keyed. The MANUAL LOCAL KEY switch is active only in the MANUAL mode. When the MANUAL LOCAL KEY switch is activated, any previous fault indications will be cleared. If a fault is detected while this switch is active, the 1 KW LPA will drop back to STANDBY and the MANUAL LOCAL KEY switch must be turned off before the fault can be cleared. The MANUAL LOCAL KEY switch will key only the 1 KW LPA; the 100 Watt Transceiver must be keyed independently.

d. MANUAL TUNE Switch. The MANUAL TUNE switch allows the operator to fine tune the 1 KW LPA by controlling the position of the servo coil. Moving the switch to the left or to the right causes the coil to be moved toward MIN L or to MAX L by discrete steps. Holding the switch either to the left or to the right causes the coil to continue being moved by discrete steps, and causes the step size to be increased. The MANUAL TUNE switch is active only in the manual mode.

e. ANTENNA Loading Selection. The ANTENNA loading switch controls the output impedance to the antenna for the 1 KW LPA in the MANUAL mode. The 1 KW LPA microprocessor controls the output impedance to the antenna in the AUTOmatic mode. The manual ANTENNA switch selects between LOW Z, 50 OHMS, and HIGH Z loading. When a new ANTENNA switch position is selected, in the manual mode, the 1 KW LPA microprocessor will not make the impedance change until after an RF MUTE request is sent to the 100 Watt Transceiver and the 1 KW LPA is unkeyed.

f. SELF TEST Button. With the AUTO/MANUAL BAND switch in any position except AUTO (the band selected should contain the frequency displayed on the 100 Watt Transceiver's front panel) and with the METER switch in the STATUS/FAULT position, pushing the SELF TEST Button initiates the BIT (Built-In-Test) procedure. The BIT procedure tests all functional modules and displays failures on the meter display when the STATUS/FAULT position of the METER switch is selected. At the start of the test, all front panel LCD segments and LED indicators are lighted. They remain lighted until the test is completed.

NOTE

If the test is initiated while the LPA is in warmup (STANDBY LED was flashing before the SELF TEST button was pushed), only fault codes 2-01 through 2-08 can be displayed. This is because the full routine cannot be run until the LPA is warmed up (refer to the automatic diagnostic BIT test description in the Appendix at the end of Chapter 6).

(1) A "PASS" message on the METER display indicates that the BIT (Built-In-Test) has been passed.

(2) A fault code (0001 through 0022) on the METER display indicates that a part of the test has failed. All further testing is stopped. Refer to Table 6-2 (in Chapter 6) for an explanation of the fault codes.

(3) Moving the METER switch out of the STATUS/FAULT position removes the LPA from the test mode. The fault code may be cleared by commanding the LPA to OPERATE from the 100 Watt Transceiver (if the LPA is placed in AUTO) or by moving the METER selector switch to the STATUS/FAULT position and then out again.

g. METER Select Switch. The METER select switch controls the inputs to the METER LCD display. The eleven possible functions that can be displayed are shown in Table 6-1 in Chapter 6. Table 6-1 describes each function, indicates the range of measurement of each function, and indicates what the normal operating ranges are.

4-9. TRANSCEIVER CONTROLLED OPERATIONS. Automatic tuning of the 1 KW LPA is controlled completely by the companion 100 Watt Transceiver when the AUTO/MANUAL BAND select switch is in the AUTO position.

4-10. MICROPROCESSOR CONTROLLED OPERATIONS.

a. Meter Display Update.

(1) Periodically the microprocessor reads the appropriate inputs and calculates a new value for the METER LCD display. The Meter Display routine is inactive during the BIT routine. The analog inputs are read every 100 milliseconds and an average or peak value is displayed every second for the functions indicated in table 4-2.

Table 4-2. Meter Display Reading

Meter Function	Type of Reading
PRI PWR (%)	Average
13.5 VDC	Average
DC PLATE (VOLTS)	Average
I_K	Average
RF IN (WATTS)	Peak
RF PLATE (VOLTS)	Peak
FWD PWR (WATTS)	Peak
REFL PWR (WATTS)	Peak
ANT VSWR	Peak

(2) If COIL POS is selected, the coil position is displayed. Range is 100 to 1770.

(3) If the STATUS/FAULT position is selected and the FAULT LED is lit, a fault code is displayed. When the METER select switch is moved out of the STATUS/FAULT position, the fault code is cleared and the FAULT LED is turned off.

b. Fault Check. The 1 KW LPA performs periodic status checks on itself whenever it is energized. These checks are performed automatically and require no interaction or commands from the operator. These checks include the following and result in the indications or actions listed:

Check	Result
LPA temperature, I_K (cathode current)	If out of range for more than 2 seconds, the FAULT light comes on and the LPA goes into STANDBY (STANDBY light comes on)
Primary power, 13.5 V power supply, DC plate voltage, Forward power output, Reflected power output	If out of range for more than 3 seconds, the FAULT light comes on and the LPA goes into STANDBY (STANDBY light comes on)
The 1 KW LPA also performs operational status checks on itself. During tuning, keying, STANDBY/OPERATE status changes, it checks for expected reactions from the band switch, tuning coil, key relay, RF input sensor, forward and reflected power sensors, and the sensors for cathode current, DC plate voltage, and RF plate voltage. It also checks the serial control data link between the 100 Watt Transceiver and the 1 KW LPA.	If a fault is detected, the FAULT light comes on and the LPA goes into STANDBY (STANDBY light comes on)

NOTE

When the FAULT light comes on, the appropriate fault code will be displayed on the meter if the selector switch is moved to the STATUS/FAULT position. When the meter selector switch is moved out of the STATUS/FAULT position, the fault code will be cleared and the FAULT light will be turned off. The fault can also be cleared by commanding the 1 KW LPA back to OPERATE from the 100 Watt Transceiver's front panel or from the 1 KW LPA's front panel (if in manual); but if the fault condition continues to exist, the FAULT light will come on again.

c. Built-In-Test (BIT). The BIT software for the 1 KW LPA tests all of its functions for the purpose of detecting hardware faults. For instructions on how to initiate the BIT test, see paragraphs 3-4 and 3-5; for a complete description of the events that occur during the BIT test, see the Appendix at the end of Chapter 6.

CHAPTER 5

THEORY OF OPERATION

5-1. INTRODUCTION. The 1 KW LPA is a microprocessor based amplifier designed for automatic operation with other HF transmitting and receiving system elements. In addition to the many automatic operating features, the amplifier also includes fault detection and isolation features and manual operating options as required to satisfy sophisticated user requirements.

a. Tuning. Tuning is either completely automatic, in response to serial data inputs from a compatible 100 Watt Transceiver; or manual, using the few simple front panel setup controls. Tuning times are minimal, limited only by the travel times for the servo-controlled tuning element. These circuits work with the microprocessor control system to minimize travel and response times.

b. Metering and Protection Circuits. Metering and protection circuits provide the operator and technician with visual feedback for all vital performance indicators. Similar inputs to the microprocessor continuously work to protect the unit and to provide optimum performance.

5-2. FUNCTIONAL ASSEMBLIES. Figures 5-1 and 5-2 are simplified functional diagrams of the 1 KW LPA that show all input and output functions. Figure 5-1 shows the RF signal path, and Figure 5-2 shows the support functions group. All major component assemblies are shown in a functionally related format. The microprocessor controls these functions to automate and optimize performance for a wide range of conditions. It is important that the technician understand these interrelationships so that the equipment can be most effectively used and maintained. The major subassemblies can be divided into four major subgroups as follows:

a. The RF signal processing subgroup, consisting of A1, A2, A3, and A10.

b. The power control subgroup, consisting of A3, A5, and A8.

c. The microprocessor control system, which includes the front panel, and consists of assemblies A6 and A7.

d. The support supply function, consisting of A4 and A9.

5-3. RF SIGNAL PROCESSING.

a. Refer to figure 5-1. RF drive from the 100 Watt Transceiver enters the 1 KW LPA at A3J3 on the rear panel and is routed by T/R relay A3K1 to the A1 tube assembly in the transmit mode. In the receive mode, A3K1 is deenergized and the J5 ANTENNA input is connected through the A10 LP Filter Assembly to A3J3 for receiver operation. T/R switching is controlled by the A6 PWB in response to an LPA Key Control input from either the 100 Watt Transceiver or the LPA front panel. The 100 Watt Transceiver RF input level is sampled and detected on the A3 assembly to develop metering and logic control outputs.

b. All amplification is accomplished by a single power triode operating in a grounded grid configuration. RF drive from the 100 Watt Transceiver is applied to the cathode circuit. Both cathode bias and cathode current for the power triode are controlled by the A5 Power Control PWB in response to both keyline and tune control signals. An RF plate voltage sample is sensed at the A1 Tube Assembly for use by the A6 Micro Control PWB Assembly for tuning and by the A5 Power Control PWB Assembly for protection against high plate voltage swings. Because of the power triode configuration, only one B+ voltage is required. The 3000 Vdc for this purpose is supplied by the Power Supply PP-7913/URC. The output of the A1 Tube Assembly goes directly to the A2 Tank Assembly.

c. The plate impedance of the power triode of the A1 Tube Assembly is transformed to the output antenna impedance, nominally 50 ohms, by the A2 Tank Assembly. The Tank Assembly contains seven component subassemblies as shown in figure 5-1. All functions are controlled by the A6 Micro Control PWB assembly in response to inputs from the A1 Tube Assembly and either the 100 Watt Transceiver or the front panel. Subassemblies A2A1 through A2A5 make lumped capacitance and inductance changes through a bandswitch controlled by an open-seeking

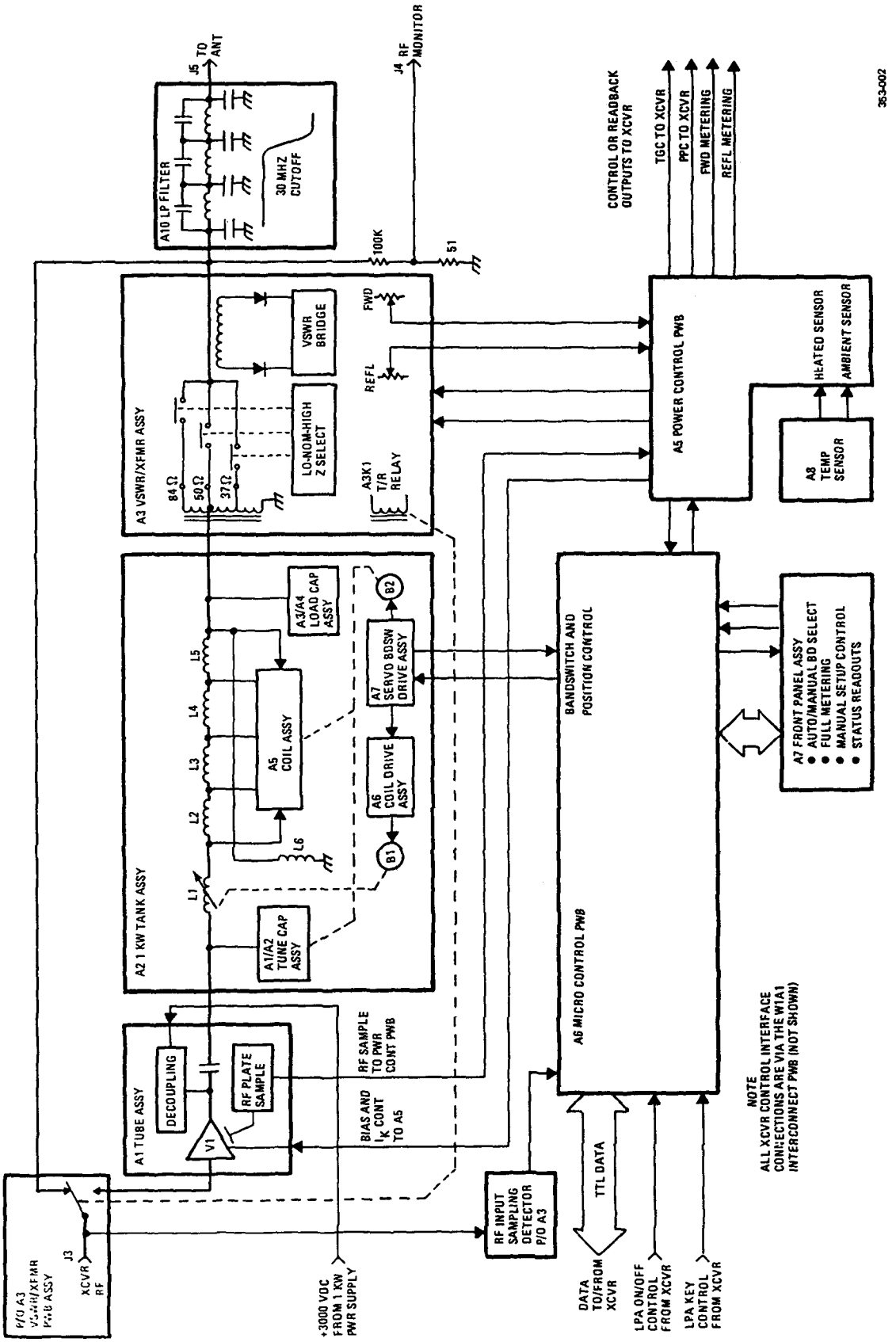

Figure 5-1. Functional Block Diagram

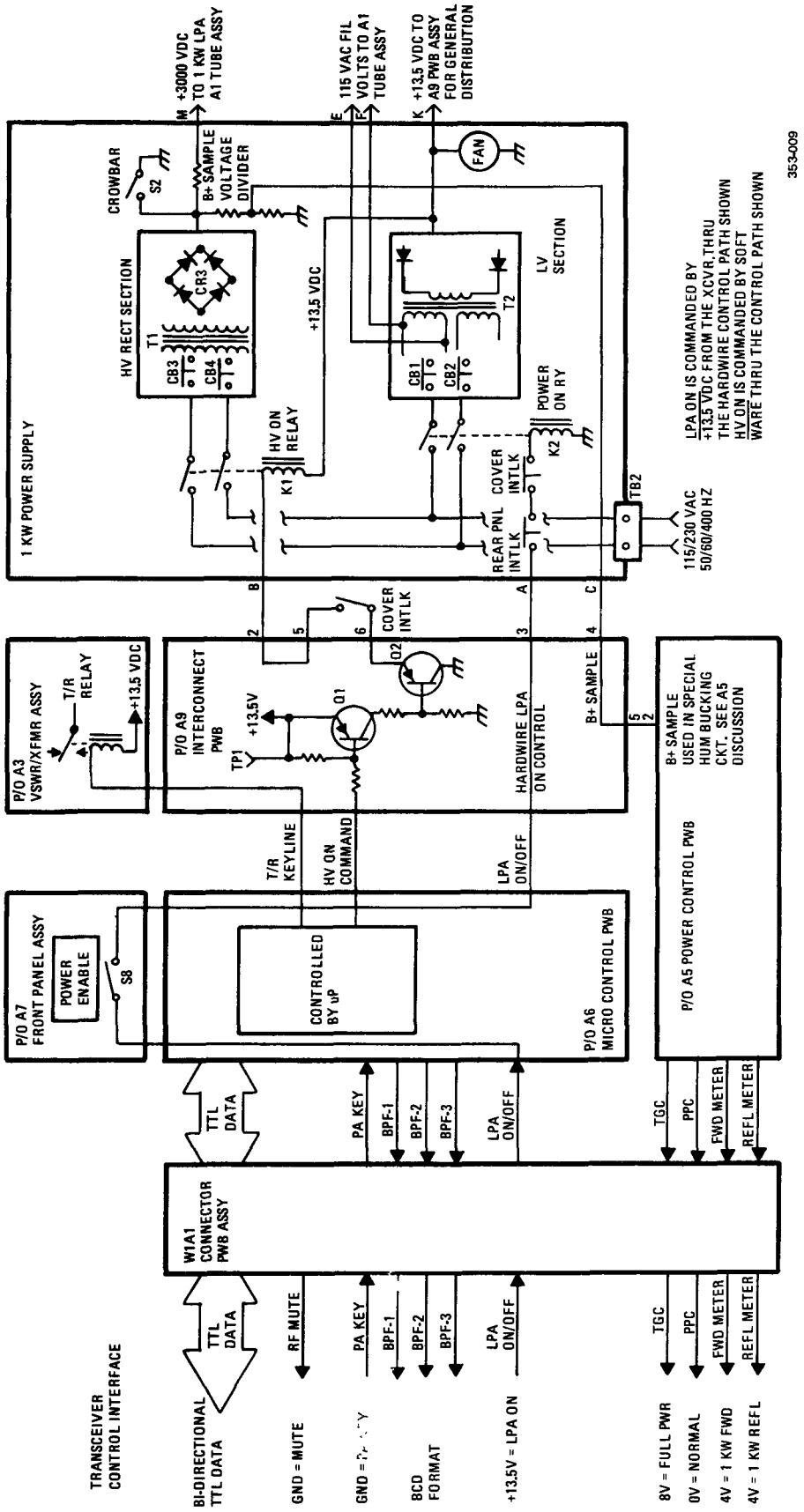

Figure 5-2. Support Function Block Diagram

wafer, motor B2, and subassembly A2A7. Fine tuning is accomplished by variable inductor A2L1 driven by subassemblies A2A6 and A2A7.

d. The output from the A2 Tank Assembly is applied to the A3 VSWR/XFMR Assembly through impedance transformer T1, as shown in figure 5-1. The microprocessor automatically selects either the high, the nominal, or the low impedance transformation tap to optimize performance into various VSWRs. The VSWR Bridge, also part of the A3 Assembly, provides very precise analog outputs that are directly proportional to the forward and reflected power components on the output transmission line. These outputs are used for metering, power control (TGC and PPC), and in a number of software related control functions at A6. A separate 50 ohm RF Monitor is provided at J4. This provides a divided down sample of the rf output voltage that is usable with common test equipment.

e. RF output from the VSWR/XFMR Assembly is routed through the A10 Low Pass Filter Assembly to the J5 ANTENNA connector. The Low Pass Filter Assembly is designed to attenuate all signals, both harmonic and spurious, above 30 MHz, while not affecting those below 30 MHz. The nominal output impedance is 50 ohms.

f. Figure 5-2 shows the complete control interface between the transceiver and the 1 KW Power Supply. The power supply provides all operating voltages required at the 1 KW LPA other than the 115 Vac 400 Hz required for the B1 Fan Assembly. This voltage is generated at the A4 Fan Inverter, using +13.5 Vdc from the 1 KW Power Supply as the source. As shown in figure 5-2, all functions are controlled by the microprocessor, other than the LPA ON/OFF command, which is hardwired.

5-4. POWER CONTROL SUBGROUP. The power control subgroup consists of the A5 Power Control PWB Assembly, the Temperature Sensor PWB Assembly and the VSWR/XFMR Assembly. The Power Control Assembly uses the signals from the VSWR/XFMR Assembly to generate a TGC control signal that is representative of the envelope of the RF output signal. The TGC control signal is routed to the 100 Watt Transceiver for control of the system RF output level. The transceiver compares the TGC signal to an internal IF sample and adjusts its drive to maintain these two samples at equal amplitudes. Thus, if the IF sample is low, the power output of the 1 KW LPA will be correspondingly low. The advantage of this type of control is that the system gain does not vary unnecessarily. As an example, should the operator stop talking, the system gain control loop does not increase in an attempt to artificially maintain a given output. Instead, the comparator type of TGC control system used maintains the same peak-to-valley ratio in the 1 KW LPA output as in the 100 Watt transceiver IF. The TGC signal in the 1 KW LPA is modified by the reflected power sample from the VSWR/XFMR Assembly and by the ambient temperature sample from the Temperature Sensor PWB Assembly as well as from other samples on the Power Control PWB Assembly, i.e. cathode current sample and RF plate to DC plate comparison sample, in order to maintain the 1 KW LPA within its safe operating parameters.

