



**Programmable AC Source
31005/31010/31015/31020/31040
31005A/31010A/31015A/31020A/31040A
User's Manual**

Version A4
January 2009
P/N 151001

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Material Contents Declaration

A regulatory requirement of The United States of America defined by specification SJ/T 11364-2006 mandates that manufacturers provide a material contents declaration of electronic products. QuadTech's materials are listed below.

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls	Polybromodiphenyl Ethers
	Pb	Hg	Cd	Cr ⁶⁺	PBB	PBDE
PCBA	×	○	○	○	○	○
CHASSIS	×	○	○	○	○	○
ACCESSORY	×	○	○	○	○	○
PACKAGE	○	○	○	○	○	○

“○” indicates that the level of the specified chemical substance is less than the threshold level specified in the standards.

“×” indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards.

1. QuadTech, Inc. is not fully transitioned to lead-free solder assembly at this moment; however, most of the components used are RoHS compliant.
2. The environment-friendly usage period of the product is assumed under the operating environment specified in each product's specification.

Disposal

Do not dispose of electrical appliances as unsorted municipal waste. Please use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new ones, the retailer is legally obligated to take back your old appliances for disposal free of charge.



CE-Conformity Declaration

For the following equipment:

Product Name: Programmable AC Source

Model Name: 31005/31010/31015/31020/31040 / 31005A/31010A/31015A/31020A/31040A

Manufacturer's Name: QuadTech, Inc.

Manufacturer's Web Address: www.quadtech.com

is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States Relating to Electromagnetic Compatibility (89/336/EEC) and electrical equipment designed for use within certain voltage limits (73/23/EEC;93/68/EEC)

For electromagnetic compatibility, the following standards were applied:

EMC:	EN61326-1 (1997) :CISPR22 : 1994 + A1 Class A
	IEC 1000-3-2 : 1995 Harmonics Current
	IEC 1000-3-3 : 1995 Voltage Fluctuations
	IEC 1000-4-2 : 1995 Electrostatic Discharge
	IEC 1000-4-3 : 1995 Radio-Frequency Electromagnetic Field
	IEC 1000-4-4 : 1995 Fast Transient Burst
	IEC 1000-4-5 : 1995 Surge Immunity test
	IEC 1000-4-6 : 1996 Immunity To Conducted Disturbances, Induced By Radio Frequency Fields
	IEC 1000-4-11 : 1994 Voltage Dips, Short Interruptions and Voltage Variations Immunity Test

For safety requirement, the following standard was applied:

Safety: EN61010-1(1993)+A2(1995)

Maynard, MA, USA January, 2009

Place

Date

Vice President, Engineering

Warning :

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service and repair of this instrument. Failure to comply with these precautions or specific WARNINGS given elsewhere in this manual will violate safety standards of design, manufacturing and intended use of the instrument.

QuadTech, Inc. assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER

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

PROTECTIVE GROUNDING

Make sure to connect the protective grounding to prevent an electric shock before turning the power on.

NECESSITY OF PROTECTIVE GROUNDING

Never cut off the internal or external protective grounding wire or disconnect the wiring of the protective grounding terminal. Doing so will cause a potential shock hazard that may bring injury to a person.

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) can be used. Do not use different fuses or short-circuited fuseholders. To do so might 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 COVER OF THE INSTRUMENT

Operating personnel must not remove the cover of the instrument. Only qualified service personnel can do component replacement and internal adjustment.

WARNING	<i>LETHAL VOLTAGES. AC sources can supply 426V 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.</i>
----------------	--

Safety Symbols

	DANGER: High voltage.
	Explanation: To avoid injury, death of personnel or damage to the instrument, the operator must refer to an explanation in the instruction manual.
	Protective grounding terminal: To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
WARNING	A WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like which may result in injury or death of personnel if it is not rightly observed.

ACOUSTIC NOISE INFORMATION

This product has a sound pressure emission (at the operator's side) < 65dB(A).

Protection Plates

In order to protect the terminals of the QuadTech, Inc. 31000 AC power source from damage during shift or transportation, users can choose to install the enclosed rear panel protection plates (2 pieces).

Installation Instruction:

1. Remove the four screws from both sides of the rear panel (Figure 1).
2. Mount the protection plates with the screws included in the bag (Figure 2).

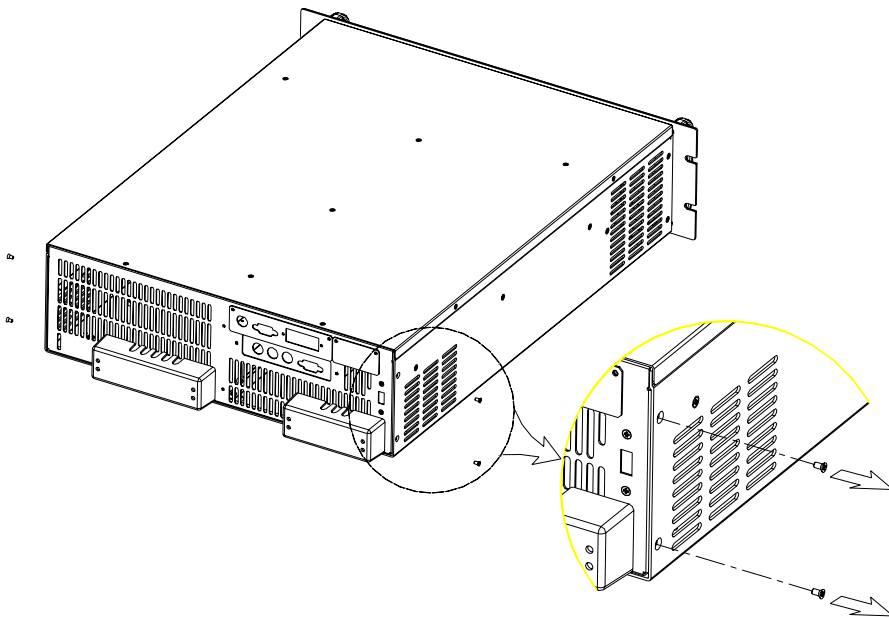


Figure 1

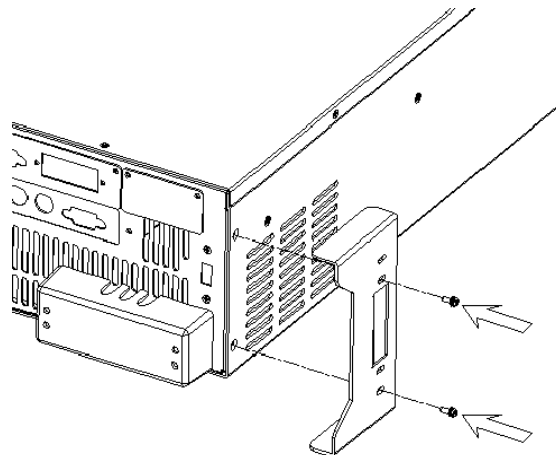


Figure 2

Revision History

The following lists the additions, deletions and modifications in this manual at each revision.

Date	Version	Revised Sections
Jan. 2009	1.0	Initial Release
Oct. 2009	A2	Move update
April 2010	A3	Update for 31000A Series
January 2011	A4	Update 2-1a and 2-1b Figures

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1. General Information

1.1 Introduction

The series of the QuadTech, Inc. AC sources 31000 Series and 31000A Series are high efficiency providing sine wave output with low distortion and accurate measurements of power. The DSP microprocessor generates accurate, stable output voltage and frequency. The PWM design of power stage allows for full volt-ampere into loads. The front panel has both RPG (rotary pulse generator) and keypad controls for setting the output voltage and frequency. The LCD provides a complete operating state of the unit to the user. Remote programming is accomplished either through the GPIB bus or the RS-232C serial port.

1.2 Key Features

A. Configuration

- Local operation from the keypad on the front panel.
- Remote operation via GPIB or RS-232C interface.
- Protection against Over-power, Over-Current, Over-temperature, Fan-fail.
- Temperature-controlled fan speed.
- Built-in output isolation relays.

B. Input/Output

- Selective output voltage with a full scale of 150V/300V/Auto.
- Remote control by the use of analog voltage reference.
- Universal of input voltage range 90Vac ~ 250Vac.
- Measurement of V, I, P, CF and PF.
- Remote inhibited control.
- AC ON/OFF output signal.

1.3 Specifications

The operation specifications of the models 31005/31010/31015/31020/31040 are listed. All specifications have been tested according to the standard QuadTech, Inc. test procedures. All specifications are based on a remote sense connection, $25 \pm 1^\circ\text{C}$ and resistor load unless otherwise specified.

Specifications	31005/31005A	31010/31010A	31015/31015A	31020/31020A	31040/31040A
Power/Phase					
Output Phase	1	1	1	1	1
Output Rating-AC	500VA	1000VA	1500VA	2000VA	4000VA
Voltage					
Range/Phase	150V/300V/Auto	150V/300V/Auto	150V/300V/Auto	150V/300V/Auto	150V/300V/Auto
Accuracy	0.2%+0.2%F.S.	0.2%+0.2%F.S.	0.2%+0.2%F.S.	0.2%+0.2%F.S.	0.2%+0.2%F.S.
Resolution	0.1V	0.1V	0.1V	0.1V	0.1V

Distortion*1		0.3% @ 50/60Hz1%, 15-1KHz (Typical)	0.3% @ 50/60Hz1%, 15-1KHz (Typical)	0.3% @ 50/60Hz1%, 15-1KHz (Typical)	0.3% @ 50/60Hz1%, 15-1KHz (Typical)	0.3% @ 50/60Hz1%, 15-1KHz (Typical)
Line Regulation		0.1%	0.1%	0.1%	0.1%	0.1%
Load Regulation *2		0.2%	0.2%	0.2%	0.2%	0.2%
Max. Current/Phase						
R.m.s.		4A/2A (150V/300V)	8A/4A (150V/300V)	12A/6A (150V/300V)	16A/8A (150V/300V)	32A/16A (150V/300V)
Peak		24A/12A (150V/300V)	48A/24A (150V/300V)	72A/36A (150V/300V)	96A/48A (150V/300V)	192A/96A (150V/300V)
Frequency						
Range		DC,15-1KHz	DC,15-1KHz	DC,15-1KHz	DC,15-1KHz	DC,15-1KHz
Accuracy		0.15%	0.15%	0.15%	0.15%	0.15%
Output Rating-DC						
Power		250W	500W	750W	1000W	2000W
Voltage		212V/424V	212V/424V	212V/424V	212V/424V	212V/424V
Current(per phase)		2A/1A (212V/424V)	4A/2A (212V/424V)	6A/3A (212V/424V)	8A/4A (212V/424V)	16A/8A (212V/424V)
Programmable Output Impedance						
Range		0Ω+200μH ~ 1Ω+1mH				
Harmonics & Inter-harmonics Simulation						
Bandwidth		2400Hz	2400Hz	2400Hz	2400Hz	2400Hz
Input Rating						
Voltage Range		90-250V, 1ø	90-250V, 1ø	90-250V, 1ø	90-250V, 1ø	190-250V, 3ø
Frequency Range		47-63Hz	47-63Hz	47-63Hz	47-63Hz	47-63Hz
Current(per phase)		10A Max. @ 90V	18A Max. @ 90V	22A Max. @ 90V	28A Max. @ 90V	14A Max. @ 190V
Power Factor *3		0.97 Min.	0.97 Min.	0.98 Min.	0.98 Min.	0.98 Min.
Measurement						
Voltage						
Range/Phase		150V/300V	150V/300V	150V/300V	150V/300V	150V/300V
Accuracy		0.2%+0.2%F.S.	0.2%+0.2%F.S.	0.2%+0.2%F.S.	0.2%+0.2%F.S.	0.2%+0.2%F.S.
Resolution		0.1V	0.1V	0.1V	0.1V	0.1V
Current						
Range(peak)		24A	48A	72A	96A	192A
Accuracy(r.m.s.)		0.4%+0.3%F.S.	0.4%+0.3%F.S.	0.4%+0.3%F.S.	0.4%+0.3%F.S.	0.4%+0.3%F.S.
Accuracy(peak)		0.4%+0.6%F.S.	0.4%+0.6%F.S.	0.4%+0.6%F.S.	0.4%+0.6%F.S.	0.4%+0.6%F.S.
Power						
Accuracy		0.4%+0.4%F.S.	0.4%+0.4%F.S.	0.4%+0.4%F.S.	0.4%+0.4%F.S.	0.4%+0.4%F.S.
Resolution		0.1W	0.1W	0.1W	0.1W	0.1W
Others						
Interface		GPIB,RS-232 (Optional)				
Temperature						
Operating		0~40°C	0~40°C	0~40°C	0 ~ 40°C	0 ~ 40°C
Storage		-40~+85°C	-40~+85°C	-40~+85°C	-40~+85°C	-40~+85°C
Safety & EMC						
CE (Include EMC & LVD)						
Dimensions(WxHxD)		482 x 132.6 x 570mm	482 x 132.6 x 570mm	482 x 132.6 x 570mm	482 x 132.6 x 570mm	482 x 265.9 x 570 mm
Weight		20 kg	20 kg	21 kg	21 kg	36 kg

Remarks:

*1: Maximum distortion is tested on output 125VAC (150V RANGE) and 250VAC (300V RANGE) with the maximum current to the linear load.

*2: Load regulation is tested with sine wave and remote sense.

*3: Efficiency is tested on input voltage 110V.

1.4 Names of Parts

1.4.1 The Front Panel

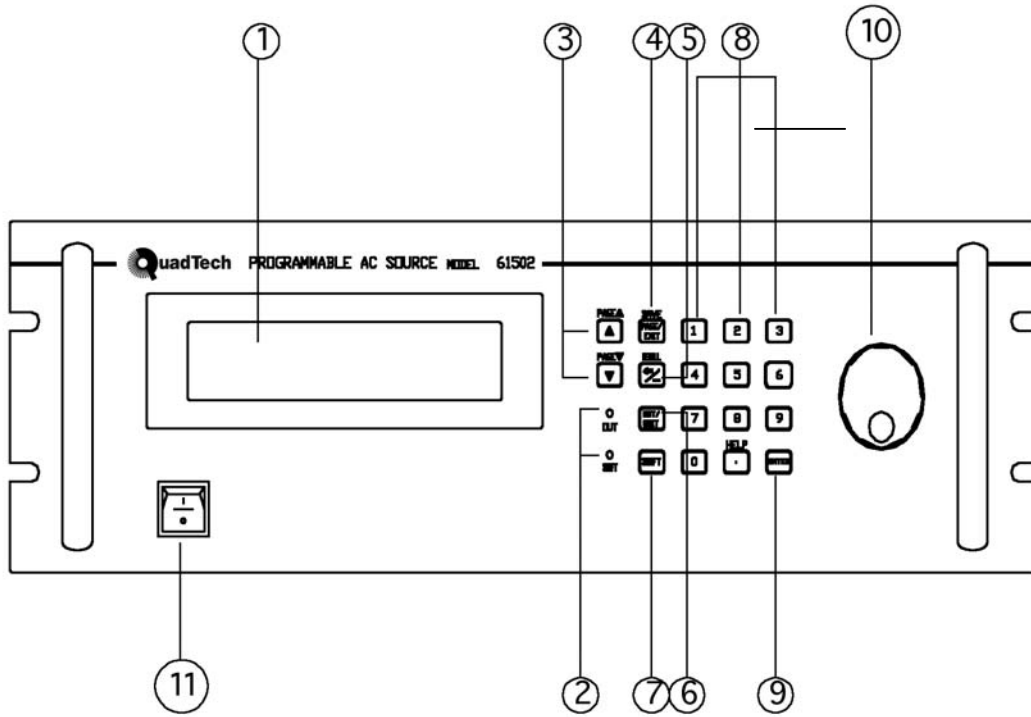












Figure 1-1 The Front Panel 31005 – 31020 and 31005A – 31020A

Table 1-1 The Description of the Front Panel 31005 – 31020 and 31005A – 31020A

Item	Symbol	Description
1		Display: The LCD is to display configuration, output setup and measurement results.
2		Indicator LED: "OUT" and "SHIFT" show the activation of output and shift modes, are available. They are on the keypad area next to the corresponding keys.
3	  -----or----- PAGE ▲ PAGE ▼	Cursor moving keys: These two keys are to move the cursor to different directions respectively. In normal mode, pressing any of these two keys will change the place of the cursor. Under shift mode, these keys enable the LCD display to change to the last page or the next page if there are ▲ or ▼ patterns in right-down side of display.
4	 -----or----- SAVE	PAGE or EXIT command key: Press this key to make the LCD display switch between the MAIN PAGE and the CHOICE PAGE. Change to the CHOICE PAGE in each functional list. Press this key under shift mode on the MAIN PAGE and users can save the output settings (see 3.8.1). If this key is pressed on the CHOICE PAGE, the user can save system data (see 3.8.2).
5	 -----or----- RECALL	Backspace and Minus command key: Press this key to erase the key-in number. It may show " - ," if no number is in front of the cursor. Under shift mode, press the key on the MAIN PAGE and the user can recall the output settings (see 3.8.1). If this key is pressed on the CHOICE PAGE, the user can recall system data (see 3.8.2).
6		OUT/QUIT command key: Press this key to enable the AC source output voltage or quit the output voltage.
7		Shift mode selection key: Press this key to switch the AC source from normal operational mode to the shift mode.
8	 -----or----- HELP	Numeric and decimal keys: The user can program numeric data by pressing the digital keys and the decimal key. Under shift mode, press the  to enable the HELP function. The LCD display will show more information about the cursor locating place.
9		ENTER key: It is to confirm the setting of parameters.
10		RPG: The user can input programming data or options by turning the RPG to the desired ones.
11		Main power switch: Powers system on and off.

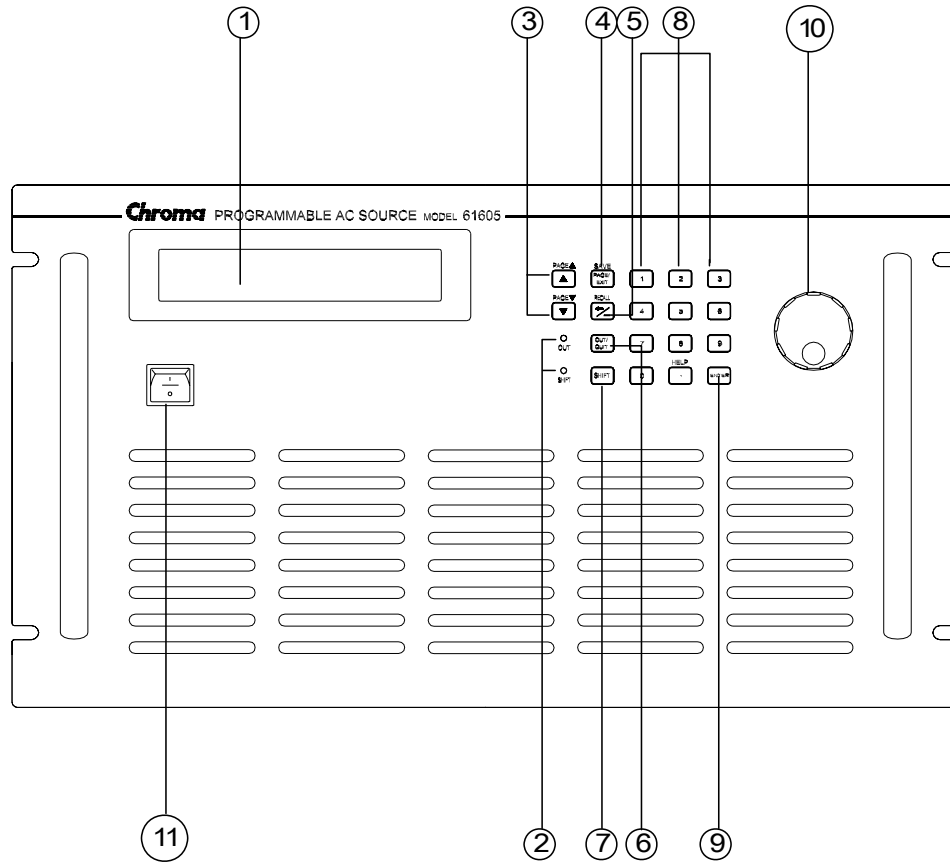











Figure 1-1A The Front Panel 31040 and 31040A

Table 1-1A The Description of the Front Panel 31040 and 31040A

Item	Symbol	Description
1		Display: The LCD is to display configuration, output setup, and measurement results.
2		Indicator LED: "OUT" and "SHIFT", for showing activation of output and shift mode, are available which are located on the keypad area next to the corresponding keys.
3	  -----or----- PAGE ▲ PAGE ▼	Cursor moving keys: These two keys are to move the cursor to different directions respectively. In normal mode, pressing any of these two keys will change the place of the cursor. Under shift mode, these keys enable the LCD display to change to last page or next page if there are ▲ or ▼ patterns in right-down side of display.
4	 ----- or -----	PAGE or EXIT command key: Pressing this key will make the LCD display switching between MAIN PAGE and CHOICE PAGE. Or change to CHOICE PAGE in each functional list. Under shift mode, pressing this key on MAIN PAGE, the user

	SAVE	can save the output setting (see 3.8.1). If pressing the key on CHOICE PAGE, the user can save system data (see 3.8.2).
5	 -----or----- RECALL	Backspace and Minus command key: Pressing this key will erase the keyin number. Or it may show " - ", if no number is in front of cursor. Under shift mode, pressing the key on MAIN PAGE, the user can recall the output setting (see 3.8.1). If pressing the key on CHOICE PAGE, the user can recall system data (see 3.8.2).
6	OUT/QUIT	OUT/QUIT command key: Pressing this key may enable the AC source output voltage or quit the output voltage.
7	SHIFT	Shift mode selection key: Pressing this key will switch the AC source from normal operational mode to the shift mode.
8	 to  , and  -----or----- HELP	Numeric and decimal keys: The user can program numeric data by pressing the digital keys and the decimal key. Under shift mode, pressing  acts the HELP function. The LCD display will show more information about cursor locating place.
9	ENTER	ENTER key: It is to confirm the setting of parameters.
10		RPG: The user can input programming data or options by turning the RPG to the desired ones.
11		Main power switch: It is to power on or off.

1.4.2 The Rear Panel

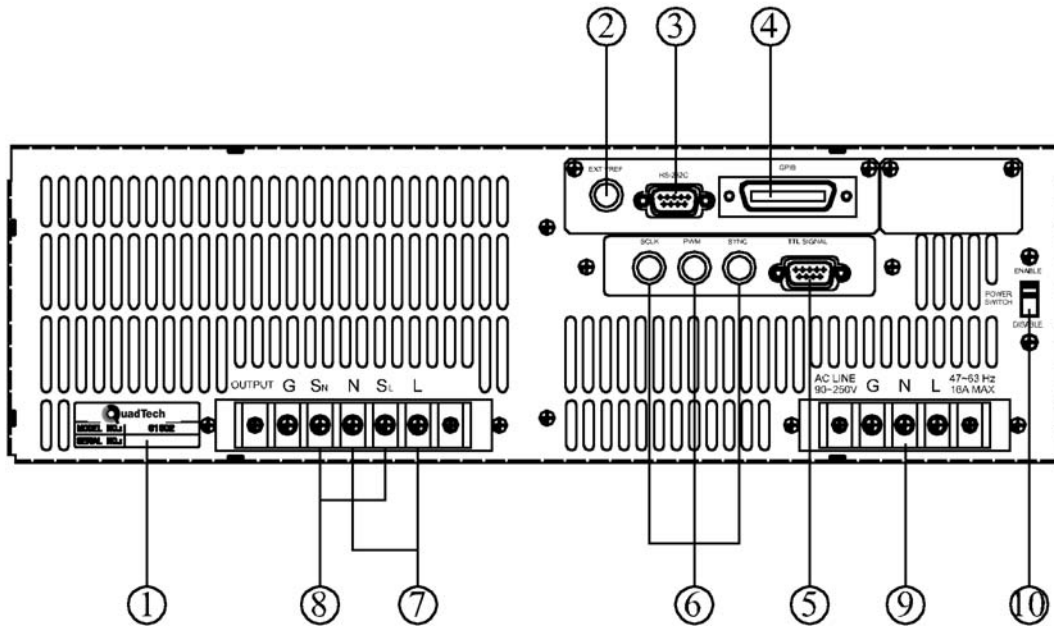


Figure 1-2 The Rear Panel 31005 – 31020 and 31005A – 31020A

Table 1-2 The Description of the Rear Panel

Item	Name	Description
1	Label	The label includes the model number and the series number of the AC source.
2	Ext. Ref.	The BNC connector inputs control waveform amplitude from the external analog signal.
3	RS-232C	The 9-pin, D-type female connector transfers control commands to and from the remote PC for remote operation.
4	GPIB Connector	A remote controller using GPIB bus is connected to the AC source through this connector for remote operation.
5	TTL SIGNAL	The 9-pin, female connector transfers control signals (fault_out, remote inhibit, and AC_ON).
6	SCLK, PWM, SYNC	The BNC connectors SCLK and PWM are only for the AC source parallel connectivity. SYNC transfers a pulse signal synchronously when output changes. It also sends synchronizing signal for 3-PHASE MODE operation.
7	Output Connector	This connector outputs power to the loading device.
8	Remote Sense Connector	It senses directly at the terminals of the load to eliminate any voltage drop on the connecting cable. Be sure to connect the terminal “SL” of the remote sense connector to the terminal “L” of the load and the “SN” to the “N” of the load. Reverse polarity is not allowed.
9	Power Line in Connector	Power line input is connected to the AC source through this connector.
10	POWER SWITCH	It enables or disables the main power switch. Users can power

on or off with the main power switch when the power switch is set to "ENABLE." Equally, the main power switch is inactive when the power switch is set to "DISABLE."

