

AETECHRON®



2110/2120/7794MRL Operator's Manual

Gradient Amplifiers

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2507 Warren Street, Elkhart, IN 46516

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DECLARATION OF CONFORMITY

Technical Construction File Route

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This Declaration of Conformity is issued under the sole responsibility of AE Techron, Inc., and belongs to the following product:

Equipment Type: Industrial Power Amplifiers

Model Name: 2110

EMC Standards:

- EN 61326-1: 2013 – Electrical equipment for measurement, control and laboratory use
 - EMC Requirements
- EN 55011: 2009 + A1: 2010 – Industrial, scientific and medical (ISM) radio-frequency equipment:
 - Radio disturbance characteristics
 - Limits and methods of measurement
- EN 61000-4-2: 2009 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Electrostatic discharge immunity test
- EN 61000-4-3: 2006 + A2: 2010 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Radiated radio-frequency electromagnetic field immunity test
- EN 61000-4-4: 2004 + A1:2010 – 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: 2009 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Immunity to conducted disturbances induced by radio frequency field
- EN 61000-4-8: 2010 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Power frequency magnetic field immunity test

Safety Standard:

BSEN61010-1:2010 (inc Corr. May 2011) – 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 (until 19th April, 2016) and Directive 2014/30/EU (from 20th April, 2016), and the Low Voltage Directive 2006/95/EC (until 19th April, 2016) and Directive 2014/35/EU (from 20th April, 2016).

Signed:

Larry Shank
President



Place of Issue: Elkhart, IN, USA
Date of Issue: March 18, 2016

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 - Limits and methods of measurement
- EN 61000-4-2: 2009 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Electrostatic discharge immunity test
- EN 61000-4-3: 2006 + A2: 2010 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Radiated radio-frequency electromagnetic field immunity test
- EN 61000-4-4: 2004 + A1:2010 – 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: 2009 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Immunity to conducted disturbances induced by radio frequency field
- EN 61000-4-8: 2010 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
 - Power frequency magnetic field immunity test

Safety Standard:

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Equipment Type: Industrial Power Amplifiers

Model Name: 7794MRL

EMC Standards:

- EN 61326-1: 2013 – Electrical equipment for measurement, control and laboratory use
— EMC Requirements
- EN 55011: 2009 + A1: 2010 – Industrial, scientific and medical (ISM) radio-frequency equipment:
— Radio disturbance characteristics
— Limits and methods of measurement
- EN 61000-4-2: 2009 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
Electrostatic discharge immunity test
- EN 61000-4-3: 2006 + A2: 2010 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
Radiated radio-frequency electromagnetic field immunity test
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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: 2009 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
Immunity to conducted disturbances induced by radio frequency field
- EN 61000-4-8: 2010 – Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques:
Power frequency magnetic field immunity test

Safety Standard:

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Figure 1.1 – 2110 Front Panel

1 Introduction

The AE Techron 2110/2120/7794MRL are high-powered AC/DC linear amplifiers and integrated power supplies that offer exceptional control of drift and distortion. The 2110/2120/7794MRL function as a voltage or current source, making them a great choice for use in the lab or classroom. Their linear design provides a very-low noise floor and fast current rise times. Because the 2110/2120/7794MRL have no ripple noise, no synching with the console is required.

The 2110/2120/7794MRL also possess a number of important physical attributes. They combine small footprints, integrated power supply/amplifier design, rugged construction and modest weight, to make them a great choice for field-deployable, low-field or small-bore MRI systems.

The AE Techron brand is known throughout the world for its robust, low-noise gradient amplifiers as well as its product service and support.

1.1 Features

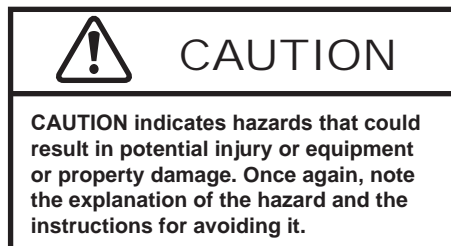
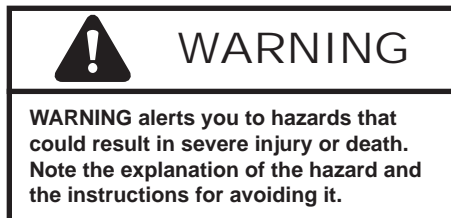
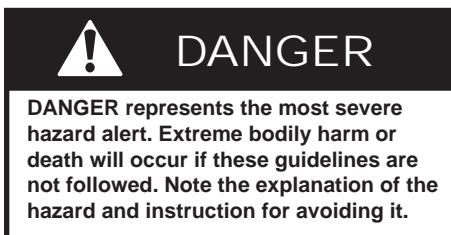
- Output of up 200 amperes peak, 180 volts (2120), 110 amperes peak, 195 volts (2110) or 200 amperes peak, 100 volts (7794MRL).
- 4-quadrant linear design.
- Blanking feature lowers the noise floor on the amplifier by shutting down the output stage. This action occurs in less than 10 μ s.
- Current mode response: -3 dB at 5 kHz (compensation dependent); Voltage mode response: DC-20 kHz at rated power.
- Robust, linear power supply results in extremely low noise; bi-level switch design limits heat dissipation to output devices.
- Provides precision control of output offset, DC drift and gain linearity.
- Protection circuitry guards against input overloads, improper output connection (including shorted and improper loads), over-temperature, over-current, and supply voltages that are too high or low.
- Shipped ready to operate from 208-volt ($\pm 10\%$) 3-phase AC mains; 400-volt model available on request.

2 Amplifier Unpacking and Installation

The 2110/2120/7794MRL 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 that require extra precaution.



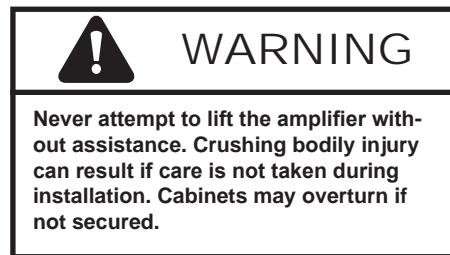
2.2 Unpacking

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 2110/2120/7794MRL amplifiers ship with the following:

1. Toolkit (contains one 1/8-inch Allen drive and three 2.7-ohm resistors)
2. NEMA connector for power cord
3. 2110/2120/7794MRL Operator's Manual and Quick Start



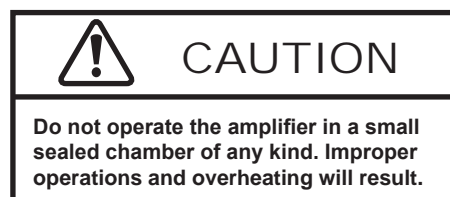
2.3 Installation

The 2110/2120/7794MRL amplifiers have 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.

NOTE: The 2110 weighs approximately 103 pounds and the 2120 and 7794MRL weigh approximately 153 pounds. Be sure this weight is properly supported using all the screw locations.

When mounting the amplifier in a rack cabinet, the sidewalls of the rack must be at least 2 inches away from the chassis on both sides.

Allow for hot air discharge through the amplifier's rear grill. If your cabinet has a rear door, you must provide adequate airflow through the door. Provide a source of cool air for fan intakes. If the rack is crowded or rack ventilation is poor, use a vent tube to the outside of the rack. Cooling capacity required is 300 ft³/min. total per amp.



When operating the 2110/2120/7794MRL in a dusty environment, use commercial furnace filters, or equivalent, to prevent rapid clogging of the filters on the amplifier.



3 Connections and Startup

This section details the wiring and startup procedures for a single 2110, 2120, or 7794MRL amplifier operating in Controlled-Voltage mode (factory default). Before connecting the amplifier, make sure the AC power is disconnected.

3.1 Other Operation Modes and Configurations

The 2110/2120/7794MRL amplifier can be field-configured for operation in a number of different ways. These would include Controlled-Voltage or Controlled-Current mode, and it also can be configured for operation as a part of a multi-amplifier system. These alternate configurations may require special output wiring and/or additional components.

3.1.1 Controlled-Current Operation of a Stand-Alone Amplifier

If your application requires Controlled-Current operation, the 2110/2120/7794MRL amplifier first should be wired and tested in Controlled-Voltage mode to verify that the amplifier and input signal are operating correctly. Once proper operation is confirmed, refer to the “**Applications**” section of this manual for instructions on configuring and operating your amplifier in Controlled-Current mode.

3.1.2 Multi-Amp Operation

If your application requires multi-amp operation for increased voltage or current, each amplifier should first be wired and tested individually in Controlled-Voltage mode to ensure proper operation.

For **Series operation in Controlled-Voltage mode**, refer to the **Multi-Amp Configuration Guide** (available for download from aetechron.com) for information on Series system configuration.

For **Series operation in Controlled-Current mode**, you should select one amplifier to be operated as the “Master” amplifier of the system, and then refer to the “**Applications**” section of this manual for instructions on configuring this amplifier for operation in Controlled-Current mode. After the Master amplifier is configured and tested for Controlled-Current operation, refer to the **Multi-Amp Configuration Guide** (available for download from aetechron.com) for information on Series system configuration.

For **Parallel operation in Controlled-Voltage mode**, refer to the **Multi-Amp Configuration Guide** (available for download from aetechron.com) for information on Parallel system configuration.

For **Parallel operation in Controlled-Current mode**, please contact **AE Techron Technical Support** for assistance.

3.2 Connecting the Load

3.2.1 Preparation and Cautions

Before connecting the amplifier, make sure the AC power is disconnected.

Connection to the output of the amplifier is to a four-position terminal barrier block (accepts up to #4 AWG wire). 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 2110/2120/7794MRL amplifier comes with a factory-installed 2.7-ohm, 2W, 5%, metal-oxide resistor connecting the terminals marked “SAMPLED COMMON” and “CHASSIS GROUND” (see **Figure 3.1**). **This resistor should NOT be removed. WARNING:** Removing this resistor can

cause dangerous output and/or damage to the load unless the amplifier is being used as a Follower amplifier in a Series multi-amp system. See the AE Techron **Multi-amp Configuration Guide** for more information on these advanced configurations.

3.2.2 Connecting the Outputs

Locate the four-position terminal barrier block labeled **OUTPUTS** on the amplifier back panel. See **Figure 3.2**.

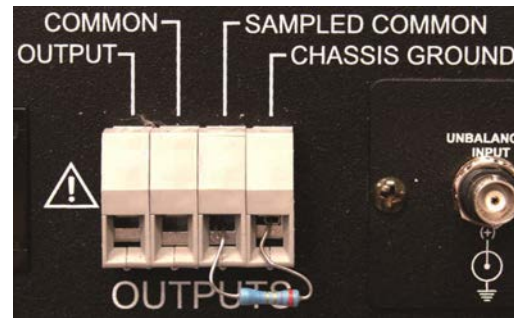


Figure 3.1 – Closeup of the Output Terminal Resistor

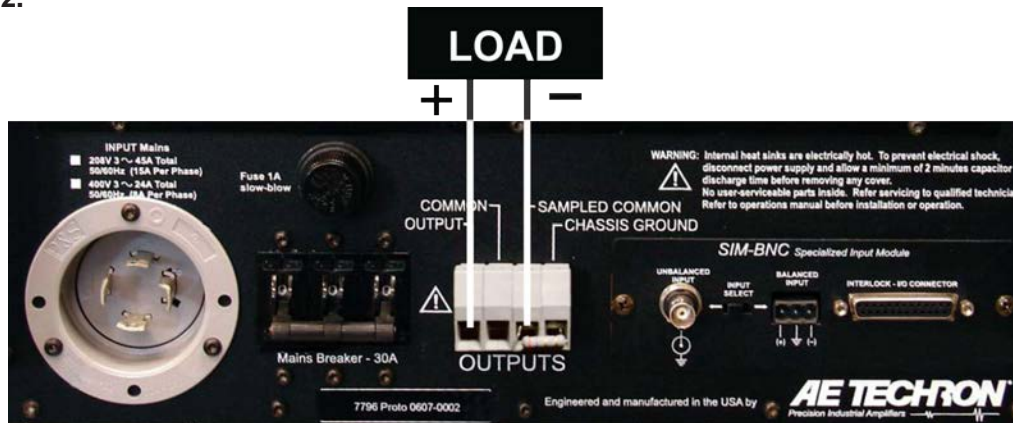


Figure 3.2 – Controlled Voltage Hookup

Connect the negative terminal of the load to the **SAMPLED COMMON** terminal.

