AE TECHRON®
Precision Industrial Amplifiers

7224

Operator's Manual

Single-Channel Industrial Amplifier for Demanding, High-Power Systems

574.295.9495 | www.AETechron.com
2507 Warren Street, Elkhart, IN 46516

Limited One-Year Warranty

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AE TECHRON INC., of Elkhart, Indiana (Warrantor) warrants to you, the ORIGINAL COMMERCIAL PURCHASER ONLY of each NEW **AE TECHRON INC.** product, for a period of one (1) year from the date of purchase, by the original purchaser (warranty period) that the product is free of defects in materials or workmanship and will meet or exceed all advertised specifications for such a product. This warranty does not extend to any subsequent purchaser or user, and automatically terminates upon your sale or other disposition of our product.

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You are not entitled to recover from us any consequential or incidental damages resulting from any defect in our product. This includes any damage to another product or products resulting from such a defect.

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

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

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There is no warranty that extends beyond the terms hereof. This written warranty is given in lieu of any oral or implied warranties not contained herein. We disclaim all implied warranties, including, without limitation, any warranties of merchantability or fitness for a particular purpose. No action to enforce this Warranty shall be commenced later than ninety (90) days after expiration of the warranty period.

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DECLARATION OF CONFORMITY

Technical Construction File Route

Issued By: AE Techron, Inc.
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Equipment Type: Industrial Power Amplifiers
Model Name: 7224

EMC Standards:

EN 61326-1: 2006 Electrical Equipment for Measurement, Control and Laboratory use:
EMC Requirements

EN 55011: 2007 + A2: 2007 Industrial, Scientific and Medical (ISM) Radio-frequency Equipment:
Radio Disturbance Characteristics
Limits and Methods of Measurement

EN 61000-3-2: 2006 Electromagnetic Compatibility (EMC) Part 3: Limits:
Limits for Harmonic Current Emissions (equipment input current up to and including 16A per phase)

EN 61000-3-3: 2008 Electromagnetic Compatibility (EMC) Part 3: Limits:
Limitation of Voltage Changes, Voltage Fluctuations and Flicker in Public Low-voltage Supply Systems,
for equipment with rated current up to and including 16A per phase and not subject to conditional connection

EN 61000-4-2: 1995 + A1: 1998 + A2: 2001: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Electrostatic Discharge Immunity Test

EN 61000-4-3: 2006: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Radiated Radio-frequency Electromagnetic Field Immunity Test

EN 61000-4-4: 2004: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Electrical Fast Transient/Burst Immunity Test

EN 61000-4-5: 2006: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Surge Immunity Test

EN 61000-4-6: 2007: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Immunity to Conducted Disturbances Induced by Radio Frequency Field

EN 61000-4-8: 1994 + A1: 2001: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Power Frequency Magnetic Field Immunity Test

EN 61000-4-11: 2004: Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques:
Voltage Dips, Short Interruptions and Voltage Variations Immunity Test

Safety Standard:

BSEN61010-1:2001 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

I certify that the product identified above conforms to the requirements of the EMC Council Directive 2004/108/EC, and the Low Voltage Directive 2006/95/EC.

Signed: 

Larry Shank
President

Date of Issue: April 1, 2011

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Figure 1.1 – 7224 Front Panel

1 Introduction

Congratulations on your purchase of the 7224 AE Techron power amplifier—one of the most precise power amplifiers ever produced for industrial applications and testing. The 7224 amplifiers are built and tested to the most stringent quality standards for long life and outstanding performance. The AE Techron brand is known throughout the world for its robust precision amplifiers as well as its product service and support.

1.1 Features

The 7224 is a single-channel linear amplifier designed for use in demanding applications requiring low noise, low distortion, and accurate power amplification from DC to 300 kHz. They feature:

- Frequency bandwidth of DC to 300 kHz at rated power.
- Continuous output of over 1,100 watts RMS at 4 ohms.
- 40 mSec pulses of up to 52 amperes peak into a 0.5 ohm load.
- System output of over 4,000 watts or over 200 amperes maximum is possible with multiple, interconnected amplifiers.
- Efficient design and light weight chassis materials allow amplifier to occupy only 2U height, and weigh only 41 lbs.
- Robust, linear power supply results in extremely low noise; bi-level switch design limits heat dissipation to output devices.
- Protection circuitry protects the *AE Techron 7224* from input overloads, improper output connection (including shorted and improper loads), over-temperature, over-current, and supply voltages that are too high or low.
- 7224 with "P" option offers precision control of output offset, DC drift and gain linearity.
- Shipped ready to operate from 120-volt (±10%) single-phase AC mains; 220/240-volt model available on request.

2 Amplifier Setup

The 7224 amplifiers are precision instruments that can be dangerous if not handled properly. Lethal voltages are present in both the AC input supply and the output of these amplifiers. For this reason, safety should be your primary concern when you setup and operate this amplifier.

2.1 Safety First

Throughout this manual special emphasis is placed on good safety practices. The following graphics are used to highlight certain topics which require extra precaution.

DANGER

DANGER represents the most severe hazard alert. Extreme bodily harm or death will occur if these guidelines are not followed. Note the explanation of the hazard and instruction for avoiding it.

WARNING

WARNING alerts you to hazards that could result in severe injury or death. Note the explanation of the hazard and the instructions for avoiding it.

CAUTION

CAUTION indicates hazards that could result in potential injury or equipment or property damage. Once again, note the explanation of the hazard and the instructions for avoiding it.

2.2 Unpacking

All amplifiers are tested and inspected for damage before leaving the factory. Carefully unpack and inspect the amplifier for damage. Please note any damage for future reference and notify the shipping company immediately if damage is found.

Also, please save the shipping carton and materials as evidence of damage and/or for returning the amplifier for repair.

Along with any additional accessories purchased by the customer, all 7224 amplifiers ship with the following:

- 7224 Amplifier
- Toolkit (contains one #2 Phillips screwdriver and four rubber feet)
- Power Cord
- 7224 Operator's Manual and Quick Start

2.3 Installation

The 7224 amplifiers are packaged in a rugged powder-coated aluminum chassis. This chassis is 2U (rack units) tall, and has rack "ears" on each side of the front panel for mounting to a standard EIA (Electronic Industries Association) rack. Use standard rack mounting hardware to mount the amplifier. Use nylon washers if you wish to protect the powder-coat finish on the front of the amplifier. Optionally, the amplifier can be placed on a bench top; please keep in mind that the protective powder-coating can be scratched when placed on other equipment or on a bench top, especially when there is dirt present. To protect the finish, a set of rubber feet is included in the toolkit that can be installed on the bottom of the amplifier.

CAUTION

Do not operate the amplifier in a small sealed chamber of any kind. Improper operation and overheating will result.

Allow ample space on the sides and especially the back of the amplifier for heated air to escape. The amplifier should be mounted in a rack that is adequately ventilated and not sealed. Likewise, the front of the amplifier should be unobstructed to allow cool air to enter the amplifier.

Figure 2.1 – 7224 Back Panel

WARNING

ELECTRIC SHOCK HAZARD.
Output potentials can be lethal. Make connections only with AC Power OFF and input signals removed.

2.4 Connecting the Load

Before connecting the amplifier, make sure the AC power cord is unplugged.

This section describes output wiring to the load when using the default amplifier configuration: Single (or Master) amplifier operated in Controlled Voltage mode. The 7224 amplifier also can be field-adjusted for operation in Controlled Current mode or for operation as a Slave amplifier in a multi-amplifier system. These alternate configurations may require special output wiring and/or additional components.

If your application requires Controlled Current and/or Slave operation, change the default settings on the main board before connecting the amplifier. (See **Section 4, Advanced Configuration,** for more information.) Also, visit the AE Techron website at **www.aetechron.com** for additional information on these advanced configurations.

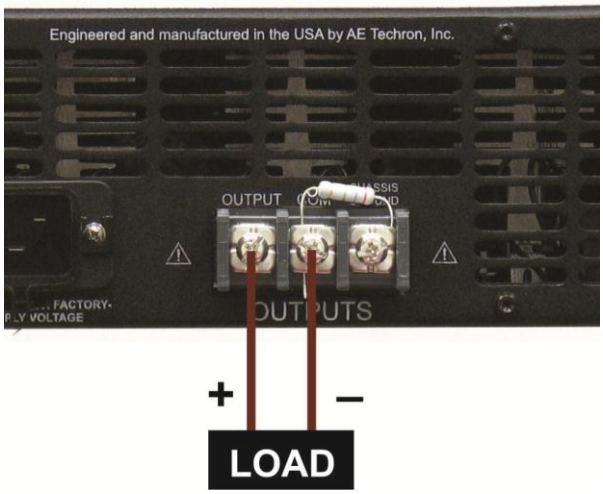


Figure 2.2 – Connecting the Load

Connection to the output of the amplifier is to a 3-position terminal strip with #8 screws. Wires terminated with #8 ring terminals, tinned wires up to 10GA in size, or bus bars with 0.18 in. (4.6 mm) holes are recommended when connecting to the output terminals. Connect the load across the terminals marked "OUTPUT" (positive) and "COM" (negative/ground). The third terminal, "CHASSIS GROUND" can be connected to an external ground point such as the rack chassis. See **Figure 2.2.**

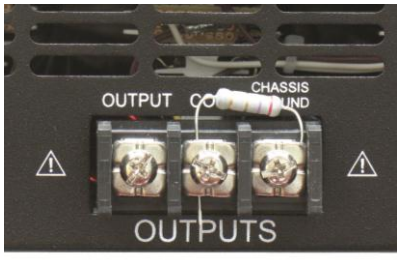


Figure 2.3 – Close-up of the Output Terminals

Always use the appropriate wire size and insulation for the maximum current and voltage expected at the output. Never connect the output of the amplifier to any other model amplifier, power supply, signal source, or other inappropriate load; fire can result.

NOTE: The 7224 amplifier comes with a factory-installed resistor connecting the terminals marked "COM and "CHASSIS GROUND" (see **Figure 2.3**). This resistor should NOT be removed. **WARNING: Removing this resistor can cause dangerous output and/or damage to the load.**

2.5 Connecting the Input Signal

Figure 2.4 – Close-up of SIM Card

The signal is connected to the amplifier through a "SIM (Specialized Input Module) Card" located on the amplifier back panel (see **Figure 2.4**). The standard SIM card includes both an Unbalanced Input BNC jack and a Balanced Input "Weco" terminal block connector, an Input Select switch, and an Interlock – I/O Connector. **See Section 5, Applications,** for information on using the Interlock – I/O Connector.

Position the **Input Select** switch to the left to select the Unbalanced Input connector and to the right to select the Balanced Input connector. Note that **when the Input Select switch is in the right position, both Unbalanced and Balanced Input connectors are enabled.**

IMPORTANT: The Input Select switch also functions as a Ground Lift switch for the Unbalanced Input connector. If circulating currents/ground loops/60-Hz Hum occur when using the Unbalanced Input, move the Input Select switch to the right to lift the ground on the connector.

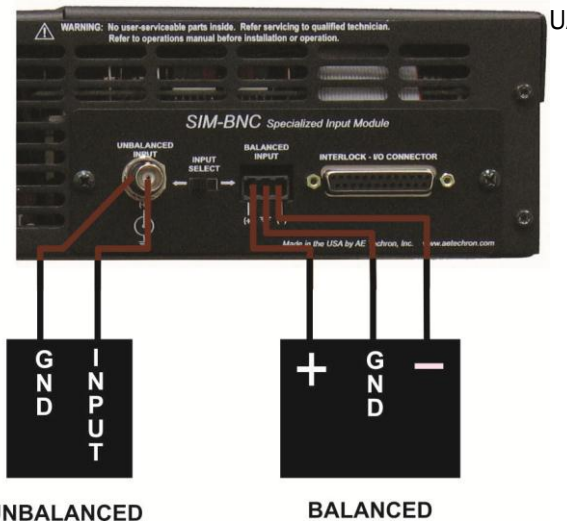


Figure 2.5 – Wiring for Unbalanced or Balanced Input Connector

Connect your input signal to the amplifier's unbalanced or balanced input connector as shown in **Figure 2.5.** Use cables that are high quality and shielded to minimize noise and to guard against possible feedback.

2.6 Connecting the AC Supply

The power cord connects to a standard 20 amp 3-pin IEC-type male connector on the back panel (see **Figure 2.6**). Make sure the Breaker/Switch on the front panel is switched to the OFF (O) position. Make sure the power cord is inserted and seated fully into the IEC connector by moving it slightly back and forth and up and down while pushing in. The power cord is relatively stiff and should be routed so that there is no excessive force pulling to the sides or up or down that would stress the pins or internal connections. Tighten the cord strain relief screw to lock the power cord in place.

