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Regenerative Grid Simulator
61809/61812/61815
User's Manual

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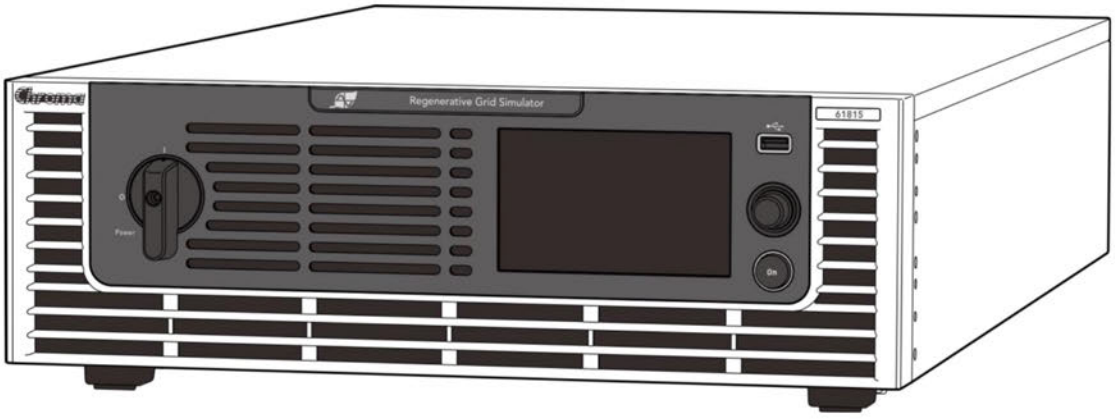
Regenerative Grid Simulators
9KW, 12KW, 15KW
User's Manual for
Models 61809/61812/61815



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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 and 2015/863/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 :

Regenerative Grid Simulator

(Product Name/ Trade Name)

61805, 61809, 61810, 61812, 61815

(Model Designation)

CHROMA ATE INC.

(Manufacturer Name)

88 Wenmao Rd., Guishan Dist., Taoyuan City 333001, 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 61326-2-1:2013

EN 61000-3-12:2011, EN 61000-3-11:2000

EN 61326-1:2013 (industrial electromagnetic environment)

EN 61000-4-2:2009, EN 61000-4-3:2006+A1:2008+A2:2010,
EN 61000-4-4:2012, EN 61000-4-5:2014+A1:2017, EN 61000-4-6:2014,
EN 61000-4-8:2010, EN 61000-4-34:2004+A1:2017

IEC 61010-1:2010+A1:2016(Edition 3.1), EN 61010-1:2010+A1:2019

The equipment describe above is in conformity with Directive 2011/65/EU and 2015/863/EU of the European Parliament and of the Council 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)

88 Wenmao Rd., Guishan Dist., Taoyuan City 333001, Taiwan

(Company Address)

Person responsible for this declaration:

Mr. Vincent Wu

(Name, Surname)

T&M BU Vice President

(Position/Title)

Taiwan	**2020.12.30**	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 device. 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 device.

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, the output is up to 495V peak voltage.
2. Do not connect the output terminal to the unit's output when the power is on, serious injury or death could result.
3. Be aware that in Y connections, all lines including L1/L2/L3, NEU have maximum current generation. Ensure all wire diameters meet the maximum current ratings.
4. The equipment should be placed horizontally during transportation and operation. Do not place instrument on its sides or upside down to prevent damage to the equipment.

Safety Symbols

	DANGER – High voltage.
	Explanation: To avoid injury, death of personnel, or damage to the instrument, the operator must refer to an explanation in the instruction manual.
	High temperature: This symbol indicates the temperature is hazardous. Do not touch to avoid personal injury.
	Protective grounding terminal: To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
	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)
	The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.
	The **CAUTION** sign denotes a hazard. It may result in personal injury or death if not noticed timely. It calls attention to procedures, practices and conditions.
	The **Notice** sign denotes important information in procedures, applications or the areas that require special attention. Be sure to read it carefully.

Revision History

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

Date	Version	Revised Sections
Sep. 2020	1.0	Complete this manual.
Dec. 2020	1.1	Update "*Output Mode Setting*" section in "*Local Operation*" chapter.
Mar. 2021	1.2	Update the following: − "*Specifications*" section in "*Overview*" chapter − "*Rotary Knob Input Mode*", "*Wave Selection*", "*External Vref.*", and "*Protection*" sections in "*Local Operation*" chapter Add "*CAN Interface*" section to "*Remote Operation*" chapter.
Jul. 2021	1.3	Add specification and relate description for Regenerative AC Load (Option). Modify the following: − "*Connecting Remote Sense*" section in "*Installation*" chapter − "*Numeric Keypad*", "*More Setting*", "*Configuration Menu*", "*Factory Default*", "*Basic Setting*", "*Measurement Setting*", and "*Protection*" sections in "*Local Operation*" chapter − "*Verification*" chapter − "*Instrument Command Dictionary*" section in "*Remote Operation*" chapter Add "*Screenshot*" section in "*Local Operation*" chapter.
Mar. 2022	1.4	Modify the following: – "*Specifications*" and "*Rear Panel*" sections in "*Overview*" chapter – "*Initial Inspection*" and "*Input Power Specification*" sections in "*Installation*" chapter – "*Interface*" and "*Factory Default*" sections in "*Local Operation*" chapter – "*Pulse Mode*" section in "*Application*" chapter – "*Connecting Cables for Three Units*" section in "*Parallel Operation*" chapter – "*Regenerative AC Load Mode (Option)*" chapter – "*Instrument Command Dictionary*" and "*Command Summary of Regenerative AC Load (Option)*" sections in "*Remote Operation*" chapter – Appendix "*TTL Signal Pin Assignments*"

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1. Overview

1.1 Introduction

The distributed power grids of today such as solar power and wind power generation are growing rapidly. To cope with this trend, equipment manufacturers are turning to industrial standards (IEEE 1547 / IEC 61000-3-15 / IEC 62116 for instance) to perform tests to certify their equipment meets these standards. The Chroma 61800 Series Regenerative Grid Simulators can provide test solutions required for parallel grids. Its full four quadrant operation, energy recycling and voltage waveform editing functions (I.e. simulation of voltage rise and fall and harmonic distortion) are allow for testing in compliance with these standards. Most importantly, the 61800 provides an effective energy saving solution that can return energy generated during testing back to the grid instead of dissipating it as heat energy. In addition to distributed power test applications, the 61800 Series Regenerative Grid Simulators can also be used for a wide range of other green products testing including Electric Vehicle to Grid (V2G) and Energy Saving Systems (ESS).

1.2 Feature

- Voltage: 0~350V
- Frequency: DC, 30Hz~100Hz
- Energy regenerative function with 100% rated current recycling capability
- Conform to test applications of PV inverters, Smart Grids and EV associate products
- Selectable 1-phase/3-phase AC output
- Controllable voltage and frequency and rates of change
- Output limit setting for voltage and current
- Voltage waveform setting for 0~360 degrees
- Sync TTL signal Output for changed voltage
- LIST, STEP, PULSE mode for Power Line Disturbance (PLD) simulation
- Voltage interruption/transient simulation (conform with LVRT test)
- Distortion waveform synthesis of harmonics and interharmonics
- Parameter measurement functions including step of harmonic current
- Programmable analog interface
- Digital interface: GPIB, CAN, USB, and LAN
- Supports parallel mode operation to meet high power output requirements (only for three-phase output)

1.3 Specifications

The following table lists the specifications of Chroma 61809/61812/61815 Regenerative Grid Simulators. All specifications are verified in accordance with Chroma's standard test procedure. Unless otherwise specified, all specifications are tested under the condition of remote connected voltage sense within the temperature of 25 ± 1°C with a resistive load.

Model	61809	61812	61815
AC Output Rating			
1-Phase Power[*13]	9kVA	12kVA	15kVA
3-Phase Total Power[*13]	9kVA	12kVA	15kVA
Power per Phase[*13]	3kVA	4kVA	5kVA
Voltage			
Output Voltage	0~350V_{LN}		
Accuracy[*1]	0.1%+0.2%F.S.		
Resolution	0.1 V		
Distortion [*1*2]	< 0.5% @50/60Hz < 0.8% @30Hz~100Hz		
Line Regulation	0.10%		
Load Regulation [*3]	0.20%		
Maximum Current (1-Phase)			
Output Current (RMS)	87A	96A	105A
Output Current (Peak)	261A	288A	315A
Maximum Current (3-Phase/per phase)			
Output Current (RMS)	29A@103.45V (maximum CP)	32A@125V (maximum CP)	35A@142.85V (maximum CP)
Output Current (Peak)	87A	96A	105A
Frequency			
Range	DC, 30Hz ~ 100Hz		
Accuracy[*1]	0.01%		
Resolution	0.01Hz		
DC Output Rating (1-Phase)			
Power	9kW	12kW	15kW
Voltage[*4]	495VDC		
Current	65.25A	72A	78.75A
DC Output Rating (3-Phase/per phase)			
Power	3kW	4kW	5kW
Voltage[*4]	495VDC		
Current	21.75A	24A	26.25A
Current Harmonic Distortion [*5]	Compliant with EN 61000-3-12:2011 standard		
Power Factor	0.98 (Typical)		
Input 3-Phase Rating (Each Phase)			
Voltage Range [*6*10]	3Φ 200Vac - 240Vac ± 10% / 47-63Hz 3Φ 380Vac - 480Vac ± 10% / 47-63Hz		
Frequency Range	47-63 Hz		
Maximum Current	39A Max./Phase (3Φ 200Vac - 240Vac ± 10%) 21A Max./Phase (3Φ 380Vac - 480Vac ± 10%)	51A Max./Phase (3Φ 200Vac - 240Vac ± 10%) 27A Max./Phase (3Φ 380Vac - 480Vac ± 10%)	51A Max./Phase (3Φ 200Vac - 240Vac ± 10%) 34A Max./Phase (3Φ 380Vac - 480Vac ± 10%)
Measurement			
Voltage			
Range	0~350V_{LN}		
Accuracy	0.1%+0.2%F.S.		
Resolution	0.01 V		

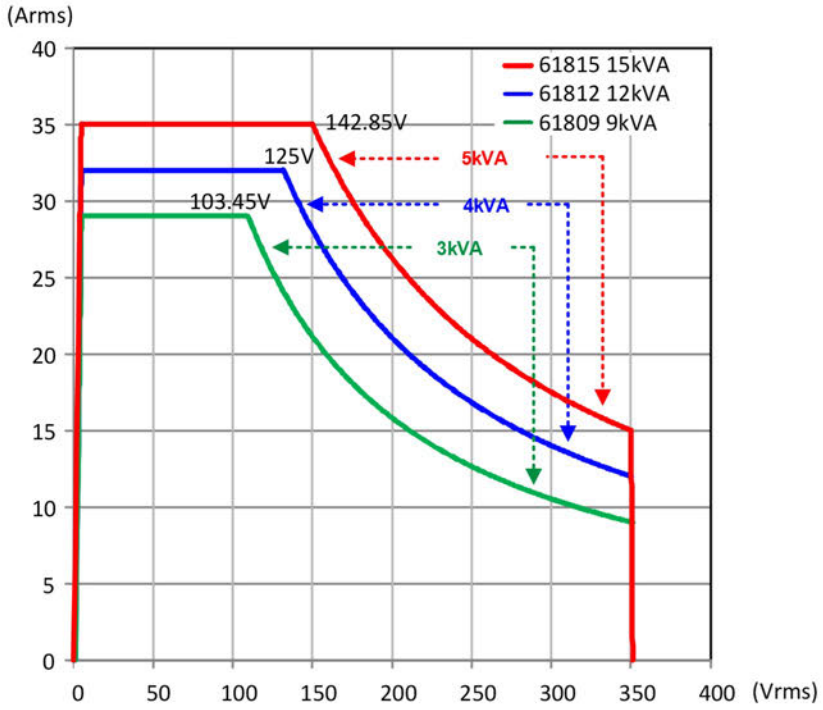
Model	61809	61812	61815
Current (Each Phase)			
Range	87A	96A	105A
Accuracy (RMS) *11	0.4%+0.3%F.S.		
Accuracy (Peak) *11	0.4%+0.6%F.S.		
Resolution *7	0.01 A		
Power			
Accuracy	0.4%+0.4% F.S.		
Resolution	0.1 W		
Others			
Efficiency*8	87%(Typical)		
Dimension (W×D×H)	428 x 700 x 132.8 mm / 16.85 x 27.55 x 5.23 inch		
Weight	50kg/110lbs		
Protection	OVP, OCP, OPP, OTP, FAN		
Remote Interface	GPIB, CAN, USB&USB Host, LAN		
Temperature Range			
Operating	0°C to 40°C		
Storage	-40°C to 85°C		
Humidity *9	0% to 95%		
Safety & EMC	CE		

Note

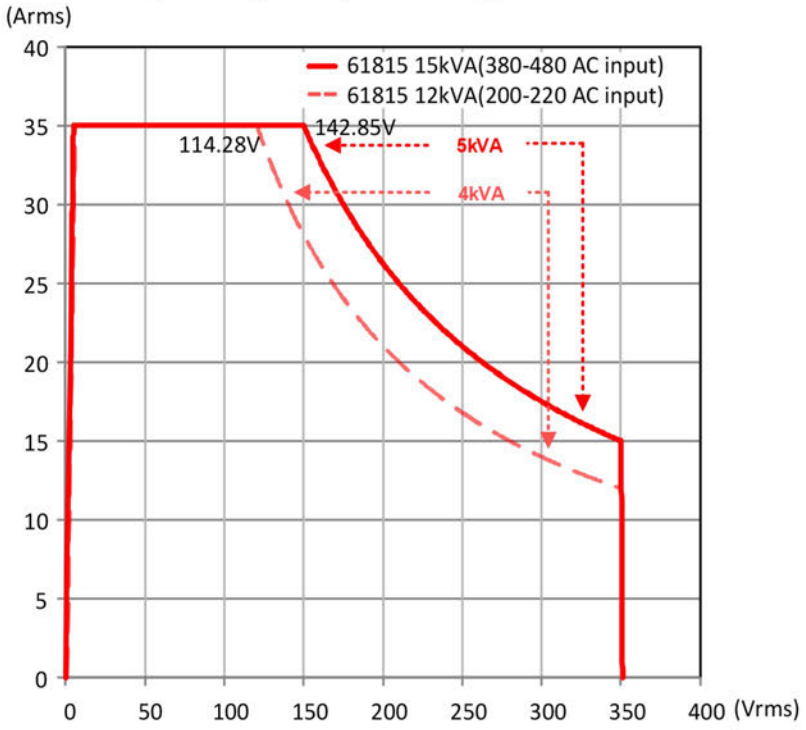
*1: The accuracy of voltage, frequency and maximum distortion tests were measured using a Power Analyzer with a line filter=6kHz, update rate=500ms using a linear load. The referenced instrument is CHROMA 66204.
*2: The maximum distortion test was measured at maximum output power into a linear load when the output voltage was set to 350VAC.
*3: The load regulation condition was measured using a sine wave output.
*4: The purpose of DC voltage output is to set the DC-bias for AC+DC.
*5: Based on the input voltage of a system with balanced three-phase.
*6: If an extra breaker is used the breaker should be larger than 50A.
*7: The current measurement display is 4 digits (for example10.00A or 99.99A. The minimum display digits are 00.01.
*8: The test efficiency was measured at maximum output power into a linear load when the output voltage was set to 250VAC.
*9: The operating humidity is in non-condensing only.
*10: The input voltage range of 61815 is 3Φ 200Vac - 240Vac ± 10% and the maximum output power is12kVA at 47-63Hz.
*11: When measuring the RMS accuracy in parallel mode, the total accuracy requires addition of the number of parallel units. For instance, if the RMS accuracy is 0.4%+0.3%F.S, it has to be above >N Amp with output voltage set to 250VAC and frequency set to 60Hz to meet the specification.(N is the number of parallel units.)
*12: To calculate the measurement accuracy in parallel mode the full scale (F.S.) current and power needs to be multiply by the number of paralleled units, for instance, the output RMS current of 3 paralleled units is 35x3=105A and the output peak current is 315A.
*13: When the power input of model 618xx series is 3Φ 200Vac - 240Vac, the output power will derate to 80%.
*14: See the voltage/current operating diagram below for the Regenerative Grid Simulator's output capability.

Voltage / Current Operating Area

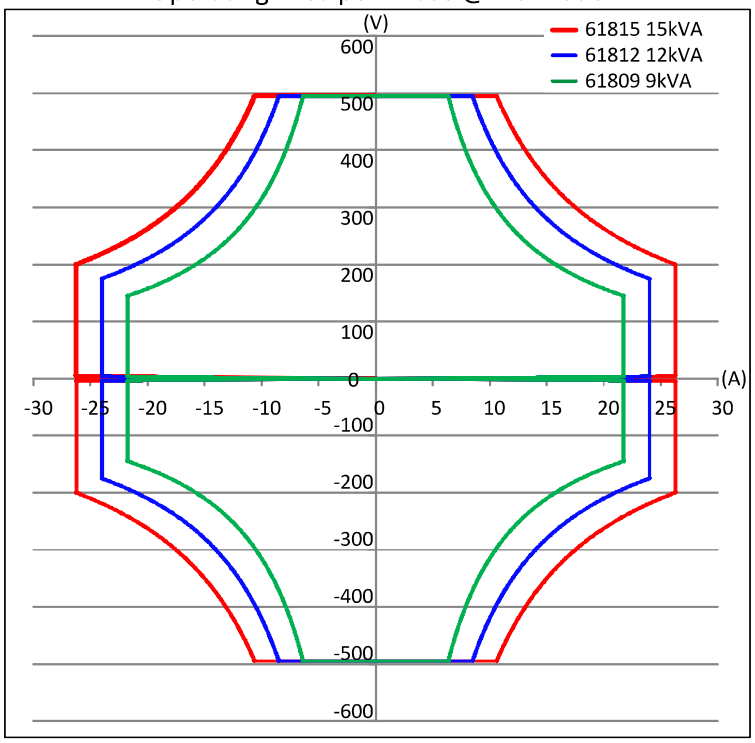
Operating Area per Phase @ AC Mode



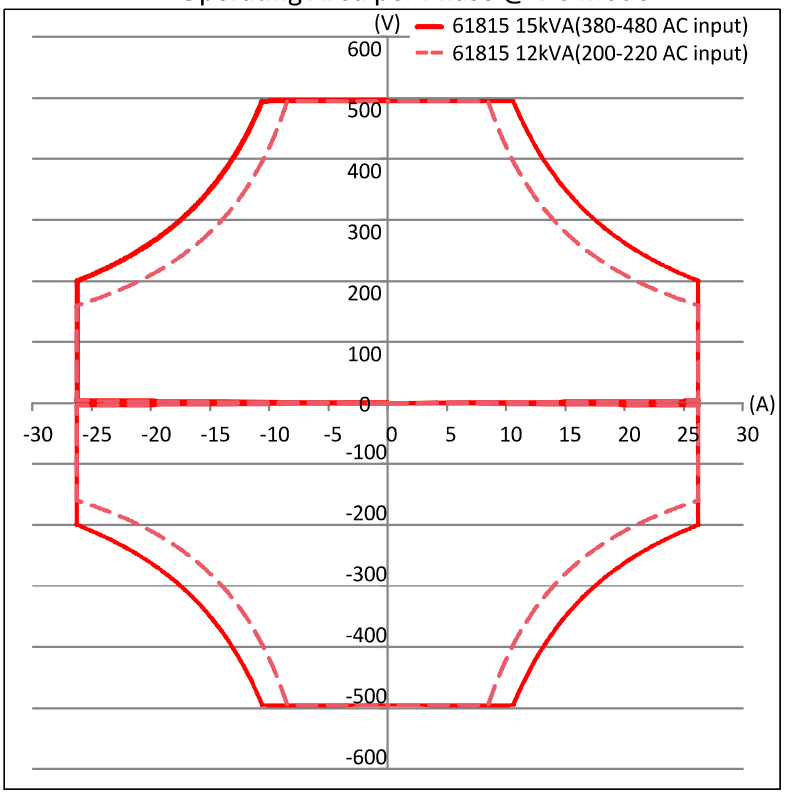
Operating Area per Phase @ AC Mode



Operating Area per Phase @ DC Mode



Operating Area per Phase @ DC Mode



Regenerative AC Load (Option)

Model No.	61809	61812	61815
Operating Range (each phase)			
Max. Current (RMS)	29Arms	32Arms	35Arms
Max. Current (Peak)	87Apeak	96Apeak	105Apeak
Voltage	30 ~ 350Vrms	30 ~ 350Vrms	30 ~ 350Vrms
Frequency	30 ~ 100Hz	30 ~ 100Hz	30 ~ 100Hz
CC/CS Rectified Mode (each phase)			
Current	0 ~ 29Arms	0 ~ 32Arms	0 ~ 35Arms
Accuracy (A) *1	0.3%+ 0.5%F.S.	0.3%+ 0.5%F.S.	0.3%+ 0.5%F.S.
Resolution (A)	0.01Arms	0.01Arms	0.01Arms
Power	0 ~ 3kVA	0 ~ 4kVA	0 ~ 5kVA *8
Accuracy (VA)*2	0.3% + 0.3%F.S.	0.3% + 0.3%F.S.	0.3% + 0.3%F.S.
Resolution (VA)	1VA	1VA	1VA
Crest Factor	1.414 ~ 3.000	1.414 ~ 3.000	1.414 ~ 3.000
Accuracy (CF) *3	3.0%F.S.	3.0%F.S.	3.0%F.S.
Resolution (CF)	0.001	0.001	0.001
CC Phase Lead / Lag Mode (each phase)			
Current	0 ~ 29Arms	0 ~ 32Arms	0 ~ 35Arms
Accuracy (A) *1	0.3% + 0.5%F.S.	0.3% + 0.5%F.S.	0.3% + 0.5%F.S.
Resolution (A)	0.01Arms	0.01Arms	0.01Arms
Phase*6	-90° ~ +90° (Current Source Mode: +90.01° ~ +180° & -90.01° ~ -180°)	-90° ~ +90° (Current Source Mode: +90.01° ~ +180° & -90.01° ~ -180°)	-90° ~ +90° (Current Source Mode: +90.01° ~ +180° & -90.01° ~ -180°)
Accuracy (deg)	1%F.S.	1%F.S.	1%F.S.
Resolution (deg)	0.01°	0.01°	0.01°
CS Phase Lead / Lag Mode (each phase)			
Power	0 ~ 3kVA	0 ~ 4kVA	0 ~ 5kVA*8
Accuracy (VA) *2	0.3%+ 0.3%F.S.	0.3%+ 0.3%F.S.	0.3%+ 0.3%F.S.
Resolution (VA)	1VA	1VA	1VA
Phase	-84.26°~ +84.26°	-84.26°~ +84.26°	-84.26°~ +84.26°
Accuracy (deg) *4	1%F.S.	1%F.S.	1%F.S.
Resolution (deg)	0.01°	0.01°	0.01°
PF *7	0.100 ~ 1.000 (Lead or Lag)	0.100 ~ 1.000 (Lead or Lag)	0.100 ~ 1.000 (Lead or Lag)
Accuracy (PF) *1	1% F.S.	1% F.S.	1% F.S.
Resolution (PF)	0.001	0.001	0.001
CR Mode (each phase)			
Resistance	1~ 300Ω	1~ 300Ω	1~ 300Ω
Accuracy (Ω) *4	0.3% + 0.5%F.S.	0.3% + 0.5%F.S.	0.3% + 0.5%F.S.
Resolution (Ω)	0.01Ω	0.01Ω	0.01Ω
CC/CP Mode (each phase)			
Current	0 ~ 29Arms	0 ~ 32Arms	0 ~ 35Arms
Accuracy (A) *1	0.3%+ 0.5%F.S.	0.3%+ 0.5%F.S.	0.3%+ 0.5%F.S.
Resolution (A)	0.01Arms	0.01Arms	0.01Arms
Power	0 ~ 3kW	0 ~ 4kW	0 ~ 5kW *8
Accuracy (W) *5	0.3% + 0.3%F.S.	0.3% + 0.3%F.S.	0.3% + 0.3%F.S.
Resolution (W)	1W	1W	1W

Model No.	61809	61812	61815
Crest Factor	1.414 ~ 3.000	1.414 ~ 3.000	1.414 ~ 3.000
Accuracy (CF) *3	3.0%F.S.	3.0%F.S.	3.0%F.S.
Resolution (CF)	0.001	0.001	0.001
Power Factor	0.100 ~ 1.000 (Lead or Lag)	0.100 ~ 1.000 (Lead or Lag)	0.100 ~ 1.000 (Lead or Lag)
Accuracy (PF) *4	1% F.S.	1% F.S.	1% F.S.
Resolution (PF)	0.001	0.001	0.001
Measurement			
Voltage Read Back			
Voltage	0 ~ 350Vrms	0 ~ 350Vrms	0 ~ 350Vrms
Resolution	0.01Vrms	0.01Vrms	0.01Vrms
Accuracy (RMS)	0.1% + 0.2%F.S.	0.1% + 0.2%F.S.	0.1% + 0.2%F.S.
Current Read Back			
Current	0 ~ 29Arms	0 ~ 32Arms	0 ~ 35Arms
Resolution	0.01Arms	0.01Arms	0.01Arms
Accuracy (RMS)	0.4%+0.3%F.S.	0.4%+0.3%F.S.	0.4%+0.3%F.S.
Peak Current Range	0 ~ 87Apeak	0 ~ 96Apeak	0 ~ 105Apeak
Resolution	0.01A	0.01A	0.01A
Accuracy (Peak)	0.4%+0.6%F.S.	0.4%+0.6%F.S.	0.4%+0.6%F.S.
Active Power			
True Power Range	0 ~ 3kW	0 ~ 4kW	0 ~ 5kW
Accuracy*2	0.4%+0.8%F.S.	0.4%+0.8%F.S.	0.4%+0.8%F.S.
Reactive Power			
Reactive power	0 ~ 3kVAR	0 ~ 4kVAR	0 ~ 5kVAR
Accuracy*2	0.4%+0.8%F.S.	0.4%+0.8%F.S.	0.4%+0.8%F.S.
Apparent Power			
Apparent power	0 ~ 3kVA	0 ~ 4kVA	0 ~ 5kVA
Accuracy*2	0.4%+0.8%F.S.	0.4%+0.8%F.S.	0.4%+0.8%F.S.
Frequency			
Frequency	30 ~ 100Hz	30 ~ 100Hz	30 ~ 100Hz
Resolution	0.01Hz	0.01Hz	0.01Hz
Accuracy*4	0.1%F.S.	0.1%F.S.	0.1%F.S.
Power Factor			
Power factor	0.100 ~ 1.000	0.100 ~ 1.000	0.100 ~ 1.000
Resolution	0.001	0.001	0.001
Accuracy*4	1% F.S.	1% F.S.	1% F.S.
Crest Factor			
Crest factor Range	1.414 ~ 3.000	1.414 ~ 3.000	1.414 ~ 3.000
Resolution	0.001	0.001	0.001
Accuracy*3	3.0%F.S.	3.0%F.S.	3.0%F.S.

Note

*1: Conditions to meet specification: Irms ≥ 0.5A and the UUT is a sinusoidal voltage.
*2: Conditions to meet specification: S ≥ 100VA and the UUT is a sinusoidal voltage.
*3: Conditions to meet specification: Irms ≥ 2A and the UUT is a sinusoidal voltage (V_{UUT} ≥ 50Vrms). The DUT voltage and the regenerative AC load current must be in the same phase.
*4: Conditions to meet specification: Irms ≥ 2A and the UUT is a sinusoidal voltage (V_{UUT} ≥ 50Vrms).
*5: Conditions to meet specification: P ≥ 100W and the UUT is a sinusoidal voltage. The

DUT voltage and the regenerative AC load current must be in the same phase.
*6: Supports current source mode and needs to set Phase limit to OFF. See section 7.4.4.1 for the setting method.
*7: Supports PF setting mode and needs to set Power Factor to ON. See section 7.4.5.1 for the setting method.
*8: When the input of model 61815 regenerative AC load is 3Φ 200Vac-240Vac, its load power will be derated to 80%.

1.4 Function Buttons

1.4.1 Front Panel

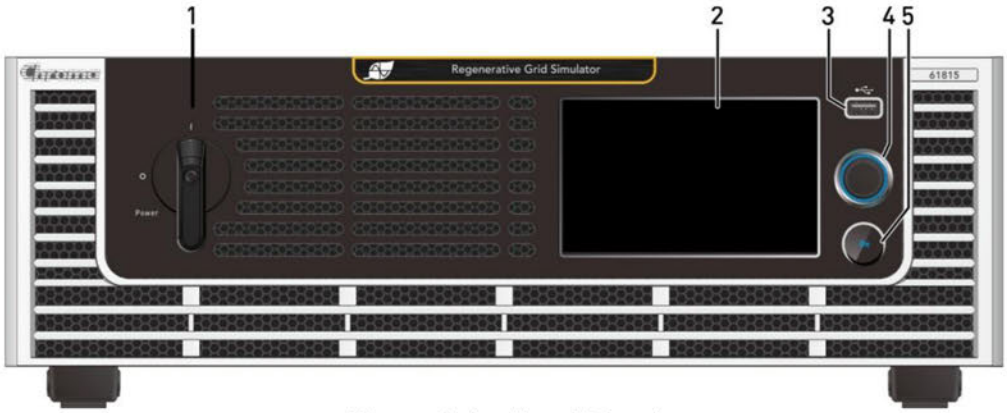


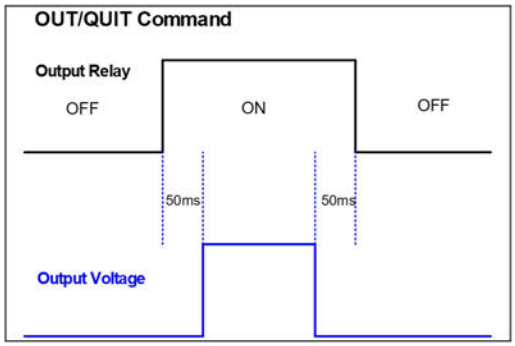
Figure 1-1 Front Panel

Table 1-1 Front Panel Description

Item	Symbol	Description
1		***Main Power Switch***: Powers the Regenerative Grid Simulator on and off.
2		***LCD Touch Panel***: 5.0 inch LCD displays output settings and measurement results.
3		***USB HOST***: Captures the LCD screen. Only for use with a flash (thumb) drive to record data. See warning below.
4		***RPG rotary knob***: Turning the RPG rotary knob allows for adjustments to voltage and frequency and allows for inputting programmed data.
5		***Output ON button***: Allows for output to be turned on and off without turning off instrument. Light on means the output is ON and light off means the output is OFF.

Notice

To extend the life of the internal output relay, circuit delays for 50ms when QUIT is selected. If the load is inductive, instrument will discharge current during the delay time to avoid switching current across the relays.



⚠WARNING The USB HOST on the front panel can only be used to connect USB flash drive. Do not connect to power banks and other 3C products.

1.4.2 Rear Panel

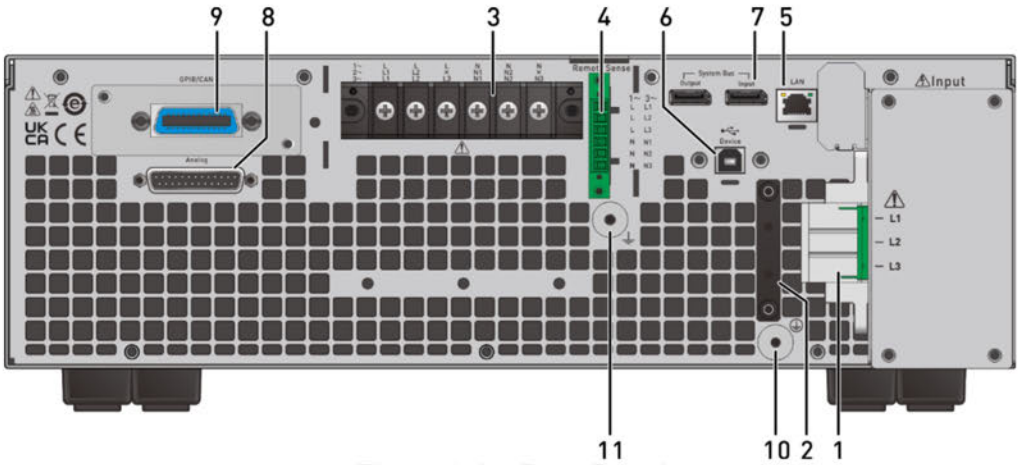


Figure 1-2 Rear Panel

Table 1-2 Rear Panel Description

Item	Name	Description
1	Input Connector	Used to connect the regenerative grid simulator to the utility mains.
2	Power Input Wire Fixing Bar	Allows for convenient connections to input connecting wires.
3	Output Connector	For connecting the output to the UUT. ⚠ means it is an output when the 61809/61812/61815 is a regenerative grid simulator and an input when the 61809/61812/61815 is a regenerative AC load (option).
4	Remote Sense	Remote voltage sense connection. Used to connect remote sense lines to the load to compensate for voltage drop caused by the output cable. Be sure that the “L1” terminal of the remote sense connects to the “L1” terminal of load while the “N” connects to the “N” terminal of load. (Do not use reverse polarity for connection.)
5	LAN	Used to connect to a network (LAN) control interface.
6	USB	USB control interface to connect external host computer for remote operation.
7	Parallel Signal	Used to interconnect devices for Master/Slave parallel

	Comm. Port	operation.
8	Analog	Ext.Vref port inputs analog signals to control the output waveform amplitude and the TTL I/O terminal to transmit the I/O control signal (Fault_out, Remote Inhibit & AC_ON.) See Appendix A for detailed pin assignment.
9	GPIB/CAN Connector (Option)	GPIB/CAN interface to connect the PC for remote operation.
10	Input Ground Terminal	Input ground terminal of regenerative grid simulator to connect the earth.
11	Output Ground Terminal	Output ground terminal of regenerative grid simulator to connect the earth.

Notice

1. Figure 1-3 shows the optional GPIB/CAN interface of model 618xx (item 9). A cover plate is provided if this option is not ordered.

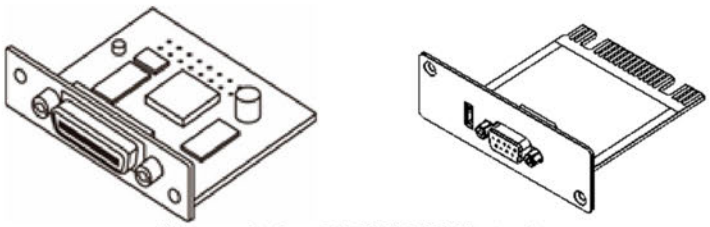


Figure 1-3 GPIB/CAN Interface

2. Figure 1-4 shows the docking board of Analog terminal on the rear panel. The installation is shown below.

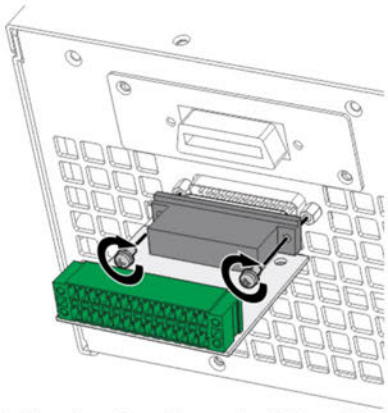


Figure 1-4 Analog Terminal Docking Board

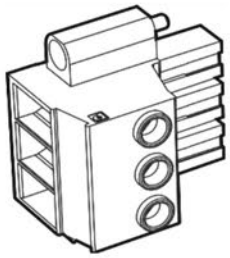
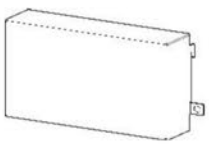
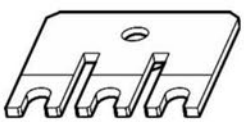
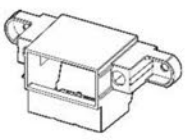
2. Installation

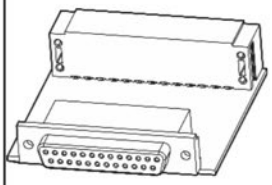
2.1 Initial Inspection

Before shipment, this device was inspected and found to be free of mechanical and electrical defects. When unpacking, inspect for damage that may have occurred in transit. Save all packing materials in case the instrument needs to be returned. If damage is found, file a claim with the carrier immediately. Do not return the product to Chroma without prior approval.

(1) Please check if there is any damage during transportation or missing accessories after unpacking.
(2) If any damage is found, file a return shipping request with Chroma in order to receive authorization to return device.

The accessories of model 61809/61812/61815 are listed in the table below.

Standard Accessories				
Item				
Name	Input terminal block *1pcs	Capacitive Stylus pen *1pcs	M4*10 screw *2pcs	M4*12 Screw *3pcs
P/N	W52-000098	A55-000289	H61-401052	H69-401290
Item				
Name	M4*16 screw *2pcs	M3*8 screw *2pcs	M4*12 screw *8pcs	M5*10 Screw *1pcs
P/N	H69-401550	H69-300850	H61-401220	H61-501020
Item				
Name	Output terminal block *1pcs	Output busbar *1pcs	Input terminal block *1pcs	Output cable cleat *1pcs
P/N	G29-000116	G52-000351	G29-000106	G32-015248

Item				
Name	Output cable cleat *1pcs	Rack mounting kit *2pcs	Stylus lanyard *1pcs	Docking board for APG signal*1pcs
P/N	G32-015296	G28-000146	G55-001131	8-61810026
Item				
Name	#4-40*7.93 screw *2pcs s			
P/N	H66-000021			

Notice

1. Please keep all of the packing materials in case the device has to be returned for repair.
2. Do not return the instrument to the factory without obtaining prior RMA acceptance from Chroma.
3. Check if all accessories that are listed in the packing list are all received.

CAUTION The power supply is too heavy for one person to safely lift and assemble. To avoid injury, ask for assistance during installation.

2.2 Precautions before Use

The grid simulator has to properly connect to an AC source for operation. Since the device is fan cooled, install in a location with sufficient air flow. The environment temperature should be under 40°C. When the instrument input configuration is a Y connection, ensure that L1/L2/L3 and NEU are proper wire diameters meet the maximum current requirements.

CAUTION

1. The weight of the simulator upper cover cannot exceed 10Kg (22lbs). Do not stack any objects on top which exceed this weight.
2. The Regenerative Grid Simulator is a fan cooled instrument thus needs to be installed in a place with sufficient air flow.
3. The ambient operating air temperature cannot exceed 40°C.

2.3 Input Power Specification

2.3.1 Ratings

Input voltage range:

61809	61812	61815
3Ø 200-240V±10%V_{LL} (39A Max./Phase) 3Ø 380-480V±10%V_{LL} (21A Max./Phase)	3Ø 200-240V±10%V_{LL} (51A Max./Phase) 3Ø 380-480V±10%V_{LL} (27A Max./Phase)	3Ø 200-240V±10%V_{LL} (51A Max./Phase) 3Ø 380-480V±10%V_{LL} (34A Max./Phase)

All of the input voltage specifications are based on 3-phase AC line voltage (L-L).

Input frequency: 47-63 Hz

⚠WARNING The Regenerative Grid Simulator could be damaged if the input voltage is out of the specification.

2.3.2 Connecting for Input

The input connection is located on the right of the simulator rear panel. The power cable should be at least 105°C rated. The power cable input should have rated current larger or equal to the maximum rated current of Regenerative Grid Simulator.

Perform the steps below for connection as Figure 2-1 shows:

a. Secure the power cable to the AC power terminal.
b. Insert the AC power terminal into the AC terminal block and lock the power input protection cover.
c. Secure the grounding terminal of input power supply to the copper column on the chassis (a M4*0.7 flange nut is used).
d. Lock the safety anti-pull device to prevent the AC power terminal from falling off.

⚡CAUTION
1. To protect the operator, the metal wire connected to GND terminal has to be earth grounded. In no cases should the Regenerative Grid Simulator be operated without proper earth ground.
2. The power cable installation has to be performed by professional personnel in compliance with the local electrician regulation.

Voltage Range	Cable Spec.	Terminal Spec.
(3Ø 200-240V±10%V_{LL} 380-480V±10%V_{LL})	8AWG (L1/L2/L3/GND)	E10-12(L1/L2/L3) 8-6(GND)

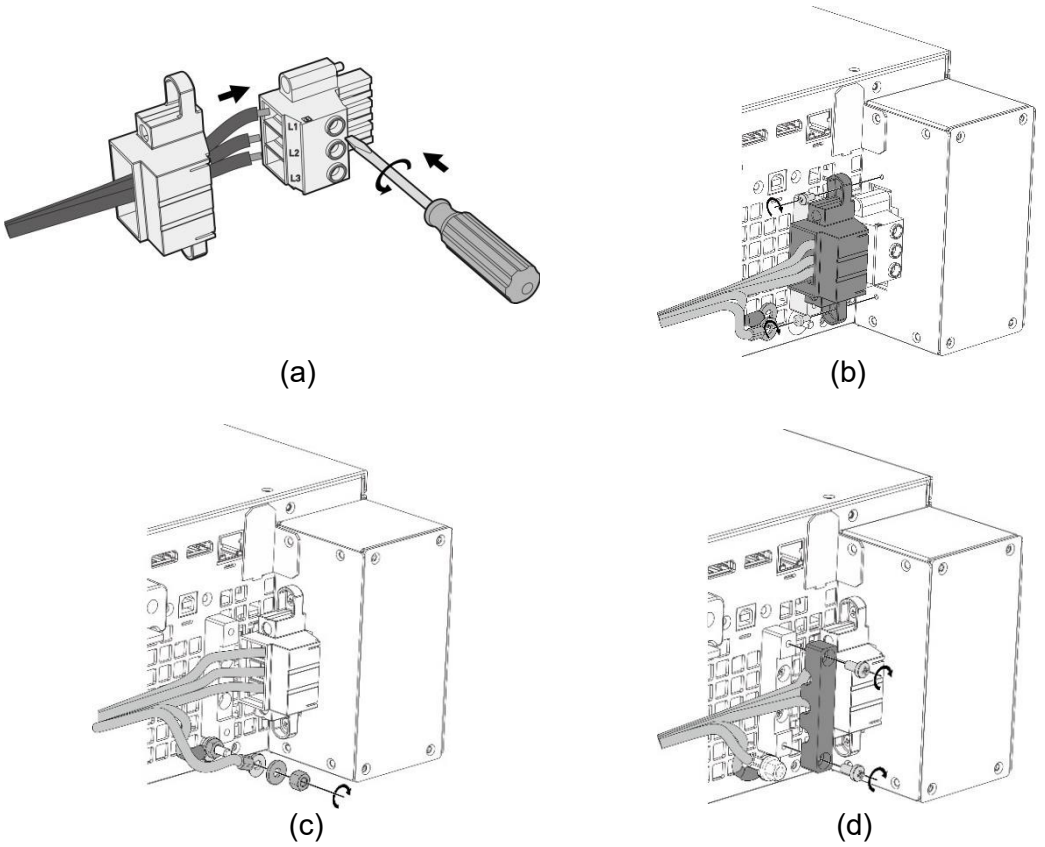


Figure 2-1 Input Power Connection and Wiring Fixed Diagram

Notice

1. The input voltage specifications are based on 3-phase AC line voltage (L-L).
2. The green or green with yellow inlaid grounding wire is to be connected to the ⏚ terminal.
3. The red, black or blue power wire is to be connected to L1, L2, and L3 terminals.

⚠WARNING

1. To protect the operator, the metal wire connected to GND ⏚ terminal has to be earth grounded. In no cases should the Regenerative Grid Simulator be operated without proper earth ground.
2. The power cable installation has to be performed by professional personnel in compliance with the local electrician regulation.

CAUTION

1. Be sure to select the input wire with appropriate withstand voltage based on the input voltage.
2. To ensure safe operation, please select the breaker closest to the current rating of each phase based on the input power during installation, and connect it in series before the input terminal.
3. The breaker should be installed within the building for safe operation, please refer to Table 2-3 for related ratings.

The section area of input current conductor and the outer diameter of anti-pull wire should to comply with the safe currents listed in Table 2-1

Table 2-1 Recommended Wire Spec.

Conductor Area Section Area mm²	Save Current (A) Copper Conductor	Anti-pull Diameter (mm)
8.0	55	6.65 ± 0.15

Table 2-2 lists the PVC (105°C) wire specifications when the ambient temperature is 30°C.

Table 2-2 PVC (105°C) Wire Spec.

Conductor Area Section Area mm²	Save Current (A)	
	Copper Conductor	Aluminum Conductor
1.25	15	--
2.0	20	--
3.5	30	--
5.5	40	--
8.0	55	--
14	70	50
22	90	70
30	120	90
38	145	100
50	175	120
80	230	150
100	260	200
125	300	240
150	350	270
200	425	330
250	500	380
325	600	450
400	700	500
500	800	600

Table 2-3 Minimum Breaker Ratings

Model	Breaker Rating(A)
61815	51A max.@ 3Ø 200-240V±10%V_{LL} 34A max.@3Ø 380-480V±10%V_{LL}
61812	51A max.@ 3Ø 200-240V±10%V_{LL} 27A max.@3Ø 380-480V±10%V_{LL}
61809	39A max.@ 3Ø 200-240V±10%V_{LL} 21A max.@3Ø 380-480V±10%V_{LL}

2.4 Output Connection

The output terminal socket is located at the rear side of Regenerative Grid Simulator. The load is connected to the output terminal. For safety, the AC input/output cable must be secured with an appropriate tool and the casing has to be tightened up securely. The cable diameter connected to the load has to be large enough so that it will not over heat if the output is over current, see Figure 2-2.

Notice

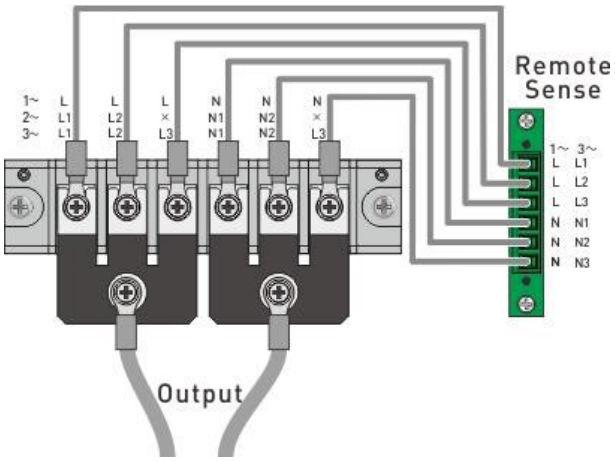
1. The output terminal "L" means "+" and "N" means "-".
2. This Regenerative Grid Simulator can output 1-/3-phase. When set to 1-phase mode, the short circuit copper bar must be used to short-circuit the L1/L2/L3 output. The UUT L/N points are connected to the L1/L2/L3 and GROUND short circuit copper bar respectively as shown in Figure 2-2.
3. In regenerative AC load mode (optional accessory), it supports loading and use of UUT in Y-connection (with neutral line N) but not △ connection (without neutral line N).

⚠WARNING For the simulator to dissipate heat properly, it is necessary to keep at least 1 meter space free of obstruction in front and in the rear panel for ventilation. Do not place the device against a wall or any other objects.

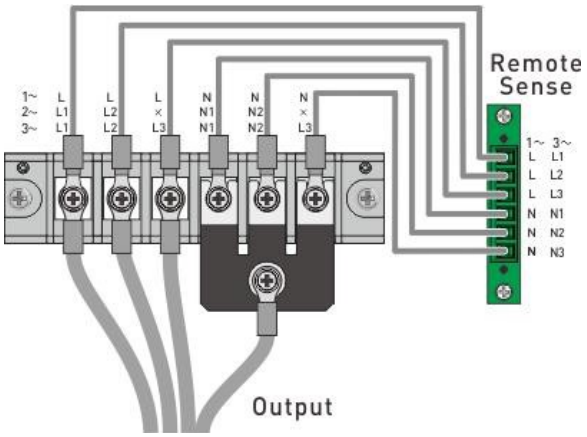
2.5 Connecting Remote Sense

The Remote Sense of the Regenerative Grid Simulator compensates automatically for load cable voltage drops and ensures the voltage transmitted to load is the set voltage.

Remove the cable connected to "L1", "L2", "L3", "N1", "N2" and "N3" from the Remote Sense terminal and change it by connecting to Load as Figure 2-3 shows. As the sense wire only sends a few MA (milliamps current), the sense metal wire is much thinner than the load wire. The sense wire is part of the Regenerative Grid Simulator feedback circuit, thus it has to keep low resistance in order to maintain the best performance. If the sense wire is not connected or becomes open during operation, the Regenerative Grid Simulator may not output voltage. It is necessary to ensure that the sense wire connection is secure and cannot open during operation. The sense wire should be twisted to reduce interference from external voltage and needs to be as short as possible.

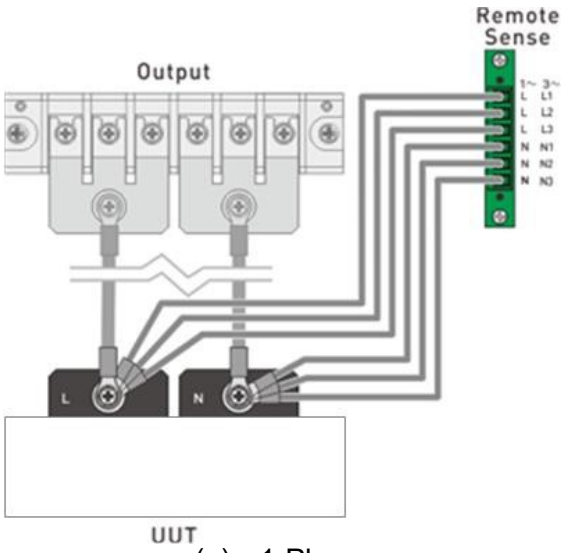


(a) 1-Phase

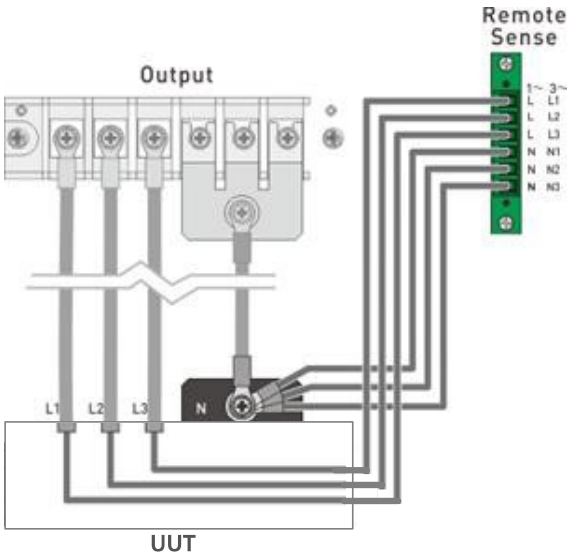


(b) 3-Phase

Figure 2-2 Connecting Output and Local Voltage Sense



(a) 1-Phase



(b) 3-Phase

Figure 2-3 Connecting Output and Remote Voltage Sense

Notice

1. The sensing leads should be as close as possible to the load and twisted together to reduce external voltage interference. The sensing leads only transmits a small amount of current (mA current), thus 18 AWG wire is recommended.
2. The output power cable of the Regenerative Gird Simulator is at N contact. Since it will withstand 3 times of L current, it is recommended to use 2AWG wire.

2.6 Installing the Handle

Use for M4x12 flat-head screws to attached the handle of the rack mounting kit when installing as shown in Figure 2-4.

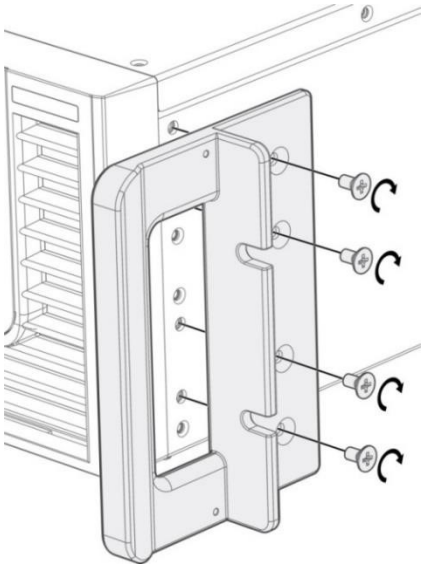
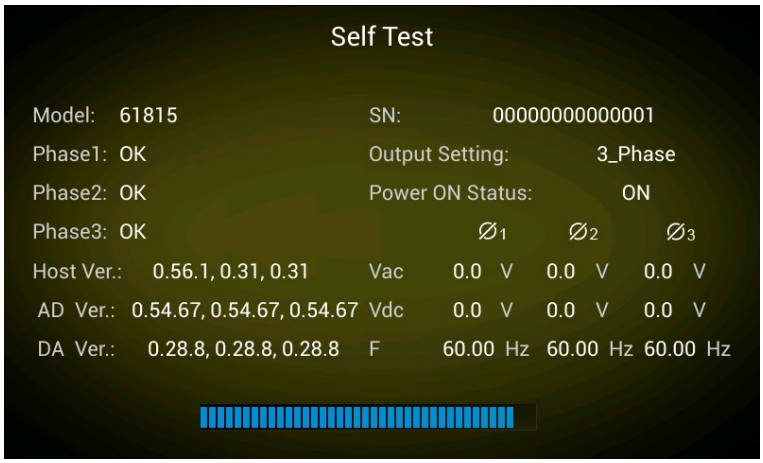


Figure 2-4

2.7 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 ground may cause potential electric shock hazard and result in personal injury or death

Connect the power line and turn on the power switch located on the front panel. The Regenerative Gird Simulator will begin a series of self tests. The LCD on the front panel will be on and display will appear as shown below.



During initialization the Regenerative Gird Simulator executes memory, data and communication self tests. The display shows the Model Number and Regenerative Gird Simulator's Serial Number after executing the self-test routines and each test item will show "OK" on the right if no error is found. The software version will show on the display.

When the self tests of memory, data and communication are done, the Regenerative Gird Simulator 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 accidently damaged to avoid injury to operators. The Regenerative Gird Simulator sets the output to 300Vac for the voltage measurement. If the power self-test fails the display shows NO-GO "NG" when the measured voltage is over 300V±30V. If the self-test is OK, the screen will change to the MAIN PAGE automatically.

Notice

1. You can run self-diagnosis during power on self-test to see if there are any error conditions.
2. Self-test requires about 20 seconds completing.

2.8 Maintenance and Cleaning

Remove all connected wires and cables from the instrument before cleaning. Use a brush to clean dust and if there are stains on the chassis that cannot be removed by brush, wipe 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 VFD front panel display or a screen

cleaner designed for displays. Please send unit back to the Chroma if internal cleaning is needed

2.9 Common Environment Conditions

1. In door use only.
2. Altitude up to 2000m.
3. Temperature 0°C to 40°C.
4. Operating temperature is 0°C to 40°C.
5. Operating humidity is 0%rh to 90%rh (non-condensing).
6. Storage temperature is -25°C to 70°C.
7. Storage humidity is 0%rh to 90%rh (non-condensing).
8. The input AC power voltage fluctuates up to ±10% of the rated voltage.
9. The transient overvoltage is CAT II pulse withstand voltage.
10. The pollution degree is II.

3. Local Operation

3.1 Introduction

The Regenerative Grid Simulator can be configured to operate in local or remote mode. In remote mode, the instruments are controllable via GPIB or other interfaces, see chapter 8 for detailed information. 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 Regenerative Grid Simulator is turned on. The command tree is shown below.