NOTE: Alternately, the COMMON terminal may be used when operating in Controlled-Voltage mode; however, the integrated current monitor will not function if the COMMON terminal is used, since it depends on feedback from the Sampled Common terminal. For operation in Controlled-Current mode, the SAMPLED COMMON terminal must be used.

Connect the load's positive terminal to the amplifier's **OUTPUT** terminal.

3.3 Connecting the Input Signal

The signal is connected to the amplifier through a "SIM" (Specialized Input Module) located on the amplifier back panel (see **Figure 3.3**). The SIM card offers the choice of BNC or terminal block input connectors.

The Input Select switch, located on the SIM module between the input connectors, allows convenient selection of balanced or unbalanced input wiring and also can function as a ground-lift switch for the BNC input connector. The Input Select switch functions by connecting/ disconnecting the inverting (–) pin on each input connector to the amplifier ground through a 4.7-ohm resistor (see **Figure 3.4**). When the Input Select switch is in the LEFT position, the shield on the BNC connector and the inverting (–) pin on the terminal block connector are tied to the amplifier ground, allowing the connectors to be used for Unbalanced input wiring. When the Input Select switch is in the RIGHT



Figure 3.3 – Closeup of SIM card

position, the inverting (–) pin on the terminal block connector is floating, allowing the connector to be used for Balanced input wiring.

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

We recommend that you use cables that are high quality and shielded to minimize noise and to guard against possible feedback.

Note: See the “**Applications**” section for information on using the Interlock – I/O Connector located on the SIM card.

⚠ DANGER

The risk of lethal **ELECTRICAL SHOCK** exists when connecting AC mains! Disconnect the source before connecting AC power wires to the connector.

3.4 Connecting the AC Supply

The 2110/2120/7794MRL amplifier requires 3-phase wiring. Always operate the 2110/2120/7794MRL amplifier from proper AC mains. The 3-phase, 47 - 60 Hz voltage must be

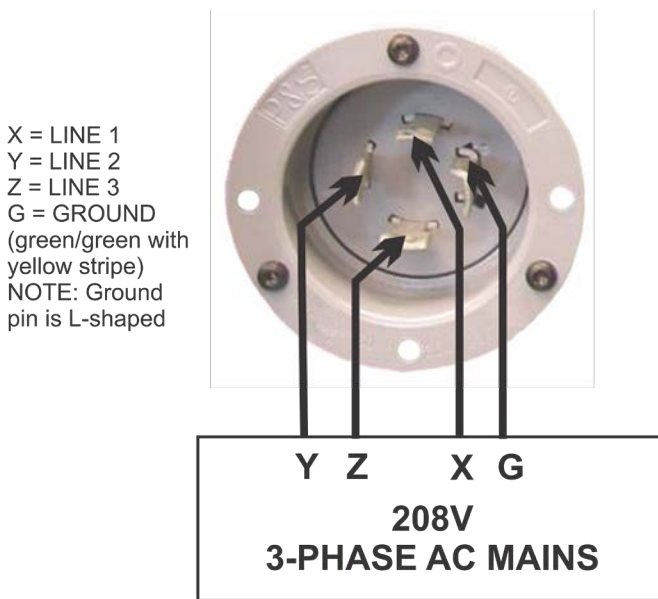


Figure 3.5 – 208V 3-Phase AC Mains Wiring

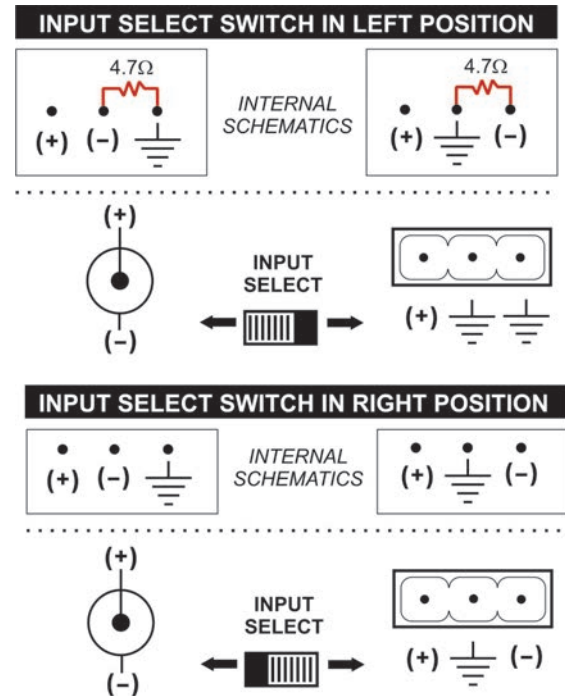


Figure 3.4 – Input Select switch functions on the Input Terminals

208 VAC (or optionally 400 VAC) with no more than 10% variance above or below the line voltage. The amplifier will not operate properly outside these limits.

The 2110/2120/7794MRL amplifier includes a NEMA style locking AC connector as standard equipment. Connect the amplifier to the proper

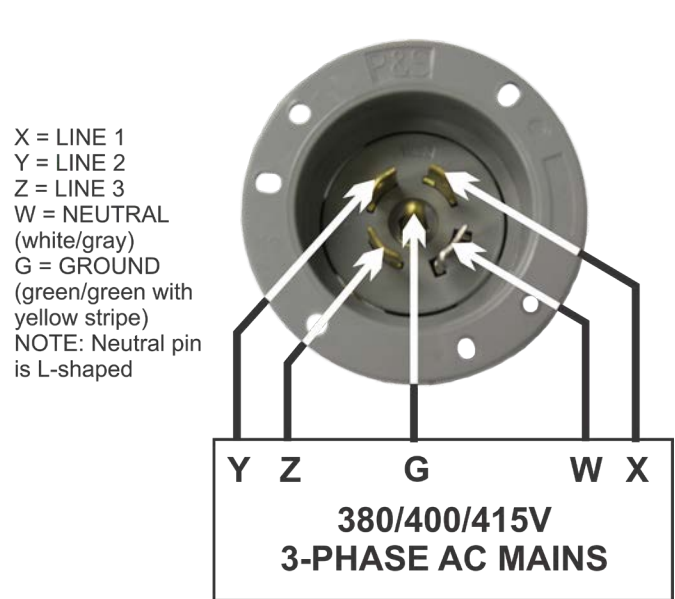


Figure 3.6 – 380/400/415V 3-Phase AC Mains Wiring

3-phase AC mains with this connector. See **Figures 3.5 and 3.6** for proper AC Mains wiring. The connector then plugs into the 2110/2120/7794MRL amplifier.

3.5 Start-up Procedure

3.5.1 Voltage-Mode Operation

1. Turn down the level of your signal source.
2. Check to make sure the AC Mains Switch/Circuit Breaker is in the off position (DOWN).
3. Apply AC power to the amplifier.
4. Move the AC Mains Switch/Circuit Breaker to the on position (UP) to turn the amplifier ON. 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.

3.5.1 Current-Mode Operation

Before configuring your amplifier for Current mode operation, it is important to verify the amplifier is operating correctly in Voltage mode. Perform the steps provided in the **“Voltage-Mode Operation”** Start-up Procedure to test the amplifier in Controlled-Voltage mode. Use care if your load is very-low impedance since high currents can be caused by low input levels. Then refer to the **“Applications”** section of this manual for instructions on Controlled-Current configuration and operation.

4 Amplifier Operation

4.1 Front-Panel Controls & Display

This section provides an overview of Front-Panel controls and indicators found on the 2110/2120/7794MRL.

The Front Panel contains the following:

1. Push buttons
2. Main status indicators
3. Fault status indicator
4. Multi-function LCD display (7794MRL model only)
5. Navigation buttons (7794MRL model only)

4.1.1 Push Buttons

The 2110/2120/7794MRL provides three front-panel soft-touch Push Buttons (see **Figure 4.1**):

Enable – For stand-alone amplifiers, Enable will release the amplifier from Standby mode and place the amplifier in Run mode (both Ready and Run LEDs will be lit). When the amplifier is placed in Run mode, the amplifier will amplify the input signal. If an amplifier is disabled using a Remote Standby application, the amplifier will be placed in Ready mode (both Ready and Standby LEDs will be lit). To return the amplifier to Run mode, release the Standby condition using the remote switch. See the **“Applications”** section of this manual for more information on remote amplifier operation.

By default, the amplifier will automatically be Enabled and enter Run mode on power-up. To change the factory-default setting and configure the amplifier to power-up in Standby mode, please see the **“Advanced Configuration”** section.

In multi-amp systems that have been configured to start up in Run mode (factory default setting), when an amplifier is powered on, the amplifier will be placed in Ready mode (Ready and Standby LEDs lit) and remain in Ready mode until all amplifiers in the system have been powered on. The system will automatically proceed to Run mode when all amplifiers in the system are powered on and achieve Ready mode.

In multi-amp systems that have been configured to start up in Standby mode, when an amplifier is powered on, the amplifier will be placed in Standby mode (Stop and Standby LEDs lit). When the Enable button is pressed on each amplifier, that amplifier will be placed in Ready mode (Ready and Standby LEDs lit) and remain in Ready mode until all amplifiers in the system have been Enabled. The system will automatically proceed to Run mode when all amplifiers in the system achieve Ready mode.

Stop – For stand-alone amplifiers, Stop will place the amplifier in Standby mode (both Standby and Stop LEDs will be lit). When the amplifier is part of a multi-amp system, pressing the Stop button on any amplifier in the system will place all amplifiers in Standby mode. When an amplifier is in Standby mode, the low-voltage transformer is energized but the high-voltage transformers are not.

Reset – For stand-alone amplifiers, when the amplifier has stopped due to a fault condition, pressing the Reset button will return the amplifier to Run

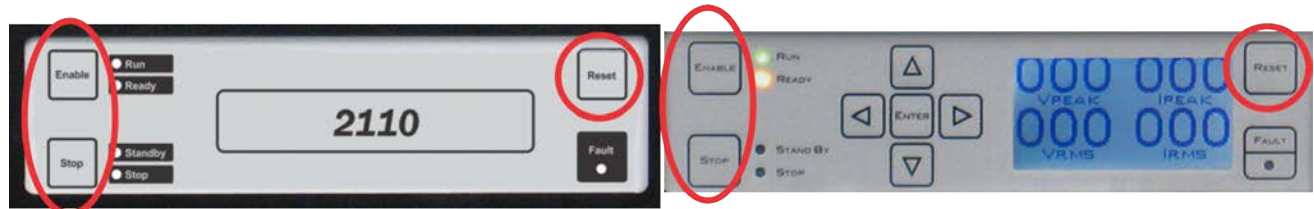


Figure 4.1 – Push Buttons (2110 and 7794MRL models shown)

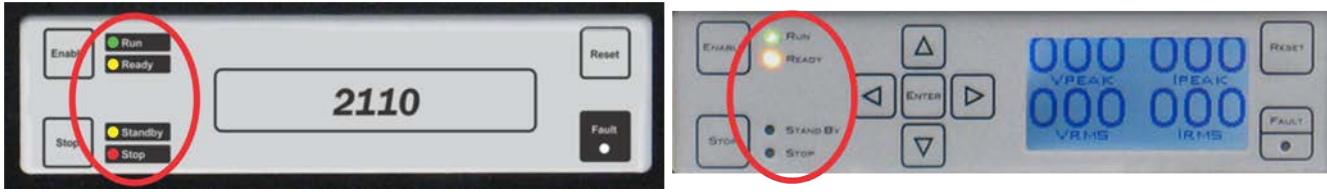


Figure 4.2 – Main Status Indicators (2110 and 7794MRL models shown)

mode if the condition causing the fault condition has been cleared. When the amplifier is part of a multi-amp system, pressing the Reset button on the amplifier reporting the fault condition will return all of the amplifiers to Run mode if the condition causing the fault condition has been cleared; however, pressing the Reset button on other amplifiers in the system will NOT clear the fault condition.

