Chroma

Programmable AC Source
61507/61508/61509
User's Manual

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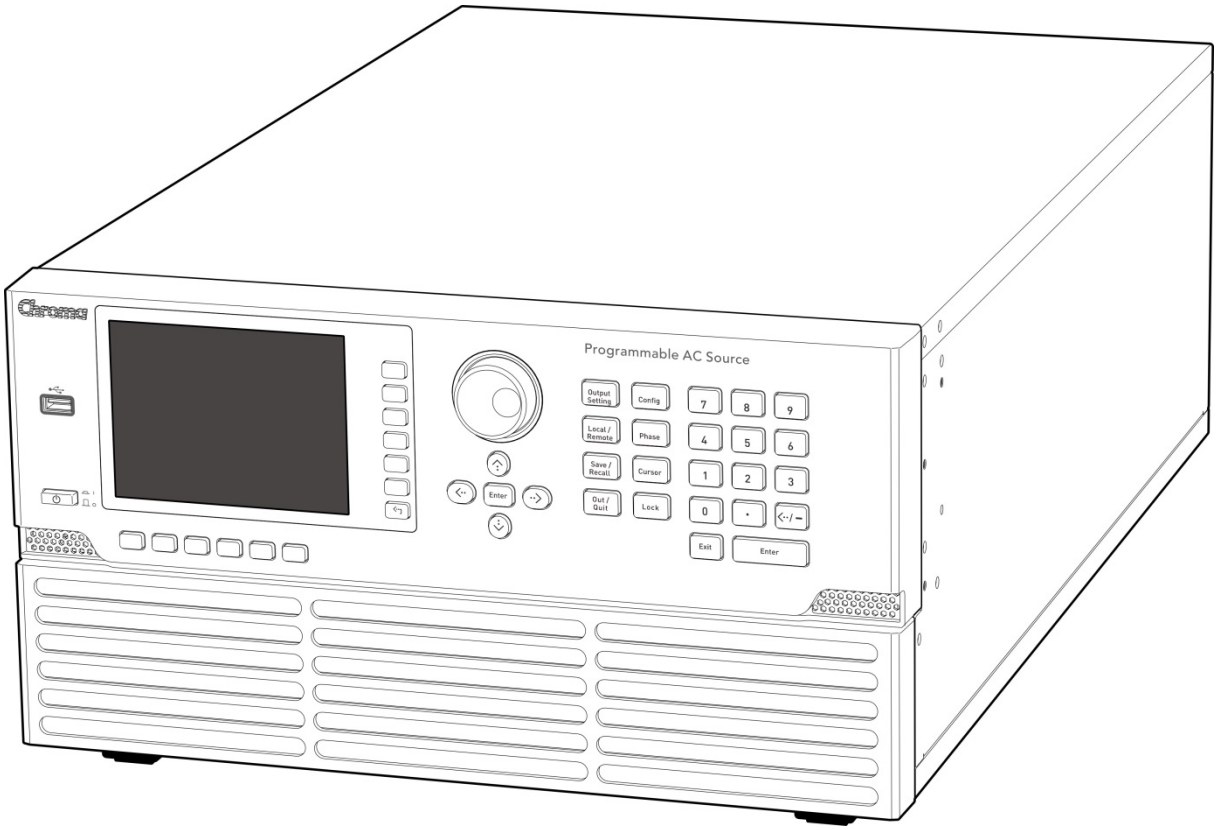

Version 1.1
November 2019

Legal Notices

The information in this document is subject to change without notice.

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CHROMA ATE INC.
66 Huaya 1st Road, Guishan, Taoyuan 33383, Taiwan

Warranty

All of Chroma's instruments are warranted against defects in material and workmanship for a period of one year from date of shipment. Chroma agrees to repair or replace any assembly or component found to be defective, under normal use during this period. Chroma's obligation under this warranty is limited solely to repairing any such instrument, which in Chroma's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Purchaser is responsible for the shipping and cost of the service item to Chroma factory or service center. Shipment should not be made without prior authorization by Chroma.

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http://www.chromaate.com

Material Contents Declaration

The recycling label shown on the product indicates the Hazardous Substances contained in the product as the table listed below.


: See **<Table 1>**.


: See **<Table 2>**.

<Table 1>

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls/ Polybromodiphenyl Ethers	Selected Phthalates Group
	Pb	Hg	Cd	Cr^{6+}	PBB/PBDE	DEHP/BBP/DBP/DIBP
PCBA	O	O	O	O	O	O
CHASSIS	O	O	O	O	O	O
ACCESSORY	O	O	O	O	O	O
PACKAGE	O	O	O	O	O	O

“O” indicates that the level of the specified chemical substance is less than the threshold level specified in the standards of SJ/T-11363-2006, EU Directive 2011/65/EU, and 2015/863/EU.

“×” indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards of SJ/T-11363-2006, EU Directive 2011/65/EU, and 2015/863/EU.

Remarks:
1. The CE marking on product is a declaration of product compliance with EU Directive 2011/65/EU.
2. This product is complied with EU REACH regulation and no SVHC in use.

Disposal

Do not dispose of electrical appliances as unsorted municipal waste, 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 one, the retailer is legally obligated to take back your old appliances for disposal at least for free of charge.

<Table 2>

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls/ Polybromodiphenyl Ethers	Selected Phthalates Group
	Pb	Hg	Cd	Cr^{6+}	PBB/PBDE	DEHP/BBP/DBP/DIBP
PCBA	×	O	O	O	O	O
CHASSIS	×	O	O	O	O	O
ACCESSORY	×	O	O	O	O	O
PACKAGE	O	O	O	O	O	O

"O" indicates that the level of the specified chemical substance is less than the threshold level specified in the standards of SJ/T-11363-2006, EU Directive 2011/65/EU, and 2015/863/EU.

"×" indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards of SJ/T-11363-2006, EU Directive 2011/65/EU, and 2015/863/EU.

1. Chroma 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.
3. This product is complied with EU REACH regulation and no SVHC in use.

Disposal

Do not dispose of electrical appliances as unsorted municipal waste, 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 one, the retailer is legally obligated to take back your old appliances for disposal at least for free of charge.

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CE

Declaration of Conformity

For the following equipment :

Programmable AC Source

(Product Name/ Trade Name)

61509, 61508, 61507, 61609, 61608, 61607

(Model Designation)

CHROMA ATE INC.

(Manufacturer Name)

66 Huaya 1st Road, Guishan, Taoyuan 33383, Taiwan

(Manufacturer Address)

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 (2014/30/EU) and Low Voltage Directive (2014/35/EU). For the evaluation regarding the Directives, the following standards were applied :

EN 61326-1:2013 Class A

EN 61326-1:2013(industrial locations)

EN 61000-4-2:2009, EN 61000-4-3:2006+A1:2008+A2:2010,
EN 61000-4-4:2012, EN 61000-4-5:2014, EN 61000-4-6:2014,
EN 61000-4-8:2010, EN 61000-4-11:2004

EN 61010-1:2010

The equipment describe above is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

The following importer/manufacturer or authorized representative established within the EUT is responsible for this declaration :

CHROMA ATE INC.

(Company Name)

66 Huaya 1st Road, Guishan, Taoyuan 33383, Taiwan

(Company Address)

Person responsible for this declaration:

Mr. Vincent Wu

(Name, Surname)

T&M BU Vice President

(Position/Title)

Taiwan	**2018.03.12**	Vincent Wu
(Place)	(Date)	(Legal Signature)

Safety Summary

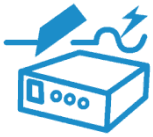
The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or specific WARNINGS given elsewhere in this manual will violate safety standards of design, manufacture, and intended use of the instrument. *Chroma* assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER

Verify that the power is set to match the rated input of this power supply.

PROTECTIVE GROUNDING

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



NECESSITY OF PROTECTIVE GROUNDING

Never cut off the internal or external protective grounding wire, or disconnect the wiring of 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.) should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. The instrument should be used in an environment of good ventilation.

DO NOT REMOVE THE COVER OF THE INSTRUMENT

Operating personnel must not remove the cover of the instrument. Component replacement and internal adjustment can be done only by qualified service personnel.

⚠WARNING

1. Lethal voltage. AC source may output 495 V peak voltage.
2. Touching the connected circuit or output terminal on the front or rear panel when power is on may result in death.
3. Be noted that the L1/L2/L3 and NEU may generate maximum current when the configuration is Y connection. Thus, the wire diameter should meet the maximum current requirement.
4. The equipment should be placed horizontally during transportation. It is strictly prohibited to place on the side. Transportation by the side may cause damage to the device.

Safety Symbols

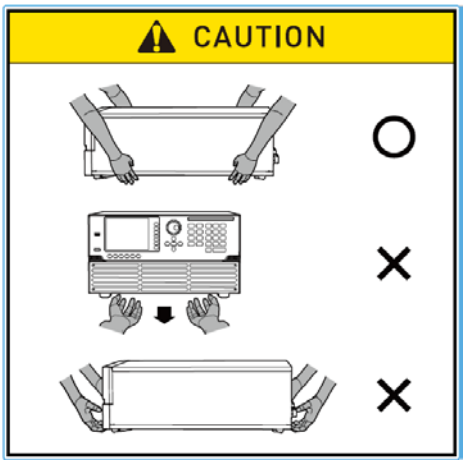
	**DANGER –** High voltage.
	**Explanation:** To avoid injury, death of personnel, or damage to the instrument, the operator must refer to the explanation in the instruction manual.
	**High temperature:** This symbol indicates the temperature is hazardous to human beings. Do not touch it to avoid any personal injury.
	**Protective grounding terminal:** This symbol indicates that the terminal must be connected to ground before operation of the equipment to protect against electrical shock in case of a fault.
	**Functional grounding:** To identify an earth (ground) terminal in cases where the protective ground is not explicitly stated. This symbol indicates the power connector does not provide grounding.
	**Frame or chassis:** To identify a frame or chassis terminal.
	**Alternating Current (AC)**
	**Direct Current (DC) / Alternating Current (AC)**
	**Direct Current (DC)**
	**Push-on/Push-off power switch**
	The **WARNING** sign highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury to, or death of, personnel or long term health hazards.
	The **CAUTION** sign highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to, or destruction of, equipment.
	The **Notice** sign highlights an essential operating or maintenance procedure, condition, or statement.

ACOUSTIC NOISE INFORMATION

This product has a sound pressure emission (at the operator's side) < 70dB(A).

Moving

Since the AC Source has a certain weight, it should be carried out by two people as shown in the diagram below for movement.



The AC Source should always be placed horizontally during transportation and use. It is strictly prohibited to place it on the side, otherwise it may cause the AC Source to be damaged.

Cleaning

It is recommended to perform internal maintenance and cleaning regularly. The standard recommendation period is 1 year; however, the maintenance period may adjust based on the environment in use. For any related service request, please contact local technical service personnel.

Revision History

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

Date	Version	Revised Sections
Aug. 2018	1.0	Complete this manual.
Nov. 2019	1.1	Modify the following: – "*Specifications*"section in "*General Information*" chapter – "*Main Page (Output Setting and Measurement)*" section in "*Local Operation*" chapter – Appendix "*TTL Signal Pin Assignments*" Add "*Programmable Output Impedance*" section to "*Local Operation*" chapter

Table of Contents

1. General Information

1.1 Introduction

The Chroma 61507/61508/61509 Series AC Source is a highly efficient programmable instrument which provides a low distortion sine wave output. The Digital Signal Processor (DSP) microprocessor generates an accurate, stable output voltage and frequency. The Pulse Width Modulation (PWM) designed power stage provides apparent power into loads. The front panel has a Rotary Pulse Generator (RPG) and keypad control for setting the output voltage and frequency, while the Liquid Crystal Display (LCD) displays the operating status. Remote programming is accomplished using the GPIB bus, RS-232C serial port, USB port, or ETHERNET port.

1.2 Key Features

A. Configuration

- Local operation using the keypad on the front panel
- Remote operation via GPIB, RS-232C, USB, or ETHERNET interface
- Protection against over power, over current, over temperature, and fan failure
- Thermostatically controlled fan speed
- Built-in output isolation relays

B. Input / Output

- Selectable output voltage with full scale of 175V/350V/Auto (3 ranges)
- Analog (simulation) reference voltage for remote control
- V, I, Po, F, CF, PF, Idc, Vdc, Vac, Iac, Ipk, Vpk, VA, and Isurge measurements
- Remote inhibited control
- AC ON/OFF output signal

1.3 Specifications

The specifications for the 61507/61508/61509 models are listed below. All specifications are tested using Chroma's standard test procedures at 25 ± 1°C with a resistive load unless specified otherwise.

Model	61507	61508	61509
AC Output Rating			
Output Phase	1 or 3 selectable	1 or 3 selectable	1 or 3 selectable
Total Power	3kVA	4.5kVA	6kVA
Per Phase Power	1kVA	1.5kVA	2kVA
Voltage			
Range	175V/350V/Auto		
Output Voltage (Standard)	0~175V / 0~350V (@15~2000Hz)		
Output	0~175V / 0~350V (@15~3000Hz)		

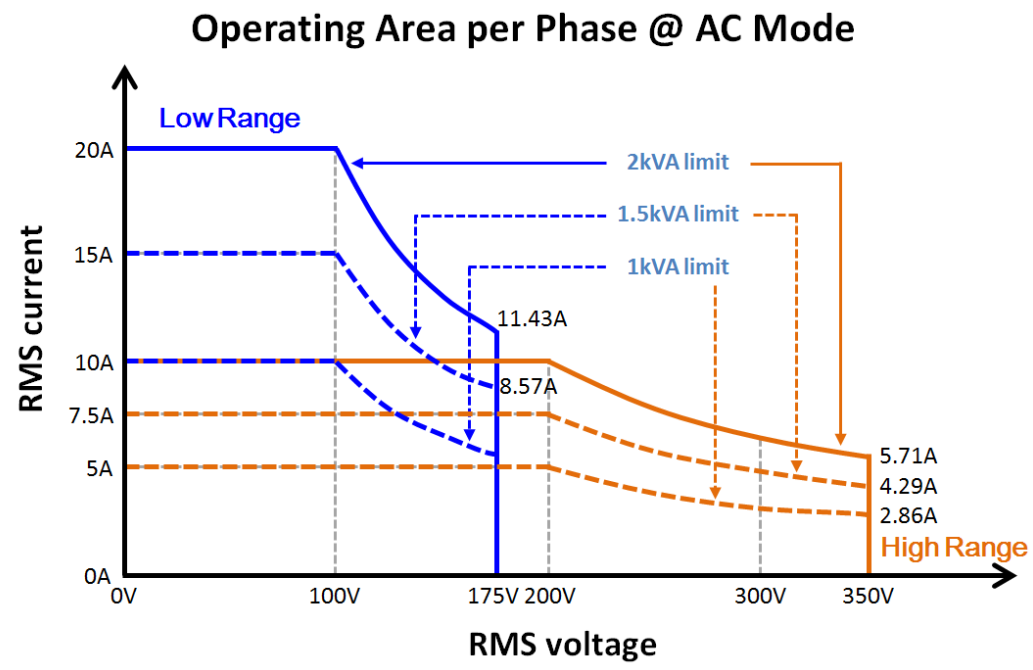
Voltage (5kHz Option)	0~115V / 0~230V (@3001~5000Hz)		
Accuracy	0.1% of RD +0.2% of F.S. Above 1 kHz, add 0.2%/kHz to FS up to 5kHz **(5kHz Option)**		
Resolution	0.1 V		
Distortion[*1]	< 0.3% @50/60Hz, < 1%@15- 500Hz , 1% maximum to 500Hz, add 0.5%/kHz up to 5 kHz **(5kHz Option)**		
Line Regulation	0.10%		
Load Regulation[*2]	0.20%		
Maximum Current (1-Phase Mode)			
Output Current (RMS)	30A/15A	45A/22.5A	60A/30A
Output Current (Peak)	120A/60A	180A/90A	240A/120A
Maximum Current (3 – Phase Mode / per phase)			
Output Current (RMS)	10A/5A	15A/7.5A	20A/10A
Output Current (Peak)	40A/20A	60A/30A	80A/40A
Frequency			
Range	15Hz ~ 2000Hz (Standard) 15Hz ~ 5000Hz **(Option)**		
Accuracy	0.01%		
Phase			
Range	0 ~ 359.9°		
Resolution	0.1°		
DC Output (1- Phase Mode)			
Power	3.0kW	4.5kW	6.0kW
Voltage	247.5V/494.9V	247.5V/494.9V	247.5V/494.9V
Current	30A/15A	45A/22.5A	60A/30A
DC Output (3-phase Mode / per phase)			
Power	1.0kW	1.5kW	2.0kW
Voltage	247.5V/494.9V	247.5V/494.9V	247.5V/494.9V
Output Current	10A/5A	15A/7.5A	20A/10A
Harmonic Function			
Waveform Synthesis	50 order @50/60 Hz		
Programmable Output Impedance			
Range	R: 0Ω – 1Ω L: 0.2mH – 2mH		
Input 3-Phase Rating (Each Phase)			
Input Type	3-Phase 4 Wire ,Delta Connection or 3-Phase 5 Wire ,Y Connection		
Voltage operation Range	3Φ 200-240V±10% V_{LN} (Delta: L-L, Y: L-N) [*3]		

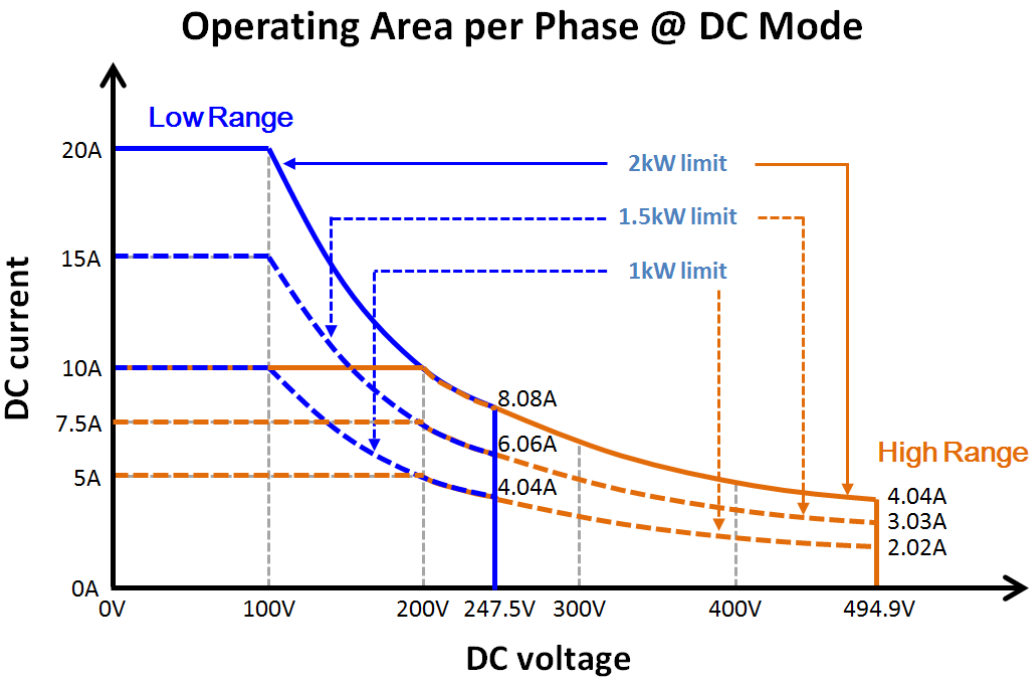
Frequency Range	47-63 Hz		
Maximum Current	15A Max./Phase (3Ø 200-240V±10%VLL)	20A Max./Phase (3Ø 200-240V±10%VLL)	25A Max./Phase (3Ø 200-240V±10%VLL)
Power Factor	0.97(Typical)		
Measurement			
Voltage			
Range	175V / 350V/Auto		
Accuracy	0.1% of RD+0.2% of FS Above 1 kHz, add 0.2(%/kHz) to FS up to 5kHz **(5kHz Option)**		
Resolution	0.1 V		
Current (Each Phase)			
Range(Peak)	60A/30A	90A/45A	120A/60A
Accuracy(RMS)	0.2% of RD+0.2% of F.S. Above 1 kHz, add 0.2(%/kHz) to FS up to 5kHz **(5kHz Option)**		
Accuracy(Peak)	0.2% of RD+0.4% of F.S. Above 1 kHz, add 0.2(%/kHz) to FS up to 5kHz **(5kHz Option)**		
Power			
Accuracy	0.2% of RD+0.4% of F.S. Above 1 kHz, add 0.2(%/kHz) to FS up to 5kHz **(5kHz Option)**		
Others			
Remote Interface	RS 232/USB/GPIB/Ethernet		
Other feature	Parallel Function (Master/Slave) up to 2 units EXT V Ref Port Remote Inhibit Port USB Host Trigger Function		
Efficiency[*4]	>80%(Typical)		
Protection	OVP,OCP,OPP,OTP,FAN		
Safety & EMC	CE mark		
Dimension (WxDxH)	221.5×425×680mm 8.72×16.73×26.77 inch	221.5×425×680mm 8.72×16.73×26.77 inch	221.5×425×680 mm 8.72×16.73×26.77 inch
Weight	50 kg / 110 lbs	50 kg / 110 lbs	50 kg / 110 lbs
Temperature Range			
Operation	0°C to 40°C		
Storage	-40°C to 85°C		
Humidity	30 % to 90 %		
	All specifications are subject to change without notice. Please visit our website for the most up to date specifications. **Note 1**: Maximum distortion is tested on 250Vac/125Vac with maximum current to linear load **Note 2**: The DC function is capable of meeting DC to DC converter test requirement **Note 3**: In standard version output voltage can be full out at High and Low range and in 5000Hz option version when output frequency is under 3000.1Hz that output voltage can be full out at High and Low range, when output frequency is over 3000.1~5000.0Hz that output voltage will be reduce to 230V/115V at High/Low range.		

Notes

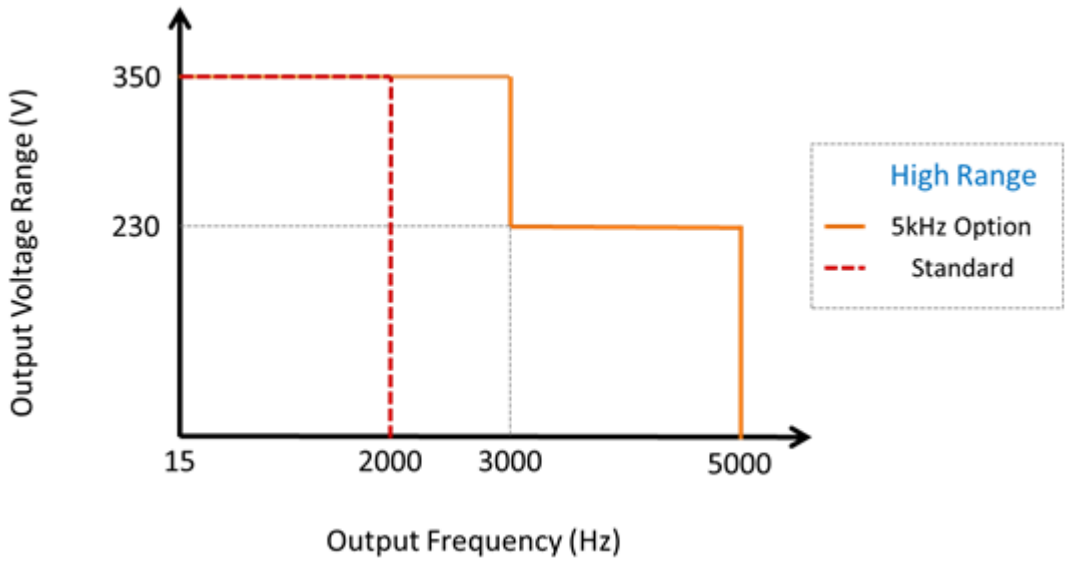
*1: Maximum distortion is tested at 125Vac (175V RANGE) and 250Vac (350V RANGE) with maximum current to a linear load.
*2: Load regulation is tested using a sine wave under linear load.
*3: 3-phase voltage input Y connection is 3-phase / 5-wire, while Delta connection is 3 phase / 4-wire.
*4: Efficiency is tested using an input voltage of 220Vac sine wave under linear load.

Voltage / Current Operating Area

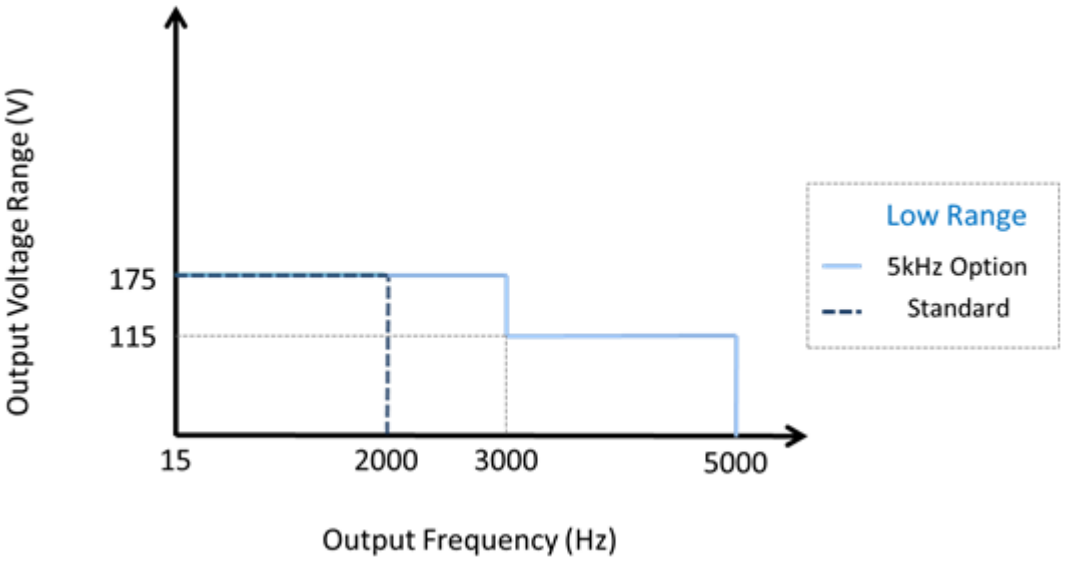




Frequency/Voltage Derating curve



Frequency/Voltage Derating curve @ High range



Frequency/Voltage Derating curve @ Low range

1.4 Names of Parts

1.4.1 Front Panel

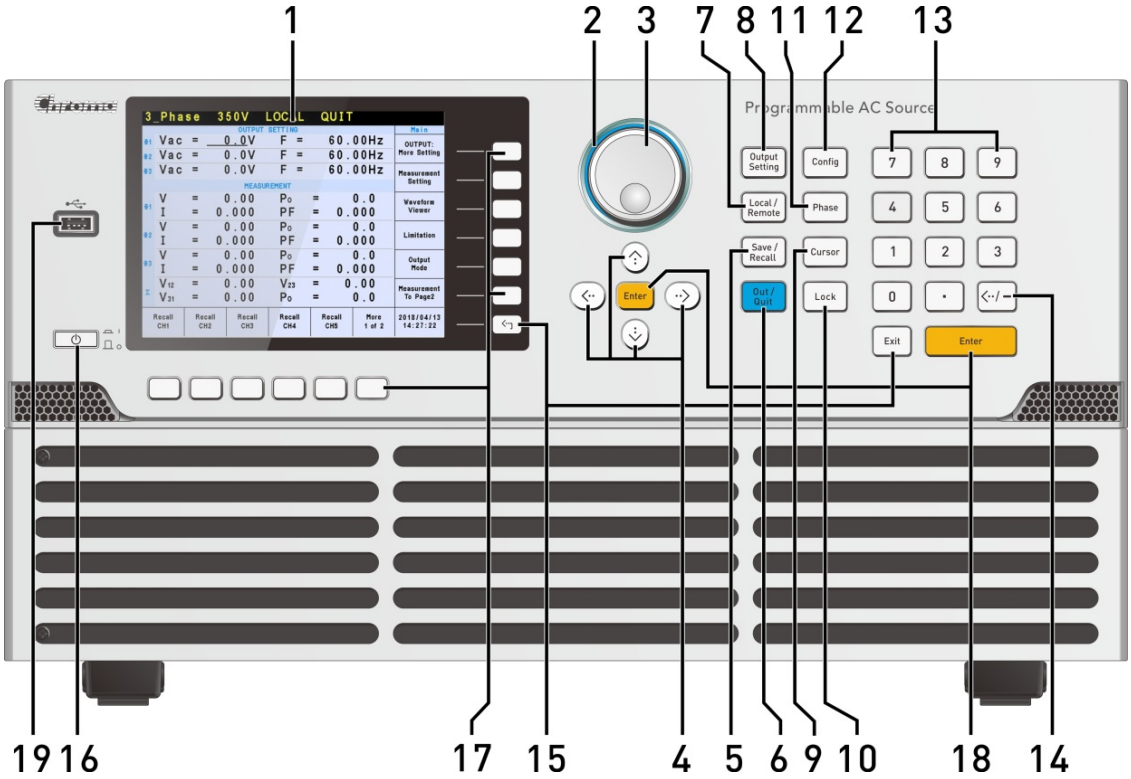


Figure 1-1 Front Panel

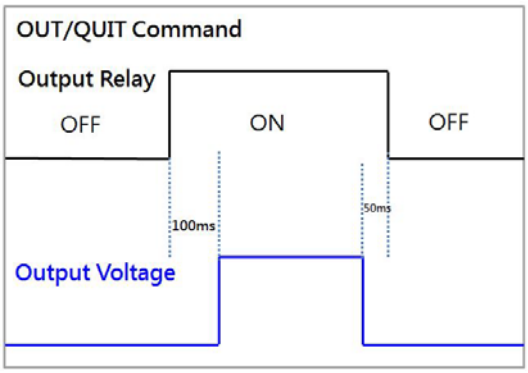
Table 1-1 Front Panel Description

Item	Icon	Description
1		***Display:*** The 5.7" LCD displays the configuration, output setup, and measurement results.
2		***Indicator LED:*** The Power-On indicator surrounds the rotary knob showing the activation status.
3		***RPG Rotary****:* Turn the RPG rotary knob to adjust the voltage or frequency, and input programmed data or options.
4		***Cursor Movement Keys***: These four keys move the cursor in different directions. In normal mode, pressing any of these four keys will change the cursor position.
5		***Save or Recall:*** Press this key in the MAIN PAGE to save the output settings (see section 3.10.1). Press this key in the CHOICE PAGE to save the system data (see section 3.10.2).
6		***Out/Quit :*** Press this key to Enable/Disable the output voltage of the AC source.
7		***Local/Remote :*** Press this key to switch the "Remote" control mode to "LOCAL" for front panel input.

8	Output Setting	***Output Setting:*** Changes the screen to “Output: More Setting” for additional settings.
9	Cursor	***Cursor:*** Used to set or adjust the value.
10	Lock	***Lock:*** Press for 1 second to lock up “all keys” and the “rotary” knob. Press for 3~3.5 seconds to unlock them.
11	Phase	***Phase:*** Sets single/3-phase.
12	Config	***Config:*** Switches the screen to the “CONFIG” screen for various settings.
13	0 to 9 and .	***Numeric and Decimal:*** Use the “numeric” and “decimal” keys to input digital data.
14	<·· / –	***Backward and Decreasing:*** Press this key to delete an entered number. The LCD displays " - " if no number exists.
15	Exit and ↩	***Exit and return:*** Press to return to the previous screen.
16	⏻	***Main Power Switch:*** Turns the power ON or OFF.
17		***Indicator:*** Refers to the description on screen for parameter and function setting.
18	Enter	**Enter**: Confirms the parameter setting.
19		***USB HOST***: LCD screen capture.

Notice

To extend the product life of the output relay, it will delay 50ms before releasing after pressing **QUIT**. When an inductive load is connected, a discharge path will be provided for the inductive current to decay during the delay period.



1.4.2 Rear Panel

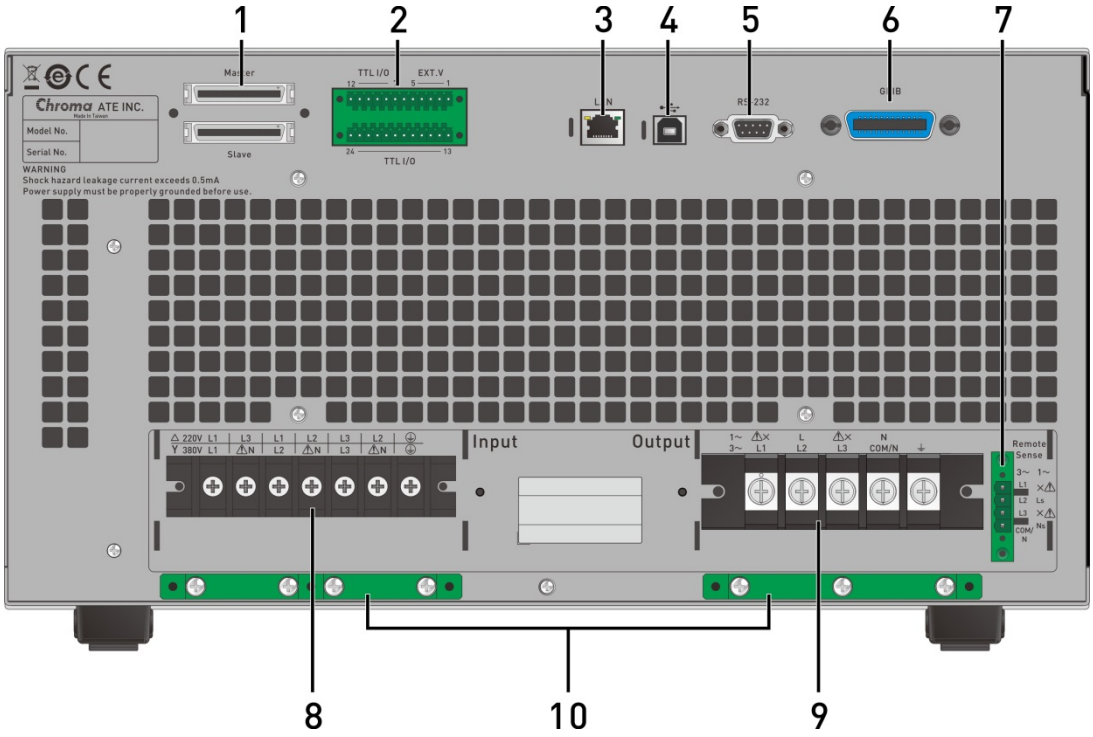


Figure 1-2 Rear Panel

Table 1-2 Rear Panel Description

Item	Name	Description
1	Master/Slave Port	Used for signal transmission between 2 AC Sources connected in parallel.
2	Ext. Vref./TTL I/O	Inputs the control waveform amplitude from an external analog (simulated) signal with a TTL transmission control signal (Fault_out, Remote inhibit and AC_ON.)
3	Ethernet	The network (LAN) control terminal.
4	USB	Connects the remote controller to a computer for remote operation.
5	RS-232C	9-pin D type male connector that transmits control commands among distant PCs for remote operation.
6	GPIB Connector	The remote controller uses the GPIB bus to connect the PC via the connector for remote operation.
7	Remote Sense	Terminal that senses the load directly to ignore any voltage drop across the connecting cable. Ensure the "L1" terminal of the Remote Sense connector is connected to the "L1" terminal of the Load, and the "N" terminal is connected to the "N" terminal of the Load. Do not reverse the polarity.
8	Input Connecting Terminal	Connects the mains to the AC Source.
9	Output Connection Terminal	Connects the AC Source output to the UUT.
10	I/O Cable Secure Strip	Secures the input/output connection cable.

CAUTION When connecting the Ext. Vref./TTL I/O cable, first remove the connected terminal and then secure it on the host for operation.

2. Installation

2.1 Initial Inspection

This instrument was inspected before shipment and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials in case the instrument needs to be returned. If damage is found, immediately file a claim with the carrier. Do not return the instrument to Chroma without prior approval.

2.2 Preparation for Use

Connect the AC source to an appropriate AC line input. The instrument is cooled by fans; install it in a place with good air circulation. It should be in an area where the ambient temperature does not exceed 40°C. The L1/L2/L3 and NEU may generate maximum current when using a Y connection; insure the wire diameter meets the maximum current requirement.

CAUTION The carring weight of the AC Source cover must not exceed 5KG.

2.3 Requirements for Input Power

2.3.1 Ratings

Input Voltage Range:

61507	61508	61509
15A Max./Phase (3Ø 200-240V±10%V_{LL} Δ)	20A Max./Phase (3Ø 200-240V±10% V_{LL} Δ)	25A Max./Phase (3Ø 200-240V±10% V_{LL} Δ)
12A Max./Phase (3Ø 200-240V±10%V_{LN} Y)	16A Max./Phase (3Ø 200-240V±10%V_{LN} Y)	20A Max./Phase (3Ø 200-240V±10%V_{LN} Y)

Input Frequency: 47-63 Hz

WARNING The AC Source may be damaged and unable to power on if the input voltage exceeds the configured range.

2.3.2 Input Connection

The input terminal block is located beneath the device's rear panel. The power cord should be rated for at least 85°C and the current rating of the power line input must be equal to or greater than the maximum current rating of the AC Source. Do not use three separate lead wires to connect the power to the AC power supply's input. Adjust the short circuit connector according to the power input (Delta or Y) method.

CAUTION Select the model in accordance with the local voltage specification. The 200-240V_{LL} 3-phase 4-wire (Delta) and 380-400V_{LL} 3-phase 5-wire (Y) can be selected during the input wiring selection before power-on. Select the correct iron tagger and secure the power wire to the AC Source input terminal.

Perform the steps below:

1. Remove the safety cover from the back of the AC Source.
2. Connect the wires to the AC Source terminal blocks (see Figure 2-1 and Figure 2-2).
3. Secure it with the I/O cable trim strip and screws.
4. Attach the safety cover to the back of the AC Source.

CAUTION
1. To protect the operator, the wire connected to the GND terminal must be connected to the earth.
2. Under no circumstances should this AC Source be operated without adequate grounding.

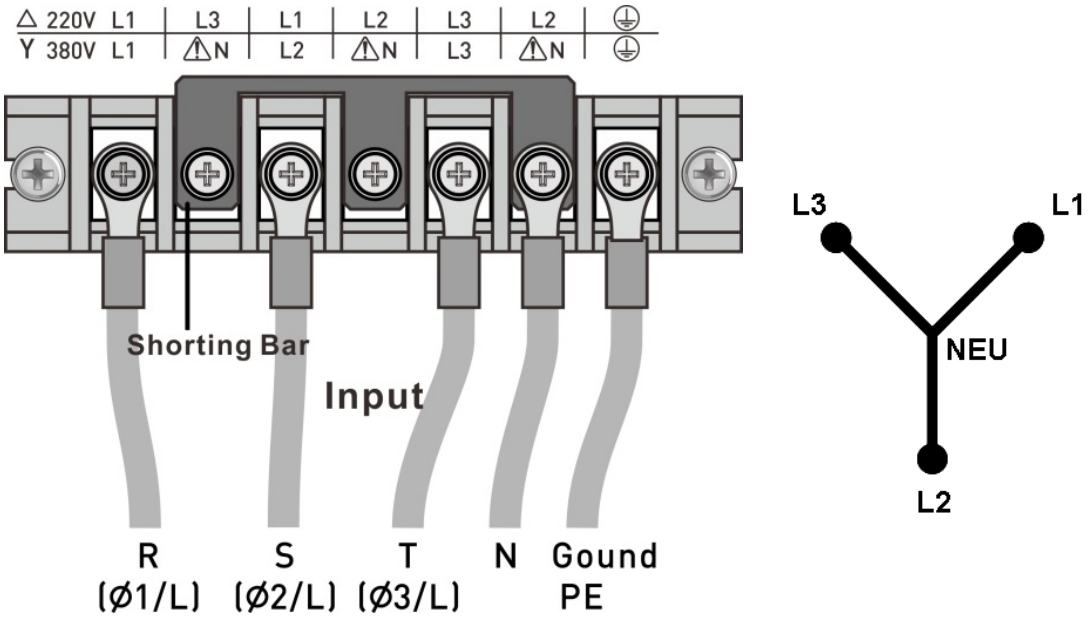


Figure 2-1 3-Phase 380V Power Input Connection (Y Connection)

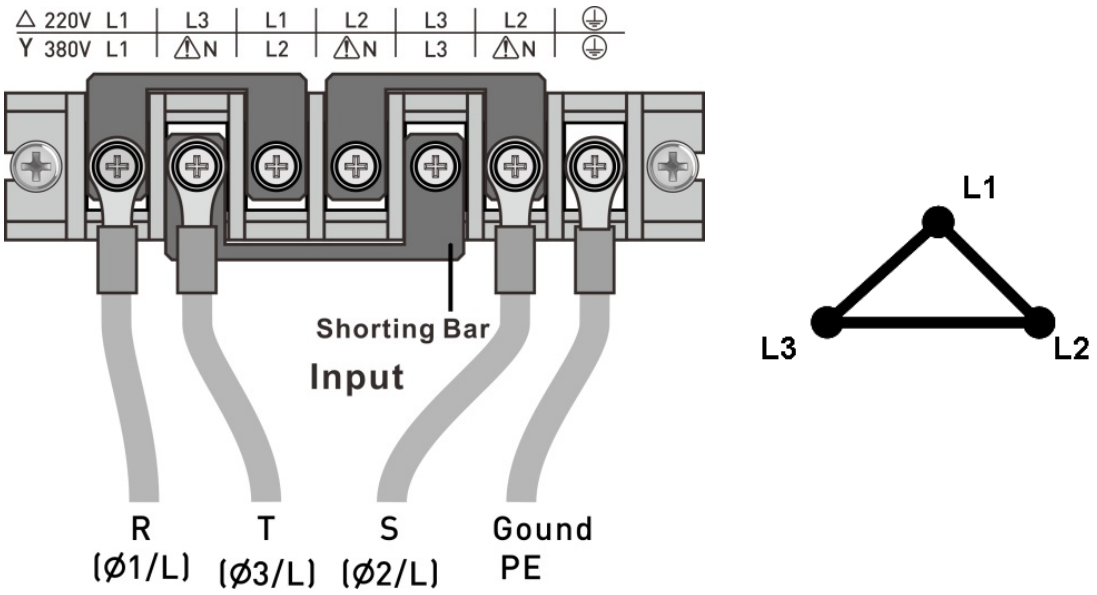


Figure 2-2 3-Phase 220V Power Input Connection (Delta Connection)

Voltage Range	Wire Spec.	Terminal Spec.
3Ø 200-240V±10%V_{LN} (Delta:L-L,Y:L-N)	14AWG (L1/L2/L3/NEU/GND)	3-5(L1/L2/L3/NEU/GND)

Notice

1. Installation of the wires must be performed by professional personnel according to the device required voltage.
2. If the input wiring selection is 220V 3~ (Δ type), the specification of the Circuit Breaker configured for the Δ type needs to be at least 220Vac/20A (61507), 220Vac/30A (61508), and 220Vac/30A (61509).
3. If the input wiring selection is 380V 3~ (Y type), the specification of the Circuit Breaker configured for the Y type needs to be at least 380Vac/20A(61507), 380Vac/20A(61508), and 380Vac/30A(61509).
4. If the input wiring selection is Y type, be sure to select 4P type (L1/L12/L3/N) when using with the leakage circuit breaker.
5. Be aware of the color distinction between the insulation tube or wire before connecting the power wire. The black insulation tube or power wire is used for L1, L2 and L3, the blue insulation tube or power wire is used for NEU, while the green insulation tube or power wire is used for GROUND.

2.4 Output Connection

The output terminal block is located on the rear of the AC Source. The Load is connected to the output terminals. To meet the safety requirements, the I/O input/output wires need to be tied together by a safety strip and the cover must be secured. The diameter of the wire connected to the load should be large enough so that it will not overheat when conducting current (see Figure 2-5).

Notice

1. The output terminal labeled “L” is the “+” terminal and the output terminal labeled “COM/N” is the “-” terminal when the output voltage contains a DC component.

2. This AC source can perform 1-phase/3-phase output. When set to single-phase mode, the internal relay will guide L1 and L3 to L2 (note that the L1 and L3 terminals will still be charged during output) as it allows the user to short circuit the output terminal L1/L2/L3 on the UUT or connect the L2/N two dots to UUT (be aware of the wire diameter for current withstand capacity is enough in this connection).

CAUTION For proper ventilation, the UUT should be placed at least 1 meter distance from the front and rear panels of the AC source. Do not place the AC source against the wall or other objects.

2.5 Remote Sense Connection

The remote sense function of the AC Source monitors the voltage at the load and the automatic compensation ensures the voltage delivered to the load is the one programmed.

Remove the connecting wires "L1", "L2", "L3" and "COM" from the Remote Sense terminal and connect the remote sense to the load as shown in Figure 2-3. The sensing leads are part of the feedback circuit of the AC Source, so they must be low resistance for the best performance. Connect the sensing leads carefully so that they will not be open-circuited. If the sensing leads are disconnected or become open-circuited during operation, the AC Source may be unable to output any voltage.

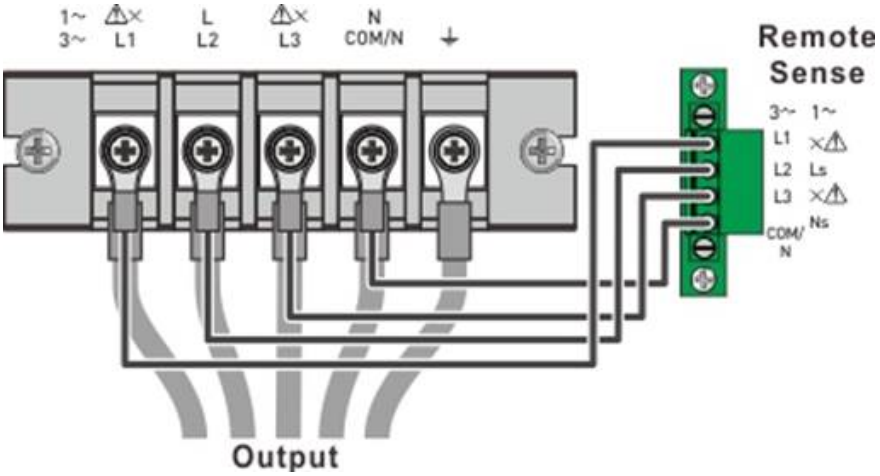


Figure 2-3 Output and Local Voltage Sense Connection

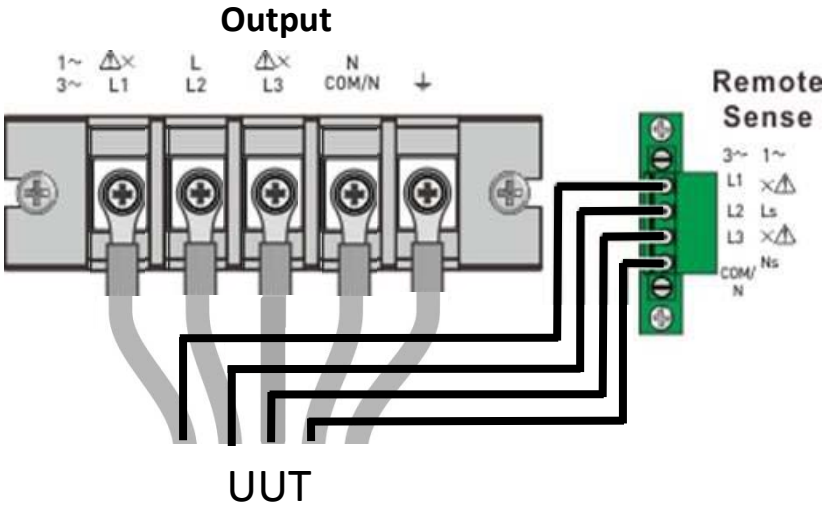


Figure 2-4 Output and Remote Voltage Sense Connection

Notice

The sensing leads must be a twisted pair to minimize the interference from external voltages. The sensing leads need to be connected as close as possible to the load. As the sensing leads carry only a few milliamperes, it is suggested to use 18 AWG wire.

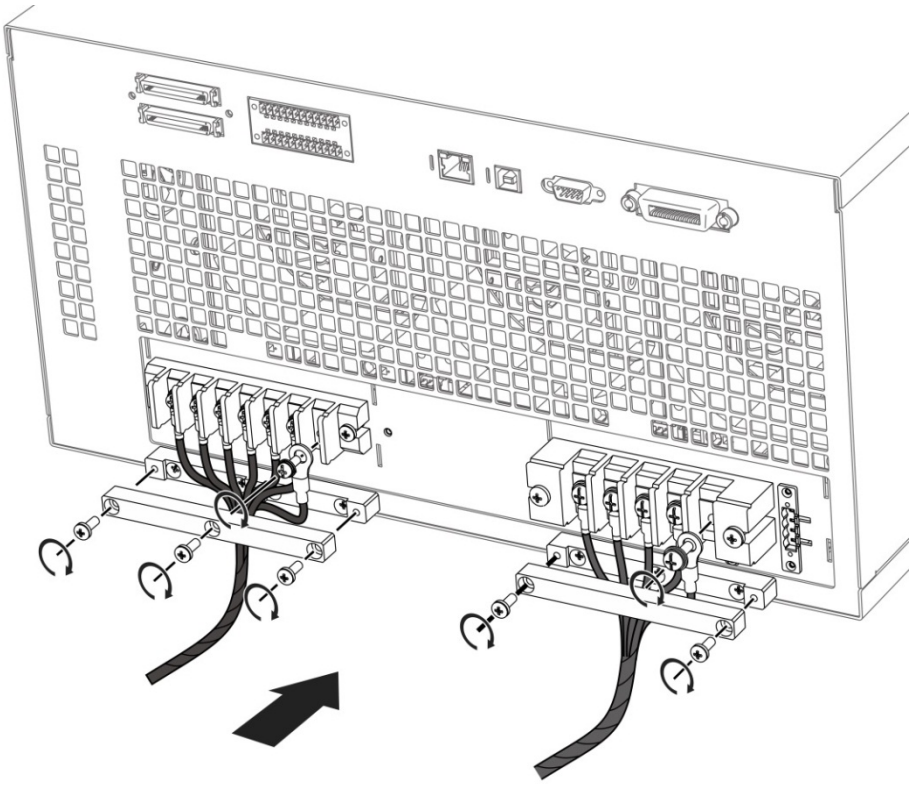
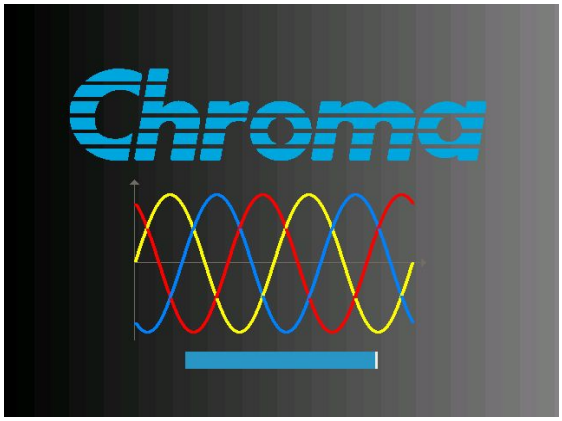


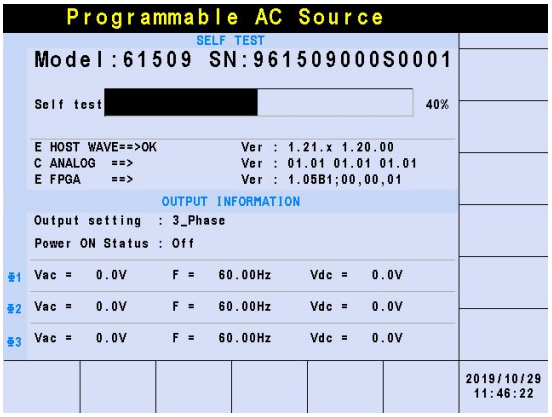
Figure 2-5 Input / Output Wire Securing Diagram

2.6 Power on Procedure

CAUTION Before turning on the instrument, 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 may cause a potential electric shock hazard that could result in personal injury or death.

Connect the power line and turn on the power switch on the front panel. The AC Source will begin a series of self-tests. The LCD on the front panel will display the following:





During this time the AC Source executes memory, data, and communication self-tests. The display shows the Model Number and the AC Source's Serial No. after executing the self-test routines. Each test item will show "OK" on the right if no error is found. It takes about 10 seconds for self-test to finish the routines and then the software version will show on the display.

"ERROR CODE" will appear on the right if one of the test items has failed (see section *8.2 Self Test* for detailed information).

When the memory, data, and communication self-tests are done, the AC Source will conduct a power output self-test. The output relay is OFF during the procedure to ensure the load connected to the output terminal will not be damaged. The AC Source sets the output to 350Vac and if the measured voltage exceeds 350V±100V, the power self-test fails and the display shows "SELF TEST NG". If everything passes self-test, the screen will switch to the MAIN PAGE automatically.

Notice

1. Self diagnostics can be run during the power-on self-test to see if there are any errors or NG (No Good) conditions (see section *8.2 Self Test* for detailed information).
2. The AC Source needs about 20 seconds to finish the self-test.

2.7 Maintenance and Cleaning

Remove all wires and cables connected to the instrument before cleaning. Use a brush to clean the dust off and if there are stains on the chassis that cannot be removed by brush, wipe it with a volatile liquid. Do not use any corrosive liquid to avoid damaging the chassis. Use a damp cloth with soap and water or a soft detergent to clean the LCD front panel. Send the unit back to the distributor or Chroma agent for internal cleaning. Do not open the chassis cover.

2.8 Common Environment Conditions

1. In-door use only.
2. Altitude up to 2000m.
3. Temperature 0°C to 40°C.
4. Transient over voltage is CAT II impulse withstand.
5. Pollution degree 2.

