D-60
SM-6
S1-P2-22-0

crown

SERIAL NO. ______________

ISSUED TO ______________

SERVICE MANUAL
D-60
DUAL-CHANNEL
POWER AMPLIFIER

Div. of INTERNATIONAL RADIO & ELECTRONICS CORP. BOX 1000 ELKHART, INDIANA 46514

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INTRODUCTION

FIGURE 1-1
MODEL D-60 DUAL-CHANNEL POWER AMPLIFIER
(Shown without cabinet)

1.1 SCOPE OF MANUAL

This manual is intended to provide the user and service technician necessary technical information required to install, operate and repair the CROWN D-60 Dual-Channel Power Amplifier properly and to maintain the unit in optimum operating condition.

The manual is comprehensive; containing a physical description of the D-60, electrical and mechanical specifications, complete installation and operating instructions, a detailed circuit description and service procedures to include troubleshooting and repair. Also included are complete parts lists, a unit schematic and exploded view drawings to assist in identification of parts and understanding the functional operation of the D-60 amplifier.

A thorough reading of this manual and strict adherence to the instructions, procedures and cautions will assure many years of professional quality service and listening enjoyment from your CROWN D-60 Dual-Channel Power Amplifier.

1.2 EQUIPMENT DESCRIPTION

The CROWN D-60 dual-channel, medium power amplifier is specifically designed for ultra-low distortion amplification from 5 Hz to 20 KHz with operation into loads of 4 ohms and higher. The unit features extremely low harmonic and intermodulation distortion, very low noise, highest "damping factor" and quality components and workmanship. The unit may be wired to produce a balanced 25-volt monaural output. The D-60 is fully protected against mismatched and shorted loads by a resetting V-I (voltage-ampere) limiter which eliminates obnoxious muting or program delays.

The input IC voltage-amplifiers are powered by two voltage-regulated power supplies featuring large computer-grade filter capacitors. This results in complete channel-to-channel isolation and independence from line voltage variations.

Two front panel LEVEL controls provide for balancing and optimizing system sound levels. Also located on the front panel is a power ON-OFF switch and an associated indicator lamp.

SECTION 2
SPECIFICATIONS

Frequency Response	$\pm$0.1db 20-20KHz at 1 watt into 8 ohms, $\pm$1.2db (3.14) — 100KHz.
Power Response	$\pm$1db 5Hz - 30KHz at 30 watts, both channels. RMS into 8 ohms.
Phase Response	See graphs, next pages.
Power at Clip Point	Typically 41 watts RMS into 8 ohms, 64 watts RMS into 4 ohms per channel (see graphs).
Total Output (1HF)	Typically 104 watts RMS into 8 ohms, 165 watts RMS into 4 ohms (see graphs).
I.M. Distortion (60-7KHz 4:1)	Less than 0.05% from 0.01 watt to 30 watts RMS into 8 ohms, less than 0.01% at 30 watts, typically below 0.02% and .003% respectively (see graphs).
Total Harmonic Distortion	Below .05% at 30 watts 8 ohms (see graphs).
Damping Factor	Greater than 200 (Zero to 1KHz into 8 ohms) see graph.
Hum and Noise	106db below 30 watts RMS output (unweighted band limited 20Hz - 20KHz typically 115db).
Slewing Rate	6 volts per micro-second. S-R is the maximum value of the first derivative of the output signal.
Load Impedance	4 ohms or greater. Stable with all speaker loads. For V-I limiting values see Section 3.
Input Sensitivity	.75 volt $\pm$2% for 30 watts into 8 ohms (see graph).
Input Impedance	25K ohms
Output Impedance	See graphs, next pages.
DC Output Offset	10mv or less.
Turn-On	Instantaneous, with no thumps or program delay.
Load Protection	Short, mismatch, and open-circuit proof. V-I limiting is instantaneous with no annoying thumps, cutout, etc.
Overall Protection	The line voltage is fused. Controlled-slewing-rate voltage amplifiers protect overall amplifier against RF burnouts. Input overload protection is furnished by internal resistance at inputs of amp.
Power Supply	Computer-grade filter capacitors with a special design low profile transformer. Two regulated supplies for complete isolation and stability.
Power Requirements	Requires 50 to 400Hz AC on 120V or 240V $\pm$10% operation. Draws 15 watts or less on idle 120 watts at 60 watts output into 8 ohms.
Heat Sinking	The entire amplifier is used as a heat sink. Front panel extrusion acts as a heat sink along with the chassis covers.
Chassis	Aluminum chassis construction for maximum heat conduction and minimum weight.
Controls	Two input level controls on front panel with power switch and pilot light.
Connectors	Input ¼ in. phone jack Output — Color coded binding posts with stereo ¼ in. earphone jack on front panel. AC Line — Three-wire (grounded) male connector on 5 ft. min. cable.
Dimensions	17 in. long, 8¾ in. deep and 1¾ in. high (8 in. deep from mounting surface) 19 in. standard rack mounting hardware available.
Weight	10 pounds net weight
Finish	Front panel is bright anodized brushed aluminum with black leatherette insert.

SECTION 3
INSTALLATION & OPERATION

3.1 GENERAL

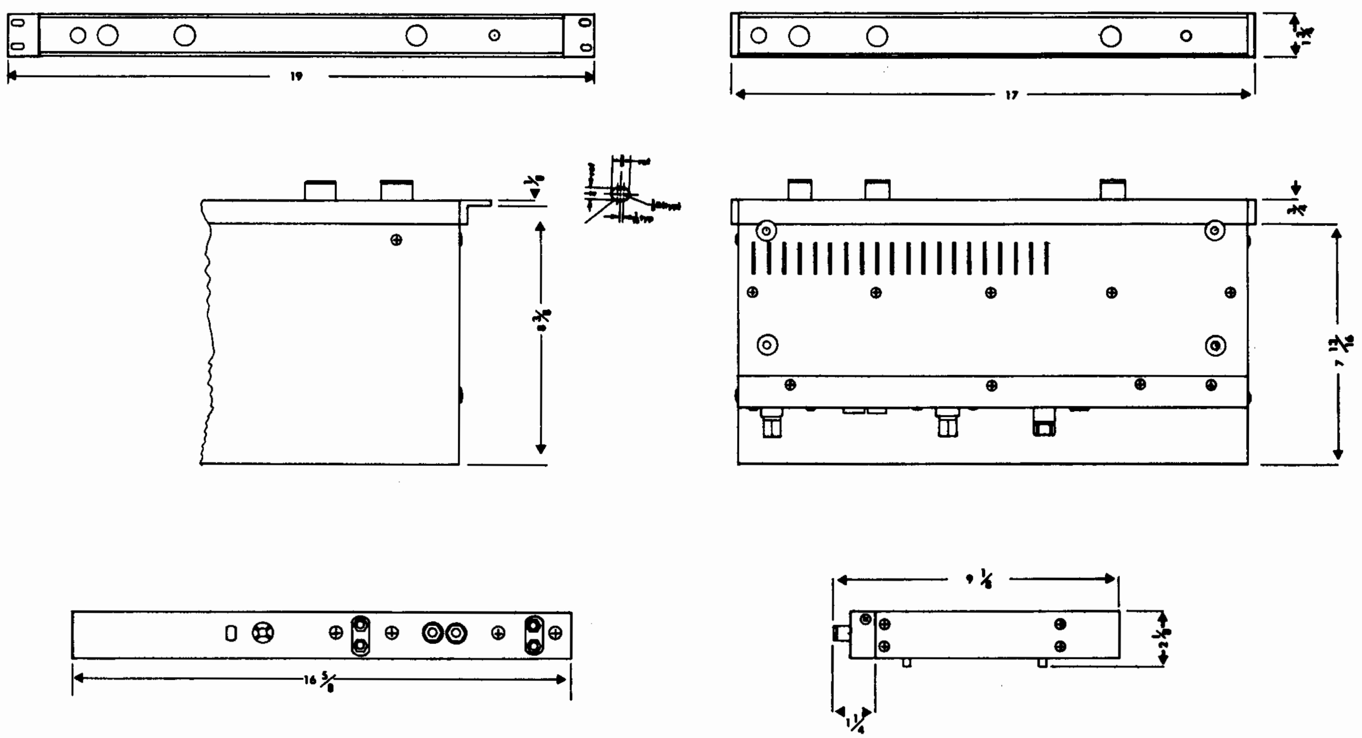
This section contains installation and operation instructions for the D-60 amplifier. Also included are descriptions of the protective mechanisms for the amplifier and the load, together with a list of operating precautions to help clarify proper operating procedures.

3.2 UNPACKING

Immediately upon receipt of the amplifier shipment, inspect the unit for any damage incurred in transit. The amplifier was carefully inspected and tested and left the factory unmarred. Notify the transportation company immediately if any damage is found. Only the consignee may initiate a claim with the carrier for damage during shipment. However, CROWN will cooperate fully in such an event. Be sure to save the carton as evidence of damage for the shipper's inspection.

CROWN recommends that you save the packing materials, even if the unit arrives in perfect condition. They will prove valuable in preventing damage should there be occasion to transport or ship the unit. Both the carton and internal pack are specifically designed for protection during transit. **Do not ship the unit without this factory pack!**

Be sure to return the warranty registration form to the CROWN factory within ten days for the full warranty coverage.



NOTE: The "basic" D-60 shown at right may be converted to rack mounting by installing the brackets as shown above.

FIGURE 3-1
D-60 MOUNTING DIMENSIONS

3.3 MOUNTING

The D-60 is shipped from the factory with end bars and rubber feet installed. In this format it can be shelf-mounted (see below) or the rubber feet can be removed and the unit can be mounted in a custom made enclosure.

Included with the D-60 is a rack-mount kit. The standard D-60 may be converted for 19" rack mounting by replacing the end bars with rack-mounting brackets as shown in Figure 3-2, A.

Shelf Mounting — To shelf-mount the D-60 (with optional end bars) refer to Figure 3-2, B and:

1. Carefully cut out the panel opening.
2. Fabricate a shelf with minimum dimensions of 17" length, 6½" deep and ½" thickness.
3. Drill two 5/16" diameter holes in shelf.
4. Install shelf with top surface flush with the bottom of the panel cutout.
5. Insert the amplifier into the panel cutout until the two holes in the amplifier bottom cover line up with the two 5/16" holes drilled in the shelf in Step 3 above.
6. Attach the amplifier to the shelf with the two ¾" #8 self-tap truss-head screws.

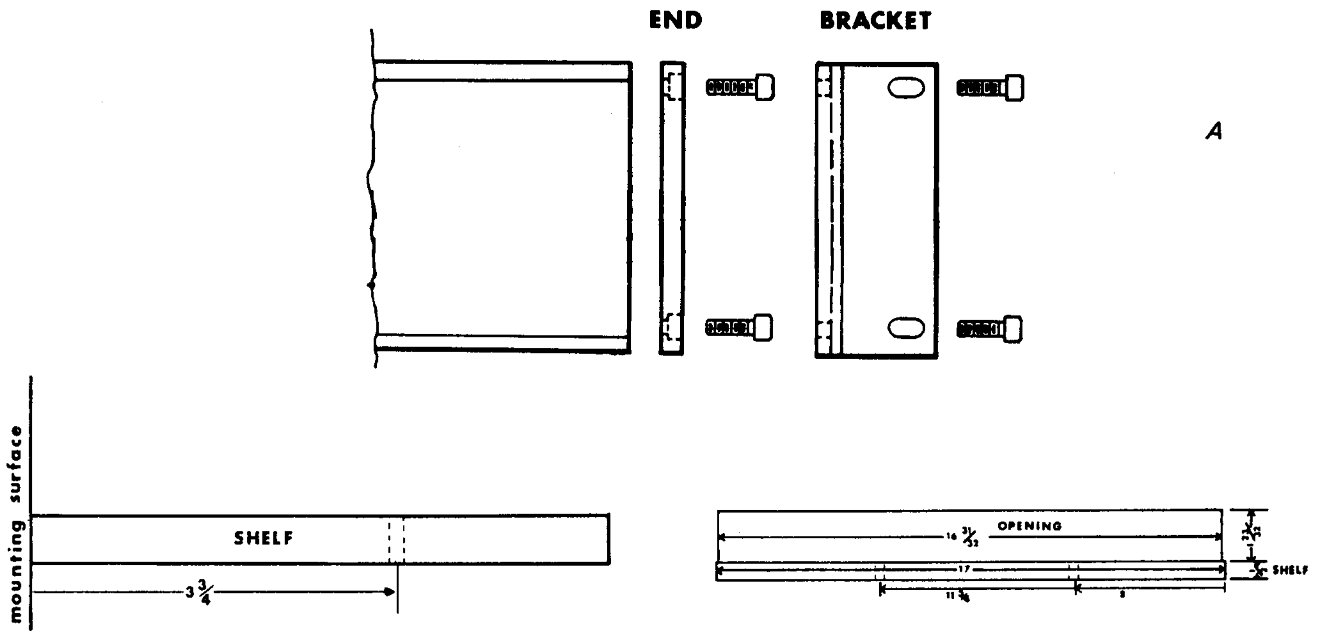


FIGURE 3-2
INSTALLATION OF END BAR ACCESSORIES AND SHELF-MOUNTING DETAILS

3.4 AMPLIFIER PROTECTION MECHANISMS

The D-60 amplifier is protected against the common hazards which plague power amplifiers, including shorted, open and mismatched loads; overloaded power supplies; chain destruction phenomena; inout overload damage; and high frequency overload blowups.

Protection against shorted and mismatched loads is provided by a limiter which instantaneously limits at the volt-ampere product to the maximum safe-stress value for the output transistors.

The operating area in which the amplifier will drive the load without being V-I limited is depicted by the cross-hatched area in Figure 3-3.

If a load initiates the amplifier protection circuitry, it can generally be detected by watching the amplifier transfer characteristics on an oscilloscope or by plotting the V-I behavior of the load on Figure 3-3. In applications where the load is a loudspeaker, amplifier protection will be evidenced by distortion in the speaker. The audible effect ranges from something resembling cross-over notch distortion to a snapping sound, depending on the overall load characteristics. Speaker systems which are truly 4 ohms or greater will not initiate the protection system.

The ac line for 120 VAC is fused with a 2A, 250V type AG fuse (on 240, 250 VAC, 1 A type AG). The use of any other type fuses will invalidate the warranty.

The D-60 voltage-amplifier circuitry is designed to be inherently

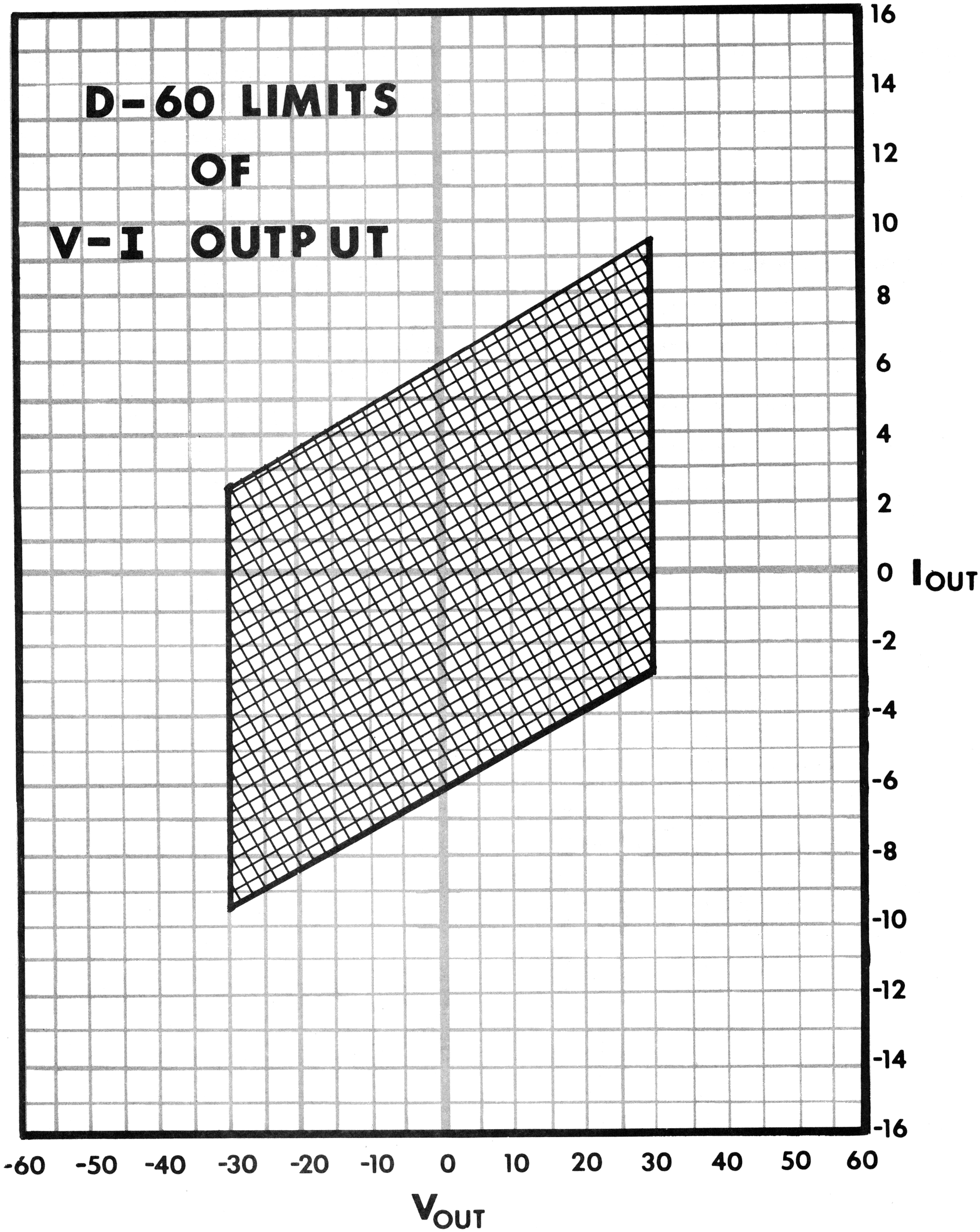


FIGURE 3-3
D-60 LIMITS OF V-I OUTPUT

current-limited. Should any of the devices fail (extremely rare), no damage will occur to the rest of the stages.

