California Instruments

Revision B
April 1996

P/N 5001-967

iL-Series AC Power Source / Analyzers User Manual

User's Manual
AC Power Source/Analyzers
California Instruments
Models :

- 3000iL
- 3000iL-400
- 4500iL
- 4500iL-400
- 4801iL
- 4801iL-400

April 1996

Manual conventions

The following symbols are used on the product and throughout this manual:

	***This sign denotes hazardous voltages.***
	***Instruction manual symbol. The instrument will be marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the instrument.***
	***This sign indicates an earth grounded terminal.***
WARNING	***This denotes a hazard. It calls attention to a procedure, practice, or the like which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.***
CAUTION	***This denotes a hazard. It calls attention to a procedure, practice, or the like which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the instrument. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met. Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.***

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation of this power module. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. California Instruments assumes no liability for the user's failure to comply with these requirements.

WARNING: LETHAL VOLTAGES. AC sources can supply 425 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage.

GROUND THE INSTRUMENT

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the AC power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

ATTENTION: Un circuit de terre continu est essentiel en vue du fonctionnement sécuritaire de l'appareil. Ne jamais mettre l'appareil en marche lorsque le conducteur de mise à la terre est débranché

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

DO NOT REMOVE THE INSTRUMENT COVER

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.

DO NOT EXCEED INPUT RATINGS

Operation at line voltages or frequencies in excess of those stated on the line rating label may cause leakage currents in excess of 5.0 mA peak.

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1. Introduction

1.1 About this chapter

This chapter covers general information concerning the AC power source/analyzer and also provides and overview of related documentation that is supplied with the iL Series products.
Options and accessories available for the iL Series are listed as well as replacement parts.

1.2 Document Reference

This manual describes the operation of the California Instruments iL Series AC Source/Analyzers .The following documents are shipped with your AC source:

- a User's Manual, containing detailed installation, checkout, and front panel information
- a Programming Manual, containing detailed IEEE-488 programming information

You will find information on the following tasks in these manuals. Refer to the table of contents of each manual for a complete list of the topics.

Table 1 : User Manual Organization

Topic	Location
Accessories and Options	Chapter 1
Calibrating the AC source	Chapter 6
Front panel keys	Chapter 4
Front panel programming examples	Chapter 4
Line voltage connections	Chapter 2
Line voltage ratings	Chapter 5
User replaceable parts	Chapter 1
Operator troubleshooting	Chapter 2
Operating characteristics	Chapter 5
Performance specifications	Chapter 5
Quick operating checkout	Chapter 2
Rack mounting	Chapter 2
RS-232C operation	Chapter 2
SCPI programming commands	Chapter 4 - Programming Manual
SCPI programming examples	Chapter 5 - Programming Manual
Turn-on/checkout	Chapter 3
Wiring discrete fault indicator (DFI)	Chapter 2
GPIB controller	Chapter 2
load or loads	Chapter 2
Voltage sensing (local and remote)	Chapter 2
remote inhibit (RI)	Chapter 2

1.3 Safety Considerations

This AC source is a Safety Class 1 instrument, which means it has a protective earth terminal. That terminal must be connected to earth ground through a power source equipped with a ground receptacle. Refer to the Safety Summary page at the beginning of this manual for general safety information. Before installation or operation, check the AC source and review this manual for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places in the manual.

1.4 General Description

The AC source combines three instruments in one unit as shown in the following figure. The function generator produces waveforms with programmable amplitude, frequency, and shape. The power amplifier amplifies the function generator signal to produce the AC power for your application. The measurement functions range from a simple readback of rms voltage and current, to sophisticated capabilities such as waveform analysis.

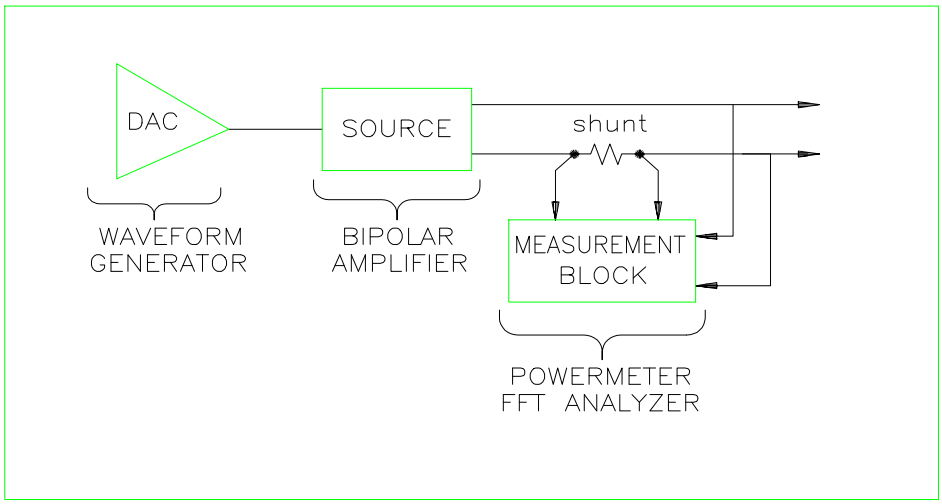


Figure 1: AC Source Functional Elements

The following descriptions apply to all models in the California Instruments iL Series product line. Specifically, the following models are included:

Table 2: iL Series model numbers

Model	Maximum power output	Operating Modes
3000iL	3000 VA	Single or Three phase. 208 V L-L 3ø input
3000iL-400	3000 VA	Single or Three phase. 400 V L-L 3ø input
4500iL	4500 VA	Single or Three phase. 208 V L-L 3ø input
4500iL-400	4500 VA	Single or Three phase. 400 V L-L 3ø input
4801iL	4800 VA	Single phase output. 208 V L-L 3ø input
4801iL-400	4800 VA	Single phase output. 400 V L-L 3ø input

1.4.1 Capabilities

- Programmable AC voltage, frequency, phase, and current limit.
- Sine, square, clipped sine, and user-definable waveforms.
- Voltage and frequency slew control.
- Synthesized waveform generation for high resolution and accuracy in frequency, low waveform distortion, and glitch-free phase transitions.
- Step and pulse output transients for generating surge, sag, dropout, and other line disturbance simulations.
- Nonvolatile list programming for generating complex output transients or test sequences.
- Extensive measurement capability:
  - Ac rms, dc, ac+dc voltage and current and peak current.
  - Real, reactive, and apparent power.
  - Harmonic analysis of voltage and current waveforms gives amplitude, phase, and total harmonic distortion results up to the 50th harmonic.
  - Triggered acquisition of digitized voltage and current with extensive post-acquisition calculations.
  - Additional total power and neutral current measurements in the three-phase mode.
  - All measurements made with 16-bit resolution.
- Trigger In and Trigger Out for synchronizing transient events or measurements with external signals.
- Front panel control with 14-character vacuum fluorescent display, keypad, and rotary pulse generators for voltage and frequency settings.
- Built-in IEEE-488 and RS-232C interface programming with SCPI command language.
- Non-volatile state and waveform storage and recall.
- Over-voltage, over-current, over-temperature, and RI/DFI protection features.
- Built-in output disconnect relays.
- Extensive selftest, status reporting, and software calibration.

1.4.2 Front Panel Controls

The front panel has both rotary (rotary pulse generator - RPG) and keypad controls for setting the output voltage and frequency. The panel display provides digital readouts of a number of output measurements. Annunciators display the operating status of the AC source. System keys let you perform system functions such as setting the IEEE-488 address and recalling operating states. Front panel Function

keys access the AC source function menus. Front panel Entry keys let you select and enter parameter values.

Note: Refer to chapter 4 for a complete description of the front panel controls.

1.4.3 Remote Programming

The AC source may be remotely programmed via the IEEE-488 bus and/or from an RS-232C serial port. IEEE-488 bus programming is with SCPI (Standard Commands for Programmable Instruments) commands that make the AC source programs compatible with those of other manufacturers' IEEE-488 programmable instruments. AC source status registers permit remote monitoring of a wide variety of AC source operating conditions

Refer to the iL Series SCPI Programming Manual (part number 5001-969) for further information about remotely programming the AC source.

1.4.4 Output Characteristic

Ranges
The AC source's output characteristic is shown in the following figure. The output voltage of the AC source may be adjusted to any value within the range of the unit. On three-phase units, each phase can be adjusted independently of the other two.

Rated output VA and conversion efficiency is greatest when the output voltage is set near maximum. For this reason, the AC source is designed to operate on one of two ranges: 150 volts full-scale, or 300 volts full-scale.

Note: For best results, always choose the range that allows you to operate nearest the full-scale output capability of the selected range.

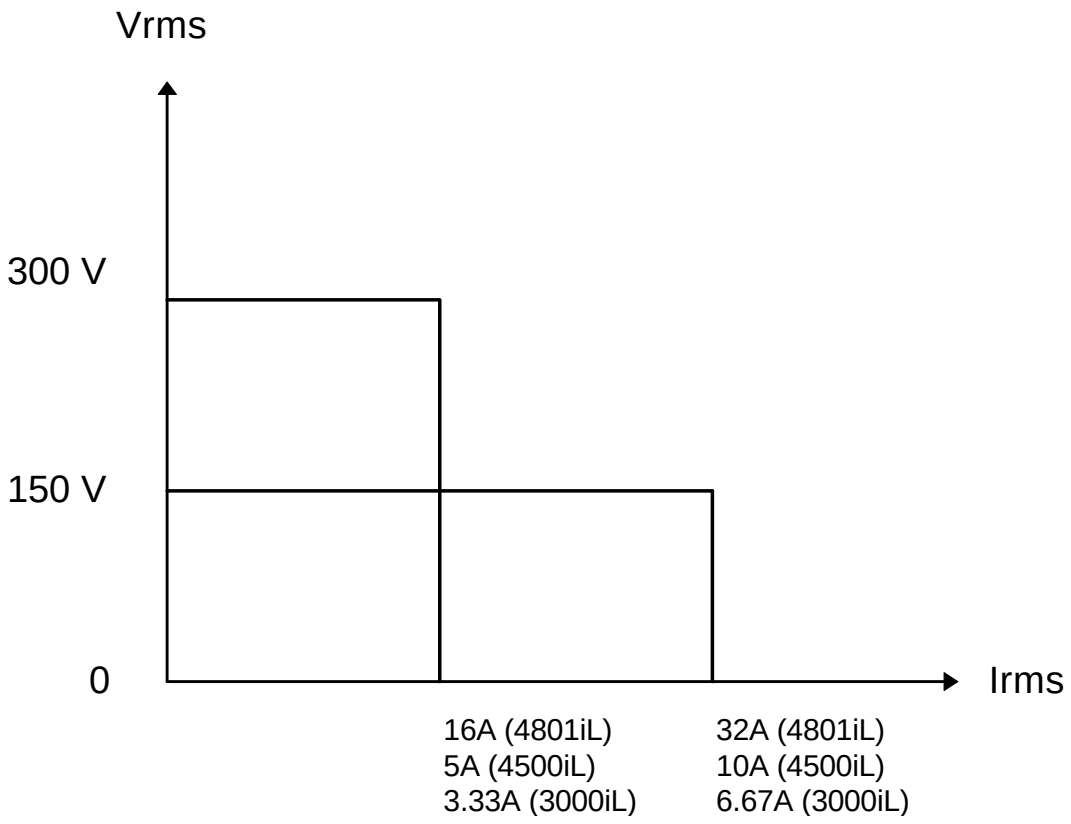


Figure 2: AC Source Output Characteristic

Output VA Capability

The output capability of each output phase is limited by VA (volts-amps) rather than power (watts). The amount of VA available to a load can be determined by examining figure 1-3, the output power curve. This curve rates the available VA versus output voltage. Full VA is available only at full-scale voltage. Full current is available at voltages between 50% and 100% of the output voltage range.

The load on the AC source may draw full VA at any power factor between 0 and 1. If the load draws current in excess of the maximum rated rms or peak current, the voltage amplitude will be reduced to prevent excessive internal power dissipation.

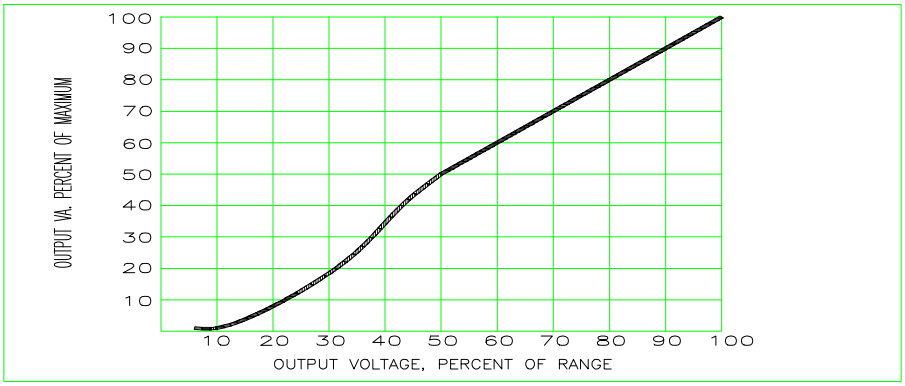


Figure 3: AC Source VA Capabilities

Note: Chapter 5 documents the AC source's specifications and supplemental characteristics.

1.5 Options and Accessories

Option	Description
-400	Input power 360-440 Vac, three-phase, 47-63 Hz

Table 3 : Options

Item	CI Part Number
Rack slides (General Devices S-120-B307-2)	210960
Rack mount ears (4 required)	5001-249-1

Table 4 : Accessories

1.6 User-replaceable Parts

The following table lists some common operator-replaceable parts:

Description	CI Part No.
Rack slides	see "Accessories"
Rack mount ears	see "Accessories"
7-terminal sense connector plug	410637
Sense connector cover	250578
4-terminal digital connector plug	410636
AC input safety cover	5001-226-1
AC input safety cover strain relief	211112
AC input safety cover bushing	211114
Screw (4), AC input safety cover (6-32 x 1.5 in)	FS1144
AC output safety cover	250576
Screw (2), AC output safety cover (6-32 x 5/16 in)	FS1028
Fuse safety cover	250577
Screw (2), fuse safety cover (6-32 x 5/16 in)	FS1028
User's Manual (this manual)	5001-967
Programming Manual	5001-969

Table 5 : Service part numbers

2. Installation

2.1 About this chapter

This chapter provides information on unpacking and installing the iL Series AC power source. If you are setting up this instrument for the first time, please study this chapter carefully before proceeding. If the AC source has already been setup, this chapter can be used for periodic inspection of the setup.
For regular operating information, proceed to chapter 3.

2.2 Inspection

When you receive your AC source, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the shipping carrier immediately.

2.3 Packaging Material

Until you have checked out the AC source, save the shipping carton and packing materials in case the AC source has to be returned. Obtain a Return Material Authorization number by contacting California Instruments Customer Service department prior to returning any equipment for service. Also attach a tag identifying the model number and the owner and include a brief description of the problem.

Note: Returning equipment to California Instruments without an RMA number may result in considerable delays.

2.4 Items Supplied

Check that the following items are included with your AC source (see Table 4 for part numbers):

Sense/Digital connectors	A 4-terminal digital plug that connects to the back of the unit A 7-terminal sense plug that connects to the back of the unit
Safety Covers	AC input cover with strain relief AC output cover Fuse cover
Manuals	User's Manual on CD ROM Programming Manual on CD ROM
Change page	If applicable, change sheets may be included with this manual. If there are change sheets, make the indicated corrections in this manual.

2.5 Bench Operation

The outline diagram in Figure 4 gives the dimensions of your AC source. The feet may be removed for rack mounting. Your AC source must be installed in a location that allows sufficient space at the sides and rear of the cabinet for adequate air circulation. Minimum clearances are 1 inch (25 mm) along the sides.

Note: Do not block the fan exhaust at the rear of the unit.

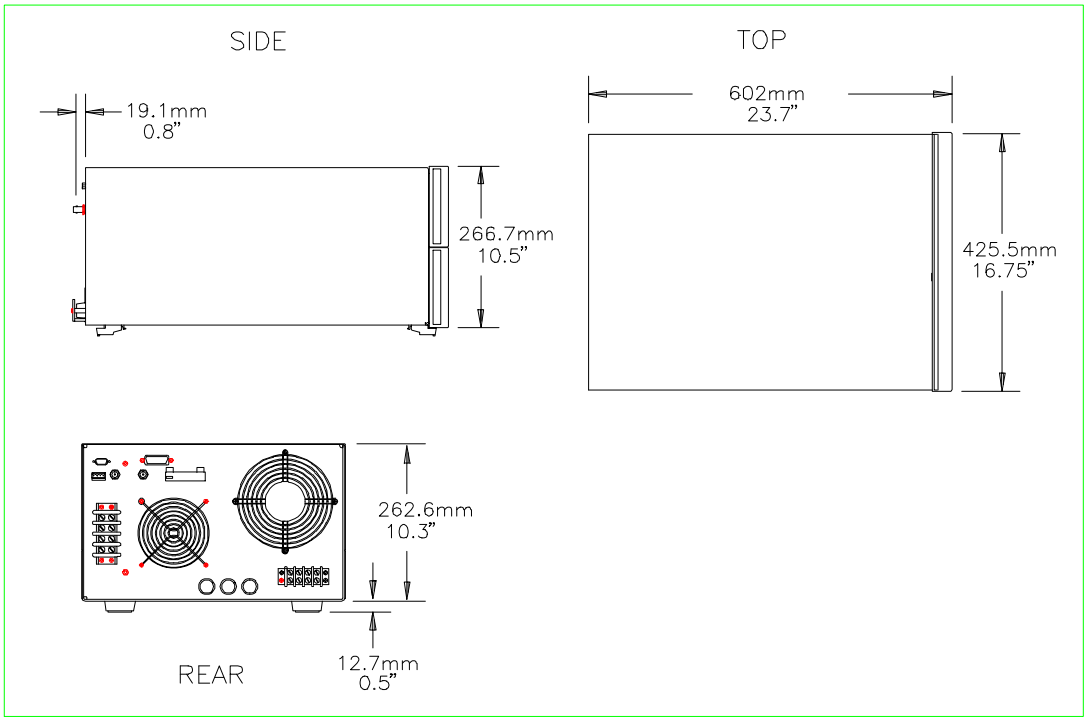


Figure 4 Outline Diagram

2.6 Rack Mounting

Due to their size and weight, iL Series AC power sources are frequently rack mounted. The three iL models weigh 87.7 kg (193 lbs).

Note: Obtain adequate help when moving or mounting the unit in the rack.

The AC source can be mounted in a standard 19-inch rack panel or cabinet. Rack slides and rack ears are available as accessories

Note: All iL Series models require instrument support rails for non-stationary installations. These are normally ordered with the cabinet and are not included with the rack mounting kits.

2.7 Input Connections

The AC source requires a 3-phase power service that provides 7350 VA (6000 W) maximum. The power service should have a current rating greater than or equal to the AC source's fuse rating. The AC source has a delta input (no neutral connection) and will accept power from either delta (triangle) or wye (star) services.

Caution: ***Two input voltage ranges are available (see "AC Input Ratings" in chapter 5). The AC source will be damaged if it is operated at an input voltage that is outside of its configured input range.***

In order to maintain phase current balancing, the power service should be a dedicated line with only iL Series AC sources drawing current from it. A disconnect box located near the AC source is recommended for all installations and is *mandatory for direct-wired installations.*

2.7.1 Installing the Power Cord

Installation of the power cord must be done by a qualified electrician and in accordance with local electrical codes.

See Figure 5 and proceed as follows:

- Check the line fuses as follows:
  - Examine the FUSES label on the rear panel.
  - Remove the safety cover in front of the fuse caps.
  - Unscrew the line fuse caps from the rear panel and verify that all fuses are as specified on the label. Reinstall the fuses.
  - Reinstall the safety cover in front of the fuse caps.
- Remove the AC input cover from the back of the unit.
- Open the line clamp on the AC input cover and insert the line cord through the opening.
- Position the power cord so that the clamp is near the end of the outside insulating sheath on the power cord. Tighten the screws to secure the clamp. Secure the three AC lines to the AC power strip as follows:
  - Phase 1 to L1 (black).
  - Phase 2 to L2 (red).
  - Phase 3 to L3 (orange).
- Secure the ground wire (green) to the chassis earth ground terminal.
- Slip the safety cover over the AC input terminal strip and secure the cover with the four screws.
- If required, wire the appropriate power plug to the other end of the power cord. Strip back the sheath 10 cm (4 in).

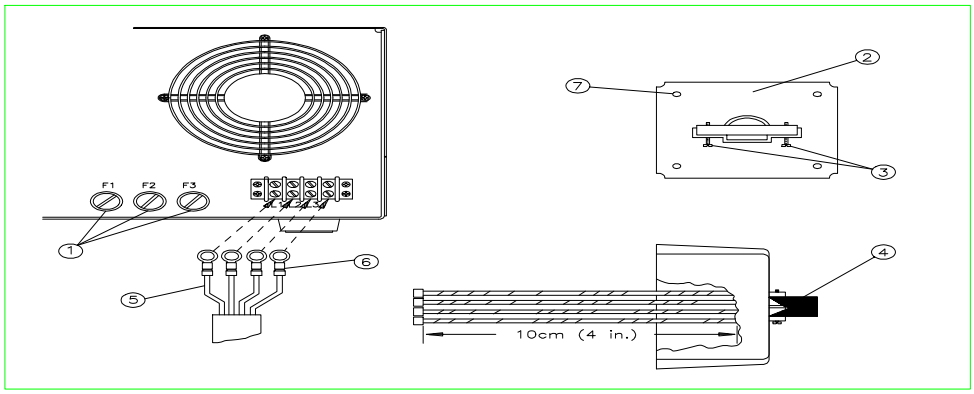


Figure 5 Connecting the Power Cord

2.7.2 Output Connections

The power output terminal block has a termination for each of the output phases and a floating neutral line for the phase return connections. A separate earth ground terminal is located near the output terminals.

