Operation Manual

APF Series – Rev 1.0 P/N 160956-10

APF Series
Programmable AC Power Sources

–

APS™ ADAPTIVE POWER SYSTEMS

ADAPTIVE Power Systems

Worldwide Supplier of Power Equipment

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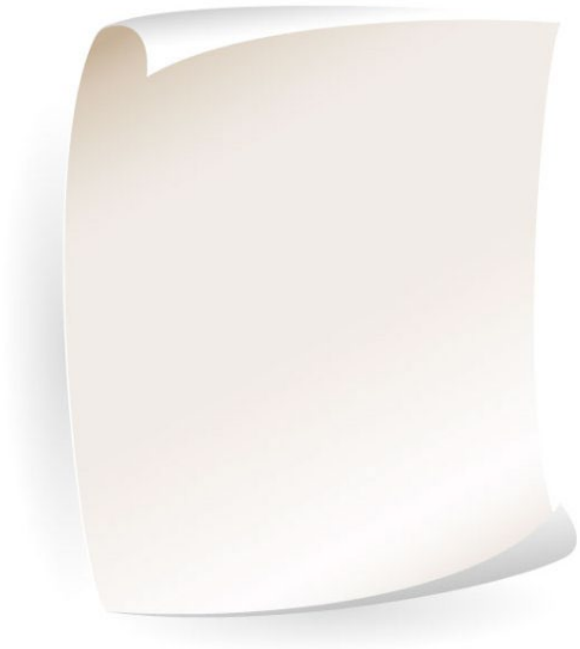

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1 Contact Information

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2 Front Matter

2.1 Limited Warranty

Adaptive Power Systems, Inc. (APS) warrants each unit to be free from defects in material and workmanship. For the period of one (1) year from the date of shipment to the purchaser, APS will either repair or replace, at its sole discretion, any unit returned to the factory in Irvine, California or one of its designated service facilities. It does not cover damage arising from misuse of the unit or attempted field modifications or repairs. This warranty specifically excludes damage to other equipment connected to this unit.

Upon notice from the purchaser within (30) days of shipment of units found to be defective in material or workmanship, APS will pay all shipping charges for the repair or replacement. If notice is received more than thirty (30) days from shipment, all shipping charges shall be paid by the purchaser. Units returned on debit memos will not be accepted and will be returned without repair.

This warranty is exclusive of all other warranties, expressed or implied.

2.2 Service and Spare Parts Limited Warranty

APS warrants repair work to be free from defects in material and workmanship for the period of ninety (90) days from the invoice date. This Service and Spare Parts Limited Warranty applies to replacement parts or to subassemblies only. All shipping and packaging charges are the sole responsibility of the buyer. APS will not accept debit memos for returned power sources or for subassemblies. Debit memos will cause return of power sources or assemblies without repair.

This warranty is exclusive of all other warranties, expressed or implied.

2.3 Safety Information

This chapter contains important information you should read BEFORE attempting to install and power-up APS Equipment. The information in this chapter is provided for use by experienced operators. Experienced operators understand the necessity of becoming familiar with, and then observing, life-critical safety and installation issues. Topics in this chapter include:

- Safety Notices
- Warnings
- Cautions
- Preparation for Installation
- Installation Instructions

Danger 

- Dangerous high voltages exist inside this machine. Do not open any covers of this machine unless authorized and done by trained technicians. Otherwise, electrical shock to persons may happen.
- In case the machine needs to be moved or re-wired, all electricity to the machine must be disconnected and removed. After electricity is removed, please wait for at least 20 minutes before touching any live parts of this machine or electrical shock may occur: the electrical charges on the bulky capacitors inside the machine need some time to be fully discharged.
- For optimal safety protection to the users, this machine must have solid connections to the earth. Do not use this machine if it is not grounded.
- In case of fire, use an extinguisher with powder chemicals instead of liquid agents. Electrical shock may occur if liquid extinguishing products are used.
- Any foreign objects and/or liquid are strictly prohibited from entering to the inside of this machine.

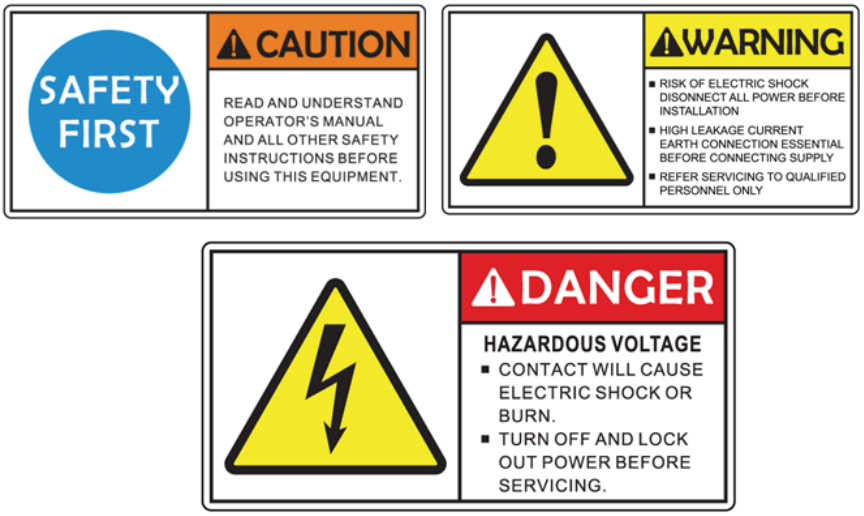
Caution 

- Storage and operating environment have a certain degree of influence on the life and reliability of this product. Therefore, avoid placing and/or operating this machine in environments with the following:
  (a) Having extreme ambient temperature or humidity that exceeds the allowable limit stated in the specification, temperature: 0℃-45℃, humidity: 0-90%.
  (b) Having direct sunlight exposure, or being near a heat source.
  (c) Places that tend to be vibrated or hit by other objects.
  (d) Having heavy dust, heavy salt, corrosive chemicals or inflammable chemicals in the air.
- Please keep air ventilation inlets and outlets clear and clean. Obstruction on the inlet or outlet will have a significant negative impact on the machine's quality and reliability.
- If the machine is not used for a long time, please store it in a dry and clean environment with a temperature in the range of -40°C to +70°C.
- This machine is composed of many delicate and precision devices. Please do not open any covers of this machine unless authorized and done by trained technicians. Warranty is voided if the quality seal is broken.

SAFETY SUMMARY

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

Adaptive Power Systems assumes no liability for the customer's failure to comply with these requirements.



1) BEFORE APPLYING POWER

Verify that the equipment is set to match with the power line input.

2) PROTECTIVE GROUNDING

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

3) 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.

4) DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

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

5) DO NOT REMOVE THE COVER OF THE EQUIPMENT

Hazardous voltages may be present when the covers are removed. Component replacement and internal adjustment can be done only by qualified service personnel.

Caution
LETHAL VOLTAGES. **Depending on configuration, this equipment can supply 310Vac L-N or 400Vac L-N or 600V L-N at its output. DEATH on contact may result if either the output terminals or the circuits connected to the output are touched when the power is applied.**

3 Product Overview

This chapter provides an overview of the APS APF Series programmable, AC power sources. It introduces the reader to general operating characteristics of these power sources. Operational information and menu navigation details are provided in Section 6, “Front Panel Operation”.

3.1 General Description

The APF series is a high power programmable AC power source utilizing advanced PWM technology to deliver power with THD ≤0.5% and up to 100kVA. Available output frequency range configurations options are 45~500Hz (type A), 45-120Hz (type B) with accuracy of ± 0.02%, or 300-840Hz (type C) expanded frequency. The APF series is ideal to simulate different region’s power grid voltage and frequency conditions, and can cover a wide range of applications such as renewable energy, EV charger, motor, medical equipment, and EMC laboratory.

The APF series features STEP and RAMP programmable functions to easily simulate single or continuous output changes. Three phase independent adjustment, optional remote sensing and optional phase angle adjustment all provide convenient control to simulate different types of line disturbance. These features are ideal for test applications in R&D design verification, quality assurance and production test. For remote control, the APF series has a standard RS-232/RS-422/RS-485/Ethernet interface combination card and optional USB, GPIB and Analog interfaces for easy setup and programming.

The standard dual AC Voltage ranges (High and Low) support maximum RMS current for loads with power factors of 0.775 or less. For loads with power factors greater than 0.775 through 1.0, maximum available RMS current derated from 120Vac/240Vac to max. voltage on each voltage range as shown in the figure below.

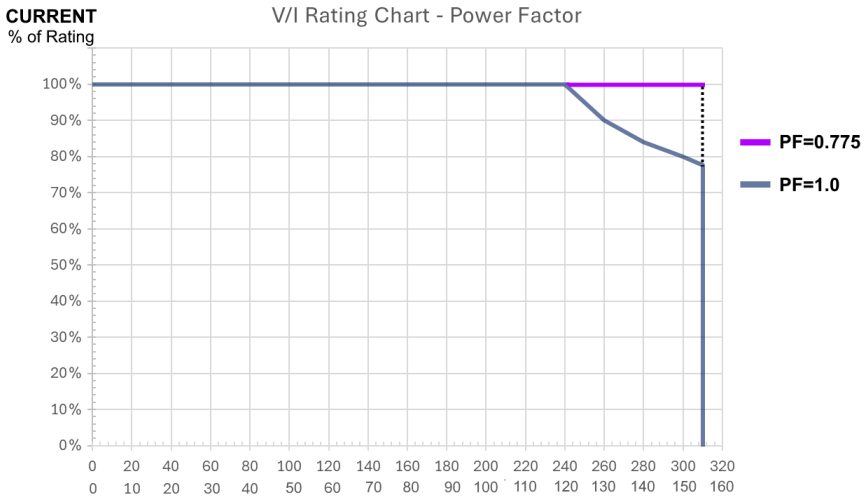


Figure 3-1: V/I Profile for APS Series vs Load Power Factor

3.2 Key Product Features

1 User Control

a) Local front panel operation using large color touch screen on front panel

b) Remote control using RS485, RS422, RS232 serial, Ethernet LAN or optional USB, GPIB or analog I/O controls.

c) Protection against Over Voltage (OVP), Over Current (OCP), Over Power (OPP), Over Temperature (OTP) and AC input voltage low line (Vin LVP).

2. Input / Output Voltage and Frequency

a) Selective output voltage range with HIGH range 0-310V or LOW range 0-155V.

b) Input voltage is 380V±15% and customized input voltage is available.

c) Output voltage 0-310VAC (L-N)

d) Output Frequency Models:

A version: 45-500Hz,
B version: 45-120Hz,
C version: 300-840Hz.

e) Precise Meter Measurement

f) Single phase output: V/F/I/VA/W/PF

g) Three phase output: V(L-N) /I(L-N)/P(L-N)/VA/W/PF/Σ of three phases (for three-phase balanced only)

h) Output frequency B version 45-120Hz characteristic chart

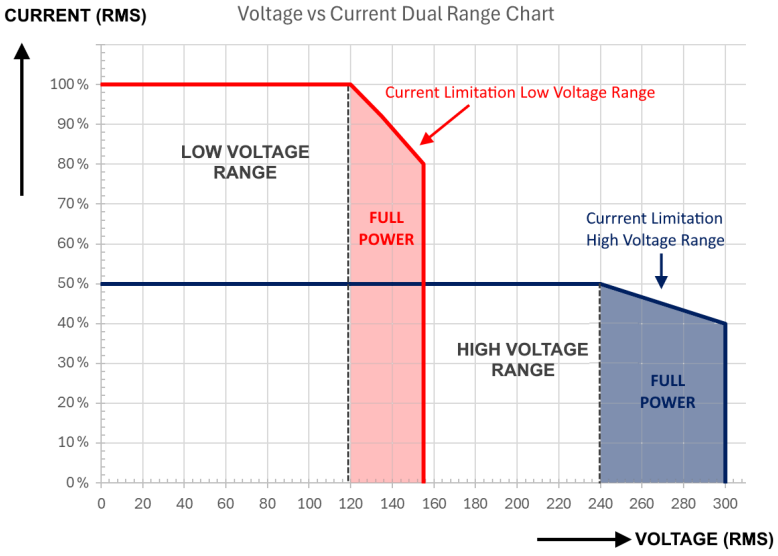


Figure 3-2: Output Voltage Current Charts -B Version 45-120 Hz

i) Output frequency A version 45-120Hz characteristic chart

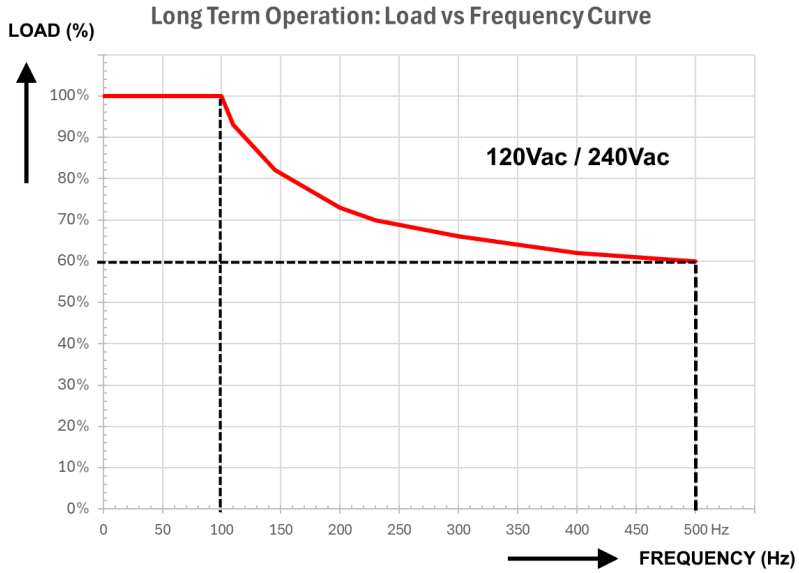


Figure 3-3: Output Load Rating vs Frequency Curve -A Version 45-500 Hz

Note: The short term operation time versus frequency setting under 100% rated load is shown in the Figure below. When choosing version A series output frequency 45-500 Hz, the output power will be influenced per the information here (Figures Figure 3-3 and Figure 3-4). It is suggested the user selects the optimal model to meet their needs or a higher output power model to circumvent this limitation.

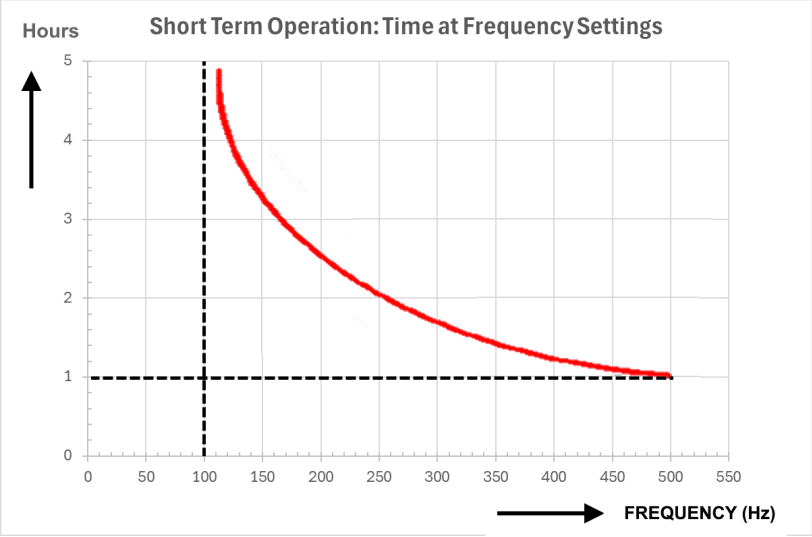


Figure 3-4: Short Term Operation Output Time vs Frequency Setting

j) Output frequency A version 45-120Hz characteristic chart

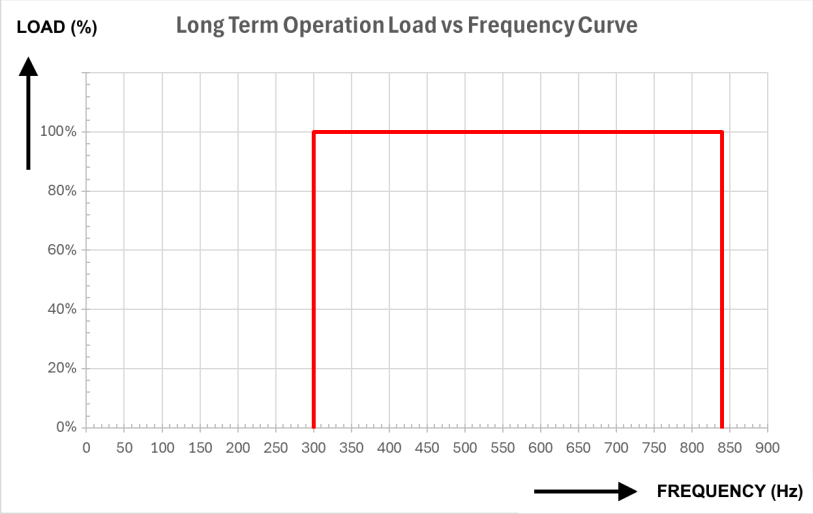


Figure 3-5: Output Load vs Frequency Curve C Version

3.3 Available Models

The table below lists the available APF Series Models, Output Phase Modes, Power Levels and 3 Phase AC input power options.

Model	Rated Power (KVA)	Frequency Range options	Output	Input Voltage Specified at time of order
APF1010	10	A:45-500 Hz B:45-120 Hz C: 300-840 Hz	Single Phase Output	-208 / -480 Va 3ø
APF1020	20		Single Phase Output	-208 / -480 Va 3ø
APF1045	45		Single Phase Output	-480 Va 3ø
APF3015	15		Three Phase Output	-208 / -480 Va 3ø
APF3030	30		Three Phase Output	-480 Va 3ø
APF3045	45		Three Phase Output	-480 Va 3ø
APF3060	60		Three Phase Output	-480 Va 3ø
APF3075	75		Three Phase Output	-480 Va 3ø
APF3100	100		Three Phase Output	-480 Va 3ø

3.4 Available Options

There are several optional features that can be fitted on the APF Series models. These options are **not retrofittable** however so **must** be specified at the time or order

The list of available options is shown below.

Options:	
A	Type A: Output Frequency 45-500Hz*3. Changes "B" postfix to A
B	Type B: Output Frequency 45-120Hz*3. No Charge.
C	Type C : Output Frequency 300-840Hz*1*3 Changes "B" postfix to C
-200	Input Voltage 200V*3
-208	Input Voltage 208V*3
-240	Input Voltage 240V*3
-400	Input Voltage 400V
-480	Input Voltage 480V
PS	Programmable Start Angle 0-359°*3
OL	Overload Capability 200% 2 sec, 150% 5 sec, 125% 15 sec*3
FV	Fast Voltage Response Option (with Time Setting Resolution 0.01S)*2
IO	Analog Control Interface
G	GPIB Interface
P3	Three Phase Angle Adjustment (3 Phase Models only)
V400	Output Voltage 0-400V (L-N)
V600	Output Voltage 0-600V (L-N)
U	Interface Card (Ethernet/RS-232&RS-485/USB) Replaces standard Ethernet / RS232 / RS485

4 Technical Specifications

Technical specifications shown here apply at an ambient temperature of 25° C ± 5°.

4.1 Single Phase Output Models – 10kVA to 45kVA

Model:		APF1010	APF1020	APF1045
AC Output				
Power (kVA / kW)		10	20	45
Phase Mode		Single Phase, 2 Wire + Ground		
Voltage Range	Low	0 ~ 155 V L-N		
	High	0 ~ 310 V L-N		
Resolution		0.1 V		
Accuracy		0.5% F.S. + 4 Counts		
Frequency Range[1]		A version: 45~500Hz, B version: 45~120Hz, C version: 300~840Hz		
Resolution		0.1 Hz		
Accuracy		± 0.02% F.S.		
Current RMS max.	Low Vrange	83.3 A	166.7 A	375.0 A
	High Vrange	41.7 A	83.3 A	187.5 A
Line Regulation		< 0.5 %		
Load Regulation		≤ 0.5% (Resistive Load)		
Voltage Distortion	THD[2]	≤ 0.5% (Resistive Load)		
Response Time	V change	≤ 1 msec		
Crest Factor	Current	≥ 3:1		
Measurements				
		Range	Resolution:	Accuracy:
Voltage	Vrms	0 ~ 310V	0.1 V	0.5% F.S. + 4 counts
Frequency	Hz	45.0 ~ 840 Hz	0.01 Hz	±0.02% F.S.
Current	Arms	See Current Spec.	0.1 A	0.5% F.S. + 4 counts
Power	KWatt	See kVA Spec.	0.1 kW	1.0% F.S + 6 counts
AC Input Mains				
Frequency Line		47 Hz ~ 63 Hz		
Phase Mode		3 Phase / 3 Wire + Ground		
Input Voltage[3]	-208	208Vac ± 10%		
Line Current	Max[4]	40	80	181
Input Voltage[3]	-480	480Vac ± 10%		
Line Current	Max[4]	17	35	78
Input Power Factor		≥ 0.9 @ Max. Power		
General Specifications				
Efficiency		> 90% at Max. Power		
User Interface		7” Color Touch Screen		
Program Modes		STEP : 24 sets / 255 cycles. (Volt./Freq./Time) RAMP : 12 sets / 255 cycles. (Volt./Freq./Time)		
Soft Start		Setting : Rated Volt. / Rated Freq. / Start Volt. / Start Freq. / Delay Time / Ramp Time		

Model:		APF1010	APF1020	APF1045
Protections	Input : Input No Fuse Breaker (N.F.B), Over Voltage, Under Voltage, Output : Over Voltage, Over Current, Over Temperature Unit will display the error code and give a warning sound.			
Remote Control	Standard: RS-232/RS-422/RS-485/Ethernet Available Options: GPIB, Analog, USB			
Temperature	0° ~ 45° operating			
Humidity	0 ~ 90%, non-condensing			
Mechanical				
Dimensions[5] (Including wheels)	H x W x D	1045x628x840 mm 41.2”x24.7”x33”	1440x628x840 mm 56.7”x24.7”x33”	1645x828x840 mm 64.8”x32.6”x33”
Weight[5]	Kg / lbs	230 / 507	320 / 705.5	580 / 1278.7

Notes: All specifications are subject to change without notice.

1. For type A(45-500Hz) and models with output power of 20kVA and higher, the available output power will be as shown in the frequency characteristic curve in section 3.2.
2. THD shown is for the output frequency from 45 to 65Hz and output voltage setting from 90 - 140Vac on Low voltage range or 180 - 280Vac on High voltage range and with a resistive load. THD for type C 300-840Hz frequency range models is ≤ 2%,
3. Please contact Adaptive Power Systems for other available input voltage specifications options.
4. The max. input current is calculated at stated AC input voltage nominal - 15% (low line)
5. Dimensions and weight are for input voltage 208V or 480V AC standard unit. Please contact us for dimensions and weight for other input voltage.

4.2 Three Phase Output Models – 15kVA to 45kVA

Model:		APF3015	APF3030	APF3045
AC Output				
Power (kVA / kW		15	30	45
Phase Mode		Three Phase, 4 Wire + Ground		
Voltage Range	Low	0 ~ 155 V L-N		
	High	0 ~ 310 V L-N		
Resolution		0.1 V		
Accuracy		0.5% F.S. + 4 Counts		
Frequency Range[1]		A version: 45~500Hz, B version: 45~120Hz, C version: 300~840Hz		
Resolution		0.1 Hz		
Accuracy		± 0.02% F.S.		
Current RMS max.	Low Vrange	41.7 A	83.3 A	125.0 A
	High Vrange	20.8 A	41.7 A	62.5 A
Line Regulation		< 0.5 %		
Load Regulation		≤ 0.5% (Resistive Load)		
Voltage Distortion	THD[2]	≤ 0.5% (Resistive Load)		
Response Time	V change	≤ 1 msec		
Crest Factor	Current	≥ 3:1		
Measurements				
		Range	Resolution:	Accuracy:
Voltage	Vrms	0 ~ 310V	0.1 V	0.5% F.S. + 4 counts
Frequency	Hz	45.0 ~ 840 Hz	0.01 Hz	±0.02% F.S.
Current	Arms	See Current Spec.	0.1 A	0.5% F.S. + 4 counts
Power	KWatt	See kVA Spec.	0.1 kW	1.0% F.S + 6 counts
AC Input Mains				
Frequency Line		47 Hz ~ 63 Hz		
Phase Mode		3 Phase / 3 Wire + Ground		
Input Voltage[3]	-208	208Vac ± 10%		
Line Current	Max[4]	60	121	181
Input Voltage[3]	-480	480Vac ± 10%		
Line Current	Max[4]	26	52	78
Input Power Factor		≥ 0.9 @ Max. Power		
General Specifications				
Efficiency		> 90% at Max. Power		
User Interface		7” Color Touch Screen		
Program Modes		STEP : 24 sets / 255 cycles. (Volt./Freq./Time) RAMP : 12 sets / 255 cycles. (Volt./Freq./Time)		
Soft Start		Setting : Rated Volt. / Rated Freq. / Start Volt. / Start Freq. / Delay Time / Ramp Time		
Protections		Input : Input No Fuse Breaker (N.F.B), Over Voltage, Under Voltage, Output : Over Voltage, Over Current, Over Temperature Unit will display the error code and give a warning sound.		
Remote Control		Standard: RS-232/RS-422/RS-485/Ethernet Available Options: GPIB, Analog, USB		

Model:		APF3015	APF3030	APF3045
Temperature	0° ~ 45° operating			
Humidity	0 ~ 90%, non-condensing			
Mechanical				
Dimensions[5] (Including wheels)	H x W x D	1440x628x840 mm 56.7” x 24.7” x 33”	1440 x 628 x 840 mm 56.7” x 24.7” x 33”	1645 x 828 x 840 mm 64.8” x 32.6” x 33”
Weight[5]	Kg / lbs	305 / 672.4	400 / 882	560 / 1234.6

Notes: All specifications are subject to change without notice.

