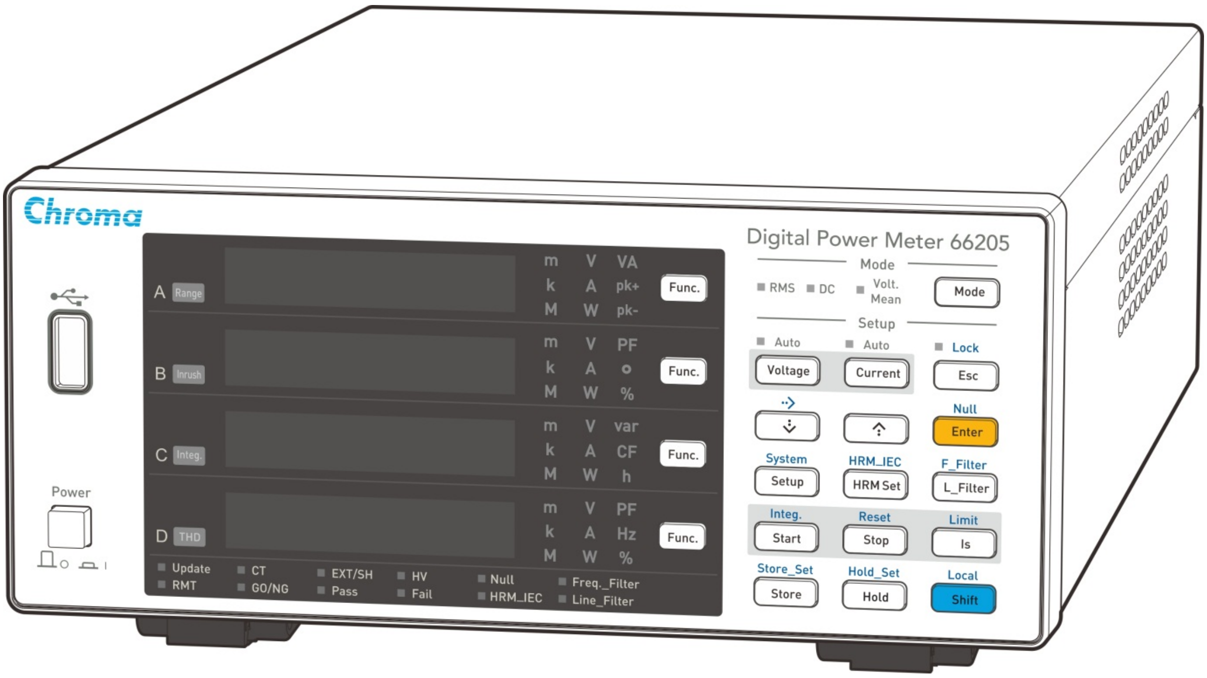
Chroma

Digital Power Meter

66205

User's Manual

Digital Power Meter
66205
User's Manual



Version 1.0
July 2017

Legal Notices

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

Chroma ATE INC. makes no warranty of any kind with regard to this manual, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Chroma ATE INC. shall not be held liable for errors contained herein or direct, indirect, special, incidental or consequential damages in connection with the furnishing, performance, or use of this material.

CHROMA ATE INC.

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

Warranty

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

This warranty does not apply to any products repaired or altered by persons not authorized by Chroma, or not in accordance with instructions furnished by Chroma. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

Chroma assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. Chroma assumes no liability for secondary charges or consequential damages and in any event, Chroma's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by Chroma regarding the use of its products are based upon tests believed to be reliable; Chroma makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for Chroma any liability in connection with the sale of our products other than set forth herein.

CHROMA ATE INC.
66 Huaya 1st Road, Guishan,
Taoyuan 33383, Taiwan
Tel: 886-3-327-9999
Fax: 886-3-327-8898
e-mail: info@chromaate.com

http://www.chromaate.com

Material Contents Declaration

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

: See **<Table 1>**.

: See **<Table 2>**.

<Table 1>

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

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

www.chromaate.com Chroma

Declaration of Conformity

For the following equipment :

Digital Power Meter

(Product Name/ Trade Name)

66205

(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 61000-3-2:2014, EN 61000-3-3:2013,
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 3.0 2014-05,
IEC 61000-4-6 Edition 4.0 2013-10, 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)

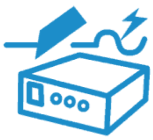
Taiwan	**2017.06.29**	Vincent Wu
(Place)	(Date)	(Legal Signature)

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

Revision History

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

Date	Version	Revised Sections
July 2017	1.0	Complete this manual.

Table of Contents

1. Overview

1.1 Product Introduction

The 66205 is a power meter for single channel measurement. It has broad current measurement ranges from the lowest 5mA to the highest 30A total 10 ranges available for setting. It can also uses external sensor (option A662017~A662020) to increase the current range for measurement. There are 6 voltage ranges available for selection and the highest range is 600V. External sensor (option A662012) can be used to increase the voltage range to 1.2kV. The large scale of measurement range is applicable for both low and high power testing. The voltage, current and power have 0.05% low range error especially the standby power test of energy star has high accuracy of performance.

The power integration calculation with smart measurement is one the major features of the 66205 power meter. Auto range measurement can be applied to the constantly changing load conditions. It discards the limit of using fixed range only for measurement, and the user is no longer bothered with problems of missing data and not enough resolution when a fixed range or waveform is used.

Inherited the previous 66200 series of high-performance harmonic measurement design, the 66205 further provides the requirements of IEC 61000-4-7 harmonic measurement. With non-interrupted high-performance harmonic measurement, 5Hz frequency resolution and packet harmonic function, it can perform accurate measurement on sub-harmonics, inter-harmonics and harmonics.

The 66205 offers 4 types of communication interfaces including GPIB, USB, RS-232 and LAN for remote control use. Using the soft panel, it can create a complete test report and perform the power quality as well as regulation tests. Furthermore, it has STORE function to record the measured values and save them to USB storage device.

The Limit function can be used for production tests by performing GO/NG judgment on the upper and lower limits of voltage, current and power parameters; moreover, it can be integrated into automated production when I/O port is used.

1.2 Initial Inspection

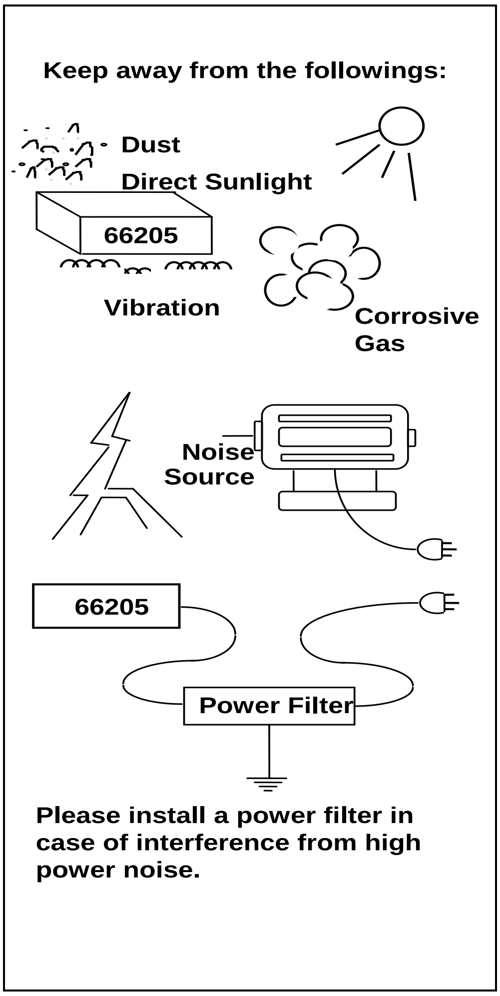
Before shipment, this Model 66205 was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, user should inspect for any damage that may have occurred in transit. Save all packing materials in case the instrument has to be returned. If damage is found, 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 -20°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 Voltage

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

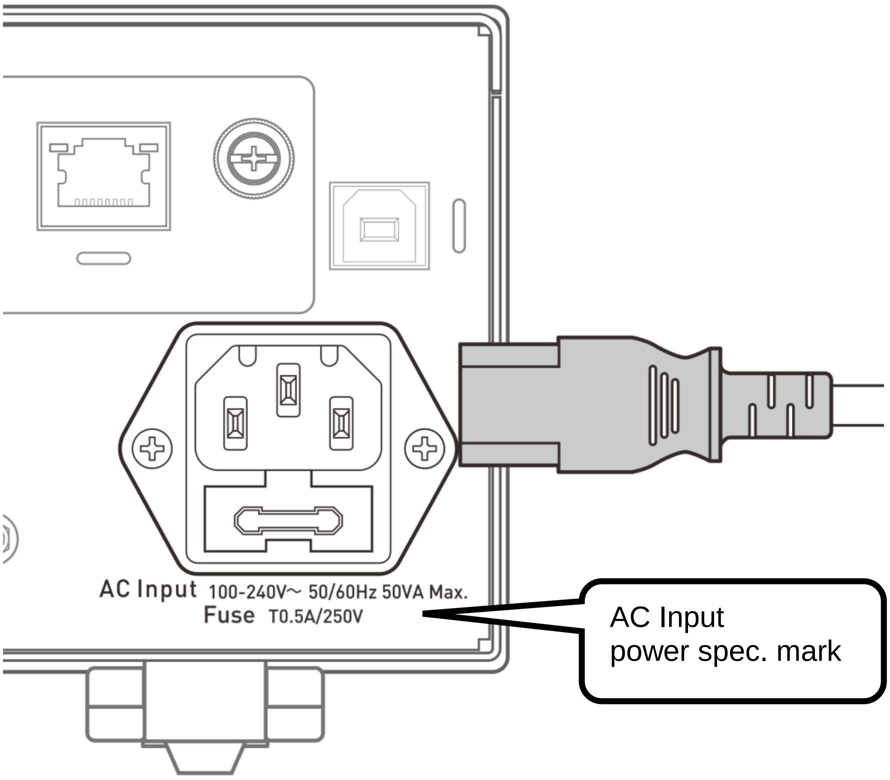


Figure 1-1 AC Input Power Spec.

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

Fuse	Specification
	Slow blow 0.5A / 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, it is prohibited to wipe the meter with a damp cloth to avoid damaging the device due to internal short circuit.

2. Specifications

2.1 Standard Specification

Input

<table>
<tr><th colspan="2">Measurement Ranges</th></tr>
<tr><td>Voltage Measurement Ranges (rms)</td><td>15V/30V/60V/150V/300V/600V/Auto
The crest factor of all measurement ranges is 2.</td></tr>
<tr><td rowspan="4">Current Measurement Ranges (rms)</td><td>Internal current sensor</td></tr>
<tr><td>0.005A/0.02A/0.05A/0.2A/0.3A/0.5A/2A/5A/20A/30A/Auto
The crest factor of all measurement ranges is 4.</td></tr>
<tr><td>External current sensor</td></tr>
<tr><td>10mV/25mV/50mV/100mV/150mV/Auto
The crest factor of all measurement ranges is 4.</td></tr>
<tr><td>Power Measurement Ranges</td><td>75mW/…/18kW, 60 ranges</td></tr>
<tr><th colspan="2">Input Impedance</th></tr>
<tr><td>Voltage Measurement Range</td><td>Approx. 2MΩ</td></tr>
<tr><td>Current Measurement Ranges</td><td>Approx. 500mΩ (for 0.005A/0.02A/0.05A/0.2A/0.3A current range)
Approx. 7mΩ (for 0.5A/2A/5A/20A/30A current range)</td></tr>
<tr><td>External Measurement Range</td><td>Approx. 100kΩ</td></tr>
<tr><th colspan="2">Bandwidth</th></tr>
<tr><td colspan="2">Approx. 60kHz</td></tr>
<tr><th colspan="2">Protection Alarm Message</th></tr>
<tr><td>Over Voltage Range (OVR)</td><td>When the measured value exceeds “Voltage Range×CF”</td></tr>
<tr><td>Over Current Range (OCR)</td><td>When the measured value exceeds “Current Range×CF”</td></tr>
<tr><td>Over Load (OL)</td><td>OL will occur when the following measured conditions are exceeded.
1. 1200Vrms
2. 1200Vpk
3. 36Arms
4. 120Apk</td></tr>
<tr><th colspan="2">Maximum Allowable Input</th></tr>
<tr><td>Instantaneous (1s or less)</td><td>Voltage: Peak value of 2.0 kV or RMS value of 1.5 kV, whichever is less.
Current: Peak value of 150 A or rms value of 40 A, whichever is less.
External Input: Peak value less than or equal to 10 times the range.</td></tr>
<tr><td>Continuous</td><td>Voltage: Peak value of 1.5 kV or RMS value of 1.2 kV, whichever is less.
Current: Peak value of 120 A or rms value of 36 A, whichever is less.
External Input: Peak value less than or equal to 5 times the range.</td></tr>
</table>

Continuous Common Mode Voltage (50Hz/60Hz)	Voltage: 600Vrms Current: 600Vrms External Input: 600Vrms

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-850Hz	**850Hz-10kHz**	**Temperature Coefficient**
% reading + % range		**(ppm of reading + ppm of range) /°C**
0.1+0.05	(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.
3. The effective input range is 1% -100% for range under the pure DC input signal test.
4. The effective input range is 10% -100% for range under the pure AC input signal test.

Current / Harmonics Specifications		
DC, 10Hz-850Hz	**850Hz-10kHz**	**Temperature Coefficient**
% reading + % range		**(ppm of reading + % of range) /°C**
0.1+0.05	(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-null.
4. Influence of self-generated heat caused by current input lasts until falling the temperature of the shunt resistor even if current input decreases. Add $0.00002*I^2$% of reading.
5. The permitted frequency of current harmonics is up to 6 kHz.
6. The effective input range is 1% -100% for range under the pure DC input signal test.
7. The effective input range is 10% -100% for range under the pure AC input signal test.

Specifications of the External Current Sensor input		
DC, 10Hz-850Hz	**850Hz-10kHz**	**Temperature Coefficient**
% reading + % range		**(ppm of reading + % of range) /°C**
0.1+0.05	(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, 10Hz-850Hz	**850Hz-10kHz**

% reading + % range	
0.1+0.05	(0.1+0.07*kHz)+0.15

Note

1. The temperature coefficient is same as the temperature coefficient for voltage and current.
2. Influence of self-generated heat caused by current input lasts until falling the temperature of the shunt resistor even if current input decreases. Add $0.00002*I^2$% of reading.
3. Influence of power factor(0<PF<1)：
   Add the power reading × (0.0015/PF*Hz)% for 0.5A/2A/5A/20A/30A current range
   Add the power reading × (0.0006/PF*Hz)% for 0.005A/0.02A/0.05A/0.2A/0.3A current range

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/current source

Note

1. The amplitude of the voltage source should be larger than 10% of voltage range.
2. The amplitude of the current source should be larger than 30% of current range.
3. The measuring range is decreased to 45Hz~10kHz under setting the frequency filter to OFF when frequency source is current.

Measurement Function and Measurement Conditions

Measurement Parameters
Vrms, Vpk+, Vpk-, V_harm, V_THD, CFV, Irms, Ipk+, Ipk-, I_harmonic, I_THD, Is, CFi, W, VA, var, PF, Freq_V, Freq_I, Wh, Ah, ° (degree)

Filter	
Line filter(digital filter)	OFF/500Hz/5.5kHz
Anti-aliasing filter	Approx. 60kHz
Frequency filter	OFF/500Hz

Note

1. The cutoff frequency of 500Hz and 5.5kHz of the digital line-filter is defined by that the fundamental frequency is 50Hz or 60Hz of power system.
2. The anti-aliasing filter can be also as a line-filter.

Synchronization Source
Voltage/Current/OFF

Note

1. The amplitude of the voltage synchronization source should be larger than 10% of voltage range.
2. The amplitude of the current synchronization source should be larger than 30% of current range.

Display Update Rate and Data update rate
0.05sec/0.1sec/0.25sec/0.5sec/1sec/2sec/5sec/10sec

2.2 Common Specifications

Display Resolution	5 Digits
Power Supply	100V-240V, 50Hz/60Hz, 50 VA
Interface	USB/GPIB/RS-232/LAN(option)
Operating Temperature	0°C - 40°C
Storage Temperature	-20°C - 85°C
Safety	EN61010-1, EN61010-2-030 Measurement category CATII Pollution degree 2
EMC	European Standard EN 61326-1(EN 55011 Class A, EN61000-3-2, EN 61000-3-3, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-11)
Ingress Protection Rating	IP20
Dimension (W×H×D)	208 x 88.1 x 348 mm / 8.19 x 3.47 x 13.70 inch (excluding projections)
Weight	4.4 kg / 9.7 lbs

Note

1. Measurement Category II (CAT II) applies to electrical equipment that is powered through a fixed installation such as a wall outlet wired to a distribution board and measurement performed on such wiring.
2. Pollution Degree applies to the degree of adhesion of a solid, liquid, or gas which deteriorates withstands voltage or surface resistivity. Pollution Degree 1 applies to closed atmospheres (with no, or only dry, non-conductive pollution). Pollution Degree 2 applies to normal indoor atmospheres (with only non-conductive pollution).

3. Panel Description

3.1 Front Panel

The front panel of 66205 Digital Power Meter is as shown below and the functions numbered from 1 to 18 are described below.

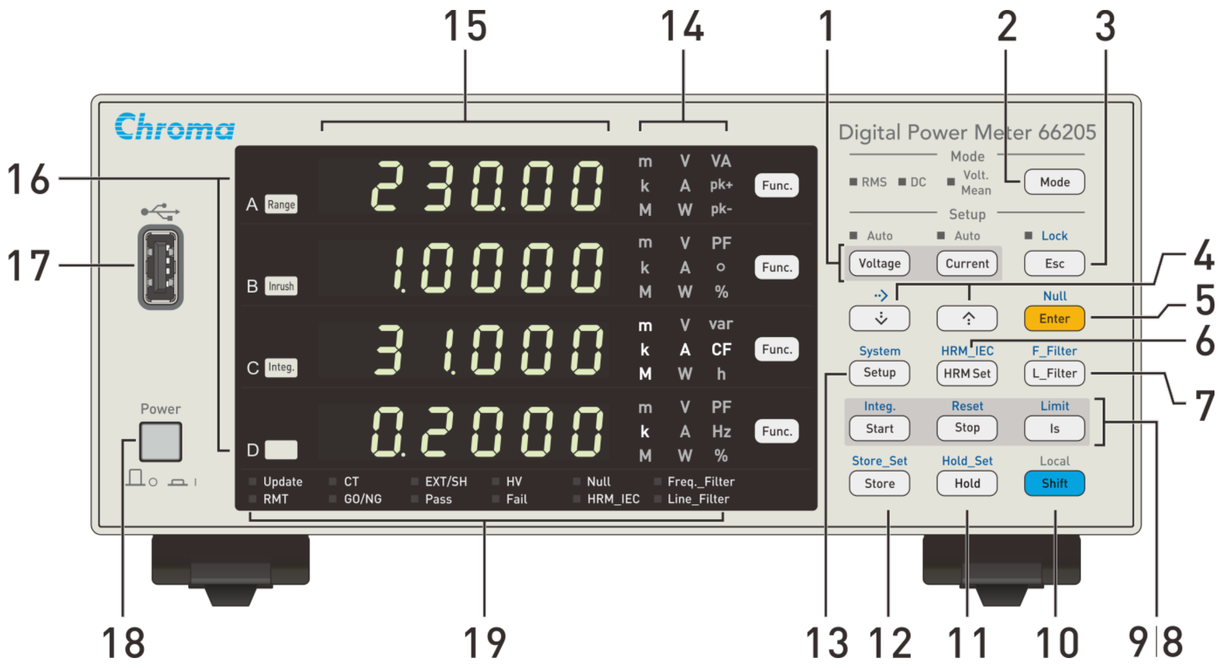


Figure 3-1 Front Panel of 66205 Digital Power Meter

(1) Voltage/Current range selection & auto range indicator : Press the Voltage and Current keys to view the range in use at present. Use the ↑ or ↓ keys to select the range. (See section 5.2)

(2) Measurement mode selection & status indicator : The mode can be set to true rms value (RMS), simple average (DC) or rectified mean value calibrated to the rms value (Volt Mean) for the voltage and current measurement. (See section 5.1)

(3) ESC, Lock (Shift + ESC) : Press ESC key to quit the page you are setting. Press LOCK key to lock all the keys on the front panel, and the LOCK indictor illuminates. Press LOCK key again to unlock all keys.

