INSTRUCTION MANUAL

*AMPFET P400

400 WATT
AM BROADCAST TRANSMITTER
535kHz TO 1705kHz

(STEREO CAPABLE)

*AMPFET is a registered Trade Mark

nautel

NAUTICAL ELECTRONIC LABORATORIES LIMITED
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LIST OF EFFECTIVE PAGES

The list of effective pages lists the status of all pages in this manual. Pages of the original issue are identified by a zero in the Change No. column. Pages subsequently changed are identified by the date of the change number. On a changed page, the text affected by the latest change is indicated by a vertical bar in the margin opposite the changed material.

Original . . . . 01 April 1986

Total number of printed sides in this manual is 174 as listed below:

PAGE	CHANGE No.	DATE	PAGE	CHANGE No.	DATE
Title	0	01 April 1986	2-7	0	01 April 1986
-	-	Blank	2-8	0	01 April 1986
Effective (Page 1)	0	01 April 1986	2-9	0	01 April 1986
Effective (Page 2)	0	01 April 1986	2-10	0	01 April 1986
Effective (Page 3)	0	01 April 1986	2-11	0	01 April 1986
Effective (Page 4)	-	Blank	2-12	0	01 April 1986
Safety (Page 1)	0	01 April 1986	2-13	0	01 April 1986
Safety (Page 2)	0	01 April 1986	2-14	0	01 April 1986
Safety (Page 3)	0	01 April 1986	2-15	0	01 April 1986
Safety (Page 4)	-	Blank	2-16	0	01 April 1986
Warranty (Page 1)	0	01 April 1986	2-17	0	01 April 1986
Warranty (Page 2)	0	01 April 1986	2-18	0	01 April 1986
Contents (Page 1)	0	01 April 1986	3-1	0	01 April 1986
Contents (Page 2)	0	01 April 1986	3-2	0	01 April 1986
Contents (Page 3)	0	01 April 1986	3-3	0	01 April 1986
Contents (Page 4)	0	01 April 1986	3-4	0	01 April 1986
Contents (Page 5)	0	01 April 1986	3-5	0	01 April 1986
Contents (Page 6)	0	01 April 1986	3-6	0	01 April 1986
Contents (Page 7)	0	01 April 1986	3-7	0	01 April 1986
Contents (Page 8)	0	01 April 1986	3-8	0	01 April 1986
1-1	0	01 April 1986	3-9	0	01 April 1986
1-2	0	01 April 1986	3-10	0	01 April 1986
1-3	0	01 April 1986	3-11	0	01 April 1986
1-4	0	01 April 1986	3-12	0	01 April 1986
1-5	0	01 April 1986	3-13	0	01 April 1986
1-6	0	01 April 1986	3-14	0	01 April 1986
1-7	0	01 April 1986	3-15	0	01 April 1986
1-8	0	01 April 1986	3-16	-	Blank
2-1	0	01 April 1986	4-1	0	01 April 1986
2-2	0	01 April 1986	4-2	0	01 April 1986
2-3	0	01 April 1986	4-3	0	01 April 1986
2-4	0	01 April 1986	4-4	0	01 April 1986
2-5	0	01 April 1986	4-5	0	01 April 1986
2-6	0	01 April 1986	4-6	0	01 April 1986

LIST OF EFFECTIVE PAGES (Continued)

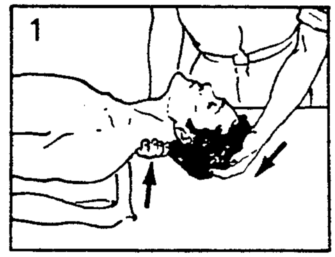
PAGE	CHANGE No.	DATE	PAGE	CHANGE No.	DATE
4-7	0	01 April 1986	6-11	0	01 April 1986
4-8	0	01 April 1986	6-12	0	01 April 1986
4-9	0	01 April 1986	6-13	0	01 April 1986
4-10	0	01 April 1986	6-14	0	01 April 1986
5-1	0	01 April 1986	6-15	0	01 April 1986
5-2	0	01 April 1986	6-16	0	01 April 1986
5-3	0	01 April 1986	6-17	0	01 April 1986
5-4	0	01 April 1986	6-18	0	01 April 1986
5-5	0	01 April 1986	6-19	0	01 April 1986
5-6	0	01 April 1986	6-20	0	01 April 1986
5-7	0	01 April 1986	6-21	0	01 April 1986
5-8	0	01 April 1986	6-22	0	01 April 1986
5-9	0	01 April 1986	7-1	0	01 April 1986
5-10	0	01 April 1986	7-2	0	01 April 1986
5-11	0	01 April 1986	7-3	0	01 April 1986
5-12	0	01 April 1986	7-4	0	01 April 1986
5-13	0	01 April 1986	7-5	0	01 April 1986
5-14	0	01 April 1986	7-6	0	01 April 1986
5-15	0	01 April 1986	7-7	0	01 April 1986
5-16	0	01 April 1986	7-8	0	01 April 1986
5-17	0	01 April 1986	7-9	0	01 April 1986
5-18	0	01 April 1986	7-10	0	01 April 1986
5-19	0	01 April 1986	7-11	0	01 April 1986
5-20	0	01 April 1986	7-12	0	01 April 1986
5-21	0	01 April 1986	7-13	0	01 April 1986
5-22	0	01 April 1986	7-14	0	01 April 1986
5-23	0	01 April 1986	7-15	0	01 April 1986
5-24	0	01 April 1986	7-16	0	01 April 1986
5-25	0	01 April 1986	7-17	0	01 April 1986
5-26	0	01 April 1986	7-18	0	01 April 1986
5-27	0	01 April 1986	7-19	0	01 April 1986
5-28	0	01 April 1986	7-20	0	01 April 1986
5-29	0	01 April 1986	7-21	0	01 April 1986
5-30	0	01 April 1986	7-22	0	01 April 1986
5-31	0	01 April 1986	7-23	0	01 April 1986
5-32	0	01 April 1986	7-24	0	01 April 1986
5-33	0	01 April 1986	7-25	0	01 April 1986
5-34	-	Blank	7-26	-	Blank
6-1	0	01 April 1986	FO-1	0	01 April 1986
6-2	0	01 April 1986	FO-2	0	01 April 1986
6-3	0	01 April 1986	FO-3	0	01 April 1986
6-4	0	01 April 1986	FO-4	0	01 April 1986
6-5	0	01 April 1986	FO-5	0	01 April 1986
6-6	0	01 April 1986	FO-6	0	01 April 1986
6-7	0	01 April 1986	FO-7	0	01 April 1986
6-8	0	01 April 1986	FO-8	0	01 April 1986
6-9	0	01 April 1986	FO-9	0	01 April 1986
6-10	0	01 April 1986	FO-10	0	01 April 1986

LIST OF EFFECTIVE PAGES (Continued)

PAGE	CHANGE No.	DATE	PAGE	CHANGE No.	DATE
FO-11	0	01 April 1986	FO-19	0	01 April 1986
FO-12	0	01 April 1986	FO-20	0	01 April 1986
FO-13	0	01 April 1986	FO-21	0	01 April 1986
FO-14	0	01 April 1986	FO-22	0	01 April 1986
FO-15	0	01 April 1986	FO-23	0	01 April 1986
FO-16	0	01 April 1986	FO-24	0	01 April 1986
FO-17	0	01 April 1986	FO-25	0	01 April 1986
FO-18	0	01 April 1986			

ARTIFICIAL RESPIRATION (MOUTH TO MOUTH METHOD)

1. START MOUTH TO MOUTH BREATHING IMMEDIATELY, SECONDS COUNT. Do not wait to, loosen clothing, warm the casualty, or apply stimulants.

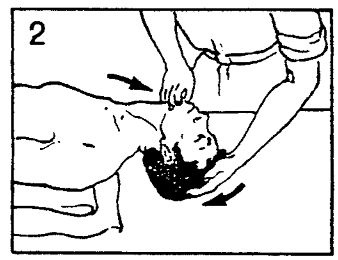


2. LAY CASUALTY ON HIS BACK and place any available jacket or blanket under his shoulders.

3. LIFT THE NECK. (Fig. 1)

4. MOVE FOREHEAD BACK as far as possible and open mouth by lifting jaw forward. (Fig. 2)

5. TAKE A DEEP BREATH and open your mouth widely.

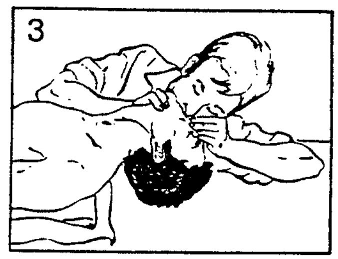


6. PINCH CASUALTY'S NOSE and blow into casualty until you see the chest rise. (Fig. 3)

7. REMOVE YOUR MOUTH and let casualty's chest deflate. (Fig. 4)

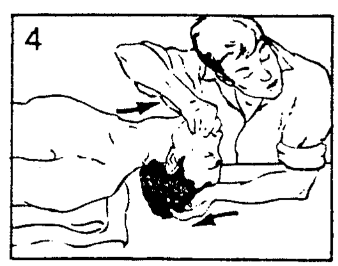
8. CONTINUE MOUTH-TO-MOUTH BREATHING without interruption at the rate of 10 to 12 breaths a minute. If any air retained in the stomach after exhalation by casualty, press gently on stomach to expel air.

9. IF CHEST DOES NOT RISE CHECK for obstruction in casualty's mouth: Clear foreign material by turning the head to one side and using finger, tissues, etc. Check neck extension and recommence mouth-to-mouth breathing.



10. WHILE MOUTH-TO-MOUTH BREATHING IS CONTINUED have someone else:
    (a) Loosen casualty's clothing
    (b) Summon medical aid.
    (c) Keep the casualty warm.

11. DON'T GIVE UP. Continue without interruption until the casualty is revived, or until a doctor pronounces the casualty is dead. Four hours or more may be required.



12. DO NOT LEAVE CASUALTY when he revives. Be ready to resume artificial respiration if necessary.

13. DO NOT give liquids while victim is unconscious.

GENERAL RULES FOR TREATMENT FOR BURNS, BLEEDING, AND SHOCK

1. After casualty has revived, treat for injuries and shock.
2. Reassure casualty.
3. Try to make him comfortable.
4. Keep him reasonably warm but do not apply heat.
5. If thirsty, liquids may be given but no alcohol (no liquids should be given in cases of severe burns).
6. Treat burns or wounds. Infection danger in treating burns or wounds is very great so ensure hands are clean and do not handle affected areas more than necessary.
7. Do not apply salves, grease, etc. to burns.
8. Do not remove burned clothing which adheres to the skin or break blisters.
9. Cover the burn with a dry sterile dressing, piece of sheeting, etc.
10. Bandage lightly over blisters where care must be taken to cover and not to break.
11. If severe bleeding of wound, elevate affected area, except in the case of a fracture.
12. Expose wound, remove visible foreign bodies and apply pressure.
13. Apply dressing, pad and bandage.
14. For burns and bleeding, immobilize injured part using splints if necessary and keep patient in restful position during removal to hospital or expert medical attention.
15. In all cases, send for medical aid immediately.

ELECTRIC SHOCK - RESCUE METHODS

Electricity can damage the body in a number of ways. It may interfere with the proper functioning of the nervous system and the heart action, it can subject the body to extreme heat and can cause severe muscular contractions. The path that the current of electricity takes through the body is important. Currents which pass from hand to hand or from hand to foot may pass directly through the heart and upset its normal functioning. This threat to life is related to the amount of current or amperage which will flow through a victim's body. Very little current (as little as 10 milliamps) can result in severe shock.

Speed in the application of first aid measures is absolutely essential in cases of electrical injury. As soon as the victim is freed safely from the source of the electrical current, if breathing has stopped, artificial respiration should be commenced immediately. If the carotid pulse cannot be felt, external cardiac massage should be commenced simultaneously. Resuscitation should be continued until the patient is breathing on his own or until medical aid arrives. Survival rates can be quite high if cardio-pulmonary resuscitation is started within 3 to 4 minutes of the injury being received.

ACT AT ONCE - DELAY OR INDECISION MAY BE FATAL

1. Remove source or casualty from electrical contact.
2. Commence artificial respiration immediately.
3. Treat for burns, bleeding and shock.

REMOVING A CASUALTY FROM ELECTRICAL CONTACT

LOW VOLTAGE - 0 to 240 volts (household use)

Switch off the current, if possible and time permits. If the switch cannot be located immediately and the supply is through a flexible cord or cable, the current may be shut off by removing the plug or even breaking the cable or wrenching free. Never attempt to shut off current by cutting cord with a knife or scissors.

If the current cannot be shut off, the greatest care is necessary in removing the casualty. Household rubber gloves, rubber or plastic hose (if there is no water in them), a dry unpainted stick or a clean dry rope can be used to free victim.

HIGH VOLTAGE - 240 volts and up (industrial machines and power lines)

Do not touch any person or equipment in contact with a wire.

Use a dry unpainted pole, clean dry rope, dry rubber or plastic water hose to separate the casualty from the contact.

Keep as far away as possible.

Do not touch the casualty until he is free.

WARRANTY

Nautical Electronic Laboratories Limited/Nautel Maine Incorporated, hereinafter referred to as Nautel, guarantees all mechanical and electrical parts of the equipment for a period of thirteen months from date of shipment.

1. A "Part Failure" shall be deemed to have occurred when the part has become defective, or does not have the characteristics required for the specified equipment performance:

   (a) When the equipment is operated within the design parameters, and

   (b) When the equipment is installed and adjusted according to Nautel's prescribed procedures as stated in the instruction manual.

2. Nautel shall provide replacements for all "Parts" at no cost to the Customer when they become defective during the warranty period, and upon the return of the defective part.

3. In the event that a "Part" fails during the warranty period and causes damage to a sub-assembly which cannot be readily repaired in the field, the entire sub-assembly so damaged may be returned to Nautel for repair. The repairs will be made without charge to the Customer.

4. Where no-charge warranty replacements or repair are provided under items 2 or 3, Nautel will pay that part of the shipping costs incurred in returning the part/assembly to the Customer.

5. Nautel will not assume responsibility for any charges incurred by other than Nautel employees.

6. Nautel shall have the privilege of investigating whether failures have been caused by factors beyond its control.

7. Nautel shall in no event be liable for any consequential damages arising from the use of this equipment.

8. When requesting a warranty repair/replacement, please provide complete and accurate information. Observe the instructions regarding 'Equipment Being Returned to Nautel' on page two of this warranty and provide the information requested.

9. When ordering spare/replacement parts; please provide complete and accurate information. Refer to the parts list of this manual for ordering information. Provide as much of the information requested for 'Equipment Being Returned to Nautel' on page two of this warranty as is practical. The information identified by an asterisk is the minimum required.

EQUIPMENT BEING RETURNED TO NAUTEL

All equipment being returned to Nautel and all requests for repairs or replacements should be marked 'field return' and addressed to the appropriate Nautel facility.

United States of America customers use:	Nautel Maine Incorporated 201 Target Industrial Circle Bangor, Maine 04401 Telephone 207-947-8200 (24 hours) Telex 944466
All other customers use:	Nautical Electronic Laboratories Limited Hackett's Cove, RR#1 Tantallon Halifax County, Nova Scotia, Canada B0J 3J0 Telephone 902-823-2233 (working hours) 903-422-9641 (non-working hours) Telex 019-22552

Complete and accurate information regarding the equipment being returned will ensure prompt attention and will expedite the dispatch of replacements. Refer to the nameplate on the transmitter and/or the appropriate module/assembly to obtain name, type, part and serial number information. Refer to the parts list of this manual or the appropriate plug-in module appendix for additional ordering information.

The following information should accompany each request:

Station name/call sign
* Model of Transmitter
* Serial number of Transmitter
Transmitted Frequency
* Name of Part/Assembly
Serial number of Part/Assembly
* Complete reference designation of Part/Assembly
* Nautel's part number of Part/Assembly
* OEM's part number of Part/Assembly
Number of hours in Use
Nature of defect
* Return shipping address

* Denotes minimum information required to order spare/replacement parts

CUSTOMER SERVICE NOTICE

A 'Technical Assistance' and 'Plug-in Module Exchange' service is available to AMPFET users. Direct all communications/requests to the appropriate Nautel facility (refer to top of this page).

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1
GENERAL INFORMATION

INTRODUCTION

1.1 The AMPFET P400 is a 400 Watt, totally solid state, stereo capable, medium wave, amplitude modulated, broadcast transmitter. The AMPFET P400 operates over the 535 kHz to 1705 kHz frequency range into a nominal 50 ohm, unbalanced, transmission line. Typically, the AMPFET P400 transmitter will operate continuously at 125 percent positive peak modulation. Interfacing is provided to enable the transmitter to be remotely controlled.

PURPOSE AND SCOPE OF MANUAL

1.2 This manual provides the information necessary to install, operate and maintain Nautel AMPFET P400 medium wave broadcast transmitters. Nautel provides a service facility for repair of all subassemblies used in the transmitter. See page two of the warranty for details.

PURPOSE OF EQUIPMENT

1.3 The AMPFET P400 transmitter is intended for use in a conventional AM broadcasting station. Remote control facilities are incorporated to allow unattended operation at a transmitter site remotely located from the station studio.

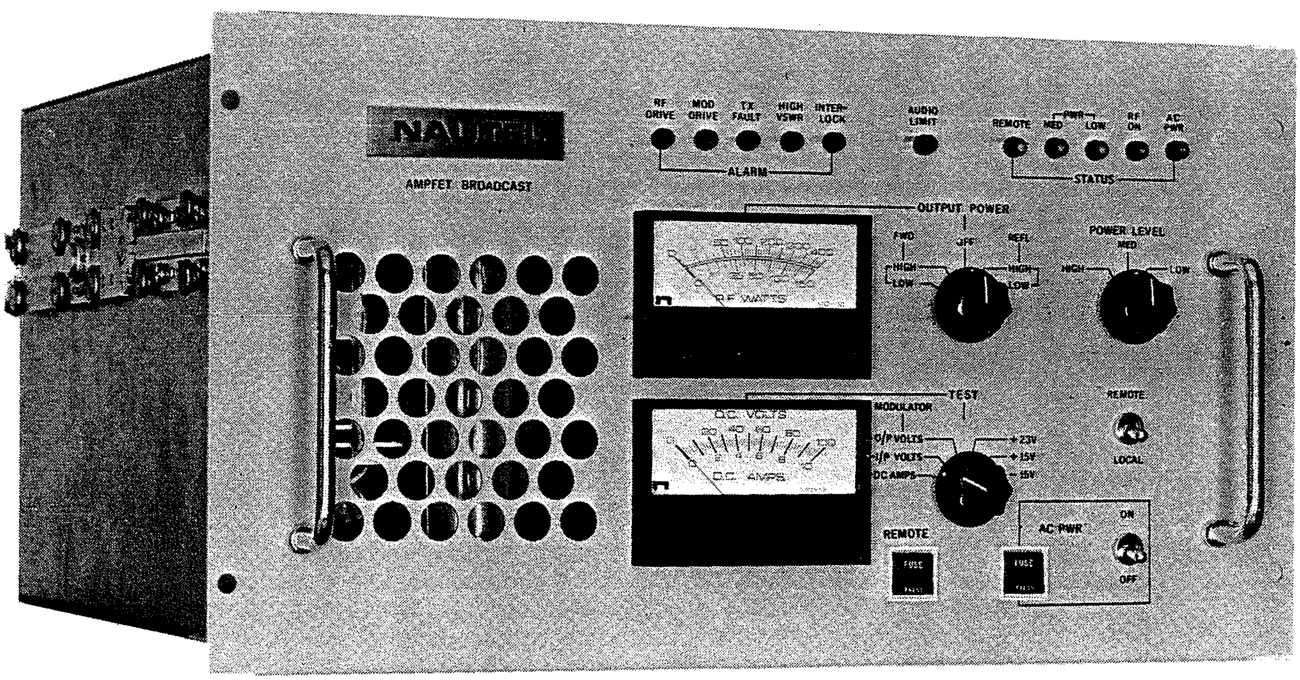


Figure 1-1 AMPFET P400 Transmitter

Table 1-1 Technical Summary

Nautel Model Number	AMPFET P400
RF Carrier Output	Can be locally or remotely selected to any three preset levels in the 400 to 25 Watts range. Lower levels available with slight increase in distortion.
RF Frequency Range (supplied to one frequency as ordered)	535 kHz to 1705 kHz
RF Terminating Impedance	50 ohms, unbalanced
Audio Frequency Response	±1.0 dB over range of 30 Hz to 10,000 Hz
Audio Frequency Distortion	Better than 2% (THD) at 95% modulation 30-10,000 Hz Reduced antenna bandwidth may degrade specification
Audio Intermodulation Distortion	
(1)	1.0% or less, 60/7000 Hz 1:1 ratio at 400W output
(2)	2.0% or less, 60/7000 Hz 4:1 ratio at 400W output
(3)	SMPTE Standards at 80% modulation
AM Stereo (RF Phase Shift)	Less than 2° = 0.035 radians (1 radian = 57.29°) incidental phase at 1 kHz
Modulation Capability	125% positive peak modulation
Carrier Shift	Typically 0.1%, not exceeding 1.0%
RF Harmonics	69 dB or more below 400 W output
Spurious Outputs	69 dB or more below 400 W output
Noise (unweighted)	60 dB or more below 100% modulation at 400 W
Frequency Stability	±5 Hz or ±5ppm whichever is greater
Audio Input	600 or 150 ohms/0 dBm to +12 dBm
External RF Carrier Input	2.8 to 8.4 volts (peak-to-peak)
Power Input	230Vac 50/60Hz or 115Vac, 60Hz
Permissible Power Supply Variation	-10/+20 volts ac, ±5% frequency
Power Consumption at 400 Watts output:	
0% modulation	615 Watts
100% modulation	923 Watts
Power Factor	0.8 typical
Overall Efficiency	65% typical

Table 1-1 Technical Summary (Continued)

Metering:

(1) . . . . Forward/reflected output power on high and low ranges
(2) . . . . Dc current/voltage to modulator/power amplifier
(3) . . . . Low voltage dc supplies

Remote Control:

(1) . . . . Transmitter ON/OFF
(2) . . . . Select one of three output power levels
(3) . . . . External gain (zero to +15 volts dc)
Change rf carrier level by ratio of 1:2 to 1

Remote Monitor:

(1) Forward Power . . . . . Voltage source (10K ohms max load) 5.63 Vdc @ 400W

(2) Reflected Power . . . . Voltage source (10K ohms max load) 5.63 Vdc @ 400W

(3) Tx Fault . . . . Current sink (100 mA max) to ground when no fault present. Open collector when fault present.

(4) VSWR Fault . . . . . . Current sink (100 mA max) to ground when high VSWR present. Open collector when VSWR satisfactory.

(5) Rf Monitor . . . . . . Rf output voltage sample (set for 5 volt rms into 1000 ohms in high, med and low power operation)

Environmental Limits:

Temperature . . . . 0 - 50°C
Relative Humidity . . . . 0 - 95%
Altitude . . . . 0 - 10,000 feet

Dimensions:

Height . . . . 8.75 inches (22.3 cm)
Width . . . . 19 inches (48.3 cm)
Depth (Inside Cabinet) . . . . 20.75 inches (52.8 cm)
Depth (Including Handles). . . . . 23.0 inches (58.4 cm)

Weight . . . . 82 pounds (37 kg)

DESIGN CONSIDERATIONS/CHARACTERISTICS

1.4 The AMPFET P400 has been designed to meet the stringent requirements for state-of-art AM broadcast transmitters (see table 1-1). Additionally, two areas of special concern have been given full consideration in the design of the AMPFET series of transmitters. These are: (a) maintainability; (b) efficiency.

1.4.1 EFFICIENCY: Overall efficiency of the AMPFET P400 transmitter is 65 percent from ac power input to rf power available at the antenna terminals. This has been achieved by the use of all solid-state devices throughout the transmitter with all the devices in the power sections of the transmitter operating in a switched mode. The effect of an overall 65 percent efficiency is a major reduction in operation costs and physical size of the transmitter.

1.4.2 SERVICEABILITY: The design concept of the AMPFET P400 is that all printed circuit boards are accessible by withdrawing the unit on ball bearing drawer slides and removing the top cover. Tilting the front of the unit upward through 90 degrees and removing the lower cover allows access to the high power subassemblies. All circuit boards and subassemblies are easily removable, allowing modular replacement during servicing.

MECHANICAL DESCRIPTION

1.5 The AMPFET P400 transmitter is packaged in a single cabinet that weighs 82 pounds (37 kilograms). It is intended for installation in a standard 19-inch equipment rack. All external wiring interconnections are made at the rear of the transmitter cabinet.

1.5.1 CABINET (see FO-10 thru FO-14): The AMPFET P400 cabinet is a fabricated metal chassis in the form of a drawer with full-depth front, side and rear panels. An internal horizontal tray is positioned close to the top of the chassis. The top of this tray provides a mounting surface for most of the printed circuit boards. Access to these boards is gained by removal of the top cover plate. A hinged front section of this top cover allows access to internal adjustment points that may require routine readjustment. Two power supply subassemblies are mounted on the lower surface of the horizontal tray and are accessible by removal of the bottom cover plate.

1.5.1.1 Front Panel Assembly (see FO-10 and FO-11): The front surface of the cabinet houses all the functional controls necessary for normal operation of the transmitter. A pattern of holes at the left-hand side provides an exhaust port for the transmitter's forced air cooling system. Two handles are provided to assist in withdrawing the cabinet on its slides. The panel contains two fuses (AC PWR and REMOTE CONTROL); two toggle switches (AC POWER ON/OFF and REMOTE/LOCAL); three rotary switches (TEST, OUTPUT POWER and POWER LEVEL; five ALARM lamps (RF DRIVE, MOD DRIVE, TX FAULT, HIGH VSWR and INTERLOCK); and five STATUS lamps (REMOTE, MED PWR, LOW PWR, RF ON and AC PWR). NAPC8/1 meter printed circuit board assembly is mounted directly on the terminals of the TEST meter and is accessible by removal of the bottom cover plate.

1.5.1.2 Rear Panel Assembly (see FO-14): The rear panel assembly contains two terminal boards that accept the external monitor and control interconnecting wiring, a type N rf output coaxial connector, a BNC rf monitor coaxial connector, a three pin ac line power receptacle and a ground stud for the station reference ground. It also contains the inlet port for forced air cooling.

1.5.2 NAPE28 RF OSCILLATOR DRIVER PCB (see figures FO-12 and FO-15): The NAPE28 rf oscillator/driver printed circuit board (A1) is a double sided printed wiring board. The electrical components are soldered directly to plated through mounting holes. It contains glass piston trimmer capacitor, for fine tuning the internally generated rf carrier frequency; standoffs that accommodate selection of the appropriate divide-by-2 or two divide-by-4 solder links; two potentiometers, that are adjusted during calibration to set the current protection thresholds and three mass termination assembly (MTA) square post headers, to accept the interconnecting wiring from the cabinet cableform. Three MTA connectors (P1, P12 and P13) on the cabinet cable harness mate with the MTA square pin headers on the printed circuit board. The printed circuit board is mounted on four hexagonal pillars, by screws. The pillars provide the rf ground connection to the boards printed wiring from the cabinet chassis.

1.5.3 NAPE22/1 MODULATOR DRIVER PCB (see figures FO-12 and FO-16): The NAPE22/1 modulator driver printed circuit board (A2) is a double sided printed wiring board. The electrical components are soldered directly to plated through mounting holes. It contains two sets of DIP switches, that are used to select high- and low-pass audio filters; eleven miniature potentiometers (R4 AUDIO, R6 LO PWR 1, R7 LO PWR 2, R16 HI LIMIT, R18 LO LIMIT, R92 O/P PWR, R29 X BAL, R42 OFFSET ADJ, R47 X BAL, R70 OFFSET BAL and R75 RAMP ADJ) and one trimmer capacitor (C15 FREQ ADJ), that are adjusted during calibration and two mass termination assembly (MTA) square post headers, to accept the interconnecting wiring from the cabinet cableform. Two MTA connectors (P2 and P3) on the cabinet cable harness mate with the MTA square pin headers on the printed circuit board. The printed circuit board is mounted on six hexagonal pillars, by screws. The pillars provide the rf ground connection to the boards printed wiring from the cabinet chassis. All adjustments on this printed circuit board are accessible through a hinged panel at the front of the top cover when it is installed in the transmitter. The inside surface of this hinged cover is imprinted with the factory adjustment procedure.

1.5.4 NAA13/1 MODULATOR/POWER AMPLIFIER ASSEMBLY (see figures FO-17 and FO-18): The NAA13/1 modulator/power amplifier assembly (A3) utilizes an extruded, finned heatsink as its chassis. Two barrier terminal strips (TB1 and TB2) and two separate insulated terminals (E1 and E2) project through holes in the cabinet's horizontal tray when the assembly is bolted into position beneath the tray. Electrical connections are made from the upper surface side of the tray. Interconnections to a thermostat, used to control operation of the system's forced air cooling system, are made to floating 'fast-on' connectors located beneath the tray. There are no adjustable components in this assembly.

1.5.5 NAF34 RF OUTPUT FILTER ASSEMBLY (see figure FO-19): The NAF34 rf output filter assembly (A4) is contained in a formed metal box located at the rear of the transmitter. It utilizes the full height of the cabinet and is secured in position by four screws which are accessible from the top of the transmitter cabinet. Three fixed, tuned inductors and three cast mica capacitors are mounted inside the box formed by its wraparound base and three removable covers. An insulated feedthrough terminals is used as the rf input connection and a wire that is terminated by a terminal lug is used as the rf output connection. These connections must be disconnected before the assembly can be removed from the transmitter cabinet.

Table 1-2 AMPFET P400 Assemblies

NAME DESIGNATOR	ASSEMBLY DESIGNATOR	DESCRIPTION	QTY
NAPE28	A1	RF Oscillator/Driver PCB Assembly	1
NAPE22/1	A2	Modulator/Driver PCB Assembly	1
NAA13/1	A3	Modulator/Power Amplifier Assembly	1
NAF34	A4	RF Output Filter Assembly	1
NAFP11	A5	RF Power Probe Assembly	1
NAPC9/1	A6	Interface PCB Assembly	1
NAS18	A7	Low Voltage Power Supply Assembly	1
NAS17	A8	PA Power Supply Assembly	1
NAPC8/1	A9	Meter PCB Assembly	1

1.5.6 NAFP11 RF POWER PROBE ASSEMBLY (see figure FO-20): The NAFP 11 rf power probe assembly (A5) utilizes a small formed metal chassis that is fastened to the rear of the transmitter cabinet using four screws. The assembly contains a printed circuit board subassembly (A5A1) which is mounted on four hexagonal pillars inside the chassis. Two mass termination assembly (MTA) connectors(P4 and P5) on the cabinet's cable harness interconnect with mating MTA square pin headers on the printed circuit board where it projects from one side of the probe chassis. The probe utilizes a 3-way barrier strip (TB1) for its rf input connection and a type 'N' coaxial connector (J1) for its rf power output. Two toroidal rf transformers, located inside the chassis, are connected to the printed circuit board by soldered connecting wires. A surge arrester (E1) is mounted in a spring clip on the outer surface of the assembly.

1.5.7 NAPC9/1 INTERFACE PCB ASSEMBLY (see figure FO-21): The NAPC9/1 interface printed circuit board assembly (A6) is a double sided printed wiring board. The electrical components are soldered directly to plated through mounting holes. It contains nine miniature potentiometers; R1 - LOW Monitor, R2 - MED Monitor, R3 - HIGH Monitor, R24 - HIGH Threshold, R26 - MED Threshold, R28 - LOW Threshold, R44 - HIGH B-, R45 - MED B- and R46 - LOW B- that are adjusted during calibration, four DIP relays, (K1, K2, K3 and K4), two selectable diode links, and three mass termination assembly square pin header assemblies. Three mass termination assembly (MTA) connectors (P7, P8 and P9) on the transmitter's main cable harness interconnect with mating MTA square pin headers on the printed circuit board's upper surface. The printed circuit board is mounted on the upper surface of the cabinet tray assembly, on four hexagonal pillars. The pillars provide the rf ground connection to the boards printed wiring from the cabinet chassis.

1.5.8 NAS18 LOW VOLTAGE POWER SUPPLY MODULE (see figure FO-22): The NAS18 low voltage power supply module (A7) is a formed metal chassis fitted with four captive nuts that is secured to the underside of the cabinet tray assembly by four screws. Printed circuit boards A1, A6 and A10 must be removed from the upper surface of the tray to gain access to these screws. On the outside surface of its chassis, two electrolytic capacitors (C1 and C5), an ac line transformer (T10) and an interconnecting barrier terminal strip (TB1) are mounted on the top and three power semiconductors (Q1, U2 and U3) are mounted on one side. The inside surface of the chassis contains all its other electronic components, including all component interconnection wiring. TB1 is connected to the cabinet's main wiring harness using spade solder terminals.

Table 1-3 Special Tools

NOMENCLATURE	PART, MODEL, OR TYPE NUMBER (EQUIVALENTS MAY BE USED)	APPLICATION
Tuning Tool	HAG38*	Setting carrier frequency. Adjust output levels.

* Denotes manufactured by, or available from, Nautel

1.5.9 NAS17 PA POWER SUPPLY ASSEMBLY (see figures FO-23 and FO-24) The NAS17 PA power supply assembly (A8) is a formed metal chassis constructed with heavy gauge material to support the weight of its heavy components. It is secured to the underside of the cabinet tray assembly by six screws that thread into captive nuts which are riveted to its bottom flanges. Printed circuit boards A2 and A6 must be removed from the upper tray surface to gain access to these screws. The assembly's top outside surface contains a large transformer and choke (T1 and L1); a rectifier block (U1); a barrier terminal strip (TB2); together with several other smaller electronic components and their associated interconnecting wiring. A second barrier terminal strip (TB1) is mounted directly to transformer T1. A large resistor (R3) is mounted by clips on the side of the chassis. The inside of the chassis contains a power semiconductor (Q1); relay socket (XK1) and a factory adjusted, stainless steel current shunt (R4). Interconnections to the transmitter's main cable harness are made using insulated fast-on connectors. The number of the wire that connects to each terminal is silkscreened on labels adjacent to each terminal strip.

1.5.10 NAPC8/1 METER PCB ASSEMBLY (see figures FO-11 and FO-25) The NAPC8/1 meter printed circuit board assembly (A9) is a printed circuit board that is mounted directly to the terminals of TEST meter M1. Two plugs (P10 and P11) on the transmitter's main cable harness interconnect with mating MTA square pin headers on the printed circuit board's upper surface. The printed circuit board contains three miniature potentiometers of which two (A9R11 an A9R13) are used to calibrate the OUTPUT POWER meter (M2) on its upper and lower scales respectively, and one (A9R6) is used to calibrate the DC AMPS indication of the TEST meter (M1). It also contains thirteen fixed resistors used for metering purposes.

TECHNICAL SUMMARY

1.6 Table 1-1 - Technical Summary, contains a detailed technical summary for the AMPFET P400 transmitter.

PLUG-IN MODULES

1.7 Table 1-2 - Assemblies and Modules - AMPFET P400, lists the major assemblies used in the AMPFET P400 transmitter.

SPECIAL TOOLS AND TEST EQUIPMENT

1.8 Table 1-3 - Special Tools, lists the special tools and table 1-3 - Test Equipment, lists the test equipments that are required to operate and maintain the AMPFET P400 transmitter.

Table 1-4 Test Equipment

NOMENCLATURE	PART, MODEL, OR TYPE NUMBER (EQUIVALENTS MAY BE USED)	APPLICATION
Dummy Load	50 ohms, 1,000 Watts VSWR: 1.1 Bird Model	'off-air' testing
Digital Multimeter	3 1/2 digit, ac and dc volts (10M ohms input), ohms and amps, ±0.5% accuracy, Beckman 3010	testing and maintenance
Frequency Counter	5ppm up to 10 MHz Fluke Model 1900A	measure carrier frequency
Oscilloscope	15 MHz Tektronix Model T922	testing and maintenance
Current Probe	Tektronix Model P6022	measure rf drive current
DC Ammeter	30 Amps dc UYEW type 3228	to calibrate current shunt
Modulation Monitor	-100% to +125% TFT Model 753	to set up audio level
Audio Signal Generator	10 Hz to 10 MHz, 600 ohms, 0 to +15 dBm Hewlett Packard model 651B	simulates modulating audio input during testing and maintenance
Distortion Analyzer	20 Hz to 20 kHz Marconi Model TF231A	measures audio distortion during testing and maintenance
Function Generator	sine, square and triangular waveform with dc offset Hewlett Packard model 3310A	signal source for module tests
RF Voltmeter	HP400E	Precise measurement of rf voltages.
15 Vdc Power Supply	15 volts dc, 1 ampere	Dc supply for setting current threshold potentiometer.

SECTION 2
THEORY OF OPERATION

GENERAL

2.1 The theory of operation for the stereo capable AMPFET P400 amplitude modulated (AM) broadcast transmitter is presented in this section. The information is presented initially as an overview, and then this information is expanded in more detail, using the electrical schematics of the associated circuits within the transmitter as a reference.

TRANSMITTER OVERVIEW (see figure FO-1)

2.2 The AMPFET P400 AM broadcast transmitter operates in the AM radio broadcast band (535 kHz to 1705 kHz) at 400 Watts maximum rf carrier power. It may be operated as an AM stereo transmitter when an external phase modulated carrier signal is applied as the rf carrier source or as a monaural transmitter when the internal rf carrier oscillator is used as the rf carrier source. The transmitter may be operated in a local configuration, where the station is co-located, or in a remote configuration where the transmitter site and antenna are located separately from the station itself. Provision is made to remotely control the ON/OFF and HIGH/MED/LOW power status of the transmitter, to monitor the forward and reflected power levels and also to monitor INTERLOCK OPEN, Tx FAULT and high SWR alarms.

2.2.1 RF DRIVE OVERVIEW (see figures FO-1 and FO-2): The rf drive for the transmitter's rf power stages is produced by NAPE28 rf driver printed circuit board A1. When it is connected for stereo operation; a phase modulated, rf carrier signal is applied from an external source. When it is connected for monaural operation; an internal, crystal controlled oscillator is used as the rf carrier source. The appropriate rf carrier source is amplified and converted to a constant amplitude (approximately 23 volts peak-to-peak) square wave as the rf drive.

2.2.1.1 Carrier Oscillator Overview: The 'carrier oscillator' is used as the rf drive source when the internally generated rf carrier signal is to be used during monaural operation. It is a crystal controlled oscillator that operates between 2.0 and 4.0 Mhz. When the assigned carrier frequency is between 535 kHz and 1000 kHz, the oscillator frequency is four times the carrier frequency. When the assigned carrier frequency is between 1000 kHz and 1705 kHz, the oscillator frequency is twice the carrier frequency. An integral switch controls the operating dc voltage for the carrier oscillator and determines its enable/inhibit state. The carrier oscillator is inhibited during stereo operation to prevent interference with the externally applied rf carrier signal.

2.2.1.2 Frequency Divider Overview: The frequency divider consists of two 'D' flip-flops which can be connected to divide the carrier oscillator frequency by two or by four, as appropriate, to produce a square wave output at the assigned rf carrier frequency. When the assigned carrier frequency is between 535 kHz and 1000 kHz, the frequency divider is set to divide by four. When the assigned carrier frequency is between 1000 kHz and 1705 kHz, the frequency divider is set to divide by two. An integral switch determines whether the frequency divider's output is applied to the balanced drive or not. It is applied only when the internally generated rf carrier signal is to be used as the rf drive source.

2.2.1.3 External Rf Carrier Buffer Overview: The external rf carrier buffer contains an isolation transformer that couples the externally generated rf carrier signal to the stereo enable circuit.

2.2.1.4 Stereo Enable Overview: The stereo enable circuit is a double OR gate that converts the output of the external rf carrier buffer to a square wave at the input rf carrier frequency. An integral switch controls the operating dc voltage for the stereo enable circuit and determines its enable/inhibit state. The operating dc voltage is removed, inhibiting the output of the stereo enable circuit, when the internally generated rf carrier signal is to be used as the rf drive source. A second integral switch determines whether the stereo enable circuit's output is applied to the balanced drive or not. It is applied only when the externally generated rf carrier signal is to be used as the rf drive source.

2.2.1.5 Balanced Drive Overview: The balanced drive consists of two switching stages that produce a constant amplitude rf drive signal and a detector circuit that produces a positive dc voltage which is proportional to the level of the rf drive. The first switching stage is a buffer stage that switches between +15 volts dc and ground, at the assigned carrier frequency, as the drive to the coupling transformer for the power switching stage. The power switching stage switches between +23 volts dc and ground, at the assigned carrier frequency, as the rf drive to the transmitters power amplifier.

2.2.2 MODULATOR DRIVER OVERVIEW (see figure FO-1): NAPE22/1 modulator driver (A2) processes the 600-ohm audio input signal and converts this processed audio to a pulse width modulation signal that contains the carrier level and audio information. Logic circuits monitor the level of the rf drive, the rf stress current and the modulation pulse width output and produce alarm signals when safety thresholds are exceeded.

2.2.2.1 Low-pass Filter Overview (see figure FO-3): This circuit provides a selective audio bandwidth with precise control of high frequency roll-off characteristics, depending upon the switch configuration selected (refer to chart on figure FO-3).

2.2.2.2 High-pass Filter Overview (see figure FO-3): The high-pass filter provides provides a choice of heavy or light processing of the audio. A selective audio bandwidth, with precise control of low frequency roll-off characteristics, depending upon the switch configuration selected (refer to chart on figure FO-3); determines the degree of processing.

2.2.2.3 Audio Limiter Overview (see figure FO-3): The audio limiter is a variable gain, wideband, linear amplifier. The output of the amplifier is an offset dc voltage, with superimposed audio, when audio is present. Normally the gain of the amplifier is fixed. When the audio peaks and troughs exceed preset thresholds, the gain of the amplifier is decreased by a control voltage from the audio limiter control. The audio information will be linearly attenuated for the duration of the excessive peaks and/or troughs.

2.2.2.4 Audio Peak/Trough Detector Overview (see figure FO-3): The audio peak/trough detector provides two adjustable reference threshold voltages; one for the peaks of the audio signal, the other for the troughs of the audio signal. The peak threshold reference voltage is set for the voltage that represents the maximum desired modulation peaks (adjusted to limit between 100 and 125 percent) on the modulated rf output of the transmitter. The trough threshold reference voltage is set for the voltage that represents the maximum desired negative modulation troughs (adjustable from 95 to 100 percent) on the modulated rf output of the transmitter. When the audio peaks or troughs exceed these thresholds, negative going pulses are produced as the output of the peak/trough detector.

2.2.2.5 Audio Limiter Control Overview (see figure FO-3): The audio limiter control circuit is a fast attack, slow recovery integrating circuit that provides a positive dc voltage as the gain reference voltage for the audio limiter. Normally the output of the audio limiter control is a fixed, positive dc voltage. This voltage will bias the 'audio limiter' for a fixed gain. When negative going pulses are being applied, from the peak/trough detector, the bias voltage to the audio limiter will change and automatically set the limiter's output within the peak/trough threshold limits. If peak/trough thresholds are exceeded when the audio output signal has been decreased by 3 dB, a signal will be applied to the audio limit lamp on the front panel of the transmitter for the period of time that the thresholds are exceeded. The limit lamp will flash to alert user/maintainers.

2.2.2.6 Line Volts Compensation Control Overview (see figure FO-3): The line volts compensation control circuit is a linear amplifier that amplifies the dc offset voltage, with superimposed audio, from the audio limiter. The gain of the amplifier is determined by the level of the 'B-' voltage and the amplitude of the positive dc voltage applied as the 'external gain' input. If the 'B-' voltage changes, from the voltage present at the last calibration, the composite 'PWM Reference' signal will be be amplified or attenuated in the direction required to maintain the rf carrier and modulation depth at the preset levels. When the positive dc voltage applied as the 'external gain' input is varied from zero volts dc to +15 volts dc, the composite 'PWM reference' signal will be increased and increase the rf carrier level by a ratio of 1:2. If the 'external gain' input voltage is set to mid-range (+7.5 volts dc), the rf carrier level can be increased or decreased by ten percent.

2.2.2.7 High Rf Current/Low Rf Drive Attenuator Overview (see figure FO-4): The high rf current/low rf drive attenuator compares the rf drive signal to a preset threshold. When the rf drive signal exceeds the threshold, the attenuator circuit is a high impedance to ground, for the 'audio' signal from line volts control compensation circuit. When the rf drive signal is less than the threshold, the attenuator circuit is a low impedance to ground and effectively reduces the 'PWM reference' signal to a level that will provide a minimal rf output. An 'rf drive alarm' signal is also generated when the 'rf drive' level is below acceptable limits.

2.2.2.8 Low/Med Pwr Level Attenuator Overview (see figure FO-4): The low/med pwr level attenuator circuit is a switched attenuator that is enabled by the selection of medium or low power levels. When neither is selected, the attenuator circuit is a high impedance to ground, for the 'PWM reference' signal from line volts control compensation circuit. When either is selected, the attenuator circuit is an adjustable impedance to ground and linearly reduces the 'PWM reference' signal to the level required to produce the desired rf carrier level for that power selection.

2.2.2.9 Rf Stress Current Protection Overview (see figure FO-4): The rf stress current protection circuit compares a dc voltage 'rf stress current' input, which is representative of the peak rf output current and/or the phase difference between the rf drive and the rf output, with a fixed reference threshold. When the 'rf stress current' is less than the threshold, the rf stress current protection circuit has no influence. When the 'rf stress current' exceeds the threshold level, rf stress current protection circuit produces a dc control voltage. The level of this control voltage is proportional to the amount the 'rf stress current' exceeds the threshold.

2.2.2.10 Linear Attenuator Overview (see figure FO-4): The linear attenuator circuit is effectively a switched, linear, variable shunt resistance between the 'PWM reference' signal and ground. When a control voltage is not being produced by the rf stress current protection circuit, the linear attenuator circuit is a high impedance to ground and has no effect on the 'PWM reference' signal. When a control voltage is being produced by the rf stress current protection circuit, the linear attenuator circuit is enabled, and its impedance is inversely proportional to the level of the control voltage. The 'PWM reference' signal will be linearly attenuated to the level that will maintain the rf stress current at its threshold level.

2.2.2.11 PWM Square Wave Generator Overview (see figure FO-4): The PWM square wave generator circuit is an oscillator that produces a square wave output. The oscillator is adjusted to a precise frequency between 65.88 kHz and 74.12 kHz, dependent on the rf carrier frequency.

2.2.2.12 Ramp Integrator Overview (see figure FO-4): The square wave output of the PWM square wave generator is applied to the ramp integrator circuit and converted to a linear sawtooth waveform at the frequency of the PWM square wave generator. The sawtooth waveform is superimposed on an adjustable ramp offset voltage.

2.2.2.13 Variable Pulse-width Generator Overview (see figure FO-4): The variable pulse-width generator circuit is a differential amplifier that compares the linear sawtooth waveform from the ramp integrator with the 'audio' signal and produces a rectangular waveform, at the frequency of the PWM square wave generator, as the pulse-width modulation signal. The on/off ratio of the pulse width modulation signal determines the rf output level of the transmitter. When there is no audio present, the dc component of the audio signal is adjusted to set the on/off period to a fixed ratio that will produce the desired high power rf carrier output level. When audio is present, the on/off ratio will vary in proportion to the amplitude of the audio component.

2.2.2.14 Balance Drive Overview (see figure FO-4): The balanced drive is a switching circuit that is driven by the variable pulse width modulation signal from the variable pulse-width generator. The output of the balanced drive is a rectangular waveform with sharp leading and trailing edges switching between +15 volts dc and ground.

2.2.2.15 Pulse-width Fault Detector Overview (see figure FO-4): The pulse-width fault detector circuit monitors the pulse width modulation signal for the presence of +15 volt dc pulses. When pulses are present an integrating circuit produces a dc voltage which is compared with a fault reference threshold voltage. When the integrator voltage exceeds the reference threshold, a low level 'mod drive enable' signal is produced and a 'mod drive alarm' signal is not produced. When pulses are not present, the integrator voltage will be less positive than the reference threshold. The 'mod drive enable' output will be removed and a low level 'mod drive alarm' will be produced causing the MOD DRIVE ALARM lamp to turn on.

2.2.2.16 VSWR Alarm Control Overview (see figure FO-4): The VSWR alarm control circuit is switching circuit that is controlled by the output of the rf stress current protection circuit. With no output from the rf stress current protection circuit, a 'VSWR alarm' output is not produced. When the output of the rf stress current protection circuit reaches a negative voltage, of approximately -1.0 volt dc, the VSWR alarm control circuit is biased on, causing the local and remote VSWR ALARM lamps to be turned on.

2.2.3 MODULATOR/POWER AMPLIFIER OVERVIEW (see figure FO-1): NAA13/1 modulator/power amplifier (A3) contains a logic circuit that converts the positive voltage pulses of the 'mod drive' input to negative voltage pulses when a low level 'mod drive enable' input is present. The negative voltage 'mod drive' pulses are applied to a switched-modulator/filter circuit. The output of this circuit is a negative dc (B-) voltage, with superimposed modulating audio, for the power MOSFET's of the power amplifier. A sample of this voltage is provided, as the 'mod output volts' for metering purposes. Eight power MOSFET's form a class 'D' switched mode rf power amplifier that are switched by the rf drive frequency. The amplifier is capable of supplying 400 Watts of carrier power with a 100 percent amplitude modulated waveform, over a frequency range of 0.5 MHz to 2.0 MHz. A thermal switch activates a cooling air fan when the temperature exceeds 65°C, and an output from the modulator circuit to the front panel of the transmitter which allows monitoring of the modulator's output voltage.

2.2.4 POWER AMPLIFIER POWER SUPPLY OVERVIEW (see figure FO-1): NAS17 power amplifier power supply A8 contains a step-down transformer with a tapped primary and a tapped secondary winding. The primary tap selection is determined by the voltage of the ac power source. The secondary windings provide a choice of four voltages and are selected to provide the voltage to produce the desired output level. A relay, controlled by the status of the 'reduce pwr' input selects one of two tap options. A bridge rectifier provides the operating B- voltage for the transmitter. A current shunt resistor in the return path of the B- voltage provides a voltage, that is representative of the power amplifier current, for metering purposes.

2.2.5 LOW VOLTAGE POWER SUPPLY OVERVIEW (see figure FO-1): NAS18 low voltage power supply circuit A7 contains full-wave rectifiers which produce a +23 volt dc unregulated voltage, a +15 volt dc regulated voltage and a -15 volt dc regulated voltage. The +15 volt dc voltage regulator circuit is controlled by the status of the 'vdc enable' input. When the 'vdc enable' input is present (23 volts dc) the regulated +15 volts dc output is produced. When the 'vdc enable input' is not present, the regulated +15 volts dc output is inhibited.

2.2.6 INTERFACE OVERVIEW (see figure FO-1): NAPC9/1 interface circuit A6 provides a constant voltage rf output sample for external monitoring and an adjustable B- reference voltage for application to the line volts compensation circuit in mod driver A2; in high, medium or low modes of operation. It also contains circuits that compare the forward power level, in high, medium or low modes of operation, to adjustable preset thresholds and generates a tx fault alarm output when then the forward power level falls below the preset thresholds. Buffered forard power and reflected power outputs are also provided for external monitoring. The interface pcb also contains an interlock relay that controls the on/off status of the powr amplifier stage. It produces a 'vdc enable' signal when en the external interlock is intact and removes it when the external interlock is open. This board also provides a 'reduce pwr' output (23 volts dc) when the transmitter is switched to medium or low power mode of operation and a reduced voltage is required by the power amplifier for the selected mode.

2.2.7 RF STRESS CURRENT PROTECTION OVERVIEW (see figure FO-2): The rf stress current protection circuit continuously monitors the 'rf current sample' for amplitude and phase. It generates a dc voltage, as the 'rf stress current', that is representative of the peak rf output current and/or the amount the rf drive/rf output current phase differs.

2.2.7.1 <u>Rf Drive Digitizer Overview:</u> The rf drive digitizer circuit converts the rf drive sample to a square wave that has sharp leading and trailing edges.

2.2.7.2 <u>PA Current Digitizer Overview:</u> The PA current digitizer circuit converts the 'rf current sample to a square wave that has that has sharp leading and trailing edges.

2.2.7.3 <u>Phase Difference Detector Overview:</u> The phase difference detector is an exclusive OR gate that has the digitized rf drive sample applied to one input and the digitized rf current sample applied to its other input. When the leading and trailing edges of the rf drive and rf current samples are in coincidence, there is no output from the phase difference detector. When the leading and trailing edges are not in coincidence, the phase difference detector produces a dc voltage that is proportional to the difference.

2.2.7.4 <u>PA Current Detector Overview:</u> The PA current detector is a simple peak detector that produces a dc voltage which is proportional to the amplitude of the rf output current.

2.2.7.5 <u>Buffer Amplifier Overview:</u> The output of the phase difference detector and the rf current detector are summed and applied to a buffer amplifier. The buffer amplifier amplifies the resultant and provides a buffered dc voltage, that is representative of the peak rf output current and/or the amount the phase of the rf drive and rf output current differs, as the 'rf stress current' output.

2.2.8 RF OUTPUT FILTER OVERVIEW (see figure FO-1): NAF34 rf output filter (A4) is a fixed tuned, three-pole filter circuit consisting of a resonant L/C network connected in a series-parallel configuration. The rf output filter reduces all harmonic levels of the transmitter's rf output signal to a minimum of 69dB below the carrier frequency level.

2.2.9 RF POWER PROBE OVERVIEW (see figure FO-1): NAFP11 rf power probe contains voltage and current transformers that form the voltage and current arms of a forward/reflected power bridge. The rf output is continuously sampled and dc voltages representing the forward and reflected power are produced for monitoring and metering purposes. This circuit also contains a surge arrestor that protects the transmitter from voltage transients induced on the transmission line by lightning strikes. The rf power probe also provides a sample of the rf output for monitoring.

DETAILED THEORY OF OPERATION

2.3 The following descriptions expand on the overview descriptions presented in paragraph 2.2. They provide detailed descriptions of each circuit using the electrical schematics as references.

2.3.1 RF DRIVE DESCRIPTION (see figure FO-2): The rf drive for the transmitter's rf power stages is produced by the NAPE28 rf driver printed circuit board (A1). The rf carrier signal may be internally generated by a crystal controlled oscillator or it may be generated and applied from an external source. When it is connected for stereo operation; a phase modulated, rf carrier signal is applied from an external source. When it is connected for monaural operation; an internal, crystal controlled oscillator is used as the rf carrier source. The appropriate rf carrier source is amplified and converted to a constant amplitude (approximately 23 volts peak-to-peak) square wave as the rf drive .

2.3.1.1 <u>Carrier Oscillator Description:</u> The carrier oscillator circuit consists of transistor Q1; crystal Y1 and associated components. WHen switch S1-4 is closed, +15 volts dc is applied to and enables the carrier oscillator, which is a crystal controlled oscillator that operates between 2.0 and 4.0 Mhz. When the assigned carrier frequency is between 535 kHz and 1000 kHz, the oscillator frequency is four times the carrier frequency. When the assigned carrier frequency is between 1000 kHz and 1705 kHz, the oscillator frequency is twice the carrier frequency. Variable capacitor C4 provides fine tuning for the oscillator circuit. The output of the oscillator is applied to the base of Q2 via C7. Transistor Q2 and its associated components form a buffer amplifier which provides a buffered rf oscillator output to the frequency divider. This output can be monitored at test point TP1. When switch S1-4 is open the the carrier oscillator will be inhibited.

2.3.1.2 <u>Frequency Divider Description:</u> The frequency divider consists of dual 'D'type flip-flop U1 and its associated associated divide by links. When switch S1-4 is closed, +15 volts dc is applied to and enables the frequency divider. When the assigned carrier frequency is between 535 kHz and 1000 kHz, both divide by four links are installed. Flip-flop U1 will be connected to divide by four and the output of the carrier oscillator will be applied to the clock input of U1B. When the assigned carrier frequency is between 1000 kHz and 1705 kHz, both divide by two links are installed. Flip-flop U1B will be removed from the circuit, the output of the carrier oscillator will be applied to the clock input of U1A and flip-flop U1A will divide it by two. The output of the frequency divider is a square wave, switching between +15 volts dc and ground' at the assigned rf carrier frequency. Switch S1-2 will be closed when S1-4 is closed and it will be open when S1-4 is open. When S1-2 is closed, the output of the frequency divider will be applied to the base of balance drive transistors Q3/Q4. When S1-2 is open, the output of the frequency divider is removed and isolated from the base of balance drive transistors Q3/Q4.