The input stage is protected against overdrive damage by a series limiting resistor should the input signal level become excessive.

A controlled slewing-rate, coupled with the V-I limiter, protects the D-60 from blowups when fed large rf input signals.

3.5 LOAD PROTECTION METHODS

The most common of all protection schemes is a fuse in series with the load. The fuse may be single, fusing the overall system. Or, in the case of a multi-way speaker system, it may be multiple with one fuse on each speaker.

Fuses help to prevent damage due to prolonged overload, but provide essentially no protection against damage that may be done by large transients and such. To minimize this problem, high-speed instrument fuses such as Littlefuse 361000 series are most appropriate for such applications. For a nomograph showing fuse size vs. loudspeaker ratings refer to Figure 3-4.

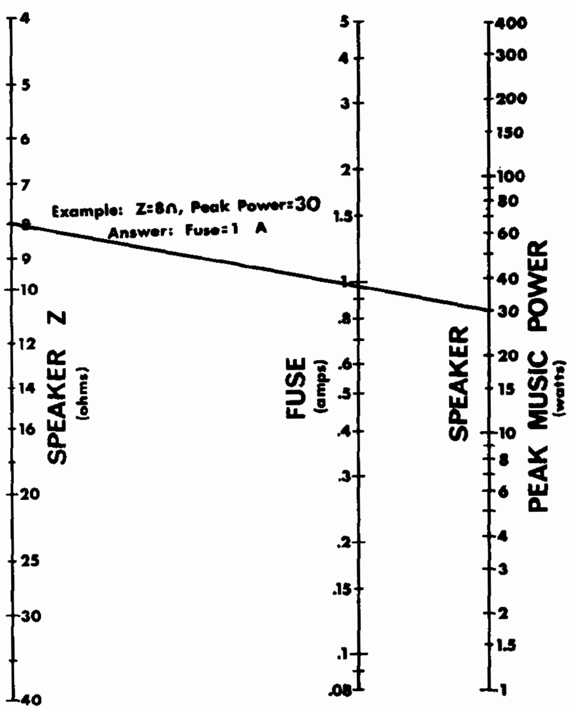


FIGURE 3-4
FUSE SELECTOR NOMOGRAPH FOR LOUDSPEAKER PROTECTION

Another form of load protector is shown schematically in Figure 3-5. Whenever the load is overdriven, a relay switches a lamp in series with the load, smoothly relieving the overload. The lamp then doubles as an overdrive indicator as it glows. If overdrive is unreasonably severe, the lamp will serve as a fuse. By adjusting the relay tension adjustment and the protection level control, this system is useful from 25 to 200 watts for a typical 8 ohm load.

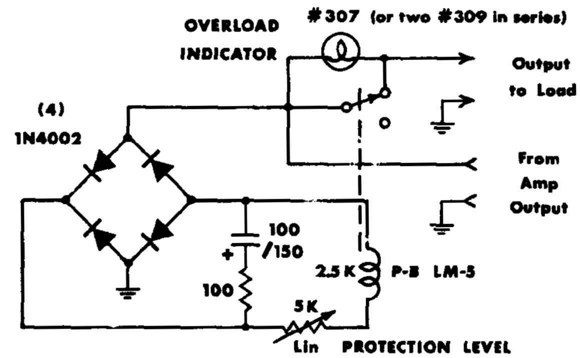


FIGURE 3-5
RELAY-CONTROLLED PROTECTOR WITH OVERLOAD INDICATOR

Another more sophisticated form of overload protector relieves the overload by controlling the amplifier's input signal which is creating the overload. This form of protector not only saves the load but also eliminates amplifier overload. With this device, it is possible to operate the amplifier at its maximum level with a minimum of clipping. This device is shown schematically in Figure 3-6. It features an overdrive indicator, distortionless photo-optical control, and a Protection Level control giving adjustment from 1W to 200W when driving 8 ohms.

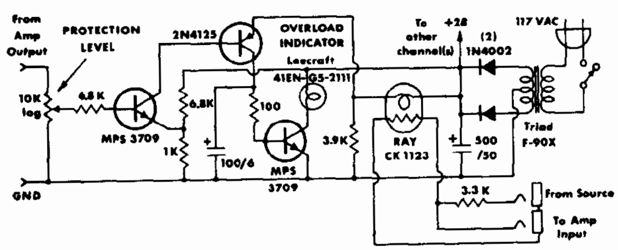


FIGURE 3-6
PEAK POWER LIMITING COMPRESSOR WITH OVERDRIVE INDICATOR

A common problem which causes damage and irritation is the turn-on thump problem typical to many signal sources. Figure 3-7 shows the schematic of a muter which, when inserted in the input signal line, mutes for several seconds before connecting the source to the amplifier, thereby eliminating turn-on transients. It also removes turn-off transients occurring after the relay drops open (0.1 sec.).

NOTE: When using the CROWN IC-150 this muter is not required. A built-in muter protects your speakers from any signal source whose AC power is switched by the IC-150.

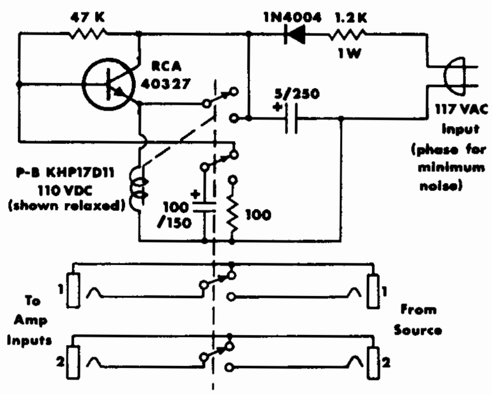


FIGURE 3-7
TURN-ON-TRANSIENT MUTER
FOR LOAD PROTECTION

3.6 OPERATING PRECAUTIONS

The following are a number of operating precautions given as an aid to understanding proper and improper amplifier usage:

1. Use care in making connections, selecting signal sources, and controlling the output level. The loudspeaker you save may be your own. CROWN is not liable for any damage done to loads due to careless amplifier usage or deliberate over-powering. For pointers on load protection see Section 3.4.
2. Never parallel the two outputs by directly tying them together or parallel them with any other amp's output. Such connection does not result in increased power output. Damage incurred by such operation is not covered by the warranty.
3. Never drive a transformer-coupled device or any other device which appears as a low frequency short (less than 3 ohm) without a series isolating capacitor. Such operations may damage the device and/or needlessly activate the V-I limiting (see Figure 3-3).
4. Do not short the ground lead of an output cable to the input signal ground as oscillations may result from forming such a ground loop.
5. Operate and fuse the amplifier only as set forth in Section 3.4.
6. Operate the amplifier from AC mains of not more than 10% above the selected line voltage and only on 50, 60 or 400Hz AC. Failing to comply with these limits will also invalidate the warranty.
7. Never connect the output to a power supply output, battery, or power main. Damage incurred by such a hookup is not covered by the warranty.
8. Do not expose the amplifier to corrosive chemicals such as soft drinks, lye, salt water, etc.
9. The amplifier is not recommended for high power industrial usage at frequencies above 30KHz.
10. Tampering in the circuit by unqualified personnel or the making of unauthorized circuit modifications invalidates the warranty.
11. Do not expose the output leads to areas likely to be struck by lightning. Such an installation could invalidate the amplifier.

3.7 CONNECTING OUTPUT LINES

Input and output connectors are located on the chassis as shown in Figure 3-8.

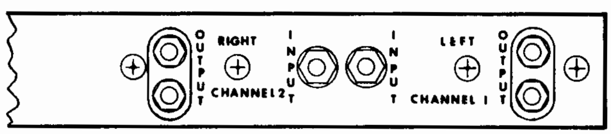


FIGURE 3-8
REAR VIEW OF CHASSIS

It is always wise to remove power from the unit and turn the input level controls off while making connections, especially if the load is a loudspeaker system. This will eliminate any chance of loud blasts. CROWN is not liable for damage incurred at any transducer to its being overpowered! The use of speaker fuses is recommended.

Before making connections, it is recommended that the operator familiarize himself with the amplifier's protective system. See paragraph 3.4. Paragraph 3.6 entitled "Operating Precautions" should also be read.

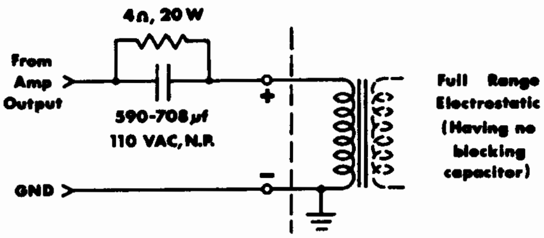


FIGURE 3-9
SCHEMATIC FOR FULL RANGE ELECTROSTATIC SPEAKER CONNECTION

Because the output wire gauge and length raises the resultant source impedance or lowers the Damping Factor by adding series resistance, the nomograph (Figure 3-10) is provided for wire selection. For dynamic moving-coil loudspeakers the value R_L should preferably be that measured by an ohmmeter across the voice coil, rather than the manufacturer's rating. For electrostatic speakers and such, the manufacturer's rated impedance should be used for R_L.

If the load (matching transformer, inductance, or full-range electrostatic speaker system) appears as a short-circuit at low frequencies, a large non-polarized capacitor (paralleled with a resistor) should be placed in series with the load.

For electrostatic speakers (if the manufacturer has not provided a capacitor) an external non-polar capacitor of 590-708 mfd and 4 ohm power resistor should be placed in series with the plus (+) speaker lead. This will prevent large low-frequency currents from damaging the electrostatic transformer or from unnecessarily activating the D-60's protective system. An effective test to determine if such parts are needed is to measure the DC resistance between the output terminals with an ohmmeter. If the resistance is less than 3 ohms, the parts should be added as shown schematically in Figure 3-9.

When selecting connectors for the load (speaker) end of the output lines, the following general precautions apply (with all power connectors):

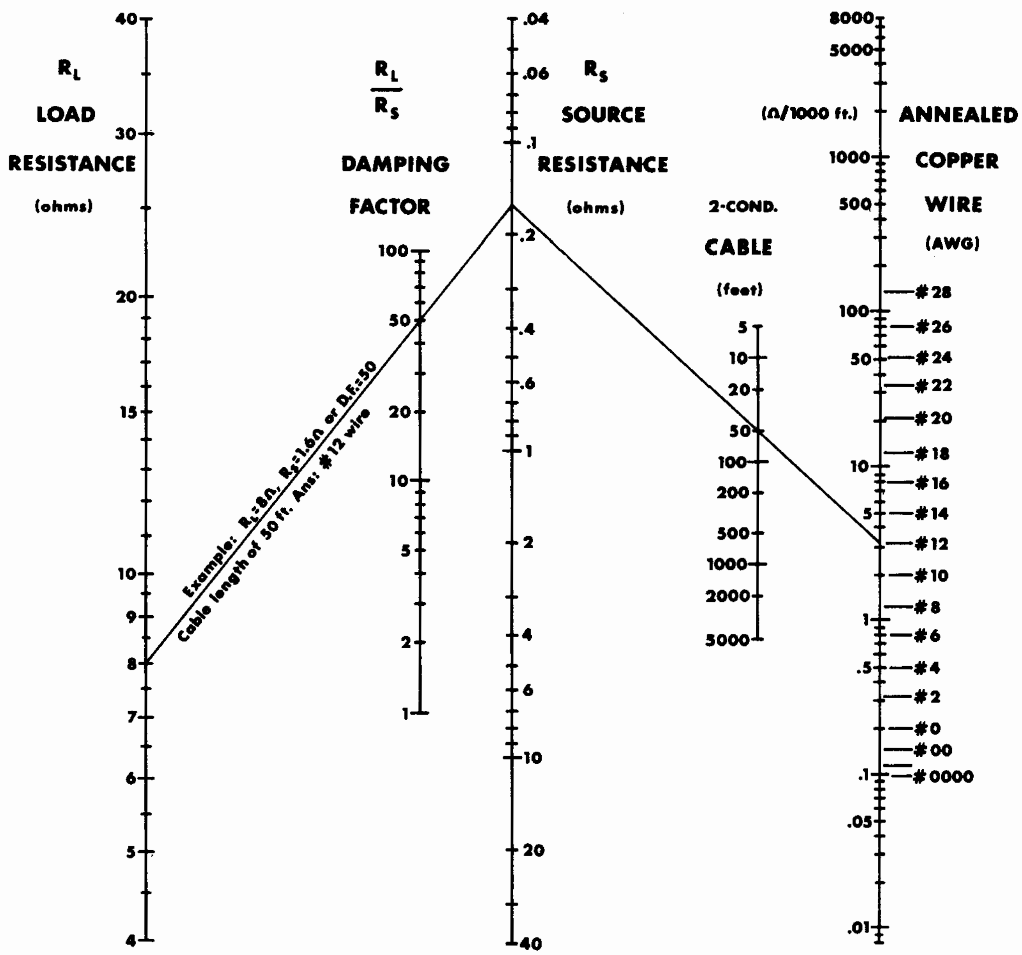


FIGURE 3-10
SOURCE RESISTANCE and DAMPING FACTOR VS. LENGTH and SIZE of OUTPUT LEADS

1. A male plug, carrying signal, must not be on the far end of the line where it can be exposed, giving rise to both shock and short-circuit hazards.
2. Connectors which might accidentally cause the two channels to be tied together during making and breaking of connection should not be used.
3. Connectors which can be plugged into AC power receptacles should **never** be used.
4. Connectors having low-current carrying capacity are "verboten."
5. Connectors having any tendency to short, or having shorted leads, are unadvisable.

3.8 CONNECTING INPUT LINES

Connecting the inputs will require observance of three basic precautions: Undesirable signals to the inputs, "ground loops," and feed back from output(s) to input(s).

In high-fidelity audio applications any good vacuum-tube or solid-state control center will operate successfully into the 25K ohm inputs of the D-60. Occasionally a high-impedance output of poorly-designed preamps will be encountered, and/or a larger output coupling capacitor may be required (to prevent excessive low-frequency rolloff).

For loudspeaker-driving applications, the input should be free of large sub-audio or undesired low frequencies, as they cause overheating and overloading of the loudspeaker. To remove such low frequencies, a series capacitor may be placed in the input signal line. (The graph of Figure 3-11 indicates the effect of the size of the capacitor on the frequency response.) Only a low-leakage paper, mylar, or tantalum capacitor should be used for this purpose.

If large amounts of ultrasonic or RF frequencies are found on the input, such as bias from tape recorders, etc., a low-pass filter should be placed on the input. While practically-obtainable RF input levels will not damage the amplifier, they may cause burn-out of tweeters or other sensitive loads, activate the amplifier's protective systems, or cause general overload in the controlled-slewing-rate stage of the amp (which is employed to provide RF overload protection). The following filters are recommended for such applications.

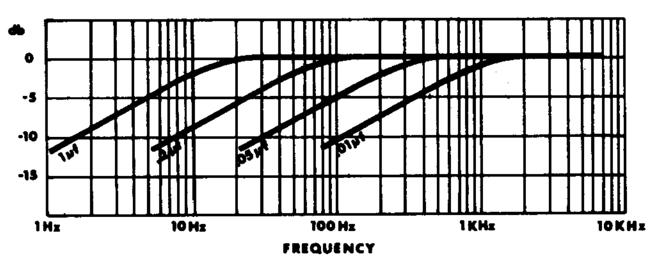


FIGURE 3-11
GRAPH for SELECTION of INPUT CAPACITOR

A second precaution is "ground loops" — electronic jargon for undesirable circulating currents flowing in a grounding system. A common form of loop (possibly resulting in hum in the output) is a pair of input cables whose area is subjected to a magnetic hum field. In practice, both cables should lie together along their length, and away from the power transformer. Tying the input and output grounds together may also form a ground loop.

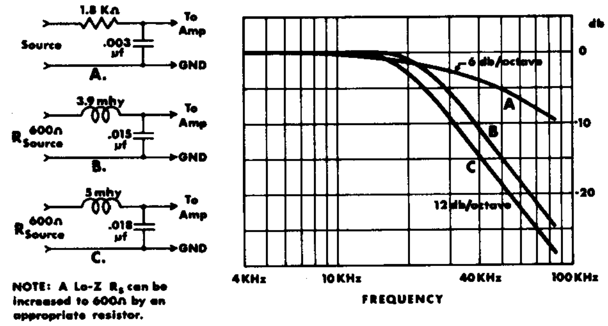


FIGURE 3-12
LOW-PASS FILTERS
FOR SEVERE RF AT INPUTS

A third precaution (with input and output grounds together, as in testing or metering) is feedback oscillation, from load current flowing in the loop. In industrial use, even the AC power line may provide this feedback path. Proper grounding, and isolation of inputs, of common-AC-line devices is good practice. Refer to paragraph 3.6 for testing precautions.

3.9 CONNECTING POWER

The amplifier is furnished with a three-wire AC plug as standard equipment. Adapters are readily available commercially for adapting this to a two-wire system if necessary.

