TECHNICAL MANUAL

MAINTENANCE INSTRUCTIONS
WITH ILLUSTRATED PARTS BREAKDOWN
(DEPOT)

RADIO FREQUENCY AMPLIFIER,
AM-7223/URC, P/N 10086-000

(ATOS)

BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION

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SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe all safety regulations. Do not replace components with the power supplies turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid casualties, always remove power and discharge circuits to ground before touching any circuit components. Remove watches and rings before performing any maintenance procedures.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into or enter the enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation. Cardiopulmonary resuscitation procedures are outlined in T.O. 31-1-141-1, and annual refresher training requirements are outlined in AFOSH STD 127-50.

The following warnings appear in the text in this volume, and are repeated here for emphasis.

WARNING

Dangerous voltages exist in this radio equipment. Before removing the top cover, disconnect the primary power and wait 30 seconds. This allows time for all voltages to bleed off.

WARNING

High voltage present on this assembly.

WARNING

The Rectifier/Bleeder PWB Assy develops the high voltage (+2000 Vdc) for the Tube Assy. Therefore, do not attempt to measure any voltages on the Rectifier/Bleeder PWB Assy. Limit yourself to resistance measurements with power off and the high voltage shorted out (crowbar switch S5 shorts out the high voltage when the mounting bracket for the Power Control PWB Assy is removed).

HANDLING OF ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (EDSD)

Electrostatic Discharge Sensitive Devices (EDSD) must be handled with certain precautions that must be followed to minimize the effect of static build-up. Consult T.O. 00-25-234, DOD Std-1686, and DOD HDBK 263. ESDS Devices are identified in this technical order by the following symbol:

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NOTE

For chapters 1-5, see the On-Equipment Manual, T.O. 31R2-2URC-101.

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GLOSSARY

A	Ampere(s)
A/D	Analog-to-Digital (Converter)
AFSK	Audio frequency shift keying; a baseband modulation scheme in which two audio frequencies are used to represent binary coded data; the frequency is shifted to one frequency to represent a 1 (mark) and to the other to represent a 0 (space).
AGC	Automatic gain control
ALE	Address latch enable
AM	Amplitude modulation; a modulation scheme in which the carrier is made to vary in amplitude in accordance with the modulating signal.
AME	Amplitude modulation equivalent
ANTIVOX	Prevents false VOX operation; see VOX
BFO	Beat Frequency Oscillator, used in SSB detection circuits
BIT	Built-in Test
BIU	Bus interface unit
BW	Bandwidth
CPU	Central processing unit
CREV	Converter reverse
CW	Continuous wave; a wave that does not vary in amplitude or frequency and is turned on and off to carry intelligence, e.g., Morse Code
D/A	Digital-to-Analog (Converter)
dB	Decibel(s)
dBm	Decibel(s) relative to one milliwatt
EMI	Electromagnetic interference
EPROM	Erasable programmable read-only memory
EU	Execution unit
HF	High frequency; a radio frequency band extending from about 3 MHz to 30 MHz; in this manual, HF includes 1.6 to 30 MHz.
HV	High voltage
IF	Intermediate frequency
IM	Intermodulation (distortion)
I/O	Input/Output
KREV	Keyer reverse
LCD	Liquid crystal display
LED	Light emitting diode
LPA	Linear power amplifier
LSB	Lower sideband; a modulation scheme in which the intelligence is carried on the first sideband below the carrier frequency; see SSB
MIC	Microphone
mA	Milliampere(s)
mV	Millivolt(s)
NBSV	Narrow band secure voice
PEP	Peak envelope power
PPC	Peak power control
PWB	Printed wiring board
RAM	Random access memory
rms	Root mean square
RTC	Real time clock
RX	Receive

GLOSSARY (Continued)

S TONE	Sidetone
SSB	Single sideband; a modulation scheme in which the intelligence is carried by one of the carrier sidebands, the other sideband and the carrier center frequency being suppressed
TGC	Transmitter gain control
TX	Transmit
uA	Microampere(s)
uP	Microprocessor
USB	Upper sideband; a modulation scheme in which the intelligence is carried on the first sideband above the carrier frequency; see SSB
uV	Microvolt(s)
Vac	Volts, alternating current
VCO	Voltage controlled oscillator
Vdc	Volts, direct current
VOX	Voice operated transmission
VSWR	Voltage standing wave ratio; the ratio of the maximum to the minimum voltage of a standing wave on a radio frequency transmission line
W	Watt(s)

INTRODUCTION

The purpose of this manual is to provide information necessary for the depot-level maintenance of Amplifier, Radio Frequency, AM-7223/URC, manufactured by Harris Corporation, Rochester, New York. The manual is divided into three chapters. The contents of each chapter are briefly described in the following paragraphs.

NOTE

> This manual only contains three chapters, because chapters 1-5 are contained in the On-Equipment Manual, T.O. 31R2-2URC-101. For a description of the contents of these chapters, see the INTRODUCTION in T.O. 31R2-2URC-101.

Chapter 6 describes the depot-level maintenance procedures. The maintenance procedures in this chapter are based on performance testing and trouble analysis of the subassembly or PWB to locate and replace faulty parts at the lowest replaceable unit level (LRU).

Chapter 7 contains the Illustrated Parts Breakdown (IPB) information at the depot level. This includes assemblies and parts that may be replaced at the depot location.

Chapter 8 contains foldout (FO) drawings, which consist of the schematic diagrams for all the PWB assemblies. A cross reference list is also provided. The diagrams are numbered FO-1, FO-2, etc. They are printed on sheets with page-size blank aprons to permit viewing the diagram with the rest of the book closed or opened to another page.

The following specifications, standards, and publications were used in the preparation of this manual.

APPLICABLE SPECIFICATIONS

SPECIFICATION	NAME
MIL-M-38798B, para. 3.4	Combined Operation and Maintenance Instructions Manual (Equipment).
MIL-M-38807, Amend. 4	Preparation of Illustrated Parts Breakdown.
MIL-M-38790 and MIL-M-38784A	General Requirements for Preparation of Technical Manuals.

APPLICABLE STANDARDS

STANDARD	NAME
MIL-STD-12	Abbreviations for use on Drawings and in Technical Type Publications.
MIL-STD-15-1A	Graphic Symbols for Electrical Components.
MIL-STD-17-1	Mechanical Symbols.
MIL-STD-806	Graphic Symbols for Logic Diagrams.

APPLICABLE PUBLICATIONS

PUBLICATION	NAME
DOD 5200.20	Distribution Statements on Technical Documents.
USAS Y14.15-1966	Electrical and Electronic Diagrams.
USAS Y32.16-1968	Electrical and Electronic Reference Designations.
T.O. 31-1-141 (Series)	Technical Manual-Basic Electronic Technology and Testing Practices.

CHAPTER 6

MAINTENANCE

WARNING

Voltages dangerous to life exist in this radio equipment. Before removing the top cover, disconnect the primary power and wait 30 seconds. This allows time for all voltages to bleed off.

Section I. INTRODUCTION

6-1. CHAPTER ORGANIZATION. This chapter is divided into four sections. Section I tells how the chapter is organized. Section II contains alignment procedures for the replaceable modules. This information is also contained in the On-Equipment Manual, T.O. 31R2-2URC-101, and is repeated here for convenience. Section III consists of diagnostic procedure which will enable you to troubleshoot faulty modules to the component level. These procedures are based on use of the BIT feature. For more information on BIT, as well as removal/replacement procedures and periodic maintenance procedures, see the On-Equipment Manual, T.O. 31R2-2URC-101. Section IV contains removal/replacement procedures for the internal components of the Tank Assembly.

Section II. ALIGNMENT PROCEDURES

6-2. INTRODUCTION. This section contains instructions for checking and adjusting the replaceable subassemblies in the 500 Watt LPA. This section also contains circuit board layouts to help you identify the components that can be adjusted. To do the procedures described in this section, you need the test equipment listed in table 6-1 or equivalent equipment.

Table 6-1. Test Equipment*

Generic Name	Military Designation	Manufacturer, Model No.	National Stock No.	Required Range
Electronic Voltmeter w/ AC Probe & T-connector		Hewlett Packard, Model 410C Model 11036A Model 11042A	6625-00-469-2258 6625-00-910-5973 5985-00-713-4356	10 to 244 V rms; 1.6 to 30 MHz (peak reading)
Digital Multimeter		Fluke, Model 8012A	6625-01-140-0221	200 mV to 250 Vac; 200 mV to 40 Vdc; 0 to 20 megohms
Dummy Load		Bird, Model 8833	6625-00-225-9074	500 W (pk), 250 W (avg), 50 ohms
100 Watt Transceiver	RT-1446/URC	RF Communications Model RF-350	5820-01-162-3406	
500 Watt LPA	AM-7223/URC	RF Communications Model RF-355	5820-01-162-3312	
PROM Programmer		Data I/O, Model System 19	7045-01-115-8993	

* NOTE: Equivalent items authorized

NOTE

Ensure that the primary power meter % reading is in accordance with table 6-2 throughout the performance of the alignment procedures.

6-3. ALIGNMENT PROCEDURES.

NOTE

After each of the following alignment procedures, disconnect test equipment and reconfigure equipment (module or circuit card) to normal operating condition.

NOTE

Refer to figure 1-3 in the On-Equipment Manual, T.O. 31R2-2URC-101, for identification of subassemblies.

a. Tube Assy, A1

No adjustments.

b. Tank Assy, A2

No adjustments.

c. Output Filter PWB Assy, A3 (Fig. 6-1)

WARNING

High voltage present on this assembly.

(1) R4, Null Adjustment

NOTE

This adjustment assumes the following initial conditions:

- The LPA has been turned off for at least 10 seconds.
- The LPA's AUTO/MANUAL BAND Switch is in the AUTO position.

(a) Connect the 500 Watt LPA Antenna connector J5 to a dummy load.

(b) Remove the top cover from the LPA.

(c) Connect a digital multimeter between test point TP2 and ground on the Power Control PWB Assy (see figure 6-3).

(d) Turn the LPA on and set the operating frequency at the transceiver to 16.0000 MHz in CW mode. After the LPA has warmed up (is in STANDBY), place the LPA in OPERATE and tune the system.

(e) Key the system and adjust R4 (on the Output Filter PWB Assy -- see figure 6-2) for a null (may go into negative region) on the multimeter.

(2) R7, Forward Power Sample

NOTE

This adjustment assumes the following initial conditions:

- The LPA has been turned off for at least 10 seconds.
- The LPA's AUTO/MANUAL BAND Switch is in the AUTO position.

(a) Using a Model 11042A T-connector, connect an HP-410C Voltmeter (or equivalent) between the LPA's RF output connector J5 and the dummy load.

(b) Remove the top cover from the LPA.

(c) Connect a digital multimeter between test point TP1 and ground on the Power Control PWB Assy (see figure 6-3). Rotate R34 on the Power Control PWB Assy fully counterclockwise. Adjust R74 fully clockwise.

(d) Turn the LPA on and set the operating frequency at the transceiver to 16.0000 MHz in CW mode. After the LPA has warmed up (is in STANDBY), place the LPA in OPERATE and tune the system.

(e) Key the system and observe the output voltage on the HP-410C and the forward power sample voltage on the digital multimeter. The HP-410C should read 158 ±2 Vac and the multimeter should read 7.00 ±0.05 Vdc. If they do, proceed to step (j).

(f) If they do not, adjust Loop Gain Potentiometer R29 on the Power Control PWB Assy so that the HP-410C reads 158 Vac.