2.3.1.3 External RF Carrier Buffer Description: The 'external rf carrier (stereo)' input is applied thru J3-2 to the primary winding of impedance matching transformer T2. The secondary winding of T2 is clamped to 7.5 volts dc by the voltage at the junction of voltage divider R15/R16. The rf carrier signal coupled to the secondary winding of T2 referenced to this voltage and applied thru a limiter circuit, comprising CR4/CR5, to one input of OR gate U2A. Diode CR5 shunts negative excursions of the rf carrier signal that are in excess of -7.5 volts dc to ground while diode CR4 prevents positive half cycles from exceeding 15 volts dc when switch S1-3 is closed.

2.3.1.4 Stereo Enable Description: The stereo enable circuit consists of OR gates U2A/U2B and their associated components. When switch S1-3 closed, +15 volts dc will be applied to U2 as the voltage source for U2A/U2D. A ground is permanently applied thru J3-4/CR6 to U2A-2 and U2D-13 as the 'Stereo Enable' input. With U2A-2 and U2D-13 are held low, their outputs will follow and invert the logic levels on their other input. The external rf carrier signal applied to U2A-1 will be passed to the output of U2D as a 15 volt dc square wave, at the external rf carrier frequency. Switch S1-1 will be closed when S1-3 is closed and it will be open when S1-3 is open. When S1-1 is closed, the output of U2D will be applied to the base of balance drive transistors Q3/Q4. When S1-1 is open, the output of U2D is removed and isolated from the base of balance drive transistors Q3/Q4.

2.3.1.5 Balanced Drive Description: A 15 volt dc square wave, at the assigned carrier frequency, from S1-1 or S1-2, is applied to the base of transistors Q3/Q4 When the square wave is +15 volts dc, Q3 is forward biased (turned on) and Q4 is reverse biased (turned off). Capacitor C9 will charge, thru Q4, towards +15 volts dc. When the square wave is zero volts, Q3 is reverse biased (turned off) and Q4 is forward biased (turned on). Capacitor C9 will discharge, thru Q3, to ground potential. The resultant current flow in the primary winding of transformer T1 will be a 15 volt square wave, at the carrier frequency, with sharp leading and trailing edges. The secondary of T1 has two identical sets of windings. Each secondary winding is connected across the gate and source of a power MOSFET (Q5 or Q6). The voltage applied to the gate of Q5 will be 180 degrees out of phase with the voltage applied to the gate of Q6. When the gate of Q5 is negative relative to its source, the gate of Q6 will be positive relative to its source; Q5 will be switched on and Q6 will be switched off. Capacitor C12 will charge thru Q5 to 23 volts. During the next half cycle, the gate of Q5 will be positive relative to its source and the gate of Q6 will be negative relative to its source. Q5 will switch off and Q6 will switch on. Capacitor C12 will discharge thru Q6. The resulting output at test point TP3 will be a +23 vdc peak to peak square wave at the rf carrier frequency. Capacitor C12 and inductor L6 form a series-resonant filter network that attenuate the harmonics of the signal and prevents excessive rf flow. The values of L6 and C12 are determined by the assigned rf carrier frequency . The 'rf drive' output applied to J1-4 is a slightly distorted sinusoidal waveform. Diode CR3, capacitor C13 and resistors R12/R13 form a half-wave rectifier circuit that produces a dc voltage that is proportional to the amplitude of the 'rf drive' this dc voltage is applied to J1-2 as the 'rf drive level' output. A sample of the rf drive is also applied thru resistor R21 as a phasing reference to the rf stress current protection circuit (see paragraph 2.3.7).

2.3.2 MODULATOR DRIVER PCB DESCRIPTION (see figures FO-3 and FO-4): NAPE22/1 modulator driver pcb A2 contains circuits that process the audio input and convert the audio information to a pulse width modulated output.

2.3.2.1 Low-pass Filter Description: Operational amplifier U1A, switch S1 and their associated components form a three-pole, low pass filter for the 'audio' input signal. AUDIO potentiometer R4 is adjusted to apply the desired audio level to the filter. The low pass filter has a nominal cutoff frequency of 12.5 kHz (10.5 kHz at 1.0 dB down) when S1(1) and S1(2) are open. The high frequency roll-off can be reduced to 9.5 kHz, 8.5, kHz or 7.5 kHz depending on the settings of S1(1) and S1(2). Refer to the low pass filter chart on figure FO-3 for switch settings. Varistor RV1 shunts unwanted voltage transients over 4.0 volts, that enter the the transmitter on the audio input lines, to ground.

2.3.2.2 High-Pass Filter Description: Operational amplifier U1B, switch S2 and their associated components form a two-pole, high pass filter for the audio signal. The low frequency roll-off (1.0 dB down) is selective to 9.0 Hz, 26 Hz, 45 Hz or 63 Hz depending on the settings of S2(1), S2(2), S2(3) and S2(4). Refer to the high pass filter chart on figure FO-3 for switch settings. Test point TP1 provides a test monitoring point for the filtered audio signal.

2.3.2.3 Audio Limiter Description: The audio limiter consists of wideband monolithic four-quadrant multiplier U4, which is connected as a variable gain, wideband, linear amplifier, and its associated components. The filtered audio is applied to the X offset input of U4. Resistors R28/R29/R30/R33 form an adjustable voltage divider that applies a balance voltage to the X input of U4. X BAL potentiometer R29 is adjusted to balance the amplifier and provide a constant dc voltage at test point TP5 regardless of the voltage differential between the Y input and Y offset inputs of U4, when audio is not being applied. OFS ADJ potentiometer R42 is adjusted for a 1.75 volts dc offset voltage at TP5. This voltage ultimately controls the unmodulated rf carrier output level of the transmitter. When audio is being applied, the voltage differential between the Y input and Y offset inputs of U4 determines the audio gain of amplifier U4 and the resultant audio is superimposed on the 1.75 volts dc offset voltage.

2.3.2.4 Audio Peak/Trough Threshold Description: The audio peak/trough thresholds circuit consists of comparators U2A, U2B and their associated resistors. The 1.75 volts dc offset voltage, with superimposed audio, is applied to the inverting gate of U2A and the non-inverting gate of U2B. Resistors R13 thru R18 form a voltage divider, that provide reference threshold voltages. HI LIMIT potentiometer R16 is adjusted to provide a threshold voltage that represents the maximum modulation peaks (positive modulation) of the rf output. Adjustment range of R16 is between 100 and 125 percent positive peaks. LO LIMIT potentiometer R18 is adjusted to provide a threshold voltage that represents the maximum modulation troughs (negative modulation) of the rf output. Adjustment range of R18 is between 95 and 100 percent negative troughs. Under normal operation the positive and negative going excursions of the composite signal applied to the inverting gate of U2A and the non-inverting gate of U2B will not exceed their reference thresholds. The outputs of U2A and U2B will be a high impedance to ground. When either threshold is exceeded, the output of U2A and/or U2B will switch to a low impedance to ground for period of time the thresholds are being exceeded.

2.3.2.5 Audio Limiter Control Description: The audio limiter control circuit consist of operational amplifier U3B, comparators U2C, U2D and their associated components. When the output of the peak/trough thresholds circuit is a high impedance to ground, capacitors C10 and C12 will be discharged. The non-inverting input of U3B will be maintained at the reference voltage applied from the junction of R13/R14 (nominally 8.0 volts dc). The output of unity gain amplifier U3B is applied thru zener diode CR5 and applies approximately 3.3 volts dc to the Y offset input of U4. When the output of the peak/trough thresholds circuit is a series of low impedance pulses to ground, C10 and C12 will charge towards +8.0 volts dc thru diodes CR1 and CR2 during the time the low impedance is applied and discharge thru R20 and R25 when the impedance is high. The fast attack and slow recovery characteristics of this circuit cause C10 and C12 to charge to an average value that is proportional to the low/high impedance ratio. The voltage on the non-inverting input of U3B will be less positive by this amount, resulting in the voltage on the Y offset input of U4 decreasing an equal amount. The output of U3B is also applied to the non inverting inputs of comparators U2C and U2D. A 3.0 dB down reference threshold voltage, from the junction of R14/R15 is applied to the inverting inputs of U2C and U2D. Normally, the output of U3B will be more positive than the reference threshold and the outputs of U2C/U2D will be a high impedance to ground. When the output of U3B decreases by an amount that causes the audio output of U4 to be reduced by 3 dB (approximately 1.0 volts dc), the non-inverting inputs of U2C/U2D will be less positive than their inverting inputs. The output of U2C/U2D will switch to a low impedance to ground. This low impedance is applied thru J1-5 as the 'audio limit' output to AUDIO LIMIT lamp DS6 on the front panel. AUDIO LIMIT lamp DS6 will flash and/or remain on while this low impedance is present.

2.3.2.6 Line Volts Compensation Control Description: The line volts compensation control consists of wideband monolithic four-quadrant multiplier U5, which is connected as a dynamic analog divider, operational amplifier U8A and their associated components. Analog divider U5 is effectively connected as a feedback circuit between the output of U8A and its inverting input. The gain of analog divider U5 is controlled by one of two inputs; the 'B-' voltage applied to its 'Y' input and the 'external gain' dc voltage applied to its scaling inputs. The 'external gain' dc voltage input may be varied from zero to +15 volt dc and will permit a plus/minus ten percent control of the rf carrier if it is set to +7.5 volts dc during calibration. Any 'external gain' dc voltage change causes a corresponding change to the scale factor and therefore the gain of analog divider U5. An increase in the 'external gain' voltage causes an increase in the gain of U5. X BAL potentiometer R47 is adjusted to set the gain of analog divider U5 at unity when the 'B-' voltage is ideal. When the 'B-' voltage varies, the gain of analog divider U5 is changed by an amount that is inversely proportional to any variation. U5 will provide a negative feedback when the 'B-' voltage goes more negative and a positive feedback when it goes less negative. OFS ADJ potentiometer R70 is adjusted to balance the divider and minimize the amount of ac ripple being coupled thru U5 to the input of U8A. U8A is connected as an inverting amplifier for the dc offset voltage with superimposed audio applied to its inverting input from the output of U3C. Its output will be -1.75 volts dc when the 'B-' voltage is ideal, the 'external gain' input is set at the dc voltage present during the last calibration and there is no modulation present.

2.3.2.7 High Rf Current/Low Rf Drive Attenuator Description: The high rf current/low rf drive attenuator circuit consists of comparators U7A, U7B, transistors Q3, Q4 and their associated components. The 'rf current' input on J2-12 is not connected in this application, therefore the inverting input of U7B will always be less positive than its inverting input and the output of U7B will be a high impedance to ground. U7B will not have any influence on the voltage applied to the base of Q3. Normally, the 'rf drive level' applied to the inverting pin of U7A, from J2-11, will be a dc voltage that is more positive than the reference threshold voltage applied to its non-inverting input from the junction of R58/R59. The output of U7A will be a low impedance to ground, resulting in the base/emitter junction of Q3 to be forward biased. The resultant positive voltage at the junction of R82/R83 will reverse bias Q4. Q4 will be turned off and have no influence on the 'PWM reference' signal. When the 'rf drive level' falls to a level that is less positive than the reference threshold voltage, the output of U7A will switch to a high impedance to ground. Q3 will be reverse biased and turned off. The resultant negative voltage at the junction of R82/R83 will forward bias Q4. Q4 will be turned on and clamp the 'PWM reference' signal to a near ground potential thru R85. Inverter U10A follows and inverts the logic level on the output of U7A. When U7A's output is high, indicating the rf drive level is low, a ground potential 'rf drive alarm' signal is applied thru J2-5 to RF DRIVE ALARM lamp DS11 on the front panel; causing it to turn on. J2-6, 'rf current alarm', is not connected in this application.

2.3.2.8 Low/Med Pwr Level Attenuator Description: The low/medium power level attenuator circuit consists of transistors Q1, Q2 and their associated components. When the high power level of operation is selected, the 'low level' and 'med level' inputs to J1-12 and J1-6 are an open circuit. Transistors Q1 and Q2 will be reverse biased and have no influence on the 'PWM reference' signal. When low power level of operation is selected, a -15 volt dc 'low level' input is applied to the base of Q1 thru R1. Q1 will be forward biased and place LOW PWR 1 potentiometer R6 between the 'PWM reference' signal and ground. LOW PWR 1 potentiometer R6 is adjusted to provide a voltage at the junction of R84/R6 that represents the low level rf carrier output of the transmitter. When medium power level of operation is selected, a -15 volt dc 'med level' input is applied to the base of Q2 thru R2. Q2 will be forward biased and place LOW PWR 2 potentiometer R7 between the 'PWM reference' signal and ground. LOW PWR 2 potentiometer R7 is adjusted to provide a voltage at the junction of R84/R7 that represents the medium level rf carrier output.

2.3.2.9 Rf Stress Current Protection Description: The rf stress current protection circuit consists of operational amplifier U8D and its associated components. When the 'rf stress current' input from J2-1, that is applied to the inverting pin of U8D, is less positive than the dc reference voltage, from the junction of R86/R88, on U8D's non-inverting input; the output of U8D is a positive voltage. A positive voltage output will have no influence on the operation of the linear attenuator or the VSWR alarm circuits. When the 'rf stress current' applied to U8D exceeds the dc reference voltage level, the output of U8D will be a negative voltage. Any negative voltage in excess of approximately -0.6 volts will be passed thru diode CR3 as the control voltage for the linear attenuator circuit. Diode CR4 limits the maximum negative excursion of this control voltage to approximately -0.6 volts. Capacitor C21 provides a fast attack and slow recovery time by charging instantaneously thru CR3 when a negative voltage is present, and discharges thru R95/R96 when the negative voltage is removed.

2.3.2.10 Linear Attenuator Description: The linear attenuator consists of operational amplifiers U8B, U8C, transistors Q5, Q6 and their associated components. U8B and Q5 are configured to effectively be a diode to ground and result in a bias voltage of approximately 0.6 volts dc being applied to the emitter of Q6. Normally the control voltage applied to the non-inverting input of U8C, from the junction of CR3/CR4, is zero volts. Unity gain amplifier U8C applies this zero voltage to the base of Q6, causing it to be reverse biased. The 'linear attenuator' will be a high impedance between the 'PWM reference' level and ground. When a negative control voltage is applied to the non-inverting input of U8C, from the junction of CR3/CR4, U8C produces a negative voltage at its output. This negative voltage will forward bias Q6 and it will start to conduct. When Q6 is conducting, the impedance of the linear attenuator will decrease in proportion to the current flow thru Q6. The attenuation factor varies in direct proportion to the control voltage at the junction of CR3/CR4. (A control voltage variation from 0.0 volts to -0.6 volts dc causes the attenuation factor to vary from 0.98 to 0.01).

2.3.2.11 PWM Square Wave Generator Description: The PWM square wave generator consist of programmable timer U1 and its associated components. The oscillator frequency is adjusted to a precise frequency between 68.55 kHz and 74.12 kHz, dependent on the assigned rf carrier frequency, by 'FREQ ADJ' variable capacitor C15. The output of the generator is 15 volt square waves at the oscillator frequency. This square wave can be monitored at test point TP4.

2.3.2.12 Ramp Integrator Description: Ramp integrator circuit consists of operational amplifier U9A and its associated components. The 15 volt square wave from the PWM square wave generator is applied to the inverting input of U9A. Capacitor C19/resistor R81, which are located in the feedback circuit of U9A, result in a linear sawtooth waveform being produced at the output of U9A. This waveform can be monitored at test point TP8. 'Ramp ADJ' potentiometer R75 is adjusted to set the positive peaks of the linear sawtooth waveform to a dc reference potential of zero volts.

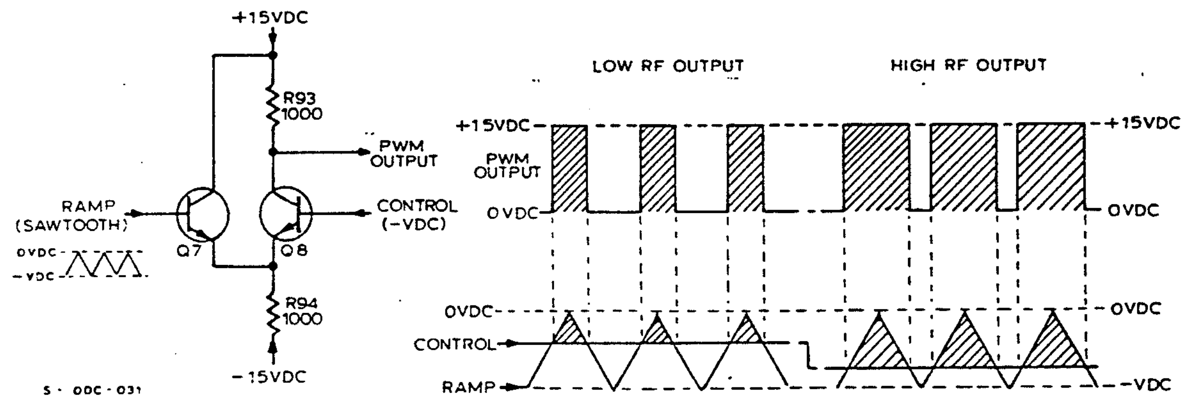


Figure 2-1 Simplified Schematic of PWM Differential Amplifier

2.3.2.13 Variable Pulse-width Generator Description: The variable pulse-width generator consists of operational amplifier U9B, transistors Q7, Q8 and their associated components. They are configured to form an emitter coupled differential amplifier. A portion of the 'PWM reference' signal is applied to the non-inverting input of unity gain buffer amplifier U9B from the wiper of O/P PWR potentiometer R92. The output of U9B is appliesd to the base of Q8. The linear sawtooth waveform from ramp integrator U9A is applied to the base of Q7. Refer to figure 2-1 for a simplified schematic of the differential amplifier.

For initial explanation purposes, assume the 'PWM reference' (control) input is a negative dc reference voltage that does not contain the audio component and the linear sawtooth waveform (ramp) voltage is varying from -15 to zero volts dc. When the control voltage is more positive than the ramp voltage, Q8 will be forward biased and Q7 will be reverse biased. When the ramp voltage is more positive than the control voltage, Q7 will be forward biased and Q8 will be reverse biased. The output at the collector of Q8 will be approximately zero volts dc when Q8 is forward biased and +15 volts dc when it is reverse biased.

When audio is superimposed on the control ('PWM reference') input, the voltage applied to the base of Q8 will change at the audio rate. The magnitude of the change, which determines the forward/reverse bias ratio of Q8, will be determined by the amplitude of the audio component. When the audio component causes the control voltage to go more negative, Q8 will be reverse biased for a longer portion of the ramp period. When it causes the control voltage to go less negative, Q8 will be reverse biased for a shorter portion of the linear sawtooth waveform period. The resultant pulse-width modulated output, at the collector of Q8, is a rectangular waveform, at the repetition rate of the square wave generator (nominally 70 kHz). The on/off ratio of this rectangular waveform is determined by the dc reference level of the control ('PWM reference') input and the amplitude of the superimposed audio.

2.3.2.14 Balance Drive Description: Balanced drive consist of buffer amplifier U10C, transistor Q9, Q10 and their associated components. The pulse-width modulated signal is inverted by buffer amplifier U10C. Transistors Q9 and Q10 will be gated on and off at the nominal 70kHz switching frequency. The switching action of Q9/Q10 ensures the leading and trailing edges of the rectangular waveform are sharp. The 'mod drive' output at J2-9 is a low impedance pulse-width modulated signal switching between +15 volts dc and ground.

2.3.2.15 Pulse-width Fault Detector Description: The pulse-width fault detector circuit consists of comparator U7D, inverter U10D, transistor Q12 and their associated components. Integrator circuit R100/R101/R108/C23, continuously monitors the 'mod drive' output for the presence of positive voltage pulses. When they are present, C23 will charge to an average value, dependent on the on/off ratio. Normally the voltage on C23, which is applied to the inverting input of U7D, will exceed the reference threshold voltage applied to the non-inverting input of U7D from the junction of R58/R59. The output of U7D will be a low impedance to ground, resulting in the output of U10D being +15 volts dc. A 'mod drive alarm' signal will not be applied to J2-3. The base/emitter junction of Q12 will be forward biased, resulting in a ground potential 'mod drive enable' output being applied to J2-2. When the voltage on C23 does not exceed the reference threshold voltage applied to the non-inverting input of U7D, the output of U7D will be a high impedance to ground. The output of U10D will be zero volts dc. A zero potential 'mod drive alarm' signal will be applied thru J2-3 to MOD DRIVE ALARM lamp DS10 on the front panel and turn it on. The base/emitter junction of Q12 will be reverse biased, and remove the ground potential 'mod drive enable' output from J2-2. Zener diode CR6 ensures switching transients do not exceed 33 volts.

2.3.2.16 VSWR Alarm Control Description: VSWR alarm control circuit consists of transistor Q11, inverter U10 and their associated components. When the output of the rf stress current protection circuit is a positive voltage, Q11 will be reverse biased and turned off. The 'VSWR alarm' output at J2-4 will be +15 volts dc. When the output of the rf stress current protection circuit is a negative voltage, Q11 will be forward biased and turned on. A ground potential 'VSWR alarm' output will be applied thru J2-4 and turn on VSWR ALARM lamp DS8.

2.3.3 MODULATOR/POWER AMPLIFIER NAA13/1 DESCRIPTION (see figure FO-5): Modulator/power amplifier A3 produces the rf carrier power of the transmitter and an output for monitoring purposes.

2.3.3.1 Modulator Description: The 'mod drive' (zero to +15 volt dc pulses) input is applied to one input of gate A1U1A, from TB2-6. When a ground potential 'mod drive enable' is applied to the other input of A1U1A, from TB2-5, the output of A1U1A will follow the logic level changes of the 'mod drive' input. When the 'mod drive enable' input is an open collector, the output of A1U1A will be held at a high level (+15 volts dc), and the 'mod drive' information will be inhibited.

Transistors A1Q1 and it associated components forms a logic level converter that changes the positive voltage logic of the 'mod dive' input to a negative voltage logic. When the output of A1U1A is +15 volts dc, A1Q1 is reverse biased and will be turned off. When the output of A1U1A is zero volts dc, A1Q1 is forward biased and will be turned on. The base of A1Q2/Q3 will be switched to approximately -15 volts dc.

Transistors A1Q2/Q3 and their associated components form a balanced drive switching circuit for power MOSFET's Q1 and Q2. Zener diode A1CR1/resistor R4 establish a reference voltage which is 13 volts dc below the B- voltage input. This reference voltage is applied to the collector of A1Q2. When the base of A1Q2/Q3 is at the B- potential, A1Q2 will be reverse biased and turned off and A1Q3 will be forward biased and turned on. The voltage at the junction of A1Q2/Q3 emitters will be at the B- level. When the base of A1Q2/Q3 is at -15 volts dc, A1Q2 will be forward biased and turned on and A1Q3 will be reverse biased and turned off. The output at the junction of A1Q2/Q3 will be a rectangular waveform, at the nominal 70kHz switching frequency, that is switching from the B- voltage to a voltage that is approximately 13 volts less than the B- voltage

Power MOSFET's Q1, Q2, inductors A2L1, A2L2, A2L3 and capacitors A2C1 thru A2C5 form a switched modulator that produce a filtered negative dc voltage that is proportional to the on/off ratio of the nominal 70 kHz rectangular waveform applied to the gates of power MOSFET's Q1/Q2 thru resistors R6 and R9. When the gates of Q1/Q2 are less negative than the B- voltage being applied to their source inputs, Q1/Q2 will turn on simultaneously, and the sum of their current flow will be applied thru A2L1 to capacitors A2C1, A2C2 and A2C4 in the low pass filter. The capacitors will start to charge towards the B- voltage. When the gates of Q1/Q2 are at the same potential as the B- voltage, Q1/Q2 will turn off simultaneously and capacitors A2C1/A2C2/A2C4 will start to discharge thru the load presented by the power amplifier stage. The fast attack, slow recovery action of this circuit results in the output of the 'low pass filter' being the average value which is determined by the on/off ratio of power MOSFET's Q1/Q2, for example; when the on/off ratio is 50 percent, the voltage on the capacitor network will be approximately half of the B- voltage. Free wheeling diode CR1 shunts positive voltage spikes that occur when current flow thru the inductors is switched on and off. Inductors A2L1/L2/L3 and capacitors A2C1 thru A2C5, form a filter circuit that removes the nominal 70 kHz switching frequency but allows audio information to pass without attenuation. The resultant negative dc voltage with superimposed audio is applied to the power amplifier switching circuit as the modulator output voltage. A sample of this voltage is also applied thru R2/TB2-3 as the 'mod output volts' to the metering circuits for monitoring purposes.

2.3.3.2 Power Amplifier Description: The 'rf drive' input is applied to the primary windings of transformers T1 and T2, from TB2-1/2 , and coupled to their secondary windings. The output of each secondary winding is applied across the gate and source of a power MOSFET. When the gate of a MOSFET device is positive relative to its source, the device will be turned on. When the gate is negative, relative to its source, the device will be turned off. A hot carrier diode is placed across the source/drain junction of each power MOSFET device, to ensure switching transients do not damage the device. The secondary windings of T1/T2 are configured to ensure that the voltage applied to Q3/Q6 and Q7/Q10 (push-pull arrangement) are in phase and that the voltage applied to Q4/Q5 and Q8/Q9 are in phase. The voltage applied to Q3/Q6 and Q7/Q10 is 180 degrees out of phase with the voltage applied to Q4/Q5 and Q8/Q9 When Q3/Q6 and Q7/Q10 are turned on, Q4/Q5 and Q8/Q9 will be turned off. Current will flow from the modulator output voltage source, thru the source/drain junction of Q3/Q7 to TB2-1, thru the primary windings of an impedance matching transformer (T2 of figure FO-1), thru TB2-2, thru the source/drain junction of Q6/Q10 to ground. During the next half cycle, Q3/Q6 and Q7/Q10 are turned off, Q4/Q5 and Q8/Q9 will be turned on. Current will flow from the modulator output voltage source, thru the source/drain junction of Q5/Q9, thru the primary windings of impedance matching transformer T2 (in the reverse direction), thru the source/drain junction of Q4/Q8 to ground. The resultant rf output on the secondary of T2 is applied across TB4-1 and TB4-2 (see figure FO-1). The maximum and minimum undistorted rf carrier output that the power amplifier can produce is dictated by the magnitude of the 'B-' voltage applied to E1/E2. Refer to paragraph 5.6.4 for an explanation of the range of unmodulated rf carrier outputs levels that can be produced with the four possible B- voltages available, noting that the magnitude of the B- voltage will be relative to the rms ac voltage selected from A8T1.

2.3.3.3 Thermal Switch: Switch S1 is normally open. When the temperature in the power amplifier reaches 65°C switch S1 closes and turns on a cooling fan within the transmitter chassis. Switch 'S1' opens when the temperature falls below 65°C.

2.3.4 NAS17 PA POWER SUPPLY ASSEMBLY DESCRIPTION (see figure FO-9): The 'ac power' source is applied to one of three primary winding taps on step-down transformer T1. The tap selected is dictated by the mean rms level of the ac power source. The secondary winding is tapped to provide four output voltages. The tap or taps selected is dictated by the power levels assigned to the transmitter's three power operating modes. Refer to paragraph 3.7.4 for the logic in selecting the secondary taps of T1. The tap selected for the high power mode is connected to K1-5/8 and the tap selected for any power level that is not in the range of the high power selection is connected to K1-1/4. When a 23 volt dc 'reduce pwr' signal is not applied to K1-14 thru TB1-5, relay K1 will be de-energized and the ac voltage applied to K1-5/8 will be applied to bridge rectifier U1 thru K1-9/12. When a 23 volt dc 'reduce pwr' signal is applied to K1-14, relay K1 will be energized and the ac voltage applied to K1-1/4 will be applied to bridge rectifier U1. The resultant negative dc voltage, at the negative terminal of U1, is applied thru choke L1 to TB1-6 as the 'B- vdc' output for the power amplifier's power MOSFETs. Choke L1 and capacitor C1,(capacitor C1 is located on the transmitter chassis) provide filtering and smoothing of the negative dc voltage. The positive terminal of U1, is connected thru shunt resistor R4 to ground as the B- return path. Taps on resistor R4 provide a dc voltage that is representative of the current flow in the power amplifier. This voltage is applied across TB2-5(+) and TB2-6(-) for metering purposes.

2.3.4.1 Power MOSFET Q1, zener diodes CR1, CR2; and resistors R1, R2, R3 form an over-voltage regulator. When the B- voltage is less than 82 volts dc, CR1 will not breakdown and the gate of Q1 will be maintained at the same potential as its source. Q1 will be reverse biased and have no influence on the B- voltage. When the B- voltage exceeds -82 volts, diode CR1 will break-down, and drop any voltage in excess of 82 volts across R1. The gate of Q1 will be less negative than the B- voltage on its source. Power MOSFET Q1 will be forward biased and current will flow thru Q1 and resistor R3. The additional loading of the B- power supply will reduce the B- voltage to a safe operating level and provide protection for the power MOSFET's in the power amplifier. Zener diode CR3 ensures the voltage applied to the gate of Q1 is not permitted to exceed 13 volts relative to its source.

2.3.5 NAS18 LOW VOLTAGE POWER SUPPLY DESCRIPTION (see figure FO-8): The ac power is applied to the primary winding of step-down transformer T1. A 36 volt RMS ac voltage is coupled to its center-tapped secondary winding and applied to dual full wave rectifier U1. The output at the positive terminal of U1 is an unregulated +23 volts dc that is applied to the collector of Q1 and thru TB1-3 to the transmitter circuits. Capacitor C5 is a smoothing capacitor which reduces the ac ripple.

2.3.5.1 +15 Volt Dc Regulator: Darlington transistor Q1 is employed as a switch that turns on when a +23 volt dc 'VDC enable' input is applied to its base from TB1-4, or turns off when the +23 volt dc 'VDC enable' input is removed. Capacitor C6 filters any ac ripple from the 'VDC enable' input. Zener diode CR2 clamps the base of Q1 to 20 volts dc when the 'VDC enable' input is applied and ensure the voltage applied to U3 is 18 volts dc regardless of the load on the '+15 vdc' output. When Q1 is turned on, approximately 18 volts dc is applied to +15 volt dc regulator U3. The +15 volt dc output of U3 is applied to the logic and metering circuits of the transmitter thru TB1-5. Capacitors C7 and C8 are rf capacitors that provide stability for U3, and C9 provides smoothing.

2.3.5.2 -15 Volt Dc Regulator: The output at the negative terminal of U1 is an unregulated -23 volts dc that is applied to -15 volt dc regulator U2 thru R1. The -15 volt dc output of U2 is applied to the logic and metering circuits of the transmitter thru TB1-6. Zener diode CR1 ensures the negative voltage applied to U2 does not exceed -33 volts dc due to transients on the ac power source. Capacitor C1 smooths the unregulated -23 volt dc input, while C1, C2 are rf capacitors that provide stability. C4 provides smoothing for the regulated -15 volt dc output.

2.3.6 NAPC9/1 INTERFACE PCB (see figure FO-7): Interface pcb A6 contains a B-/rf monitor circuit, an interlock control circuit, a VSWR alarm circuit, a tx fault threshold circuit, a tx fault alarm circuit, a buffered forward power circuit and a buffered reflected power circuit. Each of these circuits is described independently in the following paragraphs.

2.3.6.1 B-/RF Monitor Level Control Description: A sample of the rf output is applied to auto transformer T1-1, thru J1-12, as the 'rf monitor' input and the B- voltage being applied to power amplifier A3 is applied to J1-1.

When the transmitter is operating in the high power mode of operation, a -15 volt dc 'hi pwr' input is applied to the base of transistor Q1, thru J1-10, diode CR1 and resistor R5. Q1 will be forward biased and cause relay K1 to be energized. A portion of the voltage on T1-4/5, dependent on the setting of HIGH Monitor potentiometer R3, is applied to J2-1 as the 'rf monitor' output. Normally this voltage is set to 5.0 volts rms when the resistance of the monitoring equipment is 1000 ohms, but may be set to a lesser voltage if required. The B-voltage is connected to HIGH B- potentiometer R44. The setting of HIGH B- potentiometer R44 determines the B- reference voltage (nominally -6.4 volts dc) that will be applied to the line volts compensation circuit in mod driver pcb A2 during high power operation.

When the transmitter is operating in the medium power mode of operation, a -15 volt dc 'med pwr' input is applied to the base of transistor Q2, thru J1-8, diode CR2 and resistor R7. Q2 will be forward biased, cause relay K2 to be energized and apply 23 volts dc to J2-3, thru R38, as the 'medium pwr lamp' output. MED PWR lamp DS4 on the front panel will be turned on. A portion of the voltage on T1-2/3, dependent on the setting of MED Monitor potentiometer R2, is applied to J2-1 as the 'rf monitor' output. MED Monitor potentiometer R2 is adjusted to provide the same 'rf monitor' output voltage as was present during high power operation. The B- voltage is connected to MED B- potentiometer R45. The setting of MED B- potentiometer R45 determines the B- reference voltage (nominally -5.4 volts dc) that will be applied to the line volts compensation circuit in mod driver pcb A2 during medium power operation.

When the transmitter is operating in the low power mode of operation, a -15 volt dc 'lo pwr' input is applied to the base of transistor Q3, thru J1-6, diode CR3 and resistor R9. Q3 will be forward biased, cause relay K3 to be energized and apply 23 volts dc to J2-5, thru R39, as the 'low pwr lamp' output. LOW PWR lamp DS3 on the front panel will be turned on. A portion of the voltage on T1-1, dependent on the setting of LOW Monitor potentiometer R1, is applied to J2-1 as the 'rf monitor' output. LOW Monitor potentiometer R1 is adjusted to provide the same 'rf monitor' output voltage as was present during high power operation. The B- voltage is connected to LOW B- potentiometer R46. The setting of LOW B- potentiometer R46 determines the B- reference voltage (nominally -5.4 volts dc) that will be applied to the line volts compensation circuit in mod driver pcb A2 during low.

When a -15 volt dc 'med pwr' input is applied to J1-8, it is coupled thru CR5 to J2-7 as the 'med level' control signal for the attenuator in mod driver A2. When a -15 volt dc 'lo pwr' input is applied to J1-6, it is coupled thru CR4 to J2-5 as the 'low level' control signal for the attenuator in mod driver A2. Connection of diode links A and/or B across relays K2/K3 is dictated by the power levels assigned to the transmitter's three power operating modes (refer to paragraph 6.6.4). If in medium or low power of operation and the diode links have been installed a 23 volt dc 'reduce pwr' signal is applied to J2-4 thru transistor Q2 or Q3.

2.3.6.2 Interlock Control Description: When a ground potential 'interlock' input is applied to K4-6 from J2-9, indicating the interlock circuit is closed, relay K4 will be energized. 23 volts dc will be applied to J2-7, thru R36, as the 'rf on lamp' output. RF ON lamp DS2 on the front panel will turn on. 23 volts dc will also be applied to J2-8, thru R37, as the 'vdc enable' output. The regulated +15 volt dc output of power supply A7 will be enabled. When the 'interlock' input on J2-9 is not a ground potential, indicating the interlock circuit is open, relay K4 will be de-energized. 23 volts dc will be removed from J2-7 and J2-8. RF ON lamp DS2 on the front panel will turn off and the regulated +15 volt dc output of power supply A7 will be inhibited. 23 volts dc will be applied to J2-6, thru R35, as the 'interlock alarm lamp' output. INTERLOCK ALARM lamp DS7 on the front panel will turn on.

2.3.6.3 VSWR Alarm Description; The 'high VSWR' alarm input to J1-4 will be a ground potential when a high rf stress current is sensed by mod driver A2 and will be +15 volts dc, thru A9R5 and HIGH VSWR ALARM lamp DS8, when the rf stress current is satisfactory. When a +15 volt dc 'high VSWR' input is applied to the base of Q6, thru J1-4 and resistor R17, Q6 will be reverse biased. Q7 will be reverse biased and an open collector output will be applied to J2-12 as the 'VSWR alarm (external)' output. When a ground potential 'high VSWR' input is applied to the base of Q6, thru J1-4 and resistor R17, Q6 will be forward biased. Q7 will be forward biased and a ground potential 'VSWR alarm (external)' output will be applied to J2-12. Zener diode CR10 protects the circuit against voltage transients in excess of 33 volts, that may be introduced on external interconnecting wiring.

2.3.6.4 Tx Fault Threshold Description; The Tx Fault threshold circuit consists of comparators U1C, U1D, U2C, transistors Q4, Q5, analog switches U3B, U3C and their associated components. A 'fwd pwr' input, which is a positive dc voltage that is representative of the forward power output of the transmitter, is applied to the non-inverting inputs of comparators U1C, U1D and U2C, thru J3-4/5 and resistor R29.

When the transmitter is operating in its low power mode of operation, transistors Q4 and Q5 will be reverse biased. Analog switches U3B and U3C will have zero volts dc applied to their control gates and will be an open circuit. A reference voltage is applied to the inverting input of U2C from the wiper of LOW potentiometer R28. LOW potentiometer R28 is adjusted to provide a voltage that represents the low power fault threshold level. When the 'fwd pwr' input is more positive than the reference threshold voltage, the output of comparator U2C will be a high impedance to ground.

When the transmitter is operating in its medium power mode of operation, a -15 volt dc 'med pwr' input is applied to the base of transistor Q4, thru J1-8 and resistor R10. Q4 will be forward biased and apply 15 volts dc to the control gate of U3C. U3C will be a closed switch and apply the resistance presented by U1D to the control gate of U3A. Transistor Q5 will still be reverse biased and analog switch U3B will be an open circuit. A reference voltage is applied to the inverting input of U1D from the wiper of MED potentiometer R26. MED potentiometer R26 is adjusted to provide a voltage that represents the medium power fault threshold level. When the 'fwd pwr' input is more positive than the reference threshold voltage, the output of comparator U1D will be a high impedance to ground. When the 'fwd pwr' input is less positive than the reference threshold, the output of comparator U1D will be a low impedance to ground.

When the transmitter is operating in its high power mode of operation, a -15 volt dc 'hi pwr' input is applied to the base of transistor Q5, thru J1-10 and resistor R14. Q5 will be forward biased and apply 15 volts dc to the control gate of U3B. U3B will be a closed switch and apply the resistance presented by U1C to the control gate of U3A. Transistor Q4 will be reverse biased and analog switch U3C will be an open circuit. A reference voltage is applied to the inverting input of U1C from the wiper of HIGH potentiometer R24. HIGH potentiometer R24 is adjusted to provide a voltage that represents the high power fault threshold level. When the 'fwd pwr' input is more positive than the reference threshold voltage, the output of comparator U1C will be a high impedance to ground. When the 'fwd pwr' input is less positive than the reference threshold, the output of comparator U1C will be a low impedance to ground.

2.3.6.5 Tx Fault Alarm Description: When the output of the tx fault threshold circuit is a high impedance, 15 volts dc will be applied to the control gate of U3A thru R31 and to the base of Q8 thru R32. 15 volts dc will be applied thru U3A to the base of Q9 thru R33. Q9 will be forward biased and apply a ground potential 'tx fault alarm (external)' output to J3-2. Q8 will be reverse biased and present an open collector 'tx fault lamp' output to J3-1. When the output of the tx fault threshold circuit is a low impedance, the control gate of U3A and the base of Q8 will be clamped to ground. U3A will be an open circuit and remove the 15 volt dc bias from the base of Q9. Q9 will be reverse biased and present an open collector 'tx fault alarm (external)' output to J3-2. Q8 will be forward biased and apply 15 volts dc thru R34 to J3-1 as the 'tx fault lamp' output. TX FAULT ALARM lamp DS9, on the front panel, will turn on. Zener diode CR11 protects the circuit against voltage transients in excess of 33 volts, that may be introduced on external interconnecting wiring.

2.3.6.6 Buffered Forward Power Description: The 'fwd pwr' input, which is a positive dc voltage that is representative of the forward power output of the transmitter, applied thru J3-4/5 is also applied thru R29 to the non-inverting input of comparator U2D, which is connected as a follower amplifier. The filter network of capacitor C4 and resistor R22/R29 removes the modulation component of the 'fwd pwr' signal, resulting in a smoothed dc voltage, that is 0.924 of its original level being applied to J3-3 as the 'buffered fwd pwr' output for remote monitoring. Capacitor C5 provides additional smoothing for the output of U2D.

2.3.6.7 Buffered Reflected Power Description: The 'refl pwr' input applied to J3-8/9/10, which is a positive dc voltage that is representative of the reflected power output of the transmitter, is applied thru R16 to the non-inverting input of comparator U1B, which is connected as a follower amplifier. The filter network of capacitor C2 and resistors R13/R16, removes the modulation component of the 'refl pwr' signal, resulting in a smoothed dc voltage, that is 0.924 of its original level being applied to J3-11 as the 'buffered refl pwr' output for remote monitoring. Capacitor C3 provides additional smoothing for the output of U1B.

2.3.7 RF STRESS CURRENT PROTECTION DESCRIPTION (see figure FO-2): The rf stress current protection circuit continuously monitors the 'rf current sample' for amplitude and phase. It produces a dc voltage, that is representative of the peak rf output current and/or the amount the rf drive/rf output phase differs, as the 'rf stress current'.

2.3.7.1 RF Drive Digitizer Description: The 'rf drive sample' at the junction of L6/R12 is applied to the base of transistor Q1 thru resistor R21. Resistors R23, R24 and capacitor C18 provide an R/C circuit that compensates for phase shift that occurs in power amplifier A3. Transistors Q7/Q8 are connected as a digitizer circuit that produces a square wave at the rf drive frequency with sharp leading and trailing edges. The square wave output on the collector of Q8 will be +15 volts during dc the positive half cycles of the rf drive and will be near ground potential during the negative half cycles.

2.3.7.2 PA Current Digitizer Description: The 'RF current sample' input at terminal 'A' is applied to the base of Q9 thru resistor R22. Transistors Q9/Q10 are connected as a digitizer circuit that produces a square wave signal of the rf output current, with sharp leading and trailing edges. The square wave output on the collector of Q10 will be +15 volts dc during the positive half cycles of the rf current sample' input and will be near ground potential during negative half cycles.

2.3.7.3 Phase Difference Detector Description: The rf drive square wave output, from the collector of Q8, is applied to one input of exclusive 'OR' gate U3A. The rf current square wave output, from the collector of Q10, is applied to the other input of U3A. When the square waves are in phase, the output of U3A will be zero volts dc. As a phase difference occurs, the output of U3A will be +15 volt pulses for the period of time the square waves are not in phase. Resistor R29/capacitor C19 form an integrator that charges to the average value of the +15 volt/zero volt ratio. The wiper of PHASE potentiometer R30 is adjusted during calibration for the voltage that represents the maximum phase difference before the resultant rf output current will stress the rf output devices.

2.3.7.4 PA Current Detector Description: The 'RF current sample' input at terminal A is also applied to diode CR7, which is connected as a half-wave rectifier. Capacitor C20 shunts the rf component to ground. The resultant dc voltage is proportional to the magnitude of the rf output current. The wiper of CURRENT LEVEL potentiometer R31 is adjusted during calibration for the voltage that represents the maximum peak rf output current, before the rf output devices are stressed.

2.3.7.5 Buffer Amplifier Description: The phase difference voltage, from the wiper of PHASE potentiometer R30, and the rf output voltage, from the wiper of CURRENT LEVEL potentiometer R31, are summed and applied to the non-inverting input of U4B. The output of U4B is applied to J2-4 as the 'rf stress current' output, and will be a positive dc voltage that is approximately four times the sum of the inputs applied to the non-inverting input of U4B.

2.3.8 RF OUTPUT FILTER DESCRIPTION (see figure FO-1): NAF34 rf output filter A4 consists of a three-pole, fixed-tuned, L/C network that is resonant at the assigned rf carrier frequency. This circuit is connected in a series-parallel configuration. All noise and harmonic signals on the rf output will be reduced to a level that is a minimum of 69dB below the carrier frequency.

2.3.9 RF POWER PROBE ASSEMBLY (see figure FO-6): NAFP11 rf power probe A5 consists of voltage transformer T1, current transformer T2 and their associated components. The rf output is applied thru the primary winding of T1 and across the primary winding of T2. The resultant rf voltage coupled to the secondary winding of T2 is summed with the resultant rf voltages coupled to two sets of secondary windings of T1. The rf voltage across T1-3/4 is added to the rf voltage from T2-1 and applied to half-wave rectifier diode CR1. The rf component on the resultant ripple dc voltage is filtered by inductors L1/L2 and capacitor C1 and applied to J1-2 as the 'fwd pwr' output. The 'fwd pwr' output is a positive dc voltage, with superimposed modulating audio, that is representative of the rf carrier's forward power level. The rf voltage across T1-5/6 is subtracted from the rf voltage from T2-1 and applied to half-wave rectifier diode CR4. The rf component on the resultant ripple dc voltage is filtered by inductors L3/L4 and capacitor C2 and applied to J1-3 as the 'refl pwr' output. The 'refl pwr' output is a positive dc voltage, with superimposed modulating audio, that is representative of the rf carrier's reflected power level. A third secondary winding of T1, applies a sample of the rf output voltage to J2-3/4 as the 'rf mon' output for external monitoring. Surge arrestor E1 protects the transmitter circuits from voltage transients induced on the transmission line by lightning strikes.

SECTION 3
INSTALLATION AND PREPARATION FOR USE

GENERAL

3.1 This section contains the information required to prepare the equipment site to receive the transmitter and the information required to unpack, install and prepare the transmitter for use.

TEST EQUIPMENT AND SPECIAL TOOLS

3.2 The test equipment required for initial installation is listed in table 1-4 and the special tools are listed in table 1-3.

SITE REQUIREMENTS

3.3 The transmitter is designed to be installed on drawer slides in a standard 19-inch mounting rack. There should be a minimum clearance of at least three feet at the front of the mounting rack. The area should be as free as possible from dust to prevent clogging of the screen cover on the cooling air fan.

3.3.1 LIGHTNING/SAFETY GROUND: The transmitter site must contain a lightning/safety ground system to protect the transmitter from lightning induced voltage transients. Refer to the Lightning Protection for Broadcast Stations appendix supplied with this manual.

3.3.2 ANTENNA SYSTEM: The antenna system must present a 50 ohm unbalanced load to the rf output of the transmitter with a maximum VSWR of 1.2:1. Provision to protect the transmitter from lightning induced voltage transients must be incorporated in the antenna system. Refer to Lightning Protection for Broadcast Stations appendix.

3.3.3 ELECTRICAL POWER: The AMPFET P400 transmitter requires a nominal 115 volt rms, 60 Hz single phase, ac power source rated at a minimum of 1000 volt amperes. A 230 volt rms, 50 Hz, single phase, ac power source rated option is also available. Provision must be made to protect the ac line from lightning induced voltage transients. Refer to the Lightning Protection for Broadcast Stations appendix.

3.3.4 ELECTRICAL POWER CABLING: A two-metre (six foot) ac power cable complete with a polarized 15 ampere, 115 volt ac, 60 Hz plug is provided with the transmitter. When the transmitter is fitted with the 230 volt rms, 50 Hz power source option, the 115 volt ac, 60 Hz plug must be replaced by an appropriate 230 volt ac, 50 Hz plug.

3.3.5 RF OUTPUT CABLE: The rf output cable is connected to at a type 'N' coaxial connector which is located on the rear of the transmitter cabinet.

3.3.6 CONTROL/MONITOR CABLING: Control and monitoring connections are made to two terminal boards which are located on the rear of the transmitter cabinet. Refer to figures 3-1 and FO-14 for information to assist in determining cable length.

3.3.7 19-INCH MOUNTING RACK: The transmitter is designed to be mounted in a standard 'F' opening (10 15/32 inches) in a 19-inch mounting rack. The transmitter requires a minimum mounting rack depth of 22.0 inches. The transmitter is supplied with drawer slides for ease of access during maintenance procedures. The rack mounted portion of the slides must be securely installed during installation. The mounting rack must be securely fastened or counter-balanced to ensure the 37 kilogram (82 pound) weight of the transmitter does not cause the mounting rack to topple when the transmitter is fully extended on its drawer slides.

3.3.8 EXTERNAL MONITORING FEATURES: The transmitter provides outputs to monitor critical parameters. The following provides additional information on the outputs available.

3.3.8.1 Forward Power: A buffered dc voltage that is representative of the forward power level is provided at a terminal board (TB2-1) on the rear of the transmitter. This voltage is a non-linear function of the forward power level and will be 5.7 ±10% volts dc at 400 Watts. An external panel meter that is accurate at all power levels would require the same modified square scale law as meter M2, with a 100uA movement and a series resistor of 56K ohms.

3.3.8.2 Reflected Power: A buffered dc voltage that is representative of the reflected power level is provided at a terminal board (TB2-2) on the rear of the transmitter. This voltage is a non-linear function of the reflected power level and will be 5.7 ±10% volts dc at 400 Watts. An external panel meter that is accurate at all power levels would require the same modified square law scale as meter M2, with a 100uA movement and a series resistor of 56K ohms.

3.3.8.3 Tx Fault Alarm: A switching transistor provides a current sink to ground or an open collector as its 'Tx Fault' alarm output to a terminal board (TB2-3) on the rear of the transmitter. A current sink to ground is provided when the transmitter is operating satisfactorily. When a fault is sensed, the switching transistor provides an open collector as its output. The switching transistor is protected against transients by a 33 volt zener diode. The voltage source for the 'tx fault' alarm circuit should not exceed +24 volts dc.

3.3.8.4 High VSWR Alarm: A switching transistor provides a current sink to ground or an open collector as its 'High VSWR' alarm output to a terminal board (TB2-4) on the rear of the transmitter. A current sink to ground is provided when a high VSWR is sensed. When the VSWR is satisfactory, an open collector is provided as its output. The switching transistor is protected against transients by a 33 volt zener diode. The voltage source for the 'High VSWR' alarm circuit should not exceed +24 volts dc.

3.3.8.5 Rf Monitor: A sample of the rf output is provided by a BNC connector (J3) on the rear of the transmitter as the 'Rf Monitor' output. This rf voltage is intended to be applied to a 1000 ohm load and is set during calibration to be equal at a maximum of 5.0 volts rms for the assigned rf carrier output levels in high, medium and low power operating modes.

3.3.9 VENTILATION: The interior of the building must contain a ventilation system that will ensure the inside temperature does not exceed 50°C.

3.3.10 HEATING: The interior of the building must contain a heating system that will ensure the inside temperature does not go below 0°C.

3.3.11 WORK AREA: It is recommended that a suitable work area be provided adjacent to the transmitter to permit bench inspection/repair of removable assemblies.

UNPACKING

3.4 The transmitter is packed fully assembled in a wooden crate that is 66 cm (26 inches) x 58.5 cm (234 inches) x 38 cm (15 inches). Shipping weight is approximately 56 kilograms (123 pounds). Open the crate and remove the transmitter as follows:

CAUTION

All crates should be inspected for transit damage prior to shipment acceptance and/or uncrating.

(a) Remove two bolts securing transmitter to bottom of packing crate.

(b) Locate the crate in an upright position, as marked on the crate, in a clear area that will permit extraction of the transmitter without risk of damage to the unit or injury to personnel.

(c) Remove the panel identified as the top from the crate by carefully prying it open using a small pry bar or other suitable tool.

(d) Remove the two wooden braces securing the transmitter and carefully remove the transmitter.

ANCILLARY PARTS

3.5 An ancillary parts kit is provided with each transmitter. Refer to table 3-3 for an itemized listing.

PARTS REQUIRED BUT NOT SUPPLIED

3.6 Some parts required to complete an AMPFET P400 transmitter installation are not supplied with the transmitter. The user must supply these parts. A specific installation will dictate the parts required, and will normally include the following:

(a) A suitable 50 ohm rf output coaxial cable, terminated by a type 'N' coaxial connector at the transmitter end, is required.

(b) If the external rf monitoring feature is to be used, a suitable rf coaxial cable, terminated by a BNC coaxial connector at the transmitter end, is required.

(c) All external control/monitor wiring must be provided by the user.

(d) The 19-inch mounting rack and all external control and monitoring equipment must be provided by the user.

(e) A suitable 230 volt ac, 50 Hz power plug must be provided to replace the 115 volt ac male plug supplied in the ancillary parts kit when the transmitter is fitted for 230 volts rms, 50 Hz operation.

PRE-INSTALLATION PROCEDURES

3.7 Assembly of the transmitter must be completed and the following pre-installation procedures performed prior to applying power to the transmitter or attempting to install it in the mounting rack.

3.7.1 DISASSEMBLY REQUIRED: Disassemble the transmitter to the extent required to install the PA power supply and complete the pre-installation procedures as follows:

(a) Remove the transmitter's bottom cover plate by removing six attaching screws and lifting off bottom cover plate.

(b) Remove the transmitter's top cover plate by removing five attaching screws and lifting off top cover plate.

(c) Remove and discard meter shorting clips from terminals of TEST meter M1 and OUTPUT POWER meter M2. Ensure nuts on meter terminals are firmly tightened.

Table 3-1 PA Power Supply AC Input Voltage (rms) Tap Selection

A8TB1 TERMINAL	AC PWR SOURCE (NO LOAD) 115VAC	AC PWR SOURCE (NO LOAD) 230VAC	A8T1 PRIMARY (FULL LOAD) 115VAC	A8T1 PRIMARY (FULL LOAD) 230VAC
1	130 - 140	230 - 240	125 - 135	225 - 235
2	120 - 130	220 - 230	115 - 125	215 - 225
3	105 - 120	205 - 220	105 - 115	205 - 215

3.7.2 VISUAL INSPECTION: Perform a visual inspection of transmitter interior as follows:

(a) Ensure all attaching hardware is firmly tightened.

(b) Visually inspect all electrical parts and interconnecting wiring for obvious damage, loose connections and freedom from dirt, oil, or other foreign objects, paying particular attention for unwanted conductive materials.

3.7.3 INITIAL SELECTION OF PA POWER SUPPLY INPUT VOLTAGE TAPS: Connect the appropriate primary winding tap of PA power supply A8's power transformer as follows:

NOTE

Final selection of the primary winding of power transformer A8T1 is determined at initial turn-on of the transmitter.

(a) Measure the unloaded rms ac voltage at the transmitter's power source ac receptacle.

(b) Enter table 3-1 and determine the terminal of terminal board A8TB1 for the no-load rms ac power source voltage obtained in step (a).

(c) Connect wire #9 of the chassis wiring harness to the terminal of A8TB1 identified in step (b).

3.7.4 INITIAL SELECTION OF PA POWER SUPPLY OUTPUT VOLTAGE TAPS: The preset power levels and therefore the B- voltages provided by PA power supply output voltage taps were preselected during final calibration and testing at the factory. The factory test results sheet will identify the factory preset power levels. The customer's assigned power levels will be preset provided they were identified prior to delivery, otherwise the factory preset power levels will be 400W (high), 250W (Medium) and 100W (low). The factory preset power levels should be used during initial installation and testing of the transmitter. If the assigned power levels differ from the factory preset power levels, select the appropriate power amplifier B-voltage and connect the appropriate PA power supply output voltage taps as detailed in paragraph 5.6.4 on completion of initial testing.

3.7.5 SETTING OF RF CARRIER SOURCE SWITCH A1S1 (see figure FO-15): Select the desired rf carrier source for the transmiter by setting the sections of switch S1, on NAPE28 rf driver printed circuit board A1, to the appropriate settings as follows:

3.7.5.1 Internal Rf Carrier Source: When the transmitter is to be operated as a monaural transmitter and the internal crystal controlled oscillator is to be used as the rf carrier source; set rf driver A1's Rf Carrier Source switch S1 for monaural operation (S1-1 open, S1-2 closed, S1-3 open, and S1-4 closed).

3.7.5.2 External Rf Carrier Source: When the transmitter is to be operated as a stereo transmitter and an external rf carrier generator is to be used as the rf carrier source; set rf driver A1's Rf Carrier Source switch S1 for stereo operation (S1-1 closed, S1-2 open, S1-3 closed and S1-4 open).

3.7.6 INSTALLATION OF CABINET DRAWER SLIDES: Install the drawer slides, provided with the transmitter, ensuring they are level and their vertical position in the transmitter opening coincides with the portion of the slides attached to the transmitter.

FINAL INSTALLATION

3.8 Install the transmitter in the mounting rack, ensuring drawer slides on each side of the transmitter are mated, both portions of each drawer side are locked together and complete the installation as follows:

NOTE

The transmitter must be fully extended on its drawer slides to complete the installation unless access to the transmitter is available from the rear of the mounting cabinet.

3.8.1 EXTERNAL INPUT/OUTPUT INTERFACE CONNECTIONS: Connect the external input/output wiring to the transmitter observing the following:

CAUTION

Ensure external input/output cabling is long enough to permit transmitter to be extended on its drawer slides and tilted upwards without putting undue strain on the cabling or its wire terminating terminal lugs.

(a) Route the external input/output interface cables to terminal boards TB1 and TB2, located at the rear of the transmitter.

