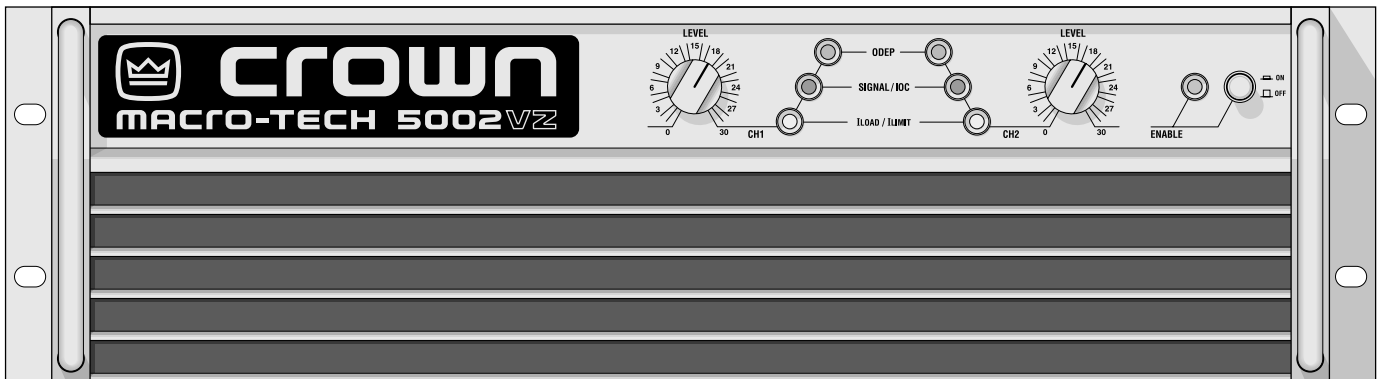




Macro-Tech®

POWER AMPLIFIER

# SERVICE MANUAL



## Models:

MA-5002VZ

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

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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.

*Mail:* P.O. Box 1000 Elkhart IN 46515-1000  
*Shipping:* Plant 2 SW 1718 W. Mishawaka Road Elkhart IN 46517  
*Phone:* (800) 342-6939 / (219) 294-8200  
*FAX:* (219) 294-8301

<p style="text-align: center;"><b>CAUTION</b></p> <p><b>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.</b></p>	<p style="text-align: center;"><b>AVIS</b></p> <p><b>À PRÉVENIR LE CHOC ÉLECTRIQUE N'ENLEVEZ PAS LES COUVERTURES. RIEN DES PARTIES UTILES À L'INTÉRIEUR. DÉBRANCHER LA BORNE AVANT D'OUVRIER LA MODULE EN ARRIÈRE.</b></p>
--	--

**WARNING**

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



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.

## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Comments</b>
Rev. A	02-2000	Initial Printing

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# 1 Introduction

## 1.1 Introduction

This manual contains complete service information on the Crown<sup>®</sup> MA-5002VZ power amplifier. It is designed to be used in conjunction with the Reference Manual; however, some important information is duplicated in this Service Manual in case the Reference Manual is not readily available.

**NOTE: THE INFORMATION IN THIS MANUAL IS INTENDED FOR USE BY AN EXPERIENCED TECHNICIAN ONLY!**

## 1.2 The MA "02" Series Amplifiers

The *Macro-Tech*<sup>®</sup> series is a complete family of amplifiers designed for pro sound reinforcement. Macro-Tech amplifiers are designed to provide enormous levels of pure, undistorted power in a rugged low-profile package, utilizing Crown's patented *Grounded Bridge*<sup>™</sup> output topology. They also employ Crown's patented *ODEP*<sup>®</sup> protection circuitry, which keeps the amplifier working under extreme conditions that would shut down a lesser amplifier. Crown's new Macro-Tech "02" series amplifiers feature Crown's enhanced *PIP2*<sup>™</sup> (Programmable Input Processor) expansion system. The PIP2 expansion system makes it easy to tailor the amplifier to a specific application. Providing high power amplification from 20 Hz to 20 kHz with minimum distortion, Macro-Tech series amplifiers feature balanced inputs with bridged and parallel mono-

phonic capability. The MA-5002VZ includes additional features not found on other Macro-Tech series models including switchable compression, switchable loud-speaker offset integration (LOI), and I<sub>LOAD</sub>/LIMIT indication.

## 1.3 Scope

This Service Manual is intended to apply to all versions of the MA-5002VZ amplifier. The Parts Listings include parts specific for the US version and the European version (E13). For parts specific only to other versions contact the Crown Technical Support Group for help in finding part numbers.

## 1.4 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 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 Reference Manual for warranty details. To find the location of the nearest Authorized Warranty 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). If you are an Authorized Warranty Service Center and have questions regarding the warranty of a product, please contact the Field Service Manager or the Technical Support Group.

### Crown Customer Service

Technical Support Group  
Factory Service  
Parts Department

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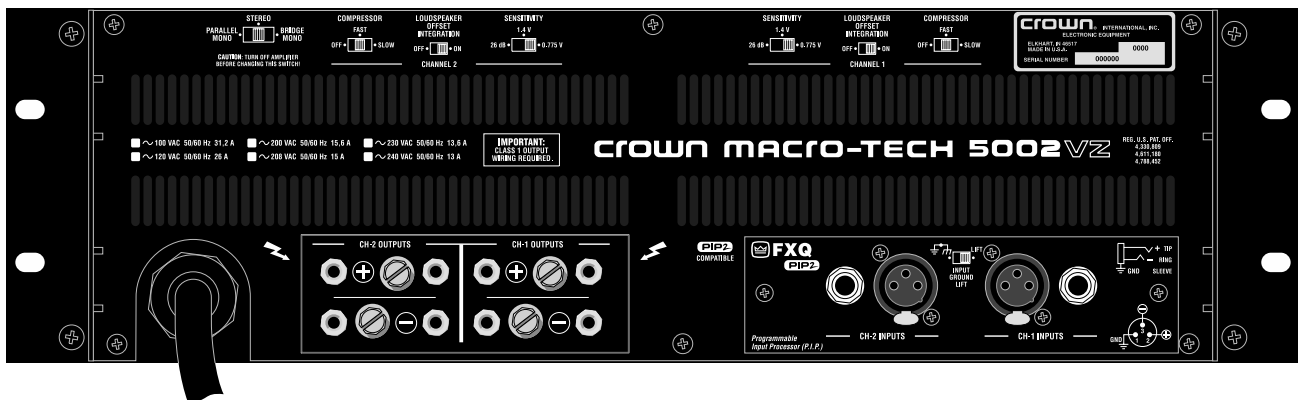
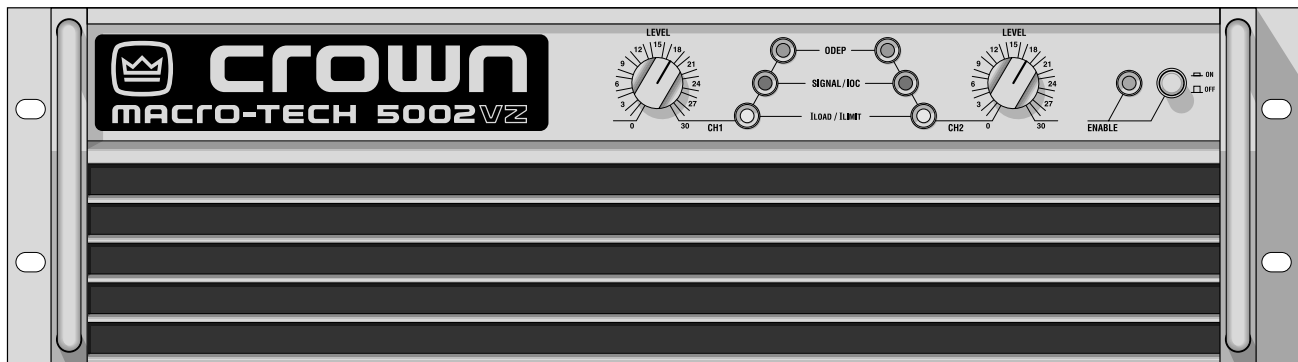


Figure 1.1 MA-5002VZ Front and Rear Views



## 2 Specifications

### Specifications

The following applies to 120-VAC, 60-Hz units in Stereo mode with 8-ohm loads and an input sensitivity of 26-dB gain unless otherwise specified. Specifications for units supplied outside the U.S.A. may vary slightly at different AC voltages and frequencies.

#### Power

##### Output Power

<b>MA-5002VZ</b>	*1 kHz Power	**20 Hz- 20 kHz Power
2-ohm Dual (per ch.)	<b>2,500W</b>	<b>2,155W</b>
4-ohm Dual (per ch.)	<b>2,000W</b>	<b>1,775W</b>
8-ohm Dual (per ch.)	<b>1,300W</b>	<b>1,090W</b>
4-ohm Bridge-Mono	<b>5,000W</b>	
8-ohm Bridge-Mono	<b>4,000W</b>	<b>3,670W</b>

\*1 kHz Power: refers to maximum average power in watts at 1 kHz with 0.1% THD.  
\*\*20 Hz- 20 kHz Power: refers to maximum average power in watts from 20 Hz to 20 kHz with 0.1% THD.

**Load Impedance:** Safe with all types of loads. Rated for 2 to 8 ohms in Stereo, 4 to 16 ohms in Bridge-Mono and 1 to 4 ohms in Parallel-Mono mode.

#### Voltage Gain to 1-kHz, 8-ohm rated output:

132:1  $\pm$ 12% or 42 dB  $\pm$ 1 dB gain at 0.775 volt sensitivity;  
71:1  $\pm$ 12% or 37 dB  $\pm$ 1 dB gain at 1.4-volt sensitivity;  
20:1  $\pm$ 3% or 26 dB  $\pm$ 0.25 dB gain at the maximum level setting.

**Required AC Mains:** 50 or 60 Hz; 100-, 120-, 200-, 208-, 230-, 240- VAC ( $\pm$ 10%).

#### AC Line Current,

Current, voltage and frequency requirements are provided on the unit's back panel.

**At Idle:** All units draw 90 watts or less.

**AC Line Connector:** 10 AWG cordset with NEMA TT30P plug is provided on 120-VAC, 60-Hz North American units.

#### Performance

**Frequency Response:**  $\pm$ 0.1 dB from 20 Hz to 20 kHz at 1 watt (see Figure 2.3).

**Phase Response:**  $\pm$ 10 degrees from 10 Hz to 20 kHz at 1 watt (see Figure 2.2).

#### Signal-to-Noise Ratio, A-weighted:

Better than 105 dB below rated 1-kHz power.

**Total Harmonic Distortion (THD):** 1-kHz rated power, 0.05% or less true THD.

**Intermodulation Distortion (IMD):** (60 Hz and 7 kHz at 4:1) Less than 0.05% from rated power to 35 dB below rated power at 8 ohms.

**Damping Factor:** Greater than 1,000 from 10 Hz to 400 Hz (see Figure 2.4).

**Controlled Slew Rate:** (Slew rates are limited to useful levels for ultrasonic/RF protection.) Greater than 30 volts per microsecond.

### Controls

**Compressor:** A three-position back-panel switch is used to control each channel's input compressor. The "fast" setting provides an attack time of 4 milliseconds and a release time of 300 milliseconds; the "slow" setting provides an attack time of 12 milliseconds and a release time of 600 milliseconds; the "off" setting defeats output-driven compression.

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

**Input Ground Lift:** A two-position back-panel switch located on the PIP2-FXQ used to isolate the input audio signal grounds from the AC (chassis) ground.

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

**Loudspeaker Offset Integration:** A two-position back-panel switch for each channel used to turn the loudspeaker protection circuitry on and off. The circuitry protects against DC, off-center woofer cone movement, and unwanted subsonic and ultrasonic frequencies.

**Sensitivity:** A three-position back-panel switch for each channel used to select input sensitivity: 0.775 volts or 1.4 volts for standard 1-kHz power, or a 26 dB voltage gain.

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

**VZ Mode:** A four-position switch for each channel inside the front-panel used to control the switching mode of the VZ power supplies.

#### Indicators

**Enable:** An amber front-panel LED that shows the on/off status of the low-voltage power supply.

**Signal/IOC:** A green front-panel LED for each channel that flashes to show amplifier output. If a channel's output waveform differs from its input by 0.05% or more, the indicator flashes brightly to show distortion.

**ODEP:** An amber front-panel LED for each channel that shows thermal-dynamic energy reserve. Normally, each ODEP indicator is lit to show available reserve energy. In the rare event that a channel has no reserve, its indicator will dim in proportion to ODEP limiting.

**ILoad/ILimit:** A two-color (green/red) LED for each channel that shows load current and limit current. They glow green to indicate load current flowing out the amplifier, and they turn red when maximum current is being delivered to the load.

#### Input/Output

**Input Connectors:** Balanced three-pin XLR and balanced ¼-inch (6.35-mm) TRS connectors are provided on the factory-installed PIP2-FXQ module.

**Input Impedance:** Greater than 10 ohms, balanced. Greater than 5 ohms, unbalanced.

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

**Output Connectors:** A multifunction, high-current output block is provided. Crown output blocks include three pairs of connectors for each channel (a total of 12 connectors). This allows multiple loudspeakers to be easily connected to each channel. High current screw terminals and banana jacks are provided which accept spade lugs, banana plugs or bare wire.

**Output Impedance:** Less than 10 milliohms in series with less than 2.5 microhenries (see Figure 2.5).

**DC Output Offset:** ±10 millivolts.

**Output Signal**

**Stereo:** Unbalanced, two-channel.

**Bridge-Mono:** Balanced, single-channel. Channel 1 controls are active; Channel 2 controls are removed from operation.

**Parallel-Mono:** Unbalanced, single-channel. Channel 1 controls are active; Channel 2 controls are by passed.

**Protection**

Macro-Tech amplifiers are protected against shorted, open or mismatched loads; overloaded power supplies; excessive temperature; chain destruction phenomena; input overload damage; and high-frequency blowups. They also protect loudspeakers from input/output DC and turn-on/turn-off transients.

If unreasonable operating conditions occur, the patented ODEP circuitry will proportionally limit the drive level to protect the output transistor stages, particularly in the case of elevated temperature. Transformer overheating will result in a temporary shutdown of the affected channel; when it has cooled to a safe temperature, the transformer will automatically reset itself. Controlled slew rate voltage amplifiers protect against RF burnouts.

And input overload protection is provided by the input compressors and current-limiting resistance at the input.

**Turn On:** The four second turn-on delay prevents dangerous turn-on transients. It also has "soft start" to avoid tripping the AC circuit breaker by gradually bringing the supplies up to full voltage.

**Accessories:** Crown PIP and PIP2 modules including IQ-PIP modules.

**Construction**

Steel chassis with durable black finish, aluminum front panel with Lexan overlay, and specially designed flow-through ventilation from front to back panels.

**Cooling:** Internal heat sinks with on-demand, proportional forced-air cooling controlled by ODEP. Includes custom heat diffusers and patented circuitry to promote uniform dissipation.

**Dimensions:** 19-inch (48.3-cm) standard rack mount width (EIA RS-310-B), 5.2-inch (13.3-cm) height, 15.875-inch (40.3-cm) depth behind mounting surface, and 2.875 inches (7.3 cm) in front of mounting surface (see Figure 2.1). Allow 3 inches (7.6 cm) behind the back panel for adequate air flow.

**Approximate Weight:** 77 pounds, 9 ounces (35.2 kg) net; 88 pounds, 10 ounces (40.2 kg) shipping weight.

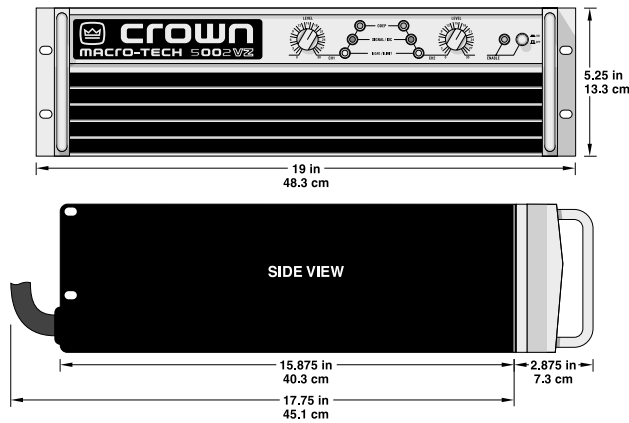


Figure 2.1 Dimensions

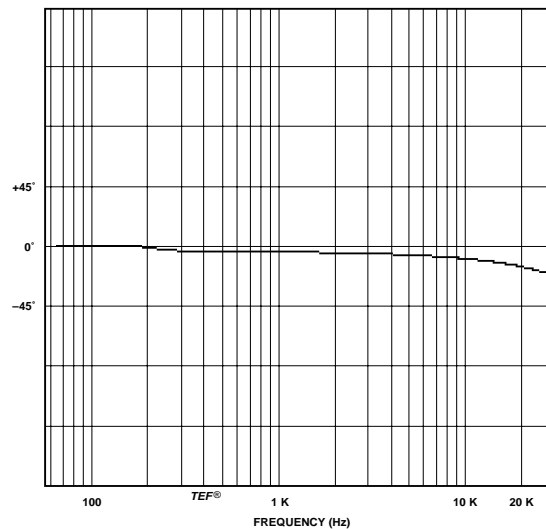


Figure 2.2 Typical Phase Response

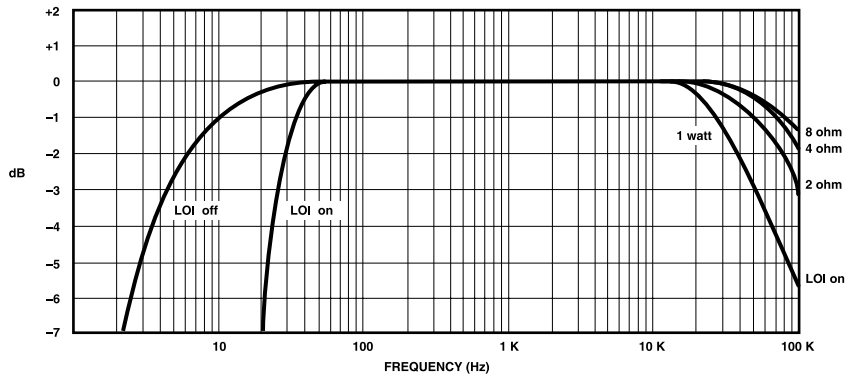


Figure 2.3 Typical Frequency Response

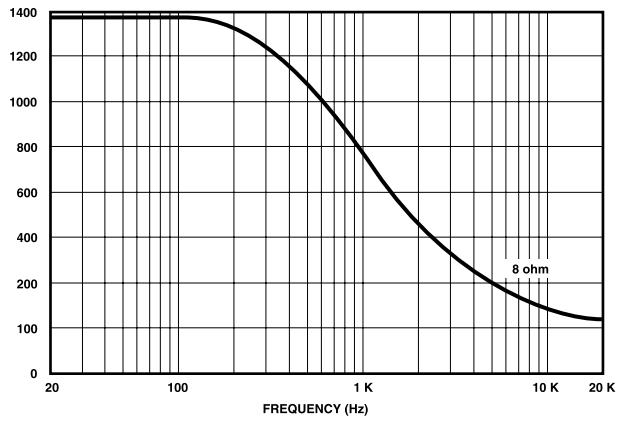


Figure 2.4 Typical Damping Factor

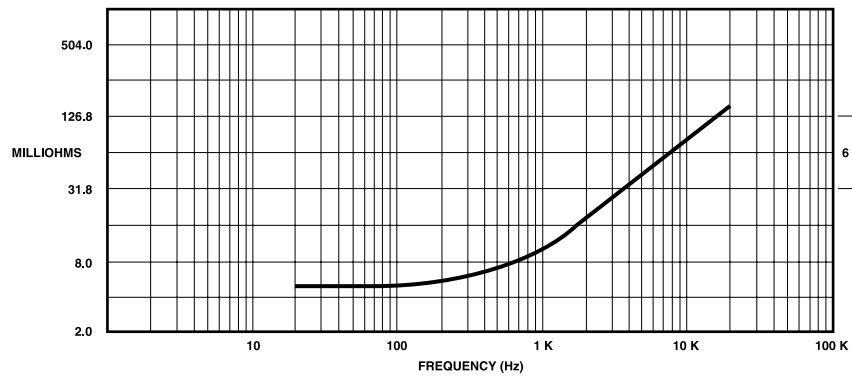


Figure 2.5 Typical Output Impedance

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## 3 Voltage Conversion

The MA-5002VZ power amplifier may easily be converted to a variety of AC mains voltages and may operate at 50 or 60 Hz. Complete directions to accomplish line voltage and/or frequency changes are found on a label under the top cover of the unit. For convenience this information is duplicated here and on the following page.

Control Board Wiring for Different AC Voltages						
NO.**	100 V	120 V	200 V	208 V	230 V	240 V
P712	BLK	BLK	BLK	BLK	BLK	BLK
P711	WHT	WHT	--NONE--	--NONE--	--NONE--	--NONE--
P724B	BLU*	BLU*	BLU*	BLU*	BLU*	BLU*
P707	BLK/GRN	BLK/YEL	BLK/GRN	BLK/GRN	BLK/YEL	BLK/YEL
P704	--NONE--	--NONE--	BLK/YEL	BLK/YEL	WHT	WHT
P705	--NONE--	--NONE--	WHT	WHT	BLK/GRN	BLK/GRN
P710	WHT/GRN	WHT/YEL	WHT/RED	WHT/YEL	WHT/YEL	WHT/YEL
P709	WHT/RED	WHT/RED	WHT/GRN	WHT/GRN	WHT/GRN	WHT/RED
P708	WHT/YEL	WHT/GRN	WHT/YEL	WHT/RED	WHT/RED	WHT/GRN
P703	BLK/YEL	BLK/GRN	--NONE--	--NONE--	--NONE--	--NONE--
P701	GRY	GRY	GRY	GRY	GRY	GRY
P700	GRY	GRY	GRY	GRY	GRY	GRY
P702	GRN/YEL	GRN/YEL	GRN/YEL	GRN/YEL	GRN/YEL	GRN/YEL
P713	BLK/YEL	BLK/GRN	--NONE--	--NONE--	--NONE--	--NONE--
P714	WHT/YEL	WHT/GRN	WHT/YEL	WHT/RED	WHT/RED	WHT/GRN
P722	BRN*	BRN*	BRN*	BRN*	BRN*	BRN*
P749	WHT/RED	WHT/RED	WHT/GRN	WHT/GRN	WHT/GRN	WHT/RED
P750	WHT/GRN	WHT/YEL	WHT/RED	WHT/RED	WHT/YEL	WHT/YEL
P718	--NONE--	--NONE--	WHT	WHT	BLK/GRN	BLK/GRN
P716	--NONE--	--NONE--	BLK/YEL	BLK/YEL	WHT	WHT
P721	BLK/GRN	BLK/YEL	BLK/GRN	BLK/GRN	BLK/YEL	BLK/YEL
P719	BLK	BLK	BLK	BLK	BLK	BLK
P715	WHT	WHT	--NONE--	--NONE--	--NONE--	--NONE--
P724A	BLU*	BLU*	BLU*	BLU*	BLU*	BLU*
P736	GRN/YEL	GRN/YEL	GRN/YEL	GRN/YEL	GRN/YEL	GRN/YEL
P735	GRY	GRY	GRY	GRY	GRY	GRY
P734	GRY	GRY	GRY	GRY	GRY	GRY
P742	BLK/YEL	BLK/GRN	--NONE--	--NONE--	--NONE--	--NONE--
P737	WHT/YEL	WHT/GRN	WHT/YEL	WHT/RED	WHT/RED	WHT/GRN
P744	WHT/RED	WHT/RED	WHT/GRN	WHT/GRN	WHT/GRN	WHT/RED
P743	WHT/GRN	WHT/YEL	WHT/RED	WHT/YEL	WHT/YEL	WHT/YEL
P738	--NONE--	--NONE--	WHT	WHT	BLK/GRN	BLK/GRN
P739	--NONE--	--NONE--	BLK/YEL	BLK/YEL	WHT	WHT
P745	BLK/GRN	BLK/YEL	BLK/GRN	BLK/GRN	BLK/YEL	BLK/YEL
P724C	BLU*	BLU*	BLU*	BLU*	BLU*	BLU*
P741	WHT	WHT	--NONE--	--NONE--	--NONE--	--NONE--
P740	BLK	BLK	BLK	BLK	BLK	BLK
P729***	120 V Position		240 V Position			
P730***						

Figure 3.1 Voltage/Frequency Conversion Chart

## INSTRUCTIONS

**CAUTION:** Because there is a risk of electric shock, only a qualified technician should change the line voltage configuration.



1. Turn the amplifier off and disconnect it from the AC power source. (The enable switch alone does not remove lethal voltage from the line cord.) Wait at least 10 seconds before proceeding.
2. Drain any remaining energy from the power supplies by shorting them as follows: Touch a 100 ohm, 10 watt resistor across terminals A1 and A2 and across B1 and B2 as shown in the illustration. The resistor should be held across the terminals for 10 seconds. Be careful—the resistor can become hot.
3. Locate the Control Board. It is the circuit board closest to the front of the amplifier. It contains numerous power supply connections which set the voltage and one jumper block which sets the frequency.
4. Use the information in Figure 3.1 to connect the color-coded wiring harness correctly for the desired voltage. Configure each wire group one at a time so the wires are not confused. Do not mix wires between groups. This step may require you to cut one or more tie wraps. If you do, replace them to make sure no loose wires are able to prevent the fans from rotating.
5. Locate the frequency jumper (JP1) and set it for either 60 Hz (left) or 50 Hz (right).
6. Locate the fan connector (P729/P730) and move it to the appropriate voltage connector (left for 200-240 VAC or right for 100-120 VAC).
7. Double check that all connections are correct and replace the top cover.

\* Wire colors marked with a single asterisk connect to the power cord.

\*\* The connector numbers are listed in clockwise order from left to right as you face the front of the amplifier.

\*\*\* Connection P729 and P730 are combined on a single four-pin connector. It mates to a "120V" connector for 100V or 120V operation or a "240V" connector for 200, 208, 230 or 240 volts.

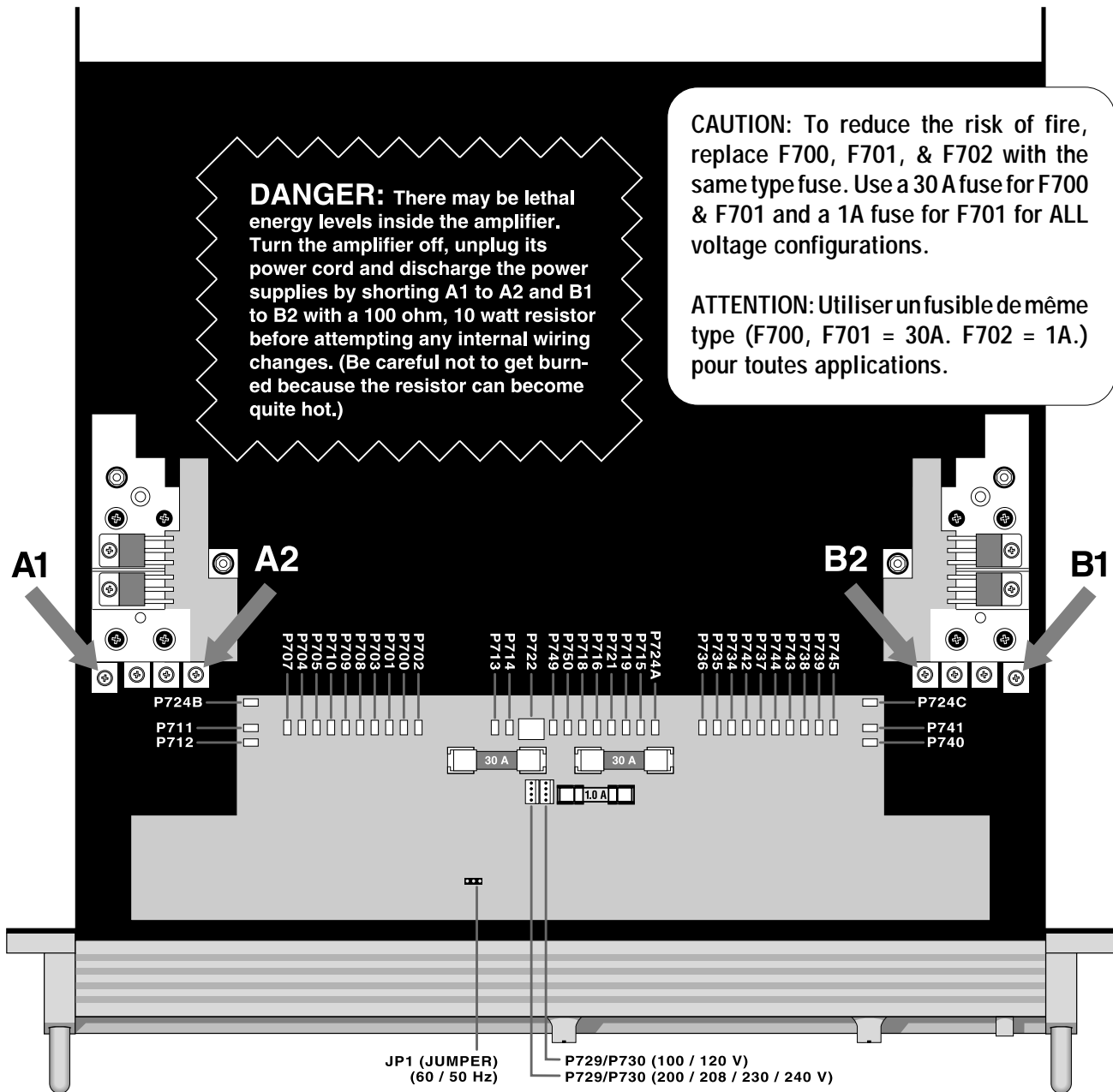


Figure 3.2 Voltage/Frequency Conversion Physical Layout

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## 4 Circuit Theory

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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. Sketches have been added to this section for clarification of the various concepts presented, as well as block diagrams for the amplifier and specific portions of the amplifier. For detailed schematics refer to Section 6.

The Macro-Tech 5002VZ amplifier incorporates several new technological advancements, including real-time computer simulation of output transistor stress, low-stress output stages, an advanced heat diffuser embodiment, a programmable input processor (PIP) expansion system, and articulated VZ power supplies.

Custom circuitry is incorporated to limit temperature and current to safe levels-making it highly reliable and tolerant of faults. Unlike many lesser amplifiers, the Macro-Tech 5002VZ can operate at its voltage and current limits without self-destructing.

Real-time computer simulation is used to create an analog reading of the junction temperature of the output transistors (herein referred to as the output devices). Current is limited only when the device temperature becomes excessive-and just by the minimum amount necessary. This patented approach, called ODEP (Output Device Emulation Protection) maximizes the available output power and eliminates overheating-the major cause of device failure. ODEP in the MA-5002VZ also provides indication of amplifier thermal reserve (front panel ODEP indicators) and may provide control of VZ mode when the VZ mode select switches are placed in the VZ-ODEP position.

The amplifier is protected from all common hazards that plague high-power amplifiers, including shorted, open or mismatched loads, overloaded power supplies, excessive temperature, chain-destruction phenomena, input-overload damage, and high-frequency blowups. The unit protects loudspeakers from DC in the input signal and from turn-on and turn-off transients. It also detects and prevents unwanted DC on the outputs. Additional protection features include input voltage sense as well as overvoltage (AC mains).

A mode of protection which may be switched on or off

is called Loudspeaker Offset Integration (LOI). The LOI circuit, when switched on, prevents excessive bass frequency cone excursions below the audible frequency range. It operates essentially as a band-pass filter. The low frequencies are rolled off at 18 dB/octave with a -3 dB corner of 35 Hz (Butterworth response). Ultrasonics are rolled off with a second order Bessel response and -3 dB corner of 50 kHz.

A compression circuit in each channel may be switched off, on slow, or on fast by switches on the rear panel. This compressor is activated by either input overload or distortion (clipping). Input overload compression is in fast speed when the compressor switch is in the off position. The compression ratio is infinite (it operates as a peak limiter).

The four-quadrant topology used in the grounded output stages is called the Grounded Bridge, and it makes full use of the power supplies. This patented topology also makes peak-to-peak voltages available to the load which are twice the voltage any output device is ever exposed to. The Grounded Bridge is covered in detail in Section 4.2.

The two channels may be used together to double the voltage (bridged-mono) or the current (parallel-mono) presented to the load. This feature gives the user flexibility in maximizing the power available to the load.

Macro-Tech amplifiers utilize a wide bandwidth multiloop feedback design with state of the art compensation techniques. This produces ideal behavior and results in ultra-low distortion values.

Aluminum extrusions have been widely used for heatsinks in power amplifiers due to their low cost and reasonable performance. However, measured on a watts per pound or watts per volume basis, that extrusion technology doesn't perform nearly as well as the cut fin radiator technology developed for the Macro-Tech 5002VZ power amplifier.

Our thermal diffusers are custom cut radiator fins on a solid heat sink block. They provide an extremely high ratio of area to volume, or area to weight. All power devices are mounted directly to massive heat spreaders, which are electrically hot. Making the heat spreaders electrically hot allows improved thermal performance by eliminating the insulating interface underneath the power devices. The chassis itself is used as part of the thermal circuit, and this maximizes utilization of the available resources.

### 4.2 Grounded Bridge Theory

The Grounded Bridge topology is ground-referenced

## Simplified Grounded Bridge... In Operation

(MA-5002VZ with supply in high voltage mode)

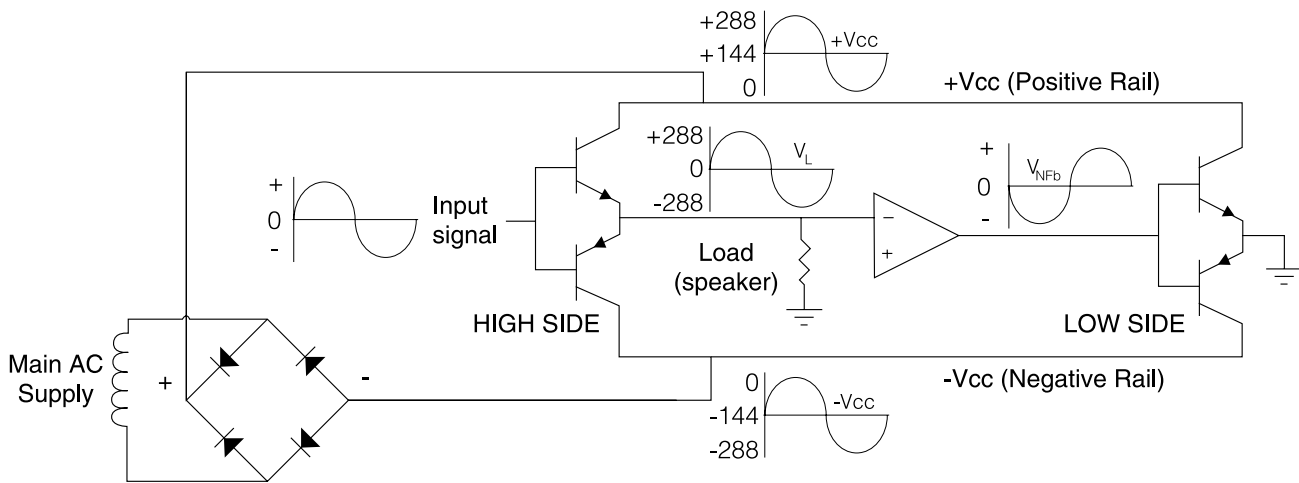


Figure 4.1 Simplified Grounded Bridge

by the output stages rather than the power supply. Composite devices are constructed to function as gigantic NPN and PNP devices since the available currents exceed the limits of existing individual 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 voltage is delivered to the load by increasing conductance simultaneously in the high-side NPN and low-side PNP stage. At the same time, conductance of the high-side PNP and low-side NPN is being decreased.

### 4.2.1 Grounded Bridge Operation

Figure 4.1 is a simplified example of Crown's patented Grounded Bridge output topology (ignoring the articulating characteristics of the VZ supply). 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 cross-over region.

The high side of the bridge operates similar to a conventional bipolar push-pull output configuration. As the input drive voltage becomes more positive, the high side NPN conducts current and delivers positive voltage to the speaker load. Eventually, full +Vcc is across the load. At this time the high side PNP is biased off. When the drive signal is negative going, the high side PNP con-

ducts to deliver -Vcc to the load and the high side NPN stage is off.

The low side operates quite differently. The power supply bridge rectifier is not ground referenced. 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 low side of bridge uses inverted feedback from the high side output to control the ground reference for the rails.

As the output swings positive, the output signal is fed back to the low side and is inverted to drive the low side with a negative signal. The negative signal causes the low side PNP to conduct (as the high side NPN conducts) shifting the ground reference toward -Vcc until, at the peak, -Vcc = 0V. At this time +Vcc equals the full potential (from rail to rail, not rail to ground) of the power supply with positive polarity. Since the high side is delivering +Vcc to the speaker load (which is ground referenced at all times), the speaker sees the full potential developed by the power supply with a positive polarity.

When the input drive signal is negative and the high side PNP conducts to deliver a negative voltage to the load, that output is again fed to the low side and inverted to cause the low side NPN to conduct. As the low side NPN conducts, +Vcc swings toward the 0V ground potential. At the peak: +Vcc = 0V. At this time -Vcc equals the full potential developed by the power supply, but with negative polarity. Since the high side is delivering -Vcc to the speaker load, the load sees the



full (negative) potential developed by the power supply.

The total effect is to deliver a peak to peak voltage to the speaker load which is twice the (static) 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).

#### 4.2.2 Output Stage Circuitry

Circuitry on the positive and negative output modules include bias circuitry, current limit circuitry, last voltage amplifiers (LVAs), pre-drivers, drivers, output devices, and the Low Side error amp. Temperature sensors are also mounted to the heatsinks via the output modules.

The positive LVAs (Q501, Q502, and Q503) convert the negative output of the voltage translator stage to a positive drive voltage for the NPN High Side (HS) predriver. There are three LVA transistors in parallel due to the very high voltages (therefore higher current and thermal requirements) that are present when the power supply is in high voltage mode. D522 prevents the +LVAs from producing a high negative output to the HS NPN stage.

Q507, Q508, and Q509 are the -LVAs and are arranged in mirror image to the +LVAs, including D513.

On the positive side, D514, D515, and C506 via the +LVAs act to limit slew rate. D514 and D515 also prevent dangerously excessive current through the LVAs. D516, D517, and C507 are the negative HS mirror image.

Q534 and Q540 provide two-speed current limiting in the output stage. Sense lines are arranged such that excessive current through any single HS output device will result in current limit protection. Q535 and Q541 are the negative side mirror image.

Q505 on the positive output module works in tandem with Q505 on the negative output module as a  $V_{be}$  multiplier circuit. They produce and, with great stability, control bias for the High Side NPN and PNP devices. Potentiometer R505 is used to precisely set bias voltage. Bias voltage is easily measured from pin 2 (hot) to pin 4 of ATE ports TP1 and TP2. Refer to Section 2 for appropriate test procedures.

Q504 is the HS NPN pre-driver and Q511 is the HS NPN driver. These devices are biased class AB for ultra low distortion in the zero-crossing region.

Q513, Q515, Q517, and Q536 are the HS NPN output devices. These devices are biased class B, in soft cut-off. Together with driver and pre-driver, they function as a three-deep Darlington. The output devices work in parallel as a giant composite. The over-all bias topology is referred to as AB+B, originally conceived and patented by Crown engineers in 1966. This is still the most efficient, stable, and distortion free method used today in BJT output stages.

D506 is the flyback diode for the HS NPN output quadrant. In the event that a back EMF (flyback) pulse exceeds power supply voltage, the flyback diode will shunt this voltage to the supply in order to protect the output devices.

PNP pre-drivers, drivers, output devices, and flyback diode D508 are a mirror image of the NPN side.

Overall, the High Side of the bridge operates much like a conventional output stage, but the Low Side (LS) is quite unique.

The LS senses output voltage and common buss (0.04 ohms above ground) potential. The audio output is inverted by U503. Also in the U503 input circuitry are static and dynamic balance controls. These controls provide a fine balance of the grounded bridge. Output of the op-amp drives the LS pre-driver circuits through the LS bias network.

LS bias is controlled in a fashion similar to that of the HS. Two transistors, Q529 and Q530, fix LS bias voltage as measured from pin 15 (hot) to pin 13 of applicable ATE port TP1 or TP2. Potentiometer R556 adjusts bias in the LS.

Diodes D504 and D505 control polarity of applied LS drive signal. Via the bias transistors, signal is delivered to the bases of the pre-drivers Q527 (NPN) and Q528 (PNP). Pre-drivers, drivers, and output devices in the LS operate class AB+B, exactly like the HS. The major difference is that rather than driving a load, the NPN and PNP stages control the ground reference for the high voltage rails. As the HS NPNs conduct, LS PNP's conduct, and vice versa (as explained in section 4.2.1).

When the ODEP circuit senses that limiting drive is necessary to prevent a dangerous thermal condition, it provides an output which limits drive to the output stages. For the HS, this limiting is accomplished on the main module and is explained in section 4.4. For the LS, ODEP provides (via wires labeled  $\pm LL$ ) a signal which limits bias feed to the LS output devices. This is accomplished through current mirrors Q532 and Q531 (LS NPN quadrant), and Q542 and Q543 (LS PNP quadrant).

### 4.3 VZ Power Supply

VZ means Variable Impedance and is the name of Crown's patented articulated power supply technology. It enables Crown to pack tremendous power into just 5.25 inches of vertical rack space.