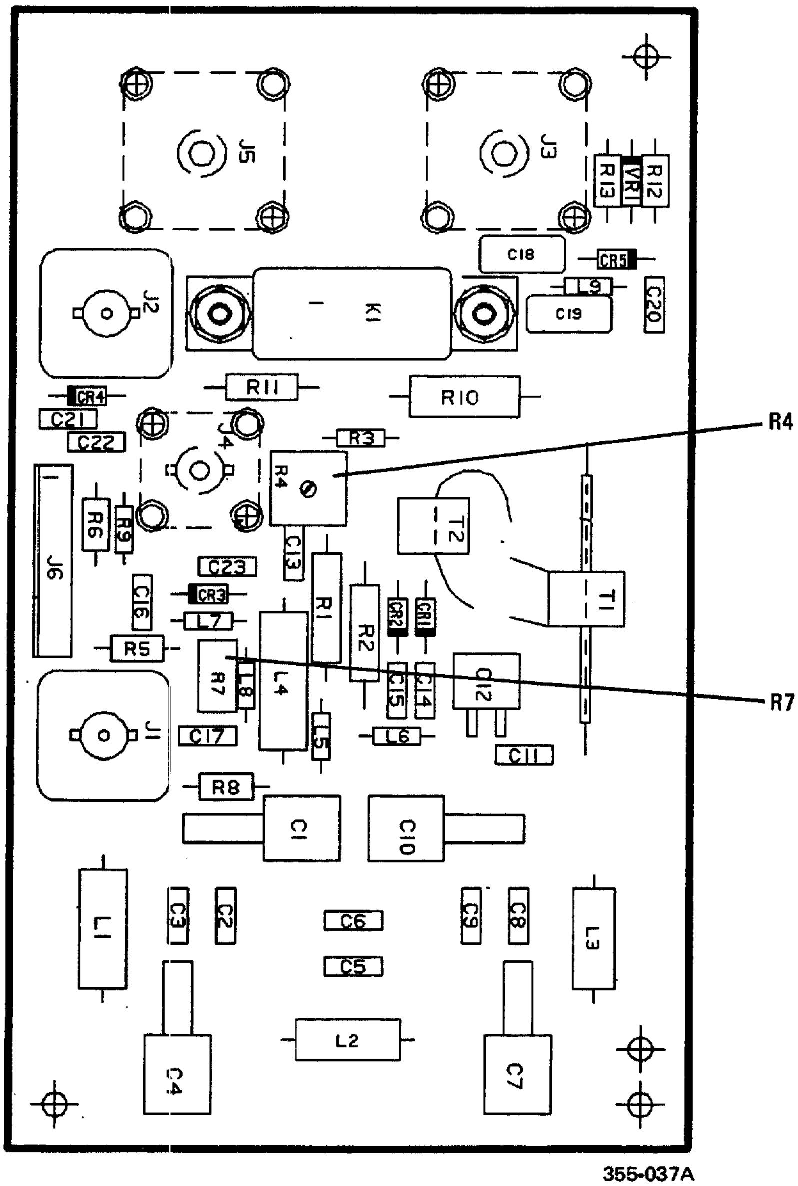

Figure 6-1. Output Filter PWB Assy

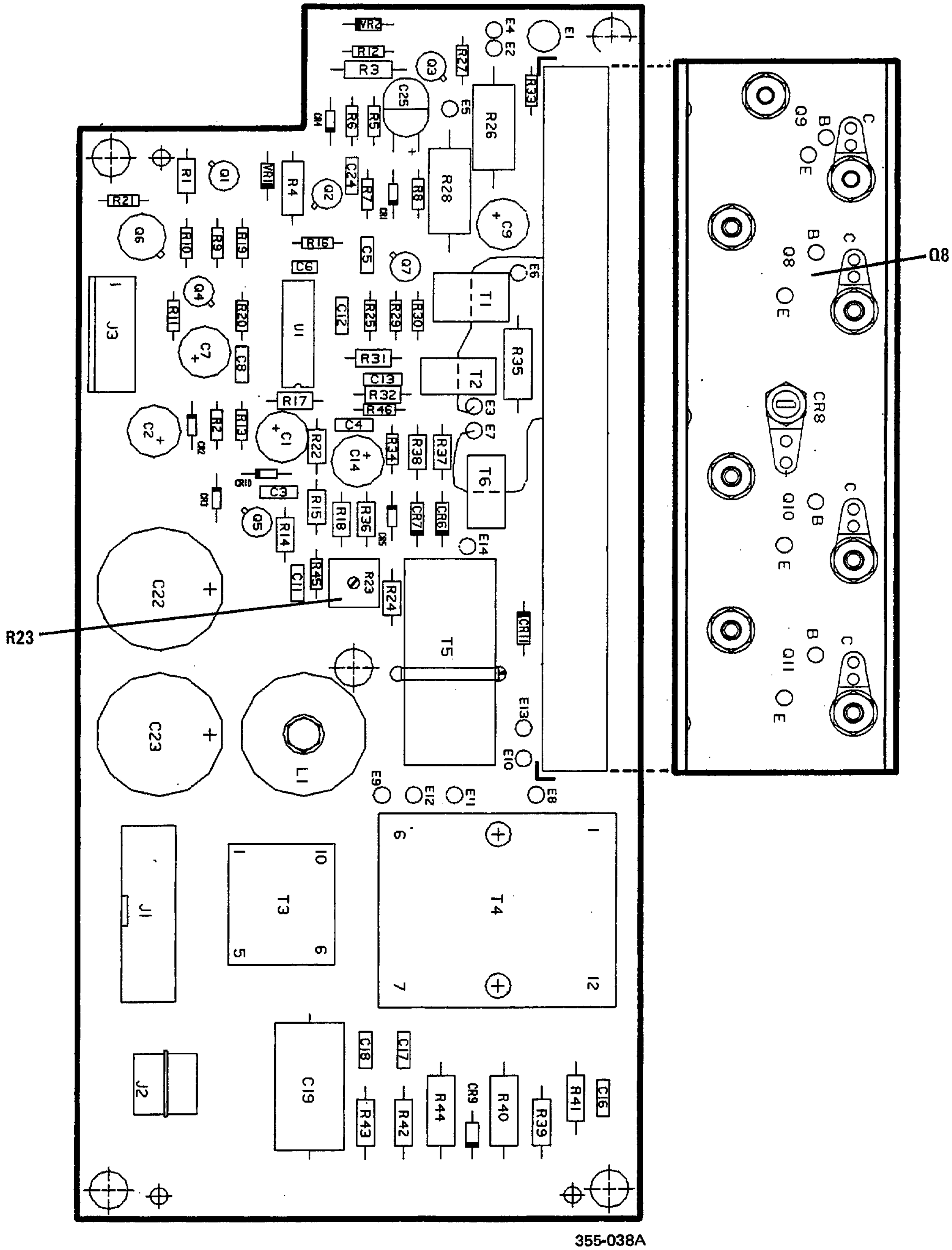

Figure 6-2. Low Voltage Power Supply PWB Assy

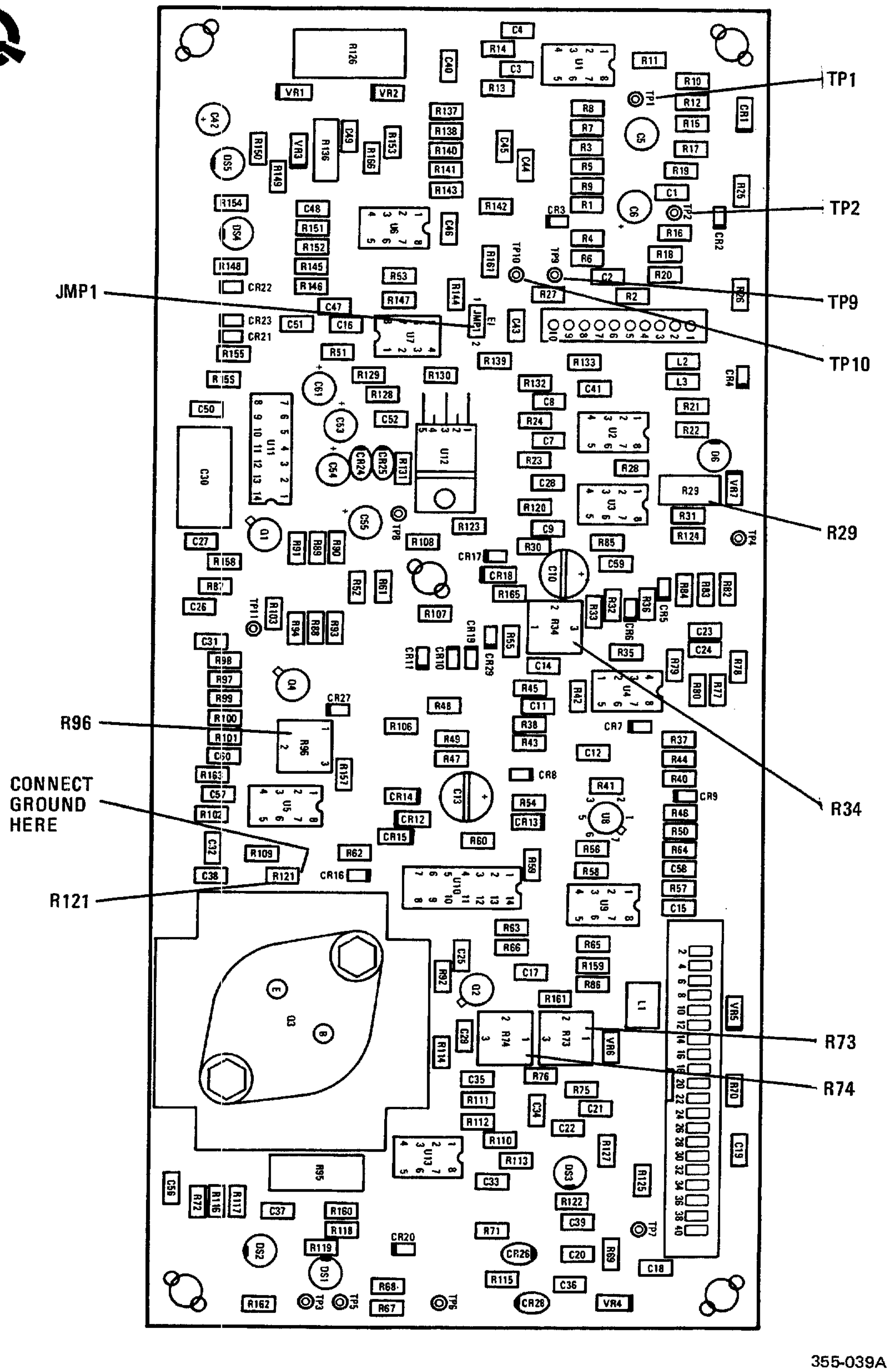

Figure 6-3. Power Control PWB Assy

(g) Observe the voltage on the multimeter. If the multimeter reads 7.00 ±0.05 Vdc, no further adjustment is required. Proceed to step (j).

(h) If the multimeter reads less than 6.95 Vdc, adjust R29 on the Power Control PWB Assy for a reading of slightly less than 150 Vac on the HP-410C. Then adjust R7 on the Output Filter PWB Assy for a reading of 7 volts on the multimeter. Readjust R29 to increase the HP-410C reading toward 158 Vdc. Continue to alternately adjust R7 toward 7 Vdc and R29 toward 158 Vac until the HP-410C reads 158 ±2 Vac and the multimeter reads 7.00 ±0.05 Vdc. Proceed to step (j).

(i) If the multimeter reads more than 7.05 Vdc, adjust R7 on the Output Filter PWB Assy for a reading of slightly less than 6.95 Vdc. Then adjust R29 on the Power Control PWB Assy for 158 Vac on the HP-410C. Readjust R7 toward 7 Vdc and readjust R29 to 158 Vdc. Continue to alternately adjust R7 and R29 until the multimeter reads 7.00 ±0.05 Vdc and the HP-410C reads 158 ± 2 Vac.

(j) Readjust R34 on the Power Control PWB Assy so that the HP-410C reads 112 ±2 Vac when the system is keyed in CW mode.

d. <u>Low Voltage Power Supply PWB Assy, A4 (Fig. 6-2)</u>

WARNING

Set amplifier in standby mode before R23, Voltage Adjustment, to avoid high voltage risk.

(1) R23, +13.5 Vdc Voltage Adjustment.

NOTE

No adjustment required if front panel reads +13.5 Vdc.

(a) Connect Digital Voltmeter to the collector of Q8 (see figure 6-2).

(b) Adjust R23 for +13.5 Vdc ±0.05 Vdc while PA is in standby mode.

e. <u>Power Control PWB Assy, A5 (Fig. 6-3)</u>

(1) R29, Loop Gain Control

NOTE

To adjust R29, perform the forward power sample adjustment as described in c (2) above. The two adjustments are interactive.

(2) R34, CW/FSK Power Adjustment

(a) Using a Model 11042-A T-connector, connect an HP-410C Voltmeter (or equivalent) between the LPA's RF output connector J5 and the dummy load.

(b) Turn the LPA on and set the operating frequency at the transceiver to 16.0000 MHz in CW mode. After the LPA has warmed up (is in STANDBY), place the LPA in OPERATE and tune the system.

(c) Key the system and adjust R34 (see figure 6-3) for a reading of 112 ±2 Vac on the HP-410C.

(3) R73, Coupler Tune Power Adjustment

NOTE

This adjustment assumes the following initial conditions:

- The LPA has been turned off for at least 10 seconds.
- The LPA's AUTO/MANUAL BAND Switch is in the AUTO position.

R4 and R7 on the Output Filter PWB Assy are correctly adjusted.

(a) Connect the LPA's RF output connector J5 to a dummy load.

(b) Turn the LPA on and set the operating frequency at the transceiver to

16.0000 MHz in CW mode. After the LPA has Warmed up (is in STANDBY), place the LPA in OPERATE and tune the system.

(c) Connect a ground to the J1 side of R121 on the Power Control PWB Assy (see figure 6-3). This will place the Power Control PWB Assy into the coupler tune mode.