To minimize the possibility of instability on the AC source output, keep the load leads as short as possible and bundle them together tightly.

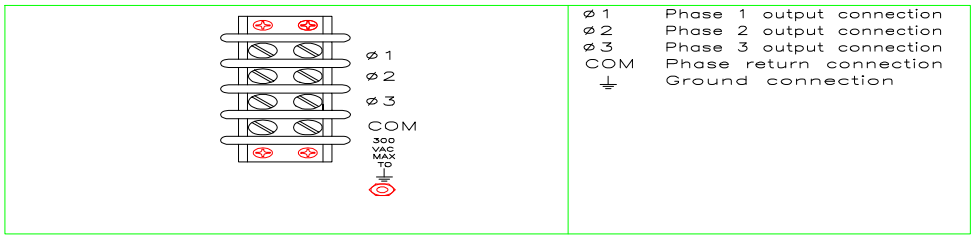


Figure 6 Output Connections

2.7.3 Wire Considerations

Current Ratings

Fire Hazard: ***To satisfy safety requirements, load wires must be large enough not to overheat when carrying the maximum short-circuit current of the AC source. If there is more than one load, then any pair of load wires must be capable of safely carrying the full-rated current of the AC source.***

Table 6 lists the characteristics of AWG (American Wire Gage) copper wire.

Stranded Copper Wire Capacity and Resistance

AWG No.	Ampacity	Resistance (W/m)	AWG No.	Ampacity	Resistance (W/m)
14	25	0.0103	6	80	0.0016
12	30	0.0065	4	105	0.0010
10	40	0.0041	2	140	0.00064
8	60	0.0025	1/0	195	0.00040

Table 6 : American Wire Gage (AWG) characteristics

NOTES:

1. Ampacity is based on 30 ºC ambient temperature with conductor rated at 60 ºC. For ambient temperature other than 30 ºC, multiply the above ampacities by the following constants:

Temp (ºC)	Constant	Temp (ºC)	Constant
21 to 25	1.08	41 to 45	0.71
26 to 30	1.00	46 to 50	0.58
31 to 35	0.91	51 to 55	0.41
36 to 40	0.82		

Table 7 : AWG temperature coefficients

2. Resistance is nominal at 75 ºC wire temperature.

Voltage Drops

The load wires must also be large enough to avoid excessive voltage drops due to the impedance of the wires. In general, if the wires are heavy enough to carry the maximum short circuit current without overheating, excessive voltage drops will not be a problem. The voltage drops across the load wires should be limited to less than 2% of the output voltage.

Refer to Table 6 if you need to calculate the voltage drop for some commonly used AWG copper wire.

2.7.4 Remote Sense Connections

During operation, the AC source senses the output voltage at the output terminals on the back of the unit. External sense terminals on the back of the unit allow the output voltages to be sensed at the load, which compensates for impedance losses in the load wiring. The sense connector accepts wires sizes from AWG 22 to AWG 12. Disconnect the mating plug to make your wire connections. As shown in the following figure.

- Connect the phase 1 (Ø1) through phase 3 (Ø3) sense terminals to the side of the load that connects to the corresponding output terminal.
- Connect the Neutral (COM) sense terminal connector to the neutral side of the load.

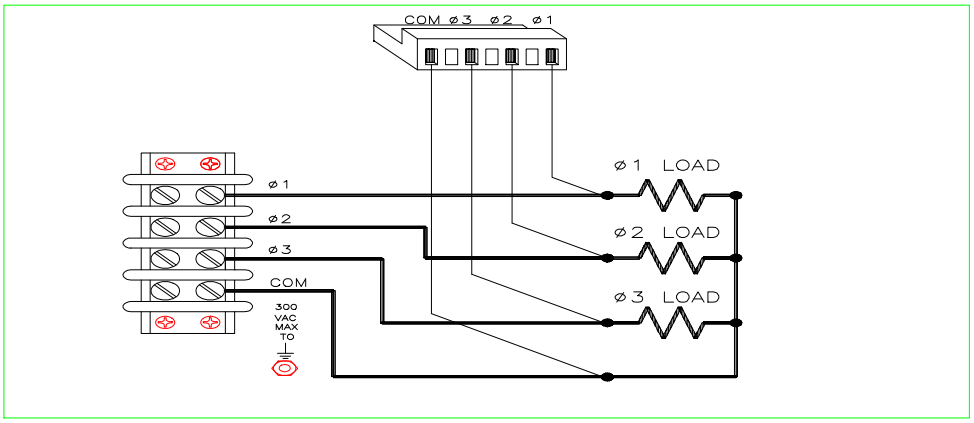


Figure 7 Remote Sense Connections

The sense leads are part of the AC source's feedback path and must be kept at a low resistance in order to maintain optimal performance. Connect the sense leads carefully so that they do not become open-circuited. If the sense leads are left unconnected or become open during operation, the AC source will regulate at the output terminals, resulting in an increase in output over the programmed value.

Note: It is good engineering practice to twist and shield all signal wires to and from the sense connectors.

Note: Set the ALC command to EXT (external) to enable remote sensing. The ALC command is located under the Voltage key as explained in chapter 4. Set the ALC command to INT (internal) to disable remote sensing.

2.8 OVP Considerations

The overvoltage protection circuit senses voltage near the output terminals, not at the load. Therefore the signal sensed by the OVP circuit can be significantly higher than the actual voltage at the load. When using remote sensing, you must program the OVP trip voltage high enough to compensate for the voltage drop between the output terminals and the load.

2.9 Output Rating

In remote sense applications, the voltage drop in the load leads subtracts from the available load voltage (see "Remote Sensing Capability" in Section 5) As the AC source increases its output to overcome this voltage drop, the sum of the programmed voltage and the load-lead drop may exceed the AC source's maximum voltage rating. This will not damage the unit, but may trip the OV protection circuit, which senses the voltage at the output terminals.

2.10 Trigger Connections

The BNC trigger connectors on the rear panel let you apply trigger signals to the AC source as well as generate trigger signals from the AC source. The electrical characteristics of the trigger connectors are described in section 5.3. More information on programming external triggers is found in chapter 5 of the AC source SCPI Programming Manual.

- Trigger IN allows negative-going external trigger signals to trigger the ac source.
- Trigger OUT generates a negative-going pulse when the selected transient output has occurred.

2.11 Digital Connections

This connector, which is on the rear panel, is for connecting the fault and the inhibit signals. The fault (FLT) signal is also referred to as the DFI signal in the front panel and some SCPI commands. The inhibit (INH) signal is also referred to as the RI signal in the front panel and some SCPI commands.

The connector accepts wires sizes from AWG 22 to AWG 12. Disconnect the mating plug to make your wire connections. The electrical characteristics of the digital connectors are described in section 5.3. More information on programming the digital connectors is found in chapter 6 of the AC source SCPI Programming Manual.

Note: It is good engineering practice to twist and shield all signal wires to and from the digital connectors

The following examples show how you can connect the FLT/INH circuits of the AC source.

In example A, the INH input connects to a switch that shorts pin + to GND pin whenever it is necessary to disable output of the unit. This activates the remote inhibit (RI) circuit, which turns off the AC output. The front panel **Prot** annunciator

comes on and the RI bit is set in the Questionable Status Event register. To re-enable the unit, first open the connection between pin + and GND pin and then clear the protection circuit. This can be done either from the front panel or over the IEEE-488 or RS-232C bus.

In example B, the FLT output of one unit is connected to the INH input of another unit. A fault condition in one of the units will disable all of them without intervention either by the controller or external circuitry. The controller can be made aware of the fault via a service request (SRQ) generated by the Questionable Status summary bit.

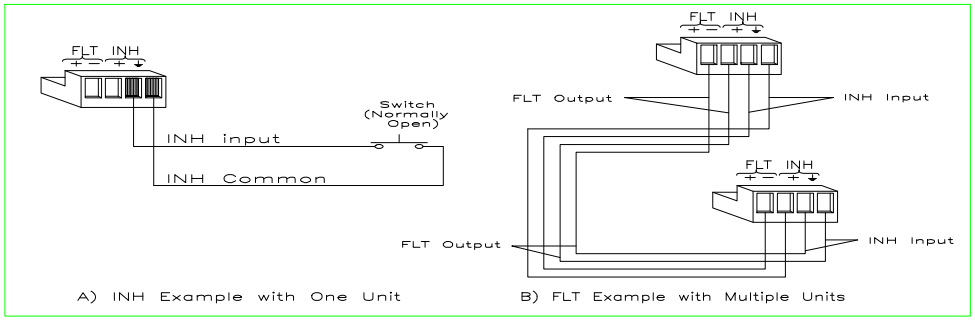


Figure 8 FLT/INH Examples

2.12 Controller Connections

The iL Series comes standard equipped with both IEEE-488 and RS232C remote control interfaces, both of which are accessible from the rear panel. Either interface can be used to connect the AC source to a controller.

2.12.1 IEEE-488 Connector

Each AC source has its own IEEE-488 bus address. AC sources may be connected to the bus in series configuration, star configuration, or a combination of the two. You may connect from 1 to 15 AC sources to a controller IEEE-488 interface. The AC source is shipped from the factory with its IEEE-488 address set to 5. This address can be changed as described in section 4.10 of this manual.

2.12.2 RS-232C Connector

The AC source provides an RS-232C programming interface, which is activated by commands located under the front panel Address key. The Address key commands are explained in detail in section 4.10. When the RS-232C interface is selected, the IEEE-488 interface is disabled.

The RS-232C data format is an 11-bit word. There is always one start bit and two stop bits. You can specify one of the following parity options:

- seven data bits with even parity
- seven data bits with odd parity
- eight data bits without parity

You can also specify one of the following baud rates:
300 600 1200 2400 4800 9600

Note: All SCPI commands are available through RS-232C programming.

Note: The SYSTem:LOCal, SYSTem:REMote, and SYSTem:RWLock commands are only available through the RS-232C interface.

RS-232C Connector Pinout
Table 8 lists the pinout assignment of the DB-9 RS232C port located on the back of the unit. A suitable cable to connect the iL Series power source to a standard 9 pin PC serial port is shown in Figure 9

Pin	Input/Output	Description
1	Output	Reserved for service use
2	Input	Receive Data (RxD)
3	Output	Transmit Data (TxD)
4	Output	Data Terminal Ready (DTR)
5		Signal ground
6	Input	Data Set Ready (DSR)
7		no connection
8		no connection
9	Output	Reserved for service use

Table 8 : RS232C DB-9 connector pin assignments

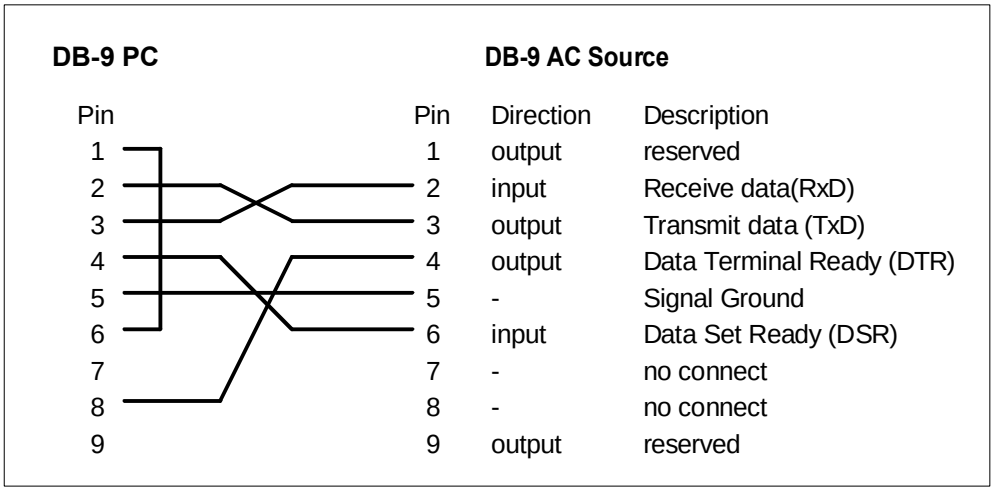


Figure 9 RS232C PC to AC Source cable wiring diagram

Hardware Handshake

The RS-232C interface uses the DTR (data terminal ready) line as a holdoff signal to the bus controller. When DTR is true, the bus controller may send data to the power source. When DTR goes false, the bus controller must stop sending data within 10 characters, and must not send any more data until DTR goes true again. The power source sets DTR false under two conditions:

1. When the input buffer is full (approximately 100 characters have been received), it will set DTR false. When enough characters have been removed to make space in the input buffer, DTR will be set to true, unless condition 2 (see below) prevents this.
2. When the power source wants to "talk", which means that it has processed a query, and has seen a <newline> message terminator, it will set DTR false. This implies that once a query has been sent to the power source, the bus controller should read the response before attempting to send more data. It also means that a <newline> must terminate the command string. After the response has been output, the power source will set DTR true again, unless condition 1 (see above) prevents this.

The power source monitors the DSR (data set ready) line to determine when the bus controller is ready to accept data. It checks this line before each character is sent, and the output is suspended if DSR is false. When DSR goes true, transmission will resume. The power source will leave DTR false while output is suspended. A form of deadlock exists until the bus controller asserts DSR true to allow the power source to complete the transmission.

Control-C is the equivalent to the IEEE-488 device clear command. For the control-C character to be recognized by the power source while it holds DTR false, the bus controller must first set DSR false.

Response Data Terminator
All RS-232C response data sent by the AC source is terminated by the ASCII character pair <carriage return><newline>. This differs from IEEE-488 response data which is terminated by the single character <newline>.

3. Turn-On Checkout

3.1 Preliminary Checkout

Successful tests in this chapter provide a high degree of confidence that the AC source is operating properly. For verification tests, see section 6.2 . This chapter provides a preliminary introduction to the AC source front panel. See chapter 6 for more details.

WARNING: LETHAL VOLTAGES. AC sources can supply 425 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.

If you have not already done so, connect the power cord to the AC source and plug it in.

- Turn the front panel power switch to ON (1).
- The AC source undergoes a self-test when you turn it on.
- The following items appear on the display:
  - A brief pattern that lights all display segments, followed by the model number and the software revision number.
  - The display then goes into the meter mode with the **Dis** annunciator on, and all others off. "Meter mode" means that the **VOLTS** digits indicate the output voltage and the **FREQ** digits indicate the output frequency. The voltage will be at or near zero and the frequency will be at 60 Hertz.

Note: If the AC source detects an error during self-test, the Err annunciator on the display will be lit. Pressing the Shift and Error keys will show the error number. Go to "In Case of Trouble" at the end of this chapter.

  - Check that both fans are on. You should be able to hear the fans and feel air coming from the unit.
  - Press Output on/off once. The **Dis** annunciator will go off and the **CV** annunciator will go on.
  - Turn the unit off.

3.2 Using the Keypad

Shifted Keys
Some of the front panel keys perform two functions, one labeled in black and the other in blue. You access the blue function by first pressing the blue shift key. When the **Shift** annunciator is on, you will know you have access to the key's shifted function.

▲ and ▼ Keys
These keys let you scroll up and down through the choices in the presently selected function menu. All menu lists are circular; you can return to the starting position by continuously pressing either key.

↑ and ↓ Keys

These keys let you select the previous or the next parameter for a specific command. If the command has a numeric range, these keys increment or decrement the existing value.

← Key
The backspace key is an erase key. If you make a mistake entering a digit and have not yet pressed Enter, you can delete the digit by pressing ←. Delete more digits by repeatedly pressing this key.

Enter Key
Executes the entered value or parameter of the presently accessed command. Until you press this key, the parameters you enter with the other keys are displayed but not entered into the AC source. After pressing Enter, the AC source returns to Meter mode in most cases. In Harmonic or List mode, the AC source displays the next point in the list.

3.3 Output Checkout

WARNING: LETHAL VOLTAGES. AC sources can supply 425 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.

The output checkout test requires that you connect light bulbs to the output of the unit and apply a potentially hazardous voltage of 120 Vac. Properly shield all connections and wires.

The test in this section checks for output voltage and current on the AC source by having you connect light bulbs to the output of the unit. The following equipment is recommended for performing this output checkout procedure:

- 3 - 100 W /120 V light bulbs (use only one bulb for 4801iL)
- 3 - sockets
- wires for connecting sockets to the unit

When the AC source is turned on as shipped from the factory, it asserts the *RST state. You can subsequently program the unit to turn on according to the state stored in *RCL location 0, as explained in section 4.11. The following procedures assume that the unit turns on in the *RST state.

Make sure that the unit is turned off, and make the following connections to the output.

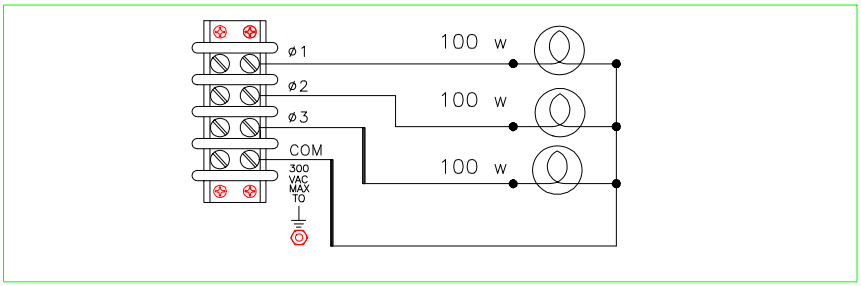


Figure 10 Verification Connections

Step	Procedure	Display	Explanation
1.	Turn the unit on.	Meter mode	Meter mode is active and the **Dis** annunciator should be on.
2.	Press Voltage key	**VOLT 0.00**	Display indicates the default settings. If you are verifying a three phase source, all phase annunciators should be on.
3.	Press 1 2 0 Enter	**VOLT 120**	Programs the output on 1 to 120 volts. After the value is entered, the display returns to Meter mode, which indicates that no voltage is applied to the output.
4.	Press Output on/off	**120 V 60 HZ**	Turns the output on and applies 120 volts to the 1 light bulb. The **Dis** annunciator should be off and **CV** should be on. Repeat steps 3 and 4 for phase 2 and phase 3 of three phase sources. All three light bulbs should be lit when this action is complete.
5.	Press Voltage	**VOLT 120**	
6.	Press Phase Select	**VOLT 120**	Select until all phase annunciators are lit on three phase source.
7.	Press 0 Enter	**VOLT 0**	Turns off all light bulbs connected to the source.
8.	Press Voltage 1 2 0 Enter	**VOLT 120**	Turns on all light bulbs connected to the source.
9.	Press Protect	**PROT:CLEAR**	Display accesses the protection menu list.
10.	Press ▲ or ▼ and scroll to the **VOLT:PROT** item.	**VOLT:PROT 500**	Display shows the overvoltage protection trip voltage for your unit.
11.	Press 1 0 0 Enter	**VOLT:PROT 100**	Programs the OVP to 100 volts, which is less than the previously set output voltage.
		0 V 60 HZ	Because the OVP voltage entered was less than the output voltage, the OVP circuit tripped. The output dropped to zero, **CV** turned off, and **Prot** turned on.

Step	Procedure	Display	Explanation
12.	Press Protect, scroll to the **VOLT:PROT** item, and press 3 2 0 Enter	**VOLT:PROT 320**	Programs the OVP to a value greater than the output voltage of the Unit. Note: You cannot clear an OVP trip until you have first removed the cause of the condition.
13.	Press Protect and Enter	**120 V 60 HZ**	Executes the PROT:CLEAR command, restoring the output. **Prot** turns off and **CV** turns on.
14.	Press Shift and Current	**CURR:LEV 1**	Indicates the default output current limit setting.
15.	Press . 5 Enter	**CURR:LEV .5**	Sets the current limit to 0.5 amperes. The **CC** annunciator is on, indicating that the unit is in current limit mode and the light bulbs are dimmer because the output voltage has dropped in its attempt to limit output current.
16.	Press Protect, scroll to the **CURR:PROT** item, and press ↓ to select **ON**. Then press Enter.	CURR:PROT ON	You have enabled the overcurrent protection circuit. The circuit then tripped because of the output short. The **CC** annunciator turns off and the **OCP** and **Prot** annuciators come on. The output current is near zero.
17.	Press Output On/Off	**0.5 V 60 HZ**	The output is off and the **Dis** annunciator turns on.
18.	Press Protect, scroll to the **CURR:PROT** item, and press ↓ to select **OFF**. Then press Enter.	**CURR:PROT OFF**	You have disabled the overcurrent protection circuit. The **Prot** annunciator turns off.
19.	Turn the unit off.		The next time the unit turns on it will be restored to the *RST or factory default state.

Table 9 : Connection Verification Steps

3.4 In Case of Trouble

3.4.1 Error Messages

AC source failure may be detected during power-on selftest or during operation. In either case, the display may show an error message that indicates the reason for the failure.

3.4.2 Selftest Errors

Pressing Shift and Error will show the error number. Selftest error messages appear as:

ERROR <n>

Where "n" is a number listed in the following table. If this occurs, turn the power off and then back on to see if the error persists. If the error message persists, the AC source requires service.