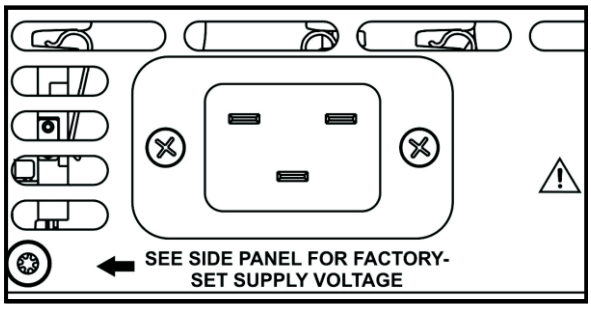


Figure 2.6 – Close-up of AC Mains Outlet

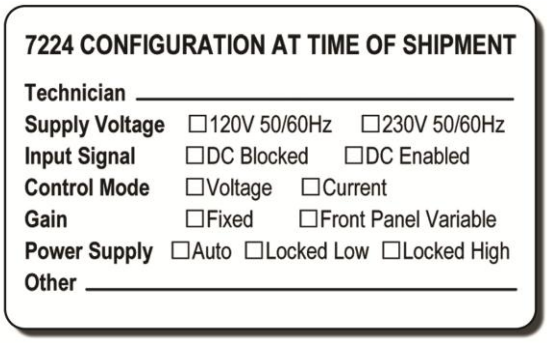


Figure 2.7 – Sample of Configuration Settings Label

Review the factory-set supply voltage and amplifier configuration detailed on the label placed on the side of the amplifier (see **Figure 2.7**). This configuration can be changed by the user. **See Section 4, Advanced Configuration,** for more information.

2.7 Start-up Procedure

1. Turn down the level of your signal source.
2. Turn down the gain control of the amplifier.
3. Depress the POWER switch to turn the amplifier ON.
4. Wait for the yellow READY and green RUN LEDs to illuminate.
5. Adjust the level of your input signal source to achieve the desired output level.
6. Turn up the Gain control on the amplifier until the desired voltage or power level is achieved.
7. Adjust the input signal level to achieve the desired output level.

3 Amplifier Operation

3.1 Front-Panel Controls

This section provides an overview of Front-Panel controls and indicators found on the 7224.

3.1.1 Power Switch

The Power Switch controls the AC mains power to the amplifier. Switch to the ON position (|) to turn the amplifier on. Switch to the OFF position (O) to turn the amplifier off. See **Figure 3.1.**

Figure 3.1 – Power Switch

The Power Switch also serves as a Breaker. When the Breaker is tripped, the Power Switch moves to a neutral position between ON and OFF. To reset the Breaker, turn the amplifier OFF (O) and then turn it back ON (I).

3.1.2 Gain Control

The Gain Control Knob increases/decreases the gain from 0 – 100% of the overall Gain (factory default Gain is 20). See **Figure 3.2.**

Figure 3.2 – Gain Control

3.1.3 Push Buttons

There are three Push Buttons on the 7224.

- **Enable –** puts the amplifier in Run/Ready mode.
- **Stop –** puts the amplifier in Standby/Stop mode.
- **Reset –** returns the amplifier to a Run/Ready mode or Standby/Stop mode, depending on the fault condition.

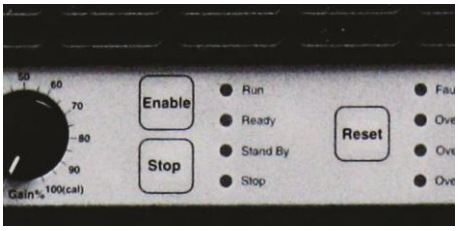


Figure 3.3 –Push Buttons

3.2 Front-Panel Indicators

Four Main Status Indicators located on the front panel monitor and indicate the internal conditions of the amplifier.

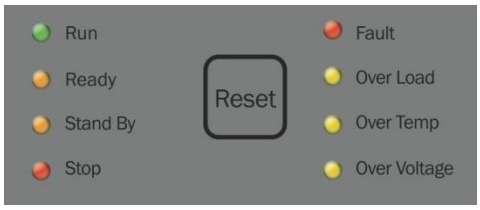


Figure 3.4 - Indicators

- **Run (green) –** This indicates that the unit will amplify the input signal. The amplifier will only pass a signal when the Run Indicator is lit.
- **Ready (orange) –** This indicates that all fault status modes are in ready condition. Ready mode is initiated by: (1) the Enable push button, or (2) when the amplifier powers up in Enable mode. See **Section 4, Advanced Configuration,** for more information.
- **Standby (orange) –** This indicates that the amplifier is in Standby mode. When in Standby mode, the Low-Voltage Transformer is energized but the High-Voltage Transformers are not.
- **Stop (red) –** This indicates that the unit is Stop Mode. Stop Mode is initiated by: (1) the Stop push button, (2) a fault condition, or (3) when the amplifier powers up in Standby Mode. See **Section 5, Advanced Configuration,** for more information.

Four Fault Status Indicators located on the amplifier front panel monitor and indicate the fault conditions of the amplifier. All fault conditions will put the amplifier in Stop Mode.

- **Fault (red) –** This indicates that a fault condition has occurred. Usually the Fault indicator lights up along with one or more of the following fault condition indicators. The Fault indicator may light up by itself; if this happens, see **Section 8, Troubleshooting,** for more information.
- **OverLoad (yellow) –** This indicates that the output of the amplifier could not follow the input signal.
- **OverTemp (yellow) –** The amplifier monitors the temperature inside the High-Voltage Transformers, Low-Voltage Transformer and in the Output Stage Heat Sinks. The OverTemp indicator will be lit when the temperature sensors detect a condition that would damage the amplifier. Please see **Section 8, Troubleshooting,** for more information.
- **OverVoltage (yellow) –** This indicates that the AC mains voltage is more than 10% of nominal. Either the AC mains must be brought down to the nominal value or the three internal transformers need to be rewired. Please see **Section 8, Troubleshooting,** for more information.

3.3 Back-Panel Controls and Connectors

This section provides an overview of Back-Panel controls and connectors found on the 7224. Please refer to **Figure 3.5** for visual locations.

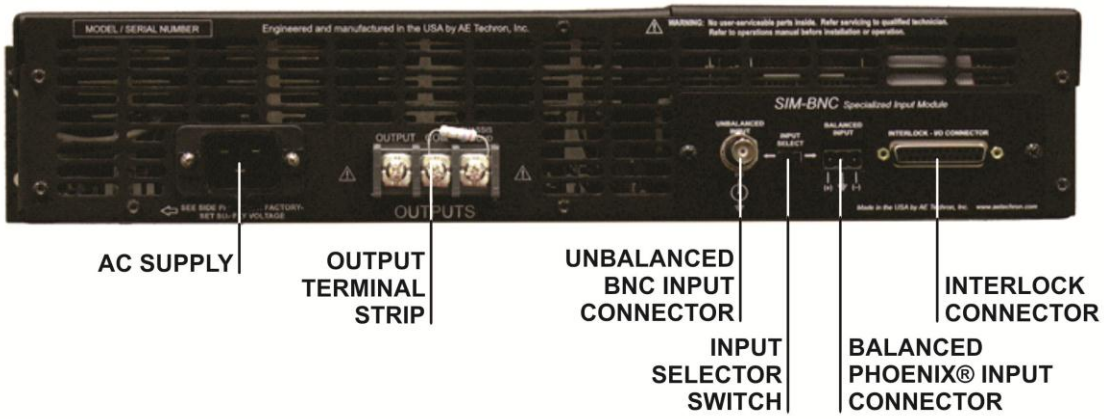


Figure 3.5 – Back-Panel Controls and Connectors

- **AC Supply -** Standard 20 amp 3-pin IEC-type male connector.
- **Output Terminal Strip -** Connect output lines from the load to this 3-position terminal strip with #8 screws. It accepts up to #10 AWG wire.
- **Unbalanced BNC Input Connector -** This input option provides a standard unbalanced input.
- **Input Selector Switch –** When in the LEFT position, the unbalanced BNC input connector is enabled. When in the RIGHT position, both unbalanced BNC and balanced Phoenix® input connectors are enabled. The Input Select switch also functions as a Ground Lift switch for the Unbalanced BNC input connector. If circulating currents/ground loops/60-Hz Hum occur when using the unbalanced input, move the Input Select switch to the right to lift the ground on the connector.
- **Balanced Phoenix® Input Connector -** This input option provides a balanced input.
- **Interlock Connector -** This 25-pin, D-sub connector is used for interlocking and combining functions in a system of multiple amplifiers. It can also be used for remote control and monitoring applications (see **Section 5, Applications**).

4 Advanced Configuration

The 7224 amplifier was designed to offer exceptional versatility in operation. You can choose from a range of field-configurable options, including:

- Operate as a stand-alone amplifier or as part of a multiple-amplifier system.
- Operate with variable gain control or at a fixed gain setting of 20.
- Select Controlled-Current or Controlled-Voltage modes of operation.
- Trigger Standby Mode when specified fault conditions occur during operation.
- Select the Standby Mode state at power-up, or go immediately to the Ready state at power-up.
- Configure for use in high voltage applications, high current applications, or for applications requiring mid-level amounts of both voltage and current.

Your 7224 amplifier has been pre-configured to your specifications before shipping from the factory. These initial settings are detailed on your 7224 Proof of Performance sheet and on a label located on the side of the amplifier.

If you need to make changes to your amplifier's configuration, please follow the instructions contained in this chapter.

WARNING

Do not attempt to access the Main Board while amplifier is running. Turn the amplifier off and disconnect the AC Mains before removing amplifier front panel.

CAUTION

After turning the amplifier off, let the unit sit for 3-5 minutes before removing the front panel. This will allow the electrical charge in the Power Supply capacitors to discharge.

4.1 Configuration Access Panel

The 7224 amplifier contains an Access Panel built into the top cover. Most configuration settings can be made through this Access Panel. For your convenience, a #2 Phillips screwdriver is provided in your Toolkit for use in this procedure.

IMPORTANT: Before removing the Access Panel, make sure the amplifier is turned off for at least 3-5 minutes and the AC mains are disconnected.

1. Locate the Access Panel as shown in Figure 4.1. Make sure that all 8 screws are accessible. Remove the unit from its rack, if necessary.
2. Using a #2 Phillips screwdriver (provided), remove the 8 screws located on the top and side of the amplifier.
3. Remove the Access Panel and set it aside.

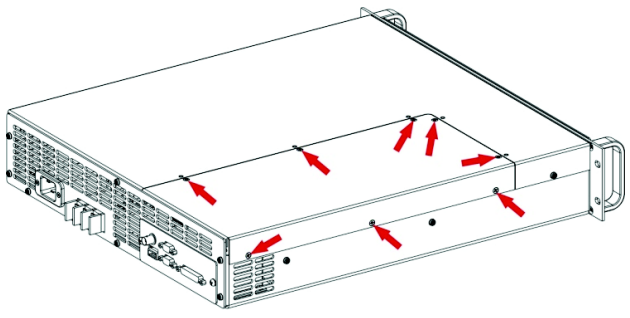


Figure 4.1 – Access Panel Screw Locations

4.2 Configuration Settings Located on the Main Board

The following custom settings can be made via jumper settings on the Main Board, which is located inside the Access Panel compartment, as shown in **Figure 4.2.**

- Master/Slave setting for stand-alone or multiple-amplifier systems.
- Variable or Fixed Gain setting.
- Controlled Current/Controlled Voltage setting.
- Compensation setting to select RC network when operating in Controlled Current mode.
- Standby Mode/Ready Mode setting for selection of power-up state.
- Stop Mode on OverTemp setting to trigger Stop Mode when amplifier senses an OverTemperature state.
- Stop Mode on OverLoad setting to trigger Stop Mode when amplifier senses an OverLoad state.

