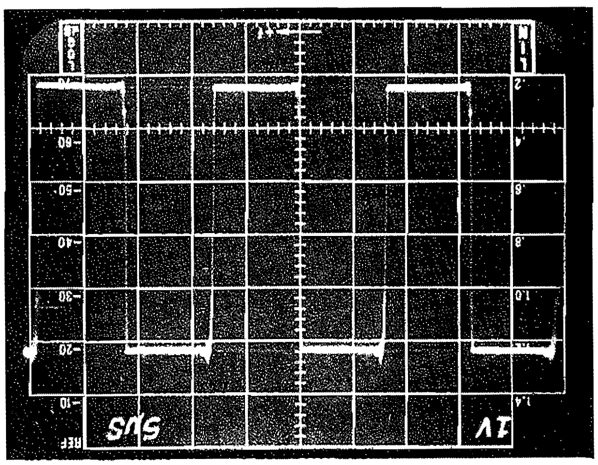
CHANNEL A: TYPICAL PROGRAM PATTERN, FIRST HALF (Control Pulse Portion)

CHANNEL B: $FLAG_0$ PULSE (Signals Program Start)

MICROPROCESSOR INDICATOR: $\boxed{0}\boxed{0}$

TEST POINT: A PATCH PANEL PIN 4
B U6 PIN 10 ON PROCESSOR BOARD

SYNC: U6 PIN 10 ON PROCESSOR BOARD

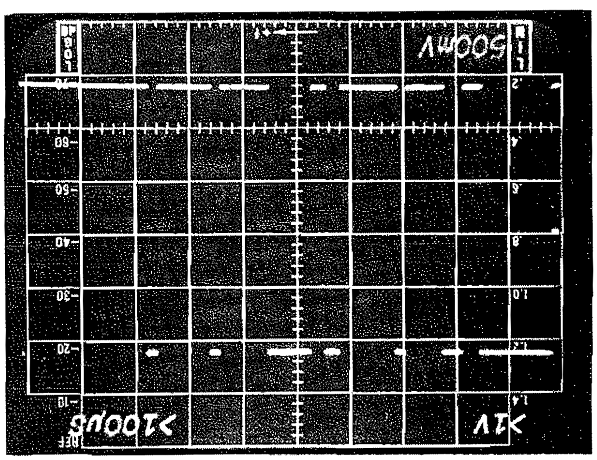


CHANNEL A: CLOCK PATTERN (15us - 66kHz)

MICROPROCESSOR INDICATOR: $\boxed{0}\boxed{0}$

TEST POINT: U6 PIN 14 ON PROCESSOR BOARD

SYNC: SCOPE



CHANNEL A: DATA BUS PATTERN

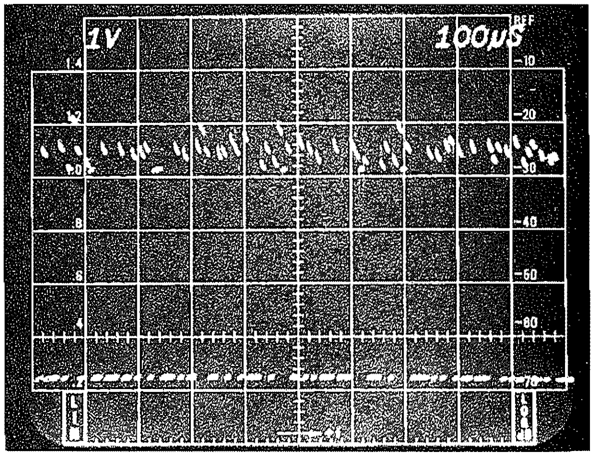
MICROPROCESSOR INDICATOR: $\boxed{0}\boxed{0}$

TEST POINT: PATCH PANEL PIN 17

SYNC: U6 PIN 10 ON PROCESSOR BOARD

597-0003-35B

FIGURE 2-2. MICROPROCESSOR CONTROLLER TYPICAL WAVEFORMS (Sheet 2 of 3)

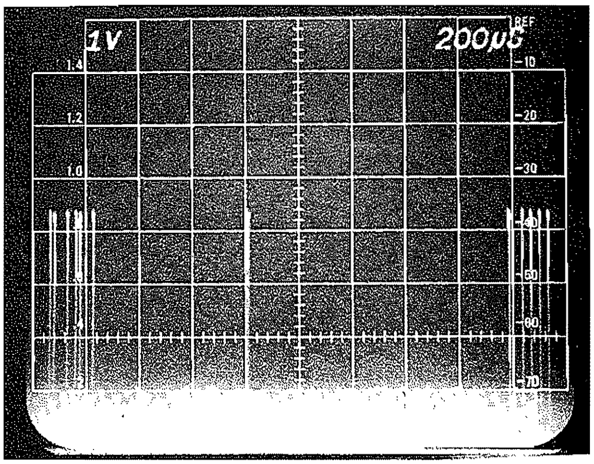


CHANNEL A: TYPICAL ADDRESS BUS PATTERN (A_0 BUS)

MICROPROCESSOR INDICATOR: $\boxed{0|0}$

TEST POINT: PATCH PANEL PIN 13

SYNC: U6 PIN 10 ON PROCESSOR BOARD

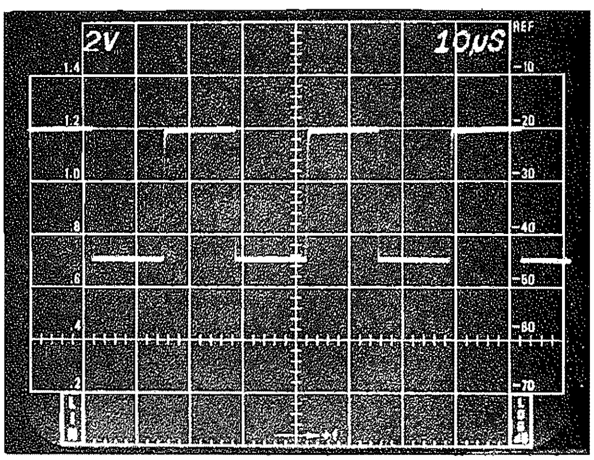


CHANNEL A: WRITE BUS PATTERN

MICROPROCESSOR INDICATOR: $\boxed{0|0}$

TEST POINT: PATCH PANEL PIN 8

SYNC: U6 PIN 10 ON PROCESSOR BOARD



CHANNEL A: BLOWER TIMER PATTERN

MICROPROCESSOR INDICATOR: $\boxed{0|0}$

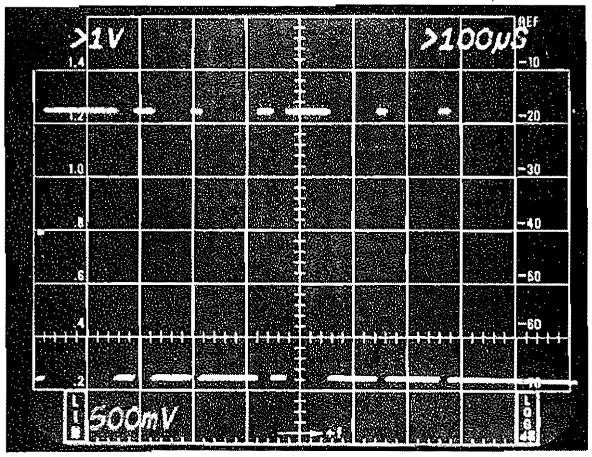
TEST POINT: U1 PINS 6 AND 7 ON CONTROL/TIMER BOARD

SYNC: SCOPE

597-0003-35C

FIGURE 2-2. MICROPROCESSOR CONTROLLER TYPICAL WAVEFORMS (Sheet 3 of 3)

WARNING: DISCONNECT POWER PRIOR TO SERVICING



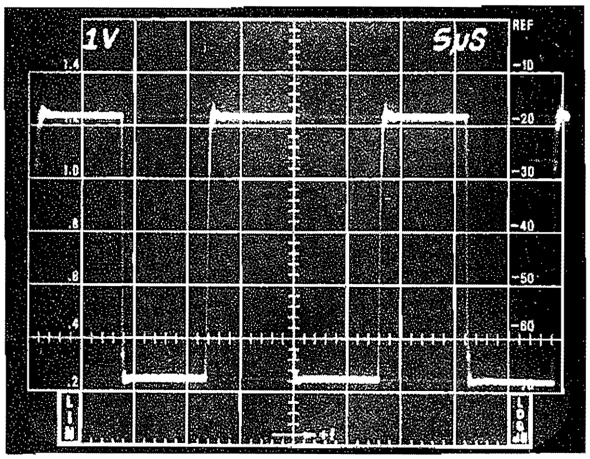
CHANNEL A: TYPICAL PROGRAM PATTERN, FIRST HALF (Control Pulse Portion)

CHANNEL B: $FLAG_0$ PULSE (Signals Program Start)

MICROPROCESSOR INDICATOR: | 0 | 0 |

TEST POINT: A PATCH PANEL PIN 4
B U6 PIN 10 ON PROCESSOR BOARD

SYNC: U6 PIN 10 ON PROCESSOR BOARD



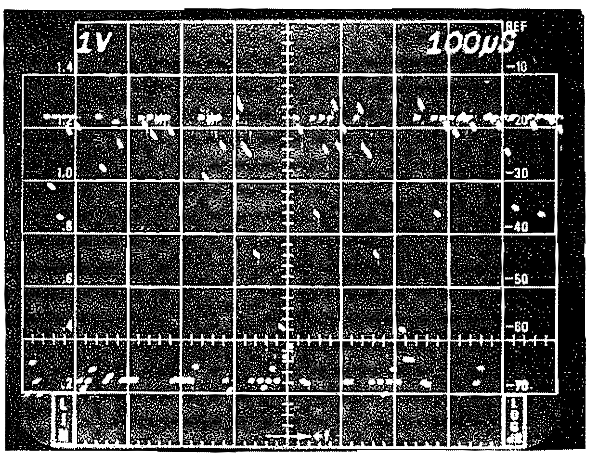
CHANNEL A: CLOCK PATTERN (15us - 66kHz)

MICROPROCESSOR INDICATOR: | 0 | 0 |

TEST POINT: U6 PIN 14 ON PROCESSOR BOARD

SYNC: SCOPE

3



CHANNEL A: DATA BUS PATTERN

MICROPROCESSOR INDICATOR: | 0 | 0 |

TEST POINT: PATCH PANEL PIN 17

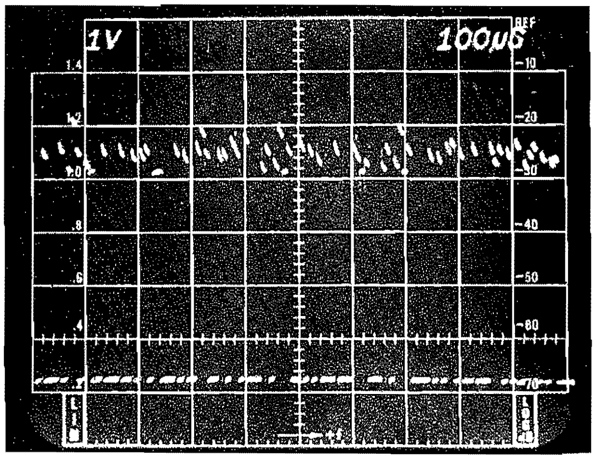
SYNC: U6 PIN 10 ON PROCESSOR BOARD

597-0003-35B

FIGURE 2-2. MICROPROCESSOR CONTROLLER TYPICAL WAVEFORMS (Sheet 2 of 3)

WARNING: DISCONNECT POWER PRIOR TO SERVICING

REVISED

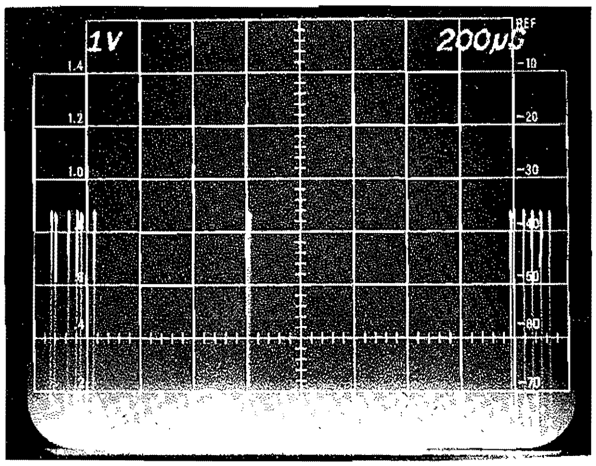


CHANNEL A: TYPICAL ADDRESS BUS PATTERN (A_0 BUS)

MICROPROCESSOR INDICATOR: $\boxed{0}\boxed{0}$

TEST POINT: PATCH PANEL PIN 13

SYNC: U6 PIN 10 ON PROCESSOR BOARD

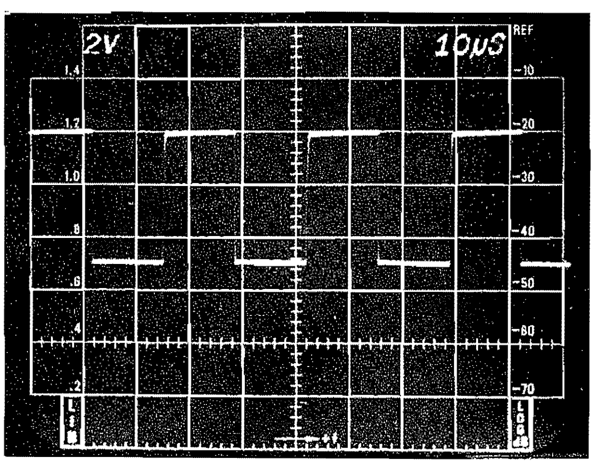


CHANNEL A: WRITE BUS PATTERN

MICROPROCESSOR INDICATOR: $\boxed{0}\boxed{0}$

TEST POINT: PATCH PANEL PIN 8

SYNC: U6 PIN 10 ON PROCESSOR BOARD



CHANNEL A: BLOWER TIMER PATTERN

MICROPROCESSOR INDICATOR: $\boxed{0}\boxed{0}$

TEST POINT: U1 PINS 6 AND 7 ON CONTROL/TIMER BOARD

SYNC: SCOPE

597-0003-35C

FIGURE 2-2. MICROPROCESSOR CONTROLLER TYPICAL WAVEFORMS (Sheet 3 of 3)

SECTION III
MICROPROCESSOR CONTROLLER DRAWINGS

3-1. INTRODUCTION

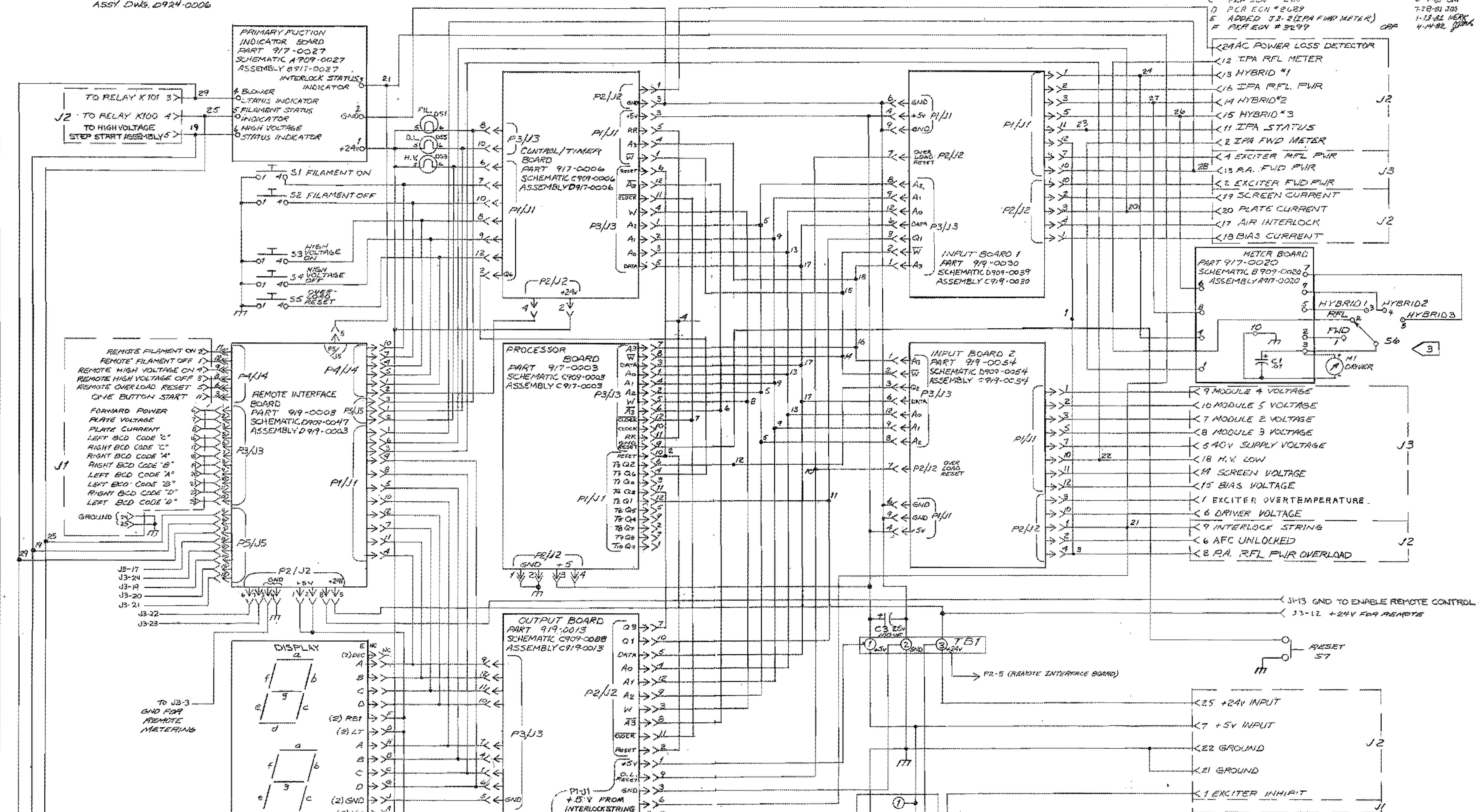
3-2. This section provides assembly drawings, schematic diagrams, and wire lists as indexed below for the FM-30 Transmitter Microprocessor controller.

FIGURE	TITLE	NUMBER
3-1	Schematic, Microprocessor Interconnect	D909-0030
3-2	Schematic, Processor Board	C909-0003
3-3	Assembly, Processor Board	C917-0003
3-4	Schematic, Output Board	C909-0088
3-5	Assembly, Output Board	C919-0013
3-6	Schematic, Control/Timer Board	D909-0006
3-7	Assembly, Control/Timer Board	C917-0006
3-8	Schematic, Remote Control Interface	D909-0047
3-9	Assembly, Remote Control Interface	D919-0003
3-10	Schematic, Input Board 1	D909-0039
3-11	Assembly, Input Board 1	C919-0030
3-12	Schematic, Input Board 2	D909-0054
3-13	Assembly, Input Board 2	C919-0054
3-14	Schematic, Primary Function Indicator	A909-0027
3-15	Assembly, Primary Function Indicator	B917-0027
3-16	Schematic, Microprocessor Bypass Assembly	B909-0056
3-17	Schematic, Microprocessor Bypass Circuit Board	C909-0057
3-18	Assembly, Microprocessor Bypass Circuit Board	B919-0009

NOTES:
1. DASHED LINES DENOTE REAR PANEL JACK CONNECTIONS.
2. NUMBERED DOTS (•#) DENOTE MICROPROCESSOR PATCH PANEL CONNECTIONS.
3. B/M 924-0006
ASSY DWG. D924-0006

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN #2567	2-19-81	
B	PER ECN #2587	3-16-81	
C	PER ECN #2710	6-4-81	
D	PER ECN #2689	7-28-81	
E	ADDED J2-2 (IPA FWD METER)	1-13-82	
F	PER ECN #3299	4-14-82	



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

DRAWN | DATE 10-22-80
CHECKED | DATE 11-15-80
PROJECT ENGR | DATE 4-8-81
APPROVED BY
TREATMENT OR FINISH

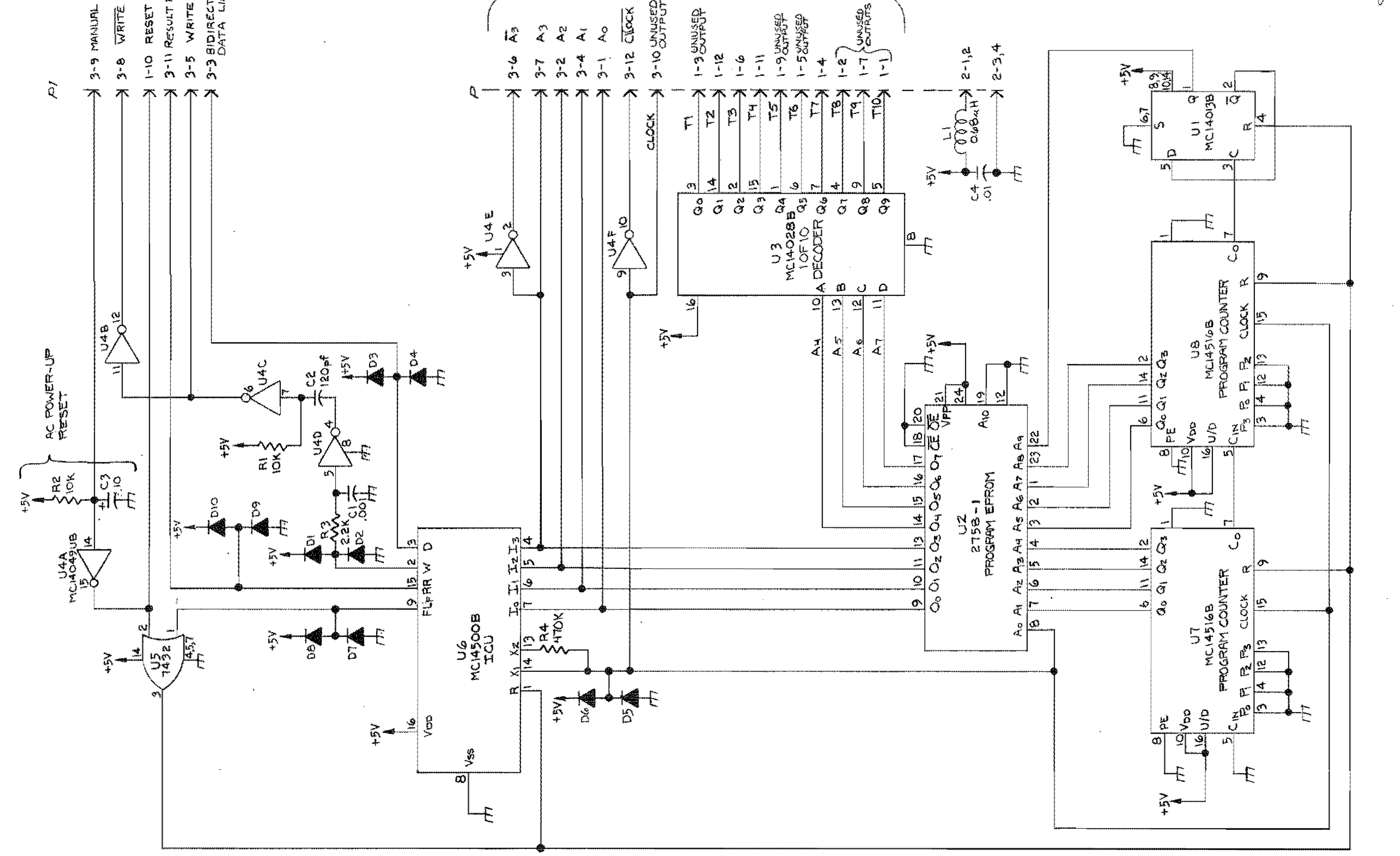
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE: SCHEMATIC, MICROPROCESSOR INTERCONNECT