3. Local Operation

3.1 Introduction

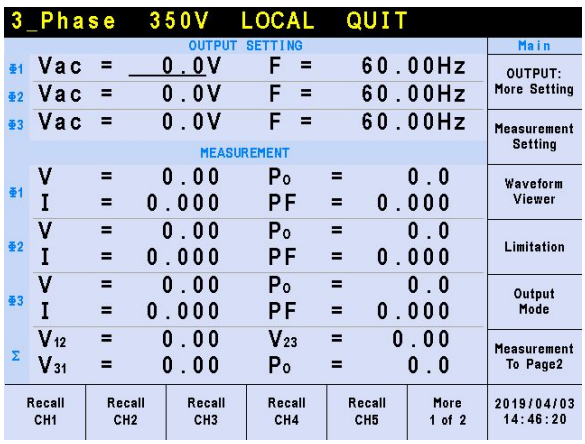
The AC Source can be configured to operate in local or remote mode. The remote mode operation is through a remote GPIB or RS-232C interface as described in Chapter 9.

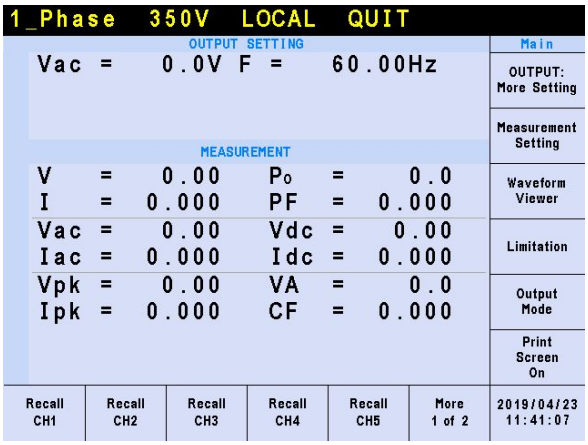
This section describes the operation in local mode using the keypad on the front panel for data entry and test. Local operation can be used directly when the AC Source is turned on.

3.2 Using Keyboard and RPG

The AC Source is equipped with a user friendly interface consisting of a keypad and a Rotary Pulse Generator (RPG) on the front panel. The LCD on the AC Source displays the operations menu.

Figure 3-1 shows the command tree. The following describes how to use both the keypad and the RPG to set the commands. When the power-on procedure has completed (see 0), the display will show the MAIN PAGE (3_Phase Mode/1_Phase Mode) seen below:





Press the ▲, ▼, ◀, ▶ keys to move the cursor for item selection. Use the numeric and decimal keys or RPG to set values and press **ENTER** to confirm them. Use the indicators located at the bottom or lower right of the LCD to set the parameters or functions following the description at the bottom or lower right of the screen, or press ↩ to return to MAIN PAGE.

In MAIN PAGE, press the indicators located at the bottom or lower right of the LCD to select the function list. Use ▲, ▼, ◀, ▶ to move the cursor after inputting each list. For digital settings use the numeric and decimal keys or the RPG to set the value and then press **ENTER** for confirmation. For text setting, turn the RPG for selection and press **ENTER** for confirmation.

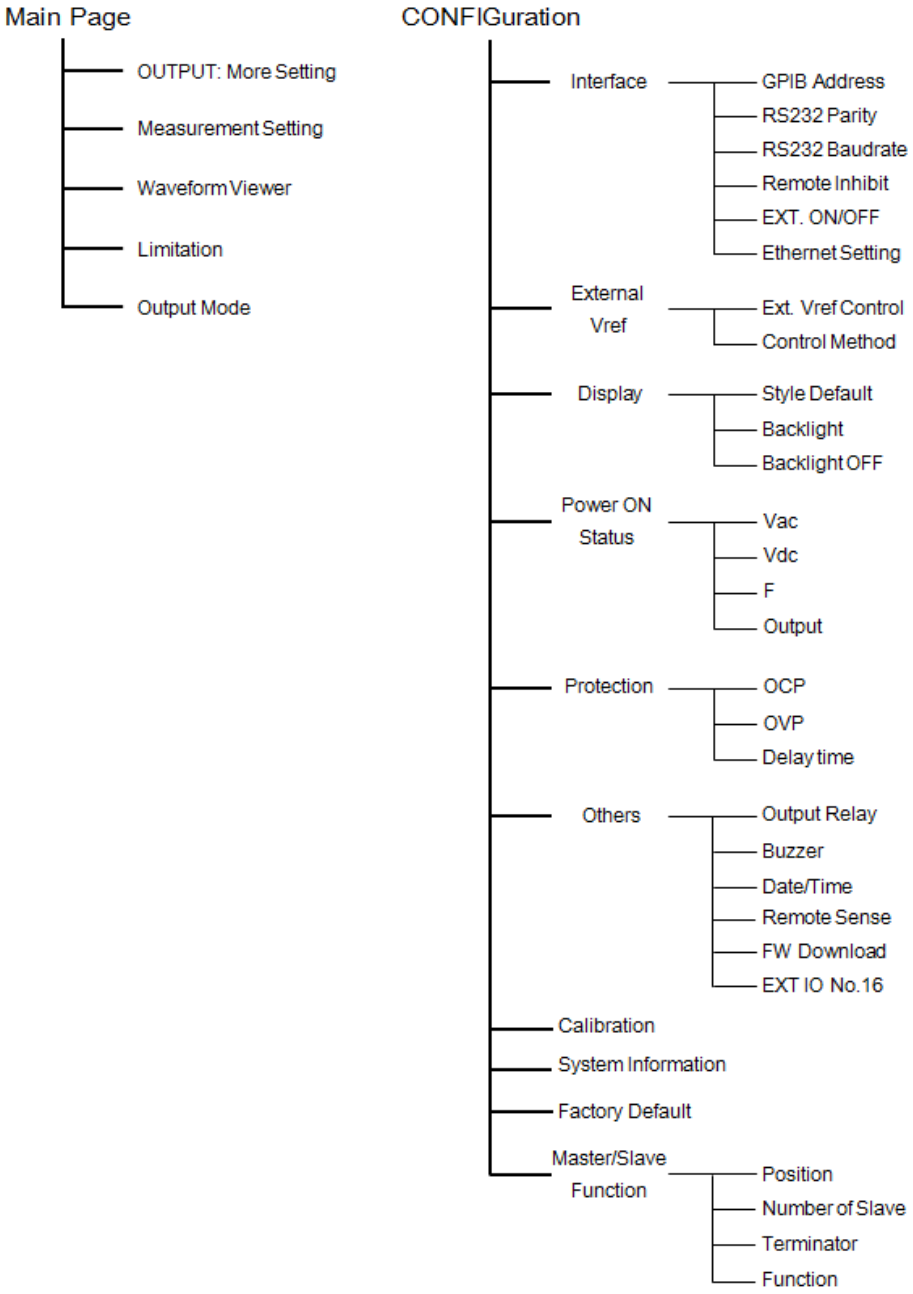

Main Page
OUTPUT: More Setting
Measurement Setting
Waveform Viewer
Limitation
Output Mode
CONFIGuration
Interface
GPIB Address
RS232 Parity
RS232 Baudrate
Remote Inhibit
EXT. ON/OFF
Ethernet Setting
External Vref
Ext. Vref Control
Control Method
Display
Style Default
Backlight
Backlight OFF
Power ON Status
Vac
Vdc
F
Output
Protection
OCP
OVP
Delay time
Others
Output Relay
Buzzer
Date/Time
Remote Sense
FW Download
EXT IO No.16
Calibration
System Information
Factory Default
Master/Slave Function
Position
Number of Slave
Terminator
Function

Figure 3-1

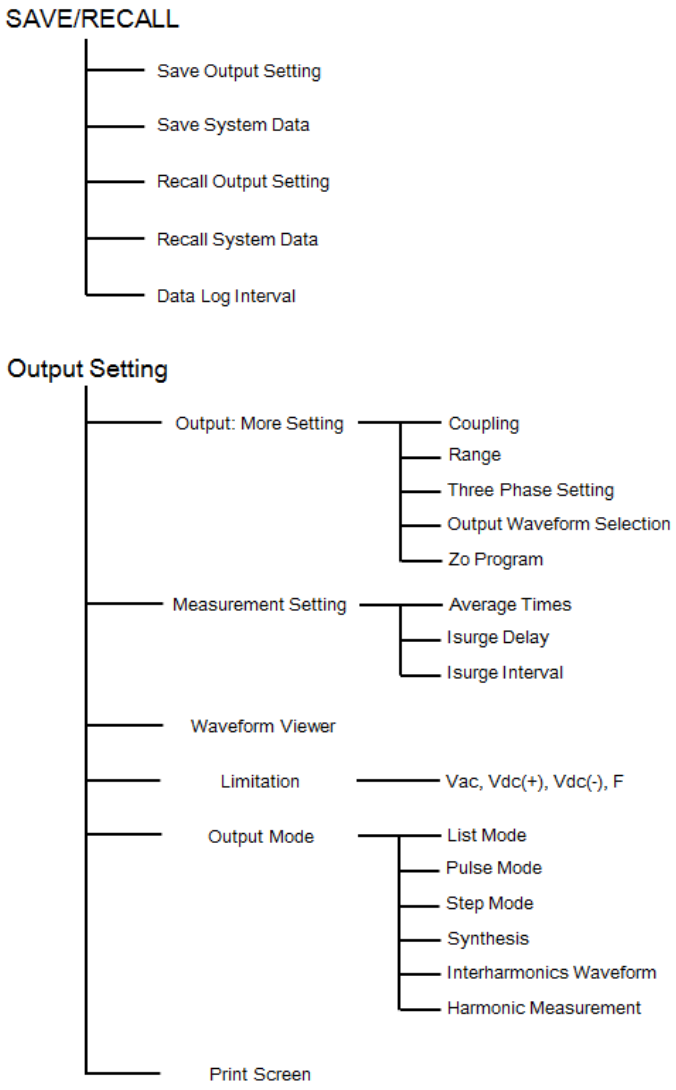
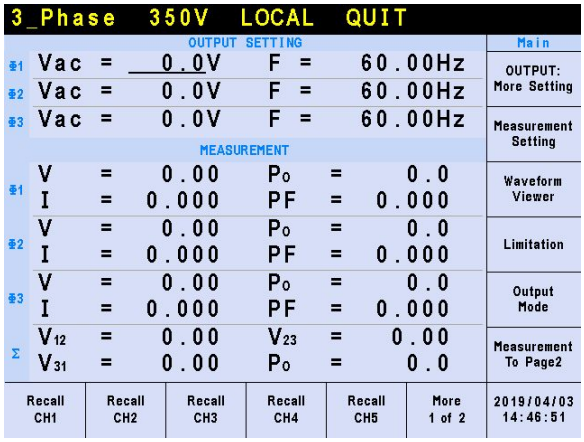
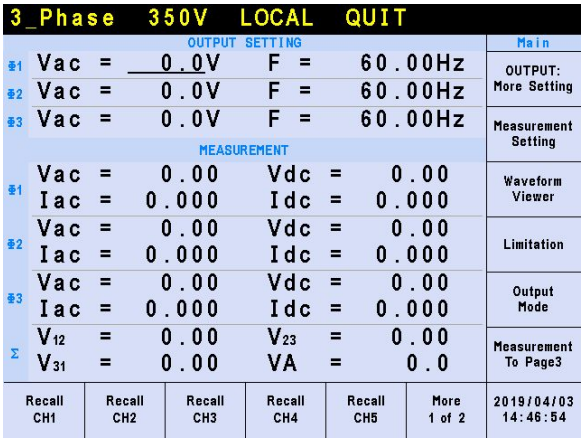


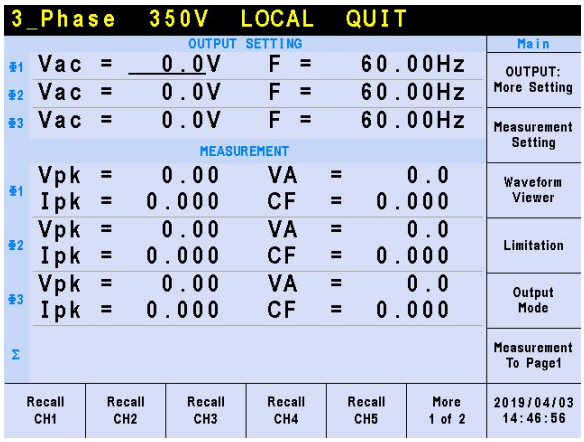
Figure 3-2

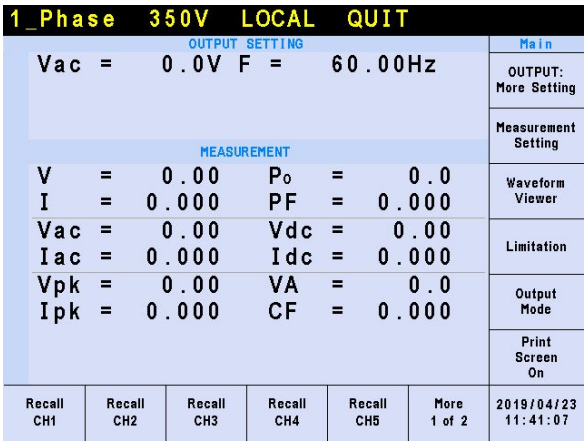
3.3 Main Page (Output Setting and Measurement)

When the AC Source is turned on and finishes the self-test, the screen displays the MAIN PAGE (3_Phase Mode/1_Phase Mode). A line on the screen shows the output setting. The default output setting can be set by the Power-ON Status (see 3.4.4) under the CONFIG function key. The MEASUREMENT on the screen shows the items measured by the AC Source and each of them has 12 types totaling 3 pages as shown below:









On the top of the screen, the range displayed (350V) is the Range status (see 0). There are 3 ranges:

1. 175V Range
2. 350V Range
3. AUTO Range

Output parameter definitions:

Vac : AC output voltage in Volts
F : Output frequency in Hertz.
Vdc : DC output voltage in Volts.

Pressing **OUT/QUIT** enables the AC Source's output using the previously set Vac, F, and Vdc values. Press it again and the AC Source output is disabled.

Notice

When Coupling = AC+DC the output is the sum of Vac and Vdc. The combination of peak voltages cannot exceed the limit of each range (range 175V : 247.5V and range 350V : 494.9V.) The output voltage will drop to 0V automatically and trigger the protection circuit if the voltage limit (OVP) is exceeded.

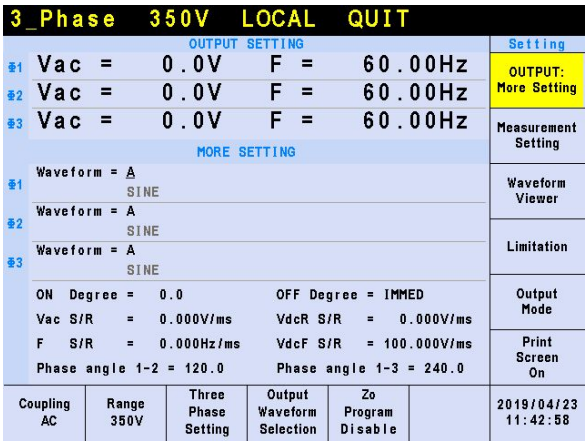
Measurement parameter definitions:

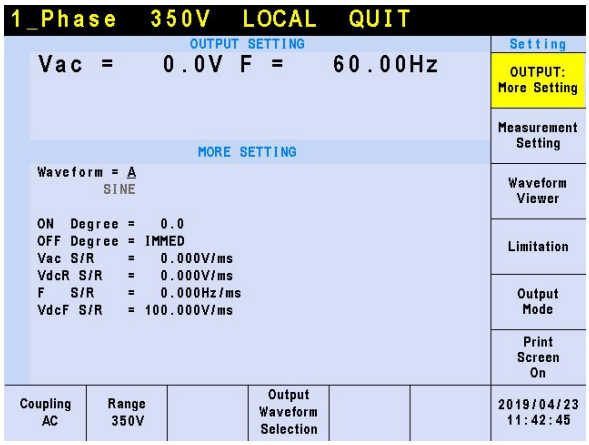
V : Voltage measurement in Volts. (True RMS measurement)
F : Output frequency in Hertz.

I	: Current measurement in Amps. (True RMS measurement)
P	: Real power measurement in Volts.
PF	: Power Factor [calculation formula = Real Power / (Vrms × Irms)]
CF	: Crest Factor [calculation formula = Ipeak/Irms]
Vdc	: DC voltage measurement in Volts.
Idc	: DC current measurement in Amps.
Ip	: Peak current measurement in Amps. The Ipeak display is the Ip (+) or Ip (-), whichever is larger.
Is	: I surge that only measured when output changes.
VA	Apparent power in Volt-Ampere [calculation formula = Vrms × Irms]
VAR	: The calculation formula = $\sqrt{VA^2 - P^2}$

3.3.1 OUTPUT: More Setting

Press OUTPUT: More Setting in the MAIN PAGE (3_Phase Mode/1_Phase Mode) (see section 3.3). A line of output functions will appear at the bottom of the screen as described below:



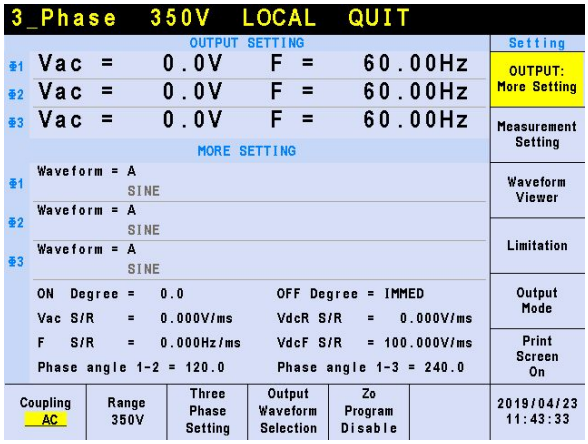


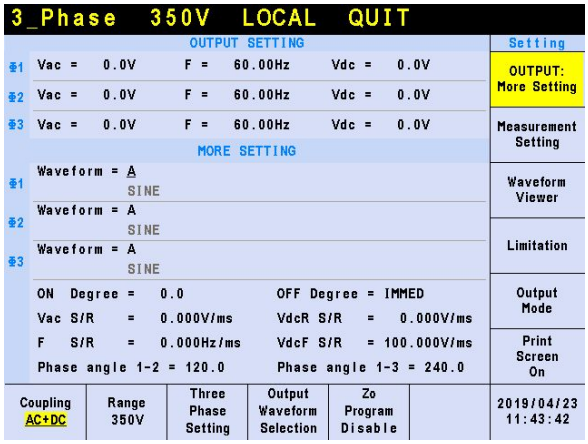
3.3.1.1 Coupling Output Mode (AC+DC, AC, DC)

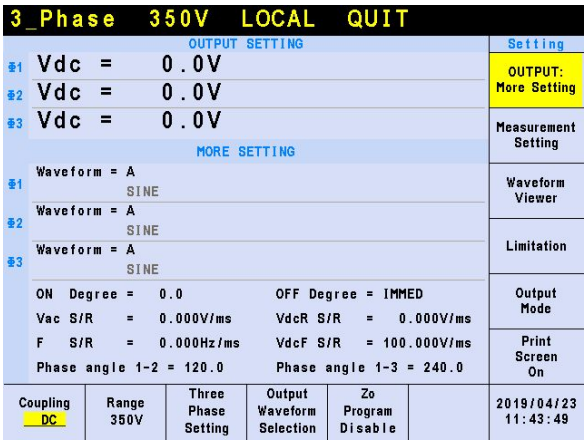
There are 3 types of AC Source output: AC+DC, AC, and DC. The coupling can be set to meet a variety of applications.

The procedure for switching from AC to DC is described below:

1. Press ‘Coupling’ at the bottom.
2. Turn the RPG to change the selection from AC to AC+DC and press **ENTER**.
3. Turn the RPG to change the selection from AC+DC to DC and press **ENTER**.







Notice

1. Since the AC Source does not have as many capacitors as the common DC Power Supply, some voltage fluctuations and transient load characteristics are not the same. This AC Source is able to provide positive and negative voltage without changing the output connector. The output capacitance cannot exceed 240mC (for DC output, the external electrolytic capacitor restrictions are 175V Range <1200uF, 350V Range <390uF) according to the Q=CV formula as it may cause the device to be damaged due to unstable output.
2. For parallel operation, the coupling of Master and Slave can only be set under the same condition and no changes during operation, otherwise it may cause output error.

Even though the AC Source has AC/DC/AC+DC output modes, these features are still different from the common DC Power Supply when in pure DC mode, as explained below:

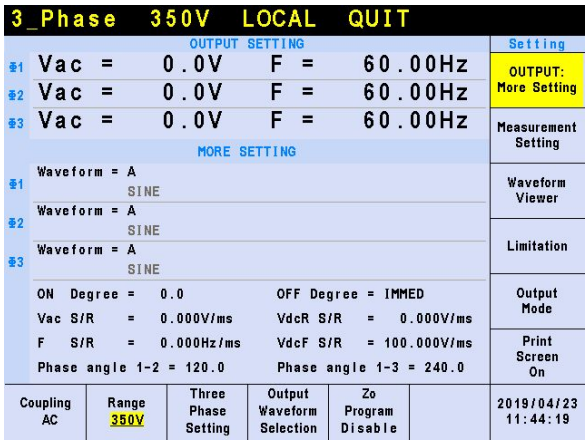
1. The output voltage ripple is larger because there is no output capacitor.
2. When the output current reaches the current limit set point, the output voltage will be cut off and the unit will go into protection mode. It will not stay in constant current mode with a voltage drop like common DC sources.

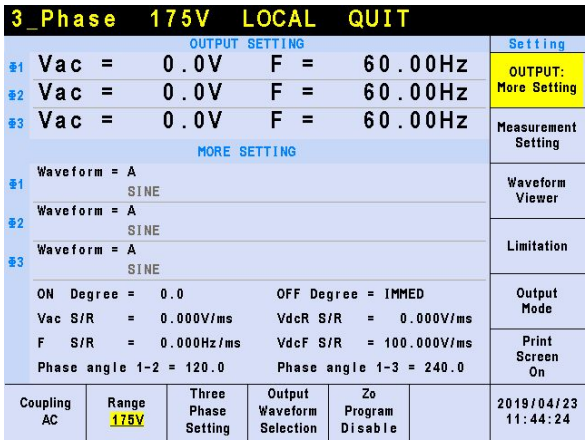
3.3.1.2 Range

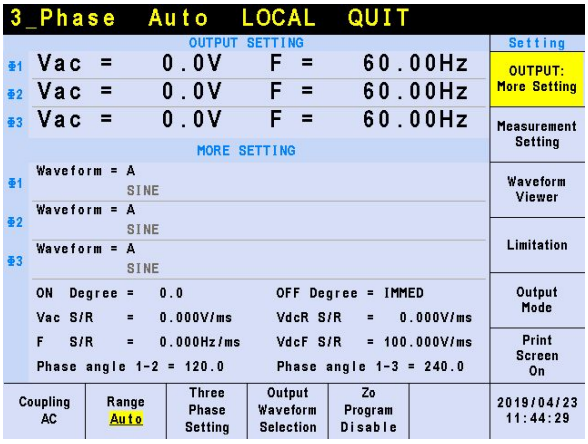
The AC Source has full scale voltage ranges of 175V, 350V, and AUTO. Set the Range using the function OUTPUT: More Setting. This parameter controls the power stage relay for parallel (range 175V) or series (range 350V) for more current or higher voltage. AUTO range indicates the output range will change between 175V and 350V automatically as required.

Set the output voltage range to 175V as described below:

1. Press ‘Range’ at the bottom.
2. Turn the RPG to change “350V” to “175V” and press **ENTER**.







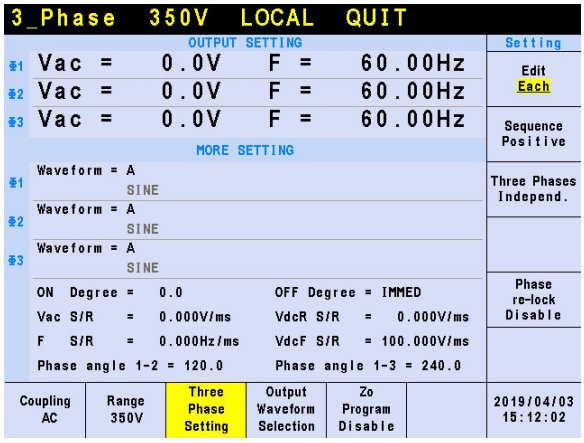
Notice The output voltage will be set to 0V before the range changes to eliminate the peak voltage, and then the output voltage will be set. Note that it may cause the UUT to be suspended and/or damaged when changing the range.

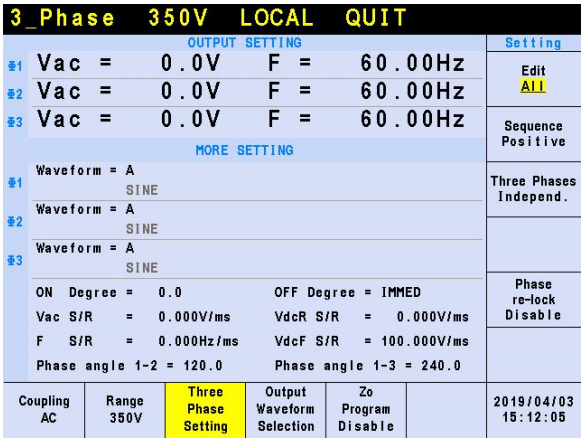
3.3.1.3 Setting Three Phase Output

Press ‘Three Phase Setting’ to enter into the function, as shown below:

Edit: All and Each.

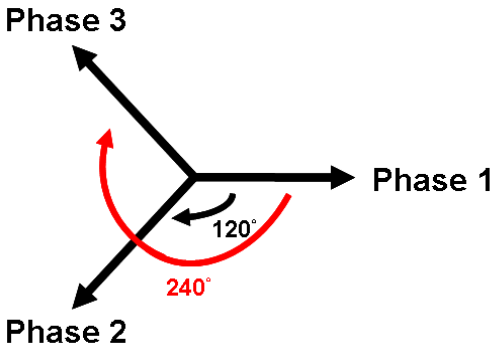
Press ‘Edit’ to set “Each” or “All” for 3-phase output voltage limit.





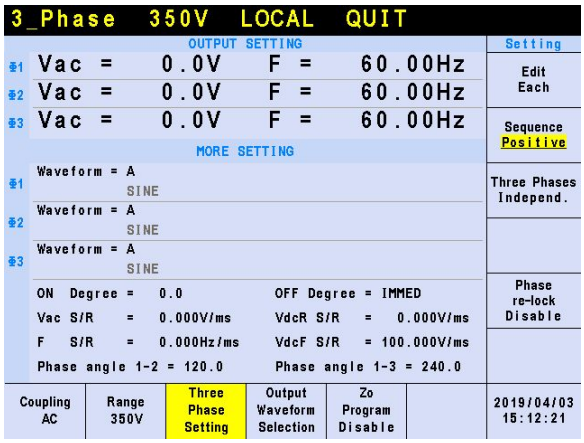
Sequence: Positive and Negative.

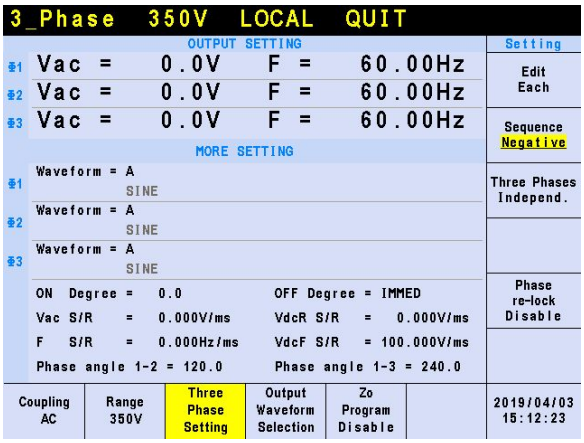
For example, the phase difference degree of 3-phase in positive balance is 120 degrees as shown below:



Press 'Sequence' to set the Positive/Negative sequence for the AC Source's 3-phase voltage output. The following describes the procedure to set the 3-phase output voltage sequence to Negative.

1. Press 'Sequence' on the right.
2. Use the RPG to select "Negative" and press **ENTER**.



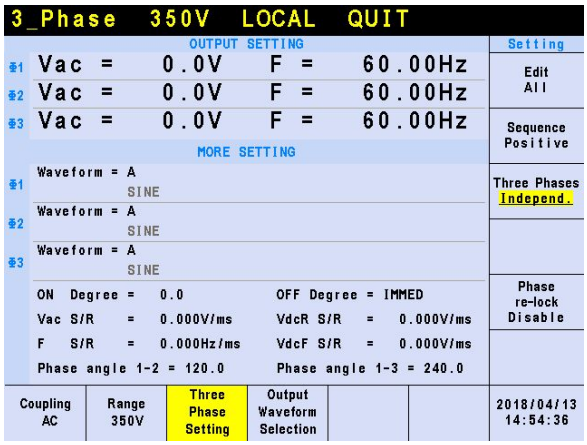


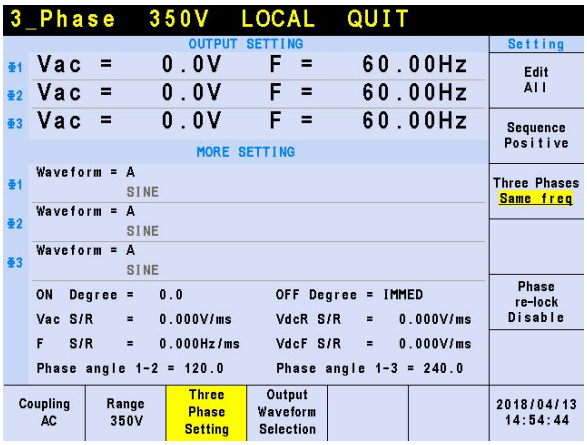
Three Phases: Independ, Same Freq and Balance.

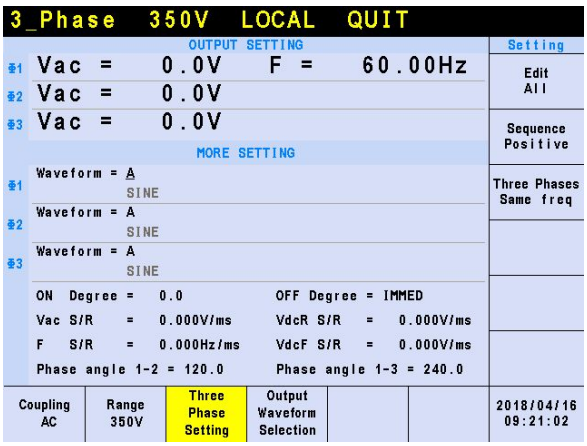
Press ‘Three Phases’ to set the relationship among the AC Source 3-phase output voltages, which are Independ, Same Freq, and Balance.

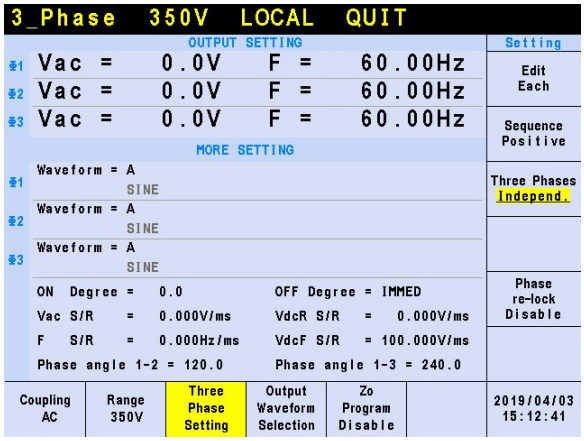
The following procedure describes how to set the same frequency for 3-phase voltage output.

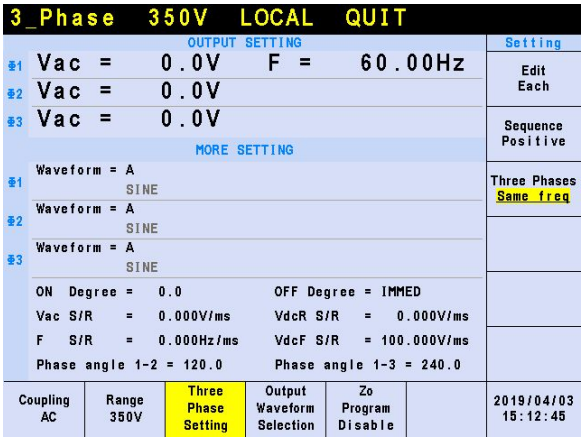
1. Press ‘Three Phases’ on the right.
2. Use the RPG to select “Same freq” and press **ENTER**.

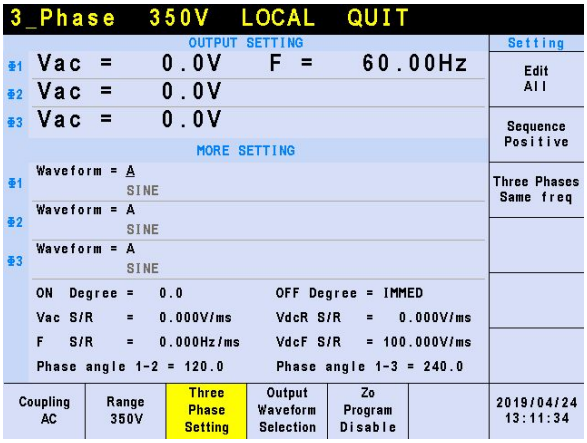






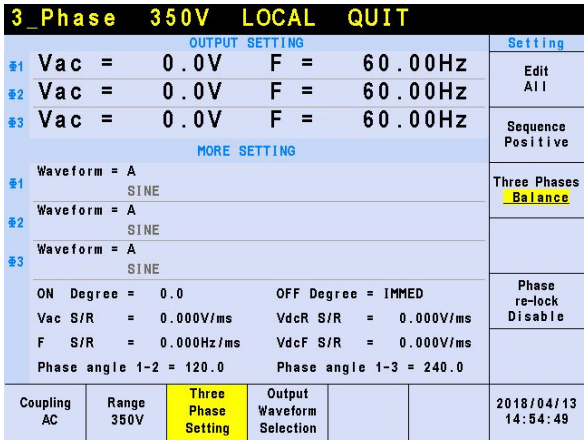


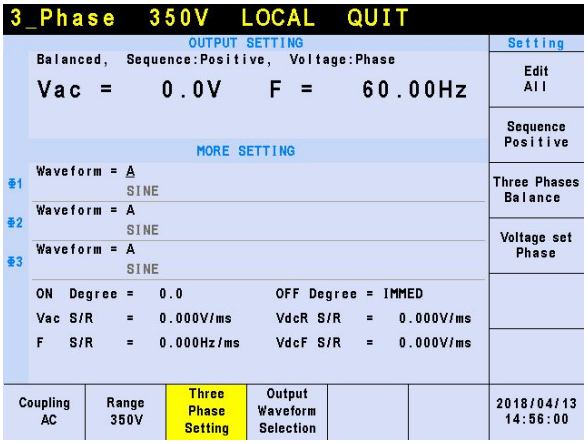


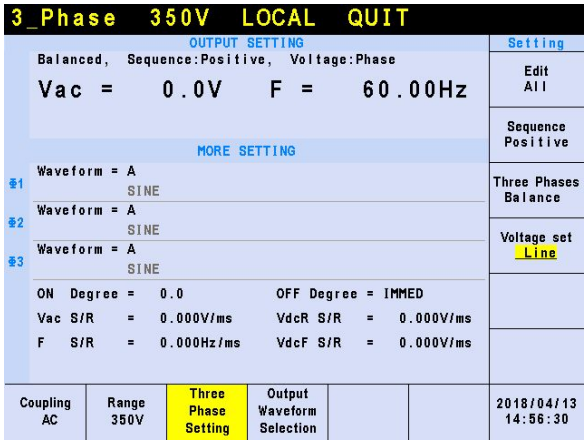


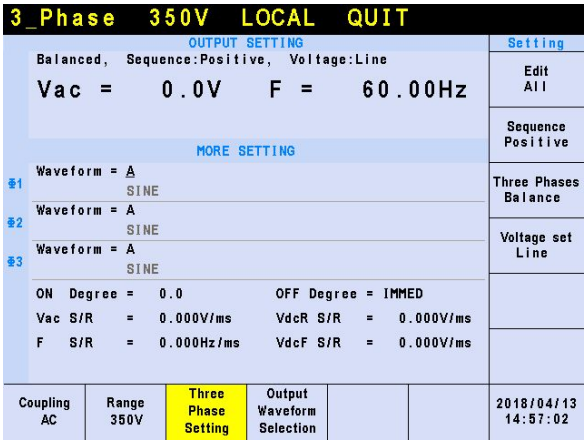
When 3-phase balance is in use, the output voltage may be set to be Phase Volt or Line Volt. Follow the procedure below for setting the 3-phase voltage output to 3-phase balance.

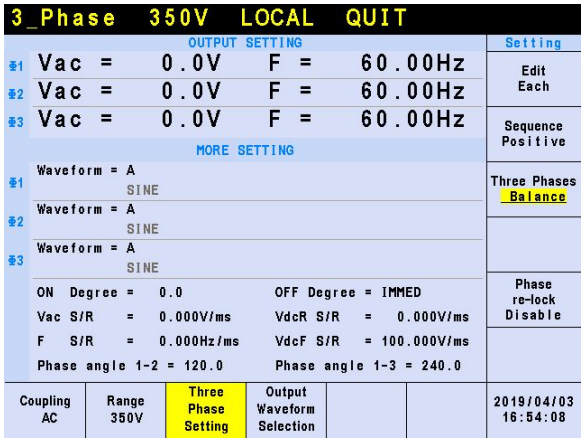
1. Press 'Three Phases' on the right.
2. Use the RPG to select "Balance" and press **ENTER**.
3. Press 'Voltage set' on the right.
4. Use the RPG to select "Line" and press **ENTER**.

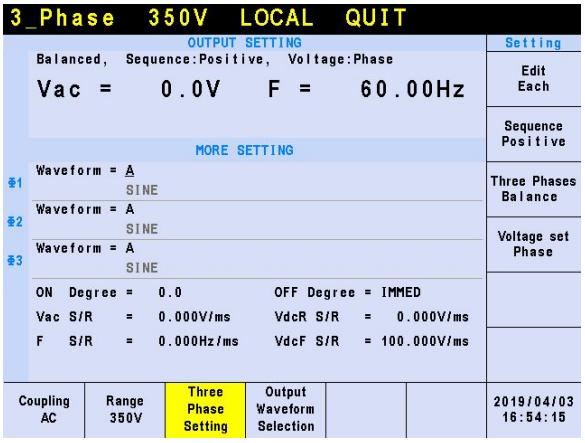


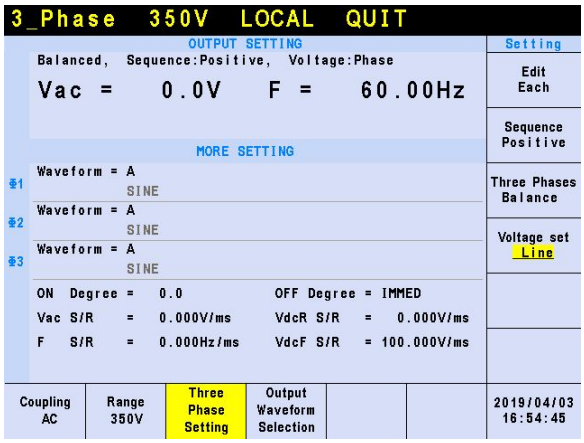


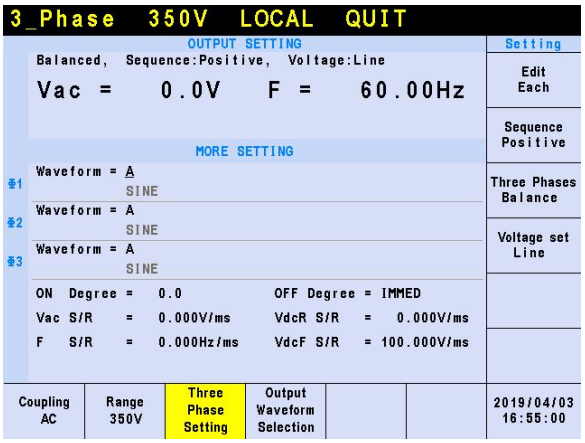








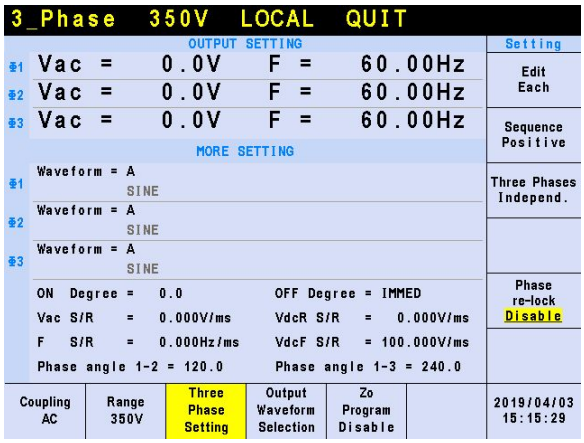


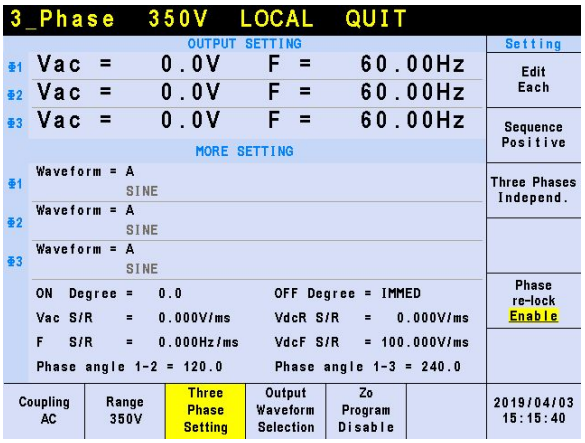


Phase re-lock: Enable and Disable.

Phase re-lock is used to lock the phases again. Since the output voltage and frequency are set separately when the AC Source is in the 3-phase mode, the three phases may have different frequencies. Assuming the 3-phase output frequencies are different and they are set to the same frequency when the phase re-lock function is disabled, the phase difference of the 3-phase output does not return to default (each phase difference is 120°) as Figure 3-3 shows. The phase differences of the 3-phase output will return to default (each phase difference is 120°) as shown in Figure 3-4 when the phase re-lock function is enabled.

Press ‘Phase re-lock’ on the right to enable or disable the function.





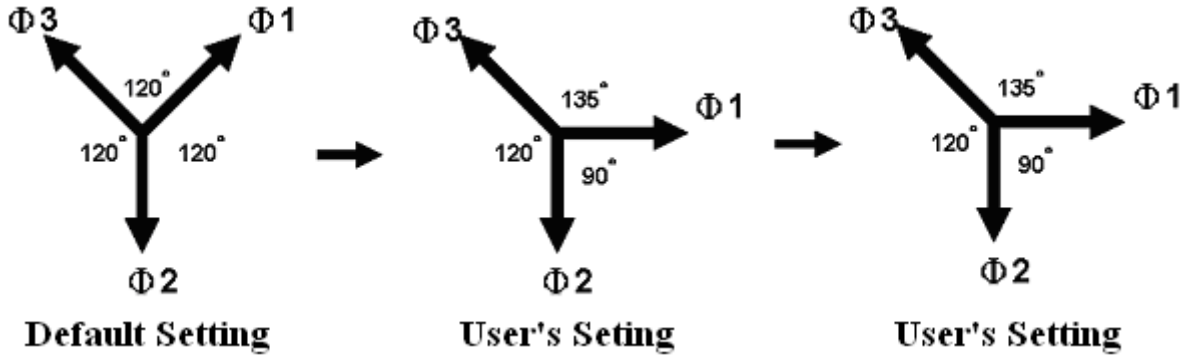


Figure 3-3 Phase Re-lock Disabled

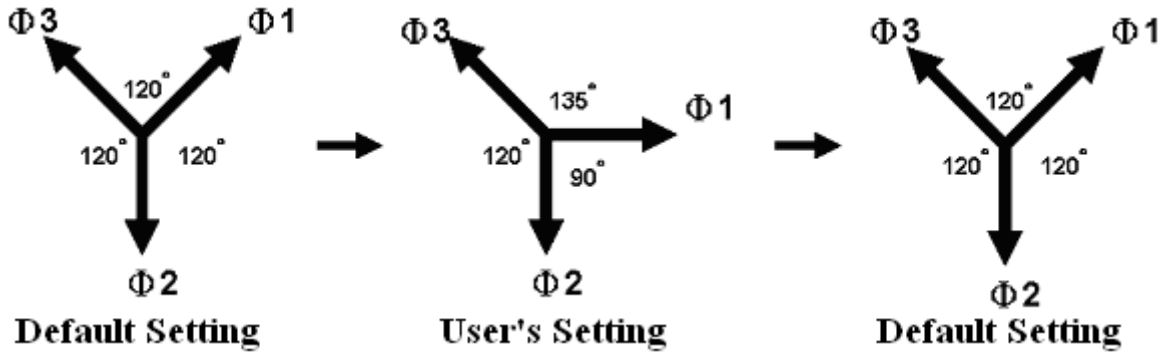


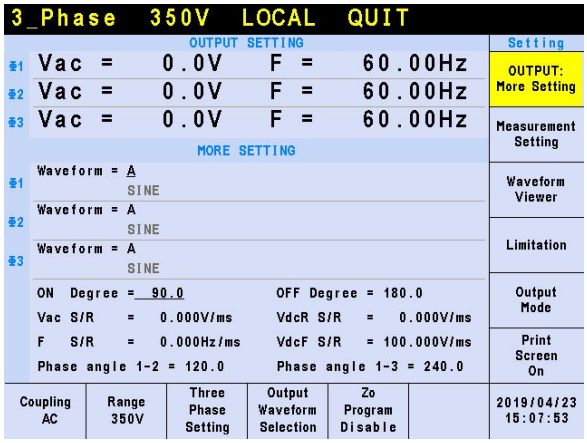
Figure 3-4 Phase Re-lock Enabled

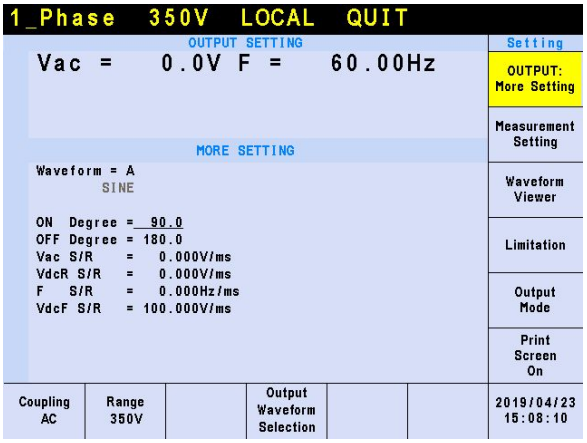
3.3.1.4 Output Degree

The AC Source can control the degree of the waveform during output or when stopping the output. In MAIN PAGE (3_Phase Mode/1_Phase Mode) (see 3.3) press 'OUTPUT: More Setting' on the right to set ON Degree and OFF Degree.

The procedure for setting the output phase degree to ON (Degree = 90) and OFF (Degree=180) in 1_Phase Mode /3_Phase Mode is shown below:

1. Press 'OUTPUT: More Setting' on the right.
2. Move the cursor to the "ON Degree=" command position.
3. Press **9**, **0**, and **ENTER** to change the value to "90.0".
4. The cursor moves to the "OFF Degree=" command position automatically.
5. Press **1**, **8**, **0**, and **ENTER** to change the value to "180.0".





Notice

If "OFF Degree=IMMED" when **QUIT** is pressed, the output voltage turns off immediately. If a degree is already set, it will output voltage until it reaches the set degree. “OFF Degree= 360” will turn into “OFF Degree= IMMED”.

3.3.1.5 Slew Rate of Output Transient

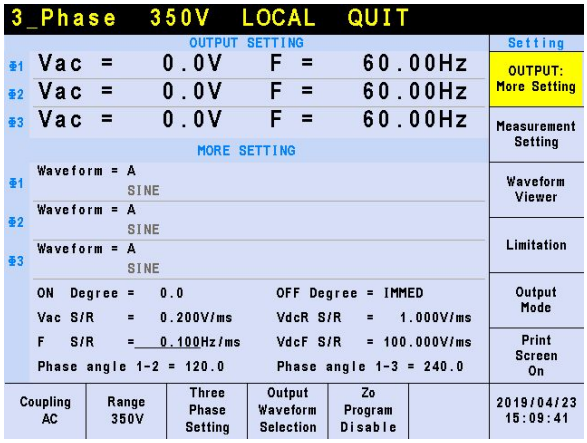
The AC Source has the ability to set the slew rates of the voltage waveform. This is done through 4 commands in the OUTPUT: More Setting, which are Vac S/R, F S/R, VdcR S/R, and VdcF S/R, which control the slew rate changes of the voltage waveform.

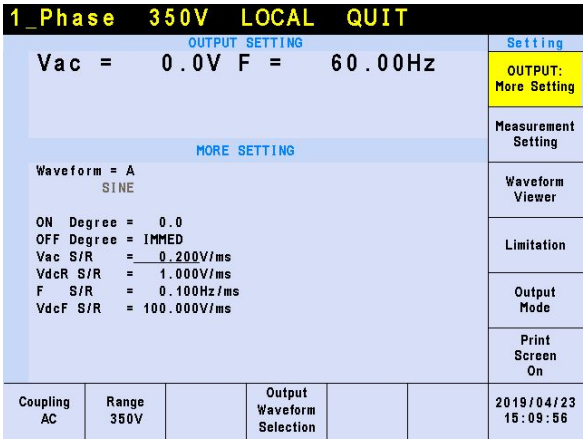
Vac S/R : Slew rate of Vac output.
F S/R : Slew rate of frequency output.
VdcR S/R : Rising slew rate of Vdc output.
VdcF S/R : Falling slew rate of Vdc output.

Change the output setting in MAIN PAGE. When the AC Source is in OUT mode, the output voltage and frequency will change to follow the Vac S/R, F S/R, VdcR S/R, and VdcF S/R settings.

The procedure to set Vac S/R =0.2, F S/R =0.1, and VdcF S/R =1 in 1_Phase Mode /3_Phase Mode is described below:

1. Move the cursor to the “Vac S/R = ” command line.
2. Press **0**, **.**, **2** and **ENTER** to change the value to “0.2”.
3. The cursor moves to the “VdcR S/R =” command automatically. Press **1** and **ENTER**.
4. The cursor moves to the “F S/R =” command automatically. Press **0**, **.**, **1** and **ENTER**.



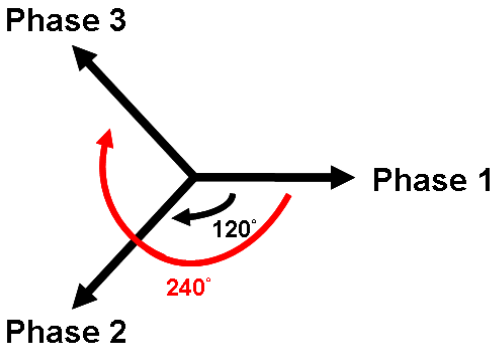


Notice

1. If Vac S/R = 0, F S/R = 0, Vdc S/R = 0, the output slew rate is set to the maximum rate.
2. Though the input range of Vac S/R, F S/R, and VdcR S/R is quite large when using the software editor, the output voltage may not apply the slew rate properly due to the hardware limit when the Vac S/R, F S/R, and Vdc S/R are too large. The maximum for Vac S/R is is 1200V/ms and the minimum is 0.001V/ms. The maximum of VdcR S/R and VdcF S/R is 1200V/ms and the minimum is 0.001V/ms. The maximum for F S/R is 1600Hz/ms and the minimum is 0.001Hz/ms.
3. When executing **OUT** on the AC Source the output will reach the final state as set. When QUIT is executed, the output drops to 0V immediately. To reduce the voltage to 0V using the set slew rate, key in 0V and press **ENTER** instead of pressing **QUIT**.

3.3.1.6 Output Degree of 3-phase Voltage Output

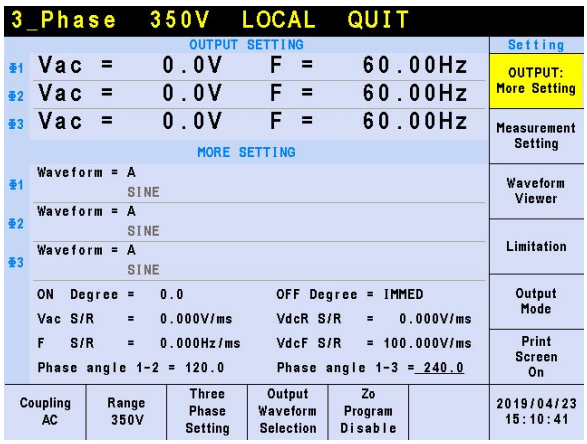
The AC Source can set the phase angles individually for each of the phases of the 3-phase output voltage. For instance, the phase difference between the 3 phases is 120 degrees for the output voltage with the 3-phase balance positive sequence shown below:



The procedure for setting the output voltage to 3-phase balance with a 120 degree phase difference between the 3 phases is shown below:

1. Move the cursor to the "Phase angle 1-2 =" command line.
2. Press **1**, **2**, **0** and **ENTER**.
3. Move the cursor to the "Phase angle 1-3 =" command line.

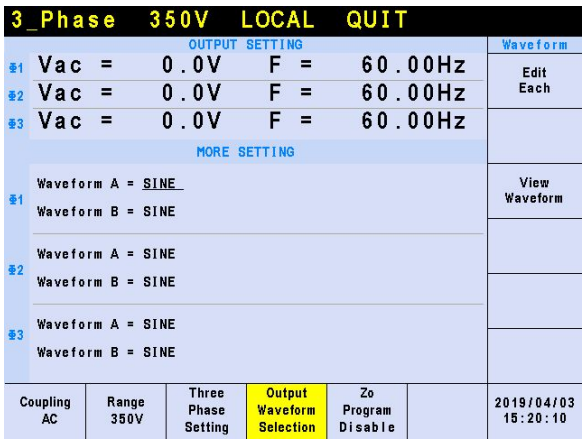
4. Press **2**, **4**, **0** and **ENTER**.