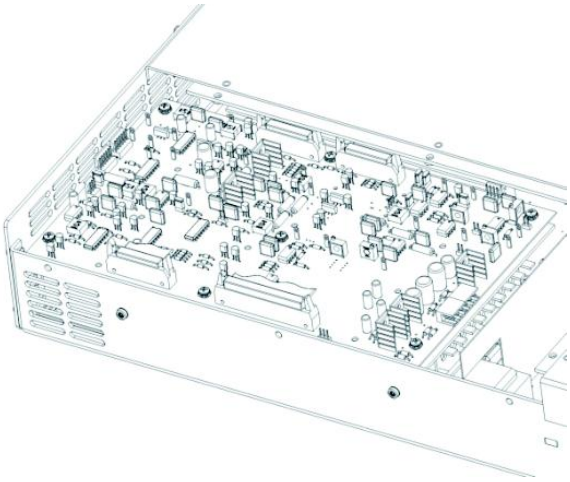


Figure 4.2 – Main Board Location inside Access Panel

4.2.1 Master/Slave Setting

To enable the 7224 amplifier for use as a single amplifier or as the Master amplifier in a multi-amplifier system, set jumpers **P1** and **P2** in the **Master** position (jumpers across top two pins of each set). To enable the 7224 amplifier for use as a Slave amplifier in a multi-amplifier system, set jumpers **P1** and **P2** in the **Slave** position (jumpers across bottom two pins of each set). See **Figure 4.3.**

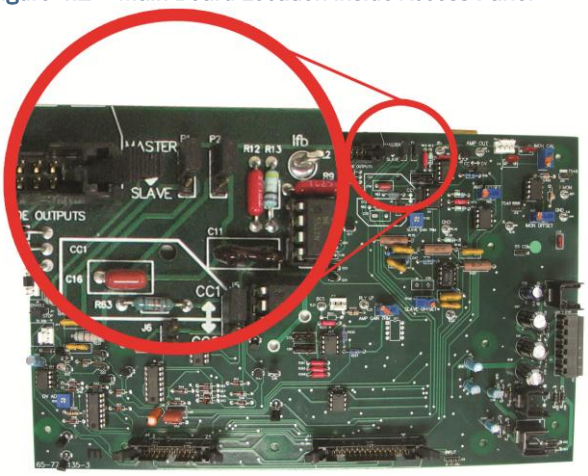


Figure 4.3 - Master / Slave Setting

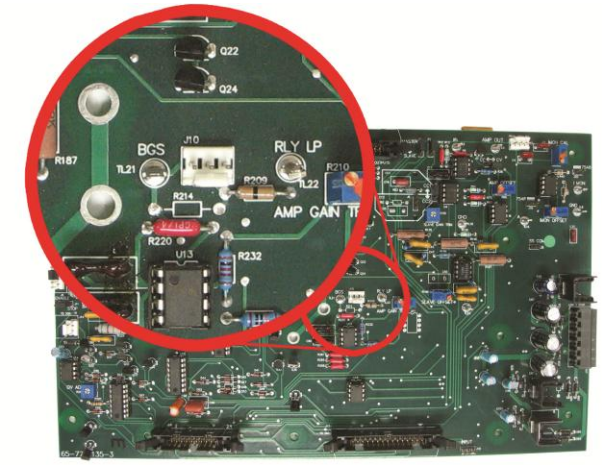


Figure 4.4 - Gain Trim Control

4.2.2 Fixed Gain/Variable Gain Setting

The 7224 amplifier ships with an enabled Gain Control knob (located on the amplifier front panel). To disable the **Variable Gain** control and set for a **Fixed Gain** of 20, locate and unplug the red connector from jumper **J10.** Then place a **jumper on the left two pins** at that location**.** See **Figure 4.4.**

4.2.3 Controlled Voltage/Controlled Current Setting

To allow the 7224 amplifier's **output voltage** to be controlled by its input voltage signal, place jumper **J4** in the **Right** position. To allow the 7224 amplifier's **output current** to be controlled by its input voltage signal, place jumper **J4** in the **Left** position. See Figure 4.5.

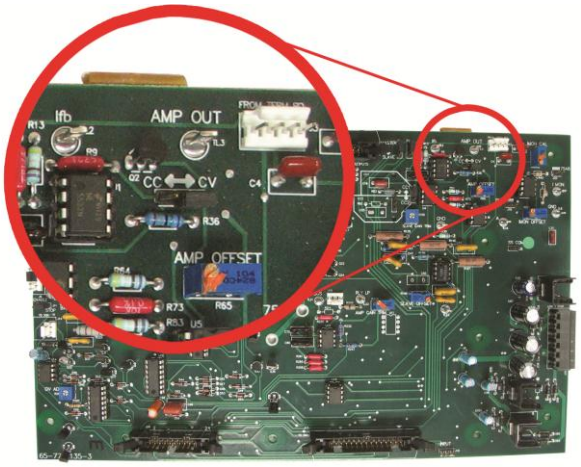


Figure 4.5 - Controlled Voltage / Controlled Current Setting

CAUTION

In Controlled-Current Mode, the load is part of the amplifier circuit, and the relationship of the load to the amplifier is critical. For proper and safe operation in Controlled-Current mode, you must observe the following guidelines:

1. **Properly attach a load before operating the amplifier.**
2. **DO NOT use a blocking capacitor.** The load must have a DC path.
3. **Never leave the load open.** If you feel the load must be fused, which could lead to a potential open circuit, please contact AE Techron Application Engineering department.
4. **Check to make sure the load has some inductive component.**
5. **Provide appropriate Compensation for the load.**
6. **If oscillation occurs, turn off the amplifier immediately.**

Failure to follow these guidelines may result in damage to the amplifier or load.

4.2.4 Compensation Setting (Controlled Current Mode)

When the 7224 amplifier is used in Controlled Current mode, the current control loop is tuned with one of two available RC networks. Place jumper **J5** in the **Up** position to select **CC1** network. Place jumper **J5** in the **Down** position to select **CC2** network. See **Figure 4.6.**

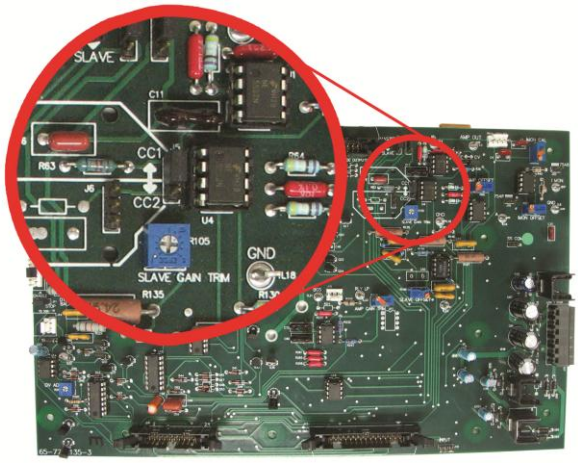


Figure 4.6 – Compensation Setting

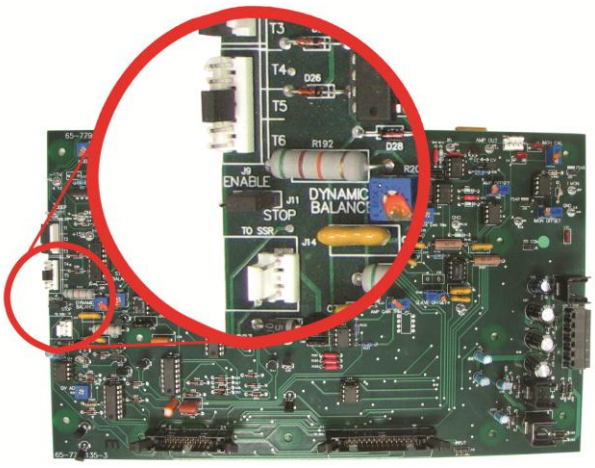


Figure 4.7 – Ready Mode/Standby Mode Power Up Setting

4.2.5 Ready Mode/Standby Mode Power-up Setting

The 7224 amplifier will power-up **to Ready Mode** on Power-up when jumper **J11** is in the **Left** position (default setting). To cause the 7224 amplifier to enter Standby Mode on Power-up, place jumper **J11** in the **Right** position. See **Figure 4.7.**

4.2.6 Stop Mode on OverTemp Setting

When enabled, the 7224 amplifier will move into Stop Mode when it senses any activation of the **OverTemperature circuit.** The amplifier will remain in Stop Mode until the Reset switch on the front panel is pushed or a Reset signal is received on the Interlock – I/O Connector. Once reset, the amplifier will return to Ready/Run (operational) Mode. To enable **Stop Mode on OverTemp,** place the jumper across the two pins labeled **J12.** See **Figure 4.8.**

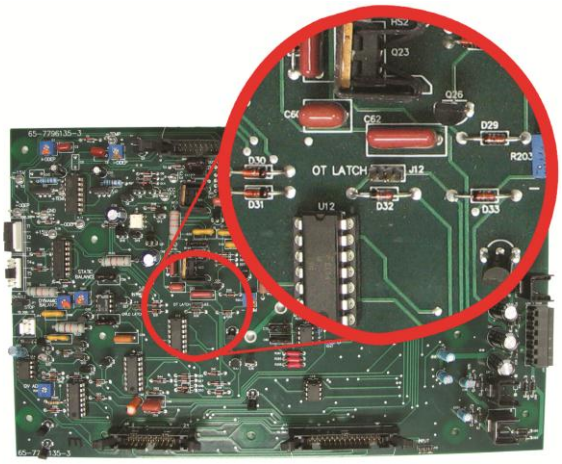


Figure 4.8 – Stop Mode on OverTemp Setting

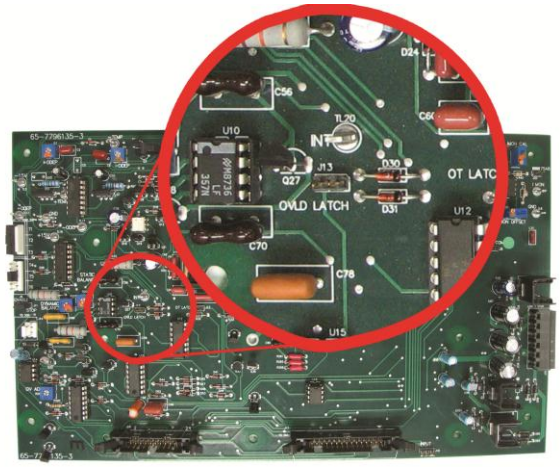


Figure 4.9– Stop Mode on OverLoad Setting

4.2.7 Stop Mode on OverLoad Setting

When enabled, the 7224 amplifier will move into Stop Mode when it senses an activation **of the IOC (Input/Output Comparator) Distortion Alert circuit.** The IOC Distortion Alert circuit continuously compares the input waveform to the output waveform. When a distortion of more than 0.5% occurs, the IOC circuit will activate. The amplifier will remain in Stop Mode until the Reset switch on the front panel is pushed or a Reset signal is received on the Interlock – I/O Connector. Once reset, the amplifier will return to Ready/Run (operational) Mode. To enable **Stop Mode on OverLoad,** place the jumper across the two pins labeled **J13.** See **Figure 4.9.**

4.3 Configuration Settings Located on the Power Supply Board

The following custom settings can be made via plug-in connectors located on the Power Supply Board:

- Amplifier Voltage Potential setting (high current or high voltage)
- Bi-Level Power Supply setting

To access the Power Supply Board, follow the instructions in Section 4.1 to open the Configuration Access Panel. The Power Supply Board is located to the right of the Main Board, as shown in **Figure 4.10.**

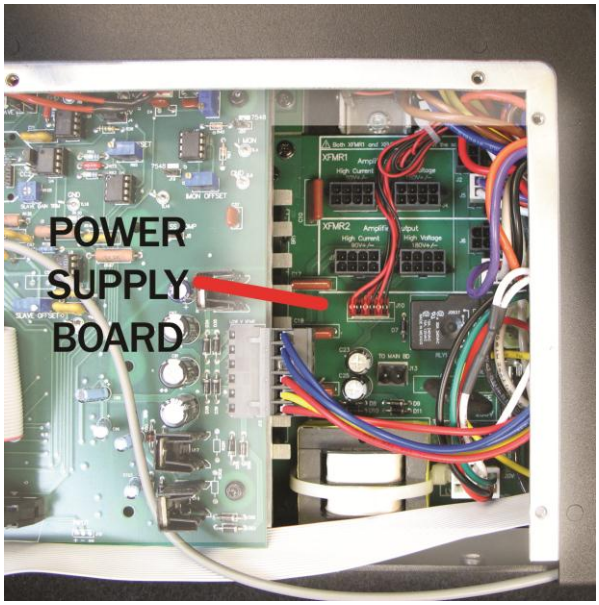


Figure 4.10– Accessing the Power Supply Board

4.3.1 Changing Amplifier Voltage Potential

The 7224 can be configured for High Current (90V) or High Voltage (180V) operation via user-selectable plugs on the Power Supply Board.