(b) Using figure 3-1 to determine the final destination of each conductor, cut each conductor to its required length.

(c) Remove approximately 0.5 inches of insulation from the end of each conductor. Terminate each conductor with an HV09 lug provided in the kit of ancillary parts.

NOTE

The external interlock provides a means of turning the transmitter off from an external source. It is used in conjunction with station antenna switching circuits to turn the transmitter off immediately before any action that will cause the transmitter to operate into an open circuit; such as when switching from an antenna to a dummy load or to another antenna. By incorporating an additional manually operated switch, the interlock will also provide a positive method of ensuring the transmitter is off when personnel are required to work on the antenna or associated rf output circuitry. Terminals TB1-10 and TB1-11 must be shorted by an external switch or by a jumper before the transmitter can be turned on.

(d) Connect the input/output conductors to the appropriate terminals of terminal boards TB1 and TB2 using figure 3-1 as a guide.

NOTE

If the audio input provides 125 percent positive/100 percent negative modulation, the positive input must be connected to TB1-3/negative to TB1-1. The shield of the audio input cable is normally grounded at one end only, to avoid ground loops. Ground end that is most satisfactory.

(e) Route the external rf monitor cable to RF MONITOR connector J3, which is located at the rear of the transmitter.

CAUTION

Rf monitor cable must not exceed 5 feet in length. Damage may result to NAPC9/1 interface circuit A6 as a result of capacitive loading caused by excessive cable lengths. To prevent this from occurring, a suitable inductor must be utilized between rf monitor J3 and the monitoring equipment to achieve resonance at the carrier frequency.

(f) Cut the rf monitor cable to the required length. Install a BNC coaxial connector and connect it to RF MONITOR connector J3.

(g) For installations that use an external rf carrier (stereo), route the external rf carrier cable between TB2-11 (conductor) and TB2-12 (shield). Terminate the conductor and shield with HV09 lugs provided in the ancillary parts kit.

3.8.2 RF OUTPUT CABLE CONNECTION: Install the 50-ohm rf output coaxial cable as follows:

(a) Route the rf output coaxial cable to rf output coaxial connector A5J1, which is located on the side of rf power probe A5 at the rear of the transmitter.

(b) Cut the rf output coaxial cable to the required length. Install a type 'N' coaxial connector and connect it to rf output connector A5J1.

3.8.3 LIGHTNING/SAFETY GROUND CONNECTION: Connect a continuous, insulated 4 AWG copper wire or one-inch copper braid, from the station lightning/safety ground system, directly to the safety ground connection, on the rear of the transmitter, Ensure the conductor wire does not contact any other metal surface of the cabinet.

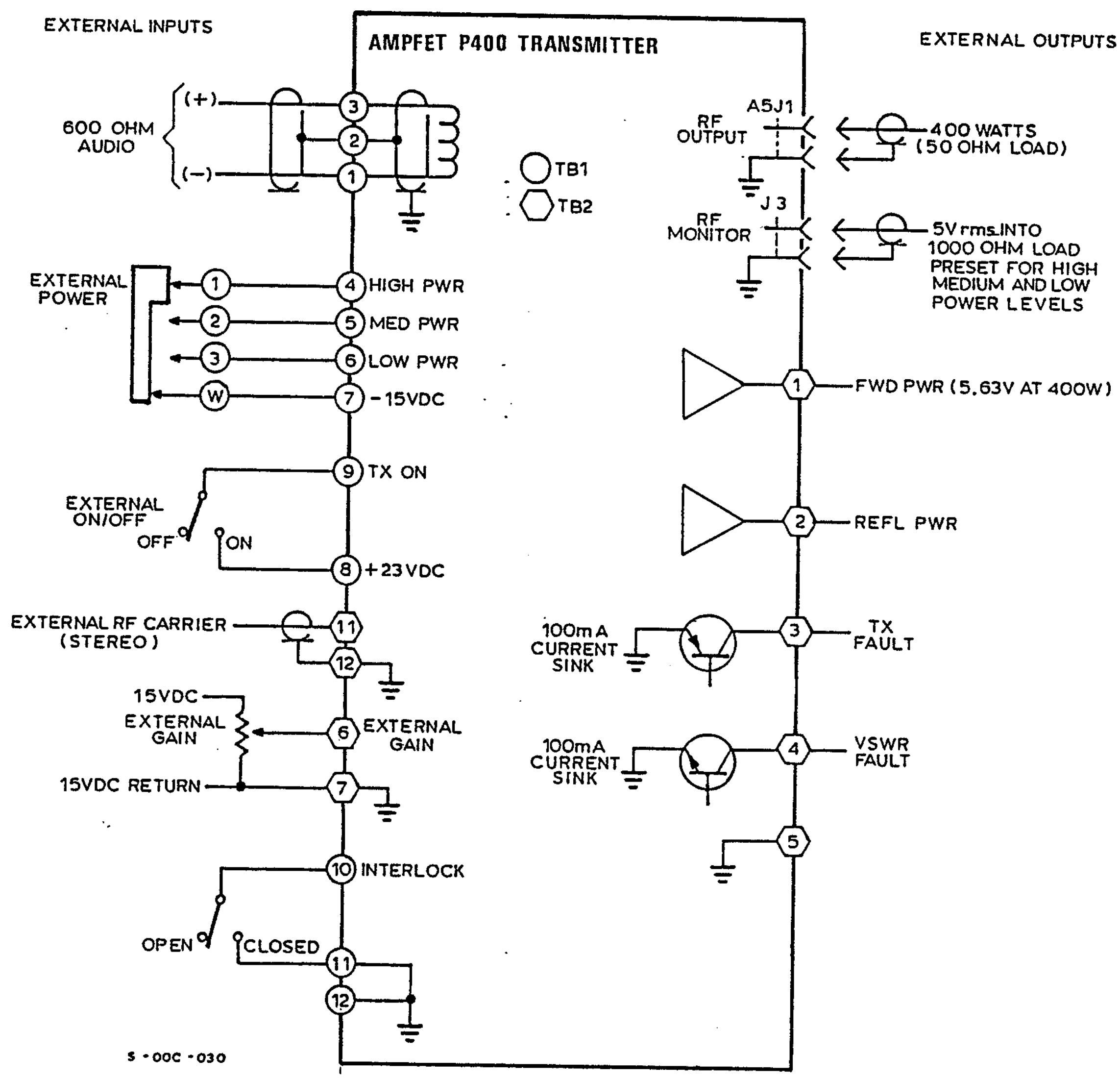
3.8.4 AC POWER CONNECTION: Connect the ac power as follows:

(a) Switch off transmitter ac power source at service entrance.

(b) Obtain the ac power cable from the ancillary parts kit.

(c) If the transmitter is fitted to operate from 230 volts ac, 50 Hz; remove the 15 ampere, 115 volt ac, 60 Hz power plug from the service entrance end of the ac power cable and install an appropriate 230 volt ac, 50 Hz power plug.

(d) Connect the female plug to the mating receptacle (J2) at the rear of the transmitter and the insert the male plug into the applicable ac power receptacle.



NOTE: Connect dc return for external FWD PWR and REFL PWR outputs to TB2-5

If trasmitter's +23 vdc is used as voltage source for external TX FAULT and VSWR FAULT circuit, connect circuit +vdc to TB1-8.

If external dc power supply is used as voltage source for external TX FAULT and VSWR FAULT circuit, connect dc return to TB1-12. External dc powr supply should not exceed +24 volts dc

Figure 3-1 External Input/Output Interface

3.8.5 FINAL PRE-STARTUP INSPECTION: When the transmitter installation is completed, perform a final inspection prior to applying power, as follows:

(a) Verify the requirements of paragraphs 3.8.1 thru 3.8.5 are completed.

(b) Verify spark gap E1 is in place and securely held in place by its mounting clips (see figure FO-20).

(c) Perform a general visual inspection for loose or damaged parts. Pay particular attention for foreign objects and loose or disconnected electrical connections.

INITIAL START-UP

3.9 The following are step-by-step start-up procedures for the subject transmitter. It is recommended the instructions be followed sequentially and exactly as presented.

NOTE

The transmitter was precisely calibrated at the factory and subjected to a minimum burn-in period of seven days. There should not be any need for adjustment of calibration controls at initial turn-on. If the following tests reveal that calibration is not optimum, perform the appropriate calibration procedure as detailed in section 5 prior to proceeding with additional tests.

3.9.1 PRECAUTIONS TO BE OBSERVED: The AMPFET P400 transmitter contains many solid state devices that may be damaged if they are subjected to excessive heat or high voltage transients. Every effort must be taken to ensure the circuits are not overdriven and they are not disconnected from their loads while turned on. The precautionary information included in the operating instructions of section four should be read and fully understood prior to applying power and must be observed during operation.

3.9.2 PRELIMINARY SETTINGS: Verify the transmitter is ready to turn on as follows:

(a) Obtain the factory test result sheets that were packed with the transmitter.

(b) Verify all switches are set as tabulated for Initial Setting in table 4-1.

(c) Terminate or verify the transmitter rf output is terminated into a 50 ohm resistive dummy load that is rated at a minimum of 800 Watts.

NOTE

It is recommended that a precision 50-ohm resistive dummy load be used during initial turn-on. The use of a dummy load will ensure any problems with the antenna system are not interpreted as a transmitter defect.

(d) Verify the voltage of the input power source is within 5% of the voltage used as the mean RMS voltage when selecting the primary winding taps of the PA power supply's power transformer (refer to paragraph 3.7.3).

(e) Verify the power source is rated at a minimum of 1000 volt amperes.

(f) Turn off or verify the audio input is turned off.

(g) If the external gain control feature is in use, set the external gain control to the normal center of its operating range (+7.5 volts dc output).

Table 3-2 Typical Readings for LOW (100W), MED (250W) and HIGH (400W) Power Levels

POWER LEVEL	OUTPUT POWER		TEST					
	FWD (WATTS)	REFL (WATTS)	DC AMPS	I/P VOLTS	O/P VOLTS	+23V	+15V	-15V
LOW	100	1.0	3.2	36	13	23	15	15
MED	250	2.5	4.2	70	22	23	15	15
HIGH	400	4.0	7.0	68	29	23	15	15

3.9.3 INITIAL TURN-ON: Turn on the transmitter and verify it is functioning as follows:

NOTE

The transmitter's three operating power levels (HIGH, MED and LOW) have been preset at the factory to 400, 250 and 100 Watts respectively unless otherwise specified by the customer. On initial turn-on; it is recommended that normal operation at these power levels be verified, by comparing meter readings with the typical readings tabulated in table 3-2; prior to adjustment to the assigned operating power levels. Conciliation between readings obtained at initial turn-on and readings tabulated in table 3-2 will only be approximate since, the following factors may influence meter readings obtained at the operating site.

* The rf output power level is dependent on the precise impedance of the transmitter's rf output terminating load.

* Modulator DC AMPS, I/P VOLTS, and +23V indications on TEST meter are dependent on the precise level of the ac supply voltage.

(a) Verify the male plug of the ac power cable is plugged into an appropriate ac power receptacle.

(b) Close or verify the external interlock is closed. If necessary, connect a shorting jumper between TB1-10 and TB1-11.

(c) Set AC PWR switch S1 to ON.

(d) AC PWR (DS1), LOW PWR (DS3), RF ON (DS2) lamps shall turn on.

(e) Remaining lamps and cooling air fan should be off.

NOTE

It is possible the TX FAULT lamp (DS9) may turn on, but this should not be interpreted as a fault initially.

(f) RF WATTS indication on OUTPUT POWER meter M2 should be near the value tabulated for LOW power level in the OUTPUT POWER-FWD column of table 3-2. Set OUTPUT POWER switch S5 to FWD-LOW and read lower scale to obtain a more accurate reading when rf output is less than 150 Watts.

(g) Set OUTPUT POWER switch S5 to REFL-LOW and read lower scale of OUTPUT POWER meter M2.

(h) RF WATTS indication on OUTPUT POWER meter M2 should be near zero as tabulated for LOW power level in the OUTPUT POWER-REFL column of table 3-2.

(i) DC AMPS indication on lower scale of TEST meter M1 should be near the value tabulated for LOW power level in the TEST METER - DC AMPS column of table 3-2.

(j) Set TEST switch S4 to I/P VOLTS.

(k) Indication on upper scale of TEST meter M1 should be near the value tabulated for LOW power level in the TEST METER - I/P VOLTS column of table 3-2.

(l) Set TEST switch S4 to O/P VOLTS.

(m) Indication on upper scale of TEST meter M1 should be near the value tabulated for LOW power level in the TEST METER - O/P VOLTS column of table 3-2.

(n) Set TEST switch S4 to +23V.

(o) Indication on upper scale of TEST meter M1 should be approximately 23 volts dc.

(p) Set TEST switch S4 to +15V.

(q) Indication on upper scale of TEST meter M1 should be approximately 15 volts dc.

(r) Set TEST switch S4 to -15V.

(s) Indication on upper scale of TEST meter M1 should be approximately 15 volts dc.

(t) Set OUTPUT POWER switch S5 to FWD-HIGH.

(u) Set TEST switch S4 to DC AMPS.

(v) Set POWER LEVEL switch S3 to MED and repeat steps (f) thru (u), substituting 'MED' for 'LOW' operating power level.

(w) Set POWER LEVEL switch S3 to HIGH and repeat steps (f) thru (u), substituting 'HIGH' for 'LOW' operating power level.

3.9.4 FINAL SETTING OF PA POWER TRANSFORMER INPUT TAPS: Select the final setting of PA power supply A8's power transformer input taps, with the transmitter operating at its assigned high power level, as follows:

(a) Verify the requirements of paragraph 3.9.3 have been completed.

(b) Set OUTPUT POWER switch S5 to FWD-HIGH.

(c) Set TEST switch S4 to DC AMPS.

(d) Set POWER LEVEL switch S3 to HIGH.

(e) Adjust O/P PWR potentiometer A2R92 for an indication of the assigned high power rf carrier output level.

(f) Using an ac voltmeter, measure the ac voltage present on the terminal of PA power supply A8's terminal board TB1 that has wire #9 connected to it.

(g) Refer to table 3-1 and determine if wire #9 has been connected to the correct terminal of A8TB1.

(h) If the correct terminal has not been selected, switch off the ac power by setting AC PWR switch S1 to OFF and connect wire #9 to the appropriate terminal.

(i) Set or verify AC PWR switch S1 is set to OFF.

(j) Install the bottom cover plate on the transmitter using six screws originally removed.

3.9.5 SETTING OF TX FAULT THRESHOLD LEVELS: Set the tx fault thresholds to the desired levels in high, medium and low power operating modes as follows:

NOTE

The tx fault threshold levels are determined by the user. They are normally set to a level that is slightly below the assigned rf carrier output level for each of the three available power levels. When the rf carrier level falls to the preset threshold level, TX FAULT alarm lamp DS9 will turn on and the external 'tx fault' alarm will be switched from a current sink to ground to an open collector output.

(a) Verify the requirements of paragraphs 3.9.1 thru 3.9.4 have been completed.

(b) Set OUTPUT POWER switch S5 to FWD-HIGH.

(c) Set TEST switch S4 to DC AMPS.

(d) Set POWER LEVEL switch S3 to HIGH.

(e) Adjust O/P PWR potentiometer A2R92 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the desired high power tx fault threshold level.

(f) If TX FAULT lamp DS9 is turned on, adjust HIGH Threshold potentiometer A6R24 clockwise until TX FAULT lamp DS9 turns off.

(g) Slowly adjust HIGH Threshold potentiometer A6R24 counter clockwise until TX FAULT lamp DS9 just turns on.

(h) Adjust O/P PWR potentiometer A2R92 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned high power rf carrier output level. TX FAULT lamp DS9 shall turn off.

NOTE

High power rf carrier output level adjustment affects medium and low rf carrier output levels. Any change in O/P PWR potentiometer A2R92 setting will alter medium and low rf carrier output levels.

(i) Record DC AMPS indication on TEST meter M1.

(j) Set TEST switch S4 to I/P VOLTS and record TEST meter M1 indication.

(k) Using the formula in paragraph 4.6.1 (for unmodulated carrier), calculate the dc current consumption using the assigned rf carrier output level and the input dc voltage recorded in step (j). Calculated dc current level should be within 5% of DC AMPS indication recorded in step (i).

(l) Set POWER LEVEL switch S3 to MED. MED PWR lamp DS4 shall turn on.

(m) Adjust LOW PWR 2 potentiometer A2R7 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the desired medium power tx fault threshold level.

(n) If TX FAULT lamp DS9 is turned on, adjust MED Threshold potentiometer A6R26 clockwise until TX FAULT lamp DS9 turns off.

(o) Slowly adjust MED Threshold potentiometer A6R26 counter clockwise until TX FAULT lamp DS9 just turns on.

(p) Adjust LOW PWR 2 potentiometer A2R7 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned medium power rf carrier output level. TX FAULT lamp DS9 shall turn off.

(q) Set TEST switch S4 to DC AMPS and repeat steps (i) thru (k).

(r) Set POWER LEVEL switch S3 to LOW. LOW PWR lamp DS3 shall turn on.

(s) Adjust LOW PWR 1 potentiometer A2R6 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the desired low power tx fault threshold level.

(t) If TX FAULT lamp DS9 is turned on, adjust LOW Threshold potentiometer A6R28 clockwise until TX FAULT lamp DS9 turns off.

(u) Slowly adjust LOW Threshold potentiometer A6R28 counter clockwise until TX FAULT lamp DS9 just turns on.

(v) Adjust LOW PWR 1 potentiometer A2R6 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned low power rf carrier output level. TX FAULT lamp DS9 shall turn off.

(w) Set TEST switch S4 to DC AMPS and repeat steps (i) thru (k).

3.9.6 FINAL RF CARRIER OUTPUT LEVEL SETTINGS: Set the rf carrier output levels with the transmitter operating into its antenna system as follows:

(a) Verify the requirements of paragraphs 3.9.1 thru 3.9.5 are completed.

(b) Set AC PWR switch S1 to OFF.

(c) Disconnect the 50-ohm dummy load and connect the antenna system to the transmitter's rf output connector (A5J1).

(d) Set OUTPUT POWER switch S5 to FWD-HIGH.

(e) Set TEST switch S4 to DC AMPS.

(f) Set POWER LEVEL switch S3 to HIGH.

(g) Set AC PWR switch S1 to ON.

(h) RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(i) Set OUTPUT POWER switch S5 to REFL-HIGH.

(j) RF WATTS indication on OUTPUT POWER meter M2 should be near zero. Set OUTPUT POWER switch S5 to REFL-LOW to obtain a more accurate reading.

(k) Set OUTPUT POWER switch S5 to FWD-HIGH.

(l) Adjust O/P PWR potentiometer A2R92 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned high power rf carrier output level. TX FAULT lamp DS9 shall be off.

NOTE

High power rf carrier output level adjustment affects the medium and low rf carrier output levels. Any change in O/P PWR potentiometer A2R92 setting will alter medium and low rf carrier output levels.

(m) Record DC AMPS indication on TEST meter M1.

(n) Set TEST switch S4 to I/P VOLTS and record TEST meter M1 indication.

(o) Using the formula in paragraph 4.6.1 (for unmodulated carrier), calculate the dc current consumption using the assigned rf carrier output level and the input dc voltage recorded in step (n). Calculated dc current level should be within 5% of DC AMPS indication recorded in step (m).

(p) Set POWER LEVEL switch S3 to MED. MED PWR lamp DS4 shall turn on.

(q) Adjust LOW PWR 2 potentiometer A2R7 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned medium power rf carrier output level. TX FAULT lamp DS9 shall be off.

(r) Set TEST switch S4 to DC AMPS and repeat steps (m) thru (o).

(s) Set POWER LEVEL switch S3 to LOW. LOW PWR lamp DS3 shall turn on.

(t) Adjust LOW PWR 1 potentiometer A2R6 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned low power rf carrier output level. TX FAULT lamp DS9 shall be off.

(u) Set TEST switch S4 to DC AMPS and repeat steps (m) thru (o).

3.9.7 RF MONITOR OUTPUT VOLTAGE ADJUSTMENTS: Set the the rf monitor output voltage to provide an equal output in high, medium and low power operating modes as follows:

(a) Verify the requirements of paragraphs 3.9.1 thru 3.9.6 are completed.

(b) Connect a 1000 ohm resistive load to RF MONITOR coaxial connector J3 using a suitable coaxial connector.

(c) Connect an rms ac voltmeter across 1000 ohm load connected in step (b).

(d) Set POWER LEVEL switch S3 to HIGH. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(e) Adjust HIGH Monitor potentiometer A6R3 for desired rms ac voltage (maximum of 5.0 volts ac rms) indication on rms ac voltmeter.

(f) Set POWER LEVEL switch S3 to MED. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned medium power rf carrier output level.

(g) Adjust MED Monitor potentiometer A6R2 for precisely the same ac voltmeter obtained in step (e).

(h) Set POWER LEVEL switch S3 to LOW. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned low power rf carrier output level.

(i) Adjust LOW Monitor potentiometer A6R1 for precisely the same ac voltmeter obtained in step (e).

3.9.8 AUDIO LEVEL ADJUSTMENTS: Apply the modulating audio and adjust the transmitter audio controls as follows:

(a) Verify the requirements of paragraphs 3.9.1 thru 3.9.6 are completed.

(b) Set POWER LEVEL switch S3 to HIGH. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(c) Connect station modulation monitor to RF MONITOR coaxial connector J3.

(d) Turn on normal station program modulating audio (nominal +10 dBm).

(e) Set audio low-pass and high-pass switches (A2S1 and A2S2) for the desired audio bandwidth using tables shown in figure FO-3.

(f) Simultaneously monitor station modulation monitor and adjust AUDIO LEVEL potentiometer A2R4 for the desired modulation depth.

(g) Simultaneously monitor station modulation monitor and adjust HI LIMIT potentiometer A2R16 counter clockwise until positive modulation peaks are just being limited and then adjust clockwise until just not limiting.

(h) Simultaneously monitor station modulation monitor and adjust LO LIMIT potentiometer A2R18 clockwise until negative modulation peaks are just being limited and then adjust counter clockwise until just not limiting.

PLACING TRANSMITTER IN OPERATION

3.10 When the requirements of paragraph 3.9 have been completed the transmitter may be placed in operation. Set the controls as specified for 'operating setting' in table 4-1.

Table 3-3 Ancillary Parts

NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.	(OEM) MFR CODE	TOTAL IDENT PARTS
$ Fuse, 5A, 250V, Slo-Blo, Type 3AG	FA14	313005	75915	5
# Fuse, 10A, 250V, Slo-Blo, Type 3AB	FB35	326010	75915	5
Fuse, 0.25A, 250V, Slo-Blo, Type 3AB	FB11	323.250	75915	5
Tool, Tuning	HAG38	8605	CGE	1
Lug, Crimp, Non-In 4-6 Screw, O, 22-18	HV09	YAD18-6F	07693	18
Cord, Line Assembly, Mates with JN24	JN25	17250	70903	1
* Toroid, 2 inches	LXP37	400T750-3C8	02114	2
Toroid	LXP38	J-43806-TC	90797	6
Transistor, Field Effect, N Channel	QA04	IRF130	81483	1
Diode, General Purpose, Small Signal	QAP29	1N4938	01295	2
Transistor, Field Effect, N Channel	QI07	IRF140	81483	4
Diode, General Purpose, Fast Recovery	QK06	1N4942	12969	2
Diode, Light Emitting, Green	QK12	5082-4992	50434	1
Diode, Light Emitting, Red	QK13	5082-4693	50434	2
Diode, Light Emitting, Amber	QK14	5082-4592	50434	1
Socket, LED	QK25	PS-200-B	15513	2
Surge Arrester, 600Vdc ±15%	UC34	CG2-600	89397	1
Crystal (customer's frequency)	XA19	Special	37338	1

$ Denotes provided when transmitter is fitted for 230 vac, 50 Hz operation.

# Denotes provided when transmitter is fitted for 115 vac, 60 Hz operation.

* Denotes LXP37 may be replaced by:

Toroid, H5B Material	LY35	H5B-T31-51-13	54538	2

SECTION 4
OPERATING INSTRUCTIONS

GENERAL

4.1 This section provides the information required to operate the AMPFET P400 transmitter. Normally, the transmitter will not be attended during use. The following instructions are primarily intended for persons involved in testing or maintenance of the equipment.

EMERGENCY SHUTDOWN PROCEDURE

4.2 There are no special precautions to be taken if an emergency shutdown is required. Switch off the transmitter by placing AC PWR switch to its OFF position; or switch off the ac power source at the service entrance.

CONTROLS AND INDICATORS

4.3 The following paragraphs list modules or major areas of the transmitter that contain controls and indicators, identify illustrations that depict their location/markings and reference tables that describe their purpose/function.

4.3.1 FRONT PANEL CONTROLS AND INDICATORS: Figure FO-10 depicts the controls and indicators on the front panel of the transmitter. Table 4-2 is keyed to the reference designation assigned to each control and indicator and explains their function.

4.3.2 NAPE28 RF DRIVER PCB CONTROLS: Figure FO-15 depicts the controls in the NAPE28 rf driver printed circuit board. Table 4-3 is keyed to reference numbers assigned to the controls and indicators and explains their functions.

4.3.3 NAPE22/1 MODULATOR DRIVER PCB CONTROLS: Figure FO-12 depicts the location of the NAPE22/1 modulator driver printed circuit board (A2) and figure FO-17 depicts the location of its controls. Table 4-4 is keyed to the reference designation assigned to each control and explains their function. This information is supplemented by a diagram on the inside surface of the hinged portion of the top panel.

4.3.4 NAPC9/1 INTERFACE PCB CONTROLS: Figure FO-12 depicts the location of the NAPC9/1 interface driver printed circuit board (A6). Figure FO-21 depicts the location of its controls. Table 4-5 is keyed to the reference designation assigned to each control and explains their function.

4.3.5 NAPC8/1 METER PCB CONTROLS: Figure FO-25 depicts the location of the NAPC8/1 meter printed circuit board controls. Table 4-6 references illustrations that depict the controls and indicators in the meter printed circuit board. The table is keyed to reference numbers assigned to the controls and indicators and explains their functions.

PRE-START-UP CHECKS

4.4 Prior to applying ac power to the transmitter, observe the following:

(a) Verify all assemblies/modules are installed and mating connectors are fully engaged.

(b) Verify the external input/output wiring is connected as detailed in paragraph 3.8.

(c) Visually inspect the internal electrical wiring for defects such as; damaged insulation, broken wires, wrong connections and/or loose connections.

(d) Verify all panels are installed and securely tightened.

(e) Verify the requirements of section 3 have been completed.

(f) Verify the transmitter rf output is terminated into a 50 ohm load - an antenna that is interfaced by an appropriate matching system for normal operation, or a 50 ohm resistive dummy that is rated at 800 Watts (twice the rated carrier power of the transmitter) for calibration and testing procedures.

(g) Verify the appropriate primary winding taps of the PA power supply's power transformer have been selected to match the voltage of the input power source (refer to paragraph 3.7.3).

(h) Verify the power source has a minimum rating of 1000 volt amperes.

TURNING ON TRANSMITTER

4.5 Turn on the transmitter as described in paragraph 3.9 for initial startup and after repairs that may have affected the calibration. At other times, set the switches to the positions tabulated for calibration setting in table 4-1 initially and then to the settings tabulated for operational setting.

MODULATION LEVELS

4.6 The modulation criteria is detailed in section 5. The modulation level can be adjusted for 100 percent modulation when the input modulating audio is between +10 dBM and 0 dBM at 600 ohms. If any adjustment in the audio input level is required, refer to section 5.

4.6.1 The efficiency by which the transmitter converts dc power into rf power is quite constant at 77 percent. A useful check of correct operation is to calculate the dc input current of the modulator which should result for a particular set of operating conditions. To do this, proceed as follows:

(a) Operate the transmitter at the intended operating power level.

(b) Disconnect the modulation signal and record the FWD PWR indicated on M2 and MODULATOR I/P VOLTS on M1. The anticipated MODULATOR DC AMPS without modulation is:

$$\text{DC AMPS} = \frac{\text{FWD PWR}}{\text{MOD I/P VOLTS} \times 0.77}$$

If the transmitter is modulated by a continuous sine wave at 100 percent modulation, this current will increase by a factor of 1.5. When the transmitter is modulated by normal program material, the factor by which this current will increase will depend upon the degree of signal compression. A figure between 1.2 and 1.3 can be anticipated.

Table 4-1 Preliminary Switch Settings

PANEL MARKING/ NOMENCLATURE USED IN TEXT	REF DES	INITIAL SETTING	CALIBRATION SETTING	OPERATING SETTING
CONTROL PANEL				
AC PWR	S1	OFF	ON	ON
REMOTE/LOCAL	S2	LOCAL	LOCAL	LOCAL or REMOTE
POWER LEVEL	S3	LOW	LOW	As Required
OUTPUT POWER	S5	FWD/HIGH	FWD/HIGH	OFF
TEST	S4	DC AMPS	DC AMPS	DC AMPS

OPERATING PRECAUTIONS

4.7 The AMPFET P400 transmitter contains many solid state devices that may be damaged if they are subjected to excessive heat or high voltage transients. Every effort must be taken to ensure the circuits are not overdriven and they are not disconnected from their loads while turned on. The following should be routinely observed.

4.7.1 The transmitter must transmit into a 50-ohm load (antenna or resistive dummy load). Do not permit the load to be open circuited, by switching or disconnection, when the transmitter is turned on. Turn off the transmitter prior to changing or removing the load. It is not recommended that the transmitter be turned on and operated into an open circuit.

4.7.2 The modulator input current, as indicated on TEST meter M1, must not exceed prescribed maximums. It is recommended that the modulator input current be routinely monitored whenever the carrier or modulation levels are changed. Paragraph 4.6.1 provides a method of calculating the modulator input current for the full rf carrier forward power output range; when there is no modulation, when the modulation source is normal station programming, and when the modulation source is a continuous sine wave from an audio signal generator. Verify these values are not exceeded when the carrier level is varied, when the modulation level is varied and when the rf output loading changes.

REMOTE OPERATION

4.8 The AMPFET P400 transmitter will normally be operated by remote control from the station studios. Remote control of the transmitter ON/OFF and HIGH/MED/LOW power functions, as well as remote monitoring of the critical operating parameters are provided. To enable the remote controls, REMOTE/LOCAL switch S2 must be set to its REMOTE position.

4.8.1 Operating details of the transmitter by remote control must be established by the station engineering personnel as details of the operating procedure will depend upon the remote control system used in conjunction with the AMPFET P400.

4.8.2 Some corrective maintenance may be carried out over the remote control system from the station studios. Details of these procedures are given in section 6.

Table 4-2 Front Panel Controls and Indicators

REF DES	FIG NO.	PANEL MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
DS1	FO-10	AC PWR	Indicates ac power is turned on when on.
DS2	FO-10	RF On	Indicates transmitter's rf output is turned on when on.
DS3	FO-10	LOW PWR	Indicates transmitter is operating in its low power operating mode when on.
DS4	FO-10	MED PWR	Indicates transmitter is operating in its medium power operating mode when on.
DS5	FO-10	REMOTE	Indicates transmitter's ON/OFF and HIGH/MED/ LOW power status is being remotely controlled when on.
DS6	FO-10	AUDIO LIMIT	Turns on when audio limiting is occurring.
DS7	FO-10	INTERLOCK ALARM	Turns on when the interlock circuit is opened.
DS8	FO-10	HIGH VSWR ALARM	Turns on when the transmitter's power level is being automatically reduced to protect against excessive rf output currents caused by low terminating impedance.
DS9	FO-10	TX FAULT ALARM	Turns on when the transmitter's rf output level falls below a preset value.
DS10	FO-10	MOD DRIVE ALARM	Turns on when the average value of the pulse width modulated control signal exceeds a critical safe level.
DS11	FO-10	RF DRIVE	Turns on when the rf drive signal falls below a critical safe level and the transmitter's output power is being cut back to a very low level.
F1	FO-10	AC PWR	Fuses the transmitter ac line supply at 10 amperes when ac power source is 115 vac, 60 Hz or 5 amperes when ac power source is 230 vac, 50 Hz.
F2	FO-10	REMOTE	Fuses the 23 volt supply to the remote control circuits at 1/4 amperes.
M1	FO-10	TEST	Displays critical voltages and current as selected by TEST switch S4.
M2	FO-10	OUTPUT POWER	Displays forward and reflected power levels on high and low ranges as selected by OUTPUT POWER switch S5.

Table 4-2 Front Panel Controls and Indicators (Continued)

REF DES	FIG NO.	PANEL MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
S1	FO-10	AC PWR	Controls ac power to transmitter.
S2	FO-10	REMOTE/LOCAL	Switches ON/OFF and HIGH/MED/LOW operating power control to remote position when set to REMOTE.
S3	FO-10	POWER LEVEL	Determines local operating mode. Selects high, medium or low operating power when REMOTE/LOCAL switch is set to LOCAL.
S4	FO-10	TEST	Selects parameter (MODULATOR - DC AMPS, MODULATOR - I/P VOLTS, - MODULATOR O/P VOLTS, VOLTS - +23V, VOLTS - +15V or VOLTS - -15V) to be displayed on TEST meter M1.
S5	FO-10	OUTPUT POWER	Selects rf output parameter to be displayed on OUTPUT POWER meter M2.

Table 4-3 NAPE28 Rf Driver PCB Controls

REF DES	FIG NO.	BOARD MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
-	FO-15	Divide-by-Two LINKS or Divide-by-Four LINKS	Both divide-by-2 or both divide-by-4 links are installed to select a frequency division of two or four for the output of the carrier oscillator.
A1C4	FO-15	Fine Tune	Provides fine tuning for the operating carrier frequency.
A1R30	FO-15	PHASE	Adjust output level from the rf current phase detector.
A1R31	FO-15	CURRENT LEVEL	Adjust output level from the rf current level detector.
A1TP1	FO-15	OSCILLATOR O/P	Provides a test point to monitor the output of the carrier oscillator.
A1TP2	FO-15	FREQUENCY DIVIDER O/P	Provides a test point to monitor the output of the frequency divider.
A1TP3	FO-15	BALANCED DRIVE	Provides a test point to monitor the balanced rf drive output signal.
A1TP4	FO-15		Provides a test point to monitor the ac voltage representing the rf current output of the modulator/power amplifier.
A1TP5	FO-15	PHASE	Provides a test point to monitor the dc voltage representing the phase difference between the voltage and the current of the rf output of the transmitter.
A1TP6	FO-15	CURRENT LEVEL	Provides a test point to monitor the dc voltage representing the amplitude of the rf current of the transmitter.
A1TP7	FO-15	BUFFER AMP	Provides a test point to monitor the dc voltage representing the rf stress current cutback signal of the transmitter.
A1S1	FO-15	Rf Carrier Source	See switch settings below.

A1S1 Rf Carrier Source switch settings:

OPERATION	S1-1	S1-2	S1-3	S1-4
Stereo	Closed	Open	Closed	Open
Monaural	Open	Closed	Open	Closed

Table 4-4 NAPE22/1 Modulator Driver PCB Controls

REF DES	FIG NO.	BOARD MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
A2C15	FO-16	Frequency Adjust	Provides fine adjustment to the frequency of the 70 kHz square wave generator to suit the operating carrier frequency.
A2R4	FO-16	Audio	Adjusts the level of the audio signal at the input to the modulator driver.
A2R6	FO-16	LOW PWR 1	Adjusts the amount that the high power output level is reduced when LOW PWR is selected.
A2R7	FO-16	LOW PWR 2	Adjusts the amount that the high power output level is reduced when MED PWR is selected.
A2R16	FO-16	HI LIMIT	Adjusts the threshold of limiting for positive modulation peaks.
A2R18	FO-16	LO LIMIT	Adjusts the threshold of limiting for negative modulation peaks (troughs).
A2R29*	FO-16	X BAL	Adjusts the bias at the X input of audio limiter U4.
A2R42*	FO-16	OFFSET ADJ	Provides an offset bias at the input of amplifier U3C.
A2R47*	FO-16	X BAL	Adjusts the bias at the X input of U5.
A2R70*	FO-16	OFFSET BAL	Adjusts the offset bias at the input of amplifier U8.
A2R75*	FO-16	RAMP ADJ	Adjusts the bias for ramp integrator U9A.
A2R92	FO-16	O/P PWR	Adjusts the level of the high power output level.
A2S1	FO-16	Low-pass Filter	A two-section DIP switch that selects component values in the low-pass filter to control its high frequency rolloff and transient response characteristics.
A2S2	FO-16	High-pass Filter	A four-section DIP switch that selects component values in the high-pass filter to control its low frequency rolloff.
A2TP1	FO-16	Filtered Audio	Provides a test point to monitor the audio signal after low- and high-pass filtering.
A2TP2	FO-16	Audio Limiter Control	Provides a test point to monitor the control signal of audio limiter U4.

Table 4-4 NAPE22/1 Modulator Driver PCB Controls (Continued)

REF DES	FIG NO.	BOARD MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
A2TP3	FO16	Line Volts Compensation	Provides a test point to monitor the Y input to U5 used to provide line volts compensation.
A2TP4	FO-16	70 kHz Generator O/P	Provides a test point to monitor the output of the 70 kHz square wave generator.
A2TP5	FO-16	Audio Limiter O/P	Provides a test point to monitor the output of the audio limiter.
A2TP6	FO-16	Low rf Drive Detector O/P	Provides a test point to monitor the output signal of the low rf drive level detector.
A2TP7	FO-16	Compensated Control Signal	Provides a test point to monitor the output signal of the line volts compensation control circuit.
A2TP8	FO-16	Ramp	Provides a test point to monitor the output of the ramp integrator circuit.
A2TP9	FO-16	Pulse Width Generator Control Signal	Provides a test point to monitor the variable pulse width generator control signal.
A2TP10	FO-16	Pulse Width Generator Output	Provides a test point to monitor the output of the variable pulse width generator.

* Denotes controls that are preset and sealed during factory alignment procedures. Readjustment should only be necessary following component replacement or during routine major overhaul.

Table 4-5 NAPC9/1 Interface PCB Controls

REF DES	FIG NO.	BOARD MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
-	FO-21	DIODE LINK A	When installed, energizes relay K1 in the PA power supply when transmitter is operated in the MED PWR operating mode.
-	FO-21	DIODE LINK B	When installed, energizes relay K1 in the PA power supply when transmitter is operated in the LOW PWR operating mode.
A6R1	FO-21	LOW Monitor	Adjusts the transmitter's rf monitor output level to 5V rms in 1000 ohms when the transmitter is operated in the LOW PWR operating mode.
A6R2	FO-21	MED Monitor	Adjusts the transmitter's rf monitor output level to 5V rms in 1000 ohms when the transmitter is operated in the MED PWR operating mode.
A6R3	FO-21	HIGH Monitor	Adjusts the transmitter's rf monitor output level to 5V rms in 1000 ohms when the transmitter is operated in the HIGH PWR operating mode.
A6R24	FO-21	HIGH Threshold	Adjusts the TX FAULT threshold to a level just below the normal HIGH operating power level.
A6R26	FO-21	MED Threshold	Adjusts the TX FAULT threshold to a level just below the normal MED operating power level.
A6R28	FO-21	LOW Threshold	Adjusts the TX FAULT threshold to a level just below the normal LOW operating power level.
A6R44	FO-21	HIGH B-	Adjusts the B- reference voltage, applied to modulator driver A2, to -6.4 volts dc in the HIGH PWR operating mode.
A6R45	FO-21	MED B-	Adjusts the B- reference voltage, applied to modulator driver A2, to -5.4 volts dc in the MED PWR operating mode.
A6R46	FO-21	LOW B-	Adjusts the B- reference voltage, applied to modulator driver A2, to -5.4 volts dc in the LOW PWR operating mode.

Table 4-6 NAPC8/1 Meter PCB Controls

REF DES	FIG NO.	BOARD MARKING/ NOMENCLATURE USED IN TEXT	FUNCTION
A9R6	FO-25	DC AMPS CAL	Calibrates the TEST meter's indication of MODULATOR DC AMPS.
A9R11	FO-25	HIGH PWR CAL	Calibrates the output power meter's indication of FWD and REFL power when reading on the upper scale.
A9R13	FO-25	LOW PWR CAL	Calibrates the output power meter's indication of FWD and REFL power when reading on the lower scale.

SECTION 5
TESTING AND CALIBRATION

GENERAL

5.1 This section contains an on-air test procedure, detailed step-by-step calibration procedures and minimum performance test procedures. Since many of the operating parameters, the audio interfacing equipment and the antenna system are dictated by each individual station, it is necessary that personnel performing these procedures be familiar with the technical details of the transmitter, the associated equipment and the operational requirements of the station.

OPERATION OF EQUIPMENT

5.2 Operating procedures for the transmitter are provided in section 4. Detailed control and indicator information is presented in tables 4.2 thru 4.7.

CAUTION

It is essential that the operating precautions detailed in paragraph 4.7 be read, fully understood and observed prior to operation of the equipment.

5.2.1 SETTING OF OUTPUT POWER SWITCH: OUTPUT POWER switch S5 selects the upper or lower scale of OUTPUT POWER meter M2. The upper scale is read when HIGH (FWD or REFL) is selected and the lower scale is read when LOW (FWD or REFL) is selected. The following procedures specify a FWD-HIGH or REFL-HIGH setting for initial switch settings. Always select the appropriate HIGH setting and verify the meter indication is less than the maximum reading on the lower scale (150 Watts). Switch to the appropriate LOW setting to obtain more accurate readings when the parameter being measured is less than 150 Watts. Set OUTPUT POWER switch to OFF or a HIGH setting after any LOW reading has been obtained.

NOTE

OUTPUT POWER meter M2 has square law scales. Resulting non-linearity makes it difficult to read below 10 Watts. Any indication that is less than fifty percent of the 10 Watt scale mark is less than 2.5 Watts.

TEST EQUIPMENT

5.3 The test equipment required for testing and calibration is listed in table 1-4.

ON-AIR FUNCTIONAL TEST

5.4 The on-air functional test is a quick and reliable method of determining the operating status of the transmitter without disrupting its operation or station programming.

5.4.1 INITIAL CONTROL SETTINGS: Set or verify the controls are set for normal operation as follows:

(a) Set or verify the switches are set as tabulated for 'Operating Setting' in table 4-1.

(b) Set or verify LOCAL/REMOTE switch S2 is set to REMOTE.

NOTE

If a remote control system has not been incorporated in the transmitter installation, set LOCAL/REMOTE switch S2 to LOCAL and control the on/off status of the transmitter using AC PWR switch S1 and the output power level using POWER LEVEL switch S3 in the following procedures.

(c) Set or verify the transmitter is operating in its high power mode of operation by selecting HIGH POWER at the remote control site.

(d) If the external gain control feature is in use, set the external gain control to the normal center of its operating range (+7.5 volts dc output).

(e) Set or verify the remote ON/OFF switch has been set to ON and the transmitter is being controlled remotely.

(f) AC PWR (DS1), RF ON (DS2), and REMOTE (DS5) STATUS lamps shall be on.

NOTE

One or more ALARM lamps will turn on when an abnormal condition is sensed and AUDIO LIMIT lamp DS6 will flash when it is limiting the modulating audio by more than 3 dB.

(g) LOW-PWR (DS3) and MED-PWR (DS4) STATUS lamps, INTERLOCK (DS7), HIGH VSWR (DS8), TX FAULT (DS9), MOD DRIVE (DS10) and RF DRIVE (DS11) ALARM lamps shall be off.

5.4.2 RF OUTPUT LEVELS: Check the forward and reflected rf power levels as follows:

(a) Set OUTPUT POWER switch S5 to REFL-HIGH and record OUTPUT POWER meter M2's reflected power indication.

(b) Reading recorded in step (a) should be less than 10 Watts.

(c) Set OUTPUT POWER switch S5 to FWD-HIGH and record OUTPUT POWER meter M2's forward power indication.

(d) Reading obtained in step (c) should be the desired high level, rf carrier, forward power output (maximum of 400 Watts) and should be within 5% of the reading recorded for high power during the most recent calibration.

(e) Set TEST switch S4 to DC AMPS and record DC AMPS indication on lower scale of TEST meter M1.

(f) Set TEST switch S4 to MOD I/P VOLTS and record DC VOLTS indication on upper scale of TEST meter M1.

(g) Enter the formula in paragraph 4.6.1 with the forward power level recorded in step (c) and the modulator input voltage recorded in step (f) and calculate the modulator current. Calculated modulator current should be within 5% of DC AMPS indication recorded in step (e).

(h) Set TEST switch S4 to MOD O/P VOLTS and record DC VOLTS indication on upper scale of TEST meter M1. Reading should be within 2.5% of the reading recorded during the most recent calibration.

(i) Set the transmitter to its medium power mode of operation by selecting MEDIUM POWER at the remote control site.

(j) MED PWR lamp DS4 shall turn on indicating the transmitter has changed to its medium power mode of operation.

(k) Record OUTPUT POWER meter M2's forward power indication. Reading obtained should be the desired medium level, rf carrier, forward power output [cannot exceed high power level recorded in step (c)] and should be within 5% of the reading recorded for medium power during the most recent calibration.

(l) Set TEST switch S4 to DC AMPS and record DC AMPS indication on lower scale of TEST meter M1.

(m) Set TEST switch S4 to MOD I/P VOLTS and record DC VOLTS indication on upper scale of TEST meter M1.

(n) Enter the formula in paragraph 4.6.1 with the forward power level recorded in step (k) and the modulator input voltage recorded in step (m) and calculate the modulator current. Calculated modulator current should be within 5% of DC AMPS indication recorded in step (l).

(o) Set TEST switch S4 to MOD O/P VOLTS and record DC VOLTS indication on upper scale of TEST meter M1. Reading should be within 2.5% of the reading recorded for medium power during the most recent calibration.

(p) Set the transmitter to its low power mode of operation by selecting LOW POWER at the remote control site.

(q) MED PWR lamp DS4 shall turn off and LOW PWR lamp DS3 shall turn on indicating the transmitter has changed to its low power mode of operation.

(r) Record OUTPUT POWER meter M2's forward power indication. Reading obtained should be the desired low level, rf carrier, forward power output [must not exceed medium power level recorded in step (k)] and should be within 5% of the reading recorded for low power during the most recent calibration.

(s) Set TEST switch S4 to DC AMPS and record DC AMPS indication on lower scale of TEST meter M1.

(t) Set TEST switch S4 to MOD I/P VOLTS and record DC VOLTS indication on upper scale of TEST meter M1.

(u) Enter the formula in paragraph 4.6.1 with the forward power level recorded in step (r) and the modulator input voltage recorded in step (t) and calculate the modulator current. Calculated modulator current should be within 5% of DC AMPS indication recorded in step (s).

(v) Set TEST switch S4 to MOD O/P VOLTS and record DC VOLTS indication on upper scale of TEST meter M1. Reading should be within 2.5% of the reading recorded for low power during the most recent calibration.

5.4.3 CARRIER FREQUENCY ACCURACY: Measure the rf carrier frequency as follows:

(a) Connect a frequency counter in parallel with station modulation monitor connected to RF MONITOR connector J3.

(b) Momentarily interrupt the modulating audio, measure and record the frequency indication on the frequency counter.

(c) Measurement obtained in step (b) should be the assigned carrier frequency $\pm$ 5.0 Hz or 5ppm whichever is greater.

5.4.4 MODULATION LEVELS AND QUALITY: Monitor the transmitted signal by using a suitable station modulation monitor and verify the modulation levels are at the desired level and the detected audio is of satisfactory quality.

ROUTINE CALIBRATION PROCEDURES

5.5 Routine calibration consists of adjusting variable electrical components to bring the operating parameters of a fully assembled transmitter into required or desired limits.

NOTE

The following procedures are presented in a logical sequence to accommodate a complete recalibration of the transmitter. The calibration procedures may also be performed independently to correct an out-of-tolerance condition discovered during a minimum performance test. It is recommended a complete minimum performance test be completed after completion of any calibration procedures.

5.5.1 CALIBRATION TEST EQUIPMENT: The test equipment required for calibration is listed in table 1-4.

5.5.2 PRE-CALIBRATION REQUIREMENTS: Prepare the transmitter for calibration as follows.

CAUTION

If the circuits on modulator driver A2 have been repaired or if it is suspected that they are out of calibration, disable the rf output stage by disconnecting wire #57 from A3TB2-5 of modulator/power amplifier A3, until the requirements of paragraphs 5.5.3 thru 5.5.9 have been completed. Failure to observe this precaution could cause damage to the solid state devices in modulator/power amplifier A3.

(a) Turn off transmitter by setting AC PWR switch S1 to OFF and fully extend the transmitter on its drawer slides.

(b) Disconnect or verify the antenna system is disconnected and connect a precision, 50 ohm, resistive dummy load rated at a minimum of 800 Watts; to the rf output using a suitable coaxial cable. Determine precise resistance of dummy load.

(c) Remove the transmitter's top cover plate by removing five attaching screws and lifting off top cover plate.

(d) Remove the transmitter's bottom cover plate by removing six attaching screws and lifting off bottom cover plate.

(e) Verify that all assemblies are installed and securely fastened.

(f) Set the modulating input signal to zero (turned off).

(g) Set O/P PWR potentiometer A2R92, LOW PWR 2 potentiometer A2R7, LOW PWR 1 potentiometer A2R6, LO LIMIT potentiometer A2R18 fully counter clockwise and HI LIMIT potentiometer A2R16 fully clockwise

(h) Set sections of Rf Carrier Source switch A1S1 to the settings required for the desired rf carrier source (internal or external) as detailed in paragraph 3.7.5).

(i) Set all switches as tabulated for 'Initial Setting' in table 4-1.

(j) AC PWR (DS1), LOW PWR (DS3), RF ON (DS2) TX FAULT (DS9) lamps should be on.

(k) Remaining lamps and cooling air fan should be off. (When operating the transmitter in the high power mode, the cooling fan should be jumpered to allow it to remain on).

5.5.3 VOLTAGE CHECKS: Check the operating voltages as follows:

5.5.3.1 AC Power Source Voltage Check: Connect an ac voltmeter between TB3-1 and TB3-3 (see figure FO-1) and verify the rms ac voltage from the ac power source is between 105 vac and 135 vac for the 115 volt operation or 205 vac and 240 vac for the 230 volt operation and is connected to the proper taps (ref. table 3-1) on transformer A8T1 in the PA power supply.

5.5.3.2 +23 Volt DC Voltage Check: Check unregulated +23 volts dc output of low voltage power supply A7 as follows:

(a) Connect a dc voltmeter between A7TB1-3(+) and chassis ground.

(b) Dc voltmeter indication shall be between +23.0 and 26.0 volts dc.

(c) Set TEST switch S4 to +23V. TEST meter M1 indication should be near reading recorded in step (b).

5.5.3.3 +15 Volt DC Voltage Check: Check regulated +15 volts dc output of low voltage power supply A7 as follows:

(a) Connect a dc voltmeter between A7TB1-5(+) and chassis ground.

(b) Dc voltmeter indication shall be between +14.5 and 15.5 volts dc.

(c) Set TEST switch S4 to +15V. TEST meter M1 indication should be near reading recorded in step (b).

5.5.3.4 -15 Volt DC Voltage Check: Check regulated -15 volts dc output of low voltage power supply A7 as follows:

(a) Connect a dc voltmeter between A7TB1-6(-) and chassis ground (+).

(b) Dc voltmeter indication shall be between -14.5 and -15.5 volts dc.

(c) Set TEST switch S4 to -15V. TEST meter M1 indication should be near reading recorded in step (b).

5.5.3.5 PA Power Supply B- Voltage Check: Check B- output of PA voltage power supply A8 as follows:

(a) Connect a dc voltmeter between A8TB1-6 and chassis ground.

(b) Dc voltmeter indication shall be determined by the tap and and diode link configuration selected as detaild in paragraph 5.6.4 and and recorded in table 5-1 for high power operation.

(c) Set TEST switch S4 to MOD I/P VOLTS. TEST meter M1 indication should be near reading recorded in step (b).

5.5.4 RF CARRIER FREQUENCY CALIBRATION: Calibrate or verify rf driver A1's carrier oscillator frequency is calibrated as follows.

NOTE

The rf carrier frequency calibration procedure is only applicable when the internal crystal oscillator is used as the rf carrier source. When an external rf carrier source is used, it is necessary to verify its frequency is the assigned carrier frequency ± 5Hz or 5ppm whichever is greater.

(a) Verify the appropriate carrier oscillator crystal (four times the assigned carrier frequency for frequencies between 535 kHz and 1000 kHz or two times the assigned carrier frequency for frequencies between 1000 kHz and 1705 kHz, is installed in crystal holder A1XY1.

(b) Verify the appropriate links (divide x 4 for frequencies between 535 kHz and 1000 kHz or divide x 2 for frequencies between 1000 kHz and 1705 kHz) are installed on rf driver A1, noting there are two links for each frequency range.

(c) Verify the appropriate values of capacitor A1C12 and inductor A1L6 are installed on rf driver A1, using table shown in figure FO-2 as a reference.

(d) Connect a frequency counter between A1TP2 and chassis ground.

(e) Frequency counter indication shall be the assigned carrier frequency ± 5Hz or 5ppm whichever is greater.

(f) If necessary, adjust trimming capacitor A1C4 to obtain the desired frequency.

5.5.5 RF DRIVE FILTER CALIBRATION: Calibrate or verify the rf drive filter is calibrated as follows:

NOTE

If external rf carrier is used as the rf drive source, ensure the carrier level at A1J3-2 is between 2.8 and 8.4 volts (peak-to-peak).

(a) Clip a Tecktronix P6022 current probe on wire #53, at A3TB2 of modulator/power amplifier A3.

(b) Connect current probe's output to a HP400E rf voltmeter.

(c) Adjust variable inductor L1 for minimum rf drive current indication on rf voltmeter.

(d) Rf drive current reading obtained in step (c) shall be less than 100 milliamperes.

(e) Monitor peak-to-peak rf drive voltage by connecting an oscilloscope between A3TB2-2 and chassis ground.

(f) Rf drive voltage measurement obtained in step (e) shall be between 14.0 and 20.0 volts peak-to-peak.

(g) Disconnect current probe and oscilloscope.

5.5.6 SQUARE WAVE GENERATOR FREQUENCY CALIBRATION: Calibrate or verify the frequency of the modulator's square wave generator is calibrated to the required frequency as follows:

(a) Determine the optimum square wave generator frequency (Fosc) for the assigned rf carrier frequency using the following formula.

$$F_{osc} = \frac{F_c + 35}{N}$$

When: Fc = assigned carrier frequency in kHz.

$$N = \frac{F_c + 35}{70}$$ rounded off to nearest whole number.

(b) Optimum square wave generator frequency determined in step (a) shall be between 65.88 kHz and 74.12 kHz.

(c) Record required square wave generator frequency for future reference.

(d) Connect a frequency counter between A2TP4 and chassis ground and determine square wave generator frequency.

(e) Frequency measurement obtained in step (d) should be the same as that recorded in step (c) $\pm$50 Hz.

(f) If necessary, adjust variable capacitor A2C15 to meet the requirements of step (e).

5.5.7 RAMP INTEGRATOR CALIBRATION: Calibrate or verify the sawtooth waveform output of the modulator's ramp integrator is calibrated as follows:

(a) Connect oscilloscope (dc coupled) between A2TP8 and chassis ground.

(b) Positive peak of sawtooth waveform on oscilloscope should be at zero volts dc.

(c) If necessary, adjust RAMP ADJ potentiometer A2R75 until the requirements of step (b) are met.

5.5.8 AUDIO LIMITER BALANCE CALIBRATION: Calibrate or verify the audio limiter balancing circuits are calibrated as follows:

(a) Set or verify the modulating input signal is set to zero (turned off).

(b) Set or verify LO LIMIT potentiometer A2R18 is set fully counter clockwise and HI LIMIT potentiometer A2R16 is set fully clockwise

(c) Connect oscilloscope (dc coupled) between A2TP5 and chassis ground.

(d) Simultaneously monitor oscilloscope while repeatedly placing and then removing a ground on A2TP2.

(e) Dc level of oscilloscope trace should not change with A2TP2 grounded or not grounded.

(f) If necessary, adjust X-BAL potentiometer A2R29 until the requirements of step (e) are met.

(g) Remove oscilloscope and connect a dc voltmeter between A2TP5 and chassis ground.

(h) Dc voltmeter indication should be 1.75 volts dc.

(i) If necessary, adjust OFS ADJ potentiometer A2R42 until the requirements of step (h) are met.

(j) Disconnect dc voltmeter.

5.5.9 LINE VOLTS COMPENSATION CONTROL CALIBRATION: Calibrate or verify the line volts compensation control is calibrated as follows:

(a) Disconnect MTA connector P1 from rf driver connector A1J1.

(b) Connect a 1.0 volts rms, 60 Hz signal to A2TP3 through a 1.0 uF capacitor.