Notice Since each phase of the 3-phase voltage output of the AC Source is running independently, it is possible to set the phase differences of the 3-phase output to be unbalanced, such as Phase angle 1-2 = 100, Phase angle 1-3 = 200.

3.3.1.7 Output Waveform Selection

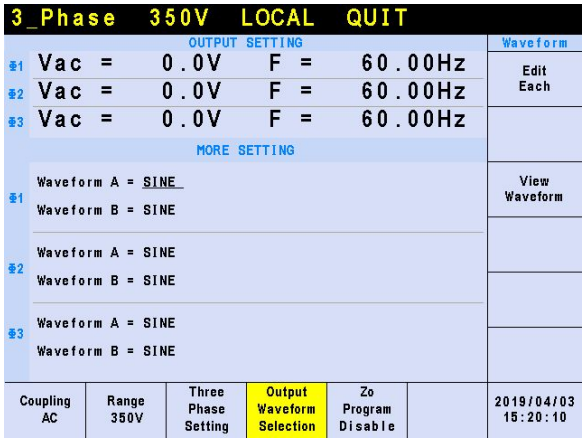
The AC Source has two sets of unique waveforms, A and B. Each of them has sine, square, and clipped sine waveforms and 30 sets of built-in waveforms along with 30 sets of user defined waveforms.

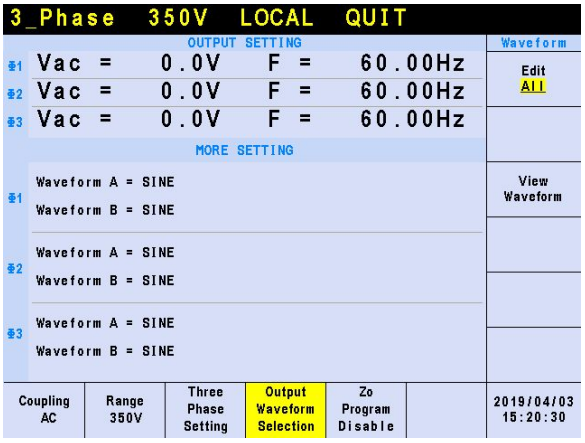


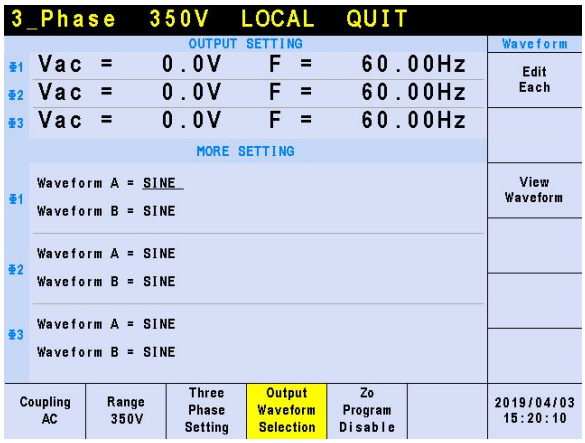
Follow the steps below to set the 3-phase waveform to A and to sine:

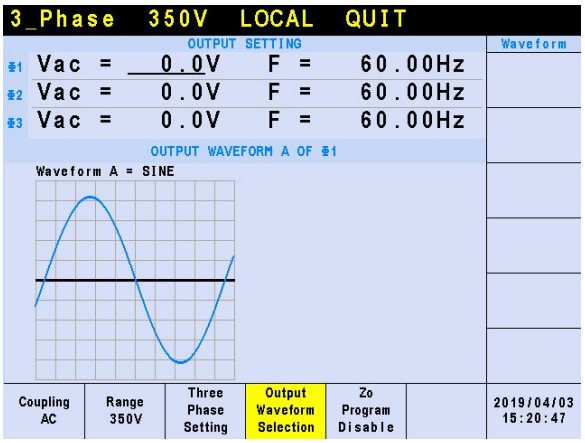
1. Press ‘Edit’ on the right and use the RPG to change the selection to All.
2. Move the cursor to the WAVE A command line.
3. Turn the RPG to select “SINE” and press **ENTER**.

Press “View Waveform” on the right to view the set waveform.





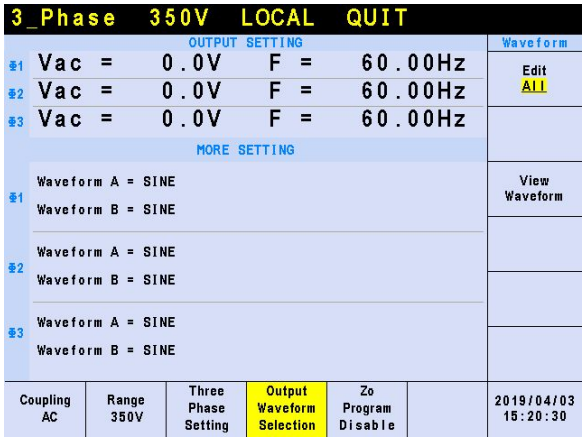


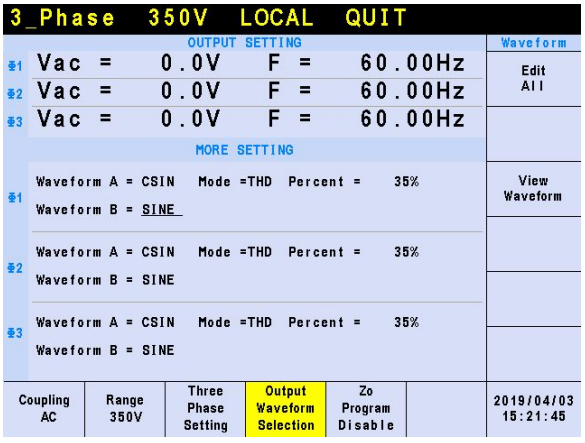


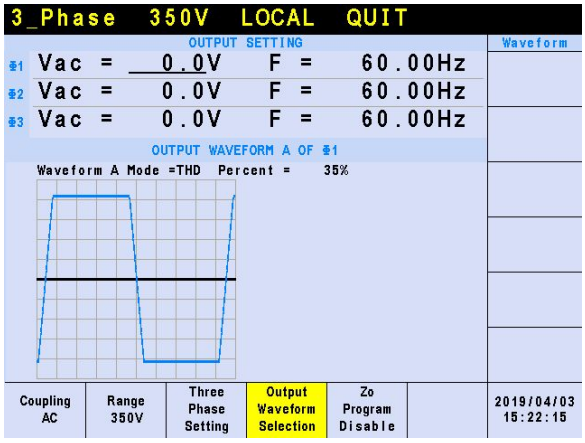
Follow the steps below to set the A waveform of 3-phase to clipped sine with a total harmonic distortion of 35%:

1. Press 'Edit' on the right and use the RPG to change the selection to All.
2. Move the cursor to the WAVE A command line and select "CSIN".
3. The LCD screen shows MODE and PERCENT.
4. Turn the RPG to change MODE to "THD" and press **ENTER**.
5. Press **3**, **5** and **ENTER** to set the THD to be 35%.

Press "View Waveform" on the right to view the set waveform.







Notice

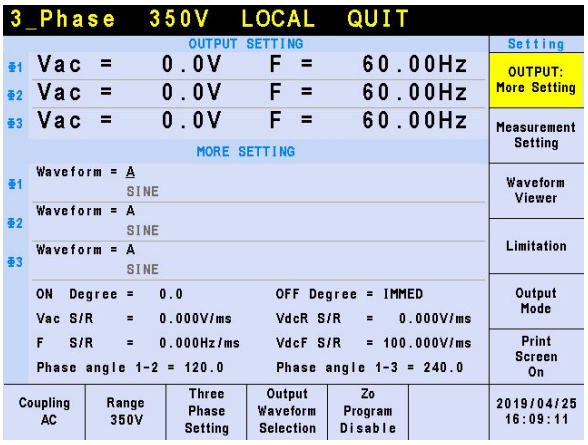
1. The clipped sine waveform can be programmed via “Amplitude” or “Total Harmonic Distortion”. The amplitude range is from 0 to 100% (100%: without clipping) while the Total Harmonic Distortion range is from 0 to 43% (0%: without distortion.)
2. A user defined waveform needs to be defined by and downloaded from the remote PC.
3. For a detailed waveform, see *Appendix B Built-in Waveforms*.

CAUTION

1. When using a user defined waveform, the AC Source may be damaged if the waveform frequency exceeds 1000Hz.
2. Due to the bandwidth restriction of the AC Source, distortion may occur on the output, especially when the user defined waveform contains high frequency.

3.3.1.8 Programmable Output Impedance

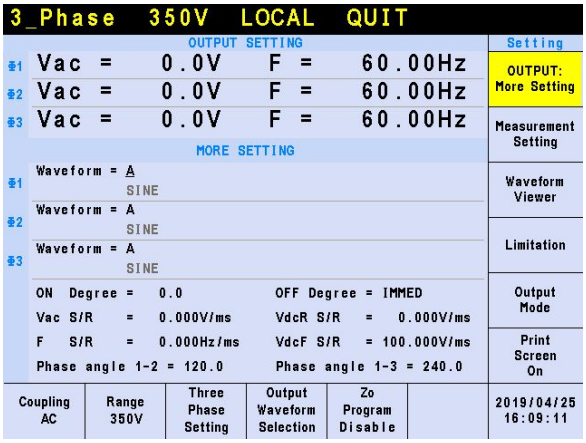
The output impedance of AC source is very low; however the user may require special output impedance in some test conditions. Using the Zo Program in OUTPUT menu (see section 3.3.1) can edit the output impedance in certain range.

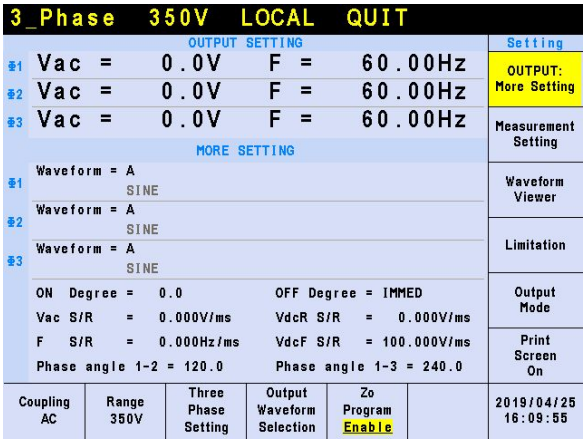


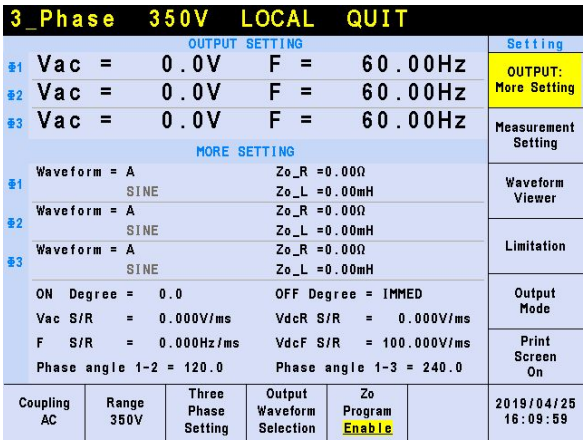
Set Zo Program = Enable, R = 1.0Ω, and L = 1.0mH as described below.

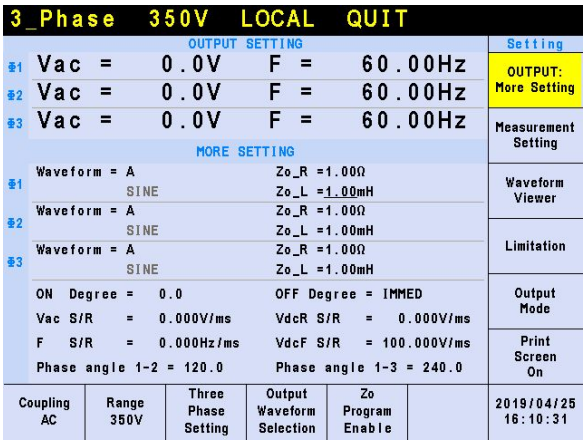
1. Press the key that maps to Zo Program.
2. Turn RPG to switch it to “Enable” and press **ENTER**.

3. The cursor automatically moves to "Zo_R = " command line.
4. Press **1**, **.**, **0** and **ENTER** to change Zo_R to "1.0Ω".
5. Press **1**, **.**, **0** and **ENTER** to change Zo_L to "1.0 mH".









Notice

1. When Zo Program = Enable, the AC source will reprogram the output waveform to meet the setting via current feedback. However, when the Zo Program = Disable, the output impedance will be the original value of AC source.
2. The programmable output impedance function is invalid for DC output.
3. The programmable output impedance function is invalid for standalone unit in single phase mode and multiple units in parallel mode.

⚠WARNING

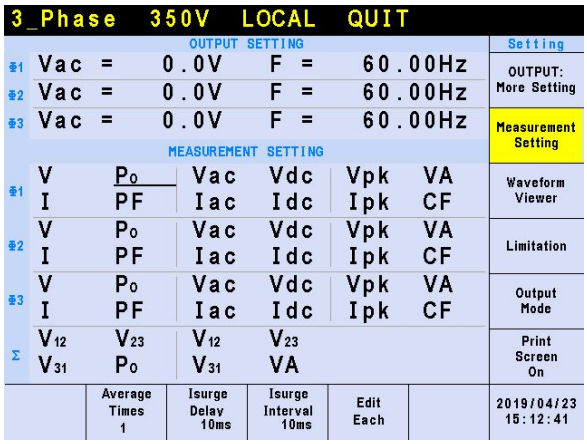
The maximum values of Zo_R and Zo_L are 1.0Ω and 2.0 mH. However, if L is over 0.5 mH and the output voltage is too low (<100Vac), it could cause the AC source to be unstable especially when the output current is too big. The user has to program the inductance to the desired level slowly. If there is abnormal high frequency voltage output or noise, monitor the output voltage and the AC source noise. Do not program the output impedance but use external impedance circuit if instability occurs.

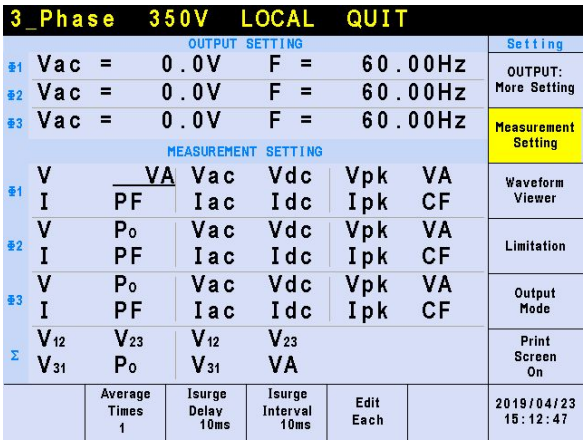
3.3.2 Measurement Setting

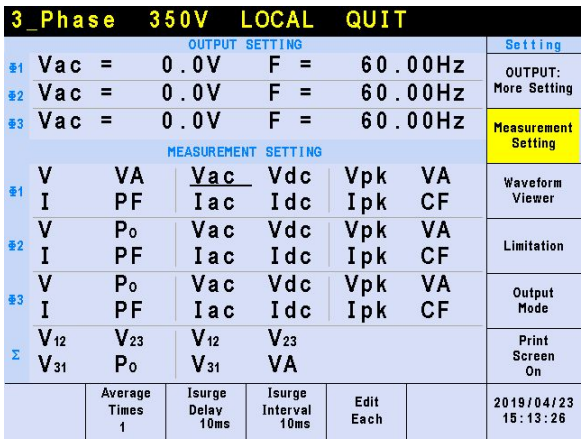
Press ‘Measurement Setting’ on the right in MAIN PAGE (3_Phase Mode/1_Phase Mode) to set the measurement as shown below. There are 12 measurement items in the setting screen such as voltage, current, output power, etc. The setting is done by moving the cursor to each item and using the RPG to select the required test item and pressing **ENTER**.

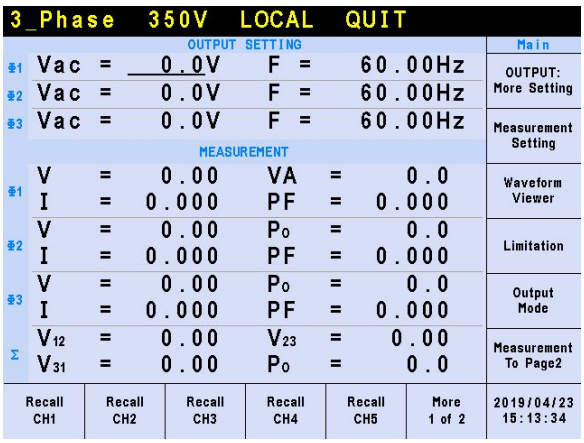
Follow the procedure below to change the 3rd measurement item from Po to VA in 3-phase mode.

1. Press ‘Measurement Setting’ on the right in MAIN PAGE (3_Phase Mode).
2. Move the cursor to “Po”.
3. Use the RPG to select “VA” and press **ENTER**.
4. Press ⏎ to return to MAIN PAGE.



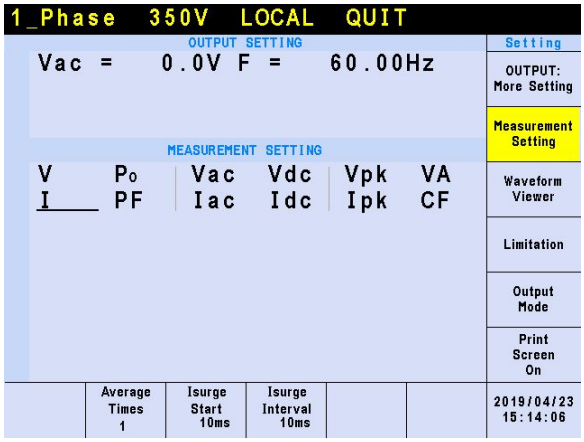


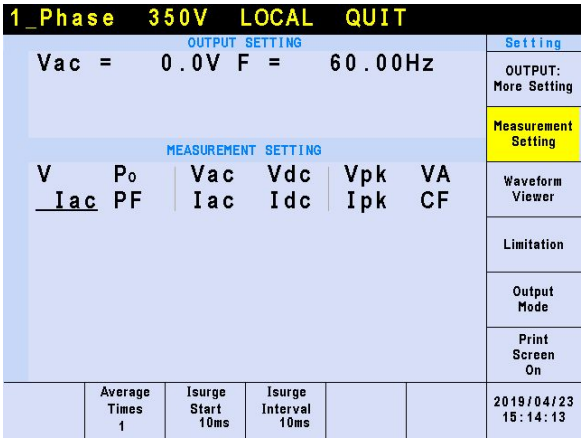


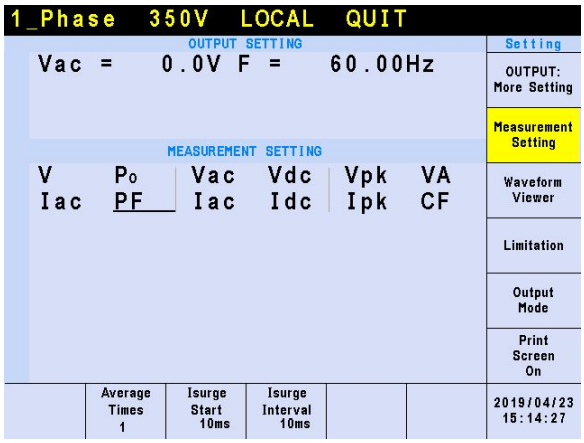


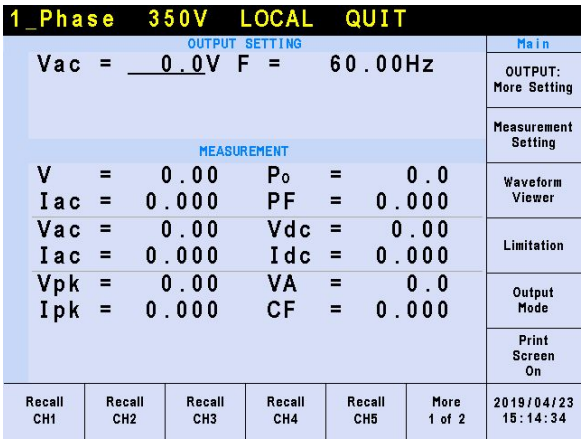
Follow the procedure below to change the 2nd measurement item from I to Iac in 1-phase mode.

1. Press ‘Measurement Setting’ on the right in MAIN PAGE (1_Phase Mode).
2. Move the cursor to “I”.
3. Use the RPG to select “Iac” and press **ENTER**.
4. Press ⏎ to return to MAIN PAGE.









3.3.2.1 Average Times

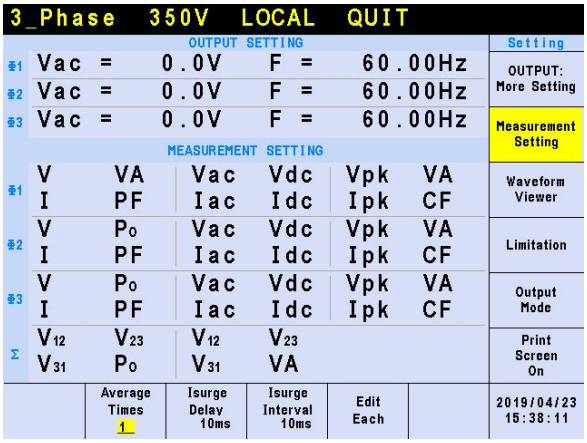
Average Times is the sampling average of RMS voltage/current and peak voltage/current. The AC Source uses moving windows for sampling. When "4" is selected for Average Times it indicates it will be sampling 4 times in the moving windows.

Press 'Average Times' at the bottom to set the average times for sampling. If the measurement is fluctuating severely, higher sampling average times can be set to improve the measurement accuracy. The average times for sampling that can be set are listed below.

Average Times: 1, 2, 4, 8, 16 and 32.

The steps for setting the sampling average times to 1 are described below.

1. Press 'Average Times' at the bottom.
2. Turn the RPG to switch to "1" and press **ENTER**.

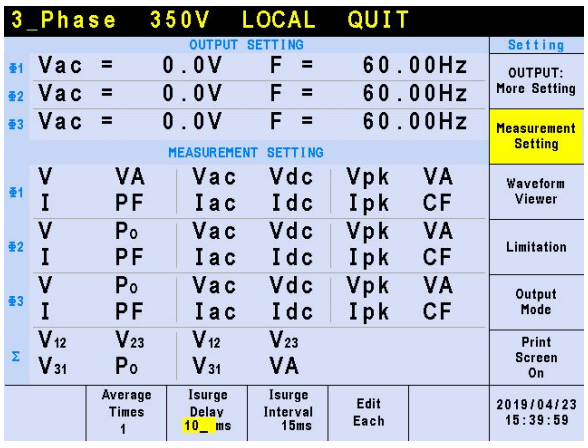


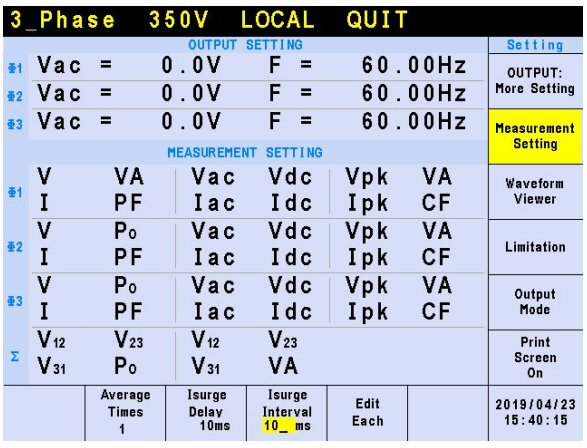
3.3.2.2 Isurge Delay, Isurge Interval

Isurge is the peak current output surge by the AC Source. The Isurge measurement starts after the Isurge Delay when the voltage output changes. The measurement time is set by the Isurge Interval. These two functions can be set in the Measurement Setting.

The procedure for setting Isurge Delay = 10 ms and Isurge Interval = 10 ms is described below:

1. Move the cursor to the “Isurge Delay =” command line.
2. Press **1**, **0** and **ENTER** to change the value to “10.0”.
3. Move the cursor to the “Isurge Interval =” command line.
4. Press **1**, **0** and **ENTER** to change the value “10.0”.





3.3.3 Waveform Viewer

The Waveform Viewer can be used to see the real time output voltage/current waveform. There are a total of 3 Channels available. Voltage, current, and time can be adjusted by the Scale command. The figure below shows the Waveform Viewer.

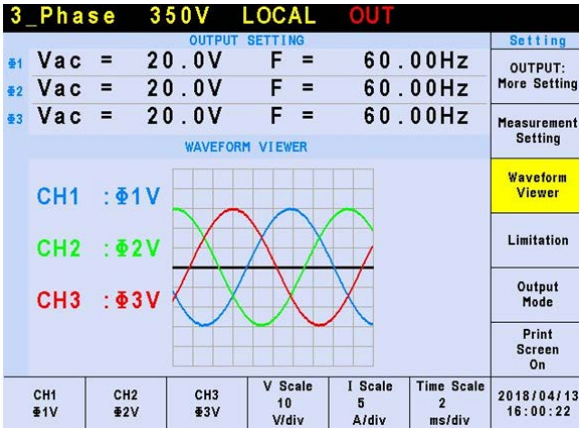
Ch1: Φ1V, Φ2V, Φ3V, Φ1I, Φ2I, Φ3I.
Ch2: Φ1V, Φ2V, Φ3V, Φ1I, Φ2I, Φ3I.

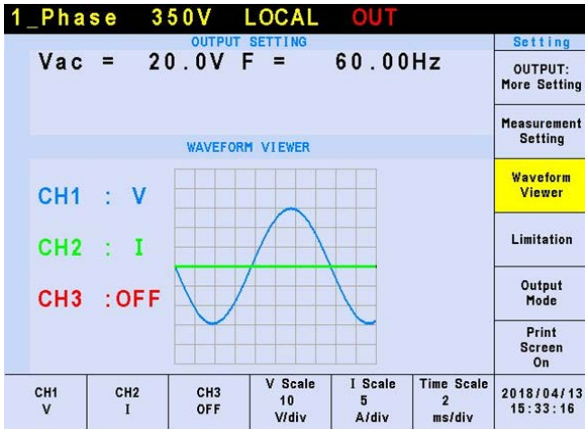
Ch3: Φ1V, Φ2V, Φ3V, Φ1I, Φ2I, Φ3I.

V Scale: 10, 20, 40, 80, 120V/div.
I Scale: 1, 2, 5, 10, 20A/div
Time Scale: 0.2, 0.5, 1, 2, 5, 10, 50, 100, 200ms/div.

The procedure for setting CH1 =Φ1V, CH2 =Φ2V, CH3 =Φ3V, V Scale = 10 V/div, I Scale = 5A/div, and Time Scale = 2 ms/div in 1_Phase Mode /3_Phase Mode is described below:

1. Press 'CH1' at the bottom.
2. Turn the RPG to change to "Φ1V" and press **ENTER**
3. Press 'CH2' at the bottom.
4. Turn the RPG to change to "Φ2V" and press **ENTER**.
5. Press 'CH3' at the bottom.
6. Turn the RPG to change to "Φ3V" and press **ENTER**.
7. Press 'V Scale' at the bottom.
8. Turn the RPG to change to "10" and press **ENTER**.
9. Press 'I Scale' at the bottom.
10. Turn the RPG to change to "5" and press **ENTER**.
11. Press 'Time Scale' at the bottom.
12. Turn the RPG to change to "2" and press **ENTER**.





3.3.4 Limitation

The limits for the AC Source 1-phase/3-phase output modes are set separately. For instance, the Vac Limit setting will use the settings of the 1-phase mode when changing from the 3-phase mode.

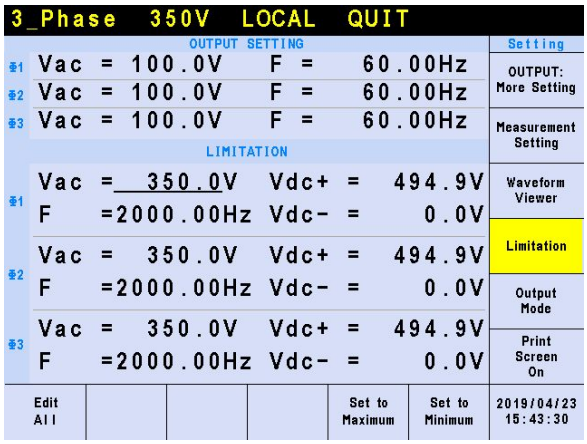
3.3.4.1 Vac Limit

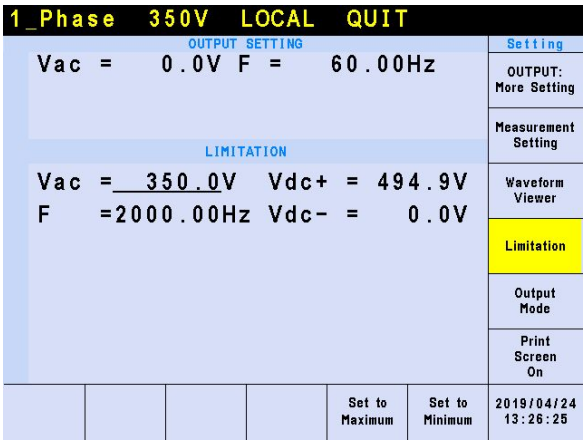
Vac Limit sets the Vac value in MAIN PAGE (3_Phase Mode/1_Phase Mode). Press 'Limitation' on the right in MAIN PAGE (3_Phase Mode/1_Phase Mode) to set the Vac Limit.

Press 'Edit' at the bottom to set the limitation for the 3-phase output voltage to "Each" or "All".

The procedure to set Vac Limit = 350V in 1_Phase Mode /3_Phase Mode is described below:

1. Move the cursor to the “Vac =” command line.
2. Press [3], [5], [0] and [ENTER] to change the value to “350.0”.





Notice

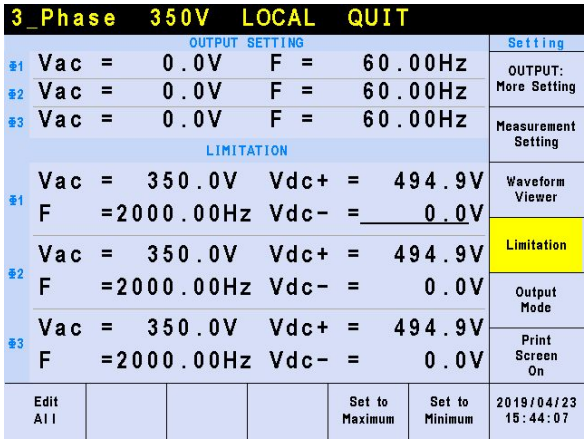
The Vac Limit *setting* is not restricted by the range; however, the Vac in MAIN PAGE is restricted by the range. For example, assuming the range is 175V, even though Vac Limit = 350V, the maximum Vac setting is 175V.

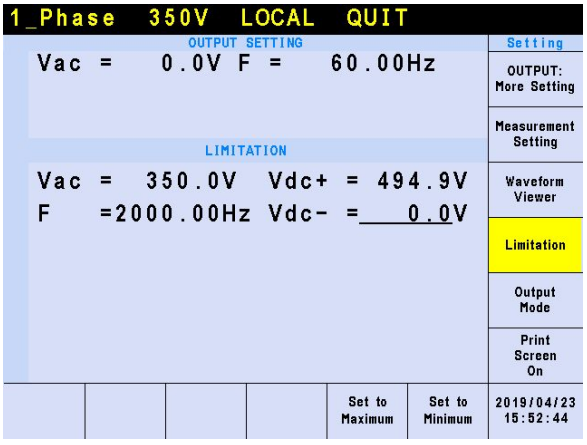
3.3.4.2 Vdc Limit (+), Vdc Limit (-)

Vdc Limit (+) and Vdc Limit (-) restrict the Vdc settings in MAIN PAGE (3_Phase Mode/1_Phase Mode). These two items can be set in the Limitation function (see 3.3.4). The Vdc setting can exceed the Vdc Limit (+) but cannot be less than the Vdc Limit (-).

The procedure for setting Vdc (+) = 494.9V, Vdc (-) = 0V in 1_Phase Mode /3_Phase Mode is described below:

1. Move the cursor to the “Vdc (+) =” command line.
2. Press [4], [9], [4], [.], [9] and [ENTER] to change the value to “494.9”.
3. Move the cursor to the “Vdc (-) =” command line.
4. Press [0] and [ENTER] to change the value to “0.0”.





Notice

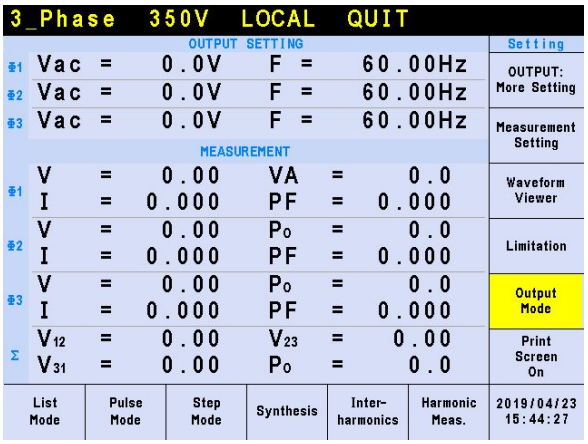
1. The Vdc Limit *setting* is not restricted by range; however, the Vdc in MAIN PAGE is restricted by the range. For example, assuming the

range is 175V, even though Vdc Limit=494.9V, the maximum Vdc setting is 247.5V.

2. The Vdc value setting should be restricted to the range. Damage to the equipment/UUT may occur if the output polarity is reversed, especially the load polarity.

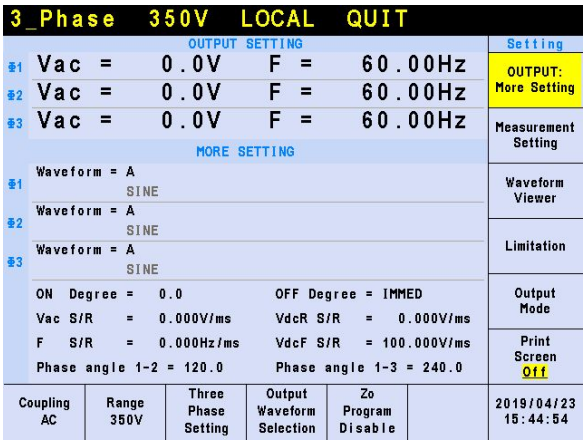
3.3.5 Output Mode

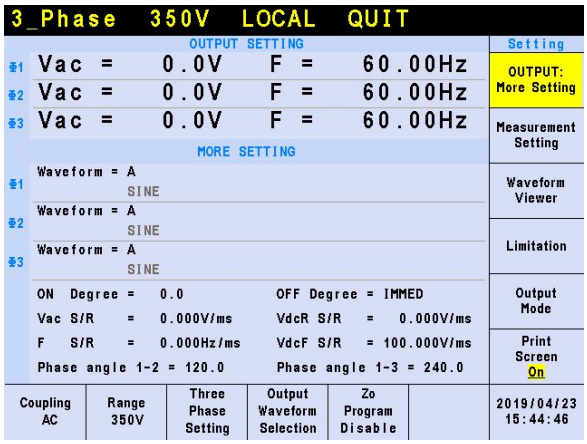
In Output Mode, there are List Mode, Pulse Mode, Step Mode, Synthesis, Inter-harmonics, and Harmonic Measurement functions for selection. See Chapter 5 for detailed description of mode usage.

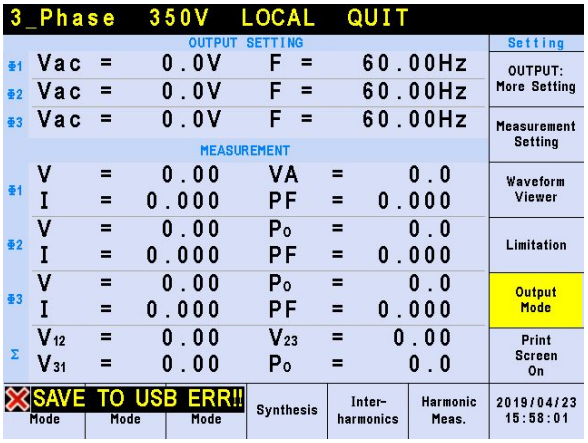


3.3.6 Print Screen

This function captures the LCD screen when it is on. Press Local/Remote FUNCTION key to capture the screen.







Notice The Local/Remote cannot capture the screen when the AC Source is in Remote mode as it is controlled by remote device. The Local/Remote key can only release the remote control function at this time.

3.4 CONFIG Function Key

Press the **CONFIG** **FUNCTION** key shown below to enter into the CONFIG function. (3_Phase Mode/1_Phase Mode).

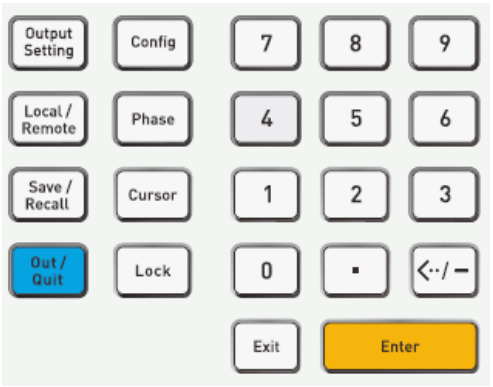
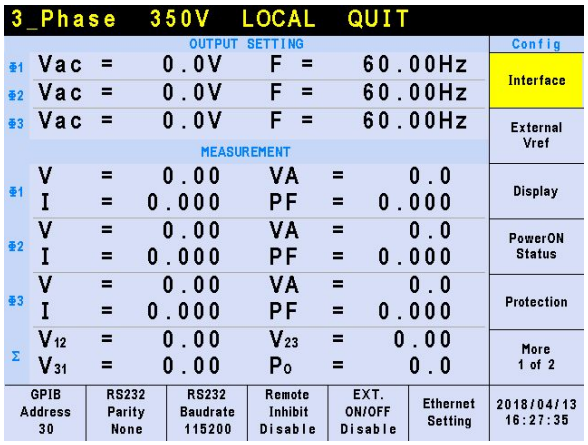
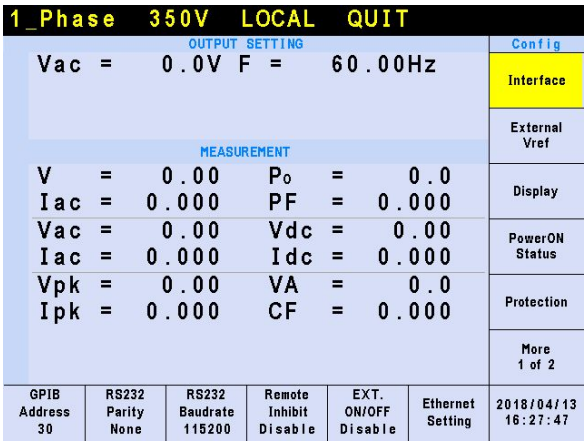


Figure 3-5 FUNCTION Keys



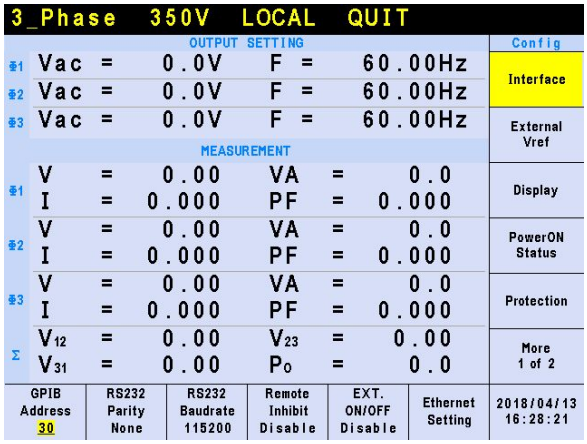


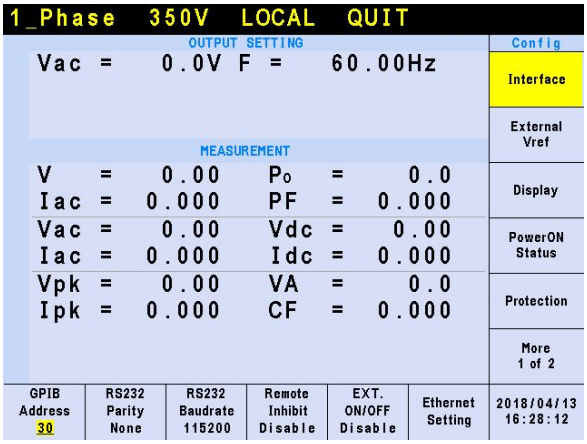
3.4.1 Interface

3.4.1.1 GPIB Address, RS-232C Parity/Baudrate

The AC Source has a remote operation mode that can be activated by the CONFIG function (3_Phase Mode/1_Phase Mode). Set the GPIB address to 30 before conducting remote operation in 1_Phase Mode /3_Phase Mode.

1. Press 'GPIB address' at the bottom.
2. Turn the RPG to change the address and press **ENTER** to set address 30.

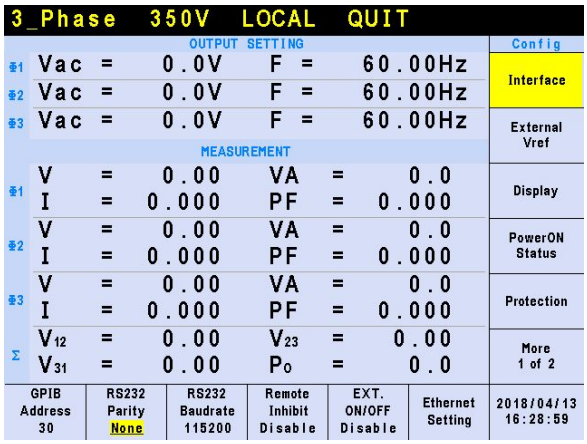


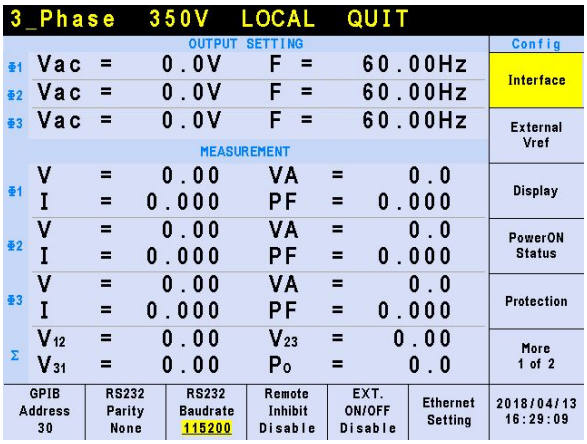


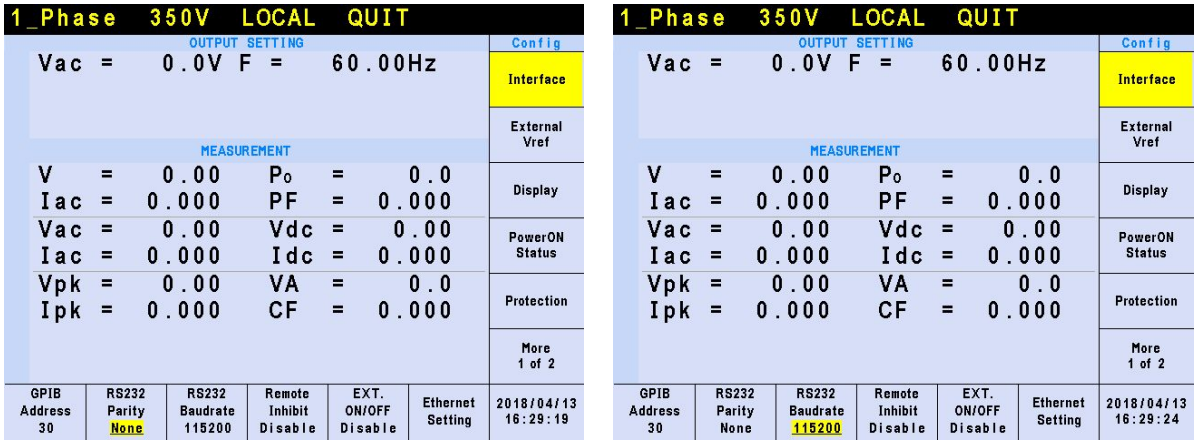
Notice The address range is from 1 to 30.

The AC Source uses the RS-232C bus to provide remote operation. Follow the steps below to set the communication protocol. Set Parity=None and Baudrate =115200 in 1_Phase Mode /3_Phase Mode as described below:

1. Press 'RS232 Parity' at the bottom.
2. Turn the RPG to select None and press **ENTER**.
3. Press 'RS232 Baudrate' at the bottom.
4. Turn the RPG to "115200" and press **ENTER**.







Notice The baudrate selections are 9600/19200/38400/57600/115200 and the selections for parity are EVEN/ODD/NONE.

3.4.1.2 Remote Inhibit, EXT. ON/OFF

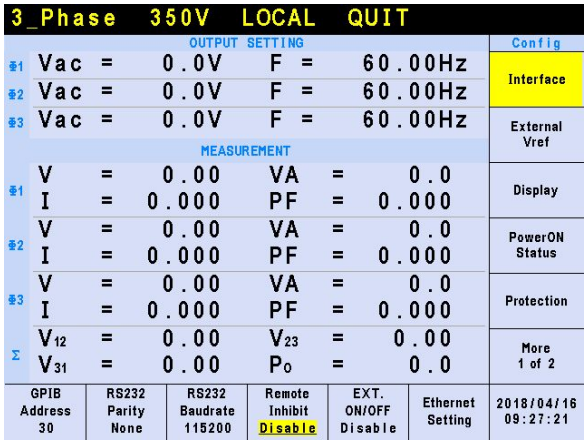
The output of the AC Source can be inhibited by an external signal or manual trigger. The output signal of the remote inhibit (remote control) is received from the TTL terminal on the rear panel (see *Appendix A*.) Remote Inhibit and EXT. ON/OFF are set by the CONFIG function (3_Phase Mode/1_Phase Mode). There are two remote inhibit output states: Enable and Disable.

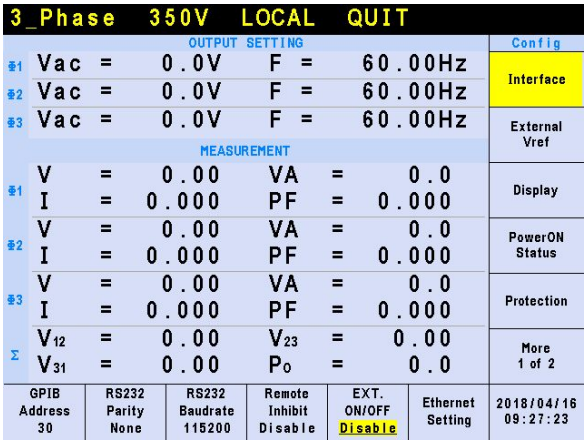
Remote Inhibit: When the Remote Inhibit is enabled on the AC Source and the Remote Inhibit signal is LOW, the AC Source will disable the output. The AC Source keeps the output disabled even when the Remote Inhibit signal goes HIGH. In order to re-enable the output, the user must press **OUT/QUIT**.

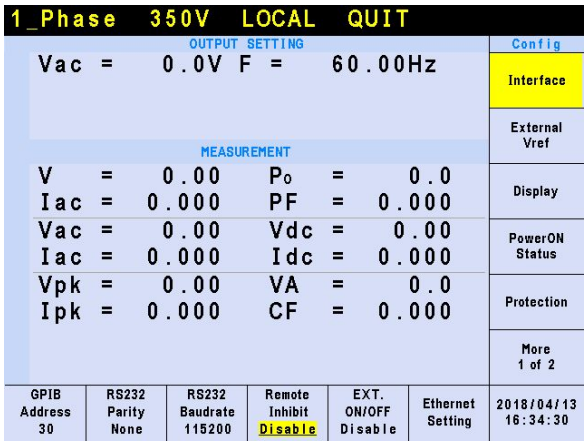
EXT. ON/OFF: When the EXT. ON/OFF is enabled on the AC Source and the EXT. ON/OFF signal is LOW the AC Source will disable the output. The AC Source will re-enable the output when the EXT. ON/OFF signal goes HIGH.

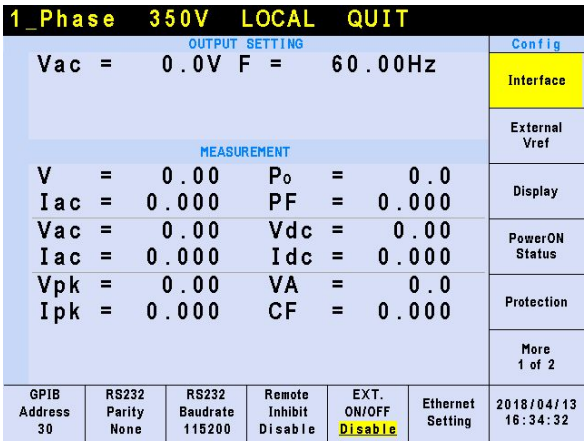
The procedure for setting Remote Inhibit/EXT. ON/OFF to disable in1_Phase Mode /3_Phase Mode is described below:

1. Press Remote Inhibit/EXT. ON/OFF' at the bottom.
2. Turn the RPG to change to "Disable" and press **ENTER**.









Notice The output of the Remote Inhibit (Remote Control) transmits the TTL signals via a special I/O connector. See *Appendix A* for the TTL signal pin assignments.

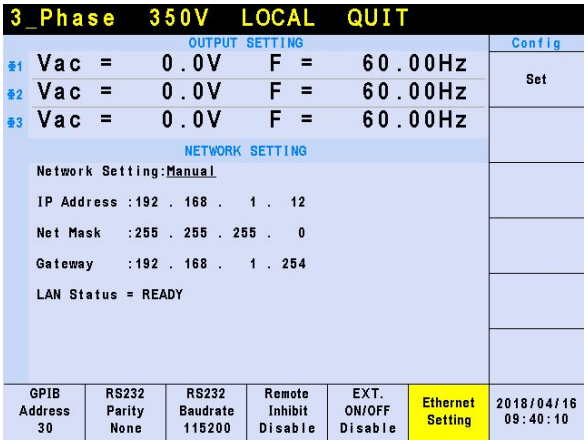
3.4.1.3 Ethernet Setting

The AC Source can be operated remotely through a network once the Ethernet Settings are complete.

Network Setting: Auto and Manual.

The procedure for setting Network Settings manually in 1_Phase Mode/3_Phase Mode is described below:

1. Press 'Ethernet Setting' at the bottom.
2. Move the cursor to "Network Setting:"
3. Turn the RPG to change to Manual and press **ENTER**.
4. Set the IP Address, Net Mask, and Gateway.



3.4.2 External Vref

The AC Source accepts analog control signals (simulated) from an external device to set its output (optional card is required) through the External Vref terminal socket on the rear panel. The External Vref and the Control Method can be set by the CONFIG function (3_Phase Mode/1_Phase Mode). External Vref has two coupled modes to indicate the output of the AC Source: Amplifier and Level. When using single phase Ext. Vref, the signal received by terminal pin Ext-V Φ2 is the main control signal. Refer to Appendix A for the pin assignment of the TTL terminal.

Amplifier: The output voltage (Vout) is composed of the voltage set in MAIN PAGE and the supplemental programmed voltage received externally. The external V reference voltage range is from -10 V to 10V. When Vac=0 and Vdc=0 in MAIN PAGE, the following formula can be used to calculate Vout:

Vout (dc) = Vref (dc) / 10 Vdc × 494.9 Vdc (range 350V)
Vout (dc) = Vref (dc) / 10 Vdc × 247.5 Vdc (range 175V)
or
Vout (ac) = Vref (ac) / 7.072 Vac × 350 Vac (range 350V)
Vout (ac) = Vref (ac) / 7.072 Vac × 175 Vac (range 175V)

Ex (1): Set Vout to 100Vdc:

1. When selecting the 350V range in the SETUP function, the applied external output voltage is V= 2.021Vdc, Vout = 100Vdc.
2. When selecting the 175V range in the SETUP function, the applied external output voltage is V= 4.040Vdc, Vout = 100Vdc.

Ex. (2): Set Vout to 100Vac:

1. When selecting the 350V range in the SETUP function, the applied external output voltage is V= 2.021Vac, Vout = 100Vac.
2. When selecting the 175V range in the SETUP function, the applied external output voltage is V= 4.040Vac, Vout = 100Vac.