A power supply must be large enough to handle the maximum voltage and current necessary for the amplifier to drive its maximum rated power into a specified load. In the process of fulfilling this requirement, conventional power supply designs produce lots of heat, are heavy, and take up precious real estate. And it's no secret that heat is one of a power amplifiers worst enemies.

According to Ohm's Law, the bigger the power supply, the more heat the power transistors must dissipate. Also, the lower the resistance of the power transistors, the more voltage you can deliver to the load. But at the same time that you lower the resistance of the transistors, you increase the current passing through them, and again increase the amount of heat they must dissipate.

#### 4.3.1 VZ Supply Operation

An articulated power supply, like VZ, can circumvent much of this problem by reducing the voltage applied to the transistors when less voltage is required. Reducing the voltage reduces the heat. Since the amplifier runs cooler, you can safely pack more power into the chassis.

The VZ supply is divided into segments to better match the voltage and current requirements of the power transistors. Remember that audio signals like music are complex waveforms. Refer to Figures 4.2 and 4.3.

For music the average level is always much less than the peak level. This means a power supply does not need to produce full voltage all the time.

The VZ supply is divided into two parts. When the voltage requirements are not high, it operates in a parallel mode to produce less voltage and more current.

The power transistors stay cooler and are not forced to needlessly dissipate heat. This is the normal operating mode of the VZ power supply.

When the voltage requirements are high, VZ switches to a series mode to produce higher voltage and less current. The amplified output signal never misses a beat and gets full voltage only when it needs it.

Sensing circuitry watches the voltage of the output signal to determine when to switch VZ modes. The switching circuitry is designed to prevent audible switching distortion to yield the highest dynamic transfer function - you hear only the music and not the amplifier. You get not only the maximum power with the maximum safety, you also get the best power matching to your load.

In Figure 4.2, the individual components are shown. Upstream of the toroid transformer, though not shown, is where shutdown protection and soft-start circuitry taps in to control AC mains input to the power supply. The VZ Control circuitry senses audio level and switches the articulating VZ supplies to either parallel (high current) mode for lower level audio, or series (high voltage) mode for high program peaks.

Figure 4.3 shows current flow with power supply and grounded bridge operating together. Notice that the ungrounded VZ supply operates much like a battery. More exactly, it is a floating DC supply made up of two internal batteries which operate in either series or parallel.

In both examples it can be seen that when the MOSFET switch is off, the dual supplies are forced to operate in a parallel mode. Audio level is sensed via a line tapping off the NFb loop. When audio level is rising and at about 80% of the parallel mode supply voltage, the MOSFETs (the switch is actually a three-device compos-

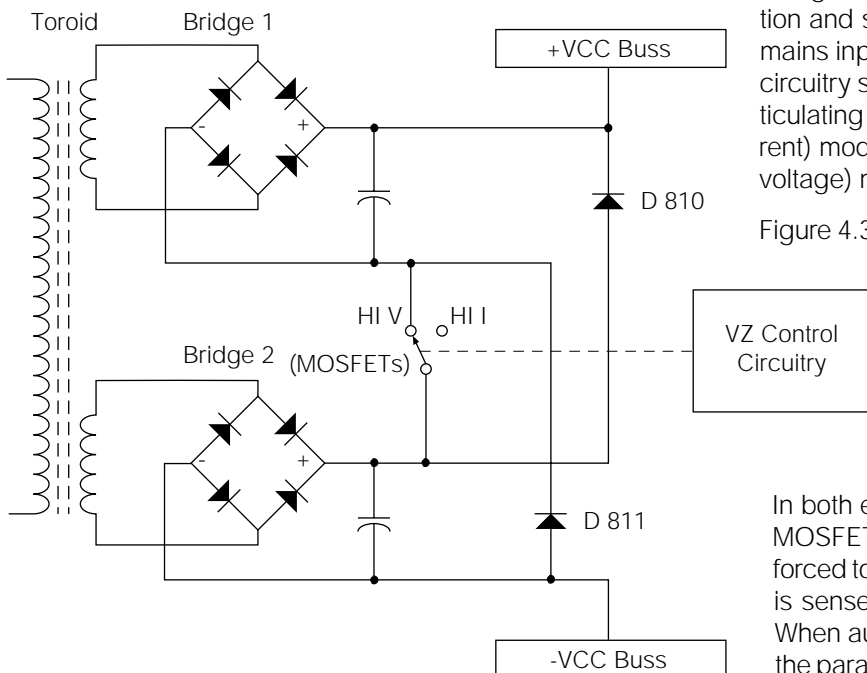


Figure 4.2 Simplified VZ Supply

## VZ Power Supply & Grounded Bridge Output Topology

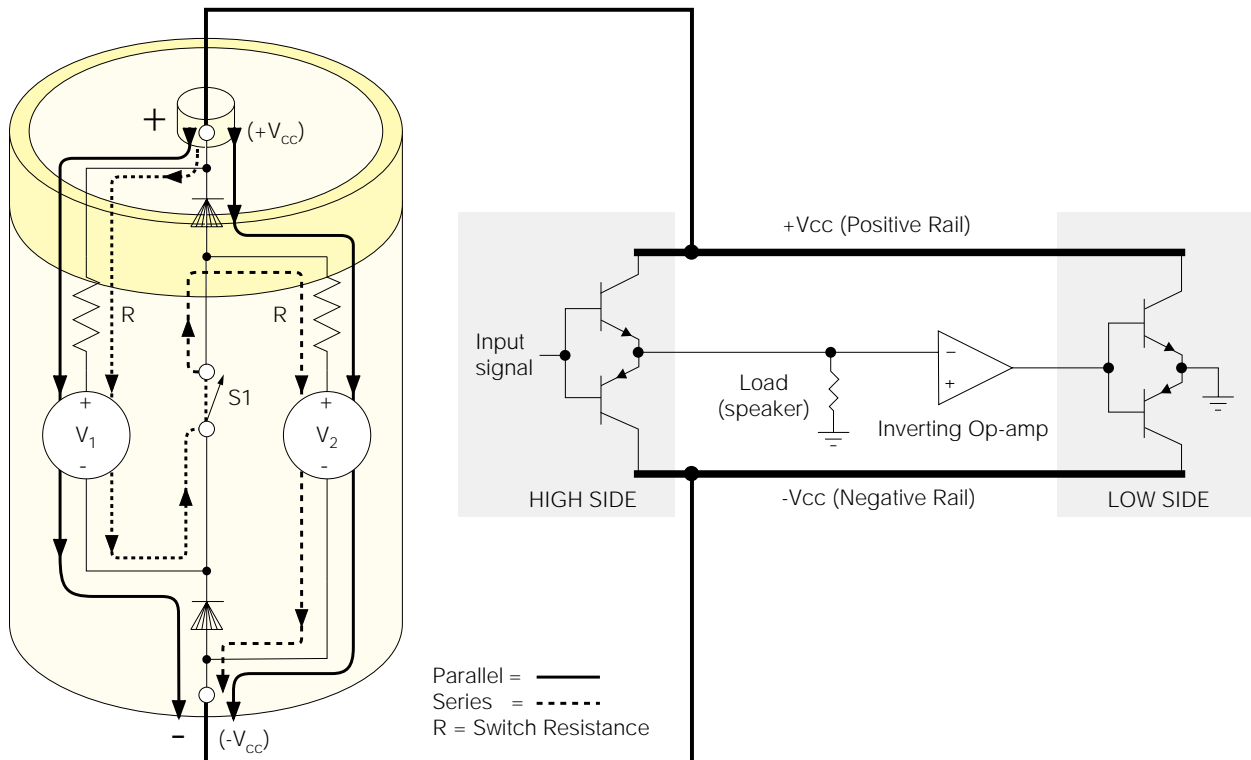


Figure 4.3 Simplified VZ Supply in Operation

ite switch) are turned on. No current will flow through either of the control diodes (D810 and D811, as shown for channel 1) because reverse polarity is applied through the MOSFET switch. Since this happens to both rectifier sources at the same time, and the negative side of Bridge 1 is then shorted to the positive side of Bridge 2, the supplies are forced to operate in series mode. Like two batteries, the supplies will provide double voltage in series mode, double current in parallel mode.

Although shipped from the factory in VZ-ODEP mode, the user may switch modes to Lock Low voltage (high current), or operate the supply in VZ-AUTO mode. VZ-ODEP is similar to VZ-AUTO mode, except that in AUTO mode, in the event ODEP is activated to protect the amplifier, the VZ will automatically lock into low voltage (high current) mode. While this mode of operation will cool the amplifier more quickly in the event that the thermal reserve is exhausted, it may cause voltage clipping rather than ODEP limiting. Seldom will the amplifier be operated locked in high current mode unless a very low impedance is being driven.

### 4.3.2 VZ Supply Circuitry

For simplicity, only channel 1 circuitry will be covered unless noted otherwise. The actual VZ switch circuitry is located on the VZ switch assembly. This assembly contains the filter capacitors, MOSFET switches, and control diodes (D810 and D811). Three MOSFETs are used in parallel for sharing the high current supplied to the rails. Operation of this section was covered in detail, minus circuit designations, in Section 4.3.1.

**WARNING: From a service standpoint, it is critical to note that VZ switch control circuitry is NOT ground referenced. Any attempt to take voltage measurements using a ground reference when voltage is applied will not only be unreliable, but may be extremely dangerous. Serious damage to equipment or personnel may occur if this is attempted.**

The output of a 555 timer (U703) on the control module determines whether the MOSFETs are switched on (high) or off (low). This 555 device and the various sources that feed the 555 are the things that make the articulation work.

The master 555 trigger is controlled by the output of



U702A. S700, physically accessible from behind the front grille, determines the VZ operating mode. In high voltage mode (Q42930-0 Control Module only) the output of U702A is held low. This in turn keeps the 555 output high and the MOSFETs are kept on. In the high current mode, U702A is held in the opposite polarity, keeping the output of the 555 low and the MOSFETs off. In the AUTO position of S700, the audio level sense circuitry controls the threshold and reset inputs to the 555. The 555 will then switch states to high voltage when the audio level is sufficient and will switch back down automatically when level has dropped sufficiently. Capacitors in the U705 circuitry control the speed of the down-shift. In the VZ-ODEP mode, the switch operates as it would in AUTO mode unless ODEP limiting is in progress. When ODEP limiting occurs, optic coupler U704 pulls the reset control low to the 555 to turn the MOSFET switches off, and keep them off (low voltage/high current mode) until the ODEP limiting condition clears.

Upstream of the toroids are the soft-start and protection mechanisms used to power down the amplifier. Although tied into the power supply primary, these circuits are covered in Section 4.6, Protection Systems.

The low voltage power supply utilizes a separate transformer. The front panel power switch and a 1A fuse (F702) are the only components upstream of this transformer. The output of the rectifier produces  $\pm 24\text{VDC}$  unregulated. U715 and U716 produce regulated  $\pm 15\text{VDC}$  respectively. (A separate fullwave rectifier produces pulsed DC for Over-voltage sense and Soft-start control.)

## 4.4 ODEP Theory

To protect the output stages from adverse thermal conditions, a specially developed "ODEP" (Output Device Emulator Protection) circuit is used. It produces a complex analog output signal proportional to the always changing safe-operating-area (SOA) margin of the output transistors. This output signal controls the Voltage Translator stage and Low Side output stage bias. This action removes only the drive that may exceed the safe-operating-area of the output stage.

Thermal sensors give the ODEP circuitry vital information on the operating temperature of the heat sinks on which the output devices are mounted. This temperature signal combines with the complex ODEP signal to form the heart of our patented ODEP protection scheme.

### 4.4.1 ODEP Operation

Refer to Figure 4.4 for a diagram of the basic operation of the ODEP system.

The ODEP circuitry actually comes in two parts, one positive and the other negative. For the purposes of this discussion, only the channel 1 ODEP circuitry is covered here, and the focus will primarily be on the positive half.

An LM-334Z thermal sensor provides a calibrated output from the output modules. At  $25^{\circ}\text{C}$  its output is 2.98V, with a 10 mV increase per every  $1^{\circ}\text{C}$  rise in heatsink temperature.

This thermal sensor output, from the positive sensor, goes to three destinations. First is a buffer which drives the calibrated temperature test point at pin 7 of TP1/TP2. Second is an over-temperature limit trip (thermal limit amplifier, as shown below). This will cause both the positive and the negative ODEP circuit to go into, and remain in, hard ODEP until the heatsinks cool. Third, it goes down into a circuit which combines thermal and output power information.

The thermal sensor from the negative output module only performs this last function.

A pair of sense lines from the Low Side emitter resistors provide current information. Combined with VCC information, actual instantaneous power is calculated. A combining circuit determines the net thermal condition based on the power being delivered for the existing heat level. The ODEP amplifier accepts this input information and, using an RC model of the heat transfer characteristics of the output devices (as mounted in the heatsinks), creates a complex output proportional to the thermal reserve of the output devices.

Output from the positive ODEP amplifier ranges from -12V (cold) to +9V (hard ODEP). This output drives the positive LS bias feed control circuit (see Section 4.2.2) and the negative HS Voltage Translator feed control circuit (see Section 4.5.2). Also, this circuit provides test point monitoring information and VZ-ODEP VZ mode control information.

Output from the negative ODEP amplifier ranges from +12V (cold) to -9V (hard ODEP). This output drives the negative LS bias feed control circuit (see Section 4.2.2) and the positive HS Voltage Translator feed control circuit (see Section 4.5.2). Also, this circuit provides test point monitoring information, VZ-ODEP control information, and front panel ODEP (thermal reserve) LED control information.

Also tapping into the ODEP output control of LS bias feed and Voltage Translator feed are signals from the fault, power (turn-on delay), and power loss (brown-out) circuits. By using the output of ODEP for  $\pm\text{LL}$  and  $\pm\text{LH}$  control, these sources can mute the audio to the

## Channel 1 ODEP Circuitry shown

ODEP Inputs:  
Temperature  
 $\pm VCC$   
Output Current

ODEP Outputs:  
Calibrated Temperature, for monitoring  
 $\pm ODEP$  Level, for monitoring  
 $\pm ODEP$  Level, for Bi-ODEP control of VZ Supply  
 $\pm ODEP$  Level, to limit drive at  $\pm$  Voltage Translators ( $\pm LH$ )  
 $\pm ODEP$  Level, to limit Low Side Bias ( $\pm LL$ )  
ODEP Indication (front panel LEDs)

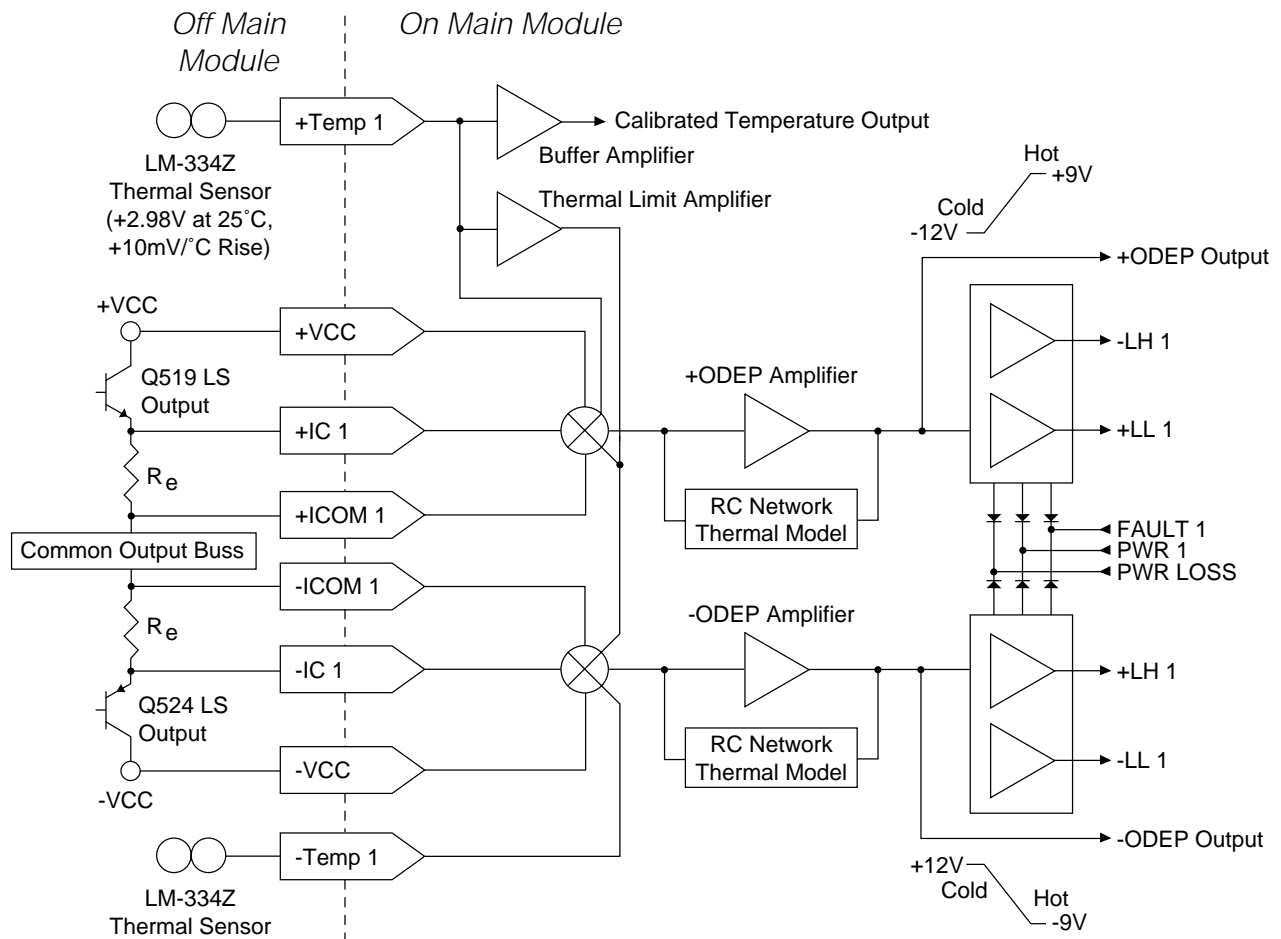


Figure 4.4 Simplified ODEP Circuitry

output stage: a. until power-up delay has timed out; b. immediately upon indication of any failure mode; c. immediately upon loss of AC mains (power-down or actual loss of AC service).

#### 4.4.2 ODEP Circuitry

$\pm TEMP$  signals are produced by U500 and U501 on the output modules. U108, on the main module, is a buffer which drives the temperature sense test point. U117A has a fixed window voltage of 6.2V via Zener D129. If heatsink temperature level exceeds about 130°C, U117A output will cause both the positive and negative ODEP amplifiers to go into hard ODEP limit-

ing. When the thermal condition clears, this limiting condition will also clear.

+VCC enters via dual PNP transistor pack U116. Positive ODEP bias is adjusted by R182. The voltage at that point controls the static balance of the U116 device. U116 combines the VCC and output current sense information, the output of which represents output power level. The common output is brought into RN101 where it provides the reference for temperature and power. U112B is the active device and, together with the power signal, drives the ODEP amplifier U112A. The RC network in the feedback path of U112A models the thermal junctions from output device die to housing, hous-

ing to case, and case to heatsink under both static and dynamic conditions.

The output of the positive ODEP amplifier drives +ODEP test point pin 11. It also drives U114A and U114B which in turn drive - LH and +LL respectively. The output of the negative ODEP amplifier drives the ODEP indication circuitry and - ODEP test point pin 9. Negative ODEP also drives U114C and U114D which in turn drive +LH and - LL respectively.

Also entering the U114 comparator networks are the PWR (power relay engage), PWRLOSS (brown-out), and FAULT (any protection which shuts down the amplifier) signals via blocking diodes. If any of these signals drop low, the feed to the LS bias and Voltage Translator drive will be shut down via  $\pm$ LL and  $\pm$ LH. This action mutes all audio in the event of a dramatic failure.

### 4.5 Front End Theory

Figure 4.5 explodes the front-end portion of the overall block diagram. Once again, only channel 1 will be discussed in detail.

Input to the amplifier is only via a PIP module. The standard module shipped with the MA-5002VZ is the PIP2-FXQ. Whether this, or any other module is used, the amplifier senses a balanced input from the installed module.

#### 4.5.1 Balanced Gain Stage

The Balanced Gain Stage (BGS) amplifier U100A converts the input audio from a balanced configuration to single-ended with (electrical) unity gain. The compression device is essentially a resistive shunt across the balanced BGS input. The BGS drives the Variable Gain Stage and provides information to the compressor control circuit and to the PIP connector.

#### 4.5.2 Variable Gain Stage

The Variable Gain Stage (U100B) taps signal from the wiper of the front panel level control (R120). Gain of the front-end is set by the gain of this stage. The sensitivity switch (S100, located on the rear panel) selects the amount of gain in this stage. Overall amplifier sensitivity may be set for 26 dB fixed gain (about 5.1Vrms), 1.4V, or 0.775V. Since overall amplifier gain after this stage is 26 dB, this stage will have a fixed gain of 0 dB (26 dB setting), about +12 dB (1.4V setting), or about +16 dB (0.775V setting). The output of this stage drives the Error Amp.

#### 4.5.3 Error Amp

The Error Amp (U105) input comes from the Variable Gain Stage with or without Loudspeaker Offset Integration (LOI), and is summed with amplifier output in a negative feedback (NFB) configuration. Output of the Error Amp drives the Voltage Translators and provides error

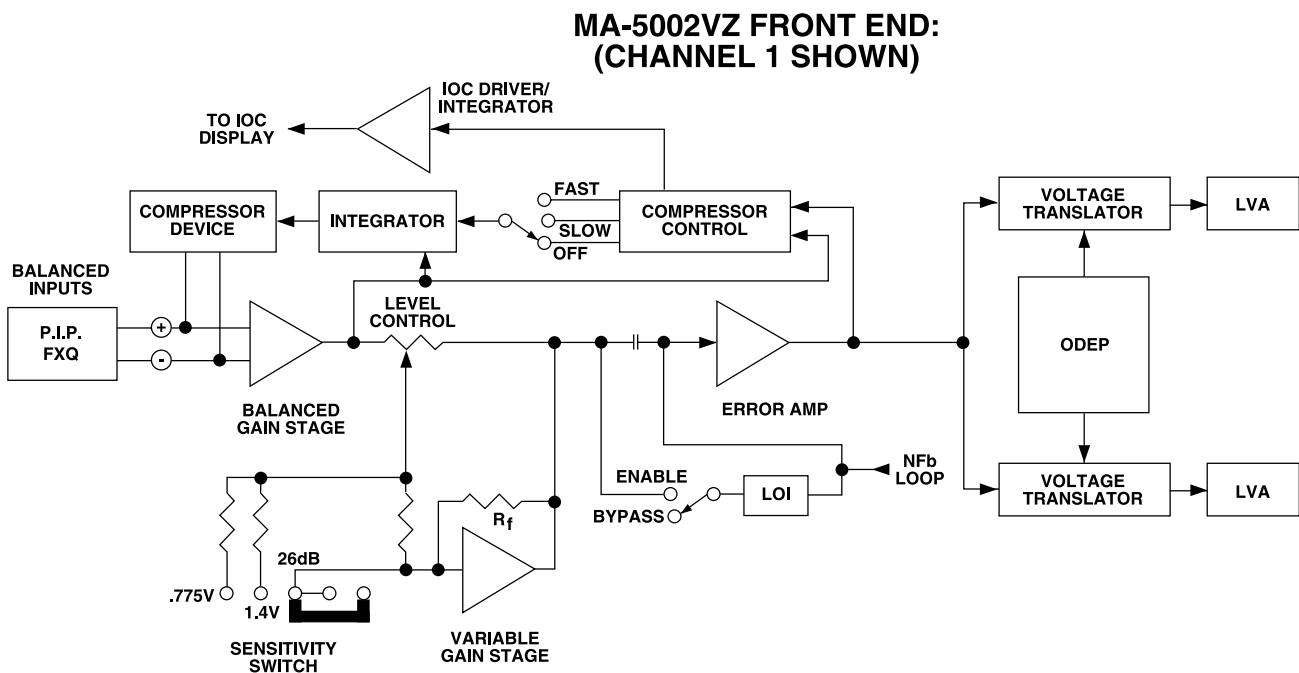


Figure 4.5 Front End Circuitry Block Diagram

signal information. An error signal (spike) is produced any time the shape of the output waveform differs from the output of the Variable Gain Stage and LOI by more than 0.05%. This error signal drives the error signal (ES) input to the PIP connector, the error signal sense test point, and the compression control circuit.

#### 4.5.4 Compressor

The compression circuitry senses error signal and BGS level. If the BGS overloads, or an error signal is present, the compression control circuit (U101) produces a compression drive pulse. A switch on the rear panel selects the speed of the integrator circuit to follow. In the off position, the error driven compression is disabled, but the input overload compression remains on (in fast speed) to protect the front end. The compression drive pulse also drives the IOC Integrator (U102). The IOC integrator not only tells the IOC indicator circuit when to turn on, but ensures that the indicator will remain on long enough to be visible to the human eye.

The compression integrator (U102, Q100) sets compression speed and produces an output pulse which controls attack and decay times. An optic device (U103) provides a resistive shunt to the input audio according to the degree of compression required and the duration of that compression. The amplifier input impedance is not affected by compressor operation.

#### 4.5.5 Loudspeaker Offset Integration

LOI (U104A/B) senses amplifier feedback and prevents dynamic DC offset. It operates essentially as a dual filter system with band pass from about 35 Hz to about 50 kHz. The upper roll-off has a second order Bessel response while the lower roll-off has a third order Butterworth response.

#### 4.5.6 Voltage Translator and LVA Stages

The Voltage Translator stages (Q104, Q104) channel the signal to the Last Voltage Amplifiers (LVAs, located on the output modules), depending on the signal polarity, from the error amp U105. The  $\pm$ LVAs, with their push-pull effect through the High Side bias servo devices, drive the fully complementary output stage. For more information on the LVAs, refer to Section 4.2.

U106 and U107 bring in feedback information and protection muting to the Voltage Translator stages. The feedback controls gain from the Voltage Translators to the output jacks. The protection inputs ( $\pm$ LH) pull off feed to the Voltage Translators in proportion to ODEP limiting, and completely shut down the feed in the event of power-down or a Fault.

#### 4.5.7 Inverting Stages

Overall, the amplifier is non-inverting. Four stages within the amplifier, however, do invert the audio signal for a net non-inversion. The individual stages are: the BGS, which inverts the audio; the Variable Gain Stage, which inverts it back; the input side of U106 and U107 (which drives the Voltage Translators) re-inverts the audio (the Voltage Translators are a common-base configuration for high voltage gain); and finally, the LVAs invert the audio for the last time for a net non-inversion through the amplifier.

### 4.6 Protection Systems

The MA-5002VZ has several protection mechanisms to limit drive or shutdown the amplifier completely in the event of a fault of almost any kind. Mechanisms include: ODEP (covered in depth in Section 4.4), current limit (covered in Section 4.2.2), over-voltage (on AC mains), DC/LFI, common mode output current, output thermal, transformer thermal, FET thermal, loss of AC mains, compression (covered in Section 4.5.4), LOI (covered in Section 4.5.5), and slew rate limit (covered in Section 4.2.2). After any non-latching fault which has shut down the amplifier clears, the amplifier will automatically power back up via soft-start. Because the fans within the MA-5002VZ cool the amplifier (under normal conditions) to prevent thermal shutdowns and ODEP limiting, the fan control circuit is also covered in this section.

Refer to Figures 4.6, 4.7, and 4.8. Figure 4.6 shows soft-start and fan control. Figure 4.7 shows the soft-start control signals. Figure 4.8 shows the over-all protection scheme of the MA-5002VZ. Each augments the others, and explode the basic block diagram of the unit (Figure 4.9).

#### 4.6.1 Soft-start

Soft-start circuitry controls the rate at which power is initially applied to the primary of the toroid transformers for the high-voltage power supplies. For ease of explanation, assume the amplifier is operating properly and is just being turned on from the front panel power switch.

Before the power switch push-button is depressed, the input to the low voltage supply is open. The high voltage supply is isolated via input relay K700 and triac Q701 (which is in parallel with K700).

Several things occur immediately at turn-on. First, the low voltage supply powers up and produces its main unregulated  $\pm 24$ VDC and regulated  $\pm 15$ VDC. It also immediately produces pulsed DC via full-wave rectifier D709/D714.

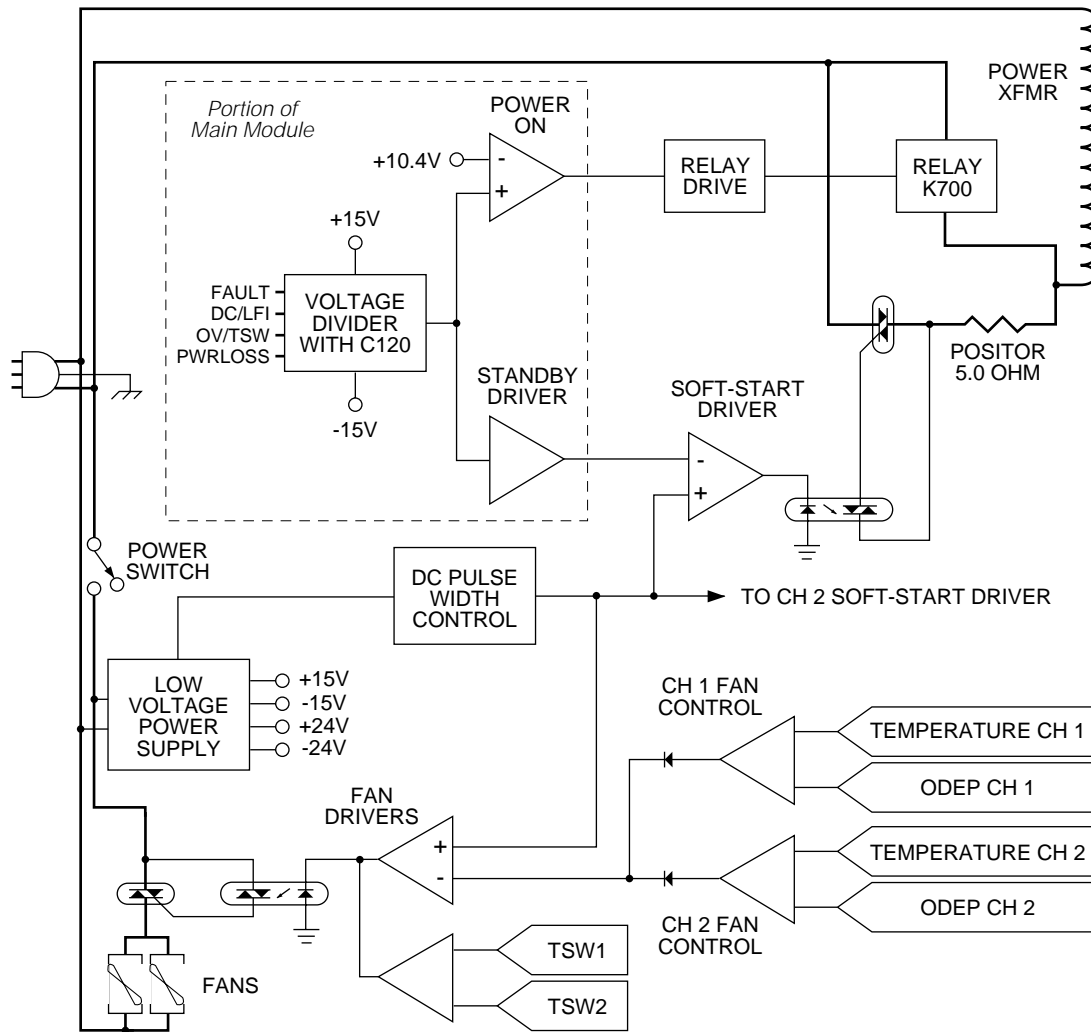


Figure 4.6 Soft-start and Fan Control

As this occurs, all op-amps in the amplifier receive power, including front-end stages, relay power control U111C, and standby control U111B. The output of U111C powers relay K700 via relay drive transistor Q700. When the output of this op-amp goes high, Q700 turns on and the relay closes. The output of U111C is held low until the amplifier delay times out by comparing a high voltage on its inverting input to an RC network voltage on its non-inverting input. R329 and R330 fix a window at about +10.4VDC. At turn-on, C220 (a 10  $\mu$ F cap) is fully discharged. In that first instant, it keeps -15V on the non-inverting input of U111C, keeping its output low. As the capacitor charges it produces a ramped rise in voltage as it charges through R327. After about 4 seconds, the voltage between R327 and R328 exceeds the window voltage and U111C output goes high, in turn causing relay K700 to close.

Note: Any protection signal within the amplifier which is used to shut it down will discharge this capacitor (C120), immediately causing the relay (K700) to open. Upon clearance of such a shut-down protection signal, the charge will begin again with the same ramp effect and same delay.

The ramped voltage on the capacitor C120 is also sensed by Standby amplifier U111B. Its unity gain output is non-inverting. It drives the Soft-start op-amp (U701A) inverting input with its ramp to control the rate at which the field develops in the toroid. On the non-inverting input to U701A is the pulsed DC drive from the U701B/Q708 pulse circuit. Jumper JP1 may be set to 50 or 60 Hz, but must be set properly to have the correct pulse width for soft-start. Pulse width is determined by C717 and either R777 (50 Hz) or R777 in parallel with R806 (60 Hz).



The output of U701A controls the Soft-start. Refer to Figure 4.6 for a graphic of Soft-start operation.

When the output of U701A goes low, the opto-triac device U700 turns on. While on, the input triac Q700 conducts. Posistor R702 limits peak input current to the toroid to a maximum of 22A peak (with 120VAC mains). U701A combines the sloped input from the C120 circuitry on the main module with the pulsed DC. As the portion of time which the output of U701A goes low increases, the amount of time where AC mains conduct to the transformer (via Q700 and R702) increases until it remains on. When the U111C PWR circuit times out, the relay closes, bypassing the current limiting soft-start circuit. Soft-start control signals are shown in Figure 4.7. The upper signal is that produced by C120. At time 0 the amplifier is off. At time 1 the power switch is pressed (on). At time 2 C120 has fully charged, the magnetic

fields have built up in the high voltage supply, and the main relay closes. At time 3 a protective action occurs; note that the DC supply remains. At time 4 the condition clears and the restart begins. Time 5 is akin to time 2, and time 6 is another protective action. The lower graph shows Q701 operation (high = on).

Any time a protection mechanism has acted and the condition then clears, this entire process repeats.

#### 4.6.2 Over-voltage

One mode of amplifier protection is a shutdown in the event of over-voltage on the AC mains. This is sensed by the pulsed DC signal produced by the full-wave rectifier in the low voltage supply.

R780 picks off the pulsed DC, and U707D will, if the voltage is too high, shift its output to a low. When this happens, the over-volt/therm red LED on the control module lights and signal OV1 goes low to the main module.

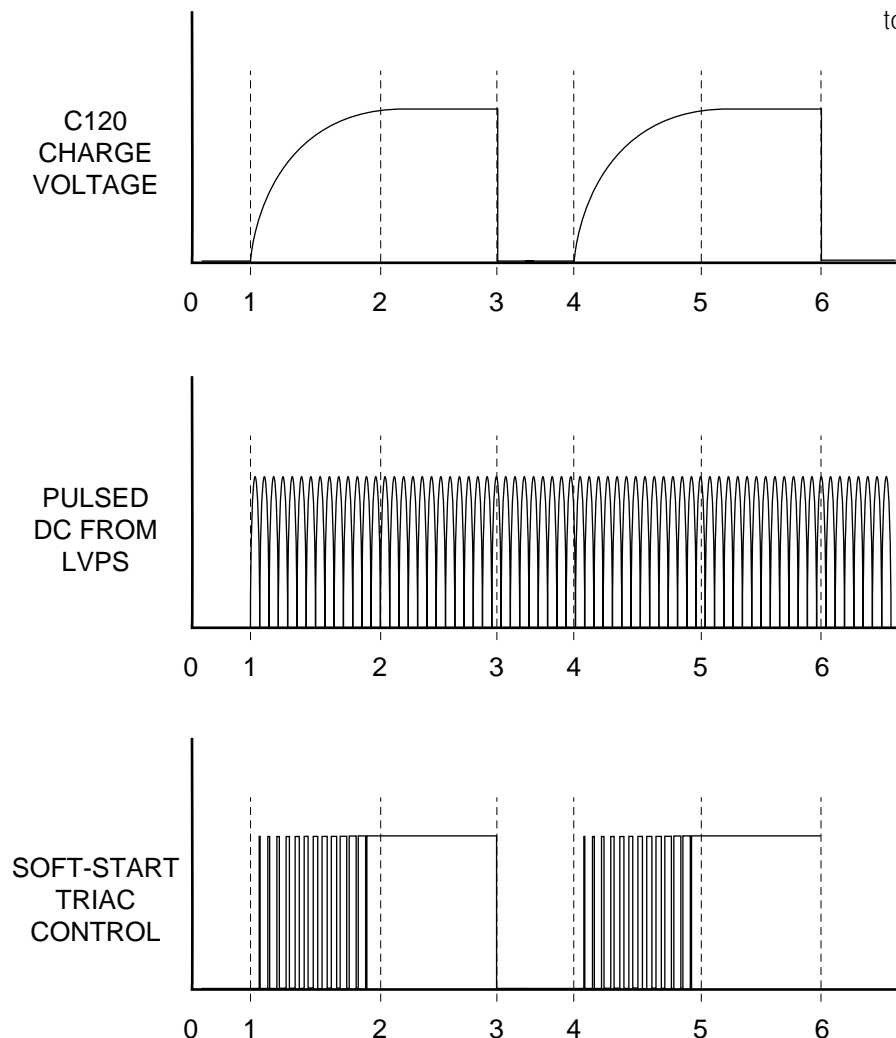


Figure 4.7 Soft-start Signal

A low (over-voltage condition) on OV1 causes U211C to shift to a low output. This low, through D1, causes C120 to discharge immediately. This in turn causes the main relay to drop out, soft-start to reset, and the  $\pm$ LL and  $\pm$ LH to clamp audio drive. Over-voltage is a non-latching fault condition.

#### 4.6.3 DC/LF

The amplifier senses its own output for DC or very low frequency and will interrupt the amplifier channel in the event of DC or low frequency.

The feedback loop is sensed for voltage and the current sense signal provides current information. An RC network at the input to U109C/D will prevent the LF circuit from activating with normal audio frequency material, and will ensure activation with high level subsonic currents or voltages.

If U109C/D sense a DC (or LF) level, it will output a low, which will, through D102, discharge C120 and initiate power supply

shutdown. A low will also cause the DC/LF red LED on the main module to light. DC/LF is a non-latching protection mechanism.

#### 4.6.4 Common Mode Output Current

Common mode current in the output stage can only be due to an output stage failure or full power output of RF energy. Common mode current occurs when a high current level exists in both the positive and the negative halves of the output stage.

U115 is a specialty device. It serves as both an Opto-SCR, and as a conventional SCR. It must have both an optic gate and conventional gate firing at the same time in order to latch. The conventional gate is fired by current sense of the output stage Low-side. The optic gate is fired by the High-side current sense. If high currents exist in both sides simultaneously, the SCR will latch on, and remain on until the unit is turned off.

When the SCR latches, low voltage causes the red LED (labeled Output Module) to light, and places a low on the FAULT signal line. A low on the FAULT line is sensed, via D112, by C120. Once again, a low here discharges C120 and shuts down the amplifier. FAULT is a latching protection mechanism (the only one in the amplifier).

#### 4.6.5 Output Thermal

Output over-temperature protection has been covered, to a degree, in Section 4.4.2, ODEP Circuitry. The calibrated temperature sense from the positive half of the output stage drives an over-temperature amp, U117A. If heatsink temperature exceeds a limit of about 130°C, the amplifier will go into hard ODEP. This does not shut down the amplifier, but does clamp the audio. Refer to Section 4.4.2.

#### 4.6.6 Transformer Thermal

The main power transformers have built-in thermal switches which open in the event of transformer over-temperature. In the event that the thermal switch opens in the channel 1 toroid, Q709 turns on, causing U707D to go low. When it does, the over-voltage/thermal switch LED on the control module is energized and the OV1 signal is tripped; the fans are also forced to high speed. Transformer thermal protection is self-resetting. This

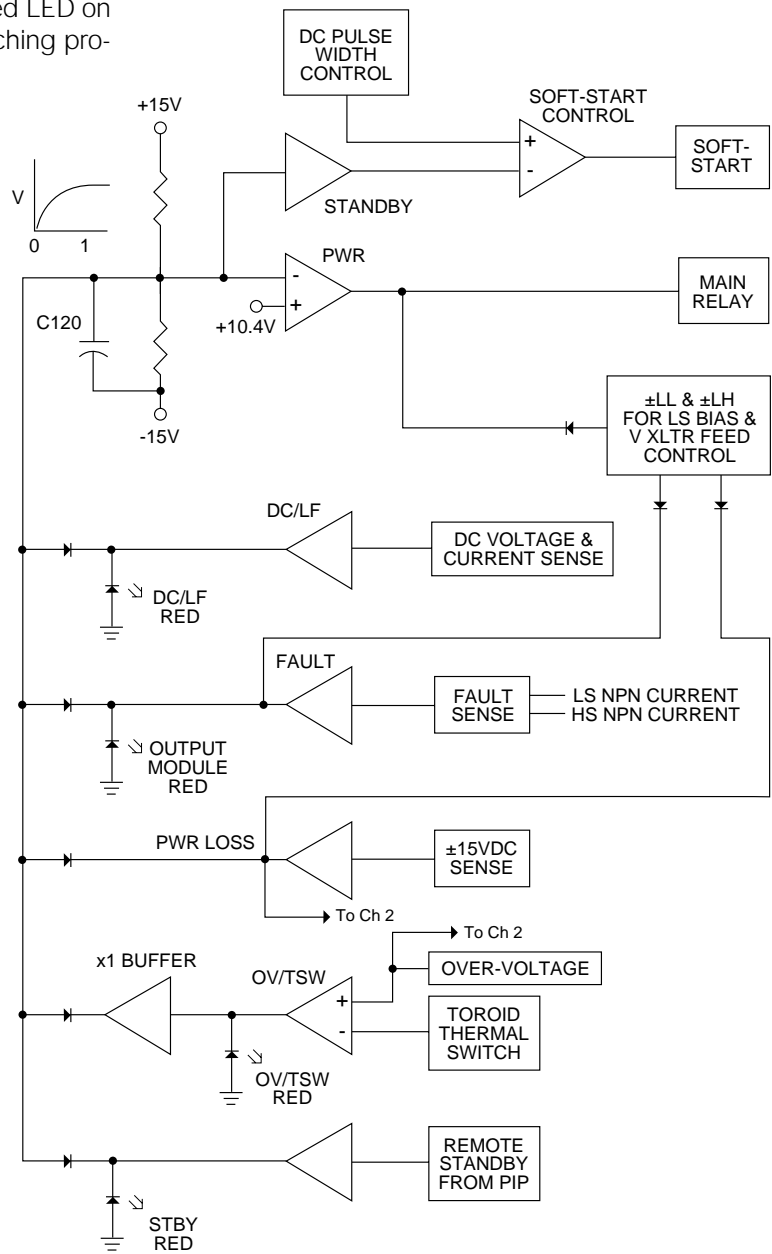


Figure 4.8 Over-all Protection Scheme

results in amplifier shutdown by way of shared over-voltage circuitry. Refer to Section 4.6.2.

