SECTION 4: REPAIR AND MAINTENANCE

4.1 Introduction

This section contains information for proper servicing of the D-150A II amplifier including disassembly and reassembly procedures, required test equipment lists, repair procedures, and basic troubleshooting tips.

Two other sections will be of assistance in D-150A II service: **Section 5** covers General Circuit Theory that could aid a technician in investigating an unusual problem. **Section 6** covers Test Procedures that are required following component replacement.

NOTE: The information in this section is intended for use by a qualified electronics technician. We have made no effort to provide the general background information that is essential for the proper servicing of any complex piece of electronic equipment.

4.2 Required Test Equipment

Routine service work on the D-150A II can be performed with a minimum amount of test equipment. However, to insure that the unit is maintained in accord with "factory specifications", we provide the following list of required test equipment. The "Requirements" column provides information for selecting test equipment from various manufacturers.

REQUIRED TEST EQUIPMENT

EQUIPMENT	REQUIREMENTS	APPLICATIONS	SUGGESTED MODEL
Oscilloscope	Capable of displaying a 10M Hz signal	Monitoring output during service and testing	Tektronics or equivalent
Volt-ohmmeter (VOM)	Low-voltage resistance probe (100mv range). High voltage resistance probe. (1.5V range)	Check resistance values (low voltage probe). Check semi-conductor junctions for opens or shorts (high voltage probe) Check DC voltages	Fluke 8020, 8024, 8060 or equivalent
Signal Generator	Sine/Square wave available; flat frequency response.THD. 1% maximum	Provide test signals for service and checkout	Wavetek 130-Series or equivalent
Circuit Breaker	15 ampere rating	In AC line to unit; protects circuitry from overload if power supply has shorted	
AC Line Voltage Monitor	Peak reading meter (displays rms equivalent to a sinu-sodial peak for any wave form)	Monitor line voltage	Information available from CROWN
AC Voltmeter	100mv low range, flat frequency response to 100K Hz	Set output level for testing; check noise level	Hewlett-Packard 400F or equivalent
Filter	20-20K Hz bandpass, low noise 20Hz-20K Hz	Between preamplifier and voltmeter in noise test	Information available from CROWN
Intermodulation	Residual (.002% or lower)	Check IM distortion	Information available from CROWN

Table 4-1
Required Test Equipment

4.3 Basic Troubleshooting

Troubleshooting of electronic equipment is a unique blend of art and science. Most of the following suggestions would apply equally well in the repair of any electronic gear. The underlying principle is an obvious one: You want to get the unit back in service with a minimum of time and effort. By making an initial, methodical review of the service problem, you may be able to avoid chasing down time-consuming dead ends.

4.3.1 Establishing the Problem

User complaints about effective operation may not always be clear or simple. Furthermore, the trouble the user has experienced may be due to the system and not the unit itself. If possible, talk to the user about this problem. This will usually be simpler than trying to understand written complaints. A first hand account of the problem can help in gaining an understanding of the probable cause and in getting the problem to re-occur on the service bench.

Some troubles will be obvious upon visual inspection. But when the trouble or its symptoms are not so obvious, you need answers to such questions as:

a. Exactly what was/is the problem?

b. How was it noticed?

c. How was the unit being used?

d. Has the system as a whole been carefully examined for possible problems?

e. How long had the unit been operating when the problem occurred? Was it heat related?

If the user is unavailable or unable to explain the trouble, the next step is a thorough visual inspection.

4.3.2 Visual Inspection

A good visual inspection may often save hours of tedious troubleshooting. Make a habit of proceeding in an orderly manner to insure that no vital part of the following procedure is omitted. The visual inspection can be performed in 10 to 15 minutes. It is recommended both as a preventive maintenance procedure and also as a valuable tool in determining cause of malfunction.

1. Check that all external screws are tight and that none are missing.
2. Check all fuses/circuit breakers.
3. Check for smooth and proper operation of switches and other external controls.
4. Inspect line cord for possible damage to plug, jacket and conductors.
5. Remove protective covers as outlined in "Disassembly" in **Section 4.4.2**
6. Verify that all attaching parts for internal circuits are tight and that none are missing.
7. Inspect all wiring for charred insulation, or discoloration as evidence of previous overheating.
8. Verify that all electrical connections are secure including wire terminals, screw and stud type terminals, and all soldered connections.
9. Check for obvious destruction of internal structural parts. Distortion in any of these parts could mean that the unit has been dropped or subjected to severe shock.