D | DWG. NO. 909-0030 | REV. F

SCALE — SHEET 1 OF 1

REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN #2237	8-11-80	mm
B	PER ECN # 2466	12-17-80	MJS
C	PER ECN # 3634	JAH 7-6-82	JML



NOTES:
1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS, DIODES IN4148, UNLESS NOTED OTHERWISE.
2. LAST COMPONENTS USED: C4, D10, J3, L1, R4, U8.
SEE B/M #917-0003
SEE PCB ASSY. #C-917-0003

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

MATERIAL

DRAWN BY M. HAYDEN DATE 6-4-79
CHECKED BY DATE
PROJECT ENGR. DATE
APPROVED BY

TREATMENT OR FINISH

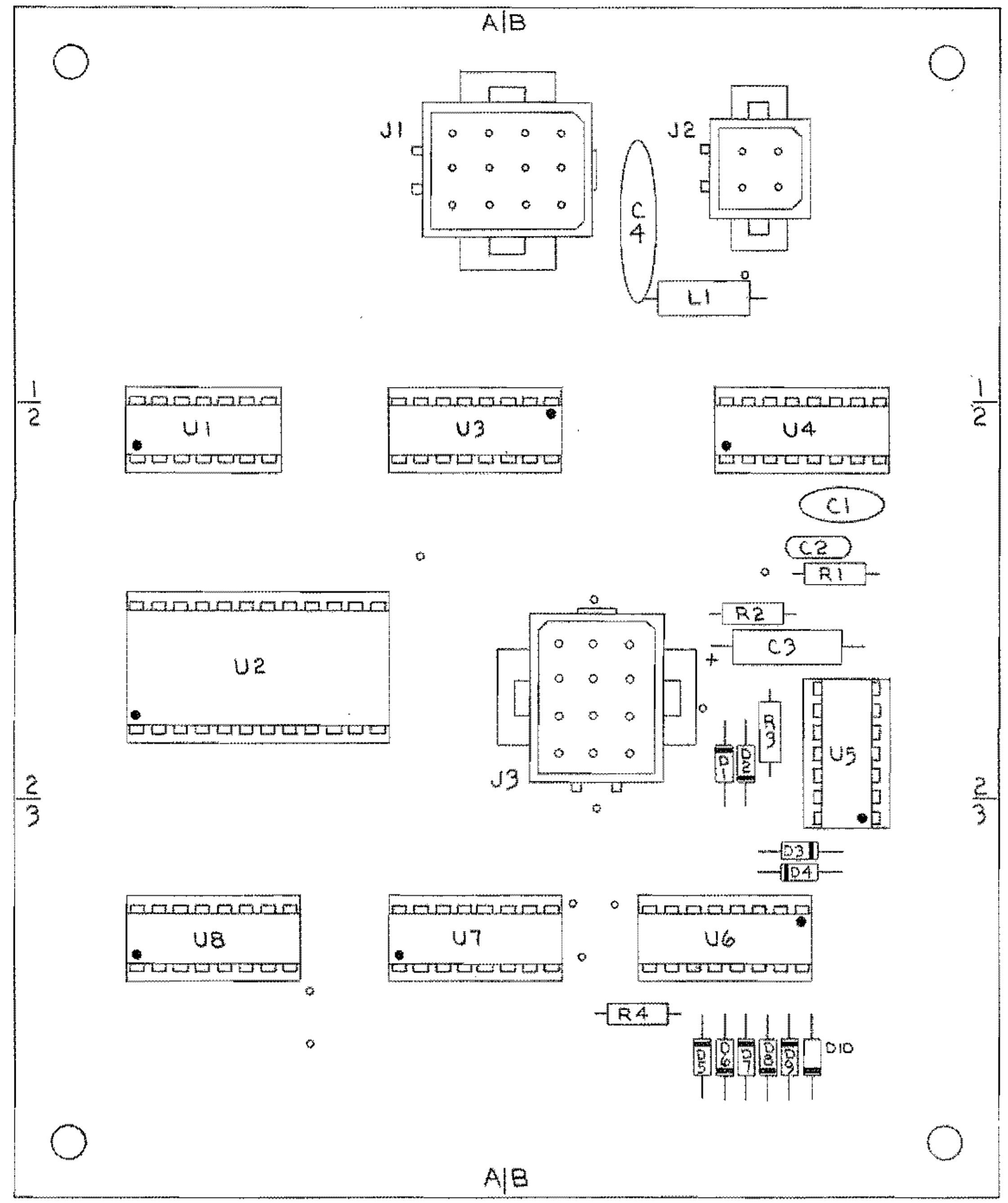
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC PROCESSOR BOARD

C DWG. NO. 909-0003 REV. C

30KW TRANSMITTER SCALE SHEET 1 OF 1

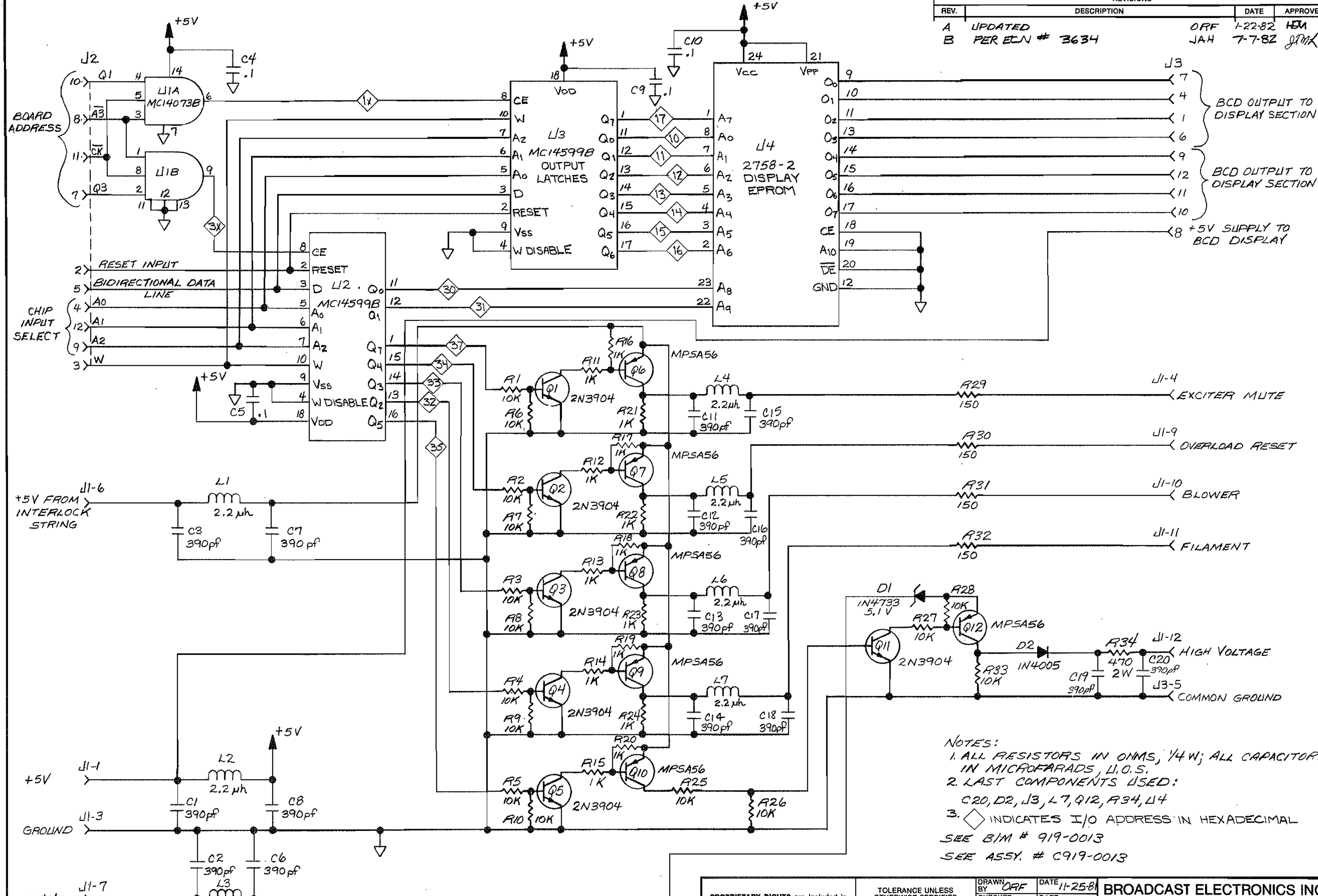
REVISIONS				
REV.	DESCRIPTION		DATE	APPROVED
A	PER ECN # 2634	CRF	7-8-82	JMH



SEE B/M # 917-0003
SEE SCHEMATIC # 909-0003

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY M. HAYDEN	DATE 5-25-79	BROADCAST ELECTRONICS INC. —A FILMWAYS COMPANY—
	CHECKED BY	DATE	TITLE PCB ASSEMBLY PROCESSOR BOARD
	PROJECT ENGR.	DATE	C DWG. NO. 917-0003 REV. A
	APPROVED BY		
MATERIAL	TREATMENT OR FINISH		30KW XMTR CONTROL SCALE 2/1 SHEET 1 OF 1

REV.	DESCRIPTION		DATE	APPROVED
A	UPDATED	ORF	1-22-82	HEM
B	PER ECN # 3634	JAH	7-7-82	JMK



NOTES:
1. ALL RESISTORS IN OHMS, 1/4 W; ALL CAPACITORS IN MICROFARADS, U.O.S.
2. LAST COMPONENTS USED:
C20, D2, J3, L7, Q12, R34, U4
3. ◇ INDICATES I/O ADDRESS IN HEXADECIMAL
SEE B/M # 919-0013
SEE ASSY. # C919-0013

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

MATERIAL

DRAWN BY ORF	DATE 11-25-81	
CHECKED BY HEM	DATE 1-25-82	
PROJECT ENGR. HEM	DATE 1-25-82	
APPROVED BY MH	3-25-82	

TREATMENT OR FINISH

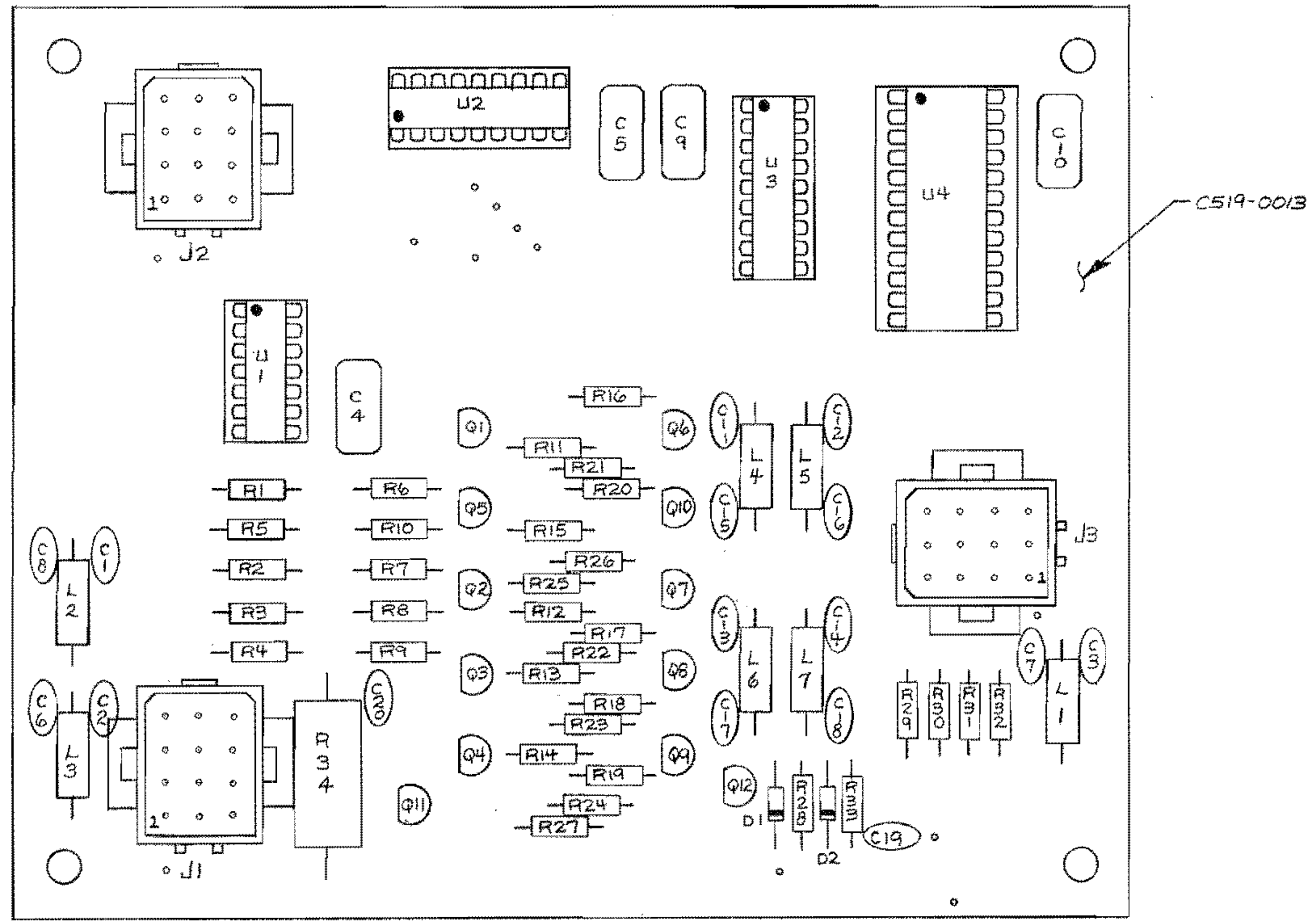
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC MICROPROCESSOR OUTPUT

C DWG. NO. 909-0088 REV. B

TRANSMITTERS SCALE — SHEET 1 OF 1

REV.	DESCRIPTION		DATE	APPROVED
A	UPDATED	ORF	1-22-82	HBM



SEE SCHEMATIC C 909-0088
SEE B/M # 919-0013

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

MATERIAL

TREATMENT OR FINISH

DRAWN BY ORF — DATE 12-4-81
CHECKED BY HBM — DATE 1-25-82
PROJECT ENGR. HBM — DATE 1-25-82
APPROVED BY MH 3-25-82

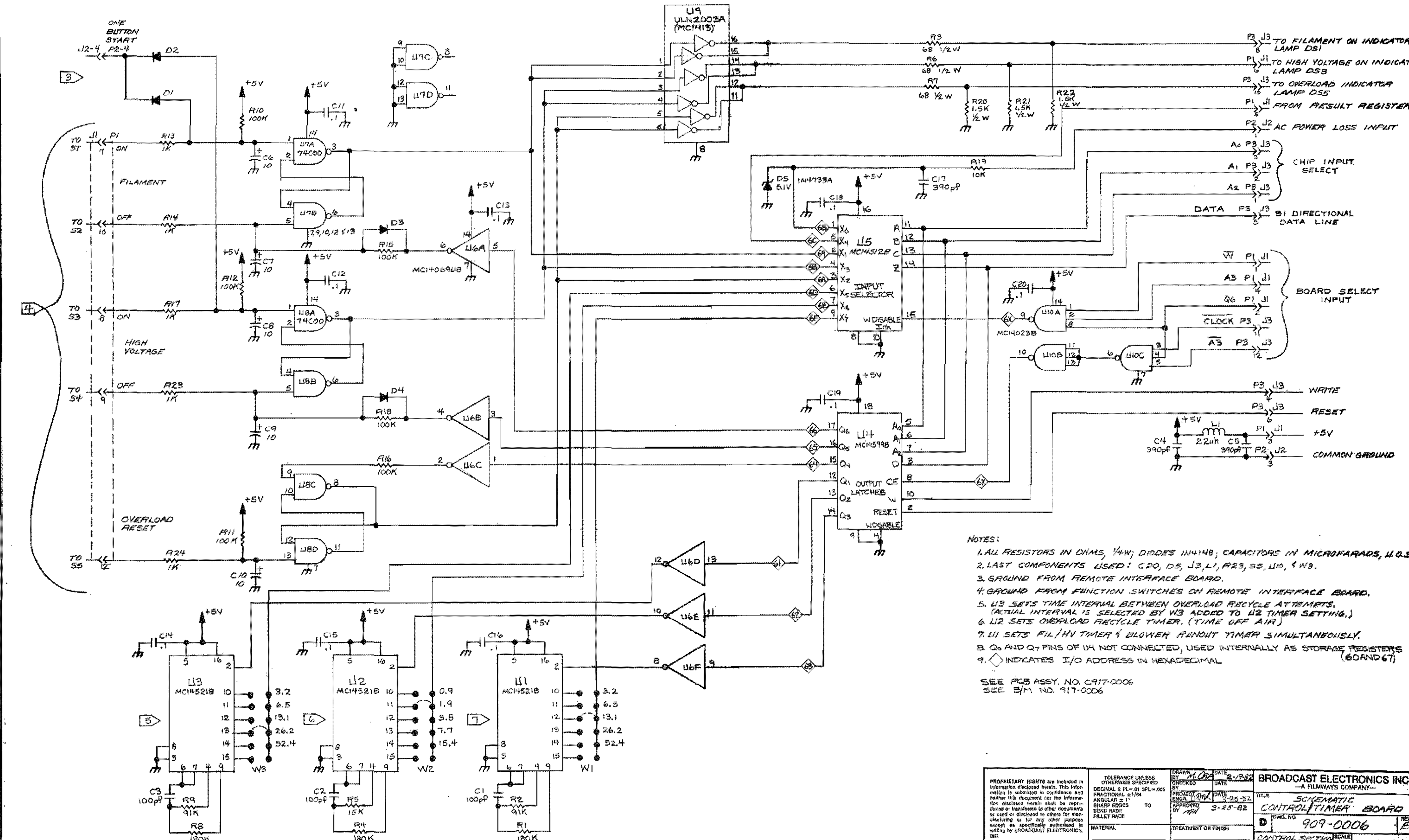
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY MICROPROCESSOR OUTPUT

C — DWG. NO. 919-0013 — REV. A

TRANSMITTERS — SCALE 2/1 — SHEET 1 OF 1

REV.	DESCRIPTION	DATE	APPROVED
E	PER ECN #3299	CMF 3-26-82	
F	PER ECN #3634	JAH 7-7-82	



NOTES:

1. ALL RESISTORS IN OHMS, 1/4W; DIODES 1N4148; CAPACITORS IN MICROFARADS, U.O.S.
2. LAST COMPONENTS USED: C20, D5, J3, L1, R23, S5, U10, & W3.
3. GROUND FROM REMOTE INTERFACE BOARD.
4. GROUND FROM FUNCTION SWITCHES ON REMOTE INTERFACE BOARD.
5. U3 SETS TIME INTERVAL BETWEEN OVERLOAD RECYCLE ATTEMPTS. (ACTUAL INTERVAL IS SELECTED BY W3 ADDED TO U2 TIMER SETTING.)
6. U2 SETS OVERLOAD RECYCLE TIMER. (TIME OFF AIR)
7. U1 SETS FIL/HV TIMER & BLOWER RUNOUT TIMER SIMULTANEOUSLY.
8. Q_0 AND Q_7 PINS OF U4 NOT CONNECTED, USED INTERNALLY AS STORAGE REGISTERS (60 AND 67)
9. ◇ INDICATES I/O ADDRESS IN HEXADECIMAL