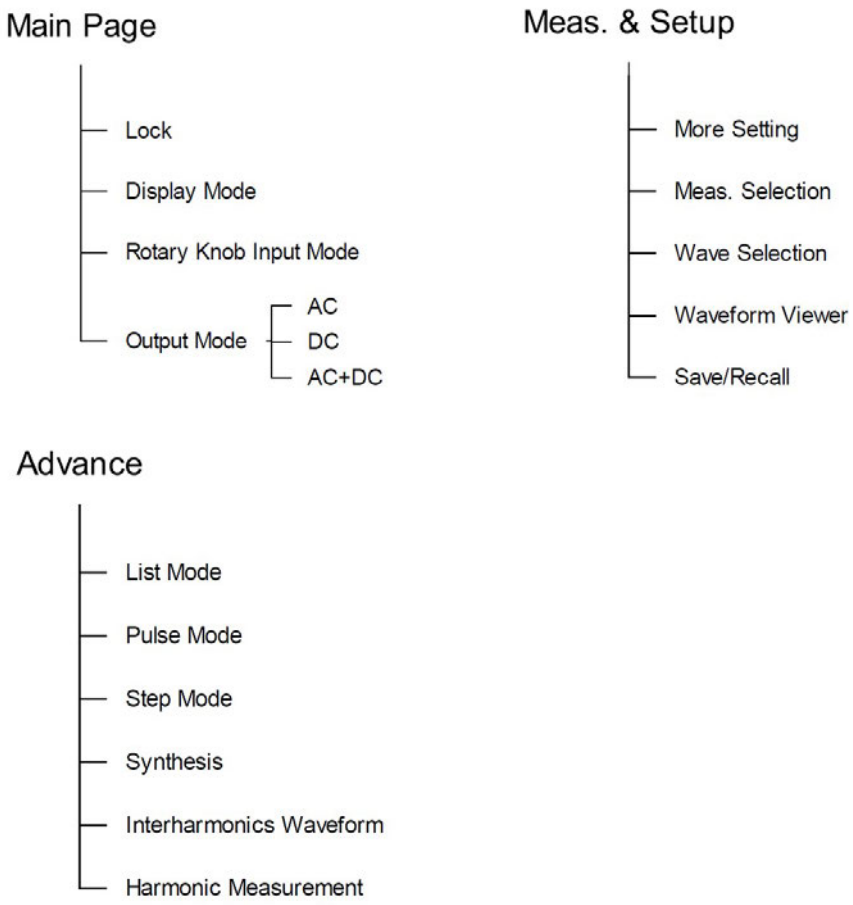


Figure 3-1

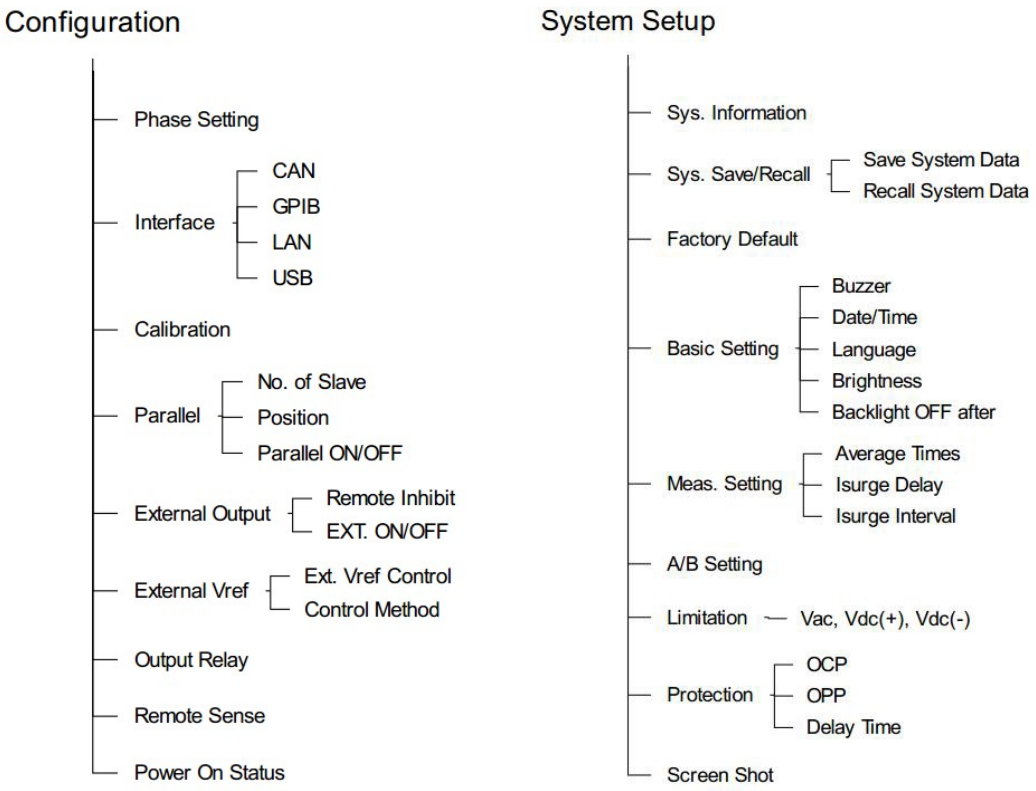
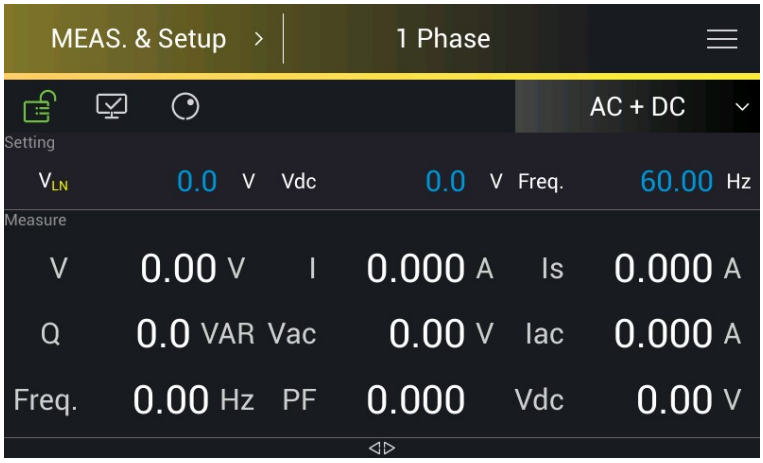


Figure 3-2

3.2 Using Meas. & Setup

When the Regenerative Grid Simulator is turned on and self-test is completed, the screen displays the Meas. & Setup (3_Phase Mode/1_Phase Mode) main page as shown below.



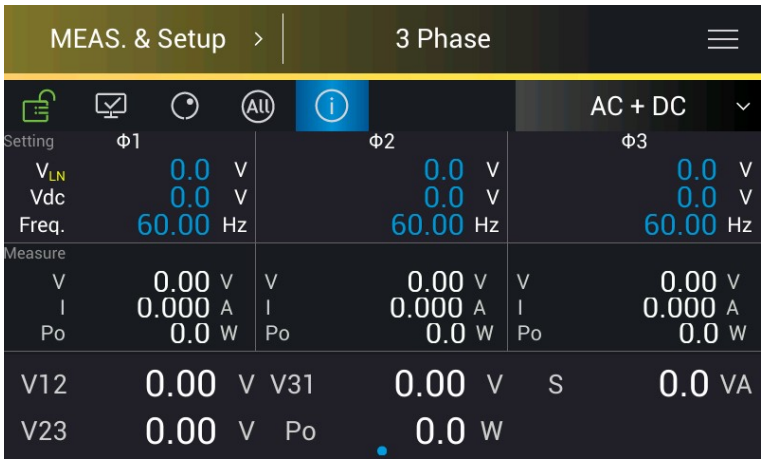
The definition of output parameters on the main page:

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

Tapping **OUT/QUIT** enables the Regenerative Grid Simulator's output to the entered values of Vac, F and Vdc. Tap again to disable the output.

Notice

1. When Coupling = AC+DC, the output is the sum of Vac and Vdc. However, the combination of peak voltage cannot exceed 495V. The output voltage will skip to 0V automatically and trigger an over voltage protection (OVP) error voltage exceeds the voltage limit.
2. On the main page, tap ⓘ to display the hidden V12, V23, V31, S, and Po measurements.



The Regenerative Grid Simulator provides an easy-to-use programming interface. Simply use the touch screen on the front panel and the RPG (rotary pulse generator) knob to complete operations and enter data. Following describes the usage of Meas. & Setup.

3.2.1 Numeric Keypad

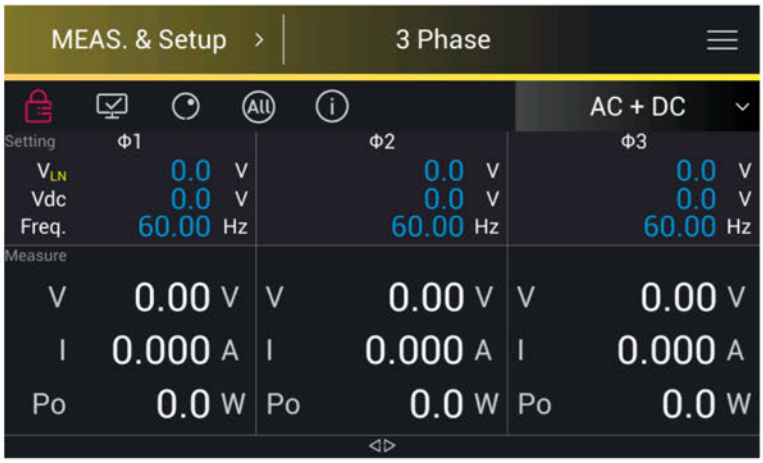
In the main page, numeric values can be entered using the touch screen keypad to enter values, tap ↵ when done. Tap ✕ to cancel the value entered value and return to the previous page. The measured value is displayed on the top of the screen. Tap ← and CLR during data input to modify and clear the settings.

Notice

The user can set the value based on the value displayed on upper left of the numeric keypad, and use the Max and Min keys to quickly set to the maximum and minimum values available for the command.

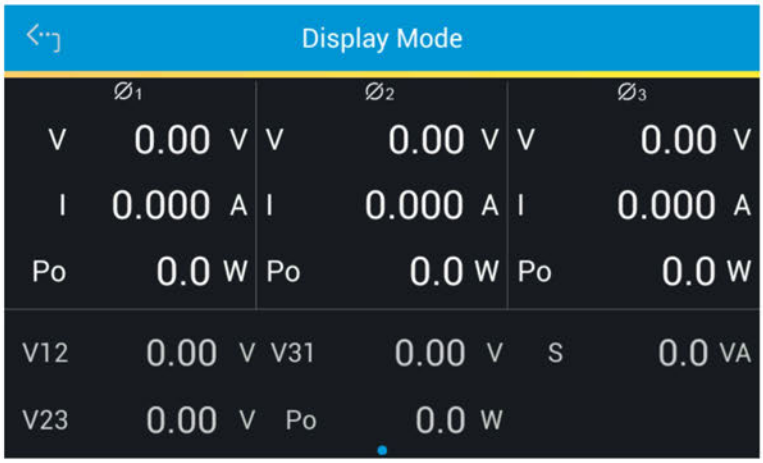
3.2.2 Lock Button

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap 🔓 to lock the panel selection functions. All touch functions are disabled except the lock key. Tap 🔒 again to unlock it.



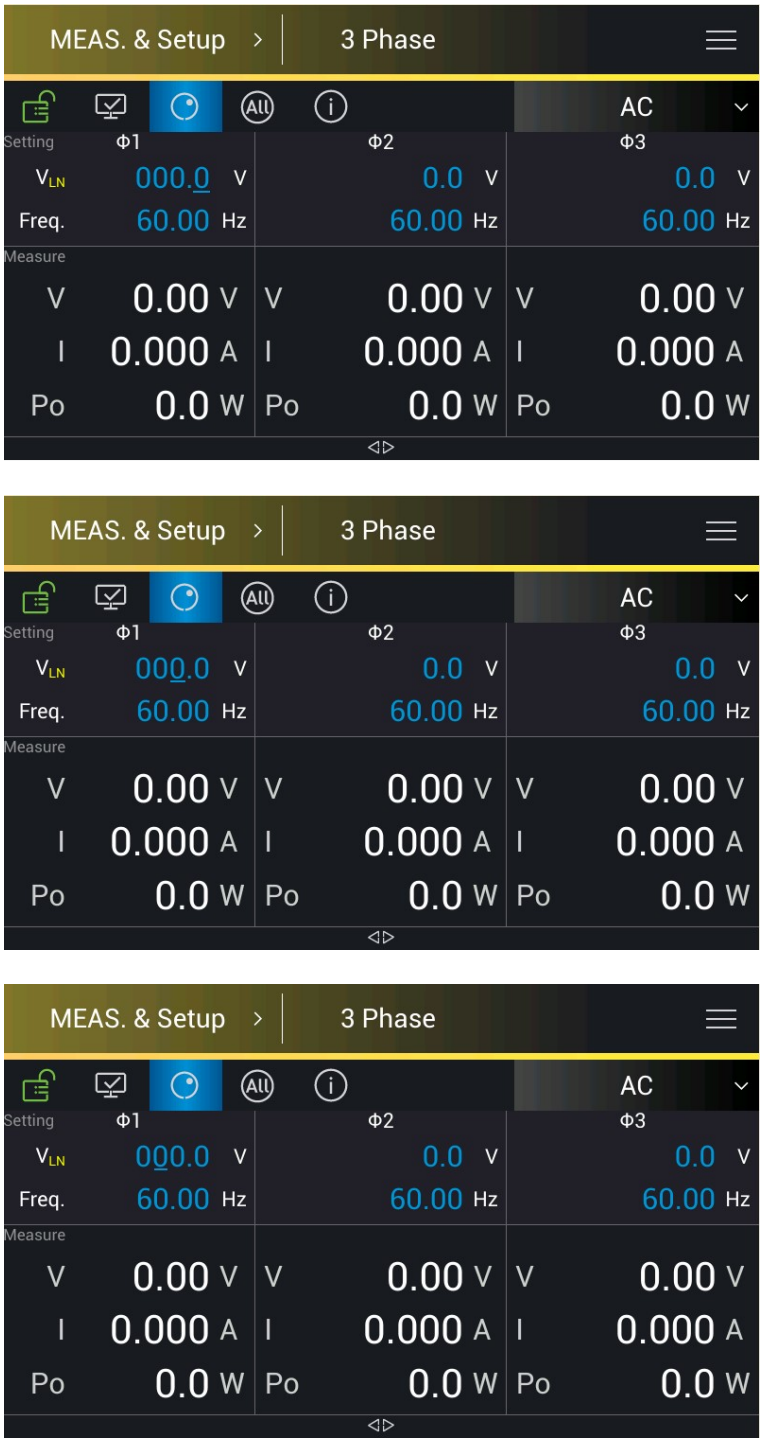
3.2.3 Display Mode

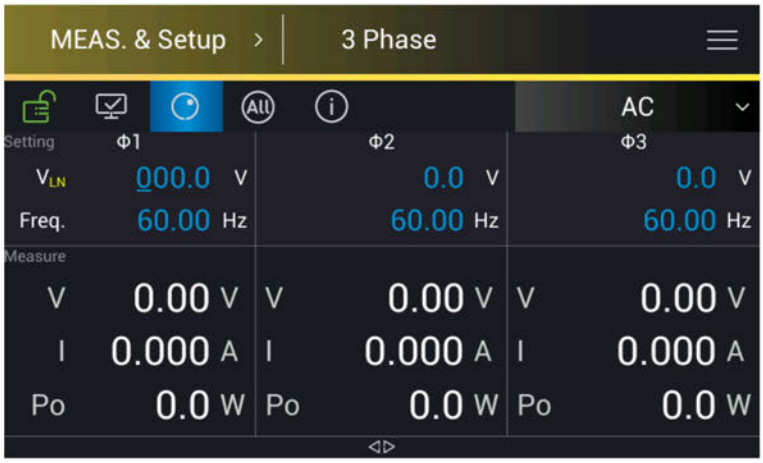
In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap to display the measurements, tap to return to the main page.



3.2.4 Rotary Knob Input Mode

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap to use the rotary knob function. Tap to select the voltage or frequency to be set. When the cursor appears, press down the rotary knob and the cursor can be moved to set the number of digits to be entered.


MEAS. & Setup
3 Phase
AC
Setting
Φ1
Φ2
Φ3
VLN
000.0 V
0.0 V
0.0 V
Freq.
60.00 Hz
60.00 Hz
60.00 Hz
Measure
V 0.00 V
I 0.000 A
Po 0.0 W
V 0.00 V
I 0.000 A
Po 0.0 W
V 0.00 V
I 0.000 A
Po 0.0 W
MEAS. & Setup
3 Phase
AC
Setting
Φ1
Φ2
Φ3
VLN
000.0 V
0.0 V
0.0 V
Freq.
60.00 Hz
60.00 Hz
60.00 Hz
Measure
V 0.00 V
I 0.000 A
Po 0.0 W
V 0.00 V
I 0.000 A
Po 0.0 W
V 0.00 V
I 0.000 A
Po 0.0 W
MEAS. & Setup
3 Phase
AC
Setting
Φ1
Φ2
Φ3
VLN
000.0 V
0.0 V
0.0 V
Freq.
60.00 Hz
60.00 Hz
60.00 Hz
Measure
V 0.00 V
I 0.000 A
Po 0.0 W
V 0.00 V
I 0.000 A
Po 0.0 W
V 0.00 V
I 0.000 A
Po 0.0 W

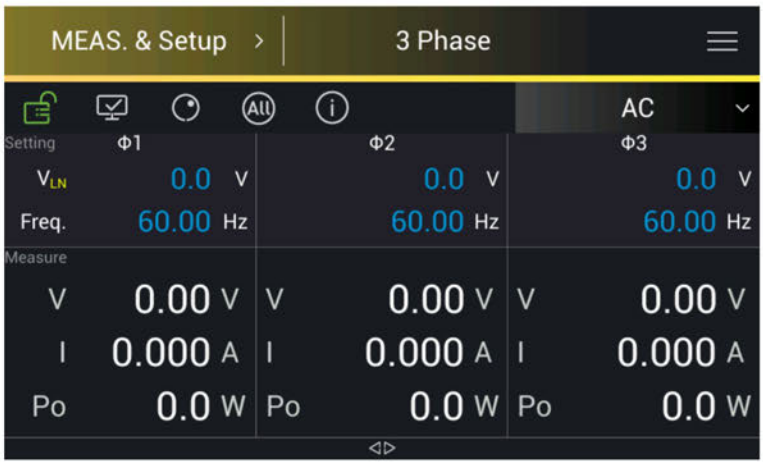


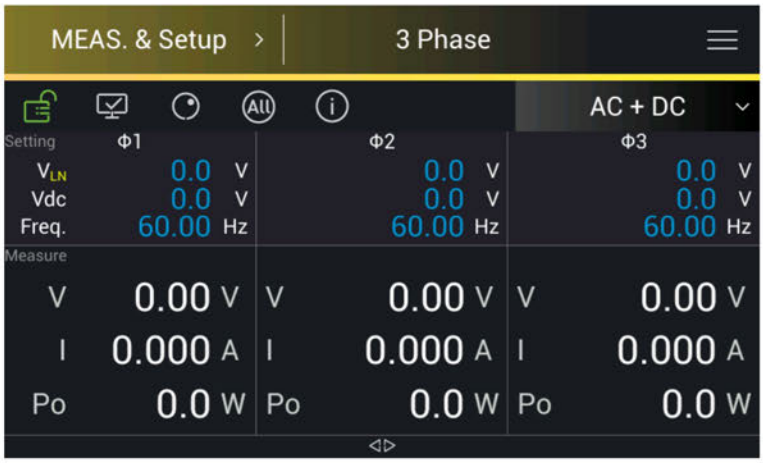
3.2.5 Output Mode Setting (AC+DC, AC, DC)

The Regenerative Grid Simulator has 3 output modes: AC+DC, AC and DC by using the coupling setting.

The setting procedure from AC to AC+DC is described below:

1. Tap the output mode indicator AC on the upper right.
2. Select “AC+DC”.





Notice

The Regenerative Grid Simulator does not have as many capacitors on its output as the common DC Power Supplies do. Therefore, some voltage fluctuations and transient load characters are not the same. This Regenerative Grid Simulator is able to provide positive and negative voltage without changing the output connector. According to the Q=CV formula, the Q connected to the output terminal cannot exceed 240mC (the external electrolytic capacitor limit is <390uF when DC is outputted). Exceeding the capacitance value when outputting DC will cause the simulator output to be unstable and trigger protection.

Because the Regenerative Grid Simulator has been designed with AC/DC/AC+DC output modes, its performance is somewhat different from a common DC Power Supply when in pure DC mode as explained below.

1. The output voltage ripple may be large due to minimal output capacitance.
2. When the output current reaches the current limit set point, the output voltage will be cut off and unit will enter protection mode. It will not stay in constant current mode like common DC sources.

3.3 Meas. & Setup Menu

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap to enter the menu that has More Setting, Meas. Selection, Waveform Selection, Waveform Viewer, and Output Save/Recall five functions available for use.

3.3.1 More Setting

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap to enter the menu and select More Setting to perform advanced settings as described below.

3.3.1.1 Output Degree

The Regenerative Grid Simulator includes phase angle control of the waveform at turning on or off. Use ON Degree and OFF Degree on the screen enable and disable the feature.

The following is the procedure to set the output phase angle to turn on at 90 degrees, and off at 180 degrees in 1_Phase Mode /3_Phase Mode.

1. Tap “On Degree”.
2. Tap **9**, **0**, and ↵ to change the value to “90.0 “.
3. Tap “Off Degree”.
4. Tap **1**, **8**, **0**, and ↵ to change the value to “180.0”.

Notice If "OFF Degree=IMMED", when **QUIT** is tapped the output voltage will shut off immediately and Off Degree is invalid for setting.

3.3.1.2 Slew Rate of Output Transient

The Regenerative Grid Simulator has the ability to set the slew rates of the voltage waveform. There are Vac S/R, Freq. S/R, Vdc S/R, and Vdc Off S/R, which control the slew rates of the waveform.

Vac S/R : Slew rate of Vac output.
Freq. S/R : Slew rate of frequency output.
Vdc S/R : Slew rate of Vdc output.
Vdc Off S/R : Fall slew rate when Vdc output stops.

If the output setting is changed in main page when the Regenerative Grid Simulator is on, the output voltage and frequency will change immediately.

The procedure of setting S/R =0.2, Freq. S/R =0.1, and Vdc Off S/R =1 in 1_Phase Mode /3_Phase Mode is described below.

1. Tap "Vac S/R".
2. Tap **0**, **.**, **2**, and ↵ to change the value to "0.2".
3. Tap "F S/R".
4. Tap **0**, **.**, **1**, and ↵ to change the value to "0.1".
5. Tap "Vdc Off S/R".
6. Tap **1**, and ↵ to change the value to "1.0".

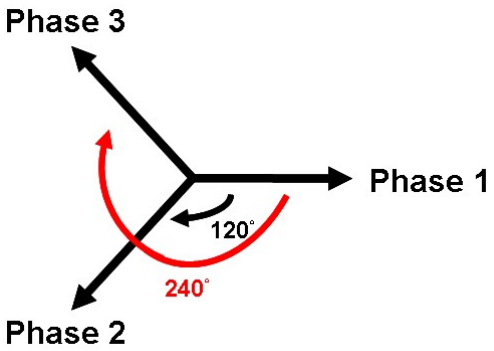
Notice

1. Though the input range of Vac S/R, Freq. S/R, Vdc 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, Freq. S/R, and Vdc S/R are too large. The maximum of Vac S/R, Vdc S/R, and Vdc Off S/R is 2000V/ms and the minimum is 0.01V/ms. The maximum of Freq. S/R is 1000Hz/ms and the minimum is 0.001Hz/ms.
2. When **ON** is executed on the Regenerative Grid Simulator, the output will reach the final state as set. Once OFF is executed, the output turns to 0V immediately. If you wish to set the slew rate to

0V, it is necessary to enter 0V and tap ↵ instead of executing **OFF** directly.

3.3.1.3 Output Degree of 3-Phase Voltage Output

The Regenerative Grid Simulator is able to set the phase difference between phases in 3-phase mode. For instance the phase difference among the 3 phases is 120 degree for the output voltage with 3-phase balance positive sequence as the figure shown below.



The following procedure shows how to set the output voltage to 3-phase mode with balanced 120 degree phase difference.

1. Tap “Phase Angle 1-2 =”.
2. Tap **1**, **2**, **0**, and ↵ to change the value to “120.0”.
3. Tap “Phase Angle 1-3”.
4. Tap **2**. **4**, **0**, and ↵ to change the value to “240.0”.

Notice Since each phase of the Regenerative Grid Simulator is controlled separately, it is able to set the phase difference in 3-phase mode to be unbalance in desired such as Phase Angles 1 & 2 = 100deg, Phase Angle 3 = 200 deg.

3.3.2 Meas. Selection

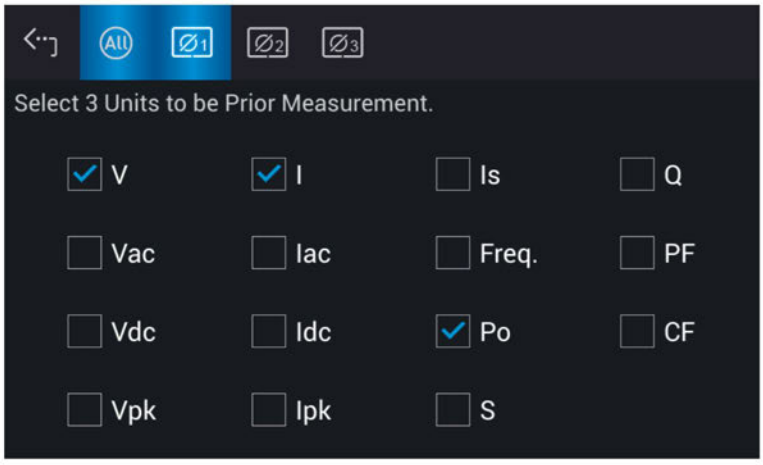
In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap : Meas. Selection as the figure shows below. There are measurement items in the setting screen such as voltage, current, output power and etc. Each phase can set 3 different measurement items to display on the main page.

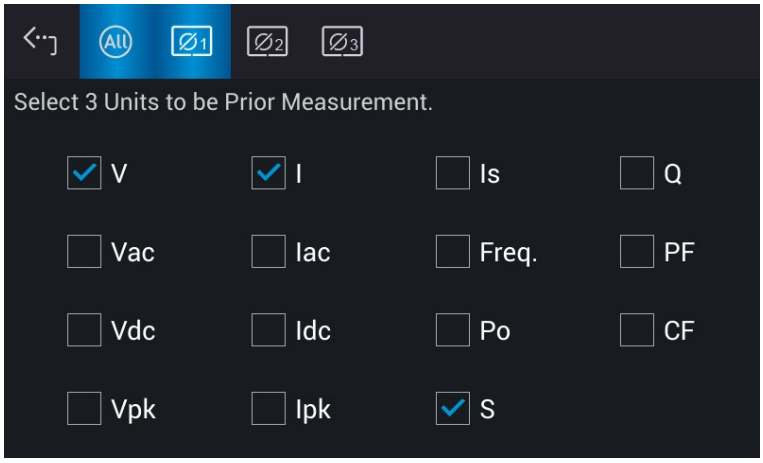
The definition of parameters:

V	:	It is the voltage measurement in Volts. (RMS measurement)
Freq.	:	It is the output frequency in Hertz.
I	:	It is the current measurement in Amps. (RMS measurement)
Vac	:	It is the AC voltage measurement in Volts and the calculation formula = Vac=$\sqrt{}$(Vrms^2 - Vdc^2)
Iac	:	It is the AC current measurement in Amps and the calculation formula = Iac=$\sqrt{}$(Irms^2 - Idc^2)
PF	:	It is Power Factor and the calculation formula = Real Power / (Vrms × Irms)
CF	:	It is Crest Factor and the calculation formula = Ipeak/Irms
Vdc	:	It is the DC voltage measurement in Volts.
Idc	:	It is the DC current measurement in Amps.
Vpk	:	It is the peak voltage measurement in Volts. The Vpeak display is the Vp(+) or Vp(-) whichever is larger.
Ipk	:	It is the peak current measurement in Amps. The Ipeak display is the Ip(+) or Ip(-) whichever is larger.
Is	:	It is I surge that is only measured when output changes.
Po		It is the Real Power measurement in Watt.
Q	:	It is the reactive power in VAR and the calculation formula = $\sqrt{(V_{rms}I_{rms})^2 - P_o^2}$
S	:	It is the apparent power in volt-amperes and the calculation formula = Vrms × Irms

Below the procedure to change the 3rd measurement item from Po to S in 3-phase mode.

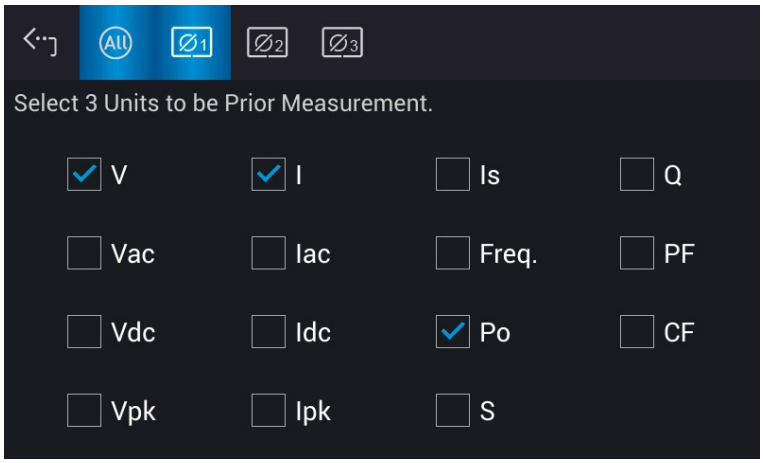
1. In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap : Meas. Selection.
2. Tap ALL icon.
3. Unselect "Po".
4. Select "S".

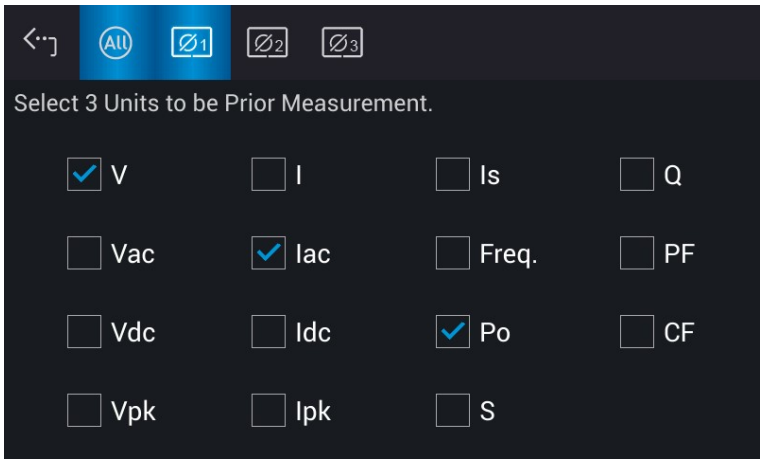




Below is the procedure to the 2nd measurement item from I to IMac in 1 phase mode.

1. In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap : Meas. Selection.
2. Unselect “I”.
3. Select “Iac”.



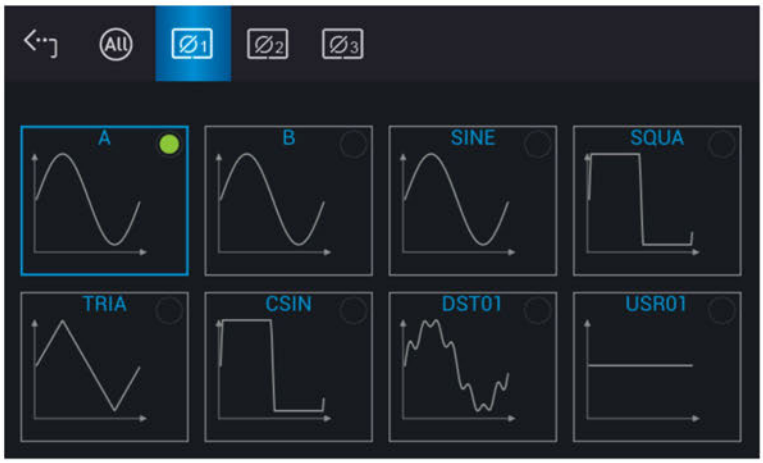


Notice When changing the selected measurement items, it is necessary to delete one before adding a new item if three items have already been selected

3.3.3 Wave Selection

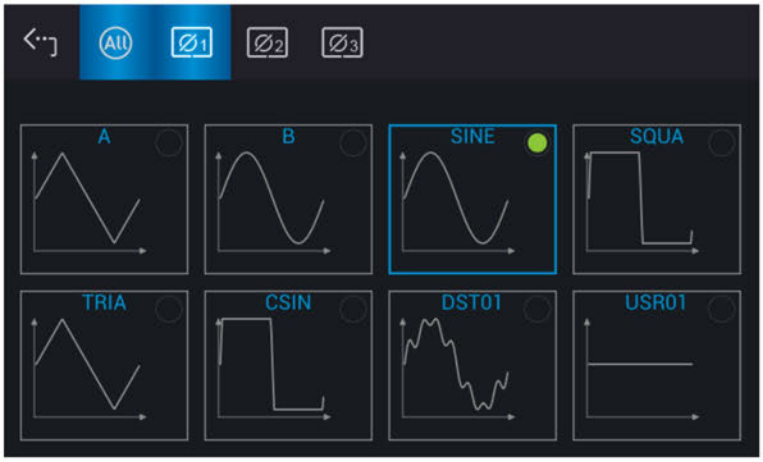
The Regenerative Grid Simulator allows the user to select the waveform type for each phase.

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap : Waveform Selection to enter the waveform selection menu. Included are sine, square, triangle waves, clipped sine waveforms, etc. A total 30 sets of built-in waveforms along with 30 sets of user-defined waveforms are provided.

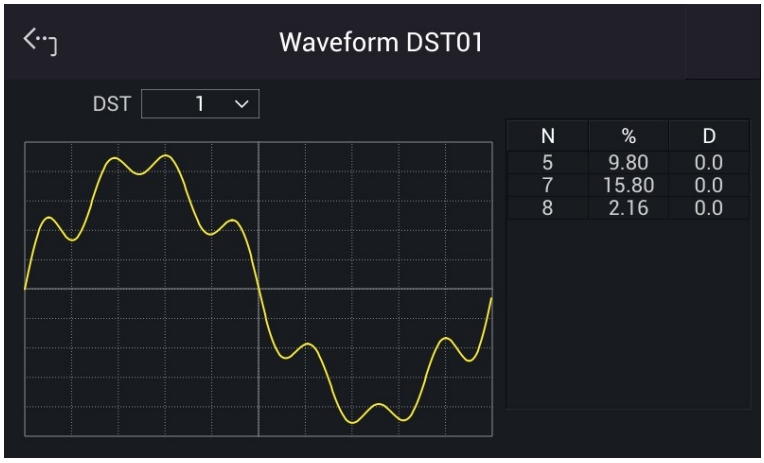


Follow these steps to set the 3-phase waveform to sine:

1. Tap indicator to set the output to All.
2. Select "SINE". (Tap for 1 second.)

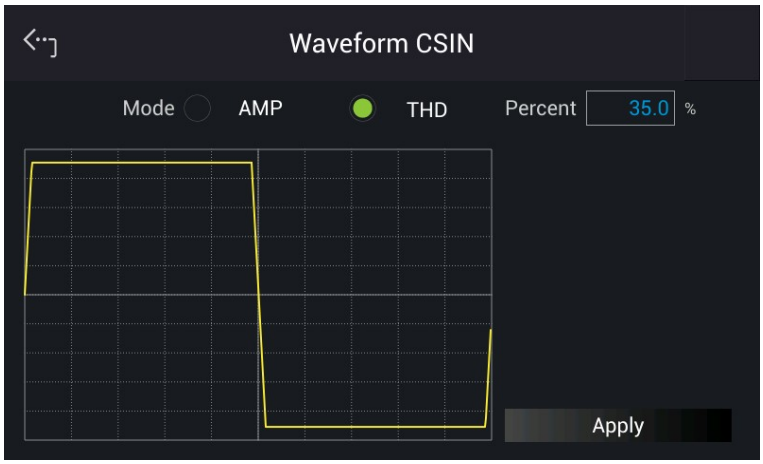


Tap the icon "Waveform selection" to view the set waveform.



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

1. Tap indicator to set the output to All.
2. Select “CSIN”.
3. Tap “CSIN” to set the Mode and Percent.
4. Select “THD” for Mode.
5. Tap “Percent”.
6. Tap **3**, **5**, and to set the THD percentage to 35%.
7. View the set waveform as the figures show below and tap Apply to complete the setting.



Notice

1. 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. The user-defined waveform needs to be defined by and downloaded from the remote PC.
3. For detail DST waveform, please see *Appendix B Built-in DST Waveform*.

⚠WARNING

1. When using the user-defined waveform, the Regenerative Grid Simulator could be damaged if the waveform frequency exceeds 100Hz.

2. Due to the bandwidth restriction of Regenerative Grid Simulator, distortion may occur on the output when the user-defined waveform contains frequency components above 100Hz.
3. If the user-defined waveform or the set DST waveform exceeds the voltage limit, a protection error will occur (OVP or DST).

3.3.4 Waveform Viewer

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap : Waveform Viewer to view 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.

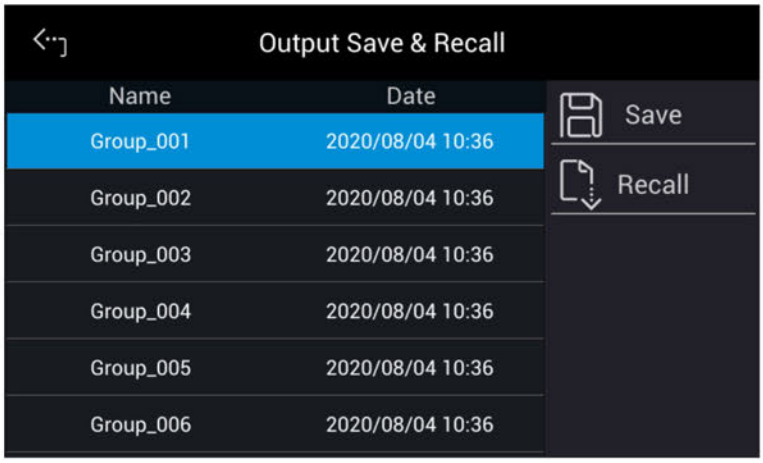
Ch1: #1V, #2V, #3V, #1I, #2I, #3I.
Ch2: #1V, #2V, #3V, #1I, #2I, #3I.
Ch3: #1V, #2V, #3V, #1I, #2I, #3I.
V (Scale): 10, 20, 40, 80, 120V/div.
I (Scale): 5, 10, 20, 40, 60A/div.
Time (Scale): 0.2, 0.5, 1, 2, 5, 10, 50, 100, 200ms/div.

The procedure for setting CH1 =Φ1V, CH2 =Φ2V, CH3 =Φ3V, V (Scale) = 40 V/div, I (Scale) = 5A/div, Time (Scale) = 2 ms/div in 1_Phase Mode /3_Phase Mode is described as below.

1. Tap CH1 on the right.
2. Select "#1V".
3. Tap CH2 on the right
4. Select "#2V".
5. Tap CH3 on the right.
6. Select "#3V".
7. Tap V on the left.
8. Select "40V/div" to complete the setting.
9. Tap I on the left.
10. Select "5A/div" to complete the setting.
11. Tap Time on the left.
12. Select "2ms/div" to complete the setting.

3.3.5 Output Save & Recall

The Regenerative Grid Simulator has 10 groups of memory to save the frequently used Vac, F and Vdc for later recall. Below is an example of saving these parameters to Group_001 memory location.

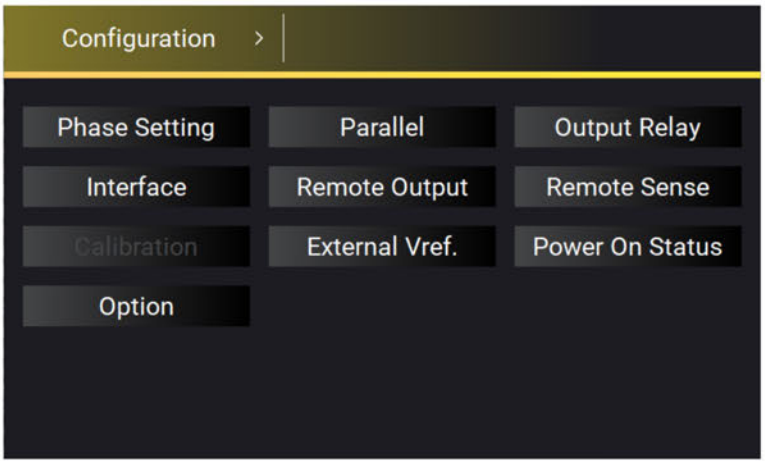


Notice

1. The save and recall output setting function can only be set in MEAS. & Setup menu.
2. In different coupling modes (see section 3.2.5), instrument will automatically adjust to Vac=0V, F=60Hz, Vdc=0V for any missing settings. For instance, Vac=0V, F=60Hz, and Vdc is the setting in MEAS. & Setup menu when executing a save command in DC output mode.

3.4 Configuration Menu

Tap Menu and select Configuration to show the Configuration menu. There are Phase Setting, Interface, Calibration, Parallel, Remote Output, External Vref., Output Relay, Remote Sense, Power On Status, and Option 10 functions available for use.

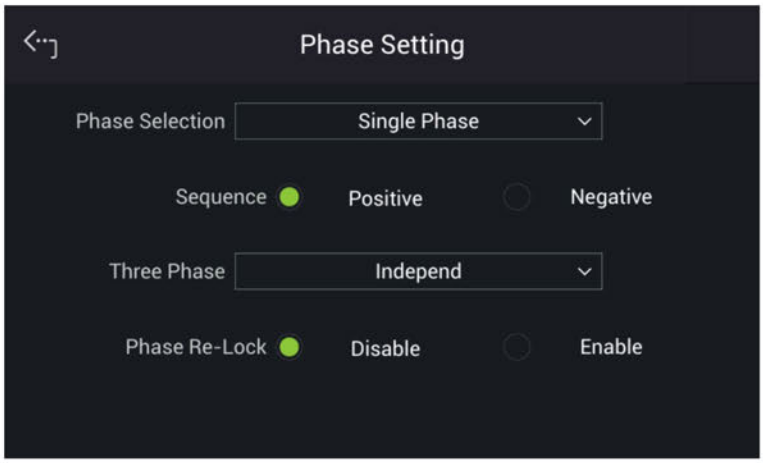


Notice

When optional accessories are purchased, you can use them by tapping the Option function.

3.4.1 Phase Setting

Tap Menu and select Configuration to show the Phase Setting menu. Users can also switch the mode to 3-phase or 1-phase.

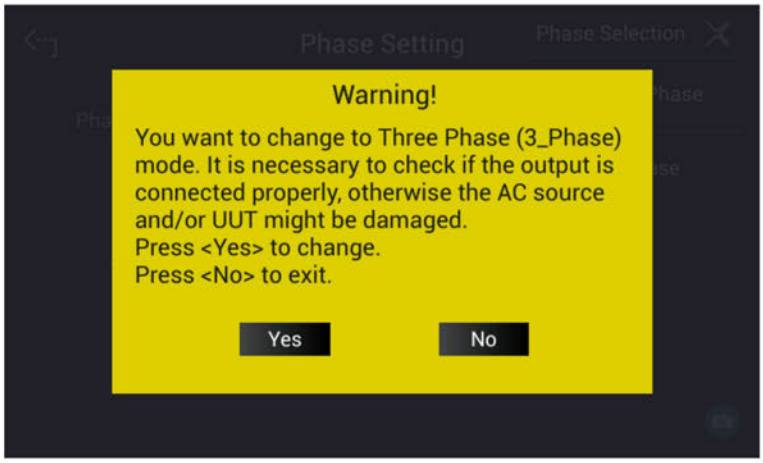


3.4.1.1 Three Phase Mode

The Regenerative Grid Simulator can be set to 3-phase AC power mode by tapping Menu and selecting Configuration to show the Phase Setting menu and switch to 3-phase mode if desired.

The procedure for setting the Regenerative Grid Simulator to 3-phase mode is described below.

1. Tap Phase Selection
2. Select "3 Phase" mode.
3. Make sure the output connection is in 3-phase mode and tap Yes to change it.

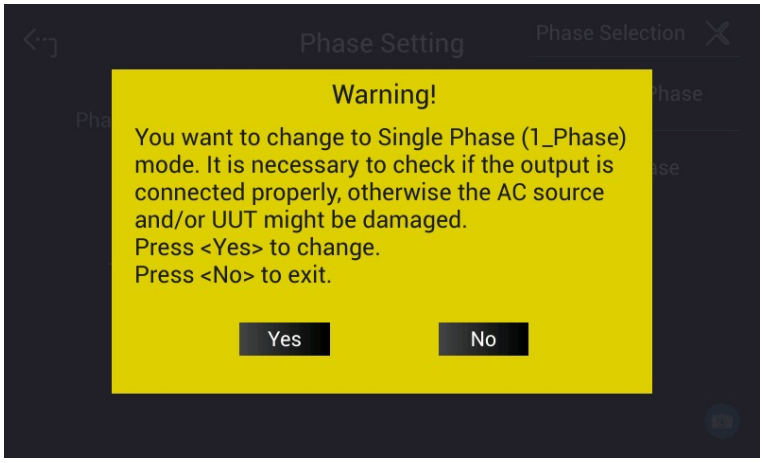


3.4.1.2 Single Phase Mode

The Regenerative Grid Simulator can be set to 1-phase AC power mode by tapping Menu and select Configuration to show the Phase Setting menu and switch to 1-phase mode when it is required.

The procedure for setting the Regenerative Grid Simulator to 1-phase mode is described below.

1. Tap Phase Selection.
2. Select “Single Phase” mode.
3. Make sure the output connection is in 1-phase mode and tap Yes to change it.



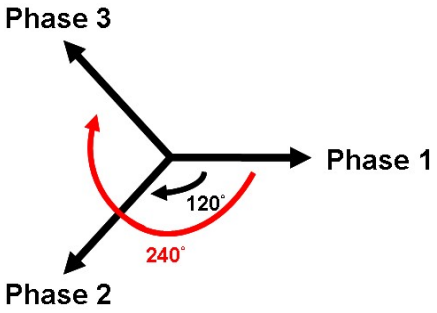
Notice

1. 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).
2. When switching 1-phase mode to 3-phase mode, the user should check if the output L_1, L_2, and L_3 short-circuit copper bars are removed to prevent the Regenerative Grid Simulator from triggering a protection error.

3.4.1.3 Setting Three Phase Output

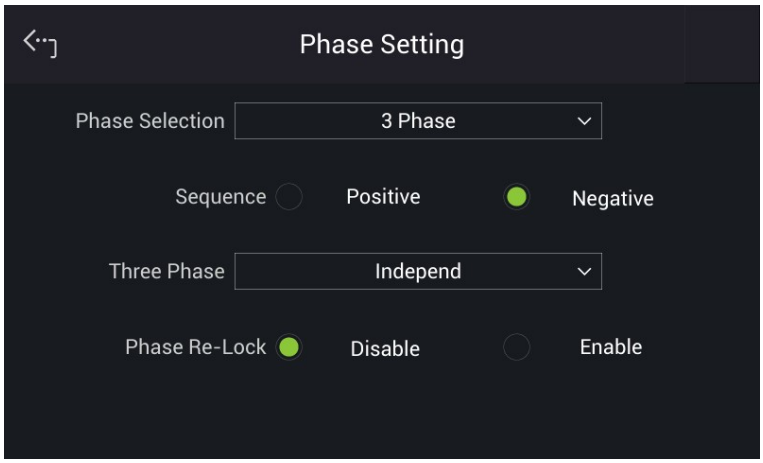
Sequence: Positive, Negative.

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



You can set the Positive/Negative sequence for Regenerative Grid Simulator's 3-phase voltage output. The following lists the procedure to set the 3-phase output voltage sequence to Negative.

Select "Negative" for Sequence as the figure shown below



Three Phases: Independ, Same Freq., and Balance

Three Phases can be used to set the relationship among the Regenerative Grid Simulator 3-phase output voltage, which are Independ, Same freq and Balance.

Following lists the procedure to set the same frequency for 3-phase voltage output.

1. Tap 3 Phase.
2. Select "Same Freq." mode.

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

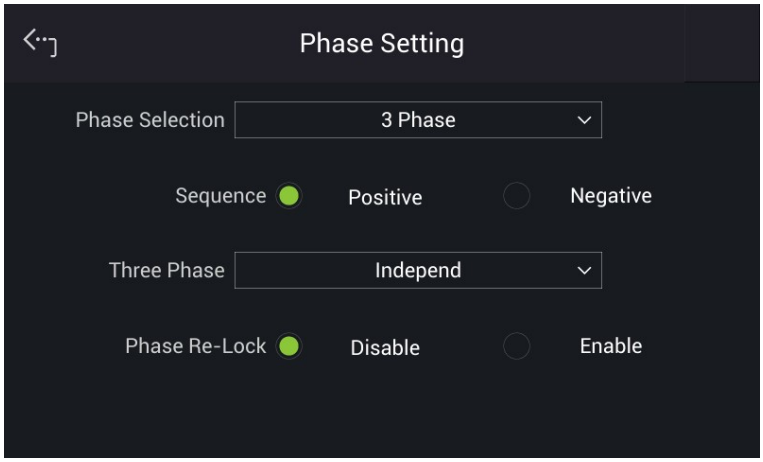
1. Tap 3 Phase.
2. Select "Balance".
3. Select "Line" for Voltage set as the figure shown below.

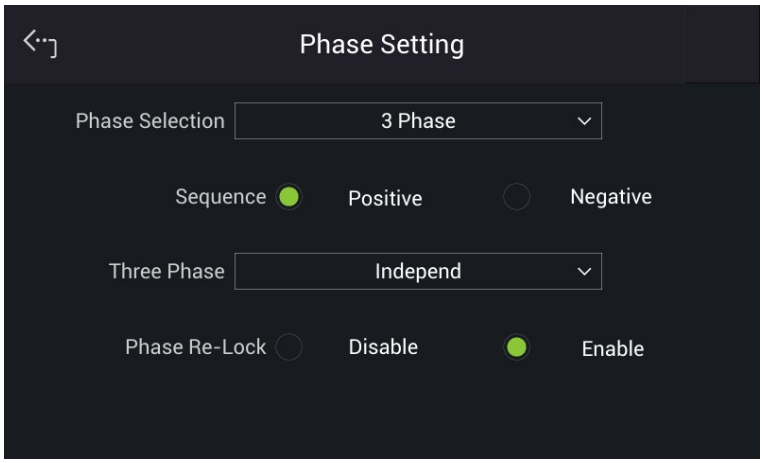
Notice When the user switches to Balance mode, the output mode setting (AC+DC, AC, DC) will automatically switch to AC.

Phase Re-Lock: Enable, Disable

Phase Re-Lock is used to lock the phase again. Since the output voltage and frequency are set separately when the Regenerative Grid Simulator is in 3-phase mode, you can set the 3-phase for different frequency output. Assuming the 3-phase output frequencies are varied and you set them to the same 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 difference of 3-phase output will return to default (each phase difference is 120°) as Figure 3-4 shows when the phase re-lock function is enabled.

Tap Phase Re-Lock on the right to enable or disable the function.





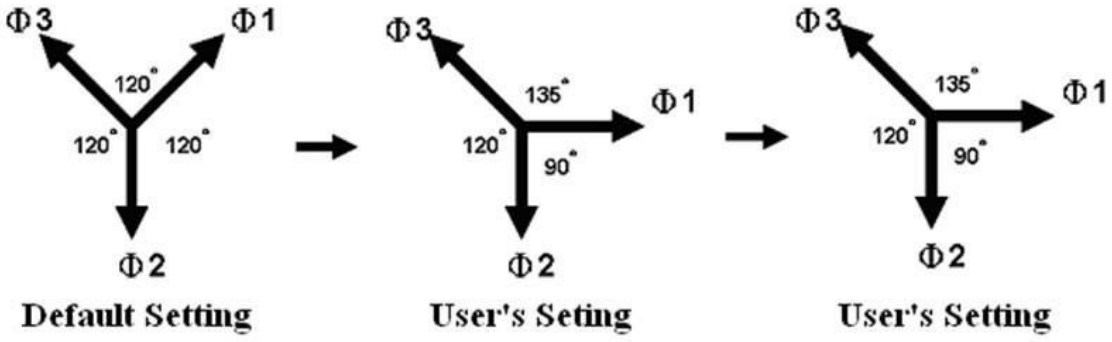


Figure 3-3 When Phase Re-Lock is Disabled

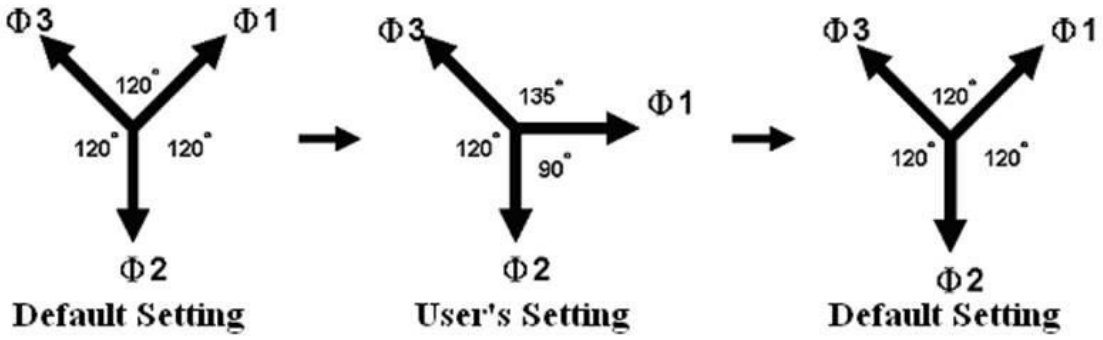


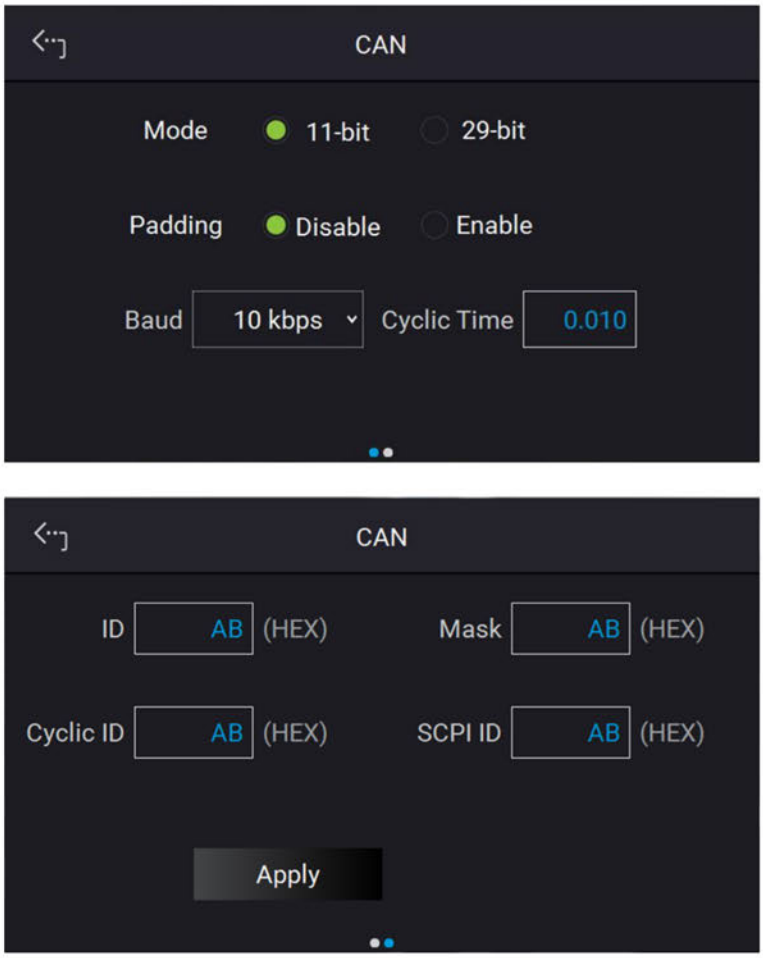
Figure 3-4 When Phase Re-Lock is Enabled

3.4.2 Interface

3.4.2.1 CAN

Tap Menu, select Configuration and Interface to show the Interface Select menu. Set the CAN baudrate before tapping CAN for setting.

1. Tap CAN in “Interface” menu.
2. Tap the bit number for Mode.
3. Tap Disable or Enable for Padding.
4. Tap Baud to select the baud rate.
5. Tap Cyclic Time to set the desired time.
6. Slide left to the second page on the right, tap ID to set the position.
7. Tap Mask to set the position.
8. Tap Cyclic ID to set the position.
9. Tap SCPI ID to set the position.
10. Tap Apply to execute each parameter setting.
11. Tap the upper left corner to return to Menu setting.
12. Tap “MEAS. & Setup” to return to the main screen.



3.4.2.2 GPIB

Tap Menu, select Configuration and Interface to show the Interface Select menu. Tap GPIB to enable. It is necessary to set GPIB address below 30 before conducting remote operation in 1_Phase Mode /3_Phase Mode.

1. Tap GPIB address.
2. Input value from 1-30 to complete the setting.

Notice The address range is from 1 to 30.

3.4.2.3 LAN

Tap Menu, Configuration and Interface to show Interface Select menu. Tap LAN to set it.

Notice

1. The user needs to connect the network cable to the Regenerative Grid Simulator for auto detection.
2. If the network cable is not connected properly, it may cause the Regenerative Grid Simulator screen to show abnormally. Turn off the Regenerative Grid Simulator to resolve the network cable problem and reboot it to clear the abnormal screen.

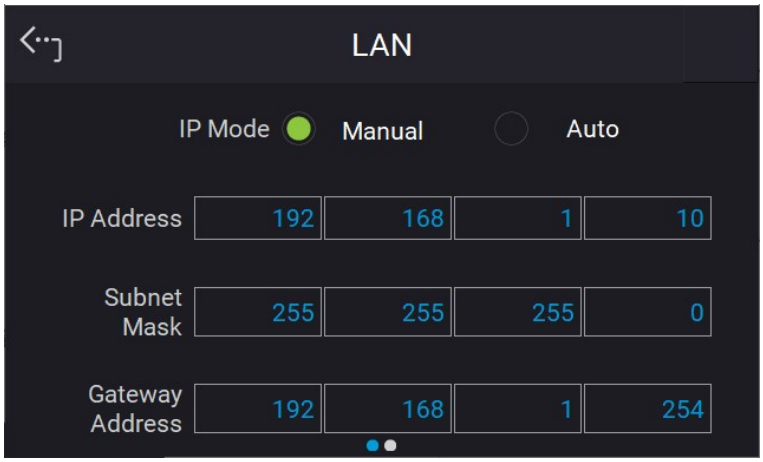
1. Tap LAN to enter into the address setting screen.