4.4 Disassembly

Complete disassembly of the D-150A II should rarely, if ever, be required. Disassemble the unit only as far as is necessary to make a full inspection and to perform repairs, testing, and adjustment.

To aid in matching part numbers with the assembly illustrations, each part is identified with a reference number matching its illustration number. The same number system is used throughout the manual.

WARNING

WHEN CONNECTED TO AC POWER MAINS, THE UNIT IS A POTENTIALLY LETHAL HAZARD, PARTICULARLY DURING INITIAL INSPECTION. UNTIL YOU HAVE IDENTIFIED THE SOURCE OF THE TROUBLE OR HAVE DETERMINED THAT THE UNIT IS SAFE TO POWER UP, MAKE SURE IT IS DISCONNECTED FROM AC MAINS.

(Refer to **Illustration 7-1** and **7-2** for the following steps.)

4.4.1 Front Panel Removal

To remove the front panel (4), loosen the two hex screws (1) behind each rack mount bracket (2) and remove the six phillips screws (3) that secure the front panel to the amplifier chassis. Gently pull the front panel straight off. Avoid straining the cables connected to the input level controls, power switch or IOC board.

4.4.2 Main Board Cover Removal

To remove the main board cover (15), remove the two screws (14) that secure the dress plate (13). Remove the dress plate and gently pull the main board cover off. Most main board components are now easily accessible for testing and replacement.

4.4.3 Main Board Replacement

Remove the front panel (4) and main board cover (15) as described above. Note the routing and placement of the various wires connected to the main circuit board. To avoid errors in reassembly, a simple, hand drawn diagram could be very helpful.

Unsolder and remove the wires connected to the main board. Remove the two screws (81) that mount the main board to the amplifier chassis and remove the main board.

4.4.4 Power Switch Removal

Remove the front panel as described in **4.4.1.** Remove AC wires from the power switch (5) by gently pulling them off. Remove the screw (6) that secures the switch mounting bracket (14) to the front panel. The switch can now be removed from the mounting bracket for replacement.

4.4.5 Filter Capacitor Removal

Remove the front panel as described in **4.4.1.** Remove the two screws (11) that secure the transformer cover (9) to the power transformer (28). Lift off the transformer cover and the transformer wraparound (8). With the front of the amplifier facing upward, remove screws and mounting hardware from the filter capacitors (38) and (39). It should not be necessary to unsolder any of the wires connected to the capacitor.

4.4.6 Power Transformer Removal

Remove the front panel as described in **4.4.1.** Remove the two screws (11) that secure the transformer cover (9) to the power transformer (28). Lift off the transformer cover and the transformer wraparound (8). Note location and routing of all wires coming from the power transformer (a diagram would be helpful).

Unsolder and remove the following wires:

a. the green wire to the main circuit board (83);

b. the yellow wire to the power supply capacitors (38) and (39);

c. the primary wires to terminal strips (26) and (27);

d. the red wires to the bridge rectifier (41) by pulling the Faston connecters straight away from the rectifier.

Gently pull all the wires through the hole in the chassis. Finally, remove all the mounting hardware that secures the transformer to the chassis and remove the power transformer.

4.4.7 Output and Driver Transistor Replacement

Remove the front panel (4) and main board cover (15) as described above. Unsolder the wires going to the transistor to be replaced and remove the hardware securing the transistor to the chassis. Gently pull it away from the chassis. When installing the new transistor, insure that the insulator has new heat-sink compound applied to it for proper thermal conduction. Install the transistor and hardware making sure that the transistor is snugly mounted to the chassis to insure good thermal conduction is maintained.

4.5 Reassembly

Reassembly is essentially the reverse of disassembly. To check the type of size of attaching parts, refer to the appropriate illustration in **Section 6.**

SECTION 5: GENERAL CIRCUIT THEORY

This section is a summary of D-150A II theory of operation. For schematic reference, use diagram JO23-0 in the Appendix.

Model D-150A II units with serial numbers 59428 and above incorporate some engineering improvements in the input stage; however, the circuitry described here applies to all units.