3.4.3 Power-On Selftest Errors

Error No.	Failed Test
Error 1	Non-volatile RAM RD0 section checksum failed
Error 2	Non-volatile RAM CONFIG section checksum failed
Error 3	Non-volatile RAM CAL section checksum failed
Error 4	Non-volatile RAM WAVEFORM section checksum failed
Error 5	Non-volatile RAM STATE section checksum failed
Error 6	Non-volatile RAM LIST section checksum failed
Error 10	RAM selftest
Error 11 to 18	DAC selftest 1 to 8

Table 10 : Power on selftest Error codes

3.4.4 Runtime Error Messages

Under unusual operating conditions, the front panel display may show **OVLD** . This indicates that the output voltage or current is beyond the range of the meter readback circuit, but does not necessarily mean that there has been a failure within the AC source. Chapter 11 lists other error messages that may appear at runtime.

3.4.5 Line Fuse

If the AC source appears "dead" with a blank display and the fan not running, first check your voltage mains to be certain line voltage is being supplied to the AC source. If the mains voltage is normal, the AC source line fuse may be defective. If the AC source has a defective fuse, replace it only once. If it fails again, investigate the reason for the failure. Proceed as follows:

1. Turn off the front panel power switch and remove the input power (unplug the power cord or open the safety disconnect).
2. Remove the fuse cover from the rear panel.
3. Unscrew the fuse caps and remove the fuses.

4. If any fuses are defective, replace all three with fuses of the same type (see section 1.6).
5. Turn on the AC source and check the operation. If it is normal, replace the fuse cover.

Note: It is recommended that new line fuses be installed every four years.

4. Front Panel Operation

4.1 Introduction

This chapter covers front panel operation of the iL Series AC power sources. Instrument control is accomplished using a combination of function keys, numeric data entry and a set of rotary knobs. Specifically, this chapter covers the following areas:

- a complete description of the front panel controls
- front panel programming examples that describe:
  - ◊ how to program the output voltage and frequency
  - ◊ how to measure the output
  - ◊ how to program output pulses and lists
  - ◊ how to trigger output changes

4.2 Front Panel Description

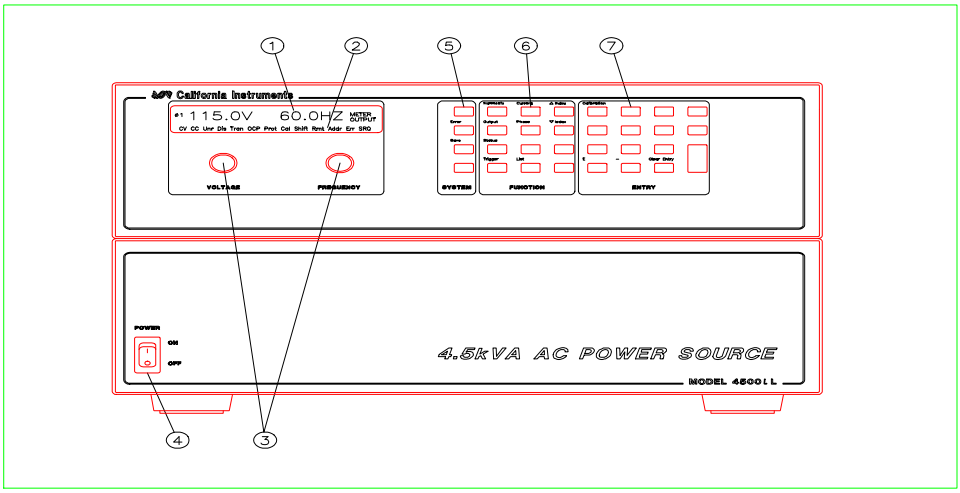


Figure 11 Front Panel, Overall View

① Display — 14-character vacuum fluorescent display for showing programming commands and measurement values.

② Annunciators — Annunciators light to indicate operating modes and status conditions:

Annunciator	Description
Ø1 Ø2 Ø3	Phase 1, 2, or 3 is being controlled or metered. When simultaneous control is selected, all three annunciators are on.
CV	The AC source output is in constant-voltage mode.
CC	The AC source output is in current-limit mode. In three phase mode, **CC** from any phase overrides display of **CC** from the other phases.

Annunciator	Description
Unr	The AC source output is in an unregulated state. In three phase mode, **UNR** from any phase overrides display of **CV** or **CC** from the other phases.
Dis	The AC source output is disabled (off).
Tran	The AC source output is initialized to output a transient.
OCP	The overcurrent protection state is ON.
Prot	One of the AC source's output protection features is activated.
Cal	The AC source is in calibration mode.
Shift	The Shift key is pressed to access an alternate key function.
Rmt	The selected interface (IEEE-488 or RS-232C) is in a remote state.
Addr	The interface is addressed to talk or to listen.
Err	A message is available in the SCPI error queue.
SRQ	The interface is requesting service from the controller.
METER AC + DC	Front panel measurement functions are : AC only, DC only, or AC + DC

Table 11 : Display annunciator descriptions

③ Voltage/ Frequency knobs.

These rotary pulse generators let you set the output voltage and frequency when the AC source is in local mode. Their response is rate sensitive.

- Turning a control rapidly provides coarse control of the value
- Turning a control slowly provides fine control of the value

④ Line

This turns the AC source on or off.

⑤ System Keys

The system keys let you:

- Return to local mode (front panel control)
- Set the GPIB address
- Select single phase or three phase output configuration
- Set the RS-232C interface communication baud rate and parity bit
- Display SCPI error codes and clear the error queue
- Save and recall up to 16 instrument operating configurations

⑥ Function Keys

Function access command menus that let you:

- Program output voltage, current limit, frequency, and output waveforms
- Turn the output on and off
- Select metering functions
- Send immediate triggers from the front panel
- Program transient output functions
- Set and clear protection functions
- Select output phases
- Select the coupling for output and meter functions
- Monitor instrument status

⑦ Entry Keys

Entry keys let you:

- Enter programming values
- Increment or decrement programming values
- Calibrate the AC source

4.3 System Keys

Refer to the examples later in this chapter for more details on the use of these keys.

Shift — This is the blue, unlabeled key, which is shown as Shift in this manual. Pressing this key accesses the alternate or shifted function of a key (such as Error). The **Shift** annunciator is lit when this key is pressed.

Local — Press to change the AC source's selected interface from remote operation to local (front panel) operation. Pressing the key will have no effect if the interface state is already Local, Local-with-Lockout, or Remote-with-Lockout.

Address — Press to access the system address menu. This menu lets you configure the AC source's interface and output mode (1Ø or 3Ø) for 3000iL and 4500iL only. Menu entries will be stored in nonvolatile memory. Use ▲ and ▼ to scroll through the following command list. Use ↑ and ↓ to scroll through the parameter list.

Display	Command Function
ADDRESS <value>	Set IEEE-488 address
INTF <char>	Select interface (GPIB or RS232)
BAUDRATE <char>	Set RS-232C baud rate (300 600 1200 2400 4800 9600)
PARITY <char>	Choose RS-232C message parity (NONE, EVEN or ODD)
LANG <char>	Set language (SCPI or E9012)
NOUTPUTS <char>	Set number of output phases (1 or 3) for 3000iL and 4500iL only

<value> = a numeric value
<char> = a character string parameter

Table 12 : Interface selection

Recall — Press to place the AC source into a previously stored state. You can recall up to 16 (0 through 15) previously stored states.

Shift Error — Press to display the system error codes stored in the SCPI error queue. This action also clears the queue. If there is no error in the queue, 0 is displayed.

Shift Save — Press to store an existing AC source state in nonvolatile memory. The parameters saved are listed under *SAV in the AC source SCPI Programming Manual. You can save up to 16 states (0 through 15).

4.4 Function Keys

Refer to the examples later in this chapter for more details on the use of these keys.

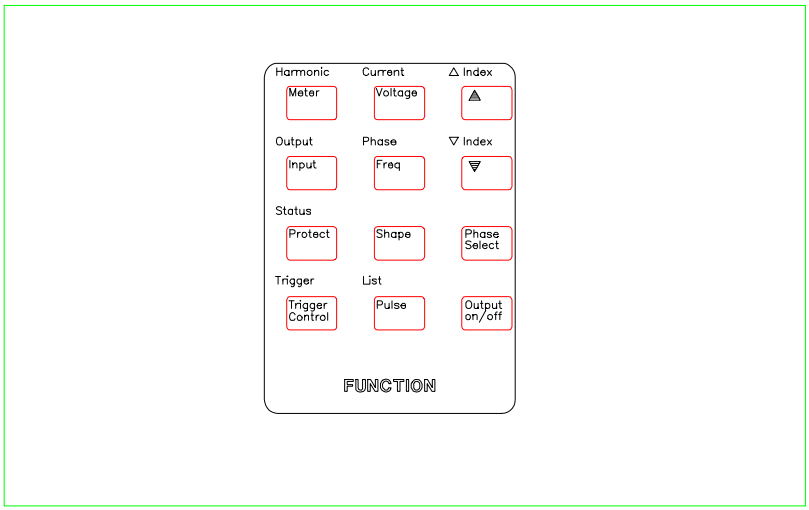


Figure 12 Function Keys

4.4.1 Immediate Action Keys

Immediate action keys *immediately* execute their corresponding function when pressed. Other function keys have commands underneath them that are accessed when the key is pressed.

Output On/Off	This key toggles the output of the AC source between the on and off states. It immediately executes its function as soon as you press it. When off, the AC source output is disabled and the **Dis** annunciator is on.
Shift Trigger	Sends an immediate trigger to the AC source.
Phase Select	This key selects the phase to which function commands will be sent, as well as the phase that will be monitored by the Meter and Harmonic functions. The key is available only with 3000iL and 4500iL. At power-on, all phases are selected or coupled, indicating that commands will be sent to all phases. The presently selected phase is indicated by a phase annunciator. Pressing Phase Select immediately selects a different phase. Phase selection is circular; you can return to the starting position by continuously pressing Phase Select.

Table 13 : Immediate action keys

Annunciator On	Phase Selected

Annunciator On	Phase Selected
Ø1, Ø2, Ø3	All phases selected (phases coupled ALL)[1]
Ø1	Phase #1 selected (phases coupled NONE)
Ø2	Phase #2 selected (phases coupled NONE)
Ø3	Phase #3 selected (phases coupled NONE)

Table 14 : Phase selection display annunciators

[1] Does not apply to Meter or Harmonic functions.

When the Meter and Harmonic functions are active, Phase Select only rotates through Ø1, Ø2, and Ø3. This is because the Meter and Harmonic functions cannot display multiple phase readings simultaneously. Therefore, it is not possible to select all phases in combination with these functions.

4.4.2 Scrolling Keys

Scrolling keys let you move through the choices in the presently selected function menu.

▲ and ▼	These scroll keys let you move through the choices in a command list. Press ▼ to bring up the next command in the list. Press ▲ to go back to the previous command in the list. Command lists are circular; you can return to the starting position by continuously pressing either key.
Shift ▲ Index Shift ▼ Index	These shifted scroll keys apply only to the Harmonic and List functions. Press these keys to step through integers 0 through 50 when specifying the desired harmonic number, or 0 through 99 when specifying the desired list point. Hold down these keys to rapidly access any harmonic or list point.
↑ and ↓	These Entry keys let you scroll through choices in a parameter list that apply to a specific command. Parameter lists are circular; you can return to the starting position by continuously pressing either key. If the command has a numeric range, these keys increment or decrement the existing value.

4.4.3 Meter Display Keys

Meter display keys control the metering function of the AC source.

Meter	Press this key to access the meter menu list.

Display	Measurement
<reading>V <reading>HZ	rms voltage and frequency (the default)
<reading>V <reading>A	rms voltage and rms current
<reading>A <reading>HZ	rms current and frequency
<reading>V <reading>W	rms volt and power
<reading>CREST F	current crest factor
<reading>A PK REP	peak current, repetitive
<reading>A PK NR	peak current, nonrepetitive[1]
<reading>VA	apparent power
<reading>VAR	reactive power
<reading>W TOTAL	total power of all phases[2]
<reading>PFACTOR	power factor
<reading>A NEUTRAL	neutral rms current[2]

Table 15 : Measurement display readouts

[1] Displays the highest peak current since it was last cleared. The value is cleared when you scroll into this selection or press Enter or Clear Entry.

[2] This selection is only valid for three phase output mode.

Input — Press this key to select the input coupling for the meter function. The parameter selections allow the meter functions to display measurements that include AC components only, DC components only, or AC+DC components.

Display	Command Function
INP:COUP <char>	Choose meter coupling (AC, DC or ACDC)
WINDOW <char>	Select harmonic measurement window meter (KBESSEL or RECT)
CURR:RANG <char>	Choose current meter range (HIGH or LOW) 4801iL only

Shift Harmonic — Press this key to access the harmonic menu list.

Display	Measurement
<reading>A I:MAG:<index>	current harmonic magnitude
<reading>º I:PHASE:<index>	current harmonic phase
<reading>V V:MAG:<index>	voltage harmonic magnitude
<reading>º V:PHASE:<index>	voltage harmonic phase
<reading>A N:MAG:<index>	neutral current harmonic magnitude
<reading>º N:PHASE:<index>	neutral current harmonic phase
<reading> CURR:THD	current total % harmonic distortion
<reading> VOLT:THD	voltage total % harmonic distortion

Table 16 : Harmonic measurement display readouts

4.4.4 Output Control Keys

Output control keys control the output functions of the AC source.

Voltage — Press this key to access the voltage menu list.

Display	Command Function	Phase selectable
VOLT <value>	Set immediate AC output voltage.	yes
VOLT:T <value>	Set triggered output voltage.	yes
VOLT:M <char>	Select the voltage mode. (FIXED, STEP, PULSE or LIST)	yes
RANGE <char>	Select the voltage range (150 or 300).	yes
SLEW <value>	Set immediate voltage slew rate in volts/second.	yes
SLEW:T <value>	Set triggered voltage slew rate in volts/second.	yes
SLEW:M <char>	Select the voltage slew mode. (FIXED, STEP, PULSE or LIST)	yes
ALC <char>	Select the voltage sense source (INT or EXT).	
ALC:DET <char>	Select voltage control mode (RMS or RTIME) 4801iL only.	

Table 17 : Output control display readouts

Notes:

reading = the returned measurement
index = a numeric value that represents the harmonic number from 0 to 50
value = a numeric value
char = a character string parameter
▲ and ▼ scroll through the command list.
↑ and ↓ scroll through the parameter list.
▲ Index and ▼ Index; specify the desired harmonic.

Shift Current Press this key to access the current limit menu list.

Display	Command Function	Phase selectable
CURR:LEV <value>	Set immediate rms output current limit.	yes

Table 18 : Current limit display readouts

Freq Press this key to access the frequency menu list.

Display	Command Function
FREQ <value>	Set immediate output frequency.
FREQ:T <value>	Set triggered output frequency.
FREQ:M <char>	Select the frequency mode (FIXED, STEP, PULSE or LIST)
SLEW <value>	Set immediate frequency slew rate in Hertz/second.
SLEW:T <value>	Set triggered frequency slew rate in Hertz/ second.
SLEW:M <char>	Select the frequency slew mode. (FIXED, STEP, PULSE or LIST)

Table 19 : Frequency control display readouts

Shift Phase Press this key to access the phase menu list.

Display	Command Function	Phase selectable
PHASE <value>	Set immediate output phase.	yes
PHASE:T <value>	Set triggered output phase.	yes
PHASE:M <char>	Select the phase mode. (FIXED, STEP, PULSE or LIST)	yes

Table 20 : Phase control display readouts

Shape Press this key to access the shape menu list.

Display	Command Function	Phase selectable
SHAPE <char>	Select the immediate output wave shape. (SINE, SQUARE, or CSIN) CSIN = clipped sine wave. User-defined waveshapes will also appear in this list when created.	yes
SHAPE:T <char>	Select the triggered output wave shape. (SINE, SQUARE, or CSIN) CSIN = clipped sine wave. User-defined waveshapes will also appear in this list when created.	yes
SHAPE:M <char>	Select the shape mode (FIXED, STEP, PULSE or LIST).	no
CLIP <value>	Set the clipping level of the CSIN wave shape. This specifies the point where clipping starts as a percentage of the peak amplitude or percentage of THD.	no

Table 21 : Waveform control display readouts

Notes:
value = a numeric value
char = a character string parameter
▲ and ▼ scroll through the command list.
↑ and ↓ scroll through the parameter list.

Pulse Press this key to access the pulse menu list.

Display	Command Function
WIDTH <value>	Set the pulse width.
COUNT <value>	Set the number of output pulses.
DCYCLE <value>	Set the pulse duty cycle as a percentage of pulse period.
PER <value>	Set the pulse period.
HOLD <char>	Select parameter that will be held constant as the other parameters change (**WIDTH** or **DCYCLE**).

Table 22 : Pulse menu display readouts

Shift Output Press this key to access the output menu list.

Display	Command Function
***RST**	Execute *RST command to place the AC source in the factory-default state.
TTLT:SOUR <char>	Select Trigger Out source (**BOT**, **EOT** or **LIST**).
	BOT beginning of transient
	EOT end of transient
	LIST TTLT trigger list (see SCPI Programming Manual)
TTLT:STATE <char>	Set Trigger Out state (**ON** or **OFF**).
IMP:STATE <char>	Set programmable output impedance state (**ON** or **OFF**). 4801iL only
IMP:REAL <value>	Set the real (resistive) component of output impedance to **value** between 0 and 1 ohm. 4801iL only
IMP:REAC <value>	Set the reactive (inductive) component of output impedance to **value** between 0.00002 and 0.001 Henries. 4801iL only
PON:STATE <char>	Select power-on state command (**RST** or **RCL0**).
RI <char>	Set remote inhibit mode (**LATCHING**, **LIVE** or **OFF**).
DFI <char>	Set discrete fault indicator state (**ON** or **OFF**).
DFI:SOUR <char>	Select DFI source (**QUES**, **OPER**, **ESB**, **RQS** or **OFF**). These status summary bits are explained in chapter 4 of the SCPI Programming Manual.

Table 23 : Output menu list display readouts

Notes:
value = a numeric value
char = a character string parameter
▲ and ▼ scroll through the command list.
↑ and ↓ scroll through the parameter list.

4.4.5 Protection and Status Control Keys

The Protect and Status keys control the protection functions and status registers of the AC source. Refer to chapter 6 of the SCPI Programming manual for more information on the status registers.

Protect — Press this key to access the protection menu list.

Display	Command Function
PROT:CLEAR	Clear the status registers of all activated protection signals. The fault causing a signal must be corrected or removed before the register can be cleared.
CURR:PROT <char>	Set overcurrent protection function (**ON** or **OFF**).
VOLT:PROT <value>	Set the overvoltage protection level.
DELAY <value>	Set the time delay for activating a protection fault after programming the AC source output.

Table 24 : Protection menu list display readouts

Shift Status — Press this key to access the status menu list. Note that in the following list, commands ending in ? clear the registers when they are read. For this reason the registers are read only after you press Enter, not when you scroll to the command.

Display	Command Function
***CLS**	Execute *CLS command
STATUS:PRESET	Execute STATus:PRESet command
***ESR? <value>**	Return Event Status register value
***STB <value>**	Return Status Byte register value
OPER:EVEN? <value>	Return STAT:OPER:EVENT? value
OPER:COND <value>	Return STAT:OPER:COND? value
QUES:EVEN? <value>	Return STAT:QUES:EVENT? value
QUES:COND <value>	Return STAT:QUES:COND? value

Table 25 : Status menu list display readouts

Notes:
value = a numeric value
char = a character string parameter
▲ and ▼ scroll through the command list.
↑ and ↓ scroll through the parameter list.

4.4.6 Trigger and List Control Keys

The Trigger Control key controls output transient triggers. The List key controls the generation of output lists. A list can contain up to 100 points, each of which can specify an output change (or transient). Refer to chapter 4 of the SCPI Programming Manual for more information about programming triggers and lists.

Trigger Control Press this key to access the trigger control list.

Display	Command Function
INIT:IMMED	Initiate the transient trigger sequence immediately.
INIT:CONT <char>	Set continuous trigger initiation (**ON** or **OFF**).
TRIG:SOUR <char>	Select transient trigger source (**BUS**, **EXT**, **TTLT** or **IMM**).
DELAY <value>	Set trigger delay in seconds.
ABORT	Abort all trigger sequences.
SYNC:SOUR <char>	Select trigger sync source (**PHASE** or **IMM**).
SYNC:PHAS <value>	Set synchronous phase reference angle in degrees.

Table 26 : Trigger control list display readouts

Shift List Press this key to access the list commands.

Display	Command Function	Phase selectable
COUNT<value>	Specifies the number of times a list repeats.	no
DWEL:<index> <value>	List of output dwell times.	no
FREQ:<index> <value>	List of output frequencies.	no
FSLW:<index> <value>	List of output frequency slew rates	no
PHASE:<index> <value>	List of output voltage phase angles.	yes
SHAP:<index> <char>	List of output waveform shapes. (**SINE**, **SQUARE** or **CSIN**) **CSIN** = clipped sine wave. User-defined waveshapes will also appear in this list when created.	no
STEP<char>	Response of list to triggers (**ONCE** or **AUTO**).	no
TTLT:<index> <value>	List of Trigger Out pulses (0=no pulse; 1=pulse).	no
VOLT:<index> <value>	List of AC output voltages.	yes
VSLW:<index> <value>	List of output voltage slew rates.	yes

Table 27 : List command display readouts

Notes:
value = a numeric value
char = a character string parameter
index = a numeric value that represents a list point from 0 to 99
▲ and ▼ scroll through the command list.
↑ and ↓ scroll through the parameter list.
▲ Index and ▼ Index scroll through the desired list points. **EOL** is displayed when the end of the list is reached. When a value is edited, pressing Enter automatically advances to the next list point.