5-5. MICROPROCESSOR CONTROL. The microprocessor control system consists of the A6 Micro Control PWB Assembly and the A7 Front Panel Assembly. The Micro Control has a 64K memory and operates at a clock rate of approximately 5 MHz. It controls the automatic tuning and operating sequences for the 1 KW LPA. The Front Panel Assembly provides monitoring, metering, and manual controls as described in chapter 4.

5-6. SUPPORT FUNCTION GROUP. The W1A1 Connector PWB serves only as a wiring interface and contains no active components. The A9 Interconnect PWB serves a similar function; however, this PWB also includes the HV ON Relay Driver and logic level inverting transistor required to interface the Micro Control PWB A6 output with the HV ON Relay in the 1 KW Power Supply.

5-7. DETAILED DISCUSSIONS. The detailed discussions for each subassembly contain simplified functional diagrams, as appropriate. Refer also to the related schematic (circuit board schematics are contained in the depot manual) and the Interconnection Diagram FO-4, for circuit detail. The discussions are grouped functionally, in the same order used in the introductory paragraphs.

5-8. TUBE ASSEMBLY A1. Refer to the 1 KW Watt Tube Assembly schematic diagram in the Depot Manual, and also to figure 5-3, for this discussion. Figure 5-3 is a simplified diagram of the bias and I_K limit control circuits for the amplifier.

a. Cathode Circuits. The power triode, V1, is connected in a cathode driven, grounded grid

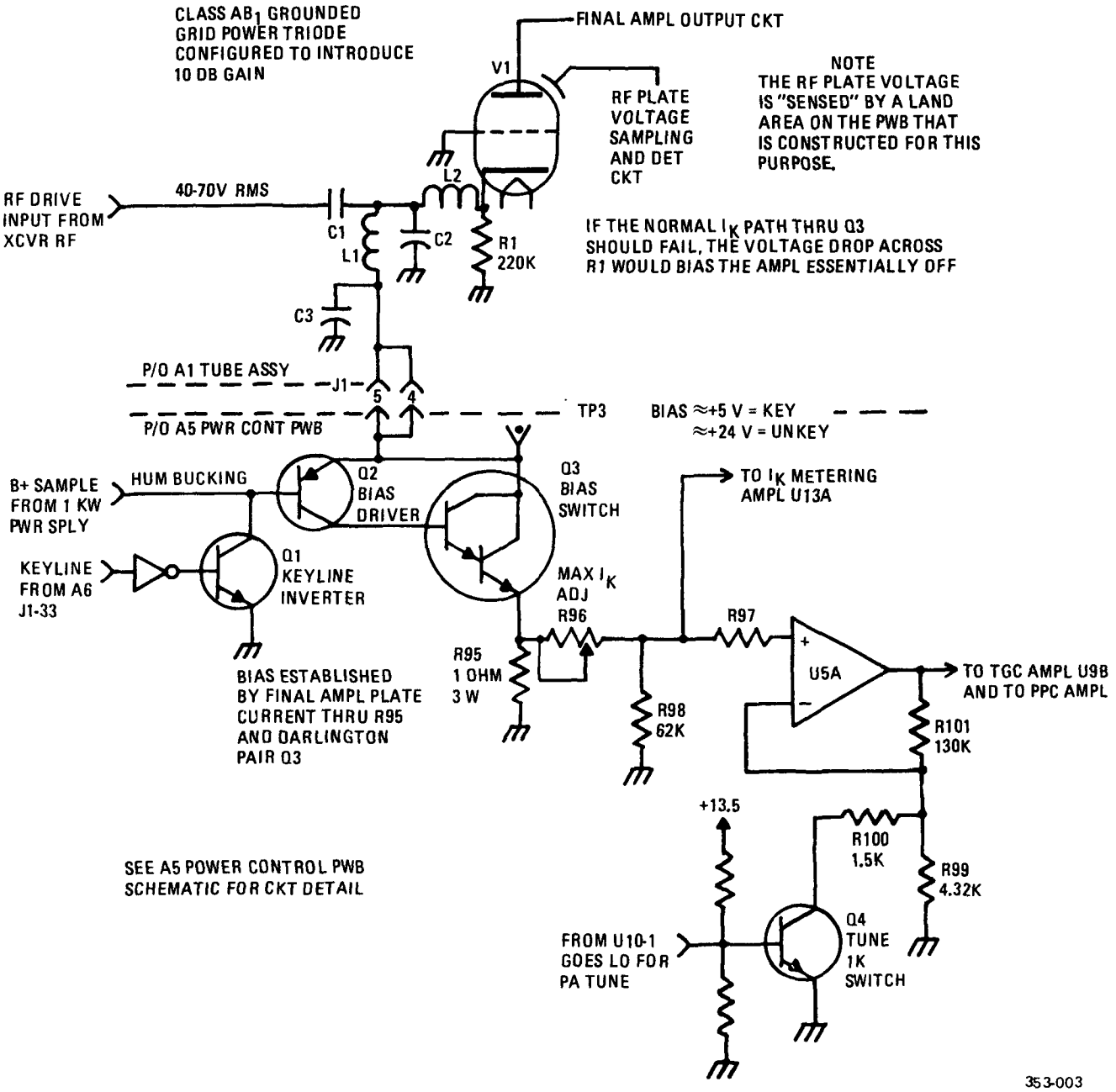

Figure 5-3. Bias and I_K Limit Control

configuration. In this configuration, the tube is biased off with a positive voltage with respect to the grid, which is at ground potential. This voltage, approximately 20 volts, guarantees that the tube does not conduct when the transmitter is unkeyed. When the LPA is keyed, the tube is biased on, at approximately 10 volts, for class AB operation. Rf drive from the transceiver is applied to the cathode of the tube, causing the bias voltage to vary about the DC bias point. This variation causes the tube to conduct more when the bias voltage decreases and conduct less as the voltage increases. The rf voltage swing at the plate of the tube varies in phase with voltage variation at the cathode, causing amplification of the Rf drive present at the cathode of the tube.

With the transmitter keyed, the 100 Watt Transceiver output is connected through the T/R relay on the VSWR/XFMR PWB Assy to the RF input, A1J1-9, of the Tube PWB Assy. A1C1 is a DC blocking capacitor that prevents the cathode bias voltage from being fed back to the transceiver's output. Capacitor A1C2 and inductor A1L2 are a high frequency L-C matching network. The cathode bias voltage from the Power Control PWB Assy enters the Tube PWB Assy through connector A1J1-4/5 and is rf filtered by capacitor A1C3 and inductor A1L1. If the normal cathode bias circuit should fail open, resistor A1R1 at the cathode of V1 would develop a cutoff bias for V1. For a complete discussion of the bias circuit see paragraph 5-12-f for the Power Control PWB Assy. The cathode of the amplifier tube, V1, is indirectly heated by an isolated filament whose power, 5 Vac, is derived from the secondary of filament transformer T1. The primary voltage, 115 Vac, of T1 enters the tube Assembly through A1J1-12 and A1J1-14.

b. Plate Circuits. The DC plate voltage enters the Tube PWB Assy through a high voltage connector, P1, and is filtered by plate choke L1 and bypass capacitor C5. The rf output of tube, V1, passes through the output coupling/DC blocking capacitor C4 to the output connector. The DC plate voltage is sampled and divided down to a level usable by both the Power Control PWB Assy and the Micro Control PWB Assy by resistors R1 and A1R2. Zener diode A1VR2 provides protection and capacitor A1C4 acts as an rf bypass.

c. RF Plate Sample Circuit. The rf plate sample circuit provides an output that is proportional to the rf voltage present at the plate of the tube. This output is used by the Micro Control PWB Assy for tuning of the Tank Assy and is compared with a DC plate voltage sample as part of the power control and protection circuitry on the Power Control PWB Assy.

The RF plate sample circuit is made up of a capacitor divider, a peak detector, and a resistor divider. The capacitor divider is formed by capacitors C2 and C3. Diode CR1, inductor L2, and capacitor C7 form the peak detector. Resistors A1R3, A1R4, and A1R5 divide the output of the peak detector to a level that is usable by the Micro Control PWB Assy. One volt of output at A1J1-3 represents 1000 volts of peak rf voltage swing at the plate of the tube. VR1 prevents the output at J1-3 from going above a level that is usable by the Micro Control PWB Assy.

5-9. TANK ASSEMBLY A2. Tank Assembly A2 includes all of the reactive tuning and loading components and their related control systems. Schematic coverage for this assembly is on two separate schematics (in the depot manual). The overall assembly schematic includes all detail except the Servo/Bandswitch Drive Assembly. A separate schematic details the Servo/Bandswitch Drive Assembly only.

a. RF Circuits. The Tank Assembly uses a pi network to transform the output impedance, nominally 50 ohms, to a higher impedance at the plate of the amplifier tube, nominally 1600 ohms. The pi network is composed of bandswitched tune capacitors, Tune Cap PWB Assemblies A1 and A2, variable inductor L1, fixed inductors on coil PWB Assembly A5, bandswitched load capacitors, and Load Cap PWB Assemblies A3 and A4. Both the Tune CAP PWB Assemblies and the Load Cap PWB Assemblies are made up of groups of fixed capacitors that are added together by a three-pole bandswitch. As an example, the tune capacitors for band 1 are capacitors A1C1, A1C2, A1C3, A1C4. A1C5, and A1C6, while the tune capacitors for band 2 are A1C3, A1C4, A1C5, A1C6, A1C7, and A1C8. Likewise, the Load Cap PWB Assy follows in a similar manner. The fixed inductors on the Coil PWB Assembly are switched in and out by bandswitch S1C (refer to figure 5-4). Bandswitch S1 (S1A, S1B, and S1C) is driven by motor B1 whose control is from the Servo/Bandswitch Drive PWB Assy and open seeking switch wafer S2. The variable coil L1 is the only tuning element in the Tank Assy, and its control is through the Coil Drive Assy and the Servo/Bandswitch Drive PWB Assy.

b. Bandswitch Drive Circuit. The Servo/Bandswitch Drive PWB Assy A2A7 is the control interface for all

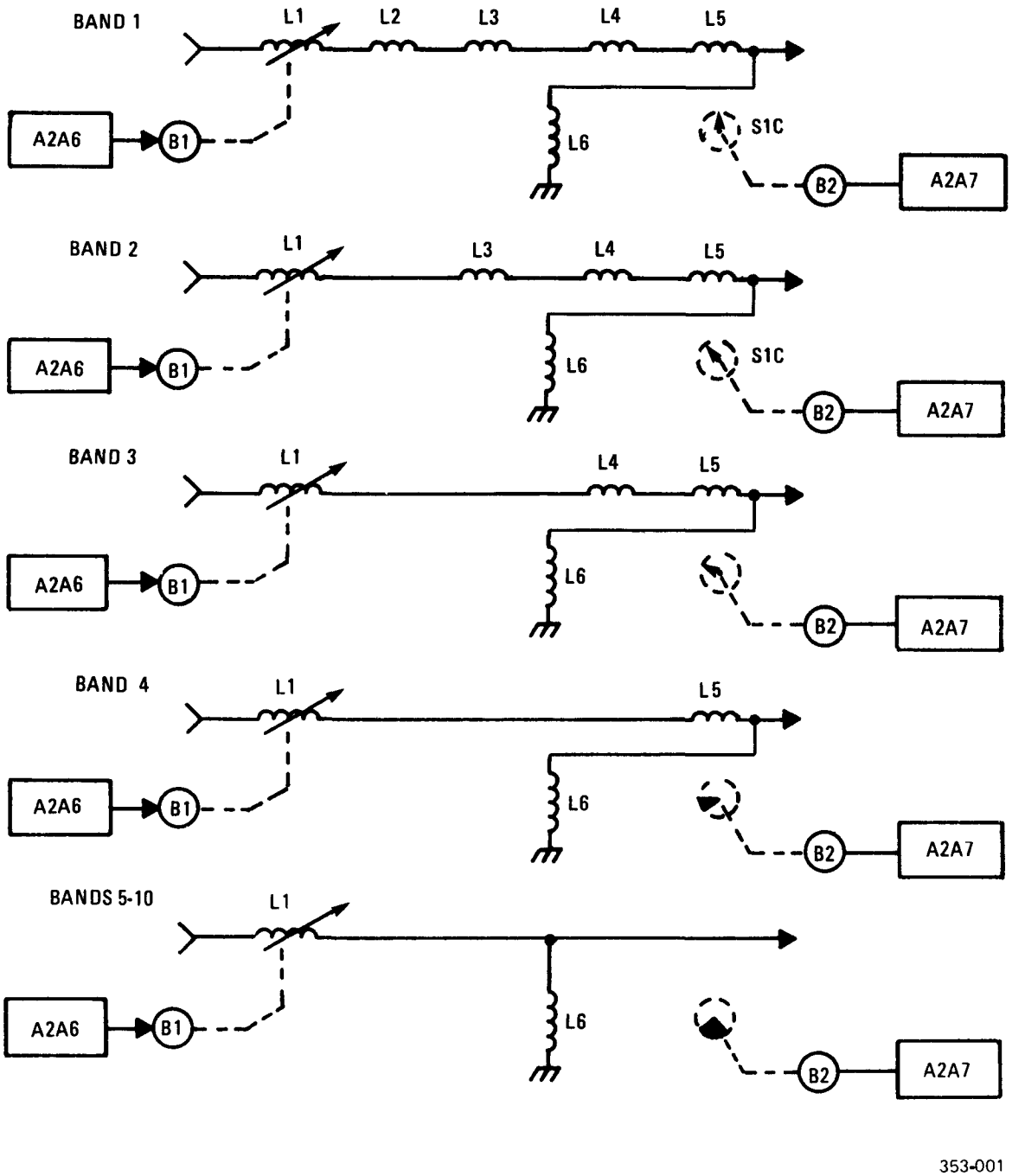

Figure 5-4. S1C Selected Output Inductor Sections

units that make up the Tank Assembly A2. All control is from the Micro Control PWB Assy A6. Bandswitch control from A6 is a BCD code which is converted to a decimal code by BCD-to-decimal decoder A7U1. The output of U1 presents a high, 5 volts, on one of the ten output lines indicating the band that is selected. The ten outputs are connected to the bandswitch decoding wafer, S2, through steering diodes A7CR5 through A7CR14 and RF filters A7R43 through A7R46 and A7C16 through A7C25. The decoding wafer is open seeking; that is, when a new band is selected, the output of the decoder U1 for that band goes high. That output is connected through its steering diode and rf filter to switch S2, through S2 and its common, S2-C, back to the Servo/Bandswitch Drive PWB Assy. The high from S2-C turns on bandswitch drivers A7Q10 and A7Q11, energizing the bandswitch motor B1 through connector A7J3-1/2 and A7J3-3/4. The bandswitch motor runs until the decoding wafer's common opens at the band selected, removing the high from the bandswitch drive transistors and the drive to the motor. Resistors A7R21 and A7R22 divide the output motor voltage, 13.5 volts, down to 5 volts for a signal to the Micro Control PWB Assy to indicate that power is being supplied to the bandswitch motor. The Micro Control PWB Assy then generates an RF Mute signal to remove rf drive from the 100 Watt transceiver to prevent hot switching of the bandswitches.

c. Coil Drive Control Circuits. All in-band tuning is accomplished by the Coil Drive Assy A6 and Servo/Bandswitch Drive PWB Assy A7.

The Coil Drive Assy, A6, contains the coil drive motor, A6B1, and a limit switch, A6S1, which indicates when the variable coil is at either minimum or maximum inductance. Also, the A6 assembly has a shaft encoder, G1, that rotates turn for turn with the variable inductor. The outputs of the encoder, TWA and TWB, are pulses that are representative of the degree of rotation of the variable inductor. The two signals are shifted in phase such that the direction of rotation can be determined by sampling and comparing the two outputs.

The Servo/Bandswitch Drive PWB Assy, A7, contains the coil drive circuit. Since the circuit for driving the variable inductor toward minimum inductance is identical to that which drives the inductor toward maximum inductance, only one of the circuits will be discussed.

Control for driving the inductor toward minimum inductance enters the A7 assembly through J1-15. MIN L DRIVE, a low level signal, biases transistor Q4 on, which in turn biases both Q5 and Q6 on. With Q5 on, 13.5 volts is present at connector J2-5/6; and with Q6 on, ground is present at connector J2-7/8. This places 13.5 volts across the motor, such that it rotates the inductor toward minimum inductance. The MIN L DRIVE signal also biases Q7 on through resistor R13, which places 13.5 volts at the base of Q1. This inhibits Q1 from turning on, preventing the MAX L drive circuit from being active.

When no drive signal (either MIN L DRIVE OR MAX L DRIVE) from the Micro Control PWB Assembly is present at the A7 Assembly, the coil drive motor A6B1 is dynamically braked. Q9 is biased on through resistor R15. This biases both Q3 and Q6 on, which in turn places a ground at both J2-5/6 and J2-7/8 and across the motor. When either the MIN L DRIVE or MAX L DRIVE signal is present, Q9 is biased off through either CR2 or CR1, respectively, biasing both Q3 and Q6 off.

Limit switch information, either MIN L STOP or MAX L STOP, enters the A7 Assembly at J2-16 and J2-14. These signals are a high level, 13.5 volts. When the MIN L Stop is active, indicating that the variable inductor is at minimum inductance, transistor Q4 is biased off through CR16, thus inhibiting the MIN L drive circuit and shutting off the drive to the motor. Also, Q14 is biased on, applying a ground to J1-5, which indicates to the Micro Control PWB Assembly that the inductor is at minimum inductance. The Micro Control Assembly the removes the MIN L DRIVE signal.

The 5 volt regulator circuit supplies 5 volts for the encoder A6G1 and the BCD-to-decimal decoder A7U1. This circuit is made up of pass transistor Q12, zener diode VR1, and bias resistor R24. Resistor R23 drops part of the voltage, reducing the power dissipation in Q12; and capacitors C13 and C14 filter the output.

5-10. VSWR/XFMR PWB ASSEMBLY A3. Refer to the VSWR/XFMR schematic diagram for the following discussion. This schematic is found in the Depot Manual.

The VSWR/XFMR PWB Assembly contains an RF IN sample, a T/R relay, a VSWR bridge, an rf sample of the output power, and a transformer circuit that is

used to aid in matching the output impedance of the Tank Assembly to the antenna load impedance.

The RF IN sample contains a capacitor divider of the RF input, a peak detector, and a resistor divider network. Capacitors C11 and C12 form the divider sampling the RF input from the 100 Watt Transceiver. Inductor L6, diode CR4, and capacitor C13 make up the peak detector. Resistors R12 and R13 divide the output of the peak detector to a level usable by the Micro Control PWB Assembly for sampling and display.

T/R relay K1 switches the RF input from the 100 Watt Transceiver from the antenna when in receive to the Tube Assembly when in transmit.

The VSWR bridge is designed to provide analog outputs for both the forward and the reflected power output components. Current transformers T2 and T3 and resistors R2 and R3 produce a voltage that is proportional to the current on the RF output line. Capacitors C1 and C2 provide a voltage divider on the RF output line. The above two voltages are vectorily added to produce two voltages. One voltage is proportional to the forward power and one is proportional to the reflected power. Resistors R4 and R5 and capacitor C4 provide an adjustment to balance the bridge into a purely 50 ohm resistive output impedance. Diode CR1 rectifies the reflected sample, while diode CR2 recitifies the forward sample. Resistor divider R6 and R7 provides a calibrated output for the reflected power sample. This sample is nominally adjusted for 7 volts output for 1000 watts reflected. Likewise, resistor divider R8 and R9 provides a calibrated output for the forward power, which is also set for 7 volts at 1000 watts forward output.

An rf monitor is picked off the rf output line between the VSWR bridge and the output connector P2. Resistors R10 and R11 comprise a voltage divider whose output is capable of being connected to standard test equipment.