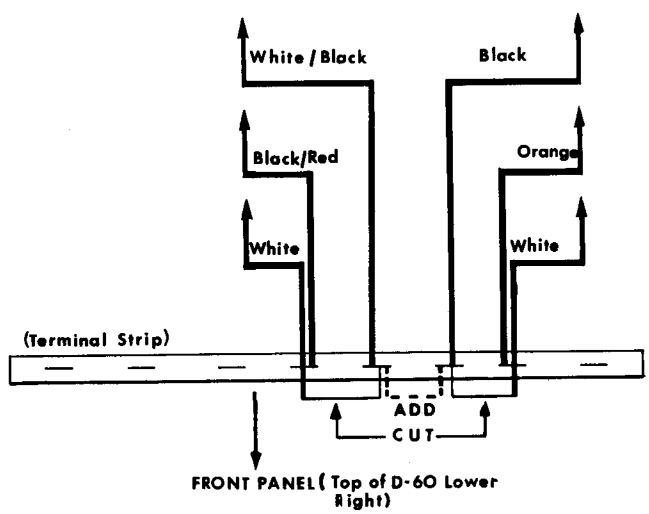


FIGURE 3-13
LINE VOLTAGE CONNECTIONS (240 VAC)

Converting the D-60 power supply from 120 volts to 240 volts can be simply accomplished with a soldering iron and a pair of wire cutters. The accompanying diagram shows the wiring involved in the following sequence of operations.

1) Remove the top cover of the D-60 (held on by 8 screws).

2) With the unit right side up, and the front panel toward you, locate the terminal strip on the front in the near right-hand corner.

3) Cut the jumper wires running between the white, orange and black conductors, and between the black/white, white and red/black conductors.

4) Connect the black/white and black conductors together by soldering a jumper wire to their terminals.

5) Replace the 2 amp line fuse with a 1 amp type 3AG fuse.

6) Change the line cord tag to read 240 volts.

When testing the amplifier, the line voltage must be the peak equivalent to a sinusoid of the indicated line voltage when at full load. Line regulation problems can introduce serious errors in the measurements on an amplifier.

Only a competent technician should attempt alteration of the line voltage connections.

3.10 OPERATING CONTROLS

The D-60 contains all the facilities essential for a high performance amplifier.

The input level controls are mounted on the front panel. Each control should be adjusted for the desired amplifier gain or output level. When the control is fully CW, the gain is 26db as determined by precision 1% resistors in the D-60's feedback loop.

3.11 NORMAL HI-FI INSTALLATION

1. Two-conductor speaker cables must connect to the OUTPUT dual binding posts using terminal lugs, tinned ends, or "banana" plugs.

2. Since the D-60 is a "basic amplifier," the main outputs of the control-center or "preamplifier" must be connected via shielded audio-cables to the two jacks marked INPUT. Use RCA-pin at preamp and standard ¼ in. phone-plug at the D-60.

   The two cables should be tied parallel along their entire length using the accessory cable ties.

3. U/L requirements prefer a 3-wire AC power connector; however, proper connections to a switched outlet on the control center requires the use of a 3-to-2 wire adapter. NOW, plug the AC into a **switched** outlet on the control center.

4. Your Control Center may now be turned on. Then advance the D-60 Input-Gain Controls about ½-open (150° clockwise).

When using the CROWN IC-150 Control-Center, the LOUDNESS should attain almost full rotation (2 to 4 o'clock) for loudest "concert-hall" volume. If at 3 o'clock the volume is low, increase the D-60 input gain controls; if too high, decrease the D-60 gains.

3.12 CLEANING

The CROWN D-60 has a rugged anodized front panel for life-time service. The panel can be cleaned with a moist cloth and mild detergent. Never use steel wool, scouring powder, lye solution, or any strong abrasive cleaner as these will damage the panel's finish.

The chassis should require no more cleaning than periodic dusting with a clean dry cloth.

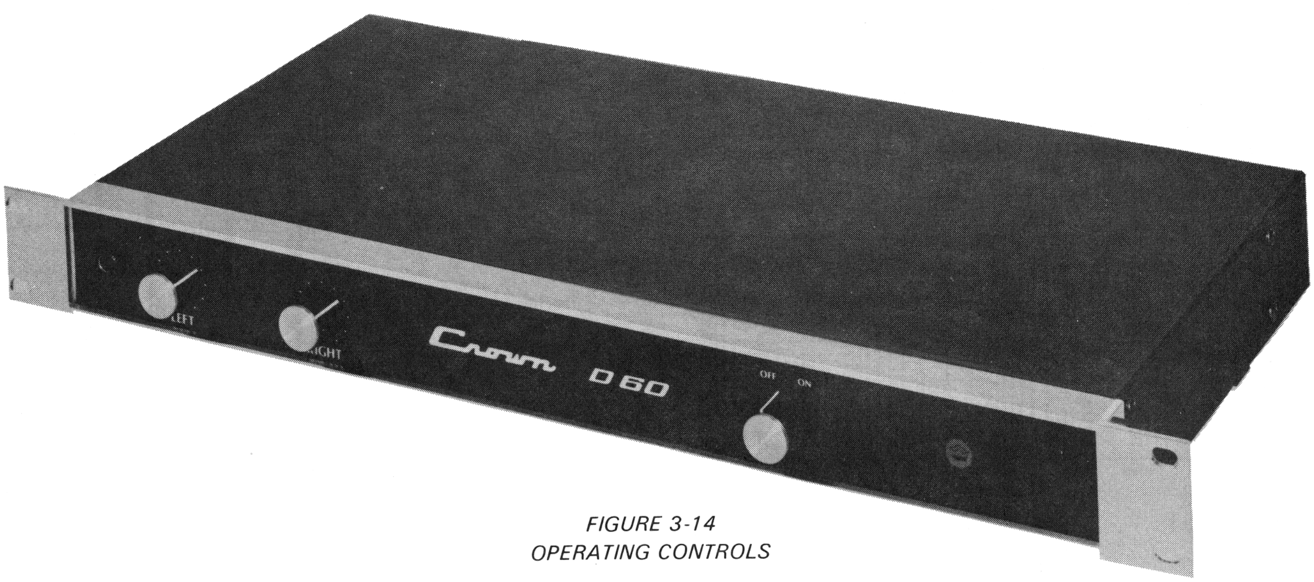


FIGURE 3-14
OPERATING CONTROLS

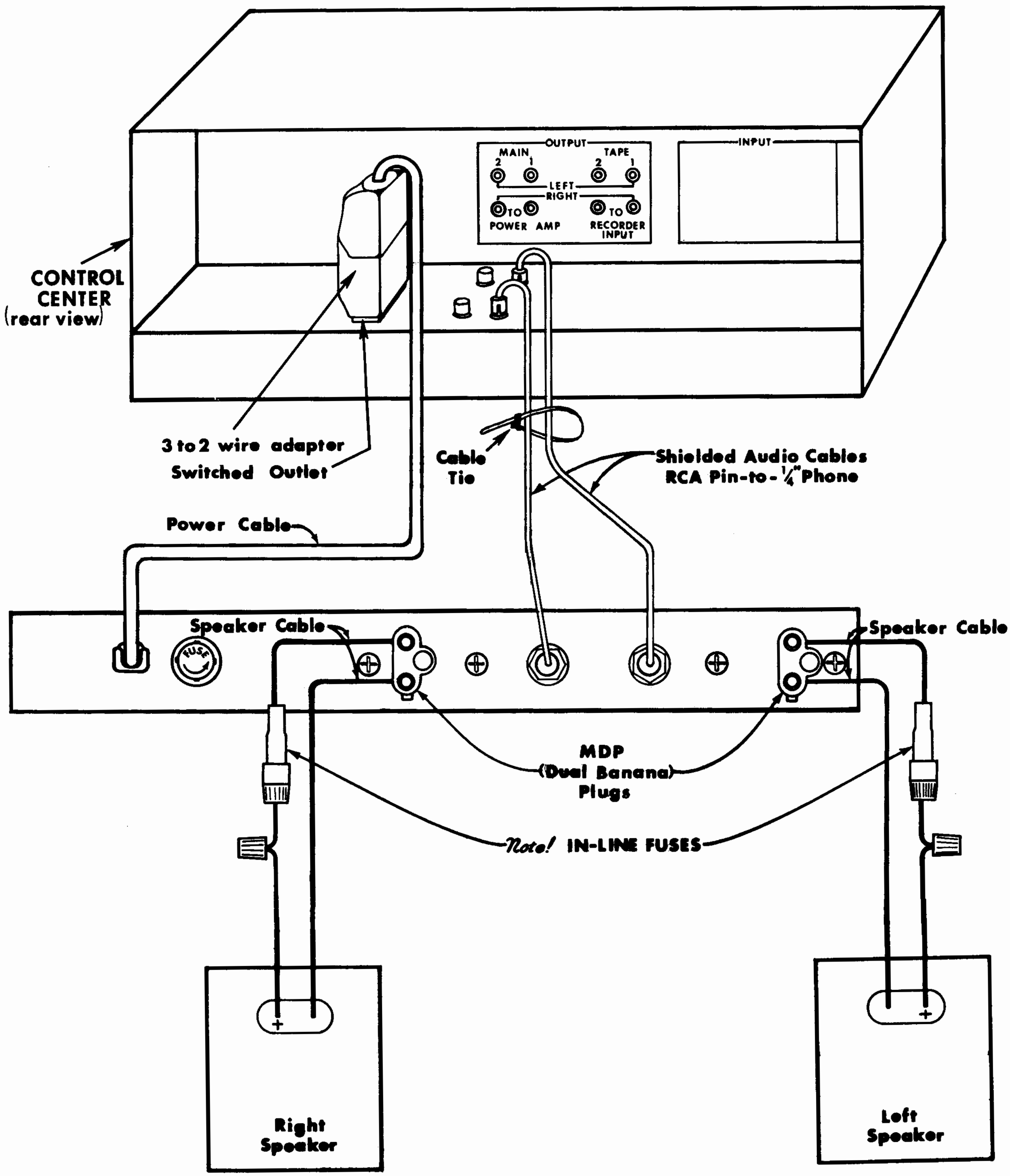


FIGURE 3-15
NORMAL HI-FI CABLING DIAGRAM

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

This section contains a description of circuitry operation to better enable a qualified service technician to understand and maintain the CROWN D-60 amplifier in optimum operating condition. Refer to the amplifier schematic diagram in Section 6 while reading the circuitry description to facilitate your understanding of the amplifier operation.

4.2 PRINCIPLES OF OPERATION

The D-60 has two direct-coupled amplifier circuits which employ a dual IC op amp and silicon transistors in all stages. The CROWN designed and developed circuit represents a level of quality and performance presently unequaled in the field of audio amplifier design.

The dual IC op amp is of a low noise type having a large gain bandwidth. The results of using it for the input voltage amplifier is that a maximum amount of feedback is applied reducing distortion to record low values. The typical full output (30w, 8 ohms) SMPTE IM is 0.002%. This implies that the full power 1KHz THD is in the vicinity of 0.0005% which is below the capability of present harmonic distortion measurement systems. Multiple feedback loops are employed to allow a maximum of overall feedback.

The lack of noise is evidenced by a typical 20Hz - 20KHz effective input noise of 1.25 u volts which produces an effective 8 ohm output of 80 micro-micro (pica) watts.

The output stage is a quasi-complementary format employing the CROWN class AB+B technique which uses no bias current in the output transistors. The result is maximum efficiency with minimum crossover notch distortion and idling amplifier-heat. Thus there is no bias current adjustment, as the output circuit is not temperature-tolerance critical.

In the new output circuit, the driver transistors carry the bias current, while the output transistors serve only as boosters. The output transistors sense when the driver transistors are delivering significant current to the load and take over and deliver the large load currents.

The output circuit is protected by a V-I limiter which limits the drive to the output configuration whenever the output transistors are overloaded. V-I (volt-ampere) limiting is inherently superior to all other forms of protection as it directly senses the overload condition and acts instantly to relieve the overload, acting only so long as the overload exists. The result is complete freedom from program delays with reliability and maximum safe output power.

The power supply is a continuous-duty type. The main DC supplies are full-wave capacitor input type with a heavy duty bridge rectifier assembly and computer grade electrolytics.

The D-60 represents nothing short of the highest quality in both circuitry and components. It should provide a lifetime of trouble-free service for the most discriminating users.

4.3 POWER SUPPLY CIRCUITS

Ac power is applied to the power transformer, T1, which may be wired for either 120 VAC or 240 VAC operation. The ac input line is fused with a 2A (3AG) fuse for 120 VAC operation or a 1A fuse for 240 VAC operation. The bridge rectifier, DM1, together with C23 and C24 form a full-wave capacitor input supply to furnish a + and - 30V for operation of the amplifier output circuitry. Transistor Q1 and R5, tied back to the +30V supply, provide a +10V at IC1, pin 14; Q3 and R13, tied back to the -30V supply provide -10V at IC1, pin 7, for operation of the dual operational amplifier circuitry.

4.4 INPUT CIRCUITRY

The signal at the input jack is applied through level control (R1) to the dual IC operational amplifier IC1. The output of IC1 is fed to the base of Q2 where it is amplified for use in the ±30 volt driver/output circuits and applied to the base of voltage amplifier Q4.

4.5 PROTECTION CIRCUITS

Resistors R28 and R30 are current-sensing resistors which carry the output current from output transistors, Q11 and Q13, respectively. Before the output current becomes dangerously high, the voltage induced across these resistors will turn on limiters Q6 and Q7. This action cuts off the drive voltage for predrivers Q10 and Q12 effectively limiting the signal level whenever it threatens to push the output transistors too hard. This limiting action occurs at the instant an overload appears at the output and removes itself when the overload is removed.

4.6 OUTPUT CIRCUITRY

Output transistors (Q11 and Q13) draw no current in the quiescent state. The driver transistors (Q10 and Q12) are biased on in the quiescent state, however, the bias current is not sufficient to turn on the outputs. Any demand for large amounts of current causes the voltage across bias resistors (R20 and R27) to rise, turning on output transistors (Q11 and Q13) and supplying the heavy current required for high power operation through emitter resistors (R28 and R30).

Predrivers (Q8 and Q9) are complementary stages cascaded with drivers (Q10 and Q12) to provide sufficient current gain to turn on the outputs. The bias voltage supply acts as a current source to bias predrivers (Q8 and Q9) which in turn biases drivers (Q10 and Q12). The bias level voltage is adjusted by changing the value of the selected bias resistor (R11) until a bias voltage of 310-345 mv appears across bias resistors (R20 and R27) in the emitter circuits of driver transistors (Q10 and Q12). Refer to Section 5 for a detailed procedure for selecting the appropriate value for resistor R11.

SECTION 5
SERVICE PROCEDURES

5.1 INTRODUCTION

This section contains technical information required to properly service and repair the CROWN D-60 Dual-Channel Power Amplifier. Included are disassembly and reassembly procedures, a troubleshooting chart (for isolating and identifying defective components), adjustments, test setups and procedures, and component replacement procedures. Use this information in conjunction with Section 6, Schematics, Parts Lists and Component Location, to obtain best results.

5.2 SERVICE POLICIES

Due to the sophisticated circuitry, only a fully-trained competent service technician should be allowed to service the D-60 Amplifier. User servicing should be confined to routine replacement of the fuse on the rear panel or replacement of damaged control knobs on the front panel. Please observe the following label on the rear panel.

CAUTION. TO PREVENT ELECTRIC SHOCK, DO NOT OPEN. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO A QUALIFIED TECHNICIAN.

For other service, it is recommended that the unit be returned to the factory in the original packing or replacement packing obtained from the CROWN factory. The CROWN warranty is described in paragraph 5.3. For warranty service the unit must be returned to the factory or approved warranty stations.

Before returning a CROWN D-60 amplifier to the factory for service, authorization should be obtained from the service manager. All shipments must be sent by UPS, Railway Express or Truck Freight, prepaid and insured at total value. The factory will return your serviced unit by UPS, Railway Express or Truck Freight.

5.3 WARRANTY

CROWN guarantees this equipment to perform as specified. CROWN also warrants the components and workmanship of this equipment to be free from defects for a period of 90 days from date of purchase.

This warranty does not extend to fuses, and/or component or equipment damage due to negligence, misuse, shipping damage or accident; or if the serial number has been defaced, altered or removed.

An application for a FREE 3-year WARRANTY TITLE is included with the instruction manual received with the equipment. Upon receipt of this completed form, CROWN will issue the Warranty Title — subject to the conditions contained therein. This title applies to the original end-purchaser and will be issued only upon receipt of the application.

Important!! Note the following caution which is screened on the amplifier rear panel. **CAUTION!!** NEVER DIRECTLY CONNECT THE OUTPUT TERMINALS OF ONE CHANNEL IN PARALLEL WITH THOSE OF ANY OTHER. ANY RESULTING DAMAGE IS NOT COVERED BY WARRANTY.

5.4 DISASSEMBLY FOR SERVICING

The D-60 amplifier is specifically designed for easy servicing. It may be partially disassembled and still be made operational for bench testing and servicing. This may be accomplished by removing the top and bottom covers (par. 5.4.1).

These two steps provide easy access to all major components of the amplifier. Detailed procedures are given in this paragraph for replacing individual subassemblies and critical components.

CAUTION!

DO NOT attempt component replacement or other repairs with power applied.

5.4.1 REMOVAL OF TOP AND BOTTOM COVERS

(Figure 6-3)

1. Remove power from amplifier.
2. Place amplifier on bench.
3. Remove four screws (14) and four screws (15) from each end of the amplifier and remove the top cover. **NOTE:** These two types of screws are not interchangeable. Be sure to replace them in their original positions when reassembling amplifier.
4. Position amplifier with bottom up.
5. Remove five screws (11) from the front edge of the bottom cover.
6. Remove two screws (9) and two screws (10) from the rear edge of the bottom cover and remove the bottom cover from the amplifier chassis.

Reverse above sequence of actions to reassemble amplifier.

5.4.2 REPLACEMENT OF COMPONENTS ON MAIN MODULE PC BOARD

Refer to Figure 6-4.

1. Remove top and bottom covers from amplifier (paragraph 5.4.1). Both component and solder sides of the pc board are accessible.
2. Carefully unsolder and replace (with identical parts) any defective components.

CAUTION: Use normal soldering precautions. Do not use excessive heat and heatsink adjacent components to prevent damage.

3. Note that the IC is a plug-in component.

5.4.3 REPLACEMENT OF LEVEL POTENTIOMETERS (R101, R201)

Refer to Figures 6-2 and 6-3.