(c) Connect a jumper wire (short circuit) between A2TP5 and ground.

(d) Connect an ac coupled oscilloscope between A2TP7 and ground.

(e) 60 Hz ac waveform on oscilloscope should be less than 10 millivolts.

(f) If necessary, adjust OFS BAL potentiometer A2R70 until the requirements of step (e) are met.

(g) Remove 60 Hz signal from A2TP3 and disconnect oscilloscope.

(h) Connect a dc voltmeter between A2TP7 and chassis ground.

(i) Dc voltmeter indication should be zero volts dc.

(j) If necessary, adjust X-BAL potentiometer A2R47 until the requirements of step (i) are met.

(k) Install MTA connector P1 on rf driver connector A1J1, remove jumper wire from A2TP5 and disconnect dc voltmeter.

5.5.10 MODULATOR/POWER AMPLIFIER OUTPUT CHECKS: Verify modulator/power amplifier A3 is functioning normally by setting rf output to assigned levels and verifying modulator voltages and current are within prescribed limits as follows:

(a) Set AC PWR switch S1 to OFF and connect or verify wire #57 is connected to A3TB2-5.

(b) Determine the precise resistance of 50-ohm dummy load.

(c) Connect an rms rf voltmeter across 50-ohm dummy load.

(d) Set or verify all switches are set as tabulated for 'Calibration Setting' in table 4-1.

(e) Set AC PWR switch S1 to ON.

(f) Set POWER LEVEL switch S3 to HIGH and OUTPUT POWER switch S5 to FWD-LOW.

(g) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the voltage required for 100 Watts rf carrier output, using the formula:

$$V = \sqrt{P \times R}$$ where:

V = Rf voltmeter indication
P = Rf carrier output level
R = Precise resistance of 50-ohm dummy load.

NOTE:
TX FAULT lamp DS9 may be on at this stage. Ignore indication, as tx fault levels are established in paragraph 5.5.11.

(h) RF WATTS indication on lower scale of OUTPUT POWER meter M2 should be 100 Watts.

(i) Set OUTPUT POWER switch S5 to REFL-LOW and read lower scale of OUTPUT POWER meter M2.

(j) RF WATTS indication on OUTPUT POWER meter M2 should be near zero.

(k) Set TEST switch S4 to I/P VOLTS.

(l) Record indication on upper scale of TEST meter M1 as modulator input voltage. Note typical values tabulated in table 3-1.

(m) Calculate anticipated modulator current (DC AMPS) as detailed in paragraph 4.6.1, using actual rf carrier output level established in step (g) as the forward power level. Note typical values tabulated in table 3-1.

(n) Set TEST switch S4 to DC AMPS.

(o) DC AMPS indication on lower scale of TEST meter M1 should be within 5% of the modulator current value calculated in step (m).

(p) Set TEST switch S4 to O/P VOLTS.

(q) Indication on upper scale of TEST meter M1 should be near the typical value tabulated in table 3-1.

(r) Set OUTPUT POWER switch S5 to FWD-HIGH.

(s) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the voltage required for 250 Watts rf carrier output using the formula provided in step (g).

(t) RF WATTS indication on OUTPUT POWER meter M2 should be 250 Watts.

(u) Repeat steps (i) thru (q) with the rf output set to 250 Watts.

(v) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the voltage required for 400 Watts rf carrier output using the formula provided in step (g).

(w) RF WATTS indication on upper scale of OUTPUT POWER meter M2 should be 400 Watts.

(x) Repeat steps (i) thru (q) with the rf output set to 400 Watts.

5.5.11 RF CARRIER LEVEL/TX FAULT THRESHOLD LEVEL CALIBRATION: Set rf carrier output to the assigned levels in high, medium and low power operating modes. Set tx fault thresholds to the desired levels in high, medium and low power operating modes as follows:

NOTE

The tx fault threshold levels are determined by the user. They are normally set to a level that is slightly below the assigned rf carrier output level for each of the three available power levels. When the rf carrier level falls to the preset threshold level, TX FAULT alarm lamp DS9 will turn on and the external 'tx fault' alarm will be switched from a current sink to ground to an open collector output.

(a) Connect or verify an rms rf voltmeter is connected across 50-ohm dummy load.

(b) Set or verify all switches are set as tabulated for 'Calibration Setting' in table 4-1.

(c) Set POWER LEVEL switch S3 to HIGH.

(d) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the desired high power tx fault threshold level, using the formula provided in paragraph 5.5.10(g). OUTPUT POWER meter M2 indication should be the desired level.

(e) If TX FAULT lamp DS9 is turned on, adjust HIGH Threshold potentiometer A6R24 clockwise until TX FAULT lamp DS9 turns off.

(f) Slowly adjust HIGH Threshold potentiometer A6R24 counter clockwise until TX FAULT lamp DS9 just turns on.

(g) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the assigned high power rf carrier output level. OUTPUT POWER meter M2 indication should be the desired level. TX FAULT lamp DS9 shall turn off.

NOTE

High power rf carrier output level adjustment affects medium and low rf carrier output levels. Any change in O/P PWR potentiometer A2R92 setting will alter medium and low rf carrier output levels.

(h) Set POWER LEVEL switch S3 to MED. MED PWR lamp DS4 shall turn on.

(i) Adjust LOW PWR 2 potentiometer A2R7 for an rf voltmeter indication that is precisely the desired medium power tx fault threshold level, using the formula provided in paragraph 5.5.10(g). OUTPUT POWER meter M2 indication should be the desired level.

(j) If TX FAULT lamp DS9 is turned on, adjust MED Threshold potentiometer A6R26 clockwise until TX FAULT lamp DS9 turns off.

(k) Slowly adjust MED Threshold potentiometer A6R26 counter clockwise until TX FAULT lamp DS9 just turns on.

(l) Adjust LOW PWR 2 potentiometer A2R7 for an rf voltmeter indication that is precisely the assigned medium power rf carrier output level. OUTPUT POWER meter M2 indication should be the desired level. TX FAULT lamp DS9 shall turn off.

(m) Set POWER LEVEL switch S3 to LOW. LOW PWR lamp DS3 shall turn on.

(n) Adjust LOW PWR 1 potentiometer A2R6 for an rf voltmeter indication that is precisely the desired low power tx fault threshold level, using the formula provided in paragraph 5.5.10(g). OUTPUT POWER meter M2 indication should be the desired level.

(o) If TX FAULT lamp DS9 is turned on, adjust LOW Threshold potentiometer A6R28 clockwise until TX FAULT lamp DS9 turns off.

(p) Slowly adjust LOW Threshold potentiometer A6R28 counter clockwise until TX FAULT lamp DS9 just turns on.

(q) Adjust LOW PWR 1 potentiometer A2R6 for an rf voltmeter indication that is precisely the assigned low power rf carrier output level. OUTPUT POWER meter M2 indication should be the desired level. TX FAULT lamp DS9 shall turn off.

5.5.12 EXTERNAL RF OUTPUT MONITORING CALIBRATION: Set the rf monitor output voltage to the level required by the station modulation monitor; ensuring voltages are equal in high, medium and low power operating modes; as follows:

NOTE

The following procedure specifies using a 1000 ohm resistive load and an rms rf voltmeter to establish the rf monitor output levels. Users may use a modulation monitor in lieu of this equipment.

(a) Verify the requirements of paragraphs 5.5.3 thru 5.5.11 are completed.

(b) Connect a 1000 ohm resistive load to RF MONITOR coaxial connector J3 using a suitable coaxial connector.

(c) Connect an rms ac voltmeter across 1000 ohm load connected in step (b).

(d) Set POWER LEVEL switch S3 to HIGH. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(e) Adjust HIGH Monitor potentiometer A6R3 for desired rms ac voltage (maximum of 5.0 volts ac rms) indication on rms ac voltmeter.

(f) Set POWER LEVEL switch S3 to MED. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned medium power rf carrier output level.

(g) Adjust MED Monitor potentiometer A6R2 for precisely the same ac voltmeter obtained in step (e).

(h) Set POWER LEVEL switch S3 to LOW. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned low power rf carrier output level.

(i) Adjust LOW Monitor potentiometer A6R1 for precisely the same ac voltmeter obtained in step (e).

(j) Disconnect 1000 ohm resistor and rms ac voltmeter.

5.5.13 MODULATION LEVEL CALIBRATION: Set the modulation to the desired level as follows:

(a) Verify the requirements of paragraphs 5.5.3 thru 5.5.11 are completed.

(b) Set POWER LEVEL switch S3 to HIGH.

(c) RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(d) Connect a station modulation monitor, with an input impedance of not less than 1000 ohms, to RF MONITOR coaxial connector J3.

(e) Set audio low-pass and high-pass switches (A2S1 and A2S2) for the desired audio bandwidth using tables shown in figure FO-3. Where heavy external audio processing is not used, it is recommended that all sections of switches A2S1 and A2S2 be set to the closed position. This selection will provide the best transient response (low overshoot) and protection from undesirable low frequencies (thumps,etc).

(f) Turn on normal station program modulating audio (nominal +10 dBm).

(g) Simultaneously monitor station modulation monitor and adjust AUDIO LEVEL potentiometer R4 for the desired modulation depth.

(h) Simultaneously monitor station modulation monitor and adjust HI LIMIT potentiometer R16 counter clockwise until positive modulation peaks are just being limited and then adjust clockwise until just not limiting, noting that circuit design restricts limiting range between 100% to 125% (nominal) positive modulation peaks.

(i) Simultaneously monitor station modulation monitor and adjust LO LIMIT potentiometer R18 clockwise until negative modulation peaks are just being limited and then adjust counter clockwise until just not limiting, noting that circuit design restricts limiting range between 95% to 100% (nominal) negative modulation peaks.

SPECIAL CALIBRATION PROCEDURES:

5.6 Procedures referred to as special calibration procedures require test equipment that is not normally available at transmitter sites. The adjustments have been precisely set at the factory prior to shipment and should not require further adjustment. The accuracy of the settings will affect the accuracy of the routine calibration settings, therefore they should not be disturbed unless their accuracy is suspect and then only if the specified test equipment is available.

5.6.1 TEST METER M1 CALIBRATION: Test meter M1 has been precisely calibrated to indicate the modulator current flow thru the power amplifier when DC AMPS has been selected by TEST switch S4. If all other readings presented by TEST meter M1 appear to be satisfactory, the most likely cause is the modulator current metering circuit. Calibrate the modulator current metering circuit as follows:

(a) Turn off transmitter by setting AC POWER switch S1 to OFF.

(b) Connect a precision 50 ohm dummy load, rated at a minimum of 800 Watts to rf output connector A5J1.

(c) Gain access to the interior of the transmitter by removing its bottom cover.

(d) Set the modulating audio signal to zero (turned off).

(e) Disconnect wire 15 from A8TB1-6 and connect an ammeter between wire 15 and A8TB1-6.

(f) Set OUTPUT POWER switch S5 to FWD HIGH.

(g) Set or verify REMOTE/LOCAL switch S2 is set to LOCAL.

(h) Set TEST switch S4 to DC AMPS.

(i) Set POWER LEVEL switch S3 to HIGH.

(j) Turn on transmitter by setting AC POWER switch S1 to ON.

(k) Verify the transmitter is operating in the high power mode of operation, the rf output is not exceeding 400 Watts, and there are no alarm lamps on.

(l) If the indication on TEST meter M1 is not the same as the ammeter indication, adjust variable resistor A9R6 until the indications are identical.

(m) Turn off transmitter by setting AC POWER switch S1 to OFF.

(n) Disconnect the ammeter and connect wire 15 to A8TB1-6.

(o) If procedures requiring access to the interior of the transmitter have been completed, replace bottom cover.

(p) Perform a functional test as detailed in paragraph 5.7.

5.6.2 OUTPUT POWER METER M2 CALIBRATION: Calibrate the upper and lower scale indications on OUTPUT POWER meter M2 as follows.

(a) Turn off transmitter by setting AC POWER switch S1 to OFF.

(b) Connect a precision 50 ohm dummy load, rated at a minimum of 800 Watts to rf output connector A5J1.

(c) Connect a precision rms rf voltmeter across the dummy load.

(d) Gain access to the interior of the transmitter by removing its bottom cover.

(e) Set the modulating audio signal to zero (turned off).

(f) Set or verify REMOTE/LOCAL switch S2 is set to LOCAL.

(g) Set or verify TEST switch S4 is set to DC AMPS.

(h) Set or verify POWER LEVEL switch S3 is set to HIGH.

(i) Set OUTPUT POWER switch S5 to FWD HIGH.

(j) Turn on transmitter by setting AC POWER switch S1 to ON.

(k) Verify the transmitter is operating in the high power mode of operation, the rf current is not excessive, and there are no alarm lamps on.

(l) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the voltage required for 400 Watts rf carrier output, using the formula:

$$V = \sqrt{P \times R} \quad \text{where:}$$

V = Rf voltmeter indication
P = Rf carrier output level
R = Precise resistance of 50-ohm dummy load.

(m) Adjust potentiometer A9R11 for an RF WATTS indication on upper scale of OUTPUT POWER meter M2 of precisely 400 Watts.

(n) Adjust O/P PWR potentiometer A2R92 for an rf voltmeter indication that is precisely the voltage required for 100 Watts rf carrier output, using the formula provided in step (l).

(o) Set OUTPUT POWER switch S5 to FWD LOW.

(p) Adjust potentiometer A9R13 for an RF WATTS indication on upper scale of OUTPUT POWER meter M2 of precisely 100 Watts.

(q) Set OUTPUT POWER switch S5 to FWD HIGH.

(r) If procedures requiring access to the interior of the transmitter have been completed, replace bottom cover.

(s) Calibrate the rf carrier output levels as detailed in paragraph 5.5.11.

5.6.3 RF OUTPUT CURRENT PROTECTION THRESHOLD CALIBRATION: Calibrate the rf output current protection circuits as follows.

(a) Turn off transmitter by setting AC POWER switch S1 to OFF.

(b) Connect a precision 50 ohm dummy load, rated at a minimum of 800 Watts to rf output connector A5J1.

(c) Gain access to the interior of the transmitter by removing its top cover.

(d) Replace station modulating audio signal connected to TB1-1/2/3 with an audio signal generator.

(e) Set or verify REMOTE/LOCAL switch S2 is set to LOCAL.

(f) Set or verify TEST switch S4 is set to DC AMPS.

(g) Set or verify POWER LEVEL switch S3 is set to HIGH.

(h) Set OUTPUT POWER switch S5 to FWD HIGH.

(i) Connect an oscilloscope to RF MONITOR coaxial connector J3.

(j) Set PHASE potentiometer A1R30 and CURRENT LEVEL potentiometer A1R31 fully counterclockwise.

(k) Turn on transmitter by setting AC POWER switch S1 to ON.

(l) Verify the transmitter is operating at the assigned power level in the high power mode of operation, the rf current is not excessive, and there are no alarm lamps on.

(m) Set the audio signal generator to 1000 Hz and adjust its output level for 95% modulation as observed on the oscilloscope.

(n) Monitor OUTPUT POWER meter M2 and simultaneously adjust CURRENT LEVEL potentiometer A1R31 clockwise for a 3dB reduction in output power, as indicated on OUTPUT POWER meter M2.

(o) HIGH VSWR ALARM lamp DS8 shall be on and a ground potential 'VSWR alarm' output shall be applied to TB2-4 for external monitoring.

(p) Set CURRENT LEVEL potentiometer potentiometer A1R31 fully counterclockwise.

(q) OUTPUT POWER meter M2 indication shall return to the assigned rf carrier level as noted in step (l).

(r) Set output of audio signal generator to zero (turned off).

(s) Turn off transmitter by setting AC POWER switch S1 to OFF.

(t) Remove MC14070BAL integrated circuit device A1U3 from socket A1XU3.

(u) Apply +7.5 volts dc between A1U3-3 (+) and ground, noting one end of A1R29 can be used as connection point for A1U3-3.

(v) Turn on transmitter by setting AC POWER switch S1 to ON.

(w) Monitor OUTPUT POWER meter M2 and simultaneously adjust PHASE potentiometer A1R30 clockwise until rf output indication on OUTPUT POWER meter M2 just starts to decrease.

(x) Measure dc voltage between A1TP7 (+) and ground using digital multimeter.

(y) Reading obtained in step (x) should be nominally 3.48 volts dc. Record this reading as the phase difference reference voltage.

(z) Turn off transmitter by setting AC POWER switch S1 to OFF.

(aa) Disconnect +7.5 volts dc from A1U3-3.

(ab) Reinstall MC14070BAL integrated circuit device A1U3, removed in step (t), in socket A1XU3.

(ac) Turn on transmitter by setting AC POWER switch S1 to ON.

(ad) Measure dc voltage between A1TP4 (+) and ground using digital multimeter.

(ae) Reading obtained in step (x) should be near zero (nominally 0.33 volts dc).

(af) Calculate forty percent of reading recorded as phase difference voltage in step (y) (nominally 1.76 volts dc).

(ag) Simultaneously measure dc voltage between A1TP7 (+) and ground, using digital multimeter, and adjust CURRENT LEVEL potentiometer A1R31 clockwise for reading calculated in step (af).

(ah) Turn off transmitter by setting AC POWER switch S1 to OFF.

(ai) Replace audio signal generator connected to TB1-1/2/3 with the station modulating audio signal.

(aj) If procedures requiring access to the interior of the transmitter have been completed, replace top cover.

(ak) Perform a functional test as detailed in paragraph 5.7.

Table 5-1 Power Amplifier B- Voltage Versus RF Output Level

A8TB2 TERMINAL	A8T1 SECONDARY VOLTAGE (RMS)	RF CARRIER OUTPUT POWER (WATTS)		
		MAXIMUM	PREFERRED MINIMUM	ABSOLUTE MINIMUM
1	80	—	—	100
2	57	—	—	50
3	41	—	—	25
4	29	—	—	12.5

5.6.4 SELECTING POWER AMPLIFIER B- VOLTAGES: Select the secondary taps of power transformer A8T1 and the diode links of interface printed circuit board A6; that determine the B- voltage to be applied to power amplifier A3, for each of the assigned HIGH, MED and LOW power levels, as follows:

NOTE

Only two of the available B- voltages can be used, therefore, one of the B- voltages must accommodate two of the three preset power levels. The user must enter table 5-1, filled in as detailed in steps (c) thru (f), and determine which B- voltage can be used for two or more power levels, noting one of the B- voltages is dictated by the 'high' power level. The ideal situation will be when all three preset power levels fall between the Pmax and Preferred Pmin limits of two B- voltages. In some cases, it will be necessary to select a B- voltage, for two power levels, that results in the lower power level being less than the preferred Pmin or in extreme cases less than the absolute Pmin. The penalty for operating below the Absolute Pmin level may be a distortion of the modulation envelope at high modulation levels.

(a) Determine the assigned rf carrier output power levels for 'high', 'medium' and 'low' power operation.

(b) Using the 'high' power level determined in step (a), connect or verify wire #27 of PA power supply A8's wiring harness is connected to the appropriate terminal of A8TB2, using the following:

- A8TB2-1 when 'high' power level is between 400 and 200 Watts.
- A8TB2-2 when 'high' power level is between 200 and 100 Watts.
- A8TB2-3 when 'high' power level is between 100 and 50 Watts.
- A8TB2-4 when 'high' power level is between 50 and 25 Watts.

(c) Enter table 5-1 at the row corresponding to the terminal of A8TB2 that wire #27 was connected to in step (b). Fill in the assigned 'high' power level as Pmax for that terminal.

(d) Referring to table 5-1, determine the terminals of A8TB2 that provide a secondary voltage from A8T1 which is greater than the voltage provided by the terminal that wire #27 is connected to. Enter a not applicable (NA) in the Pmax and Preferred Pmin columns of table 5-1 for these terminals.

(e) Determine Pmax for the remaining terminals of A8TB2, in descending order of the voltages they provide, by dividing Pmax for the terminal providing the next higher voltage by two. Enter the resultant in the Pmax column of table 5-1.

(f) Fill in Preferred Pmin for each terminal of A8TB2, by dividing its Pmax by two.

(g) Enter table 5-1 with assigned 'medium' and 'low' power levels, and determine if the B- voltage for 'high' power level can be used for the 'medium' power level or which of the remaining B- voltages can be used for the 'medium' and 'low' power levels.

NOTE

It is possible for all three preset power levels to fall between the Pmax and Preferred Pmin limits of a single B- voltage.

(h) If the B- voltage for 'high' power level can be used for 'medium' power level, remove or verify diode link to terminal A on interface printed circuit board A6 is removed.

(i) If the B- voltage for 'high' power level can also be used for 'low' power level, remove or verify diode link to terminal B on interface printed circuit board A6 is removed.

(j) If the second B- voltage is to be used for 'medium' and 'low' power levels, connect wire #26 to the terminal of A8TB2 that will provide the required B- voltage and then connect or verify diode links are connected to terminals A and B on interface printed circuit board A6, as depicted in figure FO-21.

NOTE

The diode links on interface pcb A6 determine if relay A8K1 energizes and applies the secondary voltage selected by wire #26 when operating in 'medium' and/or 'low' power.

(k) If the second B- voltage is to be used for 'low' power level only, connect wire #26 to the terminal of A8TB2 that will provide the required B- voltage and then connect or verify a diode link is connected to terminal B on interface printed circuit board A6, as depicted in figure FO-21.

(l) If the second B- voltage is not required, tywrap wire #26 back into its cable harness, ensuring it is not shorted.

(m) Calibrate the B- reference voltage, applied to the line volts compensation circuit in modulator diver pcb A2, as detailed in paragraph 5.6.5.

5.6.5 B- REFERENCE VOLTAGE CALIBRATION: Calibrate the B- reference voltage, applied to the line volts compensation circuit in modulator driver A2, as follows.

NOTE

The B- reference voltage must be calibrated whenever a change in the preset rf power output levels dictates a change in the secondary taps of power transformer T1 in PA power supply A8 or the diode links on interface pcb A6.

(a) Set or verify all switches are set as tabulated for 'Calibration Setting' in table 4-1.

(b) Connect a digital voltmeter between test point A2TP3 (-) and chassis ground.

(c) Set POWER LEVEL switch S3 to HIGH.

(d) Adjust HIGH B- potentiometer A6R44 for digital voltmeter indication of -6.4 volts dc.

(e) Adjust O/P PWR potentiometer A2R92 until OUTPUT POWER meter M2 indication is the desired 'high' power output.

(f) Repeat steps (d) and (e) until their requirements are met without further adjustment.

(g) Set POWER LEVEL switch S3 to MED.

(h) Adjust MED B- potentiometer A6R45 for digital voltmeter indication of -5.4 volts dc.

NOTE

The B- reference voltage on A2TP3 must be 1.0 volts less negative in the 'medium' and 'low' power modes than it is in the 'high' power mode. This differential ensures any power setting, that is equal to or less than the 'high' power setting, is available for the 'medium' and 'low' power modes.

(i) Adjust LOW PWR 2 potentiometer A2R7 until OUTPUT POWER meter M2 indication is the desired 'medium' power output.

(j) Repeat steps (h) and (i) until their requirements are met without further adjustment.

(k) Set POWER LEVEL switch S3 to LOW.

(l) Adjust LOW B- potentiometer A6R46 for digital voltmeter indication of -5.4 volts dc.

(m) Adjust LOW PWR 1 potentiometer A2R6 until OUTPUT POWER meter M2 indication is the desired 'low' power output.

(n) Repeat steps (l) and (m) until their requirements are met without further adjustment.

(o) Calibrate rf carrier level output as detailed in paragraph 5.5.11.

MINIMUM PERFORMANCE TEST

5.7 The minimum performance test is an off-air test that verifies the transmitter is functioning within its design limits. The rf output is applied to a precision, 50-ohm, resistive, dummy load for these tests. The test instructions are presented in a detailed step-by-step format. It is recommended that personnel who are not intimately familiar with the transmitter circuits follow the instructions in the order presented, since prerequisites for some procedures are established in preceding steps. A minimum performance test should be performed and the results recorded, for comparison with past and future minimum performance tests, on completion of calibration procedures and as a routine part of a scheduled maintenance program.

5.7.1 PRELIMINARY REQUIREMENTS: Prepare the transmitter for a minimum performance test as follows.

(a) Turn off transmitter by setting AC PWR switch S1 to OFF.

(b) Disconnect antenna system and connect a precision, 50 ohm, resistive dummy load rated at a minimum of 800 Watts; to the rf output using a suitable coaxial cable. Determine precise resistance of dummy load.

(c) Fully extend the transmitter on its drawer slides and remove the top cover plate.

(d) Set the modulating audio input signal to zero (turned off).

(e) If used, set external gain control to center of its operating range.

(f) Set AC PWR switch S1 to ON.

(g) Set remaining switches to settings tabulated for 'calibration setting' in table 4-1.

(h) AC PWR (DS1),RF ON (DS2) and LOW-PWR (DS3) STATUS lamps shall be on.

NOTE

One or more ALARM lamps may turn on momentarily when power is first applied. They will remain on when an abnormal condition is sensed. AUDIO LIMIT lamp DS6 will flash when the modulating audio's positive and negative peaks exceed preset thresholds and the modulating audio is being limited by more than 3 dB.

(i) MED-PWR (DS4) STATUS lamp, INTERLOCK (DS7), HIGH VSWR (DS8), TX FAULT (DS9), MOD DRIVE (DS10) and RF DRIVE (DS11) ALARM lamps shall be off.

5.7.2 LOW VOLTAGE LEVELS: Verify the outputs of the low voltage power supplies are acceptable as follows:

(a) Measure ac voltage between TB3-1 and TB3-3 using an rms ac voltmeter. Ac voltage must be between 105 and 135 volts ac.

(b) Set TEST switch S4 to +23V.

(c) TEST meter M1 indication indication will vary with variation in voltage of ac power source (normally between 22.0 and 26.0 volts dc).

(d) Set TEST switch S4 to +15V.

(e) TEST meter M1 indication indication shall be within 0.5 volt of reading recorded during most recent calibration (normally between 14.0 and 16.0 volts dc).

(f) Set TEST switch S4 to -15V.

(g) TEST meter M1 indication indication shall be within 0.5 volt of reading recorded during most recent calibration (normally between 14.0 and 16.0 volts dc).

5.7.3 RF DRIVE TESTS: Check the frequency and level of the rf drive as follows:

NOTE

If external rf carrier is used as the rf drive source, ensure the carrier level at A1J3-2 is between 2.8 to 8.4 volts (peak-to-peak).

(a) Connect a frequency counter between A1TP3 and chassis ground.

(b) Measure and record the frequency indication on the frequency counter.

(c) Measurement obtained in step (b) should be the assigned carrier frequency, ±5.0 Hz or 5ppm whichever is greater.

(d) Connect a digital voltmeter between junction of A1R13/C13 and chassis ground.

(e) Voltmeter indication should be between 1.87 and 2.68 volts dc.

5.7.4 MODULATOR RAMP OPERATION: Check the modulator ramp as follows:

(a) Connect a frequency counter between A2TP4 and chassis ground.

(b) Measure and record the frequency indication on the frequency counter.

(c) Reading recorded in step (b) should be within 50 Hz of optimum frequency recorded for modulator square wave generator at last calibration.

(d) Connect an oscilloscope between A2TP8 and chassis ground.

(e) Oscilloscope indication should be a symmetrical ramp waveform of approximately 3.0 volts peak-to-peak, with positive peak of ramp at zero volts. Waveform frequency shall be the same as recorded in step (c).

(f) Connect an oscilloscope between A2TP9 and chassis ground.

(g) Oscilloscope indication should be a dc control reference line that is within the limits of the ramp waveform on A2TP8.

(h) Connect an oscilloscope between A2TP10 and chassis ground.

(i) Oscilloscope indication should be a rectangular waveform at the square wave generator frequency, switching between zero and 15.0 volts.

5.7.5 FORWARD AND REFLECTED POWER/MODULATOR CURRENT LEVELS: Measure the forward and reflected power and modulator input current levels as follows.

(a) Set AC PWR switch S1 to OFF.

(b) Determine the precise resistance of 50-ohm dummy load.

(c) Connect an rms rf voltmeter across 50-ohm dummy load.

(d) Set or verify all switches are set as tabulated for 'Calibration Setting' in table 4-1.

(e) Set AC PWR switch S1 to ON.

(f) Measure the rms voltage across the 50-ohm dummy load and determine the actual rf carrier output level using the following formula:

$$P = \frac{V^2}{R}$$ where:

P = Rf carrier output level (Watts)
V = Rf voltmeter indication (rms Volts)
R = Precise resistance of 50-ohm dummy load (Ohms)

(g) Resultant obtained in step (f) shall be the desired low power rf carrier output level.

(h) RF WATTS indication on OUTPUT POWER meter M2 should be desired low power rf carrier output level.

(i) Set OUTPUT POWER switch S5 to REFL-LOW and read lower scale of OUTPUT POWER meter M2.

(j) RF WATTS indication on OUTPUT POWER meter M2 should be near zero.

(k) Record DC AMPS indication on lower scale of TEST meter M1 as modulator current. Reading recorded is dependent on level of ac line volts.

(l) Set TEST switch S4 to I/P VOLTS.

(m) Record indication on upper scale of TEST meter M1 as modulator input voltage. Reading recorded is dependent on level of ac line volts.

(n) Set TEST switch S4 to O/P VOLTS.

(o) Record indication on upper scale of TEST meter M1 as modulator output voltage. Value recorded shall be within 2.5% of reading recorded at last calibration.

(p) Set OUTPUT POWER switch S5 to FWD-HIGH.

(q) Set POWER LEVEL switch S3 to MED. MED PWR lamp DS4 shall turn on.

(r) Measure the rms voltage across the 50-ohm dummy load and determine the actual rf carrier output level using the formula provided in step (f).

(s) Resultant in step (r) shall be the desired medium power rf carrier output level.

(t) RF WATTS indication on OUTPUT POWER meter M2 should be desired medium power rf carrier output level.

(u) Repeat steps (i) thru (p) for medium power.

(v) Set POWER LEVEL switch S3 to HIGH.

(w) Measure the rms voltage across the 50-ohm dummy load and determine the actual rf carrier output level using the formula provided in step (f).

(x) Resultant in step (w) shall be the desired high power rf carrier output level.

(y) RF WATTS indication on OUTPUT POWER meter M2 should be desired high power rf carrier output level.

(z) Repeat steps (i) thru (p) for high power.

5.7.6 TX FAULT ALARM THRESHOLD LEVEL CHECK: Check the tx fault alarm thresholds as follows:

NOTE

Checking of the tx fault alarm thresholds require the high, medium and low power levels settings to be disturbed.

(a) Set or verify all switches are set as tabulated for 'Calibration Setting' in table 4-1.

(b) Set POWER LEVEL switch S3 to HIGH.

(c) Record high power rf carrier forward power output reading on OUTPUT POWER meter M2.

(d) Decrease rf output by adjusting O/P PWR potentiometer A2R92 counter clockwise until TX FAULT lamp DS9 just turns on.

(e) Indication on OUTPUT POWER meter M2 shall be the desired high power tx fault threshold level.

(f) An external tx fault alarm condition shall be generated.

(g) Adjust O/P PWR potentiometer A2R92 for a forward power indication on OUTPUT POWER meter M2 that is precisely the high power rf carrier forward power output recorded in step (c).

(h) TX FAULT lamp DS9 shall turn off and external tx fault alarm condition shall be removed.

(i) Set POWER LEVEL switch S3 to MED.

(j) Record medium power rf carrier forward power output reading on OUTPUT POWER meter M2.

(k) Decrease rf output by adjusting LOW PWR 2 potentiometer A2R7 counter clockwise until TX FAULT lamp DS9 just turns on.

(l) Indication on OUTPUT POWER meter M2 shall be the desired medium power tx fault threshold level.

(m) Adjust LOW PWR 2 potentiometer A2R7 for a forward power indication on OUTPUT POWER meter M2 that is precisely the medium power rf carrier forward power output recorded in step (j).

(n) TX FAULT lamp DS9 shall turn off.

(o) Set POWER LEVEL switch S3 to LOW.

(p) Record low power rf carrier forward power output reading on OUTPUT POWER meter M2. Set OUTPUT POWER switch S5 to FWD-LOW and read lower scale to obtain a more accurate reading when rf output is less than 150 Watts.

(q) Decrease rf output by adjusting LOW PWR 1 potentiometer A2R6 counter clockwise until TX FAULT lamp DS9 just turns on.

(r) Indication on OUTPUT POWER meter M2 shall be the desired low power tx fault threshold level.

(s) Adjust LOW PWR 1 potentiometer A2R6 for a forward power indication on OUTPUT POWER meter M2 that is precisely the low power rf carrier forward power output recorded in step (p).

(t) TX FAULT lamp DS9 shall turn off.

5.7.7 MODULATION LEVELS: Verify the modulation levels and response are within acceptable limits as follows:

CAUTION

Modulation levels of more than 60% should be avoided when the audio input is a continuous sine/square wave from an audio signal generator. Overheating may occur if the rf output is 400 Watts and it is modulated at a continuous 100% for more than ten minutes.

(a) Set or verify AC PWR switch S1 is set to OFF.

(b) Connect an audio signal generator with an output impedance of 600 ohms between terminals 1 and 3 of terminal board TB1, as the transmitter's source of modulation audio, in lieu of the normal station modulating audio source.

(c) Connect a modulation monitor with an input impedance of not less than 1000 ohms to RF MONITOR coaxial connector J3 using an appropriate coaxial cable.

(d) Connect a distortion analyzer with a 15 kHz bandwidth to the demodulated audio output of the modulation monitor.

(e) Set AC PWR switch S1 to ON.

(f) Set or verify the transmitter is operating in its high power mode of operation.

(g) Set or verify OUTPUT POWER switch S5 is set to FWD-HIGH and OUTPUT POWER meter M2's forward power indication is the desired high level, rf carrier, forward power output (maximum of 400 Watts).

5.7.7.1 Modulation Control: Verify the modulation level can be adjusted for 100% modulation when the 600 ohm audio input signal is from 0 dBm to +10 dBm as follows:

(a) Verify the modulation level has been preset as detailed in paragraph 5.5.13.

(b) Set LO LIMIT potentiometer A2R18 fully counter clockwise and HI LIMIT potentiometer A2R16 fully clockwise

(c) Set the audio signal generator's frequency to 1000 Hz.

(d) Adjust audio signal generator's output level for 100% modulation as indicated on the monitoring system's modulation percentage indicator and record the audio signal generator's output level.

NOTE
Audio signal generator output level recorded in step (d) represents the normal station programming signal level to obtain 100% modulation.

(e) Set audio signal generator's output level to +10 dBm.

(f) Adjust AUDIO LEVEL potentiometer A2R4 for 100% modulation, as indicated on the monitoring system's modulation percentage indicator. End of A2R4 travel shall not have been obtained.

(g) Set audio signal generator's output level to 0.0 dBm.

(h) Adjust AUDIO LEVEL potentiometer A2R4 clockwise for 100% modulation, as indicated on the monitoring system's modulation percentage indicator. End of A2R4 travel shall not have been obtained.

(i) Set audio signal generator's output to the level recorded in step (d).

(j) Adjust AUDIO LEVEL potentiometer A2R4 for 100% modulation, as indicated on the monitoring system's modulation percentage indicator.

5.7.7.2 Audio Frequency Response: Check the modulation audio frequency response as follows:

(a) Record the switch settings for each section of switch A2Sl and A2S2 and then set all sections of each switch to their open positions.

(b) Set the audio signal generator's frequency to 1000 Hz.

(c) Adjust the audio signal generator's output level for 25% modulation, as indicated on the monitoring system's modulation percentage indicator.

(d) Record the audio signal generator's output level.

(e) Repeat steps (c) and (d) with the audio signal generator's frequency set to 50 Hz, 100 Hz, 400 Hz, 5000 Hz, 7500 Hz and 10000 Hz.

(f) The results recorded as the signal generator's output for the frequencies specified in steps (a) and (d) shall be within ±1.0 dB.

(g) Repeat steps (a) thru (e) with the modulation level set to 50% in step (b).

(h) Repeat steps (a) thru (e) with the modulation level set to 95% in step (b).

(i) Set each section of switches A2S1 and A2S2 to the settings recorded in step (a).

5.7.7.3 Signal-To-Noise Ratio: Check the combined noise and hum to signal ratio as follows:

(a) Set the audio signal generator's frequency to 1000 Hz.

(b) Adjust the audio signal generator's output level for 100% modulation.

(c) Record the signal level on the distortion analyzer's signal level indicator.

(d) Set the audio signal generator's output level to zero.

(e) The combined noise and hum level on the distortion analyzer's signal level indicator shall be a minimum of 60 dB below the signal level recorded in step (c).

5.7.7.4 Audio Distortion: Check the demodulated audio for distortion as follows:

(a) Set the audio signal generator's frequency to 1000 Hz.

(b) Adjust the audio signal generator's output level for 25% modulation.

(c) Measure the audio distortion level using the distortion analyzer.

(d) The distortion measured in step (c) shall not exceed two percent.

(e) Repeat steps (b) thru (d) with the audio signal generator's frequency set to 50 Hz, 100 Hz, 400 Hz, 5000 Hz, 7500 Hz and 10000 Hz.

(f) Repeat steps (a) thru (e) with the audio signal generator's output level set for 50% modulation in step (b).

(g) Repeat steps (a) thru (e) with the audio signal generator's output level set for 95% modulation in step (b).

5.7.7.5 Carrier Shift: Check the carrier shift with 1000 Hz modulation as follows:

(a) Set the audio signal generator's frequency to 1000 Hz.

(b) Set the audio signal generator's output level to zero (0% modulation).

(c) Measure and record the carrier level indication on the modulation monitor.

(d) Adjust the audio signal generator's output level for 95% modulation.

(e) Measure and record the carrier level indication on the modulation monitor.

(f) Measurement recorded in step (e) shall not vary from the measurement recorded in step (c) by more than one percent.

5.7.8 RADIATED HARMONICS/NOISE LEVEL: Measure the radiated harmonics and noise levels as follows:

CAUTION

Modulation levels of more than 60% should be avoided when the audio input is a continuous sine/square wave from an audio signal generator. Overheating may occur if the rf output is 400 Watts and it is modulated at a continuous 100% for more than ten minutes.

(a) Set or verify AC PWR switch S1 is set to OFF.

(b) Connect or verify an 600-ohm audio signal generator is connected between terminals 1 and 3 of terminal board TB1.

(c) Set the audio signal generator to 1000 Hz at the output level required for 100% modulation (see paragraph 5.7.7.1).

CAUTION

A 1000 ohm resistor must be placed in series between J3 and the spectrum analyzer to protect the RF monitor level control circuit and the spectrum analyzer. Caution should also be used in the length of the testing cable so as to avoid capacitive loading (up to 4 feet of test cable is ideal).

(d) Connect a spectrum analyzer to RF MONITOR coaxial connector J3 using an appropriate coaxial cable.

(e) Set AC PWR switch S1 to ON.

(f) Set or verify the transmitter is operating in its high power mode of operation.

(g) Perform a spectrum analysis of the rf output.

(h) All harmonics and spurious outputs shall be a minimum of 69 dB below the fundamental rf carrier frequency.

(i) Set AC PWR switch S1 to OFF.

(j) Disconnect spectrum analyzer and audio signal generator and reconnect the transmitter's normal modulating source to terminals 1 and 3 of terminal board TB1.

5.7.9 REMOTE CONTROLS, LOCAL/REMOTE ALARMS AND REMOTE MONITORING: Check remote control operation, activation of local and remote alarms and level of buffered forward and reflected power metering outputs as follows:

5.7.9.1 <u>Remote On/off Control:</u> Verify the on or off status can be controlled remotely as follows:

(a) Set switches to settings tabulated for 'calibration setting' in table 4-1.

(b) Set remote ON/OFF switch to its OFF position.

(c) Set the transmitter to its remote mode of operation by setting REMOTE/LOCAL switch S2 to REMOTE.

(d) REMOTE lamp DS5 shall turn on.

(e) RF ON lamp DS2 shall turn off and indication on OUTPUT POWER meter M2 shall go to zero.

(f) Set remote ON/OFF switch to its ON position.

(g) RF ON lamp DS2 shall turn on and indication on OUTPUT POWER meter M2 shall be the transmitter's rf carrier output level.

5.7.9.2 Remote Power Level Control: Verify the selection of the high, medium and low power operating modes can be controlled remotely as follows:

(a) Set remote Power Level switch to its 'Low' position.

(b) LOW PWR lamp DS3 shall turn on indicating the transmitter has changed to its low power mode of operation.

(c) OUTPUT POWER meter M2 indication shall be the desired low level, rf carrier, forward power output.

(d) Set remote Power Level switch to its 'Medium' position.

(e) LOW PWR lamp DS3 shall turn off and MED PWR lamp DS4 shall turn on, indicating the transmitter has changed to its medium power mode of operation.

(f) OUTPUT POWER meter M2 indication shall be the desired medium level, rf carrier, forward power output.

(g) Set remote Power Level switch to its 'High' position.

(h) MED PWR lamp DS4 shall turn off, indicating the transmitter has changed to its high power mode of operation.

(i) OUTPUT POWER meter M2 indication shall be the desired high level, rf carrier, forward power output.

5.7.9.3 Local and Remote Interlock Alarms: Verify an interlock alarm condition is generated whenever the interlock circuit is interrupted as follows.

(a) Open or cause the external interlock circuit to be opened by opening any external switch or relay in the interlock circuit.

(b) INTERLOCK ALARM lamp DS7 shall turn on and an external 'interlock open alarm' condition shall be generated.

(c) OUTPUT POWER meter M2 indication shall go to zero indicating the transmitter has turned off. Modulation current indication on TEST meter M2 indication shall also go to zero.

(d) Close or cause the interlock circuit to be closed by closing any external switch or relay contacts that were opened in step (a).

(e) The transmitter shall turn on and OUTPUT POWER meter M2's indication shall be the desired high level, rf carrier, forward power output.

(f) INTERLOCK ALARM lamp DS7 shall turn off and the external 'interlock open alarm' condition shall be removed .

5.7.9.4 Local and Remote Tx Fault Alarm: The 'Tx fault alarm' function was tested while the tx fault alarm threshold levels were being checked. See paragraph 5.7.6.

5.7.9.5 Local RF Drive Alarm: The rf drive alarm test is a go/no go check that does not check the specific rf drive alarm threshold level.

(a) Disable rf carrier oscillator by removing crystal A1Y1 from crystal socket A1XY1.

(b) Indication on OUTPUT POWER meter M2 shall drop to zero.

(c) RF DRIVE ALARM lamp DS11 and TX FAULT ALARM lamp DS9 shall turn on.

(d) Replace crystal A1Y1 in crystal socket A1XY1.

(e) RF DRIVE ALARM lamp DS11 and TX FAULT ALARM lamp DS9 shall turn off. Indication on OUTPUT POWER meter M2 shall be restored to its original level.

5.7.9.6 Local Mod Drive Alarm: The modulator drive alarm test is a go/no go check that does not check the pulse width fault detection circuit for a specific pulse width fault.

(a) Activate pulse width fault detector by placing a short circuit across capacitor A2C23.

(b) Indication on OUTPUT POWER meter M2 shall drop to zero.

(c) MOD DRIVE ALARM lamp DS10 and TX FAULT ALARM lamp DS9 shall turn on.

(d) Remove short circuit placed across capacitor A2C23 in step (a).

(e) RF DRIVE ALARM lamp DS11 and TX FAULT ALARM lamp DS9 shall turn off. Indication on OUTPUT POWER meter M2 shall be restored to its original level.

5.7.9.7 Local and Remote SWR Alarm: The VSWR alarm test is a go/no go check that checks the basic operation of the rf output current phase detection circuit and the rf output limiting action of the linear attenuator on modulator driver A2. It does not check for operation at a specific phase error threshold or for excessive rf output current.

CAUTION

Do not adjust PHASE potentiometer A1R30 or CURRENT LEVEL potentiometer A1R31 to simulate an rf output phase error or excessive current problem. These adjustments control the amplitude of the 'rf stress current' signal. When the 'rf stress current' exceeds the rf stress current protection threshold, as the result of an excessive phase difference between the rf output current and rf drive or by an excessive rf output current, the modulator driver's linear attenuator causes the rf output to be reduced to a safe level. Incorrect setting of these potentiometers may result in reduced protection to modulator/power amplifier circuits when an abnormal rf output condition occurs.

(a) Set the transmitter to operate at the assigned high power rf output level and adjust the audio input (continuous sine wave from a signal generator or normal program material) for normal modulation level.

(b) Verify no ALARM lamps are turned on.

(c) Connect a short circuit across resistor A1R24.

(d) Rf output indication on OUTPUT POWER meter M2 will be reduced.

NOTE

Rf output reduction will vary with degree of audio compression, but will typically reduce to 250 Watts or less if rf output was originally 400 Watts.

(e) Local HIGH VSWR alarm lamp DS8 and TX FAULT ALARM lamp DS9 shall turn on. An external 'VSWR alarm' condition will be generated.

(f) Remove short circuit placed across resistor A1R24 in step (c).

(g) Local HIGH VSWR alarm lamp DS8 and TX FAULT ALARM lamp DS9 shall turn off. External 'VSWR alarm' condition will be removed and and indication on OUTPUT POWER meter M2 shall be restored to its original level.

5.7.9.8 Remote Forward/Reflected Power Monitoring: Check the buffered forward and reflected power dc voltage outputs which are provided for remote metering as follows:

NOTE

The buffered forward and reflected power outputs are dc voltages that are intended to be used by remote monitoring circuits to remotely display the forward and reflected power levels. The following procedure specifies the use of a dc voltmeter to monitor the output voltages. Users that have external meters as monitoring devices may use the meter indications as verification the outputs are satisfactory.

(a) Set the transmitter to operate at the assigned high power rf output level.

(b) Connect a dc voltmeter between TB2-1, at rear of transmitter, and TB2-5.

(c) Dc voltmeter indication should be representative of forward power level. Record reading obtained as buffered forward power output.

(d) Connect a dc voltmeter between TB2-2, at rear of transmitter, and TB2-5.

(e) Remove MTA connector P4 from connector A5A1J1 and then connect MTA connector P4 with A5A1J1 in reverse (pin 1 of P4 mates with pin 4 of A5A1J1).

(f) Dc voltmeter indication should be the same as the forward power reading recorded in step (c). Record reading obtained as buffered reflected power output.

(g) Disconnect dc voltmeter.

(h) Connect MTA connector P4 to connector A5A1J1 in its original position (pin 1 of P4 mates with pin 1 of A5A1J1).

5.7.9.9 Remote External Gain Control: If used, verify the rf output level can be trimmed by the external gain control as follows:

(a) Set or verify the external gain control is set to the center if its operating range and is applying 7.5 volts between TB2-6 (+) and TB2-7.

(b) Set remote Power Level switch to its 'High' position.

(c) OUTPUT POWER meter M2 indication shall be the desired high level, rf carrier, forward power output.

(d) Simultaneously monitor OUTPUT POWER meter M2 and slowly adjust external gain control to its maximum gain setting.

(e) Rf output indication on OUTPUT POWER meter M2 shall follow changes in the external gain control setting and shall be a minimum of ten percent higher than the reading noted in step (c) when the external gain control is set to maximum.

NOTE
The external gain control must apply 15.0 volts dc between TB2-6 (+) and TB2-7 when it is set to its maximum setting.

(f) Simultaneously monitor OUTPUT POWER meter M2 and slowly adjust external gain control to its minimum gain setting.

(g) Rf output indication on OUTPUT POWER meter M2 shall follow changes in the external gain control setting and shall be a minimum of ten percent lower than the reading noted in step (c) when the external gain control is set to minimum.

NOTE
The external gain control must apply zero volts dc between TB2-6 (+) and TB2-7 when it is set to its minimum setting.

(h) Set the external gain control to the center if its operating range.

PLACING TRANSMITTER IN SERVICE

5.8 After a completion of minimum performance test, place the transmitter in service as follows:

5.8.1 FINAL RF CARRIER OUTPUT LEVEL SETTINGS: Set the rf carrier output levels with the transmitter operating into its antenna system as follows:

(a) Verify the requirements of paragraph 5.7 are completed.

(b) Set AC PWR switch S1 to OFF.

(c) Disconnect the 50-ohm dummy load and connect the antenna system to the transmitter's rf output connector (A5J1).

(d) Set OUTPUT POWER switch S5 to FWD-HIGH.

(e) Set TEST switch S4 to DC AMPS.

(f) Set POWER LEVEL switch S3 to HIGH.

(g) Set AC PWR switch S1 to ON.

(h) RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(i) Set OUTPUT POWER switch S5 to REFL-HIGH. RF WATTS indication on OUTPUT POWER meter M2 should be near zero. Set OUTPUT POWER switch S5 to REFL-LOW to obtain a more accurate reading.

(j) Set OUTPUT POWER switch S5 to FWD-HIGH.

(k) Adjust O/P PWR potentiometer A2R92 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned high power rf carrier output level. TX FAULT lamp DS9 shall be off.

NOTE

High power rf carrier output level adjustment affects medium and low rf carrier output levels. Any change in O/P PWR potentiometer A2R92 setting will alter medium and low rf carrier output levels.

(l) Record DC AMPS indication on TEST meter M1.

(m) Set TEST switch S4 to I/P VOLTS and record TEST meter M1 indication.

(n) Using the formula in paragraph 4.6.1 (for unmodulated carrier), calculate the dc current consumption using the assigned rf carrier output level and the input dc voltage recorded in step (m). Calculated dc current level should be within 10% of DC AMPS indication recorded in step (l).

(o) Set POWER LEVEL switch S3 to MED. MED PWR lamp DS4 shall turn on.

(p) Adjust LOW PWR 2 potentiometer A2R7 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned medium power rf carrier output level. TX FAULT lamp DS9 shall be off.

(q) Set TEST switch S4 to DC AMPS and repeat steps (m) thru (o).

(r) Set POWER LEVEL switch S3 to LOW. LOW PWR lamp DS3 shall turn on.

(s) Adjust LOW PWR 1 potentiometer A2R6 for an RF WATTS indication on OUTPUT POWER meter M2 that is precisely the assigned low power rf carrier output level. TX FAULT lamp DS9 shall be off.

(t) Set TEST switch S4 to DC AMPS and repeat steps (m) thru (o).

5.8.2 RF MONITOR OUTPUT VOLTAGE ADJUSTMENTS: Set the the rf monitor output voltage to provide an equal output in high, medium and low power operating modes as follows:

(a) Verify the requirements of paragraph 5.8.1 are completed.

(b) Connect a 1000 ohm resistive load to RF MONITOR coaxial connector J3 using a suitable coaxial connector.

(c) Connect an rms ac voltmeter across 1000 ohm load connected in step (b).

(d) Set POWER LEVEL switch S3 to HIGH. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(e) Adjust HIGH Monitor potentiometer A6R3 for desired rms ac voltage (maximum of 5.0 volts ac rms) indication on rms ac voltmeter.

(f) Set POWER LEVEL switch S3 to MED. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned medium power rf carrier output level.

(g) Adjust MED Monitor potentiometer A6R2 for precisely the same ac voltmeter obtained in step (e).

(h) Set POWER LEVEL switch S3 to LOW. RF WATTS indication on OUTPUT POWER meter M2 should be the assigned low power rf carrier output level.

(i) Adjust LOW Monitor potentiometer A6R1 for precisely the same ac voltmeter obtained in step (e).

5.8.3 AUDIO LEVEL ADJUSTMENTS: Apply the modulating audio and adjust the transmitter audio controls as follows:

(a) Verify the requirements of paragraphs 5.8.1 are completed.

(b) Set POWER LEVEL switch S3 to HIGH.

(c) RF WATTS indication on OUTPUT POWER meter M2 should be the assigned high power rf carrier output level.

(d) Connect a station modulation monitor, with an input impedance of not less than 1000 ohms, to RF MONITOR coaxial connector J3.

(e) Set audio low-pass and high-pass switches (A2S1 and A2S2) for the desired audio bandwidth using tables shown in figure FO-3. Where heavy external audio processing is not used, it is recommended that all sections of switches A2S1 and A2S2 be set to the closed position. This selection will provide the best transient response (low overshoot) and protection from undesirable low frequencies (thumps,etc).

(f) Turn on normal station program modulating audio (nominal +10 dBm).

(g) Simultaneously monitor station modulation monitor and adjust AUDIO LEVEL potentiometer A2R4 for the desired modulation depth.

(h) Simultaneously monitor station modulation monitor and adjust HI LIMIT potentiometer A2R16 counter clockwise until positive modulation peaks are just being limited and then adjust clockwise until just not limiting.

(i) Simultaneously monitor station modulation monitor and adjust LO LIMIT potentiometer A2R18 clockwise until negative modulation peaks are just being limited and then adjust counter clockwise until just not limiting.

(j) Install top and bottom cover plates on the transmitter and place the transmitter in its mounting rack.

(k) Set switches to settings specified for Operating Setting in table 4-1.

SECTION 6
MAINTENANCE

GENERAL

6.1 This section contains scheduled and corrective maintenance information for the subject transmitter. Fault symptoms should be analyzed to determine the corrective action required. Normally, faults will be isolated to an assembly which is then removed from the transmitter and repaired on a work bench. Replacement of the defective assembly with a serviceable assembly will restore the transmitter to an operational status. In any event, the most practical way to isolate a fault is to perform a minimum performance test in conjunction with trouble shooting procedures. This section contains wiring information for each hard wired assembly and references illustrations in the foldout section that depict the mechanical assembly of the transmitter components, and provide information regarding the location, marking of all controls and indicators.

ELECTRICAL SCHEMATICS/LOGIC DIAGRAMS

6.2 An electrical schematic for each electrical assembly in the AMPFET P400 am broadcast transmitter is provided.

6.2.1 COMPONENT VALUES: Unless otherwise specified on the schematic:

- All resistor values are shown in ohms (K = 1 000 and M = 1 000 000).
- All capacitor values are shown in microfarads (uF).
- Unidentified diodes are part number 1N4938.

6.2.2 GRAPHIC SYMBOLS: The graphic symbols used on the electrical schematics are in accordance with American National Standard ANSI Y32.2-1975 - Graphic Symbols for Electrical and Electronic Diagrams.

6.2.3 LOGIC SYMBOLS: The logic symbols used on electrical schematics and logic diagrams are in accordance with American National Standard ANSI Y32.14-1975 - Graphic Symbols for Logic Diagrams.

6.2.4 REFERENCE DESIGNATIONS: Reference designations have been assigned in accordance with American National Standard ANSI Y32.16-1975 - Reference Designations for Electrical and Electronic Parts and Equipments. Each electrical symbol has been identified with its basic reference designation. To obtain the full reference designation for a specific part, this basic identifier must be prefixed with the reference designation assigned to all higher assemblies.

WIRING INFORMATION

6.3 Point-to-point wiring information for hard wired assemblies is provided in tables 6-1 thru 6-3.

6.3.1 AMPFET P400 CHASSIS WIRING: Table 6-1 provides a tabular wiring list for the AMPFET P400 transmitter chassis.

6.3.2 NAA13/1 MODULATOR/POWER AMPLIFIER ASSEMBLY WIRING: Table 6-2 provides a tabular wiring list for NAA13/1 modulator/power amplifier assembly A3. Additional wiring information is depicted in figure FO-17.

6.3.3 NAF34 RF OUTPUT FILTER ASSEMBLY WIRING: Wiring information for NAF34 rf output filter assembly A4 is depicted in figure FO-19.

6.3.4 NAFP11 RF POWER PROBE ASSEMBLY WIRING: Wiring information for NAFP11 rf power probe assembly A5 is depicted in figure FO-20.

6.3.5 NAS18 LOW VOLTAGE POWER SUPPLY ASSEMBLY WIRING: Table 6-3 provides a tabular wiring list for NAS18 low voltage power supply assembly A7. Additional wiring information is depicted in figure FO-22.

6.3.6 NAS17 POWER AMPLIFIER POWER SUPPLY ASSEMBLY WIRING: Table 6-4 provides a tabular wiring list for NAS17 power amplifier power supply assembly A8. Additional wiring information is depicted in figure FO-23.

MECHANICAL DRAWINGS

6.4 Mechanical drawings that depict the location of electrical components and show assembly detail are provided in the foldout section. The assembly illustrations are presented in the order of their assigned reference designations.

6.4.1 AMPFET P400 TRANSMITTER CABINET: Assembly detail of the AMPFET P400 transmitter is depicted in figures FO-10 thru FO-14.

6.4.2 NAPE28 RF DRIVER PCB ASSEMBLY: Assembly detail for NAPE28 rf driver printed circuit board assembly A1 is depicted in figure FO-15.

6.4.3 NAPE22/1 MODULATOR DRIVER PCB ASSEMBLY: Assembly detail for NAPE22/1 modulator driver printed circuit board assembly A2 is depicted in figure FO-16.