For general guidelines in selecting the best setting for your requirements, see **Section 4.3.3.**

1. Locate the two XFMR sections (left of Line Voltage sections) (see **Figure 4.11**).

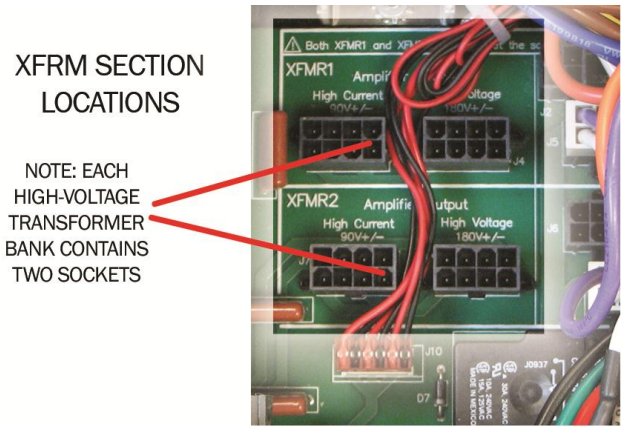


Figure 4.11– Location of Amplifier Voltage Output Sockets

2. For High Current (90V) Output (see **Figure 4.12**).

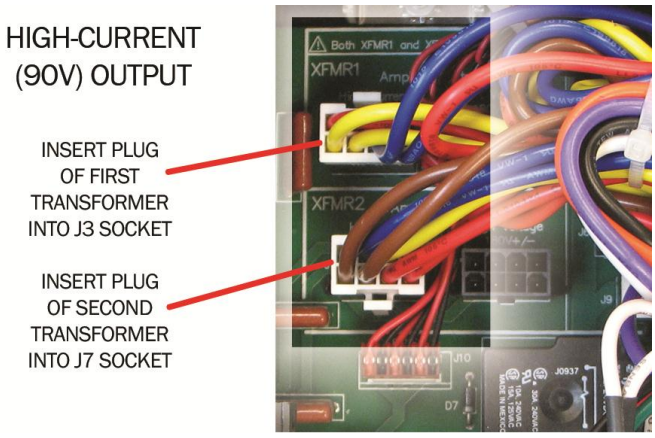


Figure 4.12– Location of Amplifier Voltage Output Sockets

3. For High Voltage (180V) Output (see **Figure 4.13**).

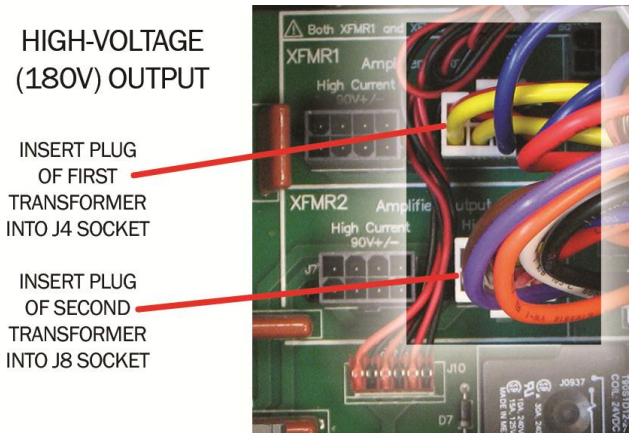


Figure 4.13– Location of Amplifier Voltage Output Sockets

4.3.2 Changing Bi-Level Power Supply Function

The 7224 offers three Bi-Level switch settings: Automatic, High, or Low. The user can select between settings via a switch on the Power Supply Board.

For general guidelines in selecting the best setting for your requirements, see **Section 4.3.3.**

Figure 4.14– Bi-Level Power Switch Location

To access and change the Bi-Level Power Switch, follow these steps:

1. Locate the SIM Input Card on the right side of the rear panel of the amplifier.
2. Using a #2 Phillips screwdriver (provided), remove the 2 screws located at the edges of the SIM card.
3. Keeping the ribbon cable attached, remove the SIM card from the amplifier until it is completely clear from the card bay.
4. Locate Bi-Level Power Switch, S1, a black, three-position switch at the rear of the card bay. (See Figure 4.14.)
5. Move Black switch to desired setting. If necessary, use a pointed, non-metallic object (such as a pen) to help in moving the switch.
   a. Automatic – Left
   b. Low – Middle
   c. High – Right

4.3.3 Selecting the Best Voltage Potential and Bi-Level Power Switch Settings for Your Application

The output of the amplifier will be determined by the combination of settings used for both Voltage Potential and Bi-Level Power Switch.

OUTPUT VOLTAGE		
Bi-Level Switch Setting	Voltage Potential Setting	
	90	180
Auto	45 - 90	90 - 180
High	90	180
Low	45	90

Use the following general guidelines to select the best combination of settings to fit your requirements:

OUTPUT	LOAD		Settings
	Continuous	Pulse	
High Voltage	16, 8 ohm	16, 8, 4 ohm	180V Auto
Mid-Level	4, 2 ohm	2, 1 ohm	90V Auto
High Current	1, 0.5 ohm	0.75 – 0.25 ohm	90V Low

Also see **Section 9, Specifications,** for more information.

5 Applications

5.1 Remote Status and Control using the SIM Interlock I/O Connector

The procedures outlined in this section assume competence on the part of the reader in terms of amplifier systems, electronic components, and good electronic safety and working practices.

AE Techron 7224 amplifiers come with a SIM-BNC input module that also contains a female, 25-pin D-Sub connector. This connector can be used to provide remote control and monitoring of the amplifier.

The information provided here will instruct you in the wiring of several control and status applications including:

- Over-temperature status
- Run status
- Overload status
- Overvoltage status
- Reset after Over-temperature or Overload error
- Voltage monitor
- Current monitor

Figure 5.1 maps the pins used for these applications.

For a detailed chart of all DB-25 pinouts, see **Appendix 1.**

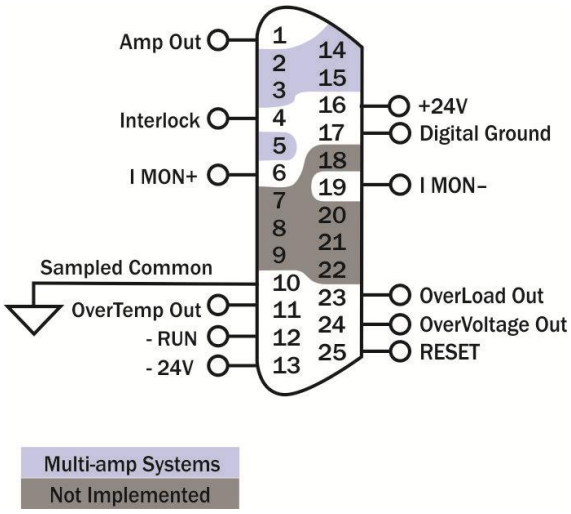


Figure 5.1 – Remote Status and Control Pinouts

5.1.1 Remote Enable / Standby

Using the SIM-BNC Interlock connector located on the back panel of the amplifier, you can remotely Enable the amplifier and/or place the unit in Standby mode.

Remote Enable/Standby
Purpose: Use a switch or optocoupler to remotely disable the amplifier and place it in Standby mode. Also, return the amplifier from Standby mode to the Run condition.

Method: Short PIN 4 of amplifier to Digital Ground (PIN 17) using a dry contact switch or optocoupler. In multi-amp applications, a switch can be used for Parallel systems, but an optocoupler must be used for Series systems. Multiple amplifiers (sharing the same Sampled Common power connections) can be simultaneously forced to Standby by daisy-chaining Interlock (PIN 4) across amps. When Interlock (PIN 4) is shorted to Digital Ground (PIN 17), amplifier is placed in Standby mode. When switch is open, amplifier is released to the Run condition. See **Figure 5.2.**
Signal Type: DC
Level when Asserted: 0 to 8 V
Level when Deasserted: 10 to 15 V
IMPORTANT: The amplifier must be configured for Ready mode at startup (factory default) or the Run button must be pressed at the amplifier front panel at startup. The Remote Enable/Standby circuit will not function if the Startup to Standby Latch has been activated on the amplifier.

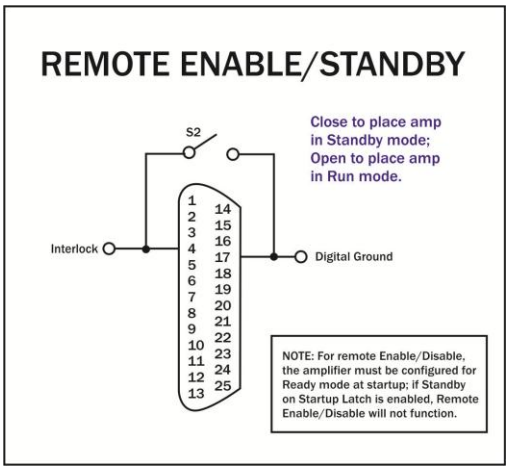


Figure 5.2 – Remote Enable/Standby

5.1.2 Remote Amplifier Status and Reset

The SIM Interlock I/O Connector can be used to create a circuit to monitor remotely one or more amplifier conditions, including Run status, Over-temperature, Overload and Overvoltage. The circuit can also be constructed to allow remote reset of the amplifier when it is forced to Standby by Over-temperature or Over-load conditions.

Use a male, 25-pin D-Sub connector and high-quality wire to build the circuit. **Figure 5.3** schematic details the circuit and components required for all status and reset functions.

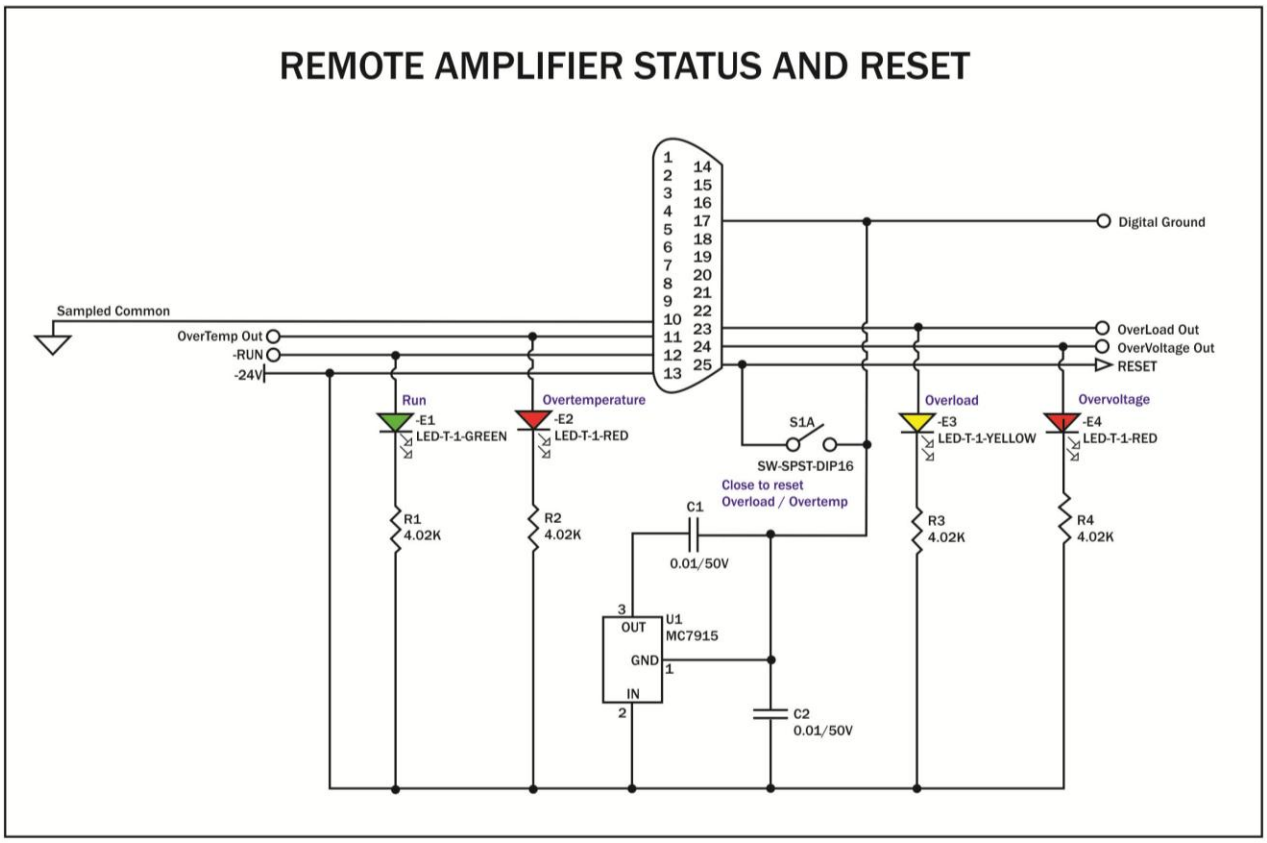


Figure 5.3 – Remote Status and Reset Schematic

Remote Signal of Over Temperature Condition
Purpose: LED, when lit, signals Over Temperature condition.
Method: Use a 6mA series resistor of 4.02 Kohm for LED or OPTO, tie OverTemp Out (PIN 11) to -24V source (PIN 16).
Signal Type: DC
Level when Asserted: –24V
Level when Deasserted: 0V
Note: When amp is normal, this pin is pulled to –24V through a 47.5K-ohm resistor; when amp is in OverTemp state, transistor Q37 turns on and sources chassis ground as an output. Do not exceed 20 milliamps.

OverTemp condition will force amp to Standby (default) or to Stop (when Stop Mode on OverTemp option is enabled). If in Standby, amp will automatically move to Run when temperature cools to operating levels. If in Stop, Reset must be triggered via front-panel Reset button or remote Amplifier Reset.

Remote Signal of Run Condition
Purpose: LED, when lit, signals Run state.
Method: Use a 6mA series resistor of 4.02K-ohm for LED or OPTO, tie Run (PIN 12) to –24V source (PIN 16).
Signal Type: DC
Level when Asserted: –24V
Level when Deasserted: 0V

Remote Signal of OverLoad Condition
Purpose: LED, when lit, signals Overload condition.
Method: Use a 6mA series resistor of 4.02K-ohm for LED or OPTO, tie OverLoad Out (PIN 23) to –24V source (PIN 16).
Signal Type: DC
Level when Asserted: –24V
Level when Deasserted: 0V
Note: When amp is normal, this pin is pulled to –24V through a 47.5K-ohm resistor; when amp is in Overload state, transistor Q36 turns on and sources chassis ground as an output. Do not exceed 20 milliamps.

