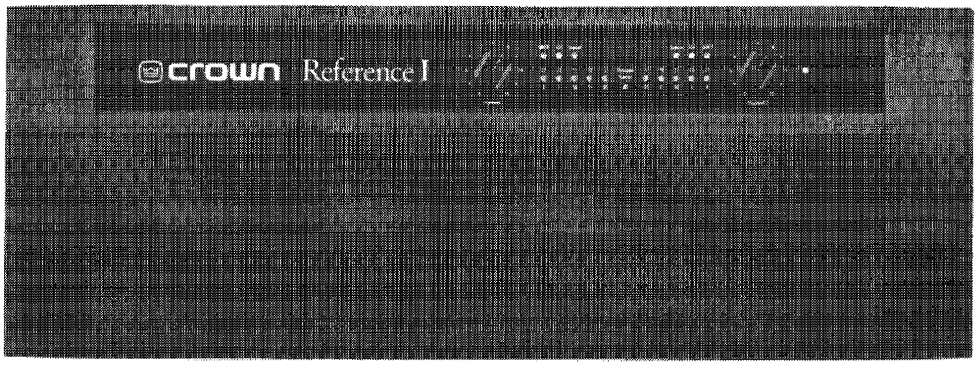
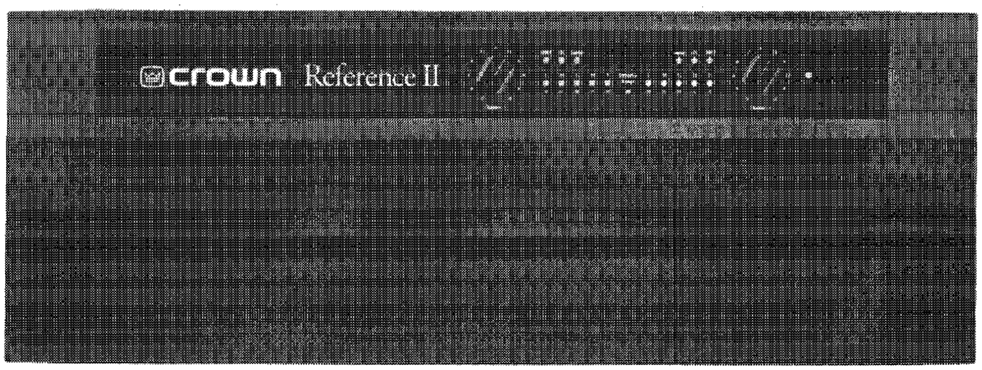
Crown®

Studio Reference™

Service Manual





PROFESSIONAL STUDIO AMPLIFIERS

Models:

Studio Reference I & Studio Reference II

Some models may be exported under the name *Amcron®*

KSVCREF1/2
12/98

The information furnished in this manual does not include all of the details of design, production, or variations of the equipment. Nor does it cover every possible situation which may arise during installation, operation or maintenance. If you need special assistance beyond the scope of this manual, please contact the Crown Technical Support Group.

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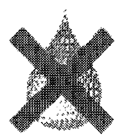
CAUTION

TO PREVENT ELECTRIC SHOCK DO NOT REMOVE TOP OR BOTTOM COVERS. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL. DISCONNECT POWER CORD BEFORE REMOVING REAR INPUT MODULE TO ACCESS GAIN SWITCH.

AVIS

À PRÉVENIR LE CHOC ÉLECTRIQUE N'ENLEVEZ PAS LES COUVERTURES. RIEN DES PARTIES UTILES À L'INTÉRIEUR. DÉBRANCHER LA BORNE AVANT D'OUVRIR LA MODULE EN ARRIÈRE.



WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE!

Revision History

Revision Number	Date	Changes
Rev. 0	12-98	Initial Printing

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1 Introduction

1.1 The Studio Reference

The Studio Reference amplifiers are the flagship of Crown International. They offer the best in sound reproduction with a dynamic range capable of accurately reproducing 20-bit digital recordings. Super low harmonic and intermodulation distortion provides the best transfer function in the business. And the ultra-high damping factor of 20,000 delivers superior loudspeaker motion control for a tight and clean low-end.

1.2 Scope

This manual contains service information for the Crown Studio Reference power amplifiers. It is designed to be used with the applicable Reference Manual. However, some important information is duplicated in this Service Manual in case the Reference Manual is not readily available.

This Service Manual includes several sections. These sections include Specifications, Voltage Conversion, Circuit Theory, Electrical Checkout, Parts Information, Module Information, and Exploded View Drawings. Schematics are included. Note that a Module is comprised of the circuit board with the component parts installed. Crown does not sell blank (unpopulated) circuit boards.

CAUTION: The information in this manual is intended to be used by an experienced technician only!

1.3 Warranty

Each Reference Manual contains basic policies as related to the customer. In addition, it should be stated that this service documentation is meant to be used only by properly trained service personnel. Because most Crown products carry a 3 Year Full Warranty (including round trip shipping within the United States), all warranty service should be referred to the Crown Factory or Authorized Warranty Service Center. See the applicable Owner's Manual for warranty details. To find the location of the nearest Authorized Service Center, or to obtain instructions for receiving Crown Factory Service, please contact the Crown Technical Support Group (within North America) or your Crown/Amcron Importer (outside North America).

Crown
Technical Support Group
Factory Service
Parts Department

Mailing Address:
PO Box 1000
Elkhart, IN USA 46515-1000

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Plant 2 S.W.
1718 W. Mishawaka Rd.
Elkhart, IN USA 46517

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2 Specifications

The following specifications apply to units in Stereo Mode, with an 8 Ohm load, and an input sensitivity of 26dB, unless otherwise specified.

Low-Distortion 1 kHz Power: Refers to maximum average power in watts at 1 kHz with 0.02% THD and noise.

Standard 1 kHz Power: Refers to maximum average power in watts at 1 kHz with 0.1% THD and noise.

Full Bandwidth Power: Refers to maximum average power in watts from 20 Hz to 20 kHz with 0.1% THD and noise.

2.1 Performance

Frequency Response: ±0.1 dB from 20 Hz to 20 kHz at 1 watt.

Phase Response: +5 to -15 degrees from 20 Hz to 20 kHz at 1 watt.

Signal-to-noise: (A-weighted)
Studio Reference I: Greater than 120 dB below full bandwidth power.
Studio Reference II: Greater than 117 dB below full bandwidth power.

Total Harmonic Distortion (THD): Less than 0.02% at rated low-distortion 1 kHz power. Less than 0.1% at rated full bandwidth power.

Intermodulation Distortion (IMD): (60 Hz & 7 kHz 4:1)
Studio Reference I: Less than 0.005% from full bandwidth power to 78 watts rising linearly to 0.025% at 78 milliwatts.
Studio Reference II: Less than 0.005% from full bandwidth power to 36 watts rising linearly to 0.025% at 36 milliwatts.

Damping Factor: Greater than 20,000 from 10 Hz to 200 Hz, and greater than 2,500 at 1 kHz.

Crosstalk: (At rated full bandwidth power.)
Studio Reference I: Better than 100 dB from 20 Hz to 100 Hz, falling linearly to better than 70 dB at 20 kHz.
Studio Reference II: Better than 100 dB from 20 Hz to 100 Hz, falling linearly to better than 65 dB at 20 kHz.

Common Mode Rejection (CMR): Better than 100 dB below rated full bandwidth power from 20 Hz to 400 Hz, rising linearly to better than 70 dB at 20 kHz.

Voltage Gain: (With level controls set for maximum output.) At the 26 dB gain setting, 20:1 ±3% or 26 dB ±0.25 dB.
Studio Reference I: At 0.775 volt sensitivity, 103:1 ±12% or 40 dB ±1 dB; at 1.4 volt sensitivity, 57:1 ±12% or 35 dB ±1 dB.
Studio Reference II: At 0.775 volt sensitivity, 69:1 ±12% or 37 dB ±1 dB; at 1.4 volt sensitivity, 38:1 ±12% or 32 dB ±1 dB.

2.2 Power

Power Bandwidth: (At standard 1 kHz power.)
Studio Reference I: –1 dB from 5 Hz to 27.5 kHz and –3 dB from 3 Hz to 32.8 kHz.
Studio Reference II: –1 dB from 5 Hz to 28.6 kHz and –3 dB from 2.3 Hz to 34.4 kHz.

The following power ratings are for units configured for 120 VAC, 60 Hz. For information on power specifications for units configured for other voltages, see the reference manual.

Low-Distortion 1 kHz Output Power:
Studio Reference I:
Stereo Mode with both channels driven:
1,160 watts per channel into 4 ohms.
760 watts per channel into 8 ohms.

Bridge-Mono mode:
2,220 watts into 8 ohms.
1,580 watts into 16 ohms.

Parallel-Mono mode:
2,315 watts into 2 ohms.
1,565 watts into 4 ohms.

Studio Reference II:
Stereo Mode with both channels driven:
555 watts per channel into 4 ohms.
355 watts per channel into 8 ohms.

Bridge-Mono mode:
1,110 watts into 8 ohms.
715 watts into 16 ohms.

Parallel-Mono mode:
1,115 watts into 2 ohms.
710 watts into 4 ohms.

2 Specifications

Standard 1 kHz Output Power:

Studio Reference I:

Stereo mode with both channels driven:
1,190 watts per channel into 4 ohms.
800 watts per channel into 8 ohms.

Bridge-Mono mode:
2,375 watts into 8 ohms.
1,595 watts into 16 ohms.

Parallel-Mono mode:
2,350 watts into 2 ohms.
1,580 watts into 4 ohms.

Studio Reference II:

Stereo mode with both channels driven:
565 watts per channel into 4 ohms.
360 watts per channel into 8 ohms.

Bridge-Mono mode:
1,145 watts into 8 ohms.
720 watts into 16 ohms.

Parallel-Mono mode:
1,135 watts into 2 ohms.
715 watts into 4 ohms.

Full Bandwidth Output Power: (20 Hz to 20 kHz)

Studio Reference I:

Stereo mode with both channels driven:
1,075 watts per channel into 4 ohms.
760 watts per channel into 8 ohms.

Bridge-Mono mode:
2,150 watts into 8 ohms.
1,535 watts into 16 ohms.

Studio Reference II:

Stereo mode with both channels driven:
495 watts per channel into 4 ohms.
340 watts per channel into 8 ohms.

Bridge-Mono mode:
1,020 watts into 8 ohms.
690 watts into 16 ohms.

Load Impedance: Safe with all types of loads. Rated for 4 to 8 ohms in stereo mode, 8 to 16 ohms in Bridge-Mono mode, and 2 to 4 ohms in Parallel-Mono mode.

Required AC Mains: 50 or 60 Hz; 100, 120, 200, 220 or 240 VAC (±10%). Both units draw 90 watts or less at idle.

2.3 Controls

Enable: A front panel push button used to turn the amplifier on and off.

Level: A front panel rotary potentiometer for each channel with 31 detents, used to control the output level.

Stereo/Mono: A three-position back panel switch used to select either Stereo, Bridge-Mono or Parallel-Mono mode.

Sensitivity: A three-position switch inside the P.I.P. compartment used to select the input sensitivity for both channels: 0.775 or 1.4 volts for standard 1 kHz power, or 26 dB voltage gain.

Meter On/Off: A two-position switch behind the front panel used to turn the front panel meters on or off.

Meter Display Mode: A two-position switch behind the front panel used to set the display mode for the front panel meters. Display modes include dynamic range of the output signal in dB or output levels in dB.

Ground Lift: A two-position back panel switch used to isolate the input phone jack and AC (chassis) grounds.

Reset: A two-position back panel switch used to reset the AC mains circuit breaker.

2.4 Indicators

Enable: This indicator shows the on/off status of the unit's low-voltage power supply.

Signal: Each channel has a signal indicator that flashes to show audio output.

IOC: Each channel has an *IOC* indicator that flashes if the output waveform differs from the input waveform by 0.05% or more. The LEDs act as sensitive distortion indicators to provide proof of distortion-free performance. In Parallel-Mono mode the channel 2 *IOC* light stays on.

ODEP: Each channel has an *ODEP* indicator that shows the channel's reserve energy status. Normally, the LEDs are brightly lit to show that reserve energy is available. In the rare event that a channel has no reserve, its indicator will dim in proportion to *ODEP* limiting.

2 Specifications

Dynamic Range/Level Meter: Each Channel has a five-segment meter that displays either the dynamic range of the output signal in dB or the output level in dB. (From the factory, the amplifier is set to display dynamic range.) As dynamic range meters, they show the ratio of peak to average power of each channel. As output level meters they show how high the output levels are relative to standard 1 kHz power.

2.5 Input/Output

Input Connector: Two balanced 1/4-inch jacks on the back panel and two balanced three-pin XLR connectors on the factory-installed P.I.P.-FX.

Input Impedance: Nominally 10 K ohms, balanced. Nominally 5 K ohms, unbalanced.

Input Sensitivity: Settings include 0.775 volts or 1.4 volts for standard 1 kHz power, or 26 dB voltage gain.

Output Connectors: Two sets of color-coded 5-way binding posts for each channel (for connecting banana plugs, spade lugs or bare wire).

Output Impedance: Less than 10 milliohms in series with 2.5 microhenries.

DC Output Offset: (Shorted input) ±2 millivolts.

2.6 Output Signal

Stereo: Unbalanced, two-channel.

Bridge-Mono: Balanced, single-channel. Channel 1 controls are active; channel 2 should be turned down.

Parallel-Mono: Unbalanced, single-channel. Channel 1 controls are active; channel 2 is bypassed.

2.7 Protection

ODEP: If unreasonable operating conditions occur which could stress the output circuitry, the *ODEP* circuit limits the output current level until safe operating conditions exist.

Transformer: Transformer overheating will result in a temporary shut-down due to a thermal switch in the transformer primary.

RF Burnout: Controlled slew-rate voltage amplifiers protect the unit against RF burnouts.

Input: Input overload protection is furnished at the amplifier input to limit current.

Turn On: The four second turn-on delay prevents dangerous turn-on transients.

2.8 Construction

Steel chassis with durable black finish, aluminum front panel with super-gloss Imron finish, Lexan overlay, and a specially designed flow-through ventilation system from front to side panels.

Cooling: Convection cooling with assistance from the computerized, on-demand proportional cooling fan.

Dimensions: Standard 19 inch (48.3 cm) rack mount width (EIA RS-310-B), 7 inch (17.8 cm) height, 16 inch (40.6 cm) depth behind mounting surface and 2.75 inch (7 cm) protrusion in front of mounting surface (see Fig. 2.1 below).

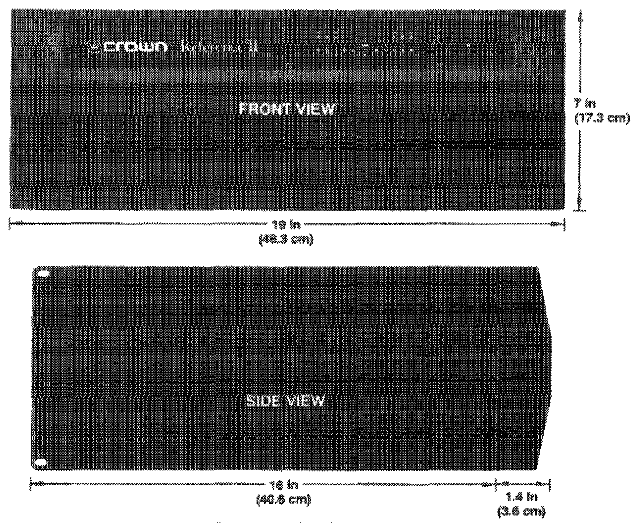

Figure 2.1: Studio Reference Dimensions

Approximate Weight: Center of gravity is about 6 inches (15.2 cm) behind the front mounting surface.

> Studio Reference I: 60 pounds, 11 ounces (27.6 kg) net; 74 pounds, 3 ounces (33.7 kg) shipping weight.
>
> Studio Reference II: 56 pounds, 2 ounces (25.5 kg) net; 69 pounds, 10 ounces (31.6 kg) shipping weight.

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3 Voltage Conversion

The Studio Reference Amplifiers can be wired for 100 VAC, 120 VAC, 200 VAC, 220 VAC or 240 VAC operation. This is made possible by the use of a multitap transformer for the high energy power supplies. Perform the following procedure and refer to Figures 3.1 and 3.2 to convert the operating voltage. You may have to order the approprate circuit breaker using the part number listed in Figure 3.2.

CAUTION: Because there is a risk of electric shock, only an experienced technician should attempt to alter the line voltage configuration.

1. Remove the top cover of the Studio Reference amplifier (held on by 8 screws).
2. With the front panel toward you, locate the control module (front center) and the tab connectors (upper right hand corner of module).
3. Cut and remove the wire ties to access the jumpers and wires.
4. Refer to Figure 3.1 and make the appropriate changes for the desired operating voltage.
5. Install wire ties to dress the wires above the connections.
6. Note the 60 Hertz/50 Hertz switch on the left hand side of the module and change, if necessary, for the operating line frequency.
7. Refer to Figure 3.2 and change the Circuit Breaker if necessary.
8. On the rear of the unit, change the line cord tag to read the correct voltage. This is on the lower right hand side of the rear panel, just above the serial tag.
9. Reassemble the unit.

SPECIFIC VOLTAGE WIRING			
VOLTAGE	JUMPER	WP17 WHITE	WP16 BLACK
100V	P26—P14	P16	P17
120V	P26—P15	P16	P18
200V	P14—P16	P13	P17
220V	P15—P16	P13	P17
240V	P15—P16	P13	P18

Figure 3.1 Specific Voltage Wiring

CIRCUIT BREAKER SELECTION		
	100V, 120V	200V, 220V, 240V
REF 1	30 AMP, C 7756-7	20 AMP, C10193-8
REF 2	20 AMP, C10193-8	10 AMP, C10192-0

Figure 3.2 Circuit Breaker Selection

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4.1 Overview

It should be noted that over time Crown makes improvements and changes to their products for various reasons. This manual is up to date as of the time of writing. For additional information regarding these amplifiers, refer to the applicable Technical Notes provided by Crown for this product.

This section of the manual explains the general operation of a Crown Studio Reference power amplifier. Topics covered include Front End, Grounded Bridge, ODEP and others. Due to variations in design from vintage to vintage (and similarities with other Crown products) the theory of operation remains simplified.

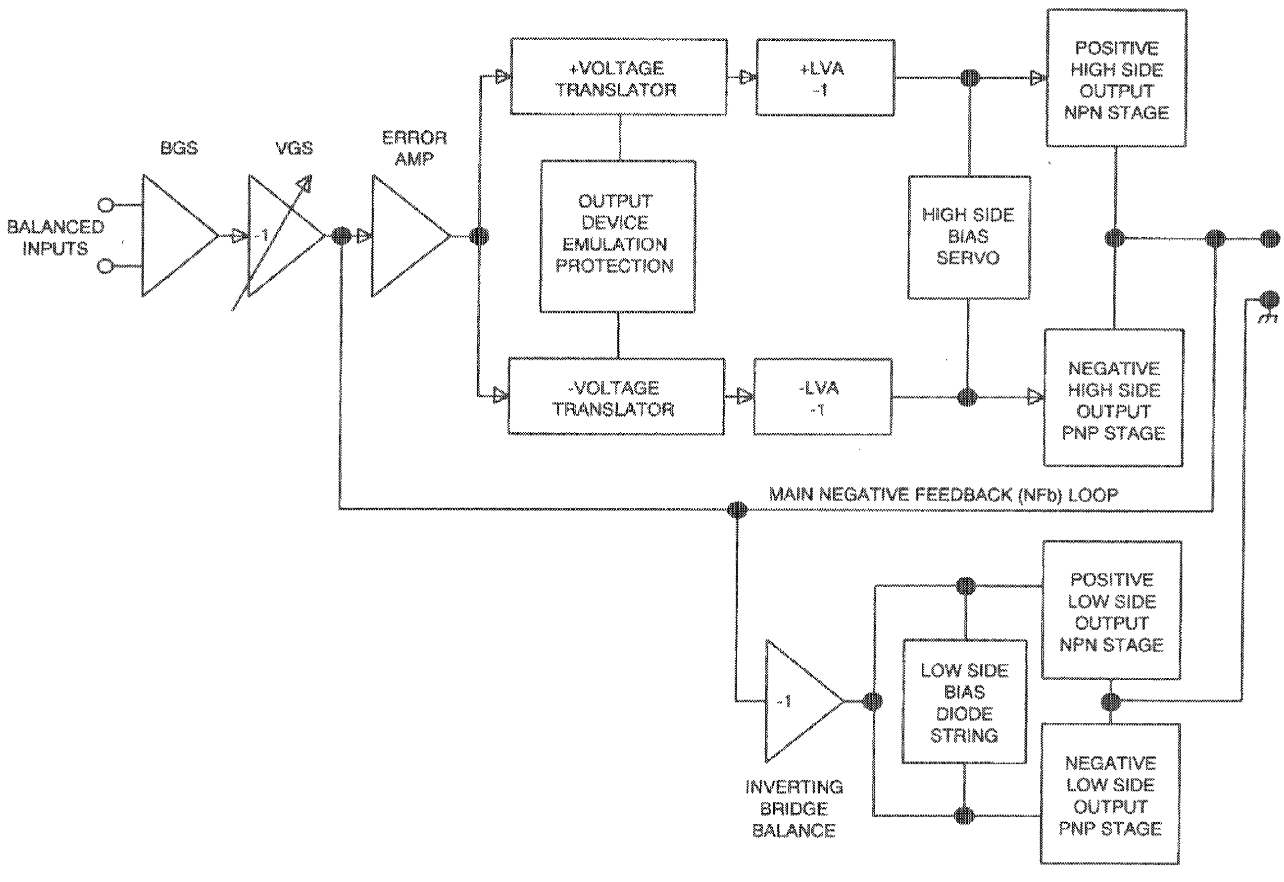

Figure 4.1 Simplified Studio Reference Block Diagram

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4.2 Features

Studio Reference amplifiers utilize numerous Crown innovations, including grounded bridge and ODEP technologies. Cooling techniques make use of what is essentially air conditioner technology. Air flows bottom to top, and front to side. Air flows a short distance across a wide heatsink. This type of air flow provides significantly better cooling than the "wind tunnel" technology used by many other manufacturers. Output transistors are of the metal can type, rather than the plastic case style. This allows for a significantly higher thermal margin for the given voltage and current ratings. All devices used are tested and graded to ensure maximum reliability. Another electronic technique used is negative feedback. Almost all power amplifiers utilize negative feedback to control gain and provide stability, but Crown uses multiple nested feedback loops for maximum stability and greatly improved damping. Studio Reference amplifiers have damping in excess of 20,000 in the bass frequency range. This feedback, along with our compensation and ultra-low distortion output topology, make the Crown Studio Reference amplifier superior.

Features specific to the Studio Reference include: A high power toroidal transformer; Computer controled, variable speed, whisper quiet fan; Built in AC power filter; Soft start circuit to control inrush current; Full overvoltage and internal fault protection. This amplifier can operate in either Bridged or Parallel Mono mode, as well as in Dual (stereo) mode. A sensitivity switch allows selection of input voltage required for rated output. Level controls are mounted on the front panel and are of the rotary type. Front panel indicators let the user know the status of amplifier enable, ODEP, signal presence (SPI), and distortion (IOC). Also included on the front panel is a five-segmet display for each channel which displays either dynamic range in dB or output level in dB.

For additional details refer to the specification section, or to the applicable Reference Manual.

4.3 Front End Operation

The front end is comprised of three stages: Balanced Gain Stage (BGS), Variable Gain Stage (VGS), and the Error Amp. Figure 4.2 shows a simplified diagram of the front end and voltage amplification stages.

4.3.1 Balanced Gain Stage (BGS)

Input to the amplifier is balanced. The shield from the 1/4" inputs may be isolated from chassis ground by an RC network to interrupt ground loops via the Ground Lift Switch. The non-inverting (hot) side of the balanced input is fed to the non-inverting input of the first op-amp stage. The inverting (negative) side of the balanced input is fed to the inverting input of the first op-amp stage. A potentiometer is provided for common mode rejection adjustment (R512). Electrically, the BGS is at unity gain. (From an audio perspective, however, this stage actually provides +6dB gain if a fully balanced signal is placed on its input.) The BGS is a non-inverting stage. It's output is delivered to the Variable Gain Stage.

4.3.2 Variable Gain Stage (VGS)

From the output of the BGS, the signal goes to the VGS, where gain is determined by the position of the Sensitivity Switch, and level is determined by the level control. VGS is an inverting stage with the input being fed to its op-amp stage. Because gain after this stage is fixed at 26 dB (factor of 20), greater amplifier sensitivity is achieved by controlling the ratio of feedback to input resistance. The Sensitivity Switch sets the input impedance to this stage and varies the gain such that the overall amplifier gain is 26 dB, or is adjusted appropriately for 0.775V or 1.4V input to attain rated output.

4.3.3 Error Amp

The inverted output from the VGS is fed to the non-inverting input of the Error Amp op-amp stage through an AC coupling capacitor (C100) and input resistor (R101). Amplifier output is fed back via the negative feedback (NFb) loop resistor (R103). The ratio of feedback resistor to input resistor fixes gain from the Error Amp input to the output of the amplifier at 26 dB. Diodes (D108, D122) prevent overdriving the Error Amp. Because the Error Amp amplifies the difference between input and output signals, any difference in the two waveforms will produce a near open loop gain condition which, in turn, results in high peak output voltage. The output of the Error Amp, called the Error Signal (ES) drives the Voltage Translators.

4.4 Voltage Amplification

The Voltage Translator stage separates the output of the Error Amp into balanced positive and negative drive voltages for the Last Voltage Amplifiers (LVAs), translating the signal from ground referenced ±15V to ±Vcc reference. LVAs provide the main voltage amplification and drive the High Side output stages. Because there is a slight loss of gain in the translator stage, the gain after the translator is a factor of 25.2.

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4.4.1 Voltage Translators

A voltage divider network splits the Error Signal (ES) into positive and negative drive signals for the balanced voltage translator stage. These offset reference voltages drive the input to the Voltage Translator transistors (Q101, Q102). A nested NFb loop from the output of the amplifier mixes with the inverted signal riding on the offset references. This negative feedback fixes gain and adds stability in the gain stages. The Voltage Translators are arranged in a common base configuration for a non-inverting signal with equal gain. They shift the audio from the ±15V reference to VCC reference. Their outputs drive their respective LVA.

Also tied into the Voltage Translator inputs are ODEP limiting transistors (Q100, Q103) which also act as muting transistors. The ODEP transistors steal drive as dictated by the ODEP circuitry or shunt the audio as dictated by the fault circuit.

4.4.2 Last Voltage Amplifiers (LVAs)

The Voltage Translator stage channels the signal to the Last Voltage Amplifiers (LVAs) in a balanced configuration. The +LVAs (Q105/104) and -LVAs (Q110/111), with their push-pull effect through the Bias Servo, drive the fully complementary output stage. The LVAs are configured as common emitter amplifiers. This configuration provides sufficient voltage gain and inverts the audio. The polarity inversion is necessary to avoid an overall polarity inversion from input jack to output jack, and it allows the NFb loop to control Error Amp gain by feeding back to its non-inverting input (with its polarity opposite to the output of the VGS). With the added voltage swing provided by the LVAs, the signal then gains current amplification through the Darlington emitter-follower output stage.

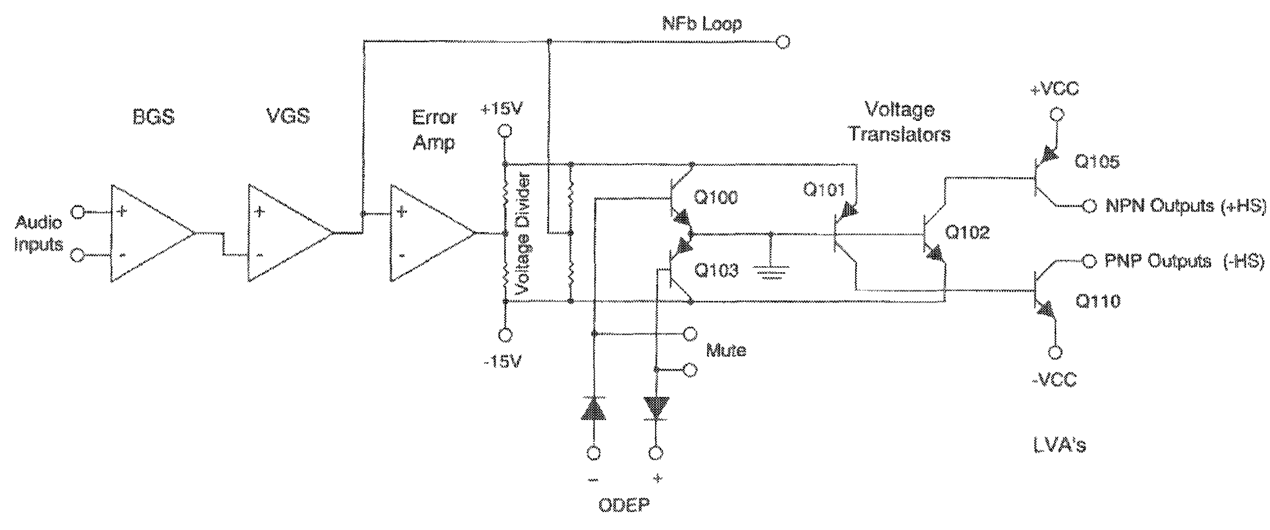

Figure 4.2 Simplified Amplifier Front End and Voltage Amplification Stages

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4.5 Grounded Bridge Topology

Figure 4.3 is a simplified example of the grounded bridge output topology. It consists of four quadrants of three deep Darlington (composite) emitter-follower stages per channel: one NPN and one PNP on the High Side of the bridge (driving the load), and one NPN and one PNP on the Low Side of the bridge (controlling the ground reference for the rails). The output stages are biased to operate class AB+B for ultra low distortion in the signal zero-crossing region and high efficiency.

4.5.1 High Side (HS)

The High Side (HS) of the bridge operates much like a conventional bipolar push-pull output configuration. As the input drive voltage becomes more positive, the HS NPN conducts and delivers positive voltage to the load. Eventually the NPN devices reach full conduction and +Vcc is across the load. At this time the HS PNP is biased off. When the drive signal is negative going, the HS PNP conducts to deliver -Vcc to the load and the HS NPN stage is off.

The output of the +LVA drives the base of the predriver device. Together, the predriver and driver form the first two parts of the three-deep Darlington and are biased class AB. They provide output drive through the bias resistor, bypassing the output devices, at levels below about 100mW. An RLC network between the predriver and driver provide phase shift compensation and limit driver base current to safe levels. Output devices are biased class B, just below cutoff. At about 100mW output they switch on to conduct high current to the load. Together with predriver and driver, the output device provides an overall class AB+B output.

The negative half of the HS is almost identical to the positive half, except that the devices are PNP. One difference is that the PNP bias resistor is slightly greater in value so that PNP output devices run closer to the cutoff level under static (no signal) conditions. This is because PNP devices require greater drive current.

HS bias is regulated by Q18, the Bias Servo. Q18 is a Vbe multiplier which maintains approximately 3.2V Vce under static conditions. The positive and negative halves of the HS output are in parallel with this 3.2V. With a full base-emitter on voltage drop across predrivers and drivers, the balance of voltage results in approximately .3V drop across the bias resistors in the positive half, and about .5V across the bias resistor in the negative half. Q18 conduction (and thus bias) is adjustable.

A diode string prevents excessive charge build up within the high conduction output devices when off. Flyback diodes shunt back-EMF pulses from reactive loads to the power supply to protect output devices from dangerous reverse voltage levels. An output terminating circuit blocks RF on output lines from entering the amplifier through its output connectors.

4.5.2 Low Side (LS)

The Low Side (LS) operates quite differently. The power supply bridge rectifier is not ground referenced, nor is the secondary of the main transformer. In other words, the high voltage power supply floats with respect to ground, but ±Vcc remain constant with respect to each other. This allows the power supply to deliver +Vcc and -Vcc from the same bridge rectifier and filter as a total difference in potential, regardless of their voltages with respect to ground. The LS uses inverted feedback from the HS output to control the ground reference for the rails (±Vcc). Both LS quadrants are arranged in a three-deep Darlington and are biased AB+B in the same manner as the HS.

When the amplifier output swings positive, the audio is fed to an op-amp stage where it is inverted. This inverted signal is delivered directly to the bases of the positive (NPN) and negative (PNP) LS predrivers. The negative drive forces the LS PNP devices on (NPN off). As the PNP devices conduct, Vce of the PNP Darlington drops. With LS device emitters tied to ground, -Vcc is pulled toward ground reference. Since the power supply is not ground referenced (and the total voltage from +Vcc to -Vcc is constant) +Vcc is forced higher above ground potential. This continues until, at the positive amplifier output peak, -Vcc = 0V and +Vcc equals the total power supply potential with a positive polarity. In the Reference 1, for example, the power supply produces a total of 144V from rail to rail (±72VDC measured from ground with no signal), therefore, the amplifier output can reach a positive peak of +144V.

Conversely, during a negative swing of the HS output where HS PNP devices conduct, the op-amp would output a positive voltage forcing LS NPN devices to conduct. This would result in +Vcc swinging toward ground potential and -Vcc swinging further from ground potential. At the negative amplifier output peak, +Vcc = 0V and -Vcc equals the total power supply potential with a negative polarity. Using the same ex-

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ample as above, a 144V supply would allow a negative output peak of -144V. In summary, a power supply which produces a total of 144VDC rail to rail (or ±72VDC statically) is capable of producing 288V peak-to-peak at the amplifier output when the grounded bridge topology is used.

The total effect is to deliver a peak to peak voltage to the speaker load which is twice the voltage produced by the power supply. Benefits include full utilization of the power supply (it conducts current during both halves of the output signal; conventional designs require two power supplies per channel, one positive and one negative), and never exposing any output device to more than half of the peak to peak output voltage (which does occur in conventional designs).

Low side bias is established by the same method as high side bias. Q00 is the bias transistor. Bias is adjustable via potentiometer. Flyback diodes perform the same function as the HS flybacks. The output of the LS is tied directly to chassis ground via ground strap.

4.6 Output Device Emulation Protection (ODEP)

To further protect the output stages, a specially developed ODEP circuit is used. It produces a complex analog output signal. This signal is proportional to the always changing safe-operating-area margin of the output transistors. The ODEP signal controls the Voltage Translator stage by removing drive that may exceed the safe-operating-area of the output stage.

ODEP senses output current by measuring the voltage dropped across LS emitter resistors. LS NPN current (negative amplifier output) and +Vcc are sensed, then multiplied to obtain a signal proportional to output power. Positive and negative ODEP voltages are adjustable via two potentiometers. Across ±ODEP are a PTC and a thermal sense (current source). The PTC is essentially a cutoff switch that causes hard ODEP limiting if heatsink temperature exceeds a safe maximum, regardless of signal level. The thermal sense device causes the differential between +ODEP and -ODEP to decrease as heatsink temperature increases. An increase in positive output signal into a load will result in -ODEP voltage dropping; an increase in negative output voltage and current will cause +ODEP voltage to drop. A complex RC network between the ±ODEP circuitry is used to simulate the thermal barriers between the interior of the output device die (immeasurable by normal means) and the time delay from heat generation at the die until heat dissipates to the thermal sensor. The combined effects of thermal history and instantaneous dynamic power level result in an accurate simulation of the actual thermal condition of the output transistors.

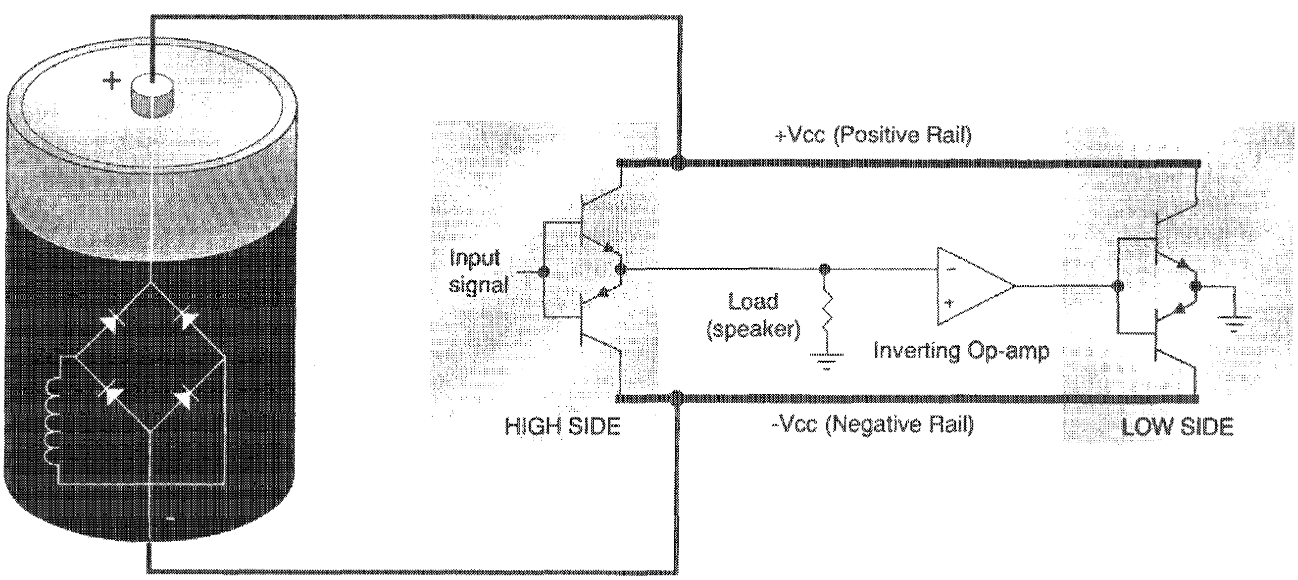

Figure 4.3 Simplified Grounded Bridge

4 Circuit Theory

4.7 Control Circuitry

The Reference amplifiers have fault protect circuitry to guard against dangerous DC voltages and turn on/off transients. At the heart of this circuitry is the window comparator U102. The fan control circuit monitors the thermal conditions, via the ODEP circuit, and regulates the fan speed accordingly.

4.7.1 DC/LF Protect

The amplifier output signal is passed through a low pass filter (R184, C119, R186 and C107) to the window comparator (U102). If the DC component exceeds a predetermined level, the output of the comparator (pins 1 and 2) goes low. The result is U102 pin 13 going to a high state which turns on the muting transistors and disables the high energy supply by opening the relay K2.

4.7.2 Fault Circuit

The fault circuitry is designed to mute the audio and disable the high energy supply in the event of an output fault. A *fault* is defined as any time in which the output semiconductors, in both the negative and positive sections, draw excessive currents.

The low side of bridge fault detection consists of Q128, Q129 and Q130. If both NPN and PNP output devices are conducting excessive currents, the output of U102 (pin 13) is forced high. This disables the high energy supply and mutes the audio path.

The high side of bridge fault detection consists of Q126, Q127 and U101. This circuit compares the NPN and PNP drive to the feedback signal, giving a representation of output device current. If excessive current occurs, the window comparator U102 is triggered through the opto isolator U101.

4.7.3 Turn On Delay

During power up, the capacitor C110 is charging, which causes the non-inverting input (pin 10) of U102 to be low and the output (pin 13) to be high. With pin 13 high, the high energy rails are disabled by the relay K2, and the audio is muted by the muting transistors. After approximately 4 seconds, C110 is fully charged and pin 10 is pulled high, thus causing pin 13 to go low and the amplifier to come out of standby.

4.7.4 Fan Control

The *Fan Control Signal* is taken from the positive ODEP bias voltages. Both channel 1 and channel 2 ODEP voltages are combined to create the fan control signal. As the output transistor/heatsink increases in temperature, the ODEP voltage level will drop from +10VDC to near 0VDC. If there is a drop in one or both ODEP voltages it will cause the fan control signal to change. The fan control signal starts out around -12.5VDC, and after complete ODEP limiting, ends up at +12.5VDC. This voltage is fed into the inverting input of the op-amp U1B. The initial output of U1B is high (+24V), and as the fan control signal becomes more positive, this output will become low, thus turning on the fan accordingly. The output of U1B drives U4, an opto-triac, which in turn drives Q4, a triac in the AC supply for the fan.

The *Gating Signal* is fed into the non-inverting input of the op-amp U1B. This gating signal is a product of U1A, Q3, and the *Fan Enable* signal from the display module. C12 and R19 form an RC timing circuit that, from the +15V supply, begins to charge. U1A monitors the line voltage wave form and is a 0V crossing detector. Every time the line waveform crosses 0V, Q3 is turned on and discharges C12. This causes a ramping type waveform. The higher positive portion of the waveform is used to turn off the opto-triac, even when the fan control signal itself is of a value to turn on the fan. Therefore, the fan control current has a duty cycle.

The *Fan Enable* signal comes from the display module and holds the *Gating Signal* high when the amplifier is in standby. Therefore the fan will not turn when the amplifier is in standby.

4.8 Power Supply

At the heart of the power supply is a multi-tap torroidal power transformer. There are two ungrounded, high energy, secondary windings, one for each channel, and there is one low voltage winding for the 24V supplies. There is also a thermal cut off switch built into the transformer which will disable the secondary windings in the event of the transformer overheating.

4.8.1 AC Line Filter

D24 and D25 are in the AC primary. They are wired such that they null out any DC component in the AC power. This is done because the torriodial transformer may develop a mechanical buzz if there is any DC shift in the AC waveform applied to the transformer primary.

4.8.2 Soft Start

Due to the high inrush current that is possible with the torroidal transformer, a *Soft Start* Circuit has been in-

4 Circuit Theory

corporated into the amplifier. This circuit allows the transformer to be energized before full power is applied to it. When power is first applied to the amplifier, K1 is open, and power is applied to the transformer through the PTC R1. As current is drawn through R1 it heats up and the resistance lowers. This allows the power to the transformer to ramp up. When the 24V supply is enough to energize the relay K1, it closes and power is applied directly to the transformer.

4.8.3 Over Voltage Protection

U1D serves as a window comparator for the purpose of over line voltage control. In the event that the line voltage exceeds 10% over the rated line voltage, the high energy power supplies are disabled. R7 supplies the regulated +15V to pin 10 of U1D and serves as the window reference level. With pin 10 in control of U1D, the output (pin 13) has a logic low which is applied across D13 and D14. This prevents conduction and allows Q1 to remain on, which thus allows K2 to remain energized

Resistors R3, R4, R5 and R6 serve as a resistor dropping network from the unregulated +24V supply to ground. As the line voltage increases, the unregulated supply will increase. The voltage level on the wiper of R4 is applied to Pin 11 (non-inverting input). When the level exceeds the window level of pin 10, the circuit switches states. This allows D13 and D14 to conduct, placing a logic high on the base of Q1. This, in turn, biases off Q1 and de-energizes K2.

4.9 Display Circuitry

4.9.1 IOC

U3A and U3B serve as a voltage comparator with R13, R15 and R17 as the resistor dropping network. Pin 7 has a window level of +7V and pin 4 has a window of -7V. U3A and U3B have a logic high which turns off Q1 and the IOC LED E1. When the error signal from the error amp appears, the 7V window is overcome and switches the state of U3A and U3B. Q1 is then biased on and the IOC LED, E1, illuminates. The capacitor C27 makes sure the LED is lit long enough for the human eye to see it.

4.9.2 ODEP

U1D on the display module is the current source for the ODEP LED E15. Under normal operating conditions pin 14 of U1D is a negative voltage. This allows D7 to conduct and E15 to illuminate. As the ODEP signal drops to the point where ODEP limiting takes place, Pin 14 becomes less negative and the LED begins to fade.

U5C is a comparator and switches its output high when the channel is in standby. This keeps D7 from conducting and the LED from illuminating when the channel is in standby.

4.9.3 Signal Indication

Incorporated on the display module are three modes of signal indication.

SPI (Signal Presence Indication)

U1A and D3 serve to rectify the amplifier output signal. U1B takes this rectified signal and drives the LED, E3, which illuminates any time there is signal present at the output of the amplifier channel.

Dynamic Range

With the switch S1 in the Dynamic position, this rectified audio signal is placed on the inverting inputs of a sequence of window comparators. This signal is rectified but unfiltered, therefore it contains the peak value of the audio waveform. U3C, U3D, U5A, U5B and U5D serve as the current sources for the five Dynamic Range LEDs. R29, R31, R33, R35, R37 and R39 provide a resistor dropping network for the inverting inputs to the LED drivers.

This same rectified signal is placed on the non-inverting inputs via the filtering function of C3 and the op-amp, U1C. This filtered signal is of an RMS value. With the non-inverting inputs receiving the RMS value, and the inverting inputs receiving the peak value, the output of each LED comparator equals the dynamic range of the signal.

Output Level

With the switch, S1, in the Level position, the peak signal is still placed on the inverting inputs of the comparator drivers. A small DC level is placed on all of the non-inverting inputs. This DC level serves as a calibrated reference for comparators. R78 calibrates the display balance between the two channels of the amplifier.

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5 Electrical Checkout and Adjustment Procedures

5.1 General Information

The following test procedures are to be used to verify operation of this amplifier. DO NOT connect a load or inject a signal unless directed to do so by the procedure. These tests, though meant for verification and alignment of the amplifier, may also be very helpful in troubleshooting. For best results, tests should be performed in order.

All tests assume that AC power is from a regulated 120 VAC source. Test equipment includes an oscilloscope, a DMM, a signal generator, loads, and I.M.D. and T.H.D. noise test equipment.

5.2 Standard Initial Conditions

Level controls fully clockwise.
Stereo/Mono switch in Stereo.
Sensitivity switch in 26 dB fixed gain position.
It is assumed, in each step, that the conditions of the amplifier are per these initial conditions unless otherwise specified.

5.3 DC Offset

Spec: 0 VDC, ±2 mV.
Initial Conditions: Controls per standard, inputs shorted.
Procedure: Measure DC voltage at the output connectors (rear panel). There is no adjustment for output offset. If spec is not met, there is an electrical malfunction. Slightly out of spec measurement is usually due to U104/U204 out of tolorance.

5.4 Output Bias Adjustment

Spec: 300 to 320 mVDC.
Initial Conditions: Controls per standard, heatsink temperature less than 40°C.
Procedure: Measure DC voltages on the output module across R02, adjust R26 if necessary. Measure DC voltages on the output module across R21, adjust R23 if necessary. Repeat for second channel.

5.5 ODEP Voltage Adjustment

Spec: Bias Per Chart, ±0.1V DC.
Initial Conditions: Controls per standard, heatsink at room temperature 20 to 30°C (68 to 86°F). Note: This adjustment should normally be performed within 2 minutes of turn on from ambient (cold) conditions. If possible, measure heatsink temperature; if not, measure ambient room temperature. Use this information when referencing the following chart.

°F	°C	V_{-ODEP}	V_{+ODEP}
66	18.9	–10.31	10.31
68	20.0	–10.26	10.26
70	21.1	–10.20	10.20
72	22.2	–10.14	10.14
74	23.3	–10.09	10.09
76	24.4	–10.03	10.03
77	25.0	–10.00	10.00
78	25.6	-9.97	9.97
80	26.7	-9.91	9.91
82	27.8	-9.86	9.86
84	28.9	-9.80	9.80
86	30.0	-9.74	9.74
88	31.1	-9.69	9.69
90	32.2	-9.63	9.63
92	33.3	-9.57	9.57
94	34.4	-9.51	9.51

–ODEP Procedure: Measure pin 3 of J500 and, if necessary, adjust R121 to obtain V_{-ODEP} as specified above. Measure pin 3 of J700 and, if necessary, adjust R221 to obtain V_{-ODEP} as specified above.
+ODEP Procedure: Measure pin 4 of J500 and, if necessary, adjust R132 to obtain V_{+ODEP} as specified above. Measure pin 4 of J700 and, if necessary, adjust R232 to obtain V_{+ODEP} as specified above.

5.6 AC Power Draw

Spec: 70 Watts maximum quiescent.
Initial Conditions: Controls per standard.
Procedure: With no input signal and no load, measure AC line wattage draw. If current draw is excessive, check for high AC line voltage or high bias voltage.

5.7 High Line Cutout

Spec: Unit goes into standby when the AC line voltage goes 10% to 12% above nominal.
Initial Conditions: Controls per standard.
Procedure: No load, no signal. Bring up AC line voltage with a variac 10% to 12% high. For 120VAC units this is 132VAC to 134.4VAC. Unit should go into standby. Adjust R4 on the control module if necessary.

5.8 Common Mode Rejection

Spec: >70 dB at 1 kHz.
Initial Conditions: Controls per standard.
Procedure: No load. Inject a 0 dBu (.775VRMS), 1 kHz sine wave into each channel, one channel at a time, with inverting and non-inverting inputs shorted together. Adjust R512 (Ch1) and R612 (Ch2) for less than 4.9mVRMS (-44 dBu) at the amplifier output.

5 Electrical Checkout and Adjustment Procedures

5.9 Voltage Gain

Spec 26dB Gain: Gain of 20.0 ±3%.
Spec 0.775V Sensitivity: REF I —Gain of 100.65 ±3%.
REF II —Gain of 68.28 ±3%.
Spec 1.4V Sensitivity: REF I —Gain of 55.71 ±3%.
REF II —Gain of 37.80 ±3%.
Initial Conditions: Controls per standard.
26 dB Procedure: Inject a 0.775 VAC 1 kHz sine wave with the Sensitivity Switch in the 26 dB position. Measure 15.5 VAC ±0.5 VAC at the amplifier output.
0.775V Procedure: Inject a 0.775 VAC 1 kHz sine wave with the Sensitivity Switch in the 0.775V position. REF I measure 78 VAC, ±2.3 VAC, at the amplifier output. REF II measure 52.9 VAC, ±1.6 VAC, at the amplifier output.
1.4V Procedure: Inject a 1.4 VAC 1 kHz sine wave with the Sensitivity Switch in the 1.4V position. REF I measure 78 VAC, ±2.3 VAC, at the amplifier output. REF II measure 52.9 VAC, ±1.6 VAC, at the amplifier output.

5.10 Level Controls

Spec: Level controlled by level controls.
Initial Conditions: Controls per standard.
Procedure: No Load. Inject a 1 kHz sine wave. With level controls fully clockwise you should see full gain. As controls are rotated counterclockwise, observe similar gain reduction in each channel. When complete, return level controls to fully clockwise position.

5.11 Current Limit

Spec: REF I —Current limit at 43 amps, ±3 amps.
REF II —Current limit at 30 amps, ±3 amps.
Initial Conditions: Controls per standard.
Procedure: Load each channel to 1 Ohm. Inject a 1 kHz differentiated (or 10% duty cycle) square wave. See Figure 5.1. Increase output level until current limiting occurs. Refer to Figure 5.2 for wave form.
REF I will limit (clip) at 43 volt peak, ±3 volts.
REF II will limit (clip) at 30 volt peak, ±3 volts.

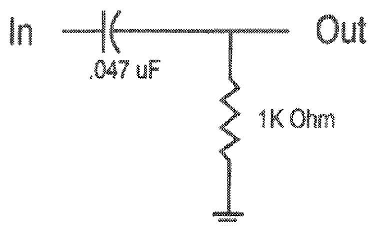

Figure 5.1 Differentiator Circuit

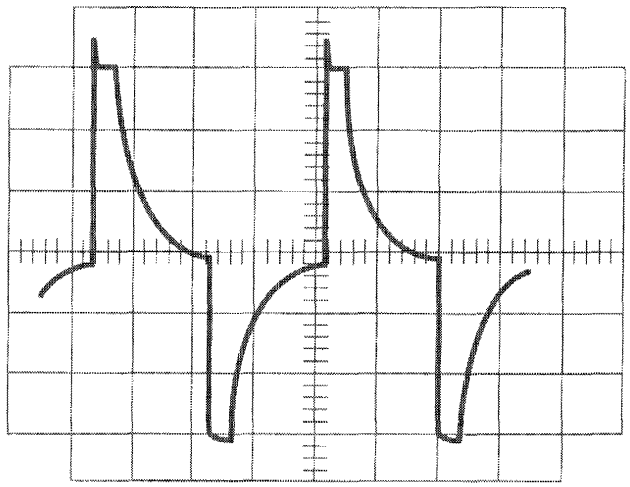

Figure 5.2 Differentiated Square Wave

5.12 Slew Rate & 10 kHz Square Wave

Spec: REF I —23 ±3 V/µS.
REF II —19 ±3 V/µS.
Initial Conditions: Controls per standard.
Procedure: Load each channel to 8 ohms. Inject a 10 kHz square wave at a level of 2 to 5 volts below clip. Observe the slope of the waveform and calculate the slew rate. Any ringing must die out in less than 1/4 of the period, and its amplitude must be less then 2% of the waveform amplitude. See Figure 5.3.

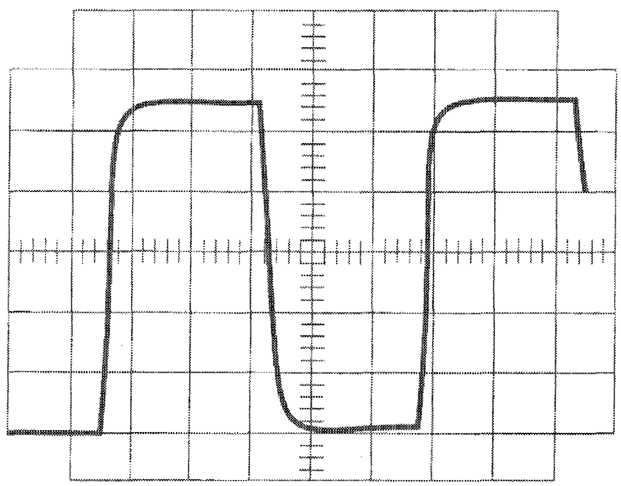

Figure 5.3 10 kHz Square Wave

5 Electrical Checkout and Adjustment Procedures

5.13 Crosstalk

Spec: -60dB at 20 kHz.
Initial Conditions: Controls per standard. Terminate input of channel not driven with 600 ohms.
Procedure: 8 ohm load on each channel. Inject a 20 kHz sine wave into the channel 1 input and increase output level to full power (REF I =78 VAC, REF II =52 VAC). For REF I measure less than 78 mVAC at the output of channel 2. For REF II measure less than 52 mVAC at the output of channel 2. Repeat by injecting the signal into channel 2 and measuring channel 1.

5.14 Output Power

For 120V 60Hz units:
Spec at 8 Ohm Stereo: REF I ≥ 780W at 0.02% THD.
REF II ≥ 355W at 0.02% THD.
Spec at 4 Ohm Stereo: REF I ≥ 1160W at 0.02% THD.
REF II ≥ 555W at 0.02% THD.
For International 50Hz units:
Spec at 8 Ohm Stereo: REF I ≥ 750W at 0.1% THD.
REF II ≥ 355W at 0.1% THD.
Spec at 4 Ohm Stereo: REF I ≥ 1095W at 0.1% THD.
REF II ≥ 535W at 0.1% THD.
Initial Conditions: Controls per standard.
Procedure: Load each channel to 8 ohms. Inject a 1 kHz sine wave and measure output power, at specified THD, with both channels driven.
Next, load each channel to 4 ohms. Inject a 1 kHz sine wave and measure output power, at specified THD, with both channels driven.