Level: The linear proportional output of the RMS output voltage (Vout (ac)) programmed by the DC V reference. The Vreference range is from -10V to 10V. The following formula can be used to calculate Vout:

Vout (ac) = ｜Vref (dc)｜ / 10 Vdc × 350Vac (range 350V)

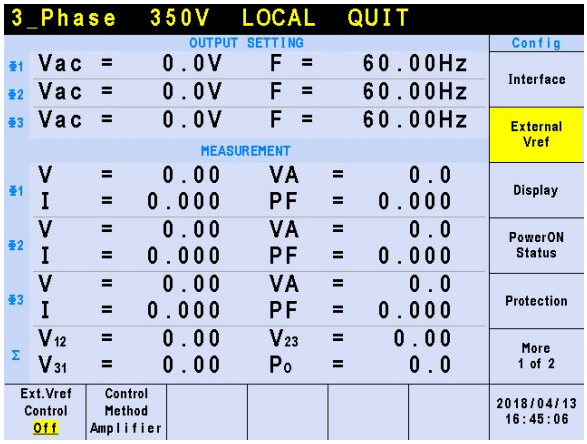
Vout (ac) = ｜Vref (dc)｜ / 10 Vdc × 175Vac (range 175V)

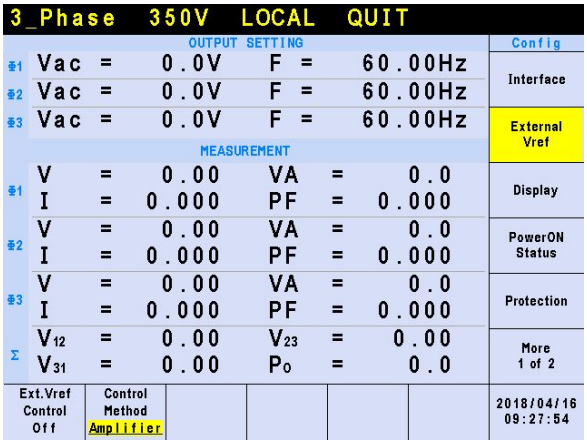
Ex. (1): Set Vout to 100Vac:

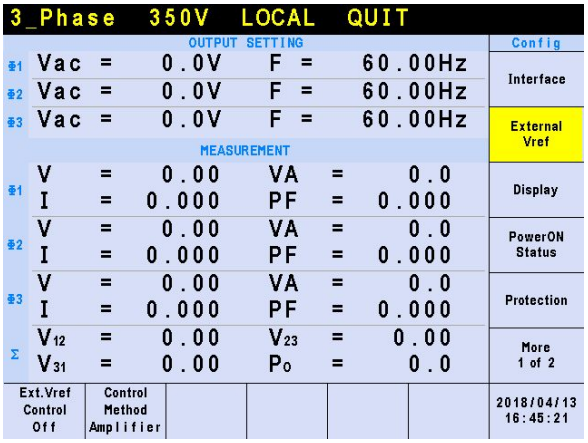
1. When selecting the 350V range in the SETUP function, the applied external output voltage is V= 2.857Vdc (or -2.857Vdc), Vout = 100Vac.
2. When selecting the 175V range in the SETUP function, the applied external output voltage is V= 5.714Vdc (or -5.714Vdc), Vout = 100Vac.

The setting of Ext. Vref Control = OFF, Control Method = Amplifier is described below:

1. Press 'Ext. Vref Control' at the bottom.
2. Turn the RPG to change ON to OFF and press **ENTER**.
3. Press 'Control Method' at the bottom.
4. Turn the RPG to select 'Amplifier' and press **ENTER**.







5. Press Exit to return to the Main screen. The output parameter F for the measurement frequency should be the same as the Ext.V input frequency.

Notice

When Ext. Vref Control = ON and Control Method = Level, the output voltage (Vout) can only be controlled by the level of the external DC programming voltage. The output voltage (Vout) can only be controlled from the front panel keys when Ext. Vref Control=OFF.

CAUTION

1. When Control Method = Amplifier and the Vref frequency exceeds 2000Hz, the AC Source could be damaged. This formula should be followed exactly – Vref (pk-pk, V) × F (Vref, Hz) < 10000 VHz.
2. The output may be distorted due to the bandwidth restriction of the AC Source, especially when the external V reference has too many high frequency components.
3. If the input voltage range exceeds ±10V (exceeding ±12V could damage the AC Source), the AC Source will trigger Over Voltage Protection (OVP).

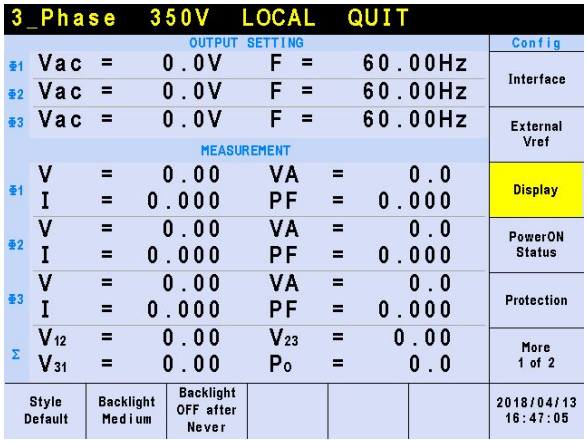
3.4.3 Display

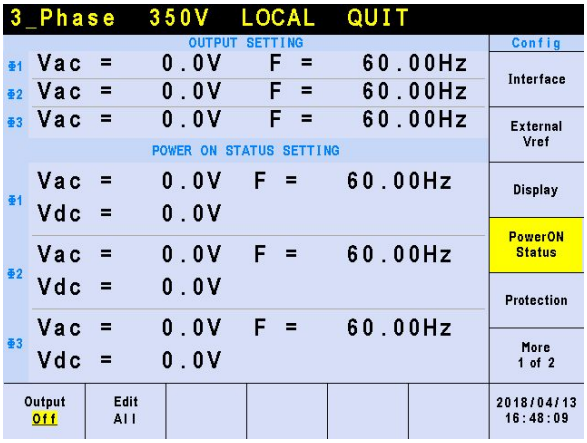
The brightness of the backlight and power save mode settings of the LCD can be set in the CONFIG function. (3_Phase Mode/1_Phase Mode).

Style: Default.
Backlight: Low, Medium, and High.
Backlight OFF after: Never, 1 min, 3 mins, 5 mins, 10 mins, 30 mins, 1 hour, and 3 hours.

The procedure for setting Backlight = Medium, Backlight OFF after = Never in 1_Phase Mode /3_Phase Mode is listed below:

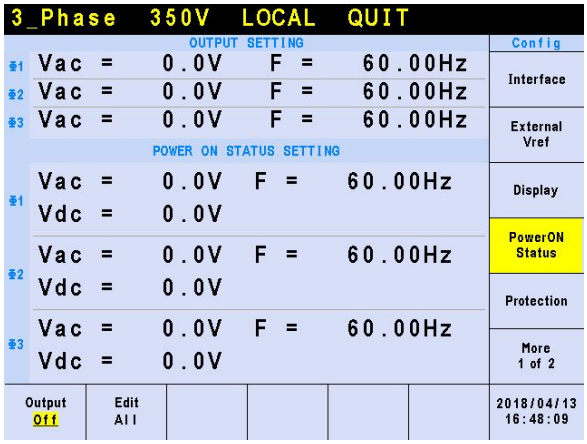
1. Press ‘Backlight’ at the bottom.
2. Turn the RPG to Medium and press **ENTER**.
3. Press ‘Backlight OFF after’ at the bottom.
4. Turn the RPG to select Never and press **ENTER**.

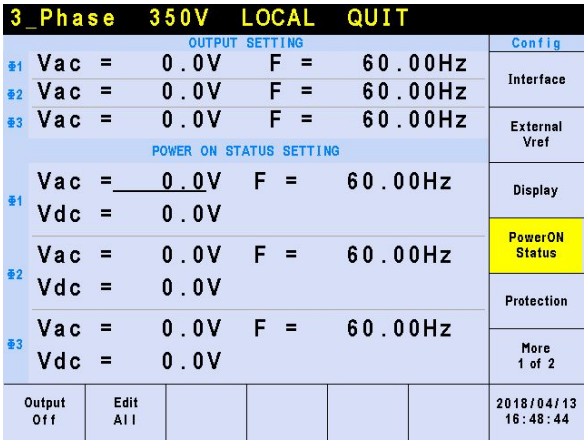


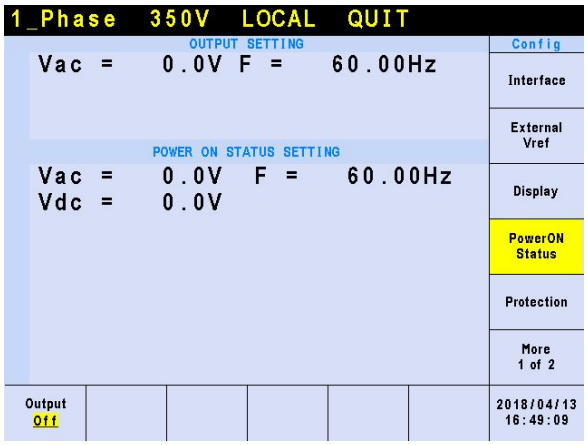


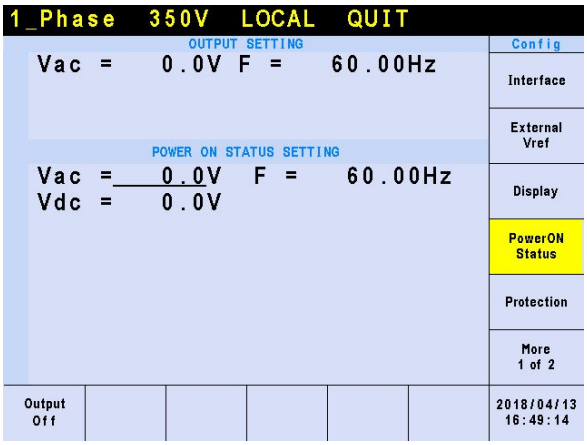
3.4.4 Power ON Status

The output state of the AC Source at power-on can be set using the Power ON Status in the CONFIG function (3_Phase Mode/1_Phase Mode). Once it is set, save the data before turning off the source. With the output set to OFF, the AC Source will not enable the output voltage after it is powered on. With it set to ON, the AC Source will enable the output by default after it is powered on.









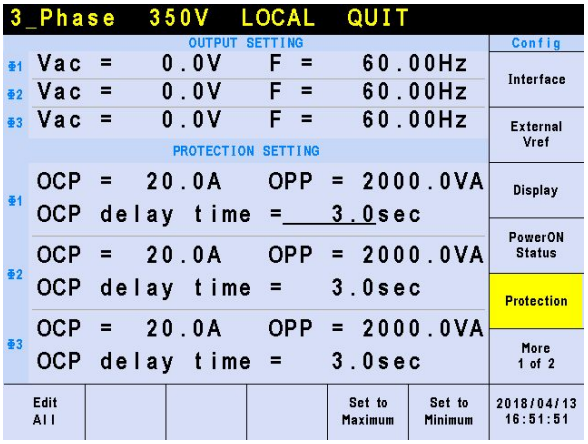
3.4.5 Protection

The AC Source's Protection for the 1-phase and 3-phase output modes is set separately. For instance, the Protection will apply the 1-phase settings when switching from 3-phase to 1-phase mode rather than the Protection settings of any phase under 3-phase mode.

The Protection in the CONFIG function (3_Phase Mode/1_Phase Mode) sets the limit of the output RMS current (OCP), output power (OPP), and the Delay Time for triggering the current protection. The limit in this command is to protect the program instead of the hardware.

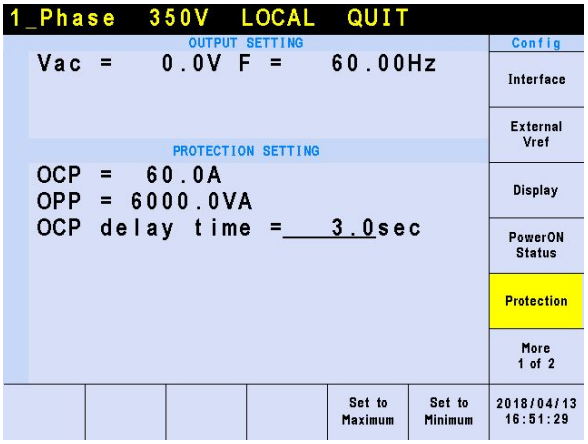
The procedure for setting the current limit = 20A (15A for 61508 and 10A for 61507), power limit = 2000VA (1500VA for 61508 and 1000VA for 61507), and delay time for trigger current protection = 3 sec. for 61509 in 3_Phase Mode is shown below:

1. Move the cursor to the "OCP =" command line.
2. Press **2**, **0** and **ENTER** to change the value to "20.0".
3. Move the cursor to the "OPP =" command line.
4. Press **2**, **0**, **0**, **0**, **ENTER** to change the value to "2000.0".
5. Move the cursor to the "Delay time =" command line.
6. Press **3**, **ENTER** to change the value to "3.0".



The procedure for setting the current limit = 60A (45A for 61508, 30A for 61507), power limit = 6000VA (4500VA for 61508, 3000VA for 61507), and delay time for trigger current protection = 3 sec. for 61509 in 1_Phase Mode is shown below:

1. Move the cursor to the “OCP =” command line.
2. Press **6**, **0** and **ENTER** to change the value to “60.0”.
3. Move the cursor to the “OPP =” command line.
4. Press **6**, **0**, **0**, **0**, **ENTER** to change the value to “6000.0”.
5. The cursor moves to the “Delay time =” command line automatically.
6. Press **3**, **ENTER** to change the value to “3.0”.



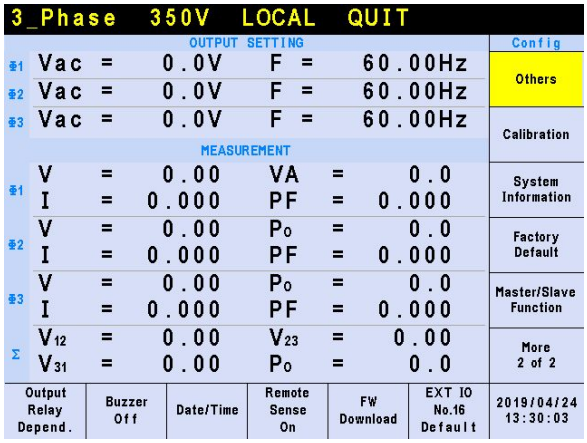
Notice

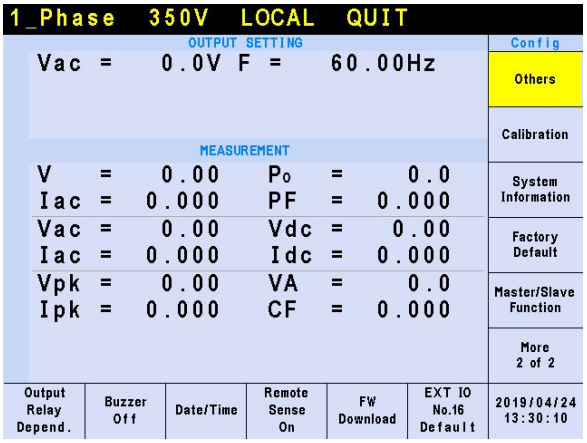
1. When “OCP = 0.0 A”, the output current limit is set to the specification limit.
2. The delay time setting for trigger current protection is only valid when the current is within the specification. When the output is over the specification, the time delay set between 0.1 and 1s for triggering current protection is valid. However, if the current is over the output specification and the protection delay time is set to more than 1s, then 1s will be the maximum delay protection time. The resolution is 0.1s.
3. The protection point varies by the measurement error, thus it may act before reaching the protection point set.

3.4.6 Others

Press 'MORE' on the right in the CONFIG function (3_Phase Mode/1_Phase Mode) to go to the second page and press 'Others' on the right to set the Output Relay, Buzzer, and Date/Time.

Output Relay: Depend and Always ON.
Buzzer: ON and OFF.
Date/Time: Year, Month, Day, Hour, Minute, and Second.
Remote sense: On, Off.
FW Download: E_FPGA, E_HOST, E_WAVE, and C_ANALOG.
EXT IO No.16: Default , Phase.

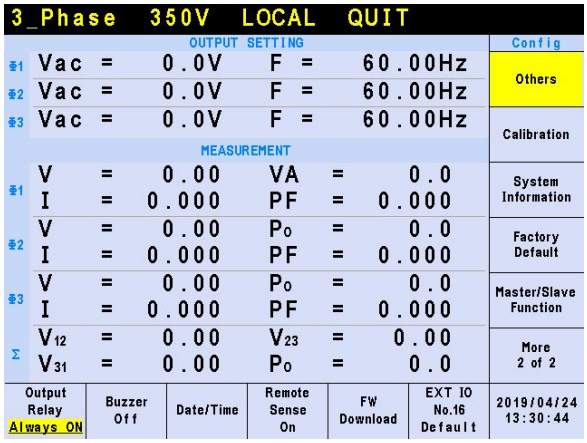


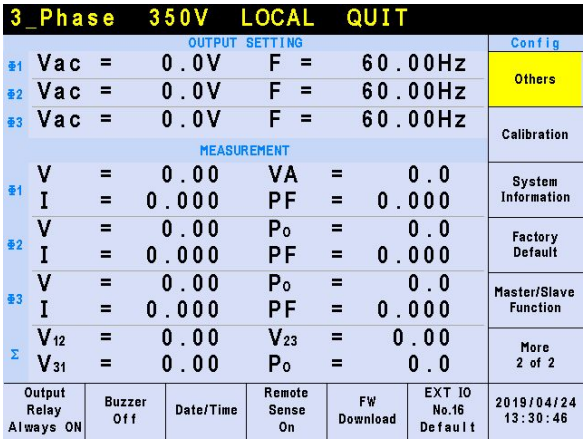


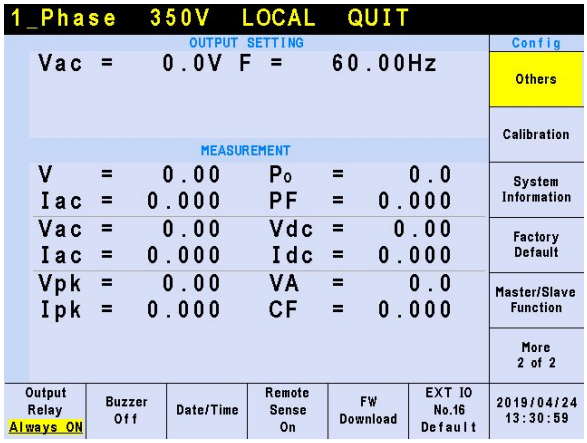
The output circuit on the AC Source has a relay to connect to the load. When the output relay is "Always ON", it indicates the output relay is closed (connected) even if the AC Source output state is in QUIT mode. When the output relay is "Depend." the output relay is closed (connected) only when the output state is in OUT mode. If the output state is in QUIT mode, the output relay will be opened (disconnected.) The Output relay function can be set in the SETUP function.

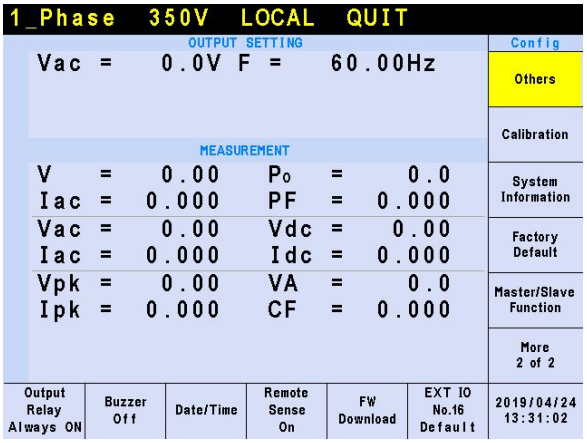
The procedure for setting the output relay to Always ON in 1_Phase Mode /3_Phase Mode is described below:

1. Press 'Output Relay' at the bottom.
2. Turn the RPG to set the output relay to 'Always ON' and press **ENTER**. When the output relay is working, the AC Source will click once.







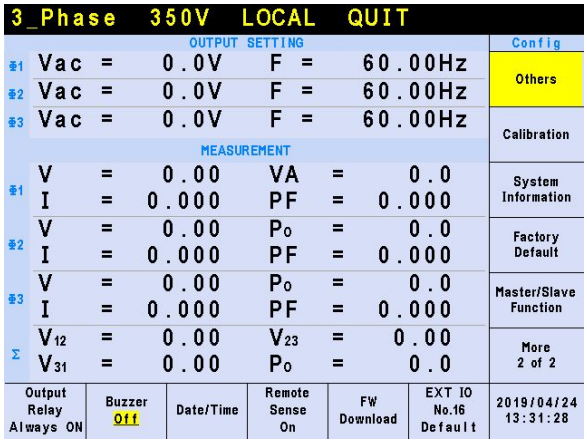


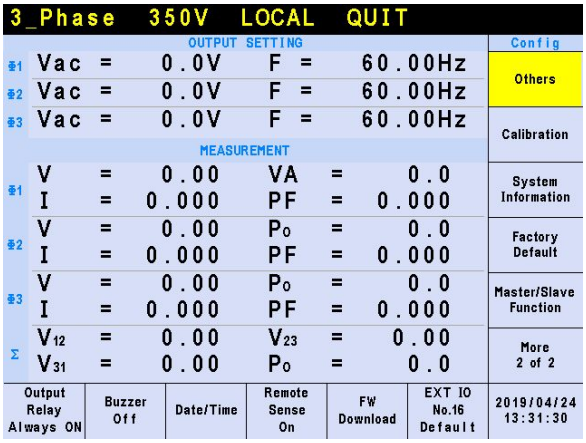
CAUTION Check if the AC Source is outputting voltage before powering it off. To ensure the safety of the hardware, DO NOT power off the AC Source when it is still outputting a voltage.

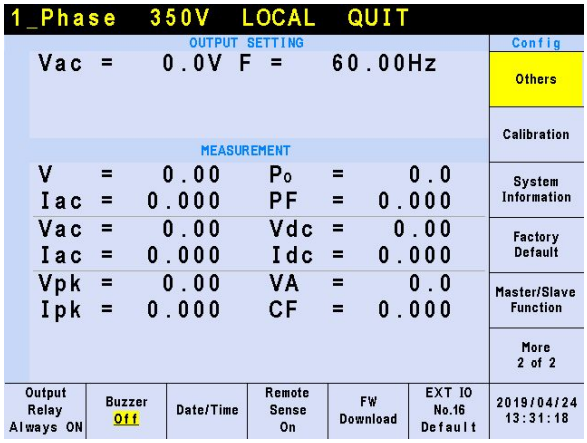
The AC Source buzzer beeps when the panel keys are pressed or the RPG rotary is turned. If desired, the buzzer may be turned off.

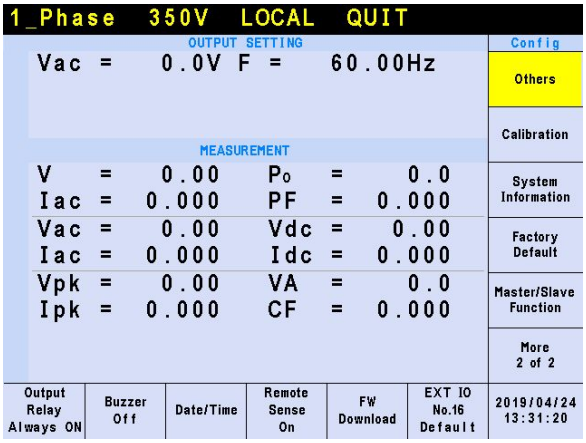
The following procedure describes the procedure for turning off the buzzer in 1_Phase Mode /3_Phase Mode:

1. Press ‘Buzzer’ at the bottom.
2. Turn the RPG to change ON to OFF and press **ENTER**.







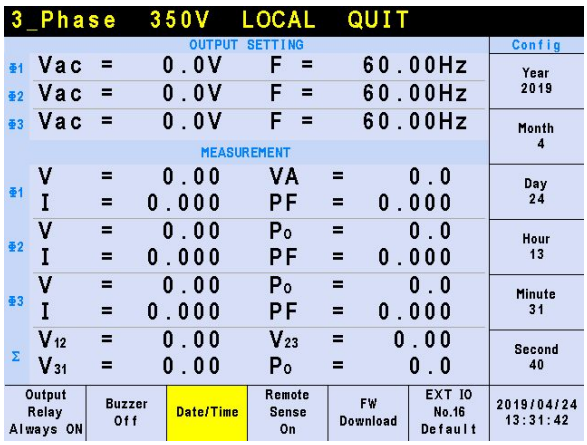


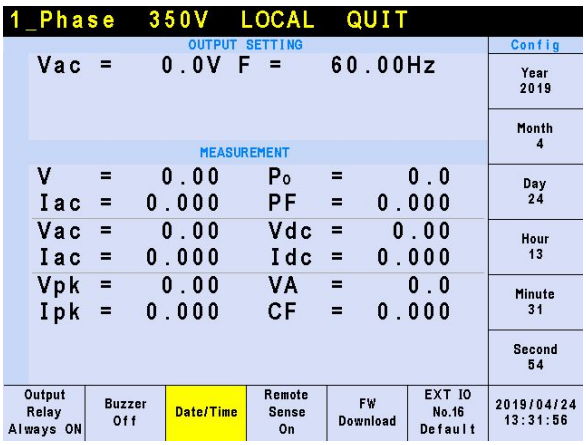
Set the time and date of the AC Source.

Date/Time: Year, Month, Day, Hour, Minute, Second.

Follow the procedure below to set the time and date in 1_Phase Mode /3_Phase Mode:

1. Press 'Date/Time' at the bottom.
2. Select the item (Year/Month/Day/Hour/Minute/Second) to be set and press the button on the right.
3. Use the RPG to change the selected item and press **ENTER**.



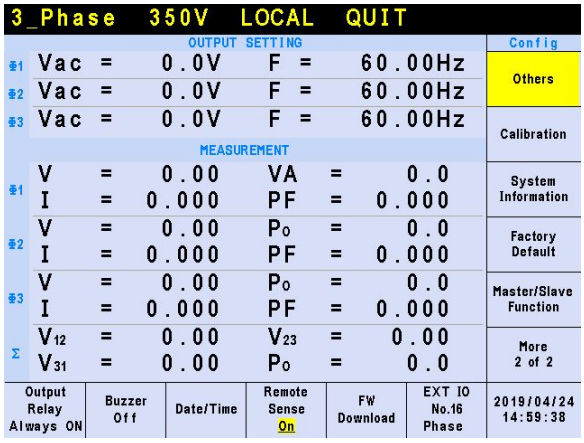


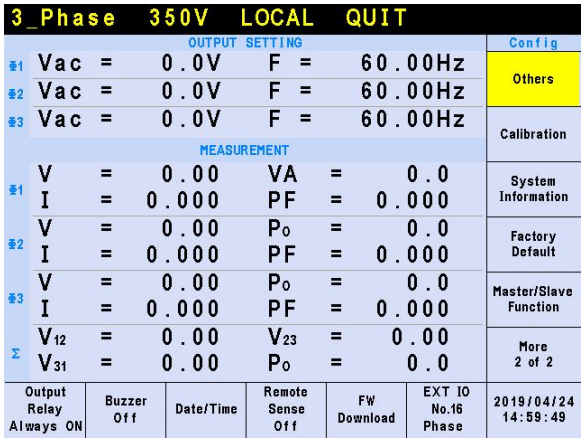
The AC source has remote compensation function (factory default is on). For some particular tests, the remote compensation function can be disabled if not required.

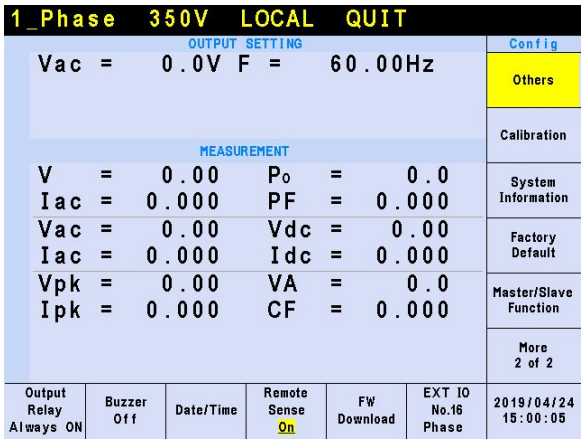
Remote sense: on, off

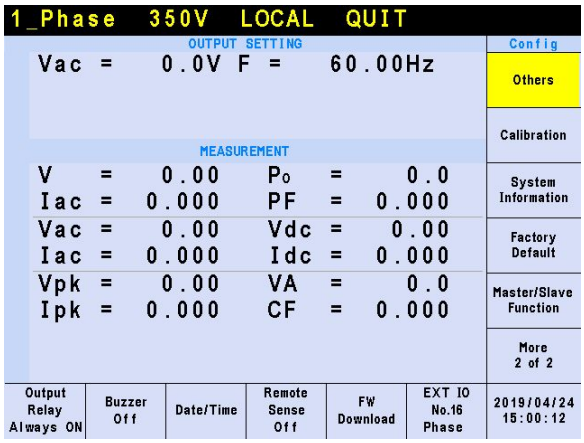
Set voltage compensation in single/3-phase mode as described below.

1. Press the key that maps to Remote sense.
2. Use RPG to change the selected item and press **ENTER**.



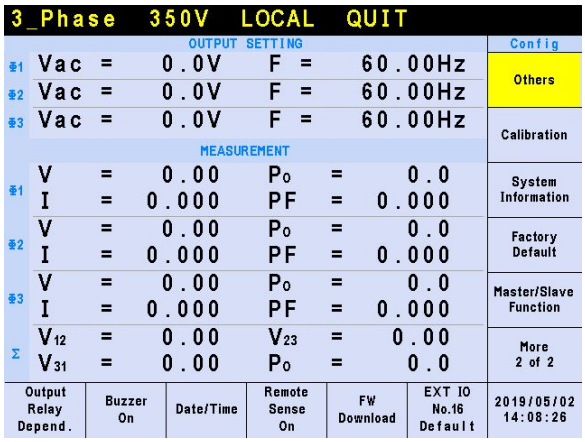






The AC source provides this selection for Chroma service center to upgrade the device when a new version of firmware is released. (This item must be preformed by Chroma's engineer.)

FW Download:

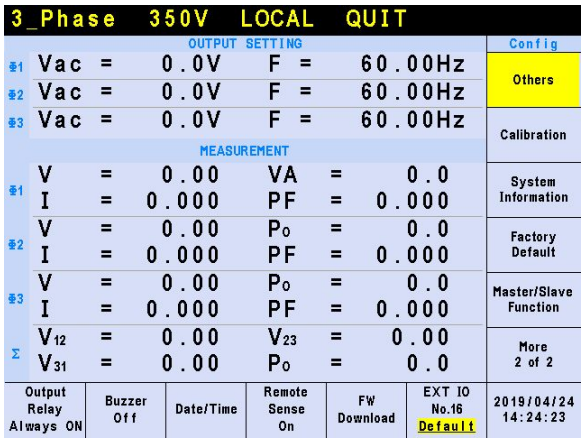


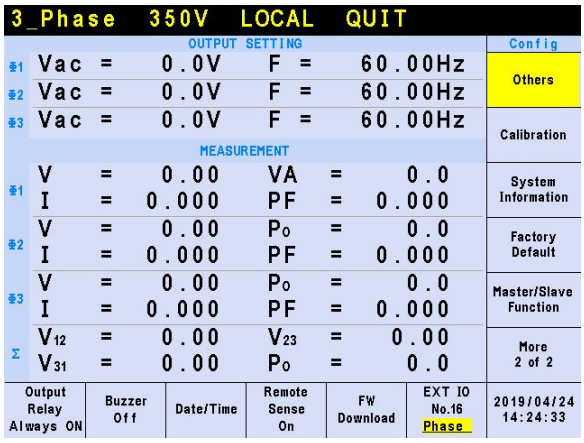
As the AC source has 3_Phase/1_Phase output selection and the EXT IO Pin.16 has 1 set of linkage control output signal mapping to the work status of 3_Phase/1_Phase, when Phase is selected, the pin output will be logic High leve in 3_Phase output mode and logic Low level in 1_Phase output mode.

EXT IO No.16: Default, Phase.

Set the EXT IO No.16 pin working mode as described below.

1. Press the key that maps to EXT IO No.16.
2. Use RPG to change the selected item to Phase and press **ENTER**.





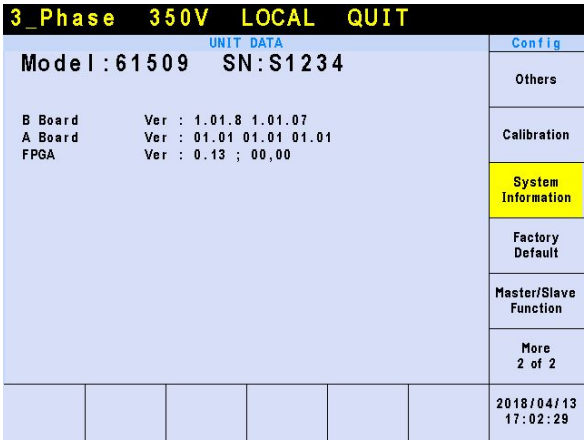
Notice When the Ext. IO output current is a voltage signal, the drive capability is 10mA.

3.4.7 Calibration

For detailed calibration procedures, refer to Chapter 4.

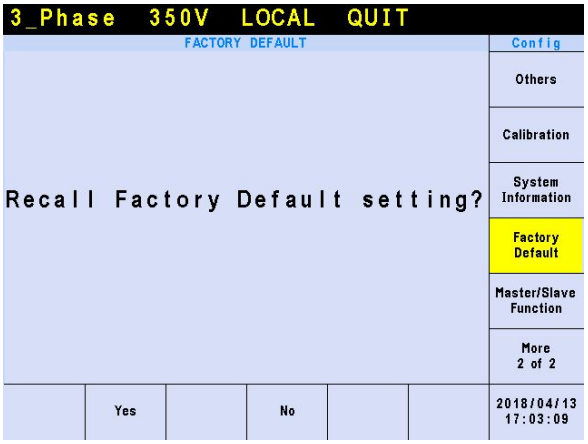
3.4.8 System Information

Press 'MORE' on the right in the CONFIG function (3_Phase Mode/1_Phase Mode) to go to the next page. Press 'System Information' on the right to display the system information of the AC Source.



3.4.9 Factory Default

Press ‘MORE’ on the right in the CONFIG function (3_Phase Mode/1_Phase Mode) to go to the next page. Press ‘Factory Default’ on the right and ‘Yes’ at the bottom to return to the factory default.



3.4.10 Master/Slave Function

When the 61507/61508/61509 AC Sources are required to be paralleled for use, press ‘MORE’ on the right in the CONFIG function (3_Phase Mode/1_Phase Mode) to go to the next page, and then press Master/Slave Function on the right to turn on the parallel function. See Chapter 6 for detailed operating procedure.

3.5 PHASE Function Key

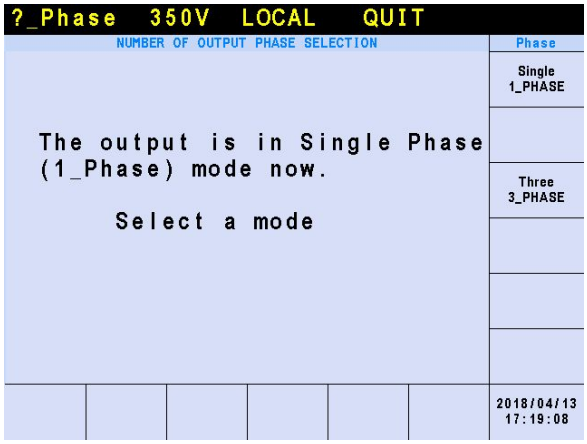
Press the **PHASE** function key (shown in Figure 3-5) to switch the 3_Phase Mode/1_Phase Mode.

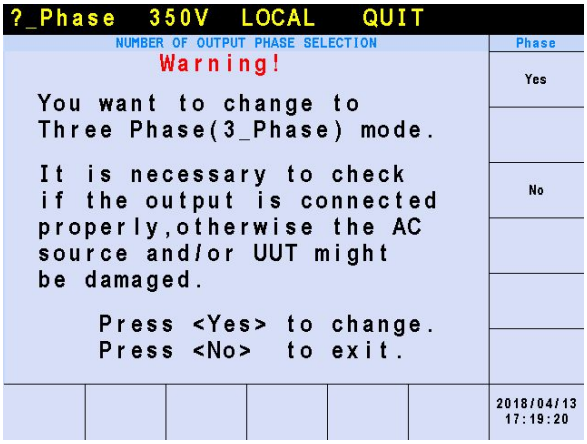
3.5.1 3_Phase Mode

The AC Source can be set to 3-phase AC power by pressing the **PHASE** function key to switch to 3_Phase Mode when it is required.

The procedure for setting the AC Source to 3-phase mode is described below:

1. Press the **PHASE** function key.
2. Press ‘Three 3_PHASE’ on the right.
3. Press ‘Yes’ on the right to confirm the change.



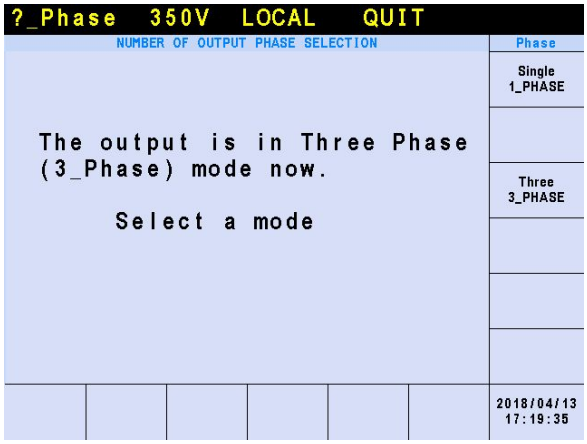


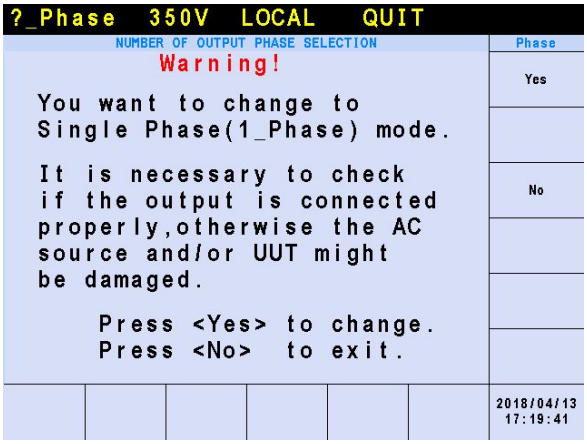
3.5.2 1_Phase Mode

When the 3-phase power of the AC Source is not enough to drive the load, the 3-phase output can be paralleled to one of the phases. Pressing the **PHASE** function key changes the AC Source setting from 3-phase to 1-phase.

The procedure for setting the AC Source to 1-phase mode is described below:

1. Press the **PHASE** function key.
2. Press 'Single 1_PHASE' on the right.
3. Press 'Yes' on the right to confirm the change.





Notice

When switching between 1-phase and 3-phase mode, the set output value will be reset to zero to avoid damaging the Unit Under Test (UUT). Switch phase should be done when the output is quit. It could cause the AC source or UUT to be damaged when switching phase during output.

3.6 CURSOR Function Key

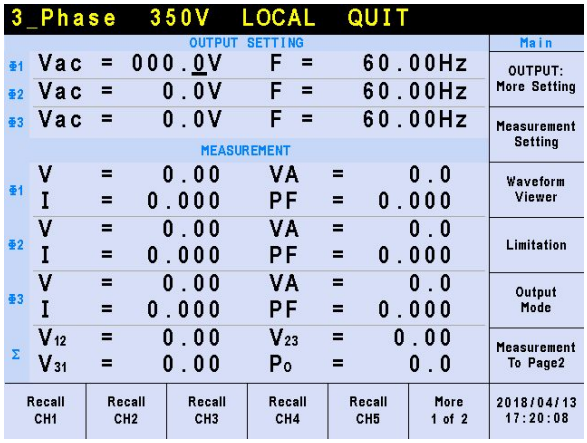
Press the **CURSOR** function key (shown in Figure 3-5) to set the value of a single digit.

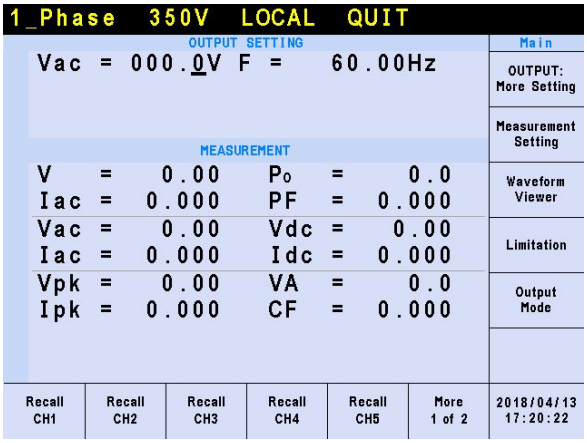
The RPG can be used to set the hundred, decade, figure, and 1st place after the decimal point

digits for voltage or frequency to save time in inputting the values.

The procedure for setting the 1st place after the decimal point for Vac output voltage in 1_Phase Mode /3_Phase Mode is described below:

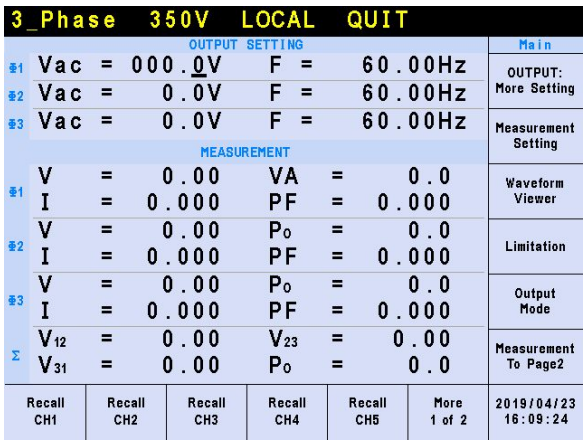
1. Move the cursor to the “Vac =” command line.
2. Press the **CURSOR** function key.
3. The cursor will shorten to the one digit range.
4. Move the cursor to the 1st digit after decimal point and use the RPG to change the value.
5. Press the **CURSOR** function key again to exit.

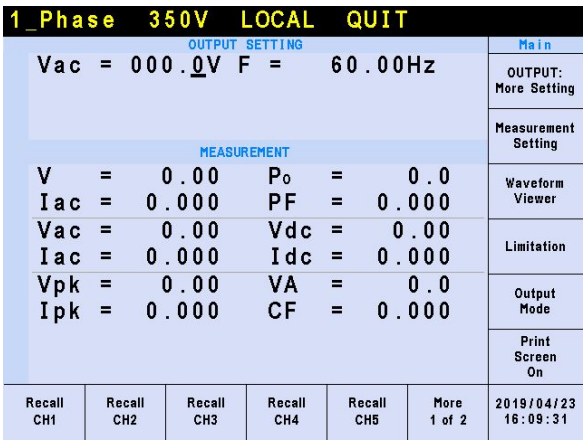




3.7 LOCK Function Key

Press the **LOCK** function key (shown in Figure 3-5) to lock the function.
Press this key to lock all functions on the panel and make all keys invalid. Press **LOCK** for 3-3.5 seconds to unlock it.





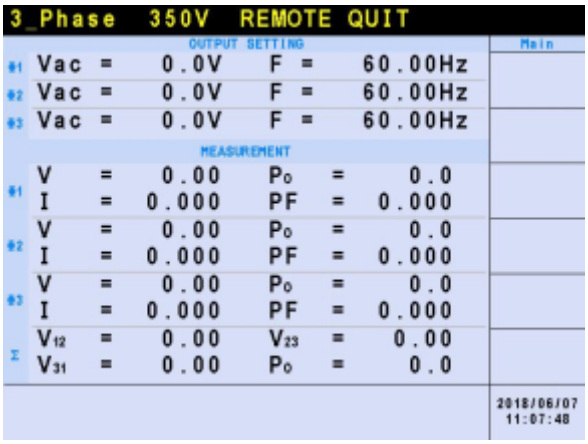
3.8 OUTPUT Function Key

Refer to section 3.3.1 for a detailed description of the OUTPUT function key.

3.9 LOCAL/REMOTE Function Key

Press the **LOCAL/REMOTE** function key (shown in Figure 3-5) to switch to remote control.

When the AC Source is in the REMOTE state and controlled by an external device, press this key to cancel the REMOTE state and return to LOCAL control.

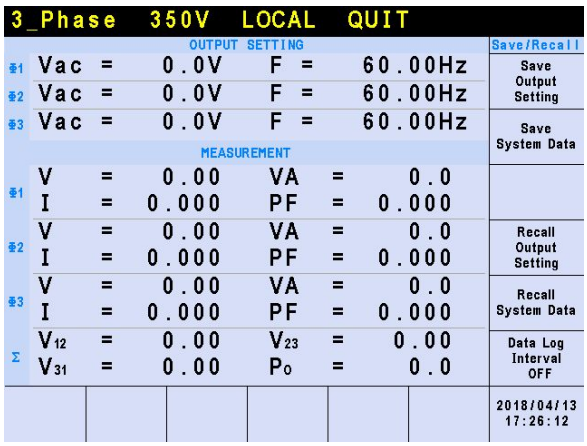


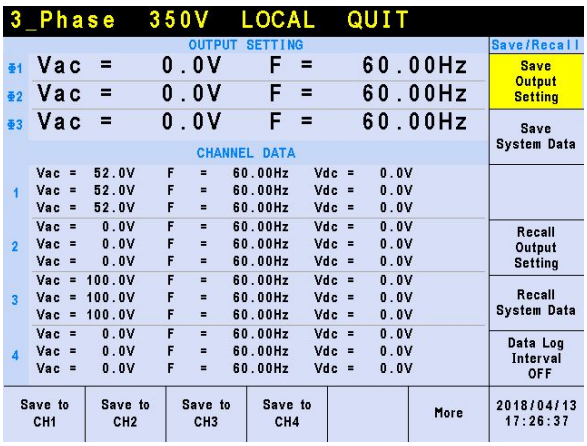
3.10 SAVE/RECALL Function Key

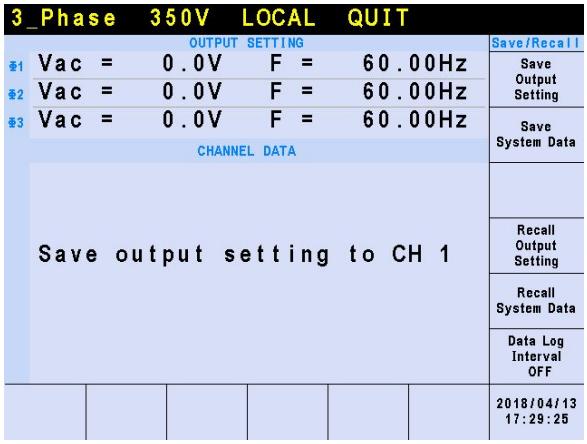
The AC Source has two modes to save and recall the output settings or system information as described in section 3.10.1 and 3.10.2. Press the **SAVE/RECALL** function key can access the save and recall functions.

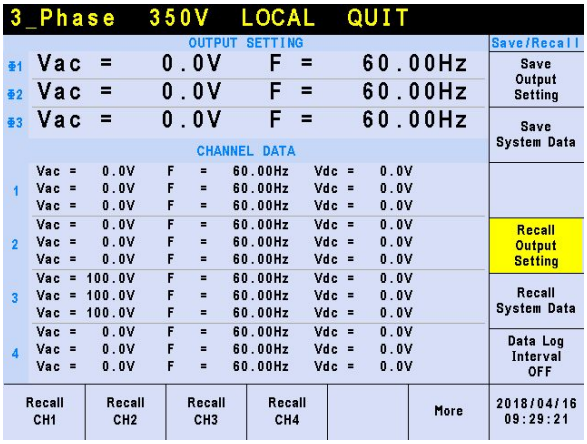
3.10.1 Save/Recall Output Setting

The AC Source has 10 channels to save the frequently used Vac, F, and Vdc for recall. For example, enter the setting and save it to CH1 memory in MAIN PAGE (3_Phase Mode) (see 3.3.)







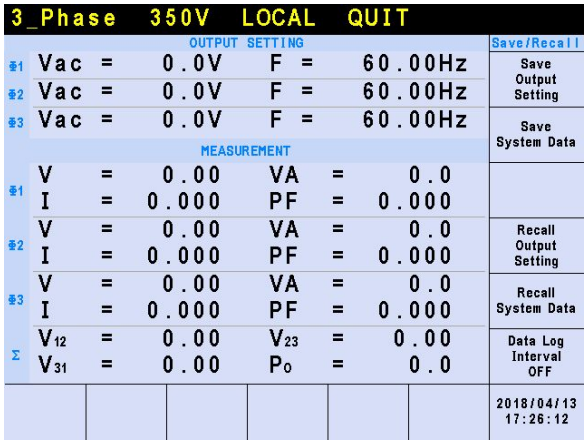


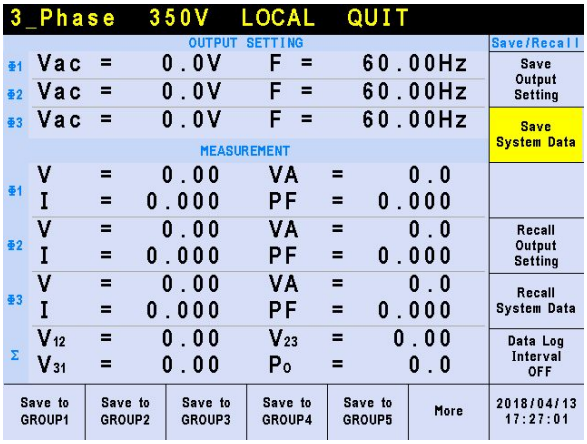
Notice

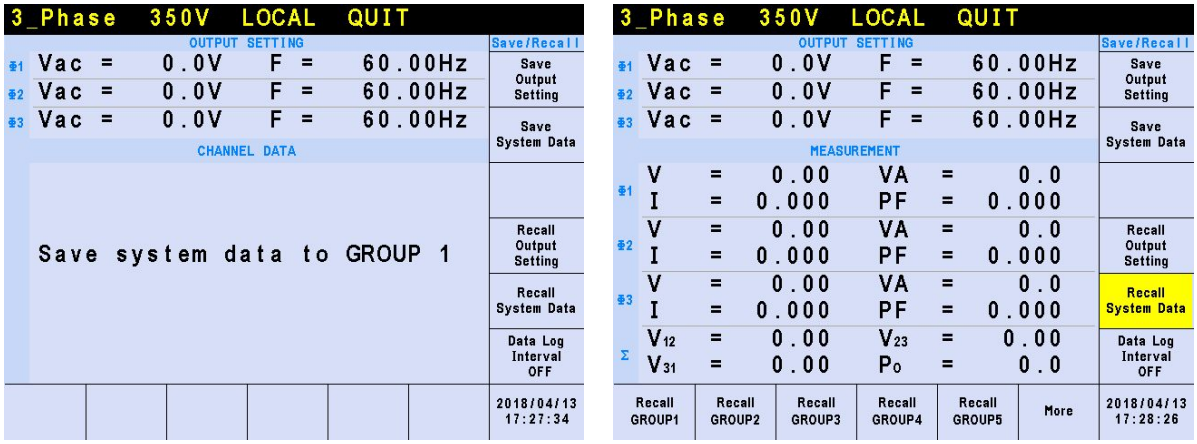
1. Only the save and recall settings are set in MAIN PAGE. Other parameters are ignored.
2. In different output coupling modes (see 3.3.1.1) the missing settings will be adjusted to Vac=0V, F=60Hz, Vdc=0V automatically. For example, when executing save in DC output mode Vac=0V, F=60Hz, Vdc is the setting in MAIN PAGE.

3.10.2 Save/Recall System Data

The AC Source has 10 groups of memory to save and recall system data. System data consists of all the parameters in the function keys such as MAIN PAGE (see 3.3) and CONFIG (see 3.4). Press **SAVE/RECALL** in MAIN PAGE (3_Phase Mode) (see 3.3) and press the LCD at the bottom to save the system data as shown below.







Notice The AC Source has 11 groups of memory: GROUP 0 and GROUPs 1-10. GROUP 0 will save the power-on default. The data saved in GROUP 0 will be recalled automatically and loaded when the AC Source powers on again. The data saved in GROUPs 1-10 need to be loaded manually.

3.11 Protection

The AC Source has both software and hardware protection. When protection occurs the AC Source will stop the output and disconnect the output relay. The display shows that the source is in protection mode. To return to normal output after the protection is triggered for recovery, remove the error load and press **ENTER** to release protection for normal operation. To return to normal output after the protection is triggered for latch, remove the error load and press ⏻ to restart and release protection for normal operation.

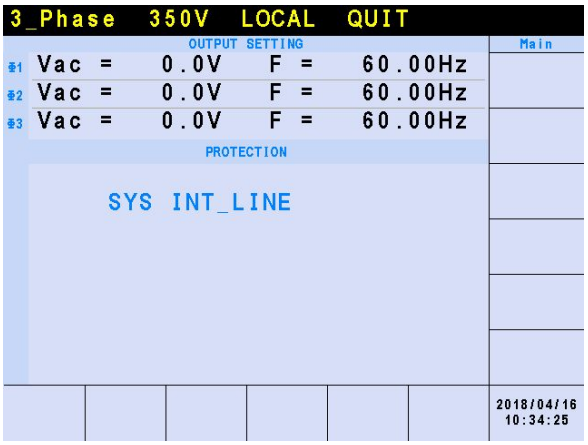
The table below lists the software protection:

Protection	Description
SYS OCP(1/2/3)	Occurs when the output current exceeds the limit or specification.
SYS OPP(1/2/3)	Occurs when the output power exceeds specification.
SYS OVP(1/2/3)	Occurs when the output voltage exceeds the limit of each range.
Remote - Inhibit	Executes remote inhibit.
SYS SENSE FAULT	The REMOTE SENSE is not connected or the voltage compensation is over 10V.
SYS SELF-TEST NG(1/2/3)	The power on self-test has output error.

The table below lists the hardware protection:

Protection	Description
(Φ1/2/3) AD_FAN FAIL	AC/DC stage fan failure protection.
(Φ1/2/3) DA_FAN FAIL	DC/AC stage fan failure protection.
(Φ1/2/3) AD_PFC_OVP	The internal AD power stage protection indicating the output voltage is over the specification.
(Φ1/2/3) AD_PFC_UVP	The internal AD power stage protection indicating the output voltage is under the specification.
(Φ1/2/3) DD_VDC1_OVP	The internal DD power stage protection indicating the output

	voltage is over the specification.
(Φ1/2/3) DD_VDC1_UVP	The internal DD power stage protection indicating the output voltage is under the specification.
(Φ1/2/3) DD_VDC2_OVP	The internal DD power stage protection indicating the output voltage is over the specification.
(Φ1/2/3) DD_VDC2_UVP	The internal DD power stage protection indicating the output voltage is under the specification.
SYS SHORT(1/2/3)	Short circuit protection.
SYS INT_ LINE	Occurs when the line input voltage is under 170Vac or over 270Vac.
OTP	Occurs when the AC Source's internal temperature is too high.