(4) ↑, ↓, → (Shift + ↓) : The ↑ and ↓ keys can select the function and increase or decrease the setting range or value.
Press → key to move along the digits of the value from the left to the right.

(5) ENTER, NULL (Shift + Enter) : Confirms the specified range, function, or value.
When the NULL key is pressed, the NULL function menu is opened. Performing the NULL function procedure which subtracts the DC component and AC noise of the current measurement circuit from the sampled data. (See section12 and section 5.3.7)

(6) HRM_IEC(Shift + HRM : Turn on or turn off the harmonic function with

	Set), HRM Set		IEC61000-4-7. Displays the setup menu of harmonic measurement for setting the THD formula, measuring window, etc. (See section 9)
(7)	**L_Filter, F_Filter (Shift + L_F_filter)**	:	Turn on or turn off the line_filter and the frequency_filter. (See section 5.4)
(8)	**Integ., Is, Limit (Shift + Is)**	:	Set the parameters of integration, inrush current and GO/NG function. (See section 6, 7 and 8)
(9)	**Start, Stop, Reset (Shift + Stop)**	:	Trigger (Start key), pause (Stop key) and reset the process of integration, inrush current and GO/NG function. (See section 6, 7 and 8)
(10)	**Shift, Local**	:	Switch the 66205 from remote mode (REMOTE indicator illuminated) to local mode (enable front panel key operation on the 66205). However, the key is invalid when the 66205 is in local lockout mode.
(11)	**Hold_set (Shift + Hold), Hold**	:	Displays the setup menu of HOLD function. Execute or reset the HOLD process. (See section 10)
(12)	**Store_set (Shift + Store), Store**	:	Displays the setup menu of STORE function for setting the store interval, store count, etc. Execute or reset the STORE process. (See section 11)
(13)	**Setup, System (Shift + Setup)**	:	Display the menu of measurement setup or system configuration. (See section 5.3 and 13)
(14)	**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.
(15)	**Display window**	:	They are Display A, Display B, Display C and Display D function menus from the top down to show the function menu, the measurement range and measurement parameters values.
(16)	**Function operation indicator**	:	The indicator illuminates when the function assigned to the indicator is in operation.
(17)	**USB port**	:	Connect a USB storage device. (See section 11.4)
(18)	**Power switch**	:	"I" represents power is turned on, "o" represents power is turned off. (See section 4.1)
(19)	**Measurement function setup indicator**	:	Indicators that signify the status of measurement function setup, GO/NG function and remote control.

3.2 Rear Panel

The rear panel of 66205 Digital Power Meter is as shown below and the functions numbered from 1 to 9 are described below.

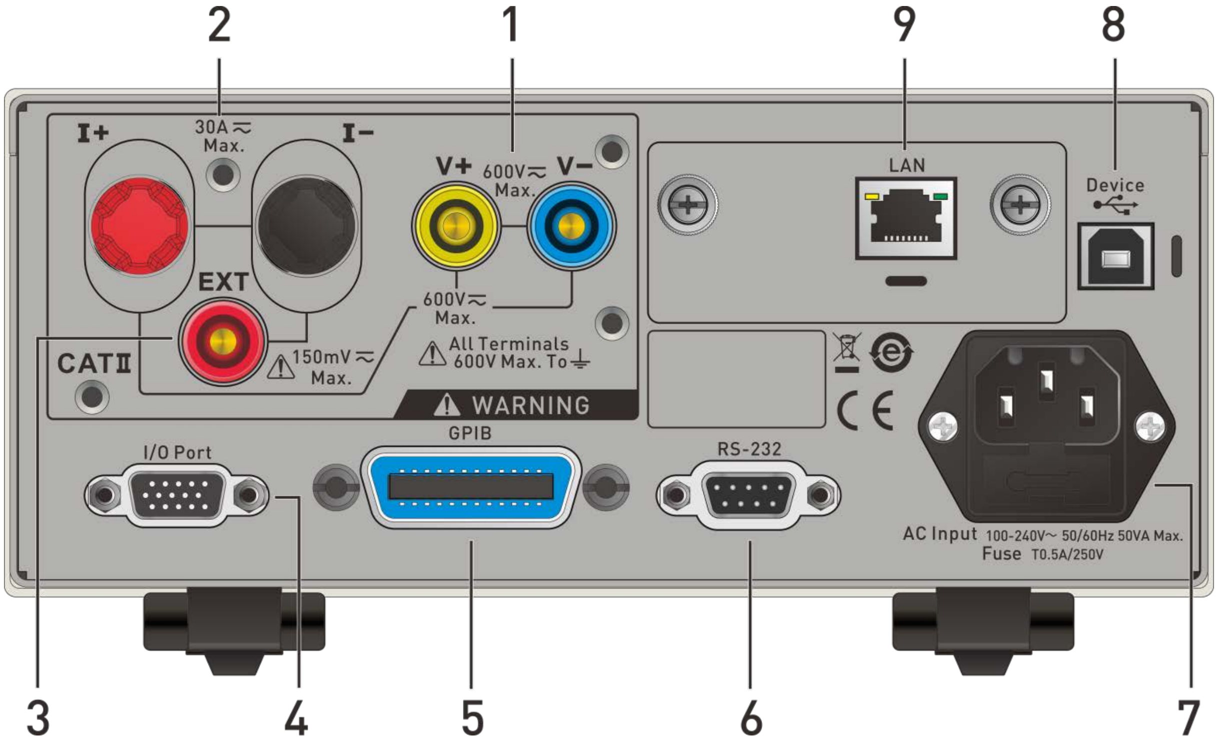


Figure 3-2 Rear Panel of 66205 Digital Power Meter

(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 30Arms.
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 150mVrms.

(4) Control signal input/output terminal

(5) GPIB Port

(6) RS-232 Port

(7) 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.

(8) USB Port

(9) LAN Port

4. Preparation before Testing

4.1 Preparation before Turning on the Power

(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.
(3) Use the three-pin type power cord that comes with the instrument.
(4) Make sure to perform protective grounding to prevent the possibility of electric shock. Connect the power cord to a three-prong power outlet with a protective earth terminal.
(5) Appliance coupler used for disconnection, noted that equipment shall location over the corner that can be easy to disconnect it.

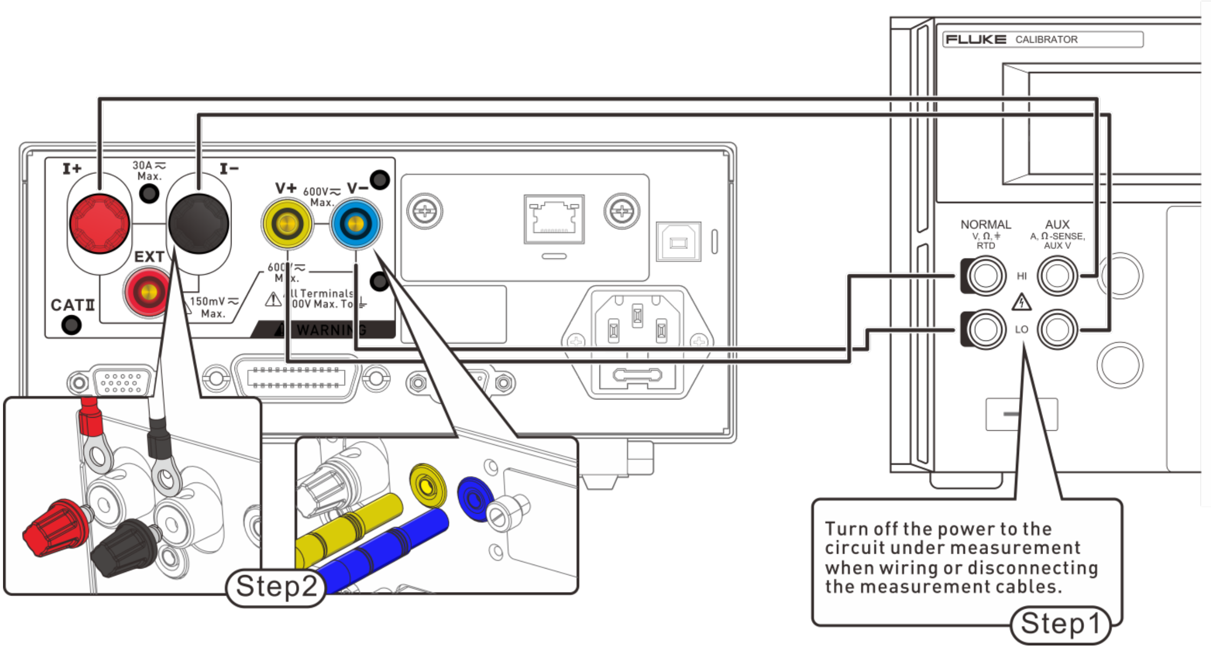
⚠WARNING Be sure to remove the power cord before replacing the fuse to avoid the hazard of electric shock.

4.2 Wiring Precautions

To prevent the possibility of electric shock and damage to the instrument, follow the warnings below.

⚠WARNING

1. Turn OFF the power to the circuit under measurement, when wiring or disconnecting the circuit. Connecting or removing measurement cables while the power is ON is dangerous.
2. Take special caution not to wire a current circuit to the voltage input terminal or a voltage circuit to the current input terminal.
3. The conductive parts (bare wires) of current measurement cables do not protrude from the terminal. Also, make sure to fasten the input terminal screws securely so that the cable does not come loose.
4. Use cables with safety terminals that cover the conductive parts for connecting to the voltage input terminals. Using a terminal with bare conductive parts (such as a banana plug) is dangerous if the terminal comes loose.
5. The current in the measurement loop is very large due to the UUT short-circuit fault. To prevent the possibility of electric shock and damage to the instrument (66205), it is strongly recommended to add an appropriate rated fuse into the current measurement loop.



4.3 Making Accurate Measurements

The following two ways can be used for wiring the circuit for measurement. The measurement theory is shown in the diagram (a) and (b) below. To meet the accuracy listed in the specification it is suggested to warm up for at least 30 minutes and to perform zero-level compensation after warmed up.

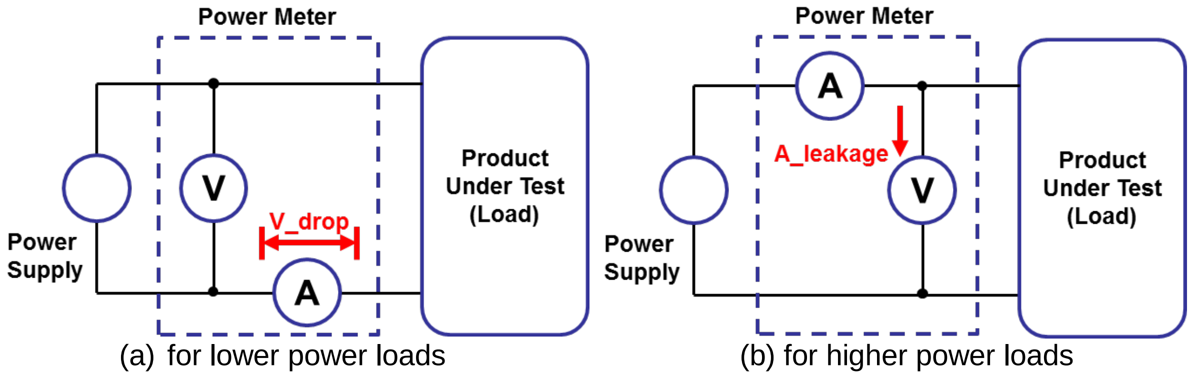


Figure 4-1 Ways to Wire the Power Meter

The connection of (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 criterion for selecting this wiring is $I_m \leq V_s \times \sqrt{1/(R_a \times R_v)}$

The connection of (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. The criterion for selecting this wiring is $I_m > V_s \times \sqrt{1/(R_a \times R_v)}$

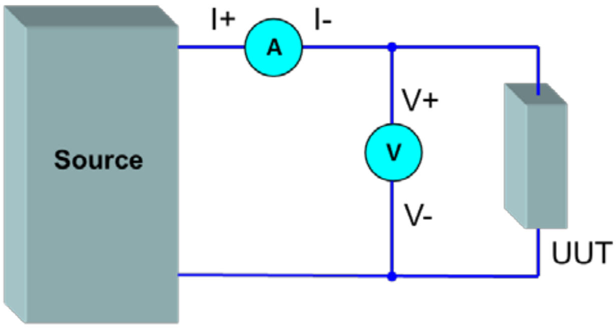
Notice

I_m is the measured r.m.s current of of the load in amps (A);
V_s is the power supply (V);
R_a is the input impedance of ampere meter (in Ω);
R_v is the input impedance of voltmeter (in Ω).

4.4 Connecting Test Device

4.4.1 Wiring Circuit for Direct Input (without Using External Sensor)

The wiring of a medium and large power for testing a UUT is as shown below for example.



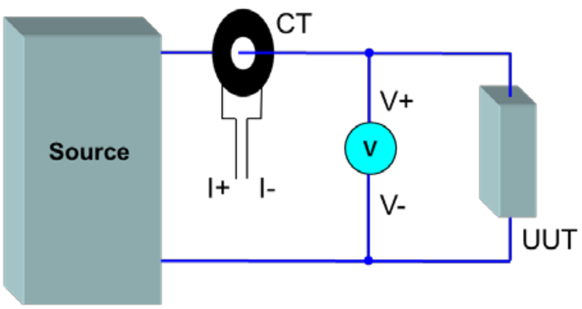
WARNING

The current in the measurement loop is very large due to the UUT short-circuit fault. To prevent the possibility of electric shock and damage to the instrument (66205), it is strongly recommended to add an appropriate rated fuse into the current measurement loop. A test application of less than 10A can use the model A662022.

4.4.2 Using External Sensor

The wiring of a medium and large power for testing a UUT is as shown below for example.

Using current transducer (section 5.3.4)

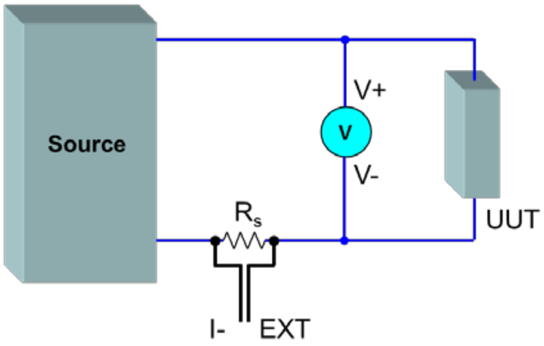


WARNING

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.

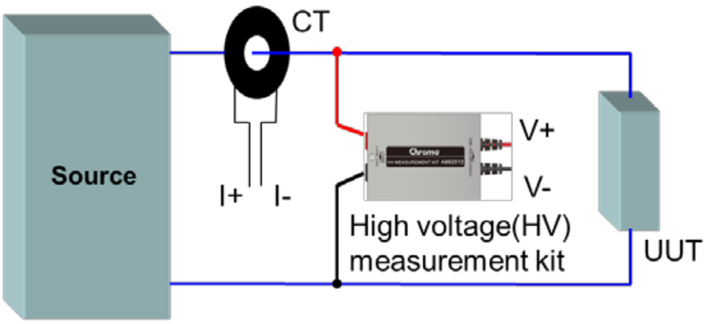
Using external shunt (section 5.3.5)



⚠WARNING

1. The max. input voltage allowed for EXT input terminal is 150mVrms.
2. The max. voltage difference allowed for EXT input terminal to Ground is 600V.

Using HV measurement kit (section 5.3.6)



⚠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.

5. Setting Measurement Range and Conditions

5.1 Setting Measurement Mode (RMS, DC, Volt._Mean)

Figure 5-1 The panel for measurement mode setting

Voltage and current measurement values are displayed by depending on measurement mode selection. The different measurement modes follow the specified calculation equations that are listed in the below table.

■ Calculation equation

Mode	Calculation equation, f(t):input signal
RMS	$\sqrt{\frac{1}{T}\int_0^T f^2(t)dt}$
DC	$\frac{1}{T}\int_0^T f(t)dt$
Volt._Mean (a rectified mean value calibrated to the RMS value)	$\frac{\pi}{2\sqrt{2}}\cdot\frac{1}{\mathrm{T}}\int_0^{\mathrm{T}}\lvert \mathrm{f(t)}\rvert dt$

■ RMS mode

- This function is true RMS calculation. The sampled waveform data which may include fundamental, DC and harmonic component that is calculated to RMS value during the specified measurement period.

■ DC mode

- Averaging the every sampling waveform data during the specified measurement period.
- If the test signals contain AC and DC portions, the synchronization source frequency will determine the sampling frequency of digital-analog converter. If there is only DC component or no synchronization source, the sampling frequency will use AC LINE INPUT frequency (60Hz) to determine the sampling frequency.

- When the input signal contains AC and DC components, the stable synchronization frequency needs to be obtained for separating the DC component form the input signal totally and calculating DC value.
- 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.
- 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.

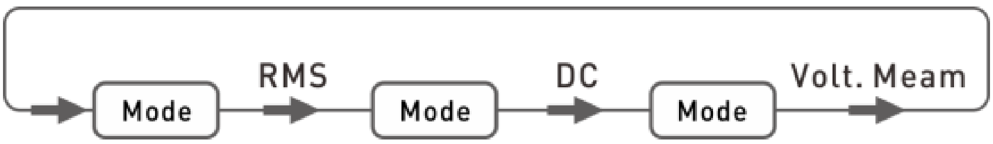
■ Volt._Mean mode (a rectified mean value calibrated to the RMS value)

- This function rectifies one period of the voltage or current signal, determines the average, and multiplies the result by a coefficient. The coefficient is a value that when applied to a sinusoidal input signal, gives the true rms value.
- Since a sine wave is used for calibration, the value displayed will be the same as that obtained in RMS mode if a sine wave is measured when the measurement mode is set to Volt._Mean.

■ Definition of display value

Mode	Voltage	Current
RMS	True RMS value	True RMS value
DC	DC value	DC value
Volt._Mean	A rectified mean value calibrated to the RMS value	True RMS value

■ Procedure
The measurement mode setting procedure is shown below.



5.2 Setting Measurement Range (Voltage, Current, Ext)

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 66205 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 66205 will not provide the measurement at this time.

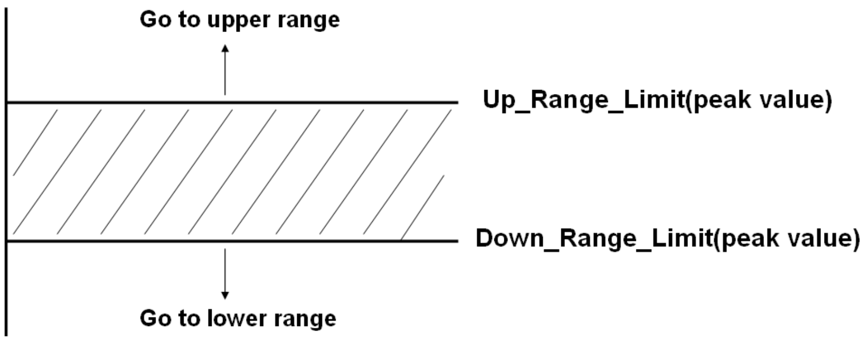


Figure 5-2 Range Selection Rule

Under the 66205 allowed rated power, to keep the protection mechanism from being too sensitive, the OCR or OL 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.