The impedance transofrmer T1 is used to better match the antenna impedance to that of the Tank Assembly. The transformer has three taps, one that equates to an antenna impedance of 36 ohms, one at 50 ohms, and one at 81 ohms. The Micro Control PWB Assembly monitors the forward power sample and the rf plate voltage sample during the tune cycle. When the ratio of the rf plate voltage to the forward power is below a specified value, the Micro Control PWB Assembly actives the LOW Z input (an active low). When the ratio is within the specified window, the NOM Z input is activated. And when the ratio is higher than a specified value, the HIGH Z input is activated.

When the NOM Z input is selected, the active low biases on transistor Q2, which applies a positive 13.5 volts to the NOM Z relay K2. Relay K2 closes, connecting the output of the Tank Assembly directly to the antenna output connector P2.

When the LOW Z input is selected, the active low signal biases on Q1, which applies a positive 13.5 volts to the LOW Z relay K3. The rf output of the Tank Assembly is connected through transformer T1 and relay K3 to the antenna output connector P2. Transformer T1 and relay K3 to the antenna output connector P2. Transformer T1 has a 7:6 turns ratio, which equates to an impedance transformation of 49:36 ohms, thus optimizing the tank impedance for an antenna impedance of 36 ohms.

When the HIGH Z input is selected, transistor Q3 is biased on, activating HIGH Z relay K1. The rf output of the Tank Assembly is connected through transformer T1 with a 7:9 turns ratio. This equates to an impedance transformation of 50:81 ohms, thus optimizing the Tank Assembly's output impedance for matching to an antenna impedance of 81 ohms.

Only one of these inputs is active and then only when the LPA is in the transmitting mode. When in receive, all inputs are inactive, disconnecting the Tank Assembly from the antenna.

5-11. FAN INVERTER PWB ASSEMBLY A4. The schematic for the Fan Inverter Assembly is located in the Depot Manual. The assembly contains a fan inverter circuit that converts the 13.5 Vdc to 115 Vac at 400 Hz.

The fan inverter circuit contains both a driver transformer, T1, which sets the frequency of oscillation and an output transformer, T2, which sets the output voltage. The 13.5 volt output of the regulator circuit is applied to the center tap of the output transformr and to the center tap of the driver transformer through a filter network, capacitors C1 and C2 and inductor L1, and a bias network, C3, CR1, R1, R2, and R3, which supplies the return path for the driver transistors, Q1 and Q2. Resistor R4 provides an offset voltage across T1 such that transistor Q2 is

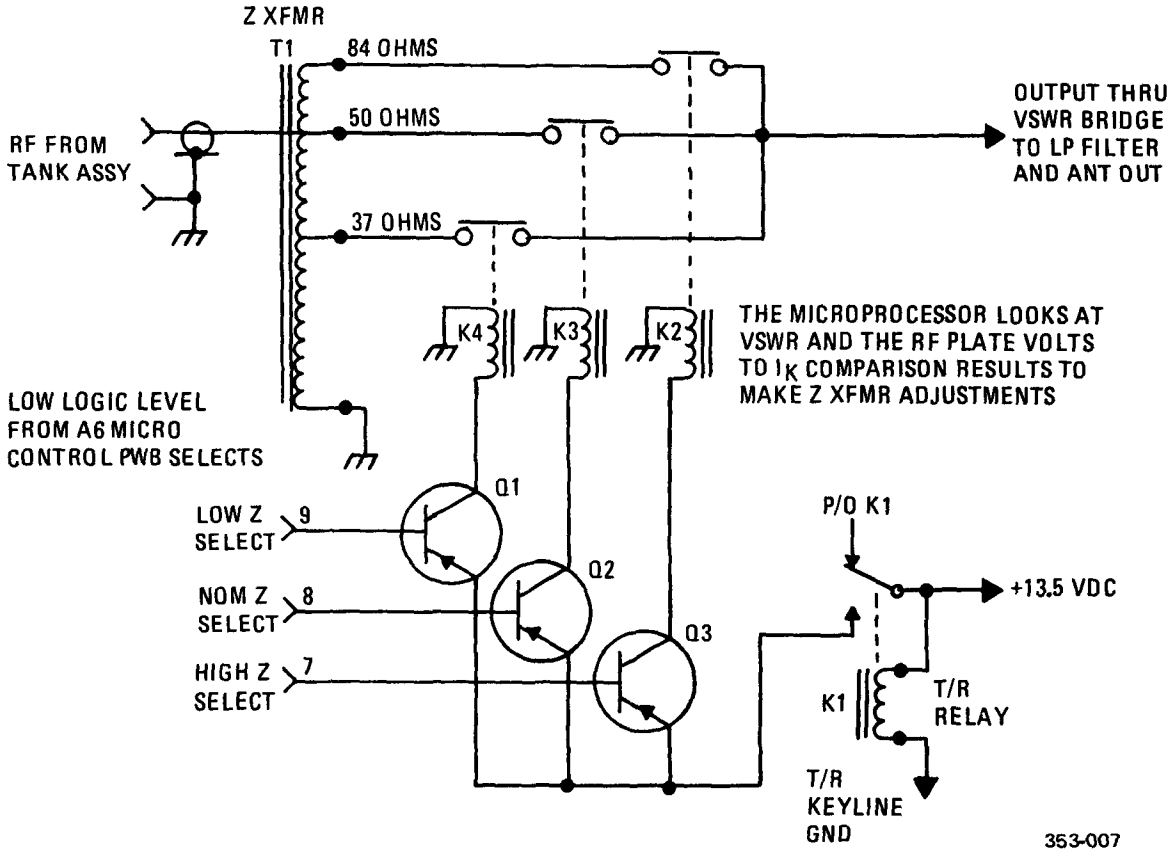

Figure 5-5. Z Transformation Simplified Diagram

biased on more than Q1 when power is first applied. This starts the inverter oscillating.

As Q2 conducts, a voltage is induced in winding T2-5/6 with a polarity that makes terminal 5 more positive than terminal 6. Then, by transformer action, terminal 1 is more positive than terminal 2. A voltage is also induced in driver transformer T1's primary that makes terminal T1-5 more positive than T1-1. By transformer action, secondary winding terminal T1-10 is more positive than terminal T1-8, causing Q2 to be more strongly forward biased. This action continues until Q2 is driven into saturation. When this occurs, the primary voltage can no longer increase and a condition of quasi-stable equilibrium is maintained. With a constant voltage across the windings, both the current and the magnetic flux increase until the core reaches saturation. At this time, the exciting current required by the transformer exceeds that which can be supplied by the Q2, causing Q2 to turn off. As the flux in the transformer collapses, the polarity in the transformer is opposite to that originally induced. Therefore, Q1 is biased on and is driven to saturation in a like manner. The flux will then again collapse, turning off Q1 and turning on Q2, thus completing the cycle. R-C networks R5/C4 and R6/C5 provide snubbing action to protect the transistors from any spikes that might be generated.

The AC voltage induced in the primary of T2 is coupled by transformer action to the secondary and to the output pins of J2. Capacitor C6 provides a phase shift for the fan.

5-12. POWER CONTROL PWB ASSEMBLY A5.

The Power Control PWB Assembly performs the following functions: meter processing, TGC and PPC generation, cathode biasing, and temperature sensor processing. Figure FO-2 is a simplified diagram of the Power Control PWB Assembly. The Power Control PWB Assembly schematic is located in the Depot Manual.

a. Meter Processing Circuits. The forward and reflected power samples from the VSWR/XFMR PWB Assembly A3 are directed to the Power Control PWB Assembly for processing for both metering information for the LPA front panel and for power control processing for generation of the TGC and PPC control signals.

The forward power sample enters the Power Control PWB Assembly at J2-8. Resistor network R5 and R9 sets the appropriate bias level for the forward power sample from the output filter. Operational amplifier U1A has a gain of one and acts as a buffer to prohibit any interaction between the VSWR bridge on the VSWR/XFMR Assembly and the processing of the signal on the Power Control PWB Assembly. Diode CR1, resistors R15, and capacitor C5 peak detect the forward power sample, while divider network R17 and R19 sets the full power voltage to 4 volts at the input to FWD METERING AMP U2A. Amplifier U2A also has a gain of one and supplies the forward metering sample to the Micro Control PWB Assembly through J1-9 and to the 100 Watt Transceiver through J1-17. Zener diode VR4 inhibits the output from going above 5.1 volts.

The reflected power sample enters the Power Control PWB Assembly at J2-7. Resistor network R6 and R27 sets the appropriate bias level for the reflected power sample from the VSWR/XFMR PWB Assembly. Operational amplifier U1B has a gain of three and acts as a buffer to prohit any interaction between the VSWR bridge on the VSWR/XFMR PWB Assembly and the processing of the signal on the Power Control PWB Assembly. Diode CR2, resistor R16, and capacitor C6 peak detect the reflected power sample, while divider network R18 and R20 sets the full power reflected voltage to 4 volts at the input to REFLD METERING AMP U2B. Amplifier U2B also has a gain of one and supplies the forward metering sample to the Micro Control PWB Assembly through J1-6 and to the 100 Watt Transceiver through J1-18. Zener diode VR5 inhibits the output from going above 5.1 volts.

b. TGC Circuits. The TGC signal is generated from a combination of the forward power and reflected power samples. FWD/REFLD AMP U3A uses the higher of the two signals to generate the TGC signal. The reflected power sample becomes equal to the forward power sample when the output VSWR is 2:1. At VSWRs above 2:1, the reflected power sample will be the dominant sample and thus control the level of the TGC voltage. The gain of U3A is adjustable from 1 to 1.25 and is set to amplify the input voltage to 8 volts as well as compensate for any variation of the IF sample in the 100 Watt Transceiver. The output of U3B is fed to the Control Loop Variable Gain Amp consisting of U9A and U8.

Unijunction transistor U8 acts as a voltage variable resistor which modifies the gain of amplifier U9A. As the voltage at U8-3 goes negative, the gain of U9A is increased, causing the envelope of the forward

and/or reflected power sample to increase. This increase is detected by the 100 Watt Transceiver's TGC circuits as an rf power output signal increase, causing the rf power drive level to be reduced. There are four inputs that can cause a gain change if any of their thresholds are exceeded. The four inputs are the CW/FSK power threshold, the I_K cathode sample, the over temperature threshold, and the RF/DC plate sample.

The TGC output of amplifier U9A is connected through solid state switch U10 to output amplifier TGC Amp U9B. Switch U10 controls which signal is used as the TGC signal to the transceiver. When the LPA is in the tune mode, switch U10 is open, causing the power control of the LPA to be generated by the cathode current sample; and when in the ready mode, U10 is closed, enabling the control through the above path. LED DS1 indicates that there is TGC voltage being sent to the 100 Watt Transceiver, and diode CR26 prevents the TGC signal from going negative.

c. CW/FSK Power Control. This control is not normally used in the 1 KW LPA, but its operation if used is described below.

The forward/reflected power envelope is sampled through diode CR5 from the output of the FWD/REFLD Amp in the TGC control circuit by an averaging network consisting of diode CR6, capacitor C10, and resistors R32 and R33. Resistor R34 provides an adjustment of the output of this network to the input of the CW/FSK Avg Pwr Amp, U4A, which has a gain of two. The output of U4A is diode or-ed with the cathode sample, the ambient temperature sample, and the RF/DC plate sample to the Gain Control Threshold Amp U4B. When any of these samples exceed the threshold of 5 volts set by resistor divider R42 and R43, the output of U4B goes positive. The output of U4B is inverted by Gain Control Polarity Inverter U7A and fed to the controlling input of the unijuction transistor U8, thus increasing the gain of the Control Loop Gain Amp U9A and thereby causing the output power of the LPA to be decreased.

d. PPC Control Circuit. The PPC control circuit samples the outputs from the RF/DC plate comparator, the cathode current amplifier, and the FWD/REFLD Amp U3A. The cathode current sample and the forward/reflected power sample are divided by resistor network R107 and R108 and diode ORed to the output of the RF/DC plate comparator and inputted to the PPC Unit Gain Amp U5B. Amplifier U5B has unity gain and acts as a buffer amplifier to supply a PPC voltage to the 100 Watt Transceiver where it is thresholded at 5 volts. When the output of the PPC amplifier exceeds this level, the transceiver's PPC circuits cause the transceiver's Rf output to drop to minimum output, thus causing an immediate power cutback out of the LPA. This circuit is used only as protection in the event that the TGC does not or cannot react to an overload to prevent damage to the LPA. The output of the PPC amplifier is also fed to the PPC Indicator Threshold Amp U13B. When the PPC output voltage exceeds 5 volts as set by resistor divider R116 and R117, the output of U13B goes high, lighting LED DS2, which indicates that the control loop is under PPC control.

e. RF/DC Plate Voltage Comparator. The peak rf voltage swing at the plate of the amplifier tube A1V1 is compared to the DC plate voltage. If the rf voltage swing approaches the maximum available swing as set by the DC plate voltage, a voltage is generated by the RF/DC Comparator and fed to both the TGC circuit and the PPC circuit for power cutback. This prevents the RF plate voltage swing from equalling the DC plate voltage and thus will prevent excessive grid current from being drawn by the amplifier tube.

The RF plate sample enters the Power Control PWB Assembly on connector J1-36 and is fed to the Micro Control PWB Assembly through J1-10 for monitoring and display. Likewise, the DC plate sample enters the Power Control PWB Assembly through J1-1 and is fed to the Micro Control PWB Assembly through J1-8. Zener diode VR7 and resistor network R83, R84, and R85 set both the threshold level and the gain of the RF/DC Comparator U3B. When the threshold is exceeded (this varies directly with the DC plate voltage), the output of U3B goes high and is fed to both the TGC through diode CR29 and the PPC circuit through CR18. The rate at which the rf plate voltage approaches the DC plate voltage will determine whether the TGC loop or the PPC loop will control the output power.

f. Cathode Current and Bias Circuits. The Power Control PWB Assembly contains both the cathode bias circuit and the cathode current control and metering circuits.

The cathode bias is set by the B+ sample voltage, resistors R93 and R94, and transistors Q1, Q2, and Q3. When Q1 is biased off, the amplifier tube is biased off at approximately 20 volts. This voltage is

set by a resistor divider network in the 1000 Watt Power Supply, resistors R93 and R94, and transistors Q2 and Q3. An active low KEYLINE signal present at J1-3 is inverted by Keyline Schmitt Trigger U11A to a high, which biases on Q1 and shorts out R94, lowering the voltage at the base of Q2 to about 5 volts, thus biasing on Q2, Q3, and A1V1. The B+ sample also contains an AC component that is representative of the AC ripple on the DC plate supply. This affects the bias point in such a way that the AC hum component on the RF output signal is cancelled or reduced.

Resistor R95 in the emitter lead of Q3 measures the cathode current. The resultant voltage is divided by resistors R96 and R98 and amplified by amplifier U5A. Resistor R96 is used to adjust the maximum plate current allowable before TGC/PPC cutback will take place. The gain of U5A is changed from approximately 31 during normal operation to approximately 120 during a tune cycle by the Tune I_K Switch being biased on by resistor R106 when Control Logic Switch U10 is open.

The LPA tunes on constant cathode current, and this is controlled by the output of U5A being fed to the input of the TGC Amp U9B through resistor R62 and diode CR16. During the TUNE mode, switch U10 is open, removing the forward/reflected power signal from the input to the TGC Amp and releasing the ground from diode CR15, allowing CR16 to conduct. During normal operation, switch U10 is closed, connecting the forward/reflected signal to the TGC Amp and grounding CR15, which reverse biases CR16 and biases off Tune I_K Switch Q4 through CR14.

The output of the cathode current amplifier is connected to the Gain Control Threshold Amp U4B through diode CR10, resistor divider R47 and R48, and diode CR8. If the output of the amplifier exceeds 7.4 volts, then the threshold of the Gain Control Threshold Amp causes the gain of the TGC loop to increase, thus reducing the RF power output. In addition, the output of the I_K amplifier U5A is connected to the PPC Amp U5B through CR19 to generate a PPC signal if the cathode current should exceed approximately 800 milliamperes.

g. Control Logic Switch. Control Logic Switch U10, in addition to switching the TGC input from the forward/reflected sample in normal to the cathode current sample in tune, also removes the internal power control potentiometer from the circuit in tune mode and antenna tune mode. Also, U10 switches the coupler tune power potentiometer into the TGC circuit when the antenna tune mode is selected (an active low signal). Both the Power Control potentiometer and the Coupler Tune Power potentiometer feed voltages to the input of the TGC Gain Control Polarity Inverter, which increases/decreases the gain of the TGC loop, thereby reducing/increasing the RF output power of the LPA.

h. Temperature Sensor Circuits. The Power Control PWB Assembly contains the processing circuits for the Temperature Sensor PWB Assembly outputs. There are two outputs for the temperature sensor: an output that is proportional to the ambient temperature and one that is proportional to the air flow past the sensor assembly.

The ambient sensor input at J2-3 is directed to two comparators, one for air flow and one for overtemperature. The output of the sensor is 10 millivolts per degreee Kelvin, which correlates to 2.73 volts for 0 degrees Centigrade. The Over Temp Threshold Amp U6B compares the output of the ambient sensor to the threshold voltage equating to 150 degrees C, above which its output goes positive. The output of the amplifier is directed to the variable gain stage of the TGC loop through diode CR11, resistors R49 and R47, and diode CR8, thus causing cutback of the output power when this threshold is exceeded. If the ambient temperature is not reduced through power cutback but increases, this increased level is detected by Fault Inverter U11E. The output of the inverter goes low, indicating a XMTR FAULT and causing the LPA to go in standby. Feedback resistor R152 sets up a hysteresis loop in the Over Temp Threshold Amp so that once cutback has occurred, the temperature must decrease beyond a certain point before the LPA can be brought back to full output power.

The ambient sensor output is also compared to the heated sensor input by Air Flow Comparator U6A. When the heated sensor is between 15 and 21 degrees above the ambient sensor, the output of the Air Flow Comparator goes positive, such that the Air Flow Fault Threshold Amp U7B is enabled. The positive output of U7B goes positive lighting LED DS4, LO AIR, and causing the output of Fault Inverter U11E to go low, indicating a XMTR FAULT.

i. -8 Volt Regulator. The -8 volt regulator consists of an oscillator, an amplifier, a rectifier, and a filter. Schimitt Trigger Oscillator U11C, resistor R129, and capacitor C51 form an oscillator whose frequency is

approximately 12 KHz. Power Amp U12 amplifies the output of U11C to 13.5 volts. Capacitor C54 couples the output of U12 to rectifiers CR24 and CR25 and filter C55. The output voltage is approximately -8 volts.

5-13. MICRO CONTROL PWB ASSEMBLY A6. The Micro Control PWB Assembly controls all functions within the LPA except for Power Enable, which is a hardwired signal from the 100 Watt Transceiver used to turn on the LPA, and TGC/PPC control signals that are hardwired and under control of the Power Control PWB Assembly. Refer to the Micro Control PWB schematic for the following discussion. This schematic is found in the Depot Manual.

a. Transceiver Data Link. Data between the 100 Watt Transceiver and the LPA is serialized and transmitted via a two wire link. Opto isolator U4 isolates the link from the receive data input of microprocessor U1. The TXD output of microprocessor U1 is normally high when in the receive mode. This output biases transistor Q2 on through hex buffer U10-4/5, which enables the opto isolator's input for reception of data from the 100 Watt Transceiver. The receive data from U4-1 is inverted by NAND gate U3-5/6/4 and inputted to the RXD input of the microprocessor. The transmit data is from the TXD output of the microprocessor and is transmitted to the 100 Watt Transceiver via hex buffer U10-4/5, transistor Q2, and opto isolator U4.

b. Clock Circuits. The clock control signals for the Micro Control PWB Assembly are generated by the clock oscillator circuit. This circuit consists of crystal oscillator Y1, capacitors C38 and C39, resistors R1 and R2, and hex inverters U8-1/2, U8-3/4, and U8-5/6. The output frequency of this circuit is 4.9152 MHz. This signal is connected to both the XTAL1 input of microprocessor U1 and a dual 4-bit counter, U31, from which all other clock frequencies are derived.