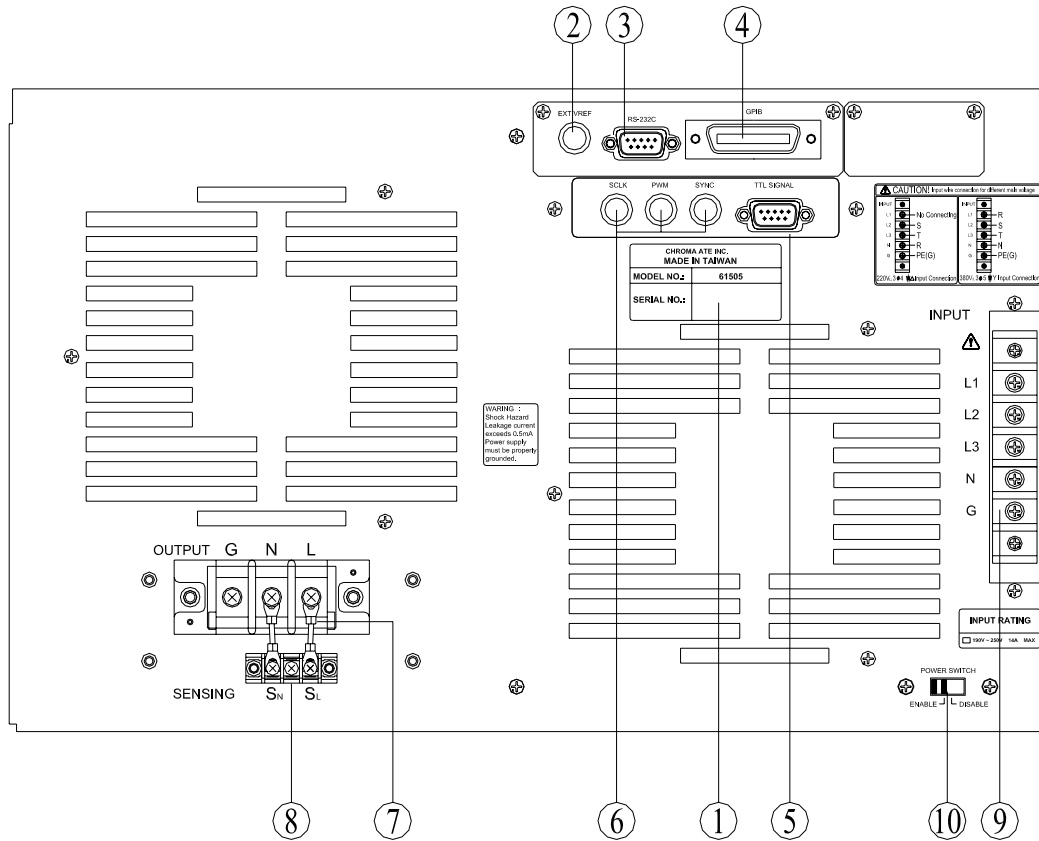


Figure 1-2A The Rear Panel 31040/31040A

Table 1-2A The Description of the Rear Panel

Item	Name	Description
1	Label	The label includes model number, series number of the AC source.
2	Ext. Ref.	The BNC connector inputs control waveform amplitude from external analog signal.
3	RS-232C	The 9-pin, D-type female connector transfers control commands to and from the remote PC for remote operation.
4	GPIB Connector	A remote controller using GPIB bus is connected to the AC source through this connector for remote operation.
5	TTL SIGNAL	The 9-pin, female connector transfers control signals (fault out, remote inhibit, and AC ON).

6	SCLK, PWM, SYNC	The BNC connectors SCLK and PWM are for AC source parallel connectivity only. SYNC transfers a pulse signal synchronously when output changes. It also sends synchronizing signal for 3-phase mode operation.
7	Output Connector	This connector outputs power to the loading device.
8	Remote Sense Connector	It senses directly at the terminals of the load to eliminate any voltage drop on the connecting cable. Make sure of connecting the terminal “SL” of the remote sense connector to the terminal “L” of the load, and the “SN” to the “N” of the load. Reverse polarity is not allowed.
9	Power Line in Connector	Power line input is connected to the AC source through this connector.
10	POWER SWITCH	It enables or disables the main power switch. Users can power on or off the main power switch when the power switch is set to “ENABLE”. Conversely the main power switch is inactive when the power switch is set to “DISABLE”.

2. Installation

2.1 Inspection

After unpacking the instrument, please inspect any damage that may have occurred during the shipment. Save all packing materials in case the instrument has to be returned.

If any damage is found, please file a claim with the carrier immediately. Do not return the instrument to the factory without obtaining the prior RMA acceptance from QuadTech, Inc.

2.2 Preparation for the Use

In the beginning, the instrument must be connected with an appropriate AC line input. Since the instrument is automatically cooled by fans, it must be installed in sufficient space for circulation of air. It should be used in an area where the ambient temperature does not exceed 40°C.

2.3 Requirements for Input Power

2.3.1 Ratings 31000 and 31000A Series excluding the 31040/31040A

Input Voltage Range:	90 ~ 250 Vac, single phase
Input Frequency:	47-63 Hz
Max. Current:	31005/31005A : 4A
	31010/31010A : 8A
	31015/31015A : 12A
	31020/31020A : 16A

Caution: The AC source will be damaged if it is operated at an input voltage that is outside its configured input range.

2.3.2 Input Connection 31000 and 31000A Series excluding the 31040/31040A

The input terminal block is located on the rear panel of the instrument. The power cord must be a three-conductor cord rated for at least 85°C. The power line input must have a current rating, which is greater than or equal to the maximum current rating of the AC source. Do not use three separate wires to connect power to the input of the AC source.

See figure 2-1 and do the following one by one:

1. Remove the safety cover from the back of the AC source.
2. Screw the power cord to the terminal blocks of the AC source as follows:
 - Green or green/yellow wire to the terminal labeled "G."
 - White or blue wire to the terminal labeled "N."

Black or brown wire to the terminal labeled “L.”

3. Slip the safety cover over the ac input terminal strip and secure the cover with two screws.

***** WARNING *****

To protect the operators, the wire connected to the GND terminal must be connected to the earth ground. Under no circumstances shall this AC source be operated without an adequate ground connection.

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

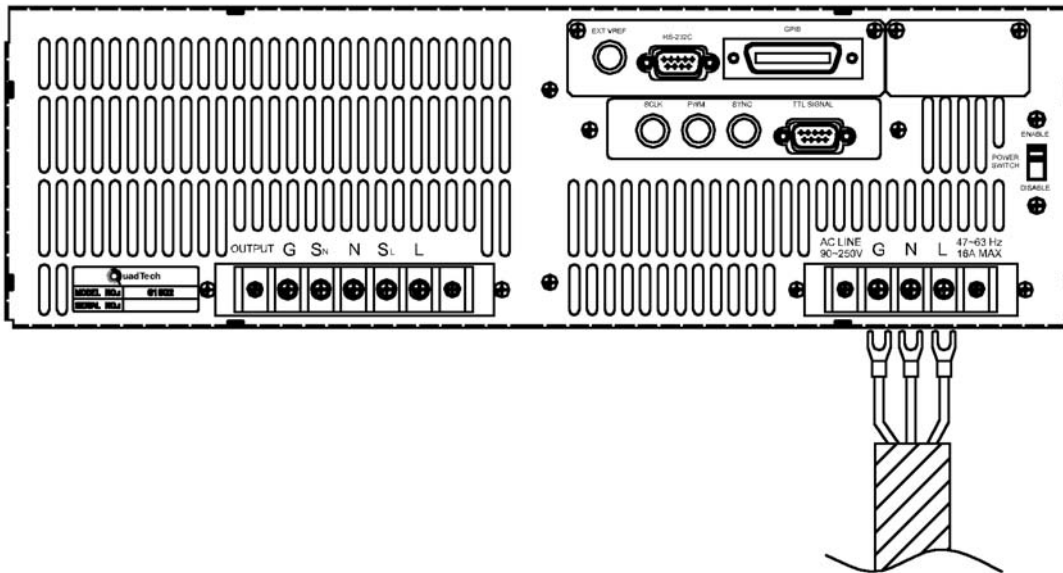


Figure 2-1 Input Connection 31000 Series excluding the 31040

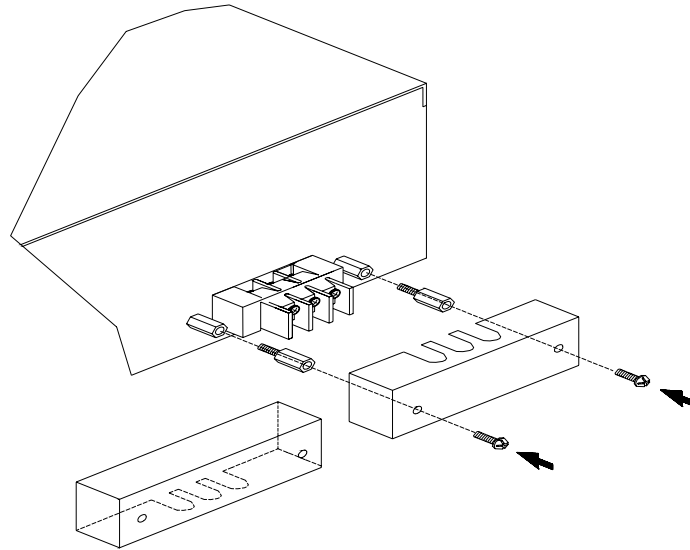


Figure 2-2 Input Terminal Cover 31000 Series excluding the 31040

2.3.3 Ratings for 31040 and 31040A

Input Voltage Range:	190-250 V _{LL} , 3 phases 4 wires Δ , or 329-433 V _{LL} , 3 phases 5 wires Y
Input Frequency:	47-63 Hz
Max. Current:	14 A, per phase.

Caution: The AC source will be damaged if operated at an input voltage that is outside the configured input range.

2.3.4 Input Connection for 31040 and 31040A

The input terminal block is located on the rear downside panel of the instrument. The power cord must be rated at least for 85°C. The power line input must have a current rating, which is greater than or equal to the maximum current rating of the AC source.

***** CAUTION *****

There are two different input voltage rating. One is 380 V_{LL} 3 phases 5 wires (Y), and another is 220 V_{LL} 3 phases 4 wires (Δ). Be careful to verify that what kind of the main voltage you have.

See figure 2-2 and do the following things one by one:

4. Remove the safety cover from the back of the AC source.
5. Screw the power cord to the input terminal blocks of the AC source (see Figure 2-1).

- Slip the safety cover over the AC input terminal strip and secure the cover with two screws.

***** WARNING *****

To protect the operators, the wire connected to the GND terminal must be connected to the earth ground. Under no circumstances shall this AC source be operated without an adequate ground connection.

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

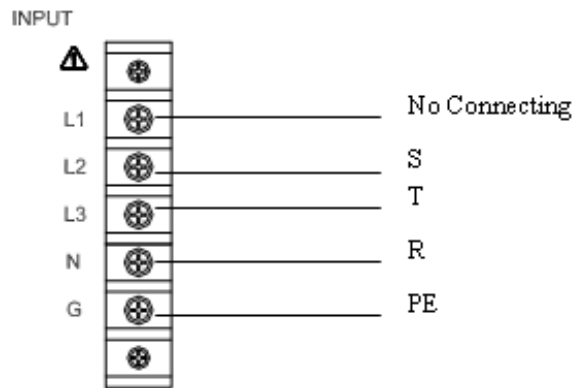


Figure 2-1a 220 3-Δ Input Connection

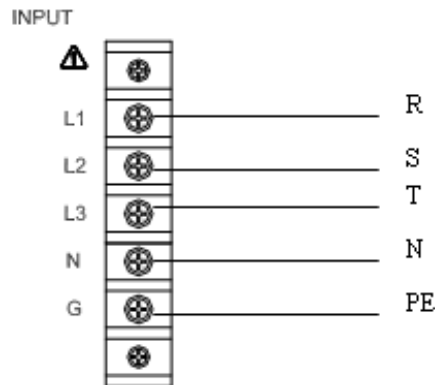


Figure 2-1b 380 3-Y Input Connection

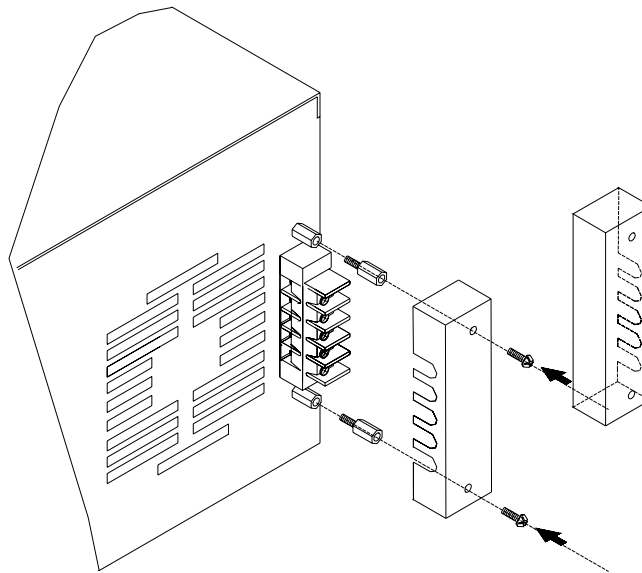


Figure 2-2 Input Terminal Cover 31040

2.4 Output Connection

The output terminal block is located at the rear of the AC source. Loads connecting to the "N" and "L" are done at the output terminals. To meet the safety requirements, the safety cover must be fastened. The wires to the load must be sufficiently large gauges, so they will not overheat while carrying the output current. Please see figure 2-3 on the next page.

***** NOTICE *****

Output terminal labeled "L" is the "+" terminal, terminal labeled "N" is the "-" terminal when output voltage contains DC composition.

2.5 Remote Sense Connection

The remote sense function of the AC source monitors the voltage at the load instead at the output terminal of the AC source. It ensures the delivery of accurate voltage as programmed at the load by automatically compensating the output voltage drop over the connecting cable.

Remove the iron jumper from the “S_N” and “S_L” terminals, connect the remote sense to the load as shown in Figure 2-3. Because the sensing leads carry only a few milliamperes, the wires for sensing are a much smaller gage than the load leads. The sensing leads are part of the feedback path of the AC source therefore, they must be kept at a low resistance in order to maintain the best performance. Carefully connect the sensing leads so they will not be open-circuited. If the sensing leads are left unconnected or become open-circuited during operation, the AC source will disable the output. The sensing leads must be a twisted pair to minimize the pickup of external noise. The sensing leads need to be connected to the load as closely as possible.

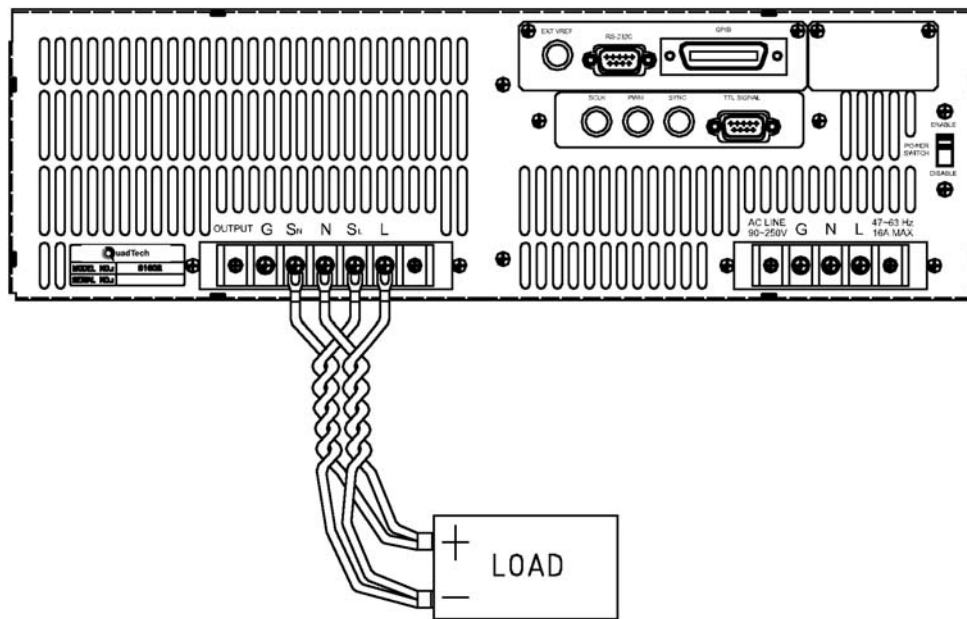


Figure 2-3 Output and Remote Sense Connection 31005 - 31020

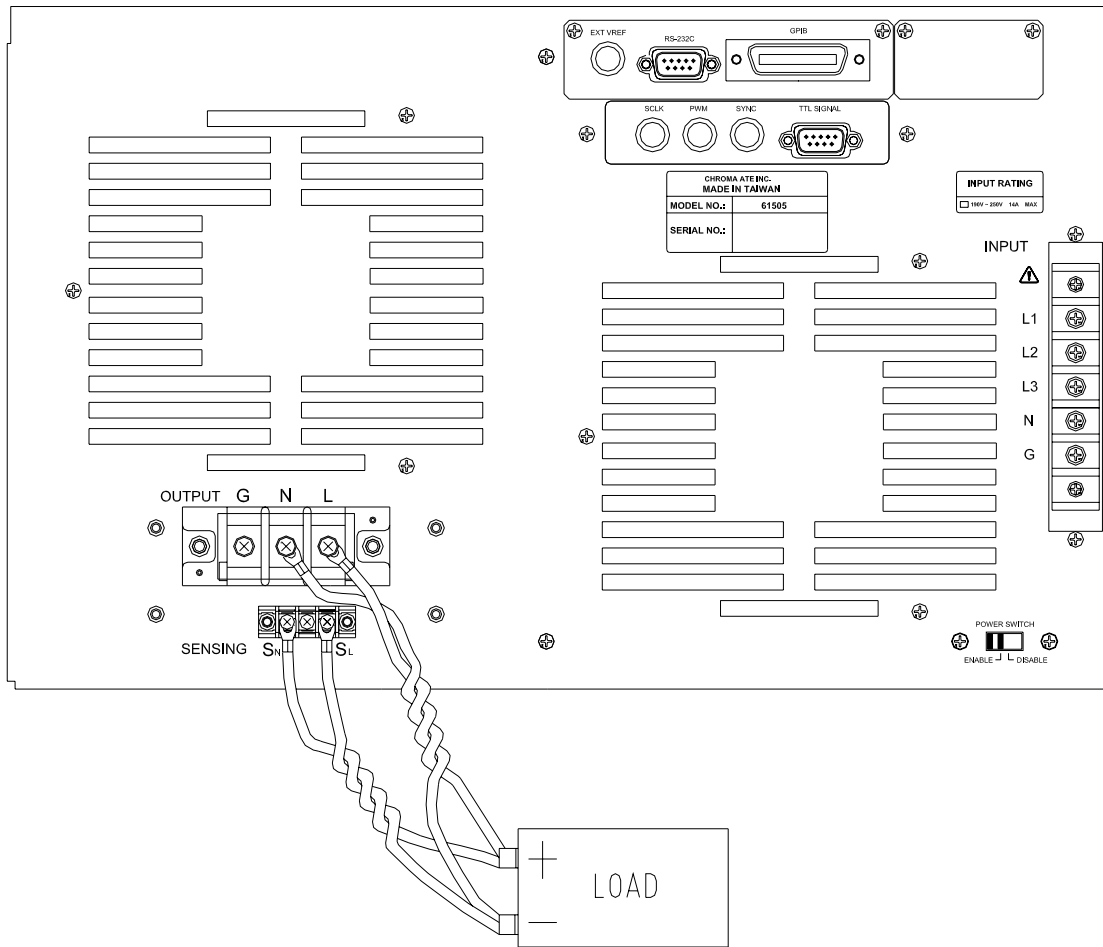


Figure 2-3A Output and Remote Sense Connection 31040 and 31040A

2.6 The Procedures of Power-on

***** WARNING *****

Before turning the instrument on, all protective earth terminals, extension cords and devices connected to the instrument must be connected to a protective earth ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Apply the line power and turn on the power switch on the front panel. The AC source will do a series of self-tests. The LCD on the front panel will light up and display as below:

SELF TEST
WAIT

Meanwhile, the AC source self-tests the memory, data and communication. After the routines of the self-test are complete, the display shows the MODEL number and the serial number of the AC source. It will also display an "OK" at the right side of each test item indicating that the item is no problem. It takes about six seconds to complete the routines of the self-test. The display then shows the versions of the software as below.

MODEL : 31010	SERIAL NO : 123456
1. DISPLAY < OK >	Ver : 1.25
2. WAVEFORM < OK >	Ver : 1.34
3. REMOTE < OK >	Ver : 1.20

If any failure is detected on a certain item, an "ERROR CODE" will be shown at the right side of that item. The error messages and trouble-shooting are shown in Section 6.2. The test item "3. REMOTE" shows < EMPTY >, if the option board (with GPIB and RS-232) is not connected.

After finishing memory, data and communication self-test, the AC source will perform the power output self-test. In this procedure, the output relays are in the OFF status to sure not harming the load connecting on the output terminal. The AC source will program 300VAC and measure the voltage. If the measured voltage is over $300V \pm 5V$, the power self-test fails, and the display will show "NG." If the test passes, the display is shown below. Next, it will automatically change to the MAIN PAGE.

PE N T S R PF

***** NOTICE *****

1. The user can do diagnosis if an error or NG happens in the power-on self-test procedure. Please see 6.2.
2. The digital circuit inside the AC source may not reset if you turn off power then turn it back on immediately. QuadTech, Inc. suggests waiting more than three seconds before restoring power.

2.7 I/O Connectors (Option)

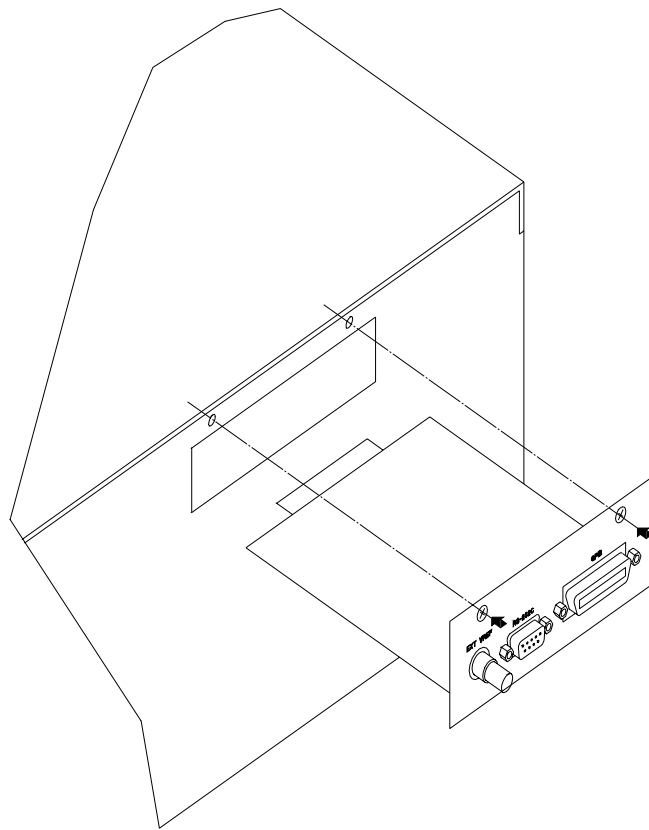


Figure 2-4 Option Board

3. Local Operation

3.1 Introduction

The AC source can be configured to operate in local or remote mode. The operation in remote mode through a remote GPIB controller or RS-232C will be described in Chapter Seven. In this section the operation in local mode through the keypad on the front panel for data entry and test will be described. The AC source is configured for local operation when it is powered-on.

3.2 Operation through Keypad and RPG

The AC source provides the user-friendly programming interface using the keypad and RPG (Rotary Pulse Generator) on the front panel to the user. Each display of the LCD on the AC source represents an operational menu.

The command tree is shown in Figure 3-1. Before describing each menu, the following figure shows how to use the keypad and RPG to set command. When the procedure of power-on is finished (see 2.6), the display will show the MAIN PAGE as below.

Vac = 0.0	F = 60.00	Vdc = 0.0	H
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

Press the ▲, ▼ to move cursor and choose the item. Use numeric and decimal keys or RPG to set value and then press **ENTER** to confirm. The user can press **PAGE/EXIT** to change to the CHOICE PAGE as below. Or press **PAGE/EXIT** again to return to the MAIN PAGE.

PAGE CHOICE = 1_
1. SETUP 2.CONF 3.OUTPUT 4. MANUAL CALI

In the CHOICE PAGE, the user can press the numeric key then **ENTER** to choose the functional lists. After entering each functional list, press the ▲, ▼ to move cursor to a destination. If the setting is expressed by a number, the user can use the numeric and the decimal keys, or RPG, to set value. Press **ENTER** to confirm. If the setting is expressed by words, the user can turn RPG to choice, then press **ENTER** to confirm.

If there are ▲ or ▼ patterns on the right-down side of the display, it means there are functional lists on the last page or next page. The user can press **SHIFT**, then ▲ or ▼ to change page. When finished setting, press **PAGE/EXIT** to return to the CHOICE PAGE.