6.4.4 NAA13/1 MODULATOR/POWER AMPLIFIER ASSEMBLY: Assembly detail for NAA13/1 modulator/power amplifier assembly A3 is depicted in figures FO-17 and FO-18.

6.4.5 NAF34 RF FILTER ASSEMBLY: Assembly detail for NAF34 rf output filter assembly A4 is depicted in figure FO-19.

6.4.6 NAFP11 RF POWER PROBE ASSEMBLY: Assembly detail for NAFP11 rf power probe assembly A5 is depicted in figure FO-20.

6.4.7 NAPC9/1 INTERFACE PCB ASSEMBLY: Assembly detail for NAPC9/1 interface printed circuit board assembly A6 is depicted in figure FO-21.

6.4.8 NAS18 LOW VOLTAGE POWER SUPPLY ASSEMBLY: Assembly detail for NAS18 low voltage power supply assembly A7 is depicted in figure FO-22.

6.4.9 NAS17 POWER AMPLIFIER POWER SUPPLY ASSEMBLY: Assembly detail for NAS17 power amplifier power supply assembly A8 is depicted in figure FO-23 and FO-24.

6.4.10 NAPC8/1 METER PCB ASSEMBLY: Assembly detail for NAPC8/1 meter printed circuit board assembly A9 is depicted in figure FO-25.

SCHEDULED MAINTENANCE

6.5 Scheduled maintenance consists of performing a visual inspection of the transmitter in conjunction with a minimum performance test procedure (see paragraph 5.7) at scheduled intervals. The recommended minimum time between scheduled maintenance visits is three months. Local operating and environmental conditions may dictate more frequent visits and in the case of remote sites, less frequent visits may be acceptable. Experience and system reliability will determine the most practical schedule for a specific installation.

CORRECTIVE MAINTENANCE

6.6 Corrective maintenance procedures consist of identifying and correcting defects or deficiencies that arise during operation and/or calibration and testing of the AMPFET P400 transmitter. Local and remote alarm signals will be generated when a defect occurs. Fault analysis and rectification may be conducted from three different levels with a different technical competence level required for each.

6.6.1 REMOTE ON-AIR TROUBLE SHOOTING: Remote on-air troubleshooting consists of monitoring the transmitter's radiated signal using an on-air monitor and observing the status of remote fault alarm indicators. Figure 6-1 provides remote, on-air, trouble shooting assistance information. This information should enable an operator to decide whether the standby transmitter must be enabled (if one is available) and/or immediate corrective action must be taken or if response may be deferred to a more convenient time. It is recommended that this information be incorporated into a station's standard operating procedures.

6.6.2 LOCAL ON-AIR TROUBLESHOOTING: Local on-air troubleshooting consists of monitoring the transmitter's integral meters and fault alarm indicators, analysing the readings and indications obtained and determining whether a minor calibration adjustment will restore the transmitter to fully operational status or if the standby transmitter must be enabled and off-air trouble shooting procedures initiated. Figure 6-2 provides local, on-air, trouble shooting assistance information.

6.6.3 OFF-AIR TROUBLESHOOTING: Off-air trouble shooting must be performed when a minor calibration adjustment will not correct a fault. Figure 6-3 is a step-by-step trouble shooting assistance chart for use in fault isolation when the transmitter has been taken off the air and is connected to a precision, 50-ohm, resistive dummy load.

CAUTION

Discharge or ensure power amplifier B- volts on storage capacitor C1 is discharged to a safe level (less than 10 volts) prior to using conductive tools or materials in the vicinity of circuits that contain the B- volts. Discharge the capacitor by placing the tip of a discharge probe on the E1 connection (at high voltage warning. It may take up to ten seconds to fully discharge the capacitor.

Table 6-1 Wiring List - AMPFET P400 Transmitter Chassis

SOURCE	DESTINATION	CODE		SIZE	REMARKS
J2-L	S1-2	1	Grey	18	
J2-N	TB3-1	2	Grey/White	18	
XF1-2	TB3-3	3	Grey	18	
TB3-5	A3S1-1	4	Grey	20	
TB3-3	A3S1-2	5	Grey	20	
TB3-2	A7TB1-2	6	Grey/White	18	
TB3-2	A8TB1-4	7	Grey/White	18	
TB3-4	A7TB1-1	8	Grey	18	
TB3-4	A8TB1-1, 2 or 3	9	Grey	18	
A7TB1-4	P8-8	10	Orange	22	
A8TB1-5	P8-4	11	Orange	22	
A8TB2-6	P10-1	12	White	22	
A8TB2-5	S4-1	13	White	22	
A8TB1-6	S4-2	14	White	22	
A8TB1-6	A3E1	15	White	18	
A3E1	P7-1	16	Blue	22	
A7TB1-3	S2-4	17	Orange	22	
A7TB1-5	S4-11	18	Red	22	
A7TB1-5	A3TB2-4	19	Red	22	
A3TB2-4	P1-1	20	Red	22	
P1-1	P2-10	21	Red	22	
P2-10	P8-11	22	Red	22	
A7TB1-6	S2-3	23	White	22	
A7TB1-6	P2-11	24	White	22	
TB1-1	T1-1	25	Black	22	3-conductor
TB1-3	T1-4	26	White	22	shielded
TB1-2	T1-Ground	-	Shield	-	
T1-5	P2-8	27	white	22	1-conductor
T1-8	P2-9	-	Shield	-	shielded
TB1-4	S3-1	28	White	22	
TB1-5	S3-2	29	White	22	
TB1-6	S3-3	30	White	22	
S3-1	P7-10	31	White	22	
S3-2	P7-8	32	White	22	
S3-3	P7-6	33	White	22	
TB1-7	P10-4	34	White	22	
TB1-8	XF2-2	35	White	22	
TB1-9	S2-6	36	White	22	
S2-6	P7-9	37	White	22	
TB1-10	P8-9	38	White	22	
J3	P8-1	39	White	22	1-conductor
Ground	P8-2	-	Shield	-	shielded
TB2-1	P9-3	40	White	22	
TB2-2	P9-11	41	White	22	
TB2-3	P9-2	42	White	22	
TB2-4	P8-12	43	White	22	
P3-1	P12-4	44	White	22	
S5W-2	P9-9	45	White	22	
Ground	P9-7	-	Shield		
P4-3	P9-8	46	White	22	1-conductor
P4-4	P9-7	-	Shield	-	shielded

Table 6-1 Wiring List - AMPFET P400 Transmitter Chassis (Continued)

SOURCE	DESTINATION	CODE		SIZE	REMARKS
P4-2	P9-5	47	White	22	1-conductor
P4-1	P9-6	-	Shield	-	shielded
S5W-1	P9-4	48	White	22	1-conductor
Ground	P9-6	-	Shield	-	shielded
P5-3	P7-12	49	White	22	1-conductor
P5-4	P7-11	-	Shield	-	shielded
P2-6	P7-7	50	White	22	
P2-12	P7-5	51	White	22	
P1-2	P3-11	52	White	22	
P1-4	A3TB2-2	53	White	22	1-conductor
P1-3	A3TB2-1	-	Shield	-	shielded
XDS8-Cathode	P7-4	54	White	22	
P7-4	P3-4	55	White	22	
P3-9	A3TB2-6	56	White	22	
P3-2	A3TB2-5	57	White	22	
P2-5	XDS6-Cathode	58	White	22	
P3-5	XDS11-Cathode	59	White	22	
P3-3	XDS10-Cathode	60	White	22	
A3TB2-3	S4-3	61	White	22	
P11-6	XDS1-Anode	62	White	22	
P8-7	XDS2-Anode	63	White	22	
P8-5	XDS3-Anode	64	White	22	
P8-3	XDS4-Anode	65	White	22	
P8-6	XDS7-Anode	66	White	22	
P9-1	XDS9-Anode	67	White	22	
P13-4	P12-1	68	black	22	
P2-11	P12-3	69	White	22	
S1-4	XF1-1	70	Grey	20	
XF2-1	S4-10	71	Orange	22	
S4-10	S2-4	72	Orange	22	
S2-3	S4-6	73	White	22	
S2-2	XDS5-Anode	74	White	22	
S2-5	S3W-1	75	Black	22	
P13-3	P7-9	76	Orange	22	
P2-3	TB2-6	77	White	22	
-	-	78	Not Used		
-	-	79	Not Used		
-	-	80	Not Used		
-	-	81	Not Used		
S4-11	P10-12	82	Red	22	
P11-1	Ground	83	Black	22	
S2-1	P10-5	84	White	22	
P11-2	XDS5-Cathode	85	White	22	
XDS6-Anode	P10-11	86	White	22	
XDS10-Anode	P10-10	87	White	22	
XDS11-Anode	P10-9	88	White	22	
XDS8-Anode	P10-8	89	White	22	
P10-2	S4-7	90	White	22	
M2(+)	P11-12	91	White	22	
S5-10	P11-11	92	White	22	
S5-9	P11-10	93	White	22	

Table 6-1 Wiring List - AMPFET P400 Transmitter Chassis (Continued)

SOURCE	DESTINATION	CODE		SIZE	REMARKS
S5-5	P11-4	94	White	22	
S5-8	P11-3	95	White	22	
S4-12	P10-6	96	White	22	
S4W-1	P10-3	97	White	22	
S4W-2	P10-7	98	White	22	
P13-2	TB2-11	99	White	22	1-conductor
P13-1	TB2-12	-	Screen	-	shielded
S1-4	S1-3	100	Grey	20	
S1-1	S1-2	101	Grey	20	
M2(-)	Ground	102	Black	22	
S5-1	S5-10	103	Tinned Copper	22	
S5-2	S5-9	104	Tinned Copper	22	
S5-3	S5-4	105	Tinned Copper	22	
S5-4	S5-5	106	Tinned Copper	22	
S5-6	S5-7	107	Tinned Copper	22	
S5-7	S5-8	108	Tinned Copper	22	
S4-4	S4-5	109	Tinned Copper	22	
S4-5	S4-8	110	Tinned Copper	22	
S4-8	S4-9	111	Tinned Copper	22	
S4-9	S4-12	112	Tinned Copper	22	
T1-2	T1-3	113	Tinned Copper	22	
T1-6	T1-7	114	Tinned Copper	22	
T1-9	Ground	115	Black	22	
J2-Ground	Ground	116	Black	20	
TB1-11	Ground	117	Black	22	
-	-	118	Not Used		
TB3-1	TB3-2	119	Grey	20	
TB3-3	TB3-4	120	Grey	20	
P6-1	TB3-1	121	Black		Leads of fan
P6-2	TB3-5	122	Black		cable assembly
-	-	123	Not Used		
-	-	124	Not Used		
A3TB2-1	L1-1	125	White	20	
A3TB2-2	L1-2, 3, 4, 5 or 6	126	White	20	
P11-9	S2-4	127	Orange	22	
TB4-1	A4TB1-1	128	Core		RG58A/U
TB4-2	A4-Ground	-	Shield		
P7-2	P2-2	129	white	22	
A1-A	TB4-4	-	-	-	
A1-B	TB4-5	-	-	-	
T3-1	TB4-4	-	-	-	Lead of T3
T3-2	TB4-5	-	-	-	Lead of T3
T2-3	A3TB1-1	-	-		Lead of T2
T2-4	A3TB1-2	-	-		Lead of T2
T2-1	TB4-1	-	-		Lead of T2
T2-2	TB4-2	Routed thru T3 core			Lead of T2
TB2-5	Ground	-	Black	22	
TB2-7	Ground	-	Black	22	
XDS1 Cathode	Ground	-	-		XDS1 Terminal

Table 6-1 Wiring List - AMPFET P400 Transmitter Chassis (Continued)

SOURCE	DESTINATION	CODE		SIZE	REMARKS
XDS2 Cathode	Ground	-	-		XDS2 Terminal
XDS3 Cathode	Ground	-	-		XDS3 Terminal
XDS4 Cathode	Ground	-	-		XDS4 Terminal
XDS7 Cathode	Ground	-	-		XDS7 Terminal
XDS9 Cathode	Ground	-	-		XDS9 Terminal

Table 6-2 Wiring List - NAA13/1 Modulator/Power Amplifier Assembly

SOURCE	DESTINATION	CODE		SIZE	REMARKS
A1-1	TB2-4	-	Red	22	
A1-2	TB2-5	-	White	22	
A1-3	Q2-Gate	-	White	22	
A1-4	Q2-Source	-	White	22	
A1-5	TB2-6	-	White	22	
A1-6	Q1-Gate	-	White	22	
T1-1	TB2-1	-	Blue	-	Lead of T1
T1-2	TB2-2	-	Blue	-	Lead of T1
T1-3	TB2-1	-	White	-	Lead of T1
T1-4	TB2-2	-	White	-	Lead of T1
T1-5	Q3-Source	-	Green	-	Lead of T1
T1-6	Q3-Gate	-	Green	-	Lead of T1
T1-7	Q4-Gate	-	Gray	-	Lead of T1
T1-8	Q4-Source	-	Gray	-	Lead of T1
T1-9	Q5-Gate	-	Violet	-	Lead of T1
T1-10	Q5-Source	-	Violet	-	Lead of T1
T1-11	Q6-Source	-	Black	-	Lead of T1
T1-12	Q6-Gate	-	Black	-	Lead of T1
T2-1	TB2-1	-	Blue	-	Lead of T2
T2-2	TB2-2	-	Blue	-	Lead of T2
T2-3	TB2-1	-	White	-	Lead of T2
T2-4	TB2-2	-	White	-	Lead of T2
T2-5	Q7-Source	-	Green	-	Lead of T2
T2-6	Q7-Gate	-	Green	-	Lead of T2
T2-7	Q8-Gate	-	Gray	-	Lead of T2
T2-8	Q8-Source	-	Gray	-	Lead of T2
T2-9	Q9-Gate	-	Violet	-	Lead of T2
T2-10	Q9-Source	-	Violet	-	Lead of T2
T2-11	Q10-Source	-	Black	-	Lead of T2
T2-12	Q10-Gate	-	Black	-	Lead of T2
TB2-3	TT2 (R2)	-	White	22	
A3L1	Q2-Case	-	White	14	
A3L3	TT1	-	White	14	
TT1	Q5-Source	-	White	16	
TT1	Q9-Source	-	White	16	

Table 6-3 Wiring List - NAS18 Low Voltage Power Supply Assembly

SOURCE	DESTINATION	CODE	SIZE	REMARKS
* T1-Black	TB1-1	1 Black		
# T1-Yellow	TB1-1	1 Yellow		
* T1-Black	TB1-2	2 Black		
# T1-Yellow	TB1-2	2 Yellow		
* T1-Green/Yellow	Ground	3 Green/Yellow		
# T1-Brown/Yellow	Ground	3 Brown/Yellow		
* T1-Green	U1-N	4 Green		
# T1-Brown	U1-N	4 Brown		
* T1-Green	U1-N	5 Green		
# T1-Brown	U1-N	5 Brown		
TB1-3	Q1-C	6 White	22	
TB1-4	Term-1	7 Orange	22	
TB1-5	U3-2	8 Red	22	
TB1-6	U2-1	9 Blue	22	
Term-1	Q1-B	Tinned Copper	20	
Q1-E	U3-1	Tinned Copper	20	
U2-2	Ground	Tinned Copper	20	
Q1-C	U1(+)	Tinned Copper	20	
U1(+)	C5(+)	Tinned Copper	20	
C5(-)	Ground	Tinned Copper	20	
C1(-)	CR1-A	Tinned Copper	20	

* Denotes used when ac power source is 115 Vac, 60 Hz

\# Denotes used when ac power source is 230 Vac, 50/60 Hz

Table 6-4 Wiring List - NAS17 PA Power Supply Assembly

SOURCE	DESTINATION	CODE		SIZE	REMARKS
T1-Shield	Ground	-	-		
T1	TB1-1	1	Black/Red		
T1	TB1-2	2	Black/Orange		
T1	TB1-3	3	Black/Yellow		
T1	TB1-4	4	Black		
T1	TB2-1	5	Red		
T1	TB2-2	6	Orange		
T1	TB2-3	7	Yellow		
T1	TB2-4	8	Brown		
TB1-5	XK1-14	9	Orange	20	
XK1-13	Ground	10	Black	20	
-	-	11	Not Used		
-	-	12	Not Used		
U1-N	XK1-12	13	White	18	
TB2-5	R4-3	14	White	20	
TB2-6	R4-2	15	White	20	
R4-1	R3-1	16	Black	18	
U1(-)	L1-1	17	Blue	18	
TB1-6	L1-2	18	Blue	18	
L1-2	Q1-S	19	Blue	18	
Q1-D	R3-2	20	Black	18	
U1(+)	R3-1	21	Black	18	
R3-1	CR1-C	22	Black	20	
Q1-S	CR2-A	23	Blue	20	
Q1-G	CR2-C or R2-2	24	White	20	
CR1-A	R2-1	25	White	20	
TB2-1 or 2	XK1-5	26	Grey	18	
TB2-3 or 4	XK1-4	27	Grey/White	18	
XK1-5	XK1-8	Tinned Copper		20	Jumper
XK1-1	XK1-4	Tinned Copper		20	Jumper
XK1-9	XK1-12	Tinned Copper		20	Jumper

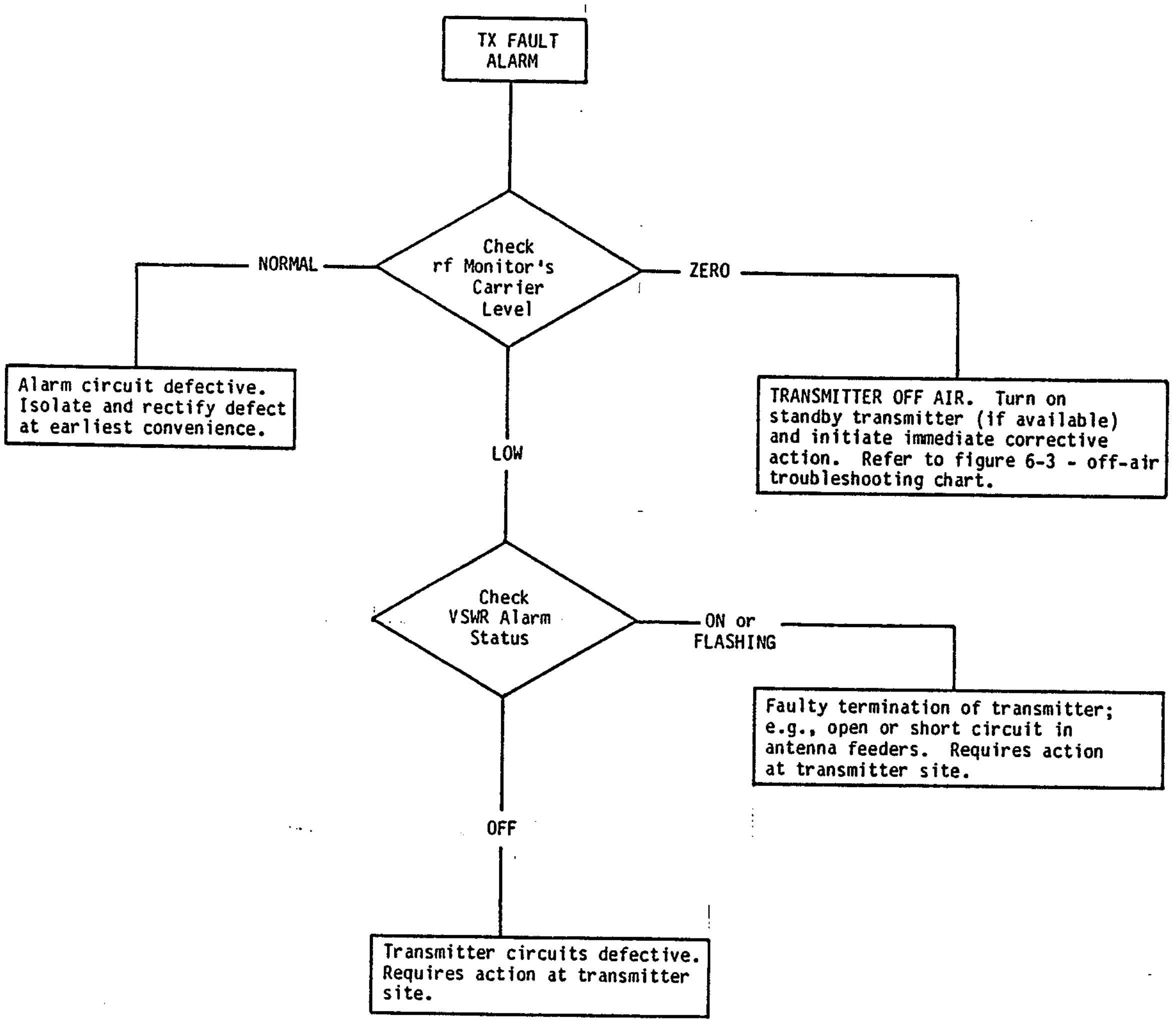
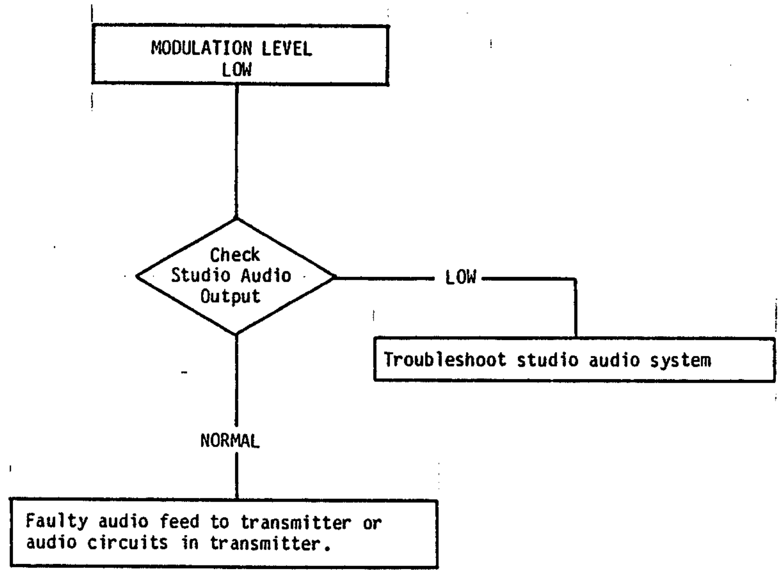


Figure 6-1 Remote On-Air Troubleshooting Assistance Information (Sheet 1)



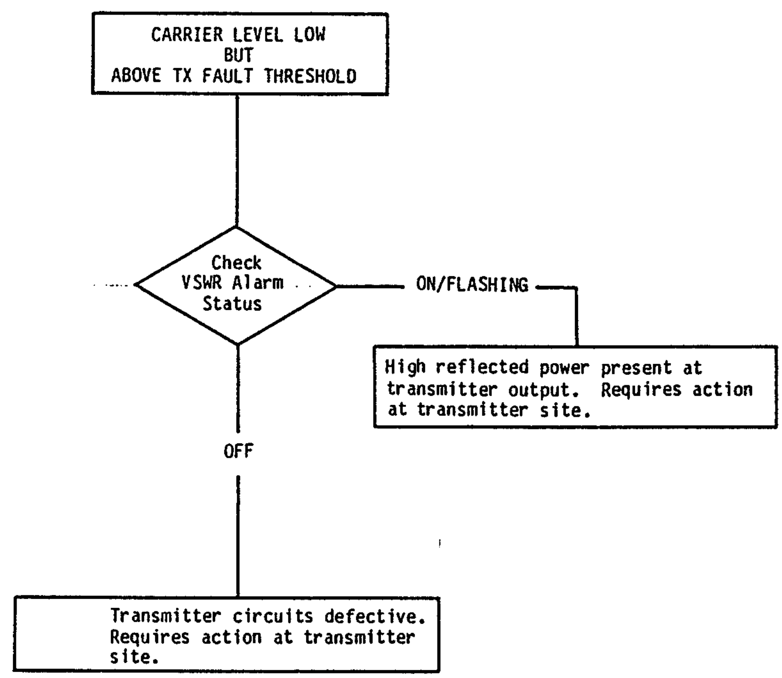


Figure 6-1 Remote On-Air Troubleshooting Assistance Information (Sheet 2)

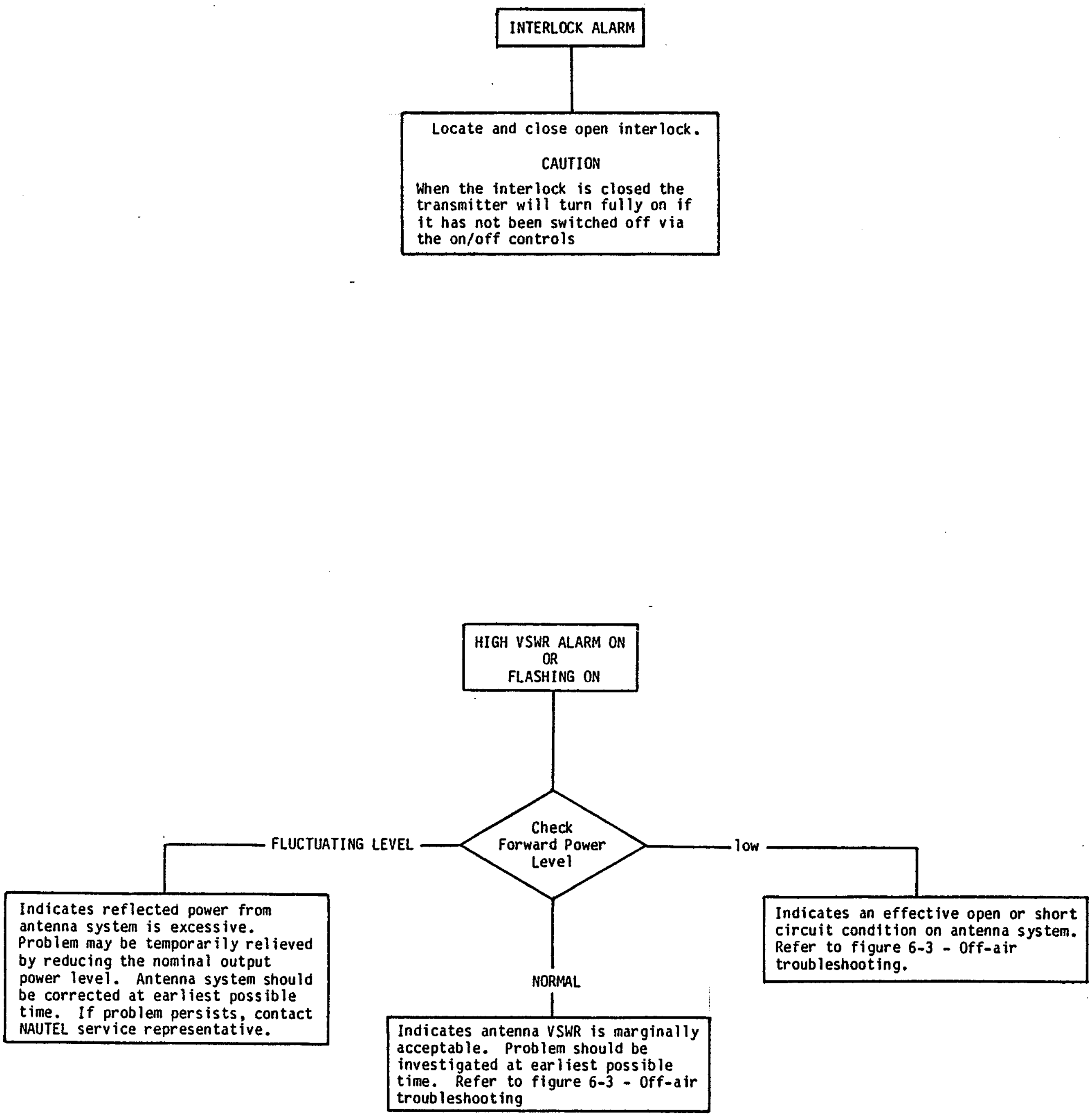


Figure 6-2 Local On-Air Troubleshooting Assistance Information

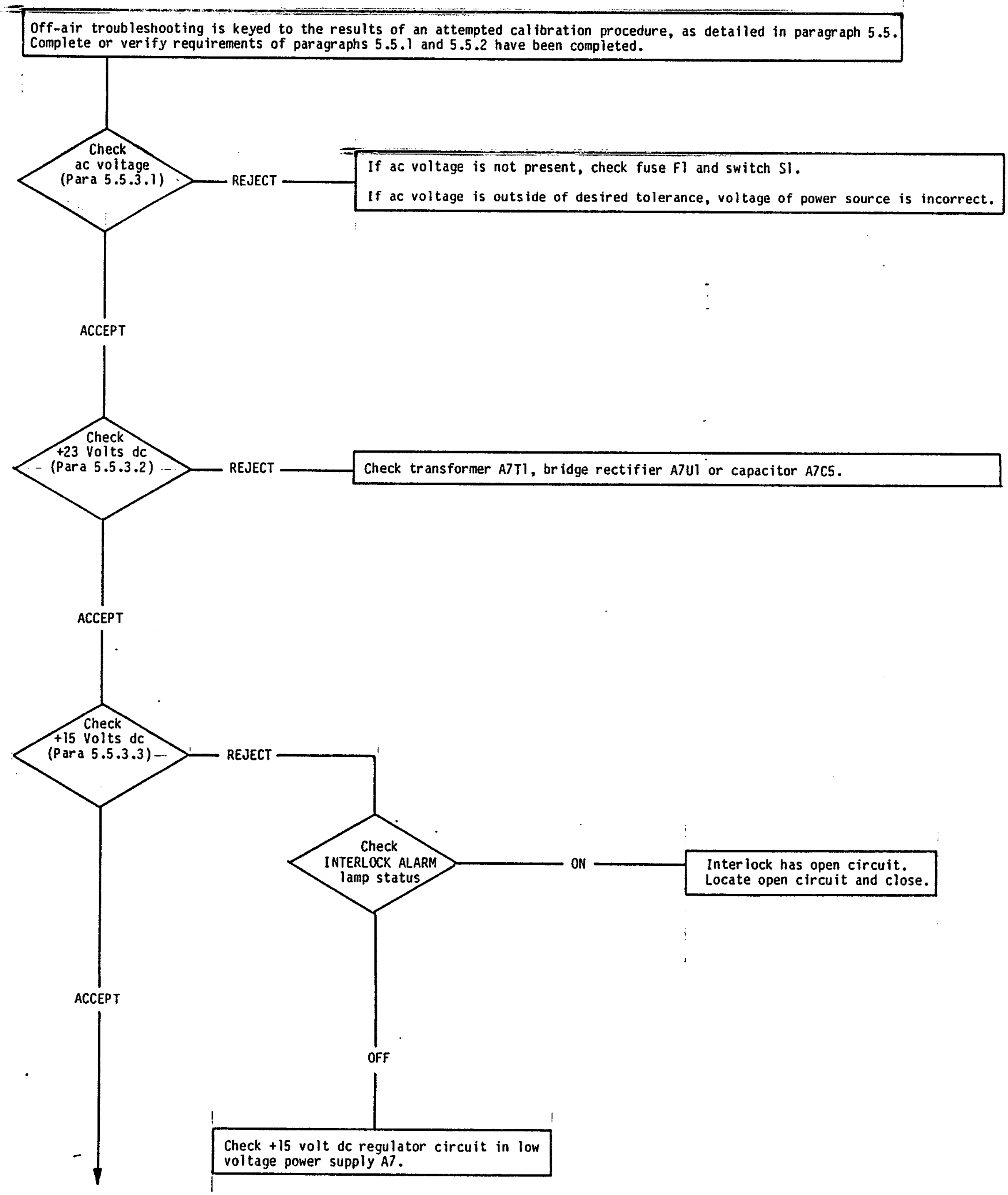


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 1)

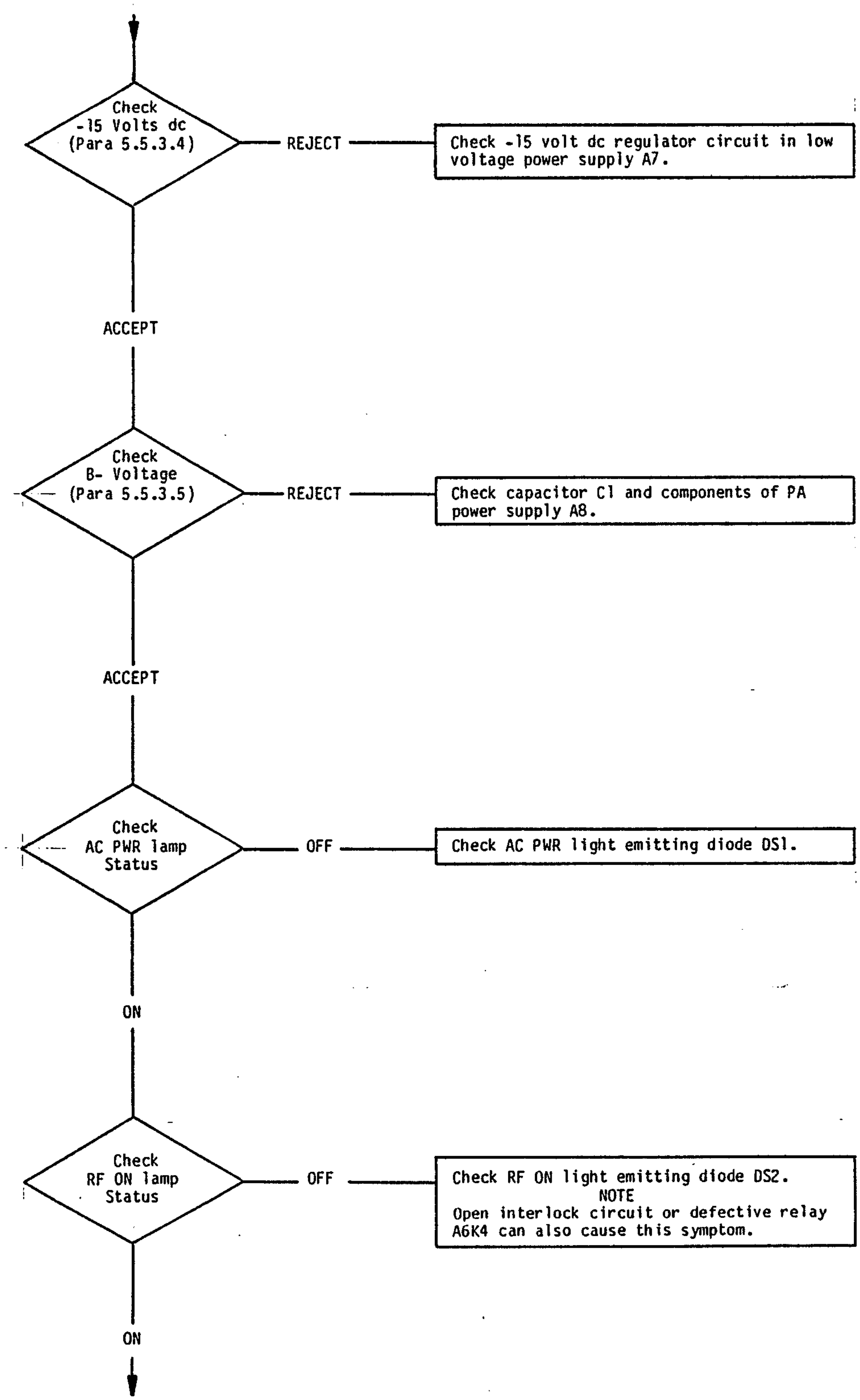


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 2)

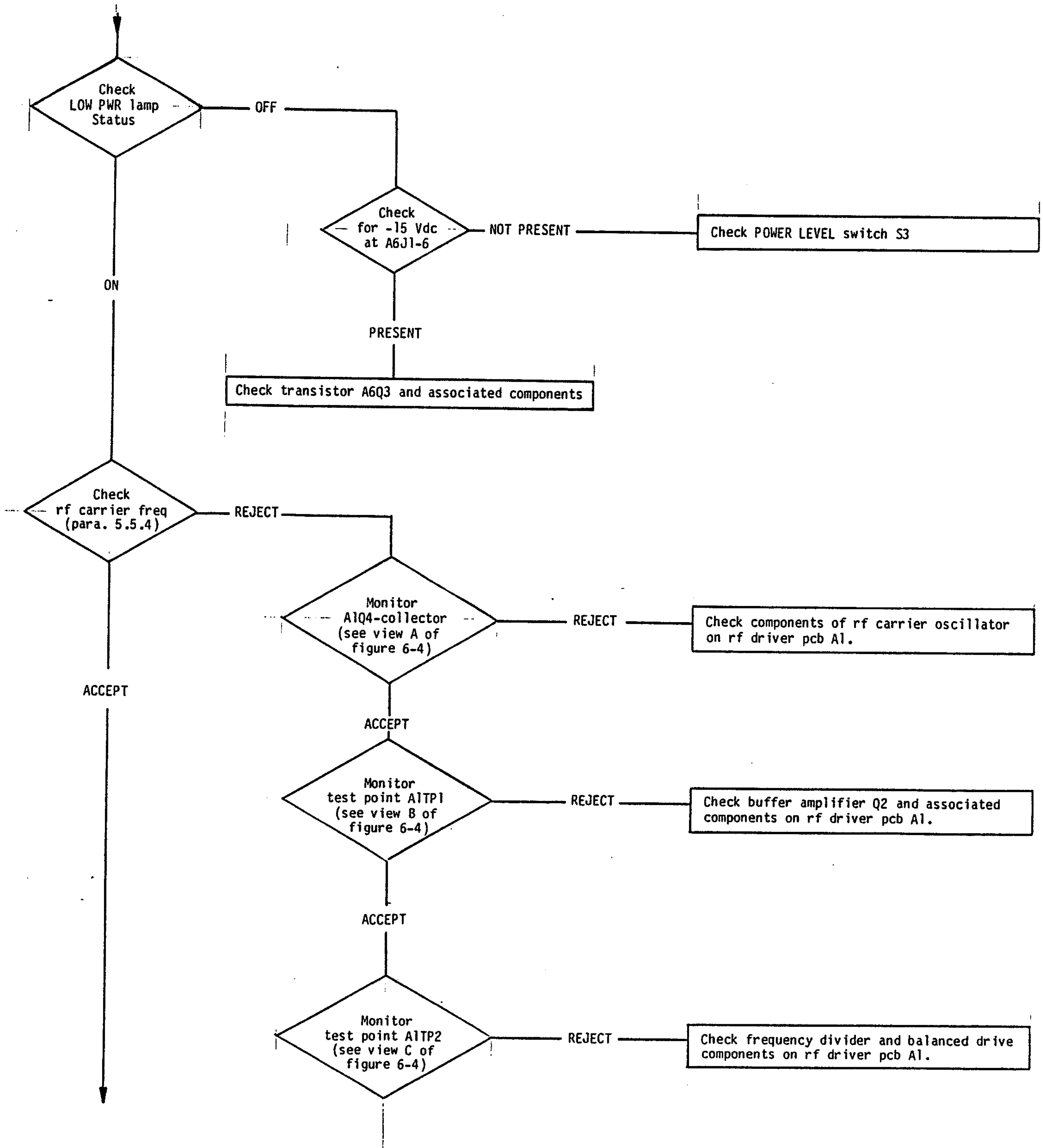


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 3)

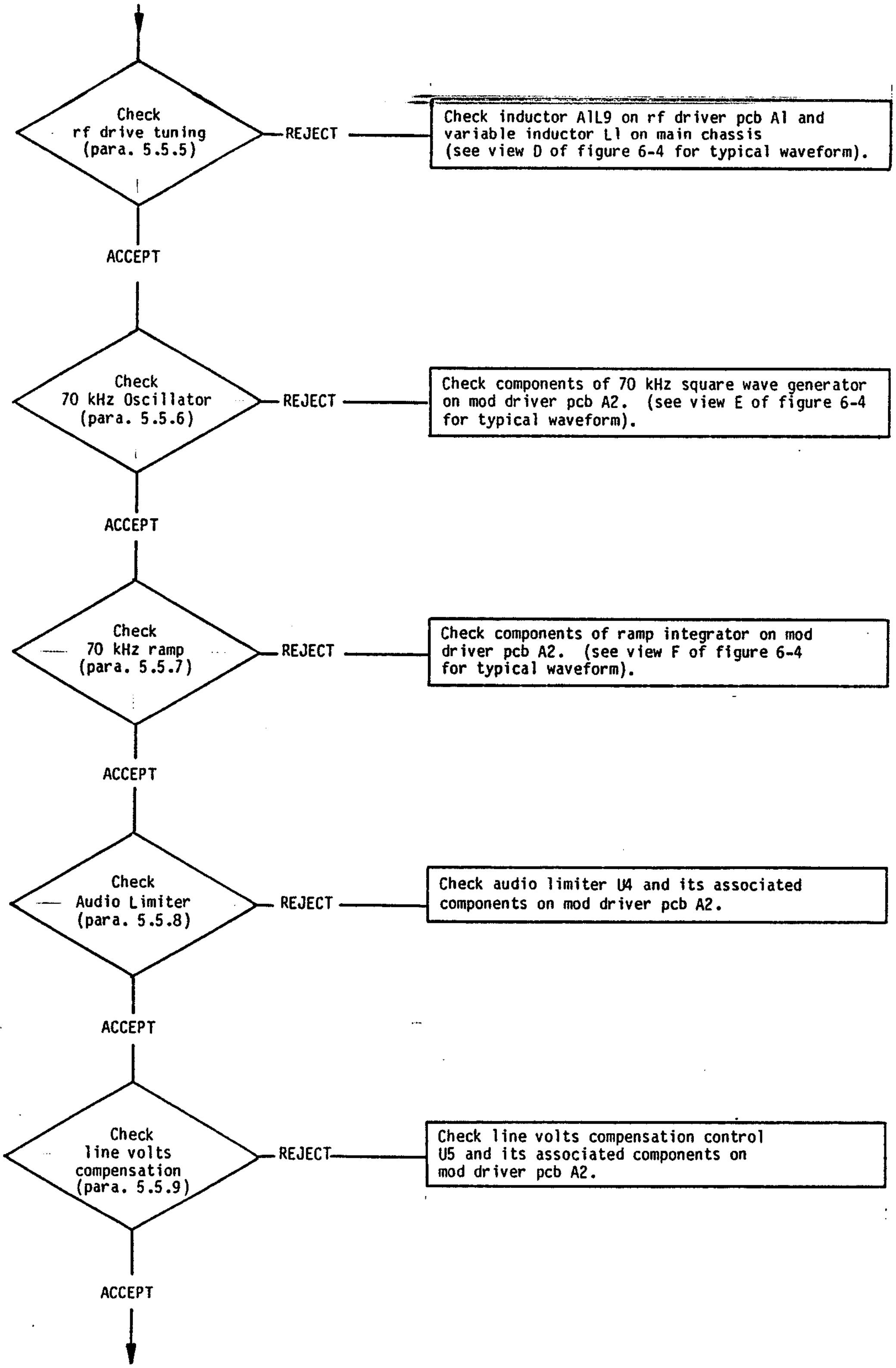


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 4)

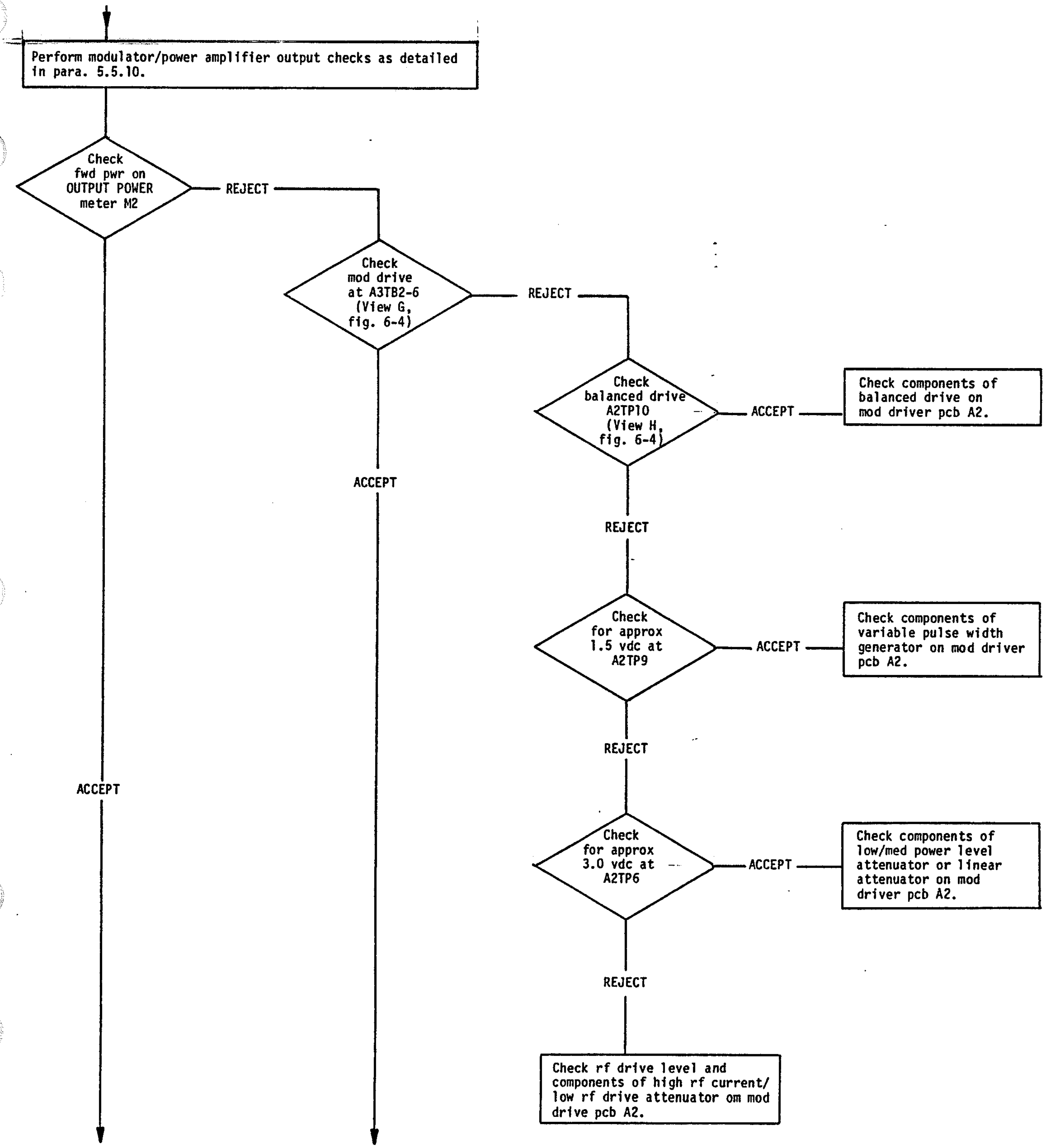


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 5)

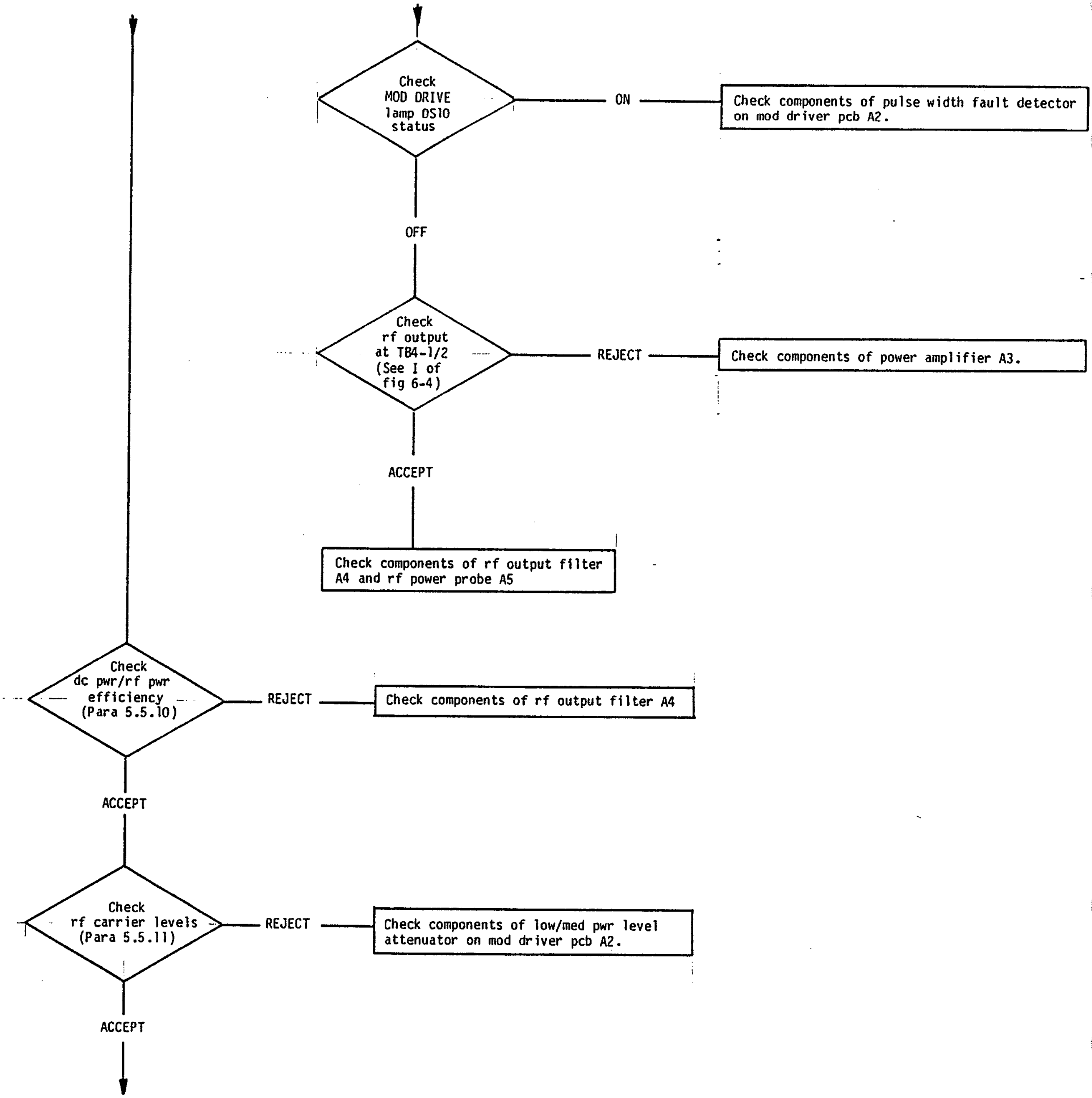


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 6)

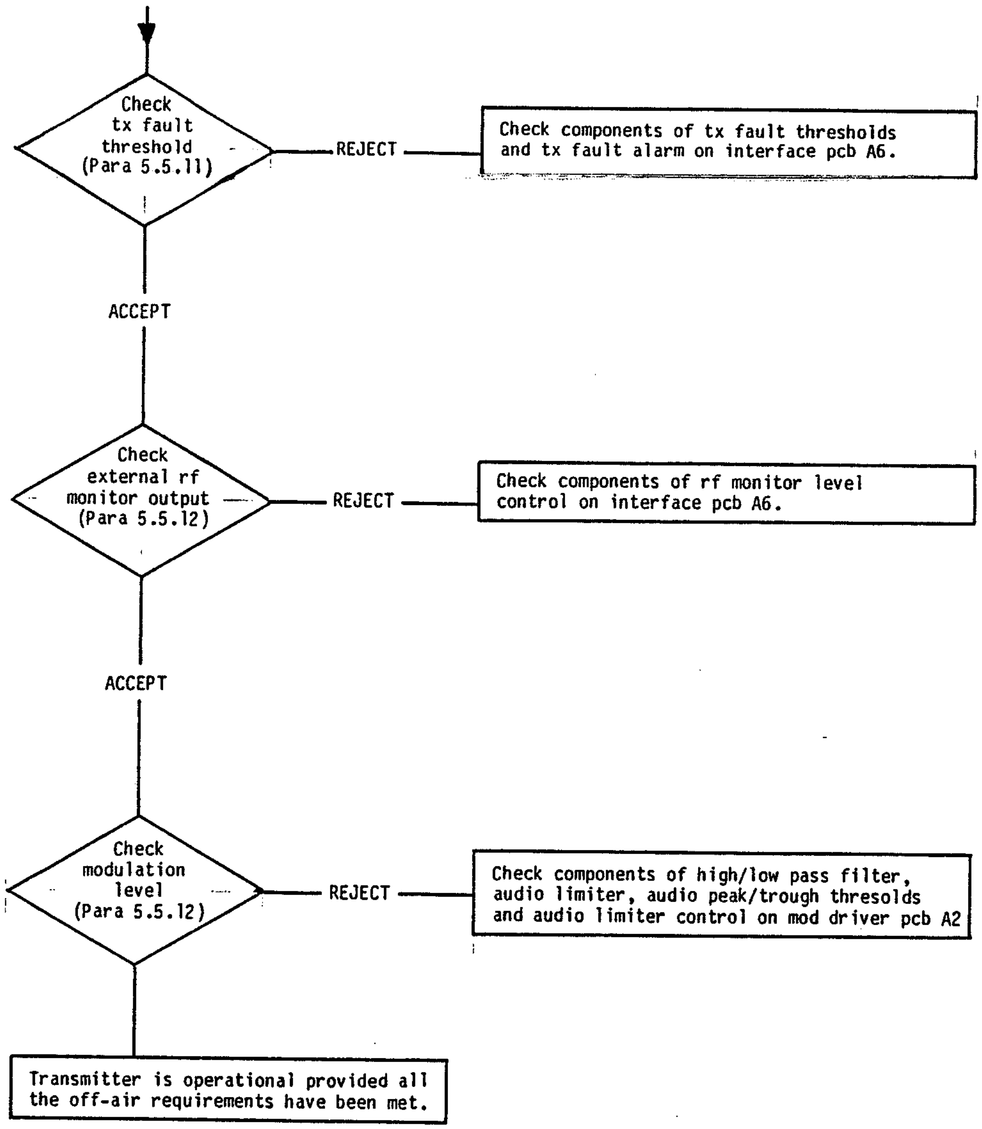
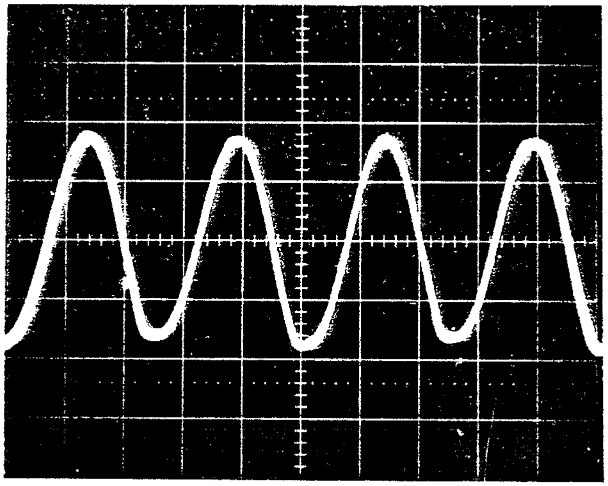


Figure 6-3 Off-Air Troubleshooting Assistance Information (Sheet 7)

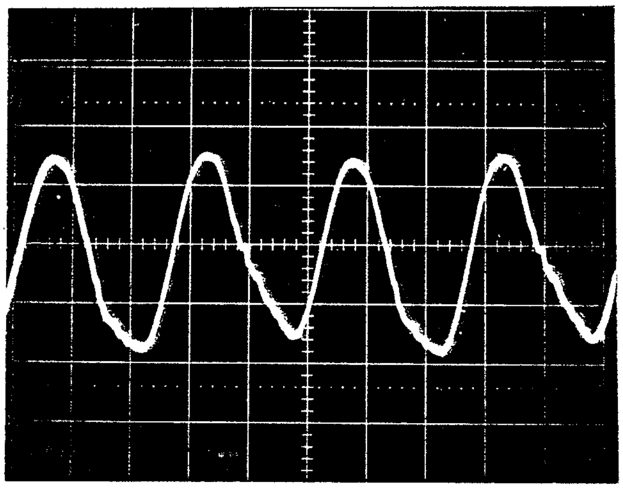


CRYSTAL OSCILLATOR

Frequency 2/4 x Carrier

(A) A1Q1 Collector

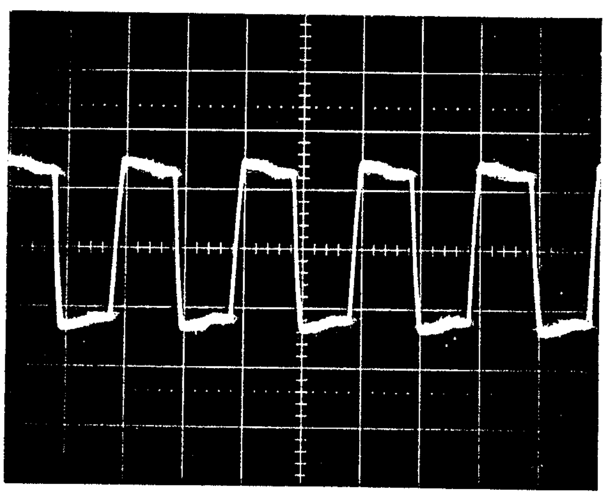
0.2 us time/division
2 volts/division
Scale centered at +14 vdc



BUFFER AMPLIFIER OUTPUT

(B) Test Point A1TP1

0.2 us time/division
200 mV/volts/division
Scale centered at +0.4 vdc

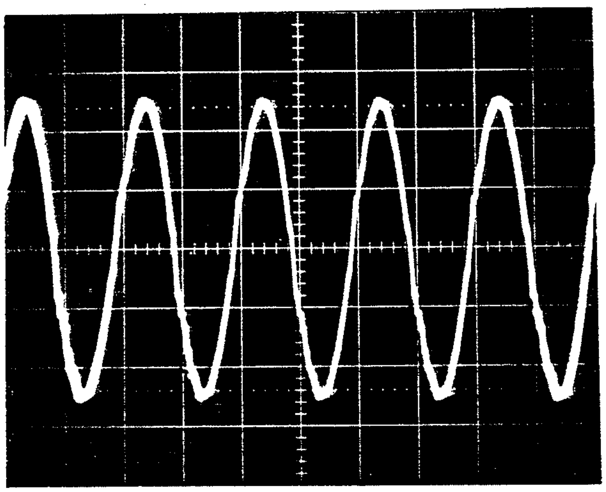


BALANCE DRIVE OUTPUT

(C) Test Point A1TP2

0.5 us time/division
5 volts/division
Scale centered at zero vdc

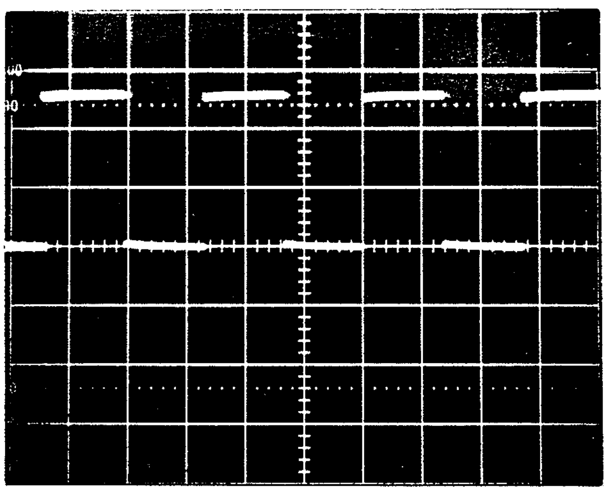
Figure 6-4 Waveforms - Off-air Troubleshooting (Sheet 1)



RF DRIVE OUTPUT

(D) A3TB2-2

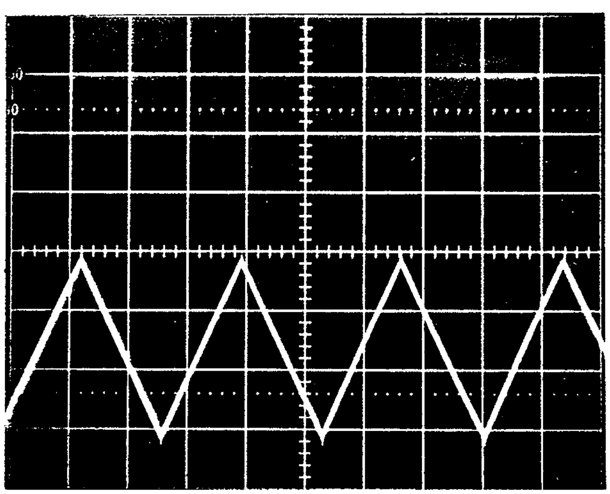
0.5 us time/division
5 volts/division
Scale centered at zero vdc



PWM SQUARE WAVE GENERATOR OUTPUT

(E) Test Point A2TP4

5 us time/division
5 volts/division
Scale centered at zero vdc

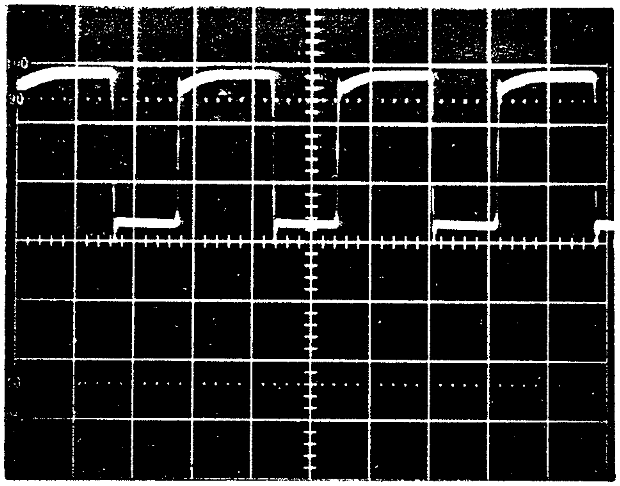


RAMP INTEGRATOR OUTPUT

(F) Test Point A2TP8

5 us time/division
1.0 volts/division
Scale centered at zero vdc

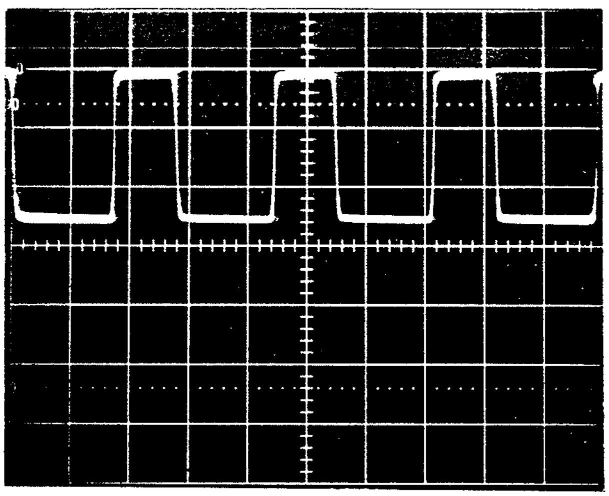
Figure 6-4 Waveforms - Off-air Troubleshooting (Sheet 2)



MOD DRIVE INPUT

(G) A3TB2-6

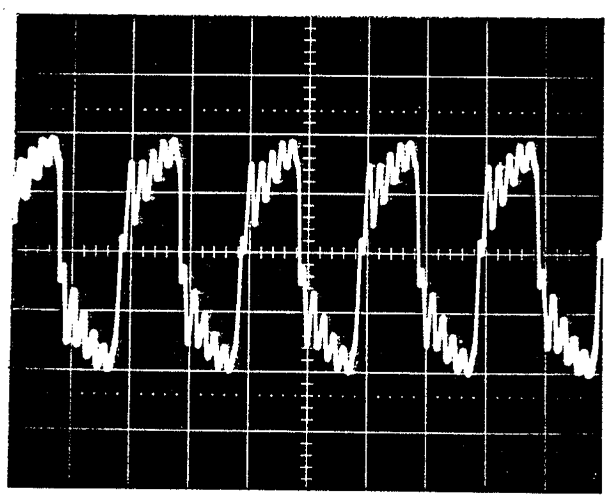
5 us time/division
5 volts/division
Scale centered at zero vdc



VARIABLE PULSE WIDTH
GENERATOR OUTPUT

(H) Test Point A2TP10

5 us time/division
5 volts/division
Scale centered at zero vdc



POWER AMPLIFIER OUTPUT

(I) TB4-1/2

0.5 us time/division
100 volts/division
Scale centered at zero vdc

Figure 6-4 Waveforms - Off-air Troubleshooting (Sheet 3)

SECTION 7
PARTS LIST

INTRODUCTION

7.1 This section contains a complete listing of all electrical and mechanical parts that have been assigned a reference designation and form a part of the subject transmitter.