OverLoad condition will force amp to Standby (default) or to Stop (when Stop Mode on OverTemp option is enabled). If in Standby, amp will automatically move to Run when overload is remedied. If in Stop, Reset must be triggered via front-panel Reset button or remote Amplifier Reset.

Remote Signal of OverVoltage Condition
Purpose: LED, when lit, signals Overvoltage condition.
Method: Use a 6mA series resistor of 4.02K-ohm for LED or OPTO, tie OverVoltage Out (PIN 24) to –24V source (PIN 16).
Signal Type: DC
Level when Asserted: –24V
Level when Deasserted: 0V
Note: When amp is normal, this pin is pulled to –24V through a 47.5K-ohm resistor; when amp is in Overvoltage state, transistor Q29 turns on and sources chassis ground as an output. Do not exceed 20 milliamps.

Reset from Standby or Stop
Purpose: Switch, when thrown, returns amp to Ready/Run condition after Over-temperature or Overload conditions.
Method: Use a dry-contact switch, voltage regulator (MC7915), and two 0.01/50V capacitors; wire the circuit as shown (above). Assert 15V for at least 100 ms to clear the error condition.
Signal Type: DC
Level when Asserted: –15V
Level when Deasserted: 0V
Note: Tie to PIN 13 (–24V dc) and create a –15V dc source; <2mA required for reset. Connect the –15V dc source to PIN 25 (Reset) through a 1K buffer resistor to reset.

5.1.3 Remote Monitoring of Voltage and Current

Using the SIM-BNC Interlock connector located on the back panel of the amplifier, you can remotely monitor both voltage and current output.

Use a male, 25-pin D-Sub connector and high-quality wire to build the desired circuits.

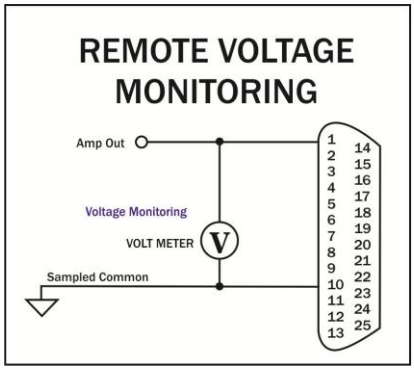


Figure 5.4 – Remote Voltage Monitoring Schematic

Remote Monitoring of Voltage Output
Purpose: Use a voltage meter to monitor output voltage.
Method: Connect a voltage meter to monitor the output voltage being produced by the amplifier. Connect across PIN 1 (Amp Out) and PIN 10 (Sampled Common). **See Figure 5.4.**

Signal Type: AC or DC
Level when Asserted: Can be greater than +/–200Vpeak
Level when Deasserted: 0V
Note: Used for monitoring amplifier output voltage; driving slave amplifiers in multi-amp systems. Wired to amplifier output. Do not connect to any impedance of less than 10K ohm. High voltage output possible. Use appropriate safety precautions.

Remote Monitoring of Current Output
Purpose: Use a voltage meter to monitor output current.
Method: Connect a voltage meter to monitor the output current being produced by the amplifier. Connect across PIN 6 (I MON+) and PIN 10 (Sampled Common). See **Figure 5.5.**
Signal Type: DC
Level when Asserted: 7212/7224: 5A/V; /7796: 20A/V
Level when Deasserted: 0V

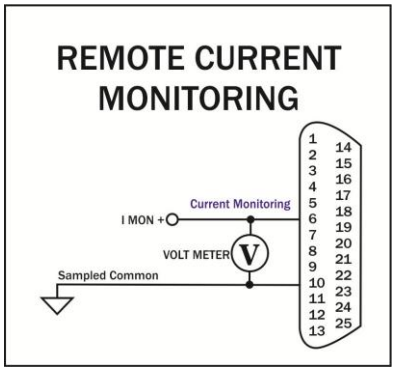


Figure 5.5 – Remote Current Monitoring Schematic

Remote Monitoring of Current Output - Alternate Method
Purpose: Use a voltage meter to monitor output current when output is not balanced.
Method: Connect a voltage meter to monitor the output current being produced by the amplifier. Connect across PIN 6 (IMON+) and PIN 19 (IMON-). See **Figure 5.6.**
Signal Type: AC
Level when Asserted: 7212/7224: 2.5A/V; 7548/7796: 10A/V
Level when Deasserted: 0V
CAUTION: To avoid ground loops, isolation from ground must be provided. Use of a differential probe is recommended.

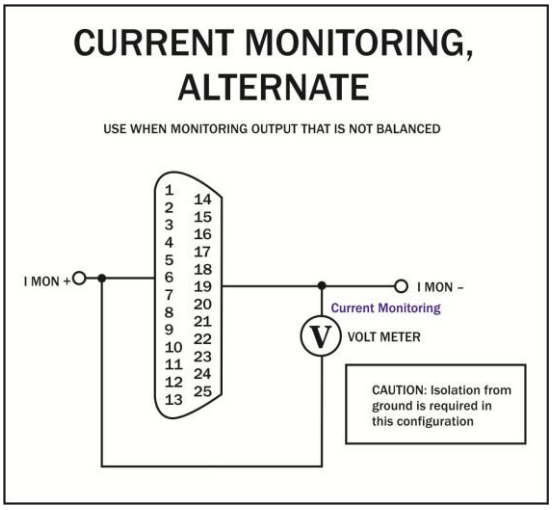


Figure 5.6 – Remote Current Monitoring Schematic, Alternate Method

5.2 Controlled Current Operation

The procedures outlined in this section assume competence on the part of the reader in terms of amplifier systems, electronic components, and good electronic safety and working practices.

5.2.1 Controlled-Voltage vs. Controlled-Current Modes of Operation

AE Techron 7224 amplifiers can be field-configured to operate as **Voltage Amplifiers** (Voltage-Controlled Voltage Source) or as **Transconductance Amplifiers** (Voltage-Controlled Current Source). The mode selection is made via a jumper setting located on the amplifier main board. See **Section 4, Advanced Configuration.**

When configured as a **Controlled-Voltage** source (voltage amplifier), the amplifier will provide an output voltage that is constant and proportional to the control (input) voltage. If the load's impedance changes, the amplifier will seek to maintain this ratio of input to output voltage by increasing or decreasing the current it produces, as long as it is within the amplifier's ability to create the required current. Use this mode if you want the output voltage waveform to be like the input waveform.

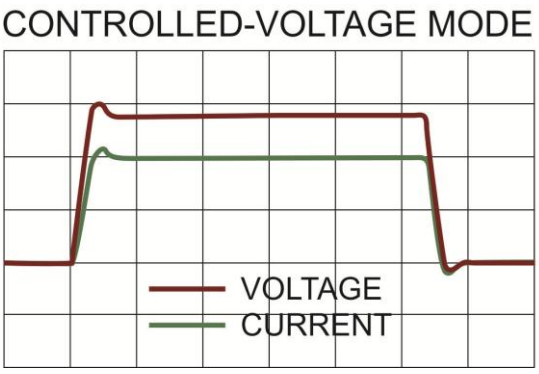


Figure 5.7 – Input to Output Comparison, Controlled-Voltage Operation

Conversely, when configured as a **Controlled-Current** source (transconductance amplifier), the amplifier will

provide an output current that is constant and proportional to the control (input) voltage. If the load's impedance changes, the amplifier will seek to maintain this transconductance (ratio of input voltage to output current) by increasing or decreasing the voltage it produces, as long as it is within the amplifier's ability to create the required voltage. Use this mode if you want the output current waveform to be like the input waveform.

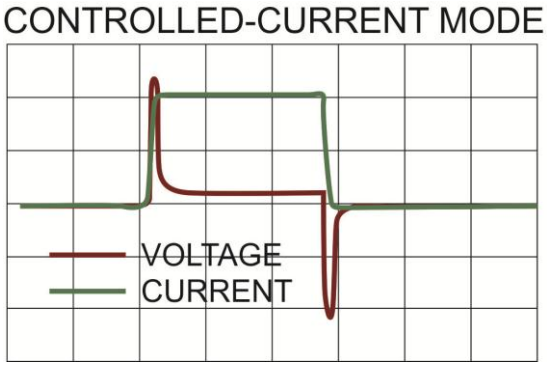


Figure 5.8 – Input to Output Comparison, Controlled-Current Operation

5.2.2 Safety and Operation Considerations for Controlled Current Operation

When an AE Techron amplifier is configured as a Controlled Current source, care needs to be exercised in its operation. **Any voltage controlled current source should never be turned on without a load, (with some impedance, real or effective) connected to its output terminals.** When asked to operate in this way, any current source (including an AE Techron amplifier) will increase its output voltage in an attempt to drive the requested current into the load. In an open-circuit condition, creating current flow will be impossible. The current source will increase its output voltage until it reaches its voltage limit. This is a potentially dangerous condition for both the AE Techron amplifier and for any user who might come in contact with the amplifier output terminals.

When operating in Controlled Current (CC) mode, a compensation circuit is required to ensure accurate output current. Since the load is a critical circuit component in CC mode, the inductive and resistive values of the load will determine the required compensation values. While the factory-default compensation setting will be sufficient for some applications, the compensation setting may also be adjusted in the field. The following section describes methods for determining and setting proper compensation when operating in Controlled-Current mode.

5.2.3 Controlling Compensation for CC Operation

AE Techron 7224 amplifiers can be configured for either Controlled Voltage (CV) or Controlled Current (CC) mode of operation. When operating the amplifier in Controlled Voltage (CV) mode, compensation is not required. However, when operating in Controlled Current (CC) mode, the amplifier load becomes an integral part of the system. In order to ensure system stability and to control available bandwidth, compensation via an RC network is required for CC operation. The following steps will allow you to compensate your amplifier for operation in CC mode safely and effectively.

STEP 1: Check Amplifier Operation in CV mode.

We recommend that you power-up and enable the amplifier in Controlled Voltage mode without attaching a load before configuring your amplifier for Controlled Current operation. This will allow you to verify that the input signal and the amplifier are operating correctly.

Once this initial check is completed, power down the amplifier and access the amplifier main board to place the amplifier in CC mode. (Refer to **Section 4, Advanced Configuration**.)

One of two compensation settings can be selected via jumpers on the main board: CC1 which enables the factory-installed RC network (see Figure 1), or CC2 which allows installation of a custom RC network.

STEP 2: Determine Required Compensation.
When operating an amplifier in Controlled Current mode, the load becomes an integral part of the system. In order to determine the required compensation for your load, begin by consulting the following table to determine the approximate compensation capacitance (C) required based on the inductance of your load:

	Load Inductance (L)		
	<200 microHenries	> 200 microHenries to < 1 milliHenry	>1 milliHenry
Compensation Capacitance (Cc)	0.001 microfarad	0.01 microfarad	0.1 microfarad

NOTE: Load Resistance (R) is assumed to be <5 ohms.

STEP 3: Determine if Default or Custom Compensation is Required.
If your load inductance is between 200 microHenries and 1 milliHenry, and your load resistance is less than 5 ohms, then you can likely use the default compensation provided by the amplifier's factory-installed RC network. To select the factory-default compensation, please see **STEP 4** below.

If your load inductance falls outside of the mid-range, or if your load resistance is greater than 5 ohms, then you must calculate your required compensation. If, after calculating your required compensation, you determine that the default compensation will be insufficient for your load, then you will need to enable and install a custom RC network. See **STEP 6** below.

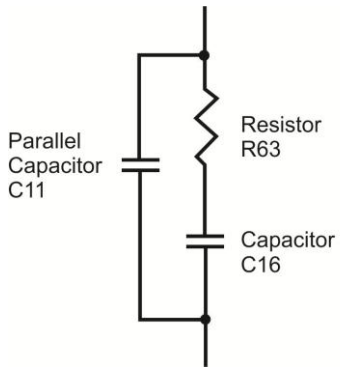


Figure 5.9 – Factory-installed default RC network

STEP 4: Enabling Your Compensation Setting.
AE Techron 7000 Series amplifiers can be enabled with one of two compensation settings: default RC network or custom RC network. The required network can be selected via jumpers on the main board. CC1 enables the default (factory-installed) RC network, while CC2 allows installation of a custom RC network. **Figure 5.9** describes the default RC circuit.

To select CC1, place jumper J5 in the UP position; to select CC2, place jumper J5 in the DOWN position. (For jumper location, see **Section 4, Advanced Configuration**.)

IMPORTANT: If CC2 is selected, you must calculate the compensation requirements for your custom RC network and install the network on your amplifier main board before operating the amplifier in CC mode.

STEP 5: (Optional) Verify Suitability of Default Compensation (CC1)
If desired, the following values of the components contained in the default RC network can be used with the formulas provided in **STEP 6** below to verify the suitability of the default compensation for your uses.