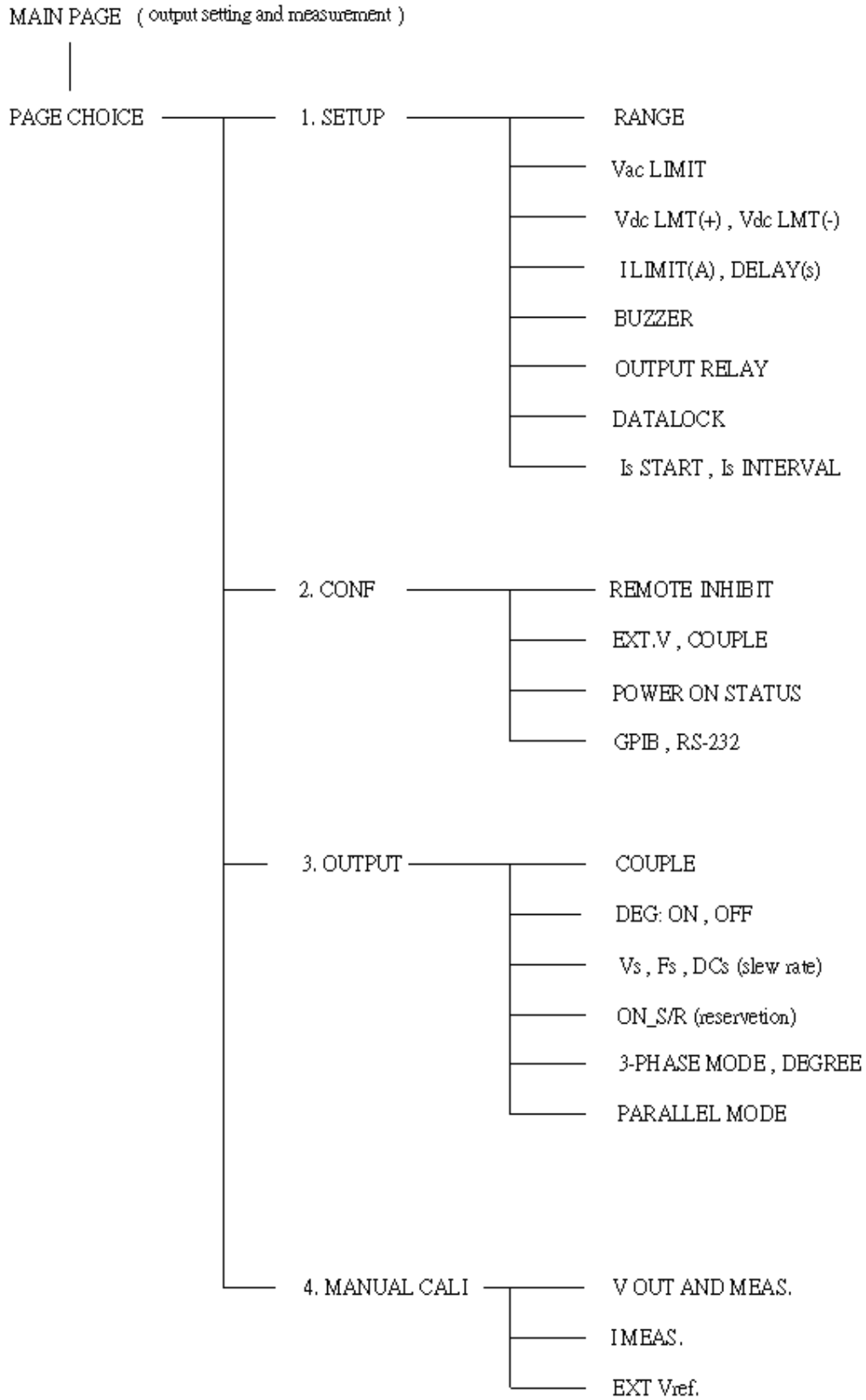


Figure 3-1

3.3 MAIN PAGE (Output Setting and Measurement)

When the user turns on the AC source and after the self test completes, the display shows the MAIN PAGE. The upper line of the display shows the output settings. The state of the default output settings can be set on POWER-ON STATUS in CONF functional list (see 3.6.3). The lower lines show the measurements of AC source output. Please see the following.

Vac = 0.0	F = 60.00	Vdc = 0.0	L
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

Press the **SHIFT**, then ▲ or ▼ to change to next page. Please see the following.

Vac = 0.0	F = 60.00	Vdc = 0.0	L
Vdc = 0.00	Idc = 0.00	Ip = 0.0	▲
Is = 0.0	VA = 0.0	VAR = 0.0	▼

On the right-up side of the display, a letter "L" shows the status of RANGE (see 3.5.1). The definition of the letters:

- L: 150V RANGE
- H: 300V RANGE
- : 600V RANGE
- A: AUTO RANGE

The definitions of the output setting parameters:

- Vac: The AC composition of output voltage in Volts.
- F: The output frequency in Hertz.
- Vdc: The DC composition of output voltage in Volts.

***** NOTICE *****

When COUPLE = AC+DC, the output is the combination of Vac and Vdc. The combination of peak voltage cannot exceed the limit of each range (150V RANGE: 212.1V, 300V RANGE: 424.2V). If this occurs, the output voltage will be shutoff to 0V automatically and show the protection condition.

The definitions of measurement parameters:

V : The measurement reading of Voltage in Volts. (true RMS measurement)

F : The output Frequency in Hertz.

I : The measurement reading of Current in Amperes. (true RMS measurement)

P : The true Power measurement in Watts.

PF : The Power Factor and its calculation formula = true power/ (Vrms × Irms)

CF : The Crest Factor and its calculation formula = Ipeak/Irms.

Vdc : The DC composition measurement reading of Voltage in Volts.

Idc : The DC composition measurement reading of Current in Amperes.

Ip : The peak current measurement in Amperes.

Is : I surge and only measured from the occurrence of output transition as defined in 3.5.8.

VA : Apparent Power in Watts and its calculation formula = Vrms × Irms.

VAR : Calculation formula = $\sqrt{VA^2 - P^2}$

3.4 CHOICE PAGE (Functional List Choice)

If displays on the MAIN PAGE or on functional list, press the **PAGE/EXIT** to change to the CHOICE PAGE as below :

PAGE CHOICE = 1_

1. SETUP 2.CONF 3.OUTPUT 4. MANUAL CALI

Users can press **1** - **4** to choose operational list items, then press **ENTER** to confirm it.

The display will switch to the MAIN PAGE when **PAGE/EXIT** is pressed on the CHOICE PAGE.

3.5 SETUP Functional List

On the CHOICE PAGE (see 3.4), press **1** then **ENTER**, choose the SETUP functional list.

PAGE CHOICE = 1_

1. SETUP 2.CONF 3.OUTPUT 4. MANUAL CALI

RANGE = 150V	[SETUP]
Vac LIMIT = 300V	
Vdc LMT (+) = 424.2 V	Vdc LMT (-) = 0.0V
I LIMIT (A) = 0.0	DELAY (S) = 0.0
	▼

Press the **SHIFT**, then ▼ to change to next page.

BUZZER = ON	OUTPUT RELAY = ON	[SETUP]
DATALOCK = OFF		
Is START = 0.0	ms	
Is INTERVAL = 50.0	ms	▲

3.5.1 RANGE

The AC source supplies a full range of output voltage with three options of 150 V, 300 V or AUTO. The user can set RANGE on SETUP functional list (see 3.5). This parameter controls relays to the parallel (150V RANGE) or series (300V RANGE) power stages to obtain more current or higher voltage. The 600V range can only work with the optional A615003 Boost Transformer. The AUTO range means that the output range switches automatically between 150V and 300V as needed.

Set the range of output voltage to AUTO as below:

1. Move the cursor to the command line, Range.

Range = 300V_

2. Turn the RPG to change the option from "300V" to "AUTO," then press **ENTER**.

Range = AUTO

***** NOTICE *****

The AC source will initially set the output voltage as 0V in order to eliminate a voltage spike when the range changes. Then, it will set the output voltage as the set value. It may cause the UUT to shutdown if the output is active when range changes.

3.5.2 Vac LIMIT

The setting of the Vac LIMIT will restrict the value of Vac in the MAIN PAGE. The user can set the Vac LIMIT on the SETUP functional list (see 3.5). This command is about user-programmable protection, not hardware protection.

The procedures for setting the Current Vac LIMIT = 120V, are described as below:

1. Move the cursor to the command line of "Vac LIMIT = ."

Vac LIMIT = 300.0_

2. Press **[1]**, **[2]**, **[0]**, then press **ENTER** to change the value to "120.0."

Vac LIMIT(A) = 120.0

*** NOTICE ***

The setting of the Vac LIMIT is not restricted by the RANGE, but the Vac on the MAIN PAGE is restricted by the RANGE. For example, in 150V RANGE, although Vac LIMIT=200V can be set, the largest value of the Vac setting is 150V.

3.5.3 Vdc LIMIT (+), Vdc LIMIT (-)

Vdc LIMIT (+) and Vdc LIMIT (-) control the setting value of the Vdc on the MAIN PAGE. The user can set both on the SETUP functional list (see 3.5). The setting value of Vdc cannot be higher than the Vdc LIMIT (+), or can not be lower than Vdc LIMIT (-). The Vdc LIMIT (+) must be positive or zero, the Vdc LIMIT (-) must be negative or zero. This command is about user-programmable protection, not hardware protection.

The procedures of the setting of Vdc LMT (+)=200V, Vdc LMT (-)=-50V, are described below:

1. Move the cursor to the command line of "Vdc LIMIT(+) = ."

Vdc LMT(+) = 424.2_ Vdc LMT(-) = 0.0

2. Press **[2]**, **[0]**, **[0]**, then press **ENTER** to change the value to "200.0."

Vdc LMT(+) = 200.0 Vdc LMT(-) = 0.0_

3. The cursor moves to the command line of "Vdc LIMIT(-) = " automatically.

Vdc LMT(+) = 200.0 Vdc LMT(-) = -50_

4. Press **[← / -]**, **[5]**, **[0]**, then press **ENTER** to change the value to "-50.0."

Vdc LMT(+) = 200.0 Vdc LMT(-) = -50.0

***** NOTICE *****

1. The setting of the Vdc LIMIT is not restricted by the RANGE, but the Vdc on the MAIN PAGE is still restricted by the RANGE. For example, in 150V RANGE, although Vdc LIMIT=250V can be set, the largest value of Vac setting is 212.1V.
2. When the AC source output contains Vdc, it's better to restrict the value of the Vdc. It may cause damage if the output polarity is reverse, especially if the load is polar.

3.5.4 I LIMIT, DELAY

Limitation of the output RMS current and delay time are the parameters for triggering over-current protection. The user can set both on SETUP functional list (see 3.5). The discussion of limitation in this command is about user-programmable protection, not hardware protection.

The procedures of setting the Current limit = 4A, Delay time = 1 sec. are described as below:

1. Move the cursor to the command line of "I LIMIT(A) = ."

I LIMIT(A) = 0.00_ DELAY(S) = 0.0

2. Press **4**, then press **ENTER** to change the value to "4.00."

I LIMIT(A) = 4_ DELAY(S) = 0.0

3. The cursor moves to the command line of "DELAY(S) =" automatically.

I LIMIT(A) = 4.00 DELAY(S) = 0.0_

4. Press **1**, then **ENTER** to change the value to "1.0."

I LIMIT(A) = 4.00 DELAY(S) = 1.0_

***** NOTICE *****

1. "I LIMIT (A) = 0," means the limitation of the output current is equal to the specification.
2. DELAY time is valid for eliminating a transient current spike, but will not work when the output current is over specification. The resolution is 0.5s.

3.5.5 OUTPUT RELAY

There are relays on the output of the AC source for the connection to load. When the output relay is “ON,” the output relay is closed regardless of the fact that the output status of the AC source is in QUIT mode. When output relay is “OFF,” the output relay is closed only if the output status is in RUN mode. If the output status is in QUIT mode, the output relay will be opened. The user can set the OUTPUT RELAY on SETUP functional list (see 3.5).

Set the output relay to ON as below:

1. Move the cursor to the command of OUTPUT RELAY.

OUTPUT RELAY=OFF_

2. Turn RPG to set output relay ON, then press **ENTER**.

A click will sound from the AC source when output relay is activated.

OUTPUT RELAY= ON

*** NOTICE ***

Before powering off, please confirm that the AC SOURCE is NOT Outputting voltage. To ensure the life of the AC SOURCE, powering off under output status ON is NOT recommended.

3.5.6 BUZZER

The buzzer of the AC source beeps when the user presses the keypad on the front panel or turns the PRG knob. If the user does not need it, it can be turned off. The user can set the BUZZER on the SETUP functional list (see 3.5).

To turn off the buzzer as follows:

1. Move the cursor to the command line of the “Buzzer=.”

Buzzer = ON_

2. Turn RPG to change the option from ON to OFF, then press **ENTER**.

Buzzer = OFF

3.5.7 DATA LOCK

The AC source allows the user to lock data entries, so the pre-defined parameters will be protected from being modified by an unauthorized user. The user can set DATA LOCK on the SETUP functional list (see 3.5). The user also can set DATA LOCK = FUNC to operate “One-key Recall.” This it means the user can recall the voltage output setting, which is stored in the memory (see 3.8.1) by pressing **1**- **9** key directly in the Main Page.

The procedures for setting data lock are shown as below:

1. Move the cursor to the command line of "DATALOCK=."

DATALOCK = OFF_

2. Turn RPG to change the option from OFF to ON, then press **ENTER** .

DATALOCK = ON

***** NOTICE *****

1. The user must select OFF to unlock.
2. If users use FUNC, please be sure the voltage output settings are stored in the memory. Unexpected voltage output may damage the UUT.

3.5.8 Is START, Is INTERVAL

"Is" is the surge peak current of the AC source output shown in the MAIN PAGE. "Is" measurement starts at Is START after the output voltage transition. The length of measurement time is called "Is INTERVAL." The user can set both on the SETUP functional list (see 3.5).

The procedures of setting Is START=10ms, Is INTERVAL=200 ms, are described as below :

1. Move the cursor to the command line of "Is START= ."

Is START= 0.0_ ms

2. Press **1**, **0**, then press **ENTER** to change the value to "10.0."

Is START = 10.0 ms

3. The cursor moves to the command line of "Is INTERVAL =" automatically.

Is INTERVAL = 50.0_ ms

4. Press **2**, **0**, **0**, then press **ENTER** to change the value to "200.0."

Is INTERVAL = 200.0_ ms

3.6 CONF Functional List

On the CHOICE PAGE (see 3.4), press **2**, then **ENTER** and choose the CONF functional list.

```

PAGE CHOICE = 2_
1. SETUP  2.CONF  3.OUTPUT  4. MANUAL CALI
  
```

```

REMOTE INHIBIT = OFF           [ CONF ]
EXT. V =OFF           COUPLE = AC-AMPLIFIER
                                                                    ▼
  
```

Press **SHIFT**, then **▼** to change to next page.

```

POWER ON STATUS :  Output = OFF   [ CONF ]
Vac = 0.0          F = 60.00      Vdc = 0.0
ADDR = 0           PARITY = NONE
BAUD = 9600
                                                                    ▲
  
```

3.6.1 REMOTE INHIBIT

The output of the AC source can be inhibited by the external control or by the manual trigger. The remote inhibit signal is received from a 9-pin male connector on the rear panel (see Appendix A). The user can set the REMOTE INHIBIT on the CONF functional list (see 3.6). There are three states for the feature of remote inhibit: OFF, LIVE and TRIG.

OFF: Disables the feature of remote inhibit.

LIVE: The output of the AC source will be disabled if TTL signal is LOW but will be enabled if the TTL signal is HIGH.

TRIG: The output of the AC source will be disabled if TTL signal is LOW and will remain in that state even if the TTL signal becomes HIGH. The user has to press **ENTER** to reset the AC source.

The procedures of setting from OFF to LIVE are shown as below:

1. Move the cursor to the command of "REMOTE INHIBIT" to set the inhibition by the TTL signal from the external control.

```

REMOTE INHIBIT =OFF_
  
```

2. Turn RPG to change the option from OFF to LIVE, then press **ENTER**.

REMOTE INHIBIT =LIVE

***** NOTICE *****

The remote inhibit is a TTL signal transferred by a special I/O connector. For details please refer to pin assignment in Appendix A.

3.6.2 EXT. V, COUPLE

The AC source allows users to utilize the controlled analog signals from external devices for setting the output. The BNC connector of the EXT Vref on the rear panel allows the user to apply signals to the AC source for setting the output voltage. The user can set EXT. V and COUPLE on the CONF functional list (see 3.6). There are two coupling modes to present the AC source output from external V reference: AC_AMPLIFIER and DC_LEVEL_CTL.

AC_AMPLIFIER : The output voltage (Vout) is the synthesis of voltage programming on the MAIN PAGE and the amplification of external V reference with Voltage range from -10 V to 10 V. When Vac=0 and Vdc=0 on the MAIN PAGE, Vout can be calculated using the following formula :

$$\begin{aligned} V_{out} (dc) &= V_{ref} (dc) / 10 V_{dc} \times 424.2 V_{dc} \quad (300V \text{ RANGE}) \\ V_{out} (dc) &= V_{ref} (dc) / 10 V_{dc} \times 212.1 V_{dc} \quad (150V \text{ RANGE}) \end{aligned}$$

or

$$\begin{aligned} V_{out} (ac) &= V_{ref} (ac) / 7.072 V_{ac} \times 300 V_{ac} \quad (300V \text{ RANGE}) \\ V_{out} (ac) &= V_{ref} (ac) / 7.072 V_{ac} \times 150 V_{ac} \quad (150V \text{ RANGE}) \end{aligned}$$

Example (1): set Vout to 100Vdc:

1. Select RANGE = 300V in SETUP functional list, apply external V= 2.357Vdc, the Vout = 100Vdc.
2. Select RANGE = 150V in SETUP functional list, apply external V= 4.715Vdc, the Vout = 100Vdc.

Example (2) : set Vout to 100Vac :

1. Select RANGE = 300V in SETUP functional list, apply external V= 2.357Vac, the Vout = 100Vac.
2. Select RANGE = 150V in SETUP functional list, apply external V= 4.715Vac, the Vout = 100Vac.

DC_LEVEL_CTL: The output voltage (Vout (ac)) responds linearly proportional to the controlled DC level with voltage ranging from -10 V to 10 V. Vout can be calculated using the following formula:

$$\begin{aligned} V_{out} (ac) &= | V_{ref} (dc) | / 10 V_{dc} \times 300V_{ac} \quad (300V \text{ RANGE}) \\ V_{out} (ac) &= | V_{ref} (dc) | / 10 V_{dc} \times 150V_{ac} \quad (150V \text{ RANGE}) \end{aligned}$$

Example (1): set V_{out} to 100Vac :

1. Select RANGE = 300V in SETUP functional list, apply external $V = 3.333V_{dc}$ (or $-3.333V_{dc}$), the $V_{out} = 100V_{ac}$.
2. Select RANGE = 150V in SETUP functional list, apply external $V = 6.667V_{dc}$ (or $-6.667V_{dc}$), the $V_{out} = 100V_{ac}$.

The procedures of setting EXT. V = ON, COUPLE = DC_LEVEL_CTL, are described as below:

1. Move the cursor to the command of "EXT. V = ."

EXT.V = OFF_ COUPLE=AC_AMPLIFIER
2. Turn RPG to change the option from OFF to ON, then press **ENTER** .

EXT.V = ON COUPLE=AC_AMPLIFIER_
3. The cursor moves to the command line of "COUPLE =" automatically.

EXT.V = ON COUPLE=DC_LEVEL_CTL
4. Turn RPG to select DC_LEVEL_CTL, then press **ENTER**.

EXT.V = ON COUPLE=DC_LEVEL_CTL_

***** NOTICE *****

When EXT. V=ON, COUPLE=DC_LEVEL_CTL, the output voltage (V_{out}) will respond only to the external control DC voltage level. The user cannot control V_{out} amplitude through the keypad on the front panel, until it reads EXT.V=OFF.

***** WARNING *****

1. As COUPLE = AC_AMPLIFIER and the frequency of V_{ref} is over 1000Hz, it might cause AC source damage. The user should obey the formula if $F > 1000Hz$:
 $V_{ref} (pk-pk, V) \times F (V_{ref}, Hz) < 10000 VHz$
2. Because of the bandwidth limitation of the AC source, the output may distort. This occurs especially when the external V reference consists of a high frequency composition.

3.6.3 POWER-ON STATUS

The AC source allows the user to set the status of the output when power is turned on. The user can set POWER-ON STATUS on the CONF functional list (see 3.6). After setting, the user should save the parameters before powering off (see 3.8.2).

Set the output to on, as 120 Vac, 50Hz, 10Vdc when powered-on.

1. Move the cursor to the line of "POWER-ON STATUS : output =."

POWER-ON STATUS : output = OFF_

2. Turn RPG to set output ON, then press **ENTER**.

POWER-ON STATUS : output = ON

3. Press **1** , **2** , **0** , **ENTER** to set Vac=120.

Vac = 120.0 F=60.0_ Vdc = 0.0

4. Press **5** , **0** , then press **ENTER** to set F=50.

Vac = 120.0 F=50.0 Vdc = 0.0

5. Press **1** , **0** , then press **ENTER** to set Vdc=10.

Vac = 120.0 F=50.0 Vdc = 10.0

3.6.4 GPIB Address, RS-232C

The AC source offers the mode of remote operation as well. The user can set them on the CONF functional list (see 3.6). For details please refer to Chapter 7. Prior to remote operation the user has to set the GPIB address 10 as below:

1. Move the cursor to the command line of GPIB address.

ADDR = 30_

2. Press **1** , **0** , **ENTER** to set address 10.

ADDR = 10

***** NOTICE *****

Addresses ranges from 1 to 30.

The AC source offers another remote operation through the RS-232C bus. Communication protocol is set as follows:

To set parity=ODD, baud rate=19200.

1. Move the cursor to the command line of PARITY.

PARITY= NONE_ BAUD=9600

2. Turn RPG to select ODD, then press **ENTER**.

PARITY=ODD BAUD=9600_

3. The cursor moves automatically to the setting position of "BAUD". Turn RPG to select "19200," then press **ENTER**.

PARITY=ODD BAUD=19200

***** NOTICE *****

The options of baud rate are 9600/19200. The options of parity are EVEN/ODD /NONE.

3.7 OUTPUT Functional List

On the CHOICE PAGE (see 3.4), press **3** then press **ENTER** and choose the OUTPUT functional list.

PAGE CHOICE = 3_
1. SETUP 2.CONF 3.OUTPUT 4. MANUAL CALI

COUPLE = AC+DC_ DEG : ON= 0.0 OFF=IMMED
Vs (V/ms) = 0.000 Fs (Hz/ms) = 0.000 ▲
DCs (V/ms) = 0.000 ON S/R = OFF ▼

Press **SHIFT**, then **▼** to change to the next page.

HIGH VOLTAGE OPTION = NONE [OUTPUT]
3-PHASE MODE = OFF ▲
DEGREE = 0.0 ▼

Press **SHIFT**, then **▼** to change to the next page.

PARALLEL MODE = OFF_ [OUTPUT]
Check the AC sources 1. ONLY ONE MASTER
2. SAME RANGE
CHECK OK = NO ▲

3.7.1 COUPLE Mode of Output (AC+DC, AC, DC)

There are three couple modes of AC source output: AC+DC, AC and DC. The user can set COUPLE on the OUTPUT functional list (see 3.7) to fit the application. Then, the display of the MAIN PAGE will change corresponding to the mode.

The procedures of setting from AC+DC to AC are shown as below:

1. Move the cursor to the command of "COUPLE="

COUPLE = AC+DC_

2. Turn RPG to change the option from AC+DC to AC, then press **ENTER**.

COUPLE = AC

***** NOTICE *****

The DC mode of the AC source is applied to running voltage tests. The AC source does not have many output capacitors. Some features like voltage ripple and load transient are not as good as the DC source. However, it can supply positive and negative DC voltage without changing the output connector.

***** WARNING *****

The QuadTech, Inc. 31000 AC source has AC/DC/AC+DC output functions at the DC output part. The AC Sources differ from DC sources, the reasons are below:

1. High ripple noise at the DC output occurs because the AC source has no output capacitor.
2. The AC source output relay will switch off when the current is over the specification. This will cause output voltage interruption.
Note: Normally a DC source will change to C.C. mode, and the output voltage will be reduced.
3. Large capacitance of more than 20uF at the output side can cause the output to be unstable and damage the AC source.

The fixture shown below can be used to reduce the possibility of damage to the AC Source due to large output capacitance.

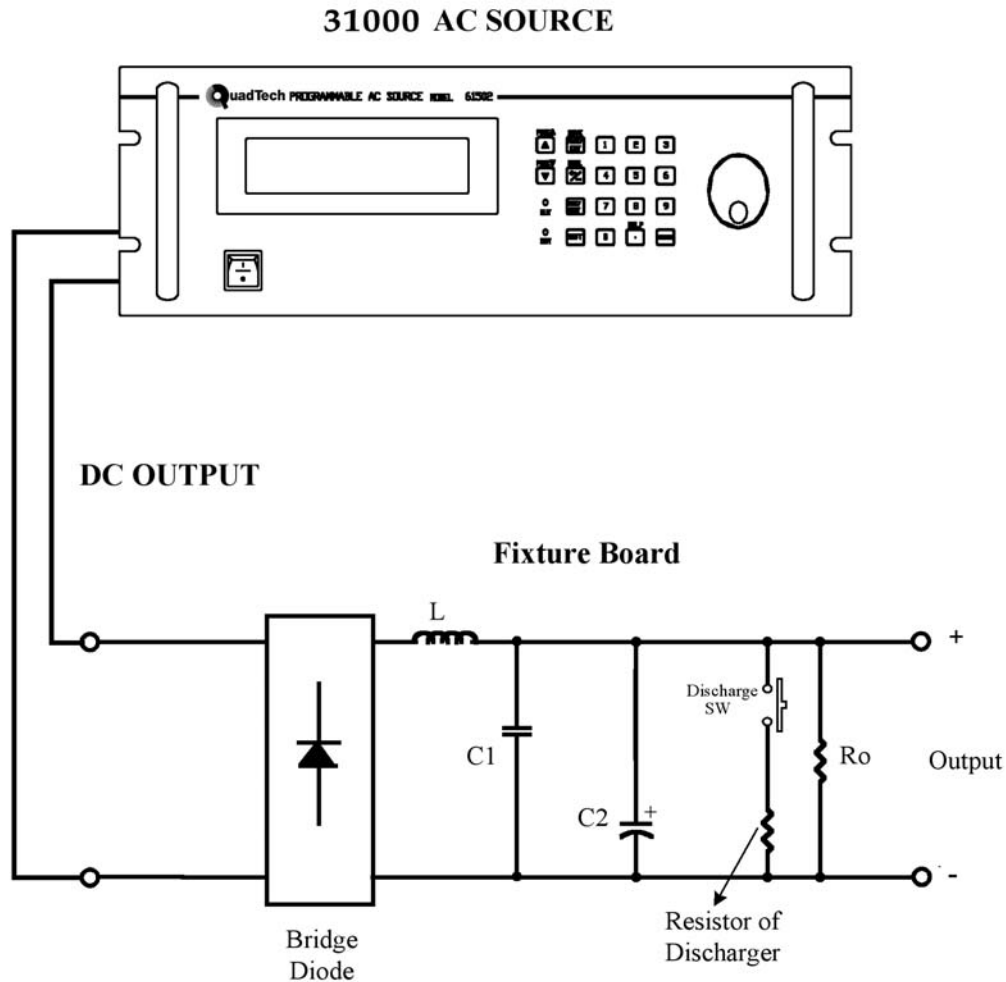


Illustration for fixture:

1. Bridge diode: Because of the internal control circuit of the AC source, if users connect more than 20 μ F capacitor on the output side, it may cause output to be unstable. It's better to use a bridge diode for isolating the external capacitance. It can also prevent a wrong connection of polarity of output on the DC level. It will cause a 1.6V drop when adding a bridge diode. (The user can compensate the output DC voltage by setting the voltage level. For example, the user can program 11.6V in order to get 10 V on the output of the fixture board.)
2. L and high frequency capacitor: An inductor and capacitor can be used to filter the high frequency ripple and noise if needed.

