Chroma

Digital Power Meter

66203/66204

User's Manual

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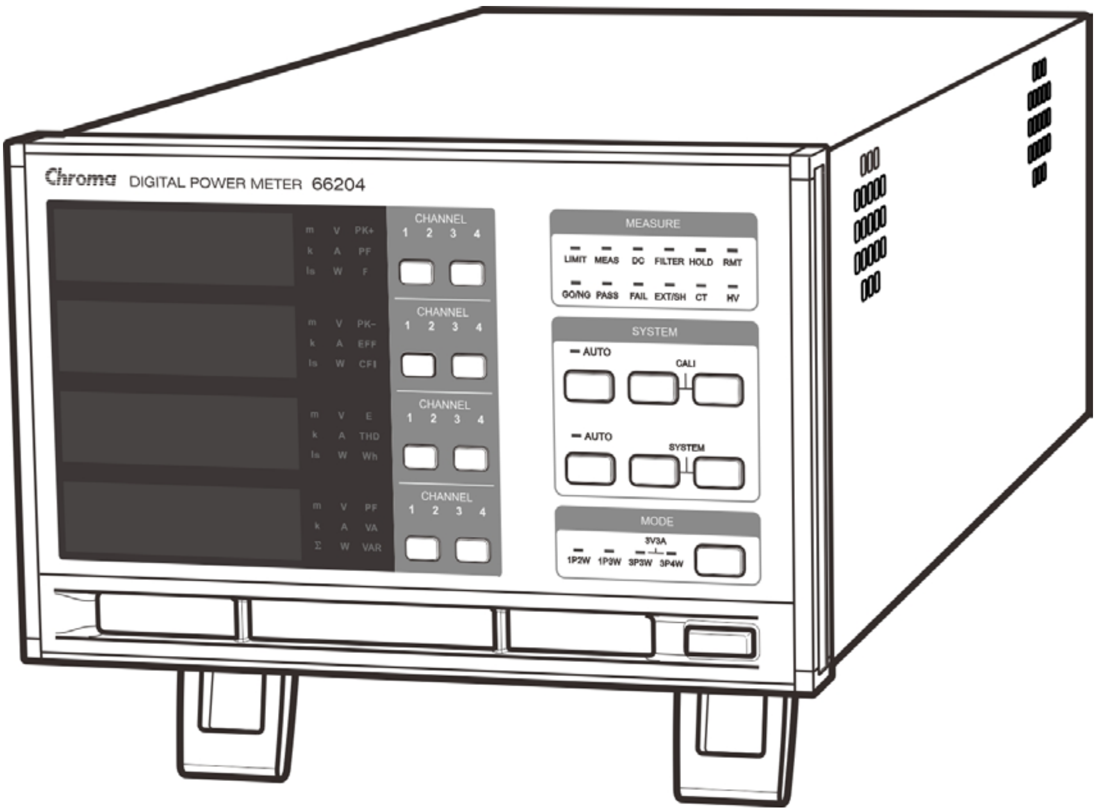

Version 1.4
July 2018

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

Warranty

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Material Contents Declaration

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

: See **<Table 1>**.

: See **<Table 2>**.

<Table 1>

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

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

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

Remarks: The CE marking on product is a declaration of product compliance with EU Directive 2011/65/EU.

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

<Table 2>

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

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

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

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

Disposal

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

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Declaration of Conformity

For the following equipment :

Digital Power Meter

(Product Name/ Trade Name)

66203, 66204

(Model Designation)

CHROMA ATE INC.

(Manufacturer Name)

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

(Manufacturer Address)

Is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility (2014/30/EU) and Low Voltage Directive (2014/35/EU). For the evaluation regarding the Directives, the following standards were applied :

EN 61326-1:2013

EN 55011:2009+A1:2010 Group I Class A, EN 61000-3-2:2006/A1:2009 and /A2:2009,
EN 61000-3-3:2008, IEC 61000-4-2 Edition 2.0 2008-12,
IEC 61000-4-3 Edition 3.2 2010-04, IEC 61000-4-4 Edition 3.0 2012-04,
IEC 61000-4-5 Edition 2.0 2005-11, IEC 61000-4-6 Edition 3.0 2008-10
IEC 61000-4-8 Edition 2.0 2009-09, IEC 61000-4-11 Edition 2.0 2004-03

EN 61010-1:2010 and EN 61010-2-030:2010

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

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

CHROMA ATE INC.

(Company Name)

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

(Company Address)

Person responsible for this declaration:

Mr. Vincent Wu

(Name, Surname)

T&M BU Vice President

(Position/Title)

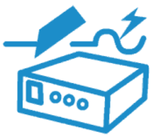
Taiwan	**2017.02.21**	Vincent Wu
(Place)	(Date)	(Legal Signature)

Safety Summary

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

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

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



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

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

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE
Do not operate the instrument in the presence of flammable gases or fumes. The instrument should be used in an environment of good ventilation.

DO NOT REMOVE THE COVER OF THE INSTRUMENT
Operating personnel must not remove the cover of the instrument. Component replacement and internal adjustment can be done only by qualified service personnel.

Safety Symbols

	DANGER – High voltage.
	Explanation: To avoid injury, death of personnel, or damage to the instrument, the operator must refer to an explanation in the instruction manual.
	High temperature: This symbol indicates the temperature is now higher than the acceptable range of human. Do not touch it to avoid any personal injury.
	Protective grounding terminal: To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
	Functional grounding: To identify an earth (ground) terminal in cases where the protective ground is not explicitly stated. This symbol indicates the power connector does not provide grounding.
	Frame or chassis: To identify a frame or chassis terminal.
	Alternating Current (AC)
	Direct Current (DC) / Alternating Current (AC)
	Direct Current (DC)
	Push-on/Push-off power switch
WARNING	The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.
CAUTION	The **CAUTION** sign denotes a hazard. It may result in personal injury or death if not noticed timely. It calls attention to procedures, practices and conditions.
Notice	The **Notice** sign denotes important information in procedures, applications or the areas that require special attention. Be sure to read it carefully.

Revision History

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

Date	**Version**	**Revised Sections**
Mar. 2014	1.0	Complete this manual.
Sep. 2016	1.1	Update CE *Declaration of Conformity*. Modify the following sections: – “*Computing Equation for Measurement Parameters*”, “*Setting Measurement Functions*” and “*Wiring Mode*” in the chapter of “*Operation*”. – “*Instrument Commands*” in the chapter of “*Using Remote Control*”. Add “*Selecting 3V3A Wiring Mode, Three-Wattmeter Method*” under the section of “*Wiring Mode*”.
Apr. 2017	1.2	Update “*Material Contents Declaration*” and CE “*Declaration of Conformity*”.
March. 2018	1.3	Update the HV function description in “*Setting Measurement Functions*” section. Add OPFR warning description.
July 2018	1.4	Update the notice of PF in “*Computing Equation for Measurement Parameters*” section.

Table of Contents

1. Overview

1.1 Introduction

This manual covers the 66203 and 66204 Digital Power Meters that have 3 and 4 channels respectively to test multiple UUTs at the same time reducing the testing time and improving the productivity. The Digital Power Meter can also test the products with 3-phase power system through the test parameters of voltage, current, power and power factor. It can test the input and out power of a UUT at the same time and compute the efficiency easily via the function of efficiency calculation.

The 66203 and 66204 Digital Power Meters have two internal shunts (low shunt and high shunt) which are configured within 5mA~20A current range. They can be applied to low and high power measurements comprehensively especially the highly accurate capability equipped in testing the standby power for energy star. This Digital Power Meter also has external sampling function to expand the current measurement range if the test current is over the range of maximum 20Arms. Moreover, the Digital Power Meter is able to analyze the voltage and current measurement for power quality test. Working with the exclusive soft panel, the Digital Power Meter is able to create a complete test report and comply with the power quality test standard.

The limit function utilized in production test is able to perform GO/NG judgment based on the upper/lower limits for voltage, current and power total 16 parameters. In addition, the measurement functions such as energy, inrush current and crest factor, etc. are also available for use.

1.2 Initial Inspection

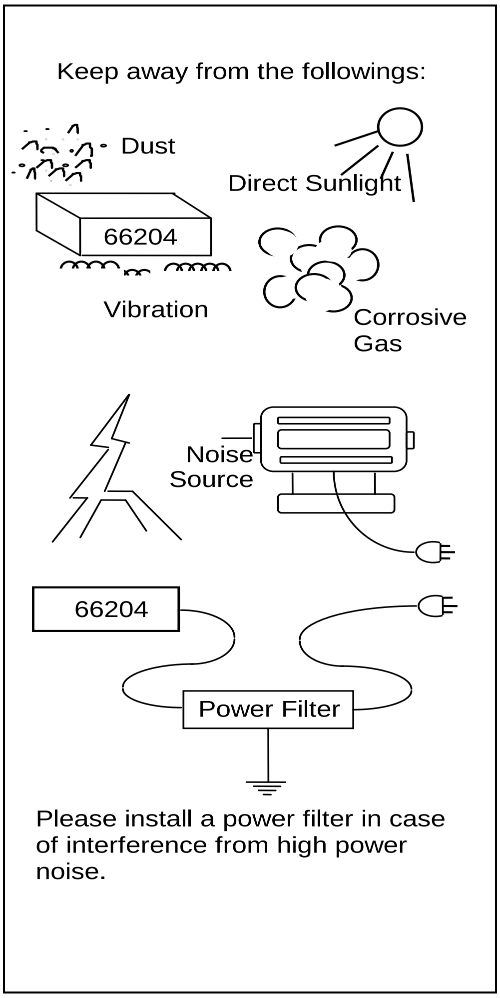
Before shipment, this Model 66203/66204 was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, user should inspect for any damage that may have occurred in transit. Save all packing materials in case the instrument has to be returned. If damage is found, please file a claim with the carrier immediately. Do not return the product to Chroma without prior approval.

1.3 Ambient Environment

1. Do not use the meter in a dusty or vibrating location. Do not expose it to sunlight or corrosive gas. Be sure that the ambient temperature is 0°C ~ +40°C and the relative humidity is 20% ~ 80%.

2. The meter has been carefully designed to reduce the noise from the AC power source. However, it should be used in a noise-free or as low as possible environment. If the noise is inevitable, please install a power filter.

3. The meter should be stored within the temperature range of -40°C ~ +85°C. If the unit is not to be in use for a long time, please store it in its original or similar package and keep it from direct sunlight and humidity place to ensure its accuracy when using again.



1.4 Power Line Connection

Before plugging in the power cord, make sure the power switch is OFF and the power voltage is within the labeled range. Please use the power supply frequency of 50Hz or 60Hz.

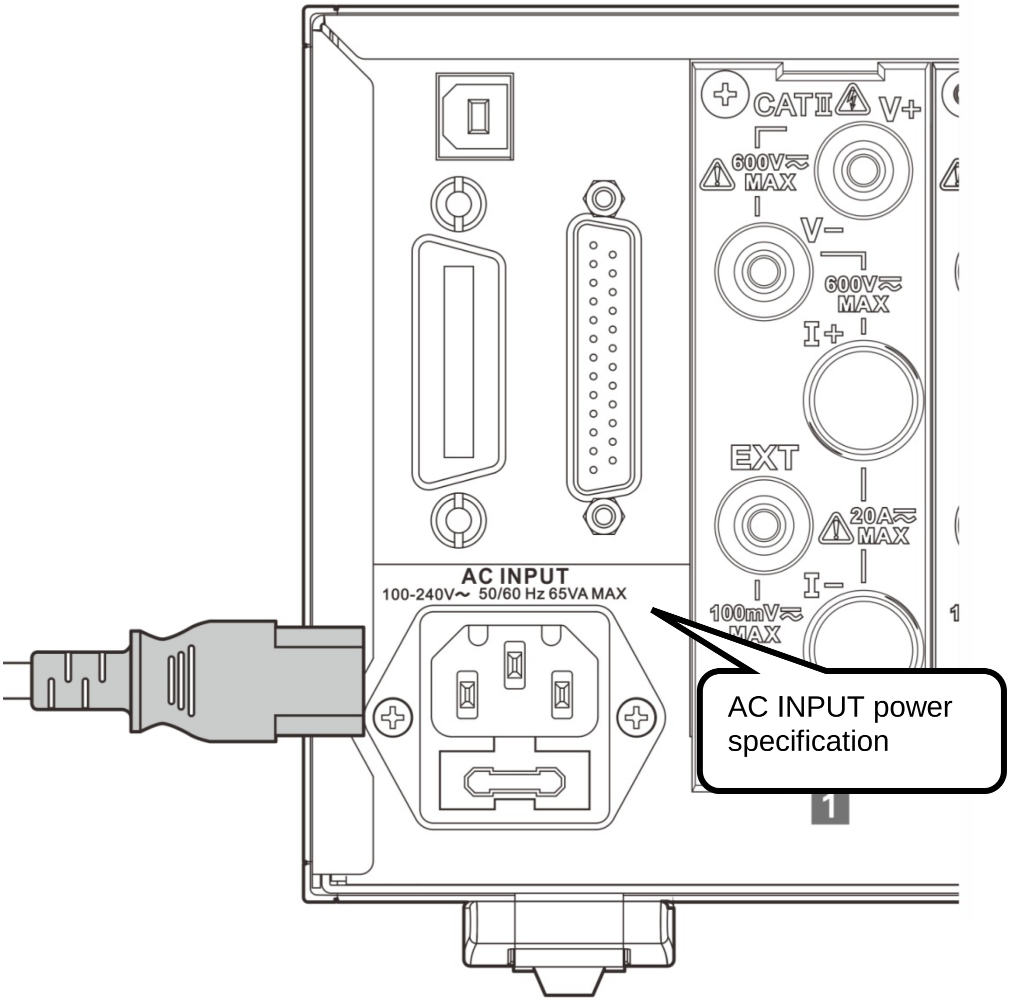


Figure 1-1 AC INPUT Power Spec. Label

1.5 Fuse

The meter has one fuse installed on the rear panel. Please be aware of the following when replacing it:

(1) Be sure to turn off the power and unplug the power cord before changing the fuse.
(2) Since visual check cannot make sure the fuse to be used is appropriate, it is necessary to test its resistance to see if it is below 2Ω which is normal for usage.

Table 1-1 Specification of Fuse

Power Fuse	Specification
	Slow blow 2.5A / 250V

⚠WARNING To prevent fire from occurring it is required to use the fuse of same type and same specification for replacement.

1.6 Time for Warm-Up

All functions of this meter are active when it is powered on; however, to meet the accuracy listed in the specification it is suggested to warm-up for at least 30 minutes.

1.7 Cleaning

Ensure all cables and power cords are removed before cleaning the power meter. Use a dry cloth to clean the chassis. As the rear panel of the power meter connects to the internal circuit board, to avoid damaging the device due to short circuit internally it is prohibited to wipe it with damp cloth.

2. Specification

2.1 Standard Specification

Functions

Model	66203	66204
Channel	**3 Channel**	**4 Channel**
Measurement Parameters	Vrms, Vpk+, Vpk-, VTHD, Irms, Ipk+, Ipk-, ATHD, Is, CFi, W, VA, VAR, PF, F, Energy	

Input

Measurement Ranges		
Voltage Measurement Ranges (rms)	15V/30V/60V/150V/300V/600V/Auto The crest factor of all measurement ranges is 2.	
Current Measurement Ranges (rms)	**Internal current sensor**	
	0.005A/0.02A/0.05A/0.2A/0.5A/2A/5A/20A/Auto, when shunt range is auto. 0.005A/0.02A/0.05A/0.2A/Auto, when shunt range is low. 0.5A/2A/5A/20A/Auto, when shunt range is high. The crest factor of all measurement ranges is 4.	
	External current sensor	
	10mV/25mV/50mV/100mV/Auto The crest factor of all measurement ranges is 4.	
Power Measurement Ranges	75mW/…/12KW, 48 ranges	
Input Impedance		
Voltage Measurement Range	Approx. 4MΩ	
Current Measurement Ranges	Approx. 500mΩ (Low Shunt Range) Approx. 20mΩ (High Shunt Range)	
External Measurement Range	Approx. 100kΩ	
Bandwidth		
Approx. 60kHz		
Protection		
Over Voltage Range(OUR)	When the measured value exceeds “Voltage Range × CF”	
Over Current Range(OCR)	When the measured value exceeds “Current Range × CF”	
Over Current Protection (OCP)	OCP will occur when the following measured current conditions are exceeded. 1. 1.1Arms for low shunt range 2. 23Arms or 80Apeak for high shunt range 3. Burnt out of the 25A fast acting fuse (the current measurement loop will become open circuit)	

Accuracy

Requirements
1. Temperature: 23°C±5°C 2. Humidity: 80%RH. 3. Input waveform: Sine wave 4. Power factor: 1. 5. Warm-up time: ≧30 minutes. 6. Connect the power cord to a three-prong power outlet with proper grounding.

Voltage / Harmonics Specifications		
DC, 10Hz-1kHz	**1kHz-10kHz**	**Temperature Coefficient**
% reading + % range		**(ppm of reading + ppm of range) /°C**
0.1+0.08	(0.1+0.05*kHz)+0.08	120+150

Note:
1. The temperature coefficient accuracy is used for the situation when the ambient is beyond the accuracy-permitted temperature. This accuracy should be added into the voltage accuracy written above.
2. The permitted frequency of voltage harmonics is up to 6 kHz.

Current / Harmonics Specifications		
DC, 10Hz-1kHz	**1kHz-10kHz**	**Temperature Coefficient**
% reading + % range		**(ppm of reading + % of range) /°C**
0.1+0.1	(0.1+0.05*kHz)+0.1	120+0.05

Note:
1. When measuring current, the voltage of 1/10 larger than the voltage range has to be inputted for frequency generation, voltage calculation and current measurement.
2. The temperature coefficient accuracy is used for the situation when the ambient is beyond the accuracy-permitted temperature. This accuracy should be added into the voltage accuracy and the current accuracy written above.
3. The power meter should be in a thermally stable environment with power turned-on for at least 30 minutes before performing auto-calibration (Cali).
4. The permitted frequency of current harmonics is up to 6 kHz.

Specifications of the External Current Sensor input		
DC, 10Hz-1kHz	**1kHz-10kHz**	**Temperature Coefficient**
% reading + % range		**(ppm of reading + % of range) /°C**
0.1+0.1	(0.1+0.05*kHz)+0.1	120+0.05

Note: Add DC values 50uV to accuracies for the external current sensor range.

Active Power Specifications			
DC	**47Hz-63Hz**	**10Hz-1kHz**	**1kHz-10kHz**
% reading+% range			
0.1+0.1	0.1+0.1	0.1+0.18	(0.1+0.1*kHz)+0.18

Note:
1. The temperature coefficient is same as the temperature coefficient for voltage and current.
2. Influence of power factor: Add the power reading × (0.0015/PF*Hz)% when 0<PF<1

Power Factor Specifications	
Range	Range : 0.0000-1.0000
Accuracy	0.001+(15ppm/PF)*Hz

Frequency Measurement	
Range	10Hz～10kHz
Accuracy	±(0.06% of reading value)
Frequency Source	voltage source

Effective Input Range	
Voltage	10% – 100% for range
Current	10% – 100% for range

Note: The effective input range is 1% -100% for range under the pure DC input signal test.

2.2 Common Specification

Display Resolution	5 Digits
Display Update Rate	0.25sec/0.5sec/1sec/2sec
Power Supply	90V-264V, 50Hz/60Hz, 65 VA
Interface	USB or GPIB
Operating Temperature	0°C - 40°C
Storage Temperature	-40°C - 85°C
Safety & EMC	CE (include EMC & LVD)
Dimension (W×H×D)	210 x 132 x 419 mm / 8.27 x 5.20 x 16.50 inch (excluding projections)
Weight	8.5 kg / 18.72 lbs (Model 66204) 7.8 kg / 17.18 lbs (Model 66203)

3. Panel Description

3.1 Front Panel

The front panel of 66203/66204 Digital Power Meter is as Figure 3-1 shows and the functions numbered from 1 to 10 are described below.

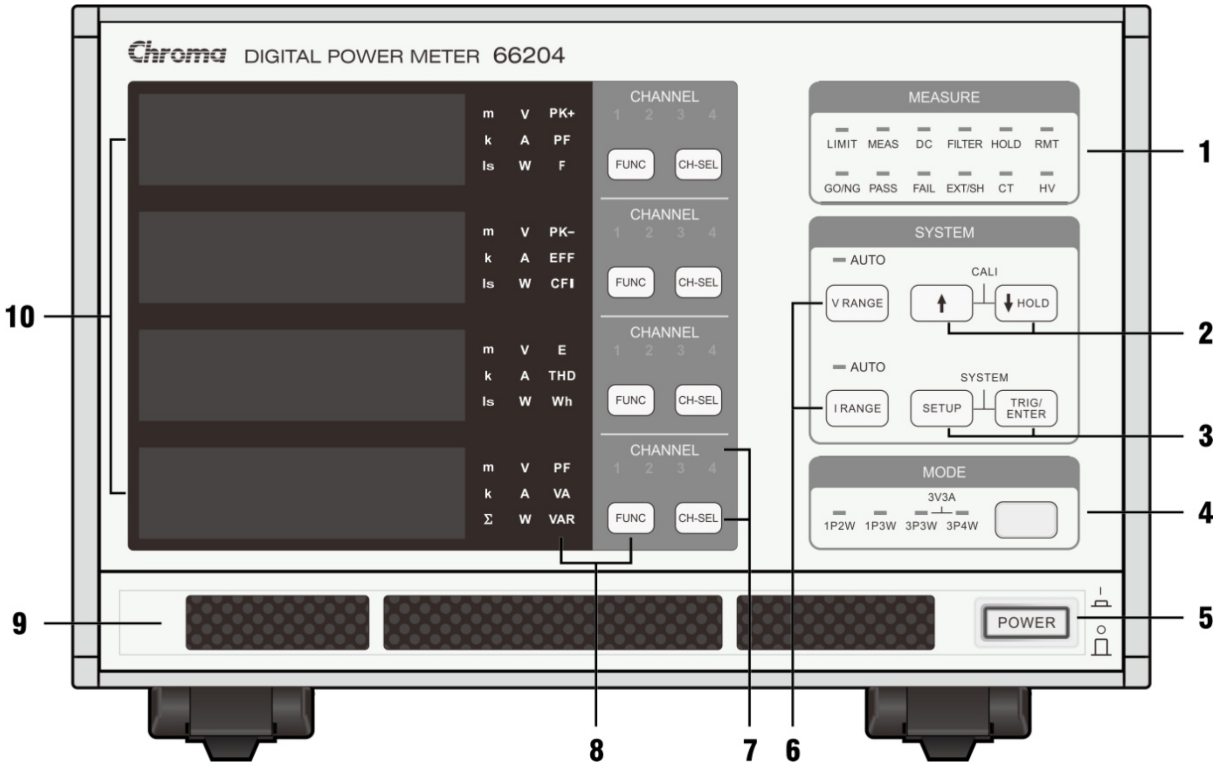


Figure 3-1 Front Panel of 66204 Digital Power Meter

1.	**Function menu setup & operation indicator** :	Use the **SETUP** key to select the Limit, Meas and DC function menus. After the function is set via the menu, the indicators FILTER, HOLD, RMT, GO/NG, PASS, FAIL, EXTSH, CT and HV will be on indicating the function is under operation.
2.	**↑↓ cursor, HOLD & CALI keys** :	The Up and Down keys can select the function and increase or decrease the setting range or value. Press down the HOLD key, the HOLD indicator will be on and the function is enabled. Press the Up and Down keys simultaneously can enter into the CALI menu to do zero calibration for current measurement.

3. **SETUP, TRIG/ENTER & SYSTEM** : The **SETUP** key is able to select the function menu and set the functions in it.
The **TRIG/ENTER** key is to confirm the selection of function and measurement range, also to trigger the Energy, Is and limit for GO/NG.
Press **SETUP** and **TRIG/ENTER** keys simultaneously can enter into the SYSTEM menu to set the button sound, screen brightness, GPIB communication IP, storage and recall of setting files, as well as to view the version no. of firmware.
4. **Wiring mode setup** : It selects the correct wiring mode before performing the test. See the related chapters below for detail description.
5. **Power switch**
6. **Voltage/Current range selection & auto range indicator** : Press down the **V RANGE** and **I RANGE** keys to view the range in use at present. Use the Up/Down key to select the range. The AUTO range indicator is only on when the voltage or current range of all channels (channel 1~channel 4) are set to auto range.
7. **Measurement channel selection & channel indicator** : Press the channel key to select the measurement channel. The channel indicator will switch accordingly. The basic measurement function keys on the left can check the value. The channel selection key near the function menu in the display window has the Down ↓ key function that can decrease the value coarsely when conducting adjustment.
8. **Basic measurement parameter selection & measurement parameter indicator** : Use the **FUNC** key to select the measurement parameter value to be viewed. The indicator next to it will be on accordingly.
The **FUNC** key near the function menu in the display window has the Up ↑ key function that can increase the value coarsely when conducting adjustment.
9. **Cooling air intake** : The outside air is entered from this intake. The two fans on the right of the power meter deflate the air to help ventilation. Please keep the air intake clear.
10. **Display window** : They are Display 1, Display 2, Display 3 and Display 4 function menus from the top down to show the function menu, the measurement range and basic measurement parameters values.

3.2 Rear Panel

The rear panel of 66203/66204 Digital Power Meter is as Figure 3-2 shows and the functions numbered from 1 to 7 are described below.

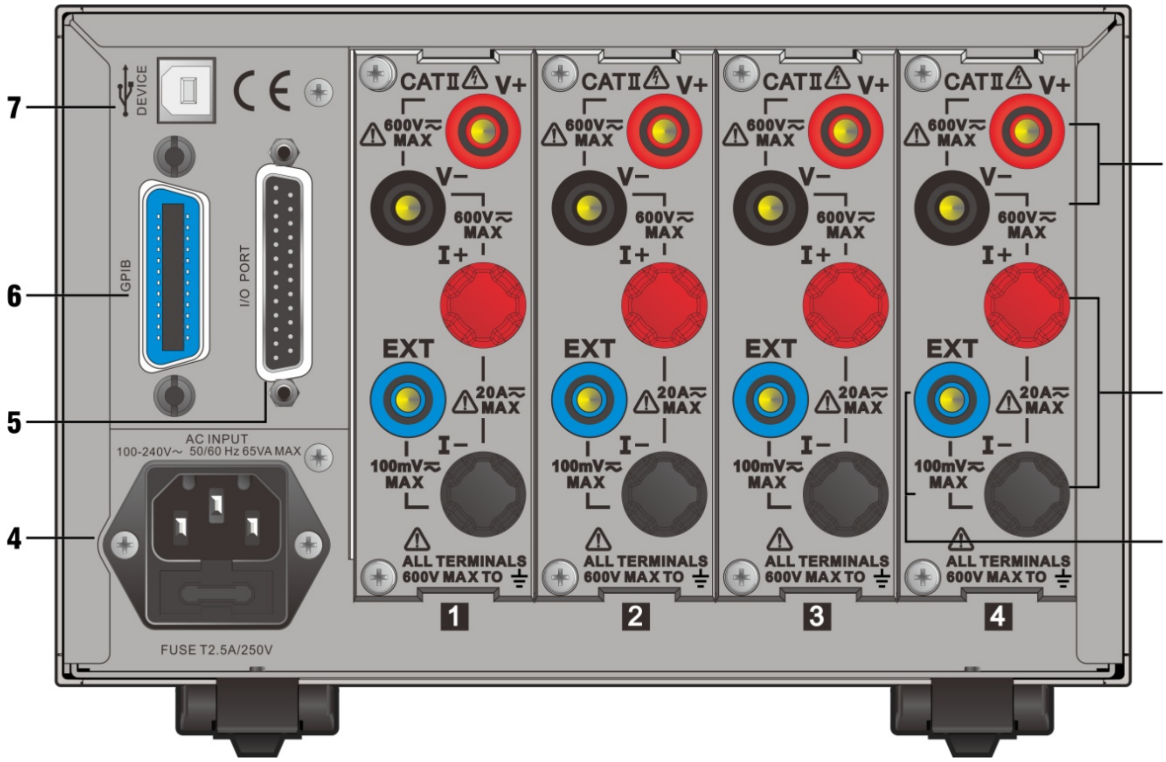


Figure 3-2 Rear Panel of 66204 Digital Power Meter

1. **Voltage measurement input terminal** : It is the DC/AC voltage signal input terminal. The maximum input voltage is 600Vrms.
2. **Current measurement input terminal** : It is the DC/AC current signal input terminal. The maximum input current is 20Arms.
   The affordable locking torque is ≤30kg-cm.
   Insert the 3.5mm diameter soldering bare lead to go through round hole and secure it. The plastic panel affordable weight for connection is ≤20kg.
3. **External sensing voltage signal input terminal** : It is the sensing voltage signal positive input and the negative is connected to I-. The maximum input voltage is 100mVrms.
4. **AC LINE socket** : It is the power connecting socket. Please follow the voltage range and frequency spec as labeled above the socket for power input.
5. **Control signal input/output terminal**
6. **GPIB Port**
7. **USB Port**

4. Operation

4.1 Preparation for Test

(1) Check the input range of power voltage on the rear panel and make sure the power switch is OFF before plugging in the power cord.
(2) Make sure the fuse used is applicable. See the section of 1.5 *Fuse* for the specification required.

⚠WARNING Be sure to remove the power cord first when replacing the fuse to avoid the hazard of electric shock.

4.2 System Setup

4.2.1 Checking the Firmware & Digital Version

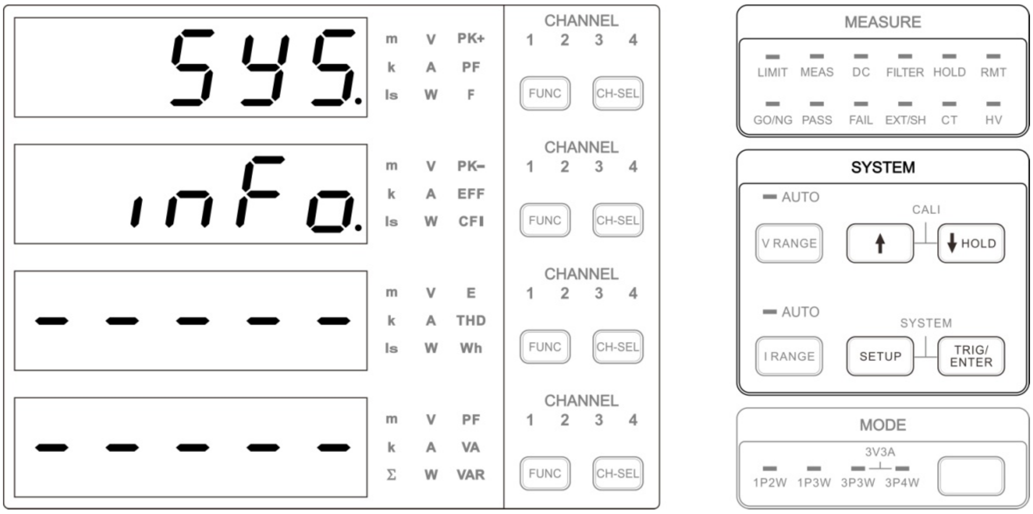


Figure 4-1 Menu for Checking Firmware & Digital Version

1. After the power-on self-test is done, press **SETUP** and **TRIG/ENTER** at the same time to enter into the system menu. Select Info. and the first screen shows the firmware and digital version no. of Main Frame. Press **TRIG/ENTER** continuously can check the firmware and digital version of channel 1～channel 4.
2. When the version is confirmed, press **SETUP** again to return to the system menu and perform the setting for other parameters or press **SETUP** again to return to the measurement screen.

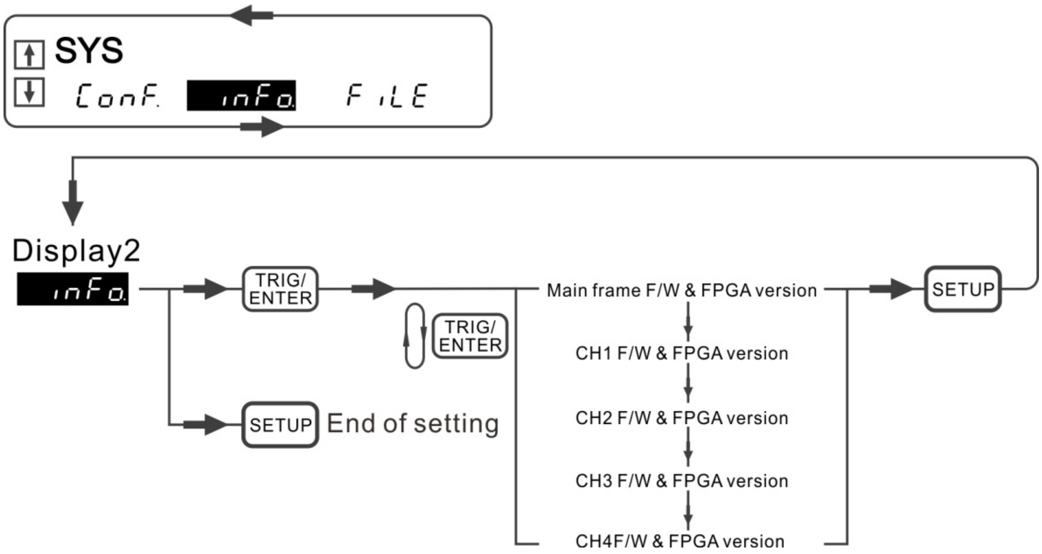


Figure 4-2　Process for Checking Firmware & Digital Version

4.2.2　Setting GPIB Address, Display Backlight & Sound

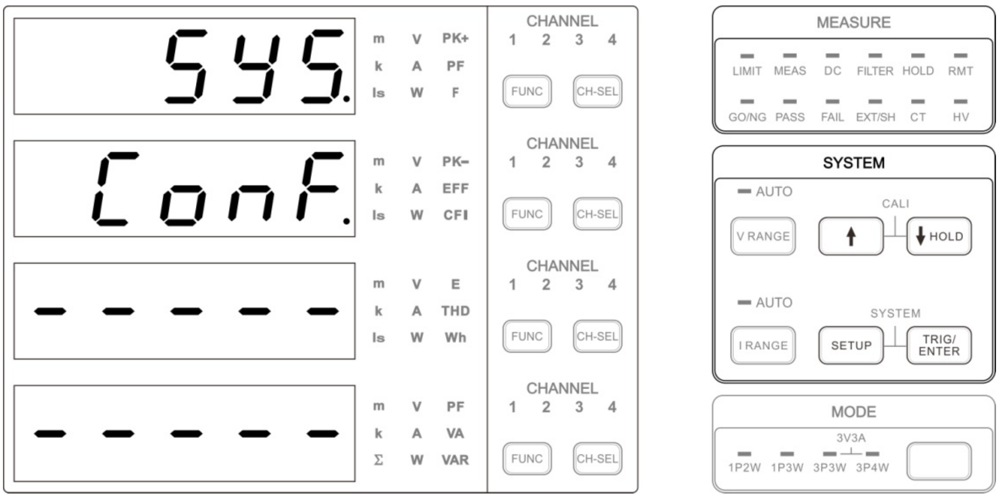


Figure 4-3　Menu for Setting Communication Address, Display Backlight & Sound

1. After the power-on self-test is done, press **SETUP** and **TRIG/ENTER** at the same time to enter into the system menu. Select Conf. and press **TRIG/ENTER** to confirm it.
2. Select Addr. in Conf. menu and use ↑, ↓ key to set the GPIB address. Press **TRIG/ENTER** to confirm it and then return to Conf. menu for other parameter settings.
3. Select Brigh. In Conf. menu and use ↑, ↓ key to set the display backlight to high, middle, or low. Press **TRIG/ENTER** to confirm it and then return to Conf. menu for other parameter settings.
4. Select Sound in Conf. menu and use ↑, ↓ key to set the sound to ON or OFF. Press **TRIG/ENTER** to confirm it.
5. Press **SETUP** to return to the system menu for other settings or press **SETUP** again to return to the measurement screen.

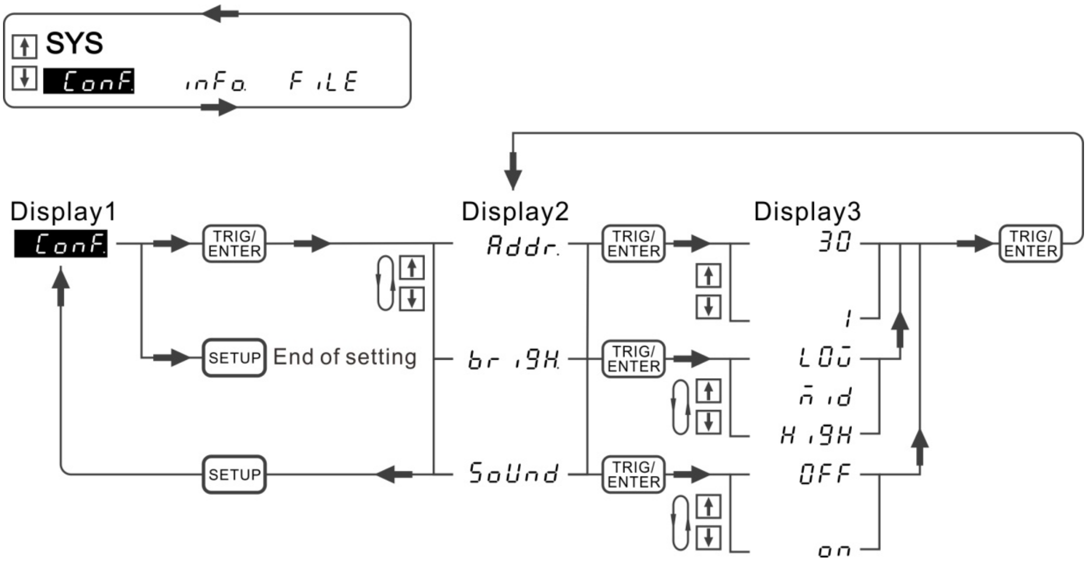


Figure 4-4 Process for Setting Communication Address, Display Backlight & Sound

4.2.3 Storing & Recalling Setting File

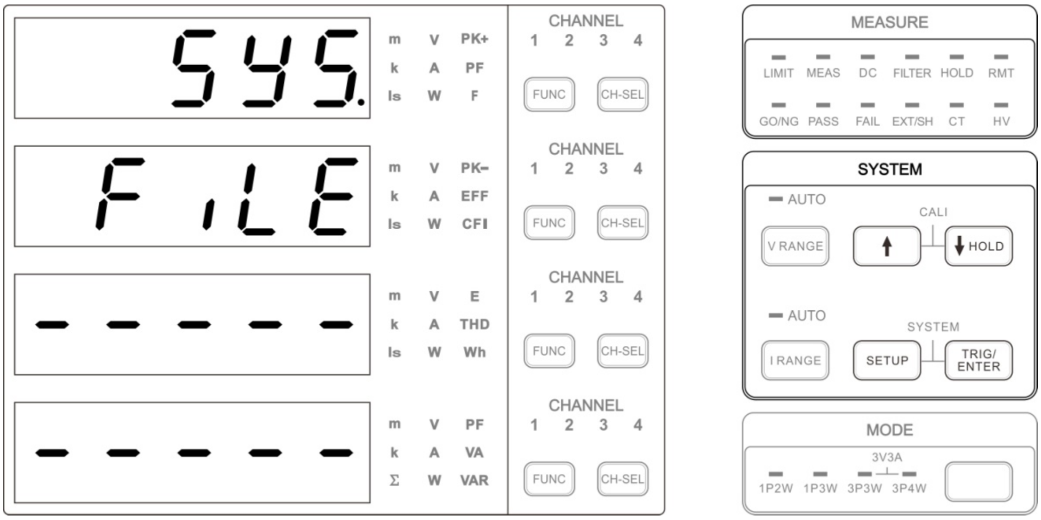


Figure 4-5 Menu for Storing & Recalling Setting File

Since the measurement function and parameter setting on the multi-channel power meter is much more complicate than the single channel power meter, the 66203/66204 Digital Power Meter provides 10 groups of settings for storing and recalling to facilitate the usage.

1. After the power-on self-test is done, press **SETUP** and **TRIG/ENTER** at the same time to enter into the system menu. Select File and press **TRIG/ENTER** to confirm it.
2. Use ↑, ↓ key to select store or recall and press **TRIG/ENTER** to confirm it.
3. For instance, it can select D_FEF to return to the factory default under recall and press **SETUP** to return to the measurement screen.