5.2.1 Setting Voltage Range

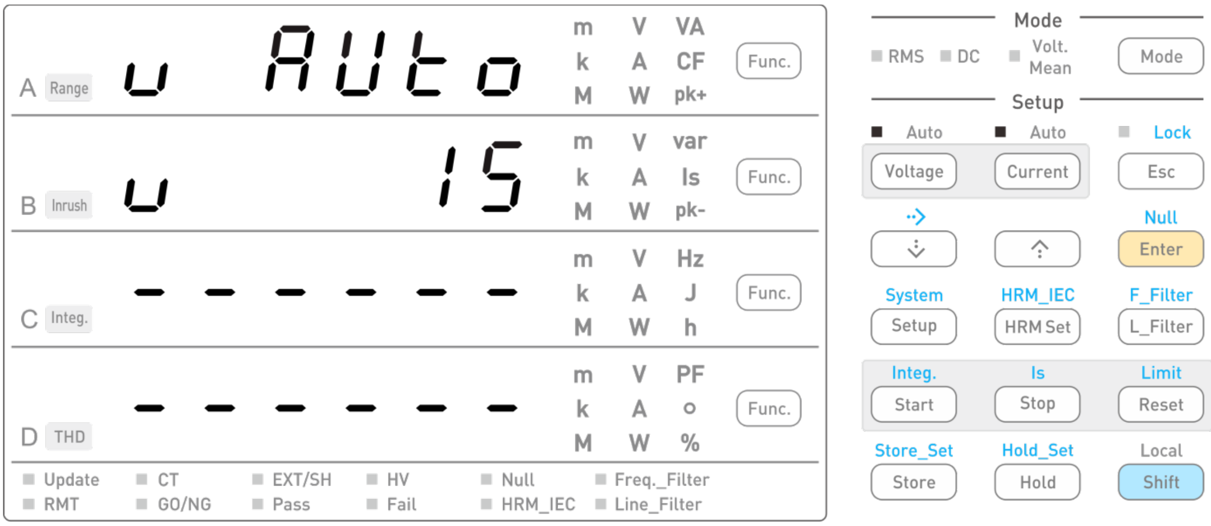
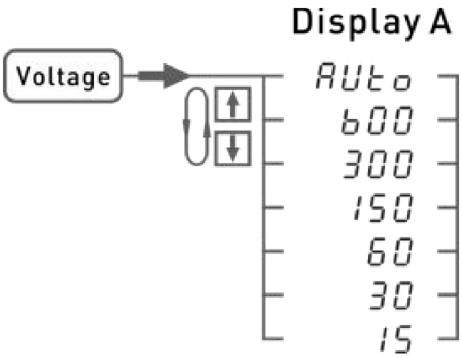


Figure 5-3 Voltage Range Setup Screen

There are 6 measurement ranges for voltage measurement, which are 600Vrms/300Vrms/150Vrms/60Vrms/ 30Vrms/15Vrms/AUTO. The crest factor (CF) of each range is 2, thus the measureable range for peak voltage is ± (range×CF).

Procedure

- After pressing the Voltage key, select a voltage measurement range by pressing ↑or ↓ key. The setting procedure is showed as below.
- The message of the measurement range being used is showed on the display B.
- The available measurement range is showed on the display A which should be larger than or equal to the one showed on the display B.



Auto Range

- Increase range: Increase range when meets the one of the below conditions.
  - The measured peak value exceeds 200% of range.
  - The measured rms. value exceeds 125% of range.

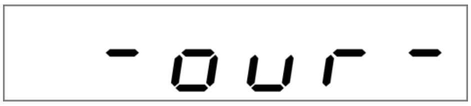
- Decrease range: Decrease range when meets all of the below condition.
  - The measured peak value is less than 180% of the next lower measurement range.
  - The measured rms. value is less than or equal to 40% of the measurement range.

- AUTO indicator illuminates.

Over Range Alarm

The over voltage range conditions are listed as below. When over voltage range happens, 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.

- Auto range condition: The measured peak value exceeds 1.2kV.
- Manual range condition: The measured peak value exceeds 200% of range.



CAUTION The maximum measureable voltage is 600Vrms. Though the measureable peak is 1.2kV, the maximum allowable input DC voltage is still 600Vdc. It could cause dangerous if the voltage input range is over.

5.2.2 Setting Current Range

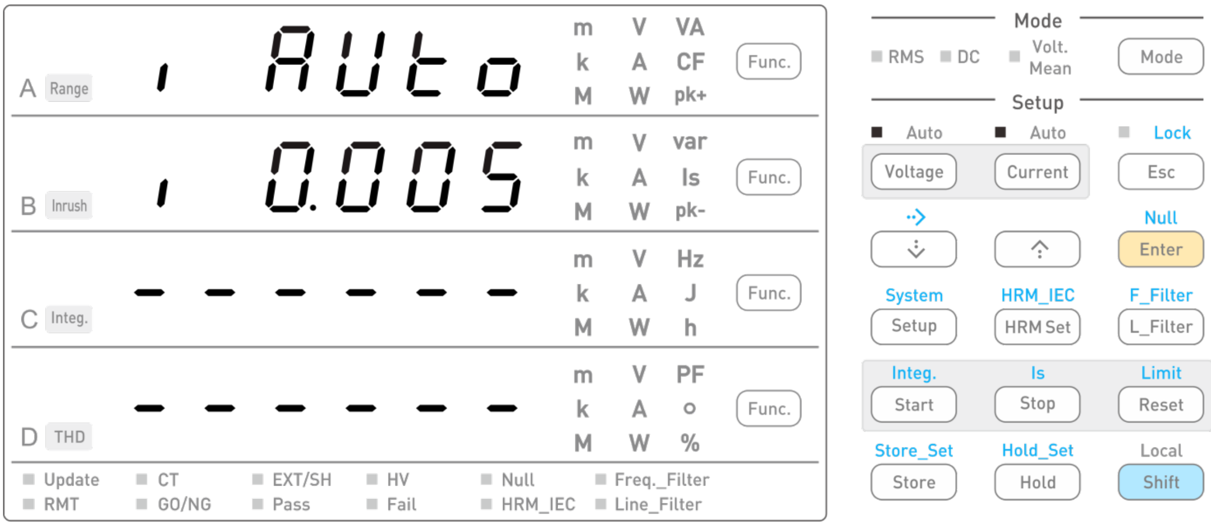
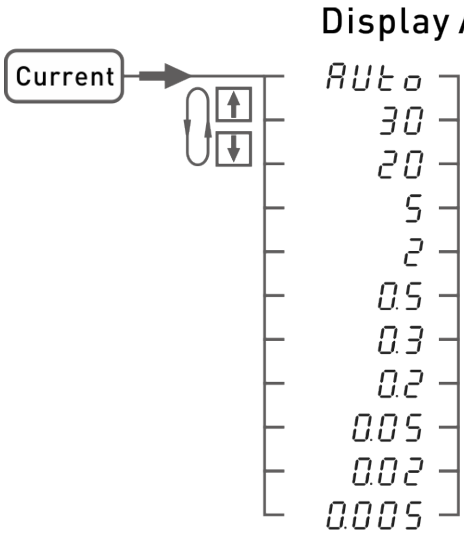


Figure 5-4 Current Range Setup Screen

There are 10 measurement ranges for current measurement, which are 30Arms/20Arms/5Arms/2Arms/0.5Arms/0.3Arms/0.2Arms/0.05Arms/0.02Arms/0.005Arms/AUTO. The crest factor (CF) of each range is 4, thus the measureable range for peak current is ± (range×CF).

Procedure

- After pressing the Current key, select a current measurement range by pressing ↑or ↓key. The setting procedure is showed as below.
- The message of the measurement range being used is showed on the display B.
- The available measurement range is showed on the display A which should be larger than or equal to the one showed on the display B.



Notice

Auto Range

- Increase range: Increase range when meets the one of the below conditions.
  - The measured peak value exceeds 400% of range.
  - The measured rms. value exceeds 200% of range.

- Decrease range: Decrease range when meets all of the below condition.
  - The measured peak value is less than 360% of the next lower measurement range.
  - The measured rms. value is less than or equal to the next lower measurement range.

- AUTO indicator illuminates.

Over Range Alarm

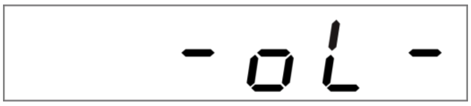
The over current range conditions are listed as below. When the measured current exceeds the current range condition, the display will show Over Current Range (OCR) warning message and beep. When the signal amplitude is down to the measureable range or a proper range is selected, the over voltage range warning message will disappear automatically.

- Auto range condition: The measured peak value exceeds 120A.
- Manual range condition: The measured peak value exceeds 400% of range.
  - When the range is set to 0.3A/0.2A/0.05A/0.02A/0.005A, the protection mechanism will set the range to AUTO if the measured peak value or rms current exceeds 1.2A.

Over Load Alarm

The over load warning conditions are listed as below. It will show a -OL- message and beep while the input current exceeds the conditions which are related to the rated power of inner current shunt of 66205. Remove the input current immediately is suggested. The over load warnings must press ENTER key to be released.

- The measured peak current exceeds 120A.
- The measured rms. current exceeds 36A.
- The measured peak value or rms current exceeds 1.2A when the range is set to 0.3A/0.2A/0.05A/0.02A/0.005A.



CAUTION

1. The maximum measureable current is 30Arms and 120Apk. It could cause dangerous if the measured current exceeds the allowable input range.
2. Even the inner protection circuit of 66205 could endure a short term over load current. To prevent the possibility of damage to instrument under a long term over load condition, suggest a fuse added into the current measurement loop.

5.2.3 Setting External Input Range

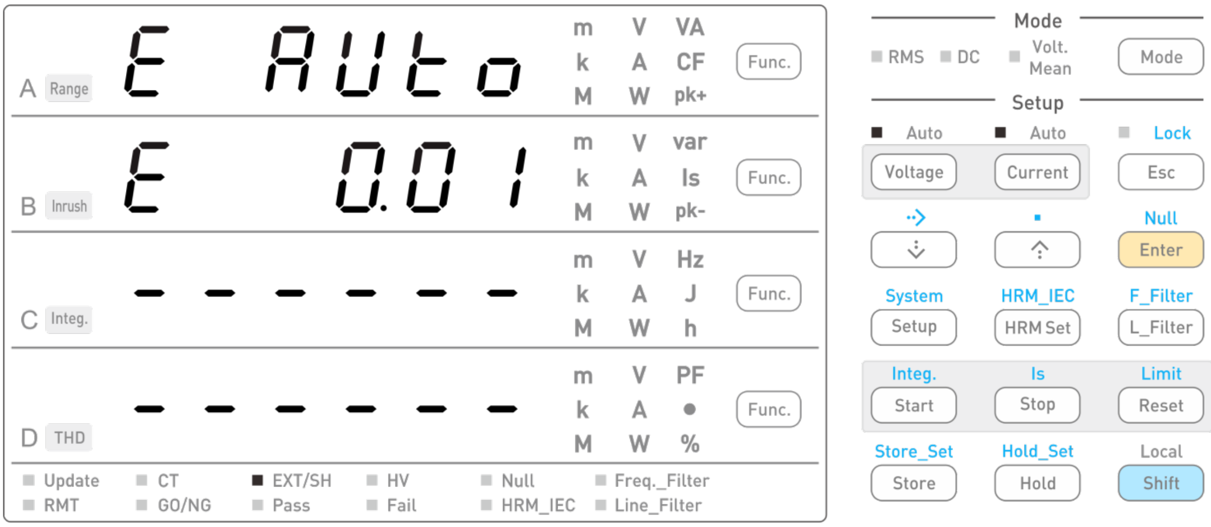


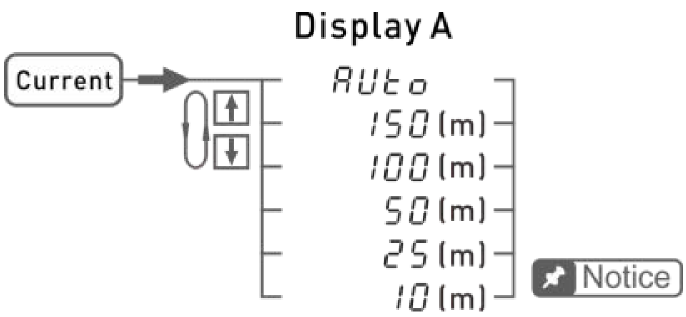
Figure 5-5 External Input Range Setup Screen

There are 5 measurement ranges for current measurement with using the external range, which are 150mVrms/100mVrms/50mVrms/25mVrms/10mVrms/AUTO. The crest factor (CF) of each range is 4, thus the measureable range for peak current is ± (range × CF). The External ranges need to go with the EXT/SH measurement function. An example is explained as below.

- Use an external shunt with the 100A/100mV rated specification. If 100mV measurement range is select, the external resistor should be set to 1mΩ.
- Use an external shunt with the 50A/100mV rated specification. If 100mV measurement range is select, the external resistor should be set to 2mΩ.

Procedure

- Enable the EXT/SH function firstly. The detail operation is described on the section 5.3.5.
- After pressing the Current key, select a current measurement range by pressing ↑or ↓key. The setting procedure is showed as below.
- The message of the measurement range being used is showed on the display B.
- The available measurement range is showed on the display A which should be larger than or equal to the one showed on the display B.



Auto Range

- ■ Increase range: Increase range when meets the one of the below conditions.
  - ● The measured peak value exceeds 400% of range.
  - ● The measured rms. value exceeds 200% of range.

- ■ Decrease range: Decrease range when meets all of the below condition.
  - ● The measured peak value is less than 360% of the next lower measurement range.
  - ● The measured rms. value is less than or equal to the next lower measurement range.

- ■ AUTO indicator illuminates.

Over Range Alarm

Due to the displayed measurement value is ampere finally. The over range warning message is showed to Over Current Range (OCR). The over current range conditions are listed as below. When the signal amplitude is down to the measureable range or a proper range is selected, the over voltage range warning message will disappear automatically.

- ■ Auto range condition: The measured peak current exceeds (0.6V) the external resistor setting value.
- ■ Manual range condition: The measured peak current exceeds (400% of range) the external resistor setting value.

Notice It is either "30A/20A/5A/2A/0.5A/0.3A/0.2A/0.05A/0.02A/0.005A" or "150mV/100mV/50mV/25mV/10mV". When the EXT/SH function is enabled, only the external measurement range will be kept.

CAUTION The External terminal only receives voltage signal input. The maximum allowable signal is 150mVrms. If the signal amplitude exceeds the rated input, it could cause hazard and damage the device.

5.3 Setting Measurement Functions

The measurement setup of model 66205 digital power meter comprises the AVG, DISP, SYNC, CT, EXTSH, HV and O.COMP functions as explained below.

5.3.1 Average

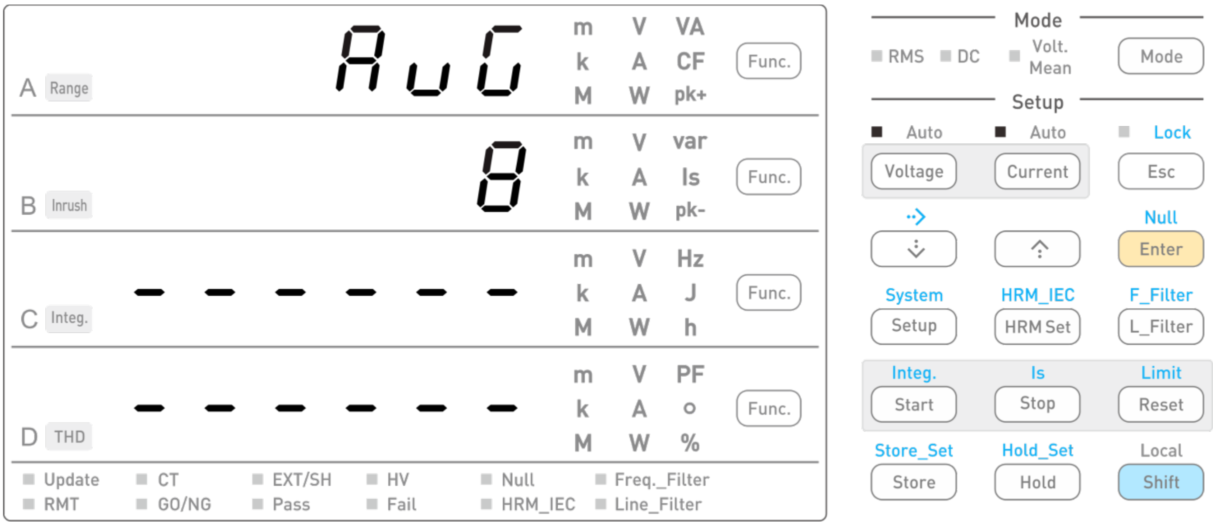


Figure 5-6 Average Setup Screen

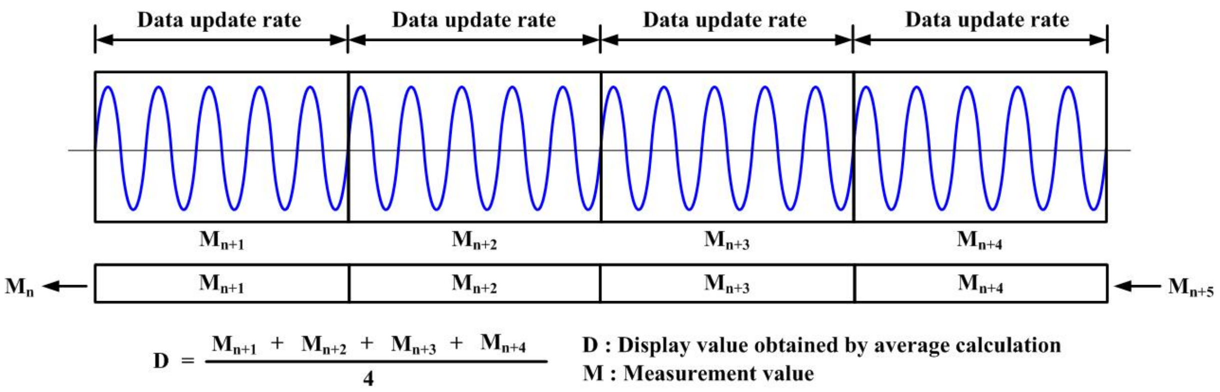
When measuring unsteady or fluctuated signals, it can use moving average method to get a steady measurement. The measurement is steadier when a larger average number is set. The average number can be set to 1, 4, 8, 16, 32 and 64.

- Moving average method
  Dn=[Mn + M(n+1) + … + M(n+(m-2)) + M(n+(m-1))] / m
  Mn: The number *n* measurement.
  M(n+1): The first measurement after the number *n* measurement.
  Mn+(m-2): The (m-2) measurement after the number *n* measurement.
  Mn+(m-1): The (m-1) measurement after the number *n* measurement.
  Mn+m: The *m* measurement after the number *n* measurement.
  Dn: The average measurement.
  M: The total number of averaged measurement.
- The measurement M is calculated by the data update rate set.
- Every measurement M is successive without interruption.

Example:

Use the model 66205 to measure the rms value of 50Hz signal:

- Set the data update rate to 0.1 second.
- Set AVG=4.
- Calculate an rms value every 0.1 second (containing 5 cycles of signals, a total of 20480 sampling points).
- Get an average value of every four consecutive valid values.
  - The total data length is 0.4 seconds (20 cycles), a total of 81920 consecutive sampling points.
  - The averaged effective value is the calculation of approximately 81920 consecutive sampling points.
  - Update an rms value (e.g. M_n moves out, M_{n+5} moves in) accordingly in the average formula to calculate the new averaged rms value.