FAMILY TREE

7.2 Figure 7-1 depicts the family tree for an AMPFET P400 (STEREO) AM broadcast transmitter.

MANUFACTURER'S INDEX

7.3 Table 7-1 provides a cross reference from the original equipment manufacturers (OEM) codes to the manufacturer's name and address. The listing is sorted alpha/numerically by the manufacturers' codes.

REFERENCE DESIGNATION INDEX

7.4 Table 7-2 provides a detailed parts listing for the subject transmitter, in alpha/numeric order of its reference designations. The reference designation index is divided into four columns as an aid to locating specific information. Refer to paragraph 7.6 for an explanation of column contents.

PARTS PER UNIT INDEX

7.5 Table 7-3 provides a listing of the total number of each part in the subject transmitter, in alpha/numeric order of the Nautel part number. The parts per unit index is divided into five columns as an aid to locating specific information, including a column that identifies the original equipment manufacturer for each part. Refer to paragraph 7.6 for an explanation of column contents.

COLUMN CONTENT EXPLANATION

7.6 The following paragraphs provide an explanation of the purpose and contents of each column in the reference designation and parts per unit indexes.

7.6.1 REF DES COLUMN: The first column in the reference designation index contains the full reference designation, in accordance with American National Standard Specification ANSI Y32.16, assigned to a specific part. The reference designation index is sorted and listed alpha/numerically according to the reference designation in this column. Reference designations that represent frequency dependent parts are listed more than once, with each listing assigned a letter code prefix. The letter code is explained at the end of the reference designation index and identifies which part is used in a specific transmitter. There is no Ref Des column in the parts per unit index.

7.6.2 NAME OF PART AND DESCRIPTION COLUMN: The second column of the reference designation and the parts per unit indexes contains the name and descriptive information for each part. The key word or noun is presented first, followed by the adjective identifiers.

Table 7-1 Manufacturers' Code to Address Index

00213	Nytronics Incorporated, Nytronics Components Group, Orange Street, Darlington, South Carolina 29532
00779	AMP Incorporated, P O Box 3608, Harrisburg, Pa 17105
00853	Sangamo Weston Incorporated, Sangamo Capacitor Division, PO Box 128, Route 3, Sangamo Road, Pickens, South Carolina 29671
00809	Croven, 500 Beech Street, Whitby, Ontario, L1N 5S5
01295	Texas Instruments Incorporated, US Semiconductor Group, PO Box 225012, M/S 49, 13500 North Central Expressway, Dallas, Texas 75265
02111	Spectrol Electronics Corporation, 17070 East Gale Avenue, City of Industry, California 91745
02660	Bunker Ramo Corporation, Amphenol Connector Division, 2801 South 25th Avenue, Broadview, Illinois 60153
04713	Motorola Incorporated, Semiconductor Products Group, 5005 East McDowell Road, Phoenix, Arizona 85008
08372	Cutler-hammer Canada Limited, 45 Progress Avenue, Scarborough, Ontario, Canada, M1P 2T6
09482	AMP of Canada Ltd., 20 Esna Park Drive, Markham, Ontario, L3R 1E1
11711	General Instrument Corporation, Rectifier Division, 600 West John Street, Hicksville, New York 11802
12617	Hamlin Incorporated, Grove & Lake Streets, Lake Mills, Wisconsin 53551
14604	Elmwood Sensors Inc., 1655 Elmwood Avenue, Cranston, Rhode Island 02907
14655	Cornell Dubilier Electronics Division, Federal Pacific Electric Company, 150 Avenue L, Newark, New Jersey 07101
14674	Corning Glass Works, Electronic Products Division, Houghton Park, Corning, New York 14830
15513	Data Display Products, P O Box 91072, 5428 West 104th St., Los Angeles, Ca 90009
28875	IMC Magnetics Corp., New Hampshire Division, Route 16, Rochester, New Hampshire 03867
33062	Ferronics Incorporated, 60 North Lincoln Road, East Rochester, New York 14445
35005	Dale Electronics Canada Limited, 18 Howden Road, Scarborough, Ontario

Table 7-1 Manufacturers' Code to Address Index (Continued)

36002	Dale Electronics Canada Limited, PO Box 5484, 1255 Brydges Street, London, Ontario, Canada, N6A 4L6
37338	Nautel See 'Warranty' page for address of appropriate facility
37903	Siemens Electric Ltd., 7300 Trans Canada Highway, Pointe Clare, Quebec, H9R 107
50434	Hewlett Packard Company, Optoelectronics Division, 640 Page Mill Road, Palo Alto, California 94304
56289	Sprague Electric Company, Distributors' Division, 87 Marshall Street, North Adams, Massachusetts 01247
56699	Mapco/Electra Inc., 6071 St. Andrew's Road, Columbia, S.C. 29210
70903	Belden Corporation, 200 South Batavia Avenue, Geneva, Illinois 60134
71785	TRW Incorporated, TRW Cinch Connectors, 1501 Morse Avenue, Elk Grove Village, Illinois 60007
72982	Erie Technological Products Inc., 645 West 11th Street, Erie, Pennsylvania 16512
73631	Curtis Instruments Inc., Helipot Division. 2500 Harbour Blvd., Fullerton, California 92634
73831	Hammond Manufacturing Co. Ltd., 394 Edinburgh Road North, Guelph, Ontario, Canada
75042	TRW Electronic Components, IRC Fixed Resistor Division, 401 North Broad Street, Philadelphia, Pennsylvania 19108
75915	Littlefuse Incorporated, 800 East Northwest Highway, Des Plaines, Illinois 60016
80294	Bourns Incorporated, Instrument Division, 6135 Magnolia Avenue, Riverside, California 92506
81073	Grayhill Incorporated, PO Box 373, 561 Hillgrove Avenue, La Grange, Illinois 60525
81483	International Rectifier, 9220 Sunset Boulevard, PO Box 2321, Terminal Annex, Los Angeles, California 90054
82877	Rotron Inc., 7-9 Hasbrouk Lane, Woodstock, New York 12498
83003	VARO Incorporated, PO Box 401426, 2203 Walnut Street, Garland, Texas 75040
89397	General Instrument Corp., Automatic Mfg. Div., 3101 Pratt Boulevard, Chicago, Illinois 60645
89473	General Electric Distributing Corp., 1 River Road, Schenactady, New York 12305
91506	Augat Incorporated, PO Box 779, 33 Perry Avenue, Attleboro, Massachusetts 02703

7.6.3 NAUTEL'S PART NO. COLUMN: The third column of the reference designation index and the first column of the parts per unit index contains the Nautel in-house part number assigned to each part. This number is a Nautel inventory management aid that allows a single number to represent two or more different manufacturers part numbers for interchangeable parts. The parts per unit index is sorted and listed alpha/numerically according to the part number in this column.

7.6.4 JAN, MIL OR MFR PART NO. COLUMN: The fourth column of the reference designation index and the third column of the parts per unit index contains an original equipment manufacturer's part number for a part. A single part number is listed for each part, even though there may be more than one known manufacturer. The listed number is Nautel's usual or preferred choice. A JAN or MIL number has been assigned as the manufacturer's part number, where practical, to assist the user in finding a suitable replacement part. The use of this number does not restrict Nautel from selecting and using commercial equivalents, where their use will not degrade circuit operation or reliability, during manufacture.

7.6.5 OEM CODE COLUMN: The fourth column of the parts per unit index contains a five digit coded group as the original equipment manufacturer's (OEM) identifier. The code is based on and was extracted from Cataloging Handbook H4-2 - Federal Supply Code for Manufacturers (United States and Canada). Manufacturers that were not listed in the H4 catalog at the time this listing was compiled have been assigned a five letter code. The five letter code is assigned arbitrarily and has no other significance. The manufacturers identified for parts that have JAN or MIL part numbers are Nautel's normal supply source for that part. There is no OEM Code column in the reference designation index.

7.6.6 TOTAL IDENT PARTS COLUMN: The fifth column of the parts per unit index contains a number that represents the total quantity of that specific part in the subject exciter drawer assembly. Parts that are frequency dependent are identified by a letter code suffix on the quantity. The letter code is explained at the end of the parts per unit index. This explanation identifies which code and therefore which frequency dependent parts are used in a specific transmitter. There is no Total Ident Parts column in the reference designation index.

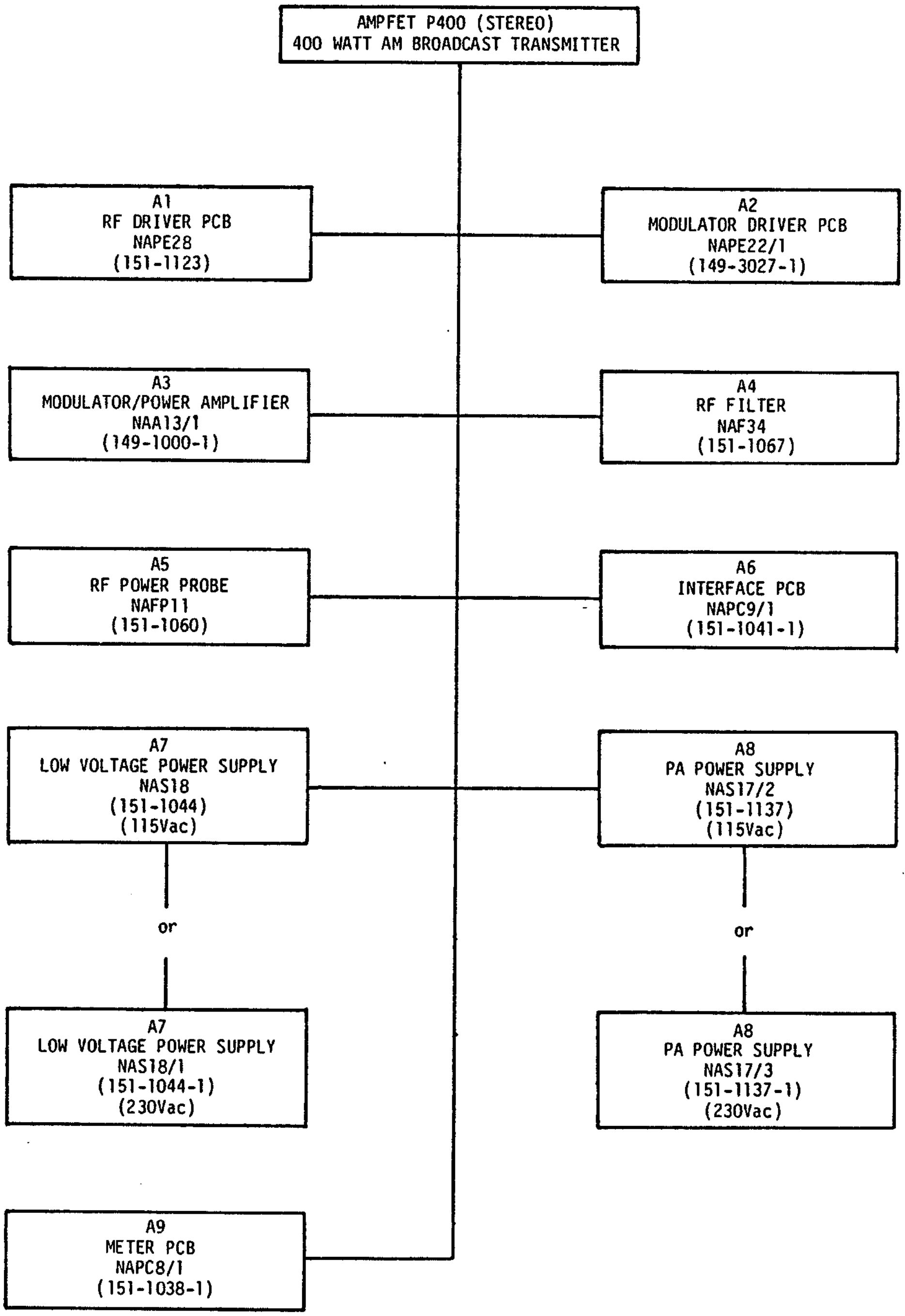


Figure 7-1 AMPFET P400 (Stereo) Family Tree

Table 7-2 AMPFET P400 Reference Designation Index

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
@ -	Transmitter, AM Broadcast 400W (115Vac)	AMPFET P400	151-1000-3
& -	Transmitter, AM Broadcast 400W (230Vac)	AMPFET P400	151-1000-4
* A1	RF Driver PCB Assy (535-922 kHz)	NAPE28/1	151-1123-1
¢ A1	RF Driver PCB Assy (923-1500 kHz)	NAPE28/2	151-1123-2
# A1	RF Driver PCB Assy (1501-1705 kHz)	NAPE28/3	151-1123-3
A1C1	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
A1C2	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C3	Capacitor, Mica, 180pF 2%, 500V	CB28	CM05FD181G03
A1C4	Capacitor, Variable, 0.8-23pF, 750V	CY18	527-000
A1C5	Capacitor, Mica, 47pF 2%, 500V	CB21	CM05ED470G03
A1C6	Capacitor, Mica, 1000pF 2%, 500V	CB37	CM06FD102G03
A1C7	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
A1C8	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C9	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C10	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A1C11	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
* A1C12	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
¢ A1C12	Capacitor, Ceramic, 0.0068uF 10%, 100V	CCG30	CKR05BX682KL
# A1C12	Capacitor, Ceramic, 0.0047uF 10%, 100V	CCG03	CKR05BX472KL
A1C13	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
A1C14	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
A1C15	Capacitor, Ceramic, 1.0uF 10%, 50V	CCG10	CKR06BX105KL
A1C16	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A1C17	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A1C18	Capacitor, Mica, 180pF 2%, 500V	CB28	CM05FD181G03
A1C19	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C20	Capacitor, Ceramic, 0.001uF 10%, 200V	CCG01	CKR05BX102KL
A1CR1	Diode, Hot Carrier	QK09	1N6263
A1CR2	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR3	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR4	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR5	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR6	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR7	Diode, Hot Carrier	QK09	1N6263
A1J1	MTA, Square Post Header Assy, 4-pin	JU20	640383-4
A1J2	MTA, Square Post Header Assy, 4-pin	JU20	640383-4
A1J3	MTA, Square Post Header Assy, 4-pin	JU20	640383-4
A1L1	Toroid	LY09	11-122-B
A1L2	Inductor, Moulded, Shielded, 1000uH	LAP39	SWD1000
A1L3	Toroid	LY09	11-122-B
A1L4	Toroid	LY09	11-122-B
A1L5	Toroid	LY09	11-122-B
* A1L6	Inductor, Moulded, Shielded, 5.6uH	LAP30	SWD5.6
¢ # A1L6	Inductor, Moulded, Shielded, 2.7uH	LAP24	SWD 2.7
A1L7	Toroid	LY09	11-122-B
A1L8	Toroid	LY09	11-122-B
A1L9	Toroid	LY09	11-122-B
A1Q1	Transistor, NPN	QAP06	2N2222

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A1Q2	Transistor, NPN	QAP06	2N2222
A1Q3	Transistor, NPN	QAP05	2N2219
A1Q4	Transistor, PNP	QAP08	2N2905
A1Q5	Transistor, Field Effect, N Channel	QA36	IRFF112
A1Q6	Transistor, Field Effect, N Channel	QA36	IRFF112
A1Q7	Transistor, NPN	QE10	2N3227
A1Q8	Transistor, NPN	QE10	2N3227
A1Q9	Transistor, NPN	QE10	2N3227
A1Q10	Transistor, NPN	QE10	2N3227
A1R1	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A1R2	Resistor, Film, 8200 ohms, 2% 1/2W	RD06	RL20S822G
A1R3	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R4	Resistor, Film, 180 ohms, 2% 1/2W	RAP06	RL20S181G
A1R5	Resistor, Film, 27K ohms, 2% 1/2W	RD12	RL20S273G
A1R6	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R7	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A1R8	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
A1R9	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R10	Not Used		
A1R11	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
A1R12	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R13	Resistor, Film, 68K ohms, 2% 1/2W	RD17	RL20S683G
A1R14	Resistor, Film, 56 ohms, 2% 1/2W	RAP04	RL20S560G
A1R15	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R16	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R17	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R18	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R19	Resistor, Film, 33 ohms, 2% 1/2W	RAP03	RL20S330G
A1R20	Resistor, Film, 33 ohms, 2% 1/2W	RAP03	RL20S330G
A1R21	Resistor, Film, 1500 ohms, 2% 1/2W	RC39	RL20S152G
A1R22	Resistor, Film, 560 ohms, 2% 1/2W	RAP08	RL20S561G
A1R23	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R24	Resistor, Film, 330 ohms, 2% 1/2W	RAP07	RL20S331G
A1R25	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R26	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R27	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R28	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R29	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R30	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A1R31	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A1R32	Resistor, Film, 180K ohms, 2% 1/2W	RAP18	RL20S184G
A1R33	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R34	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R35	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A1S1	Switch, Dip, 4-way, 1PST	SC31	76SB4
A1T1	Transformer Assembly	151-1092	151-1092
A1T2	Transformer	139-3072	139-3072
A1U1	IC, CMOS, Dual, Type D, Flip Flop	UB15	MC14013BAL

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A1U2	IC, CMOS, Quad, 2-input NOR Gates	UB01	MC14001BAL
A1U3	IC, CMOS, Quad, 2-input Exclusive OR	UB09	MC14070BAL
A1U4	IC, Operational Amplifier, Quad	UC15	MC3403L
A1XU1	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU2	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU3	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU4	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XY1	Crystal Socket, Teflon, PCB Mount	BAP39	8000-DG4
A1Y1	Crystal, 2-4 MHz (Fc x 2 or Fc x 4)	XA19	A061DXA-50
A2	Modulator Driver PCB Assembly	NAPE22/1	149-3027-1
A2C1	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C2	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C3	Capacitor, Mica, 1000pF 2%, 500V	CB37	CM06FD102G03
A2C4	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C5	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C6	Capacitor, Mica, 1000pF 2%, 500V	CB37	CM06FD102G03
A2C7	Capacitor, Mica, 1000pF 2%, 500V	CB37	CM06FD102G03
A2C8	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C9	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C10	Capacitor, Ceramic, 0.22uF 10%, 50V	CCG08	CKR06BX224KL
A2C11	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C12	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C13	Capacitor, Tantalum, 22uF 10%, 35V	CCP20	CSR13F226KM
A2C14	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C15	Capacitor, Variable, 7-25pF, 350V	CY23	538-011-B7-25
A2C16	Capacitor, Mica, 100pF 2%, 500V	CB25	CM05FD101G03
A2C17	Capacitor, Ceramic, 0.0047uF 10%, 100V	CCG03	CKR05BX472KL
A2C18	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C19	Capacitor, Mica, 330pF 2%, 500V	CB31	CM05FD331G03
A2C20	Capacitor, Ceramic, 0.001uF 10%, 200V	CCG01	CKR06BX102KL
A2C21	Capacitor, Tantalum, 3.3uF 10%, 15V	CCP10	CSR13D335KM
A2C22	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A2C23	Capacitor, Ceramic, 0.22uF 10%, 50V	CCG08	CKR06BX224KL
A2C24	Capacitor, Ceramic, 0.22uF 10%, 50V	CCG08	CKR06BX224KL
A2C25	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C26	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C27	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C28	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C29	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A2C30	Capacitor, Ceramic, 0.022uF 10%, 100V	CCG05	CKR06BX223KL
A2CR1	Diode	QAP29	1N4938
A2CR2	Diode	QAP29	1N4938
A2CR3	Diode	QAP29	1N4938
A2CR4	Diode	QAP29	1N4938
A2CR5	Diode, Zener, 4.7V	QL22	1N4732
A2CR6	Diode, Zener, 33V	QL24	1N4752
A2J1	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2
A2J2	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A2L1	Toroid	LY09	11-122-B
A2L2	Toroid	LY09	11-122-B
A2L3	Toroid	LY09	11-122-B
A2L4	Toroid	LY09	11-122-B
A2L5	Toroid	LY09	11-122-B
A2L6	Toroid	LY09	11-122-B
A2L7	Toroid	LY09	11-122-B
A2L8	Toroid	LY09	11-122-B
A2Q1	Transistor, PNP	QAP09	2N2907
A2Q2	Transistor, PNP	QAP09	2N2907
A2Q3	Transistor, PNP	QAP09	2N2907
A2Q4	Transistor, PNP	QAP09	2N2907
A2Q5	Transistor, PNP	QAP09	2N2907
A2Q6	Transistor, PNP	QAP09	2N2907
A2Q7	Transistor, NPN	QE10	2N3227
A2Q8	Transistor, NPN	QE10	2N3227
A2Q9	Transistor, NPN	QAP06	2N2222
A2Q10	Transistor, PNP	QAP09	2N2907
A2Q11	Transistor, NPN	QAP06	2N2222
A2Q12	Transistor, NPN	QA31	2N930A
A2R1	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A2R2	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A2R3	Resistor, Film, 1200 ohms, 2% 1/2W	RC38	RL20S122G
A2R4	Resistor, Variable, 1000 ohms, 1/2W	RW07	63P102
A2R5	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A2R6	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A2R7	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A2R8	Resistor, Film, 22K ohms, 2% 1/2W	RD11	RL20S223G
A2R9	Resistor, Film, 82K ohms, 2% 1/2W	RD18	RL20S823G
A2R10	Resistor, Film, 39K ohms, 2% 1/2W	RD14	RL20S393G
A2R11	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R12	Resistor, Film, 5600 ohms, 2% 1/2W	RAP12	RL20S562G
A2R13	Resistor, Film, 8200 ohms, 2% 1/2W	RD06	RL20S822G
A2R14	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A2R15	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R16	Resistor, Variable, 1000 ohms, 1/2W	RW07	63P102
A2R17	Resistor, Film, 3900 ohms, 2% 1/2W	RD02	RL20S392G
A2R18	Resistor, Variable, 100 ohms, 1/2W	RW24	RJ50CP104
A2R19	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R20	Resistor, Comp, 1.8M ohms, 5% 1/2W	RF34	RC20GF185J
A2R21	Resistor, Film, 39K ohms, 2% 1/2W	RD14	RL20S393G
A2R22	Resistor, Film, 82K ohms, 2% 1/2W	RD18	RL20S823G
A2R23	Resistor, Film, 150K ohms, 2% 1/2W	RD21	RL20S154G
A2R24	Resistor, Film, 330K ohms, 2% 1/2W	RAP19	RL20S334G
A2R25	Resistor, Comp, 3.3M ohms, 5% 1/2W	RF37	RC20GF335J
A2R26	Resistor, Film, 180K ohms, 2% 1/2W	RAP18	RL20S184G
A2R27	Resistor, Film, 82K ohms, 2% 1/2W	RD18	RL20S823G
A2R28	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A2R29	Resistor, Variable, 1000 ohms, 1/2W	RW07	63P102
A2R30	Resistor, Film, 560 ohms, 2% 1/2W	RAP08	RL20S561G
A2R31	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R32	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R33	Resistor, Film, 68K ohms, 2% 1/2W	RD17	RL20S683G
A2R34	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A2R35	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A2R36	Resistor, Film, 3900 ohms, 2% 1/2W	RD02	RL20S392G
A2R37	Resistor, Film, 15K ohms, 2% 1/2W	RD09	RL20S153G
A2R38	Resistor, Film, 15K ohms, 2% 1/2W	RD09	RL20S153G
A2R39	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R40	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R41	Resistor, Film, 1200 ohms, 2% 1/2W	RC38	RL20S122G
A2R42	Resistor, Variable, 100 ohms, 1/2W	RW24	RJ50CP104
A2R43	Resistor, Film, 120 ohms, 2% 1/2W	RC26	RL20S121G
A2R44	Resistor, Film, 2200 ohms, 2% 1/2W	RC41	RL20S222G
A2R45	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A2R46	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A2R47	Resistor, Variable, 100K ohms, 1/2W	RW28	63P104T000
A2R48	Resistor, Film, 8200 ohms, 2% 1/2W	RD06	RL20S822G
A2R49	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A2R50	Resistor, Film, 2700 ohms, 2% 1/2W	RC42	RL20S272G
A2R51	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A2R52	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R53	Resistor, Film, 6800 ohms, 2% 1/2W	RD05	RL20S682G
A2R54	Resistor, Film, 6800 ohms, 2% 1/2W	RD05	RL20S682G
A2R55	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R56	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R57	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R58	Resistor, Film, 15K ohms, 2% 1/2W	RD09	RL20S153G
A2R59	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R60	Resistor, Film, 330K ohms, 2% 1/2W	RAP19	RL20S334G
A2R61	Resistor, Film, 3900 ohms, 2% 1/2W	RD02	RL20S392G
A2R62	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R63	Resistor, Film, 12K ohms, 2% 1/2W	RD08	RL20S123G
A2R64	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A2R65	Resistor, Film, 22K ohms, 2% 1/2W	RD11	RL20S223G
A2R66	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A2R67	Resistor, Film, 47K ohms, 2% 1/2W	RD15	RL20S473G
A2R68	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A2R69	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R70	Resistor, Variable, 1000 ohms, 1/2W	RW07	63P102
A2R71	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A2R72	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R73	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A2R74	Resistor, Film, 15K ohms, 2% 1/2W	RD09	RL20S153G
A2R75	Resistor, Variable, 1000 ohms, 1/2W	RW07	63P102
A2R76	Resistor, Film, 1200 ohms, 2% 1/2W	RC38	RL20S122G

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A2R77	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R78	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R79	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A2R80	Resistor, Film, 270 ohms, 2% 1/2W	RC30	RL20S271G
A2R81	Resistor, Comp, 680K ohms, 5% 1/2W	RF29	RC20GF684J
A2R82	Resistor, Film, 22K ohms, 2% 1/2W	RD11	RL20S223G
A2R83	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A2R84	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A2R85	Resistor, Film, 56 ohms, 2% 1/2W	RAP04	RL20S560G
A2R86	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A2R87	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A2R88	Resistor, Film, 8200 ohms, 2% 1/2W	RD06	RL20S822G
A2R89	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A2R90	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A2R91	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A2R92	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A2R93	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A2R94	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A2R95	Resistor, Comp, 1.8M ohms, 5% 1/2W	RF34	RC20GF185J
A2R96	Resistor, Film, 1M ohms, 2% 1/2W	RD31	RL20S105G
A2R97	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A2R98	Resistor, Film, 18 ohms, 2% 1/2W	RAP02	RL20S180G
A2R99	Resistor, Film, 180K ohms, 2% 1/2W	RAP18	RL20S184G
A2R100	Resistor, Film, 150K ohms, 2% 1/2W	RD21	RL20S154G
A2R101	Resistor, Film, 47K ohms, 2% 1/2W	RD15	RL20S473G
A2R102	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A2R103	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A2R104	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A2R105	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A2R106	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A2R107	Resistor, Film, 2700 ohms, 2% 1/2W	RC42	RL20S272G
A2R108	Resistor, Film, 82K ohms, 2% 1/2W	RD18	RL20S823G
A2RV1	Varistor, 4V rms	QI20	V8ZA1
A2S1	Switch, Dip, 2-way, 1PST	SC33	76SB2
A2S2	Switch, Dip, 4-way, 1PST	SC31	76SB4
A2U1	IC, Operational Amplifiers, Dual	UL12	TL082IJG
A2U2	IC, Comparator, Quad	UL02	MC3302L
A2U3	IC, Operational Amplifiers, Dual	UL12	TL082IJG
A2U4	IC, Multiplier, Four Quadrant	UL21	MC1595L
A2U5	IC, Multiplier, Four Quadrant	UL21	MC1595L
A2U6	IC, CMOS, Programmable Timer	UL42	MC14536BAL
A2U7	IC, Comparator, Quad	UL02	MC3302L
A2U8	IC, Operational Amplifiers, Quad	UL01	TL084IJ
A2U9	IC, Operational Amplifiers, Dual	UL12	TL082IJG
A2U10	IC, CMOS, Hex Inverter/Buffer	UL41	MC14049UBAL
A2XU1	Socket, Integrated Circuit, 8-pin	UC01	640463-1
A2XU2	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A2XU3	Socket, Integrated Circuit, 8-pin	UC01	640463-1

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A2XU4	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A2XU5	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A2XU6	Socket, Integrated Circuit, 16-pin	UC03	640358-1
A2XU7	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A2XU8	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A2XU9	Socket, Integrated Circuit, 8-pin	UC01	640463-1
A2XU10	Socket, Integrated Circuit, 16-pin	UC03	640358-1
A3	Modulator/Power Amplifier Assembly	NAA13/1	149-1000-1
A3A1	Modulator PCB Assembly	151-1056	151-1056
A3A1C1	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A3A1CR1	Diode, Zener, 13V	QK31	1N5928B
A3A1Q1	Transistor, PNP, Power, High Voltage	QE38	MM5415
A3A1Q2	Transistor, NPN	QAP06	2N2222
A3A1Q3	Transistor, PNP	QAP09	2N2907
A3A1R1	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A3A1R2	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A3A1R3	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A3A1R4	Resistor, Comp, 6800 ohms, 5% 1W	RH05	RC32GF682J
A3A1R5	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A3A1R6	Resistor, Film, 10 ohms, 2% 1/2W	RAP01	RL20S100G
A3A1R7	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A3A1R8	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A3A1R9	Resistor, Film, 10 ohms, 2% 1/2W	RAP01	RL20S100G
A3A1U1	IC, CMOS, Quad, 2-input OR Gates	UB22	MC14071BAL
A3A1XU1	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A3A2	Low Pass Filter PCB Assembly	149-1077	149-1077
A3A2C1	Capacitor, Plastic, 3.0uF 10%, 250V	CNP36	730P305X9250
A3A2C2	Capacitor, Plastic, 3.0uF 10%, 250V	CNP36	730P305X9250
A3A2C3	Capacitor, Plastic, 0.39uF 10%, 250V	CNP35	730P394X9250
A3A2C4	Capacitor, Plastic, 1.8uF 10%, 250V	CNP34	730P185X9250
A3A2C5	Capacitor, Plastic, 0.39uF 10%, 250V	CNP35	730P394X9250
A3A2L1	Inductor, 15.8uH	149-1061-1	149-1061-1
A3A2L2	Inductor, 12.6uH	149-1061	149-1061
A3A2L3	Inductor, 12.6uH	149-1061	149-1061
A3C1	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C2	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C3	Not used		
A3C4	Not Used		
A3C5	Not Used		
A3C6	Not Used		
A3C7	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C8	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C9	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C10	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C11	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C12	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C13	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250
A3C14	Capacitor, Plastic, 0.22uF 10%, 250V	CNP07	5200-0.22/10/250

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

	REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
	A3CR1	Diode, Schottky Rectifier, 60A	QL15	60 HQ 100
	A3CR2	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR3	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR4	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR5	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR6	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR7	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR8	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR9	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3CR10	Diode, Schottky Rectifier, 4.5A	QL10	50 SQ 100
	A3Q1	Transistor, Field Effect, N Channel	QA04	IRF130
	A3Q2	Transistor, Field Effect, N Channel	QA04	IRF130
	A3Q3	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q4	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q5	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q6	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q7	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q8	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q9	Transistor, Field Effect, N Channel	QI07	IRF140
	A3Q10	Transistor, Field Effect, N Channel	QI07	IRF140
	A3R1	Not Used		
	A3R2	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
	A3S1	Switch Thermmal, NO 65°C/45°C	SC35	3450-82-483 F65C
	A3T1	Transformer	151-1047	151-1047
	A3T2	Transformer	151-1047-1	151-1047-1
	A3TB1	Terminal Block, Barrier, 2-terminal	JP12	GFTSA-2
	A3TB2	Terminal Block, Barrier, 6-terminal	JP38	GFT-6
A	A4	RF Filter Assembly (535-666 kHz)	NAF34/10	151-1067-10
B	A4	RF Filter Assembly (667-816 kHz)	NAF34/11	151-1067-11
C	A4	RF Filter Assembly (817-1000 kHz)	NAF34/12	151-1067-12
D	A4	RF Filter Assembly (1001-1210 kHz)	NAF34/13	151-1067-13
E	A4	RF Filter Assembly (1211-1480 kHz)	NAF34/14	151-1067-14
F	A4	RF Filter Assembly (1481-1705 kHz)	NAF34/15	151-1067-15
A	A4C1	Capacitor, Mica, 3300pF 2%, 2000V	CF04	27120B332G00
B	A4C1	Capacitor, Mica, 2700pF 2%, 2000V	CF03	27120B272G00
C	A4C1	Capacitor, Mica, 2200pF 2%, 3000V	CF10	27130B222G00
D	A4C1	Capacitor, Mica, 1800pF 2%, 3000V	CF09	27130B182G00
E	A4C1	Capacitor, Mica, 1500pF 2%, 3000V	CF08	27130B152G00
F	A4C1	Capacitor, Mica, 1200pF 2%, 3000V	CF07	27130B122G00
A	A4C2	Capacitor, Mica, 0.015uF 2%, 1000V	CCC01	27110B153G01
B	A4C2	Capacitor, Mica, 12000pF 2%, 1000V	CF01	27110B123G00
C	A4C2	Capacitor, Mica, 0.01uF 2%, 1000V	CZ06	27110B103G01
D	A4C2	Capacitor, Mica, 8200pF 2%, 1500V	CF02	27115B822G00
E	A4C2	Capacitor, Mica, 6800pF 2%, 2000V	CF06	27120B682G00
F	A4C2	Capacitor, Mica, 5600pF 2%, 2000V	CF05	27120B562G00
A	A4C3	Capacitor, Mica, 3300pF 2%, 2000V	CF04	27120B332G00
B	A4C3	Capacitor, Mica, 2700pF 2%, 2000V	CF03	27120B272G00
C	A4C3	Capacitor, Mica, 2200pF 2%, 3000V	CF10	27130B222G00

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

	REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
D	A4C3	Capacitor, Mica, 1800pF 2%, 3000V	CF09	27130B182G00
E	A4C3	Capacitor, Mica, 1500pF 2%, 3000V	CF08	27130B152G00
F	A4C3	Capacitor, Mica, 1200pF 2%, 3000V	CF07	27130B122G00
A	A4L1	Coil Assembly	151-1094-1	151-1094-1
B	A4L1	Coil Assembly	151-1094-2	151-1094-2
C	A4L1	Coil Assembly	151-1094-3	151-1094-3
D	A4L1	Coil Assembly	151-1094-4	151-1094-4
E	A4L1	Coil Assembly	151-1094-5	151-1094-5
F	A4L1	Coil Assembly	151-1094-6	151-1094-6
A	A4L2	Coil Assembly	151-1033-1	151-1033-1
B	A4L2	Coil Assembly	151-1033-2	151-1033-2
C	A4L2	Coil Assembly	151-1033-3	151-1033-3
D	A4L2	Coil Assembly	151-1033-4	151-1033-4
E	A4L2	Coil Assembly	151-1033-5	151-1033-5
F	A4L2	Coil Assembly	151-1033-6	151-1033-6
A	A4L3	Coil Assembly	151-1035-1	151-1035-1
B	A4L3	Coil Assembly	151-1035-2	151-1035-2
C	A4L3	Coil Assembly	151-1035-3	151-1035-3
D	A4L3	Coil Assembly	151-1035-4	151-1035-4
E	A4L3	Coil Assembly	151-1035-5	151-1035-5
F	A4L3	Coil Assembly	151-1035-6	151-1035-6
	A4TB1	Terminal Block, Barrier, 1-terminal	JP40	GFTSA-1
	A5	RF Power Probe Assembly	NAFP11	151-1060
	A5A1	RF Power Probe PCB Assembly	151-1063	151-1063
	A5A1C1	Capacitor, Mica, 1800pF 2%, 500V	CB40	CM06FD182G03
	A5A1C2	Capacitor, Mica, 1800pF 2%, 500V	CB40	CM06FD182G03
	A5A1CR1	Diode	QAP29	1N4938
	A5A1CR2	Diode	QAP29	1N4938
	A5A1CR3	Diode	QAP29	1N4938
	A5A1CR4	Diode	QAP29	1N4938
	A5A1J1	MTA, Square Post Header Assy, 4-pin	JU20	640383-4
	A5A1J2	MTA, Square Post Header Assy, 4-pin	JU20	640383-4
	A5A1L1	Inductor, Moulded, Shielded, 10000uH	LAP41	SWD10000
	A5A1L2	Inductor, Moulded, Shielded, 10000uH	LAP41	SWD10000
	A5A1L3	Inductor, Moulded, Shielded, 10000uH	LAP41	SWD10000
	A5A1L4	Inductor, Moulded, Shielded, 10000uH	LAP41	SWD10000
	A5A1R1	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R2	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R3	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R4	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R5	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R6	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R7	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5A1R8	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
	A5E1	Surge Arrester, 600Vdc ±15%	UC34	CG2-600
	A5J1	Connector, Panel, RF Coaxial, Type N	JDP21	UG58/U
	A5T1	Transformer, Voltage	151-1065	151-1065
	A5T2	Transformer, Current	151-1066	151-1066

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A5TB1	Terminal Block, Barrier, 3-terminal	JC23	3-142Y
A5XE1	Holder, Surge Arrester	UC32	CGH-1
A6	Interface PCB Assembly	NAPC9/1	151-1041-1
A6C1	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A6C2	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A6C3	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A6C4	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A6C5	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A6CR1	Diode	QAP29	1N4938
A6CR2	Diode	QAP29	1N4938
A6CR3	Diode	QAP29	1N4938
A6CR4	Diode	QAP29	1N4938
A6CR5	Diode	QAP29	1N4938
A6CR6	Diode	QAP29	1N4938
A6CR7	Diode	QAP29	1N4938
A6CR8	Diode	QAP29	1N4938
A6CR9	Diode	QAP29	1N4938
A6CR10	Diode, Zener, 33V	QL24	1N4752
A6CR11	Diode, Zener, 33V	QL24	1N4752
A6J1	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2
A6J2	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2
A6J3	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2
A6K1	Relay, 24Vdc Coil, DPST	KB42	HE722A2400
A6K2	Relay, 24Vdc Coil, DPST	KB42	HE722A2400
A6K3	Relay, 24Vdc Coil, DPST	KB42	HE722A2400
A6K4	Relay, 24Vdc Coil, SPDT	KB16	HE721C2400
A6L1	Toroid	LY09	11-122-B
A6Q1	Transistor, PNP	QAP09	2N2907
A6Q2	Transistor, PNP	QAP09	2N2907
A6Q3	Transistor, PNP	QAP09	2N2907
A6Q4	Transistor, PNP	QAP09	2N2907
A6Q5	Transistor, PNP	QAP09	2N2907
A6Q6	Transistor, PNP	QAP09	2N2907
A6Q7	Transistor, NPN	QAP04	2N2219A
A6Q8	Transistor, PNP	QAP09	2N2907
A6Q9	Transistor, NPN	QAP04	2N2219A
A6R1	Resistor, Variable, 2K ohms, 1/2W	RW31	3339P-1-202
A6R2	Resistor, Variable, 2K ohms, 1/2W	RW31	3339P-1-202
A6R3	Resistor, Variable, 2K ohms, 1/2W	RW31	3339P-1-202
A6R4	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R5	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A6R6	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R7	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A6R8	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R9	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A6R10	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A6R11	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R12	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A6R13	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A6R14	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A6R15	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R16	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A6R17	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A6R18	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A6R19	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A6R20	Resistor, Film, 5600 ohms, 2% 1/2W	RAP12	RL20S562G
A6R21	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A6R22	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A6R23	Resistor, Film, 27K ohms, 2% 1/2W	RD12	RL20S273G
A6R24	Resistor, Variable, 20K ohms, 1/2W	RV34	3386P-1-203
A6R25	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A6R26	Resistor, Variable, 20K ohms, 1/2W	RV34	3386P-1-203
A6R27	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A6R28	Resistor, Variable, 20K ohms, 1/2W	RV34	3386P-1-203
A6R29	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A6R30	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A6R31	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A6R32	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A6R33	Resistor, Film, 5600 ohms, 2% 1/2W	RAP12	RL20S562G
A6R34	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A6R35	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R36	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R37	Resistor, Film, 330 ohms, 2% 1/2W	RAP07	RL20S331G
A6R38	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R39	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R40	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A6R41	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A6R42	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A6R43	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A6R44	Resistor, Variable, 20K ohms, 1/2W	RV34	3386P-1-203
A6R45	Resistor, Variable, 20K ohms, 1/2W	RV34	3386P-1-203
A6R46	Resistor, Variable, 20K ohms, 1/2W	RV34	3386P-1-203
A6T1	Transformer, Auto	151-1043	151-1043
A6U1	IC, Comparator, Quad	UL02	MC3302L
A6U2	IC, Comparator, Quad	UL02	MC3302L
A6U3	IC, CMOS, Quad, Analog Switch	UB10	MC14066BAL
A6XU1	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A6XU2	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A6XU3	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A6XK1	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A6XK2	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A6XK3	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A6XK4	Socket, Integrated Circuit, 14-pin	UC02	640357-1
@ A7	Low Voltage Power Supply Assembly	NAS18	151-1044
& A7	Low Voltage Power Supply Assembly	NAS18/1	151-1044-1
A7C1	Capacitor, Electrolytic, 1400uF, 50V	CCD24	3186BA142T050AL

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

	REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
	A7C2	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
	A7C3	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
	A7C4	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
	A7C5	Capacitor, Electrolytic, 9600uF, 40V	CCD23	3188BE962U040ALA1
	A7C6	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
	A7C7	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
	A7C8	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
	A7C9	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
	A7CR1	Diode, Zener, 33V	QL24	1N4752
	A7CR2	Diode, Zener, 20V	QL26	1N5932B
	A7Q1	Transistor, NPN	QA06	2N6295
	A7R1	Resistor, Comp, 18 ohms, 5% 2W	RI16	RC42GF180J
@	A7T1	Transformer, Power, 115Vac, 60 Hz	TB40	167J36
&	A7T1	Transformer, Power, 230Vac, 50 Hz	TC28	151-1113
	A7TB1	Terminal Block, Barrier, 6-terminal	JB07	6-140Y
	A7U1	Diode, Bridge Assembly, 200V	UL30	VH247TT
	A7U2	IC, Voltage Regulator, -15 Volt	UL22	MC7915CK
	A7U3	IC, Voltage Regulator, +15 Volt	UL36	MC7815AK
@	A8	PA Power Supply Assembly, 400 Watt	NAS17/2	151-1137
&	A8	PA Power Supply Assembly, 400 Watt	NAS17/3	151-1137-1
	A8CR1	Diode, Zener, 82V	QK24	1N3042
	A8CR2	Diode, Zener, 13V	QK31	1N5928B
	A8CR3	Diode	QAP29	1N4938
	A8K1	Relay, 24Vdc Coil	KB38	K10P11D15
	A8L1	Inductor, Choke, 20mH	TC31	195M10
	A8Q1	Transistor, Field Effect, N Channel	QA04	IRF130
	A8R1	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
	A8R2	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
	A8R3	Resistor, Wirewound, 100 ohms, 5% 130W	RWP07	HL130-100 ohms-5%
	A8R4	Resistor Assembly, Meter Shunt	151-1079	151-1079
@	A8T1	Transformer, Power, 115Vac, 60 Hz	TC40	151-1089
&	A8T1	Transformer, Power, 230Vac, 50/60 Hz	TC29	151-1112
	A8TB1	Terminal Block, Barrier, 6-terminal	JP38	GFT-6
	A8TB2	Terminal Block, Barrier, 6-terminal	JP38	GFT-6
	A8U1	Diode, Bridge Assembly, 600V, 25A	UA42	GIB2506
	A8XK1	Socket, Relay	KB39	27E48820C217
	A9	Metering PCB Assembly	NAPC8/1	151-1038-1
	A9J1	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2
	A9J2	MTA, Square Post Header Assy, 12-pin	JU21	1-640383-2
	A9R1	Resistor, Film, 330 ohms, 2% 1/2W	RAP07	RL20S331G
	A9R2	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
	A9R3	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
	A9R4	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
	A9R5	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
	A9R6	Resistor, Variable, 100 ohms, 1/2W	RV02	3339W-1-101
	A9R7	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
	A9R8	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
	A9R9	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
A9R10	Resistor, Film, 6800 ohms, 2% 1/2W	RD05	RL20S682G
A9R11	Resistor, Variable, 2000 ohms, 1/2W	RV38	3339W-1-202
A9R12	Resistor, Film, 5600 ohms, 2% 1/2W	RAP12	RL20S562G
A9R13	Resistor, Variable, 1000 ohms, 1/2W	RV36	3339W-1-102
A9R14	Resistor, Film, 2700 ohms, 2% 1/2W	RC42	RL20S272G
A9R15	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A9R16	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
@ B1	Fan, 115V, 50/60 Hz, Muffin XL	ZA06	MX2B3-028422
& B1	Fan, 230V, 50/60Hz, Muffin XL	ZA13	MX3B3-028423
C1	Capacitor, Electrolytic, 18000uF, 100V	CCD22	3188GH183T100BL
DS1	Diode, Light Emitting, Green	QK12	5082-4992
DS2	Diode, Light Emitting, Green	QK12	5082-4992
DS3	Diode, Light Emitting, Amber	QK14	5082-4592
DS4	Diode, Light Emitting, Amber	QK14	5082-4592
DS5	Diode, Light Emitting, Amber	QK14	5082-4592
DS6	Diode, Light Emitting, Red	QK13	5082-4693
DS7	Diode, Light Emitting, Red	QK13	5082-4693
DS8	Diode, Light Emitting, Red	QK13	5082-4693
DS9	Diode, Light Emitting, Red	QK13	5082-4693
DS10	Diode, Light Emitting, Red	QK13	5082-4693
DS11	Diode, Light Emitting, Red	QK13	5082-4693
@ F1	Fuse, 10A, 250V, Slo-Blo, Type 3AB	FB35	326010
& F1	Fuse, 5A, 250V, Slo-Blo, Type 3AG	FA14	313005
F2	Fuse, 0.25A, 250V, Slo-Blo, Type 3AB	FB11	323.250
J1	Not Used		
J2	Connector, 3-pin, Recessed	JN24	17252
J3	Connector, RF Coaxial, BNC	JDP25	69475
L1	Inductor	151-1084	151-1084
M1	Meter, Test	MD12	151-1076
M2	Meter, Output Power	MD10	151-1074
P1	MTA, Closed End Housing, 4-pin, 22 AWG	JU01	640433-4
P2	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P3	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P4	MTA, Closed End Housing, 4-pin, 22 AWG	JU01	640433-4
P5	MTA, Closed End Housing, 4-pin, 22 AWG	JU01	640433-4
P6	Cord & Connector Assembly	ZA22	69-74
P7	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P8	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P9	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P10	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P11	MTA, Closed End Housing, 12-pin, 22 AWG	JU03	1-640433-2
P12	MTA, Closed End Housing, 4-pin, 22 AWG	JU01	640433-4
P13	MTA, Closed End Housing, 4-pin, 22 AWG	JU01	640433-4
S1	Switch, Toggle, 2PDT	SCP03	8373K107
S2	Switch, Toggle, 2PDT	SCP03	8373K107
S3	Switch, Rotary, Non-shorting	SA32	T206
S4	Switch, Rotary, Non-shorting	SA32	T206
S5	Switch, Rotary, Shorting	SC29	T202

Table 7-2 AMPFET P400 Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.
T1	Transformer, Audio	TC18	850G
T2	Transformer, Matching	151-1100	151-1100
T3	Transformer Assembly	151-1082	151-1082
TB1	Terminal Block, Barrier, 12-terminal	JB13	12-140
TB2	Terminal Block, Barrier, 12-terminal	JB13	12-140
TB3	Terminal Block, Barrier, 6-terminal	JC01	6-140
TB4	Terminal Block, Barrier, 5-terminal	JR25	5-173
XDS1	Socket, LED	QK25	PS-200-B
XDS2	Socket, LED	QK25	PS-200-B
XDS3	Socket, LED	QK25	PS-200-B
XDS4	Socket, LED	QK25	PS-200-B
XDS5	Socket, LED	QK25	PS-200-B
XDS6	Socket, LED	QK25	PS-200-B
XDS7	Socket, LED	QK25	PS-200-B
XDS8	Socket, LED	QK25	PS-200-B
XDS9	Socket, LED	QK25	PS-200-B
XDS10	Socket, LED	QK25	PS-200-B
XDS11	Socket, LED	QK25	PS-200-B
XF1	Fuseholder, Panel, Type 3AG	BAP31	348651
XF2	Fuseholder, Panel, Type 3AG	BAP31	348651

@ Denotes used when ac power supply is 115Vac 60 Hz
& Denotes used when ac power supply is 230Vac 50 Hz

* Denotes used when frequency is between 535 kHz and 922 kHz
¢ Denotes used when frequency is between 923 kHz and 1500 kHz
# Denotes used when frequency is between 1501 kHz and 1795 kHz

A Denotes used when frequency is between 535 kHz and 666 kHz
B Denotes used when frequency is between 667 kHz and 816 kHz
C Denotes used when frequency is between 817 kHz and 1000 kHz
D Denotes used when frequency is between 1001 kHz and 1210 kHz
E Denotes used when frequency is between 1211 kHz and 1480 kHz
F Denotes used when frequency is between 1481 kHz and 1705 kHz