1. Remove top cover (paragraph 5.4.1).
2. Remove knob from potentiometer shaft (Figure 6-3, 1).
3. Remove hex nut from potentiometer shaft (front panel side).
4. Carefully remove potentiometer from front panel. **NOTE:** Resistor R33 (2.7 ohm) is attached to a solder lug mounted on the shaft of R101. **Do not** unsolder.
5. Unsolder and mark for identification, two green wires and two black wires at the potentiometer terminals.
6. Resolder wires onto new potentiometer.
7. Install new potentiometer (place solder lug on shaft of R101) and secure to front panel with hex nut removed in Step 3.
8. Replace knob.

5.4.4 REPLACEMENT OF POWER SWITCH (SW-1)

Refer to Figure 6-2.

1. Remove top cover from amplifier (paragraph 5.4.1).
2. Remove knob from shaft of SW-1.
3. Remove hex nut (8) and washer (7) from shaft of SW-1.
4. Remove SW-1 from front panel together with star washer (4) washer (7) and hex nut (8).
5. Carefully unsolder two orange wires from terminals on the defective SW-1 and solder them to corresponding terminals on the new switch.
6. Replace new SW-1 and associated hardware removed in Steps 3 and 4 above.
7. Replace knob on shaft of new switch.
8. Replace top cover on amplifier (paragraph 5.4.1).

5.4.5 REPLACEMENT OF POWER TRANSFORMER, T1

Refer to Figure 6-2 and amplifier schematic, Figure 6-1.

1. Remove top and bottom amplifier covers (paragraph 5.4.1).
2. Unsolder and tag for identification, four wires from the transformer primary running to the adjacent terminal strip (11) as follows:

   1 each — BLACK: WHITE: BLACK-WHITE: RED-BLACK.

3. Unsolder and tag for identification, six wires from the transformer secondary running to following destinations:

2 wires (RED)	To terminal on bridge DM1 (Figure 6-5)
2 wires (RED-GREEN)	To terminal on bridge DM1 (Figure 6-5)
2 wires (RED-YELLOW)	To solder lugs at junction of filter capacitors, C23-C24. These two wires pass through the board bracket next to DM1 to reach the filter capacitors.

4. Pull the two RED-YELLOW wires carefully back through the board bracket toward the power transformer.
5. Remove two nylon pins (15) and two speed nuts (16) from the side of the transformer nearest the amplifier front panel.
6. Remove two white cable ties through which the BLACK and RED-BLACK transformer primary wires go to the terminal strip.
7. Carefully remove the transformer from its position on the amplifier chassis.
8. Remove two screws, two washers and two rubber transformer mounts (14) from the defective transformer and remount them on the new transformer.
9. Remove two cable ties holding the six wires from the defective transformer secondary, form the corresponding six wires on the new transformer into an identical harness (cut wires to same lengths as those removed) and place cable ties on the new harness.
10. Cut four wires on new transformer primary to same length as the old wires and solder to appropriate terminals on the terminal strip.
11. Carefully place the new transformer in position on the amplifier chassis and replace the two nylon pins (15) and speed nuts (16) .
12. Replace two cable ties holding BLACK and RED-BLACK wires from the transformer primary.
13. Place the harness holding six wires from the transformer secondary beneath the power cord and the fuseholder.
14. Feed two RED-YELLOW wires through the board bracket and solder to lug at the junction of filter capacitors C23-C24.
15. Solder two RED wires and two RED-GREEN wires to appropriate terminals on bridge DM1.
16. Replace top and bottom amplifier covers (paragraph 5.4.1).

5.4.6 REPLACEMENT OF BRIDGE RECTIFIER, (DM-1)

Refer to Figure 6-5.

1. Remove top and bottom amplifier covers (paragraph 5.4.1).
2. Remove screw (9), solder lug (7) and hex nut (8) from DM-1.
3. Carefully remove DM-1 from the board bracket.
4. Unsolder two RED wires, two RED-GREEN wires and one VIOLET wire from DM-1 terminals and resolder these wires to the corresponding terminals on the new bridge rectifier.
5. Coat the surface of the new DM-1 adjacent to the board bracket with heatsink compound (DC-340).
6. Insert DM-1 into the mounting hole in the board bracket and reinstall hardware removed in Step 2 above.
7. Replace top and bottom covers on amplifier (paragraph 5.4.1).

5.4.7 REPLACEMENT OF FILTER CAPACITORS (C23, C24)

Refer to Figure 6-5.

1. Remove top and bottom amplifier covers (paragraph 5.4.1).
2. Place the amplifier on the bench, with bottom up.

   NOTE: It is not necessary to unsolder any connections to the filter capacitor terminals. When replacing either capacitor, it will be necessary to loosen or remove the center screw from the adjacent capacitor to gain working room.

3. Carefully remove screw (3), star washer (4), solder lug (2) and washer (5) from two terminals on C23 or C24.
4. Remove defective filter capacitor (C23 or C24) from the board bracket.
5. Insert new filter capacitor in mounting holes on board bracket and reinstall hardware removed in Step 3 above.
6. Replace top and bottom amplifier covers (paragraph 5.4.1).

5.4.8 REPLACEMENT OF OUTPUT COILS (L102, L202)

Refer to Figure 6-7.

1. Remove top and bottom covers from amplifier (paragraph 5.4.1).
2. Place amplifier on bench, with top up.
3. Carefully unsolder one end of output coil brown wire from the adjacent RED output binding post screw; unsolder the other end of the output coil brown wire from adjacent terminal strip.
4. Carefully remove hex nut (17), terminal strip (19), nylon washer (15), star washer (16), output coil assembly (12), nylon spacer (14), and nylon washer (15).
5. Reinstall new output coil assembly and associated hardware removed in Step 4 above.
6. Solder one end of output coil brown wire to the adjacent RED output binding post screw; solder the other end of the output coil brown wire to the appropriate terminal on terminal strip (19).
7. Replace top and bottom covers on amplifier (paragraph 5.4.1).

5.4.9 REPLACEMENT OF OUTPUT TRANSISTORS (Q111, Q113, Q211, Q213)

Refer to Figure 6-2.

1. Remove top and bottom covers from amplifier (paragraph 5.4.1).
2. Place amplifier on bench, with top up.
3. Unsolder and tag for identification wires connected to two center terminals (base and emitter) of the transistor.

   NOTE: Connections made to solder lugs used in mounting transistors need not be unsoldered.

4. Remove two hex nuts (24), one solder lug (23) and insulator (20).
5. Turn amplifier with bottom up and remove two screws (21), star washers (22), one solder lug (23), transistor and anodized insulator (19).
6. Coat both sides of anodized insulator (19) with heatsink compound (DC-340).
7. Install new transistor (2N3055) (Q111, Q113, Q211, Q213) and associated hardware removed in Steps 4 and 5 above. Tighten mounting screws, snugly and evenly, to assure good heatsinking.
8. Resolder connections removed in Step 3 above.
9. Replace top and bottom covers on amplifier (paragraph 5.4.1).

5.4.10 REPLACEMENT OF DRIVER TRANSISTORS (Q10, Q12)

Refer to Figure 6-4.

The driver transistors are located on the four corners of the Main Module PC Board. The board mounting screws pass through the transistor cases and secure the board to the amplifier chassis.

1. Remove top and bottom covers from the amplifier (paragraph 5.4.1). Both sides of the Main Module PC Board are now accessible.
2. Carefully unsolder three transistor leads from the PC Board.

   CAUTION!!

   It will be necessary to temporarily reposition some chassis wiring when removing and replacing the defective transistor. Do this carefully to avoid unnecessary strain on solder joints. It may be necessary to loosen or remove several or all of the four driver transistor mounting screws to properly position and install the new transistor.

3. Remove hex nut, screw, mica insulating washer and the transistor.

4. Insert three leads on new transistor through holes in board. Carefully bend leads until transistor case is in proper mounting position.

5. Replace mounting screw, mica insulating washer and hex nut.

6. Retighten or replace all other mounting screws.

7. Carefully solder three transistor leads and clip excess lengths of leads on the solder side of the board.

8. Replace top and bottom covers on the amplifier (paragraph 5.4.1).

5.5 TEST EQUIPMENT

The D-60 amplifier is a relatively complex unit, and consequently requires a comprehensive array of standard and special test equipment for complete servicing. A recommended list of equipment is shown in Table 5-1.

In the absence of a complete set of test equipment, it should be noted that most troubleshooting can be successfully done with an oscilloscope, an ohmmeter, a voltmeter and a signal generator. Any amplifier malfunctions which cannot be identified and repaired with this basic equipment should be referred to the CROWN factory or authorized service center.

5.5.1 CALIBRATION OF TEST EQUIPMENT

It is important that test measurements made during servicing be accurate and dependable. Otherwise the performance of the amplifier cannot be properly evaluated. Test equipment shown in Table 5-1 should remain properly calibrated with only periodic check (6 month intervals). If less expensive (and thereby less dependable) test equipment is used, frequent calibration is necessary to assure the accuracy required for proper servicing.

5.6 TEST PROCEDURES

This paragraph lists precautions essential to obtain accurate test measurements when dealing with high-purity amplifiers such as the CROWN D-60.

1. Use the proper line voltage (120 VAC or 240 VAC) for which the power supply has been wired for normal operation. The line voltage should be measured with a peak reading ac voltmeter and adjusted to the rms equivalent voltage (to compensate for line voltage regulation errors during the course of the test measurements). All measurements should be taken at the amplifier power plug. When testing for IHF music-power measurements, the line voltage is to be set at 120V when the amplifier is wired for 120V (IHF Standards). If the amplifier is wired for 240V, the equivalent test may be given by applying 240 volts.

2. The loads should be resistive, having less than 10% reactive components at any frequency up to five times the highest test frequency. All output measurements should be taken at the output terminals and not at any other points along the output cables through which the load current is flowing. The load should employ only high-current connectors and be connected to the output binding-post terminals.

3. The input level controls should be set to maximum for all distortion tests to assure repeatability of all measurements.

4. When measuring hum and noise, all inputs should be disconnected from the amplifier and the level controls set to minimum or to maximum, preferably minimum.

5. Whenever possible avoid ground loops in the test equipment caused by connecting the output ground to the input ground. **Never** connect the ground of the cable going to the load back to the input ground.

   Ground loops are especially obnoxious when measuring distortion. An IM distortion analyzer, for example, has its input and output terminals tied to a common ground. Such a test should use an ungrounded output return, with the output lead(s) wrapped around the well-shielded and grounded input cable.

6. Always monitor the test oscillator when measuring frequency response. Use a wide-band ac voltmeter; or use the same meter for both input and output level measurements, if the meter's frequency response is known not to be dependent on attenuator settings.

7. Accuracy in measuring voltages for computing wattage is critical. For example, a 2% voltage error together with a 1% resistance error can result in an error of 10 watts power into an 8-ohm load.

8. Residual distortion and noise levels should be fully known for all the test equipment in order to accurately evaluate amplifier performance.

9. Never attempt to measure damping factor by placing abnormal loads on the output. DF measurements taken during clipping, or any other form of overload, are meaningless. The preferred method is to apply an externally generated current to the output terminals and measure the resultant voltage at the terminals. A convenient current is one ampere — as the resultant voltage will read directly in ohms for (Z_O). Damping factor is defined as (Z_L/Z_O), where (Z_L) is typically 8 ohms. A convenient generator for the 1A current is that amplifier channel not under test. A non-inductive resistance of 8 ohms — coupled between both channels' output terminals — will provide 1A when 8 volts are impressed across the resistor (by that channel not under test).

EQUIPMENT	REQUIREMENTS	APPLICATION	SUGGESTED MODEL
Oscilloscope	Capable of displaying a 10 megahertz signal.	Monitoring output during service and testing.	Telequipment SS4A or equivalent.
Voltohmmeter (VOM)	Low-voltage resistance probe (100mv range). High-voltage resistance probe (1.5 v range).	Check resistance values (low voltage probe). Check semiconductor junctions for opens or shorts (high voltage probe). Check DC voltages.	Triplett 601 or equivalent
Signal Generator	Sine/square wave available; flat frequency response.	Provide test signals for service and checkout. (10KHz sq; 20KHz sine)	Wavetek 130-Series or equivalent
Wattmeter	Reasonable accuracy at 20W without cutting into voltage at high power levels.	Check power consumption.	Simpson 390 (panel meter 1379) or equivalent
Circuit Breaker	15 ampere rating.	In AC line to amplifier; protects circuitry from overload if power supply has shorted.	
AC Line Monitor	Peak reading meter.	Monitor line voltage for amplifier testing.	Information available from CROWN.
Variac		Keep line voltage at 120V during tests.	Superior Powerstat 116B or equivalent.
AC Voltmeter	100 mv low range.	Set output level for testing; check noise level.	Hewlett-Packard 400F or equivalent
Filter	20-20KHz bandpass, low noise.	Between amplifier and voltmeter in noise test.	Information available from CROWN.
Intermodulation Distortion Analyzer		Check IM distortion from 150W to 15 MW.	Available from CROWN
Dummy Load	2, 4, 8 Ohm; able to dissipate 500W without strain; less than 10% reactive component at any frequency up to 5 times the highest test frequency. (100KHz x 5 = 500KHz)	Check amplifier performance under load.	Information available from CROWN.

TABLE 5-1
LIST OF TEST EQUIPMENT

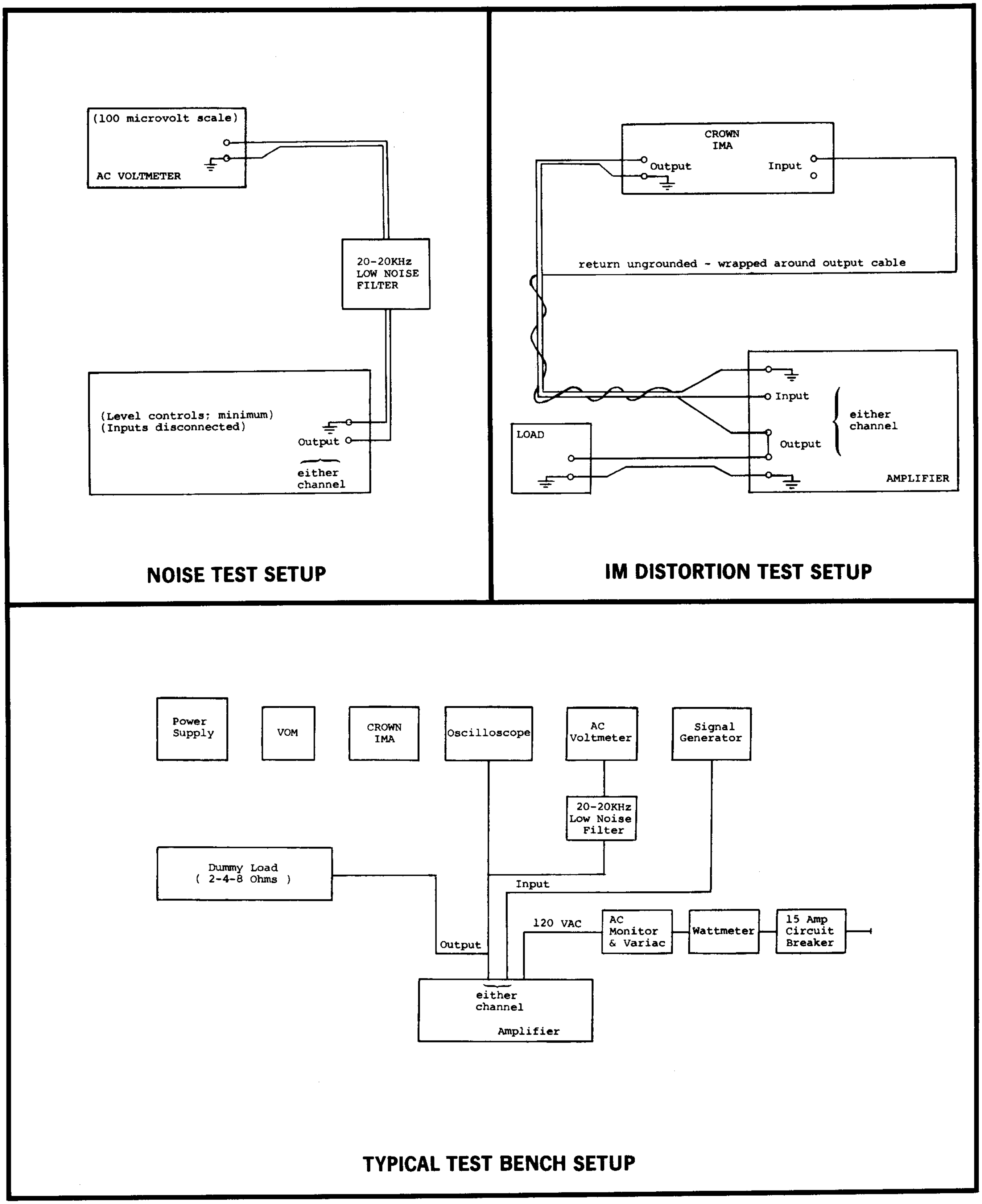


FIGURE 5-1
TEST EQUIPMENT COMPLEMENT

10. Never measure hum and noise when in the presence of strong magnetic fields. The amplifier should be at least 4 inches away from any large metallic objects or shield plates for a reading to be meaningful.

11. Noise measurements should be taken with a bandpass filter of 20-20KHz. For audio purposes the measurement of noise above 20KHz is unimportant.

12. When repairing an amplifier it should not normally be operated with a load until it performs properly unloaded. If serious problems with the amplifier exist, a load will only compound those problems by blowing fuses and causing additional damage by drawing high current.

13. Ohmmeter tests can usually be performed on semiconductors with the 1.5-volt probe. On the RX1 scale, the normal forward breakdown resistance for semiconductors will usually fall in the 5-15 ohms range.