Three outputs of counter U31 are used. The 614.4 KHz clock is used for the clock for the analog to digital converter U6. The 307.2 KHz clock output is inputted to counter U32 where it is further divided down to a 150 Hz clock. This is connected to the second 4-bit counter of U31 where it is divided down to produce a 9.373 Hz clock. This clock is inverted by hex inverter U17-1/2 and ANDed with the power on reset circuit of resistor R20 and capacitor C13 by NAND gate U3-1/2/3. The output of U3 is connected to the reset line of microprocessor U1. This both holds the microprocessor reset until the power supply stablizes during power on and resets the micro if U31 is not reset within the clock frequency (approximately every .1 seconds) by the P3.4 output of U1 going low.

Counter U32, in addition to the 150 Hz clock, has three other clock outputs: a 153.6 KHz clock, a 300 Hz clock, and a 75 Hz clock. The first two are used by microprocessor U1, while the 75 Hz clock is used by the Front Panel PWB Assembly as the clock for the data display by the LCD.

c. Interrupts. The microprocessor has two interrupts: one is the 300 Hz clock, and the other is generated from the inputs of the Tank Assembly coil drive encoder, TWA and TWB. The TWA signal is shaped by schmitt trigger inverter U17-9/8 and fed to an edge detector circuit, capacitors C36 and C37, resistors R5-8 and R5-10, and hex inverter U17-5/6. This circuit detects both a positive going and a negative going pulse. Likewise, the TWB signal is shaped by U17-11/10 and fed to an edge detector circuit, capacitors C24 and C29, resistors R5-6 and R5-7, and hex inverter U17-3/4. These four outputs, TWA positive going, TWA negative going, TWB positive going, and TWB negative going, are ORed and inverted by NOR gate U26. The output of U26 is fed to the second interrupt of microprocessor U1. When any motion of the coil drive assembly is detected, the microprocessor is interrupted and records the motion of the variable inductor, thus keeping track of its position.

d. Input Latch. The input latch U28 converts eight parallel inputs to a BYTE word that is read into the microprocessor as required. Five of these inputs are from the Tank Assembly: BD SW ON indicates bandswitch motion, TWA and TWB indicate direction and rotation of the variable inductor, and MIM L LIMIT and MAX L LIMIT indicate when the variable inductor is at either end stop. The EXT INTLK input is not used. The XMTR FAULT is from the Power Control PWB Assembly and indicates a temperature fault. LPA KEY is a hardwired signal from the 100 Watt Transceiver, and when low activates the keylines in the LPA. The microprocessor polls the input latch as required by software by enabling the output enable input (OE) of U28.

e. Analog to Digital Converter. A/D Converter U6 converts any one of the eight inputs to a digital BYTE that is representative of the analog signal. All inputs are based on a 5 volt maximum value, while the output

is an 8 Bit word. Microprocessor U1 selects which input is to be converted through address inputs A0, A1, A2, and address enable input ALE of U6. The START input of U6 starts the conversion process, while the OE input enables the output lines so that the microprocessor can read the BYTE word.

f. Microprocessor Circuits. The microprocessor U1 is an 8 bit control oriented CPU. It contains a 128 byte read/write data memory, a full duplex UART, two 16 bit timer/counters, a programmable I/O, a 64 K byte bus expansion control, and oscillator and clock circuits. It can address up to 64 K bytes of external program memory and/or 64 bytes of external data.

The external program memory is contained in EPROM U2, while the data is held both in the on-chip memory as well as in the external RAM U29.

Input/output ports P0.0 through P0.7 serve as both address data outputs as well as data inputs. I/O ports P2.0 through P2.7 serve only as output address ports. Latch U12 latches the output address data, while the I/O ports are accepting data. Address decoder U27 decodes the address and the read and write commands for control of the external RAM U29, the Input Latch U28, the A/D Converter U6, and the Output Latch U13. Parallel to serial converter U15 converts up to eight parallel inputs to a serial eight bit word. The 1000 Watt LPA identification bit (KW ID) is the only input to U15.

I/O ports P1.0 through P1.7 are used for control and data to/from the Front Panel Assembly. Data is sent to and received from the Front Panel Assembly in serial form through the serial data line. Serial Clk is the clock signal for clocking in/out data to/from the shift registers on the Front Panel Assembly. LCD OUT ENABLE enables the LCD display, while F.P. IN ENABLE enables the front panel switch data to be sent to the microprocessor. F.P. OUT ENABLE enables the front panel LEDs.

g. Output Latches. Serial data from the microprocessor is clocked into 2 serial to parallel output latches U19 and U25 for control of the LPA. Output drivers U20 and U30 are open collector darlington transistor arrays that act as buffers between the output device and the serial to parallel latches. One output RF MUTE is sent to the 100 Watt Transceiver as a hardwired input for shutting off the RF drive form the transceiver during certain LPA operations.

Output Latch U13 is a parallel in/parallel out latch for latching parallel data from the microprocessor to the output. These outputs are also buffered by an open collector darlington transistor array and serve as control for the Tank Assembly.

There are a number of hardwired jumpers on the Micro Control PWB Assembly that program the method of control of the keylines. Both the T/R KEYLINE and the KEYLINE are programmed to be under microprocessor U1 control according to the inputs from either the 100 Watt Transceiver in AUTO mode or the front panel in MANUAL mode.

5-14. FRONT PANEL ASSEMBLY A7. The Front Panel Assembly contains both display and manual controls for operation of the LPA. Display is from both a group of LEDs and from an LCD whose input is controlled by a rotary switch. There are four toggle switches, one pushbutton switch, and two rotary switches.

a. LED Display. Information for four of the five LEDs is sent to the Front Panel Assembly via the serial data line from the Micro Control PWB Assembly. The serial data is clocked into the serial to parallel converter U26 by the F.P. OUT EN signal from the Micro Control PWB Assembly. The data is converted to parallel data by U26, and the parallel outputs of U26 drive their respective LED transistor drivers and LEDs.

The fifth LED, POWER ENABLE, is controlled by the 5 volt supply from the Micro Control PWB Assembly to indicate that power is present in the LPA.

b. LCD Display. The LCD display DS1 is a 4 digit, 8 segment display that is driven by LCD driver U28. The information for display is serially clocked into the driver chip U28 by the LCD CLK line and the LCD OUT EN line from the Micro Control PWB Assembly.

c. Manual Control Switches. Manual control switches, TUNE PWR, LOCAL KEY, TUNE, AND ANTENNA, as well as the SELF TEST pushbutton switch, are inputted to parallel in serial out chip U20. When the microprocessor activates the FP IN EN line along with the SERIAL CK, the data from the switches is sent to the microprocessor on the Micro Control PWB Assembly.

d. Rotary Switches. Data from the two rotary switches, METER and AUTO MANUAL BAND, is inputted to parallel in serial out chips U17, U18, and

U19. These converters are controlled via the FP IN EN and SERIAL CK lines from the Micro Control PWB Assembly. It should be noted that the serial data from all front panel switches with the exception of the POWER ENABLE switch are linked together through parallel to serial converters U17, U18, U19, and U20.

5-15. TEMPERATURE SENSOR PWB ASSEMBLY A8. Refer to the Power Control PWB Assembly schematic for the following discussion. This schematic is found in the Depot Manual.

The Temperature Sensor PWB Assembly contains two temperature sensitive integrated circuits, U1 and U2. The output of the ICs varies directly with their temperature. For every degree Kelvin, the output increases 10 millivolts, such that at a room ambient of 20 degrees centigrade, the output would be 2.93 volts. Both outputs are fed to the Power Control PWB Assembly for processing.

a. Heated Sensor Circuit. The Heated Sensor U1 is preheated by resistor R1 to raise its temperature above the ambient temperature. If there is sufficient air flow past this sensor, it will be held at a lower temperature than if there was no air flow but still at a higher temperature than the ambient. This temperature is typically 7 degrees. Thus, the output of U1 will be representative of the air flowing past the sensor assembly.

b. Ambient Sensor Circuit. Ambient Sensor U2 measures the ambient temperature. It also contains an adjustment R2 to calibrate it with the U1 heated sensor. Resistor R3 acts to equate the thermal mass of U1 to that of U2.

5-16. INTERCONNECT PWB ASSEMBLY A9. Refer to the Interconnect PWB Assembly schematic for the following discussion. This schematic is found in the Depot Manual.

The Interconnect PWB Assembly serves as a distribution board for the low voltage DC supply from the 1000 Watt Power Supply and also contains the H.V. ON driver and the primary power sample circuits.

Resistor divider R1 and R2 sample the low voltage power supply as an indication of the primary power input.

The active low H.V. ON signal from the Micro Control PWB Assembly that controls the high voltage contactor in the 1000 Watt Power Supply enters the Interconnect PWB Assembly on connector J1-2. This signal when low biases on transistor Q1, which in turn biases on Q2, providing a low signal on J3-2 if interlock switch S1 is closed. Diode CR2 clamps the contactor's coil when turned off.

5-17. LOW PASS FILTER ASSEMBLY A10. Refer to the VSWR/XFMR Schematic diagram for the following discussion. This schematic is found in the Depot Manual.

The Low Pass Filter Assembly is a three section filter designed to attenuate any signal, whether harmonic or spurious related, above 30 MHz. It is in both the transmit and the receive path.

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 five sections. Section I tells how the chapter is organized, describes the on-equipment maintenance philosophy, and introduces you to the concept of BIT (Built-In Test). Section II is a detailed presentation of how to use BIT to troubleshoot and repair the 1 KW Linear Power Amplifier (hereafter referred to as the LPA). Section III consists of removal and replacement procedures for the faulty modules identified by BIT. Section IV is dedicated to Periodic Maintenance Procedures. Section V contains alignment procedures for the replaceable modules.

6-2. ON-EQUIPMENT MAINTENANCE PHILOSOPHY. The 1 KW LPA is designed so that you can make most repairs without removing the equipment from its location. The procedures in this chapter should enable you to identify and correct most equipment malfunctions within 15 minutes.

NOTE

Field and organizational maintenance of the modules and circuit card assemblies is limited only to the removal, replacement, and alignments given in chapter 6.

Tool List

Screwdrivers:
- 3/16-inch flat blade (4 inches long)
- No. 1 Phillips
- No. 2 Phillips
- Phillips, right-angle, ratchet (optional)

Wrenches:
- 6-inch adjustable
- 0.050-inch Allen

Nut Drivers: 3/16, 9/16, 1/4, 5/16 (optional)

Needle Nose Pliers (optional)

Alignment Tool Kit

6-3. BIT (BUILT-IN TEST). The key to servicing the 1 KW LPA is a feature called BIT. BIT, which is an acronym for Built-In Test, consists of several systems, some manual and some automatic. These systems are the front panel controls and displays (including a multi-function meter), periodic automatic status checking, a manual diagnostic routine, and two different automatic diagnostic routines (an overall system test initiated from the 100 Watt Transceiver and an LPA self-test initiated from the 1 KW LPA). When used in conjunction with this manual, these systems allow rapid and accurate fault diagnosis.

MAINTENANCE

Section II. PERFORMANCE TESTING AND TROUBLE ANALYSIS USING BIT

6-4. FRONT PANEL CONTROLS AND DISPLAYS. The front panel controls and displays are utilized to control and monitor equipment operation during fault diagnosis. The displays provide an indication of equipment status, and a built-in meter allows digital monitoring of the parameters listed in Table 6-1. See Chapter 4 in this manual for a detailed discussion of all the controls and indicators.

6-5. PERIODIC AUTOMATIC STATUS CHECKING. The equipment performs periodic status checks on itself whenever it is energized. These checks are performed automatically and require no interaction or commands from the operator. These checks include the following and result in the indications or actions listed:

Check	*Result*
LPA temperature, I_K (cathode current)	If out of range for more than 2 seconds, the FAULT light comes on and the LPA goes into STANDBY (STANDBY light comes on)
Primary power, 13.5 V power supply, DC plate voltage, Forward power output, Reflected power output	If out of range for more than 3 seconds, the FAULT light comes on and the LPA goes into STANDBY (STANDBY light comes on)
The 1 KW LPA also performs operational status checks on itself. During tuning, keying, and STANDBY/ OPERATE changes, it checks for expected reactions fom the band switch, tuning coil, key relay, RF input sensor, forward and reflected power sensors, and the sensors for cathode current, DC plate voltage, and RF plate voltage. It also checks the serial control data link between the 100 Watt Transceiver and the 1 KW LPA.	If a fault is detected, the FAULT light comes on and the LPA goes into STANDBY (STANDBY light comes on)

NOTE

When the FAULT light comes on, the appropriate fault code will be displayed on the meter if the selector switch is moved to the STATUS/FAULT position. When the meter selector switch is moved out of the STATUS/FAULT position, the fault code will be cleared and the FAULT light will be turned off. The fault can also be cleared by commanding the 1 KW LPA back to OPERATE from the 100 Watt Transceiver's front panel or from the 1 KW LPA's front panel (if in manual); but if the fault condition continues to exist, the FAULT light will come on again.

6-6. MANUAL DIAGNOSTIC BIT ROUTINE. A manual diagnostic BIT routine is included in this section to assist in fault diagnosis. Figure 6-1, which is a flowchart of the major steps in this routine, provides a sequence of observations which can be used to supplement the automatic BIT routines described in the following paragraph. In addition to Figure 6-1, which is the main flowchart, there are four supplementary flowcharts. Two of these (Flowcharts A and B) are referenced from Figure 6-1. The other two (Flowcharts C and D) are used for troubleshooting high and low output power conditions, respectively. For convenience, all flowcharts (Figures 6-1 through 6-16) are located at the end of this section.

6-7. AUTOMATIC DIAGNOSTIC BIT ROUTINES. The automatic diagnostic BIT routines available for troubleshooting the 1 KW LPA are of two kinds. The first is an overall system test, which checks not only the LPA, but also the 100 Watt Transceiver and the Remote Control Unit. You initiate this routine from the transceiver front panel by pressing 2ND, TX KEY; 2ND, TEST; and 2ND, TX KEY. The second automatic BIT routine is a self-test for the 1 KW LPA only, which you initiate from the LPA (refer to the detailed procedure for running the LPA self-test in paragraph 6-8, d). In the first routine, fault codes are displayed on the transceiver's display (and also on the LPA's front panel meter when the selector switch is in the STATUS/FAULT position); in the second routine, fault codes are displayed on the LPA's front-panel meter (the meter selector switch must be in the STATUS/FAULT position). Upon detection of a fault, the test process stops and the corresponding fault code is displayed. The Appendix at the end of this chapter lists the events that occur during the LPA self-test (this same sequence of events occurs during the LPA portion of the overall system test, with minor variations). Successful completion of these routines assures you that the LPA is operationally ready for use. Running the automatic diagnostic BIT routines for performance testing and verification is therefore another major use of the BIT feature.

6-8. TROUBLESHOOTING WITH BIT. The first stage in the troubleshooting process is becoming aware that a fault condition exists. This usually happens as the result of an observation (for example, you notice that a FAULT light is on) or as the result of a deterioration in the equipment's peformance (for example, the person you're communicating with informs you that your signal is very weak). You can also use the front panel meter on the LPA to see whether its key operating parameters are within the normal range (see Table 6-1). In any case, it's always a good idea to make a note whenever you notice anything unusual. This will come in handy if you have to do any troubleshooting. The nature of the fault determines whether you should use the manual diagnostic BIT routine or one of the automatic diagnostic BIT routines.

a. Using the FAULT lights. Whenever a FAULT light comes on during normal operation of the equipment, the first thing you should do is press 2ND, TEST on the transceiver front panel. This causes a fault code to be displayed. You can then look up the fault code in Table 6-2, which tells you what to do to identify and correct the problem.

b. Using the Manual Diagnostic BIT Flowchart. The manual diagnostic BIT flowchart, Figure 6-1, should be used whenever you observe an obvious problem while operating the 1 KW LPA, but none of the FAULT lights comes on. It suggests preliminary observations and actions that you should perform before you initiate one of the automatic diagnostic BIT routines. Sometimes, when there is a problem with the display or when the microprocessor is inoperative, you cannot use the automatic diagnostic BIT routines at all. In these cases, you must rely entirely on the manual diagnostic BIT flowchart.

c. Using the Automatic Diagnostic BIT Routines. When you initiate one of the automatic diagnostic BIT routines, you must use Table 6-2 to interpret the results. This table lists in numerical order all the possible fault codes for the 1 KW LPA (codes 2-01 through 2-02). Fault codes for the 100 Watt Transceiver (codes 1A1A1-0 through 1A1A19-2) and the Remote Control Unit (code 4-01) are listed in Chapter 6 of the technical manuals for those components. Note that in some cases the fault code itself is sufficient to identify the faulty module. In other cases, you will be required to so some additional checking to isolate the problem (this is the reason why flowcharts are used for many of the fault codes). Table 6-2 and the flowcharts tell you what to do to fix the problem, which in most cases consists of simply replacing a module. Instructions for removing and replacing the modules can be found in Section III of this chapter, "Removal/Replacement Procedures."

d. Running the LPA Self-Test. Use the following procedure to run the LPA self-test:

(1) Rotate the AUTO/MANUAL BAND switch on the LPA front panel to the band that

contains the frequency displayed on the transceiver (bands begin at 0000 and end at 9999; for example, 1.7999 would fall in the 1.6 to 1.8 band, but 1.8000 would fall in the 1.8 to 2.2 band).

(2) Rotate the METER switch on the LPA front panel to the STATUS/FAULT position.

(3) Press the SELF TEST button on the LPA front panel.

(4) Check that all LPA front panel LEDs come on and that all LCD segments on the meter display are on. NOTE: if the test is initiated while the LPA is in warmup (STANDBY LED was flashing before the SELF TEST button was pushed), only fault codes 2-01 through 2-08 can be displayed. This is because the full routine cannot be run until the LPA is warmed up (refer to the automatic diagnostic BIT test description in the Appendix at the end of this chapter).

NOTES

The automatic BIT routine transmits full power into the antenna system at the selected frequency. The consequences of this transmission should be considered before exercising BIT into an antenna. An alternative is to replace the antenna with a dummy load. Another important consideration when using the automatic BIT routine is that this routine tests the LPA only at the frequency currently selected by the 100 Watt Transceiver.

Table 6-1. 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 +5000 Vdc	0	2400 to 3200(1)
I_K	Displays the average cathode (plate) current of the power amplifier tube	0 to 2000 mA	0	700 to 1100(1)
RF IN (WATTS)	Displays the peak RF input power from the 100 Watt Transceiver	0 to 250 W	0 to 100(2)	15 to 100(1)

(1) With a power output of 1 KW, as indicated on the FWD PWR meter.

(2) With the transceiver keyed; otherwise, the reading will be 0 W.

Table 6-1. Meter Functions and Normal Operating Ranges (Continued)

Position	Function	Range/Units	Normal (Stby/ Warmup)	Normal (Operate, Keyed in CW)
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 5000 Vdc	0	1800 to 2400(1)
FWD PWR (WATTS)	Displays the peak forward power at the RF output	0 to 1500 W	0	900 to 1100
REFL PWR (WATTS)	Displays the peak reflected power at the RF output	0 to 1500 W	0	0 to 100, depending on load(1)
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(1)
COIL POS	Displays the servo coil position	100 to 1770	See Figure 3-1	See Figure 3-1
STATUS/ FAULT	Displays a fault code. If the FAULT light is lit and the meter is switched to the STATUS/FAULT position, a fault code will be displayed. When the selector switch is moved out of the STATUS/FAULT position, the fault code will be cleared and the FAULT light will be turned off.	Fault codes		

Table 6-2. Fault Code Chart

NOTES

This table lists only the fault codes for the LPA (codes 2-01 through 2-22). For an explanation of the fault codes for the 100 Watt Transceiver (codes 1A1A1-0 through 1A1A19-2) and the Remote Control Unit (code 4-01), refer to Chapter 6 of the technical manuals for those equipments.