#### 4.6.7 FET Thermal

A special circuit has been designed into the MA-5002VZ to protect the MOSFET switches in the VZ supply. The voltage drop across the FETs (while conducting) is proportional to device temperature. Control circuitry senses the voltage and, if necessary, the supply will be forced into low voltage (high current) mode to allow the FET devices to cool.

#### 4.6.8 Power Loss

The MA-5002VZ has the ability to sense a “brown-out” condition on the AC service. This is accomplished by sensing the low-voltage power supply at U111A. Local capacitors on the  $\pm 15\text{VDC}$  keep this chip powered for a short time after the low voltage supply drops out on power-down/loss.

An RC network, consisting of C1 and R6, will cause the output of U111A to shift low the instant low voltage is lost. This negative potential discharges C120 causing immediate opening of the main relay, and reset of the Soft-start circuitry. It is essential that C120 be discharged immediately in the event that power is restored before C120 would otherwise discharge. The power-loss circuit is common to both channels. Its output goes to  $\pm\text{LL}$  and  $\pm\text{LH}$  to immediately mute audio upon power-down or power-loss, thus preventing turn-off audio noise.

#### 4.6.9 Fan Control

The MA-5002VZ, unlike other members of the Macro-Tech family, has two onboard fans. They are mounted to the chassis divider assembly and pull cool air from the front and discharge it across the output stage heatsinks to the rear of the amplifier. Also unlike the other Macro-Techs, the fans are fully ODEP proportional (they operate in proportion to output stage temperature and calibrated ODEP control voltage).

U713B combines channel 1 temperature and ODEP level, U713A for channel 2. D706 and D707 form a diode OR gate. The output of the OR gate drives one input to U707B. The other input to U707B is from the DC pulse width control circuit (U701B). U707B operates in a fashion similar to that of U707A, the Soft-start control amplifier. A graphic example of the fan control waveforms would look a good deal like those in Figure 4.7, except that the thermal drive would be unique from that of the Soft-start ramp.

The fans will also be forced to operate at full speed in the event a toroid transformer thermal switch trips open.

### 4.7 Display

Amplifier front panel indication includes a total of 7 LEDs. These include Enable, ODEP, SPI/IOC, and  $I_{\text{LOAD}}/I_{\text{LIMIT}}$ .

The Enable indicator is an amber light which indicates presence of the low voltage supply. It is powered by the unregulated  $+24\text{VDC}$  supply. It will be on any time the power switch is depressed (unless the low voltage fuse blows).

ODEP indicators provide an on-line indication of ampli-

fier thermal reserve. The LEDs are amber (although they may have a reddish appearance) and are normally on. They dim and/or extinguish in the event that the amplifier's thermal reserve is exhausted. ODEP indicators will also extinguish whenever the main supply relays are open (such as a protection action being activated, or during Soft-start time-out).

Green SPI/IOC LEDs show signal presence (SPI) and any form of distortion (IOC). They flash dimly with the audio to show signal. In the event of an IOC condition (output waveform differs from input by  $>0.05\%$ , or input overload) the light will be on brightly. An occasional flash of IOC usually indicates clipping. If the IOC light locks in, it usually indicates a protective action, or “hard” ODEP limiting.

$I_{\text{LOAD}}/I_{\text{LIMIT}}$  LEDs flash green with the audio when program material is being delivered to a load. Its function is similar to that of the SPI, except that SPI is voltage driven and does not require a load.  $I_{\text{LOAD}}$  comes on when the amplifier is loaded, and its brightness is in proportion to the output current. This is the  $I_{\text{LOAD}}$  function. In the event of current limiting action, the light will flash to red. This is the  $I_{\text{LIMIT}}$  function.

### 4.8 Mono Modes

The MA-5002VZ has three main operating modes, namely dual (stereo), bridge mono, and parallel mono.

There are a number of precautions which should be taken when operating the amplifier in either of the mono modes. The VZ mode switches for each channel must be set to the same setting. Sensitivity, LOI, and Compressor switches for channel 2 make no difference. The input must be to channel 1 only. The input to channel 2 and controls for channel 2 are NOT defeated in either mono mode, therefore no connection to channel 2 may be made in either of the mono modes. The channel 2 level control should be turned down (counterclockwise) fully in either mono mode.

Monaural amplifier operating modes are covered in detail in the MA-5002VZ Reference Manual. The discussion below primarily aids in understanding how the mono modes work for testing purposes.

#### 4.8.1 Bridge Mono

Bridge mono is intended for loads of 4 ohms or greater. The feedback loop for channel 1 also drives the input to channel 2 in this mono mode. The input to channel 2 is, however, inverted. This causes the output of channel 2 to be of equal magnitude and opposite polarity (for double voltage output). The output of the amplifier

is balanced, and channel 1 hot output is connected to load hot (+), channel 2 hot output is connected to load return (-).

### 4.8.2 Parallel Mono

Parallel mono is intended for loads less than 4 ohms (as low as 1 ohm) in a monaural amplifier configuration.

The channel 1 and 2 amplifier hot outputs must be shorted by an external shorting buss (10 AWG or larger). The amplifier output to the load(s) is taken from either channel's hot output to load hot, and either channel's negative output to the load return (-). The shorting buss must be removed prior to changing from parallel mono to either other mode.

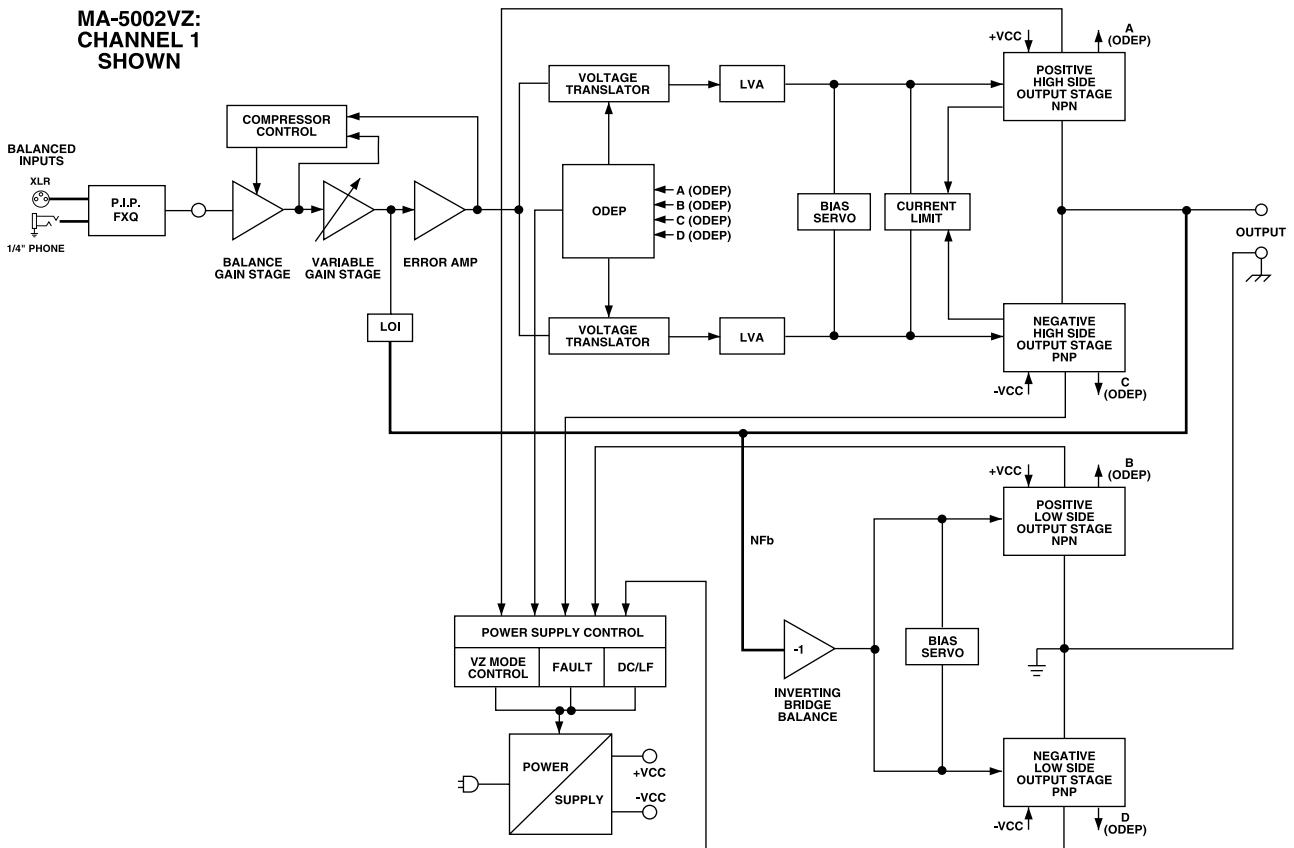


Figure 4.9 Macro-Tech 5002VZ Amplifier Block Diagram

## 5 Maintenance

### 5.1 Cautions and Warnings



**DANGER:** The outputs of this amplifier can produce LETHAL energy levels! Be very careful when making connections. Do not attempt to change output wiring until the amplifier has been off at least 10 seconds.

**WARNING:** This unit is capable of producing high sound pressure levels. Continued exposure to high sound pressure levels can cause permanent hearing impairment or loss. User caution is advised and ear protection is recommended when using at high levels.



**WARNING:** Do not expose this unit to rain or moisture.

**WARNING:** Only properly trained and qualified technicians should attempt to service this unit. There are no user serviceable parts inside.

**WARNING:** When performing service checks with the power off, discharge the main power supply filter capacitors fully before taking any measurements or touching any electrical components. A 300-ohm 10-W resistor is recommended for this. Hold the resistor with pliers, as the resistor may become extremely hot.



**WARNING:** Under load, with a sine wave signal at full power into both channels, the amplifier may draw in excess of 30 amperes from the AC service mains.

**WARNING:** Do not change the position of the Mode Switch when the amplifier is turned on. If the position of this switch is changed while the amplifier is powered, transients may damage your speakers.



**WARNING:** Heatsinks are not at ground potential. Simultaneously touching either heatsink and ground, or both heatsinks will cause electrical shock.

**CAUTION:** Eye protection should be worn at all times when protective covers are removed and the amplifier is plugged in.



**CAUTION:** Disconnect the power cord before installing or removing any cover or panel.

### 5.2 General Information

In most cases you will be using the test procedures in Section 5.4 after conducting your repairs. Before initially powering up the amplifier you should review Section 5.1 and take appropriate steps for personal and equipment safety. Section 5.3 will help to determine whether the amplifier should be safe to turn on. This section also includes some additional checks that should be made prior to starting the actual check-out. Italicized print in the test procedures (Section 5.4) includes basic troubleshooting hints to augment procedures in Section 5.3. These hints do not cover every possibility, but should be helpful for a variety of symp-

toms. After troubleshooting and repair (or as a part of), the final step is to thoroughly test the amplifier to be certain that it meets the factory specifications. Test procedures in Section 5.4 will help you do this as well as aid you in locating the cause of problem(s).

### 5.3 Troubleshooting

#### 5.3.1 Pre-AC-Checks

A number of checks can be made prior to powering up the unit. These should be done in order to prevent an unwanted disaster when turning the unit on. Once these checks are made power may be applied for further checks. Note: It will be necessary to remove top, rear, and bottom panels for complete access to all modules.

**Step 1:** Acquire all information possible from the person(s) having the problem to determine the nature of the complaint. Ask questions like "Why was the amplifier brought in for repair?" "Does it do this right at turn on, does it take a while, or does it only happen sometimes?" If you observe nothing wrong, inquire tactfully how the unit was being used when the malfunction occurred to determine if it may have been misused, if the user misunderstood what happened, or if another system component may be at fault.

**Step 2:** Always do a complete visual inspection. A problem may be obvious just by looking. Things to look for include burned components, wires not connected, fan obstructions, loose hardware or connections, and soldering. Dirty air filters or plugged heatsinks greatly reduce amplifier efficiency and result in pre-mature ODEP limiting. The fan blades should spin freely. Burns and other physical damage should be repaired and components in the affected circuit areas should be checked carefully before continuing.

Whether a problem is identified by visual inspection or not, several checks should be performed prior to turning the amplifier on. These should be performed if catastrophic failure has been reported, no signal output with constant IOC is reported, or the condition of the amplifier is otherwise unknown but failure is suspected.

Channel 1 uses 100/300 series numbering and channel 2 uses 200/400 series numbering on the main module. 500 series numbering is used on the output and emitter modules, regardless of the channel. 700 and 800 series numbers are used on control, current sense, and terminator modules.

The third item on the "to do" list involves a number of electrical checks. Due to the protection features of the MA-5002VZ, it should be safe to turn-on under all circumstances, but these preliminary checks may allow a

partial, if not complete, repair before power is ever applied. These checks are designed to find problems in the output stages. The ultimate guide should always be common sense.

To access all of the modules, simply remove the top cover, rear panel, and bottom cover. The main module will slide up and back for access to output module components by loosening four screws. The main module tray need not be removed in order to remove an output assembly, however, to perform component replacement on the main module the tray should be removed completely and the module removed from the tray. Note that the current sense module is actually comprised of two separate boards, connected by dual ribbon cables, hardwired at both ends. The smaller board is called current sense, the larger is, by itself, referred to as the terminator. Either name, however, may be applied to the pair. In Section 8 they are covered as a single part, D 7994-3.

a.) Locate the flyback diodes D506, D507, D508, and D509 on the emitter modules and check for indications of a short. If a short is indicated, this means that an output device or driver transistor in parallel with that diode is shorted, usually not the diode itself. If a faulty output device is found, the entire output assembly may be replaced, or only the affected components. If an output device is found to be defective, emitter resistors should also be checked. If no output device is found defective, perform a quick check of driver, pre-driver, and bias transistors. Then, if no problem is found, move to power-on checks.

b.) Check driver and pre-driver transistors for shorts or opens. If a fault is found, do an in-circuit static check of all semiconductors on the output modules. If no output device and nothing upstream is found defective, move to power-on checks. Otherwise continue.

c.) If a failure has occurred anywhere in the output stages, check bias servo transistors on each (positive and negative) output module. Any failure associated with bias transistors may result in repeat failure of the affected channel even if all other defective components have been found and replaced.

d.) If a failure is found in any LVAs, checks should continue up onto the main module in the voltage translator stage.

e.) Failure within the power supply itself is very rare, however a cursory check of major items is always prudent. A 30A fuse should not blow unless a catastrophic failure has occurred in the output stage or power supply. The low voltage fuse should not blow unless a failure has occurred, probably in the supply itself. If a failure has occurred in the output stages, check the MOSFET switches and other VZ control components, such as bridge rectifiers.

### 5.3.2 LED Checks

When power-off checks are complete and any defects found are corrected during that phase, the next step is to apply power. The MA-5002VZ includes several LED indicators to assist you in troubleshooting an amplifier malfunction.

All indicators on the amplifier, both front panel and internal, are important. External indicators include Enable, ODEP, SPI/IOC, and I<sub>LOAD</sub>/I<sub>LIMIT</sub>. Internal indicators include DC/LF, Fault (output module), Standby, and Over-voltage/Transformer Thermal.

A chart on the following pages lists likely LED combinations and likely causes. In each case it is assumed that the LED circuit itself is operating properly. If a failure is suspected, compare amplifier indicators with the chart.

In order to ensure that the problems are assessed correctly, perform the LED checks under the following conditions: Before power is applied, ensure that the Stereo/Mono switch is in the STEREO position. Do NOT connect any signal source or load to the amplifier. Turn the amplifier on. After approximately 4 seconds the turn-on delay should time out. During the delay, IOC indicators will usually be on and ODEP indicators should be off. After the delay times out, relays click on, IOC indication should go off, and ODEP indicators should come on. If this does not occur, definitely refer to the chart that follows. Although this chart contains most likely failures, it does not cover every possibility. Common sense and a study of schematics and circuit theory (provided in Section 4) should ultimately lead to a proper repair.

<b>Indicator</b>	<b>Condition</b>	<b>Cause</b>
ODEP SPI/IOC I <sub>LOAD</sub> /I <sub>LIMIT</sub> STBY OV/THERM DC/LF OUTPUT MOD	One OFF Both OFF Both OFF Both OFF Both OFF Both OFF Both OFF	At any time the main relay is off (open), the ODEP indicator is also held off. Any protective action which will result in amplifier shut-down will cause the ODEP indicator on the affected channel to be off. The ODEP indicator will also be off when the amplifier is into "full ODEP" limiting. Under the initial conditions described, the conditions in the left column will only occur when there is a failure in one relay or relay control circuit, in the ODEP circuit itself, or in a thermal sensor for the ODEP circuit.
ODEP SPI/IOC I <sub>LOAD</sub> /I <sub>LIMIT</sub> STBY OV/THERM DC/LF OUTPUT MOD	One OFF Both OFF Both OFF One/Both ON Both OFF Both OFF Both OFF	An ODEP indicator off coupled with one or both internal STBY indicators lit is most often caused by low line voltage. It may also be caused by placing a logical low on a RS (remote standby function) connection to the PIP module. First, verify AC mains voltage and check the amplifier to ensure it is wired for the appropriate AC mains. The RS port from the PIP module is not likely to be at fault, but if an IQ-PIP is installed, it may be necessary to replace it with a blank module (such as the PIP2-FXQ) for testing purposes.
ODEP SPI/IOC I <sub>LOAD</sub> /I <sub>LIMIT</sub> STBY OV/THERM DC/LF OUTPUT MOD	Both OFF Both OFF Both OFF Both OFF Both ON Both OFF Both OFF	Both ODEP indicators off coupled with both internal OV/THERM indicators lit is most often caused by high line voltage (>10% above what the amplifier is wired for). It is extremely unlikely that the thermal switches in both amplifier channels will be activated. First, verify AC mains voltage and check the amplifier to ensure it is wired for the appropriate AC mains. If fans are running at full speed, a transformer thermal condition is probably being stimulated by a failed IC such as U707.
ODEP SPI/IOC I <sub>LOAD</sub> /I <sub>LIMIT</sub> STBY OV/THERM DC/LF OUTPUT MOD	One OFF Both OFF Both OFF Both OFF One ON Both OFF Both OFF	One ODEP indicator off coupled with one internal OV/THERM indicator lit will result from an open thermal switch in the toroid of the affected channel. Except for very early units with control module Q42930-0, fans should both be operating at high speed. If they are, a thermal switch is in fact open. If fans are off or nearly off (and control module is Q43096-9 or later), the problem is more likely a failed Q709 (Ch 1) or Q707 (Ch 2).
ODEP SPI/IOC I <sub>LOAD</sub> /I <sub>LIMIT</sub> STBY OV/THERM DC/LF OUTPUT MOD	One OFF One ON Both OFF Both OFF Both OFF One ON Both OFF	One ODEP indicator off coupled with IOC and DC/LF indications indicates a DC offset at the amplifier's output. The amplifier may attempt to cycle if a small offset is being caused by a malfunction. This may not be the direct result of an output device failure. It may rather be caused by a grossly maladjusted or faulty balance control within the amplifier. It may also be caused by any number of minor components failing in an unexpected manner. It could also be the result of an unbalanced ODEP circuit ( $\pm$ ODEP bias potentials unequal). If the DC/LF indication remains locked in, the OUTPUT MOD Fault circuit may be activated, but on occasion the DC/LF circuit will trigger faster causing this indication. Observe the output with a scope to determine if cycling action is in fact occurring.

Indicator	Condition	Cause
ODEP SPI/IOC ILOAD/ILIMIT STBY OV/THERM DC/LF OUTPUT MOD	Both OFF Both ON Both OFF Both OFF Both OFF Both ON Both OFF	Both ODEP indicators off coupled with both IOC and DC/LF indications indicates a DC offset at both outputs. If possible, inquire if the user was operating the amplifier in a mono mode when the failure occurred. If so, then it is likely that output stage damage has occurred in both channels. If not, two unique problems may have occurred, or there may be an unexpected short on the terminator/current sense module. Other unexpected shorts may be possible. Mechanical integrity should be carefully checked.
ODEP SPI/IOC ILOAD/ILIMIT STBY OV/THERM DC/LF OUTPUT MOD	One OFF Either OFF/ON Either OFF/ON Both OFF Both OFF Both OFF One ON	An ODEP indicator off coupled with one internal OUTPUT MOD indicator lit may be accompanied with IOC and ILOAD/ILIMIT for the affected channel. Such a fault is latching and keeps the high voltage rails off. This type of fault is caused by conduction in both the positive and negative half of the output stage simultaneously. Under normal conditions this cannot occur at levels much above 100mW, assuming the amplifier is properly biased. A fault like this is usually the result of a failed output device, or possibly a failed bias network. It may also be caused by operating the amplifier at extremely high levels with ultra-sonics.
ODEP SPI/IOC ILOAD/ILIMIT STBY OV/THERM DC/LF OUTPUT MOD	Both OFF Both OFF Both OFF Both OFF Both OFF Both OFF Both OFF	Both ODEP indicators off with no other abnormal indication is almost impossible unless both relays fail, or the Power Loss IC (U111A) circuit has failed.

## 5.4 Test Procedures

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.



**WARNING! Most adjustments are made with the covers removed. Prior to any AC power off testing, discharge all power supply capacitors. Also, use extreme caution when making internal adjustments when the unit is powered.**

### 5.4.1 Standard Initial Conditions

The start of each step assumes all switches are pre-set to the following positions:

- Dual Mono Switch: STEREO position.
- Sensitivity Switches: Both to 0.775V position.
- Compressor Switches: Both to OFF position.
- LOI Switches: Both to OFF position.
- VZ Mode Switches: Both to VZ position.
- Level Controls: Both up (clockwise) fully.

### 5.4.2 Equipment Required

The following is a list of standard equipment needed to perform all the tests listed in Section 2.3.3:

- Line Voltage Variac: 5 kW or larger.
- Oscilloscope: 2 Channel, 10 MHz or better.
- Digital Multimeter: Various measurements.
- Watt Meter: For AC line draw.
- ACVM: Peak reading RMS calibrated (all AC line voltage and amplifier output voltage checks).
- I.M.D. Analyzer: 60 Hz/7 kHz in 4:1 ratio, accurate to 0.001% I.M.D.
- T.H.D. Analyzer: Accurate to 0.001%.
- Loads: 3000 W continuous at 1 ohm.





**WARNING: Do not connect any load to the MA-5002VZ power amplifier during these tests until specifically instructed to do so.**

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
1. Turn-on Delay	No Signal No Load	Check for a delay of approximately 4 seconds from the time the power push button is pressed until the IOC indication clears and ODEP indicators come on. <i>If the IOC fails to clear in one channel, check for presence of rail voltages and for a DC offset. Also check circuit board LED for indication of a fault - DC/LF, Output Module, and OV/TSW. Turn unit off, disconnect the power cord, discharge power supplies, and check for a failure in the output stage of the affected channel, or other applicable circuit area. If the fans lock in high speed after delay times out, check fan control components, ODEP output, and LM334Z devices on the output modules.</i>
2. DC Output Offset	No Signal No Load	With the input level controls turned fully clockwise, the DC offset for both channels should be less than $\pm 15$ millivolts. <i>Note: There are no output offset adjustments for the MA-5002VZ. A small DC offset may indicate an ODEP failure. A large DC offset usually indicates a failure in the output stage, though such an offset should have shut down the amplifier on a DC/LFI signal.</i>
3. Quiescent Power	No Signal No Load	While there is no published specification on quiescent power, it should be checked. A power draw with the fans off or operating slowly will normally be less than 150 W ( $< 1.5$ A). <i>If quiescent power greatly exceeds expectation then turn the amplifier off immediately and search for power supply or output failure. If quiescent draw exceeds expectation by a "small" amount check bias immediately.</i>
4. High Side Bias	No Signal No Load	Bias voltage is set while the amplifier is at room temperature. If the amplifier is hot from prior testing for repair or other purposes, it should be set aside until it has cooled before continuing with this check. Bias, once factory set, normally will not require adjustment. For channel 1: Measure the voltage at TP1 pin 2 with respect to pin 4 (DO NOT measure from ground reference). The bias voltage should equal $.330\text{VDC} \pm 10$ millivolts. If the bias voltage needs to be adjusted, adjust R505 on the channel 1 output assembly for the correct bias voltage. For channel 2: Measure the voltage at TP2 pin 2 with respect to pin 4 (DO NOT measure from ground reference). The bias voltage should equal $.330\text{VDC} \pm 10$ millivolts. If the bias voltage needs to be adjusted, adjust R505 on the channel 2 output assembly for the correct bias voltage.

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
5. Low Side Bias	No Signal No Load	Bias voltage is set while the amplifier is at room temperature. If the amplifier is hot from prior testing for repair or other purposes, it should be set aside until it has cooled before continuing with this check. Bias, once factory set, normally will not require adjustment. For channel 1: Measure the voltage at TP1 pin 15 with respect to pin 13 (DO NOT measure from ground reference). The bias voltage should equal .330VDC ± 10 millivolts. If the bias voltage needs to be adjusted, adjust R556 on the channel 1 output assembly for the correct bias voltage. For channel 2: Measure the voltage at TP2 pin 15 with respect to pin 13 (DO NOT measure from ground reference). The bias voltage should equal .330VDC ± 10 millivolts. If the bias voltage needs to be adjusted, adjust R556 on the channel 2 output assembly for the correct bias voltage.
6. O.D.E.P Null	No Signal No Load	ODEP Nulls are based on heatsink temperatures. A reference voltage is supplied at TP1/TP2 which is proportional to the heatsink temperature. For positive ODEP: Measure TP1/TP2 pin 18 with respect to ground. Refer to the chart (Figure 5.1) below. If measured voltage falls outside the listed range, the amplifier is too hot or too cold. Now measure TP1/TP2 pin 11 and adjust, if necessary, R182/R282 for the set voltage on the chart, ±0.1 V. For negative ODEP: Measure TP1/TP2 pin 17 with respect to ground. Refer to the chart (Figure 5.1) below. If measured voltage falls outside the listed range, the amplifier is too hot or too cold. Now measure TP1/TP2 pin 9 and adjust, if necessary, R191/R291 for the set voltage on the chart, ±0.1 V. Note that the negative ODEP set voltage is a negative voltage with respect to ground.

Voltage Measured	ODEP Set Voltage	Voltage Measured	ODEP Set Voltage
2.90 V	12.96 V	3.00 V	11.76 V
2.91 V	12.64 V	3.01 V	11.64 V
2.92 V	12.72 V	3.02 V	11.52 V
2.93 V	12.60 V	3.03 V	11.40 V
2.94 V	12.48 V	3.04 V	11.28 V
2.95 V	12.36 V	3.05 V	11.16 V
2.96 V	12.24 V	3.06 V	11.04 V
2.97 V	12.12 V	3.07 V	10.92 V
2.98 V	12.00 V	3.08 V	10.80 V
2.99 V	11.88 V	3.09 V	10.68 V

Figure 5.1 ODEP Set Voltage Chart



**WARNING:** Many of the following checks are done by connecting a resistive load to the output of the amplifier. Use caution and follow check-out procedures carefully to ensure correct results. These tests require a resistive load capable of over 3000 W continuous into as low as 1 ohm.



**WARNING:** The MA-5002VZ is capable of drawing in excess of 80 Amperes of current from 120VAC Mains when loaded to 2 ohms per channel and with both channels driven by a 1 kHz sine wave.



**CAUTION:** 30 A fuses should be replaced after completion of tests, as they will be stressed during high power tests. Special 30 A test fuses may be used during testing if they are replaced with the stock fuses after the tests. 30 A fuse part number is A10285-30.

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
7. CMR Null	0.775V (0 dBu), 1-kHz Sq. Wave No Load	With the sensitivity switch in the high gain position (0.775V), insert a common mode 1-kHz 0 dBu square wave into channel 1 (phono tip & ring shorted or XLR pins 2 and 3 shorted). At the output jacks measure less than 25 mV. If necessary adjust R105. Repeat test for channel 2, adjust R205 if necessary. This adjustment is easiest when done with an oscilloscope at the output and adjusting the square wave for a flat line. (Set scope for high vertical sensitivity.)
8. Sensitivity (Gain)	1-kHz Sine Wave No Load	Set the sensitivity switches to the 26-dB position, check both level controls full clockwise. Insert a .775V 1-kHz sine wave and measure 14.8V-16.1V at the output of each channel. Set sensitivity to the 0.775V position and measure 95V-104V at the output of each channel. Set the sensitivity switches to 1.4V position and measure 51.8V-57.2V at the output of each channel.
9. Bridge Mono	1kHz Sine Wave No Load	<i>Note: Always turn power to the amplifier off prior to changing the position of the Stereo/Mono Switch.</i> With the dual/mono switch in the bridge mono position, set the channel two input level control to full CCW. Insert a .775 Vrms 1-kHz signal into channel one input. There should be signal present on both channel outputs, equal in amplitude, with channel two 180 degrees out of polarity from channel one (see Figure 5.2). Channel one input level control should control the output level for both channels. Return the amplifier to stereo operation.

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
10. Parallel Mono	1-kHz Sine Wave No Load	<i>Note: Always turn power to the amplifier off prior to changing the position of the Stereo/Mono Switch.</i> With the dual/mono switch in the parallel mono position, insert a .775 Vrms 1-kHz signal into channel one. There should be two signals with the same polarity present, equal in amplitude, at the outputs of channels one and two. Both of these signals will be controlled by the channel one input level control. Switch the stereo/mono switch to stereo. There should be signal present only on the channel one output.
11. Current Sense Balance	No Signal No Load	Place the Stereo/Mono switch in the PARALLEL MONO position. Measure VDC of the channel 1 + output with respect to the channel 2 + output. Verify null of less than $\pm 10$ mVDC. If necessary adjust null via R2 current sense balance pot on the Main Module.
12. Static Balance	No Signal No Load	Place the VZ Mode switches in the VZ-ODEP position (see Figure 5.4). Measure $\pm VCC$ with respect to ground for channel 1 (P852 & P851 on Control board). Values should be of equal magnitude and opposite polarity. If magnitudes vary by more than 500mV, adjust static balance pot R568 on the output module for null (no difference in magnitude). Switch to VZ (AUTO) position and verify null is maintained. Re-adjust only if necessary. Repeat check for channel 2 (P854 & P853 on Control board), adjust R568 if necessary.
13. Dynamic Balance	1-kHz Sine Wave No Load	With no load on the amplifier, increase the input to achieve 125.0 Vrms, $\pm .3$ Vrms, at the output of the channel under test. Measure TP1/TP2 pin 16 and adjust R566 on the output module for 3.500 Vrms, $\pm .200$ Vrms.

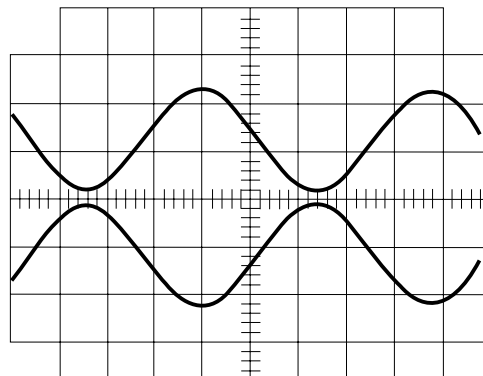


Figure 5.2 Bridge MONO

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
14. Over-voltage	No Signal No Load	With the amplifier powered from a variac, increase AC mains line voltage to 12% above the line voltage for which the amplifier is wired. The amplifier should trip off at 10.5% to 11% above the line voltage for which it is wired. If it does not, then set line voltage to 10.5% high and slowly adjust R780 on the control module until the amplifier trips into protect mode. If adjustment is performed, retest new adjustment.
15. LOI	Sine Wave 8-ohm Load	Place sensitivity switches in 26 dB position; check or place LOI (EPS) switches to OFF (BYPASS) position. Insert a 1-kHz sine wave and adjust for 2.8 Vrms (1 W) output into 8 ohms. Adjust to 30 Hz then to 20 Hz, level should remain constant. Switch LOI (EPS) to ON (ENABLE). Check output at 30 Hz at -2 dB $\pm$ 0.1 dB. Adjust frequency to 20 Hz and measure output level at -11 dB $\pm$ 0.1 dB. Return LOI/ESP and sensitivity switches to initial condition (Section 5.4.1).
16. Compressor	1-kHz Sine Wave 8-ohm Load	With each channel loaded to 8 ohms, insert a 1-kHz sine wave and increase level until the amplifier is well into clip. Place the compressor switches in SLOW position and check for non-clipped output. Move switches to FAST position and again verify non-clipped output. Return switches to OFF position.
17. Parallel Balance	1-kHz Sine Wave 8-ohm Load	Place the Stereo/Mono switch in the PARALLEL MONO position. Load each channel to 8 ohms separately, (loads must be precisely equal) and insert a 1 kHz sine wave. Adjust for 60 Vrms output. Measure VAC of the channel 1 + output with respect to the channel 2 + output. Verify null of less than 100 mVrms with signal applied. If necessary adjust null via R4 parallel balance pot on the Main Module. Make sure the Stereo/Mono switch is returned to STEREO upon test completion.
18. Current Sense Cal.	1-kHz Sine Wave 1-ohm Load	Factory set adjustment normally will not require recalibration. Perform this check as a verification, adjust only if the measurement is out of tolerance. With channel 1 loaded to 1 ohm, insert a 1 kHz sine wave and adjust for an output of 10.00 Vrms, $\pm$ 20 mV. Measure TP1 pin 1 with respect to ground. Value should be 2.00 Vrms $\pm$ 10 mV. If necessary adjust V/A cal pot R759 on the current sense module. Repeat test for channel 2 measuring TP2 pin 1; adjust R859 if necessary.

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
19. LED Check, Current Limit Check	1-kHz Sine/Sq Wave Various Loads	Turn the amplifier on after being off at least 10 seconds. Observe that the ODEP lights come on after about 4 seconds. The SPI/IOC lights should go off (if on during delay) at this time. Input a 1-kHz 2 Vrms sine wave into each channel and observe that the SPI/IOC lights are on bright. Turn down the input level to about 0.5 Vrms and observe that the SPI/IOC lights remain on, but dimly. Remove the input signal and load the amplifier to 8 ohms/Ch. Insert the 0.5 Vrms signal again and note that the I <sub>LOAD</sub> /I <sub>LIMIT</sub> indicators come on green. Change the load to 1 ohm/Ch, switch to a square wave (20% Duty Cycle), and increase input level to 2 Vrms. Note that the I <sub>LOAD</sub> /I <sub>LIMIT</sub> indicators turn red. This check also constitutes the Current Limit Check.
20. 10 kHz Square Wave Slew Rate Test	10-kHz Sq. Wave 8 ohm Load	With an 8-ohm load on each channel, insert a 10-kHz square wave and adjust amplitude to produce an output 10V below clipping (see Figure 5.3). Observe a 30V/μS (or higher) slew rate. The output waveform should be stable with no ringing or over-shoot.
21. DC/LF Protect	4-Hz Sq. Wave 8-ohm Load	Insert a 5Vpp 4-Hz square wave with an 8-ohm load on the output. The protection relay should cycle.

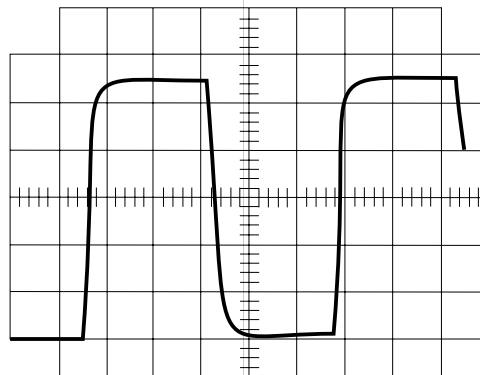


Figure 5.3 10-kHz Square Wave

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
22. 1 kHz Power + THD	1-kHz Sine Wave Various Loads	<p>Note: Operation with a sine wave into a low impedance load, when operating at AC voltages of less than 200VAC, will cause the 30 A fuses to blow after 30 to 60 seconds. 30 A Fuse = Part Number A10285-30.</p> <p><b>AC Mains of 120 VAC, 60 Hz; or 230/240 VAC, 50 Hz:</b> 8-ohm Load: Minimum voltage is 102.0 Vrms (1,300 W) with &lt;0.1% THD.</p> <p>4-ohm Load: Minimum voltage is 89.1 Vrms (1,985 W) with &lt;0.1% THD.</p> <p>2-ohm Load: Minimum voltage is 70.7 Vrms (2,500 W) with &lt;0.1% THD.</p> <p><b>AC Mains of 100-220 VAC, 50Hz:</b> 8-ohm Load: Minimum voltage is 100.0 Vrms (1,250 W) with &lt;0.1% THD.</p> <p>4-ohm Load: Minimum voltage is 86.3 Vrms (1,865 W) with &lt;0.1% THD.</p> <p>2-ohm Load: Minimum voltage is 68.9 Vrms (2,375 W) with &lt;0.1% THD.</p>
23. Functional ODEP & VZ-ODEP operation	60-Hz Sine Wave 2-ohm Load	<p>For these tests, the cooling fan blade must be stopped. To stop the fans, turn off and unplug the amplifier. Lift the fan wire connector from P729/P730 on the control module. Turn the amplifier back on and perform these tests. At the end of these tests, turn the amplifier off, unplug it, and return the fan wires to the appropriate position (P729 or P730).</p> <p>Place the VZ mode switches in the AUTO position (see Figure 5.4; remove top filter to access switches). With a 2-ohm load per channel and output voltage of 60 Vrms 60 Hz to both channels, allow the heatsinks to heat up until the ODEP protection circuit starts to limit the output signal (this should take a few minutes). A waveform like that shown in Figure 5.5 should be observed. Note: In VZ AUTO mode the flattened portion of the wave will probably not have the "clean" appearance of Figure 5.5, but should still resemble it. Check to see that the IOC LED is lit and that the ODEP LED dims and extinguishes when ODEP is activated. While ODEP limiting is taking place, switch the VZ mode switches to the VZ-ODEP position and verify that the amplifier locks into low voltage mode (the ODEP waveform should appear much more "clean").</p>

Type of Test or Adjustment	Input Signal and Load Parameters	Comments
24. Intermodulation Distortion (I.M.D.)	I.M. Signal Source 8-ohm Load	<p>Next configure the amp for parallel mono operation. With the input signal now present on channel one only, load channel one output with 8 ohms and channel two with 2 ohms. Observe that channel two ODEP protection circuit is limiting both channel one and channel two outputs. Next load channel one with 2 ohms and channel two with 8 ohms. Observe that channel one ODEP protection circuit is limiting both channel one and channel two outputs.</p> <p>Return the cooling fan blade to normal operation after these tests have been completed, and allow a few minutes for the amplifier to cool with no signal input. Return all controls to initial conditions per Section 5.4.1.</p> <p><i>Correct operation of the ODEP circuit is dependent upon correct ODEP null settings (Step 6).</i></p> <p>Place the sensitivity switches in the 26 dB position. Use a 60-Hz/7-kHz (standard SMPTE IM signal) input signal summed in a 4:1 ratio. Set the 60-Hz portion for 73.8 Vrms at the output of the channel under test. This is your 0 dB reference. Measure the I.M. distortion. Check in -5 dB (power) steps until -35 dB is reached (range is 1,065 W down to 0.34 W). Readings should be less than .05% at each level.</p>

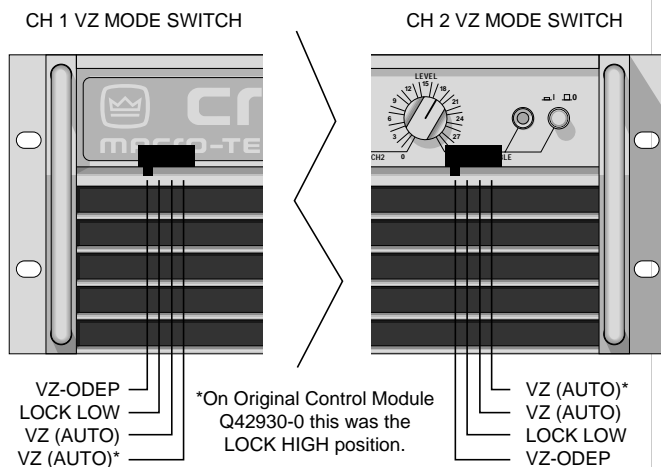


Figure 5.4 VZ Mode Switch Locations

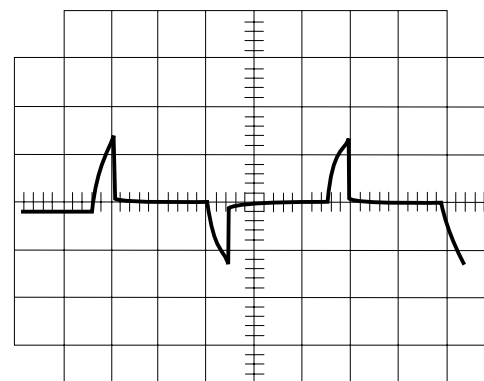


Figure 5.5 ODEP Protection



Type of Test or Adjustment	Input Signal and Load Parameters	Comments
25. Noise	No Signal No Load	Make sure the sensitivity switches are in the 26-dB position and the level controls are fully clockwise. Terminate the input with a 600-ohm load. Using a 20 Hz-20 kHz bandpass filter, measure the noise on the output of the channel under test. Noise should be less than 574 $\mu$ Vrms (105 dB down from 1300 watts into 8 ohms).
26. Crosstalk Check	20-kHz Sine Wave 8-ohm Load	<p>Make sure the sensitivity switches are set in the 26-dB position. Load each channel to 8 ohms. Insert a 20-kHz sine wave into channel 1 and adjust for 45 Vrms output. Terminate channel 2 input with 600 ohms. Measure less than 80 mVrms at the output of channel 2. (Greater than 55 dB down at 20 kHz)</p> <p>Move the input signal from channel 1 to channel 2 and the 600-ohm termination from channel 2 to channel 1. Ensure there is 45 Vrms at the output of channel 2. Measure less than 80 mVrms at the output of channel 1.</p>
27. VZ Modes	1-kHz Sine Wave 8-ohm Load	<p><i>Note: VZ-ODEP mode was checked during the ODEP test, Step 23. I.M.D. and 1-kHz power checks adequately tested the VZ (AUTO) mode. LOCK HIGH (if present) was checked adequately in the static balance adjustment check, Step 12. Place the VZ Mode Switches in LOCK LOW (see Figure 5.4). With an 8-ohm load on each channel, insert a 1-kHz sine wave into each channel. Clipping should occur at approximately 36 Vrms (410 W).</i></p>
Post-testing Procedure:		<p>At the completion of testing, replace the 30 A fuses (if testing was done at 100-120VAC), and set all switches per customer request. If none are specified by the customer, the following are standard factory settings for original shipment:</p> <p>Dual Mono Switch: STEREO position. Sensitivity Switches: Both to 1.4V position. Compressor Switches: Both to FAST position. LOI Switches: Both to ON position. VZ Mode Switches: Both to VZ-ODEP position. Level Controls: Both down (counter-clockwise) fully.</p> <p>In most applications, VZ-ODEP is the VZ Mode to use for best thermal performance.</p>

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## 6 Parts

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### 6.1 General Information

Replacement parts for this Crown amplifier can be ordered from the Crown parts department.