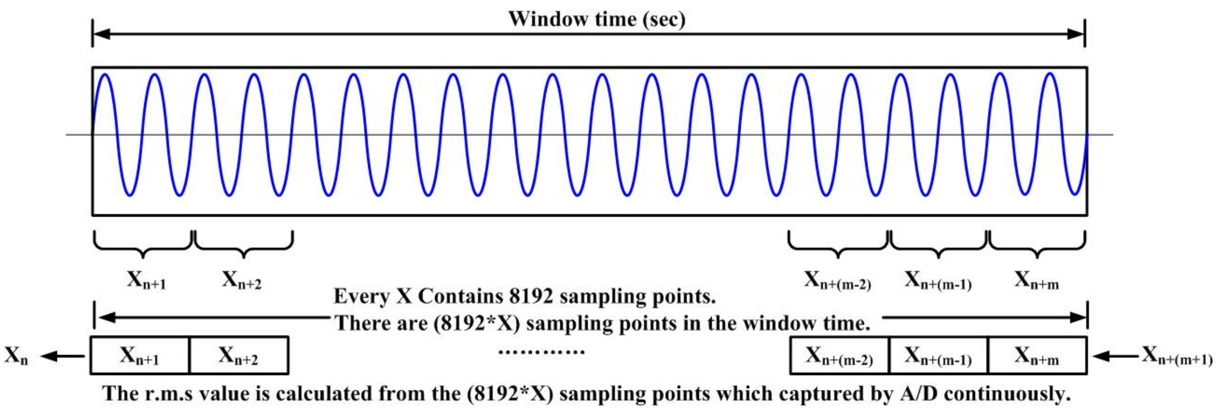
Notice

1. The average calculation of 66205 is to calculate the waveform of update rate.
2. The average calculation of 66202 and 66204 is to calculate the waveform of two fixed sample cycles, which is different from 66205.
3. The window calculation of 66202 and 66204 is similar to the average calculation of 66205. In simple terms, the measured data length of window calculation (unit: second, resolution: 0.1 seconds) is equal to the data update rate (seconds) * average number of 66205.

Example (for Notice 3)

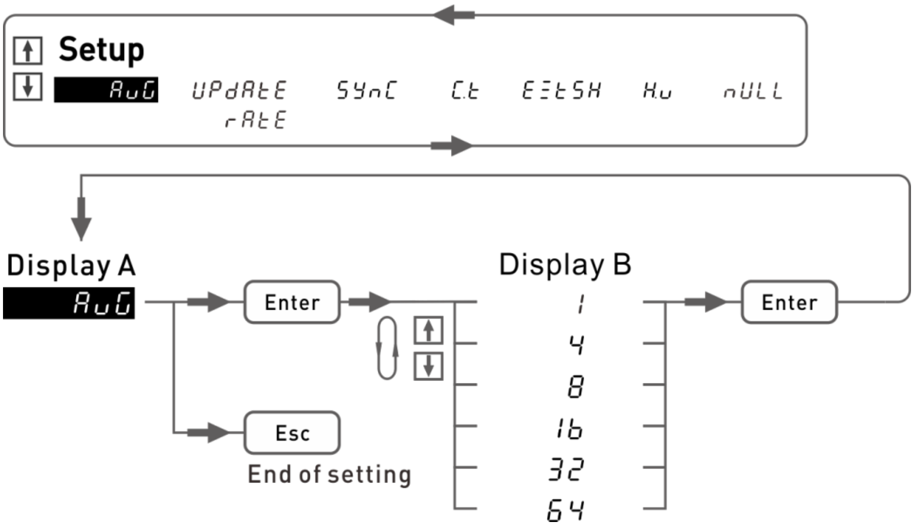
Use the model 66204 to measure the rms value of 50Hz signal:

- Set the window time to 0.4 second.
- The window time comprises 20 cycles with a total of 81920 consecutive sampling points. The rms value is calculated by the 81920 sampling points.
  - The rms value can be calculated using the average of approximately 4 data update rates per 0.1 second.
  - Use the data updated every two cycles (e.g. X_n moves out, $M_{n+(m+1)}$ moves in) accordingly to calculate the new rms value.
- For window calculation, see also the 66204 user's manual.



Setting the function

The parameter setting procedure is shown in the figure below.



5.3.2 Display Update Rate

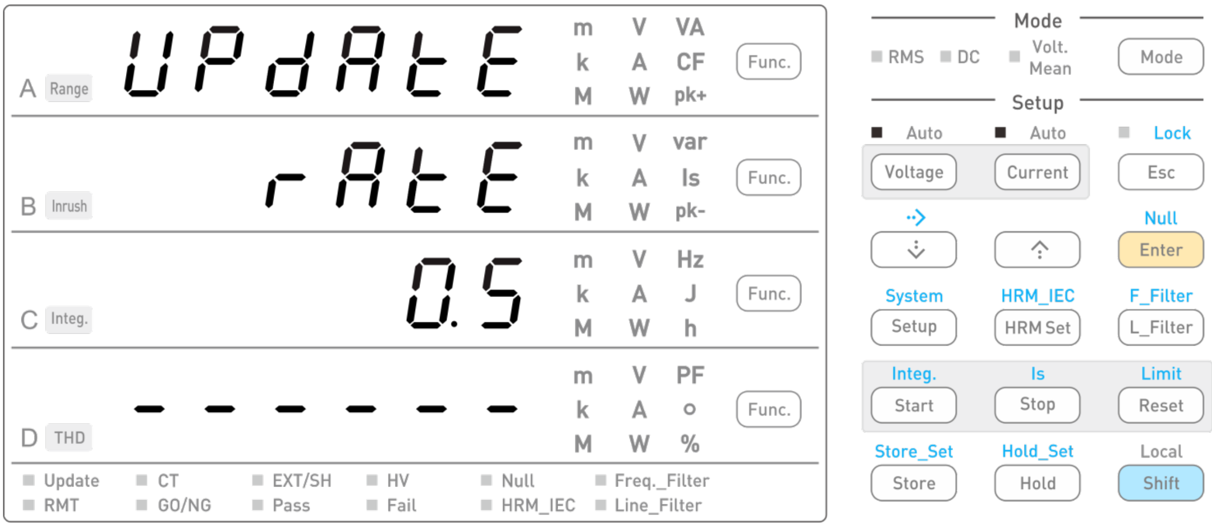


Figure 5-7 Update Rate Setup Screen

The display update rate or display update interval has 0.05, 0.1, 0.25, 0.5, 1, 2, 5, 10 (unit: second) available for selectin. The user can speed up the update rate to view and measure the fast changed voltage, current and power. The update rate can also be lowered down to measure the signal with long period. The initial setting is 0.25 second. The Update indicator blinks synchronously to the selected update speed.

The effect of update rate on sync signal frequency

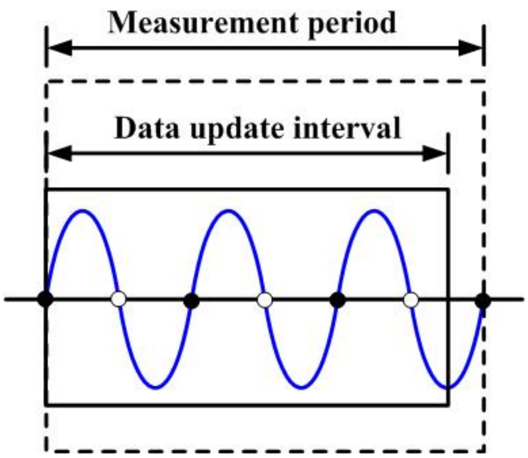
The data update rate and data update interval are the same. In general, when measuring the periodic signal the data update interval setting needs to be larger or equal to signal period in order to find the frequency of sync signal source. The larger the data update interval, the more the number of signal periods covered and the frequency of the measured value will be more stable.

The effect of update rate on measurement period

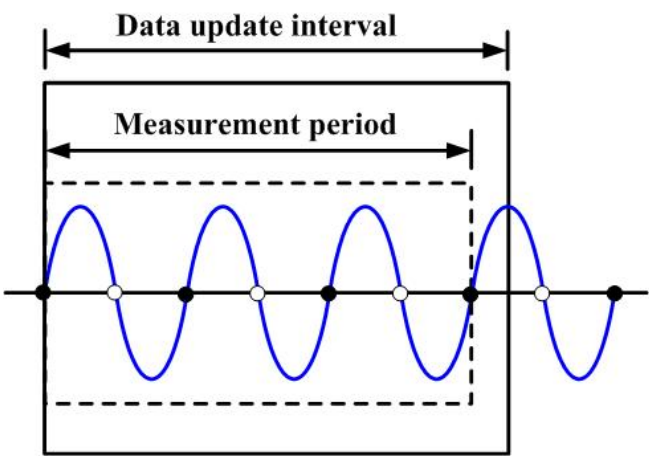
■ Update rate larger or equal to signal period

For the measurement of periodic signals, it is very important to obtain a relatively stable synchronization signal frequency. The measurement procedure follows the sync frequency to calculate the sampling rate required by an integer cycle. The actual measurement period (also call measurement window) is defined by integer signal cycles close to the data update interval as explained below.

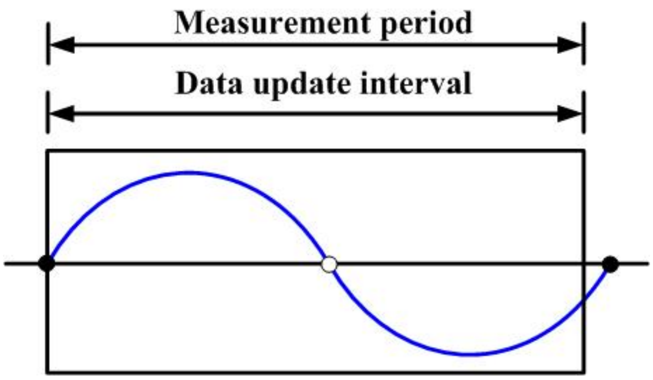
- Case 1
  When the input signal frequency is 55Hz and the data update interval is set to 50ms, the data update interval contains 2.75 cycles and rounds up to 3 cycles



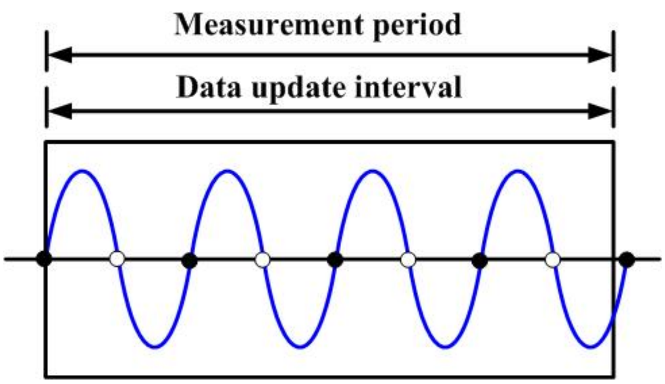
- Case 2
  When the input signal frequency is 65Hz and the data update interval is set to 50ms, the data update interval contains 3.25 cycles and rounds down to 3 cycles.



■ Update rate smaller than signal period
When the set data update interval is smaller than the signal period, the data update interval will be used as measurement period. Since the signals in each measurement period will not be the same, it will result in a less stable measurement. It is recommended to increase the data update rate.



■ No sync signal source for reference
If the sync signal frequency is not detected or the sync signal source is not set (see Setting Sync. to Off), the measurement period will set to equal to data update interval. Even if there is no sync signal frequency for reference, it can increase the data update interval to cover more signal waveforms and improve the stability of the measured value.



The effect of update interval on measurement range change
The setting of data update interval affects the speed of decreased range but not the speed of increased range. The condition of the decreased range will be judged based on the measured value after each update. When the update interval is set slower, the speed of decreased range is relatively slow.

The effect of update interval on harmonic measurement

■ Standard (IEC) harmonic measurement mode
When the IEC measurement function is enabled, the display update rate is fixed to 200ms, and it will not be affected even if the other display update rate is selected. The harmonic measurement period will be slightly adjusted based on the data update interval and sync signal source frequency. Each measured value will be consecutive without interruption.

Example:

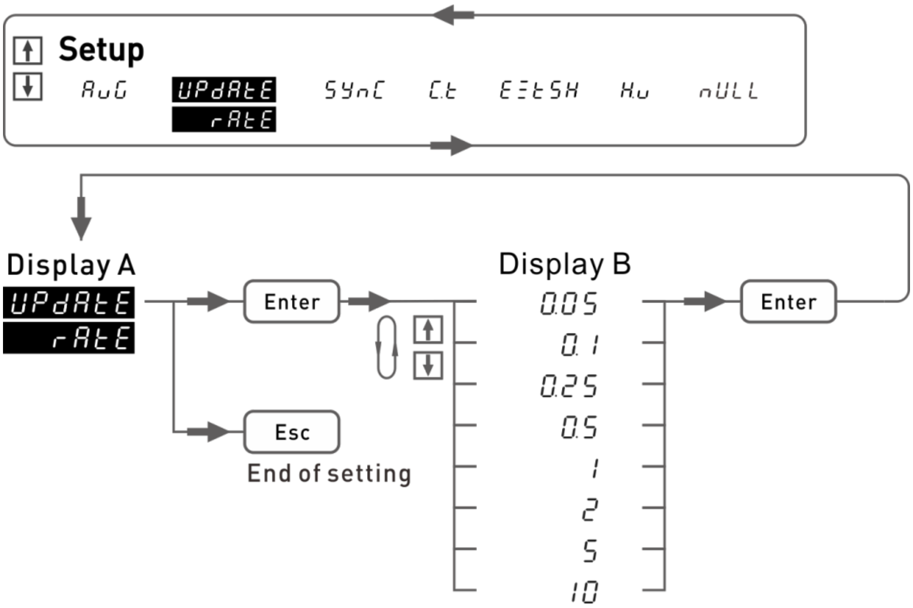
When conducting harmonic measurement on the fundamental 50.002Hz frequency signal waveform, the measurement period is approximately 199.99ms, where the sync signal source frequency detection also updates with approximately 200ms. It can be used as the next measurement period adjustment.

- General harmonic measurement mode
  The display update rate and data update interval of general harmonic measurement mode are not the same. The data update interval is determined by the set cycles (see *Harmonic Measurement Function* chapter for detailed info) while display update rate is the same as the one of general measurement mode.

  Example:

  When conducting harmonic measurement on the fundamental 50.002Hz frequency signal waveform and the measurement period is set to 1, 20ms (the reciprocal of 50Hz) data update interval is determined. If the display update rate is set to 0.1 second, it will have 5 harmonic measurements calculated when the next measurement display updates.

Procedure
The parameters setting procedure is shown in the figure below.



5.3.3 Setting Sync Source

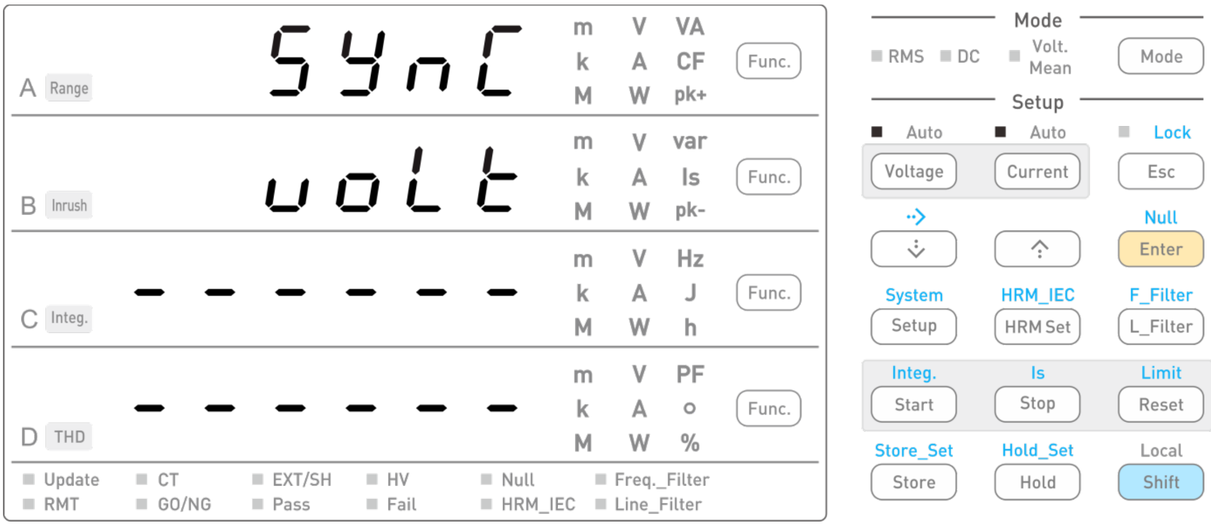
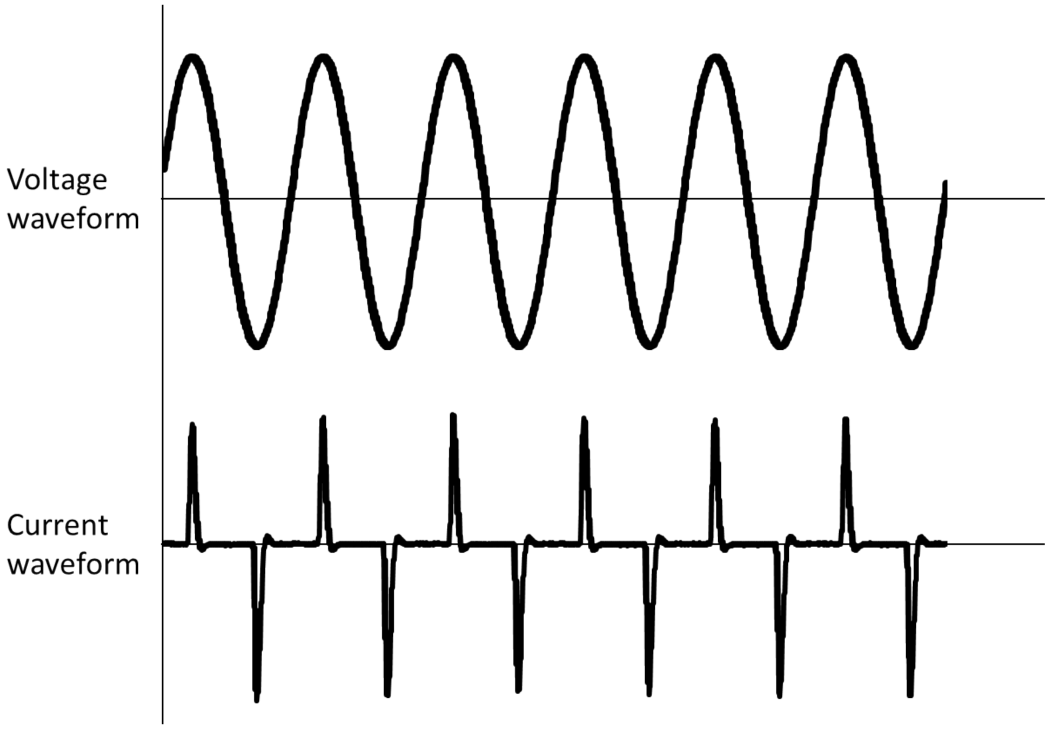


Figure 5-8 Sync Source Setup Screen

In order to get an accurate measurement, it is necessary to select a more stable or less distortion voltage or current input waveform. Check if the frequency measurement is stable and correct to determine if the sync source is stable. Following are the examples of selecting sync signal source.

Selecting voltage signal as sync signal
When measuring the input power of a switching power supply, the voltage signal distortion will be less than current and more stable, thus voltage is selected as sync signal source.