Fault codes for the LPA are listed as they appear on the 100 Watt Transceiver's display. On the LPA's display, "2-" appears as "00." For example, code 2-09 on the transceiver's display would appear as "0009" on the LPA's display.

Code	Explanation	Procedure
2-01	MICRO-CONTROL FAULT.	Replace Micro Control PWB Assy.
2-02	Not used	
2-03	PRIMARY POWER FAULT.	Refer to flowchart 2-03.
2-04	13.5 V SUPPLY FAULT.	Refer to flowchart 2-04.
2-05	TRANSMITTER FAULT.	Refer to flowchart 2-05.
2-06	BAND SWITCH DRIVE FAULT.	Replace Tank Assy. If problem persists, replace Micro Control PWB Assy.
2-07	SERVO COIL DRIVE FAULT.	Replace Tank Assy. If problem persists, replace Micro Control PWB Assy.
2-08	HIGH VOLTAGE ON IN STANDBY.	Refer to flowchart 2-08.
2-09	HIGH VOLTAGE FAULT IN OPERATE.	Refer to flowchart 2-09.
2-10	PLATE CURRENT ON W/BIAS OFF.	Refer to flowchart 2-10.
2-11	PLATE CURRENT FAULT W/BIAS ON.	Refer to flowchart 2-11.
2-12	RF MUTE NOT WORKING.	Check interconnecting cable between transceiver and LPA. Replace if necessary. If problem persists, replace Micro Control PWB Assy. If problem still persists, replace LPA/Coupler Interface PWB Assy in 100 Watt Transceiver (see transceiver technical manual).

Table 6-2. Fault Code Chart (Continued)

Code	Explanation	Procedure
2-13	NO RF INPUT W/TUNE POWER (Code 2-20 is displayed during auto tune.)	Refer to flowchart 2-13.
2-14	PLATE CURRENT FAULT WHEN KEYED	Refer to flowchart 2-14.
2-15	NO TUNE PEAK W/RF INPUT POWER.	Refer to flowchart 2-15.
2-16	FORWARD POWER FAULT.	Refer to flowchart 2-16.
2-17	VSWR/REFLECTED POWER FAULT. (Meter indicates VSWR >2.25:1.)	Check coax connections to Low Pass Filter Assy. If problem persists, check output coax cable to antenna system. If problem still persists, check antenna system. If AN/URA-38( ) Antenna Coupler is installed, refer to troubleshooting procedure in Chapter 4 of its technical manual. If problem still persists. replace VSWR/XFMR PWB Assy.
2-18	POWER GAIN FAULT.	Replace Tube Assy. If problem persists, replace Tank Assy. If problem still persists, replace Low Pass Filter Assy, or the VSWR/XFMR Assy.
2-19	Not used.	
2-20	AUTO TUNE FAULT. (This is not an automatic BIT fault code. This code should appear only during normal operation and only if the LPA fails to tune correctly.)	Initiate the LPA self-test (see par. 6-8, d), and use this table to diagnose the problem.
2-21	LPA-TRANSCEIVER LINK FAULT.	Check interconnecting control cable between transceiver and LPA. Replace if necessary. If problem persists, replace LPA/Coupler Interface PWB Assy in transceiver (refer to transceiver technical manual). If problem still persists, replace Micro Control PWB Assy.
2-22	CATHODE CURRENT W/NO FWD PWR (This is not an automatic BIT fault code. This code should appear only during normal operation. The meter indicates cathode current (I_K), but no FWD PWR.)	Initiate the automatic diagnostic BIT routine (either from the transceiver or from the LPA -- see par. 6-7 and 6-8, d), and use this table to diagnose the problem.

MANUAL DIAGNOSTIC BIT ROUTINE FAULT ISOLATION CHART

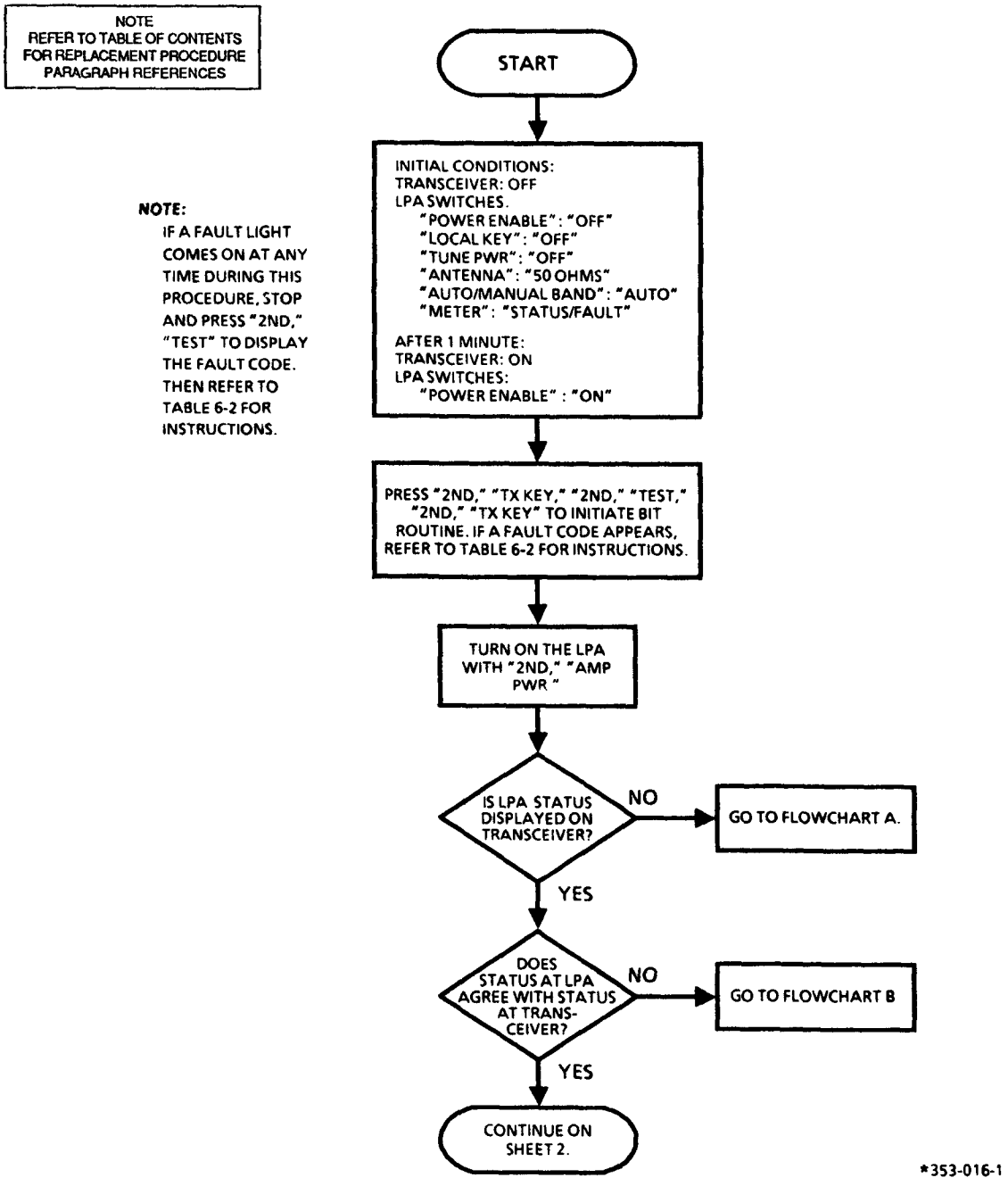

Figure 6-1. Manual Diagnostic BIT Routine, Fault Isolation Chart (Sheet 1 of 3)

MANUAL DIAGNOSTIC BIT ROUTINE FAULT ISOLATION CHART (Cont.)

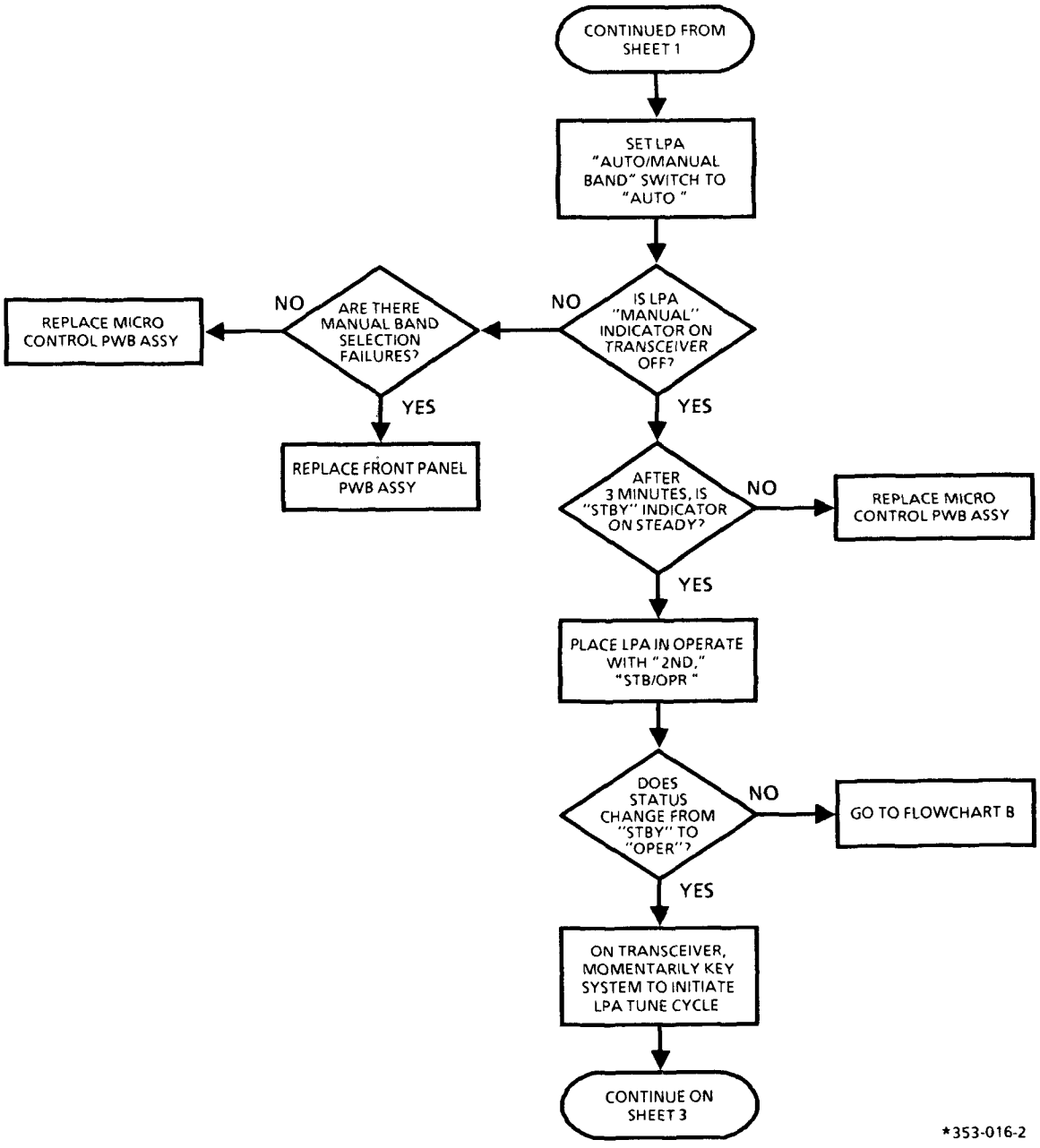

Figure 6-1. Manual Diagnostic BIT Routine, Fault Isolation Chart (Sheet 2 of 3)

MANUAL DIAGNOSTIC BIT ROUTINE FAULT ISOLATION CHART (Cont.)

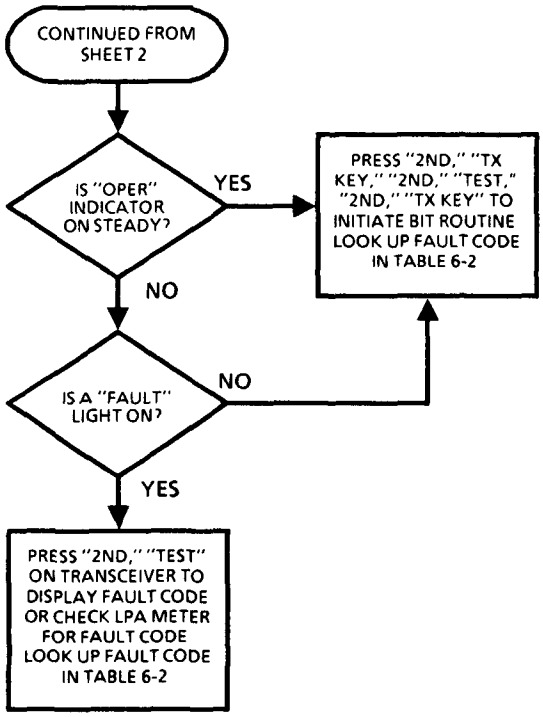

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Figure 6-1. Manual Diagnostic BIT Routine, Fault Isolation Chart (Sheet 3 of 3)

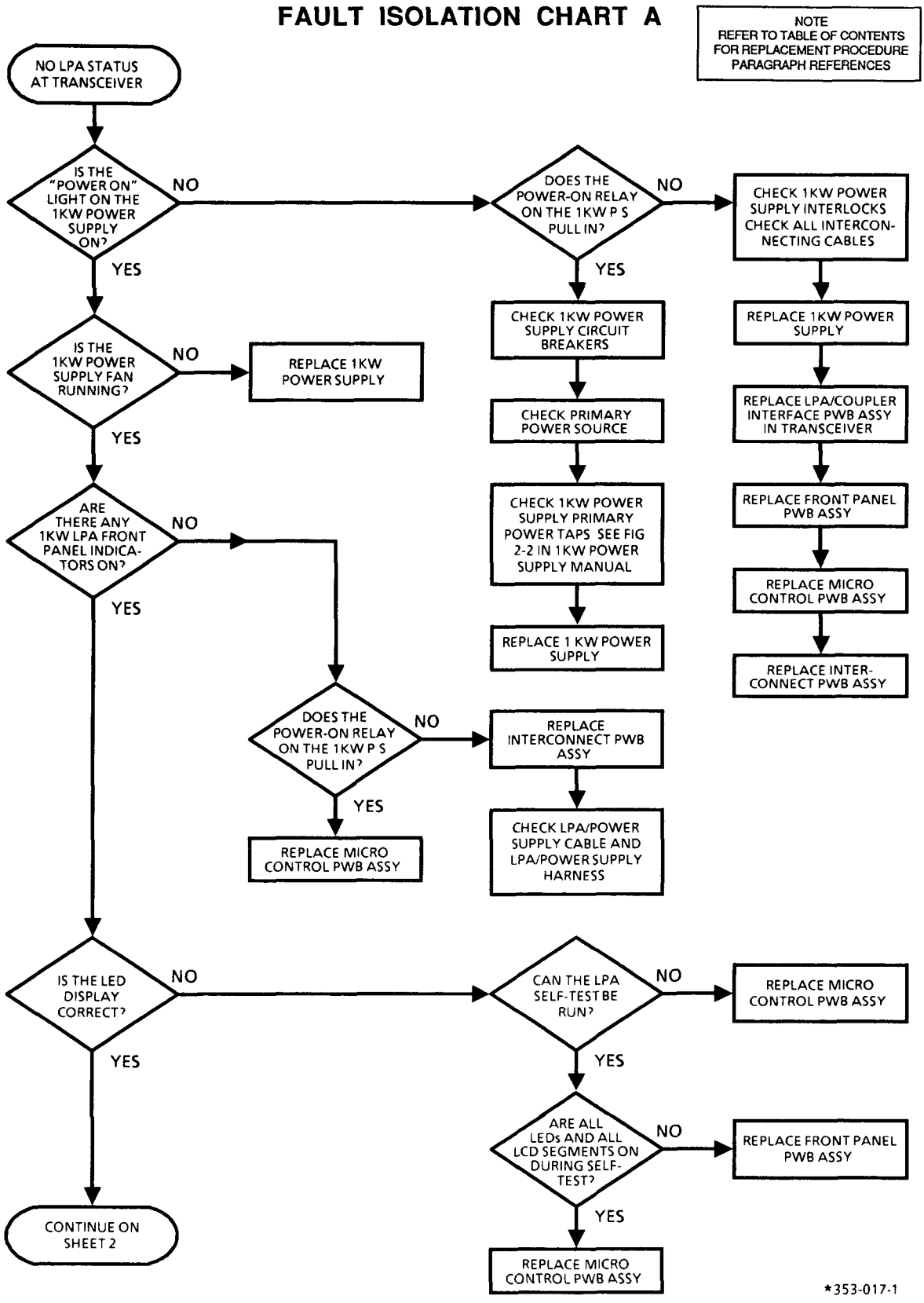

Figure 6-2. Fault Isolation Chart A (Sheet 1 of 2)

FAULT ISOLATION CHART A (Cont.)