5.15 Reactive Loads

Spec: No oscillations. Safe with all types of loads.
Initial Conditions: Controls per standard.
Procedure Capacitive: Load each channel to 8 ohms in parallel with 2 µF. Inject a 20 kHz sine wave. REF I output level = 45 VAC, REF II output level = 30 VAC. Drive load for 10 seconds. No oscillations.
Procedure Inductive: Load each channel to 8 ohms in parallel with 159 µHenries. Inject a 1 kHz sine wave. REF I output level = 36 VAC. REF II output level = 28 VAC. See Figures 5.4 and 5.5 for typical waveform shapes. Test duration is 5 seconds.
Procedure Torture: Load each channel with the primary (red and black leads) of a PSU transformer (D 7040-5). Inject a 20 Hz sine wave into each channel. REF I output level = 40 VAC. REF II output level = 37.5 VAC. Observe 3 to 7 flyback pulses in both polarities. Test duration is 10 seconds. See Figure 5.6 for typical waveform shape.

Procedure Short: Inject a 60 Hz sine wave. REF I output level = 40 VAC. REF II output level = 28 VAC. After establishing signal, short the output for 10 seconds.

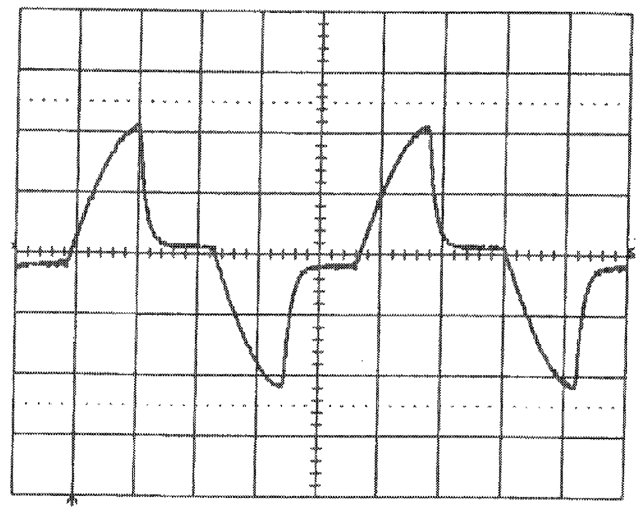

Figure 5.4 Inductive Load Cold

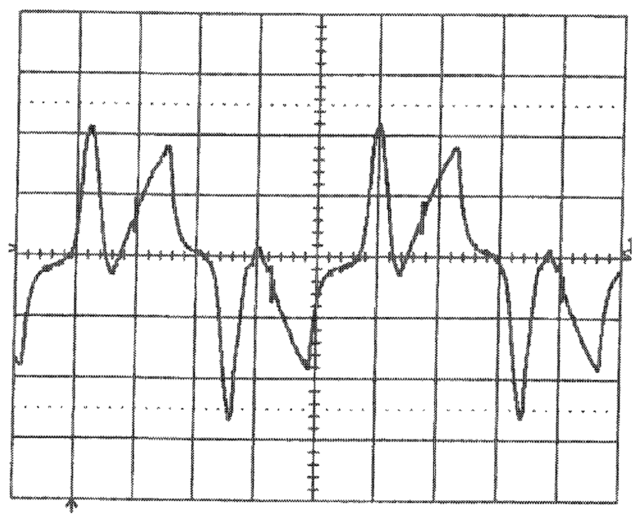

Figure 5.5 Inductive Load Warm

5 Electrical Checkout and Adjustment Procedures

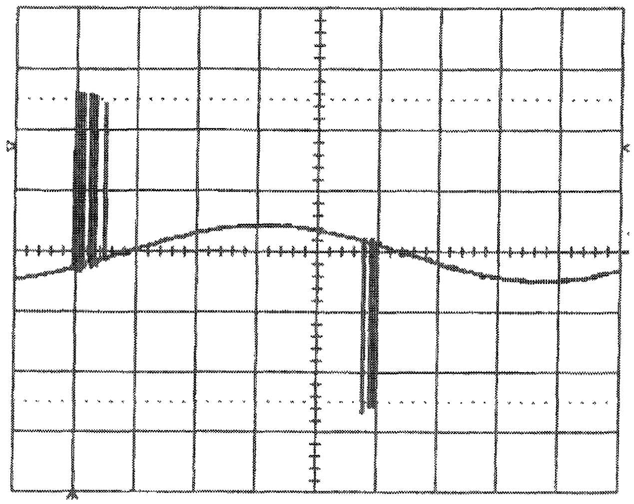

Figure 5.6 Torture Test Waveform

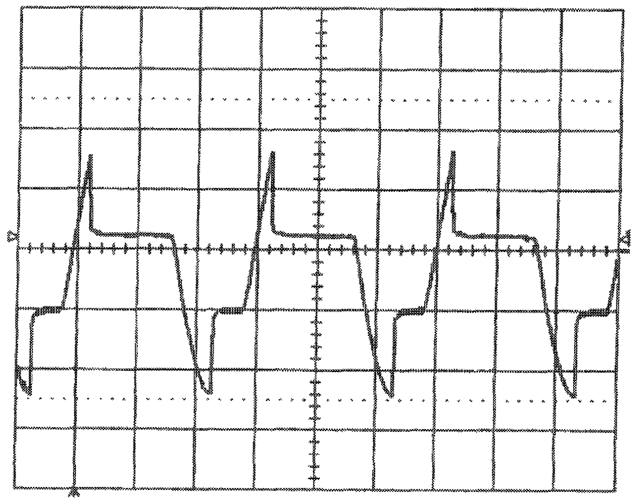

Figure 5.7 ODEP Limiting Waveform

5.16 ODEP Limiting

Spec: No oscillation on ODEP Limiting wave form. ODEP LED dims and is out as the amplifier starts ODEP limiting. Either channel controls limiting in Parallel Mono Mode.

Initial Conditions: Controls per standard; rag or other obstruction blocking fan so that it does not turn.

Procedure: Load the amplifier to 4 ohms on each channel. Inject a sine wave with the same frequency as the AC power line. REF I output level = 40 VAC. REF II output level = 28 VAC. After a few minutes observe a wave form similar to Figure 5.7. Remove the input signal from both channels and allow the amplifier to cool for a few minutes. Switch the amplifier to Parallel Mono and remove the load from channel 1. Inject the signal into channel 1 and observe that ODEP limiting occurs at the output of both channels. Remove the load from channel 2, and install the load on channel 1. Again, observe that both channels limit. Return all amplifier controls to standard initial conditions. Remove the fan obstruction.

5.17 Mute and Turn On Delay

Spec: Clamps signal; 3 to 5 second turn on delay.

Initial Conditions: Controls per standard.

Procedure: No load. Inject a 1 kHz sine wave into both channels. Observe the output signal with an oscilloscope. Turn the amplifier off with the front panel switch. The amplifier should clamp the signal, not allow it to decay with the power supplies. Turn the amplifier back on and observe the 3 to 5 second delay before it comes back out of standby. Note that both channels may not come out of standby at the exact same time.

5.18 Low Frequency Protection

Spec: Amplifier mutes for low frequency.

Initial Conditions: Controls per standard.

Procedure: No load. Inject a 0.5 Hz 12 volt peak-to-peak square wave, or a 1 Hz 17 V peak-to-peak sine wave into each channel, one channel at a time, and verify that the channel driven cycles into standby. Once in standby, it will try to cycle out of standby every 3 to 5 seconds.

5 Electrical Checkout and Adjustment Procedures

5.19 Signal to Noise Ratio

Spec: REF I 120 dB, A weighted.
REF II 117 dB, A weighted.
Initial Conditions: Controls per standard. Short inputs.
Procedure: Load each channel to 8 ohms. For REF I measure less than 78µV at the output of each channel. For REF II measure less than 74µV at the output of each channel.

5.20 Intermodulation Distortion

Spec at 0 dB Output (Full Power): 0.005%.
Spec at –35 dB Output: 0.02%.
Initial Conditions: Controls per standard.
Procedure: Load each channel to 8 ohms. Inject a SMPTE standard IM signal (60 Hz and 7 kHz sine wave mixed at 4:1 ratio). For REF I set the 60 Hz portion of the sine wave for 62 volts RMS output. For REF II set the 60 Hz portion of the sine wave for 41 volts RMS output. Set the 7 kHz portion to 25%. With an IM analyzer measure less than 0.005% IMD. Repeat test at –35 dB and measure less than 0.02% IMD.

5.21 LED Functions

Enable LED: On when power is applied and front panel switch is engaged.
Signal LED: On with signal at output of amplifier.
IOC LED: On when THD reaches approximately 0.05%.
ODEP LED: Dims and goes out as the amplifier starts to ODEP limit.

5.22 Display Set-Up

Spec: Ladder displays balance each other; Indicators illuminate at output voltages per chart below.
Initial Conditions: Controls per standard. Meter Mode Switch in the Output Level position.
Procedure: With the display set to read output level inject a 1 kHz sine wave into both channels of the amplifier. Adjust the level so that the –10 dB LEDs pulse on and off. Adjust R78 on the display board until the Ch 1 and Ch 2 –10 dB LEDs pulse at the same frequency. Note: The complete front panel needs to be disassembled in order to access the display board.
Next, verify that each indicator illuminates per the chart below.

Level Indicator	Output Voltage
–20 dB	6.95 - 8.75 VAC
–15 dB	12.36 - 15.56 VAC
–10 dB	21.90 - 27.67 VAC
–5 dB	39.09 - 49.21 VAC
0 dB	69.51 - 87.51 VAC

5.23 Turn On Transients

Spec: No dangerous transients.
Initial Conditions: Controls per standard.
Procedure: From an off condition, turn on the amplifier and monitor the output noise at the time of turn on. Note: Turn on noise may increase significantly if the amplifier is cycled off and on.

5.24 Turn Off Transients

Spec: No dangerous transients.
Initial Conditions: Controls per standard.
Procedure: From an on condition, turn off the amplifier and monitor the output noise at the time of turn off. Note: Turn off noise may increase significantly if the amplifier is cycled off and on.

5.25 Post Testing

After completion of testing, if all tests are satisfactory, the amplifier controls should be returned to the positions required by customer. If conditions are unknown or unspecified, factory settings are as follows:
Level Controls: 9 to 11 O'Clock.
Sensitivity Switch: 0.775V U.S., 1.4V International.
Stereo/Mono Switch: Stereo.
Meter Switch: On.
Meter Mode Switch: Dynamic.
Ground Lift: Lift.
Power: Off.

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6 Schematics

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7 Parts Information

7.1 General Information

This chapter contains illustrations and parts lists for the Studio Reference amplifiers. The parts lists in this chapter are for all mechanical parts and parts not included on a module (circuit board). Chapter 8 contains artwork and parts lists for all modules.

7.2 Standard and Special Parts

Many smaller electrical and electronic parts used in the Studio Reference amplifiers are stocked by, and available from, electronic supply houses. However, some electronic parts that appear to be standard are actually special. A part ordered from Crown will assure an acceptable replacement. Structural items such as covers and panels are available only from Crown.

7.3 Ordering Parts

When ordering parts, be sure to give the amplifier model and serial number and include a description and Crown Part Number (CPN) from the parts listing. Price quotes are available on request.

7.4 Shipment

Shipment will be normally made by UPS or best other method unless you specify otherwise. Shipments are made to and from Elkhart, IN, only. Established accounts with Crown will receive shipment freight prepaid and will be billed. All others will receive shipment on a C.O.D. or pre-payment (check or credit card) basis.

7.5 Terms

Normal terms are pre-paid. Net-30 days applies to only those firms having pre-established accounts with Crown. If pre-paying, the order must be packed and weighed before a total bill can be established, after which an amount due will be issued and shipment made upon receipt of pre-payment. New parts returned for credit are subject to a 10% re-stocking fee, authorization from the Crown Parts Department must be obtained before returning parts for credit.

The Crown Parts Department is not a general parts warehouse. Parts sold by Crown are solely for servicing Crown products.

Part prices and availability are subject to change without notice.

7.6 Illustrated Parts Lists

Contained within this section are the illustrated parts lists for the Studio Reference I and II amplifiers. The electrical and electronic parts in the assembly drawings are referred to by Crown Part Number (CPN), and quantities used are indicated. Those parts are also shown in the circuit schematics (chapter 6), and are identified there by circuit designation.

Crown
Parts Department

Mailing Address:
PO Box 1000
Elkhart, IN USA 46515-1000

Shipping Address:
Plant 2 S.W.
1718 W. Mishawaka Rd.
Elkhart, IN USA 46517

Phone: (219) 294-8200
Toll Free: (800) 342-6939
FAX: (219) 294-8124

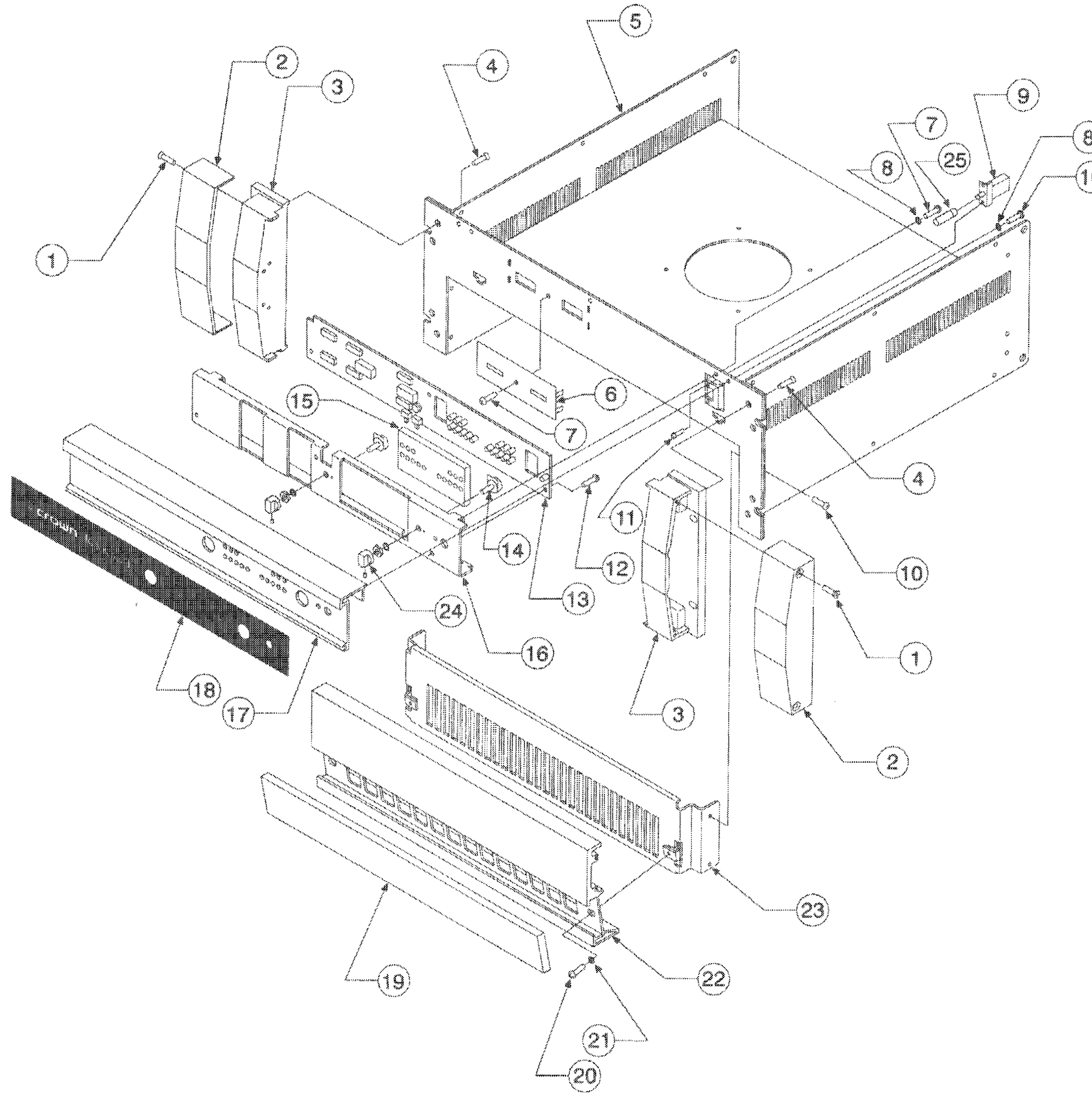

Figure 7.1 Front Panel Parts

Front Panel Parts

See Figure 7.1

Item #	Description	Part # (CPN)	Qty.	Notes
1	Screw, 8-32 x .75 FLTHD	A10091-70812	4	End Cap
2	End Cap	101101-1	2	
3	Handle	101102-1	2	
4	Screw, 8-32 x 0.5 FLTHD	A10091-70808	4	Handles
5	Main Chassis	F12875-5	1	
6	Holder, Cable Fishpaper	F11564-6	1	
7	Screw, 6-32 x .312 PNHD T15	C9491-9	3	Display Brkt
8	#8 Star Washer	A10094-5	2	
9	DPDT On/Off Push Button Switch	C10181-3	1	
10	Screw, 6-32 x 3/8 PNHD Tri	C104510	24	Covers, etc.
11	Screw, 4-40 x .375	C5961-5	2	On/Off Switch
12	Screw, 6-32 x .3125	A10086-10605	3	Display
13	Display Module, REF I	Q43018-3	1	
	Display Module, REF II	Q43312-0	1	
14	Pot, 5K ohm Linear 31 Det.	C8401-9	2	
15	Isolator, LED Foam	F11787-3	1	
16	Display Bracket	M21435-9	1	
17	Front Panel, Top Extrusion	101100-1	1	
18	Overlay, REF I	D 8669-0	1	
	Overlay, REF II	D 8647-6	1	
19	Air Filter	D 8763-1	1	
20	Screw, 8-32 x .37 RDHD	A10086-70806	2	Btm Extrusion
21	#8 Star Washer	A10094-5	2	
22	Front Panel, Bottom Extrusion	101099-1	1	
23	Finger Guard	F12876-3	1	Sub Front
24	Knob	D 8466J0	2	Level
	Set Screw, 6-32 x .18	C 6005-0	2	Level Knobs
Not Shown	Screw, 8-32 x .5 PNHD Taptite	A10110-70808	8	Handles
25	Push Button	D 8221J9	1	On/Off

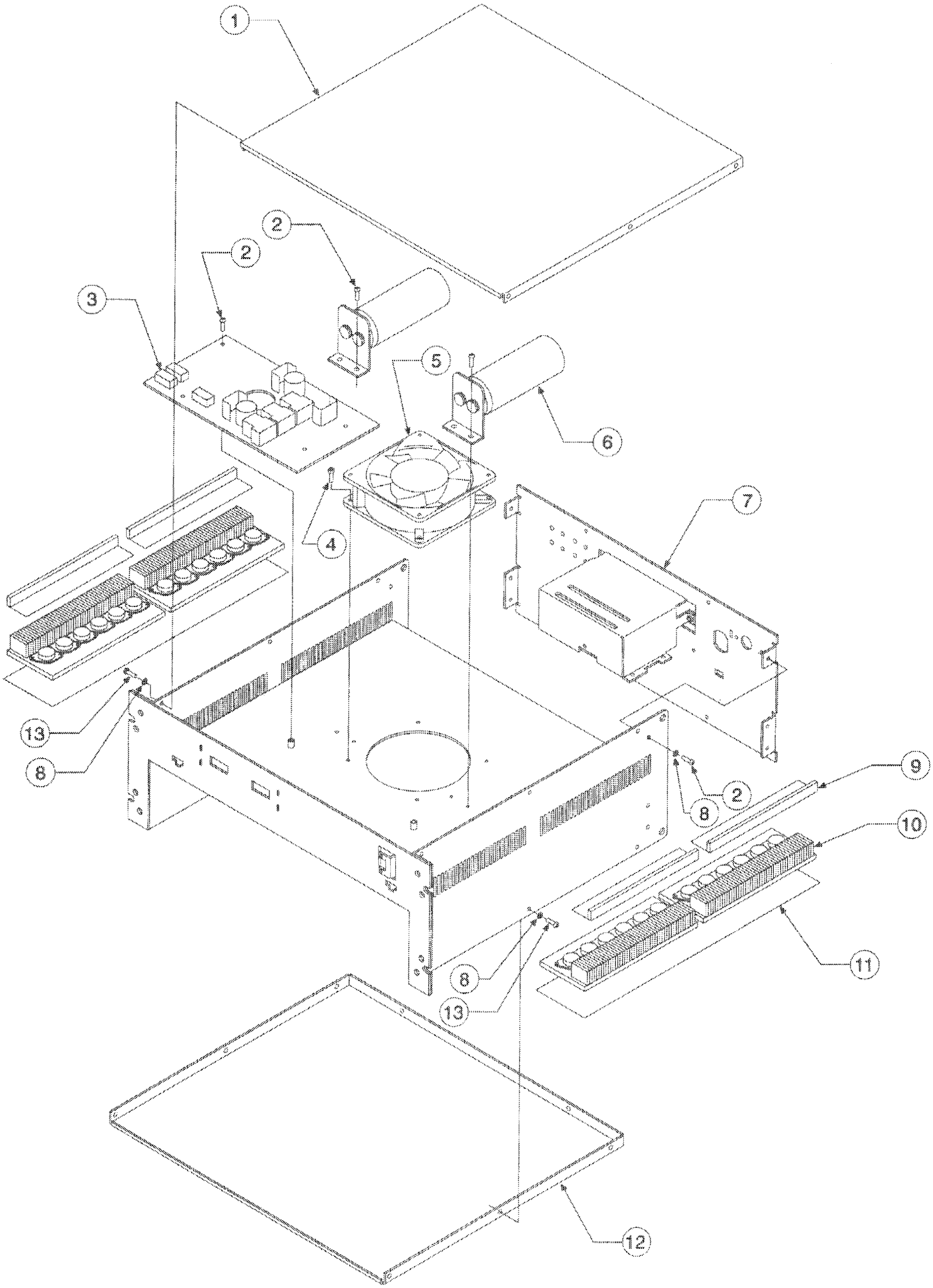

Figure 7.2 Top Main Assembly Parts

Top Main Assembly

See Figure 7.2

Item #	Description	Part # (CPN)	Qty.	Notes
1,12	Cover	F12873-0	2	Top/Bottom
2	Screw, 6-32 x .312	C 9491-9	26	
3	Control Module, REF I	Q43450-8	1	
	Control Module, REF II	Q43183A3	1	
4	Screw, 6-32 x .625 Skt Cap	A10092-10610	4	Mounts Fan
5	Fan	C 7858-1	1	
6	Capacitor Assembly	—	2	See Page 7-13
7	Back Panel Assembly	—	1	See Page 7-9
8	Washer, #6 Int. Star, Black	A10094-3	10	
9	Top Shield Fin Guard	F11697-4	4	
10	Output Assembly	—	2	See Page 7-11
11	Silpad	—	2	See Page 7-11
13	Screw, 6-32 x 3/8 PNHD Tri	C10451-0	24	Covers, etc.

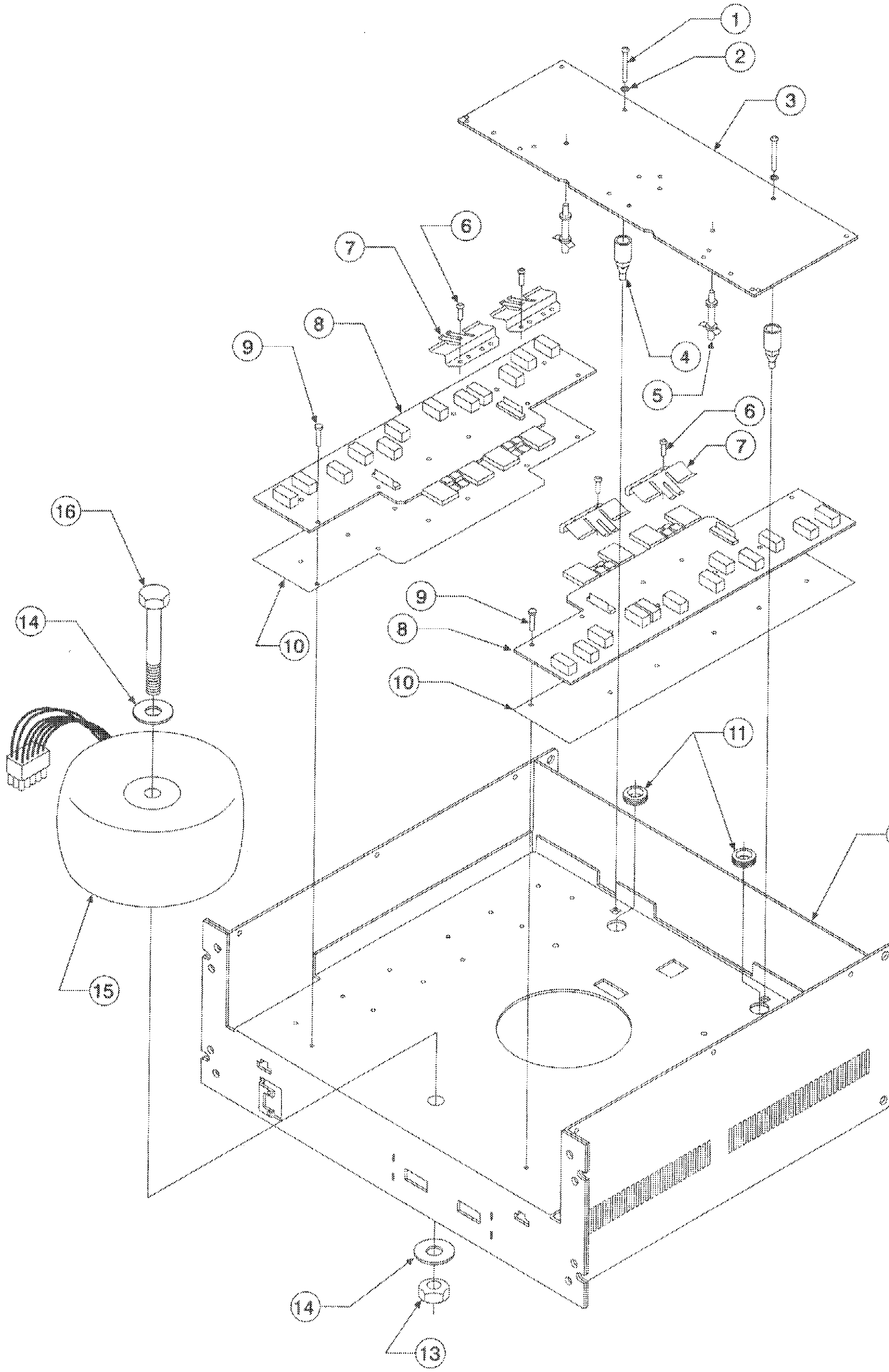

Figure 7.3 Bottom Main Assembly Parts

Bottom Main Assembly

See Figure 7.3

Item #	Description	Part # (CPN)	Qty.	Notes
1	Screw, 8-18 x 1.375 PNHD	A10109-10822	2	Main Board
2	Nylon Washer	D4137-2	2	
3	Main Module	—	1	See Sec. 8
4	Spacer, .875 Toggle Nut Plastic	C 6873-1	2	
5	Board Support, 7/8 Lock	C 7862-3	2	
6	Screw, 6-32 x .312 Pan Hd. T15	C 9491-9	12	
7	Clamp, TO-220/TO-3P	D8300-2	4	
8	Output Assembly	—	2	See Page 7-11
9	Screw, 6-32 x .56 Washer Head T15	A10315-1	24	
10	Output Pad	D7839-0	2	
11	1 x .625 Rubber Grommet	A10224-6	2	
12	Back Panel Assembly	—	1	See Page 7-9
13	Nut, 1/2-20	A10102-19	1	
14	Washer, 1/2 Steel	A10100-25	2	
15	Power Transformer, REF I	102097-1	1	
	Power Transformer, REF II	102098-1	1	
16	Screw, 1/2-20 x 4 Hex Cap	A10161-4	1	

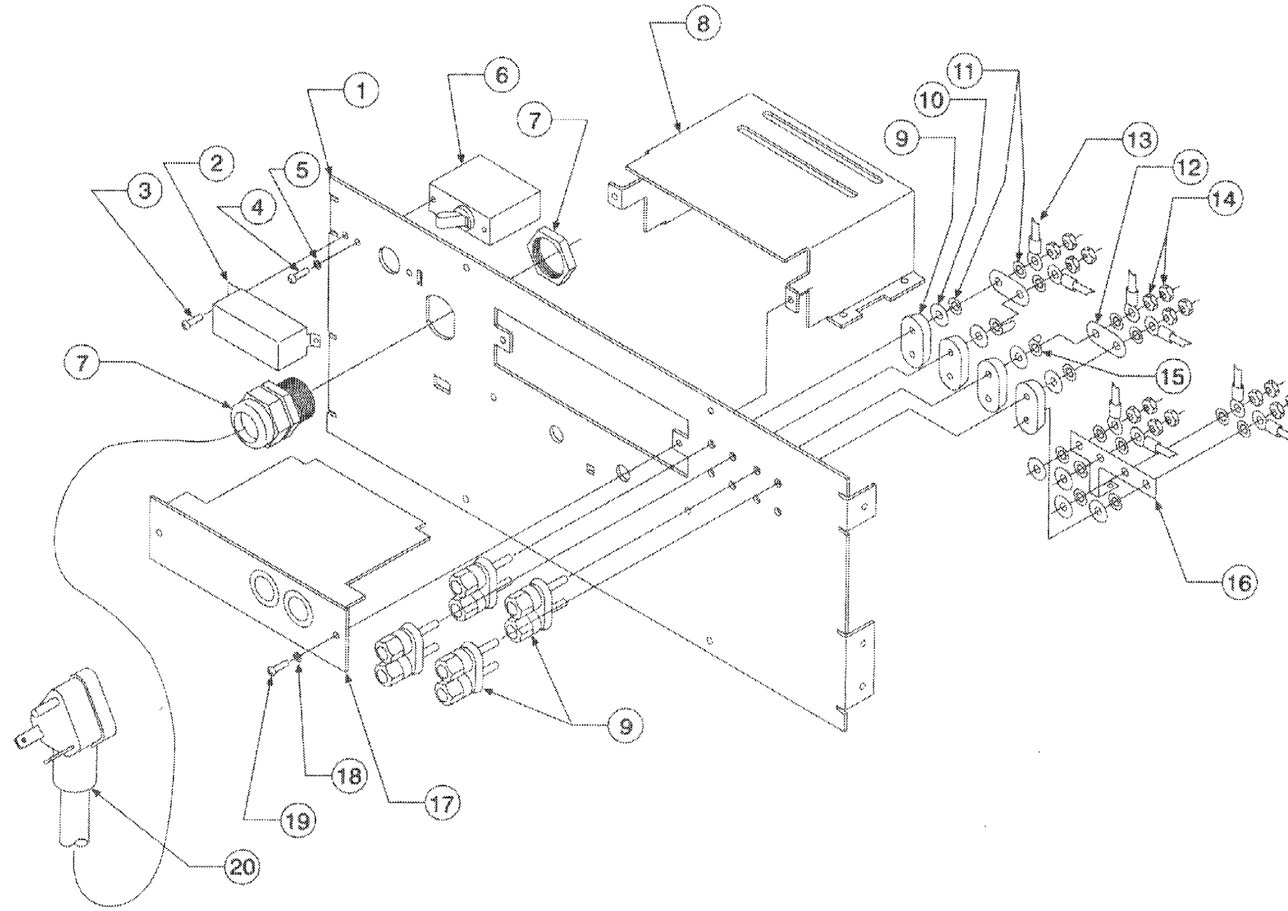

Figure 7.4 Back Panel Assembly Parts

Back Panel Assembly

See Figure 7.4

Item #	Description	Part # (CPN)	Qty.	Notes
1	Back Panel Plate	F12874-8	1	
2	Shield, Circuit Breaker	F11624J7	1	
3	Screw, 6-32 x 3/8 PNHD	C10451-0	1	Breaker Cover
4	Screw, 6-32 x .25	A10086-70604	2	
5	Washer, #6 Int. Star	A10094-3	2	
6	REF I Circuit Breaker, 30A	C 7756-7	1	
	REF II Circuit Breaker, 20A	C10193-8	1	
7	Strain Relief	F11160-3	1	
8	Pip Cage Assembly	—		See Pg. 7-14
9,10,11,14	Dual Binding Post, Gold Pltd	C 8013-2	4	
12	Jumper, 2 Position	F12812-8	2	
13	Wire, #12 BLK 22 in.	D 8846-4	2	W/Ring Term
	Wire, #12 BLK 15 in.	D 8847-2	2	W/Ring Term
	Wire, #12 RED 20 in.	D 8848-0	2	W/Ring Term
	Wire, #12 RED 13 in.	D 8849-8	2	W/Ring Term
15	Solder Lug, #8 Hole	D 2935-1	2	
16	Jumper, Four Output Ground	D 8855-5	1	
17	PIP-FX Input Connector	M44018-6	1	Standard PIP
18	Washer, #8 Star	A10094-5	2	PIP Module
19	Screw, 8-32 x .37 RDHD	A10086-70806	2	PIP Module
20	REF I Power Cord, 10-3 TT30P	A11793-0507F	1	
	REF II Power Cord, 12-3 W/15A	D 7538-8	1	

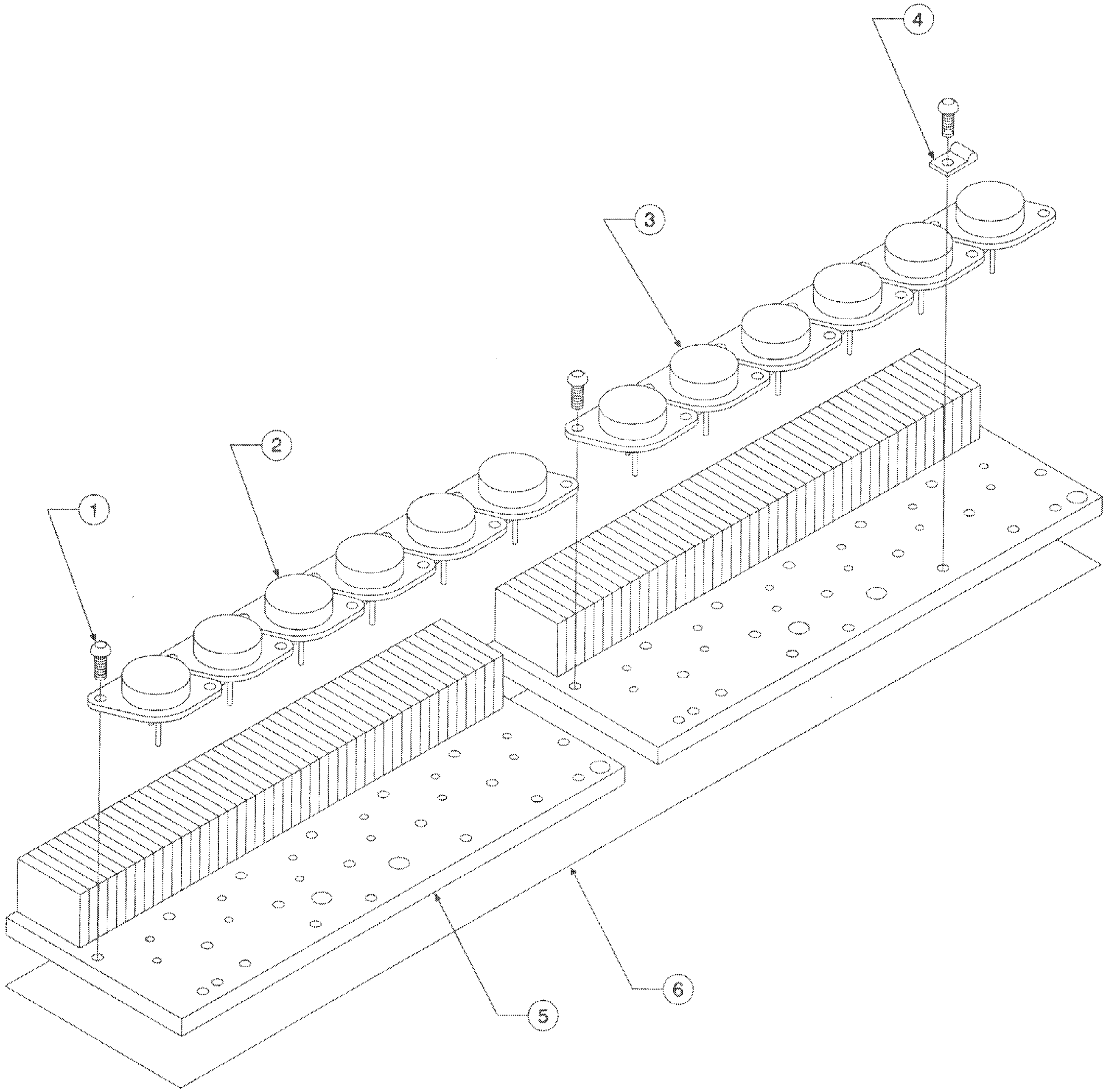

Figure 7.5 Output Assembly Parts

Output Assembly

See Figure 7.5

Item #	Description	Part # (CPN)	Qty.	Notes
1	Screw, 6-32 x .312 T15	C 9491-9	29	
2	NPN Power Transistor, REF I	C 8187-4	6	
	NPN Power Transistor, REF II	C 4751-1	6	
3	PNP Power Transistor, REF I	C 8188-2	6	
	PNP Power Transistor, REF II	C 6492-0	6	
4	PTC, 95 Deg C	D 8774-8	1	
5	Heatsink with Fins, REF I	M21322J8	2	
	Heatsink with Fins, REF II	M21324-5	2	
6	Sil Pad, 2.87 x 14.57 7 Mil	D 7796-2	1	

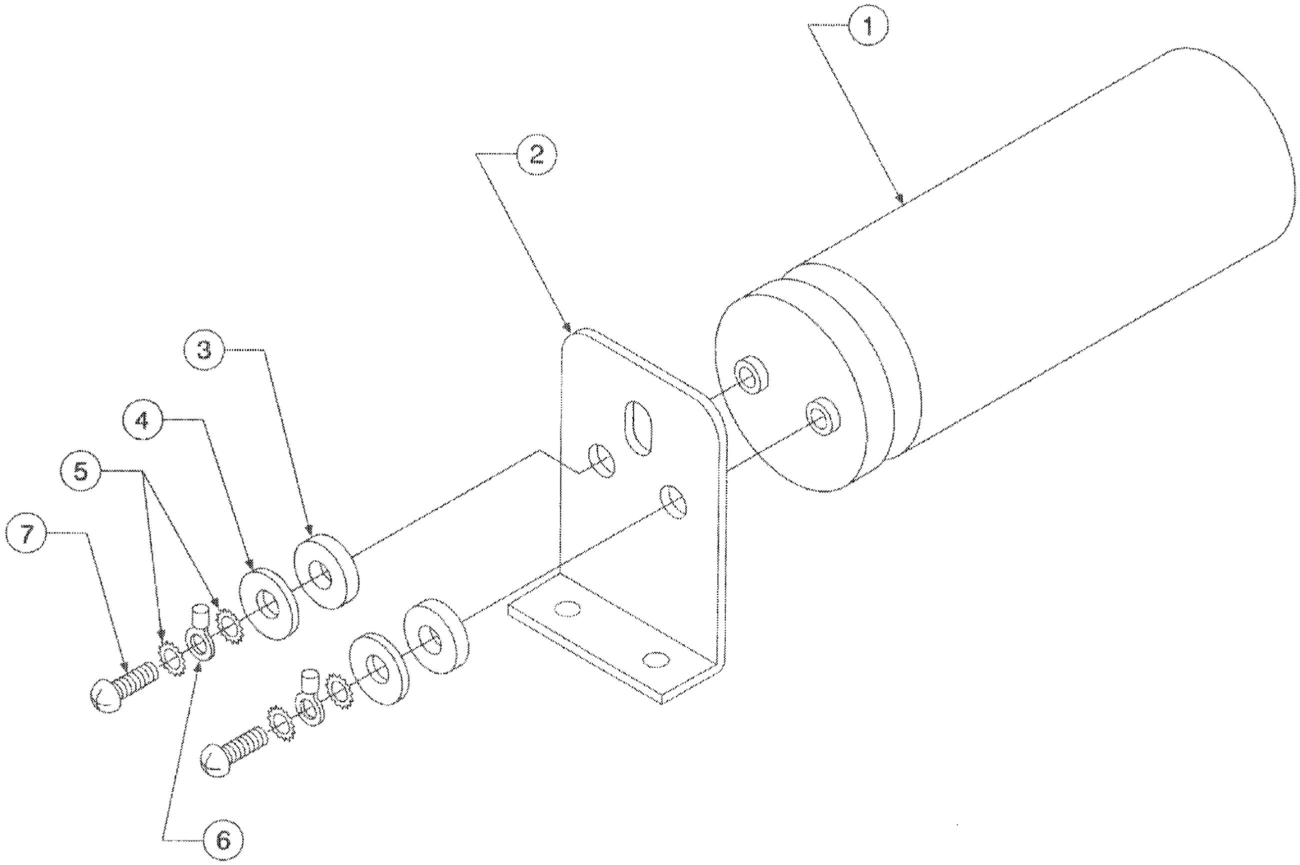

Figure 7.6 Capacitor Assembly Parts

Capacitor Assembly

See Figure 7.6

Item #	Description	Part # (CPN)	Qty.	Notes
1	Capacitor, 6300µF 150V (REF I)	D 8639-3	1	
	Capacitor, 10000µF 100V (REF II)	C 6485-4	1	
2	Bracket	F12474-7	2	
3	Shoulder Washer	D 6764-1	2	
4	Washer, 1/4" Belleville Spring	A10098-5	2	
5	Lock Washer, #10 Int. Tooth	A10094-8	4	
6	Wire, #16 Blue (Ch 1)	H43480-5	1	Ch 1 Only
	Wire, #16 Blue (Ch 2)	H43483-9	1	Ch 2 Only
	Wire, #16 Red (Ch 1)	H43481-3	1	Ch 1 Only
	Wire, #16 Red (Ch 2)	H43482-1	1	Ch 2 Only
7	Screw, 10-32 x .5	A10086-11008	2	

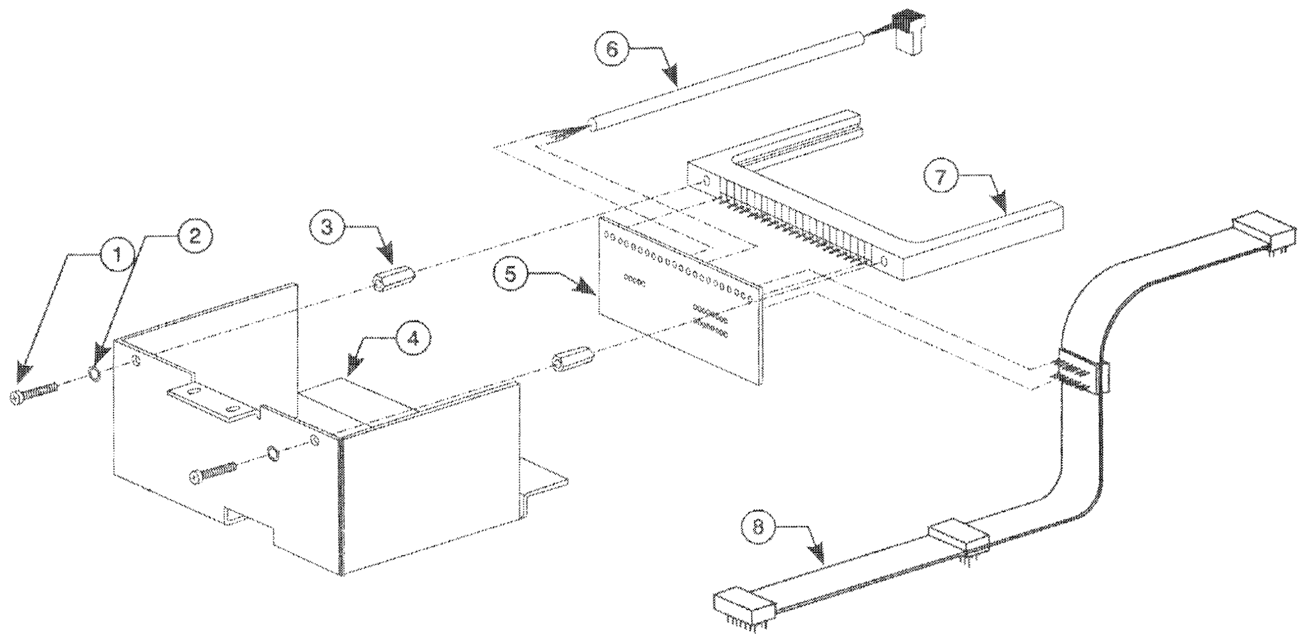

Figure 7.7 PIP Cage Assembly Parts

PIP Cage Assembly

See Figure 7.7

Item #	Description	Part # (CPN)	Qty.	Notes
1	Screw, 4-40 x .62 RDHD	A10086-10410	2	
2	#4 Star Lockwasher	A10094-2	2	
3	Aluminum Spacer	A10100-7	2	
4	PIP Shield	M21271J7	1	
5	PWB, PIP Interconnect	101240-1	1	
6	10" PIP Cable	D7623-8	1	
7	22 Contact Edge Connector	C6821-0	1	
8	PIP Daisy Ribbon Connector	D6899-5	1	

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8 Module Information

8.1 General Information

Since the introduction of the Studio Reference amplifiers, there has been several updates and revisions. Some of these updates required new modules. This list of modules is complete up to this date, August 1996.

Following the module information is the parts list for each module. Included in the parts list is a map location. Refer to the component map at the end of each parts list for location of each component.

An important part of the parts list is the Circuit Designation. Below is a code to help determine what type of part each designation is:

C = Capacitor
D = Diode
E = LED
HW = Hardware
J = Socket or Connector
K = Relay
L = Inductor
N = Resistor Network
P = Terminal
Q = Transistor
R = Resistor
S = Switch
TP = Test Point
U = Integrated Circuit
X = Misc.
Z = Jumper

If, in the circuit designation, there are two numbers the first is for channel 1 of the amplifier and the second is for channel 2. The parts will be identical and there will be two map locations. The first for channel 1 and the second for channel 2.

C.P.N. stands for Crown Part Number. When ordering a specific part refer to this number. You may reach the Crown parts department at (219) 294-8200 or 1-800-342-6939.

8.2 Studio Reference I Module Information

Main Module:
Q43371-6 main module built on PC board D 8825-8 or D 8920-7. For schematic see J 0674-2. For parts list see page 8-2.

Output Module:
Q43369-0 output module built on PC board P10423-5. For schematic see J 0674-2. For parts list see page 8-8.

Control Module:
Q43183A3 control module built on PC board D 8165A7. For schematic see J 0558A5. For parts list see page 8-11.
Q43450-8 control module built on PC board D 8853-0. For schematic see J 0696-5. For parts list see page 8-14.
Q43504-2 control module built on PC board D 9099-9. For schematic see J 0739-3. For parts list see page 8-17.

Display Module:
Q43018-3 display module built on PC board D 7940-6. For schematic see J 0510-8. For parts list see page 8-20.

8.3 Studio Reference II Module Information

Main Module:
Q43311-2 main module built on PC board D 8688-0. For schematic see J 0652-8. For parts list see page 8-23.
Q43388-0 main module built on PC board D 8825-8 or D 8920-7. For schematic see J 0652-8. For parts list see page 8-28.

Output Module:
Q43389-8 output module built on PC board P10423-5. For schematic see J 0652-8. For parts list see page 8-33.

Control Module:
Q43183A3 control module built on PC board D 8165A7. For schematic see J 0558A5. For parts list see page 8-11.
Q43450-8 control module built on PC board D 8853-0. For schematic see J 0696-5. For parts list see page 8-14.
Q43504-2 control module built on PC board D 9099-9. For schematic see J 0739-3. For parts list see page 8-17.

Display Module:
Q43312-0 display module built on PC board D 7940-6. For schematic see J 0510-8. For parts list see page 8-36.

8 Module Information

8.4 Q43371-6 Main Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 5362-6	2.2µF 50V	I4
C2	C 3913-8	470µF 35V	G4
C4	C 6802-0	.47µF 50V	I5
C7	C 6804-6	.1µF 35V	D2
C100/200	C 8576-8	100µF 35V	J2/F2
C101/201	C 8338-3	47pF 300V	J3/E2
C102/202	C 8576-8	100µF 35V	J5/F5
C103/203	C 6805-3	.022µF 100V	I3/F3
C104/204	C 6805-3	.022µF 100V	J3/G3
C105/205	C 6813-7	27pF 200V	M3/A3
C106/206	C 6813-7	27pF 200V	N3/C3
C107/207	C 7870-6	.33µF 63V	I5/G5
C108/208	C 6813-7	27pF 200V	N4/B4
C109/209	C 8576-8	100µF 35V	K5/E5
C110/210	C 5362-6	2.2µF 50V	J5/F5
C111/211	C 6807-9	.001µF 100V	J3/F3
C112/212	C 8581-8	.27µF 100V	N2/B2
C113/213	C 9465-3	10µF 50V	N2/B2
C114/214	C 8576-8	100µF 35V	N2/B2*
C115/215	C 8576-8	100µF 35V	N1/B1
C116/216	C 9465-3	10µF 50V	N1/B1
C117/217	C 8581-8	.27µF 100V	M1/B1
C118/218	C 6813-7	27pF 200V	N4/B4
C119/219	C 6802-0	.47µF 50V	J5/F5
C120/220	C 6804-6	.1µF 50V	O4/D4
C121/221	C 6804-6	.1µF 50V	L4/A4
C122/222	C10176-3	33pF 200V	O4/D5
C123/223	C 6808-7	470pF 100V	J3/F3
C124/224	C10176-3	33pF 200V	L5/A4
C129/229	C 6812-9	47pF 100V	J4/F3
C130/230	C 6814-5	12pF 200V	J5/F5
C131/231	C 6814-5	12pF 200V	J4/F5
C132/232	C 6806-1	.01µF 100V	L3/D3
C133/233	C 6813-7	27pF 200V	H2/G2
C134/234	C 6805-3	.022µF 100V	N2/A2
C135/235	C 6805-3	.022µF 100V	L3/D3
C136/236	C 6808-7	470pF 100V	O2/A2
C137/237	C 6808-7	470pF 100V	L2/D2
C138/238	C 6812-9	47pF 100V	I3/G3
C139/239	C 6812-9	47pF 100V	I3/G3
C140/240	C 6814-5	12pF 200V	N3/B3
C141/241	C 6814-5	12pF 200V	N3/B3
C143/243	C 6808-7	470pF 100V	N4/C4
C144/244	C 8576-8	100µF 35V	I2/G2
C145/245	C 6812-9	47pF 100V	J2/F2
C146/246	C 6812-9	47pF 100V	J3/F3
C147/247	--- Not Used ---		N3/C3
C148/248	C 6808-7	470pF 100V	M4/A4
C149/249	C 6807-9	.001µF 100V	N4/B4
C150/250	--- Not Used ---		O5/D5
C151/251	C 6806-1	.01µF 100V	L5/A5
C152/252	C 6811-1	100pF 200V	N4/C4
C153/253	C 6804-6	.1µF 50V	J2/F2
C154/254	C 8426-6	.1µF 250V	N5/B5
C155/255	C 6804-6	.1µF 50V	K2/E2
C156/256	C 6804-6	.1µF 50V	N1/A1
C157/257	C 6813-7	27pF 200V	J3/F3
C159/259	C 8551-1	.01µF 400V	I2/G2
C160/260	C 6811-1	100pF 200V	M4/A4
C161/261	C10176-3	33pF 200V	O4/C5
C162/262	C10176-3	33pF 200V	L5/A4

*For board D 8920-7 C114 map location is M2, and C214 is C2.