Pins Jumped	Compensation Resistor	Compensation Capacitor	Parallel Capacitor
1 & 2 UP	**R63 68 K-ohms**	**C16 0.047 microfarad**	**C11 47 picofarad**

STEP 6: Installing an RC Network for Custom Compensation

If the default RC network does not provide suitable compensation for your intended load, you will need to install a custom RC network that is matched to your load. This network will require two components (a resistor (R) and a capacitor (C)) to be installed on the main board. To calculate the approximate values required for each component, use the fomulas provided below.

COMPENSATION FORMULAS:

To find the value for the resistor (Rc) in the RC network: **Rc = 20,000 x 3.14 x L x BW**
where:
Rc is compensation resistance in ohms.
L is load inductance in henries.
BW is bandwidth in hertz.

To find the value for the capacitor (Cc) in the RC network: Cc = L/ (R x Rc)
where:
Cc is compensation capacitance in farads.
L is load inductance in henries.
R is resistance of load in ohms.
Rc is compensation resistance in ohms.

STEP 7: Optimizing the Compensation Values.
Once an approximate Rc and Cc have been computed, these values will need to be evaluated. To do this, install components with the required values in the main board at locations R82 and C25 as shown in **Figure 5.10.**

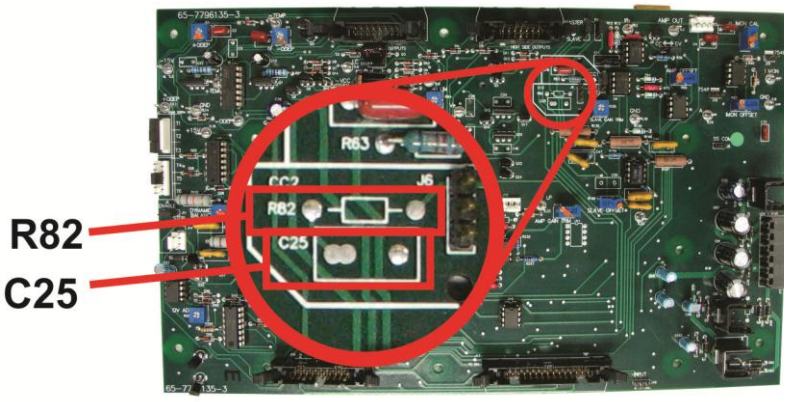


Figure 5.10 – Custom Compensation Location

Remember the load you are connecting is a part of the system and the amplifier should not be turned on without the load being connected.

After installing the components, check to ensure that jumper J5 is correctly installed (see **STEP 4**), then power up the amplifier without signal input.

To begin testing, input a square wave with a frequency of 100 Hz to 1 kHz, or a squared pulse at a low level (typically 0.25 to 2.0 volts). A limited-rise-time, repetitive pulse of low duty cycle is preferred.

Observe the output current through a current monitor or current probe. Look for clean transition edges. The presence of ringing or rounding on the transition edges indicates compensation problems. (See **Figure 5.11**.)

If a change in compensation is necessary, an adjustment to the resistor component of the Compensation circuit is probably required.

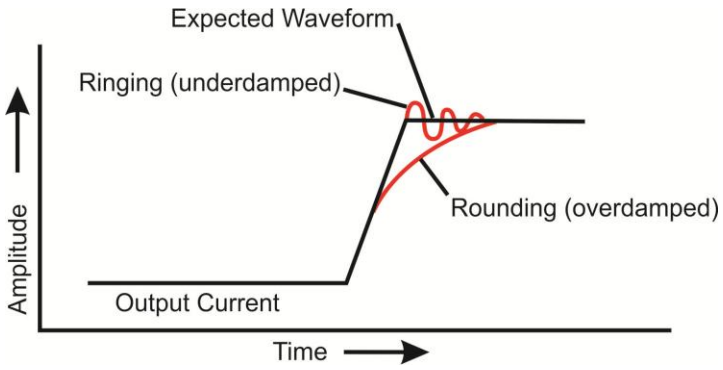


Figure 5.11 – Compensation Effects on Waveform

If the output current waveform is ringing, the circuit is underdamped: You have too much gain and should lower the resistance (see **Figure 5.12**).

If the output current waveform is rounded, the circuit is overdamped: You have too little gain and should increase resistance (see Figure **5.13**).

If the output current waveform is neither underdamped or overdamped, but the top of the squarewave is not level, then you should instead increase the capacitor value (see **Figure 5.14**).

When making adjustments:
Resistor: Increase or decrease resistance values in increments of +/- 10%.
Capacitor: Incrementally increase capacitor values by a factor of 2 or 3.

After final adjustments have been made to the circuit, the final waveform for your planned application should be tested to confirm the amplifier's compensation setting.

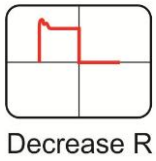


Figure 5.12 – Square Wave Showing a Decrease in R is Required

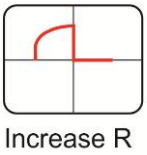


Figure 5.13 – Square Wave Showing an Increase in R is Required

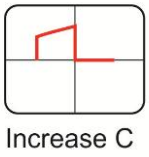


Figure 5.14 – Square Wave Showing an Increase in C is Required

NOTE:

- If possible, use 1% metal film resistors. AE Techron discourages installation of potentiometers in the resistor location of the compensation circuit because this can decrease stability and may increase inductance.
- The parallel capacitor in the RC network serves to increase stability but can be removed, if it is not required for system stability. If the parallel capacitor is used, it will usually decrease the value of resistance needed.
- In multiple amplifier systems, expect to decrease the value of R63 in series systems by 1/2.

5.3 Multi-amplifier Systems

The 7224 amplifier may be used with other 7224 amplifiers to increase voltage or current. Because the internal circuitry of a 7224 amplifier is not connected to chassis ground, the amplifier is well suited for use in series or parallel with other 7724 amplifiers.

Figure 5.15 – Series Multi-amp Kit

Figure 5.16 – Parallel Multi-amp Kit

Up to four 7224 amplifiers may be configured in series or parallel, and configurations with more amplifiers may be possible, depending on the application. Please contact AE Techron **Application Support** for information on these more complex multi-amp systems.

For routine applications, two-amplifier systems can be configured using **AE Techron Multi-amp Kits.** The resulting systems can provide up to 316 Vpeak (two in Series) or up to 90 Apeak (two in Parallel).

Request the Series Multi-amp Kit for series systems or the Parallel Multi-amp Kit for parallel systems (see **Figures 5.14** and **5.15**). Visit the AE Techron website at **www.aetechron.com** for additional information.

Two 7224s in Series

High Voltage Low Current

	5 Min, 30% duty Cycle		1 Hr, 100% duty Cycle	
Ohms	Volts Peak	Amps Peak	Volts Peak	Amps Peak
32	316	9.8	316	9.8
16	272	16.3	272	16.3
8	216	25.7	122	14.5

Medium Voltage Medium Current

	5 Min, 30% duty Cycle		1 Hr, 100% duty Cycle	
Ohms	Volts Peak	Amps Peak	Volts Peak	Amps Peak
8	138	16.4	138	16.4
4	114	26.2	114	26.2
2	86	39.6	42	21

Low Voltage High Current

	5 Min, 30% duty Cycle		1 Hr, 100% duty Cycle	
Ohms	Volts Peak	Amps Peak	Volts Peak	Amps Peak
2	58	29	58	29
1.5	52	34	52	34
1	45.4	45	45.4	45

Two 7224s in Parallel

High Voltage Low Current

	5 Min, 30% duty Cycle		1 Hr, 100% duty Cycle	
Ohms	Volts Peak	Amps Peak	Volts Peak	Amps Peak
8	158	19.6	158	19.6
4	136	16.3	136	16.3
2	108	25.7	61	14.5

Medium Voltage Medium Current

	5 Min, 30% duty Cycle		1 Hr, 100% duty Cycle	
Ohms	Volts Peak	Amps Peak	Volts Peak	Amps Peak
2	69	32.8	69	32.8
1	57	54.2	57	52.4
0.5	43	79.2	21	42

Low Voltage High Current

	5 Min, 30% duty Cycle		1 Hr, 100% duty Cycle	
Ohms	Volts Peak	Amps Peak	Volts Peak	Amps Peak
0.5	29	58	29	58
0.375	26	68	26	68
0.25	22.7	90	22.7	90

6 Amplifier Signal Flow

6.1 Input Signals

The input signal is routed from the SIM (Specialized Input Module) on the back panel to the Mainboard. From there, the signal is amplified through low noise operational amplifier gain stages, compensation networks, and current limiting/ODEP and then final gain stage to the Output board. At the Output board, the signal is sent through predrivers, output stage drivers, then to the Output stage whose topology is a full-complimentary, full-bridge, AB+B mode transistor design. Amplifier control and status is handled by logic circuits tied to the Display/Control board on the front panel. Protection is provided by current limiting circuits and special junction temperature simulation circuits using thermal feedback from the main heat sinks on the Output board

6.2 AC Mains Power

Power to the amplifier is connected through a 20 amp IEC-type inlet connector with an integral EMI filter network on the back panel. AC mains power is first routed through the front panel switch/breaker, then to the Power Supply board. From there, the AC mains are distributed to the main power transformers, and then from the transformers back through the Power Supply board to the Main board.

The Power Supply board allows for easy configuration of primary and secondary voltages The Power Supply board also performs the "bi-level" function. This allows the power supply rails to the Output section to increase or decrease depending on demand and keeps the voltage dropped across the outputs to a minimum, thereby decreasing heat dissipation.

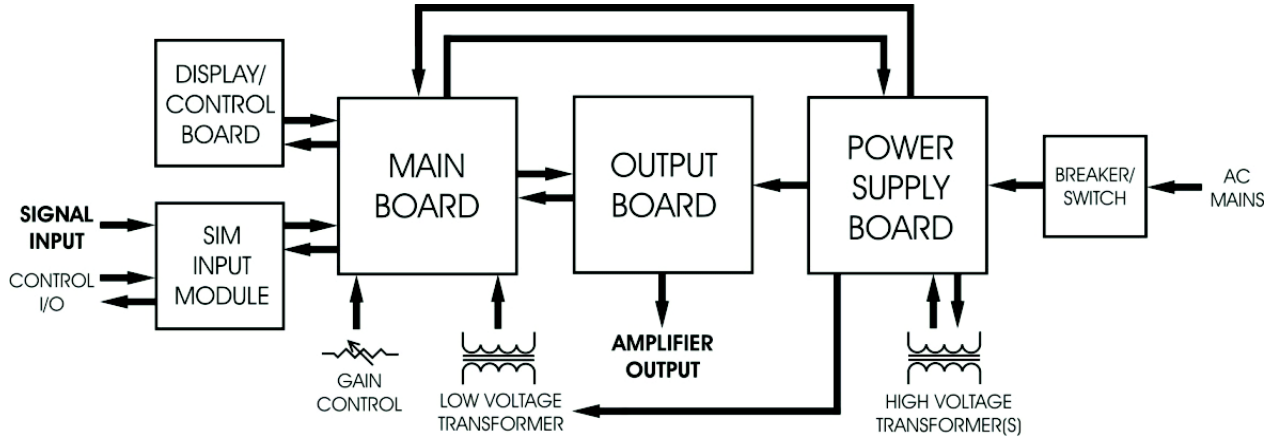


Figure 6.1– Board-Level Functional Block Diagram

7 Maintenance

Simple maintenance can be performed by the user to help keep the equipment operational. The following routine maintenance is designed to prevent problems before they occur. See **Section 8, Troubleshooting,** for recommendations for restoring the equipment to operation after an error condition has occurred.

Preventative maintenance is recommended after the first 250 hours of operation, and every three months or 250 hours thereafter. If the equipment environment is dirty or dusty, preventative maintenance should be performed more frequently.

7.1 Clean Amplifier Filter and Grills

7.1.1 Tools Required

The recommended equipment and supplies needed to perform the functions required for this task are described below.

CAUTION

Before you begin, make sure your amplifier is disconnected from the power source, with power switch in the OFF position and all level controls turned completely down (counter-clockwise).

- Vacuum cleaner
- Damp cloth (use water only or a mild soap diluted in water)

To ensure adequate cooling and maximum efficiency of the internal cooling fans, the amplifier's front and rear grills should be cleaned periodically. To clean the amplifier grills and filter, complete the following steps:

1. Turn completely down (counter-clockwise) all level controls and turn the amplifier OFF. Disconnect the amplifier from its power source.
2. Using a vacuum cleaner, vacuum the front ventilation grill, including the filter behind the grill, and the back ventilation exit grill.
3. Using a damp cloth, clean the front and rear ventilation grills. Dry with a clean cloth or allow to air dry. **IMPORTANT: Grills should be completely dry before plugging in or restarting amplifier.**

8 Troubleshooting

8.1 Introduction & Precautions

This section provides a set of procedures for identifying and correcting problems with the 7224 amplifier. Rather than providing an exhaustive and detailed list of troubleshooting specifications, this section aims to provide a set of shortcuts intended to get an inoperative amplifier back in service as quickly as possible.