SEE PCB ASSY. NO. C917-0006
SEE B/M NO. 917-0006

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

MATERIAL

DRAWN BY M. CRA DATE 3-19-82
CHECKED BY DATE
PROJECT ENGR. DATE 7-26-82
APPROVED BY 3-25-82
TREATMENT OR FINISH

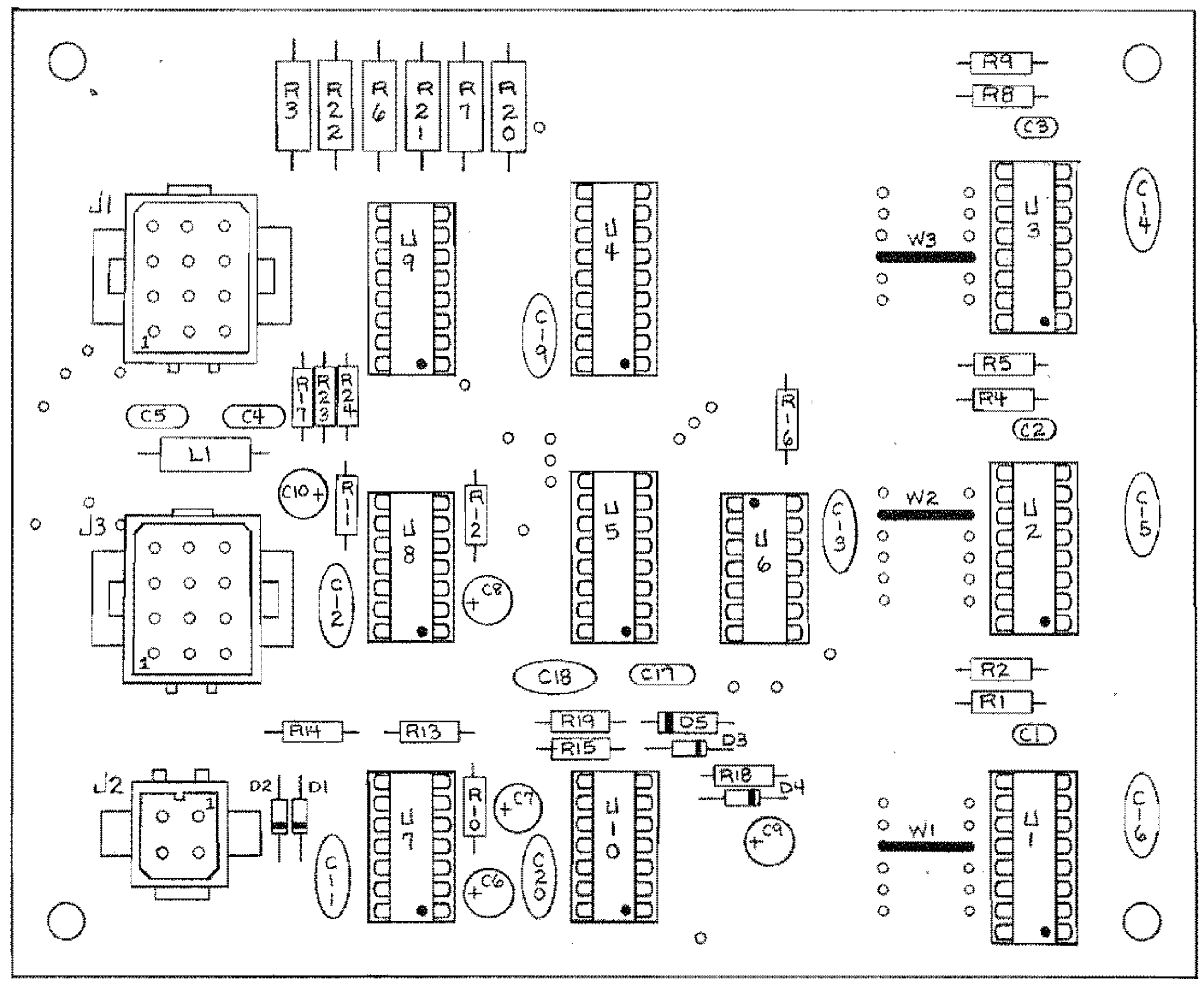
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC CONTROL/TIMER BOARD

D DWG. NO. 909-0006 REV. F

CONTROL SECTION 30KW XMTR SCALE NTS SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
B	PER ECN #3299 OY	3-26-82	JMK



SEE B/M # 917-0006
SEE SCHEMATIC D909-0006

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

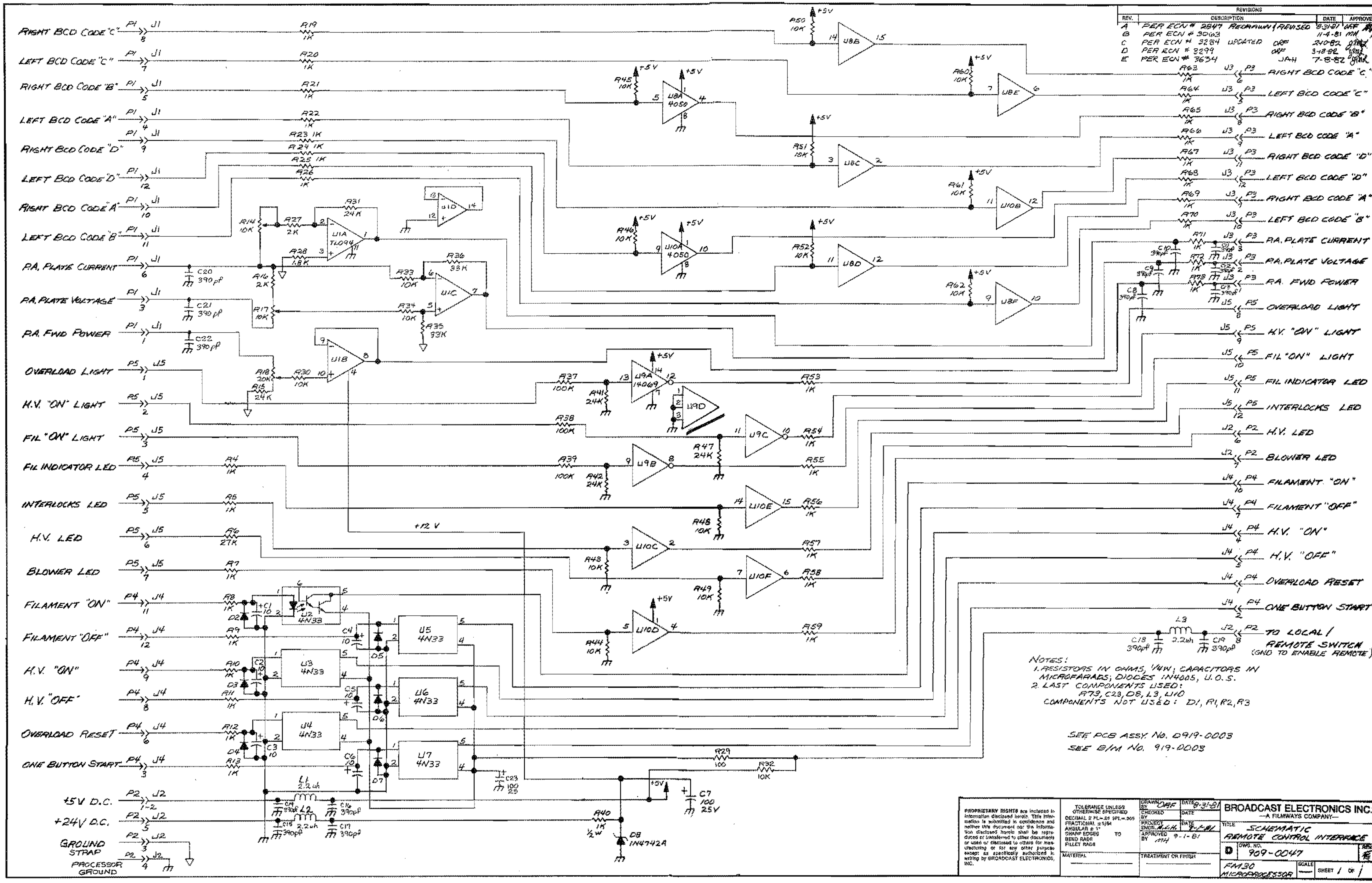
MATERIAL

DRAWN BY ORF	DATE 3-1-82	
CHECKED BY	DATE	
PROJECT ENGR. MMd	DATE 3-25-82	
APPROVED BY MH	3-25-82	
TREATMENT OR FINISH		

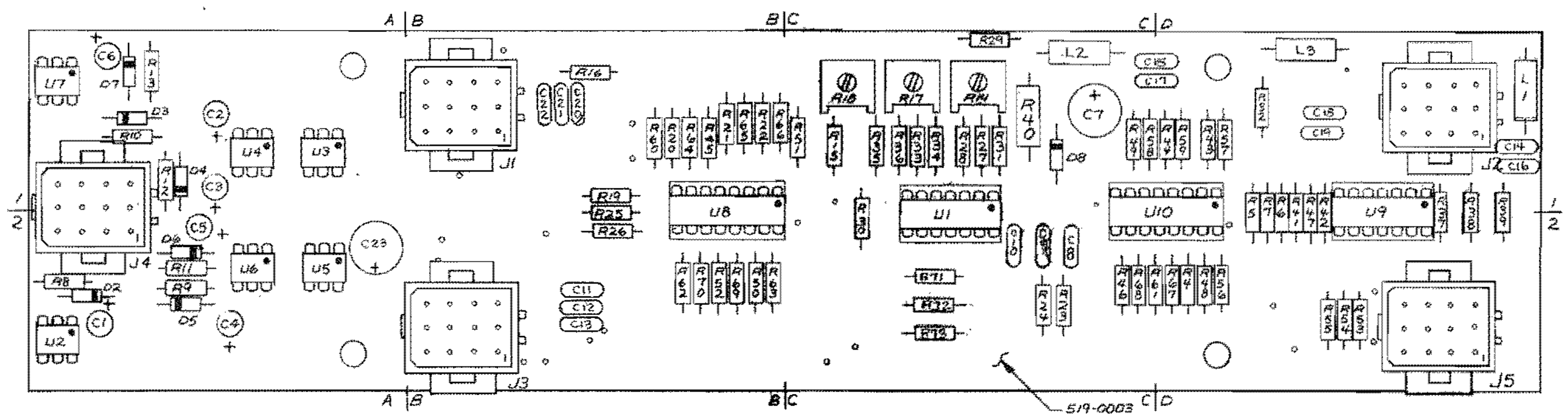
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY
CONTROL/TIMER BOARD

C	DWG. NO. 917-0006	REV. B
CONTROL SECTION 30KW XMTR	SCALE 2/1	SHEET 1 OF 1


REVISIONS
A PER ECN # 2847 REDRAWN / REVISED 8-31-81
B PER ECN # 3063 11-4-81
C PER ECN # 3284 UPDATED 2-10-82
D PER ECN # 3299 3-8-82
E PER ECN # 3654 7-8-82
RIGHT BCD CODE "C"
LEFT BCD CODE "C"
RIGHT BCD CODE "B"
LEFT BCD CODE "A"
RIGHT BCD CODE "D"
LEFT BCD CODE "D"
RIGHT BCD CODE "A"
LEFT BCD CODE "B"
P.A. PLATE CURRENT
P.A. PLATE VOLTAGE
P.A. FWD POWER
OVERLOAD LIGHT
H.V. "ON" LIGHT
FIL "ON" LIGHT
FIL INDICATOR LED
INTERLOCKS LED
H.V. LED
BLOWER LED
FILAMENT "ON"
FILAMENT "OFF"
H.V. "ON"
H.V. "OFF"
OVERLOAD RESET
ONE BUTTON START
+5V D.C.
+24V D.C.
GROUND STRAP
PROCESSOR GROUND
TO LOCAL / REMOTE SWITCH (GND TO ENABLE REMOTE)
NOTES:
1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS; DIODES 1N4005, U.O.S.
2. LAST COMPONENTS USED: R73, C23, D8, L3, U10
COMPONENTS NOT USED: D1, R1, R2, R3
SEE PCB ASSY. No. 0919-0003
SEE B/M No. 919-0003
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—
TITLE SCHEMATIC REMOTE CONTROL INTERFACE
DWG. NO. 909-0047
FM30 MICROPROCESSOR
SHEET 1 OF 1

REV.	DESCRIPTION		DATE	APPROVED
A	PER ECN # 2847 REDRAWN & REVISED		8-29-81	ORF
B	PER ECN # 2908		9-17-81	
C	PER ECN # 3063		11-2-81	
D	PER ECN # 3284 UPDATED	ORF	2-10-82	
E	PER ECN # 3299	ORF	3-18-82	
F	PER ECN # 3503	JAH	5-25-82	
G	PER ECN # 3634	JAH	7-7-82	



SEE B/M # 919-0003
SEE SCHEMATIC # D909-0047

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

MATERIAL

DRAWN BY ORF DATE 8-29-81
CHECKED BY DATE
PROJECT ENGR. W.L.M. DATE 9-1-81
APPROVED BY MH 9-1-81

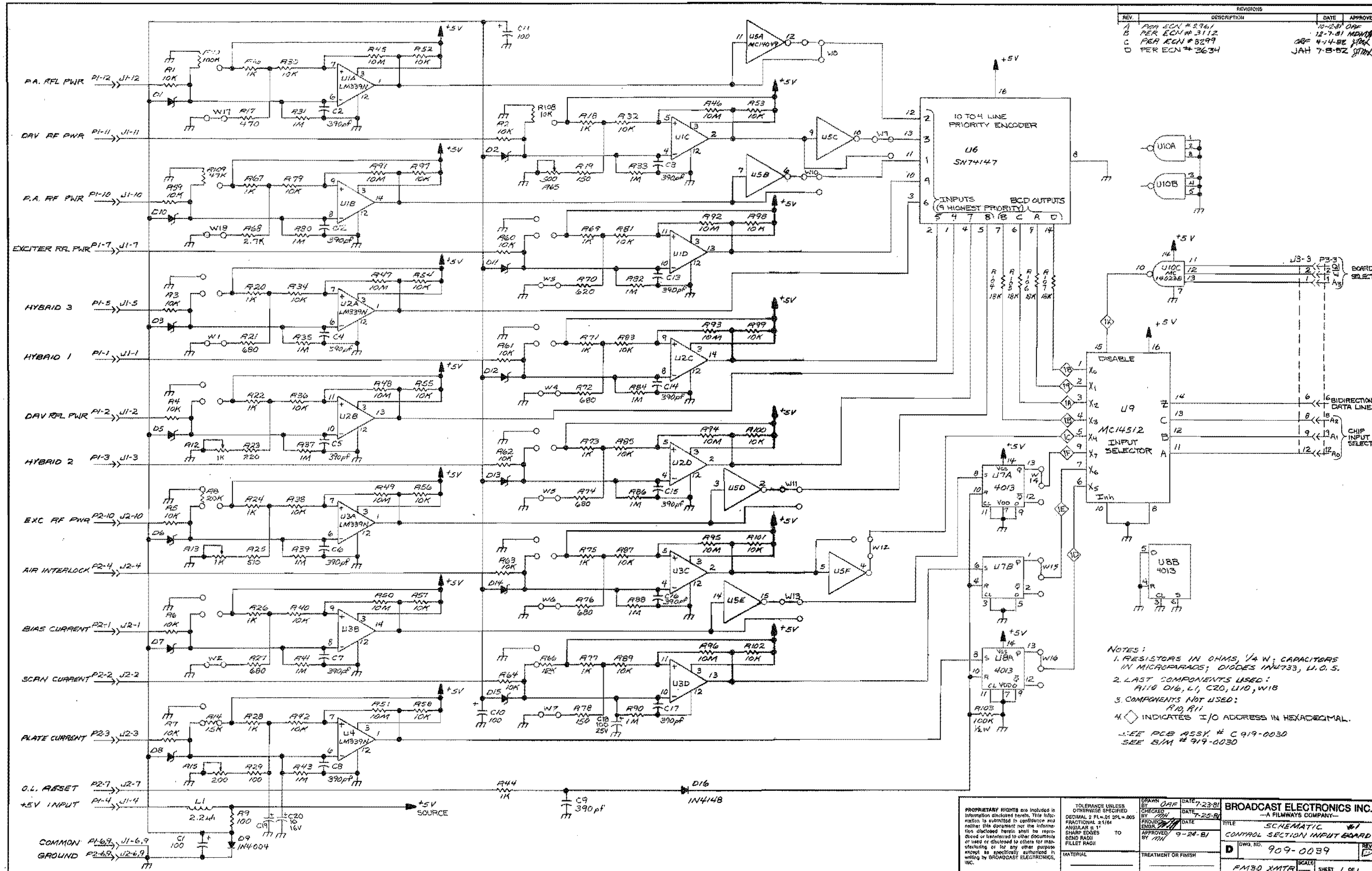
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY
REMOTE CONTROL INTERFACE

D DWG. NO. 919-0003 REV. G

FM30 XMTR MICROPROCESSOR SCALE 2/1 SHEET 1 OF 1


REVISIONS
A PER ECN # 2961 10-12-81 ORF
B PER ECN # 3112 12-7-81
C PER ECN # 3299 4-14-82
D PER ECN # 3634 JAH 7-8-82
P.A. RFL PWR P1-12 J1-12
DRV RF PWR P1-11 J1-11
P.A. RF PWR P1-10 J1-10
EXCITER RF. PWR P1-7 J1-7
HYBRID 3 P1-5 J1-5
HYBRID 1 P1-1 J1-1
DRV RFL PWR P1-2 J1-2
HYBRID 2 P1-3 J1-3
EXC RF PWR P2-10 J2-10
AIR INTERLOCK P2-4 J2-4
BIAS CURRENT P2-1 J2-1
SCRN CURRENT P2-2 J2-2
PLATE CURRENT P2-3 J2-3
O.L. RESET P2-7 J2-7
+5V INPUT P1-4 J1-4
COMMON P1-6,9 J1-6,9
GROUND P2-6,9 J2-6,9
+5V SOURCE
10 TO 4 LINE PRIORITY ENCODER
U6 SN74147
INPUTS (9 HIGHEST PRIORITY)
BCD OUTPUTS
U9 MC14512 INPUT SELECTOR
DISABLE
BOARD SELECT
BIDIRECTIONAL DATA LINE
CHIP INPUT SELECT
U10C MC14023B
U7A 4013
U7B
U8A 4013
U8B 4013
NOTES:
1. RESISTORS IN OHMS, 1/4 W; CAPACITORS IN MICROFARADS; DIODES 1N4733, U.O.S.
2. LAST COMPONENTS USED: R110 D16, L1, C20, U10, W18
3. COMPONENTS NOT USED: R10, R11
4. ◇ INDICATES I/O ADDRESS IN HEXADECIMAL.
SEE PCB ASSY. # C 919-0030
SEE B/M # 919-0030
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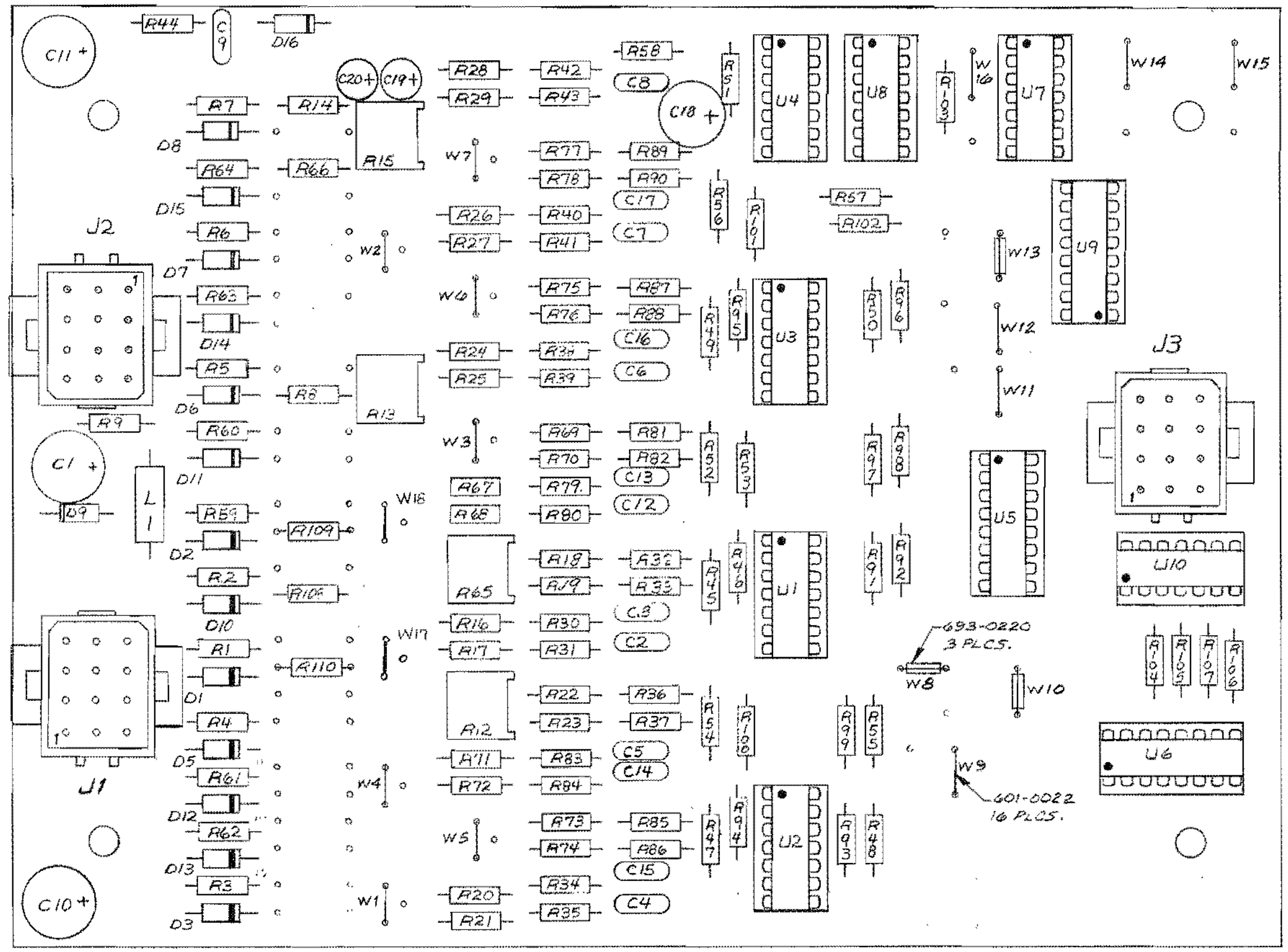
TOLERANCE UNLESS OTHERWISE SPECIFIED
DRAWN BY ORF DATE 7-23-81
CHECKED BY MH DATE 7-25-81
APPROVED BY MH 9-24-81
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—
TITLE SCHEMATIC #1 CONTROL SECTION INPUT BOARD
D DWG. NO. 909-0039 REV. D
FM30 XMTR SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 2961	10-12-81	ORF
B	PER ECN # 3066	11-2-81	MH
C	PER ECN # 3112	12-2-81	MDM
D	PER ECN # 3299 ORF	4-14-82	JMK
E	PER ECN # 3634 JAH	7-8-82	JMK