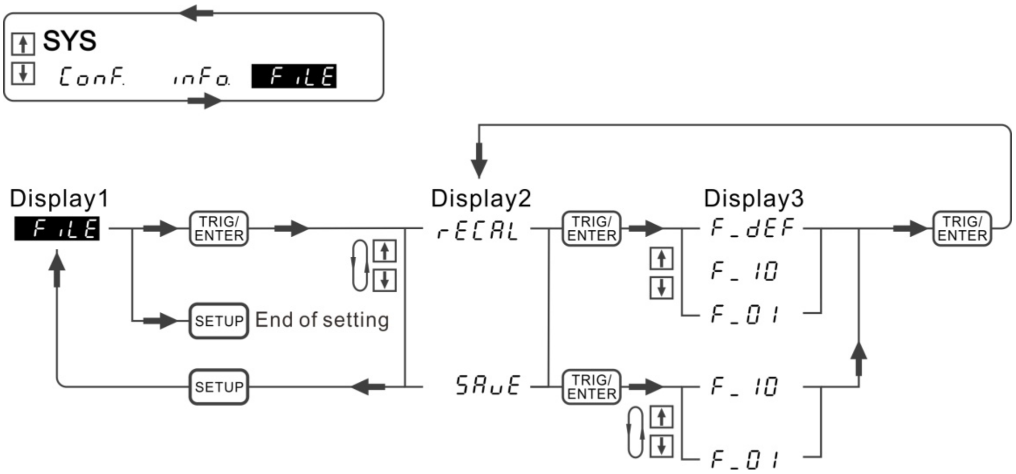


Figure 4-6 Process for Saving & Recalling Setting File

4.3 Connecting Test Device

4.3.1 Standard Connection

The connection of every channel on the single phase or multi-phase (3-phase) of power meter can select the following two ways. The measurement theory is shown in Figure 4-7 as the diagram (a) and (b) shows.

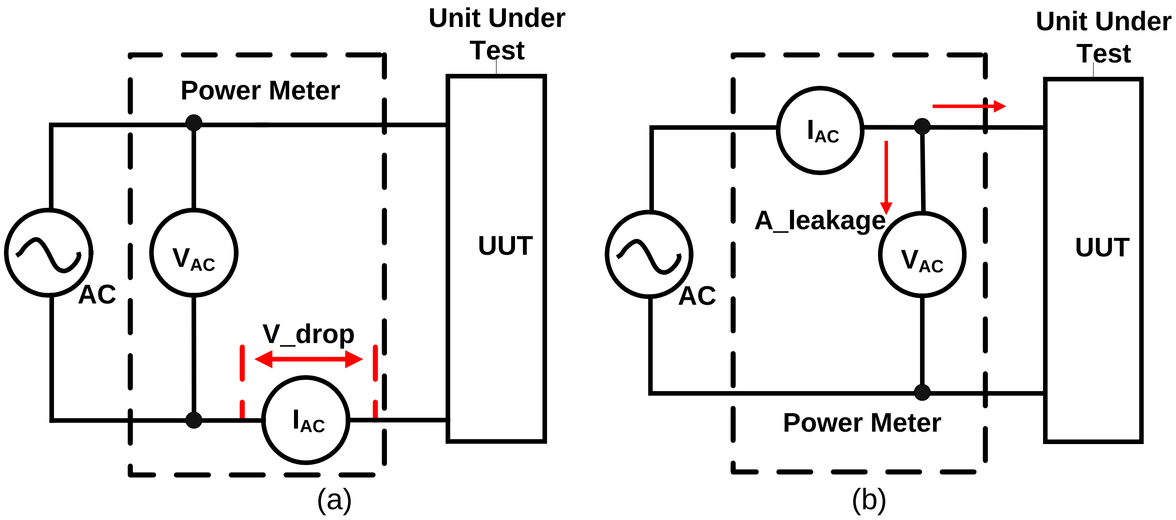


Figure 4-7 Measurement Theory for Power Meter Connection

The connection of Figure 4-7 (a) is more accurate for current measurement; however, there is a slight error caused by the measured voltage value plus the voltage drop on the current meter. It is applicable for middle or small power UUT.

The connection of Figure 4-7 (b) is more accurate for voltage measurement; however, the measured current will add the leakage current on the voltage meter. It is applicable for middle or larger power UUT.

4.3.2 Efficiency Test for Converter

When using the 66204 Digital Power Meter to test the converter's efficiency, the converter will convert the single phase power to 3-phase power output. Following is the installation and setup procedure.

Wiring

1. To determine the wiring mode for 66204 and the 3-phase power system of converter secondary side, it can be 3P3W (two wattmeter method), 3V3A (three wattmeter method) or 3P4W (three wattmeter method). If 3P3W wiring mode is selected, it can decide the wiring distribution of each channel (wattmeter) on the 66204 Digital Power Meter for efficiency test as the figure shown below. See the detail description in section 4.6.2 for the application of efficiency test and section 4.7 for wiring mode.

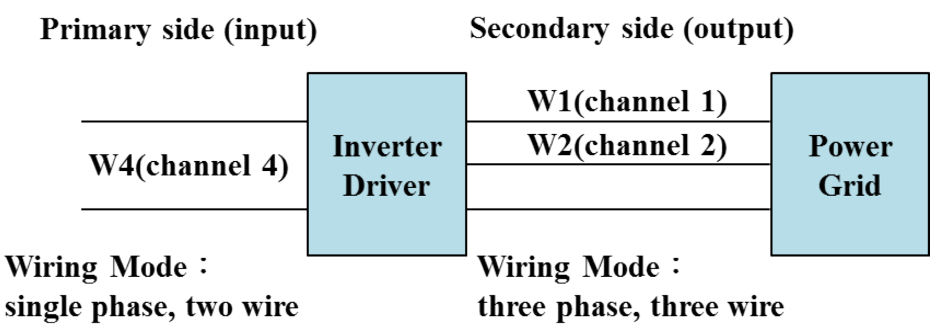


Figure 4-8 Power Meter Configuration for Testing Converter's Efficiency

$$Efficiency = \frac{output\ \ power}{input\ \ power} \times 100\% = \frac{W_1 + W_2}{W_4} \times 100\%$$

2. Wiring for testing 66204:

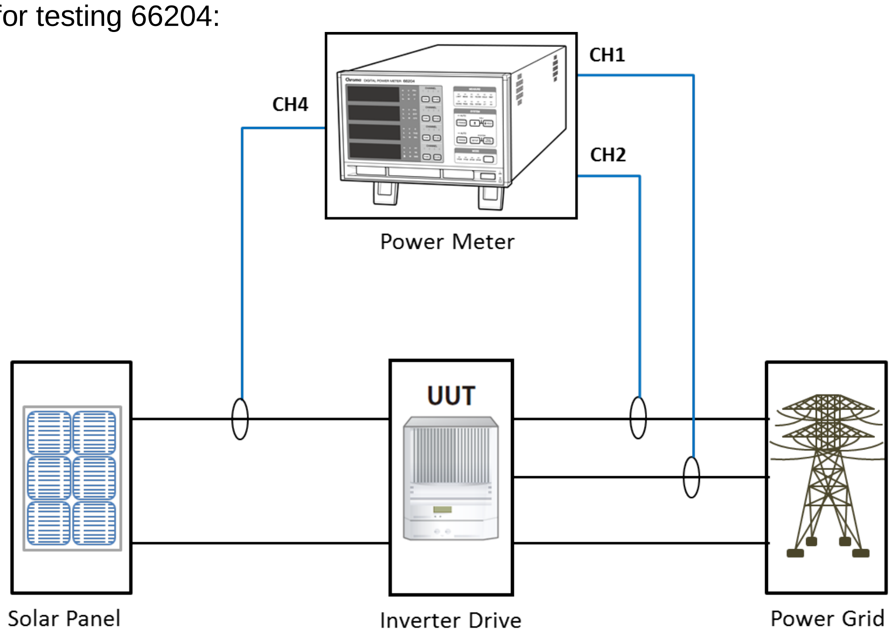


Figure 4-9 Wiring Diagram of 66203/66204 & Converter for Efficiency Test

a. Wiring for converter primary side (input side)

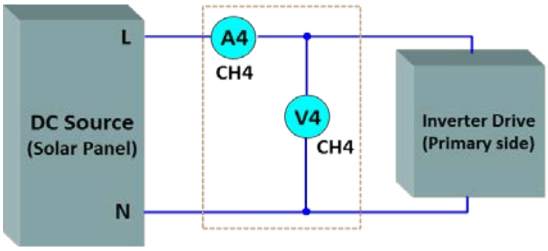


Figure 4-10 Input Wiring of 66203/66204 & Converter for Efficiency Test

b. Wiring for converter secondary side (output side)

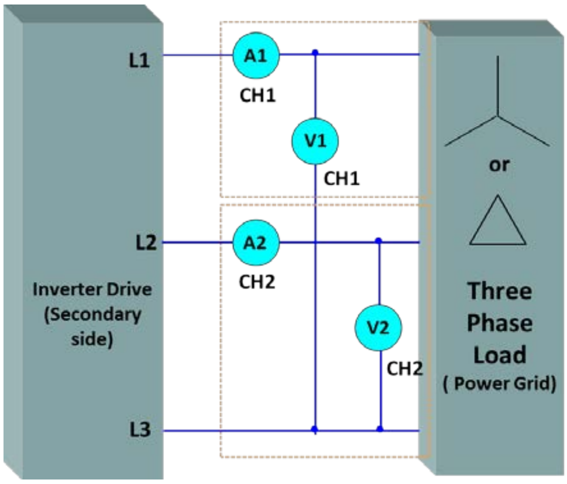


Figure 4-11 Output Wiring of 66203/66204 & Converter for Efficiency Test

⚠WARNING Be sure the connecting cable of voltage and current are in correct position as it may cause the internal circuit to burnout if connected mistakenly.

3. Make sure the power switch of the 66204 is OFF. Plug in the power cord to the 66204 AC INPUT socket with the other end to the power socket. Press down the power switch to turn on the 66204, the display will show the power-on message accordingly and then go to the measurement screen.

4. Use **V RANGE** key to select an appropriate voltage range for each channel to conduct testing.

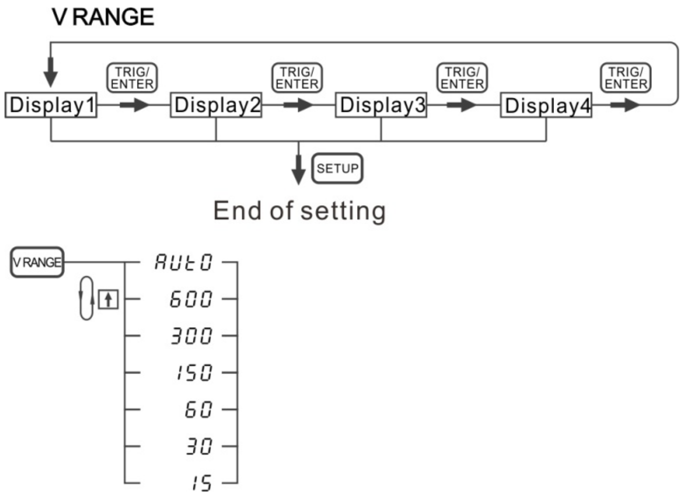


Figure 4-12 Process for Setting Voltage Range

5. Use **I RANGE** key to select an appropriate current range for each channel to conduct testing.

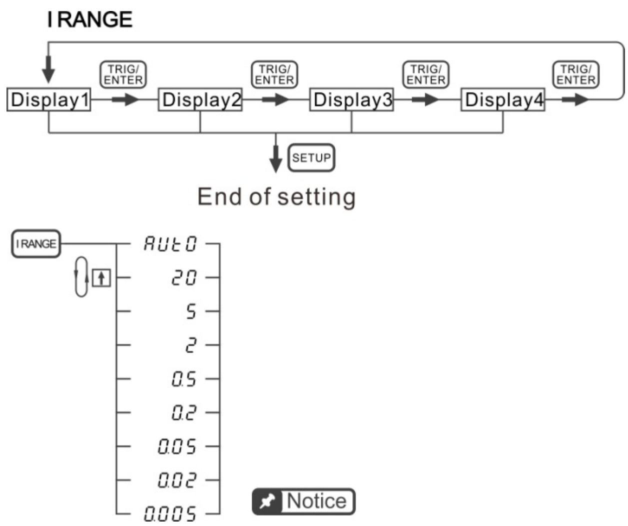


Figure 4-13 Process for Setting Current Range

6. Turn on the converter after all wirings are confirmed correct, secured and safe.

7. Set the wiring mode of the 66204 to 3P3W.

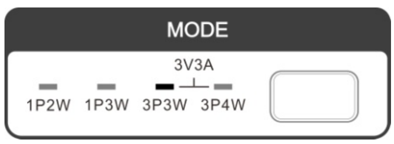


Figure 4-14 Wiring Mode Selection

Measurement Display

1. To display the measurement of converter primary side (input side): Press the **FUNC** key of display 1~display 4 to set the indicator of basic measurement parameter to V, A, W, PF respectively, and then press the **CH-SEL** of display 1~display 4 to set all channels to 4.

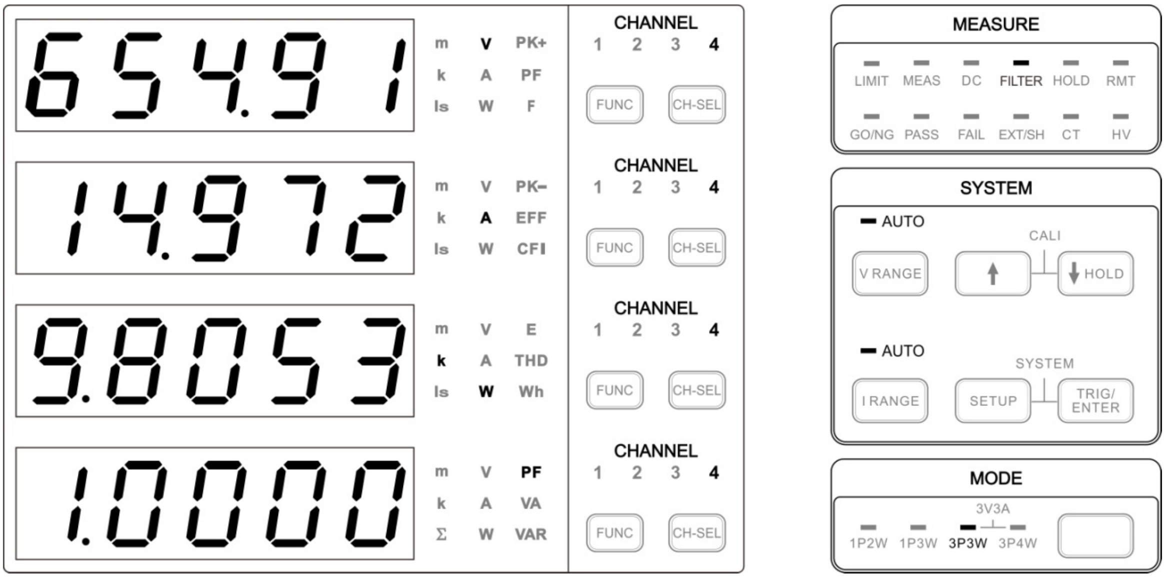


Figure 4-15 Test Value of Converter Input Side

2. To display the measurement of converter secondary side (output side): Press the **FUNC** key of display 1~display 4 to set the indicator measurement parameter to V, A, W, PF respectively, and then press the **CH-SEL** of display 1~display 4 to set the channel to 1 or 2 for respective check. To check the total output power of secondary side, press the **FUNC** key of display 4 to set indicator of measurement parameter to ΣW, ΣVA, ΣVAR and ΣPF.

3. To display the efficiency of converter: Go to the Meas menu, select EFF function, and set the a/b calculation efficiency. Exit the menu and press the **FUNC** key of display 2 to select the indicator of measurement parameter to EFF.

   To check the input power, output power and efficiency simultaneously, it can select the indicator of measurement parameter to W, ΣW, EFF for Display 1, Display 4, Display 2 respectively and set the display 1 channel to 4.

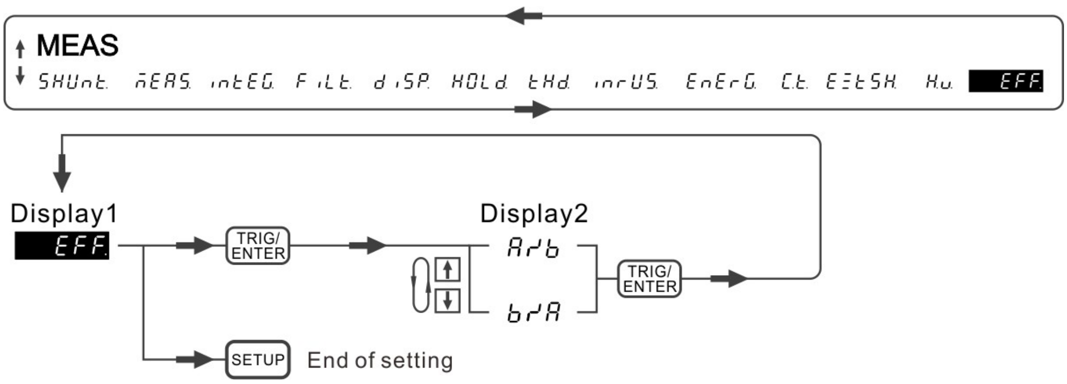


Figure 4-16 Process for Efficiency Calculation

4.4 Computing Equation for Measurement Parameters

Following explains the computing equation for the measurement parameters of true rms value, mean value, maximum value, crest factor, integration and frequency.

The 66203/66204 Digital Power Meter will sample the input voltage and current waveform simultaneously. The calculation of rms values includes both AC and DC portions while the AC waveform could be distorted, thus the rms value is true rms value. The calculation of delivered power and received power also includes the AC and DC portions of voltage and current waveform, thus the value of active power (W) is true power value and the positive/negative sign indicates the power direction.

Power Factor is universally defined as the ratio of average power (watts) to apparent power (volt-amps). IEEE 1459-2010 uses this correct definition. Although Power Factor should be between 0~1 upon its physical meaning which is the utilization rate of power, considering the mathematical definition it is between -1~+1. Apparent power is the product of r.m.s. volts and r.m.s. amps which ensures a positive value. Therefore, when power is negative, Power Factor is, by definition, negative. When power is positive, Power Factor is, by definition, positive. Finally the negative Power Factor simply means that power is negative. The power factor calculation of the 66203/66204 Digital Power Meter contains the portion of fundamental wave and all harmonic distortion. It also takes the fundamental power factor caused by the phase difference between voltage and current fundament wave as well as the calculation of distorted power factor caused by harmonic portion into consideration. Thus, it is the true power factor. Moreover the fundamental power factor (can be also called displacement power factor) and the all harmonic power factor which can be obtained by harmonic measurement function.

Besides the measurement of true r.m.s. value, mean value also can be measured by averaging all the sample data of an integer period of measured waveform in DC measurement function. The power of DC portion of measured waveform is the product of mean value of voltage and mean value of current.

The measurement of maximum voltage and current is to get the maximum of positive and negative half waves from the waveform period. The crest factor (CFi) is calculated from the peak amplitude of the current waveform divided by the rms value of the current waveform. The crest factor of sine wave is 1.414. For distorted or rectified waveform, the CFi is usually larger than 1.414.

The 66203/66204 Digital Power Meter follows the definition of IEC to total harmonic calculation to compute the ratio of the sum of the squares of the rms value at all higher harmonic frequency waveforms to the square of the rms at the fundamental waveform. The power meter gets the voltage and current sampling data through the analog/digital converter, and sends the sampling data back to DSP for Fourier conversion to get the valid value of fundamental wave and harmonic of each level for THD. For the detail of THD measurement, please see section 4.6.2.

The integration is to calculate the average energy and power for a period of time. The time can be defined by the user. The average energy measurement is often applied to evaluate and monitor the usage of house appliance in a long period of time. The average power measurement is applied to the UUT running under a period of time or certain mode to measure the input or output average power repeatedly for efficiency evaluation. The function of average energy and average power measurements can work in parallel as both of them can be operated separately.

The frequency measurement detects the input voltage signal frequency. It is a computed average value after captured the input voltage signal within a time interval. The measured voltage frequency can also be the base of current measurement time.

When measuring the AC voltage frequency, the input signal voltage amplitude should be 10% or above over the range as the hysteresis comparator circuit will detect the input voltage's zero-crossing. The filter design before the hysteresis comparator circuit can help filtering out the noise on the input signal. However, if the noise peak is too big that cannot be processed by the filter, it could cause frequency measurement error or affect the AC measurement accuracy.

Single Phase Measurement Parameter

Measurement Parameter	Computing Equation
True rms value	
V_{rms}	$\sqrt{\frac{1}{T}\int_0^T v^2(t)dt}$
I_{rms}	$\sqrt{\frac{1}{T}\int_0^T i^2(t)dt}$
W	$\frac{1}{T}\int_0^T v(t)\, i(t)\, dt$
VAR	$\sqrt{VA^2 - W^2}$
VA	$V_{rms} \times I_{rms}$
PF	$\frac{W}{VA}$
Mean value	
V_{dc}	$\frac{1}{T}\int_0^T v(t)dt$
I_{dc}	$\frac{1}{T}\int_0^T i(t)dt$
W_{dc}	$V_{dc} \times I_{dc}$
Peak value	
V_{PK+}	The maximum sampling value of the positive half wave of $v(t)$ during two continuous cycles.
V_{PK-}	Absolute value of the maximum sampling value of the negative half wave of $v(t)$ during two continuous cycles.
I_{PK+}	The maximum sampling value of the positive half wave of $i(t)$ during two continuous cycles.
I_{PK-}	Absolute value of the maximum value of the negative half wave of $i(t)$ during two continuous cycles.

Crest Factor	
CFi	$\frac{\max imum\ of\ (I_{pk+}, I_{pk-})}{I_{rms}}$
Integration	
Energy (Wh or Joule)	$\frac{1}{T}\int_0^T v(t)\,i(t)\,dt$ T is a setting integration time by user.
Integration(W)	$\int_0^T v(t)\,i(t)\,dt$ T is a setting integration time by user.
Frequency	
F	Zero crossing detection

Notice When the input signal is zero, the PF has no significance.

Harmonic Measurement Parameter

The harmonic mode specifies the measurement window in number of cycles of the fundamental frequency. The window type is rectangular and the FFT data length is 4096. The sampling rate is synchronized to the fundamental frequency of voltage source.

The measurement signal values obtained in harmonic mode are only available by communication command. The harmonic mode functions as shown below.

Measurement Functions during Harmonic Measurement	Method of Determination, Equation			
	dc (when k=0)	1 (when k=1)	k (when k=2 to max)	Total
Voltage V()[V]	V(dc)=Vr(0)	$V(k)=\sqrt{V_r(k)^2+V_j(k)^2}$		$V=\sqrt{\sum_{k=1}^{\max} V(k)^2}$
Current I()[A]	I(dc)=Ir(0)	$I(k)=\sqrt{I_r(k)^2+I_j(k)^2}$		$I=\sqrt{\sum_{k=1}^{\max} I(k)^2}$
Active power P()[W] or W()[W]	P(dc)= Vr(0) • Ir(0)	$P(k)=V_r(k)\bullet I_r(k)+V_j(k)\bullet I_j(k)$ or $P(k)=V(k)\bullet I(k)\bullet\cos\varphi(k)$		$P=\sum_{k=1}^{\max} P(k)$
Apparent power S()[VA] or VA()[VA]	S(dc)=P(dc)	$S(k)=\sqrt{P(k)^2+Q(k)^2}$		$S=\sqrt{P^2+Q^2}$
Reactive power Q()[var] or VAR()[var]	Q(dc)=0	$Q(k)=V_r(k)\bullet I_j(k)-V_j(k)\bullet I_r(k)$		$Q=\sum_{k=1}^{\max} Q(k)$
Power factor	$\frac{P(dc)}{S(dc)}$	$\frac{P(k)}{S(k)}$		$\frac{P}{S}$
Phase φ ()[°]	–	$\varphi(k)=\tan^{-1}\{\frac{Q(k)}{P(k)}\}$		$\varphi=\tan^{-1}\{\frac{Q}{P}\}$
Phase different with respect to V(1)	Vdeg(k) = Phase different of V(k) with respect to V(1)			

Vdeg()[˚]	
Phase different with respect to I(1) Ideg()[˚]	Ideg(k) = Phase different of I(k) with respect to I(1)

Measurement Functions during Harmonic Measurement	Method of Determination, Equation
Voltage harmonic distortion factor Vhdf()[%]	$\frac{V(k)}{V(1)} \cdot 100$
Current harmonic distortion factor Ihdf()[%]	$\frac{I(k)}{I(1)} \cdot 100$
Active power harmonic distortion factor Phdf()[%]	$\frac{P(k)}{P(1)} \cdot 100$
Total harmonic distortion of voltage Vthd[%] or THDV	$\frac{\sqrt{\sum_{k=2}^{\max} V(k)^2}}{V(1)} \cdot 100$ See 4.6.2 *Meas* for detailed settings.
Total harmonic distortion of current Ithd[%] or THDI	$\frac{\sqrt{\sum_{k=2}^{\max} I(k)^2}}{I(1)} \cdot 100$ See 4.6.2 *Meas* for detailed settings.
Total harmonic distortion of power Pthd[%]	$\left\lvert\frac{\sum_{k=2}^{\max} P(k)}{P(1)}\right\rvert \cdot 100$

Note
1. Parameter k, r and j indicate harmonic order, real part and imaginary part.
2. Parameter V(k), Vr(k), Vj(k), I(k), Ir(k) and Ij(k) are all RMS.

Σ Measurement Parameter

The Σ function contains the wiring systems of 1P3W, 3P3W, 3V3A and 3P4W. Besides, this function provides the three measurement types which are type1, type2 and type3 to meet the various definitions of 3-phase power measurement. Those definitions involve the calculation of arithmetic apparent power and vector apparent power of IEEE 1459-2010.

Computing equation of 3-phase active power, apparent power and reactive power					
Wiring system		Single-phase, three-wire 1P3W	Three-phase, three-wire (two wattmeter method) 3P3W	Three-phase, three-wire (three voltage, three current) 3P3W(3V3A)	Three-phase, four-wire (three wattmeter method) 3P4W
ΣP		$P_1 + P_2$			$P_1 + P_2 + P_3$
ΣS	TYPE1 (ΣS_A, Arithmetic Method)	$S_1 + S_2$	$\frac{\sqrt{3}}{2}(S_1 + S_2)$	$\frac{\sqrt{3}}{3}(S_1 + S_2 + S_3)$	$S_1 + S_2 + S_3$

	TYPE2 (ΣS_A, Arithmetic Method)				
	TYPE3 (ΣS_V, Vector Method)	$\sqrt{(\Sigma P)^2+(\Sigma Q)^2}$			
ΣQ	TYPE1	Q_1+Q_2			$Q_1+Q_2+Q_3$
	TYPE2	$\sqrt{(\Sigma S)^2-(\Sigma P)^2}$			
	TYPE3	Q_1+Q_2			$Q_1+Q_2+Q_3$
ΣPF	$\frac{\Sigma P}{\Sigma S}$ ΣPF_A :Power factor of TYPE1 and TYPE2 ΣPF_V :Power factor of TYPE1 and TYPE2				

Notice

1. For Q [var] computation, when the current leads the voltage, the Q value is displayed as a negative value; when the current lags the voltage, the Q value is displayed as a positive value.
2. The value of QΣ may be negative, because it is calculated from Q of each element including the sign.
3. When three-phase system is balance, $\Sigma PF_V = \Sigma PF_A$; when three-phase system is unbalance, $\Sigma PF_V > \Sigma PF_A$.
4. The sign (±) of the active power represents power flow direction.
5. When power is negative, power factor is negative; when power is positive, power actor is positive.
6. No matter what the 3-phase 3-wire system is balance, two wattmeter method can measure correct total active power (ΣP); however this method only be applied into the balance 3-phase system to measure apparent power (ΣS) and power factor (ΣPF).
7. To measure the total apparent power (ΣS) and power factor (ΣPF) more accurately on an unbalanced three-phase circuit, it is recommended that using 3V3A wiring mode to make the measurement on 3-phase, 3-wire system.
8. To measure the total apparent power (ΣS) and power factor (ΣPF) most accurately on an unbalanced 3-phase 4-wire system, 3-wattmeter method is recommended that is get every phase-power which is correct information.
9. The sign (±) of power represents phase angle information between voltage and current while firmware version <1.20; the sign (±) of power represents power flow direction while firmware version ≥1.20.

4.5 Setting Measurement Range

There are auto and manual two measurement ranges for selection. The auto range is a digital signal processor that selects the most appropriate range for measurement based on the signal peak without processed by the digital filter. The manual range is set by the user based on the actual test requirement and fixed to a certain range for testing.

When in auto range, the judgment condition for upper or lower range is different as the figure shown below. When a signal peak exceeds the Up_Range_Limit of a certain range, it means the signal needs to be measured in the higher range, and when the signal peak turns to small, a lower range is required for measurement and Down_Range_Limit is used for judgment. The gap between Up_Range_Limit and Down_Range_Limit is to measure the dynamic signal or to avoid changing the range constantly when the signal is unstable and cause low measurement speed or unable to measure effectively.

Compared with auto range the manual range is often used to reduce the range change time during measurement. The user has to know the signal peak in the test process specifically to select the proper range. Otherwise, the measurement will be incorrect if the signal peak is much smaller than the range. When the signal peak is higher than the range limit, the 6203/66204 will prompt an over range (OVR or OCR) message. The OVR or OCR message means the measured signal peak has been cut and could cause the measurement incorrect. The 66203/66204 will not provide the measurement at this time.

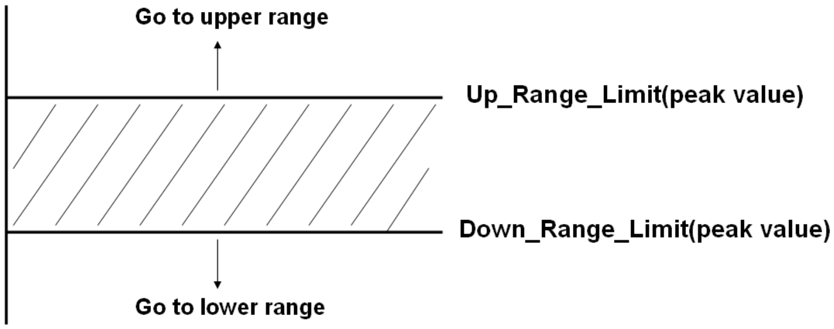


Figure 4-17 Range Selection Rule

Under the 66203/66204 allowed rated power, to keep the protection mechanism from being too sensitive, the OCR or OCP warning message will occur after confirmed the signal peak is over the protection limit for 0.5 seconds. Even if the sound of operation is disabled, the sound will not be turned off when the protection message is occurred.

No matter it is in AUTO range or Manual range, it would take some time to switch the range as there will be transient for measurement circuit to switch the range. The transient will cause the measurement data error and the DSP stops computing the data during range change. The DSP will compute again when the transient is over.

4.5.1 Setting Voltage Range

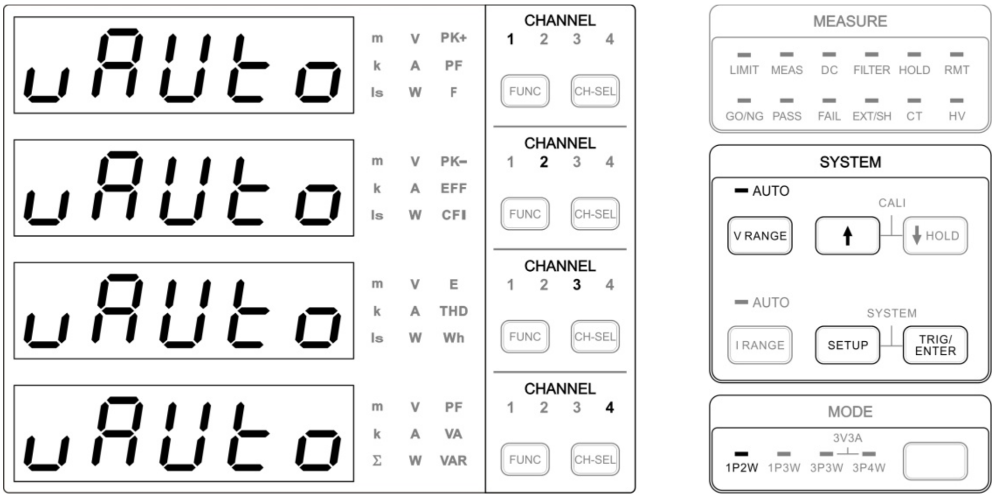


Figure 4-18 Voltage Range Setup Screen

The 66203/66204 Digital Power Meter has 6 ranges for voltage measurement, which are 600Vrms/300Vrms/150Vrms/60Vrms/ 30Vrms/15Vrms and the crest factor (CF) of each range is 2. Thus, the measureable range for voltage peak is ± (range×CF).

When using Manual range or Auto range in 600V, if the input voltage peak is twice over the range, the display will show Over Voltage Range (OVR) warning message and beep. When the signal peak is down to the measureable range or proper range is selected, the over voltage range warning message will disappear automatically.

Figure 4-19 Over Voltage Range Message

Following is the procedure to select the voltage range:

1. Press **V RANGE**, the 1st to 4th display windows will show the voltage range status at present respectively. The channel indicators will show channel 1~channel 4 respectively as well.
2. In the 1st display window, the range of channel 1 will blink. Use ↑, ↓ to select the voltage range. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 2 in the 2nd window will blink.
3. Use ↑, ↓ to select the voltage range in the 2nd display window. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 3 in the 3rd window will blink.
4. Use ↑, ↓ to select the voltage range in the 3rd display window. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 4 in the 4th window will blink.
5. Use ↑, ↓ to select the voltage range in the 4th display window. When done, press **TRIG/ENTER** to confirm it. Then, it returns to the 1st display window.
6. When the settings are done, press **SETUP** to exit the menu.
7. To skip to the desired channel for range setup, press **TRIG/ENTER** continuously to skip the channel setting or press the mapping **FUNC** key to select the display window for range setting.

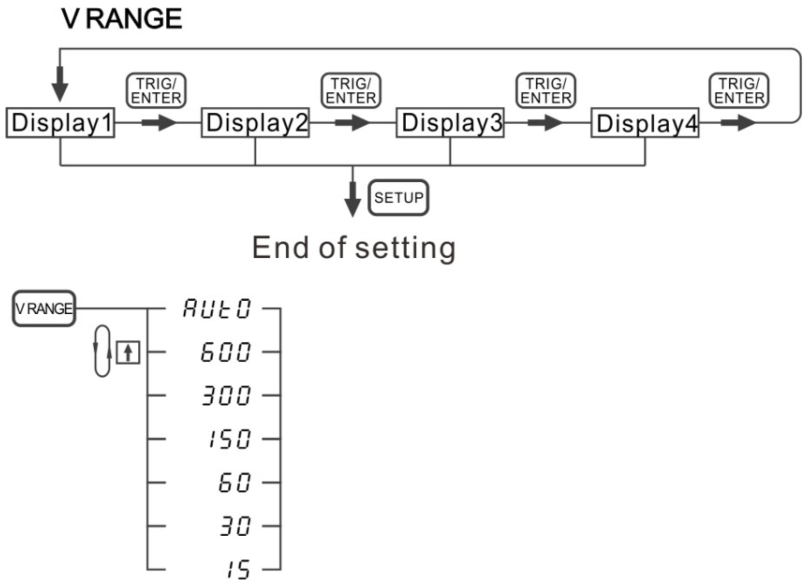


Figure 4-20 Process for Setting Voltage Range

Notice

1. If any of the channel's voltage range is set to Manual, the AUTO indicator will not be on. In other word, the AUTO indicator only turns on when all the voltage range of all channels are set to AUTO.
2. If an over range message appears when the range is set to Manual, press **V RANGE** to adjust the voltage range higher. Press once to increase a range.
3. Press **V RANGE** continuously can see the measurement range at present.

CAUTION

The maximum measureable voltage is 600Vrms. Though the measureable peak is 1200V, the maximum allowable input DC voltage is still 600Vdc. It could cause dangerous if the voltage input range is over.

4.5.2 Setting Current Range

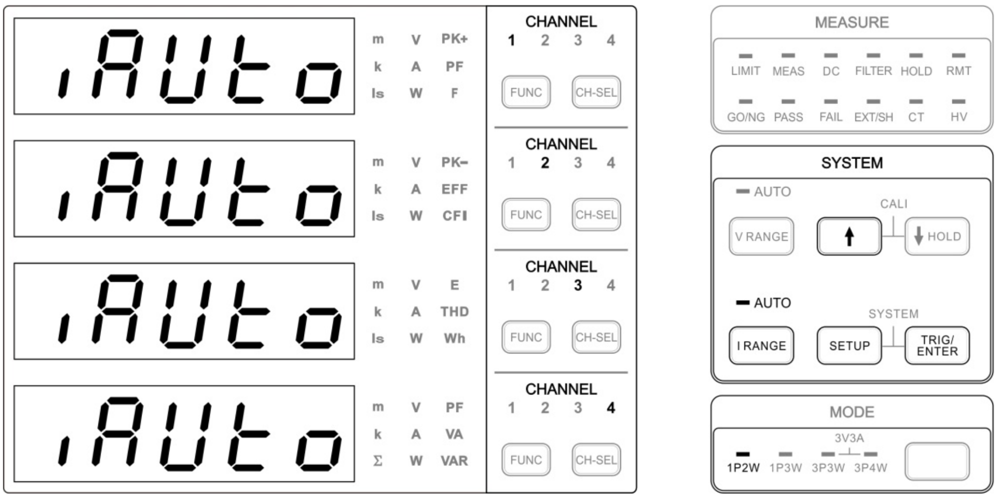


Figure 4-21 Current Range Setup Screen

The 66203/66204 Digital Power Meter has 8 ranges for current measurement, which are 20Arms/5Arms/2Arms/0.5Arms/0.2Arms/ 0.05Arms/0.02Arms/0.005Arms and the crest factor (CF) of each range is 4. Thus, the measureable range for current peak is ± (range×CF).

When using Manual range or Auto range in 20A (high shunt range) or 0.2A (Low shunt range), if the input current peak is four times over the range, the display will show Over Current Range (OCR) warning message and beep. When the signal peak is down to the measureable range or proper range is selected, the over current range warning message will disappear automatically.

Figure 4-22   Over Current Range Message

When the shunt range is in auto or high, the Over Current Protection (OCP) warning message will appear and beep if the input current exceeds 23Arms no matter the current range is set to Manual or AUTO. Similarly, when the shunt range is low and the input current is over 0.92Arms, the display will show the over current protection warning message. Over current protection is to short circuit the input terminal internally to protect the measurement circuit. To restore to normal measurement function, it needs to troubleshoot the cause for over current protection and press **TRIG/ENTER** to clear the error message.

Figure 4-23   Over Current Protection Message

Following is the procedure to select the current range:

1. Press **I RANGE**, the 1st to 4th display windows will show the current range status at present respectively. The channel indicators will show channel 1~channel 4 respectively as well.
2. In the 1st display window, the range of channel 1 will blink. Use ↑, ↓ to select the current range. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 2 in the 2nd window will blink.
3. Use ↑, ↓ to select the current range in the 2nd display window. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 3 in the 3rd window will blink.
4. Use ↑, ↓ to select the current range in the 3rd display window. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 4 in the 4th window will blink.
5. Use ↑, ↓ to select the current range in the 4th display window. When done, press **TRIG/ENTER** to confirm it. Then, it returns to the 1st display window.
6. When the settings are done, press **SETUP** to exit the menu.
7. To skip to the desired channel for range setup, press **TRIG/ENTER** continuously to skip the channel setting or press the mapping **FUNC** key to select the display window for range setting.