1. For type A(45-500Hz) and models with output power of 20kVA and higher, the available output power will be as shown in the frequency characteristic curve in section 3.2.
2. THD shown is for the output frequency from 45 to 65Hz and output voltage setting from 90 - 140Vac on Low voltage range or 180 - 280Vac on High voltage range and with a resistive load. THD for type C 300-840Hz frequency range models is ≤ 2%,
3. Please contact Adaptive Power Systems for other available input voltage specifications options.
4. The max. input current is calculated at stated AC input voltage nominal - 15% (low line)
5. Dimensions and weight are for input voltage 208V or 480V AC standard unit. Please contact us for dimensions and weight for other input voltage.

4.3 Three Phase Output Models – 60kVA to 100kVA

Model:		APF3060	APF3075	APF3100
AC Output				
Power (kVA / kW		60	75	100
Phase Mode		Three Phase, 4 Wire + Ground		
Voltage Range	Low	0 ~ 155 V L-N		
	High	0 ~ 310 V L-N		
Resolution		0.1 V		
Accuracy		0.5% F.S. + 4 Counts		
Frequency Range[1]		A version: 45~500Hz, B version: 45~120Hz, C version: 300~840Hz		
Resolution		0.1 Hz		
Accuracy		± 0.02% F.S.		
Current RMS max.	Low Vrange	166.7 A	208.3 A	277.8 A
	High Vrange	83.3 A	104.2 A	138.9 A
Line Regulation		< 0.5 %		
Load Regulation		≤ 0.5% (Resistive Load)		
Voltage Distortion	THD[2]	≤ 0.5% (Resistive Load)		
Response Time	V change	≤ 1 msec		
Crest Factor	Current	≥ 3:1		
Measurements				
		Range	Resolution:	Accuracy:
Voltage	Vrms	0 ~ 310V	0.1 V	0.5% F.S. + 4 counts
Frequency	Hz	45.0 ~ 840 Hz	0.01 Hz	±0.02% F.S.
Current	Arms	See Current Spec.	0.1 A	0.5% F.S. + 4 counts
Power	KWatt	See kVA Spec.	0.1 kW	1.0% F.S + 6 counts
AC Input Mains				
Frequency Line		47 Hz ~ 63 Hz		
Phase Mode		3 Phase / 3 Wire + Ground		
Input Voltage[3]	-480 Model	480Vac ± 10%		
Line Current	Max[4]	105	131	184
Input Power Factor		≥ 0.9 @ Max. Power		
General Specifications				
Efficiency	> 90% at Max. Power			
User Interface	7” Color Touch Screen			
Program Modes	STEP : 24 sets / 255 cycles. (Volt./Freq./Time) RAMP : 12 sets / 255 cycles. (Volt./Freq./Time)			
Soft Start	Setting : Rated Volt. / Rated Freq. / Start Volt. / Start Freq. / Delay Time / Ramp Time			
Protections	Input : Input No Fuse Breaker (N.F.B), Over Voltage, Under Voltage, Output : Over Voltage, Over Current, Over Temperature Unit will display the error code and give a warning sound.			
Remote Control	Standard: RS-232/RS-422/RS-485/Ethernet Available Options: GPIB, Analog, USB			
Temperature	0° ~ 45° operating			
Humidity	0 ~ 90%, non-condensing			

Model:		APF3060	APF3075	APF3100
Mechanical				
Dimensions[5] (Including wheels)	H x W x D	1645 x 828 x 840 mm 64.8” x 32.6” x 33.1”	1900 x 1178 x 1200 mm 74.8” x 46.4” x 47.2”	
Weight[5]	Kg / lbs	670 / 1477.1	960 / 2116.4	1170 / 2579.4

Notes: All specifications are subject to change without notice.

1. For type A(45-500Hz) and models with output power of 20kVA and higher, the available output power will be as shown in the frequency characteristic curve in section 3.2.
2. THD shown is for the output frequency from 45 to 65Hz and output voltage setting from 90 - 140Vac on Low voltage range or 180 - 280Vac on High voltage range and with a resistive load. THD for type C 300-840Hz frequency range models is ≤ 2%,
3. Please contact Adaptive Power Systems for other available input voltage specifications options.
4. The max. input current is calculated at stated AC input voltage nominal - 15% (low line)
5. Dimensions and weight are for input voltage 208V or 480V AC standard unit. Please contact us for dimensions and weight for other input voltage.

4.4 Safety & Regulatory

Refer to Declaration of Conformity sheet in Section 11, “CE MARK Declaration of Conformity” at the end of this manual.

4.5 Cabinet Dimensions

Cabinet dimensions and weights by model are shown in the table below.

Models	Height	Width	Depth	Chassis No.
APF1010	945 mm 1045 incl casters	628 mm	840 mm	1
AFP1015, APF3015, APF3020, APF3030	1340 mm 1440 incl casters	628 mm	840 mm	2
APF1045, APF3045, APF3060	1545 mm 1645 incl casters	828 mm	840 mm	3
APF3075, APF3100	1900 mm	1178 mm	1200 mm	4

Table 4-1: Cabinet dimensions by Model

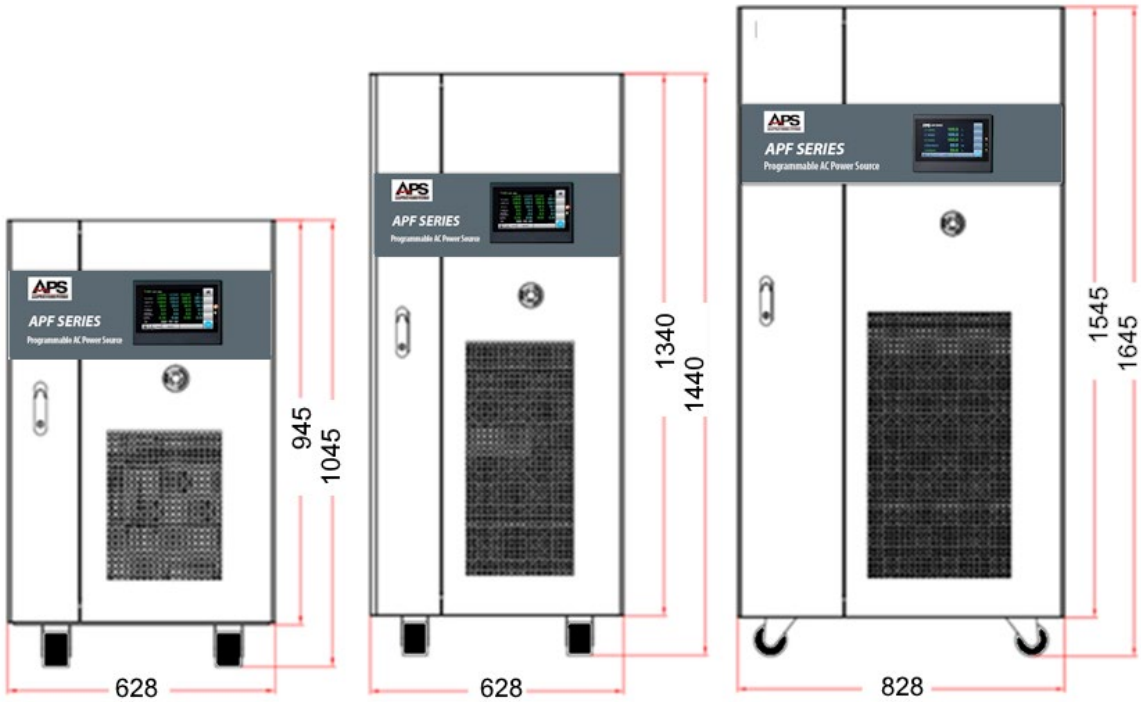


Figure 4-1: Cabinet Types 1, 2 & 3 Dimensions

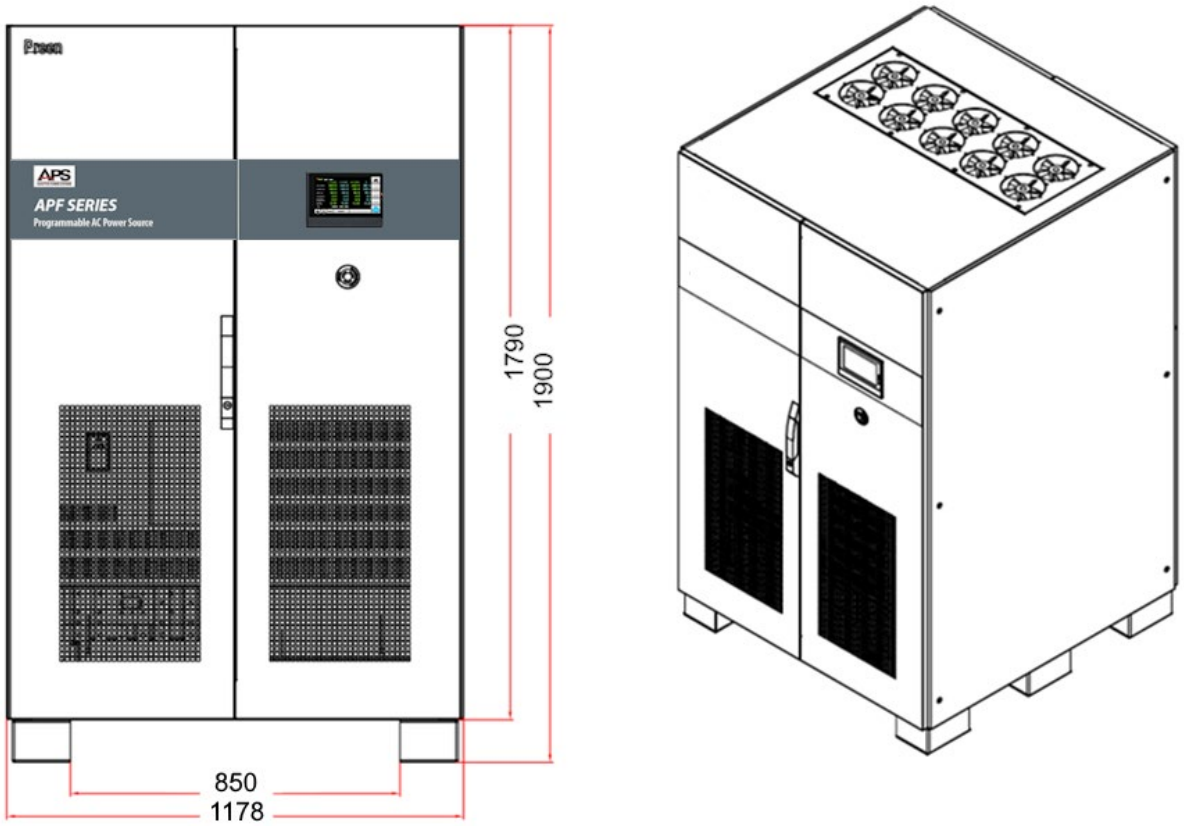


Figure 4-2: Cabinet Type 4 Dimensions

4.6 Location of Controls and Terminal Blocks

Controls and terminal blocks for connection of AC input and AC output wires can be found inside the cabinet by opening the front door. This should always be done while the unit is disconnected from mains input power and is fully de-energized.

The locations for cabinet sizes 1 through 3 is shown on the next page. The table calls out the location numbers from the illustration and describes the purpose of each.

No.	Name	Description
1	Touch Screen	Input programming data or options by the touch screen.
2	Emergency Stop	When the user presses the emergency stop button, the output will shut down immediately
3	Interfaces	RS-232/RS-485/ Ethernet communication ports
4	Input Switch	Switch to turn on/ turn off the product.
5	AC Input Terminal	R,S,T,G (from left to right)
6	AC Output Terminal	U,V,W,N,G (from left to right)

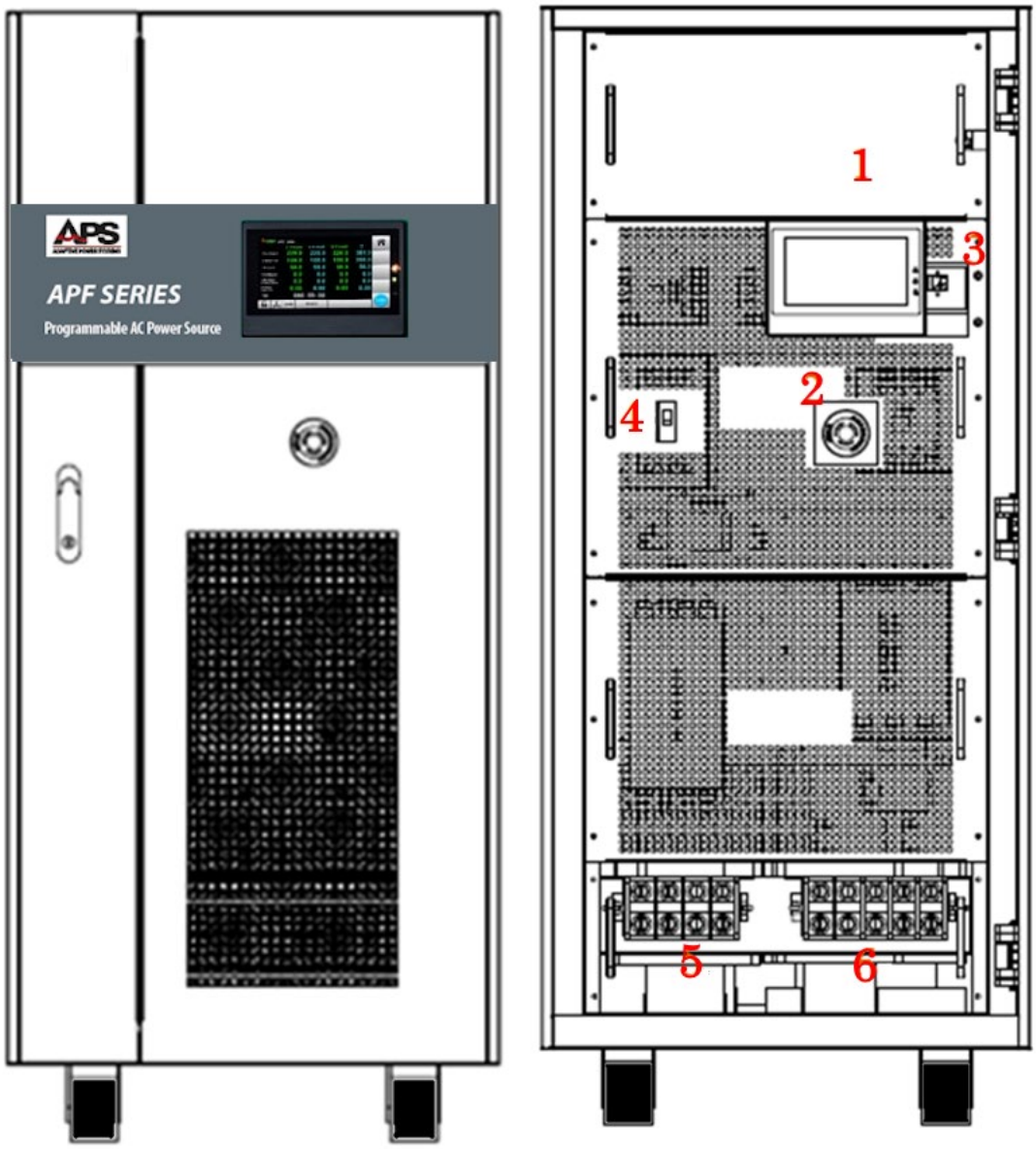


Figure 4-3: Cabinet Types 1, 2 & 3 Controls & Terminals

The locations for cabinet size 4 is shown on the next page. The table calls out the location numbers from the illustration and describes the purpose of each.

No.	Name	Description
1	Touch Screen	Input programming data or options by the touch screen.
2	Emergency Stop	When the user presses the emergency stop button, the output will shut down immediately
3	Interfaces	RS-232/RS-485/ Ethernet communication ports
4	Input Switch	Switch to turn on/ turn off the product.
5	AC Input Terminal	R,S,T,G (from left to right)
6	AC Output Terminal	U,V,W,N,G (from left to right)

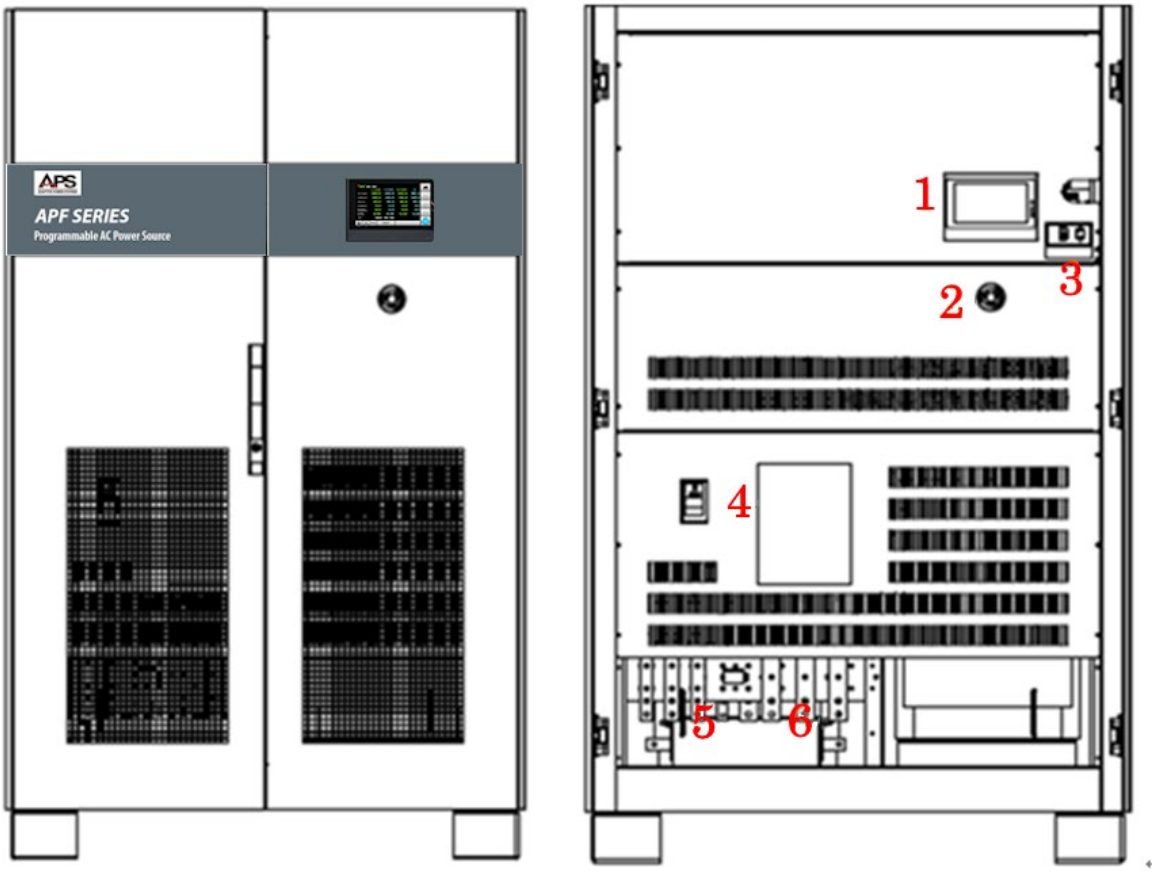


Figure 4-4: Cabinet Type 4 Controls and Terminals

4.7 Remote Control Interfaces

APF units come standard with serial and LAN remote control interfaces. Optional interfaces available are USB and GPIB.

4.7.1 Series Control Interfaces

To remotely control the power source output via one of the serial interfaces - RS-232 / RS-485 / RS-422 - connect a computer via the 9-pin D-type connector according to the following instructions.

The definition for the pins of the RS-232 / RS-485 / RS-422 9-pin D-type female connector is given as follows:

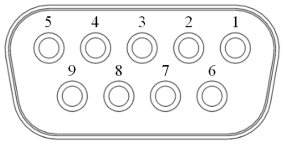


Figure 4-5: RS232/RS485/RS422 DB9 Female Connector

Pin No.	Signal	RS232	RS485	RS422A
1	RX-(B)	--	RS485B	Receive Data
2	RXD	Receive Data	--	--
3	TXD	Send Data	--	--
4	TX-	--	--	Send Data
5	SG	Signal Ground		
6	$RX^{+}A$	--		Receive Data
7	NC	Delete Send	--	--
8	NC	Request Send	--	--
9	TX^{+}	--	--	Send Data

Table 4-2: Serial Interface Signal pin assignments

4.7.2 LAN Control Interface

The LAN interface RJ45 socket is located to the right of the LCD touch screen (See area #3 in Section 4.6) and can be connected when the front panel door is open. Make sure power to the unit is OFF when connecting the unit to a local Ethernet.

5 Unpacking and Installation

5.1 Unpacking & Inspection

The APF Series power sources are shipped in a crate box with protective foam inserts. Use proper equipment to open the shipping crate and remove the unit from its packaging before use.

Removal Steps:

1. Remove crate panels.
2. Use a forklift to carefully remove the unit from its crate.

The APF Series of power sources are carefully inspected before shipment. Every reasonable precaution is taken to ensure that the product is not damaged before shipping, however some damage may occur on the product during shipping. Please inspect the product carefully after unpacking and save all packing materials until an inspection is complete. If damage has occurred during transport, please inform the shipping company and Adaptive Power Systems' nearest sales and service office or representative. Do not return the product to the factory without obtaining a Return Merchandise Authorization from Adaptive Power Source.

5.2 User Preparation

Be sure the power source is connected to the correct power line input voltage that meets the models AC input specifications. The device must be installed in an area with good air-circulation, so that the fans built-in are able to ventilate the heat generated by internal components properly. The ambient temperature in the area where the unit is placed should be controlled within 40° C max.

5.2.1 Installation Information

1. The device must be installed on a horizontal surface rated to support the unit's weight and should be located as close to the load as possible so that the power connections are as short as possible.
2. Leave sufficient space around the device for ventilation and maintenance access (refer to Figure 5-1). Do not block the cooling fan opening in case of internal temperature gets too high and has a negative impact on product life.
3. The device should be located in an area with proper ventilation. Ambient temperature and humidity should not be high. Keep the unit away from any liquids, flammable gases, corrosive substance, heat sources or direct sunlight. Keep the vent openings free from dust.
4. The operating environment should be free from dust, volatile organic compounds, high salinity or any corrosive substances.
5. Do not operate the unit outdoors.

6. Use correct cable type and gauge and a proper power clearance and positioning to ensure the safety of the device and the operator.

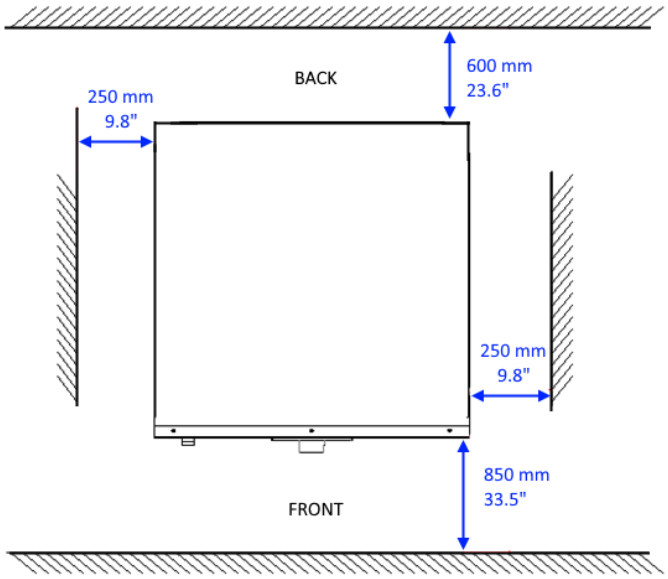


Figure 5-1: Required Clearance Placement

5.2.2 Ship Kits

All units are shipped with a ship kit that may contain several items. Ship kits can vary by model so check the contents of the ship kit you received against the relevant table below. If any items appear to be missing, contact Adaptive Power Systems customer service. (support@adaptivepower.com).