(d) Set the LPA meter select switch to the FWD PWR (WATTS) position and key the system. Adjust R73 on the Power Control PWB Assy for 200 watts on the front panel meter.

(e) Unkey the system and remove the ground from R121.

(4) R74, Power Control Adjustment.

This potentiometer is normally set fully clockwise. If reduced output power is required in all modes, then this is accomplished by adjusting R74 counterclockwise until the desired output power is attained.

(5) R96, Max Plate Current Adjustment

NOTE

This adjustment assumes the following initial conditions:

- The LPA has been turned off for at least 10 seconds.
- The LPA's AUTO/MANUAL BAND Switch is in the AUTO position.
- R4 and R7 on the Output Filter PWB Assy are correctly adjusted.

(a) Connect the LPA's RF output connector J5 to a dummy load.

(b) Turn the LPA on and set the operating frequency at the transceiver to 16.0000 MHz in CW mode. After the LPA has warmed up (is in STANDBY), set the LPA's AUTO/MANUAL BAND Switch to the 16-24 position.

(c) Set the TUNE PWR Switch to the ON position, and set the METER Switch to the I_K (mA) position.

(d) Adjust R96 on the Power Control PWB Assy for 225 ±8 on the front panel meter.

f. <u>Micro Control PWB Assy, A6</u>

No adjustments.

g. <u>Front Panel PWB Assy, A7</u>

No adjustments.

h. <u>Rectifier/Bleeder PWB Assy, A8</u>

No adjustments.

i. <u>DC Control PWB Assy, A9</u>

No adjustments.

j. <u>Temp Sensor PWB Assy, A10 (Fig. 6-4)</u>

NOTE

This adjustment can be performed on a "cold" LPA (one that has been turned off for at least 15 minutes) or a "hot" LPA (one that has been turned on for more than 10 seconds). If you remove the JMP1 jumper (on the Power Control PWB Assy) from a cold LPA, you can begin the adjustment procedure immediately (as soon as you turn the LPA on). However, if you remove the jumper from an LPA that has been on for more than 10 seconds, then you must allow 15 minutes for the temperature sensors to stabilize at ambient before doing the adjustment.

(1) Remove JMP1 on the Power Control PWB Assy (see figure 6-3).

NOTE

With Jumper 1 removed, equipment will show a fault (JMP-1 PN is 65474-001).

(2) With the LPA in warmup (for a cold LPA) or standby (for a hot LPA), connect a digital

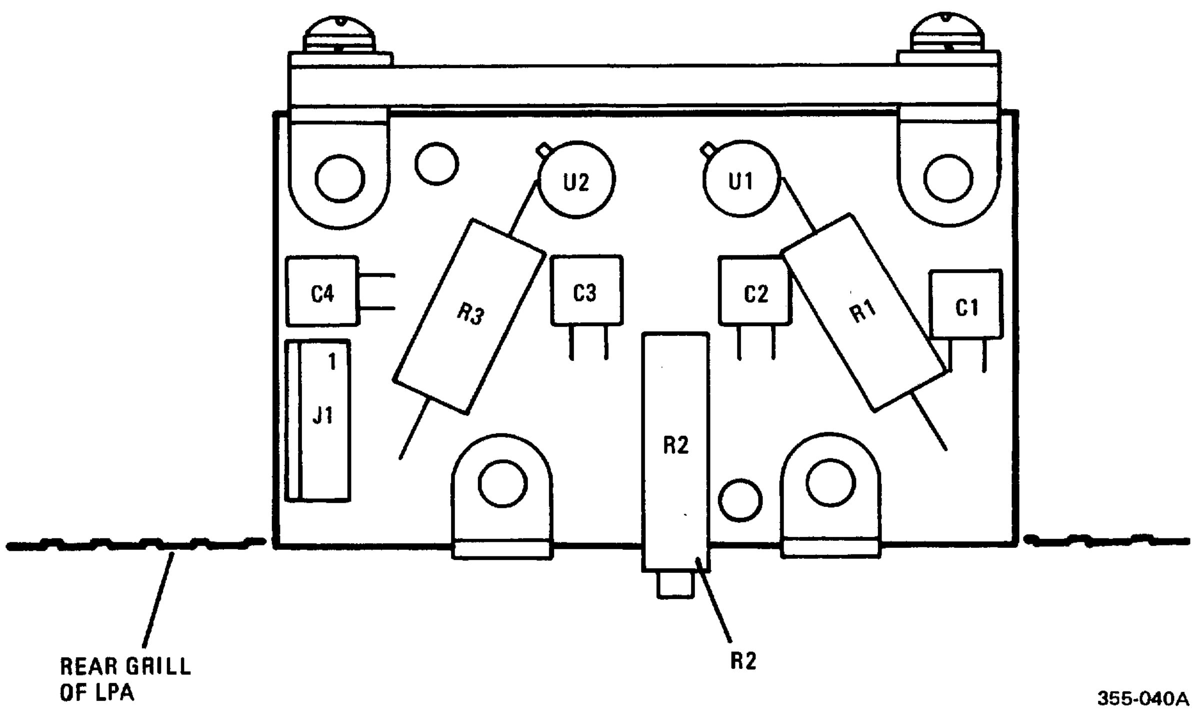

Figure 6-4. Temp Sensor PWB Assy

multimeter between test points TP9 and TP10 on the Power Control PWB Assy.

(3) If the voltage is 0 ± 2 mVdc, no adjustment is necessary. If not, adjust R2 (R2 is accessible through the rear grille of the LPA-- see fig. 6-4) until the voltage is within the limits.

(4) Re-install JMP1 on the Power Control PWB Assy.

k. Low Voltage Filter Assy, A11

No adjustments.

MAINTENANCE

Section III. DIAGNOSTIC PROCEDURES

6-4. DEPOT MAINTENANCE PHILOSOPHY. The maintenance procedures presented in this chapter assume that equipment problems have already been isolated to one of the replaceable subassemblies listed below. This has been accomplished in the field using the BIT (Built-In Test) troubleshooting approach. (For a detailed description of BIT, see Chapter 6 in the On-Equipment Manual for the 500 Watt Linear Power Amplifier, T.O. 31R2-2URC-101.) As a depot maintenance technician, your job is to take these defective subassemblies returned from the field, swap them with known good subassemblies in a properly functioning 500 Watt Linear Power Amplifier (the "test bed"), and troubleshoot the defective subassemblies to the component level. Once you have identified and replaced the faulty component (resistor, capacitor, transistor, etc.), you will then perform whatever adjustment or alignment procedures are required to restore the subassembly to peak operating condition. To accomplish these tasks, you will need the procedures contained in this chapter, a complete set of schematics (in Chapter 8 of this manual), and the test equipment listed in Table 6-1. Also, refer to Table 6-2 in the Appendix for front panel meter functions and normal operating ranges. The following is a list of the subassemblies covered in Section III:

SUBASSEMBLY	PARAGRAPH
Tube Assy, A1	6-5
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6-5. TUBE ASSY, A1.

a. Preliminary Procedure

(1) Remove the good Tube Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Tube Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter).

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the Tube Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, start at the beginning of the following procedures and work your way through to the end.

CODE 9

This fault code indicates that the DC plate voltage is not between 1200 and 3000 Vdc when the 500 Watt LPA is put into OPERATE.

If the Tube Assy is known to be bad and this fault code occurs, it means that there is probably a short on the Tube Assy's B+ line. With power off and all voltages discharged, remove the faulty Tube Assy from the test bed and take resistance measurements to determine the cause of the short.

CODE 11

This fault code indicates that when the 500 Watt LPA is put into OPERATE and the bias is turned on, the DC plate current is not between 20 and 150 mA.

With power off and all voltages discharged, remove the faulty Tube Assy from the test bed. Using an ohmmeter, do the following:

(1) Check for continuity in the bias line between pins 1 and 2 of J1 and the cathode of the tube.

(2) Check for continuity between the tube grid (pins 4, 7, and 11 of the tube socket) and ground.

(3) Check for continuity in the filament line between pins 7 and 8 of J1 and ground.

(4) Check for an open in the plate circuit between the tube anode an the high-voltage connector P1.

If the above circuitry checks good, replace the tube.

CODE 14

This fault code indicates that although the plate voltage, bias, and RF drive from the transceiver is within tolerance, the plate current is not between 160 and 280 mA.

With power off and all voltages discharged, remove the faulty Tube Assy from the test bed. Using an ohmmeter, look for a problem in the RF input circuit between J2 and C1/C2. If the RF input circuitry checks good, replace the tube.

CODE 15

This fault code indicates that although the plate current is within tolerance for the RF drive at the cathode, the microprocessor was unable to find a tune peak.

With power off and all voltages discharged, remove the faulty Tube Assy from the test bed. Check for a problem in the output coupling capacitors (C1 and C2 on the small circuit board) or in the RF output connector J3 (also on the small circuit board).

CODE 18

This fault code indicates that the ratio of forward power to RF input power is not between 5 and 60.

With power off and all voltages discharged, remove the faulty Tube Assy from the test bed. Using an ohmmeter, do the following:

(1) Check the inductive load components of the plate circuit; i.e., L3 and L4.

(2) If these components check good, replace the tube.

6-6. TANK ASSY, A2.

a. Preliminary Procedure.

(1) Remove the good Tank Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Tank Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter.)

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the

Tank Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, start at the beginning of the following procedures and work your way through to the end.

CODE 4

This fault code indicates that the +13.5 Vdc, as measured at the output f the Low Voltage Power Supply Assy, is not within the normal operating range (+10 to +16 Vdc).

Since the Tank Assy is known to be faulty, the problem is most likely a short on the Tank Assy's +13.5 V line or a short in one of the motors. Since this is a run-time fault (the FAULT light comes on whenever the +13.5 V supply is out of range for more than 3 seconds), you can easily determine whether the problem is in the supply line or in one of the motors:

(1) If the fault occurs as soon as you turn the equipment on, the problem is in the +13.5 Vdc line.

(2) If the fault occurs only during band selection, the problem is in the band switch drive motor.

(3) If the fault occurs only during coil positioning, the problem is in the coil drive motor.

CODE 6

This fault code indicates either that the band switch did not turn or that it did not reach the specified band within 10 seconds.

The problem could be in the following areas:

(1) The Band Switch Motor. Check it as follows:

(a) Check to see whether the motor turns when you change bands in manual mode. If not, check TP14 on the Servo/Band Switch Drive PWB Assy for approximately +13 Vdc. If the voltage is good, check to see whether the problem is in the motor cable or the motor itself. If the voltage at TP14 is bad, check for approximately +2.5 Vdc at TP15. If TP15 is good, the problem must be Q10, Q11, or one of their associated components. Or there might be an open in the +13.5 V line. If TP15 is bad, the problem could be in the band selection circuitry (see paragraph 2 below), the band switch, or the connector (P1/J3).

(b) If the motor does turn, check to see whether it turns fast enough (in other words, see if there is any mechanical binding which is slowing it down). If the motor appears to be turning freely, see if it stops within 10 seconds. If the motor does not stop within 10 seconds and does not appear to have any mechanical binding, look for a problem with the band switch or the band selection circuitry (see paragraph 2 below).

(2) The band selection circuitry (U1 and its associated components on the Servo/Band Switch Drive PWB Assy). Check this circuitry as follows:

(a) In manual mode, select a band other than the one you're in now.

(b) At TP17-TP20 on the Servo/Band Switch Drive PWB Assy, check to see that the bit pattern is correct for the band you have selected. For example, if you selected Band 1 (1.6 to 2.2 MHz), you should see a high on the BDSW 1 input to U1 and lows on BDSW 2, BDSW 4, and BDSW 8.

(c) If the input pattern to U1 is correct, check for a high on the corresponding output pin. In our example, pin 14 of U1 should be high; all other output pins (1-7, 9, 15) should be low.

(d) If the inputs and outputs of U1 are correct, check for continuity of the lines between U1 and connector J3/P1.

CODE 7

This fault code indicates either that the coil drive motor did not turn or that the coil position is incorrect.

Check the coil drive circuitry as follows:

(1) Check to see whether the motor turns when you move the manual TUNE switch to either MIN L or MAX L. (The AUTO/MANUAL BAND

switch on the front panel must set to a manual band).

(a) If not, check TP6 (with the TUNE switch in the MAX L position) and TP10 (with the TUNE switch in the MIN L position) on the Servo/Band Switch Drive PWB Assy for approximately +13 Vdc. If the voltages are good, check to see whether the problem is in the motor cable or the motor itself. Also check to see whether there is any mechanical binding that might prevent the motor from turning.

(b) If the voltages at TP6 and TP10 are bad, check for an open in the +13.5 V line.

(c) If the motor turns in one direction but not the other, then check the appropriate driver transistors (Q1, Q2, and Q3 for MAX L; Q4, Q5, and Q6 for MIN L). Also check TP7 (MAX L) and TP8 (MIN L) for highs to turn the transistors on. When TP7 is high, check that Q8 (MIN L DISABLE) is turned off; when TP8 is high, check that Q7 (MAX L DISABLE) is turned off.