To check resistor values without removing them from the circuit and without forward biasing any junctions, the low voltage probe (100 mv range) should be used.

The effect of parallel resistance paths must be considered in determining whether a test reading is normal. The simplest procedure is a comparison with the same reading under identical conditions on a properly functioning channel. If both channels are defective, compare the reading with those on a good amplifier.

Approximate resistance measurements for transistors (outside a circuit) appear below. Large resistance means little or no indication on the RX1 ohms scale. Base-emitter and base-collector readings in a transistor should match within several ohms. The first lead in the list below takes the positive meter probe for an NPN transistor; the negative meter probe for a PNP transistor.

Base-emitter	5-15 ohms
Emitter-base	Large
Base-collector	5-15 ohms
Collector-base	Large
Collector-emitter	Large
Emitter-collector	Large

Diodes should show approximately 5-15 ohms forward resistance and large reverse resistance.

Know your ohmmeter — all types do not operate the same. Some have the positive lead common, others the negative. You must be aware of this when measuring forward or reverse junction resistances. Some meters use a nine-volt test voltage on high resistance scales which can forward bias enough junctions in a solid state circuit to cause avalanche confusion. Know the test voltage for the scale used.

5.7 TROUBLESHOOTING

The information contained in the troubleshooting chart has been compiled from data gathered from field service reports and factory experience. It contains symptoms and usual causes for the service problems described; however, do **not** assume that these are the only problems that may occur. The D-60 amplifier is a complex piece of electronic equipment and all available data concerning the reported trouble should be systematically analyzed before undertaking any drastic repairs or component replacement procedures. The following general procedure should be used in servicing the D-60.

a. Verify and Identify the Problem

Assemble and analyze all data accompanying the amplifier. Do **not** automatically assume that the amplifier is, in fact, defective. Problems arising from the system configuration in which the amplifier is being used may be blamed on the amplifier. Most written complaints are sketchy, sometimes ambiguous, and generally tend to oversimplify problems. Some problems may be painfully obvious — blown fuses, broken parts, or the smell of burned components. Should the problem not be simple to find, it may be helpful to contact the user directly and ask the following questions:

(1) What are the details of the system in which the amplifier was being used? Has the system been carefully checked for possible problems outside the amplifier?

(2) Describe the problem? Symptoms? One channel affected or both? Which channel?

(3) Did the problem occur more than once? Were circumstances identical for all occurrences?

(4) What kind of input signal and load were used?

(5) How long was the amplifier in operation when the failure occurred? Was it warmer than usual?

If the user is not available and the problem is not obvious, perform the regular factory checkout procedure. The troubleshooting chart is organized according to the sequence of the factory checkout procedure and common service problems appear in the order they are most likely to occur.

b. Visual Inspection

A detailed visual inspection is worth performing for almost all problems and may avoid unnecessary additional damage to the amplifier.

(1) Check for loose wires and wires that may be crimped or squeezed against components or the chassis in assembly. Suspicious wires may be pulled gently to assure they are securely fastened.

(2) Check for loosened screws holding wiring connections.

(3) Check for bad solder connections. Loose transistor leads may cause oscillation, noise or DC imbalance.

(4) Check for parts damaged by heat or high power. Usually apparent by discoloration or burned odor.

5.7.1 TURN-ON PROCEDURE

Plug in the D-60 amplifier with no signal input and no load. Set POWER switch to ON to apply ac line voltage.

SYMPTOM	PROBABLE CAUSE AND REMEDY
AC fuse blown	Wrong size fuse. Replace with correct value.
	Wrong line voltage. Check ac line voltage
	Pinched wires in power supply. Make visual check of power supply wiring. See schematic.
	Short in power cord or transformer primary. Make ohmmeter check of power cord for hot-to-ground short (with switch ON, contacts of plug should show about .35 ohms). This is transformer primary resistance; it should not be zero.
	Miswiring of transformer primary. Check primary wiring according to color code on schematic.
	Short in rectifier bridge, DM1. Replace.
No AC power; fuses OK	Defective POWER switch, SW1. Replace.

5.7.2 OUTPUT OFFSET VOLTAGE CHECK

Check output offset voltages for both channels. Measurement to be taken across output terminals with no input signal. If voltage exceeds 10 mv, check:

SYMPTOM	PROBABLE CAUSE AND REMEDY
Excessive offset with no input signal	IC defective; replace
	No +10V supply to pin 14 of IC.
	No -10V supply to pin 7 of IC.
	C3 leaky. Replace.
	D1 open. Replace
	D4 or D5 shorted. Replace.
	Poor solder joint at terminals of C23, C24.

5.7.3 BIAS LEVEL CHECK

Check bias level voltage across resistor (R20 or R27). If voltage does not fall within specified limits (310-345 mv), perform procedure for selecting proper value for resistor, R11, as shown in paragraph 5.8. If still unable to obtain correct voltage:

SYMPTOM	PROBABLE CAUSE AND REMEDY
Low or no bias.	Check R15, R16, R19, R20, R25, R32, R27.
	Check bias transistor, Q14, and associated components.
	Check for leaky driver transistor (Q10 or Q12).
High bias on + output transistor	Check for leaky output transistor (Q11).
High bias on - output transistor	Check for leaky output transistor (Q13)

5.7.4 CHECKOUT PROCEDURE — 1 KHz INPUT, NO LOAD

Connect a signal generator set at 1 KHz to the amplifier input. Turn up the level control(s) and monitor the output with an oscilloscope. The waveform should appear undistorted at all amplitudes until it clips. Clipping should be sharp, with no ringing or other oscillation. If these conditions are not met, check:

SYMPTOM	PROBABLE CAUSE AND REMEDY
Fuse blows or + or - 30V appears at output	Output transistors shorted (Q11, Q13 in both channels). Replace.
	or
	Driver transistor shorted. (Q10, Q12 in both channels). Replace.
	or
	Pre-driver transistor shorted. (Q8, Q9 in both channels). Replace.
	D4 or D5 shorted. Replace.

NOTES:

1. Usually a component in both + and - output circuitry must short to blow the fuse with no load.

5.7.4 CHECKOUT PROCEDURE — 1 KHz INPUT, NO LOAD (Continued)

SYMPTOM	PROBABLE CAUSE AND REMEDY
	2. Usually, if only one output, driver, pre-driver or diode shorts with no load, the opposite polarity protection will actuate, blocking excess current and leaving the amplifier with a + or -30V at the output.
	3. Check for open emitter resistor associated with a shorted output transistor.
	4. **Replacement of output transistors.** Refer to Figure 6-2. Replacement transistors should be of the same make as those removed. Be sure to include all insulating material from the original transistors on the replacement. Be sure new transistors are adequately heat-sinked by using a good heat-conducting compound (Dow-Corning 340) on the transistor case where it fits against the heat sink. Tighten all mounting screws snugly and evenly.
Continuous DC voltage at output.	Shorted transistors or diodes in output circuitry. Check and replace as necessary. If offset is positive check the + side; if offset is negative check the - side. Defective bias transistor (Q14). Replace. **NOTE:** As a general procedure use a voltmeter to compare voltage readings with those shown on the schematic. Begin at the input, move stage by stage through the circuitry, and note any large deviations from the quiescent voltage levels shown. Determine whether specific components are defective or simply responding to a problem elsewhere.
Oscillation at output with or without signal.	Check components on Main Module PC Board by alternately heating and cooling (use small solder iron and circuit cooler spray) while observing the oscillation on the oscilloscope. Concentrate on transistors and diodes. Significant changes in the oscillation may pinpoint a defective component. Check diodes and resistors by paralleling with a capacitor. This may help isolate the source of an unwanted oscillation. **CAUTION!!** In some cases this technique may cause oscillation so use with care. Check capacitors by paralleling them with a known good capacitor of the same value. If oscillation is eliminated, an open capacitor may be indicated.
Output unstable when adjusting level pot	Dirty internal contacts on level pot. Temporary correction of this problem may sometimes be had by turning the pot back and forth repeatedly to allow the contacts to clean themselves. If this is unsuccessful, replace the pot.

5.7.5 CHECKOUT PROCEDURE — 1 KHz INPUT, WITH LOAD

Most of the common service problems should have manifested themselves previously and the remaining test procedures should be fairly routine. If troubles do occur, a likely source is the output stages, since this is the first test where these stages are subjected to a load.

1. Connect an 8-ohm load to the output. (Refer to paragraph 5.6.2).
2. Monitor the output with an oscilloscope and an accurate ac voltmeter.
3. Connect a sine wave oscillator set at 1 KHz (+10dB out) to the amplifier input.
4. Turn up the level control of the channel under test. The output must clip at over 30 watts. Typically, the clip point is 40 watts (17.9 volts) or above, with the ac line voltage at 120 volts. The waveform should be clean, and should clip evenly and symmetrically with no ringing.
5. Change load to 4-ohms. Clip point should occur at approximately 60 watts.

5.7.6 CHECKOUT PROCEDURE — PROTECTION CIRCUIT TESTS

The protection circuit test is a clipping test designed to verify the operation of the limiting circuits.

1. Set the amplifier output at approximately 15.5 V across 8 ohms.
2. Switch the load to 2 ohms. At this load impedance the output will cause enough power supply sag to clip the output but may not cause the sharp clip indicative of limiter circuit operation. Slowing the oscilloscope trace to look for power supply ripple at the clip level will indicate whether the power supply or limiter circuits are causing the clip.
3. In order to insure that the limiter circuits are operating, it may be necessary to drive a 1-ohm load. If the oscilloscope trace still shows only power supply clipping, the associated limiter(s) is not turning on and the limiter circuitry is defective.

SYMPTOM	PROBABLE CAUSE AND REMEDY
+ signal does not clip on 2-ohm load	Check components in + limiter (Q6) circuit.
- signal does not clip on 2-ohm load	Check components in - limiter (Q7) circuit.
Either + or - signal clips at wrong level on 2-ohm load	Check limiter circuits. Refer to Figure 5-2 for clipping levels.

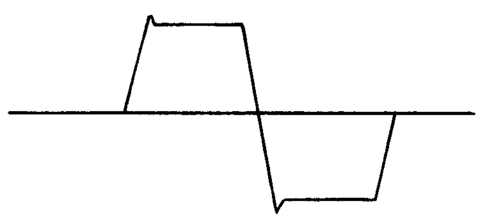


FIGURE 5-2
TYPICAL PROTECTION CLIPPING, 2-OHM LOAD

5.7.7 CHECKOUT PROCEDURE — 20 KHz SINE WAVE INPUT

1. Set the signal generator at 20 KHz at the amplifier input.
2. Connect an 8-ohm load to the amplifier output.
3. Turn the level control up until clipping occurs. Clipping must take place above 30 watts (typically in the 35-45 watt range). Refer to Figure 5-3 for output waveform characteristics.

NOTE: The output must clip before it distorts elsewhere. The dotted line in Figure 5-3 shows typical unacceptable distortion on the leading edges of the waveform.

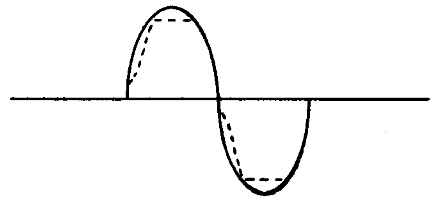


FIGURE 5-3
TYPICAL 20 KHz SINE WAVE TEST OUTPUT WAVEFORM

5.7.8 CHECKOUT PROCEDURE — 10KHz SQUARE WAVE INPUT

This test is designed to critically examine the frequency response and rise time of the amplifier to show how fast the amplifier can follow rapid signal changes.

1. Set the signal generator for a 10 KHz square wave, 20V p-p at the amplifier input.
2. Connect an 8-ohm load to the amplifier output.
3. Turn up the level control to maximum.
4. The output waveform (Refer to Figure 5-4) should be clean and sharp throughout the entire range of the level control.

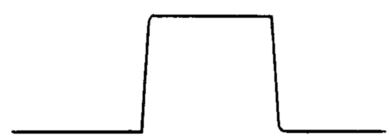


FIGURE 5-4
TYPICAL 10KHz SQUARE WAVE TEST OUTPUT WAVEFORM

5.7.9 CHECKOUT PROCEDURE — IM (INTERMODULATION) DISTORTION TEST

1. Use the IM distortion test setup shown in Figure 5-1.
2. Calibrate the IMA and set up the IM input signal at 60 - 7 KHz, 4:1 ratio as described in the IM manual.
3. Connect an 8-ohm load to the amplifier output.

4. Measure the IM distortion at 5 dB intervals from 30 watts output to 3 milliwatts as shown below. All distortion readings must be less than 0.01%.

RIGHT AND LEFT CHANNELS

.0 % 30W out	.0 % 96 mW out
.0 % 9.6W out	.0 % 30 mW out
.0 % 3W out	.0 % 9.6 mW out
.0 % .96W out	.0 % 3 mW out
.0 % .3W out	

SYMPTOM	PROBABLE CAUSE AND REMEDY
High IM distortion	IC1 defective. Replace.
	Change routing of leads from Main Module PC Board to output transistors and output binding posts.
	Change transistor, Q4.

5.7.10 CHECKOUT PROCEDURE — 20 - 20 KHz HUM AND NOISE TEST

1. Use the noise test setup shown in Figure 5-1.
2. Remove input from the amplifier.
3. Set level controls at minimum (CCW).
4. Set ac voltmeter to 100 microvolt scale.
5. Measure the noise level relative to 30 watts into 8 ohms. The hum and noise level must be 110 dB or greater below the full 30 watt output power. A typical value is -115 to -120 dB.

SYMPTOM	PROBABLE CAUSE AND REMEDY
High noise level	Bad solder joints. Visually inspect the defective channel.
	Poor ground connections. Check all ground wires. Check output jack ground. Check insulating washers on input jacks.

5.7.11 CHECKOUT PROCEDURE — QUIESCENT AC POWER CONSUMPTION

Use a wattmeter and check the power consumption at the amplifier output when the amplifier is turned on (idling) but carrying no signal. The amplifier must draw **less** than 20 watts with the ac line voltage at 120 volts. A typical reading is 12 watts.

SYMPTOM	PROBABLE CAUSE AND REMEDY
High quiescent AC power input	Bias transistor (Q14) open. Replace.
	A shorted positive output or driver stage along with a shorted negative output or driver stage.
	+30V shorted to chassis at C21 or Q10.
	Output may be shorted at C22 or Q12 collector.
	Check wire to phone jack; may be pinched under cover.

5.8 BIAS LEVEL CHECK AND ADJUSTMENT

Refer to Figure 5-5. The correct bias level for the D-60 amplifier is set at the factory and will not usually require adjustment unless components affecting the level are replaced. Component changes likely to affect bias settings are the predriver, driver, output stages and the bias transistor, Q14.

Correct bias maintains the driver and pre-driver stages at normal operating levels and keeps the output stages turned off. This condition is achieved when a voltage of 325±15 mv (.310 - .340 volts) appears across the output stage bias resistor (R11) for each channel.

a. **To check bias level:**

1. Remove top and bottom covers from amplifier (paragraph 5.4.1).
2. This check is to be made with the amplifier idling (no input and no load).
3. Connect power to amplifier and allow unit to warm up to normal operating temperature.

CAUTION!!

Do not measure bias level voltage until unit is thoroughly warmed up. Voltage begins to climb at turn-on, peaks and gradually drops to the normal level. Measurements taken during warm-up are likely to be misleading.

4. Measure the voltage across one of the output stage bias resistors for each channel (R20 or R27). Voltage should be between 310-340 mv. If voltage is abnormal, use the following procedure to obtain correct bias level voltage.

b. **To adjust bias level voltage:**

Adjustment of bias level voltage is made by changing the value of the selected resistor in the bias circuit (R11). These resistors are mounted in plug-in sockets on the Main PC Board. An auxiliary pair of holes, adjacent to each selected resistor, is used if necessary to trim the bias level voltage to fall within the specified limits (310-340 mv). Generally, selected bias resistors range from 33 to several hundred ohms. Carbon resistors, 10% tolerance, are normally used.

1. If the measured bias voltage was **high**, replace the factory-installed resistor with one of **higher** value. This will **lower** the bias voltage.
2. If the measured bias voltage was **low**, replace the factory-installed resistor with one of **lower** value. This will **raise** the bias voltage.

Continue replacing the selected resistor, using the above procedure, to bring the bias voltage as close to 325 mv as possible.