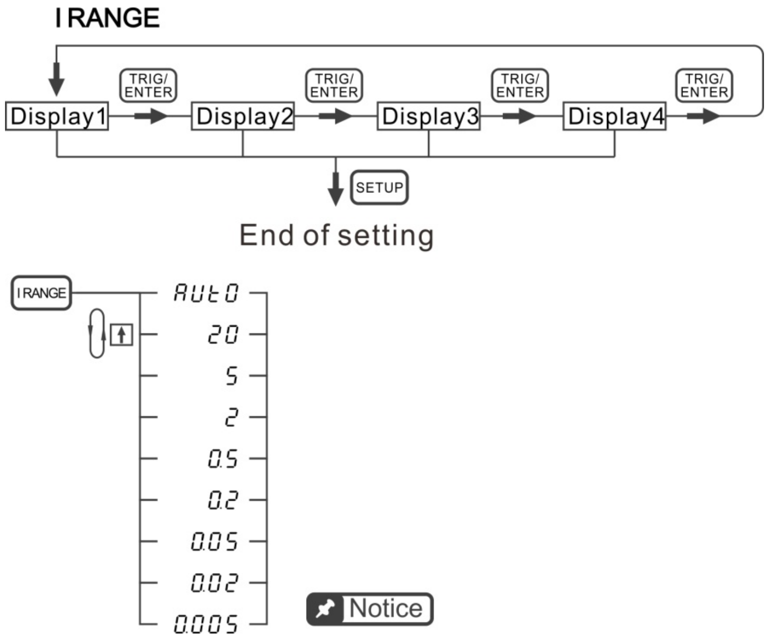


Figure 4-24 Process for Setting Current Range

Notice

1. If Shunt is set to Low, the current has only 4 ranges for selection which are 0.2Arms/0.05Arms/0.02Arms/0.005Arms. If Shunt is set High, it also has 4 ranges for selection which are 20Arms/5Arms/ 2Arms/0.5Arms.
2. The 8 current ranges are Auto when both of the Shunt and current ranges are set to Auto.
3. No matter the shunt is set to AUTO, High, or Low, the AUTO indicators will on if all channel's current ranges are set to AUTO. On the contrary, if any of the channel's current range is set to Manual, the AUTO indicator will be off.
4. If an over range message appears when the range is set to Manual, press **I RANGE** to adjust the current range higher. Press once to increase a range.
5. Press **I RANGE** continuously can see the measurement range at present.

CAUTION

1. The maximum measureable current is 20Arms. Though the measureable peak is 80A, the maximum allowable input DC current is still 20Adc. It could cause dangerous if the current input range is over.
2. If over current protection is occurred, even if the current peak is down to within the range, the protection mechanism will not be removed automatically. The purpose is to let the user to find the reason for protection.

4.5.3 Setting External Range

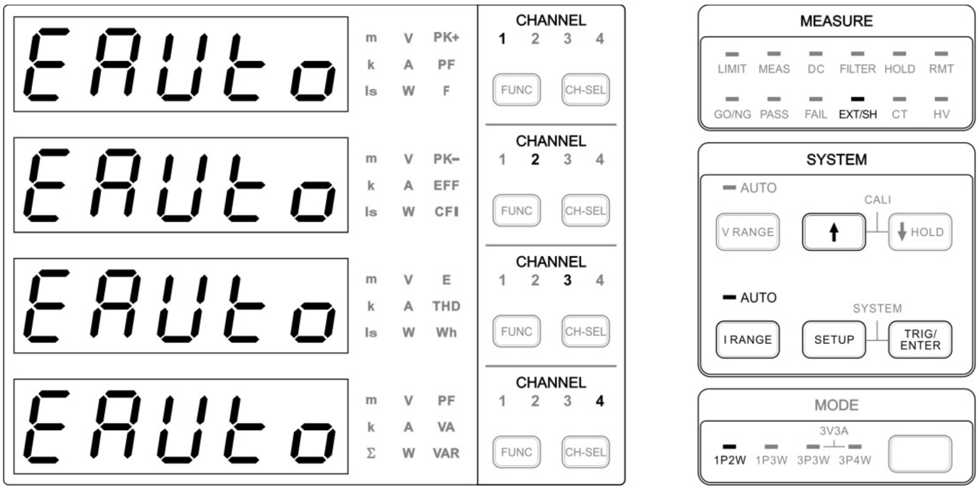


Figure 4-25 External Range Setup Screen

The 66203/66204 Digital Power Meter has 4 ranges for external measurement, which are 100mVrms/50mVrms/25mVrms/10mVrms and the crest factor (CF) of each range is 4. Thus, the measureable range for current peak is range×CF.

If the input voltage peak is four times over the range, the display will show Over Current Range (OCR) warning message and beep. When the signal peak is down to the measureable range or proper range is selected, the over current range warning message will disappear automatically.

Figure 4-26 Over Current Range Message

Following is the procedure to select the current range:

1. Press **I RANGE**, the 1st to 4th display windows will show the external range status at present respectively. The channel indicators will show channel 1~channel 4 respectively as well.
2. In the 1st display window, the range of channel 1 will blink. Use ↑, ↓ to select the external range. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 2 in the 2nd window will blink.
3. Use ↑, ↓ to select the external range in the 2nd display window. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 3 in the 3rd window will blink.
4. Use ↑, ↓ to select the external range in the 3rd display window. When done, press **TRIG/ENTER** to confirm it. Then, the range of channel 4 in the 4th window will blink.
5. Use ↑, ↓ to select the external range in the 4th display window. When done, press **TRIG/ENTER** to confirm it. Then, it returns to the 1st display window.
6. When the settings are done, press **SETUP** to exit the menu.
7. To skip to the desired channel for range setup, press **TRIG/ENTER** continuously to skip the channel setting or press the mapping **FUNC** key to select the display window for range setting.

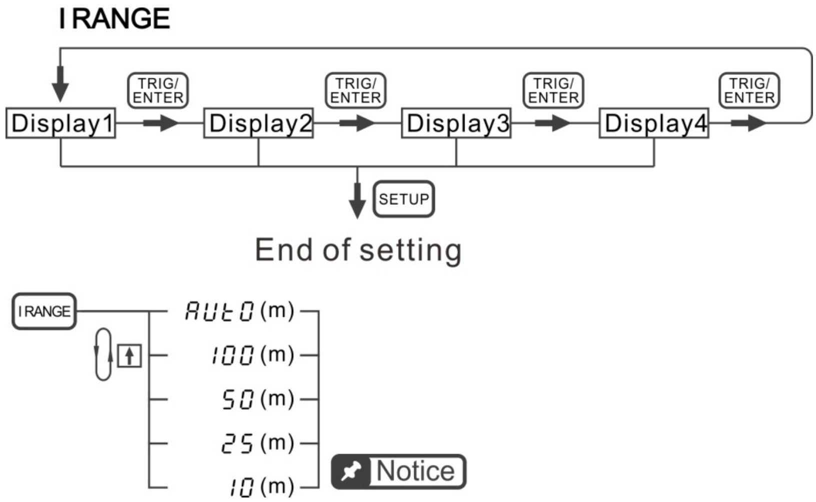


Figure 4-27 Process for Setting Current Range External

Notice

1. If any of the channel's external range is set to Manual, the AUTO indicator will not be on. In other words, the AUTO indicator is on only when the external range of all channels is set to AUTO.
2. The external terminal receives the sensed voltage signal from the external sensor; however, it measures the current signal actually. Therefore, the warning message is displayed in over current range or over current protection.
3. If an over range message appears when the range is set to Manual, press **I RANGE** to adjust the external range higher. Press once to increase a range.
4. Press **I RANGE** continuously can see the measurement range at present.

CAUTION

The External terminal only receives voltage signal input. The maximum allowable signal is 100mV. If the signal peak exceeds the rated input, it could cause hazard and damage the device.

4.6 Setting Measurement Functions

Limit, Meas and DC are three major measurement functions. The details are explained below.

4.6.1 Limit

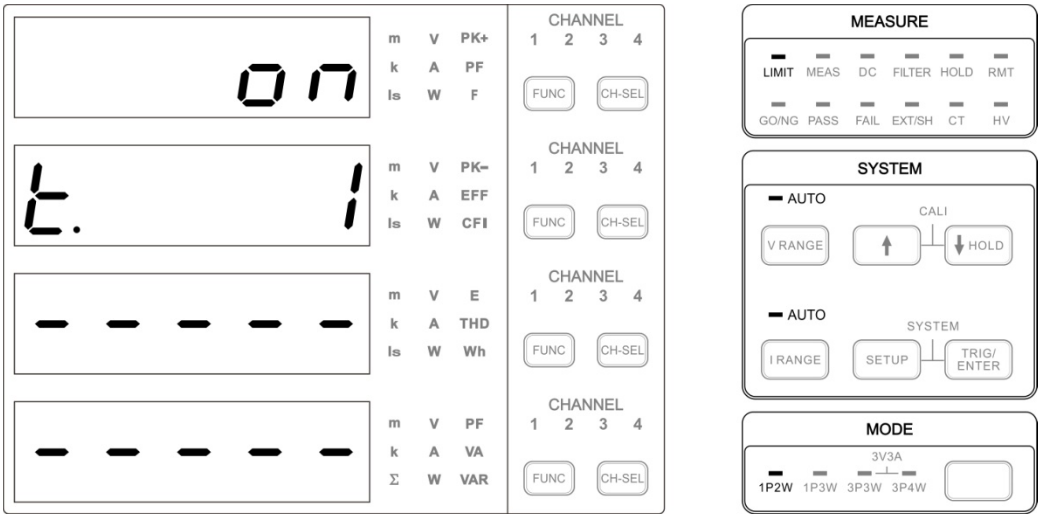
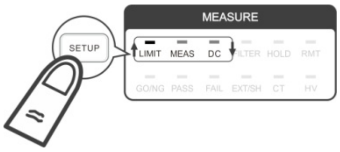


Figure 4-28 Limit Function Setup Screen

Enable the Limit function by setting the detection time and the upper/lower limits of each parameter can judge if the measured data is within the specification. The parameters include V, Vpk+, Vpk-, I, Ipk+, Ipk-, Is, W, PF, VA, VAR, CFi, VTHD, ATHD, E and F. The user can select one or several of them for setting.

Following is the procedure to set the parameter:

1. Press **SETUP** and select Limit. The Limit indicator is on indicating it is in Limit menu.



2. Use ↑, ↓ to select on in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to set the time in the 2nd display window and press **TRIG/ENTER** to enter into the parameter setting screen.
4. Use ↑ , ↓ to select the desired testing channel in the 1st display window. If the parameter upper and lower limits of every channel are the same, select all and press **TRIG/ENTER** to confirm it.
5. Use ↑, ↓ to select the test parameter in the 2nd display window and press **TRIG/ENTER** to confirm it.
6. Use ↑, ↓ to set the upper limit in the 3rd display window. If there is no upper limit, set "-----" and press **TRIG/ENTER** to confirm it.
7. Use ↑, ↓ to set the lower limit in the 4th display window. If there is no lower limit, set "-----" and press **TRIG/ENTER** to confirm it.
8. Repeat step 4~7 to set other test channel, parameters and upper/lower limits. When done, press **SETUP** to exit the menu and the GO/NG indicator will turn on.
9. Press **TRIG/ENTER** to begin the GO/NG testing on every channel. The GO/NG will blink during the test.

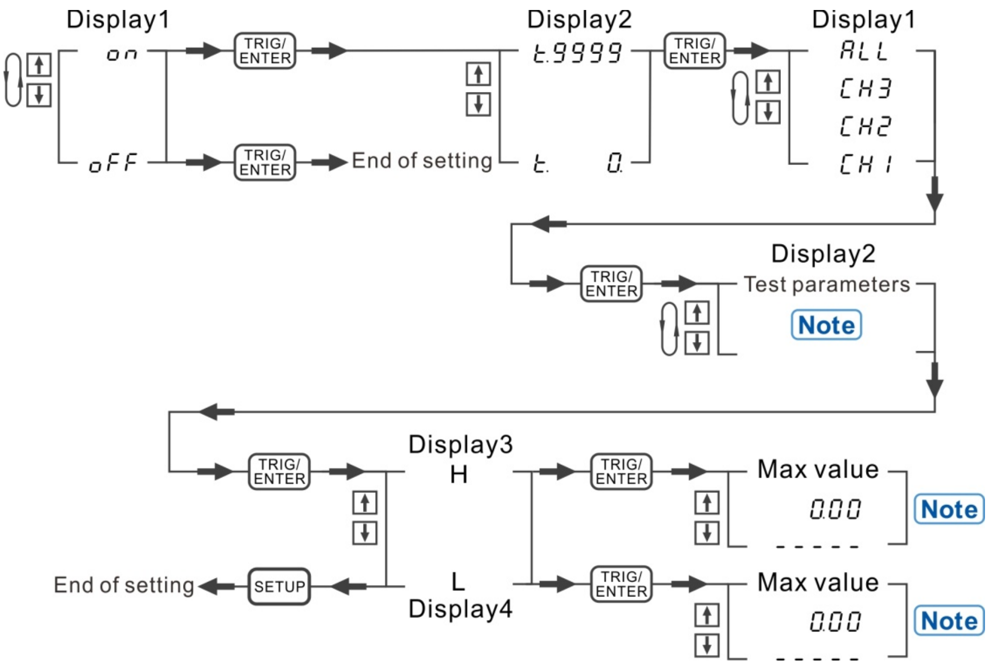


Figure 4-29 Procedure for Setting Limit Function

The figure below shows the rule for judging the measured value comparing to the upper/lower.

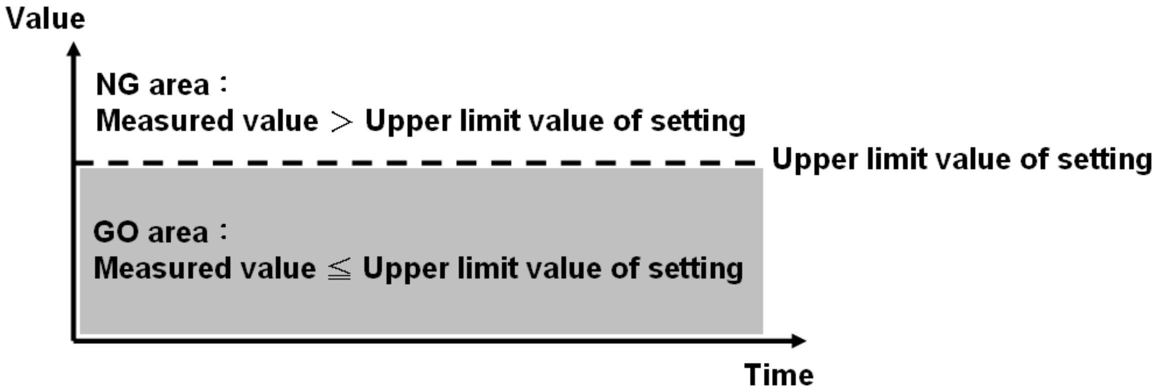


Figure 4-30 GO/NG Upper Limit Comparison Rule

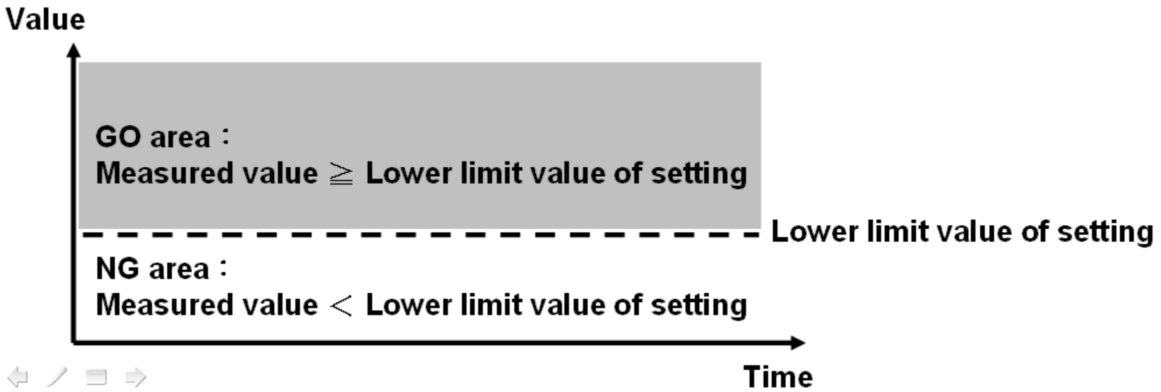


Figure 4-31 GO/NG Lower Limit Comparison Rule

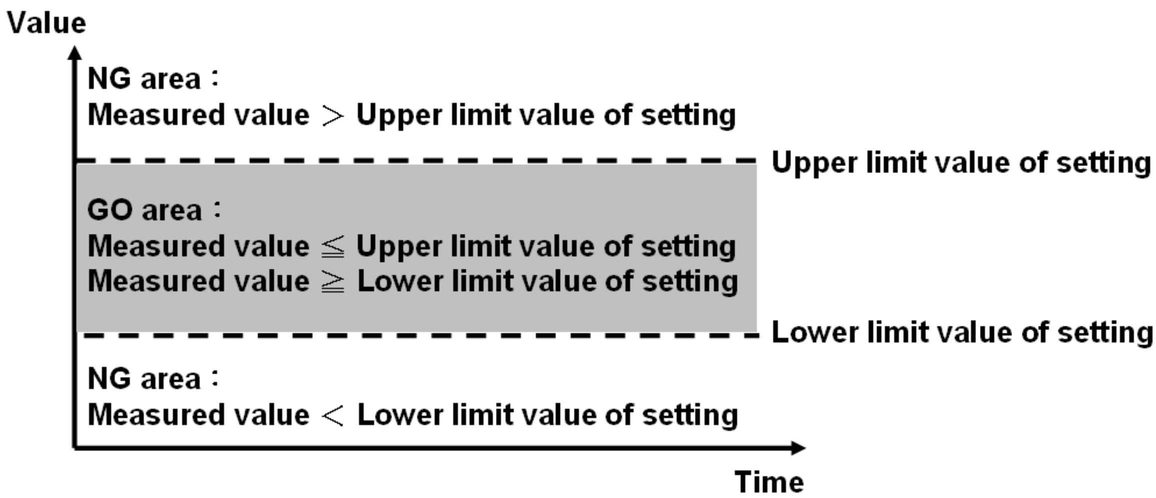


Figure 4-32 GO/NG Upper & Lower Comparison Rule

The test results are output from the PASS/FAIL indicator on the front panel and 4 PASS/FAIL pins on the rear panel I/O port respectively. The PASS indicator is on if the test results of all channels are PASS. If any of the test results is FAIL, the FAIL indicator will be on. The 4 PASS/ FAIL pins on the I/O port map to the test results of channel 1 ~ 4 to on the relay of PASS or FAIL. The user can utilize the external indicators to present the PASS or FAIL state via the figure shown below.

When the test result is FAIL, no matter it is the indicator on the front panel or the external I/O port, all of them will blink and beep. The FAIL value will be logged on the panel for check.

If the previous test result is FAIL, press **TRIG/ENTER** once to clear the test result and twice to conduct the next test. If the previous test result is PASS, press **TRIG/ENTER** to conduct the next test immediately.

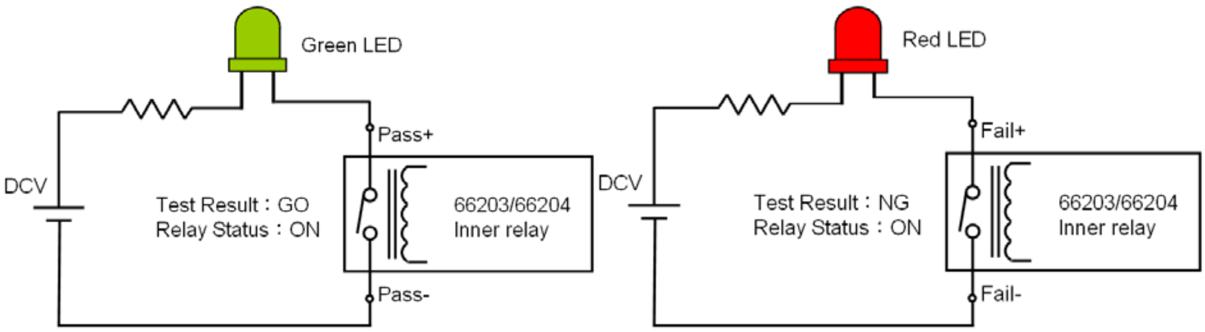


Figure 4-33 Wiring of GO/NG External Indicator

Notice

1. There are total 16 test parameters including V, Vpk+, Vpk-, I, Ipk+, Ipk-, Is, W, PF, VA, VAR, CFi, VTHD, ATHD, E and F.
2. The upper and lower limits of every test parameter are different. If the upper and lower limits are set to "- - - - -", it means no setting.
3. The 66203/66204 Digital Power Meter has 3 parameters that require pressing **TRIG/ENTER** for triggering. They are E (energy), Is (Inrush current) and GO/NG. If two of them are set for testing, the triggering priority is E > Is > GO/NG.

4.6.2 Meas

The Meas menu of the 66203/66204 Digital Power Meter has Shunt, Meas, Integ, Filt, Disp, Hold, THD, Inrush, Energy, CT, ExtenSH, HV, EFF, Formu and R.RESP total 15 functions that are described below.

SHUNT

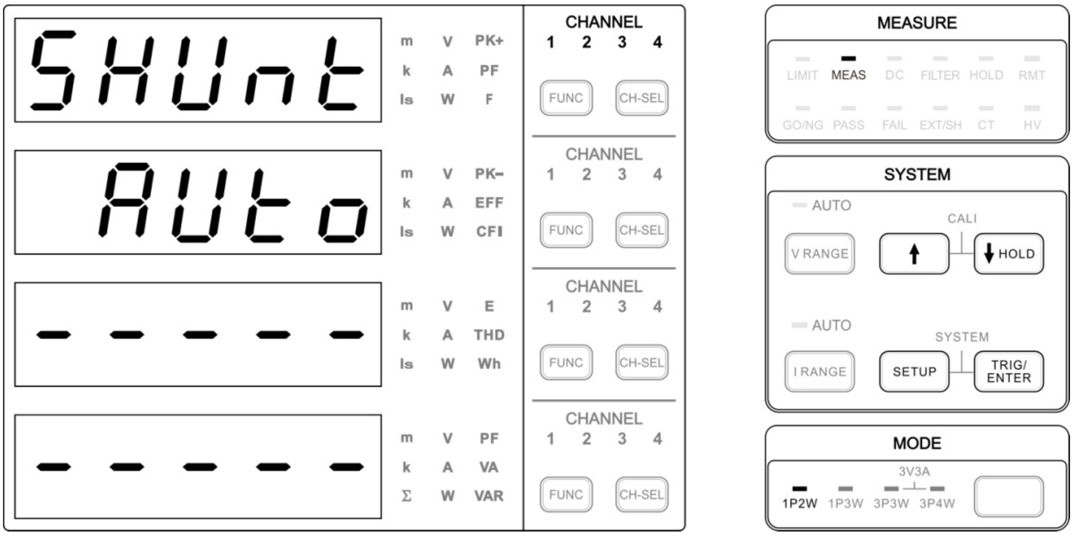
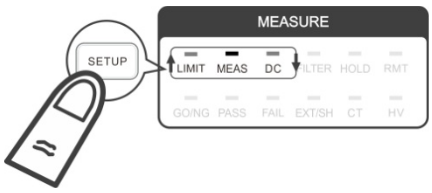


Figure 4-34 Setup Screen of SHUNT

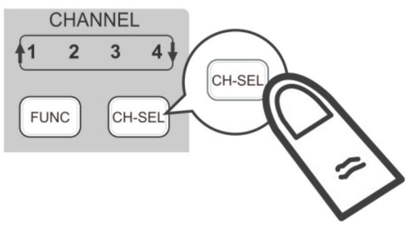
The 66203/66204 Digital Power Meter offers two internal shunts for current sensing which are 5mΩ (High shunt) and 500mΩ (Low shunt). The measurement ranges of High shunt are 20Arms/5Arms/2Arms/0.5Arms while Low shunt measurement ranges are 0.2Arms/0.05Arms /0.02Arms/0.005Arms. The Digital Power Meter has AUTO, High, and Low three types of shunt for selection.

Following is the procedure to set the range:

1. Press **SETUP** and select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select SHUNT function in the 1st display window and press **TRIG/ENTER** to confirm the selection.
3. Before setting any parameters, press **CH-SEL** to select the desired channel for testing.



4. Use ↑, ↓ to select AUTO, High or Low in the 2nd display window and press **TRIG/ENTER** to confirm it.
5. When done, press **SETUP** to exit the menu.

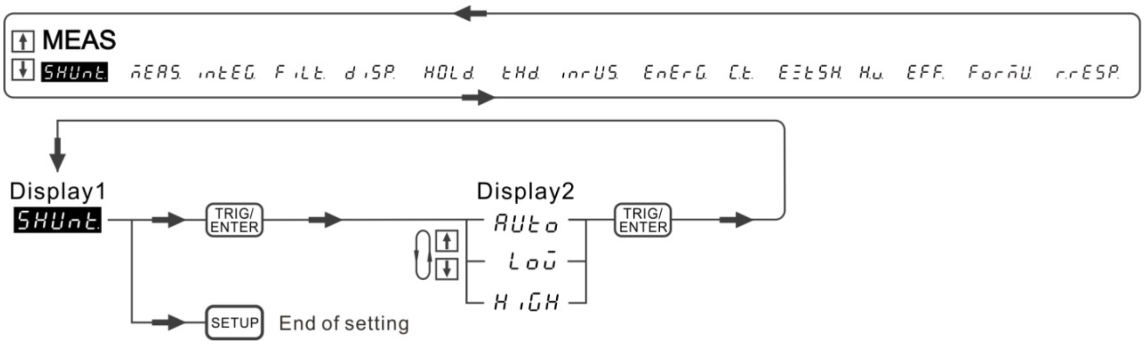


Figure 4-35 Process for Setting Shunt

Notice When switching Shunt, it will take around 300ms to dodge the transient of the switch. If the test range is concentrated in 20Arms/5Arms/2Arms/ 0.5Arms (High shunt range) or 0.2Arms/0.05Arms/0.02Arms/0.005Arms (Low shunt range), a proper shunt can be select for measurement to shorten the testing time.

MEAS

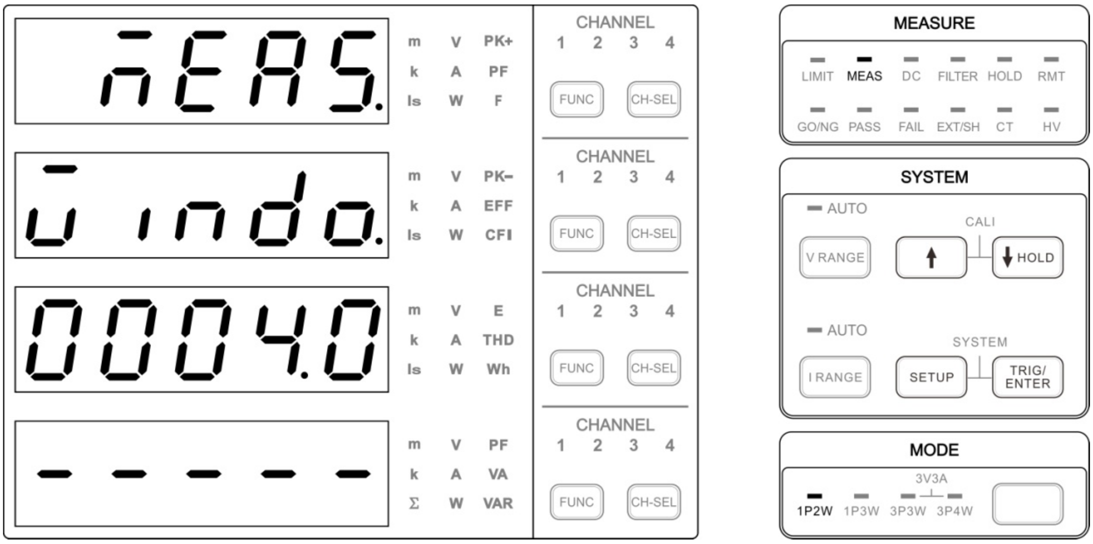


Figure 4-36 WINDOW Measurement Setup Screen

The 66203/66204 Digital Power Meter provides two average methods to calculate the measured values. They are Windo (window) and Avg (average). The major differences of them are sampling and calculation as described below.

■ **Windo**

When the UUT's voltage or current signals are unstable, it can use Moving Window Method to get a stable measured value. The longer the window time is set, the more stable the measured value is.

The Moving Window Method uses the time set to calculate the sampled data of voltage and current signals during the timeframe with the window time length fixed for two cycles of measured value update to calculate the new average. The window time range available for the 66203/66204 Digital Power Meter is 0.1 sec. ~ 60 sec. with the resolution set to 0.1 sec. The default is 4 seconds.

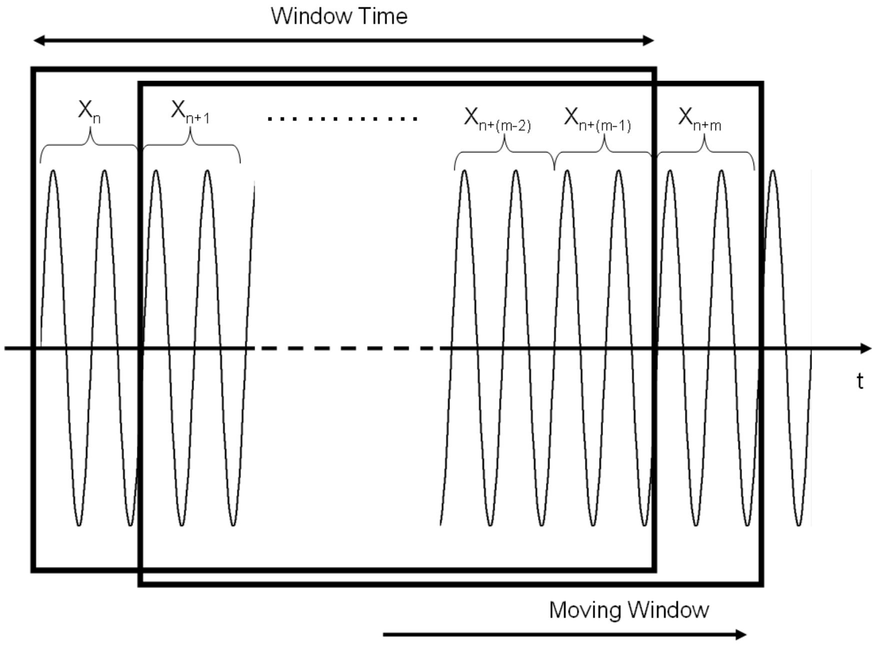
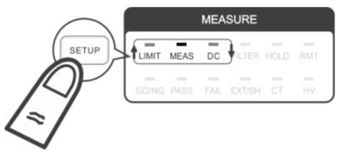


Figure 4-37 WINDOW Measurement Theory

Mn=(Xn+X(n+1)+…+X(n+(m-2)+X(n+(m-1)))/m
Xn: The *n* measured value
X(n+1): The 1st measured value after the *n* measured value
Xn+(m-2): The (m-2) measured value after the *n* measured value
Xn+(m-1): The (m-1) measured value after the *n* measured value
Xn+m: The *m* measured value after the *n* measured value
Mn: It displays the average measured value.
m: It is the measured number within the window time.

Following is the procedure to set the parameter:

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select Meas. in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select Windo in the 2nd display window and press **TRIG/ENTER** to confirm it.
4. Use ↑, ↓ to select the window time length (second) in the 3rd display window and press **TRIG/ENTER** to confirm it. Press **SETUP** to return to the main menu.

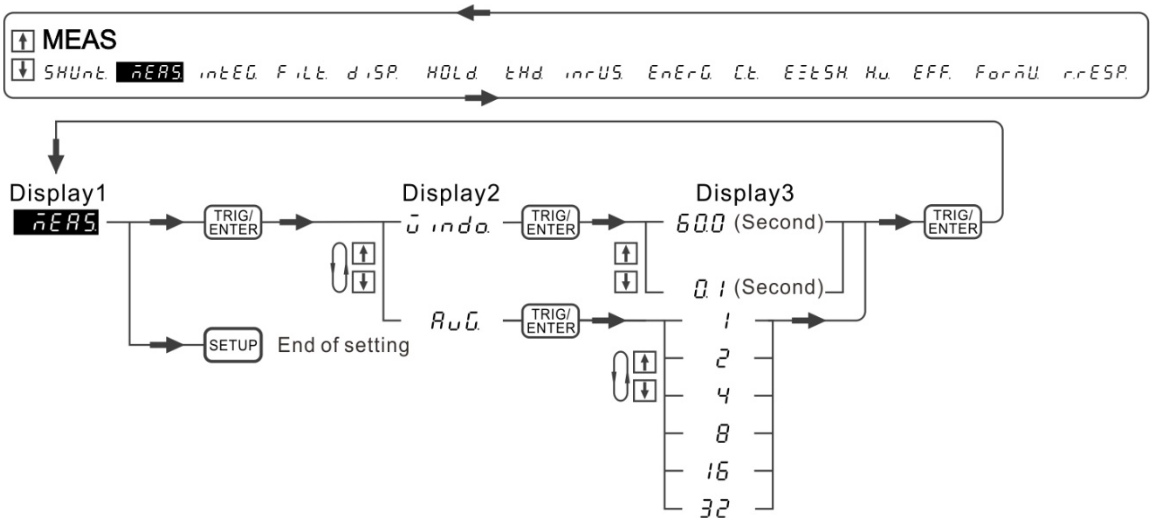
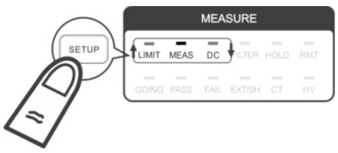


Figure 4-38 Process for Setting WINDOW & AVG Measurement Functions

- **Avg**
  If the UUT voltage or current is unstable, using the Moving Average Method can get a stable measured value. The more average number of times, the measured value is more stable. Different from the window mode, Average updates the measured value of two cycles by a fixed interval in order to calculate the new average. The average mode is more capable of reflecting the fluctuation of actual current or voltage waveform. The window mode is suggested if it is desired to get a rather stable measured value. The Avg setting is 1, 2, 4, 8, 16, 32 and the default is 1.

Following is the procedure to set MEAS function:

1. Press **SETUP** and select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select Meas. in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select Avg in the 2nd display window and press **TRIG/ENTER** to confirm it.
4. Use ↑, ↓ to select the average times in the 3rd display window and press **TRIG/ENTER** to confirm it. Press **SETUP** to return to the main menu.

Notice No matter it is Window or Average mode, the longer or larger the average time or the average number of times is set, the more stable measured value would be got. However the fluctuation of voltage or current signal cannot be reflected either.

INTEG

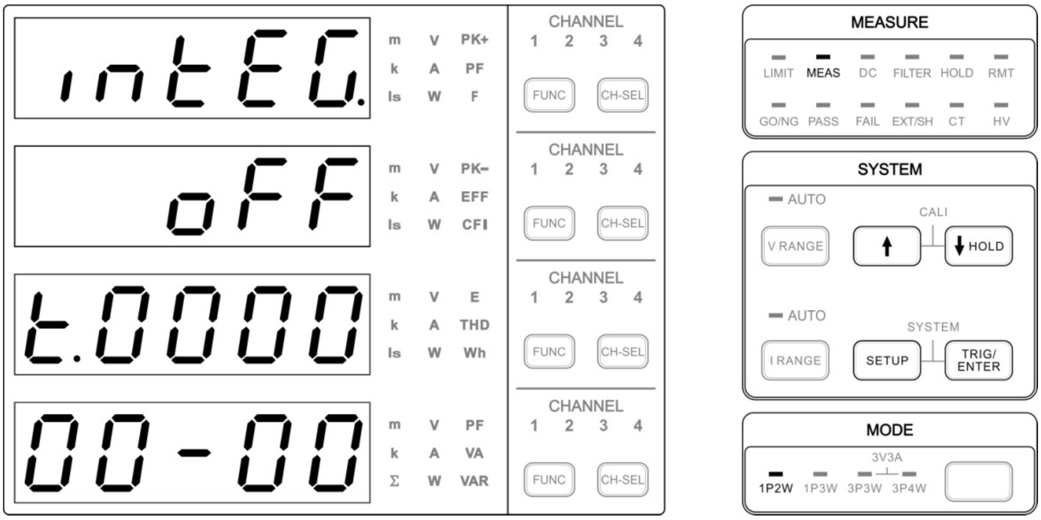


Figure 4-39   INTERGRATION Setup Screen

The 66203/66204 Digital Power Meter is able to use energy accumulation to measure the UUT power, voltage and current RMS within the fixed time consecutively in INTEGRATION mode.

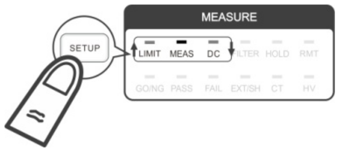
When in the INTEGRATION mode, the V, I and W indicators next to the voltage, current, power display will blink. After the integration is started, the initial displayed voltage, current and power measurement are not done for calculation within the integration time. The measured value on the display window will blink as the reminder. When the test time is met, new values will appear in the display window and the readings will not blink but start calculating for the next integration time.

When the power measurement is set to INTEGRATION mode, the voltage or current range is changed within the integration time will cause the power measurement error. The display will show Range Change Error message as Figure 4-41 shows. Thus, if the maximum condition of voltage or current peak is already known, it is suggested to set the voltage and current test range to the one that can measure the maximum amplitude of voltage and current signal before starting the integration measurement. If the range is set to AUTO, the power meter will switch it to the one suitable for the measured signal automatically when in INTEGRATION mode. During the measurement, if the signal peak exceeds the range upper limit in a short time, the power meter does not prompt Range Change Error message but continue the integration calculation due to long time measurement. However, if the signal continues to exceed the range upper limit for a long time, the power meter will prompt a Range Change Error message and start next integration calculation automatically.

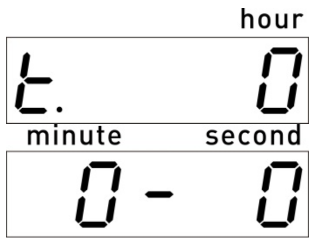
Since the range switch will affect the measured value in INTEGRATION mode, the range cannot be switched during measurement but viewable only. Similarly, the functions that may affect the accuracy of integration measurement are not open for setting except viewing in INTEGRATION mode.

Following is the procedure to set INTEG function:

1. Press **SETUP** and select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select intEG in the 1^{st} display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select ON or OFF in the 2^{nd} display window to enable or disable integration and press **TRIG/ENTER** to confirm the selection.
4. Use ↑, ↓ to set the integration time in the 3^{rd} and 4^{th} display windows. The 3^{rd} display window sets hour in the range of 0~9999, while the 4^{th} display window sets minute and second in the range of 0~59. When the time adjustment is done, press **TRIG/ENTER** to confirm it.



5. Press **SETUP** to return to the main menu.

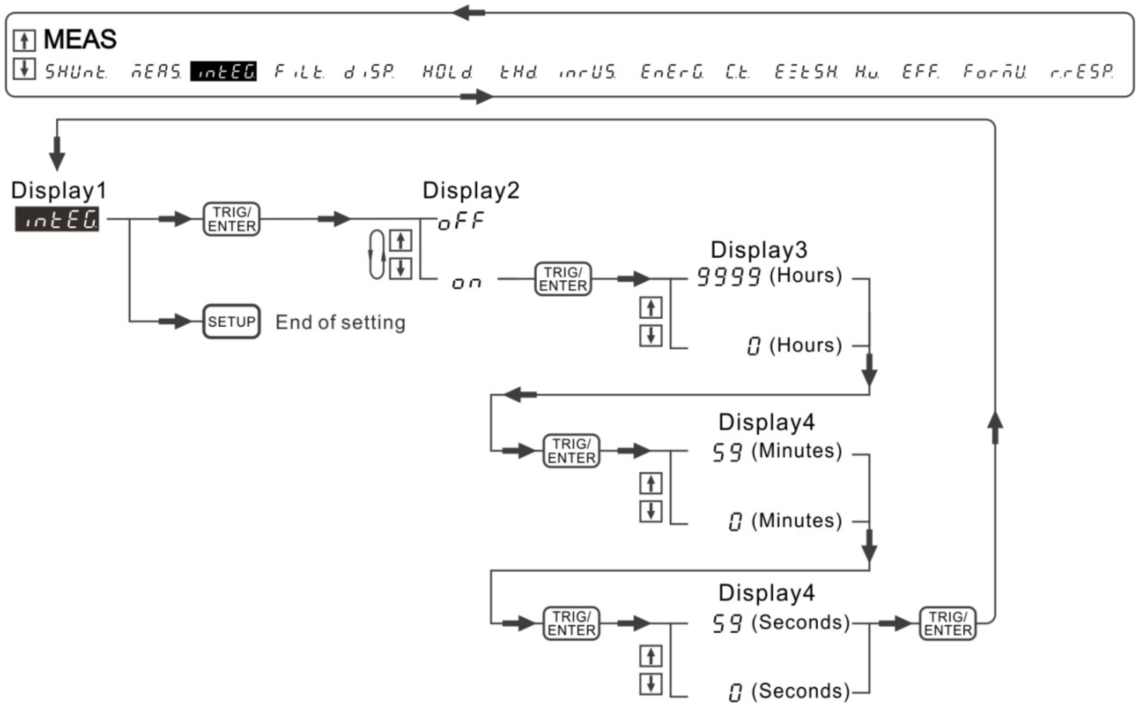


Figure 4-40　Process for Setting Integration

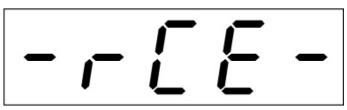


Figure 4-41　Range Change Error Message

Notice

1. When error message appears, press **TRIG/ENTER** to clear it. The power meter will conduct the next integration measurement. If **TRIG/ENTER** is not pressed, the power meter will wait until the

integration time is met to clear the error message and carry on the next integration measurement.