**PART PRICES AND AVAILABILITY ARE SUBJECT TO CHANGE WITHOUT NOTICE.**

### 6.2 Ordering and Receiving Parts

When ordering parts, be sure to give the product model, and include a description and part number from the parts listing. Price quotes are available on request.

#### 6.2.1 Terms

Normal terms are prepaid. Net-30 Days only applies to those having pre-established accounts with Crown. The Crown Parts Department does accept Visa or Master Card. If prepaying, 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 payment. New parts returned for credit are subject to a restocking fee, and authorization from the Crown Parts Department must be obtained before returning parts for credit.

#### 6.2.2 Shipment

Shipment will normally be made via UPS, or best other method unless you specify otherwise. Shipments are made to and from Elkhart, Indiana USA, 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 prepayment (check or credit card) basis.

### Crown Customer Service

Technical Support Group  
Factory Service  
Parts Department

*Mailing Address:* P.O. Box 1000, Elkhart IN 46515

*Shipping Address:* Plant 2 S. W.

1718 W. Mishawaka Rd., Elkhart IN 46517

Phone: (219) 294-8200

Toll Free: (800) 342-6939

Fax: (219) 294-8301

<http://www.crownaudio.com>

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## 7 Exploded View Parts

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### 7.1 General Information

This chapter includes a mechanical part list for this product. All serviceable parts and assemblies will have a Crown Part Number (CPN) listed in this chapter. The parts listed are current as of the date printed. Crown reserves the right to modify and improve its products for the benefit of its customers.

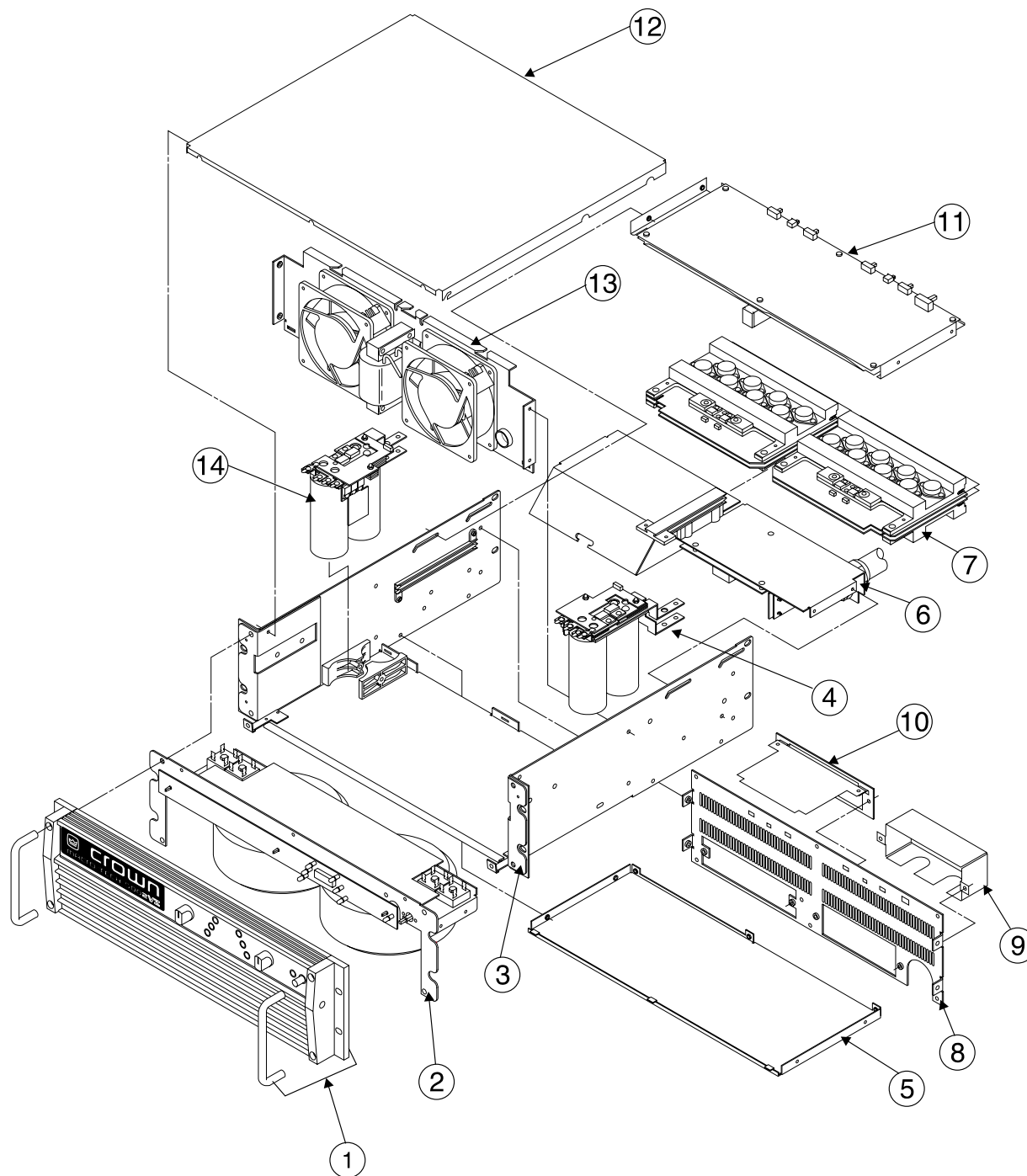


Figure 7.1 Main Chassis Exploded View

## 7.1 Main Chassis Assembly

Item #	QTY	Part Number	Description	Notes
1	1	---	Front Chassis Assembly	See Section 7.2
2	1	---	Transformer Assembly	See Section 7.6
3	1	F12701-3	Chassis	
4	1	---	Ch 1 Capacitor Assembly	See Section 7.7
5	1	F12567J7	Bottom Cover	
6	1	---	Terminator Assembly	See Section 7.9
7	1	---	Output Assembly	See Section 7.12
8	1	---	Back Panel	See Section 7.4
9	1	F12302J9	Output Cover	
10	1	102745-1	PIP2-FXQ	
11	1	---	Main Board Tray Assembly	See Section 7.11
12	1	F12176J7	Top Cover	
13	1	---	Chassis Divider Assembly	See Section 7.5
14	1	---	Ch 2 Capacitor Assembly	See Section 7.8

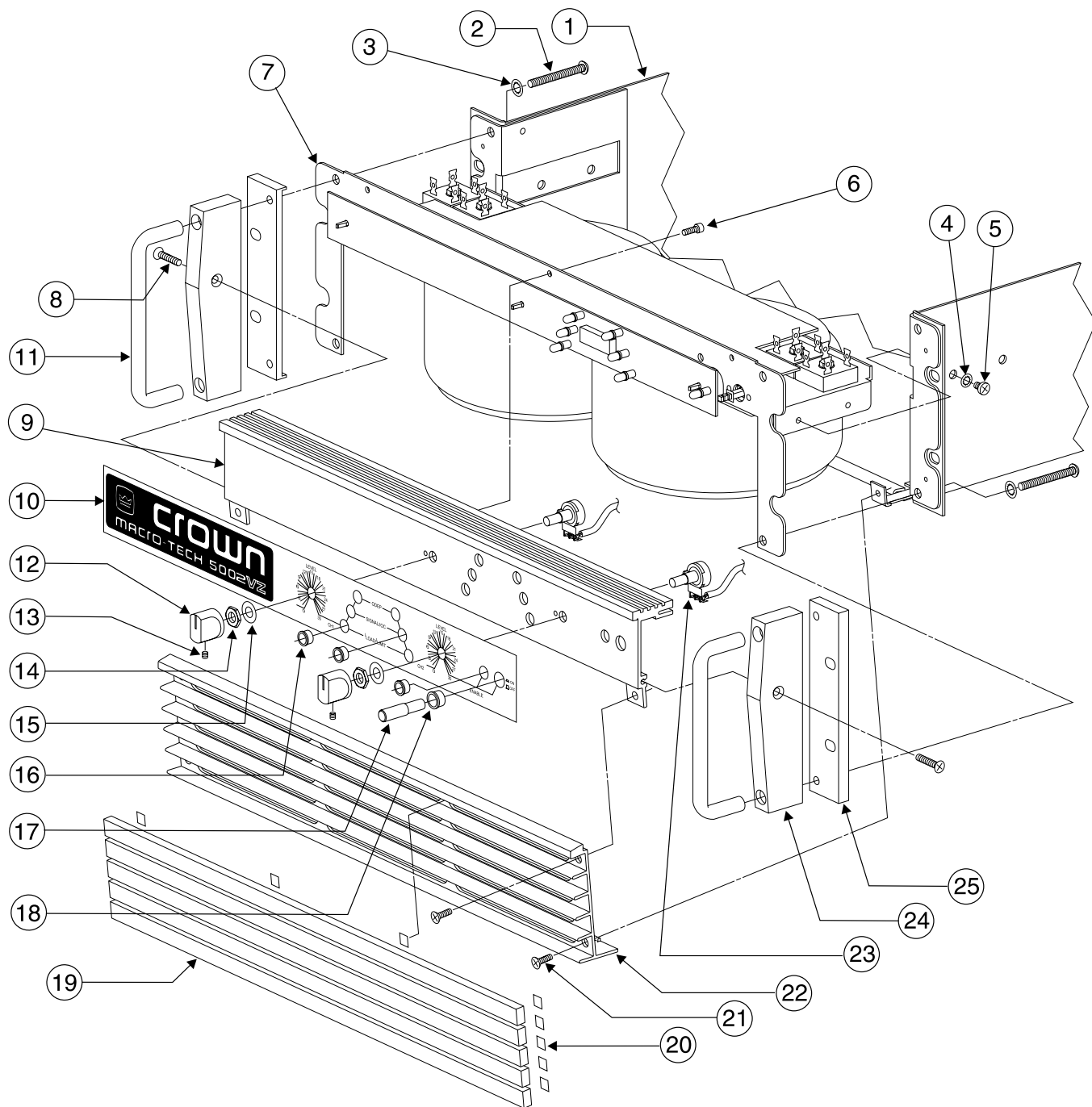


Figure 7.2 Front Chassis Assembly



## 7.2 Front Chassis Assembly

Item #	QTY	Part Number	Description	Notes
1	1	F12701-3	Chassis	
2	4	A10089-11032	Screw, 10-32 X 2	
3	4	A10094-8	Washer, #10 Int. Tooth	
4	4	A10094-5	Washer, #8 Int. Tooth	
5	4	C 8874-7	Screw, 8-18 X .375 Sht mtl	
6	3	A10092-10607	Screw, 6-32 X .437 Socket	
7	1	---	Transformer Bracket	See Transformer Assembly, Section 7.6
8	2	C 8507-3	Screw, 8-32 X 1 Flat Hd	
9	1	F12888-8	Front Panel	
10	1	128304-1	MA-5002VZ Lexan Overlay	
11	2	C 8776J3	Handle	
12	2	D 6265-9	Knob	
13	2	C 6005-0	Set Screw, 6-32 X .18	
14	2	---	Nut	Part of item 23
15	2	---	Washer	Part of item 23
16	7	D 7937-2	LED Collar	
17	1	D 7872-1	Pushbutton	
18	1	D 4108-3	Pushbutton Collar	
19	5	D 7696-4	Foam Filter	
20	20	B 5796-6	Velcro .5" x .25"	
21	4	C 7965-4	Screw, 8-32 X .37 Flat Hd	
22	1	D 7791J2	Grille Extrusion	
23	2	C 7280-8	5K ohm Level Pots	Includes hardware items 14 and 15
24	2	D 7792J0	Panel Cap	
25	2	D 7793J8	End Cap	

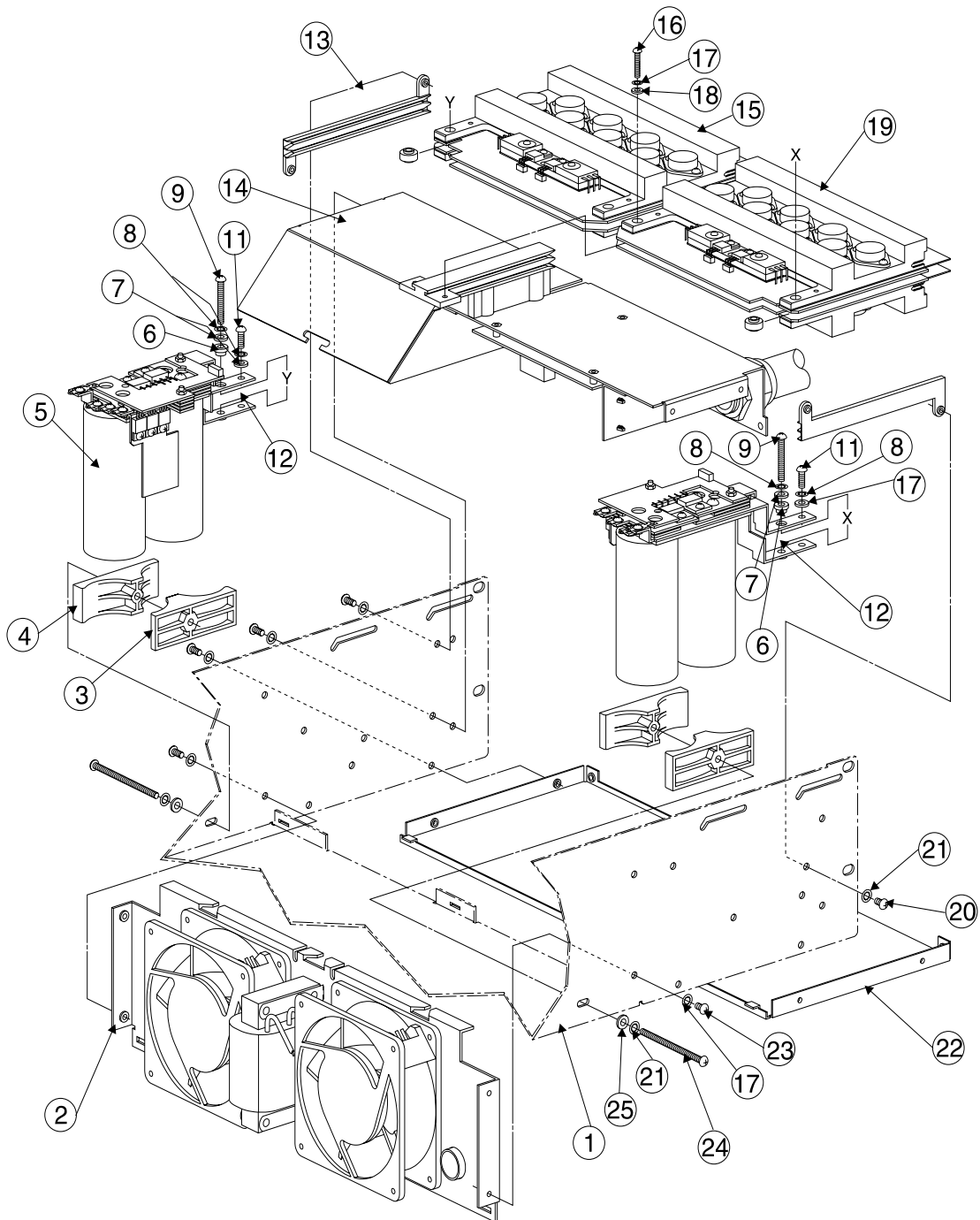


Figure 7.3 Middle Chassis Assembly

### 7.3 Middle Chassis Assembly

Item #	QTY	Part Number	Description	Notes
1	1	F12701-3	Chassis	
2	1	---	Divider Assembly	See Section 7.5
3	2	D 7927-3	Capacitor Holder, Inner	
4	2	D 7928-1	Capacitor Holder, Outer	
5	1	M46664-5	Ch 2 Bi-Level Switch Assby	See Section 7.8
6	2	D 7870-5	Valox Washer	
7	6	A10100-10	Flat Washer, #8	
8	6	A10094-6	Lock Washer, #8 Int Star	
9	2	A10089-70820	Screw, 8-32 X 1.25	
10	1	M46665-2	Ch 1 Bi-Level Switch Assby	See Section 7.7
11	2	A10089-10808	Screw, 8-32 X .5	
12	4	D 7871-3	Valox Spacer	
13	2	D 7818-4	Output Slide Guide	
14	1	---	PIP Terminator Assembly	See Section 7.9
15	1	---	Ch 1 Output Assembly	See Section 7.12 (Ch 1 & 2 are identical)
16	2	A10089-10612	Screw, 6-32 X .75	
17	2	A10094-4	Lock Washer, #6 Int Star	
18	2	A10100-4	Flat Washer, #6	
19	1	---	Ch 2 Output Assembly	See Section 7.12 (Ch 1 & 2 are identical)
20	13	C 8874-7	Screw, 8-18 X .375 sht mtl	
21	15	A10094-5	Lock Washer, #8 Int Str Blk	
22	15	F12567J7	Bottom Cover	
23	4	A10109-70604	Screw , 6-32 X .25 Black	
24	2	A10089-70844	Screw, 8-32 X 2.75	
25	2	A10100-12	Washer, 3/16 X 9/16 X 1/16	

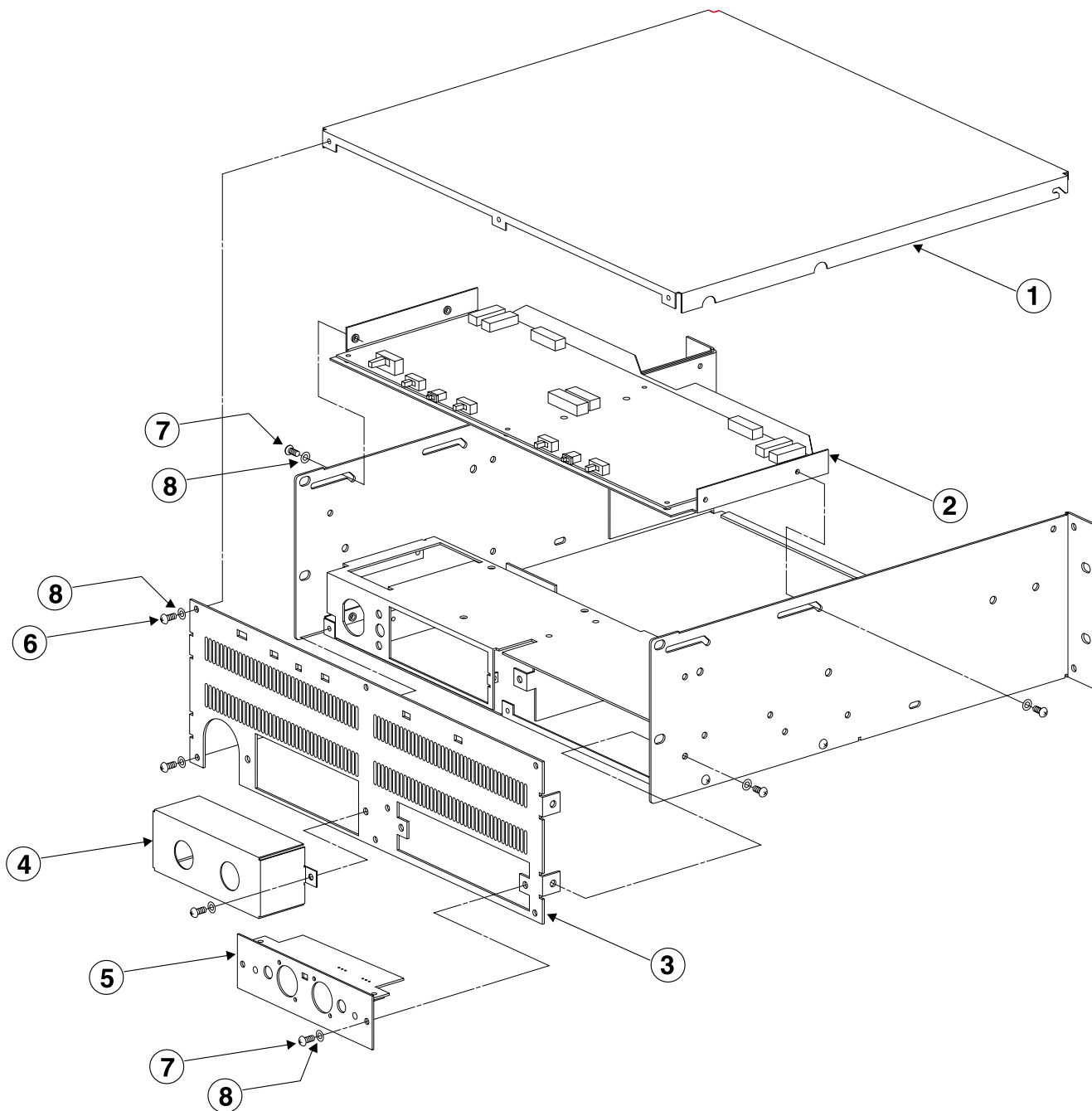


Figure 7.4 Rear Chassis Assembly

## 7.4 Rear Chassis Assembly

Item #	QTY	Part Number	Description	Notes
1	1	F12176J7	Top Cover	
2	-	---	Main Board Tray Assembly	See Section 7.11
3	1	128302-1	Back Panel	
4	1	F12302J9	Box Shield	Output post protective cover
5	1	102745-1	PIP2-FXQ	
6	4	C 8874-7	Screw, 8-18 X .375 Sht Mtl	
7	13	A10089-70806	Screw, 8-32 X .375	
8	17	A10094-5	Lock Washer, #8 Int Str Blk	

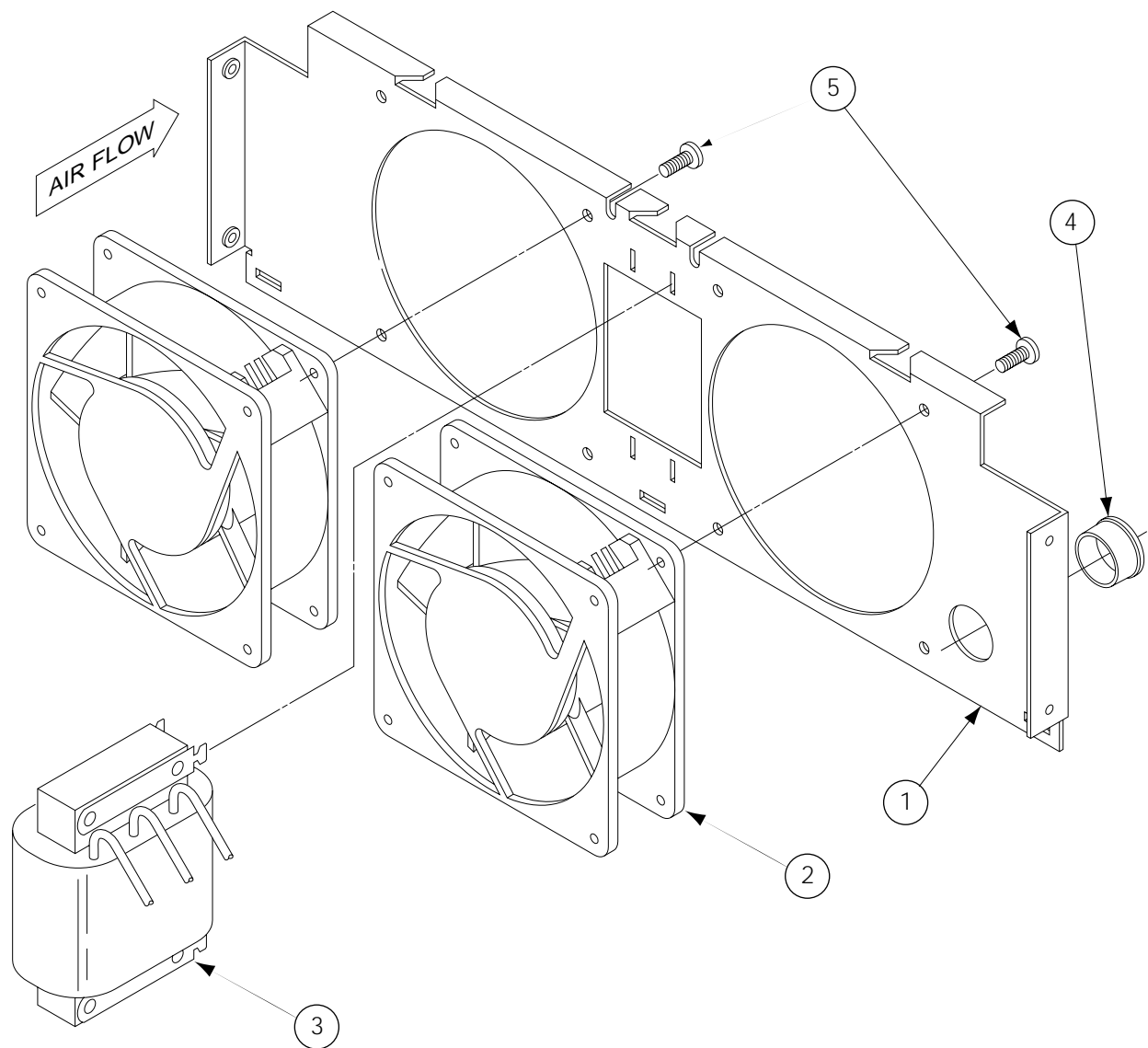


Figure 7.5 Chassis Divider (Fan) Assembly

### 7.5 Chassis Divider (Fan) Assembly

Item #	QTY	Part Number	Description	Notes
1	1	100111-1	Divider Plate	
2	2	C 7858-1	Fan	
3	1	D 7883-8	Transformer	Low Voltage Transformer
4	1	C 9069-3	Bushing, Universal 0.875	
5	8	A10106-70806	Screw, #8 X .37	Hex Washer Head

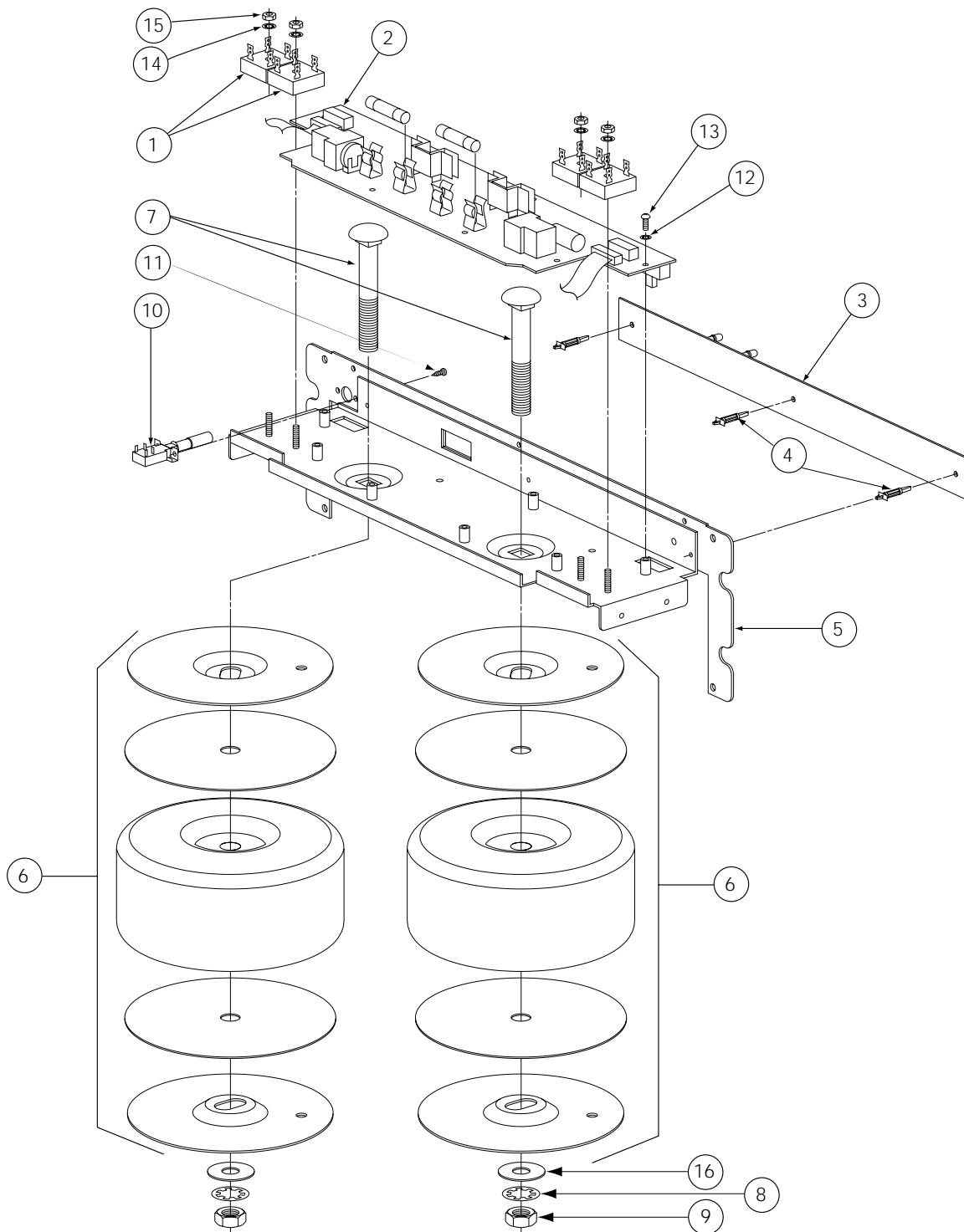


Figure 7.6 Transformer Assembly



## 7.6 Transformer Assembly

Item #	QTY	Part Number	Description	Notes
1	4	C10332-2	Bridge Rectifier, 50A EDI	
2	1		Control Module	See Section 8.
3	1	Q42929-2	Display Module	See Section 8.
4	3	C 8852-3	0.5" PC Board Support	
5	1	F12813-6	XFMR/Sub-front Bracket	
6	2	D 9019-7	Main Power Toroid XFMR	
7	2	C 8919-0	0.5" Steel Bolt	
8	2	A10095-7	0.5" Ext. Lockwasher	
9	2	A10102-21	0.5" Hex Nut	
10	1	C10180-5	DPST 6A Pushbutton Switch	
11	2	C 5961-5	4-40 X .375 Taptite	
12	7	A10094-4	#6 Int. Star Washer	
13	7	A10086-10608	6-32x.5 Machine Screw	
14	4	A10098-3	#8 HDS-4 Saftey Washer	
15	4	A10102-6	8x32 Hex Nut	
16	2	A10100-25	0.5" Plain Steel Washer	

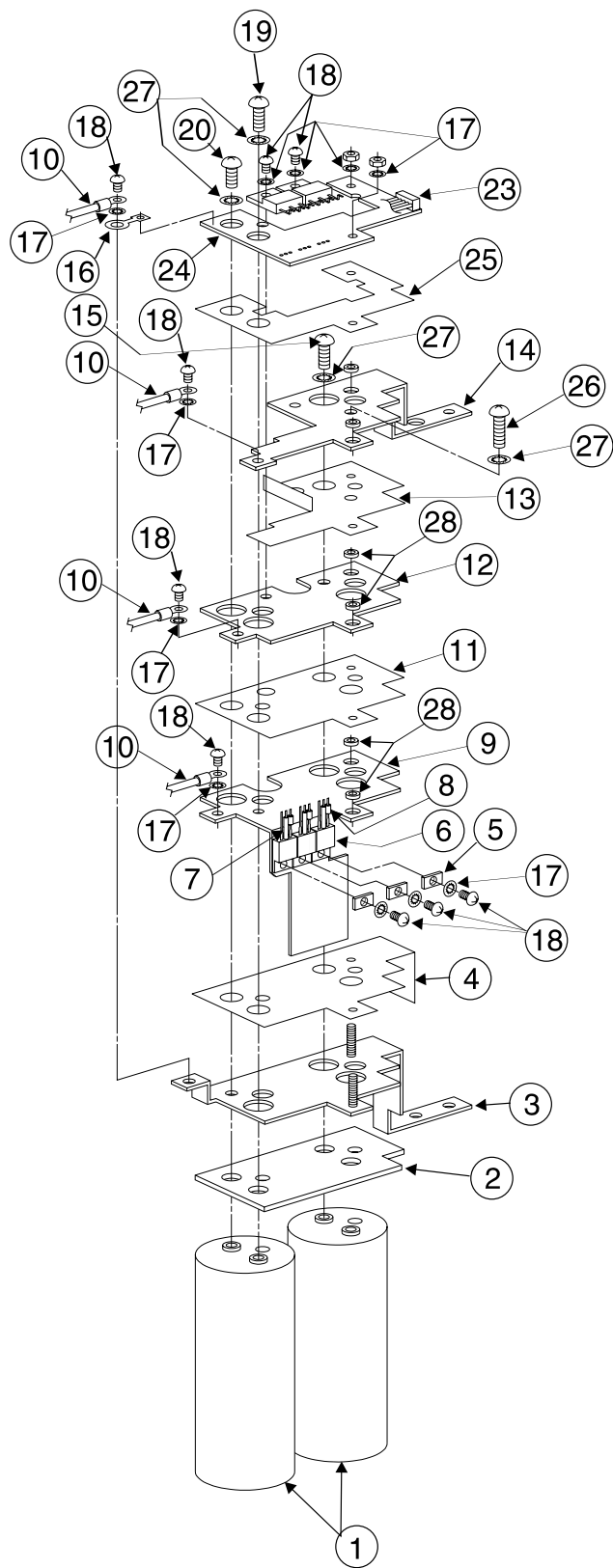


Figure 7.7 Channel 1 Bi-Level Switch Assembly

### 7.7 Ch 1 Bi-Level Switch Assembly (M46665-2)

Item #	QTY	Part Number	Description	Notes
1	2	D 7882-0	15000 $\mu$ F Capacitor	C810, C812
2	1	P10357-5	Insulator: Ch 1 & 2 #1	
3	1	M21070-4	Plate: Ch 1 -Vcc #1	
4	1	D 7821-8	Insulator: Ch 1 #2	
5	3	C 6541-4	Torque Spreader	
6	3	C 9927-2	MOSFETs	Q810, Q811, Q812
7	3	A11397-003	Lead Insulation Tube	
8	3	C 8341-7	Ferrite Bead	FB1, FB2, FB3
9	1	M21071-2	Plate: Ch 1 FET #2	
10	-	---	Wires	
11	1	D 7825-9	Insulator: Ch 1 & 2 #3	
12	1	M21072-0	Plate: Ch 1 Diode #3	
13	1	D 7822-6	Insulator: Ch 1 #4	
14	1	M21073-8	Plate: Ch 1 +Vcc #4	
15	1	A10086-11008	Screw, 10-32 X .5	
16	1	D 2934-4	Solder Lug	
17	11	A10094-4	Lock Washer, #6	
18	9	A10086-10604	Screw, 6-32 X .25	
19	1	A10086-11006	Screw, 10-32 X .375	
20	1	A10086-11005	Screw, 10-32 X .315	
21	2	C 8855-6	Dual Diode	D810, D811
22	2	A10102-5	Hex Nut, 6-32	
23	1	H43479-7	Header (with wires)	
24	1	D 7843-2	Switch Board Ch 1	(Ch 1 half of blank part D 7843-2)
25	1	D 7880-4	Insulator: Ch 1 & 2 #5	
26	1	A10086-11009	Screw, 10-32 X .562	
27	4	A10094-8	Lock Washer, #10	
28	6	A10101-26	Nylon Washer	

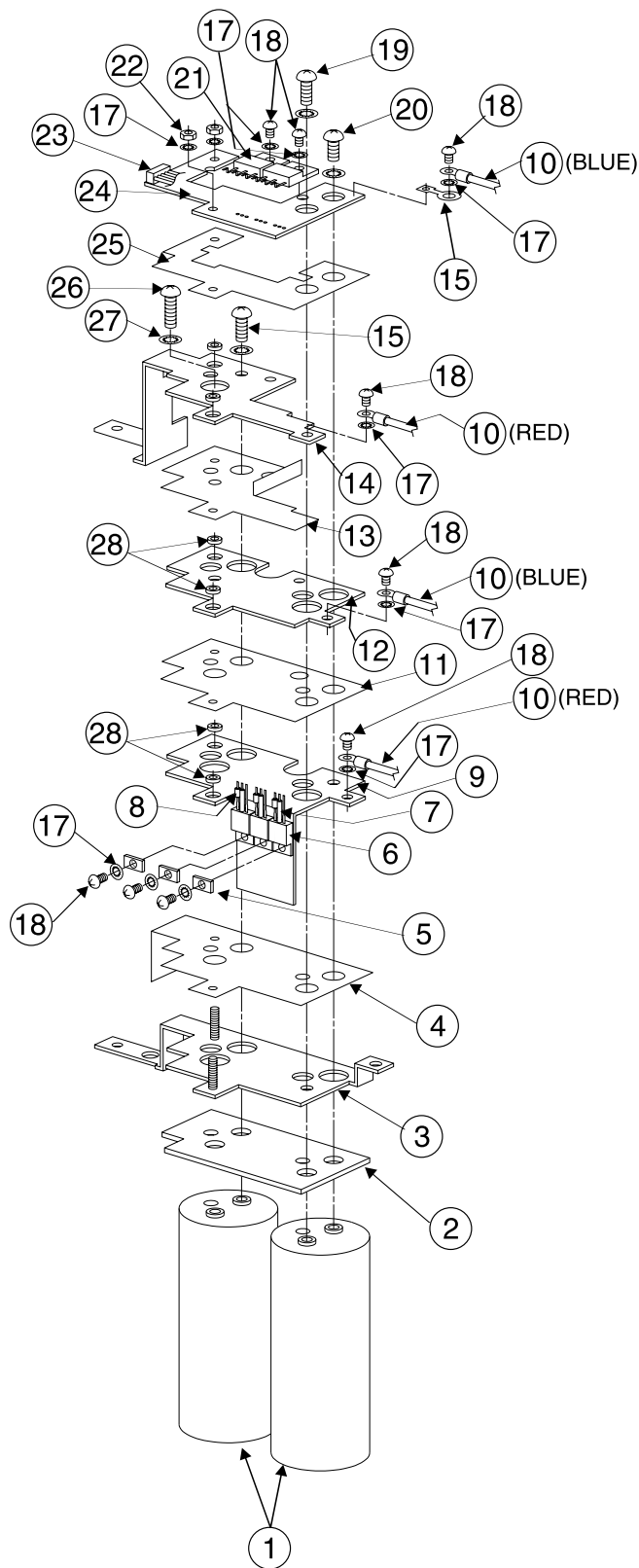


Figure 7.8 Channel 2 Bi-Level Switch Assembly

### 7.8 Ch 2 Bi-Level Switch Assembly (M46664-5)

Item #	QTY	Part Number	Description	Notes
1	2	D 7882-0	15000 $\mu$ F Capacitor	C800, C802
2	1	P10357-5	Insulator: Ch 1 & 2 #1	
3	1	M21074-6	Plate: Ch 2 -Vcc #1	
4	1	D 7824-2	Insulator: Ch 2 #2	
5	3	C 6541-4	Torque Spreader	
6	3	C 9927-2	MOSFETs	Q800, Q801, Q802
7	3	A11397-003	Lead Insulation Tube	
8	3	C 8341-7	Ferrite Bead	FB4, FB5, FB6
9	1	M21075-3	Plate: Ch 2 FET #2	
10	-	---	Wires	
11	1	D 7825-9	Insulator: Ch 1 & 2 #3	
12	1	M21076-1	Plate: Ch 2 Diode #3	
13	1	D 7820-0	Insulator: Ch 2 #4	
14	1	M21077-9	Plate: Ch 2 +Vcc #4	
15	1	A10086-11008	Screw, 10-32 X .5	
16	1	D 2934-4	Solder Lug	
17	11	A10094-4	Lock Washer, #6	
18	9	A10086-10604	Screw, 6-32 X .25	
19	1	A10086-11006	Screw, 10-32 X .375	
20	1	A10086-11005	Screw, 10-32 X .312	
21	2	C 8855-6	Dual Diode	D800, D801
22	2	A10102-5	Hex Nut, 6-32	
23	1	H43479-7	Header (with wires)	
24	1	D 7843-2	Switch Board Ch 2	(Ch 2 half of blank part D 7843-2)
25	1	D 7880-4	Insulator: Ch 1 & 2 #5	
26	1	A10086-11009	Screw, 10-32 X .562	
27	4	A10094-8	Lock Washer, #10	
28	8	A10101-26	Nylon Washer	