4.5 Entry Keys

Refer to the examples later in this chapter for more details on the use of these keys.

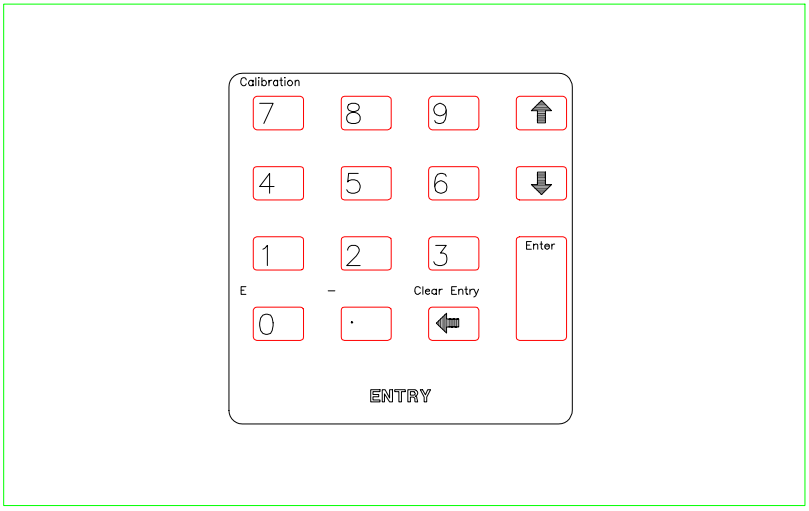


Figure 13 Entry Keys

↑ and ↓	These keys let you scroll through choices in a parameter list that applies to a specific command. Parameter lists are circular; you can return to the starting position by continuously pressing either key. If the command has a numeric range, these keys increment or decrement the existing value.
0 - 9	0 through 9 are used for entering numeric values.
.	. is the decimal point. For example, to enter 33.6 press: 3 3 . 6.
←	The backspace key deletes the last digit entered from the keypad. This key lets you correct one or more wrong digits before they are entered.
Enter	This key executes the entered value or parameter of the presently accessed command. Until you press this key, the parameters you enter with the other Entry keys are displayed but not entered into the AC source. Before pressing Enter, you can change or abort anything previously entered into the display. After Enter is pressed, the AC source returns to Meter mode in most cases. In Harmonic or List mode, the AC source displays the next point in the list.

Shift E	This key specifies an exponential power of 10. For example, the value for 100µs can be entered either as . 0 0 0 1 or as 1 E - 4.
Shift -	This key is the minus sign.
Shift Clear Entry	This key aborts a keypad entry by clearing the value. This key is convenient for correcting a wrong value or aborting a value entry. The display then returns to the previously set function. When editing a list, pressing Clear Entry truncates or clears the list at the presently displayed list point.
Shift Calibration	This key accesses the calibration menu. Refer to chapter 6 to calibrate your AC source.

4.6 Examples of Front Panel Programming

You will find these examples on the following pages:

Setting the output voltage amplitude
Setting the output frequency
Setting the overcurrent protection feature
Measuring peak inrush current
Generating step, pulse, and list transients
Programming trigger delays and phase synchronization
Programming slew rates
Saving and recalling operating states
Setting the IEEE-488 address or RS-232C parameters

The examples in the AC source SCPI Programming Manual are similar to the ones in this section, except that they use the SCPI commands.

4.6.1 Setting the Output Voltage Amplitude

The maximum voltage that the AC source can deliver is limited by the peak value of the waveform, which is 425 Vpeak. Since the output is programmed in units of rms volts, the maximum value that can be programmed is dependent on the peak-to-rms ratio of the selected waveform. For a sine wave, the maximum AC voltage that can be programmed is 300 V. For other waveforms the maximum may be different.

Procedure for Single-Phase mode
When you turn on the AC source, the default output shape is a 60-Hz sinewave at 0 V rms. There is no output from the AC source because the default output state is OFF (as indicated by the **Dis** annunciator, which will be on). Set the output to 120 V rms as follows:

Step	Action	Display
1.	On the Function keypad, press Voltage.	**VOLT 0**
2.	You can set the voltage in any of three ways:	
	On the Entry keypad, press 1 2 0 Enter. This is the easiest way to enter an accurate value.	**VOLT 120**
	On the Entry keypad, press 1 1 7 Enter. Then, press to scroll from 117 V up to 120 V. This technique is useful when you are making minor changes to an existing parameter value.	**VOLT 117**
	Rotate the panel Voltage knob to obtain 120 V. This method is best when you want to enter an approximate value without using the voltage menu.	**120 V 60 HZ**
3.	On the Function keypad, press Output On/Off to enable the output. The **Dis** annunciator will go off, indicating that the voltage is now applied to the output terminals.	**120 V 60 HZ**

Table 28 : Setting the output voltage amplitude

Procedure for Three-Phase Mode

If the AC source is in three-phase mode, you can set the rms voltage of all three phases identically, or set each one differently. This is controlled via the Phase Select Menu on the Function keypad.

The example on the following page shows how you can set the phase 1 output to 120 Vrms, phase 2 to 180 Vrms, and phase 3 to 235 Vrms.

Step	Action	Display
1.	On the Function keypad, press Voltage. Note that in the power-on default state, the **Ø1**, **Ø2**, and **Ø3** annunciators are all lit, indicating that any commands sent to the instrument will be sent to all three phases.	**VOLT 0**
2.	Scroll through the phase selections by pressing Phase Select. Pressing Phase Select moves you through phases 1, 2 and 3, as indicated by the phase annunciators. Pressing it once more returns you to the first state with all three phase annunciators on.	**VOLT 0**
3.	While in the Voltage menu, press Phase Select to access Phase 1. On the Entry pad, press 1 2 0 Enter.	**VOLT 120**
4.	Access the Voltage menu again and press Phase Select once to access Phase 2. On the Entry pad, press 1 8 0 Enter.	**VOLT 180**
5.	Access the Voltage menu again and press Phase Select once to access Phase 3. On the Entry pad, press 2 3 5 Enter.	**VOLT 235**
6.	Press Output On/Off to enable the output. The **Dis** annunciator will go off, indicating that the voltages are now applied to the output terminals.	**235 V 60 HZ**
To verify the output, you can measure it as follows:		
7.	Note that the **Ø3** annunciator is on, indicating that you are monitoring the last phase you selected, which was Phase 3.	**235 V 60 HZ**
8.	Press Phase Select once. The **Ø1** annunciator will light, indicating that you are now monitoring phase 1.	**120 V 60 HZ**

Step	Action	Display
9.	Press Phase Select once. The **Ø2** annunciator will light, indicating that you are now monitoring phase 2.	**180 V 60 HZ**
10.	Press Phase Select once. The **Ø3** annunciator will light, indicating that you have returned to monitoring phase 3.	**235 V 60 HZ**

Table 29 : Setting individuals output phases in three phase mode

Note: The Meter menu does not go to the all-phases state present in the Phase Select menu because the front panel can display only one phase at a time. Refer to the AC source SCPI Programming Manual on how to return simultaneous measurements from all three phases.

4.6.2 Setting the Output Frequency

When you turn on the AC source, the default output frequency is 60 Hz. Assuming the voltage output from example 1 is in effect (120 Vrms sinewave), change the frequency to 50 Hz as follows:

Step	Action	Display
1.	On the Function keypad, press Freq.	**FREQ 60**
2.	You can set the frequency in either of two ways:	
	On the Entry keypad, press 5 0 Enter.	**FREQ 50**
	Rotate the panel Frequency knob to obtain 50 Hz.	**120 V 50 HZ**
To verify the output, you can measure it as follows:		
3.	In single phase mode, the **Ø1** annunciator is lit. In three-phase mode, the phase annunciator of the last selected phase will be lit. The Meter menu is presently displaying the measured voltage and frequency of the selected output phase.	**120 V 50 HZ**

Table 30 : Setting the output frequency

Note: You can scroll through the measurement functions in the Meter Menu by pressing ▲ and ▼.

4.6.3 Setting a Protection Feature

You can set the AC source to disable its output if it detects an overvoltage or overcurrent fault condition. Other automatic fault conditions (such as overtemperature) also will disable the output. Set the overcurrent protection feature as follows:

Step	Action	Display
1.	On the Function keypad, press Protect.	**PROT:CLEAR**
2.	Press ▼ to obtain the overcurrent command.	**CURR:PROT OFF**

Step	Action	Display
3	On the Entry keypad, press ↑ once to scroll to the **ON** parameter and press Enter. The **OCP** annunciator will light, indicating that the overcurrent protection circuit is on	**CURR:PROT ON**
	If you wish to set a time delay between the detection of the fault and the disabling of the output, scroll to the delay command on the protection menu. The default delay is 100 milliseconds	**DELAY .1**
	Enter the delay from the Entry keypad, such as . 2 5 0 Enter.	**DELAY .250**
4.	When you want to restore normal operation after the cause of the overcurrent condition has been removed, scroll to the protection clear command and press Enter. The **OCP** annunciator then will go off	**PROT:CLEAR**

Table 31 : Setting protection parameters

4.6.4 Using Transient Voltage Modes

The voltage can be programmed in the following transient operating modes:

STEP	causes the output to permanently change to its triggered value.
PULSE	causes the output to change to its triggered value for a specific time, as determined by the Pulse menu parameters.
LIST	causes the output to sequence through a number of values, as determined by points entered in the List menu.
FIXED	disables transient operation for the selected function.

4.6.5 Step Transient

The Voltage Menu lets you specify an alternate or triggered voltage level that the AC source will apply to the output when it receives a trigger. Because the default transient voltage level is zero volts, you must first enter a triggered voltage before you can trigger the AC source to change the output amplitude. Refer to chapter 4 of the SCPI Programming Manual for more information about programming triggers.

In the following example, the voltage output is set to 120 Vrms and then stepped down to 102 Vrms.

Step	Action	Display
1.	On the Function keypad, press Output On/Off to enable the output. The **Dis** annunciator will go off.	**0 V 60 HZ**
2.	Press Voltage to access the Voltage menu. On the Entry keypad, press 1 2 0 Enter.	**VOLT 120**
3.	Access the Voltage Menu again and press ▼ to access the triggered voltage command.	**VOLT:T 0**
4.	On the Entry keypad, press 1 0 2 Enter.	**VOLT:T 102**
5.	Access the Voltage Menu again and press ▼ to access the voltage mode command. It should be in the default FIXED mode. An AC source function in the FIXED mode does not respond to triggers.	
6.	On the Entry keypad, press ↑ or ↓ to scroll through the	**VOLT:M**

Step	Action	Display
	mode parameters. When you have **STEP**, press Enter.	
7.	Press Trigger Control and Enter. This initiates (or enables) one immediate trigger action.	**INIT:IMMED**
8.	Press Shift Trigger Control. This sends the AC source an immediate trigger signal to change the output voltage. The triggered voltage value now becomes the **VOLT** value.	**102 V 60 HZ**

Table 32 : Programming a Voltage Step transient

On three-phase AC sources the voltage steps are phase selectable. You can output a different voltage step for each phase. To do this, use Phase Select to first choose the desired phase, as previously described in example 1 for setting the immediate output voltage.

4.6.6 Pulse Transients

In the following example, the output is programmed to generate four 5.5 millisecond, 120 Vrms pulses at 60 Hz. Figure 14 shows the trigger, pulse count, pulse period, and duty cycle.

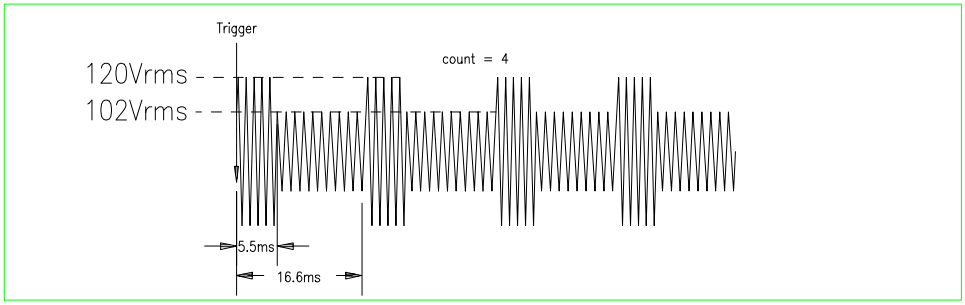


Figure 14 Pulse Transients

From the Output Menu execute the *RST command to reset the AC source. This is necessary because any previously programmed functions remain in effect until cleared.

Step	Action	Display
1.	Press Voltage to access the Voltage menu.	**VOLT 102**
2.	Press ▼ to access the triggered voltage command. On the Entry keypad, press 1 2 0 Enter.	**VOLT:T 120**
3.	Access the Voltage menu again and press ▼ to access the voltage mode command. On the Entry keypad, press ↑ or ↓ to scroll through the mode parameters to obtain **PULSE** and press Enter.	**VOLT:M PULSE**
4.	Press Pulse to access the Pulse menu. The second menu command is the pulse count. On the Entry pad, press 4 Enter.	**COUNT 4**
5.	Access the Pulse menu and press ▼ to access the duty cycle command. From the Entry keypad press 3 3 Enter	**DCYCLE 33**

Step	Action	Display
	to change the duty cycle to 33 %.	
6.	Access the Pulse menu and press ▼ to access the pulse period command. From the Entry keypad press .0 1 6 6 Enter to enter the period for 60 Hz (approximately 16.6 ms).	**PER .0166**
7.	Press Trigger Control and Enter to initiate the transient trigger sequence.	**INIT:IMMED**
8.	Press Shift Trigger Control. This sends the AC source an immediate trigger signal to generate the four output pulses.	**102 V 60 HZ**

Table 33 : Programming a Voltage Pulse transient

Note: The AC source output returns to 102 V at the completion of the output pulses.

In three-phase mode, the voltage pulses are phase selectable. You can output a different voltage pulse for each phase. To do this, use Phase Select to first choose the desired phase, as previously described in example 1 for setting the immediate output voltage.

4.6.7 List Transient

Lists are the most flexible means of generating multiple or synchronized transient outputs. The following figure shows a voltage output generated from a list. The output shown represents three different AC voltage pulses (160 volts for 33 milliseconds, 120 volts for 83 milliseconds, and 80 volts for 150 milliseconds) separated by 67-millisecond, 0-volt intervals.

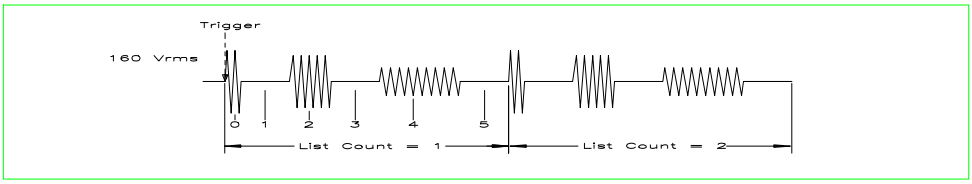


Figure 15 List Transients

The list specifies the pulses as three voltage points (point 0, 2, and 4), each with its corresponding dwell point. The intervals are three zero-voltage points (point 1, 3, and 5) of equal intervals. The count parameter causes the list to execute twice when started by a single trigger.

Note: From the Output Menu execute the *RST command to reset the AC source. This is necessary because any previously programmed functions remain in effect until cleared.

Step	Action	Display
1.	Press Voltage to access the Voltage Menu. Then press ▼ to access the voltage mode command.	**VOLT:M FIXED**

Step	Action	Display
2.	On the Entry keypad, press ↑ or ↓ to scroll through the mode parameters to obtain **LIST** and press Enter.	**VOLT:M LIST**
3.	Access the List menu (by pressing Shift List). The first menu command is the list count. From the Entry keypad, change the list count from the default (1) to 2.	**COUNT 2**
4.	Access the List menu again and press ▼ to access the dwell time list. This specifies the "on" time for each voltage point, which is effectively the output pulse width. The first dwell point (0) appears in the display. From the Entry keypad, enter .033 as the value for dwell point 0.	**DWEL 0 033**
5.	On the Entry keypad, press Shift▲Index to scroll to the next dwell point and enter .067 as the value for point 1. Note that dwell points 1, 3, and 5 specify the zero-voltage time intervals, and are all set to zero	**DWEL 1 .067**
6.	Repeat step 5 for the remaining dwell points. Enter .083 for point 2 and .150 for point 4. Enter .067 for points 3 and 5. When you finish, you will be at point 5.	**DWEL 5 .067**
7.	Press ▼ until you access the step command. Leave it at the default mode (AUTO). This lets a single trigger run your list for the specified count.	**STEP AUTO**
8.	Press ▲ until you access the voltage list. This specifies the amplitude of each output point during its corresponding dwell period. The first voltage list point (0) appears in the display. From the Entry keypad, enter 160 as the value for voltage point 0.	**VOLT 0 160**
9.	On the Entry keypad, press Shift ▲Index to scroll to the next voltage point. Since V1 is zero, just press Enter to accept the default. Note that voltage points 1, 3, and 5 are all zero.	**VOLT 1 0**
10.	Repeat step 9 for the remaining voltage points. Enter 120 for point 2 and 80 for point 3. When you finish, you will be at point 5 (which is set to 0 volts).	**VOLT 5 0**
11.	Press Trigger Control and Enter to initiate the immediate trigger.	**INIT:IMMED**
12.	Press Shift Trigger Control. This sends the AC source an immediate trigger signal to generate the voltage list.	

Table 34 : Programming Transient Lists

Note: The AC source output returns to the immediate programmed values at the completion of the list.

In three phase mode, the voltage lists are phase selectable. You can set up a different voltage list for each phase. To do this, use Phase Select to first choose the desired phase, as previously described in example 1 for setting the immediate output voltage.

4.7 Trigger Delays and Phase Synchronization

The AC source trigger system also lets you program trigger delays as well as synchronize output changes to a specific phase angle of the output waveform.

In example ①, the output transient is triggered immediately at the receipt of the trigger signal. In example ②, a delay time of approximately 16.7 milliseconds elapses between the occurrence of the trigger and the start of the output transient. In example ③, the trigger source is programmed for phase synchronization, which means that the transient occurs at the first occurrence of the specified phase angle after the trigger signal is received. Example ④ describes phase synchronization on three-phase sources.

Note that phase synchronization is referenced to an internal phase signal. The output of the unit is normally offset by 0º with respect to this internal reference. Because synchronized transient events always occur with respect to the internal reference, the output will normally be in phase with the value programmed for phase synchronization. (The Phase command can be used to change the offset of the output with respect to the internal phase reference.)

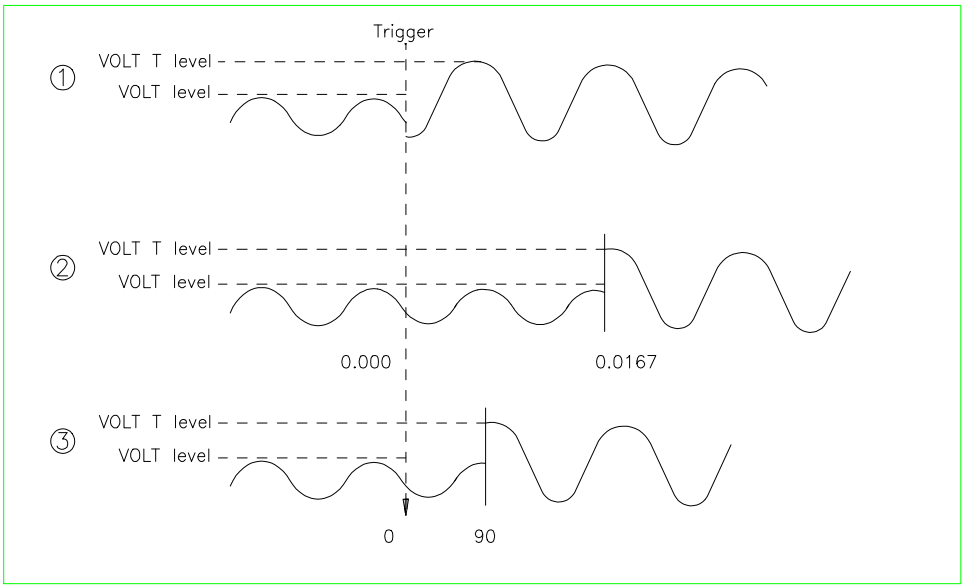


Figure 16 Trigger Delays and Phase Synchronization

① This example uses the default trigger parameters.

Step	Action	Display
1.	First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode	**VOLT 120** **VOLT:T 150** **VOLT:M STEP**
2.	Then press Trigger Control Enter followed by Shift Trigger.	**INIT:IMMED**

② In this example, you will set a trigger delay.

Step	Action	Display
1.	First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode.	**VOLT 120** **VOLT:T 150** **VOLT:M STEP**
2.	Press Trigger Control. Then press ▼ until you access the delay parameter. On the Entry keypad, press . 0 1 6 7 Enter.	**DELAY 0** **DELAY .0167**
3.	Then press Trigger Control Enter followed by Shift Trigger.	**INIT:IMMED**

③ This example uses the phase sync mode with no delay, but synchronized at 90º.

Step	Action	Display
1.	First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode.	**VOLT 120** **VOLT:T 150** **VOLT:M STEP**
2.	Press Trigger Control. Press ▼ until you access the delay parameter. If necessary, set it to 0. Press ▼ until you access the sync source command. On the Entry keypad, press ↓ to obtain PHASE. Press Enter.	**DELAY 0** **SYNC:SOUR** **PHASE**
3.	Access the Trigger Control menu again and press ▼ to access the sync phase reference parameter. On the Entry keypad, program a 90º phase reference by entering 9 0 Enter.	**SYNC:PHAS 90**
4.	Then press Trigger Control Enter followed by Shift Trigger.	**INIT:IMMED**

Note: In three-phase mode, phase 1 is normally offset by 0º from the internal phase reference while phase 2 and phase 3 are offset by 240º and 120º respectively. Therefore, synchronized transient events will occur at the phase angle programmed for the phase 1 output, but at different phase angles on the phase 2 and phase 3 outputs.