2. It is necessary to turn off the integration function first to change the range or related function settings.
3. The power meter will use Window or Average to do the measurement if the integration mode measurement is closed and returned to the measurement screen,
4. INTEG and E (energy) are two separate operations that can be tested at the same time.

FILT

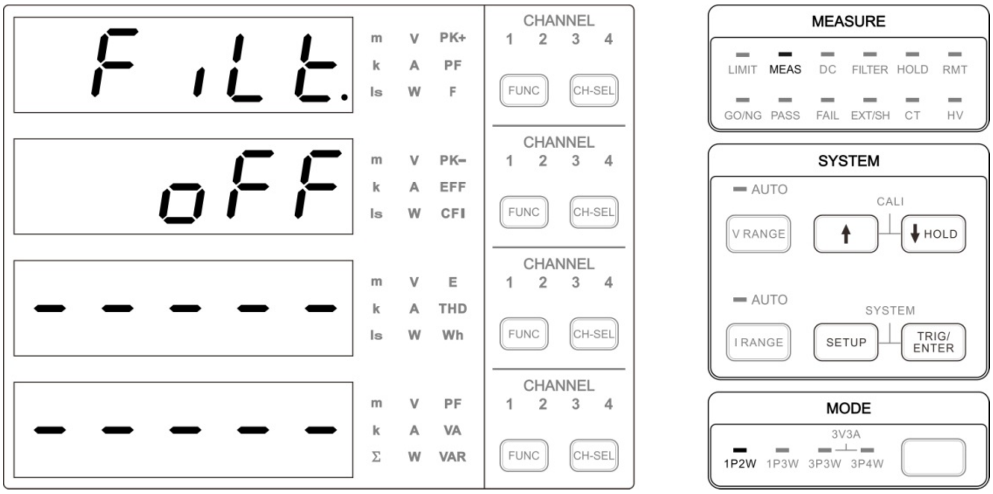


Figure 4-42 FILTER Setup Screen

The 66203/66204 Digital Power Meter has low pass digital filter function with around 6 kHz cutoff frequency that is compliant with the IEC 61000-3-2 international standard. When the filter is enabled, it can filter out the high frequency noise from the input voltage and current signal such as the switch noise of switchable power supply.

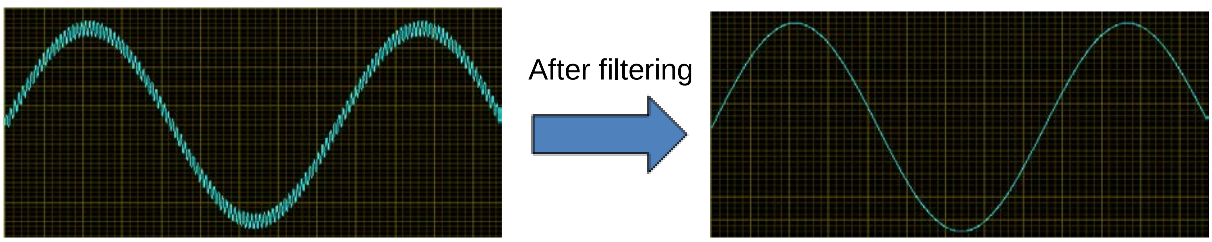


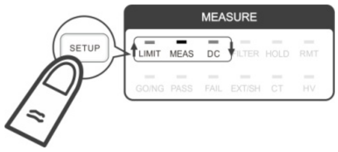
Figure 4-43 Before & After Waveform Filtering

When using the harmonic measurement function, if the harmonic frequency desired for measurement is higher than the digital filter bandwidth, the filter needs to be turned off first. Otherwise, the harmonic will be affected by the filter; for instance, to measure the fundament wave 60Hz with 100 levels of harmonic, since the harmonic frequency 6 kHz is larger than the filter's bandwidth, it is suggested to turn off the filter and then perform the measurement. The measurement bandwidth is about 60 kHz when the digital filter is OFF.

Higher measurement bandwidth is required when measuring the inrush current. Therefore, the digital filter will apply OFF state even if the filter is set to ON so that the measured inrush current will not be affected.

Following is the procedure to set the digital filter. The filter state of each module cannot be set separately.

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select FiLt in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select ON or OFF in the 2nd display window to enable or disable the digital filter and press **TRIG/ENTER** to confirm it. Press **SETUP** to return to the main menu.

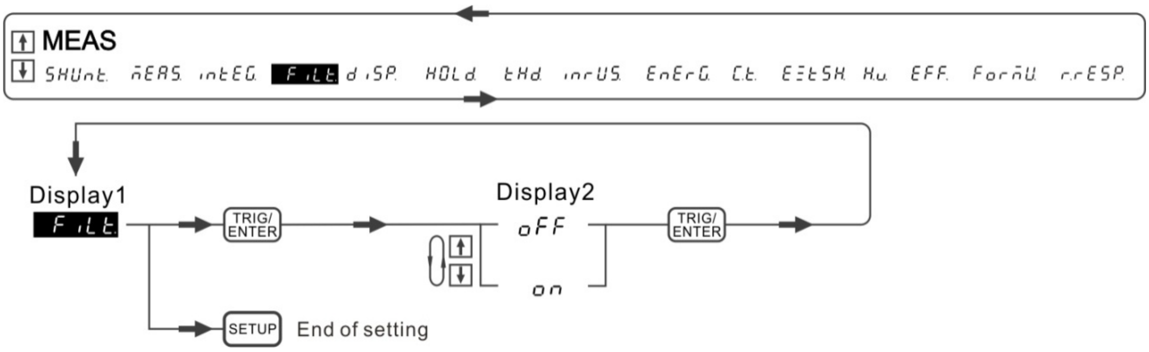


Figure 4-44 Process for Setting FILTER

Notice The bandwidth of digital filter varies with A/D sampling frequency, and sampling frequency varies with fundamental frequency. Thus, when measuring the commercial frequency45 Hz~65 Hz, the digital filter bandwidth is about 5 kHz~7 kHz.

DISP

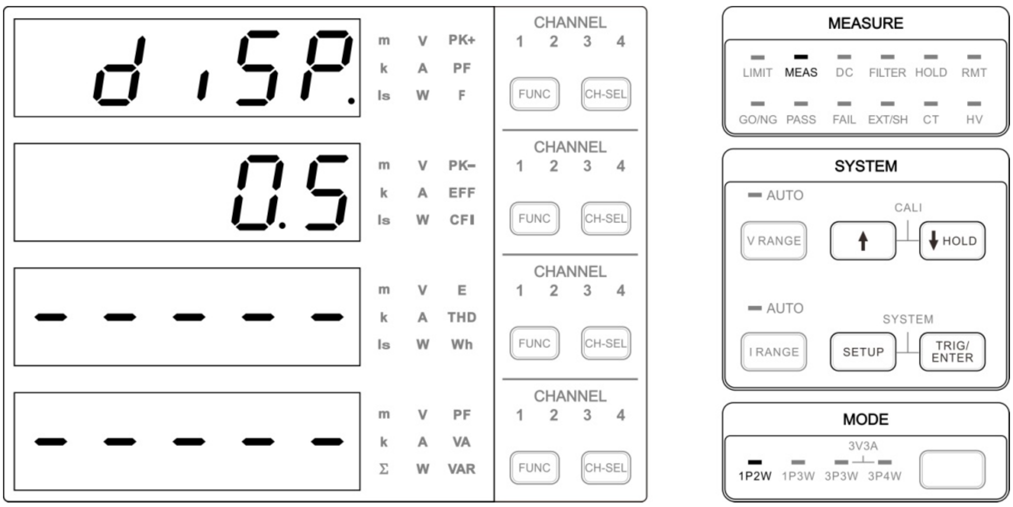
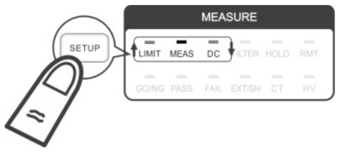


Figure 4-45 DISPLAY Refresh Rate Setup Screen

The 66203/66204 Digital Power Meter is able to adjust the display refresh rate for the measured value. The rates for adjustment are 0.25, 0.5, 1.0 and 2.0 (unit: second). The default setting is 0.5 second. The display refresh rate can be increased if the signal under test turns faster.

Following is the procedure to set DISP function:

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select diSP in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select the rate for refresh in the 2nd display window and press **TRIG/ENTER** to confirm it. Press **SETUP** to return to the main menu.

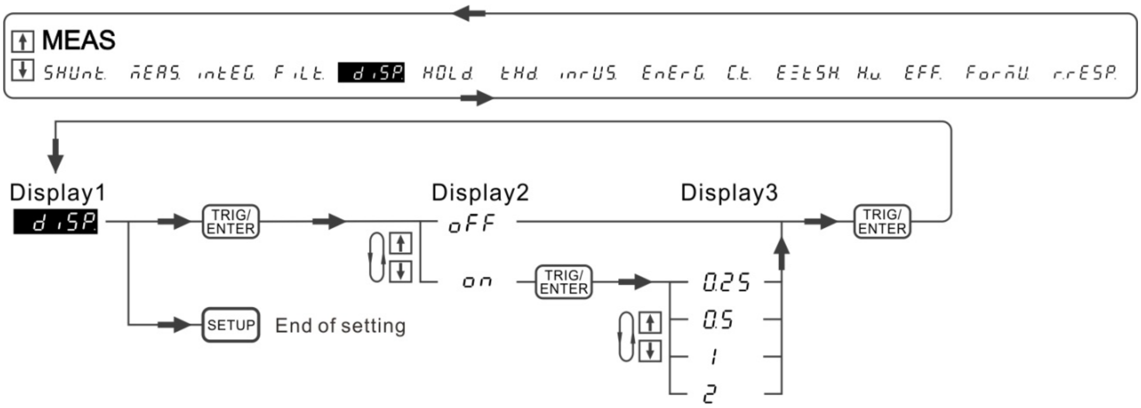


Figure 4-46 Process for Setting DISPLAY Refresh Rate

HOLD

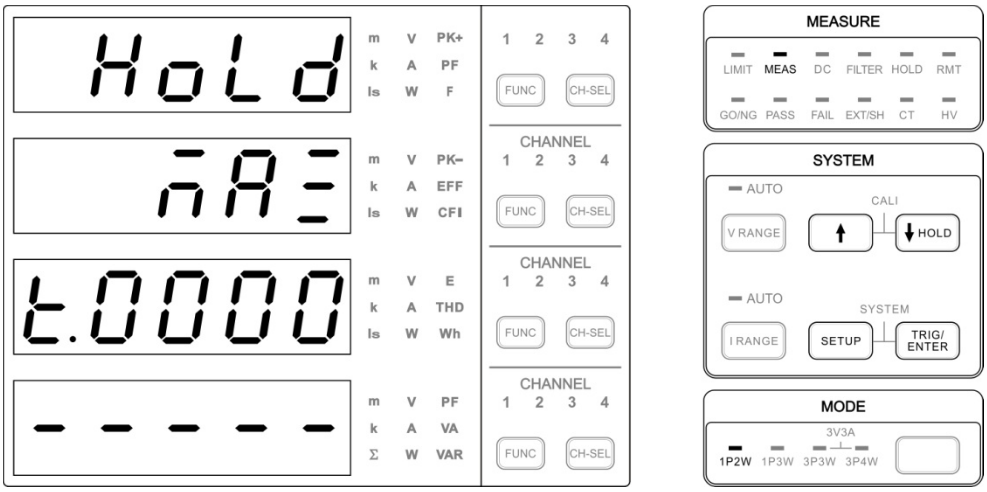
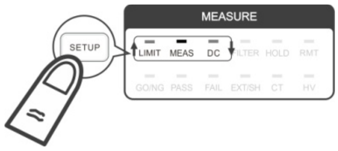


Figure 4-47 HOLD Setup Screen

The 66203/66204 Digital Power Meter has hold function that is triggered by Stop, Max and Min three kinds of conditions. The measured values can be hold are V, Vpk+, Vpk-, A, Apk+, Apk-, W, VA, VAR, PF, F, Cfi, VTHD, ATHD, EFF, Vdc, Idc and Pdc.

Following is the procedure to set HOLD function:

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select HoLd in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select one of the Stop, Max and Min in the 2nd display window and press **TRIG/ENTER**. If Max or Min is selected, it needs to set the maximum or minimum comparison time in the 3rd display window. If Stop is selected, it is no need to set the time. The time judgment range is 0~9999 seconds. The setting resolution is 1 second.

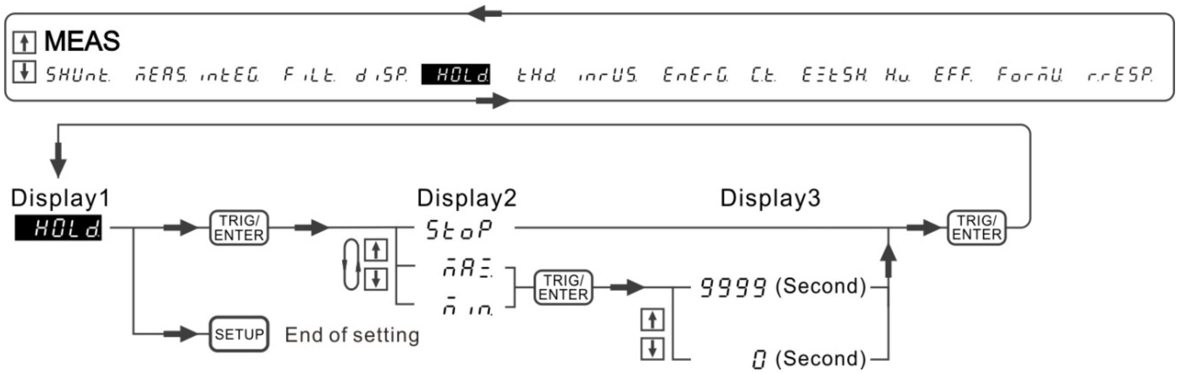


Figure 4-48 Process for Setting HOLD

4. Press **SETUP** to return to the main menu. Press **HOLD** to enable HOLD. The HOLD indicator lights up.
5. When STOP is selected, press **HOLD** the display will pause. To resume it, press any key in the SYSTEM block and the HOLD indicator will be off.
6. When Max is selected and the time is set to 0, it is equivalent to STOP. If the time is set to 10, press **HOLD** and the panel will blink and refresh for the maximum value within 10 seconds. Once the time is met, a long beep will sound to remind the user the measured maximum. Then the display will pause and make short beeps. To resume it, press any key in the SYSTEM block and the HOLD indicator will be off.
7. Min is to measure the minimum value within the set time frame. The setting is the same as Max.

THD

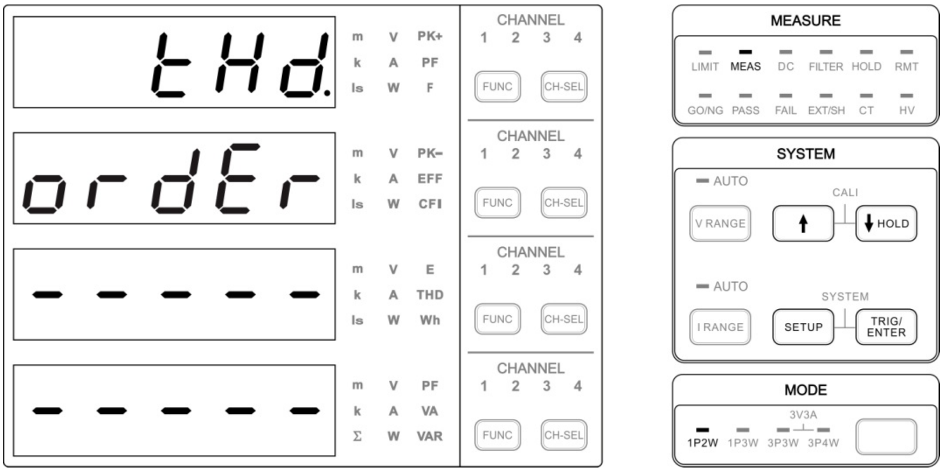


Figure 4-49 THD Setup Screen

The Total Harmonic Distortion (THD) function of the 66203/66204 Digital Power Meter is to calculate the RMS ratio from the higher order harmonics and the fundamental. Please see section 4.4 for the THD calculation formula. The power meter uses the internal zero-crossing circuit and frequency calculation module to get the fundamental wave frequency. The Digital Signal Processor (DSP) computes the sampling rate and uses analog/digital converter to perform sampling on the voltage/current signals, and then sends the data back to DSP performs Fourier transform to get the RMS value of fundamental and each harmonic. The THD is then calculated. When performing the THD measurement, if the digital filter is enabled, up to 6 kHz signal of the harmonic will be filtered out; therefore, it is necessary to evaluate the influence caused by the filter.

The 66203/66204 Digital Power Meter is unable to show the composition of harmonic but VTHD or ATHD only. However, it can view the fundamental, harmonic and DC composition via the software panel. The waveform amplitude formed by the fundamental, harmonic, interharmonic and DC determines the power meter's measurement range. Therefore, the harmonic measurement range and the RMS measurement range are the same. When the harmonic amplitude is smaller than the measurement range, the measured harmonic is also unstable due to the influence of noise and measurement resolution.

- **Cycle**

  The cycle mode specifies the measurement window in number of cycles of the fundamental frequency. The window type is rectangular and the FFT data length is 4096. The sampling rate is synchronized to the fundamental frequency of voltage source. The cycle sets to 10(50Hz-system) or 12(60Hz-system) when measure fluctuating harmonic is preferred. The setting cycle range is 1 to 20. The upper limit of the measured order is decreased when cycle number is increased. The detail upper limit of the measured order is listed on the below table.

  The larger cycle number is needed when the fundamental frequency is higher. The effective cycle setting is limited by the finite sample rate. The detail setting cycle information is showed in Figure 4-51. Even if the setting cycle is invalid, the analysis mechanism still adjusts cycle number to be effective to keep the 4096-dot rectangular window type.

Sample rate, window width, and upper limit of measured order				
Fundamental Frequency (Hz)	Sample Rate (S/sec)	Measuring Window Width (cycle)	Upper Limit of the Measured Order	
			Filter on	Filter off
10 to 60			100	100
60 to 120			50	80
120 to 180			37	50
180 to 240		See the figure of	28	40
240 to 300	(f×4096) / cycle	the effective setting cycle	22	30
300 to 360		number	17	25
360 to 480			14	20
480 to 720			9	10
720 to 1200			5	5

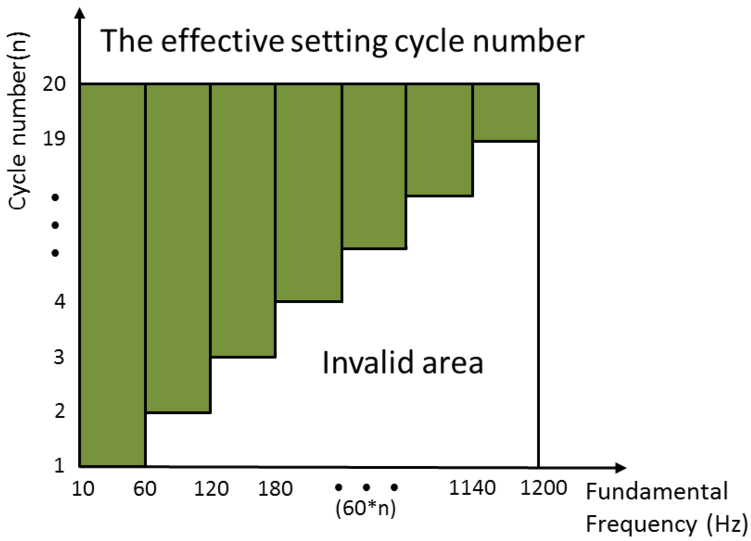
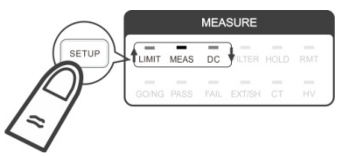


Figure 4-50 Effective Setting Cycle Number for Fundamental Frequency

- **Smooth**
  A smoothing is performed over the r.m.s. value of each harmonic order in each FFT measurement window by using a digital equivalent of a first-order low-pass filter with a time constant of 1.5 second. The smooth setting is ON or OFF. The smoothing filter sets to ON when measure fluctuating harmonic is preferred; the stable and average measured value will be obtained.

Following is the procedure to set THD function:

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select THD in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select the desired parameter FULL, Order, SMOOT or CYCLE, and press **TRIG/ENTER**.
4. User ↑, ↓ to adjust the parameters in the 3rd window for 2~100 orders, ON/OFF(SMOOT) or 1~20(CYCLE), and then press **TRIG/ENTER** .

5. Press **SETUP** to return to the main menu.

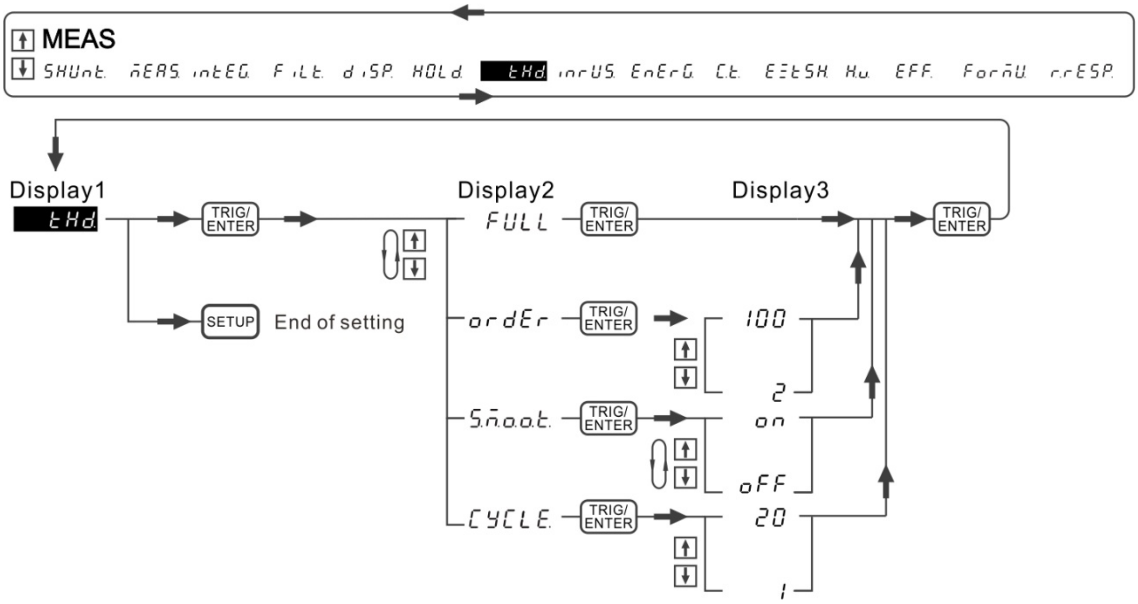


Figure 4-51 Process for Setting THD

Notice

1. Turning on the filter is able to eliminate high frequency components that are irrelevant to the harmonic measurement. For example, when measuring the input signal with a fundamental frequency of 50 Hz up to the 50th order, the frequency of the 50th order is 2.5 kHz. Thus, an approximated 6 kHz filter is used to eliminate high frequency components that are greater than or equal to approximately 6 kHz, which are irrelevant to the harmonic measurement.
2. The voltage and current total harmonic order need to be set at the same time. The 66204 Digital Power Meter does not provide the function to set them separately.
3. The Cycle and Smooth functions on 66204 power meter are only supported when the firmware version is ≥ 1.20.

INRUS

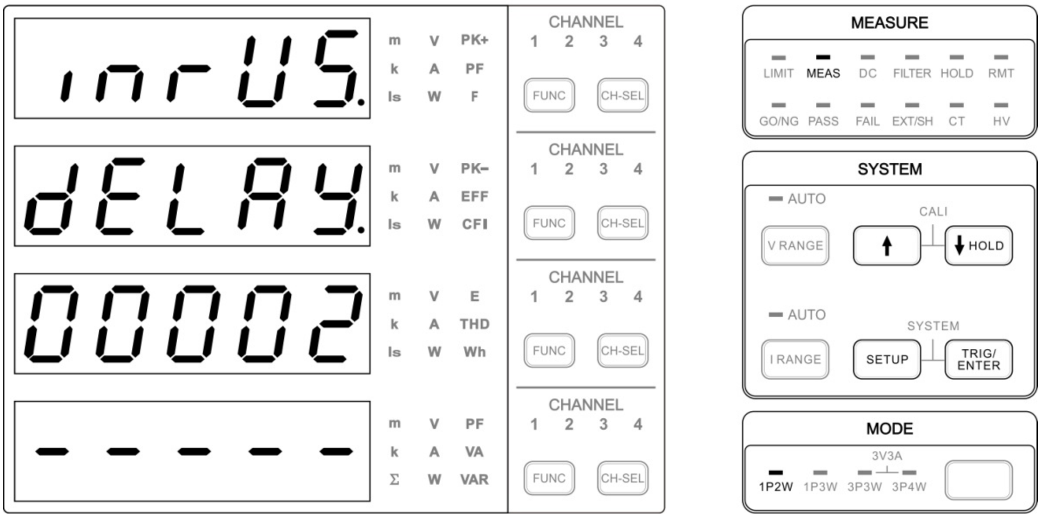


Figure 4-52 INRUSH CURRENT Setup Screen

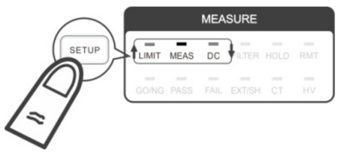
Following is the example of measuring inrush current. In order to sampling the maximum value within a period of time in the current waveform, the gain amplifier of power meter needs to scale the waveform without distortion for the analog/digital converter to do sampling on the waveform. The sampling speed determines if the maximum value of waveform can be captured. The sampling value is not processed by the low pass filter even the digital filter is turned on and it won't affect the measurement accuracy of inrush current.

The inrush current is usually huge and it related to the capacitor initial voltage of UUT's circuit. The measured current often requires to cross several current ranges of the 66203/66204 power meter. If the range is set to auto, the best measurement time may be missed when switching the range. Thus, range change is not allowed when doing inrush current measurement. For range change during AUTO or passing range during Manual, the 66203/66204 power meter will prompt a Range Change Error (RCE) message. It is suggested to fix the range to 20A or set the range manually to an appropriate one after pretesting to get the best current measurement resolution.

Besides triggered by the current level, the inrush current can also be triggered externally. When using the external trigger source to trigger the inrush current measurement, the set triggering level will be ignored but apply the delay time set before starting the measurement. Please see *Appendix A Using Control Signal Input/Output Terminal* for the pin detail of external trigger signal.

Following is the procedure to set INRUS function:

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select inrUS in the 1st display window and press **TRIG/ENTER** to confirm it.
3. The 2nd display window shows delay, use ↑, ↓ to set the delay time in the 3rd display

window with the time unit of ms and press **TRIG/ENTER**.

4. Next, the 2nd display window shows time, use ↑, ↓ to set the measurement time in the 3rd display window with the time unit of ms and press **TRIG/ENTER**.
5. Last, the 2nd display window shows level, use ↑, ↓ to set the trigger level in the 3rd display window with the level unit of Ampere and press **TRIG/ENTER** to return to the main menu of 1st display window.
6. Press **SETUP** to return to the main menu.
7. Select any Is indicator within the basic function indicators and press **TRIG/ENTER** to start measuring the inrush current.

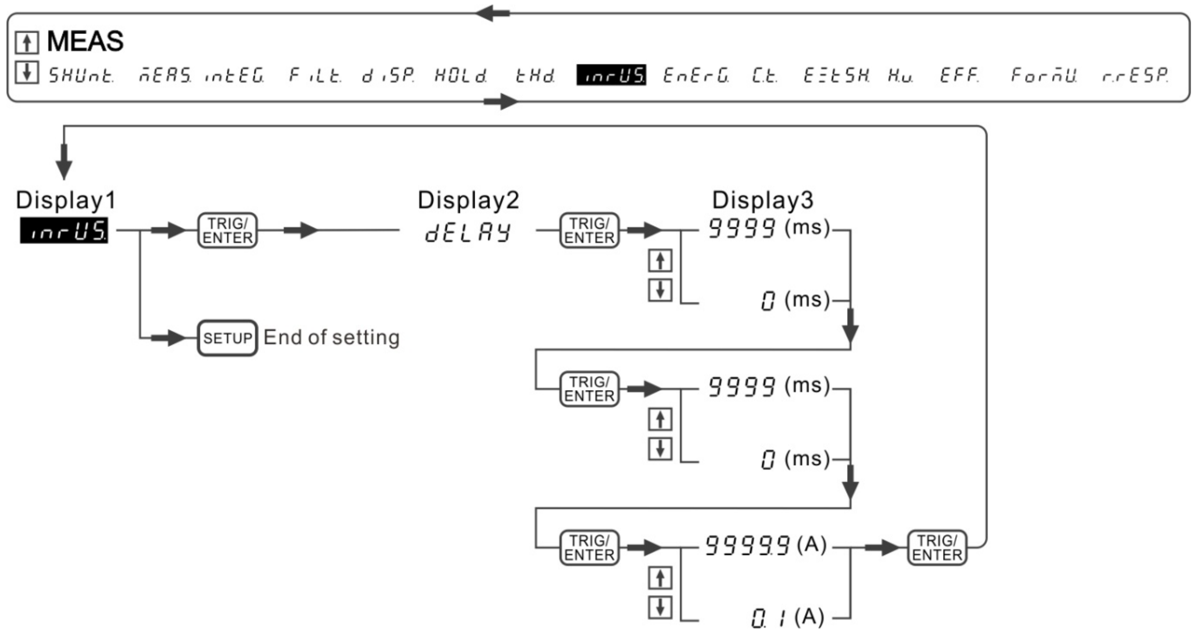


Figure 4-53 Process for Setting INRUSH CURRENT

Example:
Assuming the inrush current parameters are set as below:

(Trigger) Level: 1A
(Measurement) Delay: 0 ms
(Measurement) Time: 10 ms

It can see from the figure below that after the current exceeded the triggered current for 1A, the power meter starts to measure the inrush current for 10ms as the delay time was set to 0 second. The measured maximum inrush current is about 7A.

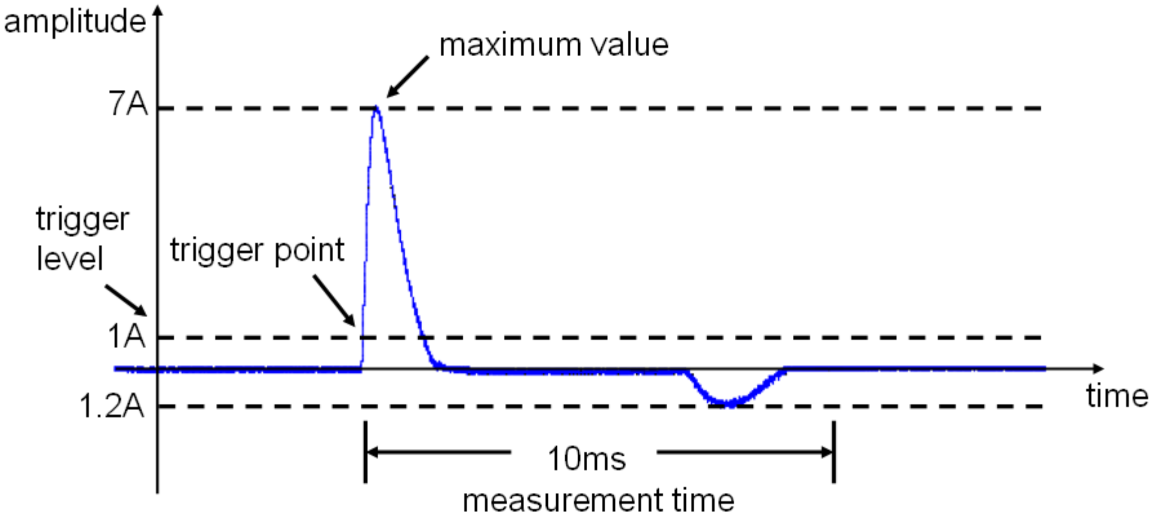


Figure 4-54 Example of Inrush Current Measurement

Notice

1. The fastest sampling rate of the 66203/66204 power meter is 4 μ s, so when the maximum inrush current is occurred within 4 μ s, the best measurement may be missed. The inrush current sampling rate varies with the voltage frequency detected. The sampling rate of measured 50Hz signal is about 5 μ s. The sampling rate of measured 60Hz is about 4 μ s.
2. The 66203/66204 Digital Power Meter has 3 types of parameters that require **TRIG/ENTER** for triggering, they are E (Energy), Is (Inrush Current) and GO/NG. The priority is E > Is > GO/NG.
3. When the inrush current measurement is triggered, every channel of the 66203/66204 power meter will start measurement at the same time. The inrush current value can be checked by pressing the channel key for switch.

ENERG

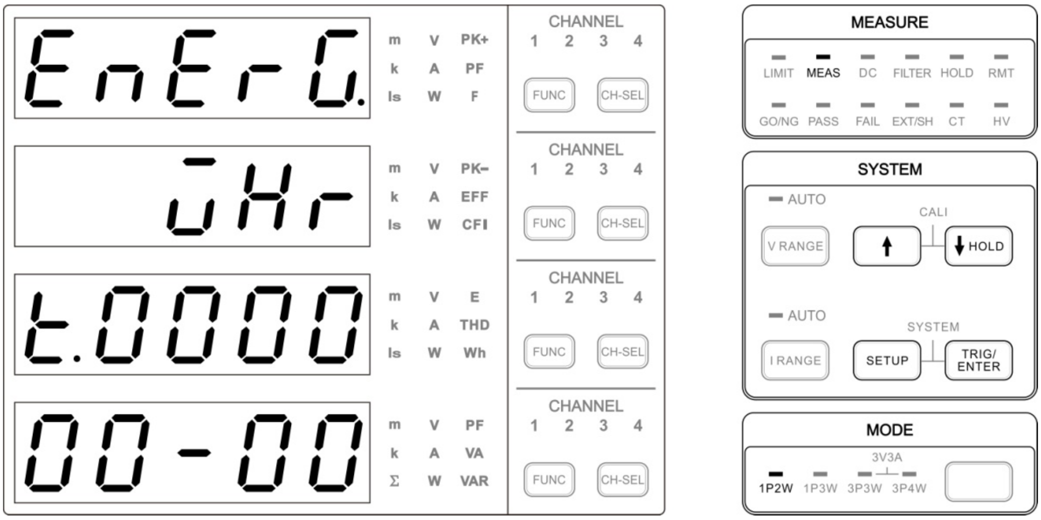
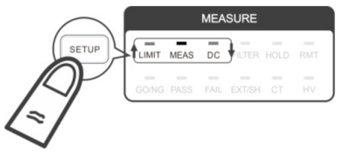


Figure 4-55 ENERGY Setup Screen

The 66203/66204 Digital Power Meter is able to measure the UUT’s energy within a period of time. The energy units for selection are Joule and WHr. The calculation of energy is the integration of active power to time. Changing the voltage or current range within the integration time may cause the 66203/66204 DSP calculation and measurement incorrect if the A/D converter sampling data is ignored during range change. Thus, the voltage and current range will be locked when the trigger key is pressed to start the energy calculation. The range change can only be accepted when the measurement is stopped. When the UUT’s voltage or current peak exceeds the measurement range upper limit, the 66203/66204 will prompt a warning message and stop measuring. However, it will not prompt an error message and stop the measurement if the signal peak is temporary. When performing the energy measurement, only the range and function setup status at present can be viewed as the range or function change could affect the accuracy of measured value.

Following is the procedure to set ENERG function:

1. Press **SETUP** to select Meas. The Meas indicator is on indicating it is in Meas menu.



2. Use ↑, ↓ to select ENERG in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select Whr or JoULE in the 2nd display window and press **TRIG/ENTER**.
4. Use ↑, ↓ to set the integration time in the 3rd and 4th display windows. The 3rd display window is for hour setting and range is 0~9999, while the 4th display window is for minute and second setting and the range is 0~59. When the time adjustment is made, press **TRIG/ENTER** to confirm it.
5. Press **SETUP** to return to the main menu.

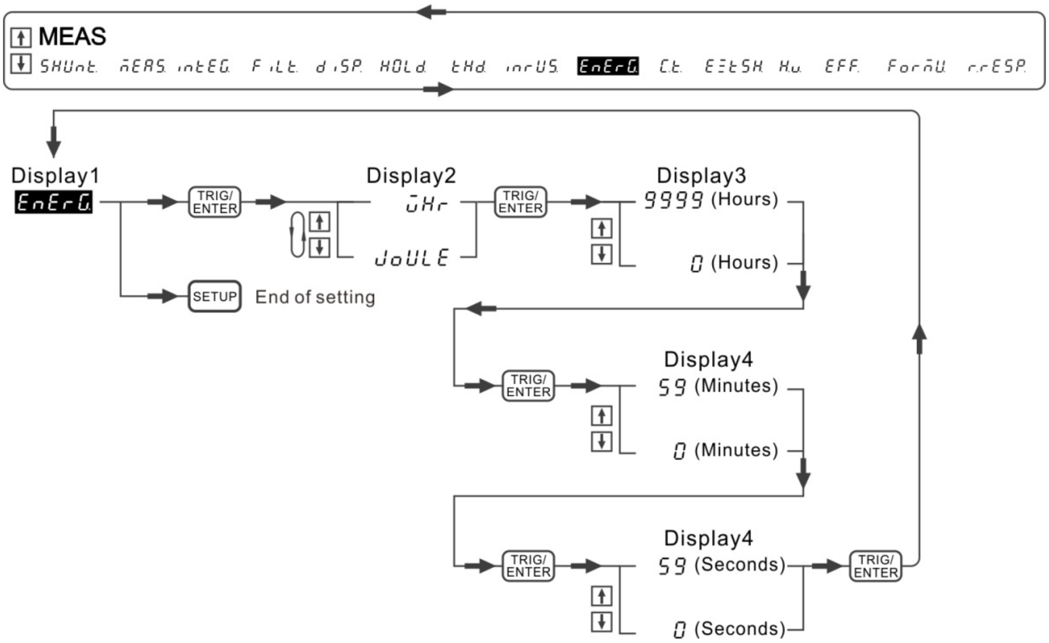


Figure 4-56 Process for Setting ENERGY

6. When the parameter settings are done, press **FUNC** next to the 3rd display window and select the indicator "E".
7. Press **TRIG/ENTER** and the power meter starts to do energy calculation. The "E" indicator will blink. When the measurement is done, the "E" indicator stops blinking and shows the calculated value in the display window.

Notice

1. The 66203/66204 Digital Power Meter has 3 types of parameters that require **TRIG/ENTER** for triggering, they are E (Energy), Is (Inrush Current) and GO/NG. The priority is E > Is > GO/NG.
2. The Integration (INTEG) and Energy (E) calculation are two separate functions that can be performed at the same time.

CT

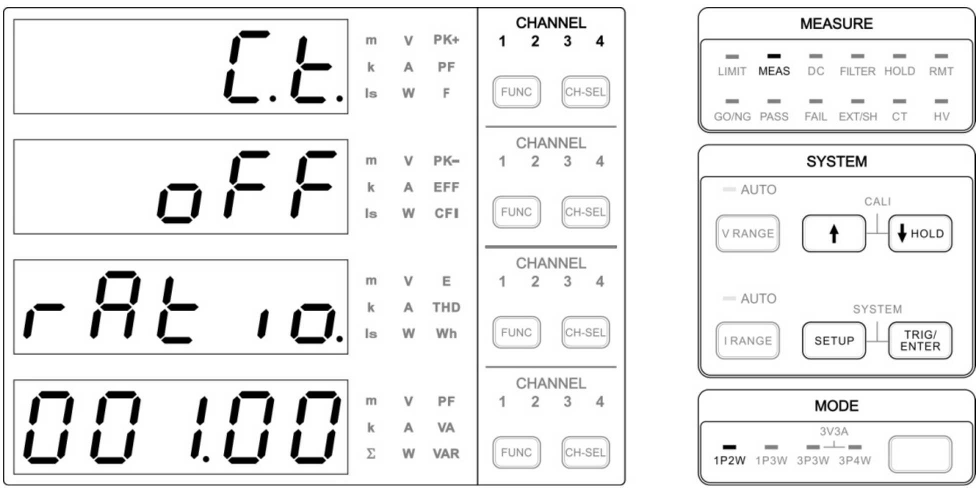


Figure 4-57 CT Setup Screen

If the UUT's maximum current exceeds the maximum range of the 66203/66204 Digital Power Meter, the Current Transducer (CT) can be selected to work with the power meter. The power meter's CT function needs to be activated and set the conversion ratio. For instance: if the CT conversion ratio is labeled 1000, the RATIO should set to 1000 and the limit is 1.00~9999.9.