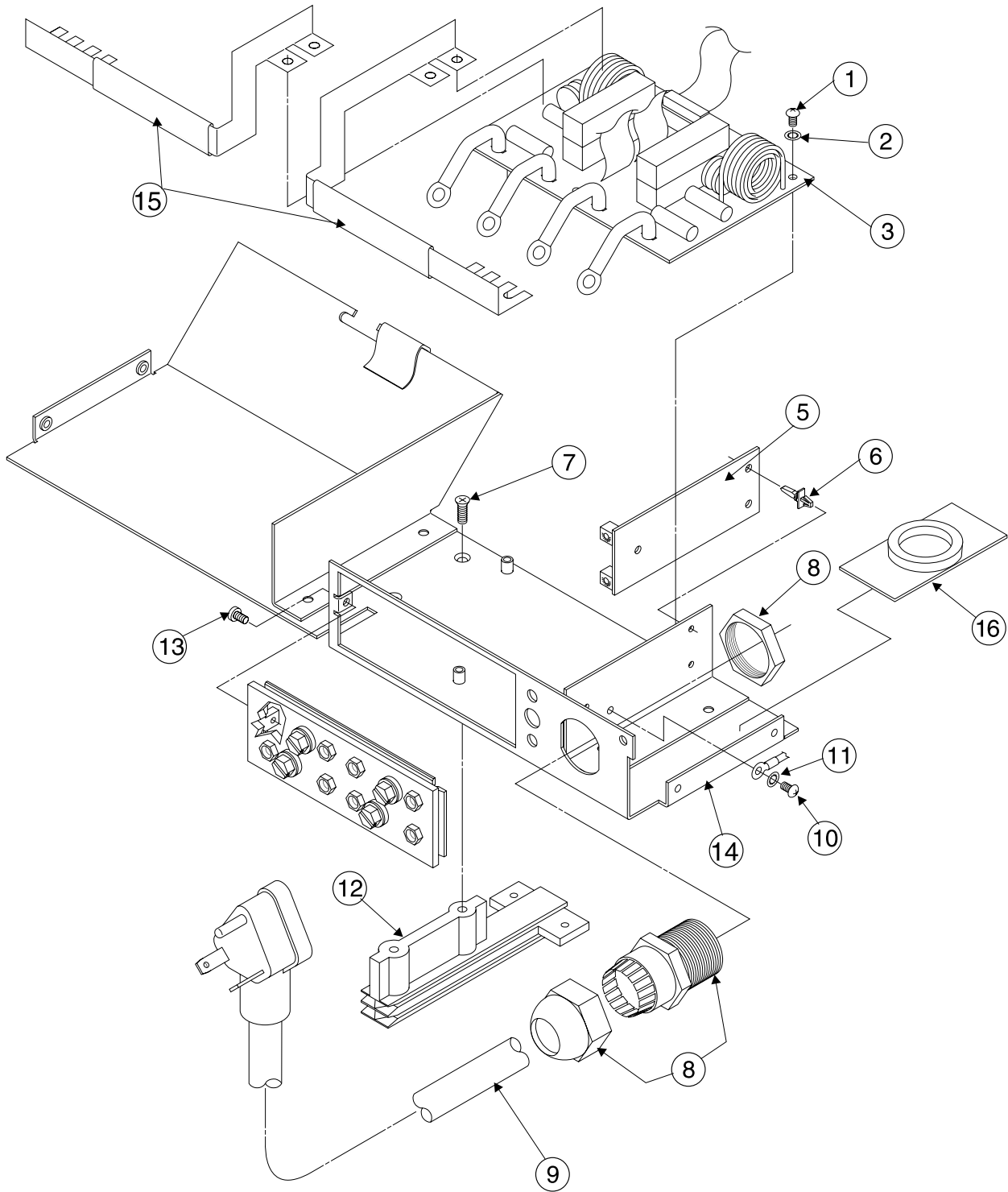


Figure 7.9 PIP Terminator Shelf Assembly

### 7.9 PIP Terminator Shelf Assembly

Item #	QTY	Part Number	Description	Notes
1	3	A10086-10604	6-32-.25 Machine Screw	Phillips, round-head
2	3	A10094-4	#6 Int. Star Washer	
3	1	---	Current Sense Module	See Section 8
4	1	C 7705-4	Cable Clamp	
5	1	---	Current Sense Module	See Section 8
6	3	C 8823-4	0.125" PC Board Support	
7	2	D 5903-6	8-32x.5 Screw	Phillips, flat-head, taptite
8	1	F11160-3	Strain Relief	For Power Cord D 7890-3
9	1	D 7890-3	Power Cord	30A 10/3 TT-30P Plug (No. America)
10	1	A10111-10806	#8x.375 Sheetmetal Screw	Pan-head
11	1	A10095-2	#8 Ext. Star Washer	
12	1	D 7817-6	Center Output Slide Guide	
13	1	A10109-7064	6-20x.25 Screw	Phillips, pan-head, black
14	1	F12699-9	Terminator/PIP Shelf Bracket	
15	1	H43430-0	Output Flex Bar Ch 1	Includes Insulating Sleeve
	1	H43431-8	Output Flex Bar Ch 2	Includes Insulating Sleeve
16	1	---	Line Filter PWA	See Section 8 (Export Only)

### 7.10 PIP Terminator Shelf Assembly, View "A" (USA Units only)

Item #	QTY	Part Number	Description	Notes
1	16	C 8835-8	.25-32 Nut	
2	12	A10094-9	Lockwasher, .25 Int. Star	
3	4	M21078-7	Terminator Bar	
4	4	D 7924-0	Bushing, Steel	
5	1	D 7816-8	Terminator Panel	
6	8	C 8794-7	Un-insulated Banana Jack	
7	4	A10170-12516	.25-20x1 Machine Screw	Output, slot hex-washer head

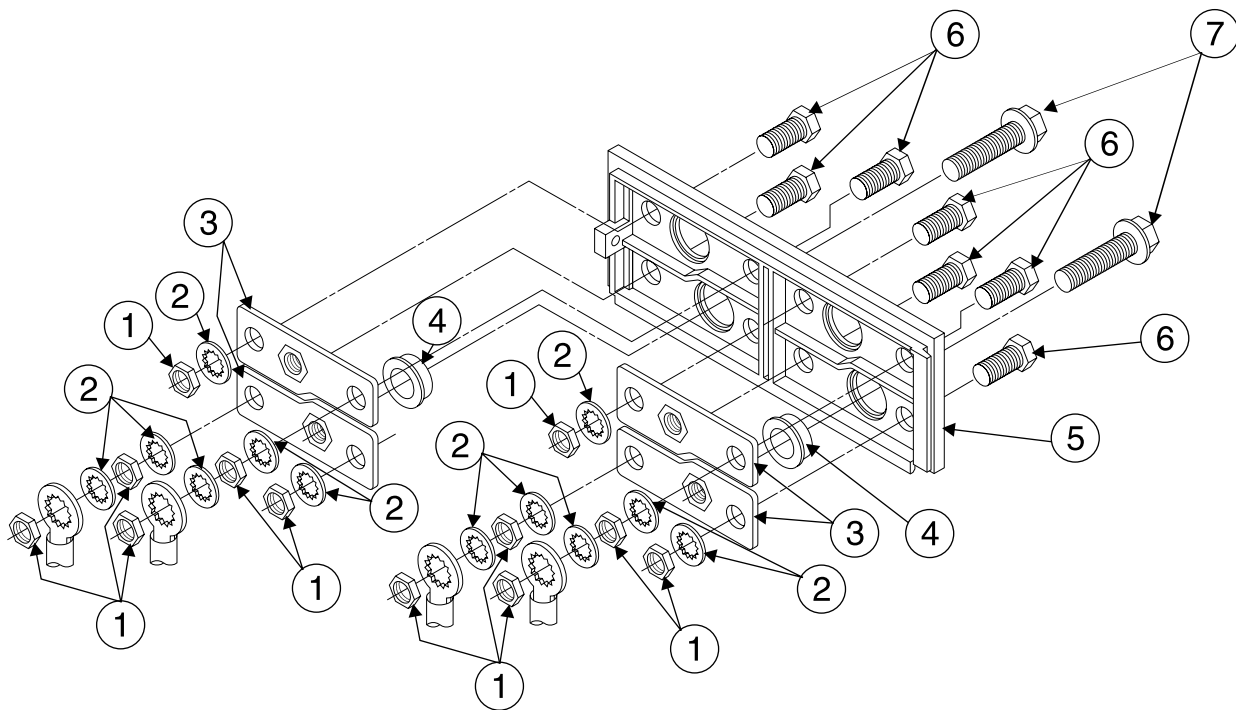


Figure 7.10 PIP Terminator Shelf Assembly, View "A"



## 7.11 Main Board Tray Assembly

Item #	QTY	Part Number	Description	Notes
1	1	100110-1	Main Board Tray	
2	1	See Section 8	Main Module	See Section 8.
3	6	A10094-4	#6 Int. Star Washer	
4	6	A10086-10604	6-32x.25 Machine Screw	Phillips, round-head

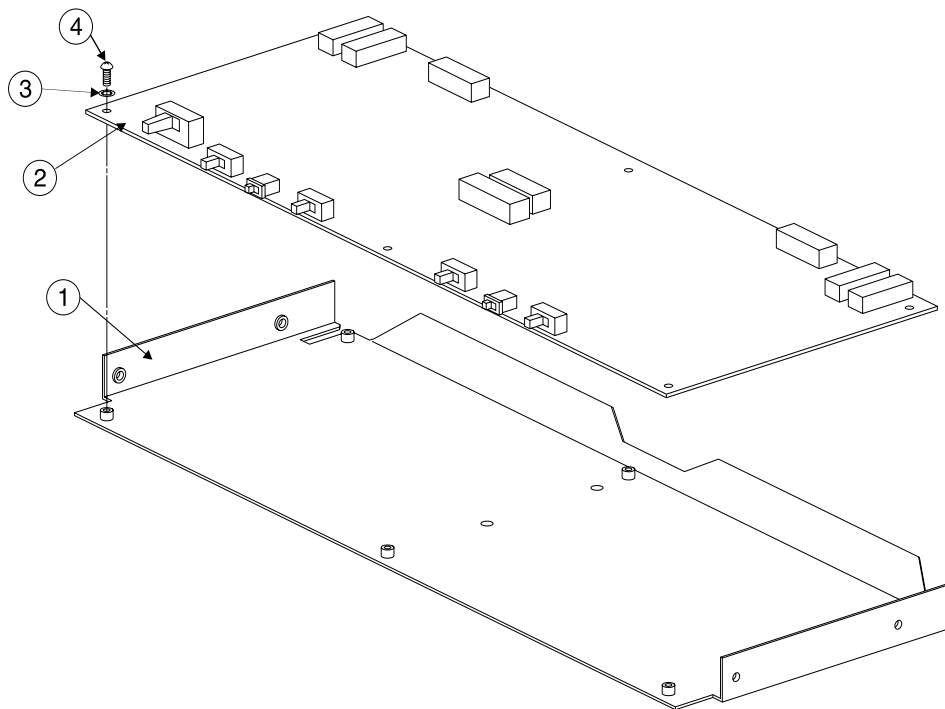


Figure 7.11 Main Module Tray Assembly

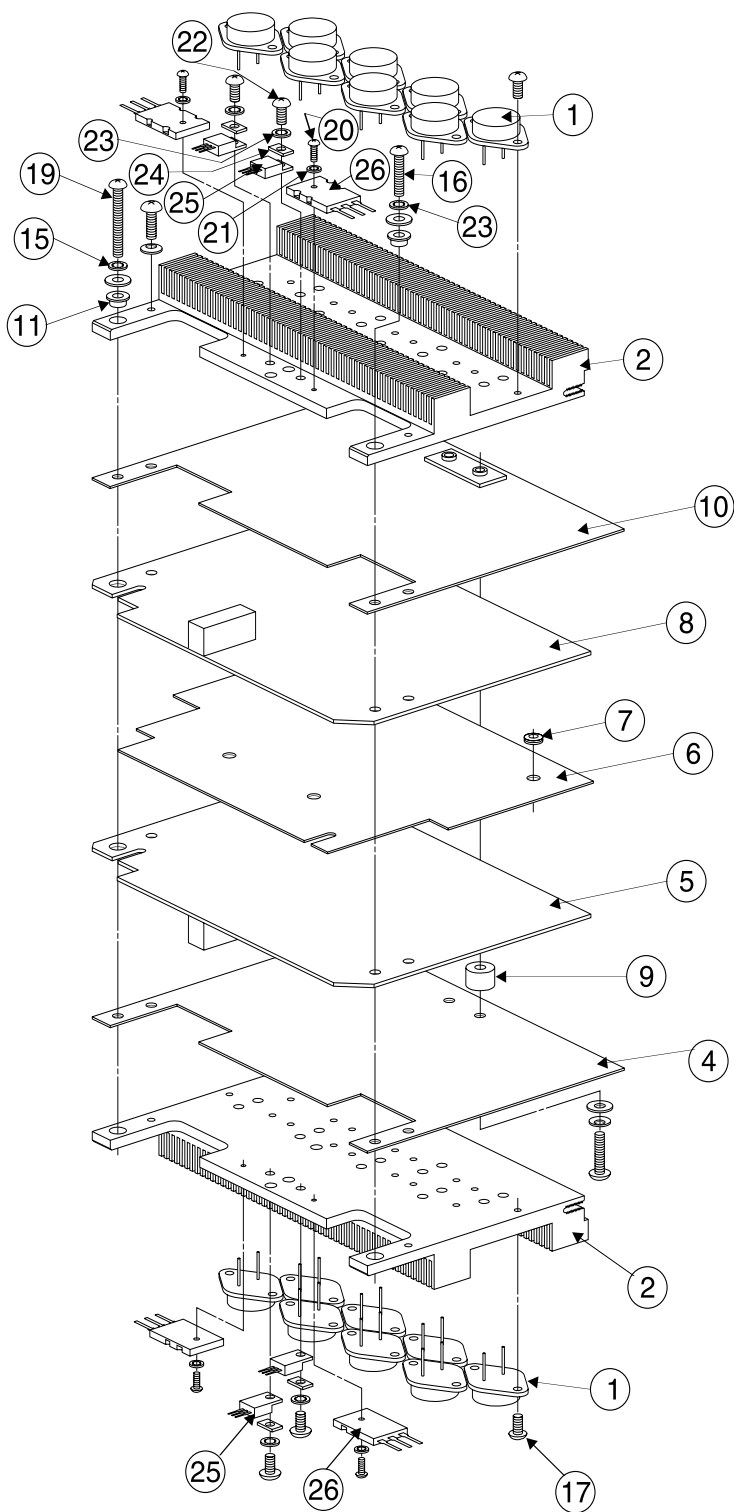


Figure 7.12 Output Assembly

## 7.12 Output Assembly (Channels 1 & 2 Identical)

Item #	QTY	Part Number	Description	Notes
1	8 8	C 8187-4 C 8188-2	NPN Outputs, PNP Outputs,	
2	1	F12154-5	Heatsink	
3	1	M21188-4	Flex Bar Fastener	
4	1	---	Negative Emitter Module	See Section 8.
5	1	---	Negative Output Module	See Section 8.
6	1	D 7922-4	Insulator	
7	4	A10224-9	Rubber Grommets	
8	1	---	Positive Output Module	See Section 8.
9	2	C 8789-7	Flex Bar Spacers	
10	1	---	Positive Emitter Module	See Section 8.
11	2	D 7870-5	Valox Washer	
12	3	A10100-16	Washer, 7/16OD X .203ID	
13	2	A10098-4	Belleville Washer, #10	
14	2	A10086-10810	Screw, 8-32 X .62	
15	3	A10094-6	Lock Washer, #8 Int. Star	
16	1	A10089-10612	Screw, 6-32 X .75	
17	32	A10110-10606	Screw, 6-32 X .375	
18	1	A10089-10808	Screw, 8-32 X .5	
19	1	A10089-70820	Screw, 8-32 X 1.25	
20	4	A10086-10406	Screw, 4-40 X .37	
21	4	A10098-1	Washer, .394OD X .126ID	
22	6	A10086-10604	Screw, 6-32 X .25	
23	4	A10094-4	Washer, #6 Int Star	
24	4	C 6541-4	Predriver Torque Spreader	
25	2 2	C 5453A1 C 6436-7	PNP, 2SA1006BR NPN, 2SC2336BR	
26	2 2	C10223-3 C10224-1	PNP, MJL1302A NPN, MJL3281A	
27	1	D 7871-3	Valox Spacer	

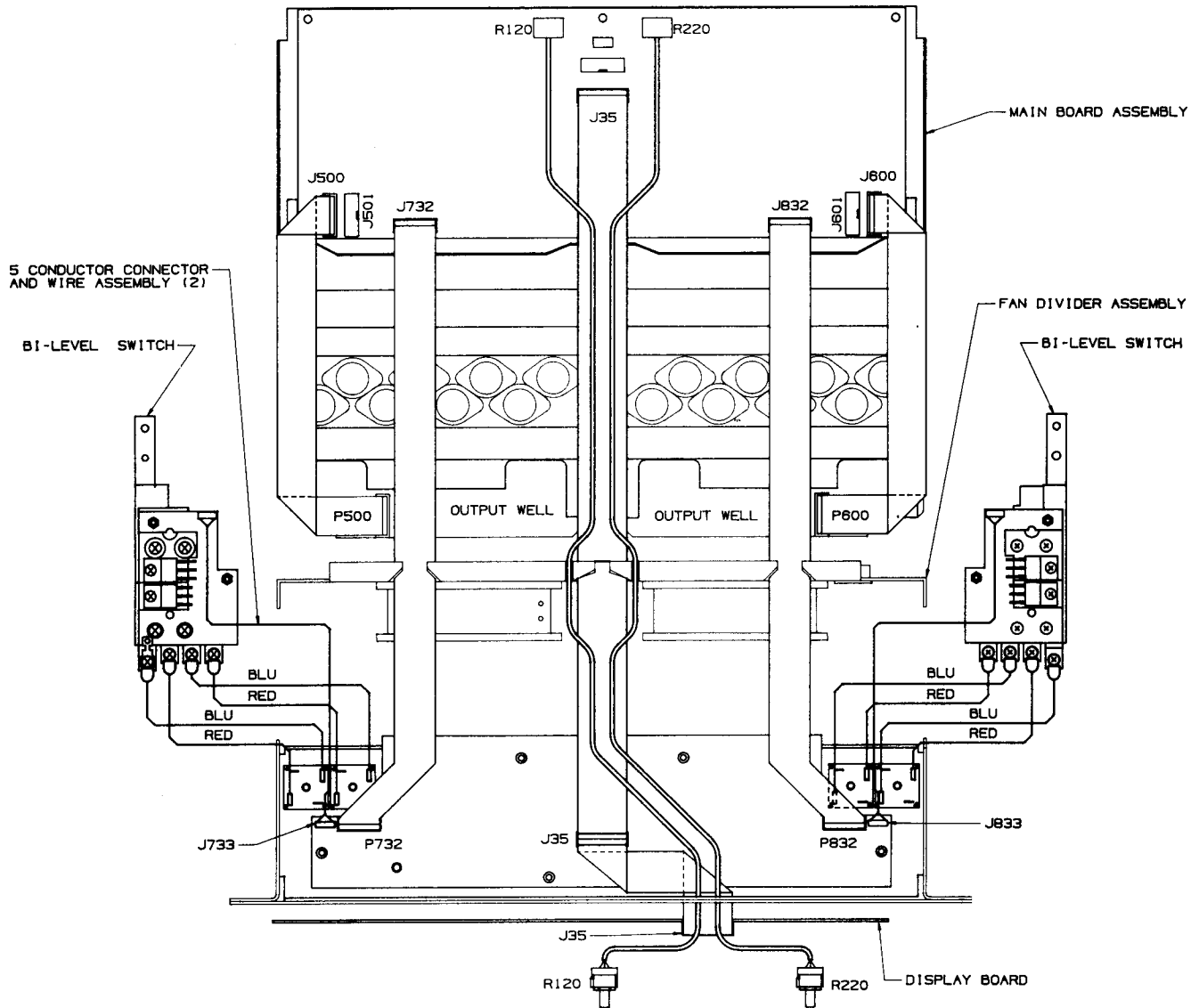


Figure 7.13 Wiring Diagram #1

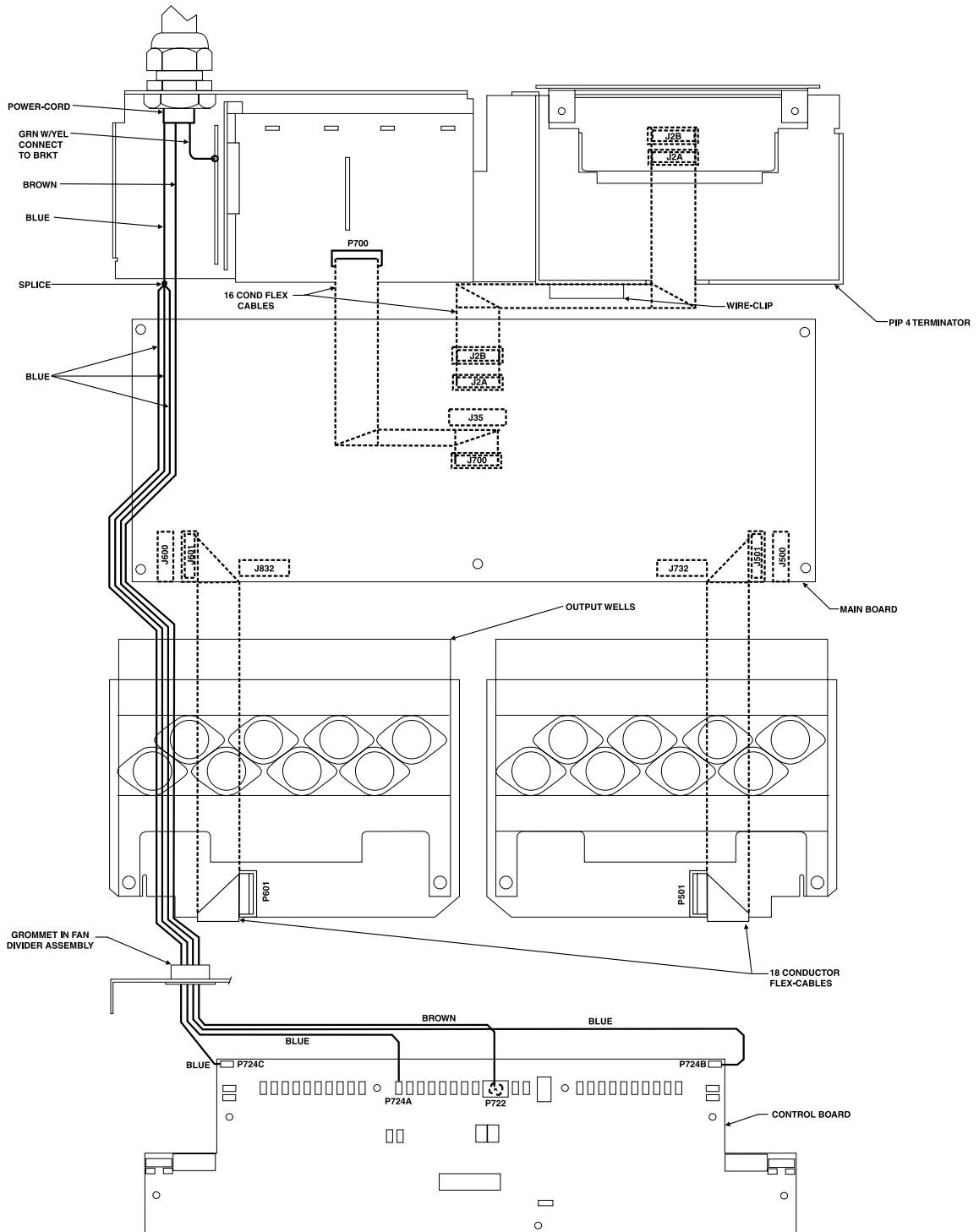


Figure 7.14 Wiring Diagram #2

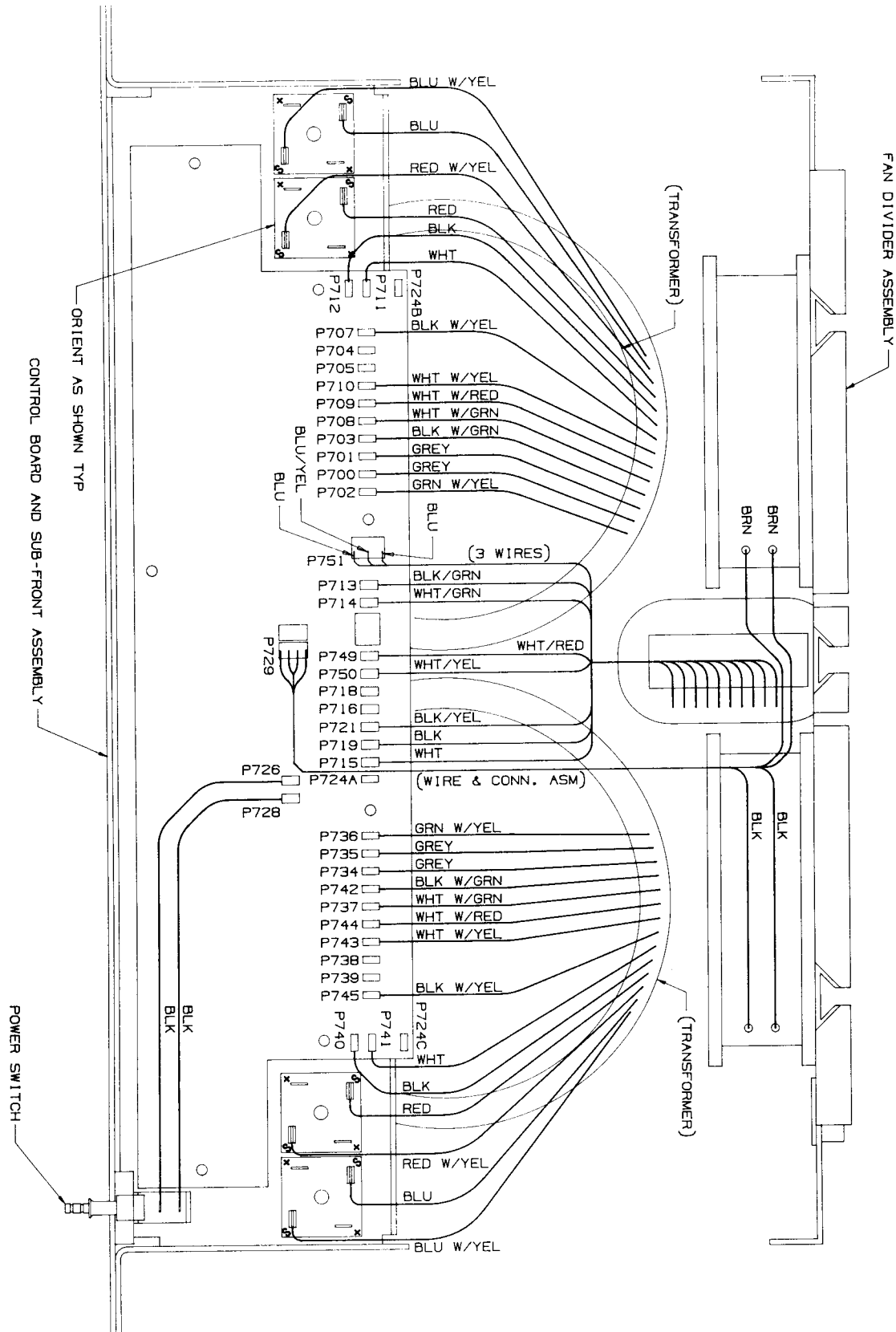


Figure 7.15 Wiring Diagram #3

### Interconnect Cables

Designation	Part Number	Description	Notes
J2A	D 9236-7	20 Wire Ribbon Cable	PIP2
J2B	D 9235-9	18 Wire Ribbon Cable	PIP2
J35	D 7886-1	16 Wire Ribbon Cable	Main to Control to Display
J500	D 7889-5	16 Wire Ribbon Cable	Main to Ch 1 Output P500 (top)
J501	D 7885-3	16 Wire Ribbon Cable	Main to Ch 1 Output P501 (bottom)
J600	D 7885-3	16 Wire Ribbon Cable	Main to Ch 2 Output P500 (bottom)
J601	D 7964-6	16 Wire Ribbon Cable	Main to Ch 2 Output P501 (top)
J700	D 7887-9	16 Wire Ribbon Cable	Main to Current Sense
J732 J832	D 7888-7 D 8542-9	16 Wire Ribbon Cable 16 Wire Ribbon Cable	Main to Control Main to Control, Part of Control Mod.
J733 J833	H43479-7	Bi-Level Control Wires	Control to Bi-Level Switches
R120 R220	H43551-3	Level Controls With Wires	Also includes hardware

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## 8 Module and Schematic Information

### 8.1 General Information

The schematics referenced and provided are representative only. There may be slight variations between amplifier to amplifier. These schematics are intended to be used for troubleshooting purposes only.

Note on circuit board designations: Crown circuit boards are referenced with a PWA and/or PWB part number. PWA stands for Printed Wire Assembly. This is the completed circuit board with all components assembled. PWB stands for Printed Wire Board. This is the circuit board only, without components.

### 8.2 Modules

#### 8.2.1 Main PWA

125903-4

Main PWA on 125902-4 PWB.

#### 8.2.2 Positive Output PWA: (left and right are identical)

Q43293-2

Positive Output PWA on D8526-2 PWB.

#### 8.2.3 Negative Output PWA: (left and right are identical)

Q43294-0

Negative Output PWA on D8527-0 PWB.

#### 8.2.4 Positive Emitter PWA: (left and right are identical)

Q42935-9

Positive Emitter PWA on P10336-9 PWB.

#### 8.2.5 Negative Emitter PWA: (left and right are identical)

Q42934-2

Negative Emitter PWA on P10342-7 PWB.

#### 8.2.6 Control PWA

127488-2

Control PWA on 127917-1 PWB.

#### 8.2.7 Display PWA

Q42929-2

Display PWA on D7845-7 PWB.

#### 8.2.8 Current Sense PWA:

102397-2

Current Sense PWA on 102395-2 PWB.

#### 8.2.9 Line Filter PWA (CE Models Only):

128273-2

Line Filter PWA on 128272-2 PWB.

### 8.3 Schematic Diagrams:

#### 8.3.1 Main PWA

125901

#### 8.3.2 Positive Output PWA

J0488-7

#### 8.3.3 Negative Output PWA

J0488-7

#### 8.3.4 Positive Emitter PWA

J0488-7

#### 8.3.5 Negative Emitter PWA

J0488-7

#### 8.3.6 Control PWA

128112-2

#### 8.3.7 Display PWA

J0491-1

#### 8.3.8 Terminator PWA

102396

#### 8.3.9 Line Filter PWA

128273-2

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## 9 Module Parts

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### 9.1 General Information

This chapter includes electrical parts lists for this product. All serviceable parts and assemblies will have a Crown Part Number (CPN) listed in this chapter. The parts listed are current as of the date printed. Crown reserves the right to modify and improve its products for the benefit of its customers. Please note: where reference designations are listed as "installed on next assembly," the CPN (Crown Part Number) for the associated part may be found in Section 7, Exploded View Parts.

**102397-2**

**125903-4**

**127488-2**

**128273-2**

**Q42929-2**

**Q42934-2**

**Q42935-9**

**Q43293-2**

**Q43294-0**

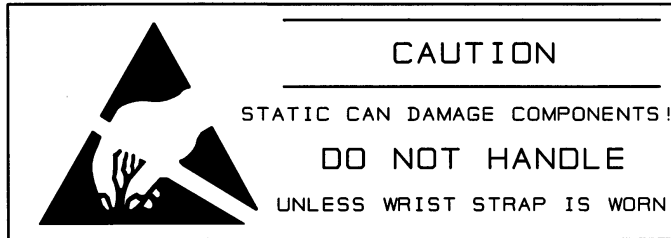
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E.C.N.	ZONE	REV.	DESCRIPTION	DATE	BY	APPROVALS			
						CHK	ME	EE	PE
		A	INITIAL RELEASE FOR PRODUCTION	06/22/99	JAW	JAW	ME	N/A	PE

UNLESS OTHERWISE SPECIFIED, THIS PRINTED WIRING ASSEMBLY SHALL MEET THE SPECIFICATION DESCRIBED IN IPC-A-610\_ CLASS 2 STANDARDS.

NOTES:

1. FOR SCHEMATIC SEE 102396
2. FOR PRINTED WIRING BOARD SEE 102395-2
3. ALL LEADS SHALL BE TRIMMED TO 0.062" OR LESS.
4. PIN NUMBER 1 OF P700 IS INDICATED BY A SQUARE COPPER PAD.
5. SEE FIGURE 1 FOR ADDITIONAL CURRENT SENSE WIRES (H43214-8) ASSEMBLY INFORMATION.
6. INSERT R753, R756, R853, AND R856 AS SHOWN IN FIGURE 1.
7. REMOVE SOLDER OR PREVENT SOLDER FROM ACCUMULATING IN HOLES INDICATED IN FIGURE 2.
8. REMOVE PANEL SCRAP EDGES FROM ASSEMBLY.
9. INSERT C1, C2, R1 AND Z1 AS SHOWN IN FIGURE 3.
10. POSITION COMPONENTS AS SHOWN ON COMPONENT MAP.



<b>CROWN INTERNATIONAL INC.</b>									
PRINTS		1718 WEST MISHAWAKA ROAD ELKHART, INDIANA 46517				PHONE (219) 294-8000			
K		<b>PWA, MA-5000VZ CURR SENSE</b>						TOL. UNLESS SPECIFIED	
								X.XX = ± 0.020 X.XXX = ± 0.010 DRILLS = ± 0.003	
DRAWN		JAW	06/22/99	APPROVED BY:		DO NOT SCALE PRINT			
CHECKED		JAW	0-23-99	ME	0-23-99	SUPERSEDES			
SCALE		NONE		EE	N/A	E.C.N.			
PROJ #		MD356D0		PE	0-23-99	DWG. NO. SHEET 1 OF 8		REV	
NEXT ASSEMBLY						102397-2		(A)	

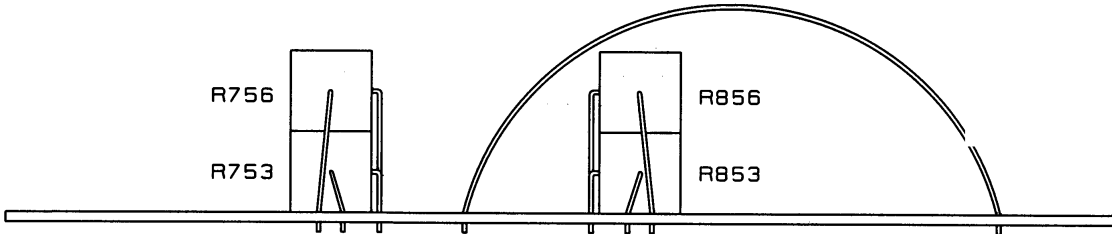
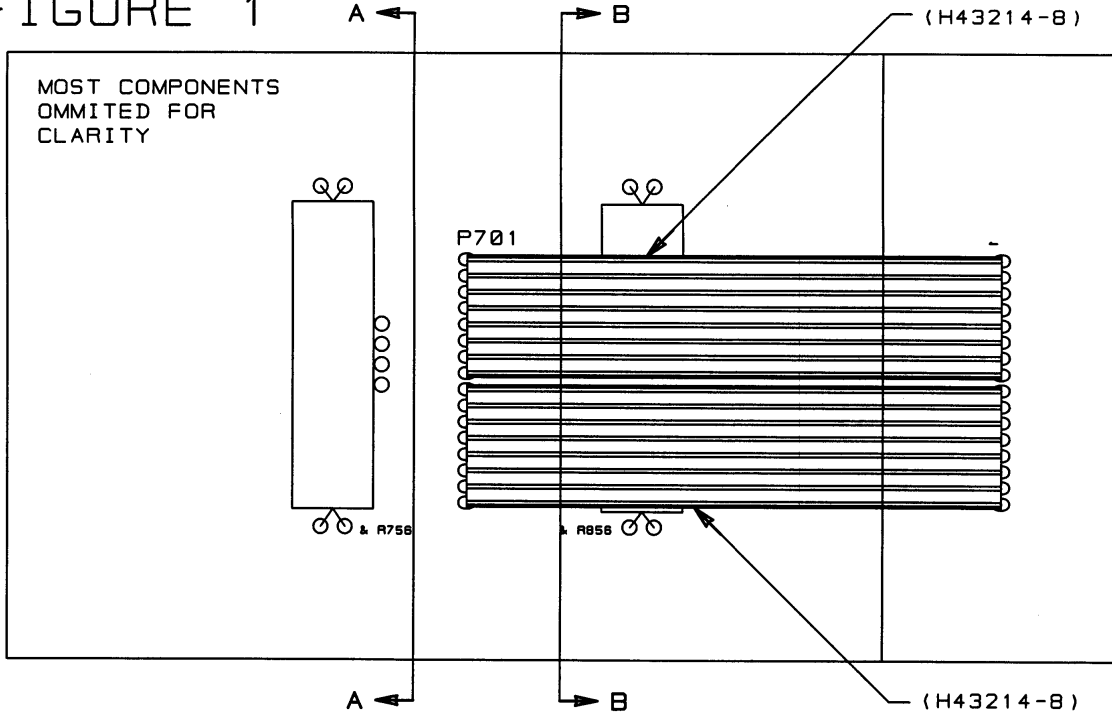
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COMPONENT LIST			
REF	CPN	DESCRIPTION	MAP LOCATION
C1	C 5234-7	0.047, 125VAC, . SEE NOTE 9	D1
C2	C 8426-6	0.1, 250V, 10%, MET POLY SEE NOTE 9	D2
C750	A10434-473JD	0.047, 250V, 5%,	B2
C751	A10434-473JD	0.047, 250V, 5%,	B1
C752	C 8512-3	0.022, 250V, 5%, FILM	A1
C753	C 6814-5	12PF, 200V, AX CERM,	F3
C754	C 6814-5	12PF, 200V, AX CERM,	F3
C755	C 6802-0	.47MF, 50V, AX CERM,	F4
C850	A10434-473JD	0.047, 250V, 5%,	E2
C851	A10434-473JD	0.047, 250V, 5%,	E2
C852	C 8512-3	0.022, 250V, 5%, FILM	D1
C853	C 6814-5	12PF, 200V, AX CERM,	G1
C854	C 6814-5	12PF, 200V, AX CERM,	G2
J701	H43214-8	WIRES, MA5000VZ CURR SENSE SEE NOTE 5	G3
L750	H43166-0	2.5UH, . . .	B2
L850	H43166-0	2.5UH, . . .	E4
P700	C 8784-8	16 POS VERT EJECT HEADER, . . .	C4
P701	H43214-8	WIRES, MA5000VZ CURR SENSE SEE NOTE 5	C3
R1	A10266-6804	68, 2W, 5%, CF T/R SEE NOTE 9	D1
R750	C 6625-5	5.6, 5W, 5%, MF	B2
R751	C 7102-4	4.7, 5W, 5%, POSITOR	A2
R752	C 6625-5	5.6, 5W, 5%, MF	B1
R753	C 8981-0	0.04, 15W, 3% SEE NOTE 6	B2
R754	A10365-20R01	20, 0.25W, 1%, MF	F3
R755	A10365-20R01	20, 0.25W, 1%, MF	F3
R756	C 8981-0	0.04, 15W, 3% SEE NOTE 6	B2
R757	A10365-20R01	20, 0.25W, 1%, MF	F3
R758	A10265-20R01	20, 0.25W, 1%, MF	F3
R759	C 8783-0	1K, . . . TRIMPOT	F1
R760	A10265-16501	165, 0.25W, 1%, MF	F1
R761	A10265-19111	1.91K, 0.25W, 1%, MF	F3
R762	A10265-21021	21K, 0.25W, 1%, MF	F3
R763	A10265-19111	1.91K, 0.25W, 1%, MF	F4
R764	A10265-21021	21K, 0.25W, 1%, MF	F4
R765	C 7102-4	4.7, 5W, 5%, POSITOR	A2
R850	C 6625-5	5.6, 5W, 5%, MF	E2
R851	C 7102-4	4.7, 5W, 5%, POSITOR	E3
R852	C 6625-5	5.6, 5W, 5%, MF	E1
R853	C 8981-0	0.04, 15W, 3% SEE NOTE 6	D2
R854	A10265-20R01	20, 0.25W, 1%, MF	G2
R855	A10265-20R01	20, 0.25W, 1%, MF	G2
R856	C 8981-0	0.04, 15W, 3% SEE NOTE 6	D2
R857	A10265-20R01	20, 0.25W, 1%, MF	G2
R858	A10265-20R01	20, 0.25W, 1%, MF	G2
R859	C 8783-0	1K, . . . TRIMPOT	G1
R860	A10265-16501	165, 0.25W, 1%, MF	G1
R861	A10265-19111	1.91K, 0.25W, 1%, MF	G3
R862	A10265-21021	21K, 0.25W, 1%, MF	G3
R863	A10265-19111	1.91K, 0.25W, 1%, MF	G3
R864	A10265-21021	21K, 0.25W, 1%, MF	G3