(d) Another reason why the motor might only turn in one direction is if the limit switch is stuck in one position or the other or if one of the limit switch transistors (Q13 or Q14) is shorted. Such a condition would cause the microprocessor to think that the motor had reached one of the end stops, thus preventing any further motion in that direction.

(2) If the coil drive motor moves freely in both directions, check to see whether the coil position is correct:

(a) Move the METER selector switch to COIL POS.

NOTE

You will have to tilt the Tank Assy to gain access to some of the test points in this procedure.

(b) Connect a voltmeter to TP1, which should read +5 Vdc.

(c) Using the manual TUNE switch, move the coil drive motor toward MIN L until the voltmeter reads 0 Vdc. At this point, the COIL POS meter on the LPA front panel should read 100 and the motor should stop. You should not be able to drive the motor any further in this direction.

(d) Connect the voltmeter to TP2, which should read +5 Vdc.

(e) Move the coil drive motor toward MAX L until the voltmeter reads 0 Vdc. At this point, the COIL POS meter should read 1770 and the motor should stop. You should not be able to drive the motor any further in this direction.

(f) If the COIL POS reading is incorrect at either end (for example, the voltage at TP1 went low when the COIL POS indicated 130; or the voltage at TP2 went low when the COIL POS indicated 1710), then you need to do an electro-mechanical realignment of the coil drive motor. See the removal/replacement procedures for the Tank Assy components in Section IV of this chapter.

(g) If the COIL POS meter does not respond to changes in coil position or responds in a random manner, then check the TWA and TWB outputs of the Encoder G1 at TP5 and TP4, respectively, with a dual-trace oscilloscope. While the motor is turning, these should both have TTL-level square waves (0 to +5 Vdc). If not, suspect the encoder or its inputs (+5 Vdc and ground).

(h) If the voltages at TP1 and TP2 do not respond correctly, look for a problem with the limit switch or transistors Q13 or Q14. For example, if the voltage at TP1 goes to 0 at a coil position of 100, but the voltage at TP2 does not go to 0 at a coil position of 1770, then look for a problem with Q13. Conversely, if TP2 switches from +5 Vdc to 0 at a coil position of 1770, but TP1 does not switch at a coil position of 100, then look for a problem with Q14. If neither test point switches at its corresponding limit, then look for a problem with the limit switch.

CODE 15

This fault code indicates that while the coil was moving from MAX L to MIN L, the microprocessor was unable to find a tune peak.

The first thing to determine is whether this fault occurs in all frequency bands or just certain ones. Therefore, you should run the BIT test in each of the frequency bands and make a note of which bands the fault occurred in.

(1) If the fault occurs in all bands, then the problem is most likely one of the following:

(a) An open in the RF line. Check for continuity between input connector P1 and output connector P2.

(b) A short on the RF line. Check for a short between the RF signal line and ground.

(c) A bad variable coil L1. For example, the coil might be shorted internally.

(d) An open wafer switch on the Tune Capacitor Assy or the Load Capacitor Assy.

(2) If the fault occurs in only certain bands, try to determine what these bands have in common. For example, if the fault occurs only in the three lowest bands, then you might look for a shorted tuning capacitor (C6) or a shorted load capacitor (C7 or C8). Or, if the fault only occurs in Band 1, then you might suspect fixed coil L2 (Band 1 is the only one in which this coil is not bypassed). Another possibility is a dirty or defective wafer switch.

CODE 16

This fault code indicates that when a tune peak is found, the forward tune power is not between 30 and 90 watts.

Use the same procedures as for code 15.

CODE 18

This fault code indicates that the ratio of forward power to RF input power is not between 5 and 60.

Use the same procedures as for code 15.

6-7. OUTPUT FILTER PWB ASSY, A3.

a. Preliminary Procedure.

(1) Remove the good Output Filter PWB Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Output Filter PWB Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter).

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the Output Filter PWB Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, first check the "Additional Symptoms" section following the fault code discussions. If your problem is not covered there, start at the beginning of the following procedures and work your way through to the end.

CODE 10

This fault code indicates that when the LPA is put into OPERATE (but without bias or RF drive), the cathode current is greater than 5 mA.

This problem is most likely caused by the T/R Relay being stuck closed, which allows RF to go to the Tube Assy, causing the tube to conduct. The relay itself could be defective, or there could be a short on the T/R keyline (C22 shorted to ground, for example), causing the T/R Relay to stay energized.

CODE 14

This fault code indicates that when the LPA is keyed in OPERATE with bias and RF drive applied, the plate current is not between 160 and 280 mA.

In this case, the problem is most likely the T/R Relay's failure to energize, preventing RF drive from being applied to the tube. This could be caused by a defect in the relay itself (open or shorted coil, for example), an open +13.5 Vdc line, or an open T/R keyline.

CODE 15

This fault code indicates that when the LPA is keyed in OPERATE with bias and RF drive applied, a tune peak cannot be found.

Look for a short or open on the RF line. Also, there could be an open in the FWD SAMPLE circuitry. Check the voltage at TP1 on the Power Control PWB Assy. If the FWD SAMPLE circuitry is working properly, this voltage should be positive (+7 Vdc indicates full forward power). If not, this voltage should be slightly negative.

CODE 16

This fault code indicates that when the LPA is keyed in OPERATE with bias and RF drive applied, the FWD PWR is not between 30 and 90 watts.

Look for a problem in the FWD SAMPLE circuitry. Check the voltage at TP1 on the Power Control PWB Assy. If the FWD SAMPLE circuitry is working properly, this voltage should be positive (+7 Vdc indicates full forward power). If not, this voltage should be slightly negative. Also, check the adjustment of R7. See the alignment procedures in Section II of this chapter.

CODE 17

This fault code indicates that the VSWR is not less than 2.25:1.

Look for a problem in the REFL SAMPLE/FWD SAMPLE circuitry by checking the voltages at TP1 and TP2 on the Power Control PWB Assy. Normally, TP1 should be close to +7 Vdc, and TP2 should be less than +1 Vdc. Also, check the adjustment of R4. See the alignment procedures in Section II of this chapter. Another possibility is an open in the RF line.

CODE 18

This fault code indicates that the ratio of forward power to RF input power is not between 5 and 60.

Look for a problem in the RF IN SAMPLE circuitry. (Power gain is computed by taking the ratio of the FWD SAMPLE to the RF IN SAMPLE. Since the FWD SAMPLE has been used in several other calculations prior to this one without generating a fault code, the problem is more likely in the RF IN SAMPLE circuitry).

ADDITIONAL SYMPTOMS

High Forward Power

Look for a problem in FWD SAMPLE circuitry. Also, check the adjustment of R7 (see the alignment procedures in Section II of this chapter).

6-8. LOW VOLTAGE POWER SUPPLY ASSY, A4.

a. Preliminary Procedure.

(1) Disconnect the three cables from the good Low Voltage Power Supply Assy, and connect them to the faulty Low Voltage Power Supply Assy. (You do not have to remove the good Low Voltage Power Supply Assy from the chassis. Just route the cables around the mounting plate and rest the faulty Low Voltage Power Supply Assy on top of the Power Control PWB Assy, being careful to insulate it sufficiently.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. If the BIT test cannot be run because the front panel is inoperative,

proceed directly to the "Additional Symptoms" section following the fault code discussions. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter).

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the Low Voltage Power Supply Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, first check the "Additional Symptoms" section following the fault code discussions. If your problem is not covered there, start at the beginning of the following procedures and work your way through to the end.

CODE 4

This fault code indicates that the output of the Low Voltage Power Supply Assy is not between +10 and +16 Vdc.

Even though the output of the Low Voltage Power Supply Assy is out of tolerance, its output must be somewhat more than 0. Otherwise, the +5 V Regulator on the Micro Control PWB Assy would not be able to put out sufficient voltage for the microprocessor to run the BIT test. Therefore, the first thing to do would be to try adjusting R23 to see if the output voltage can be brought back within tolerance. Use the front panel 13.5 VDC meter to see whether the output voltage is high or low, and then adjust R23 accordingly. See the alignment procedures in Section II of this chapter.

If you can't adjust the output voltage to the proper level with R23, then do the following:

CASE 1

Output voltage is too high.

(1) Check for a collector-emitter short in pass transistor Q8, driver Q9, or pre-driver Q7.

(2) Check the voltage divider/reference network at pins 2 and 16 of U1, which consists of R17 and R18. Pin 2 should read +2.5 Vdc, and pin 16 should read +5 Vdc. Also, check the voltage at pin 1, which should be about the same as at pin 2.

NOTE

If pin 1 (which has the feedback voltage) is lower than pin 2, the power supply will try to put out more voltage.

CASE 2

Output voltage is too low.

Check the voltage divider/reference network at pins 2 and 16 of U1, which consists of R17 and R18. Pin 2 should read +2.5 Vdc, and pin 16 should read +5 Vdc. Also, check the voltage at pin 1, which should be about the same as at pin 2.

NOTE

If pin 1 (which has the feedback voltage) is higher than pin 2, the power supply will try to cut back--no signal will appear at pins 11 and 14 of U1.

CODE 5

This fault code indicates that the ambient temperature of the 500 Watt LPA is too high, as detected at the Temp Sensor PWB Assy. Since we know that the Low Voltage Power Supply Assy is faulty, this fault code indicates that the Fan Inverter circuit, which drives the cooling fan, is not functioning properly.

(1) Check for +13.5 Vdc at pin 2 or pin 5 of T4.

(2) Check Q10 and Q11 for collector-emitter shorts.

(3) Check the bias circuitry, particularly CR9 and C16.

(4) Check C17 and C18 for shorts.

ADDITIONAL SYMPTOMS

No output voltage.

(1) Check to see if the input voltage (+28 Vdc nominal) is present at the emitter of Q8 (test

point E1). If not, troubleshoot the +28 Vdc input line.

(2) If Q8's emitter is good, check pin 15 of U1. The voltage here should be about 2 volts less than the input voltage. If this voltage is incorrect, the problem is probably in U1 and its associated circuitry.

(3) If pin 15 of U1 is good, check the signal at pins 11 and 14 with an oscilloscope. You should see a 24 V pk-pk square wave with a 75% duty cycle. If this signal is good, skip to step 6.

NOTE

If you have narrow pulses at pins 11 and 14, check for the current limit condition, which is indicated by +1.2 V at the cathode of CR5. If you are in current limit, disconnect the cable at J1 and see whether the output voltage returns to normal. If it doesn't, there is probably a short somewhere in the power supply.

(4) If the signal at pins 11 and 14 of U1 is bad, check the voltage at pin 10. If pin 10 is high, this indicates the shutdown condition, which could be caused by any of the following:

- o Incorrect line voltage
- o A failure in the Undervoltage (Q1)/Overvoltage (Q3, Q6) Protection circuits
- o Shutdown switch Q2, which can be triggered by the Undervoltage/Overvoltage Protection or Soft Start (Q2) circuits.

(5) If the voltage at pin 10 is low, check the other voltages on U1 as follows:

(a) Check for +3 to +3.5 Vdc at pin 9, which is the normal voltage if the power supply is not putting out.

(b) If pin 9 is not correct, check pin 2 for +2.5 Vdc.

(c) If pin 2 is not correct, check pin 16 for +5 Vdc.

(d) If the voltage at pin 16 is bad, either U1 or its associated circuitry is bad.

(6) If the signal at pins 11 and 14 of U1 is good, check the collector of Q7 for a signal whose pk-pk amplitude is 3 volts less than the incoming supply voltage. Trace this signal through Q9 and Q8. The signal should be approximately the same amplitude all the way through.

6-9. POWER CONTROL PWB ASSY, A5.

a. Preliminary Procedure.

(1) Remove the good Power Control PWB Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Power Control PWB Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter).

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the Power Control PWB Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, first check the "Additional Symptoms" section following the fault code discussions. If your problem is not covered there, start at the beginning of the following procedures and work your way through to the end.

CODE 5

This fault code indicates that the XMTR FAULT line (TP11 on the Power Control PWB Assy) has gone low, indicating a temperature-related fault condition.

This fault code can be generated by any one of the following:

(1) JMP 1 is not in place, or there is an open in the +13.5 Vdc line.

(2) There is a fault in the LO AIR circuit (the LO AIR LED should be on if the problem is here).

(3) There is a fault in the OVERTEMP circuit (the OVERTEMP LED should be on if the problem is here).

You should be able to isolate this problem quickly by checking the "sense" (whether the output corresponds to the inputs) of inverters U11D and U11E and of op amps U6A, U6B, and U7B.

CODE 10

This fault code indicates that when the LPA is put into OPERATE (but without bias or RF drive), the cathode current is greater than 5 mA.