If it is current output for the CT secondary side, after the R_s is connected in series, connect the current input terminal (I+, I-). The current of secondary side goes through the internal shunt of the power meter and the voltage signal sensed from the 2 ends of shunt will be transformed into the actual measured current of CT primary side by the power meter. The CT load resistance of secondary side includes the shunt value inside the power meter and the R_s connected externally. Thus, please make sure the total load resistance of secondary side is within the specification of CT.

The figure below shows the wiring:

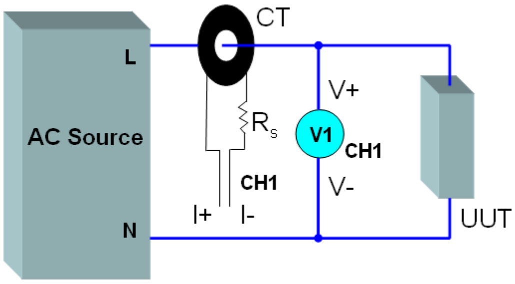


Figure 4-58 CT Wiring for I+ & I-

If the CT secondary side is connecting to the load resistance R_s, when the secondary side current goes through R_s, it will convert to sense voltage signal. The voltage signal connected to the EXT terminal (EXT, I-) will be transformed into the actual measured current of CT primary side by the power meter.

Besides the CT ratio is required for this application, it still needs to key in the R_s resistance in the ExtSH function. Please see the section of ExtSH for detail ExtSH function setting.

For the usage of DC CT (current transducer), please read the caution notes 2 below.

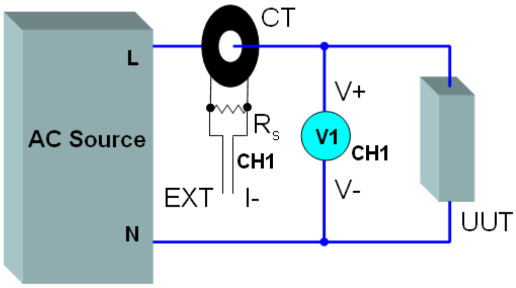
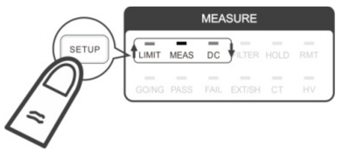


Figure 4-59 CT Wiring for EXT & I-

Following is the procedure to set CT function:

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select C.t. function in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select on in the 2nd display window and press 下 **TRIG/ENTER** to confirm it. When the CT indicator is on, it means the CT function is enabled.
4. Use ↑, ↓ to adjust ratio in the 4th display window and press **TRIG/ENTER** to confirm it.
5. When done, press **SETUP** to exit the menu.

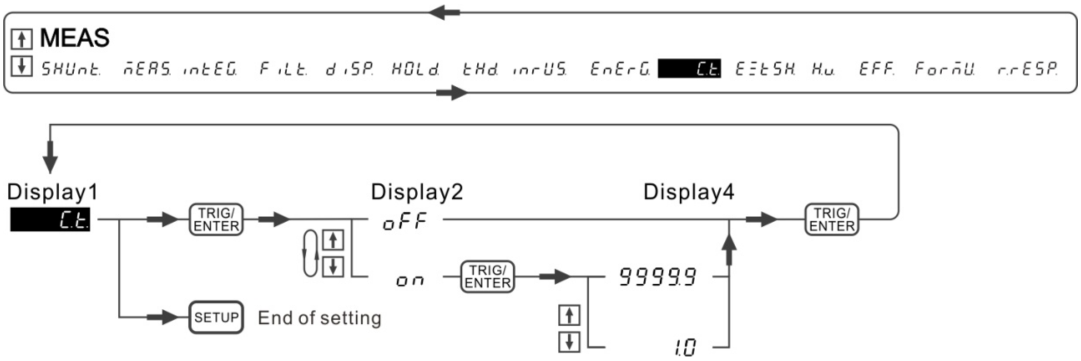


Figure 4-60 Process for Setting CT

Notice

1. If CT is not used for current measurement, the CT function should be turned off to avoid wrong calculation.
2. The internal shunt of the 66203/66204 is the load of CT secondary side. The shunt resistance is 5mΩ (High shunt) and 500mΩ (Low shunt) respectively. The shunt resistance is related to the output capacity and linearity of CT. Please use this function properly.
3. If the load of CT secondary side is external instead of using the shunt inside the 66203/66204, the CT and ExtSH function must be enabled at the same time. The CT conversion ratio and external resistance need to be set. The CT and EXT/SH indicators will be turned on.
4. Since the sensing voltage amplitude is small, the measurement cable should be as short as possible to avoid signal interference and affecting the accuracy. It is suggested to use twisted or coaxial cable for measurement.

⚠WARNING

1. When CT is in use, it should keep the secondary side coil from open as it will generate high voltage when the current is passing through the secondary side coil and it will cause hazard.
2. When DC CT is in use, the power supply of secondary side should use 1200Vrms or above for isolation to ensure the safety of usage. When multiple DC CTs are used for different measurement channels, the power supply of secondary side coil has to be isolated for 1200Vrms.

ExtSH

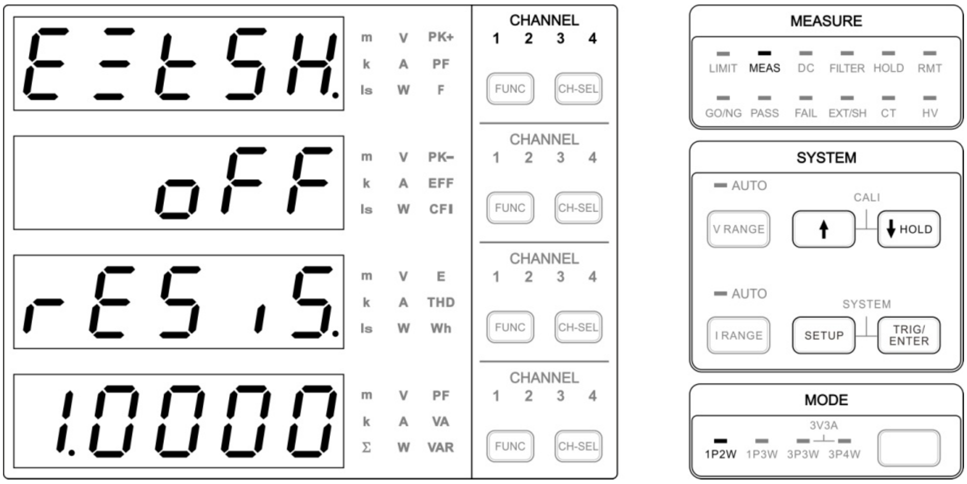


Figure 4-61 EXTERNAL Setup Screen

If the maximum current of UUT exceeds the maximum range of the 66203/66204 Digital Power Meter, it can select external shunt to work with the power meter for measurement. It would need to enable the ExtSH function on the power meter and set the external shunt resistance. The setting range is 0.0001m~99.999 and the unit is Ω. ◦

The UUT current will flow into the connected external shunt and the voltage input EXT terminal (EXT, I-) sensed from the external shunt will be transformed into the actual measured current by the power meter.

The figure below shows the wiring:

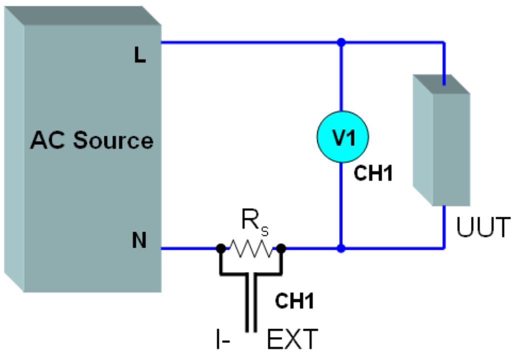
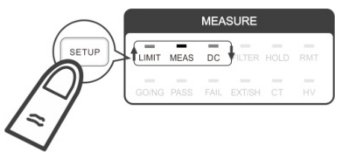


Figure 4-62 EXTERNAL Wiring

Following is the procedure to set ExtSH function:

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select ExtSH function in 1st display window and press **TRIG/ENTER** to confirm it.

3. Use **↑**, **↓** to select on in the 2nd display window and press **TRIG/ENTER** to confirm it. When the EXT/SH indicator is on, it means the ExtSH function is enabled.
4. Use **↑**, **↓** to adjust the resistance in the 4th display window and press **TRIG/ENTER** to confirm it.
5. When done, press **SETUP** to exit the menu.

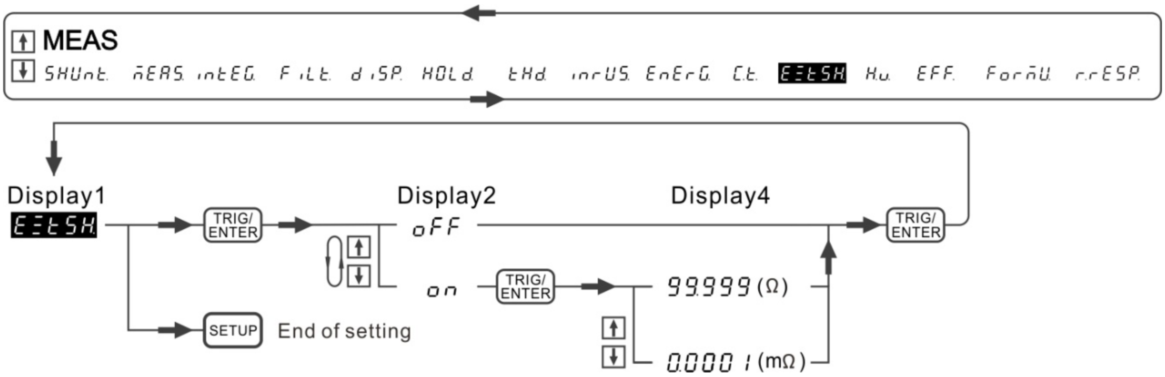


Figure 4-63 Process for Setting ExtSH

Notice

1. The input impedance of the 66203/66204 EXT terminal is 100kΩ that could affect the equivalent impedance of external shunt and the measurement accuracy. Please use this function properly.
2. When the ExtSH function is enabled, the selection of current range will change to EXT. Please see the section of range selection for the detail of range setting.
3. Since the sensing voltage amplitude is small, the measurement cable should be as short as possible to avoid signal interference and affecting the accuracy. It is suggested to use twisted or coaxial cable for measurement.

⚠WARNING

1. The maximum input voltage allowed for EXT input terminal is 100mVrms.
2. The maximum voltage difference allowed for EXT input terminal to Ground is 600V.

HV

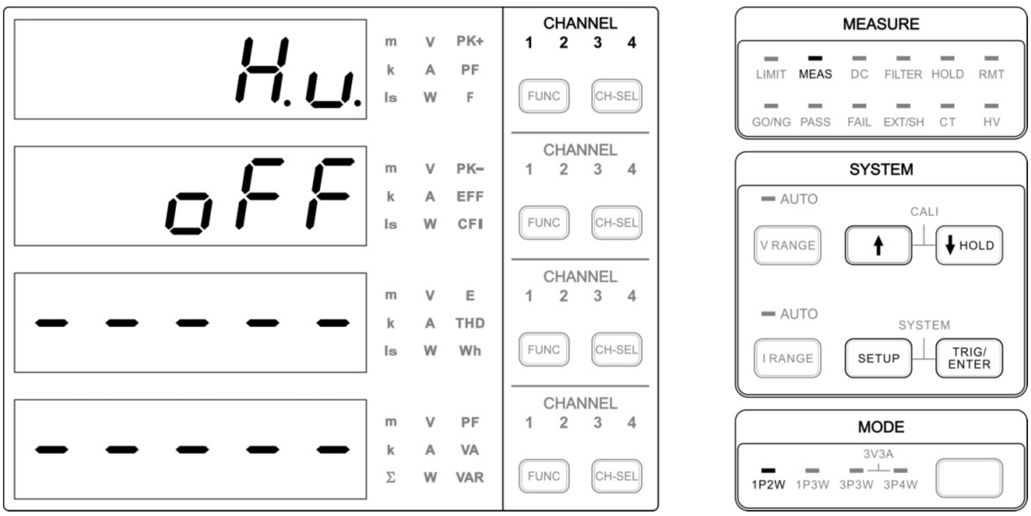


Figure 4-64 HV Setup Screen

The maximum voltage measurement range of the 66203/66204 Digital Power Meter is 600Vrms (CF=2). If the measurement voltage is higher than the range, it can use the option A662012 (1200V HV Measurement Kit) or A662023 (1800V HV Measurement Kit) to work with the power meter for measurement. The HV Measurement Kit can increase the range up to 1200V or 1800V, but the frequency applicable range is limited to DC and 47Hz~63Hz. To ensure the measurement spec, the HV function of 66203/66204 can only work with the option A662012 or A662023. Please see Appendix F for the specification of A662012. See the A662023 user's manual for its detailed applications and specifcations.

Notice A662023 (1800 V HV Measurement Kit) is only applicable to firmware version ≥ 1.21.

Following diagram shows the wiring of HV Measurement Kit for PV inverter efficient measurement.

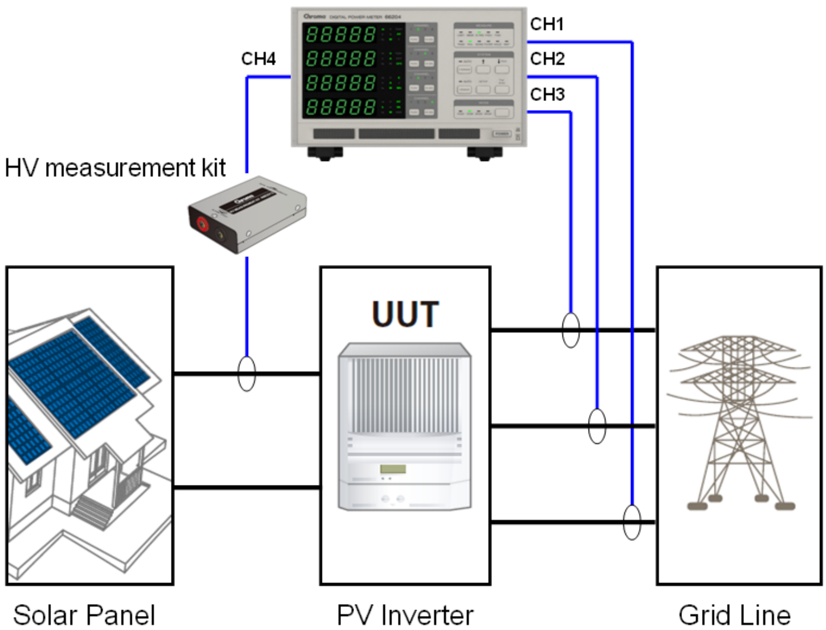
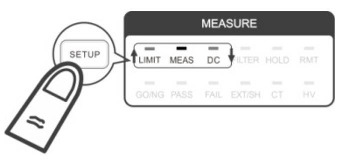


Figure 4-65 HV Measurement Kit Wiring Diagram

Following is the procedure to set HV function:

If the firmware version is < 1.21:

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select HV function in 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select on in the 2nd display window and press **TRIG/ENTER** to confirm it. When the HV indicator is on, it means the HV function is enabled.
4. When done, press **SETUP** to exit the menu.

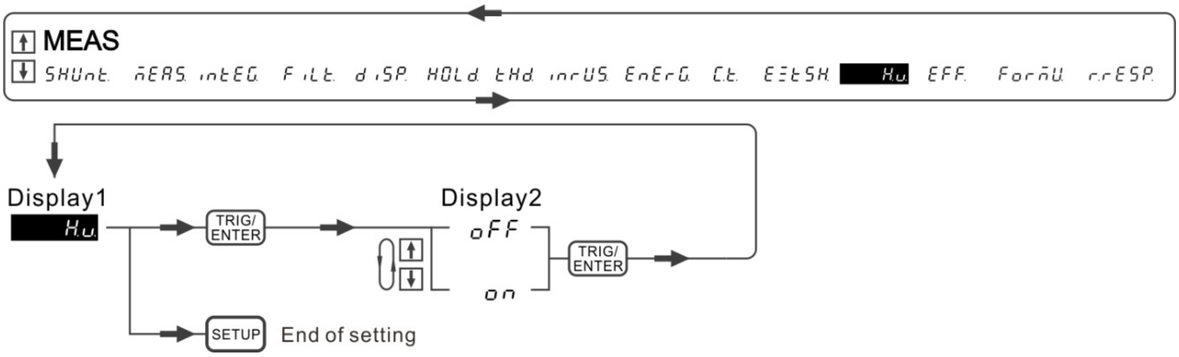
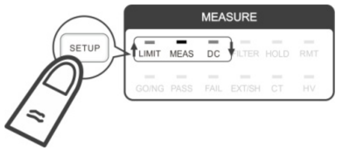


Figure 4-66 Process for Setting HV (when firmware version is < 1.21)

If the firmware version is ≥ 1.21:

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select HV function in 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select OFF/A-12/A-023 in the 2nd display window and press **TRIG/ENTER** to confirm it. When the HV indicator is on, it means the HV function is enabled.
4. When done, press **SETUP** to exit the menu.

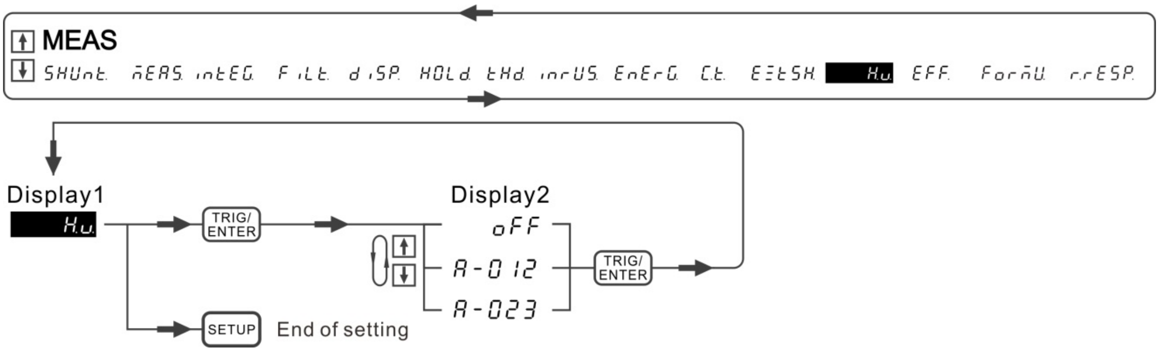


Figure 4-67 Process for Setting HV (when firmware version is ≥ 1.21)

Notice

1. The length of HV measurement kit output cable or twisted wire may affect the measured specification. Please do not change the design arbitrarily.
2. When the HV measurement kit is connected, the input impedance will increase. If the voltage meter is used alone, the input impedance is able 8MΩ.
3. To guarantee the measured specifications, be sure to select the mode that maps to the fixture in use for measurement.

WARNING

1. For the input cable of HV Measurement Kit, please use the wire with the insulation grade of 2.4kV or above.
2. The HV Measurement Kit has high voltage output and input. Do not open the case or change the input and output cable arbitrarily, or electric shock hazard may occur.

EFF

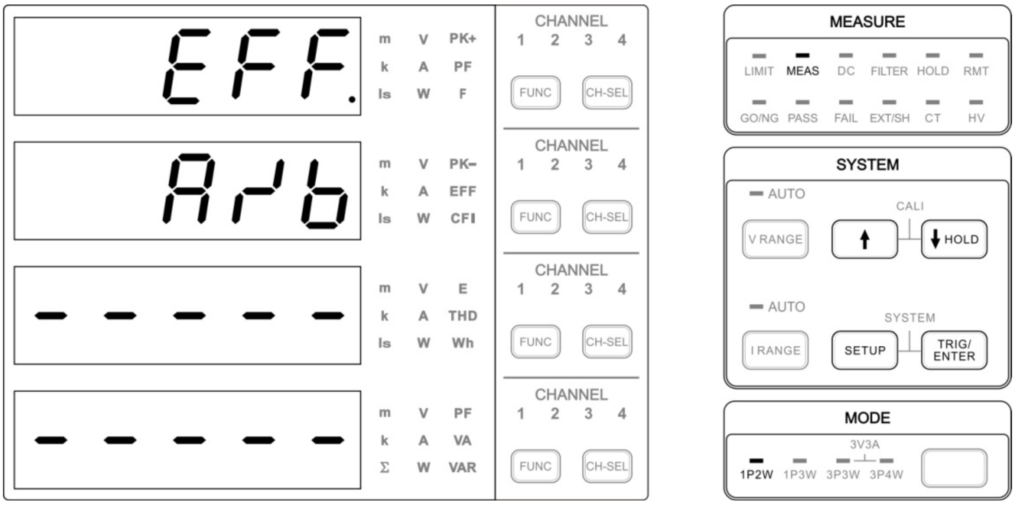
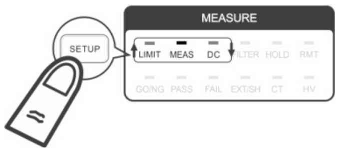


Figure 4-68 EFFICIENCY Setup Screen

The 66203/66204 Digital Power Meter has EFF function to calculate the efficiency of power supply or energy converter. The EFF defines the calculation to be A/B or B/A. Please follow the table below the assign the measurement channel to A or B based on the set wiring mode.

Following is the procedure to set EFF function:

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select EFF function in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select a/b or b/a calculation mode in the 2nd display window and press **TRIG/ENTER** to confirm it.
4. When done, press **SETUP** to exit the menu.
5. Press **FUNC** to switch the indicator to EFF in Display 2. The indicators of all measurement channels will be off.

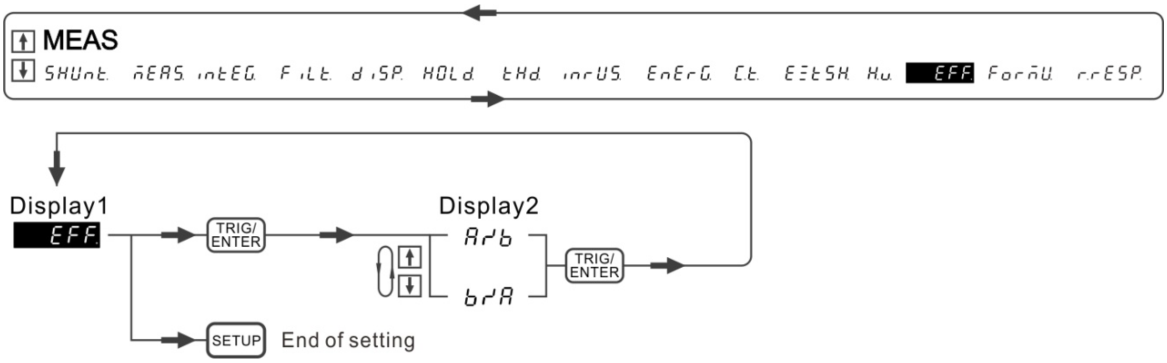


Figure 4-69 Process for Setting EFFICIENCY

A & B Definition of EFF Function of 66204				
WIRE MODE	**CH1**	**CH2**	**CH3**	**CH4**
1P2W	**A**			**B**
1P3W	**A**			**B**
3P3W	**A**			**B**
3V3A	**A**			**B**
3P4W	**A**			**B**

A & B Definition of EFF Function of 66203			
WIRE MODE	**CH1**	**CH2**	**CH3**
1P2W	**A**		**B**
1P3W	**A**		**B**
3P3W	**A**		**B**

Formu

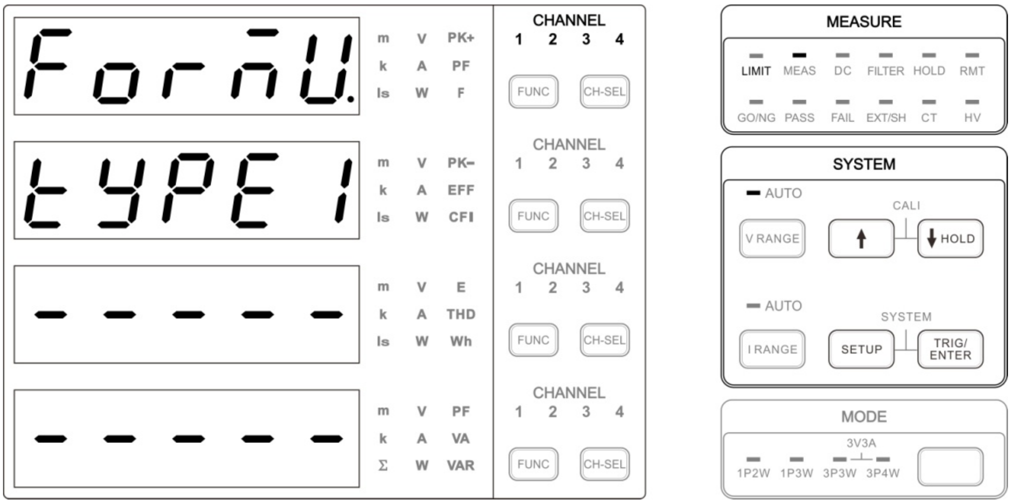


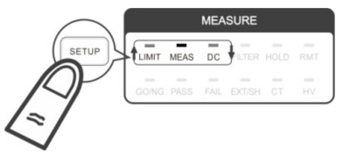
Figure 4-70 Formu Setup Screen

The 66204 Digital Power Meter provides different wiring modes for various 3-phase power systems when performing power measurement including 1P3W, 3P3W, 3V3A and 3P4W. There are also TYPE1, TYPE2 and TYPE3 to satisfy various 3-phase power measurements. These 3 types of measurement methods are set in Formu function and the detailed formula is described in 4.4 *Computing Equation for Measurement Parameters*.

Notice Formu function is only supported when the firmware version is ≥ 1.20.

Following is the procedure to set Formu function.

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select Formu function in the 1st display window and press **TRIG/ENTER** to

confirm it.

3. Use ↑, ↓ to select TYPE1, TYPE2 or TYPE3 in the 2nd display window and press **TRIG/ENTER** to confirm it.
4. When done, press **SETUP** to exit the menu.

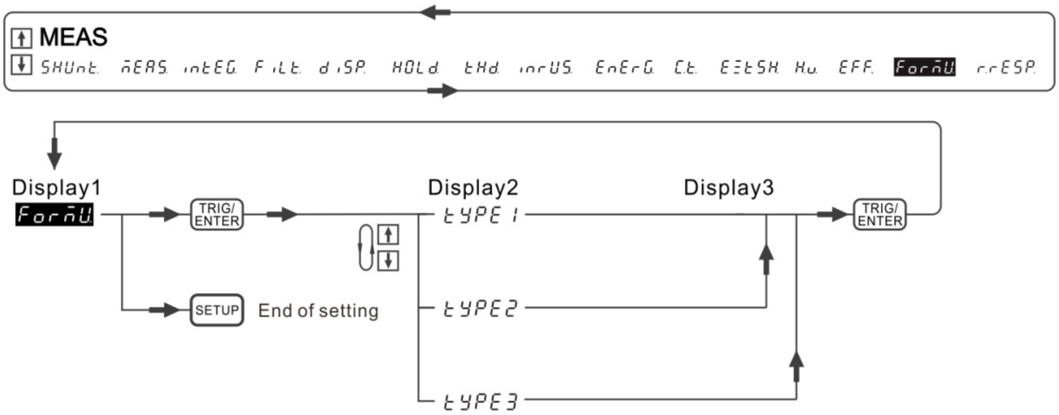


Figure 4-71 Process for Setting Formu

R.RESP

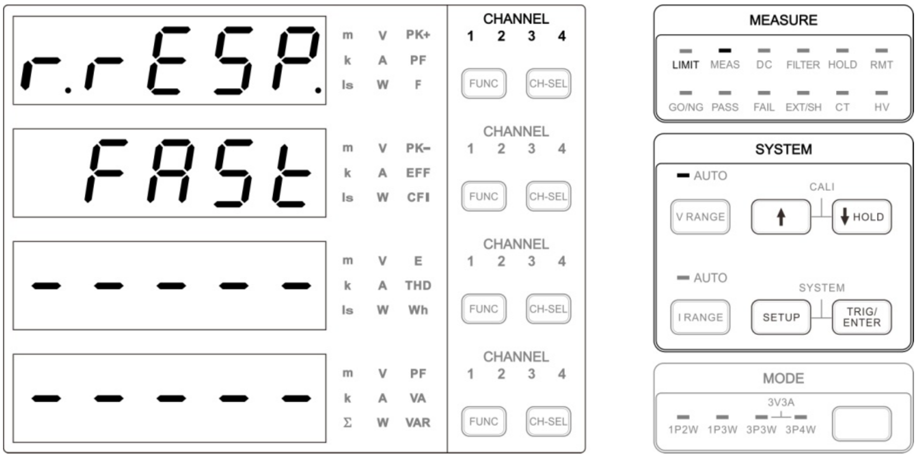


Figure 4-72 R.RESP Setup Screen

The R.RESP has FAST response and SLOW response two modes as described below.

- **FAST response mode**
  The range downscales when the peak current meets the condition within a short time (about two weeks basic wave period).

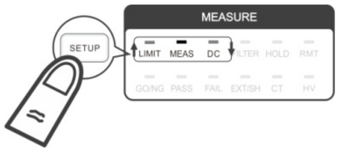
- **SLOW response mode**
  The range downscales when the peak current meets the condition within the time set.

Notice

1. R.RESP function is only valid during current measurement.
2. When the measured current change is too drastic to cause the current range over sensitive and lose data, it is suggested to set the R.RESP to SLOW.
3. R.RESP function is only supported when the firmware version is ≥1.20.

Following is the procedure to set R.RESP function:

1. Press **SETUP** to select Meas. The Meas indicator is on.



2. Use ↑, ↓ to select R.RESP function in the 1st display window and press **TRIG/ENTER** to confirm it.
3. Use ↑, ↓ to select FAST or SLOW in the 2nd display window and press **TRIG/ENTER** to confirm it.
4. When done, press **SETUP** to exit the menu.

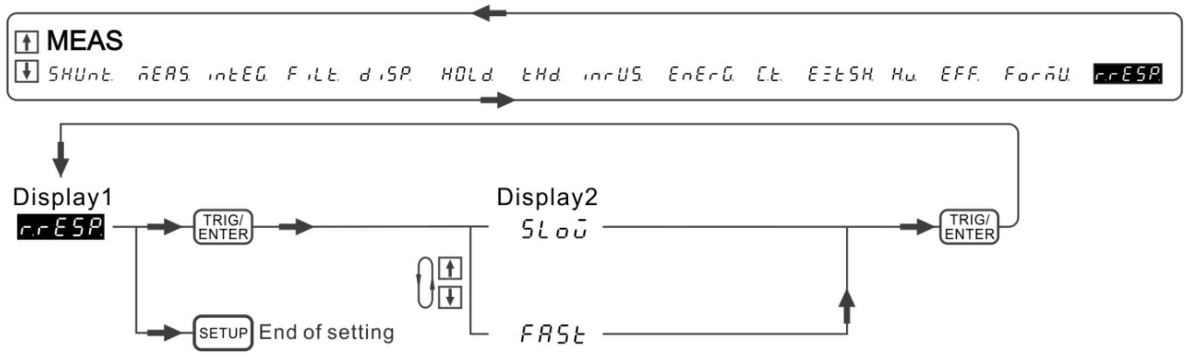


Figure 4-73 Process for Setting R.RESP

4.6.3 DC

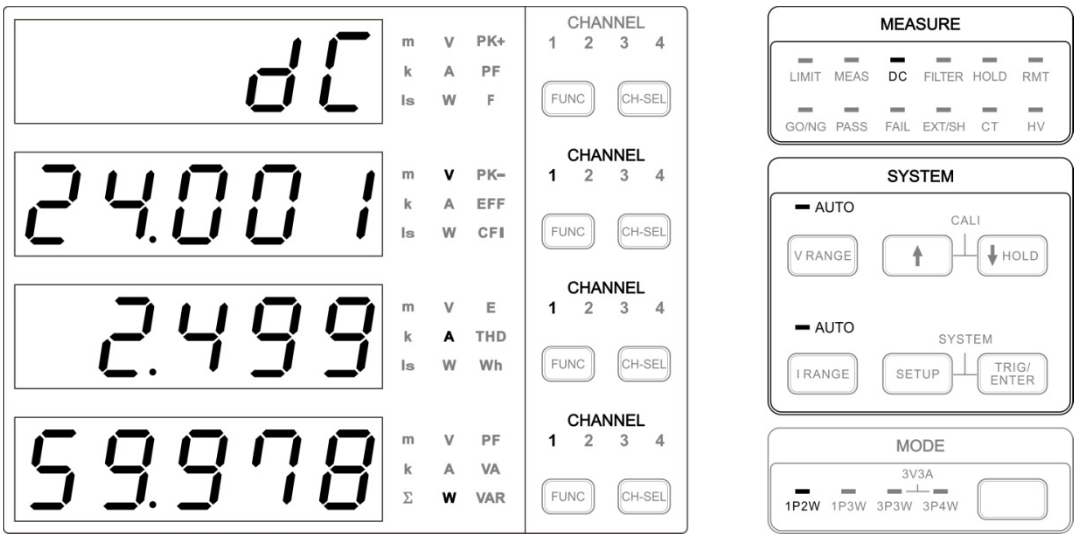
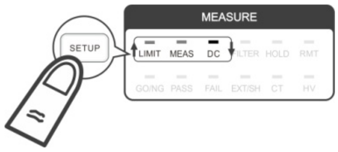


Figure 4-74 DC Measurement Setup Screen

Please see section 4.4 for the calculation formula of DC value. If the test signals contain AC and DC portions, the frequency of AC will determine the sampling frequency of digital-analog converter. If there is only DC, the sampling frequency will use AC LINE INPUT frequency to determine the sampling frequency. When doing DC measurement, it is suggested to use digital low pass filter to make the DC measured value more stable and accurate without compromising the AC measurement accuracy conditions. The setting of measurement range is determined based on the entire waveform signal amplitude. If the AC signal is much larger than the DC signal, the DC measurement accuracy will be affected caused by low resolution.

Following is the setting procedure:

1. Press **SETUP** to select DC and the DC indicator is on.



2. The voltage, current and power measured vales are shown on the 2nd ~ 4th display window respectively. Press **CH-SEL** to switch the channel for viewing the measured value.

Notice

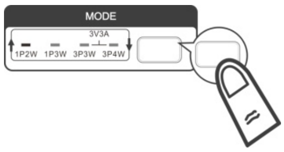
1. It is normal if there are tiny measured values fluctuating on the screen without any signals inputted. The measured values vary with the ranges set.
2. When the input signal is AC+DC, the AC voltage signal must be larger than 1/10(Voltage Range) to calculate the DC signal volume totally and then separate the signal as well as display it individually.
3. This function is to show the DC measured value. The voltage and current range cannot be selected manually in this menu. To select the range manually, please exit this menu and return to the measurement setup screen for setting.

4.7 Wiring Mode

As the table shown below, the 66203/66204 Digital Power Meter provides 6 types of wiring modes for single and 3-phase power measurements. The actual wiring has to match the selected wiring mode and follow the table or wiring diagram below to select the correct channel for measurement; otherwise, the measurement and calculation will not be correct. To measure the efficiency of selected wiring mode, please see EFF function in section 4.6.2 for detail information.

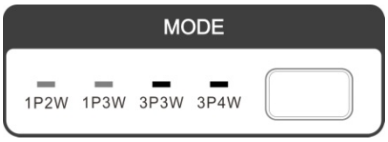
	Wiring Mode of 66203/66204			
Wiring System	**Channel 1**	**Channel 2**	**Channel 3**	**Channel 4 (66204 only)**
1P2W (Single Phase, two Wire)	1P2W	1P2W	1P2W	1P2W
1P3W (Single Phase, three Wire)	1P3W		1P2W	1P2W
3P3W (Three Phase, three Wire)	3P3W		1P2W	1P2W
3P3W (Three Phase, three Wire)	3V3A			1P2W
3P3W (Three Phase, three Wire)	3P4W			1P2W
3P4W (Three Phase, four Wire)	3P4W			1P2W

The mode can be selected from the panel is in the following sequence: 1P2W→1P3W →3P3W→3V3A→3P4W→1P2W as the figure shown below.

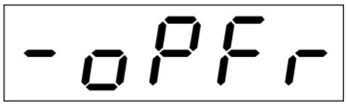


Notice

1. The 3V3A mode on 66204 digit power meter is only supported when the firmware version is ≥ 1.20. Since 3V3A is a new function, the old display panel has no printing label of 3V3A. Therefore, when the 3P3W and 3P4W lights are on simultaneously, it means 3V3A is active as the figure shown below.



2. If the actual connection does not match the measurement mode, the PF measurement could be larger than 1, the display will show PF over range warning (Over Power Factor Range, OPFR). It is only supported when the firmware version is ≥ 1.21.



4.7.1 Selecting 1P2W Wiring Mode

Single phase power is the simplest wiring for residential electricity as the diagram shown below.

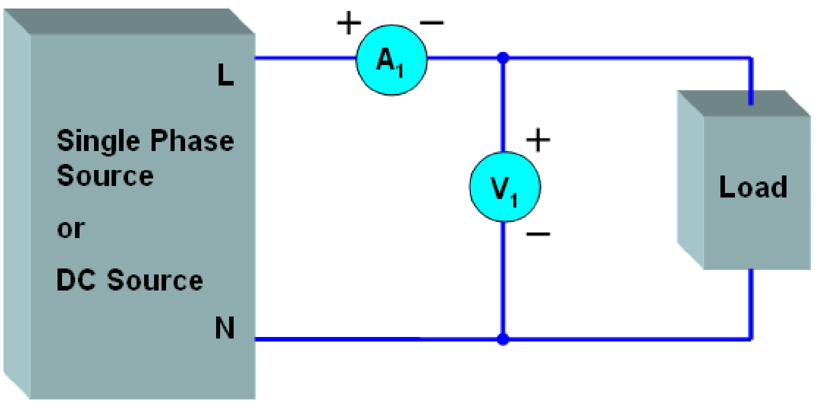


Figure 4-75 1P2W Wiring Diagram

4.7.2 Selecting 1P3W Wiring Mode

Single phase 3-wire power is the most frequent seen application for residential electricity. The L1-L2 is for the household appliance with larger capacity and the L1-N and L2-N voltage is for the household appliance with smaller capacity in phase. Figure 4-76 uses two power meters to measure the single phase 3-wire power. The total power is the sum of two power meters.

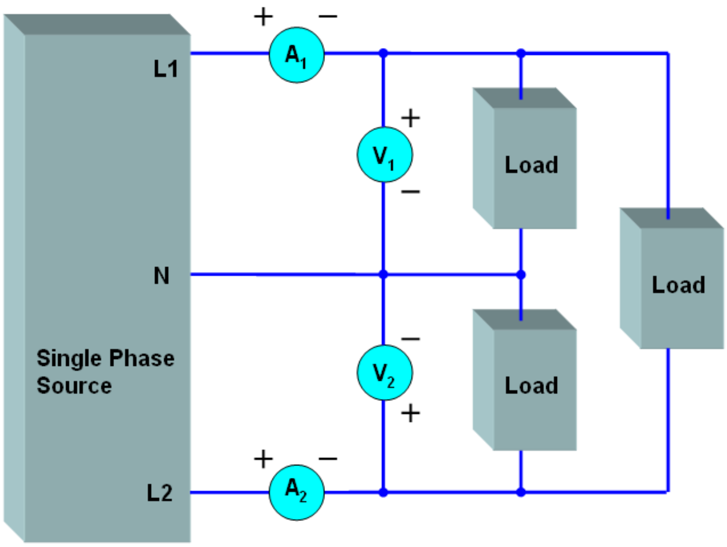


Figure 4-76   1P3W Wiring Diagram

4.7.3 Selecting 3P3W Wiring Mode, Two-Wattmeter Method

Taking the example of Y connection 3-phase power measurement, it usually uses 3 power meters to grab the individual instantaneous power of 3 phases simultaneously and calculate the average power of each phase and then sum up to get the total power.

$$p = v_1 i_1 + v_2 i_2 + v_3 i_3$$

$$p = W_1 + W_2 + W_3$$ (3-phase 4-wire – using three-wattmeter method)

Based on Kirchhoff's current law, $i_1 + i_2 + i_3 = 0$ or $i_3 = -(i_1 + i_2)$. Thus,

$$\begin{aligned} p &= v_1 i_1 + v_2 i_2 - v_3 i_1 - v_3 i_2 \\ &= (v_1 - v_3) i_1 + (v_2 - v_3) i_2 \end{aligned}$$

$$p = W_1 + W_2$$

From the formula above, it can use two wattmeters to measure the power of 3 phases that is to use the wattmeter on channel 1 to measure the L1 current i_1 and the L1 to L3 voltage $(v_1 - v_3)$ and use the wattmeter on channel 2 to measure the L2 current i_2 and the L2 to L3 voltage $(v_2 - v_3)$ as Figure 4-77 shown below. Using the two-wattmeter method can measure the 3-phase 3-wire balance or unbalance total active power (ΣP) easily; however, the fault is that it cannot measure the power of each phase directly and individual wattmeter reading is meaningless. With applications featuring 4 wire systems with a neutral return, the two-wattmeter method will only be correct if the system is balanced. The total power factor reading of the two-wattmeter method will only be correct if the system is balance.