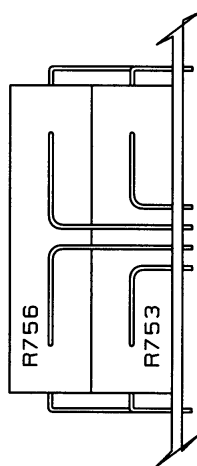
<b>CROWN INTERNATIONAL INC.</b>			
1718 WEST MISHAWAKA ROAD		ELKHART, INDIANA 46517	PHONE (219) 294-8000
DRAWN	JAW	06/22/99	DO NOT SCALE PRINT
SCALE	NONE	C.P.N.	SHEET 3 OF 8
			102397-2
			(A)



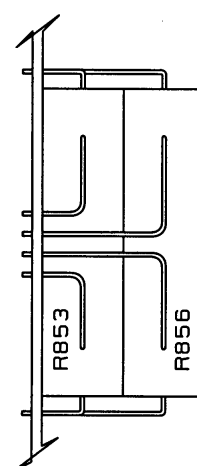
FIGURE 1



SECTION A-A  
MOST COMPONENTS  
OMMITTED FOR  
CLARITY



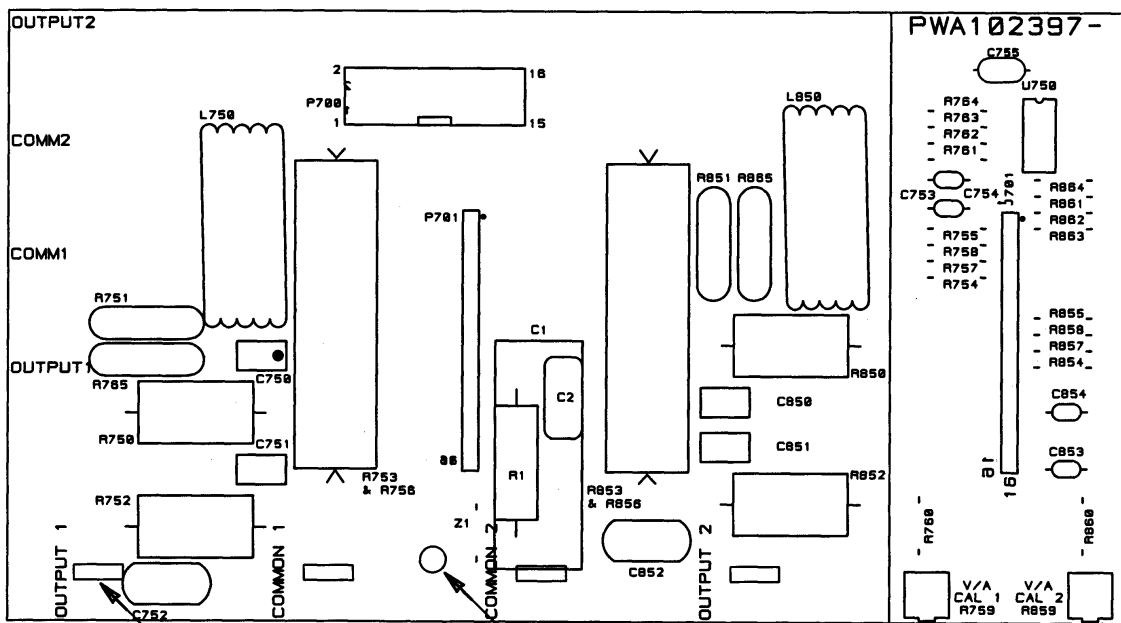
SECTION B-B  
MOST COMPONENTS  
OMMITTED FOR  
CLARITY



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1718 WEST MISHAWAKA ROAD		ELKHART, INDIANA 48517		PHONE (219) 294-8000	
DRAWN	JAW	06/22/99	DO NOT	C. P. N.	SHEET 5 OF 8
SCALE	NONE		SCALE PRINT	102397-2	REV (A)



FIGURE 2

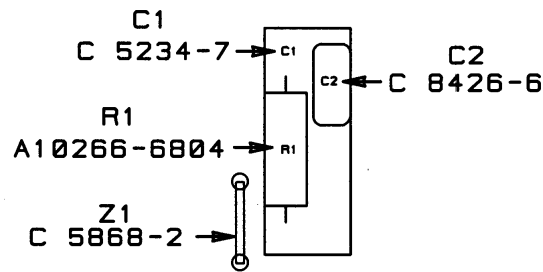
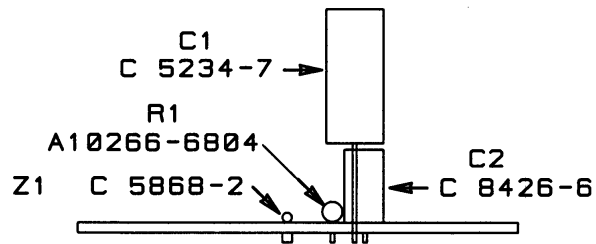


SEE NOTE 7  
4 PLACES

SEE NOTE 7

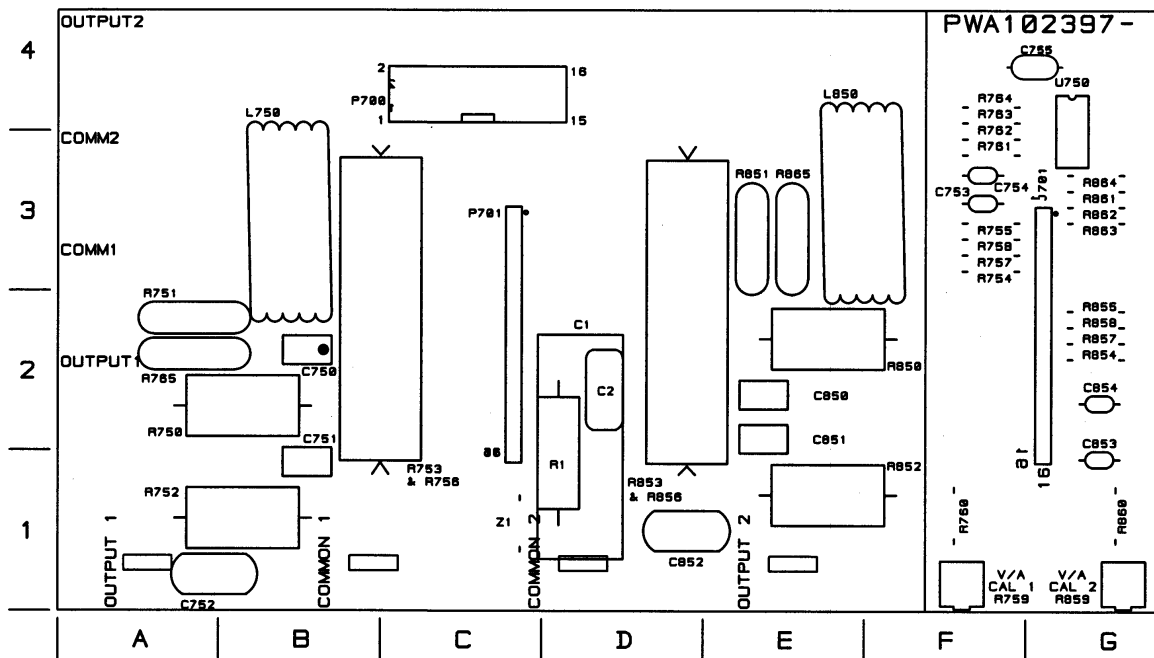
<b>CROWN INTERNATIONAL INC.</b>				
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DRAWN	JAW	06/22/99	DO NOT SCALE PRINT	C. P. N. SHEET 6 OF 8 REV
SCALE	NONE		102397-2	(A)

FIGURE 3



<b>CROWN INTERNATIONAL INC.</b>							
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DRAWN	JAW	06/22/99	DO NOT	C. P. N.	SHEET 7 OF 8	REV	
SCALE	NONE		SCALE PRINT	102397-2		(A)	

# COMPONENT MAP



## CROWN INTERNATIONAL INC.

1718 WEST MISHAWAKA ROAD ELKHART, INDIANA 46517 PHONE (219) 294-8000


DRAWN	JAW	06/22/99	DO NOT SCALE PRINT	C. P. N.	SHEET 8 OF 8	REV
SCALE	NONE			102397-2	(A)	

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E.C.N.	ZONE	REV.	DESCRIPTION	DATE	BY	APPROVALS			
						CHK	CM	EE	PE
		A	INITIAL RELEASE FOR PRODUCTION.	08-03-99	KLW	Jaw	Jml	N/A	99

NOTES:

1. FOR SCHEMATIC SEE 125901.
2. FOR PRINTED WIRING BOARD SEE 125902-4.



**CAUTION**

STATIC CAN DAMAGE COMPONENTS!

**DO NOT HANDLE**

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PRINTS TO	1718 WEST MISHAWAKA ROAD ELKHART, INDIANA 46517 PHONE (219) 294-8000
K	<b>PWA, MA5000VZ MAIN</b>
	TOL. UNLESS SPECIFIED X.XX = ± 0.020 X.XXX = ± 0.010 DRILLS = ± 0.003
DRAWN	KLW 08-03-99 APPROVED BY: DO NOT SCALE PRINT
CHECKED	Jaw 08-04-99 ME <i>[Signature]</i> 8-5-99 SUPERSEDES
SCALE	NONE EE N/A N/A E.C.N.
PROJ #	MD24750 PE <i>[Signature]</i> 8-4-99 C.P.N. SHEET 1 OF 23 REV
FILENAME: 125903-4-A-01.PCB <span style="float: right;">125903-4 <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">A</span></span>	

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
1	125902-4	MA-5000VZ MAIN	
C1	C 5362-6	2.2UF 50V VERT ELECT T/A	I 6
C100	C 5058-0	30PF PC MNT TRIMMER CAP	I 2
C101	C 9746-6	62PF 200V 5% NPO CER AXIAL T/R	J 2
C102	C 6950-7	82PF 200V 5% NPO AXIAL CER T/R	J 2
C103	C 8870-5	150UF 25V 10% NP ELECTROLYTIC	I 1
C104	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 4
C105	C 6802-0	.47UF 50V AXIAL CER T/R 474	J 3
C106	C 6096-9	3.3UF 50V LOW LEAK T/A	I 4
C107	C 8576-8	100UF 35V 10% ALUM ELECT T/A	J 1
C108	C 6814-5	12PF 200V AXIAL CER T/R 120	K 2
C109	C 6802-0	.47UF 50V AXIAL CER T/R 474	I 2
C110	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 2
C111	C 5980-5	33PF 5% NPO CER DISC CAP T/R	L 2
C112	C 7870-6	.33 UF 63V 10% POLYESTER	L 2
C113	C 8894-5	1UF 50V VERT 10% NP ELECT T/R	L 2
C114	C 6812-9	47PF 100V AXIAL CER T/R 470	O 3
C115	C 6812-9	47PF 100V AXIAL CER T/R 470	O 3
C116	C 6813-7	27PF 200V 10% NPO AXIAL CER	O 4
C117	C 6813-7	27PF 200V 10% NPO AXIAL CER	N 4
C120	C 9465-3	10UF 50V 20% VERT ELECT T/A	H 5
C130	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 3
C131	C 6803-8	.12UF 50V AXIAL CER T/R 124	L 4
C132	C 7283-2	8.9UF 35V 10% NP VERT ELEC T/R	K 4
C133	C 6950-7	82PF 200V 5% NPO AXIAL CER T/R	J 3
C134	C 6803-8	.12UF 50V AXIAL CER T/R 124	M 4
C135	C 7283-2	8.9UF 35V 10% NP VERT ELEC T/R	M 4
C137	C 8576-8	100UF 35V 10% ALUM ELECT T/A	O 5
C138	C 8576-8	100UF 35V 10% ALUM ELECT T/A	P 5
C150	C 6804-6	.1UF 50V AXIAL CER T/R 104	J 2
C151	C 6804-6	.1UF 50V AXIAL CER T/R 104	J 2
C152	C 6804-6	.1UF 50V AXIAL CER T/R 104	J 4
C153	C 6804-6	.1UF 50V AXIAL CER T/R 104	J 3
C154	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 1
C155	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 2
C156	C 6804-6	.1UF 50V AXIAL CER T/R 104	J 3
C157	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 3
C158	C 6804-6	.1UF 50V AXIAL CER T/R 104	J 6
C159	C 6804-6	.1UF 50V AXIAL CER T/R 104	I 6
C160	C 6804-6	.1UF 50V AXIAL CER T/R 104	K 6
C161	C 6804-6	.1UF 50V AXIAL CER T/R 104	L 6
C162	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 1
C163	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 1
C164	C 6804-6	.1UF 50V AXIAL CER T/R 104	O 2
C165	C 6804-6	.1UF 50V AXIAL CER T/R 104	O 2
C166	C 6804-6	.1UF 50V AXIAL CER T/R 104	N 3
C167	C 6804-6	.1UF 50V AXIAL CER T/R 104	O 3
C168	C 6804-6	.1UF 50V AXIAL CER T/R 104	L 3

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SCALE NONE  
 PROJ # MD35650

C. P. N. SHEET 7 OF 23  
 125903-4

REV  
 (A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
C169	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 3
C171	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 5
C172	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 6
C173	C 6804-6	.1UF 50V AXIAL CER T/R 104	H 5
C174	C 6804-6	.1UF 50V AXIAL CER T/R 104	L 4
C175	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 4
C176	C 6812-9	47PF 100V AXIAL CER T/R 470	M 2
C177	C 5980-5	33PF 5% NPO CER DISC CAP T/R	N 4
C178	C 6804-6	.1UF 50V AXIAL CER T/R 104	H 4
C179	C 8870-5	150UF 25V 10% NP ELECTROLYTIC	L 5
C180	C 8870-5	150UF 25V 10% NP ELECTROLYTIC	M 5
C181	C 6804-6	.1UF 50V AXIAL CER T/R 104	H 4
C182	C 6802-0	.47UF 50V AXIAL CER T/R 474	I 6
C183	C 7752-6	2.2UF 50V 10% NP ELECT T/R	I 5
C184	C 8894-5	1UF 50V VERT 10% NP ELECT T/R	I 6
C185	C 6804-6	.1UF 50V AXIAL CER T/R 104	I 5
C186	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 3
C187	C 6804-6	.1UF 50V AXIAL CER T/R 104	M 2
C188		OPEN. . . .	L 2
C189	C 9240-0	5PF 200V 10% RADIAL CER T/R	L 5
C191	C 6671-9	.033UF 100V 10% POLY CAP T/A	K 1
C192	C 8803-6	.047UF 100V 10%X7R AXL CER T/R	O 3
C193	C 8803-6	.047UF 100V 10%X7R AXL CER T/R	P 3
C194	C 6804-6	.1UF 50V AXIAL CER T/R 104	N 3
C195	C 6804-6	.1UF 50V AXIAL CER T/R 104	I 2
C196	C 6804-6	.1UF 50V AXIAL CER T/R 104	I 2
C197	C 7752-6	2.2UF 50V 10% NP ELECT T/R	J 5
C200	C 5058-0	30PF PC MNT TRIMMER CAP	H 2
C201	C 9746-6	62PF 200V 5% NPO CER AXIAL T/R	G 2
C202	C 6950-7	82PF 200V 5% NPO AXIAL CER T/R	G 2
C203	C 8870-5	150UF 25V 10% NP ELECTROLYTIC	G 1
C204	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 4
C205	C 6802-0	.47UF 50V AXIAL CER T/R 474	G 3
C206	C 6096-9	3.3UF 50V LOW LEAK T/A	G 4
C207	C 8576-8	100UF 35V 10% ALUM ELECT T/A	F 1
C208	C 6814-5	12PF 200V AXIAL CER T/R 120	F 2
C209	C 6802-0	.47UF 50V AXIAL CER T/R 474	G 2
C210	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 2
C211	C 5980-5	33PF 5% NPO CER DISC CAP T/R	D 2
C212	C 7870-6	.33 UF 63V 10% POLYESTER	D 2
C213	C 8894-5	1UF 50V VERT 10% NP ELECT T/R	E 2
C214	C 6812-9	47PF 100V AXIAL CER T/R 470	A 3
C215	C 6812-9	47PF 100V AXIAL CER T/R 470	A 3
C216	C 6813-7	27PF 200V 10% NPO AXIAL CER	A 4
C217	C 6813-7	27PF 200V 10% NPO AXIAL CER	B 4
C220	C 9465-3	10UF 50V 20% VERT ELECT T/A	F 6
C230	C 6804-6	.1UF 50V AXIAL CER T/R 104	C 3
C231	C 6803-8	.12UF 50V AXIAL CER T/R 124	D 4
C232	C 7283-2	8.9UF 35V 10% NP VERT ELEC T/R	C 4

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SCALE	NONE
PROJ #	MD35650

C. P. N.	SHEET 8 OF 23
125903-4	

REV	(A)
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PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
C233	C 6950-7	82PF 200V 5% NPO AXIAL CER T/R	G 3
C234	C 6803-8	.12UF 50V AXIAL CER T/R 124	E 4
C235	C 7283-2	8.9UF 35V 10% NP VERT ELEC T/R	E 4
C237	C 8576-8	100UF 35V 10% ALUM ELECT T/A	B 5
C238	C 8576-8	100UF 35V 10% ALUM ELECT T/A	A 5
C250	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 2
C251	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 2
C252	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 4
C253	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 3
C254	C 6804-6	.1UF 50V AXIAL CER T/R 104	E 1
C255	C 6804-6	.1UF 50V AXIAL CER T/R 104	E 2
C256	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 3
C257	C 6804-6	.1UF 50V AXIAL CER T/R 104	G 3
C258	C 6804-6	.1UF 50V AXIAL CER T/R 104	H 6
C259	C 6804-6	.1UF 50V AXIAL CER T/R 104	G 6
C260	C 6804-6	.1UF 50V AXIAL CER T/R 104	E 6
C261	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 6
C262	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 1
C263	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 2
C264	C 6804-6	.1UF 50V AXIAL CER T/R 104	A 2
C265	C 6804-6	.1UF 50V AXIAL CER T/R 104	B 2
C266	C 6804-6	.1UF 50V AXIAL CER T/R 104	B 3
C267	C 6804-6	.1UF 50V AXIAL CER T/R 104	A 3
C268	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 3
C269	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 3
C271	C 6804-6	.1UF 50V AXIAL CER T/R 104	C 5
C272	C 6804-6	.1UF 50V AXIAL CER T/R 104	C 6
C274	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 4
C275	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 4
C276	C 6812-9	47PF 100V AXIAL CER T/R 470	D 2
C277	C 5980-5	33PF 5% NPO CER DISC CAP T/R	B 4
C279	C 8870-5	150UF 25V 10% NP ELECTROLYTIC	C 5
C280	C 8870-5	150UF 25V 10% NP ELECTROLYTIC	E 5
C282	C 6802-0	.47UF 50V AXIAL CER T/R 474	G 6
C283	C 7752-6	2.2UF 50V 10% NP ELECT T/R	G 5
C284	C 8894-5	1UF 50V VERT 10% NP ELECT T/R	F 6
C285	C 6804-6	.1UF 50V AXIAL CER T/R 104	G 5
C286	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 3
C287	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 2
C288		OPEN. . . .	D 2
C289	C 9240-0	5PF 200V 10% RADIAL CER T/R	E 5
C291	C 6671-9	.033UF 100V 10% POLY CAP T/A	F 1
C292	C 8803-6	.047UF 100V 10%X7R AXL CER T/R	B 3
C293	C 8803-6	.047UF 100V 10%X7R AXL CER T/R	A 3
C294	C 6804-6	.1UF 50V AXIAL CER T/R 104	E 3
C296	C 6804-6	.1UF 50V AXIAL CER T/R 104	G 2
C297	C 7752-6	2.2UF 50V 10% NP ELECT T/R	F 5
D1	C 3181-2	DIODE. 1N4148 T/R	H 6
D2	C 3181-2	DIODE. 1N4148 T/R	H 6

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SCALE	NONE	C. P. N.	SHEET 9 OF 23	REV
PROJ #	MD35650		125903-4	(A)



PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
D100	C 3181-2	DIODE, 1N4148 T/R	K 4
D101	C 3181-2	DIODE, 1N4148 T/R	J 4
D102	C 3181-2	DIODE, 1N4148 T/R	L 6
D103	C 8158-5	DIODE 1SS143 SWITCHING T/R	M 6
D104	C 8158-5	DIODE 1SS143 SWITCHING T/R	M 6
D105	C 8158-5	DIODE 1SS143 SWITCHING T/R	N 6
D106	C 8158-5	DIODE 1SS143 SWITCHING T/R	N 6
D107	C 3181-2	DIODE, 1N4148 T/R	K 5
D110	C 3181-2	DIODE, 1N4148 T/R	N 6
D112	C 3181-2	DIODE, 1N4148 T/R	J 6
D113	C 3181-2	DIODE, 1N4148 T/R	I 6
D114	C 3181-2	DIODE, 1N4148 T/R	O 3
D115	C 3181-2	DIODE, 1N4148 T/R	O 1
D116	C 3181-2	DIODE, 1N4148 T/R	P 1
D119	C 3181-2	DIODE, 1N4148 T/R	O 4
D120	C 3181-2	DIODE, 1N4148 T/R	O 1
D121	C 3181-2	DIODE, 1N4148 T/R	P 1
D122	C 3181-2	DIODE, 1N4148 T/R	O 1
D123	C 3181-2	DIODE, 1N4148 T/R	P 2
D124	C 3181-2	DIODE, 1N4148 T/R	N 5
D125	C 3181-2	DIODE, 1N4148 T/R	O 5
D126	C 3181-2	DIODE, 1N4148 T/R	P 6
D127	C 3181-2	DIODE, 1N4148 T/R	J 3
D128	C 3181-2	DIODE, 1N4148 T/R	J 3
D129	C 8182-5	1N753A 6.2V .5W ZENER DIODE	L 2
D130	C 3181-2	DIODE, 1N4148 T/R	L 1
D131	C 3181-2	DIODE, 1N4148 T/R	L 1
D132	C 3181-2	DIODE, 1N4148 T/R	L 2
D133	C 3181-2	DIODE, 1N4148 T/R	K 3
D134	C 3181-2	DIODE, 1N4148 T/R	K 3
D135	C 3181-2	DIODE, 1N4148 T/R	J 5
D136	C 3181-2	DIODE, 1N4148 T/R	N 3
D137	C 3181-2	DIODE, 1N4148 T/R	O 1
D138	C 3181-2	DIODE, 1N4148 T/R	O 1
D139	C 3181-2	DIODE, 1N4148 T/R	O 1
D140	C 5082-0	DIODE, 1N4733A 5.1V ZENER T/R	I 2
D141	C 3181-2	DIODE, 1N4148 T/R	K 6
D142	C 3181-2	DIODE, 1N4148 T/R	K 6
D200	C 3181-2	DIODE, 1N4148 T/R	F 4
D201	C 3181-2	DIODE, 1N4148 T/R	G 4
D202	C 3181-2	DIODE, 1N4148 T/R	F 6
D203	C 8158-5	DIODE 1SS143 SWITCHING T/R	C 6
D204	C 8158-5	DIODE 1SS143 SWITCHING T/R	C 6
D205	C 8158-5	DIODE 1SS143 SWITCHING T/R	D 6
D206	C 8158-5	DIODE 1SS143 SWITCHING T/R	D 6
D207	C 3181-2	DIODE, 1N4148 T/R	E 5
D210	C 3181-2	DIODE, 1N4148 T/R	B 6
D212	C 3181-2	DIODE, 1N4148 T/R	G 6
D213	C 3181-2	DIODE, 1N4148 T/R	G 6

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	PROJ #	MD35650	SHEET 10 OF 23
125903-4			REV <b>(A)</b>



PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
Q104	C 8103-1	MPSW42 300V 1 WATT NPN T/R	P 6
Q105	C 7458-0	2N4123 30V NPN T/R	N 5
Q106	C 3625-8	2N4125 30V PNP T/R	N 5
Q107	C 3625-8	2N4125 30V PNP T/R	N 5
Q108	C 3625-8	2N4125 30V PNP T/R	O 5
Q109	C 7458-0	2N4123 30V NPN T/R	O 5
Q110	C 3786-8	MPS4250A 40V PNP T/R	K 5
Q112	C 8563-6	J177 30V P-CHANNEL T/R	L 1
Q113	C 7458-0	2N4123 30V NPN T/R	N 4
Q114	C 7458-0	2N4123 30V NPN T/R	N 3
Q115	C 3786-8	MPS4250A 40V PNP T/R	J 5
Q200	C 7458-0	2N4123 30V NPN T/R	G 4
Q201	C 3625-8	2N4125 30V PNP T/R	A 4
Q202	C 3625-8	2N4125 30V PNP T/R	A 4
Q203	C 8104-9	MPSW92 300V 1 WATT PNP T/R	A 6
Q204	C 8103-1	MPSW42 300V 1 WATT NPN T/R	B 6
Q205	C 7458-0	2N4123 30V NPN T/R	B 5
Q206	C 3625-8	2N4125 30V PNP T/R	A 5
Q207	C 3625-8	2N4125 30V PNP T/R	B 5
Q208	C 3625-8	2N4125 30V PNP T/R	A 5
Q209	C 7458-0	2N4123 30V NPN T/R	A 5
Q210	C 3786-8	MPS4250A 40V PNP T/R	E 5
Q212	C 8563-6	J177 30V P-CHANNEL T/R	D 1
Q213	C 7458-0	2N4123 30V NPN T/R	B 4
Q214	C 7458-0	2N4123 30V NPN T/R	B 3
Q215	C 3786-8	MPS4250A 40V PNP T/R	F 5
R1	A10265-10041	1.0 MOHM .25W 1% MF T/R	B 2
R2	OPEN		
R2X	C10447-8	100KOHM LINEAR TRIMPOT	B 2
R3	A10265-33221	33.2KOHM .25W 1% MF T/R	C 2
R4	C 8861-4	250 KOHM HORZ TRIMPOT	C 1
R6	A10265-10031	100. KOHM .25W 1% MF T/R	I 6
R7	A10266-3941	390.KOHM .25W 5 CF T/R	I 6
R8	A10265-10031	100. KOHM .25W 1% MF T/R	I 6
R12	A10265-10031	100. KOHM .25W 1% MF T/R	H 5
R14	A10265-24921	24.9 KOHM .25W 1% MF T/R	H 6
R100	A10265-49911	4.99 KOHM .25W 1% MF T/R	H 2
R101	A10265-49911	4.99 KOHM .25W 1% MF T/R	H 2
R102	A10265-49911	4.99 KOHM .25W 1% MF T/R	I 2
R103	A10265-49911	4.99 KOHM .25W 1% MF T/R	I 2
R104	A10266-3341	330. KOHM .25W 5% CF T/R	I 1
R105	C 8862-2	500K HORZ TRIMPOT	H 1
R106	A10265-10021	10. KOHM .25W 1% MF T/R	J 2
R107	A10265-10021	10. KOHM .25W 1% MF T/R	J 2
R108	A10265-10521	10.5KOHM .25W 1% MF T/R	I 3
R109	A10266-6212	620. OHM .5W 5% CF T/R	J 3
R110	A10266-2251	2.2 MOHM .25W 5% CF T/R	K 4
R111	A10265-51131	511. KOHM .25W 1% MF T/R	K 4

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SCALE	NONE
PROJ #	MD35650

C. P. N. SHEET 12 OF 23  
 125903-4

REV  
 (A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R112	A10265-20031	200.KOHM .25W 1% MF T/R	K 3
R113	A10265-47521	47.5 KOHM .25W 1% MF T/R	J 4
R114	A10265-28021	28. KOHM .25W 1% MF T/R	J 3
R115	A10265-18231	182. KOHM .25W 1% MF T/R	J 4
R116	A10265-19121	19.1 KOHM .25W 1% MF T/R	J 3
R117	A10265-12731	127 KOHM .25W 1% MF T/R	J 2
R118	A10265-19121	19.1 KOHM .25W 1% MF T/R	K 3
R119	A10265-88711	8.87 KOHM .25W 1% MF T/R	J 1
R120	C 7526-4	3POS .1 CENTER MTA HEADER	I 1
R121	A10265-49921	49.9 KOHM .25W 1% MF T/R	J 1
R122	A10265-49921	49.9 KOHM .25W 1% MF T/R	K 2
R123	A10266-4701	47.0 OHM .25W 5% CF T/R	K 2
R124	A10265-49911	4.99 KOHM .25W 1% MF T/R	J 2
R125	A10265-47511	4.75 KOHM .25W 1% MF T/R	J 2
R126	A10265-10031	100. KOHM .25W 1% MF T/R	K 2
R127	A10265-75021	75. KOHM .25W 1% MF T/R	K 2
R128	A10265-19121	19.1 KOHM .25W 1% MF T/R	M 2
R129	A10265-10711	1.07 KOHM .25W 1% MF T/R	M 1
R130	A10265-19121	19.1 KOHM .25W 1% MF T/R	C 2
R131	A10265-20021	20. KOHM .25W 1% MF T/R	K 1
R132	C 8906-7	19.1 KOHM .5W 1% MF T/R	M 2
R133	A10265-40201	402. OHM .25W 1% MF T/R	L 2
R134	A10266-3941	390.KOHM .25W 5% CF T/R	L 2
R135	A10265-10021	10. KOHM .25W 1% MF T/R	K 3
R136	A10265-49911	4.99 KOHM .25W 1% MF T/R	K 3
R137	A10265-33221	33.2 KOHM .25W 1% MF T/R	K 3
R138	A10265-24911	2.49 KOHM .25W 1% MF T/R	P 3
R139	A10265-49911	4.99 KOHM .25W 1% MF T/R	P 3
R140	A10265-49911	4.99 KOHM .25W 1% MF T/R	N 3
R141	A10265-24911	2.49 KOHM .25W 1% MF T/R	N 3
R142	A10265-61911	6.19 KOHM .25W 1% MF T/R	O 3
R143	A10265-15011	1.5 KOHM .25W 1% MF T/R	O 4
R144	A10265-15011	1.5 KOHM .25W 1% MF T/R	O 4
R145	A10265-61911	6.19 KOHM .25W 1% MF T/R	O 3
R146	A10265-20001	200. OHM .25W 1% MF T/R	P 3
R147	A10265-20001	200. OHM .25W 1% MF T/R	P 3
R148	A10265-23201	232OHM .25W 1% MF T/R	P 4
R149	A10265-23201	232OHM .25W 1% MF T/R	P 4
R150	A10265-23201	232OHM .25W 1% MF T/R	N 3
R151	A10265-23201	232OHM .25W 1% MF T/R	N 4
R152	A10265-24911	2.49 KOHM .25W 1% MF T/R	P 4
R153	A10265-49911	4.99 KOHM .25W 1% MF T/R	P 4
R154	A10265-10011	1.0 KOHM .25W 1% MF T/R	N 4
R155	A10265-49911	4.99 KOHM .25W 1% MF T/R	N 4
R156	A10265-24911	2.49 KOHM .25W 1% MF T/R	N 4
R157	C 8906-7	19.1 KOHM .5W 1% MF T/R	N 4
R158	A10266-2751	2.7 MOHM .25W 5% CF T/R	J 4

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SCALE	NONE
PROJ #	MD3565D

C. P. N.

SHEET 13 OF 23

REV

125903-4

(A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R159	A10265-33211	3.32 KOHM .25W 1% MF T/R	L 6
R161	A10265-13321	13.3 KOHM .25W 1% MF T/R	M 5
R162	A10265-20021	20. KOHM .25W 1% MF T/R	M 5
R163	A10265-20021	20. KOHM .25W 1% MF T/R	M 6
R164	A10265-20021	20. KOHM .25W 1% MF T/R	M 6
R165	A10265-13321	13.3 KOHM .25W 1% MF T/R	M 6
R166	A10265-20021	20. KOHM .25W 1% MF T/R	M 6
R167	A10265-13321	13.3 KOHM .25W 1% MF T/R	N 6
R168	A10265-20021	20. KOHM .25W 1% MF T/R	N 6
R169	A10265-20021	20. KOHM .25W 1% MF T/R	N 6
R170	A10265-20021	20. KOHM .25W 1% MF T/R	N 5
R171	A10265-13321	13.3 KOHM .25W 1% MF T/R	N 5
R172	A10265-20021	20. KOHM .25W 1% MF T/R	N 5
R173	A10265-10041	1.0 MOHM .25W 1% MF T/R	M 5
R174	A10265-10041	1.0 MOHM .25W 1% MF T/R	N 5
R175	A10265-10001	100. OHM .25W 1% MF T/R	L 3
R176	A10265-28021	28. KOHM .25W 1% MF T/R	I 5
R177	A10265-24921	24.9 KOHM .25W 1% MF T/R	I 5
R178	C 6406-0	8.15KOHM .25W 1% MF T/R	I 5
R179	A10265-78722	78.7 KOHM .5W 1% MF T/R	P 5
R180	A10265-10001	100. OHM .25W 1% MF T/R	L 4
R181	A10265-27431	274. KOHM .25W 1% MF T/R	L 4
R182X	C10447-8	100 KOHM TRIMMER	L 3
R182	OPEN		
R183	A10265-10021	10. KOHM .25W 1% MF T/R	I 5
R184	A10265-10011	1.0 KOHM .25W 1% MF T/R	I 5
R186	A10265-10001	100. OHM .25W 1% MF T/R	M 3
R187	A10265-78722	78.7 KOHM .5W 1% MF T/R	O 5
R188	A10265-10001	100. OHM .25W 1% MF T/R	M 3
R189	C 6406-0	8.15 KOHM .25W 1% MF T/R	M 4
R190	A10265-27431	274. KOHM .25W 1% MF T/R	M 4
R191	OPEN		
R191X	C10447-8	100 KOHM TRIMMER	M 3
R192	A10265-28021	28. KOHM .25W 1% MF T/R	L 4
R193	A10265-60421	60.4KOHM .25W 1% MF T/R	L 4
R194	A10265-33221	33.2KOHM .25W 1% MF T/R	L 4
R195	A10265-28021	28. KOHM .25W 1% MF T/R	M 4
R196	A10265-60421	60.4KOHM .25W 1% MF T/R	M 4
R197	A10265-33221	33.2KOHM .25W 1% MF T/R	M 4
R198	A10265-11301	113. OHM .25W 1% MF T/R	P 3
R199	A10265-10021	10. KOHM .25W 1% MF T/R	P 2
R200	A10265-49911	4.99 KOHM .25W 1% MF T/R	H 2
R201	A10265-49911	4.99 KOHM .25W 1% MF T/R	H 2
R202	A10265-49911	4.99 KOHM .25W 1% MF T/R	G 2
R203	A10265-49911	4.99 KOHM .25W 1% MF T/R	G 2
R204	A10266-3341	330. KOHM .25W 5% CF T/R	G 1
R205	C 8862-2	500K HORZ TRIMPOT	H 1
R206	A10265-10021	10. KOHM .25W 1% MF T/R	G 2
R207	A10265-10021	10. KOHM .25W 1% MF T/R	G 2

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SCALE	NONE
PROJ #	MD35650

C. P. N.	SHEET 14 OF 23
125903-4	

REV  
A

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R208	A10265-10521	10.5KOHM .25W 1% MF T/R	G 3
R209	A10266-6212	620. OHM .5W 5% CF T/R	G 3
R210	A10266-2251	2.2 MOHM .25W 5% CF T/R	F 4
R211	A10265-51131	511. KOHM .25W 1% MF T/R	F 4
R212	A10265-20031	200. KOHM .25W 1% MF T/R	F 3
R213	A10265-47521	47.5 KOHM .25W 1% MF T/R	G 4
R214	A10265-28021	28. KOHM .25W 1% MF T/R	G 3
R215	A10265-18231	182. KOHM .25W 1% MF T/R	G 4
R216	A10265-19121	19.1 KOHM .25W 1% MF T/R	G 3
R217	A10265-12731	127 KOHM .25W 1% MF T/R	G 2
R218	A10265-19121	19.1 KOHM .25W 1% MF T/R	F 3
R219	A10265-88711	8.87 KOHM .25W 1% MF T/R	G 1
R220	C 7526-4	3POS .1 CENTER MTA HEADER	G 1
R221	A10265-49921	49.9 KOHM .25W 1% MF T/R	G 1
R222	A10265-49921	49.9 KOHM .25W 1% MF T/R	F 2
R223	A10266-4701	47.0 OHM .25W 5% CF T/R	F 2
R224	A10265-49911	4.99 KOHM .25W 1% MF T/R	G 2
R225	A10265-47511	4.7 KOHM .25W 1% MF T/R	G 2
R226	A10265-10031	100. KOHM .25W 1% MF T/R	F 2
R227	A10265-75021	75. KOHM .25W 1% MF T/R	F 2
R228	A10265-19121	19.1 KOHM .25W 1% MF T/R	C 2
R229	A10265-10711	1.07 KOHM .25W 1% MF T/R	C 2
R230	A10265-19121	19.1 KOHM .25W 1% MF T/R	C 2
R231	A10265-20021	20. KOHM .25W 1% MF T/R	F 1
R232	C 8906-7	19.1 KOHM .5W 1% MF T/R	C 1
R233	A10265-40201	402. OHM .25W 1% MF T/R	E 2
R234	A10266-3941	390. KOHM .25W 5% CF T/R	E 2
R235	A10265-10021	10. KOHM .25W 1% MF T/R	F 3
R236	A10265-49911	4.99 KOHM .25W 1% MF T/R	F 3
R237	A10265-33221	33.2 KOHM .25W 1% MF T/R	F 3
R238	A10265-24911	2.49 KOHM .25W 1% MF T/R	A 3
R239	A10265-49911	4.99 KOHM .25W 1% MF T/R	A 3
R240	A10265-49911	4.99 KOHM .25W 1% MF T/R	B 3
R241	A10265-24911	2.49 KOHM .25W 1% MF T/R	B 3
R242	A10265-61911	6.19 KOHM .25W 1% MF T/R	A 3
R243	A10265-15011	1.5 KOHM .25W 1% MF T/R	A 4
R244	A10265-15011	1.5 KOHM .25W 1% MF T/R	B 4
R245	A10265-61911	6.19 KOHM .25W 5% CF T/R	B 3
R246	A10265-20001	200. OHM .25W 1% MF T/R	A 3
R247	A10265-20001	200. OHM .25W 1% MF T/R	A 3
R248	A10265-23201	232 OHM .25W 1% MF T/R	A 4
R249	A10265-23201	232 OHM .25W 1% MF T/R	A 4
R250	A10265-23201	232 OHM .25W 1% MF T/R	B 3
R251	A10265-23201	232 OHM .25W 1% MF T/R	B 4
R252	A10265-24911	2.49 KOHM .25W 1% MF T/R	A 4
R253	A10265-49911	4.99 KOHM .25W 1% MF T/R	A 4
R254	A10265-10011	1.0 KOHM .25W 1% MF T/R	B 4

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SCALE	NONE	C. P. N.	SHEET 15 OF 23	REV
PROJ #	MD35650	125903-4		(A)