D1	C 2851-1	1N4004	H4
D2	C 2851-1	1N4004	H4
D3	C 2851-1	1N4004	I4
D4	C 2851-1	1N4004	H4
D5	C 2851-1	1N4004	H4
D6	C 2851-1	1N4004	G4
D7	C 2851-1	1N4004	G4
D100/200	C 3181-2	1N4148	J6/F6
D101/201	C 3181-2	1N4148	J6/F6
D108/208	C 3181-2	1N4148	J2/F3
D109/209	C 3181-2	1N4148	N4/C4
D110/210	C 3181-2	1N4148	M4/A4
D111/211	--- Not Used ---		M4/A4
D112/212	C 3181-2	1N4148	N3/B3
D113/213	C 3181-2	1N4148	N3/B3
D114/214	C 8158-5	1SS143	N3/C3
D115/215	C 8158-5	1SS143	M3/A3
D119/219	C 3181-2	1N4148	O4/D4
D120/220	C 3181-2	1N4148	L4/A4
D121/221	C 3824-7	1N9708	J4/E4
D122/222	C 3181-2	1N4148	J3/F3
D123/223	--- Not Used ---		N4/C4
D124/224	C 3181-2	1N4148	K3/E3
D125/225	C 3181-2	1N4148	K4/E4
D126/226	C 8158-5	1SS143	L4/A4
D127/227	C 8158-5	1SS143	O4/D4
D128/228	C 3181-2	1N4148	J5/F5
D129/229	C 5061-4	1N3070	L3/D3
D130/230	C 3181-2	1N4148	O4/D4
D131/231	C 3181-2	1N4148	N4/C4
D132/232	C 3181-2	1N4148	M4/A4
D133/233	C 3181-2	1N4148	L4/A4
D134/234	C 2851-1	1N4004	K4/E4
D135/235	C 2851-1	1N4004	K5/E4

8 Module Information

E100/200	C 9857-1	Red LED	J5/F5
E101/201	C 9857-1	Red LED	J6/F6
HW16	C 8812-7	5.5" Cable Tie	A5
HW17	C 8812-7	5.5" Cable Tie	B5
HW18	C 8812-7	5.5" Cable Tie	N5
HW19	C 8812-7	5.5" Cable Tie	O5
J2	C 4508-5	16 Pin IC Skt.	H4
J100/200	C 8432-4	3 Cond Ph Jk	I1/G1
J100X/200X	C 6778-2	Ph Jk Cover	I1/G1
J500	D 8395-2	7.75"12pin Cbl	O5
J600	D 8397-8	2.5" 12pin Cbl	N5
J700	D 8397-8	2.5" 12pin Cbl	B5
J800	D 8395-2	7.75"12pin Cbl	A5
N101/201	D 8248-3	7 pin Res Net	M2/C2
N102/202	D 6082-8	Res Net-C	J4/E4
N101A/201A	--- Not Used ---		M2/C2
N101B/201B	--- Not Used ---		M2/C2
N101C/201C	--- Not Used ---		M2/C2
N101D/201D	--- Not Used ---		M2/C2
N101E/201E	--- Not Used ---		M2/C2
N101F/201F	--- Not Used ---		M2/C2
P1	C 7593-4	5pos Header	H2
P6	C 8418-3	3pos Header	H2
P11	C 7593-4	5pos Header	H5
P12	--- Not Used ---		G4
P101/201	C 7592-6	4pos Header	J1/F1
Q100/200	D 2961-7	2961	N3/C3
Q101/201	C 8104-9	MPSW92	M3/B3
Q102/202	C 8103-1	MPSW42	N3/C3
Q103/203	C 3625-8	2N4125	M3/B3
Q104/204	C 8104-9	MPSW92	N4/C4
Q105/205	C 8104-9	MPSW92	N4/C4
Q106/206	C 3625-8	2N4125	O3/A3
Q107/207	C 3786-8	MPS4250A	M4/B4
Q108/208	C 5891-4	MTS105 Therm	N4/C4
Q109/209	D 2961-7	2961	K3/E3
Q110/210	C 8103-1	MPSW42	M4/B4
Q111/211	C 8103-1	MPSW42	M4/B4
Q112/212	C 3625-8	2N4125	J4/E4
Q113/213	C 3625-8	2N4125	J4/F4
Q114/214	C 7458-0	2N4123	K3/E3
Q115/215	D 2962-5	MPSA18	O5/D5
Q116/216	C 3786-8	MPS4250A	L5/A5
Q117/217	D 2961-7	2961	O3/A3
Q118/218	D 2961-7	2961	O3/A3
Q119/219	C 3625-8	2N4125	K3/E3
Q120/220	C 3625-8	2N4123	K3/E3
Q121/221	C 7458-0	2N4123	O4/D4
Q122/222	C 3625-8	2N4125	L3/A3
Q123/223	C 3625-8	2N4125	K4/E4
Q124/224	C 3786-8	MPS4250A	M5/B5
Q125/225	C 5891-4	MTS105 Therm	N5/C5
Q126/226	C 3625-8	2N4125	K6/E6
Q127/227	C 7458-0	2N4123	K6/E6
Q128/228	C 3625-8	2N4125	K5/E5
Q129/229	C 7458-0	2N4123	K5/E5
Q130/230	C 3625-8	2N4125	K5/E5
Q131/231	C 3625-8	2N4125	L3/D3
Q132/232	C 3625-8	2N4125	K3/D3
Q133/233	C 3625-8	2N4125	O4/D4
Q134/234	C 7458-0	2N4123	L3/A3
Q135/235	C 3810-6	MPSA42/43	K4/E4
Q136/236	C 3578-9	MPSA93	K4/D5
R1	A10265-10021	10K 1%	E2
R4	A10265-10521	10.5K 1%	D1
R5	--- Not Used ---		H4
R7	A10266-4331	43K 5%	I6
R8	A10265-75021	75K 1%	H6
R10	--- Not Used ---		D2
R11	--- Not Used ---		L5
R12	--- Not Used ---		D5
R17	A10265-75021	75K 1%	H6
R18	A10266-4331	43K 5%	G6
R19	A10266-2R72	2.7 5% .5W	I4
R100/200	--- Not Used ---		I3/G3
R101/201	A10265-10211	1.02K 1%	J2/F2
R102/202	A10266-5111	510 5%	J3/F3
R103/203	A10265-20523	20.5K 1% 1W	J2/F2
R104/204	A10265-26711	2.67K 1%	M3/A3
R105/205	A10265-26711	2.67K 1%	N3/C3
R106/206	A10265-11821	11.8K 1%	L3/A3
R107/207	A10266-6831	68K 5%	M3/A3
R108/208	A10266-8211	820 5%	N4/C4
R109/209	A10266-9101	91 5%	N4/C4
R110/210	A10266-6831	68K 5%	N3/C3
R111/211	A10265-11821	11.8 1%	03/D3
R112/212	A10265-49921	49.9K 1%	H3/G3
R113/213	A10265-48711	4.87K 1%	J4/F4
R114/214	A10266-1521	1.5K 5%	I4/G4
R115/215	A10266-5141	510K 5%	L2/D2
R116/216	A10266-3351	3.3M 5%	J4/F4
R117/217	A10266-4731	47K 5%	H3/G3
R118/218	A10265-40201	402 1%	N4/B4
R119/219	A10265-12111	1.21K 1%	N5/C5
R120/220	A10265-40201	402 1%	N4/B4
R121/221	C 5062-2	100K LIN POT	O1/A1
R122/222	A10266-2741	270K 5%	N2/A2
R123/223	A10266-2032	20K 5% .5W	O2/A2

8 Module Information

R124/224	A10266-6821	6.8K 5%	O1/A1
R125/225	A10266-1011	100 5%	O2/A2
R126/226	A10266-1011	100 5%	O2/A2
R127/227	A10266-6821	6.8K 5%	N3/A3
R128/228	A10266-1331	13K 5%	N2/A2
R129/229	A10266-1041	100K 5%	N3/A3
R130/230	A10266-1041	100K 5%	L3/D3
R131/231	A10266-1331	13K 5%	L3/D3
R132/232	C 5062-2	100K LIN POT	K1/E1
R133/233	A10266-2741	270K 5%	K2/E2
R134/234	A10266-2032	20K 5% .5W	M3/C3
R135/235	A10266-1011	100 5%	K2/E2
R136/236	A10266-6821	6.8K 5%	L2/D2
R137/237	A10266-1011	100 5%	K2/E2
R138/238	A10266-6821	6.8K 5%	L3/D3
R139/239	A10266-8211	820 5%	M4/A4
R140/240	A10266-9101	91 5%	M4/A4
R141/241	A10266-1541	150K 5%	N3/A3
R142/242	A10266-1541	150K 5%	L3/D3
R143/243	A10266-4711	470 5%	K6/D6
R144/244	A10266-4711	470 5%	K5/D5
R145/245	A10266-4711	470 5%	K6/E6
R146/246	A10265-11821	11.8K 1%	O4/D4
R147/247	A10124-24	#24 Buss Wire	O5/D5
R148/248	A10265-20011	2K 1%	N4/C4
R149/249	A10266-1012	100 5% .5W	L5/A5
R150/250	A10265-20011	2K 1%	M4/A4
R151/251	A10265-11821	11.8K 1%	L4/A4
R152/252	A10265-11821	11.8K 1%	O2/A2
R153/253	A10124-24	#24 Buss Wire	J4/G3
R154/254	A10266-5601	56 5%	K5/D5
R155/255	A10266-4731	47K 5%	J4/F4
R156/256	A10266-1321	1.3K 5%	N2/A2
R157/257	A10266-1321	1.3K 5%	L2/D2
R158/258	A10266-9121	9.1K 5%	K2/E2
R159/259	A10266-1331	13K 5%	J3/F3
R160/260	A10266-5601	56 5%	K6/D6
R161/261	A10266-4701	47 5%	N3/B3
R162/262	A10266-4701	47 5%	N3/B3
R163/263	A10266-5601	56 5%	K5/D5
R164/264	A10266-4711	470 5%	K5/D5
R165/265	A10266-4711	470 5%	K5/D6
R166/266	A10266-4711	470 5%	K5/D5
R167/267	A10265-10011	1K 1%	O2/A2
R168/268	A10265-95301	953 1%	O2/A2
R169/269	A10266-1041	100K 5%	N3/C3
R170/270	A10265-10011	1K 1%	K3/E3
R171/271	A10265-95301	953 1%	K3/E3
R172/272	A10266-1041	100K 5%	M3/A3
R173/273	A10266-5601	56 5%	K5/D5
R174/274	A10265-10721	10.7K 1%	I2/G2
R175/275	A10265-26711	2.67K 1%	H2/G2
R176/276	A10265-10721	10.7K 1%	J2/F2
R177/277	A10265-60411	6.04K 1%	H3/G3
R179/279	A10266-1321	1.3K 5%	K4/E4
R180/280	A10266-4711	470 5%	M3/A3
R181/281	A10265-48711	4.87K 1%	N4/B4
R182/282	A10266-2201	22 5%	J2/F2
R183/283	A10266-4731	47K 5%	O3/D3
R184/284	A10266-4741	470K 5%	K5/D5
R185/285	A10266-4731	47K 5%	O4/D3
R186/286	A10266-2751	2.7M 5%	J5/F5
R187/287	A10266-3321	3.3K 5%	K6/E6
R188/288	A10266-3321	3.3K 5%	K6/E6
R189/289	A10266-2731	27K 5%	K5/E5
R190/290	A10266-2051	2M 5%	J5/F6
R191/291	A10266-4731	47K 5%	L3/A3
R192/292	A10266-4731	47K 5%	L3/A3
R193/293	A10265-10021	10K 1%	J5/F5
R194/294	A10265-20021	20K 1%	J2/F2
R195/295	A10266-4701	47 5%	K4/F3
R196/296	A10266-3921	3.9K 5%	K4/E4
R197/297	A10265-10021	10K 1%	K4/E4
R198/298	A10266-3921	3.9K 5%	K3/E3
R199/299	A10265-10021	10K 1%	K3/E3
R500/600	A10266-3041	300K 5%	J3/F3
R501/601	A10266-3041	300K 5%	J3/F3
R502/602	A10266-3041	300K 5%	J3/F3
R503/603	A10266-4702	47 5% .5W	J2/F2
R504/604	A10266-5141	510K 5%	L2/D2
R505/605	A10266-5141	510K 5%	L2/D2
R506/606	A10266-1521	1.5K 5%	J5/F5
R507/607	A10266-4711	470 5%	J5/F5
R508/608	A10266-2731	27K 5%	J5/F5
R509/609	A10265-49911	4.99K 1%	I3/G3
R510/610	A10265-49911	4.99K 1%	H2/G2
R511/611	A10265-49911	4.99K 1%	H2/G2
R512/612	C 9079-2	200/220 Pot	H3/H3
R513/613	A10265-49911	4.99K 1%	H3/G3
R514/614	C 7340-0	24 5% 3W	H1/H1
R515/615	A10266-1821	1.8K 5%	J1/F1
R516/616	A10266-1051	1M 5%	L2/D2
R517/617	A10266-9101	91 5%	N4/B4
R518/618	A10266-9101	91 5%	N4/B4
R519/619	A10265-12111	1.21K 1%	M5/A5
R520/620	A10266-1521	1.5K 5%	M5/A5
R521/621	A10265-11021	11K 1%	N5/B5
R522/622	A10266-4741	470K 5%	M5/A5
R523/623	A10266-1521	1.5K 5%	N5/C5
R524/624	A10266-4741	470K 5%	N5/C5
R525/625	A10265-11021	11K 1%	N5/B5
R526/626	A10265-10021	10K 1%	I5/F5
R527/627	A10266-3921	3.9K 5%	L4/D4
R528/628	A10265-10021	10K 1%	L4/D4

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R529/629	A10266-4731	47K 5%	L4/D4
R530/630	A10265-10021	10K 1%	O3/D4
R531/631	A10266-4731	47K 5%	L3/D3
R532/632	A10265-10021	10K 1%	L4/A4
R533/633	A10265-10021	10K 1%	O3/D3
R534/634	A10265-10021	10K 1%	L3/A3
R535/635	A10266-1R01	1 5%	O5/A5
R536/636	A10266-4701	47 5%	K5/E5
R537/637	A10265-10021	10K 1%	K4/D4
R538/638	A10265-10021	10K 1%	L4/D5
R539/639	--- Not Used ---		J1/F1
R540/640	--- Not Used ---		J1/E1
R541/641	--- Not Used ---		I2/G2
R542/642	--- Not Used ---		I3/G3
R543/643	--- Not Used ---		J5/F5
R544/644	A10266-2031	20K 5%	L4/E4
R545/645	A10266-2031	20K 5%	M4/D4
S2	C 7325-1	DPDT Switch	H1
S3	C 7960-5	3 Pos Switch	H2
S4	C 6781-6	6P3T Switch	C1
TP1	C 6564-6	10P Header	L5
TP2	C 6564-6	10P Header	D5
TP3	C 9896-9	Test Point	F4
TP4	C 9896-9	Test Point	I4

U1	C 5095-2	MC7815CT	H5
U1X	C 9494-3	Heatsink	H5
U2	C 5096-0	MC7915CT	G5
U2X	C 9494-3	Heasink	G5
U100/200	C 6911-9	UPA75	N2/B2
U101/201	C 6411-0	H11C2	J5/E5
U101X/201X	C 8019-9	6 pin IC Skt	J5/E5
U102/202	C 4345-2	LM339N	I5/G5
U102X/202X	C 3450-1	14 pin IC Skt	I5/G5
U103/203	C 6910-1	UPA76	L2/D2
U104/204	C 7558-7	MC33079P	I3/F3
U104X/204X	C 3450-1	14 pin IC Skt	I3/F3
U100B/200B	--- Not Used ---		N2/B2
U103B/203B	--- Not Used ---		L2/D2
Z01	--- Not Used ---		D1
Z02	--- Not Used ---		C1
Z03	--- Not Used ---		C1
Z04	--- Not Used ---		C2
Z05	--- Not Used ---		C2
PC Board	D 8825-8	Main #2	
	or D 8920-7	Main #3	

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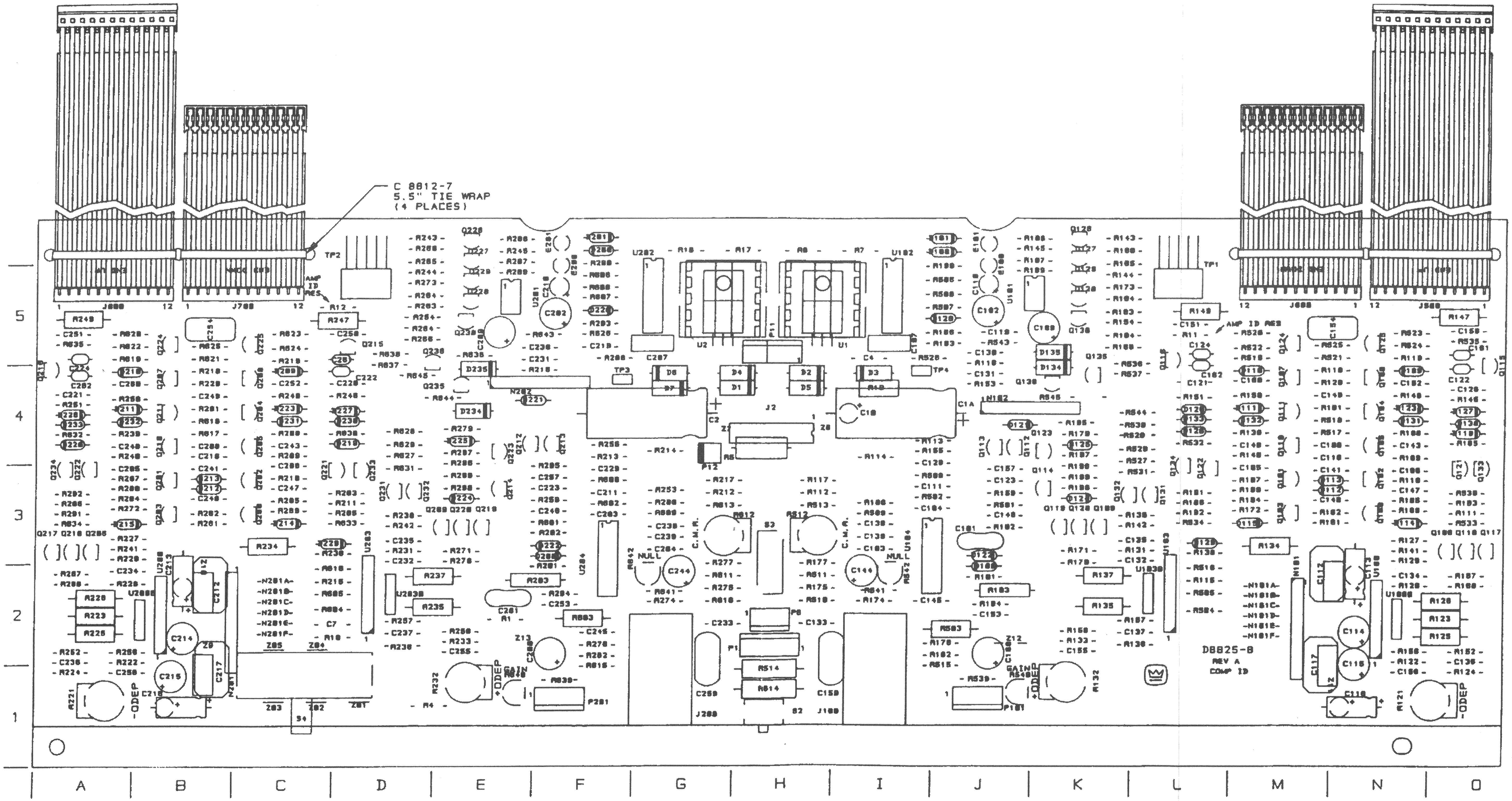

Figure 8.1 Q43371-6 Main Module Map

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8.5 Q43369-0 Output Module Parts List

Cir. Des.	C.P.N	Description	Map Loc
C01	A10434-473JD	.047μF 250V	G1
C02	C 8426-6	.1μF 250V	C2
C03	C 8426-6	.1μF 250V	L2
C04	C 6806-1	.01μF 100V	F4
C05	C 6806-1	.01μF 100V	J4
C06	C 6806-1	.01μF 100V	G4
C07	C 6807-9	.001μF 100V	F3
C08	C 6810-3	180pF 100V	E3
C09	C 6809-5	220pF 100V	J3
C10	C 6807-9	.001μF 100V	I4
C11	C 6806-1	.01μF 100V	I4
C12	--- Not Used ---		I4
C13	--- Not Used ---		G4
C13A	C 8991-9	.47μF 63V	D2
C15	--- Not Used ---		F3
C16	C 8426-6	.1μF 250V	H4
D01	C 2851-1	1N4004	E3
D02	C 2851-1	1N4004	F3
D03	C 2851-1	1N4004	I3
D04	C 2851-1	1N4004	J3
D05	C 8383-9	GI822	A2
D06	C 8383-9	GI822	M2
D07	C 8383-9	GI822	B3
D08	C 8383-9	GI822	K2
D15	C 2851-1	1N4004	A2
D16	C 2851-1	1N4004	N3
HW1	A10094-2	#4 Lockwasher	I1
HW2	A10094-2	#4 Lockwasher	I1
HW3	A10094-2	#4 Lockwasher	G2
HW4	A10094-2	#4 Lockwasher	G2
HW5	C 7481-2	4 Way Conn.	I1
HW6	C 7481-2	4 Way Conn.	G2
HW7	A10608-3	4-40X3/8 Spcr	I1
HW8	A10608-3	4-40X3/8 Spcr	I1
HW9	A10608-3	4-40X3/8 Spcr	G2
HW10	A10608-3	4-40X3/8 Spcr	G2
HW11	D 8441-4	Fishpaper	E4-K4
HW12	A10020-1	4-40X.25 Stud	I1
HW13	A10020-1	4-40X.25 Stud	I1
HW14	A10020-1	4-40X.25 Stud	G2
HW15	A10020-1	4-40X.25 Stud	G2
L00	D 7701-2	2.5μH Coil	G2
L01	C 3510-2	470μH Choke	F4
L02	C 3510-2	470μH Choke	J4
P00	--- Not Used ---		F2
P500	C 9828-2	12 Pin Header	E3
P600	C 9828-2	12 Pin Header	J3
Q00	C 4647-1	TIP47 NPN	I4
Q01	C 8159-3	2SC4029 NPN	E5
Q05	C 8186-6	2SA1553 PNP	J5
Q12	C 8159-3	2SC4029 NPN	G5
Q16	C 8186-6	2SA1553 PNP	H5
Q17	C10155-7	2SC4793 NPN	F4
Q18	C 4647-1	TIP47 NPN	F4
Q19	C10156-5	2SA1837 PNP	I4
R00	A10266-6801	68 5%	F4
R01	A10266-1011	100 5%	E4
R02	C 7778-1	5.6 5% .5W FP	F3
R03	C 6486-2	.2 5% 5W	E2
R04	C 6486-2	.2 5% 5W	C2
R05	C 6486-2	.2 5% 5W	A1
R06	C 6486-2	.2 5% 5W	I2
R07	C 6486-2	.2 5% 5W	K2
R08	C 6486-2	.2 5% 5W	N1
R09	C 7779-9	22 5% FP	J3
R10	A10266-1011	100 5%	J4
R11	C 6625-5	5.6 5% 5W	H2
R12	A10266-2R74	2.7 5% 2W	C1
R13	A10266-6801	68 5%	J4
R14	A10266-2R74	2.7 5% 2W	M1
R15	C 6486-2	.2 5% 5W	M1
R16	C 6486-2	.2 5% 5W	E2
R17	C 6486-2	.2 5% 5W	F1
R18	C 6486-2	.2 5% 5W	B1
R19	C 6486-2	.2 5% 5W	J1
R20	C 6486-2	.2 5% 5W	H1
R21	C 7778-1	5.6 5% .5W FP	F1
R22	C 7779-9	22 5% FP	H3
R23	C 6844-2	250 Pot	H3
R24	A10266-1331	13K 5%	F4
R25	A10266-2221	2.2K 5%	F3
R26	C 6844-2	250 Pot	G4
R27	A10266-3911	390 5%	G4
R28	A10266-1331	13K 5%	I4
R29	A10266-5101	51 5%	F3
R30	A10265-10201	102 1%	D3
R31	C 6625-5	5.6 5% 5W	G2
R32	--- Not Used ---		C1
R33	--- Not Used ---		C1
R34	--- Not Used ---		B1
R35	A10266-1R02	1 5% .5W	D4
R36	A10266-1R02	1 5% .5W	K4
R37	C 7779-9	22 5% FP	D3
R38	C 7779-9	22 5% FP	D2

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R39	C 7779-9	22 5% FP	D3
R40	C 7779-9	22 5% FP	K3
R41	C 7779-9	22 5% FP	K3
R42	C 7779-9	22 5% FP	J3
R43	A10266-5101	51 5%	G4
R44	A10266-2021	2K 5%	H3
R45	A10266-7511	750 5%	I4
R46	--- Not Used ---		L1
R47	--- Not Used ---		L1
R48	--- Not Used ---		L1
R49	C 7779-9	22 5% FP	F2
R50	C 7779-9	22 5% FP	D2
R51	C 7779-9	22 5% FP	B2
R52	C 7779-9	22 5% FP	M2
R53	C 7779-9	22 5% FP	K2
R54	C 7779-9	22 5% FP	I2
Z3	C 5868-2	0 Ohm Jmp	D1
Z4	C 5868-2	0 Ohm Jmp	D3
Z8	C 5868-2	0 Ohm Jmp	D2
Z00	C 5868-2	0 Ohm Jmp	E1
Z01	C 5868-2	0 Ohm Jmp	E2
Z02	C 5868-2	0 Ohm Jmp	E3
Z03	C 5868-2	0 Ohm Jmp	E3
Z04	C 5868-2	0 Ohm Jmp	H3
Z05	C 5868-2	0 Ohm Jmp	H3
Z06	C 5868-2	0 Ohm Jmp	H3
Z07	C 5868-2	0 Ohm Jmp	I3
Z08	C 5868-2	0 Ohm Jmp	J3
Z09	C 5868-2	0 Ohm Jmp	J3
Z10	C 5868-2	0 Ohm Jmp	J2
Z11	C 5868-2	0 Ohm Jmp	J1
Z12	C 5868-2	0 Ohm Jmp	J2
Z13	C 5868-2	0 Ohm Jmp	J1
Z14	C 5868-2	0 Ohm Jmp	E3
Z15	C 5868-2	0 Ohm Jmp	J2
Z16	C 5868-2	0 Ohm Jmp	E3
Z17	C 5868-2	0 Ohm Jmp	H1
Z18	C 5868-2	0 Ohm Jmp	H1
PC Board	P10423-5	THC #2	

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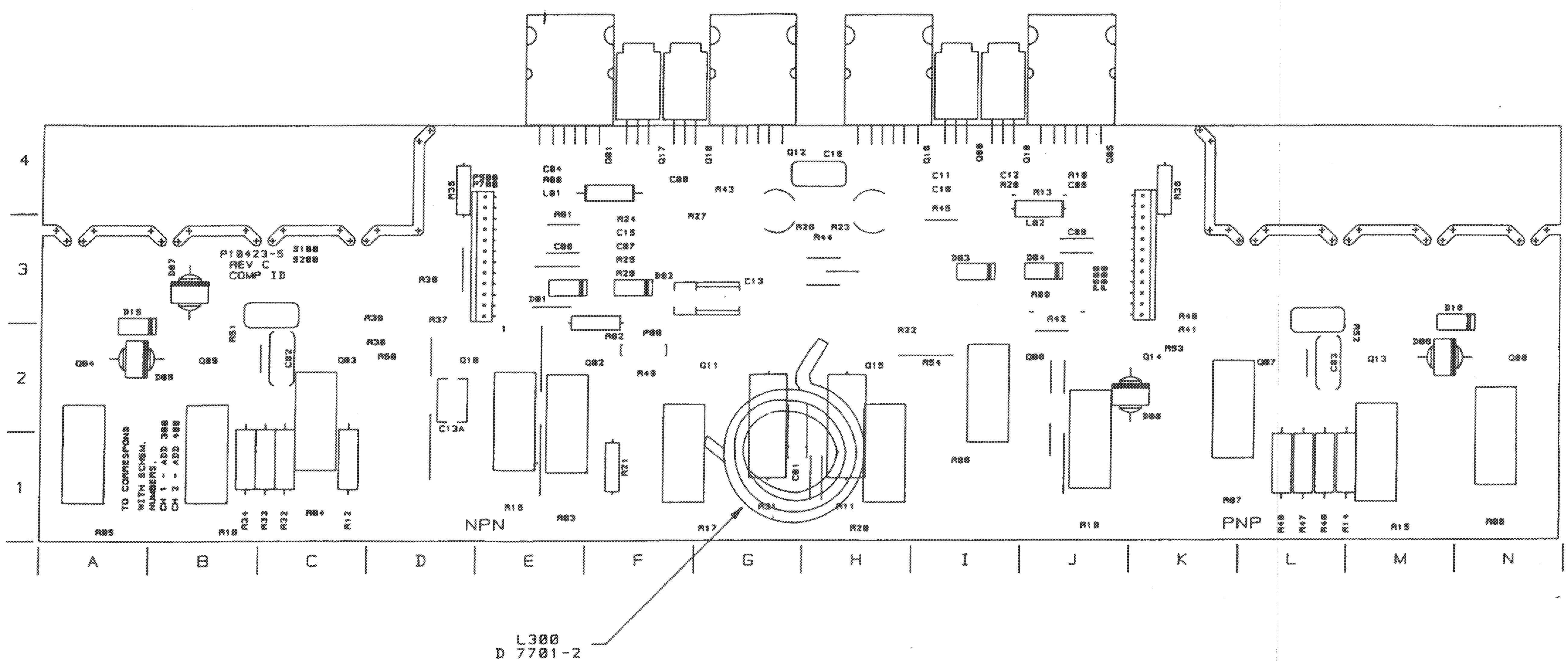

Figure 8.2 Q43369-0 Output Module Map

8 Module Information

8.6 Q43183A3 Control Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 6804-6	.1μF 50V	D4
C2	C 6096-9	3.3μF 50V	D4
C3	C 7819-3	1800μF 35V	F1
C4	C 7819-3	1800μF 35V	F5
C5	C 5362-6	2.2μF 50V	E2
C6	C 5362-6	2.2μF 50V	E5
C7	C 9943-9	.1μF 250V	I2
C8	C 9943-9	.1μF 250V	H2
C9	C 9943-9	.1μF 250V	H2
C10	C 9943-9	.1μF 250V	I2
C11	C 6804-6	.1μF 50V	C4
C12	C 6804-6	.1μF 50V	C3
C13	C 8963-8	.47μF 250V	H4
D1	C 2851-1	1N4004	F3
D2	C 2851-1	1N4004	F3
D3	C 2851-1	1N4004	F3
D4	C 2851-1	1N4004	F2
D5	C 2851-1	1N4004	E2
D6	C 2851-1	1N4004	E5
D7	C 2851-1	1N4004	E2
D8	C 2851-1	1N4004	E5
D9	C 2851-1	1N4004	F1
D10	C 3181-2	1N4148	D3
D11	C 2851-1	1N4004	F2
D12	C 3181-2	1N4148	C2
D13	C 3181-2	1N4148	D2
D14	C 3181-2	1N4148	D2
D15	C 3181-2	1N4148	D2
D16	C 3181-2	1N4148	C2
D17	C 2851-1	1N4004	H3
D18	C 2851-1	1N4004	H3
D19	C 3549-0	1N961B, 10V	C3
D20	C 3181-2	1N4148	C1
D21	C 3181-2	1N4148	C2
D22*	C10437-9	Bridge Rect.	H1
D23*	C10437-9	Bridge Rect.	I1
D24*	C10437-9	Bridge Rect.	A3
D25*	C10437-9	Bridge Rect.	A4

*Not included with module, order separately.

HW1	A10086-10605	6-32X.3125	A4
HW2	A10086-10605	6-32X.3125	E2
HW3	A10086-10605	6-32X.3125	E5
HW5	A10094-4	#6 Lockwasher	A4
HW6	A10094-4	#6 Lockwasher	E2
HW7	A10094-4	#6 Lockwasher	E5
HW10	A10102-5	6-32 Hex Nut	A4
HW11	A10102-5	6-32 Hex Nut	E2
HW12	A10102-5	6-32 Hex Nut	E5
HW14	C 6510-9	T0220 HTSNK	A4
HW15	C 6510-9	T0220 HTSNK	E2
HW16	C 6510-9	T0220 HTSNK	E5
HW18	C 6541-4	T0220 Spreader	A4
HW19	C 6541-4	T0220 Spreader	E2
HW20	C 6541-4	T0220 Spreader	E5
HW25	H43267-6	Wires	H5 & I5
HW28	C 8982-8	Holder	G4
J3	C 4508-5	16 Pin Socket	A2
J4	C 4508-5	16 Pin Socket	A1
J12	C 4508-5	16 Pin Socket	C1
J13	C 9442-2	15 Pin Conn.	I4
J29	--- Not Used ---		B2
K1	C 9787-0	30A 24V Relay	G3
K2	C 9787-0	30A 24V Relay	G1
K3	C 9787-0	30A 24V Relay	G2
P13	C 7817-7	.25 Tab	F5
P14	C 7817-7	.25 Tab	I5
P15	C 7817-7	.25 Tab	H5
P16	C 7817-7	.25 Tab	I5
P17	C 7817-7	.25 Tab	I5
P18	C 7817-7	.25 Tab	J5
P19	C 7817-7	.25 Tab	G5
P20	C 7817-7	.25 Tab	I5
P21	C 7817-7	.25 Tab	G5
P26	C 7817-7	.25 Tab	G5
P27	C 7593-4	5 Pin Header	E1
P28	C 7592-6	4 Pin Header	D2
P50	C 7817-7	.25 Tab	H5
P51	C 7817-7	.25 Tab	H5
Q1	C 3625-8	2N4125	E1
Q2	C 3625-8	2N4125	E2
Q3	C 3625-8	2N4125	C3
Q4	C 7662-7	MAC218	H4
R1	C 8960-4	5 Ohm PTC	G4
R3	A10265-82521	82.5K 1%	D4
R4	C 3093-9	10K Helitrim	D4
R5	A10265-10031	100K 1%	H3
R6	A10265-10031	100K 1%	H4
R7	A10266-3331	33K 5%	D4
R8	--- Not Used ---		D4
R9	A10266-3921	3.9K 5%	D3
R10	A10266-2221	2.2K 5%	D2
R11	A10266-2221	2.2K 5%	C1
R12	A10266-4731	47K 5%	D4

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R13	A10266-2031	20K 5%	C4
R14	A10266-4731	47K 5%	C4
R15	A10266-1021	1K 5%	C4
R16	A10266-4731	47K 5%	C4
R17	A10266-3321	3.3K 5%	C3
R18	A10266-1231	12K 5%	C3
R19	A10265-11031	110K 1%	C3
R20	A10266-4721	4.7K 5%	D2
R21	A10266-4721	4.7K 5%	D3
R22	A10266-4741	470K 5%	D3
R23	A10266-4741	470K 5%	C4
R24	A10266-2221	2.2K 5%	C5
R25	A10266-1812	180 5% .5W	H4
R26	A10266-3602	36 5% .5W	H4
R27	A10266-3021	3K 5%	D1
S2	C 7325-1	DPDT	C2
U1	C 4345-2	LM339	C4
U1X	C 3450-1	14 Pin Socket	C4
U2	C 5095-2	MC7815CT	E2
U3	C 5096-0	MC7915CT	E5
U4	C 7665-0	MOC3011	F4
X10	C 7817-7	.25 Tab	H1
X11	C 7817-7	.25 Tab	H1
X12	C 7817-7	.25 Tab	I1
X13	C 7817-7	.25 Tab	I1
PC Board	D 8165A7	REF Control	

8 Module Information

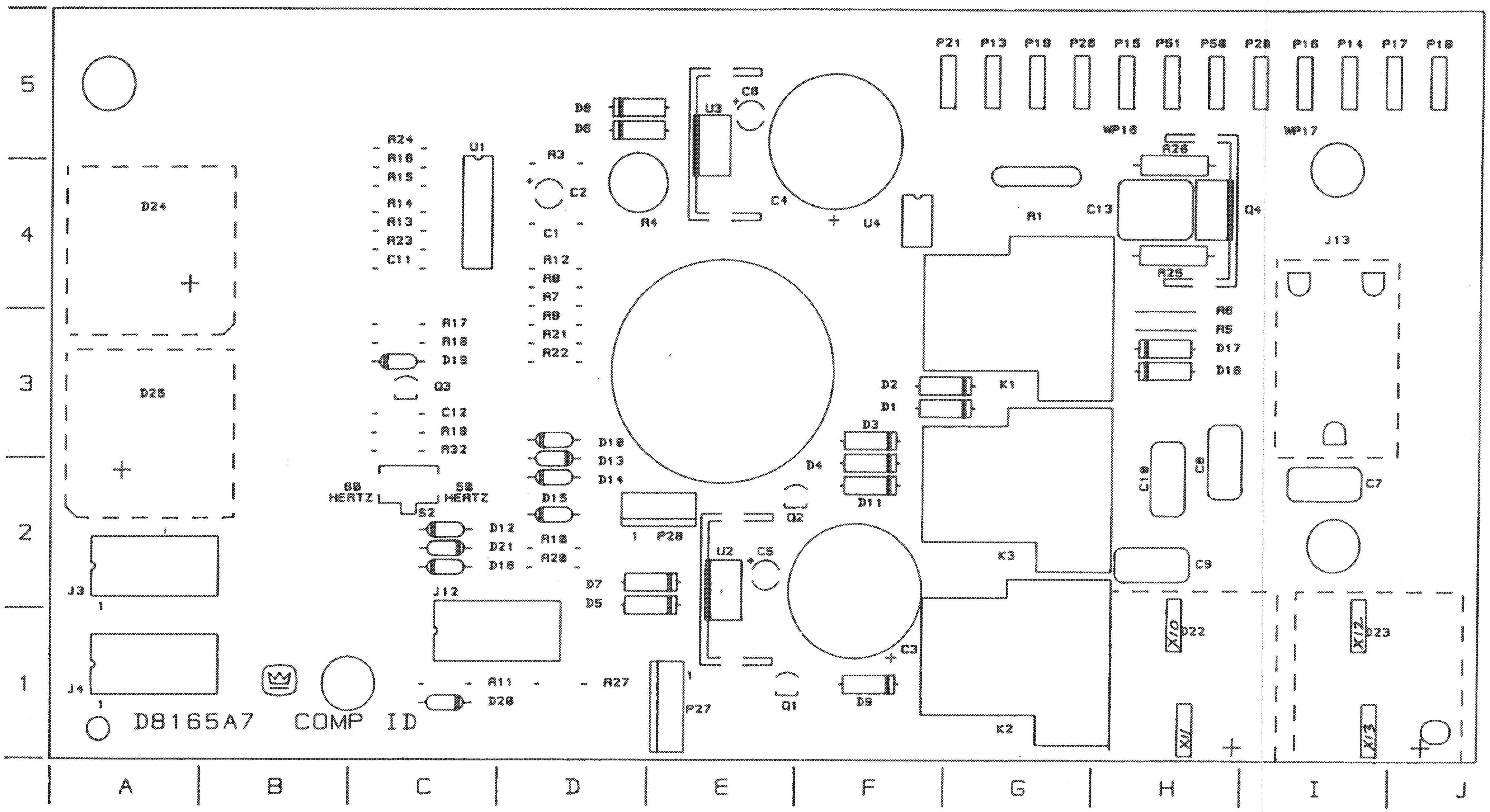

Figure 8.3 Q43183A3 Control Module Map

8 Module Information

8.7 Q43450-8 Control Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 6804-6	.1µF 50V	D4
C2	C 6096-9	3.3µF 50V	D4
C3	C 7819-3	1800µF 35V	F1
C4	C 7819-3	1800µF 35V	F5
C5	C 5362-6	2.2µF 50V	E2
C6	C 5362-6	2.2µF 50V	E5
C7	C 9943-9	.1µF 250V	I2
C8	C 9943-9	.1µF 250V	H2
C9	C 9943-9	.1µF 250V	H2
C10	C 9943-9	.1µF 250V	I2
C11	C 6804-6	.1µF 50V	C4
C12	C 6804-6	.1µF 50V	C3
C13	C 8963-8	.47µF 250V	H4
D1	C 2851-1	1N4004	F3
D2	C 2851-1	1N4004	F3
D3	C 2851-1	1N4004	F3
D4	C 2851-1	1N4004	F2
D5	C 2851-1	1N4004	E2
D6	C 2851-1	1N4004	E5
D7	C 2851-1	1N4004	E2
D8	C 2851-1	1N4004	E5
D9	C 2851-1	1N4004	F1
D10	C 3181-2	1N4148	D3
D11	C 2851-1	1N4004	F2
D12	C 3181-2	1N4148	C2
D13	C 3181-2	1N4148	D2
D14	C 3181-2	1N4148	D2
D15	C 3181-2	1N4148	D2
D16	C 3181-2	1N4148	C2
D17	C 2851-1	1N4004	H3
D18	C 2851-1	1N4004	H3
D19	C 3549-0	1N961B, 10V	C3
D20	C 3181-2	1N4148	C1
D21	C 3181-2	1N4148	C2
D22*	C10437-9	Bridge Rect.	H1
D23*	C10437-9	Bridge Rect.	I1
D24*	C10437-9	Bridge Rect.	A3
D25*	C10437-9	Bridge Rect.	A4

*Not included with module, order separately.

HW1	A10086-10605	6-32X.3125	A4
HW2	A10086-10605	6-32X.3125	E2
HW3	A10086-10605	6-32X.3125	E5
HW5	A10094-4	#6 Lockwasher	A4
HW6	A10094-4	#6 Lockwasher	E2
HW7	A10094-4	#6 Lockwasher	E5
HW10	A10102-5	6-32 Hex Nut	A4
HW11	A10102-5	6-32 Hex Nut	E2
HW12	A10102-5	6-32 Hex Nut	E5
HW14	C 6510-9	T0220 HTSNK	A4
HW15	C 6510-9	T0220 HTSNK	E2
HW16	C 6510-9	T0220 HTSNK	E5
HW18	C 6541-4	T0220 Spreader	A4
HW19	C 6541-4	T0220 Spreader	E2
HW20	C 6541-4	T0220 Spreader	E5
HW25	H43267-6	Wires	H5 & I5
HW28	C 8982-8	Holder	G4
J3	C 4508-5	16 Pin Socket	A2
J4	C 4508-5	16 Pin Socket	A1
J12	C 4508-5	16 Pin Socket	C1
J13	C 9442-2	15 Pin Conn.	I4
J29	--- Not Used ---		B2
K1	C 9787-0	30A 24V Relay	G3
K2	C 9787-0	30A 24V Relay	G1
K3	C 9787-0	30A 24V Relay	G2
P13	C 7817-7	.25 Tab	F5
P14	C 7817-7	.25 Tab	I5
P15	C 7817-7	.25 Tab	H5
P16	C 7817-7	.25 Tab	I5
P17	C 7817-7	.25 Tab	I5
P18	C 7817-7	.25 Tab	J5
P19	C 7817-7	.25 Tab	G5
P20	C 7817-7	.25 Tab	I5
P21	C 7817-7	.25 Tab	G5
P26	C 7817-7	.25 Tab	G5
P27	C 7593-4	5 Pin Header	E1
P28	C 7592-6	4 Pin Header	D2
P50	C 7817-7	.25 Tab	H5
P51	C 7817-7	.25 Tab	H5
Q1	C 3625-8	2N4125	E1
Q2	C 3625-8	2N4125	E2
Q3	C 3625-8	2N4125	C3
Q4	C 7662-7	MAC218	H4
R1	C 8960-4	5 Ohm PTC	G4
R3	A10265-82521	82.5K 1%	D4
R4	C 3093-9	10K Helitrim	D4
R5	A10265-10031	100K 1%	H3
R6	A10265-10031	100K 1%	H4
R7	A10266-3331	33K 5%	D4
R8	--- Not Used ---		D4
R9	A10266-3921	3.9K 5%	D3
R10	A10266-2221	2.2K 5%	D2
R11	A10266-2221	2.2K 5%	C1
R12	A10266-4731	47K 5%	D4

8 Module Information

R13	A10266-2031	20K 5%	C4
R14	A10266-4731	47K 5%	C4
R15	A10266-1021	1K 5%	C4
R16	A10266-4731	47K 5%	C4
R17	A10266-3321	3.3K 5%	C3
R18	A10266-1231	12K 5%	C3
R19	A10265-11031	110K 1%	C3
R20	A10266-4721	4.7K 5%	D2
R21	A10266-4721	4.7K 5%	D3
R22	A10266-4741	470K 5%	D3
R23	A10266-4741	470K 5%	C4
R24	A10266-2221	2.2K 5%	C5
R25	A10266-1812	180 5% .5W	H4
R26	A10266-3602	36 5% .5W	H4
R27	A10266-3021	3K 5%	D1
S2	C 7325-1	DPDT	C2
U1	C 4345-2	LM339	C4
U1X	C 3450-1	14 Pin Socket	C4
U2	C 5095-2	MC7815CT	E2
U3	C 5096-0	MC7915CT	E5
U4	C 7665-0	MOC3011	F4
X10	C 7817-7	.25 Tab	H1
X11	C 7817-7	.25 Tab	H1
X12	C 7817-7	.25 Tab	I1
X13	C 7817-7	.25 Tab	I1
PC Board	D 8853-0	REF Control #2	

8 Module Information

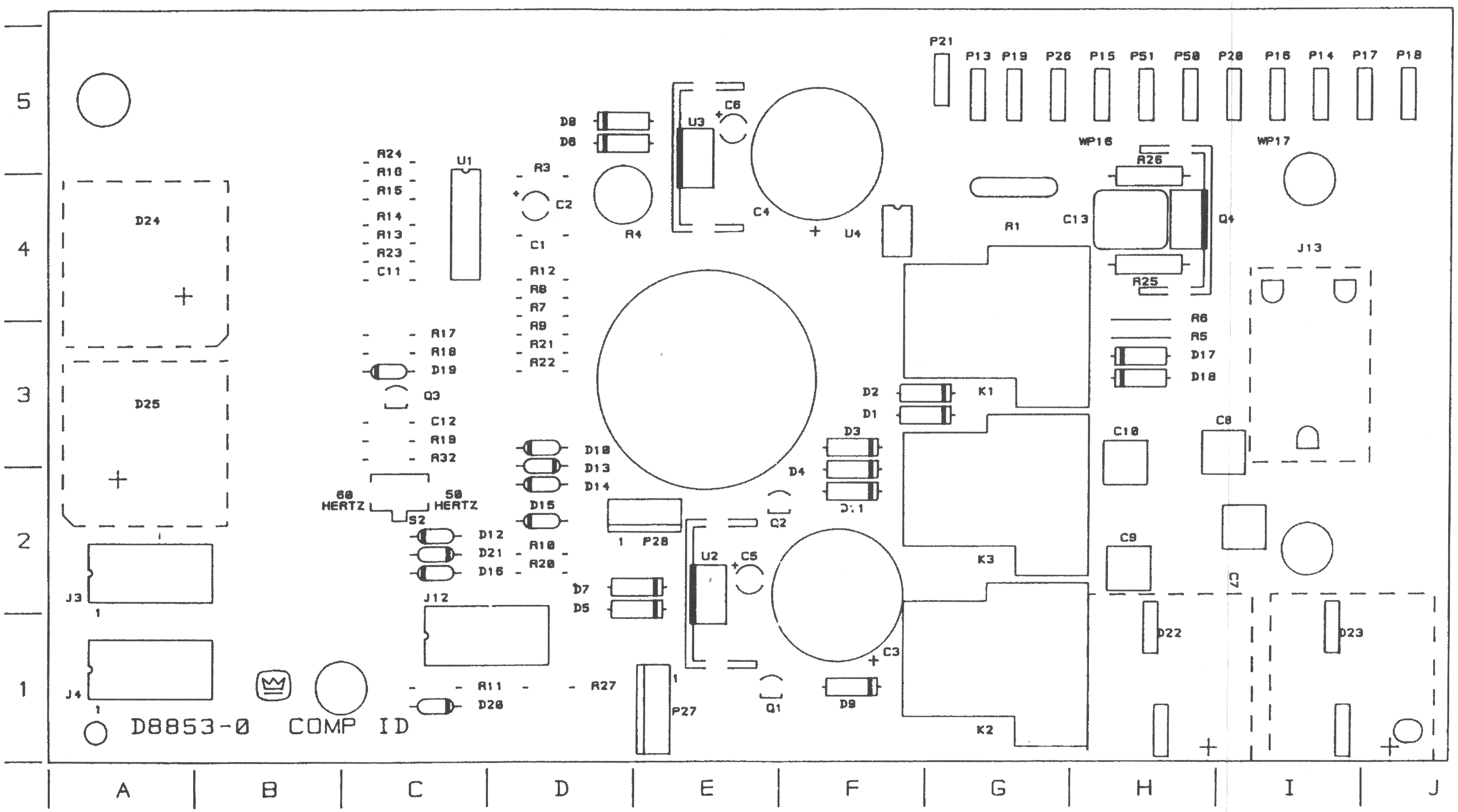

Figure 8.4 Q43450-8 Control Module Map

8 Module Information

8.8 Q43504-2 Control Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 6804-6	.1μF 50V	D4
C2	C 6096-9	3.3μF 50V	D4
C3	C 7819-3	1800μF 35V	F2
C4	C 7819-3	1800μF 35V	F5
C5	C 5362-6	2.2μF 50V	E2
C6	C 5362-6	2.2μF 50V	E5
C7	C 9943-9	.1μF 250V	I2
C8	C 9943-9	.1μF 250V	J2
C9	C 8554-5	.22μF 250V	H2
C10	C 8554-5	.22μF 250V	J2
C11	C 6804-6	.1μF 50V	C4
C12	C 6804-6	.1μF 50V	C3
C13	C 8963-8	.47μF 250V	G5
C14	C10326-4	.1μF 250V	J5
C15	C10325-6	2200pF 250V	H5
C16	C10325-6	2200pF 250V	H5
C17	C 8554-5	.22μF 250V	H2
C18	C 8554-5	.22μF 250V	J2
D1	C 2851-1	1N4004	G3
D2	C 2851-1	1N4004	F3
D3	C 2851-1	1N4004	F3
D4	C 2851-1	1N4004	F2
D5	C 2851-1	1N4004	E2
D6	C 2851-1	1N4004	D5
D7	C 2851-1	1N4004	E2
D8	C 2851-1	1N4004	D5
D9	C 2851-1	1N4004	F1
D10	C 3181-2	1N4148	D3
D11	C 2851-1	1N4004	F2
D12	C 3181-2	1N4148	C2
D13	C 3181-2	1N4148	D3
D14	C 3181-2	1N4148	D2
D15	C 3181-2	1N4148	D2
D16	C 3181-2	1N4148	C2
D17	C 2851-1	1N4004	G3
D18	C 2851-1	1N4004	F3
D19	C 3549-0	1N961B, 10V	C3
D20	C 3181-2	1N4148	C1
D21	C 3181-2	1N4148	C2
D22*	C10437-9	Bridge Rect.	H1
D22X	C 7817-7	.25 Tab	H1
D22XX	C 7817-7	.25 Tab	H1
D23*	C10437-9	Bridge Rect.	I1
D23X	C 7817-7	.25 Tab	I1
D23XX	C 7817-7	.25 Tab	I1
D24*	C10437-9	Bridge Rect.	A4
D25*	C10437-9	Bridge Rect.	A3

*Not included with module, order separately.