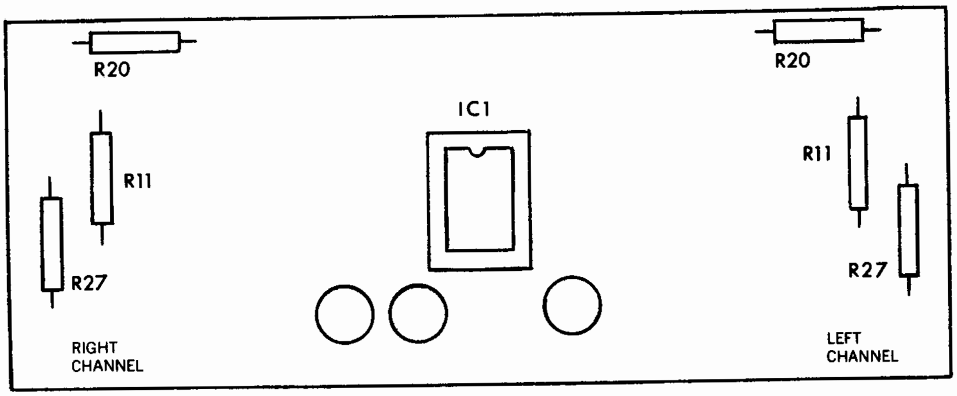


FIGURE 5-5
BIAS LEVEL COMPONENTS

SECTION 6
SCHEMATICS, PARTS LISTS AND COMPONENT LOCATION

6.1 GENERAL INFORMATION

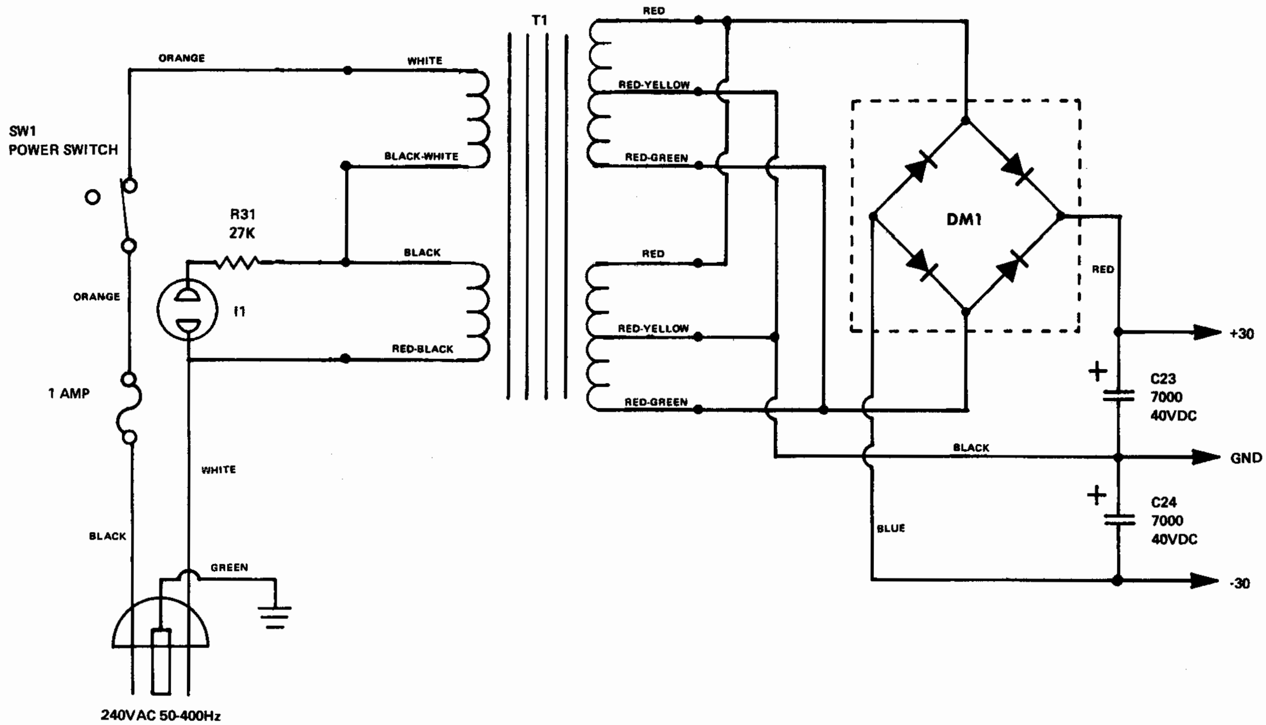
This section contains schematics, parts lists and exploded view drawings for the D-60 Dual-Channel Power Amplifier. Used in conjunction with the service instructions in Section 5, this information will aid the service technician to rapidly and accurately identify and replace defective parts and return the amplifier to a normal operating condition.

6.2 PARTS REPLACEMENT

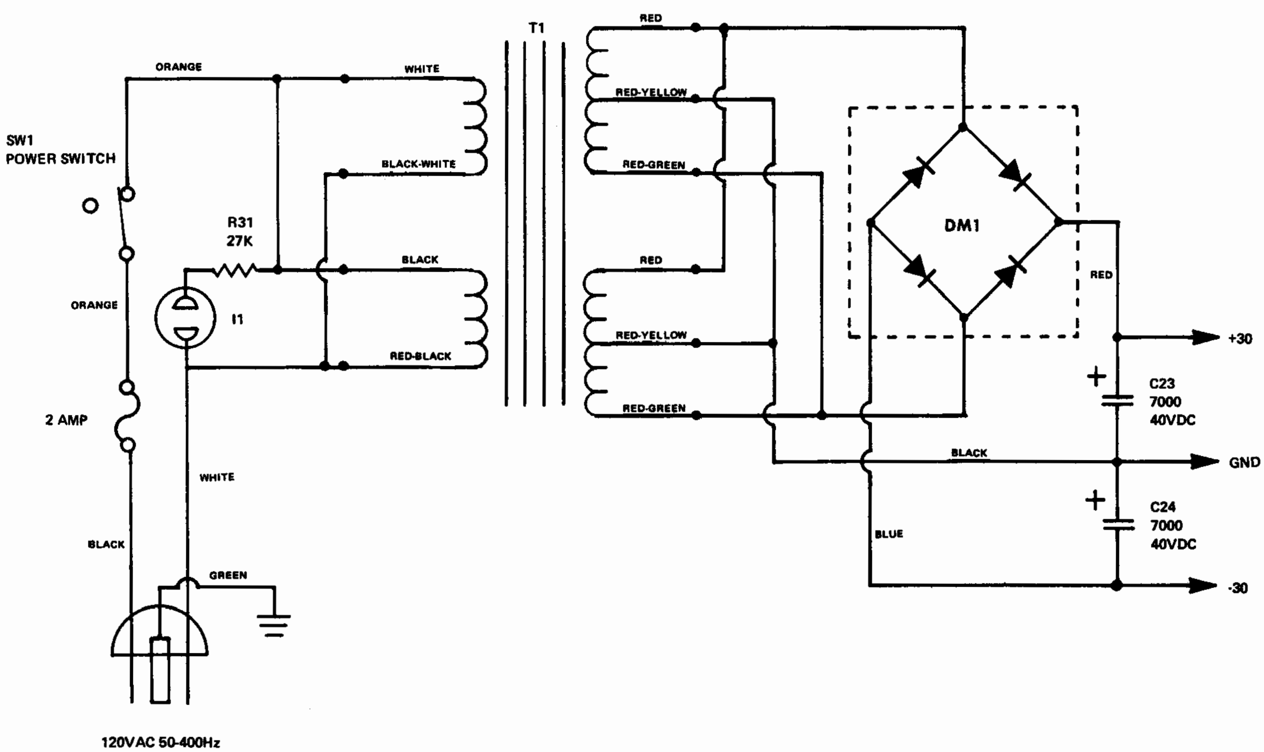
Many amplifier parts are standard items stocked by local electronics supply houses. However, some parts which appear to be standard are actually different. Best results will be obtained with CROWN factory replacement parts, although standard parts may be used in an emergency. A number of the amplifier parts are special and are available only from CROWN.

When ordering parts, be sure to give the amplifier model and serial number as well as the part number and description of the parts ordered.

D60 POWER SUPPLY



D60 POWER SUPPLY



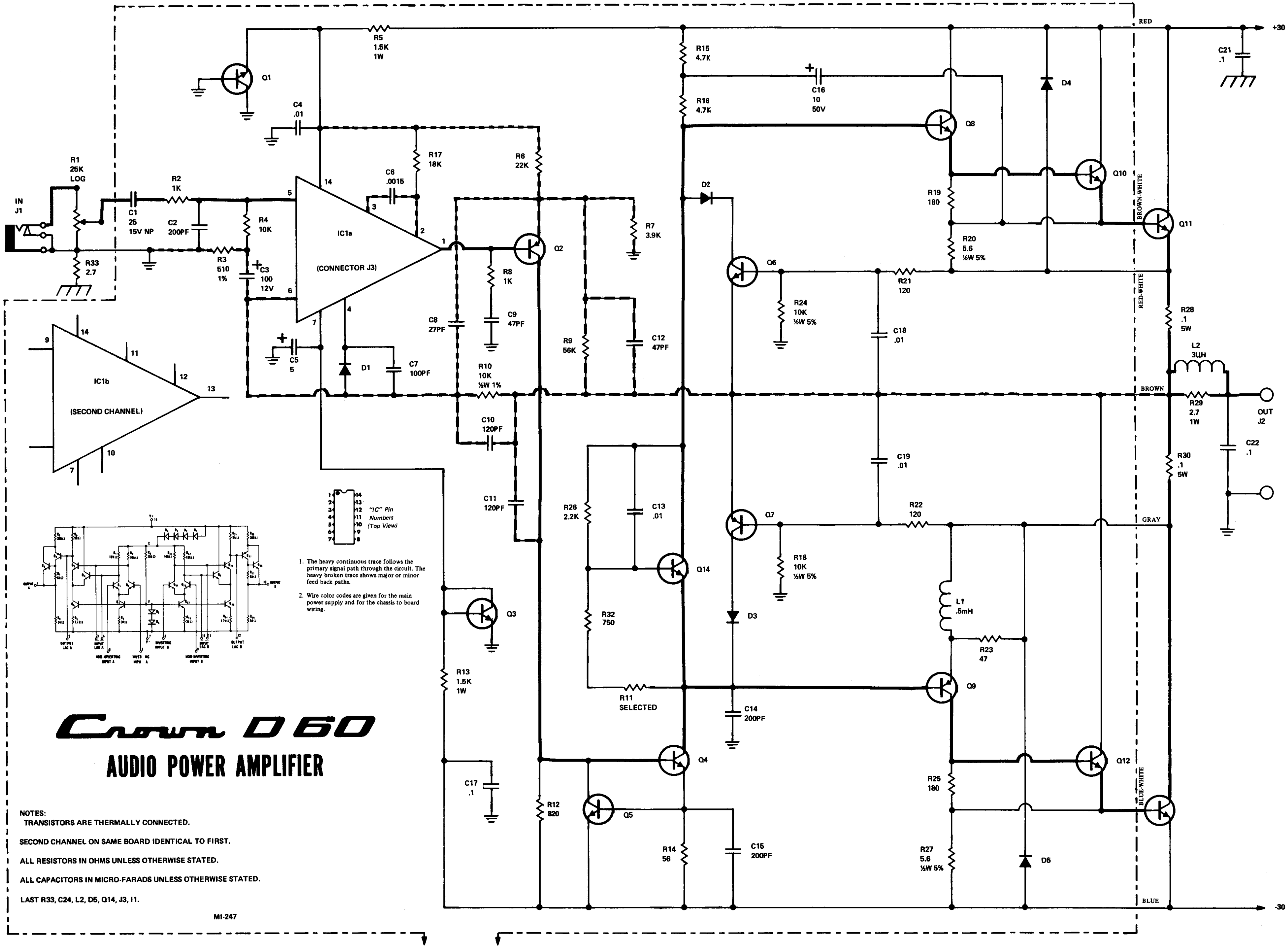
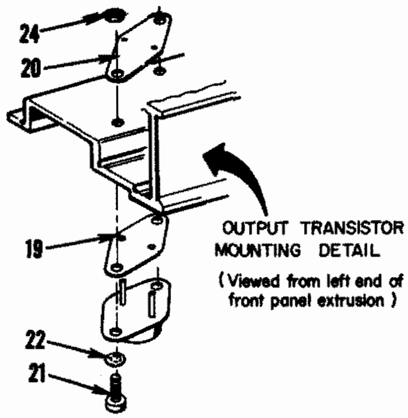


FIGURE 6-1
SCHEMATIC DIAGRAM, D-60 DUAL-CHANNEL POWER AMPLIFIER

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	FRONT PANEL ASSEMBLY	41160	1	
	Front Panel, D-60	3483		
	Overlay, Front Panel, D-60	3487	2	
HEADPHONE	Jack, Hi-D, N112B, 3-cond	3507	3	
	Washer, star, 3/8" internal	2188	4	One on jack; one on SW1
	Washer, 3/8", blk	3628	5	Mounts jack
	Nut, knurled, blk, 3/8"	3495	6	Mounts jack
	Washer, bright, control, NIC	2189	7	Two on SW1 (front-back)
	Nut, bright, control, 3/8", NIC	1288	8	Two on SW1 (front-back)
	Washer, star, 1/4" internal	2365	9	Mounts R101, 201
	Lug, solder	3515	10	Mounts over one (R101-201)
	Terminal strip, 856AJ	3503	11	
	Screw, 6-32 x 3/8 BHP, CAD	2134	12	Mounts terminal strip
	Nut, hex, 6-32 CAD	1889	13	Mounts terminal strip
	Transformer mount, rubber, .5"	3556	14	Mount on back of T1
	Transformer, pin, nylon	3557	15	Mounts T1 to front panel
	Nut, speed	3558	16	Mounts T1 to front panel
	Tape, foam, 3"	1152	17	Mounts T1 to FB
	Nut, captive, 6-32	2019	18	Mount on bottom; back edge of FP channel
	Insulator, TO-3, anodized	3570	19	Mounts outputs
	Insulator, TO-3	3179	20	Mounts outputs
	Screw, 6-32 x 1/2, BHP, CAD	2176	21	Mounts outputs
	Washer, star, #6 internal	1823	22	Mounts outputs
	Lug, solder, #6 hole	3163	23	Mounts outputs
	Nut, hex, 6-32, CAD	1889	24	Mounts outputs
	Terminals, feed-through	3502	25	
	Capacitor:			
C21	.1 mfd, 200V, filmatic	2938		Early units: to & including SN SE-5162
C21	5 mfd, 70V	1678		Later units: from SN SE-5163
I1	**Lamp:** neon, NE2H	2500		Mounts on terminal strip
	Resistors:			
R31	27K ohm, .5W, 10%	1056		Mounts on terminal strip
R33	2.7 ohm, .5W, 10%	2857		Mounts from grd lug at input pot to main board
R101, 201	25K ohm, pot, audio taper	3494		Input level control with nut
R128, 130 228, 230	.1 ohm, 5W, 10%, wire	3291		Mount on solder lugs attached to outputs
SW1	**Switch:** power, rotary, D-60	3492		
T1	**Transformer:** D-60, 46P24	3485		
Q111, 113 211, 213	**Transistor:** 2N3055, sel	3499		Output transistors on bottom of FP channel



Description	Crown Part No.	Draw No.	Other Information
The following parts have been added to conform to CSA requirements:			
Fuseblock	3776	26	
Double-sided foam tape	1152	27	Used to mount 3776
Fuse, 2½ A, 3AG	3775	28	
Label, Fuse Caution	3834	29	
NOTE: The above CSA Modification started with SN SE 6916			