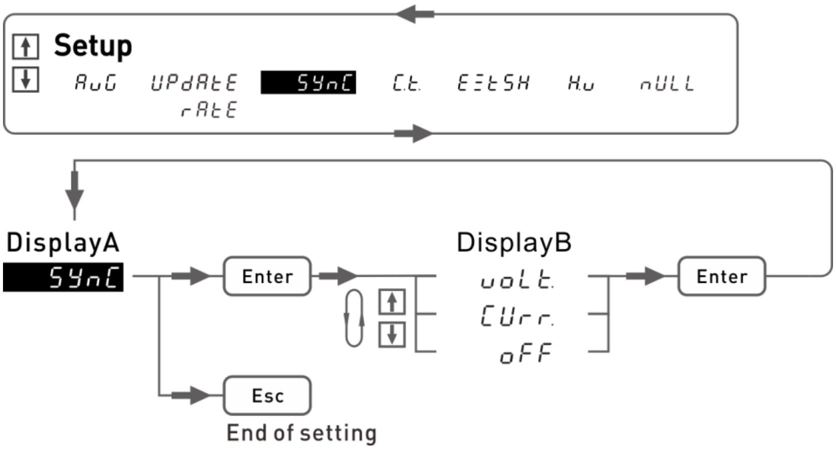


Selecting current signal as sync signal
When measuring the input power of a motor controller, the current signal distortion will be less

than voltage. Though the current signal may still has little high frequency signals, it can work with frequency filter to accurately measure the sync signal source frequency, thus current is selected as sync signal source.

Setting sync signal to OFF
If the input voltage and current signals are not stable and unable to detect stable frequency, it can set the sync signal source to OFF. It is recommended to increase data update rate to get a relatively stable measurement.

Procedure
The parameters setting procedure is shown in the figure below.



Notice

1. If the voltage signal is set as sync signal, but it is unable to get a stable sync frequency or the sync frequency is zero, the sync signal will automatically set to current.
2. If the current signal is set as sync signal, but it is unable to get a stable sync frequency or the sync frequency is zero, the sync signal will automatically set to voltage
3. If stable frequency is unable to be detected from voltage and current, the sync signal will automatically switch to OFF.

5.3.4 Setting CT Ratio

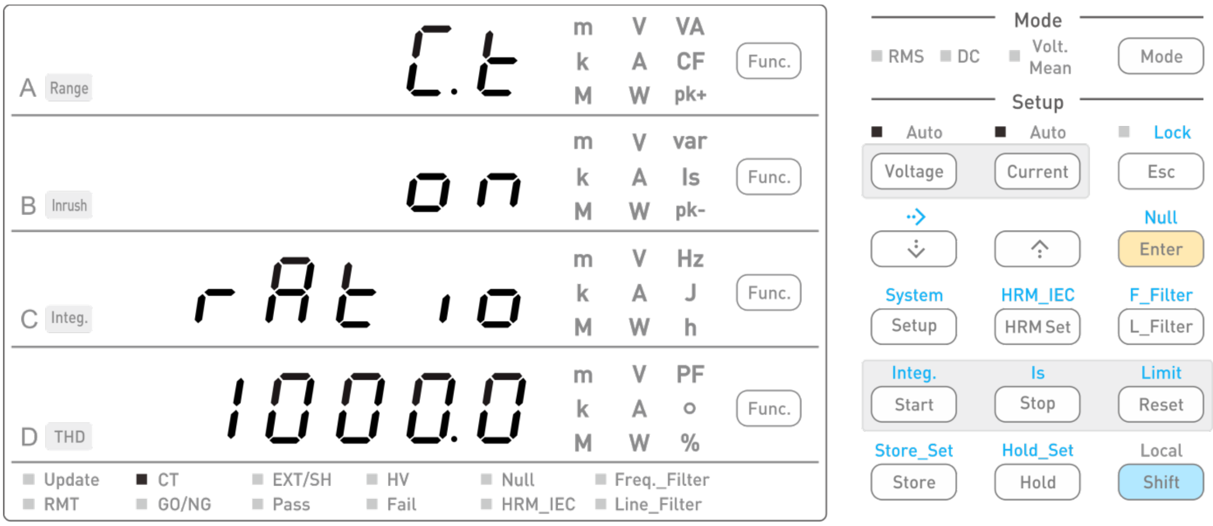
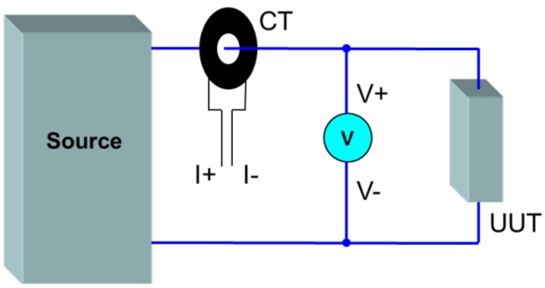


Figure 5-9 CT Ratio Setup Screen

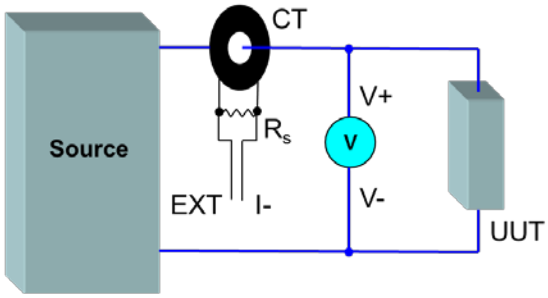
If the UUT's maximum current exceeds the maximum range of the 66205 Digital Power Meter, the Current Transducer (CT) can be selected to work with the power meter. The power meter's CT function needs to be activated and set the conversion ratio. For instance: if the CT conversion ratio is labeled 1000, the ratio should set to 1000 and the limit is 1.00~9999.9.

Wiring

■ 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.

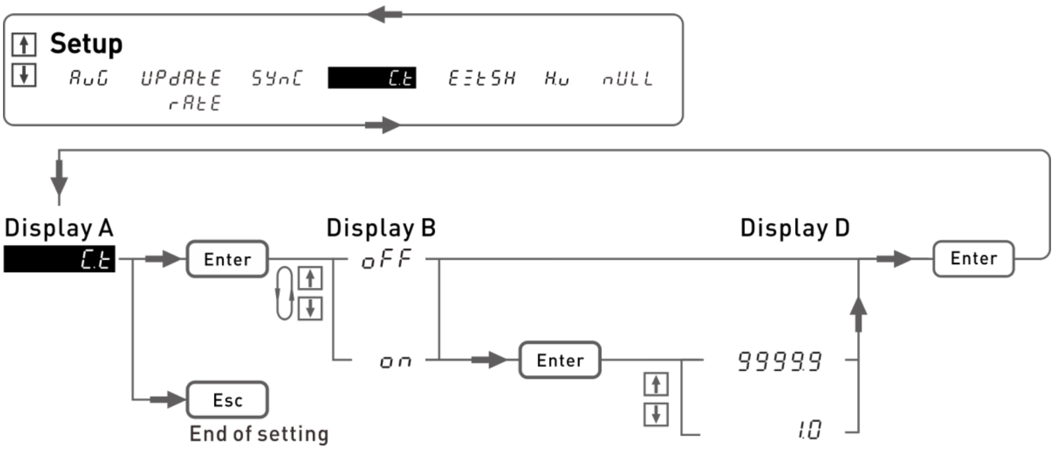


■ If the CT secondary side is connecting to the load resistance R_s, when the secondary side current goes through R_s, it will convert to sense voltage signal. The voltage signal connected to the EXT terminal (EXT, I-) will be transformed into the actual measured current of CT primary side by the power 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 5.3.5 of ExtSH for detail ExtSH function setting. For the usage of DC CT (current transducer), please read the caution notes 2 below.



Procedure

- The CT indicator illuminates after turning on the CT function.
- Setting the CT ratio.



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 66205 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 66205, 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.

5.3.5 Setting External Shunt Resistor

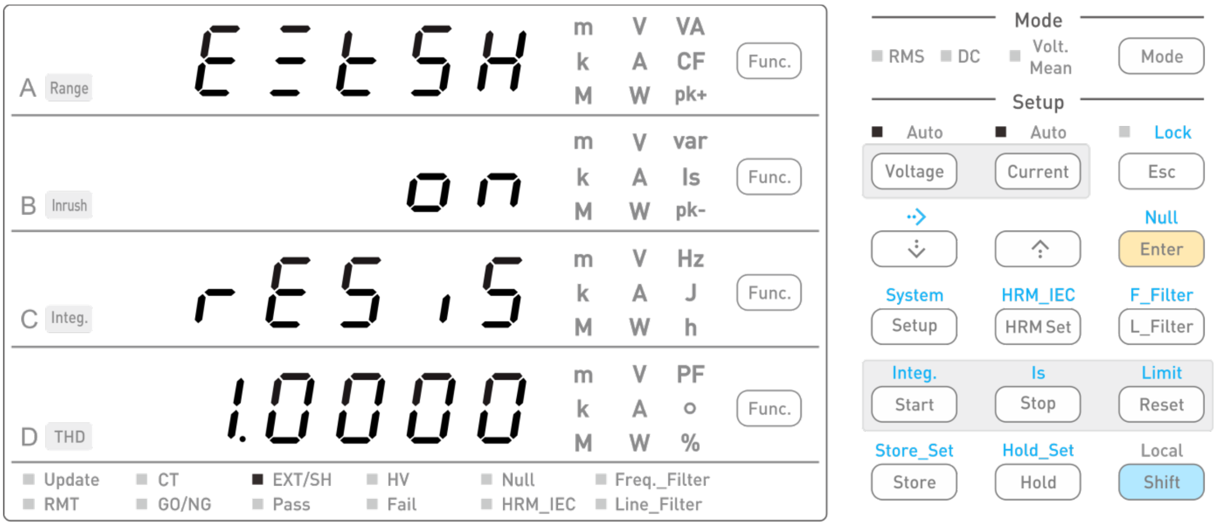


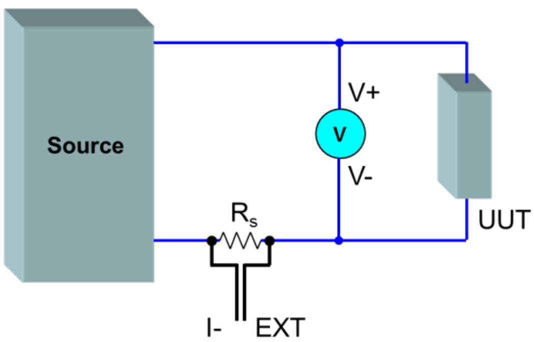
Figure 5-10 EXTSH Setup Screen

If the maximum current of UUT exceeds the maximum range of the 66205 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.

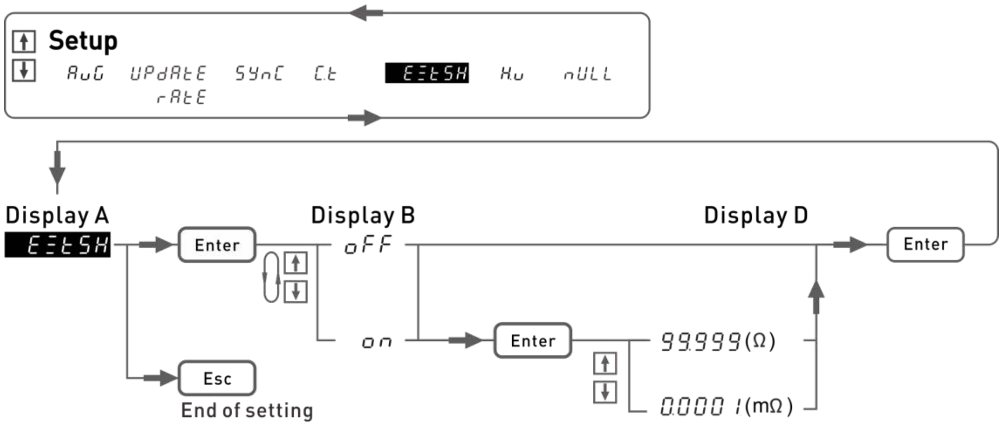
Wiring

- 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.



Procedure

- When the ExtSH function is enabled, the selection of current range will change to EXT range. Please see the section 5.2.3 of range selection for the detail of range setting.
- If you want better measurement accuracy, the resistance of the external shunt should be measured firstly and set it to RESIS on the menu.



Notice The input impedance of the 66205 EXT terminal is 100kΩ that could affect the equivalent impedance of external shunt and the measurement accuracy. Please use this function properly.

WARNING

1. The maximum input voltage allowed for EXT input terminal is 150mVrms.
2. The maximum voltage difference allowed for EXT input terminal to ground is 600V.

5.3.6 Setting High Voltage Measurement

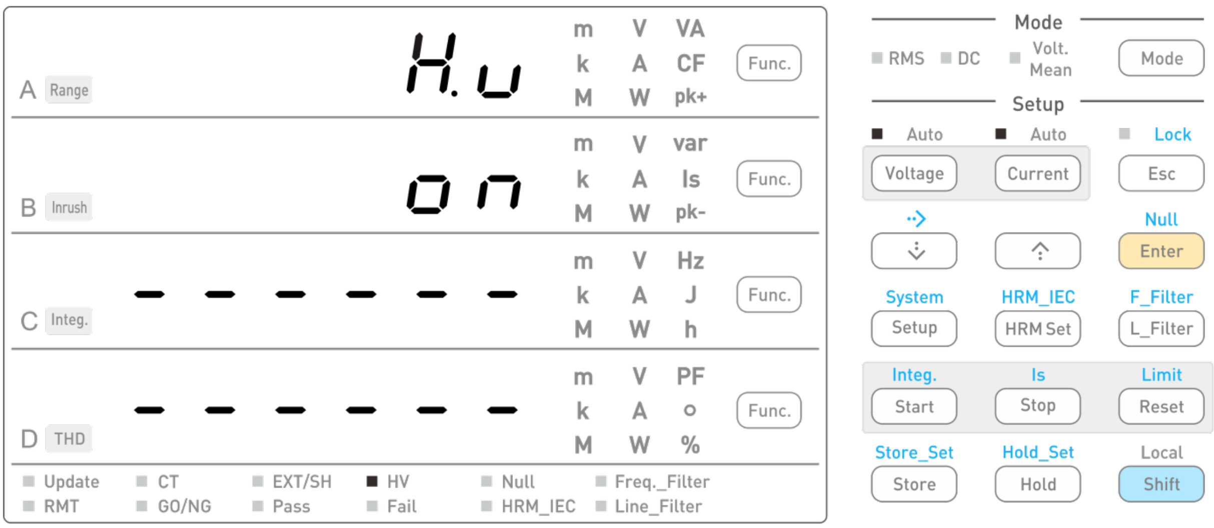
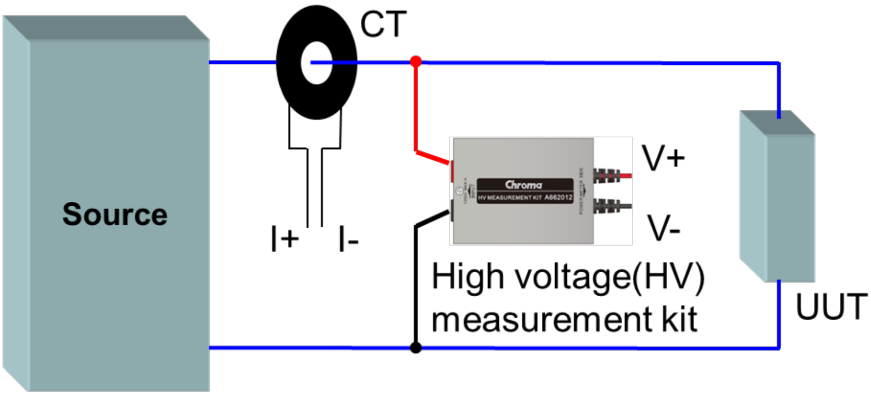


Figure 5-11 HV Setup Screen

The maximum voltage measurement range of the 66205 Digital Power Meter is 600Vrms (CF=2). If the measurement voltage is higher than the range, it can use the option A662012 HV Measurement Kit to work with the power meter for measurement. The HV Measurement Kit can increase the range up to 1200V, but the frequency applicable range is limited to DC and 47Hz~63Hz.

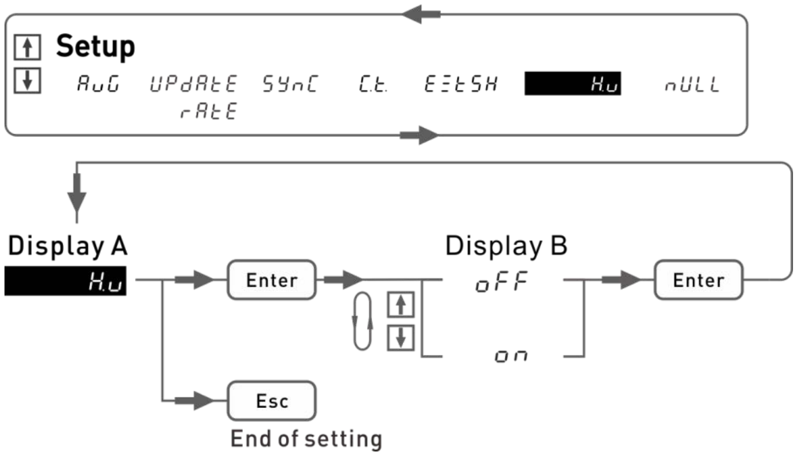
Wiring

- The length of HV measurement kit output cable or twisted wire may affect the measured specification. Please do not change the design arbitrarily.



Procedure

■ The HV indicator illuminates after turning on the HV function.



⚠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.
3. Usually use the HV Measurement Kit to measure more than 600V voltage. If you want to measure current at the same time, please use the current sensor with the high insulation grade to prevent the possibility of electric shock and damage to the instrument.

5.3.7 Enable Null function (Zero-level Compensation)

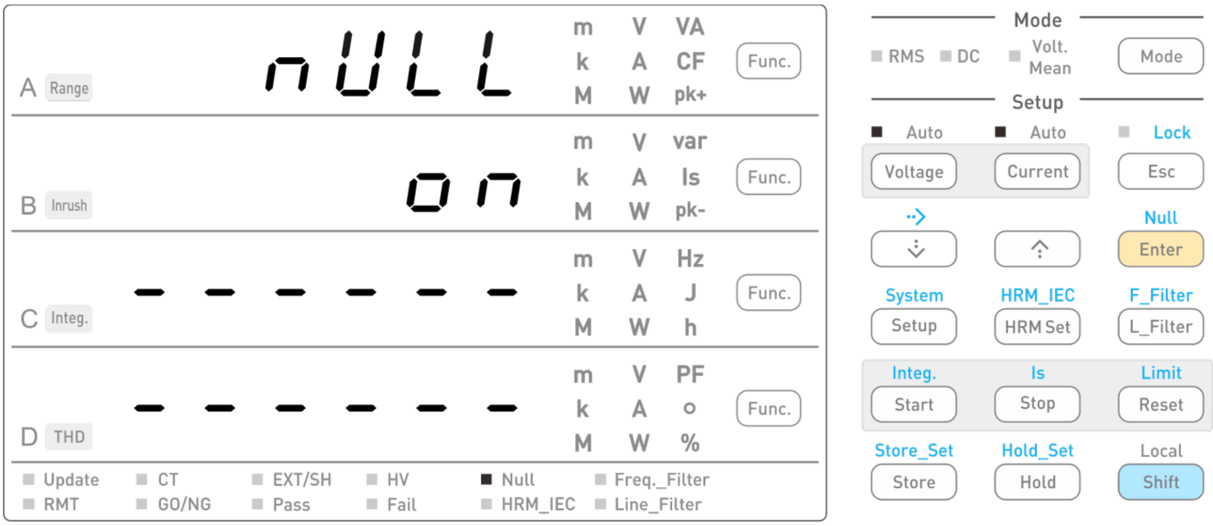


Figure 5-22 Null Function Setup Screen

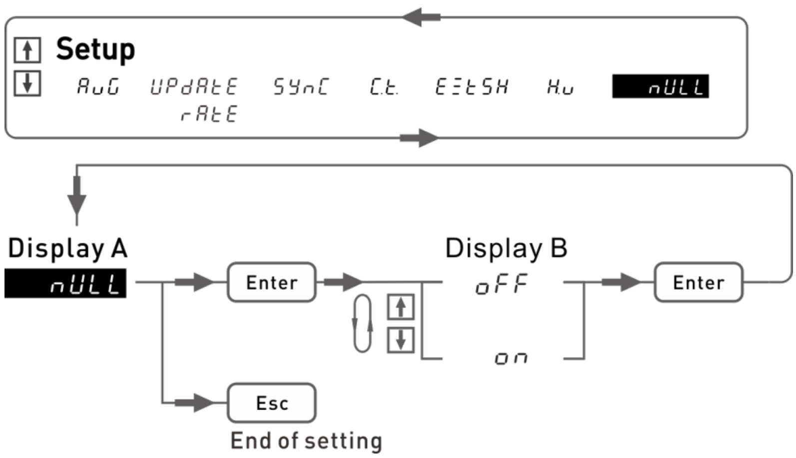
Before the 66205 receives any input signal, zero offset may occur due to different operating conditions (such as ambient temperature change, external sensor offset, noise from coupled external measurement wires, etc.) Use Auto-Null procedure to get null data (see chapter 12), and enable Null function to zero the measured value.