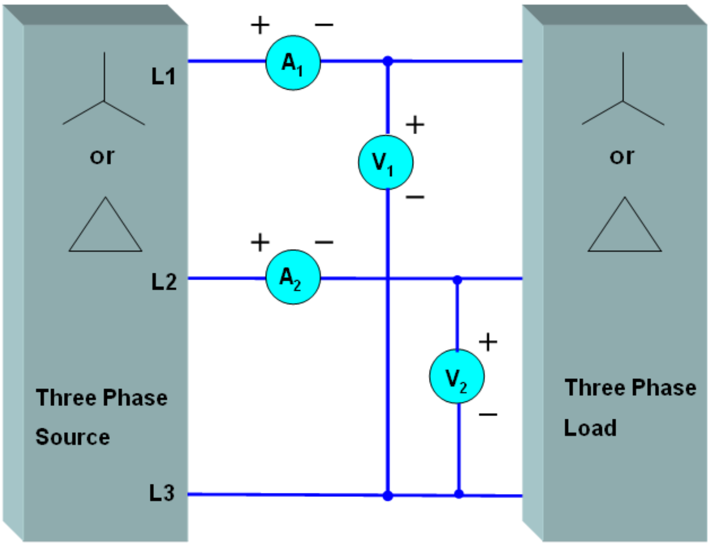


Figure 4-77 Two-Wattmeter Method Diagram

4.7.4 Selecting 3V3A Wiring Mode, Three-Wattmeter Method

To measure the total apparent power (ΣS) and power factor (ΣPF) more accurately on an unbalanced three-phase circuit, it is recommended that using 3V3A wiring mode to make the measurement on 3-phase, 3-wire system. This method will get all three voltages and current on 3-phase, 3-wire system. The measurement principle of the total active power (ΣP) is same as two-wattmeter method, thus the individual wattmeter reading is meaningless.

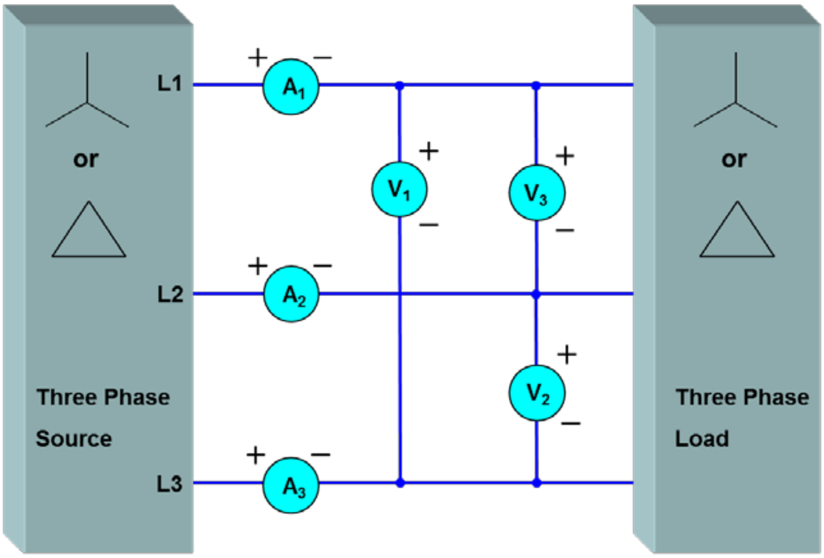


Figure 4-78 Three-Wattmeter Method (3V3A) Wiring

4.7.5 Selecting 3P4W Wiring Mode, Three-Wattmeter Method

The total power of 3-phase 3-wire power system can be measured using the two-wattmeter; however, if it is desired to get the power and voltage of each phase, it needs to connect the "-" of each voltage meter together as a false neutral for measurement as Figure 4-79 shows.

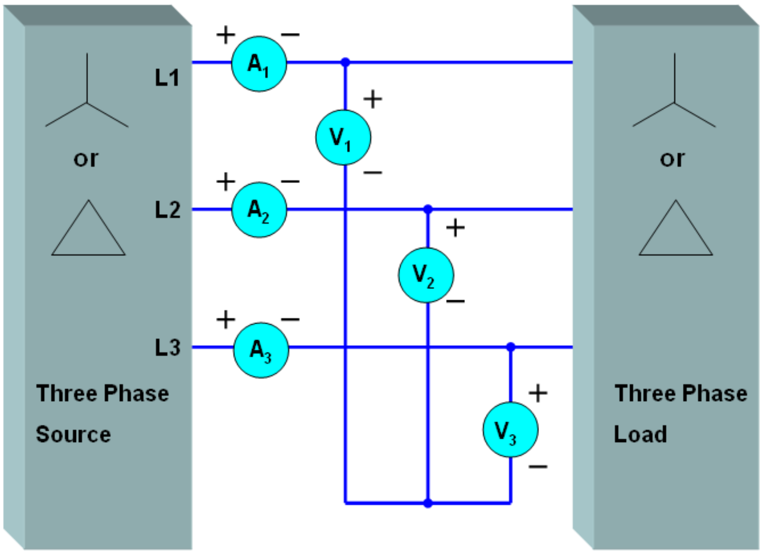


Figure 4-79 Three-Wattmeter Method Wiring

4.7.6 Selecting 3P4W Wiring Mode, Three-Wattmeter Method

Taking the example of Y connection 3-phase power measurement, it uses 3 power meters to grab the individual instantaneous power of 3 phases simultaneously and calculate the average power of each phase and then sum up to get the total power.

$$p = v_1 i_1 + v_2 i_2 + v_3 i_3$$
$$p = W_1 + W_2 + W_3$$

From the formula above, it can use three wattmeters to measure the power of 3 phases that is to use the wattmeter on channel 1 to measure the L1 current i_1 and L1 to neutral voltage $(v_1 - v_n)$ and use the wattmeter on channel 2 to measure the L2 current i_2 and L2 to neutral voltage $(v_2 - v_n)$ as well as use the wattmeter on channel 3 to measure the L3 current i_3 and L3 to neutral voltage $(v_3 - v_n)$. The advantage of using three-wattmeter method is that it can measure the power and neutral voltage of every phase directly. It can also use the 4th channel of the 66204 Digital Power Meter to measure the neutral current under the unbalanced power system or use the current of each phase for calculation.

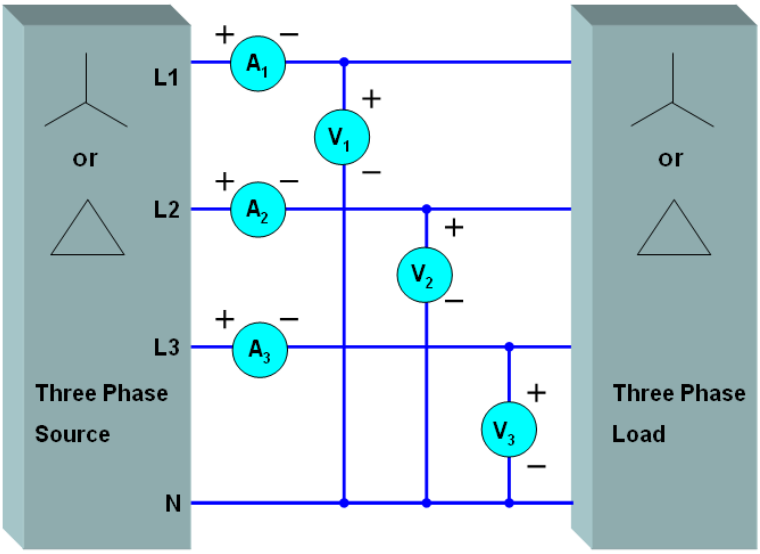


Figure 4-80 Three-Wattmeter Method Wiring

4.8 Fans Inspection

The 66203/66204 Digital Power Meter has two cooling fans which are located on the right side of the device at the front and the rear. The fan at the front runs after powered on to help dissipating the heat of internal circuit. The rear fan only enables when the current range is 0.5A/2A/5A/20A to help dissipating the heat flowing through the shunt after measured the rated current RMS up to 20A to keep high accuracy measurement. To avoid providing inaccurate measured value to the user, a warning message will prompt in the 1st display window if any of the fans is having error as Figure 4-81 shows and it will beep consistently to warn the user. The 66203/66204 Digital Power Meter will perform self-test on the fans during power-on or constant operation. Before the error is fixed, the message on the power meter cannot be cancelled. It is suggested to send the power meter back to Chroma for repair.

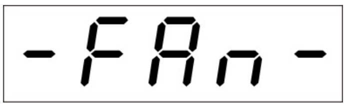


Figure 4-81 Fan Error Warning Screen

5. Using Remote Control

5.1 Overview

66203/66204 provides GPIB and USB two kinds of remote control interfaces and all functions of panel keys can be controlled by these two interfaces. The USB interface supports USB 2.0 / USB 1.1, while the GPIB interface is complied with IEEE-488 standard.

5.2 USB in Remote Control

Supported Hardware: USB 2.0 and USB 1.1
Supported Protocol: USBTMC class and USB488 subclass

Installing Driver Program:
The USB Interface of **66203/66204** supports USBTMC; therefore, if the PC's OS supports USBTMC (the PC has installed NI-VISA runtime 3.00 or above) there is no need to install other drivers in particular. The OS will search the standard USBTMC for installation automatically.

If the PC's OS does not support USBTMC, it is suggested to install NI-VISA runtime 3.00 or above first. The USBTMC driver will be in the OS once the NI-VISA runtime is installed. Power on the Digital Power Meter after connected it with the PC via USB cable and the PC can use the **66203/66204** SCPI commands through **NI-VISA** to communicate with the Digital Power Meter.

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

5.3 The GPIB Capability of the Power Meter

GPIB Capability	Response	Interface Functions
Talker/Listener	Commands and response messages can be sent and received over the GPIB bus. Status information can be read using a series poll.	AH1, SH1, T6, L4
Service Request	The Power Meter sets the SRQ line true if there is an enabled service request condition.	SR1
Remote/Local	The Power Meter powers up in local state. In local state, the front panel is operative, and the Power Meter responds to the commands from GPIB. In remote state, the ***RMT*** of indicator will be lighted up and all front panel keys except the "<SETUP>" key are disabled. Press "<SETUP>" key to return the Power Meter to local state.	RL1

Device Clear	The Power Meter responds to the Device Clear (DCL) and Selected Device Clear (SDC) interface commands. These cause the Power Meter to clear any activity that may prevent it from receiving and executing a new command. DCL and SDC do not change any programmed settings.	DCL, SDC

5.4 Introduction to Programming

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

5.4.1 Conventions

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

5.4.2 Data Formats

All data programmed to or returned from the Power Meter are ASCII. The data can be numerical or character string.

Numerical Data Formats

Chroma 66203/66204 Power Meter accepts the numerical data type listed in Table 5-1.

Table 5-1 Numerical Data Type

Symbol	Description	Example
<NR1>	It is a digit with no decimal point. The decimal is assumed to be at the right of the least significant digit.	123 , 0123
<NR2>	It is a digit with a decimal point.	12.3 , .123
<NRf>	Flexible decimal form that includes NR1 or NR2 or NR3.	123, 12.3, 1.23E+3
<NRf+>	Expanded decimal form that includes NRf and MIN, MAX. MIN and MAX are the minimum and maximum limit values for the parameter.	123, 12.3, 1.23E+3, MIN, MAX

Character Data Format

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

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

<u>Arbitrary Block Data Format</u>

The arbitrary block data returned by query command may take either of the following forms:
<DLABRD> Definite Length Arbitrary Block Response Data:

The <DLABRD> is formatted as:
#<x><yy...y><byte1><byte2><byte3><byte4>…<byteN><RMT>

Where,
<x> is the number of characters in <yy…y>.
<yy…y> is the number of bytes to transfer.

For example, if <yy…y> = 1024, then <x> = 4 and <byte1><byte2><byte3>…<byte1024>

<ILABRD> Indefinite Length Arbitrary Block Response Data:
The <ILABRD> is formatted as:
#<0><byte1><byte2><byte3><byte4>…<byteN><RMT>

5.5 Basic Definition

5.5.1 Command Tree Table

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

5.5.2 Program Headers

Program headers are key words that identify the command. They follow the syntax described in subsection <u>5.8</u> of IEEE 488.2. The Power meter accepts characters in both upper and lower case without distinguishing the difference. Program headers consist of two distinctive types, common command headers and instrument-controlled headers.

<u>Common Command and Query Headers</u>:
The syntax of common command and query headers is described in IEEE 488.2. It is used together with the IEEE 488.2-defined common commands and queries. The commands with a leading " * " are common commands.

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

Long-Form : The word is spelled out completely to identify its function. For instance, CURRENT, VOLTAGE and MEASURE are long-form.

Short-Form : The word contains only the first three or four letters of the long-form. For instance, CURR, VOLT and MEAS are short-form.
In the section *5.7.2 Instrument* Commands, the upper case is part of short-form. For instance, SYSTem : ERRor? can be wrote as SYST : ERR?

Program Header Separator (:):
If a command has more than one header, the user must separate them with a colon (example: FETC:CURR:RMS? or POW:INT 10). Data must be separated from program header by one space at least.

5.5.3 Program Message

Program message consists of a sequence of element of program message unit that is separated by program message unit separator elements of program message unit, and a program message terminator.

Program Message Unit:
Program message unit represents a single command, programming data, or query.

Example: FILT? or WIND ON

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

Example: VOLT:RANG V300 ; CURR:RANG AUTO

Program Message Terminator (<PMT>):
A program message terminator represents the end of a program message. Three permitted terminators are:

(1) <EOI> : end or identify.
(2) <LF>(i.e.: NL, new line) : line feed which is a single ASCII-encoded byte 0A (10 decimals).
(3) <LF><EOI> : line feed with EOI.

5.5.4 Response Message

Response message consists of a sequence one or more elements of response message unit that is separated by response message unit separator elements of response message unit, and a response message terminator.

Response Message Unit:
Response message unit consists of a sequence one or more elements of response data unit that is separated by response data unit separator elements of response data unit.

Example:

Query:	FILT?	Response:	ON
Query:	VOLT:RANG?	Response:	AUTO
Query:	FILT?;:COMP:LIM:V?;:COMP?	Response:	ON ; 220.0 , 50.0 ; OFF

<u>Response Message Unit Separator (;)</u>:
The separator (semicolon ;) separates the response message unit elements from one another in a response message.

Example: ON ; AUTO ; 110.01

<u>Response Data Unit</u>:
Example: ON or AUTO or 110.01 or 220.0 or VPK+

<u>Response Data Unit Separator</u>:
The separator separates the response data unit elements from one another in a response message unit. Three permitted separators are:

When sets the SYSTem:TRANsmit:SEParator as 0 :
(1) (,) : Comma.

When sets the SYSTem:TRANsmit:SEParator as 1 :
(2) (;) : Semicolon.

Example:
When querying FETCH? it will response
<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,... or
<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;...
When querying COMP:ITEM? it will response V , I , W , PF ,... or V ; I ; W ; PF ;...

<u>Response Message Terminator (<RMT>)</u>:
A response message terminator represents the end of a response message. Three permitted terminators are:

When sets the SYSTem:TRANsmit:TERMinator as 0 :
(1) LF(i.e.: NL, new line) : line feed which is a single ASCII-encoded byte 0A (10 decimals).
(2) LF+EOI : line feed with end or identify (EOI).

When sets the SYSTem:TRANsmit:TERMinator as 1 :
(3) CR+LF : cursor return and line feed which are a single ASCII-encoded byte 0D (13 decimals) and a single ASCII-encoded byte 0A (10 decimals).
(4) CR+LF+EOI : cursor return and line feed with end or identify (EOI).

5.6 Traversal of the Command Tree

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

Example:

TRIGger : STATe?	All colons are header separators.
: TRIGger : STATe?	Only the first colon is a specific root.
TRIGger : STATe? ; : VOLTage : RANGe V150	Only the second colon is a specific root.

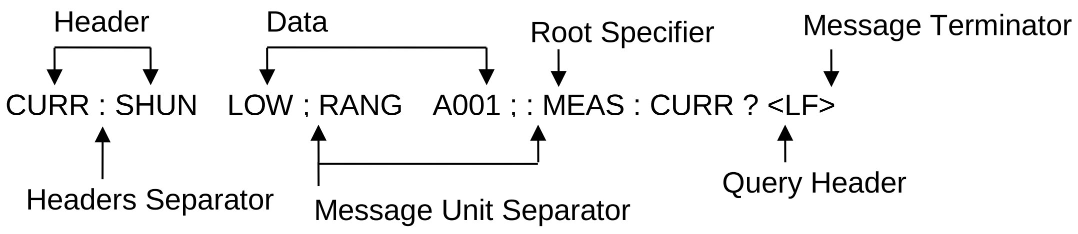


Figure 5-1 The Structure of Program Message

5.7 The Commands of the Power Meter

5.7.1 Standard Commands

***CLS**

Description: This command clears the status byte register and the event registers.
Setting syntax: *CLS<PMT>
Setting parameters: none
Setting example: none
Query syntax: none
Return parameters: none
Query example: none

***ESE**

Description: This command sets the standard event status enable register. This command programs the Standard Event register bits. If one or more of the enabled events of the Standard Event register is set, the ESB of Status Byte Register is set too.

Bit Configuration of Standard Event Status Enabled Register

Bit position	7	6	5	4	3	2	1	0
Bit name	PON	- - -	CME	EXE	- - -	QYE	- - -	- - -
CME = Command error			QYE = Query error					
EXE = Execution error			PON = Power-on					

Setting syntax: *ESE<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 255
Setting example: none
Query syntax: *ESE?<PMT>
Return parameters: <NR1>, 0 ~ 255
Header on: *ESE<space<NR1><RMT>
Header off: <NR1><RMT>
Query example: none

***ESR?**

Description: This command reads out the contents of the standard event status register (SESR).
Setting syntax: none
Setting parameters: none
Setting example: none
Query syntax: *ESR?<PMT>
Return parameters: <NR1>, 0 ~ 255
Header on: <NR1><RMT>
Header off: <NR1><RMT>
Query example: none

***IDN?**

Description: This command queries manufacturer's name, model name, serial number and firmware version.

Setting syntax: none
Setting parameters: none
Setting example: none
Query syntax: *IDN?<PMT>
Return parameters: <SRD>, “Manufacturer,Model name,Serial number,F/W version, FPGA version,PCB version”

Information	*Example*
Manufacturer	Chroma ATE
Model name	66204
Serial number	66204A000066
F/W version	1.00
FPGA version	1.00
PCB version	1.00

Header on: <SRD><RMT>
Header off: <SRD><RMT>

Query example: none

***RST**

Description: This command performs device initial setting.
Setting syntax: *RST<PMT>
Setting parameters: none
Setting example: none
Query syntax: none
Return parameters: none
Query example: none

***SRE**

Description: This command sets the service request enable register (SRER).
Setting syntax: *SRE<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 255
Setting example: none
Query syntax: *SRE?<PMT>
Return parameters: <NR1>, 0 ~ 255
Header on: *SRE<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

***STB?**

Description: This command queries the status byte register.

Bit configuration of Status Byte Register

Bit Position	7	6	5	4	3	2	1	0
Condition	---	MSS	ESB	MAV	QES	CSUM	---	---

ESB = event status byte summary
QES = questionable status summary
MSS = master status summary
MAV = message available
CSUM = channel status summary

Setting syntax: none
Setting parameters: none

Setting example: none
Query syntax: *STB?<PMT>
Return parameters: <NR1>, 0 ~ 255
Header on: <NR1><RMT>
Header off: <NR1><RMT>
Query example: none

***TST?**

Description: This command requests execution of, and queries the result of self-test.
Setting syntax: none
Setting parameters: none
Setting example: none
Query syntax: *TST?<PMT>
Return parameters: <NR1>, 0
Header on: <NR1><RMT>
Header off: <NR1><RMT>
Query example: none

***SAV <n>**

Description: This command stores the present state of the configurtion and all channel states in a specified memory location.
Setting syntax: *SAV<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 10, 1~10:User define file
Setting example: none
Query syntax: none
Return parameters: none
Query example: none

***RCL <n>**

Description: This command restores the power meter to a state that was previously stored in memory with the *SAV command to the specified location (see *SAV).
Setting syntax: *RCL<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 10, 0:Factory default file, 1~10:User define file
Setting example: none
Query syntax: none
Return parameters: none
Query example: none

5.7.2 Instrument Commands

SYSTEM Sub-system

SYSTem:ERRor?

Description:	This command queries the error string of the command parser.
Setting syntax:	none
Setting parameters:	none
Setting example:	none
Query syntax:	SYSTem:ERRor?<PMT>
Return parameters:	<SRD>, 0,"No Error" 1,"Data Format Error" 2,"Data Range Error" 3,"Command Error" 4,"Execution Error" 5,"Too many Errors"
Header on:	:SYSTEM:ERROR<space><SRD><RMT>
Header off:	<SRD><RMT>
Query example:	none

SYSTem:HEADer

Description:	This command turns response headers ON or OFF. The defult is OFF.
Setting syntax:	SYSTem:HEADer<space><CRD><PMT>
Setting parameters:	<CRD>, ON | OFF
Setting example:	none
Query syntax:	SYSTem:HEADer?<PMT>
Return parameters:	<CRD>, ON | OFF
Header on:	:SYSTEM:HEADER<space><CRD><RMT>
Header off:	<CRD><RMT>
Query example:	none

SYSTem:TRANsmit:SEParator

Description:	This command sets the message unit separator for response messages. The default is 0(Comma).
Setting syntax:	SYSTem:TRANsmit:SEParator<space><NR1><PMT>
Setting parameters:	<NR1>, 0 ~ 1; 0 : Comma(,) 1 : Semicolon(;)
Setting example:	none
Query syntax:	SYSTem:TRANsmit:SEParator?<PMT>
Return parameters:	<NR1>, 0 ~ 1
Header on:	:SYSTEM:TRANSMIT:SEPARATOR<space><NR1><RMT>
Header off:	<NR1><RMT>
Query example:	none

SYSTem:TRANsmit:TERMinator

Description:	This command sets the data terminator for response messages. The default is 0(LF).
Setting syntax:	SYSTem:TRANsmit:TERMinator<space><NR1><PMT>
Setting parameters:	<NR1>, 0 ~ 1; 0 : LF 1 : CR+LF
Setting example:	none
Query syntax:	SYSTem:TRANsmit:TERMinator?<PMT>
Return parameters:	<NR1>, 0 ~ 1

Header on: :SYSTEM:TRANSMIT:TERMINATOR<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

SYSTem:VERsion?

Description: This query returns an <NR2> formatted numeric value corresponding to the SCPI version number for which the instrument complies.
Setting syntax: none
Setting parameters: none
Setting example: none
Query syntax: SYSTem:VERsion?<PMT>
Return parameters: <SRD>, 1991.1
Header on: :SYSTEM:VERSION<space><SRD><RMT>
Header off: <SRD><RMT>
Query example: none

SYSTem:LOCal

Description: This command can only be used under control of USB. If SYST:LOC is programmed, the Power Meter will be set in the LOCAL state, and the front panel will work.
Setting syntax: SYSTem:LOCal<PMT>
Setting parameters: none
Setting example: none
Query syntax: none
Return parameters: none
Query example: none

SYSTem:REMote

Description: This command can only be used under control of USB. If SYST:REM is programmed, the Power Meter will be set in the REMOTE state, and the front panel will be disabled except the <SETUP>key pressed.
Setting syntax: SYSTem:REMote<PMT>
Setting example: none
Setting parameters: none
Query syntax: none
Return parameters: none
Query example: none

STATUS Sub-system

STATus:QUEStionable[:EVENt]?

Description: This query returns the value of the Questionable Event register. The Event register is a read-only register which holds all events that are passed by the Questionable NTR and/or PTR filter. If QUES bit of the Service Request Enable register is set, and the Questionable Event register > 0, QUES bit of the Status Byte register is set too.
Setting syntax: none
Setting parameters: none
Setting example: none
Query syntax: STATus:QUEStionable?<PMT>
Return parameters: <NR1>, 0 ~ 65535

Header on: :STATUS:QUESTIONABLE:EVENT<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

STATus:QUEStionable:CONDition?

Description: This query returns the value of the Questionable Condition register, which is a read-only register that holds the real-time questionable status of the Power Meter.
Setting syntax: none
Setting parameters: none
Setting example: none
Query syntax: STATus:QUEStionable:CONDition?<PMT>
Return parameters: <NR1>, 0 ~ 65535
Header on: :STATUS:QUESTIONABLE:CONDITION<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

STATus:QUEStionable:ENABle

Description: This command sets or reads the value of the Questionable Enable register. The register is a mask which enables specific bits from the Questionable Event register to set the questionable summary (QUES) bit of the Status Byte register.
Setting syntax: STATus:QUEStionable:ENABle<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 65535
Setting example: none
Query syntax: STATus:QUEStionable:ENABle?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 65535
Header on: :STATUS:QUESTIONABLE:ENABLE<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

STATus:QUEStionable:NTRansition

Description: This command makes the values of the Questionable NTR register set or read.

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

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

Bit Configuration of Questionable Status Register

Bit position	15	14~7	6	5	4	3	2	1	0
Condition	FAN	---	OPFR	Energy RCE	Inrush RCE	Integrate RCE	OCP	OCR	OVR

OVR : Over voltage range.
OCR : Over current range.

OCP : Over current protection.
Integrate RCE : Range change error when integrate mode running.
Inrush RCE : Range change error when inrush mode running.
Energy RCE : Range change error when energy mode running.
FAN : Fan failure.
OPFR : Over power factor range.

Setting syntax: STATus:QUEStionable:NTRansition<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 65535
Setting example: none
Query syntax: STATus:QUEStionable:NTRansition?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 65535
Header on: :STATUS:QUESTIONABLE:NTRANSITION<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

STATus:QUEStionable:PTRansition

Description: This command makes the values of the Questionable PTR register set or read. Register description please refer to the description of the previous command.
Setting syntax: STATus:QUEStionable:PTRansition<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 65535
Setting example: none
Query syntax: STATus:QUEStionable:PTRansition?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 65535
Header on: :STATUS:QUESTIONABLE:PTRANSITION<space><NR1><RMT>
Header off: <NR1><RMT>
Query example: none

STATus:PRESet

Description: This command sets the Enable, PTR, and NTR register of the status groups to their power-on value.
Setting syntax: STATus:PRESet<PMT>
Setting parameters: none
Setting example: none
Query syntax: none
Return Parameters: none
Query example: none

STATus:CHANnel:CONDition?

Type: Channel-Specific.
Description: Returns the real time channel status.
Query syntax: STATus:CHANnel:CONDition?<PMT>
Return parameters: <NR1>

Bit Configuration of Channel Status Register

Bit position	15~6	5	4	3	2	1	0
Condition	-	Energy RCE	Inrush RCE	Integrate RCE	OCP	OCR	OVR
Bit weight	-	32	16	8	4	2	1

Query example: STAT:CHAN:COND? Return the status of the power meter.
Return example: 2048

STATus:CHANnel:EVENt?

Type:	Channel-Specific.	
Description:	Record all channel events that have occurred since last time the register was read, and reset the Channel Event register.	
Query syntax:	STATus:CHANnel:EVENt?<PMT>	
Return parameters:	<NR1>	
Query example:	STAT:CHAN:EVEN?	Read and reset the Channel Event register.
Return example:	24	

STATus:CHANnel:ENABle

Type:	Channel-Specific.	
Description:	Mask to select which bit in the Event register is allowed to be summed into the corresponding channel bit for the Channel Summary Event register.	
Setting syntax:	STATus:CHANnel:ENABle<space><NR1><PMT>	
Setting parameters:	<NR1>, 0 ~ 65535, Unit = None	
Setting example:	STAT:CHAN:ENABl 24	
Query syntax:	STATus:CHANnel:ENABle?[<space><MAX | MIN>]<PMT>	
Return parameters:	<NR1>	
Query example:	STAT:CHAN:ENAB?	Return the contents of the Status Channel Enable register.
Return example:	24	

STATus:CHANnel:PTRansition

Type:	Channel-Specific.	
Description:	Programmable filters that determine 0-to-1 transition in the Condition register will set the corresponding bit of the Event register.	
Setting syntax:	STATus:CHANnel:PTRansition<space><NR1><PMT>	
Setting parameters:	<NR1>, 0 ~ 65535, Unit = None	
Setting example:	STAT:CHAN:PTR 4	Set over current bit 2 from 0-to-1.
Query syntax:	STATus:CHANnel:PTRansition?[<space><MAX | MIN>]<PMT>	
Return parameters:	<NR1>	
Query example:	STAT:CHAN:PTR?	
Return example:	4	

STATus:CHANnel:NTRansition

Type:	Channel-Specific.	
Description:	Programmable filters that determine 1-to-0 transition in the Condition register will set the corresponding bit of the Event register.	
Setting syntax:	STATus:CHANnel:NTRansition<space><NR1><PMT>	
Setting parameters:	<NR1>, 0 ~ 65535, Unit = None	
Setting example:	STAT:CHAN:NTR 4	Set over current bit 2 from 1-to-0.
Query syntax:	STATus:CHANnel:NTRansition?[<space><MAX | MIN>]<PMT>	
Return parameters:	<NR1>	
Query example:	STAT:CHAN:NTR?	
Return example:	4	

STATus:CSUMmary:ENABle

Type:	Channel-Independent.
Description:	Mask to select which bit in the Channel Event register is allowed to be summed into the CSUM (Channel Summary) bit for the Status

Byte register.
Setting syntax: STATus:CSUMmary:ENABle<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 65535, Unit = None

Bit Configuration of Channel Summary Register

Bit Position	15~4	3	2	1	0
Channel	-	4	3	2	1
Bit Weight	-	8	4	2	1

Setting example: STAT:CSUM:ENAB 3
Query syntax: STATus:CSUMmary:ENABle?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>
Query example: STAT:CSUM:ENAB?
Return example: 3

STATus:CSUMmary:EVENt?

Type: Channel-Independent.
Description: Indicate all channels of which an enabled STAT:CHAN Event has occurred since last time the register was read.
Query syntax: STATus:CSUMmary:EVENt?<PMT>
Return parameters: <NR1>
Query example: STAT:CSUM:EVEN?
Return example: 3

CHANNEL Sub-system

CHANnel

Type: System.
Description: Selects a channel of which the coming channel-specific command will be received and executed.
Setting syntax: CHANnel<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 4: Channel 1 ~ Channel 4
Query syntax: CHANnel?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 ~ 4
Header on: :CHANNEL<space><NR1><RMT>
Header off: <NR1><RMT>
Example: none

CHANnel:ID?

Type: System.
Description: This query requests the module to identify itself.
Setting syntax: none
Setting parameters: none
Query syntax: CHANnel:ID?<PMT>
Return parameters: <SRD>, "Manufacturer,Model name,Serial number,F/W version, FPGA version,PCB version"

Information	*Example*
Manufacturer	Chroma ATE
Model name	66204
Serial number	66204M000066
F/W version	1.00
FPGA version	1.00

PCB version	1.00

Header on: :CHANNEL:ID<space><SRD><RMT>
Header off: <SRD><RMT>
Example: none

FETCH & MEASURE Sub-system

FETCh? {<CRD1>{,<CRD2>{, … {,<CRD10>}}}}}}
MEASure? {<CRD1>{,<CRD2>{, … {,<CRD10>}}}}}}

Type: Channel-Specific.
Description: This command lets the user get measurement data from the Power Meter. Two measurement commands are available: MEASure and FETCh. MEASure triggers the acquisition of new data before returning data. FETCh returns the previously acquired data from measurement buffer. The return could be -1, -2, -3 and <NR2>.
-1: The first time integrated calculation is not complete yet.
-2: RCE represents "range change error" when integration process is executing.
-3: Invalid data when OVR、OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax:
FETCh?<PMT>
FETCh?<space><CRD>,<CRD>,…up to 10<PMT>
MEASure?<PMT>
MEASure?<space><CRD>,<CRD>,…up to 10<PMT>
Query parameters: <CRD>, V, VPK+, VPK-, THDV, I, IPK+, IPK-, IS, CFI, THDI, W, PF, VA, VAR, ENEG, FREQ, VDC, IDC, WDC
Return parameters: <NR2>
Example 1:
Query: FETC?<PMT>
Response:
Header on:
:FETCH<space>V<space><NR2>;VPK+<space><NR2>;VPK-<space><NR2>;THDV<space><NR2>;I<space><NR2>;IPK+<space><NR2>;IPK-<space><NR2>;IS<space><NR2>;CFI<space><NR2>;THDI<space><NR2>;W<space><NR2>;PF<space><NR2>;VA<space><NR2>;VAR<space><NR2>;ENEG<space><NR2>;FREQ<space><NR2>;VDC<space><NR2>;IDC<space><NR2>;WDC<space><NR2><RMT>

Header off:
<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2><RMT>

Separator 0:
<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2><RMT>
Separator 1:
<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<N

R2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2
><RMT>

Example 2:
Query: FETC?<space>V,I,W<PMT>
Response:
Header on:
:FETCH<space>V<space><NR2>,I<space><NR2>,W<space><NR2><RMT>
Header off:
<NR2>,<NR2>,<NR2><RMT>
Separator 0:
<NR2>,<NR2>,<NR2><RMT>
Separator 1:
<NR2>;<NR2>;<NR2><RMT>

FETCh[:SCALar]:VOLTage:RMS? {<NR1>}
MEASure[:SCALar]:VOLTage:RMS? {<NR1>}

Type: Channel-Specific.
Description: These queries return the r.m.s. voltage. The return could be -1, -2, -3 and <NR2>.
-1: The first time integrated calculation is not complete yet.
-2: RCE represents “range change error” when integration process is executing.
-3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:VOLTage:RMS?<PMT>,
FETCh:VOLTage:RMS?<space><NR1><PMT>,
MEASure:VOLTage:RMS?<PMT>,
MEASure:VOLTage:RMS?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:RMS<space><NR2><RMT>
:FETCH:VOLTAGE:RMS<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:VOLTage:PEAK+? {<NR1>}
MEASure[:SCALar]:VOLTage:PEAK+? {<NR1>}

Type: Channel-Specific.
Description: These queries return the plus value of peak voltage. The return could be -3 or <NR2>. -3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:VOLTage:PEAK+?<PMT>,
FETCh:VOLTage:PEAK+?<space><NR1><PMT>,
MEASure:VOLTage:PEAK+?<PMT>,
MEASure:VOLTage:PEAK+?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:PEAK+<space><NR2><RMT>

:FETCH:VOLTAGE:PEAK+<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:VOLTage:PEAK-? {<NR1>}
MEASure[:SCALar]:VOLTage:PEAK-? {<NR1>}

Type: Channel-Specific.
Description: These queries return the minus value of peak voltage. The return could be -3 or <NR2>. -3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:VOLTage:PEAK-?<PMT>,
FETCh:VOLTage:PEAK-?<space><NR1><PMT>,
MEASure:VOLTage:PEAK-?<PMT>,
MEASure:VOLTage:PEAK-?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:PEAK-<space><NR2><RMT>
:FETCH:VOLTAGE:PEAK-<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:VOLTage:DC? {<NR1>}
MEASure[:SCALar]:VOLTage:DC? {<NR1>}

Type: Channel-Specific.
Description: These queries return the DC voltage. The return could be -3 or <NR2>.
-3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:VOLTage:DC?<PMT>,
FETCh:VOLTage:DC?<space><NR1><PMT>,
MEASure:VOLTage:DC?<PMT>,
MEASure:VOLTage:DC?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:DC<space><NR2><RMT>
:FETCH:VOLTAGE:DC<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:VOLTage:THD? {<NR1>}
MEASure[:SCALar]:VOLTage:THD? {<NR1>}

Type: Channel-Specific.
Description: These queries return the total harmonic distortion of voltage. The return could be -3 or <NR2>. -3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none

Query syntax: FETCh:VOLTage:THD?<PMT>,
FETCh:VOLTage:THD?<space><NR1><PMT>,
MEASure:VOLTage:THD?<PMT>,
MEASure:VOLTage:THD?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:THD<space><NR2><RMT>
:FETCH:VOLTAGE:THD<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:RMS? {<NR1>}
MEASure[:SCALar]:CURRent:RMS? {<NR1>}

Type: Channel-Specific.
Description: These queries return the r.m.s. current. The return could be -1, -2, -3 and <NR2>.
-1: The first time integrated calculation is not complete yet.
-2: RCE represents “range change error” when integration process is executing.
-3: Invalid data when OCR, OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:RMS?<PMT>,
FETCh:CURRent:RMS?<space><NR1><PMT>,
MEASure:CURRent:RMS?<PMT>,
MEASure:CURRent:RMS?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:RMS<space><NR2><RMT>
:FETCH:CURRENT:RMS<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:PEAK+? {<NR1>}
MEASure[:SCALar]:CURRent:PEAK+? {<NR1>}

Type: Channel-Specific.
Description: These queries return the plus value of peak current. The return could be -3 or <NR2>. -3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh: CURRent:PEAK+?<PMT> ,
MEASure:CURRent:PEAK+?<PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:PEAK+<space><NR2><RMT>
:FETCH:CURRENT:PEAK+<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:PEAK-? {<NR1>}
MEASure[:SCALar]:CURRent:PEAK-? {<NR1>}

Type: Channel-Specific.
Description: These queries return the minus value of peak current. The return could be -3 or <NR2>. -3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:PEAK-?<PMT>,
FETCh:CURRent:PEAK-?<space><NR1><PMT>,
MEASure:CURRent:PEAK-?<PMT>,
MEASure:CURRent:PEAK-?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:PEAK-<space><NR2><RMT>
:FETCH:CURRENT:PEAK-<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:DC? {<NR1>}
MEASure[:SCALar]:CURRent:DC? {<NR1>}

Type: Channel-Specific.
Description: These queries return the DC current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:DC?<PMT>,
FETCh:CURRent:DC?<space><NR1><PMT>,
MEASure:CURRent:DC?<PMT>,
MEASure:CURRent:DC?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:DC<space><NR2><RMT>
:FETCH:CURRENT:DC<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:INRush? {<NR1>}
MEASure[:SCALar]:CURRent:INRush? {<NR1>}

Type: Channel-Specific.
Description: These queries return the inrush current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:INRush?<PMT>,
FETCh:CURRent:INRush?<space><NR1><PMT>,
MEASure:CURRent:INRush?<PMT>,
MEASure:CURRent:INRush?<space><NR1><PMT>

Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:INRUSH<space><NR2><RMT>
:FETCH:CURRENT:INRUSH<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:CREStfactor? {<NR1>}
MEASure[:SCALar]:CURRent:CREStfactor? {<NR1>}

Type: Channel-Specific.
Description: These queries return the crest factor of current. The return could be -3 or <NR2>. -3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:CREStfactor?<PMT>,
FETCh:CURRent:CREStfactor?<space><NR1><PMT>,
MEASure:CURRent:CREStfactor?<PMT>,
MEASure:CURRent:CREStfactor?<space>NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:CRESTFACTOR<space><NR2><RMT>
:FETCH:CURRENT:CRESTFACTOR<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:CURRent:THD? {<NR1>}
MEASure[:SCALar]:CURRent:THD? {<NR1>}

Type: Channel-Specific.
Description: These queries return the total harmonic distortion of current. The return could be -3 or <NR2>. -3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:THD?<PMT>,
FETCh:CURRent:THD?<space><NR1><PMT>,
MEASure:CURRent:THD?<PMT>,
MEASure:CURRent:THD?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:THD<space><NR2><RMT>
:FETCH:CURRENT:THD<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:POWer:REAL? {<NR1>}
MEASure[:SCALar]:POWer:REAL? {<NR1>}

Type: Channel-Specific.
Description: These queries return the true power. The return could be -1, -2, -3

and <NR2>. -1: The first time integrated calculation is not complete yet.
-2: RCE represents "range change error" when integration process is executing.
-3: Invalid data when OVR、OCR、OCP occur.