This is illustrated in the following figure, where the transient occurs at the 90º angle programmed for the phase 1 output, but at 330º and 210º for the phase 2 and 3 outputs, because of the default offsets for these outputs.

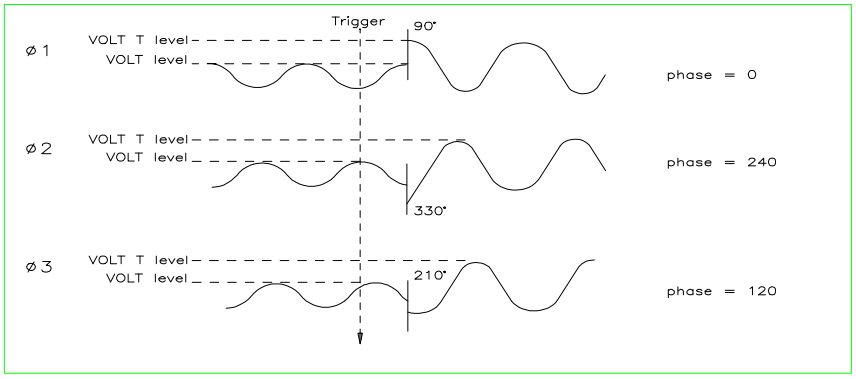


Figure 17 Phase Synchronization on Three Phase Sources

④ This example synchronizes a change at 90º on phase 1.

Step	Action	Display
1.	First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode.	**VOLT 120** **VOLT:T 150** **VOLT:M STEP**
2.	Check that the **Ø1**, **Ø2**, and **Ø3** annunciators are all lit, indicating that commands will be sent to all three phases. If not, press Phase Select until all three annunciators are lit.	
3.	Press Trigger Control and ▼ to access the sync source command. On the Entry keypad, press ↓ once to obtain **PHASE**. Press Enter.	**SYNC:SOUR** **PHASE**
4.	Access the Trigger Control menu again and press ▼ to access the sync phase reference parameter. From the Entry keypad, program a 90º synchronous phase angle by entering 9 0 Enter	**SYNC:PHAS 90**
5	Then press Trigger Control Enter followed by Shift Trigger.	**INIT:IMMED**

4.8 Programming Slew Rates

As shown in the previous examples there are a number of ways that you can generate custom waveforms. Programmable slew rates provide additional flexibility when customizing waveforms. The following figure illustrates how programmable slew rates are applied in the transient operating modes.

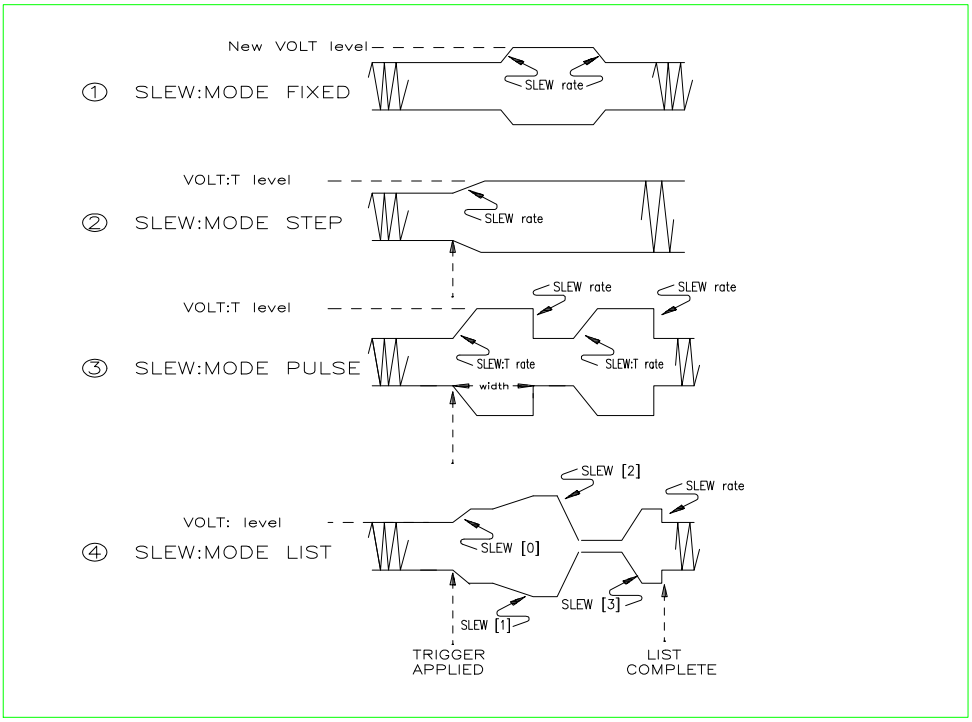


Figure 18 Programming Slew Rates

In example ①, an immediate slew rate of 50 volts/second is used whenever a new output voltage is programmed. In example ②, a triggered slew rate of 50 volts/second steps the voltage level to its new value. 50 volts/second becomes the new immediate slew rate in step mode. In example ③, a triggered slew rate of 50 volts/second is used at the start of the pulse. The immediate slew rate of infinity applies at the trailing edge of the pulse. In example ④, the slew rates are set by the values in the voltage slew list.

① This example uses the immediate slew rate.

Step	Action	Display
1.	First, access the Voltage menu and press ▼ until you access the mode command. On the Entry keypad, press ↓ to obtain FIXED. Press Enter.	**VOLT:M FIXED**
2.	Access the voltage menu and press ▼ until you access the slew command. On the Entry keypad, press 5 0 Enter to program a slew rate of 50 volts/second.	**SLEW 50**

Whenever a new immediate voltage value is entered, the output will slew to the new level at 50 volts/second.

② Step mode uses the triggered slew rate.

Step	Action	Display
1.	First, access the Voltage menu, program the immediate and triggered voltage levels, and set the slew mode to STEP.	**VOLT 120** **VOLT:T 150** **SLEW:M STEP**
2.	Access the Voltage menu and press ▼ to access the immediate slew command. On the Entry keypad, enter a value that equals infinity.	**SLEW: 9.9E+37**
3.	Access the Voltage menu and press ▼ until you access the triggered slew command. On the Entry keypad, enter a value such as 5 0 Enter, which sets the triggered slew rate to 50 volts/second.	**SLEW:T 50**
4.	Then press Trigger Control Enter followed by Shift Trigger.	**INIT:IMMED**

After the trigger has been sent, in step mode, the triggered value becomes the new immediate value.

③ Pulse mode uses the triggered slew rate at the leading edge of the pulse, and the immediate slew rate at the trailing edge of the pulse.

Step	Action	Display
1.	First, access the Voltage menu, program the immediate and triggered voltage levels, and set the slew mode to PULSE.	**VOLT 120** **VOLT:T 150** **SLEW:M PULSE**
2.	Access the Pulse menu and program the pulse count, duty cycle, and pulse period.	**COUNT 2** **DCYCLE 33** **PER .0166**
3.	Access the Voltage menu and press ▼ to access the immediate slew command. On the Entry keypad, enter a value that equals infinity.	**SLEW: 9.9E+37**
4.	Access the Voltage menu and press ▼ until you access the triggered slew command. On the Entry keypad, enter a value such as 5 0 Enter, which sets the triggered slew rate to 50 volts/second.	**SLEW:T 50**
5.	Then press Trigger Control Enter followed by Shift	**INIT:IMMED**

Step	Action	Display
	Trigger.	

④ When the voltage slew mode is set to LIST, the slew rates are set by the values in the voltage slew list. Refer to the List Transient example for more information on how to program lists. You must program the voltage values and dwell times as explained in that example. You must also program a slew rate for each point in the list (even if it is 9.9E+37).

Note: When specifying a dwell time, you must take the slew time into consideration. If the dwell time at any given list point is less than the slew time at the same point, the voltage will never reach its programmed level before the next list point becomes active.

4.9 Measuring Peak Inrush Current

Peak inrush current is a non-repetitive measurement in the sense that peak inrush current occurs only when the unit under test is first turned on. In order to repeat the measurement, you must turn the unit off and wait for any input filter capacitors to discharge completely.

This example shows you how you can measure the peak inrush current using the front panel meter. The voltage is set to 120 V rms and the output is triggered at an output phase of 75º, which optimizes the conditions under which inrush current is applied to the unit under test.

Step	Action	Display
1.	Set the immediate voltage to 0. Press Voltage, then press 0 and Enter.	**VOLT 0**
2.	Set the triggered voltage to 120 V rms. In the Voltage menu, press ▼ to access the triggered voltage command. Then press 1 2 0 Enter.	**VOLT:T 120**
3.	Set the voltage mode to step. In the Voltage menu, press ▼ to access the mode command. Press ↓ to scroll to STEP and press Enter.	**VOLT:M STEP**
4.	Make sure the unit is operating in the low voltage range. (The low voltage range has twice the output current rating of the high range.) In the Voltage menu, press ▼ to access the range command. If necessary, press ↓ to set the range to 150 and press Enter.	**RANGE 150**
5.	Make sure the triggered voltage slew rate is set to the fastest possible speed. In the Voltage menu, access the triggered slew command. If necessary, reset the slew rate to a faster speed.	**SLEW:T 9.9E+37**

6.	Make sure the rms current limit is set to a high value. In the Current menu, access the current level command. If necessary, reset the current limit to a higher value. (The CI 3000iL has a low-range current limit of 6.67 A in three phase mode, 20 A in single phase mode; the CI 4500iL has a low-range current limit of 10 A in three phase mode, 30 A in single phase mode.)	**CURR:LEV 10**
7.	Synchronize the trigger source with a reference phase angle. In the Trigger Control menu, press ▼ to access the sync source command. Press ↓ to obtain PHASE and press Enter.	**SYNC:SOUR PHASE**
8.	Set the reference phase angle to 75º. In the Trigger Control menu, press ▼ to access the sync phase command. Then press 7 5 Enter.	**SYNC:PHAS 75**
9.	Initiate (or enable) the unit for one immediate trigger from the front panel. Press Trigger Control and Enter.	**INIT:IMMED**
10.	Set the meter function to measure nonrepetitive peak inrush current. In the Meter menu, press ▼ to access the peak inrush current display.	**0 A PK NR**
11.	Enable the output by pressing Output On/Off.	**0 V 60 HZ**
12.	Send the trigger to step the output from 0 V to 120 V. Press Shift Trigger Control. The inrush current is displayed on the Meter.	**48 A PK NR**

Note: In three-phase mode, you can only return the peak inrush current from the selected phase, because the front panel can display only one phase at time. Refer to the AC source SCPI Programming Manual on how to return simultaneous measurements from all three phases.

4.10 Setting the IEEE-488 Address and RS-232C Parameters

Your AC source is shipped with the IEEE-488 address set to 5. This address can only be changed from the front panel using the Address menu located under the Address key. This menu is also used to select the RS-232C interface and specify RS-232C parameters such baud rate and parity. Set the IEEE-488 address as follows:

Step	Action	Display
1.	On the System keypad, press Address.	**ADDRESS 5**
2.	Enter the new address from the Entry keypad, such as 7 Enter.	**ADDRESS 7**

To configure the RS-232C interface, proceed as follows:

Step	Action	Display
1.	On the System keypad, press Address.	**ADDRESS 5**
2.	You can scroll through the Address menu by pressing ▼. The interface command lets you select	**INTF RS232** **BAUDRATE 600**

Step	Action	Display
	the RS-232C interface. The baudrate command lets you select the baudrate. The parity command lets you select the parity	**PARITY EVEN**
3.	Use the ↑ and ↓ keys to select your interface, baudrate, or parity	

4.11 Saving and Recalling Operating States

You can save up to 16 states (from location 0 to location 15) in nonvolatile memory and recall them from the front panel. All programmable settings are saved. To save an operating state in location 1, proceed as follows:

Step	Action	Display
1.	Set the instrument to the operating state that you want to save.	
2.	Save this state to location 1 by pressing SAVE 1 and ENTER.	***SAV 1**

To recall a saved state, proceed as follows:

Step	Action	Display
1.	Recall the state saved in location 1 by pressing Recall 1 and Enter.	***RCL 1**

To select the power-on state of the AC source, proceed as follows:

Step	Action	Display
1.	On the Function keypad, press Output, and scroll through the Output menu until you get to the PON state command.	**PON:STATE RST**
2.	Use the ↑ and ↓ keys to select either **RST** or **RCL0**. RST sets the power-on state of the unit as defined by the *RST command. RCL0 sets the power-on state of the unit to the state saved in *RCL location 0.	

5. Specifications

Table 35 lists the specifications of the AC source. Specifications are warranted over the ambient temperature range of 0 to 40 ºC. Unless otherwise noted, specifications are per phase for a sinewave with a resistive load at an output frequency range of 45 Hz to 1000 Hz and apply after a 30-minute warm-up period.

5.1 Performance Specifications

Parameter	CI 3000iL		CI 4500iL		CI 4801iL
Phases mode:	1	3	1	3	1
Output Ratings					
Power per phase:	3000 VA	1000 VA	4500 VA	1500 VA	4800 VA
Voltage Ranges (rms):	0-150 V 0-300 V	0-150 V 0-300 V	0-150 V 0-300 V	0-150 V 0-300 V	0-150 V 0-300 V
Maximum rms Current per phase:					
low range high range	20 A 10 A	6.7 A 3.3 A	30 A 15 A	10 A 5 A	32 A 16 A
Maximum Repetitive Current per phase:					
low range high range	120 A 60 A	40 A 20 A	120 A 60 A	40 A 20 A	96 A 48 A
Crest Factor (Current):	6.0		4.0		3.0
Output Frequency Range:	45 Hz - 5 kHz				45 Hz - 1 kHz
Constant Voltage Ripple and Noise:	-60 dB (20 kHz-10 MHz)				
Load Regulation:	0.5 %				
Line Regulation:	0.1 %				0.3 %
Maximum Total Harmonic Distortion:	1 % (45 Hz - 1 kHz) 1% + 1%/kHz (>1 kHz - 5 kHz)				1 % (45Hz - 1kHz)
Programming Accuracy (@ 25ºC ±5ºC)					
Voltage (rms)	0.15% + 0.3 V (45-100 Hz) 0.5% + 0.3 V (>100-500 Hz) 1% + 0.3 V (>500-5 kHz)				
Frequency:	0.01% + 0.01 Hz				
Phase:	0.1º (45-100 Hz) 1º (>100-1000 Hz) 1º + 1º/kHz (>1 kHz - 5 kHz)				
Measurement Accuracy (@ 25ºC ±5ºC) Phases:	1		3		1
rms Voltage:	0.05% + 250 mV		0.05% + 250 mV		0.05% + 250 mV
rms Current:	0.1% + 50 mA		0.1% + 25 mA		0.1% + 150mA
Frequency:	0.01% + 0.01 Hz		0.01% + 0.01 Hz		0.01% + 0.01 Hz
Power (VA):	0.15% + 5 VA		0.15% + 3 VA		0.15% + 9 VA
Power (Watts):	0.15% + 5 W		0.15% + 3 W		0.15% + 9 W
Power Factor:	0.01		0.01		0.01
AC Input Voltage Range (Vac):	180-254 Vac (3Ø) 360-440 Vac (3Ø)		180-254 Vac (3Ø) 360-440 Vac (3Ø)		180-254 Vac (3Ø) 360-440 Vac (3Ø)
AC Input Frequency:	47 - 63 Hz				

Table 35 : iL Series performance specifications

5.2 IEC Measurement Specifications

(4801iL only)*

Parameter	Range	Accuracy (±)	
Frequency	50 / 60 Hz		
Current (Low range)			
Fundamental	0 - 3.2 A	0.03 % + 3 mA	
Harmonics 2 - 49		0.03 % + 2 mA + 0.2%/KHz	
Current (High range)			
Fundamental	0 - 32 A	0.05 % + 6 mA	
Harmonics 2 - 49		0.05 % + 3 mA + 0.2%/KHz	
Flicker	Compliant with IEC 868		
Flicker perceptibility	Compliant with IEC 868		
Reference Impedance		3 % (at 0.4 Ω and 796 μH)	
Synchronization		< 1 ppm	
Current shunt burden		0 Volts	
Current harmonic smoothing filter		1.5 sec	
Pst Integration time		1, 5, 10 or 15 min	
	Sample rate	**Window width**	**Acq. overlap**
50 Hz Operation			
Rectangular measurement window	12.8 Khz	16 cycles	None
Hanning measurement window	8.533 Khz	24 cycles	50 %
60 Hz Operation			
Rectangular measurement window	15.360 KHz	16 cycles	None
Hanning measurement window	7.680 KHz	32 cycles	50 %

* Specifications are in % of reading for 4801iL sinewave output with resistive load at output frequency of 50 or 60 Hz in IEC mode of operation.

Table 36 : IEC Measurement Specifications

5.3 Typical Specifications

Typical specifications as listed in Table 37 are not warranted but are descriptions of typical performance determined either by design or type testing.

Parameter	CI 3000iL	CI 4500iL	CI 4801iL
Input Ratings			
Maximum Input Current (rms):			
180 -254 Vac (3Ø) 360-440 Vac (3Ø)	18 A 10 A	25 A 15 A	
Maximum Input Power:	5800 VA/4100 W	8900 VA/5900 W	
Output Isolation Voltage:	300 V rms		
Average Programming Accuracy:			
rms current	0.2% + 40 mA 3Ø 0.2% + 80 mA 1Ø		0.2% + 80 mA
Average Programming Resolution			
rms Voltage:	80 mV		
Overvoltage Programming (OVP):	2 V		
rms Current:	2.5 mA 3Ø 7.5 mA 1Ø	2.5 mA 3Ø 7.5 mA 1Ø	7.5 mA
Output Frequency:	0.001 Hz		
Phase:	0.001º		
Average Measurement Resolution			
rms Voltage:	10 mV		
rms Current:	6 mA 3Ø 5 mA 1Ø		1.2 mA
Time values			
List Dwell Time:	0 - 1.08 X 10^6 s		0 - 4.30 X 10^5 s
Triggering Accuracy With Respect to Phase Synchronization:	250 µs		100 µs
Trigger In Response Time:	400 µs		200 µs
Minimum Resolution for Dropout:	500 µs		
Output Response Time: (output change from 10% to 90% or 90% to 10% of its total excursion with full resistive load)	50 µs		
Remote Inhibit Response Time:	<1 ms		
Harmonic Measurement Time:	1 harmonic ≤ 100 ms; all 50 harmonics ≤ 2 s		
Miscellaneous			
Recommended Calibration Interval:	1 year		
Remote Sense Capability:	Up to 10 Vrms can be dropped across each load lead.		
Waveform Table Horizontal Resolution:	1024 points		
Trigger In / Out characteristics			
Trig Out (HC TTL output):	V_{ol} 0.8 V max. @ 1.25 mA V_{oh} 3.3 V max. @ 1.25 mA		
Trig In (10 kΩ pullup):	V_{il} 0.8 V max. V_{ih} 2 V min.		
INH/FLT Characteristics			
Maximum ratings:	16.5 VDC between INH terminals; FLT terminals; and from INH terminals to chassis ground		
INH terminals: FLT terminals	I_{ol} 1.25 mA max. V_{ol} 0.5 V max. V_{il} 0.8 V max. V_{ih} 2 V min. tw 100 µs min. td 4 ms typical		
Saveable Data (nonvolatile)			
Instrument States:	16 (0 to 15)		

Parameter	CI 3000iL	CI 4500iL	CI 4801iL
User-defined waveforms:	12 (with 1024 data points in each)		
List Data:	1 to 100 points (for each list function)		
IEEE-488 Interface Capabilities			
Language:	SCPI (Standard Commands for Programmable Instruments); Elgar 9012 PIP		
Interface:	AH1, C0, DC1, DT1, E1, LE4, PP0, RL1, SH1, SR1, TE6		
RS-232C Interface Capabilities			
Baud rates:	300, 600, 1200, 2400, 4800, 9600		
Data formats:	7 bits even or odd parity; 8 bits without parity		
Language:	SCPI (Standard Commands for Programmable Instruments)		
Regulatory Compliance			
Listing Pending:	UL 1244		
Certified to:	CSA 22.2 No. 231		
Conforms to:	IEC 1010		
RFI Suppression			
Complies with:	CISPR 11, Group 1, Class A		
Dimensions			
Height:	262.6 mm (10.3 in.) add 12.7 mm (0.5 in.) for feet		
Width:	425.5 mm (16.75 in.)		
Depth:	602 mm (23.7 in.)		
Net weight:	87.7 kg (193 lbs.)		
Shipping weight:	104 kg (230 lbs.)		

Table 37 : iL Series typical specifications

6. Calibration and performance verification

.

IMPORTANT ***Perform the verification procedures before calibrating your AC source. If the AC source passes the verification procedures, the unit is operating within its calibration limits and does not need to be recalibrated.***

WARNING: LETHAL VOLTAGES AC sources can supply 424 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment.

6.1 Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for verification and calibration.