3. C2: C2 can be eliminated if UUT already has capacitance.
4. Discharger resistor and SW: Used to discharge the capacitors to avoid residual voltage to protect the operator when the output is off. Users need to consider the power rating of the discharger resistor to be appropriate for application.

3.7.2 OUTPUT DEGREE

The AC source can control the transition angle of the waveform when it is in OUT or QUIT. The user can set DEG ON and OFF to achieve this in the OUTPUT functional list (see 3.7)

The procedures for setting output phase angle DEGREE ON=90 and OFF=180, are described as below:

1. Move the cursor to the command line of "ON = ."

DEG ON = 0.0_ OFF= IMMED

2. Press **9** , **0** , then **ENTER** to change the value to " 90.0."

DEG ON = 90.0 OFF= IMMED_

3. The cursor moves to the command line of "OFF= " automatically.

4. Press **1** , **8** , **0** , then press **ENTER** to change the value to " 180.0."

DEG ON = 90.0 OFF= 180.0

*** NOTICE ***

If "OFF=IMMED," the output voltage quits immediately when the user presses **QUIT**. However, if a value of degree is set, the output voltage will last until the setting degree. Key-in "OFF= 360" becomes "OFF= IMMED."

3.7.3 Slew Rate of Output Transient

The AC source can control the transition waveform of the output by setting the COUPLE on the OUTPUT functional list (see 3.7). Users can set three slew commands to achieve the transient state of the output waveform: Vs (V/ms), Fs (Hz/ms), DCs (V/ms).

- Vs: the slew rate of output Vac.
 Fs: the slew rate of output frequency.
 DCs: the slew rate of output Vdc.

When users press OUT on the AC source or change the output setting(s) in the MAIN PAGE, the output voltage and frequency will change corresponding to the Vs, Fs and DC commands.

The procedures of setting Vs (V/ms)=0.2, Fs (Hz/ ms)=0.1, DCs (V/ms)=1, are described as

below:

1. Move the cursor to the command line of “ON_S/R = .”

ON_S/R=OFF

2. Turn RPG to set the output to ON, then press **ENTER**.

ON_S/R=ON

3. Move the cursor to the command line of “Vs (V/ms) = .”

Vs (V/ms) = 0.000_

4. Press **0**, **.**, **2**, then press **ENTER** to change the value to “0.2,”

Vs (V/ms) = 0.200

5. The cursor moves to the command line of “Fs (Hz/ms)=” automatically. Press **0**, **.**, **1**, then press **ENTER**.

Fs (Hz/ms) = 0.100

6. The cursor moves to the command line of “DCs (V/ms)=” automatically. Press **1**, then press **ENTER**.

DCs (V/ms) = 1.000_

***** NOTICE *****

1. When the user sets Vs (V/ms)=0, Fs (Hz/ms)=0, DCs (V/ms)=0, the output transient is at the fastest speed.
2. Vs, Fs DCs have a large input range in the software’s programming, but the output cannot exactly follow the slew rate when Vs, DCs are too large.
3. When the user press **OUT** on the AC source, the output will follow the setting to “the final state.” But when user presses QUIT, the output will change to 0V immediately. If the user wants to quit the output with the setting slew rate, they must key-in 0V and press **ENTER**.

3.7.4 HIGH VOLTAGE OPTION

A new 600Vac option will be added to the Range column in the SETUP Function for setting when connected to A615003 Boost Transformer. Please note only when working with the A615003 Boost Transformer can 600Vac be output or the output voltage is 1/2 of the setting.

The procedure of setting high the voltage option:

1. Move the cursor to “HIGH VOLTAGE OPTION ” command line.
2. Turn RPG from “NONE” to “A615003.” then press **ENTER** .

HIGH VOLTAGE OPTION= NONE

HIGH VOLTAGE OPTION= A615003

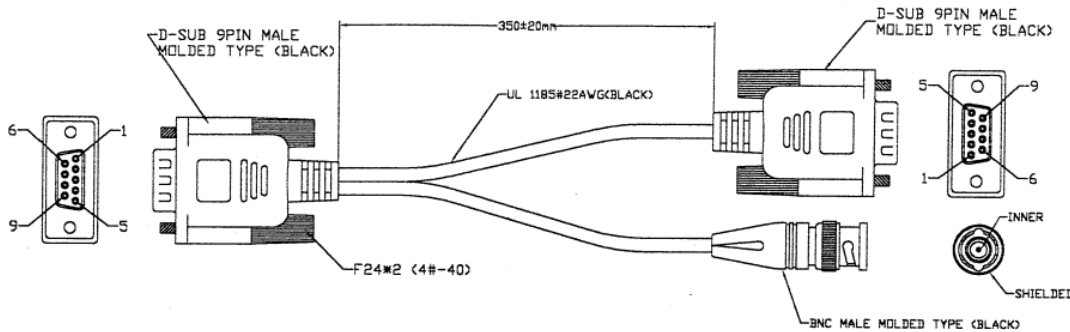
***** NOTICE *****

Connect the FAULT-OUT signal of TTL PIN8 on the AC Source rear panel to the TTL PIN8 on A615003 rear panel and select the HIGH VOLTAGE item in OPTION of The AC Source 31005 – 31040 and the A615003 can be used.

3.7.5 THREE PHASE MODE

When users need three-phase AC power, you are able to assemble three AC sources to be a three-phase AC power. Users can set 3-PHASE MODE on the OUTPUT functional list (see 3.7). The AC source setting of MASTER sends a SYNchronized signal to the SLAVES positioned phase angle. The SLAVES also use the signal to trigger and shutdown the output. To send the synchronized signal, users have to use a W38 023500 35cm Sync cable. One terminal of the cable is connected to the SYN (in rear panel, BNC connector), it is the MASTER. Another terminal connects to /Remote-Inhibit of TTL signal (in rear panel, 9-Pin, D-Type connector, see Appendix A), it is the SLAVE.

PHASE ANGLE	
Range	0 ~ 360°
Resolution	0.3°
Accuracy	<0.8°@50/60Hz



Part Details

The procedure of using 3-PHASE MODE :

1. Connect the N terminals of the AC source outputs. (For 3-phase, Y connection).
2. Connect the cable for synchronism.
3. Power-on all AC sources. Keep all in output quit state.
4. Set the 3-PHASE MODE = MATER, DEGREE = 0. Set another AC source 3-PHASE MODE = SLAVE, DEGREE = 240 or 120. Press **PAGE/EXIT** twice to the MAIN PAGE. Set the voltage and frequency on each AC source. It is better for all AC sources to set

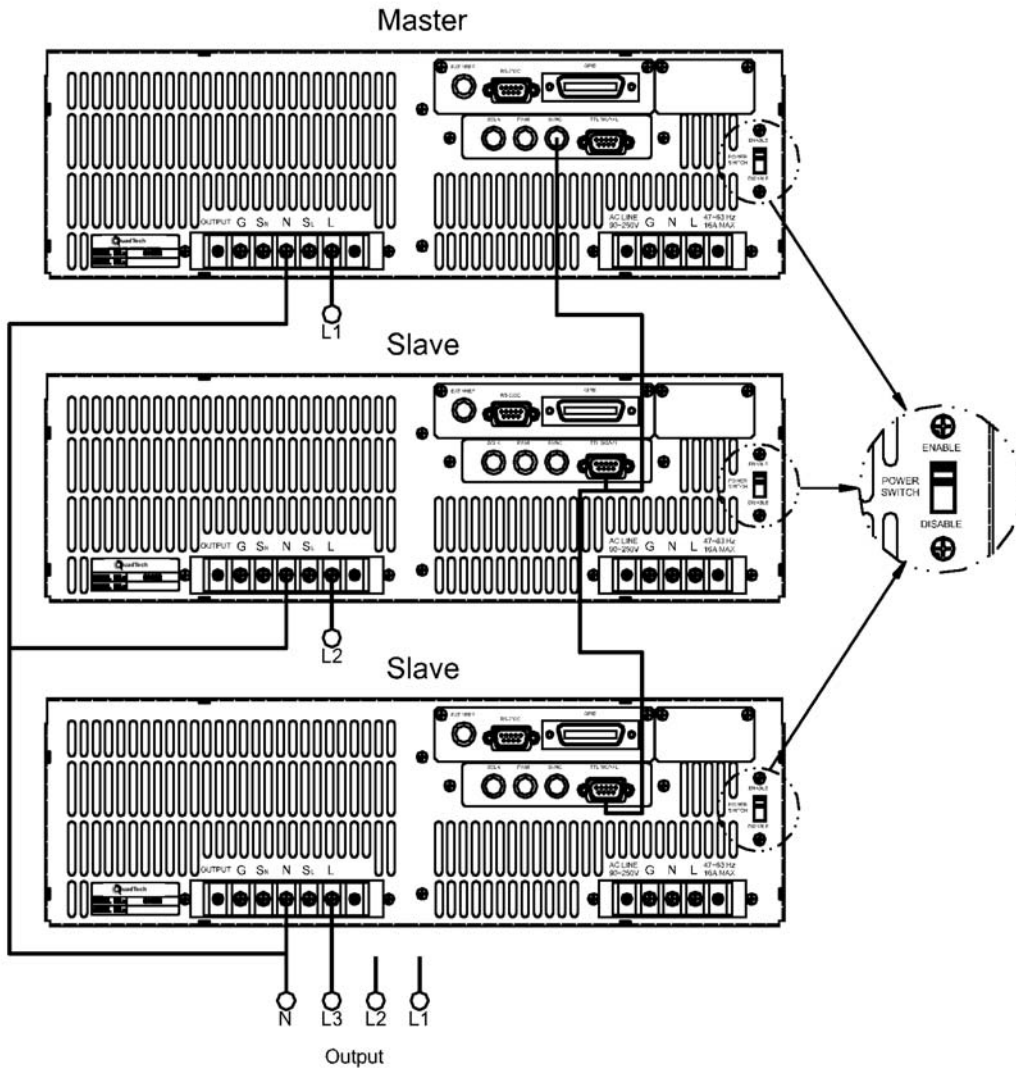
the same frequency.

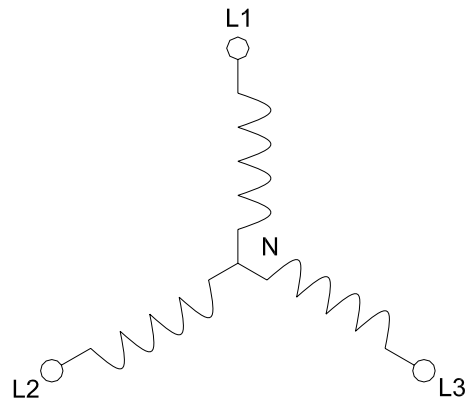
- Press **OUT/QUIT** at the MASTER to start the output. Press **OUT/QUIT** again to quit the output. **OUT/QUIT** of SLAVE cannot be used when in 3-PHASE MODE.

To change 3-PHASE MODE from OFF to SLAVE as below:

- Move the cursor to the command line of "3-PHASE MODE=".
- Turn RPG to change the option from OFF to SLAVE, then press **ENTER**.
- The cursor move to the command line of "DEGREE =" automatically.
- Press **1** , **2** , **0** , then press **ENTER**.

3-PHASE MODE = OFF_
3-PHASE MODE = SLAVE
DEGREE = 0.0_
DEGREE = 120.0





***** NOTICE *****

1. The DEGREE of MASTER is 0 and the DEGREE of SLAVE is 120. This means the SLAVE is 120 degree lead of the MASTER.
2. The first cycle of the SLAVE waveform will be distorted if the DEG ON (output on degree, see 3.7.2) isn't set correctly. For example, if the MASTER DEG ON = 90, the DEG ON of SLAVE must be 210 ($120 + 90 = 210$). Another SLAVE must be DEG ON = 330 ($240 + 90 = 330$).

***** NOTICE *****

1. If the DEG OFF (quit degree, see 3.7.2) of the MASTER and SLAVE are IMMED, the MASTER phase angle will quit on zero degrees and the SLAVE will stop at 120 or 240 degrees. But if users can assign the quit degree, for example, if the MASTER DEG OFF = 90, the DEG OFF of SLAVE must be 210 ($120 + 90 = 210$). Another SLAVE must be DEG OFF = 330 ($240 + 90 = 330$).
2. The voltage setting of 3-phase output is line-to-neutral V_{LN} for each phase. If users need the line-to-line voltage V_{LL} , the V_{LN} must equal to $V_{LL} / 1.732$.

***** NOTICE *****

The user can use two units of the 31000 AC source to connect in series to get higher voltage in the 3-PHASE MODE. The phase degree should be set on 180 degrees.

The user will also need to set the right DEG ON and OFF to get the right phase when the output is ON or OFF.

***** WARNING *****

1. Only one AC source can be set to MASTER or damage may occur when running 3-PHASE MODE.
2. Users cannot connect L terminals of the AC source outputs together, even set the DEGREE = 0 of SLAVE.
3. For safety concerns, the 3-PHASE MODE can't be saved for power-on status.

3.7.6 PARALLEL MODE

When the power of one AC source is not enough to drive the load, the user is able to parallel an AC source if they are the same model. The user can set PARALLEL MODE on the OUTPUT functional list (see 3.7). The AC source setting as MASTER sends SCLK and PWM signals to the SLAVE one. Users program output only in the MASTER and read the measurements individually.

The procedure of paralleling AC source :

1. Set the power switch of MASTER and SLAVE on the rear panel to “DISABLE.”
Assemble an additional power switch to control the power line input.
2. Quit the output of the AC sources, set $V_{out} = 0V$. Set all to the same RANGE and status of OUTPUT RELAY.
3. Connect the SCLK signal (in rear panel, BNC connector) together. Connect the PWM signal together as well. Connect the same cable used in 3.7.5, 3-PHASE MODE.
4. Connect the terminals of the AC source outputs (N to N, L to L), then connect to the load.
5. Set the AC source as MASTER first, then set the SLAVE. After setting, press **PAGE/EXIT** twice to the MAIN PAGE.
6. The other settings of the AC source cannot be changed when it is in parallel mode.
7. The MASTER can program and run or quit the output, the SLAVE only measures the output of itself.

The procedure of removing PARALLEL MODE:

1. Shut off the output of the AC source from the MASTER. Set $V_{out} = 0V$.
2. Don't change the PARALLEL MODE to OFF, power-off the MASTER and SLAVE by the additional power switch at the same time.

To change parallel mode OFF to MASTER as below:

1. Move the cursor to the command line of “PARALLEL MODE=.”

PARALLEL MODE = OFF_

2. Turn RPG to change the option from OFF to MASTER, then press **ENTER**.
After checking PARALLEL MODE setting and RANGE setting, confirm it.

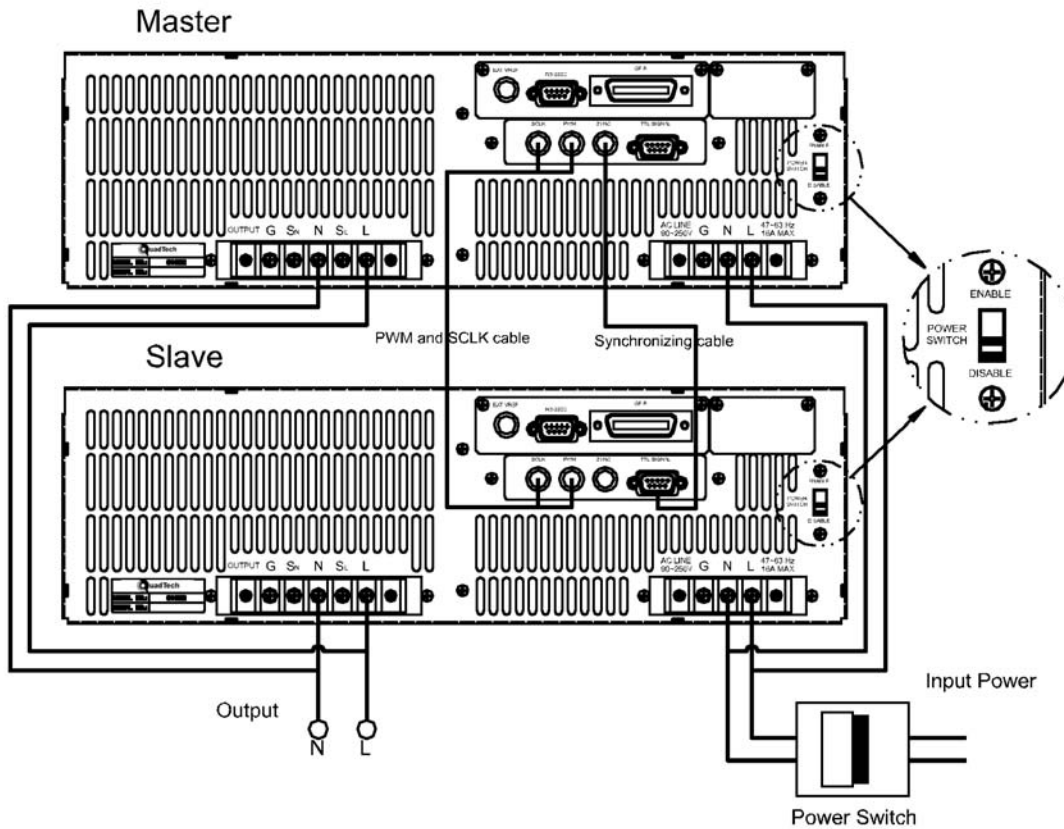
PARALLEL MODE = MASTER

3. The cursor moves to the command line of “CHECK OK” automatically.

CHECK OK = NO_

4. Turn RPG to change the option from NO to YES, then press **ENTER**.

CHECK OK = YES



***** WARNING *****

1. If there is more than one master or AC sources' RANGE is not the same, it may cause damage to the AC source when run parallel mode.
2. In parallel mode, the output power is not to exceed 90% of total power, in order to avoid damage caused by unbalanced outputs of the AC sources.
3. The procedure to turn off the AC source is very important. Power-off the MASTER and SLAVE at the same time, or the units may be damaged.

3.8 Save and Recall

The AC source offers two modes for the user to save and recall output setting or system data. They are described in 3.8.1 and 3.8.2.

3.8.1 Save and Recall Output Setting

The AC source offers nine memories for the user to save a set of frequently used Vac, F, Vdc and to recall them for later use. For example, in the MAIN PAGE (see 3.3), key-in the output settings as below and save the settings to memory channel 5.

Vac = 230.0	F = 50.00	Vdc = 10.0_	H
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

Press **SHIFT**, then **PAGE/EXIT**, to run the SAVE function. The display will show as below:

CHOICE 1 - 9, PRESS (ENTER) TO SAVE MAIN PAGE			
1.	Vac = 0.0	F = 60.00	Vdc = 0.0
2.	Vac = 120.0	F = 60.00	Vdc = 0.0
3.	Vac = 0.0	F = 60.00	Vdc = 0.0 ▼

The cursor stays in channel 1. The user can press **1** - **9** to select channel or use **▲**, **▼** or press **SHIFT**, then **▼** to change page to the destination. The cursor stays in channel 5 after pressing **5**.

CHOICE 1 - 9 , PRESS (ENTER) TO SAVE MAIN PAGE			
4.	Vac = 0.0	F = 60.00	Vdc = 0.0
<u>5.</u>	Vac = 0.0	F = 60.00	Vdc = 0.0 ▲
6.	Vac = 0.0	F = 60.00	Vdc = 0.0 ▼

Press **ENTER** to save the output settings to channel 5. The display will show saving status for about three seconds. The display is shown as below.

Saving now, do not shut down

Then output settings in the MAIN PAGE show in channel 5. The display is shown as below.

CHOICE 1 - 9, PRESS (ENTER) TO SAVE MAIN PAGE			
4.	Vac = 0.0	F = 60.00	Vdc = 0.0
<u>5.</u>	Vac = 230.0	F = 50.00	Vdc = 10.0 ▲
6.	Vac = 0.0	F = 60.00	Vdc = 0.0 ▼

Then, press **PAGE/EXIT** to return to the MAIN PAGE.

Recalling from memory channel to the MAIN PAGE is shown the following: In the MAIN PAGE, press **SHIFT**, then **←/-** to run the RECALL function. The display will show as below:

CHOICE 1 - 9, PRESS (ENTER) TO RECALL			
<u>1.</u>	Vac = 0.0	F = 60.00	Vdc = 0.0
2.	Vac = 120.0	F = 60.00	Vdc = 0.0
3.	Vac = 0.0	F = 60.00	Vdc = 0.0 ▼

The cursor stays in channel 1. The user can press **1** - **9** to select channel or use **▲**, **▼** or press **SHIFT** then **▼** to change page to the destination. The cursor stays in channel 2. after pressing **2**. The display is shown as below.

CHOICE 1 - 9, PRESS (ENTER) TO RECALL			
1.	Vac = 0.0	F = 60.00	Vdc = 0.0
<u>2.</u>	Vac = 120.0	F = 60.00	Vdc = 0.0
3.	Vac = 0.0	F = 60.00	Vdc = 0.0 ▼

Press **ENTER**, the display return to the MAIN PAGE automatically. The output settings are Vac = 120, F = 60, Vdc = 0, just as the settings saved in memory channel 2.

Vac = 120.0_	F = 60.00	Vdc = 0.00	H
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

If the recall setting is output of RANGE or over the V LIMIT (see 3.5.2, 3.5.3), the display will show the following:

Conflicting with RANGE or V LIMIT

Press ENTER key

Press **ENTER** to return to the recall page. Check if the settings violate the RANGE or V LIMIT.

***** NOTICE *****

1. Saving and recalling output settings act for MAIN PAGE only, the other parameters are ignored.
2. In different couple modes of output (see 3.7.1), the lack of settings will be regular to Vac=0V, F=60Hz, Vdc=0V automatically. For example, in the DC output mode, Vac=0V, F=60Hz, Vdc is the setting value in the MAIN PAGE as running the SAVE function.

3.8.2 Save and Recall System Data

The AC source offers three memory groups for the user to save system data and to recall them for later use. The system data includes all parameters in the function list like SETUP (see 3.5), CONF (see 3.6) and OUTPUT (see 3.7). In the CHOICE PAGE (see 3.4), press **SHIFT**, then **PAGE/EXIT**, to run the SAVE function. The displays are shown as below.

PAGE CHOICE = 1_

1. SETUP 2.CONF 3.OUTPUT 4. MANUAL CALI

Save all parameters to Group (1 - 3) : 1_

Press **1** - **3** to choose one group to save, then press **ENTER** to confirm. The display will show the saving status message for about three seconds as shown below.

Save all parameters to Group (1 - 3) : 1_
Saving now, do not shut down

Then, press **PAGE/EXIT** to return to the CHOICE PAGE.

Recalling system data from memory group is shown in the following: In CHOICE PAGE, press **SHIFT**, then **← / -** to run the RECALL function. The display will be show as below:

Recall parameters of Group (1 - 3) : 1_

Press **1** - **3** to choose one group to recall, then press **ENTER** to confirm. Then, the display will return to the CHOICE PAGE after loading the data.

***** NOTICE *****

The AC source provides three memory groups : 1, 2 and 3. Memory group 1 keeps power-on defaults. The setup data saved into memory group 1 will be recalled automatically when the AC source is powered on again. Those saved into other memory groups must be recalled manually.

3.9 Protection

The AC source provides protection for software and hardware. When protection happens, the AC source will quit the output and turn off the output relays. It will then show the condition of protection in the display. If any protection is triggered to hold normal output, please remove the errors and then press **ENTER** to unlock the protection to resume the normal operation.

Protection for software are listed as below:

Protection	Description
OVER-CURRENT	When output current is over the I limit or the current specification.
OVER-POWER	When output power is over the specification.
OUTPUT OVP	1. It is the feedback open protection meaning the feedback loop is broken or the output voltage goes wrong. 2. When the out voltage is over the limit of each RANGE. See 3.3.

Protections for hardware are listed as below:

Protection	Description
FAN FAIL	Fan failure protection and meaning the cooling fan malfunctioned.
INT - AD	The inner AD power stage (see 5.1) protection and means that the output voltage is over or under the specific value.
INT - DD	It is inner DD power stage (see 5.1) protection and meaning the output voltage is over or under the specific value.
OUTPUT SHORT	Short protection and meaning the output terminals are shorted.
INPUT FAIL	Power failure protection meaning the line input voltage is lower or higher than specification.
OVER-TEMP	Over-temperature protection and will be enabled when the internal temperature of the AC source is too high.

4. Calibration

4.1 Introduction

The AC source has a built-in, simple way to calibrate the output and measurement accuracy without opening cover. Users can perform this action by following the procedures step by step. A voltage meter, current meter, suitable load and +5V dc source are needed for the calibration procedure. For connections for these instruments, please refer to Figure 4-1. There are three items needed to calibrate. It is not necessary to calibrate all at once. Users can just choose one item if needed.