When setting RMS, DC and VOLT.MEAN mode for current measurement, the calculation will deduct the Null data (DC component or AC component).

- When measuring the current of DC mode, it deducts Null to get DC component.
- When measuring the current of RMS and VOLT.MEAN mode, it deducts Null to get DC component and AC component.
- When performing integral operation, it deducts Null to get DC component.
- When performing harmonic analysis, it will not deduct Null data.

Procedure

The parameters setting procedure is shown in the figure below.



Notice The previous Null data is not necessarily suitable for the current measurement compensation, it is recommended to execute Auto-Null procedure again before performing the next measurement.

5.4 Setting the Filter

The filter settings are split from the measurement setup menu and changed to enter from the front panel keys. The model 66205 has two filters setup menus which are line filter and frequency filter. These two filters are low pass filters. The function of line filter is to filter out the high frequency components on voltage and current signals that are related to the measured power. The function of frequency filter is to get a more accurate measurement frequency and sync signal source.

5.4.1 Line Filter

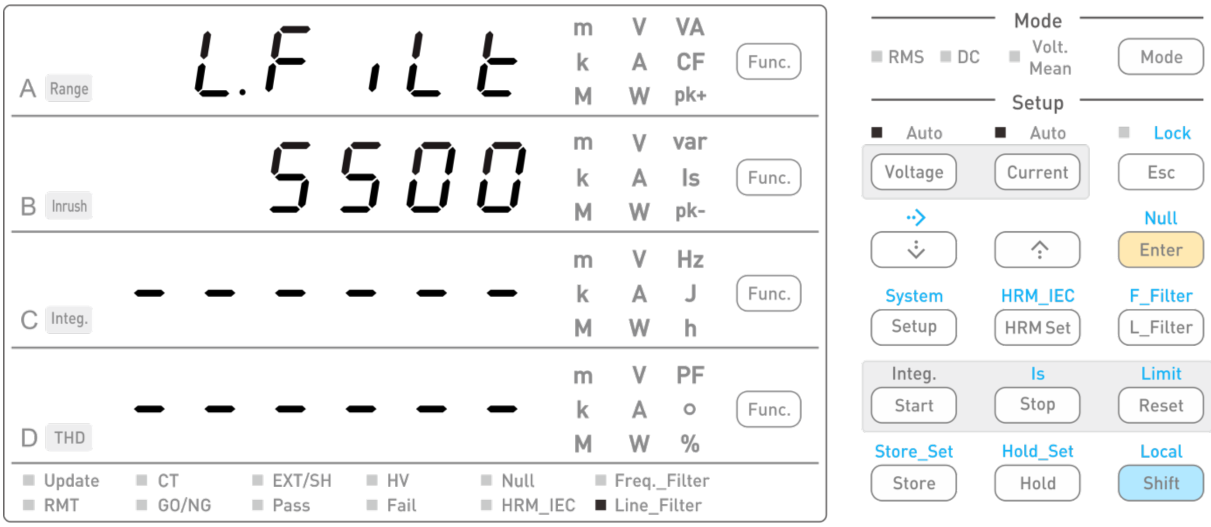
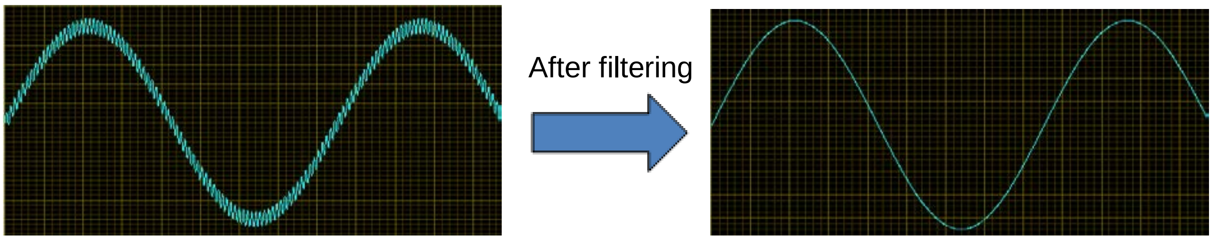


Figure 5-13 Line Filter Setup Screen

Line filter is a digital low pass filter with high attenuation rate (≥70dB). Though it is not inserted into the voltage and current measurement circuit, it still affects the measurement of voltage, current and power. When the line filter is enabled, the measured value will not comprise high frequency component such as the high frequency noise of switching converter.



- 3 cutoff frequencies available for selection which are OFF, 500 Hz and 5.5 kHz.
- Line_Filter indicator will be on when 500Hz or 5.5 kHz is selected.
- Line filter is disabled when OFF is selected.

The 66205 Digital Power Meter has low pass digital filter function with around 5.5 kHz cutoff frequency that is compliant with the IEC 61000-3-2 international standard. It is suggested to turn on this filter when measuring harmonics.

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.

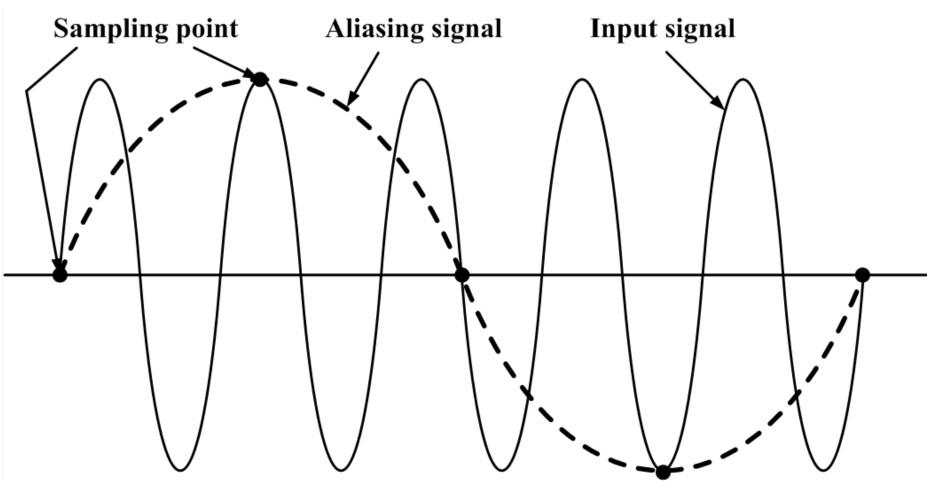
Otherwise, the harmonic will be affected by the filter; for instance, to measure the fundament wave 60Hz with 100 levels of harmonic, since the harmonic frequency 6 kHz is larger than the filter's bandwidth, it is suggested to turn off the filter and then perform the measurement.

The filter with 500Hz cutoff frequency should be selected if you only need to measure power or waveform of fundamental. If you need to measure fundamental power more accurately, it is suggested to use harmonic measurement function.

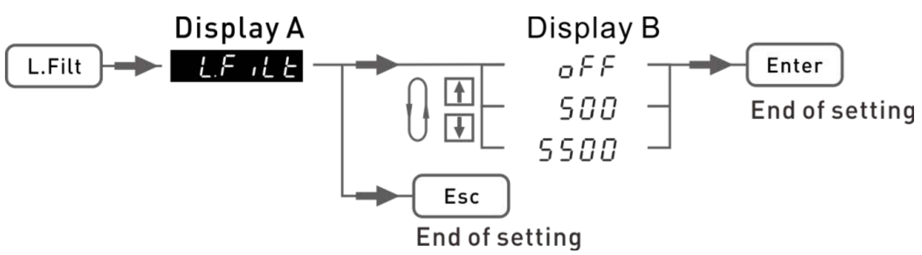
Higher measurement bandwidth is required when measuring the inrush current. Therefore, the digital filter will apply OFF state even if the filter is set to ON so that the measured inrush current will not be affected.

Anti-aliasing filter

The measurement circuit has anti-aliasing filter design in it with cutoff frequency about 60kHz. See the block diagram in Appendix C. When the A/D convertor is sampling the frequency component 0.5 times higher than the sampling rate, if the circuit has no anti-aliasing filter, the sampled signal will be a low frequency component which is called aliasing signal as shown in the figure below. The aliasing causes harmonic measurement error and the error of each harmonic angle, thus the design of anti-aliasing filter is very important for harmonic measurement. The anti-aliasing filter can make the filter more robust and flexible, also make the harmonic and power measurement functions more reliable.



Procedure
The parameters setting procedure is shown in the figure below.



Notice

1. 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 5.5 kHz.

2. No matter whether the line filter is turned on or off, the anti-aliasing filter with around 60 kHz cutoff frequency also has a line filter function. The anti-aliasing filter can be turned off, but this function is not released yet.

5.4.2 Frequency Filter

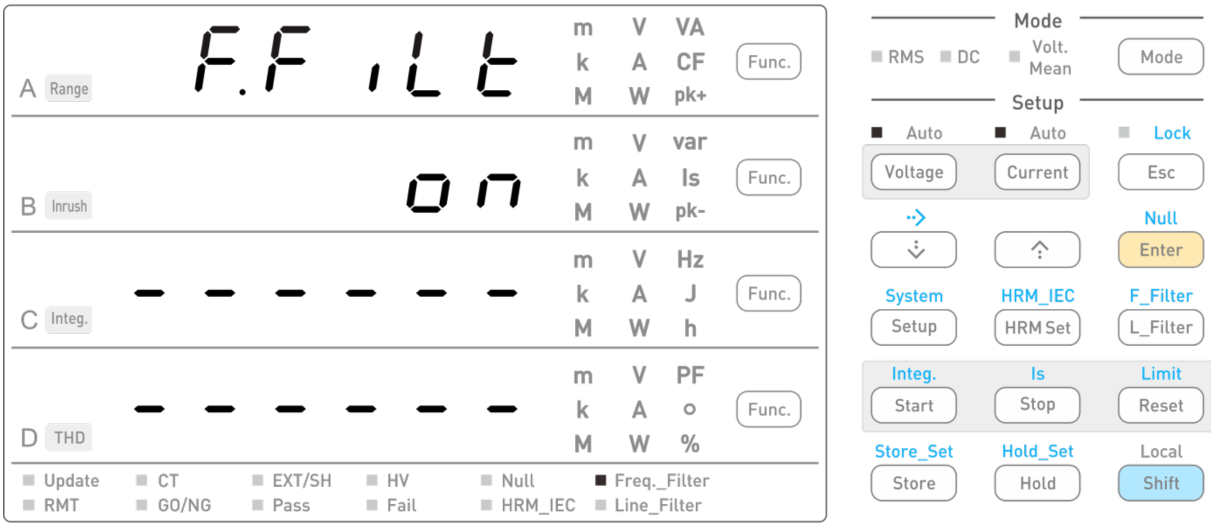


Figure 5-14 Frequency Filter Setup Screen

Frequency filter, AC coupling circuit and zero crossing circuit with hysteresis formed a pre-stage circuit with frequency detection function. When the frequency filter is enabled, it will eliminate the high frequency component on synchronization source signal. It makes the signal waveform of zero crossing detection circuit more pure to get more stable zero crossing signals. The FPGA uses the reciprocal measurement method to count the zero-crossing signals within the data update interval and calculate the frequency values. When large data update interval is set, the longer the detection time is, the more the zero-crossing signal is covered, and the frequency measurement of the synchronization source is more stable.

- AC coupling circuit
  - It filters out the signal DC component before entering zero crossing circuit.

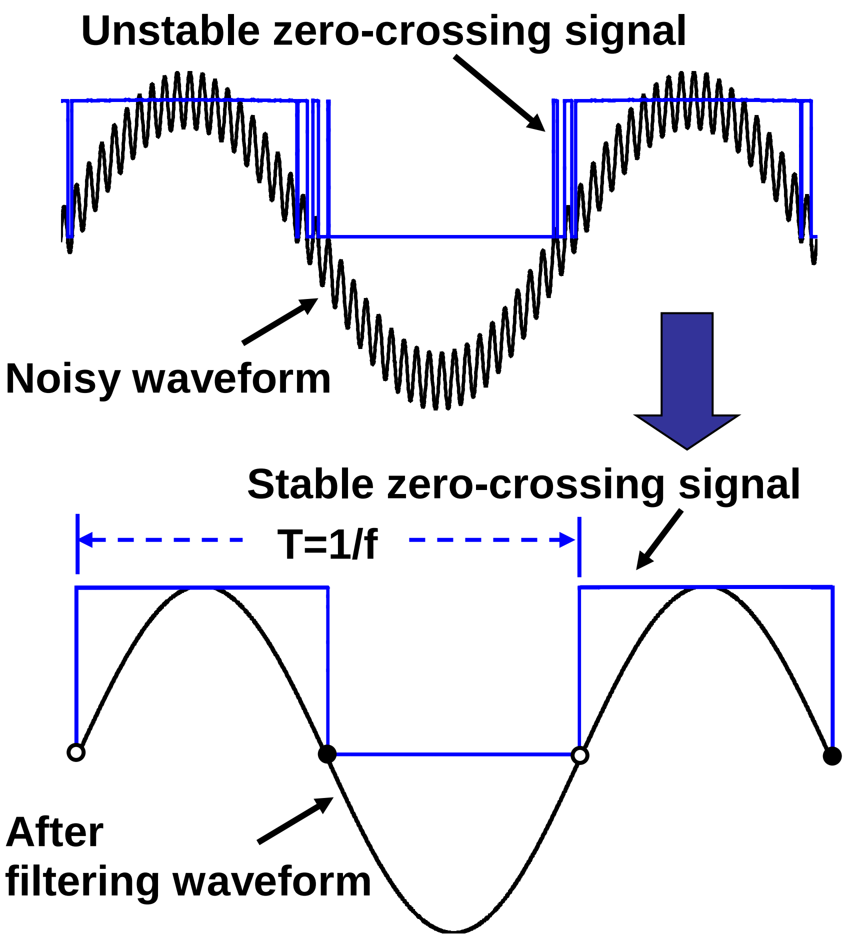
- Frequency filter
  - A low pass filter.
  - OFF and 500Hz 2 cutoff frequencies for selection, where OFF is about 20 kHz.
  - Suggested to turn on the frequency filter when measuring the frequency under 500Hz.
  - When the frequency filter is turned on, its indicator will be on.
  - It is not inserted in the voltage and current measurement circuit, so it will not affect measurements of voltage, current and power.

- Zero crossing circuit with hysteresis
  - The zero hysteresis of the sync voltage source is about 5% of the measurement range.
  - The zero hysteresis of the sync current source is about 30% of the measurement range.
  - When the input signal with higher frequency noise exceeds the hysteresis at zero crossing, it will produce unstable zero-crossing signal. It is recommended to open

the frequency filter to filter out the noise.

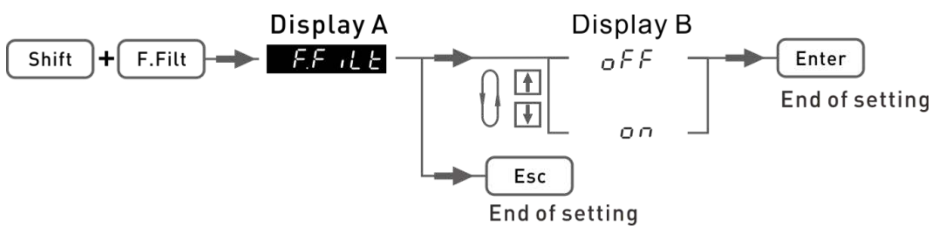
Notice

1. No matter whether the digital line filter is enabled or not, it will not affect the sync signal frequency detection.
2. The on and off of anti-aliasing filter may affect the frequency detection. See the block diagram in Appendix C for more information.



Procedure

The parameters setting procedure is shown in the figure below.



6. Integration Function

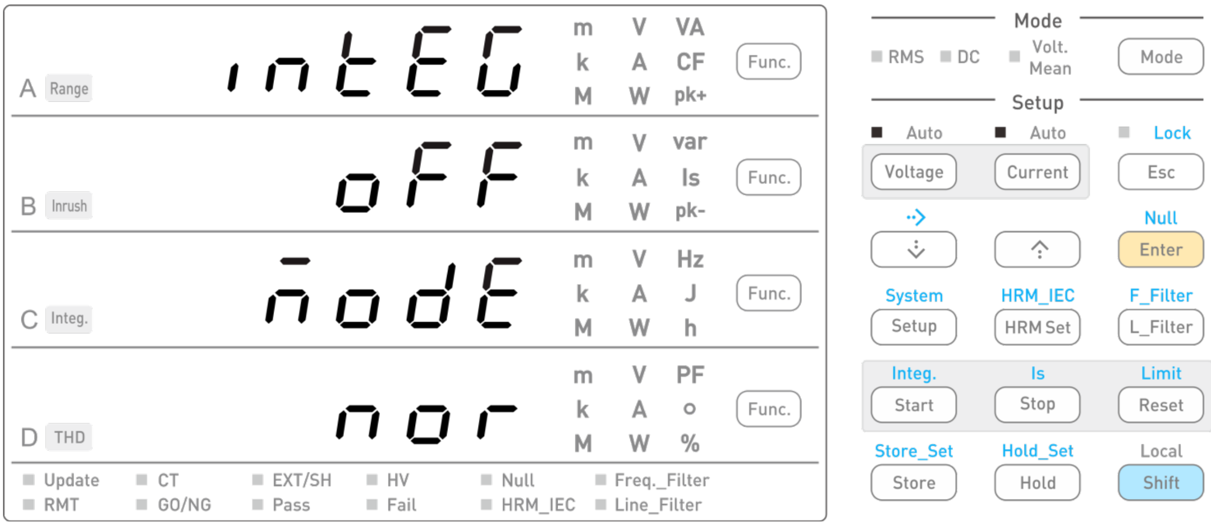


Figure 6-1 Integration Setup Screen

The 66205 can integrate the active power (watt hour), the current (ampere hour). Based on the same integration time, the active power, apparent power, reactive power, voltage and current are also be calculated. During integration, the measured value (Hz, CF, peak,…) of the normal measurement can be displayed.