Cir. Des.	C.P.N.	Description	Map Loc
HW1	A10086-10605	6-32X.3125	E2
HW2	C 6541-4	Torq. Spreader	E2
HW3	A10094-4	#6 Lockwasher	E2
HW4	A10102-5	6-32 Nut	E2
HW5	A10086-10605	6-32X.3125	E5
HW6	C 6541-4	Torq. Spreader	E5
HW7	A10094-4	#6 Lockwasher	E5
HW8	A10102-5	6-32 Nut	E5
HW9	A10086-10605	6-32X.3125	G5
HW10	C 6541-4	Torq. Spreader	G5
HW11	A10094-4	#6 Lockwasher	G5
HW12	A10102-5	6-32 Hex Nut	G5
HW13	H43267-6	Wires	I5
J3	C 4508-5	16 Pin Socket	A2
J4	C 4508-5	16 Pin Socket	A1
J12	C 4508-5	16 Pin Socket	C1
J13	C 8537-0	6 Pin Header	I4
J14	c10304-1	9 Pos Header	I3
K1	C10304-1	30A 24V Relay	G4
K2	C10304-1	30A 24V Relay	G1
K3	C10304-1	30A 24V Relay	G2
L1	H43598-4	Choke	I5
P13	C 7817-7	.25 Tab	H4
P14	C 7817-7	.25 Tab	I4
P15	C 7817-7	.25 Tab	I4
P16	C 7817-7	.25 Tab	I4
P17	C 7817-7	.25 Tab	J4
P18	C 7817-7	.25 Tab	J4
P19	C 7817-7	.25 Tab	J5
P20	C 7817-7	.25 Tab	I4
P21	C 7817-7	.25 Tab	G6
P26	C 7817-7	.25 Tab	H4
P27	C 7593-4	5 Pin Header	E1
P28	C 7592-6	4 Pin Header	D2
P50	C 7817-7	.25 Tab	H6
P51	C 7817-7	.25 Tab	H6
Q1	C 3625-8	2N4125	E1
Q2	C 3625-8	2N4125	E2
Q3	C 3625-8	2N4125	C3
Q4	C 7662-7	MAC218	G5
Q4X	C 6510-9	Heatsink	G5
R1	C 8960-4	5 Ohm PTC	H4
R1X	C 8982-8	Plastic Holder	H4
R3	A10265-82521	82.5K 1%	D4
R4	C 3093-9	10K Helitrim	D4
R5	A10265-10031	100K 1%	F4

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R6	A10265-10031	100K 1%	F4
R7	A10266-3331	33K 5%	D4
R8	--- Not Used ---		D4
R9	A10266-3921	3.9K 5%	D3
R10	A10266-2221	2.2K 5%	D2
R11	A10266-2221	2.2K 5%	C1
R12	A10266-4731	47K 5%	D4
R13	A10266-2031	20K 5%	C4
R14	A10266-4731	47K 5%	C4
R15	A10266-1021	1K 5%	C4
R16	A10266-4731	47K 5%	C4
R17	A10266-3321	3.3K 5%	C3
R18	A10266-1231	12K 5%	C3
R19	A10265-11031	110K 1%	C3
R20	A10266-4721	4.7K 5%	D2
R21	A10266-4721	4.7K 5%	D3
R22	A10266-4741	470K 5%	D3
R23	A10266-4741	470K 5%	C4
R24	A10266-2221	2.2K 5%	C5
R25	A10266-1812	180 5% .5W	G5
R26	A10266-3602	36 5% .5W	G6
R27	A10266-3021	3K 5%	D1
R32	A10266-5141	510K 5%	C3
S2	C 7325-1	DPDT	C2
U1	C 4345-2	LM339	C4
U1X	C 3450-1	14 Pin Socket	C4
U2	C 5095-2	MC7815CT	E2
U2X	C 6510-9	Heatsink	E2
U3	C 5096-0	MC7915CT	E5
U3X	C 6510-9	Heatsink	E5
U4	C 7665-0	MOC3011	F4
1	D 9099-9	REF Control Board	

8 Module Information

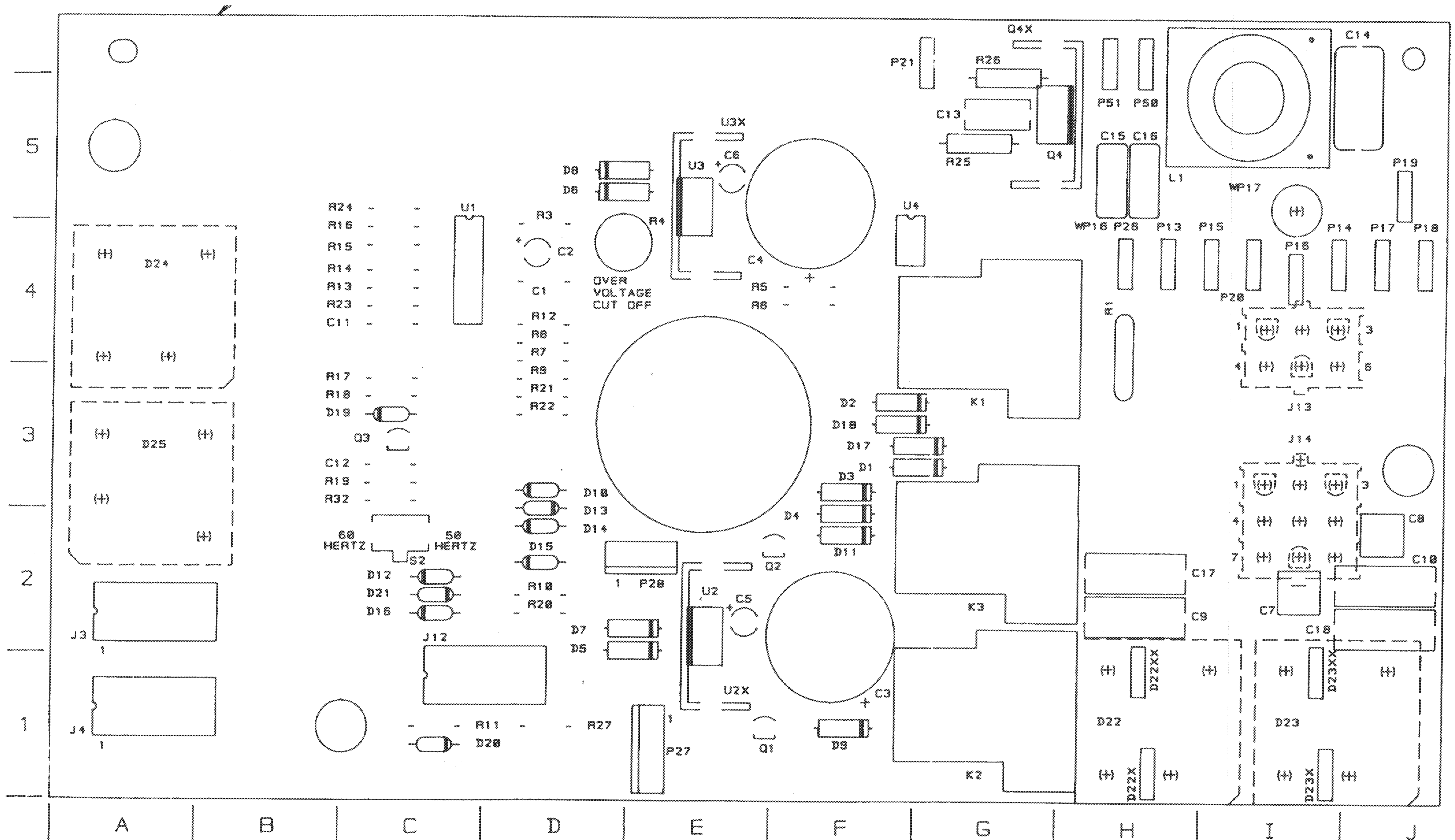

Figure 8.5 Q43504-2 Control Module Map

8 Module Information

8.9 Q43018-3 Display Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 6813-7	27pF 200V	B2
C2	C 6813-7	27pF 200V	B1
C3	C 6802-0	.47µF 50V	B3
C4	C 6802-0	.47µF 50V	B2
C5	C 6804-6	.1µF 50V	E2
C6	C 6804-6	.1µF 50V	E2
C7	C 6804-6	.1µF 50V	E2
C8	C 6804-6	.1µF 50V	E2
C9	C 6804-6	.1µF 50V	E2
C10	C 6804-6	.1µF 50V	E1
C11	C 6804-6	.1µF 50V	C3
C12	C 6804-6	.1µF 50V	C2
C13	C 6804-6	.1µF 50V	C3
C14	C 6804-6	.1µF 50V	C1
C15	C 6802-0	.47µF 50V	A3
C16	C 6802-0	.47µF 50V	A1
C17	C 6807-9	.001µF 100V	C2
C18	C 6807-9	.001µF 100V	C2
C19	C 6807-9	.001µF 100V	E2
C20	C 6807-9	.001µF 100V	E2
C21	C 6807-9	.001µF 100V	E2
C22	C 6807-9	.001µF 100V	E1
C23	C 6807-9	.001µF 100V	E1
C24	C 6807-9	.001µF 100V	E1
C25	C 6807-9	.001µF 100V	C1
C26	C 6807-9	.001µF 100V	C1
C27	C 6804-6	.1µF 50V	K2
C28	C 6804-6	.1µF 50V	L2
D1	C 3181-2	1N4148	A2
D2	C 3181-2	1N4148	A1
D3	C 3181-2	1N4148	A2
D4	C 3181-2	1N4148	A1
D5	C 3181-2	1N4148	G2
D6	C 3181-2	1N4148	M1
D7	C 3181-2	1N4148	I2
D8	C 3181-2	1N4148	L2
D9	C 3181-2	1N4148	B2
D10	C 3181-2	1N4148	B1
D11	C 3181-2	1N4148	J2
D12	C 3181-2	1N4148	L2
E1	C 4431-0	Yellow LED	I2
E2	C 4431-0	Yellow LED	L2
E3	C10592-1	Green LED	J2
E4	C10592-1	Green LED	L2
E5	C10592-1	Green LED	J1
E6	C10592-1	Green LED	K1
E7	C10592-1	Green LED	J1
E8	C10592-1	Green LED	K1
E9	C10592-1	Green LED	J1
E10	C10592-1	Green LED	L1
E11	C10592-1	Green LED	I1
E12	C10592-1	Green LED	L1
E13	C10592-1	Green LED	I1
E14	C10592-1	Green LED	L1
E15	C10592-1	Green LED	I2
E16	C10592-1	Green LED	L2
E17	C 4342-9	Amber LED	N2
J3	D 6990-2	16 pin cable	D2
P12	D 6990-2	16 pin cable	F2
Q1	C 3625-8	2N4125	J2
Q2	C 3625-8	2N4125	L2
R1	A10265-10031	100K 1%	A2
R2	A10265-10031	100K 1%	A1
R7	A10265-10031	100K 1%	A2
R8	A10265-10031	100K 1%	A1
R9	A10265-10021	10K 1%	A2
R10	A10265-10021	10K 1%	A1
R11	A10265-49911	4.99K 1%	B2
R12	A10265-49911	4.99K 1%	A1
R13	A10265-82511	8.25K 1%	C2
R15	A10265-14321	14.3K 1%	C2
R17	A10265-82511	8.25K 1%	C2
R19	A10266-8211	820 5%	J2
R20	A10266-8211	820 5%	L2
R21	A10265-10021	10K 1%	B2
R22	A10265-10021	10K 1%	B1
R23	A10266-5121	5.1K 5%	B3
R24	A10266-5121	5.1K 5%	B2
R25	A10266-8211	820 5%	K2
R26	A10266-8211	820 5%	L2
R27	A10266-1851	1.8M 5%	B2
R28	A10266-1851	1.8M 5%	B1
R29	A10265-68111	6.81K 1%	D2
R30	A10265-68111	6.81K 1%	E1
R31	A10265-16911	1.69K 1%	D2
R32	A10265-16911	1.69K 1%	E1
R33	A10265-95301	953 1%	D2
R34	A10265-95301	953 1%	D1
R35	A10265-53601	563 1%	D2
R36	A10265-53601	536 1%	D1
R37	A10266-3011	300 5%	D2
R38	A10266-3011	300 5%	D1
R39	A10266-3911	390 5%	D2
R40	A10266-3911	390 5%	D1
R41	A10266-2231	22K 5%	B2

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R42	A10266-2231	22K 5%	C1
R43	A10266-2231	22K 5%	C2
R44	A10266-2231	22K 5%	B1
R45	A10266-2231	22K 5%	E2
R46	A10266-2231	22K 5%	E1
R47	A10266-2231	22K 5%	E2
R48	A10266-2231	22K 5%	E1
R49	A10266-2231	22K 5%	E2
R50	A10266-2231	22K 5%	E1
R51	A10266-3911	390 5%	K2
R52	A10266-3911	390 5%	K1
R53	A10266-3911	390 5%	K2
R54	A10266-3911	390 5%	K1
R55	A10266-3911	390 5%	K2
R56	A10266-3911	390 5%	L1
R57	A10266-3911	390 5%	J2
R58	A10266-3911	390 5%	L1
R59	A10266-3911	390 5%	J2
R60	A10266-3911	390 5%	L1
R61	A10266-1051	1M 5%	E2
R62	A10266-1051	1M 5%	D1
R63	A10266-3351	3.3M 5%	E2
R64	A10266-3351	3.3M 5%	D1
R66	A10266-4731	47K 5%	F1
R68	A10266-1021	1K 5%	F1
R69	A10266-5151	5.1M 5%	A2
R70	A10266-5151	5.1M 5%	A1

R71	A10266-8211	820 5%	I2
R72	A10266-8211	820 5%	M1
R73	A10266-1821	1.8K 5%	I2
R74	A10266-1821	1.8K 5%	M1
R75	A10266-3321	3.3K 5%	I2
R76	A10266-3321	3.3K 5%	L1
R77	A10266-2031	20K 5%	G1
R78	C 3670-4	5K Pot	G1
R79	A10266-4741	470K 5%	K2
R80	A10266-4741	470K 5%	L1
R81	A10266-1521	1.5K 5%	I2
R82	A10266-1521	1.5K 5%	L2
S1	C 7325-1	DPDT	G1
S2	C 7325-1	DPDT	F1
U1	C 7558-7	MC33079	B2
U2	C 7558-7	MC33079	B1
U3	C 4345-2	LM339	C2
U4	C 4345-2	LM339	C1
U5	C 4345-2	LM339	F2
U6	C 4345-2	LM339	F1
Z1	--- Not Used ---		G1
Z2	--- Not Used ---		G1
1	D 7940-6	Display Board	

8 Module Information

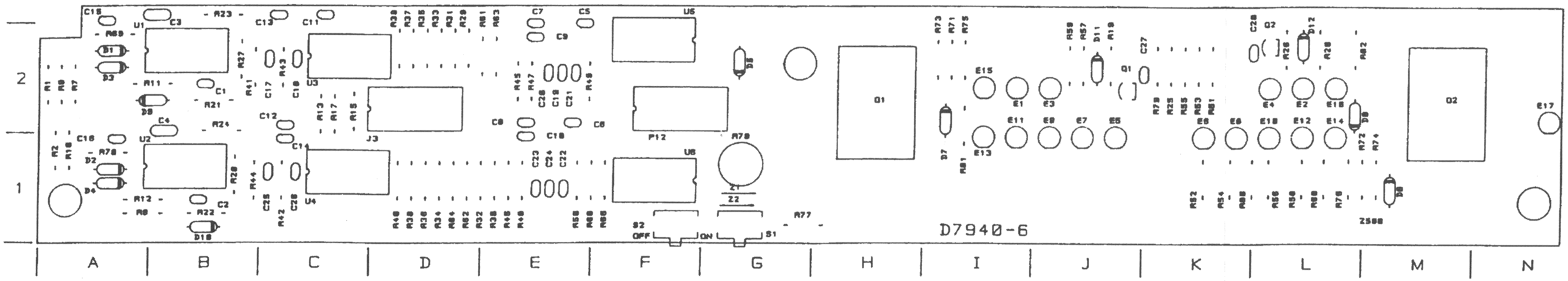

Figure 8.6 Q43018-3 Display Module Map

8 Module Information

8.10 Q43311-2 Main Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 5362-6	2.2µF 50V	I4
C2	C 3913-8	470µF 35V	G4
C4	C 6802-0	.47µF 50V	I5
C7	C 6804-6	.1µF 35V	C2
C100/200	C 8576-8	100µF 35V	J2/F2
C101/201	C 8338-3	47pF 300V	J3/F3
C102/202	C 8576-8	100µF 35V	J5/F5
C103/203	C 6805-3	.022µF 100V	I3/F3
C104/204	C 6805-3	.022µF 100V	J3/G3
C105/205	C 6813-7	27pF 200V	M3/A3
C106/206	C 6813-7	27pF 200V	N3/C3
C107/207	C 7870-6	.33µF 63V	I5/G5
C108/208	C 6813-7	27pF 200V	M4/B4
C109/209	C 8576-8	100µF 35V	K5/E5
C110/210	C 5362-6	2.2µF 50V	J5/F5
C111/211	C 6807-9	.001µF 100V	I3/F3
C112/212	C 8990-1	.18µF 63V	N2/B2
C113/213	C 8989-3	6.8µF 50V	M2/B2
C114/214	C 8576-8	100µF 35V	N2/B2
C115/215	C 8576-8	100µF 35V	M2/B2
C116/216	C 8989-3	6.8µF 50V	M1/B1
C117/217	C 8990-1	.18µF 63V	N1/B1
C118/218	C 6813-7	27pF 200V	M4/B4
C119/219	C 6802-0	.47µF 50V	J5/E5
C120/220	C 6804-6	.1µF 50V	O4/D4
C121/221	C 6804-6	.1µF 50V	L4/A4
C122/222	C 5194-3	68pF Disc	O4/D5
C123/223	C 6808-7	470pF 100V	J3/F3
C124/224	C 5194-3	68pF Disc	L5/A4
C129/229	C 6812-9	47pF 100V	I3/F3
C130/230	C 6814-5	12pF 200V	I3/G3
C131/231	C 6814-5	12pF 200V	I3/G3
C132/232	C 6806-1	.01µF 100V	L3/D3
C133/233	C 6813-7	27pF 200V	H2/G2
C134/234	C 6805-3	.022µF 100V	N2/A2
C135/235	C 6805-3	.022µF 100V	L3/D3
C136/236	C 6808-7	470pF 100V	O2/A2
C137/237	C 6808-7	470pF 100V	L2/D2
C138/238	C 6812-9	47pF 100V	I3/G3
C139/239	C 6812-9	47pF 100V	I3/G3
C140/240	C 6814-5	12pF 200V	M3/B3
C141/241	C 6814-5	12pF 200V	M3/B3
C143/243	C 6808-7	470pF 100V	N4/C4
C144/244	C 8576-8	100µF 35V	I2/G2
C145/245	C 6812-9	47pF 100V	I2/F2
C146/246	C 6812-9	47pF 100V	K4/E4
C147/247	--- Not Used ---		N3/C3
C148/248	C 6808-7	470pF 100V	M4/A4
C149/249	C 6807-9	.001µF 100V	M4/B4
C150/250	--- Not Used ---		O5/D5
C151/251	C 6806-1	.01µF 100V	L5/A5
C152/252	C 6811-1	100pF 200V	N4/C4
C153/253	C 6804-6	.1µF 50V	J2/F2
C154/254	C 8426-6	.1µF 250V	M5/B5
C155/255	C 6804-6	.1µF 50V	K2/E2
C156/256	C 6804-6	.1µF 50V	N1/A1
C157/257	C 6813-7	27pF 200V	J3/F3
C159/259	C 8551-1	.01µF 400V	H2/G2
C160/260	C 6811-1	100pF 200V	M4/A4
D1	C 2851-1	1N4004	H4
D2	C 2851-1	1N4004	H4
D3	C 2851-1	1N4004	I4
D4	C 2851-1	1N4004	H4
D5	C 2851-1	1N4004	H4
D6	C 2851-1	1N4004	G4
D7	C 2851-1	1N4004	G4
D100/200	C 3181-2	1N4148	J5/F5
D101/201	C 3181-2	1N4148	J6/F6
D108/208	C 3181-2	1N4148	I3/F3
D109/209	C 3181-2	1N4148	N4/C4
D110/210	C 3181-2	1N4148	M4/A4
D111/211	--- Not Used ---		M4/A4
D112/212	C 3181-2	1N4148	M3/B3
D113/213	C 3181-2	1N4148	M3/B3
D114/214	C 8158-5	1SS143	N3/C3
D115/215	C 8158-5	1SS143	M3/A3
D119/219	C 3181-2	1N4148	O4/D4
D120/220	C 3181-2	1N4148	L4/A4
D121/221	C 3824-7	1N9708	J4/F4
D122/222	C 3181-2	1N4148	J3/F3
D123/223	--- Not Used ---		N4/C4
D124/224	C 3181-2	1N4148	K3/E3
D125/225	C 3181-2	1N4148	K4/E4
D126/226	C 8158-5	1SS143	L4/A4
D127/227	C 8158-5	1SS143	O4/D4
D128/228	C 3181-2	1N4148	J5/F5
D129/229	--- Not Used ---		L3/C3
D130/230	C 3181-2	1N4148	O4/D4
D131/231	C 3181-2	1N4148	N4/C4
D132/232	C 3181-2	1N4148	M4/A4
D133/233	C 3181-2	1N4148	L4/A4
E100/200	C 9857-1	Red LED	J5/F5
E101/201	C 9857-1	Red LED	J6/F6
HW16	C 1811-6	4" Cable Tie	O5
HW17	C 1811-6	4" Cable Tie	N5
HW18	C 1811-6	4" Cable Tie	B5
HW19	C 1811-6	4" Cable Tie	A5

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J2	C 4508-5	16 Pin IC Skt.	H4
J100/200	C 8432-4	3 Cond Ph Jk	I1/G1
J100X/200X	C 6778-2	Ph Jk Cover	I1/G1
J500	D 8395-2	7.75"12pin Cbl	O5
J600	D 8397-8	2.5" 12pin Cbl	N5
J700	D 8397-8	2.5" 12pin Cbl	B5
J800	D 8395-2	7.75"12pin Cbl	A5
N101/201	D 7946-3	Res Net-ODEP	M2/C2
N102/202	D 6082-8	Res Net-C	J4/F4
P1	C 7593-4	5pos Header	H2
P6	C 8418-3	3pos Header	H2
P11	C 7593-4	5pos Header	H5
P101/201	C 7592-6	4pos Header	J1/F1
Q100/200	D 2961-7	2961	N3/C3
Q101/201	C 8104-9	MPSW92	M3/B3
Q102/202	C 8103-1	MPSW42	N3/C3
Q103/203	C 3625-8	2N4125	M3/B3
Q104/204	C 8104-9	MPSW92	N4/C4
Q105/205	C 8104-9	MPSW92	N4/C4
Q106/206	C 3625-8	2N4125	O3/A3
Q107/207	C 3786-8	MPS4250A	M4/B4
Q108/208	C 5891-4	MTS105 Therm	N4/C4
Q109/209	D 2961-7	2961	K3/E3
Q110/210	C 8103-1	MPSW42	M4/B4
Q111/211	C 8103-1	MPSW42	M4/B4
Q112/212	C 3625-8	2N4125	J4/E4
Q113/213	C 3625-8	2N4125	J4/F4
Q114/214	C 7458-0	2N4123	K3/E3
Q115/215	D 2962-5	MPSA18	O5/D5
Q116/216	C 3786-8	MPS4250A	L5/A5
Q117/217	D 2961-7	2961	O3/A3
Q118/218	D 2961-7	2961	O3/A3
Q119/219	C 3625-8	2N4125	K3/E3
Q120/220	C 3625-8	2N4123	K3/E3
Q121/221	C 7458-0	2N4123	O4/D4
Q122/222	C 3625-8	2N4125	L3/A3
Q123/223	C 3625-8	2N4125	K4/E4
Q124/224	--- Not Used ---		M5/B5
Q125/225	--- Not Used ---		N5/C5
Q126/226	C 3625-8	2N4125	K6/E6
Q127/227	C 7458-0	2N4123	K5/E5
Q128/228	C 3625-8	2N4125	K5/E5
Q129/229	C 7458-0	2N4123	K5/E5
Q130/230	C 3625-8	2N4125	K5/E5
Q131/231	C 3625-8	2N4125	L3/D3
Q132/232	C 3625-8	2N4125	K3/D3
Q133/233	C 3625-8	2N4125	O4/D4
Q134/234	C 7458-0	2N4123	L3/A3

R1	A10265-10021	10K 1%	E2
R4	A10265-10521	10.5K 1%	D1
R7	A10266-4331	43K 5%	I6
R8	A10265-75021	75K 1%	H6
R10	--- Not Used ---		C2
R17	A10265-75021	75K 1%	H6
R18	A10266-4331	43K 5%	G6
R19	A10266-2R72	2.7 5% .5W	I4
R100/200	--- Not Used ---		I3/G3
R101/201	A10265-10211	1.02K 1%	J2/F2
R102/202	A10266-5111	510 5%	K4/E4
R103/203	A10265-20523	20.5K 1% 1W	J3/F3
R104/204	A10265-26711	2.67K 1%	M3/A3
R105/205	A10265-26711	2.67K 1%	N3/C3
R106/206	A10265-11821	11.8K 1%	L3/A3
R107/207	A10266-6831	68K 5%	M3/A3
R108/208	A10266-8211	820 5%	N4/C4
R109/209	A10266-9101	91 5%	N4/C4
R110/210	A10266-6831	68K 5%	N3/C3
R111/211	A10265-11821	11.8 1%	03/D3
R112/212	A10265-49921	49.9K 1%	H3/G3
R113/213	A10265-48711	4.87K 1%	I4/F4
R114/214	A10266-1521	1.5K 5%	I4/G4
R115/215	A10266-5141	510K 5%	L2/C2
R116/216	A10266-3351	3.3M 5%	I4/G4
R117/217	A10266-4731	47K 5%	H3/G3
R118/218	A10265-68101	681 1%	M4/B4
R119/219	A10265-12111	1.21K 1%	N5/C5
R120/220	A10265-68101	681 1%	M4/B4
R121/221	C 5062-2	100K LIN POT	O1/A1
R122/222	A10266-2741	270K 5%	N2/A2
R123/223	A10266-2032	20K 5% .5W	O2/A2
R124/224	A10266-6821	6.8K 5%	O1/A1
R125/225	A10266-1011	100 5%	O2/A2
R126/226	A10266-1011	100 5%	O2/A2
R127/227	A10266-6821	6.8K 5%	N3/A3
R128/228	A10266-1331	13K 5%	N2/A2
R129/229	A10266-1041	100K 5%	N3/A3
R130/230	A10266-1041	100K 5%	L3/D3
R131/231	A10266-1331	13K 5%	L3/D3
R132/232	C 5062-2	100K LIN POT	K1/E1
R133/233	A10266-2741	270K 5%	K2/E2
R134/234	A10266-2032	20K 5% .5W	K2/D2
R135/235	A10266-1011	100 5%	K2/D2
R136/236	A10266-6821	6.8K 5%	L2/D2
R137/237	A10266-1011	100 5%	K2/D2
R138/238	A10266-6821	6.8K 5%	L3/C3
R139/239	A10266-8211	820 5%	M4/A4
R140/240	A10266-9101	91 5%	M4/A4
R141/241	A10266-1541	150K 5%	N3/A3
R142/242	A10266-1541	150K 5%	L3/D3
R143/243	A10266-4711	470 5%	K6/D6

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R144/244	A10266-4711	470 5%	K5/D5
R145/245	A10266-4711	470 5%	J6/E5
R146/246	A10265-11821	11.8K 1%	O4/D4
R147/247	C 5868-2	0 OHM	O5/D5
R148/248	A10265-20011	2K 1%	N4/C4
R149/249	A10266-1012	100 5% .5W	L5/A5
R150/250	A10265-20011	2K 1%	M4/A4
R151/251	A10265-11821	11.8K 1%	L4/A4
R152/252	A10265-11821	11.8K 1%	O2/A2
R153/253	A10124-24	#24 Buss Wire	I3/G3
R154/254	A10266-5601	56 5%	K5/D5
R155/255	A10266-4731	47K 5%	I4/F4
R156/256	A10266-1321	1.3K 5%	N2/A2
R157/257	A10266-1321	1.3K 5%	L2/D2
R158/258	A10266-9121	9.1K 5%	K2/E2
R159/259	A10266-1331	13K 5%	J3/F3
R160/260	A10266-5601	56 5%	K5/D5
R161/261	A10266-4701	47 5%	M3/B3
R162/262	A10266-4701	47 5%	M3/B3
R163/263	A10266-5601	56 5%	K5/D5
R164/264	A10266-4711	470 5%	K5/D5
R165/265	A10266-4711	470 5%	K5/D5
R166/266	A10266-4711	470 5%	K4/D4
R167/267	A10265-10011	1K 1%	O2/A2
R168/268	A10265-95301	953 1%	O2/A2
R169/269	A10266-1041	100K 5%	N3/C3
R170/270	A10265-10011	1K 1%	K3/E3
R171/271	A10265-95301	953 1%	K3/E3
R172/272	A10266-1041	100K 5%	M3/A3
R173/273	A10266-5601	56 5%	K5/D5
R174/274	A10265-10721	10.7K 1%	I2/G2
R175/275	A10265-46411	4.64K 1%	H2/G2
R176/276	A10265-10721	10.7K 1%	J2/F2
R177/277	A10265-13021	13.0K 1%	H2/G2
R179/279	A10266-1321	1.3K 5%	K4/E4
R180/280	A10266-4711	470 5%	M3/A3
R181/281	A10265-48711	4.87K 1%	M4/B4
R182/282	A10266-2201	22 5%	J2/F2
R183/283	A10266-4731	47K 5%	O3/D3
R184/284	A10266-4741	470K 5%	K5/D5
R185/285	A10266-4731	47K 5%	O4/D3
R186/286	A10266-2751	2.7M 5%	J5/E5
R187/287	A10266-3321	3.3K 5%	J5/E5
R188/288	A10266-3321	3.3K 5%	J6/E6
R189/289	A10266-2731	27K 5%	J5/E5
R190/290	A10266-2051	2M 5%	J5/F5
R191/291	A10266-4731	47K 5%	L3/A3
R192/292	A10266-4731	47K 5%	L3/A3
R193/293	A10265-10021	10K 1%	J5/F5
R194/294	A10265-20021	20K 1%	J2/F2
R195/295	A10266-4701	47 5%	J4/F4
R196/296	A10266-3921	3.9K 5%	K4/E4
R197/297	A10265-10021	10K 1%	K4/E4
R198/298	A10266-3921	3.9K 5%	K3/E3
R199/299	A10265-10021	10K 1%	K3/E3
R500/600	A10266-3041	300K 5%	I3/F3
R501/601	A10266-3041	300K 5%	J3/F3
R502/602	A10266-3041	300K 5%	I3/F3
R503/603	A10266-4702	47 5% .5W	J2/F2
R504/604	A10266-1041	100K 5%	L2/C2
R505/605	A10266-1041	100K 5%	L2/C2
R506/606	A10266-1521	1.5K 5%	J5/F5
R507/607	A10266-4711	470 5%	J5/F5
R508/608	A10266-1041	100K 5%	J5/F5
R509/609	A10265-49911	4.99K 1%	I3/G3
R510/610	A10265-49911	4.99K 1%	H2/G2
R511/611	A10265-49911	4.99K 1%	H2/G2
R512/612	C 9079-2	200/220 Pot	H3/H3
R513/613	A10265-49911	4.99K 1%	H3/G3
R514/614	C 7340-0	24 5% 3W	H1/H1
R515/615	A10266-1821	1.8K 5%	J2/F2
R516/616	--- Not Used ---		L2/C2
R517/617	A10266-9101	91 5%	M4/B4
R518/618	A10266-9101	91 5%	M4/B4
R519/619	A10265-12111	1.21K 1%	M5/A5
R520/620	--- Not Used ---		M5/A5
R521/621	--- Not Used ---		M5/B5
R522/622	--- Not Used ---		M5/A5
R523/623	--- Not Used ---		N5/C5
R524/624	--- Not Used ---		N5/C5
R525/625	--- Not Used ---		M5/B5
R526/626	A10265-10021	10K 1%	I5/F5
R527/627	A10266-3921	3.9K 5%	L4/D4
R528/628	A10265-10021	10K 1%	L4/D4
R529/629	A10266-4731	47K 5%	L4/D4
R530/630	A10265-10021	10K 1%	O3/D4
R531/631	A10266-4731	47K 5%	L3/D3
R532/632	A10265-10021	10K 1%	L4/A4
R533/633	A10265-10021	10K 1%	O3/D3
R534/634	A10265-10021	10K 1%	L3/A3
R535/635	A10266-1R01	1 5%	O5/A5
S2	C 7325-1	DPDT Switch	H1
S3	C 7960-5	3 Pos Switch	H2
S4	C 6781-6	6P3T Switch	C1
TP1	C 6564-6	10P Header	L5
TP2	C 6564-6	10P Header	D5
TP3	C 7873-0	2P Header	F4
TP4	C 7873-0	2P Header	I4
U1	C 5095-2	MC7815CT	H5
U1X	C 9494-3	Heatsink	H5
U2	C 5096-0	MC7915CT	G5

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U2X	C 9494-3	Heasink	G5
U100/200	C 6911-9	UPA75	N2/B2
U101/201	C 6411-0	H11C2	J5/E5
U101X/201X	C 8019-9	6 pin IC Skt	J5/E5
U102/202	C 4345-2	LM339N	I5/G5
U102X/202X	C 3450-1	14 pin IC Skt	I5/G5
U103/203	C 6910-1	UPA76	L2/D2
U104/204	C 7558-7	MC33079P	I3/F3
U104X/204X	C 3450-1	14 pin IC Skt	I3/F3
Z01	--- Not Used ---		D1
Z02	--- Not Used ---		C1
Z03	--- Not Used ---		C1
Z04	--- Not Used ---		C2
Z05	--- Not Used ---		C2
PC Board	D 8688-0	REF MAIN	

8 Module Information

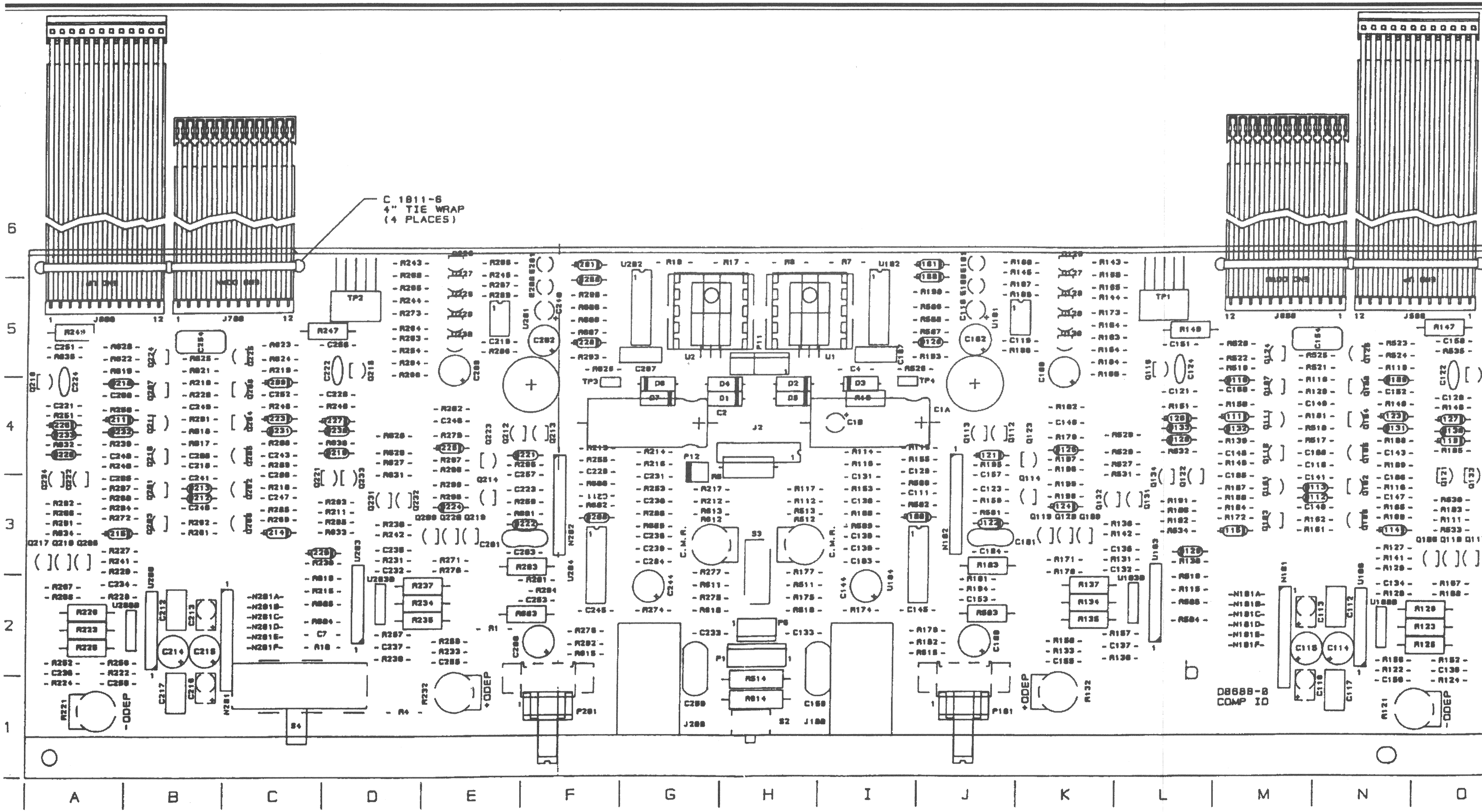

Figure 8.7 Q43311-2 Main Module Map

8 Module Information

8.11 Q43388-0 Main Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 5362-6	2.2µF 50V	I4
C2	C 3913-8	470µF 35V	G4
C4	C 6802-0	.47µF 50V	I5
C7	C 6804-6	.1µF 35V	D2
C1A	--- Not Used ---		I4
C100/200	C 8576-8	100µF 35V	J2/F2
C101/201	C 8338-3	47pF 300V	J3/E2
C102/202	C 8576-8	100µF 35V	J5/F5
C103/203	C 6805-3	.022µF 100V	I3/F3
C104/204	C 6805-3	.022µF 100V	J3/G3
C105/205	C 6813-7	27pF 200V	M3/A3
C106/206	C 6813-7	27pF 200V	N3/C3
C107/207	C 7870-6	.33µF 63V	I5/G5
C108/208	C 6813-7	27pF 200V	N4/B4
C109/209	C 8576-8	100µF 35V	K5/E5
C110/210	C 5362-6	2.2µF 50V	J5/F5
C111/211	C 6807-9	.001µF 100V	J3/F3
C112/212	C 8990-1	.18µF 63V	N2/B2
C113/213	C 8989-3	6.8µF 50V	N2/B2
C114/214	C 8576-8	100µF 35V	N2*/B2*
C115/215	C 8576-8	100µF 35V	N1/B1
C116/216	C 8989-3	6.8µF 50V	N1/B1
C117/217	C 8990-1	.18µF 63V	M1/B1
C118/218	C 6813-7	27pF 200V	N4/B4
C119/219	C 6802-0	.47µF 50V	J5/F5
C120/220	C 6804-6	.1µF 50V	O4/D4
C121/221	C 6804-6	.1µF 50V	L4/A4
C122/222	C10176-3	33pF 200V	O4/D5
C123/223	C 6808-7	470pF 100V	J3/F3
C124/224	C10176-3	33pF 200V	L5/A4
C129/229	C 6812-9	47pF 100V	J4/F3
C130/230	C 6814-5	12pF 200V	J5/F5
C131/231	C 6814-5	12pF 200V	J4/F5
C132/232	C 6806-1	.01µF 100V	L3/D3
C133/233	C 6813-7	27pF 200V	H2/G2
C134/234	C 6805-3	.022µF 100V	N2/A2
C135/235	C 6805-3	.022µF 100V	L3/D3
C136/236	C 6808-7	470pF 100V	O2/A2
C137/237	C 6808-7	470pF 100V	L2/D2
C138/238	C 6812-9	47pF 100V	I3/G3
C139/239	C 6812-9	47pF 100V	I3/G3
C140/240	C 6814-5	12pF 200V	N3/B3
C141/241	C 6814-5	12pF 200V	N3/B3
C143/243	C 6808-7	470pF 100V	N4/C4
C144/244	C 8576-8	100µF 35V	I2/G2
C145/245	C 6812-9	47pF 100V	J2/F2
C146/246	C 6812-9	47pF 100V	J3/F3
C147/247	--- Not Used ---		N3/C3
C148/248	C 6808-7	470pF 100V	M4/A4
C149/249	C 6807-9	.001µF 100V	N4/B4
C150/250	--- Not Used ---		O5/D5
C151/251	C 6806-1	.01µF 100V	L5/A5
C152/252	C 6811-1	100pF 200V	N4/C4
C153/253	C 6804-6	.1µF 50V	J2/F2
C154/254	C 8426-6	.1µF 250V	N5/B5
C155/255	C 6804-6	.1µF 50V	K2/E2
C156/256	C 6804-6	.1µF 50V	N1/A1
C157/257	C 6813-7	27pF 200V	J3/F3
C159/259	C 8551-1	.01µF 400V	I2/G2
C160/260	C 6811-1	100pF 200V	M4/A4
C161/261	C10176-3	33pF 200V	O4/C5
C162/262	C10176-3	33pF 200V	L5/A4

*For board D 8920-7 C114 map location is M2, and C214 is C2.

D1	C 2851-1	1N4004	H4
D2	C 2851-1	1N4004	H4
D3	C 2851-1	1N4004	I4
D4	C 2851-1	1N4004	H4
D5	C 2851-1	1N4004	H4
D6	C 2851-1	1N4004	G4
D7	C 2851-1	1N4004	G4
D100/200	C 3181-2	1N4148	J6/F6
D101/201	C 3181-2	1N4148	J6/F6
D108/208	C 3181-2	1N4148	J2/F3
D109/209	C 3181-2	1N4148	N4/C4
D110/210	C 3181-2	1N4148	M4/A4
D111/211	--- Not Used ---		M4/A4
D112/212	C 3181-2	1N4148	N3/B3
D113/213	C 3181-2	1N4148	N3/B3
D114/214	C 8158-5	1SS143	N3/C3
D115/215	C 8158-5	1SS143	M3/A3
D119/219	C 3181-2	1N4148	O4/D4
D120/220	C 3181-2	1N4148	L4/A4
D121/221	C 3824-7	1N9708	J4/E4
D122/222	C 3181-2	1N4148	J3/F3
D123/223	--- Not Used ---		N4/C4
D124/224	C 3181-2	1N4148	K3/E3
D125/225	C 3181-2	1N4148	K4/E4
D126/226	C 8158-5	1SS143	L4/A4
D127/227	C 8158-5	1SS143	O4/D4
D128/228	C 3181-2	1N4148	J5/F5
D129/229	C 5061-4	1N3070	L3/D3
D130/230	C 3181-2	1N4148	O4/D4
D131/231	C 3181-2	1N4148	N4/C4
D132/232	C 3181-2	1N4148	M4/A4
D133/233	C 3181-2	1N4148	L4/A4
D134/234	C 2851-1	1N4004	K4/E4
D135/235	C 2851-1	1N4004	K5/E4

8 Module Information

E100/200	C 9857-1	Red LED	J5/F5
E101/201	C 9857-1	Red LED	J6/F6
HW16	C 1812-7	5.5" Cable Tie	O5
HW17	C 1812-7	5.5" Cable Tie	N5
HW18	C 1812-7	5.5" Cable Tie	B5
HW19	C 1812-7	5.5" Cable Tie	A5
J2	C 4508-5	16 Pin IC Skt.	H4
J100/200	C 8432-4	3 Cond Ph Jk	I1/G1
J100X/200X	C 6778-2	Ph Jk Cover	I1/G1
J500	D 8395-2	7.75"12pin Cbl	O5
J600	D 8397-8	2.5" 12pin Cbl	N5
J700	D 8397-8	2.5" 12pin Cbl	B5
J800	D 8395-2	7.75"12pin Cbl	A5
N101/201	D 7946-3	Res Net-ODEP	M2/C2
N102/202	D 6082-8	Res Net-C	J4/E4
N101A/201A	--- Not Used ---		M2/C2
N101B/201B	--- Not Used ---		M2/C2
N101C/201C	--- Not Used ---		M2/C2
N101D/201D	--- Not Used ---		M2/C2
N101E/201E	--- Not Used ---		M2/C2
N101F/201F	--- Not Used ---		M2/C2
P1	C 7593-4	5pos Header	H2
P6	C 8418-3	3pos Header	H2
P11	C 7593-4	5pos Header	H5
P12	--- Not Used ---		G4
P101/201	C 7592-6	4pos Header	J1/F1
Q100/200	D 2961-7	2961	N3/C3
Q101/201	C 8104-9	MPSW92	M3/B3
Q102/202	C 8103-1	MPSW42	N3/C3
Q103/203	C 3625-8	2N4125	M3/B3
Q104/204	C 8104-9	MPSW92	N4/C4
Q105/205	C 8104-9	MPSW92	N4/C4
Q106/206	C 3625-8	2N4125	O3/A3
Q107/207	C 3786-8	MPS4250A	M4/B4
Q108/208	C 5891-4	MTS105 Therm	N4/C4
Q109/209	D 2961-7	2961	K3/E3
Q110/210	C 8103-1	MPSW42	M4/B4
Q111/211	C 8103-1	MPSW42	M4/B4
Q112/212	C 3625-8	2N4125	J4/E4
Q113/213	C 3625-8	2N4125	J4/F4
Q114/214	C 7458-0	2N4123	K3/E3
Q115/215	D 2962-5	MPSA18	O5/D5
Q116/216	C 3786-8	MPS4250A	L5/A5
Q117/217	D 2961-7	2961	O3/A3
Q118/218	D 2961-7	2961	O3/A3
Q119/219	C 3625-8	2N4125	K3/E3
Q120/220	C 3625-8	2N4123	K3/E3

Q121/221	C 7458-0	2N4123	O4/D4
Q122/222	C 3625-8	2N4125	L3/A3
Q123/223	C 3625-8	2N4125	K4/E4
Q124/224	--- Not Used ---		M5/B5
Q125/225	--- Not Used ---		N5/C5
Q126/226	C 3625-8	2N4125	K6/E6
Q127/227	C 7458-0	2N4123	K6/E6
Q128/228	C 3625-8	2N4125	K5/E5
Q129/229	C 7458-0	2N4123	K5/E5
Q130/230	C 3625-8	2N4125	K5/E5
Q131/231	C 3625-8	2N4125	L3/D3
Q132/232	C 3625-8	2N4125	K3/D3
Q133/233	C 3625-8	2N4125	O4/D4
Q134/234	C 7458-0	2N4123	L3/A3
Q135/235	C 3810-6	MPSA42	K4/E4
Q136/236	C 3578-9	MPSA93	K4/D5
R1	A10265-10021	10K 1%	E2
R4	A10265-10521	10.5K 1%	D1
R5	--- Not Used ---		H4
R7	A10266-4331	43K 5%	I6
R8	A10265-75021	75K 1%	H6
R10	--- Not Used ---		D2
R11	--- Not Used ---		L5
R12	--- Not Used ---		D5
R17	A10265-75021	75K 1%	H6
R18	A10266-4331	43K 5%	G6
R19	A10266-2R72	2.7 5% .5W	I4
R100/200	--- Not Used ---		I3/G3
R101/201	A10265-10211	1.02K 1%	J2/F2
R102/202	A10266-5111	510 5%	J3/F3
R103/203	A10265-20523	20.5K 1% 1W	J2/F2
R104/204	A10265-26711	2.67K 1%	M3/A3
R105/205	A10265-26711	2.67K 1%	N3/C3
R106/206	A10265-11821	11.8K 1%	L3/A3
R107/207	A10266-6831	68K 5%	M3/A3
R108/208	A10266-8211	820 5%	N4/C4
R109/209	A10266-1111	110 5%	N4/C4
R110/210	A10266-6831	68K 5%	N3/C3
R111/211	A10265-11821	11.8 1%	03/D3
R112/212	A10265-49921	49.9K 1%	H3/G3
R113/213	A10265-48711	4.87K 1%	J4/F4
R114/214	A10266-1521	1.5K 5%	I4/G4
R115/215	A10266-5141	510K 5%	L2/D2
R116/216	A10266-3351	3.3M 5%	J4/F4
R117/217	A10266-4731	47K 5%	H3/G3
R118/218	A10265-68101	681 1%	N4/B4
R119/219	A10265-12111	1.21K 1%	N5/C5
R120/220	A10265-68101	681 1%	N4/B4
R121/221	C 5062-2	100K LIN POT	O1/A1
R122/222	A10266-2741	270K 5%	N2/A2
R123/223	A10266-2032	20K 5% .5W	O2/A2

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R124/224	A10266-6821	6.8K 5%	O1/A1
R125/225	A10266-1011	100 5%	O2/A2
R126/226	A10266-1011	100 5%	O2/A2
R127/227	A10266-6821	6.8K 5%	N3/A3
R128/228	A10266-1331	13K 5%	N2/A2
R129/229	A10266-1041	100K 5%	N3/A3
R130/230	A10266-1041	100K 5%	L3/D3
R131/231	A10266-1331	13K 5%	L3/D3
R132/232	C 5062-2	100K LIN POT	K1/E1
R133/233	A10266-2741	270K 5%	K2/E2
R134/234	A10266-2032	20K 5% .5W	M3/C3
R135/235	A10266-1011	100 5%	K2/E2
R136/236	A10266-6821	6.8K 5%	L2/D2
R137/237	A10266-1011	100 5%	K2/E2
R138/238	A10266-6821	6.8K 5%	L3/D3
R139/239	A10266-8211	820 5%	M4/A4
R140/240	A10266-1111	110 5%	M4/A4
R141/241	A10266-1541	150K 5%	N3/A3
R142/242	A10266-1541	150K 5%	L3/D3
R143/243	A10266-4711	470 5%	K6/D6
R144/244	A10266-4711	470 5%	K5/D5
R145/245	A10266-4711	470 5%	J6/E6
R146/246	A10265-11821	11.8K 1%	O4/D4
R147/247	C 5868-2	0 OHM	O5/D5
R148/248	A10265-20011	2K 1%	N4/C4
R149/249	A10266-1012	100 5% .5W	L5/A5
R150/250	A10265-20011	2K 1%	M4/A4
R151/251	A10265-11821	11.8K 1%	L4/A4
R152/252	A10265-11821	11.8K 1%	O2/A2
R153/253	A10124-24	#24 Buss Wire	J4/G3
R154/254	A10266-5601	56 5%	K5/D5
R155/255	A10266-4731	47K 5%	J4/F4
R156/256	A10266-1321	1.3K 5%	N2/A2
R157/257	A10266-1321	1.3K 5%	L2/D2
R158/258	A10266-9121	9.1K 5%	K2/E2
R159/259	A10266-1331	13K 5%	J3/F3
R160/260	A10266-5601	56 5%	K6/D6
R161/261	A10266-4701	47 5%	N3/B3
R162/262	A10266-4701	47 5%	N3/B3
R163/263	A10266-5601	56 5%	K5/D5
R164/264	A10266-4711	470 5%	K5/D5
R165/265	A10266-4711	470 5%	K5/D6
R166/266	A10266-4711	470 5%	K5/D5
R167/267	A10265-10011	1K 1%	O2/A2
R168/268	A10265-95301	953 1%	O2/A2
R169/269	A10266-1041	100K 5%	N3/C3
R170/270	A10265-10011	1K 1%	K3/E3
R171/271	A10265-95301	953 1%	K3/E3
R172/272	A10266-1041	100K 5%	M3/A3
R173/273	A10266-5601	56 5%	K5/D5
R174/274	A10265-11821	11.8K 1%	I2/G2
R175/275	A10265-48711	4.87K 1%	H2/G2
R176/276	A10265-11821	11.8K 1%	J2/F2
R177/277	A10265-13321	13.3K 1%	H3/G3
R179/279	A10266-1321	1.3K 5%	K4/E4
R180/280	A10266-4711	470 5%	M3/A3
R181/281	A10265-48711	4.87K 1%	N4/B4
R182/282	A10266-2201	22 5%	J2/F2
R183/283	A10266-4731	47K 5%	O3/D3
R184/284	A10266-4741	470K 5%	K5/D5
R185/285	A10266-4731	47K 5%	O4/D3
R186/286	A10266-2751	2.7M 5%	J5/F5
R187/287	A10266-3321	3.3K 5%	K6/E6
R188/288	A10266-3321	3.3K 5%	K6/E6
R189/289	A10266-2731	27K 5%	K5/E5
R190/290	A10266-2051	2M 5%	J5/F6
R191/291	A10266-4731	47K 5%	L3/A3
R192/292	A10266-4731	47K 5%	L3/A3
R193/293	A10265-10021	10K 1%	J5/F5
R194/294	A10265-20021	20K 1%	J2/F2
R195/295	A10266-4701	47 5%	K4/F3
R196/296	A10266-3921	3.9K 5%	K4/E4
R197/297	A10265-10021	10K 1%	K4/E4
R198/298	A10266-3921	3.9K 5%	K3/E3
R199/299	A10265-10021	10K 1%	K3/E3
R500/600	A10266-3041	300K 5%	J3/F3
R501/601	A10266-3041	300K 5%	J3/F3
R502/602	A10266-3041	300K 5%	J3/F3
R503/603	A10266-4702	47 5% .5W	J2/F2
R504/604	A10266-5141	510K 5%	L2/D2
R505/605	A10266-5141	510K 5%	L2/D2
R506/606	A10266-1521	1.5K 5%	J5/F5
R507/607	A10266-4711	470 5%	J5/F5
R508/608	A10266-2731	27K 5%	J5/F5
R509/609	A10265-49911	4.99K 1%	I3/G3
R510/610	A10265-49911	4.99K 1%	H2/G2
R511/611	A10265-49911	4.99K 1%	H2/G2
R512/612	C 9079-2	200/220 Pot	H3/H3
R513/613	A10265-49911	4.99K 1%	H3/G3
R514/614	C 7340-0	24 5% 3W	H1/H1
R515/615	A10266-1821	1.8K 5%	J1/F1
R516/616	A10266-1051	1M 5%	L2/D2
R517/617	A10266-1111	110 5%	N4/B4
R518/618	A10266-1111	110 5%	N4/B4
R519/619	A10265-12111	1.21K 1%	M5/A5
R520/620	--- Not Used ---		M5/A5
R521/621	--- Not Used ---		N5/B5
R522/622	--- Not Used ---		M5/A5
R523/623	--- Not Used ---		N5/C5
R524/624	--- Not Used ---		N5/C5
R525/625	--- Not Used ---		N5/B5
R526/626	A10265-10021	10K 1%	I5/F5
R527/627	A10266-3921	3.9K 5%	L4/D4
R528/628	A10265-10021	10K 1%	L4/D4

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R529/629	A10266-4731	47K 5%	L4/D4
R530/630	A10265-10021	10K 1%	O3/D4
R531/631	A10266-4731	47K 5%	L3/D3
R532/632	A10265-10021	10K 1%	L4/A4
R533/633	A10265-10021	10K 1%	O3/D3
R534/634	A10265-10021	10K 1%	L3/A3
R535/635	A10266-1R01	1 5%	O5/A5
R536/636	A10266-4701	47 5%	K5/E5
R537/637	A10266-1031	10K 5%	K4/D4
R538/638	A10266-1031	10K 5%	L4/D5
R539/639	--- Not Used ---		J1/F1
R540/640	--- Not Used ---		J1/E1
R541/641	--- Not Used ---		I2/G2
R542/642	--- Not Used ---		I3/G3
R543/643	--- Not Used ---		J5/F5
R544/644	A10266-2031	20K 5%	L4/E4
R545/645	A10266-2031	20K 5%	M4/D4
S2	C 7325-1	DPDT Switch	H1
S3	C 7960-5	3 Pos Switch	H2
S4	C 6781-6	6P3T Switch	C1
TP1	C 6564-6	10P Header	L5
TP2	C 6564-6	10P Header	D5
TP3	C 9896-9	Test Point	F4
TP4	C 9896-9	Test Point	I4

U1	C 5095-2	MC7815CT	H5
U1X	C 9494-3	Heatsink	H5
U2	C 5096-0	MC7915CT	G5
U2X	C 9494-3	Heasink	G5
U100/200	C 6911-9	UPA75	N2/B2
U101/201	C 6411-0	H11C2	J5/E5
U101X/201X	C 8019-9	6 pin IC Skt	J5/E5
U102/202	C 4345-2	LM339N	I5/G5
U102X/202X	C 3450-1	14 pin IC Skt	I5/G5
U103/203	C 6910-1	UPA76	L2/D2
U104/204	C 7558-7	MC33079P	I3/F3
U104X/204X	C 3450-1	14 pin IC Skt	I3/F3
U100B/200B	--- Not Used ---		N2/B2
U103B/203B	--- Not Used ---		L2/D2
Z7	--- Not Used ---		G4
Z8	--- Not Used ---		H4
Z9	--- Not Used ---		B1
Z01	--- Not Used ---		D1
Z02	--- Not Used ---		C1
Z03	--- Not Used ---		C1
Z04	--- Not Used ---		C2
Z05	--- Not Used ---		C2
Z10	--- Not Used ---		B2
Z11	--- Not Used ---		M1

PC Board D 8825-8 or D 8920-7

8 Module Information

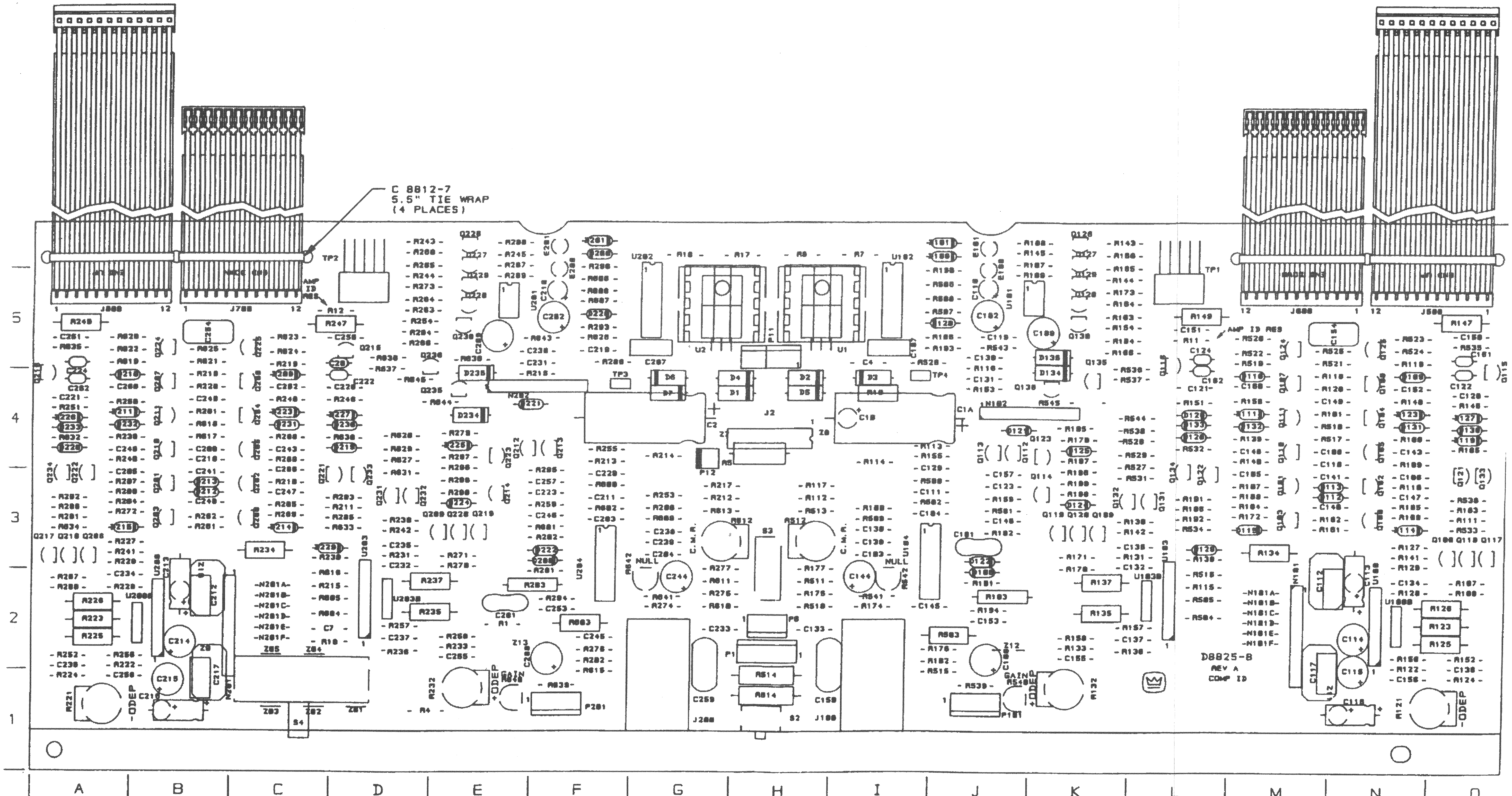

Figure 8.8 Q43388-0 Main Module Map

8 Module Information

8.12 Q43389-8 Output Module Parts List

Cir. Des.	C.P.N	Description	Map Loc
C01	A10434-473JD	.047µF 250V	G1
C02	C 8426-6	.1µF 250V	C2
C03	C 8426-6	.1µF 250V	L2
C04	C 8524-7	.0047µF 100V	F4
C05	C 6806-1	.01µF 100V	J4
C06	C 6806-1	.01µF 100V	G4
C07	C 6807-9	.001µF 100V	F3
C08	C 6810-3	180pF 100V	E3
C09	C 6809-5	220pF 100V	J3
C10	C 6807-9	.001µF 100V	I4
C11	--- Not Used ---		I4
C12	--- Not Used ---		I4
C13	--- Not Used ---		G2
C13A	C 8991-9	.47µF 63V	D3
C15	C 6811-1	100pF 200V	F3
C16	C 8426-6	.1µF 250V	H4
D01	C 2851-1	1N4004	E3
D02	C 2851-1	1N4004	F3
D03	C 2851-1	1N4004	I3
D04	C 2851-1	1N4004	J3
D05	C 2941-0	1N5402	A2
D06	C 2941-0	1N5402	M2
D07	C 2941-0	1N5402	B3
D08	C 2941-0	1N5402	K2
D15	C 2851-1	1N4004	A2
D16	C 2851-1	1N4004	N3
HW1	A10094-2	#4 Lockwasher	
HW2	A10094-2	#4 Lockwasher	
HW3	A10094-2	#4 Lockwasher	
HW4	A10094-2	#4 Lockwasher	
HW5	C 7481-2	4 Way Conn.	
HW6	C 7481-2	4 Way Conn.	
HW7	A10608-3	4-40X3/8 Spcr	
HW8	A10608-3	4-40X3/8 Spcr	
HW9	A10608-3	4-40X3/8 Spcr	
HW10	A10608-3	4-40X3/8 Spcr	
HW11	D 8441-4	Fishpaper	
HW12	A10020-1	4-40X.25 Stud	
HW13	A10020-1	4-40X.25 Stud	
HW14	A10020-1	4-40X.25 Stud	
HW15	A10020-1	4-40X.25 Stud	
L00	D 7701-2	2.5µH Coil	
L01	C 3510-2	470µH Choke	F4
L02	C 3510-2	470µH Choke	J4
P00	--- Not Used ---		F2
P500	C 9828-2	12 Pin Header	E3
P600	C 9828-2	12 Pin Header	J3
Q00	C 4647-1	TIP47 NPN	I4
Q01	C 8574-3	2SC2837 NPN	E5
Q05	C 8573-5	2SA1186 PNP	J5
Q12	C 8574-3	2SC2837 NPN	G5
Q16	C 8573-5	2SA1186 PNP	H5
Q17	C10155-7	2SC4793 NPN	F4
Q18	C 4647-1	TIP47 NPN	F4
Q19	C10156-5	2SA1837 PNP	I4
R00	A10266-6801	68 5%	F4
R01	A10266-1011	100 5%	E4
R02	C 7778-1	5.6 5% .5W FP	F3
R03	C 6486-2	.2 5% 5W	E2
R04	C 6486-2	.2 5% 5W	C2
R05	C 6486-2	.2 5% 5W	A1
R06	C 6486-2	.2 5% 5W	I2
R07	C 6486-2	.2 5% 5W	K2
R08	C 6486-2	.2 5% 5W	N1
R09	C 7779-9	22 5% FP	J3
R10	A10266-1011	100 5%	J4
R11	C 6625-5	5.6 5% 5W	H2
R12	A10266-2R74	2.7 5% 2W	C1
R13	A10266-6801	68 5%	J4
R14	A10266-2R74	2.7 5% 2W	M1
R15	C 6486-2	.2 5% 5W	M1
R16	C 6486-2	.2 5% 5W	E2
R17	C 6486-2	.2 5% 5W	F1
R18	C 6486-2	.2 5% 5W	B1
R19	C 6486-2	.2 5% 5W	J1
R20	C 6486-2	.2 5% 5W	H1
R21	C 7778-1	5.6 5% .5W FP	F1
R22	C 7779-9	22 5% FP	H3
R23	C 6844-2	250 Pot	H3
R24	A10266-1331	13K 5%	F4
R25	A10266-2221	2.2K 5%	F3
R26	C 6844-2	250 Pot	G4
R27	A10266-3911	390 5%	G4
R28	A10266-1331	13K 5%	I4
R29	A10266-5101	51 5%	F3
R30	A10265-10201	102 1%	D3
R31	C 6625-5	5.6 5% 5W	G2
R35	A10266-1R02	1 5% .5W	D4
R36	A10266-1R02	1 5% .5W	K4
R37	C 7779-9	22 5% FP	D3
R38	C 7779-9	22 5% FP	D2
R39	C 7779-9	22 5% FP	D3
R40	C 7779-9	22 5% FP	K3
R41	C 7779-9	22 5% FP	K3