PARTS LIST			
REF DES	C.P.N.	DESCRIPTION	MAP LOC.
R255	A10265-49911	4.99 KOHM .25W 1% MF T/R	B 4
R256	A10265-24911	2.49 KOHM .25W 1% MF T/R	B 4
R257	C 8906-7	19.1 KOHM .5W 1% MF T/R	B 4
R258	A10266-2751	2.7 MOHM .25W 5% CF T/R	G 4
R259	A10265-33211	3.32 KOHM .25W 1% MF T/R	F 6
R261	A10265-13321	13.3 KOHM .25W 1% MF T/R	C 5
R262	A10265-20021	20. KOHM .25W 1% MF T/R	C 5
R263	A10265-20021	20. KOHM .25W 1% MF T/R	C 6
R264	A10265-20021	20. KOHM .25W 1% MF T/R	C 6
R265	A10265-13321	13.3 KOHM .25W 1% MF T/R	C 6
R266	A10265-20021	20. KOHM .25W 1% MF T/R	C 6
R267	A10265-13321	13.3 KOHM .25W 1% MF T/R	D 6
R268	A10265-20021	20. KOHM .25W 1% MF T/R	D 6
R269	A10265-20021	20. KOHM .25W 1% MF T/R	D 6
R270	A10265-20021	20. KOHM .25W 1% MF T/R	D 5
R271	A10265-13321	13.3 KOHM .25W 1% MF T/R	D 5
R272	A10265-20021	20. KOHM .25W 1 MF T/R	D 5
R273	A10265-10041	1.0 MOHM .25W 1% MF T/R	C 5
R274	A10265-10041	1.0 MOHM .25W 1% MF T/R	D 5
R275	A10265-10001	100. OHM .25W 1% MF T/R	D 3
R276	A10265-28021	28. KOHM .25W 1% MF T/R	H 5
R277	A10265-24921	24.9 KOHM .25W 1% MF T/R	H 5
R278	C 6406-0	8.15 KOHM .25W 1% MF T/R	H 5
R279	A10265-78722	78.7 KOHM .5W 1% MF T/R	B 5
R280	A10265-10001	100. OHM .25W 1% MF T/R	D 4
R281	A10265-27431	274. KOHM .25W 1% MF T/R	D 4
R282	OPEN		
R282X	C10447-8	100 KOHM TRIMMER	C 3
R283	A10265-10021	10. KOHM .25W 1% MF T/R	H 5
R284	A10265-10011	1.0 KOHM .25W 1% MF T/R	H 5
R286	A10265-10001	100. OHM .25W 1% MF T/R	E 3
R287	A10265-78722	78.7 KOHM .5W 1% MF T/R	B 5
R288	A10265-10001	100. OHM .25W 1% MF T/R	E 3
R289	C 6406-0	8.15 KOHM .25W 1% MF T/R	E 4
R290	A10265-27431	274. KOHM .25W 1% MF T/R	E 4
R291	OPEN		
R291X	C10447-8	100 KOHM TRIMMER	E 3
R292	A10265-28021	28. KOHM .25W 1% MF T/R	D 4
R293	A10265-60421	60.4 KOHM .25W 1% MF T/R	D 4
R294	A10265-33221	33.2 KOHM .25W 1% MF T/R	D 4
R295	A10265-28021	28. KOHM .25W 1% MF T/R	E 4
R296	A10265-60421	60.4 KOHM .25W 1% MF T/R	E 4
R297	A10265-33221	33.2 KOHM .25W 1% MF T/R	E 4
R298	A10265-11301	113. OHM .25W 1% MF T/R	A 3
R299	A10265-10021	10. KOHM .25W 1% MF T/R	A 2
R300	A10265-10021	10. KOHM .25W 1% MF T/R	O 2
R301	A10265-11301	113. OHM .25W 1% MF T/R	O 2
R302	A10265-10021	10. KOHM .25W 1% MF T/R	O 2
R303	A10265-16221	16.2 KOHM .25W 1% MF T/R	O 2

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SCALE	NONE	C.P.N.
PROJ #	MD35650	

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125903-4

REV  
**(A)**

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R304	A10265-47531	475. KOHM .25W 1% MF T/R	O 2
R305	A10265-47531	475. KOHM .25W 1% MF T/R	O 2
R306	A10265-11301	113. OHM .25W 1% MF T/R	P 2
R307	A10265-16221	16.2 KOHM .25W 1% MF T/R	P 2
R308	A10265-10021	10. KOHM .25W 1% MF T/R	P 2
R309	A10265-47531	475. KOHM .25W 1% MF T/R	P 2
R310	A10265-47531	475. KOHM .25W 1% MF T/R	P 2
R311	A10265-45301	453. OHM .25W 1% MF T/R	N 5
R312	A10265-45301	453. OHM .25W 1% MF T/R	N 5
R313	A10265-45301	453. OHM .25W 1% MF T/R	N 5
R314	A10265-45301	453. OHM .25W 1% MF T/R	O 5
R315	A10265-45301	453. OHM .25W 1% MF T/R	O 5
R316	A10265-45301	453. OHM .25W 1% MF T/R	O 5
R317	A10265-20021	20. KOHM .25W 1% MF T/R	O 4
R318	A10265-20021	20. KOHM .25W 1% MF T/R	P 4
R319	A10265-11301	113. OHM .25W 1% MF T/R	O 3
R320	A10265-49911	4.99KOHM .25W 1% MF T/R	L 3
R321	A10265-11531	115. KOHM .25W 1% MF T/R	P 3
R322	A10265-60421	60.4 KOHM .25W 1% MF T/R	K 6
R323	A10265-90921	90.9 KOHM .25W 1% MF T/R	K 6
R324	A10265-47521	47.5 KOHM .25W 1% MF T/R	K 5
R325	A10265-47521	47.5 KOHM .25W 1% MF T/R	K 5
R326	A10265-33211	3.32 KOHM .25W 1% MF T/R	K 6
R327	A10265-10031	100. KOHM .25W 1% MF T/R	J 6
R328	A10265-12741	1.27 MOHM .25W 1% MF T/R	J 6
R329	A10265-82521	82.5 KOHM .25W 1% MF T/R	J 6
R330	A10265-47531	475. KOHM .25W 1% MF T/R	J 5
R331	A10265-20021	20. KOHM .25W 1% MF T/R	L 2
R332	A10265-35731	357. KOHM .25W 1% MF T/R	L 2
R333	A10265-33211	3.32 KOHM .25W 1% MF T/R	K 6
R334	A10265-10021	10. KOHM .25W 1% MF T/R	L 1
R335	A10265-47521	47.5 KOHM .25W 1% MF T/R	L 1
R336	A10265-33211	3.32 KOHM .25W 1% MF T/R	P 4
R337	A10266-8241	820. KOHM .25W 5% CF T/R	C 2
R338	A10265-47521	47.5 KOHM .25W 1% MF T/R	L 5
R339	A10265-14321	14.3 KOHM .25W 1% MF T/R	L 5
R340	A10265-47521	47.5 KOHM .25W 1% MF T/R	L 6
R341	A10265-20001	200. OHM .25W 1% MF T/R	N 4
R342	A10265-20001	200. OHM .25W 1% MF T/R	N 3
R343	A10265-20031	200 KOHM .25W 1% MF T/R	I 4
R344	A10265-39221	39.2 KOHM .25W 1% MF T/R	K 5
R345	C 6406-0	8.15 KOHM .25W 1% MF T/R	L 3
R346	A10265-25511	2.55 KOHM .25W 1% MF T/R	O 3
R347	A10265-68111	6.81 KOHM .25W 1% MF T/R	O 2
R348	A10265-68111	6.81 KOHM .25W 1% MF T/R	P 2
R349	A10265-25511	2.55 KOHM .25W 1% MF T/R	P 3
R350	A10265-10041	1.0 MOHM .25W 1% MF T/R	L 5

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SCALE	NONE	C. P. N.	SHEET 17 OF 23	REV
PROJ #	MD35650		125903-4	(A)



PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R351	A10265-33211	3.32 KOHM .25W 1% MF T/R	I 3
R352	A10265-47521	47.5 KOHM .25W 1% MF T/R	N 6
R353	A10265-47521	47.5 KOHM .25W 1% MF T/R	N 6
R354	A10265-49911	4.99 KOHM .25W 1% MF T/R	I 3
R355	A10265-68111	6.81 KOHM .25W 1% MF T/R	J 6
R356	A10265-47531	475. KOHM .25W 1% MF T/R	I 5
R357	A10265-47531	475. KOHM .25W 1% MF T/R	I 5
R358	A10265-47531	475. KOHM .25W 1% MF T/R	I 5
R359	A10265-47531	475. KOHM .25W 1% MF T/R	I 6
R360	A10265-15021	15. KOHM .25W 1% MF T/R	J 6
R361	A10265-33211	3.32 KOHM .25W 1% MF T/R	J 6
R362	A10265-10031	100. KOHM .25W 1% MF T/R	K 5
R363	A10265-10021	10. KOHM .25W 1% MF T/R	N 6
R364	A10265-19121	19.1 KOHM .25W 1% MF T/R	J 1
R367	A10265-11031	110. KOHM .25W 1% MF T/R	I 4
R368	A10265-10021	10. KOHM .25W 1% MF T/R	J 5
R369	A10265-10031	100. KOHM .25W 1% MF T/R	J 3
R370	A10265-49911	4.99 KOHM .25W 1% MF T/R	I 2
R371	A10265-49911	4.99 KOHM .25W 1% MF T/R	I 2
R372	A10265-10221	10.2 KOHM .25W 1% MF T/R	I 4
R373	A10265-14031	140 KOHM .25W 1% MF T/R	N 5
R374	A10265-82521	82.5 KOHM .25W 1% MF T/R	N 5
R375	A10265-22111	2.2 KOHM .25W 1% MF T/R	K 5
R376	A10265-15031	150. KOHM .25W 1% MF T/R	M 3
R377	A10265-56211	5.62 KOHM .25W 1% MF T/R	L 3
R378	A10265-17821	17.8 KOHM .25W 1% MF T/R	M 2
R379	A10265-34021	34.0 KOHM .25W 1% MF T/R	M 3
R380		OPEN. . . .	M 2
R381	A10266-2051	2.0 MOHM .25W 5% CF T/R	K 4
R382	A10265-10031	100. KOHM .25W 1% MF T/R	K 3
R383	A10265-45301	453. OHM .25W 1% MF T/R	K 1
R385	A10265-15011	1.5 KOHM .25W 1% MF T/R	I 3
R386	A10266-5102	51.0 OHM .5W 5% CF T/R	N 5
R387	A10266-5102	51.0 OHM .5W 5% CF T/R	P 5
R388	A10265-10021	10. KOHM .25W 1% MF T/R	K 2
R389	A10265-23701	237. OHM .25W 1% MF T/R	O 1
R392	A10265-12121	12.1 KOHM .25W 1% MF T/R	I 5
R393	A10265-10031	100. KOHM .25W 1% MF T/R	I 5
R394	A10265-15011	1.5 KOHM .25W 1% MF T/R	J 5
R397	A10265-10011	1.0 KOHM .25W 1% MF T/R	O 1
R398	A10265-49921	49.9 KOHM .25W 1% MF T/R	N 2
R399	A10265-10031	100. KOHM .25W 1% MF T/R	N 2
R400	A10265-10021	10. KOHM .25W 1% MF T/R	B 2

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SCALE	NONE
PROJ #	MD35650

C. P. N.	SHEET 18 OF 23
125903-4	

REV	(A)
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PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R401	A10265-11301	113. OHM .25W 1% MF T/R	B 2
R402	A10265-10021	10. KOHM .25W 1% MF T/R	B 2
R403	A10265-16221	16.2 KOHM .25W 1% MF T/R	B 2
R404	A10265-47531	475. KOHM .25W 1% MF T/R	B 2
R405	A10265-47531	475. KOHM .25W 1% MF T/R	B 2
R406	A10265-11301	113. OHM .25W 1% MF T/R	A 2
R407	A10265-16221	16.2 KOHM .25W 1% MF T/R	A 2
R408	A10265-10021	10. KOHM .25W 1% MF T/R	A 2
R409	A10265-47531	475. KOHM .25W 1% MF T/R	A 2
R410	A10265-47531	475. KOHM .25W 1% MF T/R	A 2
R411	A10265-45301	453. OHM .25W 1% MF T/R	B 5
R412	A10265-45301	453. OHM .25W 1% MF T/R	A 5
R413	A10265-45301	453. OHM .25W 1% MF T/R	A 5
R414	A10265-45301	453. OHM .25W 1% MF T/R	A 5
R415	A10265-45301	453. OHM .25W 1% MF T/R	A 5
R416	A10265-45301	453. OHM .25W 1% MF T/R	A 5
R417	A10265-20021	20. KOHM .25W 1% MF T/R	B 4
R418	A10265-20021	20. KOHM .25W 1% MF T/R	A 4
R419	A10265-11301	113. OHM .25W 1% MF T/R	B 3
R420	A10265-49911	4.99 KOHM .25W 1% MF T/R	C 3
R421	A10265-11531	115. KOHM .25W 1% MF T/R	A 3
R422	A10265-90921	90.9 KOHM .25W 1% MF T/R	E 6
R423	A10265-60421	60.4 KOHM .25W 1% MF T/R	E 6
R424	A10265-47521	47.5 KOHM .25W 1% MF T/R	E 5
R425	A10265-47521	47.5 KOHM .25W 1% MF T/R	E 5
R426	A10265-33211	3.32 KOHM .25W 1% MF T/R	E 6
R427	A10265-10031	100. KOHM .25W 1% MF T/R	G 5
R428	A10265-12741	1.27 MOHM .25W 1% MF T/R	G 6
R429	A10265-82521	82.5 KOHM .25W 1% MF T/R	G 6
R430	A10265-47531	473. KOHM .25W 1% MF T/R	G 6
R431	A10265-20021	20. KOHM .25W 1% MF T/R	E 2
R432	A10265-35731	357. KOHM .25W 1% MF T/R	E 2
R433	A10265-33211	3.32 KOHM .25W 1% MF T/R	E 6
R434	A10265-10021	10. KOHM .25W 1% MF T/R	E 1
R435	A10265-47521	47.5 KOHM .25W 1% MF T/R	E 1
R436	A10265-33211	3.32 KOHM .25W 1% MF T/R	B 4
R438	A10265-47521	47.5 KOHM .25W 1% MF T/R	F 5
R439	A10265-14321	14.3 KOHM .25W 1% MF T/R	F 6
R440	A10265-47521	47.5 KOHM .25W 1% MF T/R	F 6
R441	A10265-20001	200. OHM .25W 1% MF T/R	B 4
R442	A10265-20001	200. OHM .25W 1% MF T/R	B 3
R443	A10265-20031	200 KOHM .25W 1% MF T/R	H 4
R444	A10265-39221	39.2 KOHM .25W 1% MF T/R	E 5
R445	C 6406-0	8.15 KOHM .25W 1% MF T/R	D 3
R446	A10265-25511	2.55 KOHM .25W 1% MF T/R	B 3
R447	A10265-68111	6.81 KOHM .25W 1% MF T/R	A 2
R448	A10265-68111	6.81 KOHM .25W 1% MF T/R	A 2

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SCALE	NONE
PROJ #	MD356S0

C. P. N.

125903-4

SHEET 19 OF 23

REV

(A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R449	A10265-25511	2.55 KOHM .25W 1% MF T/R	A 3
R450	A10265-10041	1.0 MOHM .25W 1% MF T/R	F 5
R451	A10265-33211	3.32 KOHM .25W 1% MF T/R	G 3
R452	A10265-47521	47.5 KOHM .25W 1% MF T/R	C 6
R453	A10265-47521	47.5 KOHM .25W 1% MF T/R	C 6
R454	A10265-49911	4.99 KOHM .25W 1% MF T/R	G 3
R455	A10265-68111	6.81 KOHM .25W 1% MF T/R	G 6
R456	A10265-47531	475. KOHM .25W 1% MF T/R	G 5
R457	A10265-47531	475. KOHM .25W 1% MF T/R	G 5
R458	A10265-47531	475. KOHM .25W 1% MF T/R	G 5
R459	A10265-47531	475. KOHM .25W 1% MF T/R	G 5
R460	A10265-15021	15. KOHM .25W 1% MF T/R	H 6
R461	A10265-33211	3.32 KOHM .25W 1% MF T/R	H 6
R462	A10265-10031	100. KOHM .25W 1% MF T/R	E 5
R463	A10265-10021	10. KOHM .25W 1% MF T/R	C 6
R464	A10265-19121	19.1 KOHM .25W 1% MF T/R	G 1
R467	A10265-11031	110. KOHM .25W 1% MF T/R	G 4
R468	A10265-10021	10. KOHM .25W 1% MF T/R	G 5
R469	A10265-10031	100. KOHM .25W 1% MF T/R	G 3
R470	A10265-49911	4.99 KOHM .25W 1% MF T/R	G 2
R471	A10265-49911	4.99 KOHM .25W 1% MF T/R	G 2
R472	A10265-10221	10.2 KOHM .25W 1% MF T/R	H 4
R473	A10265-14031	140. KOHM .25W 1% MF T/R	D 5
R474	A10265-82521	82.5 KOHM .25W 1% MF T/R	D 5
R475	A10265-22111	2.21 KOHM .25W 1% MF T/R	E 5
R476	A10265-15031	150. KOHM .25W 1% MF T/R	D 3
R477	A10265-56211	5.62 KOHM .25W 1% MF T/R	C 2
R478	A10265-17821	17.8 KOHM .25W 1% MF T/R	D 2
R479	A10265-34021	34.0 KOHM .25W 1% MF T/R	D 3
R480		OPEN. . . .	D 2
R481	A10266-2051	2.0 MOHM .25W 5% CF T/R	F 4
R482	A10265-10031	100. KOHM .25W 1% MF T/R	F 3
R483	A10265-45301	453. OHM .25W 1% MF T/R	F 1
R484	A10265-28021	28. KOHM .25W 1% MF T/R	F 5
R485	A10265-15011	1.5 KOHM .25W 1% MF T/R	G 3
R486	A10266-5102	51.0 OHM .5W 5% CF T/R	B 5
R487	A10266-5102	51.0 OHM .5W 5% CF T/R	A 5
R488	A10265-10021	10. KOHM .25W 1% MF T/R	F 2
R489	A10265-23701	237. OHM .25W 1% MF T/R	B 1
R490	A10265-10001	100. OHM .25W 1% MF T/R	C 1
R491	A10265-10001	100. OHM .25W 1% MF T/R	C 1
R492	A10265-12121	12.1 KOHM .25W 1% MF T/R	F 5
R493	A10265-10031	100. KOHM .25W 1% MF T/R	F 5
R494	A10265-15011	1.5 KOHM .25W 1% MF T/R	F 5

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SCALE	NONE	C. P. N.	SHEET 20 OF 23
PROJ #	MD35650	125903-4	

REV  


PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R497	A10265-10011	1.0 KOHM .25W 1% MF T/R	B 1
R498	A10265-49921	49.9 KOHM .25W 1% MF T/R	E 2
R499	A10265-10031	100. KOHM .25W 1% MF T/R	E 2
R900	A10265-10031	100. KOHM .25W 1% MF T/R	N 2
R901	A10265-49921	49.9 KOHM .25W 1% MF T/R	N 3
R902	A10265-49911	4.99 KOHM .25W 1% MF T/R	N 3
R903	A10265-90901	909. OHM .25W 1% MF T/R	I 2
R904	A10265-20031	200. KOHM .25W 1% MF T/R	I 3
R905	A10265-10041	1.0 MOHM .25W 1% MF T/R	H 2
R906	A10265-10041	1.0 MOHM .25W 1% MF T/R	H 2
R907	A10265-10041	1.0 MOHM .25W 1% MF T/R	H 2
R908	OPEN		
R909	A10265-12121	12. KOHM .25W 1% MF T/R	J 5
R910	C 6406-0	8.15 KOHM .25W 1% MF T/R	L 3
R911	A10265-37421	37.4 KOHM .25W 1% MF T/R	K 4
R912	A10265-10021	10. KOHM .25W 1% MF T/R	K 4
R913	A10265-20011	2. KOHM .25W 1% MF T/R	K 4
R914	A10265-20011	2. KOHM .25W 1% MF T/R	K 4
R915	A10265-20011	2. KOHM .25W 1% MF T/R	N 3
R916	A10265-20011	2. KOHM .25W 1% MF T/R	N 3
R917	A10265-10021	10. KOHM .25W 1% MF T/R	N 3
R918	A10265-37421	37.4 KOHM .25W 1% MF T/R	N 3
R919	C 6406-0	8.15 KOHM .25W 1% MF T/R	N 3
R1000	A10265-10031	100. KOHM .25W 1% MF T/R	E 3
R1001	A10265-49921	49.9 KOHM .25W 1% MF T/R	E 3
R1002	A10265-49911	4.99 KOHM .25W 1% MF T/R	E 3
R1004	A10265-20031	200. KOHM .25W 1% MF T/R	G 3
R1008	OPEN		
R1009	A10265-12121	12. KOHM .25W 1% MF T/R	F 5
R1010	C 6406-0	8.15 KOHM .25W 1% MF T/R	D 3
R1011	A10265-37421	37.4 KOHM .25W 1% MF T/R	C 4
R1012	A10265-10021	10. KOHM .25W 1% MF T/R	C 4
R1013	A10265-20011	2. KOHM .25W 1% MF T/R	C 4
R1014	A10265-20011	2. KOHM .25W 1% MF T/R	C 4
R1015	A10265-20011	2. KOHM .25W 1% MF T/R	E 4
R1016	A10265-20011	2. KOHM .25W 1% MF T/R	E 4
R1017	A10265-10021	10. KOHM .25W 1% MF T/R	E 4
R1018	A10265-37421	37.4 KOHM .25W 1% MF T/R	E 4
R1019	C 6406-0	8.15 KOHM .25W 1% MF T/R	E 3
S1	C 8272-4	4P3T PC MT SLIDE SW	B 1
S100	C 8843-2	SWITCH, SLIDE SP3T GOLD	J 1
S101	C 8274-0	SPDT PC MT ON/NONE/ON SLIDE SW	K 1
S102	C 9089-1	DP3T PC MNT SLIDE SWITCH	M 1
S200	C 8843-2	SWITCH, SLIDE SP3T GOLD	F 1
S201	C 8274-0	SPDT PC MT ON/NONE/ON SLIDE SW	E 1
S202	C 9089-1	DP3T PC MNT SLIDE SWITCH	D 1

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SCALE	NONE	C. P. N.	SHEET 21 OF 23	REV
PROJ #	MD35650	125903-4		(A)



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E. C. N	ZONE	REV.	DESCRIPTION	DATE	BY	APPROVALS			
						CHK	CM	EE	PE
T991589		A	INITIAL RELEASE FOR PRODUCTION.	07-23-99	DK	KW	CM	EE	PE

NOTES:

- FOR SCHEMATIC SEE 128112-2.
- FOR PRINTED WIRING BOARD SEE 127917-1.



**CAUTION**

STATIC CAN DAMAGE COMPONENTS!

**DO NOT HANDLE**

UNLESS WRIST STRAP IS WORN

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<b>CROWN INTERNATIONAL INC.</b>									
PRINTS TO		1718 WEST MISHAWAKA ROAD ELKHART, INDIANA 46517				PHONE (219) 294-8000			
K		PWA, MA5000VZ CONTROL						TOL. UNLESS SPECIFIED	
		DRAWN DK 07-23-99		APPROVED BY:		DO NOT SCALE PRINT			
		CHECKED KW 07-29-99	CM			SUPERSEDES			
		SCALE NONE	EE	EW	07-29-99	E. C. N.			
		PROJ # MD247D0	PE	EW	07-29-99	C. P. N. SHEET 1 OF 13			REV
		NEXT ASSEMBLY				127488-2		(A)	

PARTS LIST			
REF DES	C.P.N.	DESCRIPTION	MAP LOC.
C700	C 8426-6	0.1 250V 10% MET POLY RADIAL	E 4
C701	C 6802-0	.47 MF 50V AX CERM	G 1
C702	C 9934-8	5 PF 500V +/-0.5% MICA	C 1
C703	C 8192-4	100 PF 50V 10% DISC	C 2
C704	C 9465-3	10 MF 50V 20% VERT	C 1
C705	C 8534-7	.0047 MF 100V 10% AX CERM	E 2
C706	C 9632-8	470 PF 500V 2% MICA	E 1
C707	C 8426-6	0.1 250V 10% MET POLY RADIAL	K 4
C708		--- NOT USED ---	H 3
C709	C 9934-8	5 PF 500V +/-0.5% MICA	M 1
C710	C 8192-4	100 PF 50V 10% DISC	M 1
C711	C 9465-3	10 MF 50V 20% VERT	L 1
C712	C 8534-7	.0047 MF 100V 10% AX CERM	L 1
C713	C 9632-8	470 PF 500V 2% MICA	K 1
C714	C 8554-5	.22 MF 250V 10% POLY	E 3
C715		--- NOT USED ---	J 4
C716		--- NOT USED ---	J 4
C717	C 6804-6	0.1 MF 50V 10% CERM	F 1
C718	C 4303-1	1000 MF 35V AX	C 2
C719	C 4303-1	1000 MF 35V AX	M 2
C720	C 6804-6	0.1 MF 50V 10% CERM	F 2
C721	C 6804-6	0.1 MF 50V 10% CERM	J 2
C722	C10196-1	2.2UF 50V 20% LOW LEAK CAP	I 1
C724	C 6804-6	0.1 MF 50V 10% CERM	E 2
C725	C 6804-6	0.1 MF 50V 10% CERM	K 2
C726	C 6804-6	0.1 MF 50V 10% CERM	E 2
C727	C 6804-6	0.1 MF 50V 10% CERM	F 2
C728	C 6804-6	0.1 MF 50V 10% CERM	I 1
C729	C 6804-6	0.1 MF 50V 10% CERM	J 1
C730	C 6804-6	0.1 MF 50V 10% CERM	H 1
C731	C 6804-6	0.1 MF 50V 10% CERM	H 1
C732	C 6807-9	0.001 MF 100V 10% AX CERM	C 2
C733	C 6807-9	0.001 MF 100V 10% AX CERM	M 2
C734	C 6806-1	0.01 MF 100V AX CERM	J 1
C735	C10196-1	2.2UF 50V 20% LOW LEAK CAP	I 2
C736	C 9907-4	680PF 300V 5% MICA CAP T/R	C 1
C737	C 9907-4	680PF 300V 5% MICA CAP T/R	M 1
C814	C 8576-8	100 MF 35V 10% ELEC	I 1
C815	C 6805-3	0.022 MF 100V AX CERM	H 1
C816	C 6805-3	0.022 MF 100V AX CERM	G 1
C817	C 6804-6	0.1 MF 50V 10% CERM	D 1
C818	C 6804-6	0.1 MF 50V 10% CERM	L 1
D700	C 2851-1	1N4004 SILICON RECT.	C 3
D701	C 3549-0	DIODE ZENER, 10V, 1N5240B	D 1
D702	C 6578-6	1N4735 6.2V 1 W ZENER	D 1
D703	C 2851-1	1N4004 SILICON RECT.	M 3
D704	C 3549-0	DIODE ZENER, 10V, 1N5240B	L 1

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DRAWN	DK	7/23/99	DWG. NO.	SHEET 5 OF 13	REV
PROJ.	MD24750		127488-2		(A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
D705	C 6578-6	1N4735 6.2V 1 W ZENER	L 1
D706	C 3181-2	1N4148 HI SPEED DIODE	G 1
D707	C 3181-2	1N4148 HI SPEED DIODE	H 1
D709	C 3181-2	1N4148 HI SPEED DIODE	H 2
D710	C 2851-1	1N4004 SILICON RECT.	G 2
D711	C 2851-1	1N4004 SILICON RECT.	G 2
D712	C 2851-1	1N4004 SILICON RECT.	H 2
D713	C 2851-1	1N4004 SILICON RECT.	G 2
D714	C 3181-2	1N4148 HI SPEED DIODE	H 2
D715	C 3549-0	DIODE ZENER, 10V, 1N5240B	E 1
D717	C 3181-2	1N4148 HI SPEED DIODE	C 3
D718	C 3181-2	1N4148 HI SPEED DIODE	M 3
D719	C 3181-2	1N4148 HI SPEED DIODE	I 2
D720	C 2851-1	1N4004 SILICON RECT.	I 2
D721		--- NOT USED ---	M 2
D722		--- NOT USED ---	L 2
E700	C 9857-1	LED, RED T1 0.1 LEAD SPCNG	K 2
E701	C 9857-1	LED, RED T1 0.1 LEAD SPCNG	J 2
F700		--- INSTALLED ON NEXT ASSEMBLY ---	F 4
F700X	C 8867-1	FUSE CLIP, PC MOUNT TAG	F 4
F700X	C 8867-1	FUSE CLIP, PC MOUNT TAG	G 4
F701	C 8867-1	FUSE CLIP, PC MOUNT ( QTY 2 )	J 3
F701X	C 8867-1	FUSE CLIP, PC MOUNT TAG	I 3
F701X	C 8867-1	FUSE CLIP, PC MOUNT TAG	J 3
F702	C 8908-3	FUSEHOLDER PCB UNIVERSAL	J 3
F702X	C 8908-3	INT'L FUSE CLIP, PC MOUNT	I 3
F702X	C 8908-3	INT'L FUSE CLIP, PC MOUNT	J 3
HW1	A10086-10605	6-32 X .3125 RDHD PH MSCR Z	F 2
HW2	A10086-10605	6-32 X .3125 RDHD PH MSCR Z	J 2
HW3	A10094-4	#6 INT STAR WASHER ZINC	F 2
HW4	A10094-4	#6 INT STAR WASHER ZINC	J 2
HW5	A10102-5	6 X 32 HEX NUT	F 2
HW6	A10102-5	6 X 32 HEX NUT	J 2
J35	C 9933-0	20 PIN LOCK SHRD VERT HDR	H 2
J733	C 8846-5	5 PIN 2MM VERT POST TIN	A 2
J833	C 8846-5	5 PIN 2MM VERT POST TIN	O 2
JP1	C 7746-8	3 PIN .1 SGLROW HDR GOLD .230	F 1
JP1X	C 6419-3	SHUNT, .025" SQ POST 2 POS **	F 1
K700	C 9787-0	RELAY, 30A 24V T90 SEALED	C 3
K701	C 9787-0	RELAY, 30A 24V T90 SEALED	L 4
L1X	A10124-24	WIRE, #24 SOLID BUSS	H 3
L1X	A10124-24	WIRE, #24 SOLID BUSS	H 3
P700	C 7817-7	250 FASTON PC AMP	F 4
P701	C 7817-7	250 FASTON PC AMP	E 4
P702	C 7817-7	250 FASTON PC AMP	F 4
P703	C 7817-7	250 FASTON PC AMP	E 4
P704	C 7817-7	250 FASTON PC AMP	D 4
P705	C 7817-7	250 FASTON PC AMP	D 4

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DRAWN	DK	7/23/99	DWG. NO.	SHEET 6 OF 13	REV
PROJ.	MD24750		127488-2		<b>(A)</b>

PARTS LIST			
REF DES	C.P.N.	DESCRIPTION	MAP LOC.
P707	C 7817-7	250 FASTON PC AMP	C 4
P708	C 7817-7	250 FASTON PC AMP	E 4
P709	C 7817-7	250 FASTON PC AMP	D 4
P710	C 7817-7	250 FASTON PC AMP	D 4
P711	C 7817-7	250 FASTON PC AMP	C 4
P712	C 7817-7	250 FASTON PC AMP	C 4
P713	C 7817-7	250 FASTON PC AMP	F 4
P714	C 7817-7	250 FASTON PC AMP	G 4
P715	C 7817-7	250 FASTON PC AMP	I 4
P716	C 7817-7	250 FASTON PC AMP	H 4
P718	C 7817-7	250 FASTON PC AMP	H 4
P719	C 7817-7	250 FASTON PC AMP	I 4
P721	C 7817-7	250 FASTON PC AMP	H 4
P722	C 8909-1	UNINSULATED POWER TAP	G 4
P724A	C 7817-7	250 FASTON PC AMP	I 4
P724B	C 7817-7	250 FASTON PC AMP	C 4
P724C	C 7817-7	250 FASTON PC AMP	M 4
P726	C 7817-7	250 FASTON PC AMP	F 3
P728	C 7817-7	250 FASTON PC AMP	F 3
P729	C 7592-6	4 PIN .1 MTA HEADER	G 3
P730	C 7592-6	4 PIN .1 MTA HEADER	G 3
P732	D 8542-9	9.5" 28 AWG RIBCBL 16 PIN NO	A 2
P734	C 7817-7	250 FASTON PC AMP	J 4
P735	C 7817-7	250 FASTON PC AMP	J 4
P736	C 7817-7	250 FASTON PC AMP	J 4
P737	C 7817-7	250 FASTON PC AMP	K 4
P738	C 7817-7	250 FASTON PC AMP	L 4
P739	C 7817-7	250 FASTON PC AMP	L 4
P740	C 7817-7	250 FASTON PC AMP	M 4
P741	C 7817-7	250 FASTON PC AMP	M 4
P742	C 7817-7	250 FASTON PC AMP	K 4
P743	C 7817-7	250 FASTON PC AMP	L 4
P744	C 7817-7	250 FASTON PC AMP	K 4
P745	C 7817-7	250 FASTON PC AMP	L 4
P749	C 7817-7	250 FASTON PC AMP	G 4
P750	C 7817-7	250 FASTON PC AMP	H 4
P751	C 8890-3	3 PIN .156 MTA LOCKING	H 2
P832	D 8542-9	9.5" 28 AWG RIBCBL 16 PIN NO	N 2
P851A	C 6420-1	.025 SQ POST	A 2
P851B	C 6420-1	.025 SQ POST	A 2
P852A	C 6420-1	.025 SQ POST	A 2
P852B	C 6420-1	.025 SQ POST	A 2
P853A	C 6420-1	.025 SQ POST	O 2
P853B	C 6420-1	.025 SQ POST	O 2
P854A	C 6420-1	.025 SQ POST	O 2
P854B	C 6420-1	.025 SQ POST	O 2
Q700	C 8103-1	MPSW42 NPN TRANSISTOR	C 3
Q701	125106-1	MAC9D 8 AMP 400V TRIAC	D 3

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DRAWN	DK	7/23/99	DWG. NO.	SHEET 7 OF 13	REV
PROJ.	MD247S0		127488-2		(A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
Q701X	C 8982-8	TO-220 XSISTOR HOLDER, PLASTIC	E 3
Q702	C 7458-0	2N4123 30V NPN T/R	D 1
Q703	C 8103-1	MPSW42 NPN TRANSISTOR	M 3
Q704	125106-1	MAC9D 8 AMP 400V TRIAC	K 3
Q704X	C 8982-8	TO-220 XSISTOR HOLDER, PLASTIC	K 3
Q705	C 7458-0	2N4123 30V NPN T/R	L 1
Q706	125106-1	MAC9D 8 AMP 400V TRIAC	F 3
Q706X	C 8982-8	TO-220 XSISTOR HOLDER, PLASTIC	F 3
Q707	C 7458-0	2N4123 30V NPN T/R	K 1
Q708	C 3625-8	2N4125 30V PNP T/R	E 2
Q709	C 7458-0	2N4123 30V NPN T/R	I 1
Q710	C 3625-8	2N4125 30V PNP T/R	B 1
Q711	C 3625-8	2N4125 30V PNP T/R	M 1
R700	A10266-1031	10K 0.25W 5% CF	C 3
R701	C 9930-6	11.8 OHM 3W 5% MF	E 4
R702	101103-1	PTC, 6.0 OHM 265V	D 4
R702X	C 8982-8	TO-220 XSISTOR HOLDER, PLASTIC	D 4
R703	A10266-1811	180 OHM 0.25W 5% CF	E 3
R704	A10266-8211	820 OHM 0.25W 5% CF	E 2
R705		--- NOT USED ---	J 1
R706	A10266-2231	22K 0.25W 5% CF	J 1
R707	A10265-88722	88.7K 0.50W 1% MF	A 1
R708	C 9361-4	2.4K 5W 5% WW W/FEET	B 2
R709	A10265-15831	158K 0.25W 1% MF	B 1
R710	A10265-12731	127K 0.25W 1% MF	B 1
R711	A10265-12731	127K 0.25W 1% MF	B 1
R712	C 8929-9	1 POS SGL ROW UNSHROUDED HDR	B 1
R712X	C 8929-9	1 POS SGL ROW UNSHROUDED HDR	B 1
R713	A10266-2221	2.2K 0.25W 5% CF	C 1
R714	A10265-88722	88.7K 0.50W 1% MF	B 2
R715	A10265-14031	140K 0.25W 1% MF	C 1
R716	A10265-31611	3.16K 0.25W 1% MF	C 1
R717	A10266-2241	220K 0.25W 5% CF	D 2
R718	A10266-1041	100K 0.25W 5% CF	D 2
R719	A10266-1521	1.5K 0.25W 5% CF	C 2
R720	A10266-2041	200K 0.25W 5% CF	D 1
R721	A10266-3951	3.9M 0.25W 5% CF	D 1
R722	A10266-3021	3K 0.25W 5% CF	D 1
R723	A10266-6811	680 OHM 0.25W 5% CF	E 1
R724	A10266-6231	62K 0.25W 5% CF	D 1
R725	A10265-24921	24.9K 0.25W 1% MF	E 1
R726	A10266-1031	10K 0.25W 5% CF	E 1
R727	A10266-4721	4.7K 0.25W 5% CF	E 1
R728	A10266-1531	15K 0.25W 5% CF	E 1
R729	A10266-4331	43K 0.25W 5% CF	E 1
R730	A10266-1031	10K 0.25W 5% CF	M 3
R731	C 9930-6	11.8 OHM 3W 5% MF	K 4
R732	101103-1	PTC, 6.0 OHM 265V	K 4

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DRAWN	DK	7/23/99	DWG. NO.	SHEET 8 OF 13	REV
PROJ.	MD24750		127488-2		(A)

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
R732X	C 8982-8	TO-220 XSISTOR HOLDER, PLASTIC	K 4
R733	A10266-1811	180 OHM 0.25W 5% CF	K 3
R734	A10266-8211	820 OHM 0.25W 5% CF	K 2
R735	A10266-5121	5.1K 0.25W 5% CF	F 1
R736		--- NOT USED ---	M 1
R737	A10265-88722	88.7K 0.50W 1% MF	N 1
R738	C 9361-4	2.4K 5W 5% WW W/FEET	N 2
R739	A10265-15831	158K 0.25W 1% MF	N 1
R740	A10265-12731	127K 0.25W 1% MF	N 1
R741	A10265-12731	127K 0.25W 1% MF	N 1
R742	C 8929-9	1 POS SGL ROW UNSHROUDED HDR	N 1
R742X	C 8929-9	1 POS SGL ROW UNSHROUDED HDR	N 1
R743	A10266-2221	2.2K 0.25W 5% CF	M 1
R744	A10265-88722	88.7K 0.50W 1% MF	N 2
R745	A10265-14031	140K 0.25W 1% MF	M 1
R746	A10265-31611	3.16K 0.25W 1% MF	M 1
R747	A10266-2241	220K 0.25W 5% CF	L 2
R748	A10266-1041	100K 0.25W 5% CF	L 2
R749	A10266-1521	1.5K 0.25W 5% CF	M 2
R750	A10266-2041	200K 0.25W 5% CF	L 1
R751	A10266-3951	3.9M 0.25W 5% CF	L 1
R752	A10266-3021	3K 0.25W 5% CF	L 1
R753	A10266-6811	680 OHM 0.25W 5% CF	K 1
R754	A10266-6231	62K 0.25W 5% CF	L 1
R755	A10265-24921	24.9K 0.25W 1% MF	K 1
R756	A10266-1031	10K 0.25W 5% CF	K 1
R757	A10266-4721	4.7K 0.25W 5% CF	K 1
R758	A10266-1531	15K 0.25W 5% CF	K 1
R759	A10266-4331	43K 0.25W 5% CF	K 1
R760	C 9930-6	11.8 OHM 3W 5% MF	E 4
R761	C 9930-6	11.8 OHM 3W 5% MF	E 4
R762	A10266-1811	180 OHM 0.25W 5% CF	F 3
R763	A10266-8211	820 OHM 0.25W 5% CF	F 2
R764	A10266-1551	1.5M 0.25W 5% CF	I 1
R765	A10266-1551	1.5M 0.25W 5% CF	G 1
R766	A10266-3951	3.9M 0.25W 5% CF	G 1
R767	A10266-3041	300K 0.25W 5% CF	G 1
R768	A10266-1551	1.5M 0.25W 5% CF	H 1
R769	A10266-3951	3.9M 0.25W 5% CF	H 1
R770	A10266-3041	300K 0.25W 5% CF	H 1
R771	A10266-3321	3.3K 0.25W 5% CF	J 1
R772	A10266-8221	8.2K 0.25W 5% CF	J 1
R773	A10266-8221	8.2K 0.25W 5% CF	J 1
R774	A10266-1031	10K 0.25W 5% CF	J 1
R775	A10266-4721	4.7K 0.25W 5% CF	E 1
R776	A10266-3321	3.3K 0.25W 5% CF	E 1
R777	A10266-1241	120K 0.25W 5% CF	F 1
R778	A10266-1031	10K 0.25W 5% CF	E 2

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DRAWN	DK	7/23/99	DWG. NO.	SHEET 9 OF 13	REV
PROJ.	MD24750		127488-2		(A)

PARTS LIST			
REF DES	C.P.N.	DESCRIPTION	MAP LOC.
R779	A10266-1351	1.3M 0.25W 5% CF	I 1
R780	C 8861-4	250K HORZ TRIMPOT	I 1
R781	A10266-2051	2M 0.25W 5% CF	E 1
R782	A10266-2041	200K 0.25W 5% CF	E 1
R783	A10266-1831	18K 0.25W 5% CF	E 1
R784	A10266-4731	47K 0.25W 5% CF	E 1
R785	A10266-1041	100K 0.25W 5% CF	E 1
R786	A10266-3321	3.3K 0.25W 5% CF	J 2
R787	A10266-8221	8.2K 0.25W 5% CF	I 1
R788	A10266-8221	8.2K 0.25W 5% CF	I 1
R789	A10266-1031	10K 0.25W 5% CF	I 1
R790	A10265-32411	3.24K 0.25W 1% MF	C 1
R791	A10266-1031	10K 0.25W 5% CF	F 1
R792	A10266-9111	910 OHM 0.25W 5% CF	E 2
R793	A10265-32411	3.24K 0.25W 1% MF	M 1
R794	A10266-1031	10K 0.25W 5% CF	F 1
R795	A10266-9111	910 OHM 0.25W 5% CF	K 2
R796	A10266-1041	100K 0.25W 5% CF	H 1
R797	A10266-1041	100K 0.25W 5% CF	G 1
R798	A10265-17831	178K 0.25W 1% MF	F 2
R799	A10265-36511	3.65K 0.25W 1% MF	F 2
R800	A10266-7541	750K 0.25W 5% CF	H 1
R801	A10266-7541	750K 0.25W 5% CF	G 1
R802	A10266-4721	4.7K 0.25W 5% CF	H 1
R803	A10266-1011	100 OHM 0.25W 5% CF	C 2
R804	A10266-1011	100 OHM 0.25W 5% CF	M 2
R805	A10266-1551	1.5M 0.25W 5% CF	I 2
R806	A10265-60431	604K 0.25W 1% MF	F 1
R807	A10266-1531	15K 0.25W 5% CF	E 2
R808	A10266-1531	15K 0.25W 5% CF	K 2
R809	A10266-1531	15K 0.25W 5% CF	E 2
R810	A10266-1531	15K 0.25W 5% CF	D 2
R811	A10266-1531	15K 0.25W 5% CF	K 2
R812	A10265-17831	178K 0.25W 1% MF	C 1
R813	A10265-17831	178K 0.25W 1% MF	M 1
R814	A10265-25R51	25.5 OHM 0.25W 1% MF	C 2
R815	A10265-25R51	25.5 OHM 0.25W 1% MF	M 2
R900	A10265-10042	1M 0.50W 1% MF	G 3
S700	C 8842-4	SWITCH, SLIDE UPRIGHT AU	A 1*
S701	C 8842-4	SWITCH, SLIDE UPRIGHT AU	O 1*
U700	C 7665-0	MOC3011 OPTOISOLATOR TRIAC	D 2
U701	C 4345-2	QUAD VOLTAGE COMPARATOR	F 2
U701X	C 3450-1	IC SOCKET, 14PIN DIP	F 2
U702	C 7444-0	LM393 DUAL COMPARATOR	C 1
U703	C 7445-7	CMOS 555 TIMER	C 2
U704	C 6901-0	MOC8021 DARLINGTON OPTOISOL	D 2
U705	C 4345-2	QUAD VOLTAGE COMPARATOR	D 1
U706	C 7665-0	MOC3011 OPTOISOLATOR TRIAC	K 2