4.1.2 Main Status Indicators

Four Main Status indicators are located on the amplifier's front-panel (see **Figure 4.2**). These LEDs monitor the internal conditions of the amplifier and indicate the current state of operation. The chart in **Figure 4.3** details the operational modes indicated by the Main Status indicators.

4.1.3 Fault Status Indicator

The Fault Status indicator is located on the amplifier front panel (see **Figure 4.4**). This LED monitors the internal conditions of the amplifier and will illuminate when a fault condition occurs. Depending on the fault condition and the configuration of the unit, the amplifier may be placed in Standby mode when a fault condition occurs.

4.1.4 Multi-Function LCD Display (7794MRL model only)

The multi-function LCD display provides peak and RMS values for voltage and current measured directly from the amplifier output. On startup, the LCD Display will provide readings for all four measurements: Volts peak, Volts RMS, Current

Figure 4.3 – Main Status Indicators for Stand-Alone Amplifiers

● ● ● ● Indicator is lit ● Indicator is not lit ○ Indicator may be lit

Main Status Indicators	State of Operation	Action Needed to Return to Run Mode
● Run ● Ready ● Standby ● Stop	Run mode: The amplifier's high-voltage transformers are energized and the unit will amplify the input signal. Run mode is initiated by: (1) the Enable push button, or (2) when the amplifier powers up in Run mode (factory default). See the " Advanced Configuration " section for more information.	N/A
● Run ● Ready ● Standby ● Stop	Standby mode: Standby mode indicates that the amplifier is functioning properly and all Fault Status modes are clear, but it is being held in Standby by an external condition. As configured from the factory (Run mode on startup), the amplifier will enter Standby mode briefly after powering up, and then will move automatically into Run mode. In Standby mode, the amplifier's low-voltage transformer is energized but the high-voltage transformers are not.	If the amplifier remains in Standby mode, it is being held in Standby by remote control through the SIM Interlock I/O connector. Open the Enable/Standby switch to clear this remote Standby condition and return the amplifier to Run mode. See the " Applications " section of this manual for more information on remote amplifier operation.
● Run ● Ready ● Standby ● Stop	Stop mode: When the Stop button on the amplifier front panel is pressed, the amplifier will enter Stop mode. The amplifier may also enter Stop mode after powering up if the amplifier is configured to enter Stop mode on startup. In Stop mode, the amplifier's low-voltage transformer is energized but the high-voltage transformers are not.	To release the amplifier from Stop mode, press the Enable button.



Figure 4.4 – Fault Status Indicators (2110 and 7794MRL models shown)

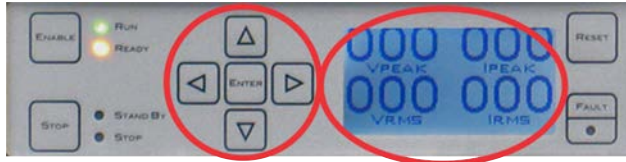


Figure 4.5 – 7794MRL LCD Display and Navigation Buttons

peak, and Current RMS (see **Figure 4.5**). Use the Navigation buttons to scroll to other available displays, such as peak voltage and current only, RMS voltage and current only, or other combinations.

If the amplifier experiences a fault condition, the LCD display will automatically display details of the fault condition and prescribed corrective actions. Refer to the chart in **Figure 4.6** to determine the fault condition being indicated and the action required to clear the fault condition.

4.1.5 Navigation Buttons

The Navigation buttons provide four arrow keys to allow navigation through the different voltage and current measurement functions on the LCD display screen. See **Figure 4.5**.

NOTE: The Enter button has been provided for future expansion and has no function at this time.

4.1.6 Main Status Indicators for **Multi-amplifier Systems**

The Main Status indicators on each amplifier in a multi-amp system are used to determine the operational status of the amplifier. When evaluated along with the statuses of other amplifiers in the system, the Main Status indicators can be used to determine the system status and the action required to return the system to Run mode. See **Figure 4.7**.

4.1.7 Fault Status Error Messages for Multi-Amp Systems (7794MRL only)

Four different fault error messages may be displayed on the amplifier's front panel LCD screen when a fault condition occurs. All amplifiers in the system may be placed in Standby mode when a fault condition occurs, depending on the fault condition and the configuration of the system. Typically, the system can be released from Standby mode by pressing the Reset button on the amplifier displaying the Fault status. Refer to the chart in **Figure 4.8** to determine the fault condition being indicated and the action required to clear the fault condition and return the system to Run mode.

Figure 4.6 – Fault Status Messages for Stand-Alone Amplifiers (7794MRL only)

● ● ● ● Indicator is lit ● Indicator is not lit ○ Indicator may be lit

Main Status Indicators	Fault Status Reported on LCD Display	State of Operation	Action Needed to Clear Fault Condition and Return to Run Mode
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	WARNING! OUTPUT DEVICE FAULT	Output Device Fault: This indicates that an Output Fault condition has occurred and the amplifier has been placed in Standby mode. The Fault indicator will light under two conditions: 1) High-frequency oscillation is causing high shoot-through current; or 2) An output transistor has shorted, causing the output fault condition.	This fault condition cannot be cleared using the front-panel Reset button. See the "Troubleshooting" section for more information on diagnosing and clearing this fault condition.
<ul style="list-style-type: none"> ● Run ● Ready ○ Standby ● Stop 	WARNING! OVERLOAD	Overload: This indicates that the output of the amplifier could not follow the input signal due to voltage or current limits. Under normal operation with the factory-default settings, an Over Load condition will not place the amplifier in Standby mode. If the amplifier has been configured to be forced to Standby on Over Load, the amplifier will be placed in Standby mode when the Over Load indicator lights.	To remedy the Overload fault during operation, turn down the level of the input signal until the Fault indicator turns off. To clear an Overload fault condition when the amplifier is forced to Standby, turn down the level of the input signal, then push the Reset button.
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	WARNING! OVERTEMP	Overtemp: The amplifier monitors the temperature inside the high-voltage transformers, low-voltage transformer and in the output stage heat sinks. The Fault indicator will light and the amplifier will be placed in Standby mode when the temperature sensors detect a condition that would damage the amplifier. If the Overtemp pulse is extremely short, as in the case of defective wiring or switches, the Fault LED may be lit too briefly to observe.	To reset after an Over Temp fault has occurred, make sure the amplifier fans in all amplifiers are running, and then remove the input signal from the system. Allow the fans to run for about 5 minutes until the system automatically returns to Run mode. If the system has been configured for Standby mode on Over Temp, then the system will not automatically return to Run mode. In that case, push and hold the Reset button on any amplifier displaying the Over Temp status until the Standby LED turns off, then release the Reset button to return the system to Run mode. Please see the "Troubleshooting" section for information on correcting the cause of an Over Temp fault condition.
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	WARNING! OVERVOLTAGE	Overvoltage: This indicates that the AC mains voltage is more than +10% of nominal. The amplifier will be forced to Standby when an Overvoltage condition occurs. When the Overvoltage condition is cleared, the amplifier will automatically return to Run mode.	To clear an Overvoltage fault condition, the AC mains must be brought down to the nominal value. If the amplifier does not return to Run mode when the Overvoltage condition has cleared, the amplifier may require servicing. Please see the "Troubleshooting" section for more information.

Figure 4.7 – Main Status Indicators for Multi-Amplifier Systems

● ● ● ● Indicator is lit ● Indicator is not lit ○ Indicator may be lit

Main Status of One or More Amps in the System	Main Status of Other Amps in the System	State of Operation	Action Needed to Return to Run Mode
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	Run mode: All of the amplifiers in the system are in Run mode. The amplifiers' high-voltage transformers are energized and the system will amplify the input signal.	N/A
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	Remote Standby Condition: All of the amplifiers in the system are being held in Standby mode by an external condition. In Standby mode, the amplifiers' low-voltage transformers are energized but the high-voltage transformers are not.	If the amplifiers remain in Standby mode, the system is being held in Standby by remote control through the SIM Interlock I/O connector. Open the Enable/Standby switch to clear this remote Standby condition and return the system to Run mode. See the "Applications" section of this manual for more information on remote amplifier operation.
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	System Not Ready: If one or more of the amplifiers has no LEDs lit, the amplifier has no power or has not been turned on, and the other amplifiers in the system will be held in Standby mode. In Standby mode, the amplifier's low-voltage transformer is energized but the high-voltage transformers are not.	Make sure all amplifiers have AC power and have been turned on. When all amplifiers attain Standby status, all amplifiers in the system will simultaneously be placed in Run mode.
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	Stop mode: When the Stop button on any amplifier in the system is pressed, that amplifier will enter Stop mode and all other amplifiers will enter Standby mode. The system may also enter Stop mode after powering up if one or more amplifiers in the system is configured to enter Stop mode on startup. In Stop mode, the amplifier's low-voltage transformer is energized but the high-voltage transformers are not.	To release the system from Stop mode, press the Enable button on the amplifier displaying the Stop mode status.

Figure 4.8 – Fault Status Indicators for Multi-Amplifier Systems

● ● ● ● Indicator is lit ● Indicator is not lit ○ Indicator may be lit

One or More Amps in System		Main Status Indicators of Other Amps in System	State of Operation	Action Needed to Clear Fault Condition and Return to Run Mode
Main Status Indicators	Fault Status Reported on LCD Display			
● Run ● Ready ● Standby ● Stop	WARNING! OUTPUT DEVICE FAULT	● Run ● Ready ● Standby ● Stop	Output Device Fault status: This indicates that an Output Fault condition has occurred in the amplifier displaying the Fault status, and the system has been placed in Standby mode. The Fault indicator will light under two conditions: 1) High-frequency oscillation is causing high shoot-through current; or 2) An output transistor has shorted, causing the output fault condition.	This fault condition cannot be cleared using the front-panel Reset button. See the "Troubleshooting" section for more information on diagnosing and clearing this fault condition.
● Run ● Ready ○ Standby ● Stop	WARNING! OVERLOAD	● Run ○ Ready ○ Standby ● Stop	Overload status: This indicates that the output of the system could not follow the input signal due to voltage or current limits. Under normal operation with the factory-default settings, an Overload condition will not place the system in Standby mode. If the system has been configured to be forced to Standby on Overload, the system will be placed in Standby mode when the Fault indicator lights.	To remedy the Overload fault during operation, turn down the level of the input signal until the Overload indicator turns off. To clear an Overload fault condition when the amplifier is forced to Standby, turn down the level of the input signal, then push the Reset button on the amplifier(s) displaying the Overload status.
● Run ● Ready ● Standby ● Stop	WARNING! OVERTEMP	● Run ● Ready ● Standby ● Stop	Overtemp status: Each amplifier in the system monitors the temperature inside the high-voltage transformers, low-voltage transformer and in the output stage heat sinks. The Overtemp indicator will light and the system will be placed in Standby mode when the temperature sensors detect a condition that would damage the amplifier system. If the Overtemp pulse is extremely short, as in the case of defective wiring or switches, the Fault LED may be lit too briefly to observe.	To reset after an Overtemp fault has occurred, make sure the amplifier fans in all amplifiers are running, and then remove the input signal from the system. Allow the fans to run for about 5 minutes until the system automatically returns to Run mode. If the system has been configured for Standby mode on Overtemp, then the system will not automatically return to Run mode. In that case, push the Reset button on any amplifier displaying the Overtemp status to return the system to Run mode. Please see the "Troubleshooting" section for information on correcting the cause of an Overtemp fault condition.