Equipment Required	Description
Digital Voltmeter:	Resolution: 10 nV @ 1 V Readout: 8.5 digits Accuracy: <20 ppm Example: HP 3458A
Current Monitor:	The 4- terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals. 0.01Ω , 200 ppm, 10 W Guildline 7320/0.01
Load Resistor:	15Ω , 1.5 kW min (3000iL & 4500iL), 4.7Ω , 4.8 kW min (4801iL).
Impedance Resistor:	1Ω , 100 W min (4801iL only).
Ratio transformer:	A ratio transformer is required only when verifying output voltage readback to MIL-STD-45662A 4:1 test equipment ratio requirements. 30:1 ratio, <50ppm
IEEE-488 Controller:	PC with National Instruments IEEE-488 controller card

Table 38 : Required Calibration equipment

Figure 19 shows the setup for the tests. Be certain to use load leads of sufficient wire gauge to carry the full output current (see section 2.7.2).

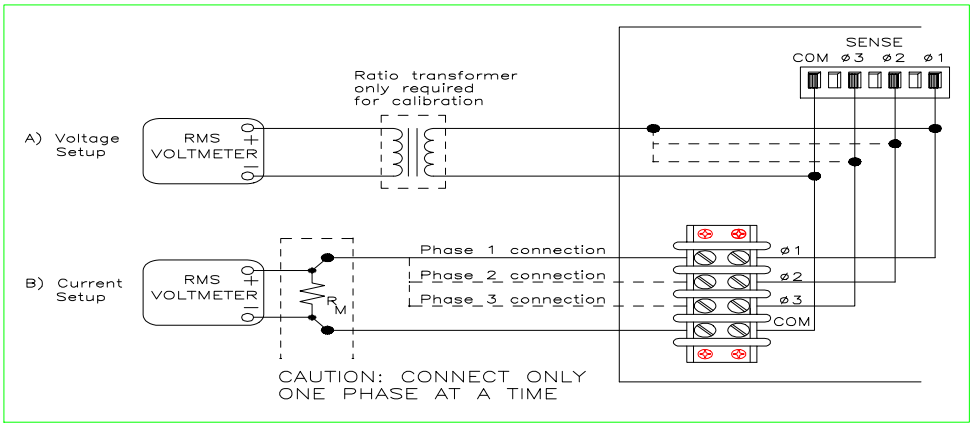


Figure 19 Verification and Calibration Test Setup

Note: Connect and program each phase individually. Never connect more than one phase at a time.

Note: When performing the verification tests from an IEEE-488 controller, you may have to consider the relatively slow settling times and slew rates of the AC source as compared to computer and system voltmeters. Suitable WAIT statements can be inserted into the test program to give the AC source time to respond to the test commands.

6.2 Operation Verification

Perform the following tests for operation verification in the order indicated.

1. Turn-On Checkout
2. Voltage Programming and Readback Accuracy
3. Current Readback Accuracy

6.2.1 Turn-On Checkout

Perform the Turn-On Checkout as directed in section 3. The AC source must pass turn-on selftest before you can proceed with the other verification tests.

6.2.2 Voltage Programming and Readback Accuracy

This test verifies the voltage programming, IEEE-488 readback, and front panel meter functions. Values read back over the IEEE-488 should be the same as those displayed on the front panel.

Figure 19 shows the setup for the tests. Measure the output voltage directly at the sense connections of the output terminals.

Step	Action	Expected Result
1.	Make sure the AC source is turned off. Connect a DVM across the sense terminals.	
2.	Turn on the AC source with no load on the output. Program the output for a 150 volt, 60 Hz sinewave, external sense. Set the output current limit to its maximum value. If the source you are verifying is in three-phase mode, start by verifying output phase 1 (Ø1).	**CV** annunciator on. Output current near 0.
3.	Record voltage readings at DVM and on front panel display.	Readings within low voltage limits specified in Table 41.
4.	Program the voltage to 300 volts.	
5.	Record voltage readings of DVM and on front panel display.	Readings within high voltage limits specified in Table 41.
6.	If the AC source you are verifying is in three-phase mode, repeat steps 1 through 5 for output phases 2 and 3. Press Phase Select to select the next phase.	

Table 39 : Voltage programming readback test steps

6.2.3 Current Programming and Readback Accuracy

This test verifies the current programming and readback. Connect the appropriate current monitoring resistor (see Table 38) as shown in Figure 19. The accuracy of the resistor must be as specified in the table.

Step	Action	Expected Result
1.	Turn off the AC source and connect the current monitoring resistor as shown in Figure 19. Be certain to use wire of sufficient size to carry the maximum rated current of the AC source (see Table 6 in chapter 2).	
2.	Connect a DVM across the resistor	
3.	Turn on the AC source and program the output for 5 volts and the Low Current value specified in Table 41. If the AC source you are verifying is in three-phase mode, start by verifying output phase 1	
4.	Enable the output (Output On/Off or OUTP ON)	
5.	Observe the DVM voltage reading. Divide this by the resistance of the current monitor resistor. Record the result as the Low Current value in Table 41.	Value within low current limits specified in Table 41.
6.	Record the front panel display readback.	Value within readback limits specified in Table 41.

Step	Action	Expected Result
7.	Change the voltage range of the unit from the 300 volt range to the 150 volt range.	
8.	Program the output for 5 volts and the High Current value specified in Table 41.	
9.	Observe the DVM voltage reading. Divide this by the resistance of the current monitor resistor. Record the result as the High Current value in Table 41.	Value within high current limits specified in Table 41.
10.	Record the front panel display readback.	Value within readback limits specified in Table 41
11.	Disable the output (Output On/Off or OUTP OFF), turn off the power, and remove the shunt from across the load.	
12	If the AC source you are verifying is in three-phase mode, repeat steps 1 through 11 for output phases 2 and 3. Press Phase Select to select the next phase.	

Table 40 : Current programming readback test steps

6.3 Verification Test Checklist

The following table provides a convenient checklist for test verification purpose.

Model			
Report No.			
Date			
Test Description	**Minimum Specification**	**Recorded Results**	**Maximum Specification**
Voltage Programming and Readback			
Low Voltage (150 V)	149.48 V	V	150.53 V
Front Panel Display Readback	Vout - 325 mV	V	Vout + 325 mV
High Voltage (300 V)	299.25 V	V	300.75 V
Front Panel Display Readback	Vout - 400 mV	V	Vout + 400 mV
3000iL Current Programming and Readback			
Low Current (3.3 A)	Iout = 3.25 A	A	3.47 A
Front Panel Display Readback	Iout - 28 mA	A	Iout + 28 mA
High Current (6.6 A)	Iout = 6.55 A	A	6.65 A
Front Panel Display Readback	Iout - 32 mA	A	Iout + 32 mA
4500iL Current Programming and Readback			
Low Current (5 A)	Iout = 4.95 A	A	5.05 A
Front Panel Display Readback	Iout - 30 mA	A	Iout + 30 mA
High Current (10 A)	Iout = 9.93 A	A	10.07 A
Front Panel Display Readback	Iout - 35 mA	mA	Iout + 35 mA
4801iL Current Programming and Readback			
Low Current (15 A)	Iout = 14.8 A	A	15.2 A
Front Panel Display Readback	Iout - 40 mA	A	Iout + 40 mA
High Current (30 A)	Iout = 29.7 A	A	30.3 A
Front Panel Display Readback	Iout - 65 mA	mA	Iout + 65 mA

Table 41 : Verification test checklist

6.4 Performing the Calibration Procedure

Table 38 lists the equipment required for calibration. Figure 19 shows the test setup. You do not have to do a complete calibration each time. If appropriate, you may calibrate only the voltage or current and proceed to "Saving the Calibration Constants". However, before you calibrate OVP, you must first calibrate the output voltage.

For models 3000iL and 4500iL, calibration may only be performed when the AC source is in the three phase mode.

The following parameters may be calibrated:

- AC output voltage
- realtime output voltage (4801iL only)
- output voltage readback
- over voltage protection
- AC output current
- output current readback (4801iL only)
- output impedance (4801iL only)

6.4.1 Front Panel Calibration Menu

The Entry keypad is used for calibration functions.

Shift Calibration Press this key to access the calibration menu list.

Display	Measurement
CAL ON <value>	turns calibration mode on when the correct password value is entered
CAL OFF	turns calibration mode off
CAL:LEV <char>	advance to next step in sequence (P1, P2, P3 or P4)
CAL:DATA <value>	input a calibration measurement
CAL:VOLT:AC	begin AC voltage calibration sequence
CAL:VOLT:PROT	begin voltage protection calibration
CAL:CURR:AC	begin AC current programming calibration sequence
CAL:CURR:MEAS	begin current measurement calibration sequence, 4801iL only
CAL:IMP	begin output impedance calibration sequence, 4801iL only
CAL:VOLT:RTIME	begin real-time voltage programming calibration, 4801iL only
CAL:SAVE	saves the calibration constants in non-volatile memory
CAL:PASS <value>	set new calibration password

6.4.2 Front Panel Calibration

WARNING: LETHAL VOLTAGES. AC sources can supply 425 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.

The following procedures assume you understand how to operate front panel keys as explained in chapter 4.

Step	Action	Display
	Enable Calibration Mode	
1.	Reset the unit by selecting Output, scrolling to the *RST command, and pressing Enter. Make sure that the phase 1 (**Ø1**) annunciator is lit. Phase 1 is the power-on default. (Press Phase Select to select a different phase.)	***RST**
2.	To begin calibration press Shift Calibration and scroll to the CAL ON command.	**CAL ON 0.0**
3.	Enter the calibration password from Entry keypad and press Enter. If the password is correct, the **Cal** annunciator will come on. If an internal switch has been set to prevent the calibration from being changed or the password is incorrect, **OUT OF RANGE** appears. (See section 6.4.4)	**OUT OF RANGE**
4.	If the active password is lost, the calibration function can recovered by setting an internal switch that defeats password protection. (See section 6.4.4.)	**OUT OF RANGE**
	Calibrating and Entering Voltage Calibration Values	
5.	Connect the DVM (ac volts mode) directly to the AC source via the ratio transformer shown in Figure 19. Do not connect the load resistor or current shunt	
6.	Press Shift Calibration, scroll to the CAL VOLT AC command, and press Enter.	**CAL:VOLT: AC**
7.	Press Shift Calibration, scroll to the CAL LEV P1 command, and press Enter to select the first calibration point.	**CAL:LEV P1**
8.	Press Shift Calibration, scroll to the CAL DATA command, and use the Entry keypad to enter the voltage value displayed on the DVM.	**CAL:DATA 0.00**
9.	Press Shift Calibration, scroll to the CAL LEV P1 command, use ↑ and ↓ to scroll to the P2 parameter, and press Enter. This selects the second calibration point.	**CAL:LEV P2**
10.	Press Shift Calibration, scroll to the CAL DATA command, and use the Entry keypad to enter the second voltage value displayed on the DVM.	**CAL:DATA 0.00**
11.	Repeat steps 9 and 10 for the third and fourth voltage values (P3 and P4). The AC source is now holding the voltage calibration constants in RAM	
12.	Press Phase Select to select the next phase and repeat steps 5 through 11 for phases 2 and 3 of three phase sources. (The phase annunciators indicate which phase is active.)	
	Calibrating Realtime Voltage (4801iL only)	
13.	Press Shift Calibration, scroll to the CAL VOLT RTIME command, and press Enter.	**CAL:VOLT:RTIME**

Step	Action	Display
14.	Press Shift Calibration, scroll to the CAL LEV P1 command, and press Enter to select the first calibration point.	**CAL:LEV P1**
15.	Press Shift Calibration, scroll to the CAL DATA command, and use the Entry keypad to enter the voltage value displayed on the DVM.	**CAL:DATA 0.00**
	Calibrating the OVP trip point	
16.	Press Shift Calibration, scroll to the CAL VOLT PROT command, and press Enter.	**CAL:VOLT: PROT**
17.	*Wait for the power supply to compute the OVP calibration constant. The display returns to Meter mode when the calculation is complete.* If the supply goes unregulated or into CC mode during OVP calibration, an error occurs. If the computed constant is out of the acceptable range, an error occurs. The AC source is now holding the new OVP calibration in RAM.	**NOT CV MODE** **DOES NOT CAL**
18.	Press Phase Select to select the next phase and repeat steps 16 and 17 for phases 2 and 3 of three phase sources. (The phase annunciators indicate which phase is active.)	
	Calibrating and Entering Current Calibration Values	
19.	Connect the appropriate current shunt and load resistor as shown in Figure 19. Connect the DVM (ac rms mode) across the current shunt. If you are calibrating a three-phase model, make sure that the phase 1 (**Ø1**) annunciator is lit. Phase 1 is the power-on default. (Press Phase Select to select a different phase.)	
20.	Press Shift Calibration, scroll to the CAL CURR AC command, and press Enter	**CAL:CURR:AC**
21.	Press Shift Calibration, scroll to the CAL LEV P1 command, and press Enter to select the first calibration point	**CAL:LEV P1**
22.	Press Shift Calibration and scroll to the CAL DATA command. Wait for DVM reading to stabilize. Then read DVM and compute the first current value (DVM reading ÷ shunt resistance). Use the Entry keypad to enter the first current value.	**CAL:DATA 0.00**
23.	Press Shift Calibration, scroll to the CAL LEV P1 command, use ↑ and ↓ to scroll to the P2 parameter, and press Enter. This selects the second calibration point	**CAL:LEV P2**
24.	Press Shift Calibration and scroll to the CAL DATA command. Wait for DVM reading to stabilize. Then read DVM and compute the second current value (DVM reading ÷ shunt resistance). Use the Entry keypad to enter the second current value.	**CAL:DATA 0.00**

Step	Action	Display
25.	Press Phase Select to select the next phase and repeat steps 19 through 24 for phases 2 and 3. (The phase annunciators indicate which phase is active.)	
Calibrating RMS Current Measurement Values (4801iL only)		
26.	Press Shift Calibration, scroll to the CAL CURR MEAS command, and press Enter	**CAL:CURR:MEAS**
27.	Press Shift Calibration, scroll to the CAL LEV P1 command, and press Enter to select the first calibration point	**CAL:LEV P1**
28.	Press Shift Calibration and scroll to the CAL DATA command. Wait for DVM reading to stabilize. Then read DVM and compute the first current value (DVM reading ÷ shunt resistance). Use the Entry keypad to enter the first current value.	**CAL:DATA 0.00**
29.	Press Shift Calibration, scroll to the CAL LEV P1 command, use ↑ and ↓ to scroll to the P2 parameter, and press Enter. This selects the second calibration point	**CAL:LEV P2**
30.	Press Shift Calibration and scroll to the CAL DATA command. Wait for DVM reading to stabilize. Then read DVM and compute the second current value (DVM reading ÷ shunt resistance). Use the Entry keypad to enter the second current value.	**CAL:DATA 0.00**
Calibrating the Output Impedance (4801iL only)		
31.	Connect only the output impedance resistor across the output of the AC source. Do not connect any other equipment.	
32.	Press Shift Calibration, scroll to the CAL IMP command, and press Enter.	**CAL:IMP**
33.	*Wait for the power supply to compute the output impedance calibration constant. The display returns to Meter mode when the calculation is complete.* The AC source is now holding the new impedance calibration constant in RAM.	
Saving the Calibration Constants		
	Storing calibration constants overwrites the existing ones in nonvolatile memory. If you are not sure you want to permanently store the new constants, omit this step. The calibration will then remain unchanged.	
34.	Press Shift Calibration, scroll to the CAL SAVE command, and press Enter	**CAL:SAVE**
35.	Press Shift Calibration, select the CAL OFF command, and press Enter to exit Calibration mode. *RST and *RCL will also set the calibration state to OFF.	**CAL OFF**

Table 42 : Front panel calibration procedure steps

6.4.3 Changing the Calibration Password

The factory default calibration password is 0. You can change the password when the AC source is in calibration mode (which requires you to enter the existing password). Proceed as follows:

Step	Action	Display
1.	Begin by pressing Shift Calibration and scrolling to the CAL ON command.	**CAL ON 0.0**
2.	Enter the existing password from Entry keypad and press Enter	
3.	Press Shift Calibration and scroll to the CAL PASS command	**CAL:PASS 0**
4.	Enter the new password from the keypad. You can use any number with up to six digits and an optional decimal point.	

Table 43 : Changing the calibration password

Note: If you want the calibration function to operate without requiring any password, change the password to 0 (zero).

6.4.4 Calibration Error Messages

Errors that can occur during calibration are shown in the following table.

Error no.	Error Meaning
401	CAL switch prevents calibration[1]
402	CAL password is incorrect
403	CAL mode is not enabled
404	Computed readback CAL constants are incorrect
405	Computed programming CAL constants are incorrect
406	Incorrect sequence of CAL commands

Table 44 : IEEE-488 Calibration Error Messages

[1] This is a hardware disable. See section 6.4.4.

6.4.5 Calibration Over the IEEE-488

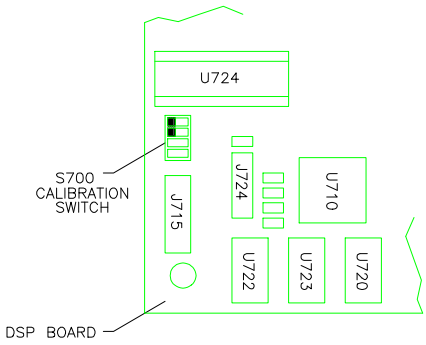
You can calibrate the AC source by using SCPI commands within your controller programming statements. Be sure you are familiar with calibration from the front panel before you calibrate from a controller. Each front panel calibration command has a corresponding SCPI command.

The SCPI calibration commands are explained in chapter 4 of the AC source Programming Manual. Calibration error messages that can occur during IEEE-488 calibration are shown in Table 44.

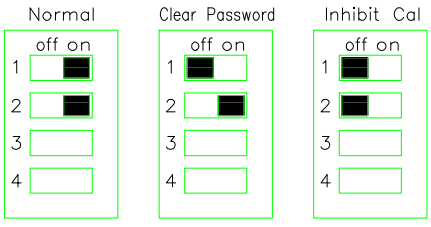
6.4.4 Calibration Configuration Switch

An internal set of DIP switches control access to calibration commands. The four DIP switches are located on the A8 DSP board and are accessible by removing the top cover. Switches 1 and 2 set the calibration configuration. Figure 20 shows the three different switch settings for switches 1 and 2.

Switch Position	Description
Normal	This is the default switch position. The calibration functions are accessible after entering a numeric password. The default password is 0 and is changeable by the user.
Clear Password	The calibration password is reset to 0 and the remote programming language is set to SCPI. This option is useful if the user has forgotten the password.
Inhibit Cal	In this position the calibration of the power source cannot be changed. All calibration commands are disabled. If the CAL ON command is sent with the switch in this position, an Out Of Range error will be displayed on the front panel. This option is useful in installations where calibration access is guarded by instrument seals.



LOCATION OF DIPSWITCHES ON A8 DSP BOARD



SWITCH SETTINGS FOR SWITCHES S1 AND S2

Figure 20 Calibration Switches

7. Troubleshooting

7.1 Introduction

WARNING: Shock Hazard The troubleshooting procedure in this chapter must be performed with power applied and protective covers removed. These procedures should be done only by trained service personnel aware of the hazard from electrical shock

SAFETY CONSIDERATIONS

This AC source is a Safety Class I instrument, which means it has a protective earth terminal. This terminal must be connected to earth ground through a power source equipped with a 4-wire, grounded receptacle. Refer to the "Safety Summary" page at the beginning of this manual for general safety information. Before operation or repair, check the AC power source and review this manual for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places in the manual.

Caution: The power source has components that can be damaged by ESD (electrostatic discharge). Failure to observe standard, antistatic practices can result in serious degradation of performance, even when an actual failure does not occur.

When working on the AC Power Source observe all standard, antistatic work practices. These include, but are not limited to:

- working at a static-free station such as a table covered with static-dissipative laminate or with a conductive table mat
- using a conductive wrist strap
- grounding all metal equipment at the station to a single common ground
- connecting low-impedance test equipment to static-sensitive components only when those components have power applied to them
- removing power from the before removing or installing printed circuit boards

7.2 Localizing the Problem

This chapter provides troubleshooting and repair information for the AC source. Before beginning troubleshooting procedures, make certain the problem is in the AC source and not with an associated circuit, the GPIB controller, or the ac input line. Without removing the covers, you can use the Verification tests in Chapter 6 to determine if the AC source is operating normally.

7.3 Troubleshooting Procedure

Table 45 gives the troubleshooting procedure to isolate a fault to a circuit board or particular circuit.

Step	Symptom	Corrective Action
1	No output voltage/front panel display and fan off	go to Figure 21
2	No or limited output/front panel display and fan on	go to Figure 22
3	Turn-on Self Test Error	
	Error 1 Non-volatile RAM RD0 section checksum failed	1
	Error 2 Non-volatile RAM CONFIG section checksum failed	1
	Error 3 Non-volatile RAM CAL section checksum failed	1
	Error 4 Non-volatile RAM WAVEFORM section checksum failed	1
	Error 5 Non-volatile RAM STATE section checksum failed	
	Error 6 Non-volatile RAM LIST STATE section checksum failed	1
	Error 10 RAM selftest	1
	Error 11 to 18 DAC selftest, tests 1 through 8	2
		2

1 Re-initialize unit and re-calibrate. If unit still has RAM error, replace the A8 DSP board. To re-initialize unit, turn CAL ON then press 0 and 9 simultaneously. Press scroll key to model number then press enter. When unit is re-initialized all CAL data, user defined WAVEFORM data and LIST data are erased.

2 Replace A8 DSP board.

Table 45 : Specific Troubleshooting Procedures

7.3.1 TROUBLESHOOTING HINTS

- If the AC power source operates properly but does not deliver full output power capability, check the AC main fuses.
- All amplifiers (A1, A2, A3) may be interchanged for troubleshooting purposes.