(1) Check the operation of U13A by placing the LPA into OPERATE and measuring the voltage on pin 1, which should be close to 0 (+12.5 mV or less). If it is greater than +12.5 mV, check the input at pin 3, which should be 40% of the voltage on pin 1. If the voltage on pin 3 is correct, then U13A is probably okay.

(2) Check the voltage across R95, which should be the same as on U13-3. Normally, with the LPA in OPERATE and unkeyed, the voltage across R95 should be 0 (in other words, there should be no cathode current).

(3) If the voltage across R95 indicates that there is cathode current, check for a problem with Q2 or Q3 (collector-emitter short) or with the keyline circuitry (U11A and Q1). With the LPA unkeyed, the output of U11A (pin 2) should be low, which keeps Q1 turned off, which in turn keeps Q2 and Q3 turned off.

CODE 11

This fault code indicates that with the LPA in OPERATE and bias applied (no RF drive), the plate current is not between 20 and 150 mA.

(1) Using the front panel controls on the transceiver, key the LPA in OPERATE with no RF drive, and check the voltage at TP3. This voltage should be +5 Vdc. When you unkey the LPA, this voltage should increase to +24 Vdc. If the voltage at TP3 is incorrect, look for a problem in the bias circuit (Q2, Q3, and their associated components) or the keyline circuit (U11A, Q1, and their associated components). When the LPA is keyed, the output of U11A should be high, which turns on Q1, which then turns on Q2 and Q3.

(2) If the voltage at TP3 is good, check the voltages at the input and output of U13A. With the LPA keyed in OPERATE (no RF drive), look for +20 to +150 mV on pin 3 and +50 to +375 mV on pin 1. If these voltages are not correct, look for a problem in U13A or its associated components.

CODE 14

This fault code indicates that when the LPA is keyed in OPERATE with bias and RF drive applied, the plate current is not between 160 and 280 mA.

The bias, keyline, and cathode current sampling circuitry are probably okay; otherwise, code 11 would have been declared. In this case, since the fault occurs with RF drive applied, look for a problem in the TGC circuitry, which controls the amount of RF drive applied to the LPA. Check this circuitry as follows:

(1) To see whether the TGC circuitry is indeed the cause of the problem, disconnect the cable from J1 on the AGC/TGC PWB Assy in the 100 Watt Transceiver. Run the BIT test again and see if Code 14 reappears. If it doesn't, continue with step 2 below. If it does, check the bias, keyline, and cathode current sampling circuitry as in Code 11 above.

(2) Reconnect the cable to the AGC/TGC PWB Assy in the 100 Watt Transceiver. The first thing to do is determine whether the problem can be corrected by adjusting the potentiometers on the Power Control PWB Assy. Go to the alignment procedures in Section II of this chapter and perform the entire alignment procedure. If this does not correct the problem, continue with step 3 below.

(3) Key the LPA from the 100 Watt Transceiver in CW mode with the CW key. Measure the voltage at TP5. Normally, this voltage should be +8 Vdc. If it is greater than +8 Vdc, the output power will be lower than normal; if it is less, the output power will be greater than normal. If the voltage at TP5 is good, skip to step 8. If it is not, continue with step 4. Place the transceiver back in USB mode.

NOTE

For all the measurements that follow, you must key the LPA from the 100 Watt Transceiver and hum into the microphone.

(4) Observe the voltage at TP1 and TP2 with an oscilloscope. TP1 should read +7 Vdc at the peak of the waveform, and TP2 should read less than +1 Vdc (almost 0). Also, check pins 1 and 7 of U1. The voltages at these pins should be about the same as on the corresponding test points. If any of these voltages are incorrect, look for a problem in U1 and its associated components.

(5) Check the output of U3A with an oscilloscope. Pin 1 (TP4) should be +8 Vdc at the peak. If this voltages is incorrect, look for a problem with U3A or its associated components.

(6) With an oscilloscope, check the output (pin 1) of U9A for +8 Vdc at the peak. Normally, U9A has unity gain. However, any one of several conditions can cause U8 to conduct. During CW power cutback, for example, after C10 charges, the output of U4A goes high, causing the output of U4B to go high, which in turn causes the output of U7A to go low, turning on U8 and increasing the gain of U9A. This same situation can occur if either CR29, CR10, or CR11 conducts (in response to an RF/DC protect voltage or an overtemperature or overcurrent condition), forcing the output of U4B to go high. If the voltages at U9A are not normal, do the following:

(a) Check the anodes of CR29, CR11, CR10, and CR7 to determine if any of these is sufficiently positive to cause pin 5 of U4B to go higher than +5 Vdc, causing the output of U4B to go low. If so, you can then identify the circuit that is causing this condition:

CR29	RF/DC protect (U3B and its associated components
CR11	Overtemperature (U6B and its associated components
CR10	Max plate current control (U5A and its associated components)
CR7	CW power cutback (U4A and its associated components)

(b) If none of the above circuits is responsible for changing the gain of U9A by causing the output of U4B to go low, check for a problem in U4B, U7A, U8, or their associated components.

(7) If the voltages at U9A are normal, check the voltages at U9B. Pin 5 should normally be at +4 Vdc (peak), and pin 7 (TP5) should be at +8 Vdc (peak). If this is not the case, check for a possible problem in quad switch U10 or in U9B and one of its associated components.

(8) Check for a possible problem in the PPC circuitry (U5B and its associated components). Measure the voltage at TP6 with an oscilloscope. Normally, this voltage should be 0 to +5 Vdc (peak). A voltage greater than this initiates the cutback condition in the transceiver (Exciter PWB Assy). Check to see whether the PPC LED illuminates (this LED should illuminate whenever the voltage at TP6 exceeds +5 Vdc, which is the threshold point for U13B). If the voltage at TP6 is consistently greater than +5 Vdc (PPC LED is on continuously), check for a problem in U5B and its associated circuitry.

CODE 16

This fault code indicates that when the LPA is keyed in OPERATE with bias and RF drive applied, the FWD PWR is not between 30 and 90 watts.

Use the same procedure as for Code 14.

ADDITIONAL SYMPTOMS

High Forward Power, Low Forward Power

Look for a problem in the TGC circuitry. Use the same procedure as for Code 14.

6-10. MICRO CONTROL PWB ASSY, A6.

a. Preliminary Procedure.

(1) Remove the good Micro Control PWB Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Micro Control PWB Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter.) If you are unable to run the BIT test, either from the 100 Watt Transceiver or from the LPA, go to the "Additional Symptoms" section following the fault code discussions.

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the Micro Control PWB Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, check the "Additional Symptoms" section following the fault code discussions. If the procedure there does not indicate that there is a problem, chances are that the Micro Control PWB Assy is all right.

CODE 1

This fault code indicates that when the microprocessor reads the RF PLATE SAMPLE input to the A-to-D Converter, it indicates full scale, which means that the metering is inaccurate.

The problem is most likely in either the microprocessor chip (U1) or the A-to-D Converter chip (U6). Check the clock signal (TP4) to U6 (it should be 614.4 KHz). If the signal is bad at TP4, trace the line back through U31-5 and U31-1 (4.9152 MHz), all the way back to the clock oscillator (U8, Y1, etc.). If the signal at TP4 is good, try replacing the microprocessor first (since it's socketed), then the A-to-D Converter.

CODE 3

This fault code indicates that when the microprocessor read the PRI PWR input to the A-to-D Converter, it found it to be out of range (which is 80 to 120% of the nominal value).

Since Code 1 was not declared, the microprocessor and the A-to-D Converter are probably okay. Look for an open (R140) or a short (C140) on the PRI PWR SAMPLE input line (J1-16 to U6-4) to the A-to-D Converter (U6).

CODE 6

This fault code indicates that the band switch, when commanded to move to a different band, did not reach the selected band within 10 seconds.

(1) With the LPA in manual mode, select a different operating band from the one you're in now. Then check the BDSW output signal lines to the Tank Assy for the correct binary code. In other words, if you switch from the 1.6 to 2.2 MHz band (Band 1) to the 6 to 8 MHz band (Band 5), you should see highs on pins 5 and 9 of Output Latch U13 and lows on pins 2 and 6. Check for the signals on the output sides of their resistors (R120-R123) also. If the code is correct, try switching to Band 2 (U13-6 should be high; pins 2, 5, and 9 should be low) and then to Band 8 (U13-2 should be high; pins 5, 6, and 9 should be low), checking the code at both bands. If the codes are correct in all cases, proceed to step 2.

(2) If the Output Latch U13 and the BDSW signal lines are functioning properly, check the BDSW ON line and the Input Latch U28. After making a band change in manual mode, check to see whether pin 13 of U17 goes high and then low again after a few seconds. Check for the opposite on pin 12 of U17 and

pin 14 of U28. If U17 appears to be working properly, suspect U28.

CODE 7

This fault code indicates that when the coil drive motor was commanded to move first to MIN L and then to MAX L, it either did not move or its position counter was found to be inaccurate (the coil's position at MIN L or MAX L did not agree with stored values).

(1) Check the MIN L and MAX L signal lines on both sides of U11. When the BIT test is run, U11-3 should be normally low and go high momentarily. The opposite should happen at U11-14. After U11-3 returns low, U11-2 should go high momentarily and then return low again. The opposite should occur at U11-15. If the signals are good at U11, check at the output sides of the respective resistors (R125, R126). If the signals are good there, proceed to step 2.

(2) Check the MIN L LIMIT and MAX L LIMIT signal lines coming into the board. When the BIT test is run, the MIN L LIMIT signal line (U28-13) should go low and then high again. After the MIN L LIMIT signal line returns high, the MAX L LIMIT signal line (U28-8) should go low and then remain there for a few seconds until the tuning portion of the BIT test, when it should go high again. If these signals are incorrect, look for a problem in the input resistors (R130, R131) or the pullup resistor pack (R20).

(3) Check the TWA and TWB signal lines (U17-9, U17-11). When the tuning coil is in motion, these signals should be TTL (0 to +5 Vdc) square waves of opposite polarity. Check these signals on both the inputs and outputs of U17. Also, check the edge detector circuit: pins 4 and 5 of U26 should be high pulses when the coil drive motor starts to move and continue to be high pulses until the motor stops. Pin 1 of U26 should be the opposite. If this is not the case, look for a problem in U17, U26, or one of their associated components (R5, C24, C29, CR1, CR2).

CODE 8

This fault code indicates that with the LPA in STANDBY, the DC plate voltage is greater than 100.

(1) Look for a problem in U25 or U20. Place the LPA in STANDBY and check the signal level at U25-12. It should be low. Then command the LPA to OPERATE, and see whether this pin goes high. If it does, check for the opposite reactions at U20-14 and the output side of R107.

(2) If the signal at U25-12 is not correct, check the inputs to U25: +5 Vdc at pins 15 and 16; GND at pin 8; the clock signal (TP2) at pin 3 and the SERIAL DATA signal (TP3) at pin 2 (also check the pullup lines through R8); and the strobe signal at pin 1. If the inputs to U25 appear to be good, replace U25.

CODE 9

This fault code indicates that with the LPA in OPERATE, the DC plate voltage is not between 1200 and 3000.

Check for an open (R141) or a short (C141) on the DC PLATE SAMPLE line (J1-38 to U6-5). With the LPA in OPERATE, this line should read approximately +1.8 to +4.5 Vdc, which corresponds to a plate voltage of +1200 to +3000 Vdc.

CODE 11

This fault code indicates that when the LPA is keyed in OPERATE without RF drive, the plate current is not between 20 and 150 mA.

Check for an open (R138) or a short (C138) on the I_K SAMPLE line (J1-42 to U6-1).

CODE 12

This fault code indicates that when the RF MUTE command was sent to the 100 Watt Transceiver, the RF input level to the LPA did not drop below 6 W in 200 ms.

(1) Look for a problem in U19 or U30. Run the BIT test and see whether U30-11, which should normally be high, goes low

momentarily and then high again. If not, check for the reverse situation at U30-6.

(2) If the signal is good at U30-6, suspect U30 itself or look for a short (CR8 or C111) or open (R111) on the RF MUTE signal line.

(3) If the signal at U30-6 is not good, suspect U19. Before replacing it, check for +5 Vdc at pins 15 and 16 and for GND at pin 8. If these inputs are good, replace U19.

CODE 13

This fault code indicates that when the TPR (Tune Power Request) and TGC TPR signals were sent to the transceiver, the RF input signal level did not rise above 5 W in 20 seconds.

(1) Check for an open (R137) or a short (C137) in the RF IN SAMPLE signal line (J1-12 to U6-28).

(2) Another possibility is a fault in the DATA lines (J1-8, 9 to U1-10, 11). With the LPA in AUTO mode, change frequency bands on the transceiver and then key the system. You should see a series of pulses on the DATA+ line. Trace these pulses from U1-11 through U10, Q2, U4-1, and out to J1-9. You should also see these pulses at U4-4, U3, and back at U1-10.