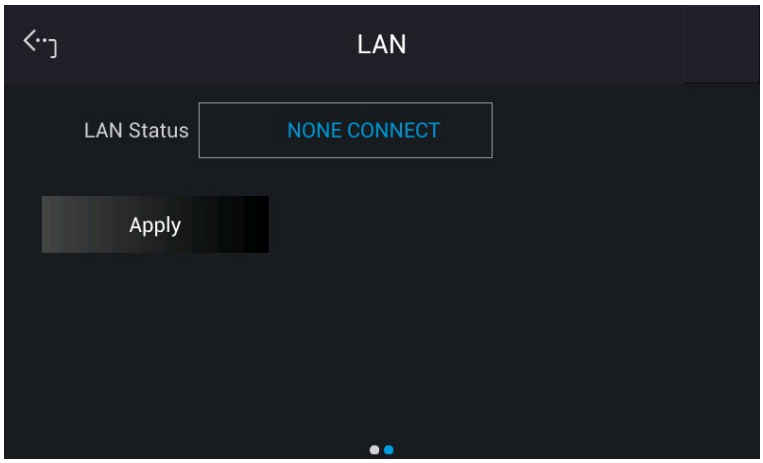
Auto Detect:

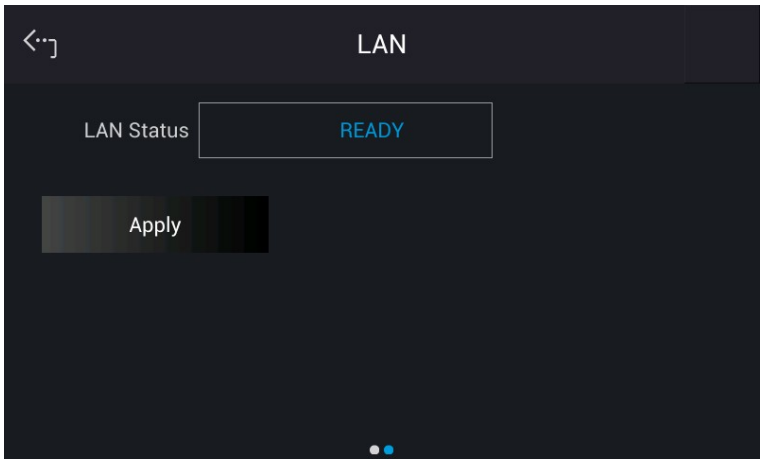
The default of IP mode is Auto. Swipe left to second page, the Regenerative Grid Simulator will automatically detect external network address.

Manual Detect:

2. Tap IP Mode to set it to Manual.
3. Tap IP Address and set it.
4. Tap Subnet Mask and set it.
5. Swipe left to the second page, tap Gateway Address and set it.
6. Tap "Apply" and wait for connection.
7. Touch the upper left corner to enter into Menu page.
8. Tap "MEAS. & Setup" to return to the main page.


LAN
IP Mode
Manual
Auto
IP Address
192
168
1
10
Subnet Mask
255
255
255
0
Gateway Address
192
168
1
254


LAN
LAN Status
NONE CONNECT
Apply


LAN
LAN Status
READY
Apply

Notice

1. The LAN STATUS is displayed automatically in the following 5 types:
   READY: Network is connected.
   CONNECTING. . . .: Network is connecting.
   NONE CONNECT: Network is not connected.
   SETTING. . . .: Network is under setting.
   ETHERNET MODULE FAIL: Network module is fail.
   DUPLICATE IP: IP setting is duplicated.
   RENEWAL FAIL: DHCP renewal is failed.
   IDENTIFY: It means the identification is performing.
   DECONFIG: Network configuration is changed.
2. The ETHERNET IP address is 0~255. In ETHERNET setting, IP MODE=Auto will get the address automatically and IP MODE=Manual will get the address manually. Once the IP address is set, it needs to set APPLY=YES for the address to be in effect.

3.4.2.4 USB Interface

Tap Menu, select Configuration and Interface to show the Interface Select menu. Tap USB to query the USB address.

1. In "Interface" page, select USB to enter into the USB Address screen.
2. Touch the upper left corner to enter into Menu page.
3. Tap "MEAS. & Setup" to return to the main page.

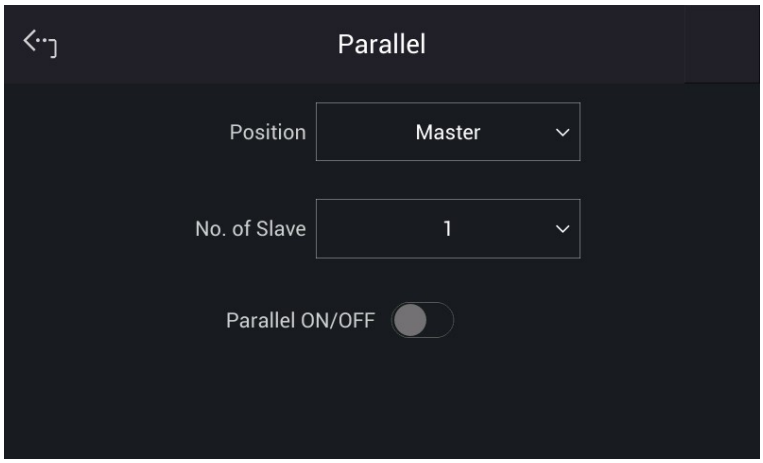
Notice This function is for users to query the USB Address only.

3.4.3 Setting Parallel Mode

3.4.3.1 Setting Regenerative Grid Simulator to Slave

To set a single regenerative grid simulator to Slave, tap Menu, Configuration and select Parallel. Follow the steps below to set the connection of multiple devices in parallel:

1. Tap Position.
2. Select "Slave 1".



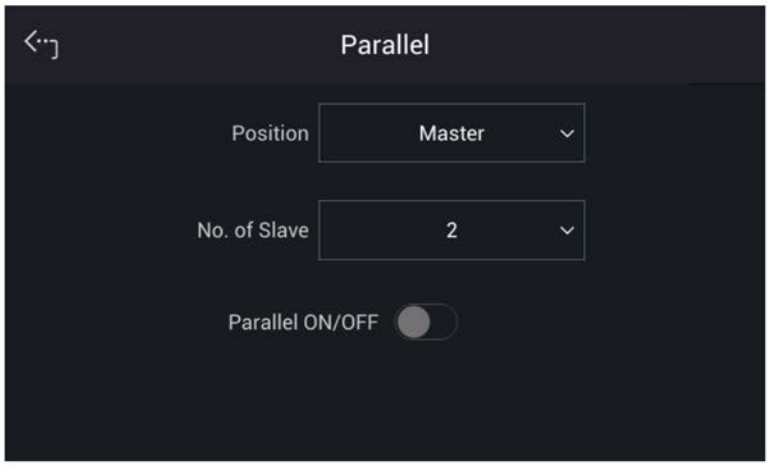
3.4.3.2 Setting Regenerative Grid Simulator to Master

To set a single regenerative grid simulator to Master, tap Menu, Configuration and select Parallel. Follow the steps below to set the connection of multiple devices to be parallel:

1. Tap Position.
2. Select “Master”.
3. Tap No. of Slave.
4. Select the number of Slave units to be used in parallel.
5. Enable Parallel ON/OFF indicator.
6. The screen returns to the main menu when set to Master, and prompts Slave when set to Slave.

Notice At least one device has to set to Slave in parallel connection, or “System Connection Fail!” will occur when setting the Master to Enable. See section 3.6 below for troubleshooting.

WARNING When setting the Number of Slave units, the rule is N-1 of total regenerative grid simulators. For instance, when setting two simulators for parallel connection, the Number of Slave is 1, and setting two simulators for series connection, the Number of Slave is 1. Incorrect setting of parallel number will result in a connection failure and could be damaging to the device.



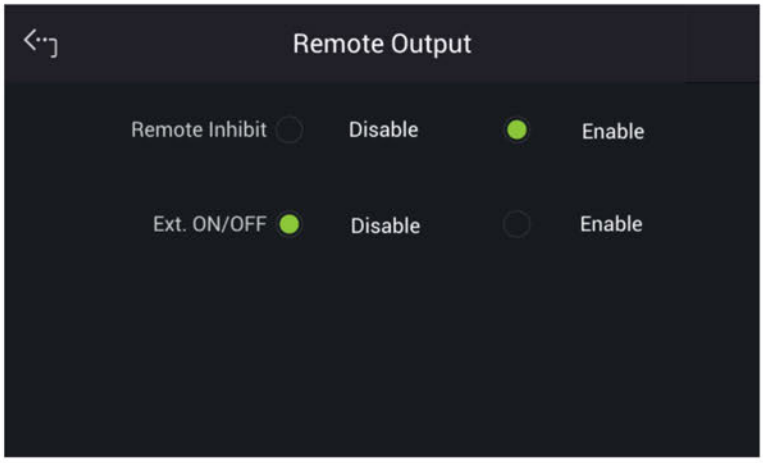
3.4.4 Remote Output

The output of Regenerative Grid Simulator can be inhibited by external control or manual trigger. To remotely inhibit the device a TTL signal is applied to the terminal on the rear panel (see *Appendix A*.) Remote Output and EXT. ON/OFF must also be set in the Configuration menu (3_Phase Mode/1_Phase Mode). There are two remote inhibit output states: Enable and Disable.

Remote Inhibit: When the Remote Inhibit is enabled when the remote inhibit signal is LOW. This will disable the output. The device remains disabled even when the Remote Inhibit returns to HIGH. In order to re-enable the output, you must tap **ON/OFF**.

The procedure for setting Remote Inhibit to enable for 1-phase/3-phase modes are described below.

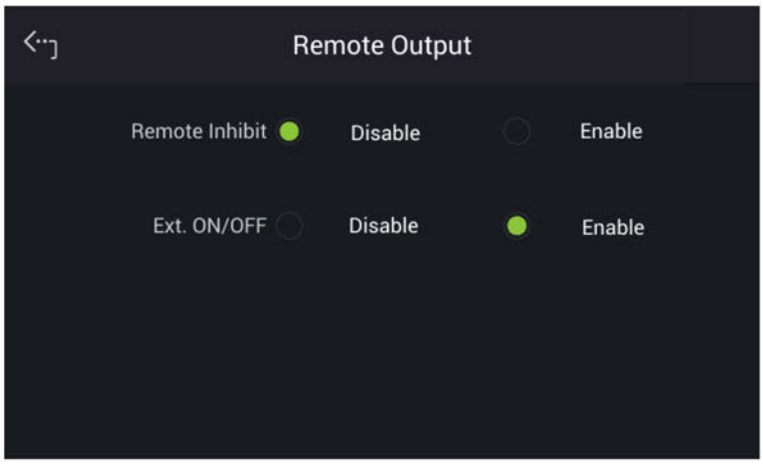
Select "Enable" for Remote Inhibit.



EXT. ON/OFF: When the EXT. ON/OFF is enabled on the Regenerative Grid Simulator and the EXT. ON/OFF signal is LOW, the Regenerative Grid Simulator will disable the output. The Regenerative Grid Simulator will re-enable the output when the EXT. ON/OFF signals turns to HIGH.

The procedure for setting EXT. ON/OFF to enable in 1-phase/3-phase mode is described below.

Select “Enable” for Ext. ON/OFF.



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

3.4.5 External Vref.

The Regenerative Grid Simulator allows for analog control signals from an external device to set its output. The External Vref terminal at the rear panel allows signals to be applied to the Regenerative Grid Simulator to control the output voltage level. The Control Method and External Vref Control can be set by tapping Menu, Configuration and select External Vref. External Vref has two coupled modes: Amplifier and Level. When using single phase Ext. Vref, the signal inputted by terminal pin Ext-V Φ2 is the main control signal. Refer to *Appendix A* for the pin assignment of the TTL terminal. The voltage delay time for External-V reference signals to when the output changes is 65us typically/75us max. (Amplifier); 5ms max. (Level).

Amplifier: The output voltage (Vout) is the composition of the voltage set in MAIN PAGE and the supplemental programmed voltage inputted 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 the output voltage (Vout);

Vout (dc) = Vref (dc) / 10 Vdc × 495 Vdc
or
Vout (ac) = Vref (ac) / 7.072 Vac × 350 Vac

Ex (1): Set Vout to 100Vdc:
The applied external output voltage is V= 2.021Vdc, Vout = 100Vdc

Ex (2): Set Vout to 100Vac:
The applied external output voltage is V= 2.021Vac, Vout = 100Vac

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

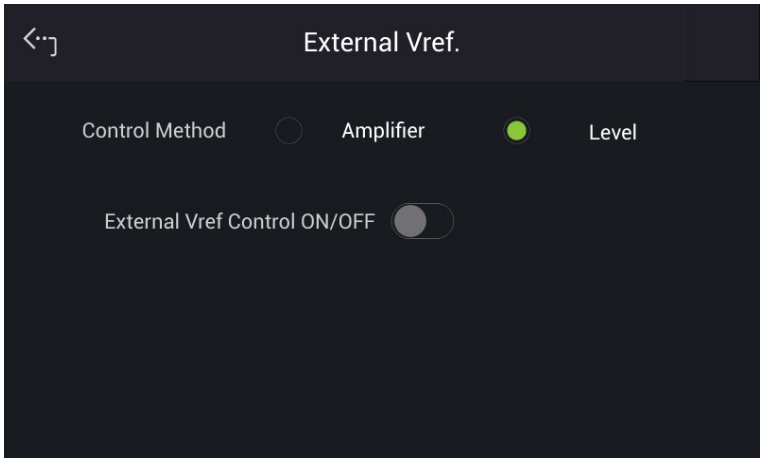
used to calculate Vout:

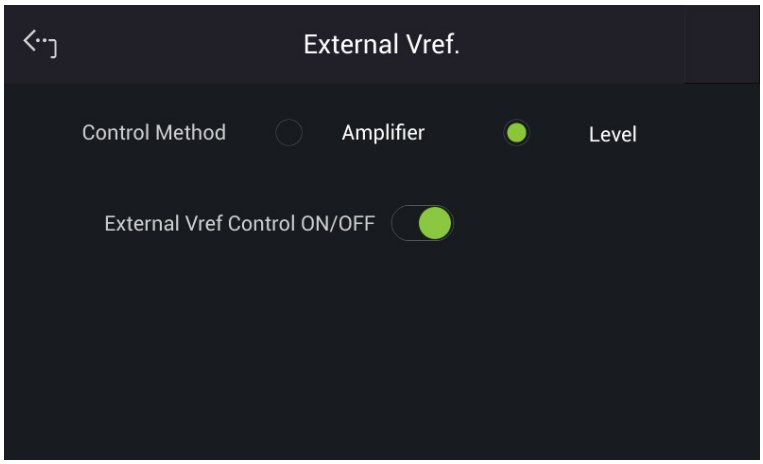
Vout (ac) = ｜Vref (dc)｜ / 10 Vdc × 350Vac

Ex (1): Set Vout to 100Vac:
The applied external output voltage is V= 2.857Vdc (or -2.857Vdc), Vout = 100Vac

The setting of Control Method = Level, Ext. Vref Control = ON is described below.

1. Select "Level" for Control Method.
2. Select "ON" for External Vref Control ON/OFF to complete the setting.





Notice

When Ext. Vref Control =ON, Control Method =Level, the output voltage (Vout) can only be controlled by an external DC voltage level. Device will be unable to control the Vout amplitude using the front panel buttons until Ext. Vref Control=OFF is set.

⚠WARNING

1. When Control Method = Amplifier and the Vref frequency exceeds 100Hz, damage to the device is possible. It is recommended to follow this formula:
   When set to **Amplifier** mode, F>100Hz: must be Vref (pk-pk, V) * F (Vref, Hz) < 5000 VHz.
   When set to **Level** mode, F>100Hz: must be Vref (pk-pk, V) * F (Vref, Hz) < 2500 VHz.
2. The output may be distorted due to the bandwidth restriction of

Regenerative Grid Simulator, especially when the external V reference is above 100Hz.

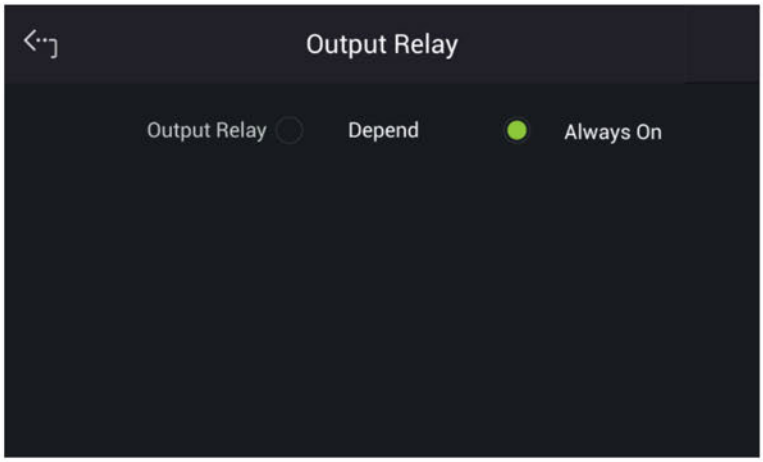
3. If the output voltage is over the limit, OUTPUT OVP or DST Protection will occur.

3.4.6 Output Relay

The Regenerative Grid Simulator has an output relay to connect or disconnect to the load. To set, tap Menu, Configuration and select Output Relay to show the Output Relay menu. “Always ON”, indicates the output relay is closed (connected) even if the Regenerative Grid Simulator output state is in off (QUIT mode). When the output relay is set to “Depend.”, it indicates the output relay is closed (connected) only when the output state is on (OUT mode). If the output state is in QUIT mode, the output relay will be opened (disconnected.)

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

Select “Always ON” for Output Relay to complete the setting.



Notice Check if the Regenerative Grid Simulator output is off before disconnecting ac power to the device. To ensure the safety of hardware, it is not recommended to power off the Regenerative Grid Simulator with the output ON.

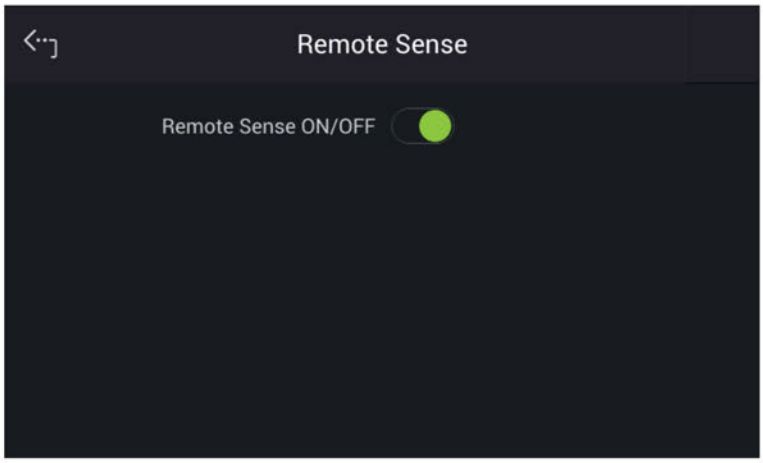
3.4.7 Remote Sense

Tap Menu, Configuration and select Remote Sense to enable the Remote Sense monitoring of the load voltage and to begin compensating automatically.

Remote Sense: ON/OFF

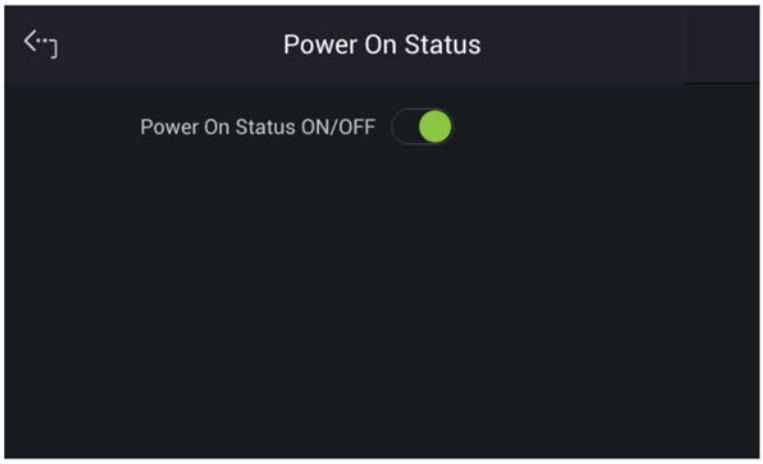
Follow the procedure below to enable the remote voltage sense in 1_Phase Mode /3_Phase mode.

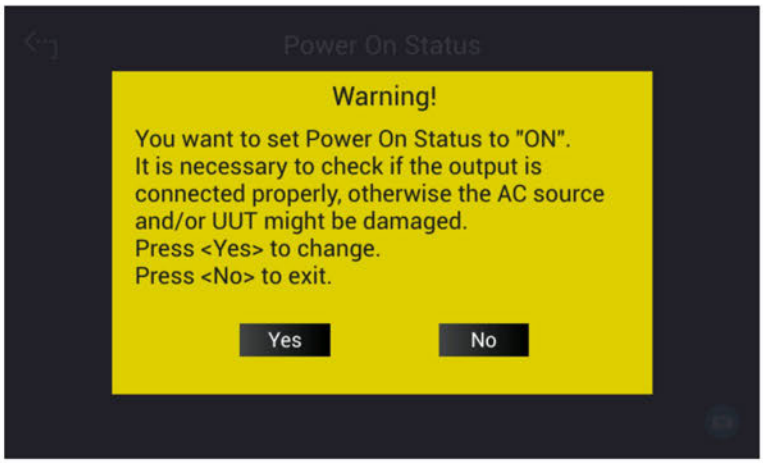
Enable Remote Sense ON/OFF to complete the setting.



3.4.8 Power ON Status

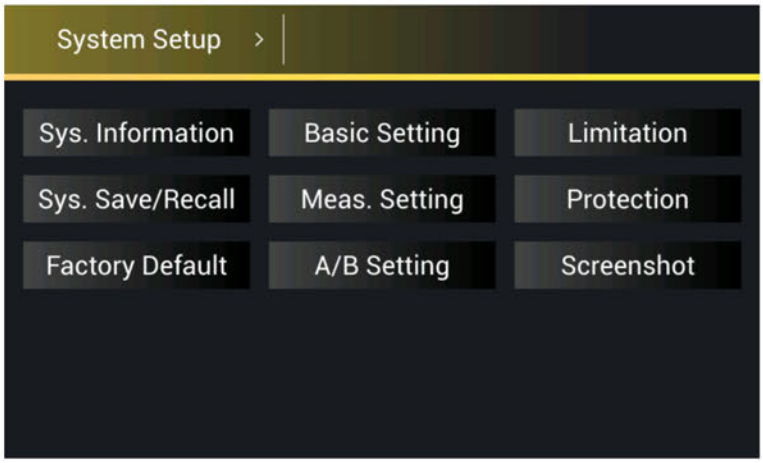
Set the output state of Regenerative Grid Simulator during power on by tapping Menu, Configuration and Power On Status. The default is OFF. When set to ON, device will prompt a warning message indicating the Regenerative Grid Simulator will save the output voltage setting shown in the main page. The Regenerative Grid Simulator will output voltage based on these values the next time it is rebooted.





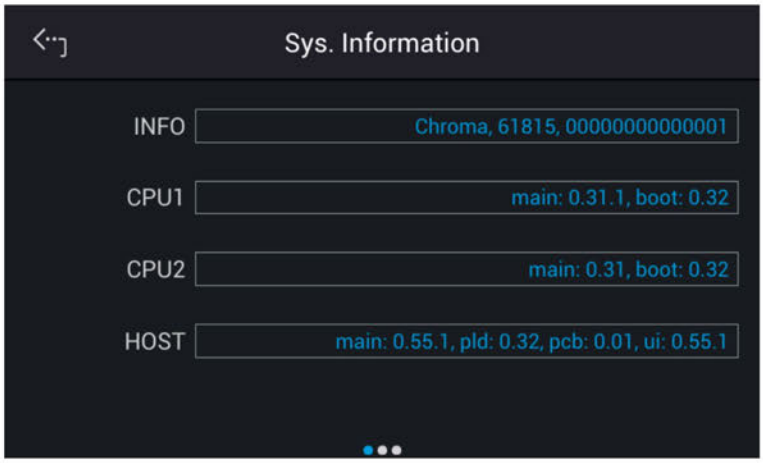
3.5 System Setup Menu

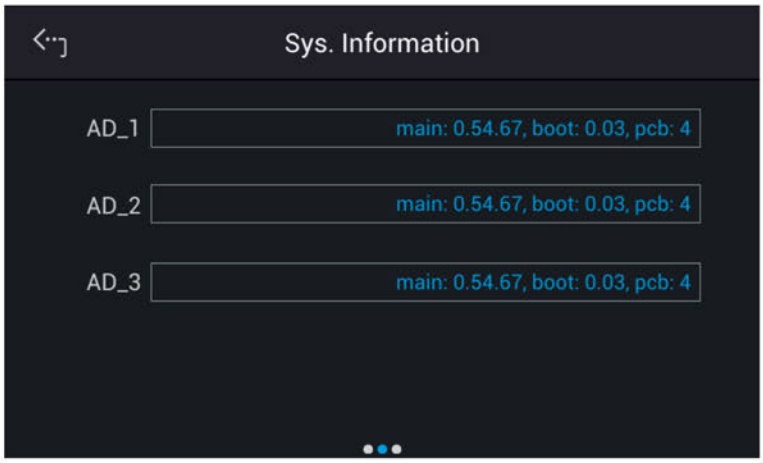
Tap Menu and select System Setup to show the System Setup menu. There are Sys. Information, Sys. Save/Recall, Factory Default, Basic Setting, Meas. Setting, A/B Setting, Limitation, Protection, and Screenshot 9 functions available for use.



3.5.1 System Information

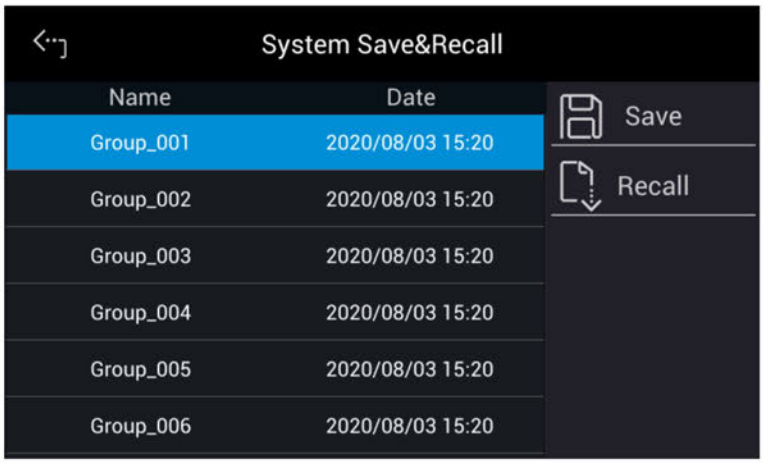
Tap Menu, System Setup and Sys. Information to view the Regenerative Grid Simulator system information.





3.5.2 System Save & Recall

The Regenerative Grid Simulator has 10 groups of memory to save and recall the output setting or system information. The system information includes setting parameters in the function menu such as Configuration menu (see section 3.4) and System Setup (see section 3.4). Tap Menu, System Setup and Sys. Save/Recall to set the save and recall function as shown below.



Notice The Regenerative Grid Simulator has 10 groups of memory: GROUP 0, GROUP1~10. The data saved in GROUP 1~10 memory groups need to be called manually for loading.

3.5.3 Factory Default

Tap Menu, System Setup and Factory Default to restore the factory setting. Select “Yes” for Recall Factory Default and a confirmation dialog box will appear. Tap “Yes” to restore the factory default.

Notice Table 3-1 the original factory parameter setting list.

Table 3-1

More Setting	Min.	Max.	Resolution	Default	Unit
On Degree	0.0	359.9	0.1	0.0	degree
Off Degree	0.0	359.9	0.1	IMMED	degree
Vdc off S/R	0.01	2000.00	0.01	100.00	V/ms
Vac S/R	0.01	2000.00	0.01	1500.00	V/ms
Freq. S/R	0.01	1000.00	0.01	1000.00	Hz/ms
Vdc S/R	0.01	2000.00	0.01	1500.00	V/ms
Phase Angle(1-2)	0.00	359.9	0.1	120.00	degree
Phase Angle(1-3)	0.00	359.9	0.1	240.00	degree

More Setting (option ACL)	Min.	Max.	Resolution	Default	Unit
Iac S/R	0.01	800.00	0.01	100.00	A/ms
S/P S/R	0.1	80000.0	0.1	1000.0	VA/ms W/ms
On Degree	0.0	359.9	0.1	0.0	degree
Off Degree	0.0	359.9	0.1	0.0	degree
Limitation	**Min.**	**Max.**	**Resolution**	**Default**	**Unit**
Vac	0.00	350.00	0.1	350.00	V
Vdc(+)	-495.00	495.00	0.1	495.00	V
Vdc(-)	-495.00	495.00	0.1	0.00	V
F	30.00	100.00	0.01	100.00	Hz
Limitation (Option ACL)	**Min.**	**Max.**	**Resolution**	**Default**	**Unit**
Iac	0.00	35.00 (3_phase) 105.00 (1_phase) @61815 32.00 (3_phase) 96.00 (1_phase) @61812 29.00 (3_phase) 87.00 (1_phase) @61809	0.001	35.00 (3_phase) 105.00 (1_phase) @61815 32.00 (3_phase) 96.00 (1_phase) @61812 29.00 (3_phase) 87.00 (1_phase) @61809	A
CF	1.414	3.000	0.001	3.000	
S	0.0	5000.0 (3_phase) 15000.0 (1_phase) @61815 4000.0 (3_phase) 12000.0 (1_phase) @61812 3000.0 (3_phase) 9000.0 (1_phase) @61809	0.1	5000.0 (3_phase) 15000.0 (1_phase) @61815 4000.0 (3_phase) 12000.0 (1_phase) @61812 3000.0 (3_phase) 9000.0 (1_phase) @61809	VA
P	0.0	5000.0 (3_phase) 15000.0 (1_phase) @61815 4000.0 (3_phase) 12000.0	0.1	5000.0 (3_phase) 15000.0 (1_phase) @61815 4000.0 (3_phase) 12000.0	W

		(1_phase) @61812 3000.0 (3_phase) 9000.0 (1_phase) @61809		(1_phase) @61812 3000.0 (3_phase) 9000.0 (1_phase) @61809	
System Protection	**Min.**	**Max.**	**Resolution**	**Default**	**Unit**
OCP	0.1	36.75	0.01	36.75	A
OPP @380-480V Vac input	0.1	5500	0.1	5000	VA
OPP @200-240V Vac input	0.1	4400	0.1	4000	VA
OCP Delay	0.1	3.0	0.1	3.0	S

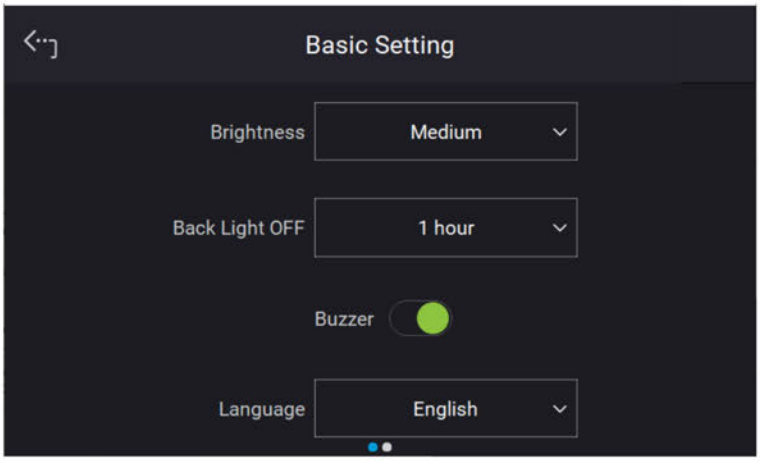
3.5.4 Basic Setting

Tap Menu, System Setup and Basic Setup to set the LCD backlight brightness, eco mode, buzzer, language, and time/date.

Backlight: Low, Medium, High
Backlight OFF: Never, 1 min, 3 mins, 5 mins, 10 mins, 30 mins, 1 hour, 3 hours

Follow the procedure below to set the Brightness = Medium, Backlight OFF = Never in 1_Phase Mode /3_Phase Mode.

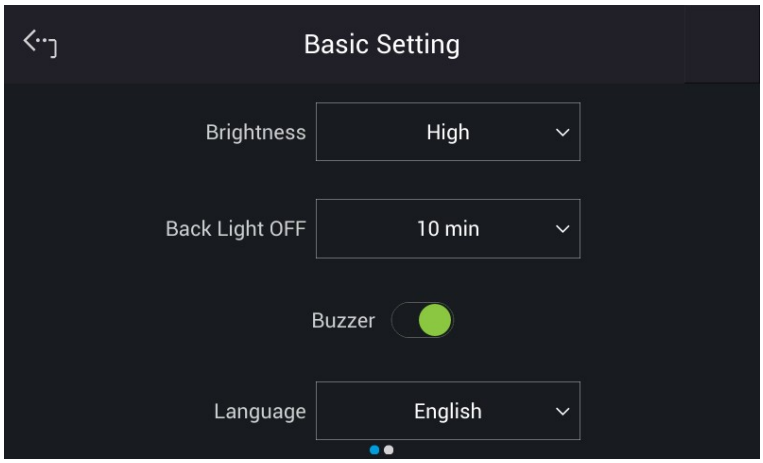
1. Tap Brightness.
2. Select “Medium” to complete the setting.
3. Tap Backlight OFF.
4. Select “1hour” to complete the setting.



Notice The user can press down the RPG rotary on the front panel to wake up the Regenerative Grid Simulator during Back Light OFF.

When tapping the menu on the front panel or turning the RPG rotary knob, a buzzer on the Regenerative Grid Simulator will beep. This can be turned.
Follow the procedure below to turn off the buzzer 1_Phase Mode /3_Phase mode.

Slide Buzzer indicator left to disable it.



Follow the procedure below to switch the language to English in1_Phase Mode /3_Phase mode.

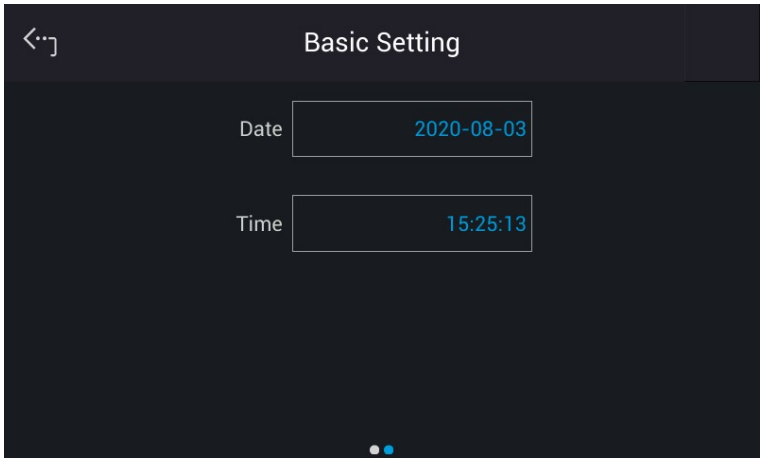
1. Tap Language.
2. Select "English".

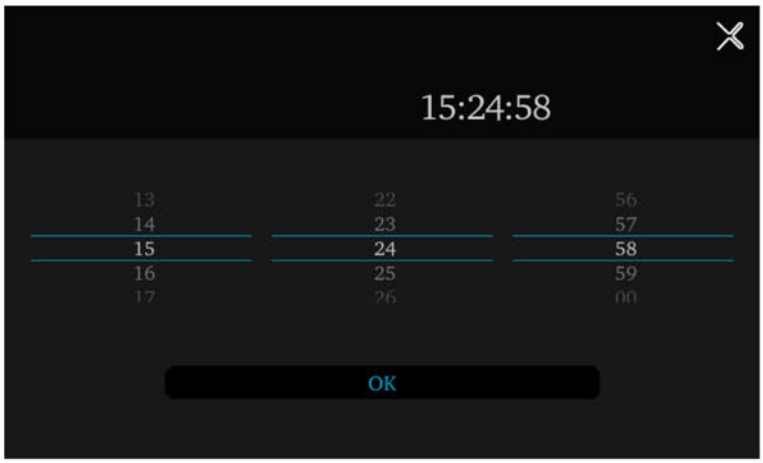
Set the time and date as follows:

Time: Hour, Minute
Date: Month, Day, Year

Follow the procedure below to set the date and time.

1. Slide the screen to second page for setting Date and Time.
2. Tap Date or Time indicator.
3. Select the desired item to begin making settings (Year/Month/Day/Hour/Minute/Second).





3.5.5 Measurement Setting

3.5.5.1 Average Times

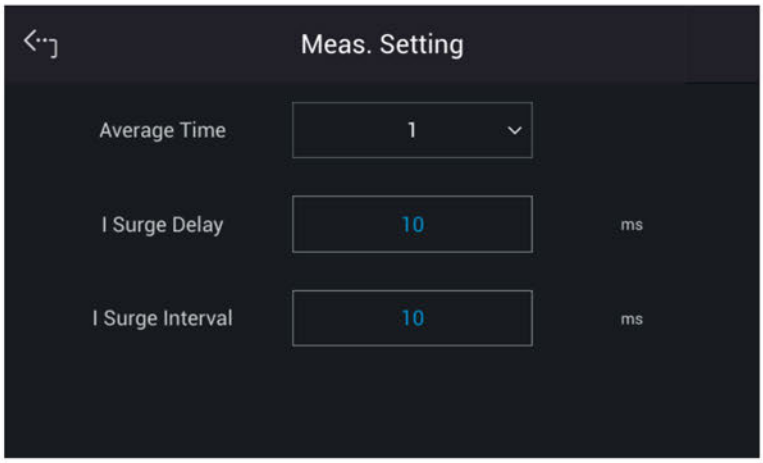
Tap Menu, System Setup and Meas. The “Average Times sets the sampling average of voltage/current RMS and voltage/current peak. The Regenerative Grid Simulator uses moving windows for sampling. When “4” is selected for Average Times it indicates it will be sampling 4 times in moving windows.

Tap Average Times to set the average times for sampling. When a measurement is fluctuating severely, higher sampling average times can be set to improve the measurement accuracy. The average times for sampling to be set are listed below.

Average Times: 1, 2, 4, 8, 16, 32. (The default is 1.)

Follow the steps below to set the sampling average times to 1.

1. Tap Average Times
2. Select “1”.

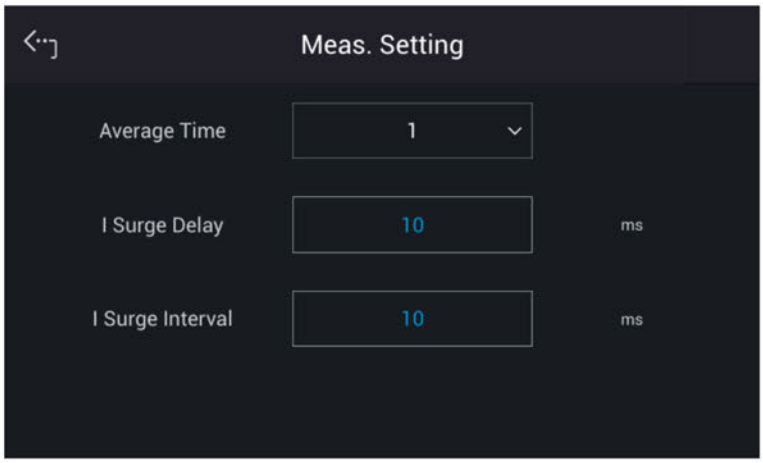


3.5.5.2 Isurge Delay, Isurge Interval

The Isurge in Meas. Setting is the surge peak current output by the Regenerative Grid Simulator. Isurge measurement starts after Isurge Delay when the voltage output changes. The measurement time is set by Isurge Interval. These two functions can be set by Meas. Setting.

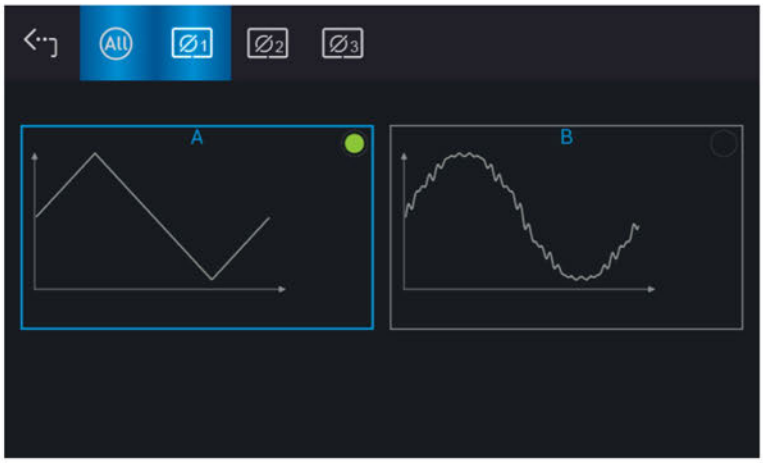
The procedure for setting Isurge Delay = 10 ms, Isurge Interval = 10 ms is described below.

1. Tap I Surge Delay.
2. Select "10".
3. Tap I Surge Interval.
4. Select "10".



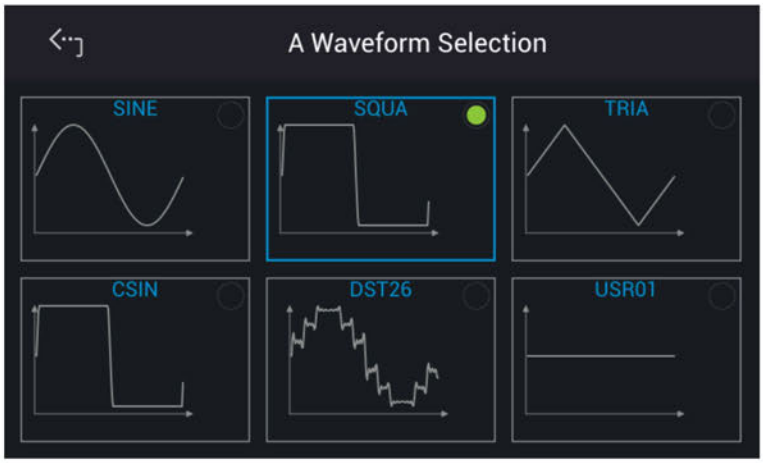
3.5.6 A/B Setting

Tap Menu, System Setup and A/B Setting to set the output waveform.



Follow the steps below to set the A Waveform setting to square wave;

1. Select “A” in A/B Waveform Setting.
2. Select “SQUA” to complete the setting.



3.5.7 Setting Limits

Certain limits of the Regenerative Grid Simulator can be user set. For instance, the Vac Limit setting will apply the settings of the 1-phase mode when changing it from the 3-phase mode. To set, tap Menu, System Setup and Limitation to set Vac Limit, Vdc Limit (+), and Vdc Limit (-).This command limits the values which can be set by the operator to protect the UUT.

3.5.7.1 Vac Limit

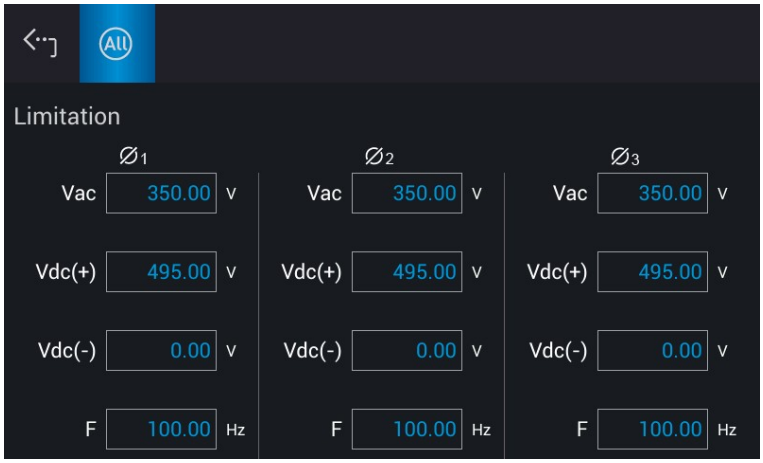
The Vac Limit restricts the Vac value in the main page (3_Phase Mode/1_Phase Mode).

Tap All to set the limitation of the 3-phase voltage output for each or all.

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

1. Tap ALL.
2. Tap “Vac”.

3. Enter **3**, **5**, **0** and tap to change the value to "350.0".

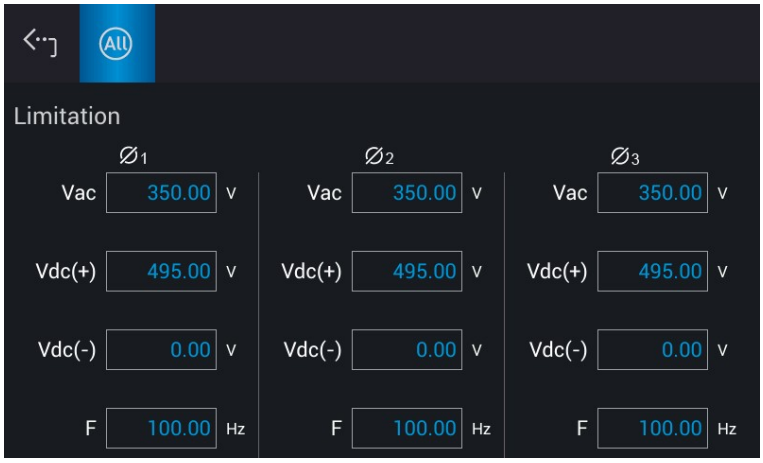


3.5.7.2 Vdc Limit (+), Vdc Limit (-)

These two items can be set in the Limitation function (see 3.5.7). The Vdc setting can exceed Vdc Limit (+) but cannot be under Vdc Limit (-).

The procedure for setting Vdc (+) = 495V, Vdc (-) = 0V in 1_Phase Mode /3_Phase mode is described below.

1. Tap ALL.
2. Tap "Vdc (+)".
3. Enter **4**, **9**, **5** and tap to change the value to "495.0".
4. Tap "Vdc (-)".
5. Enter **0** and tap to change the value to "0.0".



Notice Damage to the UUT may occur if the output polarity of the output or sense lines is reversed at the load.

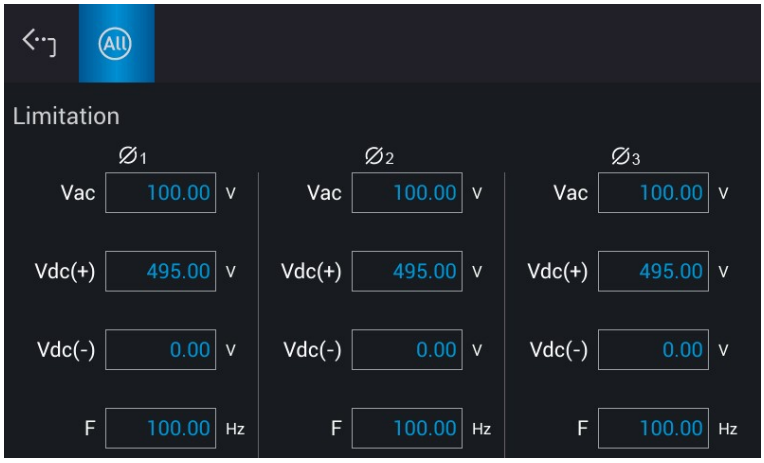
CAUTION

1. If the set Limitation is smaller than the main menu setting, the set value in main menu will equal to the Limitation set value.

Ex. (1) The original main menu sets Vac = 200V.

)

(2) The Limitation sets Vac Limit =100V.



(3) When return to the main menu, the value will be those set in the Limitation menu.

2. When AC+DC is selected for coupling output mode, the output voltage will be restricted by voltage specification.

Ex. (1) Device is unable to output a DC voltage if the AC voltage is set to maximum output voltage. For example, if the AC voltage is set to Vac = 350V, the DC voltage must be sent to 0V.

(2) The DC voltage will limit to the system protection point if the AC voltage is not set to the maximum output voltage specification. When the AC voltage sets to Vac = 200V, the DC voltage can only set to 212V at a maximum.

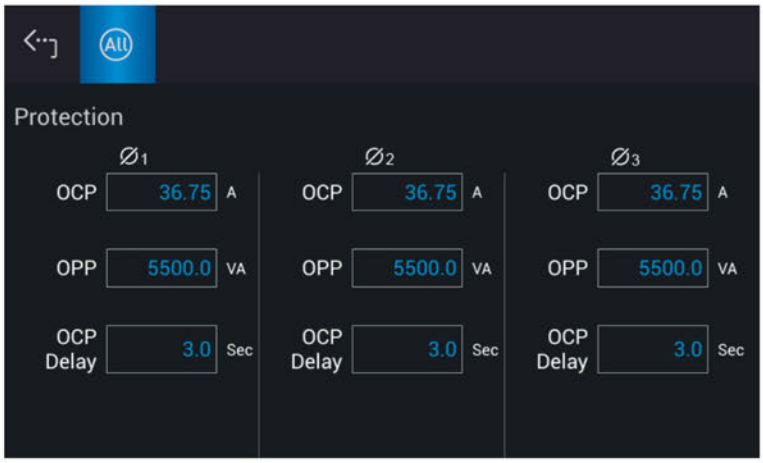
3.5.8 Protection

The Regenerative Grid Simulator's Protection for 1-phase/3-phase output mode is set separately. For instance, the Protection will apply the settings of 1-phase but when switching from 1-phase to 3-phase mode the Protection settings will be applied to each phase separately.

Tap Menu, System Setup and Protection to set the limit of the output RMS current (OCP), output power (OPP) and the Delay Time for triggering the current protection. The protection is only valid in Meas. & Setup (3_Phase Mode/1_Phase Mode). The purpose of this command is to protect the UUT.

Following shows the procedure of setting the current limit = 36.75 A (maximum for 61815), power limit = 5500VA VA (maximum for 61815), delay time for trigger current protection = 3 sec.

1. Tap ALL.
2. Select "OCP "of phase 1
3. Enter 3, 6, ., 7, 5, and tap ↵ to change the value to "36.75".
4. Tap "OPP" of phase 1.
5. Enter 5 ,5 ,0 ,0, and tap ↵ to change the value to "5500".
6. Tap "Delay time" of phase 1.
7. Enter 3, and tap ↵ to change the value to "3.0".



Notice

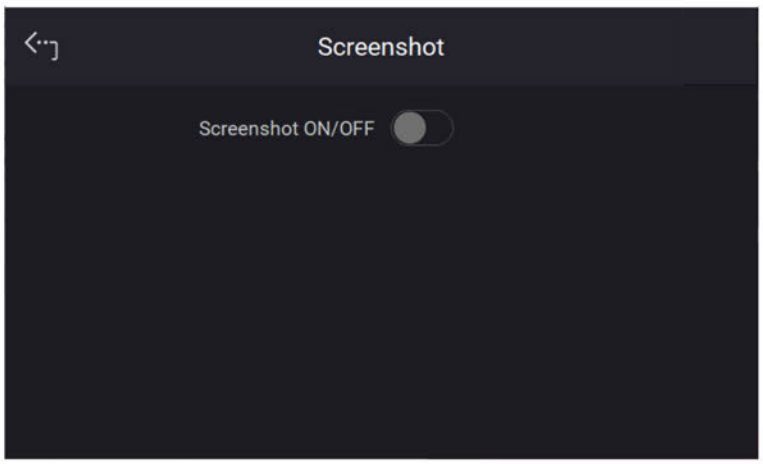
1. The setting of the delay time for current protection is only valid when the current is within the specification. When the output exceeds the specification, it is still valid if the current protection delay trigger is between the set 0.1 to1s. However, device will enter protection mode when if it exceeds 1s. The resolution is 0.1s.
2. The protection point varies by the measurement error, thus it may act before reaching the protection point set.

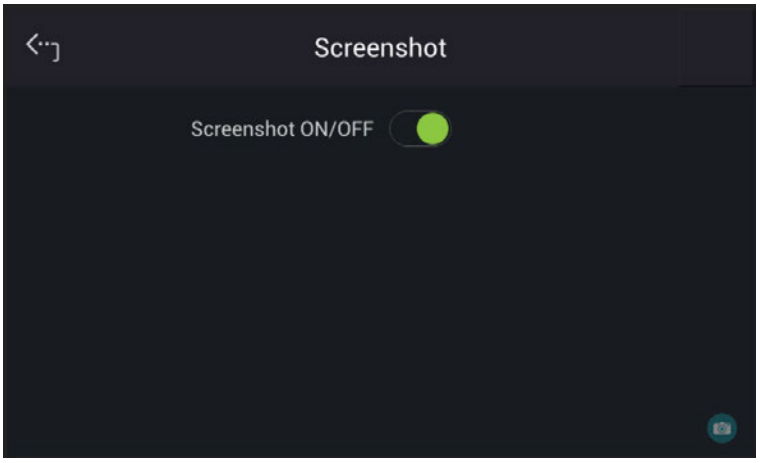
Notice

When switching between 1-phase and 3-phase mode, the setting will be reset to zero to avoid damaging the Unit Under Test (UUT).

3.5.9 Screenshot

Tap Menu, System Setup and Screenshot to perform the screenshot of Regenerative Grid Simulator.

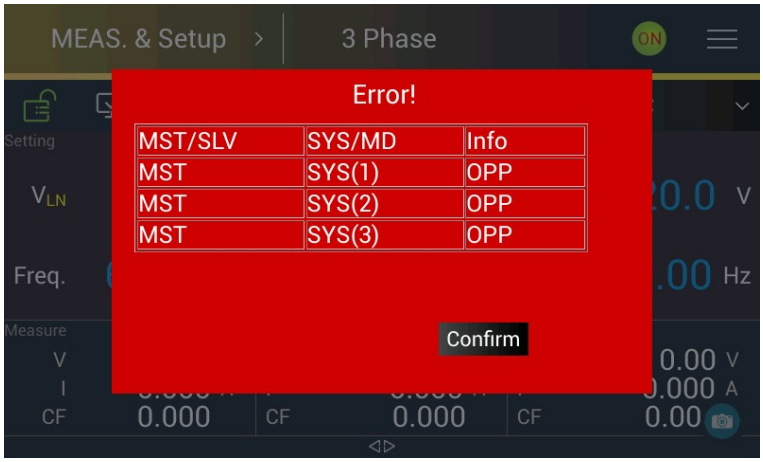




When the Screenshot ON/OFF is turned to ON, a camera icon will appear at the lower right corner on the screen. Insert a USB2.0 flash drive to the USB HOST on the front panel to save the file. Click the camera icon to perform the screenshot as desired.

3.6 Protection

The Regenerative Grid Simulator has both software and hardware protection. When protection errors occur the Regenerative Grid Simulator will disable the output and disconnect the output relay. The display will show that the source is in protection mode. Once a protection is triggered, please correct the cause and tap Confirm to release protection for normal operation.



If unable to determine the cause of the error it is recommended to remove the load and restart the Regenerative Grid Simulator to release protection for normal operation.