Table 7-3 AMPFET P400 Parts Per Unit Index

NAUTEL'S PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
AMPFET P400	Transmitter, AM Broadcast 400W (115Vac)	151-1000-3	37338	- @
AMPFET P400	Transmitter, AM Broadcast 400W (230Vac)	151-1000-4	37338	- &
139-3072	Transformer	139-3072	37338	1
149-1061	Inductor, 12.6uH	149-1061	37338	2
149-1061-1	Inductor, 15.8uH	149-1061-1	37338	1
149-1077	Low Pass Filter PCB Assembly	149-1077	37338	1
151-1033-1	Coil Assembly	151-1033-1	37338	1 A
151-1033-2	Coil Assembly	151-1033-2	37338	1 B
151-1033-3	Coil Assembly	151-1033-3	37338	1 C
151-1033-4	Coil Assembly	151-1033-4	37338	1 D
151-1033-5	Coil Assembly	151-1033-5	37338	1 E
151-1033-6	Coil Assembly	151-1033-6	37338	1 F
151-1035-1	Coil Assembly	151-1035-1	37338	1 A
151-1035-2	Coil Assembly	151-1035-2	37338	1 B
151-1035-3	Coil Assembly	151-1035-3	37338	1 C
151-1035-4	Coil Assembly	151-1035-4	37338	1 D
151-1035-5	Coil Assembly	151-1035-5	37338	1 E
151-1035-6	Coil Assembly	151-1035-6	37338	1 F
151-1043	Transformer, Auto	151-1043	37338	1
151-1047	Transformer	151-1047	37338	1
151-1047-1	Transformer	151-1047-1	37338	1
151-1056	Modulator PCB Assembly	151-1056	37338	1
151-1063	RF Power Probe PCB Assembly	151-1063	37338	1
151-1065	Transformer, Voltage	151-1065	37338	1
151-1066	Transformer, Current	151-1066	37338	1
151-1079	Resistor Assembly, Meter Shunt	151-1071	37338	1
151-1082	Transformer Assembly	151-1082	37338	1
151-1084	Inductor	151-1084	37338	1
151-1092	Transformer Assembly	151-1092	37338	1
151-1094-1	Coil Assembly	151-1094-1	37338	1 A
151-1094-2	Coil Assembly	151-1094-2	37338	1 B
151-1094-3	Coil Assembly	151-1094-3	37338	1 C
151-1094-4	Coil Assembly	151-1094-4	37338	1 D
151-1094-5	Coil Assembly	151-1094-5	37338	1 E
151-1094-6	Coil Assembly	151-1094-6	37338	1 F
151-1100	Transformer, Matching	151-1100	37338	1
BAP31	Fuseholder, Panel, Type 3AG	348651	75915	2
BAP39	Crystal Socket, Teflon, PCB Mount	8000-DG4	91506	1
CB21	Capacitor, Mica, 47pF 2%, 500V	CM05ED470G03	14655	1
CB25	Capacitor, Mica, 100pF 2%, 500V	CM05FD101G03	14655	1
CB28	Capacitor, Mica, 180pF 2%, 500V	CM05FD181G03	14655	2
CB31	Capacitor, Mica, 330pF 2%, 500V	CM05FD331G03	14655	1
CB37	Capacitor, Mica, 1000pF 2%, 500V	CM06FD102G03	14655	4
CB40	Capacitor, Mica, 1800pF 2%, 500V	CM06FD182G03	14655	2
CCC01	Capacitor, Mica, 0.015uF 2%, 1000V	27110B153G01	00853	1 A
CCD22	Capacitor, Electrolytic, 18000uF, 100V	3188GH183T100BL	56699	1
CCD23	Capacitor, Electrolytic, 9600uF, 40V	3188BE962U040ALA1	56699	1

Table 7-3 AMPFET P400 Parts Per Unit Index (Continued)

NAUTEL'S PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
CCD24	Capacitor, Electrolytic, 1400uF, 50V	3186BA142T050AL	56699	1
CCG01	Capacitor, Ceramic, 0.001uF 10%, 200V	CKR06BX102KL	56289	2
CCG03	Capacitor, Ceramic, 0.0047uF 10%, 100V	CKR05BX472KL	56289	1 #
CCG03	Capacitor, Ceramic, 0.0047uF 10%, 100V	CKR05BX472KL	56289	1
CCG04	Capacitor, Ceramic, 0.01uF 10%, 100V	CKR05BX103KL	56289	1 *
CCG04	Capacitor, Ceramic, 0.01uF 10%, 100V	CKR05BX103KL	56289	4
CCG05	Capacitor, Ceramic, 0.022uF 10%, 100V	CKR06BX223KL	56289	1
CCG07	Capacitor, Ceramic, 0.1uF 10%, 100V	CKR06BX104KL	56289	17
CCG08	Capacitor, Ceramic, 0.22uF 10%, 50V	CKR06BX224KL	56289	3
CCG30	Capacitor, Ceramic, 0.0068uF 10%, 100V	CKR05BX682KL	56289	1 ¢
CCP10	Capacitor, Tantalum, 3.3uF 10%, 15V	CSR13D335KM	56289	2
CCP19	Capacitor, Tantalum, 6.8uF 10%, 35V	CSR13F685KM	56289	15
CCP20	Capacitor, Tantalum, 22uF 10%, 35V	CSR13F226KM	56289	1
CCP24	Capacitor, Tantalum, 1.0uF 10%, 50V	CSR13G105KM	56289	5
CF01	Capacitor, Mica, 12000pF 2%, 1000V	27110B123G00	00853	1 B
CF02	Capacitor, Mica, 8200pF 2%, 1500V	27115B822G00	00853	1 D
CF03	Capacitor, Mica, 2700pF 2%, 2000V	27120B272G00	00853	2 B
CF04	Capacitor, Mica, 3300pF 2%, 2000V	27120B332G00	00853	2 A
CF05	Capacitor, Mica, 5600pF 2%, 2000V	27120B562G00	00853	1 F
CF06	Capacitor, Mica, 6800pF 2%, 2000V	27120B682G00	00853	1 E
CF07	Capacitor, Mica, 1200pF 2%, 3000V	27130B122G00	00853	2 F
CF08	Capacitor, Mica, 1500pF 2%, 3000V	27130B152G00	00853	2 E
CF09	Capacitor, Mica, 1800pF 2%, 3000V	27130B182G00	00853	2 D
CF10	Capacitor, Mica, 2200pF 2%, 3000V	27130B222G00	00853	2 C
CNP07	Capacitor, Plastic, 0.22uF 10%, 250V	5200-0.22/10/250	37903	10
CNP34	Capacitor, Plastic, 1.8uF 10%, 250V	730P185X9250	56289	1
CNP35	Capacitor, Plastic, 0.39uF 10%, 250V	730P394X9250	56289	2
CNP36	Capacitor, Plastic, 3.0uF 10%, 250V	730P305X9250	56289	2
CY18	Capacitor, Variable, 0.8-23pF, 750V	527-000	72982	1
CY23	Capacitor, Variable, 7-25pF, 350V	538-011-B7-25	72982	1
CZ06	Capacitor, Mica, 0.01uF 2%, 1000V	27110B103G01	00853	1 C
FA14	Fuse, 5A, 250V, Slo-Blo, Type 3AG	313005	75915	1 &
FB11	Fuse, 0.25A, 250V, Slo-Blo, Type 3AB	323.250	75915	1
FB35	Fuse, 10A, 250V, Slo-Blo, Type 3AB	326010	75915	1 @
JB07	Terminal Block, Barrier, 6-terminal	6-140Y	71785	1
JB13	Terminal Block, Barrier, 12-terminal	12-140	71785	2
JC01	Terminal Block, Barrier, 6-terminal	6-140	71785	1
JC23	Terminal Block, Barrier, 3-terminal	3-142Y	71785	1
JDP21	Connector, Panel, RF Coaxial, Type N	UG58/U	02660	1
JDP25	Connector, RF Coaxial, BNC	69475	02660	1
JN24	Connector, 3-pin, Recessed	17252	70903	1
JP12	Terminal Block, Barrier, 2-terminal	GFTSA-2	73631	1
JP38	Terminal Block, Barrier, 6-terminal	GFT-6	73631	3
JP40	Terminal Block, Barrier, 1-terminal	GFTSA-1	73631	1
JR25	Terminal Block, Barrier, 5-terminal	5-173	71785	1
JU01	MTA, Closed End Housing, 4-pin, 22 AWG	640433-4	09482	5
JU03	MTA, Closed End Housing, 12-pin, 22 AWG	1-640433-2	09482	7
JU20	MTA, Square Post Header Assy, 4-pin	640383-4	09482	5

Table 7-3 AMPFET P400 Parts Per Unit Index (Continued)

NAUTEL'S PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
JU21	MTA, Square Post Header Assy, 12-pin	1-640383-2	09482	7
KB13	Relay, 24Vdc	HE721A2400	12617	3
KB16	Relay, 24Vdc	HE721C2400	12617	1
KB38	Relay, 24Vdc Coil	K10P11D15	77342	1
KB39	Socket, Relay	27E48820C217	77342	1
LAP24	Inductor, Moulded, Shielded, 2.7uH	SWD 2.7	00213	1 ¢
LAP24	Inductor, Moulded, Shielded, 2.7uH	SWD 2.7	00213	1 #
LAP30	Inductor, Moulded, Shielded, 5.6uH	SWD5.6	00213	1 *
LAP39	Inductor, Moulded, Shielded, 1000uH	SWD1000	00213	1
LAP41	Inductor, 10000uH	SWD10000	00213	4
LY09	Toroid	11-122-B	33062	16
MD10	Meter, Test	151-1074	37338	1
MD12	Meter, Output Power	151-1076	37338	1
NAA13/1	Modulator/Power Amplifier Assembly	149-1000-1	37338	1
NAF34/10	RF Filter Assembly (535-666 kHz)	151-1067-10	37338	1 A
NAF34/11	RF Filter Assembly (667-816 kHz)	151-1067-11	37338	1 B
NAF34/12	RF Filter Assembly (817-1000 kHz)	151-1067-12	37338	1 C
NAF34/13	RF Filter Assembly (1001-1210 kHz)	151-1067-13	37338	1 D
NAF34/14	RF Filter Assembly (1211-1480 kHz)	151-1067-14	37338	1 E
NAF34/15	RF Filter Assembly (1481-1705 kHz)	151-1067-15	37338	1 F
NAFP11	RF Power Probe Assembly	151-1060	37338	1
NAPC8/1	Metering PCB Assembly	151-1038-1	37338	1
NAPC9/1	Interface PCB Assembly	151-1041-1	37338	1
NAPE22/1	Modulator Driver PCB Assembly	149-3027-1	37338	1
NAPE28/1	RF Driver PCB Assy (535-922 kHz)	151-1123-1	37338	1 *
NAPE28/2	RF Driver PCB Assy (923-1500 kHz)	151-1123-2	37338	1 ¢
NAPE28/3	RF Driver PCB Assy (1501-1705 kHz)	151-1123-3	37338	1 #
NAS17/2	PA Power Supply Assembly, 400 Watt	151-1137	37338	1 @
NAS17/3	PA Power Supply Assembly, 400 Watt	151-1137-1	37338	1 &
NAS18	Low Voltage Power Supply Assembly	151-1044	37338	1 @
NAS18/1	Low Voltage Power Supply Assembly	151-1044-1	37338	1 &
QA04	Transistor, Field Effect, N Channel	IRF130	81483	3
QA06	Transistor, NPN	2N6295	04713	1
QA31	Transistor, NPN	2N930A	04713	1
QA36	Transistor, Field Effect, N Channel	IRFF112	81483	2
QAP04	Transistor, NPN	2N2219A	04713	2
QAP05	Transistor, NPN	2N2219	04713	1
QAP06	Transistor, NPN	2N2222	04713	5
QAP08	Transistor, PNP	2N2905	04713	1
QAP09	Transistor, PNP	2N2907	04713	15
QAP29	Diode	1N4938	01295	23
QE10	Transistor, NPN	2N3227	04713	6
QE38	Transistor, PNP, Power, High Voltage	MM5415	04713	1
QI07	Transistor, Field Effect, N Channel	IRF140	81483	8
QI20	Varistor, 4V rms	V8ZA1	89473	1
QK09	Diode, Hot Carrier	1N6263	50434	2
QK12	Diode, Light Emitting, Green	5082-4992	50434	2
QK13	Diode, Light Emitting, Red	5082-4693	50434	6

Table 7-3 AMPFET P400 Parts Per Unit Index (Continued)

NAUTEL'S PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
QK14	Diode, Light Emitting, Amber	5082-4592	50434	3
QK24	Diode, Zener, 82V	1N3042	04713	1
QK25	Socket, LED	PS-200-B	15513	11
QK31	Diode, Zener, 13V	1N5928B	04713	2
QL10	Diode, Schottky Rectifier, 4.5A	50 SQ 100	81483	9
QL15	Diode, Schottky Rectifier, 60A, 100V	60 HQ 100	81483	1
QL22	Diode, Zener, 4.7V	1N4732	04713	1
QL24	Diode, Zener, 33V	1N4752	04713	4
QL26	Diode, Zener, 20V	1N5932B	04713	1
RAP01	Resistor, Film, 10 ohms, 2% 1/2W	RL20S100G	36002	2
RAP02	Resistor, Film, 18 ohms, 2% 1/2W	RL20S180G	36002	1
RAP03	Resistor, Film, 33 ohms, 2% 1/2W	RL20S330G	36002	2
RAP04	Resistor, Film, 56 ohms, 2% 1/2W	RL20S560G	36002	2
RAP05	Resistor, Film, 100 ohms, 2% 1/2W	RL20S101G	36002	11
RAP06	Resistor, Film, 180 ohms, 2% 1/2W	RL20S181G	36002	1
RAP07	Resistor, Film, 330 ohms, 2% 1/2W	RL20S331G	36002	3
RAP08	Resistor, Film, 560 ohms, 2% 1/2W	RL20S561G	36002	2
RAP09	Resistor, Film, 1000 ohms, 2% 1/2W	RL20S102G	36002	19
RAP10	Resistor, Film, 1800 ohms, 2% 1/2W	RL20S182G	36002	18
RAP11	Resistor, Film, 3300 ohms, 2% 1/2W	RL20S332G	36002	15
RAP12	Resistor, Film, 5600 ohms, 2% 1/2W	RL20S562G	36002	4
RAP13	Resistor, Film, 10K ohms, 2% 1/2W	RL20S103G	36002	25
RAP14	Resistor, Film, 18K ohms, 2% 1/2W	RL20S183G	36002	11
RAP15	Resistor, Film, 33K ohms, 2% 1/2W	RL20S333G	36002	10
RAP16	Resistor, Film, 56K ohms, 2% 1/2W	RL20S563G	36002	11
RAP17	Resistor, Film, 100K ohms, 2% 1/2W	RL20S104G	36002	9
RAP18	Resistor, Film, 180K ohms, 2% 1/2W	RL20S184G	36002	3
RAP19	Resistor, Film, 330K ohms, 2% 1/2W	RL20S334G	36002	2
RC26	Resistor, Film, 120 ohms, 2% 1/2W	RL20S121G	36002	1
RC30	Resistor, Film, 270 ohms, 2% 1/2W	RL20S271G	36002	1
RC38	Resistor, Film, 1200 ohms, 2% 1/2W	RL20S122G	36002	3
RC39	Resistor, Film, 1500 ohms, 2% 1/2W	RL20S152G	36002	1
RC41	Resistor, Film, 2200 ohms, 2% 1/2W	RL20S222G	36002	1
RC42	Resistor, Film, 2700 ohms, 2% 1/2W	RL20S272G	36002	3
RD02	Resistor, Film, 3900 ohms, 2% 1/2W	RL20S392G	36002	3
RD05	Resistor, Film, 6800 ohms, 2% 1/2W	RL20S682G	36002	3
RD06	Resistor, Film, 8200 ohms, 2% 1/2W	RL20S822G	36002	4
RD08	Resistor, Film, 12K ohms, 2% 1/2W	RL20S123G	36002	1
RD09	Resistor, Film, 15K ohms, 2% 1/2W	RL20S153G	36002	4
RD11	Resistor, Film, 22K ohms, 2% 1/2W	RL20S223G	36002	3
RD12	Resistor, Film, 27K ohms, 2% 1/2W	RL20S273G	36002	2
RD14	Resistor, Film, 39K ohms, 2% 1/2W	RL20S393G	36002	2
RD15	Resistor, Film, 47K ohms, 2% 1/2W	RL20S473G	36002	2
RD17	Resistor, Film, 68K ohms, 2% 1/2W	RL20S683G	36002	2
RD18	Resistor, Film, 82K ohms, 2% 1/2W	RL20S823G	36002	4
RD21	Resistor, Film, 150K ohms, 2% 1/2W	RL20S154G	36002	2
RD31	Resistor, Film, 1M ohms, 2% 1/2W	RL20S105G	14674	1
RF29	Resistor, Comp, 680K ohms, 5% 1/2W	RC20GF684J	36002	1

Table 7-3 AMPFET P400 Parts Per Unit Index (Continued)

NAUTEL'S PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
RF34	Resistor, Comp, 1.8M ohms, 5% 1/2W	RC20GF185J	36002	2
RF37	Resistor, Comp, 3.3M ohms, 5% 1/2W	RC20GF335J	36002	1
RH05	Resistor, Comp, 6800 ohms, 5% 1W	RC32GF682J	36002	1
RI16	Resistor, Comp, 18 ohms, 5% 2W	RC42GF180J	36002	1
RV02	Resistor, Variable, 100 ohms, 1/2W	3339W-1-101	80294	1
RV34	Resistor, Variable, 20K ohms, 1/2W	3386P-1-203	80294	6
RV36	Resistor, Variable, 1000 ohms, 1/2W	3339W-1-102	80294	1
RV38	Resistor, Variable, 2000 ohms, 1/2W	3339W-1-202	80294	1
RW07	Resistor, Variable, 1000 ohms, 1/2W	63P102	02111	5
RW08	Resistor, Variable, 10K ohms, 1/2W	63P103T000	02111	5
RW24	Resistor, Variable, 100 ohms, 1/2W	RJ50CP104	80294	2
RW28	Resistor, Variable, 100K ohms, 1/2W	63P104T000	02111	1
RW31	Resistor, Variable, 2K ohms, 1/2W	3339P-1-202	80294	3
RWP07	Resistor, Wirewound, 100 ohms, 5% 130W	HL130-100 ohms-5%	35005	1
SA32	Switch, Rotary, Non-shorting	T206	75042	2
SC29	Switch, Rotary, Shorting	T202	75042	1
SC31	Switch, Dip, 4-way, 1PST	76SB4	81073	2
SC33	Switch, Dip, 2-way, 1PST	76SB2	81073	1
SC35	Switch Thermmal, NO 65°C/45°C	3450-82-483 F65C	14604	1
SCP03	Switch, Toggle, 2PDT	8373K107	08372	2
TB40	Transformer, Power, 115 Vac 60 Hz	167J36	73831	1 @
TC18	Transformer, Audio	850G	73831	1
TC28	Transformer, Power, 230Vac, 50 Hz	151-1113	36338	1 &
TC29	Transformer, Power, 230Vac, 50/60 Hz	151-1112	37338	1 &
TC31	Inductor, Choke, 20mH	195M10	73831	1
TC40	Transformer, Power, 115 Vac 60 Hz	151-1089	37338	1 @
UA42	Diode, Bridge Assembly, 600V, 25A	GIB2506	11711	1
UB01	IC, CMOS, Quad, 2-input NOR Gates	MC14001BAL	04713	1
UB09	IC, CMOS, Quad, 2-input Exclusive OR	MC14070BAL	04713	1
UB10	IC, CMOS, Quad, Analog Switch	MC14066BAL	04713	1
UB15	IC, CMOS, Dual, Type D, Flip Flop	MC14013BAL	04713	1
UB22	IC, CMOS, Quad, 2-input OR Gates	MC14071BAL	04713	1
UC01	Socket, Integrated Circuit, 8-pin	640463-1	00779	3
UC02	Socket, Integrated Circuit, 14-pin	640357-1	00779	17
UC03	Socket, Integrated Circuit, 16-pin	640358-1	00779	2
UC15	IC, Operational Amplifier, Quad	MC3403L	04713	1
UC32	Holder, Surge Arrester	CGH-1	89397	1
UC34	Surge Arrester, 600Vdc ±15%	CG2-600	89397	1
UL01	IC, Operational Amplifiers, Quad	TL084IJ	01295	1
UL02	IC, Comparator, Quad	MC3302L	04713	4
UL12	IC, Operational Amplifiers, Dual	TL082IJG	01295	3
UL21	IC, Multiplier, Four Quadrant	MC1595L	04713	2
UL22	IC, Voltage Regulator, -15 Volt	MC7915CK	04713	1
UL30	Diode, Bridge Assembly, 200V	VH247TT	83003	1
UL36	IC, Voltage Regulator, +15 Volt	MC7815AK	04713	1
UL41	IC, CMOS, Hex Inverter/Buffer	MC14049UBAL	04713	1
UL42	IC, CMOS, Programmable Timer	MC14536BAL	04713	1
XA19	Crystal, 2-4 MHz (Fc x 2 or Fc x 4)	A061DXA-50	00809	1

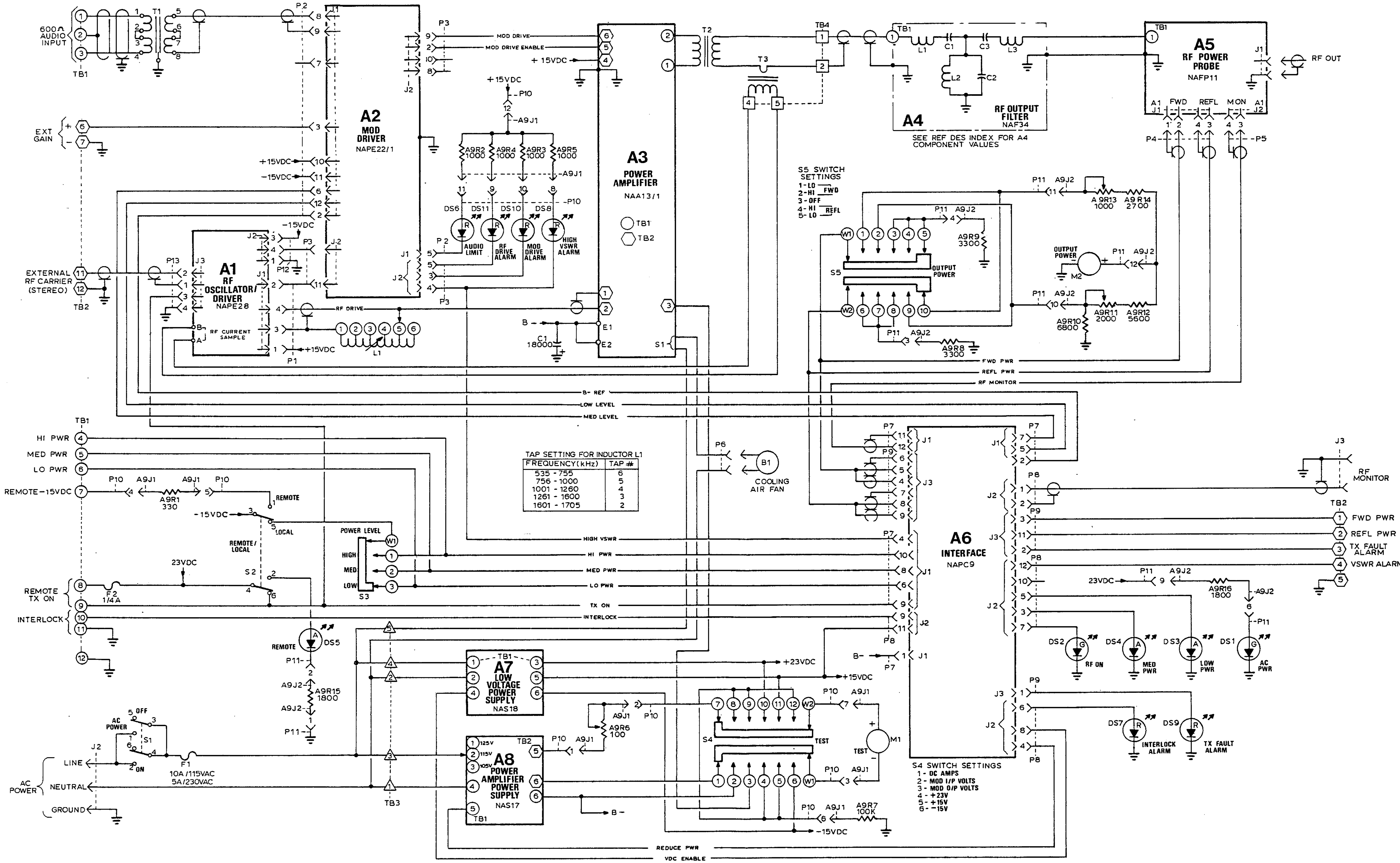
Table 7-3 AMPFET P400 Parts Per Unit Index (Continued)

NAUTEL'S PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
ZA06	Fan, 115V, 50/60 Hz, Muffin XL	MX2B3-028422	82877	1 @
ZA13	Fan, 230V, 50/60Hz, Muffin XL	MX3B3-028423	82877	1 &
ZA22	Cord & Connector Assembly	69-74	28875	1

@ Denotes used when ac power supply is 115Vac 60 Hz
& Denotes used when ac power supply is 230Vac 50 Hz

* Denotes used when frequency is between 535 kHz and 922 kHz
¢ Denotes used when frequency is between 923 kHz and 1500 kHz
# Denotes used when frequency is between 1501 kHz and 1795 kHz

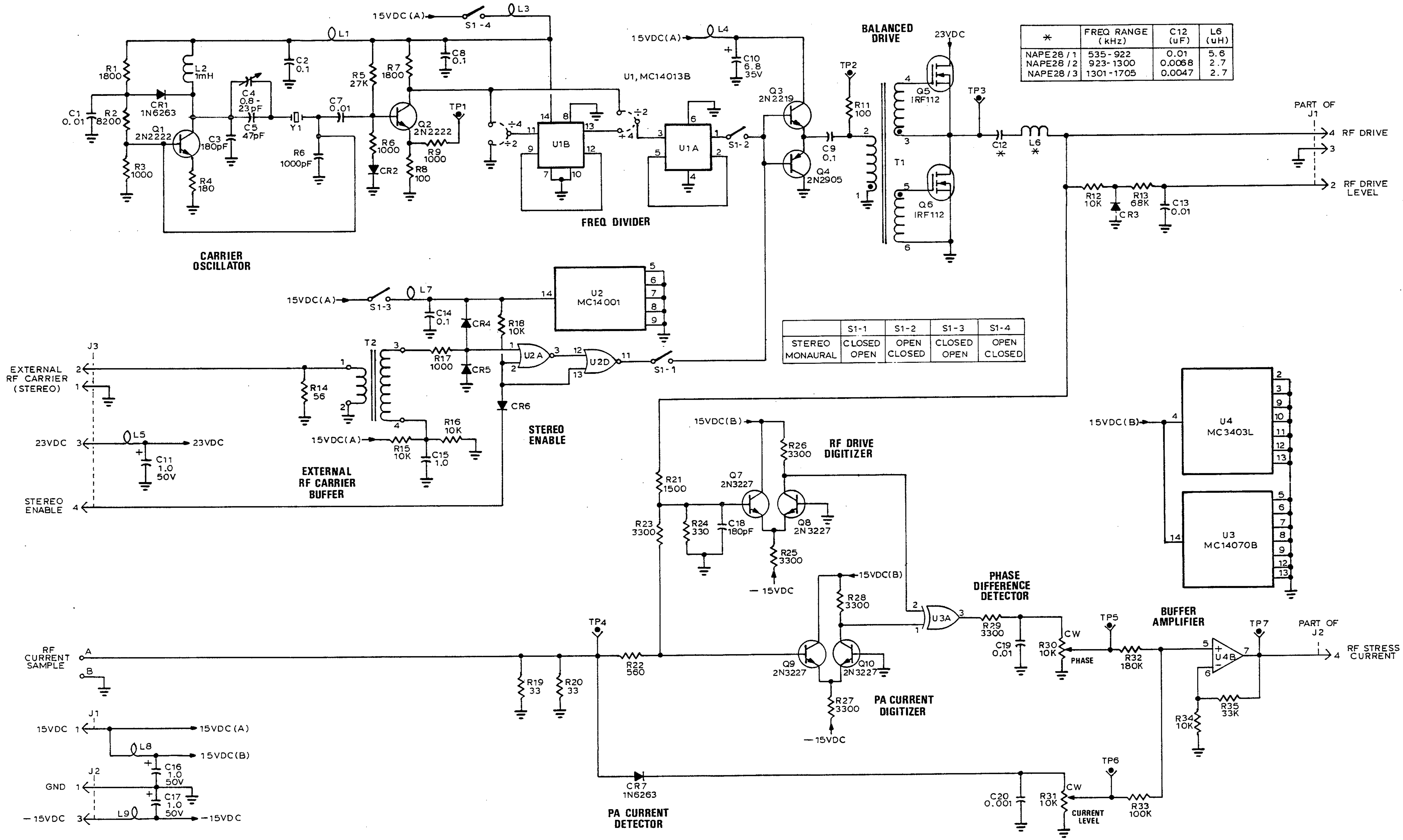
A Denotes used when frequency is between 535 kHz and 666 kHz
B Denotes used when frequency is between 667 kHz and 816 kHz
C Denotes used when frequency is between 817 kHz and 1000 kHz
D Denotes used when frequency is between 1001 kHz and 1210 kHz
E Denotes used when frequency is between 1211 kHz and 1480 kHz
F Denotes used when frequency is between 1481 kHz and 1705 kHz



TAP SETTING FOR INDUCTOR L1

FREQUENCY (kHz)	TAP #
535 - 755	6
756 - 1000	5
1001 - 1260	4
1261 - 1600	3
1601 - 1705	2

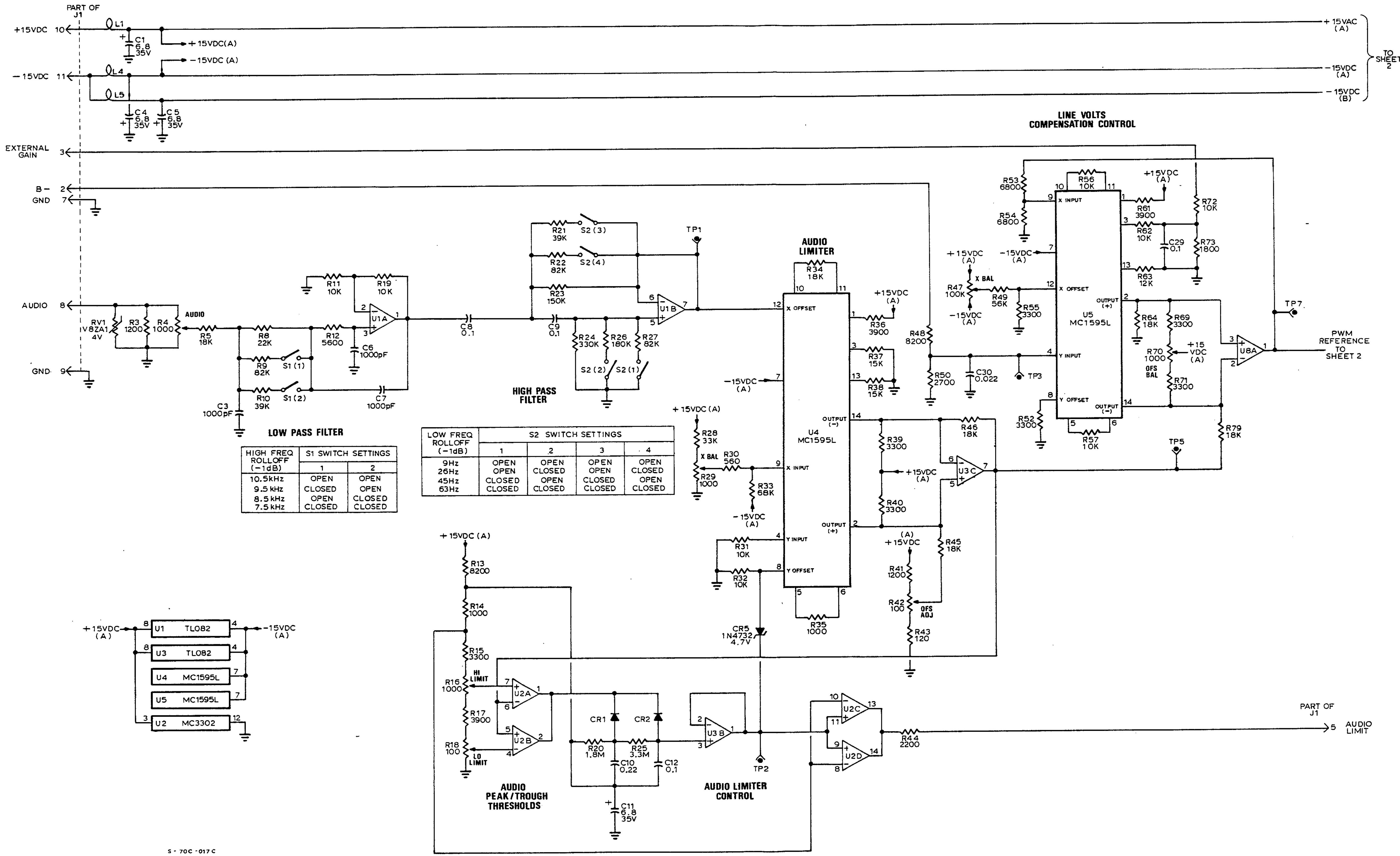
Figure FO-1 Electrical Schematic - AMPFET P400 (Stereo) Transmitter



*	FREQ RANGE (kHz)	C12 (uF)	L6 (uH)
NAPE28 / 1	535 - 922	0.01	5.6
NAPE28 / 2	923 - 1300	0.0068	2.7
NAPE28 / 3	1301 - 1705	0.0047	2.7

	S1-1	S1-2	S1-3	S1-4
STEREO	CLOSED	OPEN	CLOSED	OPEN
MONAURAL	OPEN	CLOSED	OPEN	CLOSED

Figure FO-2 Electrical Schematic - NAPE28 RF Driver PCB



HIGH FREQ ROLLOFF (-1dB)	S1 SWITCH SETTINGS 1	2
10.5kHz	OPEN	OPEN
9.5 kHz	CLOSED	OPEN
8.5 kHz	OPEN	CLOSED
7.5 kHz	CLOSED	CLOSED

LOW FREQ ROLLOFF (-1dB)	S2 SWITCH SETTINGS 1	2	3	4
9Hz	OPEN	OPEN	OPEN	OPEN
26Hz	OPEN	CLOSED	OPEN	CLOSED
45Hz	CLOSED	OPEN	CLOSED	OPEN
63Hz	CLOSED	CLOSED	CLOSED	CLOSED

Figure FO-3 Electrical Schematic - NAPE22/1 Modulator Driver PCB (Sheet 1 of 2)

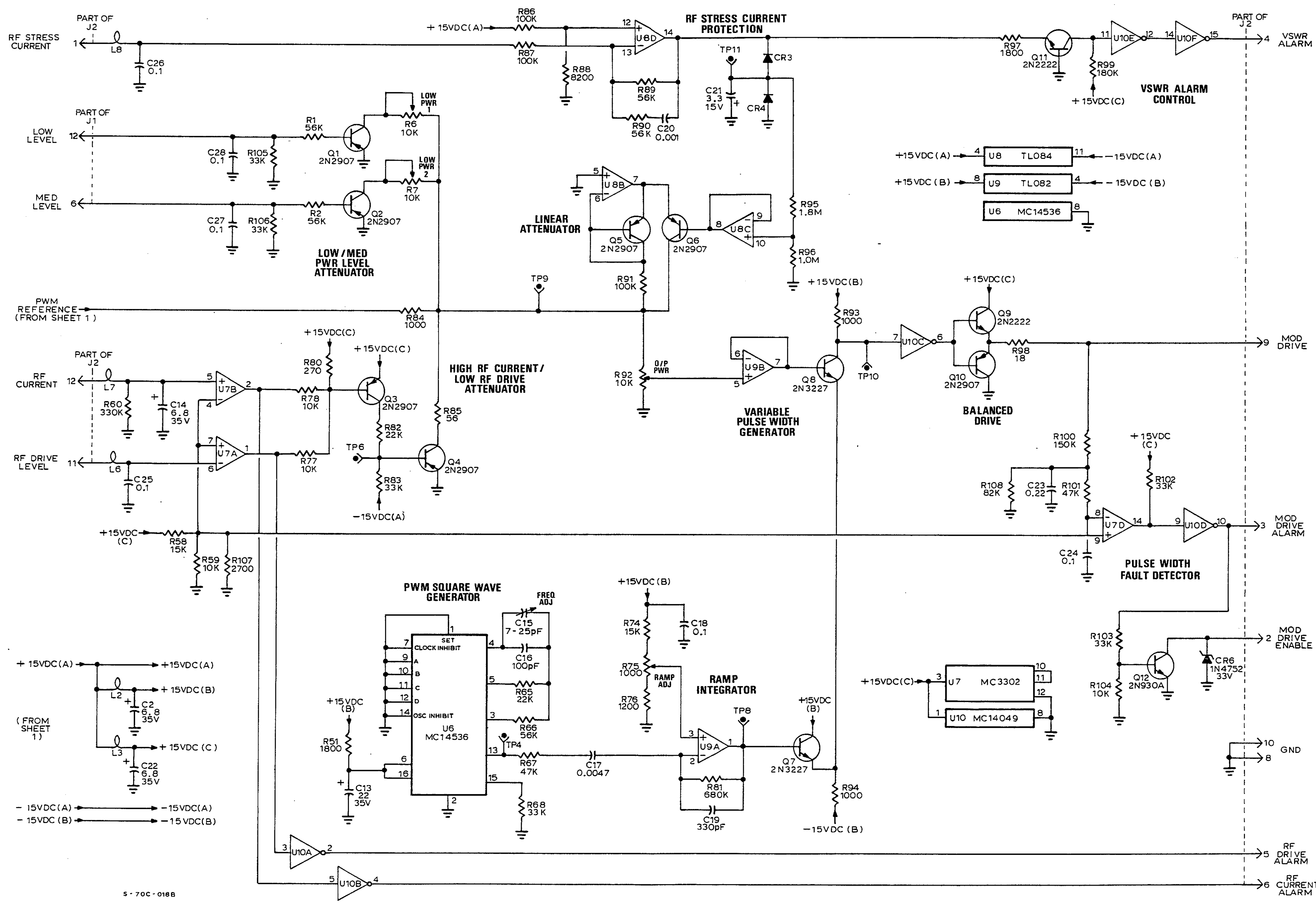


Figure FO-4 Electrical Schematic - NAPE22/1 Modulator Driver PCB (Sheet 2 of 2)

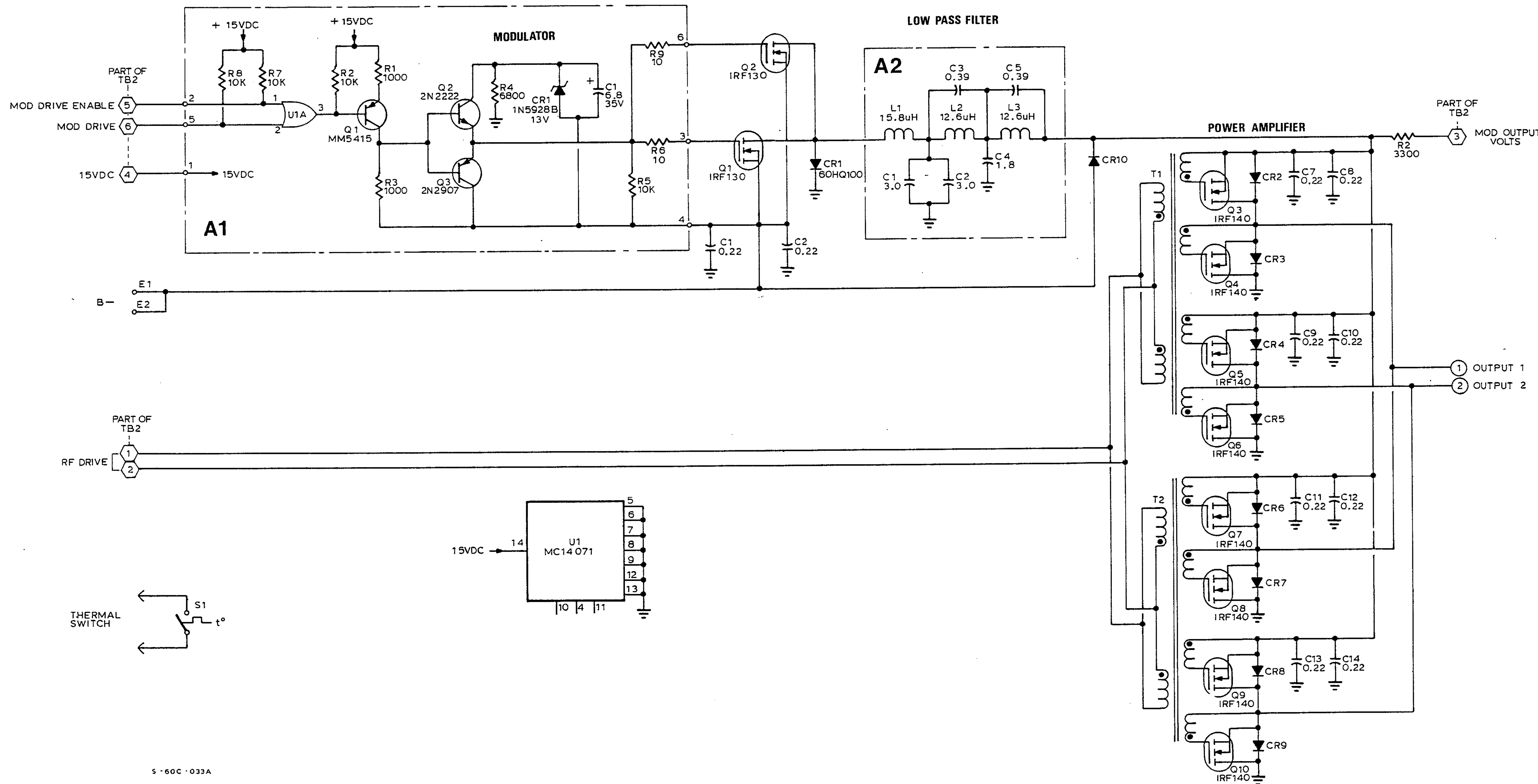


Figure FO-5 Electrical Schematic - NAA13/1 Modulator/Power Amplifier Assembly

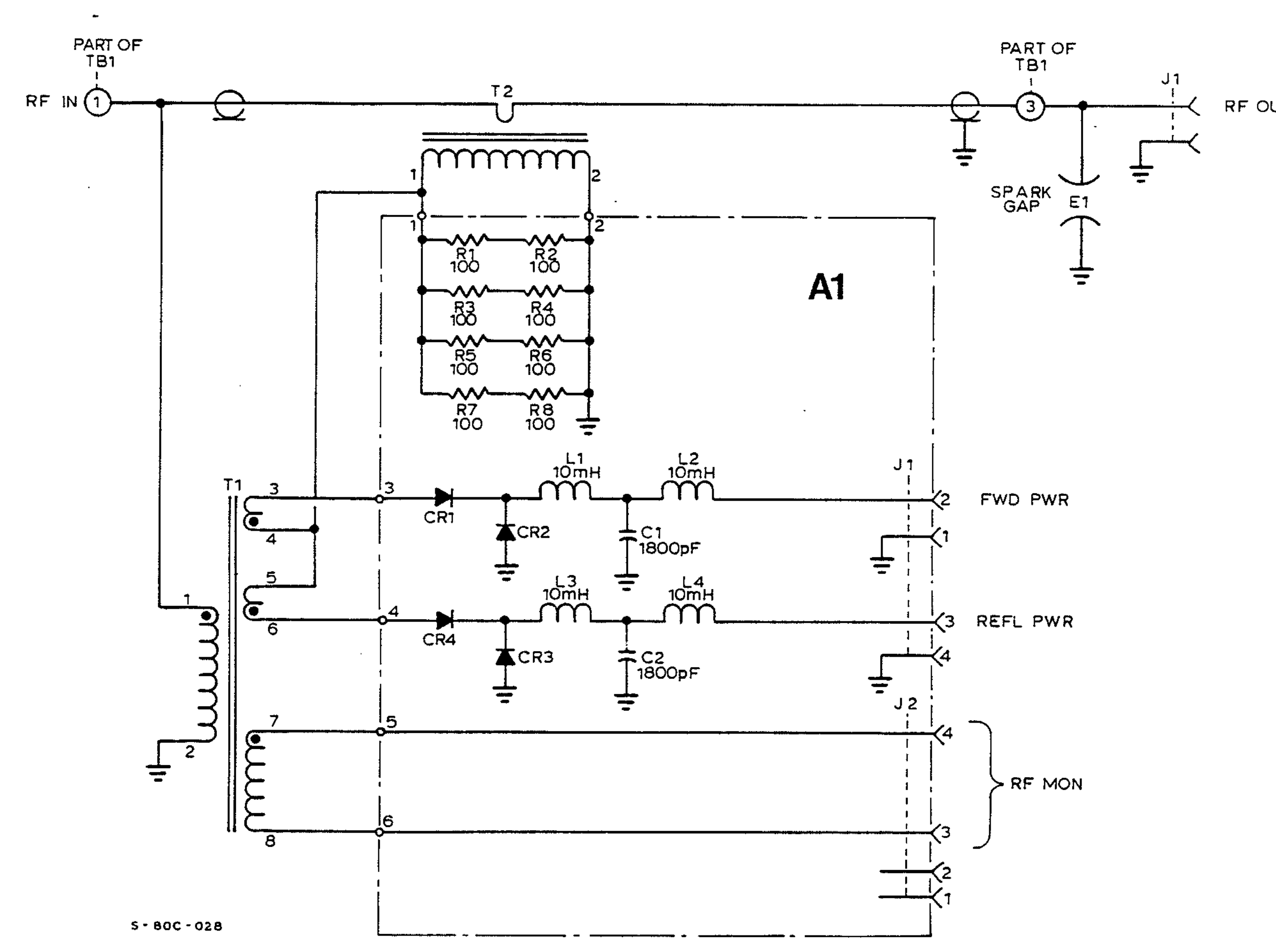


Figure FO-6 Electrical Schematic - NAFP11 RF Power Probe Assembly

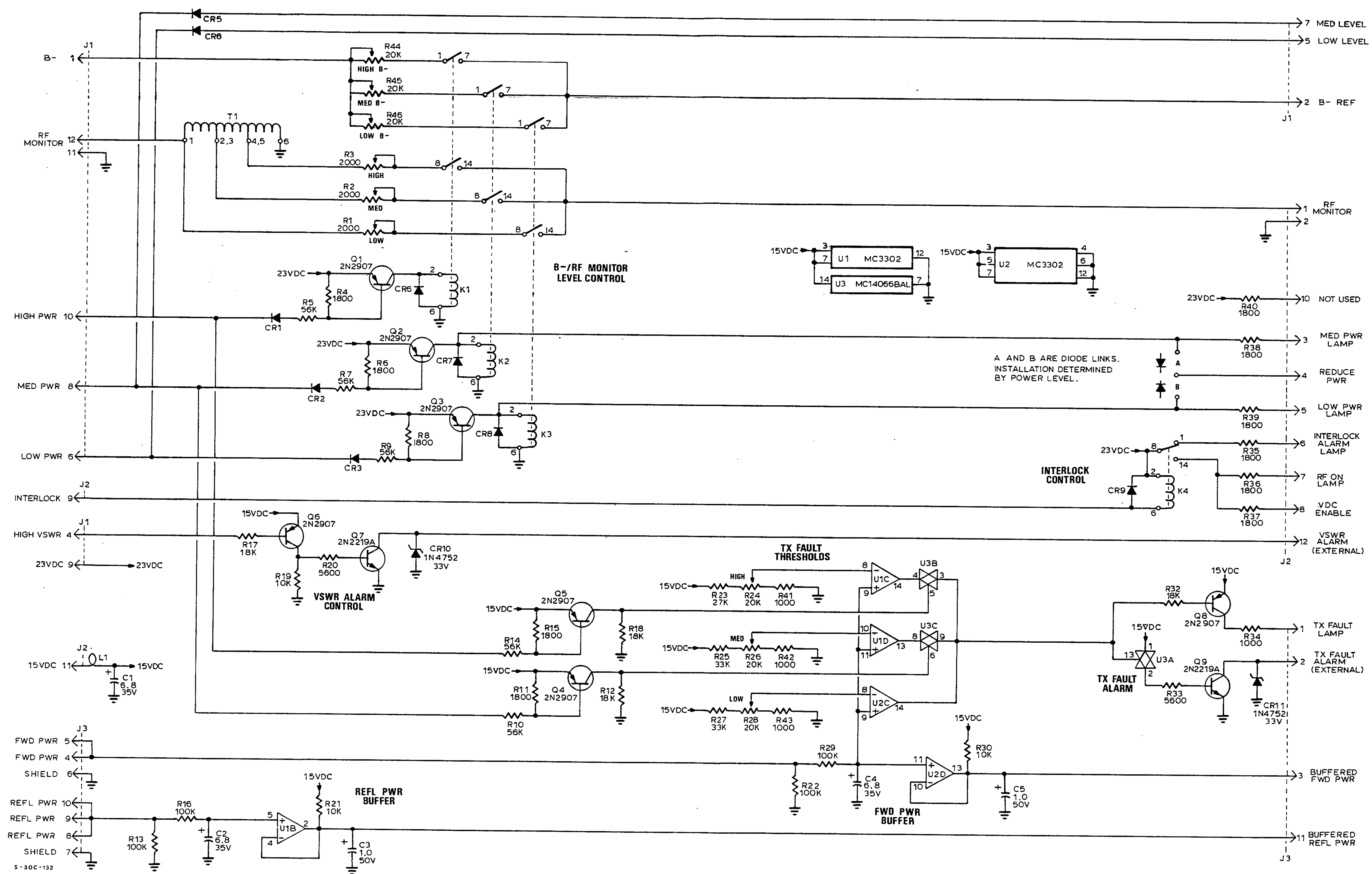


Figure FO-7 Electrical Schematic - NAPC9/1 Interface PCB

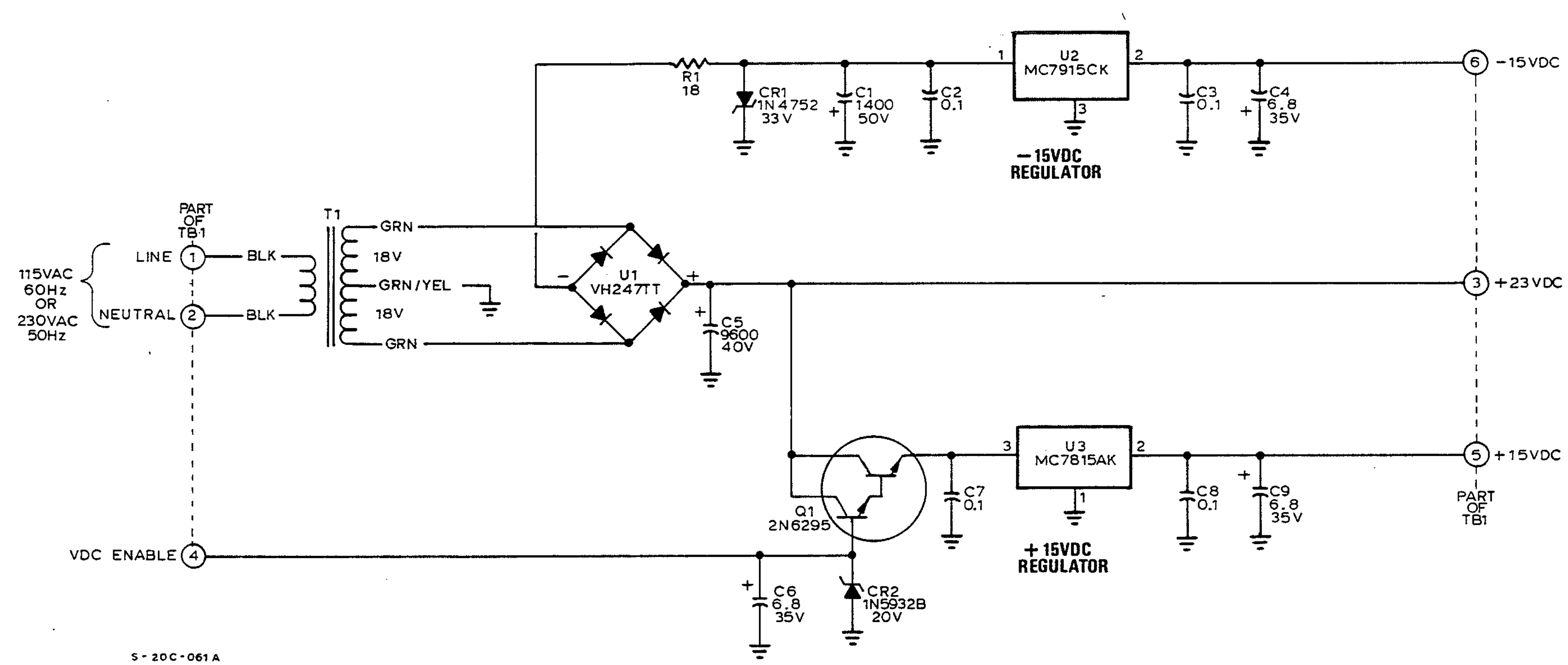
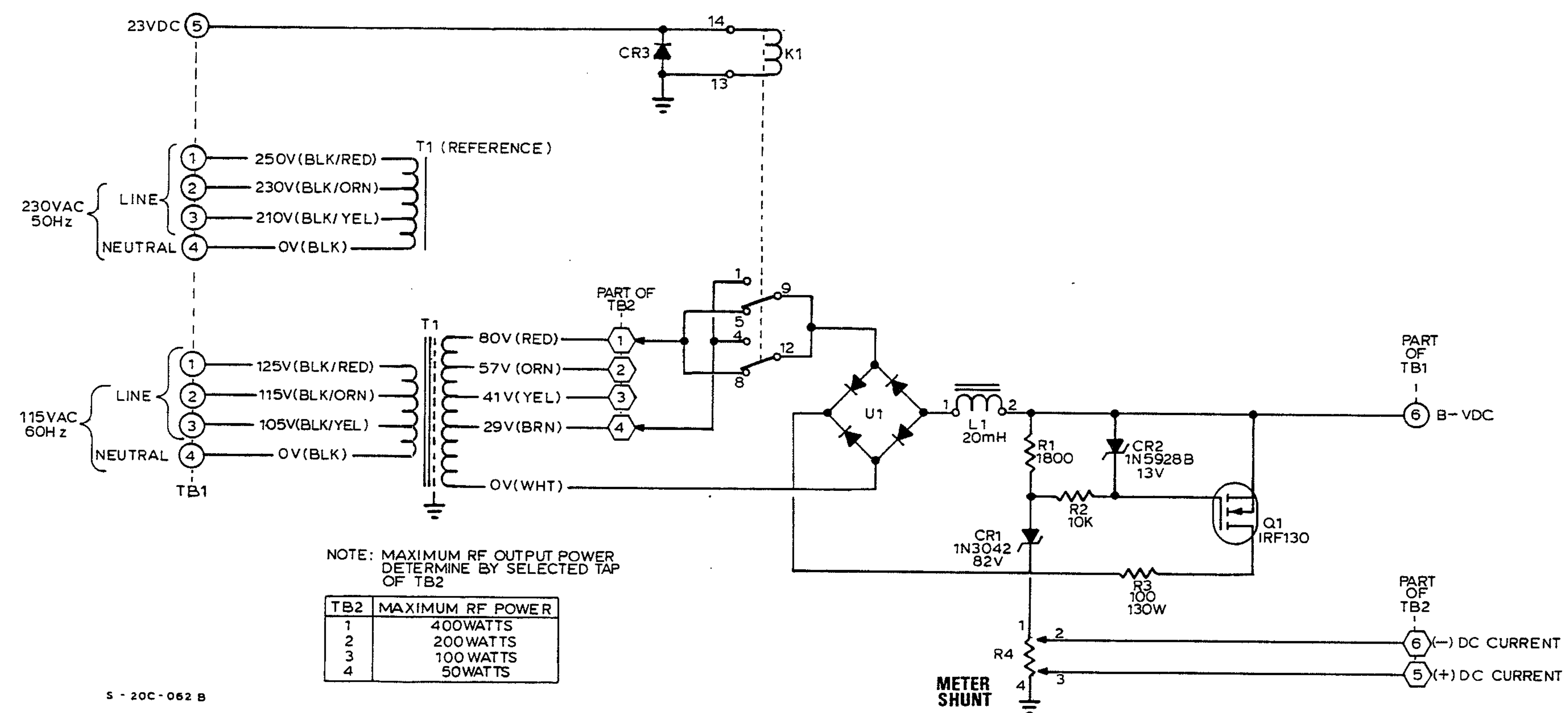