Notice The protection point varies by the measurement error; it may act before reaching the protection point set.

4. Calibration

4.1 Introduction

The AC Source has a simple built-in procedure to calibrate the output and measure the accuracy without opening the chassis. Simply follow the procedure step by step for operation. A voltage meter, current meter, and an adequate load with a +10V dc power supply are required to perform the calibration. For the connections of these instruments refer to Figure 4-1. There are 3 items required for calibration: output voltage, output current and external reference. They do not need to be calibrated at the same time. Select them for calibration as needed.

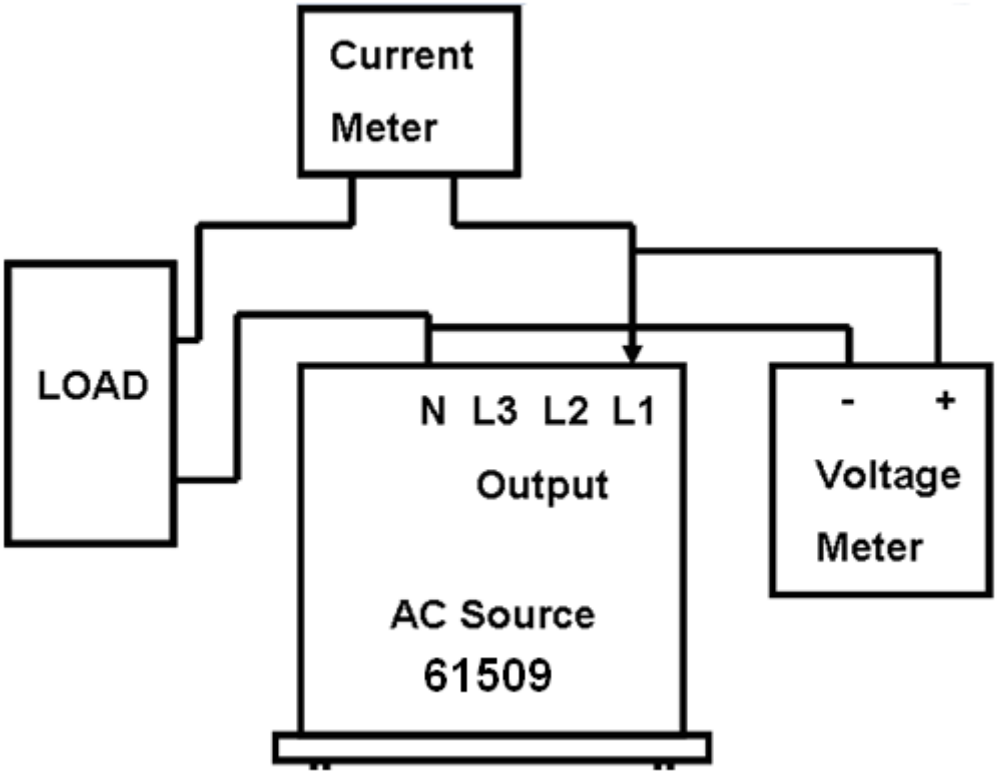
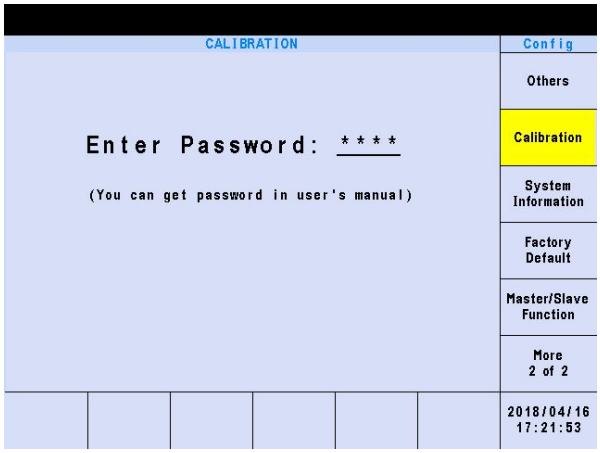


Figure 4-1

Notice If the ambient temperature is ≤25°C, the AC source needs to warm up for 20 minutes before calibration to allow the internal temperature to reach the normal operating temperature to ensure the calibration is correct.

4.2 Manual Calibration

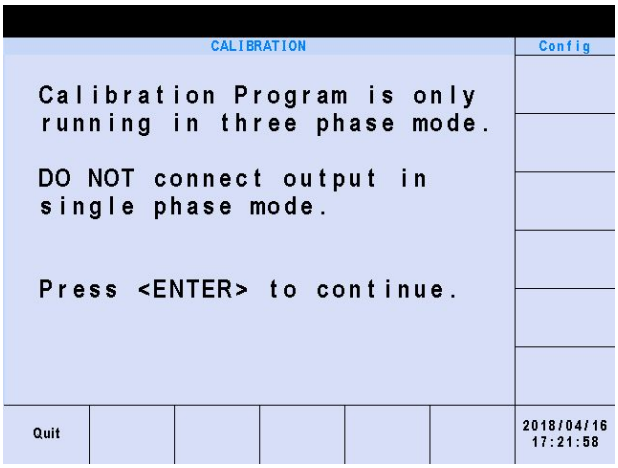
Select “Calibration” in the CONFIG function (3_Phase Mode/1_Phase Mode) to enter the calibration procedure. Before any calibration items appear, input the password. The password is included in the manual to ensure this manual is read before executing the calibration procedure.



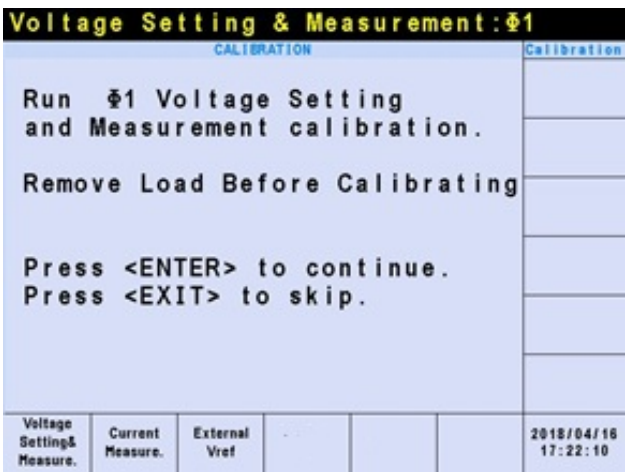
Notice

1. The password for the calibration procedure is "3621", press **ENTER** to confirm it.
2. Read the procedure clearly before calibrating the AC Source, or partial memory data could be lost due to incorrect operation.

Once the correct password is entered, the LCD shows that the calibration procedure can only be run in 3-phase mode and is prohibited in 1-phase mode. Press **ENTER** to continue the calibration procedure.



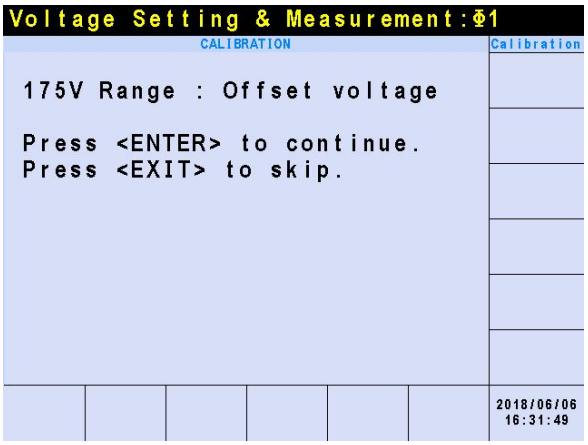
Select the voltage, current, and external reference voltage for calibration.



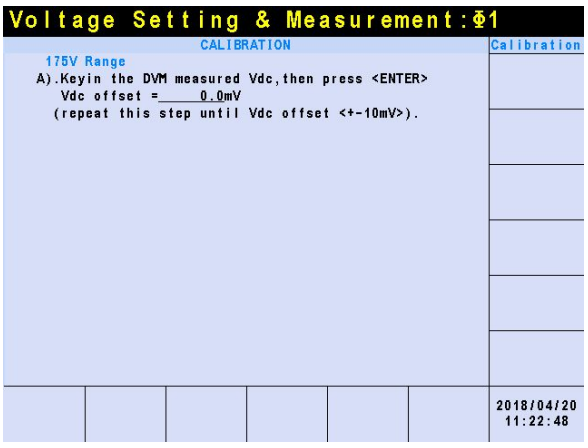
Voltage setting & Measure: This is the calibration for output voltage and measurement accuracy.
Current Measure: This is the calibration for current measurement accuracy.
External Vref.: This is the calibration of external Vref.

4.2.1 Output Voltage and Measurement Calibration

CALIBRATION CHOICE can be selected after the password has been entered (see section 4.2). Press 'Voltage Setting & Measure' at the bottom to calibrate the output voltage and measurement.



The Voltage Setting & Measurement Calibration screen provides the option of conducting the 175V Range Offset voltage calibration or the 175V Range Voltage Setting calibration. Press **ENTER** to continue to the Offset voltage calibration or press **EXIT** to go into the 175V Range Voltage Setting & Measurement calibration procedure.

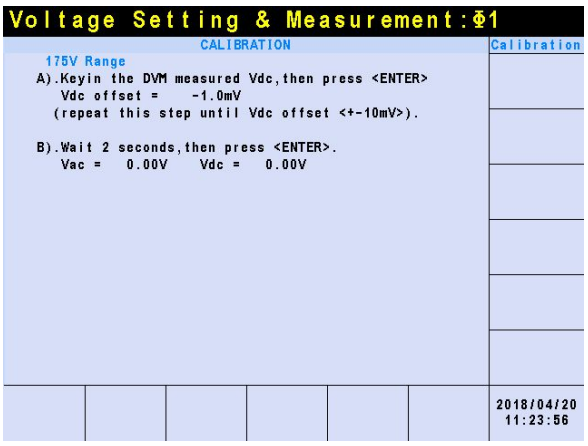


For step A in the 175V Range Offset voltage calibration procedure, use a Digital Voltage Meter (DVM) to measure the AC Source's output DC voltage in mV and key in the measured value. Keep monitoring/entering the DVM readings and input/output of the DC voltage until the DC offset is lower than ±10 mV.

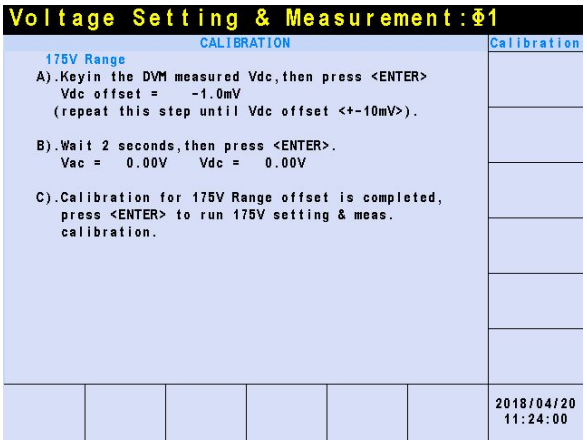
Notice

1. The Vdc offset can be positive or negative. Connect the positive terminal of the DVM to the AC Source's Line output and the negative terminal to the AC Source's Neutral output as shown in Figure 4-1.
2. The load must be off for all of the steps in ACCURACY CALI under Voltage setting & Measurement.

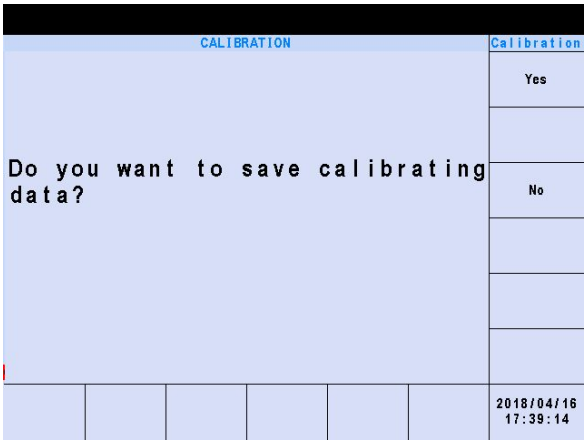
For step B in the 175V Range Offset voltage calibration procedure, wait for 2 seconds and press **ENTER**; the display will show the current Vac and Vdc offset voltages calculated by the AC Source.



For step C in the 1750V Range Offset voltage calibration procedure, the display shows the 175V Range Offset voltage calibration has been completed. Press **EXIT** to go into the save screen as shown below, or press **ENTER** to continue to the 175V Range Voltage setting and measurement calibration procedure.



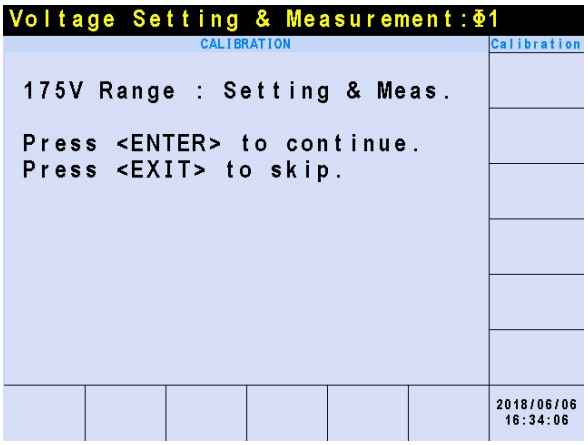
Press 'Yes' on the right to save the calibration result.



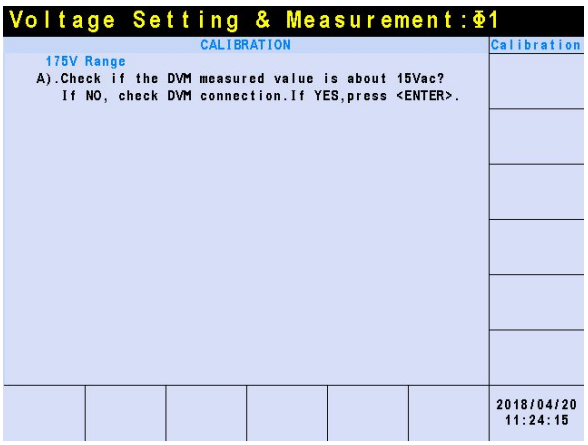
Notice

The AC Source calibration procedure steps can be executed separately; however, it is better to follow the calibration sequence step by step (step A, step B ...) or it may cause an output and measurement error.

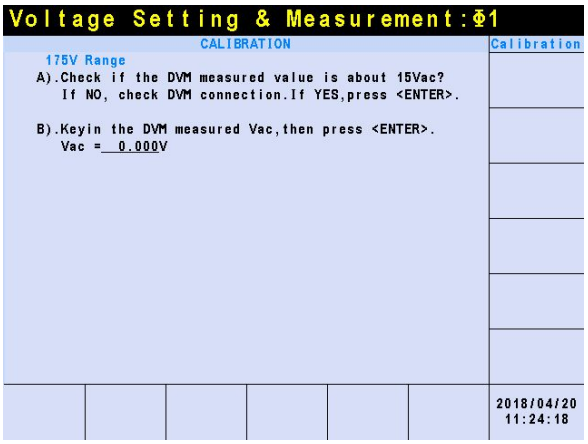
Once the 175V Range Offset voltage calibration is done, the screen provides the option of conducting the 175V Range Setting & Meas. Calibration or going to the 350V Range Offset calibration. Press **ENTER** to continue to the Setting & Meas. calibration or press **EXIT** to go to the 350V Range Offset voltage calibration procedure.



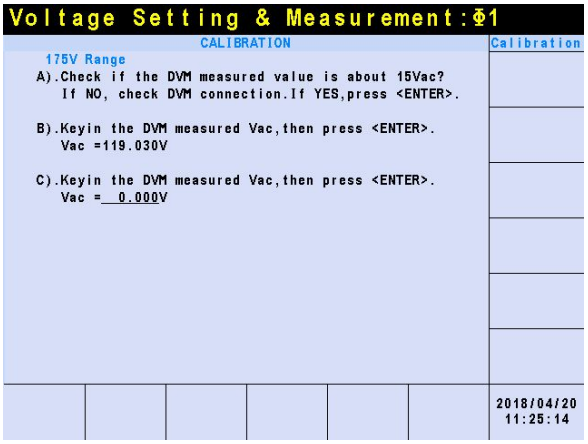
For step A in the 175V Range Setting & Meas. calibration procedure, remove the load. Check if the output AC voltage measured by the DVM is about 15Vac. This is to confirm the connection is correct. Press **ENTER**.



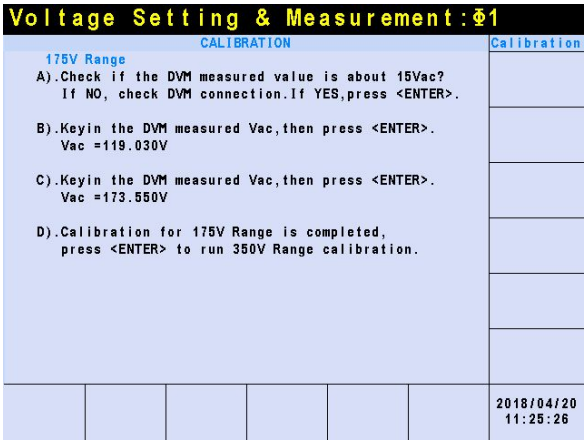
For step B in the 175V Range Setting & Meas. calibration procedure, check if the DVM measured output voltage is about 120Vac. Input the value measured by the DVM and press **ENTER**.



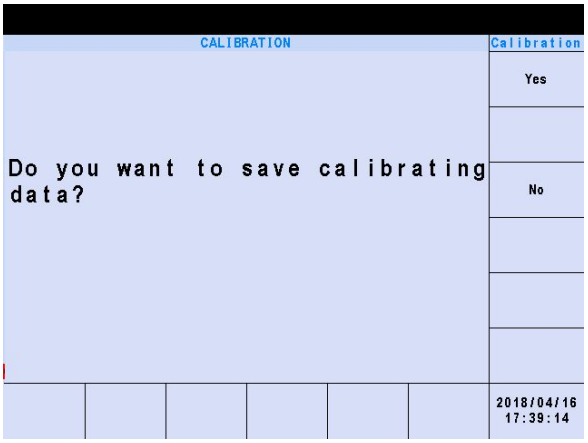
For step C in the 175V Range Setting & Meas. calibration procedure, check if the DVM measured output voltage is about 175Vac. Input the value measured by the DVM and press **ENTER**.



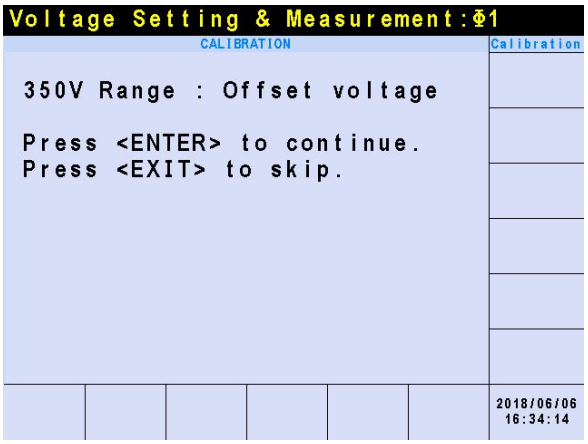
For step D in the 175V Range Setting & Meas. calibration procedure, the display shows the 175V Range Setting & Meas. calibration has been completed. Press **EXIT** to go into the save screen as shown below, or press **ENTER** to continue to the 350V Range Offset Voltage calibration.



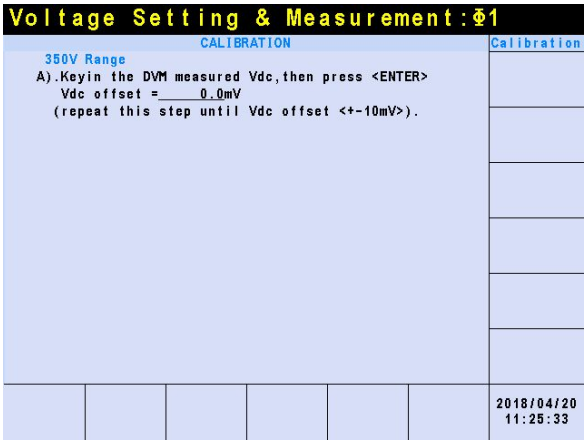
Press 'Yes' on the right to save the calibration result.



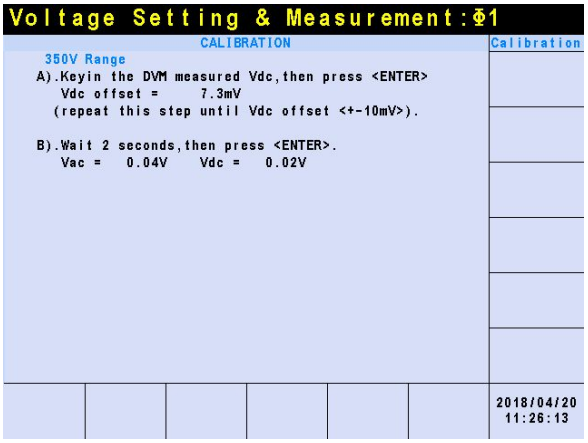
Once the 175V Range Setting & Measurement calibration is done, the screen provides the option of conducting the 350V Range Offset calibration or the 350V Range Setting & Measurement calibration. Press **ENTER** to continue to the 350V Range Offset voltage calibration or press **EXIT** to go to the 350V Range Setting & Measurement calibration.



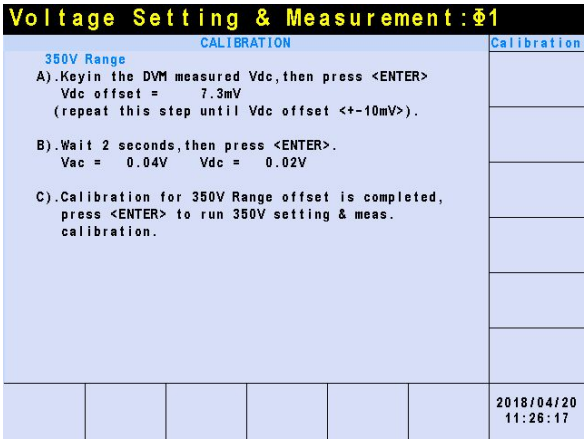
For step A in the 350V Range Offset voltage calibration procedure, use a Digital Voltage Meter (DVM) to measure the AC Source's output DC voltage in mV and key in the measured value. Keep monitoring/entering the DVM readings and input/output of the DC voltage until the DC offset is lower than ±10 mV.



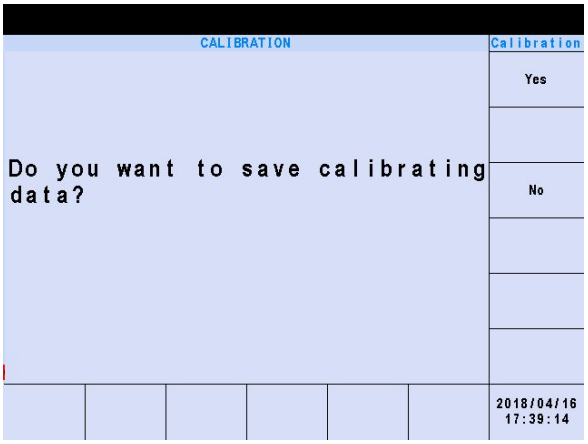
For step B in the 350V Range Offset voltage calibration procedure, wait for 2 seconds and press **ENTER**; the display will show the current Vac and Vdc offset voltages calculated by the AC Source.



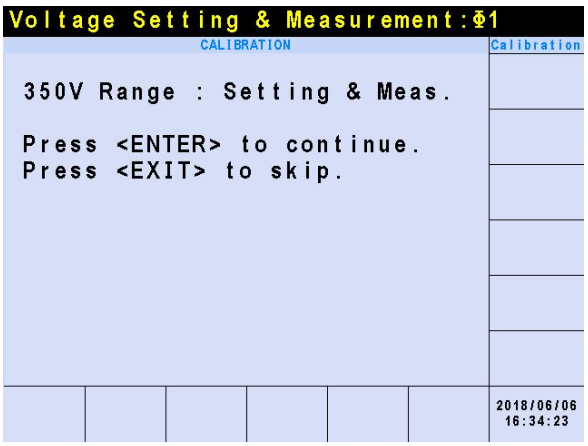
For step C in the 350V Range Offset voltage calibration procedure, the display shows the 350V range Offset voltage calibration has been completed. Press **EXIT** to go to the save screen as shown below, or press **ENTER** to continue to the 350V Range voltage setting and measurement calibration procedure.



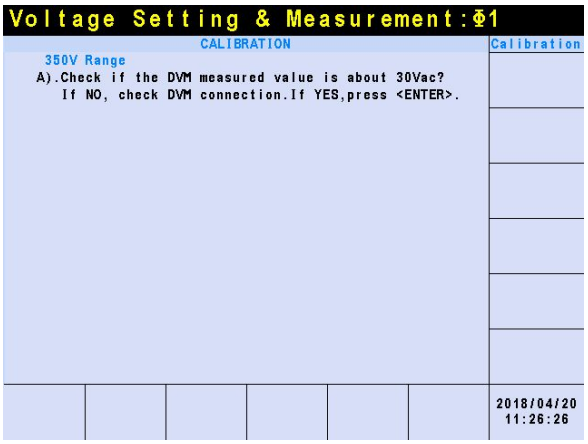
Press 'Yes' on the right to save the calibration result.



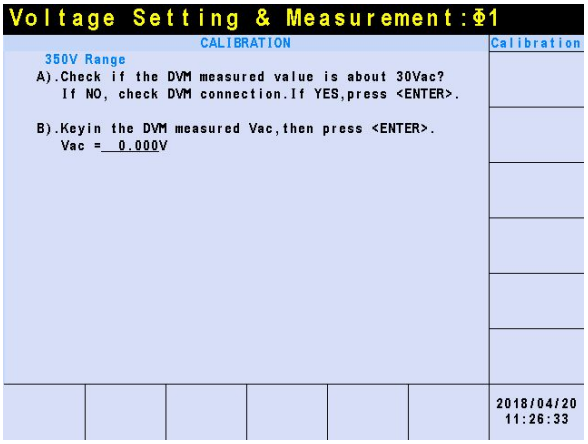
Once the 350V Range Offset voltage calibration is done, the screen will provide the option of conducting the 350V Range Setting & Measurement calibration or going to the calibration main screen. Press **ENTER** to continue to the Setting & Measurement calibration or press **EXIT** to go into the calibration main screen.



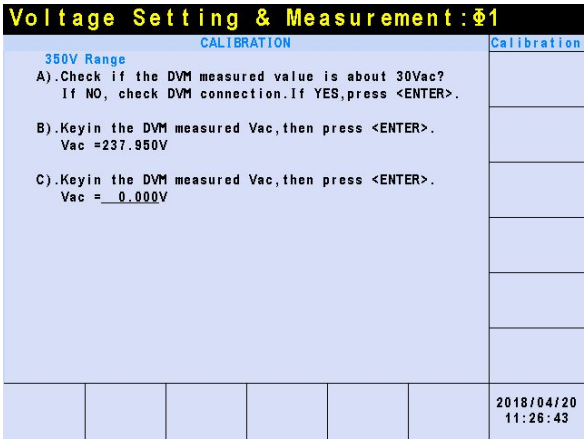
For step A in the 350V Range Setting & Measurement calibration procedure, remove the load. Check if the output AC voltage measured by the DVM is about 30Vac. This is to confirm the connection is correct. Press **ENTER**.



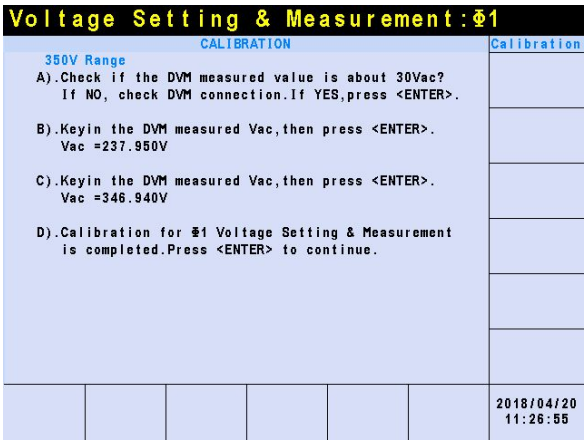
For step B in the 350V Range Setting & Measurement calibration procedure, check if the DVM measured output voltage is about 240Vac. Input the value measured by the DVM and press **ENTER**.



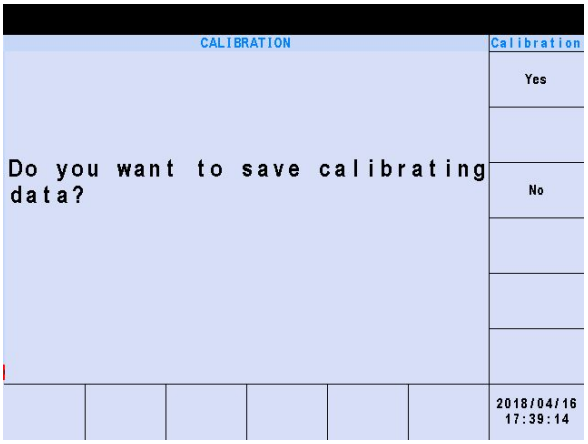
For step C in the 350V Range Setting & Measurement calibration procedure, check if the DVM measured output voltage is about 350Vac. Input the value measured by the DVM and press **ENTER**.



For step D in the 350V Range Setting & Meas. calibration procedure, the display shows the 350V Range Setting & Meas. calibration has been completed. Press **EXIT** to go to the save screen as shown below, or press **ENTER** to continue voltage calibration for other phases.



Press 'Yes' on the right to save the calibrated result.

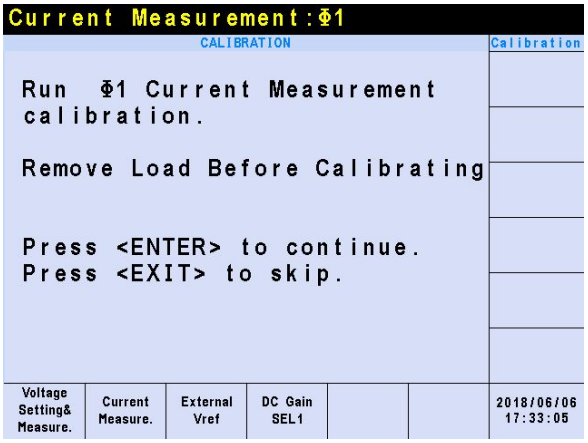


Notice

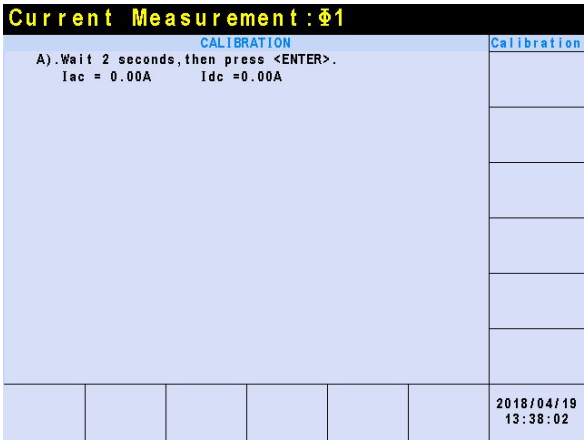
1. Press **ENTER** at the last step to continue calibrating the 2nd and 3rd phases.
2. If **EXIT** is pressed without saving the result, the calibration result is kept until the power is turned off.

4.2.2 Current Measurement Calibration

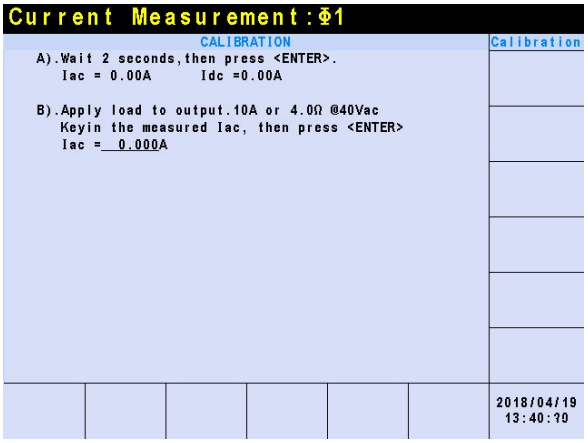
CALIBRATION CHOICE can be selected after the password has been entered (see section 4.2). Press 'Current Measure' at the bottom to calibrate the current measurement. The calibration value is different for the 61509 and will be specified in each step.



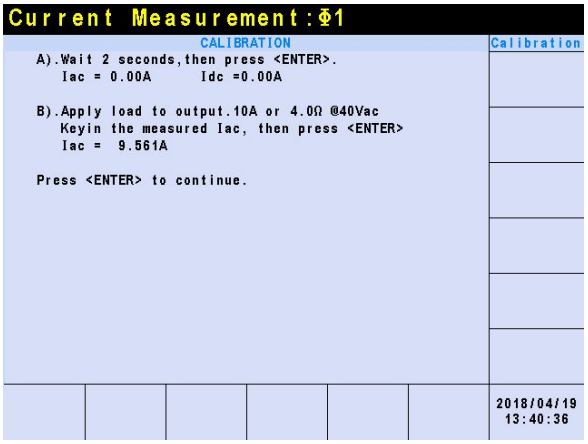
For step A of ACCURACY CALI in Current Measure, wait for 2 seconds and press **ENTER**; the display will show the current values for Iac = 0.00A and Idc = 0.00A measured by the AC Source.



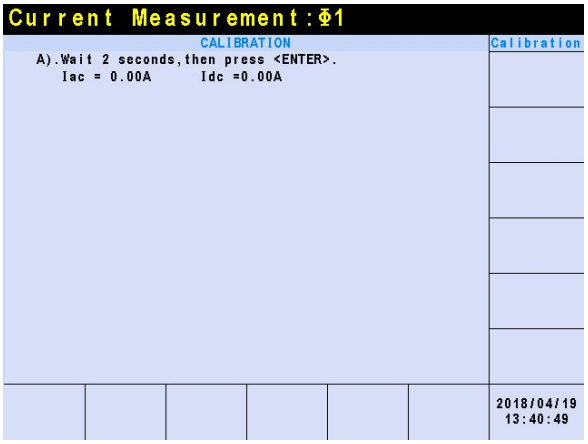
For step B, adjust the load to 4Ω for output and press **ENTER**. The AC Source will output 40Vac for the 61509. Use a Current Meter (or Power Analyzer) to measure the output current. Enter the measured value and press **ENTER**.



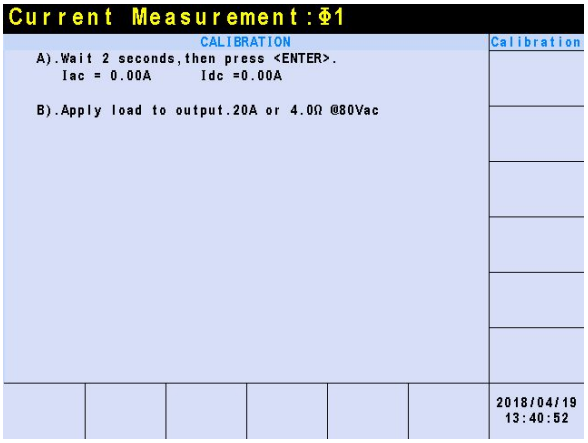
Press **ENTER** to continue the calibration procedure. The load will be disconnected.



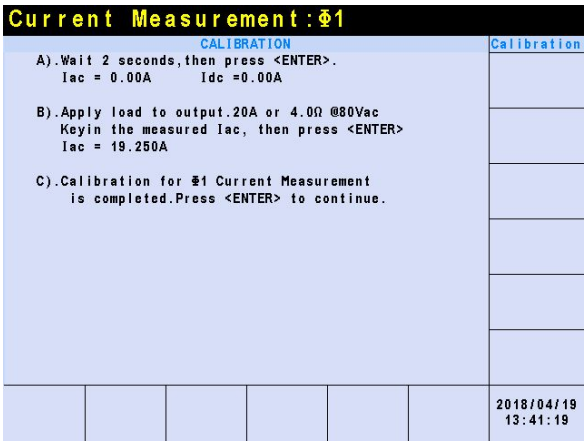
In step A, wait for 2 seconds and press **ENTER**; the display shows Iac = 0.00A and Idc = 0.00A, as measured by the AC Source.



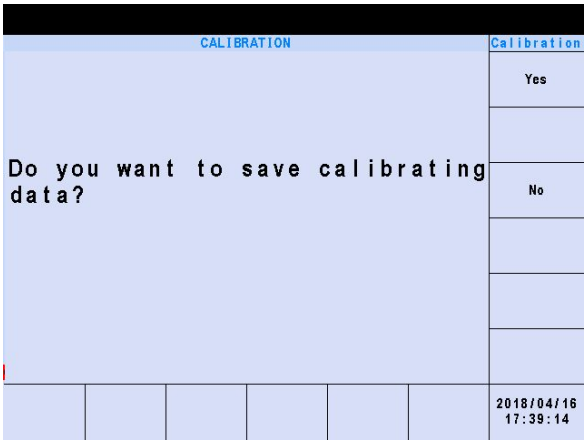
For step B, adjust the load to 4Ω for output and press **ENTER**. The AC Source will output 80Vac for the 61509. Use a Current Meter (or Power Analyzer) to measure the output current. Enter the measured value and press **ENTER**.



Step C is the last step of ACCURACY CALI in Current Measure. Press **ENTER** to continue calibrating the 2nd and 3rd phases or press **EXIT** to leave this page.



Press ‘Yes’ on the right to save the calibration results.

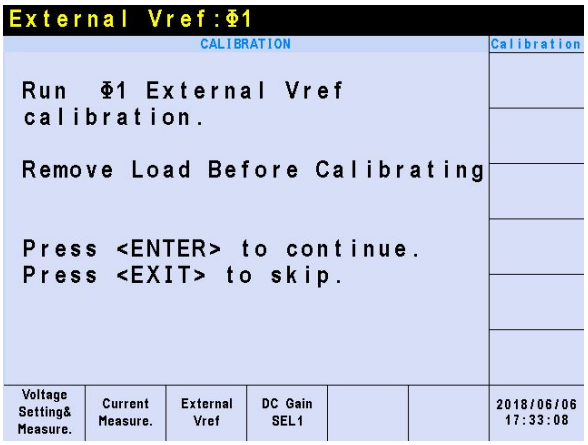


Notice

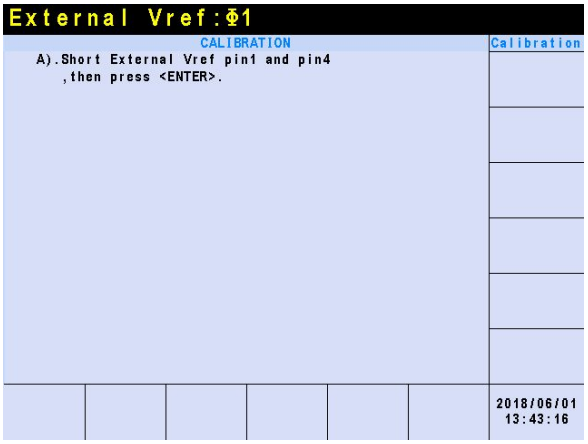
1. The resistance of the external load has to be constant; therefore, the load current and output voltage should be proportional or step B of CURRENT MEAS. ACCURACY will be meaningless.
2. Protection is removed temporarily when the calibration procedure is running. It may cause the AC Source to be damaged if the incorrect load is applied.

4.2.3 External Vref Calibration

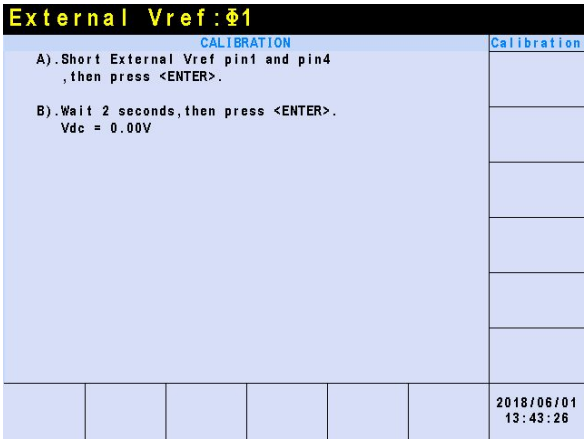
CALIBRATION CHOICE can be selected after the password is entered (see section 4.2). Press External Vref at the bottom to conduct the external Vref calibration as shown below:



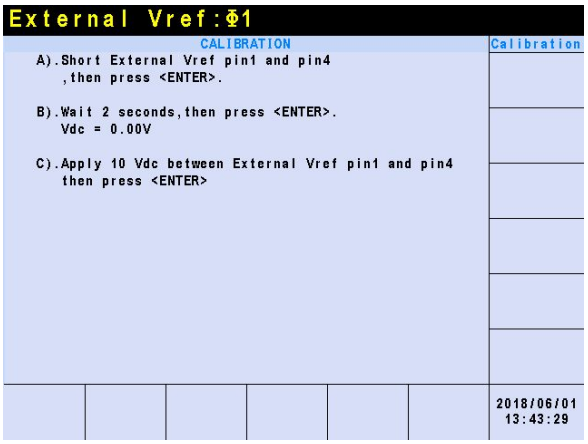
Step A: Short circuit pin 1 and pin 4 of the Ext. Vref input terminal and press **ENTER**.



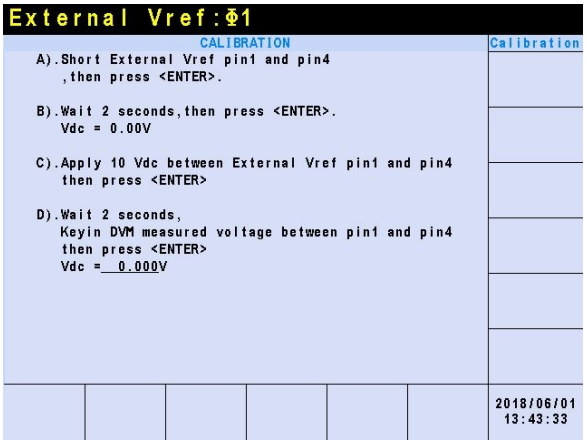
Step B: After short circuiting the external Vref input terminal, make the input 0V and the display will show the AC Source's measured Vdc. Wait for 2 seconds and press **ENTER**; the display will show the current Vdc offset voltage calculated by the AC Source.



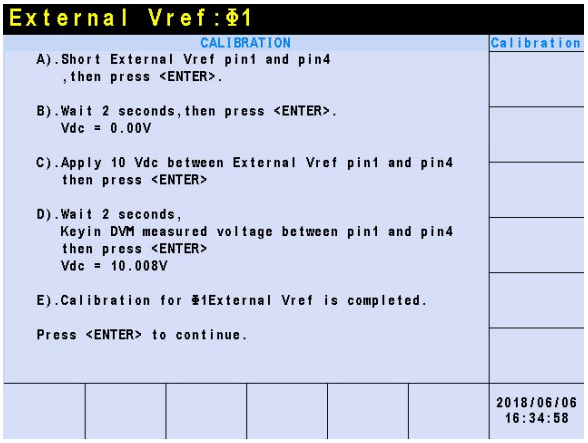
Step C: Disconnect pin 1 and pin 4 of the Ext. Vref input terminal and then input a DC voltage of 10Vdc between pin 1 and pin 4 and press **ENTER**.



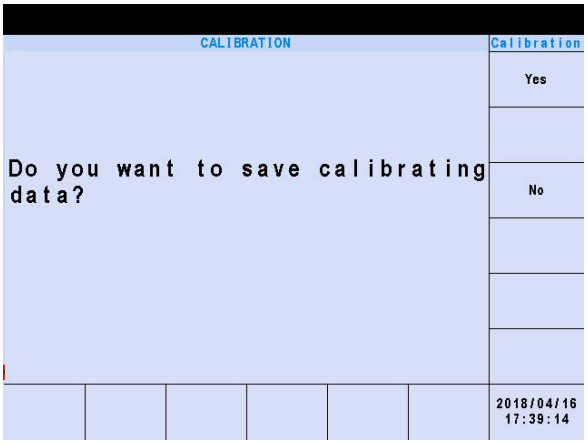
Step D: Use a DVM to measure the voltage between pin 1 and pin 4 of the Ext. Vref input terminal, then enter the DC voltage value and press **ENTER**.



Step E: Press **EXIT** to go into the save screen as shown below, or press **ENTER** to continue the voltage calibration of the other phases.



Pressing 'Yes' on the right will save the calibrated result.



Notice

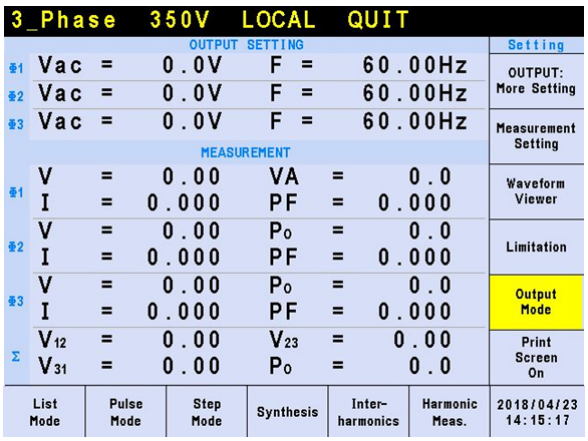
1. Connect the Ext. Vref input terminal to the corresponding pin when calibrating other phases.
2. Connect the Ext. Vref input terminal to the 2nd phase pin when calibrating 1-phase.

5. Application

5.1 Overview

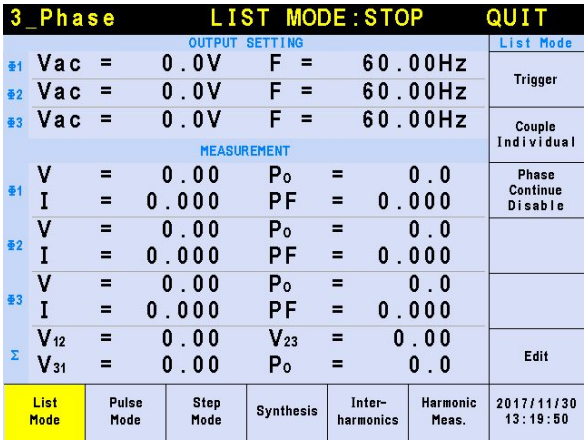
The 61507/61508/61509 AC Sources can not only program a stable sinusoidal output voltage and frequency, but also provide powerful features to simulate power line interrupts. The output can be changed using the Sequences in LIST mode (see 5.2), or changed to step by step in STEP mode (see 5.4.) With these functions, simulations of conditions such as cycle loss, transient peak, and power attenuation are very easy.

The 61507/61508/ 61509 AC Sources are able to measure the related power parameters provided in MAIN PAGE (see 3.3); they also provide harmonic measurements up to 50 orders (see 5.7). In addition, the AC Sources allow the user to edit different harmonic components to synthesize the harmonic distortion waveform (see 5.5). They have the ability to program the inter-harmonic frequency and components, as well as to sweep and overlap the static fundamental waveforms (see 5.6).

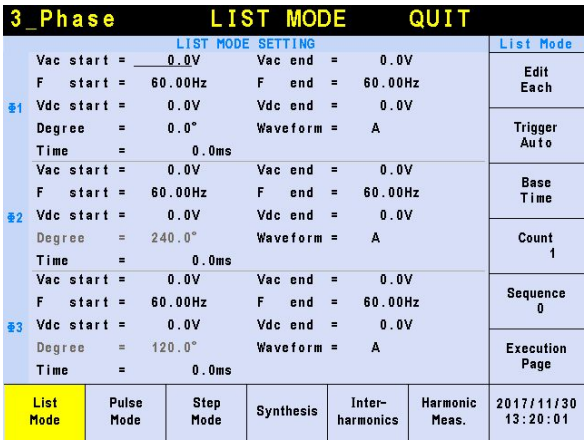


5.2 List Mode

Press ‘Output Mode’ on the right on the MAIN PAGE (see 3.3) to go to the Output Mode command line and press ‘List Mode’ at the bottom to go into the List Mode command line.



Press 'Edit' on the right to go to the setting page.



The waveform programming in List mode is a combination of Sequences. The output waveform starts from Sequence = 0 and continues one Sequence after another until the Time or Cycle = 0, stopping the action. The remaining Sequences will not be executed. The output voltage sequence can be edited as required.

Trigger method: Auto / Manual / Excite.
Auto: Finishes all counts when triggered.
Manual: Executes the sequence waveform once, same as Count = 1.
Excite: Remote-Excite via pin 13 of the TTL terminal that is triggered by the external trigger signal. See *Appendix A TTL Signal Pin Assignments* for the detailed pin assignment.

Couple: Individual / Φ1+Φ2+Φ3.
Individual: The three phases are set separately.
Φ1+Φ2+Φ3: The settings of the second and third phases are the same as the settings of the first phase; only the first phase needs to be set.

Phase Continue: Disable/Enable.
Disable: The start angle of every Sequence will follow the Degree setting of each Sequence setting.
Enable: The start angle of every Sequence will automatically change based on the last output angle of the previous Sequence. The Degree setting of every Sequence will be ignored when Enable is set.

Base sequence unit: Time / Cycle.
Time: The sequence unit is time.
Cycle: The sequence unit is cycle.

Count: The number of sequence execution times.
Count = 0: unlimited execution.

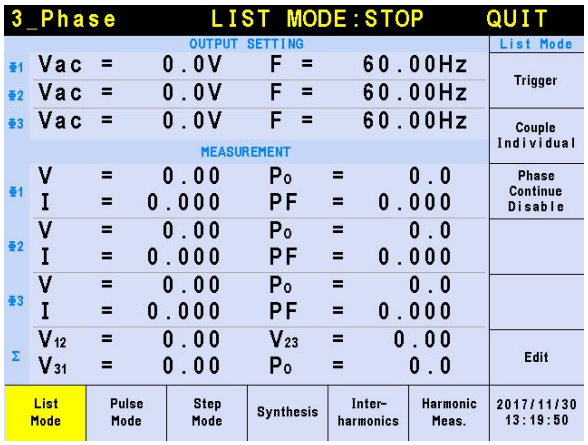
Sequence: Sequence number.
The sequence starts at 0 and the maximum number of sequences is 99. The phase difference of the second/third phase and the first phase of Sequence 0 is fixed at 120°. The angle of the second/third phase cannot be used in Sequence 0.

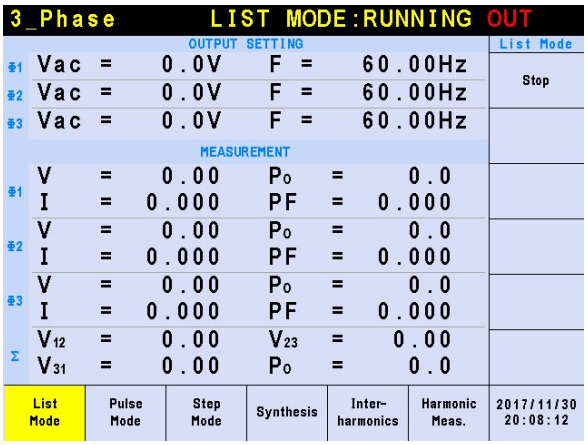
Degree: The phase angle when the sequence starts.

Vac start, F start, Vdc start: The initial waveform when the sequence starts.

Vac end, F end, Vdc end: The final waveform when the sequence ends.
Waveform= A / B: Select waveform (see 3.3.3.)

After setting the sequences, press 'Execution Page' on the right to exit List mode and the LCD will show LIST MODE: STOP on the top. STOP indicates the present trigger state. Press 'Trigger' on the right to trigger the output and the LCD will show RUNNING to indicate that the List mode is under execution. Press 'Stop' to cease the List waveform output. When the AC Source finishes all Sequences and Counts, the LCD will return to its initial state and display STOP. The AC Source will QUIT at the same time, as shown below:





If the AC Source is operating, pressing **OUT/QUIT** will stop the output and the waveform will drop to zero volts. Press **OUT/QUIT** again and the AC Source only outputs the waveform set in MAIN PAGE. 'Trigger' must be pressed to re-trigger the source. When pressing ↩ to exit the LIST page, the programmed LIST mode waveform will be closed.