Enable or disable integration function

- ON: Press **Shift** + **Start** (Integ.) keys, after selecting ON in the Integration menu, the Integ. indicator is lit. This means the integration measurement function is enabled. Other integration parameters can be set subsequently.
- OFF: Press **Shift** + **Integ.**, the Integ. Indicator is off when OFF is set. This means the integration measurement function is disabled and unable to set the integration parameter.

Setup integration mode

The integration measurement has “Manual Integration” and “Continuous Integration” two modes.

- Manual Integration Mode
  Integration start: Press **Start** to begin integration measurement.
  Integration stop: Before the preset integration time is met, press **Stop** to hold the integration measurement and keep the integration value. The integration stops when the preset integration time is met.
  Integration reset: When the integration is stopped, press **Reset** to end the integration measurement and clear the integration value.

- Continuous Integration Mode
  Integration start: Press **Start** to begin integration measurement, or automatically clear and trigger the next integration measurement when the preset integration time is met.
  Integration stop: Before the preset integration time is met, press **Stop** to hold the integration measurement and keep the integration value. The integrating stops when the preset integration time is met and then automatically clears and triggers the next

integration measurement.
Integration reset: When the integration is stopped, press **Reset** to end the integration measurement and clear the integration value.

Setup integration timer
The setting range for integration timer is 9999 hours: 59 minutes: 59 seconds.

Setup smart range
During the integration measurement, to avoid the measurement data loss caused by frequent change of measurement range, fixed range for operation is usually recommended. However, it is difficult to select a proper range when the current is dynamic and unknown. It will reduce the measurement resolution and accuracy if the range is selected too high. On the contrary it could cause data loss if the range is selected too low. When the smart range function is enabled, the measurement range will properly adjust following the variation of load current, and no measurement data loss during the range adjustment.

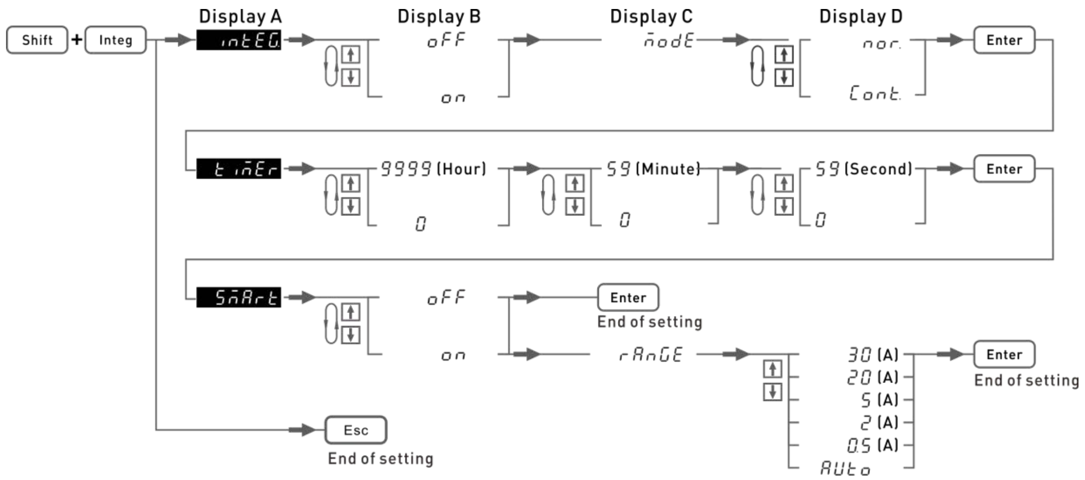
■ OFF
It disables the smartrange. During performing integration measurement, if the measurement range is set to AUTO, the waveform data will be missed due to the replacement of the range. Therefore, before starting integration measurement, it is suggested to use pre-test to estimate the maximum amplitude of the signal to be tested so that higher measurement range can be set to avoid any measurement data loss. During testing, it can only view the range status without any change. When performing integration measurement, if the signal amplitude exceeds the measurement range high limit, the power meter will prompt a range change error message.

■ ON
The smart range follows the variation of current signal to properly adjust the measurement range. When the load current rises, the measurement range will rise directly to the appropriate range. When the load current becomes smaller, the smart measurement can predict changes in the current signal, so that range down is not immediately reflected but adaptively adjusted.

Under smart range, dual measurement circuit design has the data gapless advantage for obtaining the sampling signals even when the range is changed. This not only saves the trouble of selecting range but also enhances the integration measurement reliability.

Dual measurement circuit is composed of normal and compensation measurement circuit. See the circuit diagram in Appendix C. The normal measurement range is set to auto without change. Follow the variation of signal amplitude to find the best measurement range. The compensation measurement range can be set. There are 6 ranges (Auto, 30A, 20A, 5A, 2A, 0.5A, and Auto as default) for selection. The compensation measurement circuit in addition to being responsible for the loss of the signal when the normal measurement circuit changes the range, it also provides waveform information to the smart controller for adjusting the range of normal measurement circuit. When the compensation measurement range is set to Auto, the smart controller will not allow the compensation and normal measurement range to switch at the same time to sampling data loss. If the compensation measurement circuit uses a fixed range, the range needs to be set higher than the maximum signal amplitude during the test. In the integration measurement if the waveform exceeds the compensation measurement range resulting in data loss, the compensation measurement range is forced to AUTO.

Procedure
The parameters setting procedure is shown in the figure below.



Modifying the set limits during integration
When the integration is processing (including integral hold), the setting parameters that will affect the measurement results cannot be changed as the table shown below.

Function	O: Settings can be modified. X: Settings cannot be modified.
Measurement range	X
Average	X
Display update rate	X
Filter	X
Synchronization source	X
CT ratio	X
External ratio	X
HV ratio	X
Integration timer	X
Integration mode	X
Smart measurement	X
Hold	O
Store	O
Null	X
Harmonic	X

External trigger
Besides using current level for triggering, the external trigger can be used as well. When the external trigger triggers the inrush current measurement, it will ignore the set trigger level but apply the measurement delay time set and the measurement time set to start testing. See *Appendix A Using Control Signal Input/Output Terminal* for the pin assignment of external trigger signal.

Notice

1. When error message appears, press **ENTER** to clear it. The power meter will perform next integration measurement. If **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. There are three measurement functions need to use **Start** for triggering. They are Integration, Is and Limit (GO/NG). The priority is integration > Is > GO/NG.

3. The integration function also has external trigger function. For the pin assignment, see *Appendix A Using Control Signal Input/Output Terminal.*

7. Inrush Current Measurement

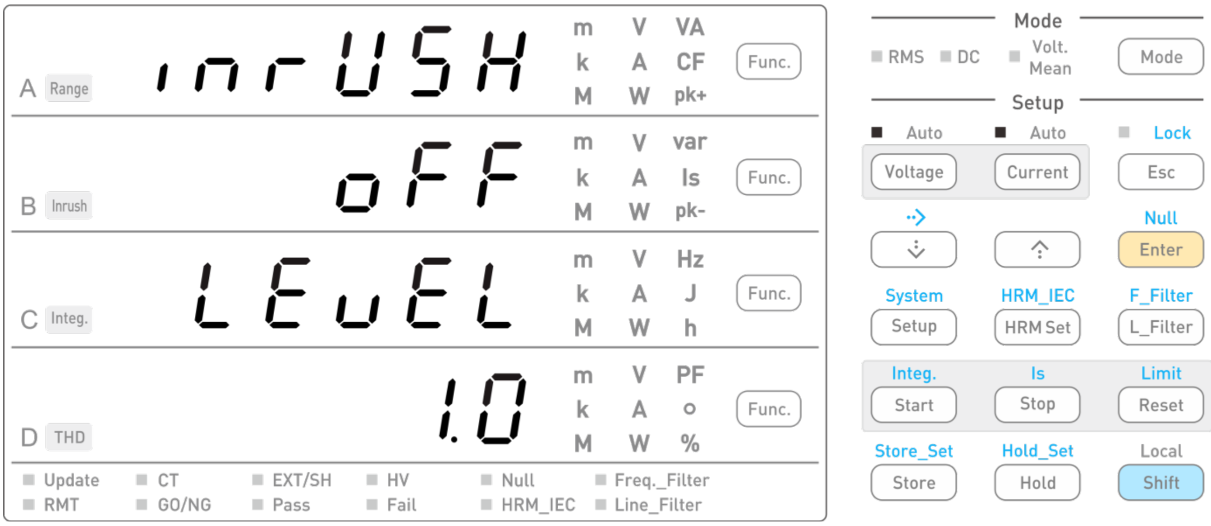


Figure 7-1   Inrush Current Setup Screen

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 66205 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 66205 power meter will prompt a Range Change Error (RCE) message. It is suggested to fix the range to 30A or set the range manually to an appropriate one after pretesting to get the best current measurement resolution.

Enable or disable Inrush

- ON: Press Is key and select ON, the Inrush indicator is on which means the measurement function is enabled and other related parameters can be set subsequently.
- OFF: Press Is key and select OFF, the Inrush indicator is off which means the measurement function is disabled and unable to set other related parameters.

Setting trigger level

When the inrush current exceeds the set trigger level, it begins to detect the inrush current. The trigger level setting rang is 0.1A~999.9A, and the resolution is 0.1A. The default is 1A.

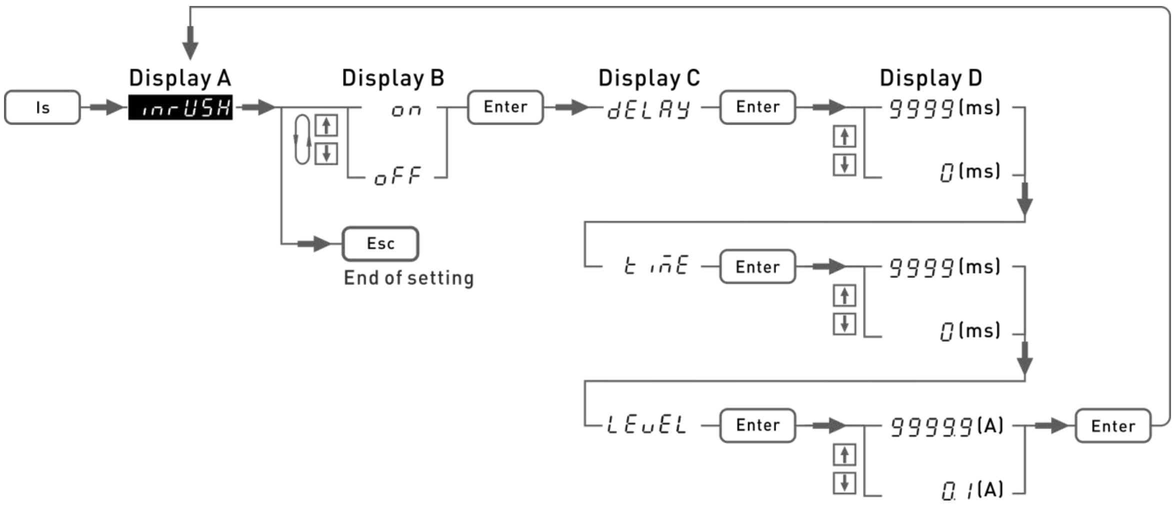
If external signal is used to trigger the inrush measurement function, the measurement procedure will ignore the current trigger level and apply the set delay time and measurement time to measure the inrush maximum value. For the pin assignment of external trigger function, see *Appendix A Using Control Signal Input/Output Terminal.*

Setting delay
When the current exceeds the trigger level, it can set the delay time to postpone entering the measurement time. For example, if the delay time is set to 0, the measured inrush current maximum value is 7A; however, if the delay time is set to 5ms, the measured inrush current maximum value is 1.2A. The delay time setting range is 0ms ~ 9999ms, and the resolution is 1ms. The default is 0ms.

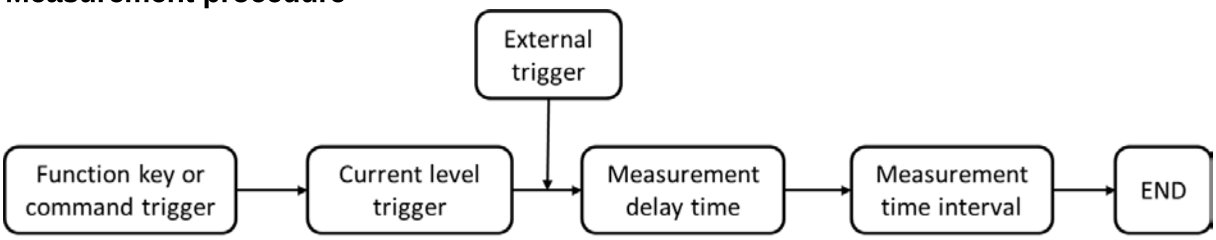
Setting measurement time
The measurement time setting range is 0ms ~ 9999ms, and the resolution is 1ms. The default is 100ms.

Procedure

■ **Setting parameter**



■ **Measurement procedure**



Modifying the set limits during Inrush current measurement
When the inrush current measurement is processing, the setting parameters that will affect the measurement results cannot be changed as the table shown below.

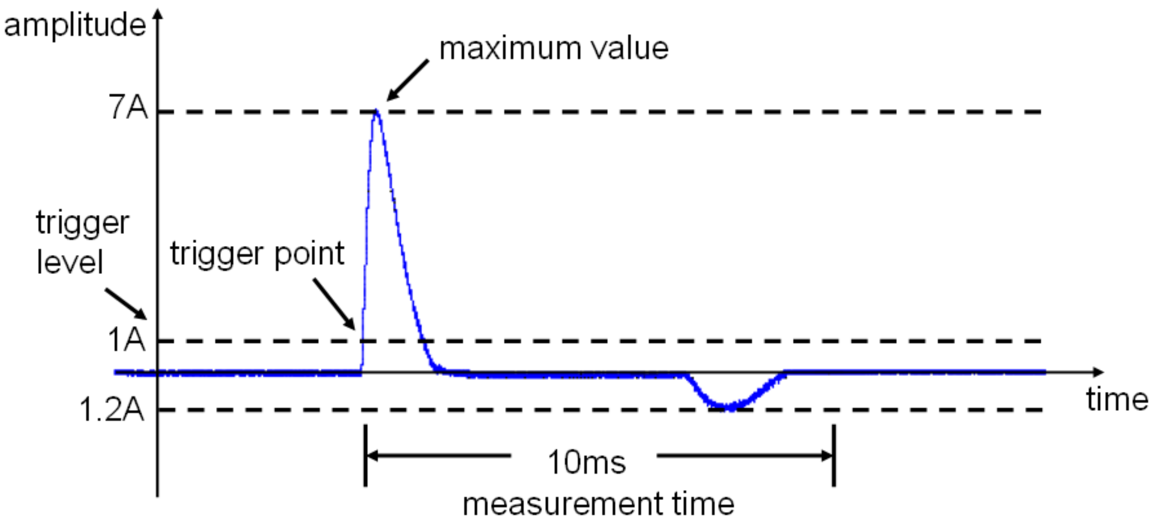
Function	O: Settings can be modified. X: Settings cannot be modified.
Measurement range	X
Average	X
Display update rate	X
Filter	X
Synchronization source	X
CT ratio	X
External ratio	X

HV ratio	X
Integration timer	X
Integration mode	X
Smart measurement	X
Hold	O
Store	O
Null	X
Harmonic	X

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.



Notice

1. The fastest sampling rate of the 66205 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 66205 Digital Power Meter has 3 types of parameters that require **Start** for triggering, they are E (Energy), Is (Inrush Current) and GO/NG. The priority is E > Is > GO/NG.

8. Limit (GO/NG) Function

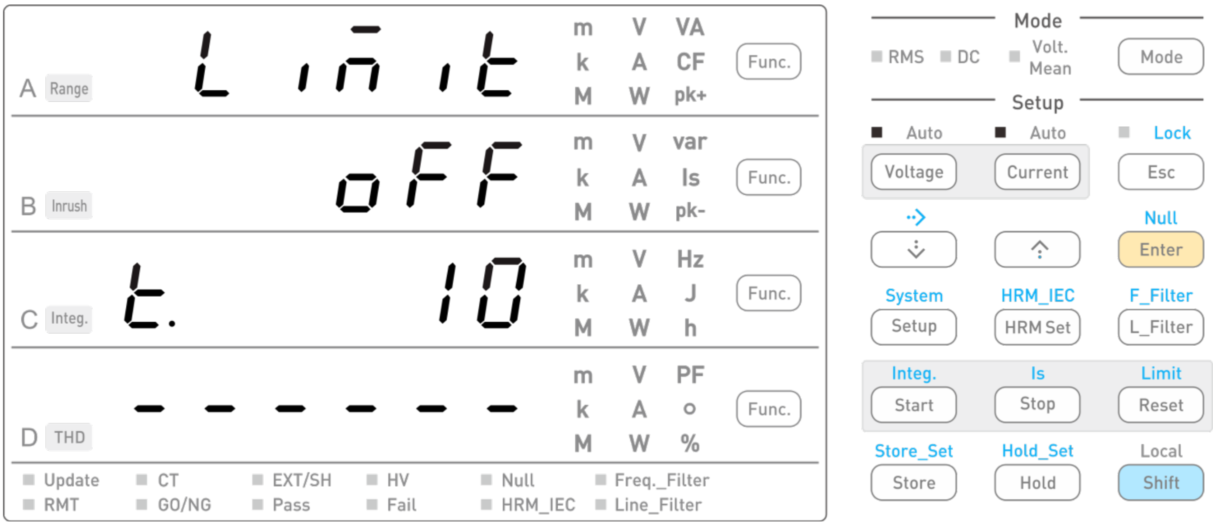
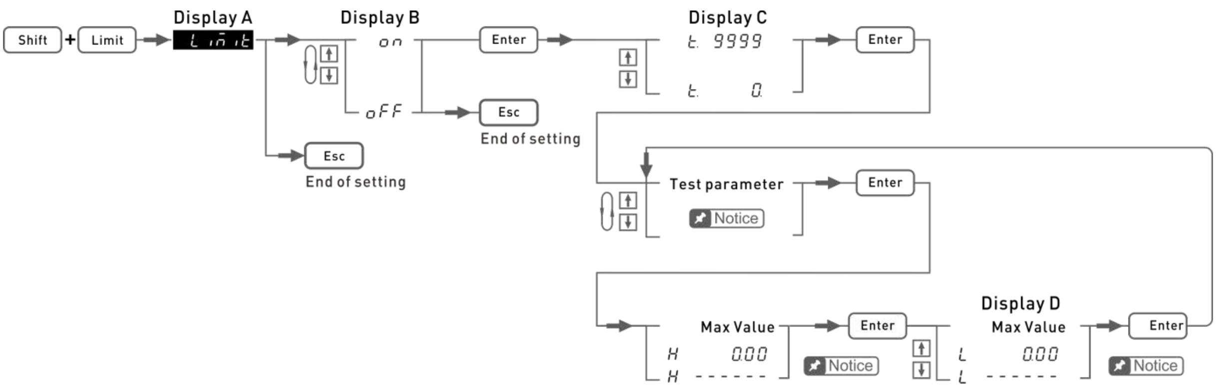


Figure 8-1 Limit Setup Screen

The measured data can be judged using the Limit function with the set detection time and the upper/lower limits of various parameters including V, Vpk+, Vpk-, I, Ipk+, Ipk-, Is, W, PF, VA, VAR, CFi, VTHD, ATHD, E and F, etc. One or several of them can be set at the same time.

Setting parameter

- First enable the function and set the testing time.
- Select test parameter from Display B.
- Set the upper limit for comparison from Display C.
- Set the lower limit for comparison from Display D.
- Set "-----" (don't care) if the upper and lower limit is not required.
- Set the upper and lower limits of multiple test parameters for comparison at the time.