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R42	C 7779-9	22 5% FP	J3
R43	A10266-5101	51 5%	G4
R44	A10266-2221	2.2K 5%	H3
R45	A10266-7511	750 5%	I4
R49	C 7779-9	22 5% FP	F2
R50	C 7779-9	22 5% FP	D2
R51	C 7779-9	22 5% FP	B2
R52	C 7779-9	22 5% FP	M2
R53	C 7779-9	22 5% FP	K2
R54	C 7779-9	22 5% FP	I2
Z3	C 5868-2	0 Ohm Jmp	D1
Z4	C 5868-2	0 Ohm Jmp	D3
Z8	C 5868-2	0 Ohm Jmp	D2
Z00	C 5868-2	0 Ohm Jmp	E1
Z01	C 5868-2	0 Ohm Jmp	E2
Z02	C 5868-2	0 Ohm Jmp	E3
Z03	C 5868-2	0 Ohm Jmp	E3
Z04	C 5868-2	0 Ohm Jmp	H3
Z05	C 5868-2	0 Ohm Jmp	H3
Z06	C 5868-2	0 Ohm Jmp	H3
Z07	C 5868-2	0 Ohm Jmp	I3
Z08	C 5868-2	0 Ohm Jmp	J3
Z09	C 5868-2	0 Ohm Jmp	J3
Z10	C 5868-2	0 Ohm Jmp	J2
Z11	C 5868-2	0 Ohm Jmp	J1
Z12	C 5868-2	0 Ohm Jmp	J2
Z13	C 5868-2	0 Ohm Jmp	J1
Z14	C 5868-2	0 Ohm Jmp	E3
Z16	C 5868-2	0 Ohm Jmp	E3
Z17	C 5868-2	0 Ohm Jmp	H1
Z18	C 5868-2	0 Ohm Jmp	H1
PC Board	P10423-5	THC #2	

8 Module Information

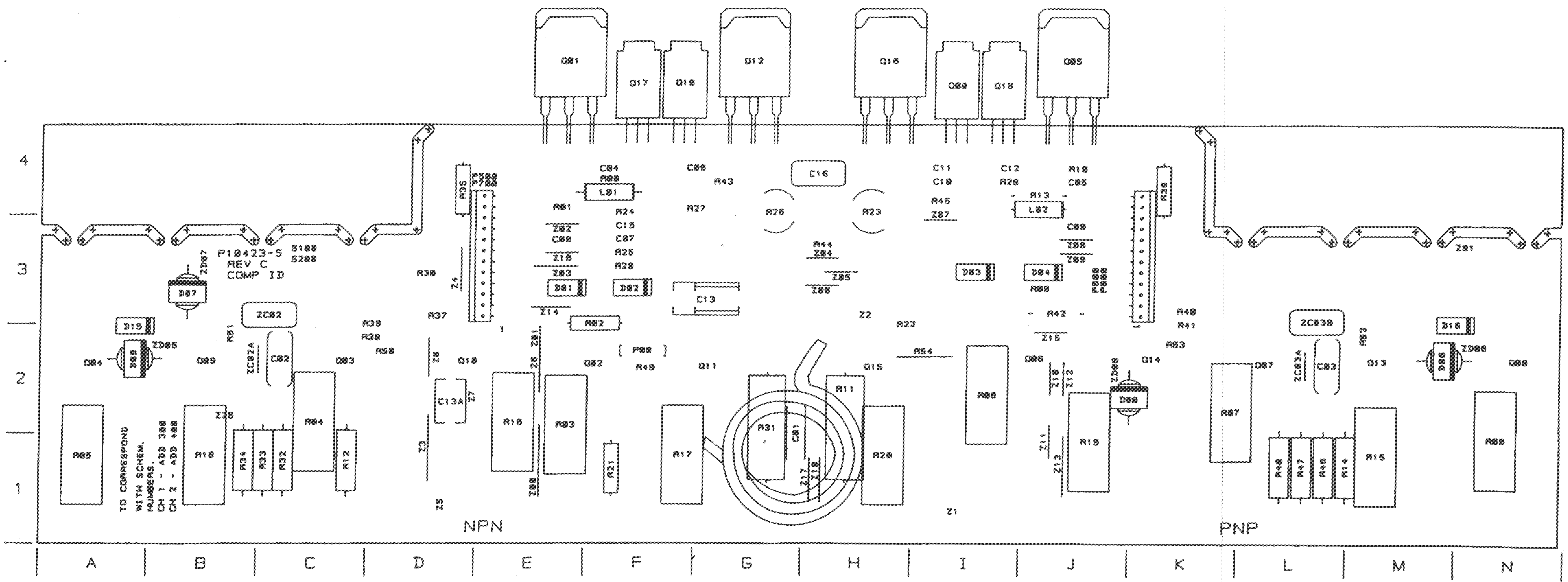

Figure 8.9 Q43389-8 Output Module Map

8 Module Information

8.13 Q43312-0 Display Module Parts List

Cir. Des.	C.P.N.	Description	Map Loc
C1	C 6813-7	27pF 200V	B2
C2	C 6813-7	27pF 200V	B1
C3	C 6802-0	.47µF 50V	B3
C4	C 6802-0	.47µF 50V	B2
C5	C 6804-6	.1µF 50V	E2
C6	C 6804-6	.1µF 50V	E2
C7	C 6804-6	.1µF 50V	E2
C8	C 6804-6	.1µF 50V	E2
C9	C 6804-6	.1µF 50V	E2
C10	C 6804-6	.1µF 50V	E1
C11	C 6804-6	.1µF 50V	C3
C12	C 6804-6	.1µF 50V	C2
C13	C 6804-6	.1µF 50V	C3
C14	C 6804-6	.1µF 50V	C1
C15	C 6802-0	.47µF 50V	A3
C16	C 6802-0	.47µF 50V	A1
C17	C 6807-9	.001µF 100V	C2
C18	C 6807-9	.001µF 100V	C2
C19	C 6807-9	.001µF 100V	E2
C20	C 6807-9	.001µF 100V	E2
C21	C 6807-9	.001µF 100V	E2
C22	C 6807-9	.001µF 100V	E1
C23	C 6807-9	.001µF 100V	E1
C24	C 6807-9	.001µF 100V	E1
C25	C 6807-9	.001µF 100V	C1
C26	C 6807-9	.001µF 100V	C1
C27	C 6804-6	.1µF 50V	K2
C28	C 6804-6	.1µF 50V	L2
D1	C 3181-2	1N4148	A2
D2	C 3181-2	1N4148	A1
D3	C 3181-2	1N4148	A2
D4	C 3181-2	1N4148	A1
D5	C 3181-2	1N4148	G2
D6	C 3181-2	1N4148	M1
D7	C 3181-2	1N4148	I2
D8	C 3181-2	1N4148	L2
D9	C 3181-2	1N4148	B2
D10	C 3181-2	1N4148	B1
D11	C 3181-2	1N4148	J2
D12	C 3181-2	1N4148	L2
E1	C 4431-0	Yellow LED	I2
E2	C 4431-0	Yellow LED	L2
E3	C10592-1	Green LED	J2
E4	C10592-1	Green LED	L2
E5	C10592-1	Green LED	J1
E6	C10592-1	Green LED	K1
E7	C10592-1	Green LED	J1
E8	C10592-1	Green LED	K1
E9	C10592-1	Green LED	J1
E10	C10592-1	Green LED	L1
E11	C10592-1	Green LED	I1
E12	C10592-1	Green LED	L1
E13	C10592-1	Green LED	I1
E14	C10592-1	Green LED	L1
E15	C10592-1	Green LED	I2
E16	C10592-1	Green LED	L2
E17	C 4342-9	Amber LED	N2
J3	D 6990-2	16 pin cable	D2
P12	D 6990-2	16 pin cable	F2
Q1	C 3625-8	2N4125	J2
Q2	C 3625-8	2N4125	L2
R1	A10265-10031	100K 1%	A2
R2	A10265-10031	100K 1%	A1
R7	A10265-10031	100K 1%	A2
R8	A10265-10031	100K 1%	A1
R9	A10265-10021	10K 1%	A2
R10	A10265-10021	10K 1%	A1
R11	A10265-49911	4.99K 1%	B2
R12	A10265-49911	4.99K 1%	A1
R13	A10265-82511	8.25K 1%	C2
R15	A10265-14321	14.3K 1%	C2
R17	A10265-82511	8.25K 1%	C2
R19	A10266-8211	820 5%	J2
R20	A10266-8211	820 5%	L2
R21	A10265-10021	10K 1%	B2
R22	A10265-10021	10K 1%	B1
R23	A10266-5121	5.1K 5%	B3
R24	A10266-5121	5.1K 5%	B2
R25	A10266-8211	820 5%	K2
R26	A10266-8211	820 5%	L2
R27	A10266-1851	1.8M 5%	B2
R28	A10266-1851	1.8M 5%	B1
R29	A10265-68111	6.81K 1%	D2
R30	A10265-68111	6.81K 1%	E1
R31	A10265-16911	1.69K 1%	D2
R32	A10265-16911	1.69K 1%	E1
R33	A10265-95301	953 1%	D2
R34	A10265-95301	953 1%	D1
R35	A10265-53601	563 1%	D2
R36	A10265-53601	536 1%	D1
R37	A10266-3011	300 5%	D2
R38	A10266-3011	300 5%	D1
R39	A10266-3911	390 5%	D2
R40	A10266-3911	390 5%	D1
R41	A10266-2231	22K 5%	B2

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R42	A10266-2231	22K 5%	C1
R43	A10266-2231	22K 5%	C2
R44	A10266-2231	22K 5%	B1
R45	A10266-2231	22K 5%	E2
R46	A10266-2231	22K 5%	E1
R47	A10266-2231	22K 5%	E2
R48	A10266-2231	22K 5%	E1
R49	A10266-2231	22K 5%	E2
R50	A10266-2231	22K 5%	E1
R51	A10266-3911	390 5%	K2
R52	A10266-3911	390 5%	K1
R53	A10266-3911	390 5%	K2
R54	A10266-3911	390 5%	K1
R55	A10266-3911	390 5%	K2
R56	A10266-3911	390 5%	L1
R57	A10266-3911	390 5%	J2
R58	A10266-3911	390 5%	L1
R59	A10266-3911	390 5%	J2
R60	A10266-3911	390 5%	L1
R61	A10266-1051	1M 5%	E2
R62	A10266-1051	1M 5%	D1
R63	A10266-3351	3.3M 5%	E2
R64	A10266-3351	3.3M 5%	D1
R66	A10266-4731	47K 5%	F1
R68	A10266-1021	1K 5%	F1
R69	A10266-5151	5.1M 5%	A2
R70	A10266-5151	5.1M 5%	A1

R71	A10266-8211	820 5%	I2
R72	A10266-8211	820 5%	M1
R73	A10266-1821	1.8K 5%	I2
R74	A10266-1821	1.8K 5%	M1
R75	A10266-3321	3.3K 5%	I2
R76	A10266-3321	3.3K 5%	L1
R77	A10265-12121	12.1K 1%	G1
R78	C 3670-4	5K Pot	G1
R79	A10266-4741	470K 5%	K2
R80	A10266-4741	470K 5%	L1
R81	A10266-1521	1.5K 5%	I2
R82	A10266-1521	1.5K 5%	L2
S1	C 7325-1	DPDT	G1
S2	C 7325-1	DPDT	F1
U1	C 7558-7	MC33079	B2
U2	C 7558-7	MC33079	B1
U3	C 4345-2	LM339	C2
U4	C 4345-2	LM339	C1
U5	C 4345-2	LM339	F2
U6	C 4345-2	LM339	F1
Z1	--- Not Used ---		G1
Z2	--- Not Used ---		G1
1	D 7940-6	Display Board	

8 Module Information

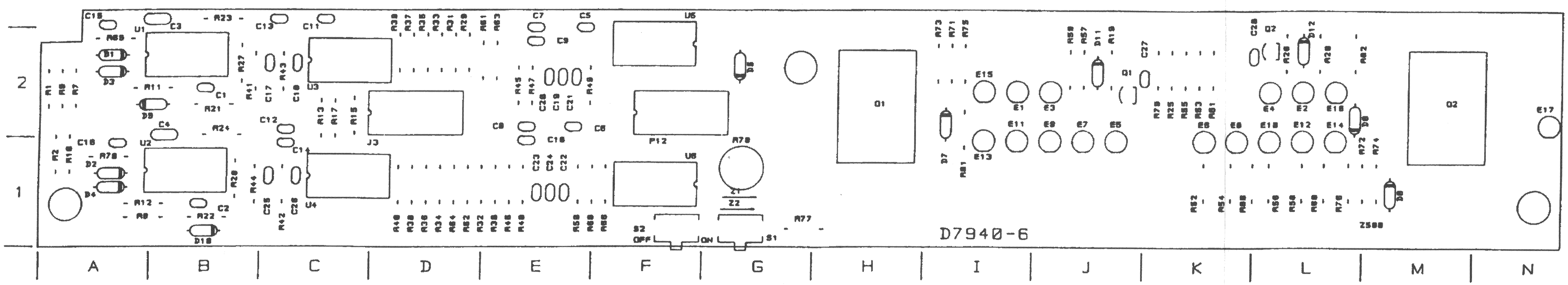
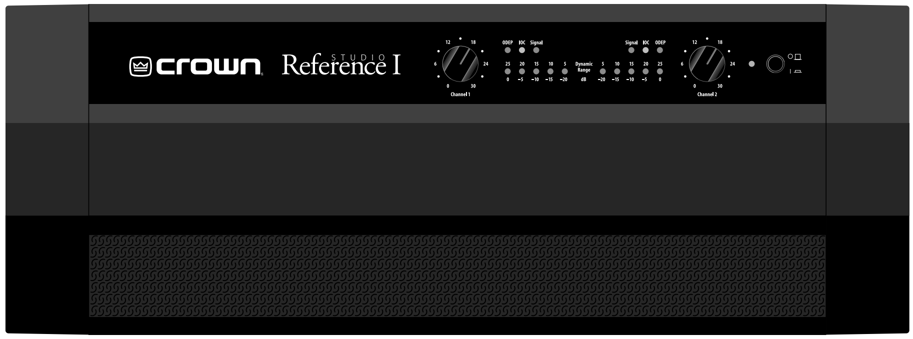


Figure 8.10 Q43312-0 Display Module Map

Studio Reference I
Studio Reference II

STUDIO REFERENCE SERIES



The stunning realism you will experience when listening to a Crown® Studio Reference™ amplifier will redefine your expectations. The evolution of this studio standard ushers in a new era of powerful, ultraquiet amplifiers capable of faithfully reproducing the most demanding of signals. This kind of sonic integrity does not happen accidentally. It demands the leadership and technical excellence for which Crown has long been known.

With the best transfer function in the industry, ultra-high dynamic range and extraordinary damping factor, your Studio Reference amplifier comes closer to the ideal "straight wire with gain" than any other amplifier. As you listen, it will become apparent—the amplifier's low-frequency transient response is the standard by which all others must be judged.

Studio Reference amplifiers integrate several cutting edge technologies that make them the most accurate reference amplifiers available. For example, in Stereo mode each channel can actually be treated as a separate amplifier because of its separate high-voltage power supplies and ultra-low crosstalk.

Crown's unconventional Grounded Bridge™ circuitry delivers incredible voltage swings without using stressful output transistor configurations like other more traditional amplifiers. This results in significantly lower distortion and superior reliability.

For more details about the Studio Reference I and Studio Reference II, contact the Crown Technical Support Group at 800-342-6939 or 574-294-8200. Also, visit the Crown Audio website at www.crownaudio.com.

Features

- **Patented ODEP® (Output Device Emulation Protection) circuitry detects and compensates for overheating and overload to keep the amplifier working when others would fail.**
- **IOC® (Input/Output Comparator) circuitry immediately alerts you of any distortion that exceeds 0.05% to provide dynamic proof of distortion-free performance.**
- **PIP™ (Programmable Input Processor) connector accepts accessories that tailor your amplifier to suit specific applications.**
- **Extremely wide dynamic range.**
- **Ultra-high damping factor delivers superior loudspeaker motion control for the cleanest, tightest bottom end you've ever felt—or heard.**
- **Super-low harmonic and intermodulation distortion give your amplifier the best transfer function in the business.**
- **Two mono modes (Bridge-Mono and Parallel-Mono) for driving a wide range of load impedances.**
- **Custom-designed, tape-wound, low-noise toroidal supplies with extremely high power density.**

Specifications

The following apply to units in dual mode with both channels driven into 8 ohm loads and an input sensitivity of 26 dB gain unless otherwise specified.

Power

Output Power: See power charts below.

Performance

Frequency Response: ±0.1 dB from 20 Hz to 20 kHz at 1watt.

Phase Response: +5 to –15 degrees from 20 Hz to 20 kHz at 1 watt.

Signal-to-Noise (A-weighted) below rated full bandwidth power: Studio Reference I: 120 dB. Studio Reference II: 117 dB.

Total Harmonic Distortion (THD): Less than 0.1% at full bandwidth power.

Intermodulation Distortion (IMD): (60 Hz and 7 kHz 4:1)

Studio Reference I: < 0.005% from full bandwidth power to 78 watts, rising linearly to 0.025% at 78 milliwatts.

Studio Reference II: < 0.005% from full bandwidth power to 36 watts rising linearly to 0.025% at 36 milliwatts.

Crosstalk (below rated full bandwidth power):

Studio Reference I: >100 dB from 20 Hz to 400 Hz and >70 dB at 20 kHz.
Studio Reference II: >100 dB from 20 Hz to 400 Hz and >65 dB at 20 kHz.

Damping Factor: >20,000 from 10 Hz to 400 Hz.

Voltage Gain (at the maximum level setting):

Studio Reference I:
103:1 ± 6% or 40 dB ±0.5 dB at 0.775 volt sensitivity.
57:1 ± 6% or 35 dB ± 0.5 dB at 1.4 volt sensitivity.
20:1 ± 6% at 26 dB gain ± 0.5 dB.

Studio Reference II:
69:1 ± 6% or 37 dB ± 0.5 dB at 0.775 volt sensitivity.
38:1 ± 6% or 32 dB ± 0.5 dB at 1.4 volt sensitivity.
20:1 ± 6% at 26 dB gain ± 0.5 dB

Load Impedance: Safe with all types of loads. 4-8 ohms in Stereo mode, 8-16 ohms in Bridge-mono mode, and 2-4 ohms in Parallel-Mono mode.

AC Line Voltage and Frequency Configurations Available (± 10%): 50 or 60 Hz; 100, 120, 200, 220 or 240VAC. Power draw at idle is 90 watts or less.

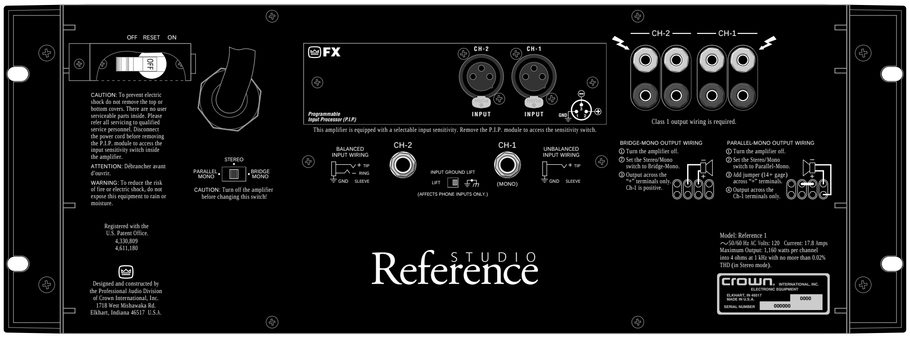
Studio Reference I	*1 kHz Power
4 ohm Stereo (per channel)	**1,160W**
8 ohm Stereo (per channel)	**780W**
8 ohm Bridge-Mono	**2,220W**
16 ohm Bridge-Mono	**1,580W**
2 ohm Parallel-Mono	**2,315W**
4 ohm Parallel-Mono	**1,565W**

*1 kHz Power: refers to maximum average power in watts at 1 kHz with 0.05% THD.

Studio Reference II	*1 kHz Power
4 ohm Stereo (per channel)	**555W**
8 ohm Stereo (per channel)	**355W**
8 ohm Bridge-Mono	**1,100W**
16 ohm Bridge-Mono	**715W**
2 ohm Parallel-Mono	**1,115W**
4 ohm Parallel-Mono	**710W**

*1 kHz Power: refers to maximum average power in watts at 1 kHz with 0.05% THD.

Studio Reference I
Studio Reference II



Controls

Power: A two-position front panel pushbutton on/off switch. Four-second turn-on delay.

Level: An independent 31-position detented front-panel level control for each channel.

Reset Switch: This back panel switch can be used to trip and reset the AC mains circuit breaker.

Stereo/Mono Switch: Back-panel switch selects between Stereo, Bridge-mono, and Parallel-mono modes.

Ground Lift Switch: The input signal ground may be isolated from the AC ground with this back-panel switch to help prevent unwanted ground loops. It affects only the phone jacks. It has no effect on the PIP module's XLR connectors. Activating the switch inserts an impedance between the sleeve of each phone input jack and the circuit ground.

Input Sensitivity Switch: The three-position input sensitivity switch inside the amplifier can be accessed by removing the PIP module. Settings include 0.775 volts and 1.4 volts for rated output, and 26 dB voltage gain.

Meter Switches: Two switches behind the front panel can make the output meters display either the dynamic range of the output signal in dB (factory default), or the output level in dB.

Indicators

Signal Presence: The green front panel indicator for each channel flashes synchronously with the channel's output signal to indicate its presence.

Enable Indicator: This indicator lights when the amplifier has been "enabled" or turned on, and AC power is available.

ODEP Indicators: During normal operation of the amplifier, the ODEP (Output Device Emulation Protection) indicators glow brightly to show the presence of reserve thermodynamic energy. They dim proportionally as energy reserves decrease. In the rare event that energy reserves are depleted, the indicators turn off and ODEP proportionally limits the output drive so the amplifier can safely continue operating even under severe conditions. These indicators also help to identify more unusual operating conditions.

Input/Output Comparator: The red Input/Output Comparator (IOC) indicator for each channel flashes if any type of distortion reaches 0.05%.

Dynamic Range/Level Meters: A five-segment output meter is provided for each channel. The meters are factory-set to show dynamic range of the signals in dB, which is computed as the ratio of peak to average output power. Also, the meter can optionally be set to show output levels.

Input/Output

Input Connectors: Balanced ¼-inch (6.35-mm) phone jack for each channel. Balanced three-pin female XLR connector on the PIP-FX for each channel.

Input Impedance: Nominally 10 k ohms, balanced. Nominally 5 k ohms, unbalanced.

Input Sensitivity: Configurable for 26 dB gain, 0.775 volt sensitivity, or 1.4 volt sensitivity.

Output Connector: Two pairs of versatile 5-way binding posts are provided for the output of each channel so multiple loudspeakers can be connected easily. They accept banana plugs, spade lugs or bare wire.

Output Impedance: <10 milliohms in series with 2.5 microhenries.

DC Output Offset: ± 2 millivolts.

Output Signal

Dual: Unbalanced, two channel.

Bridge-Mono: Balanced, single channel. Channel 1 controls are active; channel 2 controls should be turned down.

Parallel-Mono: Balanced, single channel. Channel 1 controls are active; channel 2 controls should be turned down.

Protection

Studio Reference amplifiers provide extensive protection and diagnostics capabilities. Protection systems include ODEP, standby mode, an AC circuit breaker and transformer thermal protection. These systems will prevent amplifier damage in virtually any situation. A four-second turn-on delay prevents power-on thumps.

Construction

Durable black finish on aluminum chassis.

Dimensions: EIA Standard 19-inch (48.3-cm) rack mount width (EIA RS-310B), 7 inches (17.8 cm) high and 16 inches (40.6 cm) deep behind mounting surface and 2.75-inch (7-cm) protrusion in front of mounting surface

Net Weight:

Studio Reference I: 60.7 lb (27.6 kg)
Studio Reference II: 56.1 lb (25.5 kg).

Shipping Weight:

Studio Reference I: 74.2 lb (33.7 kg)
Studio Reference II: 69.6 lb (31.6 kg).

Cooling: Flow-through ventilation from front to sides. On-demand proportional speed fan.

Crown's Three-Year, No-Fault, Fully Transferable Warranty

Crown offers a Three-Year, No-Fault, Fully Transferable Warranty for every new Crown amplifier—an unsurpassed industry standard. With this unprecedented No-Fault protection, your new Crown amplifier is warranted to meet or exceed original specifications for the first three years of ownership. During this time, if your amplifier fails, or does not perform to original specifications, it will be repaired or replaced at our expense. About the only things not covered by this warranty are those losses normally covered by insurance and those caused by intentional abuse. And the coverage is transferable, should you sell your amplifier.

See your authorized Crown dealer for full warranty disclosure and details. For customers outside of the USA, please contact your authorized Crown distributor for warranty information or call 574-294-8200.

crown

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Specifications subject to change without prior notice. Latest information available at www.crownaudio.com.

STUDIO
REFERENCE I

S T U D I O   R E F E R E N C E   S E R I E S

Architectural & Engineering Specifications

Studio Reference I (120 V, 60 Hz models)

The Crown® Studio Reference I power amplifier shall be a solid-state two-channel model employing multi-mode (AB+B) grounded bridge(TM) output circuitry with a variable impedance (VZ) power supply for each channel.

The outputs shall be switchable as stereo, bridged-mono or parallel-mono modes of operation. The bridged-mono mode shall bridge the outputs to provide increased output voltage. The parallel-mono mode shall parallel the outputs to provide increased output current.

The output impedance of each channel shall be less than 10 milliohms in series with less than 2 microhenries in stereo mode.

The variable impedance power supplies shall reduce unnecessary voltage across the output devices by automatically switching to a parallel mode when less voltage is required by the output circuitry and to a series mode when more voltage is required.

The amplifier shall contain protection circuitry which limits the drive level placed on the output devices before their SOA (Safe Operating Area) is exceeded. This protection circuitry shall calculate the instantaneous voltage across and current through the output devices while factoring in their simulated junction temperatures to predict how close they are to their operating limits. This protection will be called "ODEP."

The amplifier shall contain controlled slew-rate voltage circuitry to protect it against radio frequency interference burnouts. It shall also be protected from current overload at its output stage. The slew rate of the amplifier shall be greater than 30 volts per microsecond in stereo mode.

The amplifier shall temporarily go into a stand-by mode if its power transformer becomes excessively hot and shall automatically resume normal operation once it has cooled to a safe operating temperature.

Front-panel controls shall include an enable on/off switch and a detented input level control for each channel.

Rear-mounted controls shall include a ground lift switch to isolate the signal ground from the chassis ground, a switch which selects between stereo, bridged-mono and parallel-mono modes of operation and a reset switch for the AC mains circuit breaker.

Internal controls shall include an input sensitivity switch to select between 0.775 V, 1.4 V or a fixed voltage gain of 26 dB for full rated output.

A Crown P.I.P. and P.I.P.2-compatible expansion connector shall be provided behind an access panel in the rear to accept auxiliary input modules. It shall be fully compatible with the Crown IQ System.

Front panel indicators shall include an amber power enable indicator, an amber ODEP protection system indicator for each channel which shall normally be illuminated to confirm the availability of reserve thermodynamic energy and which shall dim in proportion to limiting when the power demands of the output stages have been exceeded, a green IOC indicator for each channel, and a green Signal indicator for each channel which shall normally flash at moderate intensity to show the presence of an audio signal.

The power amplifier shall meet or exceed the following performance criteria. Input sensitivity for rated output: 26 dB voltage gain (unbalanced). Rated FTC output in stereo mode with less than 0.1% THD: 780watts per channel (20 Hz to 20 kHz) into 8 ohms. Hum and noise: at least 120 dB (A weighted) below full rated output power. Phase response: +5 to –15 degrees from 20 Hz to 20 kHz at 1 watt. Frequency response: 20 Hz to 20 kHz, 0.1 dB at 1 watt into 8 ohms per channel in stereo mode. Damping factor: greater than 20,000 from 10 to 200 Hz into 8 ohms. Intermodulation distortion (SMPTE): less than 0.005% from full bandwidth power to 78 watts rising linearly to better than 70 dB at 20 kHz. Harmonic distortion: less than 0.02% at rated low-distortion 1 kHz power.

The amplifier shall be safe when driving any kind of load—even highly reactive ones.

The power requirements shall be 120 VAC at 60 Hz. At idle, the amplifier shall draw 90 watts or less.

The amplifier chassis shall be constructed of steel with a durable black finish and shall be designed for flow-through fan-assisted ventilation from the front panel to the side panels. The amplifier shall have an aluminum front panel with super-gloss Imron finish and Lexan overlay.

The dimensions of the amplifier shall allow for 19 inch (48.3 cm) EIA standard (RS-310-B) rack mounting. The amplifier shall be 7 inches (17.8 cm) tall, 16 inches (40.6 cm) deep behind the rack-mounting surface, and 2.75 inches (7 cm) in front of the rack-mounting surface.

The amplifier shall weigh 60 pounds, 11 ounces (27.6 kg) and shall have a center of gravity approximately 6 inches (15.2 cm) behind the front panel.

The amplifier shall be designated the Crown Studio Reference I.

A Harman International Company

Crown International
1718 W. Mishawaka Rd.
Elkhart, IN 46517-9439
TEL: 574-294-8200
FAX: 574-294-8FAX
www.crownaudio.com

crown

SR-I

STUDIO REFERENCE SERIES

AC Power Draw and Thermal Dissipation

The information provided on this page is calculated data based on driving both channels to rated output using the 1 kHz Maximum Average Power rating method.

Other parameters used in calculation include a conservative idle current estimate of 90 watts and a conservative estimate of effeciency at 65%.

Information is provided only for getting an idea of current draw and heat produced. Actual performance will vary depending on environment, program material, load, signal, and AC mains voltage and frequency.

Values of calculated current draw are intended to represent average draw corresponding to the thermal breaker requriements that should be met to handle the amplifier as a load on the AC mains.

Peak current draw with dynamic program material may be significantly higher. Thermal information is provided to assist with calculating air conditioning needs. The data here should not be construed as specifications.

Duty cycle of various program material:

Individual speech: 10%
Acoustic/chamber music: 20%
Full-range rock music: 30%
Compressed rock music: 40%
Pink noise: 50%

Here are the equations used to calculate the data presented in Figure 1:

$$\text{AC Mains Power Draw (watts)} = \frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle}}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (watts)}$$

The quiescent power draw is a maximum value and includes power drawn by the fan. The following equation converts power draw in watts to current draw in amperes:

$$\text{Current Draw (amperes)} = \frac{\text{AC Mains Power Draw (watts)}}{\text{AC Mains Voltage} \times \text{Power Factor (.83)}}$$

The value used for Power Factor is 0.83. The Power Factor variable is needed to compensate for the differnece in phase between the AC mains voltage and current. The following equation is used to calculate thermal dissipation:

$$\text{Thermal Dissipation (btu/hr)} = \left(\frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle} \times .35}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (watts)} \right) \times 3.415$$

The value used for inefficiency is 1.00-efficiency. The factor 3.415 converts watts to btu/hr. Thermal dissipation in btu is divided by the constant 3.968 to get kcal. If you plan to measure output power under real-world conditions, the following equation may also be helpful:

$$\text{Thermal Dissipation (btu/hr)} = \left(\frac{\text{Total measured output power from all channels (watts)} \times .35}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (watts)} \right) \times 3.415$$

Studio Reference I

	LOAD														
	2 Ohm Stereo / 4 Ohm Bridge					4 Ohm Stereo / 8 Ohm Bridge / 2 Ohm Parallel Mono					8 Ohm stereo / 16 Ohm Bridge / 4 Ohm Parallel Mono				
Duty Cycle	AC Mains Power Draw (watts)	Current Draw (Amps)		Thermal Dissipation		AC Mains Power Draw (watts)	Current Draw (Amps)		Thermal Dissipation		AC Mains Power Draw (watts)	Current Draw (Amps)		Thermal Dissipation	
		120V	230V	btu/hr	kcal/hr		120V	230V	btu/hr	kcal/hr		120V	230V	btu/hr	kcal/hr
50%						1874	19.3	9.7	2500	630	1290	13.3	6.7	1780	449
40%						1518	15.6	7.8	2060	519	1050	9.3	5.4	1485	374
30%						1161	11.9	6.0	1620	408	557	8.3	4.2	1190	300
20%						804	8.3	4.1	1185	299	570	5.9	2.9	900	227
10%						447	4.6	2.3	745	188	330	3.4	1.7	605	152

crown

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For more details refer to the applicable Operation Manual or contact Crown Factory Service. The provided data should not be construed as specifciations.

04/05 138354-1

Architectural & Engineering Specifications

Studio Reference II (120 V, 60 Hz models)

The Crown® Studio Reference II power amplifier shall be a solid-state two-channel model employing multi-mode (AB+B) grounded bridge(TM) output circuitry with a variable impedance (VZ) power supply for each channel.

The outputs shall be switchable as stereo, bridged-mono or parallel-mono modes of operation. The bridged-mono mode shall bridge the outputs to provide increased output voltage. The parallel-mono mode shall parallel the outputs to provide increased output current.

The output impedance of each channel shall be less than 10 milliohms in series with less than 2 microhenries in stereo mode.

The variable impedance power supplies shall reduce unnecessary voltage across the output devices by automatically switching to a parallel mode when less voltage is required by the output circuitry and to a series mode when more voltage is required.

The amplifier shall contain protection circuitry which limits the drive level placed on the output devices before their SOA (Safe Operating Area) is exceeded. This protection circuitry shall calculate the instantaneous voltage across and current through the output devices while factoring in their simulated junction temperatures to predict how close they are to their operating limits. This protection will be called “ODEP.”

The amplifier shall contain controlled slew-rate voltage circuitry to protect it against radio frequency interference burnouts. It shall also be protected from current overload at its output stage. The slew rate of the amplifier shall be greater than 30 volts per microsecond in stereo mode.

The amplifier shall temporarily go into a stand-by mode if its power transformer becomes excessively hot and shall automatically resume normal operation once it has cooled to a safe operating temperature.

Front-panel controls shall include an enable on/off switch and a detented input level control for each channel.

Rear-mounted controls shall include a ground lift switch to isolate the signal ground from the chassis ground, a switch which selects between stereo, bridged-mono and parallel-mono modes of operation and a reset switch for the AC mains circuit breaker.

Internal controls shall include an input sensitivity switch to select between 0.775 V, 1.4 V or a fixed voltage gain of 26 dB for full rated output.

A Crown P.I.P. and P.I.P.2-compatible expansion connector shall be provided behind an access panel in the rear to accept auxiliary input modules. It shall be fully compatible with the Crown IQ System.

Front panel indicators shall include an amber power enable indicator, an amber ODEP protection system indicator for each channel which shall normally be illuminated to confirm the availability of reserve thermodynamic energy and which shall dim in proportion to limiting when the power demands of the output stages have been exceeded, a green IOC indicator for each channel, and a green Signal indicator for each channel which shall normally flash at moderate intensity to show the presence of an audio signal.

The power amplifier shall meet or exceed the following performance criteria. Input sensitivity for rated output: 26 dB voltage gain (unbalanced). Rated FTC output in stereo mode with less than 0.1% THD: 355watts per channel (20 Hz to 20 kHz) into 8 ohms. Hum and noise: at least 120 dB (A weighted) below full rated output power. Phase response: +5 to –15 degrees from 20 Hz to 20 kHz at 1 watt. Frequency response: 20 Hz to 20 kHz, 0.1 dB at 1 watt into 8 ohms per channel in stereo mode. Damping factor: greater than 20,000 from 10 to 200 Hz into 8 ohms. Intermodulation distortion (SMPTE): less than 0.005% from full bandwidth power to 78 watts rising linearly to better than 70 dB at 20 kHz. Harmonic distortion: less than 0.02% at rated low-distortion 1 kHz power.

The amplifier shall be safe when driving any kind of load—even highly reactive ones.

The power requirements shall be 120 VAC at 60 Hz. At idle, the amplifier shall draw 90 watts or less.

The amplifier chassis shall be constructed of steel with a durable black finish and shall be designed for flow-through fan-assisted ventilation from the front panel to the side panels. The amplifier shall have an aluminum front panel with super-gloss Imron finish and Lexan overlay.

The dimensions of the amplifier shall allow for 19 inch (48.3 cm) EIA standard (RS-310-B) rack mounting. The amplifier shall be 7 inches (17.8 cm) tall, 16 inches (40.6 cm) deep behind the rack-mounting surface, and 2.75 inches (7 cm) in front of the rack-mounting surface.

The amplifier shall weigh 56 pounds, 2 ounces (25.5 kg) and shall have a center of gravity approximately 6 inches (15.2 cm) behind the front panel.

The amplifier shall be designated the Crown Studio Reference II.

crown

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SR-II

STUDIO REFERENCE SERIES

AC Power Draw and Thermal Dissipation

The information provided on this page is calculated data based on driving both channels to rated output using the 1 kHz Maximum Average Power rating method.

Other parameters used in calculation include a conservative idle current estimate of 90 watts and a conservative estimate of effeciency at 65%.

Information is provided only for getting an idea of current draw and heat produced. Actual performance will vary depending on environment, program material, load, signal, and AC mains voltage and frequency.

Values of calculated current draw are intended to represent average draw corresponding to the thermal breaker requriements that should be met to handle the amplifier as a load on the AC mains.

Peak current draw with dynamic program material may be significantly higher. Thermal information is provided to assist with calculating air conditioning needs. The data here should not be construed as specifications.

Duty cycle of various program material:

Individual speech: 10%
Acoustic/chamber music: 20%
Full-range rock music: 30%
Compressed rock music: 40%
Pink noise: 50%

Here are the equations used to calculate the data presented in Figure 1:

$$\text{AC Mains Power Draw (watts)} = \frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle}}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (watts)}$$

The quiescent power draw is a maximum value and includes power drawn by the fan. The following equation converts power draw in watts to current draw in amperes:

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The value used for Power Factor is 0.83. The Power Factor variable is needed to compensate for the differnece in phase between the AC mains voltage and current. The following equation is used to calculate thermal dissipation:

$$\text{Thermal Dissipation (btu/hr)} = \left(\frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle} \times .35}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (watts)} \right) \times 3.415$$

The value used for inefficiency is 1.00-efficiency. The factor 3.415 converts watts to btu/hr. Thermal dissipation in btu is divided by the constant 3.968 to get kcal. If you plan to measure output power under real-world conditions, the following equation may also be helpful:

$$\text{Thermal Dissipation (btu/hr)} = \left(\frac{\text{Total measured output power from all channels (watts)} \times .35}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (watts)} \right) \times 3.415$$

Studio Reference II

	LOAD														
	2 Ohm Stereo / 4 Ohm Bridge					4 Ohm Stereo / 8 Ohm Bridge / 2 Ohm Parallel Mono					8 Ohm stereo / 16 Ohm Bridge / 4 Ohm Parallel Mono				
Duty Cycle	AC Mains Power Draw (watts)	Current Draw (Amps)		Thermal Dissipation		AC Mains Power Draw (watts)	Current Draw (Amps)		Thermal Dissipation		AC Mains Power Draw (watts)	Current Draw (Amps)		Thermal Dissipation	
		120V	230V	btu/hr	kcal/hr		120V	230V	btu/hr	kcal/hr		120V	230V	btu/hr	kcal/hr
50%						944	9.8	4.9	1360	343	636	6.5	4.9	970	244
40%						773	8.0	4.0	1150	290	527	5.4	4.0	840	212
30%						602	6.2	3.1	940	237	418	4.3	3.1	705	178
20%						432	4.5	2.2	730	184	308	3.2	2.2	575	145
10%						261	2.7	1.4	520	131	199	2.1	1.4	440	111

A Harman International Company
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FAX: 574-294-8FAX
www.crownaudio.com

For more details refer to the applicable Operation Manual or contact Crown Factory Service. The provided data should not be construed as specifciations.

04/05 138355-1

THE PROFESSIONAL AUDIO DIVISION OF CROWN INTERNATIONAL, INC.

Exported to select countries as Amcron.

Studio Reference™

PROFESSIONAL STUDIO AMPLIFIERS

OWNER'S MANUAL

P.O. Box 1000, Elkhart, Indiana 46515-1000
Telephone: 219-294-8000

Printed on recycled paper.

K80604-0
8/95

THREE YEAR FULL WARRANTY

WORLDWIDE

SUMMARY OF WARRANTY

The Crown Audio Division of Crown International, Inc., 1718 West Mishawaka Road, Elkhart, Indiana 46517-4095 U.S.A. warrants to you, the ORIGINAL PURCHASER and ANY SUBSEQUENT OWNER of each NEW Crown[1] product, for a period of three (3) years from the date of purchase by the original purchaser (the "warranty period") that the new Crown product is free of defects in materials and workmanship, and we further warrant the new Crown product regardless of the reason for failure, except as excluded in this Crown Warranty.

[1] *Note: If your unit bears the name "Amcron," please substitute it for the name "Crown" in this warranty.*

ITEMS EXCLUDED FROM THIS CROWN WARRANTY

This Crown Warranty is in effect only for failure of a new Crown product which occurred within the Warranty Period. It does not cover any product which has been damaged because of any intentional misuse, accident, negligence, or loss which is covered under any of your insurance contracts. This Crown Warranty also does not extend to the new Crown product if the serial number has been defaced, altered, or removed.

WHAT THE WARRANTOR WILL DO

We will remedy any defect, regardless of the reason for failure (except as excluded), by repair, replacement, or refund. We may not elect refund unless you agree, or unless we are unable to provide replacement, and repair is not practical or cannot be timely made. If a refund is elected, then you must make the defective or malfunctioning product available to us free and clear of all liens or other encumbrances. The refund will be equal to the actual purchase price, not including interest, insurance, closing costs, and other finance charges less a reasonable depreciation on the product from the date of original purchase. Warranty work can only be performed at our authorized service centers. We will remedy the defect and ship the product from the service center within a reasonable time after receipt of the defective product at our authorized service center. All expenses in remedying the defect, including surface shipping costs to the nearest authorized service center, will be borne by us. (You must bear the expense of all taxes, duties and other customs fees when transporting the product.)

HOW TO OBTAIN WARRANTY SERVICE

You must notify us of your need for warranty service not later than ninety (90) days after expiration of the warranty period. All components must be shipped in a factory pack. Corrective action will be taken within a reasonable time of the date of receipt of the defective product by our authorized service center. If the repairs made by our authorized service center are not satisfactory, notify our authorized service center immediately.

DISCLAIMER OF CONSEQUENTIAL AND INCIDENTAL DAMAGES

YOU ARE NOT ENTITLED TO RECOVER FROM US ANY INCIDENTAL DAMAGES RESULTING FROM ANY DEFECT IN THE NEW CROWN PRODUCT. THIS INCLUDES ANY DAMAGE TO ANOTHER PRODUCT OR PRODUCTS RESULTING FROM SUCH A DEFECT.

WARRANTY ALTERATIONS

No person has the authority to enlarge, amend, or modify this Crown Warranty. This Crown Warranty is not extended by the length of time which you are deprived of the use of the new Crown product. Repairs and replacement parts provided under the terms of this Crown Warranty shall carry only the unexpired portion of this Crown Warranty.

DESIGN CHANGES

We reserve the right to change the design of any product from time to time without notice and with no obligation to make corresponding changes in products previously manufactured.

LEGAL REMEDIES OF PURCHASER

No action to enforce this Crown Warranty shall be commenced later than ninety (90) days after expiration of the warranty period.

THIS STATEMENT OF WARRANTY SUPERSEDES ANY OTHERS CONTAINED IN THIS MANUAL FOR CROWN PRODUCTS.

Telephone: 219-294-8200. Facsimile: 219-294-8301 9/90

NORTH AMERICA

SUMMARY OF WARRANTY

The Crown Audio Division of Crown International, Inc., 1718 West Mishawaka Road, Elkhart, Indiana 46517-4095 U.S.A. warrants to you, the ORIGINAL PURCHASER and ANY SUBSEQUENT OWNER of each NEW Crown product, for a period of three (3) years from the date of purchase by the original purchaser (the "warranty period") that the new Crown product is free of defects in materials and workmanship, and we further warrant the new Crown product regardless of the reason for failure, except as excluded in this Crown Warranty.

ITEMS EXCLUDED FROM THIS CROWN WARRANTY

This Crown Warranty is in effect only for failure of a new Crown product which occurred within the Warranty Period. It does not cover any product which has been damaged because of any intentional misuse, accident, negligence, or loss which is covered under any of your insurance contracts. This Crown Warranty also does not extend to the new Crown product if the serial number has been defaced, altered, or removed.

WHAT THE WARRANTOR WILL DO

We will remedy any defect, regardless of the reason for failure (except as excluded), by repair, replacement, or refund. We may not elect refund unless you agree, or unless we are unable to provide replacement, and repair is not practical or cannot be timely made. If a refund is elected, then you must make the defective or malfunctioning product available to us free and clear of all liens or other encumbrances. The refund will be equal to the actual purchase price, not including interest, insurance, closing costs, and other finance charges less a reasonable depreciation on the product from the date of original purchase. Warranty work can only be performed at our authorized service centers or at the factory. We will remedy the defect and ship the product from the service center or our factory within a reasonable time after receipt of the defective product at our authorized service center or our factory. All expenses in remedying the defect, including surface shipping costs in the United States, will be borne by us. (You must bear the expense of shipping the product between any foreign country and the port of entry in the United States and all taxes, duties, and other customs fees for such foreign shipments.)

HOW TO OBTAIN WARRANTY SERVICE

You must notify us of your need for warranty service not later than ninety (90) days after expiration of the warranty period. All components must be shipped in a factory pack, which, if needed, may be obtained from us free of charge. Corrective action will be taken within a reasonable time of the date of receipt of the defective product by us or our authorized service center. If the repairs made by us or our authorized service center are not satisfactory, notify us or our authorized service center immediately.

DISCLAIMER OF CONSEQUENTIAL AND INCIDENTAL DAMAGES

YOU ARE NOT ENTITLED TO RECOVER FROM US ANY INCIDENTAL DAMAGES RESULTING FROM ANY DEFECT IN THE NEW CROWN PRODUCT. THIS INCLUDES ANY DAMAGE TO ANOTHER PRODUCT OR PRODUCTS RESULTING FROM SUCH A DEFECT. **SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATIONS OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.**

WARRANTY ALTERATIONS

No person has the authority to enlarge, amend, or modify this Crown Warranty. This Crown Warranty is not extended by the length of time which you are deprived of the use of the new Crown product. Repairs and replacement parts provided under the terms of this Crown Warranty shall carry only the unexpired portion of this Crown Warranty.

DESIGN CHANGES

We reserve the right to change the design of any product from time to time without notice and with no obligation to make corresponding changes in products previously manufactured.

LEGAL REMEDIES OF PURCHASER

THIS CROWN WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE. No action to enforce this Crown Warranty shall be commenced later than ninety (90) days after expiration of the warranty period.

THIS STATEMENT OF WARRANTY SUPERSEDES ANY OTHERS CONTAINED IN THIS MANUAL FOR CROWN PRODUCTS.

Telephone: 219-294-8200. Facsimile: 219-294-8301 9/90

The information furnished in this manual does not include all of the details of design, production, or variations of the equipment. Nor does it cover every possible situation which may arise during installation, operation or maintenance. If your unit bears the name “Amcron,” please substitute it for the name “Crown” in this manual. If you need special assistance beyond the scope of this manual, please contact our Technical Support Group.

Crown Audio Division Technical Support Group
57620 C.R. 105, Elkhart, Indiana 46517 U.S.A.
Phone: **800-342-6939** (U.S.A.) or 219-294-8200   Fax: 219-294-8301

IMPORTANT

STUDIO REFERENCE AMPLIFIERS REQUIRE CLASS 1 OUTPUT WIRING.

C A U T I O N

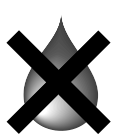
RISK OF ELECTRIC SHOCK
DO NOT OPEN

TO PREVENT ELECTRIC SHOCK DO NOT REMOVE TOP OR BOTTOM COVERS. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL. DISCONNECT POWER CORD BEFORE REMOVING REAR INPUT MODULE TO ACCESS GAIN SWITCH.

A V I S

RISQUE DE CHOC ÉLECTRIQUE
N’OUVREZ PAS

À PRÉVENIR LE CHOC ÉLECTRIQUE N’ENLEVEZ PAS LES COUVERTURES. RIEN DES PARTIES UTILES À L’INTÉRIEUR. DÉBRANCHER LA BORNE AVANT D’OUVRIR LA MODULE EN ARRIÈRE.



WARNING

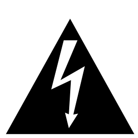
TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE!

Magnetic Field

CAUTION! Do not locate sensitive high-gain equipment such as preamplifiers or tape decks directly above or below the unit. Because this amplifier has a high power density, it has a strong magnetic field which can induce hum into unshielded devices that are located nearby. The field is strongest just above and below the unit.

If an equipment rack is used, we recommend locating the amplifier(s) in the bottom of the rack and the preamplifier or other sensitive equipment at the top.

WATCH FOR THESE SYMBOLS:



The lightning bolt triangle is used to alert the user to the risk of electric shock.

The exclamation point triangle is used to alert the user to important operating or maintenance instructions.

CONTENTS

ILLUSTRATIONS

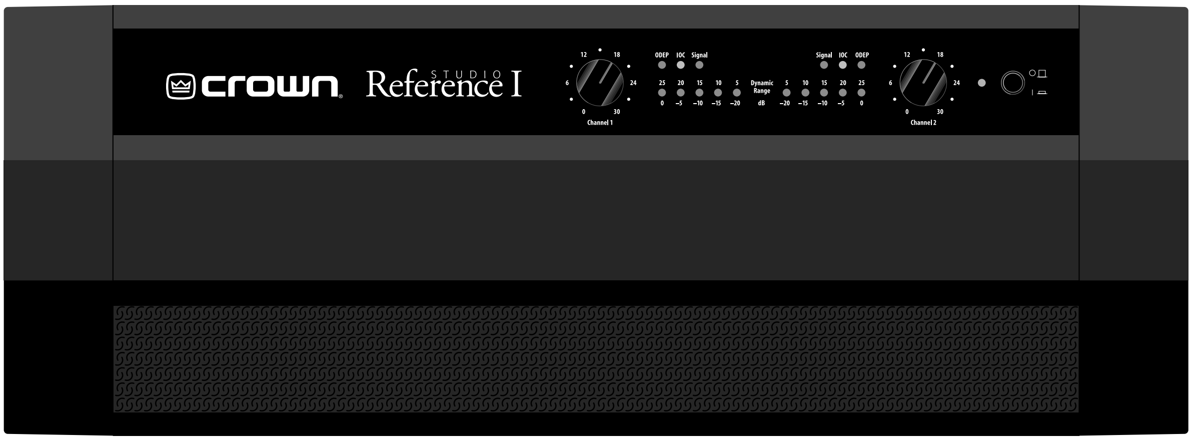
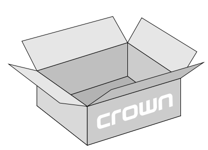


Fig. 1.1 Studio Reference I Amplifier

Unpacking Instructions

Please unpack and inspect your new amplifier for any damage that may have occurred during transit. If damage is found, notify the transportation company immediately. Only you, the consignee, may initiate a claim for shipping damage. Crown will be happy to cooperate fully as needed. Save the shipping carton as evidence of damage for the shipper's inspection.



Even if the unit arrived in perfect condition, as most do, save all packing materials so you will have them if you ever need to transport the unit. **NEVER SHIP THE UNIT WITHOUT THE FACTORY PACK.**

1 Welcome

The stunning realism you will experience when listening to a Crown *Studio Reference*™ amplifier will redefine your expectations. The evolution of this studio standard ushers in a new era of powerful, ultraquiet amplifiers capable of faithfully reproducing the most demanding signals that state-of-the-art 20-bit digital recording systems can offer. This kind of sonic integrity does not happen accidentally. It demands the leadership and technical excellence for which Crown has long been known.

With the best transfer function in the industry, ultra-high dynamic range and extraordinary damping factor, your *Studio Reference* amplifier comes closer to the ideal "straight wire with gain" than any other amplifier. As you listen, it will become apparent—the amplifier's low-frequency transient response is the standard by which all others must be judged.