Example of LIST Mode in 1_Phase Mode:

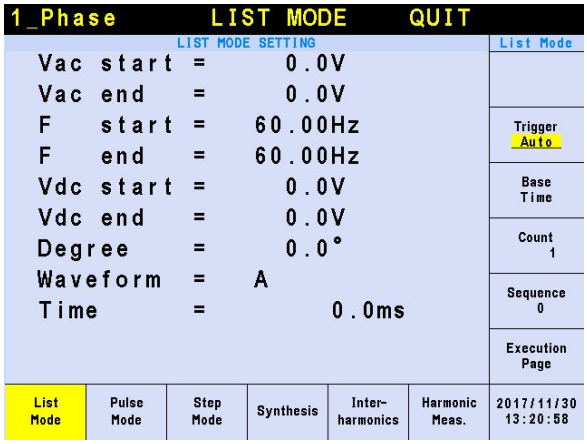
Trigger: Auto, **Base**: Time, **Count**: 1

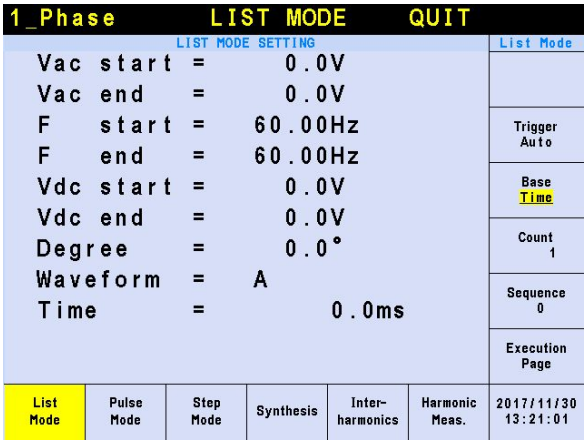
LIST MODE SETTING:
Sequence 0: Vac start = 20V, Vac end = 100V
F start = 50Hz, F end = 50Hz
Vdc start = 0V, Vdc end = 0V
Degree = 90°, Time = 75ms
Waveform = A

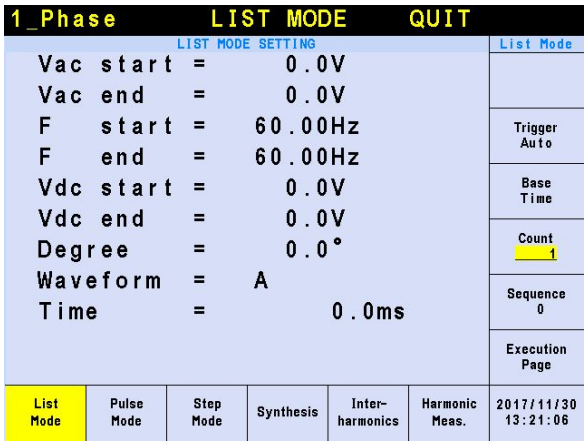
Sequence 1: Vac start = 20V, Vac end = 20V
F start = 50Hz, F end = 50Hz
Vdc start = 0V, Vdc end = 100V
Degree = 0°, Time = 80ms
Waveform = A

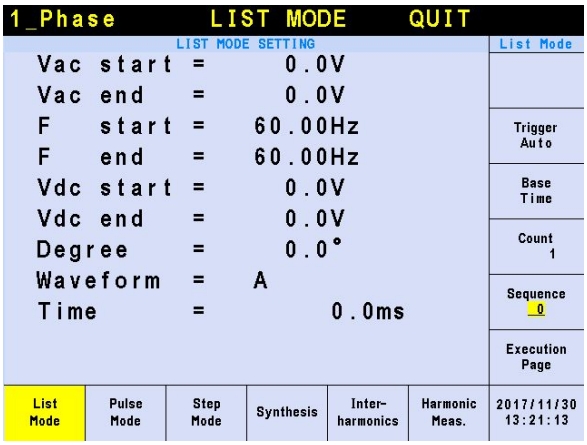
Sequence 2: Vac start = 20V, Vac end = 120V
F start = 50Hz, F end = 500Hz
Vdc start = 0V, Vdc end = 0V
Degree = 0°, Time = 100ms
Waveform = A

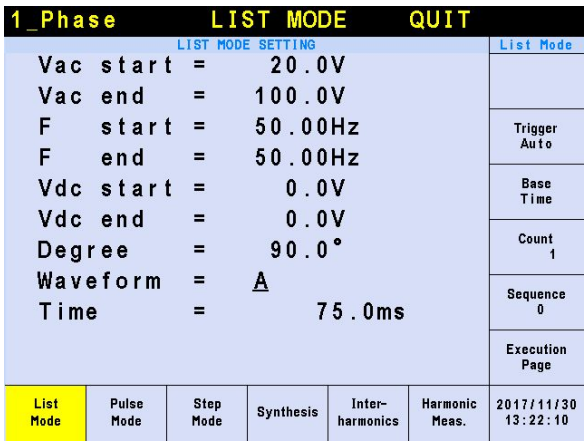
The following screens show the page settings for LIST MODE:

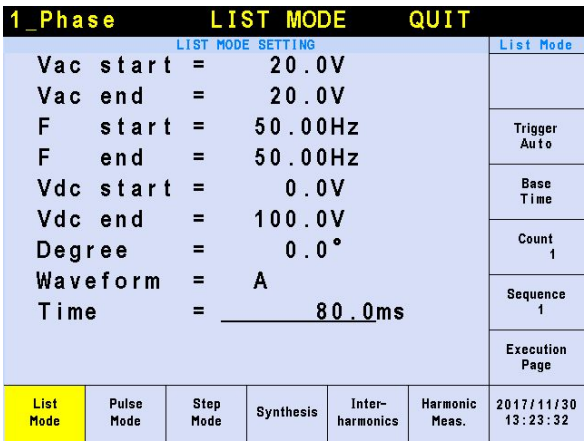

1_Phase LIST MODE QUIT
LIST MODE SETTING
Vac start = 0.0V
Vac end = 0.0V
F start = 60.00Hz
F end = 60.00Hz
Vdc start = 0.0V
Vdc end = 0.0V
Degree = 0.0°
Waveform = A
Time = 0.0ms
List Mode
Trigger Auto
Base Time
Count 1
Sequence 0
Execution Page
List Mode
Pulse Mode
Step Mode
Synthesis
Inter-harmonics
Harmonic Meas.
2017/11/30 13:20:58

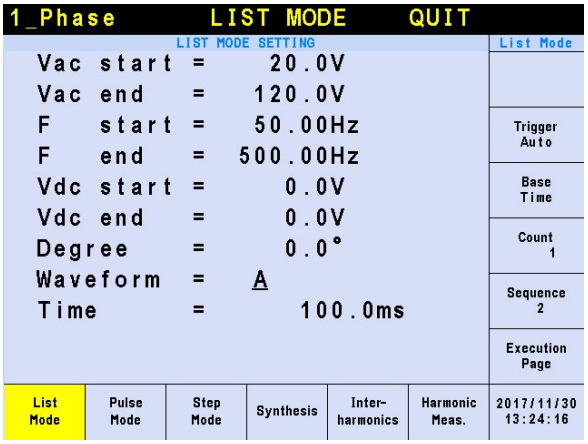

1_Phase LIST MODE QUIT
LIST MODE SETTING
Vac start = 0.0V
Vac end = 0.0V
F start = 60.00Hz
F end = 60.00Hz
Vdc start = 0.0V
Vdc end = 0.0V
Degree = 0.0°
Waveform = A
Time = 0.0ms
List Mode
Trigger Auto
Base Time
Count 1
Sequence 0
Execution Page
List Mode
Pulse Mode
Step Mode
Synthesis
Inter-harmonics
Harmonic Meas.
2017/11/30 13:21:01


1_Phase LIST MODE QUIT
LIST MODE SETTING
Vac start = 0.0V
Vac end = 0.0V
F start = 60.00Hz
F end = 60.00Hz
Vdc start = 0.0V
Vdc end = 0.0V
Degree = 0.0°
Waveform = A
Time = 0.0ms
List Mode
Trigger Auto
Base Time
Count 1
Sequence 0
Execution Page
List Mode
Pulse Mode
Step Mode
Synthesis
Inter-harmonics
Harmonic Meas.
2017/11/30 13:21:06


1_Phase LIST MODE QUIT
LIST MODE SETTING
Vac start = 0.0V
Vac end = 0.0V
F start = 60.00Hz
F end = 60.00Hz
Vdc start = 0.0V
Vdc end = 0.0V
Degree = 0.0°
Waveform = A
Time = 0.0ms
List Mode
Trigger Auto
Base Time
Count 1
Sequence 0
Execution Page
List Mode
Pulse Mode
Step Mode
Synthesis
Inter-harmonics
Harmonic Meas.
2017/11/30 13:21:13

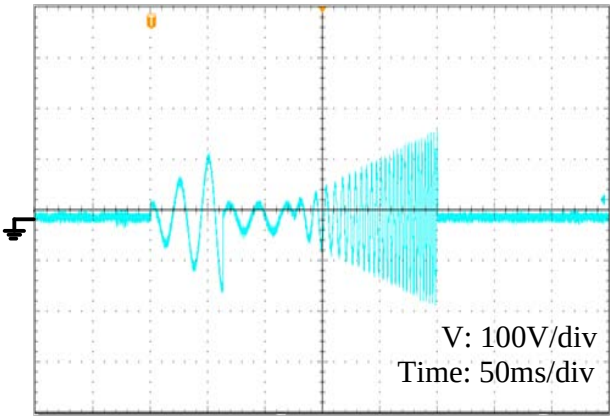

1_Phase LIST MODE QUIT
LIST MODE SETTING
Vac start = 20.0V
Vac end = 100.0V
F start = 50.00Hz
F end = 50.00Hz
Vdc start = 0.0V
Vdc end = 0.0V
Degree = 90.0°
Waveform = A
Time = 75.0ms
List Mode
Trigger Auto
Base Time
Count 1
Sequence 0
Execution Page
List Mode
Pulse Mode
Step Mode
Synthesis
Inter-harmonics
Harmonic Meas.
2017/11/30 13:22:10


1_Phase LIST MODE QUIT
LIST MODE SETTING
Vac start = 20.0V
Vac end = 20.0V
F start = 50.00Hz
F end = 50.00Hz
Vdc start = 0.0V
Vdc end = 100.0V
Degree = 0.0°
Waveform = A
Time = 80.0ms
List Mode
Trigger Auto
Base Time
Count 1
Sequence 1
Execution Page
List Mode
Pulse Mode
Step Mode
Synthesis
Inter-harmonics
Harmonic Meas.
2017/11/30 13:23:32

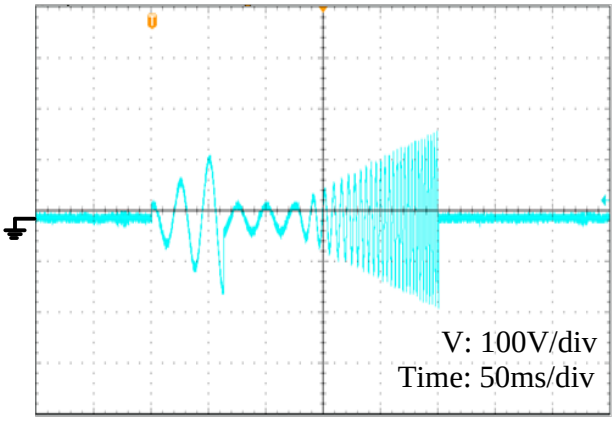


The trigger waveform when the settings are done is shown below:

Phase Continue Disable

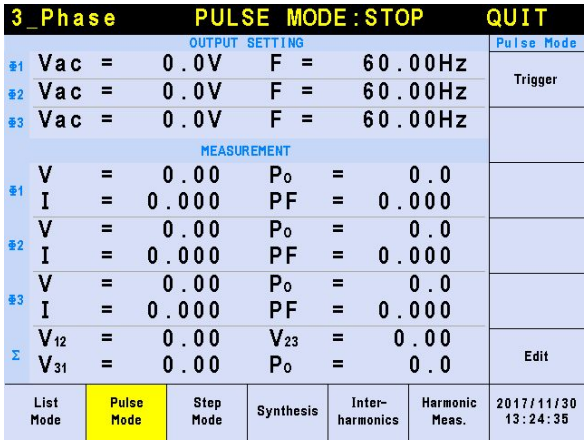


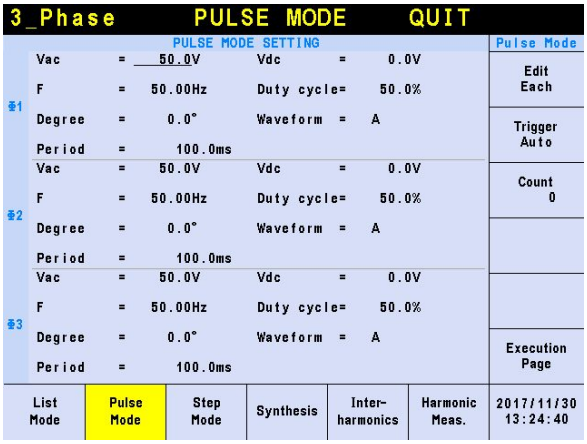
Phase Continue Enable



5.3 Pulse Mode

Press 'Output Mode' on the right on the MAIN PAGE (see 3.3) to go to the Output Mode command line and press 'Pulse Mode' at the bottom to go to the Pulse Mode command line.



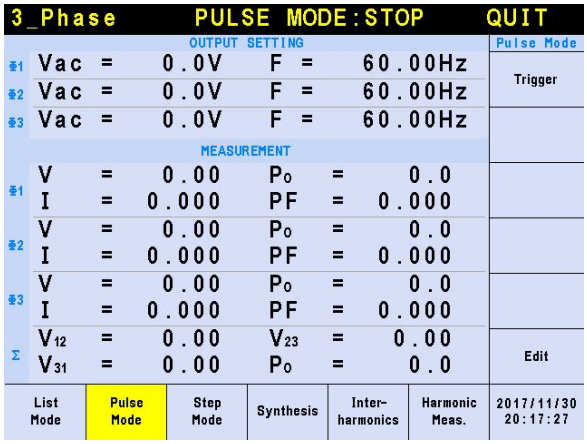


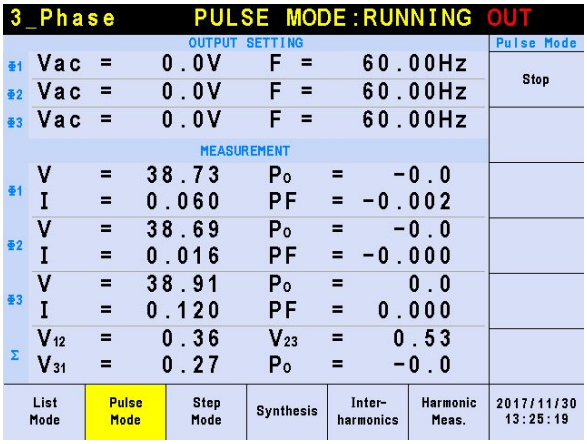
PULSE mode allows users to program a special waveform and add it to the normal output settings in MAIN PAGE. Waveform programming specifies the time ratio and the duty cycle of the pulse voltage.

Trigger method: Auto / Manual / Excite.
Auto: Finishes all counts when triggered.
Manual: Executes the sequence waveform once, same as Count = 1.
Excite: Remote-Excite via pin 13 of the TTL terminal that is triggered by the external trigger signal. See *Appendix A TTL Signal Pin Assignments* for the detailed pin assignment.

Count: The number of pulses.
Vac, F, Vdc: The Vac, F, and Vdc output pulse voltage and frequency.
Duty cycle: The pulse ratio during a duty cycle.
Period: The total length of the duty cycle.
Waveform = A / B: Select waveform (see 3.3.3).
Degree: The output pulse phase degree.

After setting the sequences, press 'Execution Page' on the right to exit the Pulse mode and the LCD will show PULSE MODE : STOP on the top. STOP indicates the present trigger state. Press 'Trigger' on the right to trigger the output and the LCD will show RUNNING to indicate Pulse mode is being executed. Press Stop to cease the Pulse waveform output. When the AC Source finishes all Sequences and Counts, the LCD will return to its initial state and display STOP. The AC Source will QUIT at the same time, as shown below:





If the AC Source is operating, pressing **OUT/QUIT** will stop the output and the waveform will drop to zero volts. Press **OUT/QUIT** again and the AC Source will output the waveform set in MAIN PAGE. Trigger must be pressed to re-trigger the source. When pressing ↩ to exit the PULSE page, the pulse will be ended.

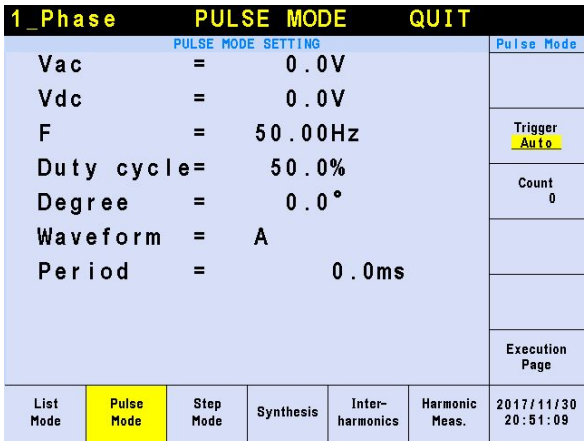
Example of PULSE Mode in 1_Phase Mode:

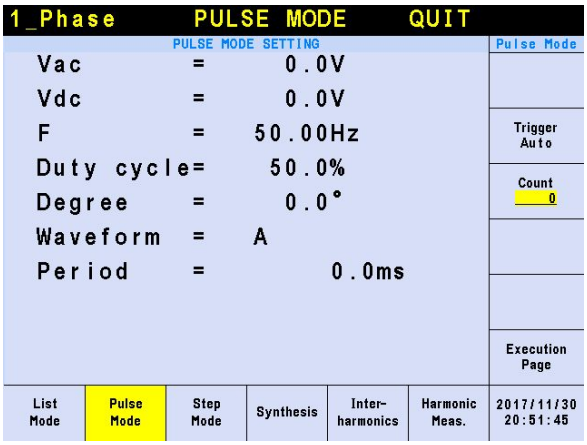
OUTPUT SETTING: Vac = 50V, F = 50Hz

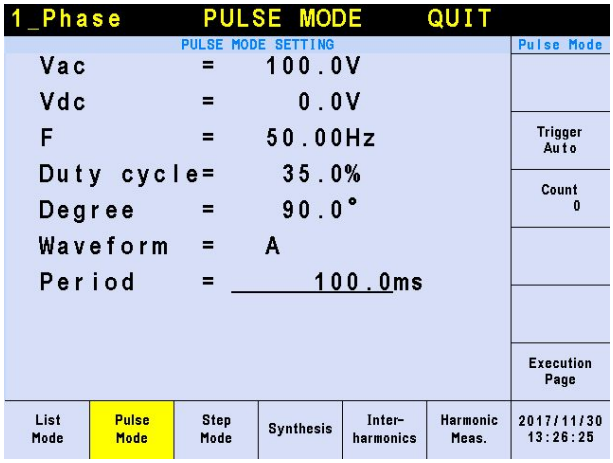
PULSE MODE SETTING:
Vac = 100V, Vdc = 0V
F = 50Hz, Duty cycle = 35%
Period = 100ms, Degree = 90°
Waveform = A

Trigger: Auto, **Count**: 0

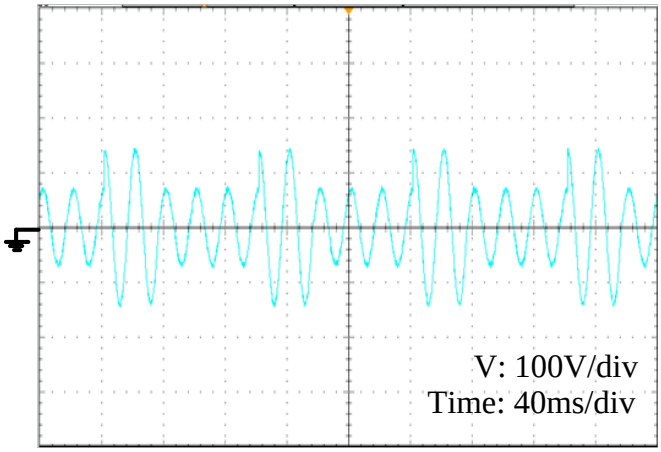
The following screens show the page settings for PULSE MODE:





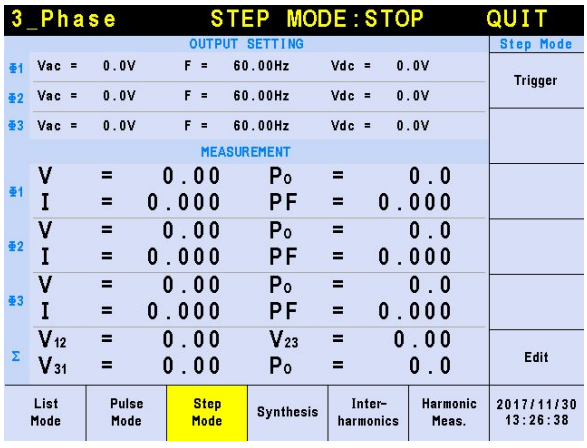


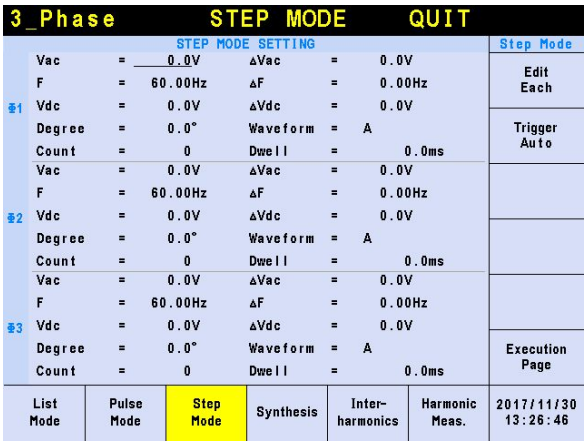
The trigger waveform when the settings are done is shown below:



5.4 Step Mode

Press 'Output Mode' on the right on the MAIN PAGE (see 3.3) to go to the Output Mode command line and press 'Step Mode' at the bottom to go to the Step Mode command line.



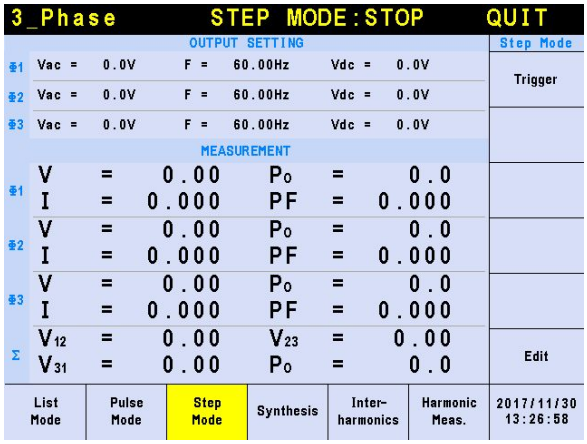


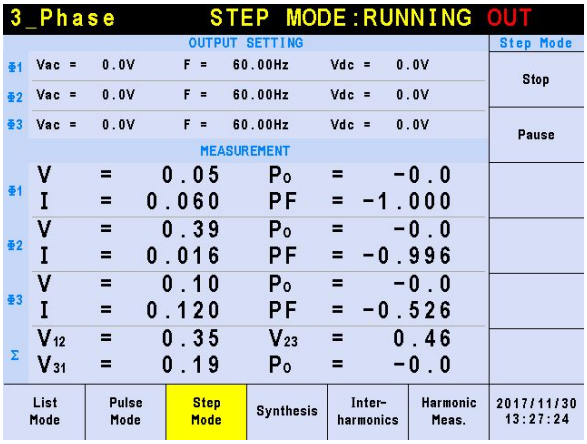
STEP Mode provides a simple auto switch function to change the output voltage in steps. Waveform programming sets the item with an initial voltage, specifies the dwell time and the change of each step, as well as the step number. The output voltage will remain in the last state after execution.

Trigger method: Auto / Manual.
Auto: Finishes all counts when triggered.
Manual: The output voltage changes a step every time it operates.

Count: The count number of each change**.**
Dwell: The time for each step.
Vac, F, Vdc: The Vac, F, and Vdc initial values when the STEP mode starts.
ΔVac, ΔF, ΔVdc: The difference value of each step (it can be negative).
Waveform = A / B: Select waveform (see 3.3.3)
Degree: The output phase angle of each step.

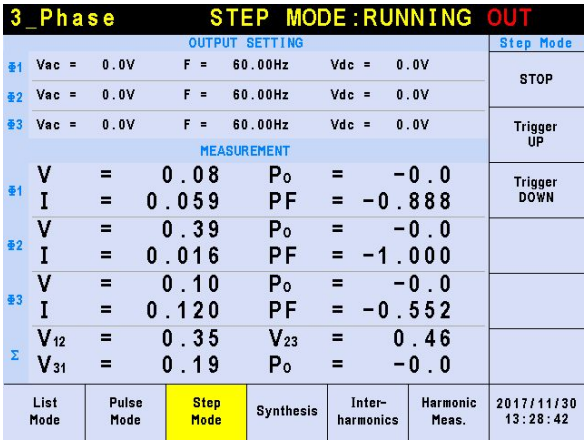
Press 'Step Mode' at the bottom to go to the STEP page. The LCD shows STEP MODE: STOP on the top. STOP indicates the present trigger state. Press Trigger to trigger the output and the LCD will show RUNNING to indicate Step mode is executing the output. Stop and Pause will show on the screen when the output is triggered. Stop ceases the waveform change of STEP, while Pause keeps the STEP waveform until TRIG_CONTINUE is pressed. When the AC Source finishes all Counts, the LCD will show STOP and the AC Source will QUIT.





If the AC Source is outputting, pressing **OUT/QUIT** will stop the output and the waveform will drop to zero volts. Press **OUT/QUIT** again and the AC Source will output the waveform set in MAIN PAGE. Press Trigger again to re-trigger the output. If the AC Source is not outputting, the user can press **ENTER** to output the STEP waveform directly. When pressing ↩ to exit the STEP page, the STEP waveform will stop execution.

The LCD shows Trigger UP and Trigger DOWN when **Trigger = Manual**. The output waveform changes to the next voltage if Trigger UP is selected; and the output waveform changes to the previous voltage if Trigger DOWN is selected.

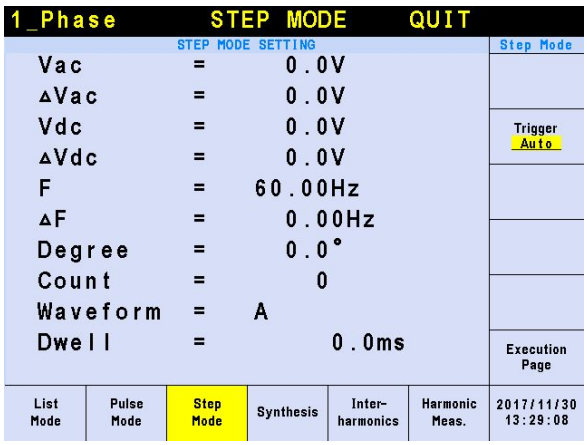


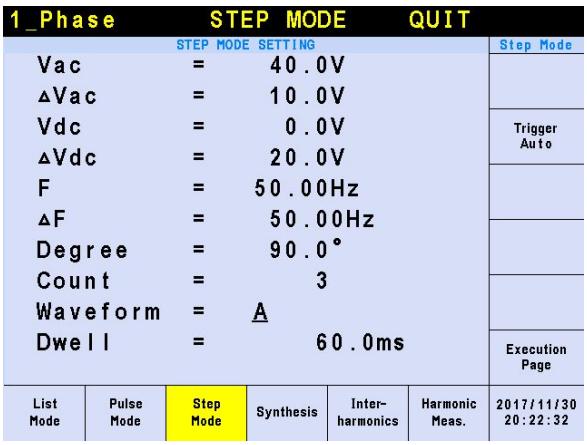
Example of STEP Mode in 1_Phase Mode:

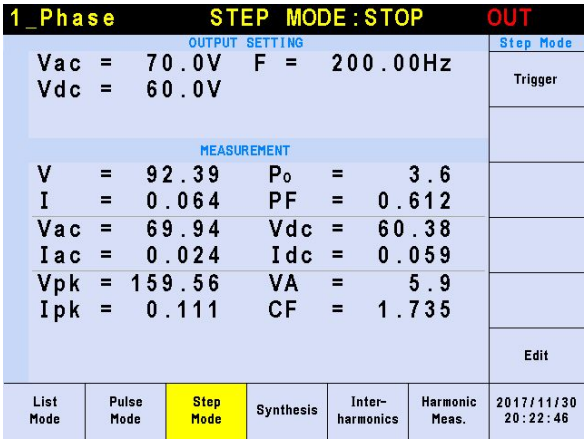
Trigger: Auto

STEP MODE SETTING:
Vac = 40V, ΔVac = 10V
F = 50Hz, ΔF = 50Hz
Vdc = 0V, ΔVdc = 20V
Degree = 90°, Dwell = 60ms
Count = 3, Waveform = A

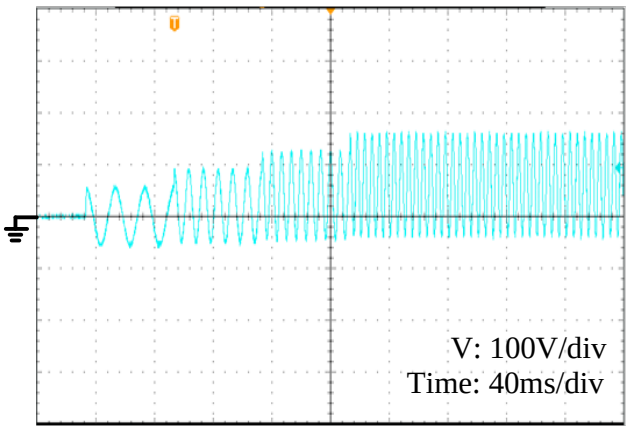
The following screen captures show the setting screens of STEP MODE.





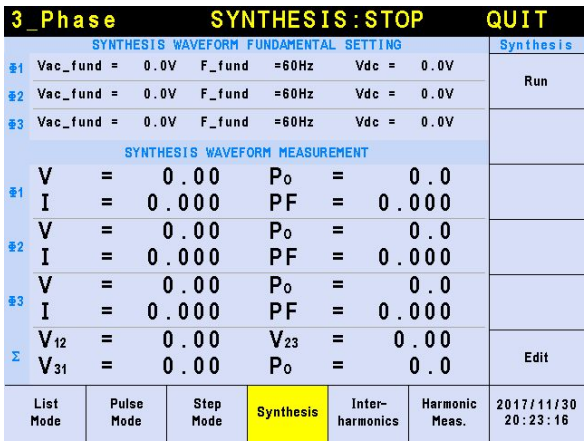


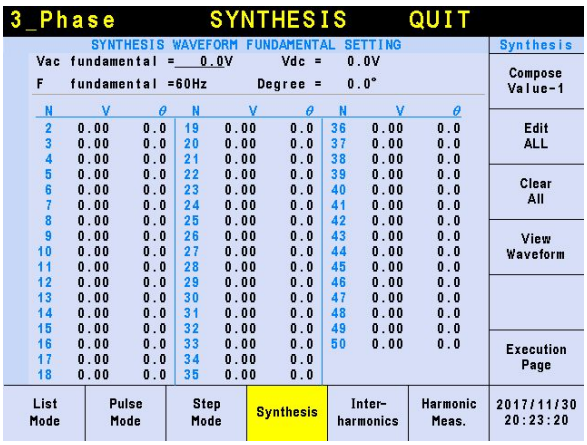
The trigger waveform when the settings are done is shown below:



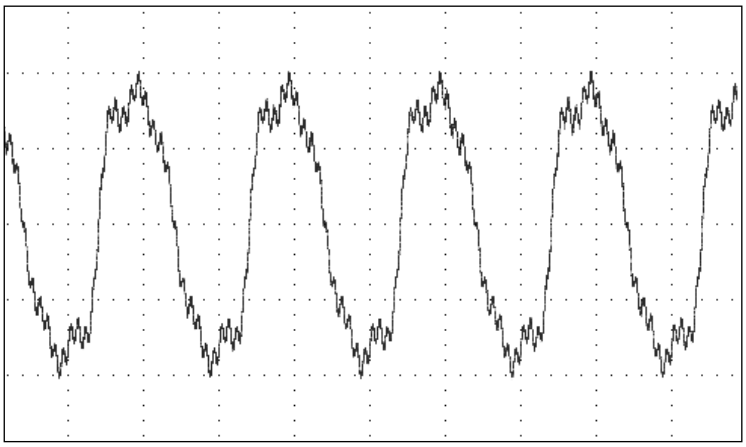
5.5 Synthesis Waveform

Press Output Mode on the right in MAIN PAGE (see 3.3) to enter into the Output Mode command line. Next press Synthesis at the bottom to go into the Synthesis command line. Pressing Edit on the right will enter the Synthesis editing window.





The 61507/61508/61509 AC Source provides a Synthesis function to synthesize a waveform. The harmonic components range up to the 50th order with the fundamental frequency limited to 50Hz or 60Hz. The size and phase of each order can be easily programmed on the LCD. The following is an example figure of the synthesis waveform.



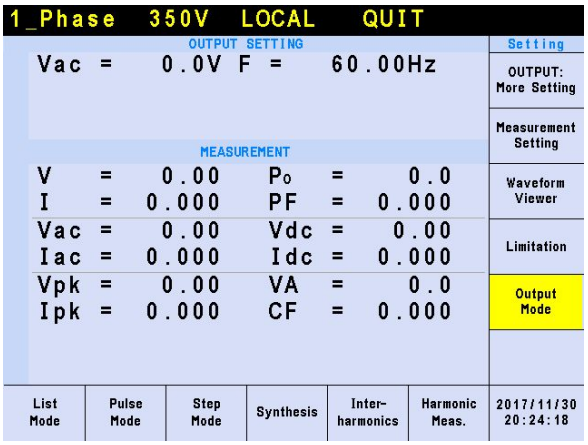
Compose = Value-1 / Value-2 / Value-3/ Percent-1 / Percent-2 / Percent-3: The data form of each harmonic order.

Value: The absolute value.
Percent: The percentage of the fundamental frequency voltage.

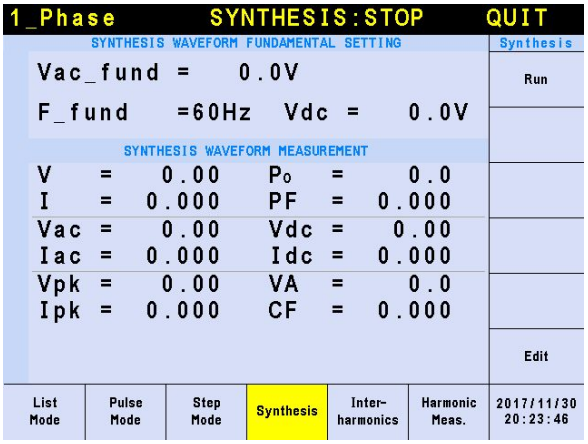
6 types of synthesis waveforms can be programmed for execution or saving.

Vac fundamental: The fundamental frequency voltage; the maximum is limited by RANGE (see 0.)
F fundamental = 50 / 60Hz: The fundamental frequency.
Vdc: The DC voltage component.
Degree: The start angle of the output waveform.

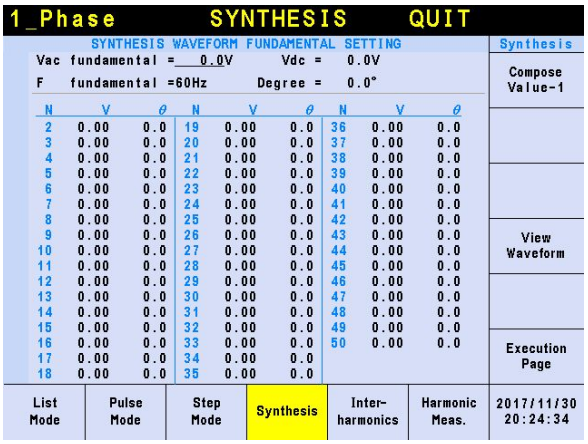
The following is an example of using Synthesis Mode in 1_Phase Mode:



Press Output Mode on the right in MAIN PAGE to select any Mode for application.



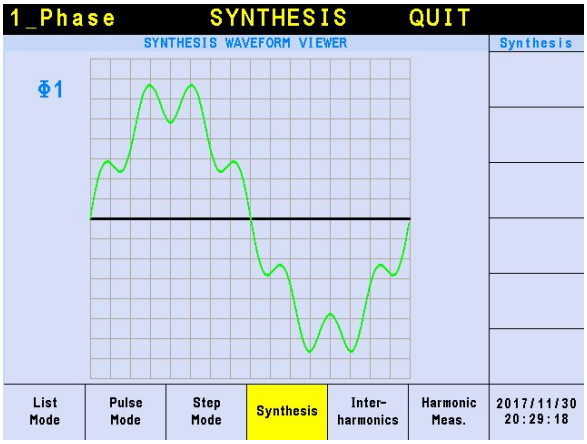
Next, press Synthesis at the bottom to go to the Synthesis Mode.



Press Edit on the right to go to the editing screen. Use the arrow keys to move the cursor to the appropriate column and use the numeric keys to key-in the setting, and then press **ENTER**. The example uses the following settings:

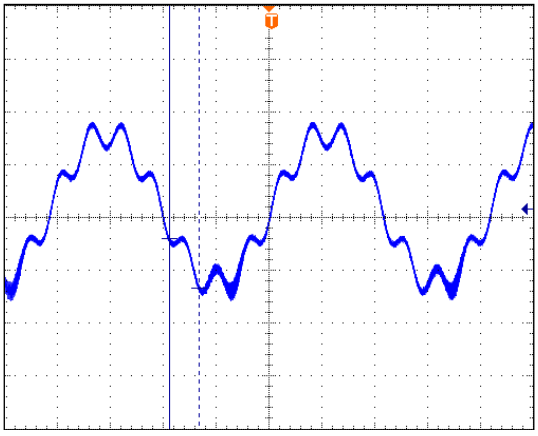
OUTPUT SETTING: Vac = 100V, F = 60Hz

Compose = Percent-1
Edit = Φ3
Vac fundamental = 100.0V
F fundamental = 60Hz
Vdc = 0.0V
Degree = 0.0°



Once the settings are edited, press View Waveform on the right to view the edited output waveform. Press Return to go to the previous page.

Press Execution Page on the right to return to the Synthesis Mode page. Next, press Run on the right to output the waveform.



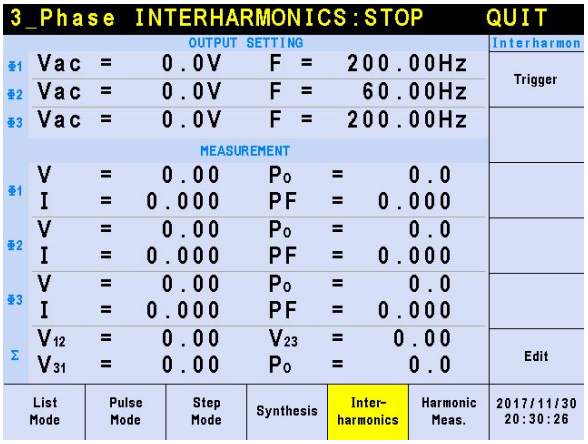
The figure above is the output voltage waveform of the AC Source, measured by an oscilloscope and is the same as the user edited waveform.

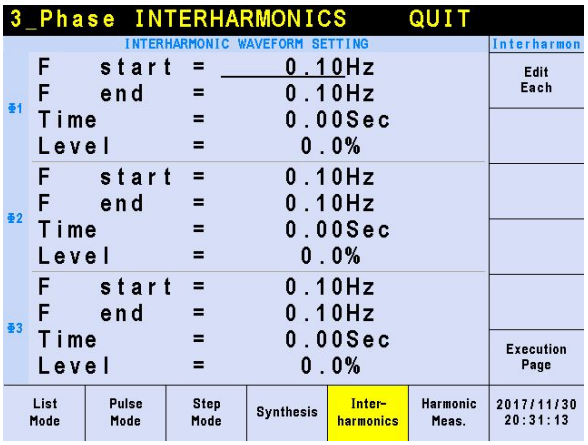
Notice

1. In order to protect the power stage of the AC Source it is necessary to limit the synthesis value or the percentage of each order.
   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%.
   41 ≤ order ≤ 50, value ≤ 30V or percentage ≤ 10% .
2. If the synthesis waveform exceeds the voltage limit, 494V for 350V range or 247V for 175V range, OUTPUT OVP will occur.

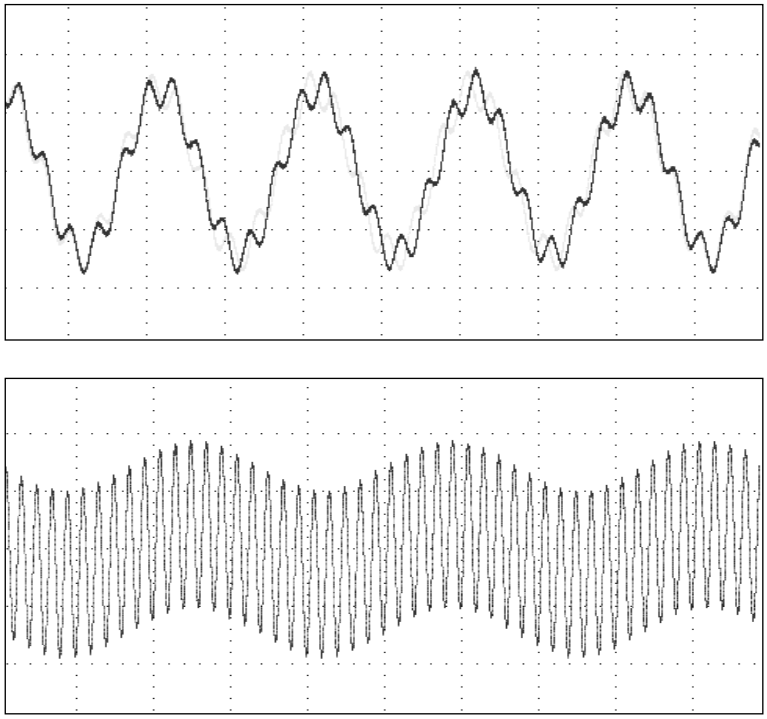
5.6 Inter-harmonics Waveform

Press Output Mode on the right in the MAIN PAGE (see 3.3) to enter into the Output Mode command line. Next press Inter-harmonics at the bottom to go to the Inter-harmonics command line. Press Edit on the right to enter the Inter-harmonics editing window.



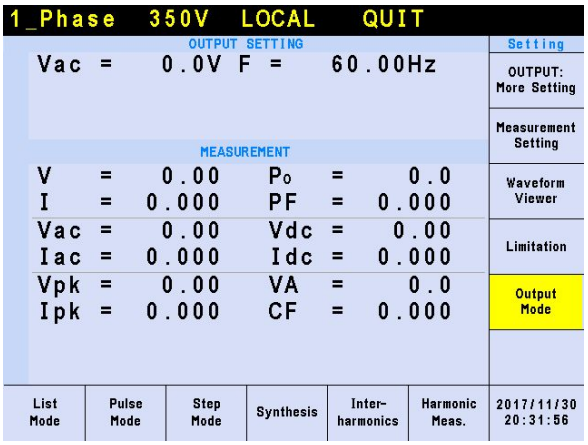


For the AC Source Inter-harmonics function, besides the fundamental voltage output, another frequency with a variable voltage component is added to test certain anti-interference. The following figure is an example of an inter-harmonic:

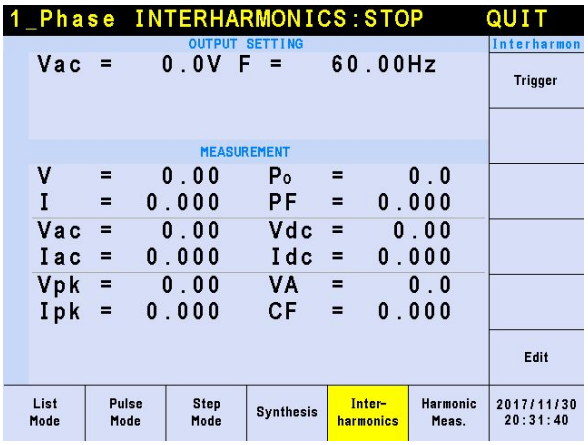


F start : The start frequency of the scanning wave. The range is 0.01Hz - 2400Hz.
F end : The end frequency of the scanning wave. The range is 0.01Hz - 2400Hz.
Level : The RMS of the scanning wave that is the percentage of the fundamental voltage set in MAIN PAGE.
Time : The scanning time from F start to F end.

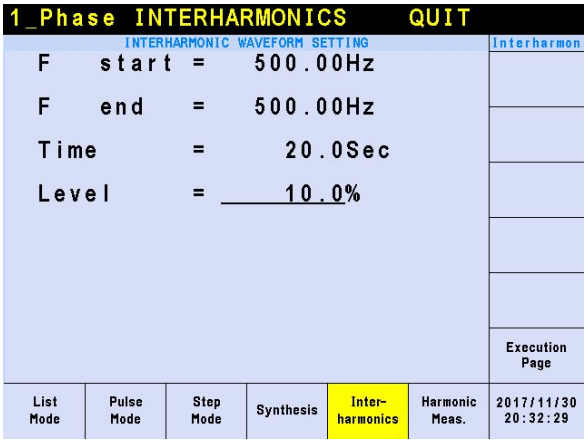
The following is an example using Inter-harmonics Mode in 1_Phase Mode:



Press Output Mode on the right in the MAIN PAGE to select any Mode for application.

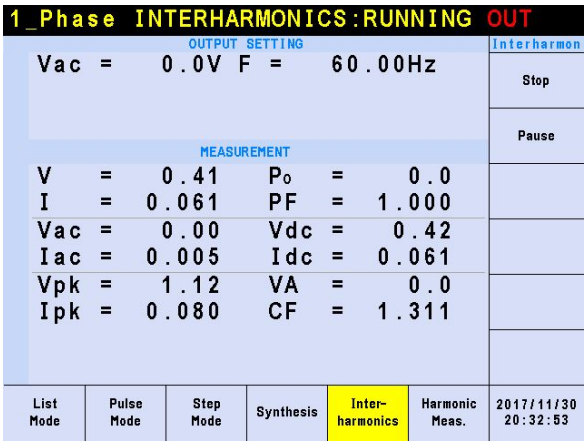


Next, press Inter-harmonics at the bottom to go to Inter-harmonics Mode.

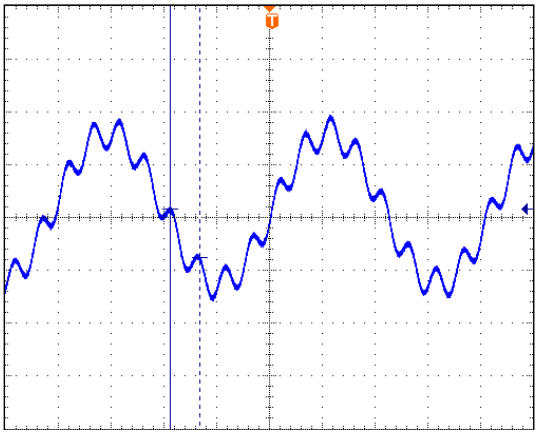


Press Edit on the right to go to the editing screen. Use the arrow keys to move the cursor to the column to be set and use the numeric keys to key-in the setting, and then press **ENTER**. The example uses the following settings:

OUTPUT SETTING: Vac = 60.0V F = 60Hz
F start = 500.0Hz
F end = 500.0Hz
Level = 20.0%
Time = 10.0Sec



Press Execution Page on the right to return to the Inter-harmonics Mode page. Next press Trigger on the right to output the waveform.



The figure above is the output voltage waveform of the AC Source measured by an oscilloscope and is the same as the user edited waveform.

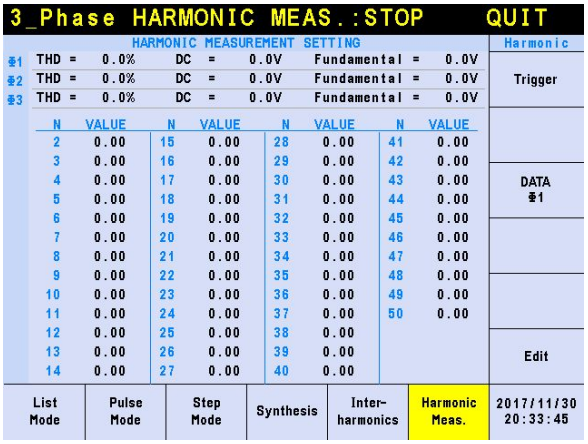
Notice

In order to protect the power stage of the AC Source it is necessary to limit the F start and F end related Level.

If 0.01Hz ≤ F start or F end ≤ 500Hz, Level ≤ 30%.
If 500Hz < F start or F end ≤ 1000Hz, Level ≤ 20%.
If 1000Hz < F start or F end ≤ 2400Hz, Level ≤ 10%.

5.7 Harmonic Waveform

Press Output Mode on the right in the MAIN PAGE (see 3.3) to enter into the Output Mode command line. Next press Harmonic Meas. at the bottom to go to the I Harmonic Meas. command line. This function can measure the Total Harmonic Distortion (THD) of the fundament frequency (50Hz or 60Hz), the DC current, the fundamental frequency of the output current or voltage, and measure 2 - 50 orders of harmonic values. Press Edit on the right to enter the Harmonic Meas. editing window.



Source = V / I: measures the source signal output voltage or output current.

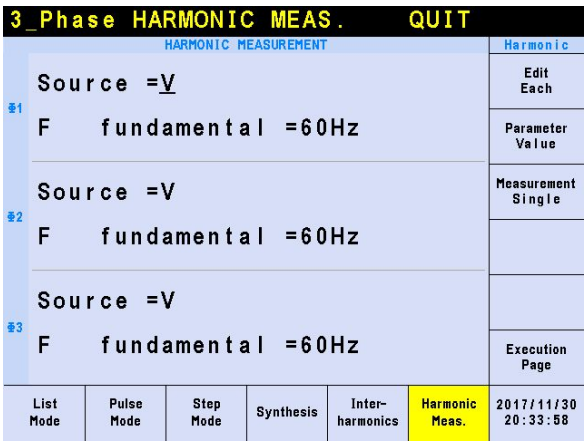
V: The output voltage.
I : The output current.

F fundamental = 50 / 60 Hz: The fundamental frequency of the source signal.
Measurement = Single / Continue: The way the measurement result displays on the LCD.

Single: The display will keep the measured data. It takes about 3 seconds to get the results.
Continue: The display updates the measured data. It takes about 10 seconds to get stable results.

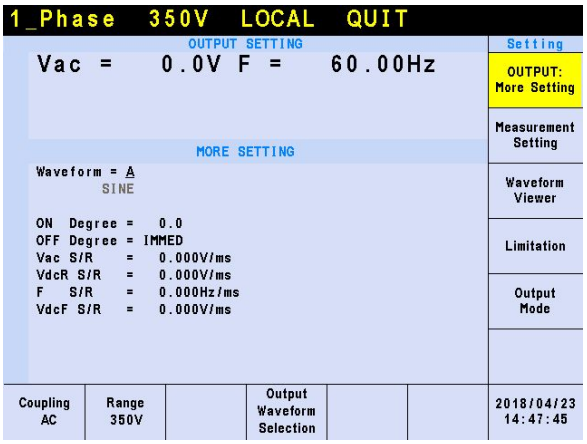
Parameter = Percent / Value: The data form of each harmonic component.

Percent: The percentage of the fundament frequency value.
Value: The absolute value.

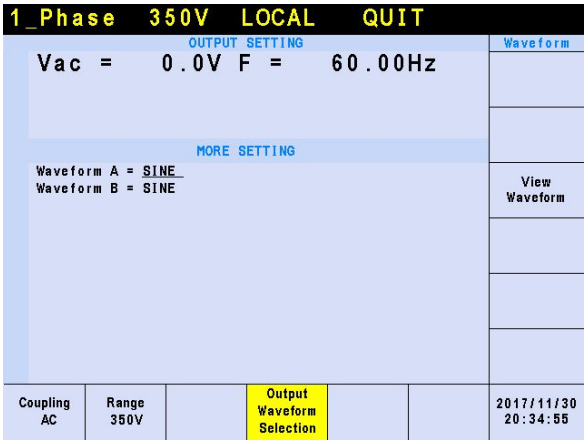


The following is an example using Harmonic Meas. Mode in 1_Phase Mode:

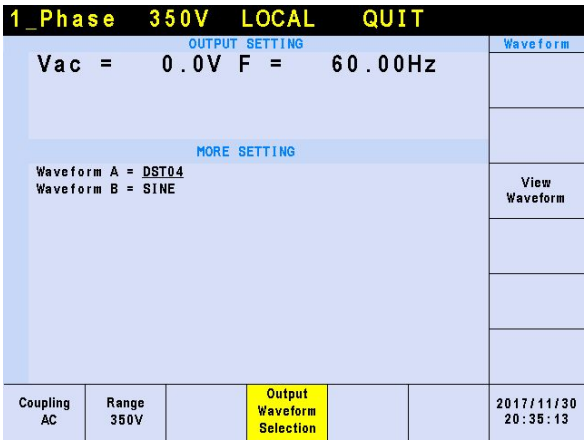
Press OUTPUT: More Settings on the right in the MAIN PAGE to enter into the output selections page.



Next, press Output Waveform Selection at the bottom to go to the output waveform selection page.

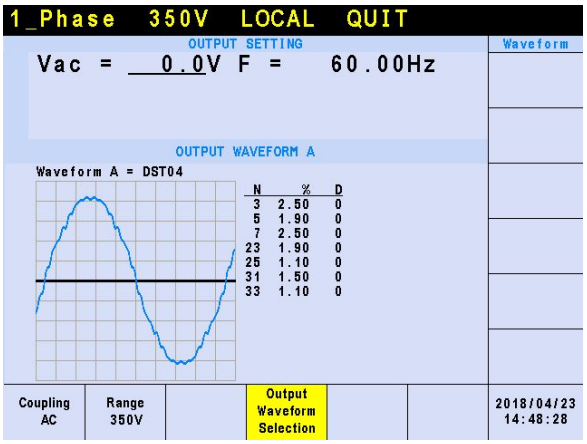


Set the Waveform A to DST04 waveform.