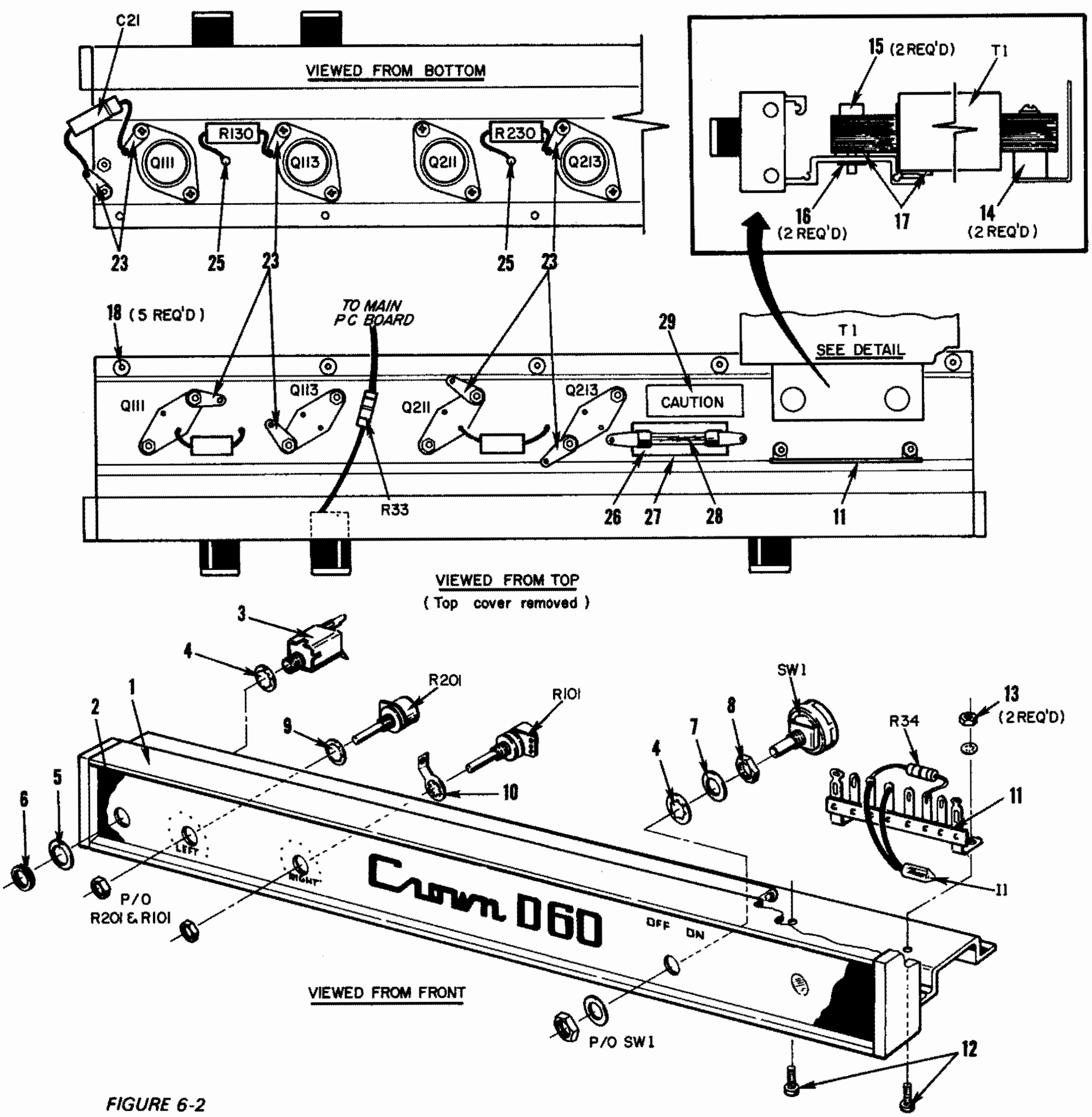


FIGURE 6-2
EXPLODED VIEW DIAGRAM,
FRONT PANEL ASSY., 41160

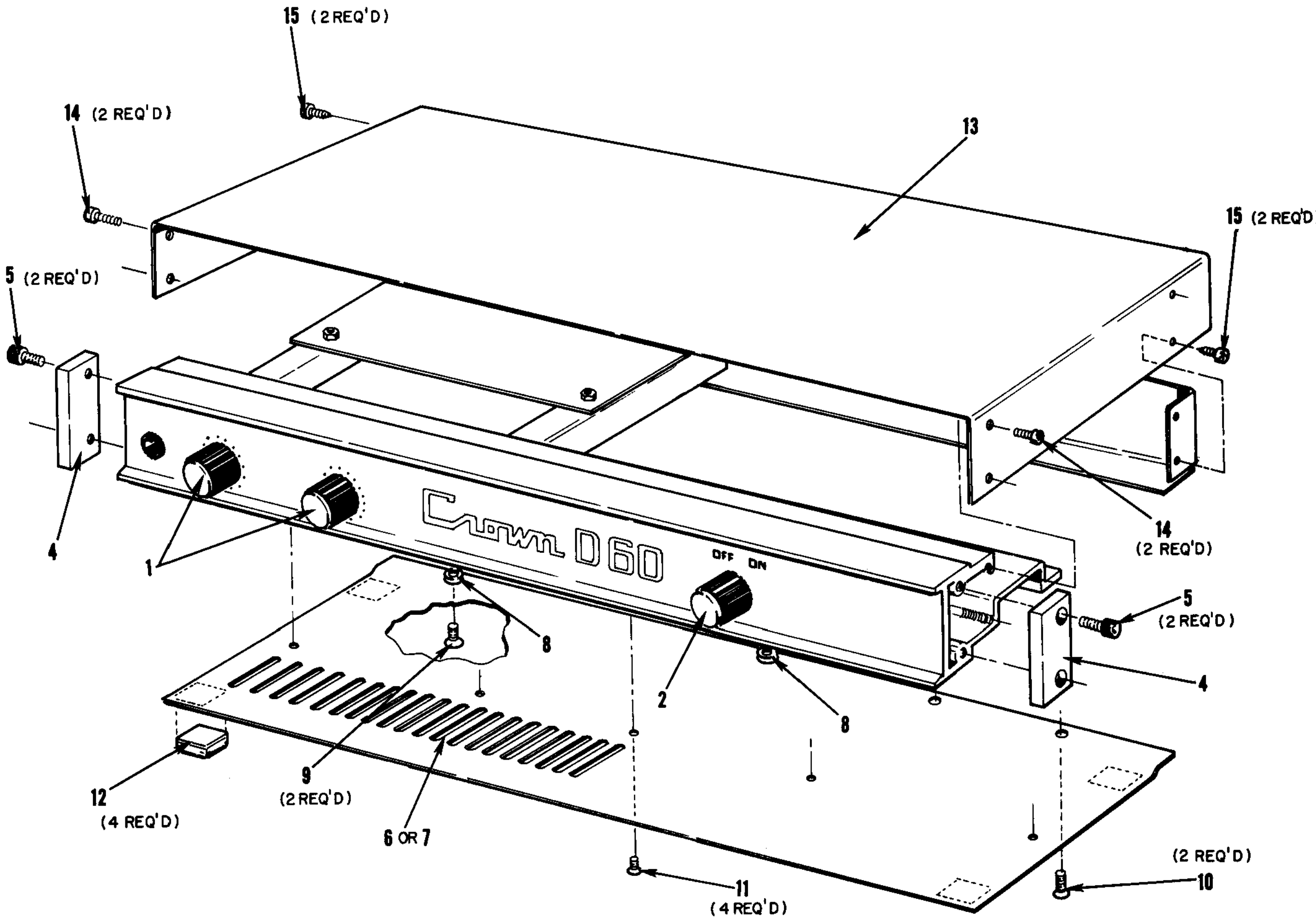


FIGURE 6-3
EXPLODED VIEW DIAGRAM, FRONT PANEL & COVERS

PARTS LIST

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	D-60 MAIN MODULE	41119ML		
	Main Module PC Board:	7925u		
	Capacitors:			
C4, 113, 118, 119, 213, 218, 219	.01 mfd, disc, ceramic	1751		
C5	5 mfd, 30V, vertical	2868		
C17	.1 mfd, 200V, filmatic	2938		
C101, 201	25 mfd, 15V, NP vertical	3186		
C102, 114, 115 202, 214, 215	200 pf, mica	3411		
C103, 203	100 mfd, 16V, vertical	3729		
C106, 206	.0015 mfd, 200V, filmatic	3089		
C107, 207	100 pf, mica	3410		Later units changed to 3411, 200 pf
C108, 208	27 pf, mica	2342		
C109, 112 209, 212	47 pf, mica	3409		Later units changed C109, C209 to 3410, 100 pf
C110, 111, 210, 211	120 pf, mica	3290		
C116, 216	10 mfd, 50V, vertical	3728		
L101, 201	**Coil:** 5 mhy, axial lead	3510		
	Diodes:			
D101, 102, 106, 201, 202, 206	IN4148	3181		
D103, 203	IN270	3447		
D104, 105 204, 205	IN4003	2851		
*	IN961B, 10V, Zener	3549		May be used in place of 2961 for Q1, Q3.
	Integrated Circuits:			
IC-1 (A & B)	u A739 or,	3231		
	A749	3643		May be substituted for uA739 with proper load resistor. See Resistors

PARTS LIST

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	Resistors:			
R5, 13	1.5K ohm, 1W, 10%	3497		
R123, 223	47 ohm, .5W, 10%	2528		
R102, 202	1K ohm, .25W, 10%	2627		
R103, 203	510 ohm, .5W, 1%	3304		
R104, 204	10K ohm, .25W, 10%	2631		
R106, 206	22K ohm, .25W, 10%	3302		
R107, 207	3.9K ohm, .25W, 10%	2630		
R109, 209	56K ohm, .25W, 10%	2882		
R110, 118, 124 210, 218, 224	10K ohm, .25W, 10%	2343		
R112, 212	820 ohm, .25W, 10%	3301		
R114, 214	56 ohm, .25W, 10%	3511		
R115, 116, 215, 216	4.7K ohm, .5W, 10%	1640		
R117, 217	18K ohm, .25W, 10%	2633		
R119, 125, 219, 225	180 ohm, .25W, 10%	2873		
R120, 127 220, 227	5.6 ohm, .5W, 5%	3299		
R121, 122, 221, 222	120 ohm, .5W, 5%	3837		
R126, 226	2.2K ohm, .5W, 5%	3145		
R132, 232	750 ohm, .25W, 5%	3509		
*	3.3K ohm, .25W, 10%	2629		When IC uA749 is used, resistor must be connected from pins 1 to 7 and 7 to 13 on IC
*	10K ohm, .25W, 10%	2631		When IC uA739 is used and instability occurs, resistor must be connected from pins 1 to 7 and 7 to 13 on IC

PARTS LIST

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	Transistors:			
Q1, 3, 104-106 114, 204-206, 214	2N3859A selected	2961		Later Models Q1, Q3 is changed to IN961B Zener (3549)
Q102, 107 202, 207	2N4125 selected	3625		
Q108, 208	MPSA06	3528		
Q109, 209	MPSL51	3500		
Q109, 209	MPSA-55	3954		On later units
Q110, 112 210, 212	2N6175	3501		
	Miscellaneous:			
	Socket, IC, 14-pin	3450		
	Cooler, TO-92, dual	3493		Used on Q108, 114, 208, 214
	Transistor lead, PC receptacle	3519		Used to mount R111, 211
	Screw, 4-40 x 3/8 RH CAD	1844	9	Used to mount Q110, 112, 210, 212 (See Fig. 6-6)
	Washer, star, #4 internal	1824	10	"
	Washer, mica, TO-5	3530	11	"
	Nut, hex, 4-40 CAD	1938	12	"

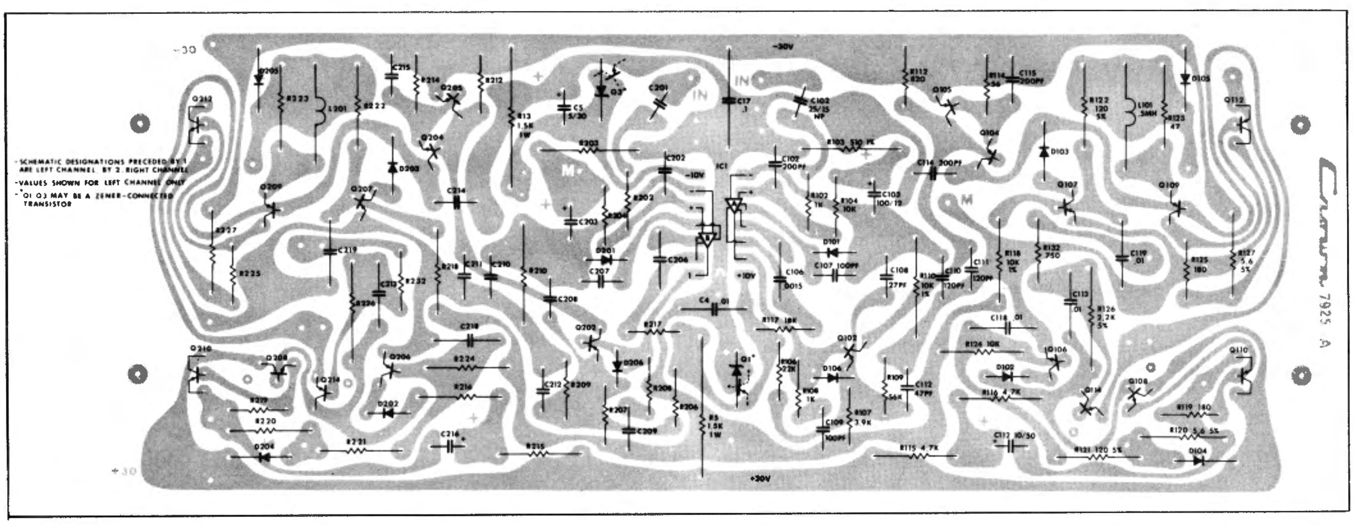


FIGURE 6-4
COMPONENT LOCATION, D-60 MAIN MODULE PC BOARD

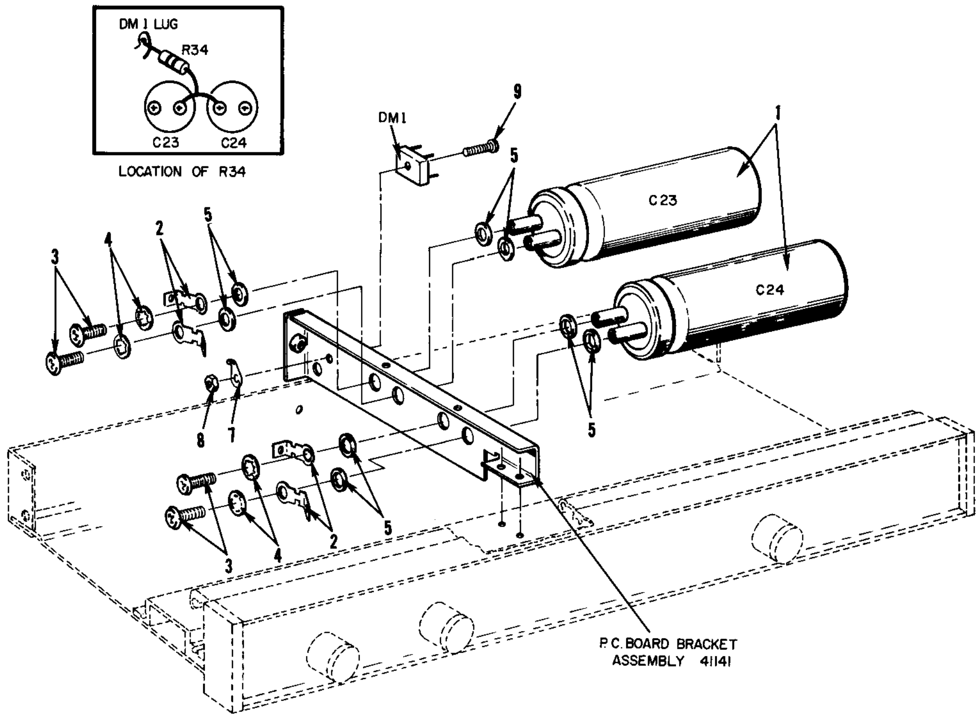


FIGURE 6-5
EXPLODED VIEW DIAGRAM,
CAPACITOR BRACKET ASSY., 41142

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	CAPACITOR BRACKET ASSEMBLY	41142		
	Board Bracket Assembly	41141		Separate Parts List
	Capacitors and Mounting Hardware:			
C23, C24	7000 mfd, 40V	3490		
	Lug, solder	2934	2	Terminals for C23, C24
	Screw, 10-32 x ½ THP NIC	2049	3	Mounts C23, C24
	Washer, star, #10 internal	2279	4	Mounts C23, C24
	Washer, shoulder, fiber, 1/4"	1648	5	Mounts C23, C24
	Bridge and Mounting Hardware:			
DM1	VH148, 6A	3062		
	Lug, solder, #6	3163	7	Mounts DM1
	Nut, hex, 6-32, CAD	1889	8	Mounts DM1
	Screw, 6-32 x 3/8, BHP, CAD	2134	9	Mounts DM1
R34	**Resistor:** 1 ohm, .5W, 10%	3612		Mounted on common terminal for C23, 24 to lug at DM1

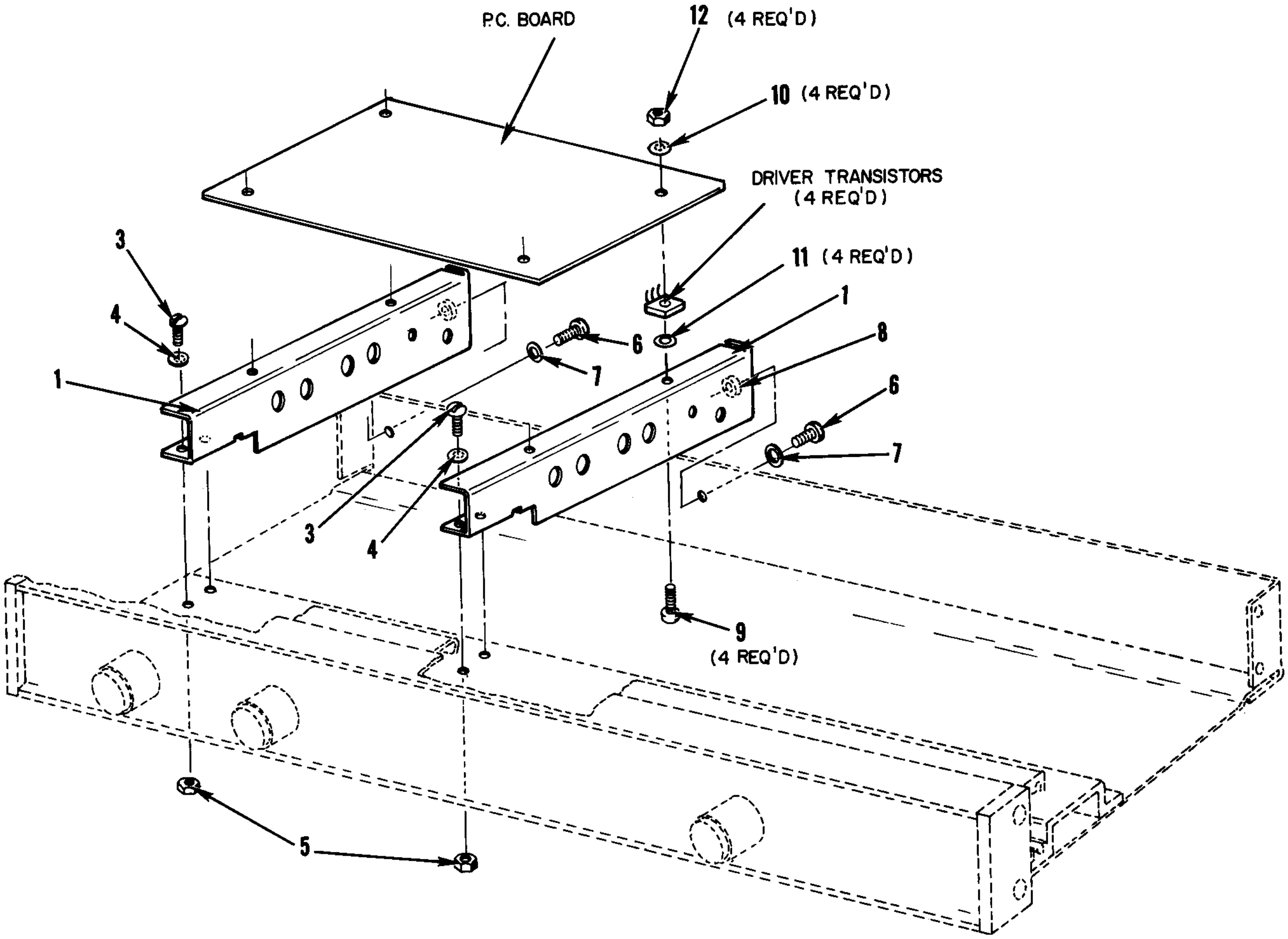


FIGURE 6-6
EXPLODED VIEW DIAGRAM, BOARD BRACKET ASSY., 41141

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	BOARD BRACKET ASSEMBLY	41141		
	Bracket, D-60	3498	1	Fastens both sides of main PC board
	Screw, 4-40 x 3/8 RH CAD	1844	3	Mounts 41141 to front panel
	Washer, #4 internal, star	1824	4	Mounts 41141 to front panel
	Nut, hex, 4-40, CAD	1938	5	Mounts 41141 to front panel
	Screw, 8-32 x 1/4 THP, CHR	2271	6	Mounts 41141 to back panel
	Washer, #8 internal, star	1951	7	Use over 2271
	Nut, captive, 8-32	2018	8	