SEE BIM # 919-0030
SEE SCHEMATIC # 909-0039

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

MATERIAL

TREATMENT OR FINISH

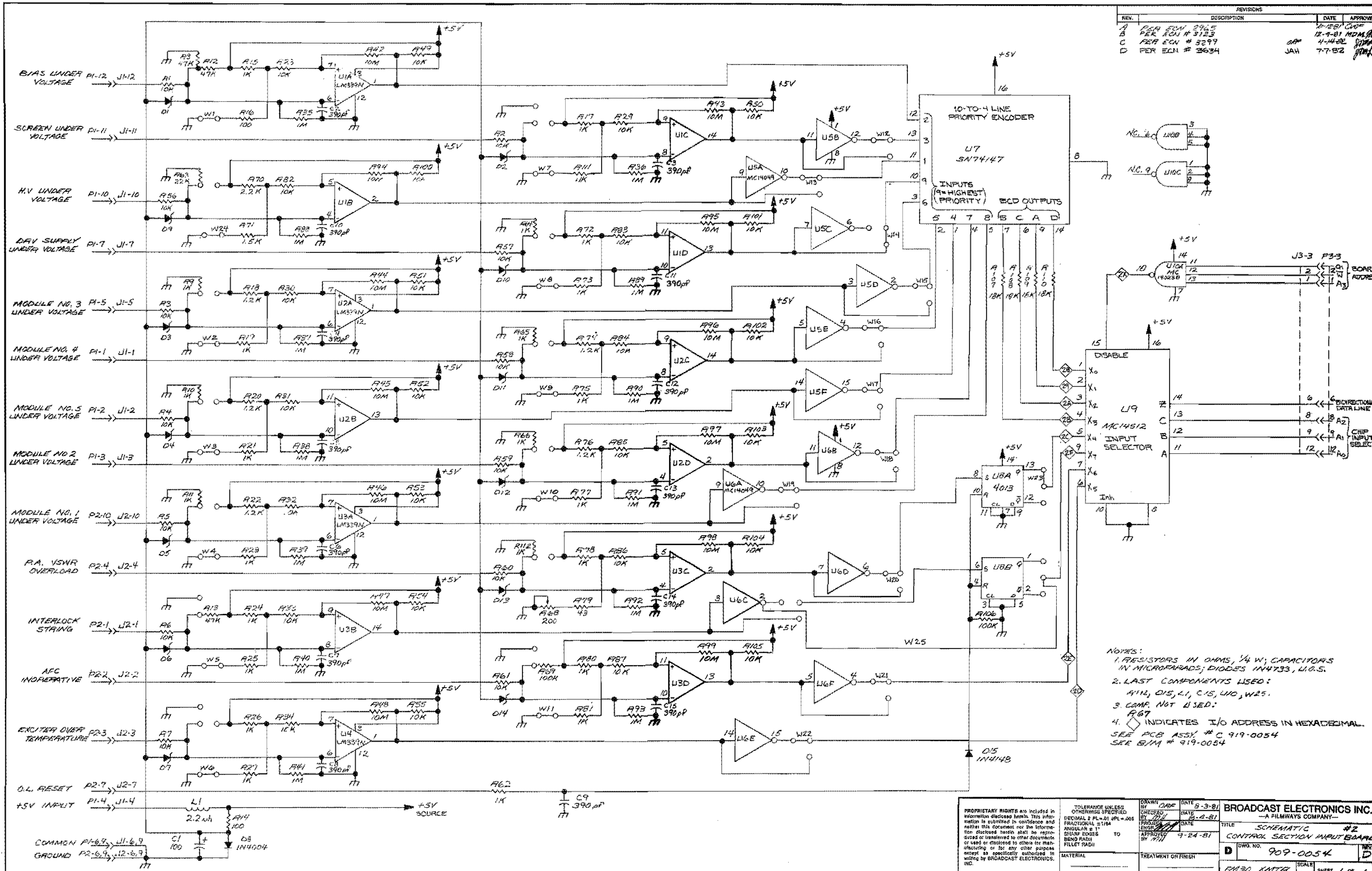
DRAWN BY ORF DATE 7-13-81
CHECKED BY MH DATE 7-14-81
PROJECT ENGR DATE
APPROVED BY MH 9-24-81

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY #1
CONTROL SECTION INPUT BOARD

C DWG. NO. 919-0030 REV. E

30 KW TRANSMITTER SCALE 2:1 SHEET 1 OF 1



REVISIONS
REV. | DESCRIPTION | DATE | APPROVED
A PER ECN 2965 10-12-81
B PER ECN # 3123 12-4-81 MDM
C PER ECN # 3299 GRF 4-14-82
D PER ECN # 3634 JAH 7-7-82
BIAS UNDER VOLTAGE P1-12 J1-12
SCREEN UNDER VOLTAGE P1-11 J1-11
H.V UNDER VOLTAGE P1-10 J1-10
DRV SUPPLY UNDER VOLTAGE P1-7 J1-7
MODULE NO. 3 UNDER VOLTAGE P1-5 J1-5
MODULE NO. 4 UNDER VOLTAGE P1-1 J1-1
MODULE NO. 5 UNDER VOLTAGE P1-2 J1-2
MODULE NO 2 UNDER VOLTAGE P1-3 J1-3
MODULE NO. 1 UNDER VOLTAGE P2-10 J2-10
P.A. VSWR OVERLOAD P2-4 J2-4
INTERLOCK STRING P2-1 J2-1
AFC INOPERATIVE P2-2 J2-2
EXCITER OVER TEMPERATURE P2-3 J2-3
O.L. RESET P2-7 J2-7
+5V INPUT P1-4 J1-4
+5V SOURCE
COMMON P1-6,9 J1-6,9
GROUND P2-6,9 J2-6,9
10-TO-4 LINE PRIORITY ENCODER
U7 SN74147
INPUTS (9 = HIGHEST PRIORITY)
BCD OUTPUTS
U9 MC14512 INPUT SELECTOR
DISABLE
U10A MC 14023B
BOARD ADDRESS
BIDIRECTIONAL DATA LINE
CHIP INPUT SELECT
D15 1N4148
D8 1N4004
NOTES:
1. RESISTORS IN OHMS, 1/4 W; CAPACITORS IN MICROFARADS; DIODES 1N4733, U.O.S.
2. LAST COMPONENTS USED: R112, D15, L1, C15, U10, W25.
3. COMP. NOT USED: R67
4. ◇ INDICATES I/O ADDRESS IN HEXADECIMAL.
SEE PCB ASSY. # C 919-0054
SEE B/M # 919-0054
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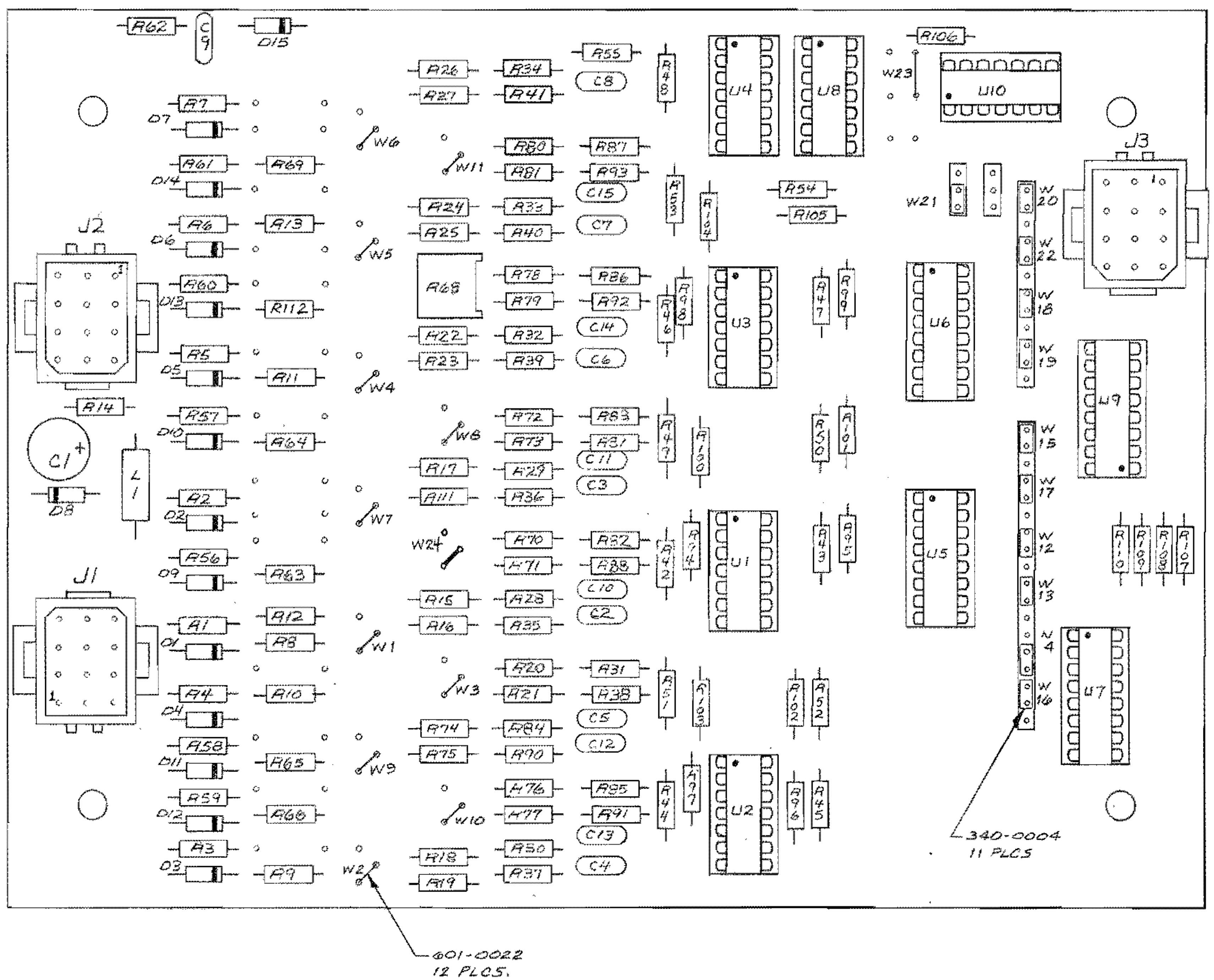
TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL ±.01 3PL ±.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII
MATERIAL
DRAWN BY GRF DATE 8-3-81
CHECKED BY DATE 8-4-81
PROJECT ENGR DATE
APPROVED BY 9-24-81
TREATMENT OR FINISH
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—
TITLE SCHEMATIC #2 CONTROL SECTION INPUT BOARD
D DWG. NO. 909-0054 REV. D
FM30 XMTR SCALE — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 2965	10-12-81	ORF
B	PER ECN # 3123	12-4-81	MDM
C	PER ECN # 3123 ECN DONE INCORRECTLY	12-15-81	MDM
D	PER ECN # 3299 ORF	4-14-82	



SEE B/M # 919-0054
SEE SCHEMATIC # D-909-0054

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

MATERIAL

DRAWN BY ORF DATE 8-11-81
CHECKED BY MH DATE 8-12-81
PROJECT ENGR. DATE
APPROVED BY MH 9-24-81

TREATMENT OR FINISH

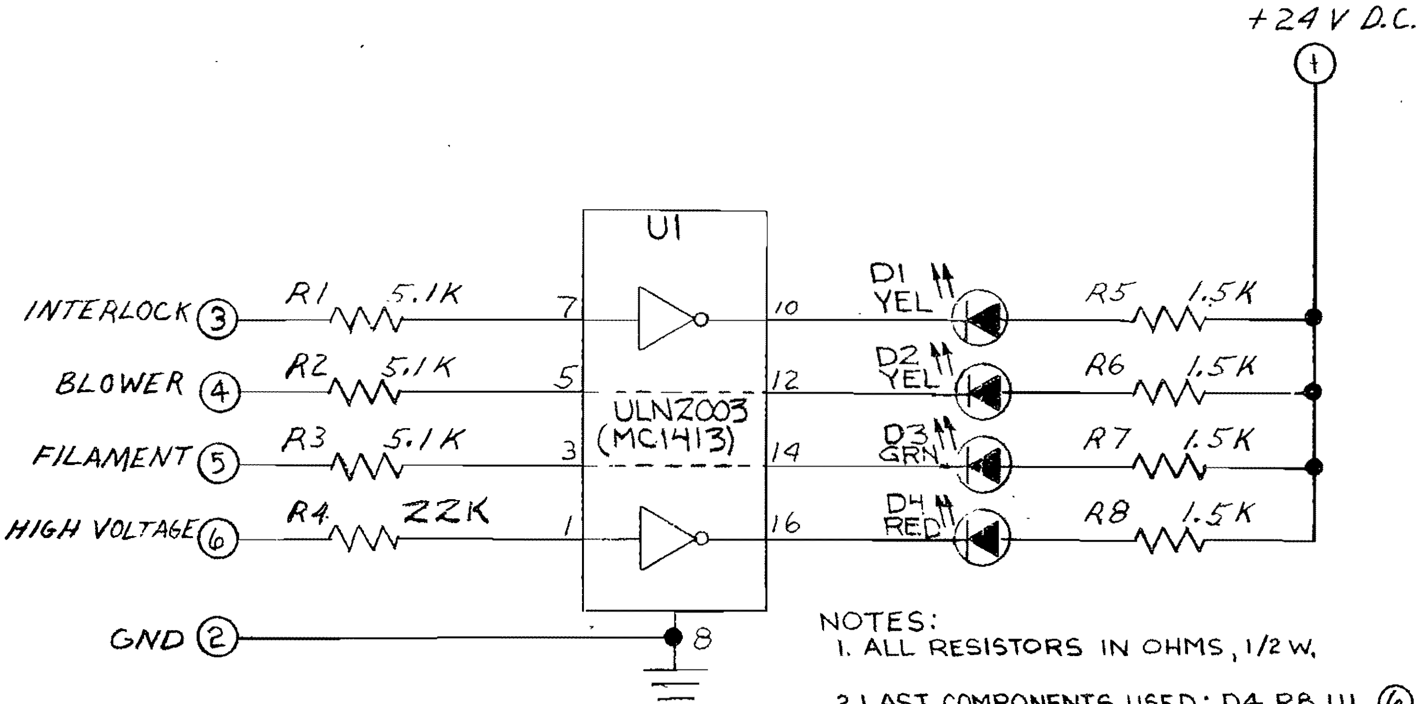
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY #2 CONTROL SECTION INPUT BOARD

C DWG. NO. 919-0054 REV. D

FM30 XMTR SCALE 2/1 SHEET 1 OF 1

REV.	DESCRIPTION		DATE	APPROVED
A	PER ECN # 3634	JAH	7-6-82	JML



NOTES:
1. ALL RESISTORS IN OHMS, 1/2 W.
2. LAST COMPONENTS USED: D4, R8, U1, (6).
3. SEE PCB ASSY # B-917-0027 & B/M # 917-0027.

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

MATERIAL

DRAWN BY J HEITZ	DATE 11-1-79
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	

TREATMENT OR FINISH

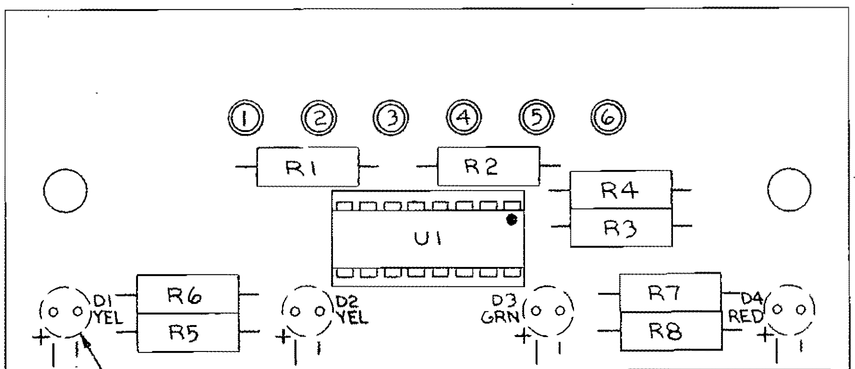
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC
PRIMARY FUNCTION INDICATOR

A DWG. NO. 909-0027 REV. A

30KW XMTR SCALE SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN # 3634 JAH	7-8-82	JTmk



D1 THRU D4 TO BE MOUNTED ON CIRCUIT SIDE.

SEE B/M # 917-0027
SEE SCHEMATIC # A-909-0027

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

MATERIAL

DRAWN BY M.HAYDEN	DATE 11-8-79
CHECKED BY	DATE
PROJECT ENGR.	DATE
APPROVED BY	
TREATMENT OR FINISH	

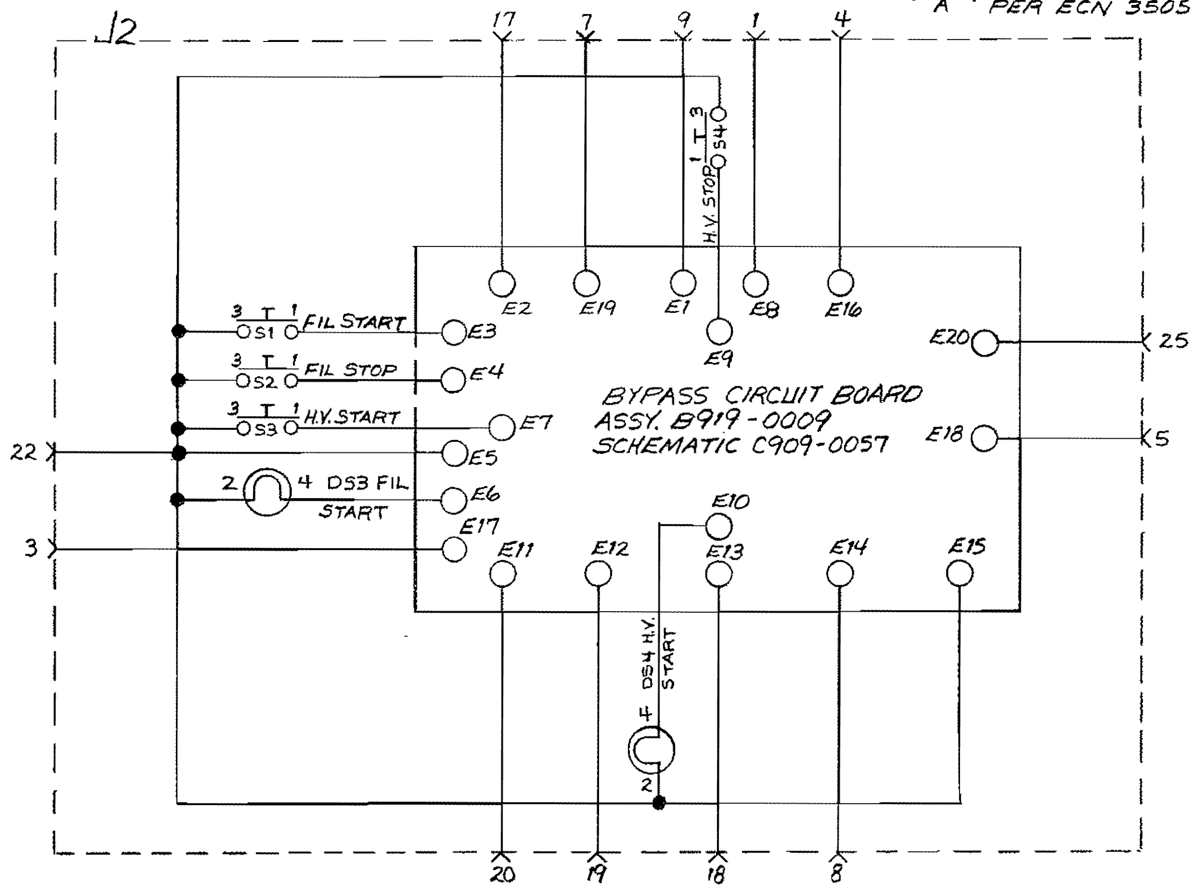
BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE PCB ASSEMBLY PRIMARY FUNCTION INDICATOR

B DWG. NO. 917-0027 REV. A

30KW XMTR SCALE 2/1 SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	PER ECN 3505 - REDRAWN ORF	6-16-82	



SEE B/M 959-0053

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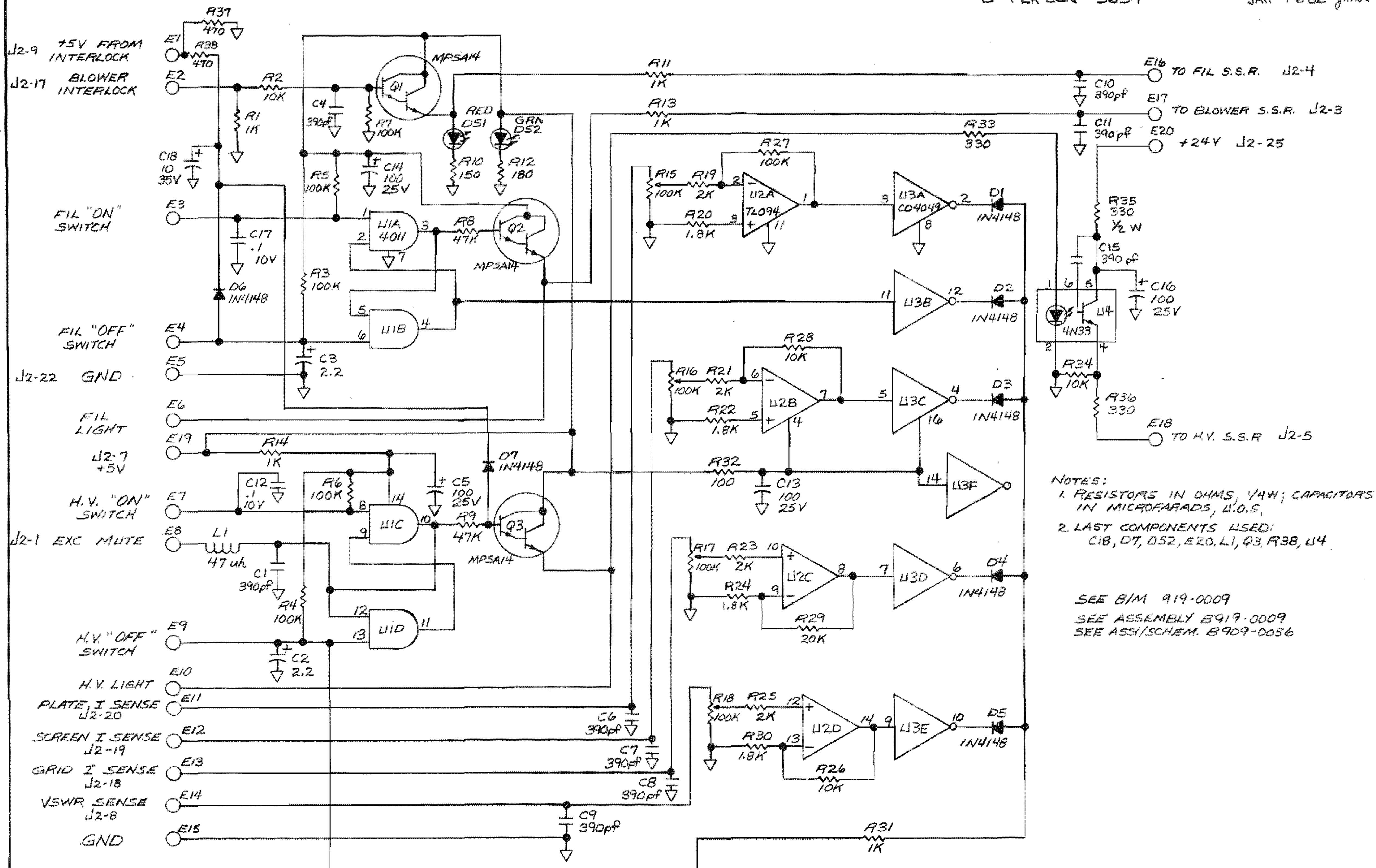
	MATERIAL	TREATMENT OR FINISH	TITLE SCHEMATIC MICROPROCESSOR BYPASS ASSY. B DWG. NO. 909-0056 REV. A SCALE — SHEET 1 OF 1

REV.	DESCRIPTION	DATE	APPROVED
C	REDRAWN & REVISED ECN#3505 ORF	4-7-82	
D	PER ECN# 3634 JAH	7-6-82	



NOTES:
1. RESISTORS IN OHMS, 1/4W; CAPACITORS IN MICROFARADS, U.O.S.
2. LAST COMPONENTS USED: C18, D7, DS2, E20, L1, Q3, R38, U4

SEE B/M 919-0009
SEE ASSEMBLY B919-0009
SEE ASSY/SCHEM. B909-0056

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

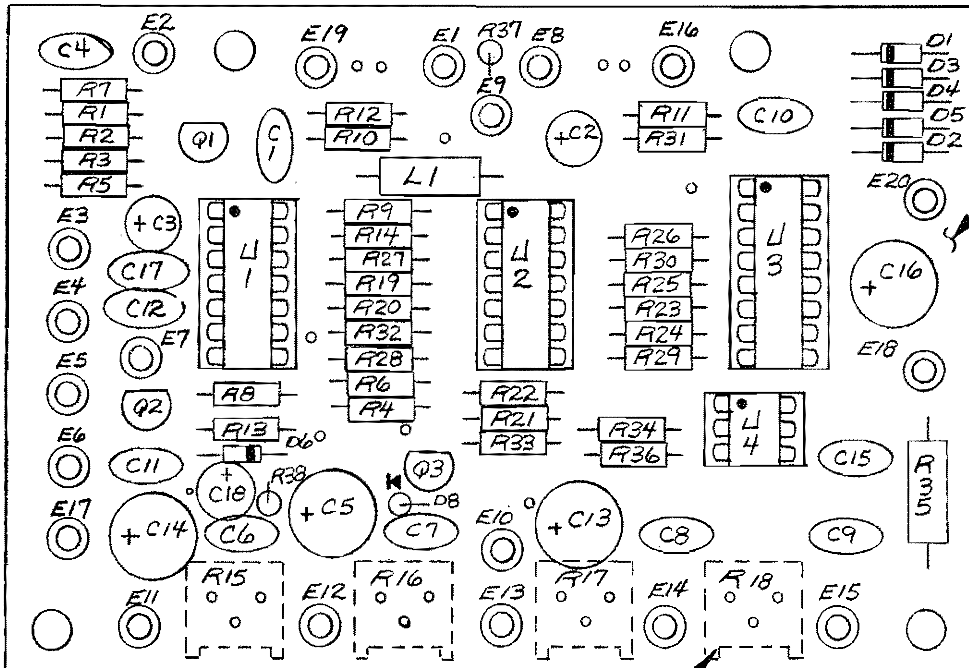
DRAWN BY ORF DATE 4-7-82
CHECKED BY DATE
PROJECT ENGR. DATE
APPROVED BY 4-7-82
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE SCHEMATIC
MICROPROCESSOR BYPASS

C DWG. NO. 909-0057 REV. D
FM-30 SCALE — SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	REDRAWN & REVISED ORF	4-6-82	
E	PARTS ADDED PER ECN 3505 ORF	4-27-82	



519-0009

R15 THRU R18 TO BE MOUNTED
ON SOLDER SIDE OF P.C. BOARD.