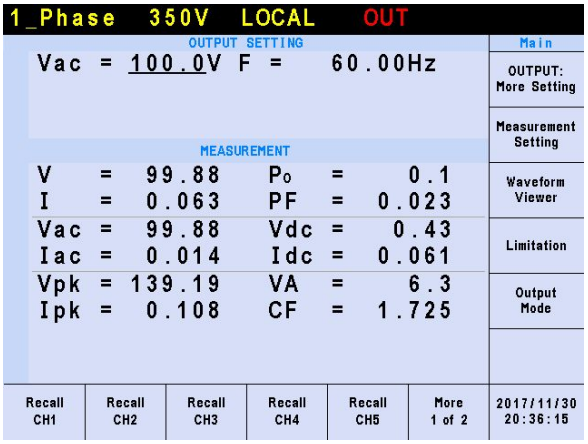


When the waveform setting is done, press View Waveform on the right to view the output

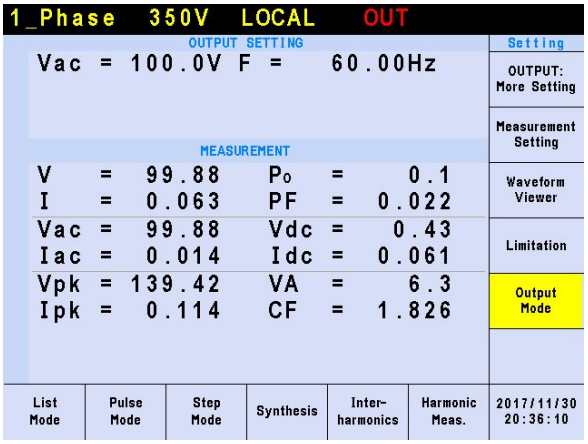
waveform, the ratio of each harmonic order, and the output angle.



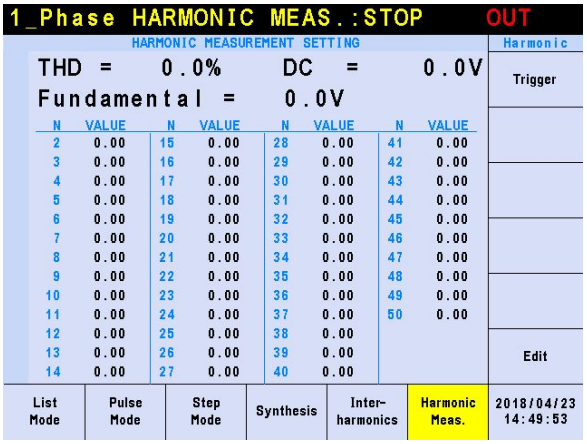
Press Return to go back to the MAIN PAGE and set the Vac to 100.0V, then press **OUT/QUIT** to output the waveform.



Press Output Mode on the right in the MAIN PAGE to select any Mode.

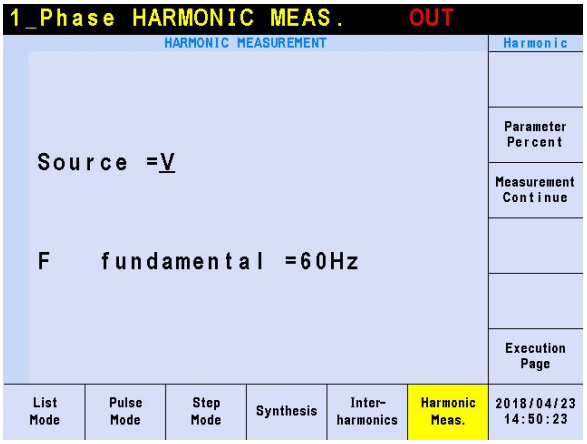


Next, press Harmonic Meas. at the bottom to go to the Harmonic Meas. Mode.

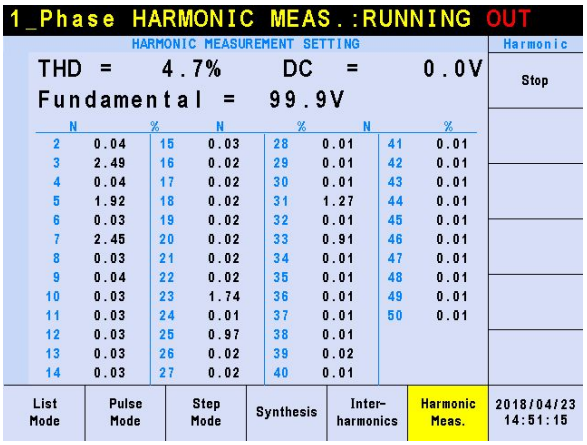


Press Edit on the right to go to the editing screen. Use the arrow keys to move the cursor to the column to be set and use the numeric keys to enter the setting, and then press **ENTER**. The example uses the following settings:

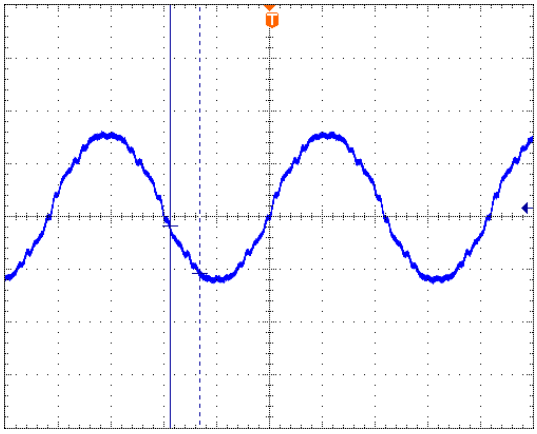
Source = V
F fundamental = 60 Hz
Measurement = Continue
Parameter = Percent



Press Execution Page on the right to return to the Harmonic Meas. Mode page. Press Trigger on the right to perform the output voltage harmonic measurement. After triggering, press DATA on the right to view the measurement of a phase.



The figure above is the output voltage waveform of the AC Source measured by an oscilloscope and is the same as the user edited waveform.



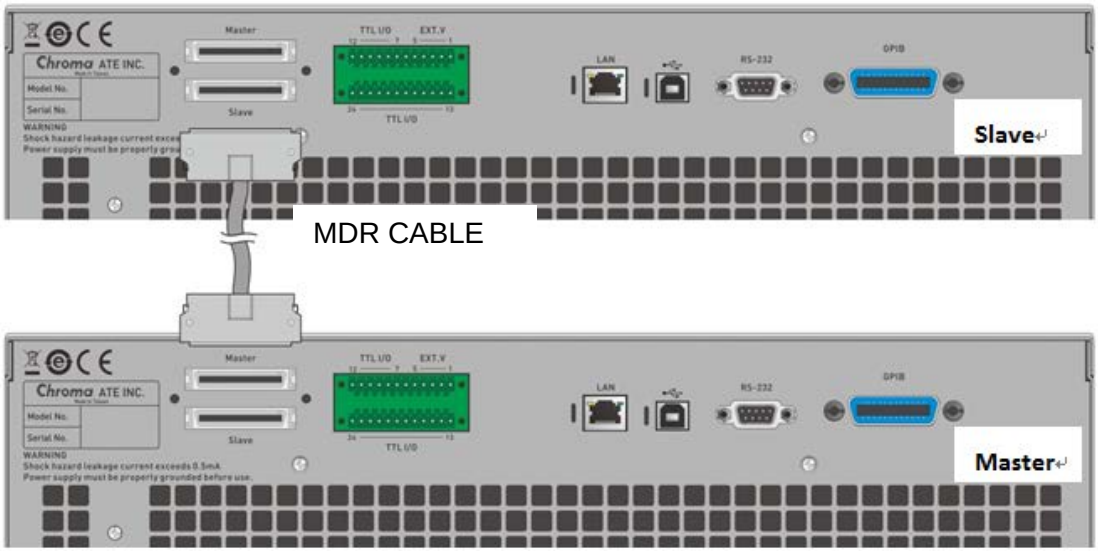
Notice

When Trigger is pressed to execute the current harmonic measurement, the AC Source will automatically adjust its internal gain based on the measured data so that the AC Source can get more accurate data of each harmonic. Wait for the load to be stable before executing the harmonic measurement. The load cannot be changed during a measurement or the retrieved data may lose its accuracy or cause an over current protection fault.

6. Parallel Operation

6.1 Parallel Connection of AC Sources

When two AC Sources (61507/61508/61509) are connected in parallel mode, they use an MDR cable to transmit parallel data. The following figure shows the parallel connecting diagram. Maximum one AC Source can be paralleled at present.



Notice

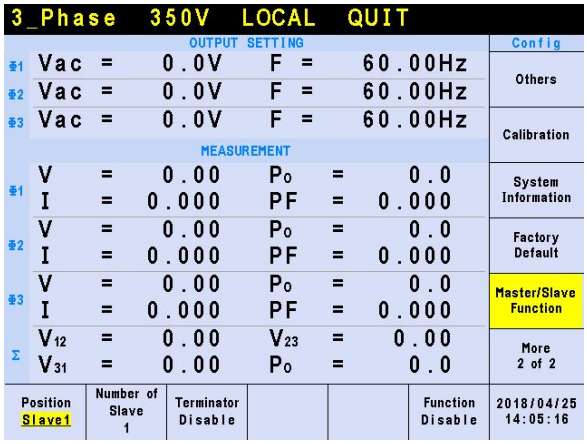
1. When the parallel mode is being used, connect the MDR cable correctly or it will cause a system connection error.
2. Before operating in parallel, the coupling setting of 2 AC sources needs be the same,otherwise it may cause output error.

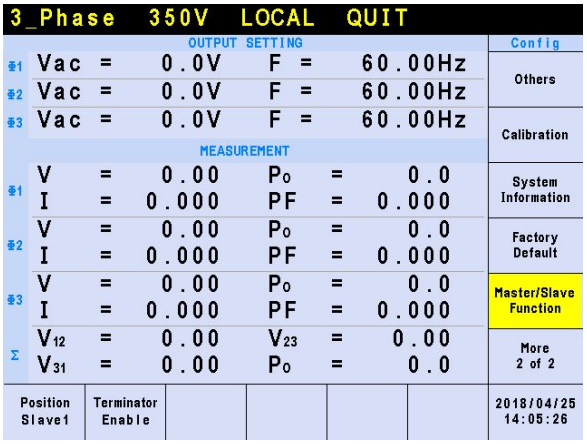
6.2 Setting Up

6.2.1 Setting the AC Source to Slave

To set an AC Source to Slave, press **CONFIG** in the **FUNCTION** keys to enter into the CONFIG function and select the Master/Slave Function to set the parallel connection. The procedure is listed below:

1. Press Position at the bottom.
2. Turn the RPG to change the Position to Slave and press **ENTER** to set it to Slave.
3. If the AC Source to be set is located between two terminals, press Terminator Disable and turn the RPG to change the Terminator to Enable and then press **ENTER** to set it.





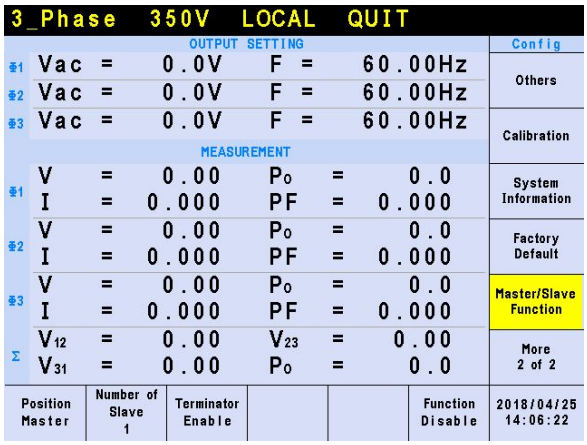
Notice This series of AC source can be used in parallel with a slave device.

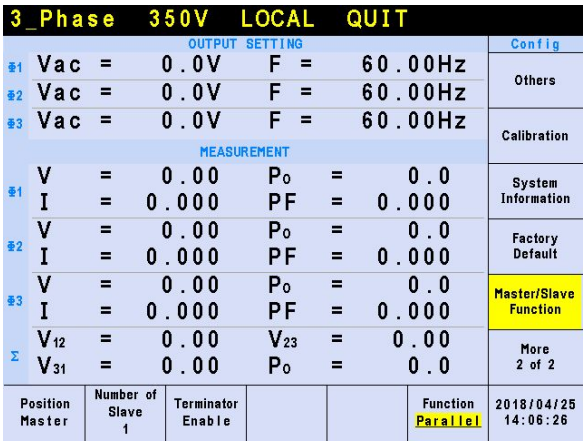
6.2.2 Setting the AC Source to Master

Press **CONFIG** in the **FUNCTION** keys to enter into the CONFIG function and select Master/Slave Function for parallel connection setting. The procedure is shown below:

1. Press Position at the bottom.
2. Turn the RPG to change the Position to Master and press **ENTER** to set it to Master.
3. Press Number of Slave at the bottom.
4. Turn the RPG to select the quantity of Slaves to connect in parallel and press **ENTER** to set it.
5. If the AC Source to be set is located between two terminals, press Terminator and turn the RPG to change the Terminator to Enable and then press **ENTER** to set it.
6. Press Function at the bottom.
7. Turn the RPG to change the Function to Enable and press **ENTER** to set it.
8. The device set to Master will return to the main menu and the one set to Slave will show Slave on the screen.

Notice At least one device needs to be set as Slave in a parallel application or it will show "System Connection Fail!" when setting the Master Enable. See the section below for a detailed description of troubleshooting.



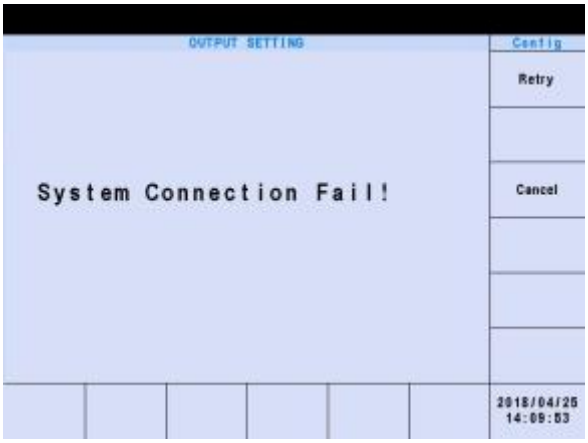


6.3 Troubleshooting

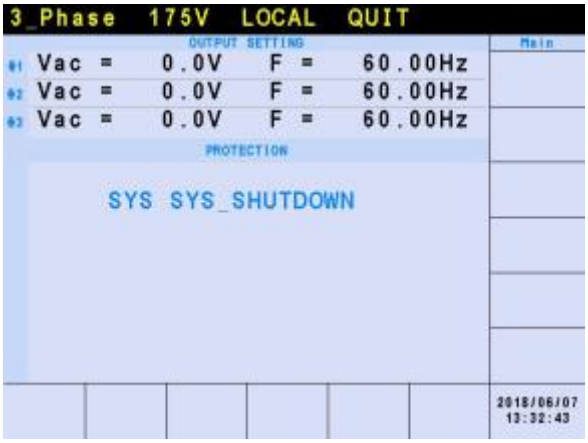
When multiple devices are connected in parallel, each standalone device has to have an MDR cable to transmit the signal. If the connection is busy or errors occurred during connection, follow the troubleshooting procedures below to resolve the problem and redo the parallel connection.

6.3.1 When the Connecting Cable Falls

If “System Connection Fail!” occurs when initiating the Master connection, check if the MDR cable is firmly connected and the other AC Source is set to Slave. When confirmed, press Retry on the Master to redo the connection.

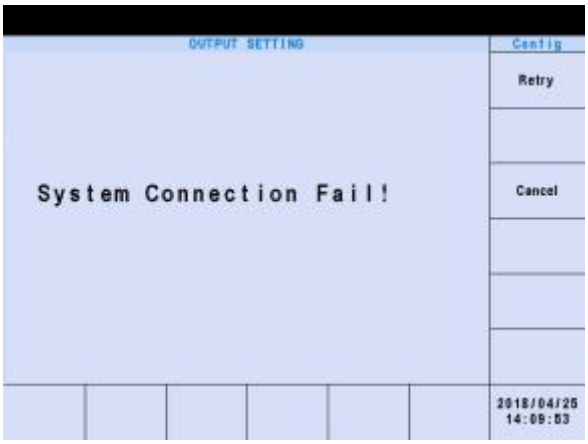


If “SYSTEM SHUTDOWN” occurs during connection, power the source off first and check if the MDR cable is firmly connected. If yes, reboot it and redo the connection.



6.3.2 Parallel Setting Error

If a "System Connection Fail!" occurred when connecting the Master, it could be a connection setting error. First, check if the Master connected devices (number of slaves) is the same as the actual number of slaves. Next, check if a parallel slave position is duplicated. The position set for slave cannot be duplicated. When confirmed, press Retry on the Master to attempt the connection again.



7. Theory of Operation

7.1 Overview

The 61507/61508/61509 AC source consists of several Printed Circuit Boards (PCB) and other components. Each of the PCBs has specific functions that are described in the following sections.

7.2 Description of Overall System

Figure 7-1 is an overall system diagram that is composed of the following portions:

- Input Stage I Board
  The I board converts the AC power to DC power with the active PFC function and isolates its output with regulation function. It can also provide the inverter a stable input DC source.

- Output Stage H/O/A Boards
  These boards are composed of an inverter that draws power from the I board allowing the 61507/61508/61509 to output DC or AC power.

- Auxiliary Power Z Board
  The Z board is an isolation DC/DC converter that converts the J board output to ±12Vdc and +5Vdc power to drive the ICs of the various PCBs and other components.

- Mains Detector J Board
  The J board detects if the mains is within the operating range. It cuts off the main circuit from the mains when abnormality occurs.

- EMI Filter L Board
  The L board is equipped with EMI filter and input fuse.

- Digital Signal Processor E Board
  The E board contains DSP, FPGA, and CPLD control elements that are responsible for the actions and measurements of the 61507/61508/61509 AC source. It is also has communication interfaces such as GPIB, RS-232, USB……and sends the signals back to the E board to accomplish the remote control function.

- Power Switch S Board
  The combination of S board and power switch transmits the start signal to J board that controls the on and off of the instrument.

- Key Input K/KL/KR Board
  The front panel key controls for the above PCBs that send the inputted signals to the E board.

- USB Port KU Board
  The USB HOST port connects to E board that can capture the screen patterns for storage.

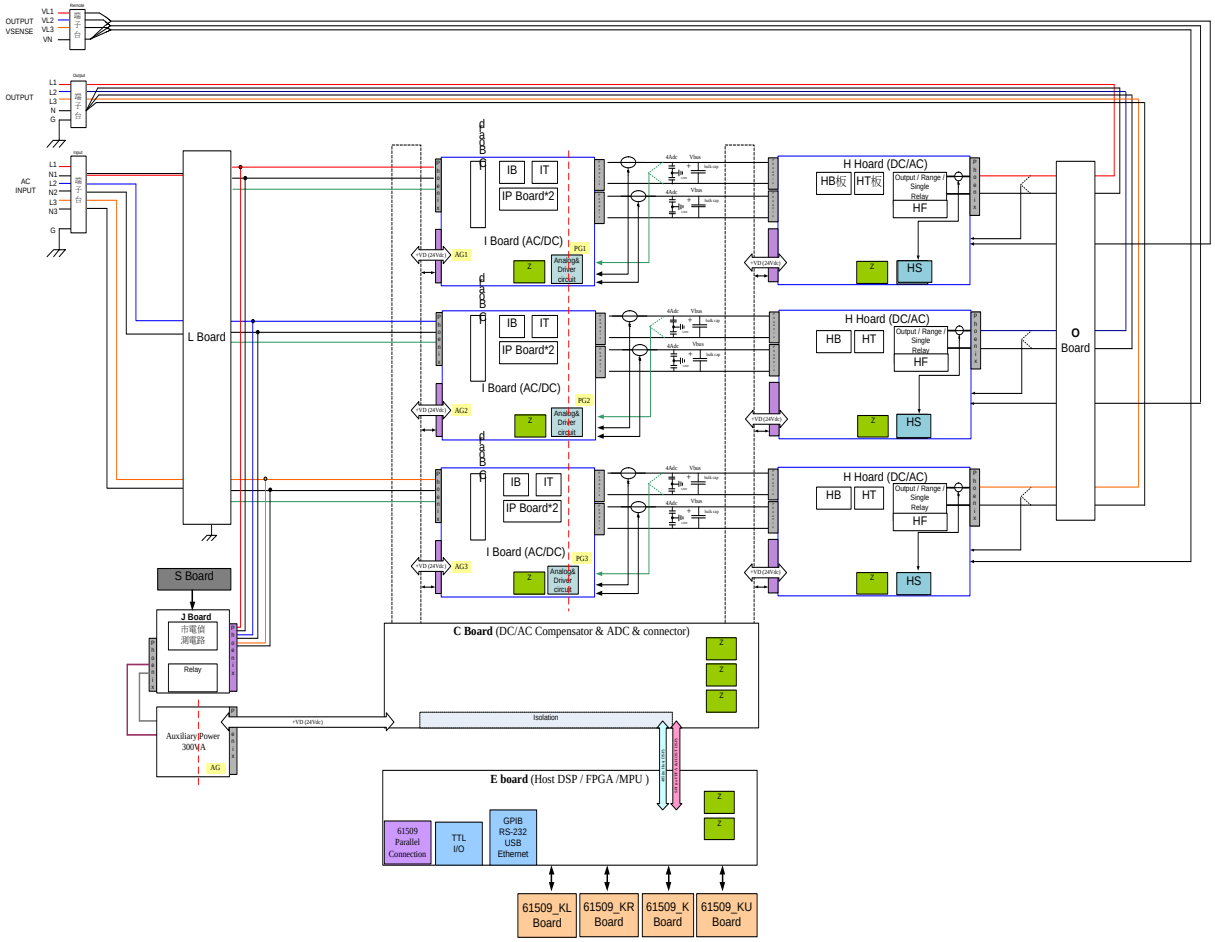


Figure 7-1 Overall System Diagram

8. Self Test and Troubleshooting

8.1 Overview

This chapter describes the self-test procedures and provides suggestions for troubleshooting when the AC Source is not operating normally. If the information provided here does not resolve the problem, contact your local Chroma distributor.

8.2 Self Test

The AC Source runs a series of self-tests during power-on. First, it executes the memory, data, and communication self-tests for the DISPLAY, WAVEFORM, and REMOTE. If any failure is detected in a certain item, an “error code” will display to the right of the item. The following table lists all of the error messages.

Error Code	Description	Remark
Bit 0	Memory error	0 – OK, 1 – ERROR
Bit 1	Waveform Generator 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 an error code shows " ERROR = 05 ", it is “00000101" in binary. Bit 0 and Bit 2 are “1”. So “ERROR = 05” means a memory error and a DATA error occurred.

Error Message	Description	Resolution
Memory error	Memory test failed.	Consult your dealer for further support
Waveform Generator error	Waveform generator test failed.	Consult your dealer for further support.
DATA error	The data in Flash or EEPROM test failed.	Consult your dealer for further support.
Communication error	Unable to send.	1. Power off the AC Source and wait for three seconds before powering it on again. 2. Consult your dealer for further support.

After the self-tests for memory, data, and communication, the AC Source executes the power output self-test. In this test, the output relays are OFF to protect any load connected to the output terminal from damage. An error message will appear on the panel if an abnormal condition is encountered during self-test.

8.3 Troubleshooting

The following table lists possible operating problems and suggested corrective actions:

Problem	Cause	Resolution
Poor measurement of V, I.	Aged components result in deviation of characteristics.	Periodic calibration is required. Refer to Chapter *4 Calibration*.
Output distortion	1. The output voltage of AC Source is too low. 2. The rectified load is too large during high frequency.	1. Program higher output voltage. 2. Reduce the load or output frequency.
Over Temperature Protection (OTP)	1. The ambient temperature is too high. 2. The airway is obstructed.	1. Operate the unit between 0 - 40°C. 2. Unblock the airway.
Over Power Protection (SYS OPP)	The output power exceeds the specification.	Reduce the output power or output voltage.
Over Current Protection (SYS OCP)	The output current exceeds the specification or I LIMIT.	Remove the overload or expand the I LIMIT.
Output Short Protection (SYS SHORT)	1. The output is shorted. 2. External current reversed.	1. Remove the short state. 2. Remove the load.
Input error protection (SYS INT_LINE)	The line input voltage of the AC Source is too low or too high.	Measure the input voltage and regulate it if over specification.
AD_PFC_OVP AD_PFC_UVP protection	1. Cycle dropout for line input voltage. 2. Instant over current during output. 3. The AD power stage is damaged.	1. Check the stability of the input voltage. 2. Remove the load. 3. If the protection cannot be reset, consult the dealer for assistance.
DD_VDC1_OVP DD_VDC1_UVP DD_VDC2_OVP DD_VDC2_UVP protection	1. Cycle dropout for line input voltage. 2. Instant over current during output. 3. The DD power stage is damaged.	1. Check the stability of the input voltage. 2. Remove the load. 3. If the protection cannot be reset, consult the dealer for assistance.
SENSE FAULT protection	1. Remote Sense is open. 2. Output voltage peak exceeds the range.	1. Connect the output to Remote Sense terminals. 2. Check the settings of Vac and Vdc on MAIN PAGE.
AD_FAN_FAIL DA_FAN_FAIL fan protection	1. The fan stops operation due to obstruction. 2. The fan is not inserted.	1. Clear the fan obstruction. 2. If the protection cannot be reset, consult the dealer for assistance.
Unable to control AC Source via GPIB	1. The address of AC Source is incorrect. 2. GPIB cable is loose at rear.	1. Update the address. 2. Check the connection and tighten the screws.

9. Remote Operation

9.1 Introduction

The AC Source is able to do remote control via USB, GPIB, RS-232, or Ethernet. The USB interface supports USB 2.0/USB 1.1. The GPIB interface is an 8-bit parallel data bus that is synchronized by the bus commands from the host. The RS-232C interface is a serial bus with less powerful functions; however, the user can do basic remote control via simple programs.

9.1.1 USB Interface

(1) Hardware Support: USB 2.0 and USB 1.1
(2) Software Support: USBTMC class and USB488 subclass
(3) OS Support: Windows 98/2000/XP/Vista
(4) Installing Driver: The AC Source USB Interface supports USBTMC, so if the PC OS supports USBTMC (installed NI-VISA runtime version 3.00 or above) there is no need to install other drivers. The OS will search for the standard USBTMC driver installation program automatically.

If the PC OS does not support USBTMC, install the NI-VISA runtime version 3.00 or above first. When the installation of the NI-VISA runtime is done, the USBTMC driver program is stored in the OS. The PC can communicate with the AC Source via NI-VISA after using the USB cable to connect them.

Related Documents:
1. USB Test and Measurement Class (USBTMC) specification, Revision 1.0, http://www.usb.org
2. USB Test and Measurement Class USB488 subclass specification, Revision 1.0, http://www.usb.org

9.1.2 GPIB Interface

The default GPIB address is 30 and it can only be changed from the “CONFIG” function menu (see 3.4.)

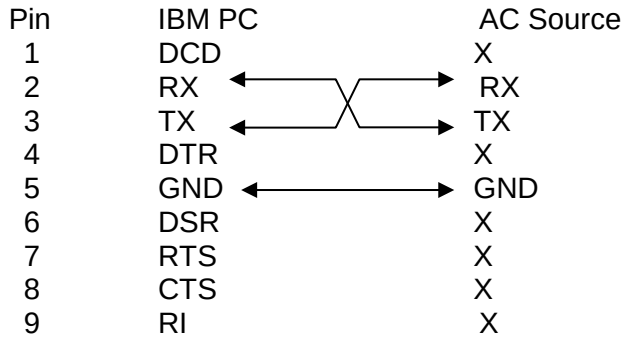
GPIB Capability	Description	Interface Function
Talker/Listener	Commands and response messages can be sent and received via the GPIB bus. Status information can be retrieved by serial query.	AH1, SH1, T6, L4
Service Request	The AC Source sets the SRQ to be true if there is a service request.	SR1
Remote/Local	When the AC Source is powered on in local mode, all front panel keys are valid. In remote mode, all keys are invalid except **LOCAL/REMOTE**. Press **LOCAL/REMOTE** to return to local mode.	RL1

9.1.3 RS-232C Interface

The baud rate of the AC Source is set to **115200** with parity set to None. For the RS-232C, parameters such as baud rate and parity can be set via the "CONFIG" function menu (see section 3.4.) Only TxD and RxD signals are used for data transmission. The connector is a 9-pin D-subminiature male connector. The following table describes the pins and signals of the RS-232C connector.

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

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



9.1.4 Ethernet Interface

To remote program an AC Power Supply via a PC through an Ethernet interface, the IP address, Gateway address, and Subnet mask need to be defined in advance (see 3.4.1.3 for detailed settings). TCP is used to ensure reliable data transmission. The communication port is 2101.

9.2 Introduction to Programming

All commands and response messages are transmitted in ASCII code. The response messages must be read completely before sending a new command, otherwise the remaining response messages will be lost and a query interrupt error will occur.

9.2.1 Conventions

Angle brackets	<	>	Items in angle brackets are parameter abbreviations.
Vertical bar		|	Vertical bar separates alternate 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.

9.2.2 Numerical Data Formats

All data programmed to or returned from the AC Source are in ASCII. The data can be numerical or character string.

Symbol	Description	Example
NR1	A digit with no decimal point. The decimal is assumed to be on 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

9.2.3 Boolean Data Format

Boolean parameter <Boolean> applies only to ON|OFF format.

9.2.4 Character Data Format

The character strings returned by a query command may be in either of the following forms:

<CRD> Character Response Data: character string with maximum length of 12.

<SRD> String Response Data: character string.

9.2.5 Basic Definition

Command Tree Table:

The commands of the AC Source are structured hierarchically, which is referred to as a ‘tree system’. The full path must be specified to obtain a particular command. 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 a position to the right under the parent node.

Program Header:

Program header is the key word used to identify the command according to the IEEE 488.2 syntax described in section 9.5. The AC Source accepts characters in both upper and lower cases without any distinction. The program header consists of two unique types: the common command header and the instrument-controlled header.

Common Command and Query Header:
The syntax of common commands and query headers are described in IEEE 488.2. They are used along with the IEEE 488.2 defined common commands and queries. The commands with leading "*" are common commands.

Instrument-Controlled Header:
An instrument-controlled header can be applied to all instrument commands. Each header has a long form and a short form. The AC Source only accepts the exact short and long forms. A special notation is used to distinguish the short form header from the long one of the same type in this section. The short form of the header is shown by upper case characters while the rest of the headers are shown in lower case.

Program Header Separator (:):
If a command has more than one header, a colon must be used to separate them (FETC: CURR?, VOLT:DC 10). At least one space is required to separate the data and program header.

Program Message:
The program message consists of many elements including zero sequence or message components that are separated by the separator (semicolon.)

Program Message Component:
A program component is a single command, programming data, or query.

Example: FREQ?, OUTPut ON.

Program Message Component Separator (;):
The separator (semicolon ;) separates the program message components from one another in a program message.

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

Program Message Terminator (<PMT>):
A program message terminator can end the program message. Three permitted terminators are:
(1) <END>: end or identify (EOI)
(2) <NL>: new line, which is a single ASCII encoded byte 0A (decimal10).
(3) <NL> <END>: new line with EOI.

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

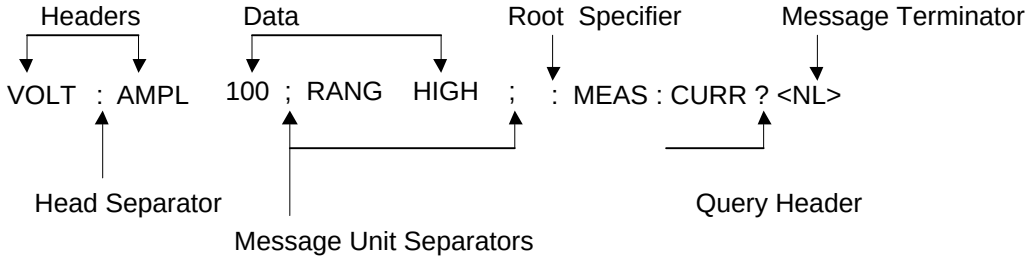


Figure 9-1 Structure of Command Message

9.3 Traversal of the Command Tree

Multiple program message units can be sent in one program message. The first command usually refers to the root node. Subsequent commands refer to the tree level the same as the previous command in a program message. When the colon is ahead of the program message component it changes the header path to root level.

Example:

OUTPut : PROTection : CLEar	All colons are header separators.
OUTPut : PROTection : CLEar; : VOLT : AC 100	Only the third colon is a specified root.

9.4 Execution Order

The AC Source executes program messages in the order received. Problems may occur if the sequence is not followed.

For example, if the current output voltage range is set to LOW, and the desired output voltage range for the new state is HIGH with amplified 220 Volt, and the commands

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

are sent out, an out of range error will appear.

9.5 AC Source Commands

This section describes the syntax and parameters of all the commands for the AC Source.

Syntax Form	The long format header is used for syntax definition; however, only the short format header syntax appears in the examples.
Parameter	Most commands require a parameter.
Return Parameter	All queries return a parameter.
Model	If a command applies to specific models, these models will be listed in the Model only entry. If there is no Model only entry, the command applies to all models.

9.5.1 Common Command Dictionary

The 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 enabled events of the Standard Event registers are set, the ESB of the 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 Completed
PON = Power On QYE = Query Error

*ESE? Returns standard event status enabled.

*ESR? The query reads the Standard Event settings of the Event register and clears it. The bits of configuration are the same as the Standard Event Status Enabled Register.

*IDN? Returns the AC Source identification string.
Returned parameter Chroma ATE,61500,123456,01.00
Chroma ATE : Company name
61500 : Model name
123456 : Serial number
01.00 : Firmware version

*RCL<n> Restores the values of the specified group previously stored in memory.
Parameter 1 - 10

*SAV<n> Saves the values to a specified group in memory.
Parameter 1 - 10

* RST Resets the AC Source to its initial state. Wait for 3 seconds before sending the next command.

*SRE Sets the 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 the 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
QUES = Questionable Status Summary
RQS = Request for Service
MSS = Master Status Summary
MAV = Message Available

* TST? Queries the self-test result of the AC Source.

9.5.2 Instrument Command Dictionary

The commands are listed in alphabetical order. Commands followed by question marks (?) are in the form of a query. When a command has both command and query forms, it is noted in the description of the query syntax.

9.5.2.1 SYSTEM Subsystem

SYSTem
:ERRor?
:VERSion?
:LOCal
:REMote
:DATE
:TIME

SYSTem:ERRor?
Description : This command queries the error string of the command parser.
Query Syntax : SYSTem:ERRor?
Parameter : None
Return Parameter : Error string response: 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?
Parameter : None
Return Parameter : Current version (XX.XX)

SYSTem:LOCal
Description : This command is only valid when the AC Source is being controlled through the RS-232C interface. If SYST: LOC is programmed, the AC source will be set in the LOCAL state, and the front panel will work.
Query Syntax : None
Parameter : None
Return Parameter : None

SYSTem:REMote
Description : This command is only valid when the AC Source is being controlled through the RS-232C interface. 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
Parameter : None
Return Parameter : None

SYSTem:DATE

Description : This command sets the date of the AC Source real time clock.
Query Syntax : SYSTem:DATE?
Parameter : <year>,<month>,<day>
Return Parameter : 2008,01,01

SYSTem:TIME

Description : This command sets the time (24H) of the AC Source real time clock.
Query Syntax : SYSTem:TIME?
Parameter : <hour>,<minute>,<second>
Return Parameter : 20,30,01

9.5.2.2 INSTRUMENT Subsystem

INSTrument

:EDIT
:Couple
:NSELect
:SELect
:PHASe

INSTrument:EDIT

Description : This command sends a programmed command to set all phases at the same time for an AC Source that is equipped with multiple phases. If INST: EDIT ALL has been programmed, the command will be sent to all phases. INST: EDIT EACH command disables the EDIT ALL command.
Query Syntax : INSTrument:EDIT?
Parameter : EACH | ALL
Return Parameter : None

INSTrument : COUPle

Description : This command sends a programmed command to set all phases at the same time for an AC Source that is equipped with multiple phases. If INST: COUP ALL has been programmed, the command will be sent to all phases. INST: COUP NONE command disables the COUP ALL command.
Query Syntax : INSTrument : COUPle?
Parameter : NONE | ALL
Return Parameter : None

INSTrument : NSELect

Description : This command sets individual outputs for subsequent commands or queries in a multi-phase model. If INST: COUP NONE has been programmed, the phase selection command will be sent to the specific output phase set by INSTrument: NSELect. If INST: COUP ALL has been programmed, all remote operation commands will be sent to all output phases. This command only affects the set voltage and queries the measurement data. For instance, if "INST: COUP ALL ", "INST : NSEL 2" and "Meas : VOLT?" are programmed, the AC Source will return the Φ 2 measurement voltage. INST: NSEL

uses the number to select the phase.
Query Syntax : INSTrument : NSELect?
Parameter : 1 | 2 | 3
Return Parameter : 1 | 2 | 3

INSTrument : SELect
Description : This command sets individual outputs for subsequent commands or queries in the multi-phase model. If INST: COUP NONE has been programmed, the phase selection command will be sent to the specific output phase set by INSTrument: SELect. If INST: COUP ALL has been programmed, all remote operation commands will send to all output phases. This command only affects the set voltage and queries the measurement data. For instance, if “INST: COUP ALL ”, “INST: SEL OUTPUT2” and “Meas: VOLT?” are programmed, the AC Source will return the Φ 2 measurement voltage. INST: SELect uses the number to select the phase.
Query Syntax : None
Parameter : OUTPUT1 | OUTPUT2 | OUTPUT3
Return Parameter : None

INSTrument : PHASe
Description : Switches between single phase and three-phase mode.
Query Syntax : INSTrument : PHASe?
Parameter : THREE | SINGLE
Return Parameter : THREE | SINGLE

9.5.2.3 FETCH and MEASURE Subsystem

FETCh | MEASure

[: SCALar]	
: CURRent	
: AC?	Queries the RMS current of the AC component.
: DC?	Queries the DC current level.
: ACDC?	Queries the current (AC+DC) RMS.
: AMPLitude : MAXimum?	Queries the peak current.
: CRESTfactor?	Queries the current crest factor.
: INRush?	Queries the inrush current.
: FREQuency?	Queries the frequency.
: POWer	
: AC	
[: REAL]?	Queries the real power.
: APParent?	Queries the apparent power.
: REACtive?	Queries the reactive power.
: PFACtor?	Queries the power factor.
: TOTal?	Queries the total power.
: TOTal : APParent?	Queries the total apparent power.
:VOLTage	
: AC?	Queries the RMS voltage of the AC component.
: DC?	Queries the DC voltage.
: ACDC?	Queries the RMS voltage
: AMPLitude : MAXimum?	Queries the peak voltage.
:LINE	

:V12?	Queries the voltage difference of phase 1 & 2.
:V23?	Queries the voltage difference of phase 2 & 3.
:V31?	Queries the voltage difference of phase 3 & 1.

This command enables users to get measurement data from the AC Source via MEASure and FETCh. MEASure triggers the acquisition to get new data before returning data, while FETCh returns the previously acquired data from the measurement buffer.

FETCh [: SCALar] : CURRent : AC?
MEASure [: SCALar] : CURRent : AC?
Description : These queries return the RMS current of the AC component that is output from the output terminal.
Query Syntax : FETCh : CURRent : AC?, MEASure : CURRent : AC?
Return Parameter : <NR2>

FETCh [: SCALar] : CURRent : DC?
MEASure [: SCALar] : CURRent : DC?
Description : These queries return the DC current that is output from the output terminal.
Query Syntax : FETCh : CURRent : DC?, MEASure : CURRent : DC?
Return Parameter : <NR2>

FETCh [: SCALar] : CURRent : ACDC?
MEASure [: SCALar] : CURRent : ACDC?
Description : These queries return the RMS current that is output from the output terminal.
Query Syntax : FETCh : CURRent : ACDC?, MEASure : CURRent : ACDC?
Return Parameter : <NR2>

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

FETCh [: SCALar] : CURRent : CREStfactor?
MEASure [: SCALar] : CURRent : CREStfactor?
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 : CREStfactor?
MEASure : CURRent : CREStfactor?
Return Parameter : <NR2>

FETCh [: SCALar] : CURRent : INRush?
MEASure [: SCALar] : CURRent : INRush?
Description : These queries return the inrush current that is output from the output terminal.
Query Syntax : FETCh:CURRent: INRush?, MEASure: CURRent : INRush?
Return Parameter : <NR2>

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

FETCh [: SCALar] : POWer : AC [: REAL] ?
MEASure [: SCALar] : POWer : AC [: REAL] ?
Description : These queries return the real power that is output from the output terminals in watts.
Query Syntax : FETCh : POWer : AC?
MEASure : POWer : AC?
Return Parameter : <NR2>

FETCh [: SCALar] : POWer : AC : APParent?
MEASure [: SCALar] : POWer : AC : APParent?
Description : These queries return the apparent power that is output from the output terminals in volt-amperes.
Query Syntax : FETCh : POWer : AC : APParent?
MEASure : POWer : AC : APParent?
Return Parameter : <NR2>

FETCh [: SCALar] : POWer : AC : REACtive?
MEASure [: SCALar] : POWer : AC : REACtive?
Description : These queries return the reactive power that is output from the output terminals in volt-amperes. Reactive power is calculated by the following formula:

$$VAR = \sqrt{APPARENTPOWER^2 - REALPOWER^2}$$

Query Syntax : FETCh : POWer : AC : REACtive?
MEASure : POWer : AC : REACtive?
Return Parameter : <NR2>

FETCh [: SCALar] : POWer : AC : PFACtor?
MEASure [: SCALar] : POWer : AC : PFACtor?
Description : These queries return the power factor that is output from the output terminals. Power factor is computed by:
PF = TRUE POWER / APPARENT POWER
Query Syntax : FETCh : POWer : AC : PFACtor?
MEASure : POWer : AC : PFACtor?
Return Parameter : <NR2>

FETCh [: SCALar] : POWer : AC : TOTal ?
MEASure [: SCALar] : POWer : AC : TOTal ?
Description : These queries return the total real power that is output from the 3-phase output terminal in watts.
Query Syntax : FETCh : POWer : AC : TOTal?
MEASure : POWer : AC : TOTal?
Return Parameter : <NR2>

FETCh [:SCALar]:POWer:AC:TOTal:APParent?
MEASure [:SCALar]:POWer:AC:TOTal:APParent?
Description : These queries return the total apparent power that is output from

the 3-phase output terminal in volt-amperes.
Query Syntax : FETCh:POWer:AC:TOTal:APParent?
MEASure:POWer:AC:TOTal:APParent?
Return Parameter : <NR2>

FETCh [: SCALar] : VOLTage : AC?
MEASure [: SCALar] : VOLTage : AC?
Description : These queries return the RMS of the AC component that is output from the output terminal.
Query Syntax : FETCh [: SCALar] : VOLTage : AC?
MEASure [: SCALar] : VOLTage : AC?
Return Parameter : <NR2>

FETCh [: SCALar] : VOLTage : DC?
MEASure [: SCALar] : VOLTage : DC?
Description : These queries return the DC composite voltage that is output from the output terminal.
Query Syntax : FETCh [: SCALar] : VOLTage : DC?
MEASure [: SCALar] : VOLTage : DC?
Return Parameter : <NR2>

FETCh [: SCALar] : VOLTage : ACDC?
MEASure [: SCALar] : VOLTage : ACDC?
Description : These queries return the RMS that is output from the output terminal.
Query Syntax : FETCh [: SCALar] : VOLTage : ACDC?
MEASure [: SCALar] : VOLTage : ACDC?
Return Parameter : <NR2>

FETCh [: SCALar] : VOLTage: AMPLitude : MAXimum?
MEASure [: SCALar] : VOLTage : AMPLitude : MAXimum?
Description : These queries return the absolute value of the peak voltage.
Query Syntax : FETCh : VOLTage: AMPLitude : MAXimum?,
MEASure : VOLTage : AMPLitude : MAXimum?
Return Parameter : <NR2>

FETCh [: SCALar] : LINE : V12?
MEASure [: SCALar] : LINE : V12?
Description : These queries return the line voltage between phase 1 and 2.
Query Syntax : FETCh [: SCALar] : LINE : V12?
MEASure [: SCALar] : LINE : V12?
Return Parameter : <NR2>

FETCh [: SCALar] : LINE : V23?
MEASure [: SCALar] : LINE : V23?
Description : These queries return the line voltage between phase 2 and 3.
Query Syntax : FETCh [: SCALar] : LINE : V23?
MEASure [: SCALar] : LINE : V23?
Return Parameter : <NR2>

FETCh [: SCALar] : LINE : V31?
MEASure [: SCALar] : LINE : V31?
Description : These queries return the line voltage between phase 3 and 1.

Query Syntax : FETCh [: SCALar] : LINE : V31?
MEASure [: SCALar] : LINE : V31?
Return Parameter : <NR2>

9.5.2.4 OUTPUT Subsystem

OUTPut
[: STATe]
: RELay
: SLEW
: VOLTage
: AC
: DC
:FREQency
: COUPling
: MODE
: PROTection
:CLEar
: IMPedance
: STATe
: RESistor
: INDuction

OUTPut [: STATe]
Description : This command enables or disables the output of the AC Source. Disabled output sets the output voltage amplitude to 0 Volt.
Query Syntax : OUTPut [: STATe]?
Parameter : OFF | ON
Return Parameter : OFF | ON

OUTPut : RELay
Description : This command sets the output relay ON or OFF.
Query Syntax : OUTPut : RELay?
Parameter : 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 Parameter : OFF | ON

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

OUTPut : SLEW : VOLTage : DC
Description : This command sets the slew rate of the DC composite voltage.
Query Syntax : OUTPut : SLEW : VOLTage : DC?
Parameter : <NR2>, the valid range is 0.000V/ms - 1200.000V/ms.
Return Parameter : <NR2>

OUTPut : SLEW : FREQuency
Description : This command sets the slew rate of the output frequency.
Query Syntax : OUTPut : SLEW : FREQuency?

Parameter : <NR2>, the valid range is 0.000 Hz/ms - 1600.000Hz/ms
Return Parameter : <NR2>

OUTPut : COUPling

Description : This command selects the coupling of the output signals.
Query Syntax : OUTPut : COUPling?
Parameter : AC | DC | ACDC
Return Parameter : AC | DC | ACDC

OUTPut : MODE

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

OUTPut : PROTection : CLEar

Description : This command clears the latch that disables the output when over current (OCP), over temperature (OTP), over power (OPP), or remote inhibit (RI) is detected. All conditions that generate the faults must be resolved before the latch is cleared.
Query Syntax : None
Parameter : None
Return Parameter : None

9.5.2.5 SOURCE Subsystem

[SOURce :]

```
CURRent
    : LIMit
    : DELay
    : INRush
        : STARt
        : INTerval
    :RANGe
FREQency
    [: {CW | IMMediate}]
     : LIMit
VOLTage
    [: LEVel][: IMMediate][:AMPLitude]
        : AC
        : DC
    : LIMit
        : AC
        : DC
            : PLUS
            : MINus
    : RANGe

POWer
    : PROTection

FUNCtion
    : SHAPe
    : SHAPe
            : A
            : A
                : MODE
                : THD
                : AMP
            : B
            : B
                : MODE
                : THD
                : AMP
```

[SOURce :] CURRent : LIMit

Description : This command sets the RMS current limit of the AC Source for over current protection.
Query Syntax : [SOURce :] CURRent : LIMit?
Parameter : <NR2>, the valid range is 0.00 - maximum current spec. of the specific model (unit: A.)
Return Parameter : <NR2>

[SOURce :] CURRent : DELay

Description : This command sets the time delay for triggering over current protection.
Query Syntax : [SOURce :] CURRent : DELay?

Parameter : <NR2>, the valid range is 0.0 - 5.0 (unit: 0.1 second.)
Return Parameter : <NR2>

[SOURce :] CURRent : INRush : STARt
Description : This command sets the time to start the inrush current measurement.
Query Syntax : [SOURce :] CURRent : INRush : STARt?
Parameter : <NR2>, the valid range is 0 - 9999 (unit: ms.)
Return Parameter : <NR2>

[SOURce :] CURRent : INRush : INTerval
Description : This command sets the measuring interval for the inrush current measurement.
Query Syntax : [SOURce :] CURRent : INRush : INTerval?
Parameter : <NR2>, the valid range is 0 - 9999 (unit: ms.)
Return Parameter : <NR2>

[SOURce :] FREQuency [: {CW | IMMediate}]
Description : This command sets the output waveform frequency of the AC Source in Hz.
Query Syntax : [SOURce :] FREQuency [: {CW | IMMediate}]?
Parameter : <NR2>, the valid range is 15.00 - 2000.0 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] FREQuency : LIMit
Description : This command sets the output frequency limit of the AC Source.
Query Syntax : [SOURce :] FREQuency : LIMit?
Parameter : <NR2>, the valid range is 15.00 - 2000.00 (unit: Hz)
Return Parameter : <NR2>

[SOURce :] POWer:PROTection
Description : This command sets the Over Power Protection (OPP) for the AC Source.
Query Syntax : [SOURce :] POWer:PROTection?
Parameter : <NR2>, the valid range is 0.0 - maximum power of the specific model (unit: W.)
Return Parameter : <NR2>

[SOURce :] VOLTage [: LEVel][: IMMediate][: AMPLitude] : AC
Description : This command sets the AC composite output voltage in Volts.
Query Syntax : [SOURce :] VOLTage [: LEVel][: IMMediate][: AMPLitude] : AC?
Parameter : <NR2>, the valid range is 0.0 - 175.0 (low range), 0.0 - 350.0 (high range.)
Return Parameter : <NR2>

[SOURce :] VOLTage [: LEVel][: IMMediate][: AMPLitude] : DC
Description : This command sets the DC composite output voltage in Volts.
Query Syntax : [SOURce :] VOLTage [: LEVel][: IMMediate][: AMPLitude] : DC?
Parameter : <NR2>, the valid range is -247.5 to +247.5 (low range), -494.9 to +494.9 (high range.)
Return Parameter : <NR2>

[SOURce :] VOLTage : LIMit : AC
Description : This command sets the Vac LIMIT to restrict the value of Vac.
Query Syntax : [SOURce :] VOLTage : LIMit : AC?

Parameter : <NR2>, the valid range is 0.0 - 350.0 (unit: V.)
Return Parameter : <NR2>

[SOURce :] VOLTage : LIMit : DC : PLUS
Description : This command sets the VdcLimit(+).
Query Syntax : [SOURce :] VOLTage : LIMit : DC : PLUS?
Parameter : <NR2>, the valid range is -494.9 to +494.9 (unit: V)
PS: The lower limit cannot exceed Vdc Limit(-).
Return Parameter : <NR2>

[SOURce :] VOLTage : LIMit : DC : MINus
Description : This command sets the Vdc Limit(-).
Query Syntax : [SOURce :] VOLTage : LIMit : DC : MINus?
Parameter : <NR2>, the valid range is -494.9 to +494.9 (unit: V)
PS: The upper limit cannot exceed Vdc Limit(+).
Return Parameter : <NR2>

[SOURce :] VOLTage : RANGe
Description : This command sets the output voltage range to LOW (175 V) or HIGH (350 V) or AUTO.
Query Syntax : [SOURce :] VOLTage : RANGe?
Parameter : LOW | HIGH | AUTO
Return Parameter : LOW | HIGH | AUTO

[SOURce :] FUNCtion : SHAPe
Description : This command selects which waveform buffer (A or B) to use.
Query Syntax : [SOURce :] FUNCtion : SHAPe?
Parameter : A | B
Return Parameter : A | B

[SOURce :] FUNCtion : SHAPe : A
Description : This command selects the type of waveform to use in buffer A.
Query Syntax [SOURce :] FUNCtion : SHAPe : A?
Parameter : SINE | SQUA | CSIN | DST<01..30> | USR<01..30>
Return Parameter : SINE | SQUA | CSIN | DST<01..30> | USR<01..30>

[SOURce :] FUNCtion : SHAPe : A : MODE
Description : This command selects the clipping mode to use in buffer A.
Query Syntax : [SOURce :] FUNCtion : SHAPe : A : MODE?
Parameter : AMP | THD
Return Parameter : AMP | THD

[SOURce :] FUNCtion : SHAPe : A : THD
Description : This command sets the clipped THD percentage to use in buffer A.
Query Syntax : [SOURce :] FUNCtion : SHAPe : A : THD?
Parameter : <NR2>, the valid range is 0.0% - 43%.
Return Parameter : <NR2>

[SOURce :] FUNCtion : SHAPe: A : AMP
Description : This command sets the clipped peak percentage to use in buffer A.
Query Syntax : [SOURce :] FUNCtion : SHAPe : A : AMP?
Parameter : <NR2>, the valid range is 0.0% - 100%.
Return Parameter : <NR2>

[SOURce :] FUNCtion : SHAPe : B

Description : This command selects the type of waveform to use in buffer B.
Query Syntax : [SOURce :] FUNCtion : SHAPe : B?
Parameter : SINE | SQUA | CSIN | DST<01..30> | USR<01..30>
Return Parameter : SINE | SQUA | CSIN | DST<01..30> | USR<01..30>

[SOURce :] FUNCtion : SHAPe : B : MODE

Description : This command selects the clipping mode to use in buffer B.
Query Syntax : [SOURce :] FUNCtion : SHAPe : B : MODE?
Parameter : AMP | THD
Return Parameter : AMP | THD

[SOURce :] FUNCtion : SHAPe : B : THD

Description : This command sets the clipped THD percentage to use in buffer B.
Query Syntax : [SOURce :] FUNCtion : SHAPe : B : THD?
Parameter : <NR2>, the valid range is 0.0% - 43%.
Return Parameter : <NR2>

[SOURce :] FUNCtion : SHAPe: B : AMP

Description : This command sets the clipped peak percentage to use in buffer B.
Query Syntax : [SOURce :] FUNCtion : SHAPe : B : AMP?
Parameter : <NR2>, the valid range is 0.0% - 100%.
Return Parameter : <NR2>

9.5.2.6 CONFIGURE Subsystem

[SOURce :]

CONFigure
: INHibit
: EXTernal
: COUPling
: EXTON

[SOURce :] CONFigure : INHibit

Description : This command sets the Remote Inhibit function.
Query Syntax : [SOURce :] CONFigure : INHibit?
Parameter : DISABLE | ENABLE
Return Parameter : DISABLE | ENABLE

[SOURce :] CONFigure : EXTernal

Description : This command enables/disables the External-V Reference function.
Query Syntax : [SOURce :] CONFigure : EXTernal?
Parameter : OFF | ON
Return Parameter : OFF | ON

[SOURce :] CONFigure : COUPling?