Figure FO-8 Electrical Schematic - NAS18 Low Voltage Power Supply Assembly



NOTE: MAXIMUM RF OUTPUT POWER DETERMINE BY SELECTED TAP OF TB2

TB2	MAXIMUM RF POWER
1	400WATTS
2	200WATTS
3	100WATTS
4	50WATTS

Figure FO-9 Electrical Schematic - NAS17 PA Power Supply Assembly

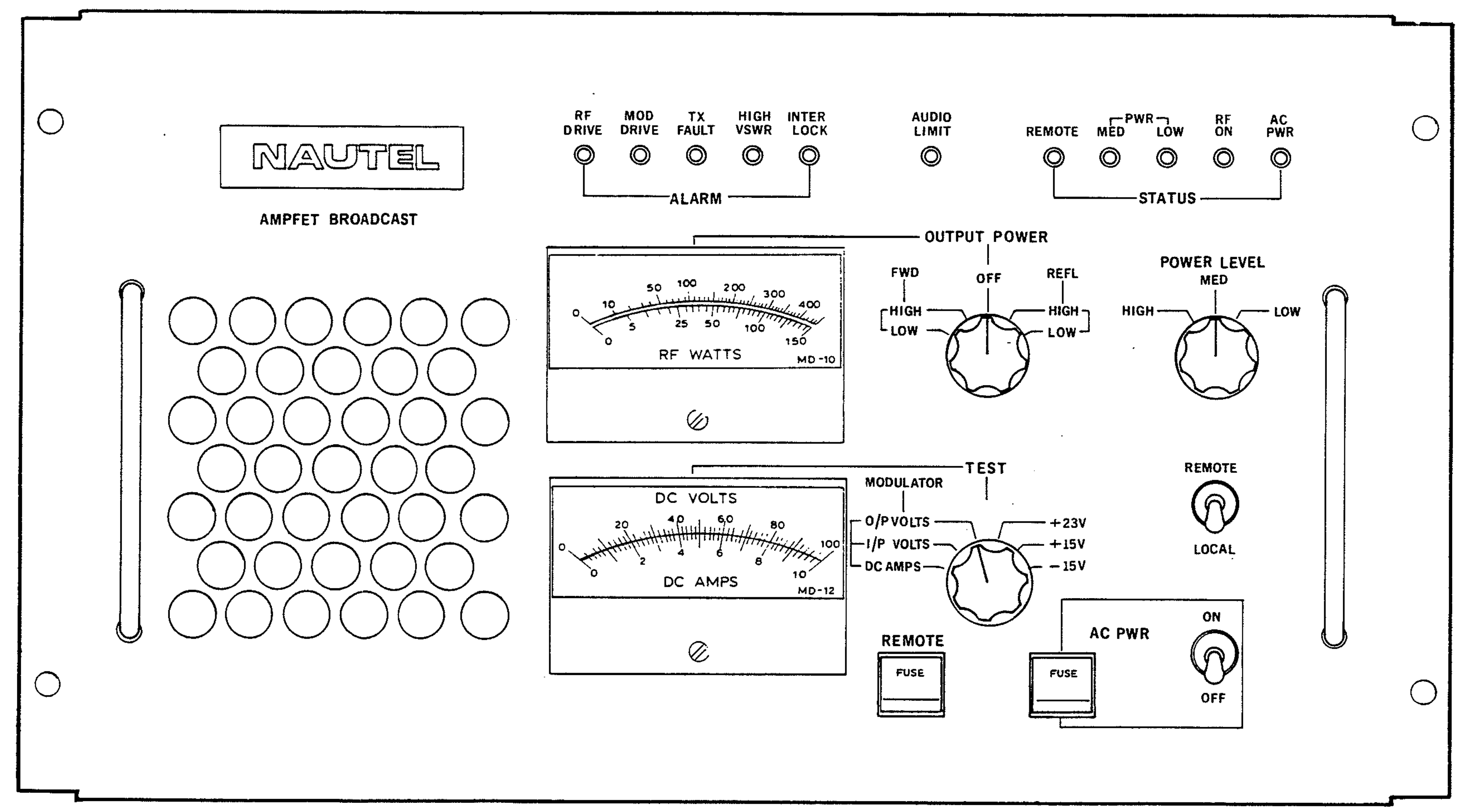


Figure FO-10 Assembly Detail - AMPFET P400 (Stereo) Transmitter (Front View)

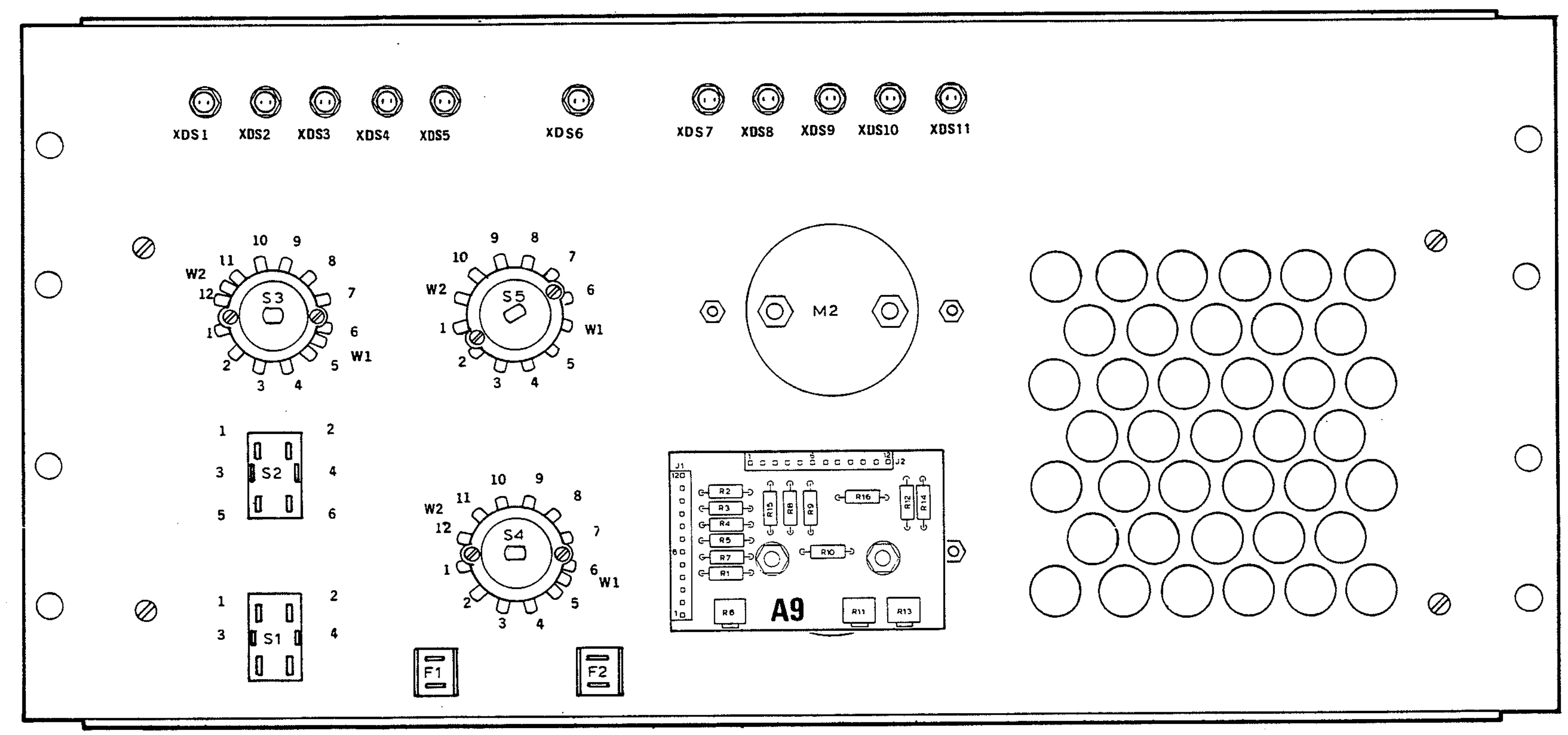


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Figure FO-11 Assembly Detail - AMPFET P400 Transmitter (Rear View of Front Panel)

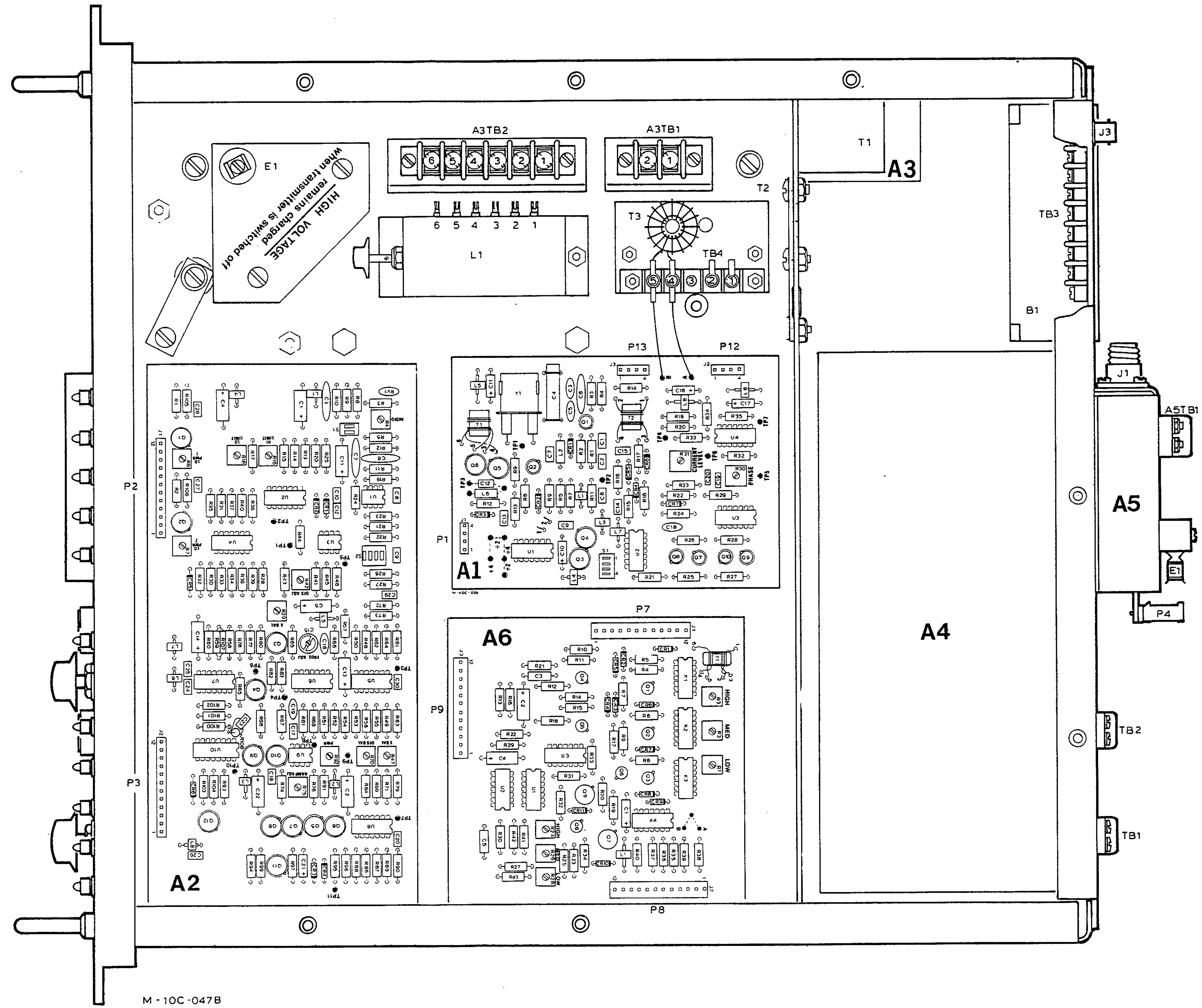

Figure FO-12 Assembly Detail - AMPFET P400 (Stereo) Transmitter (Top View)

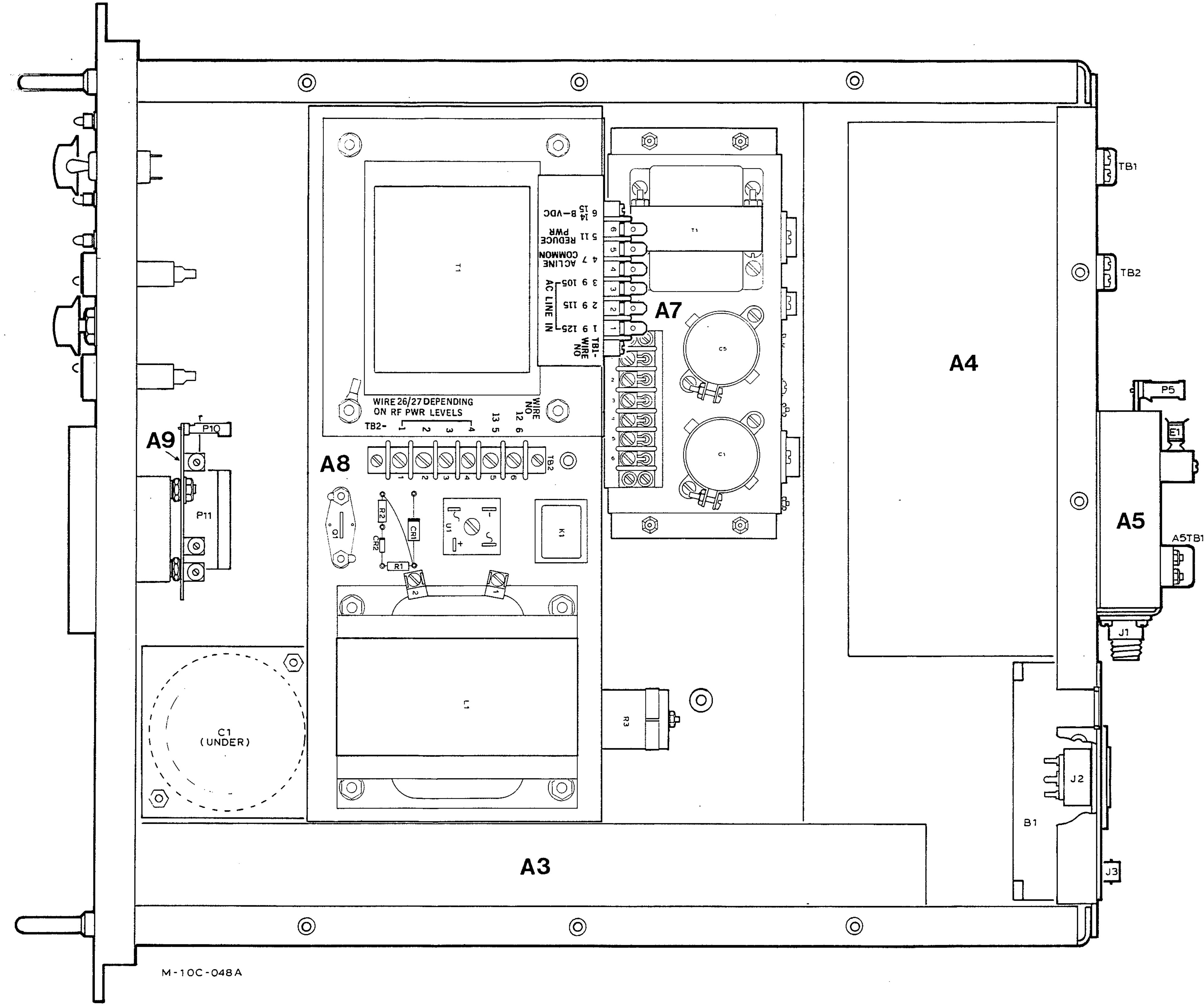

Figure FO-13 Assembly Detail - AMPFET P400 (Stereo) Transmitter (Bottom View)

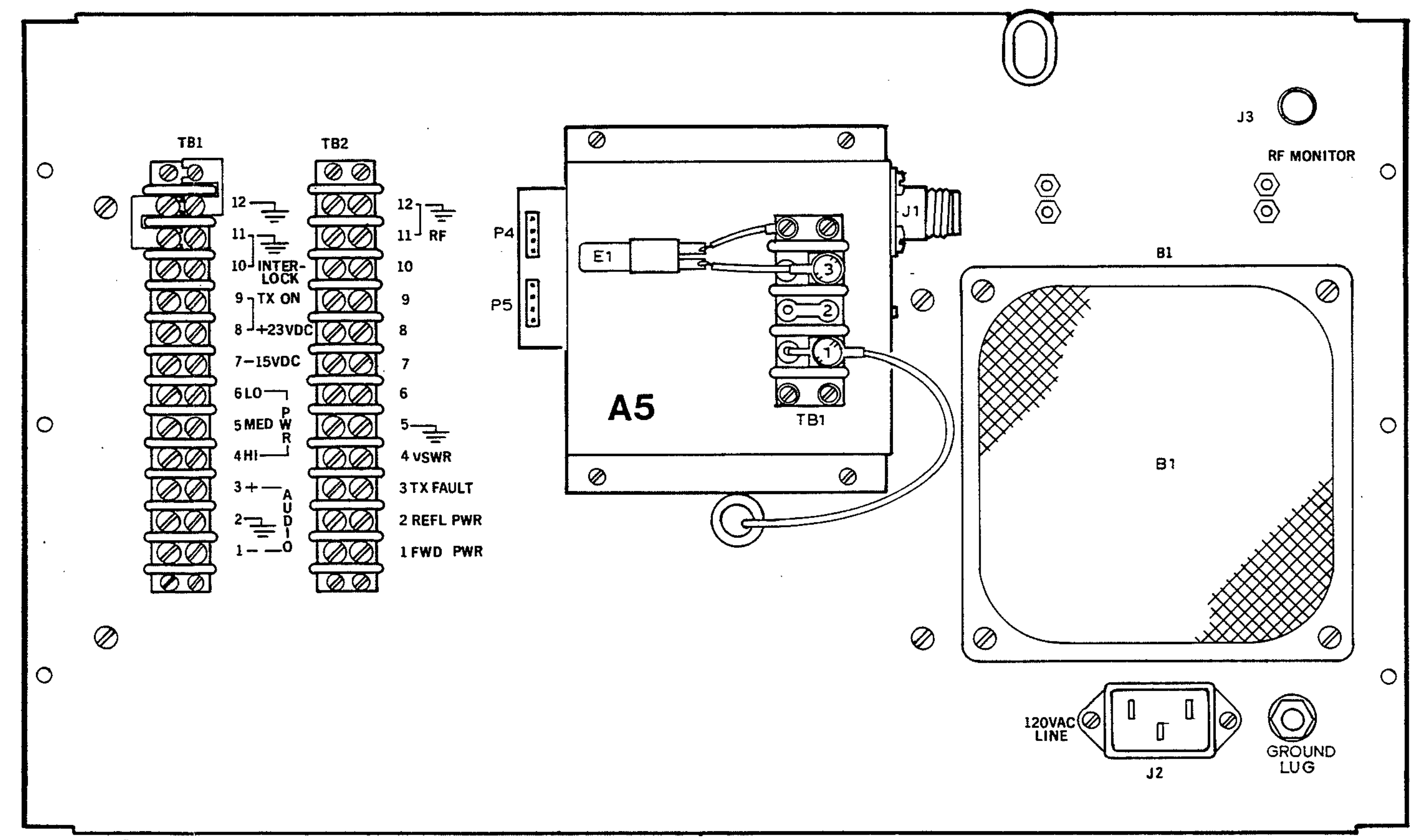

Figure FO-14 Assembly Detail - AMPFET P400 (Stereo) Transmitter (Rear View)

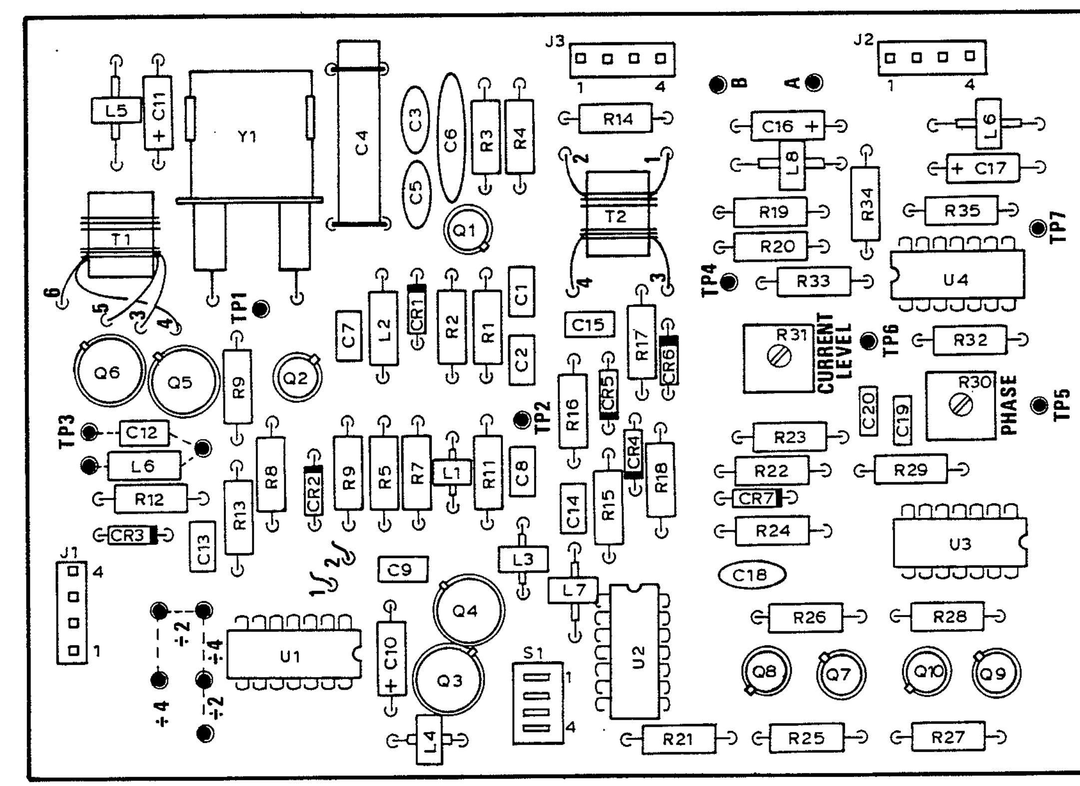

Figure FO-15 Assembly Detail - NAPE28 RF Driver PCB Assembly

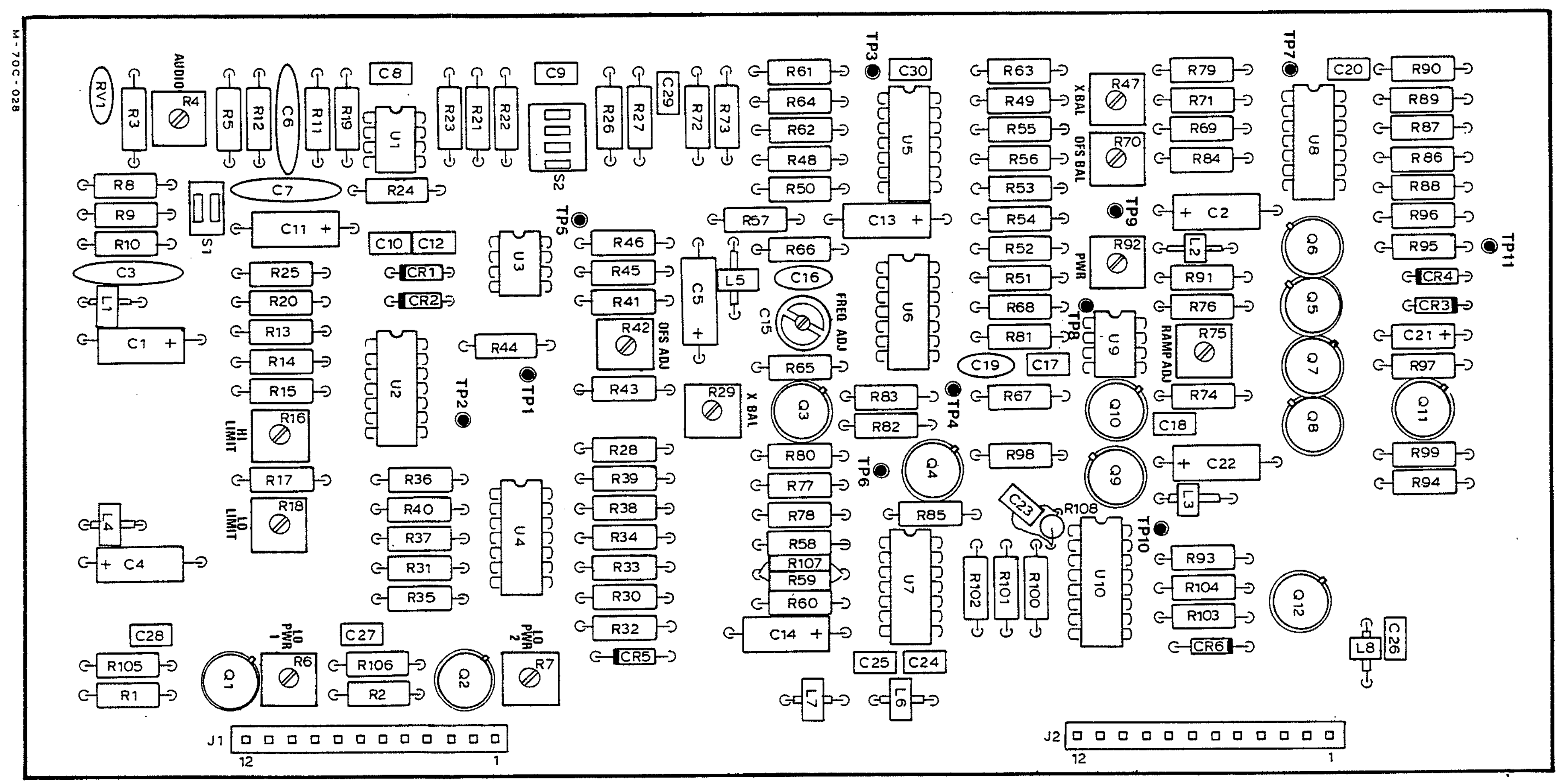

Figure FO-16 Assembly Detail - NAPE22/1 Modulator Driver PCB Assembly

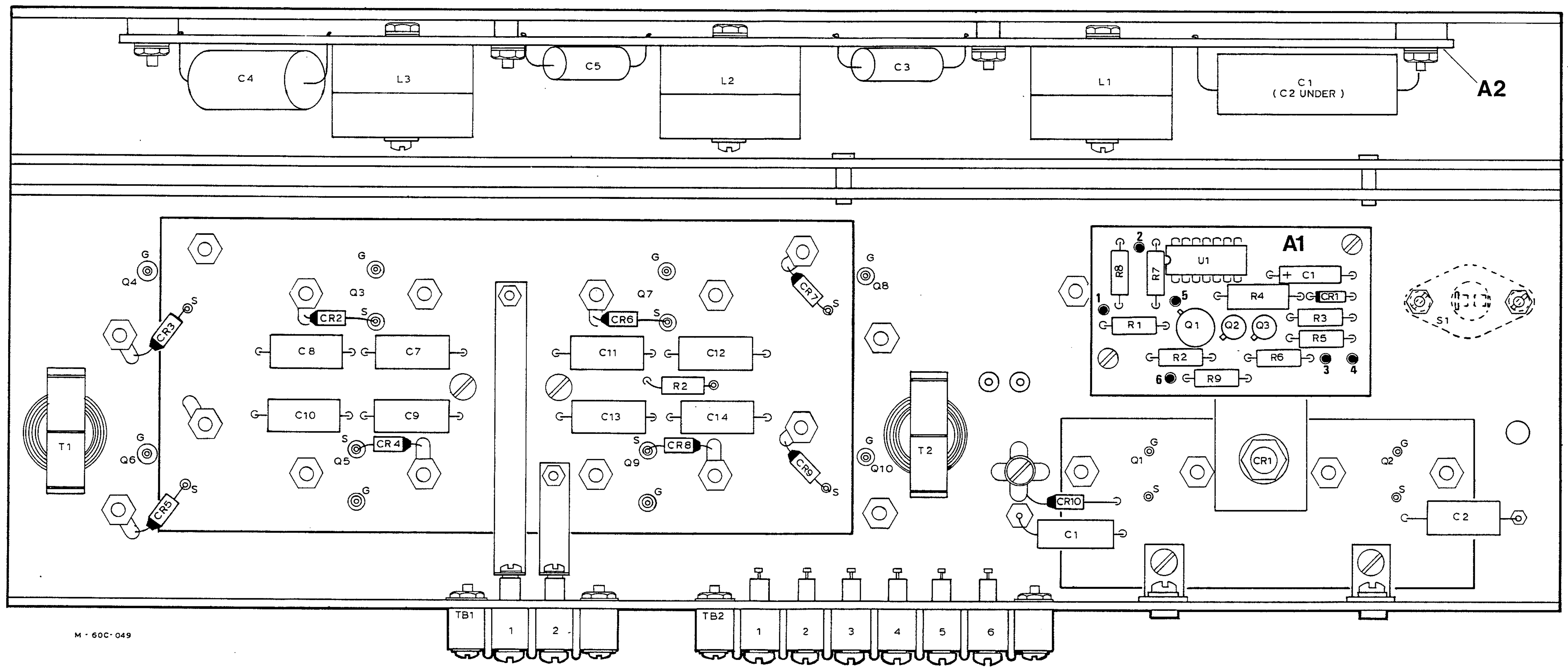

Figure FO-17 Assembly Detail - NAA13/1 Modulator/Power Amplifier Assembly (Side 1)

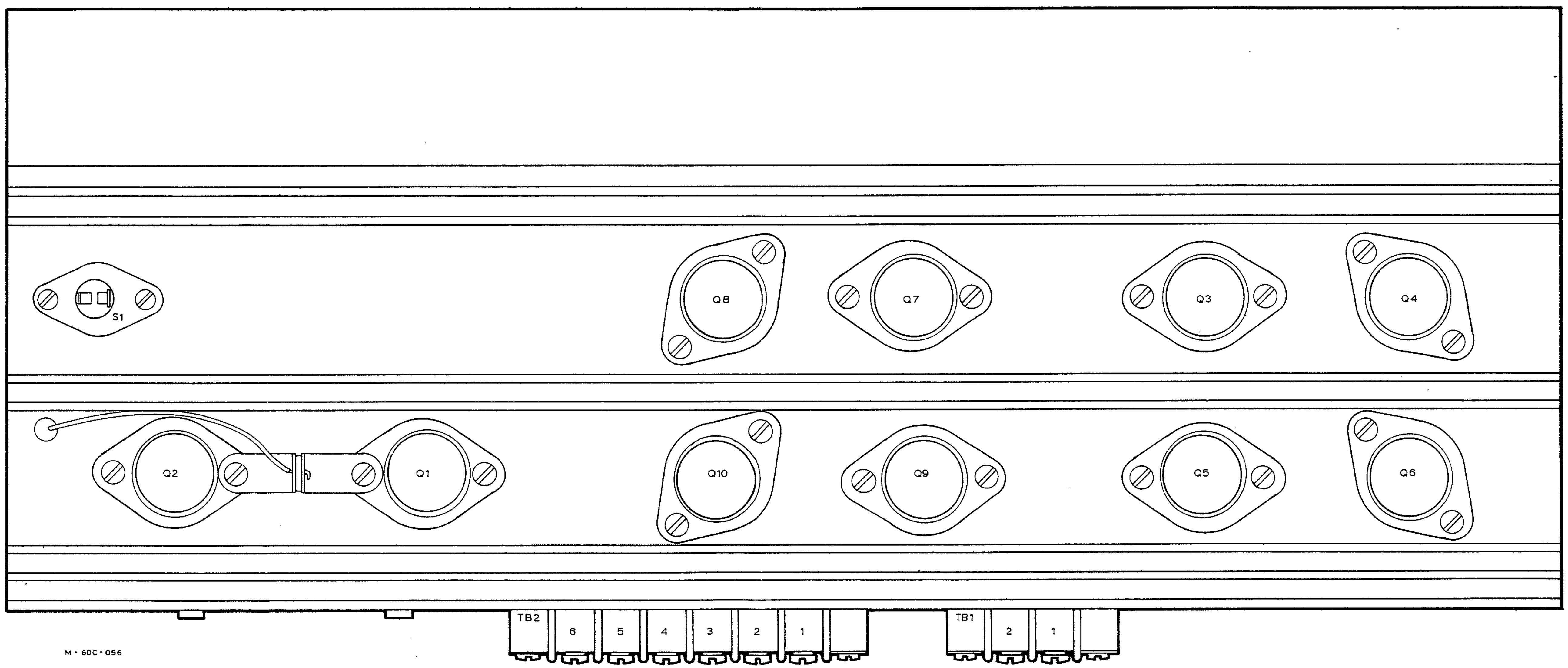

Figure FO-18 Assembly Detail - NAA13/1 Modulator/Power Amplifier Assembly (Side 2)

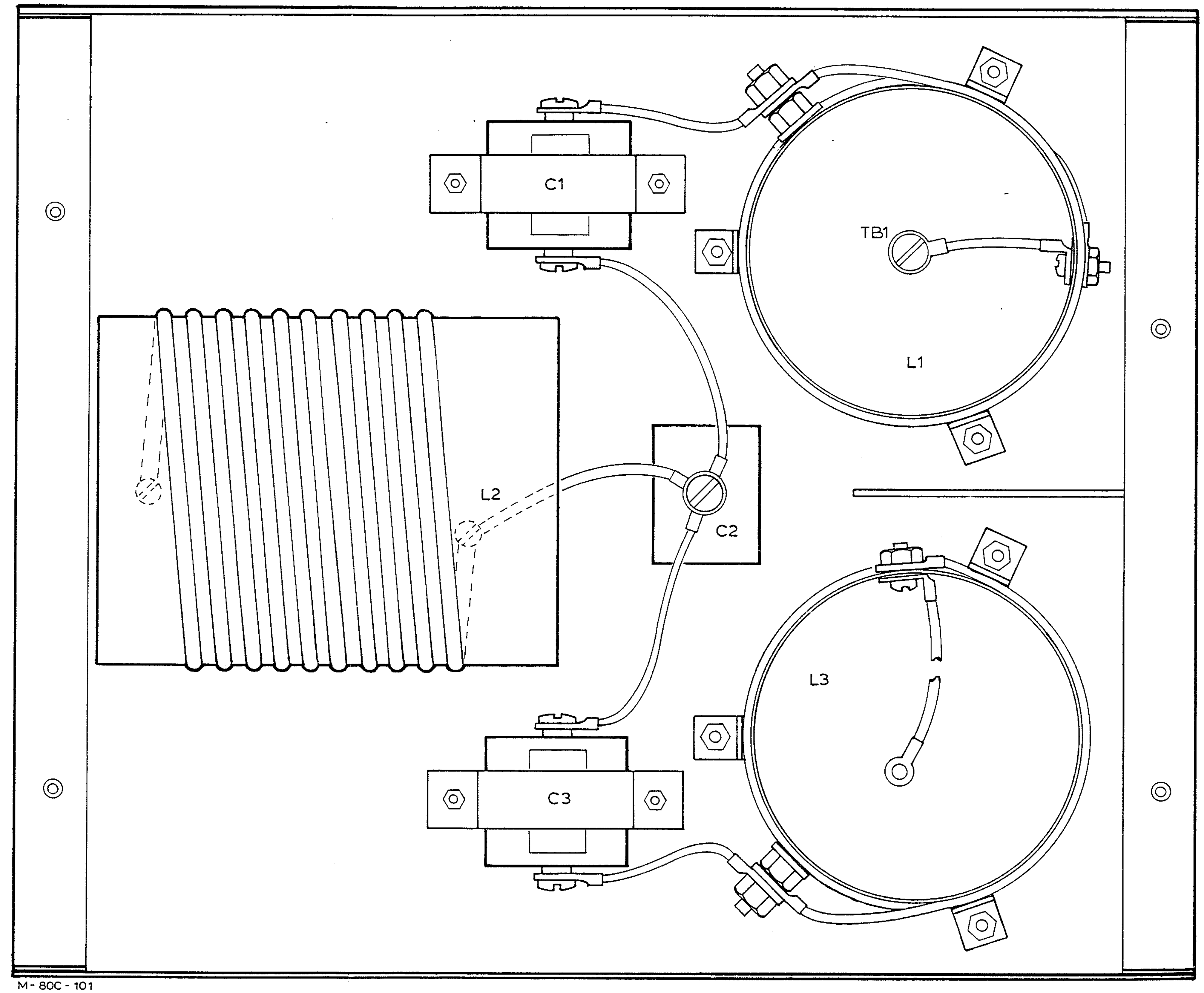

Figure FO-19 Assembly Detail - NAF34 RF Filter Assembly

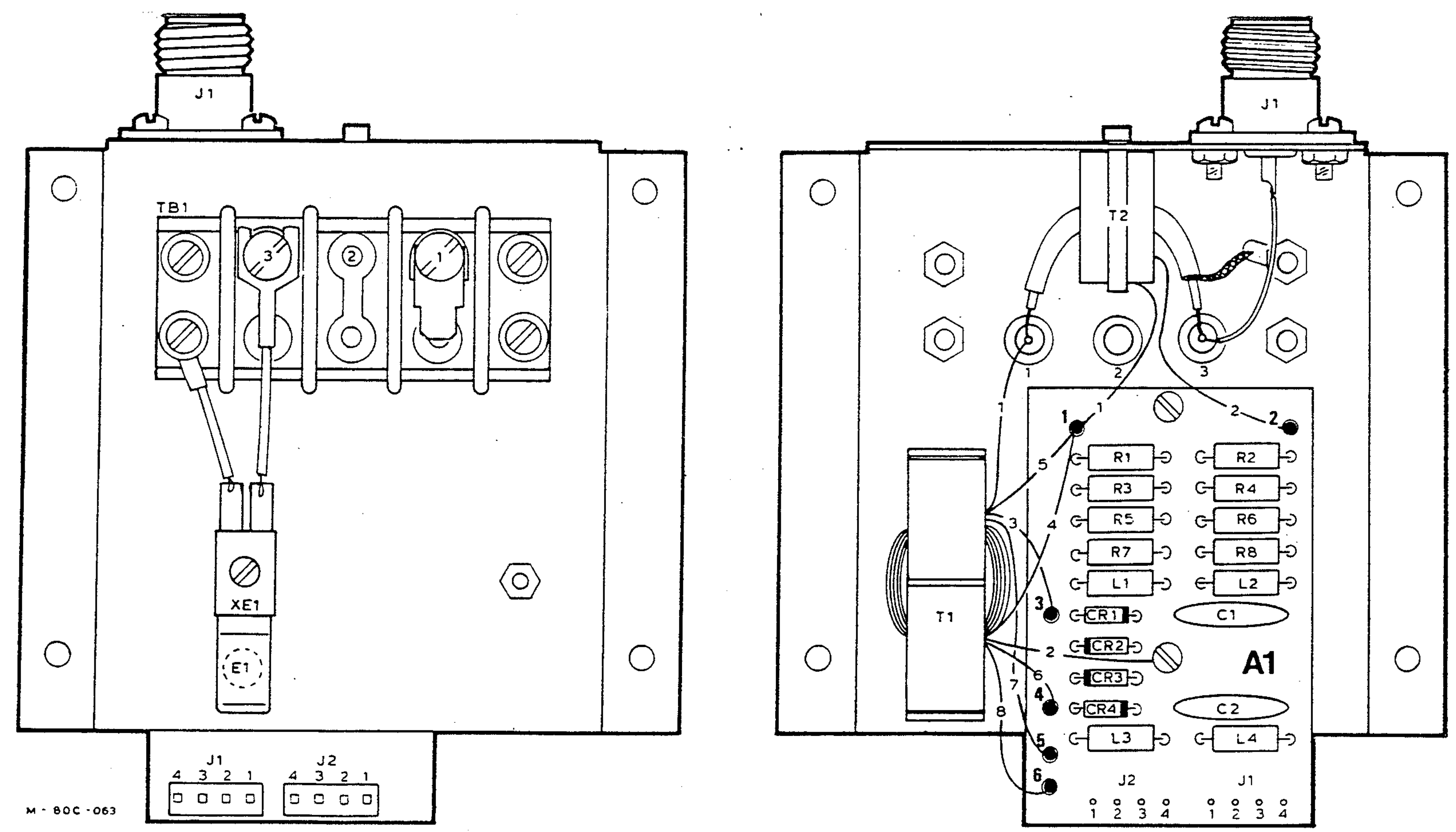

Figure FO-20 Assembly Detail - NAFP11 RF Power Probe Assembly

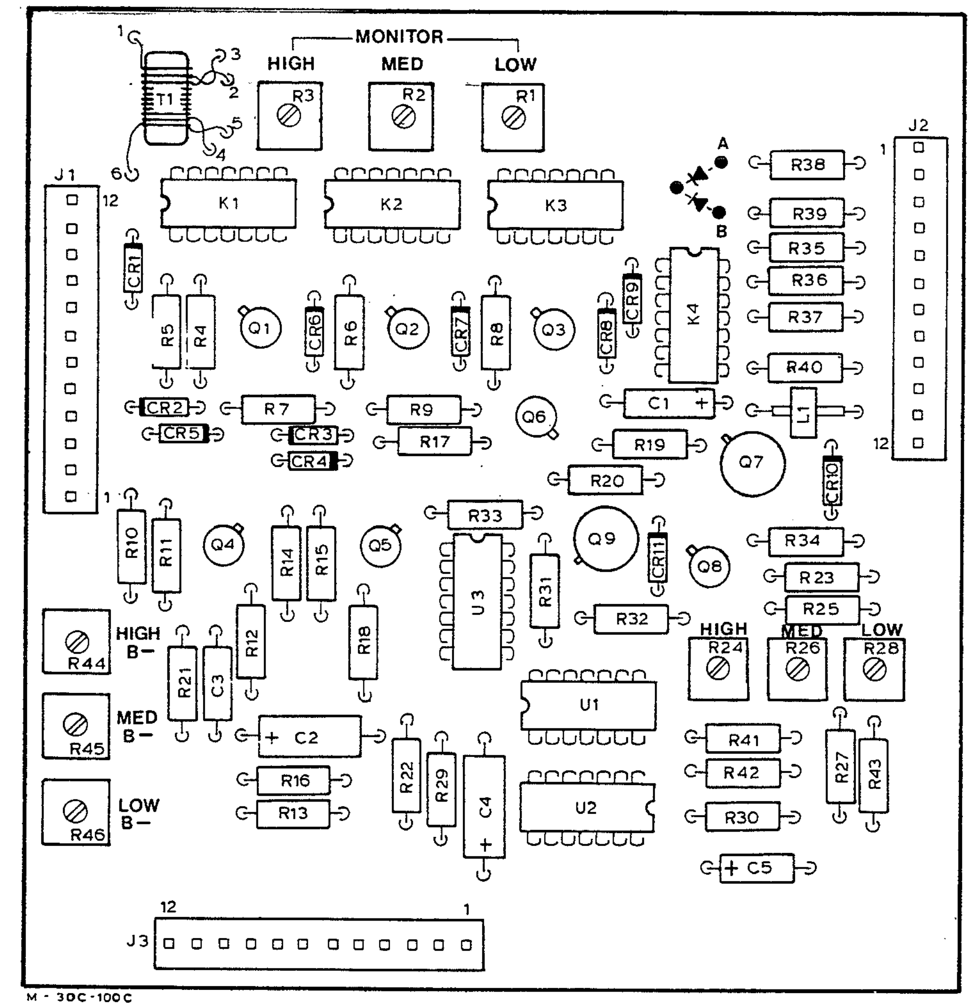

Figure FO-21 Assembly Detail - NAPC9/1 Interface PCB Assembly

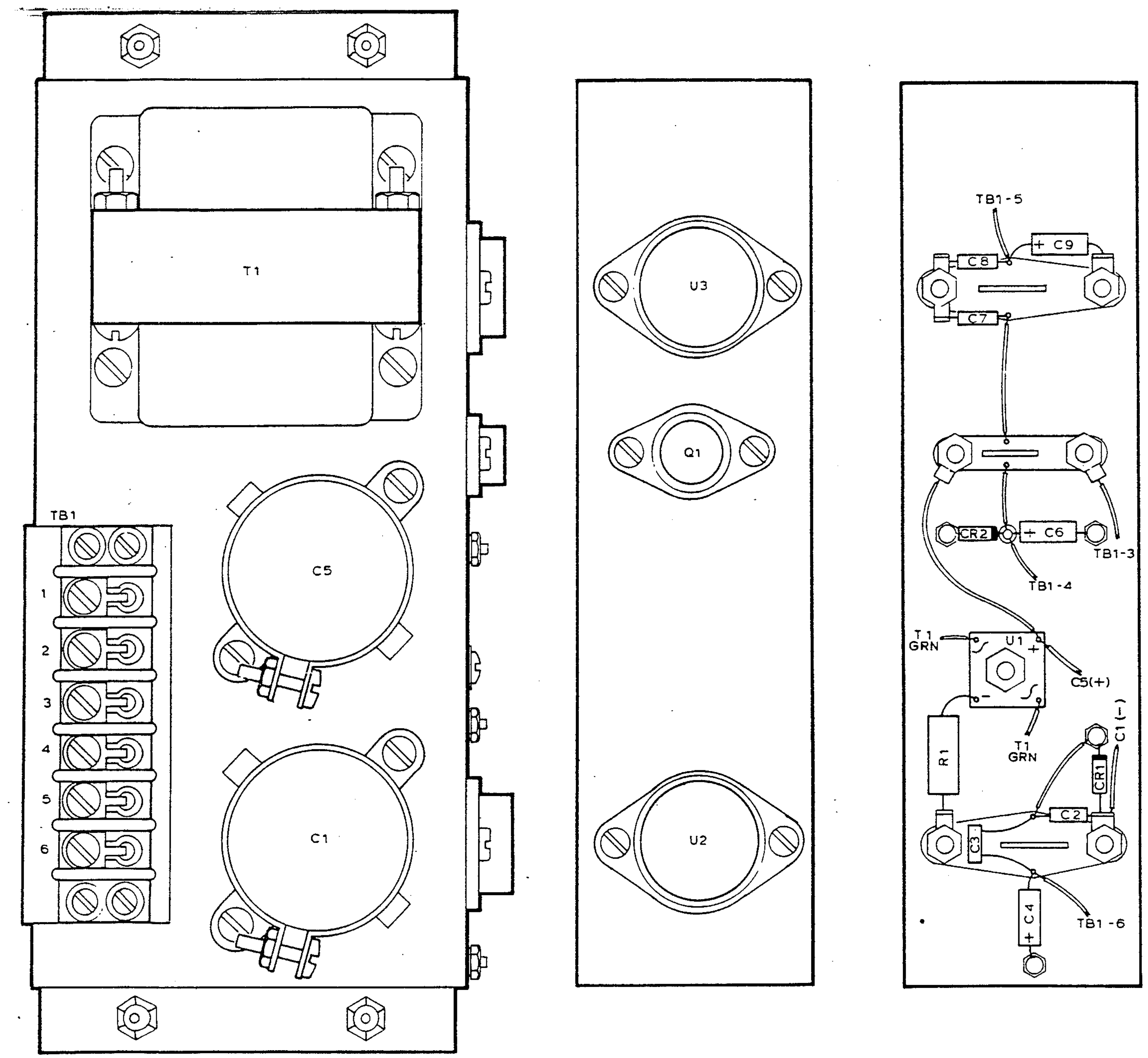

Figure FO-22 Assembly Detail - NAS18 Low Voltage Power Supply Assembly

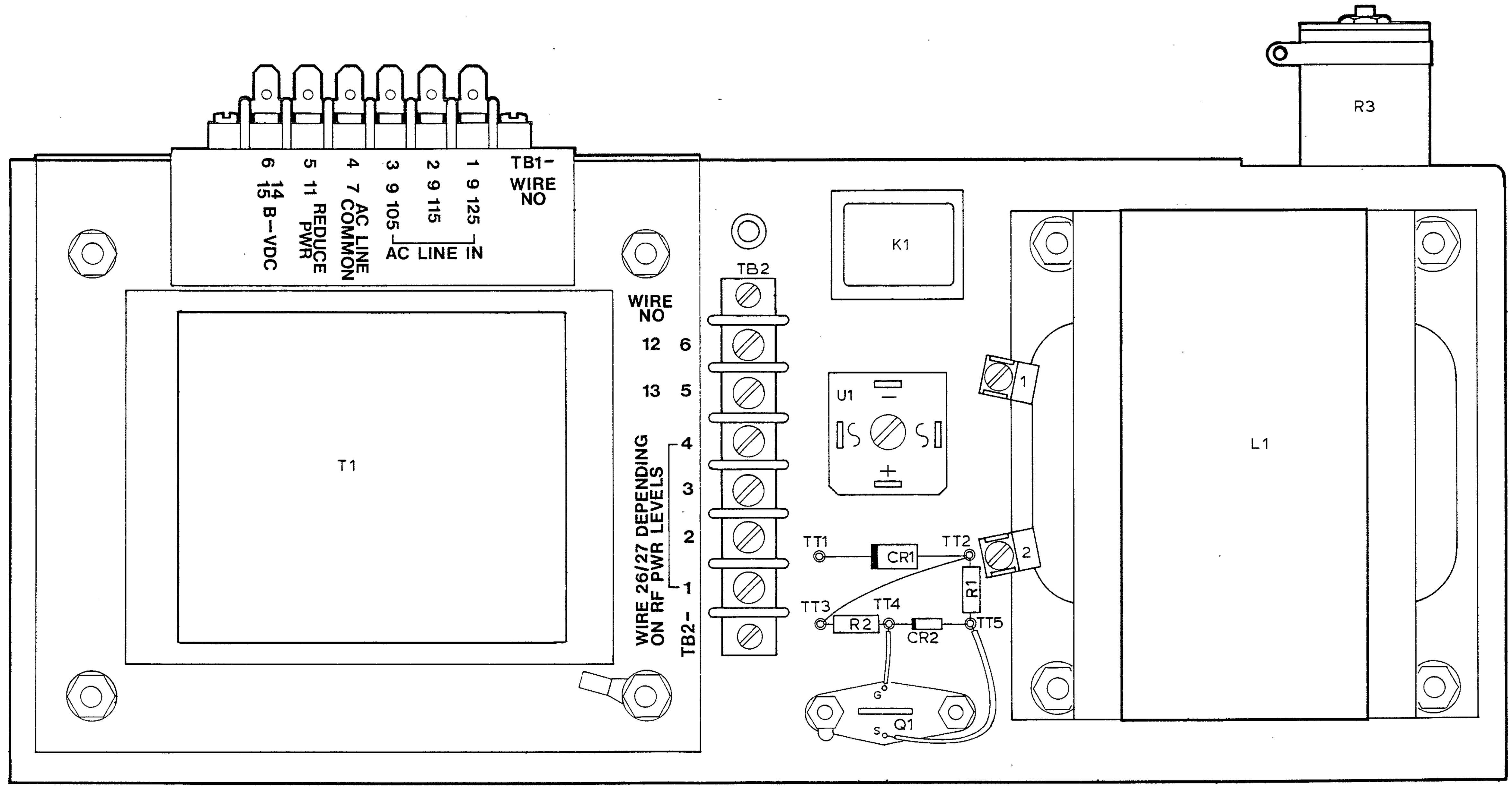

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Figure FO-23 Assembly Detail - NAS17 PA Power Supply Assembly (Side 1)

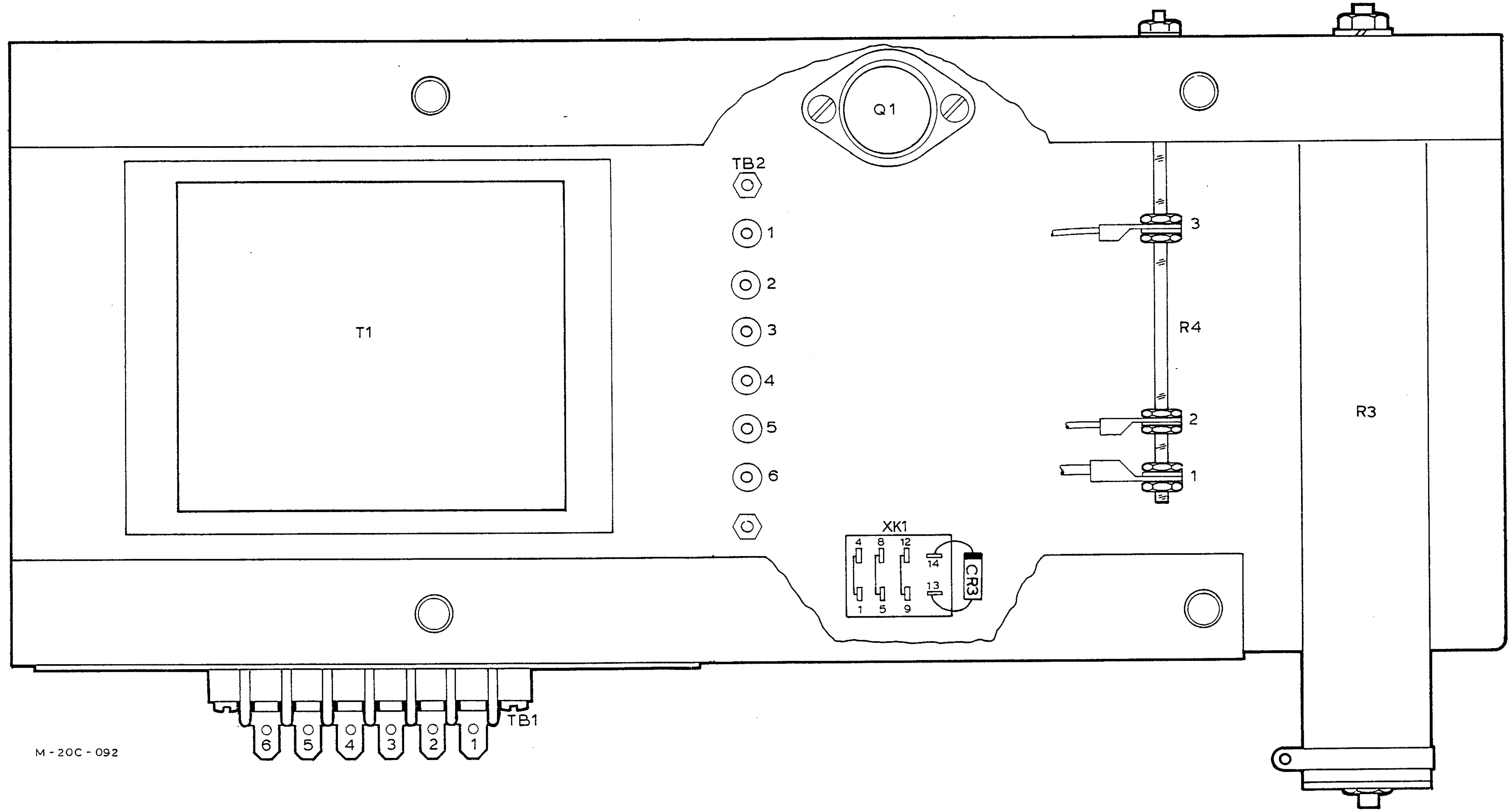

Figure FO-24 Assembly Detail - NAS17 PA Power Supply Assembly (Side 2)

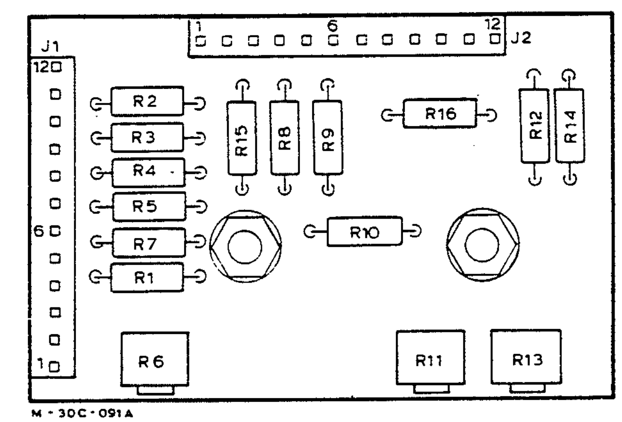

Figure FO-25 Assembly Detail - NAPC8/1 Meter PCB Assembly