7.3.2 General Measurement Techniques

Measure the output voltage directly at the sense terminals. Select an adequate gauge wire for load tests using the procedures given in the operating manual for connecting the load.

7.3.3 Current-Monitoring Resistor

The four-terminal, current-monitoring resistor (current shunt) is required to eliminate output current measurement error caused by voltage drops in leads and connections. To eliminate output current measurement error caused by voltage drops in the leads and connections, connect the current-monitoring resistor as a four terminal device.

7.3.4 Using the *TST? Query

You can get the AC source to execute a partial selftest by sending it the GPIB *TST? query command. These tests do not interfere with normal operation or cause the output to change. The command returns a value of zero if all tests pass. Otherwise, the command returns the error code of the first test that failed. No error codes are displayed on the display and the AC Power Source will attempt to continue normal operation.

7.4 Firmware Revisions

If needed, you can confirm the firmware revision of your AC Power Source with the GPIB *IDN? query command. The Windows program supplied with the iL Series AC source can be used to do this. Use the command line found in the Source interface menu. Either IEEE-488 or RS232C can be used.

7.4.1 ROM Replacement

Instruments that are being initialized for the first time or have suffered non-volatile memory corruption should be initialized with the front panel EEINIT command. To initialize the unit perform the following:

- Turn the unit on, then do the front panel CAL ON command.
- Press 0 and 9 keys simultaneously, EEINIT <model> should now be displayed.
- Scroll to the correct model number and press ENTER.

If the command is successful, the front panel display will go through a normal power-on sequence.

7.4.2 ROM Update

It is possible to update to newer ROM versions without destroying the calibration data. To update the unit to newer ROM revisions perform the following:

- Turn input power off, remove the old ROM's and install the new ROM's.
- Turn the unit on, then perform the front panel CAL ON command.
- Press 0 and 9 keys simultaneously, then scroll to the ROMUPD command.
- Scroll to correct model number and press ENTER.

If the command is successful, the front panel display will go through a normal power-on sequence. If "OUT OF RANGE" error is displayed, then the instrument will have to be re-initialized with the EEINIT command and re-calibrated. This can occur if the instrument was previously initialized with a QA firmware revision (QA.xx.xx), or if the non-volatile memory has become corrupted for any reason.

DANGER ***Dangerous/Lethal voltages are present when the power supply covers are removed.***

Step	Procedure	Indication	Action
1	Turn off AC mains, disconnect load and connect sense terminals for local sensing.		
2	Remove the top cover as follows: Remove 9 screws from the top and 3 screws from the each side. Then lift the cover straight up being careful of the lip on the front of the cover.		
3	Turn on supply and verify that AC power is on by checking for any observable indication (i.e. fan running, display on)	Is AC power ON?	If not, Check input fuses F1, F2, F3 on rear panel. Check input line filter FL1.
4	There should be a clicking sound as the 3 current limit relays on the A9 assembly energize.	Do the relays energize?	If not, Check A9F2, A9F3, A9F4 1 amp slow blow. Check A9F1 1/4 amp normal blow.
5	About 1-3 seconds after the 3 current limit relays energize, relay K1 should energize.	Does relay K1 close? Are fans running?	If not, Check C1 for 300 VDC. 300 VDC is initially supplied via 3 relays, fuses and resistors at bottom of A9 board.
6	Bias voltages are supplied from the A10 Auxiliary power supply board. The 300 VDC is used to generate the bias voltages. Check the bias voltage at the connectors along the top circuit side edge of the A10 board.	See Table 3-4 in next page for signal pin voltages.	
7	If no bias voltages are present check fuse F1 on A10 board, subminiature type 1 amp.	Is display on?	Check +5 volt HPIB bias supply from A10 Aux PS & A5 relay/sense assy. A10J6 pins 1 and 2.
8	Use front panel keys to program voltage and current to full scale and frequency for 60 Hz. Use DVM to measure output voltage at output terminal block, TB2.	Is output voltage within specification?	If voltage at TB2 is correct but front panel reading is incorrect, A8 DSP assembly is most likely at fault. If voltage at TB2 is correct but outside specification - unit requires calibration.
9		Is one phase missing?	Check F1, F2, F3 15 amp fuses in 300 VDC line on A4 mother board.

Step	Procedure	Indication	Action
			Swap the suspected faulty A1, A2, or A3 with a good A1, A2, or A3 amplifier module. Check the +/- 15 bias voltages at A10J2. +15V at pins 1,2,5,6,9,10,13,14,23,24. -15V at pins 15,19,20. COM at pins 3,4,7,8,12,15,16,21,22,25,26 .
10		Are all phases missing?	If Yes, Check 300 VDC rail from CR1, C1 to F1, F2, and F3 on A4 mother board. Check for sine wave at A6J4-1 to A6J4-2, A6J4-3 to A6J4-4, A6J4-5 to A6J4-6.

Table 46 : AC Power Source Troubleshooting Procedure

PIN NO	A10J3	A10J4	A10J5	A10J6
1	12-24 V fans	+15 V	+5 Vsec	+5 V HPIB
2	+24 V	A gnd	D gnd	HPIB gnd
3	+5 Vsec	-15 V	+5 Vunreg	
4	+24 V COM	+5 Vsec		
5	COM	D gnd		
6		2.5		
7	UVOV (high true)			
8	Phase Loss (low true)			

Table 47 : Pin and Signal Voltages at A10 Connectors

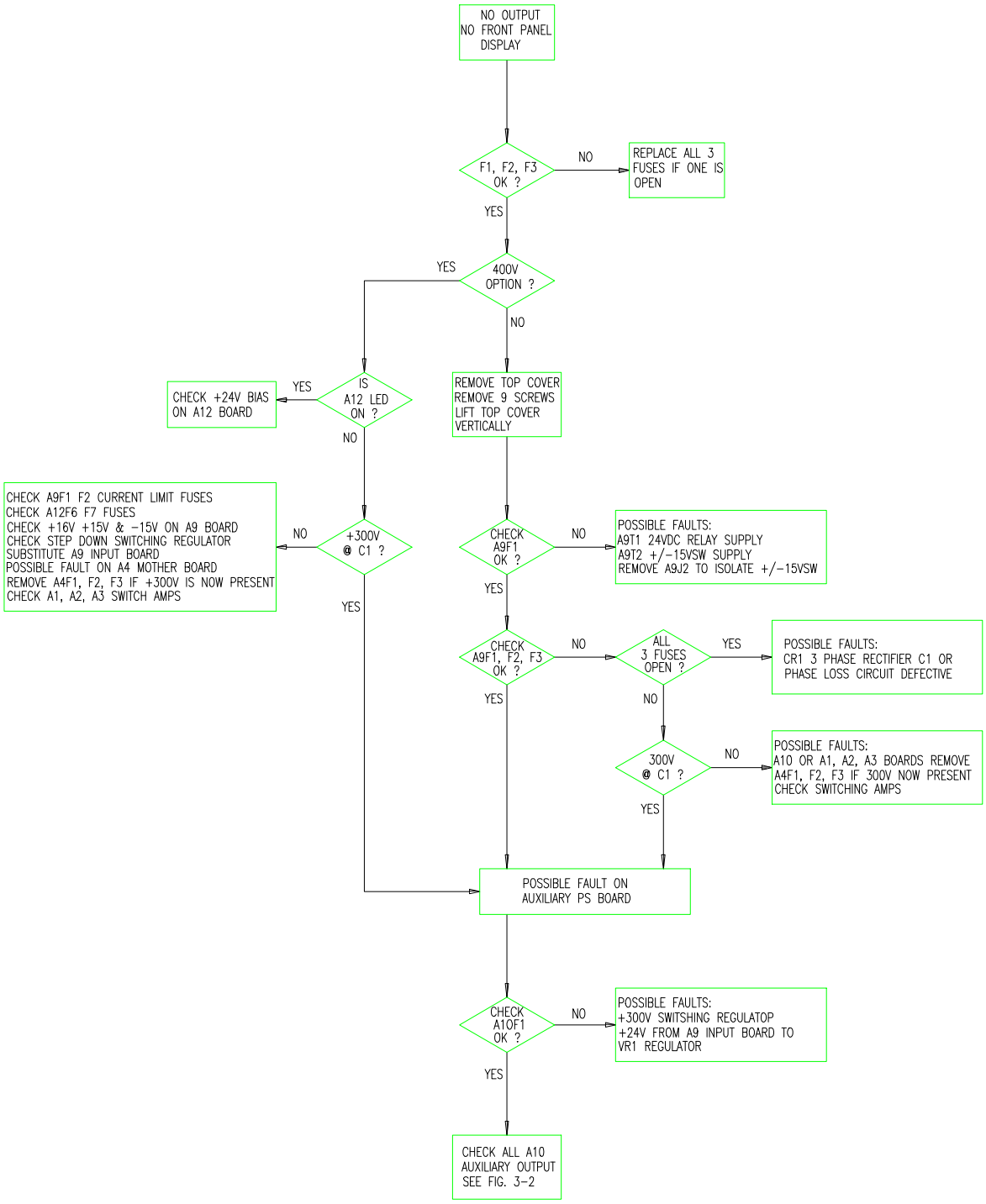


Figure 21 Troubleshooting Diagram for No Output Present

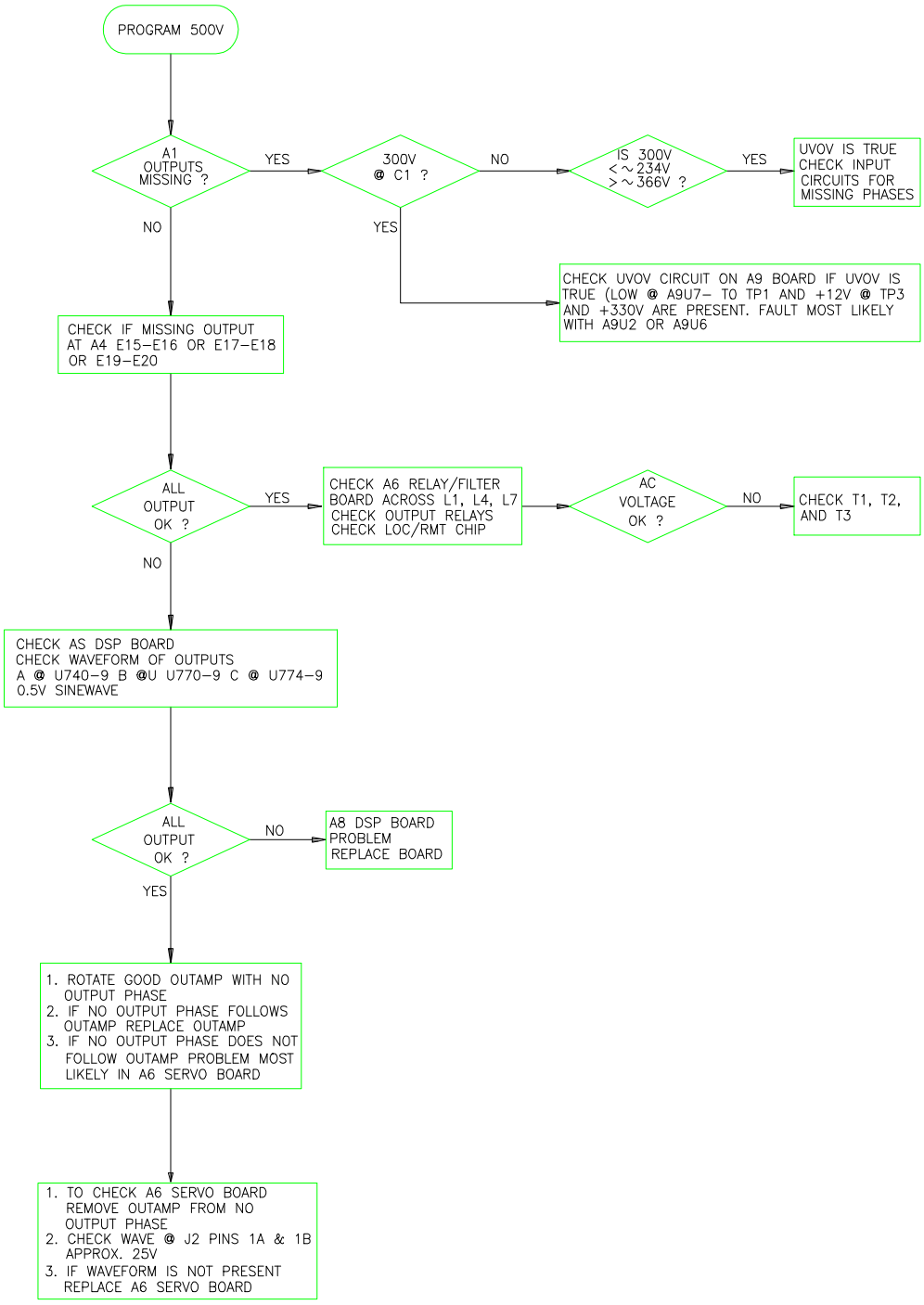


Figure 22 Troubleshooting Diagram for One or More Outputs Missing

8. Principles of Operation

8.1 Introduction

Figure 23 is a block diagram showing the major circuits within the AC Power Source. The AC Power Source consists of the following circuits:

- A1, A2, A3 Switching Amplifier Modules
- A4 Mother Board Assembly
- A5 Relay Range and Filter Assembly
- A6 Servo (Control) Assembly
- A7 IEEE-488 and RS-232 Assembly
- A8 Digital Signal Processing (DSP) Assembly
- A9 Input Power Assembly
- A10 Auxiliary Power Supply Assembly
- A11 Front Panel Assembly
- A14 Bias Power Supply Assembly
- A15 BNC Assembly

8.2 General Description

The 3-phase input power is connected to TB1 on the rear panel, where it is routed through F1, F2, and F3 to the RFI filter, FL1, and to relay K1. The 3-phase input power is also connected to the A9 Input Power Assembly. When relay K1 closes, the 3-phase input is connected to the power rectifier CR1, L1, and C1 to create 300 VDC required by the power amplifiers A1, A2, and A3. The amplifier assemblies together with the output filter and range relays produce the programmed waveform at the programmed frequency and voltage. The 300 VDC is also use by the A10 Auxiliary Power Supply Assembly to produce the bias voltages required by support circuits.

8.3 Assembly Descriptions

8.3.1 A1, A2, A3 Switching Amplifier Modules

The switching amplifier modules consist of a heat sink assembly, control board, and power board. The three amplifier modules are identical and can be interchanged for troubleshooting assistance. The amplifier assemblies are replaceable as complete assemblies only, they are not repairable to the component level.

8.3.2 A4 Mother Board Assembly

The A4 mother board interconnects the A1, A2, and A3 amplifier assemblies with the A6 servo assembly, the 300 VDC rail voltage and the +/-15 VDC bias supply. There are 15 amp fuses located in the +300 VDC line to each amplifier assembly.

8.3.3 A5 Relay/Filter Assembly

The A5 assembly consists of the output voltage filters, the output voltage range relays, A5K1, A5K2, and A5K3, the output voltage disconnect relays, A5K5, A5K7, A5K8, and A5K9, the remote sense relays, A5K4 and A5K6, the paralleling relays, A5K10 and A5K11, and other associated circuits. It also interconnects the A7 isolation assembly, A11 display assembly, A8 DSP assembly, and A15 BNC assembly with each other.

8.3.4 A6 Servo (Control) Assembly

The A6 servo or control assembly consists of control circuits for the A1, A2, and A3 power amplifiers where required. It contains the voltage and current control amplifiers and receives the voltage and current programming information from the A8 DSP assembly. It interconnects the range and protection signals between the A5 and A8 assemblies.

8.3.5 A7 Isolation Assembly

The A7 isolation assembly contains the CPU and logic circuits for communicating with either a GPIB or RS232 computer/controller.

8.3.6 A8 Controller (DSP) Assembly

The A8 DSP board contains the CPU, ROM's, Digital-to-Analog circuits and Analog-to-Digital circuits to control the output voltage and output current setting. The A8 board also contains all the logic circuits for generating arbitrary waveforms, frequency changes and phase control. At power-on, the DSP board performs a self test and reports failure via the front panel display.

8.3.7 A9 Input Power Supply Assembly (208 Volt Input)

The A9 input power supply assembly contains the following circuits: an inrush-current-limit circuit to initially charge capacitor C1 to 300 VDC, a phase loss detection circuit, the undervoltage/overvoltage detection circuits, and +/-15VSW to the A10 auxiliary power supply assembly. When ON/OFF switch, S1, is closed, a single phase is used to power two bias transformers to generate the +/-15 VDC, 12 VDC for the protection circuits, and 24 VDC to the current limit relays K1, K2, and K3.

There are four fuses on the A9 board. Fuse A9F1 is in series with the ON/OFF switch, S1. If fuse A9F1 is open, the AC source will not function at all. The remaining three fuses, A9F2, A9F3, and A9F4 are in series with the current limit resistors and relays. If all fuses are open, the unit will not function.

If one or two fuses are open, the phase loss status bit is true and full output power will not be available.

8.3.8 A9 Input Power Supply Assembly (400 Volt Input)

The A9 input power supply assembly contains a current limit circuit to initially charge C9 and C10 to 550 VDC, a step-down switching regulator to power the +300 V on

C1, a phase loss detection circuit and the undervoltage/overvoltage detection circuits.

When ON/OFF switch, S1, is closed, a single phase is used to power three bias transformers on the A14 Bias board. The A14 bias board provides +16 VDC, +15 VDC, -5 VDC, +12 VDC for protection circuits, and +24 VDC to current limit relays K1 and K2.

There are three fuses on the A9 board. The three fuses, A9F2, A9F3, and A9F4 are in series with the current limit resistors and relays. If all three fuses are open, the unit will not function. If one or two fuses are open, the phase loss status bit is true and full power will not be available.

8.3.9 A10 Auxiliary Power Supply Assembly

The 300 VDC is used by the A10 board to generate the bias voltages. The 300 VDC input line is fused by a one ampere subminiature fuse, A10F1. The A10 supplies an isolated +5 VDC for the A7 GPIB/RS-232 interface board, A15 BNC board, and A11 front panel board.

The +15 VSW goes to the A4 mother board via J2; the +/-15 V and +5 VSEC go to the A6 servo board via J4; and +5 VSEC goes to the A8 DSP board via J5. The A10 supply also supplies the 12 VDC to 24 VDC for the fan-speed control. All secondary bias windings are fused with subminiature fuses, A10F2 through A10F7.

8.3.10 A11 Display Assembly

The A11 assembly contains the display assembly, keypad, rotary pulse generators (RPG) and digital logic circuits, CPU, and ROM.

8.3.11 A14 Bias Power Supply Assembly

This assembly is used with the 400 volt input option only. The A14 board provides the DC voltages required for the low voltage regulators and the +24 VDC for the current limit relays on the A9 board. It also provides the +/-15 VSW to the A10 auxiliary board. An LED lights on the A14 board if fuse F1 opens. Fuse F2 and F3 are for the +24 VDC and +16 VDC. F4 and F5 are for the +/- 15 VSW. F6 and F7 are for the +15 VDC/-5 VDC regulators.

8.3.12 A15 BNC Assembly

The A15 BNC assembly contains the optical isolation circuits that interface the output common referred A8 DSP assembly to the chassis ground referred A7 isolation assembly, the A11 display assembly and the Trigger In/Out and RI/DFI circuits also on the BNC board.

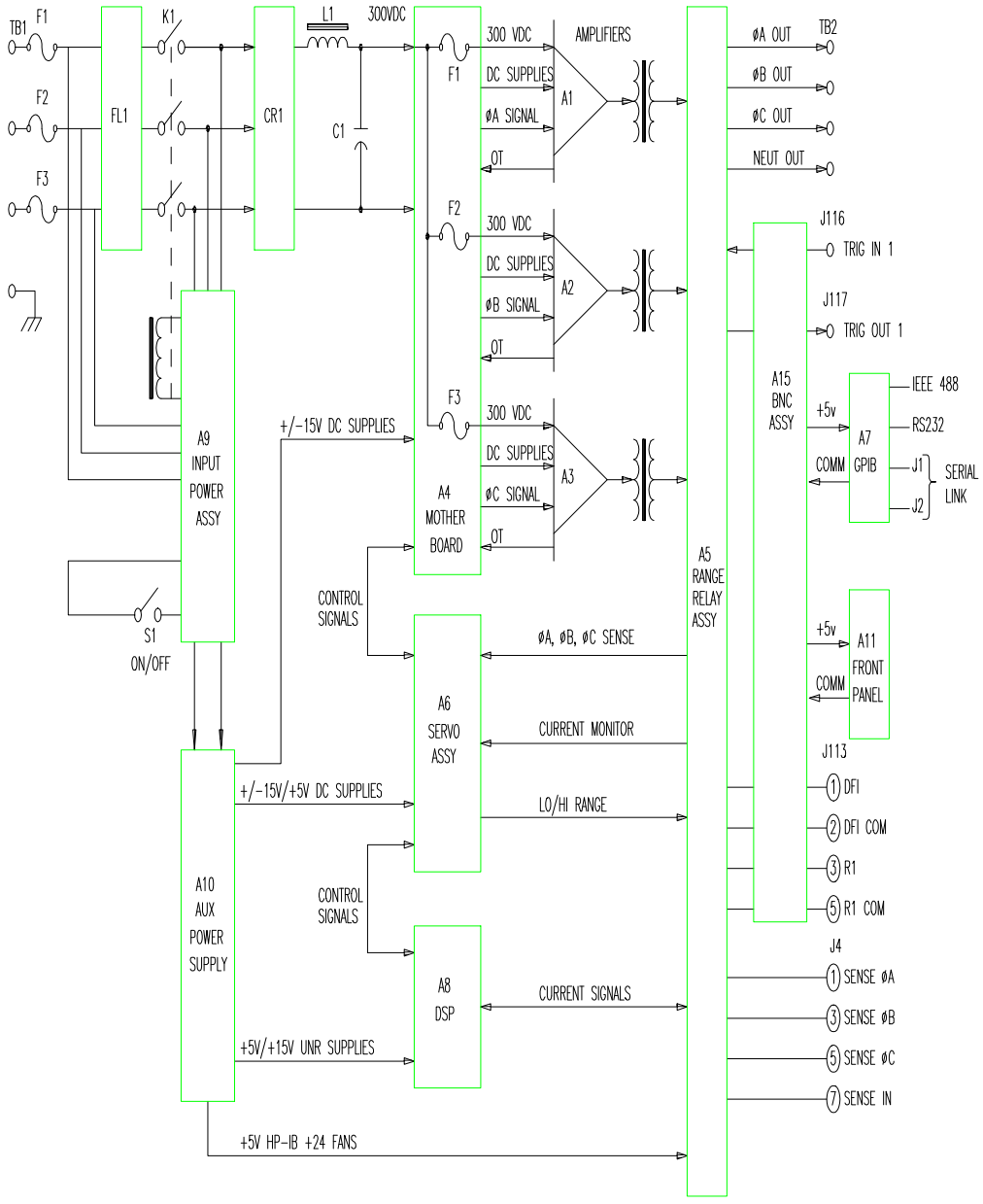


Figure 23 AC Power Source Block Diagram

9. Replaceable Parts

9.1 Introduction

This section lists the replaceable electrical and mechanical parts for the iL Series AC Power Sources.