Setting syntax: none
Setting parameters: none
Query syntax: FETCh:POWer:REAL?<PMT>,
FETCh:POWer:REAL?<space><NR1><PMT>,
MEASure:POWer:REAL?<PMT>,
MEASure:POWer:REAL?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:POWER:REAL<space><NR2><RMT>
:FETCH:POWER:REAL<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:POWer:PFACtor? {<NR1>}
MEASure[:SCALar]:POWer:PFACtor? {<NR1>}

Type: Channel-Specific.
Description: These queries return the power factor. The return could be -3 or <NR2>.
-3: Invalid data when OVR, OCR, OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:POWer:PFACtor?<PMT>,
FETCh:POWer:PFACtor?<space><NR1><PMT>,
MEASure:POWer:PFACtor?<PMT>,
MEASure:POWer:PFACtor?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:POWER:PFACTOR<space><NR2><RMT>
:FETCH:POWER:PFACTOR<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:POWer:APParent? {<NR1>}
MEASure[:SCALar]:POWer:APParent? {<NR1>}

Type: Channel-Specific.
Description: These queries return the apparent power. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:POWer:APParent?<PMT>,
FETCh:POWer:APParent?<space><NR1><PMT>,
MEASure:POWer:APParent?<PMT>,
MEASure:POWer:APParent?<space><NR1><PMT>

Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:POWER:APPARENT<space><NR2><RMT>
:FETCH:POWER:APPARENT<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:POWer:REACtive? {<NR1>}
MEASure[:SCALar]:POWer:REACtive? {<NR1>}

Type: Channel-Specific.
Description: These queries return the reactive power. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:POWer:REACtive?<PMT>,
FETCh:POWer:REACtive?<space><NR1><PMT>,
MEASure:POWer:REACtive?<PMT>,
MEASure:POWer:REACtive?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:POWER:REACTIVE<space><NR2><RMT>
:FETCH:POWER:REACTIVE<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:POWer:DC? {<NR1>}
MEASure[:SCALar]:POWer:DC? {<NR1>}

Type: Channel-Specific.
Description: These queries return the average power. The return could be -1, -2, -3 and <NR2>. -1: The first time integrated calculation is not complete yet.
-2: RCE represents “range change error” when integration process is executing.
-3: Invalid data when OVR、OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:POWer:DC?<PMT>,
FETCh:POWer:DC?<space><NR1><PMT>,
MEASure:POWer:DC?<PMT>,
MEASure:POWer:DC?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:POWER:DC<space><NR2><RMT>
:FETCH:POWER:DC<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:POWer:ENERgy? {<NR1>}
MEASure[:SCALar]:POWer:ENERgy? {<NR1>}

Type: Channel-Specific.
Description: These queries return the energy in Joule when the ENER:MODE is JOULE or return the energy in watt hour when the ENER:MODE is WHR. The return could be -3 or <NR2>. -3: Invalid data when OVR、OCR、OCP occur.
Setting syntax:none
Setting parameters:none
Query syntax: FETCh:POWer:ENERgy?<PMT>,
FETCh:POWer:ENERgy?<space><NR1><PMT>,
MEASure:POWer:ENERgy?<PMT>,
MEASure:POWer:ENERgy?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:POWER:ENERGY<space><NR2><RMT>
:FETCH:POWER:ENERGY<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:FREQuency? {<NR1>}
MEASure[:SCALar]:FREQuency? {<NR1>}

Type: Channel-Specific.
Description: These queries return the frequency in Hertz.
Setting syntax: none
Setting parameters:none
Query syntax: FETCh:FREQuency?<PMT>,
FETCh:FREQuency?<space><NR1><PMT>,
MEASure:FREQuency?<PMT>,
MEASure:FREQuency?<space><NR1><PMT>
Query parameters: <NR1>, 0 ~ 4, 0:All channel, 1~4:Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:FREQUENCY<space><NR2><RMT>
:FETCH:FREQUENCY<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2><RMT>
<NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

FETCh[:SCALar]:EFFiciency?
MEASure[:SCALar]:EFFiciency?

Type: Three-Phase.
Description: These queries return the efficiency.
Setting syntax: none
Setting parameters:none
Query syntax: FETCh:EFFiciency?<PMT>,
MEASure:EFFiciency?<PMT>,
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:EFFICIENCY<space><NR2><RMT>
Header off: <NR2><RMT>

Example: none

FETCh[:SCALar]:VOLTage:HARMonic:ARRay? <CRD>{<,><NR1>}
MEASure[:SCALar]:VOLTage:HARMonic:ARRay? <CRD>{<,><NR1>}

Type: Channel-Specific.
Description: These queries return the amplitude of all the harmonic order of voltage. The return could be -3 or <NR2>. -3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:VOLTage:HARMonic:ARRay?<space><CRD><PMT>,
FETCh:VOLTage:HARMonic:ARRay?<space><CRD>,<NR1><PMT>,
MEASure:VOLTage:HARMonic:ARRay?<space><CRD><PMT>,
MEASure:VOLTage:HARMonic:ARRay?<space><CRD>,<NR1><PMT>
Query parameters: <CRD>, VALUE | PERCENT
<NR1>, 1 ~ 4: Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:HARMONIC:ARRAY<space><NR2>,<NR2>,<NR2>,...up to 101 <RMT>
Header off: <NR2>,<NR2>,<NR2>,...up to 101 <RMT>
Separator 0: <NR2>,<NR2>,<NR2>,...up to 101 <RMT>
Separator 1: <NR2>;<NR2>;<NR2>;...up to 101 <RMT>
Example: none

FETCh[:SCALar]:CURRent:HARMonic:ARRay? <CRD>{<,><NR1>}
MEASure[:SCALar]:CURRent:HARMonic:ARRay? <CRD>{<,><NR1>}

Type: Channel-Specific.
Description: These queries return the amplitude of all the harmonic order. The return could be -3 or <NR2>. -3: Invalid data when OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:CURRent:HARMonic:ARRay?<space><CRD><PMT>,
FETCh:CURRent:HARMonic:ARRay?<space><CRD>,<NR1><PMT>,
MEASure:CURRent:HARMonic:ARRay?<space><CRD><PMT>,
MEASure:CURRent:HARMonic:ARRay?<space><CRD>,<NR1><PMT>
Query parameters: <CRD>, VALUE | PERCENT
<NR1>, 1 ~ 4: Channel 1 ~ Channel 4
Return parameters: <NR2>
Header on: :FETCH:CURRENT:HARMONIC:ARRAY<space><NR2>,<NR2>,<NR2>,...up to 101 <RMT>
Header off: <NR2>,<NR2>,<NR2>,...up to 101 <RMT>
Separator 0: <NR2>,<NR2>,<NR2>,...up to 101 <RMT>
Separator 1: <NR2>;<NR2>;<NR2>;...up to 101 <RMT>
Example: none

FETCh[:SCALar]:SIGMa:POWer:REAL?
MEASure[:SCALar]:SIGMa:POWer:REAL?

Type: Three-Phase.
Description: These queries return the true power. The return could be -1, -2, -3

and <NR2>. -1: The first time integrated calculation is not complete yet.
-2: RCE represents "range change error" when integration process is executing.
-3: Invalid data when OVR、OCR、OCP occur.

Setting syntax: none
Setting parameters: none
Query syntax: FETCh:SIGMa:POWer:REAL?<PMT>, MEASure:SIGMa:POWer:REAL?<PMT>,
Query parameters: none
Return parameters: <NR2>
  Header on: :FETCH:SIGMA:POWER:REAL<space><NR2><RMT>
  Header off: <NR2><RMT>
Example: none

FETCh[:SCALar]:SIGMa:POWer:PFACtor?
MEASure[:SCALar]:SIGMa:POWer:PFACtor?

Type: Three-Phase.
Description: These queries return the power factor. The return could be -3, -5 or <NR2>.
-3: Invalid data when OVR, OCR, OCP occur.
-5: Invalid data when OPFR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:SIGMa:POWer:PFACtor?<PMT>, MEASure:SIGMa:POWer:PFACtor?<PMT>,
Query parameters: none
Return parameters: <NR2>
  Header on: :FETCH:SIGMA:POWER:PFACTOR<space><NR2><RMT>
  Header off: <NR2><RMT>
Example: none

FETCh[:SCALar]:SIGMa:POWer:APParent?
MEASure[:SCALar]:SIGMa:POWer:APParent?

Type: Three-Phase.
Description: These queries return the apparent power. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:SIGMa:POWer:APParent?<PMT>, MEASure:SIGMa:POWer:APParent?<PMT>,
Query parameters: none
Return parameters: <NR2>
  Header on: :FETCH:SIGMA:POWER:APPARENT<space><NR2><RMT>
  Header off: <NR2><RMT>
Example: none

FETCh[:SCALar]:SIGMa:POWer:REACtive?
MEASure[:SCALar]:SIGMa:POWer:REACtive?

Type: Three-Phase.
Description: These queries return the reactive power. The return could be -3 or <NR2>.

-3: Invalid data when OVR、OCR、OCP occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh::SIGMa:POWer:REACtive?<PMT>,
MEASure:SIGMa:POWer:REACtive?<PMT>,
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:SIGMA:POWER:REACTIVE<space><NR2><RMT>
Header off: <NR2><RMT>
Example: none

FETCh[:SCALar]:HARMonic:ARRay? {<NR1>}
MEASure[:SCALar]:HARMonic:ARRay? {<NR1>}

Type: Channel-Specific.
Description: These queries return the total parameters of harmonic meaurement.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:HARMonic:ARRay?<PMT>,
FETCh:HARMonic:ARRay?<space><NR1><PMT>,
MEASure:HARMonic:ARRay?<PMT>,
MEASure:HARMonic:ARRay?<space><NR1><PMT>
Query parameters: <NR1>, 1 ~ 4: Channel 1 ~ Channel 4
Return parameters: <NR2> or NAN, NAN represents no measure value.
<Arg1>;<Arg2>;<Arg3>; 、、、 ;<Arg12>;<Arg13><PMT>
<Arg1>: V,I,P,S,Q,PF,φ(1),Vthd,Ithd,Pthd
<Arg2>: V(k) , k = 0 ~ 100
<Arg3>: I(k) , k = 0 ~ 100
<Arg4>: P(k) , k = 0 ~ 100
<Arg5>: S(k) , k = 0 ~ 100
<Arg6>: Q(k) , k = 0 ~ 100
<Arg7>: PF(k) , k = 0 ~ 100
<Arg8>: Vdeg(k) , k = 0 ~ 100
<Arg9>: Ideg(k) , k = 0 ~ 100
<Arg10>: φ(k), k = 0 ~ 100
<Arg11>: Vhdf(k) , k = 0 ~ 100
<Arg12>: Ihdf(k) , k = 0 ~ 100
<Arg13>: Phdf(k) , k = 0 ~ 100
Header on:
:FETCH:HARMONIC:ARRAY<space><NR2>,...,<NR2>;<NR2>,…,<NR2>;<NR2>,…,<NR2><RMT>
Header off: <NR2>,...,<NR2>;<NR2>,…,<NR2>;<NR2>,…,<NR2><RMT>
Separator 0: <NR2>,...,<NR2>;<NR2>,…,<NR2>;<NR2>,…,<NR2><RMT>
Separator 1: <NR2>;...;<NR2>;<NR2>;…;<NR2>;<NR2>;…;<NR2><RMT>
Example: none

COMMUNICATE Sub-system

[COMMunicate:]ADDRess:GPIB

Type: System.
Description: This command sets the GPIB address.
Setting syntax: ADDRess:GPIB<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 30

Query syntax: ADDRess:GPIB?<PMT>
Return parameters: <NR1>, 1 ~ 30
Header on: :ADDRESS:GPIB<space><NR1><RMT>
Header off: <NR1><RMT>
Example: none

CONFIGURE Sub-system

[CONFigure:]VOLTage:RANGe

Type: Channel-Specific or All channels.
Description: This command sets the voltage range of measure.
Setting syntax: VOLTage:RANGe<space><CRD><PMT>
VOLTage:RANGe<space><CRD>,<CRD>,<CRD>,<CRD><PMT>
Setting parameters: <CRD>, AUTO | V600 | V300 | V150 | V60 | V30 | V15
'/':denote no action
Query syntax: VOLTage:RANGe?<PMT>
Return parameters: <CRD>, V600 | V300 | V150 | V60 | V30 | V15
Header on: :VOLTAGE:RANGE<space><CRD>,<CRD>,<CRD>,<CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

[CONFigure:]CURRent:RANGe

Type: Channel-Specific or All channels.
Description: This command sets the current range of measure.
Setting syntax: CURRent:RANGe<space><CRD><PMT>
CURRent:RANGe<space><CRD>,<CRD>,<CRD>,<CRD><PMT>
Setting parameters: <CRD>, '/':denote no action
External shunt off:
Shunt AUTO: AUTO | A20 | A5 | A2 | A05 | A02 | A005 | A002 | A0005
Shunt HIGH: AUTO | A20 | A5 | A2 | A05
Shunt LOW: AUTO | A02 | A005 | A002 | A0005
External shunt on: AUTO | E01 | E005 | E0025 | E001
Query syntax: CURRent:RANGe?<PMT>
Return parameters: <CRD>,
External shunt off: A20 | A5 | A2 | A05 | A02 | A005 | A002 | A0005
External shunt on: E01 | E005 | E0025 | E001
Header on: :CURRENT:RANGE<space><CRD>,<CRD>,<CRD>
,<CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

[CONFigure:]CURRent:SHUNt

Type: Channel-Specific or All channels.
Description: This command sets the current shunt of measure.
Setting syntax: CURRent:SHUNt<space><CRD><PMT>
CURRent:SHUNt<space><CRD>,<CRD>,<CRD>,<CRD><PMT>
Setting parameters: <CRD>, HIGH | LOW | AUTO
Query syntax: CURRent:SHUNt?<PMT>
Return parameters: <CRD>, HIGH | LOW | AUTO
Header on: :CURRENT:SHUNT<space><CRD>,<CRD>,<CRD>,<CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

[CONFigure:]CURRent:INRush:LEVel

Type: All channels.
Description: This command sets the level of trigger of inrush current in Ampere.
Setting syntax: CURRent:INRush:LEVel<space><NR2><PMT>
Setting parameters: <NR2>, 0.1 ~ 9999.9
Query syntax: CURRent:INRush:LEVel?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 0.1 ~ 9999.9
  Header on: :CURRENT:INRUSH:LEVEL<space><NR2><RMT>
  Header off: <NR2><RMT>
Example: none

[CONFigure:]CURRent:INRush:TIME

Type: All channels.
Description: This command sets the time of measure of inrush current in Millisecond.
Setting syntax: CURRent:INRush:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 9999
Query syntax: CURRent:INRush:TIME?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 ~ 9999
  Header on: :CURRENT:INRUSH:TIME<space><NR1><RMT>
  Header off: <NR1><RMT>
Example: none

[CONFigure:]CURRent:INRush:DELay

Type: All channels.
Description: This command sets the delay of measure of inrush current in Millisecond.
Setting syntax: CURRent:INRush:DELay<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 9999
Query syntax: CURRent:INRush:DELay?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 9999
  Header on: :CURRENT:INRUSH:DELAY<space><NR1><RMT>
  Header off: <NR1><RMT>
Example: none

[CONFigure:]MEASure:MODE

Type: All channels.
Description: This command sets the mode of measure.
Setting syntax: MEASure:MODE<space><CRD><PMT>
Setting parameters: <CRD>, WINDOW | AVERAGE
Query syntax: MEASure:MODE?<PMT>
Return parameters: <CRD>, WINDOW | AVERAGE
  Header on: :MEASURE:MODE<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]MEASure:AVERage

Type: All channels.
Description: This command sets the number of measurements over which the average calculation is to be performed.
Setting syntax: MEASure:AVERage<space><NR1><PMT>
Setting parameters: <NR1>, 1 | 2 | 4 | 8 | 16 | 32 | 64
Query syntax: MEASure:AVERage?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 | 2 | 4 | 8 | 16 | 32 | 64

Header on: :MEASURE:AVERAGE<space><NR1><RMT>
Header off: <NR1><RMT>
Example: none

[CONFigure:]MEASure:WINDow

Type: All channels.
Description: This command sets the time of measure over which the window calculation is to be performed.
Setting syntax: MEASure:WINDow<space><NR2><PMT>
Setting parameters: <NR2>, 0.1 ~ 60.0 ,resolution 0.1
Query syntax: MEASure:WINDow?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 0.1 ~ 60.0
Header on: :MEASURE:WINDOW<space><NR2><RMT>
Header off: <NR2><RMT>
Example: none

[CONFigure:]MEASure:WINDow:UPDate

Type: All channels.
Description: This command sets the update rate of measure over which the window calculation is to be performed.
FIXED: The fixed interval of window sliding.
WINDOW: The varied interval according to the setting of window time, that just affects the FETCH commands.
Setting syntax: MEASure:WINDow:UPDate<space><CRD><PMT>
Setting parameters: <CRD>, FIXED | WINDOW
Query syntax: MEASure:WINDow:UPDate?<PMT>
Return parameters: <CRD>, FIXED | WINDOW
Header on: :MEASURE:WINDOW:UPDATE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: none

[CONFigure:]MEASure:FORMula

Type: System
Description: This command sets the type of 3-phase power measurement.
Setting syntax: MEASure:FORMula<space><CRD><PMT>
Setting parameters: <CRD>, TYPE1 | TYPE2 | TYPE3
Query syntax: MEASure:FORMula?<PMT>
Return parameters: <CRD>, TYPE1 | TYPE2 | TYPE3
Header on: :MEASURE:FORMULA<space><CRD><RMT>
Header off: <CRD><RMT>
Example: none

[CONFigure:]INTEGrate

Type: All channels.
Description: This command is used to switch the integration function.
Setting syntax: INTEGrate<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: INTEGrate?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INTEGRATE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: none

[CONFigure:]INTEGrate:TIME

Type:	All channels.
Description:	This command sets the time of integration in Second.
Setting syntax:	INTEGrate:TIME<space><NR1><PMT>
Setting parameters:	<NR1>, 0 ~ 35999999
Query syntax:	INTEGrate:TIME?[<space><MAX | MIN>]<PMT>
Return parameters:	<NR1>, 0 ~ 35999999
Header on:	:INTEGRATE:TIME<space><NR1><RMT>
Header off:	<NR1><RMT>
Example:	none

[CONFigure:]FILTer

Type:	All channels.
Description:	This command is used to switch the low pass filter.
Setting syntax:	FILTer<space><CRD><PMT>
Setting parameters:	<CRD>, ON | OFF
Query syntax:	FILTer?<PMT>
Return parameters:	<CRD>, ON | OFF
Header on:	:FILTER<space><CRD><RMT>
Header off:	<CRD><RMT>
Example:	none

[CONFigure:]THD:MODE

Type:	All channels.
Description:	This command sets the mode of THD measure.
Setting syntax:	THD:MODE<space><CRD><PMT>
Setting parameters:	<CRD>, FULL | ORDER
Query syntax:	THD:MODE?<PMT>
Return parameters:	<CRD>, FULL | ORDER
Header on:	:THD:MODE<space><CRD><RMT>
Header off:	<CRD><RMT>
Example:	none

[CONFigure:]THD:ORDer

Type:	All channels.
Description:	This command sets the order of THD measure.
Setting syntax:	THD:ORDer<space><NR1><PMT>
Setting parameters:	<NR1>, 2 ~ 100
Query syntax:	THD:ORDer?[<space><MAX | MIN>]<PMT>
Return parameters:	<NR1>, 2 ~ 100
Header on:	:THD:ORDER<space><NR1><RMT>
Header off:	<NR1><RMT>
Example:	none

[CONFigure:]THD:CYCLe

Type:	All channels.
Description:	This command sets the cycle of THD measure.
Setting syntax:	THD:CYCLe<space><NR1><PMT>
Setting parameters:	<NR1>, 1 ~ 20
Query syntax:	THD:CYCLe?[<space><MAX | MIN>]<PMT>
Return parameters:	<NR1>, 1 ~ 20
Header on:	:THD:CYCLE<space><NR1><RMT>
Header off:	<NR1><RMT>
Example:	none

[CONFigure:]THD:SMOothing

Type: All channels.
Description: This command sets the state of smoothing filter.
Setting syntax: THD:SMOothing<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: THD:SMOothing?<PMT>
Return parameters: <CRD>, OFF | ON
  Header on: :THD:SMOOTHING<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]RANGe:RESPonse

Type: All channels.
Description: This command sets the response of current range switch.
Setting syntax: RANGe:RESPonse<space><CRD><PMT>
Setting parameters: <CRD>, FAST | SLOW
Query syntax: RANGe:RESPonse?<PMT>
Return parameters: <CRD>, FAST | SLOW
  Header on: :RANGE:RESPONSE<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]ENERgy:MODE

Type: All channels.
Description: This command sets the mode of energy measure.
Setting syntax: ENERgy:MODE<space><CRD><PMT>
Setting parameters: <CRD>, JOULE | WHR
Query syntax: ENERgy:MODE?<PMT>
Return parameters: <CRD>, JOULE | WHR
  Header on: :ENERGY:MODE<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]ENERgy:TIME

Type: All channels.
Description: This command sets the time of energy measure in Second.
Setting syntax: ENERgy:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 35999999
Query syntax: ENERgy:TIME?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 35999999
  Header on: :ENERGY:TIME<space><NR1><RMT>
  Header off: <NR1><RMT>
Example: none

[CONFigure:]EFFiciency:MODE

Type: Three-Phase.
Description: This command sets the method of efficiency caculation.
Setting syntax: EFFiciency:MODE<space><CRD><PMT>
Setting parameters: <CRD>, A/B | B/A
Query syntax: EFFiciency:MODE?<PMT>
Return parameters: <CRD>, A/B | B/A
  Header on: :EFFICIENCY:MODE<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]HOLD:MODE

Type: System.
Description: This command sets the mode of hold function.
Setting syntax: HOLD:MODE<space><CRD><PMT>
Setting parameters: <CRD>, STOP | MAX | MIN
Query syntax: HOLD:MODE?<PMT>
Return parameters: <CRD>, STOP | MAX | MIN
  Header on: :HOLD:MODE<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]HOLD:TIME

Type: System.
Description: This command sets the time of hold function in Second.
Setting syntax: HOLD:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 9999
Query syntax: HOLD:TIME?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 9999
  Header on: :HOLD:TIME<space><NR1><RMT>
  Header off: <NR1><RMT>
Example: none

[CONFigure:]DISPlay:UPDate

Type: System.
Description: This command sets the screen display update rate.
Setting syntax: DISPlay:UPDate<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 3, 0: 0.25s, 1: 0.5s, 2: 1s, 3: 2s
Query syntax: DISPlay:UPDate?<PMT>
Return parameters: <NR1>, 0.25 | 0.5 | 1 | 2
  Header on: :DISPlay:UPDATE<space><NR1><RMT>
  Header off: <NR1><RMT>
Example: none

[CONFigure:]DISPlay:BRIGHt

Type: System.
Description: This command sets the bright of screen.
Setting syntax: DISPlay:BRIGHt<space><CRD><PMT>
Setting parameters: <CRD>, LOW | MIDDLE | HIGH
Query syntax: DISPlay:BRIGHt?<PMT>
Return parameters: <CRD>, LOW | MIDDLE | HIGH
  Header on: :IDISPLAY:BRIGHT<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]INPut:WIRing

Type: Three-Phase.
Description: This command is used to switch the input wiring mode.
Setting syntax: INPut:WIRing<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 4, 0: 1P2W, 1: 1P3W, 2: 3P3W, 3: 3P4W, 4:3V3A
Query syntax: INPut:WIRing?<PMT>
Return parameters: <CRD>, 1P2W | 1P3W | 3P3W | 3P4W | 3V3A
  Header on: :INPut:WIRING<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CONFigure:]INPut:CT

Type: Channel-Specific or All channels.
Description: This command is used to switch the CT function.
Setting syntax: INPut:CT<space><CRD><PMT>
INPut:CT<space><CRD>,<CRD>,<CRD>,<CRD><PMT>
Setting parameters: <CRD>, OFF | ON, '/':denote no action
Query syntax: INPut:CT?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INPut:CT<space><CRD>,<CRD>,<CRD>,<CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

[CONFigure:]INPut:CT:RATio

Type: Channel-Specific or all channels.
Description: This command sets the CT ratio.
Setting syntax: INPut:CT:RATio<space><NR2><PMT>
INPut:CT:RATio<space><NR2>,<NR2>,<NR2>,<NR2><PMT>
Setting parameters: <NR2>, 1.0 ~ 9999.9 , resolution 0.1, '/':denote no action
Query syntax: INPut:CT:RATio?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 1.0 ~ 9999.9
Header on: :INPUT:CT:RATIO<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

[CONFigure:]INPut:HV

Type: Channel-Specific or all channels.
Description: This command is used to switch the HV function.
Setting syntax: INPut:HV<space><CRD><PMT>
INPut:HV<space><CRD>,<CRD>,<CRD>,<CRD><PMT>
Setting parameters: <CRD>, OFF | ON | A662012 | A662023 | USERDEF, '/':denote no action
Query syntax: INPut:HV?<PMT>
Return parameters: <CRD>, OFF | ON | A662023 | USERDEF
Header on: :INPUT:HV<space><CRD>,<CRD>,<CRD>,<CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

[CONFigure:]INPut:HV:RATio

Type: Channel-Specific or all channels.
Description: This command is used to set the ratio of HV kit when USERDEF state is selected.
Setting syntax: INPut:HV:RATio<space><NR2><PMT>
INPut:HV:RATio<space><NR2>,<NR2>,<NR2>,<NR2><PMT>
Setting parameters: <NR2>, 1.000 ~ 50.000 , resolution 0.001, '/':denote no action
Query syntax: INPut:HV:RATio?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 1.000 ~ 50.000, '-----':denote invalid.
Header on: :INPUT:HV:RATIO<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

[CONFigure:]INPut:SHUNt

Type: Channel-Specific or all channels.
Description: This command is used to switch the external shunt function.

Setting syntax: INPut:SHUNt<space><CRD><PMT>
INPut:SHUNt<space><CRD>,<CRD>,<CRD>,<CRD><PMT>
Setting parameters: <CRD>, OFF | ON, ‘/’:denote no action
Query syntax: INPut:SHUNt?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INPUT:SHUNT<space><CRD>,<CRD>,<CRD>,<CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

[CONFigure:]INPut:SHUNt:RESIStance

Type: Channel-Specific or all channels.
Description: This command sets the external shunt resistance.
Setting syntax: INPut:SHUNt:RESIStance<space><NR2><PMT>
INPut:SHUNt:RESIStance<space><NR2>,<NR2>,<NR2>,<NR2><PMT>
Setting parameters: <NR2>, 0.0000001 ~ 99.9999999 , resolution 0.0000001, ‘/’:denote no action
Query syntax: INPut:SHUNt:RESIStance?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 0.0000001 ~ 99.9999999
Header on: :INPUT:SHUNT:RESISTANCE<space><NR2>,<NR2>,<NR2>,<NR2><RMT>
Header off: <NR2>,<NR2>,<NR2>,<NR2><RMT>
Example: none

TRIGger

Type: Channel-Specific or all channels.
Description: Three different modes, GONG, INRUSH and ENERGY, are triggered by this command.
Setting syntax: TRIGger<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: TRIGger?[<space><NR1>]<RMT>
Query parameters: <NR1>, 1 ~ 4: CH1 ~ CH4, 0 : All Channels
Return parameters: <CRD>, STOP | FINISH | RUNNING
When query parameter set to 1 ~ 4 :
Header on: :TRIGGER<space><CRD><RMT>
Header off: <CRD><RMT>
When query parameter set to 0:
Header on: :TRIGGER<space><CRD>,<CRD>,<CRD>, <CRD><RMT>
Header off: <CRD>,<CRD>,<CRD>,<CRD><RMT>
Example: none

TRIGger:MODE

Type: All channels.
Description: This command is used to select which mode will be triggered.
Setting syntax: TRIGger:MODE<space><CRD><PMT>
Setting parameters: <CRD>, NONE | GONG | INRUSH | ENERGY
Query syntax: TRIGger:MODE?<PMT>
Return parameters: <CRD>, NONE | GONG | INRUSH | ENERGY
Header on: :TRIGGER:MODE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: none

PROTection:CLEar

Type: All channels.
Description: This command clears the alarm message.
Setting syntax: PROTection:CLEar<PMT>
Setting parameters: none
Query syntax: none
Return parameters: none
Example: none

PROTection?

Type: All channels.
Description: This query returns the alarm message of all channels.

Bit position	15	14~7	6	5	4	3	2	1	0
Condition	FAN	-	OPFR	Energy RCE	Inrush RCE	Integrate RCE	OCP	OCR	OVR
Bit weight	32768	-	64	32	16	8	4	2	1

Setting syntax: none
Setting parameters: none
Query syntax: PROTection?<PMT>
Return parameters: <NR1> 0 ~ 65535
  Header on: :IPROTECTION<space><NR1>,<NR1>,<NR1>,<NR1><RMT>
  Header off: <NR1>,<NR1>,<NR1>,<NR1><RMT>
Example: none

WAVeform:CAPture?

Type: All channels.
Description: This query performs the acquisition of new waveform once and returns the status of this action.
Setting syntax: none
Setting parameters: none
Query syntax: WAVeform:CAPture?<PMT>
Return parameters: <CRD>, OK | WAIT | ERROR
  Header on: :WAVEFORM:CAPTURE<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

WAVeform:DATA? <CRD>

Type: Channel-Specific.
Description: This query returns voltage or current waveform data from the Power Meter in binary format. The waveform either voltage or current are consist of 2048 points in format of 32bits float point.

Low byte → *High byte*

$$\#48192\underbrace{\langle byte1\rangle\langle byte2\rangle\langle byte3\rangle\langle byte4\rangle}_{Point\ \#1}\underbrace{\langle byte5\rangle\langle byte6\rangle\langle byte7\rangle\langle byte8\rangle}_{Point\ \#2}...$$

Setting syntax: none
Setting parameters: none

Query syntax: WAVeform:DATA?<space><CRD><PMT>
Query parameters: <CRD>, V | I
Return parameters: <DLABRD>, #48192<byte1><byte2><byte3>…<byte8192>
Header on: :WAVEFORM:DATA<space><DLABRD><RMT>
Header off: <DLABRD><RMT>
Example: none

[CONFigure:]FORMat:WARNing

Type: System
Description: This command sets the format of warning message.
Setting syntax: FORMat:WARNiing<space><CRD><PMT>
Setting parameters: <CRD>, NUMBER | STRING
NUMBER message : -1, -2, -3, -4, -5
STRING message : E1, E2, E3, E4, E5
Query syntax: FORMat:WARNing?<PMT>
Return parameters: <CRD>, NUMBER | STRING
Header on: :FORMAT:WARNING<space><CRD><RMT>
Header off: <CRD><RMT>
Example: none

SHOW Sub-system

SHOW[:DISPlay]:CHANnel

Type: System.
Description: This command is used to select which channel will be displayed.
Setting syntax: SHOW:CHANnel<space><arg1>,<arg2>,<arg3>,<arg4><PMT>
Setting parameters: <arg1 ~ 4> denote four display areas, and there are in <NR1> type, 1 ~ 4: Channel 1 ~ Channel 4
Query syntax: none
Return parameters: none
Example: none

SHOW[:DISPlay]:ITEM

Type: System.
Description: This command is used to select which item of measure will be displayed.
Setting syntax: SHOW:ITEM<space><arg1>,<arg2>,<arg3>,<arg4><PMT>
Setting parameters: <arg1 ~ 4> denote four display areas, and there are in <CRD> type,
arg1: V, I, W, IS, VPK+, PF, F
arg2: V, I, W, IS, VPK-, EFF, CFI
arg3: V, I, W, IS, E, THDV, THDI
arg4: V, I, W, PF, VA, VAR, (Ew, Epf, Eva, Evar only for non-1P2W mode)
Query syntax: none
Return parameters: none
Example: none

CALCULATE Sub-system

[CALCulate:]COMParator

Type: All channels.
Description: Users can configure upper and lower boundary of measured items. 662xx will check measured items according to the boundaries. Once any item exceeds the boundaries, the item will be recorded. The command is used to turn on/off the comparison function.
Setting syntax: COMParator<space><CRD><PMT>
Setting parameters: <CRD>, ON | OFF
Query syntax: COMParator?<PMT>
Return parameters: <CRD>, ON | OFF
  Header on: :COMPARATOR<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CALCulate:]COMParator:TIME

Type: All channels.
Description: Programming "COMP:TIME" decides the dwelling time of comparison function. The unit of Setting Parameter is second.
Setting syntax: COMParator:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 9999
Query syntax: COMParator:TIME?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 9999
  Header on: :COMPARATOR:TIME<space><NR1><RMT>
  Header off: <NR1><RMT>
Example: none

[CALCulate:]COMParator:RESult?

Type: All channels.
Description: This query command returns the result of comparison. The return value is PASS/FAIL/NONE.
Setting syntax: none
Setting parameters: none
Query syntax: COMParator:RESult?<PMT>
Return parameters: <CRD>, NONE | PASS | FAIL
  Header on: :COMPARATOR:RESULT<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: none

[CALCulate:]COMParator:FAIL?

Type: Channel-Specific.
Description: This query command returns the measured items which are out of programmed boundaries. The return strings of measured item are listed in Response Parameters.
Setting syntax: none
Setting parameters: none
Query syntax: COMParator:FAIL?<PMT>
Return parameters: <CRD>, NONE, V, VPK+, VPK-, THDV, I, IPK+, IPK-, IS, CFI, THDI, W, PF, VA, VAR, ENEG, FREQ
  Header on: :COMPARATOR:FAIL<space><CRD>,<CRD>,...<RMT>
  Header off: <CRD>,<CRD>,...<RMT>
  Separator 0: <CRD>,<CRD>,...<RMT>
  Separator 1: <CRD>;<CRD>;...<RMT>

Example: none

[CALCulate:]COMParator:ITEM

Type: Channel-Specific.
Description: This command is used to select measured items as comparison items in GONG mode.
Setting syntax: COMParator:ITEM<space><CRD>,<CRD>,<CRD>,…<PMT>
Setting parameters: <CRD>, NONE, V, VPK+, VPK-, THDV, I, IPK+, IPK-, IS, CFI, THDI, W, PF, VA, VAR, ENEG, FREQ
Query syntax: COMParator:ITEM?<PMT>
Return parameters: <CRD>, NONE, V, VPK+, VPK-, THDV, I, IPK+, IPK-, IS, CFI, THDI, W, PF, VA, VAR, ENEG, FREQ
  Header on: :COMPARATOR:ITEM<space><CRD>,<CRD>,…<RMT>
  Header off: <CRD>,<CRD>,…<RMT>
  Separator 0: <CRD>,<CRD>,…<RMT>
  Separator 1: <CRD>;<CRD>;…<RMT>
Example: none

[CALCulate:]COMParator:LIMit:V

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of voltage (r.m.s) in GONG mode.
Setting syntax: COMParator:LIMit:V<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: COMParator:LIMit:V?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
  Header on: :COMPARATOR:LIMIT:V<space><NR2>,<NR2><RMT>
  Header off: <NR2>,<NR2><RMT>
  Separator 0: <NR2>,<NR2><RMT>
  Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:VPK+

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of positive peak voltage in GONG mode.
Setting syntax: COMParator:LIMit:VPK+<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: COMParator:LIMit:VPK+?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
  Header on: :COMPARATOR:LIMIT:VPK+<space><NR2>,<NR2><RMT>
  Header off: <NR2>,<NR2><RMT>
  Separator 0: <NR2>,<NR2><RMT>
  Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:VPK-

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of negative peak voltage in GONG mode.
Setting syntax: COMParator:LIMit:VPK-<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: COMParator:LIMit:VPK-?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999

Header on: :COMPARATOR:LIMIT:VPK-<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:THDV

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of total harmonic distortion of voltage in GONG mode.
Setting syntax: COMParator:LIMit:THDV<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don't care.
Query syntax: COMParator:LIMit:THDV?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99.99
Header on: :COMPARATOR:LIMIT:THDV<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:I

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of current (r.m.s.) in GONG mode.
Setting syntax: COMParator:LIMit:I<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.
Query syntax: COMParator:LIMit:I?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, -1 ~ 9999.99999
Header on: :COMPARATOR:LIMIT:I<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:IPK+

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of positive peak current in GONG mode.
Setting syntax: COMParator:LIMit:IPK+<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.
Query syntax: COMParator:LIMit:IPK+?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, -1 ~ 9999.99999
Header on: :COMPARATOR:LIMIT:IPK+<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:IPK-

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of negative peak current in GONG mode.
Setting syntax: COMParator:LIMit:IPK-<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.

Query syntax: COMParator:LIMit:IPK-?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, -1 ~ 9999.99999
Header on: :COMPARATOR:LIMIT:IPK-<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:IS

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of inrush current in GONG mode.
Setting syntax: COMParator:LIMit:IS<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don’t care.
Query syntax: COMParator:LIMit:IS?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, -1 ~ 9999.99999
Header on: :COMPARATOR:LIMIT:IS<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:CFI

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of current crest factor in GONG mode.
Setting syntax: COMParator:LIMit:CFI<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don’t care.
Query syntax: COMParator:LIMit:CFI?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99.99
Header on: :COMPARATOR:LIMIT:CFI<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:THDI

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of total harmonic distortion of current in GONG mode.
Setting syntax: COMParator:LIMit:THDI<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don’t care.
Query syntax: COMParator:LIMit:THDI?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99.99
Header on: :COMPARATOR:LIMIT:THDI<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:W

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of power in GONG mode.

Setting syntax: COMParator:LIMit:W<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: COMParator:LIMit:W?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:W<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:PF

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of power factor in GONG mode.
Setting syntax: COMParator:LIMit:PF<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9.999, -1 denote don't care.
Query syntax: COMParator:LIMit:PF?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 9.999
Header on: :COMPARATOR:LIMIT:PF<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:VA

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of apparent power in GONG mode.
Setting syntax: COMParator:LIMit:VA<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: COMParator:LIMit:VA?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:VA<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:VAR

Type: Channel-Specific.
Description: This command sets upper and lower boundaries of reactive power in GONG mode.
Setting syntax: COMParator:LIMit:VAR<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: COMParator:LIMit:VAR?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:VAR<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: none

[CALCulate:]COMParator:LIMit:FREQ

Type: Channel-Specific.

Description:	This command sets upper and lower boundaries of frequency in GONG mode.
Setting syntax:	COMParator:LIMit:FREQ<space><NR2>,<NR2><PMT>
Setting parameters:	<NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax:	COMParator:LIMit:FREQ?[<space><MAX | MIN>]<PMT>
Return parameters:	<NR2> , -1 ~ 99999.9999
Header on:	:COMPARATOR:LIMIT:FREQ<space><NR2>,<NR2><RMT>
Header off:	<NR2>,<NR2><RMT>
Separator 0:	<NR2>,<NR2><RMT>
Separator 1:	<NR2>;<NR2><RMT>
Example:	none

[CALCulate:]COMParator:LIMit:ENEG

Type:	Channel-Specific.
Description:	This command sets upper and lower boundaries of energy in GONG mode.
Setting syntax:	COMParator:LIMit:ENEG<space><NR2>,<NR2><PMT>
Setting parameters:	<NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax:	COMParator:LIMit:ENEG?[<space><MAX | MIN>]<PMT>
Return parameters:	<NR2> , -1 ~ 99999.9999
Header on:	:COMPARATOR:LIMIT:ENEG<space><NR2>,<NR2><RMT>
Header off:	<NR2>,<NR2><RMT>
Separator 0:	<NR2>,<NR2><RMT>
Separator 1:	<NR2>;<NR2><RMT>
Example:	none

CALIBRATION Sub-system

CALibration:AUTO? {<NR1>}

Type:	Channel-Specific.
Description:	The command is used to force 662xx to re-calibrate the offset of current. If ambient temperature variation is too much, user may program this command to improve the accuracy.
Setting syntax:	none
Setting parameters:	none
Query syntax:	CALibration:AUTO?<PMT>, CALibration:AUTO?<space><NR1><PMT>
Query parameters:	<NR1>, 1 ~ 4: Channel 1 ~ Channel 4
Return parameters:	<CRD>, OK | WAIT | FAIL
Header on:	:CALIBRATION:AUTO<space><CRD><RMT>
Header off:	<CRD><RMT>
Example:	none

6. Status Reporting

6.1 Introduction

This chapter explains the status data structure of Chroma 66200 Series electronic load as shown in Figure 6-1 (on the next page). The standard registers such as the Event Status register group, the Output Queue, the Status Byte and Service Request Enable registers perform the standard GPIB functions and are defined in IEEE-488.2 Standard Digital Interface for Programmable Instrumentation. Other status register groups implement the specific status reporting requirements for the electronic load. The Channel Status and Channel Summary groups are used by multiple channel electronic loads to enable the status information that will be kept at its own Status register for each channel.

6.2 Register Information in Common

■ ***Condition register***

The condition register represents the present status of electronic load signals. Reading the condition register does not change the state of its bits. Only changes in electronic load conditions affect the contents of this register.