SEE B/M #919-0009

SEE SCHEMATIC #C909-0057
B909-0056

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

MATERIAL

DRAWN BY ORF	DATE 4-6-82		
CHECKED BY	DATE		
PROJECT ENGR.	DATE		
APPROVED BY MH	4-6-82		

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY - MICROPROCESSOR BYPASS

B DWG. NO. 919-0009 REV. E

FM-30 SCALE SHEET 1 OF 1

APPENDIX A

MICROPROCESSOR CONTROLLER MANUFACTURERS DATA

A-1. INTRODUCTION

A-2. This appendix provides the following technical data relative to the operation and maintenance of the FM-30 FM transmitter microprocessor controller. Information contained in this appendix is listed in the following order.

A. Technical Data Sheet, Motorola MC 14500B Industrial Control Unit.

B. Technical Data Sheet, Motorola MC 14599B, 8-Bit Addressable Latch.

C. Technical Data Sheet, Intel 2758 8K UV Erasable Low Power PROM

D. Instruction Sheet, Dialight 7 Segment Numeric Display, No. 730-6007.

E. Operating Specifications, Dialight 7 Segment Numeric Display (730-6001) and Decoder (704-1549).

3

MOTOROLA
SEMICONDUCTORS
3501 ED BLUESTEIN BLVD., AUSTIN, TEXAS 78721

MC14500B

CMOS LSI

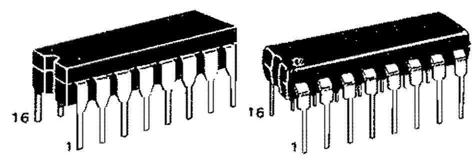
(LOW-POWER COMPLEMENTARY MOS)

INDUSTRIAL CONTROL UNIT

INDUSTRIAL CONTROL UNIT

The MC14500B Industrial Control Unit (ICU) is a single bit CMOS processor. The ICU is designed for use in systems requiring decisions based on successive single bit information. An external ROM stores the control program. With a program counter (and output latches and input multiplexers, if required) the ICU in a system forms a stored program controller that replaces combinatorial logic. Applications include relay logic processing, serial data manipulation and control. The ICU also may control an MPU or be controlled by an MPU.

- 16 Instructions
- DC to 1.0 MHz Operation at V_{DD} = 5 V
- On Chip Clock (Oscillator)
- Executes One Instruction per Clock Cycle
- 3 V to 18 V Operation
- Noise Immunity Typically 45% of V_{DD}
- Quiescent Current 5.0 μAdc Typical at V_{DD} = 5 V
- Capable of Driving One Low-Power Schottky Load or Two Low-Power TTL Loads over Full Temperature Range



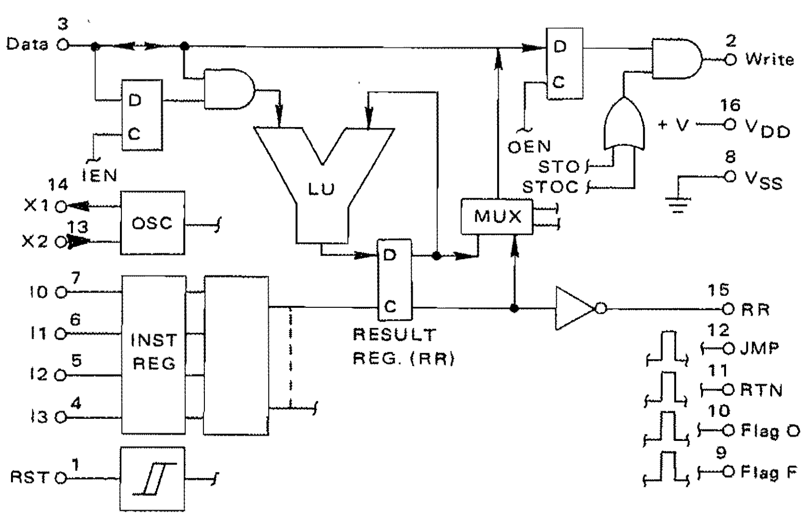
L SUFFIX	P SUFFIX
CERAMIC PACKAGE	PLASTIC PACKAGE
CASE 620	CASE 648

ORDERING INFORMATION

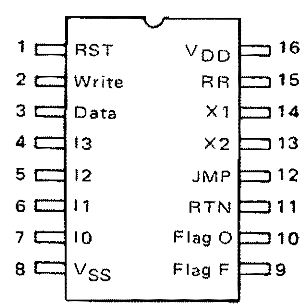
MC14XXXB — Suffix Denotes
- L Ceramic Package
- P Plastic Package
- A Extended Operating Temperature Range
- C Limited Operating Temperature Range

Detailed operation and applications are given in the "MC14500B Industrial Control Unit" handbook.

BLOCK DIAGRAM



PIN ASSIGNMENT



MAXIMUM RATINGS (Voltages referenced to V_{SS})

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	-0.5 to +18	Vdc
Input Voltage, All Inputs	V_{in}	-0.5 to V_{DD} + 0.5	Vdc
DC Current Drain per Pin	I	10	mAdc
Operating Temperature Range — AL Device CL/CP Device	T_A	-55 to +125 -40 to +85	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$.

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	V_{DD} Vdc	T_{low}* Min	T_{low}* Max	25°C Min	25°C Typ	25°C Max	T_{high}* Min	T_{high}* Max	Unit
Output Voltage	"0" Level	V_{OL}	5.0	–	0.05	–	0	0.05	–	0.05	Vdc
V_{in} = V_{DD} or 0			10	–	0.05	–	0	0.05	–	0.05	
			15	–	0.05	–	0	0.05	–	0.05	
	"1" Level	V_{OH}	5.0	4.95	–	4.95	5.0	–	4.95	–	Vdc
V_{in} = 0 or V_{DD}			10	9.95	–	9.95	10	–	9.95	–	
			15	14.95	–	14.95	15	–	14.95	–	
Input Voltage # RST, D, X2	"0 Level"	V_{IL}									Vdc
(V_O = 4.5 or 0.5 Vdc)			5.0	–	1.5	–	2.25	1.5	–	1.5	
(V_O = 9.0 or 1.0 Vdc)			10	–	3.0	–	4.50	3.0	–	3.0	
(V_O = 13.5 or 1.5 Vdc)			15	–	4.0	–	6.75	4.0	–	4.0	
	"1" Level	V_{IH}									Vdc
(V_O = 0.5 or 4.5 Vdc)			5.0	3.5	–	3.5	2.75	–	3.5	–	
(V_O = 1.0 or 9.0 Vdc)			10	7.0	–	7.0	5.50	–	7.0	–	
(V_O = 1.5 or 13.5 Vdc)			15	11.0	–	11.0	8.25	–	11.0	–	
Input Voltage # I0, I1, I2, I3	"0" Level	V_{IL}									Vdc
(V_O = 4.5 or 0.5 Vdc)			5.0	–	0.8	–	1.1	0.8	–	0.8	
(V_O = 9.0 or 1.0 Vdc)			10	–	1.6	–	2.2	1.6	–	1.6	
(V_O = 13.5 or 1.5 Vdc)			15	–	2.4	–	3.4	2.4	–	2.4	
	"1" Level	V_{IH}									Vdc
(V_O = 0.5 or 4.5 Vdc)			5.0	2.0	–	2.0	1.9	–	2.0	–	
(V_O = 1.0 or 9.0 Vdc)			10	6.0	–	6.0	3.1	–	6.0	–	
(V_O = 1.5 or 13.5 Vdc)			15	10	–	10	4.3	–	10	–	
Output Drive Current Data, Write (AL/CL/CP Device)	Source	I_{OH}									mAdc
(V_{OH} = 4.6 Vdc)			5.0	-1.0	–	-1.0	-2.0	–	-1.0	–	
(V_{OH} = 9.5 Vdc)			10	–	–	–	-6.0	–	–	–	
(V_{OH} = 13.5 Vdc)			15	–	–	–	-12	–	–	–	
(V_{OL} = 0.4 Vdc)	Sink	I_{OL}	5.0	1.6	–	1.6	3.2	–	1.6	–	mAdc
(V_{OL} = 0.5 Vdc)			10	–	–	–	6.0	–	–	–	
(V_{OL} = 1.5 Vdc)			15	–	–	–	12	–	–	–	
Output Drive Current Other Outputs (AL Device)	Source	I_{OH}									mAdc
(V_{OH} = 2.5 Vdc)			5.0	-3.0	–	-2.4	-4.2	–	-1.7	–	
(V_{OH} = 4.6 Vdc)			5.0	-0.64	–	-0.51	-0.88	–	-0.36	–	
(V_{OH} = 9.5 Vdc)			10	-1.6	–	-1.3	-2.25	–	-0.9	–	
(V_{OH} = 13.5 Vdc)			15	-4.2	–	-3.4	8.8	–	-2.4	–	
(V_{OL} = 0.4 Vdc)	Sink	I_{OL}	5.0	0.64	–	0.51	0.88	–	0.36	–	mAdc
(V_{OL} = 0.5 Vdc)			10	1.6	–	1.3	2.25	–	0.9	–	
(V_{OL} = 1.5 Vdc)			15	4.2	–	3.4	8.8	–	2.4	–	
Output Drive Current Other Outputs (CL/CP Device)	Source	I_{OH}									mAdc
(V_{OH} = 2.5 Vdc)			5.0	-2.5	–	-2.1	-4.2	–	-1.7	–	
(V_{OH} = 4.6 Vdc)			5.0	-0.52	–	-0.44	-0.88	–	-0.36	–	
(V_{OH} = 9.5 Vdc)			10	-1.3	–	-1.1	-2.25	–	-0.9	–	
(V_{OH} = 13.5 Vdc)			15	-3.6	–	-3.0	-8.8	–	-2.4	–	
(V_{OL} = 0.4 Vdc)	Sink	I_{OL}	5.0	0.52	–	0.44	0.88	–	0.36	–	mAdc
(V_{OL} = 0.5 Vdc)			10	1.3	–	1.1	2.25	–	0.9	–	
(V_{OL} = 1.5 Vdc)			15	3.6	–	3.0	8.8	–	2.4	–	

ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Symbol	V_{DD} Vdc	T_{low}* Min	T_{low}* Max	25°C Min	25°C Typ	25°C Max	T_{high}* Min	T_{high}* Max	Unit
Input Current, RST (AL/CL/CP Device)	I_{in}	15	25	—	—	150	—	—	250	μAdc
Input Current (AL Device)	I_{in}	15	—	±0.1	—	±0.00001	±0.1	—	±1.0	μAdc
Input Current (CL/CP Device)	I_{in}	15	—	±0.3	—	±0.00001	±0.3	—	±1.0	μAdc
Input Capacitance (Data)	C_{in}	—	—	—	—	15	—	—	—	pF
Input Capacitance (All Other Inputs) (V_{in} = 0)	C_{in}	—	—	—	—	5.0	7.5	—	—	pF
Quiescent Current (AL Device) (Per Package)	I_{DD}	5.0 10 15	— — —	5.0 10 20	— — —	0.005 0.010 0.015	5.0 10 20	— — —	150 300 600	μAdc
Quiescent Current (CL/CP Device) (Per Package)	I_{DD}	5.0 10 15	— — —	20 40 80	— — —	0.005 0.010 0.015	20 40 80	— — —	150 300 600	μAdc
**Total Supply Current at an External Load Capacitance (C_L) on All Outputs	I_T	—	I_T = (1.5 μA/kHz) f + I_{DD} I_T = (3.0 μA/kHz) f + I_{DD} I_T = (4.5 μA/kHz) f + I_{DD}							μAdc

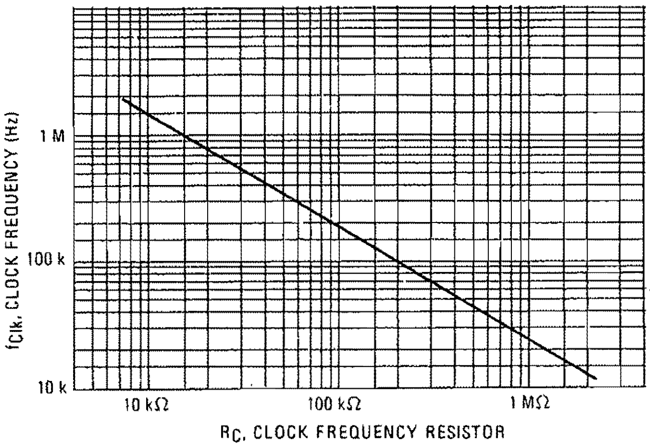
* T_{low} = −55°C for AL Device, −40°C for CL/CP Device.
T_{high} = +125°C for AL Device, +85°C for CL/CP Device.
** The formulas given are for the typical characteristics only at 25°C.
\# Noise immunity specified for worst-case input combination.

SWITCHING CHARACTERISTICS (T_A = 25°C; t_r = t_f = 20 ns for X and I inputs; C_L = 50 pF for JMP, X1, RR, Flag O, Flag F; C_L = 130 pF + 1TTL load for Data and Write.)

Characteristic	Symbol	V_{DD} Vdc	All Types Min	All Types Typ	All Types Max	Unit
Propagation Delay Time X1 to RR	t_{dR}	5.0 10 15	— — —	250 125 100	500 250 200	ns
X1 to Flag F, Flag O, RTN, JMP	t_{dF}	5.0 10 15	— — —	200 100 85	400 200 170	ns
X1 to Write	t_{dW}	5.0 10 15	— — —	225 125 100	450 250 200	ns
X1 to Data	t_{dD}	5.0 10 15	— — —	250 120 100	500 240 200	ns
RST to RR	t_{dRRR}	5.0 10 15	— — —	250 125 100	500 250 200	ns
RST to X1	t_{dRX}	5.0 10 15	— — —	450 200 150	Note 1	ns
RST to Flag F, Flag O, RTN, JMP	t_{dRF}	5.0 10 15	— — —	400 200 150	800 400 300	ns
RST to Write, Data	t_{dRW}	5.0 10 15	— — —	450 225 175	900 450 350	ns
Minimum Clock Pulse Width, X1	PW_C	5.0 10 15	— — —	200 100 90	400 200 180	ns
Minimum Reset Pulse Width, RST	PW_R	5.0 10 15	— — —	250 125 100	500 250 200	ns
Setup Time — Instruction	t_{IS}	5.0 10 15	400 250 180	200 125 90	— — —	ns
Data	t_{DS}	5.0 10 15	200 100 80	100 50 40	— — —	ns
Hold Time — Instruction	t_{IH}	5.0 10 15	100 50 50	0 0 0	— — —	ns
Data	t_{DH}	5.0 10 15	200 100 100	100 50 50	— — —	ns

NOTE 1. Maximum Reset Delay may extend to one-half clock period.

FIGURE 1 – TYPICAL CLOCK FREQUENCY versus RESISTOR (R_C)

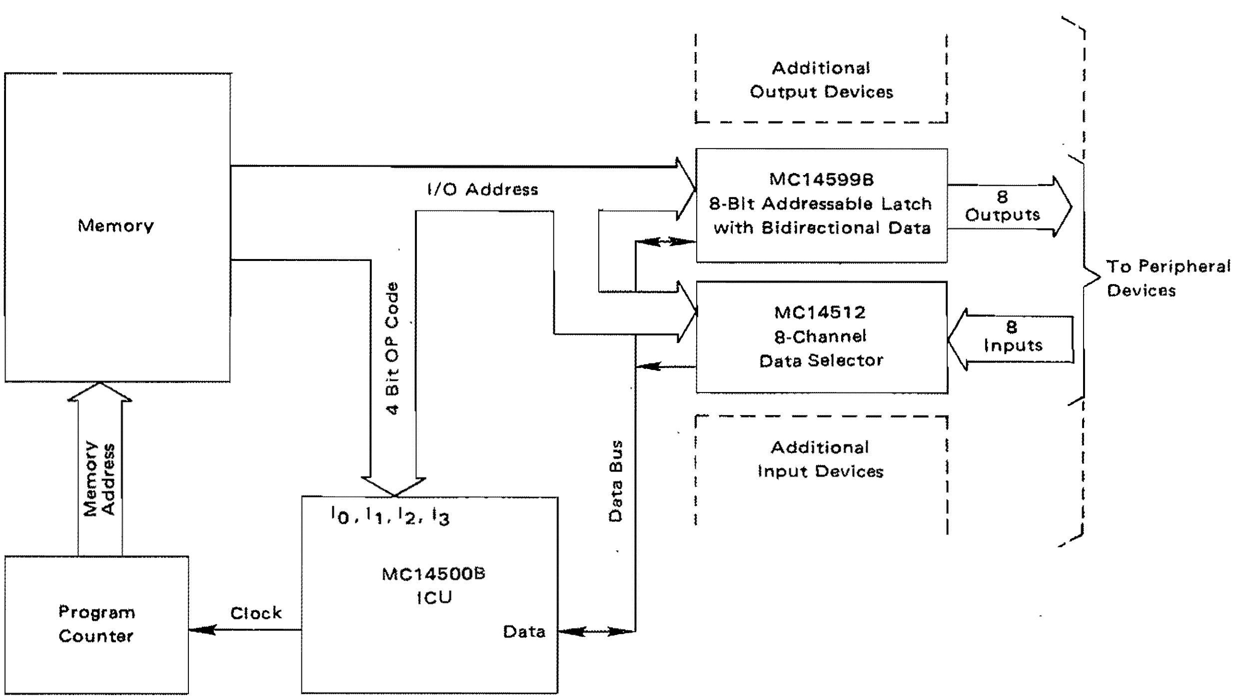


Pin No.	Function	Symbols
1	Chip Reset	RST
2	Write Pulse	Write
3	Data In/Out	Data
4	MSB Instruction Word	I_3
5	Bit 2 Instruction Word	I_2
6	Bit 1 Instruction Word	I_1
7	LSB Instruction Word	I_0
8	Negative Supply (Ground)	V_{SS}
9	Flag on NOP F	Flag F
10	Flag on NOP O	Flag O
11	Subroutine Return Flag	RTN
12	Jump Instruction Flag	JMP
13	Oscillator Input	X2
14	Oscillator Output	X1
15	Result Register	RR
16	Positive Supply	V_{DD}