The following accessories are included with each APF power source.

Item	Description	APD Series
1	User Manual Download PDF	https://tr.adaptivepower.com/
2	Calibration Certificate	

Table 5-1: APF Series Included Accessories Ship Kit

5.3 Grounding Requirements

WARNING

Before connecting power to this instrument, the protective ground (earth) terminals of this instrument must be connected to the protective conductor of the line (mains)

The chassis must be grounded. A proper Earth Ground connection must be used at all times. Correct grounding of your electrical system infrastructure according to applicable national standards must be observed.

CAUTION

Always check the AC Voltage Rating of the Power Source to make sure it matches the local grid voltage.

Input Voltage: APF models are available with 208Vac or 480Vac 3 Phase Delta Grid Inputs. Optional alternative input voltage models may be ordered if needed. Check the Model/Serial tag of the unit before connecting to AC mains to make sure the AC input voltage rating matches the local utility voltage.

It is strongly recommended to check the actual line voltage using a suitable multimeter to verify it is within range of the AC input voltage specification of the unit as shown on the Model/Serial tag. The unit could be damaged if it exceed the indicated input voltage range.

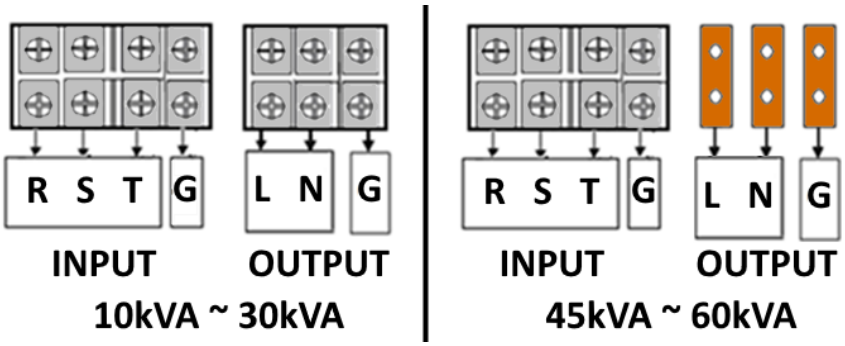
Input Frequency: AC input frequency range is 47 Hz through 63 Hz.

Line Current: Refer to Sections 4.1, 4.2 or 4.3 – Technical Specifications, depending on the model at hand.

5.4 Input & Output Wiring Diagrams

Please do not turn on the unit before connecting the input and output cables per the information below.

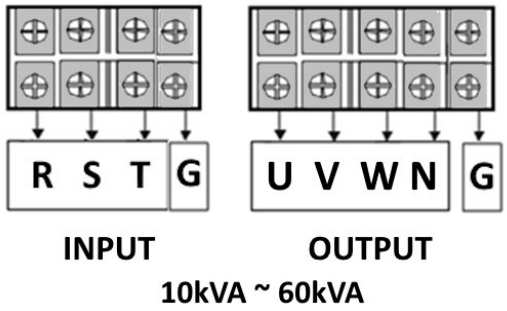
5.4.1 Three Phase Input / Single Phase Output Models APS10xx



MODEL	480Vac Input Terminal		Output Terminal		208Vac Input Terminal		Output Terminal	
	Rating	Screw Size	Rating	Screw Size	Rating	Screw Size	Rating	Screw Size
1015	30A	M4	200A	M10	100A	M8	200A	M10
1020	60A	M6	200A	M10	100A	M10	200A	M10
1045	100A	M8	Bus bar	M10	200A	M10	Bus bar	M10

Table 5-2: Currents Single Phase Output Models 480V & 208V

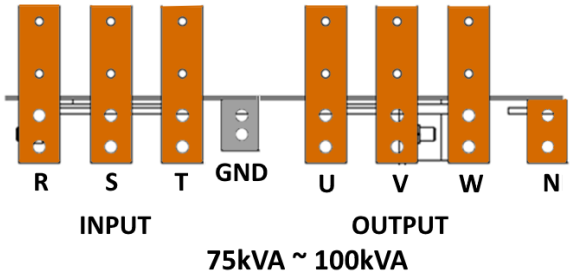
5.4.1 Three Phase Input / Three Phase Output Models APS30xx – 15kVA~60kVA



MODEL	480Vac Input Terminal		Output Terminal		208Vac Input Terminal		Output Terminal	
	Rating	Screw Size	Rating	Screw Size	Rating	Screw Size	Rating	Screw Size
3015	30A	M4	60A	M6	100A	M8	60A	M6
3030	60A	M6	100A	M8	200A	M10	100A	M8
3045	100A	M8	200A	M10	200A	M10	200A	M10
3060	100A	M8	200A	M10	300A	M10	200A	M10

Table 5-3: Currents Three Phase Output Models 480V & 208V, 15kVA~60KVA

5.4.2 Three Phase Input / Three Phase Output Models APS30xx – 75kVA~100kVA



MODEL	480Vac Input Terminal		Output Terminal		208Vac Input Terminal		Output Terminal	
	Type	Screw Size	Rating	Screw Size	Rating	Screw Size	Rating	Screw Size
3075	Bus Bar	M10	Bus Bar	M10	Bus Bar	M10	Bus Bar	M10
3100	Bus Bar	M10	Bus Bar	M10	Bus Bar	M10	Bus Bar	M10

Table 5-4: Currents Three Phase Output Models 480V & 208V, 75kVA~100KVA

5.5 Recommended Wire Sizes – Input / Output

Care must be taken to properly select wire size for the input and output of APF series according to model number. Refer to Table 5-2, Table 5-3 and Table 5-4.

For input/output connections, please remove the front of the cabinet enclosure which is fixed via screws. Please refer to section Table 5-5and Table 5-6 to connect the terminals of AC input and AC output which are inside behind the front panel with the cables. For safety requirement, ensure that the product and the DUT are switched off before connection, and reinstall and screw the front panel back after all connections are completed.

CAUTION

The front cabinet front MUST remain installed at all times when using this equipment

For 480V input models:

APF Model	Input Current	AC Input (480V) Terminals			Ground
		R	S	T	
1010	16.5A	2.5 mm^2	2.5 mm^2	2.5 mm^2	2.5 mm^2
1020	33A	4 mm^2	4 mm^2	4 mm^2	4 mm^2
1045	75A	25 mm^2	25 mm^2	25 mm^2	25 mm^2
3015	24.8A	2.5 mm^2	2.5 mm^2	2.5 mm^2	2.5 mm^2
3030	49.5A	25 mm^2	25 mm^2	25 mm^2	25 mm^2

APF Model	Input Current	AC Input (480V) Terminals			Ground
		R	S	T	
3045	74.3A	25 mm^2	25 mm^2	25 mm^2	25 mm^2
3060	99A	35 mm^2	35 mm^2	35 mm^2	35 mm^2
3075	123.8A	50 mm^2	50 mm^2	50 mm^2	50 mm^2
3100	174.8A	70 mm^2	70 mm^2	70 mm^2	70 mm^2

Table 5-5: AC Input Wire Sizes 480V input

For 208V input models:

APF Model	Input Current	AC Input (208V) Terminals			Ground
		R	S	T	
1010	40A	25 mm^2	25 mm^2	25 mm^2	25 mm^2
1020	75A	25 mm^2	25 mm^2	25 mm^2	25 mm^2
1045	200A	70 mm^2	70 mm^2	70 mm^2	70 mm^2
3015	60A	25 mm^2	25 mm^2	25 mm^2	25 mm^2
3030	121A	50 mm^2	50 mm^2	50 mm^2	50 mm^2
3045	135A	70 mm^2	70 mm^2	70 mm^2	70 mm^2

Table 5-6: AC Input Wire Sizes 208V input

Output Cable Sizes

APF Model	Max Current	Output Terminals			Neutral	Ground
		U	V	W		
1010	83.3A	25 mm^2			25 mm^2	25 mm^2
1020	125A	70 mm^2			70 mm^2	70 mm^2
1045	375A	150 mm^2			150 mm^2	150 mm^2
3015	41.7A	10 mm^2	10 mm^2	10 mm^2	10 mm^2	10 mm^2
3030	83.3A	25 mm^2	25 mm^2	25 mm^2	25 mm^2	25 mm^2
3045	125A	50 mm^2	50 mm^2	50 mm^2	50 mm^2	50 mm^2
3060	166.7A	70 mm^2	70 mm^2	70 mm^2	70 mm^2	70 mm^2
3075	166.7A	120 mm^2	120 mm^2	120 mm^2	120 mm^2	120 mm^2
3100	277.8A	150 mm^2	150 mm^2	150 mm^2	150 mm^2	150 mm^2

Table 5-7: AC Output Wire Sizes

American Wire Gauge vs Current Rating:

AWG	Current Rating	AWG	Current Rating
18	10A	4	100A
16	15A	2	130A
14	25A	1	145A
12	30A	0 (1/0)	170A
10	40A	00 (2/0)	195A
8	55A	000 (3/0)	225A
6	80A	0000 (4/0)	260A

Table 5-8: American Wire Guage vs Current Ratings

Note: The recommended wire sizes are based on an ambient temperature below 35°C, and for a temperature rating of conductor wire insulation of at least 60°C.

Note: The tables above provide minimum recommended cable sizes. These recommendations are for multi core flexible copper cables and are for reference only. The user can select different cables according to the actual input and output conditions. When the length of cabling is more than 20 meters 65 feet, the cable gauge should be doubled.

5.6 AC Input Connections

To connect the AC grid power input wiring, open the front chassis door and remove the button front panel of the product enclosure which is fixed using screws. There you will find the input terminal block as shown in Figure 5-2 below. The input power cord must be rated at least for a temperature of 85°C. The input power cord must also have a current rating current which is greater than or equal to the maximum rated input current of the product. See Section 4 for ratings by model.

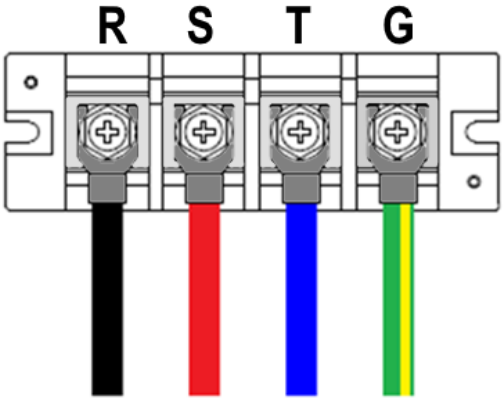


Figure 5-2: Three Phase AC Grid Power Input Terminal

Referring to Figure 5-2, follow the steps outlined here:

1. Open the front chassis door.
2. Remove the bottom front panel.
3. Remove the safety cover on the input terminal and screw the power cord tightly to the input terminals of the product as follows,
4. Connect the Ground wire to the terminal "**G**" of the input terminals;
5. Connect the A cable wire to the terminal "**R**" of the input terminals;
6. Connect the B cable wire to the terminal "**S**" of the input terminals;
7. Connect the C cable wire to the terminal "**T**" of the input terminals.
8. Slip the safety cover over the input terminals.

Notes:

Three Phase may also be referred to as A / B / C, U / V / W, R / S / T or L1 / L2 / L3.

In different countries, different colors may be used to represent three phase wires and cables. The information below for provided for reference:

Region	Wire Colors
USA	A (Black) / B (Red) / C (Blue) / N (White or Gray) / G (Green or Green with Yellow Stripe)
EU	A (Brown) / B (Black) / C (Gray) / N (Blue) / G (Green)
China	A (Yellow) / B (Green) / C (Red) / N(Blue) / G (Green with Yellow Stripe)
Taiwan	A (Red) / B (White) / C (Black or Blue) / (White) / G (Green with Yellow Stripe)

Other regions may use different designations and / or colors.

CAUTION

Protective Grounding. To protect users, the wire connected to terminal "G" (that is GND) must be connected to the earth ground. Under no circumstances shall this product be operated without an adequate protective grounding connection.

5.7 AC Output (Load) Connections

For Output connections, open the front chassis door and remove the button front panel which is secured using screws, then you will find the output terminal as shown in Figure 5-3 below. Please connect the output wires to the input of the DUT and ensure the wires to the DUT must be sufficiently large gauges, so they will not over-heat while carrying the output current.

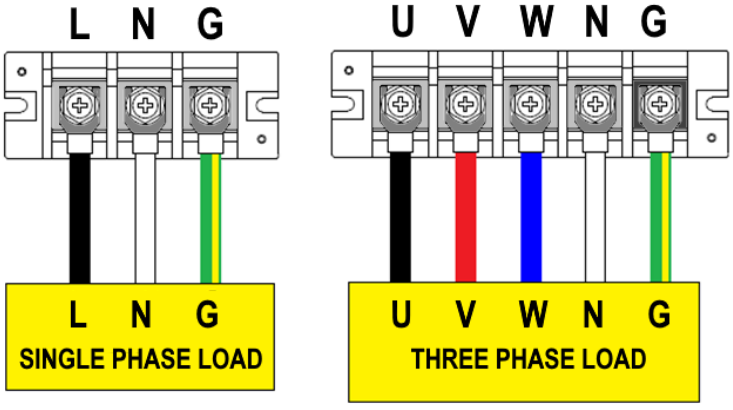


Figure 5-3: Single & Three Phase Output Terminals

5.8 Remote Voltage Sense Connections

The APF Series AC Power Sources supports Remote Voltage Sensing functions, monitoring the voltage at the point of load instead of at the output terminals of the power source. This ensures the load programmed output voltage is present at the load terminals by automatically compensating for any output voltage drop due to output connection cable impedance.

5.8.1 Disabling the Remote Voltage Sense Function if appropriate.

If the power supply and the load are in proximity of each other, the Remote Sensing function can be disabled by locally shorting the Vsense connections to the output of the power source. . Refer to 12 for bypassing the Remote Sensing function.

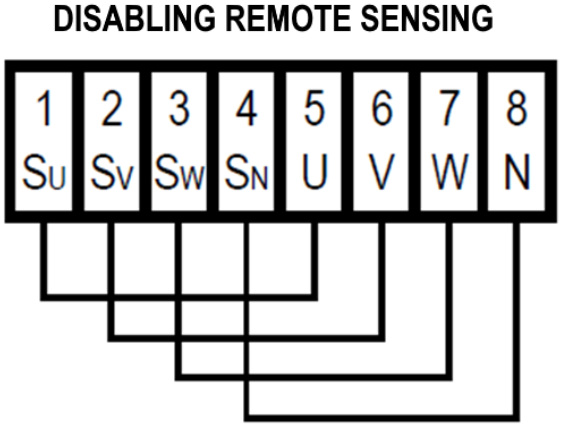


Figure 5-4: Disabling Remote Sensing

5.8.2 Enabling the Remote Voltage Sense Function

When the power supply and the load are a certain distance apart and need long connecting cable, Remote Sensing can be enabled to compensate for the output voltage drop caused by the load cable impedance. Refer to Figure 5-5 for Remote Sensing Connection use. Remove any shorting jumpers that may be installed on the Remote Sensing connector (see prior section) and connect the remote sensing connector SU\SV\SW\SN using sense wires to the corresponding load terminals U\V\W\N at point of load, as shown in Figure 5-5.

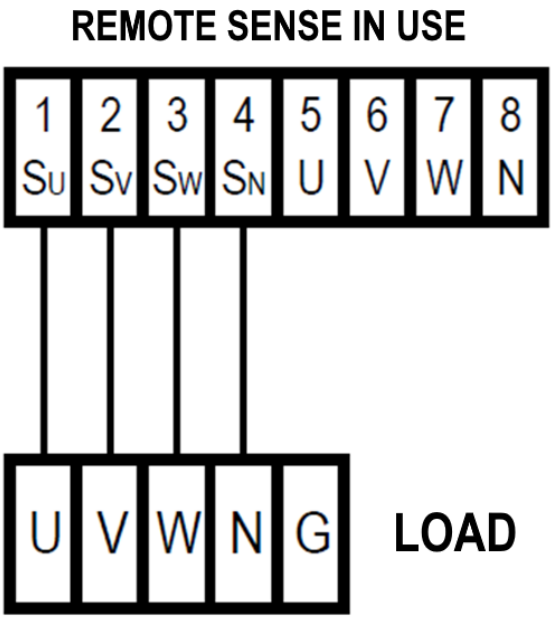


Figure 5-5: Enabling Remote Voltage Sense

5.9 Power On Procedure

After the installation of the APF Series high power AC source and closing the front of the unit, apply mains power and switch on the input circuit breaker to turn on the power source. The fan in the unit will start to operate, and the touch screen on the front panel will light up and enter the POWER-ON page (refer to Figure 5-6) for initialization self-check.

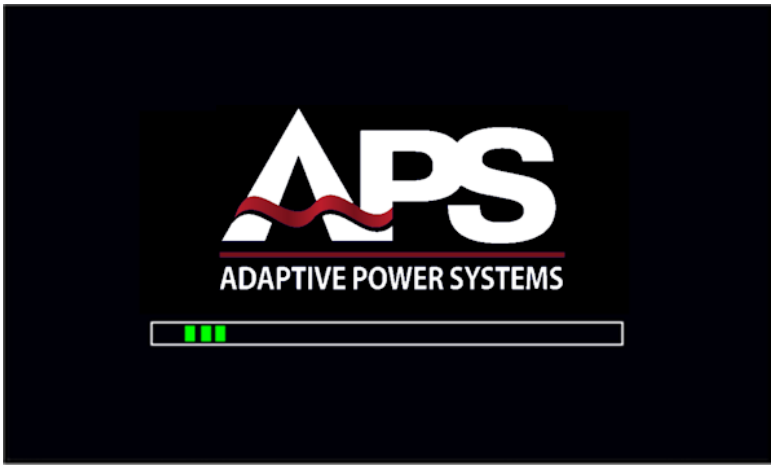


Figure 5-6: Power ON Page Screen

6 Front Panel Operation

This Chapter provides an overview of front panel operation for the APF Series power sources. The APF Series supports local operation via touch screen on the front panel, and remote operation via communication interface: standard RS-485/RS-232/RS-422/ Ethernet, optional GPIB, Analog and USB. For remote control operation, refer to Section 8, Remote Control Programming on page 79 of this manual for an overview of available programming commands.

6.1 Powering On

WARNING

Before turning on the device, all protective grounding terminals, extension cords, or any equipment connected to it must be connected to a protective ground. Any interruption of the protective ground could cause a potential shock hazard that may result in personal injury.

After the installation of the APF Series high power AC source, apply power and switch on the input circuit breaker to turn on the device. The fan in the device will start to operate, and the touch screen on the front panel will light up and enter the POWER-ON page (refer to Figure 6-1) for initializing check. An initial screen animation will appear as shown below.

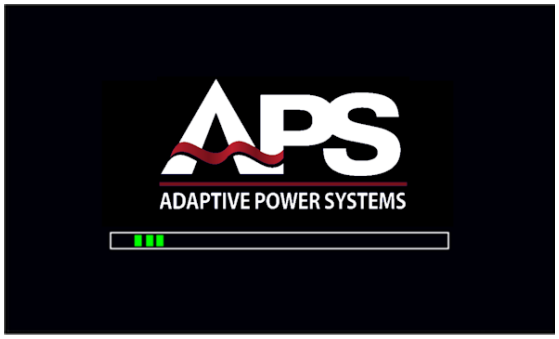


Figure 6-1: POWER ON screen

After the POWER-ON page, the touch screen will enter the MAIN page (refer to Figure 6-2). Users can input programming data or set up configurations by pressing the touch screen.

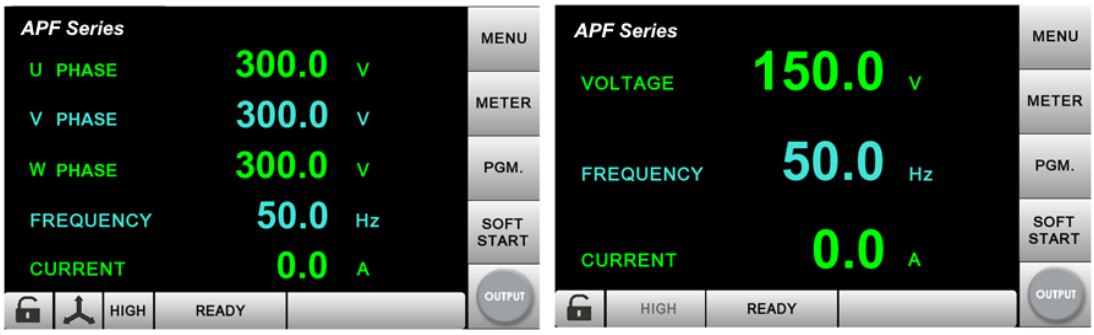


Figure 6-2: Main Screen - Three Phase (left) or Single Phase (right)

6.2 Touch Screen Operation

The APF Series provides an intuitive touch screen Human Machine Interface (HMI) for easy operation and data display. Manipulate the touch screen to enter output programming data or control options by pressing the items or icons shown on the screen directly.

Use a virtual numeric keyboard to set parameter values: select the parameter for numeric value entry and the keyboard will pop up.

For example, press the output measurement in the red square on the MAIN page (refer to Figure 6-3) and the numeric keyboard will display. The maximum and minimum value of the parameter is marked on it. Use the numeric keyboard to set parameter values and press ENTER to confirm the entry. Press DEL to delete the last digit. Press ⮌ to return to the previous page.

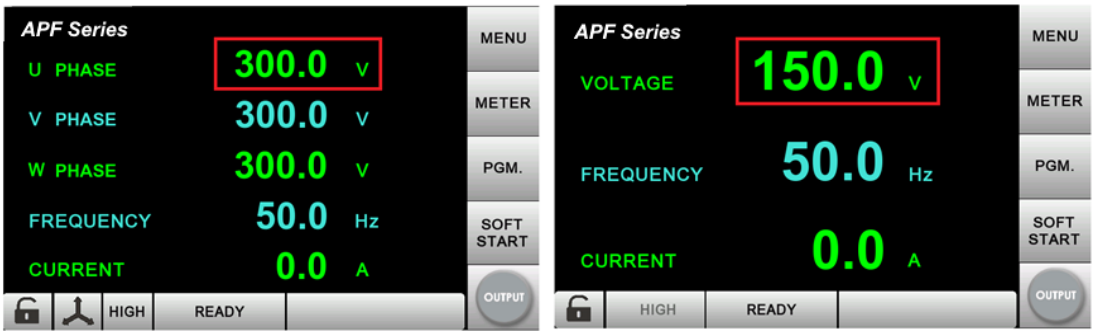


Figure 6-3: Numeric Value Entry on Three Phase or Single Phase models

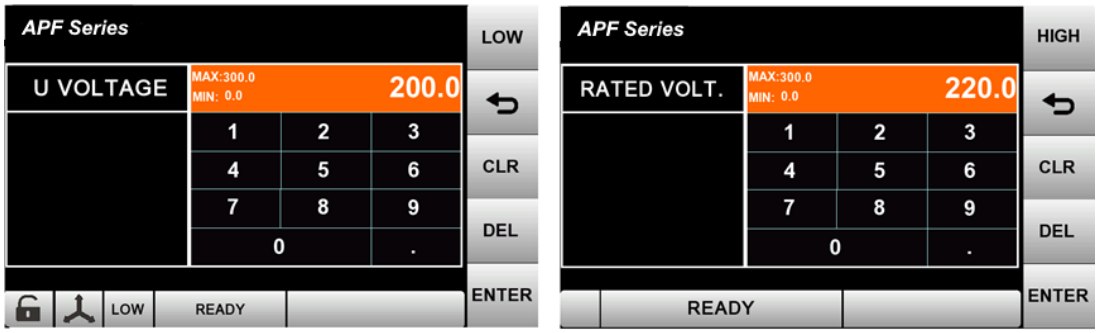


Figure 6-4: Virtual numeric keyboard - Three-Phase (left) or Single Phase (right)

6.3 MAIN Screen

When users turn on the power switch, the touch screen displays the MAIN page (refer to Section 3.3.1) after the power-on procedures. MAIN page shows the output settings and the measurement readings of the device output. Users can set output value by using the touch screen, and then press the Output & Reset Button on the touch screen to enable the device output. The touch screen will switch to Meter page (refer to Section 3.8) automatically once the device output is enabled.

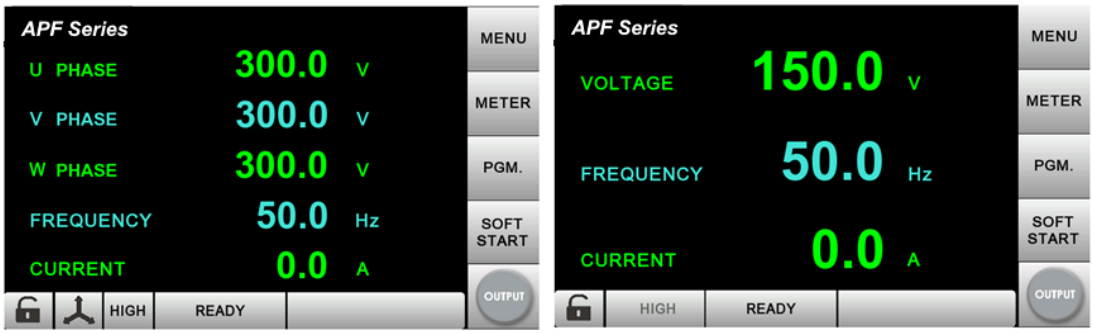


Figure 6-5: MAIN page display with Output OFF - Three-Phase (left) or Single Phase (right)

Press to set output voltage (L-N).