We have taken great care at every step in the creation of your amplifier—from the selection of its components to the routing of each wire. It is our goal to provide you with total satisfaction. This is one reason why we have spent considerable effort in providing you with the most complete *Owner's Manual* in the business. Please read it carefully—especially the instructions, warnings and cautions. It will help you successfully install and use your new amplifier. Be sure to read Sections 3.3.2 and 3.3.3 if you plan to use one of the amplifier's two mono modes.

Please send in your warranty registration card today and save your bill of sale because it is your official proof of purchase. We hope you enjoy your new amplifier, and thank you for choosing Crown.

1.1 Features

Studio Reference amplifiers integrate several cutting edge technologies that make them the most accurate reference amplifiers available. For example, in Stereo mode each channel can actually be treated as a separate amplifier because of its separate high-voltage power supplies and ultra-low crosstalk. Here are some of its many impressive features:

- ❏ Crown's unconventional *grounded bridge*™ circuitry delivers incredible voltage swings without using stressful output transistor configurations like other more traditional amplifiers. This results in significantly lower distortion and superior reliability.
- ❏ Patented *ODEP*® (Output Device Emulation Protection) circuitry detects and compensates for overheating and overload to keep the amplifier working when others would fail.
- ❏ *IOC*® (Input/Output Comparator) circuitry immediately alerts you of any distortion that exceeds 0.05% to provide dynamic *proof of distortion-free performance*.
- ❏ *P.I.P.* (Programmable Input Processor) connector accepts accessories that tailor your amplifier to suit specific applications.
- ❏ Extremely wide dynamic range capable of accurately reproducing 20-bit digital recordings.
- ❏ Ultra-high damping factor delivers superior loudspeaker motion control for the cleanest, tightest, chest-thumping bottom end you've ever felt—or heard.
- ❏ Super-low harmonic and intermodulation distortion give your amplifier *the best transfer function* in the business.
- ❏ Two mono modes (Bridge-Mono and Parallel-Mono) for driving a wide range of load impedances.
- ❏ Custom-designed, tape-wound, low-noise toroidal supplies with extremely high power density.
- ❏ High-voltage headroom and high-current headroom provide energy reserves that make it easy to drive low-impedance loads and highly reactive loads to full power.
- ❏ Full protection against shorted outputs, mismatched loads, general overheating, DC and high-frequency overloads. Full overvoltage and internal fault protection.
- ❏ Indicators include Enable, *ODEP*, *IOC*, Signal Presence and the Dynamic Range/Level meter.
- ❏ Balanced phone jacks and XLR connectors are provided for input. Two pair of 5-way binding posts per channel are provided for versatile output connection.
- ❏ Ground lift switch isolates the AC power and phone jack audio grounds.
- ❏ Efficient heat sinks and a self-contained, on-demand, infinitely variable forced-air cooling system prevents overheating and prolongs component life.
- ❏ Internal three-position input sensitivity switch provides settings of 0.775 volts and 1.4 volts for standard 1 kHz power, and 26 dB gain.
- ❏ Mounts in a standard 19 inch (48.3 cm) equipment rack, or units can be stacked directly on top of each other.
- ❏ Three year "No-Fault" full warranty completely protects your investment and guarantees its specifications.

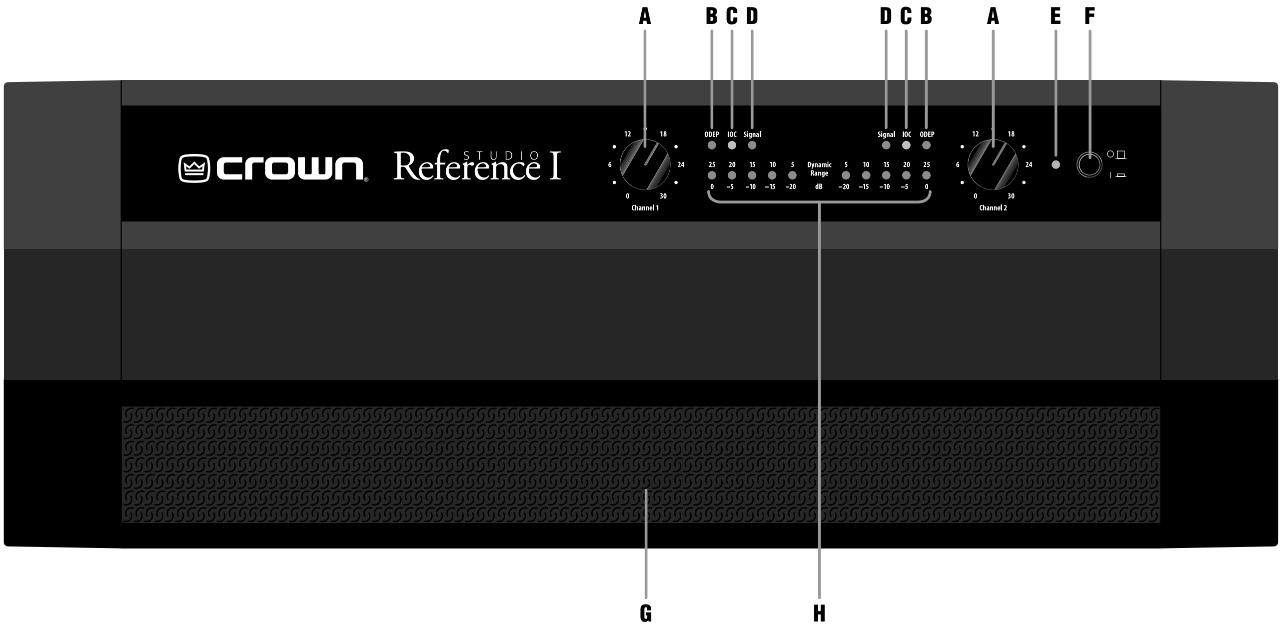


Fig. 2.1 Front Facilities

2 Facilities

A. Level Controls

Each channel's output level can be adjusted accurately using the 31-position detented level controls on the front panel (see Section 4.4).

B. *ODEP* Indicators

During normal operation of the amplifier, the *ODEP* (Output Device Emulation Protection) indicators glow brightly to show the presence of reserve thermodynamic energy. They dim proportionally as energy reserves decrease. In the rare event that energy reserves are depleted, the indicators turn off and *ODEP* proportionally limits the output drive so the amplifier can safely continue operating even under severe conditions. These indicators also help to identify more unusual operating conditions (see Figure 4.2).

C. *IOC* Indicators

The *IOC* (Input Output Comparator) indicators serve as sensitive distortion indicators to provide *proof of distortion-free performance*. Under normal conditions, the indicators remain off. They flash if the output waveform differs from the input by 0.05% or more (see Section 4.2). If the input signal level is too high, the indicators will also flash brightly with a half-second hold delay to show input overload or output clipping. *Note: The channel 2 IOC indicator stays on in Parallel-Mono mode.* See Section 4.2.

D. Signal Presence Indicators

These indicators flash synchronously with the amplifier's audio output to show signal presence. *Note: These indicators may not flash at very low input signal levels.* See Section 4.2.

E. Enable Indicator

This indicator lights when the amplifier has been "enabled" or turned on, and AC power is available.

F. Enable Switch

This push button is used to turn the amplifier on and off. When turned on, the output is muted for about four seconds to protect your system from start-up transients. This is why a power sequencer is rarely needed for multiple units. (The turn-on delay can be changed. Contact Crown's Technical Support Group for details.)

G. Dust Filter

The dust filter removes large particles from the air drawn in by the cooling fan. In most cases, the fan will not run so the filter will remain clean. If the filter becomes dirty, it can be removed for easy cleaning (see Section 4.5).

H. Dynamic Range / Level Meters

A five-segment output meter is provided for each channel. The meters are factory-set to show dynamic range of the signals in dB, which is computed as the ratio of peak to average output power. Also, the meter can optionally be set to show output levels (see Section 4.4).

❏ Meter Switches

Two switches behind the front panel can be used to customize the output meters (H). By default, the meters display dynamic range. To make the meters display signal levels or to turn them off, see Section 4.4.

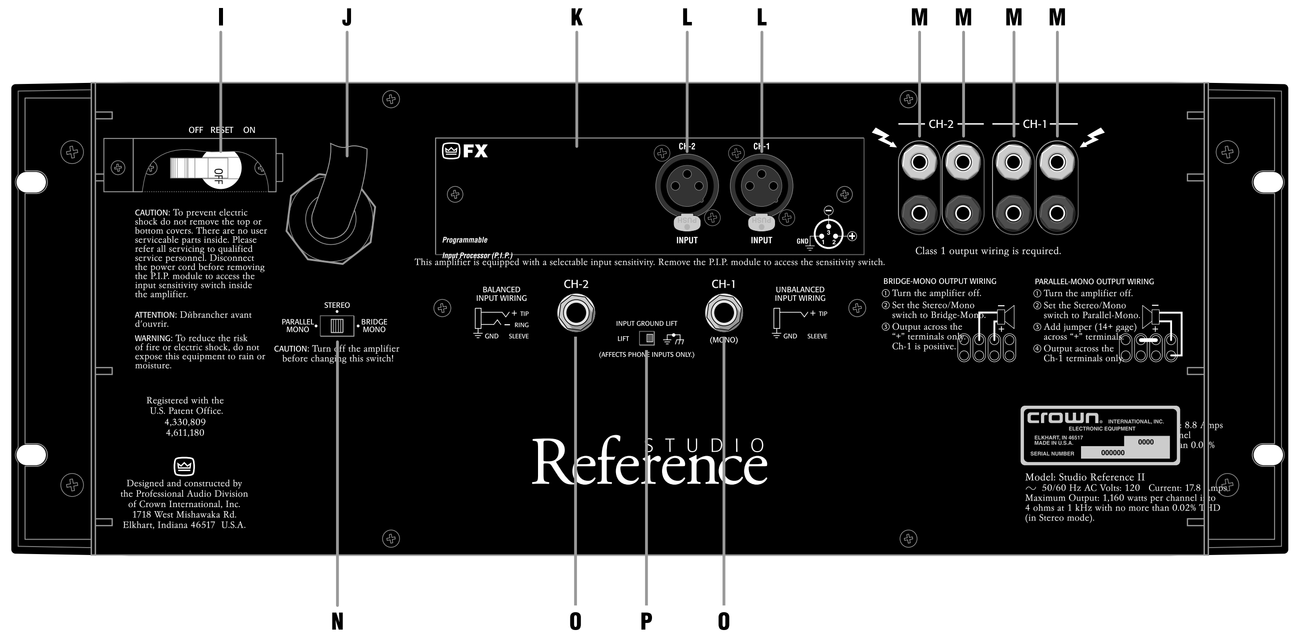


Fig. 2.2 Rear Facilities

I. Reset Switch

This back panel switch can be used to trip and reset the AC mains circuit breaker (see Section 4.3.4).

J. Power Cord

For 120 VAC, 60 Hz North American units, the *Studio Reference I* includes a 10 AWG power cord and NEMA TT30P plug, and the *Studio Reference II* includes a 12 AWG cord and NEMA 5-15P plug. Other units are shipped with an appropriate power cord and plug.

K. *P.I.P.* Module

The standard P.I.P.-FX input module is provided with your amplifier. It provides female XLR input connectors. Each pair of XLR and phone jack connectors is wired in parallel so the unused connector can be used as a "daisy chain" output to connect a source to multiple amplifiers. Other *P.I.P.* modules can be used in place of the P.I.P.-FX to provide additional features that customize your amplifier for different applications (see Section 8 for available *P.I.P.* modules).

L. Balanced XLR Inputs

A balanced three-pin female XLR connector is provided on the P.I.P.-FX (K) for input to each channel. **Caution: Do not use the channel 2 input in either mono mode.**

M. Output Connectors

Two pairs of versatile 5-way binding posts are provided for the output of each channel so multiple loudspeakers can be connected easily. They accept banana plugs, spade lugs or bare wire.

N. Stereo/Mono Switch

This switch is used to select one of three operating modes. Stereo mode is used for normal two-channel operation, Bridge-Mono mode is used to drive a single channel with a load impedance of at least 4 ohms, and Parallel-Mono mode is used to drive a single channel with a load impedance of less than 4 ohms. **WARNING: Turn off the amplifier before changing this switch (see Section 3.3).**

O. Balanced Phone Jack Inputs

A balanced 1/4-inch phone jack is provided for input to each channel. They may be used with either balanced (tip, ring and sleeve) or unbalanced (tip and sleeve) input wiring (see Section 3.3). These inputs are in parallel with the *P.I.P.* connector, so they should not be used as inputs if the installed *P.I.P.* has active circuitry. **Caution: Do not use the channel 2 input in either mono mode.**

P. Ground Lift Switch

The input signal ground may be isolated from the AC ground with this switch to help prevent unwanted ground loops. It affects only the phone jacks (O). It has no affect on the *P.I.P.* module's XLR connectors. Activating the switch inserts an impedance between the sleeve of each phone input jack and the circuit ground.

❑ Input Sensitivity Switch

The three-position input sensitivity switch inside the amplifier can be accessed by removing the *P.I.P.* module. Settings include 0.775 volts and 1.4 volts for rated output, and 26 dB voltage gain (see Section 4.4).

3 Installation

3.1 Mounting

Studio Reference amplifiers are designed for standard 19 inch (48.3 cm) rack mounting or stacking without a cabinet. In a rack, it is best to mount units directly on top of each other. This provides the most efficient air flow and support. If the rack will be transported, we recommend that you fasten the amplifier's back panel securely to the rack to help support the unit's weight.

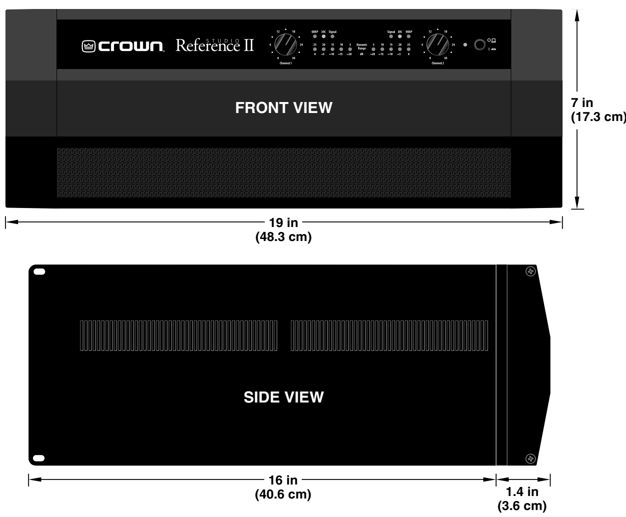


Fig. 3.1 Mounting Dimensions

Before proceeding, make sure the meter switches are set to your liking. The front panel assembly must first be removed to change these switches, so it is easier to do before the unit is mounted (see Section 4.4).

By now, you may be looking for rack ears. The rack ears are covered by two attractive end caps which are held in place by phillips screws (see Figure 3.2). To use the rack ears, remove the screws and lift off the caps. With sufficient side clearance, you can reinstall the end caps once the amplifier is mounted in the rack.

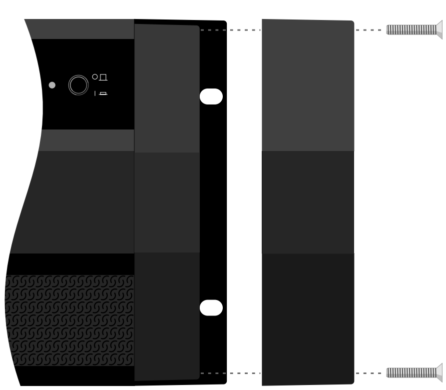


Fig. 3.2 Removing an End Cap

3.2 Cooling

Your amplifier has an internal variable speed fan that is controlled to match the unit's real-time cooling needs. With proper installation and typical studio use, the fan may never need to run. For best results, you should familiarize yourself with its cooling requirements.

Here are some tips to help keep your amplifier cool. First, never block the amplifier's front or side air vents. If the amplifier is rack-mounted, its sides should be at least 2 inches (5 cm) away from the cabinet (see Figure 3.3). Also, open rack spaces should be covered to prevent heated air from the side vents from being drawn out the front of the rack into the front air intake.

You will know when your *Studio Reference* amplifier has sufficient cooling because its *ODEP* indicators will be brightly lit. If the amplifier's *ODEP* indicators dim or turn off, overly demanding conditions are forcing it to protect itself from overheating. If you experience a cooling problem, you should consider several factors that may be contributing to the problem, including load impedance, air flow and ambient air temperature.

Low-impedance loads generate more heat than higher impedance loads. To avoid impedance-related cooling problems, connect loads to each channel with a total impedance of at least 2 ohms in Stereo, 4 ohms in Bridge-Mono, and 1 ohm in Parallel-Mono mode (see Section 3.3 for wiring instructions). If your loads are reasonable and you still have a cooling problem, check for shorts in the loudspeaker cables, and look for problems with air flow or ambient air temperature.

Air flow restrictions are the most common cause of inadequate cooling. Restrictions may result from improper

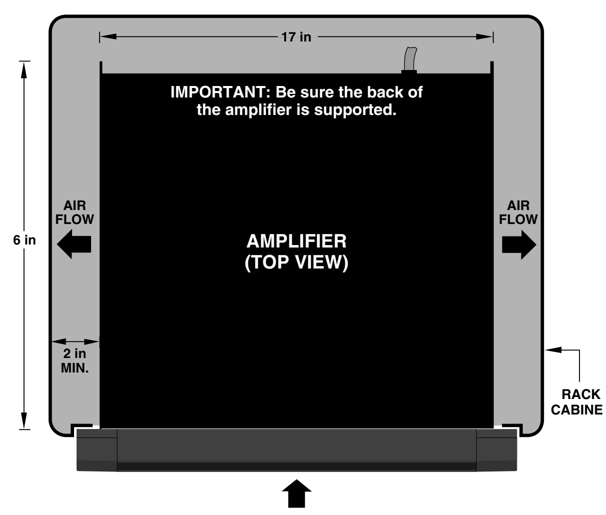


Fig. 3.3 Top View of a Rack-Mounted Unit

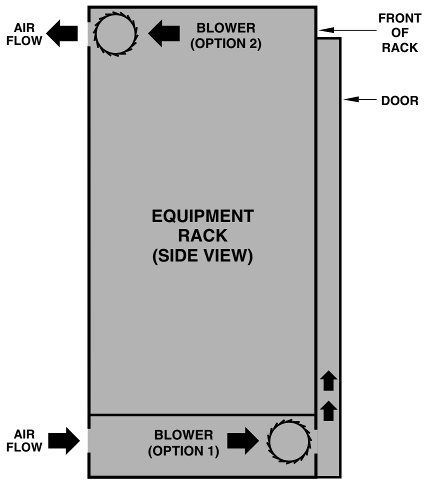


Fig. 3.4 Proper Air Flow with a Rack-Mounted Blower

mounting, piles of power cords, clogged dust filters and closed rack doors. Mount your amplifier to allow sufficient air flow into the front intake, out the side exhaust vents, and out the back of the rack. An air flow restriction like a pile of power cords can simply be moved out of the way. Air filters should be cleaned using the procedure in Section 4.5. If rack doors are the problem, you can leave them open, remove them, or install a grille. If you install a grille, we recommend using a wire grille because perforated panels restrict air flow by at least 40%.

If your *ODEP* indicators still dim under demanding conditions, we recommend that you check the table of indicator states in Figure 4.2 to eliminate other conditions that could be the source of the problem. If it is clear that the amplifier does not have sufficient air flow, you may want to install supplemental cooling like a rack-mounted blower or an air conditioner.

A "squirrel cage" blower can be installed at the bottom of the rack so it blows outside air into the space between the door and the front of the amplifiers. This will pressurize the "chimney" behind the door (Figure 3.4, Option 1). The blower should not blow air into or take air out of the space behind the amplifiers. For racks without a front door, you can evacuate the rack by mounting the blower at the top of the rack so air blows out the back (Figure 3.4, Option 2). You can estimate a rack's required air flow by adding each unit's maximum air flow rating. The *Studio Reference I* and *II* can each move up to 45 cubic feet (1.3 cubic meters) of air per minute. So if you put one of each in a rack, you would need 90 cubic feet (2.5 cubic meters) of air flow through the rack per minute under worst-case conditions (45 cubic feet + 45 cubic feet = 90 cubic feet).

Another way to increase cooling is to use air conditioning. It is rarely a necessity because internal fans and rack-mounted blowers almost always provide enough air flow for the most extreme conditions. Still, air conditioning helps reduce the ambient temperature of the air flowing through the rack. If you plan to use air conditioning, refer to Section 7 for information on calculating the hourly thermal dissipation of your system.

3.3 Wiring

Figures 3.5 through 3.7 show common ways to set up a *Studio Reference* amplifier. Input and output connectors are located on the back panel. Be careful when

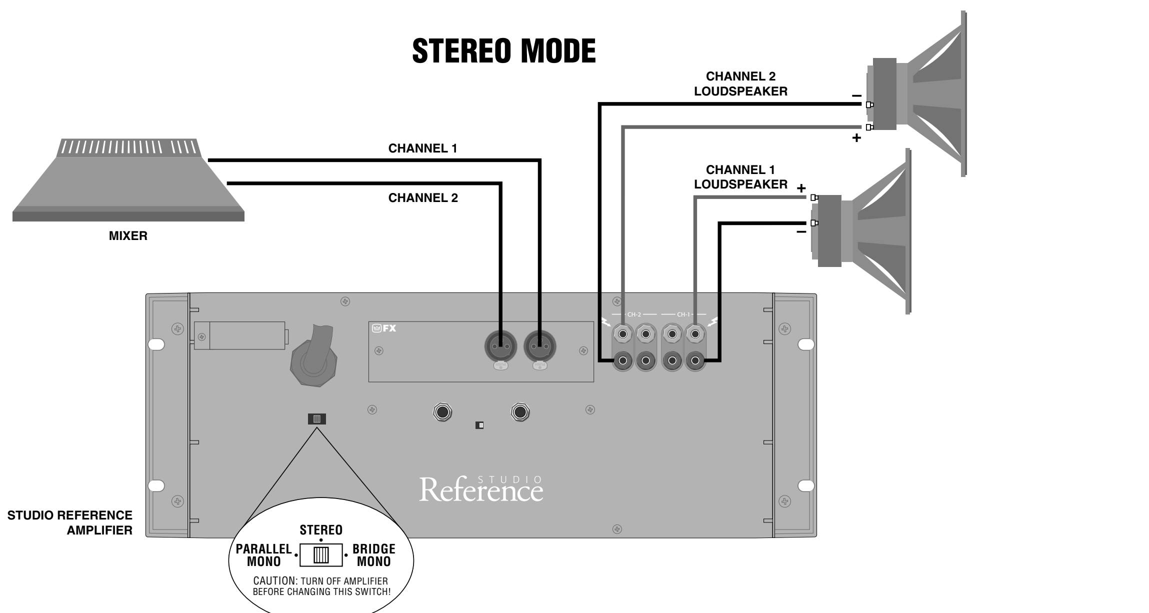


Fig. 3.5 Stereo Wiring

making connections, selecting sources and controlling output levels. The load you save may be your own! Crown is not responsible for damaged loads that result from carelessness or deliberate overpowering.

CAUTION: Always disconnect the AC power and turn the level controls down when making or breaking connections. This practice reduces the chance of loud blasts that can cause loudspeaker damage.

Studio Reference amplifiers provide three operating modes: Stereo, Bridge-Mono and Parallel-Mono. Stereo mode provides standard two-channel operation; Bridge-Mono provides a single channel with double the output voltage of Stereo mode; and Parallel-Mono mode provides a single channel with double the output current of Stereo mode. These modes can be selected using the stereo/mono switch on the back panel. Each mode is wired differently, so be sure to note any special wiring requirements for the mode you will be using.

3.3.1 Stereo (Two-Channel) Operation

Stereo mode installation is very intuitive: input channel 1 feeds output channel 1, and input channel 2 feeds output channel 2. To put the amplifier into Stereo mode, turn it off, slide the stereo/mono switch to the center position, and properly connect the output wiring as shown in Figure 3.5. Each output channel has two sets of binding posts to make it easier for you to connect multiple loudspeaker cables to each channel. Be sure to observe correct loudspeaker polarity (see Figure 3.5) and be careful not to short the outputs.

CAUTION: In Stereo mode, never tie an amplifier's outputs together directly, and never parallel them with the output of another amplifier. Such connections do not result in increased output power, but may activate the protection circuitry to prevent overheating.

3.3.2 Bridge-Mono Operation

Bridge-Mono mode is used to drive loads with a total impedance of at least 4 ohms (see Parallel-Mono if the load is less than 4 ohms). Wiring for Bridge-Mono mode is different from the other modes and requires special attention. First, turn off the amplifier. Then select Bridge-Mono mode by sliding the stereo/mono switch to the right (as you face the back panel). Both outputs receive the channel 1 input signal, but channel 2 is inverted so it can be bridged with channel 1. Do not use the channel 2 input or signal quality will be

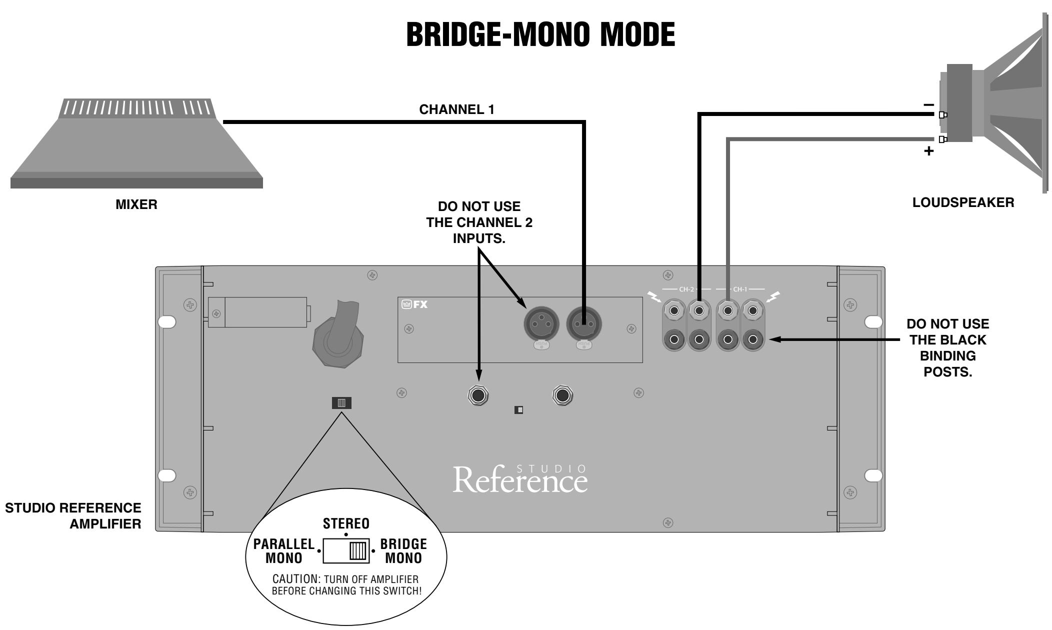


Fig. 3.6 Bridge-Mono Wiring

greatly degraded. Also, turn down the channel 2 level control (fully counterclockwise).

Note: The channel 2 input and level control are not defeated in Bridge-Mono mode. Any signal feeding channel 2 will work against the channel 1 signal, and usually results in distortion and inefficient operation.

Connect the load across the two red (+) binding posts (see Figure 3.6). The positive (+) loudspeaker lead connects to the red channel 1 binding post, and the negative (–) or ground lead from the loudspeaker connects to the red channel 2 binding post. Do not connect the black binding posts (–). Also, the load must be balanced (neither side shorted to ground).

CAUTION: Only connect balanced equipment (meters, switches, etc.) to the Bridge-Mono output. Both sides of the line must be isolated from the input grounds or oscillations may occur.

3.3.3 Parallel-Mono Operation

Parallel-Mono mode is used to drive loads with a total impedance of less than 4 ohms (see Bridge-Mono if the load is 4 ohms or more). Wiring for Parallel-Mono mode is very different from the other modes and requires special attention.

To select Parallel-Mono mode, turn off the amplifier and slide the stereo/mono switch to the left (as you face the back panel). Connect the input signal to channel 1 only. The channel 2 input and level control are bypassed in this mode, so they should not be used.

Note: It is normal for the channel 2 IOC indicator to stay on in Parallel-Mono mode.

Connect the load to the channel 1 output as shown in Figure 3.7. The positive (+) lead from the loudspeaker connects to the red channel 1 binding post, and the negative (–) or ground lead from the loudspeaker connects to the black channel 1 binding post. Finally, install a jumper wire of at least 14 gauge between the channel 1 and channel 2 red binding posts.

CAUTION: When Parallel-Mono wiring is installed, do not attempt to operate in Stereo or Bridge-Mono mode until the wiring is removed (especially the jumper wire). Failure to do so will result in high distortion and excessive heating.

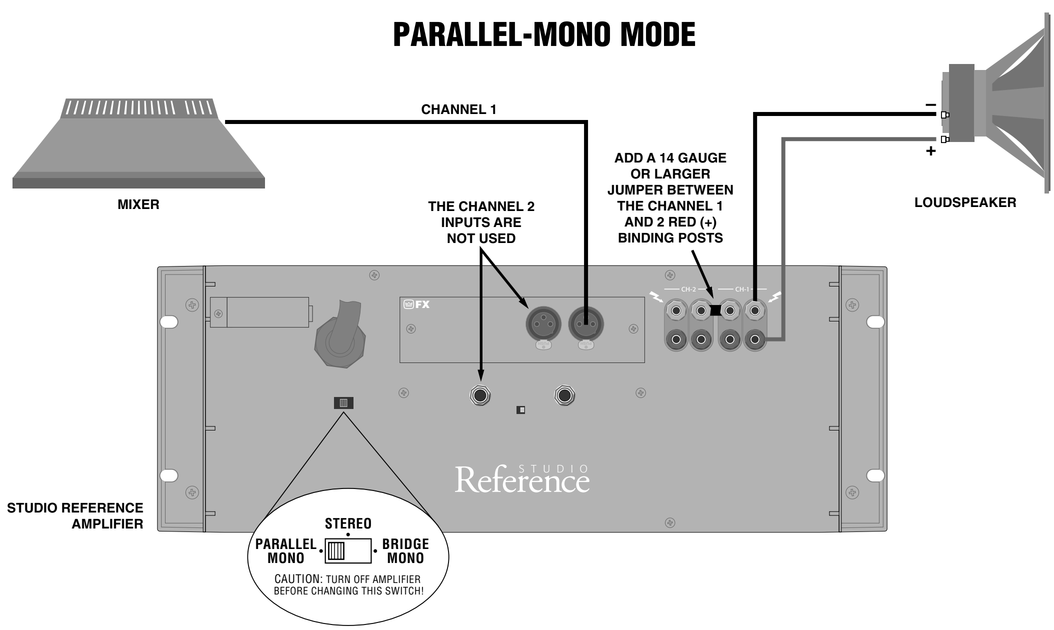


Fig. 3.7 Parallel-Mono Wiring

3.3.4 Input Connection

The balanced inputs have a nominal impedance of 10 K ohms (5 K ohms unbalanced) and will accept the line-level output of most devices. Phone jacks are provided on the back panel, while the factory-installed P.I.P.-FX provides female XLR input connectors (see Figure 2.2). Optional *P.I.P.* modules like the P.I.P.-BB and the P.I.P.-FPX can provide barrier block and phono (RCA) connectors. Various *P.I.P.s* are also available which provide a wide range of input signal processing features (see Section 8).

Correct input wiring depends on two factors: (1) whether the input signal is balanced or unbalanced, and (2) whether the signal floats or has a ground reference. Figures 3.8 and 3.9 show the recommended connection techniques for each combination of source signal characteristics.

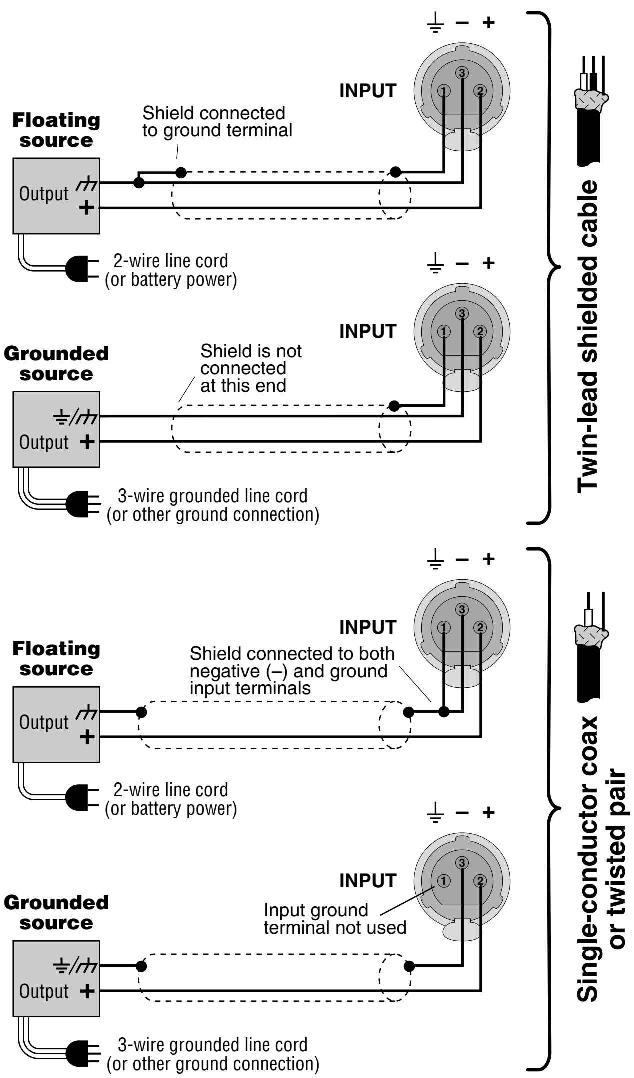


Fig. 3.8 Unbalanced Input Wiring

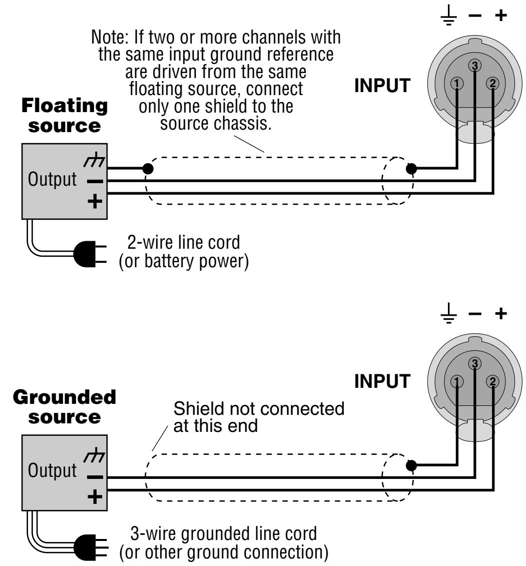


Fig. 3.9 Balanced Input Wiring

The amplifier's built-in $1\frac{1}{4}$-inch input phone jacks can be wired similarly for balanced or unbalanced, floating or ground-referenced sources. They have a standard tip-ring-sleeve (TRS) configuration: the tip is positive (+), the ring is negative (–) and the sleeve is ground (see Figure 3.10). Wiring for various sources follows the XLR wiring examples in Figures 3.8 and 3.9.

If you install a *P.I.P.* module other than the P.I.P.-FX, P.I.P.-BB, P.I.P.-FMX or P.I.P.-FPX, do not connect input signals to the phone jacks. The phone jacks are in parallel with the output of the *P.I.P.* module, so the source connected to the phone jacks can feed into the *P.I.P.* and generate a distortion in the output. The phone jacks can still be used as "daisy chain" outputs to feed the post-processed signal from the *P.I.P.* to the input of other amplifiers.

If the amplifier will be used in Bridge-Mono or Parallel-Mono mode, be sure to follow the instructions provided in Sections 3.3.2 and 3.3.3. Do not use the channel 2 input in either mono mode.

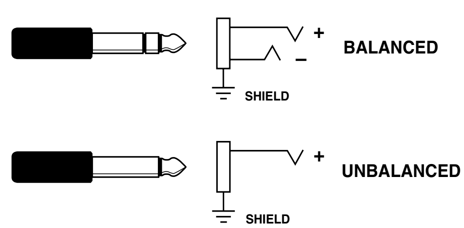


Fig. 3.10 Balanced and Unbalanced Phone Plugs

SOLVING INPUT PROBLEMS

Sometimes large **subsonic** (subaudible) **frequencies** are present in the input signal. These can damage loudspeakers by overloading or overheating them. To attenuate such frequencies, place a capacitor in series with the input signal line. The graph in Figure 3.11 shows some capacitor values and how they affect the frequency response of a *Studio Reference* amplifier. Use only low-leakage capacitors.

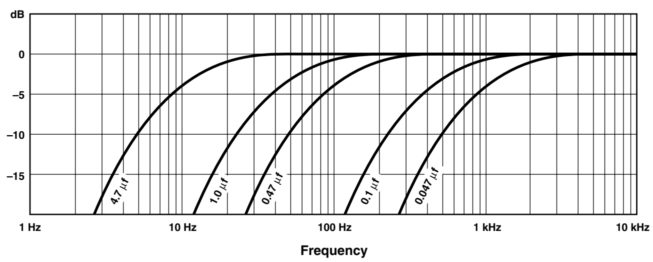


Fig. 3.11 Subsonic Filter Capacitors

Another problem to avoid is large levels of **radio frequencies** or RF in the input signal. Although high RF levels may not pose a threat to the amplifier, they can burn out tweeters or other loads that are sensitive to high frequencies. Extremely high RF levels can also cause your amplifier to prematurely activate its protection circuitry, resulting in inefficient operation. RF can be introduced into a signal by local radio stations and from the bias signal of many tape recorders. To prevent high levels of input RF, install an appropriate low-pass filter in series with the input signal. Some examples of unbalanced wiring for low-pass filters are shown in Figure 3.12.

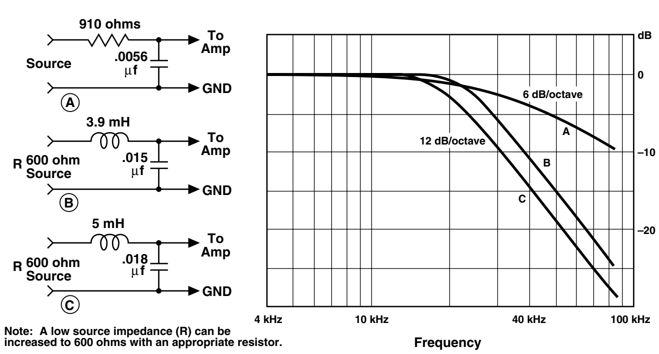


Fig. 3.12 Unbalanced RF Filters

For balanced input wiring, use an example from Figure 3.13. Filters A, B and C correspond to the unbalanced filters shown in Figure 3.12. Filter D also incorporates the subsonic filter in Figure 3.11.

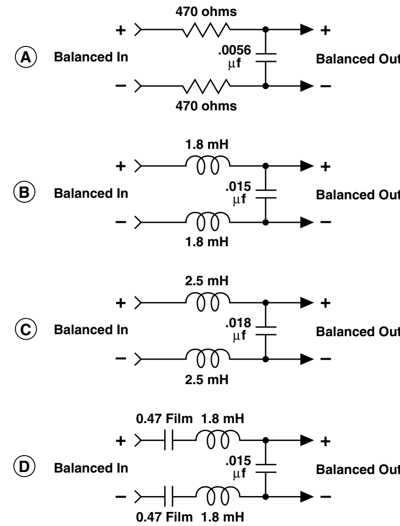


Fig. 3.13 Balanced RF Filters

Tip: The P.I.P.-FX has plenty of space on its circuit board for the addition of input filter circuitry.

Another problem to avoid is **ground loops**. These are undesired currents that flow in a grounded system and usually cause hum in the output. A common source of ground loop problems is the placement of input cables parallel to power cables or near power transformers. The magnetic field that surrounds these conductors can induce the 50 or 60 Hz alternating current into your input cables. To prevent this type of ground loop, it is always a good idea to locate input cables away from

Input Wiring Tips

1. Use only shielded cable. Cables with higher density shields are better. Spiral wrapped shield is not recommended.

2. When using unbalanced lines, keep the cables as short as possible. Avoid cable lengths greater than 10 feet (3 meters).

3. Do not run signal cables together with high-level wiring such as loudspeaker wires or AC cords. This reduces the chance of hum or noise being induced into the input cables.

4. Turn the entire system off before changing connections. Turn level controls down before powering the system back up. Crown is not liable for damage incurred when any transducer or component is overdriven.

power cables and power transformers. We also recommend using shielded or twisted pair wire. With loose wires, use tie-wraps to bundle together each pair of input wires. This helps reduce magnetically-induced current by minimizing the cross-sectional area between conductors that could bisect the magnetic field.

Ground loops often occur when the input and output grounds are tied together. DO NOT CONNECT THE INPUT AND OUTPUT GROUNDS TOGETHER. Tying the grounds together can also cause **feedback oscillation** from the load current flowing in the loop. To avoid this problem, use proper grounding, isolate the inputs, and isolate other common AC devices. When using the input phone jacks, the signal grounds can be isolated from the AC mains ground with the ground lift switch located on the amplifier's back panel (see Figure 2.2 and Section 4.4).

3.3.5 Output Connection

Consider the rated power-handling capacity of your load before connecting it to the amplifier. Crown is not liable for damage incurred at any time due to overpowering. Fusing loudspeaker lines is highly recommended (see Section 3.3.6). Also, please pay close attention to Section 4.1, *Precautions*.

You should always install loudspeaker cables of sufficient gauge (wire thickness) for the length used. The resistance introduced by inadequate output wiring will reduce the amplifier's power to and motion control of the loudspeakers. The latter problem occurs because

Use Good Connectors

1. Male connectors on loudspeaker cables should not be exposed to prevent possible short circuits.

2. Connectors which might accidentally cause the two channels to be tied together when making and breaking connections should not be used. (A common example is the standard three-wire stereo phone plug.)

3. Connectors which can be plugged into AC power receptacles should never be used.

4. Connectors having low current-carrying capacity should not be used.

5. Connectors having any tendency to short should never be used.

the damping factor decreases as the cable resistance increases. This is very important because the amplifier's excellent damping factor can be easily negated by using insufficient cable.

Use the nomograph in Figure 3.14 and the procedure that follows to find the recommended wire gauge (AWG or American Wire Gauge) for your system.

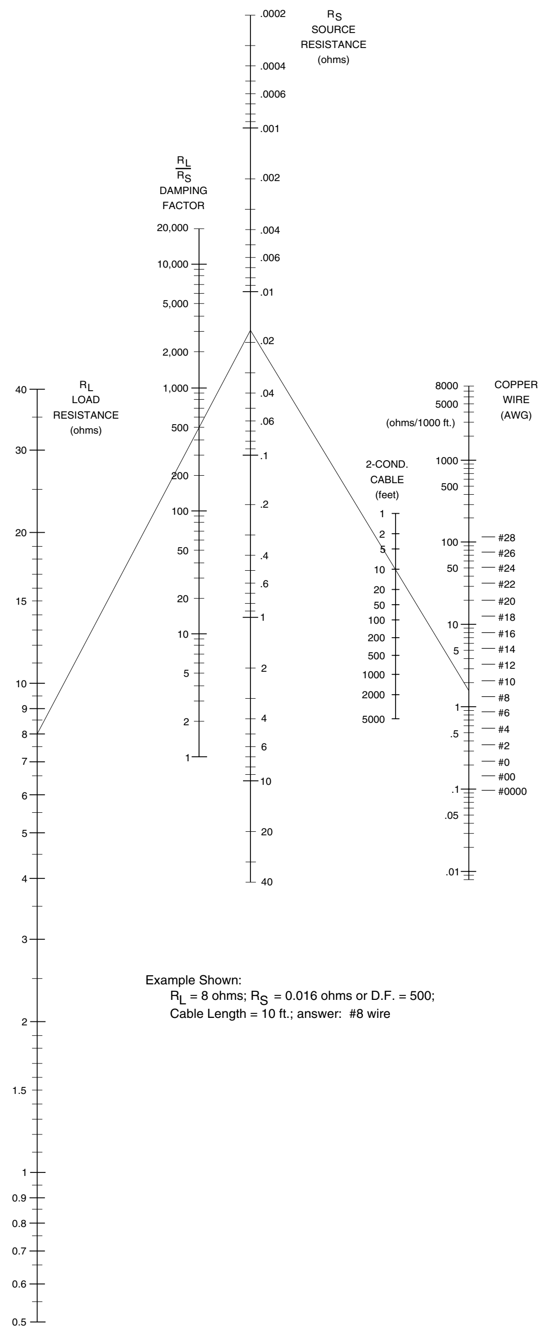


Fig. 3.14 Wire Size Nomograph

1. For loads connected in parallel, use the equation that follows to calculate each channel's total load resistance. Substitute the rated impedance of the connected loudspeakers for the Zs in the equation. When finished, mark your answer on the nomograph's "Load Resistance" line.

$$\text{Total Load Resistance in Ohms} = \left(\frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}\ldots\right)^{-1}$$

2. Select an acceptable damping factor and mark it on the "Damping Factor" line. Your amplifier can provide an phenomenal damping factor of 20,000 from 10 to 200 Hz in Stereo mode with an 8 ohm load. In contrast, most other amplifiers have a damping factor rating of 200 or less. Higher damping factors yield lower distortion and greater motion control over the loudspeakers. To give you a basis for comparison, effective damping factors for commercial applications typically run between 50 and 100. Higher damping factors may be desirable for live sound, but long cable lengths often limit the highest damping factor that can be achieved practically. (Under these circumstances, Crown's *IQ System* is often used so amplifiers can be easily monitored and controlled when they are located very near the loudspeakers.) In recording studios and home hi-fi, a damping factor of 500 or more is very desirable.

3. Draw a line through the two points with a pencil, and continue until it intersects the "Source Resistance" line.

4. On the "2-Cond. Cable" line, mark the length of the cable run.

5. Draw a pencil line from the mark on the "Source Resistance" line through the mark on the "2-Cond. Cable" line, and on to intersect the "Annealed Copper Wire" line.

6. The required wire gauge for the selected wire length and damping factor is the value on the "Annealed Copper Wire" line. *Note: Wire size increases as the AWG gets smaller*.

7. If the size of the cable exceeds what you want to use, (1) find a way to use shorter cables, like using the *IQ System*, (2) settle for a lower damping factor, or (3) use more than one cable for each line. Options 1 and 2 will require the substitution of new values for cable length or damping factor in the nomograph. For option 3, estimate the effective wire gauge by subtracting 3 from the apparent wire gauge every time the number of conductors of equal gauge is doubled. So, if #10 wire is too large, two #13 wires can be substituted, or four #16 wires can be used for the same effect.

SOLVING OUTPUT PROBLEMS

High frequency oscillations can cause your amplifier to prematurely activate its protection circuitry. The effects of this problem are similar to the effects of the RF problem described in Section 3.3.4. To prevent high-frequency oscillations, follow these guidelines:

1. When using long cable runs, or when different amplifiers share a common cable tray or jacket, use tie-wraps to bundle individual conductors so the wires for each loudspeaker are kept close together. (Do not bundle wires from different amplifiers.) This reduces the chance of conductors acting like antennas to transmit or receive the high frequencies that can cause oscillation.
2. Avoid using shielded loudspeaker cable.
3. Never tie together input and output grounds.
4. Never tie together the output of different amplifiers.
5. Keep output cables separated from input cables.
6. Install a low-pass filter in series with each input (see Section 3.3.4).
7. Install the input wiring according to the instructions in Section 3.3.4.

Another problem to avoid is the presence of large **subsonic currents** when primarily inductive loads are used. Examples of inductive loads are 70-volt step-up transformers and electrostatic loudspeakers.

Inductive loads can appear as a short circuit at low frequencies. This can cause the amplifier to produce large low-frequency currents and activate its protection circuitry. Always take the precaution of installing a high-pass filter in series with the amplifier's input when inductive loads are used. A three-pole, 18 dB per octave filter with a –3 dB frequency of 50 Hz is recommended (some applications may benefit from an even higher –3 dB frequency). Such a filter is described with the subsonic frequency problems in Section 3.3.4.

Another way to protect inductive loads from large low-frequency currents and prevent the amplifier from prematurely activating its protective systems is to parallel a 590 to 708 µF nonpolarized motor start capacitor and 4-ohm, 20-watt resistor in series with the amplifier output and the positive (+) transformer lead. This circuit is shown in Figure 3.15. It uses components that are

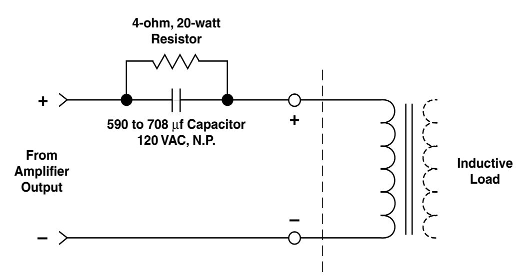


Fig. 3.15 Inductive Load (Transformer) Network

available from most electrical supply stores.

3.3.6 Additional Load Protection

Studio Reference amplifiers can deliver very high power levels, so it's a good idea to add protection for your loudspeakers if it is not built-in. Loudspeakers are subject to thermal damage from sustained overpowering and mechanical damage from large transient voltages. In both cases, fuses may be used to protect your loudspeakers, or you may opt for the convenience of a *P.I.P.* module that provides similar protection.

Thermal protection and voltage protection require different types of fuses. Slow-blow fuses are used to prevent thermal damage because they respond to thermal conditions like a loudspeaker. High-speed instrument fuses like the Littlefuse 361000 series are used to protect loudspeakers from transient voltages. The nomograph in Figure 3.16 can be used to select the correct fuse for thermal or voltage protection.

There are two common ways to install the fuses. One approach is to put a single fuse in series with each output. This is easy because there is only one fuse per channel to install. But if the fuse blows, power is removed to all of the connected loads.

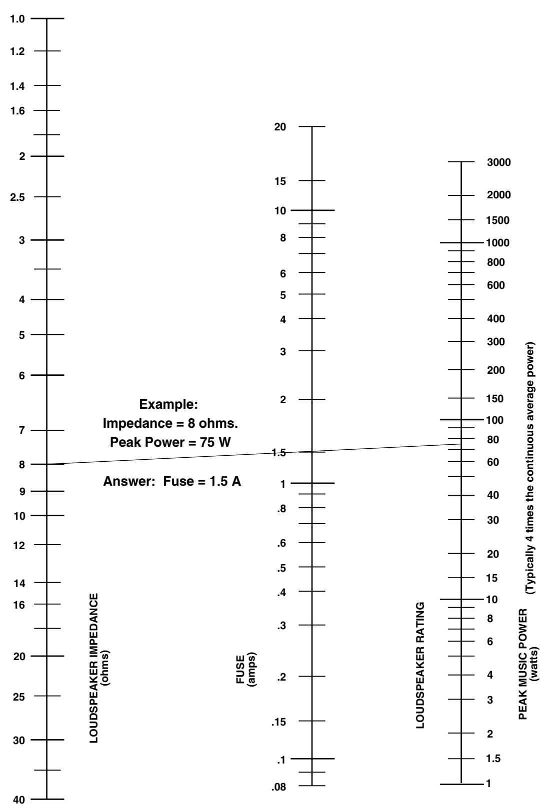


Fig. 3.16 Loudspeaker Fuse Nomograph

A better approach is to fuse each driver independently. This allows you to apply the most appropriate protection for the type of driver being used. In general, low-frequency drivers (woofers) are most susceptible to thermal damage and high-frequency drivers (tweeters) are usually damaged by large transient voltages. This means that your loudspeakers will tend to have better protection when the woofers are protected by slow-blow fuses and high-frequency drivers are protected by high-speed instrument fuses.

Depending on the application, you may want to use a specialized *P.I.P.* module to protect your loudspeakers. Again, some modules are more appropriate for long-term thermal protection, while others are more appropriate for protection against transients. A *Smart Amp*™ IQ-P.I.P. module is most commonly used for long-term loudspeaker thermal protection. Each *Smart Amp* channel provides an independent "smooth output limiter" that controls average output levels over time while it allows transients to pass.

Most of the other *P.I.P.* modules that provide signal-driven compression can be used to prevent loudspeaker damage from transient voltage. These modules include the P.I.P.-AMCb, P.I.P.-EDCb and P.I.P.-PA. While the P.I.P.-EDCb is most commonly used for general loudspeaker protection, the P.I.P.-AMCb is very popular in systems that require a high-quality crossover, and the P.I.P.-PA is the processor of choice for applications that require a microphone and line level input for each channel. And finally, the *Smart Amp* IQ-P.I.P.-DP provides both an input compressor for transient protection and a smooth output limiter for long-term thermal protection. For more information on *P.I.P.* modules, see Section 8.

3.4 AC Mains Power

All *Studio Reference* amplifiers are shipped with an appropriate line cord and plug. The 120 VAC, 60 Hz North American *Studio Reference I* has a special TT30P plug and includes a matching receptacle. Always use an isolated power receptacle whenever possible with adequate voltage and current. Excessive line voltages 10% or higher above the rated voltage will cause the amplifier to activate its standby mode (see Section 4.3.2). For example, do not exceed a 132 VAC with models rated for 120 VAC operation.

Unless otherwise noted, all specifications in this manual were measured using 120 VAC, 60 Hz power mains with voltage accurate to within 0.5% and THD of less than 1.0% under all test conditions. Performance variations can occur at other AC mains voltages and line frequencies. Line regulation problems will directly affect the output power available from the amplifier.

4 Operation

4.1 Precautions

Although your amplifier is protected from internal and external faults, you should still take the following precautions for optimum performance and safety:

1. Improper wiring for the Stereo, Bridge-Mono or Parallel-Mono modes can result in serious operating difficulties (see Sections 3.3.1 through 3.3.3).
2. When driving an inductive load like an electrostatic loudspeaker, use a high-pass filter or protective network to prevent premature activation of the amplifier's protection circuitry (see Section 3.3.4).
3. **WARNING: Do not change the position of the stereo/mono switch unless the amplifier is first turned off.**
4. **CAUTION: In Parallel-Mono mode, a jumper must be installed between the channel 1 and 2 red (+) binding post outputs. Be sure to remove this jumper for Stereo or Bridge-Mono modes, otherwise high distortion and excessive heating will occur.** Check the stereo/mono switch on the back panel for proper position.
5. **Turn off the amplifier and unplug it from the AC mains before removing the amplifier's *P.I.P.* module or dust filter.**
6. Use care when making connections, selecting signal sources and controlling the output level. The load you save may be your own!
7. Do not short the ground lead of an output cable to the input signal ground. This will form a ground loop and may cause oscillations.
8. Operate the amplifier from AC mains of not more than 10% above or below the selected line voltage and only at the rated line frequencies.
9. **Never connect the output to a power supply output, battery or power main.** Such connections may result in electrical shock.
10. Tampering with the circuitry by unqualified personnel, or making unauthorized circuit changes may be hazardous and invalidates all agency listings.

Remember: Crown is not liable for damage that results from overdriving other system components.