One or More Amps in System		Main Status Indicators of Other Amps in System	State of Operation	Action Needed to Clear Fault Condition and Return to Run Mode
Main Status Indicators	Fault Status Reported on LCD Display			
<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	<p>WARNING!</p> <p>OVERVOLTAGE</p>	<ul style="list-style-type: none"> ● Run ● Ready ● Standby ● Stop 	<p>Overvoltage status: This indicates that the AC mains voltage is more than +10% of nominal. All amplifiers in the system will be forced to Standby when an Overvoltage condition occurs. When the Overvoltage condition is cleared, the system will automatically return to Run mode.</p>	<p>To clear an Overvoltage fault condition, the AC mains must be brought down to the nominal value. If the system does not return to Run mode when the Overvoltage condition has cleared, one or more amplifiers may require servicing. Please see the “Troubleshooting” section for more information.</p>

4.2 Back-Panel Controls and Connectors

This section provides an overview of Back-Panel controls and connectors found on the 2110/2120/7794MRL amplifier. Please refer to **Figure 4.9** for visual locations.

AC Power Connector - This is a NEMA style twist lock, 4 pin (208V) or 5-pin (400V), three-phase connector. See page Error! Bookmark not defined. for terminal connections.

Low-Voltage Fuse - This is a 1A slow blow type 600-volt rated fuse.

AC Mains Switch/Circuit Breaker - This dual function power switch and circuit breaker opens all legs of the AC mains. The rating is 20A (2110) or 30A (2120) for 208 volts.

Output Terminal Block - Connect output lines from the load to this 4-terminal block. It accepts up to #4 AWG wire. Drive the load in the Controlled Current mode using the OUTPUT terminal and the SAMPLED COMMON terminal only.

BNC Input Connector - This input option provides a standard unbalanced input.

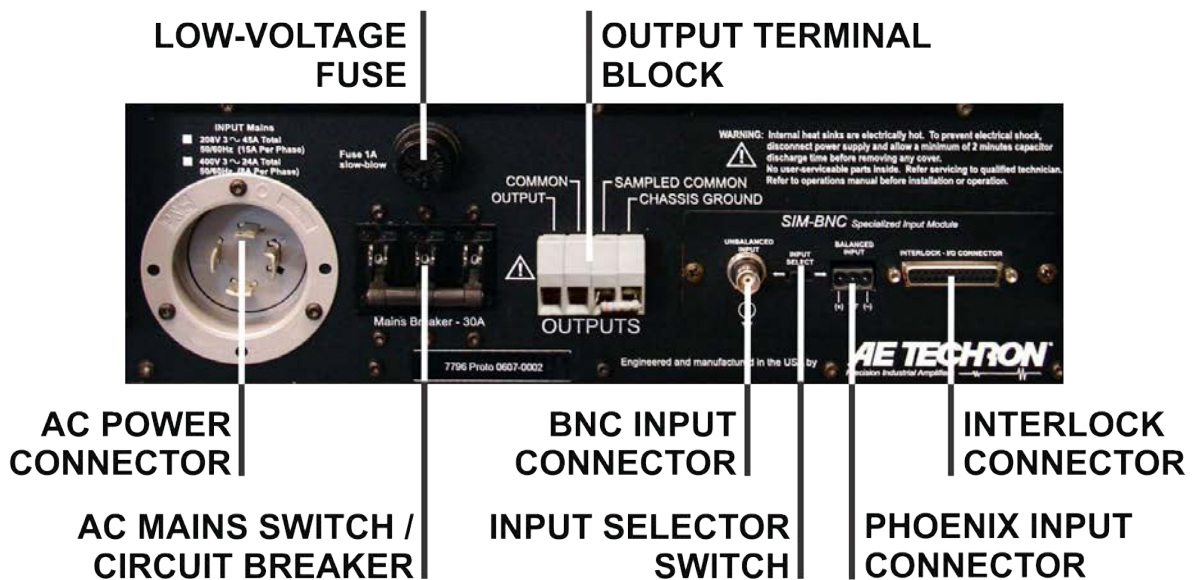


Figure 4.9 – Back Panel Controls and Connectors

Input Selector Switch - When the Input Select switch is in the LEFT position, the shield on the BNC connector and the inverting (–) pin on the terminal block connector are tied to the amplifier ground through a 4.7-ohm resistor, allowing the connectors to be used for Unbalanced input wiring. When the Input Select switch is in the RIGHT position, the inverting (–) pin on the terminal block connector is floating, allowing the connector to be used for Balanced input wiring. The Input Select

switch also functions as a Ground Lift switch for the BNC input connector.

Terminal Block 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 multi-amp system. It can also be used for remote control and monitoring applications (see the **"Applications"** section for more information).

5 Advanced Configuration

The 2110/2120/7794MRL amplifier was designed to offer exceptional power and 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.
- Trim the overall gain of the amplifier.
- Select Controlled-Current or Controlled-Voltage modes of operation.
- Adjust the Compensation for Controlled-Current mode of operation.
- Standby Mode/Ready Mode setting for selection of power-up state.
- Stop on Overload setting to trigger Standby Mode when amplifier senses an Overload state.

5.1 Factory Defaults

Your 2110/2120/7794MRL amplifier has been configured to operate to the following factory defaults:

- Controlled-Voltage mode
- Master/ Single mode
- CC1 Compensation network
- Power-Up into Ready mode
- Stop Mode on Overtemp disabled
- Stop on Overload disabled

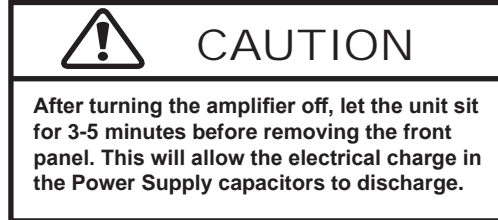
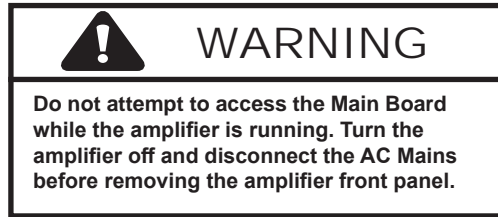
If you need to make changes to your amplifier's configuration, please follow the instructions contained in this chapter.

5.2 Accessing the Main Board

The 2110/2120/7794MRL amplifier Main Board can be accessed by removing the amplifier front panel.

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

1. Turn the power to the amplifier "OFF".
2. Remove the four hex-head screws, located along the left and right edges of the amplifier front panel using a Torx T15 driver.
3. Remove the front cover by pulling straight towards you.



5.3 Configuration Settings Located on the Main Board

The following custom settings can be made via settings on the Main Board, which is located behind the amplifier front panel.

5.3.1 Master or Follower Setting

The 2110/2120/7794MRL amplifier can be configured for operation within a multi-amplifier system, with up to four amplifiers configured for series or parallel operation. To enable the 2110/2120/7794MRL amplifier for use as a **Follow-**er amplifier in a multi-amplifier system, adjust the jumper settings on **Jumpers P1** and **P2** by placing **BOTH** jumpers in the **DOWN** position (lower pair of pins). To enable the 2110/2120/7794MRL amplifier for use as a **single amplifier** or as the **Master amplifier** in a multi-amplifier system, adjust the jumper settings on **Jumpers P1** and **P2** by placing **BOTH** jumpers in the **UP** position (upper pair of pins). See **Figure 5.1**.



Figure 5.1 – Master or Follower Setting

For information on input and output wiring for 2110/2120/7794MRL multi-amplifier applications, please refer to the **AE Techron Multi-Amp Con-**

figuration Guide available for download from the AE Techron website at www.aetechron.com.

5.3.2 Gain Trim Control

The 2110/2120/7794MRL amplifier allows control of gain via a multi-turn potentiometer (R210). **R232** resistor sets the coarse gain and **R247** sets the range or sensitivity of **R210**. See **Figure 5.2**.



Figure 5.2 – Gain Trim Control

5.3.3 Controlled Voltage or Controlled Current Setting

To allow the 2110/2120/7794MRL amplifier's output voltage to be controlled by its input voltage signal (**CV mode**), place **Jumper J4** in the **RIGHT** position (right pair of pins). To allow the 2110/2120/7794MRL amplifier's output current to be controlled by its input voltage signal (**CC mode**), place **Jumper J4** in the **LEFT** position (left pair of pins). See **Figure 5.3**.



Figure 5.3 – Controlled-Voltage or Controlled-Current Mode 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.** Use only the Output and Sampled Common terminals. **DO NOT** use the Common terminal.
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. **Turn off the amplifier immediately if oscillation occurs.**

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

5.3.4 Compensation Setting (applies to Controlled Current operation only)

When the 2110/2120/7794MRL amplifier is used in Controlled Current (CC) mode, the current control loop is tuned with one of two available RC networks: CC1 (R63 and C16) or CC2 (R82 and C25). Place **Jumper J5** in the **UP** position to select the **CC1** network (factory default). Place **Jumper J5** in the **DOWN** position to select the **CC2** network. See **Figure 5.4**.



Figure 5.4 – Compensation Setting

5.3.5 Ready/Run Mode or Standby Mode Power-up

The 2110/2120/7794MRL amplifier will bypass Standby Mode and cycle directly to Ready/Run Mode on power-up when **Jumper J11** is in the **Left** position (factory default). To set the amplifier to power-up to Standby Mode, place **Jumper J11** in the **Right** position. See **Figure 5.5**.

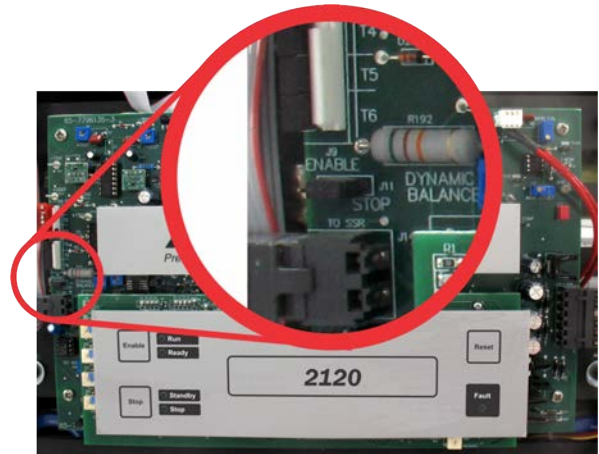


Figure 5.5 – Ready/Run Mode or Standby Mode on Power-Up Setting

5.3.6 Standby Mode on Overload

When enabled, the 2110/2120/7794MRL amplifier will move into Standby 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 Standby 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 Standby Mode on Overload, place the jumper across the **two pins labeled J13**. See **Figure 5.6**.

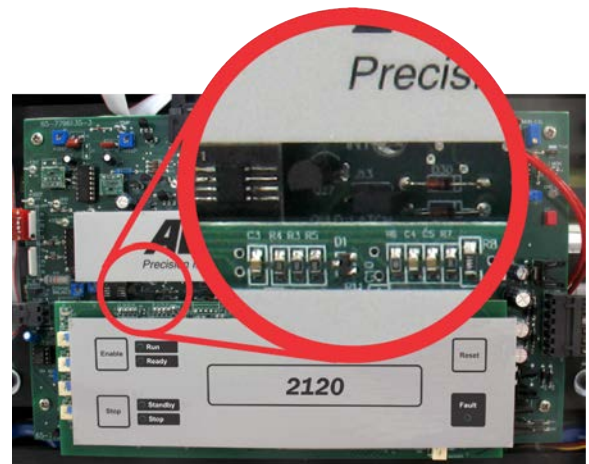


Figure 5.6 – Standby Mode on Overload Setting

5.4 Adjusting the Bi-Level Power Supply Switch

The 2110/2120/7794MRL amplifier offers three Bi-Level switch settings: Automatic, High, or Low. The user can select between settings via a switch on the Power Supply Board. The Power Supply Board is a horizontal board located below the main and display boards. To access the Bi-Level Power Supply Switch, complete the following steps to remove the front panel and access the bi-level power supply switch.