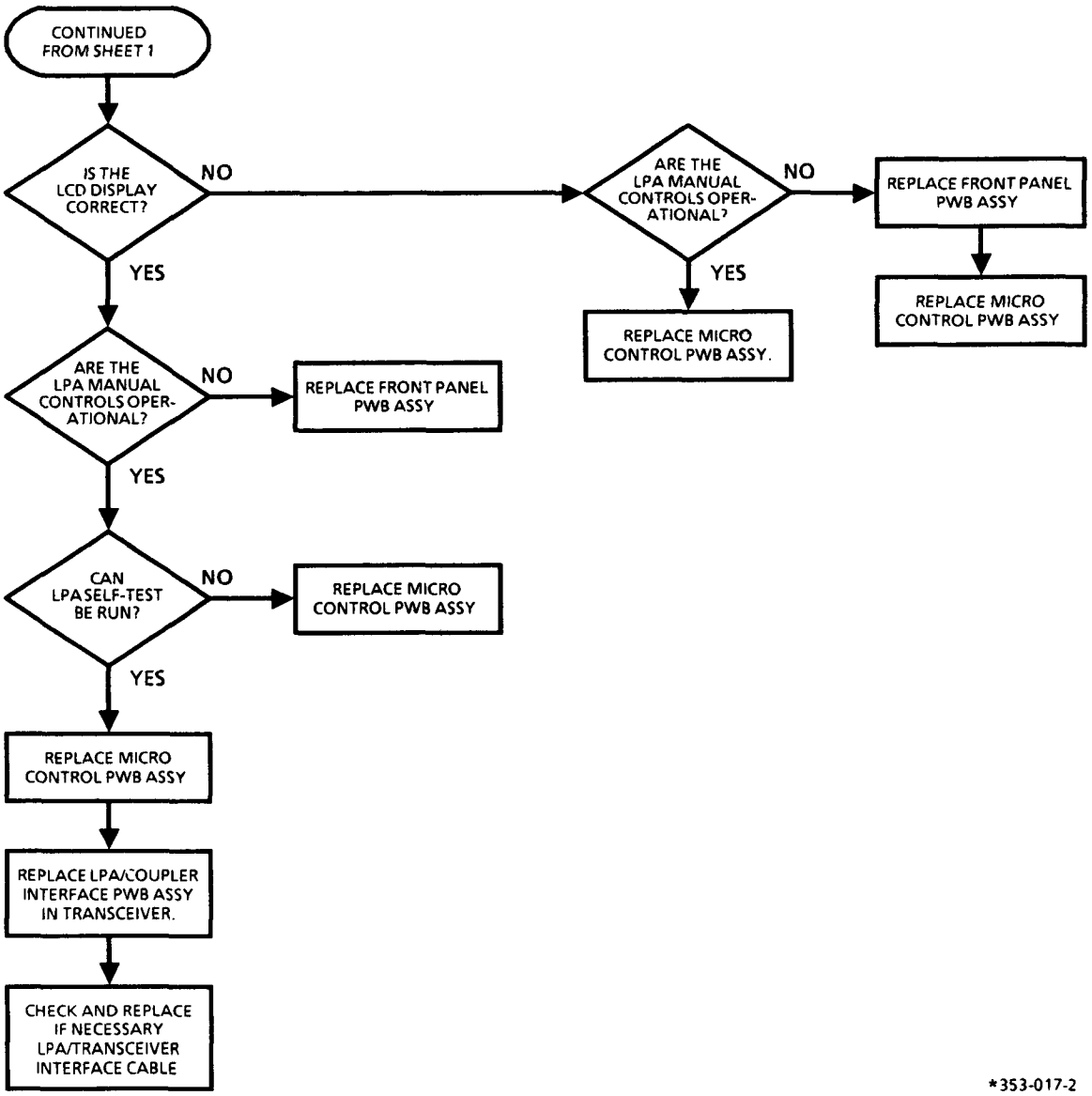

Figure 6-2. Fault Isolation Chart A (Sheet 2 of 2)

FAULT ISOLATION CHART B

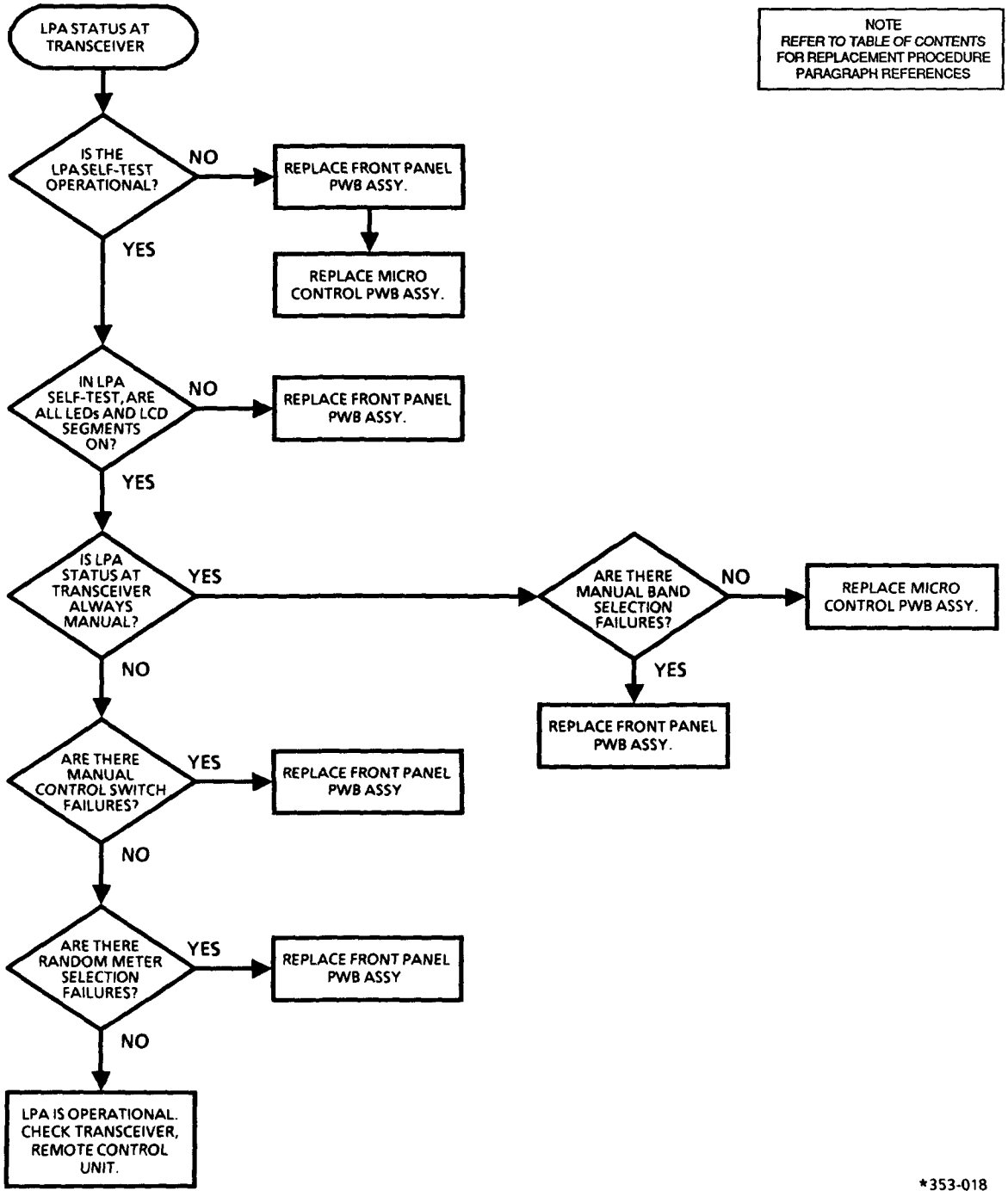

Figure 6-3. Fault Isolation Chart B

FAULT ISOLATION CHART C

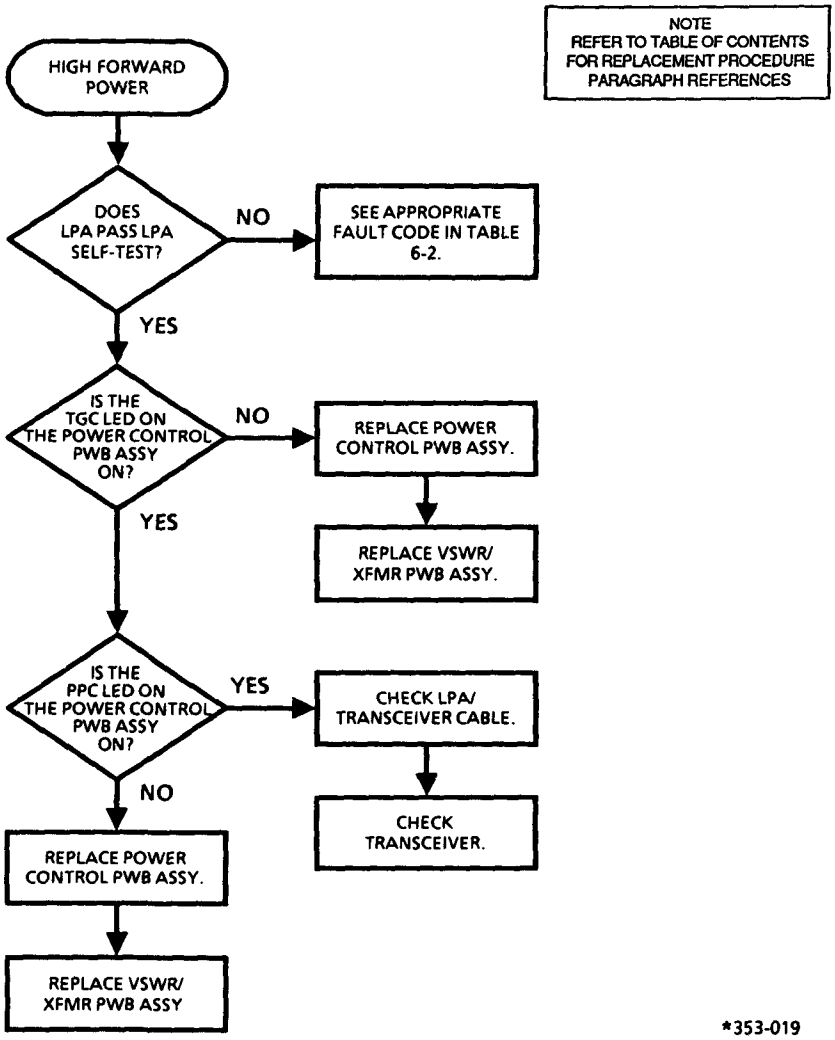

Figure 6-4. Fault Isolation Chart C

FAULT ISOLATION CHART D

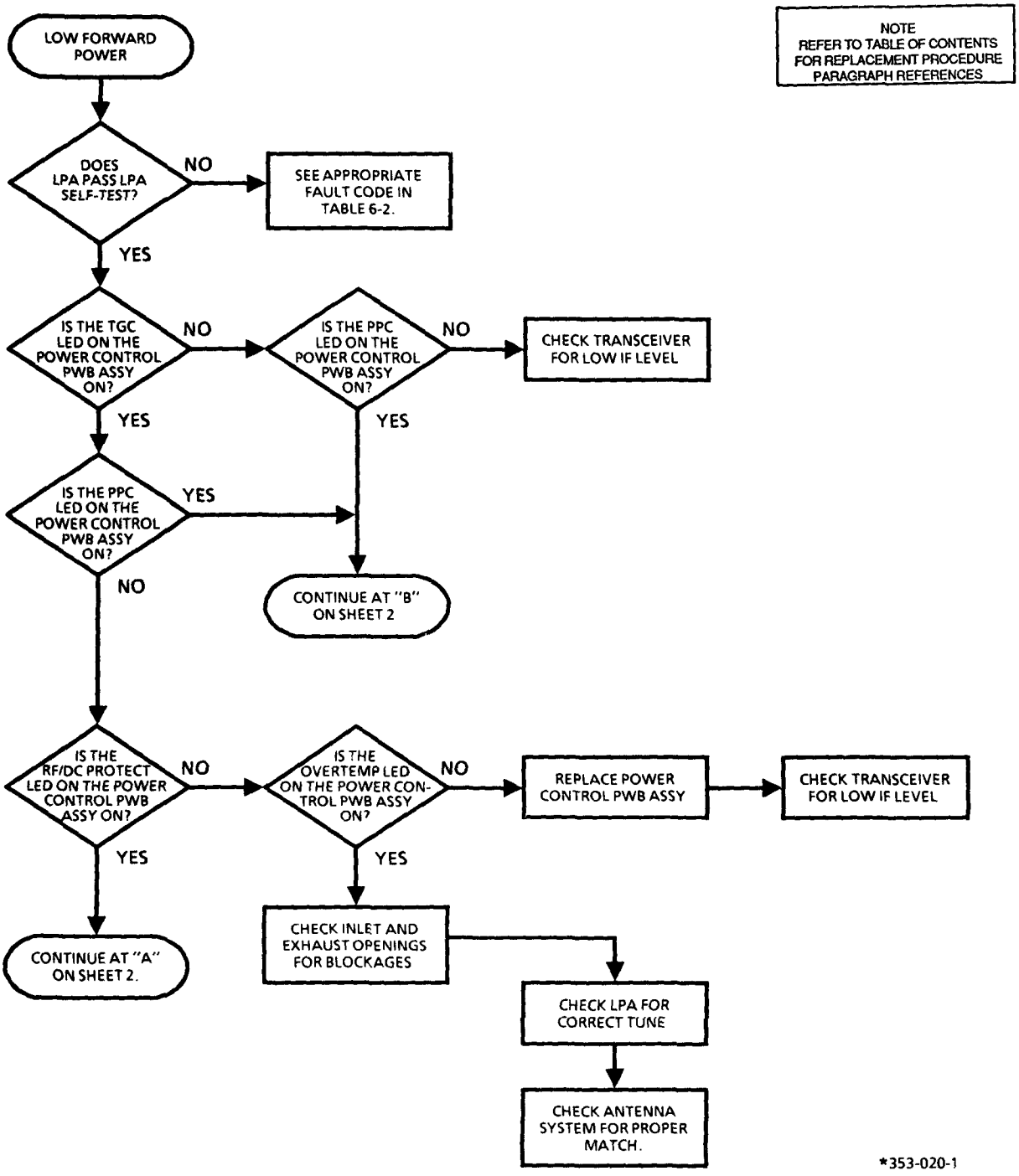

Figure 6-5. Fault Isolation Chart D (Sheet 1 of 2)

FAULT ISOLATION CHART D (Cont.)

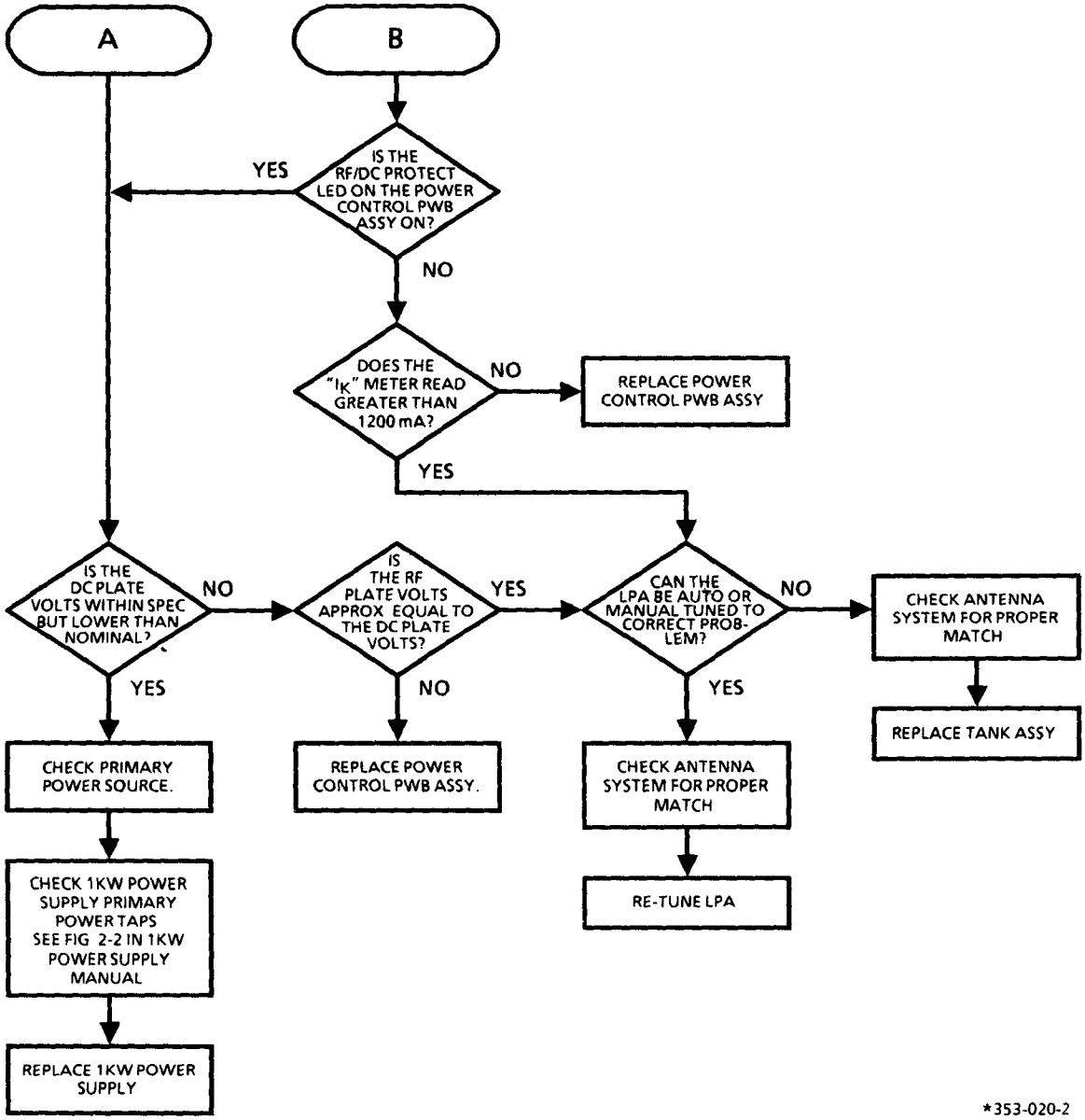

Figure 6-5. Fault Isolation Chart D (Sheet 2 of 2)

FAULT ISOLATION CHART 2-03

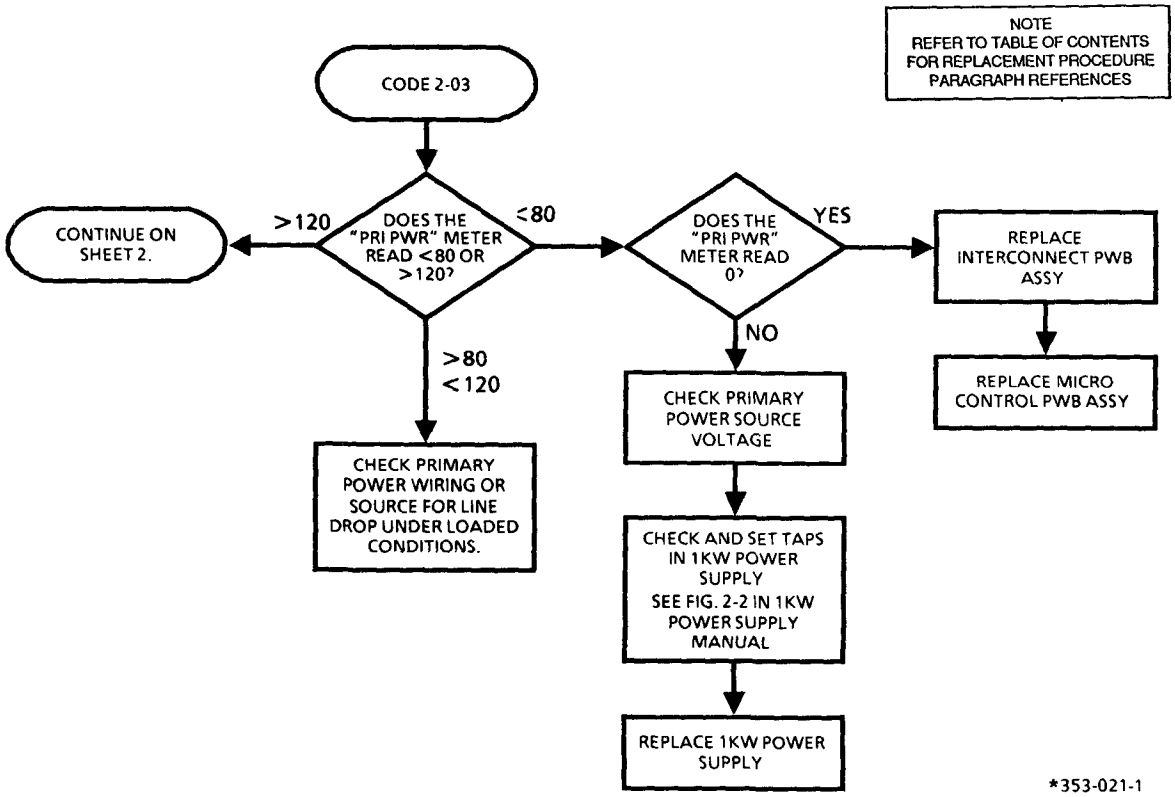

Figure 6-6. Fault Isolation Chart for Fault Code 2-03 (Sheet 1 of 2)

FAULT ISOLATION CHART 2-03 (Cont.)