■ ***PTR/NTR Filter, Event register***

The Event register captures changes in conditions corresponding to condition bits in a condition register, or to a specific condition in the electronic load. An event becomes true when the associated condition makes one of the following electronic load-defined transitions:

Positive TRansition (0 - to - 1)
Negative TRansition (1 - to - 0)
Positive or Negative TRansition (0-to-1 or 1-to-0)

The PTR/NTR filters determine what type of condition transitions set the bits in the Event register. Channel Status, Questionable Status allow transitions to be programmed. Other register groups, i.e. Channel Summary, Standard Event Status register group use an implied Rise (0-to-1) condition transition to set bits in the Event register. Reading an Event register clears it (all bits set to zero).

■ ***Enable register***

The Enable register can be programmed to enable the bit that the corresponding Event register is logically ORed into the Channel Summary.

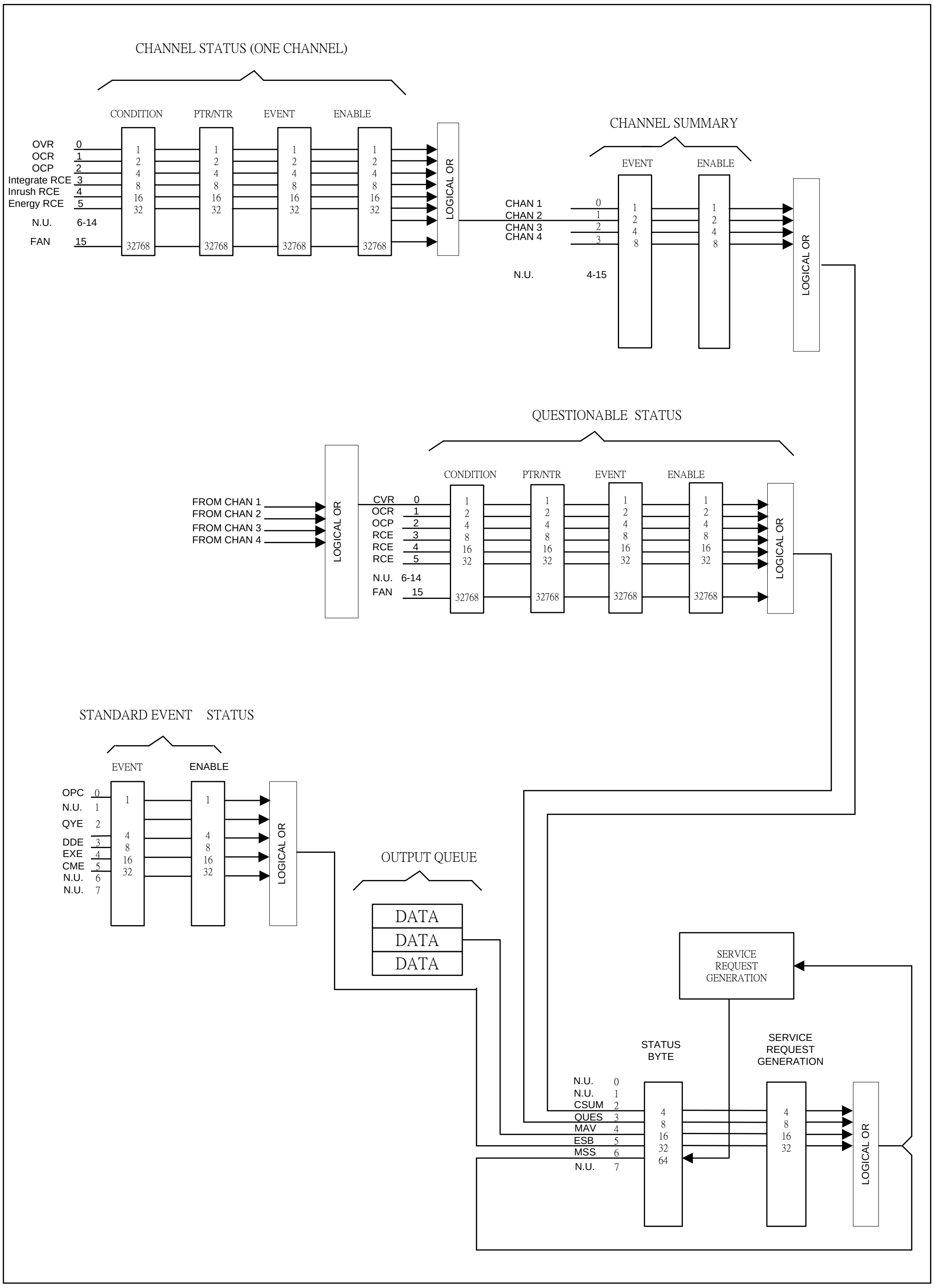


Figure 6-1 Status Registers of Electronic Load

6.2.1 Channel Status

- The Channel Status register informs you one or more channel status conditions, which indicate certain errors or faults have occurred to a specific channel. Table 6-1 explains the channel status conditions that are applied to the electronic load.
- When the bits of the Channel Status Condition register are set, the corresponding condition is true.
- Program the PTR/NTR filter to select the way of condition transition in the Channel Status Condition register that will be set in the Event registers.
- Reading the Channel Status Event register resets itself to zero.
- The Channel Status Enable register can be programmed to specify the channel status event bit that is logically ORed to become the corresponding channel bit in Channel Summary Event register.

Table 6-1 Bit Description of Channel Status

Mnemonic	Bit	Value	Meaning
OVR	0	1	*Over voltage range*. When over voltage range condition has occurred on a channel, Bit 0 is set and remains set until the over voltage range condition is removed and :PROT:CLE is programmed.
OCR	1	2	*Over current range*. When an over current range condition has occurred on a channel, Bit 1 is set and remains set until the over current range condition is removed and :PROT:CLE is programmed.
OCP	2	4	*Over current protection*. When an over current condition has occurred on a channel, Bit 2 is set and remains set until the over current condition is removed and :PROT:CLE is programmed.
Integrate RCE	3	8	*Integration range changed error.* It happens when the measured voltage or current signal is over the measurement range at performing integration measurement function.
Inrush RCE	4	16	*Inrush range changed error.* It happens when the measured voltage or current signal is over the measurement range at performing Inrush measurement function.
Energy RCE	5	32	*Energy range changed error.* It happens when the measured voltage or current signal is over the measurement range at performing Energy measurement function.

6.2.2 Channel Summary

- The Channel Summary registers summarize the channel status conditions up to 10 channels.
- When an enabled bit in the Channel Status Event register is set, it causes the corresponding channel bit in the Channel Summary Event register to be set.
- Reading the Event register will reset it to zero.
- The Channel Summary Enable register can be programmed to specify the channel summary event bit from the existing channels that is logically ORed to become Bit 2 (CSUM bit) in the Status Byte register.

6.2.3 Questionable Status

- The Questionable Status registers inform you one or more questionable status conditions which indicate certain errors or faults have occurred to at least one channel. Table 6-2 lists the questionable status conditions that are applied to the electronic load. These conditions are same as the channel status conditions. Refer to Table 6-1 for a complete description.
- When a corresponding bit of Questionable Status Condition register is set, it indicates the condition is true.
- Program the PTR/NTR filter to select the way of condition transition in the Questionable Status Condition register that will be set in the Event registers.
- Reading the Questionable Status Event register will reset it to zero.
- The Questionable status Enable register can be programmed to specify the questionable status event bit that is logically ORed to become Bit 3 (QUES bit) in the Status Byte register.

Table 6-2 Bit Description of Questionable Status

Mnemonic	Bit	Value	Meaning
OVR	0	1	Over voltage range.
OCR	1	2	Over current range.
OCP	2	4	Over current.
RCE	3	8	Integration range changed error.
RCE	4	16	Inrush range changed error.
RCE	5	32	Energy range changed error.
OPFR	6	64	Over power factor range.

6.2.4 Output Queue

- The Output Queue stores output messages until they are read from the electronic load.
- The Output Queue stores messages sequentially on a FIFO (First-In, First-Out) basis.
- It sets to 4 (MAV bit) in the Status Byte register when there are data in the queue.

6.2.5 Standard Event Status

- All programming errors that have occurred will set one or more error bits in the Standard Event Status register. Table 6-3 describes the standard events that apply to the electronic load.
- Reading the Standard Event Status register will reset it to zero.
- The Standard Event Enable register can be programmed to specify the standard event bit that is logically ORed to become Bit 5 (ESB bit) in the Status Byte register.

Table 6-3 Bit Description of Standard Event Status

Mnemonic	Bit	Value	Meaning
OPC	0	1	*Operation Complete.* This event bit generated is responding to the *OPC command. It indicates that the device has completed all of the selected pending operations.
QYE	2	4	*Query Error*. The output queue was read when no data were present or the data in the queue were lost.
DDE	3	8	*Device Dependent Error*. Memory was lost, or self-test failed.

EXE	4	16	*Execution Error*. A command parameter was out of the legal range or inconsistent with the electronic load's operation, or the command could not be executed due to some operating conditions.
CME	5	32	*Command Error*. A syntax or semantic error has occurred, or the electronic load has received a <GET> message from program.

6.2.6 Status Byte Register

- The Status Byte register summarizes all of the status events for all status registers. Table 6-4 describes the status events that are applied to the electronic load.
- The Status Byte register can be read with a serial of pull or *STB? query.
- The RQS bit is the only bit that is automatically cleared after a serial of pull.
- When the Status Byte register is read with a *STB? query, Bit 6 of the Status Byte register will contain the MSS bit. The MSS bit indicates that the load has at least one reason for requesting service. *STB? does not affect the status byte.
- The Status Byte register is cleared by *CLS command.

Table 6-4 Bit Description of Status Byte

Mnemonic	Bit	Value	Meaning
CSUM	2	4	*Channel Summary*. It indicates if an enabled channel event has occurred. It is affected by Channel Condition, Channel Event and Channel Summary Event registers.
QUES	3	8	*Questionable*. It indicates if an enabled questionable event has occurred.
MAV	4	16	*Message Available.* It indicates if the Output Queue contains data.
ESB	5	32	*Event Status Bit*. It indicates if an enabled standard event has occurred.
RQS/MSS	6	64	*Request Service/Master Summary Status*. During a serial of pull, RQS is returned and cleared. For a *STB? query, MSS is returned without being cleared.

6.2.7 Service Request Enable Register

The Service Request Enable register can be programmed to specify the bit in the Status Byte register that will generate the service requests.

Appendix A   Using Control Signal Input/Output Terminal

The rear panel of the 66203/66204 Digital Power Meter has a 24-pin D-type terminal for external trigger signal and external Pass/Fail display. The table below lists the pin definition:

Pin	Definition	Pin	Definition	Pin	Definition	Pin	Definition	Pin	Definition
1	+5V	6	M1_Pass+	11	M3_Pass+	16	M1_Fail+	21	M3_Fail+
2	Is_Trigger	7	M1_Pass-	12	M3_Pass-	17	M1_Fail-	22	M3_Fail-
3	Limit_Trigger	8	M2_Pass+	13	M4_Pass+	18	M2_Fail+	23	M4_Fail+
4	Reserve Pin	9	M2_Pass-	14	M4_Pass-	19	M2_Fail-	24	M4_Fail-
5	GND	10	GND	15	GND	20	+5V		

Limit_Trigger and Is_Trigger

The internal wiring diagram of Limit_Trigger and Is_Trigger is shown in Figure A-1. The external TTL signals can be used to substitute the **TRIG/ENTER** key on the front panel for triggering. These two triggers are defined as falling edge trigger. Before Is Trigger is active, it has to select the Is indicator first to enable the Is measurement mode. The Limit_Trigger and Is_Trigger has about 100us to handle the noise false triggering. Be sure to take this delay time into consideration for application.

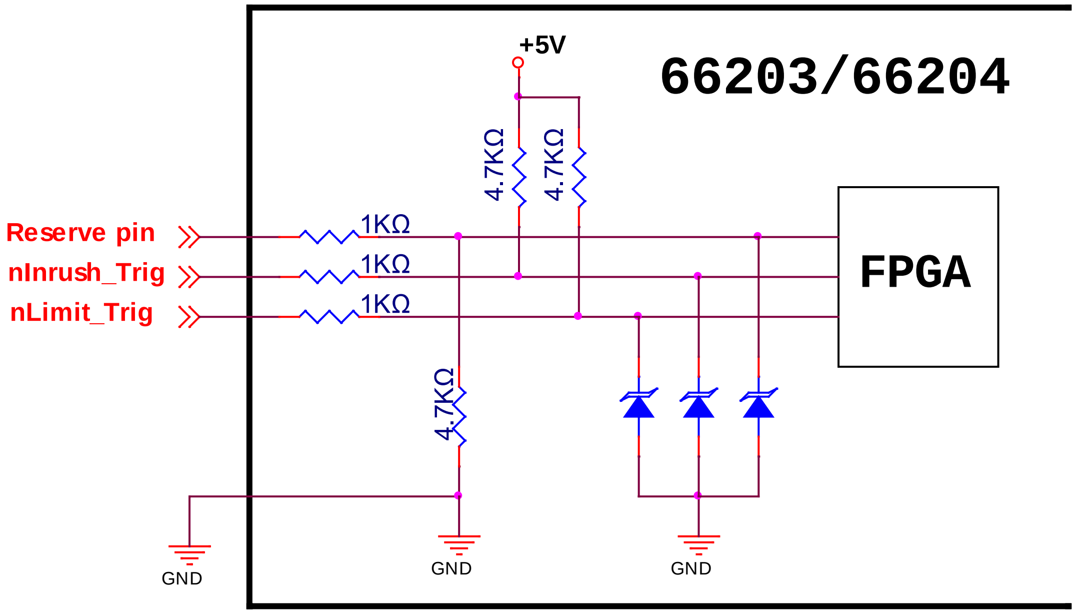


Figure A-1   Limit_Trigger & Is_Trigger Internal Wiring Diagram

Wiring for Pass + / Pass –

The internal wiring diagram of Pass + / Pass – is shown in Figure A-2. Pass + / Pass – output is the two terminals of a one-gate Relay. When running GO/NG test, the Relay will short-circuit if the test result is Pass. The Relay specification is 200VDC/0.5A Max.

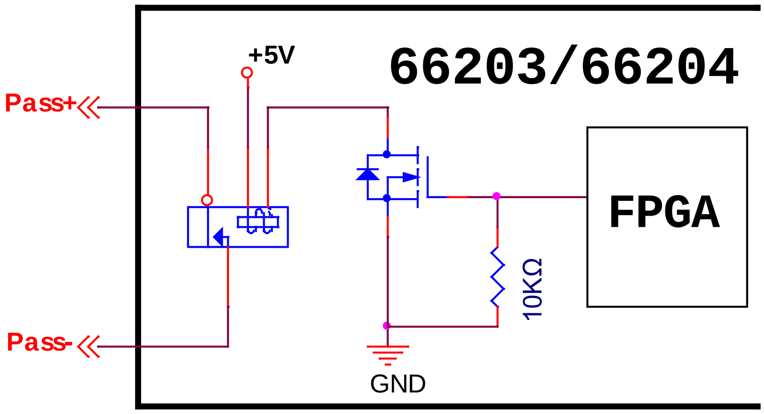


Figure A-2 Pass + / Pass – Internal Wiring Diagram

Wiring for Fail + / Fail –

The internal wiring diagram of Fail + / Fail – is shown in Figure A-3. Fail + / Fail – output is the two terminals of a one-gate Relay. When running GO/NG test, the Relay will short-circuit if the test result is Fail. The Relay specification is 200VDC/0.5A Max.

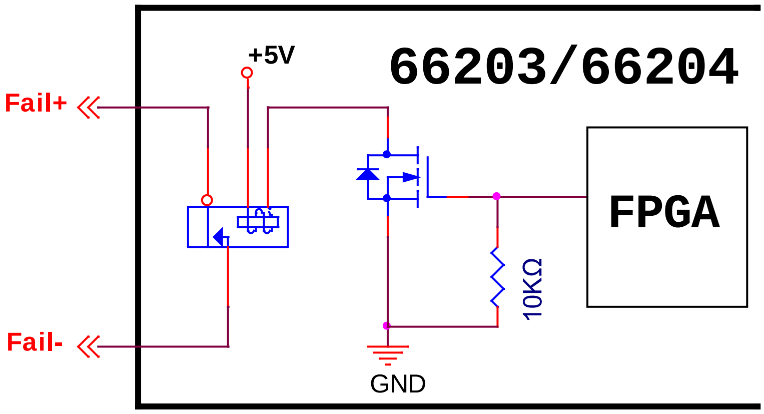


Figure A-3 Fail + / Fail – Internal Wiring Diagram

Appendix B Circuit Diagram

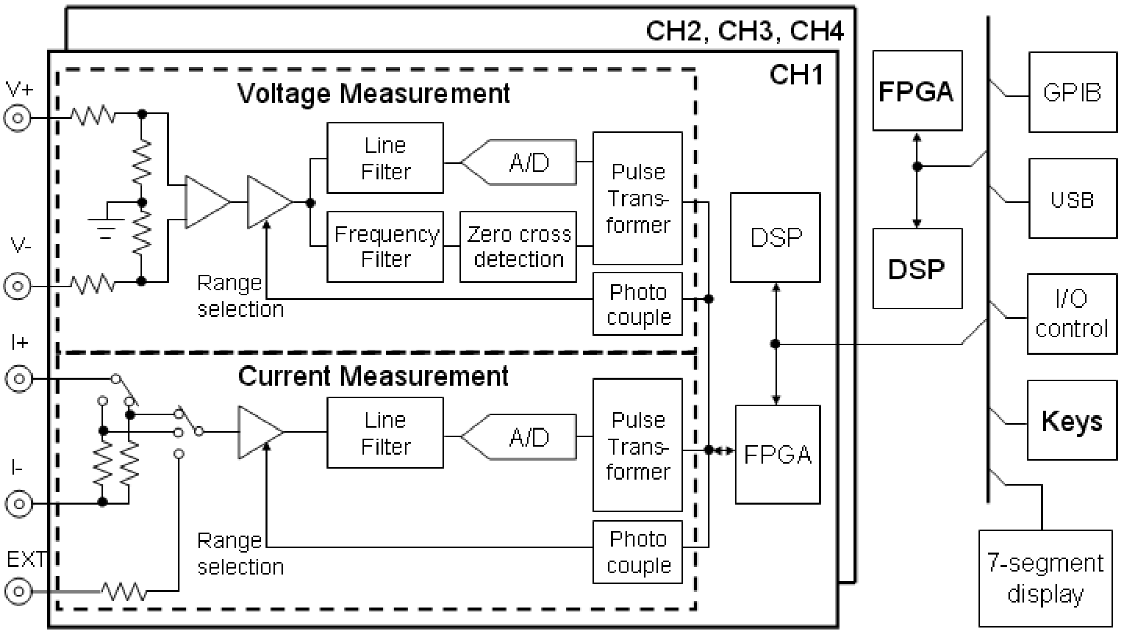


Figure B-1 Circuit Diagram

The 66203 and 66204 Digital Power Meter has 3 and 4 measurement channels respectively. Each channel has three types of input for measurements which are voltage, current and external sensing. The external sensing input signal is the voltage signal when the current flows passing through the sensor for current measurement. Thus, either current or external sensing input can be used at the same time and share the input low terminal (I-). If current input is selected for measurement, the power meter will provide two kinds of shunts - low and high for smaller and larger current measurements. The sensing voltage signal on the shunt will be processed by amplifier and filter, and then get the sample analog signal via A/D converter. The sampled data will send to FPGA for simple calculation and then send to DSP for advance calculation as well as analysis. During the measurement the DSP will adjust the range to the most appropriate based on the measured current signal to get the best measurement accuracy. If the current is more than the power meter can afford (maximum current 20A), an external sensor can be used instead.

Similarly, after the voltage input terminal is inputted with the voltage signal, the signal will be attenuated and sensed. After the sensing signal is processed by amplifier and filter, the A/D converter will get the sampling data and send to FPGA for simple calculation and then send to DSP for further calculation and analysis.

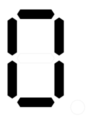
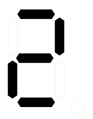
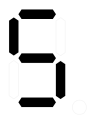
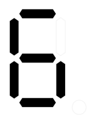
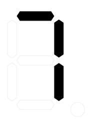
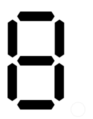
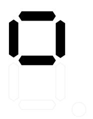
The A/D converter gets the samples of voltage and current signals simultaneously. The sampling rate is got based on the conversion of voltage frequency and varied with frequency. The voltage frequency is got using the zero-crossover detection circuit to output signal to FPGA for calculation. At the same time, the voltage and current data is got by the DSP and calculation and analysis are performed on current, power and harmonic.

Each measurement channel has its own calculation core, DSP and FPGA. Therefore, sampling of every channel can be almost at the same time for independent calculation and analysis. The integrated multi-channel DSP is responsible for the task of outside communication, user interface and 3-phase power calculation.

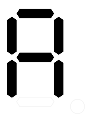
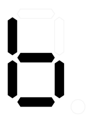
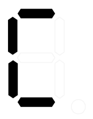
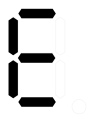
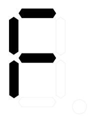
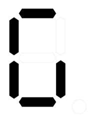
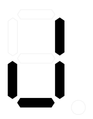
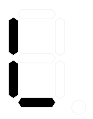
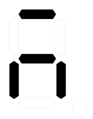
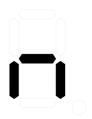
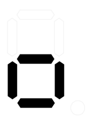
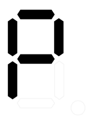
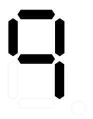
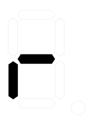
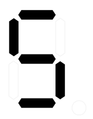
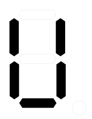
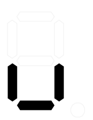
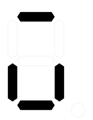
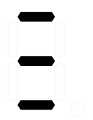
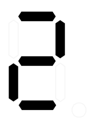
Appendix C Mapping Table for Displayed Letters

The following table shows the numbers and alphabets displayed by the 7-segment display of 66203/66204 Digital Power Meter.

Numbers:

0	1	2	3	4	5	6
						
7	8	9	–	#	/	
						

Alphabets:

A, a	**B, b**	**C, c**	**D, d**	**E, e**	**F, f**	**G, g**
						
H, h	**I, i**	**J, j**	**K, k**	**L, l**	**M, m**	**N, n**
						
O, o	**P, p**	**Q, q**	**R, r**	**S, s**	**T, t**	**U, u**
						
V, v	**W, w**	**X, x**	**Y, y**	**Z, z**		
						

Appendix D Troubleshooting

This appendix introduces the error messages displayed by the 66203/66204 Digital Power Meter and how to troubleshoot the problems. If any unlisted error appears or the procedure described here is unable to fix the problem, please contact the local Sales Distributor or Service Center of Chroma directly.

Error Message Code

The following error messages may appear on the LED panel:

Protection on Display	Full Name	Description
Err.01	SDRAM checked error	The system hardware SDRAM error, contact Chroma's dealer for service matter.
Err.02	Program code error	The system F/W program error, contact Chroma's dealer for service matter.
Err.61	Voltage calibration data error	Contact Chroma's dealer for service matter.
Err.62	Voltage calibration data error	Contact Chroma's dealer for service matter.
Err.63	Voltage calibration data error	Contact Chroma's dealer for service matter.
Err.71	Current calibration data error	Contact Chroma's dealer for service matter.
Err.72	Current calibration data error	Contact Chroma's dealer for service matter.
Err.73	Current calibration data error	Contact Chroma's dealer for service matter.
Err.81	Calibration data error of the external shunt measurement function.	Contact Chroma's dealer for service matter.
Err.82	Calibration data error of the external shunt measurement function.	Contact Chroma's dealer for service matter.
Err.83	Calibration data error of the external shunt measurement function.	Contact Chroma's dealer for service matter.
Err.99	The operation period of this equipment has expired.	Contact Chroma's dealer for access permission.
-OVR-	Over Voltage Range	The input voltage exceeds the range when switching it manually. The error message will disappear when the range is adjusted to an appropriate one and return to normal measurement function.
-OCR-	Over Current Range	The input current exceeds the range when switching it manually. The error message will disappear when the range is adjusted to an appropriate one and return to normal measurement function.
-OCP-	Over Current Protection	The input current exceeds the measurement range of the 66203/66204 Digital Power Meter. Make sure the system measurement

		current is in normal state. Long hour or frequent use of over current could result the fuse on the internal current circuit to blow out and cause the current unable to be measured.
-RCE-	Range Change Error	When the power measurement is set to run in integration time mode, switch the voltage or current range within the integration time may cause the power integration measurement error.
-Fan-	Fan Error	The fan is having error during operation. When the indicator of Channel 1 is on, it means the error is occurred on the front fan; while the indicator of Channel 2 is on, it means the error is occurred on the rear fan. The power meter won't be ready for measurement until the error is resolved. Please contact Chroma or its distributor for repair and services.
-OPFR	Over Power Factor Range	When performing 3-phase measurement, if the actual connection does not match the measurement mode, the PF measurement could be larger than 1 and over the PF range. Please make sure that the actual connection matches the measurement mode setting.

Simple Troubleshooting

Problem	Simple Troubleshooting Procedure
Unable to turn on Power Meter	1. Make sure the power cord is connected firmly. 2. Make sure the voltage range switch on the rear panel matches the input power. 3. Make sure the fuse is not damaged.
Measured data error	1. Make sure the measurement wires are connected correctly. 2. Make sure the humidity condition of test environment is within the specification. 3. Follow the steps listed in *Appendix E Specification Verification* to confirm the product measurement is within specification. 4. If the current measurement keeps showing zero after the current is inputted, it could be the fuse on the internal current circuit is blowout. Please contact Chroma's dealer for service.
Unable to do remote control	1. Make sure the remote control address setting is correct. 2. Make sure the applicable wires are used for connection.

Appendix E Specification Verification

This appendix describes the procedure of specification verification for verifying the functions of 66203/66204 Digital Power Meter. This test procedure is applicable for validating the instruments of newly purchased and repaired as well as for periodic calibration.

Only qualified professional personnel can perform the specification verification. The person should have professional knowledge of power measurement and is familiar with the test devices used in this appendix to avoid causing electric shock or other injury during verification.

CAUTION Do not perform the procedures described in this appendix except qualified personnel to avoid electric shock.

Hardware Requirements

The test devices required are:

Test Equipment	Specification	Suggested Model
Voltage Source	0~600Vrms output	Fluke 5500A or Fluke 5520A
Current Source	0~10Arms or 0~20Arms output	Fluke 5500A or Fluke 5520A
Test Wire	Withstand voltage 600Vrms, Withstand current 20Arms	

Configuring Test Wires

Connect the Fluke 5500A voltage output Hi/Lo to the 66203/66204 Digital Power Meter's rear panel V+/V- and the Fluke 5500A (or Fluke 5520A) current output to the 66203/66204 Digital Power Meter's rear panel I+/I- with test wires as Figure E-1 shows. Once the instruments are configured, power on the Fluke 5500A (or Fluke 5520A) and the 66203/66204 Digital Power Meter.

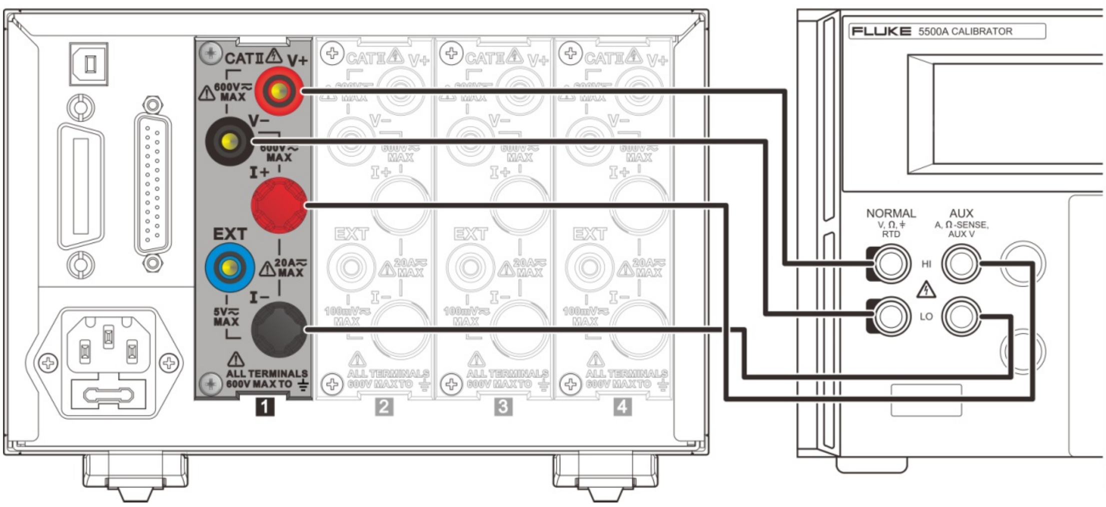


Figure E-1

WARNING Be sure the voltage and current wires position are connected correctly. It could burn out the instrument internal circuit if mistake.

Voltage Specification Verification

Steps:
1. Follow the test table to set the voltage measurement range of 66203/66204 Digital Power Meter, the parameter indicator is set to V (AC voltage RMS).
2. Follow the test table to set the voltage output of Fluke 5500A (or Fluke 5520A).
3. Set the Fluke 5500A (or Fluke 5520A) to begin output.
4. Log the voltage RMS showed on the display panel of 66203/66204 Digital Power Meter.
5. Set the Fluke 5500A (or Fluke 5520A) output to Standby.
6. Repeat step 1 to 5 and measure the voltage of the remaining ranges.
7. When the test is completed, set the Fluke 5500A (or Fluke 5520A) output to Standby.

⚠WARNING Make sure the Fluke 5500A (or Fluke 5520A) output is OFF when switching the voltage range to avoid any measurement error. Do not touch the test wire when the Fluke 5500A (or Fluke 5520A) is output voltage to prevent electric shock. Once the test is done, make sure the Fluke 5500A (or Fluke 5520A) is in Standby state before changing the wiring to avoid electric shock.

The test result of each voltage range for 66203/66204 Digital Power Meter:

66203/66204 600V Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 480Vrms, 60Hz	Vrms	480.96		479.04
Low Voltage 60Vrms, 60Hz	Vrms	60.54		59.46

66203/66204 300V Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 240Vrms, 60Hz	Vrms	240.48		239.52
Low Voltage 30Vrms, 60Hz	Vrms	30.27		29.73

66203/66204 150V Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 120Vrms, 60Hz	Vrms	120.24		119.76
Low Voltage 15Vrms, 60Hz	Vrms	15.135		14.865

66203/66204 60V Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 48Vrms, 60Hz	Vrms	48.096		47.904
Low Voltage 6Vrms, 60Hz	Vrms	6.054		5.946

66203/66204 30V Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 24Vrms, 60Hz	Vrms	24.048		23.952
Low Voltage 3Vrms, 60Hz	Vrms	3.027		2.973

66203/66204 15V Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 12Vrms, 60Hz	Vrms	12.024		11.976
Low Voltage 1.5Vrms, 60Hz	Vrms	1.5135		1.4865

Current Specification Verification

Steps:

1. Follow the test table to set current measurement range of 66203/66204 Digital Power Meter, voltage measurement range is fixed to 150Vrms. The parameter indicator is set to A (AC current RMS).
2. Follow the test table to set the voltage, current output of Fluke 5500A (or Fluke 5520A).
3. Set the Fluke 5500A (or Fluke 5520A) to begin output.
4. Log the current RMS showed on the display panel of 66203/66204 Digital Power Meter.
5. Set the Fluke 5500A (or Fluke 5520A) output to Standby.
6. Repeat step 1 to 5 and measure the current of the remaining ranges.
7. When the test is completed, set the Fluke 5500A (or Fluke 5520A) output to Standby.

⚠WARNING Make sure the Fluke 5500A (or Fluke 5520A) output is OFF when switching the current range to avoid any measurement error. Do not touch the test wire when the Fluke 5500A (or Fluke 5520A) is output voltage to prevent electric shock. Once the test is done, make sure the Fluke 5500A (or Fluke 5520A) is in Standby state before changing the wiring to avoid electric shock.

Notice The maximum current output of Fluke 5500A is 10A; therefore when verifying the range of 20A, the high current can change to 10A if Fluke 5500A is in use.

The test result of each current range for the 66203/66204 Digital Power Meter:

66203/66204 20A Range				
Fluke 5520A (or Fluke 5500A) Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Current 100V/16Arms, 60Hz	Irms	16.036		15.964
Low Current 100V/2Arms, 60Hz	Irms	2.0220		1.9780

66203/66204 5A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/4Arms, 60Hz	Irms	4.0090		3.9910
Low Current 100V/0.5Arms, 60Hz	Irms	505.50m		494.50m

66203/66204 2A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/1.6Arms, 60Hz	Irms	1.6036		1.5964
Low Current 100V/0.2Arms, 60Hz	Irms	202.20m		197.80m

66203/66204 0.5A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/0.4Arms, 60Hz	Irms	400.90m		399.10m
Low Current 100V/50mArms, 60Hz	Irms	50.550m		49.450m

66203/66204 0.2A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/0.16Arms, 60Hz	Irms	160.36m		159.64m
Low Current 100V/20mArms, 60Hz	Irms	20.220m		19.780m

66203/66204 0.05A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/40mArms, 60Hz	Irms	40.090m		39.910m
Low Current 100V/5mArms, 60Hz	Irms	5.0550m		4.9450m

66203/66204 0.02A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/16mArms, 60Hz	Irms	16.036m		15.964m
Low Current 100V/2mArms, 60Hz	Irms	2.0220m		1.9780m

66203/66204 0.005A Range				
Fluke 5520A (or Fluke 5500A) Output	Parameter	Max. Spec.	Measured Result	Min. Spec.
High Current 100V/4mArms, 60Hz	Irms	4.0090m		3.9910m
Low Current 100V/0.5mArms, 60Hz	Irms	0.5060m		0.4950m

Frequency Specification Verification

Steps:

1. Set the voltage measurement range of 66203/66204 Digital Power Meter to 150Vrms, the parameter indicator is set to F (frequency).
2. Follow the test table to set the voltage, frequency output of Fluke 5500A (or Fluke 5520A).
3. Set the Fluke 5500A (or Fluke 5520A) to begin output.
4. Log the voltage frequency showed on the display panel of 66201/66202 Digital Power Meter.
5. Set the Fluke 5500A (or Fluke 5520A) output to Standby.
6. Repeat step 1 to 5 and measure the frequency of the remaining parts.
7. When the test is completed, set the Fluke 5500A (or Fluke 5520A) output to Standby.

The test result of frequency measurement for 66203/66204 Digital Power Meter:

Fluke 5520A (or Fluke 5500A) Output	Max. Spec.	Measured Result	Min. Spec.
150V / 60Hz	60.021		59.979
150 V / 10KHz	10.003k		9.9964k
15V /50Hz	50.030		49.970
15V /10Hz	10.006		9.9940

Power Specification Verification

Steps:

1. Follow the test table to set the voltage range and current range of 66203/66204 Digital Power Meter, the parameter indicator is set to W (active power) and PF (power factor).
2. Follow the test table to set the voltage, current and PF output of Fluke 5500A (or Fluke 5520A).
3. Set the Fluke 5500A to begin output.
4. Log the active power, PF readings showed on the display of 66203/66204 Power Meter.
5. Set the Fluke 5500A output to Standby.
6. Repeat step 1 to 5, measure the active power and PF of the remaining ranges.
7. When the test is completed, set the Fluke 5500A (or Fluke 5520A) output to Standby.

The test result of power measurement:

66203/66204 Range		Voltage: 600V Range	Current: 20A Range	
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
480Vrms 16Arms 60Hz PF = 1	W	7.6996k		7.6604k
	PF	1		0.9981
66203/66204 Range		**Voltage: 300V Range**	**Current: 5A Range**	
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
240Vrms 4Arms 60Hz PF = 1	W	962.46		957.54
	PF	1		0.9981
66203/66204 Range		**Voltage: 150V Range**	**Current: 2A Range**	
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
120Vrms 1.6Arms 60Hz PF = 1	W	192.49		191.51
	PF	1		0.9981
66203/66204 Range		**Voltage: 60V Range**	**Current: 0.5A Range**	
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
48Vrms 0.4Arms 60Hz PF = 1	W	19.249		19.151
	PF	1		0.9981
66203/66204 Range		**Voltage: 30V Range**	**Current: 0.2A Range**	
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
24Vrms 160mArms 60Hz PF = 1	W	3.8498		3.8302
	PF	1		0.9981
66203/66204 Range		**Voltage: 15V Range**	**Current: 0.05A Range**	
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
12Vrms 40mArms 60Hz PF = 1	W	481.23m		478.77m
	PF	1		0.9981

66203/66204 Range		Voltage: 300V Range		Current: 0.02A Range
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
230Vrms 20mArms 60Hz PF = 1	W	4.6106		4.5894
	PF	1		0.9981
66203/66204 Range		**Voltage: 150V Range**		**Current: 0.005A Range**
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
115Vrms 5mArms 60Hz PF = 1	W	576.32m		573.68m
	PF	1		0.9981
66203/66204 Range		**Voltage 300V Range**		**Current: 0.02A Range**
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
230Vrms 20Arms 60Hz PF = 0.8	W	3.6938		3.6662
	PF	0.8021		0.7979
66203/66204 Range		**Voltage: 150V Range**		**Current:0.005A Range**
Fluke 5500 Output	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
115Vrms 5mArms 60Hz PF = 0.5	W	289.05m		285.95m
	PF	0.5028		0.4972

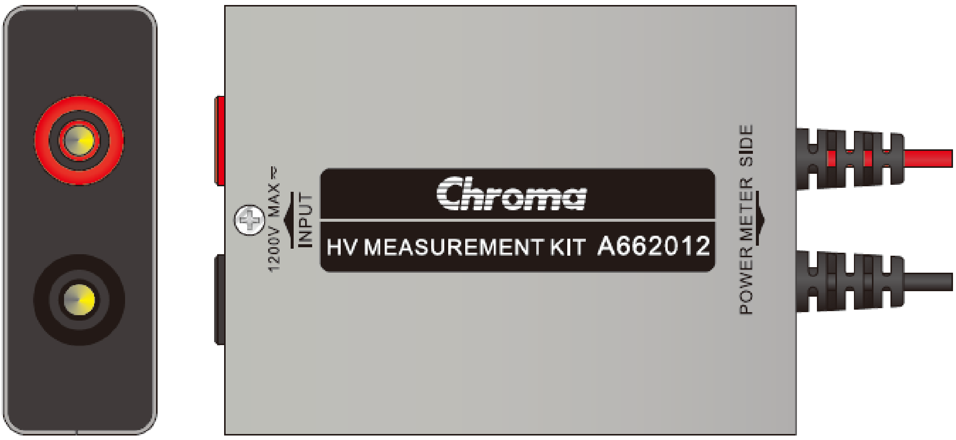
Appendix F A662012 HV Measurement Kit

When the 66203/66204 Digital Power Meter is used with the A662012 HV Measurement Kit, the maximum measured voltage can be increased up to 1200V. The A662012 is only applicable for measuring DC and the voltage signals within the frequency range of 47Hz~63Hz as well as the HV function of the 66203/66204 Digital Power Meter. In other words, Chroma cannot guarantee the overall measurement accuracy if the HV function is performed using the measurement fixture made by the user.

It is necessary to add 0.2% measurement error to the reading error spec. when using the 66203/66204 Digital Power Meter with the A662012. When calculating the measurement error spec., the actual measurement range should change to 1200V/600V/300V/120V/60V/ 30V; however, the A662012 is mainly for high voltage measurement use thus to get the best measurement accuracy, it is suggested not to use the A662012 for measuring the voltage under 600V.

Following is the example of measurement error spec. calculation:

Assuming the 600V range of the 66204 is used with the A662012 to measure the 1000V voltage signal, the measurement error spec. is calculated as below:
± {(0.2%+0.1%) ×1000V+0.08%×1200V} = ±3.96V



⚠WARNING

1. Please use the measurement cable with enough insulating intensity on the input side to ensure the usage safety.
2. Do not change the measurement cable of the power meter to ensure the usage safety.
3. Do not disassemble the device or modify its internal parts to ensure the usage safety.
4. Do not change the length of the Power Meter's measurement cable or it may affect the measurement accuracy.
5. If an external shunt is used to work with the A662012 for power measurement, please be aware that the maximum allowed voltage difference of current input terminal (I+, I-) to the GND is 600Vrms, or dangerous may occur.
6. It is suggested to use an external current sensor with insulation (CT or DC CT) to work with the A662012 for power measurement and to ensure the usage safety.

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