9.2 Replaceable Assemblies

Reference Desig.	CI Part No.	Description
ELECTRICAL PARTS		
A1-A3	5001-412-1	Switching Amp Assembly
A4	5001-704-1	Mother Board Assembly
A5	5001-718-2	Relay/Filter Assembly, 3000iL & 4500iL
A5	5001-700-4	Relay/Filter Assembly, 4801iL
A6	5001-719-2	Servo Assembly, 3000iL
A6	5001-719-1	Servo Assembly, 4500iL
A6	5001-714-1	Servo Assembly, 4801iL
A7	250570	Isolation Assembly, 3000iL & 4500iL
A7	250638	Isolation Assembly, 4801iL
A8	250648	Controller (DSP) Assembly, 3000iL & 4500iL
A8	250650	Controller (DSP) Assembly, 4801iL
A9	5001-702-1	Input PS Assembly, 208 volt
A9	5001-706-1	Input PS Assembly, 400 volt
A10	5001-703-1	Auxiliary Power Supply Assembly
A11	250571	Display Assembly
A12	5001-712-1	Input Filter Assembly, 208 volt
A12	5001-710-1	Input Filter Assembly, 400 volt
A13	5001-711-1	Bridge Capacitor Assembly, 208 volt
A13	5001-711-2	Bridge Capacitor Assembly, 400 volt
A14	5001-707-1	Bias Power Supply Assembly
A4F1-A4F3	270180	Fuse, 15 A, 600 V
A7F1	270124	Fuse, 1 A
A9F1, 208 v assy	270009	Fuse, 1/4 A
A9F2-A9F4, 208 v assy	270154	Fuse, 1 A slow blow
A9F1-A9F3, 400 v assy	270154	Fuse, 1 A slow blow
A10F1	270179	Fuse, 1 A
A10F2	270181	Fuse, 1 A
A10F3-A10F5	270124	Fuse, 1 A
A10F6-A10F7	270178	Fuse, 1/4 A
A14F1-A14F7	270124	Fuse, 1 A
MECHANICAL PARTS		
	5001-208-1	Cover, Top
	5001-209-1	Cover, Side
	410636	4-Terminal RI/DFI Connector Plug
	410637	7-Terminal Sense Connector Plug

	240541	Switch
	211171	Knob
	211090	Foot

Table 48 : Replaceable assemblies

9.3 Other User-Replaceable Parts/Options

The following table lists some common operator-replaceable parts:

Description	CI Part No.
Rack slides	see "Accessories"
Rack mount ears	see "Accessories"
7-terminal sense connector plug	410637
Sense connector cover	250578
4-terminal digital connector plug	410636
Ac input safety cover	5001-226-1
AC input safety cover strain relief	211112
AC input safety cover bushing	211114
Screw (4), ac input safety cover (6-32 x 1.5 in)	FS1144
Ac output safety cover	250576
Screw (2), ac output safety cover (6-32 x 5/16 in)	FS1028
Fuse safety cover	250577
Screw (2), fuse safety cover (6-32 x 5/16 in)	FS1028
User's Guide (this manual)	5001-967
Programming Guide	5001-969

Table 49 : User replaceable parts

9.4 Options

Option	Description
400	Input power 360-440 Vac, three-phase, 47-63 Hz

Table 50 : Available options

9.5 Accessories

Item	CI Part Number
Rack slides (General Devices CTS-120-B307-2)	210960
Rack mount ears (4 required)	5001-249-1

Table 51 : Available accessories

10. Diagrams

This chapter contains drawings and diagrams for troubleshooting and maintaining the California Instruments iL family of AC power sources. Unless otherwise specified in the drawings, a drawing or diagram applies to all models.

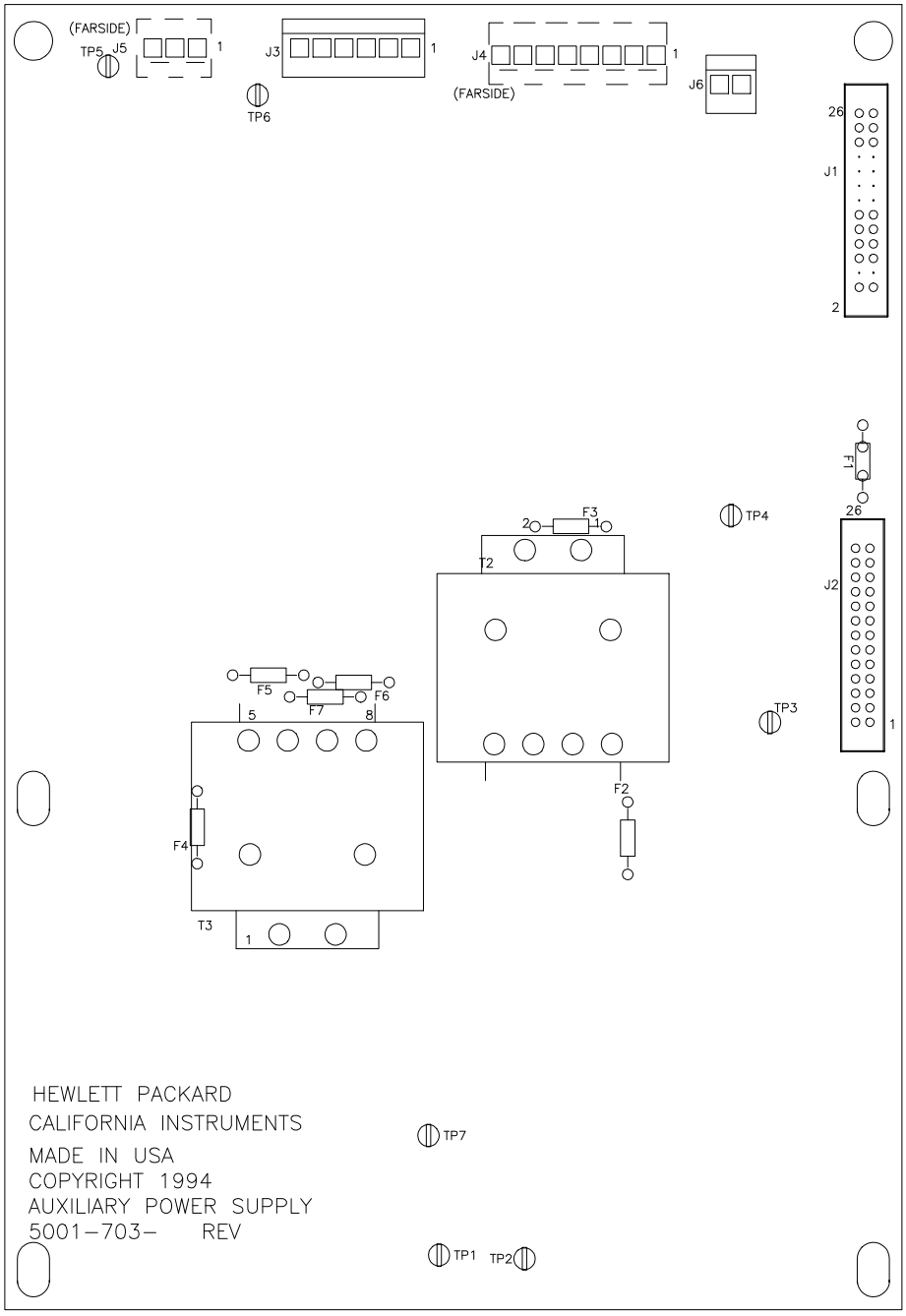


Figure 24 Auxiliary Power Supply Parts Location

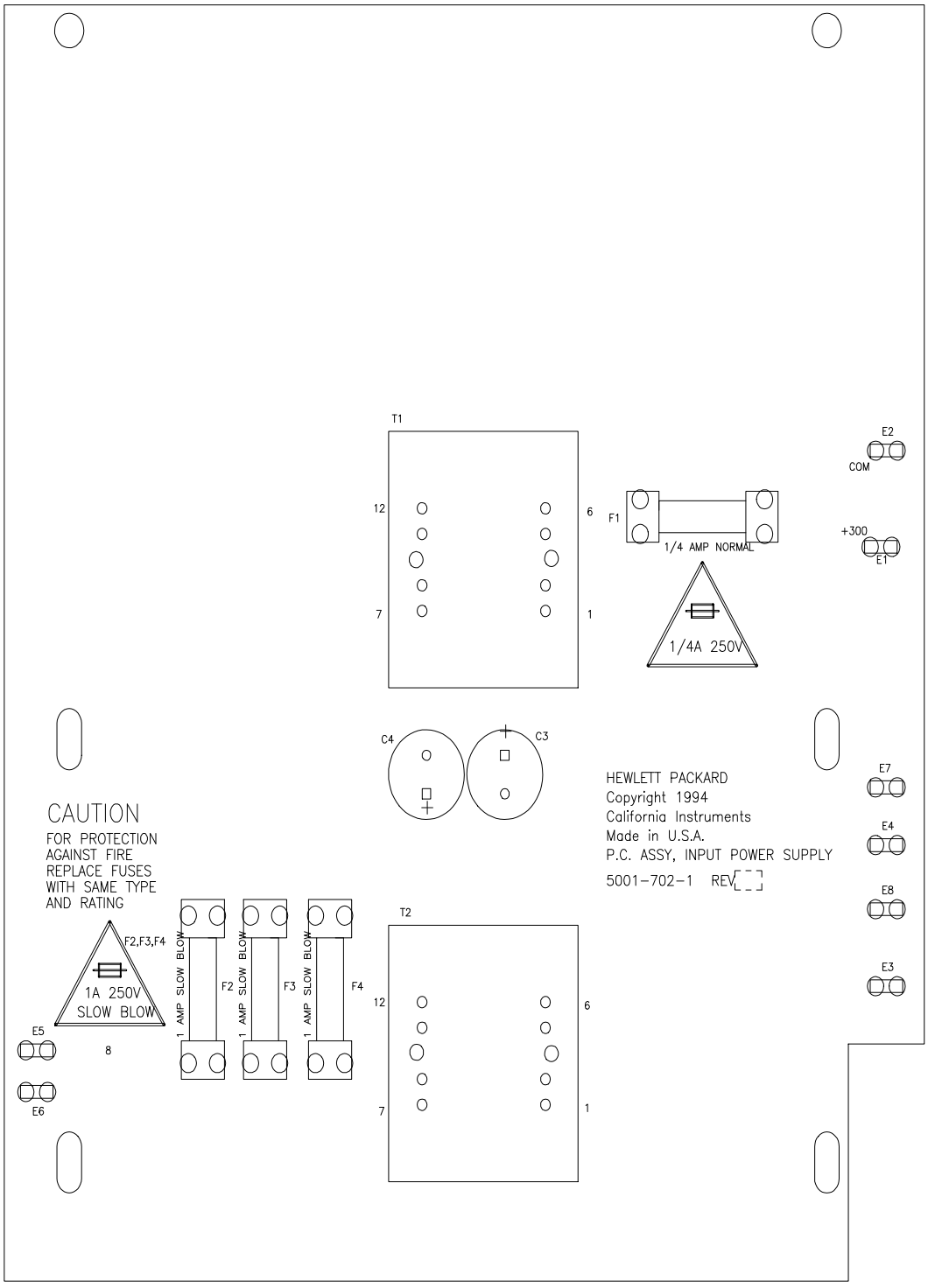


Figure 25 AC Input Board Parts Location

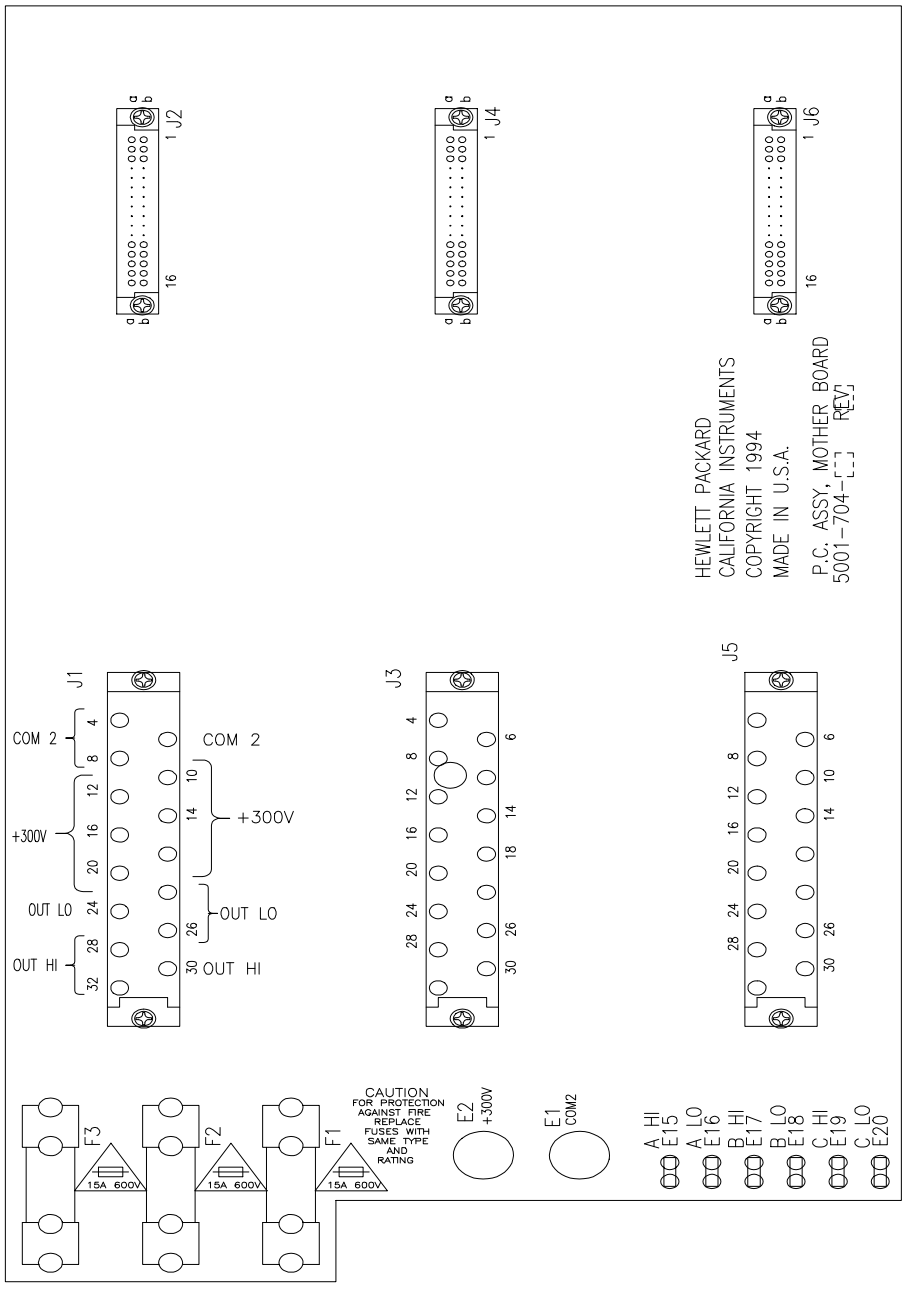


Figure 26 Mother Board Parts Location

11. Error Messages

This appendix gives the error numbers and descriptions that are returned by the AC power source. Error numbers are returned in two ways:

- Error numbers are displayed on the front panel
- Error numbers and messages are read back with the “SYSTem:ERRor?” query. SYSTem:ERRor? returns the error number into a variable and returns two parameters: an NR1 and a string.

The following table lists the errors that are associated with SCPI syntax errors and interface problems. It also lists the device dependent errors. Information inside the brackets is not part of the standard error message, but is included for clarification.

When errors occur, the Standard Event Status register records them as follows:

Bit Set	Code Error	Type
5	-100 thru -199	Command
3	-300 thru -399 or 1 thru 32767	Device-dependent
4	-200 thru -299	Execution
2	-400 thru -499	Query

Table 52 : Standard Event Status Register (ESR) bits

Table 53 shown below list all ESR error messages generated by the AC source. Messages in the table are grouped by Code Error type.

Error	Error String
-100	Command error [generic]
-101	Invalid character
-102	Syntax error [unrecognized command or data type]
-103	Invalid separator
-104	Data type error [e.g., "numeric or string expected, got block data"]
-105	GET not allowed
-108	Parameter not allowed [too many parameters]
-109	Missing parameter [too few parameters]
-112	Program mnemonic too long [maximum 12 characters]
-113	Undefined header [operation not allowed for this device]
-121	Invalid character in number [includes "9" in octal data, etc.]
-123	Numeric overflow [exponent too large; exponent magnitude >32 k]
-124	Too many digits [number too long; more than 255 digits received]
-128	Numeric data not allowed
-131	Invalid suffix [unrecognized units, or units not appropriate]
-138	Suffix not allowed
-141	Invalid character data [bad character, or unrecognized]
-144	Character data too long
-148	Character data not allowed
-150	String data error
-151	Invalid string data [e.g., END received before close quote]
-158	String data not allowed
-160	Block data error
-161	Invalid block data [e.g., END received before length satisfied]

Error	Error String
-168	Block data not allowed
-170	Expression error
-171	Invalid expression
-178	Expression data not allowed
-200	Execution error [generic]
-222	Data out of range [e.g., too large for this device]
-223	Too much data [out of memory; block, string, or expression too long]
-224	Illegal parameter value [device-specific]
-225	Out of memory
-270	Macro error
-272	Macro execution error
-273	Illegal macro label
-276	Macro recursion error
-277	Macro redefinition not allowed
-310	System error
-350	Too many errors [errors beyond 9 lost due to queue overflow]
-400	Query error [generic]
-410	Query INTERRUPTED [query followed by DAB or GET before response complete]
-420	Query UNTERMINATED [addressed to talk, incomplete programming message received]
-430	Query DEADLOCKED [too many queries in command string]
-440	Query UNTERMINATED [after indefinite response]
0	No error
1	Non-volatile RAM RDO section checksum failed
2	Non-volatile RAM CONFIG section checksum failed
3	Non-volatile RAM CAL section checksum failed
4	Non-volatile RAM WAVEFORM section checksum failed
5	Non-volatile RAM STATE section checksum failed
6	Non-volatile RAM STATE section checksum failed
10	RAM selftest
11	DAC selftest 1
12	DAC selftest 2
13	DAC selftest 3
14	DAC selftest 4
15	DAC selftest 5
16	DAC selftest 6
17	DAC selftest 7
18	DAC selftest 8
40	Voltage selftest error, output 1
41	Voltage selftest error, output 2
42	Voltage selftest error, output 3
43	Current selftest error, output 1
44	Current selftest error, output 2
45	Current selftest error, output 3
200	Outgrd not responding
201	Front panel not responding
210	Ingrd receiver framing error
211	Ingrd uart overrun status
212	Ingrd received bad token
213	Ingrd receiver buffer overrun

Error	Error String
214	Ingrd input buffer overrun
215	Outgrd output buffer overrun
216	RS-232C receiver framing error
217	RS-232C receiver parity error
218	RS-232C receiver overrun error
219	Ingrd inbuf count sync error
220	Front panel uart overrun
221	Front panel uart framing
222	Front panel uart parity
223	Front panel buffer overrun
224	Front panel timeout
401	CAL switch prevents calibration [refer to AC source Service Manual]
402	CAL passcode is incorrect
403	CAL not enabled
404	Computed readback cal constants are incorrect
405	Computed programming cal constants are incorrect
406	Incorrect sequence of calibration commands
600	Systems in mode:list have different list lengths
601	Requested voltage and waveform exceeds peak voltage capability
602	Requested voltage and waveform exceeds transformer volt-second rating
603	Command only applies to RS-232C interface
604	Trigger received before requested number of pre-trigger readings
605	Requested RMS current too high for voltage range
606	Waveform data not defined
607	VOLT,VOLT:SLEW, and FUNC:SHAPe modes incompatible

Table 53 : Standard Event Status Register (ESR) Error codes

Index