Press to set output frequency.

Press to set output current high limit (Note: this item will only be shown when the CURRENT LIMIT function in SETTING page is turned ON)

Output/Reset button: press 

over 1 second, and the button will change from grey to blue 

, which indicates that the status of output is ON.

When the button turns to red 

, it indicates there's an error on the device. Press the button 

to reset the device from error.

	Press to enter into MENU page
	Press to enter into METER page (refer to Section 3.7).
	Press to enter into PGM. Page.
	Press to enter into SOFT START setting page
	Show the output status of the device
	ess to lock/unlock the touch screen. The touch screen can only be switched between MAIN page and METER page when it is locked. Automatic Screen Lock function (refer to Section 3.5.2.6) and Screen Lock Password function (refer to Section 3.5.2.5) are available for more advanced setting.
	Show the voltage setting of the three phases is synchronized (for three-phase models only)
	Show the voltage setting can be set independently (for three-phase models only)
	Press to switch between High level (0-300V) and Low level (0-150V) output voltage setting range. Please note that when set the output voltage at 120V, the maximum output current at High level is only the half of the maximum output current at Low level.

6.3.1 Output Voltage Setting

On the MAIN page, press the item **VOLTAGE** to select the output voltage setting page (refer to Figure 6-6). Users can see the set voltage and change it by using the keypad for different testing conditions. The output voltage setting page also shows the maximum and minimum set values for the output voltage. Press ENTER to confirm and finish setting. Press CLR to clear all the input value or press DEL to modify setting.

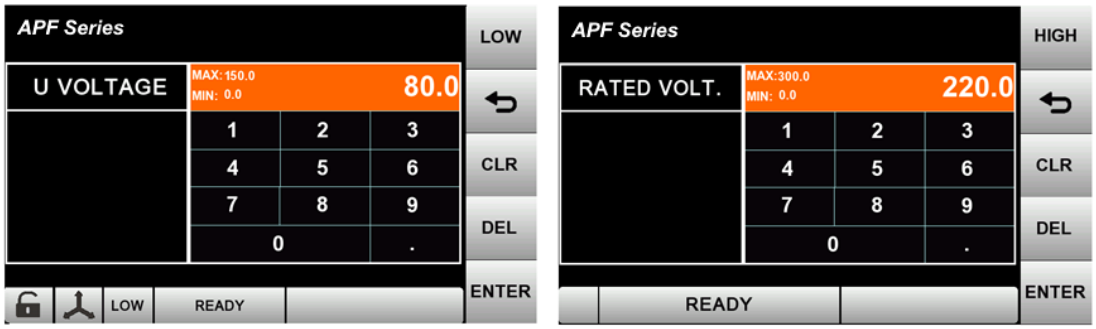


Figure 6-6: Output Voltage Settings Screen - Three-Phase (left) or Single Phase (right)

The APF Series provides two output voltage ranges, High Range and Low Range. High Range allows the maximum output voltage setting to be 0~310V. The Low Range supports setting from 0 to 155V rms. Please note that when setting the output voltage to 120V while on the high voltage range, the maximum available output current is only the half that of the maximum output current on the Low Range.

Phase Voltage Setting Coupling

For three-phase models, when this icon  is shown on the bottom left of the MAIN page, each phase's output voltage setting is synchronized with each other. As any of the U, V, or W phase's voltage changes, the other two phase voltages changes accordingly as well (Coupled mode). When this icon  is shown, each phase's output voltage can be set independently, thus U, V, or W phase voltage setting can be different from each other (Uncoupled mode). To switch between coupled and uncoupled phase voltage modes, press the  icon or  icon to switch in between two different settings.

6.3.2 Output Frequency Setting

On the MAIN page, press the item **FREQUENCY** to enter the output frequency setting page (refer to Figure 6-7). The user can see the set frequency and change it by using the keypad for different testing requirements. The output frequency setting page also shows the maximum (MAX) and minimum (MIN) available setting values for the output frequency. Press ENTER to confirm and finish setting. Press CLR to clear all the input value or press DEL to modify setting.

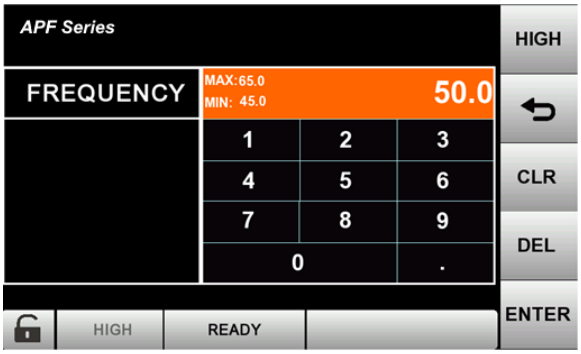


Figure 6-7: Output Frequency Setting Screen

6.3.3 Output Current Limit Setting

On the MAIN page, press the item **CURRENT** to enter the output current limit setting page (refer to Figure 6-8). Users can see the current limit set point and change it by using the keypad for different testing requirements. This setting page also shows the maximum and minimum available set value for the output current limit. Press ENTER to confirm and finish setting. Press CLR to clear all the input value or press DEL to modify setting.

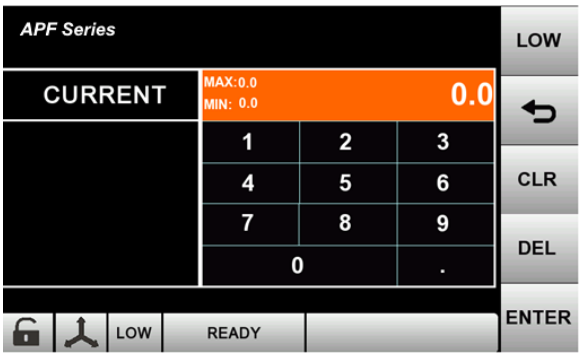


Figure 6-8: Output Current Setting Screen

Note: The output current limit setting is not available on the default MAIN page. To enable this setting, please refer to Section 6.3.5.1.1, Current High Limit Setting.

6.3.4 Menu Screen Functions

From the MAIN page screen, the user can press MENU to enter into MENU page. Refer to Figure 6-9

Figure 6-9: MENU Screen

The descriptions for the various icons in the MAIN screen above are as follows.

	Press to enter the SETTING screen
	Press to enter the PGM screen
	Press to enter the COMMUNICATION screen
	Press to enter the EVENT screen
	Press to enter the METER screen
	Press to enter the INFORMATION screen
	Press to enter the MAIN screen
	Press to return to the previous screen
	Press to move to the previous screen
	Press to enter move to the next screen

6.3.5 Setting Screen

With the MAIN screen displayed on the screen, press  to enter the SETTING screen. The SETTING screen includes two subpages:

- TEST sub-screen
- SYSTEM sub-screen

6.3.5.1 Test Sub Screen

When entering the SETTING screen, the TEST sub-screen  will be displayed on the screen. Refer to Figure 6-10.

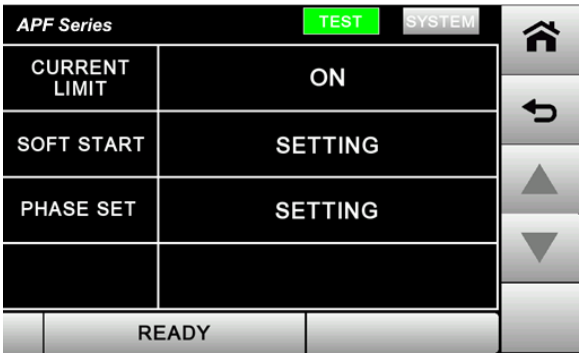


Figure 6-10: TEST sub-screen

The descriptions for the items in the above figure are given as follows.

	Press to activate/deactivate the CURRENT HIGH LIMIT function.
	Press to activate the SOFT START function
	Press to activate the PHASE ANGLE CONTROL (OPTION).

6.3.5.1.1 Current High Limit Setting

The CURRENT HIGH LIMIT function allows the product to shut down the output, if the load current exceeds the set value of CURRENT LIMIT. The condition “Over Current” will be displayed on the screen.

To activate the CURRENT HIGH LIMIT function, the user can press the item 

to switch the CURRENT LIMIT state from OFF to ON.

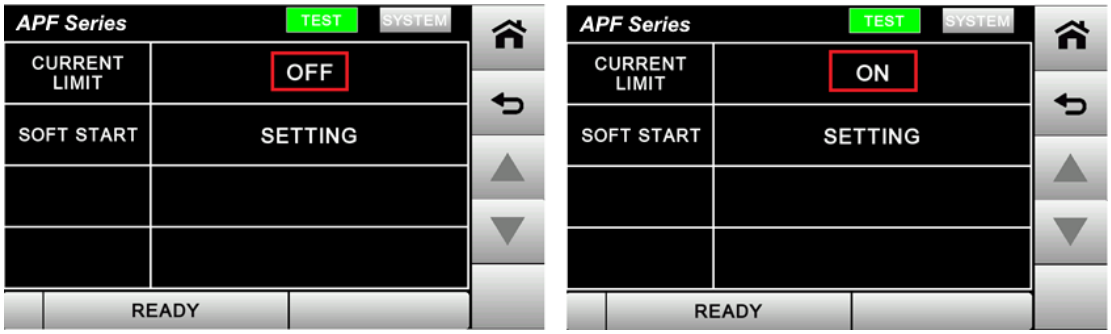


Figure 6-11: CUURENT LIMIT Screens

Note: When the CURRENT HIGH LIMIT function is activated, the MAIN screen will indicate this as shown in display as ON or OFF. The red square indicates that the CURRENT HIGH LIMIT function is activated and if it set to OFF (No current limit setting) or ON (current limit setting shown).

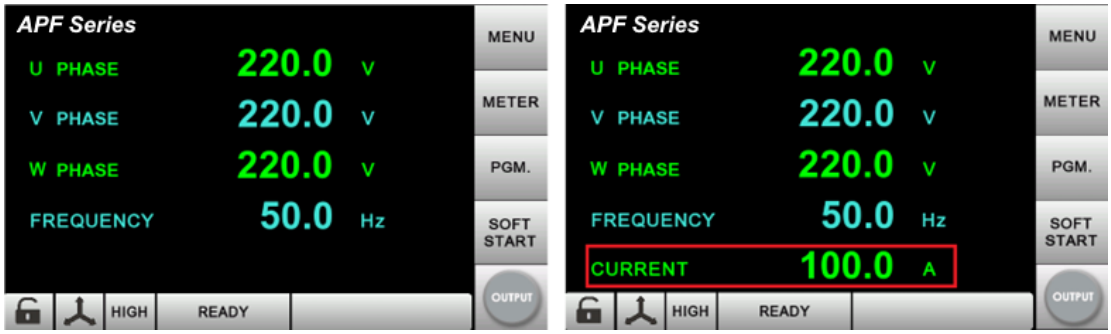


Figure 6-12: Three Phase Models Current Limit – OFF (left) or ON (right)

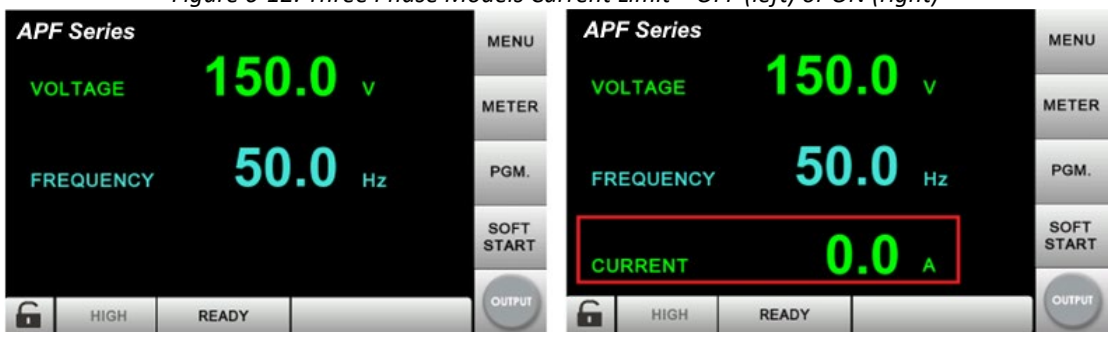


Figure 6-13: Single Phase Models Current Limit – OFF (left) or ON (right)

6.3.5.1.2 SOFT START Setting

The user can set the SOFT START function on the TEST subpage. This feature can be applied to test loads that require large start-up currents, such as motors. The inrush current of this kind of load can be high at startup and will typically drop down after startup. To prevent the load from being unable to start by the power source due to high inrush current demand, the user can set a lower START VOLT and START FREQ, then set a DELAY TIME and a RAMP TIME to allow the load to reach its RATED VOLT and RATED FREQ operation.

Press the to enter the SOFT START setting screen.

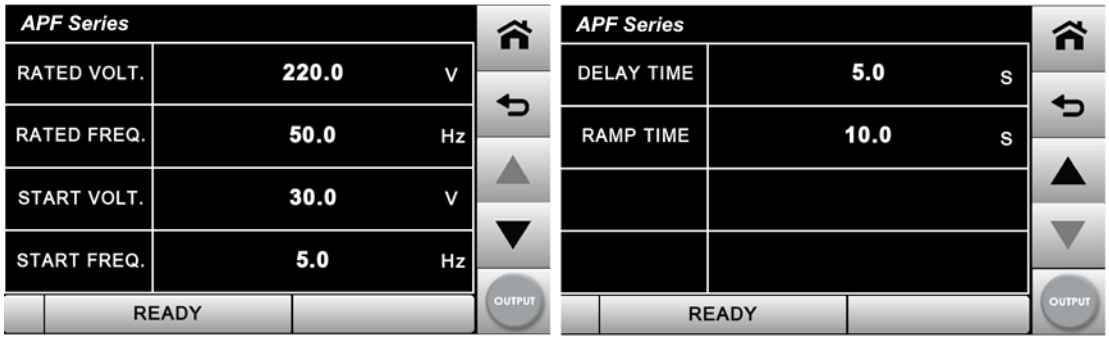


Figure 6-14: SOFT START setting screen

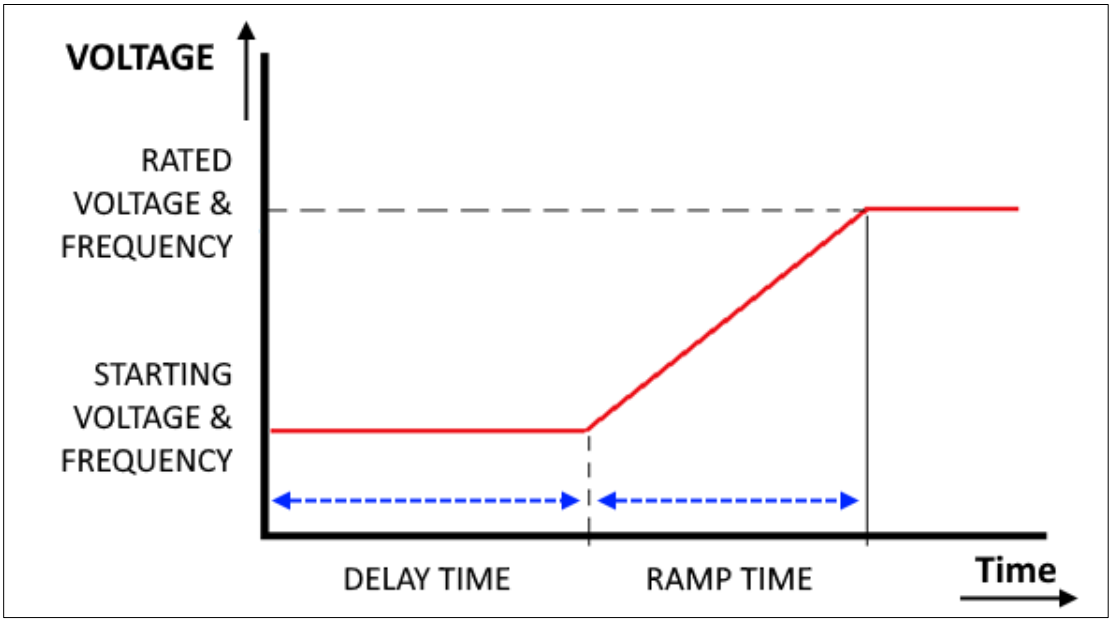


Figure 6-15: SOFT START Operation Mode

The following icons define the operation of the SOFT START mode.

Press the value field to set the rated voltage value.

Refer to Figure 6-16 for the SOFT START RATED VOLT. setting. The setting screen also shows the maximum and minimum set value for the rated voltage. Press ENTER to confirm and finish setting. Press CLR to clear all the input values or press DEL to modify this setting.

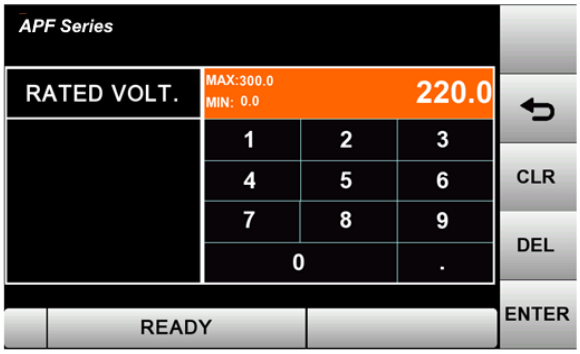


Figure 6-16: SOFT START RATED VOLT. Setting

Press the value to set rated frequency.

Please refer to Figure 6-17for the SOFT START RATED FREQ. setting. The setting screen also shows the maximum and minimum set value for the rated frequency. Press ENTER to confirm and finish setting. Press CLR to clear all the input values or press DEL to modify this setting.

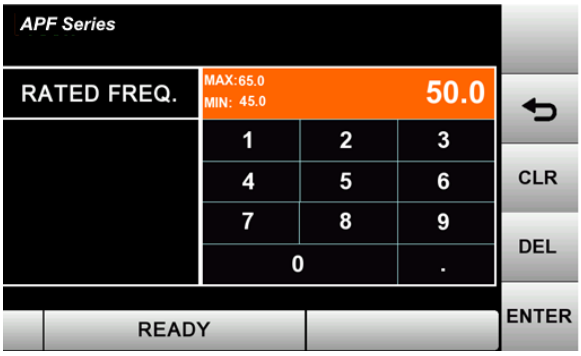


Figure 6-17: SOFT START RATED FREQ. Setting

START VOLT. 30.0 V Press the value to set start voltage.

Please refer to Figure 6-18 for SOFT START START VOLT. setting. The setting screen also shows the maximum and minimum of set value for the start voltage. Press ENTER to confirm and finish setting. Press CLR to clear all the input values or press DEL to modify this setting.

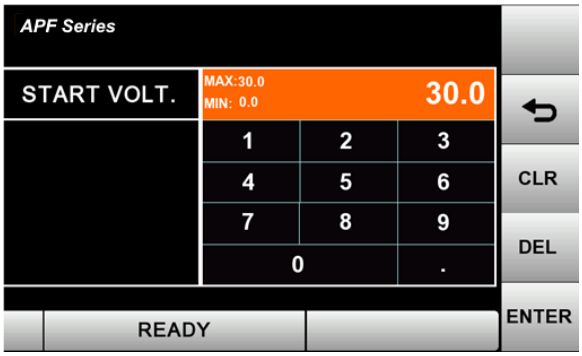


Figure 6-18: SOFT START START VOLT. setting

START FREQ. 5.0 Hz Press the value to set start frequency.

Please refer to Figure 6-19 for SOFT START - START FREQ. setting. The setting screen also shows the maximum and minimum of set value for the start frequency. Press ENTER to confirm and finish setting. Press CLR to clear all the input values or press DEL to modify this setting.

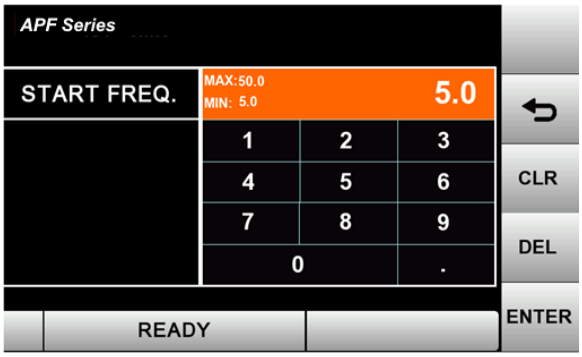


Figure 6-19: SOFT START - START FREQ. setting

DELAY TIME 5.0 S Press the value to set delay time.

Please refer to Figure 6-20 for SOFT START DELAY TIME setting. The setting screen also shows the maximum and minimum of set value for the delay time. Press ENTER to confirm

and finish setting. Press CLR to clear all the input values or press DEL to modify this setting. The setting range for delay time is 0.0 ~ 99.0 seconds, the default is 0.3 seconds.

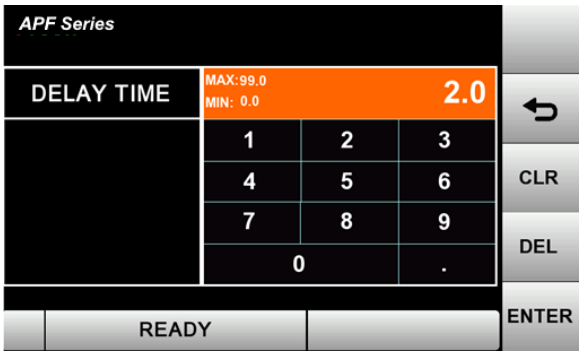


Figure 6-20: SOFT START DELAY TIME setting

Press the value to set delay time.

Please refer to figure 3.18 for the SOFT START RAMP TIME setting. This setting screen also shows the maximum and minimum of the set value for the ramp time. Press ENTER to confirm and finish setting. Press CLR to clear all the input values or press DEL to modify this setting. The setting range for ramp time is 0.0 ~ 99.0 seconds, the default is 0.3 seconds.

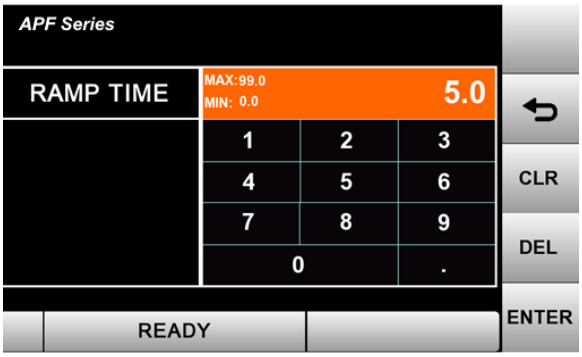


Figure 6-21: SOFT START RAMP TIME setting

Press to move to the previous screen of current screen.

Press to move to the next screen of current screen.

Note: In the SOFT START settings, the setting range of the START VOLT. and the START FREQ. will vary depending on the settings for RATED VOLT. and RATED FREQ.

6.3.5.1.3 Phase Angle Control Setting (Option -P3)

For three-phase models configured with the P3 option, the user can set phase angle between three phases at TEST subpage. The setting range is 0° to 359°. This feature can be applied to simulate phase shifts for different power conditions.

Press PHASE SET | SETTING to enter the phase angle control setting screen.

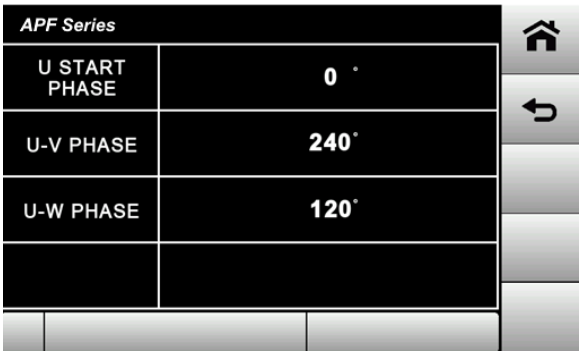


Figure 6-22: PHASE ANGLE CONTROL screen

The descriptions for the icons in the above screen image are as follows:

U START PHASE | 0 °	The starting position of the U phase always defaults to 0° and is not editable.
U-V PHASE | 240°	Press the value to the phase angle between U phase and V phase to change the V phase.

Please refer to Figure 6-23 for the phase angle setting between U phase and V phase. The setting page also shows the maximum and minimum of set value for the phase angle. Press ENTER to confirm and finish setting. Press CLR to clear all the input value or press DEL to modify setting.