For simplicity, the circuit description which follows refers to channel 1 only; the operating principles are identical for channel 2.

5.1 Input Stage

The input signal enters the unbalanced 1/4" input jack. After the signal level is adjusted to a desired amplitude through R105, it is applied to the dual IC operation amplifier U100. The direct input signal is applied to the non-inverting input (U100 pin 3) and the feedback signal is applied to the inverting input (pin 2).

Because of the feedback path, both signals entering U100 will have a common polarity and will thus produce a near-zero output (pin 6). The IC op amp will always try to keep a zero potential difference between both inputs. Any type of non-linearity will cause the op amp to produce a large output, and therefore, a substantial size correction signal in order to retain the small output level.

5.2 Voltage Amplification

D-150A II front end circuitry consisting of IC op amp through Q105 provides voltage amplification. The signal translator transistor Q101 provides no voltage amplification itself, but rather converts the ground referenced input signal to a signal with a reference to the negative supply (-45V). The result is higher voltage swing capabilities from the final voltage amplification transistor Q105. Q105 is the main source of voltage amplification.

R116 in the base circuit of Q105 serves two purposes:

1. To provide collector current for Q101.
2. To amplify the signal thus developed across the collector of Q101.

As this development is in process, Q105 emitter voltage is developed across R124. When this voltage reaches a positive 0.6V, Q106 turns on and "pulls" the drive away from the last voltage amplifier, thus acting as a current limiter for Q105.

5.3 Output Stage

The output of the final voltage amplifier provides the signal drive to the predriver (Q107, Q112), driver (Q109, Q113), and the output transistors (Q110, Q114) in order to amplify the current for final output power.

The correct bias transistor (Q111) collector-emitter voltage of 2.15VDC is distributed throughout the current amplification stages in the following manner:

1. Base-to-emitter junction of negative predriver (Q112) is .6V.
2. Base-to-emitter junction of positive driver (Q109) and predriver (Q107) is .6V.
3. Negative driver (Q113) and output transistor (Q114) have a fixed base-emitter bias in reference to the negative supply and are not involved with the bias servo circuitry.
4. .315V is present across the positive output base-to-emitter resistor (R131).

As noted above, the predrivers and drivers are biased at .6V. But also, the output transistors have a .315VDC voltage from base-emitter and are therefore at a "sub turn-on" voltage. This form of biasing is known as class AB+B where the driver transistors carry the bias current while the output transistors serve only as boosters. The output transistors sense when the driver transistors are developing significant current drawn from the load and thus take over and deliver the needed current.

The result of this format is maximum efficiency with minimum crossover notch distortion and idling amplifier heat.

5.4 Protection Circuitry Stage

The D-150A II protection circuitry is the Crown-developed SPACE (Signal Programmed Automatic Current Executor) control circuit.

R132 and R134 are current sensing resistors which carry the output current from the output transistors to the positive and negative limiting transistors (Q103, Q104). Before the output current becomes dangerously high, the limiting transistor is activated which in turn limits the drive voltage at the base of the predriver. When the predriver current and the limiter current are equal to the current available from Q102, a limit point is reached and the protection circuitry remains in this state until the overload is removed.

5.5 Bootstrap Supply

The bootstrap supply is a voltage doubler network consisting of C4, C5, D1 and D2. From the 33VAC, C4 is charged through D1 during one-half of the AC cycle. During the next half cycle, C5 is charged to approximately twice the voltage of C4 through D2. This provides a constant current source for the predriver, bias, and voltage amplifier sections of the D-150A II.

A 10V zener diode (D3) is primarily responsible for providing a constant 10V distribution across the combination R110 and Q102. This allows Q102 to provide a constant current path to the predriver, bias, and voltage amplifier sections.

The constant current source is necessary to attain maximum voltage swing from the voltage amplifier stage as well as to help isolate the front-end input stage supply from the rail supply. This, in turn, helps prevent front-end overload.

5.6 Temperature Compensation/Offset Circuitry

The output offset adjustment (R100) provides a bias voltage for the inverting (pin 2) input of op amp U100. The output offset adjustment is set with the level control fully CCW so there is zero DC voltage across the output of the amplifier. With the level control either open or closed, the non-inverting input is at 0 volts. The output offset adjustments (R100) then can vary the bias voltage on the inverting input to match this for zero output.