Description : This command sets the External-V Reference to AC_AMPLIFIER or DC_LEVEL to control the AC Source output.
Query Syntax : [SOURce :] CONFigure : COUPling?
Parameter : AC | DC
Return Parameter : AC | DC

[SOURce :] CONFigure : EXTON

Description : This command sets the External ON/OFF control.
Query Syntax : [SOURce :] CONFigure : EXTON?
Parameter : DISABLE | ENABLE
Return Parameter : DISABLE | ENABLE

9.5.2.7 PHASE Subsystem

[SOURce:]

PHASe
: ON
: OFF
: P12
: P13
: SEQuence
: THREE
: RELOCK

[SOURce:] PHASe: ON

Description : This command sets the transition angle when the waveform shifts. The default is ON (0 degrees).
Query Syntax : [SOURce :] PHASe : ON?
Parameter : <NR2>, the valid range is 0.0 - 359.9.
Return Parameter : <NR2>

[SOURce:] PHASe: OFF

Description : This command sets the transition angle when the waveform ends.
Query Syntax : [SOURce :] PHASe : OFF?
Parameter : <NR2>, the valid range is 0.0 - 360.0, 360.0: means IMMED.
Return Parameter : <NR2>

[SOURce:]PHASe:P12

Description : This command sets the phase difference between Φ1 and Φ2.
Query Syntax : [SOURce :]PHASe:P12?
Parameter : <NR2>, the valid range is 0.0 - 359.9.
Return Parameter : <NR2>

[SOURce:]PHASe:P13

Description : This command sets the phase difference between Φ1 and Φ3.
Query Syntax : [SOURce :]PHASe:P13?
Parameter : <NR2>, the valid range is 0.0 - 359.9.
Return Parameter : <NR2>

[SOURce:]PHASe:SEQuence

Description : This command sets the phase sequence in 3-phase mode.
Query Syntax : [SOURce :]PHASe:SEQuence?
Parameter : POS | NEG
Return Parameter : POSITIVE | NEGATIVE

[SOURce:]PHASe:RELOCK

Description : This command sets the relock function in 3-phase mode.
Query Syntax : [SOURce :]PHASe:RELOCK?

Parameter : ENABLE | DISABLE
Return Parameter : ENABLE | DISABLE

[SOURce:]PHASe:THREE
Description : This command set the operation mode in 3-phase mode.
Query Syntax : [SOURce :]PHASe:THREE?
Parameter : INDEPEND | SAMEFREQ | BALANCE
Return Parameter : INDEPEND | SAMEFREQ | BALANCE

9.5.2.8 STATUS Subsystem

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

STATus : OPERation [: EVENt]?
Description : This command queries the Operation Status register.
Query Syntax : STATus : OPERation [: EVENt]?
Parameter : None
Return Parameter : Always 0.

STATus : OPERation : ENABle
Description : This command sets the Operation Status Enable register. The register is a mask when the specific bit is enabled from the Operation Status register.
Query Syntax : STATus : OPERation : ENABle?
Parameter : <NR1>, the valid range is 0 - 255.
Return Parameter : Always 0.

STATus : QUEStionable : CONDition?
Description : This query command returns the value of the Questionable Condition register. It is a read only register that saves the questionable condition of the AC Source in real time.
Query Syntax : STATus : QUEStionable : CONDition?
Parameter : NONE
Return Parameter : <NR1>, the valid range is 0 - 511.

STATus : QUEStionable [: EVENt] ?
Description : This query command returns the value of the Questionable Event register. It is a read only register that saves all items that passed the Questionable NTR and/or PTR filter. If the QUES bit in the Service Request Enabled register has been set and the Questionable Event register > 0, the QUES of the Status Byte register will also be set.
Query Syntax : STATus : QUEStionable [: EVENt]?
Parameter : NONE

Return Parameter : <NR1>, the valid range is 0 - 511.

STATus : QUEStionable : ENABle

Description : The command sets or reads the value of the Questionable Enable register. The register is a mask when the specific bit is enabled to set the QUES bit of the Status Byte register from the Operation Status register.
Query Syntax : STATus : QUEStionable : ENABle?
Parameter : <NR1>, the valid range is 0 - 511.
Return Parameter : <NR1>

STATus : QUEStionable : NTRansition

Description : These commands set or read the value of the register.
The operation of these registers is the same as the polarity filter of the Questionable Enable and Questionable Event registers that enable the following actions:

* When a bit of the Questionable NTR register is set to 1, a 1-to-0 transition of the corresponding bit in the Questionable Condition register will set that bit in the Questionable Event register.

* When a bit of the Questionable PTR register is set to 1, a 0-to-1 transition of the corresponding bit in the Questionable Condition register will set that bit in the Questionable Event register.

* If the same two bits in both the NTR and PTR registers are set to 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?
Parameter : <NR1>, the valid range is 0 - 511.
Return Parameter : <NR1>

STATus : QUEStionable : PTRansition

Description : These commands set or read the values of the Questionable PTR register (refer to the description of the previous command.)
Query Syntax : STATus : QUEStionable : PTRansition?
Parameter : <NR1>, the valid range is 0 - 511.
Return Parameter : <NR1>

9.5.2.9 TRACE Subsystem

TRACe
: RMS

TRACe
Description : This command sets the user-defined waveform data. 1024 data points are required to create one period of the waveform. Normalize the data and make the maximum point equal to 32767 or the minimum point equal to -32767.
Syntax : TRACe <waveform_name>, <amplitude> {,<amplitude>}
Parameter : <waveform_name>:US<n>, n=1-30, <amplitude>:<NR1>, the valid range is -32767 to +32767.
Example : TRACe US1 100 200 …32767... 500 800 <= 1024 points
This command requires about 5 seconds for execution.

TRACe : RMS
Description : This command sets the RMS value of the waveform. Calculate the root mean square value for 1024 data points.
Syntax : TRACe : RMS <waveform_name>, <rms>
Parameter : <waveform_name>:US<n>, n=1-30, <rms>:<NR1>, the valid range is 0 - 32767.
Example : TRACe : RMS US1 27000

9.5.2.10 LIST Subsystem

[SOURce :]
LIST
: COUPling
:TRIG
: POINts?
: COUNt
: DWELl
: SHAPe
: BASE
: VOLTage
: AC
: STARt
: END
: DC
: STARt
: END
: FREQuency
: STARt
: END
: DEGRee

OUTPut
: MODE

TRIG
TRIG : STATE?

[SOURce:]LIST : COUPling

Description : This command sets the function of the list mode.
Query Syntax : [SOURce:] LIST : Coupling?
Parameter : ALL | NONE
Return Parameter : ALL | NONE

[SOURce:]LIST : TRIG

Description : This command sets the trigger type for the list mode.
Query Syntax : [SOURce:] LIST : TRIG?
Parameter : AUTO | MANUAL|EXCITE
Return Parameter : AUTO | MANUAL|EXCITE

[SOURce:] LIST : POINts?

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

[SOURce :] LIST : COUNt

Description : This command sets the number of times the list is executed before completion.
Query Syntax : [SOURce :] LIST : COUNt?
Parameter : <NR1>, the valid range is 0 - 65535.
Return Parameter : <NR1>

[SOURce :] LIST : DWELl

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

[SOURce :] LIST : SHAPe

Description : This command sets the sequence of the waveform buffer list points.
Query Syntax : [SOURce:] LIST : SHAPe?
Parameter : A|B, …, A|B
Return Parameter : A|B, …, A|B

[SOURce :] LIST : BASE

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

[SOURce :] LIST : VOLTage : AC : STARt

Description : This command sets the sequence of the AC start voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : AC : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is 0.0 - 175.0 (low range), 0.0 - 350.0 (high range.)
Return Parameter : <NR1>, …, <NR2>

[SOURce :] LIST : VOLTage : AC : END

Description : This command sets the sequence of the AC end voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : AC : END?

Parameter : <NR2>, …, <NR2>, the valid range is 0.0 - 175.0 (low range), 0.0 - 350.0 (high range.)
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : VOLTage : DC : STARt
Description : This command sets the sequence of the DC start voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : DC : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is -247.5 to +247.5 (low range), -494.9 to +494.9 (high range.)
Return Parameter : <NR1>

[SOURce :] LIST : VOLTage : DC : END
Description : This command sets the sequence of the DC end voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : DC : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is -247.5 to +247.5 (low range), -494.9 to +494.9 (high range.)
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : FREQuency : STARt
Description : This command sets the sequence of the start frequency list points.
Query Syntax : [SOURce:] LIST : FREQuency : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is 15.00 - 2000.00 (unit: Hz.)
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : FREQuency : END
Description : This command sets the sequence of the end frequency list points.
Query Syntax : [SOURce:] LIST : FREQuency : END?
Parameter : <NR2>, …, <NR2>, the valid range is 15.0 - 2000.0 (unit: Hz.)
Return Parameter : <NR2>, …, <NR2>

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

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

TRIG
Description : This command sets the LIST mode in the OFF - ON execution state after setting the OUTPut: MODE LIST. To change the parameters, set TRIG OFF then OUTPut: MODE FIXED. Then, set OUTPut : MODE LIST again to to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

9.5.2.11 PULSE Subsystem

[SOURce :]
PULSe
: VOLTage
: AC
: DC
: FREQuency
: SHAPe
: SPHase
: COUNt
: DCYCle
: PERiod
: TRIG

OUTPut
: MODE

TRIG
TRIG : STATE?

[SOURce :] PULSe : VOLTage : AC
Description : This command sets the AC voltage for the duty cycle of the PULSE mode.
Query Syntax : [SOURce :] PULSE : VOLTage : AC?
Parameter : <NR2>, the valid range is 0.0 - 175.0 (low range), 0.0 - 350.0 (high range.)
Return Parameter : <NR2>

[SOURce :] PULSe : VOLTage : DC
Description : This command sets the DC voltage for the duty cycle of the PULSE mode.
Query Syntax : [SOURce :] PULSE : VOLTage : DC?
Parameter : <NR2>, the valid range is -247.5 to +247.5 (low range), -494.9 to +494.9 (high range.)
Return Parameter : <NR2>

[SOURce :] PULSe : FREQuency
Description : This command sets the frequency for the duty cycle of the PULSE mode.
Query Syntax : [SOURce :] PULSE : FREQuency?
Parameter : <NR2>, the valid range is 15.0 - 2000.0 (unit: Hz.)
Return Parameter : <NR2>

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

[SOURce :] PULSe : SPHase
Description : This command sets the start phase angle of the duty cycle for the PULSE mode.
Query Syntax : [SOURce :] PULSE : SPHase?

Parameter : <NR2>, the valid range is 0.0 - 359.9.
Return Parameter : <NR2>

[SOURce :] PULSe : COUNt
Description : This command sets the number of times the pulse is executed before completion.
Query Syntax : [SOURce :] PULSE : COUNt?
Parameter : <NR2>, the valid range is 0 - 65535.
Return Parameter : <NR2>

[SOURce :] PULSe : DCYCle
Description : This command sets the duty cycle of the PULSE mode.
Query Syntax : [SOURce :] PULSE : DCYCle?
Parameter : <NR2>, the valid range is 0 % - 100 %.
Return Parameter : <NR2>

[SOURce :] PULSe : PERiod
Description : This command sets the period of the PULSE mode.
Query Syntax : [SOURce :] PULSE : PERiod?
Parameter : <NR2>, the valid range is 0 - 99999999.9 (unit: ms.)
Return Parameter : <NR2>

[SOURce:]PULSe : TRIG
Description : This command sets the TRIG type of the PULSE mode.
Query Syntax : [SOURce:] PULSe : TRIG?
Parameter : AUTO | MANUAL|EXCITE
Return Parameter : AUTO | MANUAL|EXCITE

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

TRIG
Description : This command sets the PULSE mode in the OFF execution state after setting OUTPut : MODE PULSE. To change the parameters, set TRIG OFF then OUTPut : MODE FIXED. Then, set OUTPut : MODE PULSE again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

9.5.2.12 STEP Subsystem

[SOURce :]
STEP
: VOLTage
: AC
: DC
: FREQuency
: SHAPe

: SPHase
: DVOLtage
: AC
: DC
: DFRequency
: DWELl
: COUNt
: TRIG

OUTPut
: MODE

TRIG
TRIG : STATE?

[SOURce :] STEP : VOLTage : AC
Description : This command sets the initial AC voltage of the STEP mode.
Query Syntax : [SOURce :] STEP : VOLTage : AC?
Parameter : <NR2>, the valid range is 0.0 - 175.0 (low range), 0.0 - 350.0 (high range.)
Return Parameter : <NR2>

[SOURce :] STEP : VOLTage : DC
Description : This command sets the initial DC voltage of the STEP mode.
Query Syntax : [SOURce :] STEP : VOLTage : DC?
Parameter : <NR2>, the valid range is -247.5 ~ +247.5 (low range), -494.9 ~ +494.9 (high range.)
Return Parameter : <NR2>

[SOURce :] STEP : FREQuency
Description : This command sets the initial frequency of the STEP mode.
Query Syntax : [SOURce :] STEP : FREQuency?
Parameter : <NR2>, the valid range is 15.0 - 2000.0 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] STEP : SHAPe
Description : This command selects the waveform buffer of the STEP mode.
Query Syntax : [SOURce :] STEP : SHAPe?
Parameter : A | B
Return Parameter : A | B

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

[SOURce :] STEP : DVOLtage : AC
Description : This command sets the AC voltage change in each step.
Query Syntax : [SOURce :] STEP : DVOLtage : AC?
Parameter : <NR2>, the valid range is -175.0 to +175.0 (low range), -350.0 to +350.0 (high range.)
Return Parameter : <NR2>

[SOURce :] STEP : DVOLtage : DC

Description : This command sets the DC voltage change in each step.
Query Syntax : [SOURce :] STEP : DVOLtage : DC?
Parameter : <NR2>, the valid range is -247.5 to +247.5 (low range), -494.9 to +494.9 (high range.)
Return Parameter : <NR2>

[SOURce :] STEP : DFRequency

Description : This command sets the frequency change in each step.
Query Syntax : [SOURce :] STEP : DFRequency?
Parameter : <NR2>, the valid range is -2000.00 to +2000.0 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] STEP : DWELl

Description : This command sets the dwell time in each step.
Query Syntax : [SOURce :] STEP : DWELl?
Parameter : <NR2>, the valid range is 0 - 99999999.9 (unit: ms.)
Return Parameter : <NR2>

[SOURce :] STEP : COUNt

Description : This command sets the number of times the step is executed before completion.
Query Syntax : [SOURce :] STEP : COUNt?
Parameter : <NR2>, the valid range is 0 - 65535.
Return Parameter : <NR2>

[SOURce:] STEP : TRIG

Description : This command sets the TRIG type of the STEP mode.
Query Syntax : [SOURce:] STEP : TRIG?
Parameter : AUTO | MANUAL
Return Parameter : AUTO | MANUAL

OUTPut : MODE

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

TRIG

Description : This command sets the STEP mode in the OFF - ON execution state after setting OUTPut : MODE STEP. To change the parameters, set TRIG OFF then OUTPut : MODE FIXED. Then, set OUTPut : MODE STEP again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

9.5.2.13 SYNTHESIS Subsystem

[SOURce :]
SYNThesis
: COMPose
: AMPLitude
: PHASe
: FUNDamental
: DC
: FREQuency
: SPHase

OUTPut
: MODE

TRIG
TRIG : STATE?

[SOURce :] SYNThesis : COMPose
Description : This command sets the data format of each harmonic order. VALUE: absolute value, PERCENT: basic computer percentage. 6 waveforms can be programmed for execution.
Query Syntax : [SOURce :] SYNThesis : COMPose?
Parameter : VALUE1 | VALUE2 | VALUE3 | PERCENT1 | PERCENT2 | PERCENT3
Return Parameter : VALUE1 | VALUE2 | VALUE3 | PERCENT1 | PERCENT2 | PERCENT3

[SOURce :] SYNThesis : AMPLitude
Description : This command sets the amplitude of each harmonic order. The maximum number of orders is 40.
Query Syntax : [SOURce :] SYNThesis : AMPLitude?
Parameter : <NR2>, …, <NR2>
Valid range:

Order	Value	Percentage
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 Parameter : <NR2>, …,<NR2>

[SOURce :] SYNThesis : PHASe
Description : This command sets the phase angle of each harmonic order.
Query Syntax : [SOURce :] SYNThesis : PHASe?
Parameter : <NR2>, …, <NR2>, the valid range: 0.0 - 359.9
Return Parameter : <NR2>, …, <NR2>

[SOURce :] SYNThesis : FUNDamental
Description : This command sets the fundamental AC voltage in the SYNTHESIS mode.
Query Syntax : [SOURce :] SYNThesis : FUNDamental?
Parameter : <NR2>, the valid range: 0.0 - 175.0 (low range), 0.0 - 350.0 (high

range)
Return Parameter : <NR2>

[SOURce :] SYNThesis : DC
Description : This command sets the DC voltage to add to the voltage waveform in the SYNTHESIS mode.
Query Syntax : [SOURce :] SYNThesis : DC?
Parameter : <NR2>, the valid range: -247.5 to +247.5 (low range), -494.9 to +494.9 (high range)
Return Parameter : <NR2>

[SOURce :] SYNThesis : FREQuency
Description : This command sets the fundamental frequency in the SYNTHESIS mode.
Query Syntax : [SOURce :] SYNThesis : FREQuency?
Parameter : 50 | 60
Return Parameter : 50 | 60

[SOURce :] SYNThesis : SPHase
Description : This command sets the start phase angle in the SYNTHESIS mode.
Query Syntax : [SOURce :] SYNThesis : SPHase?
Parameter : <NR2>, the valid range: 0.0 - 359.9
Return Parameter : <NR2>

OUTPut : MODE
Description : This command sets the operation mode. The output should be stopped before setting OUTPut : MODE SYNTH.
Query Syntax : OUTPut : MODE?
Parameter : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR
Return Parameter : FIXED | LIST | PULSE | STEP | SYNTH | INTERHAR

TRIG
Description : This command sets the SYNTHESIS mode in the OFF - ON execution state after setting OUTPut : MODE SYNTH. To change the parameters, set TRIG OFF then OUTPut : MODE FIXED. Then, set OUTPut : MODE SYNTH again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

9.5.2.14 INTERHARMONICS Subsystem

[SOURce :]
INTERHARmonics
: FREQuency
: STARt
: END
: LEVel
: DWELl

OUTPut
: MODE

TRIG
TRIG : STATE?

FETCh | MEASure
: INTERHARmonics
: FREQuency? Queries the sweeping frequency.

[SOURce :] INTERHARmonics : FREQuency : STARt
Description : This command sets the start frequency of the sweep wave for the INTERHARMONICS mode.
Query Syntax : [SOURce :] INTerharmonics : FREQuency : STARt?
Parameter : <NR2>, the valid range is 0.01 - 2400.0 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] INTERHARmonics: FREQuency : END
Description : This command sets the end frequency of the sweep wave for the INTERHARMONICS mode.
Query Syntax : [SOURce :] INTerharmonics : FREQuency : END?
Parameter : <NR2>, the valid range is 0.01 - 2400.00 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] INTERHARmonics: LEVel
Description : This command sets the RMS range of the sweep wave in percentage.
Query Syntax : [SOURce :] INTerharmonics : LEVel?
Parameter : <NR2>, the valid range is 0% - 30% in 0.01 Hz - 500 Hz
0% - 20% in 500.01 Hz - 1000 Hz
0% - 10% in 1000.01 Hz - 2400 Hz
Return Parameter : <NR2>

[SOURce :] INTERHARmonics: DWELl
Description : This command sets the dwell time of the sweep wave.
Query Syntax : [SOURce :] INTerharmonics : DWELl?
Parameter : <NR2>, the valid range is 0.00 - 99999.99 (unit: sec.)
Return Parameter : <NR2>

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

TRIG
Description : This command sets the INTERHARMONICS mode in the OFF - ON, PAUSE, or CONTINUE execution state after setting OUTPut : MODE INTERHAR. To change the parameter, set TRIG OFF and OUTPut : MODE FIXED, next set OUTPut : MODE INTERHAR in order to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON | PAUSE | CONTINUE
Return Parameter : OFF | RUNNING | PAUSE

FETCh [:SCALar] : INTERHARmonics: FREQuency?
MEASure [:SCALar] : INTERHARmonics: FREQuency?
Description : These query commands return the sweep frequency stacked on the base voltage.
Query Syntax : FETCh : INTERHARMonics : FREQuency?
MEASure : INTERHARMonics : FREQuency?
Return Parameter : <NR2>

9.5.2.15 Harmonic Sense Subsystem

[SOURce :]
CONFigure
: HARMonic
: SOURce
: TIMES
: PARameter
: FREQuency
SENSe
: HARMonic

FETCh | MEASure
[: SCALar]
: HARMonic
: THD? Returns the % of total harmonic distortion.
: FUNDamental? Returns the fundamental frequency.
: ARRay? Returns the array of all harmonic orders.

[SOURce :] CONFigure : HARMonic : SOURce
Description : This command sets the measured power source in the harmonic analysis mode.
Query Syntax : [SOURce :] CONFigure : HARMonic : SOURce?
Parameter : VOLT | CURR
Return Parameter : VOLT | CURR

[SOURce :] CONFigure : HARMonic : TIMES
Description : This command sets the way the measurement result of harmonic analysis is displayed on the LCD.
SINGLE: keeps the measured data on the display when set.
CONTINUE: updates the measured data on the display when set.
Query Syntax : [SOURce :] CONFigure : HARMonic : TIMes?
Parameter : SINGLE | CONTINUE
Return Parameter : SINGLE | CONTINUE

[SOURce :] CONFigure : HARMonic : PARameter
Description : This command sets the data format for each harmonic order.
Query Syntax : [SOURce :] CONFigure : HARMonic : PARameter?
Parameter : VALUE | PERCENT
Return Parameter : VALUE | PERCENT

[SOURce :] CONFigure : HARMonic : FREQuency
Description : This command sets the fundamental frequency for the original waveform.

Query Syntax : [SOURce :] CONFigure : HARMonic : FREQuency?
Parameter : 50 | 60
Return Parameter : 50 | 60

SENSe : HARMonic
Description : This command sets the harmonic measurement ON/OFF. It executes "ON" before every new search or measurement. Only 3 seconds are required for the result. The parameter needs to be set to "OFF" if other data is to be measured.
Query Syntax : SENSe : HARMonic?
Parameter : ON | OFF
Return Parameter : ON | OFF

FETCh [:SCALar] : HARMonic : THD?
MEASure [:SCALar] : HARMonic : THD?
Description : This query command returns the % of total harmonic distortion.
Query Syntax : FETCh : HARMonic : THD?
MEASure : HARMonic : THD?
Return Parameter : <NR2>

FETCh [:SCALar] : HARMonic : FUNDamental?
MEASure [:SCALar] : HARMonic : FUNDamental?
Description : This query command returns the fundamental frequency output current or voltage.
Query Syntax : FETCh : HARMonic : FUNDamental?
MEASure : HARMonic : FUNDamental?
Return Parameter : <NR2>

FETCh [:SCALar] : HARMonic : ARRay?
MEASure [:SCALar] : HARMonic : ARRay?
Description : This query command returns the array of all harmonic orders.
Query Syntax : FETCh : HARMonic : ARRay?
MEASure : HARMonic : ARRay?
Return Parameter : <NR2>

9.6 Command Summary

Common Commands

* CLS	Clear status
* ESE<n>	Enable standard event status
* ESE?	Return enabled standard event status
* IDN?	Return the AC Source ID
* RCL<n>	Recall the AC Source file
* RST	Reset the AC Source to 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 AC Source

Instrument Commands

SYSTem
: ERRor?
: VERSion?
: LOCal
: REMote
: DATE
: TIME

INSTrument
: EDIT
: Couple
: NSELect
: SELect
: PHASe

FETCh | MEASure
[: SCALar]
: CURRent
: AC?
: DC?
: ACDC?
: AMPLitude:MAXimum?
: CRESTfactor?
: INRush?
: FREQuency?
: POWer
: AC
[: REAL]?
: APParent?
: REACtive?
: PFACtor?
: TOTal?
: TOTal:APParent?
:VOLTage
: AC?
: DC?
: ACDC?
: AMPLitude:MAXimum?
:LINE
:V12?
:V23?
:V31?

OUTPut
[: STATe]
: RELay
: SLEW
: VOLTage
: AC
: DC
:FREQency
: COUPling

: MODE
: PROTection
:CLEar
: IMPedance
: STATe
: RESistor
: INDuction

[SOURce :]
CURRent
: LIMit
: DELay
: INRush
: STARt
: INTerval
:RANGe
FREQency
[: {CW | IMMediate}]
: LIMit
VOLTage
[: LEVel][: IMMediate][:AMPLitude]
: AC
: DC
: LIMit
: AC
: DC
: PLUS
: MINus
: RANGe

POWer
: PROTection

FUNCtion
: SHAPe
: SHAPe
: A
: A
: MODE
: THD
: AMP
: B
: B
: MODE
: THD
: AMP

LIST
: Coupling
:TRIG
: 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

    INTERHARrmonics
        : FREQuency
            : STARt
            : END
        : LEVEl
        : DWELl
        : MODe
```

[SOURce :]
PHASe
: ON
: OFF

[SOURce :]
CONFigure
: INHibit

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

TRACe
: RMS

TRIG
TRIG : STATE?

Appendix A TTL Signal Pin Assignments

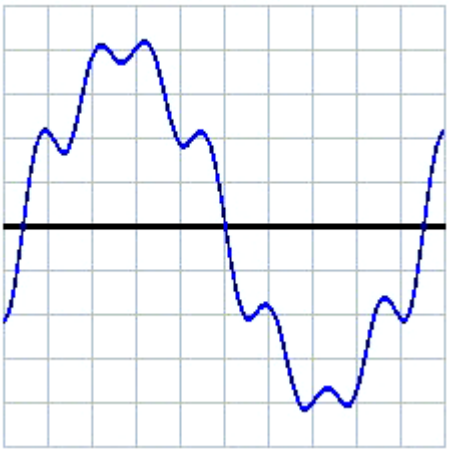
Green terminal with female connector:

Pin No.	Signal	Description
1	Ext-V Φ1	Φ1 External-V Reference signal input (-10V to +10V)
2	Ext-V Φ2	Φ2 External-V Reference signal input (-10V to +10V) This is the input pin of the external voltage signal for single phase use.
3	Ext-V Φ3	Φ3 External-V Reference signal input (-10V to +10V)
4	AGND	External-V Reference signal grounding
5	+12V	12V voltage output (providing current 0.5A)
6	AGND_ISO	12V power grounding.
7	AGND	Signal grounding.
8	AGND	Signal grounding.
9	AC-ON	This pin goes HIGH when the AC Source outputs voltage and goes LOW when the output stops.
10	/ FAULT-OUT	The voltage level of this pin is HIGH when the AC Source is in normal mode. It will go LOW when the AC Source is in protection mode.
11	/ Ext-ONOFF	When the EXT. ON/OFF is enabled on the AC Source and the EXT. ON/OFF signal is LOW, the AC Source will disable the output. The AC Source will re-enable the output when the EXT. ON/OFF signal goes HIGH
12	/ Remote-Inhibit	When the voltage level of this pin goes LOW, it inhibits the AC Source output or trigger mode.
13	/Remote-Excite	When this pin receives a negative edge signal (from High to Low), it triggers the transient output of the AC Source.
14	/Transient	When the output of the AC Source changes, this pin will go low for 64us.
15	Reserved	
16	Reserved	
17	Reserved	
18	Reserved	
19	Reserved	
20	AGND	Signal grounding.
21	Reserved	
22	Reserved	
23	Reserved	
24	AGND	Signal grounding.

Appendix B Built-in Waveforms

The ratios of all built-in waveforms' steps are measured under no load.

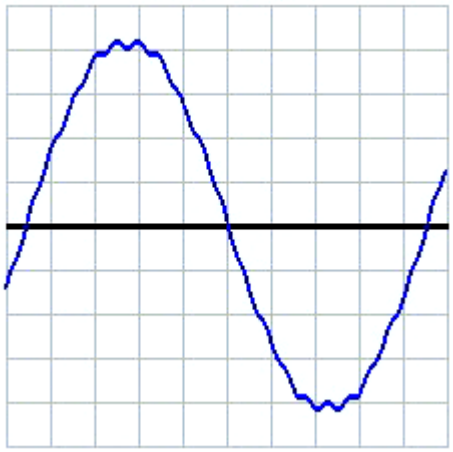
Waveform A = DST01



N	%	D
5	9.80	0
7	15.80	0
8	2.16	0

DST01

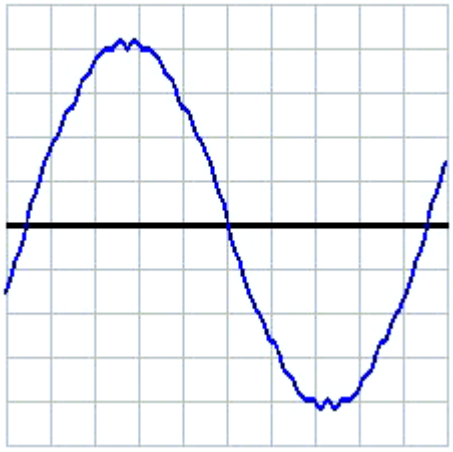
Waveform A = DST02



N	%	D
3	1.50	0
7	1.50	0
19	2.00	0

DST02

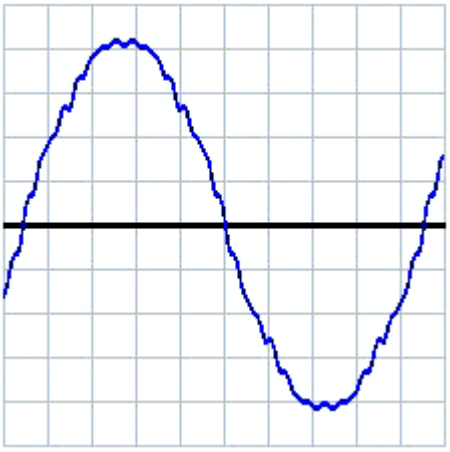
Waveform A = DST03



N	%	D
3	2.00	0
5	1.40	0
7	2.00	0
23	1.40	0
31	1.00	0

DST03

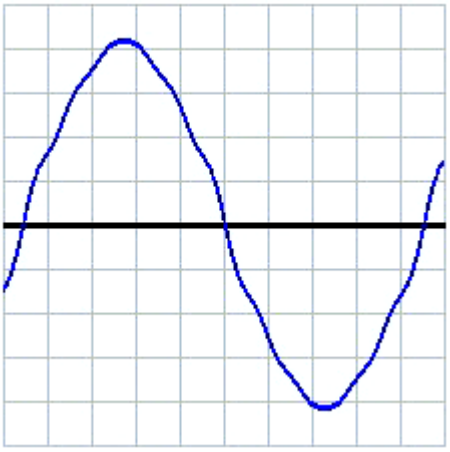
Waveform A = DST04



N	%	D
3	2.50	0
5	1.90	0
7	2.50	0
23	1.90	0
25	1.10	0
31	1.50	0
33	1.10	0

DST04

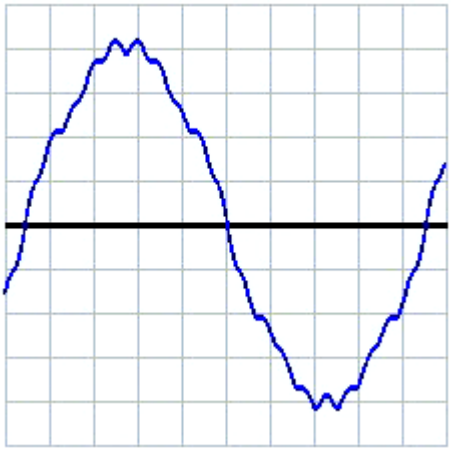
Waveform A = DST05



N	%	D
3	1.10	0
5	2.80	0
7	1.40	0
9	2.30	0
11	1.50	0

DST05

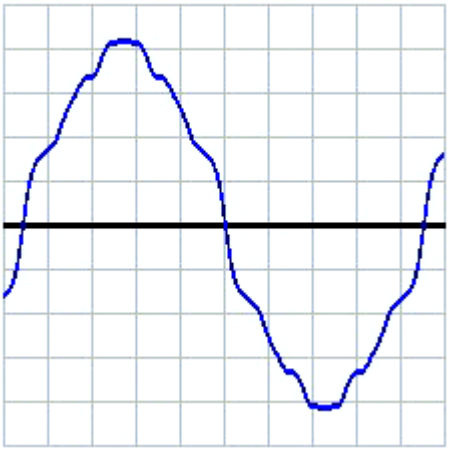
Waveform A = DST06



N	%	D
3	1.65	0
5	4.20	0
7	3.45	0
15	1.05	0
19	3.00	0

DST06

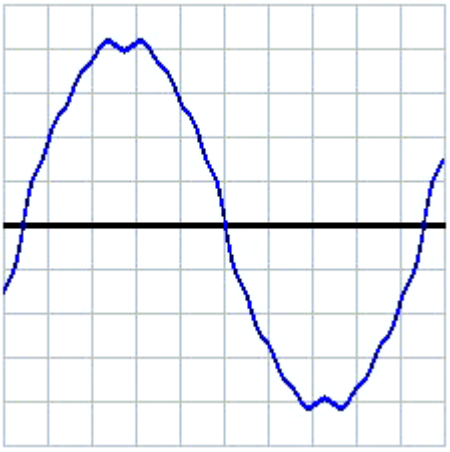
Waveform A = DST07



N	%	D
3	2.20	0
5	5.60	0
7	2.80	0
9	4.60	0
11	3.00	0
15	1.40	0
21	1.00	0

DST07

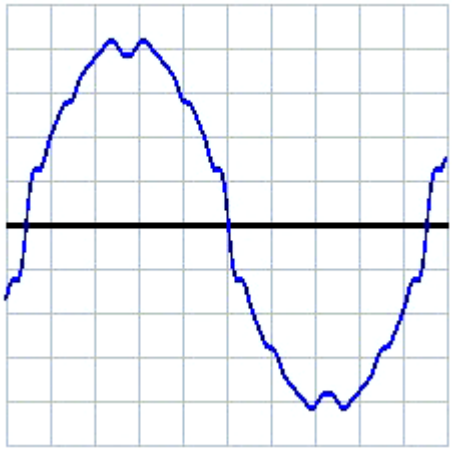
Waveform A = DST08



N	%	D
3	4.90	0
5	1.60	0
7	2.70	0
11	1.40	0
15	2.00	0
17	1.10	0

DST08

Waveform A = DST09

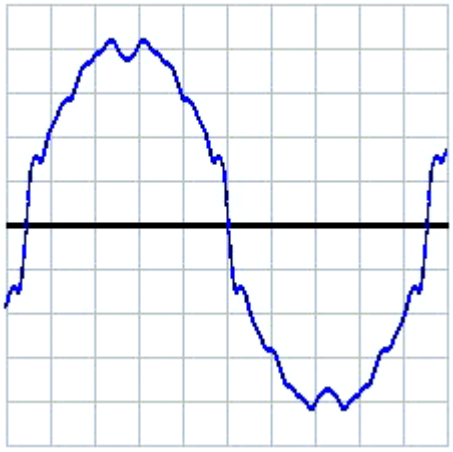


N	%	D
3	7.35	0
5	2.40	0
7	4.05	0
11	2.10	0
13	1.05	0
15	3.00	0
17	1.65	0
19	1.05	0
21	1.05	0

N	%	D
23	1.20	0
25	1.05	0

DST09

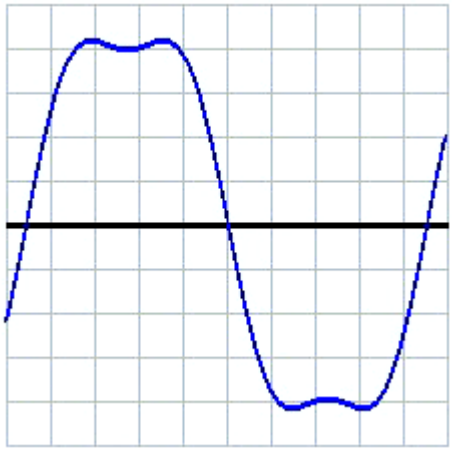
Waveform A = DST10



N	%	D	N	%	D
3	9.80	0	21	1.40	0
5	3.20	0	23	1.60	0
7	5.40	0	25	1.40	0
9	1.20	0			
11	2.80	0			
13	1.40	0			
15	4.00	0			
17	2.20	0			
19	1.40	0			

DST10

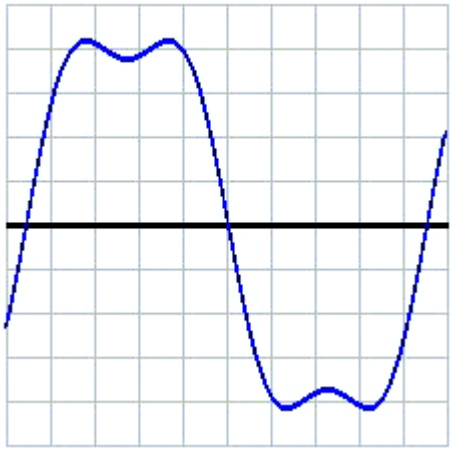
Waveform A = DST11



N	%	D
3	17.75	0

DST11

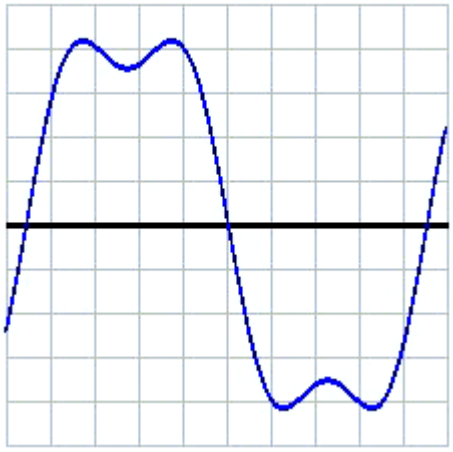
Waveform A = DST12



N	%	D
3	21.25	0

DST12

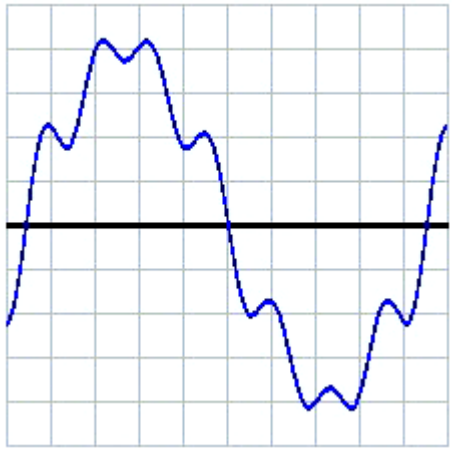
Waveform A = DST13



N	%	D
3	24.50	0

DST13

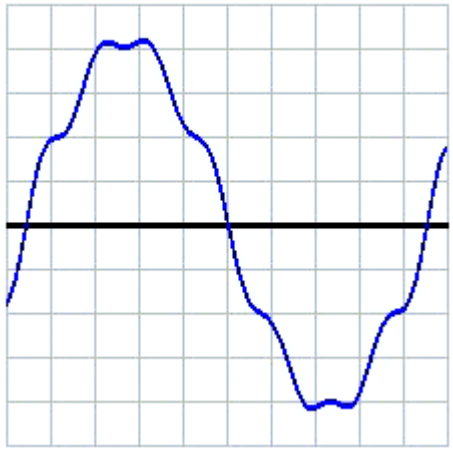
Waveform A = DST14



N	%	D
2	2.30	0
5	9.80	0
7	15.80	0
8	2.50	0

DST14

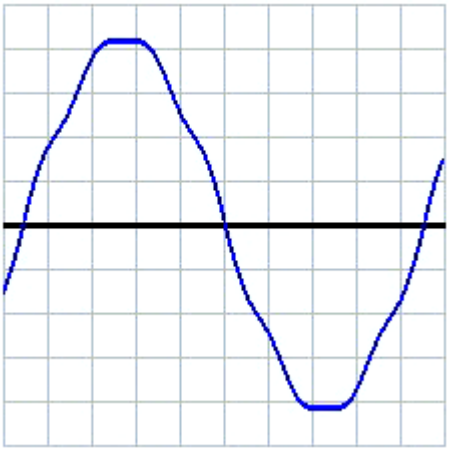
Waveform A = DST15



N	%	D
2	1.15	0
5	4.90	0
7	7.90	0
8	1.25	0

DST15

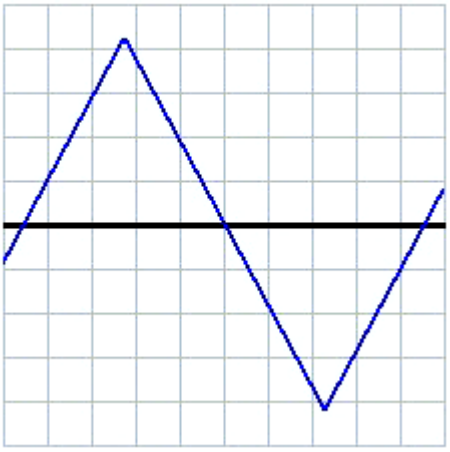
Waveform A = DST16



N	%	D
5	2.45	0
7	3.95	0

DST16

Waveform A = DST17

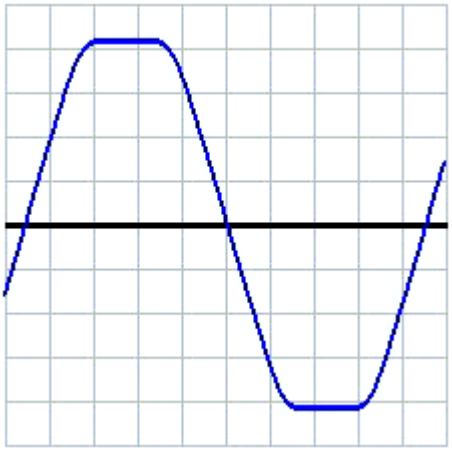


N	%	D
3	11.11	180
5	4.00	0
7	2.04	180
9	1.23	0
11	0.83	180
13	0.59	0
15	0.44	180
17	0.35	0
19	0.28	180

N	%	D
21	0.23	0
23	0.19	180
25	0.16	0
27	0.14	180

DST17

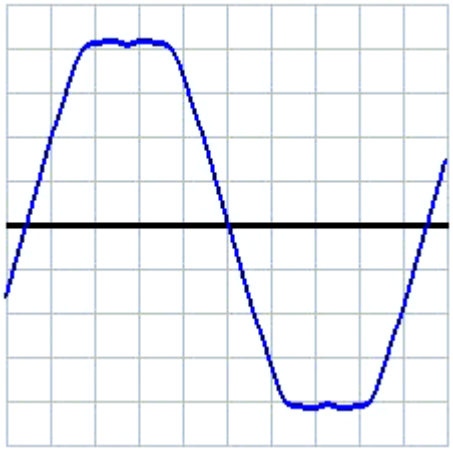
Waveform A = DST18



N	%	D
3	7.17	0
5	3.42	180
9	0.80	0

DST18

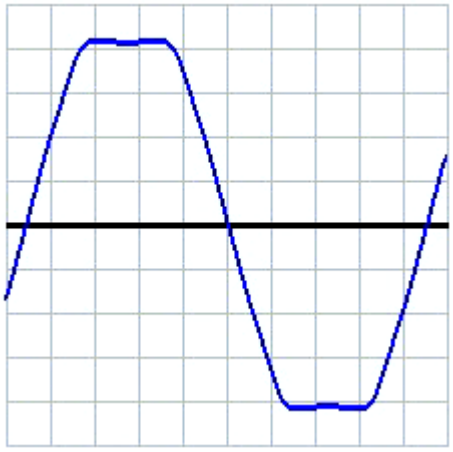
Waveform A = DST19



N	%	D
3	8.07	0
5	3.55	180
9	0.96	0
13	0.92	180

DST19

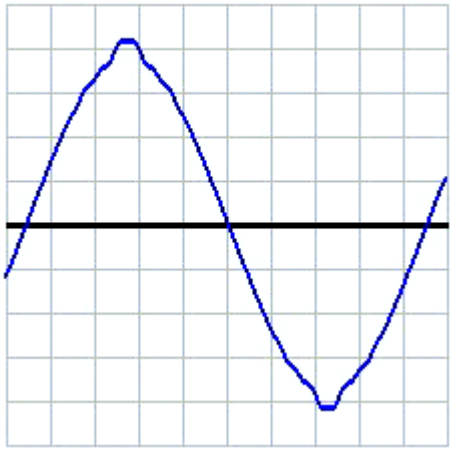
Waveform A = DST20



N	%	D
3	9.38	0
5	3.44	180
9	1.12	0
13	0.50	180

DST20

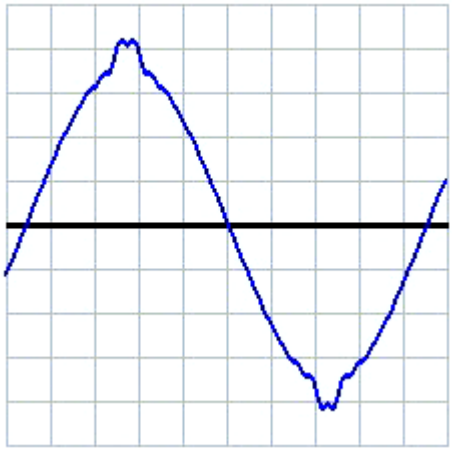
Waveform A = DST21



N	%	D
3	2.06	180
5	1.77	0
7	1.62	180
9	1.23	0
11	0.91	180
13	0.54	0
23	0.51	0
25	0.53	180

DST21

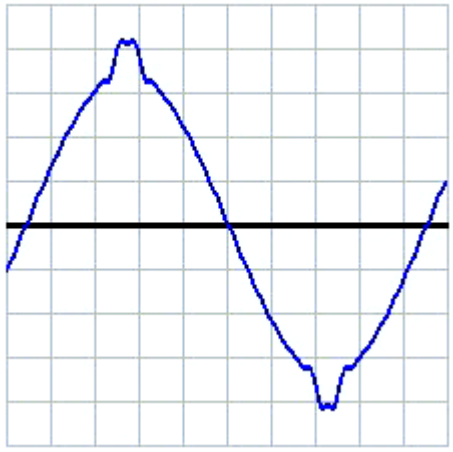
Waveform A = DST22



N	%	D	N	%	D
3	3.08	180	27	0.69	0
5	2.72	0	29	0.56	180
7	2.43	180			
9	1.97	0			
11	1.41	180			
13	0.86	0			
21	0.62	180			
23	0.73	0			
25	0.77	180			

DST22

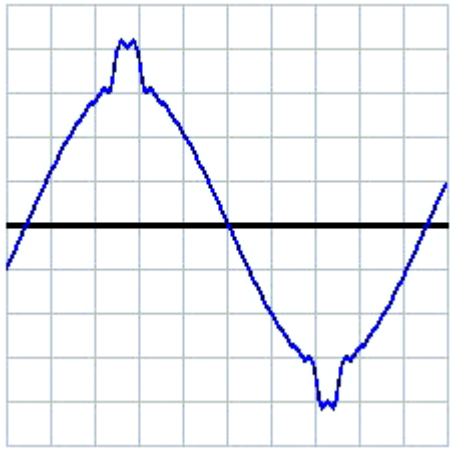
Waveform A = DST23



N	%	D	N	%	D
3	4.28	180	23	0.97	0
5	3.77	0	25	1.04	180
7	3.27	180	29	0.75	180
9	2.57	0			
11	1.93	180			
13	1.22	0			
15	0.55	180			
19	0.46	0			
21	0.83	180			

DST23

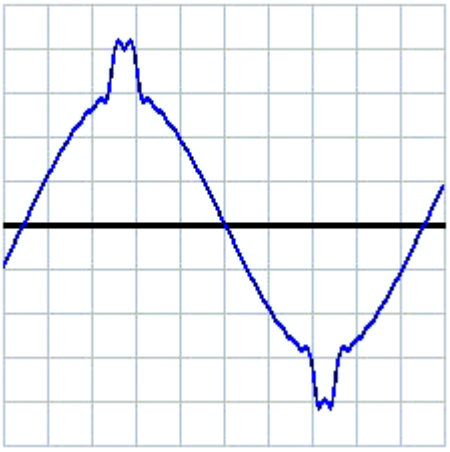
Waveform A = DST24



N	%	D	N	%	D
3	5.74	180	23	1.28	0
5	5.11	0	25	1.35	180
7	4.44	180	27	1.22	0
9	3.52	0	29	0.98	180
11	2.63	180			
13	1.65	0			
15	0.80	180			
19	0.61	0			
21	1.07	180			

DST24

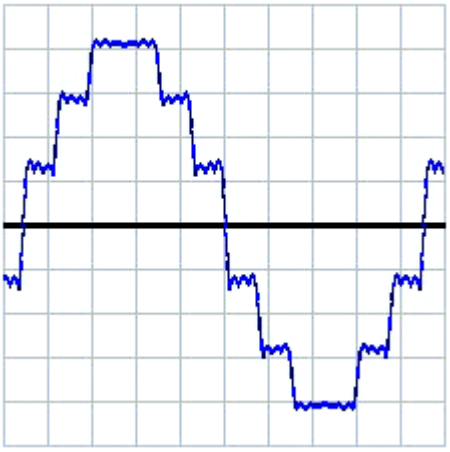
Waveform A = DST25



N	%	D	N	%	D
3	7.35	180	23	1.64	0
5	6.60	0	25	1.73	180
7	5.74	180	27	1.56	0
9	4.57	0	29	1.24	180
11	3.41	180			
13	2.16	0			
15	1.04	180			
19	0.74	0			
21	1.35	180			

DST25

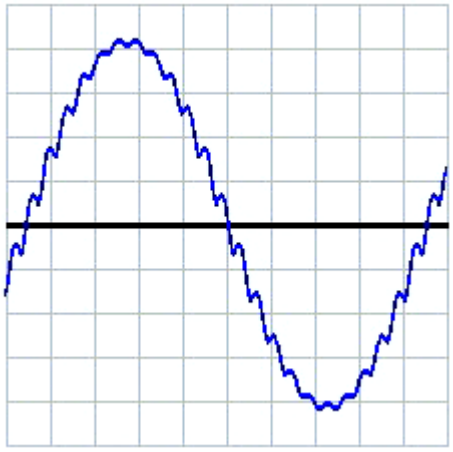
Waveform A = DST26



N	%	D	N	%	D
5	3.41	0	35	2.34	0
7	2.55	0	37	2.21	0
11	9.22	0			
13	7.68	0			
17	0.90	0			
19	0.90	0			
23	3.88	0			
25	3.56	0			
31	0.50	0			

DST26

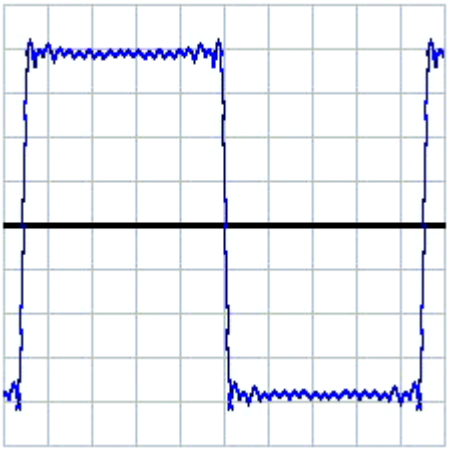
Waveform A = DST27



N	%	D
21	1.24	0
23	4.91	0
25	2.21	0

DST27

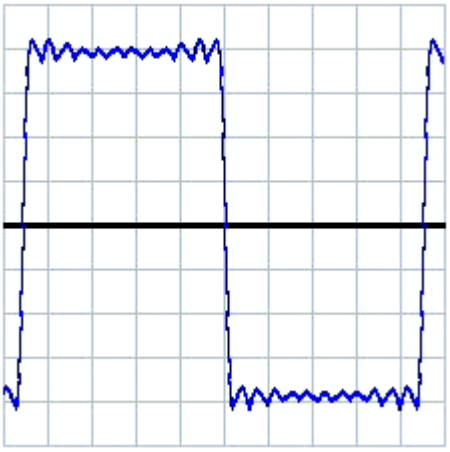
Waveform A = DST28



N	%	D	N	%	D
3	33.39	0	21	4.52	0
5	20.01	0	23	4.00	0
7	13.76	0	25	3.49	0
9	10.70	0	27	2.91	0
11	8.39	0	29	2.45	0
13	7.06	0	31	1.94	0
15	5.85	0	33	1.95	0
17	4.86	0	35	1.91	0
19	4.86	0	37	1.89	0
			39	1.83	0

DST28

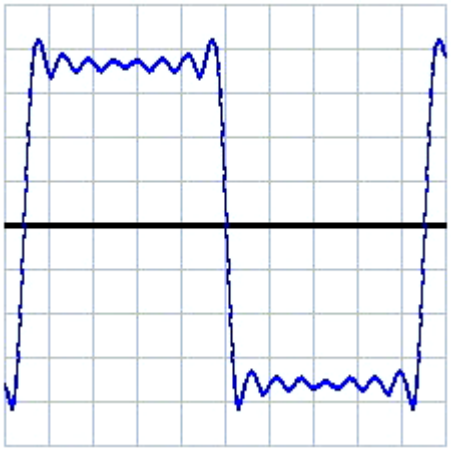
Waveform A = DST29



N	%	D	N	%	D
3	33.39	0	21	4.48	0
5	20.01	0	23	3.93	0
7	13.75	0	25	0.89	0
9	10.70	0	27	0.92	0
11	8.37	0	29	0.94	0
13	7.05	0	31	0.94	0
15	5.84	0	33	0.94	0
17	4.84	0	35	0.93	0
19	4.83	0	37	0.92	0
			39	0.91	0

DST29

Waveform A = DST30



N	%	D
3	33.39	0
5	20.01	0
7	13.75	0
9	10.70	0
11	8.33	0
13	6.99	0
15	5.26	0

DST30

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