TABLE 1. MC14500B INSTRUCTION SET

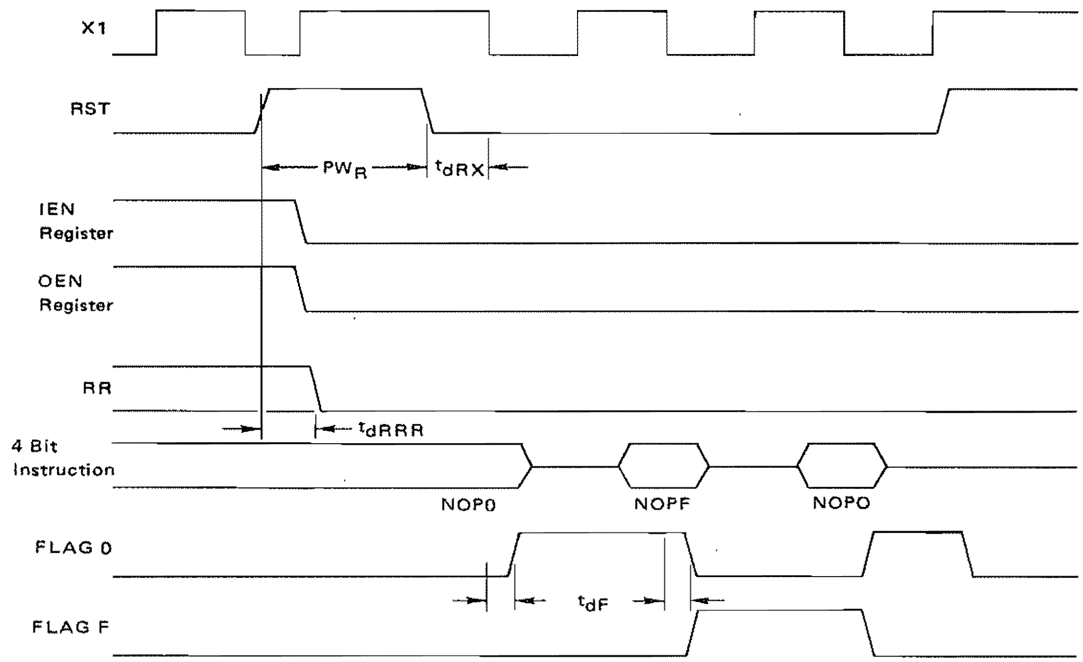
Instruction Code		Mnemonic	Action
0	0000	NOPO	No change in registers. RR → RR, Flag O → ⎍
1	0001	LD	Load result register. Data → RR
2	0010	LDC	Load complement. $\overline{\text{Data}}$ → RR
3	0011	AND	Logical AND. RR · Data → RR
4	0100	ANDC	Logical AND complement. RR · $\overline{\text{Data}}$ → RR
5	0101	OR	Logical OR. RR + Data → RR
6	0110	ORC	Logical OR complement. RR + $\overline{\text{Data}}$ → RR
7	0111	XNOR	Exclusive NOR. If RR = Data, RR → 1
8	1000	STO	Store. RR → Data Pin, Write → ⎍
9	1001	STOC	Store complement. $\overline{\text{RR}}$ → Data Pin, Write → ⎍
A	1010	IEN	Input enable. Data → IEN Register
B	1011	OEN	Output enable. Data → OEN Register
C	1100	JMP	Jump. JMP Flag → ⎍
D	1101	RTN	Return. RTN Flag → ⎍ and skip next instruction
E	1110	SKZ	Skip next instruction if RR = 0
F	1111	NOPF	No change in registers. RR → RR, Flag F → ⎍

FIGURE 2 – OUTLINE OF A TYPICAL ORGANIZATION FOR A MC14500B-BASED SYSTEM

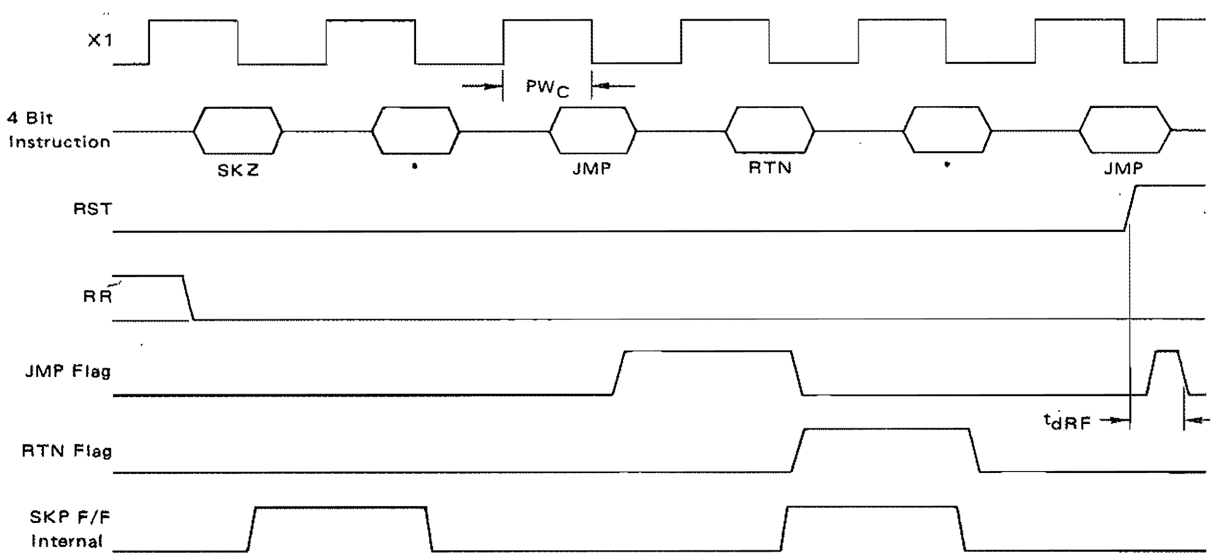


TIMING WAVEFORMS

Instructions NOPO, NOPF
RR, IEN, OEN remain unaffected



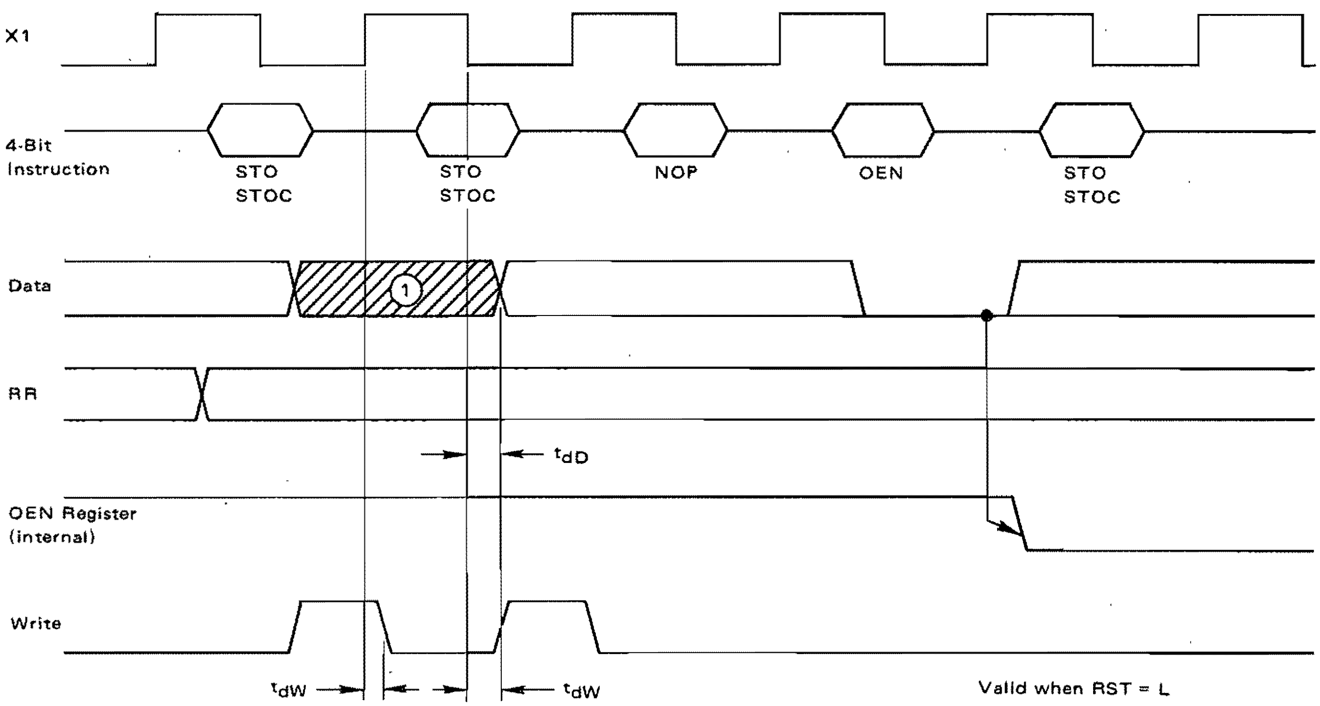
Instructions SKZ, JMP, RTN
RR, IEN, OEN remain unaffected



*Instructions Ignored.

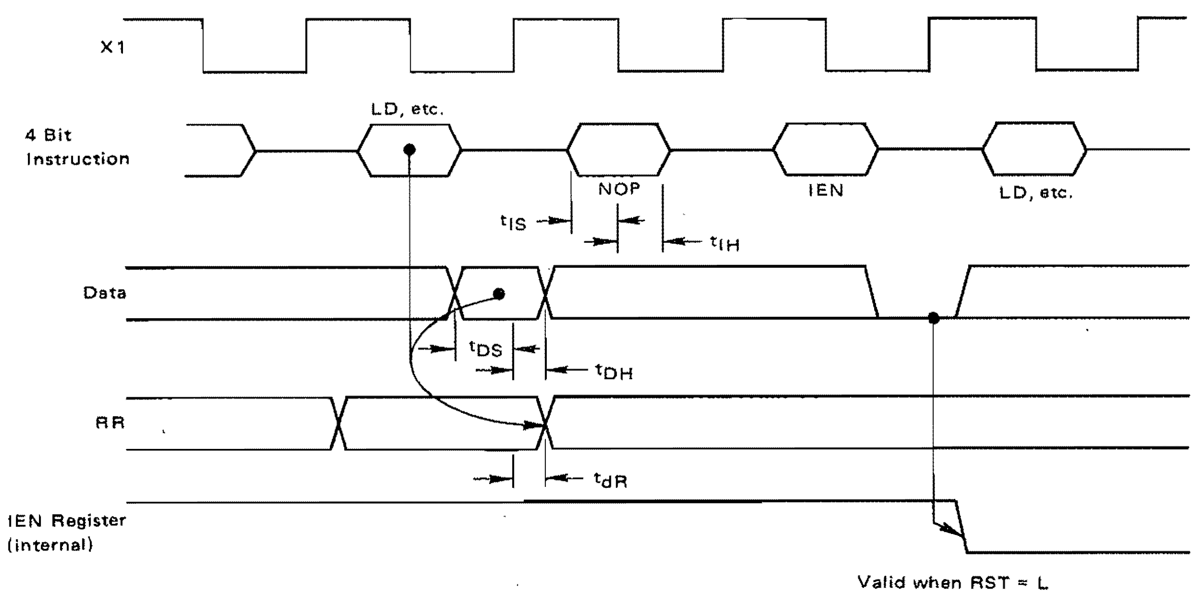
TIMING WAVEFORMS

Instructions STO, STOC, OEN



NOTE 1. Valid output data.

Instructions LD, LDC, AND, ANDC OR, ORC, XNOR, IEN



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MOTOROLA
SEMICONDUCTORS
3501 ED BLUESTEIN BLVD., AUSTIN, TEXAS 78721

MC14099B
MC14599B

8-BIT ADDRESSABLE LATCHES

The MC14099B and MC14599B are 8-bit addressable latches. Data is entered in serial form when the appropriate latch is addressed (via address pins A0, A1, A2) and write disable is in the low state. Chip enable must be high for writing into MC14599B. For the MC14599B the data pin is a bidirectional data port and for the MC14099B the input is a unidirectional write only port. The Write/$\overline{\text{Read}}$ line controls this port in the MC14599B.

The data is presented in parallel at the output of the eight latches independently of the state of Write Disable, Write/$\overline{\text{Read}}$ or Chip Enable.

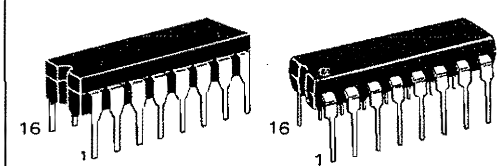
A Master Reset capability is available on both parts.

- Serial Data Input
- Parallel Output
- Low Input Capacitance – 5.0 pF typical
- Master Reset
- Noise Immunity – 45% of V_{DD} typical
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-Power TTL Loads, One Low-Power Schottky TTL Load or Two HTL Loads over the Rated Temperature Range
- MC14099B pin for pin compatible with CD4099B

CMOS MSI
(LOW-POWER COMPLEMENTARY MOS)

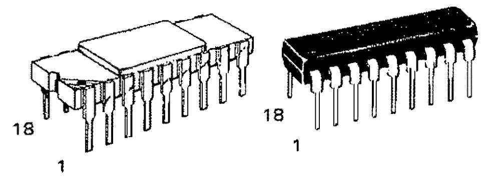
8-BIT ADDRESSABLE LATCH

MC14599B WITH BIDIRECTIONAL PORT



L SUFFIX CERAMIC PACKAGE CASE 620

P SUFFIX PLASTIC PACKAGE CASE 648



L SUFFIX CERAMIC PACKAGE CASE 680

P SUFFIX PLASTIC PACKAGE CASE 707

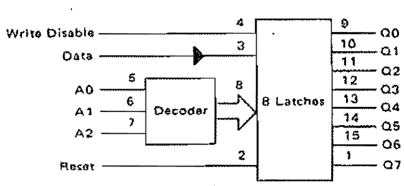
ORDERING INFORMATION

MC14XXXB — Suffix Denotes
- L Ceramic Package
- P Plastic Package
- A Extended Operating Temperature Range
- C Limited Operating Temperature Range

MAXIMUM RATINGS (Voltages referenced to V_{SS})

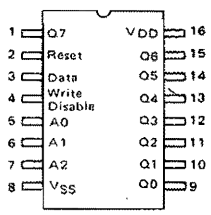
Rating	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	-0.5 to +18	Vdc
Input Voltage, All Inputs	V_{in}	-0.5 to V_{DD} + 0.5	Vdc
DC Current Drain per Pin	I	10	mAdc
Operating Temperature Range – AL Device CL/CP Device	T_A	-55 to +125 -40 to +85	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

MC14099B

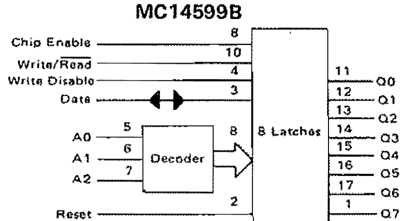


V_{DD} = 16
V_{SS} = 8

PIN ASSIGNMENT

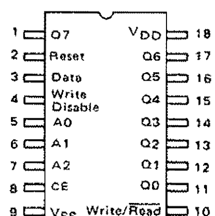


MC14599B



V_{DD} = 18
V_{SS} = 9

PIN ASSIGNMENT



This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V_{DD} Vdc	T_{low}* Min	T_{low}* Max	25°C Min	25°C Typ	25°C Max	T_{high}* Min	T_{high}* Max	Unit
Output Voltage "0" Level	V_{OL}	5.0	–	0.05	–	0	0.05	–	0.05	Vdc
$V_{in} = V_{DD}$ or 0		10	–	0.05	–	0	0.05	–	0.05	
		15	–	0.05	–	0	0.05	–	0.05	
"1" Level	V_{OH}	5.0	4.95	–	4.95	5.0	–	4.95	–	Vdc
$V_{in} = 0$ or V_{DD}		10	9.95	–	9.95	10	–	9.95	–	
		15	14.95	–	14.95	15	–	14.95	–	
Input Voltage# "0" Level	V_{IL}									Vdc
(V_O = 4.5 or 0.5 Vdc)		5.0	–	1.5	–	2.25	1.5	–	1.5	
(V_O = 9.0 or 1.0 Vdc)		10	–	3.0	–	4.50	3.0	–	3.0	
(V_O = 13.5 or 1.5 Vdc)		15	–	4.0	–	6.75	4.0	–	4.0	
"1" Level	V_{IH}									Vdc
(V_O = 0.5 or 4.5 Vdc)		5.0	3.5	–	3.5	2.75	–	3.5	–	
(V_O = 1.0 or 9.0 Vdc)		10	7.0	–	7.0	5.50	–	7.0	–	
(V_O = 1.5 or 13.5 Vdc)		15	11.0	–	11.0	8.25	–	11.0	–	
Output Drive Current (AL Device)	I_{OH}									mAdc
(V_{OH} = 2.5 Vdc) Source		5.0	-3.0	–	-2.4	-4.2	–	-1.7	–	
(V_{OH} = 4.6 Vdc)		5.0	-0.64	–	-0.51	-0.88	–	-0.36	–	
(V_{OH} = 9.5 Vdc)		10	-1.6	–	-1.3	-2.25	–	-0.9	–	
(V_{OH} = 13.5 Vdc)		15	-4.2	–	-3.4	-8.8	–	-2.4	–	
(V_{OL} = 0.4 Vdc) Sink	I_{OL}	5.0	0.64	–	0.51	0.88	–	0.36	–	mAdc
(V_{OL} = 0.5 Vdc)		10	1.6	–	1.3	2.25	–	0.9	–	
(V_{OL} = 1.5 Vdc)		15	4.2	–	3.4	8.8	–	2.4	–	
Output Drive Current (CL/CP Device)	I_{OH}									mAdc
(V_{OH} = 2.5 Vdc) Source		5.0	-2.5	–	-2.1	-4.2	–	-1.7	–	
(V_{OH} = 4.6 Vdc)		5.0	-0.52	–	-0.44	-0.88	–	-0.36	–	
(V_{OH} = 9.5 Vdc)		10	-1.3	–	-1.1	-2.25	–	-0.9	–	
(V_{OH} = 13.5 Vdc)		15	-3.6	–	-3.0	-8.8	–	-2.4	–	
(V_{OL} = 0.4 Vdc) Sink	I_{OL}	5.0	0.52	–	0.44	0.88	–	0.36	–	mAdc
(V_{OL} = 0.5 Vdc)		10	1.3	–	1.1	2.25	–	0.9	–	
(V_{OL} = 1.5 Vdc)		15	3.6	–	3.0	8.8	–	2.4	–	
Input Current (AL Device)	I_{in}	15	–	±0.1	–	±0.00001	±0.1	–	±1.0	μAdc
Input Current (CL/CP Device)	I_{in}	15	–	±0.3	–	±0.00001	±0.3	–	±1.0	μAdc
Input Capacitance (V_{in} = 0)	C_{in}	–	–	–	–	5.0	7.5	–	–	pF
Input Capacitance MC14599B – Data (pin 3) (V_{in} = 0)	C_{in}	–	–	–	–	15.0	22.5	–	–	pF
Quiescent Current (AL Device) (Per Package)	I_{DD}	5.0	–	5.0	–	0.005	5.0	–	150	μAdc
		10	–	10	–	0.010	10	–	300	
		15	–	20	–	0.015	20	–	600	
Quiescent Current (CL/CP Device) (Per Package)	I_{DD}	5.0	–	20	–	0.005	20	–	150	μAdc
		10	–	40	–	0.010	40	–	300	
		15	–	80	–	0.015	80	–	600	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) (C_L = 50 pF on all outputs, all buffers switching)	I_T	5.0	$I_T = (1.5\ \mu A/kHz)\ f + I_{DD}$							μAdc
		10	$I_T = (3.0\ \mu A/kHz)\ f + I_{DD}$							
		15	$I_T = (4.5\ \mu A/kHz)\ f + I_{DD}$							

*T_{low} = -55°C for AL Device, -40°C for CL/CP Device.
T_{high} = +125°C for AL Device, +85°C for CL/CP Device.

#Noise immunity specified for worst-case input combination.
Noise Margin for both "1" and "0" level =
1.0 Vdc min @ V_{DD} = 5.0 Vdc
2.0 Vdc min @ V_{DD} = 10 Vdc
2.5 Vdc min @ V_{DD} = 15 Vdc

†To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50\ pF) + 4 \times 10^{-3} (C_L - 50)\ V_{DD} f$$

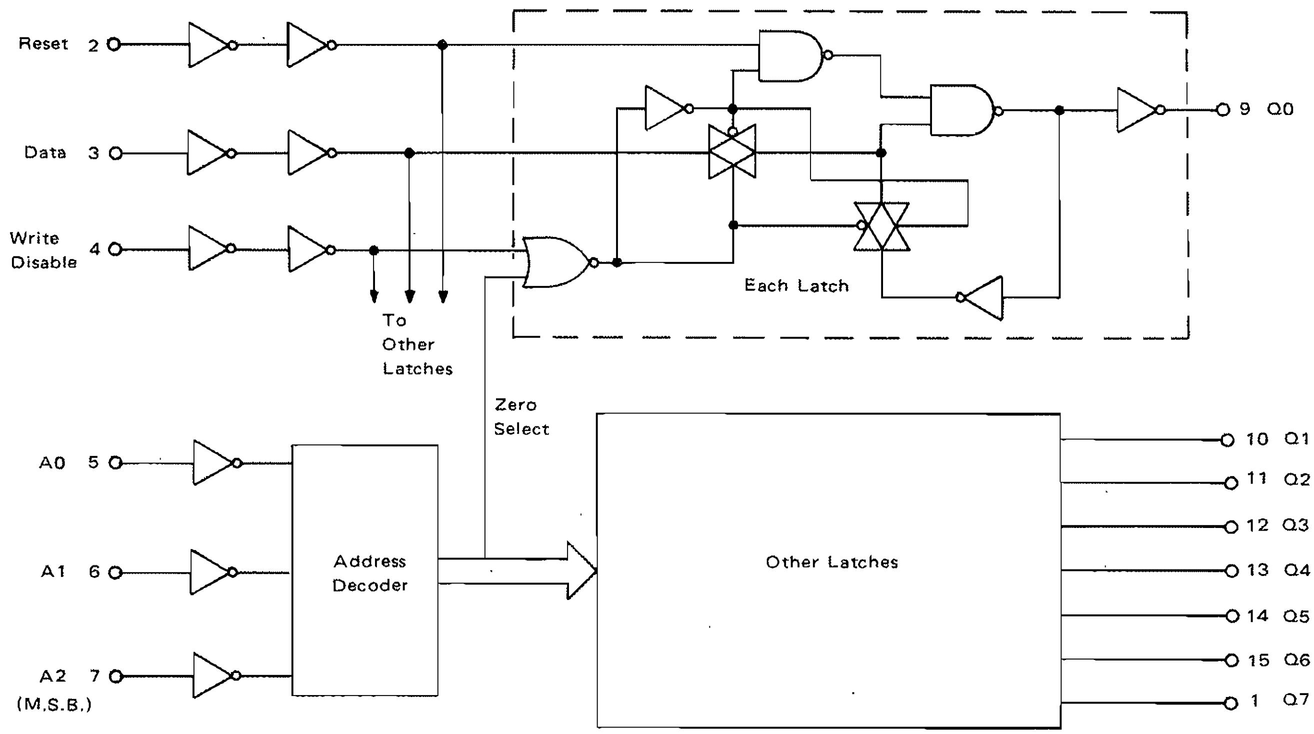
where: I_T is in μA (per package), C_L in pF, V_{DD} in Vdc, and f in kHz is input frequency.