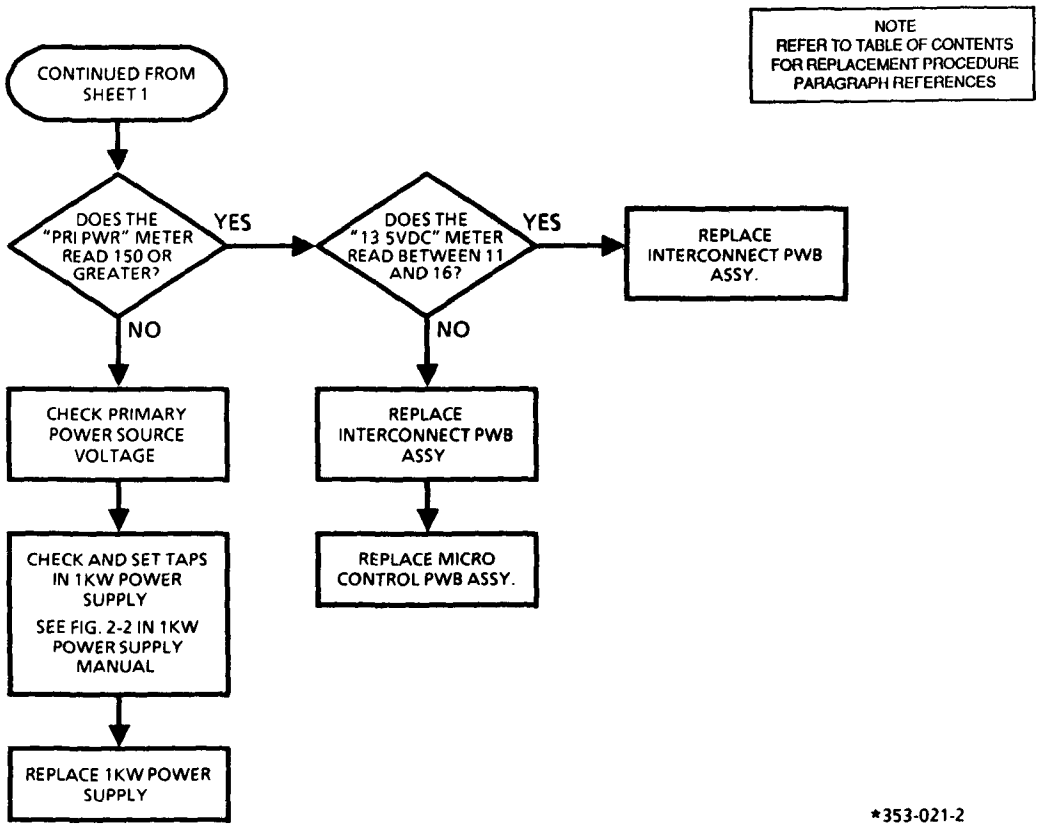

Figure 6-6. Fault Isolation Chart for Fault Code 2-03 (Sheet 2 of 2)

FAULT ISOLATION CHART 2-04

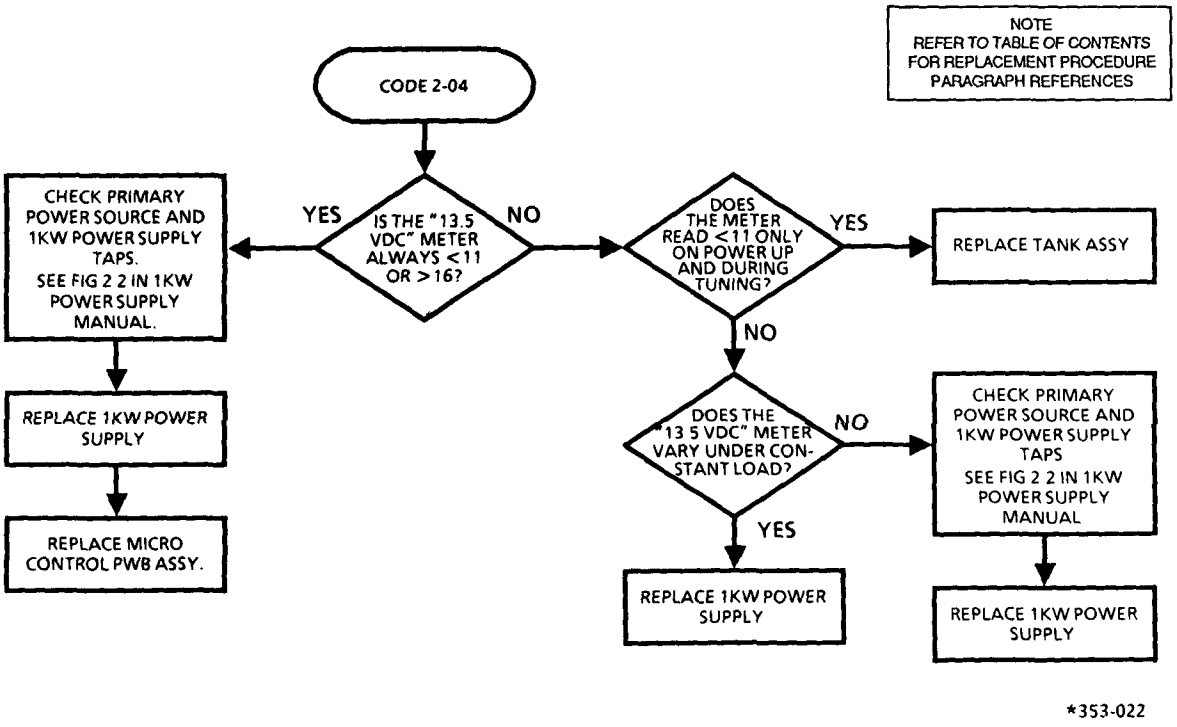

Figure 6-7. Fault Isolation Chart for Fault Code 2-04

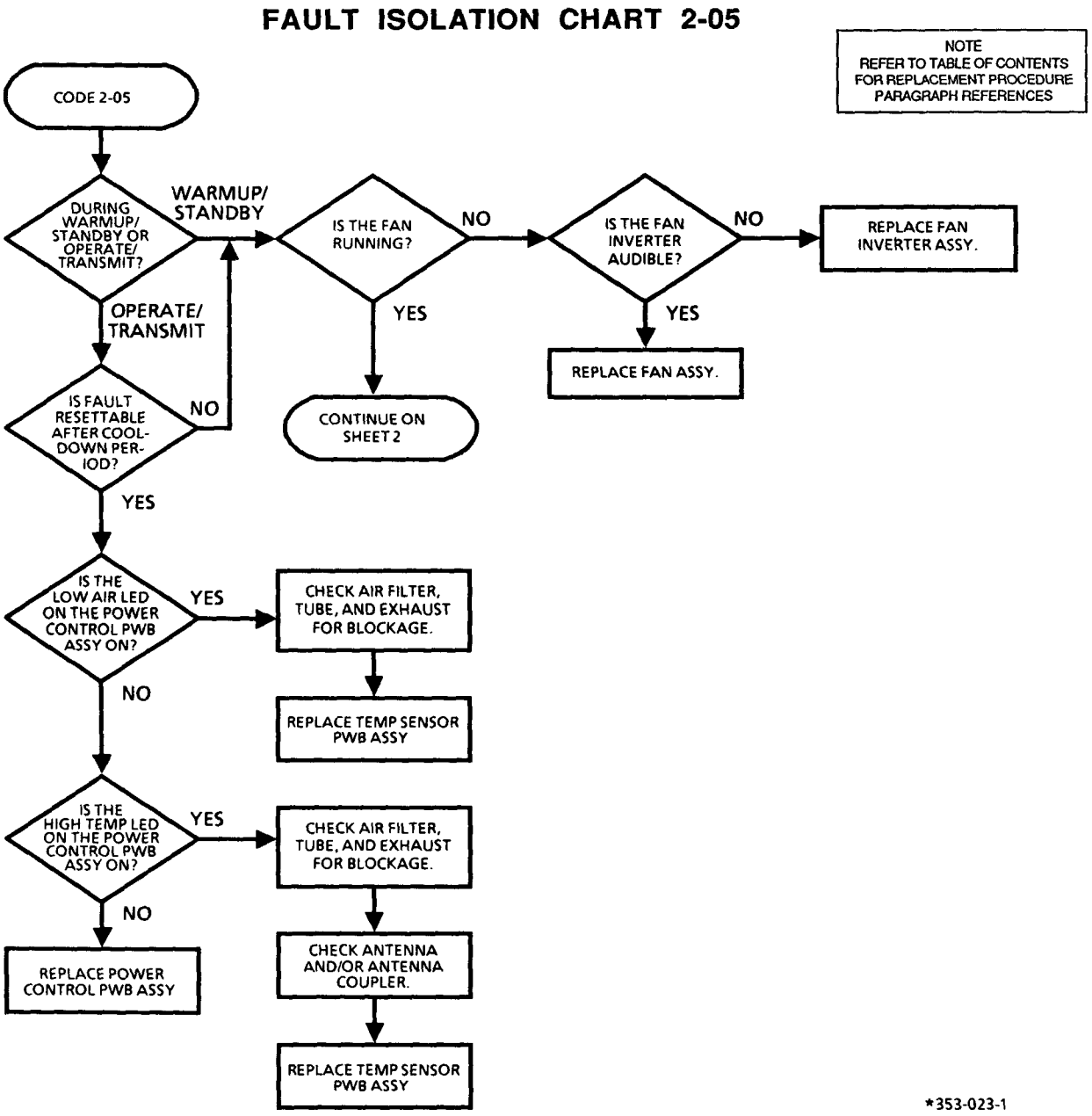

Figure 6-8. Fault Isolation Chart for Fault Code 2-05 (Sheet 1 of 2)

FAULT ISOLATION CHART 2-05 (Cont.)

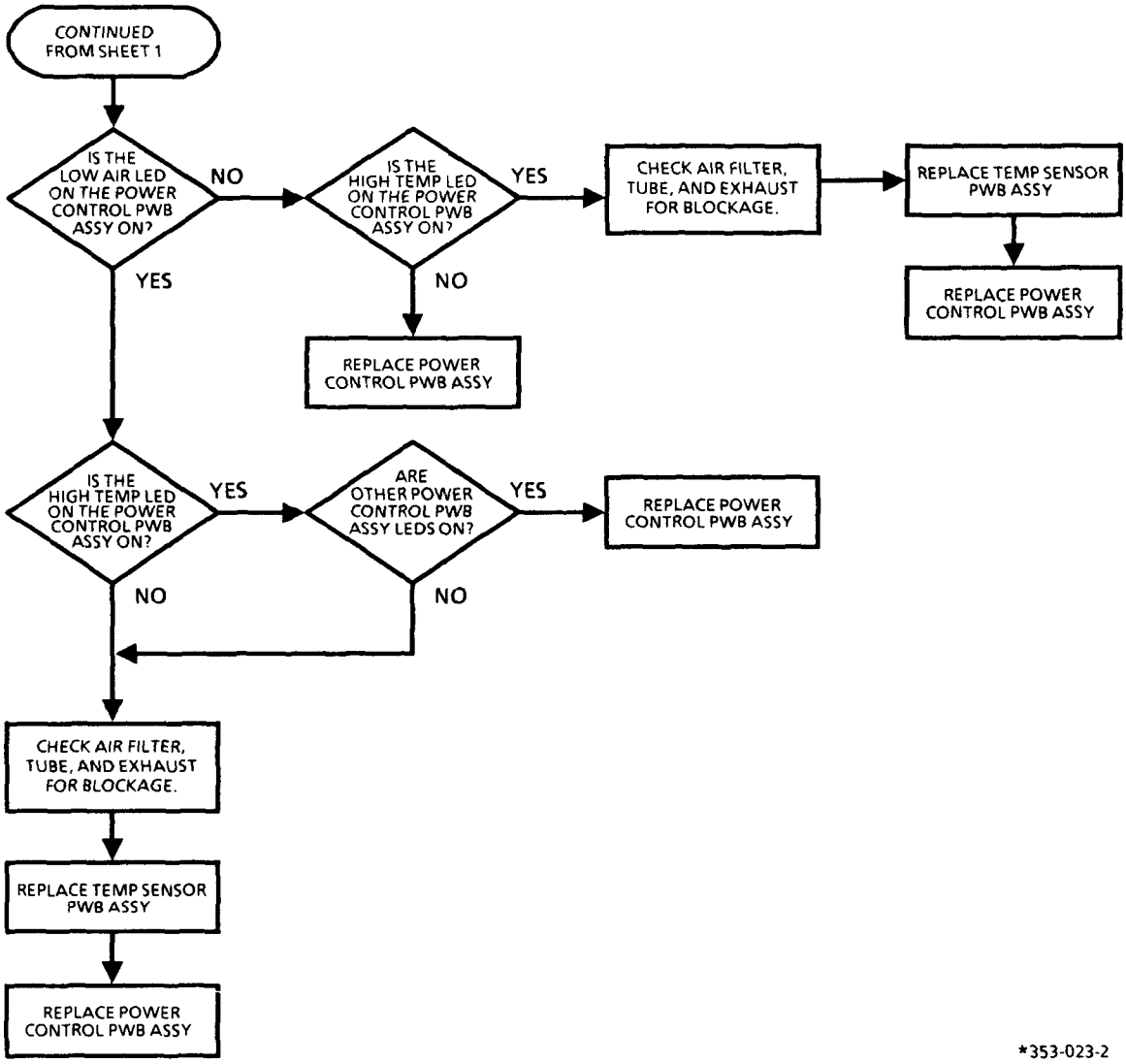

Figure 6-8. Fault Isolation Chart for Fault Code 2-05 (Sheet 2 of 2)