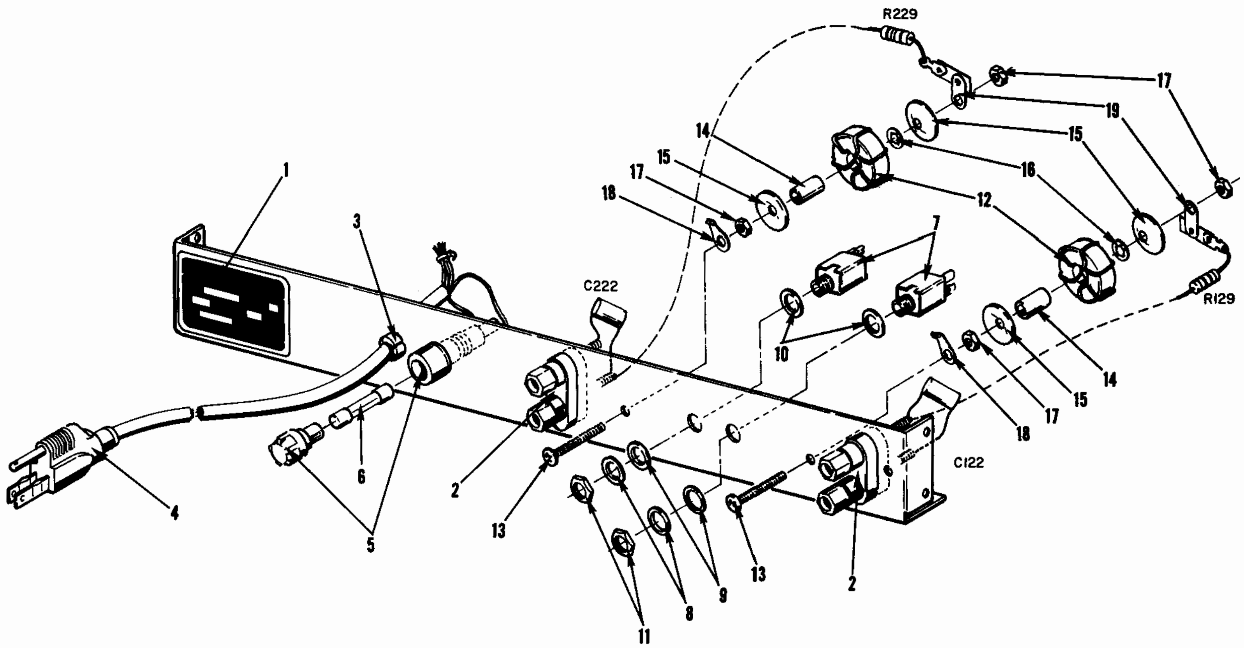


FIGURE 6-7
EXPLODED VIEW DIAGRAM, BACK CHASSIS ASSY., 41147

Schematic Designation	Description	Crown Part No.	Draw No.	Other Information
	BACK CHASSIS ASSEMBLY	41147		
	Rear Panel, D-60	9501	1	Silk screened
OUTPUT	Binding post, dual	2823	2	
	Strain relief, Heyco	2803	3	Fastens power cord
	Power cord, male, 3-18	3474	4	
	Fuseholder, HTA	3256	5	
	Fuse, 3AG-2A	2163	6	
INPUT	Jack, Hi-D Jax, 112A, 2-cond	3423	7	
	Washer, bright, control, NIC	2189	8	Mounts jack, 3423
	Washer, fiber	1646	9	Mounts jack, 3423
	Washer, fiber, shoulder	1306	10	Mounts jack, 3423
	Nut, bright, control, 3/8", NIC	1288	11	Mounts jack, 3423
L102, 202	Coil, output assembly	41145	12	
	Output toroid core	3555		
	Wire, brown, #18, 15-¾"	3585		
	Screw, 8-32 x 1-⅛, THP, CHR	2277	13	
	Spacer, nylon	2762	14	Insulates coil from screw
	Washer, nylon	3609	15	One each side of coil
	Washer, star, #8 internal	1951	16	Mounts coil
	Nut, hex, 8-32, CAD	1986	17	One each side of coil
	Lug, solder, #10 hole	3312	18	Mounted under coil
	Terminal strip, 2ALUE, #10 hole	3504	19	Mounted on top of coil
C122, 222	**Capacitor:** .1 mfd, 200V, filmatic	2938		Mounted on output terminals
R129, 229	**Resistor:** 2.7 ohm, 1W, 10%	1001		Mounted on terminal strip

SECTION 7
APPLICATION NOTES

GENERAL

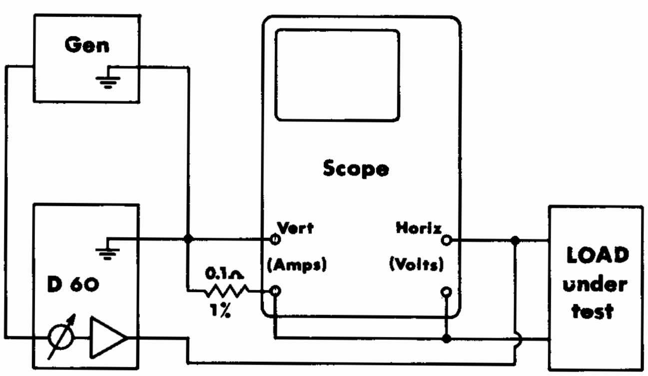
Application notes will be published periodically and distributed to owners of CROWN equipment for insertion in the instruction manual accompanying the equipment.

Information will be distributed concerning component changes, new accessories, special applications, modifications to equipment and any other technical data CROWN considers significant to help you use and maintain your equipment in optimum operating condition.

V-I NEEDS OF A LOAD

Evaluating the V-I (volt-ampere) needs of a load: Many loads exhibit large reactances (or energy storage), which limits a power amplifier's ability to deliver a maximum power. If a load stores energy, which in turn flows back into the amplifier, it is clear that the maximum power efficiency of the system is not being achieved. Power that flows back into a linear amplifier must necessarily be dissipated in the form of heat. A pure reactance is not capable of dissipating any power; therefore to drive such a load would only cause power amplifier heating.

In practice all loads exhibit some energy dissipation — however large their energy storage characteristics may be. The ideal coupling to any load is one that optimizes the desired dissipation component while minimizing the reactive or stored-energy component that is seen by the amplifier's output terminals.

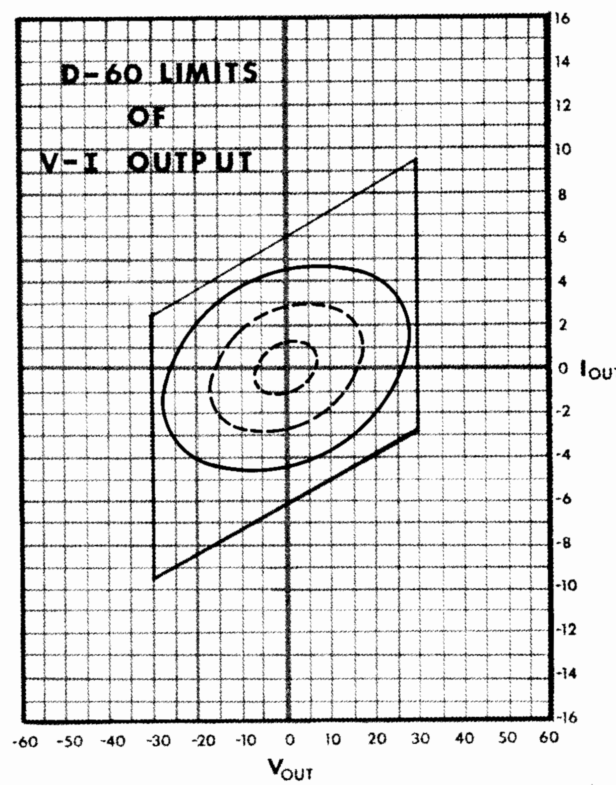


In applications where the input is sinusoidal and of small proportional frequency deviation, a relatively stable load may be resonantly tuned to present a real value of impedance to the amplifier.

Any load, no matter how complex its behavior, has a V-I operating range which may be mapped by the following test.

The maximum voltage and amperage excursions in all directions about zero (center of scope screen) define the volt-ampere operating range of the load. If a load is known to be linear over its operating range it is not necessary to supply the maximum desired power to the load. The test may be conducted at low signal levels and the current-sensing resistor (indicated as 0.1) may be enlarged to a convenient value for the oscilloscope's deflection sensitivity. The resulting plot may be then linearly scaled to the desired operating level.

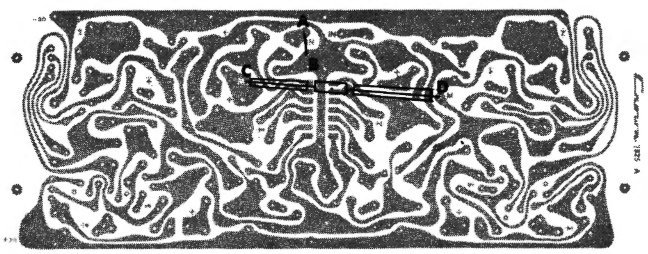
In the following example a reactive load is being fed a sinusoid of varying intensity. The V-I limits of the amplifier are super-imposed in dotted lines.



D-60 MONO CONVERSION

A. Wire Changes

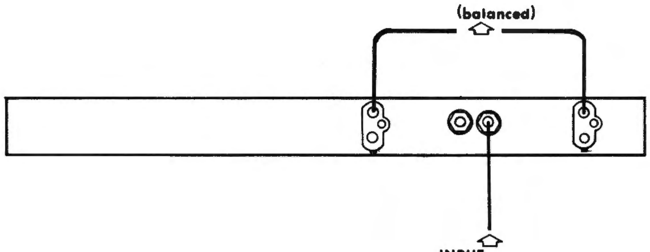
1. Remove the eight screws from the top cover. Lift cover straight up.
2. Ground No. 2 input (chan. 2) by soldering a 3/4" bare wire (as shown in Figure 1) between points A and B.



3. Connect a 10K, 1%, ½w resistor — with sleeving on both leads — between points C and D, using pre-drilled holes.

B. Operation

1. Make output cable as shown in Figure 2.



2. Connect one lead to "HOT" (red) amplifier output-post of channel 1, the other lead to "HOT" of channel 2.

CAUTION: DO **NOT** CONNECT EITHER "HOT" OUTPUT TO GROUND (EITHER BLACK POST).

3. Connect an 8 ohm (or higher) load to the output cable. A fuse is recommended! (Refer to Figure 3-15.)
4. Connect input signal, using std. 1/4 phone plug, to channel 1 input-jack. The "channel 1" gain (input level control) may be adjusted for desired output-level.
5. The 3-wire AC powercord meets U/L requirements, but many installations will require a 3-to-2 wire adapter to avoid "ground-loops" — circulating currents caused by more than one ground-path.

C. Specifications

F - Resp.	±.20db 20Hz - 20KHz 1W 8 Ohm ±1db 6Hz - 50KHz 1W 8 Ohm
Power Resp.	±1db 7Hz - 25KHz 90W 8 Ohm 90 watts into 25V line +1db 7Hz - 20KHz
Power at Clip Pt.	Typically 105W into 8 Ohm 1KHz
Total Output (1HF)	Music Power 168W 8 Ohm 104W 16 Ohm
IM Distortion	Less than .1% from 10mW to full output. Typically below .01% at 90W
Damping Factor	Greater than 150 Zero - 1KHz 8 Ohm
Hum and Noise (20Hz-20KHz)	106db below 90W (typically 112db)
Slewing Rate	12 Volt/Microsecond
Load Impedance	8 Ohm or higher (complete stability with any load)
Output Signal	Balanced
Input Sensitivity	.66V for 90W into 8 Ohm
Input Impedance	25K Nominal
Voltage Gain	32.3db ±.2db.
Protection	Short, mismatch, and open circuit proof. V-I limiting is instantaneous with no annoying thumps, cutout, etc. Thermal switch in AC line protects against overheating caused by insufficient ventilation. Controlled slewing rate voltage amplifiers protect overall amplifier against RF burnouts.
Power Supply	Computer-grade filter capacitors with a special design low profile transformer. Two regulated supplies for complete isolation and stability.
Power Requirements	Requires 50 to 400Hz AC on 120V or 240V ±10% operation. Draws 15 watts or less on idle 120 watts at 60 watts output into 8 ohms.
Heat Sinking	The entire amplifier is used as a heat sink. Front panel extrusion acts as a heat sink along with the chassis covers.
Chassis	Aluminum chassis construction for maximum heat conduction and minimum weight.
Controls	Two input level controls on front panel with power switch and pilot light.
Connectors	Input ¼ in. phone jack Output — Color coded binding posts with stereo ¼ in. earphone jack on front panel. AC Line — Three-wire (grounded) male connector on 5 ft. min. cable.
Dimensions	17 in. long, 8¾ in. deep and 1¾ in. high (8 in. deep from mounting surface) 19 in. standard rack mounting hardware available.
Weight	10 pounds net weight.
Finish	Front panel is bright anodized brushed aluminum with black leatherette insert.

PA Adapter Panel

The P-A adapter panel is used to connect the amplifier to obtain a monaural 25 volt balanced output line (see schematic, Figure 4). This is achieved by a precision push-pull transformer (inverted signal to Channel 1). This results in over 50 watts of 25 volt balanced output from the two output terminals in 16 ohms, over 90 watts when terminated in 8 ohms.

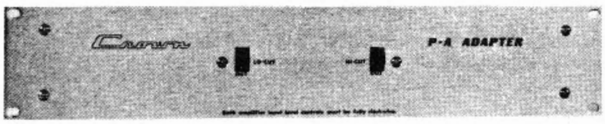


FIGURE 1
FRONT VIEW OF P-A ADAPTER PANEL

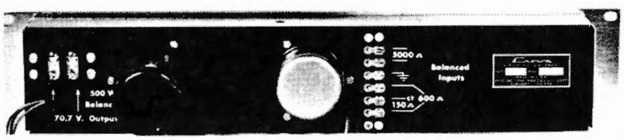


FIGURE 2
REAR VIEW OF P-A ADAPTER PANEL

The adapter panel provides balanced inputs of 150 ohms, 600 ohms CT, and 5000 ohms bridging. Sensitivity is -5dbm, 600 Ohms.

Two switches are provided on the front panel for insertion of hi-cut and lo-cut filters. The characteristics of these filters may be altered by changing internal capacitors in accordance with Figure 4.

The P-A adapter comes wired for an amplifier input impedance of 10K. Therefore it will be necessary to parallel the 18K resistors (furnished with the adapters) across the amplifier inputs as described on a note with the resistors.

The output circuit contains a roll-off capacitor (C 101) which should be used if matching transformers are used on the output line. This will prevent large low-frequency currents from flowing into their primaries.

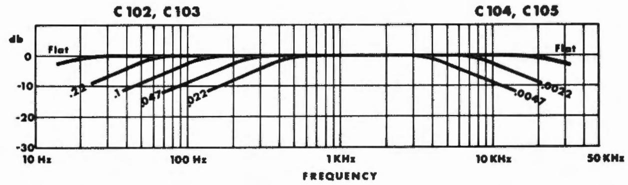


FIGURE 3
P-A ADAPTER FILTER RESPONSE

If matching transformers are not used, and the low-frequency impedance (DC resistance) of the load is 6 ohms or greater, the system may be directly coupled to the amp output terminals, bypassing C 101. Otherwise, use the output terminals on back of the adapter panel.

To ensure maximum output (without premature clipping) both amplifier level controls must be full CW.

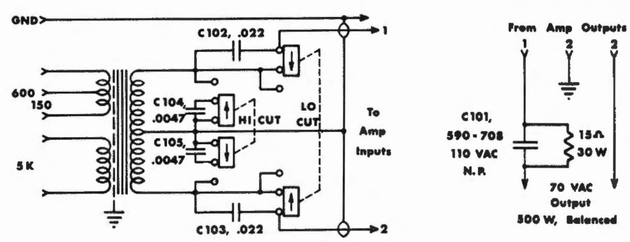


FIGURE 4
P-A ADAPTER SCHEMATIC

CROWN SERVICE BULLETIN

TO: CROWN Service Stations

DATE: October 29, 1973

RE: D-60, QC

FROM: Jim Clymer

CROWN Technical Service

INSTRUCTIONS: File in D-60 Section of Service Book III

I. For several batches, the D-60 output inductor assemblies were mounted on a metal spacer. Several shorts were discovered so the spacer was switched to a nylon unit.

Current production uses two CPN #2762 spacers per coil. If any problems are encountered, install the nylon spacer.

CROWN SERVICE BULLETIN

TO: All CROWN Service Stations

FROM: Jim Clymer, Tech. Ser.

RE: D-60 Capacitor Failure

DATE: March 22, 1974

We have been made aware of a problem in a recent batch of D-60 amplifiers, SE6699-SE6915. C16 (CPN 3728) is a vertical capacitor 10 MF @ 50 V. Recently we started using capacitors manufactured by IEC, in place of the older Mallory units. The IEC does not have different size leads and can be installed backwards.

If C16 is installed backwards it may pass the electronic tests, but it will eventually fail! We have no way of knowing how many units actually are in service now with this problem.

Service Facilities: If you are servicing a unit in this group, check carefully for the polarity of C16. You may need to stock additional capacitors.

Dealers: If you receive this bulletin, you have received a D-60 from this group. Carefully check all your stock and contact the owners of units within this group. The amps should be brought in and checked for correct C16 polarity. If the polarity is reversed, the C16 should be changed.