CODE 15

This fault code indicates that when the LPA is keyed in OPERATE with RF drive, a tune peak cannot be found as the coil is moved from MAX L to MIN L.

(1) Look for an open (R136) or a short (C136) in the FWD SAMPLE line (J1-39 to U6-27).

(2) Check that the PA TUNE line (output side of R102) goes low while the microprocessor is attempting to find a tune peak during the BIT test. If not, check for an open R102 or a problem in U20 or U25 (these two chips should be okay; otherwise, a Code 8 would have been declared).

CODE 21

This fault code indicates that data sent from pin 11 of the microprocessor (U1) was not received (echoed back) at pin 10. Normally, this code indicates a problem in the communications link between the LPA and the transceiver; but in this case, since we know that the Micro Control PWB Assy is faulty, the problem has to be in the on-board DATA lines (J1-8, 9 to U1-10, 11). With the LPA in AUTO mode, change frequency bands on the transceiver and then key the system. You should see a series of pulses on the DATA+ line. Trace these pulses from U1-11 through U10, Q2, U4-1, and out to J1-9. You should also see these pulses at U4-4, U3, and back at U1-10.

ADDITIONAL SYMPTOMS

Microprocessor Fault

Microprocessor-related faults are generally characterized by an abnormal or random display and a loss of transceiver control functions (i.e., there is no LPA status displayed on the transceiver or the status is always MANUAL). In this case, running the BIT test is of no avail. Therefore, if you think you have a microprocessor-related fault and you cannot run the BIT test, use the following procedure:

NOTE

The Micro Control PWB Assy contains the Intel 8031 microprocessor, which controls all the functions of the LPA, including the BIT test. A failure in the microprocessor, EPROM, RAM, decoder, etc. will probably disable the BIT circuitry and most of the other LPA functions as well. Unless you are thoroughly familiar with the circuitry of this board and with the operation of microprocessors, it will be very difficult for you to isolate a faulty chip or discrete component using standard test equipment and troubleshooting techniques. The following procedures, therefore, are intended to check only the most obvious and fundamental aspects of the board's operation. If these do not enable you to identify the problem, then you will need more advanced test equipment and test procedures, which are beyond the scope of this manual.

(1) Check the supply voltage (+5 Vdc) to the microprocessor at U1-40. Also check for 0 Vdc at pins 20 and 31.

(2) Check the reset pin (U1-9). Normally, this pin should be low all the time. If the microprocessor is not working properly, it will be pulsing high at a 9.375 Hz rate. If this is the case, then the clock oscillator (Y1, U8, and their associated components), counters U31 and U32, and buffers U17 and U3 are probably okay. If the reset line is continually high, look for a failure in U3 or U17.

(3) Check the clock inputs to the microprocessor: U1-19 (4.9152 MHz), U1-15 (153.6 KHz), and U1-12 (300 Hz). If any of these inputs is bad, trace the signal line(s) back to the counters (U31, U32) and/or the oscillator (U8, Y1, etc.).

(4) Check U1-30 (TP1) to see if it's pulsing high and low; it should not be stuck high or low. Do the same for U1-16, U1-17, and all the address lines.

(5) If all the above checks are good, try replacing the microprocessor U1. This chip is socketed for easy replacement.

(6) If the problem persists, replace the EPROM U2. This chip is also socketed.

(7) If the problem still persists, check the supply voltages and ground connections to all the other chips, beginning with the RAM (U29) and the address decoder (U27).

6-11. FRONT PANEL PWB ASSY., A7A1.

a. Preliminary Procedure.

(1) Disconnect the cable from the good Front Panel PWB Assy in the test-bed 500 Watt Linear Power Amplifier, and connect it to the faulty Front Panel PWB Assy. It is not necessary to mount the faulty Front Panel PWB Assy in the test bed.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) Look at the display on the front panels of both the 500 Watt LPA and the 100 Watt Transceiver. If you notice anything abnormal, either when you first power up the LPA or after the LPA is warmed up and you try to operate it, refer to the appropriate section below.

b. Troubleshooting Procedures.

Problems with the 500 Watt LPA can be grouped under the following general symptoms:

LPA does not power up.

The first thing you should do in this situation is determine whether the Front Panel PWB Assy has +5 V applied when you command the LPA to turn on from the 100 Watt Transceiver. Normally, this is indicated by the POWER ENABLE LED being on steady and the STANDBY LED blinking. If neither LED is on, look for a failure in the POWER ENABLE switch S8. If the STANDBY LED is blinking but the POWER ENABLE LED is off, look for a failure in the POWER ENABLE LED.

LPA status at 100 Watt Transceiver is missing or incorrect.

(1) If there is no LPA status at the transceiver (the AMP:STBY indicator is not visible on the transceiver's display), the problem could be anywhere on the output side of the data line (U17-U20, U11F, or the FP IN EN, SER CK, or SER DATA signal lines).

(a) Every 50 ms, you should see a series of 200 KHz clock pulses on the SER CK line (pin 10 of U17-U20). During this time, the FP IN EN line (pin 9 of U17-U20 and pin 15 of U11) should go low, which allows the serial data to be clocked out from U17-U20 through U11F. Check pin 13 of U11 for a series of data pulses every 50 ms.

(b) If the data pulses are not present, but the SER CK and FP IN EN signals are good, trace the data pulses back through U11-14 and the inputs (pin 11) and the outputs (pin 3) of U17-U20. Check for the presence of the operating voltages (+5 Vdc, GND) at each of these chips.

(2) If you do have LPA status at the transceiver (AMP:STBY indicator is on) but the status is incorrect (e.g., the LPA MAN indicator on the transceiver is on when the LPA's AUTO/MANUAL BAND switch is in the AUTO position), look for a problem with switch S1 or shift registers U17 or U18 and their associated components.

(a) Rotate AUTO/MANUAL BAND switch S1 through each of its positions. At each position, check the bit pattern on pins 1, 4-7, and 13-15 of U17 and on pins 5-7 of U18. Only one of these pins should be low for a given setting of S1, and it should be different for each setting.

(b) If the bit pattern at the parallel inputs to U17 and U18 is correct for each position of S1, then check the serial outputs (pin 3) of both U17 and U18. Using a dual-trace oscilloscope, sync on the negative transition of the FP IN EN signal and look for a series of data pulses at U17-3 and U18-3. Try changing the setting of S1 and look for a corresponding change in the data pattern.

(c) If the data signal at U17-3 and/or U18-3 is incorrect, check the operating voltages (+5 Vdc and GND) for U17 and/or U18. If the operating voltages are good, replace the appropriate chip (U17 if the data signal at U17-3 was bad; U18 if the data signal at U17-3 was good).

Meter failures.

Look for a problem with METER switch S2 or with one of the resistor packs (R17, R18). Rotate S2 through each of its positions. At each position, check the bit pattern on the control lines to U17 (pins 1, 4, 13-15) and U18 (pins 4-7, 13, 14). For each switch setting, only one of these control lines should be low; all others should be high. Presumably, the shift registers (U17-U18), the output buffer (U11F), the SER CK line, and the FP IN EN line are good; otherwise, you would probably have missing or incorrect LPA status at the transceiver.

Manual control failures.

If one of the manual control switches (TUNE PWR, LOCAL KEY, TUNE, and SELF TEST) does not appear to be functioning properly, check its operation by monitoring the logic level at its control line. For example, when you activate the TUNE PWR switch, pin 15 of U19 should go low. It should remain low until you flip the TUNE PWR switch off. For multiple switch failures, including failures at selected positions of the AUTO/MANUAL BAND and METER switches, look for a problem in one of the resistor packs (R16-R19).

LCD failures.

Typical failure modes for the LCD (DS1) are (1) the loss of an individual segment, (2) a completely blank display, or (3) a display in which the outline of the previous character persists after a new character appears.

(1) A good way to check whether a particular segment is defective is to run the BIT test. During the BIT test, all LCD segments are supposed to be lit. If a segment is not lit, check for a high at its corresponding control line on U28 (a high at the output of U28 turns the segment on). For example, if the center segment of the third character is not illuminated during BIT, check to see whether U28-15 is high during BIT. If it is, replace DS1. If it isn't, replace U28.

(2) If the display is completely blank, do the following:

(a) Check for the presence of the operating voltages (+5 Vdc, GND) at U28 and DS1. If these voltages are good, run the BIT test and check for highs on all the outputs of U28 (pins 3-29, 32, 33, 37-39). If the outputs of U28 are high, replace DS1.

(b) If the outputs of U28 are not high, check for a series of 200 KHz clock pulses at U28-40 every 50 ms, along with a series of data pulses at U28-34. If the inputs to U28 are good, replace U34.

(c) If the clock signal is bad at U28-40, check it at U11-2. Also, check for a low on the LCD OUT EN line (U11-1) while the SER CK line and the SER DATA lines are pulsing. (The LCD OUT EN line allows the SER CK pulses to be buffered through U11A to U28-40.) If the inputs to U11 (including the +5 Vdc and GND operating voltages) are good, replace U11.

(3) If the outline of a previous character persists after a new character appears, the 75 Hz LCD CLK signal is probably bad. Check it at pins 1 and 28 of DS1 and at pin 31 of U28.

LED Failures.

If you suspect that one of the front panel LEDs is defective, run the BIT test. All of the LEDs should be on during the test.

(1) If one LED fails to light, check its driver circuit. The four LEDs are controlled by U26, pins 4-7. A high on one of these pins is applied to the base of its driver transistor, thus turning it and its associated LED on. For example, if the FAULT LED fails to come on during the BIT test, check for a high on U26-4. If U26-4 is low, replace U26. If U26-4 is high, the problem is either in Q1, R6, or DS2.

(2) If two or more LEDs fail to function properly, do the following:

(a) If none of the LEDs comes on, check the supply voltages (+5 Vdc and GND) to U26: pins 15 and 16 should be at +5 Vdc, and pin 8 should be at 0 Vdc. Also, check for a series of 200 KHz clock pulses every 50 ms at pin 3 and a corresponding series of data pulses at pin 2. At the same time, pin 1 should pulse high whenever there is a change in the LED status, such as when switching the LPA from STANDBY to OPERATE. When the clock and data lines are inactive, pin 1 should be low. If all the inputs to U26 are good, replace U26. If not, trace out the defective signal line.

(b) If at least one of the LEDs comes on, replace U26.

6-12. RECTIFIER/BLEEDER PWB ASSY, A8.

WARNING

The Rectifier/Bleeder PWB Assy develops the high voltage (+2000 Vdc) for the Tube Assy. Therefore, do not attempt to measure any voltages on the Rectifier/Bleeder PWB Assy. Limit yourself to resistance measurements with power off and the high voltage shorted out (crowbar switch S5 shorts out the high voltage when the mounting bracket for the Power Control PWB Assy is removed).

a. Preliminary Procedure.

(1) Remove the good Rectifier/Bleeder PWB Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Rectifier/Bleeder PWB Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter).

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the Rectifier/Bleeder PWB Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, start at the beginning of the following procedures and work your way through to the end.

CODE 8

This fault code indicates that with the LPA in STANDBY, the DC plate voltage is greater than +100 Vdc.

Look for an open bleeder resistor: R3 would be a likely candidate.

CODE 9

This fault code indicates that when the LPA is put into OPERATE, the DC plate voltage is not between +1200 and +3000 Vdc.

(1) Check bridge rectifier CR1 with an ohmmeter.

(2) Check the resistance between CR1(+) and ground. Look for an open resistor in the voltage divider circuit.

(3) Check for a short circuit in C1 or VR1.

CODE 10

This fault code indicates that with the LPA unkeyed (bias off) in OPERATE, the plate current is greater than 5 mA.

Look for an open in the B+ SAMPLE line: R7 is the most likely culprit.

CODE 11

This fault code indicates that with the LPA keyed in OPERATE, the plate current is not between 20 and 150 mA.

Look for an open in the +2000 V line (from CR1 to J2): R8 is the most likely culprit.

6-13. DC CONTROL PWB ASSY, A9.

a. Preliminary Procedure.

(1) Remove the good DC Control PWB Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty DC Control PWB Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter). If you are unable to run the BIT test, either from the 100 Watt Transceiver or from the LPA, go to the "Additional Symptoms" section following the fault code discussions.

b. Interpreting the BIT Codes. Use the fault codes listed below as a guide in troubleshooting the DC Control PWB Assy. Refer to the section corresponding to the fault code you get. In the event that the test runs without generating a fault code, run the test again using the DC Inverter Option as the high voltage power source. If you still do not get a fault code, chances are that the DC Control PWB Assy is all right.

CODE 3

This fault code indicates that when the microprocessor read the PRI PWR SAMPLE input to the A-to-D Converter, it found it to be out of range (which is 80 to 120% of the nominal value).