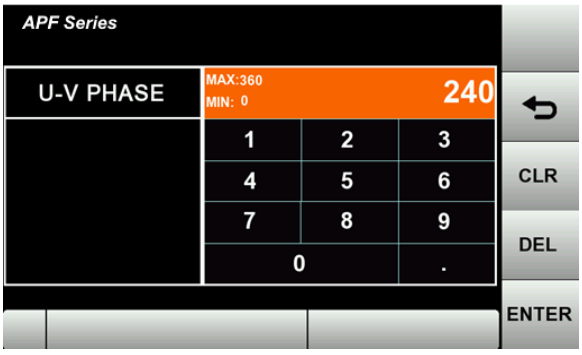


Figure 6-23: U to V Phase Angle Setting

U-W PHASE 120°	Press the value to the phase angle between U phase and W phase to change the V phase.

Please refer to Figure 6-24 for the phase angle setting between U phase and V phase. The setting page also shows the maximum and minimum of set value for the phase angle. Press ENTER to confirm and finish setting. Press CLR to clear all the input value or press DEL to modify setting.

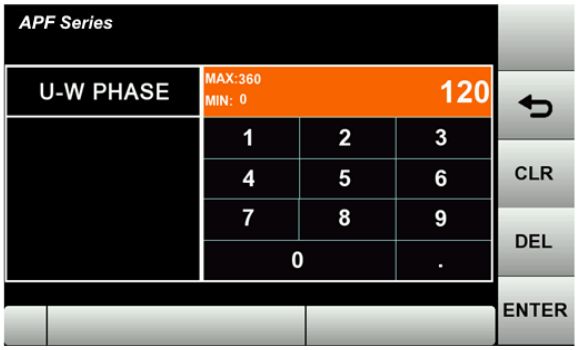


Figure 6-24: U to W Phase Angle Setting

6.3.5.2 SYSTEM Page

Press SYSTEM in the SETTING screen to enter into the SYSTEM sub screen. Refer to

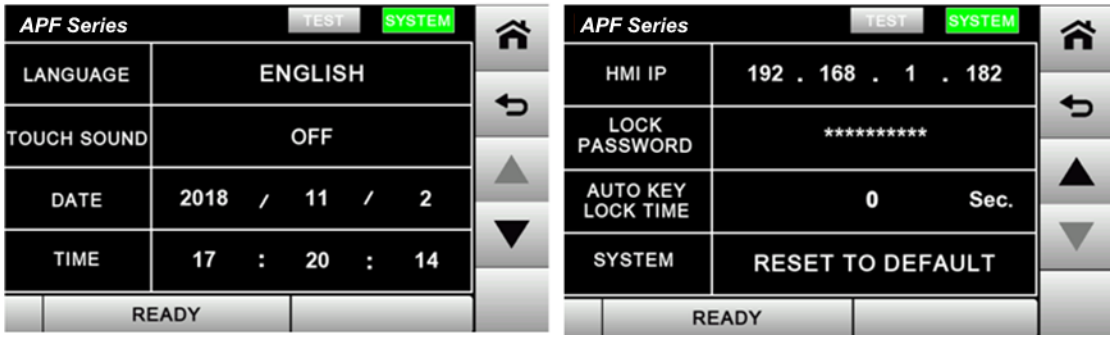


Figure 6-25: SYSTEM sub screens

The descriptions for the items and the icons in the above screens are defined as follows.

LANGUAGE ENGLISH	Press to set the operational language: English / Traditional Chinese (繁體中文) / Simplified Chinese (簡體中文)
TOUCH SOUND OFF	Press to set the touch sound: ON/OFF.
DATE 2018 / 10 / 20	Press to set the date: yyyy/mm/dd.

TIME 10 : 41 : 28	Press to set the time: hours/ minutes/ seconds
HMI IP 192 . 168 . 1 . 182	Press to set the human machine interface LAN address (HMI IP).
LOCK PASSWORD **********	Press to set the screen lock PASSWORD function. When a user sets up for the first time, enter the password directly. The maximum password length is 9 characters. When a user needs to edit the password, enter the original password first.
AUTO KEY LOCK TIME 0 Sec.	Press to set the AUTOMATIC SCREEN LOCK time (0-65535S, 0=OFF).
SYSTEM RESET TO DEFAULT	Press to restore the power source to the factory default settings.

Press to move to the previous screen of current screen.

Press to move to the next screen of current screen.

6.3.5.2.1 System Language Setting

The user can set the system language on the SYSTEM screen. Available settings are English / Traditional Chinese (繁體中文) / Simplified Chinese (簡體中文).

To set the language, press the item LANGUAGE ENGLISH to select the desired language.

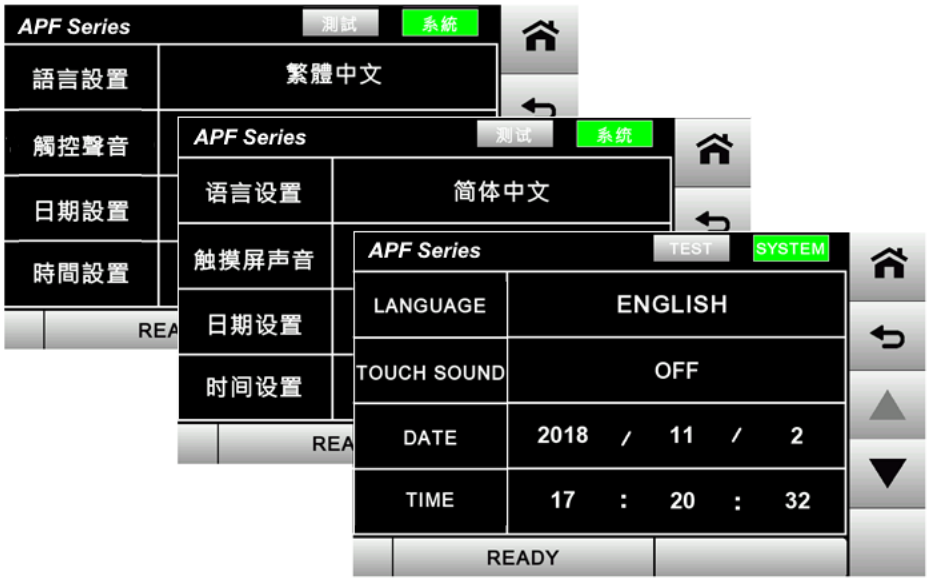


Figure 6-26: System Language Setting Screens

6.3.5.2.2 Touch Sound Setting

The user can set the touch sound ON/OFF from the SYSTEM screen. The default is OFF.

To set the touch sound, press the item 

to toggle the sound ON or OFF.

6.3.5.2.3 Date Setting

The user can set the date from the SYSTEM screen. Press each figure on item 

to set year/month/day individually.

Figure 6-27: Date Setting Screens

6.3.5.2.4 Time Setting

The user can set the time from the SYSTEM screen. Press each figure on item DATE 2018 / 10 / 20 to set hours/minutes/seconds individually.

Figure 6-28: Time Setting Screens

6.3.5.2.5 Screen Lock Setting

LOCK PASSWORD The user can set the SCREEN LOCK function from the SYSTEM screen. When setting up for the first time, enter the password directly. The maximum password length is 9 characters. To change a previously set password or edit the current password, enter the original password first. To disable the SCREEN LOCK function entirely, enter the password “0000”.

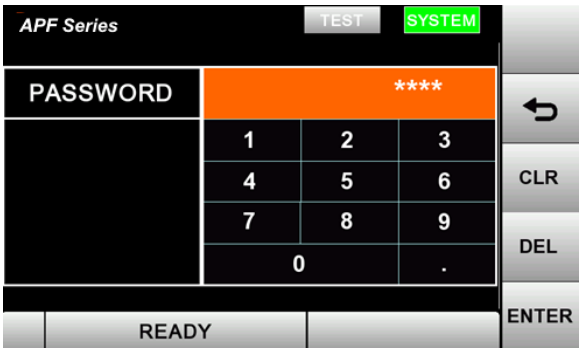


Figure 6-29: Screen Lock Setting Screen

Note: If the user forgot the password and wants to unlock the screen, enter password 8888 to unlock. If the user wants to reset the password or disable the lock function, please go to:
Setting→ System subpage→ Lock Password → enter 8888→ enter new password (max. 9 characters) or enter 0000 to disable the function.

6.3.5.2.6 Automatic Screen Lock Setting

AUTO KEY LOCK TIME

The user may set a time delay for AUTOMATIC SCREEN LOCK function. The time can be set from 0 to 65,535 seconds or enter 0 to disable the function. The screen will be locked automatically according to the time setting. The time to lock is based on the idle time of the touch screen, i.e. no operator activity).

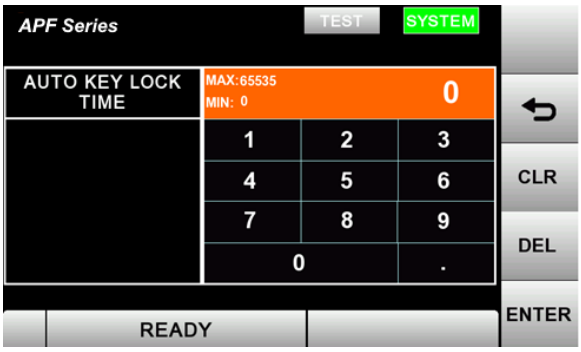


Figure 6-30: Automatic Screen Lock Setting

When the screen is automatically locked, press the screen lock icon on the bottom left corner of main screen and enter the screen lock password to unlock it.

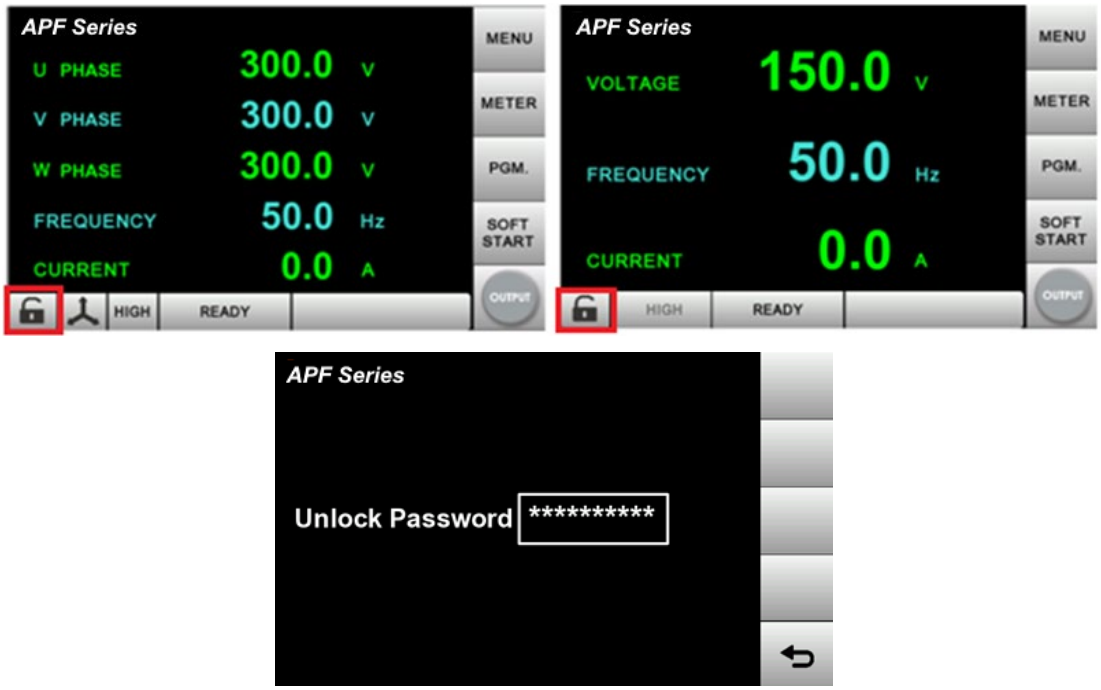


Figure 6-31: Unlock password entry screens

Note: If the user forgot the password and wants to unlock the screen, enter password 8888 to unlock.

6.3.5.2.7 System Reset

Users can reset the power source to the factory default settings. Press the item SYSTEM | RESET TO DEFAULT and the screen will display as figure 3.19 asking user to confirm the system reset. Pressing and the screen will display a notification: “Factory reset will start at power on”. System reset will be completed after restarting the product

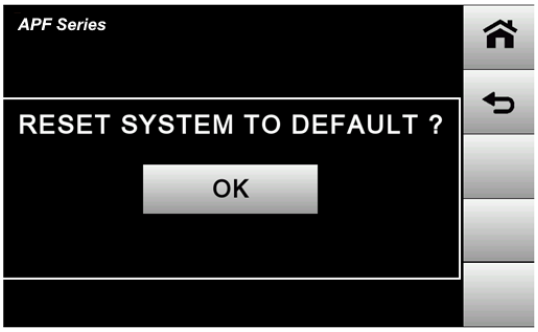


Figure 6-32: Confirm System Reset Screen

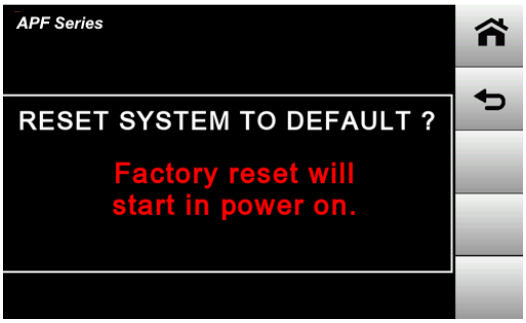


Figure 6-33: System Reset after Power ON

6.3.6 PGM (PROGRAM) Screen

To access the PGM screen, press PGM. from the MAIN screen or press at the MENU screen to enter into METER page

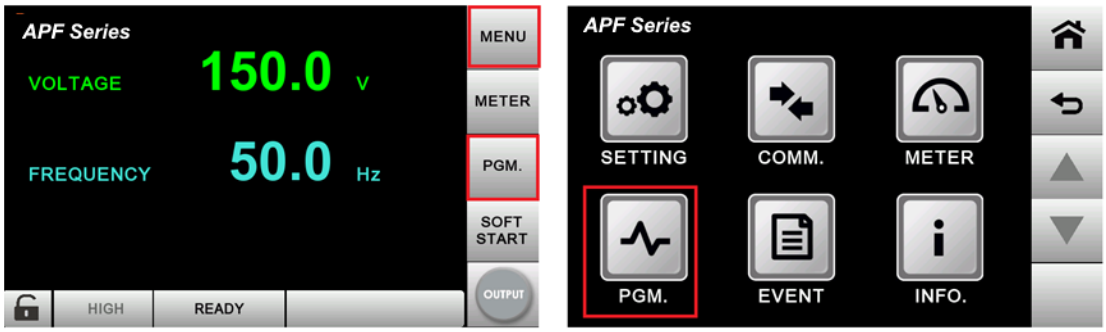


Figure 6-34: Item PGM on MAIN Screen (left) and MENU page (right)

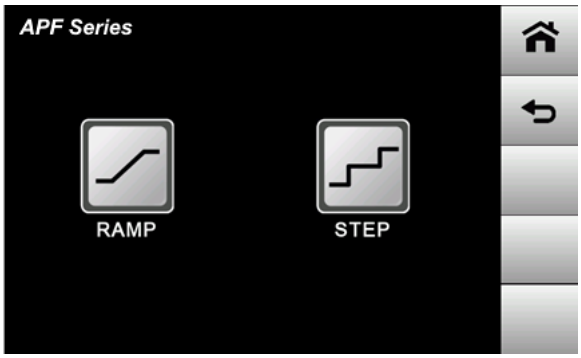


Figure 6-35: PRM (Program) Setting Screen

The descriptions for the items and icons in the above figure are given as follows.

RAMP: Sets the start and end output voltage/frequency, dwell time of ramp mode. The number of Ramps is up to 12 sets. The number of times the entire set can be repeated is 1-255.

STEP: Sets output voltage/frequency, dwell time of step mode. The number of Steps is up to 24 sets. The numbers of times the entire set can be repeated is 1-255.

Note: The minimum time unit is 1 second. When set to 0 seconds, the system will automatically change to 1 second.

6.3.6.1 RAMP Settings

When the MAIN page is displayed on the screen, the user can press  to enter the RAMP page.

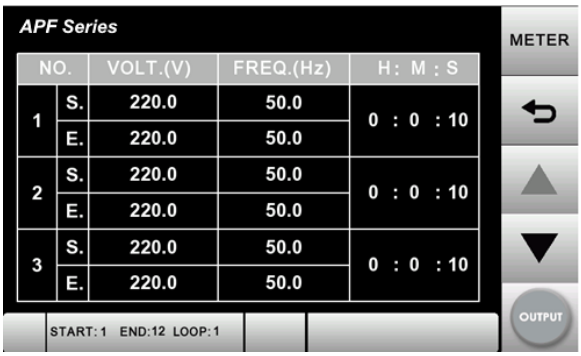


Figure 6-36: RAMP Setting Screen

The descriptions for the items and icons in the above figure are given as follows.

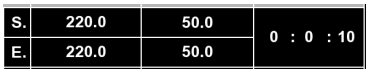
Press the corresponding value on item  of each ramp set to set start and end output voltage/frequency and dwell time. When the setup is completed, press ENTER to confirm. To edit an entry, Press CLR to clear all digits or press DEL to delete the last digit for editing.

Figure 6-37: Start/End output voltage and frequency setting screens

Note: In PGM mode, the RAMP output voltage range will be fixed to the high voltage range for a wide setting range.

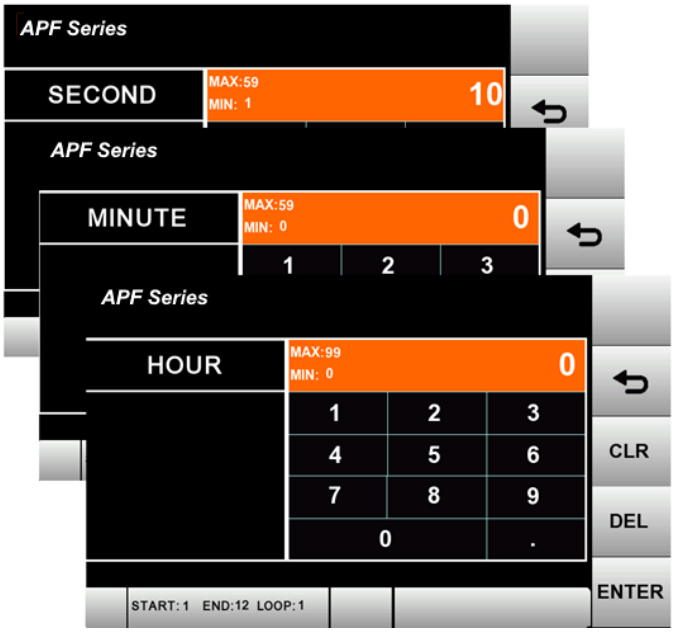


Figure 6-38: Dwell Time Setting Screens

Press item to set start and end number of Ramp set and the number of times the entire sets is repeated. When the setup is completed, press ENTER to confirm. To edit and entry, press CLR to clear all digits or press DEL to delete the last digit for editing.

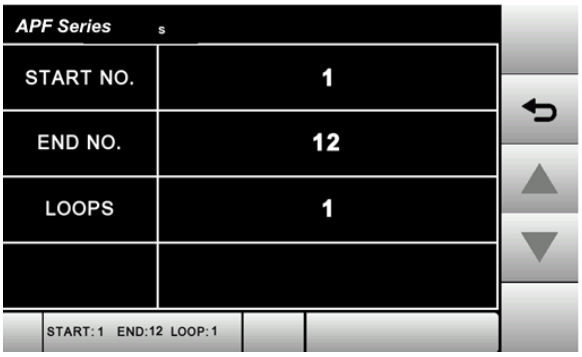


Figure 6-39: Ramp Start Group/End Group/Cycle times screen

Figure 6-40: Ramp Start Group/End Group/Cycle times setting screens

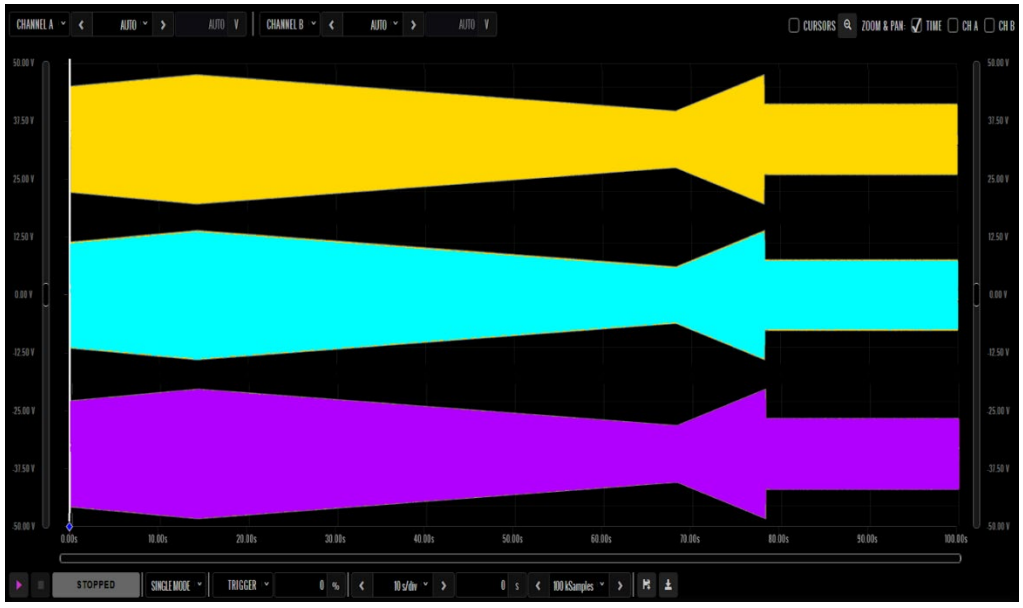


Figure 41: RAMP Mode 3 Phase Execution Sample

6.3.6.2 STEP Settings

When MAIN page displays on the screen, users can press  to enter the RAMP screen.

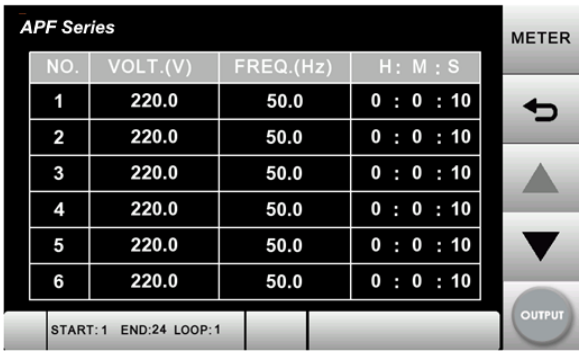


Figure 6-42: STEP Setting Screen

The descriptions for the items and icons in the above figure are given as follows.

Press the corresponding value on the item  of each step set to set the start and end output voltage/frequency values and dwell time. When this setup is completed, press ENTER to confirm. To edit an entry, press CLR to clear all digits or press DEL to delete the last digit.

Figure 6-43: STEP Voltage and Frequency Setting Screens

Note: In PGM mode, the STEP output voltage range will be fixed to the high voltage range for a wide setting range.

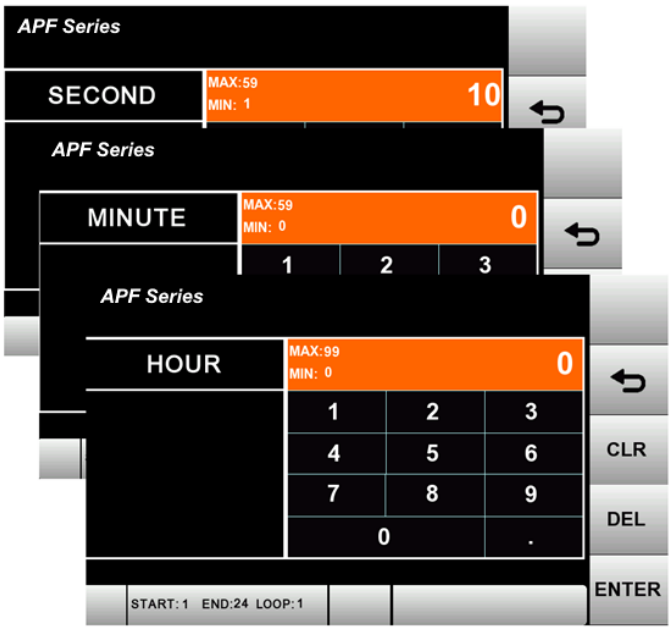


Figure 6-44:STEP Dwell Time Setting Screens

Press the item START: 1 END:24 LOOP: 1 to set start and end number of Step set and the number of times the entire sets is repeated. When setup is completed, press ENTER to confirm. To edit an entry, Press CLR to clear all digits or press DEL to delete the last digit.