The procedures outlined in this section are directed toward an experienced electronic technician; it assumes that the technician has knowledge of typical electronic repair and test procedures.

Please be aware that the 7224 will undergo frequent engineering updates. As a result, modules and electronic assemblies may not be interchangeable between units. Particularly, the Main board undergoes periodic engineering modifications that may make interchangeability between units impossible.

8.2 Visual Inspection

Before attempting to troubleshoot the amplifier while it is operating, please take time to complete a visual inspection of the internal components of the amplifier.

1. To perform a Visual Inspection, first turn the Breaker/Switch to the Off (O) position.
2. Disconnect the AC mains plug from the amplifier.
3. Wait three to five minutes for the Power Supply capacitors to discharge. You can verify the capacitor discharge by connecting a voltmeter across +Vcc and –Vcc test points on the main board **(see Figure 8.1).** Verify a reading of less than 50 volts before proceeding.
4. Inspect the amplifier's internal components. Check the following:
5. Inspect modules for charring, breaks, deformation or other signs of physical damage.
6. Look for any foreign objects lodged inside the unit.
7. Inspect the entire lengths of wires and ribbon cables for breaks or other physical damage.
8. If there is any physical damage to the amplifier, please return it to AE Techron for repair.

DANGER

Uninsulated terminals with AC mains potential are exposed when the panel is removed. Do not proceed until AC Mains have been disconnected.

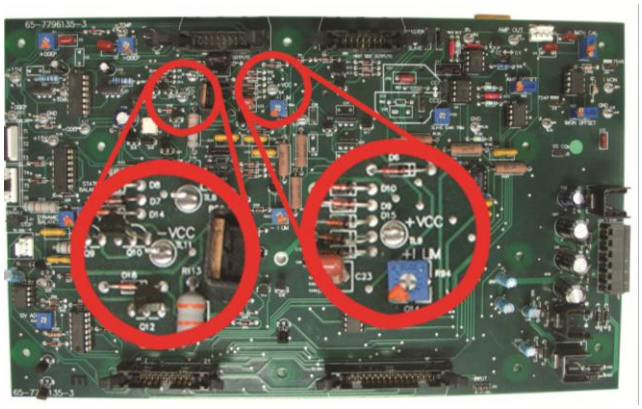


Figure 8.1– +Vcc and –Vcc Test Point Locations

8.3 No Signal

Missing Output signal may be caused by one of the following:

1. Master/Slave Jumpers are set to the Slave (down) position. The amplifier should only be configured for Slave mode if it is in a multi-amplifier system; otherwise it should be set for Master mode. See **Section 4.2.1** for more information.
2. Signal is not connected to any inputs on the SIM card. See **Section 2.5**.

8.4 No LEDs Illuminated or No Fans

If none of the LEDs on the Display Panel are illuminated and/or the fans are inoperative, check the following:

1. The AC mains are not connected or not on (see **Section 2.6**).
2. Front Panel Breaker/Switch has been tripped. Reset by turning the unit Off (O) and then On.
3. Fuse F1 is open.

To Inspect Fuse F1 follow these steps:

1. Turn Off (O) the amplifier and disconnect the AC mains.
2. Remove Access Panel (see **Section 4.1**).
3. Locate Fuse F1 (see **Figure 8.2**). Remove fuse and inspect. Replace if necessary.

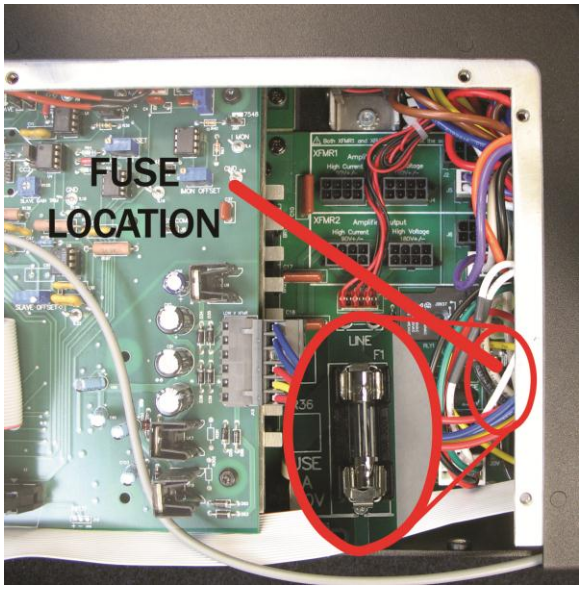


Figure 8.2 - Fuse F1 location

8.5 OverVoltage Warning Message

The amplifier will protect itself from AC mains voltage that is 10% above the voltage indicated on the back panel. If the AC mains voltage is more than 10% above the operating voltage, reduce the AC mains voltage to the proper level. When the line voltage condition is corrected, the amplifier will automatically reset unless the amplifier has been configured to enter Stop Mode on OverLoad. For information about releasing the amplifier from Stop Mode on OverLoad and on changing the Stop Mode on OverLoad setting, see **Section 4.2.7.**

8.6 Standby LED Remains Illuminated

The Standby indicator may remain illuminated under three conditions:

1. If the output wells or power transformer have overheated. If overheating is the problem, see the following topic ("Amplifier Overheats").
2. If both the Standby and Ready LEDs remain illuminated and the Interlock I/O Cable is being used, the amplifier is being held in Remote Standby Mode by another device (see **Figure 8.3**). For more information on 7224 Remote Operation, please visit the AE Techron website at www.aetechron.com.
3. If the connection to the Interlock – I/O Connector or other input/output connection isn't fully secure. Check all wiring and connections.

Figure 8.3 - Interlock I/O Connector

8.7 Amplifier Overheats (Over-Temperature Fault Condition)

There are two possible reasons why the 7224 amplifier is overheating:

1. Excessive Power Requirements
2. Inadequate Airflow

Excessive Power Requirements

An amplifier will overheat if the required power exceeds the amplifier's capabilities. High duty cycles and low-impedance loads are especially prone to cause overheating. To see if excess power requirements are causing overheating, check the following:

1. The application's power requirements fall within the specifications of the amplifier. See **Section 9, Specifications.**
2. Faulty output connections and load.
3. Undesired DC offset at the Output and Input signal.

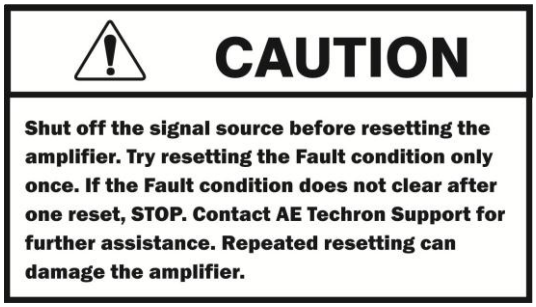
If the amplifier chronically overheats with suitable power/load conditions, then the amplifier may not be receiving adequate airflow. To check for adequate airflow, proceed with the following step:

Check for Inadequate Airflow

1. Check air filters. Over time they can become dirty and worn out. It is a good idea to clean the air filters periodically with a mild detergent and water.
2. Visually inspect fans to assure correct operation while amplifier is On (I).

Any inoperative, visibly slow, or reverse-spinning fan should be replaced. Please see **Section 8.9** for Factory Service information.

An OverTemp condition places the amplifier in Standby mode. If the OverTemp pulse is extremely short, as in the case of defective wiring or switches, the OverTemp pulse may be too brief to observe.



Resetting After OverTemp

To reset the amplifier after an OverTemp has occurred, make sure fans are running, then remove the input signal from the amplifier. Allow the fans to run for five minutes, and then push the Reset button to reset the amplifier.

8.8 Fault LED is Illuminated

The 7224 contains protection circuitry that disables the amplifier if an output stage is behaving abnormally. This usually indicates an output transistor has shorted.

To clear the Fault condition, follow these steps:

1. Turn off the signal source.
2. Turn off the AC mains.
3. Turn AC mains power back on. If the Fault LED doesn't illuminate again, turn the signal source on.
4. If the Fault LED is still illuminated and the Fault condition doesn't clear, return the amplifier for Factory Service.

8.9 Factory Service

If the troubleshooting procedures are unsuccessful, the amplifier may need to be returned for Factory Service. All units under warranty will be serviced free of charge (customer is responsible for one-way shipping charges as well as any custom fees, duties, and/or taxes). Please review the Warranty at the beginning of this manual for more information.

All service units must be given Return Authorization by AE Techron, Inc. before being returned. Return Authorizations can be requested on our website or by contacting our Customer Service Department.

Please take extra care when packaging your amplifier for repair. It should be returned in its original packaging or a suitable alternative. Replacement packaging materials can be purchased for a nominal fee.

Please send all service units to the following address and be sure to include your Return Authorization Number on the box.

AE Techron, Inc.
Attn: Service Department / RMA#
2507 Warren Street
Elkhart, IN 46516

9 Specifications

Frequency, Phase and Noise Performance (Controlled Voltage Mode)

Small Signal Frequency Response:
DC - 300 kHz +0.0 to -1.0 dB

8 ohm Power Response:
± 140 Vpk DC to 60 kHz
± 50 Vpk DC to 180 kHz
± 30 Vpk DC to 300 kHz

Slew Rate:
75 V/µSec

Unit to Unit Phase Error:
± 0.1 degrees at 60 Hz

Residual Noise:
10 Hz to 300 kHz: 950 µV (0.95 mV)
10 Hz to 80 kHz: 300 µV (0.3 mV)

Signal-to-Noise Ratio:
10 Hz - 30 kHz: –113 dB
10 Hz - 80 kHz: –106.6 dB
10 Hz - 300 kHz: –99.9 dB

THD:
DC - 30 kHz less than 0.1%

Output Offset:
7724: Less than ±5 mV
7224P: Less than ±400 µV

DC Drift:
7224: <±1.5 mV
7224P: <±200 µV
(after 20 minutes of operation)

Output Impedance:
28 mOhm in Series with 1 µH

Phase Response:
± 5 degrees (10 Hz - 10 kHz)

Input Characteristics

Balanced with ground:
Three terminal barrier block connector 20 k ohm differential

Unbalanced:
BNC connector, 10 k ohm single ended
Fixed or variable gain

Gain:
Voltage Mode: 20 volts/volt
Current Mode: 5 amperes/volt

Gain Linearity (over input signal, from 0.2V to 5V):
7224: 0.15%
7224P: 0.02% (DC); 0.05% (AC)

Max Input Voltage:
± 10 V balanced or unbalanced

Common Mode Rejection Range:
–58 dB with 5V input

Display, Control, Status, I/O

Front Panel LED Displays indicate:
Ready, Standby, Fault, Over Temp, Over Voltage, Overload

Soft Touch Switches for:
Run, Stop, Reset

Gain Control, when enabled:
Voltage gain adjustable from 20 to 0

On/Off Breaker

Back Panel Power Connection:
25 Amp IEC (with retention latch)

Signal Output:
+/Common/Sampled Common

Signal Input:
User Selectable BNC or Barrier Strip Balanced

Communication Capabilities

Current Monitor: ± 1 V / 5 A ± 1%
Voltage Monitor: ± 1 V / 1 V ± 1%

Reporting:
System Fault, Over Temp, Over Voltage, Over Load

Control:
Force to Standby, Reset after a fault

Multiple Unit Configuration

Series Operation:
Total Voltage (1, 2, 3, or 4-7224's): 150 V_{pk}, 300 V_{pk}, 450 V_{pk} or 600 V_{pk}; Increased slew rate up to 200 V/µSec

Parallel Operation:
Total Current (1, 2, 3, or 4-7224's):
50 A_{pk}, 100 A_{pk}, 150 A_{pk} or 200 A_{pk}

Physical Characteristics

Chassis:
The Amplifier is designed for stand alone or rack mounted operation. The Chassis is black aluminum with a powder coat finish. The unit occupies two EIA 19-inch-wide units.

Weight:
41 lbs (18.6 kg), **Shipping:** 51 lbs (23.2 kg)

AC Power:
Single phase, 120 VAC, 60 Hz, 20 amp service (220-240 VAC, 50-60 Hz, 10 amp model available)

Operating Temperature:
10°C to 50°C (50°F to 122°F), Maximum Output Power de-rated above 30°C (86°F).)

Humidity:
70% or less, non-condensing

Cooling:
Forced air-cooling from front to back through removable filters.