The PRI PWR SAMPLE input to the A-to-D Converter is obtained from a precision voltage divider (R5, R6) in series with the +19 to +30 Vdc from the Low Voltage Power Supply Assy. Measure the voltage across R5 and R6. The voltage across R5 should be 7.67 times greater than the voltage across R6. If the input voltage (+19 to +30 Vdc) is marginally high or low, a slight change in the ratio of these two resistors can generate a Code 3 fault.

CODE 8

This fault code indicates that with the LPA in STANDBY, the DC plate voltage is greater than 100.

Look for a fault in the HV ON circuit, specifically a shorted Q2, which is keeping the high voltage relay (K2) energized in STANDBY.

CODE 9

This fault code indicates that with the LPA in OPERATE, the DC plate voltage is not between 1200 and 3000.

(1) The most obvious cause of this fault is an open Q2 (or a fault in one of Q2's associated components), which is preventing the high voltage relay (K2) from energizing in OPERATE.

(2) Another possibility is a shorted transistor (Q5-Q8) in the step-start relay circuit, which allows the step-start relay to energize as soon as the LPA is put into OPERATE, causing the initial surge current to burn out the high voltage rectifier (CR1 on the Rectifier/Bleeder PWB Assy), thus eliminating the high voltage.

(3) A third possible failure mode is an open transistor (or a fault in one of its associated components), such as Q5-Q8, in the step-start relay circuit, which prevents the step-start relay from energizing in OPERATE. This could cause R1 to burn out, thus opening the primary circuit of high voltage transformer T1 and eliminating the high voltage.

(4) When using the DC Inverter Option, there is another possible failure mode in addition to the ones mentioned above. A failure in the tap change relay circuit could cause the high voltage to be out of range. For example, in a low-line condition (when the +19 to +30 Vdc input is on the low end), if Q1 failed open, the tap change relay could not energize, causing the high voltage to fall below spec. Conversely, in a high-line condition, if Q1 shorted, the tap change relay would remain energized, causing the high voltage to exceed the spec.

ADDITIONAL SYMPTOMS

LPA does not power up.

Look for a problem in the POWER ON circuit: Q3, Q4, and their associated components. Normally, with the POWER ENABLE switch on, the POWER ON SW line goes to +13.5 Vdc when the LPA is commanded to turn on from the 100 Watt Transceiver. R9, R10, and R11 form a biasing circuit which applies a positive voltage to the base of Q4, allowing Power On Relay K1 to energize through it. If the voltage on the +13.5 V line (J1-9, -10) goes above +16 Vdc, VR1 conducts, causing Q3 to turn on. This places the base of Q4 at near ground potential, cutting Q4 off, which in turn cause K1 to deenergize, removing power from the LPA. Among the most probable causes of failure, therefore, are an open Q4, a shorted Q3, or a shorted VR1.

6-14. TEMP SENSOR PWB ASSY, A10.

a. Preliminary Procedure.

(1) Remove the good Temp Sensor PWB Assy from the test-bed 500 Watt Linear Power Amplifier, and replace it with the faulty Temp Sensor PWB Assy.

(2) Connect a dummy load to the output (J5) of the 500 Watt Linear Power Amplifier (hereafter referred to as the 500 Watt LPA).

(3) Power up the 500 Watt LPA from the front panel of the 100 Watt Transceiver.

(4) After the 500 Watt LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter).

b. Interpreting the BIT Codes. Use the fault code listed below as a guide in troubleshooting the Temp Sensor PWB Assy. In the event that the test runs without generating a fault code, check the "Additional Symptoms" section following the discussion of the fault code.

CODE 5

This fault code indicates that the XMTR FAULT line (TP11 on the Power Control PWB Assy) went low, which could have been caused by any of the following:

Low air flow

High ambient temperature

JMP1 on the Power Control PWB Assy not being installed

Since we know that the problem is in the Temp Sensor PWB Assy, we can eliminate the last cause. To determine whether the fault code is generated by low air flow or by high ambient temperature, check whether the LO AIR LED (DS4) or the OVERTEMP LED (DS5) on the

Power Control PWB Assy comes on when the fault is declared.

(1) The LOW AIR LED indicates that the temperature sensed by U2 on the Temp Sensor PWB Assy (as measured by the voltage at TP9 on the Power Control PWB Assy) is at least 15° C to 21° C greater than the temperature sensed at U2 (as measured by the voltage at TP10). This could be caused by either a failure in the fan (which in this case we know is okay) or in one of the temperature sensing circuits (U1, U2, or their associated components). Do the following:

NOTE

This procedure can be performed on a "cold" LPA (one that has been turned off for at least 15 minutes) or a "hot" LPA (one that has been turned on for more than 10 seconds). If you remove the JMP1 jumper (on the Power Control PWB Assy) from a cold LPA, you can begin the procedure immediately (as soon as you turn the LPA on). However, if you remove the jumper from an LPA that has been on for more than 10 seconds, then you must allow 15 minutes for the temperature sensors to stabilize at ambient before doing the procedure.

(a) Remove JMP1 on the Power Control PWB Assy. With the LPA in STANDBY, measure the voltages at TP9 and TP10 on the Power Control PWB Assy. At a room temperature of 21° C (70° F), both test points should read approximately +2.94 Vdc. (For each ° C up or down, the voltage at the test points should increase or decrease by 10 mV.) If TP9 is off by more than a few tenths of a volt, replace U1. If TP10 is off, try adjusting potentiometer R2 on the Temp Sensor PWB Assy to make the voltage at TP10 match that at TP9. If adjusting R2 is ineffectual, replace U2.

(b) If the above procedure does not isolate the problem, install JMP1 and measure the voltages at TP9 and TP10 again. TP10 should read the same as before, but TP9 should indicate an increase of approximately 70 mV (in other words, with the fan running, the heat generated by the conduction of R1 should increase the temperature of U1 by approximately 7° C).

(c) If the results of the above tests are still inconclusive, try transmitting for awhile into the dummy load until the LPA reaches its normal operating temperature (95° C). Measure the voltages at TP9 and TP10 again. TP10 should read approximately +3.68 Vdc, with TP9 approximately 70 mV higher (+3.75 Vdc).

(2) The OVERTEMP LED indicates that the ambient temperature of the LPA, as measured by U2 on the Temp Sensor PWB Assy, is greater than 150° C (302° F). The problem has to be in the U2 temperature sensing circuit. Try adjusting R2 first (see the alignment procedures in Section II of this chapter). If adjusting R2 fails to correct the problem, replace U2.

ADDITIONAL SYMPTOMS

Low forward power.

This could indicate a faulty U2 or a misadjusted R2. In other words, the output voltage of U2 is high enough to initiate power cutback, but not high enough to generate an OVERTEMP fault. First try adjusting R2 (see the alignment procedures in Section II of this chapter). If this fails to correct the problem, replace U2.

6-15. LOW VOLTAGE FILTER ASSY, A11. If this assembly is defective, the problem is most likely a shorted capacitor or an open inductor. You should be able to isolate the faulty component very quickly by taking resistance measurements from the 19-30 V line to ground and from one end of the 19-30 V line to the other.

6-16. DC INVERTER OPTION

a. Preliminary Procedure.

(1) Connect the DC Inverter Option to the test-bed 500 Watt LPA (hereafter referred to as the LPA) using the DC power cable.

(2) Connect a 19-30 Vdc primary power source to the LPA.

(3) Connect a dummy load to the output (J5) of the LPA.

(4) Power up the LPA from the front panel of the 100 Watt Transceiver.

(5) After the LPA is warmed up, run the BIT test. (For a complete description of the events that take place during the BIT test, including the causes of the various fault codes, see the Appendix at the end of this chapter.

b. Troubleshooting Procedure.

The DC Inverter Option's only function is to provide 115 Vac to the primary of high voltage transformer T1. Therefore, when the BIT test is run, a failure in the DC Inverter Option will most likely generate a Code 9, which indicates that the DC plate voltage is not between +1200 and +3000 Vdc when the LPA is commanded to OPERATE. Use the following procedure to troubleshoot the DC Inverter Option:

NOTE

If a circuit breaker pops when you run the BIT test, look for a shorted switching transistor (Q1-Q4) or rectifier diode (CR2, CR3).

(1) Command the LPA to OPERATE.

(2) Using an oscilloscope with a high-impedance probe, check the collectors (cases) of switching transistors Q1/Q2 and Q3/Q4. You should see a square wave whose pk-pk amplitude matches the incoming DC line voltage (19-30 Vdc). The frequency of this square wave should be proportional to the amplitude of the voltage. For example, if the line voltage is 20 Vdc, the frequency of the square wave should be 300 Hz. This frequency should increase at the rate of 15 Hz per volt. Therefore, if the line voltage increases to 28 Vdc, the frequency should increase to 420 Hz. If you have a variable DC power supply, try changing the line voltage and see whether the square wave's voltage and frequency respond accordingly. If the signal here is good, proceed to step 3; if the signal here is bad, skip to step 4.

(3) With an average-reading (e.g., a Simpson) or rms-reading AC voltmeter or an oscilloscope, check the output voltage at P2. The frequency of this voltage should be the same as at the collectors of Q1-Q4. The amplitude of this voltage should be as follows:

Tap Select	Average Meter	RMS Meter	Oscilloscope
Low line	about 160	about 144	320-350 pk-pk
High line	about 170	about 153	350-380 pk-pk

NOTE

Tap selection is taken care of automatically by the microprocessor (on the Micro Control PWB Assy). If the microprocessor senses a low-line condition (19-24 Vdc), a TAP CHANGE signal is sent to Q1 on the DC Control PWB Assy, which applies +13.5 Vdc to tap change relay K1 in the DC Inverter Option. The relay energizes, switching the output of transformer T1 from the orange wire to the yellow wire, increasing the AC output voltage. If the input voltage is 24-30 Vdc (a high-line condition), the relay is deenergized; and the output of T1 is from the orange wire. If you have an adjustable DC power supply, you might try varying the input voltage to check the operation of the tap change relay and to see whether the AC output voltage changes accordingly.

If the signal at P2 is bad, you probably have a bad transformer or a break in the connecting wires.

(4) If the signal at the switching transistors is bad, command the LPA to STANDBY. Connect a storage scope to the emitter of Q1. Command the LPA to OPERATE and then do the following:

(a) Check to see whether K1 (on the circuit board) energizes. If it does, skip to step c. If not, check for +13.5 Vdc at pin 4 of the relay. If the voltage is not there, trace the +13.5 Vdc line back to J1.

(b) If the relay has the correct voltage, check for a problem in Q2 and its associated components. If this circuitry appears to be okay, the problem could be in the shutdown circuit (Q3 and its associated components). The shutdown circuit samples the output of the Q3/Q4 collectors. If the frequency goes much above the nominal 400 Hz, indicating an overload, the voltage developed across the R13/C2 voltage divider, rectified by CR1/CR2, and filtered by C2/C4 turns on Q3, which turns off Q2.

(c) On the oscilloscope, check for a 1 ms start pulse with an amplitude equal to the line voltage (19-30 Vdc). If the start pulse is missing, look for a problem in Q1 or its associated components (R1-R4, R9, C5). The start pulse should occur whenever the LPA is commanded from STANDBY to OPERATE.

(5) If K1 energizes and the start pulse is present, look for a open switching transistor (Q1-Q4) or an open diode (CR2, CR3).

Section IV. REMOVAL/REPLACEMENT PROCEDURES

6-17. REMOVAL/REPLACEMENT PROCEDURES. The following removal/replacement procedures are for the internal components of the A2 Tank Assy only. Removal/replacement procedures for the Tank Assy itself and for the other major subassemblies of the 500 Watt LPA are contained in the On-Equipment Manual, T.O. 31R2-2URC-101.

NOTES

When replacing switches, apply a thin film of Dow Corning No. 200 silicone lubricant to the wiping surface of the switch contacts.

Some of the screws in the following procedures are secured with Loctite No. 222 (purple). Apply a new coating of Loctite 222 when reinstalling these screws.

(1) Wafer Switches

CAUTION

Due to the shape of the shaft that runs through the center of all the wafer switches, it is possible to install the switches correctly or 180° out of phase. Therefore, before removing any of the switches, make sure that the three movable contact arms on the interior switches are pointing toward the front of the Tank Assy (where the Motion Sensor Assy is mounted). Note that in this case, the open position on the Band Select Switch (which is the exterior switch) is oriented toward the front also. When installing a new switch, make sure that its orientation is the same as that of the one you took out.

(a) Band Select Switch

i. Remove the E-ring and pull out the shaft.

ii. Remove the two Phillips screws holding the Band Switch to the chassis.

iii. Unsolder the flexible cable wires from the old switch and solder them to the new switch, being careful to orient the flexible cable correctly.

iv. Mount the new switch to the chassis, making sure that its orientation is the same as for the old switch.

v. Install the shaft and E-ring.