The table below lists the output protection:

Message	Protection	Possible Cause	Troubleshooting
SYS_FANFAIL	It occurs when the fan is checked during power-on. (Latch)	1. The fan is blocked due foreign object or dust. 2. The fan is not connected. 3. The fan is broken or invalid. 4. The fan circuit is malfunction.	1. Check the fan on the module having protection and clear the foreign object. 2. Check the connection of fan on the module having protection. 3. Replace the broken or invalid fan. 4. Replace the fan circuit board.
SYS_FANLOCK	1. It prevents damage to compulsory cooling components. 2. Prevents the fan from blocking due to foreign objects or abnormal circuit.(Latch)		
SYS_ISHARE_ERR_SIN	1. Prevents you from incorrectly connecting the output. 2. Prevents module errors to cause unbalanced current sharing. Only valid for a standalone unit in 1-phase. (Recovery)	1. Each power module is abnormal. 2. The current sharing circuit is abnormal. 3. The digital communication is abnormal.	1. Replace the power module. 2. Inspect the communication cable and make sure the connection is correct.
SYS_ISHARE_ERR_PAR	1. Prevents you from incorrectly connecting the output. 2. Prevents module errors to cause unbalanced current sharing. Only valid when paralleled in multiple devices. (Recovery)	1. Each power module is abnormal. 2. The current sharing circuit is abnormal. 3. The digital communication is abnormal.	1. Replace the power module. 2. Inspect the communication cable and make sure the connection is correct.
SYS_OVP(1/2/3)	It occurs when the output voltage exceeds the system set voltage limit. (Recovery)	1. The external source is too large. 2. The external inductive load is open. 3. The UUT capacitive load is too big.	1. Make sure the external circuit is correct. 2. Check if the circuit is short circuited. 3. Confirm the external circuit characteristics.
SYS_OCP(1/2/3)	It occurs when the output current	1. The UUT impedance is	1. Remove the UUT and make sure

	exceeds the system set current limit. (Recovery)	too low. 2. Temporary short circuit. 3. The RCD load impedance is too small. 4. The UUT capacitive load is too big.	the protection value is correctly set. 2. Remove the UUT and confirm its correctness. 3. Add a current limit resistor. 4. Set the voltage slew rate.
SYS_OPP(1/2/3)	It occurs when the output power exceeds the system set power limit. (Recovery)	1. The UUT impedance is too low. 2. Temporary short circuit.	1. Remove the UUT and make sure the protection value is correctly set. 2. Remove the UUT and confirm its correctness.
SELF_TEST_NG(1/2/3)	It occurs when the auxiliary power of DC/AC power module is running self detect protection.(Latch)	1. The auxiliary power of DC/AC module is abnormal. 2. The measurement circuit of DC/AC module is having error. 3. The digital module is having error.	1. Check and replace the auxiliary power on the DC/AC module board. 2. Check and replace the DC/AC module board. 3. Check and replace the digital module board.
SYS_DA_COM_ERR(1/2/3)	It occurs when checking the communication status between the Host and the DC/AC module. (Latch)	1. The auxiliary power of DC/AC module is abnormal. 2. The Host auxiliary power is abnormal. 3. The communication cable is abnormal.	1. Check and replace the auxiliary power on the DC/AC module board. 2. Check and replace the digital module board. 3. Check and replace the DC/AC module board. 4. Check if the communication cable is correctly connected.
SYS_AD_COM_ERR(1/2/3)	Occurs when checking the communication status between the Host and the AC/DC module. (Latch)	1. The auxiliary power of AC/DC module is abnormal. 2. The Host auxiliary power is abnormal.	1. Check and replace the auxiliary power on the AC/DC module board. 2. Check and replace the digital

		3. The communication cable is abnormal.	module board. 3. Check and replace the AC/DC module board. 4. Check if the communication cable is correctly connected.
SYS_PAR_COM_CAN_ERR SYS_PAR_COM_ERR SYS_PAR_WIRE_LOSS	The occurred digital communication error causes abnormal parallel output when paralleled multiple devices. (Recovery)	1. The auxiliary power of DC/AC module is abnormal. 2. The Host auxiliary power is abnormal. 3. The communication cable is abnormal.	1. Check and replace the auxiliary power on the DC/AC module board. 2. Check and replace the digital module board. 3. Check and replace the DC/AC module board. 4. Check if the communication cable is correctly connected.
SYS_REMOTE_INHIBIT	Occurs when remote is inhibited.		
SYS_AD_NO_MAIN	The main program for power-on AC/DC module self-test is abnormal.	The AC/DC module triggers protection.	1. Upgrade the firmware and reboot. 2. Check if the comm. cable of internal AC/DC is well connected.
SYS_DA_NO_MAIN	The main program for power-on DC/AC module self-test is abnormal.	The DC/AC module triggers protection.	1. Upgrade the firmware and reboot. 2. Check if the comm. cable of internal DC/AC is well connected.
SYS_DSP_NO_MAIN	The main program for power-on HOST self-test is abnormal.	The HOST triggers protection.	1. Upgrade the firmware and reboot. 2. Check if the SD card inside is well inserted.
SYS_CALI_BND_ERR	The calibrated value of power-on test is out of range.	The HOST triggers protection.	1. Recalibrate it. 2. Make sure the device cables are correctly connected.

The table below lists the module protection:

Message	Protection	Possible Cause	Troubleshooting
AD_VDC_OVP(1/2/3)	Occurs when the AC/DC power module outputs over VDC voltage. (Latch)	1. The output transient power is too high (the protection phase VDC is over 850V.) (Regen mode) 2. The AC/DC module measurement circuit is abnormal.	1. Remove the UUT and make sure the operation is correct. 2. Check and replace the AC/DC module board that has protection occurred.
AD_VDC_UVP(1/2/3)	Occurs when the AC/DC power module outputs under VDC voltage. (Latch)	1. The output transient power is too high (the protection phase VDC is under 720V.) (Source mode) 2. The AC/DC module measurement circuit is abnormal. 3. The AC/DC module relay drive signal is abnormal or the relay is damaged 4. The AC/DC module PWM drive signal is abnormal. 5. The AC/DC power module is abnormal or damaged.	1. Remove the UUT and make sure the operation is correct. 2. Check and replace the AC/DC module board that has protection occurred. 3. Check and replace the AC/DC module board that has protection occurred. 4. Check and replace the AC/DC power module board that has protection occurred. 5. Check and replace the AC/DC power module board that has protection occurred.
AD_VAC_UBL(1/2/3)	It indicates that the line input is unbalanced or phase failure. (Latch)	1. The input power supply is connected wrong (V_{LL} difference 10%). 2. The input power has phase failure.	1. Check if the 3-phase input line voltage meets the rated value. 2. Measure the AC/DC module fuse and replace it.

		3. The AC/DC module fuse is broken. 4. The AC/DC module measurement circuit is abnormal.	3. Check and replace the AC/DC module board that has protection occurred.
AD_VRS_OVP(1/2/3) AD_VTR_OVP(1/2/3) AD_VST_OVP(1/2/3) AD_Vd_OVP(1/2/3)	It indicates that the line input voltage is over the specification. (Latch)	1. The input power is abnormal. 2. The AC/DC module measurement circuit is abnormal.	1. Check if the input power meets the rated value. 2. Check and replace the AC/DC module board that has protection occurred.
AD_VRS_UVP(1/2/3) AD_VTR_UVP(1/2/3) AD_VST_UVP(1/2/3) AD_Vd_UVP(1/2/3)	It indicates that the line input voltage is under the specification. (Latch)	1. The input power is abnormal. 2. The AC/DC module input fuse is broken. 3. The AC/DC module measurement circuit is abnormal.	1. Check if the input power meets the rated value. 2. Measure the AC/DC module input fuse and replace it. 3. Check and replace the AC/DC module board that has protection occurred.
AD_IR_OCP(1/2/3) AD_IS_OCP(1/2/3) AD_IT_OCP(1/2/3)	It indicates that the line input current is over the limit. (Latch)	1. The output transient power is too high. 2. The AC/DC module measurement circuit is abnormal.	1. Remove the UUT and make sure the operation is correct. 2. Check and replace the AC/DC module board that has protection occurred.
AD_OTP(1/2/3)	It occurs when the internal temperature of AC/DC power module is too high. (Latch)	1. The operating environment temperature is over. 2. The module power switch is abnormal. 3. The circuit detection is malfunction.	1. Eliminate the ambient overheating problem. 2. Check the abnormal phase power module and replace it. 3. Check the abnormal fan circuit board and sensing wire, and replace them.
DA_OTP(1/2/3)	It occurs when the internal temperature of DC/AC power module is too high. (Latch)		
DA_UTP(1/2/3)	It occurs when the		

	internal temperature of DC/AC power module is too low. (Latch)		
AD_FRE_ERR(1/2/3)	It protects the module side when the AC/DC power module input voltage and frequency are abnormal. (Latch)	1. The input power is abnormal. 2. The AC/DC module input fuse is broken. 3. The AC/DC module measurement circuit is abnormal.	1. Check if the input power meets the rated value. 2. Measure the AC/DC module fuse and replace it. 3. Check and replace the AC/DC module board that has protection occurred.
AD_PFC_STARTFAIL(1/2/3)	It protects the module side when the AC/DC power module start fails.(Latch)	1. The input power is abnormal. 2. The AC/DC module input fuse is broken. 3. The AC/DC module measurement circuit is abnormal.	1. Check if the input power meets the rated value. 2. Measure the AC/DC module input fuse and replace it. 3. Check and replace the AC/DC module board that has protection occurred.
AD_AC_STARTFAIL(1/2/3)			
DD_LLC_STARTFAIL(1/2/3)			
DD_LLC_STARTFAIL(1/2/3)			
AD_MEM_ERR(1/2/3)	The AC/DC power module CPU self-tests if the memory is operating normally. (Latch)	1. The digital circuit of power supply module is abnormal. 2. The AC/DC module CPU is abnormal.	1. Check if it is the auxiliary power problem on the single board. 2. Check and replace the digital control board of AC/DC module that has protection occurred.
AD_MODEL_RES_ERR(1/2/3)	It identifies the single model of AC/DC power module.(Latch)	1. The hardware resistance for identification is broken. 2. The AC/DC module digital control board is abnormal.	1. Check and identify if the GPIO pins used by AC/DC power module are correct. 2. Check if the hardware resistance is normal and exists.

AD_PWM_TOP_FAULT(1/2/3) AD_PWM_BOT_FAULT(1/2/3)	It is the AC/DC power module drives signal protection. (Latch)	1. The drive signal is abnormal (the power parts are short-circuited.) 2. The AC/DC module digital circuit is abnormal. 3. The DC/AC module digital circuit is abnormal.	1. Check or replace the power module board that has protection occurred. 2. Check and replace the digital board of AC/DC module that has protection occurred. 3. Check and replace the digital board of DC/AC module that has protection occurred.
DA_PWM_R_FAULT(1/2/3) DA_PWM_L_FAULT(1/2/3)	It is the DC/AC power module drives signal protection. (Latch)		
DD_IP_OCP(1/2/3)	DC/DC power module primary side over current protection. (Latch)	1. The output transient power is too high. 2. The DC/DC module measurement circuit is abnormal.	1. Remove the UUT and make sure the operation is correct. 2. Check and replace the DC/DC module board that has protection occurred.
DD_IO_SRC_OCP(1/2/3) DD_IO_REG_OCP(1/2/3)	It is the DC/DC power module secondary side over current protection. (Latch)	1. The output transient power is too high. 2. The DC/DC module measurement circuit is abnormal.	1. Remove the UUT and make sure the operation is correct. 2. Check and replace the DC/DC module board that has protection occurred.
DD_VO_OVP_F(1/2/3)	It is the DC/DC power module secondary side over voltage protection in transient state. (Latch)	1. The input power is abnormal. 2. The DC/DC module measurement circuit is abnormal.	1. Check if the input power meets the rated value. 2. Check and replace the DC/DC module board that has protection occurred.
DD_VO_UVP_S(1/2/3)	It is the DC/DC power module secondary side under voltage protection in steady state. (Latch)	1. The input power is abnormal. 2. The AC/DC module input fuse is broken. AC/DC 3. The DC/DC	1. Check if the input power meets the rated value. 2. Measure the AC/DC module input fuse and replace it.

DD_VO_UVP_F(1/2/3)	It is the DC/DC power module secondary side under voltage protection in transient state. (Latch)	module measurement circuit is abnormal.	3. Check and replace the DC/DC module board that has protection occurred.
DD_SHORT(1/2/3)	It is the primary side over current protection of DC/DC power module. (Latch)	1. The DC/DC power module drive signal is abnormal (the power parts are short-circuited.) 2. The DC/AC power module output is abnormal.	1. Check and replace the DC/DC power module board that has protection occurred. 2. Check and replace the DC/AC power module board that has protection occurred. 3. Check and replace the digital board of AC/DC module that has protection occurred. 4. Check and replace the digital board of DC/AC module that has protection occurred.
DA_OVP(1/2/3)	Occurs when the transient output voltage exceeds the module voltage limit or voltage specification. (Latch)	1. The external source is too large. 2. The external inductive load is open. 3. The UUT capacitive load is too big.	1. Make sure the external circuit is correct. 2. Check if the circuit is short circuited. 3. Confirm the external circuit characteristics.
DA_OCP(1/2/3)	It occurs when the transient output current exceeds the module current limit or current specification. (Latch)	1. The UUT impedance is too low. 2. Temporary short circuit. 3. The RCD load impedance is too small. 4. The UUT capacitive load is too big.	1. Remove the UUT and make sure the protection value is correctly set. 2. Remove the UUT and confirm its correctness. 3. Add a current limit resistor. 4. Set the voltage

			slew rate.
DA_OPP(1/2/3)	It occurs when the transient output power exceeds the module power limit or power specification. (Latch)	1. The UUT impedance is too low. 2. Temporary short circuit.	1. Remove the UUT and make sure the protection value is correctly set. 2. Remove the UUT and confirm its correctness.
DA_SENSE_FAULT(1/2/3)	It occurs when the remote voltage sensing function is on and the signal line is not connected or wrong. (Recovery)	1. The remote sense wiring is not connected or connected wrong. 2. The remote connection impedance is too large. 3. The output relay is malfunction.	1. Check the remote sense wiring. 2. Shorten the distance to UUT and eliminate the impedance. 3. Replace the damaged output relay.
DA_SHORT(1/2/3)	It occurs when the output is short circuited. (Recovery)	1. The UUT impedance is too low. 2. Temporary short circuit.	1. Remove the UUT and confirm its correctness. 2. Make sure the external connection is correct.
DA_HARD_ERR(1/2/3)	It prevents the AC/DC power module or the digital power supply from being abnormal, causing the DC/AC power module to output abnormal voltage.	1. The auxiliary power supply on digital board is abnormal. 2. The AC/DC module triggers protection.	1. Check if the digital auxiliary power supply meets the rated value. 2. Check and replace the AC/DC module board that has protection occurred.
DA_FW_PWMSHORT(1/2/3)	It indicates that the digital control signal of the DC/AC power module is abnormal.(Latch)	1. The DC/AC power module digital control board is broken. 2. The auxiliary power supply on the DC/AC power module digital board is abnormal.	1. Check if the digital auxiliary power supply meets the rated value. 2. Check and replace the digital control board on DC/AC module that has protection occurred.
DA_ISHARE_ERR_F(1/2/3)	1. It prevents you from incorrectly	1. The digital control board on DC/AC power	1. Check and replace the DC/AC power

	connecting the output. 2. It prevents module errors to cause unbalanced current sharing. (Recovery)	module is broken. 2. The measurement circuit on DC/AC power module board is abnormal. 3. The output relay is malfunction.	module board that has protection occurred. 2. Check and replace the DC/AC power module digital board that has protection occurred.
DA_IC_OCP(1/2/3)	It prevents damage to the components of DC/AC power modules. (Recovery)	1. The digital control board on DC/AC power module is broken. 2. The passive component circuit on DC/AC power module is abnormal. 3. The measurement circuit on DC/AC power module board is abnormal.	1. Check and replace the DC/AC power module board that has protection occurred. 2. Check and replace the DC/AC power module digital board that has protection occurred.
DA_Vdamp_OVP(1/2/3)	It prevents damaging the damping resistance under abnormal operation. (Recovery)		
DA_UUT_UVP(1/2/3) (ACL option)	It means the UUT voltage is too low.	The DC/AC module triggers protection.	1. Remove the UUT and confirm its correctness. 2. Make sure the external connection is correct.
DA_UUT_OFP(1/2/3) (ACL option)	It means the UUT voltage frequency is over the operating range.		
DA_UUT_UFP(1/2/3) (ACL option)	It means the UUT voltage frequency is under the operating range.		
DA_UUT_OVP_VDC(1/2/3) (ACL option)	It means the UUT voltage has too much DC voltage component.		
DA_UUT_fault (Option ACL)	It means the UUT frequency has changed too much, and it cannot be restored to carry on loading.	The DC/AC module triggers protection.	1. Remove the UUT and confirm its correctness. 2. Make sure the external connection is correct.
DA_PLL_FAIL (Option ACL)	It means the DC/AC module phase lock is abnormal.	The DC/AC module triggers protection.	1. Measure the error circuit. 2. Remove the UUT and confirm its correctness.

			3. Make sure the external connection is correct.
DA_SRAM_ERR	It means the DA_SRAM power-on test is abnormal.	The DC/AC module triggers protection.	1. Replace the CD board. 2. Upgrade the FW and reboot.

Notice

The protection message is marked _F(FAST) and _S(SLOW) by transient and steady state.
The protection point varies by the measurement error, thus it may act before reaching the protection point set.

4. Verification

4.1 Introduction

This chapter contains test procedures for checking the operation and specification of Chroma 61800 Series Regenerative Grid Simulator. The tests are performed using the 61800 Series models and some required equipment. The required test equipment is listed in Table 4-1. Please refer to *Performance Tests* section for equipment connecting and test procedure. The user can use verification tables included at measurement verification section for checking the specification. The performance tests confirm Chroma 61800 Series meets its published specifications. For detailed information of operation and programming please refer to the *Chapter 3 and Chapter 5*.

If any of the models covered in the manual (61809/61812/61815) require service, refer to the list of Chroma Sales and Support Offices at the web site: www.chromaate.com/english/contact/default.asp.

4.2 Equipment Required

The following table lists the equipment or its equivalent required for verification.

Table 4-1 Equipment Suggested for Verification

Equipment	Characteristics	Recommended Model
Current Transducer	400A	DC-CT(IT 400-S)
Power Analyzer		Chroma 66204 *1 unit Chroma A662020 *1 unit (DC-CT Power)
AC Load	105Apeak 0-35Arms 30-350Vrms 30-100Hz	Chroma 61815 *1 unit (with ACL option)
Regenerative Grid Simulator		Chroma 61809/61812/61815

Connection
Connect the Regenerative Grid Simulator, AC Load, Power Analyzer, and Current Transducer as shown in Figure 4-1.

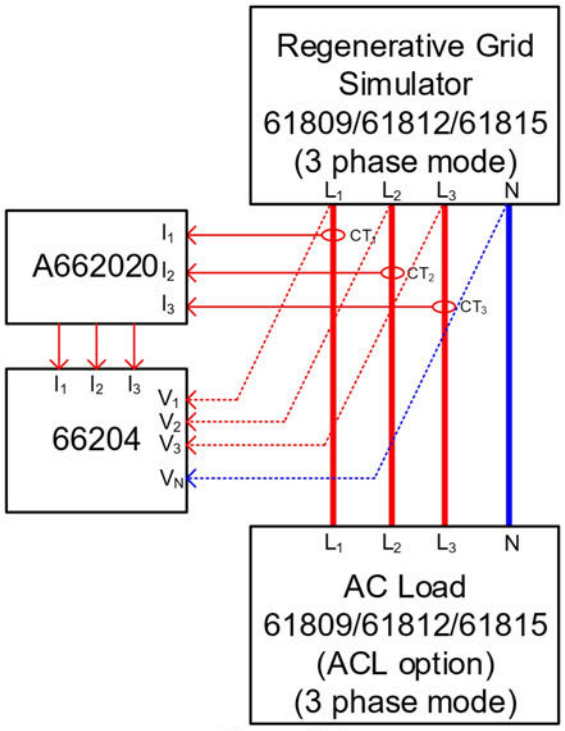


Figure 4-1

4.3 Performance Tests

4.3.1 Voltage Setting and Measurement Verification

This test verifies output voltage and measurement accuracy are within specifications when operating in Meas. & Setup (3_Phase) mode. For each Power Analyzer reading, the front panel display of voltage measurement should be within the specification.

Regenerative Grid Simulator reading in volts = voltage setting ± inaccuracy

PA (Vac): Vrms voltage measurement of Power Analyzer AC voltage
PA (Iac): Irms current measurement of Power Analyzer AC current
PA (F): frequency measurement of Power Analyzer AC voltage

Checking voltage

A. Connect the Regenerative Grid Simulator, AC/DC Load, Power Analyzer, and Current Transducer as shown in Figure 4-1. Use the Power Analyzer to measure the AC Vac voltage.
B. Enter into Meas. & Setup (3_Phase Mode) to start performing the verification listed in Table 4-2 (no load) and Table 4-3 (with load).
C. Load the test voltage and turn on the AC load to set the loading current as Table 4-3 shows. The current protection of AC load must be larger than 35Arms with power protection larger than 5kW.

Table 4-2 Voltage Setting and Measurement Verification Table (No Load)

Φ1							
Model	**Voltage Setting (std.)**	**Voltage Accuracy**		**PA(Vac) Voltage**	**Front Panel Display Reading**	**Front Panel Display Spec.**	**Freq. Spec. 0.01% F.S PA(F)**
		Max.	**Min.**				
61809	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
61812	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
61815	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
Φ2							
Model	**Voltage Setting (std.)**	**Voltage Accuracy**		**PA(Vac) Voltage**	**Front Panel Display Reading**	**Front Panel Display Spec.**	**Freq. Spec. 0.01% F.S PA(F)**
		Max.	**Min.**				
61809	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
61812	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
61815	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
Φ3							
Model	**Voltage Setting (std.)**	**Voltage Accuracy**		**PA(Vac) Voltage**	**Front Panel Display Reading**	**Front Panel Display Spec.**	**Freq. Spec. 0.01% F.S PA(F)**
		Max.	**Min.**				
61809	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
61812	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	
61815	50V	49.25V	50.75V			Std. ±0.75V	
	150V	149.15V	150.85V			Std. ±0.85V	
	250V	249.05V	250.95V			Std. ±0.95V	
	350V	348.95V	351.05V			Std. ±1.05V	

Table 4-3 Voltage Setting and Measurement Verification Table (with Load)

Φ1								
Model	**Voltage Setting (std.)**	**Loading Current Setting**	**Voltage Accuracy**		**PA(Vac) Voltage**	**Front Panel Display Reading**	**Front Panel Display Spec.**	**Freq. Spec. 0.01% F.S PA(F)**
			Max.	**Min.**				
61809	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	20A	149.15V	150.85V			Std. ±0.85V	
	250V	12A	249.05V	250.95V			Std. ±0.95V	
	350V	8A	348.95V	351.05V			Std. ±1.05V	
61812	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	26A	149.15V	150.85V			Std. ±0.85V	
	250V	16A	249.05V	250.95V			Std. ±0.95V	
	350V	11A	348.95V	351.05V			Std. ±1.05V	
61815	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	30A	149.15V	150.85V			Std. ±0.85V	
	250V	18A	249.05V	250.95V			Std. ±0.95V	
	350V	12A	348.95V	351.05V			Std. ±1.05V	
Φ2								
Model	**Voltage Setting (std.)**	**Loading Current Setting**	**Voltage Accuracy**		**PA(Vac) Voltage**	**Front Panel Display Reading**	**Front Panel Display Spec.**	**Freq. Spec. 0.01% F.S PA(F)**
			Max.	**Min.**				
61809	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	20A	149.15V	150.85V			Std. ±0.85V	
	250V	12A	249.05V	250.95V			Std. ±0.95V	
	350V	8A	348.95V	351.05V			Std. ±1.05V	
61812	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	26A	149.15V	150.85V			Std. ±0.85V	
	250V	16A	249.05V	250.95V			Std. ±0.95V	
	350V	11A	348.95V	351.05V			Std. ±1.05V	
61815	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	30A	149.15V	150.85V			Std. ±0.85V	
	250V	18A	249.05V	250.95V			Std. ±0.95V	
	350V	12A	348.95V	351.05V			Std. ±1.05V	
Φ3								
Model	**Voltage Setting (std.)**	**Loading Current Setting**	**Voltage Accuracy**		**PA(Vac) Voltage**	**Front Panel Display Reading**	**Front Panel Display Spec.**	**Freq. Spec. 0.01% F.S PA(F)**
			Max.	**Min.**				
61809	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	20A	149.15V	150.85V			Std. ±0.85V	
	250V	12A	249.05V	250.95V			Std. ±0.95V	
	350V	8A	348.95V	351.05V			Std. ±1.05V	
61812	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	26A	149.15V	150.85V			Std. ±0.85V	
	250V	16A	249.05V	250.95V			Std. ±0.95V	
	350V	11A	348.95V	351.05V			Std. ±1.05V	
61815	50V	35A	49.25V	50.75V			Std. ±0.75V	
	150V	30A	149.15V	150.85V			Std. ±0.85V	
	250V	18A	249.05V	250.95V			Std. ±0.95V	
	350V	12A	348.95V	351.05V			Std. ±1.05V	

4.3.2 Current Measurement Verification

This test verifies if the current measurement accuracy is within specifications when operating in Meas. & Setup (3_Phase) mode. For each Power Analyzer reading, the front panel display of current measurement should be within the specification.

Regenerative Grid Simulator reading is in amps= current loading ± inaccuracy

Checking voltage

A. Connect the Regenerative Grid Simulator, AC/DC Load, Power Analyzer, and Current Transducer as shown in Figure 4-1. Use the Power Analyzer to measure the AC Iac current.
B. Enter into Meas. & Setup (3_Phase Mode) to start performing the verification listed in Table 4-4.
C. Turn on the AC load and set the loading current as Table 4-4 shows. The current protection of AC load must be greater than 35Arms with power protection larger than 5kW.

Table 4-4 Current Measurement Verification Table

Φ1				
Model	**Voltage Setting (std.)**	**Loading Current Setting**	**Front Panel Current I Reading**	**Front Panel Display Spec.**
61809	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	20A		Std. ±0.167A
61812	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	26A		Std. ±0.2A
61815	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	30A		Std. ±0.225A
Φ2				
Model	**Voltage Setting (std.)**	**Loading Current Setting**	**Front Panel Current I Reading**	**Front Panel Display Spec.**
61809	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	20A		Std. ±0.167A
61812	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	26A		Std. ±0.2A
61815	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	30A		Std. ±0.225A
Φ3				
Model	**Voltage Setting (std.)**	**Loading Current Setting**	**Front Panel Current I Reading**	**Front Panel Display Spec.**
61809	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A

	150V	20A		Std. ±0.167A
61812	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	26A		Std. ±0.2A
61815	50V	11A		Std. ±0.131A
	100V	23A		Std. ±0.179A
	150V	30A		Std. ±0.225A

5. Application

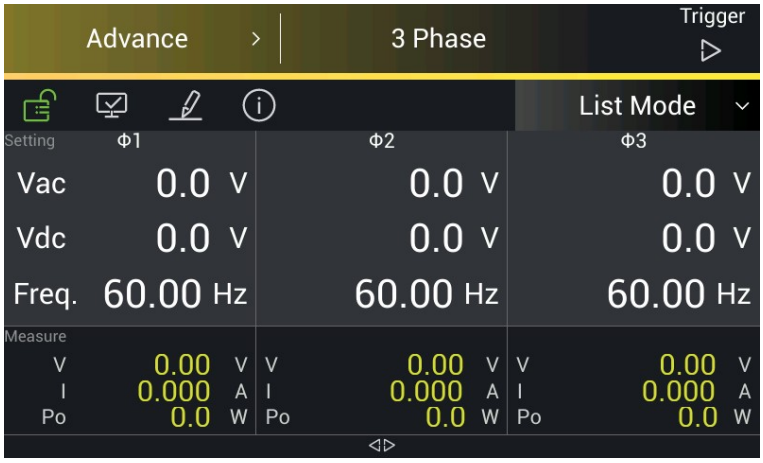
5.1 Overview

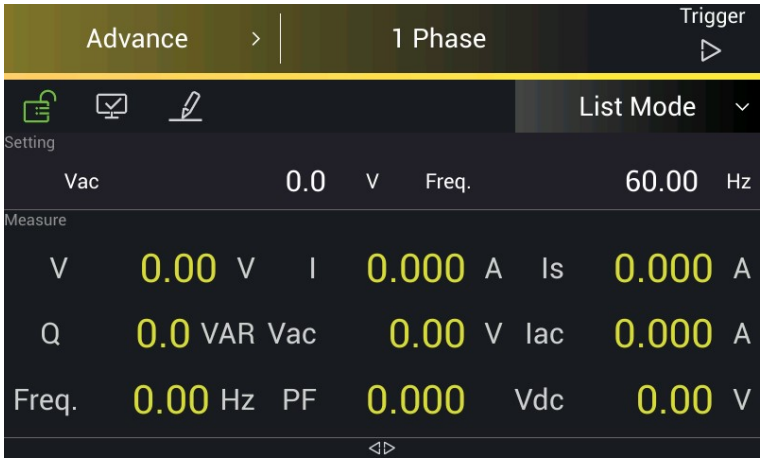
The Regenerative Grid Simulator not only can program a stable sinusoidal output voltage and frequency, but also provides powerful features to simulate power line interrupts and distorted waveforms. User may change the output settings using the Sequences in LIST mode (see 5.2), or change the output step- by- step in STEP mode (see 5.4.) With these functions, users may simulate conditions such as cycle loss, transient peak and power attenuation easily.

The Regenerative Grid Simulator is able to measure the related power parameters provided in MAIN PAGE (see 3.3); providing harmonic measurements up to 50 orders (see 0.) In addition, the Regenerative Grid Simulator allows editing different harmonic components to synthesize the harmonic distortion waveform (see 0). It has the ability to program the inter-harmonic frequency and components, as well as to sweep and overlap the static fundamental waveforms (see 5.6). To use these features tap Menu and select Advance to set the function. The default is List Mode.

5.2 List Mode

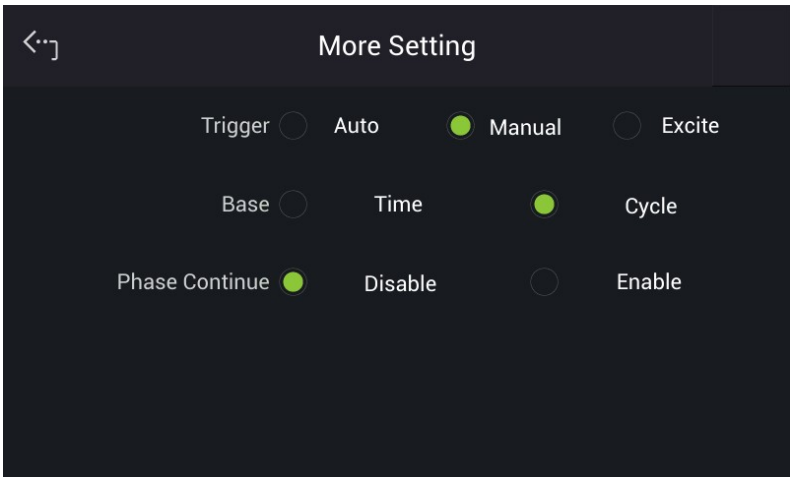
In the Advance main page (as shown in section 5.1), tap the menu on the upper right to enter the List Mode function.





Tap to enter the setup screen.

Tap on the upper right to select More Setting.



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

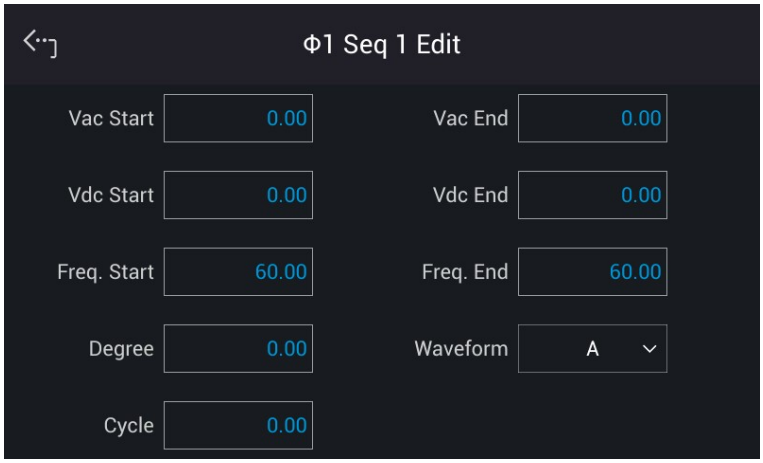
Trigger method: Auto / Manual / Excite
Auto: Finishes all round counts when triggered.
Manual: Executes the sequence waveform once, same as Round Count = 1.
Excite: Remote-Excite via the pin 13 of TTL terminal that is triggered by the external trigger signal. See *Appendix A TTL Signal Pin Assignments*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

Phase Continue: Disable/Enable
Disable: When set to disable, the starting phase angle of every sequence will follow the Degree setting for motion.
Enable: When set to enable, the starting phase angle of every sequence will vary automatically following the last output angle of previous sequence. The Degree of all sequences will be invalid when set to enable.

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

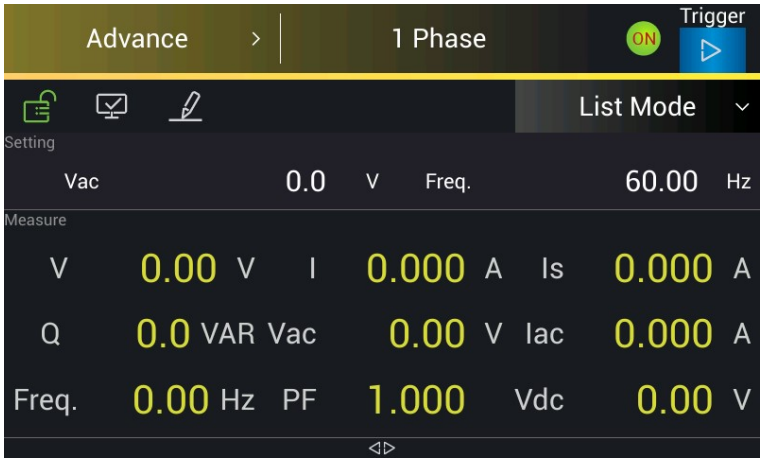
Round Count: The entire sequence execution times, Count = 0: unlimited execution.

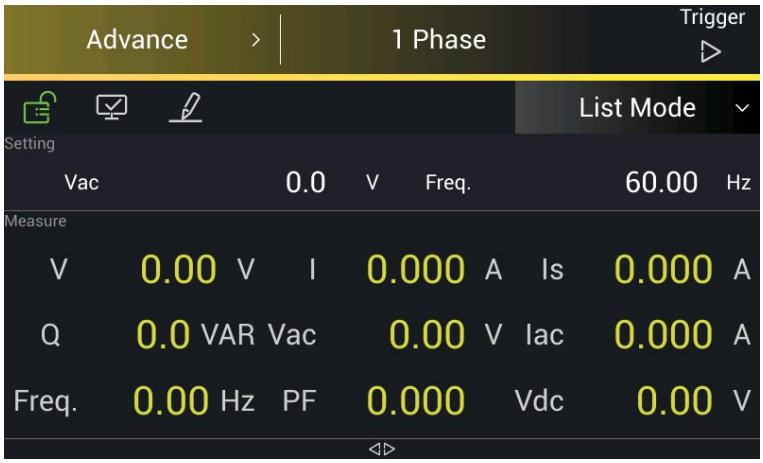
Sequence: Sequence number
The sequence has to start from 0 and the maximum sequence number is 99. The phase difference of the second/third phase and the first phase of Sequence 0 is fixed to differ 120°. Therefore, you cannot use the angle of the second/third phase in Sequence 0.



Degree: The phase angle when the sequence starts.
Vac start, Freq. start, Vdc start: The initial waveform when the sequence starts.
Vac end, Freq. end, Vdc end: The final waveform when the sequence ends.
Waveform= A / B: Select waveform (see 3.5.6.)

After setting the sequences, tap to exit List mode. Tap Trigger on the upper right to trigger the output. The Trigger appears in blue background indicating the List mode is under execution. Meanwhile, the screen will display ON on the top indicating the Regenerative Grid Simulator is ON. At the same time you can tap Trigger to cease the List waveform output. When the Regenerative Grid Simulator finishes all Sequences and Round Counts, the LCD will not display ON message. The Regenerative Grid Simulator will OFF at the same time, as shown below.

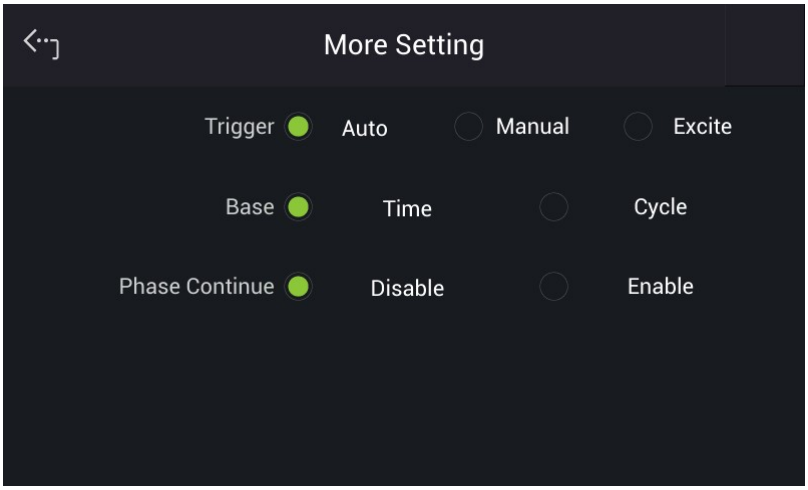




If the Regenerative Grid Simulator is operating, tapping **ON/OFF** will stop the output and the waveform will be set to zero volts. Tap **ON/OFF** again and the Regenerative Grid Simulator only outputs the waveform set in Meas. & Setup (3_Phase Mode/1_Phase Mode) menu. Trigger must be tapped to re-trigger the source.

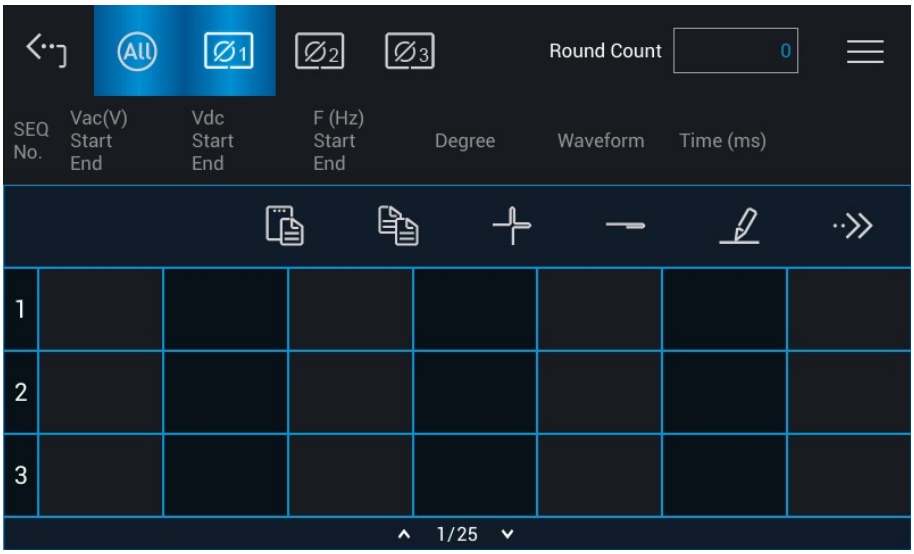
Example of LIST Mode in 1_Phase Mode:

Trigger: Auto, **Base**: Time, **Phase Continue**：Disable



LIST MODE SETTING:

Tap in the sequence setup screen to scroll the menu left. Tap to add a new sequence or to delete a sequence. Tap to start editing the sequence.

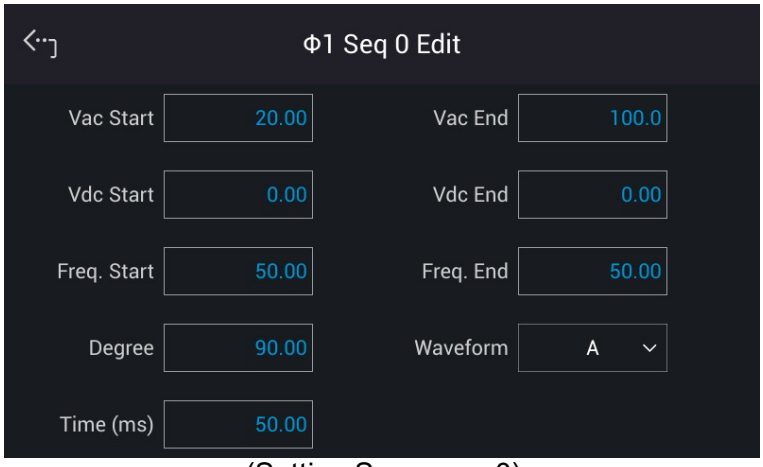


Sequence 0: Vac Start = 20V, Vac End = 100V
Freq. Start = 50Hz, Freq. End = 50Hz
Vdc Start = 0V, Vdc End = 0V
Degree = 90°, Time = 50ms
Waveform = A

Sequence 1: Vac Start = 20V, Vac End = 20V
Freq. Start = 50Hz, Freq. End = 50Hz
Vdc Start = 0V, Vdc End = 100V
Degree = 0°, Time = 50ms
Waveform = A

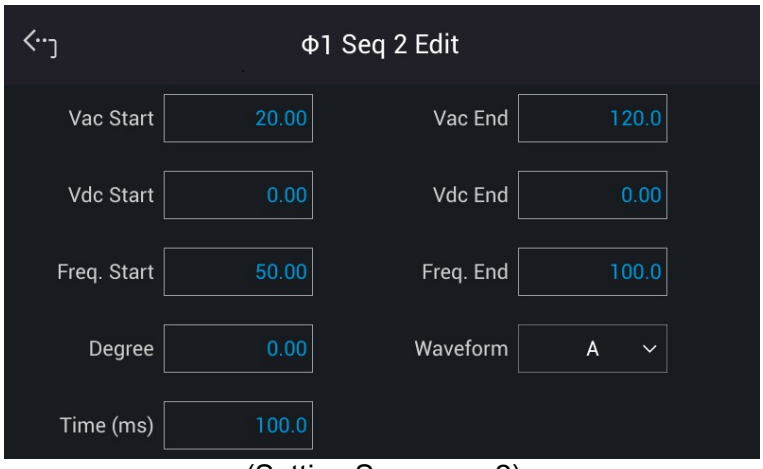
Sequence 2: Vac Start = 20V, Vac End = 120V
Freq. Start = 50Hz, Freq. End = 100Hz
Vdc Start = 0V, Vdc End = 0V
Degree = 0°, Time = 100ms
Waveform = A

Following lists the setting pages of LIST MODE.



(Setting Sequence 0)

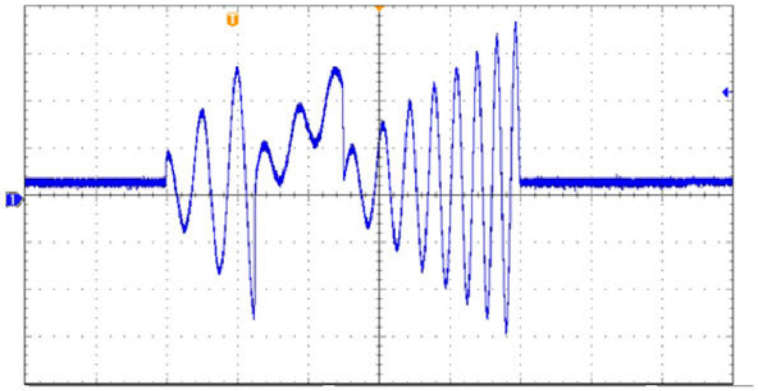
(Setting Sequence 1)



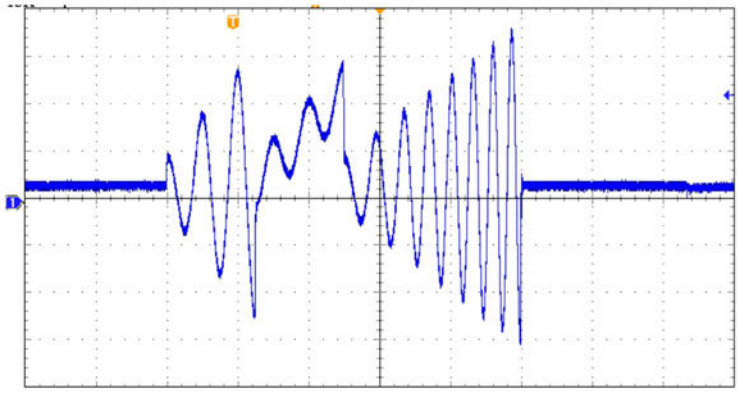
(Setting Sequence 2)

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

Phase Continue Disable:



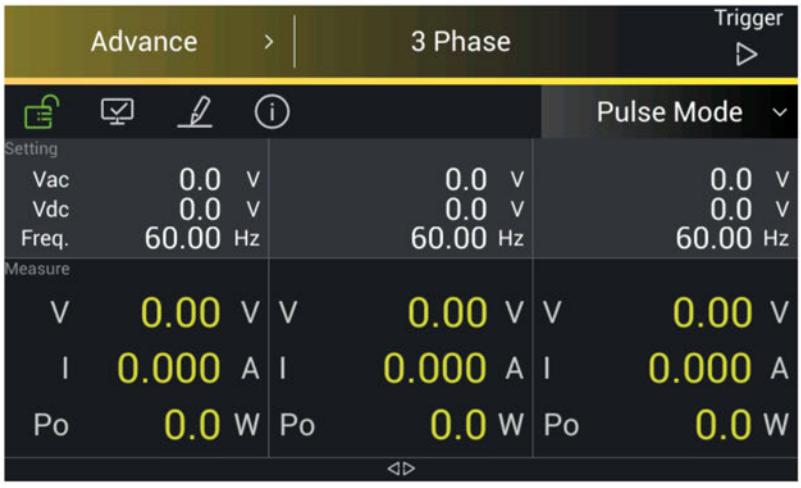
Phase Continue Enable:

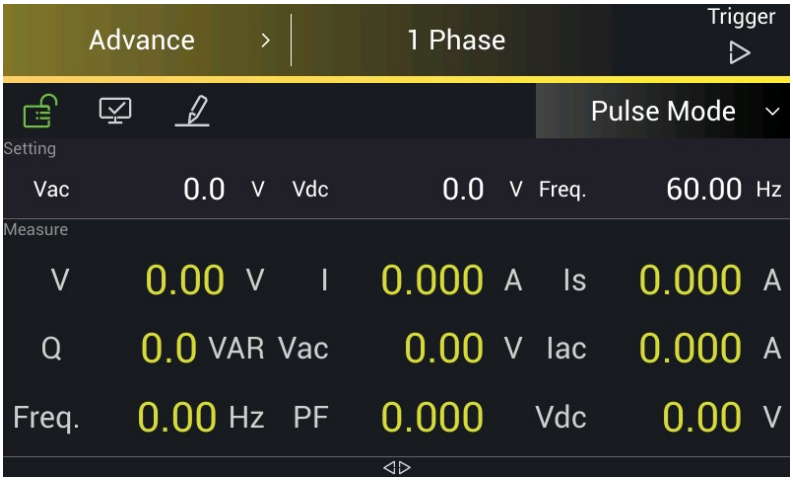


Notice Tap « and swipe left the setup screen in List mode, users can copy and paste the sequence by tapping and .

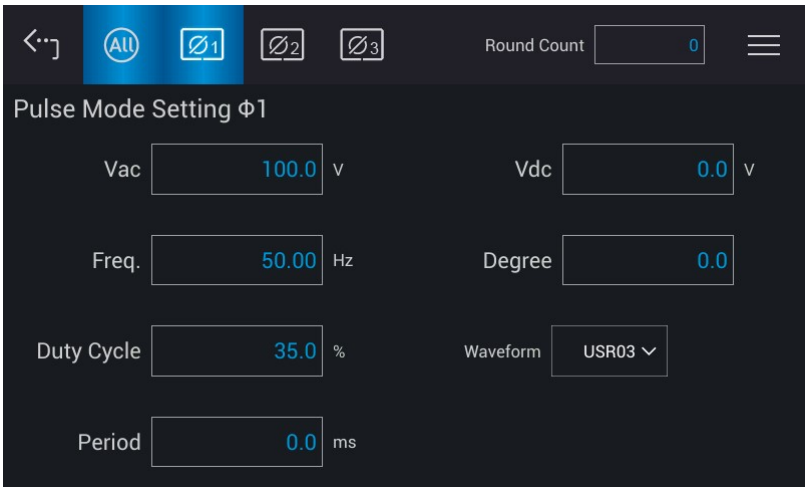
5.3 Pulse Mode

In the Advance main page (as shown in section 5.1), tap the menu on the upper right to enter the Pulse Mode function.

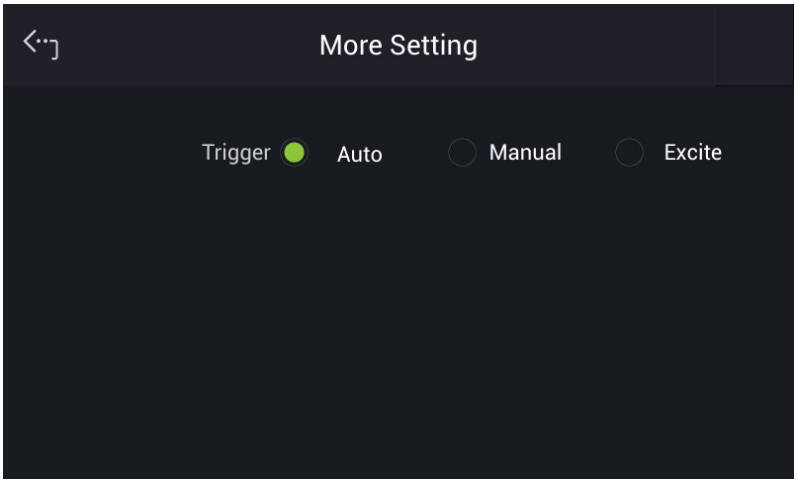




Tap to enter the setup screen.



Tap on the function bar to enter More Setting menu.

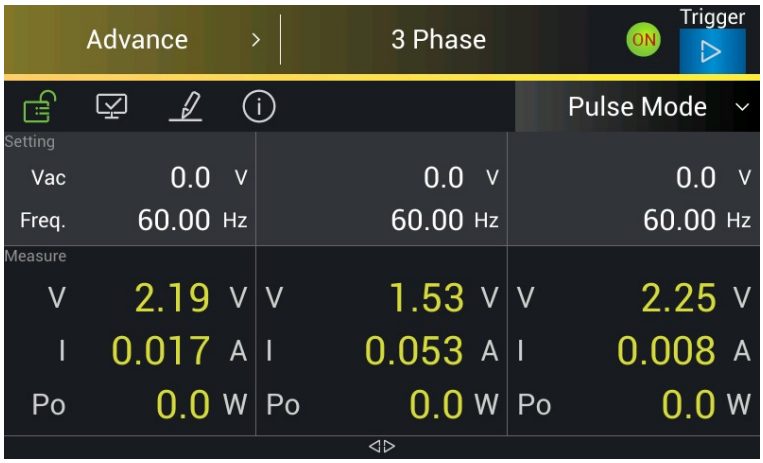


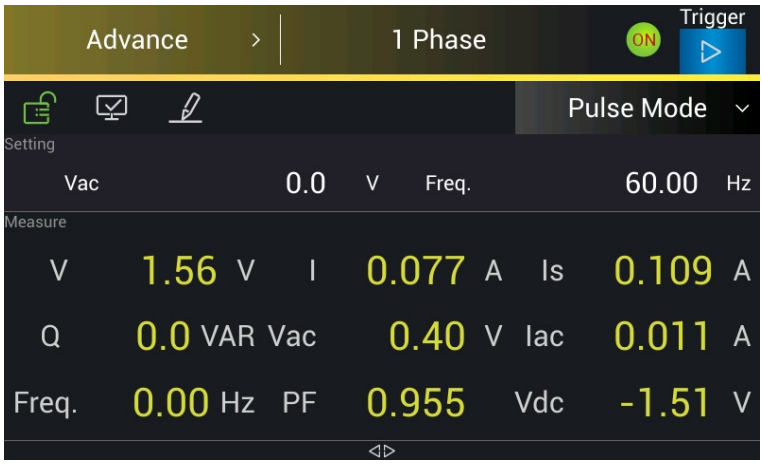
PULSE mode allows users to program a special waveform and add it to the normal output settings in MAIN PAGE. Waveform programming specifies the time ratio and the duty cycle of the pulse voltage.

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

Round Count: The count number of pulse.
Vac, Freq., Vdc: The Vac, Freq. and DC output in pulse voltage.
Duty cycle: The pulse ratio during a duty cycle.
Period: The total length of the duty cycle.
Waveform = A / B: Select waveform (see 3.5.6.)
Degree: The output phase degree of pulse.

After setting the sequences, tap to exit Pulse mode. Tap Trigger on the upper right to enable the output. The Trigger appears in blue background indicating the Pulse mode is under execution. The screen will also display on the top indicating the Regenerative Grid Simulator is ON. At the same time tapping the Trigger key again will cease the Pulse waveform output. When the Regenerative Grid Simulator finishes all Sequences and Round Counts, the LCD will return to its initial state. The Regenerative Grid Simulator will turn OFF as shown below.





If the Regenerative Grid Simulator is under operation, tapping **ON/OFF** will stop the output and the waveform will be set to zero volts. Tap **ON/OFF** again and the Regenerative Grid

Simulator will output the waveform set in Meas. & Setup (3_Phase Mode/1_Phase Mode) main page. Trigger must be tapped to restart the source.

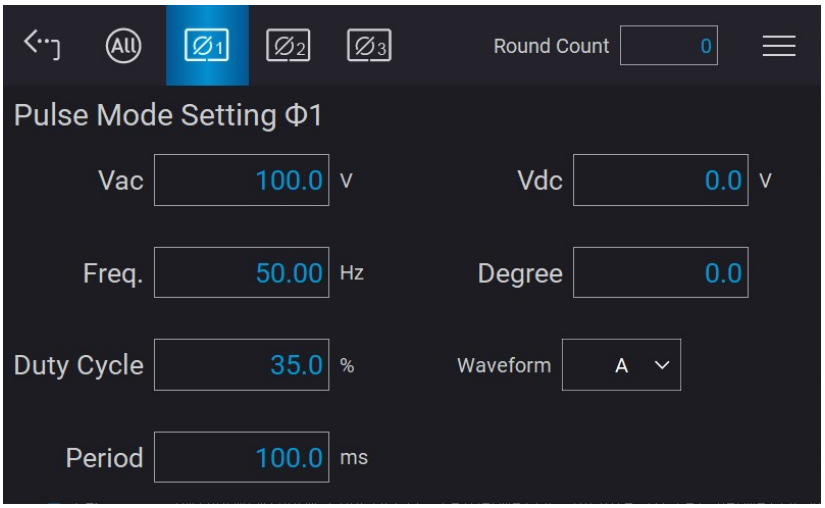
Example of PULSE Mode in 1_Phase Mode:

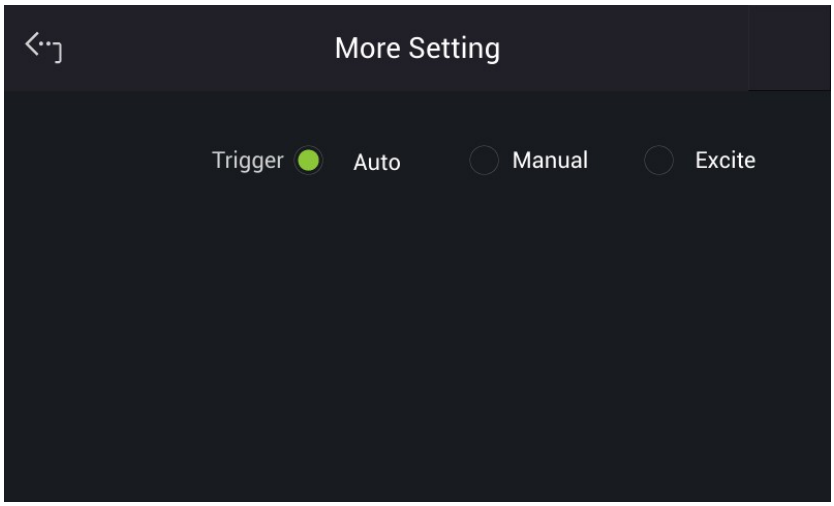
OUTPUT SETTING: Vac = 50V, F = 50Hz

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

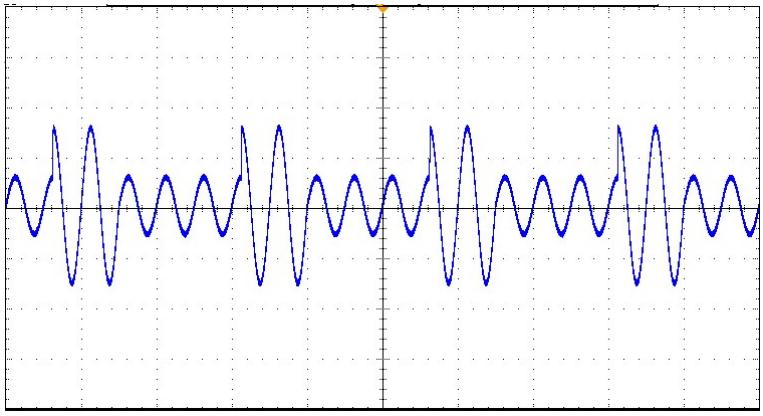
Trigger: Auto, **Round Count**: 0

The following lists the setting pages of PULSE MODE.





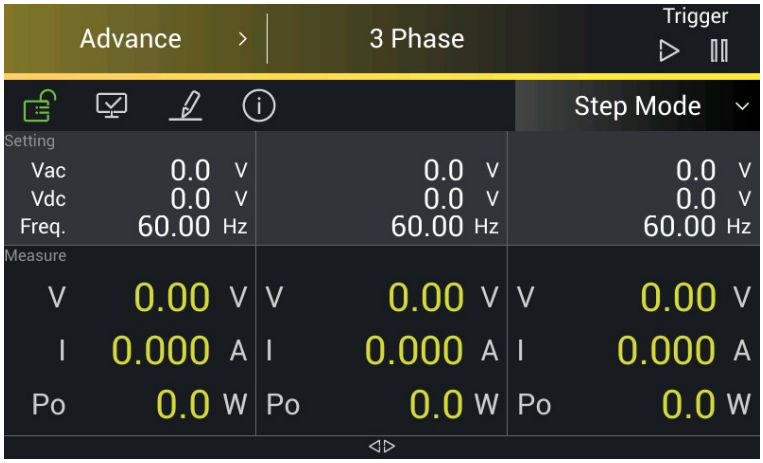
The trigger waveform when the settings are complete is shown below:

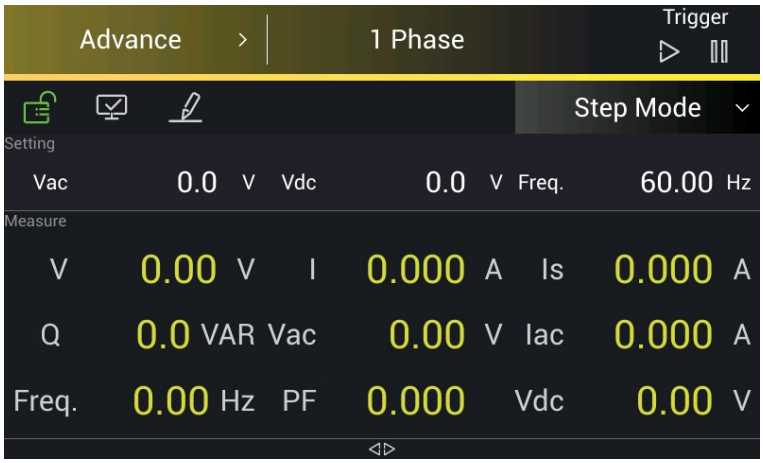


Notice The Degree function in Pulse mode can only trigger the pulse mode angle once. To trigger the pulse mode for the same angle every time, use the List mode.