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

1. Turn the power to the amplifier "OFF".
2. Remove the four hex-head screws, located along the left and right edges of the amplifier front panel using a Torx T15 driver.
3. Remove the front cover by pulling straight towards you.
4. Locate the Bi-level Power Supply Switch as shown in **Figure 5.7**.



Figure 5.7 – Bi-Level Power Switch Location

5. Adjust the switch setting based on your operating requirements, as described below:
 - **AUTO** (left position) – power supply will switch depending on voltage requirements (factory-default setting).
 - **LOCKED LOW** (center position) – power supply will remain in low-voltage mode.
 - **LOCKED HIGH** (right position) – power supply will remain in high-voltage mode.

6 Applications

6.1 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.

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

AE Techron 2110, 2120 and 7794MRL 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 the **"Advanced Configuration"** section for more information.

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 (see **Figure 6.1**).

CONTROLLED-VOLTAGE MODE

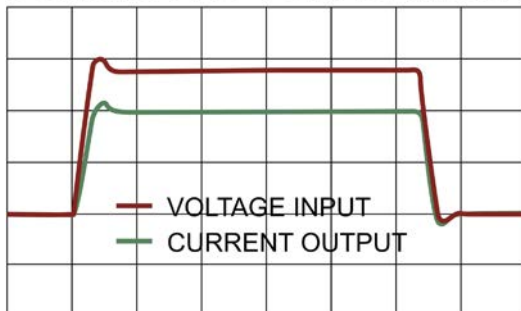


Figure 6.1 – Input to Output Comparison, Controlled-Voltage Operation

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 (see **Figure 6.2**).

CONTROLLED-CURRENT MODE

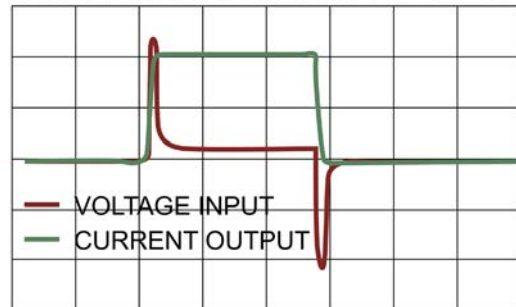


Figure 6.2 – Input to Output Comparison, Controlled-Current Operation

6.1.2 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.

6.1.3 Controlling Compensation for CC Operation

AE Techron 2110/2120/7794MRL 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 the “**Advanced Configuration**” section for more information.)

One of two compensation settings can be selected via jumpers on the main board: CC1 which enables the factory-installed RC network (see **Figure**

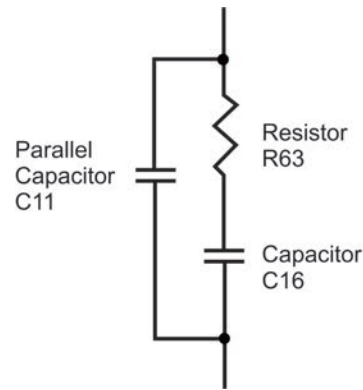


Figure 6.3 – Factory-installed Default RC Network

6.3), 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 μ H	<>200 μ H to <1 mH	>1 mH
Compensation Capacitance (CC)	0.001 μ F	0.01 μ F	0.1 μ F

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** to follow.

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.

STEP 4: Enabling Your Compensation Setting.

AE Techron 2110, 2120 and 7794MRL 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 6.3** 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 the **"Advanced Configuration"** section.)

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: 1 and 2 (UP)

Compensation Resistor: R63 (68 Kohms)

Compensation Capacitor: C16 (0.047 µF)

Parallel Capacitor: C11 (47 pF)

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 following formulas.

COMPENSATION FORMULAS:

To find the value for the resistor (Rc) in the RC network:

$$R_c = 20,000 \times 3.14 \times L \times BW$$

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:

$$C_c = L / (R \times R_c)$$

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 6.4**.

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.

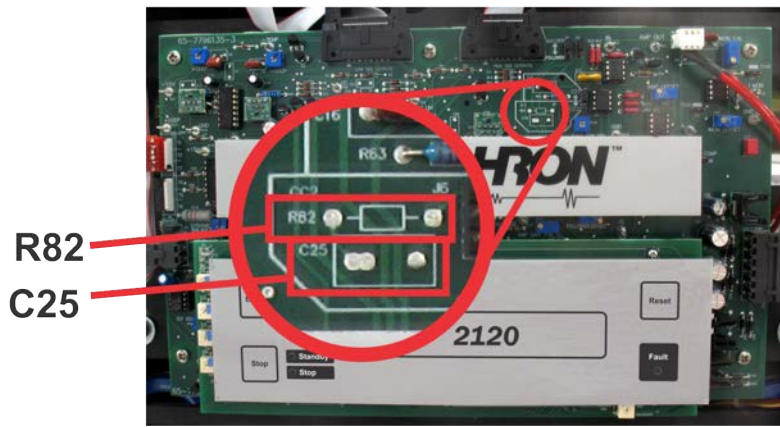


Figure 6.4 – Custom Compensation Location

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 6.5.**)

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

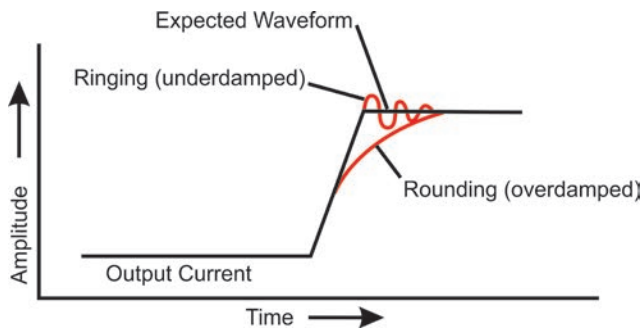
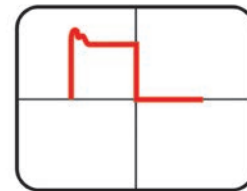


Figure 6.5 – Compensation Effects on Waveform

If the output current waveform is ringing, the circuit is underdamped: You have too much gain and should lower the resistance (see **Figure 6.6.**)

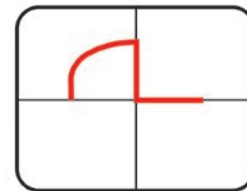
If the output current waveform is rounded, the circuit is overdamped: You have too little gain and should increase resistance (see **Figure 6.7.**)

If the output current waveform is neither underdamped or overdamped, but the top of the square-wave is not level, then you should instead increase the capacitor value (see **Figure 6.8.**)



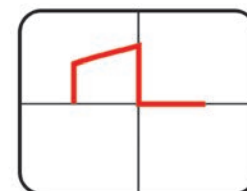
Decrease R

Figure 6.6 – Square Wave Showing a Decrease in R is Required



Increase R

Figure 6.7 – Square Wave Showing an Increase in R is Required



Increase C

Figure 6.8 – Square Wave Showing an Increase in C is Required

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.

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.

6.2 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 2110, 2120 and 7794MRL 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:

- Remote Enable / Standby control
- Run /Standby status
- Over-temperature status
- Overload status
- Overvoltage status
- Reset after Overload error
- Current monitor
- Blanking activation

Figure 6.9 maps the pins used for these applications.

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

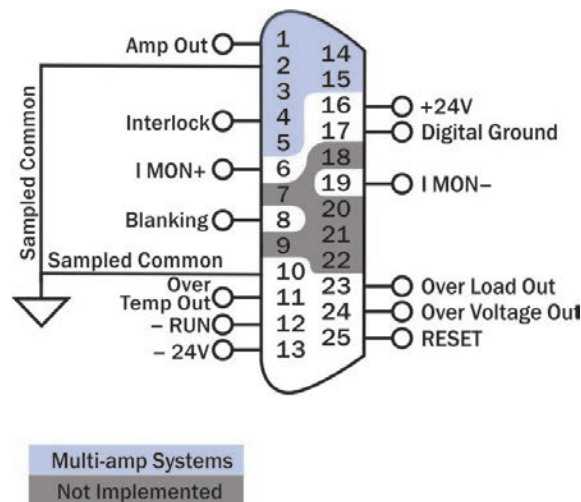


Figure 6.9 – Remote Status and Control Pinouts

6.2.1 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 due to Over-temperature or Overload conditions.

Use a male, 25-pin D-Sub connector and high-quality wire to build the circuit. **Figure 6.10** schematic details the circuit and components required for all status and reset functions.

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 13).

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.

An Overtemp condition will force the amp to Standby. The amplifier will automatically move to Run when temperature cools to operating levels.

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 13).

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 13).

Signal Type: DC

Level when Asserted: -24V

Level when Deasserted: 0V

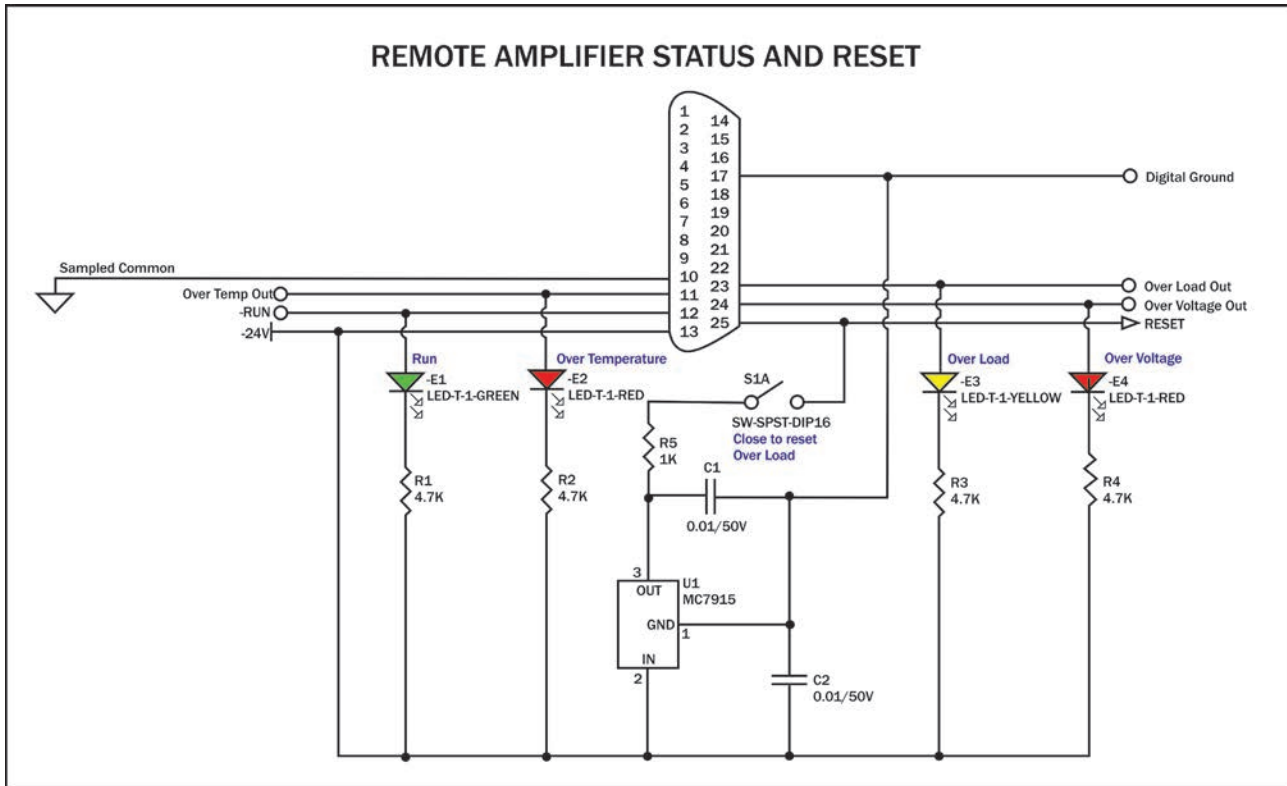


Figure 6.10 – Remote Status and Reset Schematic

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.