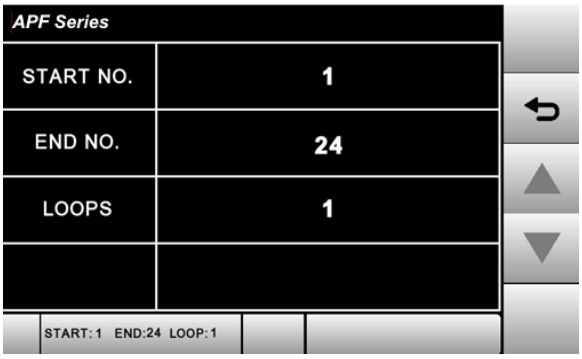


Figure 6-45: Step Start Group/End Group/Cycle Times Screen

Figure 6-46: Start Group/End Group/Cycle Times Setting Screens

Figure 47: STEP Mode 3 Phase Execution Sample

6.3.7 Communications Screen

Press the icon  to enter the Communication screen from the MENU screen.

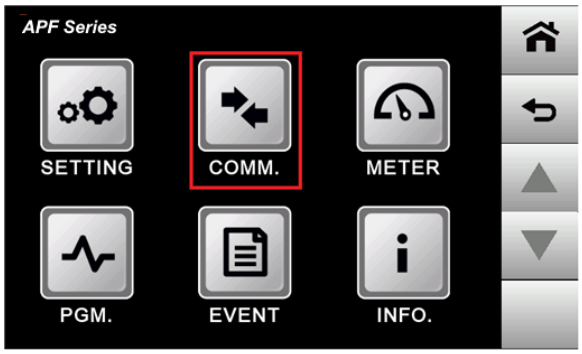


Figure 6-48: The COMM. Icon location on the MENU Screen

6.3.7.1 RS-485 Setting Screen

Press the item  to switch the communication interface to RS485.

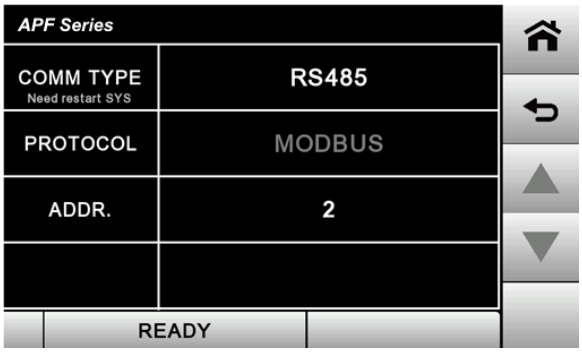


Figure 6-49: RS-485 Setting Screen

The descriptions for the items and the icons in the above figure are given as follows.

COMM TYPE Need restart SYS / RS485	Switch the communication interface to RS-485.
PROTOCOL / MODBUS	The protocol is fixed by default to MODBUS.
ADDR. / 2	The communication address can be set within the range of 1-32. Refer to the figure below.

Figure 6-50: Communication Address Setting Screen

6.3.7.2 RS-232 / GPIB Setting Screen

Press the item COMM TYPE (Need restart SYS) RS232/GPIB to switch the communication interface to RS-232/GPIB.

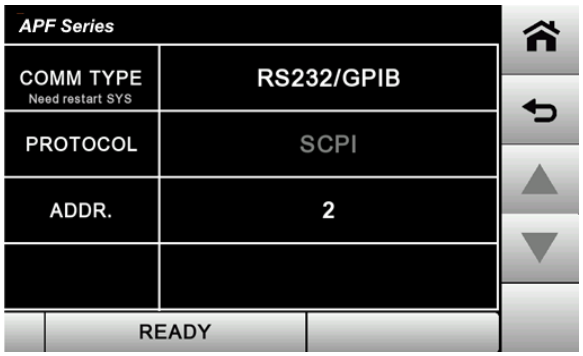


Figure 6-51: RS=232 / GPIB Setting Screen

The descriptions for the items and the icons in the above figure are given as follows.

COMM TYPE (Need restart SYS) RS232/GPIB	Switch the communication interface to RS-232 / GPIB.
PROTOCOL SCPI	The protocol is fixed by default to SCPI (Standard Commands for Programmable Instruments).
ADDR. 2	The communication address can be set within the range of 1-32. Refer to the figure below.

Figure 6-52: Communication Address Setting Screen

6.3.7.3 RS-422 Setting Screen

Press the item COMM TYPE (Need restart SYS) | RS422 to switch the communication interface to RS422.

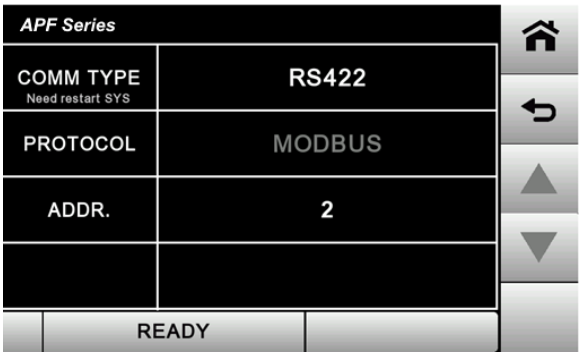


Figure 6-53: RS-422 Setting Screen

The descriptions for the items and the icons in the above figure are given as follows.

COMM TYPE (Need restart SYS) | RS422	Switch the communication interface to RS-422.
PROTOCOL | MODBUS	The protocol is fixed by default to MODBUS.
ADDR. | 2	The communication address can be set within the range of 1-32. Refer to the figure below.

Figure 6-54: Communication Address Setting Screen

6.3.7.4 Ethernet Setting Screen

Press the item 

to switch the communication interface to RS422.

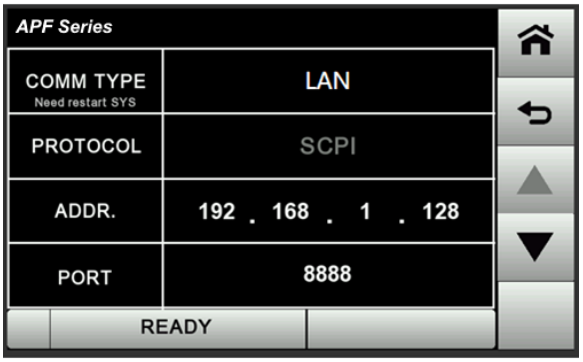


Figure 6-55: Ethernet / LAN Setting Screen

The descriptions for the items and the icons in the above figure are given as follows.

	Switch the communication interface to Ethernet.
	The protocol is fixed by default to SCPI.
	Communication address setting. For the settings on the PC, refer to the instructions below.
	The communication port is user-defined. After editing, users need to restart the device to complete the update. The default setting is 8888.

Here are the Ethernet settings for the controlling PC:

1. Open the Ethernet setting. Select Internet Protocol Version 4 and click Properties. Refer to the figure below.

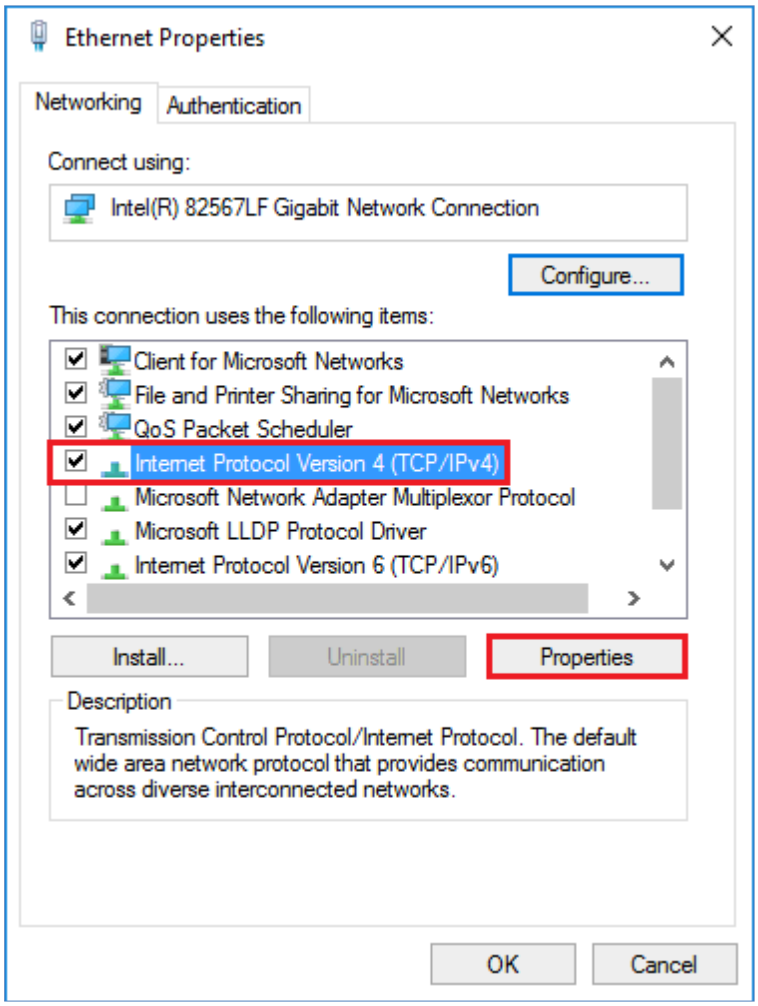


Figure 6-56: Ethernet Setting Page on Windows PC

2. Set the IP address to be the same as the device's communication address and the last set of numbers should be set to different value, ranging from 0-255.

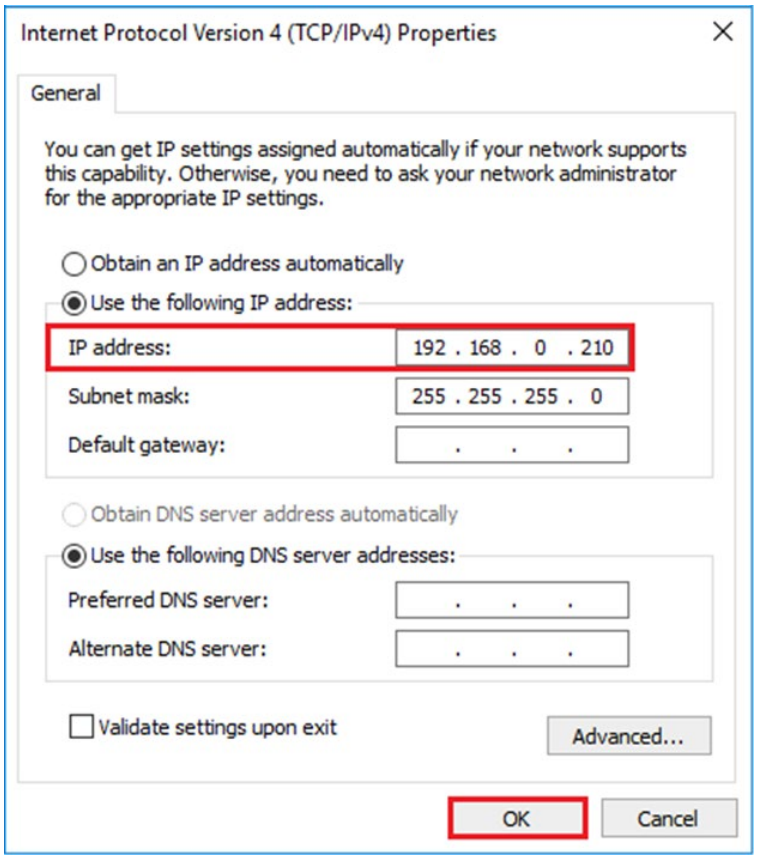


Figure 6-57: LAN IP Address Setting Screen on Windows PC

6.3.8 METER Screens

Press METER at the MAIN page or press  at the MENU page to enter into METER screen.

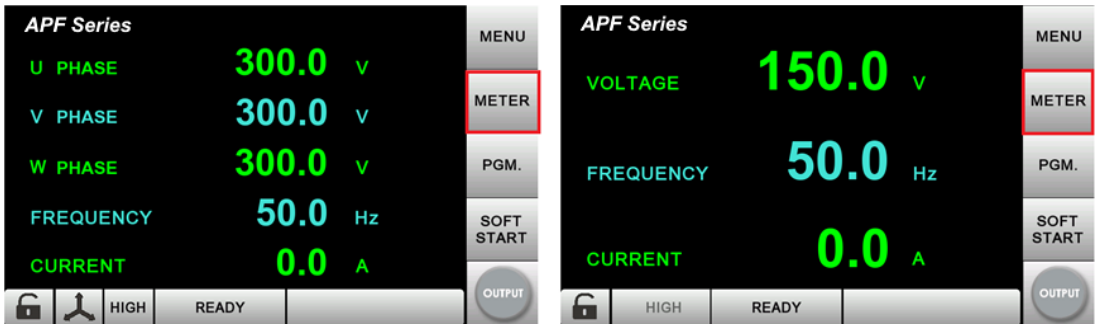


Figure 6-58: METER screens at MAIN for Three Phase (left) or Single Phase (right) models

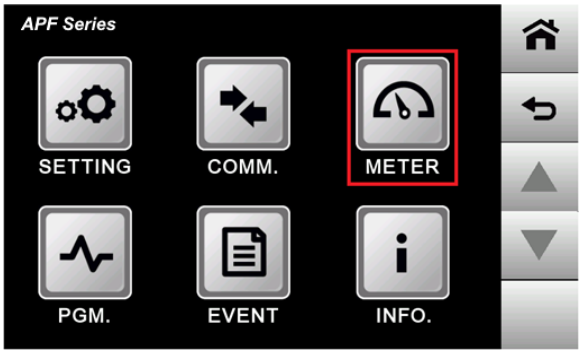


Figure 6-59: METER icon location on MENU Screen

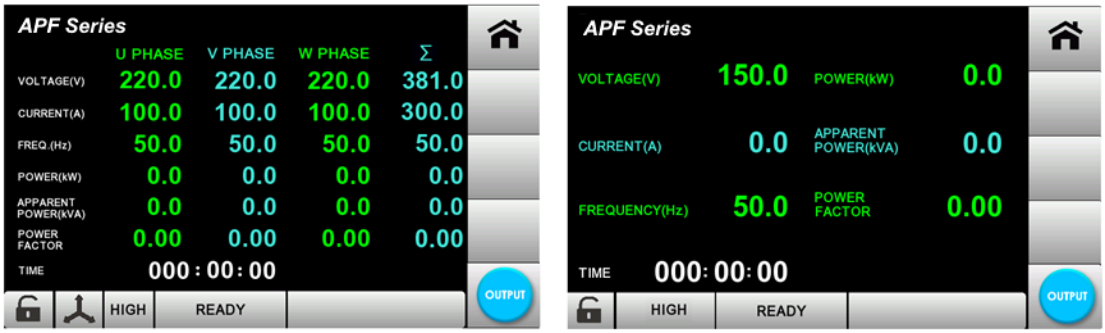


Figure 6-60 METER screens at Output Three Phase (left) or Single Phase (right) models

The **three**-phase METER screen shown in the figure below is explained here.

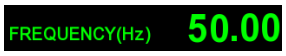
Figure 6-61: Three Phase APF Series Models METER screen

	Displays measurement of the output voltage for each phase in volts.
	Displays measurement of synchronized three-phase, for example (120V+120V+120V)/3*1.732.
	Displays measurement of the output current of each phase and the sum of total output current.

	Displays measurement of the output frequency of each phase and the sum of total output frequency.
	Displays measurement of the output power (W) of each phase and the sum of total output power.
	Displays measurement of the apparent power(VA) of each phase and the sum of total output VA.
	Displays measurement of the output power factor of each phase and the total output power factor.
	Displays run time (hours/minutes/seconds)

The **single**-phase METER screen shown in the figure below is explained here.

Figure 6-62: Single Phase APF Series Models METER Screen

	Displays measurement of the output voltage.
	Displays measurement of the output current.
	Displays measurement of the output frequency.
	Displays measurement of the output power (W).
	Displays measurement of the apparent power (VA).
	Displays measurement of the output power factor.
	Displays run time (hours/minutes/seconds).

6.3.9 Event Screen

Press  at MENU page to enter into the EVENT screen.

Figure 6-63: EVENT Icon location in MENU Screen

The Event page records error information that occurs during local operation, including the date, time of the error event.

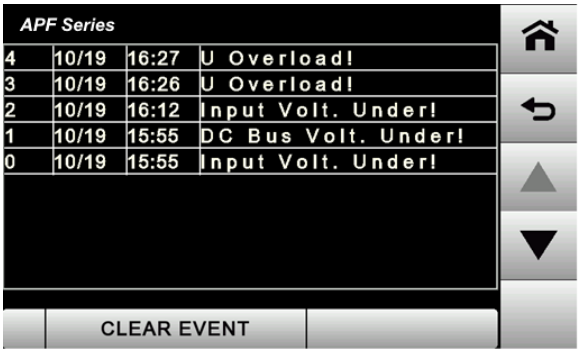


Figure 6-64: Error EVENT Screen

6.3.10 Product Information Screen

Press  on the MENU page to enter the PRODUCT INFORMATION page.

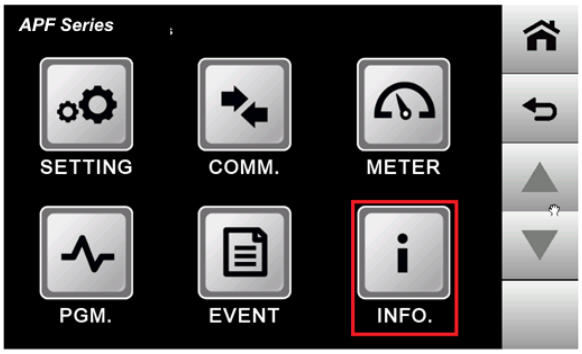


Figure 6-65: INFO. Icon location in MENU Screen

The product information screen will be displayed.

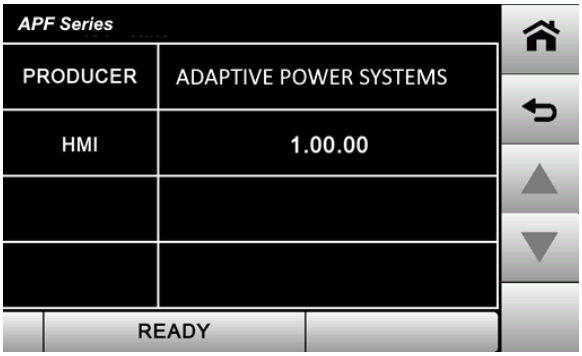


Figure 6-66: Product Information Display Screen

The following items are shown in this screen:

PRODUCER ADAPTIVE POWER SYSTEMS	Displays the Power Source's Brand.
HMI 1.00.00	Displays the Human Machine Interface (HMI_ version of the power source.

6.3.11 Error Log Screen

The APF Series has extensive protection functions. When any of these protections is triggered, the unit will shut down the output and display the corresponding error event on the screen.

Please note that if any protection is triggered, the user should eliminate the cause of the error event according to table below before resuming using the device. Once the cause of the protection is eliminated, press the OUTPUT & RESET buttons simultaneously to unlock the protection state and restart the output.

The descriptions of each protection's error code, possible cause and corresponding potential resolution are shown in the table below.

Err No.	Message	Potential Cause	Possible Solution	Error Description
1	U-phase IGBT1 Over current fault	U-phase IGBT broken	Check and replace IGBT	
2	U-phase IGBT2 Over current fault	U-phase IGBT broken	Check and replace IGBT	
3	U-phase IGBT3 Over current fault	U-phase IGBT broken	Check and replace IGBT	
4	U-phase IGBT4 Over current fault	U-phase IGBT broken	Check and replace IGBT	
5	V-phase IGBT1 Over current fault	V-phase IGBT broken	Check and replace IGBT	
6	V-phase IGBT2 Over current fault	V-phase IGBT broken	Check and replace IGBT	

Err No.	Message	Potential Cause	Possible Solution	Error Description
7	V-phase IGBT3 Over current fault	V-phase IGBT broken	Check and replace IGBT	
8	V-phase IGBT4 Over current fault	V-phase IGBT broken	Check and replace IGBT	
9	W-phase IGBT1 Over current fault	W-phase IGBT broken	Check and replace IGBT	
10	W-phase IGBT2 Over current fault	W-phase IGBT broken	Check and replace IGBT	
11	W-phase IGBT3 Over current fault	W-phase IGBT broken	Check and replace IGBT	
12	W-phase IGBT4 Over current fault	W-phase IGBT broken	Check and replace IGBT	
13	Heat sink over-temperature	Fan error	Check fan	>90℃,heat sink over-temperature
14	Transformer over-temperature	Fan error	Check fan	
15	Emergency Stop	Emergency Stop is pressed	Check Emergency Stop	
16	Fuse 1 open	Fuse burned	Check and replace fuse	
17	Fuse 2 open	Fuse burned	Check and replace fuse	
18	Fuse 3 open	Fuse burned	Check and replace fuse	
19	IGBT 1 over-temperature	Fan error	Check fan	>90℃,heat sink over-temperature
20	IGBT 2 over-temperature	Fan error	Check fan	>90℃,heat sink over-temperature
21	Input under-voltage fault	Input voltage too low	Check input voltage	<0.85*rated voltage, input under-voltage fault
22	Input over-voltage fault	Input voltage too high	Check input voltage	>1.15* rated voltage, input over-voltage fault
23	DC voltage too low	Input voltage too low	Check input voltage	<390V, DC voltage too low
24	DC voltage too high	Input voltage too high	Check input voltage	>650V, DC voltage too high
25	U-phase overload	U-phase overload	Check load	
26	V-phase overload	V-phase overload	Check load	
27	W-phase overload	W-phase overload	Check load	
28	Output under-voltage fault	Output voltage too low	Check output voltage	<0V, output under-voltage fault
29	Output over-voltage fault	Output voltage too high	Check output voltage	>300V, output over-voltage fault
30	line drop compensation error	Sensing lead broken/ voltage drop too high	Check output voltage	Single-phase model: Low level output voltage difference

Err No.	Message	Potential Cause	Possible Solution	Error Description
				>15V or output voltage >155V; High level output voltage difference >30V or output voltage >310V
31	U-phase line drop compensation error	Sensing lead broken/phase connection incorrect/ voltage drop too high	Check U-phase output voltage	Three-phase model: Low level output voltage difference >15V or output voltage >155V; high level voltage difference >30V or voltage >310V
32	V-phase line drop compensation error	Sensing lead broken/ phase connection incorrect/ voltage drop too high	Check V-phase output voltage	
33	W-phase line drop compensation error	Sensing lead broken/ phase connection incorrect/ voltage drop too high	Check W-phase output voltage	

Table 6-1: Error Messages

7 SCPI Commands Programming

7.1 Overview

A APF Series units come standard with serial and LAN remote control interfaces. Optional interfaces available are USB and GPIB. The interface allows the power source settings to be configured remotely and measurement data to be retrieved for analysis and test report generation.

7.2 SCPI Command Syntax

SCPI is short for Standard Commands for Programmable Instruments and defines a communication method for test and measurement instruments. It is based on ASCII characters.

All APF Series power sources use SCPI command syntax. Commands are not case sensitive so any combination of upper- and lower-case characters is permissible.

For consistency, this document will use UPPER CASE to indicate the required characters for each command (Short Form). Lower case characters are used to indicate the alternative Long Form of each command.

7.3 IEEE488.2 Common Commands

The following IEEE488.2 common commands (a.k.a. star commands) are supported by the power source. These commands are provided for compatibility with the IEEE488.2 standard. They are aliases to the relevant proprietary command and can be used interchangeably.

7.3.1 Command Commands Summary Table

Command	Name	Description
***RST**	Reset Command	Resets Unit to power on condition

Table 7-1: IEEE488.2 Common Commands Supported

7.3.2 *RST

Resets the instrument to original power on configuration.

7.4 SYST Commands

7.4.1 SYST:REMote

Description: Switches the unit to remote control mode.

7.4.2 SYST:LOCal

Description: Switches the unit to local control mode.

7.4.3 SYST:ERRor?

Query Command: Returns System Error Code

Response: SYST:ERR 0x 0x00000000\r\n (MEAS:MODE O\r\n 32bit)

Format: 32 bit represent a system error code. See Section Table 7-2 in section 7.13 System Error Codes.

Note: MEAS:MODE I\r\n: Answer Command 0x0000 (16bit)

7.4.4 SYST:INFO?

Query Command: Returns Information about the power source

Response: SYST:INFO 1,3,3,1,1\r\n 32bit)

Format:

Param1	Model Name 1 = APF
Param2	AC Input, 1 = Single phase ,3 = Three phase
Param3	AC Output, 1 = Single phase ,3 = Three phase
Param4	Not used
Param5	Minimum time (0 ~ 0.01 sec, 1 ~ 1 sec)

7.4.5 SYST:FUNC?

Query Command: Returns the optional functions list of the power source

Response: SYST:FUNC 1,1,1,0,0,1,0,0,1\r\n

Format:

Param1	Three phase independent adjustment, 0 = No, 1 = Yes
Param2	Step Mode function, 0 = No, 1 = Yes
Param3	Gradual (Sweep) Mode, 0 = No, 1 = Yes
Param4	Not used
Param5	Phase Angle Adjustment, 0 = No, 1 = Yes
Param6	High/Low Level Setting, 0 = No, 1 = Yes
Param7	Soft Start, 0 = No, 1 = Yes
Param8	Not used
Param9	Current Limit Function, 0 = No, 1 = Yes

7.5 Three Phase SOUR Commands

7.5.1 SOUR:VOLT:RANGe

Description: Selects High or Low Voltage Range.