5.7 Input-Output Comparator (IOC)

The IOC display is a window comparator circuit using two operational amplifiers (U1C, D) and LED indicator (D108). Any small non-linearity in the amplifier causes a feedback loop error at the inverted input of the main IC op amp (U100). The main IC output (pin 6) will rise above its normal value in an attempt to correct the problem. This signal is then responsible for raising the bias voltage on U1 and, in turn, activating Q116 which lights D108.

SECTION 6: TEST PROCEDURES

6.1 Electrical Checkout

The following outlines an orderly checkout and adjustment procedure for the D-150A II. Refer to **Section 4.2** for the test equipment required for these procedures.

6.1.1 Quiescent DC Offset

Using a DC voltmeter, measure the voltage at the output of the amplifier. It should not exceed +/- 10MV. Should the offset need to be adjusted use the following procedure.

(For units with serial numbers 51024 through 59428)

a. Allow amplifier to warm-up for 15 minutes.

b. Set input level control, located on the front panel, fully CCW.

c. Adjust Output Offset R100 or R200 for 0 (zero) reading on the DC voltmeter.

d. Slowly rotate the input level control CW until the reading on the DC voltmeter peaks in value.

e. Adjust Input Offset R102 or R202 for 0 (zero) reading on the DC voltmeter.

(For units with serial numbers 59429 and higher)

a. Allow amplifier to warm-up for 15 minutes.

b. Set input level control, located on the front panel, fully CW.

c. Adjust Output Offset R100 or R200 for 0 (zero) reading on the DC voltmeter.

6.1.2 Bias Level Adjustment

With the amplifier power on and no input signal present, check the base-emitter bias voltage using a DC voltmeter. It should fall between .31VDC to .35VDC. To adjust use the following procedure.

(For units with serial numbers 51024 through 59428)

a. Bias voltage is varied by changing the value of select resistors R128 and R228. If bias voltage is high, increase the value of the resistor. If bias voltage is low, decrease the value of the resistor. The select resistor should have a value between 30 to 300 ohms.

(For units with serial numbers 59429 and higher)

a. Adjust bias pot R128 and R228 for correct bias voltage.

6.1.3 Power Tests (one channel driven)

a. Inserting a 1kHz sine wave signal into the channel under test, the 8 ohm power rating of 98 watts (28.0VRMS) and the 4 ohm power rating of 175 watts (26.5VRMS) should be obtained before clipping occurs.

b. Inserting a 20kHz sine wave signal into the channel under test, an 8 ohm power rating of 90 watts (27.0VRMS) should be obtained before clipping occurs.

c. Inserting a 10kHz square wave input signal with an 8 ohm load on the output of the amplifier, adjust the input level for a 30V peak to peak output level. The output waveform should be clean with no overshooting or ringing occurring (see **Illustration 6-1**).

6.1.4 Protection Circuit Tests

a. Insert a 1kHz sine wave signal into the channel under test and adjust the output level for 28VRMS.

b. Place a 2 ohm load on the output of the amplifier and observe the output. It should clip the sign waveform signal evenly on both the positive and negative portion of the waveform (see **Illustration 6-2**).

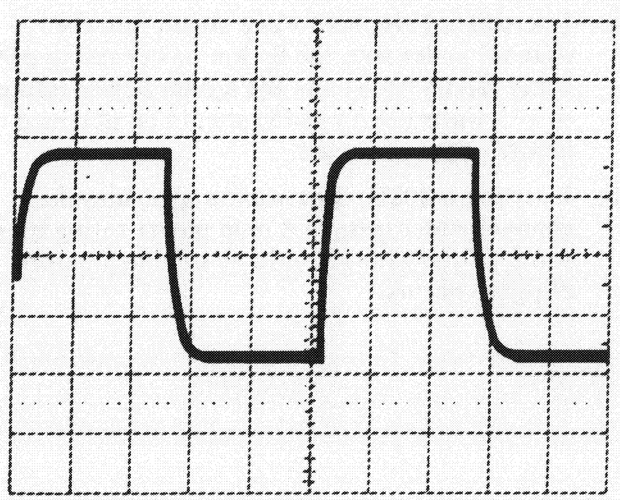

Illustration 6-1
Correct Square
Wave Operation

Illustration 6-2
Test Limiting
Waveform