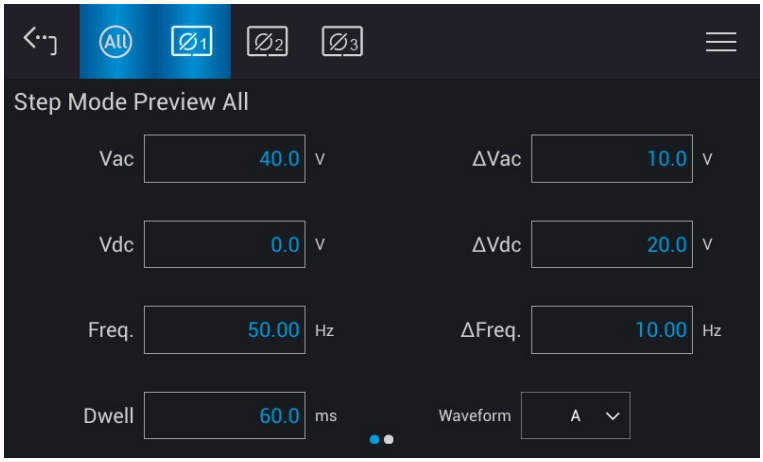
5.4 Step Mode

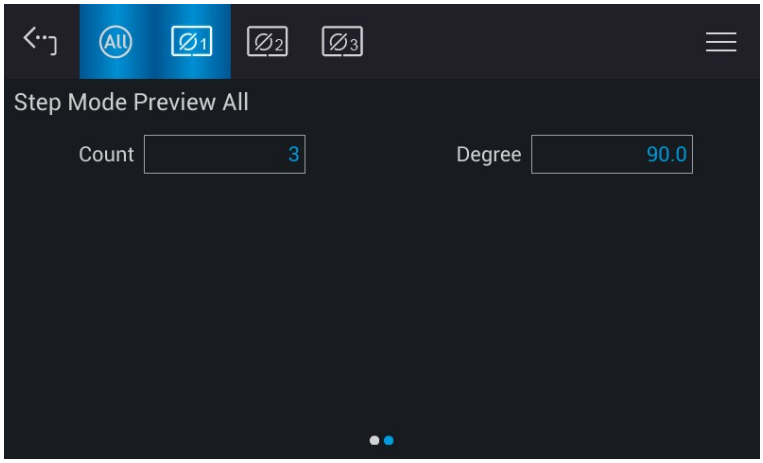
In the Advance main page (as shown in section 5.1), tap the menu on the upper right to enter the Step Mode function.



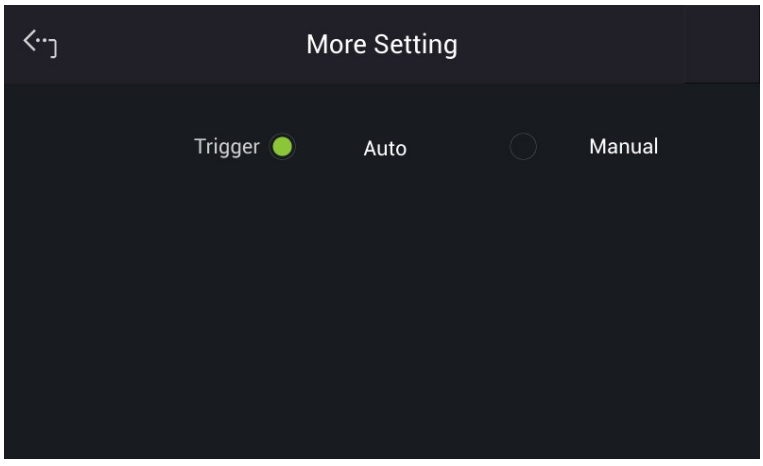


Tap to enter the setup screen.





Tap on the function bar to enter More Setting menu.



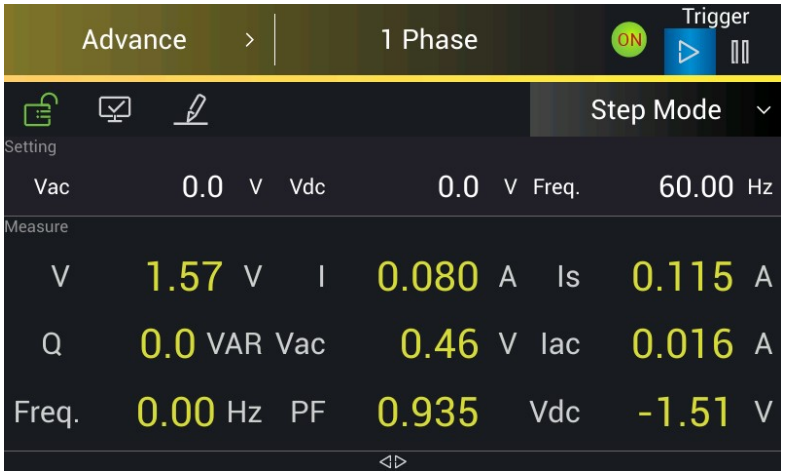
STEP Mode provides a simple auto switch function to change the output voltage by stepping. Waveform programming sets the item with an initial voltage, specifies the dwell time and the change of each step as well as the step number. The output voltage will return to the last state after execution.

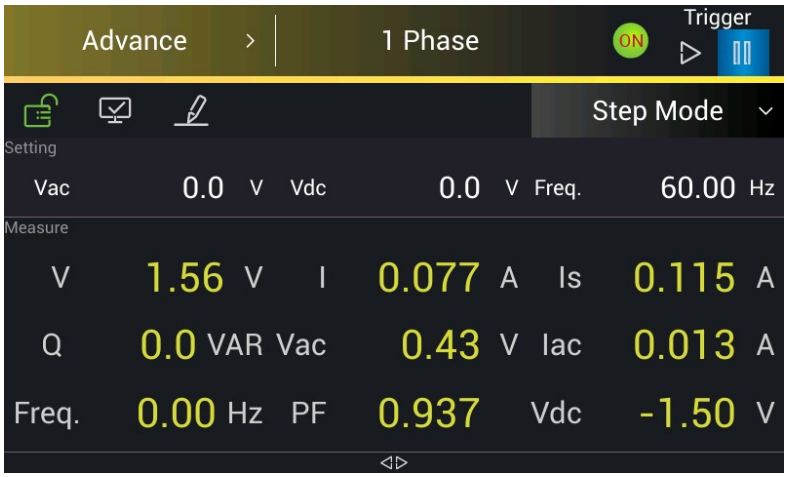
Trigger method: Auto / Manual
Auto: Finishes all counts when triggered.

Manual: The output voltage changes every time it operates.

Count: The count number of each change.
Dwell: The time for each step.
Vac, Freq., Vdc: The Vac, Freq., DC initial value when STEP mode starts.
ΔVac, ΔFreq., ΔVdc: The difference value of each step. (It can be negative.)
Waveform = A / B: Select waveform (see 3.5.6.)
Degree: The output phase angle of each step.

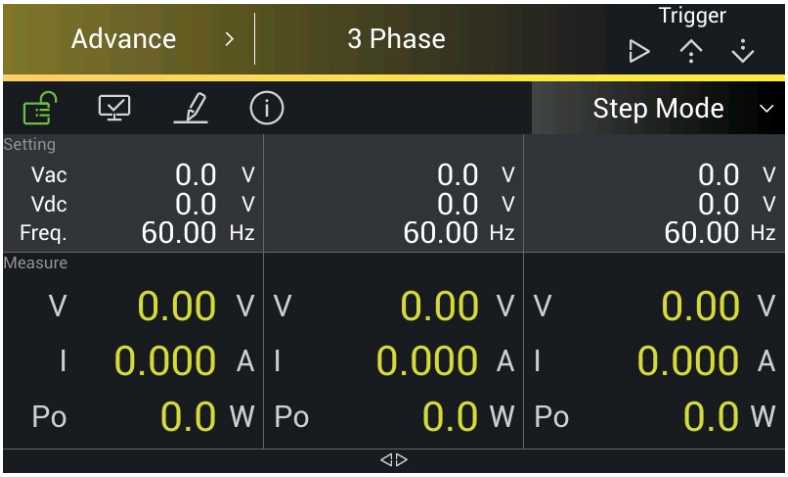
Tap to enter the STEP mode. Tap Trigger on the upper right to trigger the output. The Trigger appears in blue background indicating the Step mode is under execution. Meanwhile, the screen will display ON on the top indicating the Regenerative Grid Simulator is ON. Tap Trigger again to stop the waveform and change to the next STEP. Pause keeps the STEP waveform at the current value until Pause is tapped again. When the Regenerative Grid Simulator finishes all Counts, the LCD will return to its initial state and the Regenerative Grid Simulator will turn OFF.





If the Regenerative Grid Simulator is on, tapping **ON/OFF** will stop the output and set waveform to zero volts. Tap **ON/OFF** again and the Regenerative Grid Simulator will output the waveform set in MAIN PAGE. Trigger must be tapped to restart the source. If the Regenerative Grid Simulator is not on tap **ENTER** key to output the STEP waveform.

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 previous voltage if the Trigger DOWN is selected.

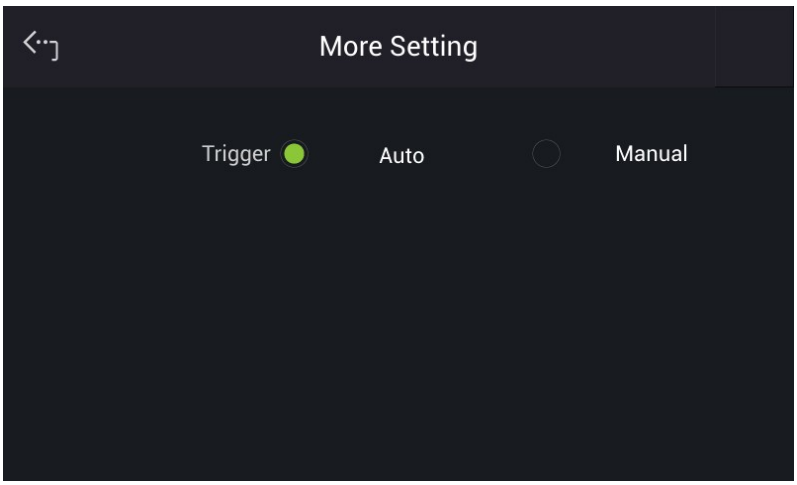


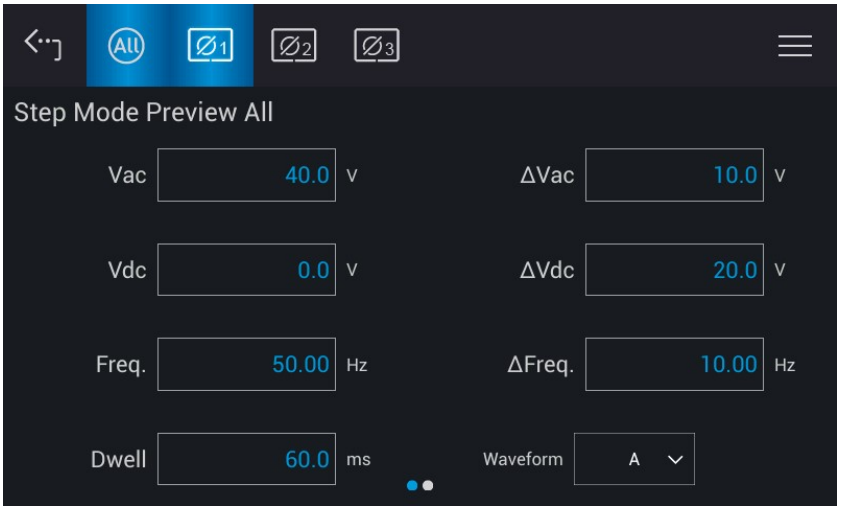
Example of STEP Mode in 1_Phase Mode:

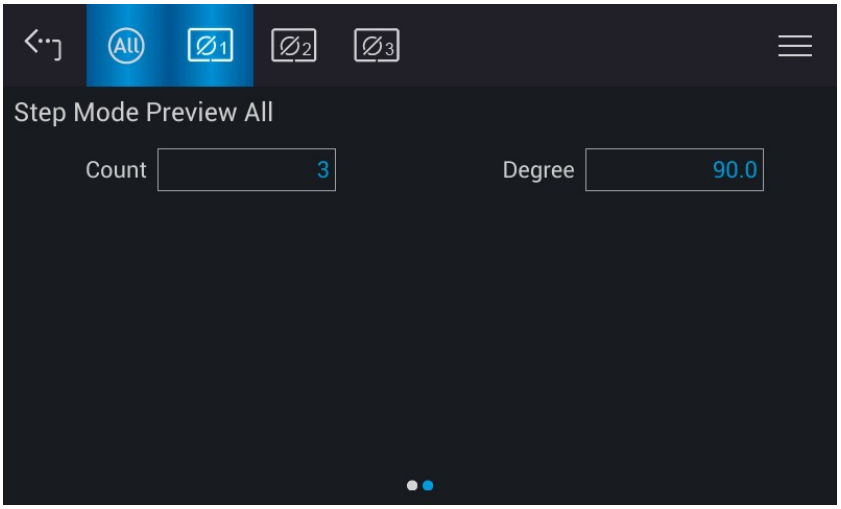
Trigger: Auto

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

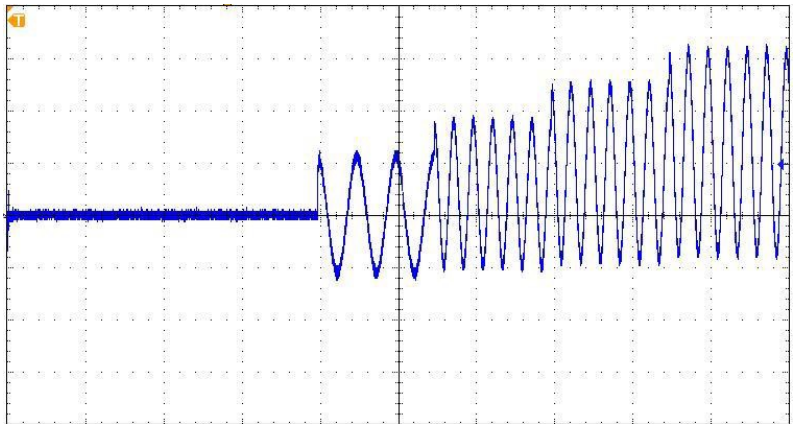
Following lists the setting pages of STEP MODE.





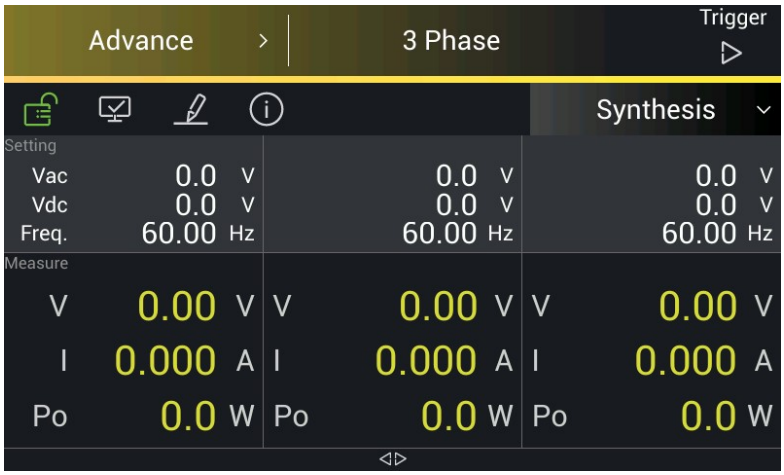


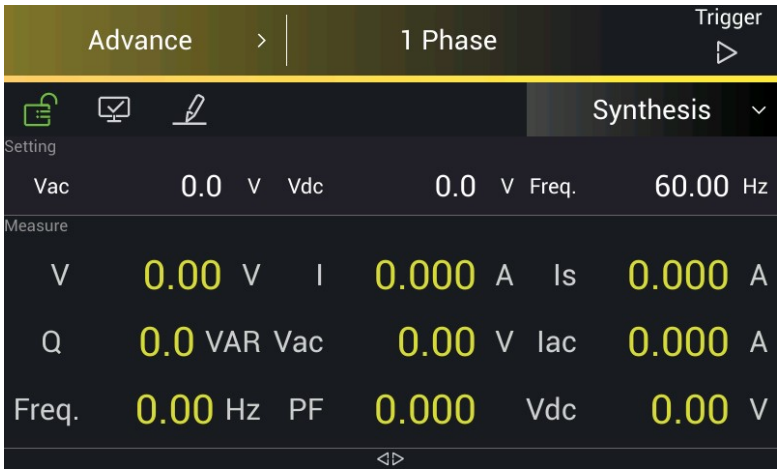
The trigger waveform for above settings
:



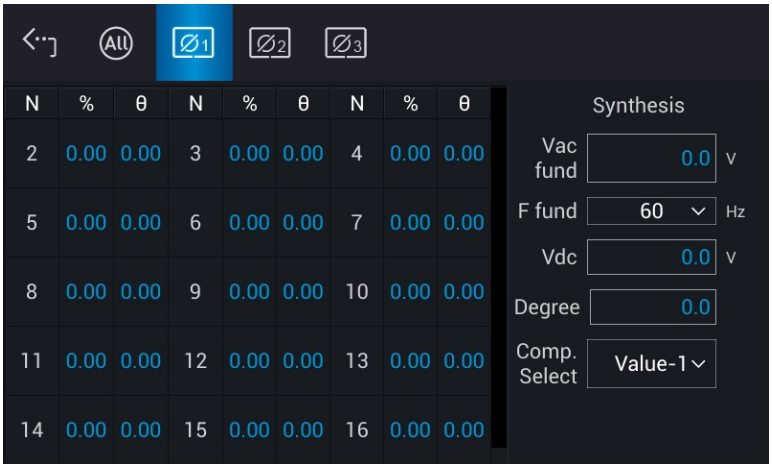
5.5 Synthesis Waveform

In the Advance main page (as shown in section 5.1), tap the menu on the upper right to enter the Synthesis function.



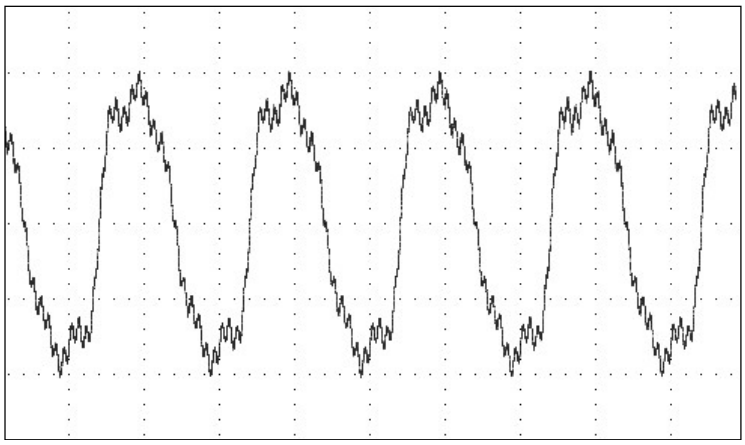


Tap to enter the setup screen.



The 61800 Series Regenerative Grid Simulator provides a Synthesis function to create complex waveforms. The harmonic components range up to 50 orders with the fundamental

frequency limited to 50Hz or 60Hz. Users can program the size and phase angle of each order easily on the LCD. The following is an example of a 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.

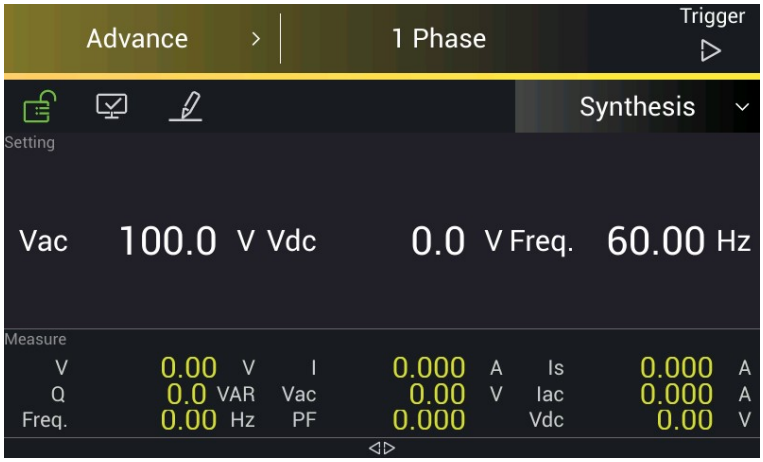
Users can program 6 types of synthesis waveform to execute or save.

Vac fund.: The fundamental frequency voltage, the maximum is limited by the RANGE setting.
F fund. = 50 / 60Hz: The fundamental frequency.
Vdc: The DC voltage component.
Degree: The start angle of the output waveform.

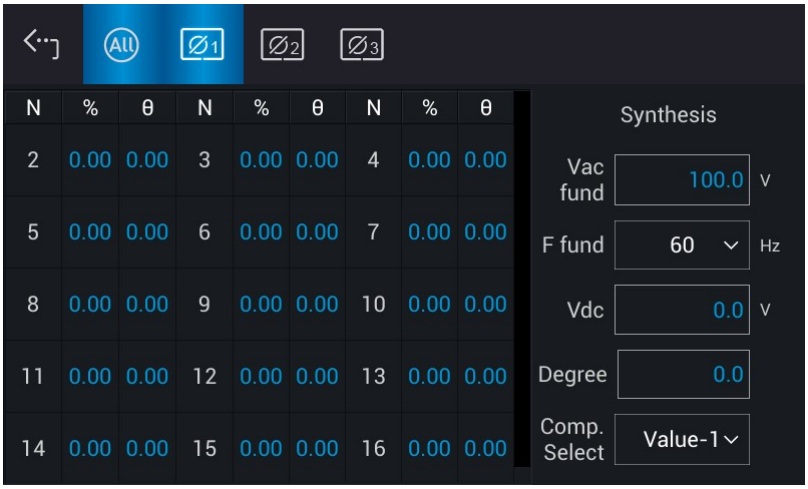
The following is an example of using Synthesis Mode in 1_Phase Mode:

Tap to enter the editing screen. Select the desired column and use the numeric buttons to enter the setting. Tap to complete the input. The example uses the following settings:

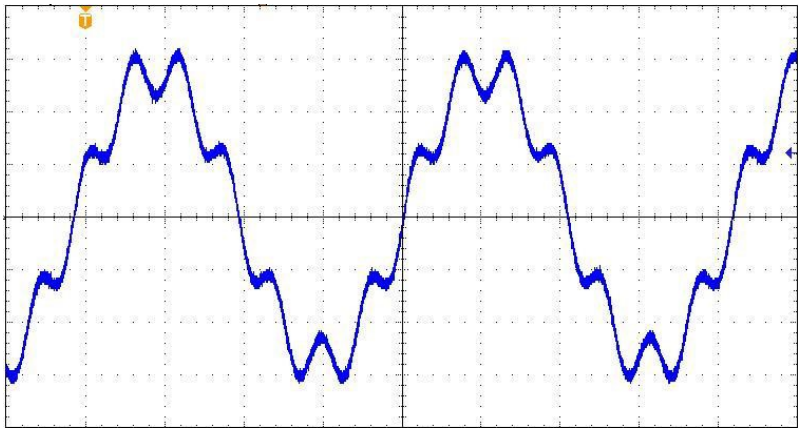
OUTPUT SETTING: Vac = 100V, F = 60Hz



Compose = Percent-1
Edit = Φ1
Vac fund. = 100.0V
F fund. = 60Hz
Vdc = 0.0V
Degree = 0.0°



Tap to return to the Synthesis main page. Waveform for the above settings is shown below.



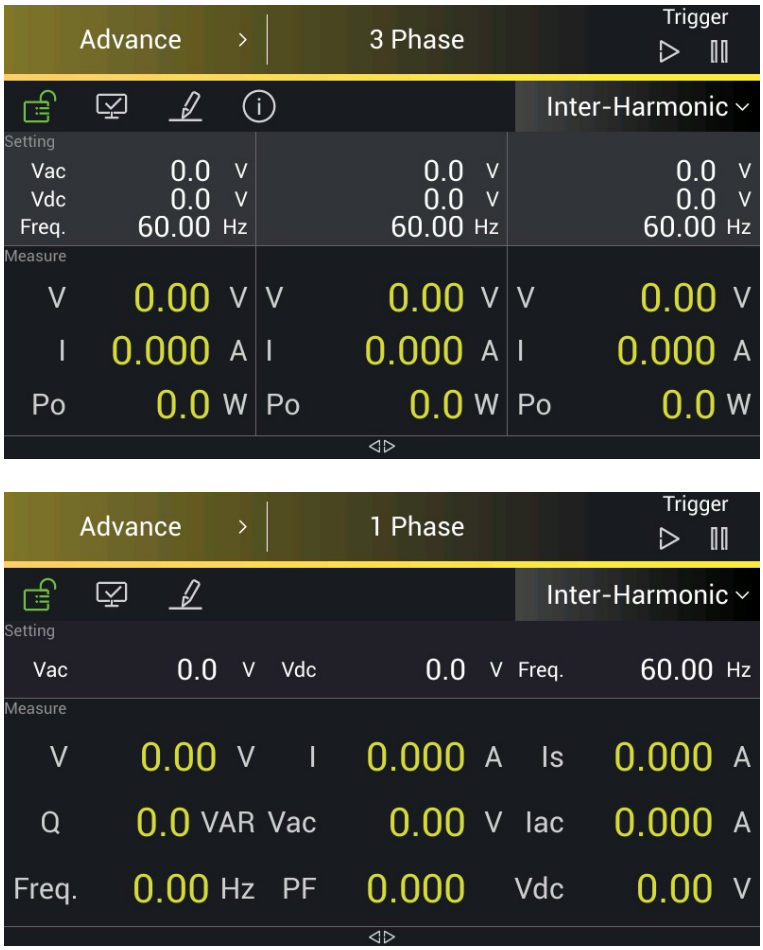
The figure above is the output voltage waveform as measured by an oscilloscope.

Notice

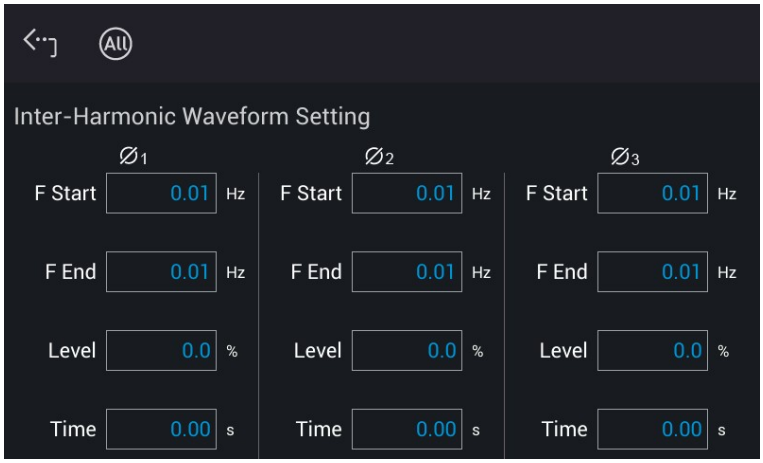
1. In order to protect the Regenerative Grid Simulator from damage, it is necessary to limit the synthesis values and percentage as follows:
   2 ≤ order ≤ 10, value ≤ 90V or percentage ≤ 30%.
   11 ≤ order ≤ 20, value ≤ 60V or percentage ≤ 20%.
   21 ≤ order ≤ 40, value ≤ 30V or percentage ≤ 10%.
   41 ≤ order ≤ 50, value ≤ 15V or percentage ≤ 5%.
2. If the synthesis waveform exceeds the voltage limit, OUTPUT overvoltage (OVP) or DST Protection will occur.

5.6 Inter-Harmonic Waveform

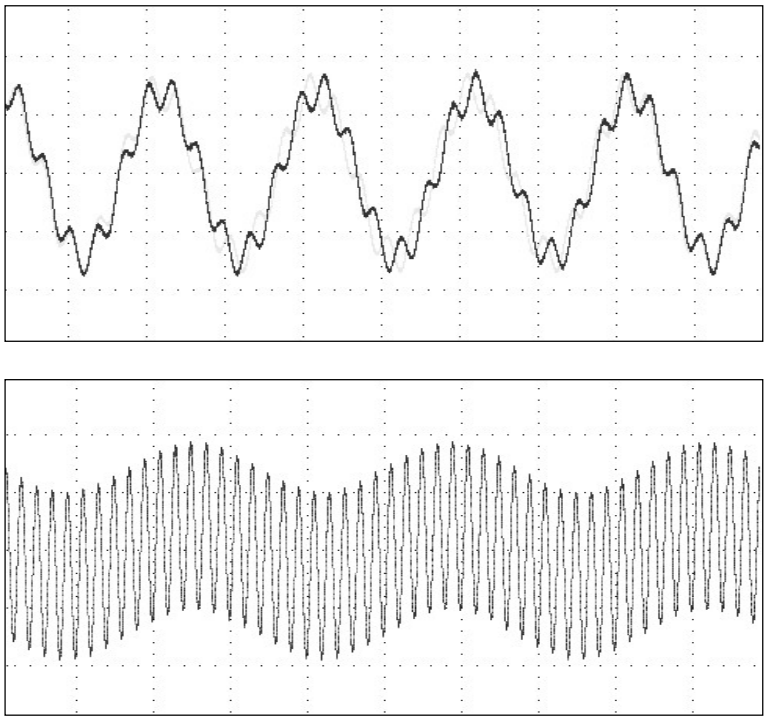
In the Advance main page (as shown in section 5.1), tap the menu on the upper right to enter the Inter-harmonics function.



Tap to enter the setup screen.



For the Regenerative Grid Simulator Inter-harmonic function, fundamental voltage output, an additional frequency of variable and voltage components are added to test create anti-interference waveforms. The following is an example of inter-harmonic waveform:

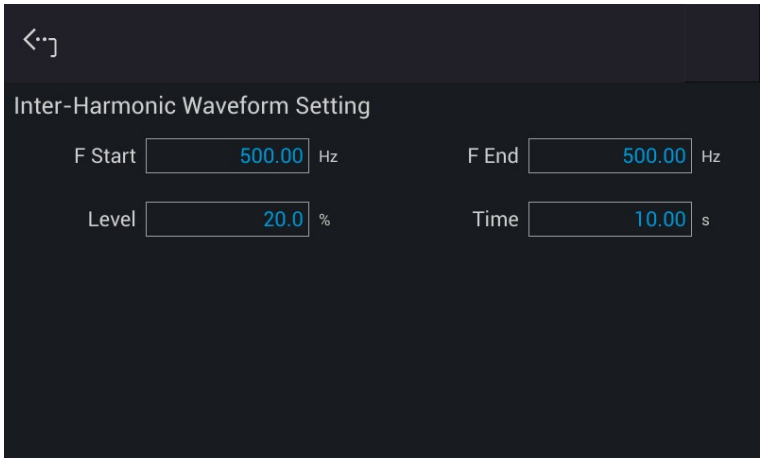


F start: The start frequency of scanning wave. The range is 0.01Hz ~ 3000Hz.
F end: The end frequency of scanning wave. The range is 0.01Hz ~ 3000Hz.
Level: The rms of scanning wave that is the percentage of fundamental voltage set in Advance main page.
Time: The scanning time from F start to F end.

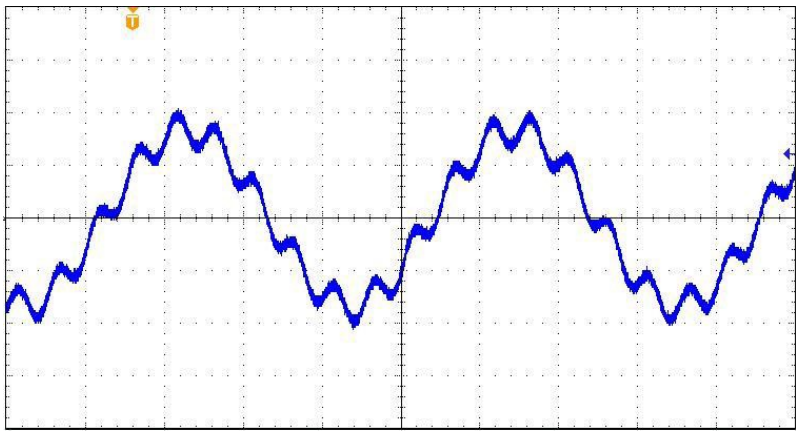
The following is the example of using Inter-harmonics Mode in 1_Phase Mode:

Tap to enter the editing screen. Select the desired column and use the numeric buttons to enter the setting. Tap to complete the input. 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



Tap to return to the Inter-harmonics main page, and tap Trigger on the upper right to output the waveform.



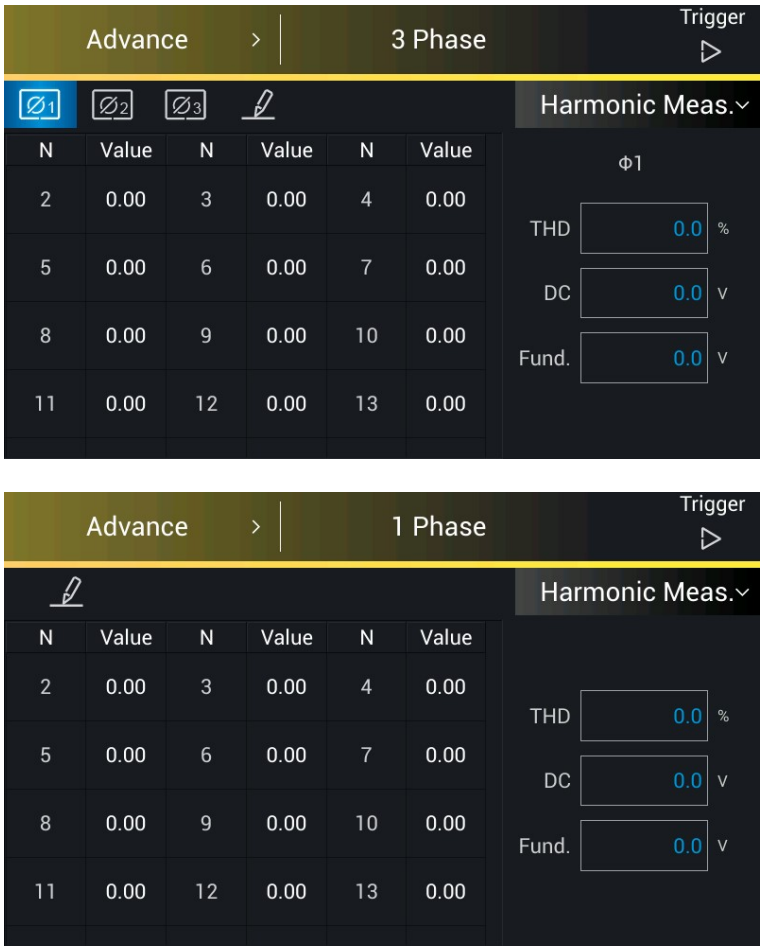
The figure above is the output voltage waveform of the Regenerative Grid Simulator as measured by an oscilloscope for the above example.

Notice

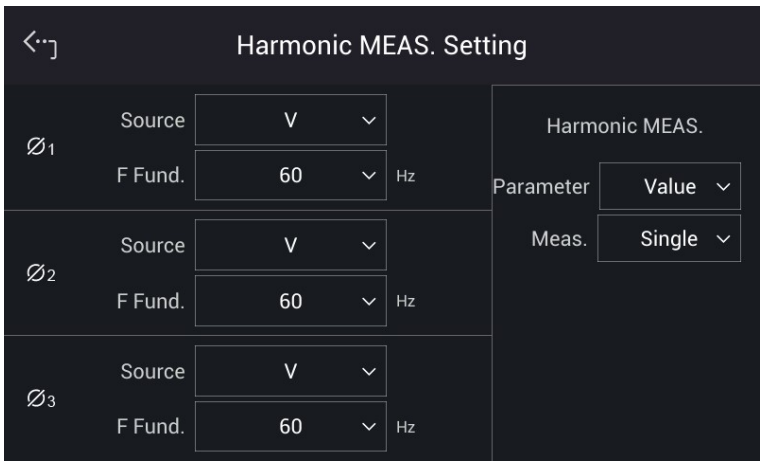
1. In order to protect the Regenerative Grid Simulator from damage it is necessary to limit the start and end Frequency Levels.
   * If 0.01Hz ≤ F start or F end ≤ 500Hz, Level ≤ 30%.
   * If 500Hz < F start or F end ≤ 1000Hz, Level ≤ 20%.
   * If 1000Hz < F start or F end ≤ 2400Hz, Level ≤ 10%.
   * If 2400Hz ≤ F start or F end ≤ 3000Hz, Level ≤ 5%.
2. If the inter-harmonics waveform is over the voltage limit, OUTPUT overvoltage (OVP) or DST Protection will occur.

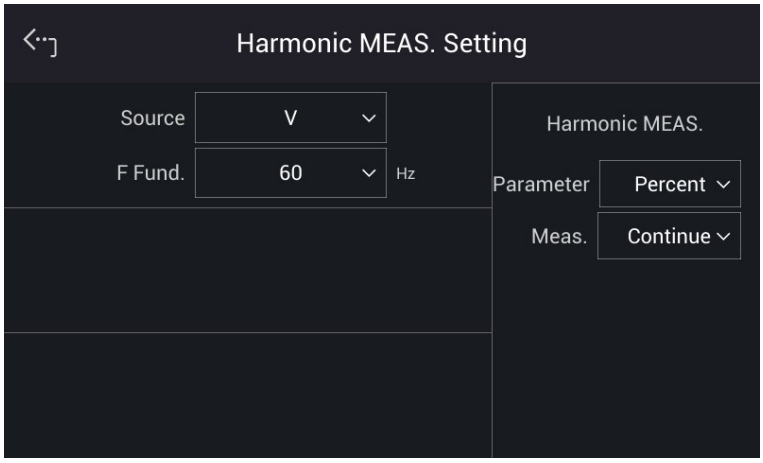
5.7 Harmonic Waveform

In the Advance main page (as shown in section 5.1), tap the menu on the upper right to enter the Harmonic Meas. function.



Tap to enter the setup screen.





This function can measure the Total Harmonic Distortion (THD) of the fundament frequency 50Hz or 60Hz, the DC current, and the fundamental frequency of output current or voltage, it can measure 2 ~ 50 orders of harmonic values.

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

F fund. = 50 / 60 Hz: The fundamental frequency of source signal.

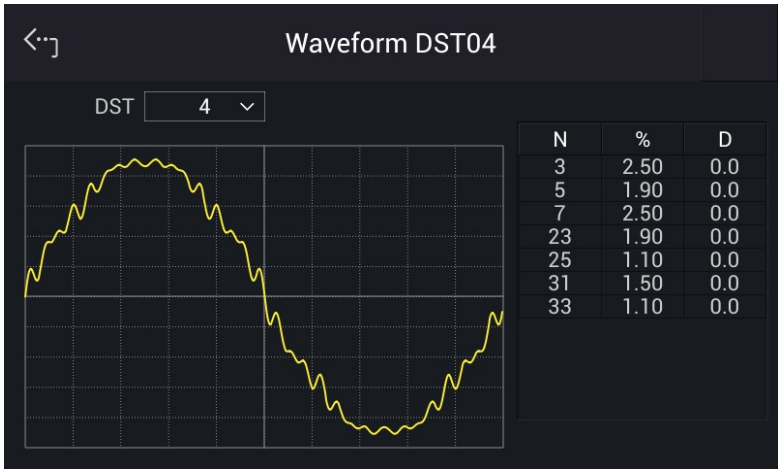
Parameter = Percent / Value: The data form of each harmonic component.
Percent: The percentage of fundament frequency value.
Value: The absolute value.

Measurement = Single / Continue: The way the measurement result displays on LCD.
Single: The display will keep the measured data when set. It takes about 3 seconds to get the results.
Continue: The display updates the measured data when set. It takes about 10 seconds to get stable results.

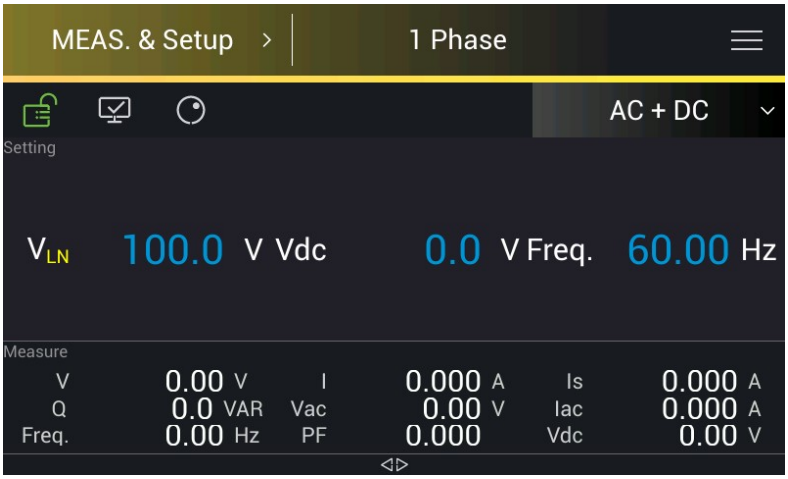
The following is an example of using Harmonic Meas. in 1_Phase Mode:

Set the Waveform A to DST04 waveform (see section 3.5.6).

When the waveform setting is done, tap waveform to view the output waveform, the ratio of each harmonic order and the output angle.



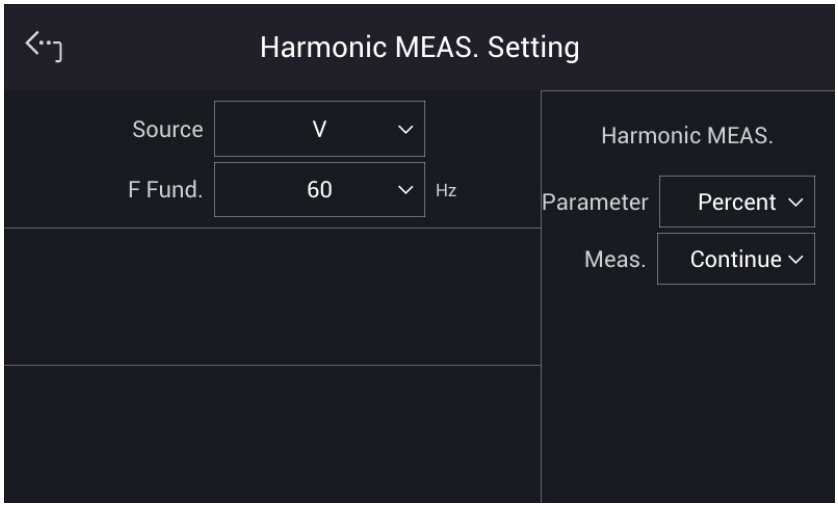
In Meas. & Setup (3_Phase Mode/1_Phase Mode) main page, set the Vac to 100.0V and then tap **ON/OFF** to enable the waveform.



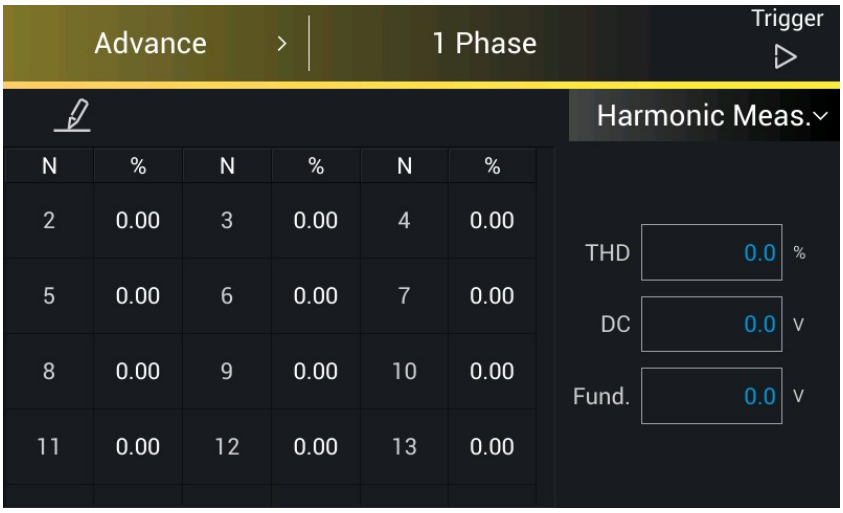
Tap MENU and select Advance, using the drop-down to enter Harmonic Meas.

Tap to enter the editing screen. Select the desired column and use the numeric buttons to enter the setting. Tap to complete the input. The example uses the following settings:

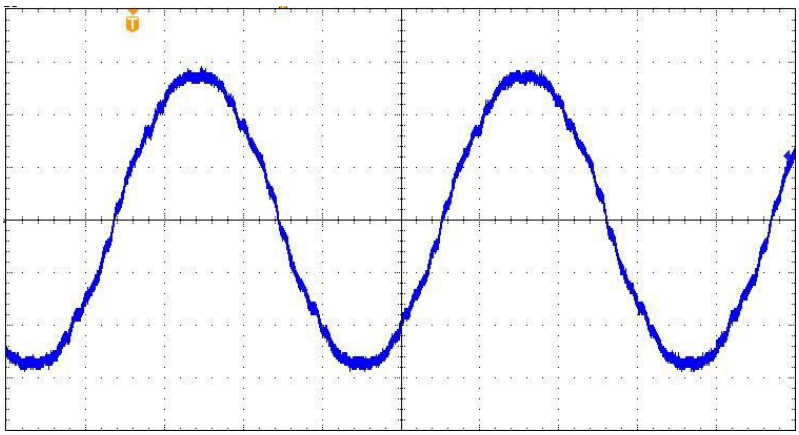
Source = V
F fund. = 60 Hz
Measurement = Continue
Parameter = Percent



Tap to return to the Harmonic Meas. main page, and tap Trigger to perform the output voltage harmonic measurement.



After triggering, tap the icons on the top to view the measurements for each phase.



Output voltage waveform of the Regenerative Grid Simulator measured by an oscilloscope for the above settings.

Notice

When the Trigger key is tapped the current harmonic measurement will adjust the internal gain automatically by the measured data so that the Regenerative Grid Simulator achieves more accurate data for each harmonic. Thus, it is better to wait for the load to be stabilized before executing the harmonic measurement. In addition, the load cannot be changed during measurement or some data may lost and/or cause an over current protection.

6. Parallel Operation

6.1 Signal Cable Connection for Parallel Mode

6.1.1 Connecting Cable for Two Units

When the Regenerative Grid Simulators are used in parallel mode, a parallel communication cable is required to transmit the data. The connection is shown below.

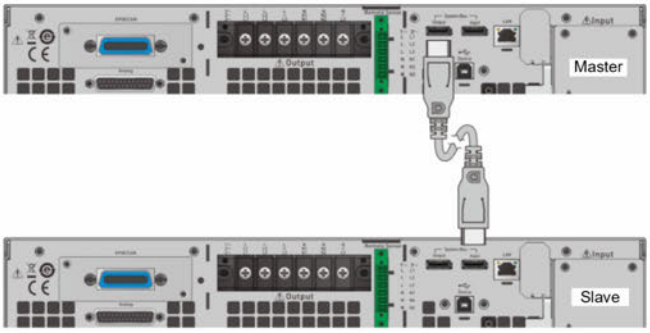


Figure 6-1 Diagram for Connecting Two Units in Parallel

6.1.2 Connecting Cables for Three Units

When the Regenerative Grid Simulators are used in parallel mode, two parallel communication cables are required to transmit the data. The connection is shown below.

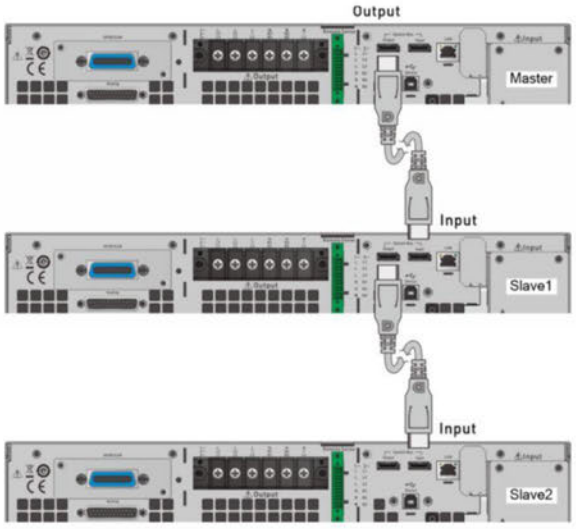


Figure 6-2 Diagram for Connecting Three Units in Parallel

Notice

1. When multiple simulators are operated in parallel, the coupling of Master and Slave must be conducted under the same conditions. It is forbidden to change settings between operations, otherwise it will cause error output.

2. When the 61800 series are operated in parallel, the maximum output current per phase is 315A as shown in Table 6-1.

Table 6-1

61800 Series Model	Parallel Mode	
	Max. Parallel No.	Max. Output Current (A) per Phase
61809	3	261
61812	3	288
61815	3	315

3. Different models cannot be paralleled for use.
4. When parallel is in use, make sure the capacity of the circuit breaker is sufficient, and the power cord earth wire is connected to the same point and grounded correctly.
5. Same models in the 61800 series can be connected in parallel, and the maximum number is 3 units. When more than 3 units are planned for paralleling, please contact the sales service or agents of CHROMA.

6.2 Settings

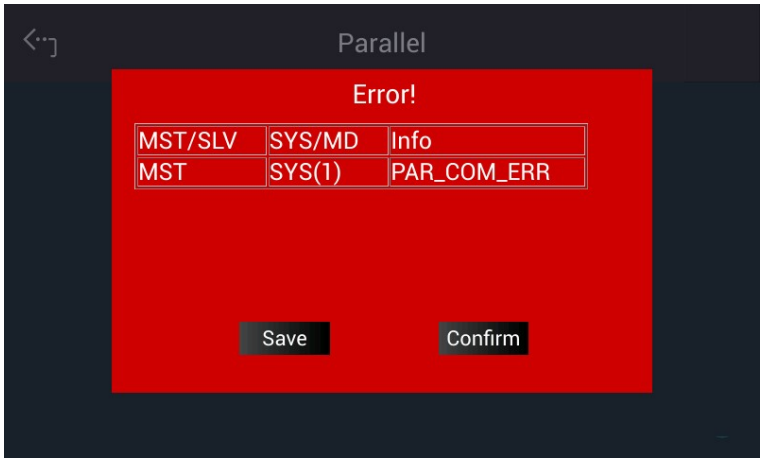
See section 3.4.3 for detailed setting information.

6.3 Troubleshooting

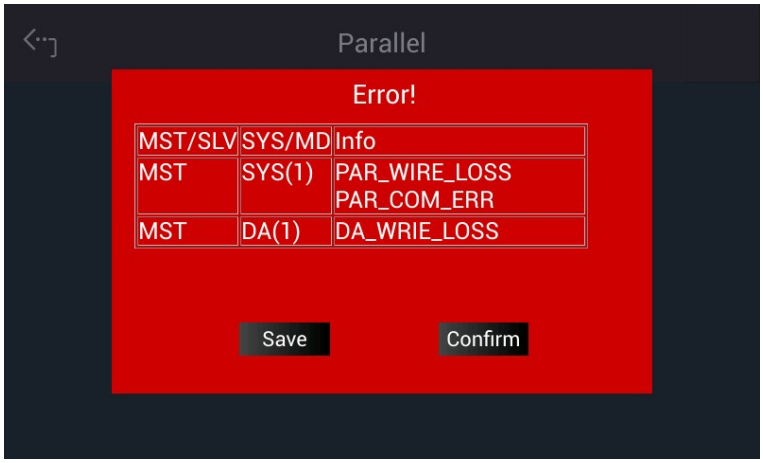
When paralleling multiple devices, each device must have a parallel cable to transmit the signals. When the Slave number is set incorrectly an error message will result, follow the procedure below for troubleshooting and re-execute parallel/series connection as needed.

6.3.1 BUS Wire Loss

If "SYS_PAR_COM_ERR" occurs when enabling the Master connection, check to see if the parallel/serial cable is properly connected and the fixture for parallel/series connection is properly installed. Also check to see if regenerative grid simulator is set to Slave.



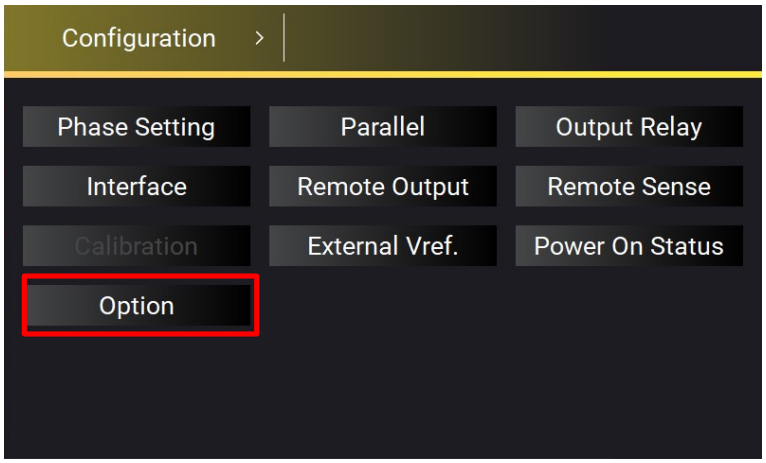
If the parallel/series cable is not connected properly or disconnected when enabling the Master connection, a “SYS_PAR_WIRE_LOSS” a warning will appear. In this case, turn the device off first and check if the parallel/serial cable is connected firmly and reboot.

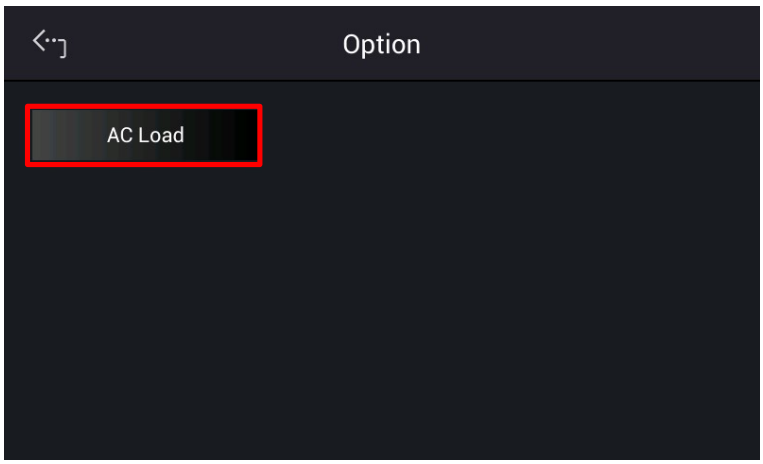


7. Regenerative AC Load Mode (Option)

7.1 Switching to AC Load Mode

Using the “Option” function in the Configuration menu and the steps listed below can switch a Regenerative Grid Simulator to AC load mode.





1. Tap “Configuration” menu.
2. Tap “Option” to enter the Option menu.
3. Tap “AC Load”.

Notice

The model 61815 needs to parallel with multiple devices via Soft Panel in order to use the Load function due to different transmission mechanisms. (Up to 3 units can be paralleled, see section 7.7 for the setting.)

7.2 AC Load Function Interface

When in AC load mode, the screen shows MAIN PAGE (3_Phase Mode/1_Phase Mode). There are CC Rectifier, CS Rectifier, CR, CC Lead/Lag and CS Lead/Lag 5 functions on the upper right for selection. The regenerative AC load measurement items are displayed under Meas. area. Each output phase has 15 measurement items in total 3 pages which are the

same as the Regenerative Grid Simulator (see section 3.3.2). When powered on, the regenerative AC load can be manually operated following the command tree diagram shown in Figure 7-1.