An Overload condition will not place the amplifier in Standby when operating with the factory default settings. In order to clear the fault condition, reduce the input levels until the Fault LED turns off. However, if the Standby Mode on Overload option is set, an Overload condition will force amp to Standby. To return the amplifier to Run mode, reduce the input signal level, then trigger a Reset command using the front-panel Reset button or a remote amplifier Reset command.

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 13).

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

Purpose: Switch, when thrown, returns amp to 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.

6.2.2 Remote Run/Standby Status Monitor

Using the SIM-BNC Interlock connector located on the back panel of the amplifier, you can remotely monitor the Run/Standby status of the amplifier.

Remote Run/Standby Status

Purpose: Use a voltage meter to monitor the status of the amplifier to determine if the amplifier is in a “Run” or “Standby” state.

Method: Connect a voltage meter to monitor the circuit voltage. Connect across PIN 4 (Interlock) and PIN 10 (Sampled Common).

When the voltage meter reads greater than 10V, the amplifier is in the Run state; when the meter reads less than 10V, the amplifier is in the Standby state. See **Figure 6.11**.

Signal Type: DC

Level when Asserted: >10 V

Level when Deasserted: <10 V

IMPORTANT: This circuit has a 100K pull-up resistor. Make sure the monitor function has sufficient impedance to avoid accidentally influencing status

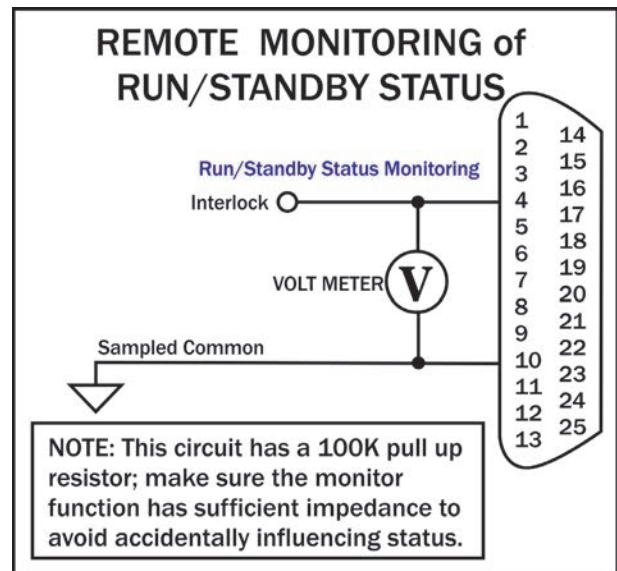


Figure 6.11 – Remote Run/Standby Monitor

6.2.3 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. See **Figure 6.12**.

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), the amplifier is placed in Standby mode. When switch is open, the amplifier is released to the Run condition.

Signal Type: DC

Level when Asserted: 0 to 8 V

Level when Deasserted: 10 to 15 V

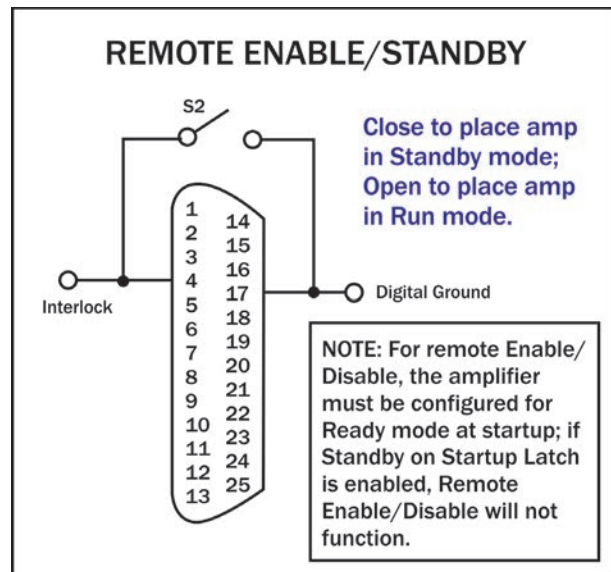


Figure 6.12 – Remote Enable/Standby

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.

6.2.4 Remote Monitoring of 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.

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 6.13**.

Signal Type: DC

Level when Asserted: 2105: 5A/V;

2110/2120/7794MRL: 20A/V

Level when Deasserted: 0V

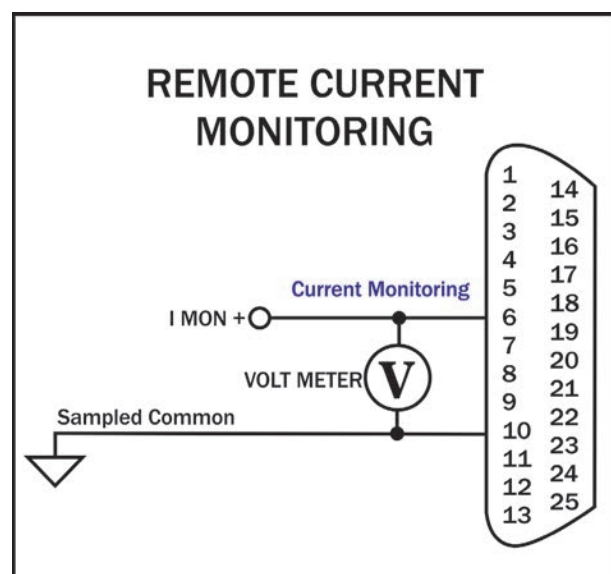


Figure 6.13 – Remote Current Monitoring

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 6.14**.

Signal Type: AC

Level when Asserted: 2105: 2.5A/V;

2110/2120/7794MRL: 10A/V

Level when Deasserted: 0V

CAUTION: To avoid ground loops, isolation from ground must be provided. Use of a differential probe is recommended.

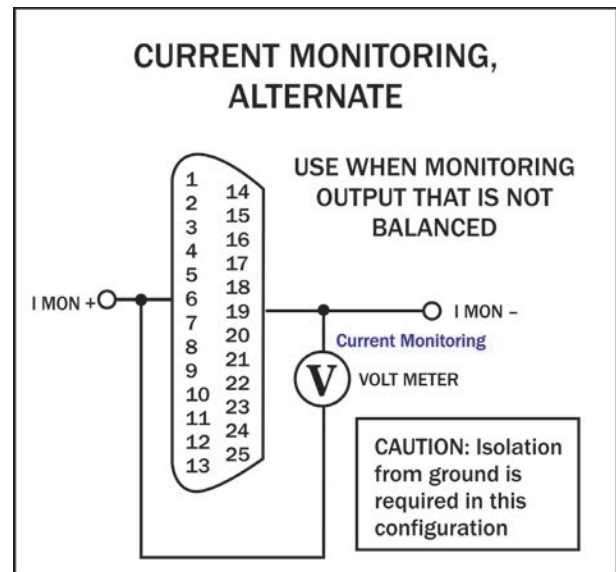


Figure 6.14 – Remote Current Monitoring, Alternate Method

Blanking Circuit Activation

Purpose: Activate the blanking circuit that shuts down the amplifier output stage in less than 10 μ s.

Method: Build a switchable circuit using an external, isolated 5V power supply that can apply a +5V signal to PIN 8. Connect across PIN 8 (Blanking) and PIN 10 (Sampled Common). See **Figure 6.15**.

Signal Type: DC

Level when Asserted: 3-5 Vdc

Level when Deasserted: 0-1 Vdc

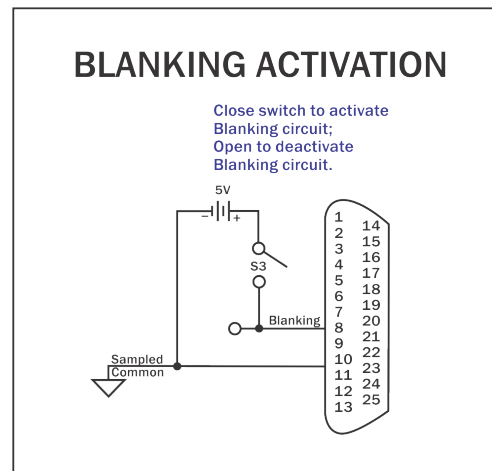


Figure 6.15 – Blanking Activation

6.3 Multi-amplifier Systems

The 2110, 2120 or 7794MRL amplifier may be used with other same-model amplifiers to increase voltage or current. Because the internal circuitry of a 2110/2120/7794MRL amplifier is not connected to chassis ground, the amplifier is well suited for use in series or parallel with other amplifiers of the same model.

Up to three 2110/2120/7794MRL amplifiers may be configured in series, and up to four may be configured in parallel. 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, controlled-voltage applications, Series or Parallel amplifier systems can be configured using the following accessories available from AE Techron:

SIM-OPTOC – The SIM-BNC-OPTOC Specialized Input Module allows multiple 2110/2120/7794MRL amplifiers to be configured as a series output system to increase the available output voltage to the load. The SIM-BNC-OPTOC kit also includes a BNC connector safety cover.

The SIM-BNC-OPTOC module is required for all Series configurations and should be used in conjunction with the DB9M CABLE (see below).

DB9M CABLE – The DB9M (OPTOC) CABLE is a high-voltage Interlock cable that provides superior insulation for multi-amp series systems running high-voltage applications.

The DB9M CABLE is required for all Series configurations and should be used in conjunction with the SIM-BNC-OPTOC module (see above)

BAL RES KIT – Three types available: 2105 BAL RES KIT, 2110 BAL RES KIT and 2120/7794MRL BAL RES KIT. Ballast resistors are required for

all Parallel configurations. The ballast resistor kits include one ballast resistor (two in the 2120/7794MRL kit) with connection terminals and mounting hardware. The 2105 BAL RES KIT also contains the shunt required to defeat the amplifier's external level control.

PARALLEL WIRING KITS – Six types available: 2105 2-AMP, 2110/2120/7794MRL 2-AMP, 2105 3-AMP, 2110/2120/7794MRL 3-AMP, 2105 4-AMP, and 2110/2120/7794MRL 4-AMP. Parallel wiring kits include the DB-25 Interlock cable for system communication, BNC T-connectors and BNC patch cables for wiring parallel inputs through the BNC input connectors, and the output wiring for connecting system amplifiers to the load. The kits also include the wire(s) needed for wiring the parallel inputs through the Removable Barrier Block (WECO) connectors and the input terminators required during system setup. Parallel wiring kits are recommended for all Parallel configurations.

To download the AE Techron **Multi-Amp Configuration Guide** or for additional information, visit the AE Techron website at www.aetechron.com.

6.3.1 Accessory Recommendations by System Type

Series Systems

2110, 2120 or 7794MRL, Two in Series:

- (2) SIM-BNC-OPTOC input cards,
- (1) DB9M OPTOC cable

2110, 2120 or 7794MRL, Three in Series:

- (3) SIM-BNC-OPTOC input cards,
- (2) DB9M OPTOC cables

Parallel Systems

2110 Two in Parallel:

- (2) 2110 BAL RES kits,
- (1) 2110/2120/7794MRL 2-AMP Parallel Wiring kit

2120 or 7794MRL Two in Parallel:

- (2) 2120/7794MRL BAL RES kits,
- (1) 2110/2120/7794MRL 2-AMP Parallel Wiring kit

2110 Three in Parallel:

- (3) 2110 BAL RES kits,
- (1) 2110/2120/7794MRL 3-AMP Parallel Wiring kit

2120 or 7794MRL Three in Parallel:

- (3) 2120/7794MRL BAL RES kits,
- (1) 2110/2120/7794MRL 3-AMP Parallel Wiring kit

2110 Four in Parallel:

- (4) 2110 BAL RES kits,
- (1) 2110/2120/7794MRL 4-AMP Parallel Wiring kit

2120 or 7794MRL Four in Parallel:

- (4) 2120/7794MRL BAL RES kits,
- (1) 2110/2120/7794MRL 4-AMP Parallel Wiring kit

6.3.2 Multi-Amp System Output Capabilities (see following pages)

Note: Performance levels typical up to 20 kHz frequency levels. Above 20 kHz, slew rate may affect

performance, reducing maximum voltage, current and power output.