Airflow:
180 CFM

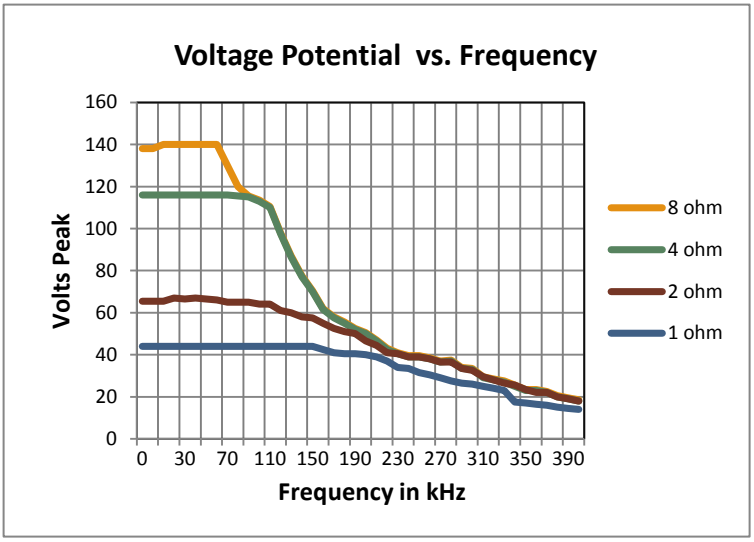
Dimensions:
19 in. x 22.75 in. x 3.5 in. (48.3 cm x 57.8 cm x 8.9 cm). Unit occupies 2 - EIA 19-inch wide rack units.

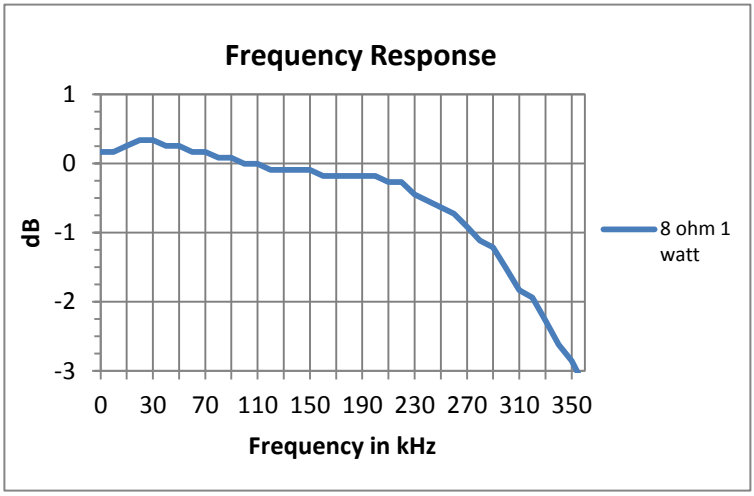
Protection

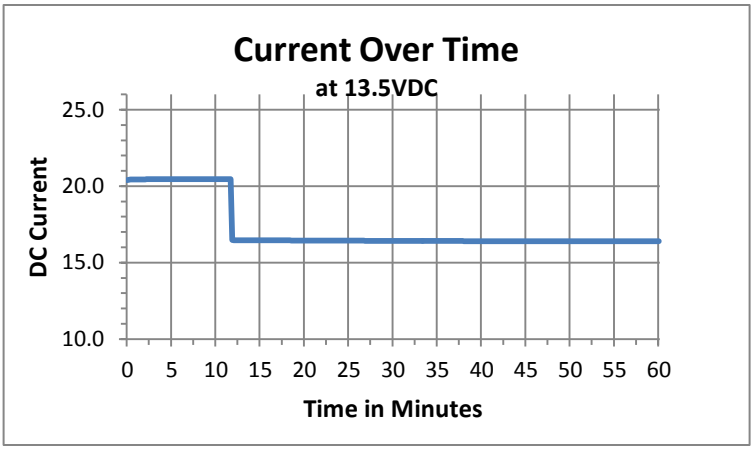
Over/Under Voltage:
± 10% from specified supply voltage amplifier is forced to Standby

Over Current:
Breaker protection on both main power and low

Over Temperature:
Separate Output transistor, heat sink, and transformer temperature monitoring and protection







AC Specifications - *High Voltage Mode*

	PEAK OUTPUT						RMS OUTPUT				
	40mSec Pulse, 20% Duty Cycle		5 Minute, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minute, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
Ohms	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
16	158	10	158	10	158	10	112	7	112	7	774
8	154	19	136	16	136	16	96	12	96	12	1108
4	124	31	108	26	61	15	76	18	43	10	442
2	98	49									

AC Specifications - *Mid-Level Mode*

	PEAK OUTPUT						RMS OUTPUT				
	40mSec Pulse, 20% Duty Cycle		5 Minute, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minute, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
Ohms	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
4	72	18	69	16	69	16	49	12	49	12	566
2	61	30	57	26	57	26	40	19	40	19	746
1	47	47	43	40	21	21	30	28	15	15	220
0.5	26	52									

AC Specifications - *High Current Mode*

	PEAK OUTPUT						RMS OUTPUT				
	40mSec Pulse, 20% Duty Cycle		5 Minute, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minute, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
Ohms	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
1			29	29	29	29	21	21	21	21	420
0.75			26	34	26	34	18	24	18	24	442
0.5			23	45	23	45	16	32	16	32	511
0.25											

DC Specifications

Low Voltage High Current	5 Min	1 Hr
Volts DC	Amps DC	Amps DC
24.0	26	20
13.5	20	16
3.0*	25	25

**A 120VAC only special configuration.*

Appendix A: SIM - Interlock I/O Connector Pinouts and Functions

Pin #	Function	Description	Type	Level Asserted	Level Deasserted	Notes	Applications
1	Amplifier Output	Used for driving slave amplifiers, monitoring amplifier output voltage	AC or DC	Can be greater than ±200V peak	0V	Used for monitoring amplifier output voltage; driving slave amplifiers in multi-amp systems. Wired to amplifier output. Do not connect to any impedance of less than 10K ohm.	**Voltage Monitoring:** Connect a voltage meter to monitor the output voltage being produced by the amplifier. Connect across PIN 1 (Amp Out) and PIN 10 (Sampled Common).
2	Sampled Common	Load connected here for Current sense	AC or DC	Up to 5V peak	0V	Used for driving slave amplifiers in multi-amp systems, controlled voltage or controlled current mode.	**Driving Slave Amplifiers:** Amplifier External Reference, 5V peak maximum from PIN 14 (Common).
3	+1 IN	Differential Slave input	AC or DC	Can be greater than ±200V peak	0V	Only used in multiple amplifier configurations - Series mode.	Can accept output of PIN 1 (Amplifier Output) OR PIN 2 (Sampled Common) from Master device when in Slave mode.
4	Interlock	Amplifier Interlock input	DC	0V to 8V	10V to 15V	When asserted, forces to Standby; when deasserted, allows Run. IMPORTANT: amplifiers must be configured for Ready mode at startup (factory default) or the Run button must be pressed at the amplifier front panel at startup.	**Multi-amplifier Systems Simultaneous Remote to Standby:** Short PIN 4 of Master amplifier to Digital Ground (PIN 17) using dry contact switch or optocoupler. Switch can be used for multi-amps paralleled; must use optocoupler for multi-amps in series. Multiple amplifiers (sharing the same sampled common power connections) can be simultaneously forced to Standby by daisy-chaining Interlock (PIN 4) across amps. When closed, places amplifiers simultaneously in Standby.
5	Amp Ready	Ready output of amplifier	DC	0V	–14V	Normally reserved for OPTOC use; do not recommend for normal customer use. Line has series resistor and unloaded will go from 0V (not ready) to -15V (ready), with an OPTOC BNC card the signal will go from 0V (not ready) to -1.2Vdc (ready)	**Not recommended for normal customer use.**
6	I MON +	Differential Current Monitor +	AC or DC	**7212/7224:** 5A/V **7548/7796:** 20A/V		Output current produced per voltage detect.	**Current Monitoring:** Connect a voltage meter to monitor the output current being produced by the amplifier. For unbalanced, for each 1V detected, current output is 5A (7212/7224) or 20A (7548/7796).
7	I SUM1+	Multiple Amplifier Summing, Amplifier 1	AC or DC			Planned for use in multiple amplifier configurations - paralleled and running Controlled Current Mode.	**Not currently used.**
8	I SUM2+	Multiple Amplifier Summing, Amplifier 2	AC or DC			Planned for use in multiple amplifier configurations - paralleled and running Controlled Current Mode.	**Not currently used.**
9	I SUM3+	Multiple Amplifier Summing, Amplifier 3	AC or DC			Planned for use in multiple amplifier configurations - paralleled and running Controlled Current Mode.	**Not currently used.**
10	Sampled Common	Amp Analog Ground				Amplifier External Reference.	Used in status reporting applications. See OverTemp (PIN 11), Run (PIN 12), Overload (PIN 23), and OverVoltage (PIN 24).

11	OverTemp Out	Over-temperature output	DC	–24V	0V	When amp is normal, this pin is pulled to –24V through a 47.5K-ohm resistor; when amp is in OverTemp state, transistor Q37 turns on and sources chassis ground as an output. Do not exceed 20 milliamps.	**Remote Signal of Over-Temperature Condition:** LED, when lit, signals Over Temperature condition. Use a 6 mA series resistor of 4.02K-ohm for LED or OPTO, tie to –24V source (PIN 16).
12	Run	Amplifier Run output	DC	–24V	0V	When amp is in Standby mode, this pin is pulled to –24V through a 10-ohm resistor in series with two solid-state relays; when amp is in Run mode, transistor Q34 turns on and sources chassis ground as an output, energizing Mains Relays. VOUT is typically –0.03V dc. Do not apply load to ground as this could enable Relays.	**Remote Signal of Run Condition:** LED, when lit, signals Run state. Use a 6mA series resistor of 4.02K-ohm for LED or OPTO, tie to –24V source (PIN 16).
13	–24V	–24V Power Output	DC			–24V dc, 30 mA	Internally tied for use in status reporting applications. See OverTemp (PIN 11), Run (PIN 12), Overload (PIN 23), and OverVoltage (PIN 24).
14	Common	Ground before Sense Resistors				This can be used as an amp internal reference but if a load is attached to this pin, current cannot be sensed on that amplifier.	Possibly series amplifiers will not need current reporting on the High side amp, since its current will be same as Master.
15	–1 IN	Differential Slave Input	AC or DC	Up to 200V peak	0V	Only used in multiple amplifier configurations, Series mode.	Can accept output of PIN 1 (Amplifier Output) OR PIN 2 (Sampled Common) from Master device when in Slave mode.
16	+24V	+24V Power Output	DC			+24V dc, 30 mA.	Used in status reporting applications. See OverTemp (PIN 11), Run (PIN 12), Overload (PIN 23), and OverVoltage (PIN 24).
17	Digital Ground	Digital circuitry ground - Interlock Common	DC	0V	0V	Used with PIN 25 (Reset) for Remote Reset from Standby or Stop after Error. Used with PIN 4 (Interlock) for simultaneous remote to Standby of all amps in a multi-amplifier system.	Used with PIN 25 for Remote Reset after error. Used with PIN 4 for Remote to Standby in multiple amplifier systems.
18	Spare	No function					Currently not used.
19	I MON –	Differential Current Monitor –	AC or DC	**7212/7224:** 5A/V **7548/7796:** 20A/V		Inverted I MON+ (PIN 6). Output current produced per voltage detect.	Current Monitoring: Connect a voltage meter to monitor the output current being produced by the amplifier. For each 1V detected, current output is 5A (7212/7224) or 20A (7548/7796).
20	I SUM1–	Multiple Amplifier Summing, Amplifier 1	DC			Planned for use in multiple amplifier configurations - paralleled and running Controlled Current Mode	Currently not used.
21	I SUM2–	Multiple Amplifier Summing, Amplifier 2	DC			Planned for use in multiple amplifier configurations - paralleled and running Controlled Current Mode	Currently not used.
22	I SUM3–	Multiple Amplifier Summing, Amplifier 3	DC			Planned for use in multiple amplifier configurations - paralleled and running Controlled Current Mode	Currently not used.

23	OverLoad Out	Overload output	DC	–24V	0V	When amp is normal, this pin is pulled to –24V through a 47.5K-ohm resistor; when amp is in Overload state, transistor Q36 turns on and sources chassis ground as an output. Do not exceed 20 milliamps.	**Remote Signal of Overload Condition:** LED, when lit, signals Overload condition. Use a 6mA series resistor of 4.02K-ohm for LED or OPTO, tie to –24V source (PIN 16).
24	OverVoltage Out	Overvoltage output	DC	–24V	0V	When amp is normal, this pin is pulled to –24V through a 47.5K-ohm resistor; when amp is in Overvoltage state, transistor Q29 turns on and sources chassis ground as an output. Do not exceed 20 milliamps.	**Remote Signal of Overvoltage Condition:** LED, when lit, signals Overvoltage condition. Use a 6mA series resistor of 4.02K-ohm for LED or OPTO, tie to –24V source (PIN 16).
25	Reset	Reset	DC	–15V	0V	Tie to PIN 13 (–24V dc) and create a –15V dc source; <2mA required for reset. Connect the –15V dc source to PIN 25 (Reset) through a 1K buffer resistor to reset.	**Reset from Standby or Stop:** Use a dry contact switch and voltage regulator to return amp to Ready/Run condition after Over-temperature or Overload conditions. Assert –15V for at least 100 ms to clear error condition. **NOTE: Do not hold low.**

Gray shaded areas indicate pin not used / feature not implemented.

Blue shaded areas indicate used only in multi-amplifier systems.