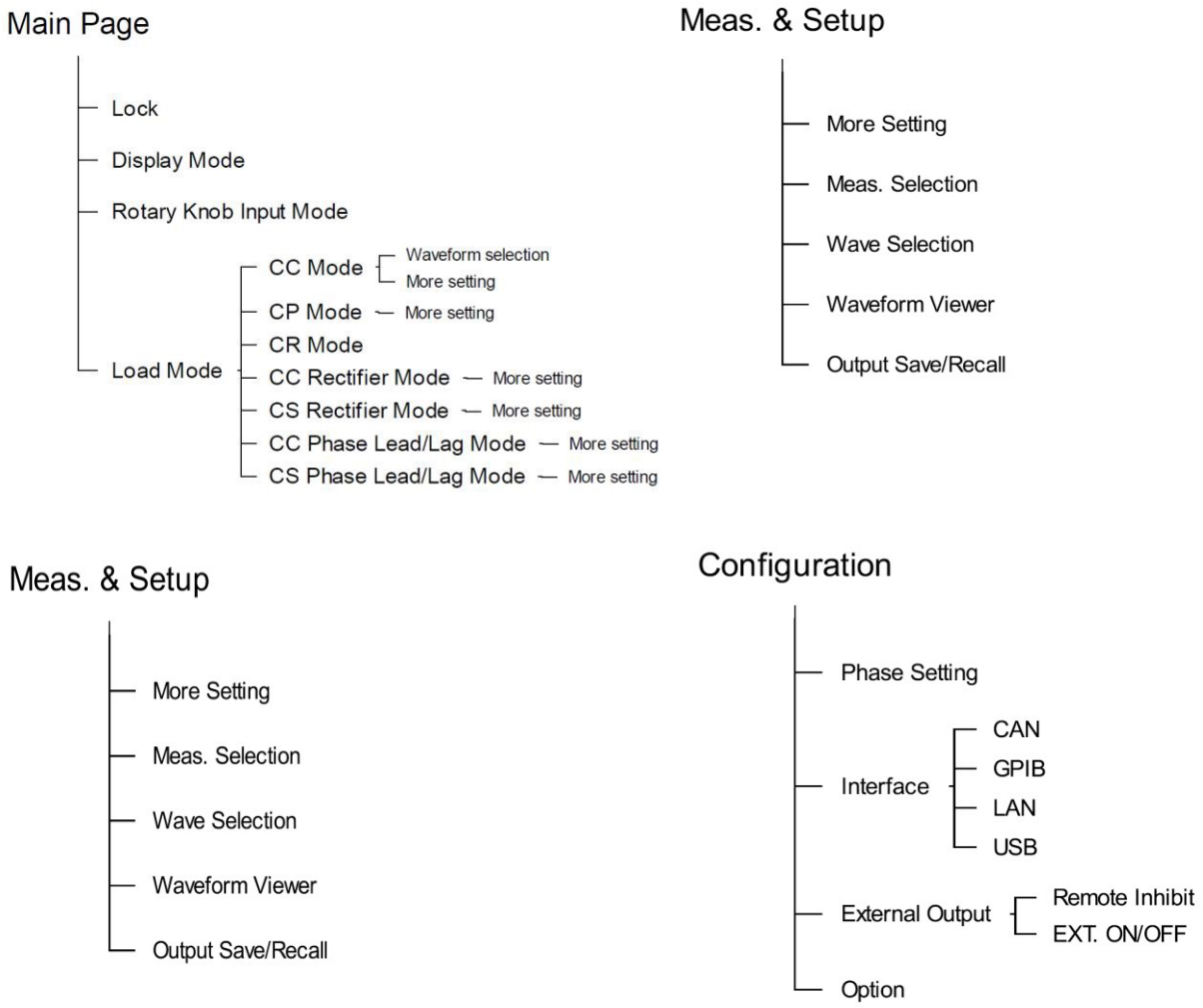


Figure 7-1

7.3 Relationship between Crest Factor and Power Factor

The crest factor is the peak current divided by the root mean square (RMS) current. When the crest factor is set to 1.414, it means that the DSP will produce a sine current waveform.

The definition of power factor is the real power divided by the apparent power. If the PF is different from the set value, the DSP will correct the position of the current waveform to match the PF value. For resistive loads, the power factor is 1. If the values of V_{rms} and I_{rms} are constant, the decrease of power factor is due to the increase of crest factor, and the effective product of voltage and current will also decrease as well.

The following relationship between PF and CF is based on the voltage waveform whose input voltage is a sine wave, because the estimation theory is based on the input voltage

waveform and the current waveform is a sine wave or a corrected sine wave. The maximum power factor of a fixed crest factor is occurred at the maximum overlap of the input voltage waveform and the current waveform. In other words, the peaks of voltage and current occur at the same time. The minimum power factor occurs at the minimum overlap of the input voltage waveform and the current waveform. In other words, the zero-crossing points of the voltage and current waveforms are the same as shown in Figure 7-2 and Figure 7-3.

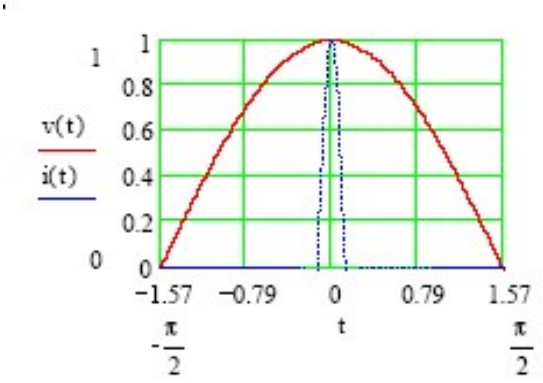


Figure 7-2 The Maximum PF Passing the Fixed CF

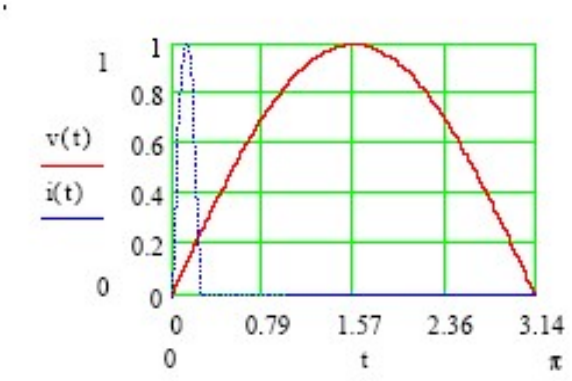


Figure 7-3 The Minimum PF Passing the Fixed CF

According to theory, the relationship between maximum PF and CF is shown in Figure 7-4

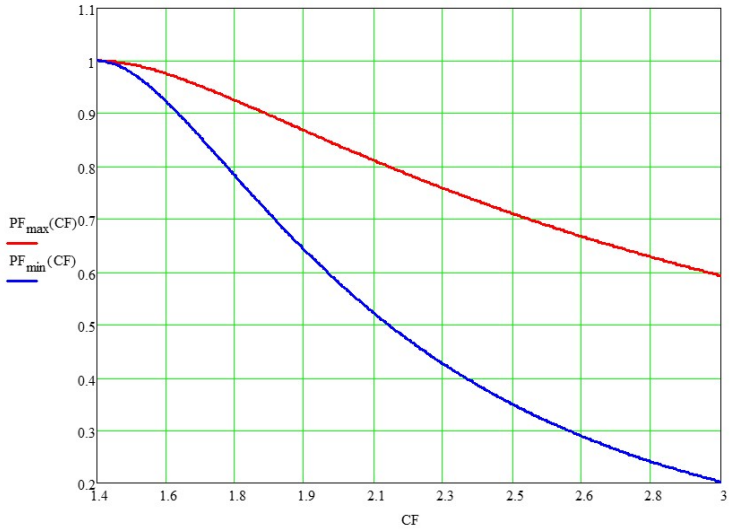


Figure 7-4 Relationship between PF and CF

Notice

1. Figure 7-2 shows the maximum PF when setting CF state in CC Rectifier mode (section 7.4.1) and CS Rectifier mode (section 7.4.2).
2. If Both mode is selected in CC mode (see section 7.4.6) and CP mode (see section 7.4.7), CF and PF values need to be entered at the same time. In Both mode, the priority of CF and PF needs to be set again. If the setting exceeds the range shown in Figure 7-4, the regenerative AC load will automatically change the setting to a valid range as explained in the following 2 examples.

Example 1: (When the priority is CF and the UUT output voltage is 200 V_{rms})

a. When setting CF=1.5 and PF=1, if the allowable PF value is under CF=1.5, the valid range is 0.977~0.993. The system will load using the closest allowable PF value. In this case, the PF value 0.993 will be used.

b. When setting CF=1.5 and PF=0.8, if the allowable PF value is under CF=1.5, the valid range is 0.977~0.993. The system will load using the closest allowable PF value. In this case, the PF value of 0.977 will be used.

c. When setting CF=3 and PF=0.1, if the allowable PF value is under CF=3, the valid range is 0.219~0.593. The system will load using the closest allowable PF value. In this case, the PF value 0.219 will be used.

d. When setting CF=3 and PF=0.7, if the allowable PF value is under CF=3, the valid range is 0.219~0.593. The system will load using the closest allowable PF value. In this case, the PF value 0.593 will be used.

Example 2: (When the priority is PF and the UUT output voltage is 200 V_{rms})

a. When setting PF=0.8 and CF=3, if the allowable CF value is under PF=0.8, the valid range is 1.750~2.153. The system will load using the closest allowable CF value. In this case, the CF value 2.153 will be used.

b. When setting PF=0.8 and CF=1.5, if the allowable CF value is under PF=0.8, the valid range is 1.750 ~ 2.153. The system will load using the closest allowable CF value. In this case, the CF value 1.750 will be used.

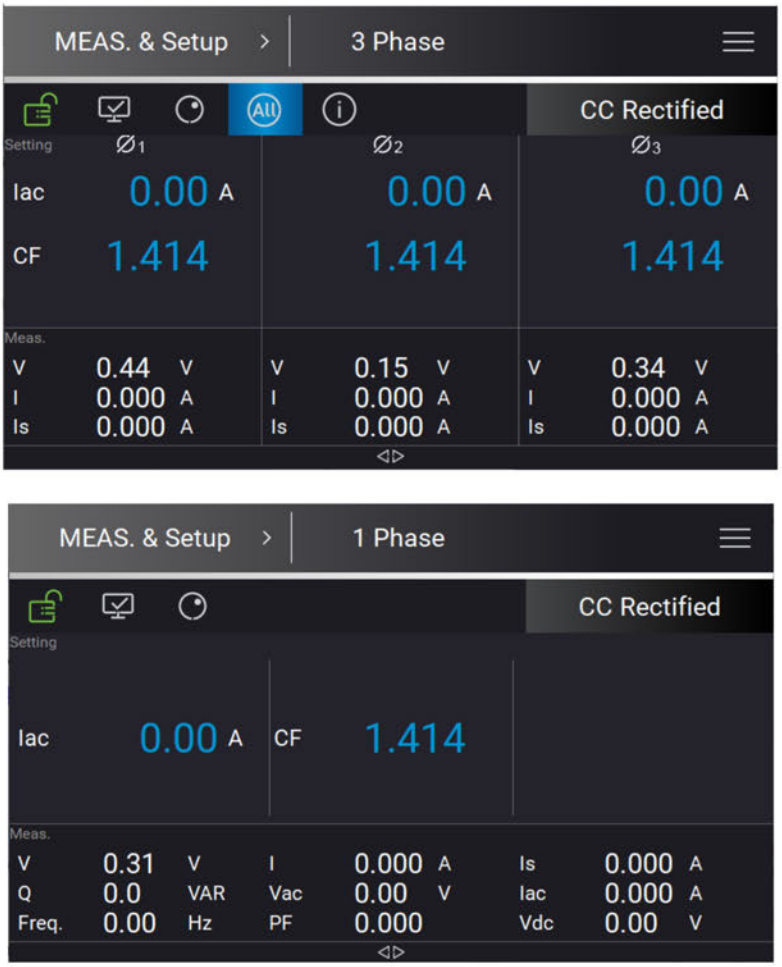
c. When setting PF=0.6 and CF=3, if the allowable CF value is under PF=0.6, the valid range is 1.972~2.866. The system will load using the closest allowable CF value. In this case, the CF value 2.866 will be used.

d. When setting PF=0.6 and CF=1.5, if the allowable CF value is under PF=0.6, the valid range is 1.972~2.866. The system will load using the closest allowable CF value. In this case, the CF value 1.972 will be used.

7.4 Manual Operation

7.4.1 CC Rectifier Mode

When in CC Rectifier mode, it can change the setting of loading current RMS amplitude (Iac) and crest factor (CF) in the MAIN PAGE.

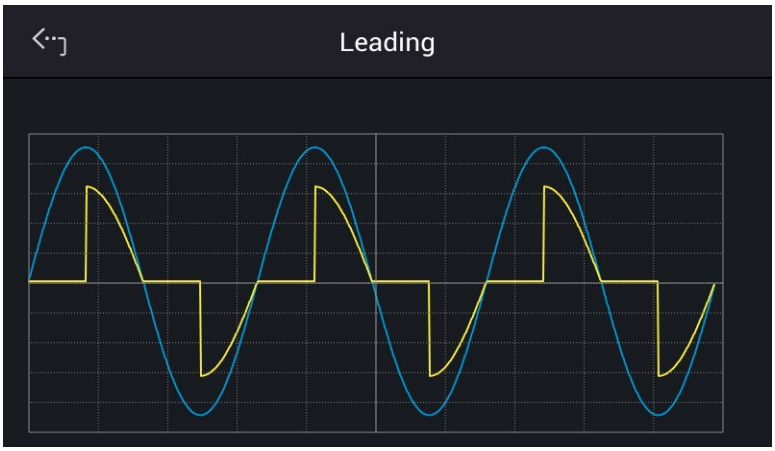


7.4.1.1 Wave Selection

The Regenerative Grid Simulator provides various output waveforms selection for each phase. In Meas. & Setup (3_Phase Mode/1_Phase Mode) menu, tap to choose Waveform Selection. There are sine wave, positive half cycle wave, negative half cycle wave, Leading-edge wave and Trailing-edge wave 5 types for selection.

Set the 3-phase waveform to Leading-edge wave at the same time:

1. Tap (All) on the top to set the output to All.
2. Tap "Leading" icon.
3. Long-press the "Leading" icon for 1 second can zoom in the set waveform for viewing.



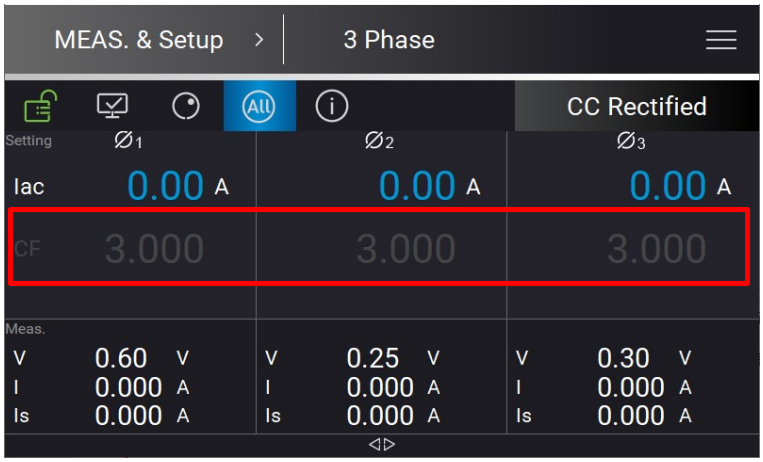
Notice The loading waveform is only provided when the CC Rectifier mode is selected.

7.4.1.2 More Settings in CC Rectifier Mode

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap ☰ to enter the menu and select More Settings to perform advanced settings as described below.

Notice

1. When the selected loading waveform is not a sine wave, “More settings” is invalid.
2. CF setting is not provided when the selected loading waveform is not a sine wave. For example, the CF setting will be grayed out and executed using CF=1.414 when returning to Meas. & Setup page after Trailing is selected as the figures shown below.



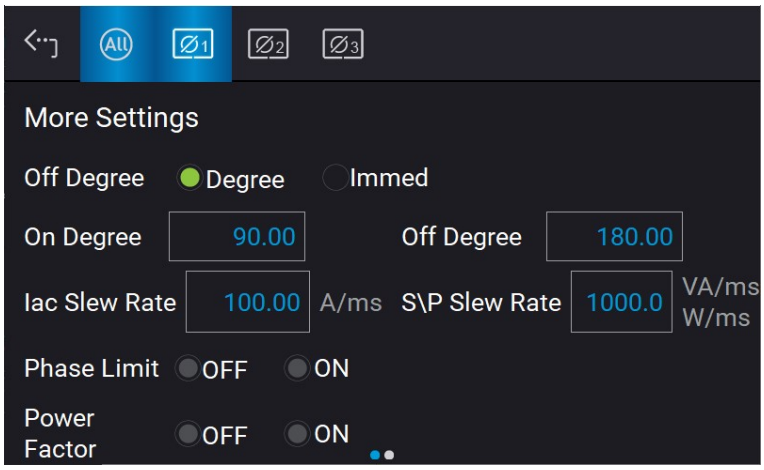
A. On/Off Degree

The regenerative AC load in CC and CS Rectifier Mode controls the output and stop

outputting angle when loading current waveform. Use On Degree and Off Degree on the screen to enable and disable the feature.

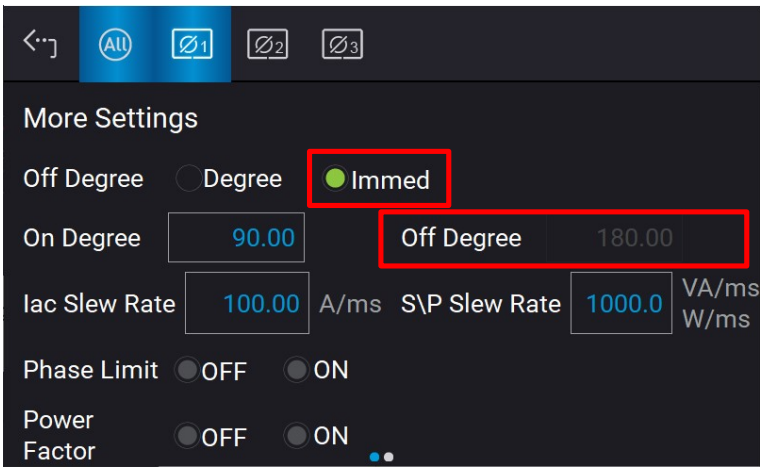
The following is the procedure to set the output phase angle to turn on at 90 degrees, and off at 180 degrees in 1_Phase Mode /3_Phase Mode.

1. Tap "On Degree".
2. Tap **9**, **0**, and ↵ to change the value to "90.0 ".
3. Tap "Off Degree".
4. Tap **1**, **8**, **0**, and ↵ to change the value to "180.0".



Notice

When **QUIT** is tapped, if " OFF Degree = IMMED", the loading current will skipped immediately. In the meantime, the Off Degree is grayed out to be invalid for setting.



B. Slew Rate

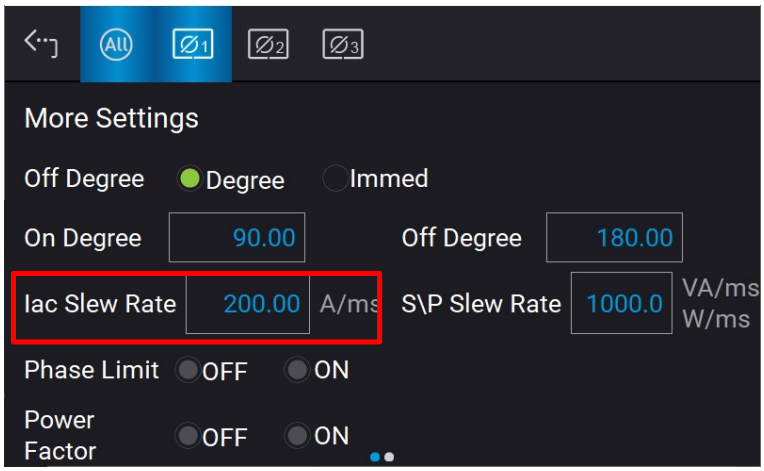
The regenerative AC load can adjust the slew rate of load transient to control the current waveform change speed when the load current and apparent power command changes. The commands are Iac Slew Rate and S/P Slew rate.

Iac Slew Rate: Slew rate of Iac command.

When the regenerative AC load is in Load On state, the setting of load current in the MAIN PAGE is varied by the Iac Slew rate set.

The procedure of setting Iac Slew Rate =200 in 1_Phase Mode /3_Phase Mode is described below.

1. Tap “Iac Slew Rate”.
2. Tap **2**, **0**, **0**, and ↵ to change the value to “200 ".

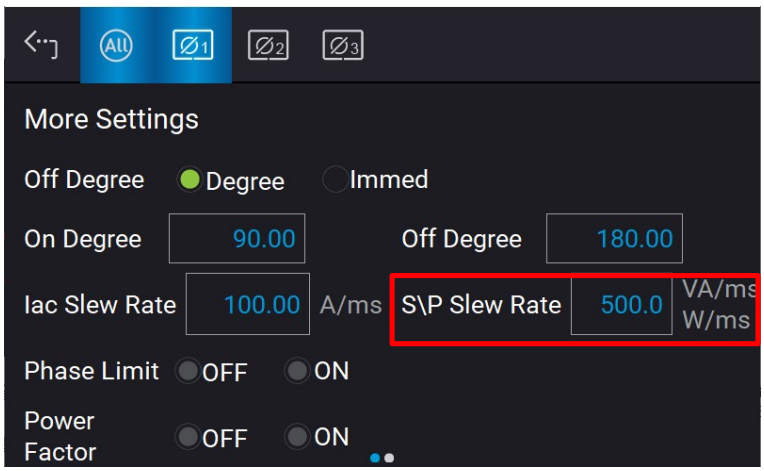


S/P Slew Rate: The slew rate of S/P command.

When the regenerative AC load is in Load On state, the setting of load current in the MAIN PAGE is varied by the S/P Slew rate set.

The procedure of setting S/P Slew Rate =500 in 1_Phase Mode /3_Phase Mode is described below.

1. Tap “S/P Slew Rate”.
2. Tap **5**, **0**, **0**, and ↵ to change the value to "500 ".

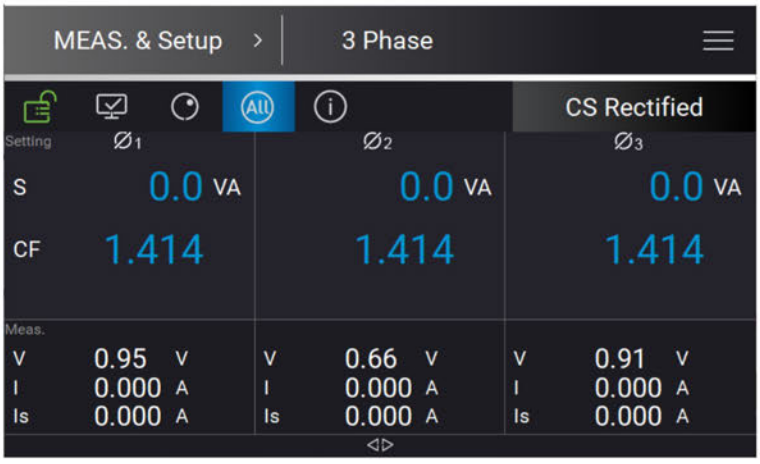


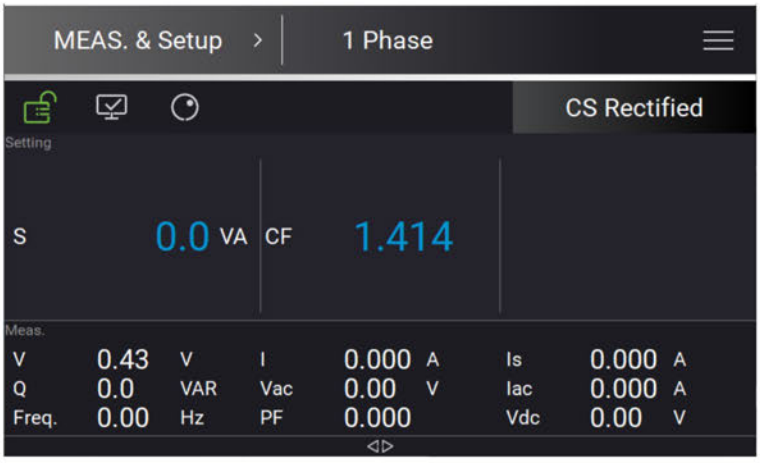
Notice

1. The maximum setting of Iac Slew Rate is 800A/ms and the minimum is 0.01A/ms.
2. When the regenerative AC load is **ON** , the output end immediately as set. When **OFF** is executed, the load will change to 0A immediately. If changing the slew rate to 0A is desired, you should key in 0A and tap instead of executing **OFF**.

7.4.2 CS Rectifier Mode

When in CS Rectifier mode, it can change the setting of apparent power (S) and crest factor (CF) in the MAIN PAGE.





Notice

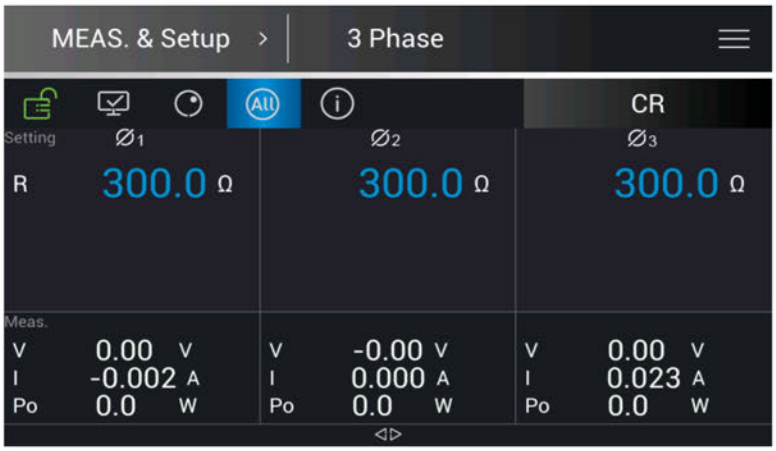
Refer to section 7.3 for the mapping diagram of the maximum measured PF when setting in CF state.

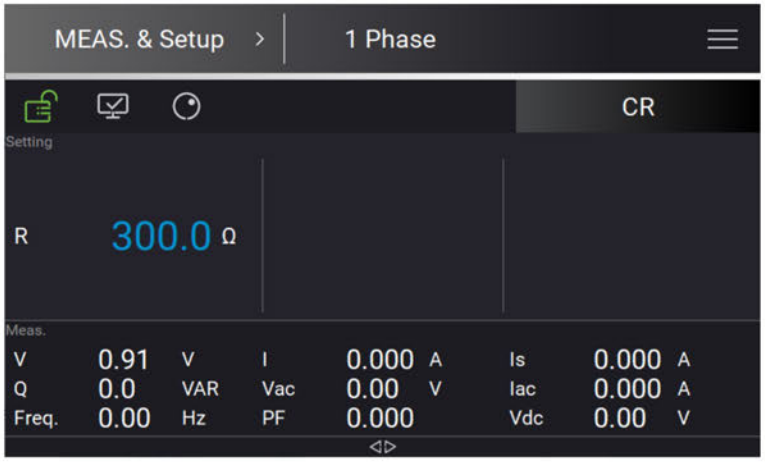
7.4.2.1 More Settings in CS Rectifier Mode

See section 7.4.1.2 for detailed description.

7.4.3 CR Mode

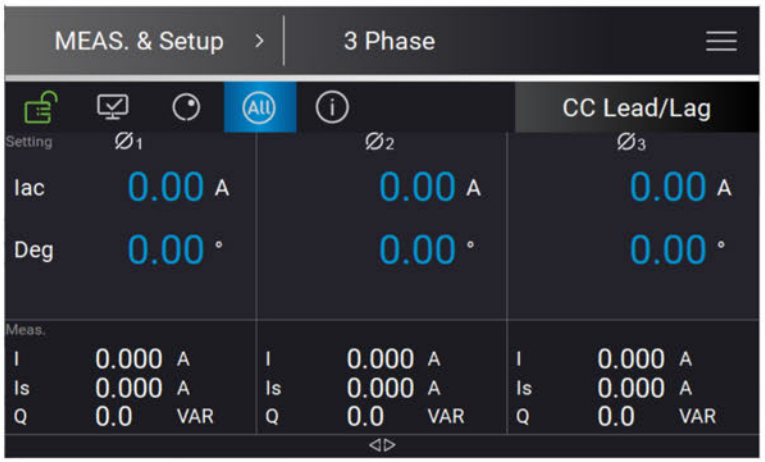
When in CR mode, it can change the resistance (R) in the MAIN PAGE.

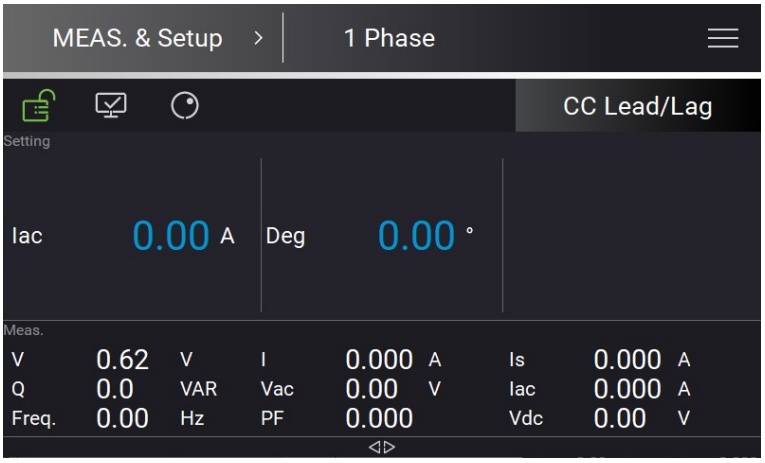




7.4.4 CC Phase Lead/Lag Mode

When in CC Phase Lead/Lag mode, it can change the current amplitude and phase setting in the MAIN PAGE.





7.4.4.1 More Settings in CC Phase Lead/Lag Mode

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap to enter the menu and select More Setting to perform advanced settings as described below.

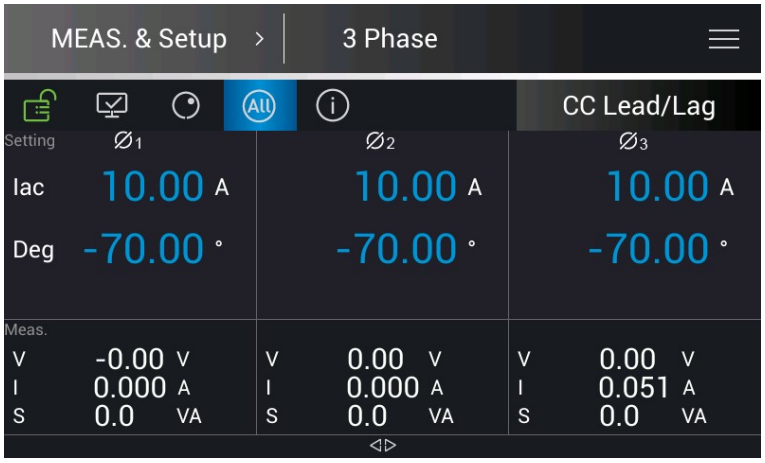
A. On/Off Degree

See section 7.4.1.2 for detailed description.

Notice

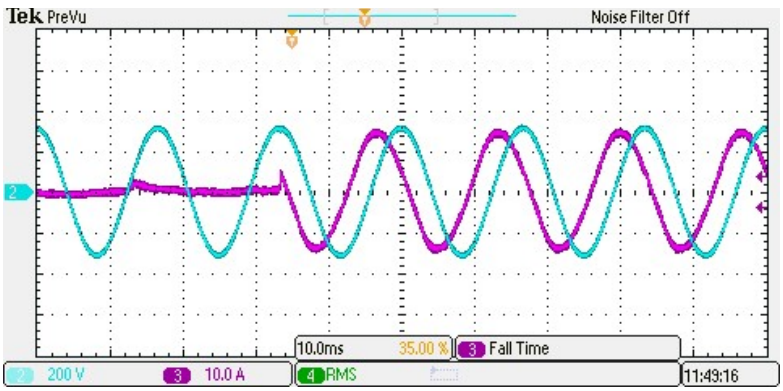
The procedure to set the phase (Deg) in MAIN PAGE and On/Off degree in More Settings at the same time, for example, to set I=10A, Deg =-70, On degree=90, and Off degree=60 in 3-phase, is as described below.

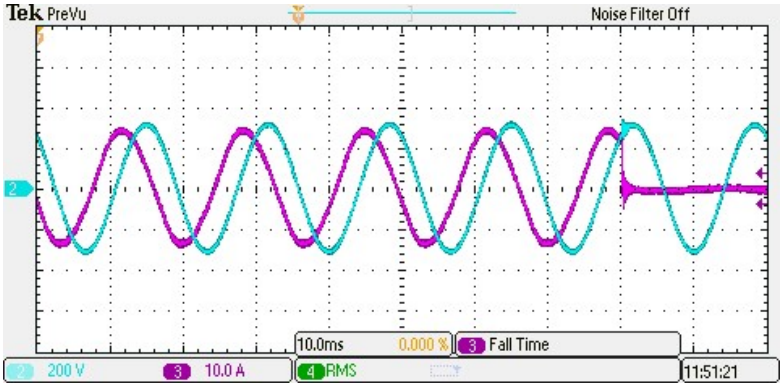
1. Tap "I" in the MAIN PAGE.
2. Tap 1, 0, and to change the value to "10".
3. Tap "Deg" in the MAIN PAGE.
4. Tap -, 7, 0, and to change the value to "-70".



5. Tap to go to More Settings menu.
6. Tap “On Degree” in More Settings.
7. Tap **9**, **0**, and to change the value to "90".
8. Tap “Off Degree” in More Settings.
9. Tap **6**, **0**, and to change the value to "60".

The measured results are as follows according to the above steps whe the UUT is in 220V phase voltage.





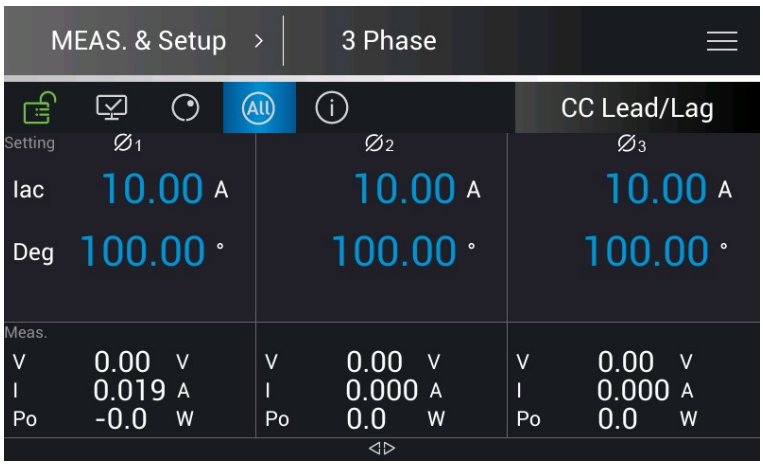
B. Slew Rate

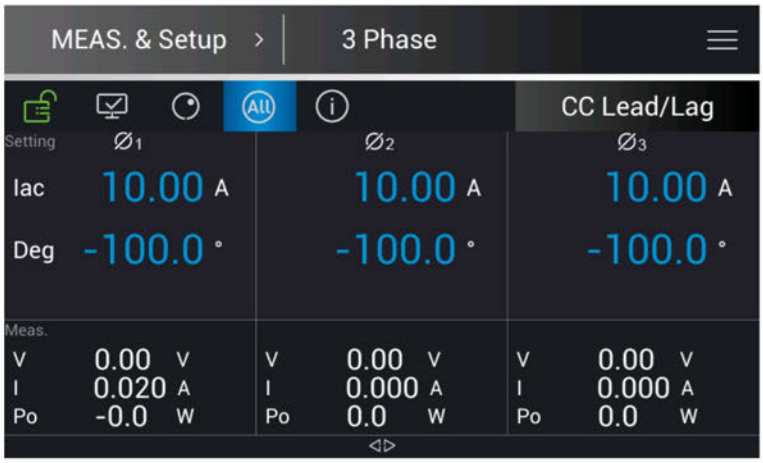
See section 7.4.1.2 for detailed description.

C. Phase Limit (default is ON)

The regenerative AC load in CC and CS Phase Lead/Lag Mode can change to Current Source Mode by setting Phase limit OFF (to >90° or <-90° range). The setting sequence is as follows.

1. Tap OFF on the Phase Limit to remove the phase setting limit.
2. Return to Meas. & Setup to set the required phase.



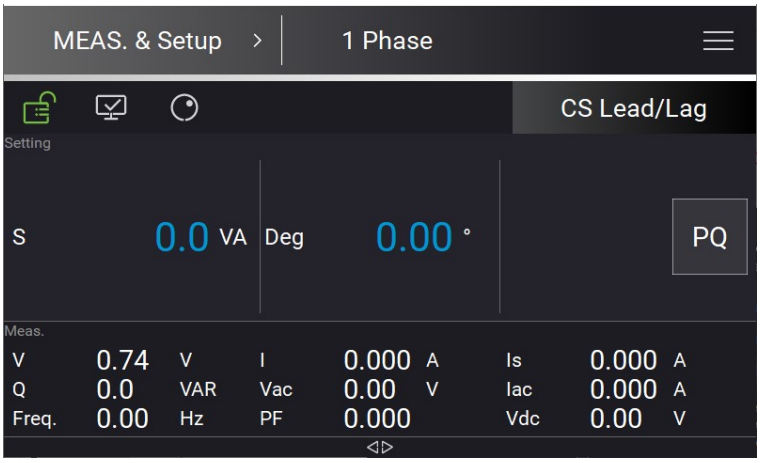


Notice When the Phase Limit is set to OFF, set the phase to >90˚ or <-90˚, and then set the Phase Limit to ON, the phase set by Meas. & Setup will return to 0˚.

⚠WARNING When the Phase Limit is set to OFF, the phase setting range can be greater than 90˚ or less than -90˚. The regenerative AC load at this time is a current source output, which will feed back power to the UUT. Be sure to confirm the characteristics of the UUT that must have recharge power consumption or power regenerative function to avoid damaging the equipment.

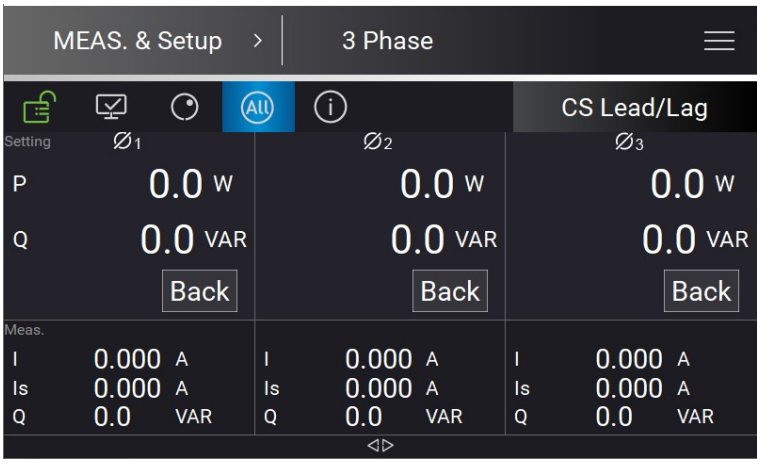
7.4.5 CS Phase Lead/Lag Mode

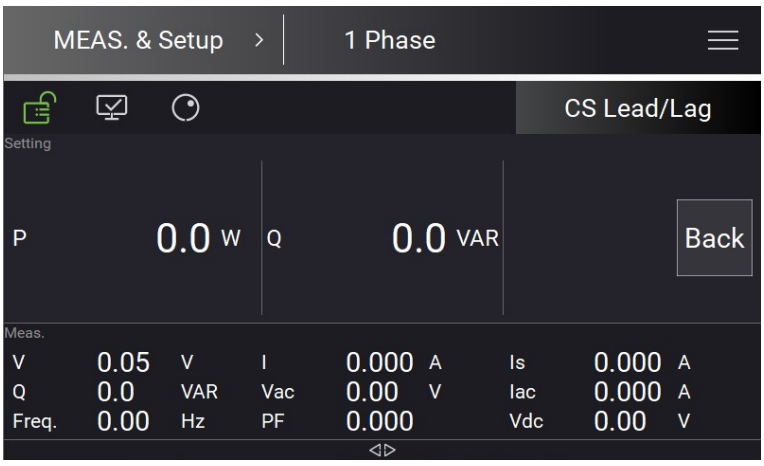
When in CS Phase Lead/Lag mode, it can change the apparent power and phase setting in the MAIN PAGE.



Notice

Tap **PQ** in the main page, it can confirm the Real power (P) and virtual power (Q). Tap **Back** to return to the setup menu.





7.4.5.1 More Settings in CS Phase Lead/Lag Mode

In Meas. & Setup (3_Phase Mode/1_Phase Mode) page, tap to enter the menu and select More Setting to perform advanced settings as described below.

A. On/Off Degree

See section 7.4.1.2 for detailed description.

B. Slew Rate

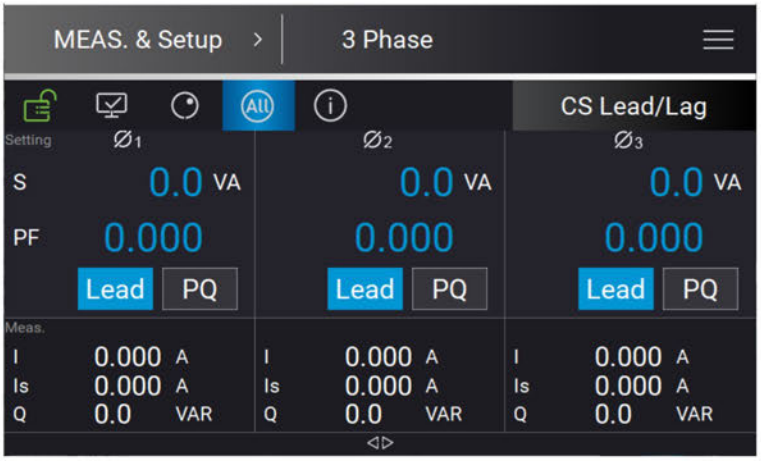
See section 7.4.1.2 for detailed description.

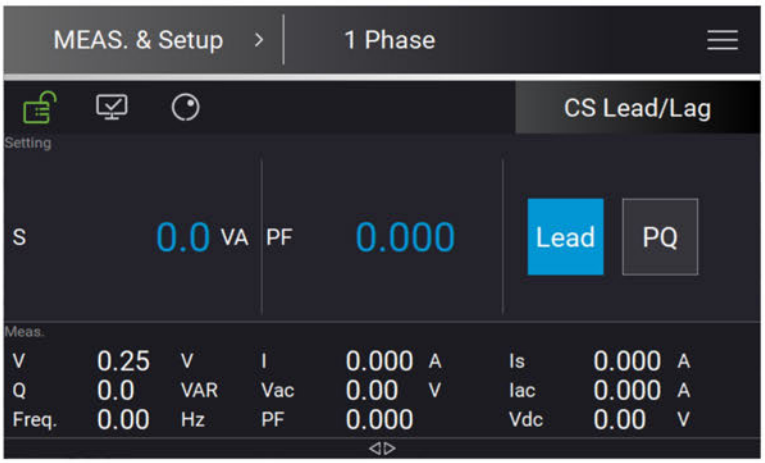
C. Power Factor (default is OFF)

The regenerative AC load in CC Phase Lead/Lag mode provides Power Factor (PF) for setting as described below.

1. Tap OFF on the Power Factor to enable the PF setting.

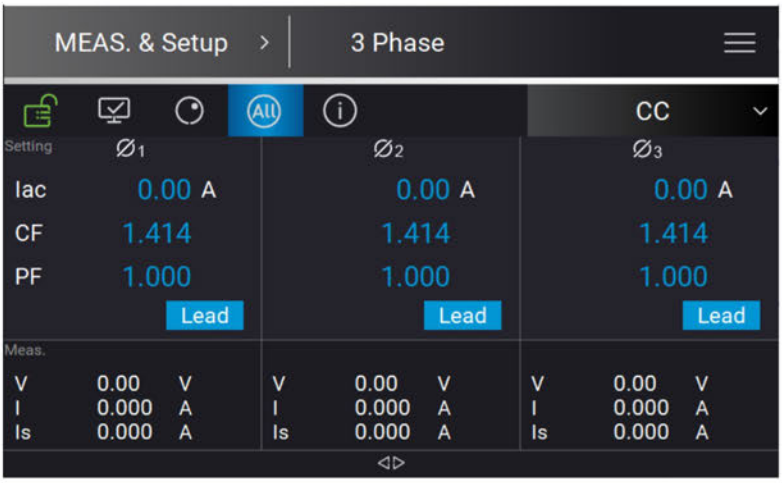
2. Return to Meas. & Setup to set the required PF.
3. When set to Lead, it means the phase of the load current is ahead of the UUT voltage phase. When set to Lag, it means the phase of the load current lags behind the UUT voltage phase.

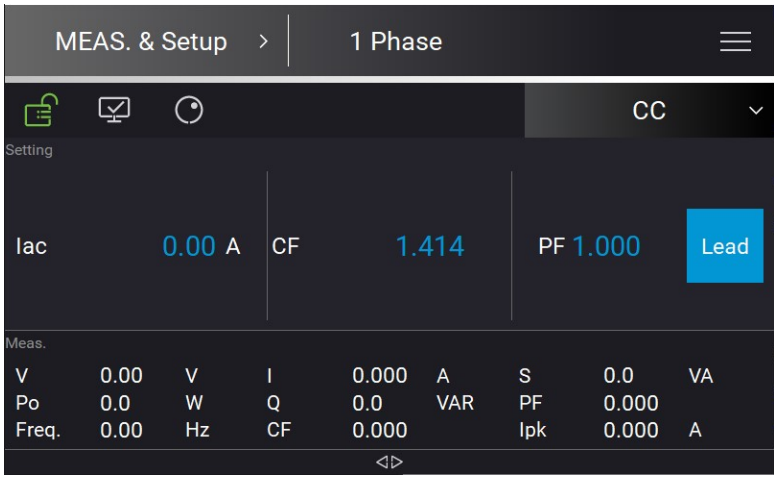




7.4.6 CC Mode

When in CC Mode, it can change the current amplitude, CF and PF settings in the MAIN PAGE.





When set to Lead, it means that the current loading phase leads the UUT voltage phase. When set to Lag, it means the current loading phase lags behind the UUT voltage phase.

7.4.6.1 More Settings in CC Mode

In Meas. & Setup (3_Phase Mode/1_Phase Mode) menu, tap to enter the menu and select More Settings to perform advanced settings as described below.

A. On/Off Degree

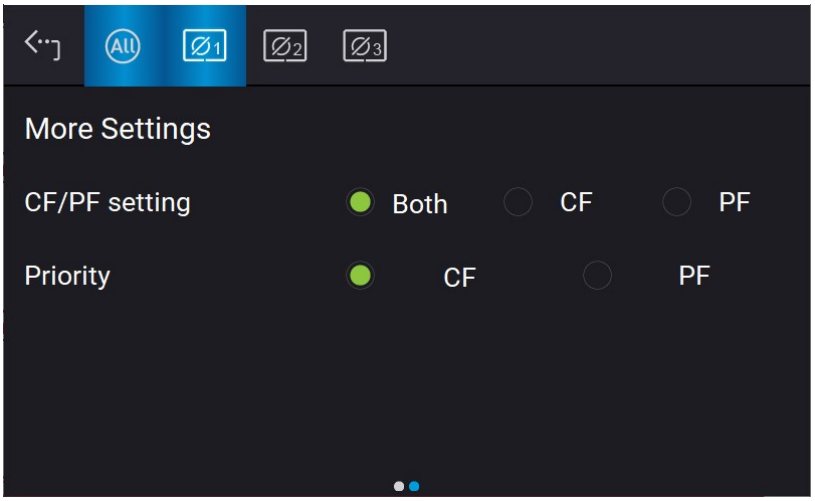
See section 7.4.1.2 for detailed description.

B. Slew Rate

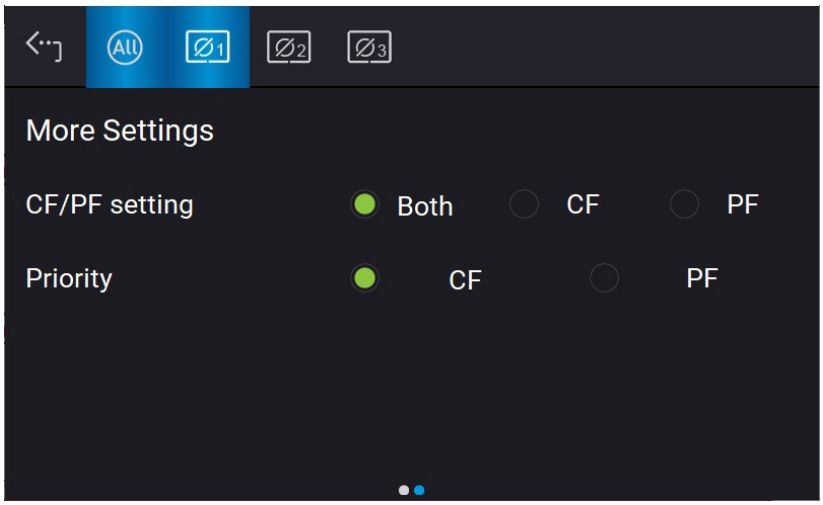
See section 7.4.1.2 for detailed description.

C. CF/PF

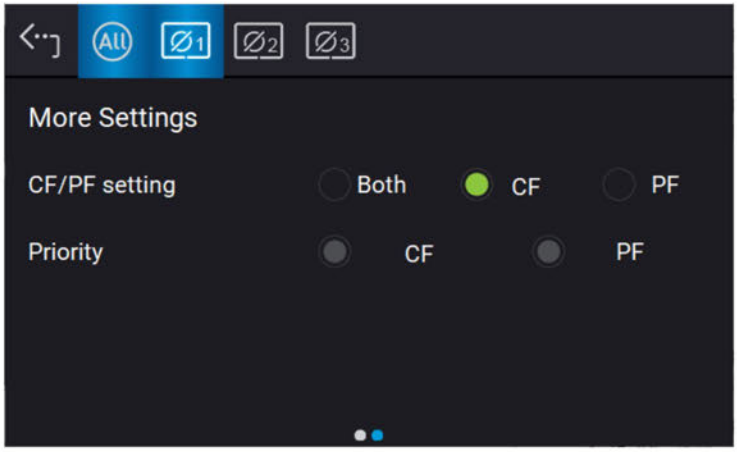
Slide to second page of More Settings to perform CF/PF settings. In CC mode, there are CF, PF, and Both 3 parameters for setting.



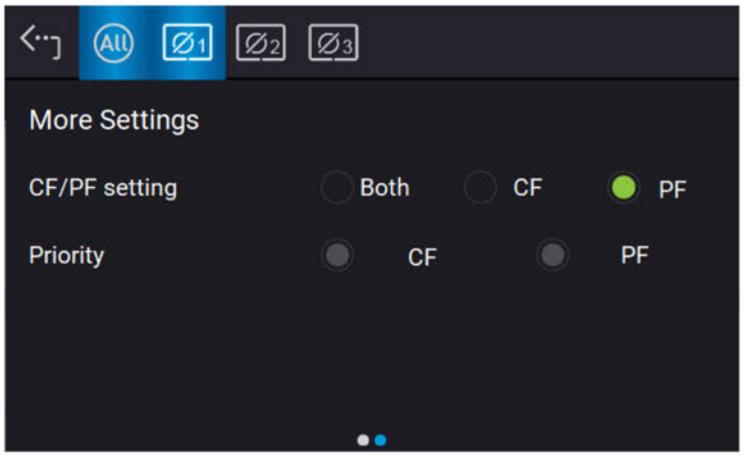
1. Both (default)
   When set to Both, it requires to set the priority. When the priority is set to CF, the PF setting range is limited by CF setting value (seeFigure 7-4). On the contrary, if the priority is set to PF, the CF setting range will be limited by the PF setting value (seeFigure 7-4).



2. CF
   When CF only is selected, the PF will be set to the maximum corresponding to the current CF setting (Figure 7-4) and cannot be changed.

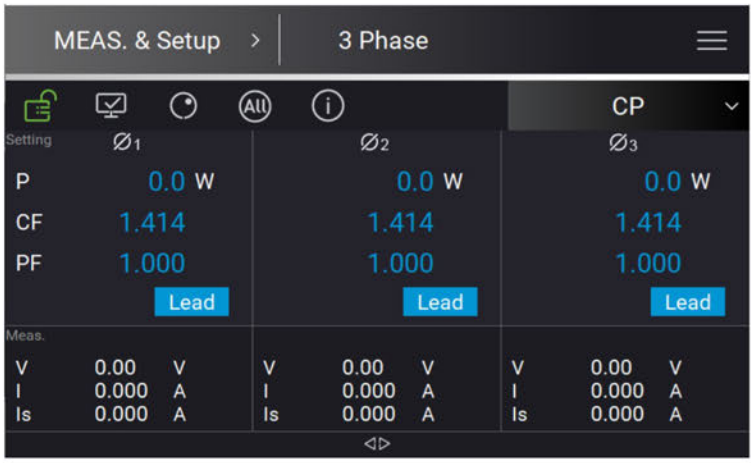


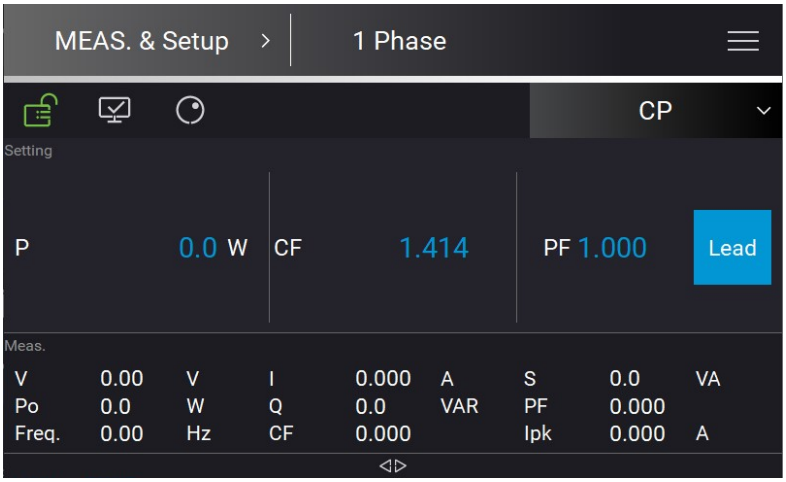
3. PF
When PF only is selected, the CF will be set to the maximum corresponding to the current PF setting (Figure 7-4) and cannot be changed.



7.4.7 CP Mode

When in CP Mode, it can change the power amplitude, CF and PF settings in the MAIN PAGE.





When set to Lead, it means that the current loading phase leads the UUT voltage phase. When set to Lag, it means the current loading phase lags behind the UUT voltage phase.

7.4.7.1 More Settings in CP Mode

In Meas. & Setup (3_Phase Mode/1_Phase Mode) menu, tap to enter the menu and select More Settings to perform advanced settings as described below.

A. On/Off Degree

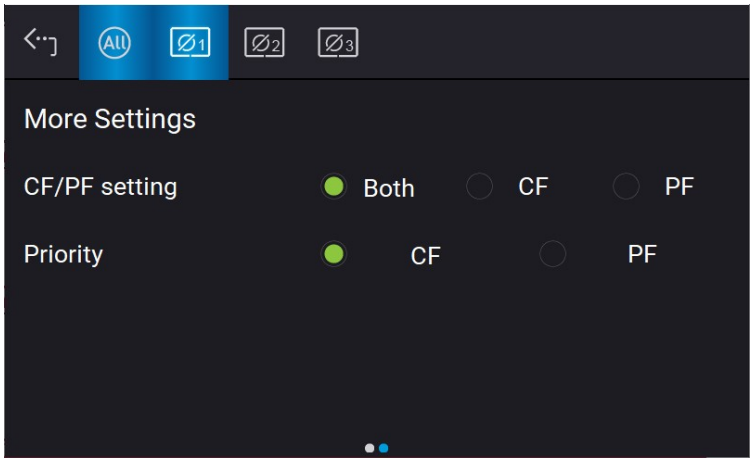
See section 7.4.1.2 for detailed description.

B. Slew Rate

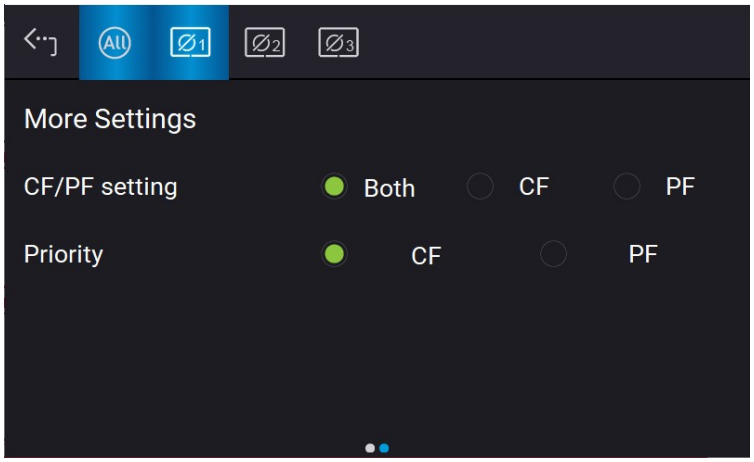
See section 7.4.1.2 for detailed description.

C. CF/PF

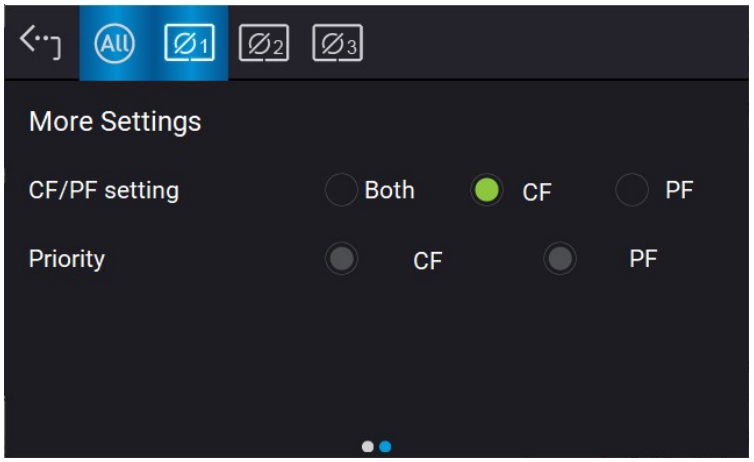
Slide to second page of More Settings to perform CF/PF settings. In CP mode, there are CF, PF, and Both 3 parameters for setting.