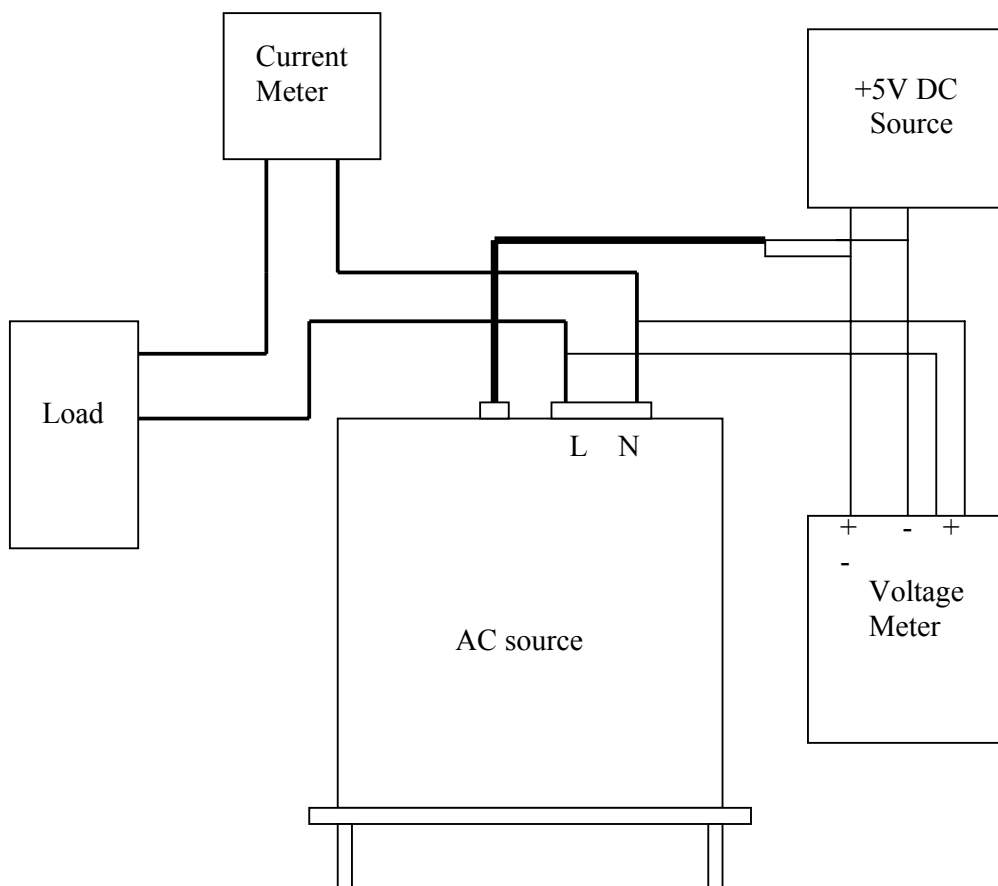


Figure 4-1

4.2 MANUAL CALI Functional List

Users can choose "4. MANUAL CALI" in the CHOICE PAGE to enter the calibration procedure. Before showing the calibration items, for safety reasons, users must enter their password. The password is shown in this manual, in order to confirm the user read the manual before doing the calibration procedure.

PAGE CHOICE = 4_
1. SETUP 2.CONF 3.OUTPUT 4. MANUAL CALI

Enter Password : _
(You can get password in user's manual !)

Enter Password : * * * * _
(You can get password in user's manual !)

***** NOTICE *****

1. The Password for entry into the calibration procedure is "7377," then press **ENTER** .
2. Before calibrating the AC source, users should read the procedure in details.
It may lose some data in memory due to of improper operation.

The display changes to the CALIBRATION CHOICE PAGE as shown below after keying the right password.

CALIBRATION CHOICE = 1_ [CALIB]
1. V OUT AND MEAS. 2. I MEAS.
3. EXT Vref.

V OUT AND MEAS.: Output voltage and voltage measurement accuracy calibration.
 I MEAS.: Current measurement accuracy calibration.
 EXT Vref.: External Vref calibration.

4.2.1 Output Voltage and Voltage Measurement Calibration

Users can enter the CALIBRATION CHOICE page after keying in the password, see 4.2. Then, press **1**, **ENTER**, to do the output voltage and voltage measurement calibration.

CALIBRATION CHOICE = 1
 1. V OUT AND MEAS. 2. I MEAS.
 3. EXT V.

Please Remove Load Before Calibrating

 Press <ENTER> to start

1. V OUT AND MEAS. ACCURACY CALI 150V RNG
 A. KEYIN THE MEASURED Vdc
 Vdc offset = _ mV

In this step A of V OUT AND MEAS. ACCURACY CALI, the user should key-in the AC source's DC output voltage measured by digital voltage meter (DVM) in mV. Then, monitor the reading of DVM, key-in the DC output voltage repeatedly until DC output is less than ±10 mV.

***** NOTICE *****

1. The Vdc offset may be positive or negative. The positive of the DVM connect to the Line of the AC source output and the negative of the DVM connect to the Neutral of AC source output. See Fig. 4.1.1.
2. The load must be off at all steps of V OUT AND MEAS. ACCURACY CALI.

Press **SHIFT**, then **▼** to change to next step.

1. V OUT AND MEAS. ACCURACY CALI 150V RNG
B. WAIT TWO SECONDS THEN (ENTER)
Vac = 0.00 V Vdc = 0.00 V ▲
▼

In this step B of V OUT AND MEAS. ACCURACY CALI., the display shows the offset of Vac and Vdc measured by the AC source. They are produced by internal components. Wait two seconds, then press **ENTER**, then Vac = 0.00, Vdc = 0.00 .

***** NOTICE *****

The AC source calibration steps are able to be done individually, but it is better to follow the calibration procedure step by step (step A, step B ...). Or, it may cause output and measurement errors.

Press **SHIFT**, then **▼** to change to next step.

1. V OUT AND MEAS. ACCURACY CALI 150V RNG
C. (ENTER) THEN CHECK OUTPUT IS 15VAC
D. (ENTER) THEN KEYIN DVM MEAS. 150VAC ▲
0.00_ V ▼

In above step C of V OUT AND MEAS. ACCURACY CALI., the user should not turn on the load. Press **ENTER**, then check that the output voltage measured by the DVM is about 15VAC. This step is just to make sure you are correctly connected.

Then go to next step D. Press **ENTER**, check that the output voltage measured by the DVM is about 150VAC. Key-in the exact value measured by DVM, then press **ENTER** .

Press **SHIFT**, then **▼** to change to next step.

1. V OUT AND MEAS. ACCURACY CALI 300V RNG
E. (ENTER) THEN CHECK OUTPUT IS 30VAC
F. (ENTER) THEN KEYIN DVM MEAS. 300VAC ▲
0.00_ V

In the above step E of V OUT AND MEAS. ACCURACY CALI., the user should not turn on the load. Press **ENTER**, then check the output voltage measured by the DVM is about 30VAC. This step is to ensure a correct connection.

Then go to the next step F. Press **ENTER**, check that the output voltage measured by the DVM is about 300VAC. Key-in the exact value measured by the DVM, then press **ENTER**.

Step F is the final step of V OUT AND MEAS. ACCURACY CALI. Press **PAGE/EXIT** to exit that page. Then a display will show as below. Press **ENTER** to save the calibration results.

Press (ENTER) to save.
Press (PAGE/EXIT) not to save.

***** NOTICE *****

1. Users can press **PAGE/EXIT** to exit to the calibration choice page at every step.
2. See the above display, if pressing **PAGE/EXIT** will not to save the result, the result of calibration will still work, until the power is turned off.

4.2.2 Current Measurement Calibration

Users can enter the CALIBRATION CHOICE page after pressing password, see 4.2. Then, press **2**, **ENTER**, to do the current measurement calibration.

CALIBRATION CHOICE = 2
 1. V OUT AND MEAS. 2. I MEAS.
 3. EXT Vref.

1. CURRENT MEAS. ACCURACY CALI 150V RNG
A. WAIT TWO SECONDS THEN (ENTER)

Iac = 0.00 A Idc = 0.00 A ▼

In above step A of CURRENT MEAS. ACCURACY CALI., the display shows the offset of Iac and Idc measured by the AC source. They are produced by internal components. Wait two seconds, then press **ENTER**, then Iac = 0.00A, Idc = 0.00A.

Press **SHIFT**, then **▼** to change to next step.

1. CURRENT MEAS. ACCURACY CALI 150V RNG
 B. (ENTER) THEN CHECK CURRENT IS 1.6A
 C. (ENTER) THEN KEYIN CURRENT MEAS. 16A
 0.00 A ▲

In above step B of CURRENT MEAS. ACCURACY CALI., press **ENTER** and the AC source will output 12.5VAC. The user should apply suitable load to the output, to make the output current measured by current meter (or power analyzer) be about 1.6A (for 31020). The different models shows different current values in the display. If the output current is ok after applying load, press **ENTER** and then AC source will output 125VAC. The output current will be 10 times of step B, 16A. Key-in the exact value of current measured by current meter. The output current of step B and step C are shown below:

Model	Step B.	Step C.
31005 (500 VA)	0.4 A	4 A
31010 (1000 VA)	0.8 A	8 A
31015 (1500 VA)	1.2 A	12 A
31020 (2000 VA)	1.6 A	16 A

Step C is the final step of CURRENT MEAS. ACCURACY CALI. Press **PAGE/EXIT** to exit that page. The display will then show as below. Press **ENTER** to save the calibration result.

Press (ENTER) to save .
 Press (PAGE/EXIT) not to save .

***** NOTICE *****

1. The resistance of the applied load must be constant, so the load current is proportional to output voltage. If not, step B of CURRENT MEAS. ACCURACY will be insignificant. Users only need to meet the current of step C. When output voltage is 125VAC.
2. When doing the procedure of calibration, the protection is temporarily removed. Damage to the AC source may occur, if applying an unsuitable load.

4.2.3 External Vref Calibration

Users can enter the CALIBRATION CHOICE page after pressing password (see 4.2). Press **3**, **ENTER**, to do the external Vref calibration. See details as shown below. It is not necessary to do this item if no option board (GPIB, RS-232 and Vref board) is installed.

CALIBRATION CHOICE = 3
 1. V OUT AND MEAS. 2. I MEAS.
 3. EXT Vref.

Please Remove Load Before Calibrating

 Press <ENTER> to start

3. EXTERNAL Vref CALI 150V RANGE
 A. Vref INPUT SHORT
 WAIT TWO SECONDS THEN (ENTER)
 Vdc = 0 00 V

In the above step A of EXTERNAL Vref CALI., short the external Vref input terminal to ensure input is 0V, then the display shows the measured Vdc from the AC source. They are offset voltages produced by internal components. Wait two seconds, then press **ENTER** and Vdc = 0V.

Press **SHIFT**, then **▼** to change to next step.

3. EXTERNAL Vref CALI	150V RANGE
B. INPUT EXT. V 5VDC	- WAIT TWO SECOND
KEYIN EXT. V DVM MEAS.	
0.000	VDC (ENTER) ▲

In the above step B of EXTERNAL Vref CALI., the user applies +5Vdc to the Vref BNC connector from the outer DC source. Check that the output voltage of the AC source is about 106Vdc, then key-in the exact value of input Vref voltage (not AC source output) measured from the DVM.

Step B is the final step of EXTERNAL Vref CALI. Press **PAGE/EXIT** to exit that page. Then display will show as below. Press **ENTER** to save the calibration result.

Press (ENTER) to save . Press (PAGE/EXIT) not to save .
--

5. 31000A Series Additional Features

5.1 General

Not only programming the steady sine output voltage and frequency, the AC source model 31005A/31010A/31015A/31020A/31040A provide several powerful functions to simulate all kinds of power line disturbance. Users can make the output change through a number of value in LIST mode (see 5.2), or make the output change to its set value for a specific period of time in PULSE mode (see 5.3), even make the output change to its set value step by step in STEP mode (see 5.4). With these functions, it is easy to simulate such as cycle dropout, transient spike, brown out, etc.

Not only measurements related to power in the MAIN PAGE (see 3.3), the AC source model 31005A/31010A/31015A/31020A/31040A also provides harmonic measurement up to 40 orders (see 5.5). For modern power testing, the AC source allows users to compose different harmonic components to synthesize harmonic distorted wave-shapes (see 5.6). The AC source can also achieve interharmonics waveform, a sweeping frequency superimposed on a static fundamental wave (see 5.7).

5.2 List Mode

On the CHOICE PAGE (see 3.4), press **5**, then **ENTER** and choose the LIST functional list.

```

PAGE CHOICE = 5_
1. SETUP  2.CONF  3.OUTPUT  4. MANUAL CALI
5. LIST    6. PULSE 7. STEP   8. HAR    9. SYN
10. INTERHAR
  
```

```

COUNT = 0 [ LIST ]
TRIG    = AUTO
BASE    = TIME
<SHIFT> <ENTER> to Execute ▼
  
```

The waveform programming of LIST mode is the assembly of the SEQUENCES. The output waveform will start from SEQ=0, then SEQ by SEQ. The execution will stop until a SEQ, which TIME or CYCLE = 0, even the following SEQs have been set will not be executed.

COUNT : the whole sequences' executing number of times. COUNT = 0 : infinity.
TRIG = AUTO / MANUAL : the way to trigger. **AUTO** : it will finish all COUNT number when trigger. **MANUAL** : it will execute sequence waveform for only once. It has the same result in COUNT=1.

BASE = TIME / CYCLE: the unit of sequence length.

Press **SHIFT**, then **▼** to change to next page for sequence programming.

SEQ = 0	DEGREE = 0.0	[LIST]	
Vs = 0.0	Fs = 60.00	DCs = 0.0	
Ve = 0.0	Fe = 60.00	DCe = 0.0	▲
WAVE = A	TIME = 0.0	ms	▼

SEQ: the number of sequence. All sequences must start by zero. The maximal number of SEQ is 99.

DEGREE: the phase angle when the sequence starts.

Vs, Fs, DCs: the initial waveform when the sequence starts.

Ve, Fe, DCe: the final waveform when the sequence ends.

WAVE = A / B: to choose waveform (see 3.6.3).

TIME / CYCLE: the length of sequence.

After setting sequences, press **PAGE/EXIT** to exit to the LIST mode page. Press **SHIFT**, then **ENTER** to change to the execution page. The LCD shows **_TRIG_ON** is under action, and *** STOP *** is the triggering status at present. Press **ENTER** to trigger. Then LCD shows status *** RUNNING *** and **TRIG_OFF** waiting for the user to stop the LIST waveform output. The LCD will shows *** STOP ,*** when the AC source executed all sequences and COUNT.

_TRIG_ON	* STOP *	[LIST]	
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

_TRIG_OFF	* RUNNING *	[LIST]	
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

If the AC Source is in running status, press **OUT/QUIT**, the output will stop the waveform and return to zero voltage. Press **OUT/QUIT** again and the AC source will output only the waveform set in the MAIN PAGE. Users must press **ENTER** to retrigger it. Or if in the quit status, users can press **ENTER** to directly output LIST waveform.

The programmed LIST mode waveform will shut down when **PAGE/EXIT** is pressed to exit the LIST execution page.

LIST mode example:

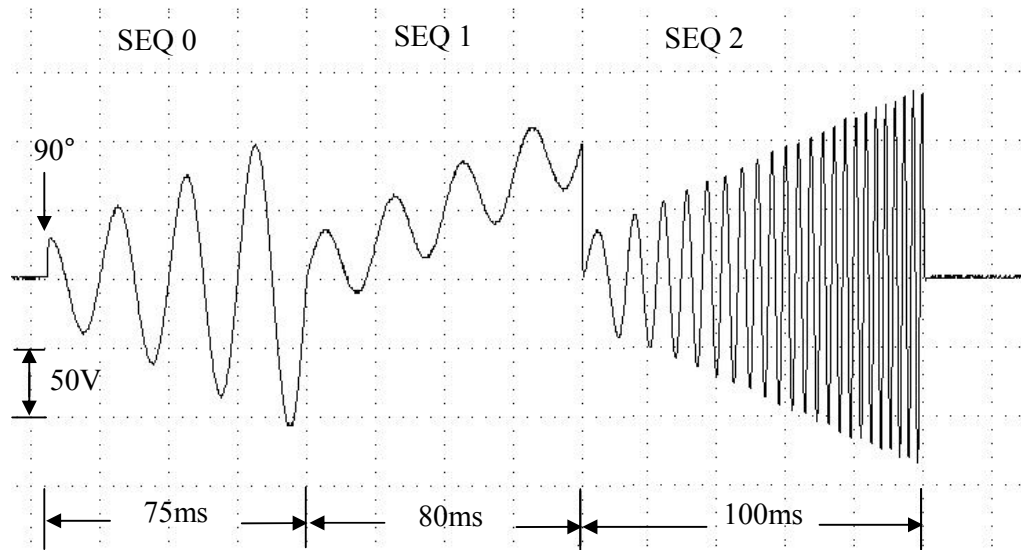
COUNT = 1	[LIST]
TRIG = AUTO	
BASE = TIME	
<SHIFT> <ENTER> to Execute ▼	

SEQ = 0	DEGREE = 90.0	[LIST]
Vs = 20.0	Fs = 50.00	DCs = 0.0
Ve = 80.0	Fe = 50.00	DCe = 0.0 ▲
WAVE = A	TIME = 75.0	ms ▼

SEQ = 1	DEGREE = 0.0	[LIST]
Vs = 20.0	Fs = 50.00	DCs = 0.0
Ve = 20.0	Fe = 50.00	DCe = 100.0 ▲
WAVE = A	TIME = 80.0	ms ▼

SEQ = 2	DEGREE = 0.0	[LIST]
Vs = 20.0	Fs = 50.00	DCs = 0.0
Ve = 100.0	Fe = 400.00	DCe = 0.0 ▲
WAVE = A	TIME = 100.0	ms ▼

The output waveform:



5.3 Pulse Mode

On the CHOICE PAGE (see 3.4), press **6**, then **ENTER**, choose the PULSE functional list.

```

PAGE CHOICE = 6_
1. SETUP  2.CONF  3.OUTPUT  4. MANUAL CALI
5. LIST   6. PULSE 7. STEP   8. HAR    9. SYN
10. INTERHAR
    
```

```

COUNT = 0                                [ PULSE ]
Vac = 0.0      F = 60.00      Vdc = 0.0
DUTY = 0.0    % PERIOD = 0.0      ms
                <SHIFT> <ENTER> to Execute ▼
    
```

Press **SHIFT**, then **▼** to change to next page.

TRIG = AUTO	WAVE = A	[PULSE]
DEGREE = 0.0		
<SHIFT> <ENTER> to Execute ▲		

The PULSE mode allows users to program a particular waveform attach to normal output set in the MAIN PAGE. The waveform programming is to specify duty percent on top of programmed output and the transient state.

COUNT: the repeat number of pulse.

Vac, F, Vdc: the Vac, F and DC output in the duty of period.

DUTY: the proportion of pulse in one period.

PERIOD: the length of a pulse period.

TRIG = AUTO / MANUAL: the way to trigger. **AUTO:** it will finish all COUNT number when trigger. **MANUAL:** it will execute pulse waveform for only once. It has the same result in COUNT=1.

WAVE = A / B: to choose waveform (see 3.6.3).

DEGREE: the output phase angle of pulse.

Press **SHIFT**, then **ENTER** to go to the PULSE execution page. The LCD shows **_TRIG_ON** is under action, and *** STOP *** is the triggering status at present. Press **ENTER** to trigger. Then LCD shows status *** RUNNING *** and **TRIG_OFF** waiting for user to stop the PULSE waveform output. The LCD shows *** STOP *** when the AC source executed all COUNT number.

_TRIG_ON	* STOP *	[PULSE]
V = 0.00	F = 0.00	I = 0.00 ▲
P = 0.0	PF = 0.000	CF = 0.00 ▼

_TRIG_OFF	* RUNNING *	[PULSE]
V = 0.00	F = 0.00	I = 0.00 ▲
P = 0.0	PF = 0.000	CF = 0.00 ▼

If the AC Source is in output status, press **OUT/QUIT** and the output will stop the waveform will return to zero voltage. Press **OUT/QUIT** again and the AC Source only output the waveform set in the MAIN PAGE. Users must press **ENTER** to retrigger it. If in quit status, users can press **ENTER** to directly output PULSE waveform.

The pulse wave will shut down, when **PAGE/EXIT** is pressed to exit PULSE execution page.

PULSE mode example:

In MAIN PAGE:

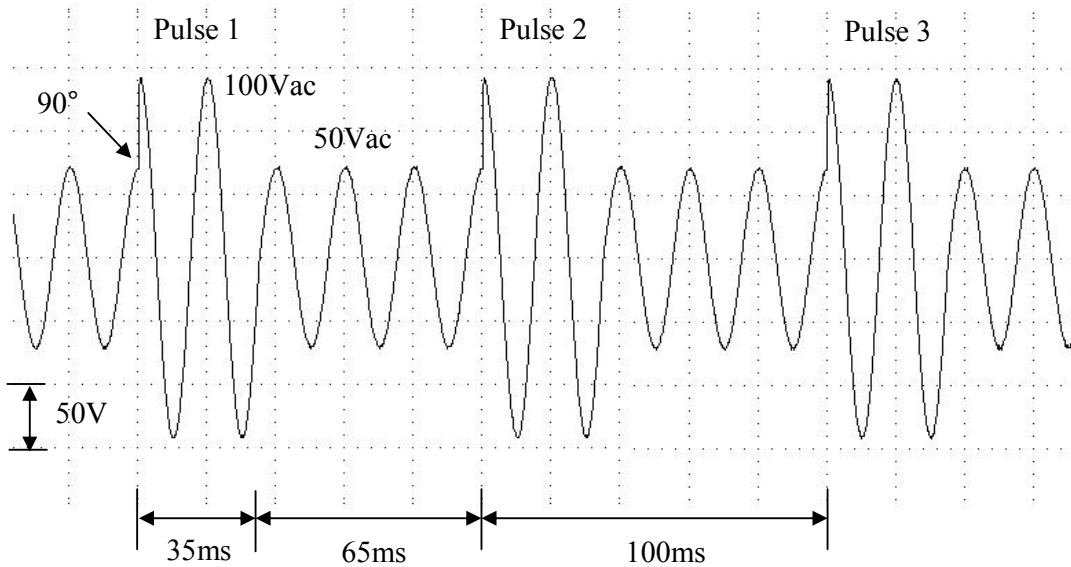
Vac = 50.0	F = 50.00	Vdc = 0.0	L
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

In PULSE setting page:

COUNT = 3	[PULSE]	
Vac = 100.0	F = 50.00	Vdc = 0.0
DUTY = 35.0 %	PERIOD = 100.0	ms
<SHIFT> <ENTER> to Execute ▼		

TRIG = AUTO	WAVE = A	[PULSE]
DEGREE = 90.0		
<SHIFT> <ENTER> to Execute ▲		

The output waveform:



5.4 Step Mode

On the CHOICE PAGE (see 3.4), press **7** then **ENTER**, choose the STEP functional list.

PAGE CHOICE = 7_		
1. SETUP	2. CONF	3. OUTPUT
4. MANUAL CALI	5. LIST	6. PULSE
7. STEP	8. HAR	9. SYN
10. INTERHAR		

COUNT = 0	DWELL = 0.0	ms [STEP]
Vac = 0.0	F = 60.00	Vdc = 0.0
dV = 0.0	dF = 0.00	dDC = 0.0
<SHIFT><ENTER> to Execute ▼		

Press **SHIFT**, then ▼ to change to next page.

TRIG = AUTO WAVE = A [STEP] DEGREE = 0.0 <SHIFT><ENTER> to Execute ▲

The STEP mode offers a easy and automatic-change function to change output waveform in a regular level and time. However, the variation between two steps changes rapidly, not gradually. The waveform programming is to set an initial waveform, specify the dwell time and change of every step, and the number of the change step. After execution, the output wave will keep on last step.

COUNT: the number of each change execute.

DWELL: the length of each step.

Vac, F, Vdc: the initial value of Vac, F, DC when STEP mode starts to execute.

dV, dF, dDC: the difference value of each step. (The negative value is allowed.)

TRIG = AUTO / MANUAL: the way to trigger. **AUTO:** it will finish all COUNT number when trigger. **MANUAL:** the output waveform will change just one step for each execution.

WAVE = A / B: to choose waveform (see 3.6.3).

DEGREE: the output phase angle of each step.

Press **SHIFT**, then **ENTER** to go to the STEP execution page. The LCD shows **_TRIG_ON** is under action, and *** STOP *** is the triggering status at present. Press **ENTER** to trigger. Then LCD shows status *** RUNNING *** and **TRIG_OFF** and **TRIG_PAUSE**. Press ▲ or ▼ to move cursor and press **ENTER** to select. **TRIG_OFF** is to stop the STEP waveform changing. **TRIG_PAUSE** is used to keep the STEP waveform until **TRIG_CONTINUE** is selected. The LCD will shows *** STOP ,*** when the AC source executed all COUNT number.

_TRIG_ON * STOP * [STEP] V = 0.00 F = 0.00 I = 0.00 ▲ P = 0.0 PF = 0.000 CF = 0.00 ▼
--

_TRIG_OFF * RUNNING * [STEP] TRIG_PAUSE V = 0.00 F = 0.00 I = 0.00 ▲ P = 0.0 PF = 0.000 CF = 0.00 ▼
--

_TRIG_CONTINUE * PAUSE * [STEP] V = 0.00 F = 0.00 I = 0.00 ▲ P = 0.0 PF = 0.000 CF = 0.00 ▼

If the AC Source is in output status, press **OUT/QUIT** and the output will stop the waveform and return to zero voltage. Press **OUT/QUIT** again and the AC Source will only output the waveform set in the MAIN PAGE. Users must press **ENTER** to retrigger it. If in quit status, users can press **ENTER** to directly output the STEP waveform.

The STEP wave will stop to execute when press **PAGE/EXIT** to exit the STEP execution page.

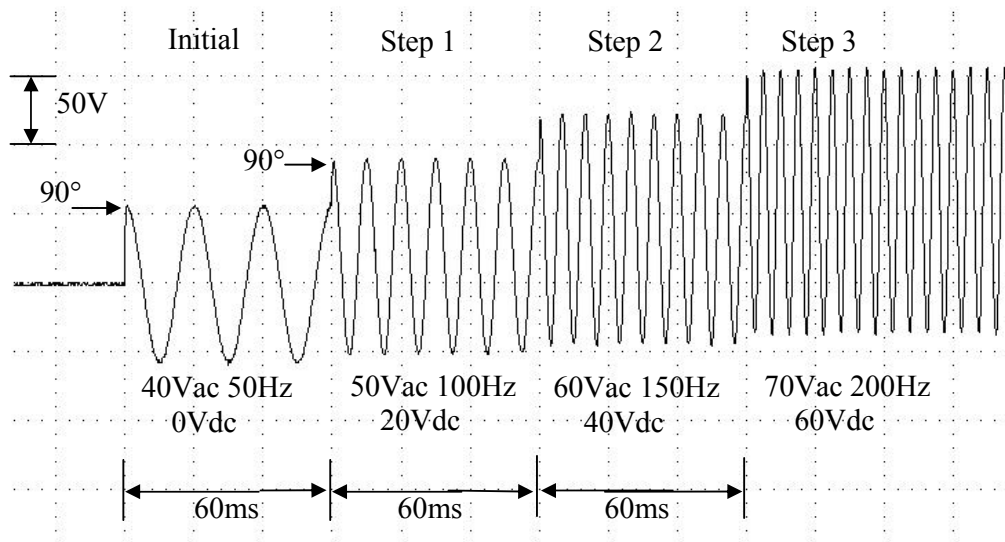
When **TRIG = MANUAL**, the LCD shows TRIG_UP and TRIG_DOWN. The output waveform is changed to the next step if TRIG_UP is selected. The output waveform is changed back to last step if TRIG_DOWN is selected.