**The formulas given are for the typical characteristics only at 25°C.

SWITCHING CHARACTERISTICS (C_L = 50 pF, T_A = 25°C)

Characteristic	Symbol	V_{DD} Vdc	Min	Typ	Max	Unit
Output Rise and Fall Time	t_r, t_f					ns
t_r, t_f = (1.35 ns/pF) C_L +32 ns		5.0	–	100	200	
t_r, t_f = (0.6 ns/pF) C_L +20 ns		10	–	50	100	
t_r, t_f = (0.4 ns/pF) C_L +20 ns		15	–	40	80	
Propagation Delay Time	t_{dDQ}					ns
Data to Output		5.0	–	200	400	
		10	–	75	150	
		15	–	50	100	
Write Disable to Output	t_{dQ}	5.0	–	200	450	ns
		10	–	80	200	
		15	–	60	150	
Reset to Output	t_{dR}	5.0	–	175	350	ns
		10	–	80	160	
		15	–	65	130	
Address, CE to Output	t_{dAQ}	5.0	–	225	500	ns
		10	–	100	230	
		15	–	75	160	
Propagation Delay Time, MC14599B only	t_{dED}					ns
Chip Enable, Write/$\overline{\text{Read}}$ to Data		5.0	–	200	400	
		10	–	80	160	
		15	–	65	130	
Address to Data	t_{dAD}	5.0	–	200	400	ns
		10	–	90	180	
		15	–	75	150	
Minimum Pulse Widths	t_{WD}					ns
Data		5.0	200	100	–	
		10	100	50	–	
		15	80	40	–	
Address	t_{WA}	5.0	400	200	–	ns
		10	200	100	–	
		15	125	65	–	
Reset	t_{WR}	5.0	150	75	–	ns
		10	75	40	–	
		15	50	25	–	
Write Disable	t_{WWD}	5.0	320	160	–	ns
		10	160	80	–	
		15	120	60	–	
Set Up Time	t_{DS}					ns
Data		5.0	100	50	–	
		10	50	25	–	
		15	35	20	–	
Hold Time	t_{DH}					ns
Data		5.0	150	75	–	
		10	75	40	–	
		15	50	25	–	

MC14099B
FUNCTION DIAGRAM

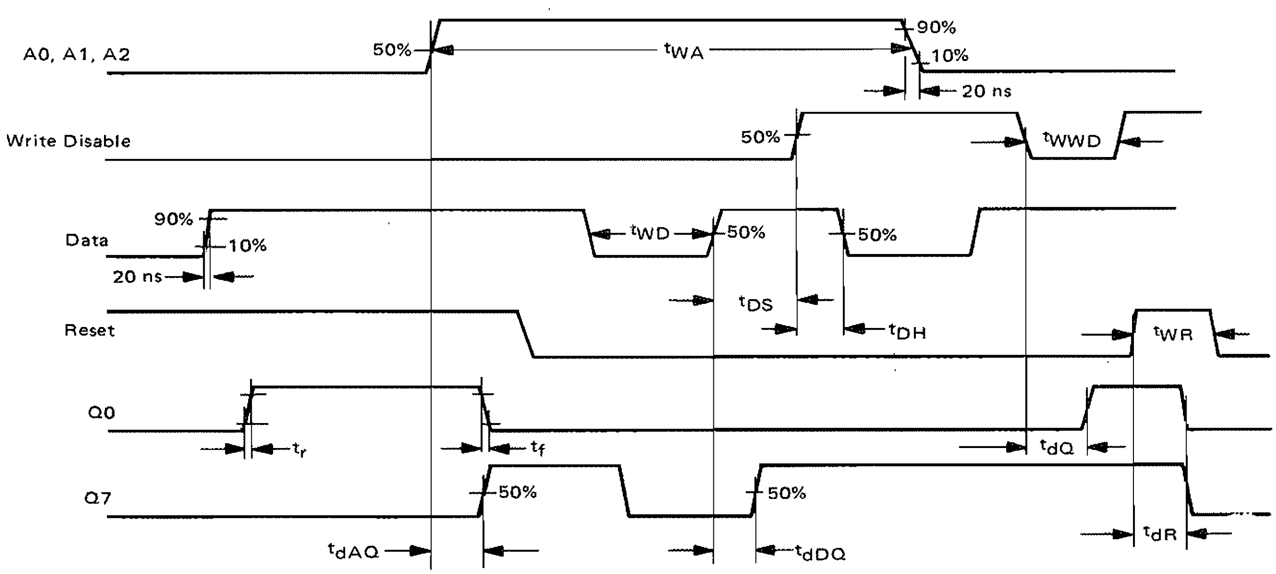


TRUTH TABLE

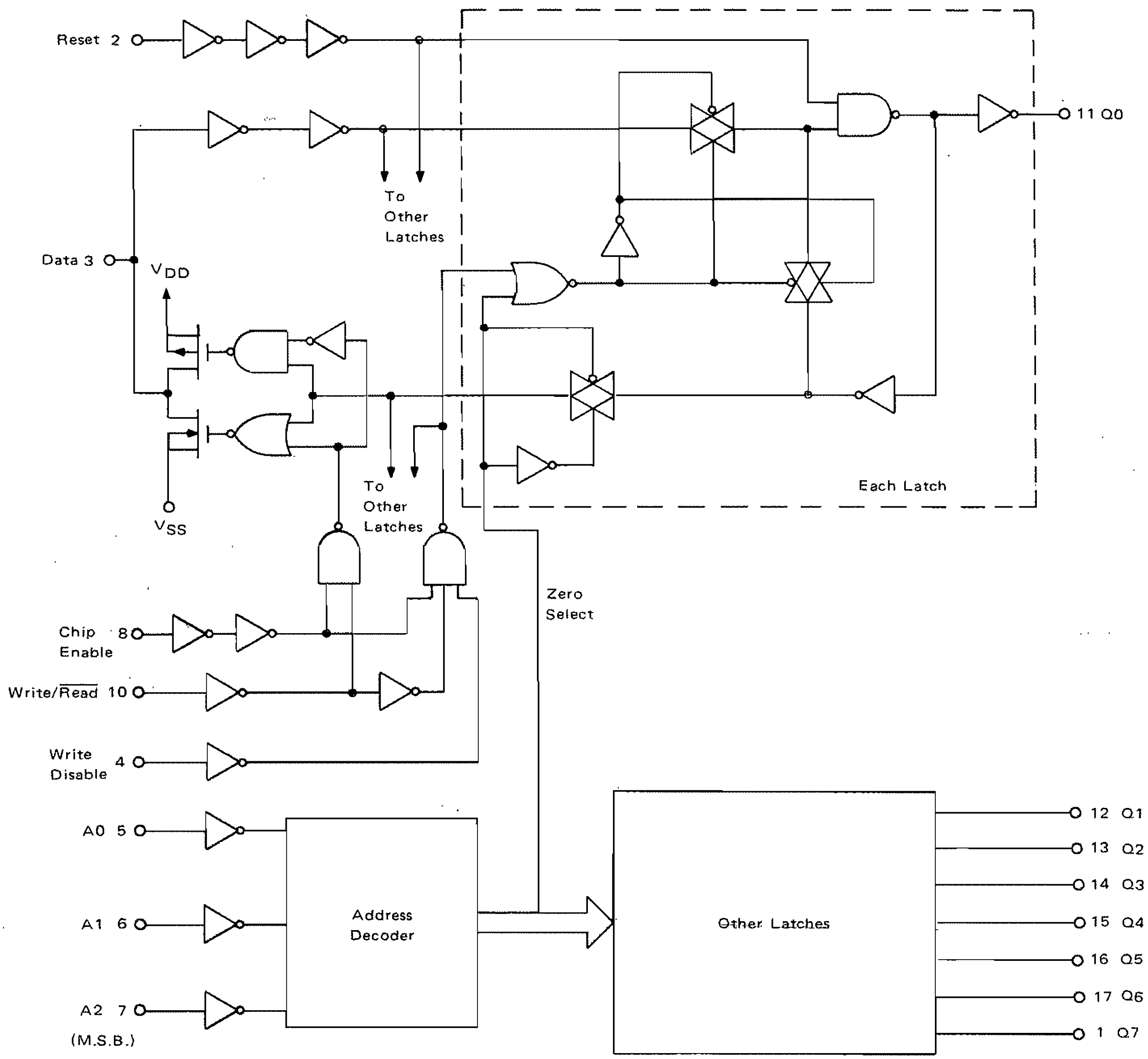
Write Disable	Reset	Addressed Latch	Unaddressed Latch
0	0	Data	Q_n*
0	1	Data	Reset†
1	0	Q_n*	Q_n*
1	1	Reset	Reset

* Q_n is previous state of latch.
† Reset to zero state.

TIMING DIAGRAM



MC14599B
FUNCTION DIAGRAM



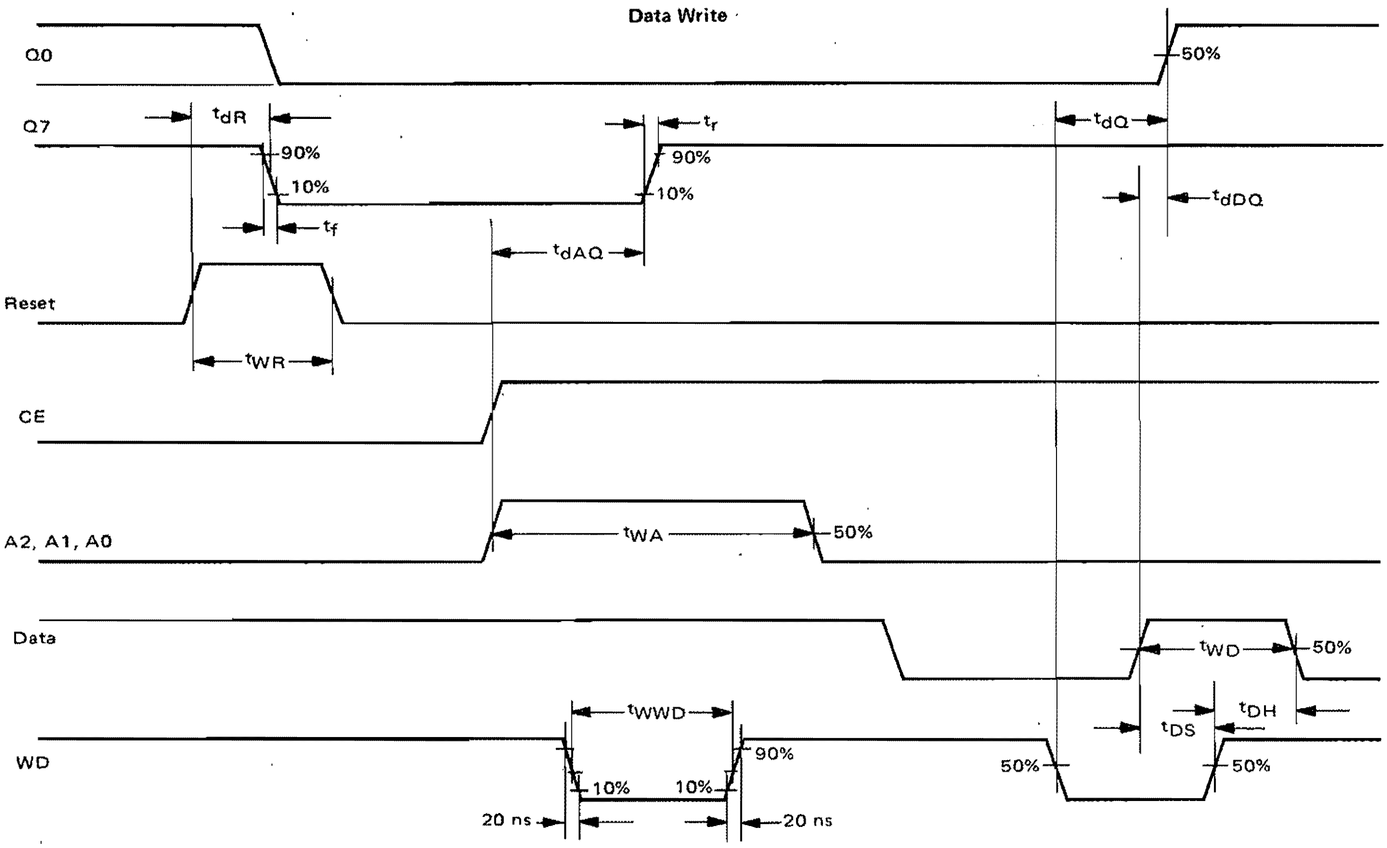
TRUTH TABLE

Chip Enable	Write/$\overline{\text{Read}}$	Write Disable	Reset	Addressed Latch	Other Latches	Data Pin
0	X	X	0	*	*	Z
1	1	0	0	Data	*	Input
1	1	1	0	*	*	Z
1	0	X	0	*	*	Q_n
X	X	X	1	0	0	Z/0

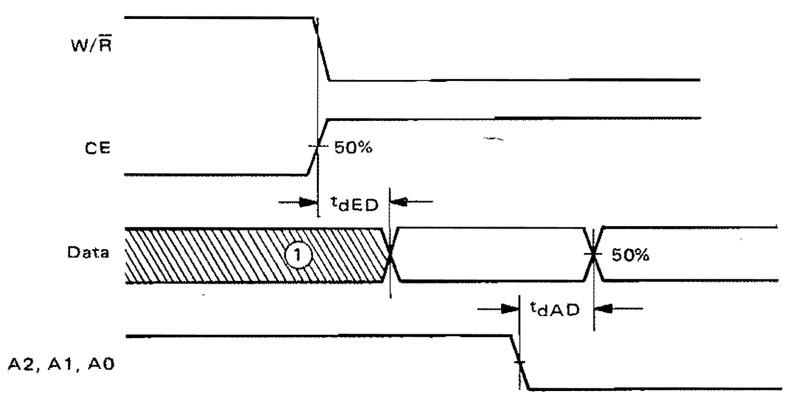
X = Don't care.
* = No change in state of latch.
Z = High impedance.
Q_n = State of addressed latch.

MC14599B
TIMING DIAGRAMS

Data Write



Data Read



NOTE: 1. Invalid Data Output
2. Reset in LOW State

intel®

2758
8K (1K × 8) UV ERASABLE LOW POWER PROM

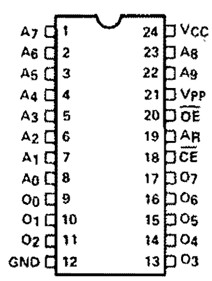
- **Single +5V Power Supply**
- **Simple Programming Requirements**
  - **Single Location Programming**
  - **Programs with One 50 ms Pulse**
- **Low Power Dissipation**
  525 mW Max. Active Power
  132 mW Max. Standby Power
- **Fast Access Time: 450 ns Max. in Active and Standby Power Modes**
- **Inputs and Outputs TTL Compatible during Read and Program**
- **Completely Static**
- **Three-State Outputs for OR-Ties**

The Intel® 2758 is a 8192-bit ultraviolet erasable and electrically programmable read-only memory (EPROM). The 2758 operates from a single 5-volt power supply, has a static standby mode, and features fast single address location programming. It makes designing with EPROMs faster, easier and more economical. The total programming time for all 8192 bits is 50 seconds.

The 2758 has a static standby mode which reduces the power dissipation without increasing access time. The maximum active power dissipation is 525 mW, while the maximum standby power dissipation is only 132 mW, a 75% savings. Power-down is achieved by applying a TTL-high signal to the $\overline{CE}$ input.

A 2758 system may be designed for total upwards compatibility with Intel's 16K 2716 EPROM (see Applications Note 30). The 2758 maintains the simplest and fastest method yet devised for programming EPROMs — single pulse TTL-level programming. There is no need for high voltage pulsing because all programming controls are handled by TTL signals. Program any location at any time — either individually, sequentially, or at random, with the single address location programming.

PIN CONFIGURATION



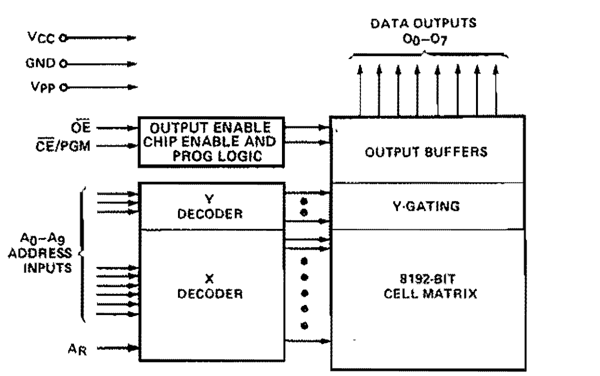
MODE SELECTION

MODE \ PINS	$\overline{CE}$/PGM (18)	A_R (19)	$\overline{OE}$ (20)	V_{PP} (21)	V_{CC} (24)	OUTPUTS (9-11, 13-17)
Read	V_{IL}	V_{IL}	V_{IL}	+5	+5	D_{OUT}
Standby	V_{IH}	V_{IL}	Don't Care	+5	+5	High Z
Program	Pulsed V_{IL} to V_{IH}	V_{IL}	V_{IH}	+25	+5	D_{IN}
Program Verify	V_{IL}	V_{IL}	V_{IL}	+25	+5	D_{OUT}
Program Inhibit	V_{IL}	V_{IL}	V_{IH}	+25	+5	High Z

PIN NAMES

A_0–A_9	ADDRESSES
$\overline{CE}$/PGM	CHIP ENABLE/PROGRAM
$\overline{OE}$	OUTPUT ENABLE
O_0–O_7	OUTPUTS
A_R	SELECT REFERENCE INPUT LEVEL

BLOCK DIAGRAM



FEBRUARY 1979

PROGRAMMING

The programming specifications are described in the Data Catalog PROM/ROM Programming Instructions section.

Absolute Maximum Ratings*

Temperature Under Bias . . . . –10°C to +80°C
Storage Temperature . . . . –65°C to +125°C
All Input or Output Voltages with
Respect to Ground . . . . +6V to –0.3V
V_{PP} Supply Voltage with Respect
to Ground During Programming . . . . . +26.5V to –0.3V

**COMMENT:* Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

READ OPERATION

D.C. and Operating Characteristics

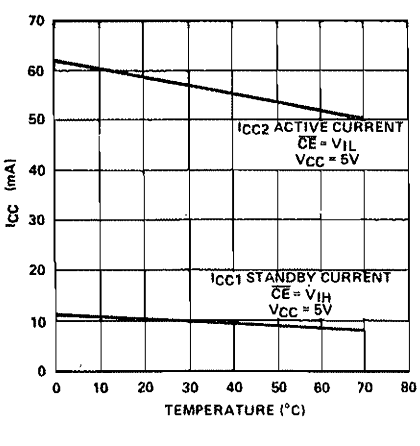
$T_A = 0°C$ to $70°C$, V_{CC}[1,2] = +5V ±5%, V_{PP}[2] = V_{CC}

Symbol	Parameter	Limits			Unit	Conditions
		Min.	Typ.[3]	Max.		
I_{LI}	Input Load Current			10	μA	V_{IN} = 5.25V
I_{LO}	Output Leakage Current			10	μA	V_{OUT} = 5.25V
I_{PP1}[2]	V_{PP} Current			5	mA	V_{PP} = 5.25V
I_{CC1}[2]	V_{CC} Current (Standby)		10	25	mA	$\overline{CE} = V_{IH}$, $\overline{OE} = V_{IL}$
I_{CC2}[2]	V_{CC} Current (Active)		57	100	mA	$\overline{OE} = \overline{CE} = V_{IL}$
A_R[4]	Select Reference Input Level	-0.1		0.8	V	I_{IN} = 10 μA
V_{IL}	Input Low Voltage	-0.1		0.8	V	
V_{IH}	Input High Voltage	2.0		V_{CC} + 1	V	
V_{OL}	Output Low Voltage			0.45	V	I_{OL} = 2.1 mA
V_{OH}	Output High Voltage	2.4			V	I_{OH} = –400 μA

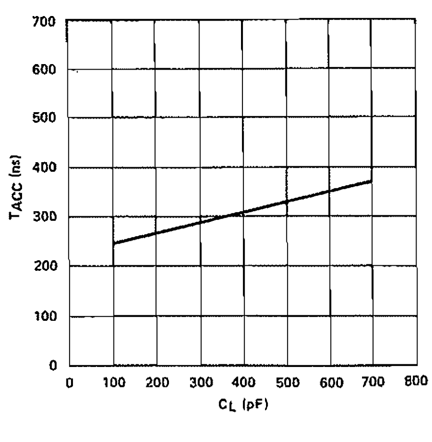
NOTES:
1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
2. V_{PP} may be connected directly to V_{CC} except during programming. The supply current would then be the sum of I_{CC} and I_{PP1}.
3. Typical values are for T_A = 25°C and nominal supply voltages.
4. A_R is a reference voltage level which requires an input current of only 10 μA. The 2758 S1865 is also available which has a reference voltage level of V_{IH} instead of V_{IL}.