4.2 Indicators

The front panel has several helpful indicators. The **enable indicator** is provided to show the amplifier has been turned on (or enabled) and that its low-voltage

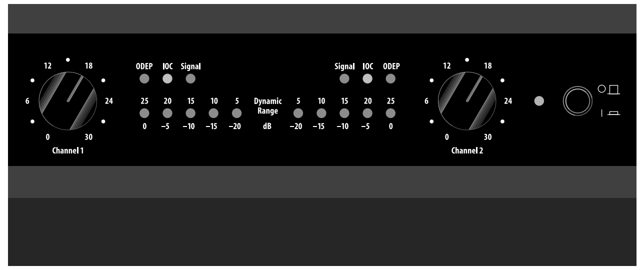


Fig. 4.1 Indicators

power supply and on-demand forced air cooling system are working. It does not indicate the status of the high-voltage power supplies. For example, the enable indicator will stay on in the improbable event that one or both channels overheat causing an internal shut down of the high voltage supplies.

The green ***ODEP* indicators** confirm the normal operation of Crown's patented Output Device Emulation Protection circuitry. During normal operation, they glow brightly to confirm the presence of reserve thermodynamic energy. They dim proportionally as the energy reserve decreases. In the rare event that there is no reserve, the indicators will turn off and *ODEP* will proportionally limit the drive level of the output stages so the amplifier can continue safe operation even when the operating conditions are severe. (For a more detailed description of *ODEP*, see Section 4.3.1.)

A channel's *ODEP* indicator also turns off if its high-voltage power supply is put in "standby" mode or the amplifier's circuit breaker is tripped. The standby mode is activated if DC or heavy common-mode current is detected in the output, if the transformer thermal protection system is activated, if a *P.I.P.* like the *Smart Amp* IQ-P.I.P. is used to shut down a high-voltage supply, or if excessive AC mains voltage is detected. For more information see Section 4.3 and the table in Figure 4.2.

The yellow ***IOC* indicators** act as sensitive distortion meters to provide *proof of distortion-free performance*. The *IOC* (Input/Output Comparator) circuitry compares the incoming signal's waveform to that of the output. Any difference between the two is distortion. The *IOC* indicators flash if there is a difference of 0.05% or more. The *IOC* indicators also show input overload by flashing brightly with a half-second hold delay. It is normal for them to light momentarily when the amplifier is first turned on. *Note: The channel 2 IOC indicator will stay on in Parallel-Mono mode. Also, an IOC indicator will stay on in abnormal situations where a high-voltage power supply is temporarily put in standby mode.*

The green **signal presence indicators** flash synchronously with the amplifier's output signal. The signal detector is connected to the signal path after the input gain stages and level controls, so a flashing indicator tells you that there is audio in and out of the amplifier. *Note: The signal presence indicators may not report signal presence if the output signal level is too low.*

The **dynamic range / level meters** are five-segment output meters that can be set to monitor either the dynamic range or the level of the output signal. They are factory-set to show dynamic range. A switch located behind the front panel is used to select the meter display mode (see Section 4.4 for complete instructions). As dynamic range meters they show each channel's ratio of peak-to-average power in dB. The dynamic range may be low for sources like AM/FM radio or low-quality recordings. Other sources like live music or high-quality recordings may be much higher. As output level meters they show how high the output levels are in dB relative to full power. At 0 dB, the unit is delivering full standard 1 kHz power (see Section 6).

4.3 Protection Systems

Studio Reference amplifiers provide extensive protection and diagnostics capabilities. Protection systems include *ODEP*, standby mode, an AC circuit breaker

Indicator Status	Amplifier Condition
ODEP: OFF, IOC: OFF, SIGNAL: OFF	**There is no power to the amplifier.** Possible reasons: (1) The amplifier's enable switch is off. (2) The amplifier is not plugged into the power receptacle. (3) The AC mains circuit breaker has been tripped. (4) The amplifier's circuit breaker has been tripped.
ODEP: ON, IOC: OFF, SIGNAL: OFF	**Normal operation for a channel with NO output.** Possible reasons: (1) There is no input signal. (2) The input signal level is very low. (3) The channel's level control is turned down.
ODEP: OFF, IOC: ON, SIGNAL: OFF	**The amplifier is in standby mode.** Possible reasons: (1) The amplifier has just been turned on and is still in the four second turn-on delay. (2) A *P.I.P.* module such as an IQ-P.I.P. has turned off the channel's high-voltage supply. (3) The DC / low-frequency protection circuitry has been activated. (4) The fault protection circuitry has been activated. (5) The transformer thermal protection circuitry has been activated. (6) The overvoltage protection circuitry has been activated.
ODEP: OFF, IOC: OFF, SIGNAL: Active	***ODEP* limiting is about to begin or has just ended.** Possible reasons: (1) The amplifier's air filter is blocked and needs to be cleaned. (2) There is insufficient cooling because of inadequate air flow or air that is too hot. (3) The load impedance for the channel is too low because the output is shorted or the amplifier is driving too many loudspeakers for the selected stereo/mono mode. (4) The amplifier channel is continuously being driven to very high output levels.
ODEP: ON, IOC: ON, SIGNAL: OFF	**Channel 2 only: The amplifier is in Parallel-Mono mode with no output.** The channel 2 *IOC* indicator always turns on when the amplifier's stereo/mono switch is moved to the Parallel-Mono position.
ODEP: ON, IOC: OFF, SIGNAL: Active	**Normal operation for a channel with audio output.** The *ODEP* indicator will remain at full intensity to show that there is reserve thermal-dynamic energy and the signal presence indicator will flash to show that there is audio output.
ODEP: OFF, IOC: ON, SIGNAL: Active	***ODEP* limiting has been activated.** Possible reasons: (1) The amplifier's air filter is blocked and needs to be cleaned. (2) There is insufficient cooling because of inadequate air flow or air that is too hot. (3) The load impedance for the channel is too low because the output is shorted or the amplifier is driving too many loudspeakers for the selected stereo/mono mode. (4) The amplifier channel is continuously being driven to very high output levels.
ODEP: ON, IOC: ON, SIGNAL: Active	**The channel's output is exceeding 0.05% distortion.** The input signal level is too high, and *IOC* is reporting either an input overload or output clipping. OR **Channel 2 only: The amplifier is in Parallel-Mono mode and has output.** The channel 2 *IOC* indicator always turns on when the amplifier's stereo/mono switch is moved to the Parallel-Mono position.

Fig. 4.2 Studio Reference Indicator States

and transformer thermal protection. These systems will prevent amplifier damage in virtually any situation.

4.3.1 *ODEP*

Crown invented *ODEP* to solve two long-standing problems in amplifier design: to prevent amplifier shutdown during demanding operation and to increase the efficiency of output circuitry.

To do this, Crown established a rigorous program to measure the *safe operating area* (SOA) of each output transistor before installing it in an amplifier. Next, Crown designed intelligent circuitry to simulate the instantaneous operating conditions of the output transistors. Its name describes what it does: Output Device Emulation Protection or *ODEP*. In addition to simulating the operating conditions of the output transistors, it also compares their operation to their known SOA. If *ODEP* sees that more power is about to be asked of the output transistors than they are capable of delivering under the present conditions, *ODEP* immediately limits the drive level until it falls within the SOA. Limiting is proportional and kept to an absolute minimum—only what is required to prevent output transistor damage.

This level of protection enables Crown to increase output efficiency to never-before-achieved levels while greatly increasing amplifier reliability.

The on-board intelligence is monitored two ways. First, the amplifier's *ODEP* indicators show whether the unit is functioning correctly or if *ODEP* is limiting output. Second, *ODEP* data is fed to the amplifier's internal *P.I.P.* connector so advanced *P.I.P.* modules like the IQ-P.I.P. can use it to monitor and control the amplifier.

This is how *ODEP* keeps the show going with maximum power and maximum protection at all times.

4.3.2 Standby Mode

An important part of a *Studio Reference* amplifier's protection systems is standby mode. Standby protects the amplifier during potentially catastrophic conditions. It temporarily removes power from the high-voltage supplies to protect the amplifier and its loads. Standby mode can be identified using the table in Figure 4.2.

Standby mode is activated in five situations. First, when you turn on the enable switch, standby mode is activated to provide turn-on protection. This power-up delay lets other system components settle before any signals are amplified and it provides some power-up "randomness" for multiple units so the system's start-up current demands are better distributed over time.

The amplifier's **overvoltage protection** circuitry will put both channels into standby when excessive AC mains voltage is detected. *Studio Reference* amplifiers should not be operated with an AC mains voltage of more than 10% over the unit's rated voltage.

If dangerous subsonic frequencies or direct current (DC) is detected in the amplifier's output, the unit will activate its **DC / low-frequency protection** circuitry and put the affected channels in standby. This protects the loads and prevents oscillations. The amplifier resumes normal operation as soon as it no longer detects dangerous low-frequency or DC output. Although it is extremely unlikely that you will ever activate the amplifier's DC / low-frequency protection system, improper source materials such as subsonic square waves or input overloads that result in excessively clipped signals can activate this system.

The amplifier's **fault protection** system will put an amplifier channel into standby mode in rare situations where heavy common-mode current is detected in the channel's output. The amplifier should never output heavy common-mode current unless its circuitry is damaged in some way, and putting the channel into standby mode helps to prevent further damage.

The amplifier's **transformer thermal protection** circuitry is activated in very unusual circumstances where the unit's transformer temperature rises to unsafe levels. Under these abnormal conditions, the amplifier will put both channels into standby mode. The amplifier will return to normal operation after the transformer cools to a safe temperature. (For more information on transformer thermal protection, refer to the section that follows.)

4.3.3 Transformer Thermal Protection

All *Studio Reference* amplifiers have transformer thermal protection which protects the power supplies from damage under <u>rare</u> conditions where the transformer temperature rises too high. A thermal switch embedded in the transformer removes power to the high-voltage power supplies if it detects excessive heat. The switch automatically resets itself as soon as the transformer cools to a safe temperature.

If your amplifier is operated within rated conditions, it is extremely unlikely that you will ever see it activate transformer thermal protection. One reason is that *ODEP* keeps the amplifier <u>working</u> under very severe conditions. Even so, higher than rated output levels, excessively low-impedance loads and unreasonably high input signals can generate more heat in the transformer than in the output devices. This can overheat the transformer and activate its protection system.

Studio Reference amplifiers are designed to keep working under conditions where other amplifiers would fail. But even when the limits of a *Studio Reference* amplifier are exceeded, it still protects itself—and your investment—from damage.

4.3.4 Circuit Breaker

A back panel circuit breaker is provided to prevent excessive current draw by the high-voltage power supplies. A *Studio Reference I* configured for 100 to 120 VAC has a 30 amp circuit breaker, while the 220 to 240 VAC version has a 20 amp circuit breaker. A *Studio Reference II* configured for 100 to 120 VAC uses a 20 amp circuit breaker, and the 220 to 240 VAC version has a 10 amp circuit breaker. With rated loads and output levels, this breaker should only trip in the incredibly rare instance of a catastrophic amplifier failure. The *ODEP* system keeps the amplifier safe and operational under most other severe conditions. The breaker can also trip in situations where extremely low-impedance loads and high output levels result in current draw that exceeds the breaker's rating. Again, this should only be possible when operating *outside rated conditions*, like when the amplifier is used to drive a 1 ohm load, or when an input signal is clipped severely.

4.4 Controls

The front panel **enable switch** is used to turn the amplifier on and off. If you ever need to make any wiring or installation changes, don't forget to disconnect the power cord first. Please follow these steps when first turning on your amplifier:

1. Turn down the level of your audio source. For example, set your mixer's volume to –□ (off).
2. Turn down the amplifier's level controls.
3. Turn on the enable switch. The enable indicator beside the switch should glow. During the four second turn-on delay that immediately follows, the indicators will flash as described in Figure 4.2. After the delay, the *ODEP* indicators should come on with full brilliance and the *IOC* and signal presence indicators should function normally.
4. After the turn-on delay, turn up your source to the maximum desired level.
5. Turn up the amplifier's level controls until the maximum desired sound level is achieved.
6. Turn down the level of your audio source to its normal range.

Each of the front panel **level controls** has 31 detents for accurately repeatable settings. In Bridge-Mono and Parallel-Mono modes, the channel 2 level control should be turned down.

The **meter switches** are located behind the front panel. They make it possible to switch between the dynamic range and signal level display modes for the meters, or you can turn the meters off. From the factory, the meters automatically display dynamic range (which is computed as the ratio of peak to average output power). To change these switches, you will need to remove part of the front panel. A phillips screwdriver will be needed, and it will help to remove the amplifier if it is mounted in a rack. Follow these steps:

1. Make sure the amplifier is turned off and its power cord is disconnected from the AC mains source.
2. Remove the two screws that hold each end cap in place and remove both end caps (see Figure 3.2).
3. Remove the six screws that hold each handle in place and remove each handle (see Figure 4.3).
4. Remove the dust filter by gently pulling it away from the front panel.
5. Remove the two screws that secure the lower half of the front panel and remove the lower front panel.
6. Locate the meter switches as shown in Figure 4.4. Set the switches as desired. The left switch is used to turn the meters on and off, and the right switch is used to change display modes.
7. Reassemble the front panel, handles and end caps in reverse order of disassembly.
8. Install the amplifier and reconnect power.

AMPLIFIER TOP VIEW

(FRONT LEFT CORNER—END CAP REMOVED)

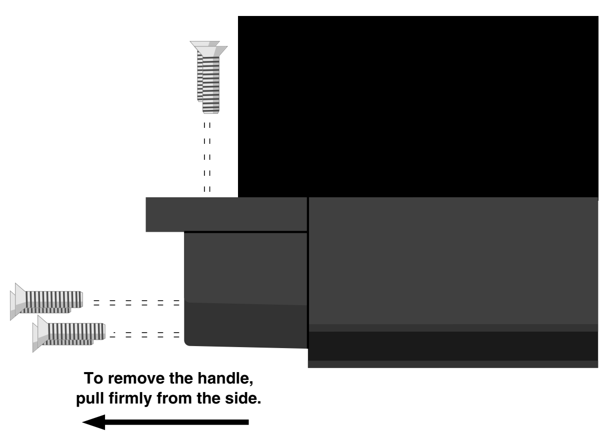


Fig. 4.3 Removing a Handle

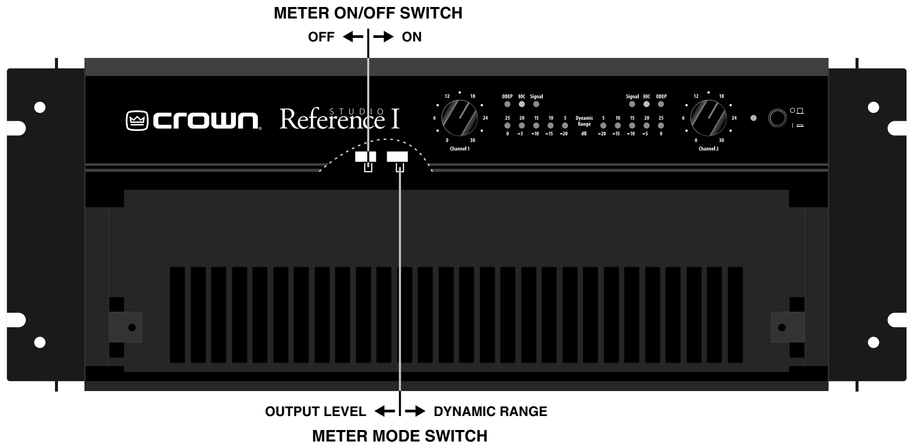


Fig. 4.4 Meter Switches

The **input sensitivity switch** is located inside the amplifier's *P.I.P.* compartment. It is factory-set to a fixed voltage gain of 26 dB. For standard 1 kHz power into 8 ohms, this is equivalent to an input sensitivity of 4.0 volts for the *Studio Reference I* and 2.7 volts for the *Studio Reference II*. If needed, it can be switched to a sensitivity of 0.775 or 1.4 volts. Here is the procedure:

1. Turn off the amplifier and disconnect the power cord from the receptacle.
2. Remove the *P.I.P.* module.
3. Locate the access hole for the sensitivity switch inside the chassis opening (see Figure 4.5).
4. Set the switch to the desired position noted on the access hole label.
5. Replace the *P.I.P.* module and restore power.

The **ground lift switch** located on the back panel can provide isolation between the phone jack input grounds and the AC (chassis) ground. It does <u>not</u> affect the *P.I.P.* module's input connectors. Slide the switch to the left to isolate or "lift" the grounds.

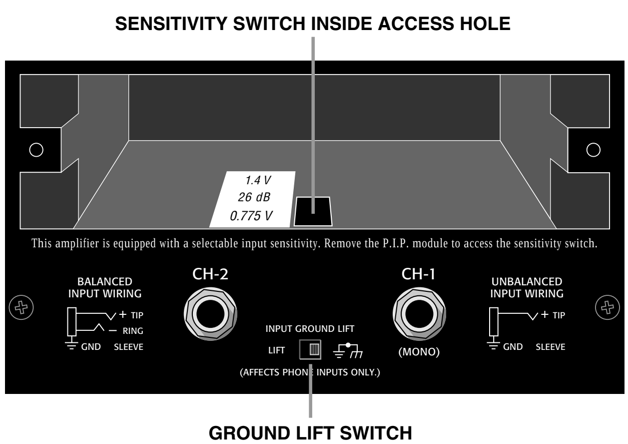


Fig. 4.5 Input Sensitivity and Ground Lift Switches

Note: The noninverted and inverted signal lines for the P.I.P. module are connected in parallel with the corresponding lines of the phone jack inputs. The input signal grounds are not paralleled. Specifically, XLR pins 2 and 3 are connected in parallel with the tip and ring of the corresponding phone jack. However, pin 1 of the XLR is not connected in parallel with the sleeve of the phone jack. This makes it possible for a P.I.P. module to handle its own signal grounds independently.

The amplifier's circuit breaker protects the power supplies from overload. The breaker's **reset switch** is located on the back panel. Facing the back panel, move the reset switch the left to disconnect power to the power supplies, or to the right to reconnect power. If the circuit breaker trips, the front panel enable indicator will turn off. If this occurs, turn off the enable switch, flip the reset switch to the right (on), and then turn the enable switch back on. If it trips again or the amplifier does not operate properly, contact an authorized service center or Crown's Technical Support Group.

4.5 Filter Cleaning

A dust filter is provided on the amplifier's air intake (see Figure 2.1). If this filter becomes clogged, the unit will not cool as efficiently as it should and high heat sink temperatures may produce lower-than-normal output.

To clean the filter, gently pull it away from the front panel and wash it with mild dishwashing detergent and warm water. Be sure the filter is dry before you reinstall it. Replacement filters may be ordered from the factory.

Dust filters are not 100% efficient—long term this may require heat sink cleaning by a qualified technician. Internal cleaning information is available from our Technical Support Group.

5 Technical Information

5.1 Overview

Studio Reference amplifiers incorporate several new technological advancements including real-time computer simulation of output transistor stress, low-stress output stages, an advanced heat sink embodiment and the Programmable Input Processor (*P.I.P.*) expansion system.

Custom circuitry is incorporated to limit temperature and current to safe levels making it highly reliable and tolerant of faults. Unlike many lesser amplifiers, it can operate at its voltage and current limits without self-destructing.

Studio Reference amplifiers are protected against all common hazards that plague high-power amplifiers including shorted, open or mismatched loads; overloaded power supplies, excessive temperature, chain-destruction phenomena, input overload and high-frequency blowups. The unit protects loudspeakers from input and output DC, as well as turn-on and turn-off transients.

Real-time computer simulation is used to create an analogue of the junction temperature of the output transistors (hereafter referred to as the output devices). Current is limited only when the device temperature becomes excessive—and only by the minimum amount necessary. This patented approach maximizes the available output power and eliminates overheating—the major cause of device failure.

Crown also invented the four-quadrant topology used in the output stages of each *Studio Reference* amplifier (see Figure 5.1). This special circuitry is called the *grounded bridge*. It makes full use of the power supply by delivering peak-to-peak voltages to the load that are twice the voltage seen by the output devices.

As its name suggests, the *grounded bridge* topology is referenced to ground. Composite devices are constructed to function as gigantic NPN and PNP devices to handle currents which exceed the limits of available devices. Each output stage has two composite NPN and two composite PNP devices.

The devices connected to the load are referred to as "high-side NPN and PNP" and the devices connected to ground are referred to as "low-side NPN and PNP." Positive current is delivered to the load by increasing conductance simultaneously in the high-side NPN and low-side PNP stage, while synchronously decreasing conductance of the high-side PNP and low-side NPN.

The two channels may be used together to double the voltage (Bridge-Mono) or the current (Parallel-Mono) presented to the load. This feature gives you the flexibility to maximize power available to the load.

A wide bandwidth, multiloop design is used for state-of-the-art compensation. This produces ideal behavior and results in ultra-low distortion values.

Aluminum extrusions are used widely for heat sinks in power amplifiers due to their low cost and reasonable performance. However, measured on a watts per pound or watts per volume basis, the extrusion technology doesn't perform nearly as well as the heat sink technology developed for *Studio Reference* amplifiers.

Our heat sinks are fabricated from custom convoluted fin stock that provides an extremely high ratio of area to volume, or area to weight. All power devices are mounted directly to the heat sinks which are also electrically at the Vcc potential. Electrifying the heat sinks improves thermal performance by eliminating the insulating interface underneath the power devices. The chassis itself is even used as part of the thermal circuit to maximize utilization of the available cooling resources.

5.2 Circuit Theory

Power is provided by low-field toroidal power transformer T1. The secondaries of T1 are full-wave rectified (by D1 through D4, D22 and D24) and filtered by large computer grade capacitors. A thermal switch embedded in the transformer protects it from overheating. Monolithic regulators provide a regulated ±15 volts.

5.2.1 Stereo Operation

For simplicity, the discussion of Stereo operation will refer to only one channel. Mono operation will be discussed later. Please refer to the block diagram in Figure 5.1 and the schematics included with this manual.

The input signal at the phone jack passes directly into the balanced gain stage (U104-A). When a *P.I.P.* module is used, the input signal first passes through the *P.I.P.'s* circuitry and then to the balanced gain stage.

The balanced gain stage (U104-A) causes balanced to single-ended conversion using a difference amplifier. From there, gain can be controlled with the front panel level controls and the input sensitivity switch. The error amp (U104-C) amplifies the difference between the

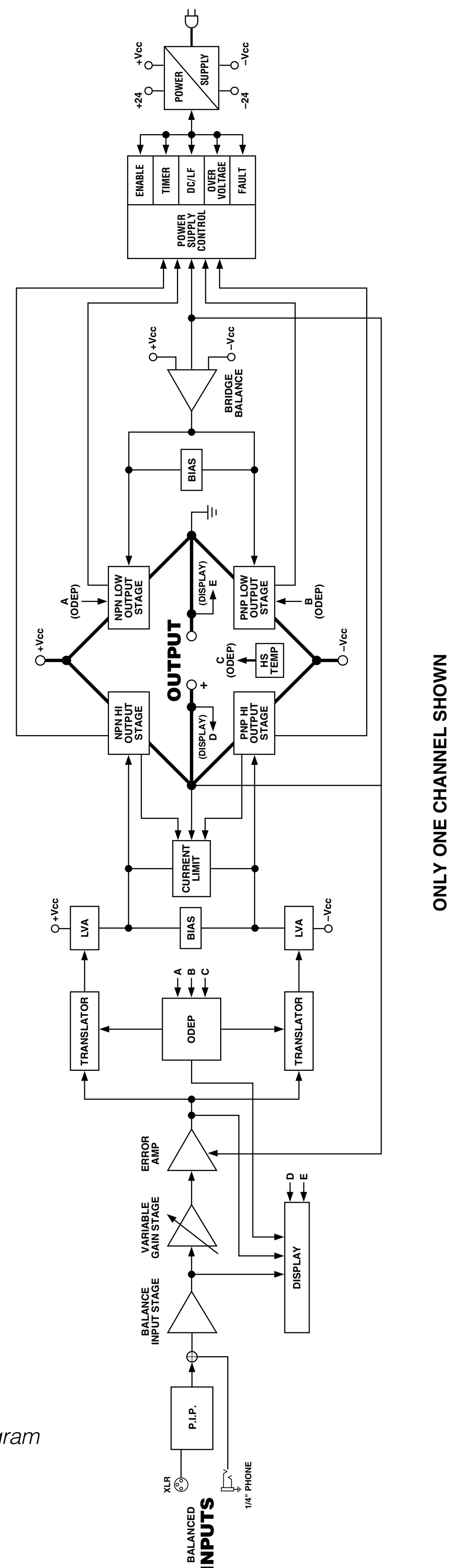


Fig. 5.1 Circuit Block Diagram

output signal and the input signal from the gain pot, and drives the voltage-translator stage.

From the error amp, the voltage translator stage channels the signal to the Last Voltage Amplifiers (LVAs) depending on the signal polarity. The +LVA (Q104 and Q105) and the –LVA (Q110 and Q111) drive the fully complementary output stage with their push-pull effect through the bias servo Q318.

The bias servo Q318 is thermally coupled to the heat sink, and sets the quiescent bias current in the output stage to lower the distortion in the crossover region of the output signal.

With the voltage swing provided by the LVAs, the signal then gains current amplification through the triple Darlington emitter-follower output stage.

The bridge-balanced circuit (U104-D) receives a signal from the output of the amplifier, and differences it with the signal at the Vcc supply. The bridge-balanced circuit then develops a voltage to drive the bridge-balanced output stage. This results in the Vcc supply having exactly one half of the output voltage added to its quiescent voltage. Bias servo Q300 sets the quiescent current point for the bridge-balanced output stage.

The protection mechanisms that affect the signal path are implemented to protect the amplifier under real-world conditions. These conditions are high instantaneous current, excessive temperature, and output device operation outside safe conditions.

Q107 and Q108 act as a conventional current limiter, sensing current in the output stage. When output current at any instant exceeds the design criteria, the limiters remove drive from the LVAs, thus limiting current in the output stage to a safe level.

To further protect the output stages, the patented *ODEP* circuitry is used. It produces an analog output proportional to the always changing *safe operating area* of the output transistors. This output controls the translator stage previously mentioned, removing any further drive that may exceed the *safe operating area* of the output stage.

Thermal sensor S100 gives the *ODEP* circuit vital information on the operating temperature of the heat sink on which the output devices are mounted.

Should the amplifier fail in such a way that would cause DC across the output leads, the DC/low-frequency protection circuit senses this on the negative feedback loop and shuts down the power supply until the DC is removed.

5.2.2 Bridge-Mono Operation

By setting the back panel stereo/mono switch to Bridge-Mono, the user can convert the amplifier into a bridged, single-channel amplifier. With a signal applied to the channel 1 input jack and the load connected across the two channels' red (+) 5-way binding posts, twice the voltage can be output.

The channel 1 output feeds the channel 2 error amp U204-C. Because there is a net inversion, channel 2 output is out of polarity with channel 1. This produces twice as much voltage across the load. Each channel's protection mechanisms work independently if a fault occurs.

5.2.3 Parallel-Mono Operation

With the stereo/mono switch set to Parallel-Mono, the output of channel 2 is paralleled with the output of channel 1. A suitable jumper capable of handling high current must be connected across the red (+) 5-way posts to gain the benefits of this mode of operation.

The signal path for channel 1 is the same as previously discussed, except channel 1 also drives the output stage of channel 2. The channel 2 balanced input, error amp, translators and LVAs are disconnected and no longer control the channel 2 output stage. Disconnecting the front-end stages from the channel 2 output causes the channel 2 *IOC* circuit to note that the input waveform (which is not present) does not match the output waveform (which is driven by the channel 1 input signal). This activates the channel 2 *IOC* indicator any time the amplifier is switched into Parallel-Mono mode. The channel 2 output stage and protection mechanisms are also coupled through S1 and function as one.

In Parallel-Mono mode, twice the current of one channel alone can be obtained. Because the channel 2 *ODEP* circuit is coupled through S1, this gives added protection if a fault occurs in the channel 2 output stage. The *ODEP* circuit of channel 2 will limit the output of both output stages by removing the drive from the channel 1 translator stages.

6 Specifications

The following applies to units in Stereo mode with 8 ohm loads and an input sensitivity of 26 dB gain unless otherwise specified.

Low-Distortion 1 kHz Power: refers to maximum average power in watts at 1 kHz with 0.02% THD and noise.

Standard 1 kHz Power: refers to maximum average power in watts at 1 kHz with 0.1% THD and noise.

Full Bandwidth Power: refers to maximum average power in watts from 20 Hz to 20 kHz with 0.1% THD and noise.

Performance

Frequency Response: ±0.1 dB 20 Hz to 20 kHz at 1 watt (see Figure 6.5).

Phase Response: +5 to –15 degrees from 20 Hz to 20 kHz at 1 watt (see Figure 6.8).

Signal-to-Noise: (A-weighted)

Studio Reference I: Greater than 120 dB below rated full bandwidth power.

Studio Reference II: Greater than 117 dB below rated full bandwidth power.

Total Harmonic Distortion (THD): Less than 0.02% at rated low-distortion 1 kHz power. Less than 0.1% at rated full bandwidth power.

Intermodulation Distortion (IMD): (60 Hz and 7 kHz 4:1)

Studio Reference I: Less than 0.005% from full bandwidth power to 78 watts rising linearly to 0.025% at 78 milliwatts.

Studio Reference II: Less than 0.005% from full bandwidth power to 36 watts rising linearly to 0.025% at 36 milliwatts.

Damping Factor: Greater than 20,000 from 10 Hz to 200 Hz, and greater than 2,500 at 1 kHz (see Figure 6.6).

Crosstalk: (At rated full bandwidth power)

Studio Reference I: Better than 100 dB from 20 Hz to 100 Hz falling linearly to better than 70 dB at 20 kHz (see Figure 6.10).

Studio Reference II: Better than 100 dB from 20 Hz to 100 Hz falling linearly to better than 65 dB at 20 kHz (see Figure 6.10).

Common Mode Rejection (CMR): (At rated full bandwidth power) See Figure 6.9.

Voltage Gain: (With level controls set for maximum output) At the 26 dB gain setting, 20:1 ±3% or 26 dB ±0.25 dB.

Studio Reference I: At 0.775 volt sensitivity, 103:1 ±12% or 40 dB ±1 dB; at 1.4 volt sensitivity 57:1 ±12% or 35 dB ±1 dB.

Studio Reference II: At 0.775 volt sensitivity, 69:1 ±12% or 37 dB ±1 dB; at 1.4 volt sensitivity 38:1 ±12% or 32 dB ±1 dB.

Power

Power Bandwidth: (At standard 1 kHz power)

Studio Reference I: –1 dB from 5 Hz to 27.5 kHz and –3 dB from 3 Hz to 32.8 kHz.

Studio Reference II: –1 dB from 5 Hz to 28.6 kHz and –3 dB from 2.3 Hz to 34.4 kHz.

Output Power: *The following are guaranteed minimums for low-distortion 1 kHz power from units configured for 120 VAC, 60 Hz power. For more information on power specifications, see the matrices that follow.*

Studio Reference I

Stereo mode (with both channels driven):
1,160 watts into 4 ohms.
780 watts into 8 ohms.

Bridge-Mono mode:
2,220 watts into 8 ohms.
1,580 watts into 16 ohms.

Parallel-Mono mode:
2,315 watts into 2 ohms.
1,565 watts into 4 ohms.

Studio Reference II

Stereo mode (with both channels driven):
555 watts into 4 ohms.
355 watts into 8 ohms.

Bridge-Mono mode:
1,110 watts into 8 ohms.
715 watts into 16 ohms.

Parallel-Mono mode:
1,115 watts into 2 ohms.
710 watts into 4 ohms.

Load Impedance: Safe with all types of loads. Rated for 4 to 8 ohms in Stereo mode, 8 to 16 ohms in Bridge-Mono mode, and 2 to 4 ohms in Parallel-Mono mode.

Required AC Mains: 50 or 60 Hz; 100, 120, 200, 220 or 240 VAC (±10%). Both units draw 90 watts or less at idle. See Section 7 for detailed information on AC power draw, current draw and thermal dissipation.

*It is extremely important to have adequate AC power for the amplifier. Power amplifiers cannot create energy—they must have the required **voltage and current** to deliver the undistorted rated power you expect.*

Controls

Enable: A front panel push button used to turn the amplifier on and off.

Level: A front panel rotary potentiometer for each channel with 31 detents used to control the output level.

Stereo/Mono: A three-position back panel switch used to select Stereo, Bridge-Mono and Parallel-Mono mode.

Sensitivity: A three-position switch inside the *P.I.P.* compartment used to select the input sensitivity for both channels: 0.775 or 1.4 volts for standard 1 kHz power, or a 26 dB voltage gain.

Meter On/Off: A two-position switch behind the front panel used to turn the front panel meters on or off.

Meter Display Mode: A two-position switch behind the front panel used to set the display mode for the front panel meters. Display modes include dynamic range of the output signal in dB or output levels in dB.

Ground Lift: A two-position back panel switch used to isolate the input phone jack and AC (chassis) grounds.

Reset: A two-position back panel switch used to reset the AC mains circuit breaker.

Indicators

Enable: This indicator shows the on/off status of the unit's low-voltage power supply.

Signal: Each channel has a signal indicator that flashes to show audio output.

IOC: Each channel has an *IOC* indicator that flashes if the output waveform differs from the input waveform by 0.05% or more. The LEDs act as sensitive distortion indicators to provide *proof of distortion-free performance*. In Parallel-Mono mode the channel 2 *IOC* light stays on.

ODEP: Each channel has an *ODEP* indicator that shows the channel's reserve energy status. Normally, the LEDs are brightly lit to show that reserve energy is available. In the rare event that a channel has no reserve, its indicator will dim in proportion to *ODEP* limiting. An *ODEP* indicator may also turn off under other more unusual circumstances (see Section 4.3).

Dynamic Range/Level Meter: Each channel has a five-segment meter that displays either the dynamic range of the output signal in dB or the output level in dB. (From the factory, the amplifier is set to display dynamic range.) As dynamic range meters, they show the ratio of the peak to average power of each channel. As output level meters they show how high the output levels are relative to standard 1 kHz power.

Input/Output

Input Connector: Two balanced phone jacks on the back panel and two balanced three-pin XLR connectors on the factory-installed P.I.P.-FX (see Section 8 for information on optional *P.I.P.* modules).

Input Impedance: Nominally 10 K ohms, balanced. Nominally 5 K ohms, unbalanced.

Input Sensitivity: Settings include 0.775 volts or 1.4 volts for standard 1 kHz power, or a 26 dB voltage gain (see Section 4.4 for more information).

Output Connectors: Two sets of color-coded 5-way binding posts for each channel (for connecting banana plugs, spade lugs or bare wire).

Output Impedance: Less than 10 milliohms in series with 2.5 microhenries.

DC Output Offset: (Shorted input) ±2 millivolts.

Output Signal

Stereo: Unbalanced, two-channel.

Bridge-Mono: Balanced, single-channel. Channel 1 controls are active; channel 2 should be turned down.

Parallel-Mono: Unbalanced, single-channel. Channel 1 controls are active; channel 2 is bypassed.

Protection

If unreasonable operating conditions occur, the protection circuitry limits the drive level to protect the output stages especially in the case of elevated temperature. Transformer overheating will result in a temporary shutdown. Controlled slew-rate voltage amplifiers protect the unit against RF burnouts. Input overload protection is furnished at the amplifier input to limit current.

Turn On: The four second turn-on delay prevents dangerous turn-on transients. To change the turn-on delay time, contact Crown's Technical Support Group.

Construction

Steel chassis with durable black finish, aluminum front panel with super-gloss Imron® finish, Lexan overlay, and a specially designed flow-through ventilation system from front to side panels.

Cooling: Convection cooling with assistance from the computerized, on-demand proportional cooling fan.

Dimensions: Standard 19 inch (48.3 cm) rack mount width (EIA RS-310-B), 7 inch (17.8 cm) height, 16 inch (40.6 cm) depth behind mounting surface and 2.75 inch (7 cm) protrusion in front of mounting surface.

Approximate Weight: Center of gravity is about 6 inches (15.2 cm) behind the front mounting surface.

Studio Reference I: 60 pounds, 11 ounces (27.6 kg) net; 74 pounds, 3 ounces (33.7 kg) shipping weight.

Studio Reference II: 56 pounds, 2 ounces (25.5 kg) net; 69 pounds, 10 ounces (31.6 kg) shipping weight.

Crown specifications are guaranteed for three years.

In an effort to provide you with as much information as possible about the high power-producing capabilities of your amplifier, we have created the following power matrices.

Minimum Guaranteed Power Specifications

Crown's minimum power specifications represent the absolute smallest amount of output power you can expect from your amplifier when it is driven to full output under the given conditions. Some spaces in each matrix may be left blank because the same guarantee is not provided for those conditions—however, your amplifier will perform well under all conditions listed in each matrix.

When measuring power, 0.1% THD appears to be the industry standard for distortion. Two of the maximum average power specifications shown in each minimum power matrix are measured at 0.1% THD so you can easily compare Crown specifications to those of other manufacturers. But this high level of distortion actually allows for some clipping which is undesirable. Because of this, a maximum average power specification at 0.05% THD is included in each minimum power matrix which represents non-clipped conditions. Also, power at 0.02% THD is provided in the preceding specifications. Although most manufacturers do not give power specifications at 0.05% or 0.02% THD, we encourage them to provide these specifications so you will have a more realistic representation of the way amplifiers should be used in the real world—without a clipped output signal.

Many manufacturers publish power specs with a tolerance of ±1 dB or worse. This means their amplifier can deviate more than 20% in output! A 100 watt amplifier would meet their specification if it only produced 79.4 watts. Other manufacturers qualify their specs by saying they are "typical," "subject to manufacturing tolerances," "single channel driven" or that they are specified with "fuses bypassed." Each of these statements effectively removes any performance guarantee. In fact, some manufacturers use these tactics to generate large power numbers, and they don't even print a disclaimer. We take a different approach at Crown—our amplifiers are *guaranteed* to meet or exceed their specifications for three years. Further, because our published specs are set below our "in-house" measurements, you can expect *every* Crown amplifier to *exceed* its published minimum power specs. We believe you should get what you pay for.

Studio Reference I – Minimum Guaranteed Power (Watts)

AC Mains	Stereo/Mono Mode	Load (Ohms)	Maximum Average 0.1% THD+N (See note 1)	Maximum Average 0.1% THD+N (See note 2)	Maximum Average 0.05% THD+N (See note 3)	FTC Continuous Average 0.1% THD + Noise (See note 4)	FTC Continuous Average 0.1% THD + Noise (See note 4)
			1 kHz	20Hz-20kHz	1 kHz	1 kHz	20Hz-20kHz
120 VAC, 60 Hz	Stereo (both channels driven)	4	1,190	1,075	1,170		
120 VAC, 60 Hz	Stereo (both channels driven)	8	800	760	790	785	750
120 VAC, 60 Hz	Bridge-Mono (balanced output)	8	2,375	2,150	2,335		
120 VAC, 60 Hz	Bridge-Mono (balanced output)	16	1,595	1,535	1,580	1,575	1,490
120 VAC, 60 Hz	Parallel-Mono	2	2,350		2,320		
120 VAC, 60 Hz	Parallel-Mono	4	1,580		1,565	1,565	
100 VAC, 50 Hz	Stereo (both channels driven)	4	1,095	970	1,075		
100 VAC, 50 Hz	Stereo (both channels driven)	8	750	725	745	750	715
100 VAC, 50 Hz	Bridge-Mono (balanced output)	8	2,200	1,985	2,160		
100 VAC, 50 Hz	Bridge-Mono (balanced output)	16	1,515	1,440	1,495	1,515	1,440
100 VAC, 50 Hz	Parallel-Mono	2	2,185		2,175		
100 VAC, 50 Hz	Parallel-Mono	4	1,500		1,480	1,490	
240 VAC, 50 Hz	Stereo (both channels driven)	4	1,255	1,135	1,255		
240 VAC, 50 Hz	Stereo (both channels driven)	8	825	820	815	820	795
240 VAC, 50 Hz	Bridge-Mono (balanced output)	8	2,505	2,280	2,460		
240 VAC, 50 Hz	Bridge-Mono (balanced output)	16	1,660	1,610	1,645	1,660	1,595
240 VAC, 50 Hz	Parallel-Mono	2	2,485		2,475		
240 VAC, 50 Hz	Parallel-Mono	4	1,655		1,640	1,640	

Fig. 6.1 Studio Reference I Minimum Power Matrix

Minimum Power Notes:

All minimum power specifications are based on 0.5% regulated AC mains with THD of less than 1.0% and an ambient room temperature of 70° F (21° C). Standard EIA power (RS-490) is not shown here because it is identical to FTC Continuous Average Power.

1. A 1 kHz sine wave is presented to the amplifier and the output monitored for nonlinear distortion. The level is increased until THD reaches 0.1%. At this point, average power per channel is reported.
2. A sine wave is presented to the amplifier over the range from 20 Hz to 20 kHz and the output monitored for nonlinear distortion. The level at each frequency is increased until THD reaches 0.1%. At this point, average power per channel is reported.
3. A 1 kHz sine wave is presented to the amplifier and the output monitored for nonlinear distortion. The level is increased until THD reaches 0.05%. At this point, average power per channel is reported.
4. Continuous power in the context of Federal Trade Commission testing is understood to be a minimum of five minutes of operation. Harmonic distortion is measured as the RMS sum total and given as a percentage of the fundamental output voltage. This applies for all wattages greater than 0.25 watts.

Studio Reference II – Minimum Guaranteed Power (Watts)							
AC Mains	Stereo/Mono Mode	Load (Ohms)	Maximum Average 0.1% THD+N (See note 1) 1 kHz	Maximum Average 0.1% THD+N (See note 2) 20Hz-20kHz	Maximum Average 0.05% THD+N (See note 3) 1 kHz	FTC Continuous Average 0.1% THD + Noise (See note 4) 1 kHz	FTC Continuous Average 0.1% THD + Noise (See note 4) 20Hz-20kHz
120 VAC, 60 Hz	Stereo (both channels driven)	4	565	495	560	555	470
		8	360	340	355	360	340
	Bridge-Mono (balanced output)	8	1,145	1,020	1,130	1,105	960
		16	720	690	715	720	680
	Parallel-Mono	2	1,135		1,125	1,105	
		4	715		715	715	
100 VAC, 50 Hz	Stereo (both channels driven)	4	535	460	525	520	440
		8	355	330	340	345	320
	Bridge-Mono (balanced output)	8	1,080	970	1,070	1,045	900
		16	700	665	695	690	655
	Parallel-Mono	2	1,065		1,055	1,030	
		4	690		685	675	
240 VAC, 50 Hz	Stereo (both channels driven)	4	595	520	585	580	465
		8	375	360	370	375	355
	Bridge-Mono (balanced output)	8	1,205	1,060	1,195	1,145	915
		16	755	720	750	740	700
	Parallel-Mono	2	1,190		1,175	1,155	
		4	755		745	735	

Fig. 6.2 Studio Reference II Minimum Power Matrix

Maximum Power Specifications

Crown's maximum power specifications represent the largest amount of output power you can expect from your amplifier when it is driven to full output under the given conditions. These specifications can be used to prevent loudspeaker and hearing damage.

The maximum power matrices include specifications for single cycle and 40 millisecond burst sine waves. Burst signals act like large transient peaks that are present in common source signals. Loudspeakers can respond to a single cycle burst, so the single cycle burst specifications should be used to help you protect your loudspeakers. In contrast, a 40 millisecond burst represents the typical response time of the human ear. Your ear will not respond to the entire dynamic change of a burst that lasts less than 40 milliseconds.

The burst power specifications are provided at 0.05% THD which is a practical low distortion condition. Operating the amplifier at levels higher than 0.05% THD can result in output power levels that are higher than those listed in the maximum power matrices.

Studio Reference I – Maximum Power (Watts)

AC Mains	Stereo/Mono Mode	Load (Ohms)	Single Cycle Tone Burst 0.05% Distortion + Noise (See note 1)			40 Millisecond Tone Burst 0.05% Distortion + Noise (See note 2)		
			50 Hz	1 kHz	7 kHz	50 Hz	1 kHz	7 kHz
120 VAC, 6 0 Hz	Stereo (both channels driven)	4	1,435	2,180	2,030	1,295	1,220	1,220
		8	900	1,165	1,120	835	820	830
	Bridge-Mono (balanced output)	8	2,855	4,355	4,080	2,635	2,425	2,400
		16	1,780	2,345	2,215	1,695	1,635	1,650
	Parallel-Mono	2	2,820	4,380	4,075	2,605	2,420	2,395
		4	1,795	2,340	2,230	1,700	1,620	1,650
100 VAC, 50 Hz	Stereo (both channels driven)	4	1,380	2,150	2,015	1,260	1,135	1,135
		8	900	1,155	1,100	820	780	790
	Bridge-Mono (balanced output)	8	2,780	4,285	4,020	2,595	2,260	2,235
		16	1,740	2,320	2,195	1,600	1,555	1,570
	Parallel-Mono	2	2,780	4,325	3,985	2,455	2,250	2,250
		4	1,780	2,320	2,190	1,620	1,545	1,575
240 VAC, 50 Hz	Stereo (both channels driven)	4	1,470	2,220	2,065	1,370	1,290	1,275
		8	930	1,190	1,135	880	850	860
	Bridge-Mono (balanced output)	8	2,945	4,360	4,090	2,695	2,560	2,505
		16	1,830	2,360	2,250	1,750	1,685	1,705
	Parallel-Mono	2	2,970	4,415	4,100	2,715	2,525	2,550
		4	1,810	2,355	2,240	1,745	1,685	1,700

Fig. 6.3 Studio Reference I Maximum Power Matrix

Maximum Power Notes:

All maximum power specifications are based on 0.5% regulated AC mains with THD of less than 1.0% and an ambient room temperature of 70° F (21° C). Although it is an unusual condition, your amplifier can function well with AC mains voltages up to 10% over the specified line voltage. With overvoltage conditions, your amplifier may be capable of delivering instantaneous power levels up to 20% greater than the specifications in the matrix.

1. A single cycle sine wave is presented to the amplifier and monitored for nonlinear distortion. The average power during the burst is reported. Loudspeakers must be able to withstand this level if they are to be safely used with this amplifier.
2. A 40 millisecond sine wave burst (10 percent duty cycle) is presented to the amplifier and monitored for nonlinear distortion. Average power during the burst is reported. This power level is a measurement of the amplifier's maximum transient power that can be perceived by the human ear.

Studio Reference II – Maximum Power (Watts)								
AC Mains	Stereo/Mono Mode	Load (Ohms)	Single Cycle Tone Burst 0.05% Distortion + Noise (See note 1)			40 Millisecond Tone Burst 0.05% Distortion + Noise (See note 2)		
			50 Hz	1 kHz	7 kHz	50 Hz	1 kHz	7 kHz
120 VAC, 6 0 Hz	**Stereo** (both channels driven)	4	630	875	820	605	580	585
		8	395	480	455	375	370	375
	Bridge-Mono (balanced output)	8	1,345	1,785	1,685	1,245	1,185	1,185
		16	800	970	935	750	755	770
	Parallel-Mono	2	1,330	1,770	1,670	1,205	1,170	1,170
		4	790	965	920	755	745	765
100 VAC, 50 Hz	**Stereo** (both channels driven)	4	690	905	855	650	610	610
		8	405	495	470	385	385	395
	Bridge-Mono (balanced output)	8	1,395	1,840	1,750	1,315	1,230	1,240
		16	830	1,005	965	785	780	800
	Parallel-Mono	2	1,405	1,830	1,730	1,330	1,220	1,220
		4	815	995	955	785	770	790
240 VAC, 50 Hz	**Stereo** (both channels driven)	4	650	880	830	595	565	565
		8	365	450	430	345	340	350
	Bridge-Mono (balanced output)	8	1,305	1,775	1,715	1,195	1,130	1,150
		16	790	965	940	735	735	755
	Parallel-Mono	2	1,295	1,765	1,655	1,185	1,120	1,130
		4	785	965	920	750	725	745

Fig. 6.4 Studio Reference II Maximum Power Matrix

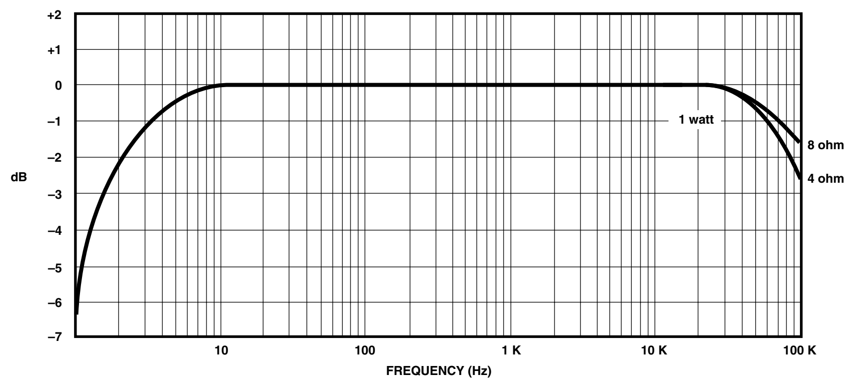


Fig. 6.5 Typical Frequency Response

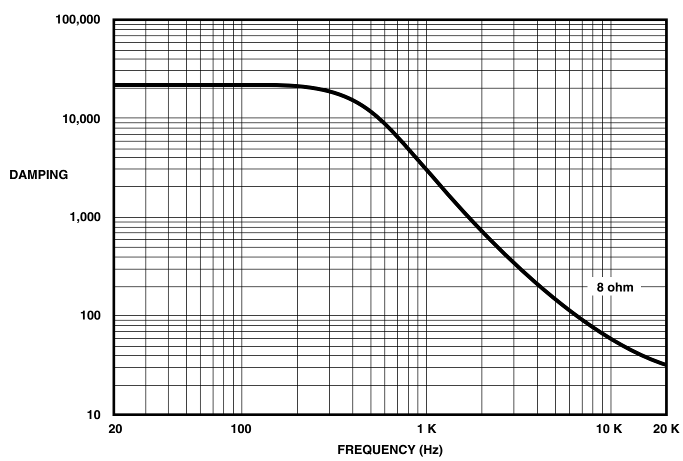


Fig. 6.6 Typical Damping Factor

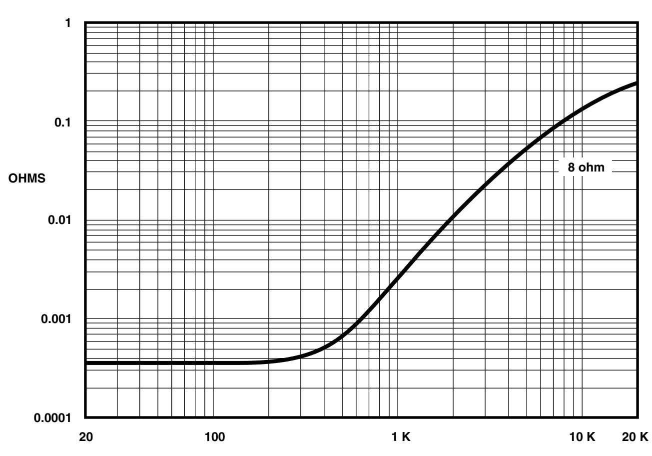


Fig. 6.7 Typical Output Impedance

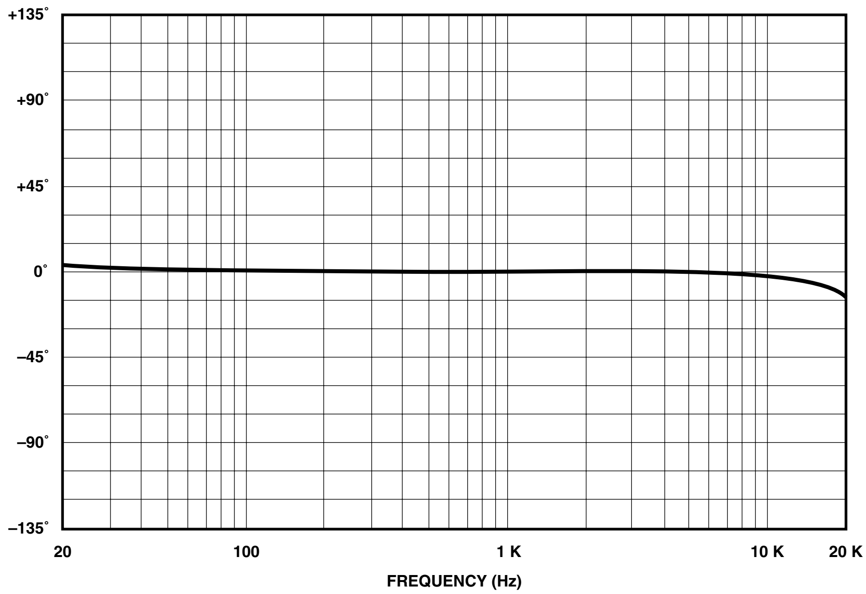


Fig. 6.8 Typical Phase Response

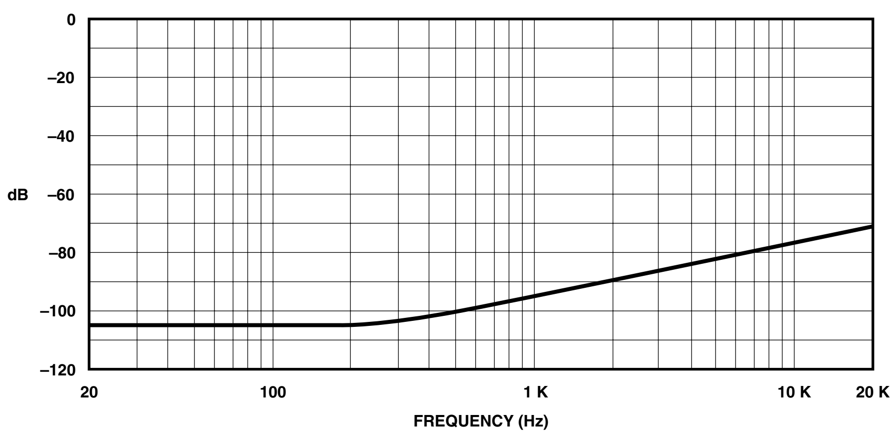


Fig. 6.9 Typical Common Mode Rejection

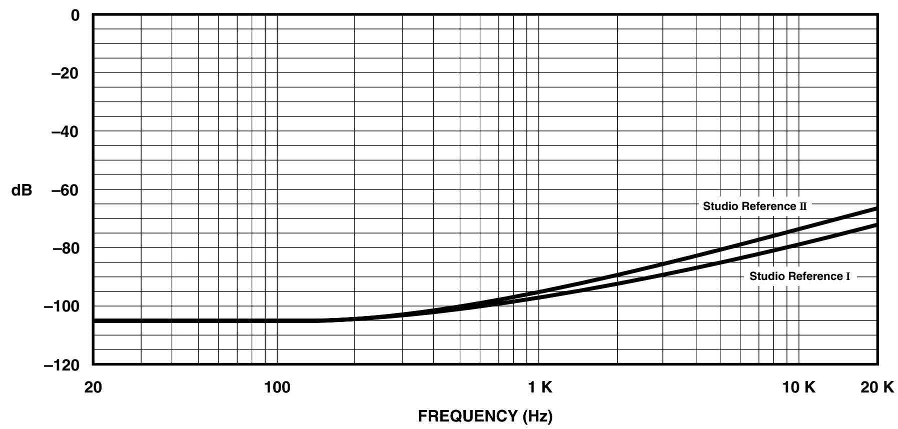


Fig. 6.10 Typical Crosstalk

7 AC Power Draw and Thermal Dissipation

This section provides detailed information about the amount of power and current drawn from the AC mains by *Studio Reference* amplifiers and the amount of heat produced under various conditions. The calculations presented here are intended to provide a very realistic and reliable depiction of the amplifiers. The following assumptions were made:

- The amplifier's available channels are loaded, and full, standard 1 kHz power is being delivered.
- Amplifier efficiency at standard 1 kHz power is estimated to be 65%.
- Quiescent power draw is 90 watts (an almost negligible amount for full-power calculations).
- Quiescent thermal dissipation equals 307 btu/hr at 90 watts.
- Duty cycle takes into account the typical crest factor for a particular type of source material.
- Duty cycle of pink noise is 50%.
- Duty cycle of highly compressed rock 'n' roll midrange is 40%.
- Duty cycle of uncompressed rock 'n' roll is 30%.
- Duty cycle of background music is 20%.
- Duty cycle of continuous speech is 10%.
- Duty cycle of infrequent paging is 1%.