_ TRIG_UP	* STOP *	[STEP]
TRIG_DOWN		
V = 0.00	F = 0.00	I = 0.00 ▲
P = 0.0	PF = 0.000	CF = 0.00 ▼

STEP mode example:

COUNT = 3	DWELL = 60.0	ms [STEP]
Vac = 40.0	F = 50.00	Vdc = 0.0
dV = 10.0	dF = 50.00	dDC = 20.0
<SHIFT><ENTER> to Execute ▼		

TRIG = AUTO	WAVE = A	[STEP]
DEGREE = 90.0		
<SHIFT><ENTER> to Execute ▲		



5.5 Harmonic Measurement

On the CHOICE PAGE (see 3.4), press **8** then **ENTER**, choose the HAR functional list.

```

PAGE CHOICE = 9_
1. SETUP  2.CONF  3.OUTPUT  4. MANUAL CALI
5. LIST   6. PULSE 7. STEP   8. HAR    9. SYN
10. INTERHAR
    
```

```

SOURCE = I          FREQ = 60 Hz      [ HAR ]
TIMES = SINGLE     PARAMETER = PERCENT

<SHIFT> <ENTER> to measure
    
```

The HARmonic function can calculate the THD, DC, fundamental value of output current or output voltage. It can also calculate 2nd ~ 40th order of harmonic value in fundamental frequency 50Hz or 60Hz.

SOURCE = V / I: the source of measured data. V: the output voltage. I: the output current.

FREQ = 50 / 60 Hz: the fundamental frequency of source.

TIMES = SINGLE / CONTINUE: the way of measurement result displayed in LCD.

SINGLE: the display will remain the measured data when execute. It takes about 3 seconds to get the result. **CONTINUE:** the display will refresh to new measurement data. It takes about 10 seconds to get a new, stable result.

PARAMETER = PERCENT / VALUE: the data form of each harmonic order.

PERCENT: the percentage of fundamental value. **VALUE:** the absolute value.

Press **SHIFT**, then **ENTER** to execute harmonics measurement.

THD = 0.0 %	[HAR]
DC = 0.0	
Fundament = 0.0	
	▼

THD : the total harmonic distortion of output wave.

DC : the dc value of output wave.

Fundament : the fundamental value of output wave.

Press **SHIFT**, then ▼ to change to next page.

N	%	N	%	[HAR]
2	0.00	3	0.00	
4	0.00	5	0.00	▲
6	0.00	7	0.00	▼

Press **SHIFT**, then ▲ or ▼ to see other harmonic orders. Press **PAGE/EXIT** to go back to the HAR set page.

The following figure shows that when PARAMETER set to VALUE.

N	VALUE	N	VALUE	[HAR]
2	0.00	3	0.00	
4	0.00	5	0.00	▲
6	0.00	7	0.00	▼

***** NOTICE *****

When users press **SHIFT**, then **ENTER** to execute harmonics measurement, the AC source will regulate the internal gain by measured data automatically. This way, the AC source can get more accurate data for each harmonic. Due to this reason, the user had best execute harmonics measurement when the load is stable, and not change load when measuring. Or, the calculated data may lose accuracy even over-current protection may occur.

5.6 Synthesize Waveform

On the CHOICE PAGE (see 3.4), press **9** then **ENTER**, choose the SYN functional list.

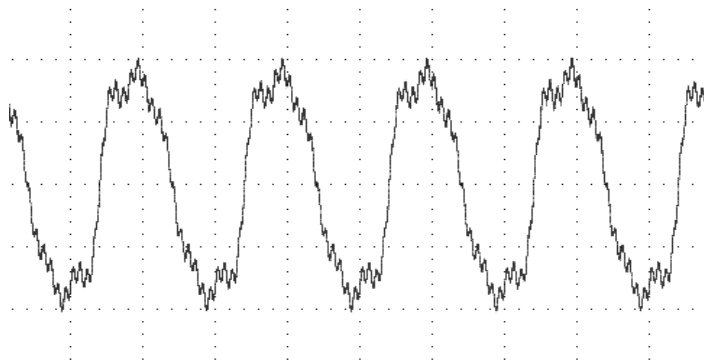
```

PAGE CHOICE = 9_
1. SETUP  2.CONF  3.OUTPUT  4. MANUAL CALI
5. LIST   6. PULSE 7. STEP   8. HAR    9. SYN
10. INTERHAR
    
```

```

COMPOSE=VALUE-1 [ SYN ]
Vac_fund = 0.0   F_fund = 60Hz
Vdc = 0.0       DEGREE = 0.0
                <SHIFT><ENTER> to Execute ▼
    
```

The 31000A series AC Source offers a SYN function to synthesize waveform with harmonic composition up to 40 orders. The fundamental frequency is restricted to 50Hz or 60Hz. Users can easy program the magnitude and phase of each order in LCD display. The following figure is an example.



COMPOSE = VALUE-1 / VALUE-2 / PERCENT-1 / PERCENT-2: the data form of each harmonic order. **VALUE:** the absolute value. **PERCENT:** the percentage of fundamental voltage. Users totally can program four kinds of synthesized waveforms to execute.

Vac_fund: the fundamental voltage. The maximum value is limited by RANGE (see 3.5.1).

F_fund = 50 / 60Hz: the fundamental frequency.

Vdc: the DC voltage adds to voltage waveform.

DEGREE: the start angle of output waveform.

Press **SHIFT**, then **▼** to next page to program the harmonic composition and its phase angle (the range of each phase angle is from 0.0 to 359.9).

N	V	θ	N	V	θ	[SYN]
2	0.0	0.0	3	0.0	0.0	
4	0.0	0.0	5	0.0	0.0	▲
6	0.0	0.0	7	0.0	0.0	▼

N	%	θ	N	%	θ	[SYN]
2	0.0	0.0	3	0.0	0.0	
4	0.0	0.0	5	0.0	0.0	▲
6	0.0	0.0	7	0.0	0.0	▼

After setting, press **PAGE/EXIT** to go back to SYN set page. Press **SHIFT**, then **ENTER** to go to SYN execution page. The LCD shows **_TRIG_ON** is under action, and *** STOP *** is the triggering status at present. Press **ENTER** to trigger. Then LCD shows status *** RUNNING *** and **TRIG_OFF** waiting for user to stop the SYN waveform output.

_TRIG_ON	* STOP *		[SYN]
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

_TRIG_OFF	* RUNNING *		[SYN]
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

If the AC Source is in output status, press **OUT/QUIT** and the output will stop the waveform and return to zero voltage. Press **OUT/QUIT** again and the AC Source will only output the waveform set in the MAIN PAGE. Press **ENTER** to retrigger it. If in quit status, users can press **ENTER** to directly output SYN waveform.

The synthesized wave will shut down when press **PAGE/EXIT** to exit SYN execution page.

***** NOTICE *****

1. For practical use and to protect the power stage of AC Source, the composing value or percentage of each order has to be restricted.
2 ≤ order ≤ 10, value ≤ 150V or percentage ≤ 100% .
11 ≤ order ≤ 20, value ≤ 120V or percentage ≤ 50% .
21 ≤ order ≤ 30, value ≤ 80V or percentage ≤ 30% .
31 ≤ order ≤ 40, value ≤ 45V or percentage ≤ 15% .
2. If the synthesized waveform is over the limit of voltage, 424V for 300V RANGE or 212V for 150V RANGE, the OUTPUT OVP protection will happen.

5.7 Interharmonics Waveform

On the CHOICE PAGE (see 3.4), press **10** then **ENTER**, choose the INTERHAR functional list.

PAGE CHOICE = 10_

1. SETUP 2. CONF 3. OUTPUT 4. MANUAL CALI
5. LIST 6. PULSE 7. STEP 8. HAR 9. SYN
10. INTERHAR

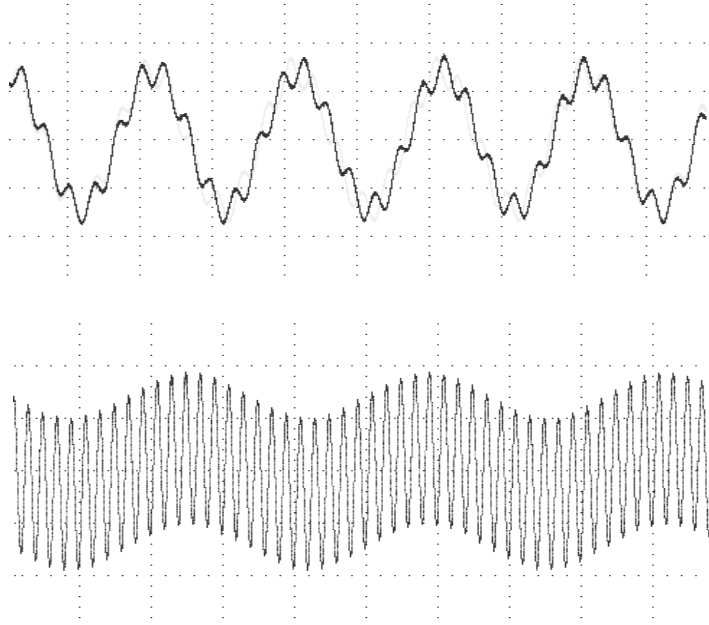
Fi_start = 0.01 Hz [INTERHAR]

Fi_end = 2400.0 Hz

LEVEL = 0.0 % TIME = 0.00 sec

<SHIFT><ENTER> to Execute

For some tests, the AC source offers a sweeping frequency, with a small magnitude level, that can superimpose on original fundamental output in the INTERHAR function. The following figures are examples.



Fi_start : the starting frequency of the sweeping wave. The range is 0.01Hz ~ 2400Hz.
Fi_end : the ending frequency of the sweeping wave. The range is 0.01Hz ~ 2400Hz.
LEVEL : the r.m.s. magnitude of the sweeping wave in percentage of fundamental voltage set in the MAIN PAGE.
TIME : the time interval from Fi_start to Fi_end.

Press **SHIFT**, then **ENTER** to go to the INTERHAR execution page. The LCD shows **_TRIG_ON** is under action, and *** STOP *** is the triggering status at present. **Fi** is the sweeping frequency. (**Fi = 0** means no sweeping wave superimpose on original fundamental output.) Press **ENTER** to trigger. Then LCD shows status *** RUNNING *** and **TRIG_OFF** and **TRIG_PAUSE**. Press **▲** or **▼** to move cursor then, press **ENTER** to select. **TRIG_OFF** is to stop the INTERHAR waveform. **TRIG_PAUSE** is to pause the INTERHAR waveform in certain frequency. The frequency will continue to sweep when users move cursor to **TRIG_CONTINUE** and press **ENTER**. The LCD shows *** FINISH *** when the sweeping frequency reaches to **Fi_end**.

_TRIG_ON	* STOP *	[INTERHAR]	
		Fi = 0.00	
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

_TRIG_OFF	* RUNNING *	[INTERHAR]	
TRIG_PAUSE		Fi = 0.00	
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

TRIG_OFF	* PAUSE *	[INTERHAR]	
_TRIG_CONTINUE		Fi = 0.00	
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

If the AC Source is in output status, press **OUT/QUIT** and the output will stop and return to zero voltage. Press **OUT/QUIT** again and the AC source will only output the waveform set in the MAIN PAGE. Users must press **ENTER** to retrigger. If in quit status, users can press **ENTER** to directly output interharmonics waveform.

The INTERHAR waveform will shut down when **PAGE/EXIT** is pressed to exit INTERHAR execution page.

***** NOTICE *****

For practical use and to protect the power stage of AC source, the LEVEL has to be restricted relate to Fi_start and Fi_end :

If $0.01\text{Hz} \leq \text{Fi_start}$ or $\text{Fi_end} \leq 500\text{Hz}$, LEVEL $\leq 30\%$.

If $500\text{Hz} < \text{Fi_start}$ or $\text{Fi_end} \leq 1000\text{Hz}$, LEVEL $\leq 20\%$.

If $1000\text{Hz} < \text{Fi_start}$ or $\text{Fi_end} \leq 2400\text{Hz}$, LEVEL $\leq 10\%$.

6. Theory of Operation

6.1 General

The AC source consists of nine print circuit boards and other components. Each of the PCBs has its specific function that will be described in the following subsection.

6.2 Description of Overall System

Figure 5-1 shows the overall system. Main power flows through the A/D, D/D, D/A power stage converter. The A/D power stage is designated as I board and generates DC voltage from the line input. The DC voltage of A/D output is applied to the D/D power stage. The G board of the D/D stage takes power from the A/D output. It generates two isolated DC outputs for the D/A power stage. The H board of D/A inverter generates the AC output through full bridge controlled by B board. The D/A power stage is through the G board relays in the parallel or a series control to obtain more current and a higher voltage.

B board is identified as the DSP processor and the D/A controller. The DSP processor is applied to control output frequency and voltage, measure voltage and current through G board, to perform remote control through GPIB, RS-232C or EXT Vref interface on Optional E board and respond to TTL signals through D board. A board is identified as user interface controller. It scans the front panel keys through K board and sends settings and measurement messages on the LCD module.

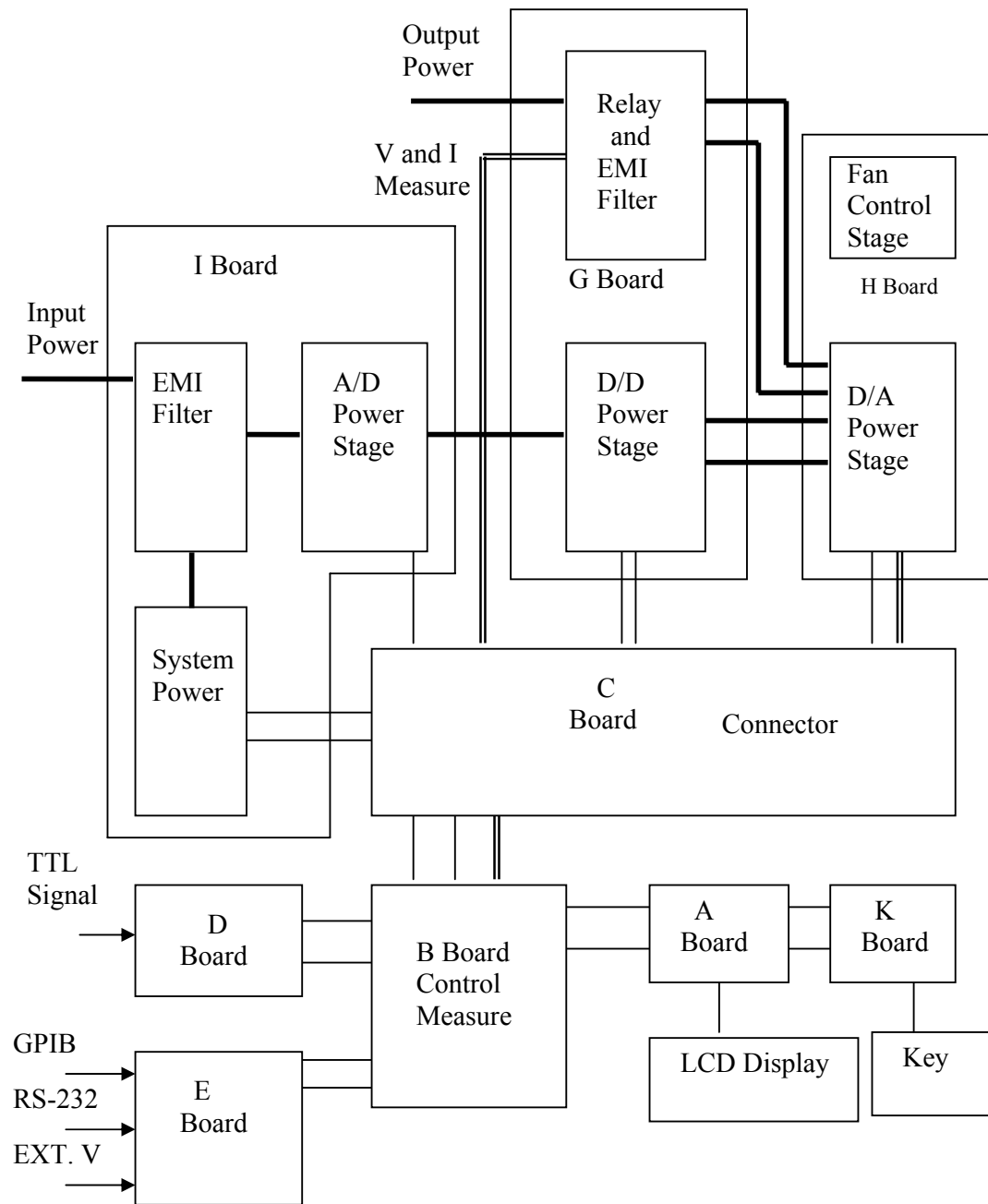


Figure 5-1

7. Self-test and Troubleshooting

7.1 General

This section describes the self-test steps and suggested troubleshooting procedures when the AC source functions abnormally. If the problem cannot be solved using the information given, consult the distributor whom you purchased the unit.

7.2 Self-test

When powering-on the AC source, it performs a series of self-tests. First, it does the memory, data and communication self-tests. They contain three items: DISPLAY, WAVEFORM and REMOTE. If any failure is detected on a certain item, an "error code" will be shown at the right side of that item. The following table shows all the error messages:

Error Code	Description	Remark
Bit 0	SRAM error	0 – OK, 1 - ERROR
Bit 1	CODE error	0 – OK, 1 – ERROR
Bit 2	DATA error	0 – OK, 1 – ERROR
Bit 3	Communication error	0 – OK, 1 - ERROR
Bit 4	Output test result	0 – OK, 1 – ERROR
Bit 5	Reserved	
Bit 6	Reserved	
Bit 7	Reserved	

Example : If the error code shows " ERROR = 05 ," the error code in binary is " 00000101." The bit 0 and bit 2 are " 1 ," So " ERROR = 05 " means SRAM error and DATA error occurs.

Error message	Description	Action
SRAM error	SRAM test fail.	Consult your dealer for assistance.
CODE error	Program code test fail.	Consult your dealer for assistance.
DATA error	Data in Flash or EEPROM test fail.	Consult your dealer for assistance.
Communication error	Can not communicate.	1. Power off the AC source, wait three seconds, power on again. 2. Consult your dealer for assistance.

After the memory, data and communication self-tests, the AC source does the power output self-test. In this procedure, the output relays are in the OFF state to ensure not to harm any load connected to the output terminals. The AC source will then check if there is any protection signal sent from hardware. If it does, the display shows " Output self test <NG>." This means the AC source is abnormal. Press **ENTER** to check the protection condition. If no protection signal, the AC source will program 300Vac and measure the voltage. If the measured voltage is over 300V±5V, the power self-test fails and the display also shows " Output self test <NG> ." Most likely, the AC source has not been calibrated (especially if

firmware was updated). Users can do following steps to verify a calibration issue.

1. Press **ENTER** to ignore the NG.
2. If there is no PROTECTION, press **PAGE/EXIT** to change to the MAIN PAGE.
3. Program a small voltage such as 10Vac then press **OUT/QUIT**. Verify the measurement from the LCD display is within tolerance around 10V or not.

If the reading of voltage is out of tolerance, the AC source needs calibration (see Chap 4). If the reading does not change, show an unreasonable value or the display shows PROTECTION, the AC source requires repair. Consult your dealer for assistance.

7.3 Troubleshooting

The following table lists the operating problems and suggests corrective actions:

Problem	Reason	Solution
Poor measurement of V, I.	Aging of the components result in deviation of characteristics.	Periodic calibration is required. Refer to Chapter 4 Calibration.
Distorted output	1. The AC source output voltage is too low. 2. The rectified load is too large at high frequency.	1. Program higher output voltage. 2. Reduce the load or lower the output frequency.
OVER TEMP protection (OTP)	1. Ambient temperature is too high. 2. Air way is obstructed.	1. Operate the unit 0 ~ 40°C 2. Unblock the air way.
OVER-POWER protection (OPP)	The output power is over specification.	Remove the over-power or lower down output voltage.
OVER-CURRENT protection (OCP)	The output current is over specification or I LIMIT.	Remove the overload or relax the I LIMIT.
OUTPUT SHORT protection	1. The output is shorted. 2. External current reverse.	1. Remove the short. 2. Remove the load.
INPUT FAIL protection (UVP)	The AC source line input voltage is too low or too high.	Measure input voltage and regulate it if it's over specification.
INT _ AD protection	1. Line input voltage cycle dropout. 2. Instant over current of output. 3. AD power stage damaged.	1. Check the stability of input voltage. 2. Remove the load. 3. If cannot reset to the status of protection, consult the dealer for assistance.
INT _ DD protection	1. Line input voltage cycle dropout. 2. Instant over current of output. 3. DD power stage damaged.	1. Check the stability of the input voltage. 2. Remove the load. 3. If it cannot reset the status of protection, consult the dealer for assistance.
OUTPUT OVP	1. Remote sense is open.	1. Connect the output to the

protection	2. Output voltage peak is over range.	remote sense terminals. 2. Check the settings of Vac and Vdc on the MAIN PAGE.
Cannot control AC source by GPIB	1. The AC source unit address is incorrect. 2. GPIB cable is loose at rear.	1. Update address. 2. Check connection, tighten the screws.

8. Remote Operation

8.1 General Information

The AC source can be controlled remotely through the GPIB or the RS-232C port.

The GPIB interface is quite different from the RS-232C interface. The GPIB interface is an 8-bit parallel data bus owning a host of bus commands for synchronization, and up to a one-Megabyte transfer rate. The RS-232C interface, a series bus with a few handshake lines for synchronization, is less capable.

8.1.1 Setting the GPIB Address and RS-232C Parameters

The AC source is shipped with the GPIB address set to 30. The address can only be changed from the "CONF" functional list menu (please refer to 3.6.4). This menu is also used to select the RS-232C interface and specify the parameters of RS-232C such as baud rate and parity.

8.1.2 Wire Connection of RS-232C

The AC source is shipped with a baud rate set at 9600 and a parity set at None. For RS-232C interface, only the signals of TxD and RxD are used for transfer of data. The RS-232C connector is a 9-pin, D-type subminiature female connector. Use a standard 9 pin to 9 pin RS232 Extension Cable for connection. The following table describes the pins and signals of RS-232C connector.

Pin No.	Input/Output	Description
1	---	No connection
2	OUTPUT	TxD
3	INPUT	RxD
4	---	No connection
5	---	GND
6	---	No Connection
7	---	No Connection
8	---	No Connection
9	---	No connection

Interconnection between the computer (compatible with PC) and the AC source is illustrated below:

PIN	PC	AC Source
1	DCD	No Connection
2	RX	← TX
3	TX	→ RX
4	DTR	No Connection
5	GND	—— GND
6	DSR	No Connection
7	RTS	No Connection
8	CTS	No Connection
9	RI	No Connection

8.2 The GPIB Capability of the AC Source

GPIB Capability	Description	Interface Functions
Talker/Listener	Command and response messages can be sent and received over the GPIB bus. Status information can be read using a series poll.	AH1, SH1, T6, L4
Service Request	The AC source sets the SRQ line true if there is an enabled service request condition.	SR1
Remote/Local	The AC source powers up in local state. In local state, the front panel is operative and the AC source responds to the commands from GPIB. In the remote state*, all front panel keys, with the exception of the “<PAGE/EXIT>” key, are disabled. Press the “<PAGE/EXIT>” key to return the AC source to local state.	RL1

*Remote State:

The panel shows remote message on the LCD display as below:

Vac = 0.0	F = 60.00	Vdc = 0.0	R H
V = 0.00	F = 0.00	I = 0.00	▲
P = 0.0	PF = 0.000	CF = 0.00	▼

There is an “R” on right up per side of the LCD display to indicate the AC source is in the remote state. In the remote state, all front panel keys, with the exception of the

“<PAGE/EXIT>” key, are disabled. Press the “<PAGE/EXIT>” key to return the AC source to the local state.

8.3 Introduction to Programming

All command and response messages are transferred in the form of ASCII codes. The response messages must be read completely before a new command is sent, otherwise the remaining response messages will be lost, and a query interrupt error will occur.

8.3.1 Conventions

Angle brackets	< >	Items in angle brackets are parameter abbreviations.
Vertical bar		Vertical bars separate alternative parameters.
Square brackets	[]	Items in square brackets are optional. For example, OUTP [: STATE] means that: STATE may be omitted.
Braces	{ }	Braces indicate the parameters that may be repeated. The notation <A> {<, B>} means that parameter “A” must be entered while parameter “B” may be omitted or entered one or more times.

8.3.2 Numerical Data Formats

All data programmed to or returned from the AC source is ASCII code. The data can be numerical or a character string.

Numerical Data Formats

Symbol	Description	Example
NR1	A digit with no decimal point. The decimal is assumed to be at the right of the least significant digit.	123, 0123
NR2	A digit with a decimal point.	12.3, .123
NR3	A digit with a decimal point and an exponent.	1.23E+2

8.3.3 Boolean Data Format

The Boolean parameter <Boolean> takes only the form ON|OFF.

8.3.4 Character Data Format

The character strings returned by query commands may take either of the following forms:

<CRD>	<u>Character Response Data</u> : Character string with maximum length of 12.
<SRD>	<u>String Response Data</u> : Character string.

8.3.5 Basic Definition

Command Tree Table:

The commands of the AC source are based on a hierarchical structure, also known as a tree system. In order to obtain a particular command, the full path to that command must be specified. This path is represented in the table by placing the highest node in the farthest left position of the hierarchy. Lower nodes in the hierarchy are indented in the position to the right, below the parent node.

Program Headers:

Program headers are key words that identify the command. They follow the syntax described in subsection 7.6 of IEEE 488.2. The AC source accepts characters in the both upper and the lower case without distinguishing the difference. Program headers consist of two distinctive types, common command headers and instrument-controlled headers.

Common Command and Query Headers:

The syntax of common command and query headers are described in IEEE 488.2. It is used together with the IEEE 488.2-defined common commands and queries. The commands with a leading “*” are common commands.

Instrument-Controlled Headers:

Instrument-controlled headers are used for all other instrument commands. Each of them has a long form and a short form. The AC source only accepts the exact short and long forms. A special notation will be taken to differentiate the short form header from the long one of the same header in this subsection. The short form of the header is shown in characters of upper case, whereas the rest of the header is shown in those of lower case.