Typical Characteristics

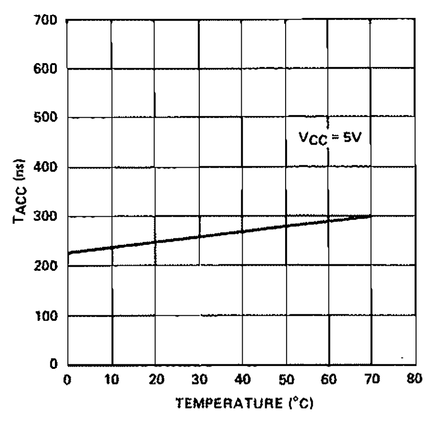
I_{CC} CURRENT vs. TEMPERATURE



ACCESS TIME vs. CAPACITANCE



ACCESS TIME vs. TEMPERATURE



A.C. Characteristics

$T_A = 0°C$ to $70°C$, V_{CC}[1] = +5V ±5%, V_{PP}[2] = V_{CC}

Symbol	Parameter	Limits			Unit	Test Conditions
		Min.	Typ.[3]	Max.		
t_{ACC}	Address to Output Delay		250	450	ns	$\overline{CE} = \overline{OE} = V_{IL}$
t_{CE}	$\overline{CE}$ to Output Delay		280	450	ns	$\overline{OE} = V_{IL}$
t_{OE}	Output Enable to Output Delay			120	ns	$\overline{CE} = V_{IL}$
t_{DF}	Output Enable High to Output Float	0		100	ns	$\overline{CE} = V_{IL}$
t_{OH}	Output Hold From Addresses, $\overline{CE}$ or $\overline{OE}$ Whichever Occurred First	0			ns	$\overline{CE} = \overline{OE} = V_{IL}$

Capacitance[4] $T_A = 25°C$, f = 1 MHz

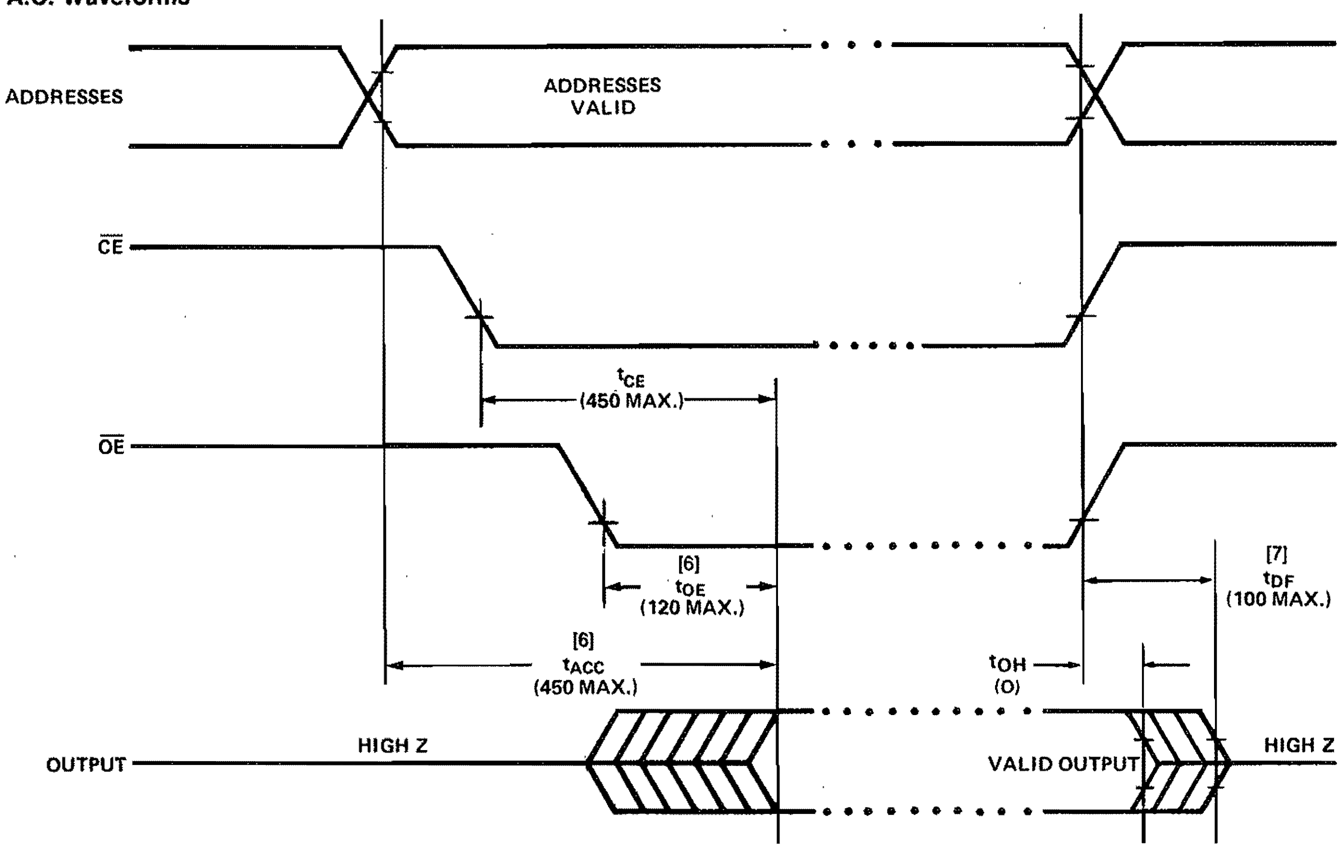
Symbol	Parameter	Typ.	Max.	Unit	Conditions
C_{IN}	Input Capacitance	4	6	pF	$V_{IN} = 0V$
C_{OUT}	Output Capacitance	8	12	pF	$V_{OUT} = 0V$

NOTE: Please refer to page 2 for notes.

A.C. Test Conditions:

Output Load: 1 TTL gate and C_L = 100 pF
Input Rise and Fall Times: ≤20 ns
Input Pulse Levels: 0.8V to 2.2V
Timing Measurement Reference Level:
Inputs 1V and 2V
Outputs 0.8V and 2V

A.C. Waveforms[5]



NOTES:
1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
2. V_{PP} may be connected directly to V_{CC} except during programming. The supply current would then be the sum of I_{CC} and I_{PP1}.
3. Typical values are for $T_A = 25°C$ and nominal supply voltages.
4. This parameter is only sampled and is not 100% tested.
5. All times shown in parentheses are minimum times and are nsec unless otherwise specified.
6. $\overline{OE}$ may be delayed up to 330 ns after the falling edge of $\overline{CE}$ without impact on t_{ACC}.
7. t_{DF} is specified from $\overline{OE}$ or $\overline{CE}$, whichever occurs first.

ERASURE CHARACTERISTICS

The erasure characteristics of the 2758 are such that erasure begins to occur when exposed to light with wavelengths shorter than approximately 4000 Angstroms (Å). It should be noted that sunlight and certain types of fluorescent lamps have wavelengths in the 3000–4000Å range. Data show that constant exposure to room level fluorescent lighting could erase the typical 2758 in approximately 3 years, while it would take approximately 1 week to cause erasure when exposed to direct sunlight. If the 2758 is to be exposed to these types of lighting conditions for extended periods of time, opaque labels are available from Intel which should be placed over the 2758 window to prevent unintentional erasure.

The recommended erasure procedure (see Data Catalog Programming Section) for the 2758 is exposure to shortwave ultraviolet light which has a wavelength of 2537 Angstroms (Å). The integrated does (i.e., UV intensity X exposure time) for erasure should be a minimum of 15 W-sec/cm^2. The erasure time with this dosage is approximately 15 to 20 minutes using an ultraviolet lamp with 12,000 μW/cm^2 power rating. The 2758 should be placed within 1 inch of the lamp tubes during erasure. Some lamps have a filter on their tubes which should be removed before erasure.

DEVICE OPERATION

The five modes of operation of the 2758 are listed in Table 1. It should be noted that all inputs for the five modes are at TTL levels. The power supplied required are a +5V V_{CC} and a V_{PP}. The V_{PP} power supply must be at 25V during the two programming modes, and must be at 5V in the other three modes. In all operational modes, A_R must be at V_{IL} (except for the 2758 S1865 which has A_R at V_{IH}).

TABLE I. MODE SELECTION

MODE \ PINS	$\overline{CE}$/PGM (18)	A_R (19)	$\overline{OE}$ (20)	V_{PP} (21)	V_{CC} (24)	OUTPUTS (9-11, 13-17)
Read	V_{IL}	V_{IL}	V_{IL}	+5	+5	D_{OUT}
Standby	V_{IH}	V_{IL}	Don't Care	+5	+5	High Z
Program	Pulsed V_{IL} to V_{IH}	V_{IL}	V_{IH}	+25	+5	D_{IN}
Program Verify	V_{IL}	V_{IL}	V_{IL}	+25	+5	D_{OUT}
Program Inhibit	V_{IL}	V_{IL}	V_{IH}	+25	+5	High Z

READ MODE

The 2758 has two control functions, both of which must be logically satisfied in order to obtain data at the outputs. Chip Enable ($\overline{CE}$) is the power control and should be used for device selection. Output Enable ($\overline{OE}$) is the output control and should be used to gate data to the output pins, independent of device selection. Assuming that addresses are stable, address access time (t_{ACC}) is equal to the delay from $\overline{CE}$ to output (t_{CE}). Data is available at the outputs 120 ns (t_{OE}) after the falling edge of $\overline{OE}$, assuming that $\overline{CE}$ has been low and addresses have been stable for at least $t_{ACC} - t_{OE}$.

STANDBY MODE

The 2758 has a standby mode which reduces the active power dissipation by 75%, from 525 mW to 132 mW. The 2758 is placed in the standby mode by applying a TTL high signal to $\overline{CE}$ input. When in standby mode, the outputs are in a high impedence state, independent of the OE input.

OUTPUT OR-TIEING

Because EPROMs are usually used in larger memory arrays, Intel has provided a 2 line control function that accommodates this use of multiple memory connections. The two line control function allows for:

a) the lowest possible memory Power dissipation, and
b) complete assurance that output bus contention will not occur.

To most efficiently use these two control lines, it is recommended that $\overline{CE}$ (pin 18) be decoded and used as the primary device selecting function, while $\overline{OE}$ (pin 20) be made a common connection to all devices in the array and connected to the READ line from the system control bus. This assures that all deselected memory devices are in their low power standby mode and that the output pins are only active when data is desired from a particular memory device.

PROGRAMMING

Initially, and after each erasure, all bits of the 2758 are in the "1" state. Data is introduced by selectively programming "0's" into the desired bit locations. Although only "0's" will be programmed, both "1's" and "0's" can be presented in the data word. The only way to change a "0" to a "1" is by ultraviolet light erasure.

The 2758 is in the programming mode when the V_{PP} power supply is at 25V and $\overline{OE}$ is at V_{IH}. The data to be programmed is applied 8 bits in parallel to the data output pins. The levels required for the address and data inputs are TTL.

When the address and data are stable, a 50 msec, active high, TTL program pulse is applied to the $\overline{CE}$/PGM input. A program pulse must be applied at each address location to be programmed. You can program any location at any time — either individually, sequentially, or at random. The program pulse has a maximum width of 55 msec.

The 2758 must be programmed with a DC signal applied to the $\overline{CE}$/PGM input.

Programming of multiple 2758s in parallel with the same data can be easily accomplished due to the simplicity of the programming requirements. Like inputs of the paralleled 2758s may be connected together when they are programmed with the same data. A high level TTL pulse applied to the $\overline{CE}$/PGM input programs the paralleled 2758s.

PROGRAM INHIBIT

Programming of multiple 2758s in parallel with different data is also easily accomplished. Except for $\overline{CE}$/PGM, all like inputs(including $\overline{OE}$) of the parallel 2758s may be common. A TTL level program pulse applied to a 2758's $\overline{CE}$/PGM input with V_{PP} at 25V will program that 2758. A low level $\overline{CE}$/PGM input inhibits the other 2758 from being programmed.

PROGRAM VERIFY

A verify should be performed on the programmed bits to determine that they were correctly programmed. The verify may be performed with V_{PP} at 25V. Except during programming and program verify, V_{PP} must be at 5V.

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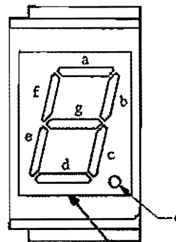
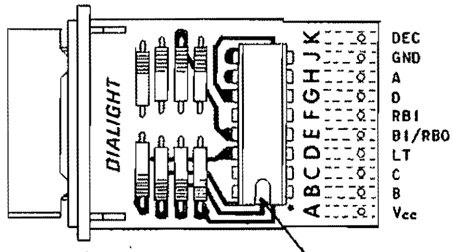
INSTRUCTION SHEET

730-6007 Assembly, Slide Mount, with Bezel





DECIMAL OR FUNCTION	INPUTS			*	RESULTANT DISPLAY
	LT	RBI	D C B A	BI/RBO	
0	1	1	0 0 0 0	1	0
1	1	X	0 0 0 1	1	1
2	1	X	0 0 1 0	1	2
3	1	X	0 0 1 1	1	3
4	1	X	0 1 0 0	1	4
5	1	X	0 1 0 1	1	5
6	1	X	0 1 1 0	1	6
7	1	X	0 1 1 1	1	7
8	1	X	1 0 0 0	1	8
9	1	X	1 0 0 1	1	9
BI	X	X	X X X X	0	
RBI	1	0	0 0 0 0	0	
LT	0	X	X X X X	1	8

'1'=HIGH LEVEL, '0'=LOW LEVEL, 'X'=ANY LEVEL

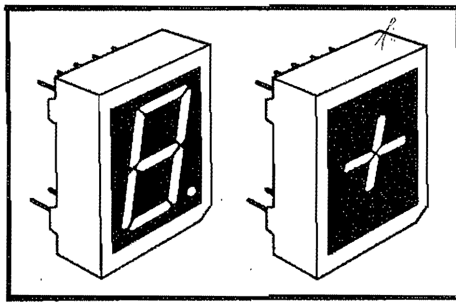
* BI/RBO IS WIRE-AND LOGIC SERVING AS AN INPUT AND/OR OUTPUT

OPERATING CHARACTERISTICS (AMBIENT TEMPERATURE 25°C)

SUPPLY VOLTAGE, V_{CC}		5 ± 0.5V
SUPPLY CURRENT		158 mA ALL SEGMENTS AND DECIMAL POINT ILLUMINATED.
LOGIC '1'	BCD INPUTS	2.0 TO 5.5V
LOGIC '0'	BCD INPUTS	0.0 TO 0.8V, SINK 1.6 mA
LOGIC '1'	DEC	OPEN
LOGIC '0'	DEC	0.0 TO 0.8V, SINK 13 mA
TEMPERATURE RANGE		0° TO 70°C

DIALIGHT

DIALCO®



730-6001, 730-6005 & 730-6006

DIODE-LITE®

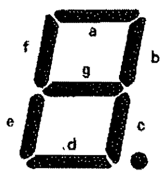
solid state LED readout

character height .600"

Features

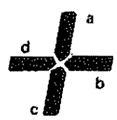
- GaP Red LED
- Large Character — .600"
- Common Anode Construction
- Seven Segment Format with Decimal Point
- Wide Viewing Angle, Single Plane Viewing
- Solid State Reliability
- Low Power Requirement, Typically 10mA per Segment
- Each Unit checked for uniformity of elements
- Package combines Filter for Contrast Enhancement
- Compact Package Design maximizes Package Density

730-6001



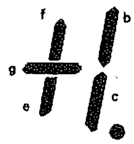
PIN 1 – CATHODE e
PIN 2 – CATHODE d
PIN 3 – CATHODE c
PIN 4 – CATHODE Decimal
PIN 5 – COMMON ANODE
PIN 6 – CATHODE b
PIN 7 – CATHODE a
PIN 8 – CATHODE g
PIN 9 – CATHODE f
PIN 10 – COMMON ANODE

730-6005

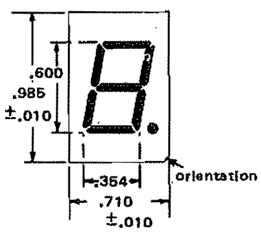


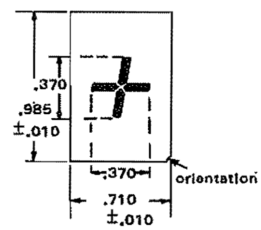
PIN 1 – CATHODE c
PIN 2 – CATHODE c
PIN 3 – CATHODE b
PIN 4 – CATHODE b
PIN 5 – COMMON ANODE
PIN 6 – CATHODE a
PIN 7 – CATHODE a
PIN 8 – CATHODE d
PIN 9 – CATHODE d
PIN 10 – COMMON ANODE

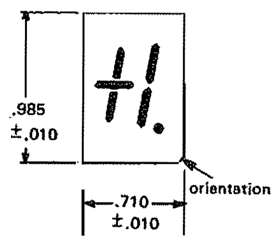
730-6006

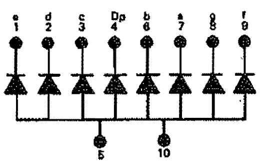


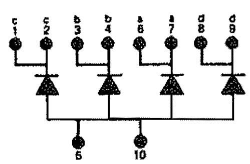
PIN 1 – CATHODE e
PIN 2 – NO CONNECTION
PIN 3 – CATHODE c
PIN 4 – CATHODE Decimal
PIN 5 – COMMON ANODE
PIN 6 – CATHODE b
PIN 7 – NO CONNECTION
PIN 8 – CATHODE g
PIN 9 – CATHODE f
PIN 10 – COMMON ANODE

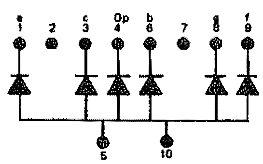




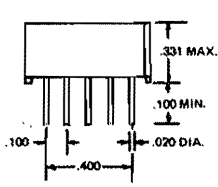


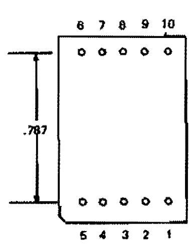




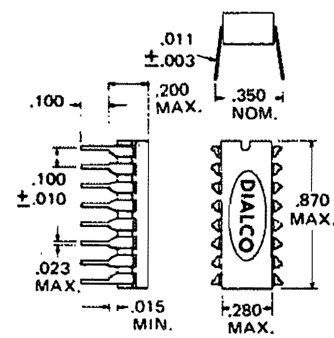


730-6001, 730-6005 and 730-6006
End and Bottom views



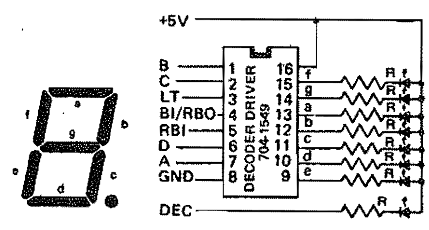


decoder/driver 704-1549
(for 730-6001)



NOTE:
Leads are for insertion in hole rows on .300" centers. They are purposely shipped with .350" spacing in order to provide sufficient tension necessary to secure the package in the board during soldering.

schematic



R=200Ω

DECIMAL OR FUNCTION	INPUTS			•	RESULTANT
	LT	RBI	D C B A	BI/RBO	DISPLAY
0	1	1	0 0 0 0	1	0
1	1	X	0 0 0 1	1	1
2	1	X	0 0 1 0	1	2
3	1	X	0 0 1 1	1	3
4	1	X	0 1 0 0	1	4
5	1	X	0 1 0 1	1	5
6	1	X	0 1 1 0	1	6
7	1	X	0 1 1 1	1	7
8	1	X	1 0 0 0	1	8
9	1	X	1 0 0 1	1	9
BI	X	X	X X X X	0	
RBI	1	0	0 0 0 0	0	
LT	0	X	X X X X	1	8

'1' = HIGH LEVEL
"0" = LOW LEVEL
'X' = ANY LEVEL

• BI/RBO IS WIRE-AND LOGIC SERVING AS AN INPUT AND/OR OUTPUT

operating specifications

Maximum ratings at 25°C ambient temperature

Reverse Voltage	−3 V
Continuous Forward Current Per Segment (See Note)	30 mA
Power dissipation per package (730-6001)	600 mW
Power dissipation per package (730-6005)	400 mW
Power dissipation per package (730-6006)	450 mW
Operating and Storage Temperature	−20°C to 75°C
Soldering Temperature for 5 secs	260°C @ 0.1" from seating plane

Note: Derate linearly to 75°C at the rate of 0.34 mA/°C.

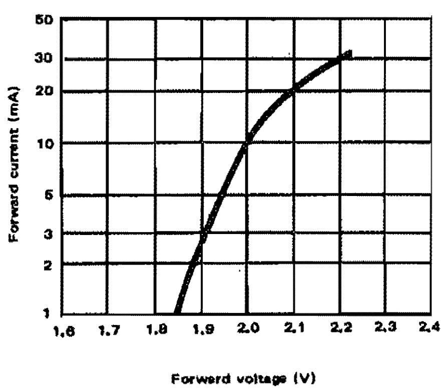
Operating characteristics of each segment at 25°C ambient temperature

PARAMETER		TEST CONDITIONS	TYP	MAX	UNIT
I_V	Luminous Intensity	I_F=10mA	300		μcd
V_F	Static Forward Voltage	I_F=10mA	2.0	2.8	V
λpeak	Peak Wavelength	I_F=10mA	700		nm
BW_λ	Spectral Bandwidth between Half-Power Points	I_F=10mA	200		nm
C	Capacitance	V=0, F=1 MHz	100		pF
I_R	Static Reverse Current	V_R=3V		10	μA

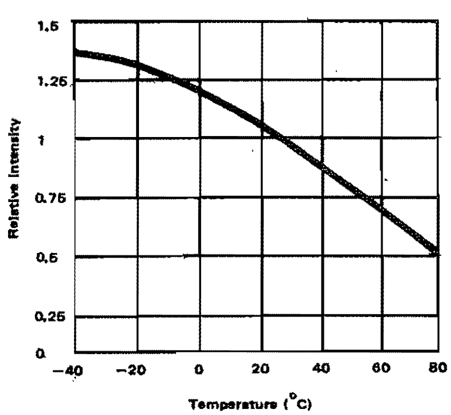
Recommended Cleaning Solution — Isopropanol

TYPICAL CHARACTERISTICS

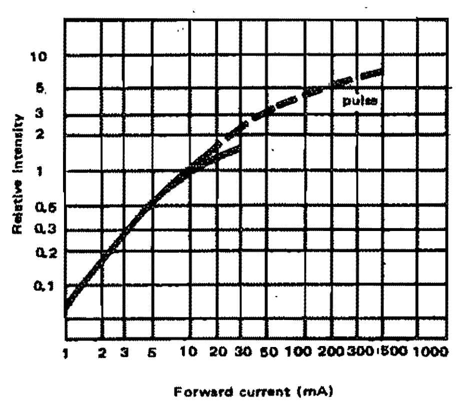
Forward current vs Forward voltage



Relative intensity vs Temperature



Relative intensity vs Forward current



PRODUCT WARRANTY

LIMITED ONE YEAR

While this warranty gives you specific legal rights, which terminate one (1) year (6 months on turntable motors) from the date of shipment, you may also have other rights which vary from state to state.

Broadcast Electronics, Inc. ("BE"), 4100 North 24th Street, P. O. Box 3606, Quincy, Illinois 62305, hereby warrants cartridge machines, consoles, transmitters and other new Equipment manufactured by BE against any defects in material or workmanship at the time of delivery thereof, that develop under normal use within a period of one (1) year (6 months for turntable motors) from the date of shipment. Other manufacturers' Equipment, if any, shall carry only such manufacturers' standard warranty. This warranty extends to the original user and any subsequent purchaser during the warranty period. BE's sole responsibility with respect to any Equipment or parts not conforming to this warranty is to replace such equipment or parts upon the return thereof F.O.B. BE's factory or authorized repair depot within the period aforesaid.

In the event of replacement pursuant to the foregoing warranty, only the unexpired portion of the warranty from the time of the original purchase will remain in effect for any such replacement. However, the warranty period will be extended for the length of time that the original user is without the services of the Equipment due to its being serviced pursuant to this warranty. The terms of the foregoing warranty shall be null and void if the Equipment has been altered or repaired without specific written authorization of BE, or if Equipment is operated under environmental conditions or circumstances other than those specifically described in BE's product literature or instruction manual which accompany the Equipment purchased. BE shall not be liable for any expense of any nature whatsoever incurred by the original user without prior written consent of BE.

BE shall not be liable to the original user for any and all incidental or consequential damages for breach of either expressed or implied warranties. However, some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. All express and implied warranties shall terminate at the conclusion of the period set forth herein.

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