*Indicates no testing performed.

Two 2110s in Series – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT					
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle			
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts	
32	390	12	390	12	390	12	276	8.6	276	8.6	2374	
16	366	31	366	23	366	23	260	16.3	260	16.3	4238	
8	330	41	330	41	330	41	234	29.3	234	29.3	6856	
4	294	75	*	*	172	43	*	*	122	30.5	3721	

Three 2110s in Series – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT					
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle			
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts	
48	585	12	585	12	585	12	414	8.6	414	8.6	3561	
24	549	31	549	23	549	23	390	16.3	390	16.3	6357	
12	495	41	495	41	495	41	351	29.3	351	29.3	10,284	
6	441	75	*	*	258	43	*	*	183	30.5	5581	

Two Paralleled 2110s – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT					
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle			
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts	
8	195	24	195	24	195	24	138	17.2	138	17.2	2374	
4	183	62	183	46	183	46	130	32.6	130	32.6	4238	
2	165	82	165	82	165	82	117	58.6	117	58.6	6856	
1	147	150	*	*	86	86	*	*	61	61	3721	

Three Paralleled 2110s – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT					
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle			
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts	
5.34	195	36	195	36	195	36	138	25.8	138	25.8	3560	
2.67	183	93	183	69	183	69	130	48.9	130	48.9	6357	
1.34	165	123	165	123	165	123	117	87.9	117	87.9	10,284	
0.67	147	225	*	*	86	129	*	*	61	91.5	5581	

Four Paralleled 2110s – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT					
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle			
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts	
4	195	48	195	48	195	48	138	34.4	138	34.4	4747	
2	183	124	183	92	183	92	130	65.2	130	65.2	8476	
1	165	164	165	164	165	164	117	117.2	117	117.2	13,712	
0.5	147	300	*	*	86	172	*	*	61	122	7442	

Two 2120s or 7794MRLs in Series – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT				
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
32	318	12	318	10	318	10	224	7	224	7	1568
16	318	19	308	19	308	19	218	13	218	13	2834
8	316	39	304	38	304	38	214	27	214	27	5778
4	314	79	*	*	282	71	*	*	200	50	10,000

Three 2120s or 7794MRLs in Series – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT				
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
48	477	12	477	10	477	10	336	7	336	7	2352
24	477	19	462	19	462	19	327	13	327	13	4251
12	474	39	456	38	456	38	321	27	321	27	8667
6	471	79	*	*	423	71	*	*	300	50	15,000

Two Paralleled 2120s or 7794MRLs – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT				
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
8	159	24	159	20	159	20	112	14	112	14	1568
4	159	38	154	38	154	38	109	26	109	26	2834
2	158	78	152	76	152	76	107	54	107	54	5778
1	157	158	*	*	141	142	*	*	100	100	10,000

Three Paralleled 2120s or 7794MRLs – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT				
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
5.34	159	36	159	30	159	30	112	21	112	21	2352
2.67	159	57	154	57	154	57	109	39	109	39	4251
1.34	158	117	152	114	152	114	107	81	107	81	8667
0.67	157	237	*	*	141	213	*	*	100	150	15,000

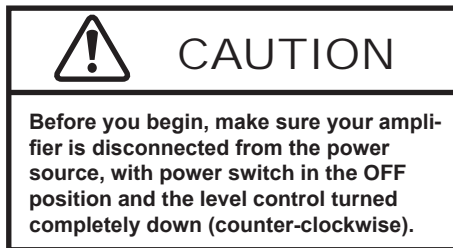
Four Paralleled 2120s or 7794MRLs – AC Specifications

Ohms	PEAK OUTPUT						RMS OUTPUT				
	40 mSec Pulse, 20% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		5 Minutes, 100% Duty Cycle		1 Hour, 100% Duty Cycle		
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Watts
4	159	48	159	40	159	40	112	28	112	28	3136
2	159	76	154	76	154	76	109	52	109	52	5668
1	158	156	152	152	152	152	107	108	107	108	11,556
0.5	157	553	*	*	141	284	*	*	100	200	20,000

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 the **“Troubleshooting”** section 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.

- Torx T15 driver
- 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 the amplifier OFF. Disconnect the amplifier from its power source.
2. Remove the four Torx-head screws, located along the left and right edges of the amplifier's front panel using a Torx T15 driver. Retain.
3. Remove the amplifier's front cover by pulling straight towards you.
4. Using a vacuum cleaner, vacuum the front and rear ventilation grills. Vacuum the filters behind the front ventilation grill.
5. 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 2110/2120/7794MRL 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 2110/2120/7794MRL 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.

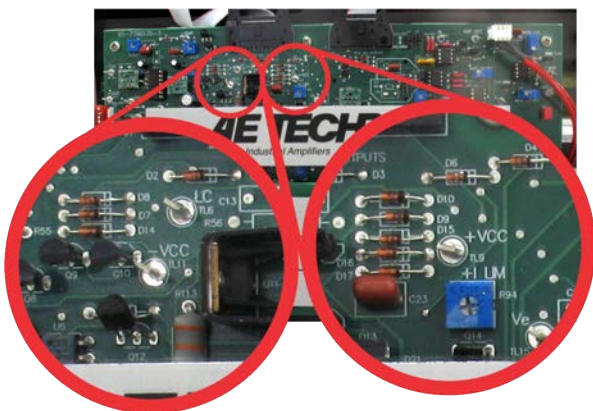
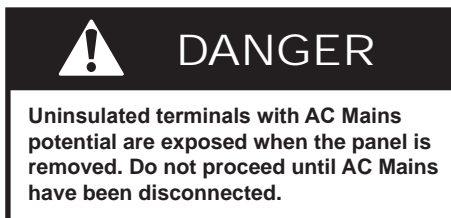


Figure 8.1 – +Vcc and –Vcc Point Locations

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 OFF the power at the rear circuit breaker.
2. Disconnect the AC mains plug from the amplifier.
3. Wait three to five minutes for the Power Supply capacitors to discharge.
4. Remove the 16 single screws from the top cover.
5. 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 5 volts before proceeding.
6. Inspect the amplifier's internal components (see **Figure 8.2**). Check the following:
 - Inspect modules for charring, breaks, deformation or other signs of physical damage.
 - Look for any foreign objects lodged inside the unit.
 - Inspect the entire lengths of wires and ribbon cables for breaks or other physical damage.
7. If there is any physical damage to the amplifier, please return it to AE Techron for repair.

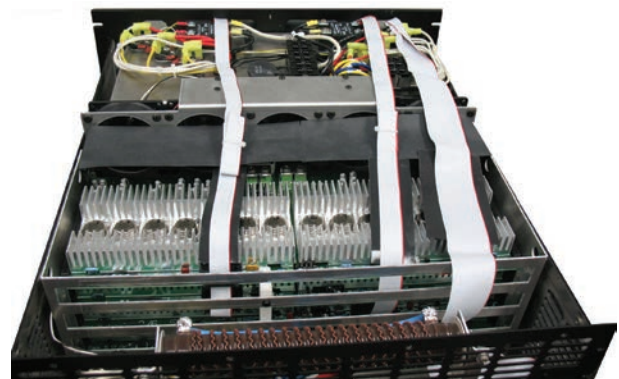


Figure 8.2 – Amplifier cover removed for inspection



Figure 8.3 – Fuse F1 Location

8.3 No Signal

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

1. Master/Follower Jumpers are set to the Follower (down) position. The amplifier should only be configured for Follower mode if it is in a multi-amplifier system; otherwise it should be set for Master mode. See the **"Advanced Configuration"** section in this manual for more information.
2. Signal is not connected to any inputs on the SIM card. See the **"Amplifier Setup"** section in this manual for more information.

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 the **"Amplifier Setup"** section for more information).
2. Back Panel Breaker is not in the UP position.
3. Fuse F1 is open.

To Inspect Fuse F1 follow these steps:

1. Turn Off the amplifier and disconnect the AC mains.
2. Locate Fuse Cover on the amplifier back panel (see **Figure 8.3**). Remove Fuse Cover.
3. Remove fuse and inspect. Replace, if necessary, with 1A slow blow fuse.

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. If the amplifier does not automatically reset, the amplifier's three internal transformers may need to be rewired. Please see the Factory Service information at the end of this section.

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 8.4**). For more information on Remote Operation, see the **"Applications"** section in this manual.
3. If the connection to the Interlock – I/O Connector or other input/output connection isn't fully

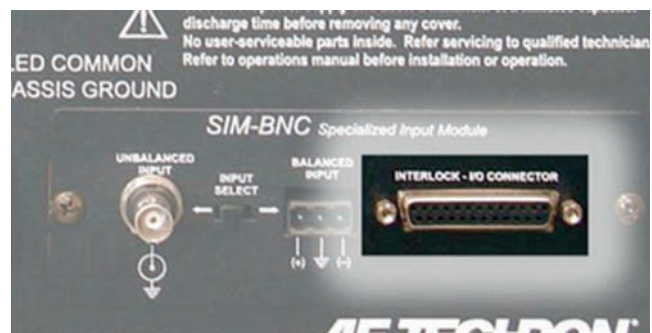


Figure 8.4 – Interlock I/O Connector

secure. Check all wiring and connections.

8.7 Amplifier Overheats (Over Temp Fault Condition)

There are two possible reasons why the amplifier is overheating:

1. Excessive Power Requirements
2. Inadequate Airflow

8.7.1 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 the **"Specifications"** section.
2. Faulty output connections and load.
3. Undesired DC offset at the Output and Input signal.

8.7.2 Monitoring Heat Sink Temperature

When running the amplifier in very difficult conditions, monitoring the amplifier's heat sink temperatures can be very instructive. The amplifier has convenient points for monitoring heat sink temperatures located on the main circuit board. See

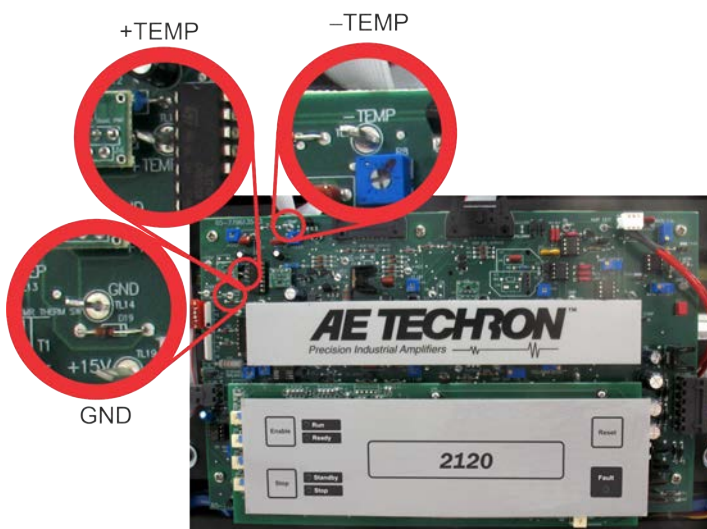


Figure 8.5 – +TEMP and -TEMP test point locations

Figure 8.5.

Connect across +TEMP and GND to monitor the heat sinks responsible for positive voltages; connect across –TEMP and GND to monitor the heat sinks responsible for negative voltages.

When running typical sine-type wave forms, readings at both monitor points should be similar. A deviation can be an indication of a DC offset that is causing one side of the amplifier to work harder than the other.