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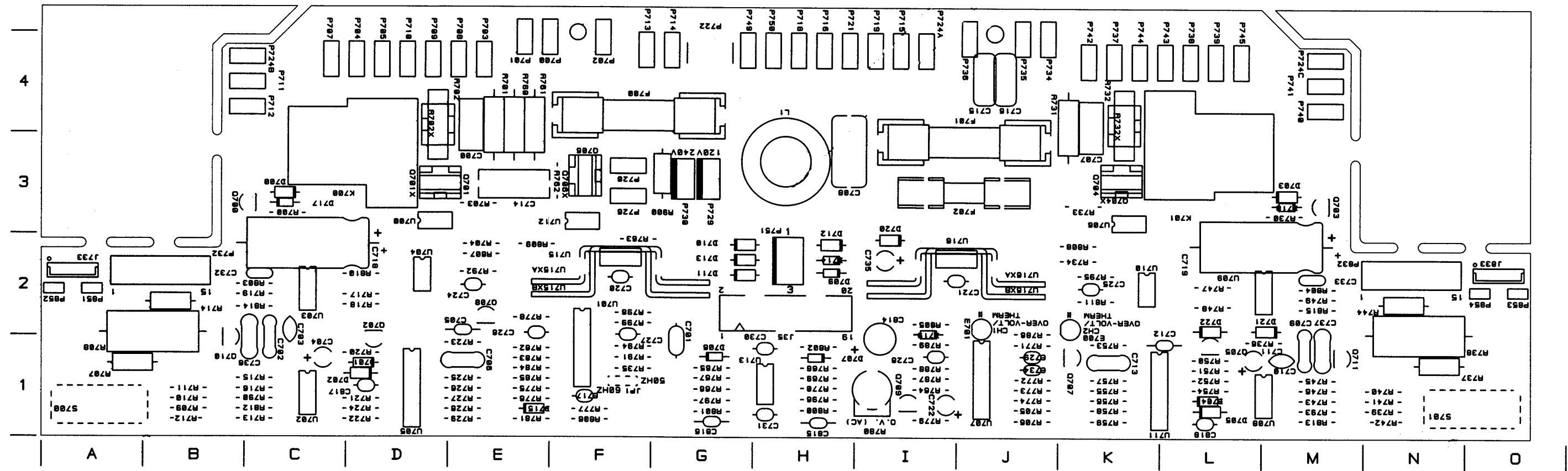
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DRAWN	DK	7/23/99	DWG. NO.	SHEET 10 OF 13	REV
PROJ.	MD24750		127488-2		(A)







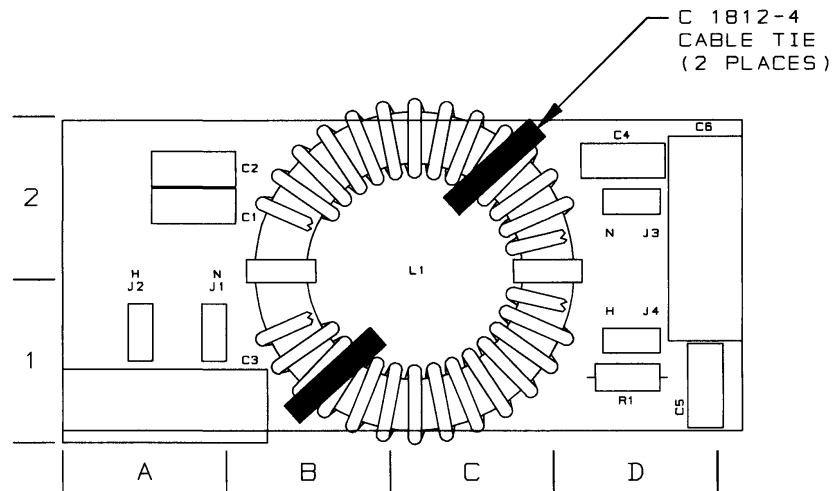
127488-2 PWA Component Map  
(Component Side)

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	3	2	1							
E. C. N.	ZONE	REV	DESCRIPTION	DATE	BY	APPROVAL				
		1	RELEASE FOR PROTOTYPE.	10-23-99	KLW	CK	CM	EE	PE	
						<i>JAW</i>	<i>DSV</i>	<i>N/A</i>	<i>AA</i>	
D	<p>UNLESS OTHERWISE SPECIFIED, THIS PRINTED WIRING ASSEMBLY SHALL MEET THE SPECIFICATION DESCRIBED IN IPC-A-610_ CLASS 2 STANDARDS.</p> <p>NOTES:</p> <ol style="list-style-type: none"> <li>1. PRINTED WIRING BOARD PART NUMBER 128272-2.</li> <li>2. ALL LEADS SHALL BE TRIMMED TO 0.093" OR LESS.</li> <li>3. POSITION COMPONENTS AS SHOWN ON COMPONENT MAPS.</li> <li>4. THE PRINTED WIRING ASSEMBLY PART NUMBER FOR THIS ASSEMBLY SHALL BE MARKED ON THE PRINTED WIRING BOARD AND SHALL BE PERMANENT.</li> </ol>									D
C										C
B	<div style="border: 1px solid black; padding: 10px; display: inline-block;"> <div style="margin-left: 20px;"> <p style="text-align: center; margin: 0;"><b>CAUTION</b></p> <p style="margin: 0;">STATIC CAN DAMAGE COMPONENTS!</p> <p style="margin: 0; font-size: 1.2em;">DO NOT HANDLE</p> <p style="margin: 0;">UNLESS WRIST STRAP IS WORN</p> </div> </div>									B
A	<div style="border: 1px solid black; padding: 5px; display: inline-block; width: 80%;"> <p style="margin: 0; font-size: 0.8em;">THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CROWN INTERNATIONAL, INC. AND SHALL NOT BE REPRODUCED, COPIED, OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS OR DEVICES WITHOUT PERMISSION.</p> </div>									A
<div style="border: 1px solid black; padding: 5px;"> <p style="margin: 0; font-size: 1.2em; font-weight: bold;">CROWN INTERNATIONAL, INC.</p> <p style="margin: 0; font-size: 0.8em;">1718 W. MISHAWAKA RD. ELKHART IN. 46517 PHONE (219) 294-8000</p> </div>										
<div style="border: 1px solid black; padding: 5px;"> <p style="margin: 0; font-size: 1.1em;">PWA, MA5000VZ 230V LINE FILTER</p> </div>						<div style="border: 1px solid black; padding: 5px; font-size: 0.8em;"> <p>TOL. UNLESS SPECIFIED</p> <p>X.XX - ±0.02"</p> <p>X.XXX - ±0.010"</p> <p>DRILLS - ±0.003"</p> </div>				
PRINTS TO	DRAWN BY	KLV	10/23/99	APPROVED BY:		DO NOT SCALE PRINT				
K	CHECKED	<i>JAW</i>	<i>10/25/99</i>	ME	<i>N/A</i>	SUPERSEDES				
	SCALE	NONE		EE	<i>N/A</i>	E. C.				
	PROJ. #	MD185D0		PE	<i>AA</i>	<i>10-26-99</i>	DWG. NO.	SHEET 1 OF 5	REV	
	FILENAME: 128273-2_1_01.PCB			NEXT ASSEMBLY:		128273-2		<span style="font-size: 1.5em; font-weight: bold;">1</span>		
	3	2	1							



COMPONENT MAP  
TOP SIDE




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DRAWN	KLW	10/23/99	DWG. NO.	SHEET 4 OF 5	REV
PROJ.	MD18550		128273-2		1

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E.C.N.	ZONE	REV.	DESCRIPTION	DATE	BY	APPROVALS			
						CHK	ME	EE	PE
		A	REMOVE Q501 AND Q601 C500 AND C600 WERE 5.9 AT 35V ARE NOW 8.1 50V 10% AX CERM BOARD D7845-7 IS NOW D7845-1 REV A	08/07/92	LCD				
		B	CORRECTED R502 AND R602 CPN WAS C 2876-9	09/18/92	TLM				TS
EAT# 96-149		C	R500 AND R600 WERE C 5727-0 RERUN MODULE DOC. FOR UPDATED CPN'S	03/18/96	LCD				PW
EAT# 96-200		D	R504, R604 WERE 2K R527, R627 WERE 910 E501, E601 WERE C 7863-1	06/26/96	LCD				

NOTES:

- FOR SCHEMATIC SEE J0491-1 REV C.
- FOR PRINTED WIRING BOARD SEE D7845-7 REV A.

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PRINTS TO		CROWN INTERNATIONAL INC. 1718 WEST MISHAWAKA ROAD ELKHART, INDIANA 46517 PHONE (219) 294-8000				TOL. UNLESS SPECIFIED X.XX - ± 0.020 X.XXX - ± 0.010 DRILLS - ± 0.003		
								K
		DRAWN	LCD	05/04/92	APPROVED BY:	DO NOT SCALE PRINT		
		CHECKED			ME	SUPERSEDES Q42929-2 REV B		
		SCALE	NONE		EE	E.C.N.		
		PROJ	D356		PE TS	05/10/92	C.P.N. SHEET 1 OF 6	
		NEXT ASSEMBLY				Q42929-2		REV <b>(D)</b>

PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
C500	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 1
C501	C 6802-0	.47UF 50V AXIAL CER T/R 474	B 1
C502	C 6804-6	.1UF 50V AXIAL CER T/R 104	C 1
C503	C 6804-6	.1UF 50V AXIAL CER T/R 104	D 1
C504	C 6804-6	.1UF 50V AXIAL CER T/R 104	G 1
C505	C 6804-6	.1UF 50V AXIAL CER T/R 104	F 1
C600	C 6804-6	.1UF 50V AXIAL CER T/R 104	G 1
C601	C 6802-0	.47UF 50V AXIAL CER T/R 474	D 1
D500	C 3181-2	DIODE, 1N4148 T/R	J 1
D502	C 3181-2	DIODE, 1N4148 T/R	B 1
D503	C 3181-2	DIODE, 1N4148 T/R	B 1
D504	C 3181-2	DIODE, 1N4148 T/R	B 1
D505	C 3181-2	DIODE, 1N4148 T/R	B 1
D506	C 3181-2	DIODE, 1N4148 T/R	C 1
D507	C 3181-2	DIODE, 1N4148 T/R	F 1
D508	C 3181-2	DIODE, 1N4148 T/R	J 1
D509	C 3181-2	DIODE, 1N4148 T/R	J 1
D510	C 3181-2	DIODE, 1N4148 T/R	I 1
D600	C 3181-2	DIODE, 1N4148 T/R	N 1
D602	C 3181-2	DIODE, 1N4148 T/R	E 1
D603	C 3181-2	DIODE, 1N4148 T/R	E 1
D604	C 3181-2	DIODE, 1N4148 T/R	E 1
D605	C 3181-2	DIODE, 1N4148 T/R	D 1
D606	C 3181-2	DIODE, 1N4148 T/R	D 1
D607	C 3181-2	DIODE, 1N4148 T/R	G 1
D608	C 3181-2	DIODE, 1N4148 T/R	N 1
D609	C 3181-2	DIODE, 1N4148 T/R	N 1
D610	C 3181-2	DIODE, 1N4148 T/R	L 1
E1	C 4342-9	LED, AMBER GI	P 1
E500	C 4342-9	LED, AMBER GI	K 2
E501	C10592-1	LED, T 1.75 GREEN	J 1
E502	C 8814-3	LED, HI EFFICIENCY GRN/RED	J 1
E600	C 4342-9	LED, AMBER GI	L 2
E601	C10592-1	LED, T 1.75 GREEN	M 1
E602	C 8814-3	LED, HI EFFICIENCY GRN/RED	M 1
J35	C 5647-0	IC SOCKET 20PIN DIP,	K 1
Q500	D 2962-5	MPSA18 45V NPN T/R	K 2
Q502	C 7458-0	2N4123 30V NPN T/R	J 1
Q503	C 7458-0	2N4123 30V NPN T/R	A 1
Q504	C 7458-0	2N4123 30V NPN T/R	I 2
Q505	C 7458-0	2N4123 30V NPN T/R	J 1
Q600	D 2962-5	MPSA18 45V NPN T/R	M 2
Q602	C 7458-0	2N4123 30V NPN T/R	M 1
Q603	C 7458-0	2N4123 30V NPN T/R	E 1
Q604	C 7458-0	2N4123 30V NPN T/R	M 1
Q605	C 7458-0	2N4123 30V NPN T/R	L 1
R1	A10266-1522	1.5 KOHM .5W 5% CF T/R	O 1

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SCALE	NONE	C. P. N.
PROJ	D356	

SHEET 3 OF 6  
**042929-2**

REV  
**(D)**



PARTS LIST			
REF DES	C.P.N.	DESCRIPTION	MAP LOC.
R500	A10265-12131	121. KOHM .25W 1% MF T/R	K 1
R501	A10266-4731	47. KOHM .25W 5% CF25 T/R	J 1
R502	A10265-15831	158. KOHM .25W 1% MF T/R	K 1
R503	A10266-3331	33. KOHM .25W 5% CF T/R	J 1
R504	A10266-3321	3.3 KOHM .25W 5 CF T/R	I 1
R505	A10266-5111	510. OHM .25W 5 CF T/R	J 1
R506	A10266-6231	62. KOHM .25W 5% CF T/R	B 1
R507	A10265-30121	30.1 KOHM .25W 1 MF T/R	C 1
R508	A10265-34021	34.0 KOHM .25W 1% MF T/R	A 1
R509	A10265-44221	44.2 KOHM .25W 1% MF T/R	B 1
R510	A10266-3031	30. KOHM .25W 5 CF T/R	C 1
R511	A10266-1031	10. KOHM .25W 5% CF T/R	C 1
R512	A10266-6831	68. KOHM .25W 5% CF T/R	B 1
R513	A10266-1031	10. KOHM .25W 5% CF T/R	B 1
R514	A10266-1031	10. KOHM .25W 5% CF T/R	C 1
R515	A10266-1031	10. KOHM .25W 5% CF T/R	F 1
R516	A10266-2741	270. KOHM .25W 5% CF25 T/R	F 1
R517	A10266-3331	33. KOHM .25W 5% CF T/R	F 1
R518	A10266-1031	10. KOHM .25W 5% CF T/R	F 1
R519	A10266-4741	470. KOHM .25W 5% CF T/R	C 1
R520	A10266-3351	3.3 MOHM .25W 5% CF T/R	B 1
R521	A10266-1021	1.0 KOHM .25W 5% CF T/R	B 1
R522	A10266-5131	51. KOHM .25W 5 CF25 T/R	B 1
R523	A10266-1041	100. KOHM .25W 5% CF25 T/R	F 1
R524	A10266-2711	270. OHM .25W 5% CF T/R	J 1
R525	A10266-8231	82. KOHM .25W 5% CF T/R	K 1
R526	A10266-3011	300. OHM .25W 5 CF T/R	K 1
R527	A10266-1521	1.5K OHM .25W 5 CF T/R	I 1
R600	A10265-12131	121. KOHM .25W 1% MF T/R	M 1
R601	A10266-4731	47. KOHM .25W 5% CF25 T/R	L 1
R602	A10265-15831	158. KOHM .25W 1% MF T/R	L 1
R603	A10266-3331	33. KOHM .25W 5% CF T/R	M 1
R604	A10266-3321	3.3 KOHM .25W 5 CF T/R	M 1
R605	A10266-5111	510. OHM .25W 5 CF T/R	M 1
R606	A10266-6231	62. KOHM .25W 5% CF T/R	E 1
R607	A10265-30121	30.1 KOHM .25W 1 MF T/R	D 1
R608	A10265-34021	34.0 KOHM .25W 1% MF T/R	E 1
R609	A10265-44221	44.2 KOHM .25W 1% MF T/R	D 1
R610	A10266-3031	30. KOHM .25W 5 CF T/R	D 1
R611	A10266-1031	10. KOHM .25W 5% CF T/R	D 1
R612	A10266-6831	68. KOHM .25W 5% CF T/R	E 1
R613	A10266-1031	10. KOHM .25W 5% CF T/R	D 1
R614	A10266-1031	10. KOHM .25W 5% CF T/R	D 1
R615	A10266-1031	10. KOHM .25W 5% CF T/R	G 1
R616	A10266-2741	270. KOHM .25W 5% CF25 T/R	G 1
R617	A10266-3331	33. KOHM .25W 5% CF T/R	G 1
R618	A10266-1031	10. KOHM .25W 5% CF T/R	G 1

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SCALE	NONE
PROJ	D356

C.P.N. SHEET 4 OF 6  
Q42929-2

REV  
**(D)**

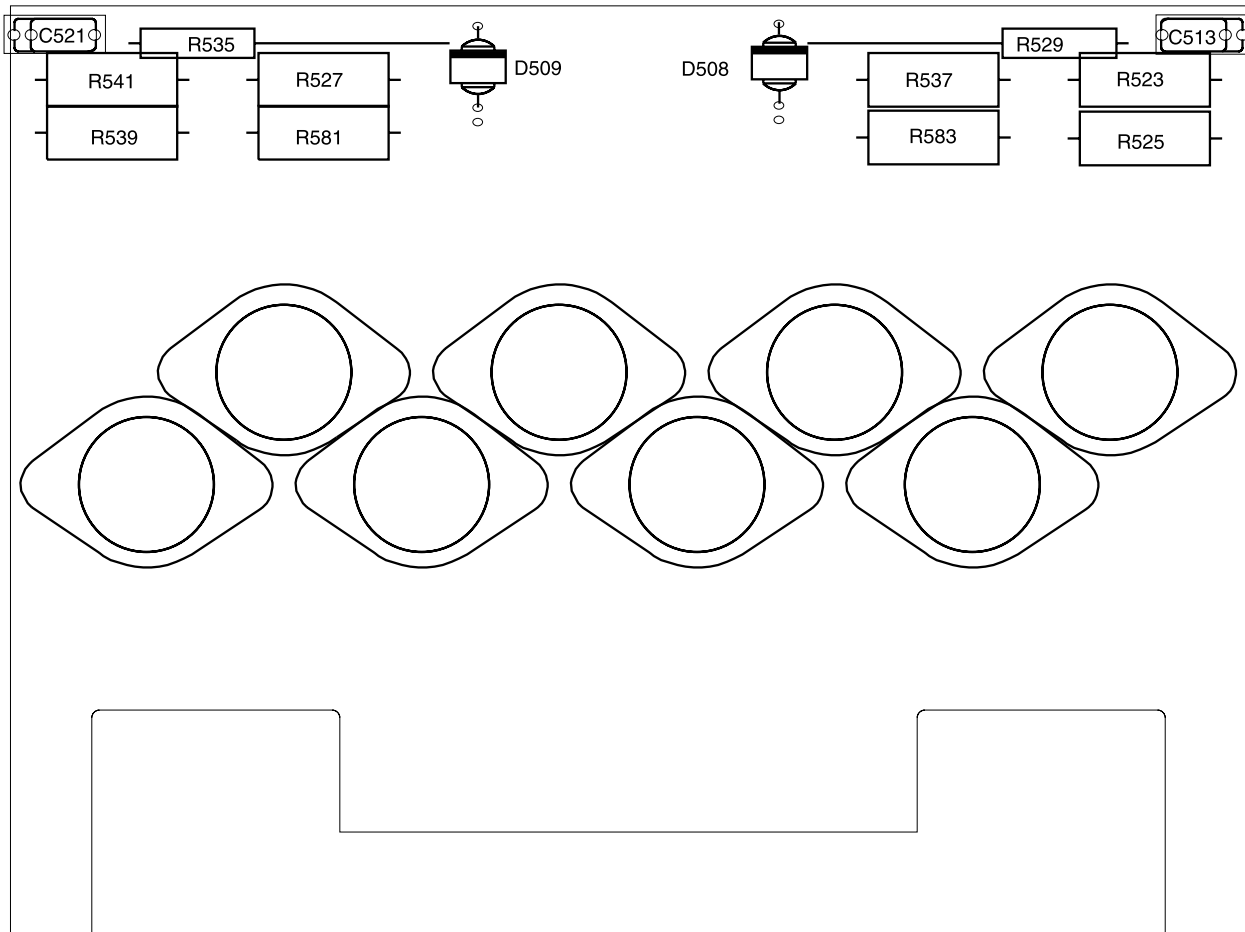




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### Q42934-2 Negative Emitter PWA

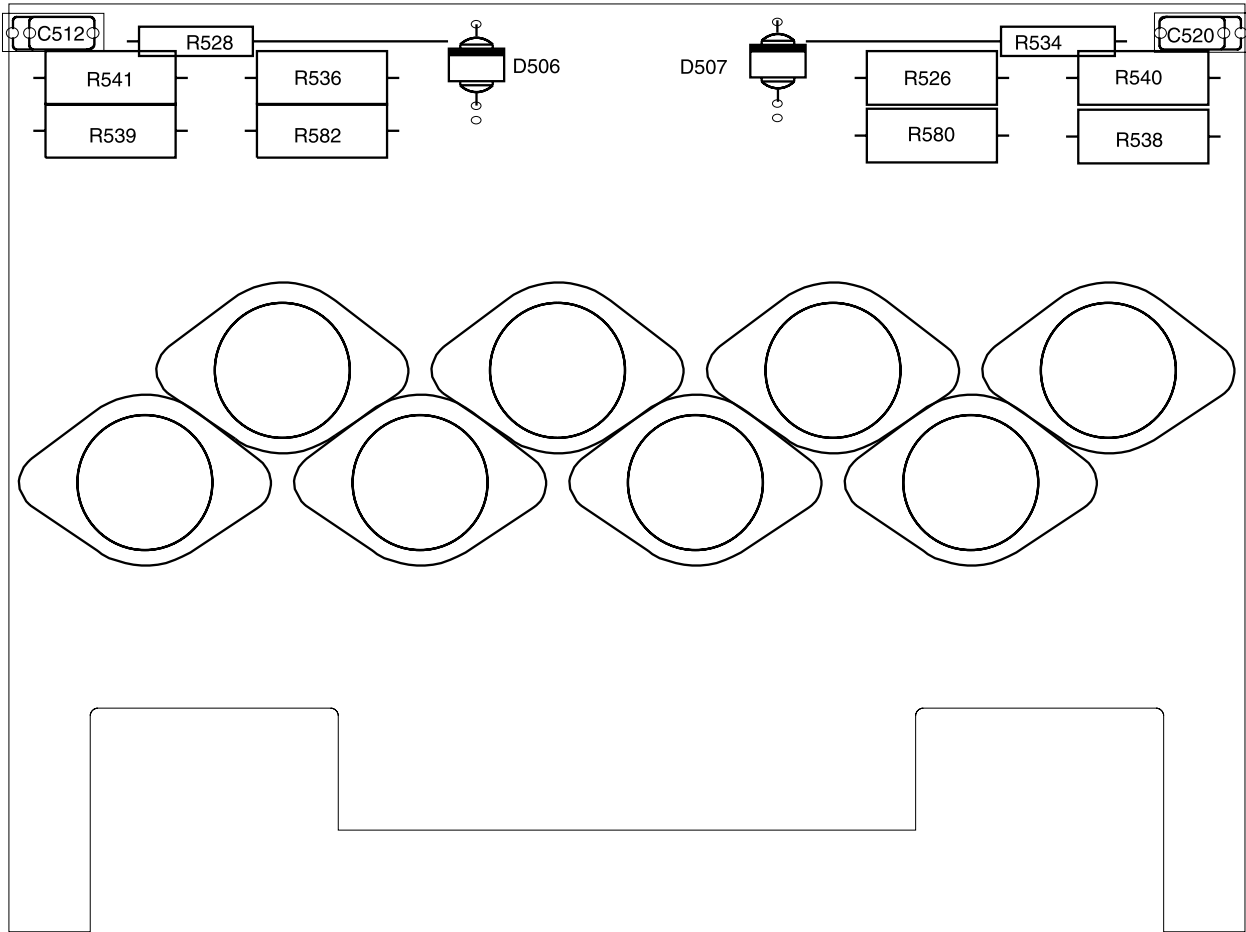
Circuit Designation	PWB: P10342-7, Schematic: J0488-7		
	Component Description	Part Number	Applicability & Notes
<b>Capacitors</b>			
C513	0.022 $\mu$ fd	C 5671-0	
C521	0.022 $\mu$ fd	C 5671-0	
<b>Diodes</b>			
D508	MR822	C 8383-9	
D509	MR822	C 8383-9	
<b>Resistors</b>			
R523	0.33 ohm 5 W	C 8787-1	
R525	0.33 ohm 5 W	C 8787-1	
R527	0.33 ohm 5 W	C 8787-1	
R529	12 ohm 12 W	A10266-1204	
R535	12 ohm 12 W	A10266-1204	
R537	0.33 ohm 5 W	C 8787-1	
R539	0.33 ohm 5 W	C 8787-1	
R541	0.33 ohm 5 W	C 8787-1	
R581	0.33 ohm 5 W	C 8787-1	
R583	0.33 ohm 5 W	C 8787-1	



PWA Q42934-2 Component Map (Component Side)

### Q42935-9 Positive Emitter PWA

Circuit Designation	PWB: P10336-9, Schematic: J0488-7		
	Component Description	Part Number	Applicability & Notes
<b>Capacitors</b>			
C512	0.022 $\mu$ fd	C 5671-0	
C520	0.022 $\mu$ fd	C 5671-0	
<b>Diodes</b>			
D506	MR822	C 8383-9	
D507	MR822	C 8383-9	
<b>Resistors</b>			
R522	0.33 ohm 5W	C 8787-1	
R524	0.33 ohm 5 W	C 8787-1	
R526	0.33 ohm 5 W	C 8787-1	
R528	12 ohm 12 W	A10266-1204	
R534	12 ohm 12 W	A10266-1204	
R536	0.33 ohm 5 W	C 8787-1	
R538	0.33 ohm 5 W	C 8787-1	
R540	0.33 ohm 5W	C 8787-1	
R580	0.33 ohm 5 W	C 8787-1	
R582	0.33 ohm 5 W	C 8787-1	



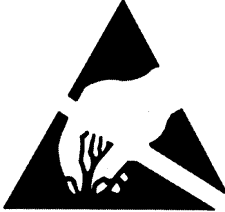
PWA Q42935-9 Component Map (Component Side)



E. C. N.	ZONE	REV.	DESCRIPTION	DATE	BY	APPROVALS			
						CHK	ME	EE	PE
93E306B		(A)	R561, 569, AND 570 WERE 1 W A10233-5133	05/18/94	TLM				TS
94-142		(B)	CHANGE NOTE 1 & 6 CORRECT COMPONENT ID ON Q504 AND Q527	09/06/94	LCD				JM
95-2163		(C)	Q511 AND Q525 WERE C 0159-3	07/25/95	LCD				<i>[Signature]</i>

**NOTES:**

1. FOR SCHEMATIC SEE J0488-7 REV G
2. FOR PRINTED WIRING BOARD SEE D8526-2



**CAUTION**

STATIC CAN DAMAGE COMPONENTS!

**DO NOT HANDLE**

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K		<b>MOD, MA5000VZ OUTPUT POS #3</b>				TOL. UNLESS SPECIFIED X.XX = ± 0.020 X.XXX = ± 0.010 DRILLS = ± 0.003			
		DRAWN	LCD	07-25-95	APPROVED BY:		DO NOT SCALE PRINT		
		CHECKED			ME		SUPERSEDES Q43293-2 REV B		
		SCALE	NONE		EE		E. C. N.		
		PROJ #	D247		PE	TS	05/13/94	C. P. N. SHEET 1 OF 8	REV
		NEXT ASSEMBLY				<b>Q43293-2</b>		(C)	



PARTS LIST			
REF DES	C. P. N.	DESCRIPTION	MAP LOC.
Q525		INSTALLED ON NEXT ASSEMBLY	E 2
Q527		INSTALLED ON NEXT ASSEMBLY	E 2
Q527X	C 8866-3	SOCKET, SIP 3 PIN TIN VERTICAL	E 2
Q529		INSTALLED ON NEXT ASSEMBLY	D 2
Q531	C 8104-9	MPSW92 300V 1 WATT PNP T/R	E 1
Q532	C 8104-9	MPSW92 300V 1 WATT PNP T/R	F 1
Q533		INSTALLED ON NEXT ASSEMBLY	D 2
Q534	C 5891-4	MTS105 THERMAL SENSE T/R	C 1
Q540	C 5891-4	MTS105 THERMAL SENSE T/R	C 1
R500	A10266-1511	150. OHM .25W 5 CF T/R	A 2
R501	A10266-7501	75.0 OHM .25W 5 CF T/R	B 2
R502	A10266-7501	75.0 OHM .25W 5 CF T/R	B 2
R503	A10266-7501	75.0 OHM .25W 5 CF T/R	A 2
R504	A10266-8211	820. OHM .25W 5% CF T/R	C 1
R505	C 8266-6	500 OHM HORZ 6MM GREEN TRIMPOT	E 1
R512	A10266-1331	13.0KOHM .25W 5% CF T/R	B 1
R514	A10266-1011	100. OHM .25W 5% CF T/R	B 2
R515	A10266-1001	10.0 OHM .25W 5% CF T/R	B 2
R518	A10266-1011	100. OHM .25W 5% CF T/R	B 2
R520	A10266-8R22	8.2 OHM .5W 5% CF T/R	C 2
R530	A10265-18211	1.82KOHM .25W 1% MF T/R	B 1
R542	A10266-4R32	4.3 OHM .5W 5% CF T/R	F 1
R544	A10266-5101	51.0 OHM .25W 5% CF T/R	F 1
R546	A10266-1011	100. OHM .25W 5% CF T/R	F 1
R547	A10265-49911	4.99KOHM .25W 1 MF T/R	H 1
R550	A10266-1331	13.0KOHM .25W 5% CF T/R	F 1
R552	A10266-1011	100. OHM .25W 5% CF T/R	E 1
R553	A10266-1011	100. OHM .25W 5% CF T/R	F 1
R554	A10265-18211	1.82KOHM .25W 1% MF T/R	E 1
R555	A10266-1021	1.0 KOHM .25W 5% CF T/R	D 1
R556	C 8266-6	500 OHM HORZ 6MM GREEN TRIMPOT	D 1
R559	A10266-3311	330. OHM .25W 5 CF T/R	G 1
R560	A10266-4731	47. KOHM .25W 5% CF25 T/R	G 1
R561	A10266-5134	51. KOHM 2W 5% CF T/R	F 1
R562	A10265-10001	100. OHM .25W 1 MF T/R	G 1
R563	A10265-90R91	90.9 OHM .25W 1% MF T/R	G 1
R564	A10265-14721	14.7K, 0.25W, 1%, MF	G 1
R565	A10266-1021	1.0 KOHM .25W 5% CF T/R	G 1
R566	C 8265-8	10KOHM HORZ 6MM BLUE TRIMPOT	G 1
R567	A10266-9131	91. KOHM .25W 5 CF T/R	G 1
R568	C 8427-4	100 KOHM HORZ 6MM RED TRIMPOT	G 1
R569	A10266-5134	51. KOHM 2W 5% CF T/R	G 1
R570	A10266-5134	51. KOHM 2W 5% CF T/R	G 1
R571	A10266-2721	2.7 KOHM .25W 5 CF T/R	D 1

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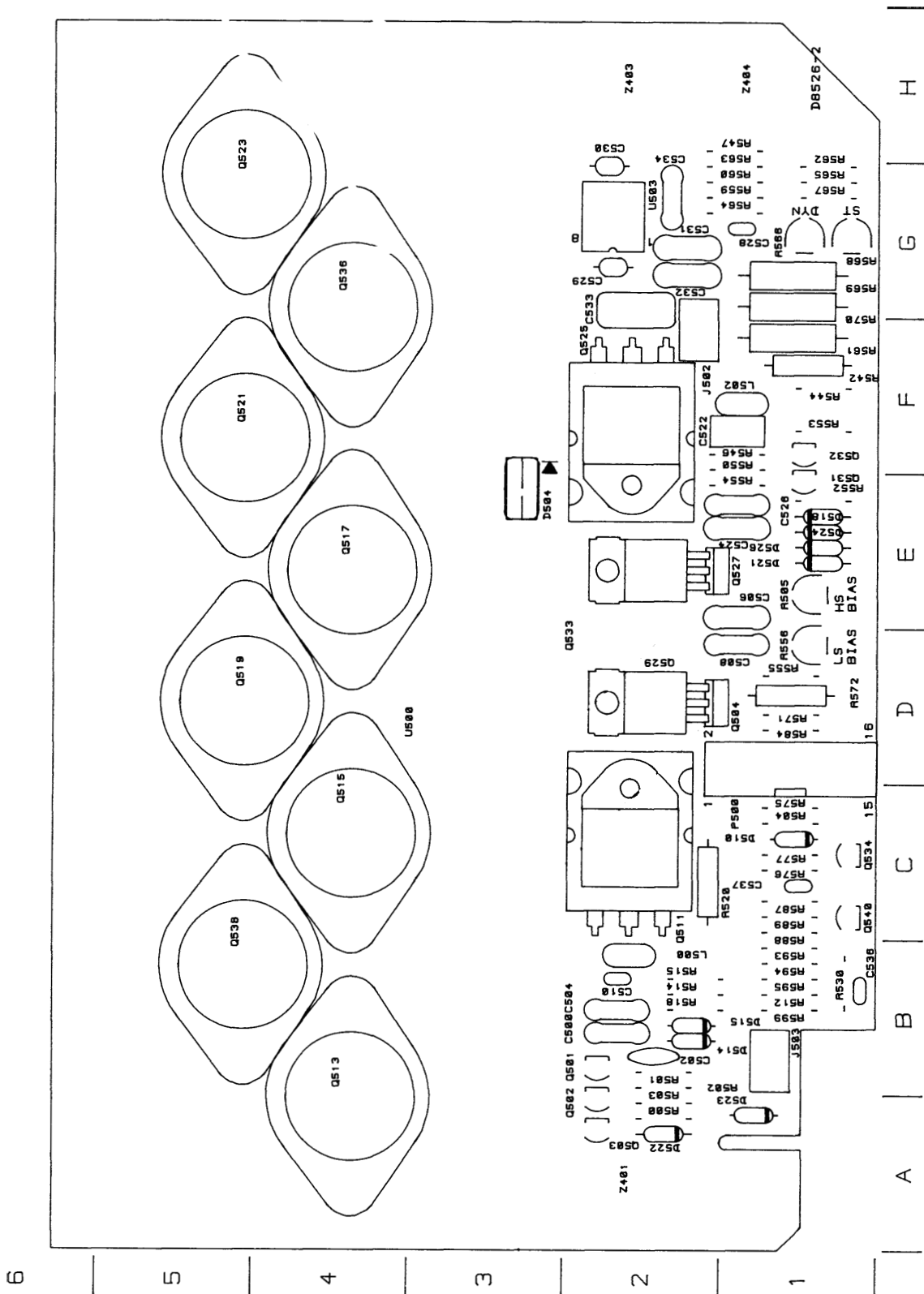
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SCALE	NONE	C. P. N.
PROJ #	D247	

SHEET 5 OF 8	REV
Q43293-2	(C)






PWA Q43293-2 Component Map (Component Side)

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E. C. N.	ZONE	REV.	DESCRIPTION	DATE	BY	APPROVALS			
						CHK	ME	EE	PE
94-141		(A)	CHANGE NOTES 1 & 6 CORRECT COMPONENT ID ON Q510 & Q520	09/06/94	LCD				TS
95-213		(B)	Q512 AND Q526 WERE C 8186-6	07/25/95	LCD				<i>[Signature]</i>

**NOTES:**

1. FOR SCHEMATIC SEE J0488-7 REV G
2. FOR PRINTED WIRING BOARD SEE D8527-0.



**CAUTION**

STATIC CAN DAMAGE COMPONENTS!

**DO NOT HANDLE**

UNLESS WRIST STRAP IS WORN

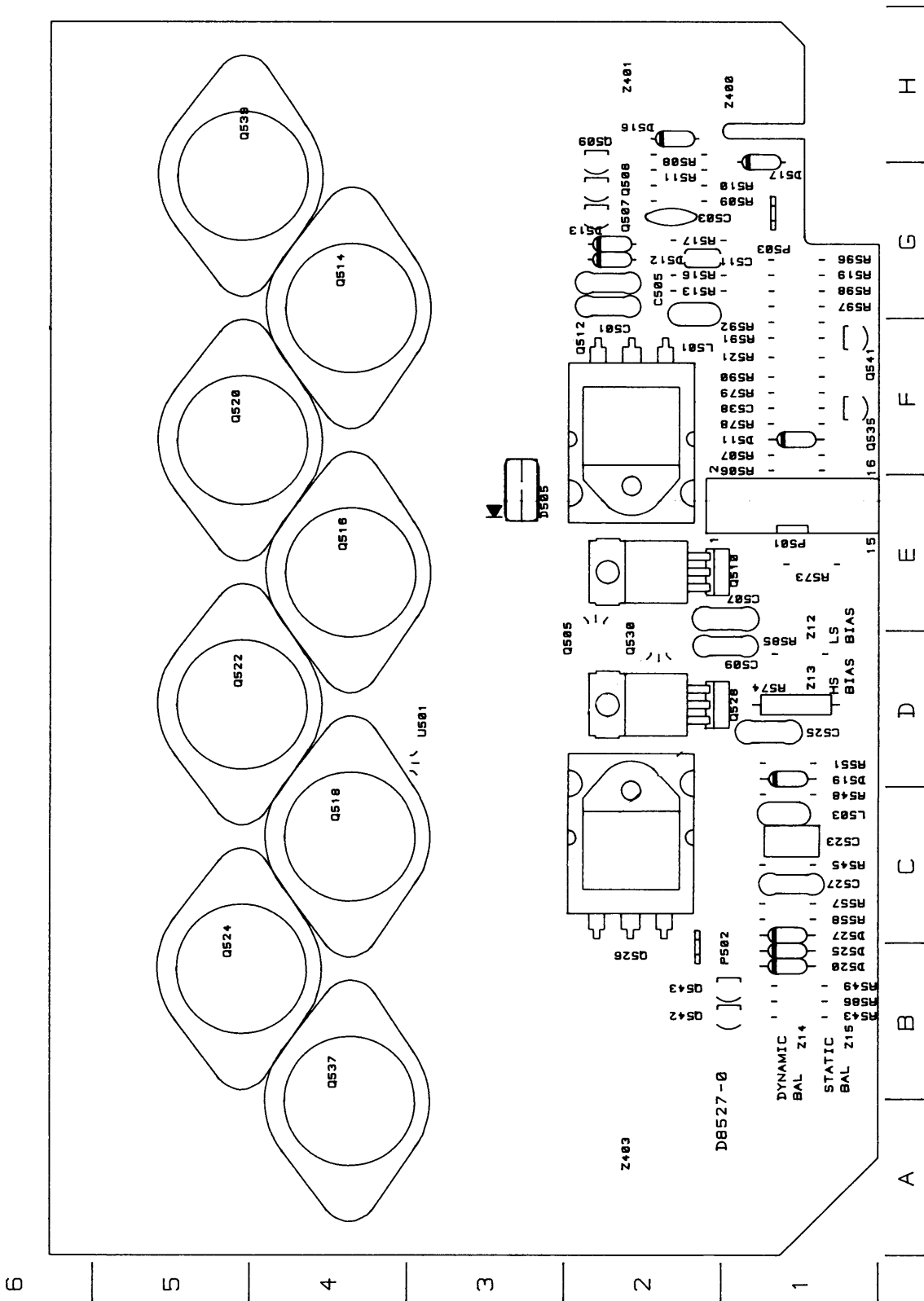
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K	MOD, MA5000VZ OUTPUT NEG
	TOL. UNLESS SPECIFIED X.XX ± 0.020 X.XXX ± 0.010 DRILLS ± 0.003
DRAWN	LCD 07-25-95 APPROVED BY: DO NOT SCALE PRINT
CHECKED	ME SUPERSEDES Q43294-0 REV A
SCALE	NONE EE E. C. N.
PROJ #	D247 PE TS 08/13/94 C. P. N. SHEET 1 OF 6 REV
NEXT ASSEMBLY	Q43294-0 (B)









PWA Q43294-0 Component Map (Component Side)

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## 10 Schematics

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The schematics referenced and provided are representative only. There may be slight variations between amplifier to amplifier. These schematics are intended to be used for troubleshooting purposes only.

**102396**

**125901**

**128112**

**128273**

**J0488-7**

**J0491-1**



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