1. Both (default)
   When set to Both, it requires to set the priority. When the priority is set to CF, the PF setting range is limited by CF setting value (seeFigure 7-4). On the contrary, if the priority is set to PF, the CF setting range will be limited by the PF setting value (see Figure 7-4).

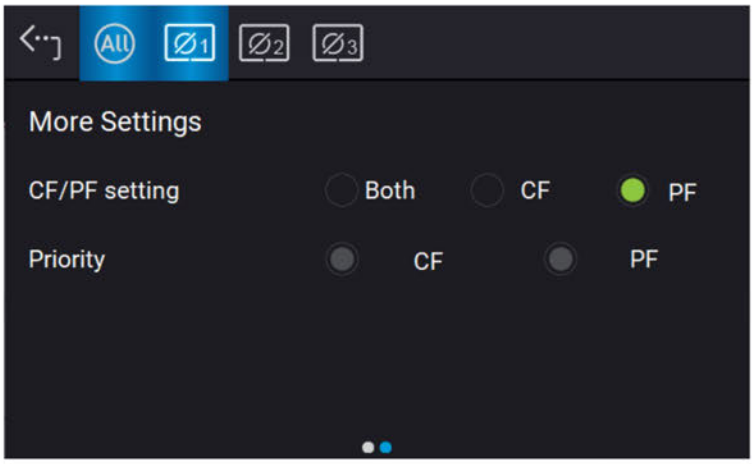


2. CF
   When CF only is selected, the PF will be set to the maximum corresponding to the current CF setting (Figure 7-4) and cannot be changed.



3. PF

When PF only is selected, the CF will be set to the maximum corresponding to the current PF setting (Figure 7-4) and cannot be changed.

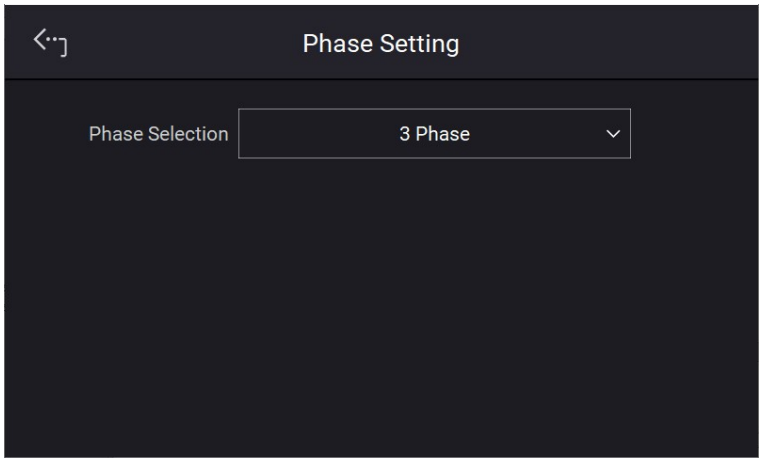


7.5 Configuration Menu

Tap Menu and select Configuration to show the Configuration menu. There are Phase Setting, Interface, Remote Output, and Stand-by 4 functions available for use.

7.5.1 Phase Setting

Tap Menu and select Configuration to show the Phase Setting menu. Users can also switch the mode to 3-phase or 1-phase.

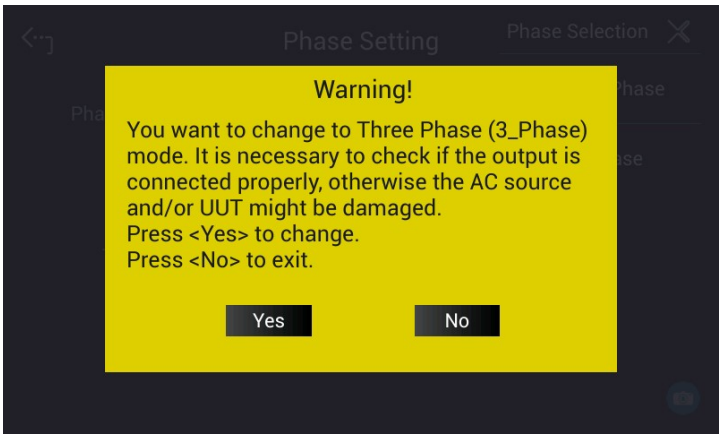


7.5.1.1 Three Phase Mode

The regenerative AC load can be set to 3-phase AC load by tapping the Menu and selecting Configuration to show the Phase Setting menu and switch to 3-phase mode if desired.

The procedure for setting the regenerative AC load to 3-phase mode is described below.

1. Tap Phase Selection
2. Select “3 Phase” mode.
3. Make sure the output connection is in 3-phase mode and tap Yes to change it.

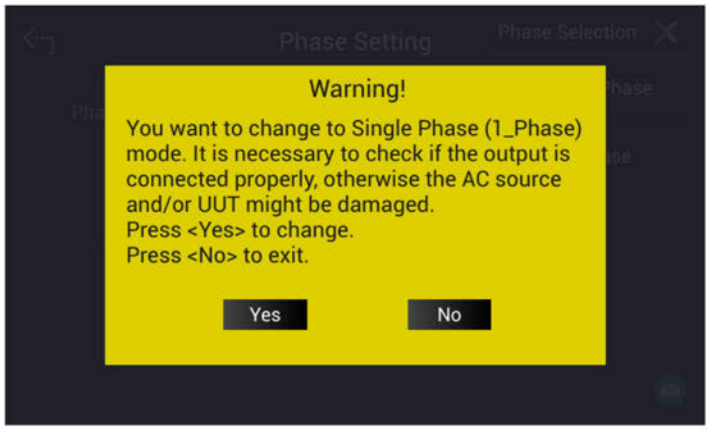


7.5.1.2 Single Phase Mode

The regenerative AC load can be set to 1-phase AC load by tapping Menu and select Configuration to show the Phase Setting menu and switch to 1-phase mode when it is required.

The procedure for setting the regenerative AC load to 1-phase mode is described below.

1. Tap Phase Selection.
2. Select “Single Phase” mode.
3. Make sure the output connection is in 1-phase mode and tap Yes to change it.



Notice

1. When switching between 1-phase and 3-phase mode, the set output value will be reset to zero to avoid damaging the UUT.
2. When switching 1-phase mode to 3-phase mode, the user should check if the output L_1, L_2, and L_3 short-circuit copper bars are removed to prevent the Regenerative AC load from triggering a protection error.

7.5.2 Interface

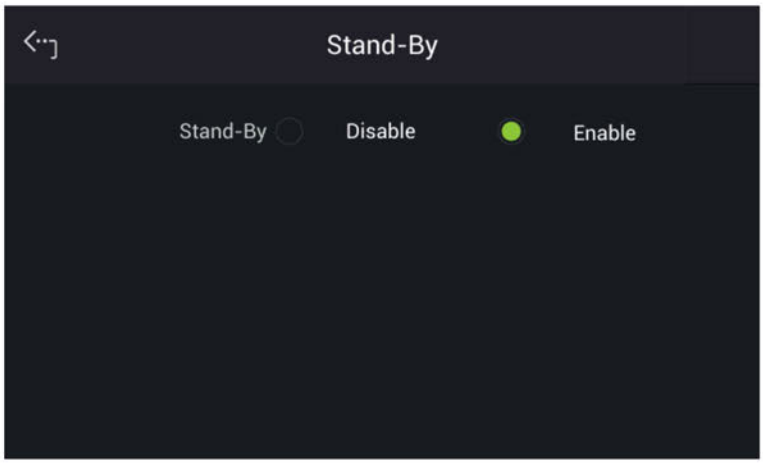
See section 3.4.2 for detailed description.

7.5.3 Remote Output

See section 3.4.3 for detailed description.

7.5.4 Stand-By

Tap Menu and Configuration on the upper left corner to select Stand-By function for setting.



Stand-by mode: Enable

The Stand-By mode is default set to Enable. When the UUT voltage is abnormal, the regenerative AC load will enter into Standby mode if it is enabled. The LED of output on key on the front panel is always on. Once the UUT output voltage reached the loading state, the regenerative AC load will use the settings in MAIN PAGE to perform loading.

Notice When the UUT output voltage is generated to loadable state, the regenerative AC load will assess it and starting loading 1s after the voltage is rebuilt.

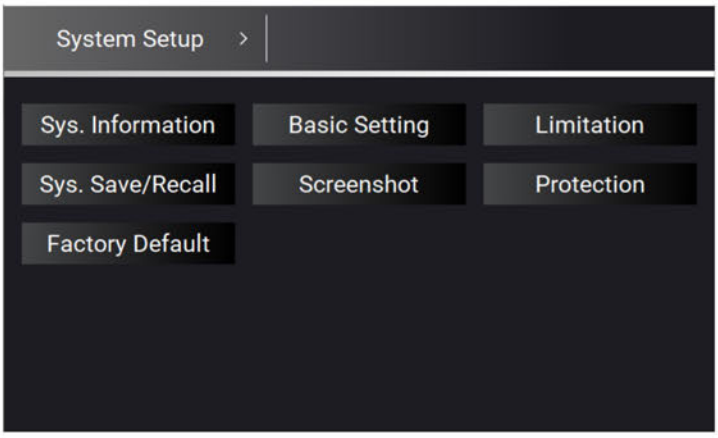
Stand-by mode: Disable

When the UUT voltage is lower than the operable range of regenerative AC load, the regenerative AC load will occur low voltage protection (DA_UUT_UVP) if this function is enabled. The protection can be cleared by command. The user must confirm the UUT voltage status at present. If the UUT voltage outputs normally, clear the protection and the loading can be performed as usual.

Notice When performing the regulation test of voltage drop within a short time (ex: UL – 2231-2, SAE-J1772), be sure to disable this function. It is suggested to use CR mode for the testing.

7.6 System Setup Menu

Tap Menu and select System Setup to show the System Setup menu. There are Sys. Information, Sys. Save/Recall, Factory Default, Basic Setting, Meas. Setting, Screenshot, Limitation, and Protection 7 functions available for use.



7.6.1 Sys. Information

See section 3.5.1 for detailed description.

7.6.2 Sys. Save/Recall

See section 3.5.2 for detailed description.

7.6.3 Basic Setting

See section 3.5.4 for detailed description.

7.6.4 Meas. Setting

7.6.4.1 Average Times

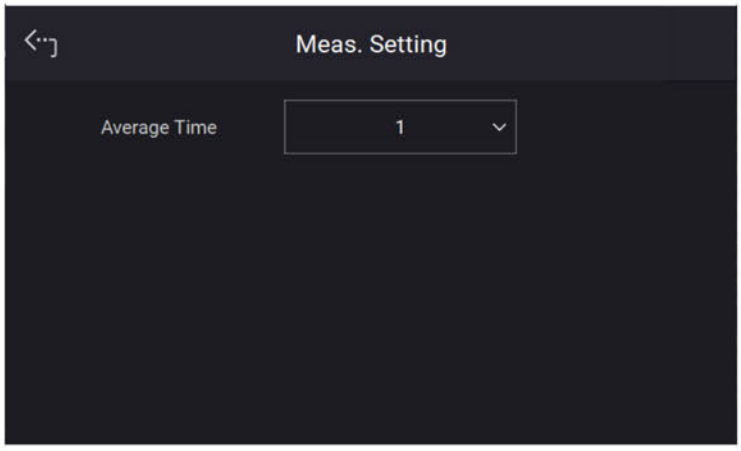
Tap Menu, System Setup and Meas. The "Average Times" sets the sampling average of voltage/current RMS and voltage/current peak. The regenerative AC load uses moving windows for sampling. When "4" is selected for Average Times it indicates it will be sampling 4 times in moving windows.

Tap Average Times to set the average times for sampling. When a measurement is fluctuating severely, higher sampling average times can be set to improve the measurement accuracy. The average times for sampling to be set are listed below.

Average Times: 1, 2, 4, 8. (The default is 8.)

Follow the steps below to set the sampling average times to 1.

1. Tap Average Times
2. Select "1".



7.6.5 Limitation

The limitation of the regenerative AC load for 1-phase and 3-phase is set individually. For instance, the Iac Limit setting will apply the settings of the 1-phase mode when changing it from the 3-phase mode. Tap Menu, System Setup and Limitation to set Iac Limit, CF Limit, and S Limit. This command protects the user's program instead of hardware.

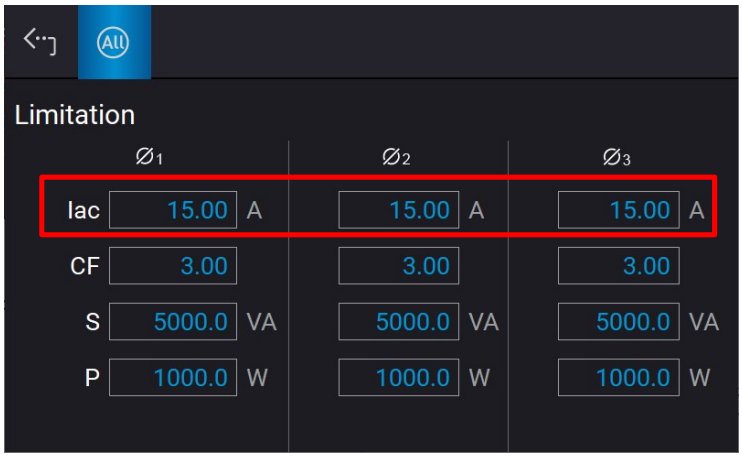
7.6.5.1 Iac Limit

The Iac Limit restricts the Iac value in the main page (3_Phase Mode/1_Phase Mode).

Tap All to set the limitation of the 3-phase loading voltage for each or all.

The procedure to set Iac Limit = 15A in 3_Phase Mode is described below.

1. Tap ALL.
2. Tap “Iac”.
3. Enter **1**, **5**, and tap ↵ to change the value to “15.0”.

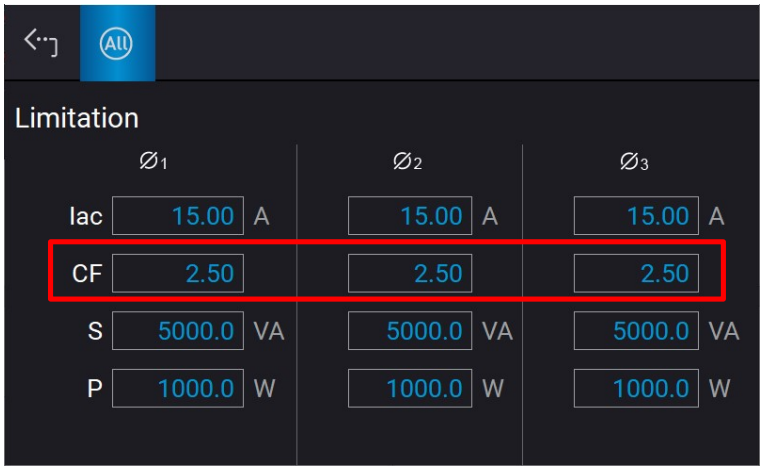


7.6.5.2 CF Limit

The CF Limit restricts the CF setting in the main page (3_Phase Mode/1_Phase Mode).

The procedure for setting CF = 2.5 in 3_Phase mode is described below.

1. Tap ALL.
2. Tap “CF”.
3. Tap **2**, **.**, **5** and tap ↵ to change the value to “2.5”.

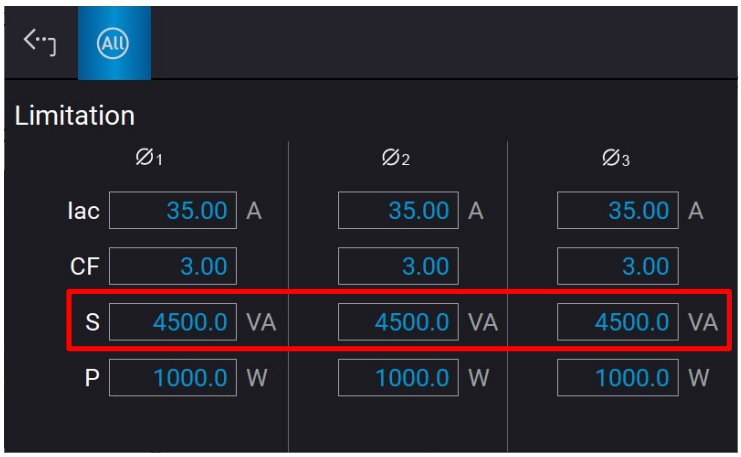


7.6.5.3 S Limit

The S Limit restricts the S value in the main page (3_Phase Mode/1_Phase Mode).

Tap All to set the limitation of the 3-phase loading voltage for each or all. The procedure to set S Limit = 4500VA in 3_Phase Mode is described below.

1. Tap ALL.
2. Tap "S".
3. Enter **4**, **5**, **0**, **0**, and tap ↵ to change the value to "4500.0".

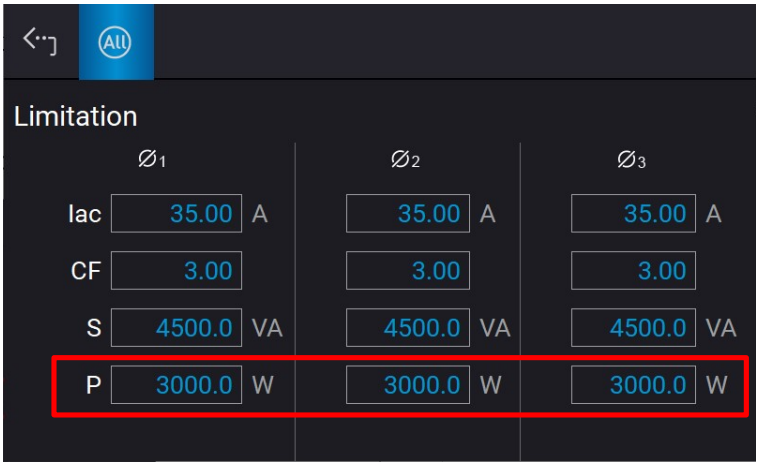


7.6.5.4 P Limit

The P Limit restricts the P value in the main page (3_Phase Mode/1_Phase Mode).

Tap All to set the limitation of the 3-phase loading power for each or all. The procedure to set P Limit = 3000W in 3_Phase Mode is described below.

1. Tap ALL.
2. Tap "P".
3. Enter **3**, **0**, **0**, **0**, and tap ↵ to change the value to " 3000.0 ".



7.6.6 Protection

See the detailed description in section 3.5.8.

7.6.7 Screenshot

See the detailed description in section 3.5.9.

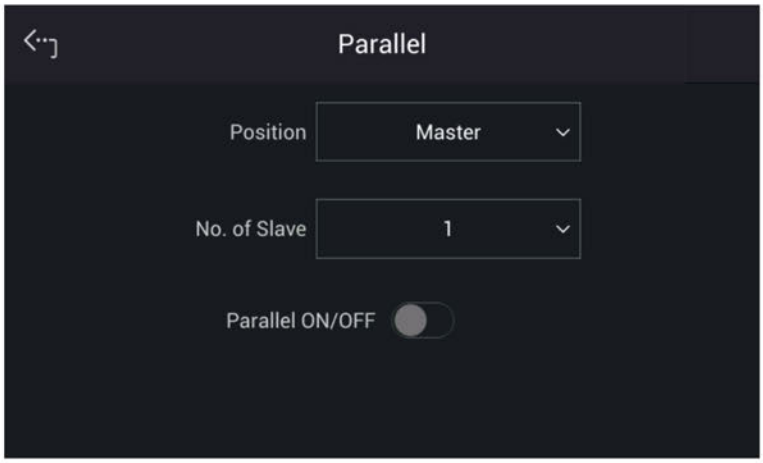
7.7 Setup for Parallel

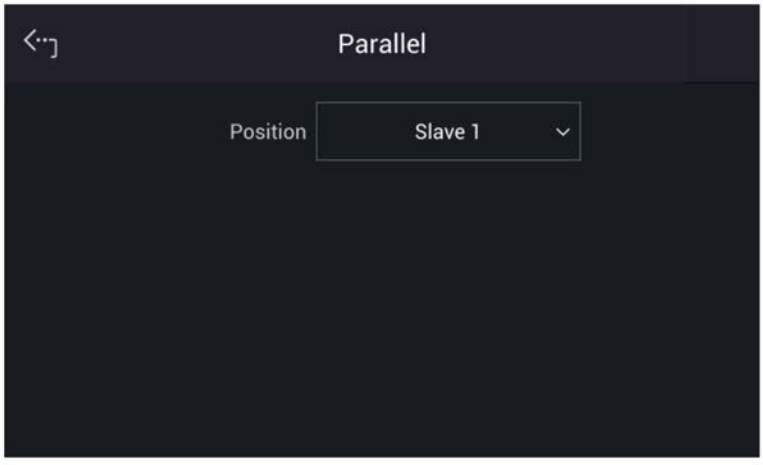
7.7.1 Paralleling by UI

7.7.1.1 Setting Regenerative AC Load to Slave

When setting the regenerative AC load to Slave, you can select Configuration from the Menu on the upper left corner to enter the Parallel menu. Follow the steps below to set the parallel function for connecting multiple devices.

1. Tap Position.
2. Select “Slave 1”.





7.7.1.2 Setting Regenerative AC Load to Master

When setting the regenerative AC load to Master, you can select Configuration from the Menu on the upper left corner to enter the Parallel menu. Follow the steps below to set the parallel function for connecting multiple devices.

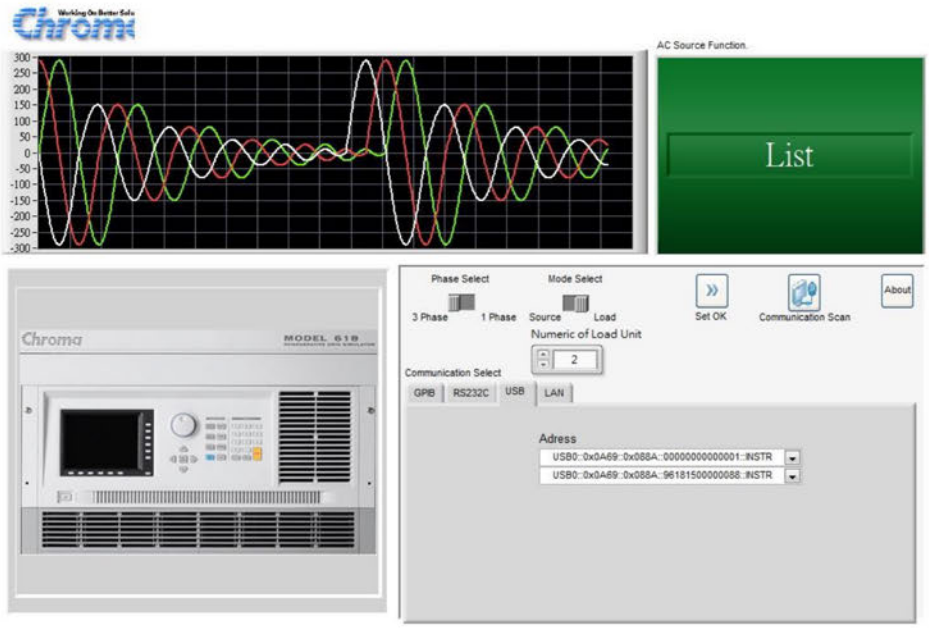
1. Tap Position.
2. Select "Master".
3. Tap No. of Slave.
4. Select the number of Slave to be paralleled.
5. Enable Parallel ON/OFF.
6. It will return to the main screen if set to Master, and Slave will show on the screen when set to Slave.

Notice For parallel, at least one of them must be set to Slave, otherwise "System Connection Fail!" will appear when Master is set to Enable. Refer to section 3.6 for the details of troubleshooting.

⚠WARNING When setting the Number of Slave for Master, the rule is N-1 for the total number of regenerative AC loads. For example, when two units are connected in parallel, the Number of Slave must be set to 1. If the parallel number is set incorrectly, the connection may fail or the device is at risk of damage.

7.7.2 Paralleling by Soft Panel

The regenerative AC load uses Soft Panel to parallel multiple devices. The procedure for connecting 2 devices in parallel via USB is described below.



1. Enter into the Soft Panel UI.
2. Click “USB” from Communication Select.
3. Click “3 Phase” from Phase Select.
4. Click “Load” from Mode Select.
5. Set “2” in Number of Load Unit (maximum 3).
6. Click Set OK.

Notice When paralleling by Soft Panel, each regenerative AC load must be operated under the same communication interface. The parallel connection will fail if different communication interface is used.

Notice When paralleling by Soft Panel, the Stand-by mode is disabled by default. If it is required to use the Stand-by mode in a parallel state, use UI for paralleling instead (see section 7.7.1).

⚠WARNING Please refer to section 2.5 for wiring the output terminal of each regenerative AC load. If the wiring is not correct, it may cause parallel failure or risk of damaging the device.

7.8 Verification

7.8.1 Introduction

This section contains test procedures for checking the operation and specification of Chroma 61800 Series Regenerative AC Load (option). The tests are performed using the 61800 Series models and some required equipment. The required test equipment is listed in Table 7-1. Please refer to *Performance Tests* section for equipment connection and test procedure. The user can use verification tables included at measurement verification section for checking the specification. The performance tests confirm Chroma 61800 Series meets its published specifications. For detailed information of operation and programming please refer to chapter 7.

If any of the models covered in the manual (61809/61812/61815) require service, refer to the list of Chroma Sales and Support Offices at the web site:
www.chromaate.com/english/contact/default.asp.

7.8.2 Equipment Required

The following table lists the equipment or its equivalent required for verification.

Table 7-1 Equipment Suggested for Verification

Equipment	Characteristics	Recommended Model
Current Transducer	400A	DC-CT(IT 400-S)
Power Analyzer		Chroma 66204*1 unit Chroma A662020*1 unit (DC-CT Power)
AC Load	105Apeak 0-35Arms 0-350Vrms 30-100Hz,DC	Chroma 61815*1 unit
Regenerative Grid Simulator		Chroma 61809/61812/61815 (with ACL option)

Connection
Connect the Regenerative AC Load, AC Source, Power Analyzer, and Current Transducer as shown below.

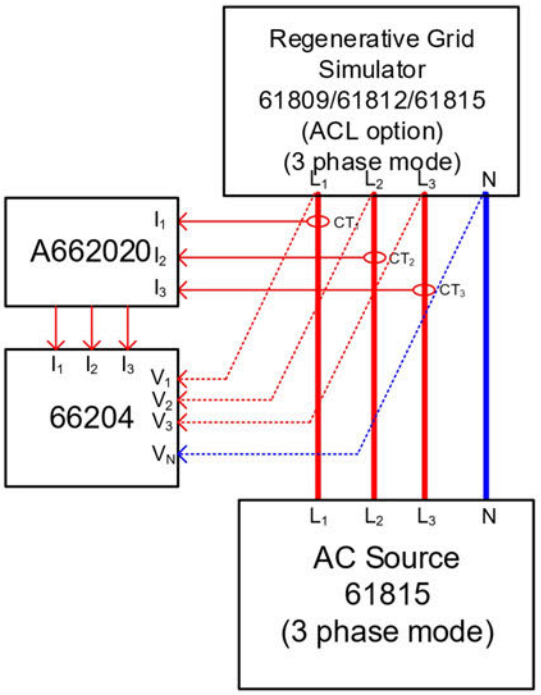


Figure 7-5

Notice When verifying the Chroma 61800 series regenerative AC load (option), be sure to connect the remote sense cable to the AC power output terminal. Refer to section 2.5 for the connection in detail.

7.8.3 Performance Tests

7.8.3.1 Current and CF Setting and Measurement Verification in CC Rectifier Mode

This test verifies if the current setting and measurement accuracy are within specifications when operating in Meas. & Setup (3_Phase) CC Rectifier mode. For each Power Analyzer reading, the front panel display of current measurement should be within the specification.

Regenerative AC Load reading amps = current setting ± inaccuracy

PA (Vac): Vrms voltage measurement of Power Analyzer AC voltage
PA (Iac): Irms current measurement of Power Analyzer AC current
PA (CF): CF measurement of Power Analyzer AC current

Checking current

A. Connect the Regenerative AC Load, AC Source, Power Analyzer, and Current Transducer as shown in Figure 7-5. Use the Power Analyzer to measure the AC Iac current.
B. Enter into Meas. & Setup (3_Phase Mode) to start performing the verification listed in Table 7-2.
C. The current protection of AC load must be greater than 35Arms with power protection larger than 5kVA.

Table 7-2 Current Setting and Measurement Verification Table (with Load)

Φ1									
Model	Current (std.)	Output Voltage	CF	Current Accuracy		PA(Iac) Current	Panel Measured Current	Panel Display Current Spec.	CF Spec. 3% F.S PA(CF)
				Max.	Min.				
61809	29A	50V	2.000	29.23A	28.76A			Std. ±0.20A	
	20A	150V	2.000	20.20A	19.79A			Std. ±0.16A	
	12A	250V	2.000	12.18A	11.81A			Std. ±0.13A	
	8A	350V	2.000	8.16A	7.83A			Std. ±0.11A	
61812	32A	50V	2.000	32.25A	31.74A			Std. ±0.22A	
	25A	150V	2.000	25.23A	24.76A			Std. ±0.19A	
	16A	250V	2.000	16.20A	15.79A			Std. ±0.16A	
	11A	350V	2.000	11.19A	10.80A			Std. ±0.14A	
61815	35A	50V	2.000	35.28A	34.72A			Std. ±0.24A	
	25A	150V	2.000	30.26A	29.73A			Std. ±0.20A	
	18A	250V	2.000	18.22A	17.77A			Std. ±0.17A	
	12A	350V	2.000	12.21A	11.78A			Std. ±0.15A	
Φ2									
Model	Current (std.)	Output Voltage	CF	Current Accuracy		PA(Iac) Current	Panel Measured Current	Panel Display Current Spec.	CF Spec. 3% F.S PA(CF)
				Max.	Min.				
61809	29A	50V	2.000	29.23A	28.76A			Std. ±0.20A	
	20A	150V	2.000	20.20A	19.79A			Std. ±0.16A	
	12A	250V	2.000	12.18A	11.81A			Std. ±0.13A	
	8A	350V	2.000	8.16A	7.83A			Std. ±0.11A	
61812	32A	50V	2.000	32.25A	31.74A			Std. ±0.22A	
	25A	150V	2.000	25.23A	24.76A			Std. ±0.19A	
	16A	250V	2.000	16.20A	15.79A			Std. ±0.16A	

	11A	350V	2.000	11.19A	10.80A			Std. ±0.14A	
61815	35A	50V	2.000	35.28A	34.72A			Std. ±0.24A	
	25A	150V	2.000	30.26A	29.73A			Std. ±0.20A	
	18A	250V	2.000	18.22A	17.77A			Std. ±0.17A	
	12A	350V	2.000	12.21A	11.78A			Std. ±0.15A	
Φ3									
Model	**Current (std.)**	**Output Voltage**	**CF**	**Current Accuracy**		**PA(Iac) Current**	**Front Panel Measured Current**	**Panel Display Current Spec.**	**CF Spec. 3% F.S PA(CF)**
				Max.	**Min.**				
61809	29A	50V	2.000	29.23A	28.76A			Std. ±0.20A	
	20A	150V	2.000	20.20A	19.79A			Std. ±0.16A	
	12A	250V	2.000	12.18A	11.81A			Std. ±0.13A	
	8A	350V	2.000	8.16A	7.83A			Std. ±0.11A	
61812	32A	50V	2.000	32.25A	31.74A			Std. ±0.22A	
	25A	150V	2.000	25.23A	24.76A			Std. ±0.19A	
	16A	250V	2.000	16.20A	15.79A			Std. ±0.16A	
	11A	350V	2.000	11.19A	10.80A			Std. ±0.14A	
61815	35A	50V	2.000	35.28A	34.72A			Std. ±0.24A	
	25A	150V	2.000	30.26A	29.73A			Std. ±0.20A	
	18A	250V	2.000	18.22A	17.77A			Std. ±0.17A	
	12A	350V	2.000	12.21A	11.78A			Std. ±0.15A	

7.8.3.2 Power and CF Setting and Measurement Verification in CS Rectifier Mode

This test verifies if the power setting and measurement accuracy are within specifications when operating in Meas. & Setup (3_Phase) CS Rectifier mode. For each Power Analyzer reading, the front panel display of power measurement should be within the specification.

Regenerative AC Load reading power = power setting ± inaccuracy

PA (Vac): Vrms voltage measurement of Power Analyzer AC voltage
PA (S): VA measurement of Power Analyzer apparent power S
PA (CF): CF measurement of Power Analyzer AC voltage

Checking current

A. Connect the Regenerative AC Load, AC Source, Power Analyzer, and Current Transducer as shown in Figure 7-5. Use the Power Analyzer to measure the apparent power S.
B. Enter into Meas. & Setup (3_Phase Mode) to start performing the verification listed in Table 7-3.
C. Turn on the AC source and set the output voltage (sinewave) as Table 7-3 shows. The current protection of AC load must be greater than 35Arms with power protection larger than 5kVA.

Table 7-3 Power Measurement Verification Table

Φ1									
Model	**Power (std.)**	**Output Voltage**	**CF**	**Power Accuracy**		**PA(Iac) Power**	**Panel Measured power**	**Panel Display Power Spec.**	**CF Spec. 3% F.S PA(CF)**
				Max.	**Min.**				
61809	1200VA	50V	1.414	1212.6VA	1187.4VA			Std. ±28.8VA	
	2000VA	150V	1.414	2015.0VA	1985.0VA			Std. ±32.0VA	
	2500VA	250V	1.414	2516.5VA	2483.5VA			Std. ±34.0VA	
	3000VA	350V	1.414	3018.0VA	2982.0VA			Std. ±36.0VA	
61812	1500VA	50V	1.414	1516.5VA	1483.5VA			Std. ±38.0VA	
	2500VA	150V	1.414	2519.5VA	2480.5VA			Std. ±42.0VA	
	3000VA	250V	1.414	3021.0VA	2979.0VA			Std. ±44.0VA	
	4000VA	350V	1.414	4024.0VA	3976.0VA			Std. ±48.0VA	
61815	1600VA	50V	1.414	1619.8VA	1580.2VA			Std. ±46.4VA	
	2500VA	150V	1.414	2522.5VA	2477.5VA			Std. ±50.0VA	
	3500VA	250V	1.414	3525.5VA	3474.5VA			Std. ±54.0VA	
	5000VA	350V	1.414	5030.0VA	4970.0VA			Std. ±60.0VA	
Φ2									
Model	**Power (std.)**	**Output Voltage**	**CF**	**Power Accuracy**		**PA(Iac) Power**	**Panel Measured Power**	**Panel Display Power Spec.**	**CF Spec. 3% F.S PA(CF)**
				Max.	**Min.**				
61809	1200VA	50V	1.414	1212.6VA	1187.4VA			Std. ±28.8VA	
	2000VA	150V	1.414	2015.0VA	1985.0VA			Std. ±32.0VA	
	2500VA	250V	1.414	2516.5VA	2483.5VA			Std. ±34.0VA	
	3000VA	350V	1.414	3018.0VA	2982.0VA			Std. ±36.0VA	
61812	1500VA	50V	1.414	1516.5VA	1483.5VA			Std. ±38.0VA	
	2500VA	150V	1.414	2519.5VA	2480.5VA			Std. ±42.0VA	
	3000VA	250V	1.414	3021.0VA	2979.0VA			Std. ±44.0VA	
	4000VA	350V	1.414	4024.0VA	3976.0VA			Std. ±48.0VA	
61815	1600VA	50V	1.414	1619.8VA	1580.2VA			Std. ±46.4VA	
	2500VA	150V	1.414	2522.5VA	2477.5VA			Std. ±50.0VA	
	3500VA	250V	1.414	3525.5VA	3474.5VA			Std. ±54.0VA	
	5000VA	350V	1.414	5030.0VA	4970.0VA			Std. ±60.0VA	
Φ3									
Model	**Power (std.)**	**Output Voltage**	**CF**	**Power Accuracy**		**PA(Iac) Power**	**Panel Measured Power**	**Panel Display Power Spec.**	**CF Spec. 3% F.S PA(CF)**
				Max.	**Min.**				
61809	1200VA	50V	1.414	1212.6VA	1187.4VA			Std. ±28.8VA	
	2000VA	150V	1.414	2015.0VA	1985.0VA			Std. ±32.0VA	
	2500VA	250V	1.414	2516.5VA	2483.5VA			Std. ±34.0VA	
	3000VA	350V	1.414	3018.0VA	2982.0VA			Std. ±36.0VA	
61812	1500VA	50V	1.414	1516.5VA	1483.5VA			Std. ±38.0VA	
	2500VA	150V	1.414	2519.5VA	2480.5VA			Std. ±42.0VA	
	3000VA	250V	1.414	3021.0VA	2979.0VA			Std. ±44.0VA	
	4000VA	350V	1.414	4024.0VA	3976.0VA			Std. ±48.0VA	
61815	1600VA	50V	1.414	1619.8VA	1580.2VA			Std. ±46.4VA	
	2500VA	150V	1.414	2522.5VA	2477.5VA			Std. ±50.0VA	
	3500VA	250V	1.414	3525.5VA	3474.5VA			Std. ±54.0VA	
	5000VA	350V	1.414	5030.0VA	4970.0VA			Std. ±60.0VA	

7.8.3.3 Resistance Setting and Measurement Verification in CR Mode

This test verifies if the resistance setting and measurement accuracy are within specifications when operating in Meas. & Setup (3_Phase) CR mode. For each Power Analyzer reading, the front panel display of current measurement should be within the specification.

Regenerative AC Load reading current = resistance setting (convert to current) ± inaccuracy

PA (Vac): Vrms voltage measurement of Power Analyzer AC voltage
PA (Iac): Irms measurement of Power Analyzer AC current
PA (F): frequency measurement of Power Analyzer AC voltage

Checking current

A. Connect the Regenerative AC Load, AC Source, Power Analyzer, and Current Transducer as shown in Figure 7-5. Use the Power Analyzer to measure the AC Irms.
B. Enter into Meas. & Setup (3_Phase Mode) to start performing the verification listed in Table 7-4.
C. Turn on the AC source and set the output voltage (sinewave) as Table 7-4 shows. The current protection of AC load must be greater than 35Arms with power protection larger than 5kVA.

Table 7-4 Resistance Setting and Measurement Verification Table (with Load)

Φ1								
Model	**Current (std.)**	**Output Voltage**	**Current Accuracy**		**PA(Iac) Current**	**Panel Measured Current**	**Panel Display Current Spec.**	**CF Spec. 3% F.S PA(CF)**
			Max.	**Max.**				
61809	1.72Ω	50V	29.23A	28.76A			Std. ±0.20A	
	7.5Ω	150V	20.20A	19.79A			Std. ±0.16A	
	20.83Ω	250V	12.18A	11.81A			Std. ±0.13A	
	43.75Ω	350V	8.16A	7.83A			Std. ±0.11A	
61812	1.56Ω	50V	32.25A	31.74A			Std. ±0.22A	
	6Ω	150V	25.23A	24.76A			Std. ±0.19A	
	15.62Ω	250V	16.20A	15.79A			Std. ±0.16A	
	31.81Ω	350V	11.19A	10.80A			Std. ±0.14A	
61815	1.42Ω	50V	35.28A	34.72A			Std. ±0.24A	
	6Ω	150V	30.26A	29.73A			Std. ±0.20A	
	13.88Ω	250V	18.22A	17.77A			Std. ±0.17A	
	29.16Ω	350V	12.21A	11.78A			Std. ±0.15A	
Φ2								
Model	**Current (std.)**	**Output Voltage**	**Current Accuracy**		**PA(Iac) Current**	**Panel Measured Current**	**Panel Display Current Spec.**	**CF Spec. 3% F.S PA(CF)**
			Max.	**Max.**				
61809	1.72Ω	50V	29.23A	28.76A			Std. ±0.20A	
	7.5Ω	150V	20.20A	19.79A			Std. ±0.16A	
	20.83Ω	250V	12.18A	11.81A			Std. ±0.13A	
	43.75Ω	350V	8.16A	7.83A			Std. ±0.11A	
61812	1.56Ω	50V	32.25A	31.74A			Std. ±0.22A	
	6Ω	150V	25.23A	24.76A			Std. ±0.19A	
	15.62Ω	250V	16.20A	15.79A			Std. ±0.16A	
	31.81Ω	350V	11.19A	10.80A			Std. ±0.14A	
61815	1.42Ω	50V	35.28A	34.72A			Std. ±0.24A	

	6Ω	150V	30.26A	29.73A			Std. ±0.20A	
	13.88Ω	250V	18.22A	17.77A			Std. ±0.17A	
	29.16Ω	350V	12.21A	11.78A			Std. ±0.15A	
Φ3								
Model	**Current (std.)**	**Output Voltage**	**Current Accuracy**		**PA(Iac) Current**	**Panel Measured Current**	**Panel Display Current Spec.**	**CF Spec. 3% F.S PA(CF)**
			Max.	**Max.**				
61809	1.72Ω	50V	29.23A	28.76A			Std. ±0.20A	
	7.5Ω	150V	20.20A	19.79A			Std. ±0.16A	
	20.83Ω	250V	12.18A	11.81A			Std. ±0.13A	
	43.75Ω	350V	8.16A	7.83A			Std. ±0.11A	
61812	1.56Ω	50V	32.25A	31.74A			Std. ±0.22A	
	6Ω	150V	25.23A	24.76A			Std. ±0.19A	
	15.62Ω	250V	16.20A	15.79A			Std. ±0.16A	
	31.81Ω	350V	11.19A	10.80A			Std. ±0.14A	
61815	1.42Ω	50V	35.28A	34.72A			Std. ±0.24A	
	6Ω	150V	30.26A	29.73A			Std. ±0.20A	
	13.88Ω	250V	18.22A	17.77A			Std. ±0.17A	
	29.16Ω	350V	12.21A	11.78A			Std. ±0.15A	

8. Remote Operation

8.1 Introduction

The Regenerative Grid Simulator is able to be controlled remotely via USB, GPIB, or LAN.

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 command from the host.

8.1.1 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 Regenerative Grid Simulator USB Interface supports USBTMC, so if the PC's operating system (OS) supports USBTMC (installed NI-VISA runtime version 3.00 or above) there is no need to install other drivers. The operating system will search for the standard USBTMC driver installation program automatically.

If the PC OS does not support USBTMC, it is suggested to install the NI-VISA runtime version 3.00 or above first. When the installation of NI-VISA runtime is done, the USBTMC driver program is stored in OS. The PC can communicate with the Regenerative Grid Simulator via NI-VISA after using USB once connected.

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

8.1.2 GPIB Interface

The default of GPIB address is 30 and it can only be changed from the "Configuration" menu (see 3.4.2.2.)

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 Regenerative Grid Simulator sets the SRQ to be true if there is a service request.	SR1
Remote/Local	When the Regenerative Grid Simulator is powered on in local mode, it can operate the front panel. In remote mode, all other touch buttons are invalid except . Tapping can return to local mode.	RL1

8.1.3 LAN Interface

To remote program a Regenerative Grid Simulator via a PC with LAN interface, confirm the IP address, Gateway address and Net Mask in advance. See 3.4.2 for detail settings. To ensure reliable data transmission, TCP is used for data transmission and the communication port is 5025.

8.1.4 CAN Interface

The pin definition is listed in the table below.

Pin	Signal	Direction	Description
1	NC	-	Not connected
2	CAN_L	Input or Output	CAN differential signal (Low)
3	DGND	-	Digital Ground
4	NC	-	Not connected
5	NC	-	Not connected
6	NC	-	Not connected
7	CAN_H	Input or Output	CAN differential signal (High)
8	NC	-	Not connected
9	NC	-	Not connected

8.2 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.

8.2.1 Conventions

Angle brackets	<	>	Items in angle brackets are parameter abbreviations.
Vertical bar		|	Vertical bar separates alternative parameters.
Square brackets	[	]	Items in square brackets are optional. For example, OUTP [: STATe] means that : STATe may be omitted.
Braces	{	}	Braces indicate the parameters that may be repeated. The notation <A> {<, B>} means that parameter "A" must be entered while parameter "B" may be omitted or entered once or many times.

8.2.2 Numerical Data Formats

All data programmed to or returned from the Regenerative Grid Simulator are in ASCII format. The data can be numerical or character string.

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

8.2.3 Boolean Data Format

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

8.2.4 Character Data Format

The character strings returned by 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.

8.2.5 Basic Definition

Command Tree Table:
The commands of the Regenerative Grid Simulator are structured hierarchically (i.e. tree system). The full path must be specified to obtain a particular command. The path is represented in the table by placing the highest node in the farthest left position of the hierarchy. Lower nodes in the hierarchy are indented in the position to the right under the parent node.

Program Header:
Program header is the key word to identify the command according to the IEEE 488.2 syntax described in section 8.4. The Regenerative Grid Simulator accepts characters in both upper and lower cases without any distinction. 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:
Instrument-controlled header can be applied to all instrument commands. Each header has a long form and a short form. The Regenerative Grid Simulator 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 in this section. The short form of 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 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 (10 decimals).
(3) <NL> <END>: new line with EOI.

Notice The response message is terminated by <NL> <END> for GPIB, and <NL> for USB and LAN.

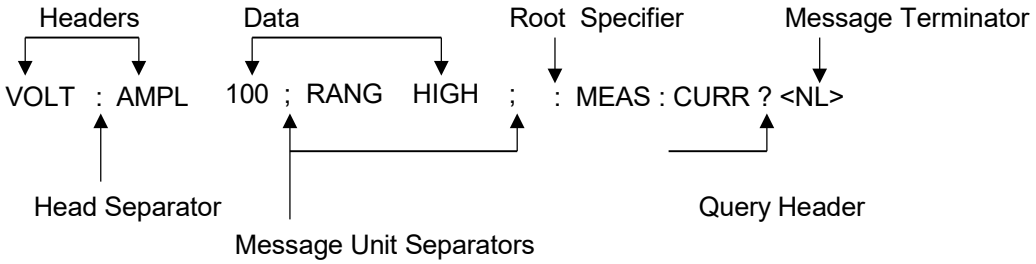


Figure 8-1 Structure of Command Message

8.3 Traversal of the Command Tree

Multiple 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 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.

8.4 Commands of Regenerative Grid Simulator

This section addresses syntax and parameters of all commands for the Regenerative Grid Simulator. The examples are common for each command.

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

8.4.1 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. The command commands and queries are listed in alphabetic order.

*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 Standard Event registers are set, the ESB of Status Byte Register is set as well.

Bit Configuration of Standard Event Status Enabled Register

Bit Position	7	6	5	4	3	2	1	0
Bit Name	PON	- - -	CME	EXE	DDE	QYE	- - -	OPC

CME = Command Error
EXE = Execution Error
PON = Power On
DDE = Device-dependent error
OPC = Operation Completed
QYE = Query Error

*ESE?

Return standard event status enabled

*ESR?

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

*IDN?

Return the Regenerative Grid Simulator identification string.
Return Parameter Chroma,61815,00000000123456,1.00
Chroma : Company name
61815 : Model name
00000000123456 : Serial number
1.00 : Firmware version

*RCL<n> Restore the values of specified group that stored in memory previously.
Parameter 0 - 10, (0: The factory default.)

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

*RST It resets the Regenerative Grid Simulator to the initial states. It's better to wait for 3 seconds to send the next command.

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

*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? It queries the self-test result of the Regenerative Grid Simulator.

8.4.2 Instrument Command Dictionary

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

8.4.2.1 SYSTEM Sub-System

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

SYSTem:ERRor?
Description : This command queries the error string of the command parser.
Query Syntax : SYSTem:ERRor?

Parameter : None
Return Parameter : Error string response

0,"No error"	-113,"Undefined header"	-211,"Data stale"
-101,"Invalid character"	-121,"Invalid character in number"	-221,"Setting conflict"
-102,"Syntax error"	-123,"Numeric overflow"	-222,"Data out of range"
-103,"Invalid separator"	-124,"Too many digits"	-223,"Too much data"
-104,"Data type error"	-131,"Invalid suffix"	-224,"Self-test failed"
-105,"GET not allowed"	-141,"Invalid character data"	-225,"Too many errors"
-106,"Illegal parameter value"	-148,"Character data not allowed"	-226,"Data exceed Vpeak value"
-108,"Parameter not allowed"	-151,"Invalid string data"	-410,"INTERRUPTED"
-109,"Missing parameter"	-158,"String data not allowed"	-430,"DEADLOCKED"
-112,"Program mnemonic too long"	-203,"Command protected"	-440,"UNTERMINATED"

SYSTem:VERSion?

Description : This query requests the Regenerative Grid Simulator to identify itself.
Query Syntax : SYSTem:VERSion?
Parameter : None
Return Parameter : Current version (XX.XX)

SYSTem:LOCal

Description : This command can only be used under the control of LAN and USB. If SYST : LOC is programmed, the Regenerative Grid Simulator 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 can only be used under the control of LAN and USB. If SYST : REM is programmed, the Regenerative Grid Simulator will be set in the REMOTE state, and the front panel will be disabled except the “<PAGE/EXIT> button.
Query Syntax : None
Parameter : None
Return Parameter : None

SYSTem:DATE

Description : This command sets the date of the Regenerative Grid Simulator real time clock.
Query Syntax : SYSTem:DATE?
Parameter : <year>,<month>,<day>
Return Parameter : 2013,01,01

SYSTem:TIME

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

SYSTem:VERSion:INTernal? [<n>]

Description : This query requests the Regenerative Grid Simulator to identify the HOST subsystem version.
Query Syntax : SYSTem:VERSion:INTernal? [<n>]
Parameter : <n>: It selects the HOST subsystem, range: 1~2, 1: DSP-CPU1, 2: DSP-CPU2.
Return Parameter : Current version (XX.XX)

SYSTem:MODule:VERSion? <n>[,<m>]

Description : This query requests the Regenerative Grid Simulator to identify the subsystem version of internal power module.
Query Syntax : SYSTem:MODule:VERSion? <n>[,<m>]
Parameter : <n>: It selects the phase of a power module, range: 1~3.
<m>: It selects the subsystem of power module, range: 1~2, 1: AD, 2: DA.
Return Parameter : Current version (XX.XX)

8.4.2.2 INSTRUMENT Sub-System

INSTrument
:EDIT
:Couple
:NSELect
:SELect
:PHASe
:STATus?

INSTrument:EDIT

Description : It is very convenient to use a programmed command to set all phases at the same time for a Regenerative Grid Simulator that is equipped with multiple phases. If INST:EDIT ALL has been programmed, it will sent all phases. INST:EDIT EACH command disables EDIT ALL command.
Query Syntax : INSTrument:EDIT?
Parameter : EACH | ALL
Return Parameter : None

INSTrument:COUPle

Description : It is easy to use a command to program all phases in a Regenerative Grid Simulator with multiple phases. If INST: COUP ALL is programmed, this command will be sent to all phases. INST: COUP NONE command will cancel COUP ALL command.
Query Syntax : INSTrument : COUPle?
Parameter : NONE | ALL
Return Parameter : None

INSTrument:NSELect

Description : This command sets individual output for subsequent commands or queries in the multi-phase model. If INST: COUP NONE has been programmed, the phase selection command will send to a specific output phase set by INSTrument: NSELect. 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 : NSEL 2” and “Meas : VOLT?” are programmed, the Regenerative Grid Simulator will return Φ 2 measurement voltage. INST: NSEL follows the number to select phase.

Query Syntax : INSTrument : NSELect?
Parameter : 1 | 2 | 3
Return Parameter : 1 | 2 | 3

INSTrument:SELect

Description : This command sets individual output for subsequent commands or queries in the multi-phase model. If INST: COUP NONE has been programmed, the phase selection command will send to a 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 Regenerative Grid Simulator will return Φ 2 measurement voltage. INST: SELect follows the number to select phase.

Query Syntax : INSTrument : SELect?
Parameter : OUTPUT1 | OUTPUT2 | OUTPUT3
Return Parameter : 1 | 2 | 3

INSTrument:PHASe

Description : This command switches between single phase and three-phase mode.

Query Syntax : INSTrument : PHASe?
Parameter : THREE | SINGLE
Return Parameter : THREE | SINGLE

INSTrument : STATus?

Description : The command queries the power module status of each phase in Regenerative Grid Simulator

Bit Configuration of Protection Status Register for Each Phase Power Module

Bit Position	15-10	9	8	7	6	5	4	3	2	1	0
State	---	INHIBIT	OVP	INP	OCP	FAN	SHT	OTP	OPP	INT-DA	INT-AD

INHIBIT: Remote Inhibit
OVP: Output Voltage Protection
INP: Line Input Protection
OCP: Over Current Protection
FAN: Fan Failure
SHT: Output Short Circuit Protection
OTP: Over Temperature Protection
OPP: Over Power Protection
INT-DA: DC/AC Power Module Protection
INT-AD: AC/DC Power Module Protection

Query Syntax : INSTrument:STATus?
Return Parameter : 0 ~ 511

INSTrument:STATus:AD?

Description : This command queries the AC/DC power module status of each phase in Regenerative Grid Simulator.
Query Syntax : INSTrument:STATus:AD?
Return Parameter : 0 ~ 4294967295 (2^{32}-1)

Bit[n]	Description	Bit[n]	Description	Bit[n]	Description	Bit[n]	Description
0	AD_VDC_OVP	8	DD_VO_OVP_F	16	DD_IO_REG_OCP	24	AD_MODEL_RES_ERR
1	AD_VDC_UVP	9	DD_VO_UVP_F	17	AD_RLY_STARTFAIL	25	DD_SHORT
2	AD_VRS_OVP	10	AD_IR_OCP	18	AD_PWM_TOP_FAULT	26	AD_MEM_ERR
3	AD_VTR_OVP	11	AD_IT_OCP	19	AD_PWM_BOT_FAULT	27	DD_LLC_STARTFAIL
4	AD_VST_OVP	12	AD_IS_OCP	20	AD_AC_STARTFAIL	28	AD_VAC_UBL
5	AD_VRS_UVP	13	AD_Vd_OVP	21	AD_PFC_STARTFAIL	29	DD_IP_OCP
6	AD_VTR_UVP	14	DD_IO_SRC_OCP	22	AD_HARD_ERR	30	AD_Vd_UVP
7	AD_VST_UVP	15	AD_OTP	23	DD_VO_UVP_S	31	AD_FRE_ERR

INSTrument:STATus:DA?

Description : This command queries the DC/AC power module status of each phase in Regenerative Grid Simulator.
Query Syntax : INSTrument:STATus:DA?
Return Parameter : 0 ~ 4294967295 (2^{32}-1)

Bit[n]	Description	Bit[n]	Description	Bit[n]	Description	Bit[n]	Description
0	DA_OCP	8	DA_HARD_ERR	16	DA_IC_OCP	24	DA_SRAM_ERR
1	DA_UUT_OVP_VLN	9	DA_PWM_R_FAULT	17	DA_VDAMP_OVP	25	DA_CALIB_ERR
2	DA_OVP	10	DA_PWM_L_FAULT	18	DA_OCP_S	26	-
3	DA_FW_PWMSHORT	11	DA_OTP	19	DA_WIRE_LOSS	27	-
4	DA_UUT_OVP_VLL	12	DA_UUT_UVP	20	DA_UTP	28	-
5	DA_OPP	13	DA_SHORT	21	DA_UUT_OVP_VDC	29	-
6	DA_SENSE_FAULT	14	DA_UUT_OFP	22	DA_UUT_FAULT	30	-
7	DA_ISHARE_ERR_F	15	DA_UUT_UFP	23	DA_PLL_FAIL	31	-

INSTrument:OPTion

Description : This command sets the simulator to be in AC Source mode or AC Load mode.
Query Syntax : INSTrument:OPTion?
Parameter : SOURCE | LOAD
Return Parameter : SOURCE | LOAD

8.4.2.3 FETCH and MEASURE Sub-System

FETCh | MEASure
[: SCALar]
: CURRent
: AC? It queries the rms current of AC component.
: DC? It queries the DC current level.
: ACDC? It queries the current (AC+DC) rms.
: AMPLitude:MAXimum? It queries the peak current.
: CRESTfactor? It queries the current crest factor.
: INRush? It queries the inrush current.
: FREQuency? It queries the frequency.
: POWer

```
        : AC
            [: REAL]?              It queries the real power.
            : APParent?            It queries the apparent power.
            : REACtive?            It queries the reactive power.
            : PFACtor?             It queries the power factor.
            : TOTal?               It queries the total power.
            : TOTal:APParent?      It queries the total apparent power.
    :VOLTage
        : AC?                      It queries the rms voltage of AC component.
        : DC?                      It queries the DC voltage.
        : ACDC?                    It queries the rms voltage
        : AMPLitude:MAXimum?       It queries the peak voltage.
    :LINE
        :V12?                      It queries the voltage difference of phase 1 & 2.
        :V23?                      It queries the voltage difference of phase 2 & 3.
        :V31?                      It queries the voltage difference of phase 3 & 1.
```

This command enables you to get measurement data from the Regenerative Grid Simulator via MEASure and FETCh. MEASure triggers the acquisition to get new data before returning data, while FETCh returns the previously acquired data from measurement buffer.