Here are the equations used to calculate the data presented in Figures 7.1 and 7.2:

$$\text{AC Mains Power Draw (watts)} = \frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle}}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (90 watts)}$$

The estimated quiescent power draw of 90 watts is a maximum figure, and assumes the fan is running at high speed. The following equation converts power draw in watts to current draw in amperes:

$$\text{Current Draw (amperes)} = \frac{\text{AC Mains Power Draw (watts)}}{\text{AC Mains Voltage} \times \text{Power Factor (.83)}}$$

The power factor constant of 0.83 is needed to compensate for the difference in phase between in the AC mains voltage and current. The following equation was used to calculate thermal dissipation:

$$\text{Thermal Dissipation (btu/hr)} = \left(\frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle} \times .35}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (90 watts)} \right) \times 3.415$$

The constant 0.35 is inefficiency (1.00 – 0.65) and the factor 3.415 converts watts to btu/hr. Thermal dissipation in btu is divided by the constant 3.968 to get kcal. If you plan to measure output power under real-world conditions, the following equation may be helpful:

$$\text{Thermal Dissipation (btu/hr)} = \left(\frac{\text{Total output power with all channels driven (watts)} \times \text{Duty Cycle} \times .35}{\text{Amplifier Efficiency (.65)}} + \text{Quiescent Power Draw (90 watts)} \right) \times 3.415$$

Studio Reference I

	LOAD									
	8 Ohm Stereo / 16 Ohm Bridge-Mono / 4 Ohm Parallel-Mono					4 Ohm Stereo / 8 Ohm Bridge-Mono / 2 Ohm Parallel-Mono				
Duty Cycle	AC Mains Power Draw (Watts)	Current Draw (Amps)		Thermal Dissipation		AC Mains Power Draw (Watts)	Current Draw (Amps)		Thermal Dissipation	
		100-120 V	220-240 V	btu/hr	kcal/hr		100-120 V	220-240 V	btu/hr	kcal/hr
50%	1325	15.9	7.2	1,780	450	1,925	23.1	10.5	2,500	630
40%	1075	12.9	5.9	1,485	375	1,555	18.7	8.5	2,060	520
30%	830	10.0	4.5	1,190	300	1,190	14.3	6.5	1,620	410
20%	585	7.0	3.2	900	230	825	9.9	4.5	1,185	300
10%	340	4.1	1.8	605	155	460	5.5	2.5	745	190

Fig. 7.1 Studio Reference I Power Draw, Current Draw and Thermal Dissipation at Various Duty Cycles

Studio Reference II

	LOAD									
	8 Ohm Stereo / 16 Ohm Bridge-Mono / 4 Ohm Parallel-Mono					4 Ohm Stereo / 8 Ohm Bridge-Mono / 2 Ohm Parallel-Mono				
Duty Cycle	AC Mains Power Draw (Watts)	Current Draw (Amps)		Thermal Dissipation		AC Mains Power Draw (Watts)	Current Draw (Amps)		Thermal Dissipation	
		100-120 V	220-240 V	btu/hr	kcal/hr		100-120 V	220-240 V	btu/hr	kcal/hr
50%	645	7.8	3.5	970	245	975	11.7	5.3	1,360	345
40%	535	6.4	2.9	840	215	795	9.6	4.4	1,150	290
30%	425	5.1	2.3	705	180	620	7.5	3.4	940	240
20%	315	3.8	1.7	575	145	445	5.3	2.4	730	185
10%	205	2.4	1.1	440	115	270	3.2	1.5	520	135

Fig. 7.2 Studio Reference II Power Draw, Current Draw and Thermal Dissipation at Various Duty Cycles

8 Accessories

8.1 *P.I.P.* Modules

One advantage of *Studio Reference* amplifiers is the ability to customize them using *P.I.P.* (Programmable Input Processor) modules. Each amplifier is equipped with an edge card connector inside the back panel *P.I.P.* compartment. The modules install easily:

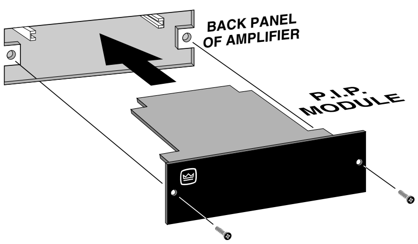
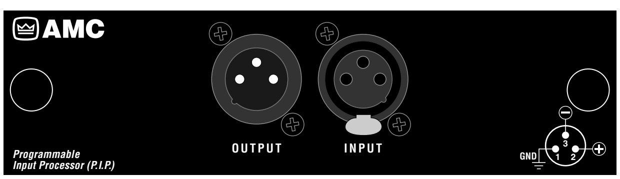


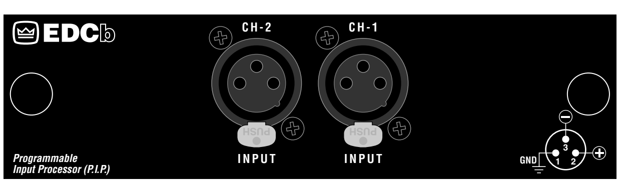
Fig. 8.1 Installing a P.I.P. Module

WARNING: Disconnect power to the amplifier when installing or removing a *P.I.P.* module.

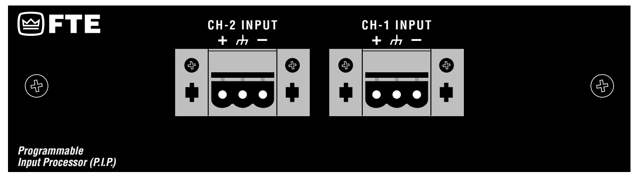
Here are some of the available *P.I.P.* modules:



P.I.P.-AMCb unites many features of the P.I.P.-XOV and P.I.P.-CLP. It offers a variable 4th-order Linkwitz-Riley crossover <u>and</u> an *IOC*-driven, variable threshold compressor. In addition, it provides "constant-directivity" horn equalization and filter-assisted B_6 vented box equalization. Biamping and triamping capabilities are provided via XLR connectors.



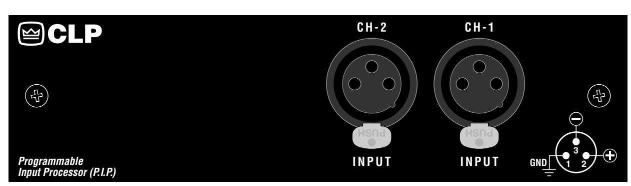
P.I.P.-EDCb combines a sophisticated error-driven compressor and smooth limiter with a subsonic filter for each channel. The compressors have adjustable attack and release times, and can be set to track each other. The compressors activate when a signal will clip the input, an *IOC* error occurs, or the output exceeds the selected threshold. The subsonic filters have corner frequencies of 24, 28, 32 and 36 Hz.



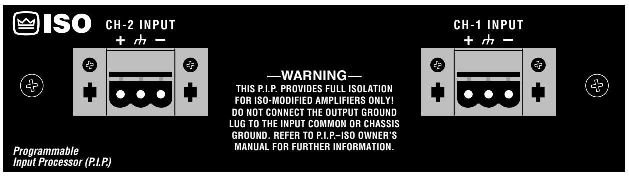
P.I.P.-FTE includes all P.I.P.-FXT features, and adds 12 dB/octave RFI filters, variable 18 dB/octave high-pass filters, and 6 dB/octave 3 kHz shelving networks for "constant-directivity" horn equalization. Screw terminal plugs are provided for input.

IQ-P.I.P.-AP integrates the amplifier into Crown's patented *IQ System*.® The *IQ System* provides centralized computer control of 1 to 2,000 amplifiers. Each amplifier channel can be monitored and controlled from an inexpensive personal computer. Any combination of mic- and line-level signals can also be mixed and routed with optional *MPX-6*,™ *SMX-6*™ and *AMB-5*™ mixer/multiplexers, and the MRX series matrixers.

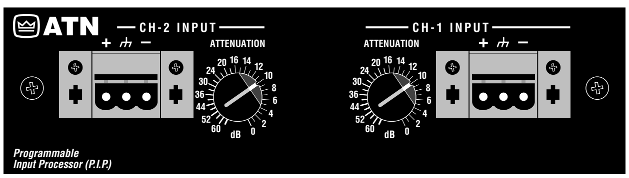
IQ-P.I.P.-AP *Smart Amp*™ offers the monitoring and control features of the IQ-P.I.P.-AP plus the ability to function as a stand-alone unit as part of the *IQ System's distributed intelligence*.™ Features include a smooth output limiter for transparent loudspeaker protection, power supply gates for energy savings, *ODEP* conservation which protects the output devices with precision input signal control, interrupt-driven reporting that lets you define error conditions, and configurable short detection.



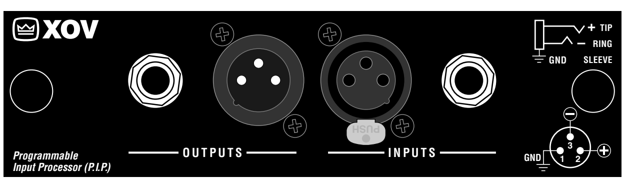
P.I.P.-CLP is designed to detect and prevent overload. Its compressor is driven by the amplifier's built-in *IOC* error detection circuitry. Unlike typical signal-driven compressors, it only compresses the signal to prevent overload. It can deliver up to 13 dB of additional headroom without being noticeable.



P.I.P.-ISO is designed especially for 25 to 140 volt distributed systems where UL®-listed isolation is required. Installation requires minor amplifier modifications. With the P.I.P.-ISO installed, the amplifier outputs are safely isolated from the input terminals <u>and</u> the chassis.



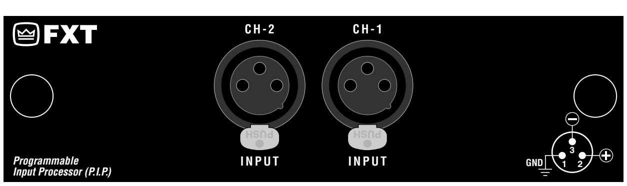
P.I.P.-ATN includes all P.I.P.-FTE features, plus a 32-step precision attenuator for each channel.



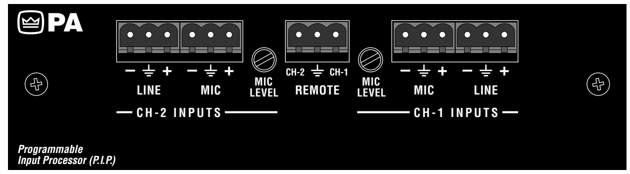
P.I.P.-XOV is a versatile 18 dB/octave mono crossover/filter with biamping and triamping capabilities.

P.I.P.-FMX facilitates “daisy-chaining” balanced amplifier inputs. Female to male three-pin XLR connectors are used to passively bridge the inputs.

P.I.P.-FXQ makes it easy to connect audio sources that have phono (RCA) connectors. It includes two balanced three-pin female XLR connectors, and two female phono jacks for quasi-balanced or unbalanced operation.

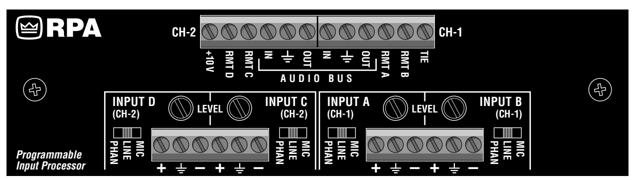


P.I.P.-FXT uses balanced 1:1 transformers to isolate the amplifier from the input signal. It has balanced female three-pin XLR connectors.



P.I.P.-PA adds a switchable balanced low-impedance mic input, a balanced line-level input and a compressor to each channel. Remote switching circuitry provides quick and quiet fades from mic to line and back.

P.I.P.-102 is a two-channel module providing equalization based on the BOSE® 102 controller. Screw terminal plugs provide balanced connections. Each input channel has an output from the *P.I.P.* that can be independently configured for output with no processing, 102 equalization or 102 equalization with bass-cut.



P.I.P.-RPA adds the features of a 4x2 mixer to your amplifier. Its four inputs accept mic- or line-level input. It offers priority switching (“voice-over”) of each input and remote level control with the RPA-RMT. Other features include bus inputs and outputs, adjustable input sensitivity, phantom power and RFI suppression. Input isolation transformers are optional.

For more information on these *P.I.P.s* or other *P.I.P.s* under development, contact your local dealer or Crown’s Technical Support Group.

9 Service

This unit has very sophisticated circuitry which should only be serviced by a fully trained technician. This is one reason why each unit bears the following label:

CAUTION: To prevent electric shock, do not remove covers. No user serviceable parts inside. Refer servicing to a qualified technician.

9.1 Worldwide Service

Service may be obtained from an authorized service center. (Contact your local Crown/Amcron representative or our office for a list of authorized service centers.) To obtain service, simply present the bill of sale as proof of purchase along with the defective unit to an authorized service center. They will handle the necessary paperwork and repair.

Remember to transport your unit in the original factory pack. We will pay the surface shipping costs both ways for warranty service to the authorized service center nearest you after receiving copies of all shipping receipts. You must bear the expense of all taxes, duties, and customs fees when transporting the unit.

9.2 North American Service

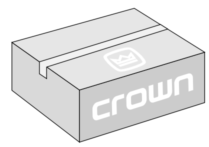
Service may be obtained in one of two ways: from an authorized service center or from the factory. You may choose either. It is important that you have your copy of the bill of sale as your proof of purchase.

9.2.1 Service at a North American Service Center

This method usually saves the most time and effort. Simply present your bill of sale along with the defective unit to an authorized service center to obtain service. They will handle the necessary paperwork and repair. Remember to transport the unit in the original factory pack. A list of authorized service centers in your area can be obtained from our Technical Support Group.

9.2.2 Factory Service

To obtain factory service, fill out the service information page that follows and send it along with your proof of purchase and the defective unit to the Crown factory. For warranty service, we will pay for ground shipping both ways in the United States after receiving copies of the shipping receipts. Shipments should be sent "UPS ground." (If the unit is under warranty, you may send it C.O.D. for the cost of freight via UPS ground.) The factory will return it via UPS ground. Please contact us if other arrangements are required.



Always use the original factory pack to transport the unit.

Factory Service Shipping Instructions:

1. When sending a Crown product to the factory for service, be sure to fill out the service information form that follows and enclose it inside your unit's shipping pack. Do not send the service information form separately.
2. To ensure the safe transportation of your unit to the factory, ship it in an original factory packing container. If you don't have one, call or write Crown's Parts Department. With the exception of polyurethane or wooden crates, any other packing material will not be sufficient to withstand the stress of shipping. Do not use loose, small size packing materials.
3. Do not ship the unit in any kind of cabinet (wood or metal). Ignoring this warning may result in extensive damage to the unit and the cabinet. Accessories are not needed—do not send the instruction manual, cables and other hardware.

If you have any questions, please call or write the Crown Technical Support Group.

Crown Audio Division
Tech. Support / Factory Service
57620 C.R. 105
Elkhart, Indiana 46517 U.S.A.

Phone: 1-219-294-8200
U.S.: 1-800-342-6939
Fax: 1-219-294-8301

Detach and send with unit.

Crown Factory Service Information

Shipping Address: Crown International, Inc., Factory Service, 57620 C.R. 105, Elkhart, Indiana 46517
Phone: 1-800-342-6939 or 1-219-294-8200 Fax: 1-219-294-8301

Owner's Name: ______________________________

Shipping Address: ______________________________

Phone Number: ______________________________

Model: ____________ **Serial Number:** ____________ **Purchase Date:** ____________

NATURE OF PROBLEM

(Be sure to describe the conditions that existed when the problem occurred and what attempts were made to correct it.)

____

Other equipment in your system: ______________________________

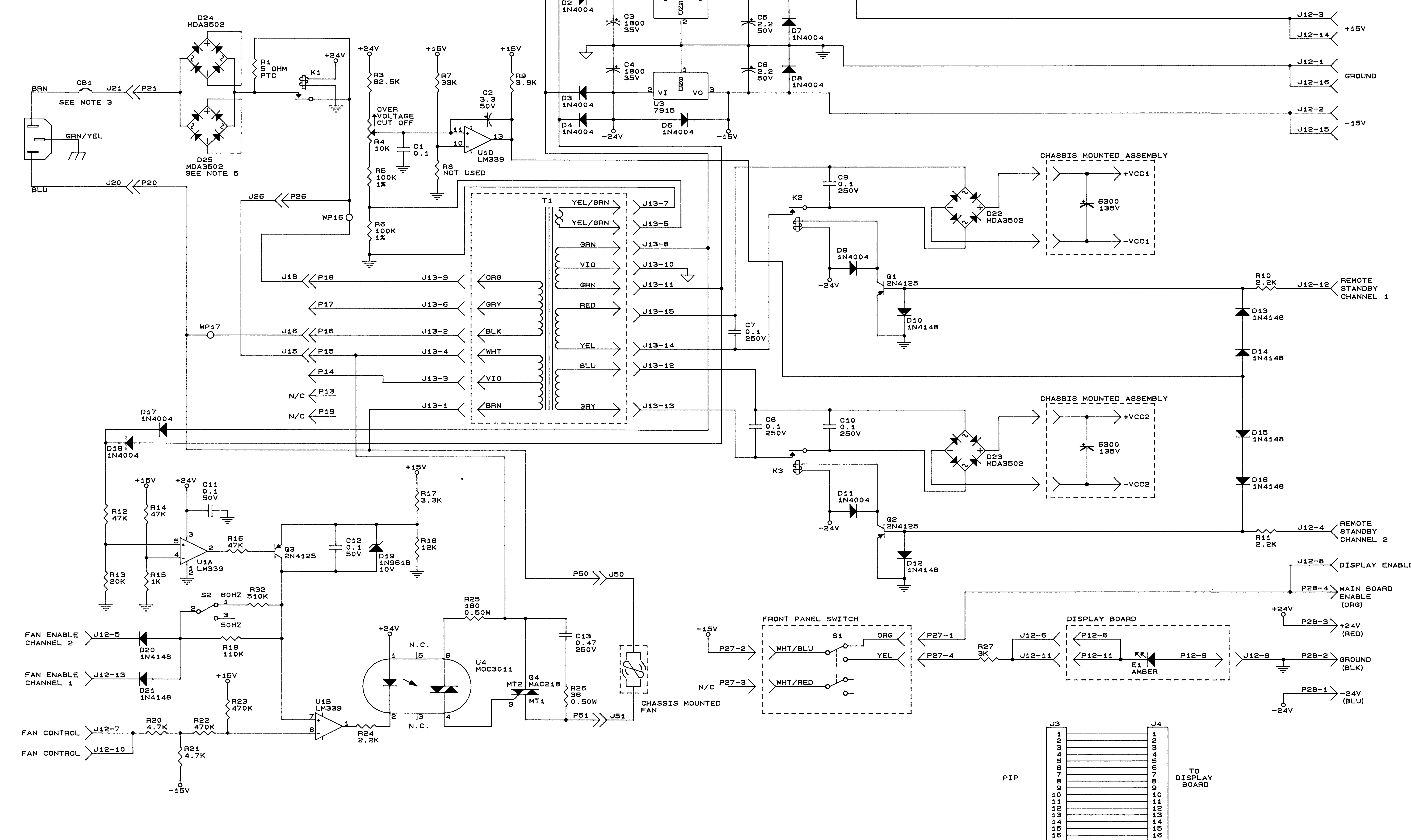
If warranty has expired, payment will be: ■ **Cash/Check** ■ **VISA** ■ **MasterCard** ■ **C.O.D.**

Card Number:____________ **Exp. Date:**_______
Signature:____________

ENCLOSE THIS PORTION WITH THE UNIT. DO <u>NOT</u> MAIL SEPARATELY.

C.P.N. J0558A5 REV (B)

EAT #	ZONE	REV	DESCRIPTION	DATE	BY	APPROVALS CK	ME	EE	PE
95-129		A	DELETED CROWN/AMCRON DIFFERENCES PERTAINING TO R19, R32, & S2. DELETED Q43105A3 FROM NOTE 4. ADDED NOTE 5.	02-15-95	KLW			JW	RS
95-279		B	C2 WAS 2.2, R3 WAS 150K, R5&R6 WERE 5%, R8 WAS100K.	11-17-95	KLW	TLB		JW	RS



LAST USED	OBSOLETED
CB1	
C19	14-19
D25	
E1	
K3	
Q4	
R32	2, 28-31
S2	
T1	
U4	
WP17	1-15

UNUSED ELEMENTS

U1C LM339

NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. CIRCUIT BREAKER RATINGS: 30 AMP / 100V - 120V 15 AMP / 220V - 240V
4. MODULE DOCUMENT AND P.C. BOARD FOR THIS SCHEMATIC ARE: Q43450-8 AND D 8853-0.
5. NOT USED ON REF2.

CROWN INTERNATIONAL, INC.
1718 WEST MISHAWAKA ROAD ELKHART, IN. 46517 PHONE (219) 294-8000

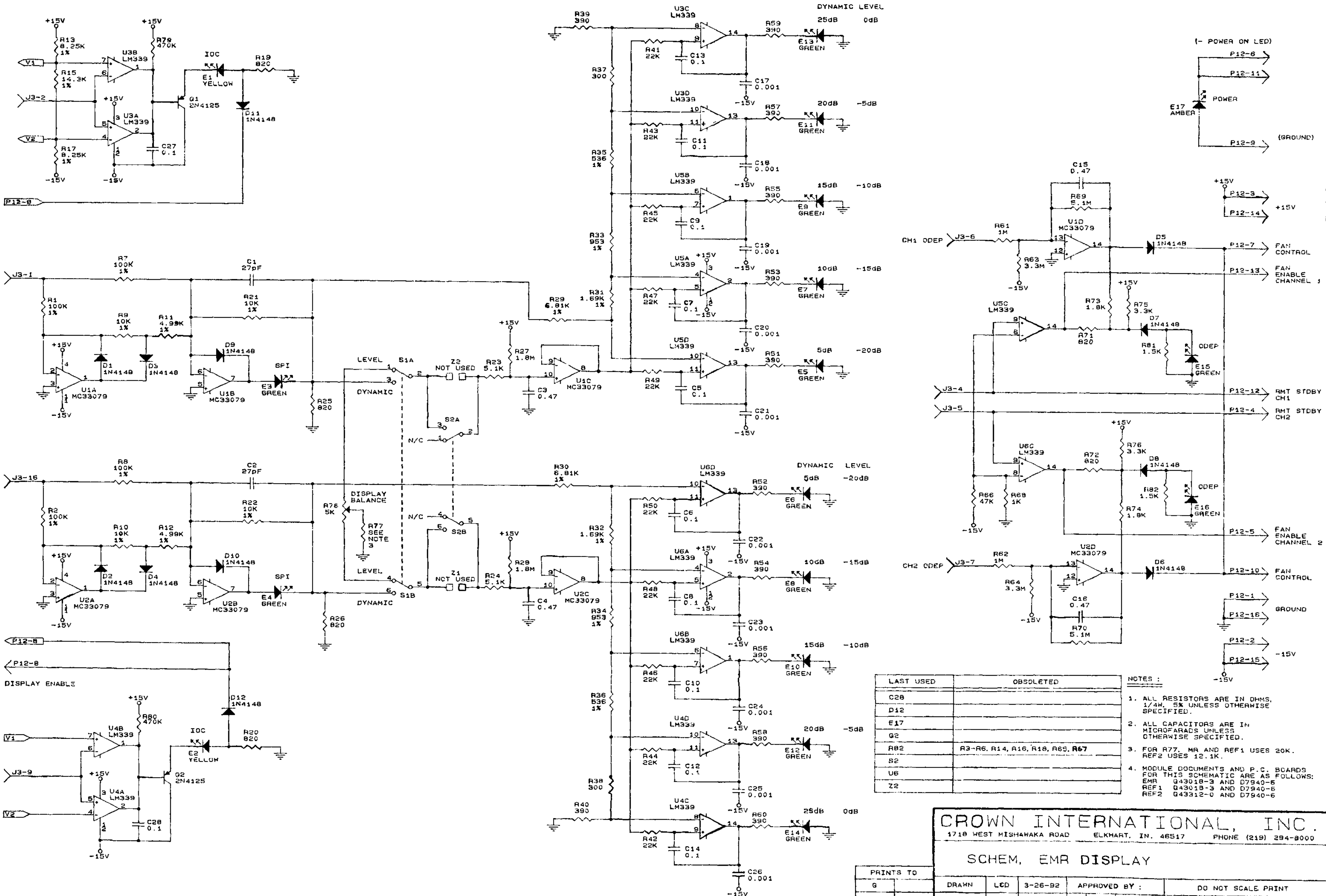
SCHEM, REF CONTROL

PRINTS TO
G

DRAWN	KLW	12-20-94	APPROVED BY :		DO NOT SCALE PRINT
CHECKED	TLB	6-12-95	ME		SUPERSEDES J0558-7
SCALE	NONE		EE	JW 6-12-95	E.C.N.
PROJ #	D182		PE		C.P.N. J0558A5 REV B
NEXT ASSEMBLY					

C.P.N. J0510-8 REV (B)

EAT #	ZONE	REV	DESCRIPTION	DATE	BY	APPROVALS CK	ME	EE	PE
		(A)	ADDED NOTES 3 & 4 AND Z1 & 2.	06-01-95	KLW	TLB			EB
		(B)	REVISED SCHEMATIC TO MATCH P.C. BOARD.	11-30-95	KLW				RS
		( )							



LAST USED	OBSOLETED
C28	
D12	
E17	
Q2	
R82	R3-R6, R14, R16, R18, R65, R67
S2	
U6	
Z2	

NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. FOR R77, MA AND REF1 USES 20K. REF2 USES 12.1K.
4. MODULE DOCUMENTS AND P.C. BOARDS FOR THIS SCHEMATIC ARE AS FOLLOWS:
   EMR Q43018-3 AND D7940-6
   REF1 Q43018-3 AND D7940-6
   REF2 Q43312-0 AND D7940-6

CROWN INTERNATIONAL, INC.
1718 WEST MISHAWAKA ROAD ELKHART, IN. 46517 PHONE (219) 294-8000

SCHEM, EMR DISPLAY

PRINTS TO		
G		

DRAWN	LCD	3-26-92	APPROVED BY :	DO NOT SCALE PRINT
CHECKED			ME	SUPERSEDES
SCALE	NONE		EE	E.C.N.
PROJ #	D283		PE EB 3-26-92	C.P.N. J0510-8 REV (B)
NEXT ASSEMBLY				

INACTIVE
For Reference Use Only

REVISION HISTORY

E.C.N.	ZONE	REV	DESCRIPTION	DATE	APPROVED DWN	CHK	CM	PE
95-227		A	CORRECT NOTE 9 ABOUT MAIN BOARD	08/30/95	LCD			
00N0112		B	CHANGED R189,289 TO 3.3K. CHANGED Q108,125,208,225 TO C 7458-0. CHANGED U100,200 TO 101374-1. CHANGED U103, 203 TO 101375-1.	02/10/00	JAW	[signature]	[signature]	[signature]

CHANNEL 1

LAST USED	OBSOLETED
C162	125-128,142,158
C316	300,314
D135	102-107,116-118
D312	300,309-312
E101	
L302	
N102	100
PTC301	300
Q136	
Q319	
R199	R178
R354	
R538	
U104	

COMMON

LAST USED	OBSOLETED
C7	3,5,6
D7	
R19	2,3,5,6,9,11-16
S4	1
U2	

NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL DIODES ARE 1N4148 UNLESS OTHERWISE SPECIFIED.
4. ON J500 AND J700 THE STRIPED WIRE GOES TO PIN 12 OF THE BOARD AND THE PIN NUMBERS MOLDED ON THE CABLE SOCKET ARE REVERSED FROM THE PIN NUMBERS ON THE BOARD AND THE SCHEMATIC.
5. STANDARD UNIT HAS R10 OPEN. INSTALL JUMPER IN R10 TO DISABLE CHANNEL 2 SIGNAL INDICATOR LIGHT IN PARALLEL MONO MODE.
6. CHANNEL 2 PRE-DRIVER BASES LOOP THROUGH STEREO-MONO SWITCH S4, SECTIONS E AND F.
7. CHANNEL 1 SHOWN. FOR CHANNEL 2 ADD 100 TO REFERENCE DESIGNATORS. (EXAMPLE : CHANNEL 1 R101 WOULD BE CHANNEL 2 R201.) CONNECTOR AND IC PIN NUMBERS FOR CHANNEL 2 ARE SHOWN IN PARENTHESIS WHEN THEY DIFFER FROM CHANNEL 1. EXCEPTIONS ARE CHAN 1 J500 CORRESPONDS TO CHAN 2 J700, AND CHAN 1 J600 CORRESPONDS TO CHAN 2 J800.
8. +VCC, -VCC = 70V NO LOAD
9. MODULE DOCUMENTS AND P.C. BOARDS FOR THIS SCHEMATIC ARE AS FOLLOWS:

   MAIN ..... Q43371-6 AND D8825-0 OR D8920-7
   OUTPUT ... Q43369-0 AND P10423-5

DISTRIBUTION: G

FILENAME: J0674-2_B.SCM

TOLERANCE UNLESS OTHERWISE SPECIFIED
.00 = ±.02"
.000 = ±.010"
DRILLS = ±.003"

DO NOT SCALE DRAWING

DWN	KLW	03-07-95
CHK	TLB	06/05/95
CM		
PE	RS	06/05/95
EE	JW	06/05/95

crown INTERNATIONAL, INC.
1718 W. MISHAWAKA RD.
ELKHART IN, 46517
PHONE(219)294-8000
WWW.CROWNINTL.COM

TITLE: SCH, REF1 MAIN/OUTPUT

SIZE: D | DWG NO.: J0674-2 | REV: B

SCALE: NONE | PROJ NO.: MD33250 | SHEET 1 OF 2

CHANNEL 2	
LAST USED	OBSOLETED
C262	225-228,242,250
C416	408,414,415
D235	202-207,216-218
D412	408,409-412
E201	
L402	
N202	208
PTC401	400
Q236	
Q419	
R299	R278
R454	
R630	
U204	

UNCONTROLLED

UNLESS OTHERWISE MARKED IN RED INK BY CM AS A CONTROLLED COPY, COPIES OF THESE DOCUMENTS INCLUDING ASSOCIATED ELECTRONIC REPRODUCTIONS ARE FOR REFERENCE ONLY.

SIZE	DWG NO.	REV
D	J0674-2	B
SCALE NONE	PROJ NO. MD33250	SHEET 2 OF 2

E.C.N.	ZONE	REV	DESCRIPTION	DATE	BY	APPROVALS CK	ME	EE	PE
95-227		A	CORRECT NOTE 9 ABOUT MAIN BOARD	08/30/95	LCD			JW	RS
EAT# 96-164		B	REVISED NOTE 9 MODULE AND BOARD REVISION LEVELS.	05/01/96	TLM				

CHANNEL 1

LAST USED	OBSOLETED
C162	125-128, 142, 158
C316	300, 314
D135	102-107, 116-118
D312	300, 309-312
E101	
L302	
N102	100
PTC301	300
Q136	
Q319	
R199	R178
R354	
R543	
U104	

COMMON

LAST USED	OBSOLETED
C7	3, 5, 6
D7	
R19	2, 3, 5, 6, 9, 13-16
S4	1
U2	

NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL DIODES ARE 1N4148 UNLESS OTHERWISE SPECIFIED.
4. ON J500 AND J700 THE STRIPED WIRE GOES TO PIN 12 OF THE BOARD AND THE PIN NUMBERS MOLDED ON THE CABLE SOCKET ARE REVERSED FROM THE PIN NUMBERS ON THE BOARD AND THE SCHEMATIC.
5. STANDARD UNIT HAS R10 OPEN. INSTALL JUMPER IN R10 TO DISABLE CHANNEL 2 SIGNAL INDICATOR LIGHT IN PARALLEL MONO MODE.
6. CHANNEL 2 PRE-DRIVER BASES LOOP THROUGH STEREO-MONO SWITCH S4, SECTIONS E AND F.
7. CHANNEL 1 SHOWN. FOR CHANNEL 2 ADD 100 TO REFERENCE DESIGNATORS. (EXAMPLE : CHANNEL 1 R101 WOULD BE CHANNEL 2 R201.) CONNECTOR AND IC PIN NUMBERS FOR CHANNEL 2 ARE SHOWN IN PARENTHESIS WHEN THEY DIFFER FROM CHANNEL 1. EXCEPTIONS ARE CHAN 1 J500 CORRESPONDS TO CHAN 2 J700, AND CHAN 1 J600 CORRESPONDS TO CHAN 2 J800.
8. +VCC, -VCC = 70V NO LOAD
9. MODULE DOCUMENTS AND P.C. BOARDS FOR THIS SCHEMATIC ARE AS FOLLOWS:

MAIN ..... Q43388-0 REV.B AND D8920-7
OUTPUT ... Q43389-8 REV.B AND P10423-5 REV C.

CROWN INTERNATIONAL, INC.
1718 WEST MISHAWAKA ROAD ELKHART, IN. 46517 PHONE (219) 294-8000

SCHEM, REF 2 MAIN/OUTPUT

PRINTS TO	
G	

DRAWN	KLW	11-04-94	APPROVED BY :			DO NOT SCALE PRINT
CHECKED	TLB	06/05/95	ME			SUPERSEDES J0652-8 REV.A
SCALE	NONE		EE	JW	06/05/95	E.C.N. EAT#96-164
PROJ #	D332		PE	RS	06/05/95	C.P.N. SHEET 1 OF 2 J0652-8 REV B
NEXT ASSEMBLY						

CHANNEL 2

LAST USED	OBSOLETED
C262	225-228, 242, 258
C416	400, 414, 415
D235	202-207, 216-218
D412	400, 409-412
E201	
L402	
N202	200
PTC401	400
Q236	
Q419	
R299	R278
R454	
R643	
U204	

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SCHEM, REF 2 MAIN/OUTPUT

DRAWN	KLW	11-04-94	APPROVED BY :			DO NOT SCALE PRINT
CHECKED	TLB	06/05/95	ME			SUPERSEDES J0652-8 REV.A
SCALE	NONE		EE	JW	06/05/95	E.C.N. EAT#96-164
PROJ #	D332		PE	RS	06/05/95	C.P.N. SHEET 2 OF 2 J0652-8 REV B
NEXT ASSEMBLY						

PRINTS TO

E.C.N.	ZONE	REV	DESCRIPTION	DATE	BY	APPROVALS CK	ME	EE	PE
95-227		A	CORRECT NOTE 9 ABOUT MAIN BOARD	08/30/95	LCD			JW	RS
EAT 96-164		B	REVISED NOTE 9 MODULE AND BOARD REVISION LEVELS.	05/01/96	TLM				
00N0002		C	Q108,Q208 WERE MTS105. R189,R289 WERE 27K. U103,U203 WERE UPA76. U100,U200 WERE UPA75.	01/18/00	JG	JAW	DDV	N/A	EB

CHANNEL 1

LAST USED	OBSOLETED
C162	125-128,142,158
C316	300,314
D135	102-107,116-118
D312	300,309-312
E101	
L302	
N102	100
PTC301	300
Q136	
Q319	
R199	R178
R354	
R543	
U104	

COMMON

LAST USED	OBSOLETED
C7	3,5,6
D7	
R19	2,3,5,6,9,13-18
S4	1
U2	

NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL DIODES ARE 1N4148 UNLESS OTHERWISE SPECIFIED.
4. ON J500 AND J700 THE STRIPED WIRE GOES TO PIN 12 OF THE BOARD AND THE PIN NUMBERS MOLDED ON THE CABLE SOCKET ARE REVERSED FROM THE PIN NUMBERS ON THE BOARD AND THE SCHEMATIC.
5. STANDARD UNIT HAS R10 OPEN. INSTALL JUMPER IN R10 TO DISABLE CHANNEL 2 SIGNAL INDICATOR LIGHT IN PARALLEL MONO MODE.
6. CHANNEL 2 PRE-DRIVER BASES LOOP THROUGH STEREO-MONO SWITCH S4, SECTIONS E AND F.
7. CHANNEL 1 SHOWN. FOR CHANNEL 2 ADD 100 TO REFERENCE DESIGNATORS. (EXAMPLE : CHANNEL 1 R101 WOULD BE CHANNEL 2 R201.) CONNECTOR AND IC PIN NUMBERS FOR CHANNEL 2 ARE SHOWN IN PARENTHESIS WHEN THEY DIFFER FROM CHANNEL 1. EXCEPTIONS ARE CHAN 1 J500 CORRESPONDS TO CHAN 2 J700, AND CHAN 1 J600 CORRESPONDS TO CHAN 2 J800.
8. +VCC,-VCC = 70V NO LOAD
9. MODULE DOCUMENTS AND P.C. BOARDS FOR THIS SCHEMATIC ARE AS FOLLOWS:

   MAIN ..... Q43388-0 REV.B AND D8920-7
   OUTPUT ... Q43389-8 REV.B AND P10423-5 REV C.

INACTIVE
For Reference Use Only

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SCHEM, REF 2 MAIN/OUTPUT

PRINTS TO	
G	

DRAWN	KLW	11-04-94	APPROVED BY :			DO NOT SCALE PRINT
CHECKED	TLB	06/05/95	ME			SUPERSEDES J0652-8 REV.A
SCALE	NONE		EE	JW	06/05/95	E.C.N. EAT
PROJ	D332		PE	RS	06/05/95	C.P.N. SHEET 1 OF 2 J0652-8 REV C
NEXT ASSEMBLY						

CHANNEL 2

LAST USED	OBSOLETED
C262	225-228,242,258
C416	400,414,415
D235	202-207,216-218
D412	400,409-412
E201	
L402	
N202	200
PTC401	400
Q236	
Q419	
R299	R278
R454	
R643	
U204	

CROWN INTERNATIONAL, INC.
1718 WEST MISHAWAKA ROAD ELKHART, IN. 46517 PHONE (219) 294-8000

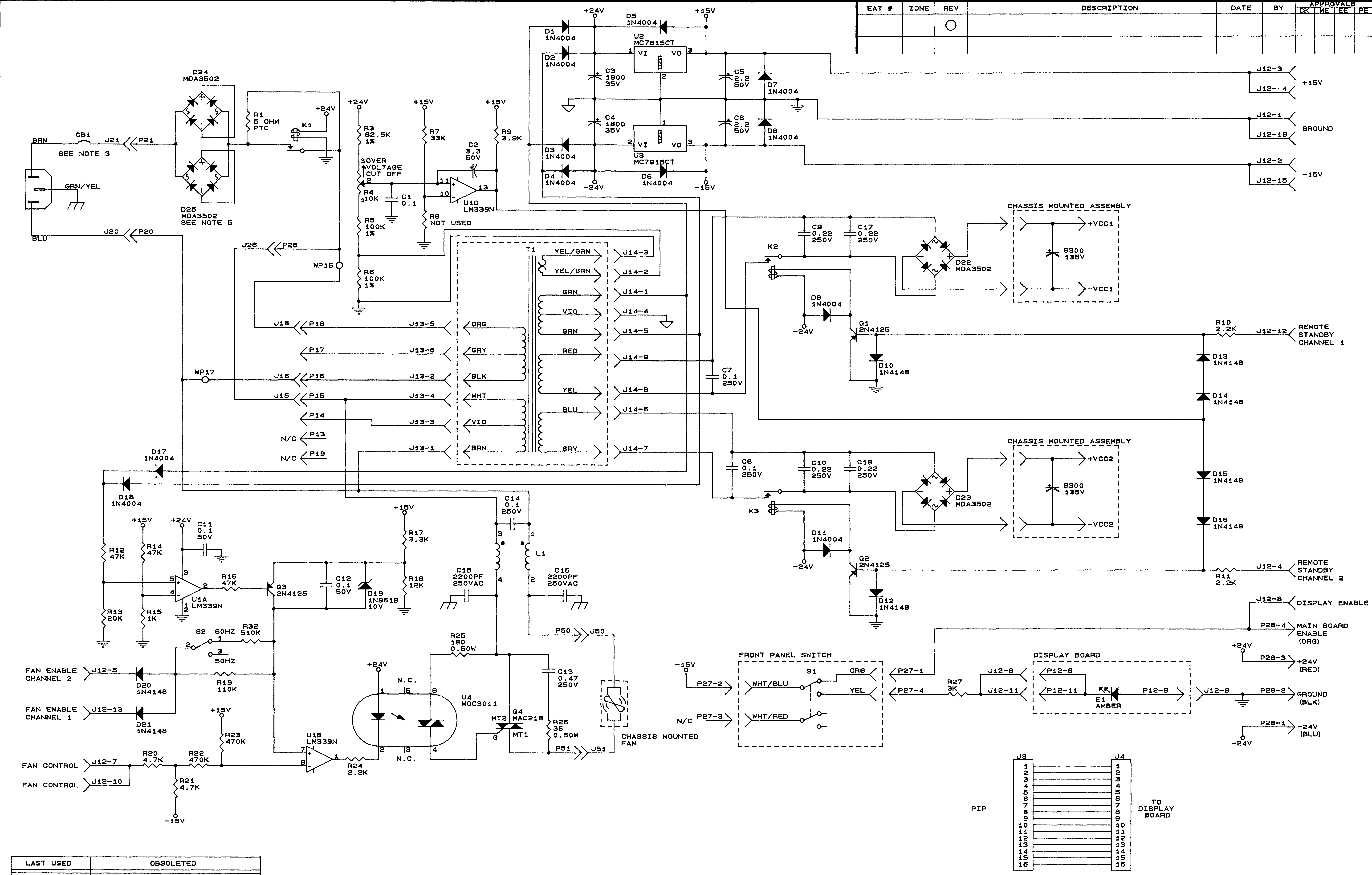
SCHEM, REF 2 MAIN/OUTPUT

DRAWN	KLW	11-04-94	APPROVED BY :			DO NOT SCALE PRINT
CHECKED	TLB	06/05/95	ME			SUPERSEDES J0652-8 REV.A
SCALE	NONE		EE	JW	06/05/95	E.C.N. EAT
PROJ	D332		PE	RS	06/05/95	C.P.N. SHEET 2 OF 2 J0652-8 REV C
NEXT ASSEMBLY						

PRINTS TO

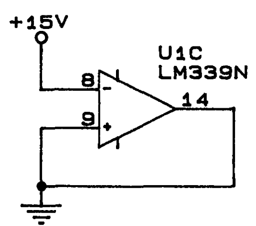
EAT #	ZONE	REV	DESCRIPTION	DATE	BY	APPROVALS CK	ME	EE	PE
		O							

C.P.N. J0739-3 REV O



LAST USED	OBSOLETED
CB1	
C18	
D25	
E1	
K3	
L1	
Q4	
R32	2, 28-31
S2	1
T1	
U4	
WP17	1-15

UNUSED ELEMENTS



NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. CIRCUIT BREAKER RATINGS: 30 AMP / 100V - 120V 15 AMP / 220V - 240V
4. MODULE DOCUMENT AND P.C. BOARD FOR THIS SCHEMATIC ARE: Q43504-2 AND D 9099-9.
5. NOT USED ON REF2.

SPECIFIC VOLTAGE WIRING

VOLTAGE	JUMPER	WP17 WHITE	WP16 BLACK
100V	P26-P14	P16	P17
120V	P26-P15	P16	P18
220V	P15-P16	P13	P17
240V	P15-P16	P13	P18

PRINTS TO	
G	

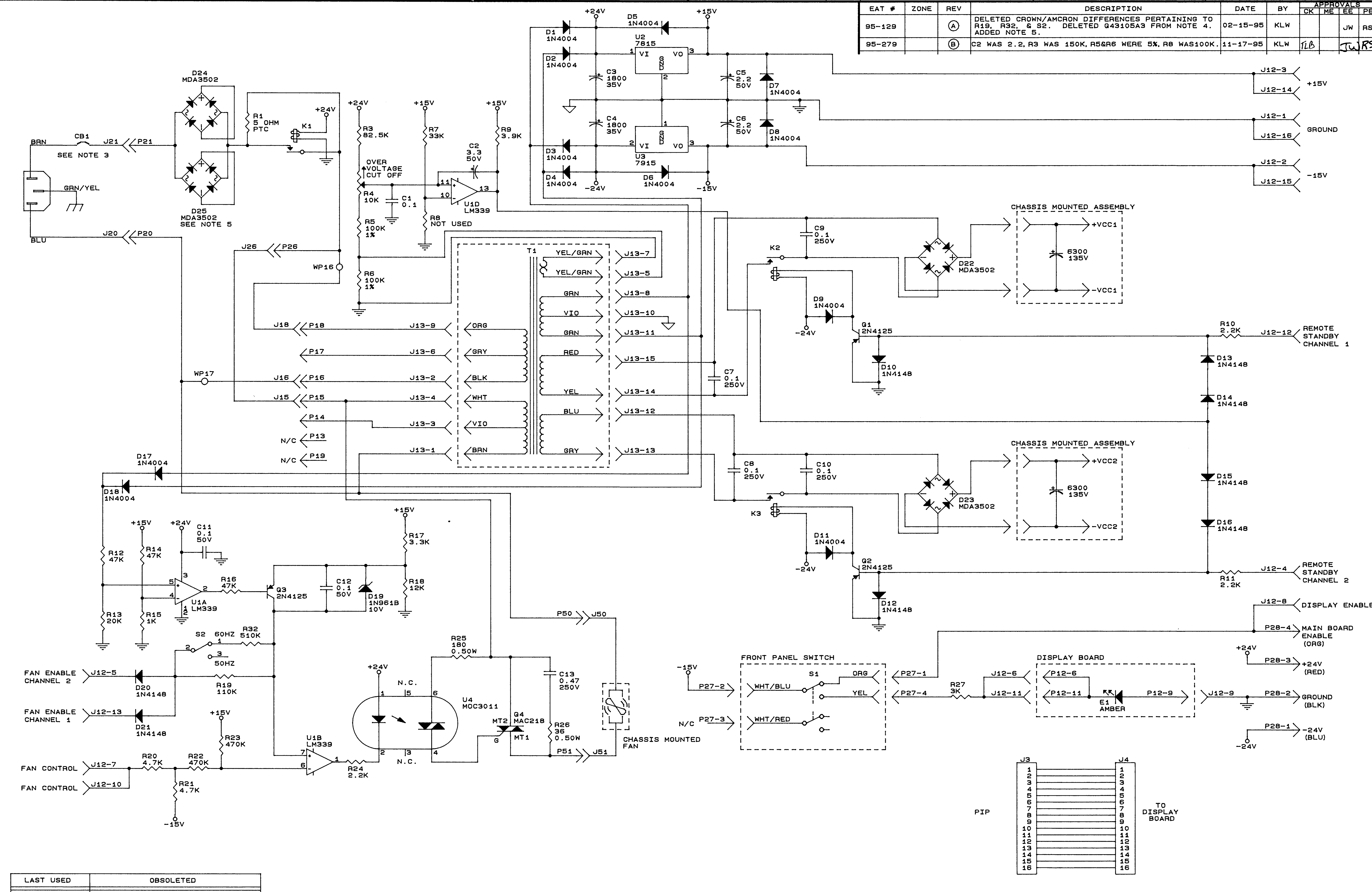
CROWN INTERNATIONAL, INC.
1718 WEST MISHAWAKA ROAD ELKHART, IN. 46517 PHONE (219) 294-8000

SCHEM, REF CONTROL #3

DRAWN	KLW	02-21-96	APPROVED BY :		DO NOT SCALE PRINT
CHECKED			ME		SUPERSEDES J0696-5
SCALE	NONE		EE	PO 3-26-96	E.C.N. EAT#96-141
PROJ #	D332		PE	B 3-26-96	C.P.N. SHEET 1 OF 1 REV O J0739-3
NEXT ASSEMBLY					

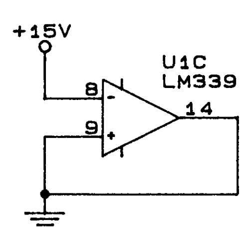
C.P.N. J0558A5 REV (B)

EAT #	ZONE	REV	DESCRIPTION	DATE	BY	APPROVALS CK	ME	EE	PE
95-129		(A)	DELETED CROWN/AMCRON DIFFERENCES PERTAINING TO R19, R32, & S2. DELETED Q43105A3 FROM NOTE 4. ADDED NOTE 5.	02-15-95	KLW			JW	RS
95-279		(B)	C2 WAS 2.2, R3 WAS 150K, R5&R6 WERE 5%, R8 WAS100K.	11-17-95	KLW	TLB		JW	RS



LAST USED	OBSOLETED
CB1	
C19	14-19
D25	
E1	
K3	
Q4	
R32	2, 28-31
S2	
T1	
U4	
WP17	1-15

UNUSED ELEMENTS



NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. CIRCUIT BREAKER RATINGS: 30 AMP / 100V - 120V 15 AMP / 220V - 240V
4. MODULE DOCUMENT AND P.C. BOARD FOR THIS SCHEMATIC ARE: G43450-8 AND D 8853-0.
5. NOT USED ON REF2.

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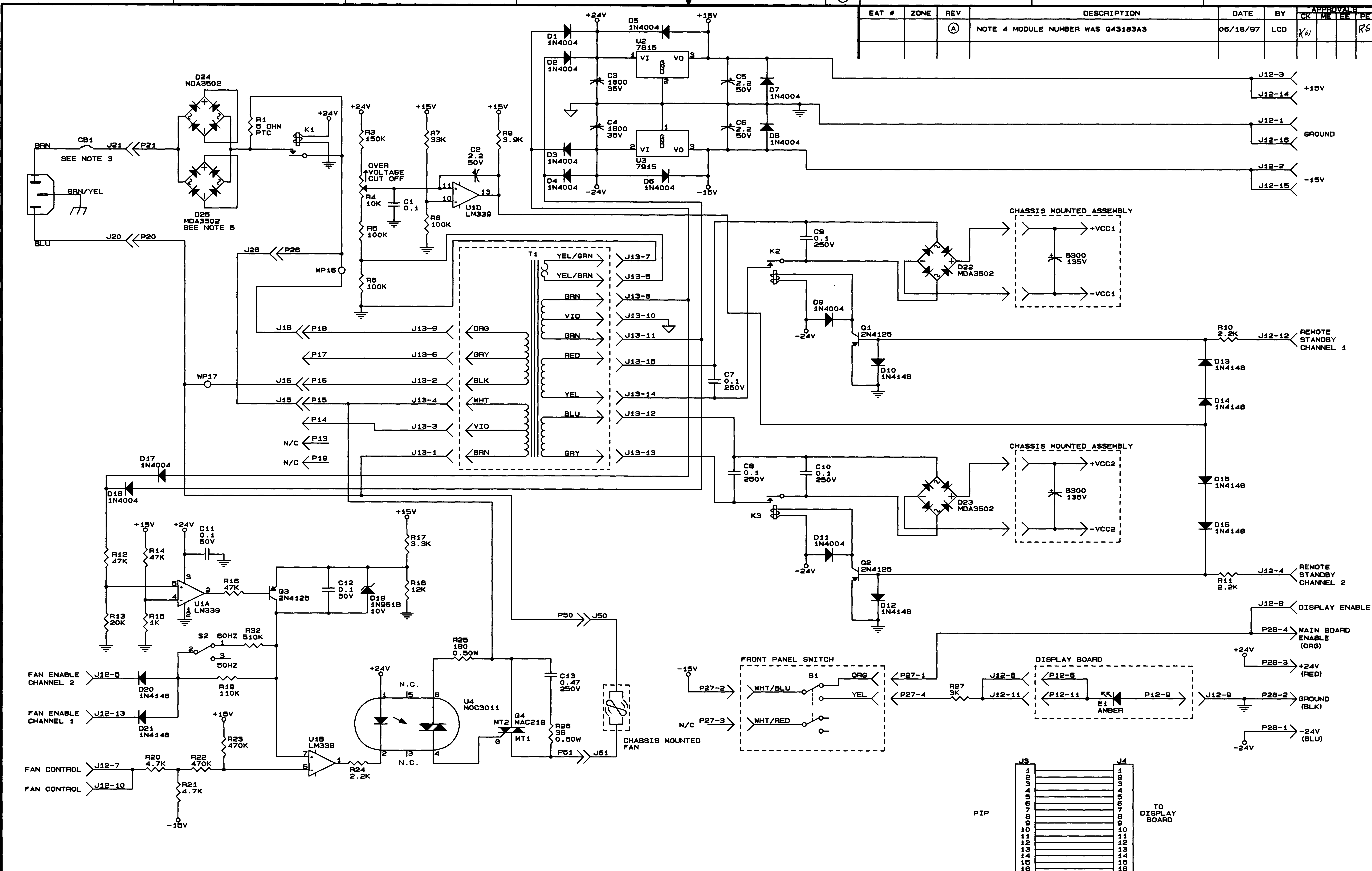
SCHEM, REF CONTROL

PRINTS TO
G

DRAWN	KLW	12-20-94	APPROVED BY :			DO NOT SCALE PRINT
CHECKED	TLB	6-12-95	ME			SUPERSEDES J0558-7
SCALE	NONE		EE	JW	6-12-95	E.C.N.
PROJ #	D182		PE			C.P.N. J0558A5 REV (B)
NEXT ASSEMBLY						

C.P.N. J0696-5 REV (A)

EAT #	ZONE	REV	DESCRIPTION	DATE	BY	CK	ME	EE	PE
		(A)	NOTE 4 MODULE NUMBER WAS Q43183A3	05/18/97	LCD	KN			RS



LAST USED	OBSOLETED
CB1	
C19	14-19
D25	
E1	
K3	
Q4	
R32	2, 28-31
S2	
T1	
U4	
WP17	1-15

UNUSED ELEMENTS

NOTES :

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. CIRCUIT BREAKER RATINGS: 30 AMP / 100V - 120V 15 AMP / 220V - 240V
4. MODULE DOCUMENT AND P.C. BOARD FOR THIS SCHEMATIC ARE: Q43450-8 AND D 8853-0.
5. NOT USED ON REF2.

SPECIFIC VOLTAGE WIRING

VOLTAGE	JUMPER	WHITE	BLACK
100V	P26-P14	P16	P17
120V	P26-P15	P16	P18
220V	P15-P16	P13	P17
240V	P15-P16	P13	P18

CROWN INTERNATIONAL, INC.
1718 WEST MISHAWAKA ROAD ELKHART, IN. 46517 PHONE (219) 294-8000

SCHEM, REF CONTROL

PRINTS TO	G				
DRAWN	KLW	06-21-95	APPROVED BY :		DO NOT SCALE PRINT
CHECKED			ME		SUPERSEDES J0558A5
SCALE	NONE		EE		E.C.N.
PROJ #	D332		PE	RS 06/29/95	C.P.N. J0696-5 REV (A)
NEXT ASSEMBLY					