Syntax: SOUR:VOLT:RANG 0|1\r\n

Format: Param1 High / Low Level, 0 = Low, 1 = High

7.5.2 SOUR:VOLT:RANGe?

Query Command: Returns High or Low Voltage Range setting

Syntax: SOUR:VOLT:RANG?\r\n

Format: Param1 High / Low Level, 0 = Low, 1 = High

Response: SOUR:VOLT:RANG 0|1\r\n

Format: Param1 High / Low Level, 0 = Low, 1 = High

7.5.3 SOUR:VOLT

Description: Setup output voltage for single phase coupled voltage settings or three phase independent voltage settings.

Syntax: SOUR:VOLT 220.0\r\n (FUNC GEN\r\n mode

Format: Param1 Output Voltage, resolution 0.1V

Syntax: SOUR:VOLT 220.0,110.0,150.0\r\n(FUNC THR\r\n mode)

Format:
Param1 Set U Phase Output Voltage, resolution 0.1V
Param2 Set V Phase Output Voltage, resolution 0.1V
Param3 Set W Phase Output Voltage, resolution 0.1V

7.5.4 SOUR:VOLT?

Description: Returns voltage setting for single phase coupled voltage settings or three phase independent voltage settings.

Syntax: SOUR:VOLT?\r\n

Response:
SOUR:VOLT 220.0\r\n (Three-Phase Synchronized)
SOUR:VOLT 220.0,110.0,115.0\r\n (Three-Phase Independent)

7.5.5 SOUR:FREQ

Description: Setup output frequency.

Syntax: SOUR:FREQ 50.0\r\n

Format: Param1 Set Frequency

7.5.6 SOUR:FREQ?

Description: Returns output frequency setting.

Syntax: SOUR:FREQ?\r\n

Response: SOUR:FREQ 50.0\r\n

7.5.7 SOUR:STEP:VOLT

Description: Setup output voltage in STEP mode.

Syntax: SOUR:STEP:VOLT 1,110.0\r\n

Format: Param1 Group no. (1 ~ 24)

Param2 Output voltage for group

7.5.8 SOUR:STEP:FREQ

Description: Setup output frequency in STEP mode.

Syntax: SOUR:STEP:FREQ 1,50.0\r\n

Format: Param1 Group no. (1 ~ 24)
Param2 Output frequency for group

7.5.9 SOUR:STEP:TIME

Description: Setup time interval in STEP mode.

Syntax: Mode1: 1 Hour, 1 Minute, 10.0 Seconds

SOUR:STEP:TIME 1,1:1:100\r\n

Mode2: 1 Hour, 1 Minute, 10.0 Seconds

SOUR:STEP:TIME 1,1:1:1000\r\n

7.5.10 SOUR:STEP:PCYC

Description: Setup running cycles STEP mode.

Syntax: SOUR:STEP:PCYC 1,24,10\r\n

Format: Param1 Start group no. (1 ~ 24)
Param2 End group no. (1 ~ 24)
Param2 Running cycles (1 ~ 255)

Note: End group No. cannot be less than start group No.

7.5.11 SOUR:STEP:LOAD

Description: Setup all STEP data to controller.

Syntax: SOUR:STEP:LOAD\r\n

Note: This command is optional.

7.5.12 SOUR:GRAD:VOLT

Description: Setup output voltage for Gradual Mode.

Syntax: SOUR:GRAD:VOLT 1,110.0,220.0r\n

Format: Param1 Start group no. (1 ~ 12)
Param2 Gradual start voltage for group
Param2 Gradual end voltage for group

7.5.13 SOUR:GRAD:FREQ

Description: Setup output frequency for Gradual Mode.

Syntax: SOUR:GRAD:FREQ 1,50.0,60.0r\n

Format:
- Param1 Start group no. (1 ~ 12)
- Param2 Gradual start frequency for group
- Param2 Gradual end frequency for group

7.5.14 SOUR:GRAD:TIME

Description: Setup output frequency in Gradual Mode.

Syntax: Mode1: 1 Hour, 1 Minute, 10.0 Seconds

SOUR: GRAD:TIME 1,1:1:100\r\n

Mode2: 1 Hour, 1 Minute, 10.0 Seconds

SOUR: GRAD:TIME 1,1:1:1000\r\n

7.5.15 SOUR:GRAD:PCYC

Description: Setup running cycles in Gradual mode.

Syntax: SOUR:GRAD:PCYC 1,12,10\r\n

Format:
- Param1 Start group no. (1 ~ 12)
- Param2 End group no. (1 ~ 12)
- Param2 Running cycles (1 ~ 255)

7.5.16 SOUR:GRAD:LOAD

Description: Setup all GRAD data to controller.

Syntax: SOUR:GRAD:LOAD\r\n

Note: This command is optional.

7.5.17 SOUR:SOFT:VOLT

Description: Setup Start Voltage and Rated Voltage of Soft Start function.

Syntax: SOUR:SOFT:VOLT 5.00,220.00\r\n

Format:
- Param1 Start voltage
- Param2 Rated voltage

7.5.18 SOUR:SOFT:FREQ

Description: Setup Start Frequency and Rated Frequency of Soft Start function.

Syntax: SOUR:SOFT:FREQ 5.00,50.00\r\n

Format:
Param1 Start frequency
Param2 Rated frequency

7.5.19 SOUR:SOFT:TIME

Description: Setup Delay Time and Ramp Time of Soft Start function.

Syntax: SOUR:SOFT:TIME 5.00,3.00\r\n

Format:
Param1 Delay time
Param2 Ramp time

7.6 FUNC Command

Description: Selects the operation function mode.

Syntax: FUNC GEN|STEP|GARD|THR|LVRT|TRAN\r\n

Format:
Param1 Function abbreviation:
- GEN General mode, Steady State operation
- STEP Step mode
- GRAD Gradual mode
- THR Three phase independent output
- SOFT Soft Start

Param2 Ramp time

Note: Before sending the OUTPut command, select the correct operation function mode.

7.7 INST Commands

7.7.1 INST:COUPling

Description: Setup Three-Phase Synchronized or Three-Phase Independent Voltage Mode

Syntax: INST:COUP 0|1\r\n

Format:
Param1 Setup voltage operation mode
0—Three-Phase Synchronized
1—Three-Phase Independent

7.7.2 INST:PHASe

Description: Setup Phase angle for three phase mode

Syntax: INST:PHASe 0,240,120\r\n

Format:

Param1	U phase angle (U phase refence angle defaults to zero, do not change.)
Param2	U=V phase angle
Param3	U-W phase angle

7.8 OUTPut Commands

7.8.1 OUTPut

Description: Enable or Disable power source output.

Syntax: OUTPut 0|1\r\n

Format:

Param1	Output Status 0—Output OFF 1—Output ON

7.8.2 OUTPut?

Description: Query power source output status

Syntax: OUTPut?\r\n

Response:

Param1	0 (Output OFF) or 1 (Output ON)

7.9 MEASurement Commands

7.9.1 MEAS:MODE

Description: Setup measurement mode.

Syntax: MEAS:MODE OUT\r\n

Format:

Param1	Measurement Mode OUT – Output side

7.9.2 MEAS:ALL?

Description: Read all output side measurement data.

Syntax: MEAS:ALL?\r\n

Response

MEAS:ALL 50,0,	Output Frequency
120.0,120.0,120.0	(Phase U, V, W output voltages)
120.0,120.0,120.0	(Phase U, V, W output currents)
120.0,120.0,120.0	(Phase U, V, W output kW)
120.0,120.0,120.0	(Phase U, V, W output kVAR)

120.0,120.0,120,0\r\n (Phase U, V, W PF)

7.9.3 MEAS:VOLT?

Description: Read all output side three phase RMS voltage measurement data.

Syntax: MEAS:VOLT?\r\n

Response MEAS:VOLT 120.0,120.0,120.0\r\n

Format:
Param1 U phase output AC voltage
Param2 V phase output AC voltage
Param3 W phase output AC voltage

7.9.4 MEAS:CURR?

Description: Read all output side three phase RMS current measurement data.

Syntax: MEAS:CURR?\r\n

Response MEAS:CURR 74.3,73.9,74.6\r\n

Format:
Param1 U phase output AC current
Param2 V phase output AC current
Param3 W phase output AC current

7.9.5 MEAS:FREQ?

Description: Read all output side frequency measurement data.

Syntax: MEAS:FREQ?\r\n

Response MEAS:FREQ 50.0\r\n

Format: Param1 Output Frequency in Hz

7.9.6 MEAS:POWer?

Description: Read all output side three phase power measurement data.

Syntax: MEAS:POW?\r\n

Response MEAS:POW 48.0,48.1,47.9\r\n

Format:
Param1 U phase output kW
Param2 V phase output kW
Param3 W phase output kW

7.9.7 MEAS:APParent?

Description: Read all output side three phase power measurement data.

Syntax: MEAS:APP?\r\n

Response MEAS:APP 52.4,51.9,52.2 \r\n

Format:

Param1	U phase output kVAR
Param2	V phase output kVAR
Param3	W phase output kVAR

7.9.8 MEAS:PFACtor?

Description: Read all output side three phase power factor measurement data.

Syntax: MEAS:PFAC?\r\n

Response MEAS:PFAC 0.98,0.99,0.97 \r\n

Format:

Param1	U phase output PF
Param2	V phase output PF
Param3	W phase output PF

7.9.9 MEAS:PCYCle?

Description: Read Step or Gradual Mode running cycle number.

Syntax: MEAS:PCYC?\r\n

Response MEAS: PCYC 1,2,00:00:09

Format:

Param1	Running parameter no.
Param2	Running cycle no.
Param3	Running parameter time interval.

7.10 LIMit Commands

7.10.1 LIMit:FREQ:LOW?

Description: Read the frequency lower (low) limit value.

Syntax: LIM:FREQ:LOW?\r\n

Response LIM:FREQ:LOW 45.0\r\n

Format: Param1 Lower frequency limit.

7.10.2 LIMit:FREQ:HIGH?

Description: Read the frequency upper (high) limit value.

Syntax: LIM:FREQ:HIGH?\r\n

Response LIM:FREQ:HIGH 65.0\r\n

Format: Param1 Upper frequency limit.

7.10.3 LIMit:VOLT:LOW?

Description: Read the voltage lower (low) limit value.

Syntax: LIM:VOLT:LOW?\r\n

Response LIM:VOLT:LOW 0.0\r\n

Format: Param1 Lower voltage limit.

7.10.4 LIMit:VOLT:HIGH?

Description: Read the voltage upper (high) limit value.

Syntax: LIM:VOLT:HIGH?\r\n

Response LIM:VOLT:HIGH 310.0\r\n

Format: Param1 Upper voltage limit.

7.10.5 LIMit:POWer?

Description: Read the rated true power capability of the power source in kW.

Syntax: LIM:POW?\r\n

Response LIM:POW 100.0\r\n

Format: Param1 Rated maximum power in kW.

7.10.6 LIMit:CURR

Description: Set the upper limit for current.

Syntax: LIM:CURR 75.0\r\n

Format: Param1 Current limit value.

Note: The current limit set value cannot exceed the maximum current rating of the power source.

7.10.7 LIMit:POWer

Description: Set the upper limit for power in kW.

Syntax: LIM:POW 75.0\r\n

Format: Param1 Upper limit power value in kW.

Note: The power limit set value cannot exceed the maximum power rating of the power source.

7.11 COMM Commands

7.11.1 COMM:ERR

Description: Read the communication status of the last command sent.

Syntax: COMM:ERR?\r\n

Response COMM:ERR? n\r\n

Format: Param1 n= 0, No Error
n = 1, No End of String
n = 2, Invalid Commands

7.12 Communication Examples

7.12.1 Remote Control

Enter Remote Control mode: SYST:REM\r\n

Read power source rating: LIM:POW?

Note: Reading the rated capacity of the power source is a good way to check if the communication works and the program can receive data successfully. (There is no response returned for SYST:REM command).

7.12.2 Read Device Information

The following sequence of commands may be used top query to complete power source configuration:

SYST:INFO?\r\n

LIM:POW?\r\n

LIM:VOLT:HIGH?\r\n

LIM:VOLT:LOW? \r\n

LIM:FREQ:HIGH? \r\n

LIM:FREQ:LOW? \r\n

SYST:FUNC? \r\n

SOUR:VOLT:RANG:LOW? \r\n

OUTP? \r\n

Note: The user can select the desired information and send the corresponding command above by including or excluding any of these.

7.12.3 Phase Angle Control

Send the following command to se the phase angles for phase V and W:

INST:PHASe 0,240,120\r\n

Note 1: The output voltage waveform of all output modes, including the steady state output, the step and the gradual modes, are affected by the phase angle control.

Note2: The default phase angle values are (0,240,120).

7.12.4 Steady State Programming (General Mode)

This example sets the unit to normal operation and programs the phase mode, voltage range, output voltage and frequency and then closes the output relay.

FUNC GEN\r\n	Set General mode
INST:COUP 0\r\n	Set Three-Phase Voltage mode
SOUR:VOLT:RANG 1\r\n	Set High/Low Level
Voltage:SOUR:VOLT 220.0\r\n	Set Output Voltage
SOUR:FREQ 50.0\r\n	Set Output Frequency
OUTP 1\r\n	Enable Output

7.12.5 Step Mode

FUNC STEP\r\n	Set for Step Mode
SOUR:STEP:VOLT 1,220.0\r\n	Set Group1 Output Voltage
SOUR:STEP:FREQ 1,50.0\r\n	Set Group1 Output Frequency
	Set Group1 Running Time Interval
SOUR:STEP:TIME 1,0:0:100\r\n	Mode 1: 0 Hour, 0 Minute, 10.0 Seconds
SOUR:STEP:TIME 1,0:0:1000\r\n	Mode 2: 0 Hour, 0 Minute, 10.00 Seconds
SOUR:STEP:VOLT 24,220.0\r\n	Set Group24 Output Voltage
SOUR:STEP:FREQ 24,50.0\r\n	Set Group24 Output Frequency
	Set Group24 Running Time Interval
SOUR:STEP:TIME 24,0:0:100\r\n	Mode 1: 0 Hour, 0 Minute, 10.0 Seconds
SOUR:STEP:TIME 24,0:0:1000\r\n	Mode 2: 0 Hour, 0 Minute, 10.00 Seconds
SOUR:STEP:PCYC 1,24,10\r\n	Set Step Mode Start group/End group/Cycles times
SOUR:STEP:LOAD\r\n(Optional)	Set All Step Data
OUTP 1\r\n	Start to Output

7.12.6 Gradual (Sweep) Mode

FUNC GRAD\r\n	Set for Gradual (sweep) Mode
SOUR:GRAD:VOLT 1,220.0\r\n	Set Group1 Output Voltage
SOUR:GRAD:FREQ 1,50.0\r\n	Set Group1 Output Frequency
	Set Group1 Running Time Interval
SOUR:GRAD:TIME 1,0:0:100\r\n	Mode 1: 0 Hour, 0 Minute, 10.0 Seconds
SOUR:GRAD:TIME 1,0:0:1000\r\n	Mode 2: 0 Hour, 0 Minute, 10.00 Seconds
SOUR:GRAD:VOLT 24,220.0\r\n	Set Group24 Output Voltage
SOUR:GRAD:FREQ 24,50.0\r\n	Set Group24 Output Frequency
	Set Group24 Running Time Interval
SOUR:GRAD:TIME 24,0:0:100\r\n	Mode 1: 0 Hour, 0 Minute, 10.0 Seconds
SOUR:GRAD:TIME 24,0:0:1000\r\n	Mode 2: 0 Hour, 0 Minute, 10.00 Seconds
SOUR:GRAD:PCYC 1,24,10\r\n	Set Gradual (sweep)Mode Start group/End group/Cycles times
SOUR:GRAD:LOAD\r\n(Optional)	Set All Gradual (sweep) Data
OUTP 1\r\n	Start to Output

7.12.7 Three Phase Independent Output Mode

FUNC THR\r\n	Set Function Mode
INST:COUP 1\r\n	Set for Three-Phase Mode
SOUR:VOLT:RANG 1\r\n	Set High/Low Level
SOUR:VOLT 220.0,220.0,110.0\r\n	Set Output Voltage
SOUR:FREQ 50.0\r\n	Set Output Frequency：
OUTP 1\r\n	Start to Output

7.12.8 Measurement Data Query

MEAS:MODE OUT\r\n	Set measurement mode
SYST:ERRor? \r\n	Read system error status
MEAS:ALL? \r\n	Read all measurement data
MEAS:PCYC? \r\n	Read running mode parameters for Step/Gradual Mode operation)

7.12.9 Set RMS Current Limit

LIM:CURR 65.0\r\n Set the RMS current limit to 65A rms.

Note 1: Once the output current exceeds the set value for upper limit current, the power source disables the output and reports the fault.

Note 2: The set value of the upper current limit cannot be greater than the maximum rated current value of the power source model.

7.13 System Error Codes

The following are the system error information bit positions for errors reported by the power source. Error codes are 32 bit long integers corresponding to the system error status.

Bit Position	Fault Description
0	AC Mains Input R-phase IGBT1 Over current fault
1	AC Mains Input R-phase IGBT2 Over current fault
2	AC Mains Input R-phase IGBT3 Over current fault
3	AC Mains Input R-phase IGBT4 Over current fault
4	AC Mains Input S-phase IGBT1 Over current fault
5	AC Mains Input S-phase IGBT2 Over current fault
6	AC Mains Input S-phase IGBT3 Over current fault
7	AC Mains Input S-phase IGBT4 Over current fault
8	AC Mains Input T-phase IGBT1 Over current fault
9	AC Mains Input T-phase IGBT2 Over current fault
10	AC Mains Input T-phase IGBT3 Over current fault
11	AC Mains Input
12	Heat sink temperature is above limit
13	AC Input Transformer over-temperature
14	Emergency Stop
15	Fuse 1 is broken
16	Fuse 2 is broken
17	Fuse 3 is broken
18	IGBT 1 is over-temperature
19	IGBT 2 is over-temperature
20	Input under-voltage fault
21	Input over-voltage fault
22	DC voltage is too low
23	DC voltage is too high

Bit Position	Fault Description
24	U-phase current overload
25	V-phase current overload
26	W-phase current overload
27	Output under-voltage fault
28	Output over-voltage fault
29	Line drop compensation error- Single-phase model or U-phase line drop compensation error – Three-phase model
30	V-phase line drop compensation error – Three-phase model
31	W-phase line drop compensation error – Three-phase model

Table 7-2: System Error Codes

8 MODBUS RTU Commands

8.1 MODBUS RTU Overview

MODBUS RTU (Remote Terminal Unit) is a serial communication protocol widely used in industrial automation and control systems. It operates on a master-slave architecture, where a master device communicates with multiple slave devices over RS-232, RS-485, or RS-422 serial interfaces. MODBUS RTU is known for its simplicity, reliability, and efficiency in transmitting data between devices such as programmable logic controllers (PLCs), sensors, meters, and other field instruments. It is commonly used in applications like energy management, process control, and building automation, enabling seamless data exchange in industrial environments.

8.1.1 Communication & Data Transmission

MODBUS RTU transmits data in **binary format**, making it more efficient than its ASCII counterpart. It typically operates over RS-232, RS-485, or RS-422 serial interfaces, with RS-485 being the most common due to its multi-drop capability, allowing multiple devices to be connected on a single bus.

Each communication follows a **request-response** cycle:

- The **master** initiates a request by sending a message to a specific slave device (or a broadcast message).
- The **slave** processes the request and responds with the requested data or an acknowledgment.

8.1.2 Message Structure

Each MODBUS RTU message consists of the following components:

1. **Slave Address (1 byte):** Identifies the target slave device (range: 1-247).
2. **Function Code (1 byte):** Specifies the action to be performed (e.g., read/write data).
3. **Data Field (Variable length):** Contains the register addresses and values for the requested operation.
4. **CRC (Cyclic Redundancy Check - 2 bytes):** Used for error detection and ensuring data integrity.

8.2 MODBUS RTU Command Format

The available MODBUS command registers are covered in this section.

In MODBUS RTU, there is no specific separator character used in multiple register write commands. Instead, the data is structured in a continuous binary format.

For a Write Multiple Registers (Function Code 0x10) command, the message structure is as follows:

MODBUS RTU Write Multiple Registers (0x10) Frame Structure:

1. Slave Address (1 byte)
2. Function Code (0x10) (1 byte)
3. Starting Register Address (2 bytes)
4. Number of Registers to Write (2 bytes)
5. Byte Count (1 byte) (Indicates the total number of data bytes that follow)
6. Register Values (N × 2 bytes) (Each register is 2 bytes, sent in a continuous stream)
7. CRC Checksum (2 bytes)

Example: Writing to 3 Registers

If writing values 0x1234, 0x5678, and 0x9ABC to register at address 0x0001, the message sent from the master would be:

Byte	Value	Description
01	0x01	Slave Address (e.g., Device 1)
02	0x10	Function Code (Write Multiple Registers)
03-04	0x0001	Starting Register Address
05-06	0x0003	Number of Registers to Write (3)
07	0x06	Byte Count (3 registers × 2 bytes each)
08-09	0x1234	Register 1 Value
10-11	0x5678	Register 2 Value
12-13	0x9ABC	Register 3 Value
14-15	CRC	Error-checking value

Since MODBUS RTU is a binary protocol, no separator character (like commas or spaces) is used between register values. The data is transmitted as a continuous byte stream with defined positions for each element in the message structure.