Program Header Separator (:):

If a command has more than one header, the user must separate them with a colon (FETC:CURR?, VOLT:DC 10). Data must be separated from program header by at least one space.

Program Message:

Program messages consist of a sequence of zero or more elements of a program message unit that is split by separator elements of program message unit.

Program Message Unit:

Program message units represent a single command, programming data or query.

Example : `FREQ?, OUTPUT ON.`

Program Message Unit Separator (;):

The separator (semicolon ;) splits the program message unit elements from one another in a program message.

Example : VOLT:AC 110 ; FREQ 120<PMT>

Program Message Terminator (<PMT>):

A program message terminator represents the end of a program message. Three permitted terminators are:

- (1) <END>: End or identify (EOI)
- (2) <NL>: New line which is a single ASCII-encoded byte 0A (10 decimals).
- (3) <NL> <END>: New line with EOI.

Note: The response message is terminated by <NL> <END> for GPIB and <NL> for RS-232C.

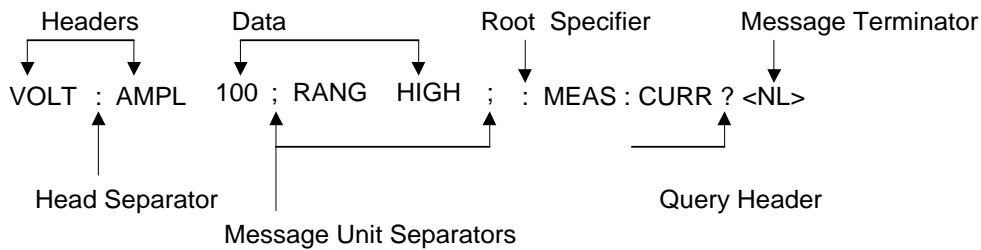


Figure 7-1 The Structure of Command Message

8.4 Traversal of the Command Tree

Multiple program message unit elements can be sent in a program message. The first command is always referred to the root node. Subsequent commands are referred to the same tree level as the previous command in a program message. A colon preceding a program message unit changes the header path to the root level.

Example:

OUTPut : PROTEction : CLEAr	All colons are header separators.
: OUTPut : PROTEction : CLEAr	Only the first colon is a specific root.
OUTPut : PROTEction : CLEAr; : VOLT : AC 100	Only the third colon is a specific root.

8.5 Execution Order

The AC source executes program messages in the order received. Program message units except coupled commands are executed in the order received. The execution of coupled commands is deferred until program message terminator is received. A coupled command sets parameters which are affected by the setting of other commands. Problems may arise, because the prior state of the AC source will affect the response of a coupled parameter to its programming.

For example, assume that the current output voltage range is LOW, a new state is desired with the output voltage range HIGH, and amplify 220 Volt. If the commands

```
VOLTage : AC          220<PMT>
VOLTage : RANGe     HIGH<PMT>
```

are sent, a data out of range error will be produced. This kind of error can be avoided by reversing the order or sending the commands in one program message. For the above example, the program message can be sent without error.

```
VOLTage:AC 220;VOLTage:RANGe HIGH<PMT>
```

8.6 The Commands of the AC Source

This subsection will discuss the syntax and parameters for all commands of the AC source. The examples given for each command are generic.

- Syntax Forms: Definitions of syntax are in long form headers, whereas only short form headers appear in examples.
- Parameters: Most commands require a parameter.
- Return Parameters: All queries return a parameter.
- Models: If a command is merely applied to specific models, these models will be listed in the Model only entry. If there is no Model only entry, the command will be applied to all models.

8.6.1 Common Command Dictionary

Common commands begin with a “*,” and consist of three letters and/or one “?” (query). Common commands and queries are listed alphabetically.

*CLS Clear status

This command clears the following registers

- (1) Questionable Status Event
- (2) Status Byte
- (3) Error Queue

*ESE<n> Standard event status enabled

This command programs the Standard Event register bits. If one or more of the enabled events of the Standard Event register is set, the ESB of Status Byte Register is set as well.

Bit Configuration of Standard Event Status Enabled Register

Bit Position	7	6	5	4	3	2	1	0
Bit Name	PON	---	CME	EXE	DDE	QYE	---	OPC
CME = Command error			DDE = Device-dependent error					

EXE = Execution error	OPC = Operation complete
PON = Power-on	QYE = Query error

*ESE? Return standard event status enabled

The query reads the Standard Event Status Event register. Reading of the register clears it. The bits of configuration are the same as Standard Event Status Enabled Register.

*IDN? Return the AC source identification string

Return Parameter QuadTech, Inc. 31005,123456,1.00,1.01,1.02
 QuadTech, Inc. : Company name
 31005 : Model name
 123456 : Serial number
 1.00, 1.01,1.02 : Firmware version of display, waveform and remote

*RCL<n> Restore the values of the specific group which is previously stored in memory.

Parameter 1 - 3

*RST This command resets the AC source to the initial states. It's better to wait about three seconds to send the next command.

*SAV<n> Save the values into the specific group in memory.

Parameter 1 - 3

*SRE This command sets conditions of the Service Request Enabled Register. If one or more of the enabled events of the Status Byte Register is set, the MSS and RQS of Status Byte Register are set as well.

*SRE? This query returns the Service Request Enabled Register.

*STB? This query returns the Status Byte Register.

Bit configuration of Status Byte Register

Bit Position	7	6	5	4	3	2	1	0
Condition	--	MSS RQS	ESB	MAV	QUES	--	--	--

ESB = event status byte summary
 QES = questionable status summary
 RQS = request for service
 MSS = master status summary
 MAV = message available

*TST? This command queries the self-test result of the AC source.

Instrument Command Dictionary

The commands are listed in alphabetical order. Commands followed by question marks (?) take only the query forms. When commands take both the command and query forms, they are noted in the query syntax descriptions.

FETCH & MEASURE Sub-system

FETCH | MEASURE

[: SCALar]	
: CURRent	
: AC?	Query the rms current
: DC?	Query the DC current level
: AMPLitude : MAXimum?	Query the peak current
: CRESfactor?	Query the current crest factor
: INRush	Query the inrush current
: FREQuency?	Query the frequency
: POWer	
: AC	
[: REAL]?	Query the true power
: APParent?	Query the apparent power
: REACTive	Query the reactive power
: PFACTor?	Query the power factor
: VOLTage	
: ACDC?	Query the rms voltage
: DC?	Query the DC voltage

This command lets the user get measurement data from the AC source. Two measurement commands are available: MEASURE and FETCH. MEASURE triggers the acquisition of new data before returning data. FETCH returns the previously acquired data from measurement buffer.

FETCH [: SCALar] : CURRent : AC?

MEASURE [: SCALar] : CURRent : AC?

Description	: These queries return the rms current which are being output at the output terminal.
Query Syntax	: FETCH : CURRent : AC?, MEASURE : CURRent : AC?
Return Parameters	: <NR2>

FETCH [: SCALar] : CURRent : DC?

MEASURE [: SCALar] : CURRent : DC?

Description	: These queries return the DC current which are being output at the output terminal.
Query Syntax	: FETCH : CURRent : DC?, MEASURE : CURRent : DC?
Return Parameters	: <NR2>

FETCh [: SCALAr] : CURRent : AMPLitude : MAXimum?

MEASure [: SCALAr] : CURRent : AMPLitude : MAXimum?

Description : These queries return the absolute value of peak current.
Query Syntax : FETCh : CURRent : AMPLitude : MAXimum?,
MEASure : CURRent : AMPLitude : MAXimum?
Return Parameters : <NR2>

FETCh [: SCALAr] : CURRent : CRESfactor?

MEASure [: SCALAr] : CURRent : CRESfactor?

Description : These queries return the output current crest factor. It is the ratio of peak output current to rms output current.
Query Syntax : FETCh : CURRent : CRESfactor?
MEASure : CURRent : CRESfactor?
Return Parameters : <NR2>

FETCh [: SCALAr] : CURRent : INRush?

MEASure [: SCALAr] : CURRent : INRush?

Description : These queries return the inrush current which are being output at the output terminal.
Query Syntax : FETCh : CURRent : INRush?, MEASure : CURRent : INRush?
Return Parameters : <NR2>

FETCh [: SCALAr] : FREQuency?

MEASure [: SCALAr] : FREQuency?

Description : These queries return the output frequency in Hertz.
Query Syntax : FETCh : FREQuency?
MEASure : FREQuency?
Return Parameters : <NR2>

FETCh [: SCALAr] : POWer : AC [: REAL] ?

MEASure [: SCALAr] : POWer : AC [: REAL] ?

Description : These queries return the true power which are being output at output terminals in watts.
Query Syntax : FETCh : POWer : AC?
MEASure : POWer : AC?
Return Parameters : <NR2>

FETCh [: SCALAr] : POWer : AC : APParent?

MEASure [: SCALAr] : POWer : AC : APParent?

Description : These queries return the apparent power which are being output at output terminals in volt-amperes.
Query Syntax : FETCh : POWer : AC : APParent?
MEASure : POWer : AC : APParent?
Return Parameters : <NR2>

FETCh [: SCALAr] : POWer : AC : REACTive?

MEASure [: SCALAr] : POWer : AC : REACTive?

Description : These queries return the reactive power which are being output

at output terminals in volt-amperes. Reactive power is
 computed as: $VAR = \sqrt{APPARENTPOWER^2 - REALPOWER^2}$

Query Syntax : FETCh : POWer : AC : REACTive?
 MEASure : POWer : AC : REACTive?

Return Parameters : <NR2>

FETCh [: SCALAr] : POWer : AC : PFACTor?**MEASure [: SCALAr] : POWer : AC : PFACTor?**

Description : These queries return the power factor which are being output at
 output terminals. Power factor is computed as:
 $PF = TRUE\ POWER / APPARENT\ POWER$

Query Syntax : FETCh : POWer : AC : PFACTor?
 MEASure : POWer : AC : PFACTor?

Return Parameters : <NR2>

FETCh [: SCALAr] : VOLTage : ACDC?**MEASure [: SCALAr] : VOLTage : ACDC?**

Description : These queries return the rms voltage which are being output at
 the output terminals.

Query Syntax : FETCh [: SCALAr] : VOLTage : ACDC?
 MEASure [: SCALAr] : VOLTage : ACDC?

Return Parameters : <NR2>

FETCh [: SCALAr] : VOLTage : DC?**MEASure [: SCALAr] : VOLTage : DC?**

Description : These queries return the DC composition of output voltage
 which are being output at the output terminals.

Query Syntax : FETCh [: SCALAr] : VOLTage : DC?
 MEASure [: SCALAr] : VOLTage : DC?

Return Parameters : <NR2>

OUTPUT Sub-system**OUTPut**

[: STATe]
 : RELay
 : SLEW
 : VOLTage
 : AC
 : DC
 : FREQuency
 : COUPling
 : IMPedance
 : STATe
 : RESistor
 : INDuction

: MODE
 : PROTection
 : CLear

OUTPut [: STATe]

Description : This command enables or disables the output of the AC source. Disable output is to set an output voltage amplitude at 0 Volt.
 Query Syntax : OUTPut [: STATe]?
 Parameters : OFF | ON
 Return Parameters : OFF | ON

OUTPut : RELay

Description : This command sets output relay on or off.
 Query Syntax : OUTPut : RELay?
 Parameters : OFF | ON, ON sets the output relay of the AC source on (closed). OFF sets the output relay of the AC source off (open).
 Return Parameters : OFF | ON

OUTPut : SLEW : VOLTage : AC

Description : This command sets the slew rate of the AC output voltage.
 Query Syntax : OUTPut : SLEW : VOLTage : AC?
 Parameters : <NR2>, valid range: 0.000V/ms ~ 1200.000V/ms
 Return Parameters : <NR2>

OUTPut : SLEW : VOLTage : DC

Description : This command sets the slew rate of the DC composition voltage.
 Query Syntax : OUTPut : SLEW : VOLTage : DC?
 Parameters : <NR2>, valid range: 0.000V/ms ~ 1000.000V/ms
 Return Parameters : <NR2>

OUTPut : SLEW : FREQuency

Description : This command sets the slew rate of the output frequency.
 Query Syntax : OUTPut : SLEW : FREQuency?
 Parameters : <NR2>, valid range: 0.000 Hz/ms ~ 1600.000Hz/ms
 Return Parameters : <NR2>

OUTPut : COUPling

Description : This command selects the couple setting of the output signal.
 Query Syntax : OUTPut : COUPling?
 Parameters : AC | DC | ACDC
 Return Parameters : AC | DC | ACDC

OUTPut : IMPedance : STATe

Description : This command enables or disables the output impedance programming capability of the ac source.
 Query Syntax : OUTPut : IMPedance : STATe?
 Parameters : ON | OFF

Return Parameters : ON | OFF

OUTPut : IMPedance : RESistor

Description : This command sets the resistance of the output impedance.
 Query Syntax : OUTPut : IMPedance : RESistor?
 Parameters : <NR2>, valid range: 0.00Ω ~ 1.00Ω
 Return Parameters : <NR2>

OUTPut : IMPedance : INDuction

Description : This command sets the induction of the output impedance.
 Query Syntax : OUTPut : IMPedance : INDuction?
 Parameters : <NR2>, valid range: 0.0mH ~ 1.0mH
 Return Parameters : <NR2>

OUTPut : MODE

Description : This command sets the operation mode. "FIXED" MODE is normal used.
 Query Syntax : OUTPut : MODE?
 Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR
 Return Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

OUTPut : PROTection : CLear

Description : This command clears the latch that disables the output when an overcurrent (OC), overtemperature (OT), overpower (OP) or remote inhibit (RI) is detected. All conditions which have generated the faults must be removed before the latch is cleared.
 Query Syntax : None
 Parameters : None
 Return Parameters : None

SOURCE Sub-system

[SOURCE :]

CURRent

: LIMit
 : DELay
 : INRush
 : START
 : INTerval

FREQuency

[: {CW | IMMEDIATE}]

FUNCTion

: SHAPE
 : SHAPE
 : A
 : A

: MODE
 : THD
 : AMP
 : B
 : B
 : MODE
 : THD
 : AMP

VOLTage

[: LEVel][: IMMEDIATE][: AMPLitude]
 : AC
 : DC
 : LIMit
 : AC
 : DC
 : PLUS
 : MINus
 : RANGE

[SOURce :] CURRENT : LIMit

Description : This command sets the rms current limit of the AC source for software protection.
 Query Syntax : [SOURce :] CURRENT : LIMit?
 Parameters : <NR2>, valid range: 0.00 ~ maximum current spec. of the specific model. (unit: A)
 Return Parameters : <NR2>

[SOURce :] CURRENT : DELay

Description : This command sets the delay time for triggering over current protection.
 Query Syntax : [SOURce :] CURRENT : DELay?
 Parameters : <NR2>, valid range: 0.0 ~ 5.0 (unit: 0.5 second)
 Return Parameters : <NR2>

[SOURce :] CURRENT : INRush : START

Description : This command sets the start time of the inrush current measurement.
 Query Syntax : [SOURce :] CURRENT : INRush : START?
 Parameters : <NR2>, valid range: 0.0 ~ 999.9 (unit: ms)
 Return Parameters : <NR2>

[SOURce :] CURRENT : INRush : INTerval

Description : This command sets the measuring interval of the inrush current measurement.
 Query Syntax : [SOURce :] CURRENT : INRush : INTerval?
 Parameters : <NR2>, valid range: 0.0 ~ 999.9 (unit: ms)

Return Parameters : <NR2>

[SOURCE :] FREQUENCY [: {CW | IMMEDIATE}]

Description : The command sets the frequency of the output waveform of the AC source in Hz.

Query Syntax : [SOURCE :] FREQUENCY [: {CW | IMMEDIATE}]?

Parameters : <NR2>, valid range: 15.00 ~ 1000.00 (unit: Hz)

Return Parameters : <NR2>

[SOURCE :] FUNCTION : SHAPE

Description : This command specifies the waveform buffer. There are two buffers for the output of the AC source, so the user must specify the contents of waveform buffer A or B of the AC source.

Query Syntax : [SOURCE :] FUNCTION : SHAPE?

Parameters : A | B

Return Parameters : A | B

[SOURCE :] FUNCTION : SHAPE : A

Description : This command specifies the waveform shape of waveform buffer A.

Query Syntax : [SOURCE :] FUNCTION : SHAPE : A?

Parameters : SINE | SQUA | CSIN | DST<01..30> | USR<01..06>

Return Parameters : SINE | SQUA | CSIN | DST<01..30> | USR<01..06>

[SOURCE :] FUNCTION : SHAPE : A : MODE

Description : This command selects the mode of the value for the clipped sine in waveform buffer A.

Query Syntax : [SOURCE :] FUNCTION : SHAPE : A : MODE?

Parameters : AMP | THD

Return Parameters : AMP | THD

[SOURCE :] FUNCTION : SHAPE : A : THD

Description : This command sets the percentage of THD at which the clipped sine clips in waveform buffer A.

Query Syntax : [SOURCE :] FUNCTION : SHAPE : A : THD?

Parameters : <NR2>, valid range: 0.0% ~ 43%

Return Parameters : <NR2>

[SOURCE :] FUNCTION : SHAPE : A : AMP

Description : This command sets the percentage of peak at which the clipped sine clips in waveform buffer A.

Query Syntax : [SOURCE :] FUNCTION : SHAPE : A : AMP?

Parameters : <NR2>, valid range: 0.0% ~ 100%

Return Parameters : <NR2>

[SOURCE :] FUNCTION : SHAPE : B

Description : This command specifies the waveform shape of waveform buffer B.

Query Syntax : [SOURCE :] FUNCTION : SHAPE : B?

Parameters : SINE | SQUA | CSIN | DST<01..30> | USR<01..06>
 Return Parameters : SINE | SQUA | CSIN | DST<01..30> | USR<01..06>

[SOURCE :] FUNCTION : SHAPE : B : MODE

Description : This command selects the mode of the value for the clipped sine in waveform buffer B.
 Query Syntax : [SOURCE :] FUNCTION : SHAPE : B : MODE?
 Parameters : AMP | THD
 Return Parameters : AMP | THD

[SOURCE :] FUNCTION : SHAPE : B : THD

Description : This command sets the percentage of THD at which the clipped sine clips in waveform buffer B.
 Query Syntax : [SOURCE :] FUNCTION : SHAPE : B : THD?
 Parameters : <NR2>, valid range: 0.0% ~ 43%
 Return Parameters : <NR2>

[SOURCE :] FUNCTION : SHAPE : B : AMP

Description : This command sets the percentage of peak at which the clipped sine clips in waveform buffer B.
 Query Syntax : [SOURCE :] FUNCTION : SHAPE : B : AMP?
 Parameters : <NR2>, valid range: 0.0% ~ 100%
 Return Parameters : <NR2>

[SOURCE :] VOLTage [: LEVel][: IMMEDIATE][: AMPLitude] : AC

Description : This command sets the AC composition of output voltage in Volts.
 Query Syntax : [SOURCE :] VOLTage [: LEVel][: IMMEDIATE][: AMPLitude] : AC?
 Parameters : <NR2>, valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)
 Return Parameters : <NR2>

[SOURCE :] VOLTage [: LEVel][: IMMEDIATE][: AMPLitude] : DC

Description : This command sets the DC composition of output voltage in Volts.
 Query Syntax : [SOURCE :] VOLTage [: LEVel][: IMMEDIATE][: AMPLitude] : DC?
 Parameters : <NR2>, valid range: -212.1 ~ 212.1 (in low range), -424.2 ~ 424.2 (in high range)
 Return Parameters : <NR2>

[SOURCE :] VOLTage : LIMit : AC

Description : This command sets the setting of Vac LIMIT which will restrict the value of Vac.
 Query Syntax : [SOURCE :] VOLTage : LIMit : AC?
 Parameters : <NR2>, valid range: 0.0 ~ 300.0 (unit: V)
 Return Parameters : <NR2>

[SOURCE :] VOLTage : LIMit : DC : PLUS

Description : This command sets the setting of Vdc LIMIT(+) which will restrict the value of Vdc.
 Query Syntax : [SOURCE :] VOLTage : LIMit : DC : PLUS?
 Parameters : <NR2>, valid range: 0.0 ~ 424.2 (unit: V)
 Return Parameters : <NR2>

[SOURCE :] VOLTage : LIMit : DC : MINus

Description : This command sets the setting of Vdc LIMIT(-) which will restrict the value of Vdc.
 Query Syntax : [SOURCE :] VOLTage : LIMit : DC : MINus?
 Parameters : <NR2>, valid range: 0.0 ~ 424.2 (unit: V)
 Return Parameters : <NR2>

[SOURCE :] VOLTage : RANGe

Description : This command sets output voltage range with three options of LOW(150 V), HIGH(300 V), or AUTO.
 Query Syntax : [SOURCE :] VOLTage : RANGe?
 Parameters : LOW | HIGH | AUTO
 Return Parameters : LOW | HIGH | AUTO

CONFIGURE Sub-system**[SOURCE :]****CONFigure**

: INHibit
 : EXTernal
 : COUPling

[SOURCE :] CONFigure : INHibit?

Description : This command sets REMOTE INHIBIT state. There are three states for the feature of remote inhibit : OFF, LIVE, and TRIG.
 Query Syntax : [SOURCE :] CONFigure : INHibit?
 Parameters : OFF | LIVE | TRIG
 Return Parameters : OFF | LIVE | TRIG

[SOURCE :] CONFigure : EXTernal

Description : This command enables or disables the external controlled analog signal input from external devices.
 Query Syntax : [SOURCE :] CONFigure : EXTernal?
 Parameters : OFF | ON
 Return Parameters : OFF | ON

[SOURCE :] CONFigure : COUPling?

Description : This command sets the coupling mode to present AC source output from external V reference : AC_AMPLIFIER and DC_LEVEL_CTL.

Query Syntax : [SOURce :] CONFigure : COUPling?
 Parameters : AC | DC
 Return Parameters : AC | DC

PHASE Sub-system

[SOURce :]
PHASe
 : ON
 : OFF

[SOURce :] PHASe : ON

Description : This command sets the transition angle of the waveform when it out. Default DEGREE ON is 0 degree.
 Query Syntax : [SOURce :] PHASe : ON?
 Parameters : <NR2>, valid range: 0.0 ~ 359.9
 Return Parameters : <NR2>

[SOURce :] PHASe : OFF

Description : This command sets the transition angle of the waveform when it quit.
 Query Syntax : [SOURce :] PHASe : OFF?
 Parameters : <NR2>, valid range: 0.0 ~ 360.0, 360.0 : means IMMED.
 Return Parameters : <NR2>

TRACE Sub-system (31000A Only)

TRACe
 : RMS

TRACe

Description : This command sets waveform data of user-defined. It needs 1024 data points to construct a period of waveform. Users have to normalize the data as the maximum point equal to 32767 or the minimum point equal to -32767.
 Syntax : **TRACe** <waveform_name>, <amplitude> {,<amplitude>}
 Parameters : <waveform_name>:US<n>, n=1~6, <amplitude>:<NR1>, valid range: -32767 ~ 32767.
 Example : **TRACe** US1 100 200 ...32767... 500 800 <= 1024 points
 This command needs about 5 sec to execute.

TRACe : RMS

Description : This command sets the rms value of user's waveform. Users need to calculate the root mean square value of 1024 data points.
 Syntax : **TRACe : RMS** <waveform_name>, <rms>
 Parameters : <waveform_name>:US<n>, n=1~6, <rms>:<NR1>, valid range:

Example 0 ~ 32767.
 : **TRACe : RMS** US1 27000

LIST Sub-system (31000A Only)

[SOURce :]

LIST

 : POINts?
 : COUNT
 : DWELl
 : SHAPe
 : BASE
 : VOLTagE
 : AC
 : START
 : END
 : DC
 : START
 : END
 : FREQuency
 : START
 : END
 : DEGRee

OUTPut

 : MODE

TRIG

TRIG : STATE?

[SOURce:] LIST : POINts?

Description : This command returns the number of sequences of the list mode.
 Query Syntax : [SOURce:] LIST : POINts?
 Parameters : None
 Return Parameters : <NR1>, valid range: 0 ~ 100

[SOURce :] LIST : COUNT

Description : This command sets the number of times that the list is executed before it is completed.
 Query Syntax : [SOURce :] LIST : COUNT?
 Parameters : <NR1>, valid range: 0 ~ 65535
 Return Parameters : <NR1>

[SOURce :] LIST : DWELl

Description : This command sets the sequence of dwell time list points.
 Query Syntax : [SOURce:] LIST : DWELl?
 Parameters : <NR2>, ..., <NR2> valid range: 0 ~ 99999999.9 (unit: ms)

Return Parameters : <NR2>, ..., <NR2>

[SOURCE:] LIST : SHAPE

Description : This command sets the sequence of waveform buffer list points .
Query Syntax : [SOURCE:] LIST : SHAPE?
Parameters : A|B, ..., A|B
Return Parameters : A|B, ..., A|B

[SOURCE:] LIST : BASE

Description : This command sets time base of list.
Query Syntax : [SOURCE:] LIST : BASE?
Parameters : TIME | CYCLE
Return Parameters : TIME | CYCLE

[SOURCE:] LIST : VOLTage : AC : START

Description : This command sets the sequence of AC start voltage list points.
Query Syntax : [SOURCE:] LIST : VOLTage : AC : START?
Parameters : <NR2>, ..., <NR2> valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)
Return Parameters : <NR1>, ..., <NR2>

[SOURCE:] LIST : VOLTage : AC : END

Description : This command sets the sequence of AC end voltage list points.
Query Syntax : [SOURCE:] LIST : VOLTage : AC : END?
Parameters : <NR2>, ..., <NR2> valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)
Return Parameters : <NR2>, ..., <NR2>

[SOURCE:] LIST : VOLTage : DC : START

Description : This command sets the sequence of DC start voltage list points.
Query Syntax : [SOURCE:] LIST : VOLTage : DC : START?
Parameters : <NR2>, ..., <NR2> valid range: -212.1 ~ 212.1 (in low range), -424.2 ~ 414.2 (in high range)
Return Parameters : <NR1>

[SOURCE:] LIST : VOLTage : DC : END

Description : This command sets the sequence of DC end voltage list points.
Query Syntax : [SOURCE:] LIST : VOLTage : DC : START?
Parameters : <NR2>, ..., <NR2> valid range: -212.2 ~ 212.1 (in low range), -424.2 ~ 414.2 (in high range)
Return Parameters : <NR2>, ..., <NR2>

[SOURCE:] LIST : FREQuency : START

Description : This command sets the sequence of start frequency list points.
Query Syntax : [SOURCE:] LIST : FREQuency : START?
Parameters : <NR2>, ..., <NR2> valid range: 15.00 ~ 1000.00 (unit: Hz)
Return Parameters : <NR2>, ..., <NR2>

[SOURCE:] LIST : FREQuency : END

Description : This command sets the sequence of end frequency list points.
 Query Syntax : [SOURce:] LIST : FREQuency : END?
 Parameters : <NR2>, ..., <NR2> valid range: 15.00 ~ 1000.00 (unit: Hz)
 Return Parameters : <NR2>, ..., <NR2>

[SOURce :] LIST : DEGRee

Description : This command sets the sequence of phase angle list points.
 Query Syntax : [SOURce:] LIST : DEGRee?
 Parameters : <NR2>, ..., <NR2> valid range: 0.0 ~ 359.9
 Return Parameters : <NR2>, ..., <NR2>

OUTPut : MODE

Description : This command sets the operation mode.
 Query Syntax : OUTPut : MODE?
 Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR
 Return Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

TRIG

Description : This command sets LIST mode in OFF, ON execution state after setting **OUTPut : MODE LIST**. If users want to change the parameters, it's necessary to set **TRIG OFF** then **OUTPut : MODE FIXED**. Then, set **OUTPut : MODE LIST** again to get ready to set **TRIG ON**.
 Query Syntax : TRIG : STATE?
 Parameters : OFF | ON
 Return Parameters : OFF | RUNNING

PULSE Sub-system (31000A Only)**[SOURce :]****PULSe**

: VOLTage
 : AC
 : DC
 : FREQuency
 : SHAPe
 : SPHase
 : COUNT
 : DCYClE
 : PERiod

OUTPut

: MODE

TRIG

TRIG : STATE?