(b) Tune Capacitor Select Switch

i. Remove the shaft and E-ring.

ii. Remove the six Phillips screws holding the Tune Capacitor Assy to the chassis.

iii. Remove the nut and disconnect the upper ring terminal from the rear end of the tuning coil assembly.

iv. At this point, you can replace the entire Tune Capacitor Assy 10086-3740 (which is certainly easier and probably cheaper); or, if desired, you can unsolder the switch and replace it. In any case, make sure that the orientation of the new switch is the same as that of the old one.

v. Install the shaft and E-ring.

(c) Load Capacitor Select Switch

i. Remove the Tune Capacitor Assy. See the above paragraph.

ii. Remove the two Phillips screws and the two standoffs holding the Load Capacitor Assy to the chassis.

iii. Unsolder the bare wire connecting the Load Capacitor Select Switch to the L2 Select Switch.

iv. Cut the cable tie holding the RF output cable to the chassis.

v. At this point, you can replace the Load Capacitor Assy 10086-3760 (this is recommended instead of trying to unsolder the old wafer switch and then soldering in a new one).

vi. To install the new Load Capacitor Assy, reverse the order of the above steps.

(d) L2 Select Switch

i. Remove the Tune Capacitor Assy and Load Capacitor Assy (you don't have to cut the cable tie in this case). See the above paragraphs.

ii. Remove the nut and disconnect the lower ring terminal from the rear end of the tuning coil assembly.

iii. Unsolder the two leads to fixed coil L2.

iv. Remove the two plastic mounting screws and remove the switch.

v. To install the new switch, reverse the order of the above steps.

(2) Coil Drive Motor

(a) Unsolder the flexible cable leads from the coil drive motor and mark them.

(b) Remove the four Phillips screws holding the Coil Drive Assy to the chassis.

(c) Pull the Coil Drive Assy straight out, disengaging the Coil drive Assy coupling from the coil shaft coupling (the pins on one coupling fit into mating slots on the other and vice versa).

(d) Slip the drive belt off the coil drive pulley.

(e) Loosen the setscrew and remove the pulley from the motor shaft.

(f) Remove the two screws holding the motor to the Coil Drive Assy mounting plate.

(g) Remove the motor.

(h) Install the new motor, reversing the order of the above steps and being careful not to disturb the position of the gears.

(3) Band Switch Drive Motor

(a) Slip the drive belt off the drive pulley.

(b) Loosen the setscrew and remove the drive pulley from the motor shaft.

(c) Remove the two Phillips screws holding the motor to the chassis.

(d) Remove the motor.

(e) Unsolder the motor flexible cable leads and mark them.

(f) Install the new motor, reversing the order of the above steps.

(4) Motion Sensor Assy

(a) Loosen the two slotted setscrews on the Motion Sensor side of the white plastic coupling.

(b) Unsolder the four Motion Sensor flexible cable wires, being careful to mark their positions.

(c) Remove the two Phillips mounting screws and remove the Motion Sensor Assy.

(d) Remove the nut and remove the Motion Sensor from its mounting plate.

(e) To install the new Motion Sensor, reverse the order of the above steps.

(5) Limit Switch

(a) Manually position the tuning coil so that it is at least a third of the way from either end stop.

(b) Remove the two Phillips screws holding the Limit Switch Assy.

(c) Remove the nut and remove the Limit Switch from its mounting plate.

(d) Unsolder the Limit Switch from its flexible cable. Note the switch's orientation.

(e) To install a new Limit Switch, reverse the order of the above steps.

(6) Tuning Coil

(a) Manually position the tuning coil to its rear end stop.

(b) Remove the Coil Drive Assy, but do not unsolder any wires (see paragraph 2 above).

(c) Remove the two nuts, and disconnect the two ring terminals at the rear of the coil.

(d) Remove the Tune Capacitor Assy. See paragraph 1b above.

(e) Remove the four Phillips screws from the white plastic handles on the top of the Tank Assy. Note the dress and position of the flexible cable, and be careful not to damage it.

(f) Remove the tuning coil assembly and its coupling half.

(g) Assemble the coupling half to the shaft of the new coil using the 2 setscrews. Manually position the new tuning coil so that it is in the same position as the old one.

(h) Fasten the new tuning coil to the top of the chassis with the four Phillips screws. Make sure that the flexible cable is positioned properly before tightening the screws.

(i) Install the Coil Drive Assy, mating the coil drive coupling to the coil shaft coupling. If the two couplings do not line up, rotate the coil shaft until they do. DO NOT ROTATE THE COIL DRIVE COUPLING.

(j) Tighten the Coil Drive Assy screws.

(k) Install the Tune Capacitor Assy.

(l) Connect the ring terminals to the rear of the coil.

APPENDIX A

CHECKS PERFORMED DURING THE AUTOMATIC BIT ROUTINE FOR THE 500 WATT LPA

NOTE

If BIT is initiated during WARMUP, only the tests up to and including the Band Switch/Servo Coil Test are performed.

1. Front Panel Test. At the start of the test, the front panel is disabled and remains so for the remainder of the test. Also at the start of the test, all front panel LCD segments and LED indicators are turned on. They stay on for the remainder of the test with the exception of the condition when tune power is requested from the 100 Watt Transceiver (see "Keying Test").

2. Micro Control Test. The microprocessor is checked. If its operation is determined to be incorrect, FAULT 2-01 is declared.

3. Primary Power Test. The primary power level is sampled. If it is not between 80 and 120% of the nominal value, FAULT 2-03 is declared.

4. Low Voltage Supply Test. The 13.5 V supply is sampled. If it is not between 10 and 16 Vdc, FAULT 2-04 is declared.

5. Transmitter Fault Test. If the XMTR-FAULT signal line (temperature sensor) is active, FAULT 2-05 is declared.

6. Band Switch/Servo Coil Test. For this test, a band other than the current operating band is selected for the band switch. Once this position is reached, the switch returns to the current operating band position. If the switch does not turn, or if it takes over 10 seconds to reach the selected band, FAULT 2-06 is declared. The coil is moved to MIN L and then to MAX L, and the coil position counter is checked at both limits. If the coil does not move, or if the position counter is inaccurate, FAULT 2-07 is declared. If the 500 Watt LPA is in WARMUP, no further testing is done.

7. High Voltage Test. With the 500 Watt LPA in STANDBY, FAULT 2-08 is declared if the DC plate voltage is greater than 100 volts. The 500 Watt LPA is put into OPERATE. If the DC plate voltage is not between 1200 and 3000 volts, FAULT 2-09 is declared. If the plate current is greater than 5 mA, FAULT 2-10 is declared.

8. Bias Test. The power amplifier bias is turned on (the LPA is keyed without RF drive). If the plate current is not between 20 and 150 mA, FAULT 2-11 is declared.

9. Keying Test. An RF MUTE message is sent to the 100 Watt Transceiver. If the RF input signal level is not below 6 watts in 200 milliseconds, FAULT 2-12 is declared. If the RF input falls below 6 watts, the T/R relay is keyed and the RF MUTE signal is removed. Tune Power Request (TPR) and Transmit Gain Control Tune Power Request (TGC TPR) messages are sent to the 100 Watt Transceiver. The message "rF" is sent to the METER LCD display to let the operator know that RF input power is required to complete the test. This message remains until the RF input signal level is greater than 5 watts. If the RF input signal is not greater than 5 watts in 20 seconds, FAULT 2-13 is declared. If the RF input signal level is sufficient, the power amplifier plate current is checked. If the power amplifier plate current is not between 160 mA and 280 mA, FAULT 2-14 is declared. The DC plate voltage is checked again at this point; and if it is not within the previously specified limits for the OPERATE mode (1200 to 3000 Vdc), FAULT 2-09 is declared.

10. Tuning Test. A TGC Lock command is sent to the 100 Watt Transceiver. Using the auto-tuning software, the coil is moved toward MIN L while searching for a tune peak. If no tune peak is found, FAULT 2-15 is declared. When the tune peak is found, forward power is checked. If the forward power is not between 30 watts and 90 watts, FAULT 2-16

is declared. If the forward power is normal, the VSWR is checked. If the VSWR is not less than 2.25:1, FAULT 2-17 is declared. If the VSWR is normal, the ratio of forward power to RF input power is checked. This ratio must be between 5 and 60. If not, FAULT 2-18 is declared. Tune Power Request Off, TGC Tune Power Request Off, and TGC Lock Off commands are sent to the 100 Watt Transceiver when this part of the test is completed.

11. Transceiver Serial Link Test. As in normal operation, certain failures in the serial link to the transceiver during the BIT test cause FAULT 2-21 to be declared.

12. Test Completion.

(a) The BIT tests described in the above paragraphs are continued until a fault is encountered. When a fault is flagged, all further testing is aborted.

(1) If the BIT test was initiated from the 100 Watt Transceiver, the fault code is displayed on the transceiver LCD display. The fault code will also appear on the LPA's LCD display if the METER selector switch is placed in the STATUS/FAULT position. The fault code may be cleared by commanding the LPA to OPERATE from the 100 Watt Transceiver or by moving the METER selector switch out of the STATUS/FAULT position.

(2) If the BIT test was initiated from the LPA, the fault code is displayed on the LPA's front panel meter. The fault code will also appear on the transceiver's LCD display if "2ND," "TEST" is pressed. To remove the LPA from the test mode, the METER selector switch must be moved out of the STATUS/FAULT position. The fault code may be cleared by commanding the LPA to OPERATE from the 100 Watt Transceiver (if the LPA is placed back in AUTO) or by moving the METER selector switch to the STATUS/FAULT position and then out again.

(b) If no fault is encountered during any of the tests, the following occurs:

(1) If the BIT test was initiated from the 100 Watt Transceiver, the message "PASSEd" is displayed on the transceiver front panel for 5 seconds; and the LPA front panel returns immediately to its normal operating mode.

(2) If the BIT test was initiated from the LPA, the message "PASS" is displayed on the meter. The message will remain there as long as the METER selector switch is in the STATUS/FAULT position. When the selector switch is moved out of the STATUS/FAULT position, the message disappears and the LPA front panel returns to its normal operating mode.

APPENDIX B

Meter Functions and Normal Operating Ranges

Position	Function	Range/Units	Normal (STBY/ WARMUP)	Normal (OPERATE, KEYED IN CW)
PRI PWR (%)	Displays the average primary power input as a percentage of the nominal value	0% to 166%	90 to 110	90 to 110
13.5 VDC	Displays the average output of the low voltage power supply	0 to +22 Vdc	11 to 16	11 to 16
DC PLATE (VOLTS)	Displays the average plate voltage of the power amplifier tube	0 to +3300 Vdc	0	1600 to 2300*
I_K	Displays the average cathode (plate) current of the power amplifier tube	0 to 2000 mA	0	350 to 500*
RF IN (WATTS)	Displays the peak RF input power from the 100 Watt Transceiver	0 to 250 W	0 to 100**	10 to 40*
RF PLATE (VOLTS)	Displays the peak RF voltage at the plate of the power amplifier tube (with respect to the average DC voltage)	0 to 3300 Vdc	0	800 to 1100*
FWD PWR (WATTS)	Displays the peak forward power at the RF output	0 to 750 W	0	200 to 300
REFL PWR (WATTS)	Displays the peak reflected power at the RF output	0 to 750 W	0	0 to 25 depending on load*
ANT VSWR	Displays the peak ratio of the mismatch between the 1 KW LPA and its load, be it antenna, antenna coupler, or dummy load	1:1 to 999:1	0	1:1 to 2:1*
COIL POS	Displays the servo coil position	100 to 1770	Refer to the Tune Chart, Figure 3-1	
STATUS/ FAULT	Displays a fault code. If the FAULT light is lit and the meter is switched to theSTATUS/FAULT position, a fault code will be displayed. When the selector switch is moved out of the STATUS/FAULTposition, the fault code will be cleared and the FAULT light will be turned off.	Fault codes		

*With a power output of 250 Watts, as indicated on the FWD PWR meter.
**With the transceiver keyed; otherwise, the reading will be 0 W.

APPENDIX C

Performance Specifications

NOTE

The following specifications assume that all normal operating voltages are applied to the circuit board or assembly. No special test fixtures are required to measure the specifications, other than standard test equipment.

Output Filter PWB Assy 10086-4500

PARAMETER	TEST CONDITIONS	ADJUSTMENT	TEST POINT	SPECIFICATION
VSWR Bridge Null	100 W at 16.0 MHz into J3; 158 Vac at J5	R4	J6-5	Null
Forward Power Sample	Same as above	R7	J6-8	+7.0 ±0.05 Vdc
		None	J4	0.280 to 0.680 V pk-pk

Low Voltage Power Supply 10086-1500

PARAMETER	TEST CONDITIONS	ADJUSTMENT	TEST POINT	SPECIFICATION
Output Voltage	LPA in STBY; 1.1 A current load; +17 ±1 to +36 ±2 Vdc into J1-15	R23	Q8-C	+13.5 Vdc
	Same as above	None	Q10-C	115 Vac at 400 ±40 Hz