8.3 Write Register Commands

8.3.1 Write Single Register Command Format

Slave Address	Function Code	Register Address	Data	CRC16
DevAddr	Func	Addr	{dat1}	CRC_H CRC_L

Byte1 (Device Address): 0x02 (Range:1-32)

Byte2 (Function Code): 0x06 (Write single register address)

Byte3,4 (Register Address): Write Register Address (Refer to section 8.5)

Byte5,6 (Data): Write Data Content

Byte7,8 (CRC16): CRC16 checksum for Byte 1 to Byte 6 (Refer to section 8.6)

8.3.2 Write Single Register Correct Answer Format

Slave Address	Function Code	Register Address	Data	CRC16
DevAddr	Func	Addr	{dat1}	CRC_H CRC_L

Byte1 (Device Address): 0x02 (Editable)

Byte2 (Function Code): 0x06 (Write single register address)

Byte3,4 (Register Address): Write Register Address (Refer to section 8.5)

Byte5,6 (Data): Write Data Content

Byte7,8 (CRC16): CRC16 checksum for Byte 1 to Byte 6 (Refer to section 8.6)

8.3.3 Write Multiple Registers Command Format

Slave Address	Function Code	Start Address	No. of Addresses	Byte Count	Data (binary)	CRC16
DevAddr	Func	StartAddr	Num	n	{dat1...;datN}	CRC_H CRC_L

Byte1 (Device Address): 0x02 (Range:1-32)

Byte2 (Function Code): 0x10 (Write multiple register addresses)

Byte3,4 (Start Address): Start address of writing register (Refer to 8.5)

Byte5,6 (Number of Addresses): The number of register addresses plan to write

Byte7 (Byte Count): Total byte count (or data length) of writing data

Byte8 to N (Data): Write Data Content

Byte N+1, N+2 (CRC16): CRC16 checksum of Byte1 to ByteN (Refer to section 8.6)

8.3.4 Write Multiple Registers Correct Answer Format

Slave Address	Function Code	Start Address	No. of Addresses	CRC16
DevAddr	Func	StartAddr	Num	CRC_H CRC_L

Byte1 (Device Address): 0x02 (Editable)

Byte2 (Function Code): 0x10 (Write multiple register addresses)

Byte3,4 (Start Address): Start writing register address (Refer to section 8.5)

Byte5,6 (Number of Addresses): The number of register addresses plan to write

Byte7,8 (CRC16): CRC16 checksum of Byte1 to Byte6 (Refer to section 8.6)

8.4 Read Register Commands

8.4.1 Read Register Command Format

Slave Address	Function Code	Start Address	No. of Addresses	CRC16
DevAddr	Func	StartAddr	Num	CRC_H CRC_L

Byte1 (Device Address): 0x02 (Editable)

Byte2 (Function Code): 0x03 (Read multiple register addresses)

Byte3,4 (Start Address): Start reading register address (Refer to section 8.5)

Byte5,6 (Number of Addresses): The number of register addresses plan to read

Byte7,8 (CRC6): CRC16 checksum of Byte1 to Byte6 (Refer to section 8.6)

8.4.2 Read Register Successful Answer Format

Slave Address	Function Code	Byte Count	Data	CRC16
DevAddr	Func	n	{dat1...;datN}	CRC_H CRC_L

Byte1 (Device Address): 0x02 (Range:1-32)

Byte2 (Function Code): 0x03 (Read multiple register addresses)

Byte3 (Number of Addresses): The number of register addresses planned to read

Byte4 to N (Data): Read Data Content

Byte N+1, N+2 (CRC16) CRC16 checksum of Byte1 to ByteN (Refer to section 8.6**)**

8.4.3 Communication Fail Answer Format

Slave Address	Function Code	Error Code	CRC16
DevAddr	Func	ErrCode	CRC_H CRC_L

Byte1 (Device Address)： 0x02 (Editable)

Byte2 (Function Code):

Function Code	Description
0x83	Read Register Address Error
0x86	Write Single Register Address Error
0x90	Write Multiple Register Addresses Error

Byte3 (Error Code):

Error Code	Description
0x01	CRC Checksum Error
0x02	Data Format Incorrect
0x03	Start Address does not exist
0x04	Data Length Out of Range

Byte4,5: CRC16 checksum of Byte1 to Byte6 (Refer to section 8.6)

8.5 Register Address Table

8.5.1 Write Register Addresses

Address (Hex)	Parameter Name	Notes
0001H	System Operation	Stop Run General Mode Run Step Mode Run Gradual Mode 3Phase Independent Setup 5-10- Reserved 11-31 ： Reserved 32-Reset
0002H	Remote/Local	Local Remote
0003H	High/Low Level	Low Level High Level

Address (Hex)	Parameter Name	Notes
0004H-0029H	Reserved Addresses	
System Settings：		
0030H	U Phase Base Angle	Phase Angle Setup (Optional)
0031H	Phase Angel between U-V	
0032H	Phase Angel between U-W	
0033H	Not available	
0034H	Limit Current Value	Limit Current Value (optional)
0035H-009fH	Reserved Addresses	
General Mode：		
0100H	General Mode Output Voltage	General Mode (3phase synchronized)
0101H	General Mode Output Frequency	
0102H	U Phase Output Voltage	General Mode (3phase Independent) (Optional Feature)
0103H	V Phase Output Voltage	
0104H	W Phase Output Voltage	
Step Mode：		
0105H	Group No.	*Note1 ：Group No. Range 1-24*
0106H	Voltage	
0107H	Frequency	
0108H	Running Time Interval- Hr	
0109H	Running Time Interval- Min	
010aH	Running Time Interval- Sec	
010bH	Start Running Group No.	
010cH	End Running Group No.	
010dH	Running Repeat Cycles	
Gradual Mode：		
010eH	Group No.	*Note1 ：Group No. Range 1-1**2***
010fH	Gradual Start Voltage	
0110H	Gradual Start Frequency	
0111H	Gradual End Voltage	
0112H	Gradual End Frequency	
0113H	Running Time Interval- Hr	
0114H	Running Time Interval- Min	
0115H	Running Time Interval- Sec	
0116H	Start Running Group No.	
0117H	End Running Group No.	
0118H	Running Repeat Cycles	
Soft Start Mode：		
012dH	Rated Voltage	Option
012eH	Rated Frequency	
012fH	Start Voltage	
0130H	Start Frequency	
0131H	Delay Time (0.1s)	
0132H	Ramp Time (0.1s)	
0136H-019fH	Reserved Addresses	

Table 8-1: MODBUS RTU Write Register Addresses

8.5.2 Read Register Addresses

Address (Hex)	Parameter Name	Notes
0010H	Equipment Type AFV+(Volt.×10, Freq.×10)	System Information
0011H	Input Phase (Single/Three)	
0012H	Output Phase (Single/Three)	
0013H	Nominal Rating	
0014H	Not Available	
0015H	Min. Time Interval	
0016H	Min. Voltage	
0017H	Max. Voltage	
0018H	Min. Frequency	
0019H	Max. Frequency	
001aH	Function Mode：3 Phase Independent Function	
001bH	Function Mode：Step Mode	
001cH	Function Mode：Gradual Mode	
001dH	Not Available	
001eH	Function Mode：Phase Angle Setup	
001fH	Function Mode：High/Low Level Selection	
0020H	Function Mode：Soft Start Function	
0021H	Not available	
Read Output Measurement Register Addresses：		
0200H	Output Status：0-Stop 1-Run	
0201H	High/Low Status：0-Low 1-High	
0202H	Output System Error High Byte (16bit)	
0203H	Output System Error Low Byte (16bit)	
0204H	Current Running Group	
0205H	Current Running Cycle	
0206H	Current Operation Time-Hr	
0207H	Current Operation Time-Min	
0208H	Current Operation Time-Sec	
0209H	Output Frequency x 100	
020aH	U Phase Output Voltage x 10	
020bH	V Phase Output Voltage x 10	
020cH	W Phase Output Voltage x 10	
020dH	U Phase Output Current x 10	

020eH	V Phase Output Current x 10	
020fH	W Phase Output Current x 10	
0210H	U Phase Output kW x 10	
0211H	V Phase Output kW x 10	
0212H	W Phase Output kW x 10	
0213H	U Phase Output kVAR x 10	
0214H	V Phase Output kVAR x 10	
0215H	W Phase Output kVAR x 10	
0216H	U Phase Output PF x 100	
0217H	V Phase Output PF x 100	
0218H	W Phase Output PF x 100	
0219H	Step/Gradual End Running Flag	
021aH-021fH	Reserved Addresses	

Table 8-2: MODBUS RTU Read Register Addresses

8.6 CRC Checksum Calculation

The following example illustrates the process to use for calculating the CRC Checksum.

```
/*****************************************************************************
**Task Name: CRCVerify
**Function Description: Calculate CRC Checksum
*****************************************************************************/
static unsigned char auchCRCHi[]={
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
```

```
0x40
};

static unsigned char auchCRCLo[256] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
0x40
};
unsigned short CRCVerify(unsigned char *pMsg,unsigned short usDataLen)
{
   unsigned char ucCRCHi = 0xff;
            unsigned char ucCRCLo = 0xff;
            unsigned short uIndex = 0;
            while(usDataLen--)
            {
               uIndex = ucCRCHi ^ *pMsg++;
                        ucCRCHi = ucCRCLo ^ auchCRCHi[uIndex];
                        ucCRCLo = auchCRCLo[uIndex];
            }
            return (ucCRCHi << 8 | ucCRCLo);
}
```

8.7 MODBUS RTU Communication Examples

8.7.1 Switch between Remote and Local Modes

Remote: 02 06 00 02 00 01 E9 F9 (hex)

Local: 02 06 00 02 00 00 28 39 (hex)

8.7.2 Switch between High and Low Voltage Range

High: 02 06 00 03 00 01 B8 39 (hex)

Low: 02 06 00 03 00 00 79 F9 (hex)

8.7.3 Query Power Source Equipment Information

Read Equipment: 02 03 00 10 00 0A C4 3B (hex)

Read Operation Mode and High/Low Status: 02 03 02 00 00 02 C5 80 (hex)

8.7.4 Three Phase Voltage Synchronized Mode

Parameter Setup: 02 10 01 00 00 02 04 08 98 01 F4 72 E3 (hex)

Run & Output: 02 06 00 01 00 01 19 F9 (hex)

8.7.5 Three Phase Voltage Independent Mode

Parameter Setup: 02 10 01 01 00 04 08 01 F4 08 98 08 98 08 98 DB 4B (hex)

Run & Output: 02 06 00 01 00 04 D9 FA (hex)

Note: All voltage values are actual value x 10, e.g. 230.4 is returned as 2304.

8.7.6 Step Mode

Setup Group1 Parameters: 02 10 01 05 00 06 0C **00 01** 08 98 01 F4 00 00 00 00 00 0A 66 84 (hex)

Setup Running Cycle Parameters: 02 10 01 0b 00 03 06 00 01 00 18 00 01 EA 5D (hex)

Run Step Mode: 02 06 00 01 00 02 59 F8 (hex)

Note 1: All voltage & frequency values are actual value x 10, e.g. 50.2Hz is returned as 502.

Note 2: The hex data shown in blue is the group number.

8.7.7 Gradual Mode

Setup Group1 Parameters:

02 10 01 0e 00 08 10 **00 01** 08 98 01 F4 04 4C 02 58 00 00 00 00 00 0A 34 FA (hex)

Setup Running Cycle Parameters: 02 10 01 16 00 03 06 00 01 00 0C 00 01 71 A3 (hex)

Run Gradual Mode: 02 06 00 01 00 03 98 38 (hex)

Note 1: All voltage & frequency values are actual value x 10, e.g. 50.2Hz is returned as 502.

Note 2: The hex data shown in blue is the group number.

8.7.8 Output Status

System Error & Output Status: 02 03 02 02 00 17 A5 8F (hex)

Note: All voltage & frequency values are actual value x 10.

8.7.9 Stop

02 06 00 01 00 00 D8 39 (hex)

8.7.10 Reset

02 06 00 01 00 20 D9 E1 (hex)

8.7.11 Set Current Limit

02 06 00 34 02 58 C8 AD (hex)

Note: The current limit values are actual value x 10.

8.7.12 Phase Angle Control (Optional)

02 10 00 30 00 03 06 00 00 00 F0 00 78 E3 AD (hex)

Note: After setting the phase angle value, it applies to all voltages phase angles.

8.8 System Error Codes

Bit Position	Fault Description
0	AC Mains Input R-phase IGBT1 Over current fault
1	AC Mains Input R-phase IGBT2 Over current fault
2	AC Mains Input R-phase IGBT3 Over current fault
3	AC Mains Input R-phase IGBT4 Over current fault
4	AC Mains Input S-phase IGBT1 Over current fault
5	AC Mains Input S-phase IGBT2 Over current fault

Bit Position	Fault Description
6	AC Mains Input S-phase IGBT3 Over current fault
7	AC Mains Input S-phase IGBT4 Over current fault
8	AC Mains Input T-phase IGBT1 Over current fault
9	AC Mains Input T-phase IGBT2 Over current fault
10	AC Mains Input T-phase IGBT3 Over current fault
11	AC Mains Input
12	Heat sink temperature is above limit
13	AC Input Transformer over-temperature
14	Emergency Stop
15	Fuse 1 is broken
16	Fuse 2 is broken
17	Fuse 3 is broken
18	IGBT 1 is over-temperature
19	IGBT 2 is over-temperature
20	Input under-voltage fault
21	Input over-voltage fault
22	DC voltage is too low
23	DC voltage is too high
24	U-phase current overload
25	V-phase current overload
26	W-phase current overload
27	Output under-voltage fault
28	Output over-voltage fault
29	Line drop compensation error- Single-phase model or U-phase line drop compensation error – Three-phase model
30	V-phase line drop compensation error – Three-phase model
31	W-phase line drop compensation error – Three-phase model

Table 8-3: System Error Codes

8.9 Inverter Error Codes

Bit Position	Fault Description
0	Over temperature in heat sink
1	DC bus soft over voltage
2	Reverse current unsymmetrical
3	Emergency Stop
4	Hard over current
5	Drive over current
6	DC under voltage error
7	Low command voltage error
8	Grid phase error
9	Grid missing phase error
10	Grid frequency error
11	Grid voltage error
12	Grid connect over current
13	Grid voltage does not match
14	Synchronized phase error
15	Hardware disconnect

Table 8-4: Inverter Error Codes

9 Calibration

9.1 Overview

This product supports calibration of the output and measurement accuracy. Users can perform the calibration according to the step by step procedures provided in this chapter. A traceable voltage meter, current meter or power analyzer and a suitable AC load are needed for performing these calibration procedures.

CAUTION

Make sure the power source is powered ON for at least 30 minutes. This is necessary to stabilize the unit to meet specifications.

Press METER CALIBRATION at the SYSTEM subpage of SETTINGS page. Use the virtual numeric keys to input the password 8888 to enter the CALIBRATION page. Please see the screen image below.

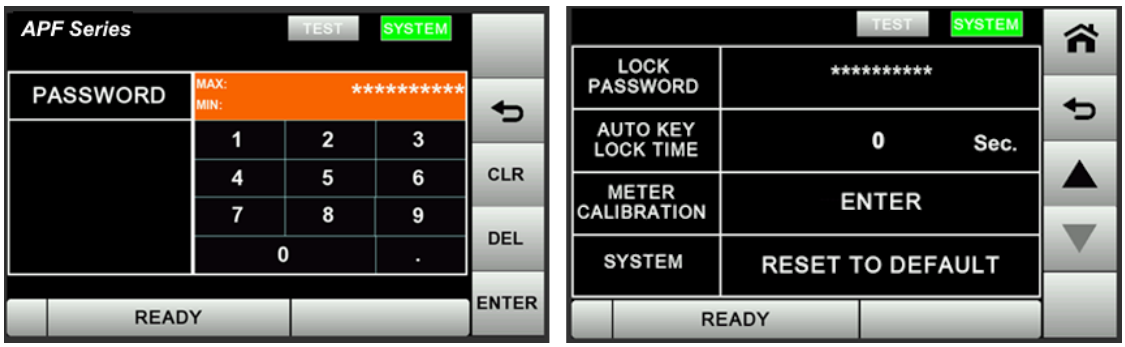


Figure 9-1: Entering the CALIBRATION Screen

9.2 Voltage Calibration

To calibrate the AC output voltage for each phase, proceed as follows:

1. Set the power source to the 310 V voltage range (High Vrange)
2. The default output settings are V set 220V and F set 50.0Hz.
3. Connect the output of APF series unit U-N, V-N and W-N to a three-phase power analyzer without connecting to any load to the power source yet.
4. Press the Output/Reset button at the touch screen to start calibration and the screen will display the output voltage value of each phase.
5. Input the voltage value displayed for each phase on the power analyzer to the U REAL / V REAL / W REAL.
6. Press SETTING to perform calibration calculation and the system will generate new output voltage value at DISPLAY.
7. Compare the DISPLAY value and the REAL value; if they are consistent, then the calibration is completed; If there are differences in one or two phases, it is only necessary to perform the above calibration again for phases with different values..

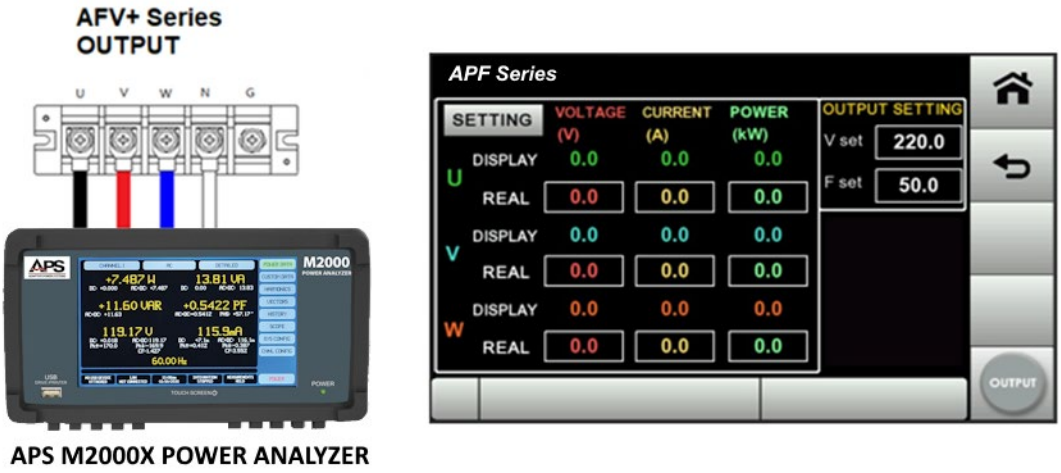
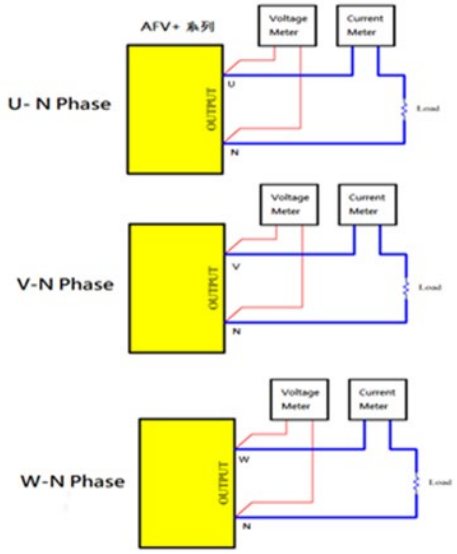


Figure 9-2: Voltage Calibration Setup and Screen

9.3 Current Calibration

To calibrate the AC output RMS current for each phase, proceed as follows:

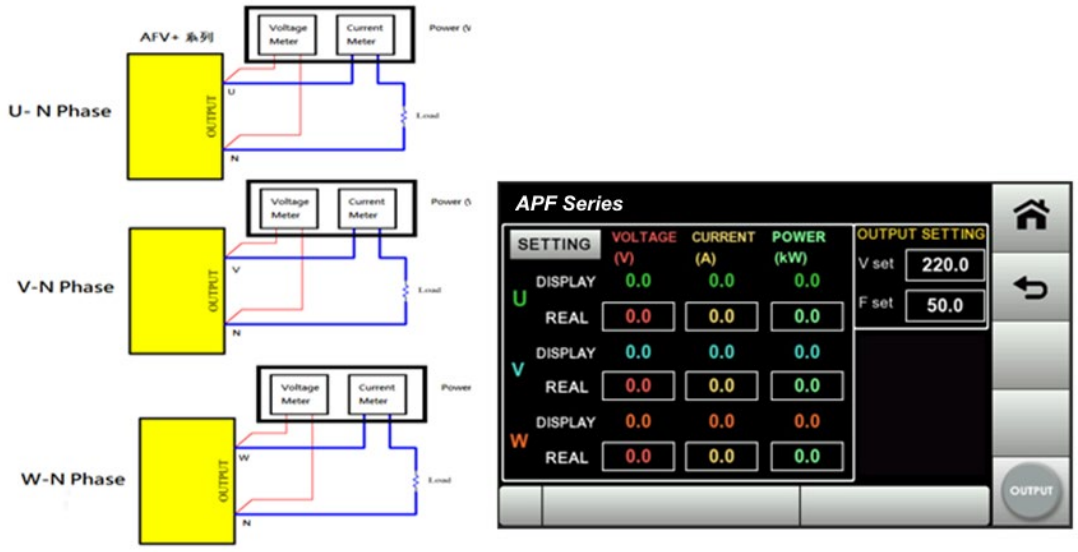
1. The default output settings are V set 220V and F set 50.0Hz.
2. Connect the output of APF series power source U-N, V-N and W-N to a three-phase power analyzer and a resistive load (it is suggested that load is set for an AC source to output of approximately 80% of the rated current.
3. Press the Output/Reset button at the touch screen to start calibration and the screen will display the current value of each phase.
4. Input the RMS current value displayed on the power analyzer to U REAL / V REAL / W REAL.
5. Press SETTING to perform calibration calculation and the system will generate new output current value at DISPLAY.
6. Compare the DISPLAY value and the REAL value; if they are consistent, then the calibration is completed; if there are differences in one or two phases, it is will be necessary to perform the above calibration again for phases with different values.



9.4 Power Calibration

To calibrate the AC output Power for each phase, proceed as follows:

1. The default output settings are V set 220V and F set 50.0Hz.
2. Connect the output of the APF series power source U-N, V-N and W-N to a three-phase power analyzer and a resistive load (it is suggested that the AFV+ output reaches 80% of the rated power).
3. Press Output/Reset button at the touch screen to start calibration and the screen will display the output power value of each phase.
4. Input the power value displayed on the power analyzer to the U REAL / V REAL / W REAL.
5. Press SETTING to perform calibration calculation and the system will generate new output power value at DISPLAY.
6. Compare the DISPLAY value and the REAL value; if they are consistent, then the calibration is completed; if there are differences in one or two phases, it is only necessary to perform the above calibration again for phases with different values.



10 Maintenance

10.1 Overview

In order to maintain the best performance of APF Series power source, it is recommended to conduct product maintenance regularly. Before attempting maintenance or repair, the operator should be familiar with the components of the systems and the theory of operation.

10.2 Maintenance Steps

WARNING

Any maintenance that requires removal of the front cover of the unit should only be done by properly trained and qualified personnel. Hazardous voltages exist inside the unit. **Disconnect the supply from the AC mains input** before performing any maintenance. Service, fuse verification, and connecting of wiring to the chassis must be accomplished at least 10 minutes **after** AC input power has been removed with an external disconnect switch. Do not touch any circuits and/or terminals that are energized.

- Pay attention to the safety summary and read the manual carefully.
- Ensue the power line input is cut off and the device has been shut down for 10 minutes before maintenance.
- Clean the device regularly, especially the air inlet, to ensure good ventilation.
- Do not block the air inlet and outlet on the panels.

10.3 Troubleshooting

Should you experience any problems operating this equipment, here are some general guidelines for troubleshooting. **DO NOT** open any panels or access any interior parts of this equipment while grid power is applied to its input or the AC mains is still connected and **on**. Instead, turn off all MAINS power to the unit. There are no user serviceable parts inside.

Following is a list of items to check.

10.3.1 Introduction

This troubleshooting guide provides step-by-step instructions to diagnose and resolve common issues encountered when using a programmable AC power source. Follow these steps systematically to identify and correct faults. If the problem persists, contact technical support.

10.3.2 General Safety Precautions

Before troubleshooting, ensure the following safety precautions are observed:

- Disconnect power before opening the unit.
- Avoid touching internal components while the unit is powered.
- Ensure proper grounding to prevent electric shock.
- Use appropriate personal protective equipment (PPE) when handling electrical components.

10.3.3 Troubleshooting Steps

- **Power and Connection Issues**

  If the unit does not power on:

  - Verify the power cord is securely plugged into a functional three phase outlet with the correct mains voltage. Check the model tag for the required AC mains input voltage.
  - Check if the main power switch is turned ON.
  - Ensure the Mains power meets the voltage and frequency requirements for the unit.
  - Verify proper grounding and electrical connections.

- **Display and Interface Issues**

  If the display is blank or unresponsive:

  - Restart the unit and observe if the issue persists.
  - If using a remote interface (USB, LAN, GPIB), ensure proper communication settings.
  - Check cable connections and inspect for damage.
  - Ensure that drivers and software are correctly installed for remote control.
  - Reset the unit to factory defaults if unresponsive.

- **Output Issues**

  If the power source does not provide the expected output:

  - Verify that the output voltage and frequency settings are correct.
  - Check load connections and verify proper wiring.
  - Measure output with an external meter to confirm expected values.
  - Inspect for overload conditions or excessive current draw.
  - Reduce the load and retry operation to rule out overcurrent conditions.

- **Error Messages and Alarms**

  If an error message or alarm is displayed:

  - Refer to the user manual for specific error code meanings.

- For overvoltage, overcurrent, or overtemperature warnings, take corrective actions (e.g., reducing load, improving ventilation).
- Clear any error messages and attempt a restart.

- **Thermal and Cooling Issues**

  If the unit overheats or shuts down unexpectedly:

  - Ensure that ventilation openings are not blocked.
  - Verify that the cooling fans are operational.
  - Check for excessive ambient temperature; operate within recommended limits.

- **Firmware and Software Issues**

  If software control or remote operation fails:

  - Ensure the latest firmware version is installed.
  - Check for compatibility issues with external control software.
  - Verify baud rate and protocol settings for communication errors.

- **Reset and Factory Defaults**

  If the issue persists:

  - Perform a soft reset via the menu or power cycle the unit.
  - If necessary, restore factory default settings.
  - Contact the manufacturer for service or further diagnostics.

- **4. Contacting Support**

  If troubleshooting steps do not resolve the issue, please contact technical support using the contact information in Section 1, “Contact Information” on page 10.

  Please provide the following information:

  - Model and serial number of the power source.
  - Detailed description of the issue, including any error messages displayed.
  - Steps already taken to troubleshoot the problem.
  - Environmental conditions (temperature, humidity, load characteristics).

11 CE MARK Declaration of Conformity

EU Directives:	**2014/30/EC**	**EMC Directive**
	2014/35/EC	**Low Voltage Directive**
	2011/65/EC	**RoHS2 directive**

Manufacturer	**Adaptive Power Systems, Inc.**
Product Name	APF Series AC Power Sources
Serial Number	_____

The manufacturer hereby declares that the products are in conformity with the following standards or other normative documents:

RoHS (DIRECTIVE 2011/65/EU)
Standard applied EN 50581:2012 (Exempt as WEEE Category 9 until 22 July 2017)
! SAFETY (DIRECTIVE 2014/35/EC):
Standard applied EN 61010–1: 2010+A1:2019
! EMC (DIRECTIVE 2014/30/EU):
Standard applied EN 61326-1: 2013

Supplemental Information:

When and Where Issued:	April 4, 2025 Irvine, California, USA
Authorized Signatory	Quality Assurance Inspector Adaptive Power Systems
Responsible Person	Production Manager Adaptive Power Systems 2802 Kelvin Avenue, Suite 100 Irvine, California, 92614-5897, USA

CE **Mark of Compliance, LVD**

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