[SOURCE :] PULSe : VOLTage : AC

Description : This command sets AC voltage in the duty cycle of PULSE mode.
Query Syntax : [SOURCE :] PULSE : VOLTage : AC?
Parameters : <NR2>, valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)
Return Parameters : <NR2>

[SOURCE :] PULSe : VOLTage : DC

Description : This command sets the DC voltage in the duty cycle of PULSE mode.
Query Syntax : [SOURCE :] PULSE : VOLTage : DC?
Parameters : <NR2>, valid range: -212.1 ~ 212.1 (in low range), -424.2 ~ 424.2 (in high range)
Return Parameters : <NR2>

[SOURCE :] PULSe : FREQuency

Description : This command sets the frequency during the duty cycle of PULSE mode.
Query Syntax : [SOURCE :] PULSE : FREQuency?
Parameters : <NR2>, valid range: 15.00 ~ 1000.00 (unit: Hz)
Return Parameters : <NR2>

[SOURCE :] PULSe : SHAPe

Description : This command selects the waveform buffer for PULSE mode.
Query Syntax : [SOURCE :] PULSE : SHAPe?
Parameters : A | B
Return Parameters : A | B

[SOURCE :] PULSe : SPHase

Description : This command sets the start phase angle of duty cycle of PULSE mode.
Query Syntax : [SOURCE :] PULSE : SPHase?
Parameters : <NR2>, valid range: 0.0 ~ 359.9
Return Parameters : <NR2>

[SOURCE :] PULSe : COUNT

Description : This command sets the number of times that the pulse is executed before it is completed.
Query Syntax : [SOURCE :] PULSE : COUNT?
Parameters : <NR2>, valid range: 0 ~ 65535
Return Parameters : <NR2>

[SOURCE :] PULSe : DCYClE

Description : This command sets the duty cycle of PULSE mode.
Query Syntax : [SOURCE :] PULSE : DCYClE?
Parameters : <NR2>, valid range: 0 % ~ 100 %
Return Parameters : <NR2>

[SOURCE :] PULSe : PERiod

Description : This command sets the period of the PULSE mode.
 Query Syntax : [SOURCE :] PULSE : PERiod?
 Parameters : <NR2>, valid range: 0 ~ 99999999.9 (unit: ms)
 Return Parameters : <NR2>

OUTPut : MODE

Description : This command sets the operation mode
 Query Syntax : OUTPut : MODE?
 Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR
 Return Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

TRIG

Description : This command sets PULSE mode in OFF execution state after setting **OUTPut : MODE PULSE**. If users want to change the parameters, it's necessary to set **TRIG OFF** then **OUTPut : MODE FIXED**. Then, set **OUTPut : MODE PULSE** again to get ready to set **TRIG ON**.
 Query Syntax : TRIG : STATE?
 Parameters : OFF | ON
 Return Parameters : OFF | RUNNING

STEP Sub-system (31000A Only)**[SOURCE :]****STEP**

: VOLTage
 : AC
 : DC
 : FREQuency
 : SHAPe
 : SPHase
 : DVOLTage
 : AC
 : DC
 : DFRequency
 : DWELl
 : COUNT

OUTPut

: MODE

TRIG

TRIG : STATE?

[SOURCE :] STEP : VOLTage : AC

Description : This command sets the initial AC voltage of STEP mode.
 Query Syntax : [SOURce :] STEP : VOLTage : AC?
 Parameters : <NR2>, valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)
 Return Parameters : <NR2>

[SOURce :] STEP : VOLTage : DC

Description : This command sets the initial DC voltage of STEP mode.
 Query Syntax : [SOURce :] STEP : VOLTage : DC?
 Parameters : <NR2>, valid range: -212.1 ~ 212.1 (in low range), -424.2 ~ 414.2 (in high range)
 Return Parameters : <NR2>

[SOURce :] STEP : FREQuency

Description : This command sets the initial frequency of STEP mode.
 Query Syntax : [SOURce :] STEP : FREQuency?
 Parameters : <NR2>, valid range: 15.00 ~ 1000.00 (unit: Hz)
 Return Parameters : <NR2>

[SOURce :] STEP : SHAPE

Description : This command selects the waveform buffer for STEP mode.
 Query Syntax : [SOURce :] STEP : SHAPE?
 Parameters : A | B
 Return Parameters : A | B

[SOURce :] STEP : SPHase

Description : This command sets the start phase angle of STEP mode.
 Query Syntax : [SOURce :] STEP : SPHase?
 Parameters : <NR2>, valid range: 0.0 ~ 359.9
 Return Parameters : <NR2>

[SOURce :] STEP : DVOLTage : AC

Description : This command sets the delta AC voltage in each step.
 Query Syntax : [SOURce :] STEP : DVOLTage : AC?
 Parameters : <NR2>, valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)
 Return Parameters : <NR2>

[SOURce :] STEP : DVOLTage : DC

Description : This command sets the delta DC voltage in each step.
 Query Syntax : [SOURce :] STEP : DVOLTage : DC?
 Parameters : <NR2>, valid range: -212.2 ~ 212.1 (in low range), -424.2 ~ 424.2 (in high range)
 Return Parameters : <NR2>

[SOURce :] STEP : DFRequency

Description : This command sets the delta frequency in each step.
 Query Syntax : [SOURce :] STEP : DFRequency?

Parameters : <NR2>, valid range: 0.00 ~ 1000.00 (unit: Hz)
 Return Parameters : <NR2>

[SOURCE :] STEP : DWELI

Description : This command sets the dwell time in each step.
 Query Syntax : [SOURCE :] STEP : DWELI?
 Parameters : <NR2>, valid range: 0 ~ 99999999.9 (unit: ms)
 Return Parameters : <NR2>

[SOURCE :] STEP : COUNT

Description : This command sets the number of times that the step is executed before it is completed.
 Query Syntax : [SOURCE :] STEP : COUNT?
 Parameters : <NR2>, valid range: 0 ~ 65535
 Return Parameters : <NR2>

OUTPut : MODE

Description : This command sets the operation mode
 Query Syntax : OUTPut : MODE?
 Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR
 Return Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

TRIG

Description : This command sets STEP mode in OFF, ON execution state after setting **OUTPut : MODE STEP**. If users want to change the parameters, it's necessary to set **TRIG OFF** then **OUTPut : MODE FIXED**. Then, set **OUTPut : MODE STEP** again to get ready to set **TRIG ON**.
 Query Syntax : TRIG : STATE?
 Parameters : OFF | ON
 Return Parameters : OFF | RUNNING

Harmonic Sense Sub-system (31000A Only)**[SOURCE :]****CONFigure**

: HARMonic
 : SOURce
 : TIMEs
 : PARAmeter
 : FREQUency

SENSE

: HARMonic

FETCh | MEASure

[: SCALar]

: HARMonic
 : THD?

Return the % of total harmonic distortion

: FUNDamental? Return the fundamental
 : ARRay? Return the amplitude of all the harmonic
 order

[SOURCE :] CONFigure : HARMonic : SOURCE

Description : This command sets the measurement source of harmonics
 analysis mode.
 Query Syntax : [SOURCE :] CONFigure : HARMonic : SOURCE?
 Parameters : VOLT | CURR
 Return Parameters : VOLT | CURR

[SOURCE :] CONFigure : HARMonic : TIMES

Description : This command sets the way of measurement result of harmonics
 analysis to display in LCD.
 SINGLE : the display will remain the measurement data when
 execute.
 CONTINUE : the display will refresh to new measurement
 data..
 Query Syntax : [SOURCE :] CONFigure : HARMonic : TIMES?
 Parameters : SINGLE | CONTINUE
 Return Parameters : SINGLE | CONTINUE

[SOURCE :] CONFigure : HARMonic : PARAmeter

Description : This command sets the data form of each harmonic order.
 Query Syntax : [SOURCE :] CONFigure : HARMonic : PARAmeter?
 Parameters : VALUE | PERCENT
 Return Parameters : VALUE | PERCENT

[SOURCE :] CONFigure : HARMonic : FREQuency

Description : This command sets the fundamental frequency of the source
 waveform.
 Query Syntax : [SOURCE :] CONFigure : HARMonic : FREQuency?
 Parameters : 50Hz | 60Hz
 Return Parameters : 50Hz | 60Hz

SENSe : HARMonic

Description : This command sets the harmonics measurement on/off. "ON"
 must be executed before each new fetching or measuring. It
 takes about 3 seconds to get a result. The parameter must be
 set to "OFF" if users want to measure other data.
 Query Syntax : SENSe : HARMonic?
 Parameters : ON | OFF
 Return Parameters : ON | OFF

FETCh [:SCALar] : HARMonic : THD?

MEASure [:SCALar] : HARMonic : THD?

Description : These queries return the % of total harmonic distortion.
 Query Syntax : FETCh : HARMonic : THD?
 MEASure : HARMonic : THD?

Return Parameters : <NR2>

FETCh [:SCALar] : HARMonic : FUNDamental?

MEASure [:SCALar] : HARMonic : FUNDamental?

Description : These queries return the fundamental of the output current or output voltage.

Query Syntax : FETCh : HARMonic : FUNDamental?
MEASure : HARMonic : FUNDamental?

Return Parameters : <NR2>

FETCh [:SCALar] : HARMonic : ARRay?

MEASure [:SCALar] : HARMonic : ARRay?

Description : These queries return the amplitude of all the harmonic order.

Query Syntax : FETCh : HARMonic : ARRay?
MEASure : HARMonic : ARRay?

Return Parameters : <NR2>

SYNTHESIS Sub-system (31000A Only)

[SOURce :]

SYNThesis

: COMPose
: AMPLitude
: PHASe
: FUNDamental
: DC
: FREQuency
: SPHase

OUTPut

: MODE

TRIG

TRIG : STATE?

[SOURce :] SYNThesis : COMPose

Description : This command sets the data form of each harmonic order. VALUE : the absolute value. PERCENT : the percentage of fundamental voltage. Users can program 4 waveforms to execute.

Query Syntax : [SOURce :] SYNThesis : COMPose?
Parameters : VALUE1 | VALUE2 | PERCENT1 | PERCENT2
Return Parameters : VALUE1 | VALUE2 | PERCENT1 | PERCENT2

[SOURce :] SYNThesis : AMPLitude

Description : This command sets the amplitude of each harmonic order. The maximum number of order is 40.

Query Syntax : [SOURce :] SYNThesis : AMPLitude?
Parameters : <NR2>, ..., <NR2>
valid range:

Order	VALUE	PERCENT
2 ~ 10	0 ~ 150.0	0 ~ 100.00
11 ~ 20	0 ~ 120.0	0 ~ 50.00
21 ~ 30	0 ~ 80.0	0 ~ 30.00
31 ~ 40	0 ~ 45.0	0 ~ 15.00

Return Parameters : <NR2>, ..., <NR2>

[SOURCE :] SYNThesis : PHASe

Description : This command sets the phase angle of each harmonic order.

Query Syntax : [SOURCE :] SYNThesis : PHASe?

Parameters : <NR2>, ..., <NR2> valid range: 0.0 ~ 359.9

Return Parameters : <NR2>, ..., <NR2>

[SOURCE :] SYNThesis : FUNDamental

Description : This command sets the fundamental AC voltage of SYNTHESIS mode.

Query Syntax : [SOURCE :] SYNThesis : FUNDamental?

Parameters : <NR2>, valid range: 0.0 ~ 150.0 (in low range), 0.0 ~ 300.0 (in high range)

Return Parameters : <NR2>

[SOURCE :] SYNThesis : DC

Description : This command sets the DC voltage which adds to voltage waveform of SYNTHESIS mode.

Query Syntax : [SOURCE :] SYNThesis : DC?

Parameters : <NR2>, valid range: -212.1 ~ 212.1 (in low range), -424.2 ~ 424.2 (in high range)

Return Parameters : <NR2>

[SOURCE :] SYNThesis : FREQuency

Description : This command sets fundamental frequency of SYSTHESIS mode.

Query Syntax : [SOURCE :] SYNThesis : FREQuency?

Parameters : 50Hz | 60Hz

Return Parameters : 50Hz | 60Hz

[SOURCE :] SYNThesis : SPHase

Description : This command sets the start phase angle of SYNTHESIS mode.

Query Syntax : [SOURCE :] SYNThesis : SPHase?

Parameters : <NR2>, valid range: 0.0 ~ 359.9

Return Parameters : <NR2>

OUTPut : MODE

Description : This command sets the operation mode. The user should quit the output before setting **OUTPut : MODE SYNTH**.

Query Syntax : OUTPut : MODE?

Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

Return Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

TRIG

Description : This command sets SYNTHESIS mode in OFF, ON execution state after setting **OUTPut : MODE SYNTH**. If users want to change the parameters, it's necessary to set **TRIG OFF** then **OUTPut : MODE FIXED**. Then, set **OUTPut : MODE SYNTH** again to get ready to set **TRIG ON**.

Query Syntax : TRIG : STATE?

Parameters : OFF | ON

Return Parameters : OFF | RUNNING

INTERHARMONICS Sub-system (31000A Only)**[SOURCE :]**

INTerharmonics
 : FREQuency
 : START
 : END
 : LEVEL
 : DWEL1

OUTPut

: MODE

TRIG**TRIG : STATE?****FETCh | MEASure**

: INTerharmonics
 : FREQuency? Query the sweeping frequency

[SOURCE :] INTerharmonics : FREQuency : START

Description : This command starts frequency of the sweep wave of INTERHARMONICS mode.

Query Syntax : [SOURCE :] INTerharmonics : FREQuency : START?

Parameters : <NR2>, valid range: 0.01 ~ 2400.00 (unit: Hz)

Return Parameters : <NR2>

[SOURCE :] INTerharmonics : FREQuency : END

Description : This command sets the end frequency of the sweep wave of INTERHARMONICS mode.

Query Syntax : [SOURCE :] INTerharmonics : FREQuency : END?

Parameters : <NR2>, valid range: 0.01 ~ 2400.00 (unit: Hz)

Return Parameters : <NR2>

[SOURCE :] INTerharmonics : LEVEL

Description : This command the r.m.s. magnitude of the sweep wave in percentage of fundamental.

Query Syntax : [SOURCE :] INTerharmonics : LEVEL?

Parameters : <NR2>, valid range: 0% ~ 30% at 0.01 Hz ~ 500 Hz
 0% ~ 20% at 500.01 Hz ~ 1000 Hz
 0% ~ 10% at 1000.01 Hz ~ 2400 Hz

Return Parameters : <NR2>

[SOURce :] INTERharmonics : DWELI

Description : This command sets the dwell time of sweep wave.
 Query Syntax : [SOURce :] INTERharmonics : DWELI?
 Parameters : <NR2>, valid range: 0.01 ~ 9999.99 (unit: sec)
 Return Parameters : <NR2>

OUTPut : MODE

Description : This command sets the operation mode
 Query Syntax : OUTPut : MODE?
 Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR
 Return Parameters : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

TRIG

Description : This command sets INTERHARMONICS mode in OFF, ON, PAUSE or CONTINUE execution state after setting **OUTPut : MODE INTERHAR**. If users want to change the parameters, it's necessary to set **TRIG OFF** then **OUTPut : MODE FIXED**. Then, set **OUTPut : MODE INTERHAR** again to get ready to set **TRIG ON**.

Query Syntax : TRIG : STATE?
 Parameters : OFF | ON | PAUSE | CONTINUE
 Return Parameters : OFF | RUNNING | COMPLETE

FETCh [:SCALAr] : INTERharmonics : FREQuency?

MEASure [:SCALAr] : INTERharmonics : FREQuency?

Description : These queries return the sweeping frequency superimposed on fundamental voltage.
 Query Syntax : FETCh : INTERHARMonics : FREQuency?
 MEASure : INTERHARMonics : FREQuency?
 Return Parameters : <NR2>

STATUS Sub-system

STATus

: PRESet
 : OPERation
 [: EVENT]?
 : ENABLE
 : QUEStionable
 [: EVENT]?
 : CONDItion
 : ENABLE
 : NTRansition
 : PTRansition

STATus : PRESet

Description : This command sets the Enable, PTR, and NTR registers of the status groups to their power-on values.

Query Syntax : STATus : PRESet

Parameters : None

Return Parameters : Always zero.

STATus : OPERation [: EVENT]?

Description : This command queries the Operation Status register.

Query Syntax : STATus : OPERation [: EVENT]?

Parameters : None

Return Parameters : Always zero.

STATus : OPERation : ENABLE

Description : This command sets the Operation Status Enable register. The register is a mask which enables specific bits from the Operation Status register.

Query Syntax : STATus : OPERation : ENABLE?

Parameters : <NR1>, valid range: 0 ~ 255

Return Parameters : <NR1>

STATus : QUEStionable [: EVENT]?

Description : This command queries the Questionable Condition register.

Query Syntax : STATus : QUEStionable [: EVENT]?

Parameters : None

Return Parameters : Always zero.

STATus : QUEStionable : CONDition?

Description : This query returns the value of the Questionable Condition register, which is a read-only register that holds the real-time questionable status of the AC source.

Query Syntax : STATus : QUEStionable : CONDition?

Parameters : NONE

Return Parameters : <NR1>, valid range: 0 ~ 511

STATus : QUEStionable [: EVENT] ?

Description : This query returns the value of the Questionable Event register. The Event register is a read-only register which holds all events that are passed by the Questionable NTR and/or PTR filter. If QUES bit of the Service Request Enabled register is set, and the Questionable Event register > 0, QUES bit of the Status Byte register is set too.

Query Syntax : STATus : QUEStionable [: EVENT]?

Parameters : NONE

Return Parameters : <NR1>, valid range: 0 ~ 511

STATus : QUEStionable : ENABLE

Description : This command sets or reads the value of the Questionable

Enable register. The register is a mask which enables specific bits from the Questionable Event register to set the questionable summary(QUES) bit of the Status Byte register.

Query Syntax : STATus : QUESTionable : ENABLE?
 Parameters : <NR1>, valid range: 0 ~ 511
 Return Parameters : <NR1>

STATus : QUESTionable : NTRansition

Description : These commands make the values of the Questionable NTR register set or read.

These registers serve as polarity filters between the Questionable Enable and Questionable Event registers, and result in the following actions:

- * When a bit of the Questionable NTR register is set at 1, a 1-to-0 transition of the corresponding bit in the Questionable Condition register will cause that bit in the Questionable Event register to be set.
- * When a bit of the Questionable PTR register is set at 1, a 0-to-1 transition of the corresponding bit in the Questionable Condition register will cause that bit in the Questionable Event register to be set.
- * If the two same bits in both NTR and PTR registers are set at 0, no transition of that bit in the Questionable Condition register can set the corresponding bit in the Questionable Event register.

Bit Configuration of Questionable Status Register

Bit Position	15-9	8	7	6	5	4	3	2	1	0
Condition	---	OVP	INP	OCP	FAN	SHT	OTP	OPP	INT-DD	INT-AD

OVP : Output voltage protection
 INP : Line input protection.
 OCP : Over current protection.
 FAN : Fan failure.
 SHT : Output short protection.
 OTP : Over temperature protection.
 OPP : Over power protection.
 INT-DD : Inner DD power stage protection
 INT-AD : Inner AD power stage protection

Query Syntax : STATus : QUESTionable : NTRansition?
 Parameters : <NR1>, valid range: 0 ~ 511
 Return Parameters : <NR1>

STATus : QUESTionable : PTRansition

Description : These commands make the values of the Questionable PTR register set or read. Please refer to the description of the previous command.

Query Syntax : STATus : QUESTionable : PTRansition?

Parameter : <NR1>, valid range: 0 ~ 511
 Return parameters : <NR1>

SYSTEM Sub-system

SYSTem

: **ERRor?**
 : **VERSion?**
 : **LOCal**
 : **REMote**

SYSTem : ERRor?

Description : This command queries the error string of the command parser.
 Query Syntax : SYSTem : ERRor?
 Parameters : NONE
 Return Parameters : Response error string:
 No Error
 Data Format Error
 Data Range Error
 Too Many Errors
 Execution Error

SYSTem : VERSion?

Description : This query requests the AC source to identify itself.
 Query Syntax : SYSTem : VERSion?
 Parameters : NONE
 Return Parameters : 1991.1

SYSTem : LOCAl

Description : This command can only be used under the control of RS-232C.
 If SYST : LOC is programmed, the AC source will be set in the
 LOCAL state, and the front panel will work.
 Query Syntax : NONE
 Parameters : NONE
 Return Parameters : NONE

SYSTem : REMote

Description : This command can only be used under the control of RS-232C.
 If SYST : REM is programmed, the AC source will be set in the
 REMOTE state, and the front panel will be disabled except the
 "<PAGE/EXIT> key."
 Query Syntax : NONE
 Parameters : NONE
 Return Parameters : NONE

Command Summary

Common Commands

* CLS	Clear status
* ESE<n>	Standard event status enables
* ESE?	Return standard event status enables
* IDN?	Return the AC source identification
* RCL<n>	Recall the AC source file
* RST	Reset the AC source to the initial states
* SAV<n>	Save the AC source status
* SRE	Set request enable register
* STB?	Return status byte
* TST?	Return the self-test result of the AC source

Instrument Commands

FETCh | MEASure

[: SCALar]
: CURRent
 : AC?
 : DC?
 : AMPLitude : MAXimum?
 : CRESTfactor?
 : INRush
: FREQuency?
: HARMonic
 : THD?
 : FUNDamental?
 : ARRay?
: INTerharmonic
 : FREQuency?
: POWer
 : AC
 [: REAL]?
 : APParent?
 : REACTIVE
 : PFACtor?
: VOLTage
 : ACDC?
 : DC?

OUTPut

[: STATe]
: RELay
: SLEW
 : VOLTage
 : AC
 : DC
 : FREQuency
: COUPLing
: IMPedance
 : STATe

```

: RESistor
: INDuction
: MODE
: PROTection
: CLear

```

[SOURCE :]

```

CURRent
: LIMit
: DELay
: INRush
: STARt
: INTerval
FREQuency
[: {CW | IMMEDIATE}]
VOLTage
[: LEVel][: IMMEDIATE][:AMPLitude]
: AC
: DC
: LIMit
: AC
: DC
: PLUS
: MINus
: RANGe
FUNCTion
: SHAPe
: SHAPe
: A
: A
: MODE
: THD
: AMP
: B
: B
: MODE
: THD
: AMP

```

LIST

```

: POINts?
: COUNT
: DWELl
: SHAPe
: BASE
: VOLTage
: AC
: STARt
: END

```

: DC
 : START
 : END
 : FREQuency
 : START
 : END
 : DEGRee
PULSe
 : VOLTagE
 : AC
 : DC
 : FREQuency
 : SHAPe
 : SPHase
 : COUNT
 : DCYClE
 : PERiod
STEP
 : VOLTagE
 : AC
 : DC
 : FREQuency
 : SHAPe
 : SPHase
 : DVOLtage
 : AC
 : DC
 : DFRequency
 : DWELl
 : COUNT
SYNThesis
 : COMPose
 : AMPLitude
 : PHASe
 : FUNDamental
 : DC
 : FREQuency
 : SPHase
INTerharmonics
 : FREQuency
 : START
 : END
 : LEVEL
 : DWELl

[SOURCE :]

 PHASe
 : ON
 : OFF

[SOURce :]

CONFigure
: INHibit
: EXTernal
: COUPling
: HARMonic
: SOURce
: TIMes
: PARAmeter
: FREQuency

SENSe

: HARMonic

TRACe

: RMS

STATus

: OPERation
[: EVENt]?
: ENABle
: QUEStionable
[: EVENt]?
: CONDition
: ENABle
: NTRansition
: PTRansition

SYSTem

: ERRor?
: VERSion?
: LOCAl
: REMote

TRIG

TRIG : STATE?

Appendix B Pin Assignment of TTL SIGNAL

9-Pin, D-Type Male Connector:

Pin No.	Signal	Pin No.	Signal
1	GND	6	GND
2	/ Remote-Inhibit	7	GND
3	GND	8	/ FAULT-OUT
4	AC-ON	9	---
5	---		

/ Remote-Inhibit: When voltage level of this pin becomes LOW, it can inhibit the output of AC source (See 3.6.1).

AC-ON: When the AC source outputs voltage, this pin will become HIGH and it becomes LOW when output is off.

/ FAULT-OUT: The voltage level of this pin is HIGH if the AC source is in normal state. It becomes LOW when the AC source is in the protection state.

Connecting the / FAULT-OUT signal of the TTL PIN8 on the AC Source rear panel to the TTL PIN8 on the A615003 rear panel turns on the functions of the A615003 thus, it can be activated.