To convert the monitor point voltage readings to degrees Celsius:

$$\text{Temperature in degrees Celsius} = (V \times 100) - 273$$

Where:

V = Voltage at Pin (ex. 3.73)

V x 100 = Degrees Kelvin (ex. 373.0)

–273 = Degrees Celsius (ex. 100°C)

It is recommended for most applications that long-term amplifier heat sink temperatures be limited to 100-120°C.

8.7.3 Check for Inadequate Airflow

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 steps:

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.

Any inoperative, visibly slow, or reverse-spinning fan should be replaced. Please see the Factory Service information at the end of this section.

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.

8.7.4 Resetting After OverTemp

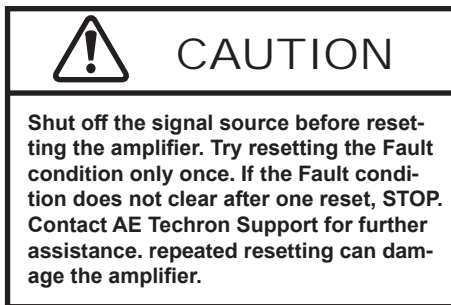
To reset the amplifier after an OverTemp has occurred, make sure fans are running, then remove the input signal from the amplifier. Allow the fans to run for five minutes, and then push the Reset button to reset the amplifier.

8.8 Fault LED is Illuminated

The 2110/2120/7794MRL 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. Please see the Factory Ser-



vice information at the end of this section.

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

2110 Pulsed Output - Current Mode

	PULSE DURATION / OFF TIME (mS)						
	DC*	500 / 500	100 / 100	10 / 20	170 / 1000	25 / 1000	4 / 100
Output (\pm A Peak)	8	16	15	22	59	110	110

2120 Pulsed Output - Current Mode

	PULSE DURATION / OFF TIME (mS)						
	DC*	500 / 500	100 / 100	10 / 20	170 / 1000	25 / 1000	4 / 100
Output (\pm A Peak)	60	50	50	80	200	200	200

*DC 1 Ω

7794MRL Pulsed Output - Current Mode

	PULSE DURATION / OFF TIME (mS)						
	DC**	500 / 500	100 / 100	10 / 20	170 / 1000	25 / 1000	4 / 100
Output (\pm A Peak)	160	200	200	200	200	200	200

**DC 0.15 Ω

9.1 Performance

Specification typical at 25°C ambient. Unless otherwise noted, testing was done in Current mode with a load = 500 μ H +200 m Ω (2110), 500 μ H +100 m Ω (2120) and 140 μ H +100 m Ω (7794MRL).

Peak Current Limit	2110: 112 A 2120: 209 A 7794MRL: 200 A
Gain Linearity***	DC: 0.0125% (over input signal, from 0.2V to 5V) AC: 0.030%
Output Offset (adjustable to zero)	Voltage Mode: Less than \pm 400 μ V Current Mode: \pm 5 mA
Input Characteristics	Three-Terminal Barrier Block Connector: Balanced with ground; 20 k Ω differential BNC Connector: Unbalanced; 10 k Ω single ended Max Input Voltage: \pm 10 V balanced or unbalanced Common Mode Rejection: -70 dB with 5 V input
Output Impedance	Current Mode (effective): 2000 Ω Voltage Mode: 3 mOhm in Series with 2.23 μ H
Load	Current Mode: 2110: 500 μ H + 200 m Ω 2120: 500 μ H + 100 m Ω 7794MRL: 140 μ H + 100 m Ω Adaptable Range: 5 μ H to 2.5 H, 0.01 Ω to 20 Ω
Current Mode Response	-3 dB at 5 kHz (compensation dependent)
Current Settling Time	Ramp 0 A to \pm50 A or \pm50 to 0 A: 2110/2120: 20 μ s to within 1.0 A or 1%; 35 μ s to within 200 mA, 0.2%
Total Harmonic Distortion	Current Mode, 2110/2120: <0.1% (Load: 500 μ H + 100 m Ω) 7794MRL: <0.05% (Load: 140 μ H + 100 m Ω)

***Gain Linearity Accuracy was measured in Voltage mode with the amplifier driven into a 10 Ω load with between 0.1VDC and 6VDC or between 0.2VAC and 5VAC presented at its inputs.

Noise Floor	200 μ A or less 5 μ A or less (when Blanking circuit is enabled)
DC Drift	Self Heating Drift, 0 to \pm60 A: 5 mA/10 minutes maximum
Noise Output	10 Hz to 1 kHz: 0.2 mA 1 kHz to 60 kHz: 0.05 mA
Ripple Noise Output	None
Slew Rate, Voltage Mode:	2110/2120: 41 V/ μ s 7794MRL: 4.5 V/ μ s
Remote Control and Monitoring (back-panel D connector)	Current Monitor: \pm 1 V / 20 A \pm 1% Reporting: System Fault, Over Temp, Over Voltage, Over Load Control: Force to Standby, Remove from Standby, Reset after a Fault
Amplifier Protection	Over Load/Distortion (IOC): Shutdown or clipped output Current vs Time (ODEP): Clipped output Each heat sink temperature: Shutdown 105°C Overvoltage Shutdown: 229 VAC / 440 VAC Undervoltage Shutdown: 187 VAC / 360 VAC
Status Indicators (front panel)	LEDs indicate a status of Run, Ready or Standby, and Fault conditions
Controls (front panel)	Soft Touch Switches: Run (Enable), Stop and Reset functions AC Mains Switch and Circuit Breaker: Dual-function power switch and circuit breaker; rating for 208 volts: 20A (2110), 30A (2120); 15A (2110 & 2120) for 400 volts; turn off and then back on to reset
Connectors (back panel)	Power Connection: NEMA-style locking receptacle; matching AC connector also included Signal Output: 4-position terminal barrier block: OUTPUT / COMMON / SAMPLED COMMON / CHASSIS GROUND; resistor between SAMPLED COMMON and CHASSIS GROUND terminals is a 2.7-ohm, 2W, 5%, metal-oxide resistor Signal Input: User-selectable unbalanced BNC or balanced Barrier Strip Interlock I/O Connection: 25-pin D connector provides for remote monitoring and control functions
Power Requirements	Three-phase, 208 VAC \pm 10%, 47-60 Hz, 30 Amp (2120) or 20 Amp (2110) AC service; (400 VAC \pm 10%, 15 Amp (2110 & 2120) service model available)
Thermal Requirements	Operating Temperature: +10°C to +50°C (+50°F to +122°F). Maximum output power de-rated above 30°C (86°F) Storage: -30°C to +85°C (-22°F to +185°F) Humidity: 70% or less, non-condensing

Physical Characteristics

Dimensions: 2110: 19" L x 8.75" H x 22.8" D (48.3 cm L x 22.3 cm H x 57.9 cm D); 2120: 19" L x 12.25" H x 22.8" D (48.3 cm L x 31.1 cm H x 57.9 cm D)

Cooling: Forced air cooling from front to back through removable filters via four (2110) or six (2120) 100 CFM fans. No space is required between rack-mounted amplifiers. Air filters are removable from the rear via one fastener per side and may be eliminated if cabinet filtration is provided.

Airflow: 2110: 400 CFM; 2120/7794MRL: 600 CFM

Weight: 2110: 103 lbs (46.7 kg); 2120/7794MRL: 153 lbs (69 kg)

Shipping Weight: 2110: 108 lbs (49.0 kg); 2120/7794MRL: 158 lbs (71.7 kg)

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

Pin #	Function	Description	Signal Type	Level when Asserted	Level when Deasserted	Notes	Applications
1	Amplifier Output	Used for driving Follower amplifiers; monitoring amplifier output voltage	AC or DC	Can be greater than $\pm 200V$ peak	0V	Used for driving Follower amplifiers in multi-amp systems. Wired to amplifier output. Do not connect to any impedance of less than 10K ohm.	Used in multi-amplifier systems.
2	Sampled Common	Load connected here for Current sense	AC or DC	Up to $\pm 2V$ peak relative to Common	0V	Used for driving Follower amplifiers in multi-amp systems, controlled voltage or controlled current mode.	Driving Follower Amplifiers: Amplifier External Reference, 2V peak maximum from PIN 14 (Common).
3	+1 IN	Differential Follower input	AC or DC	Can be greater than $\pm 200V$ 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 Follower mode.
4	Interlock	Amplifier Interlock input	DC	0V to 8V	10V to 15V	When "low", forces to Standby; when allowed to float, allows Run (if amplifier is "Ready"). IMPORTANT: amplifiers must be configured for Run mode at startup (factory default) or the Run button must be pressed at the amplifier front panel at startup.	Remote to Standby: Short PIN 4 of amplifier to Digital Ground (PIN 17) using dry contact switch or optocoupler. When closed, places amplifier in Standby. Multi-amplifier Systems, Simultaneous Enable or Disable of amplifiers: Daisy-chain Interlock (PIN4) across amps (if sharing the same Sampled Common power connections). Optocoupler must be used for multi-amps in series.
5	Amp Ready	Ready output of amplifier	DC	0V	-14V	Normally reserved for OPTOC use; not recommended 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	2105: 5A/V 2110/2120/7794MRL: 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 (2105) or 20A (2110/2120/7794MRL).
7	None	No connection					Not currently used.
8	Blanking input	Blanking control	DC	0 - 1Vdc allows normal operation	3.5 - 5Vdc output is muted	Used in amplifiers with blanking feature for blanking control.	Blanking Control: Use an external isolated 5V power supply to mute the output of the amplifier.
9	None	No connection					Not currently used.

Pin #	Function	Description	Signal Type	Level when Asserted	Level when Deasserted	Notes	Applications
10	Sampled Common	Amp Analog Ground; Blanking Ground				Amplifier ground.	Can be used as Blanking return or as a reference of the amplifier for 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, this pin is grounded. Do not exceed 7 milliamps.	Remote Signal of Over-Temperature Condition: LED, when lit, signals Over Temperature condition. Use a 6 mA series resistor of 4.7K-ohm for LED or OPTO, tie to -24V source (PIN 13).
12	Run	Amplifier Run output	DC	-24V	0V	When amp is in Standby mode, this pin is pulled to -24V; when amp is in Run mode, this pin is grounded, energizing Mains Relays and allowing drive for an external LED. DO NOT exceed 7mA; DO NOT ground this pin as this will enable Main Power Relays.	Remote Signal of Run Condition: LED, when lit, signals Run state. Use a 6mA series resistor of 4.7K-ohm for LED or OPTO, tie to -24V source (PIN 13).
13	-24V	-24V Power Output	DC			-24V dc, 30 mA max	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				Current monitor reference. Voltage between Common and Sampled Common is voltage on the Current Sense resistor.	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 Follower 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 Follower mode.
16	+24V	+24V Power Output	DC			+24V dc, 30 mA max.	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.
18	OEM App	Input Monitor (OEM only)				Used to monitor the input signal from an OEM DAC card; this is the actual input signal.	OEM modification only; normally no connection.
19	I MON – (alt.: OEM App)	Differential Current Monitor – ; (- Input Monitor, OEM only)	AC or DC	2105: 5A/V 2110/2120/7794MRL: 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 (2105) or 20A (2110/2120/7794MRL).

Pin #	Function	Description	Signal Type	Level when Asserted	Level when Deasserted	Notes	Applications
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 (amplifier output is clipping).	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, this pin is grounded. Do not exceed 6 milliamps.	Remote Signal of Overload Condition: LED, when lit, signals Overload condition. Use a 6mA series resistor of 4.7K-ohm for LED or OPTO, tie to -24V source (PIN 13).
24	OverVoltage Out	Overvoltage output (High AC line voltage).	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, this pin is grounded. Do not exceed 6 milliamps.	Remote Signal of Overvoltage Condition: LED, when lit, signals Overvoltage condition. Use a 6mA series resistor of 4.7K-ohm for LED or OPTO, tie to -24V source (PIN 13).
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: 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.
Gray shaded areas indicate pin not used / feature not implemented.						Blue shaded areas indicate used in multi-amplifier systems.	