FAULT ISOLATION CHART 2-08

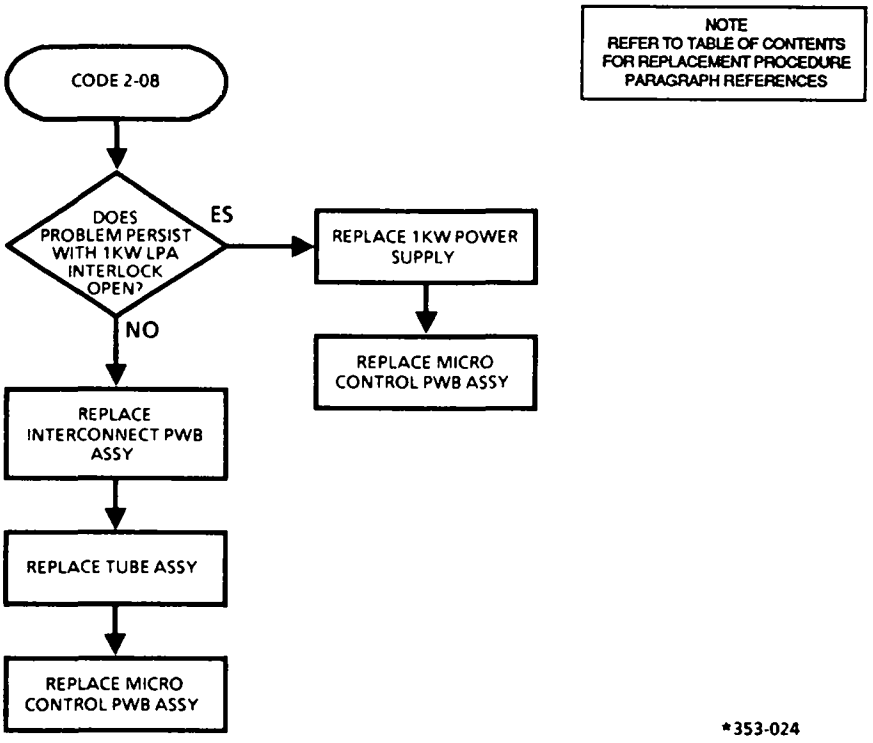

Figure 6-9. Fault Isolation Chart for Fault Code 2-08

FAULT ISOLATION CHART 2-09

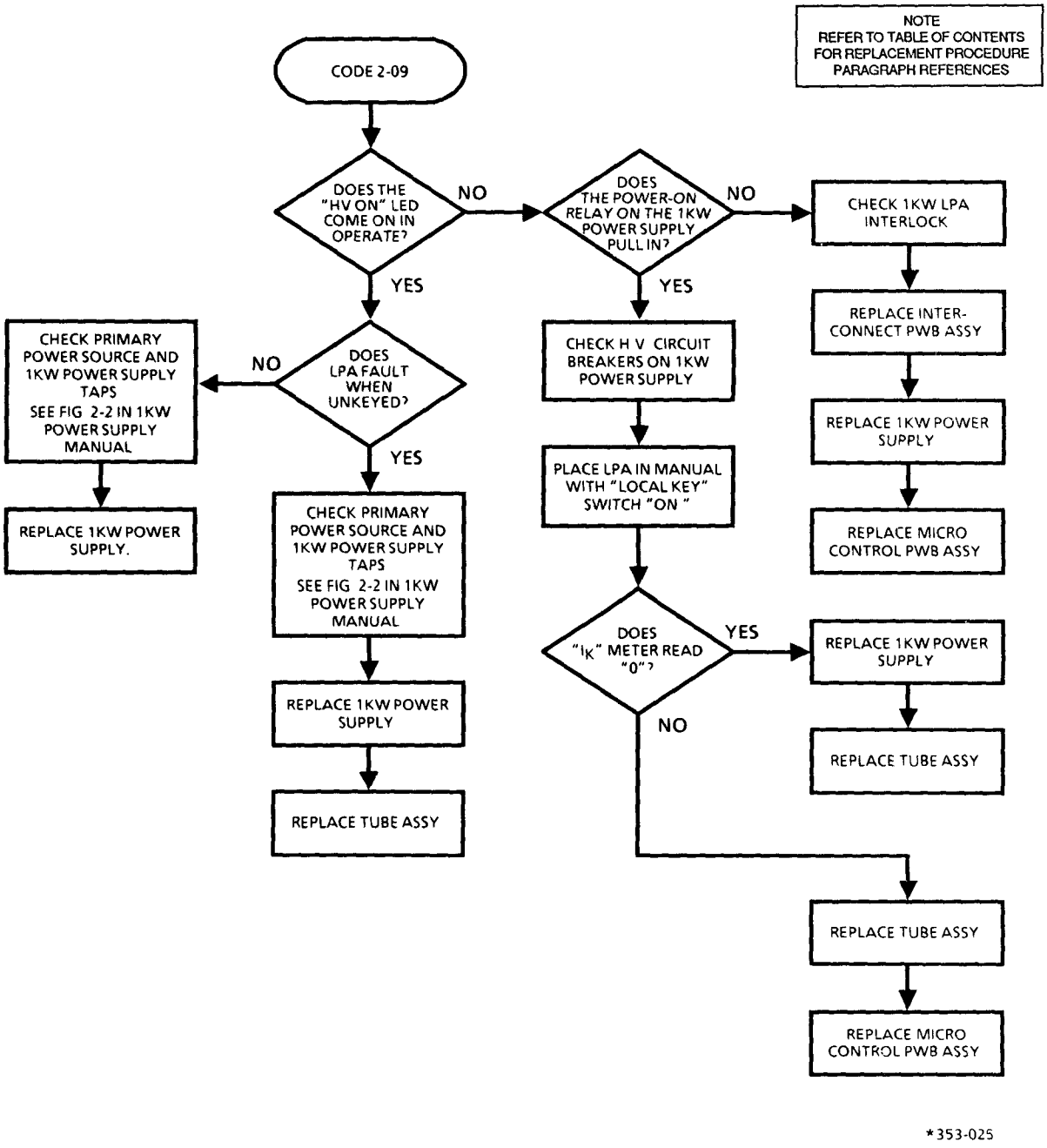

Figure 6-10. Fault Isolation Chart for Fault Code 2-09

FAULT ISOLATION CHART 2-10

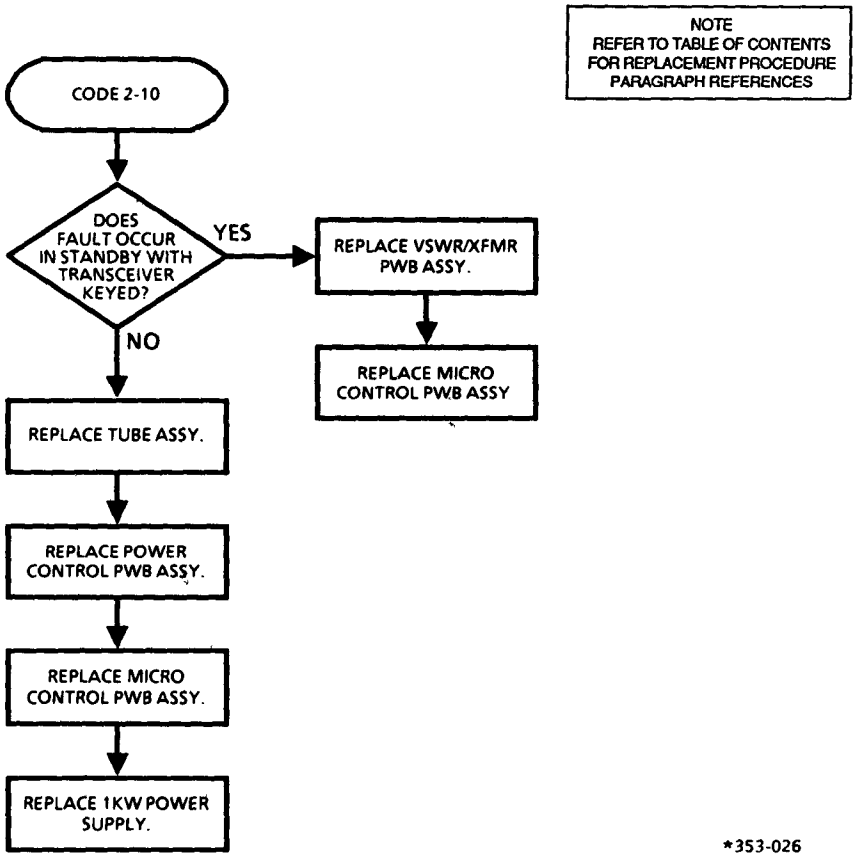

Figure 6-11. Fault Isolation Chart for Fault Code 2-10

FAULT ISOLATION CHART 2-11

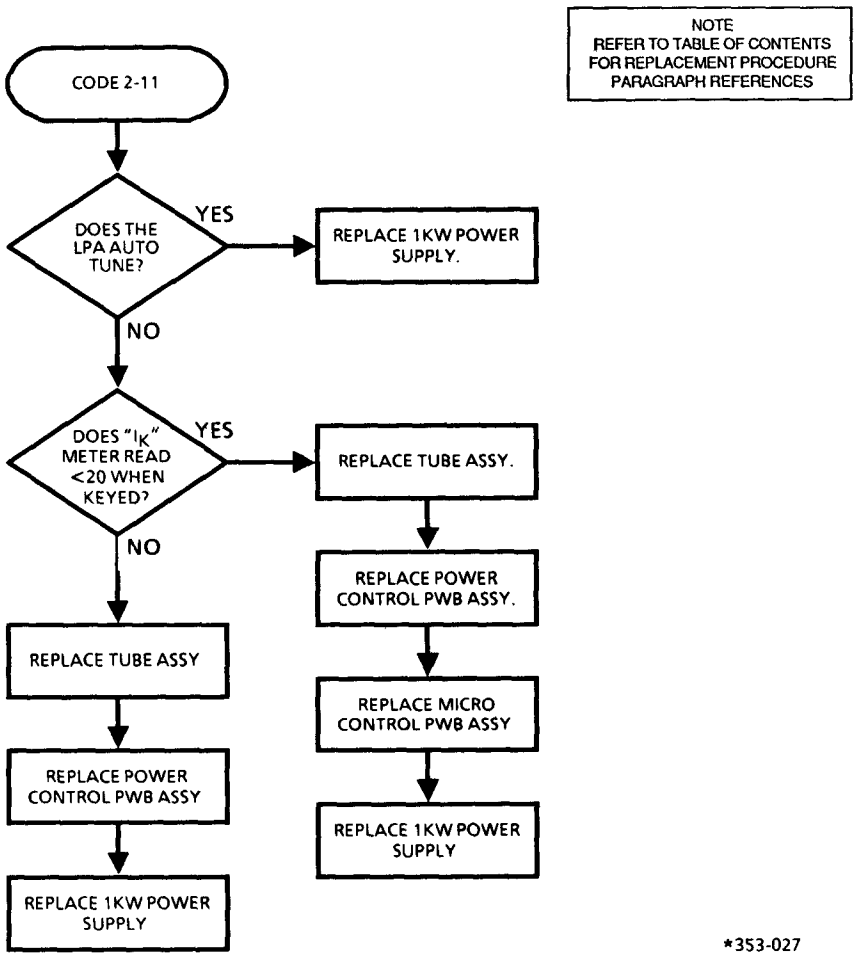

Figure 6-12. Fault Isolation Chart for Fault Code 2-11

FAULT ISOLATION CHART 2-13

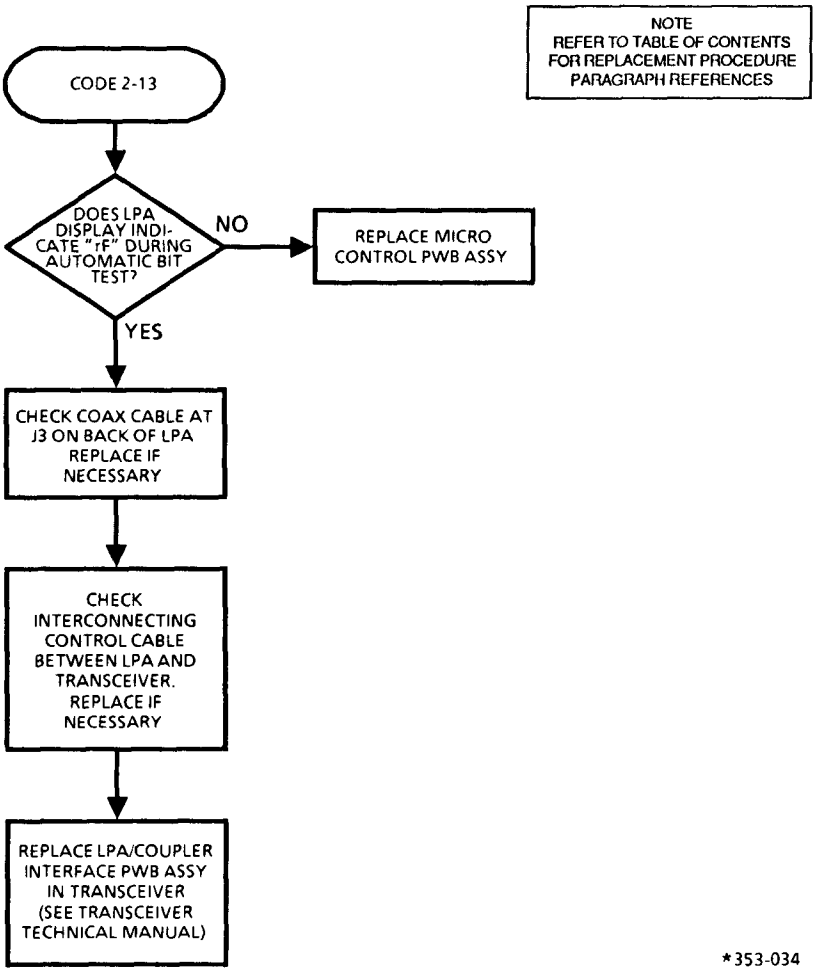

Figure 6-13. Fault Isolation Chart for Fault Code 2-13

FAULT ISOLATION CHART 2-14

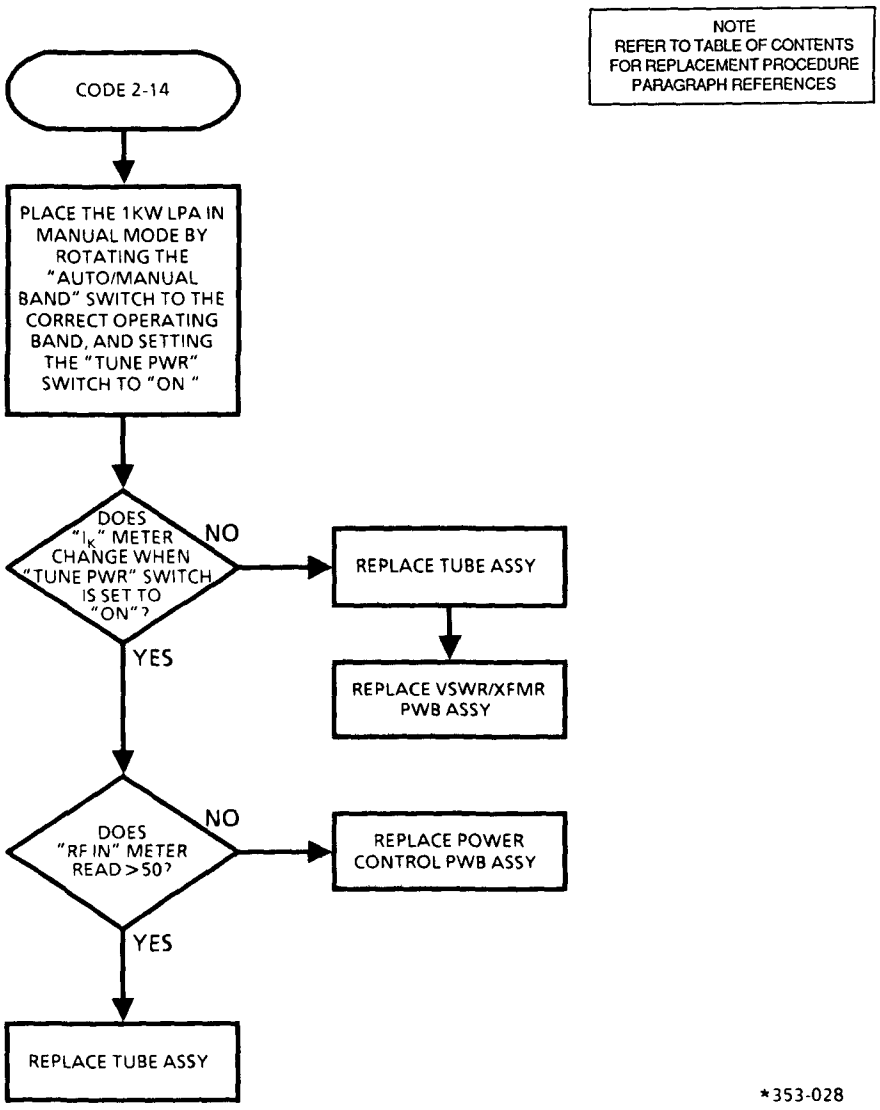

Figure 6-14. Fault Isolation Chart for Fault Code 2-14

FAULT ISOLATION CHART 2-15

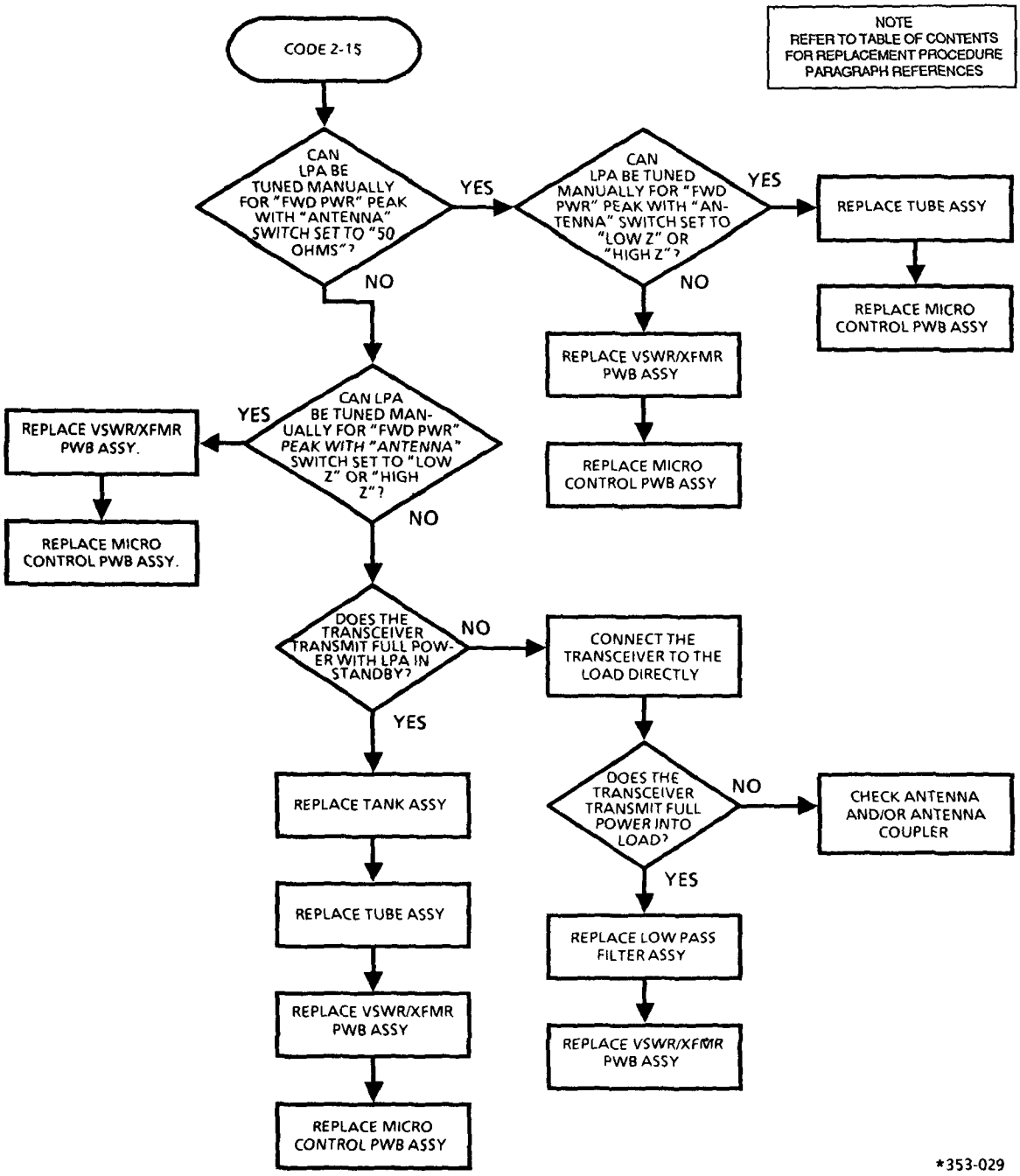

Figure 6-15. Fault Isolation Chart for Fault Code 2-15

FAULT ISOLATION CHART 2-16

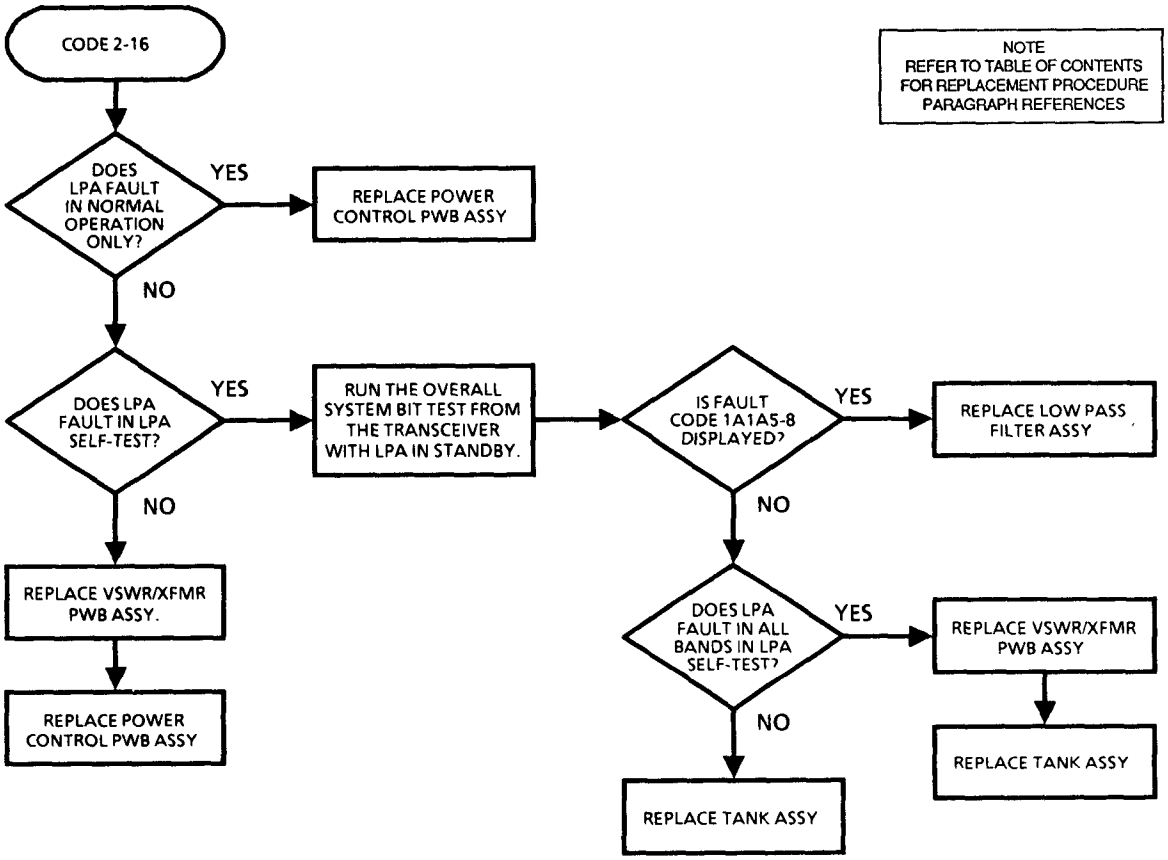

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Figure 6-16. Fault Isolation Chart for Fault Code 2-16

MAINTENANCE

Section III. REMOVAL/REPLACEMENT PROCEDURES

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.

CAUTION

Use care when disconnecting ribbon cables,coax cables, etc.

NOTE

Refer to drawing FO-3 while doing the following procedures. This drawing has an apron which allows you to look at it while reading the procedures. The numbers in parentheses in the procedural steps correspond to the numbered items on the drawing. For example,A30 refers to item 30 on view A.

6-9. TUBE ASSY.

a. Removal.

(1) Disconnect the input power from the 1 KW Linear Power Amplifier.

(2) Loosen the two 1/4-turn fasteners (B9), and remove the top cover (B10).

(3) Disconnect the Tube Assy cable (B11), and remove it from its retainer clip.

(4) Loosen the three 1/4-turn fasteners (B15) holding the Tube Assy (B16) to the Chassis.

(5) Remove the Tube Assy.

b. Replacement.

Reverse the order of the above steps.

6-10. TANK ASSY.

a. Removal.

(1) Disconnect the input power from the 1 KW Linear Power Amplifier.

(2) Loosen the two 1/4-turn fasteners (B9), and remove the top cover (B10).

(3) Disconnect the ribbon cable from J1 on the Tank Assy circuit board (B22).

(4) Disconnect the coax cable at the rear of the Tank Assy (B23).

(5) Loosen the four1/4-turn fasteners holding the Tank Assy to the chassis.

(6) Remove the Tank Assy.

b. Replacement.

Reverse the order of the above steps.

6-11. VSWR/XFMR PWB ASSY.

a. Removal.

(1) Disconnect the input power from the 1 KW Linear Power Amplifier.

(2) Disconnect the 1 KW Power Supply cable at J1 on the back of the 1 KW Linear Power Amplifier.

(3) Loosen the two 1/4-turn fasteners (B9), and remove the top cover (B10).

(4) Disconnect the coax cables (B25) from the rear of the Tank Assy (B23) and from the connector (B19) on the side of the Low Pass Filter Assy (B20).

(5) Disconnect the 14-pin connector from the VSWR/XFMR PWB Assy (B27).