FETCh [: SCALar] : CURRent : AC?
MEASure [: SCALar] : CURRent : AC?

Description : These queries return the rms current of 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 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 watt.
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-ampere.
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-ampere. 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 of real power that is output from 3-phase output terminal in watt.
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 3-phase output terminal in volt-ampere.
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 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 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>

8.4.2.4 OUTPUT Sub-System

OUTPut
[: STATe]
: RELay
: SLEW
: VOLTage
: AC
: DC
:FREQency
:OFF
: VOLTage
: DC
: COUPling
: MODE
: PROTection
:CLEar
:STATe?

OUTPut [:STATe]
Description : This command enables or disables the output of the Regenerative Grid Simulator. Disabled output is to set the output voltage amplitude to 0 Volt.
Query Syntax : OUTPut [: STATe]?
Parameter : OFF | ON
Return Parameter : OFF | ON

OUTPut:RELay
Description : This command sets output relay on or off.
Query Syntax : OUTPut : RELay?
Parameter : OFF | ON, ON sets the output relay of the Regenerative Grid Simulator on (close), OFF sets the output relay of the Regenerative Grid Simulator off (open).
Return Parameter : OFF | ON

OUTPut:SLEW:VOLTage : AC
Description : This command sets the slew rate when the AC output voltage changes.

Query Syntax : OUTPut : SLEW : VOLTage : AC?
Parameter : <NR2>, the valid range is 0.01V/ms ~ 2000.00V/ms.
Return Parameter : <NR2>

OUTPut:SLEW:VOLTage : DC
Description : This command sets the rise slew rate when DC output voltage changes.
Query Syntax : OUTPut : SLEW : VOLTage : DCR?
Parameter : <NR2>, the valid range is 0.01V/ms ~ 2000.00V/ms.
Return Parameter : <NR2>

OUTPut:SLEW:OFF:VOLTage:DC
Description ：This command sets the fall slew rate when the DC output voltage is off.
Query Syntax ：OUTPut : SLEW : VOLTage : DCF?
Parameter ：<NR2>, the valid range is 0.01V/ms ~ 2000.00V/ms.
Return Parameter ：<NR2>

OUTPut:SLEW:FREQuency
Description : This command sets the slew rate when the output frequency changes
Query Syntax : OUTPut : SLEW : FREQuency?
Parameter : <NR2>, the valid range is 0.01 Hz/ms ~ 1000.00Hz/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 and “FIXED” mode is the general 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

OUTPut:PROTection:STATe?
Description :.

Bit Configuration of Protection Status Register for Each Phase Power Module

Bit Position	15-10	9	8	7	6	5	4	3	2	1	0
State	---	INHIBIT	OVP	INP	OCP	FAN	SHT	OTP	OPP	INT-DA	INT-AD

INHIBIT: Remote Inhibit
OVP: Output voltage protection
INP: Line input protection
OCP: Over current protection
FAN: Fan failure
SHT: Output short circuit protection
OTP: Over temperature protection
OPP: Over power protection
INT-DA: DC/AC power module protection
INT-AD: AC/DC power module protection

Query Syntax : OUTPut:PROTection:STATe?
Return Parameter : 0 ~ 511

8.4.2.5 MSTSLV Subsystem

MSTSLV:
FUNC:
SEL:
SLVNUM
TERM

MSTSLV**:**FUNC
Description : This command sets parallel or unparallel.
Query Syntax : MSTSLV :FUNC?
Parameter : DISABLE | ENABLE
Return Parameter : DISABLE | ENABLE

MSTSLV**:**FUNC:STSTus?
Description ：This command queries the parallel status at present. It returns WAIT to indicate that it is under paralleling or unparalleling.
Query Syntax ：MSTSLV :FUNC : STATus?
Return Parameter ：DISABLE | ENABLE | WAIT

MSTSLV:SEL
Description : This command sets MASTER, SLAVE1, SLAVE2…
Query Syntax : MSTSLV:SEL?
Parameter : <NR1>, range: 0~2, 0:MASTER, 1:SLAVE01, and 2:SLAVE02. (See chapter 6 for parallel units.)
Return Parameter : <NR1>

MSTSLV:SLVNUM
Description : If MSTSLV:SEL 0 is set , this command can set the number of SLAVEs.
Query Syntax : MSTSLV:SLVNUM?
Parameter : <NR1>, range:1~2，1: SLAVE no. is 1，2: SLAVE no. is 2.
Return Parameter : <NR1>

MSTSLV:TERM
Description : This command sets terminal ON or OFF.
Query Syntax : MSTSLV:SLVTERM?
Parameter : OFF | ON
Return Parameter : OFF | ON

8.4.2.6 SOURCE Sub-System

[SOURce :]
CURRent
: LIMit
: DELay
: INRush
: STARt
: INTerval
FREQency
[: {CW | IMMediate}]
: LIMit
VOLTage
[: LEVel][: IMMediate][:AMPLitude]
: AC
: DC
: LIMit
: AC
: DC
: PLUS
: MINus
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 Regenerative Grid Simulator for 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 delayed for triggering over current protection.
Query Syntax : [SOURce :] CURRent : DELay?
Parameter : <NR2>, the valid range is 0.0 ~ 3.0 (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 inrush current measurement.
Query Syntax : [SOURce :] CURRent : INRush : INTerval?
Parameter : <NR2>, the valid range is 0 ~ 9999 (unit: ms.)
Return Parameter : <NR2>

[SOURce :] CURRent : PROTection

Description : This command sets the value for over current protection.
Query Syntax : [SOURce:]CURRent:PROTection?
Parameter : <NR2>, the valid range is 0.1 to the model's maximum operable current *1.05% (unit: A.)
Return Parameter : <NR2>

[SOURce:] FREQuency [: {CW | IMMediate}]

Description : This command sets the output waveform frequency for the Regenerative Grid Simulator in Hz.
Query Syntax : [SOURce :] FREQuency [: {CW | IMMediate}]?
Parameter : <NR2>, the valid range is 30.00 ~ 100.00 (unit: Hz.)
Return Parameter : <NR2>

[SOURce:] FREQuency : LIMit

Description : This command sets the output frequency limit for the Regenerative Grid Simulator.
Query Syntax : [SOURce :] FREQuency : LIMit?
Parameter : <NR2>, the valid range is 30.00 ~ 100.00 (unit: Hz)
Return Parameter : <NR2>

[SOURce:] POWer:PROTection

Description : This command sets the OPP (Over Power Protection) for the Regenerative Grid Simulator.
Query Syntax : [SOURce :] POWer:PROTection?
Parameter : <NR2>, the valid range is 0.0 ~ maximum power of 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 ~ 350.0.

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 -495 ~ 495.
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 Vdc Limit(+).
Query Syntax : [SOURce :] VOLTage : LIMit : DC : PLUS?
Parameter : <NR2>, the valid range is -495 ~ 495 (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 -495 ~ 495 (unit: V)
PS: The upper limit cannot exceed Vdc Limit(+).
Return Parameter : <NR2>

[SOURce:] FUNCtion : SHAPe
Description : This command specifies the waveform buffer. The Regenerative Grid Simulator output has two buffers and you need to specify to use the contents of the waveform buffer A or B.
Query Syntax : [SOURce :] FUNCtion : SHAPe?
Parameter : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> |
Return Parameter : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>

[SOURce:] FUNCtion : SHAPe : A
Description : This command specifies the waveform buffer A for use.
Query Syntax [SOURce :] FUNCtion : SHAPe : A?
Parameter : SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>
Return Parameter : SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>

[SOURce:] FUNCtion : SHAPe : A : MODE
Description : This command selects the mode for the clipping in waveform buffer A for use.
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 for the clipping in waveform 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 for the clipping in waveform 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 specifies the waveform buffer B for use.
Query Syntax : [SOURce :] FUNCtion : SHAPe : B?
Parameter : SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>
Return Parameter : SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>

[SOURce:] FUNCtion : SHAPe : B : MODE
Description : This command selects the mode for the clipping in waveform buffer B for use.
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 for the clipping in waveform 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 for the clipping in waveform buffer B.
Query Syntax : [SOURce :] FUNCtion : SHAPe : B : AMP?
Parameter : <NR2>, the valid range is 0.0% ~ 100%.
Return Parameter : <NR2>

8.4.2.7 CONFIGURE Sub-System

[SOURce:]
CONFigure
: INHibit
: EXTernal
: COUPling
: EXTON
: VOLTage
: SENSe

[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 sets if enabling 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 be AC_AMPLIFIER or DC_LEVEL to control the Regenerative Grid Simulator 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

[SOURce:] CONFigure : VOLTage : SENSe

Description : This command sets the measurement position for output voltage.
Query Syntax : [SOURce :] CONFigure : VOLTage : SENSe?
Parameter : LOCAL | REMOTE
Return Parameter : LOCAL | REMOTE

[SOURce:] CONFigure : AVERage

Description : This command sets the average times for measurement.
Query Syntax : [SOURce :] CONFigure : AVERage?
Parameter : 1 | 2 | 4 | 8 | 16 | 32
Return Parameter : 1 | 2 | 4 | 8 | 16 | 32

8.4.2.8 PHASE Sub-System

[SOURce:]

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

[SOURce:] PHASe: ON

Description : This command sets the transition angle when the waveform shifts. The default is ON meaning 0 degree.
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 of 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 of 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 sets the operation mode in 3-phase mode.
Query Syntax : [SOURce :]PHASe:THREE?
Parameter : INDEPEND | SAMEFREQ | BALANCE
Return Parameter : INDEPEND | SAMEFREQ | BALANCE

[SOURce:]PHASe:THREE:BALanced
Description : This command sets the voltage operation mode in 3-phase balanced mode.
Query Syntax : [SOURce :]PHASe:THREE:BAL?
Parameter : PHASE | LINE

8.4.2.9 STATUS Sub-system

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 the shield when specific bit is enabled from 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 Questionable Condition register. It is a read only register that saves the questionable condition of Regenerative Grid Simulator 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 Questionable Event register. It is a read only register that saves all items that passed Questionable NTR and/or PTR filter. If the QUES bit in Service Request Enabled register has been set and Questionable Event register > 0, the QUES of Status Byte register will be set too.
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 Questionable Enable register. The register is the shield when specific bit is enabled to set the QUES bit of Status Byte register from 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 register. The operation of these registers is the same as polarity filter of Questionable Enable and Questionable Event registers that lead 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 make that bit in the Questionable Event register to be set.

* 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 make that bit in the Questionable Event register to be set.

* If the two same bits in both NTR and PTR registers are set to 0, none 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	15-10	9	8	7	6	5	4	3	2	1	0
Condition	---	INHIBIT	OVP	INP	OCP	FAN	SHT	OTP	OPP	INT-DA	INT-AD

INHIBIT: Remote Inhibit
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-DA: DC/AC power module protection
INT-AD: AC/DC power module 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 Questionable PTR register. Please refer to the description of previous command.
Query Syntax : STATus : QUEStionable : PTRansition?
Parameter : <NR1>, the valid range is 0 ~ 511.
Return Parameter : <NR1>

8.4.2.10 TRACE Sub-system

TRACe

: RMS

TRACe

Description : This command sets the user-defined waveform data. It needs 1024 data points to create a period of waveform. You have to 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=1~6, <amplitude>:<NR1>, the valid

range is -32767 ~ 32767.
Example : TRACe US1 100 200 …32767... 500 800 = 1024 points
This command requires about 1 second for execution.

TRACe : RMS
Description : This command sets the rms value of user's waveform. You need to calculate the root mean square value for 1024 data points.
Syntax : TRACe : RMS <waveform_name>, <rms>
Parameter : <waveform_name>:US<n>, n=1~6, <rms>:<NR1>, the valid range is 0 ~ 32767.
Example : TRACe : RMS US1 27000

8.4.2.11 LIST Sub-system

[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 list mode.
Query Syntax : [SOURce:] LIST : Coupling?
Parameter : ALL | NONE
Return Parameter : ALL | NONE

[SOURce:]LIST : TRIG
Description : This command sets the trigger type of 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 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 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 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 waveform buffer list points.
Query Syntax : [SOURce:] LIST : SHAPe?
Parameter : <arg>,<arg>, …,<arg>
<arg> : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>
Return Parameter : <arg>,<arg>, …,<arg>

[SOURce :] LIST : BASE

Description : This command sets the time base of 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 AC start voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : AC : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is 0.0 ~ 350.0.
Return Parameter : <NR1>, …, <NR2>

[SOURce :] LIST : VOLTage : AC : END

Description : This command sets the sequence of AC end voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : AC : END?
Parameter : <NR2>, …, <NR2>, the valid range is 0.0 ~ 350.0.
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : VOLTage : DC : STARt

Description : This command sets the sequence of DC start voltage list points.
Query Syntax : [SOURce:] LIST : VOLTage : DC : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is -495 ~ 495.
Return Parameter : <NR1>

[SOURce :] LIST : VOLTage : DC : END

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

Parameter : <NR2>, …, <NR2>, the valid range is -495 ~ 495.
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : FREQuency : STARt
Description : This command sets the sequence of start frequency list points.
Query Syntax : [SOURce:] LIST : FREQuency : STARt?
Parameter : <NR2>, …, <NR2>, the valid range is 30.00 ~ 100.00 (unit: Hz.)
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : FREQuency : END
Description : This command sets the sequence of end frequency list points.
Query Syntax : [SOURce:] LIST : FREQuency : END?
Parameter : <NR2>, …, <NR2>, the valid range is 30.0 ~ 100.00 (unit: Hz.)
Return Parameter : <NR2>, …, <NR2>

[SOURce :] LIST : DEGRee
Description : This command sets the sequence of 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 LIST mode in OFF, ON execution state after setting OUTPut: MODE LIST. If you wish to change the parameters, it's necessary to set TRIG OFF then OUTPut: MODE FIXED. Then, set OUTPut : MODE LIST again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

8.4.2.12 PULSE Sub-system

[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 AC voltage for the duty cycle of PULSE mode.
Query Syntax : [SOURce :] PULSE : VOLTage : AC?
Parameter : <NR2>, the valid range is 0.0 ~ 350.0.
Return Parameter : <NR2>

[SOURce :] PULSe : VOLTage : DC
Description : This command sets the DC voltage for the duty cycle of PULSE mode.
Query Syntax : [SOURce :] PULSE : VOLTage : DC?
Parameter : <NR2>, the valid range is -495 ~ 495.
Return Parameter : <NR2>

[SOURce :] PULSe : FREQuency
Description : This command sets the frequency for the duty cycle of PULSE mode.
Query Syntax : [SOURce :] PULSE : FREQuency?
Parameter : <NR2>, the valid range is 30.0 ~ 100.00 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] PULSe : SHAPe
Description : This command selects the waveform buffer for PULSE mode.
Query Syntax : [SOURce :] PULSE : SHAPe?
Parameter : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>
Return Parameter : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>

[SOURce :] PULSe : SPHase
Description : This command sets the start phase angle of duty cycle for 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 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 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 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 PULSE mode in OFF execution state after setting OUTPut : MODE PULSE. If you want to change the parameters, it's necessary to set TRIG OFF then OUTPut : MODE FIXED. Then, set OUTPut : MODE PULSE again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

8.4.2.13 STEP Sub-system

[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 STEP mode.
Query Syntax : [SOURce :] STEP : VOLTage : AC?
Parameter : <NR2>, the valid range is 0.0 ~ 350.0.

Return Parameter : <NR2>

[SOURce :] STEP : VOLTage : DC
Description : This command sets the initial DC voltage of STEP mode.
Query Syntax : [SOURce :] STEP : VOLTage : DC?
Parameter : <NR2>, the valid range is -495 ~ 495.
Return Parameter : <NR2>

[SOURce :] STEP : FREQuency
Description : This command sets the initial frequency of STEP mode.
Query Syntax : [SOURce :] STEP : FREQuency?
Parameter : <NR2>, the valid range is 30.0 ~ 100.00 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] STEP : SHAPe
Description : This command selects the waveform buffer of STEP mode.
Query Syntax : [SOURce :] STEP : SHAPe?
Parameter : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>
Return Parameter : A | B | SINE | SQUA | TRIAN | CSIN | DST<01..30> | USR<01..30>

[SOURce :] STEP : SPHase
Description : This command sets the start phase angle of 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 -350.0 ~ 350.0.
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 -495 ~ 495.
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 -100.00 ~ 100.00 (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 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 TRIP type of 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 STEP mode in OFF, ON execution state after setting OUTPut : MODE STEP. If you want to change the parameters, it's necessary to set TRIG OFF then OUTPut : MODE FIXED. Then, set OUTPut : MODE STEP again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

8.4.2.14 SYNTHESIS Sub-system

[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. You can program 6 waveforms 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 order is 50.
Query Syntax : [SOURce :] SYNThesis : AMPLitude?
Parameter : <NR2>, …, <NR2>
Valid range:

Order	Value	Percentage
2 ~ 10	0 ~ 90.0	0 ~ 30.00
11 ~ 20	0 ~ 60.0	0 ~ 20.00
21 ~ 30	0 ~ 30.0	0 ~ 10.00
31 ~ 40	0 ~ 30.0	0 ~ 10.00
41 ~ 50	0 ~ 15.0	0 ~ 5.00

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 SYNTHESIS mode.
Query Syntax : [SOURce :] SYNThesis : FUNDamental?
Parameter : <NR2>, the valid range: 0.0 ~ 350.0.
Return Parameter : <NR2>

[SOURce :] SYNThesis : DC

Description : This command sets the DC voltage to add the voltage waveform in SYNTHESIS mode.
Query Syntax : [SOURce :] SYNThesis : DC?
Parameter : <NR2>, the valid range: -495 ~ 495.
Return Parameter : <NR2>

[SOURce :] SYNThesis : FREQuency

Description : This command sets the fundamental frequency in 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 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. You should quit output 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 SYNTHESIS mode in OFF, ON execution state after setting OUTPut : MODE SYNTH. If you want to change the parameters, it's necessary to set TRIG OFF then OUTPut : MODE FIXED. Then, set OUTPut : MODE SYNTH again to get ready to set TRIG ON.
Query Syntax : TRIG : STATE?
Parameter : OFF | ON
Return Parameter : OFF | RUNNING

8.4.2.15 INTERHARMONICS Sub-system

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

OUTPut
: MODE

TRIG
TRIG : STATE?

FETCh | MEASure
: INTERHARmonics
: FREQuency? It queries the sweeping frequency.

[SOURce :] INTERHARmonics : FREQuency : STARt
Description : This command sets the start frequency of sweep wave for INTERHARMONICS mode.
Query Syntax : [SOURce :] INTerharmonics : FREQuency : STARt?
Parameter : <NR2>, the valid range is 0.01 ~ 3000.0 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] INTERHARmonics: FREQuency : END
Description : This command sets the end frequency of sweep wave for INTERHARMONICS mode.
Query Syntax : [SOURce :] INTerharmonics : FREQuency : END?
Parameter : <NR2>, the valid range is 0.01 ~ 3000.00 (unit: Hz.)
Return Parameter : <NR2>

[SOURce :] INTERHARmonics: LEVel
Description : This command sets the rms. range of sweep wave in percentage level.
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
0% ~ 5% in 2400.01 Hz ~ 3000 Hz
Return Parameter : <NR2>

[SOURce :] INTERHARmonics: DWELl
Description : This command sets the dwell time of 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 INTERHARMONICS mode in OFF, ON, PAUSE or CONTINUE execution state after setting OUTPut : MODE INTERHAR. If you wish to change the Parameter, it has to set TRIG OFF and OUTPut : MODE FIXED, next 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 base voltage.
Query Syntax : FETCh : INTERHARMonics : FREQuency?
MEASure : INTERHARMonics : FREQuency?
Return Parameter : <NR2>

8.4.2.16 Harmonic Sense Sub-system

[SOURce:]
CONFigure
: HARMonic
: SOURce
: TIMES
: PARameter
: FREQuency
SENSe
: HARMonic
FETCh | MEASure
[: SCALar]
: HARMonic
: THD? It returns the % of total harmonic distortion.
: FUNDamental? It returns the fundamental frequency.

: ARRay? It returns the array of all harmonic orders.

[SOURce :] CONFigure : HARMonic : SOURce
Description : This command sets the measured power source in 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 displayed on LCD.
SINGLE: It keeps the measured data on the display when set.
CONTINUE: It 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 of 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 has to execute “ON” before every new search or measurement. Only 3 seconds are required for the result. The parameter has to set to “OFF” if you wish to measure other data.
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>

8.4.2.17 ACL Subsystem (Option)

LOAD
: MODE
: CCREctified
: CURRent
: CREStfactor
: SHAPe
: CPREctified
: POWer
: CREStfactor
: CR
: RESistor
: CCPHase
: CURRent
: DEGRee
: CPPHase
: POWer
: DEGRee
: PF
: MODE
: CCCOnstant
: CURRent
: CREStfactor
: PF
: MODE
: CPCOnstant
: POWer
: CREStfactor
: PF
: MODE
: CONStant
: MODE
:PRIOrity
: PHASe
: LIMit
: ON
: OFF
: SLEW
: LIMit
: CURRent
: CREStfactor
: POWer
: RESistor
: STANdby
: SCIRcuit

LOAD : MODE

Description : This command sets the ACL operating mode.
Query Syntax : LOAD : MODE?
Parameter : CCRE | CPRE | CR | CCPH | CPPH | CCCO | CPCO
Return Parameter : CCRE | CPRE | CR | CCPH | CPPH | CCCO | CPCO

LOAD : CCREctified : CURRent

Description : This command sets the loading current in CCREctified mode.
Query Syntax : LOAD : CCREctified : CURRent?
Parameter : <NR2>, valid range: 0.0 ~ 35.00 (unit: A)
Return Parameter : <NR2>

LOAD : CCREctified : CREStfactor

Description : This command sets the crest factor in CCREctified mode.
Query Syntax : LOAD : CCREctified : CRES?
Parameter : <NR2>, valid range: 1.414 ~ 3.000
Return Parameter : <NR2>

LOAD : CCREctified : SHAPe

Description : This command sets the waveform shape of loading current in CCREctified mode.
Query Syntax : LOAD : CCREctified : SHAPe?
Parameter : SINE | POS | NEG | LEAD | LAG
Return Parameter : SINE | POS | NEG | LEAD | LAG

LOAD : CPREctified : POWer

Description : This command sets the loading power in CPREctified mode.
Query Syntax : LOAD : CPREctified : POWer?
Parameter : <NR2>, valid range: 10 ~ 5000 (unit: W)
Return Parameter : <NR2>

LOAD : CPREctified : CREStfactor

Description : This command sets the crest factor of loading power in CPREctified mode.
Query Syntax : LOAD : CPREctified : CREStfactor?
Parameter : <NR2>, valid range: 1.414 ~ 3.000
Return Parameter : <NR2>

LOAD : CR: RESistor

Description : This command sets the corresponding resistance in CR mode.
Query Syntax : LOAD : CR : RESistor?
Parameter : <NR2>, valid range: 1 ~ 300 (unit: Ohm)
Return Parameter : <NR2>

LOAD : CCPHase : CURRent

Description : This command sets the loading current in CCPHase mode.
Query Syntax : LOAD : CCPHase : CURRent?
Parameter : <NR2>, valid range: 0.0 ~ 35.00 (unit: A)
Return Parameter : <NR2>

LOAD : CCPHase : DEGRee

Description : This command sets the phase degree between loading current and UUTvoltage in CCPHase mode.

Query Syntax : LOAD : CCPHase : DEGRee?
Parameter : Phase Limit ON: <NR2>, valid range: -90.0 ~ 90.0 (unit: Degree)
Phase Limit OFF: <NR2>, valid range: -180.0 ~ 180.0 (unit: Degree)
Return Parameter : <NR2>

LOAD : CPPHase : POWer
Description : This command sets the loading power in CCPHase mode.
Query Syntax : LOAD : CPPHase : POWer?
Parameter : <NR2>, valid range: 10 ~ 5000 (unit: W)
Return Parameter : <NR2>

LOAD : CPPHase : DEGRee
Description : This command sets the phase degree between loading current and UUT voltage in CPPHase mode.
Query Syntax : LOAD : CPPHase : DEGRee?
Parameter : Phase Limit ON :<NR2>, valid range: -84.26 ~ 84.26 (unit: Degree)
Phase Limit OFF :<NR2>, valid range: -84.26 ~ 84.26 (unit: Degree)
Return Parameter : <NR2>

LOAD : CPPHase : PF
Description : This command sets the PF value of loading current and UUT voltage in CPPHase mode. This setting is linked to LOAD : CCPHase : DEGRee.
Query Syntax : LOAD : CPPHase : PF?
Parameter : valid range: 0.1~1
Return Parameter : <NR2>

LOAD : CPPHase : PF : MODE
Description : This command sets the current in CPPHase mode to lead or lag behind the UUT voltage. This setting is linked to LOAD : CCPHase : DEGRee.
Query Syntax : LOAD : CPPHase : PF : MODE?
Parameter : LEAD | LAG
Return Parameter : LEAD | LAG

LOAD : CCCOnstant : CURRent
Description : This command sets the CCCOnstant mode loading current. .
Query Syntax : LOAD : CCCOnstant : CURRent?
Parameter : <NR2>, valid range: 0.0 ~ 35.00 (unit: A)
Return Parameter : <NR2>

LOAD : CCCOnstant : CREStfactor
Description : This command sets the loading crest factor in CCCOnstant mode. Its high and low limits are linked to the PF setting value.
Query Syntax : LOAD : CCCOnstant: CREStfactor?
Parameter : <NR2>, valid range: 1.414 ~ 3.000
Return Parameter : <NR2>

LOAD : CCCOnstant : PF
Description : This command sets the PF value of CCCOnstant mode loading current and UUT voltage. Its high and low limits are linked to the

CREStfactor setting value.
Query Syntax : LOAD : CCCOnstant: PF?
Parameter : <NR2>, valid range: 0.1~1
Return Parameter : <NR2>

LOAD : CCCOnstant : PF : MODE
Description : This command sets the CCCOnstant mode loading current leads or lags the UUT voltage.
Query Syntax : LOAD : CCCOnstant : PF : MODE?
Parameter : LEAD | LAG
Return Parameter : LEAD | LAG

LOAD : CPCOnstant : POWer
Description : This command sets the CPCOnstant mode loading power.
Query Syntax : LOAD : CPCOnstant : POWer?
Parameter : <NR2>, valid range: 0 ~ 5000 (unit: W)
Return Parameter : <NR2>

LOAD : CPCOnstant : CREStfactor
Description : This command sets the loading crest factor in CPCOnstant mode. Its high and low limits are linked to the PF setting value.
Query Syntax : LOAD : CPCOnstant : CREStfactor?
Parameter : <NR2>, valid range: 1.414 ~ 3.000

LOAD : CPCOnstant : PF
Description : This command sets the PF value of CPCOnstant mode loading current and UUT voltage. Its high and low limits are linked to the CREStfactor setting value.
Query Syntax : LOAD : CPCOnstant : PF?
Parameter : Valid range: 0.1~1
Return Parameter : <NR2>

LOAD : CPCOnstant : PF : MODE
Description : This command sets the CPCOnstant mode loading current leads or lags the UUT voltage.
Query Syntax : LOAD : CPCOnstant : PF : MODE?
Parameter : LEAD | LAG
Return Parameter : LEAD | LAG

LOAD : CONStant: MODE
Description : This command sets the operating mode for setting the CF and PF value in CC/CP constant mode.
Query Syntax : LOAD : CONStant: MODE?
Parameter : BOTH | CF | PF
Return Parameter : BOTH | CF | PF

LOAD : CONStant : MODE : PRIOrity
Description : This command sets the priority order of CF and PF value when the operation mode is BOTH.

Query Syntax ：LOAD : CONStant: PRIOrity?
Parameter ：CF | PF
Return Parameter ：CF | PF

LOAD : PHASe : LIMit
Description : This command sets the phase degree on or off in the angle set mode.
Query Syntax : LOAD : PHASe : LIMit?
Parameter : ON | OFF
Return Parameter : ON | OFF

LOAD : PHASe : ON
Description : This command sets the start angle of current waveform in AC load mode. The default is ON which means 0 degrees.
Query Syntax : LOAD : PHASe : ON?
Parameter : <NR2>, valid range: 0.0 ~ 359.9.
Return Parameter : <NR2>

LOAD : PHASe : OFF
Description : This command sets the end angle current waveform in AC load mode.
Query Syntax : LOAD : PHASe : OFF?
Parameter : <NR2>, valid range: 0.0 ~ 359.9.
Return Parameter : <NR2>

LOAD : SLEW : CURRent
Description : This command sets the current slew rate in CCRE/CCPH mode.
Query Syntax : LOAD : SLEW : CURRent?
Parameter : <NR2>, valid range: 0.01 ~ 800.0 A/ms
Return Parameter : <NR2>

LOAD : SLEW : POWer
Description : This command sets the power slew rate in CCRE/CCPH mode.
Query Syntax : LOAD : SLEW : POWer?
Parameter : <NR2>, valid range: 0.1 ~ 80000.0 VA/ms
Return Parameter : <NR2>

LOAD : LIMit : CURRent
Description : This command sets the CC setting range.
Query Syntax : LOAD : LIMit : CURRent?
Parameter : <NR2>, valid range: 0.0~ 35.00 (unit: A)
Return Parameter : <NR2>

LOAD : LIMit : CREStfactor
Description : This command limits the CF setting range.
Query Syntax : LOAD : LIMit : CREStfactor?
Parameter : <NR2>, valid range: 1.414 ~ 3.000
Return Parameter : <NR2>

LOAD : LIMit : POWer :APParent
Description ：This command limits the CS power setting range.

Query Syntax ：LOAD : LIMit : POWer :APParent?
Parameter ：<NR2>, valid range: 0 ~ 5000.0 (unit: VA)
Return Parameter ：<NR2>

LOAD : LIMit : POWer :REAL
Description ：This command limits the CP power setting range.
Query Syntax ：LOAD : LIMit : POWer :REAL?
Parameter ：<NR2>, valid range: 0 ~ 5000.0 (unit: W)
Return Parameter ：<NR2>

LOAD : STANdby
Description : This command enables the Stand-by mode.
Query Syntax : LOAD : STANdby?
Parameter : ENABLE | DISABLE
Return Parameter : ENABLE | DISABLE

[LOAD:]SCIRcuit
Description ：This enables or disables the short circuit simulation.
Query Syntax ：[LOAD:]SCIRcuit?
Parameter ：0 | OFF, 1 | ON
Return Parameter ：0 | 1

8.5 Command Summary

Common Commands

* CLS	Clear status
* ESE<n>	Enable standard event status
* ESE?	Return enabled standard event status
* IDN?	Return the Regenerative Grid Simulator ID
* RCL<n>	Recall the Regenerative Grid Simulator file
* RST	Reset the Regenerative Grid Simulator to initial states
* SAV<n>	Save the Regenerative Grid Simulator status
* SRE	Set request enable register
* STB?	Return status byte
* TST?	Return the self-test result of Regenerative Grid Simulator

Instrument Commands

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

INSTrument
: EDIT
: Couple
: NSELect
: SELect
: PHASe
: STATus?
: AD?
: DA?
: OPTion

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
: OFF
: VOLTage
: DC
: COUPling
: MODE
: PROTection
: CLEar

[SOURce :]

- CURRent
  - : LIMit
  - : DELay
  - : INRush
    - : STARt
    - : INTerval
  - FREQency
  - [: {CW | IMMediate}]
  - : LIMit
- VOLTage
  - [: LEVel][: IMMediate][:AMPLitude]
    - : AC
    - : DC
  - : LIMit
    - : AC
    - : DC
      - : PLUS
      - : MINus
- 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
: EXTernal
: COUPling
: EXTON
: VOLTage
: SENSe
: AVERage

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

TRACe
: RMS

TRIG
TRIG : STATE?

8.5.1 Command Summary of Regenerative AC Load (Option)

LOAD
: MODE
: CCREctified
: CURRent
: CREStfactor
: SHAPe
: CPREctified
: POWer
: CREStfactor
: CR
: RESistor
: CCPHase
: CURRent
: DEGRee
: CPPHase
: POWer
: DEGRee
: PF
: MODE
: CCCOnstant
: CURRent
: CREStfactor
: PF
: MODE
: CPCOnstant
: POWer
: CREStfactor
: PF
: MODE
: CONStant

: MODE
: PRIOrity
: PHASe
: LIMit
: ON
: OFF
: SLEW
: CURRent
: POWer
: LIMit
: CURRent
: CRESTfactor
: POWer
: STANdby
: SCIRcuit

Appendix A TTL Signal Pin Assignments

The Analog Interface is a 25-pin terminal located on the rear panel as shown in Figure A-1.

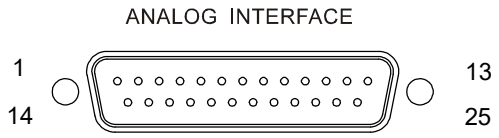


Figure A-1

Pin No.	Signal	Description
1	/ Transient	When the output of Regenerative Grid Simulator changes, this pin will send out a low level 64us or remain at high level.
2*1	AC-ON	This pin turns to HIGH when the Regenerative Grid Simulator outputs voltage and turns to LOW when quits output.
3	Reserved	
4	Phase	1-phase/3-phase mode relay signal switch for external controller. When the Phase signal is LOW, the Regenerative Grid Simulator is in 3-phase output mode, and if the Phase signal is HIGH, the Regenerative Grid Simulator is in 1-phase output mode.
5	Reserved	
6*1	/ Remote-Inhibit	Controls the Remote Inhibit signal. When the Remote Inhibit signal is LOW, the Regenerative Grid Simulator stops output; however, if the Remote Inhibit signal turns HIGH now the simulator remains no output until the ON/OFF button is tapped to restart output.
7	Reserved	
8	Ext-V Φ1	Φ1 External-V Reference signal input (-10V~10V).
9	Ext-V Φ3	Φ3 External-V Reference signal input (-10V~10V).
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14*1	/ FAULT-OUT	The voltage level of this pin is HIGH when the Regenerative Grid Simulator is in normal mode, it will turn to LOW when the Regenerative Grid Simulator is in protection mode.
15	/ Remote-Excite	When this pin receives a negative edge signal (from High to Low), it can trigger the transient output of Regenerative Grid Simulator.
16*1	APIDGND	I/O digital signal grounding.
17	Short	The Relay signal for controller external short circuit test, HIGH is Relay on.
18	/ Ext-ONOFF	It controls the External AC ON/OFF where HIGH is AC OFF and LOW is AC ON.
19*1	APIDGND	I/O digital signal grounding.
20	Reserved	
21	Ext-V Φ2	Φ2 External-V Reference signal input (-10V~10V).
22	APIGND	External-V Reference signal grounding.

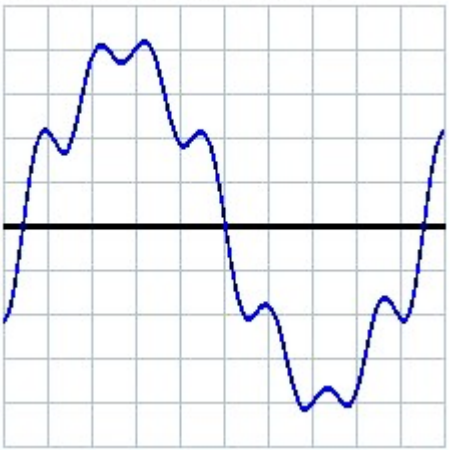
23	Reserved	
24[*1]	APIGND	I/O digital signal grounding.
25	Reserved	

Note ⋮ *1: The pin function supported in regenerative AC Load (option).

Appendix B Built-in DST Waveform

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

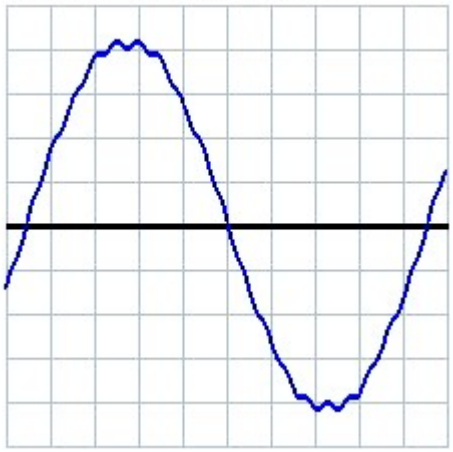
Waveform A = DST01



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

DST01

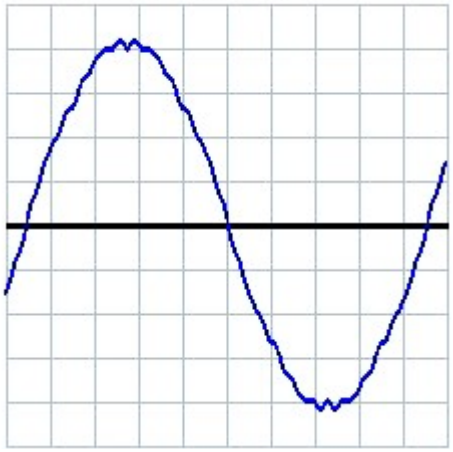
Waveform A = DST02



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

DST02

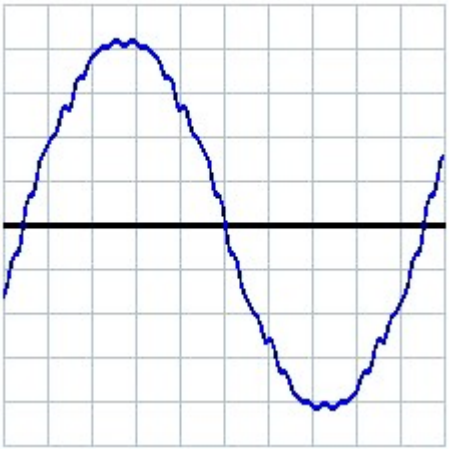
Waveform A = DST03



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

DST03

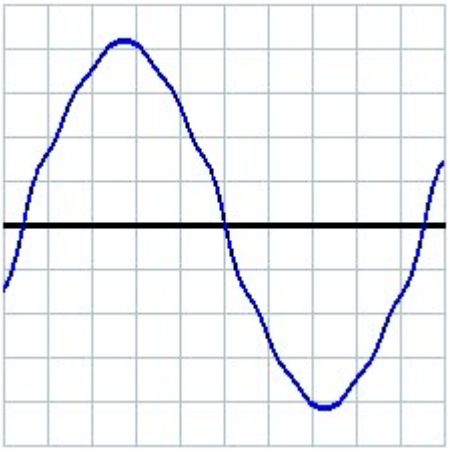
Waveform A = DST04



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

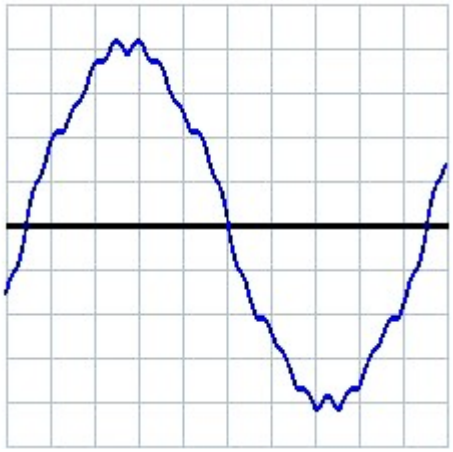
Waveform A = DST05



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

DST05

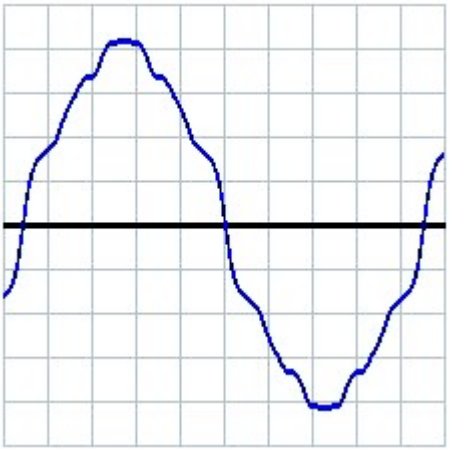
Waveform A = DST06



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

DST06

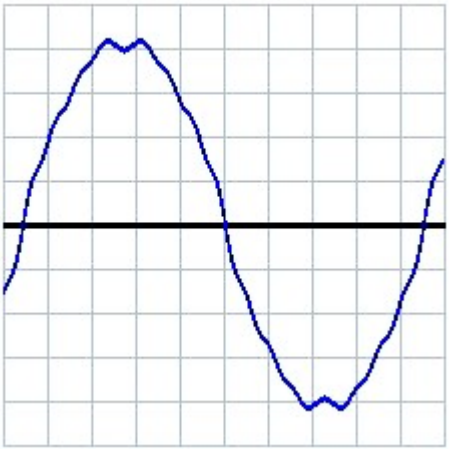
Waveform A = DST07



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

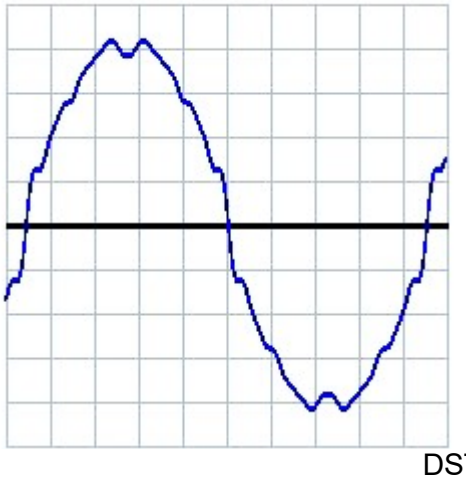
Waveform A = DST08



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

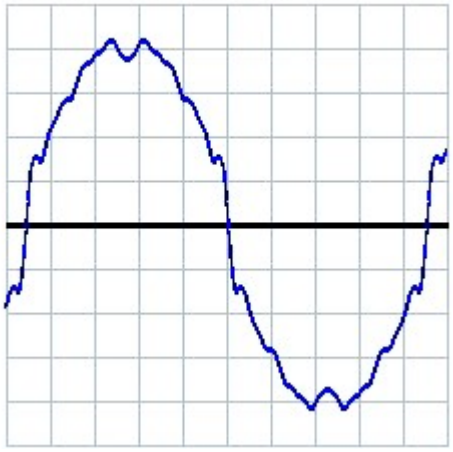


N	%	D
3	7.35	0
5	2.40	0
7	4.05	0
11	2.10	0
13	1.05	0
15	3.00	0
17	1.65	0
19	1.05	0
21	1.05	0

N	%	D
23	1.20	0
25	1.05	0

DST09

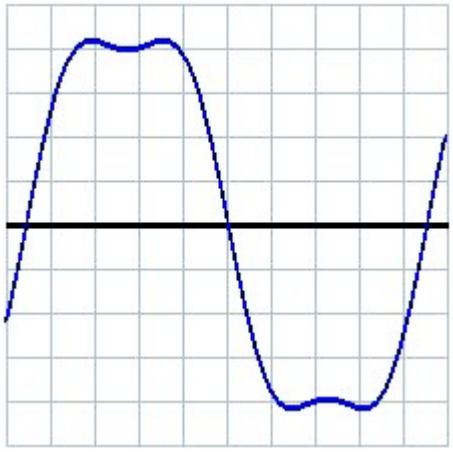
Waveform A = DST10



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

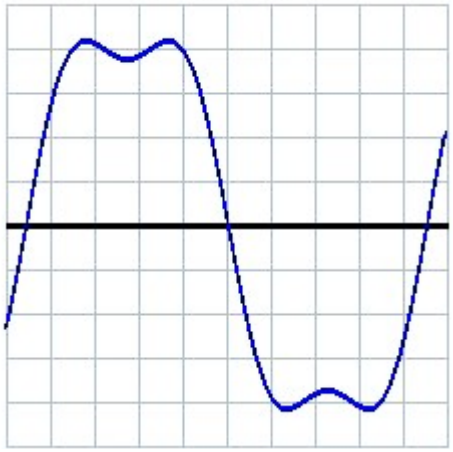
Waveform A = DST11



N	%	D
3	17.75	0

DST11

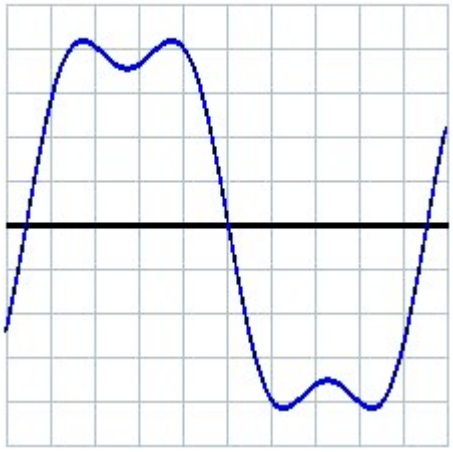
Waveform A = DST12



N	%	D
3	21.25	0

DST12

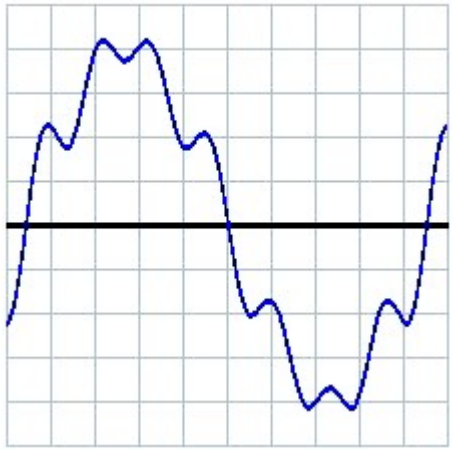
Waveform A = DST13



N	%	D
3	24.50	0

DST13

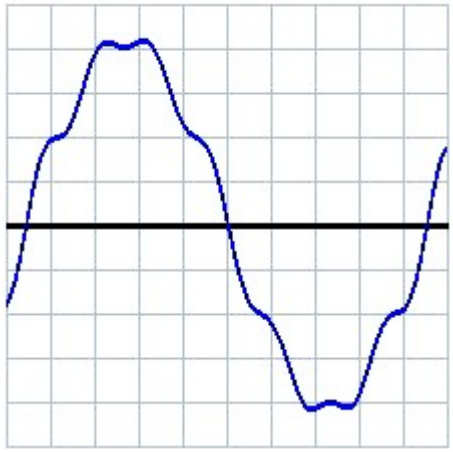
Waveform A = DST14



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

DST14

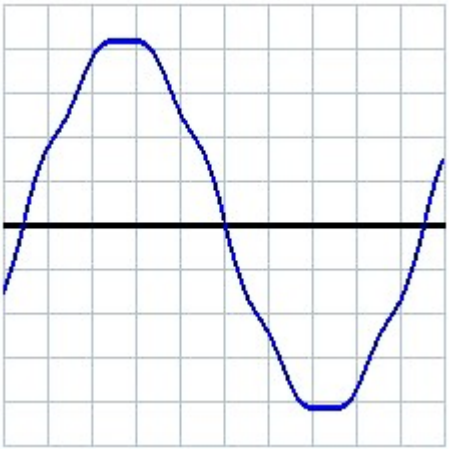
Waveform A = DST15



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

DST15

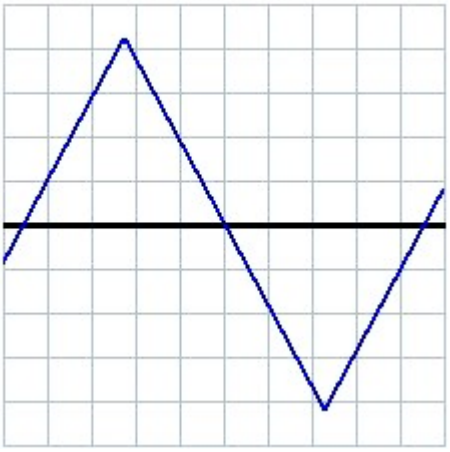
Waveform A = DST16



N	%	D
5	2.45	0
7	3.95	0

DST16

Waveform A = DST17

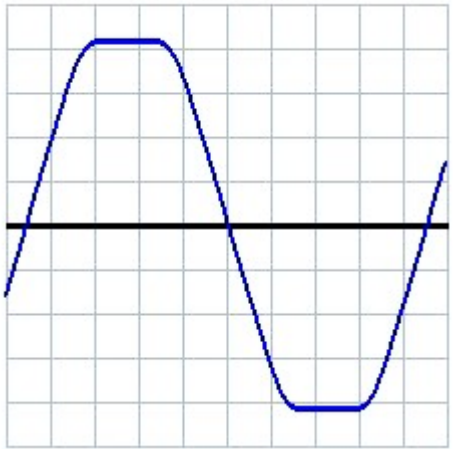


N	%	D
3	11.11	180
5	4.00	0
7	2.04	180
9	1.23	0
11	0.83	180
13	0.59	0
15	0.44	180
17	0.35	0
19	0.28	180

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

DST17

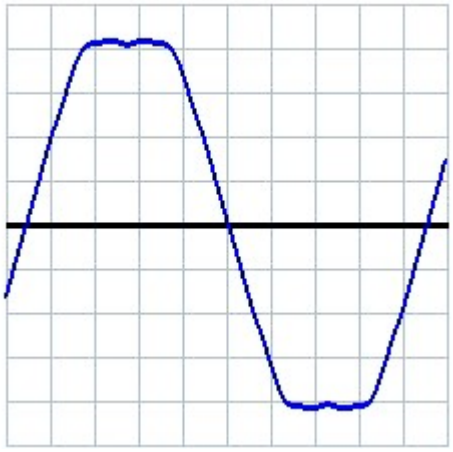
Waveform A = DST18



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

DST18

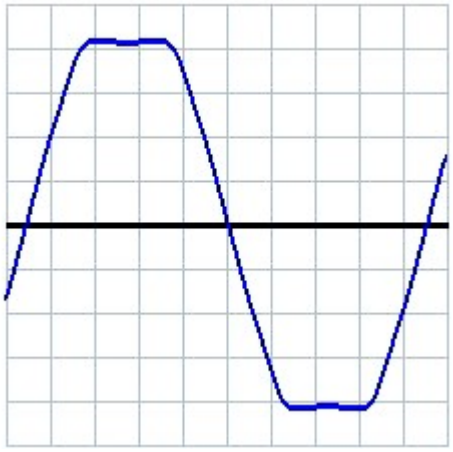
Waveform A = DST19



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

DST19

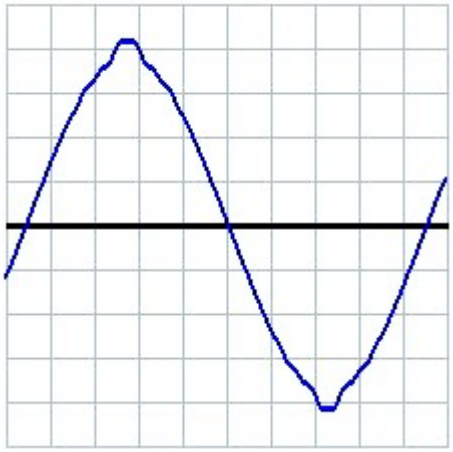
Waveform A = DST20



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

DST20

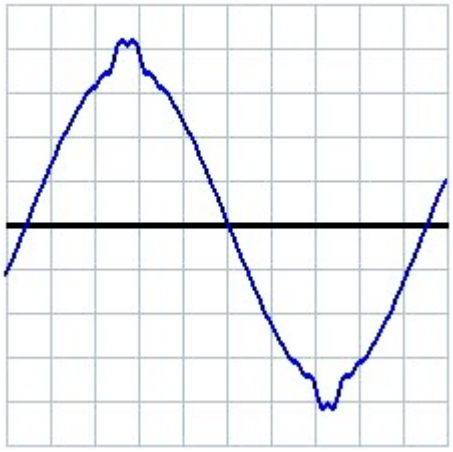
Waveform A = DST21



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

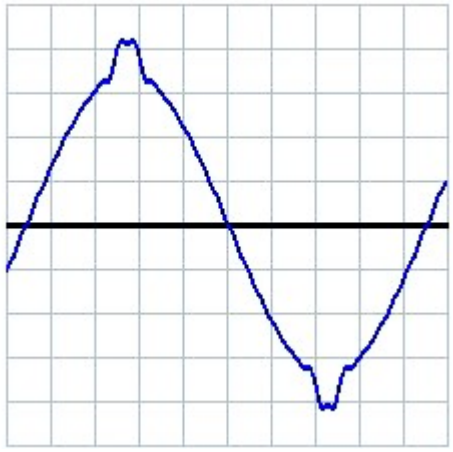
Waveform A = DST22



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

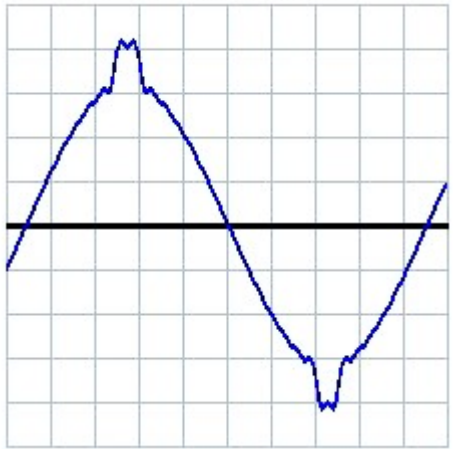
Waveform A = DST23



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

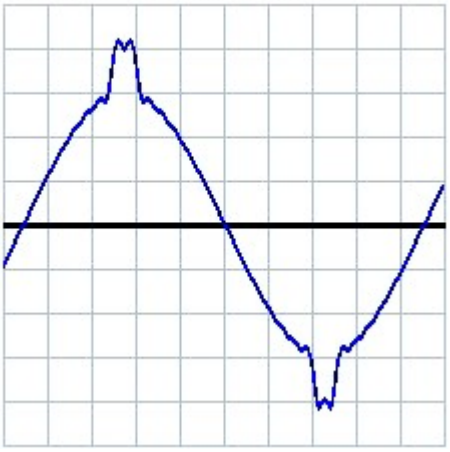
Waveform A = DST24



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

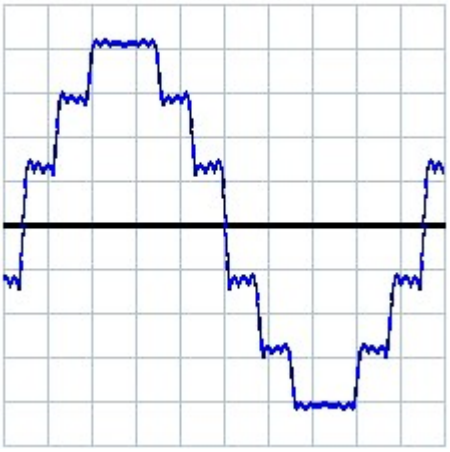
Waveform A = DST25



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

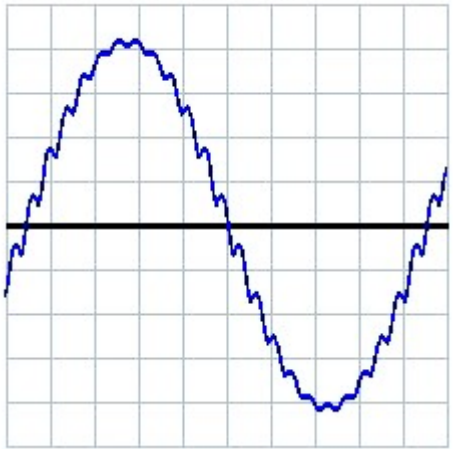
Waveform A = DST26



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

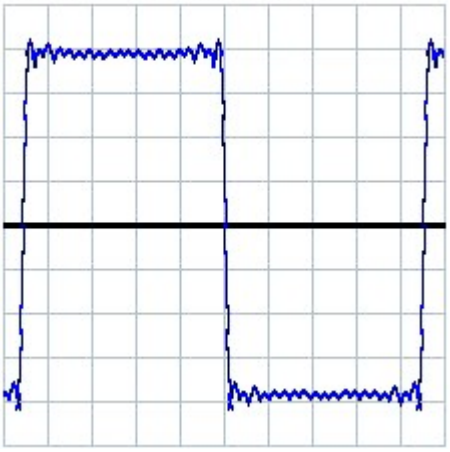
Waveform A = DST27



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

DST27

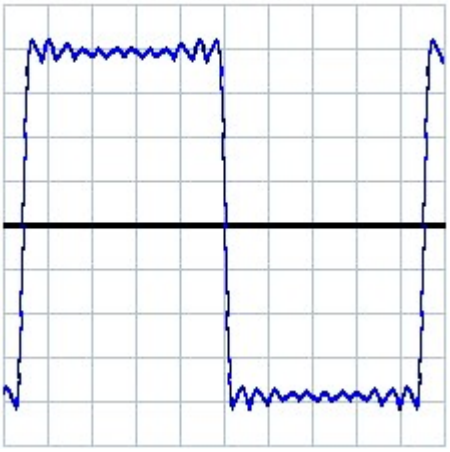
Waveform A = DST28



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

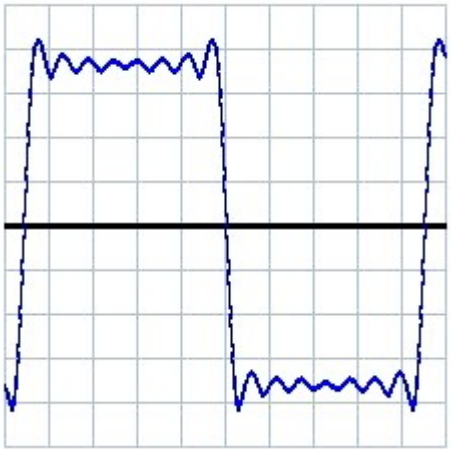
Waveform A = DST29



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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