Judgment criteria

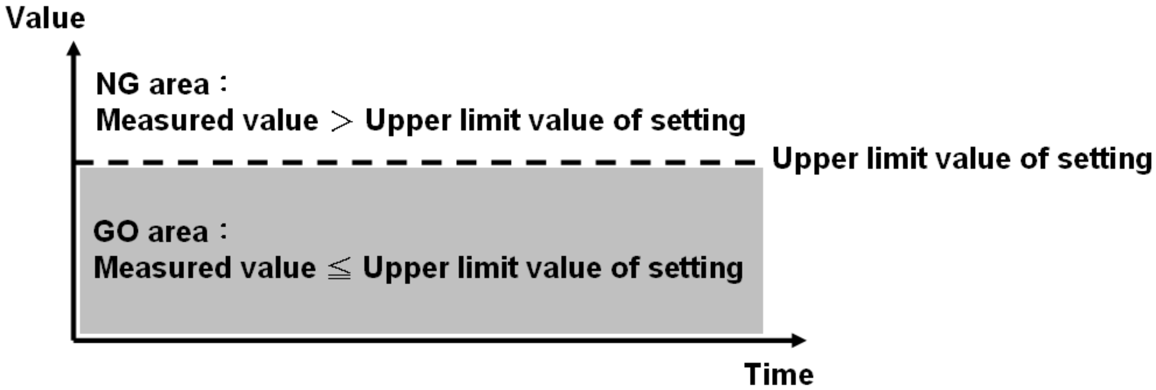


Figure 8-2　GO/NG Upper Limit Judgment Criteria

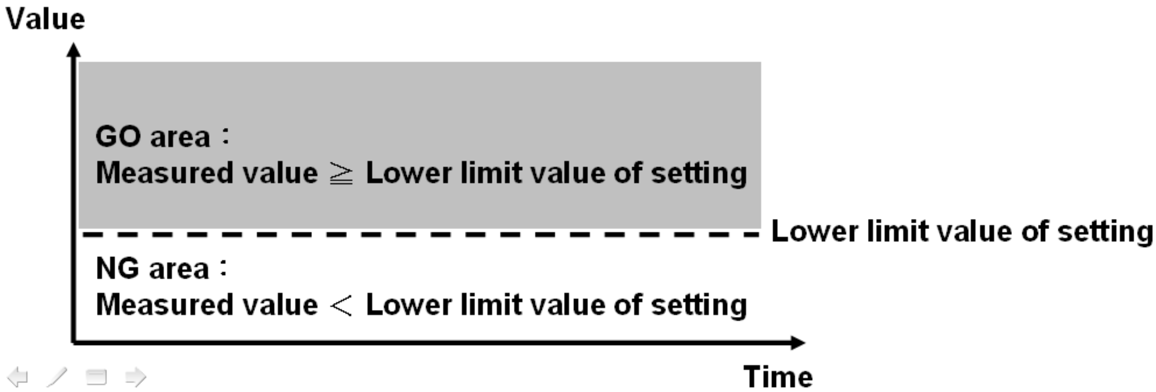


Figure 8-3　GO/NG Lower Limit Judgment Criteria

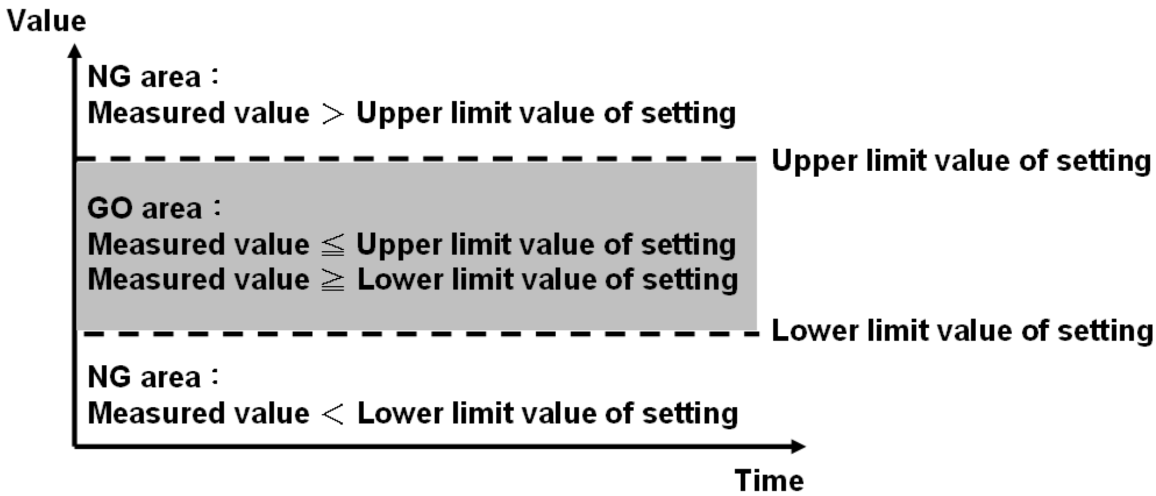


Figure 8-4　GO/NG Upper and Lower Limit Judgment Criteria

Operating procedure

- Start
    - Start GO/NG judgment.
    - Clear the previous "PASS" test results and begin to perform next GO/NG judgment.
    - Press Reset to clear FAIL state if it is unable to clear the previous "FAIL" test results.
- Stop
    - Stop GO/NG judgment being executed.

- Reset
  - Reset GO/NG judgment.
  - Clear the previous “FAIL” test results.

Testing status

- GO/NG status indicator
  - GO/NG indicator blinks during testing.
  - GO/NG indicator is on when the test stops or ends.
- Front panel PASS/FAIL indicator status
  - PASS indicator is on when the test result is PASS.
  - FAIL indicator is on when the test result is FAIL.
- Beeper status
  - Beep once when the test result is PASS.
  - Beep continuously when the test result is FAIL.
- Rear panel I/O port PASS/FAIL pin status
  - PASS relay is on when the test result is PASS.
  - FAIL relay is on when the test result is FAIL.
- Front panel measurement
  - When the test result is FAIL, the measured value will be recorded and highlighted with blinks for inspection.
- Use the external indicator to present PASS or FAIL status as the figure shown below. See *Appendix A Using Control Signal Input/Output Terminal* for detailed information.

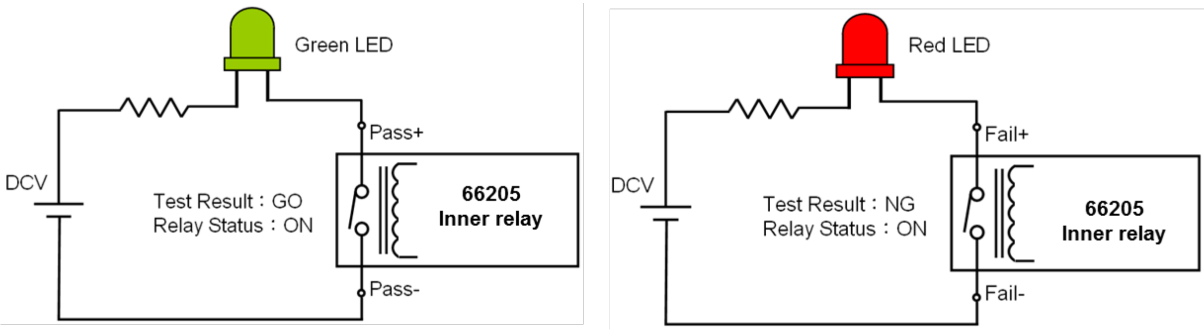


Figure 8-5 GO/NG External Indicator Wiring Diagram

Notice The 66205 Digital Power Meter has 3 functions that require pressing **Start** for triggering. They are Integration, Inrush current and GO/NG. If two of them are set for testing, the triggering priority is Integration > Inrush current > GO/NG.

9. Harmonic Measurement Function

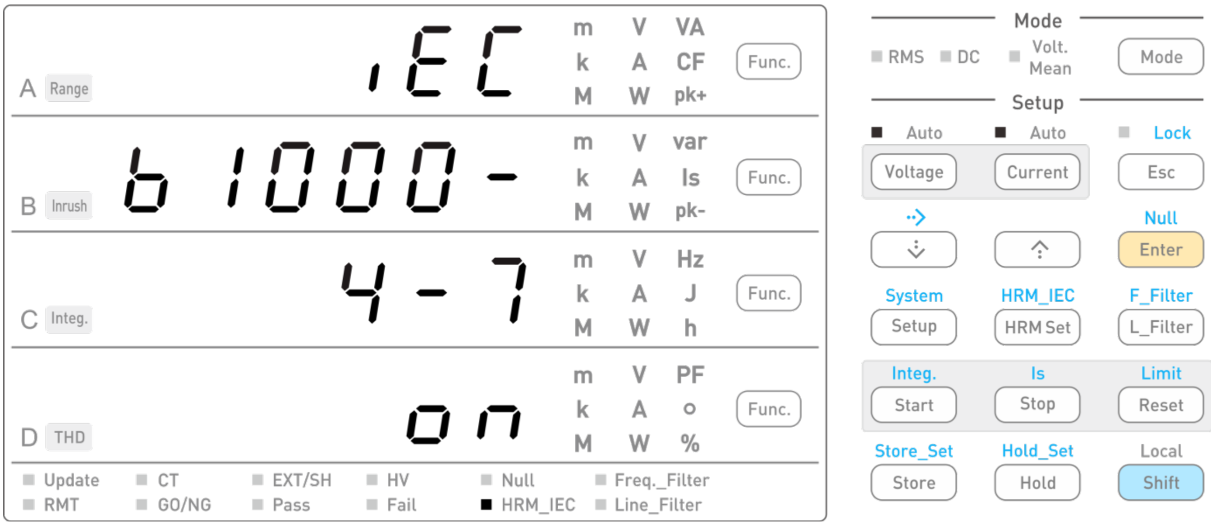
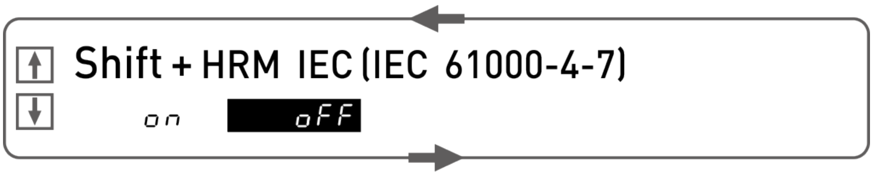


Figure 9-1 Setup Screen for Harmonic Measurement Mode Selection

The model 66205 provides a standard (IEC) and normal harmonic measurement mode.

- Standard (IEC) harmonic measurement mode: Press HRM IEC (Shift + HRM Set) keys to turn on the IEC 61000-4-7 function.
- Normal harmonic measurement mode: Press HRM IEC (Shift + HRM Set) keys to turn off the IEC 61000-4-7 function.



9.1 Standard (IEC 61000-4-7) Harmonic Measurement

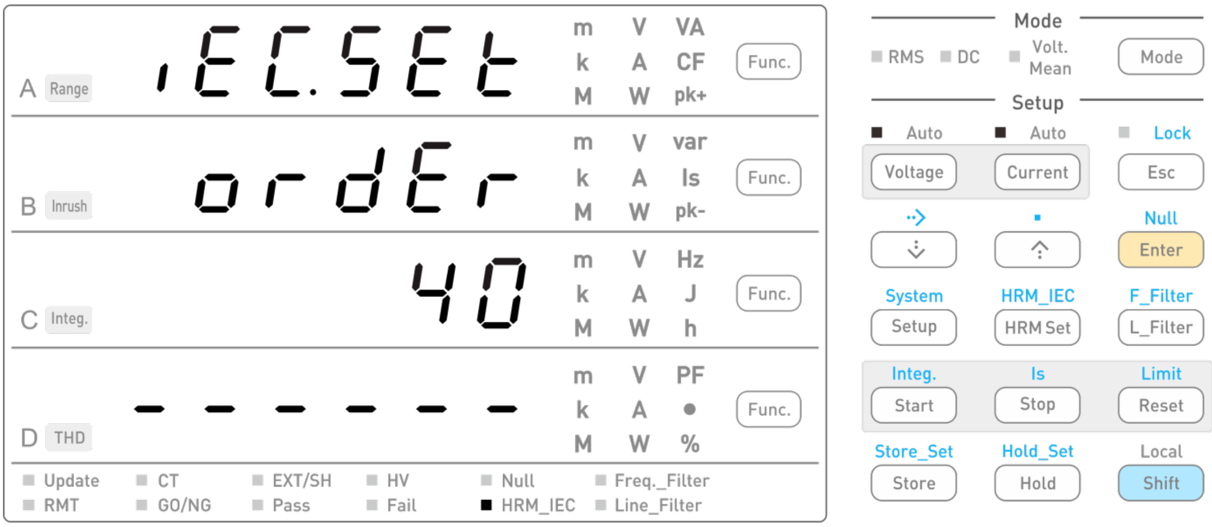
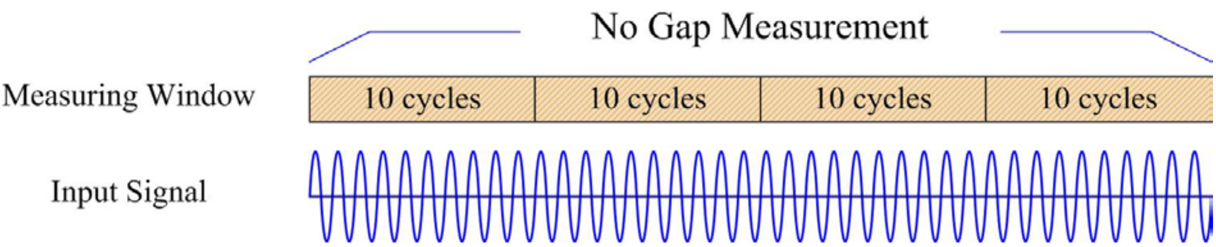


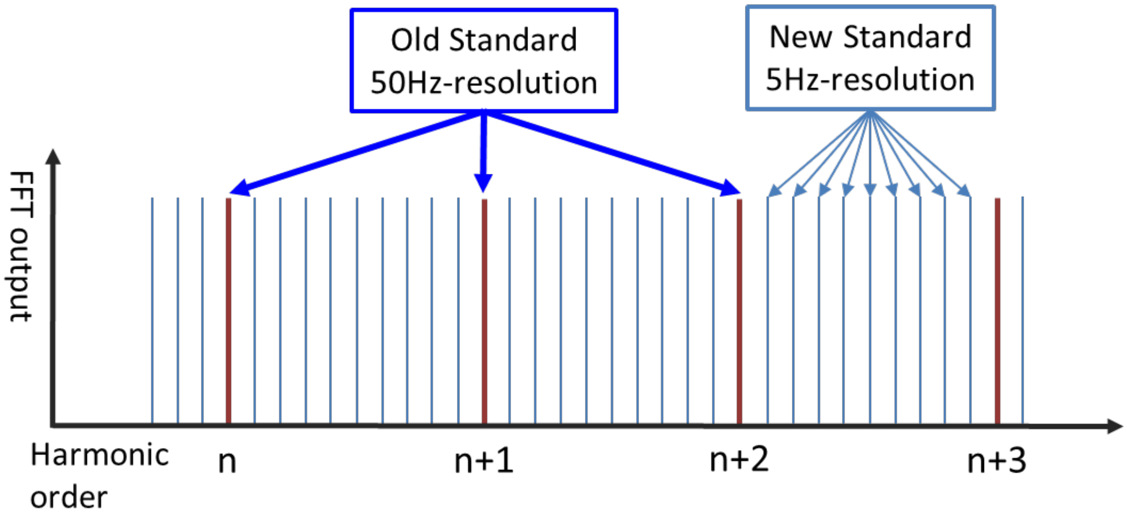
Figure 9-2 Standard (IEC 61000-4-7) Harmonic Measurement Setup Screen

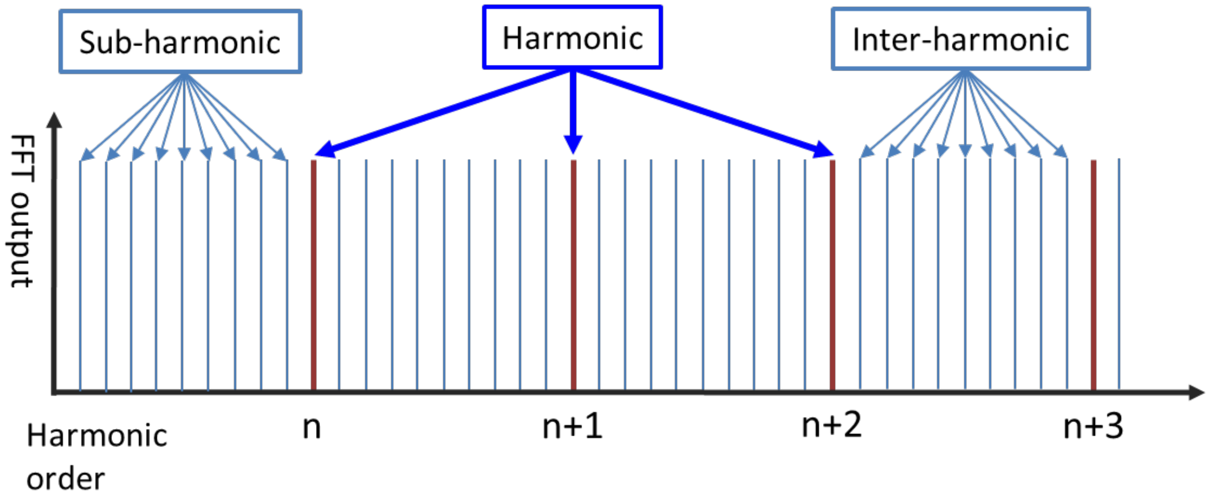
The IEC harmonic measurement mode is compliant with IEC 61000-4-7 using 200ms (10 cycles of 50Hz power system and 12 cycles of 60Hz power system) rectangular window data to conduct gapless and no overlap FFT (fast fourier transformer) analysis. The resolution of the analysis harmonics is 5Hz and the data length is 4096 sampling points.

The display update rate and data update interval of IEC harmonic measurement mode is 200ms. When the function is enabled, it will not be affected even if other display update rate is selected. The actual measuring period of time window will adjust following the frequency change of 50Hz or 60Hz sync signal to synchronize with signals of 10 cycles or 12 cycles.



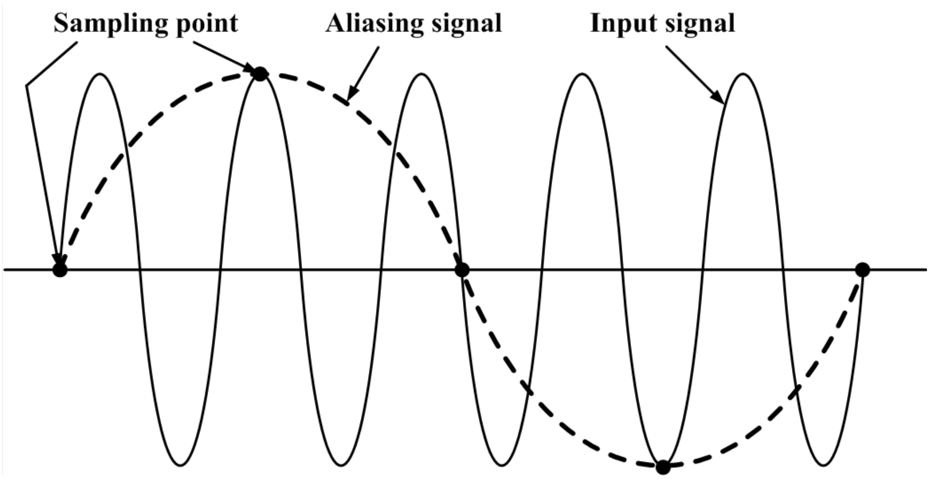
In simple terms, the reciprocal of the measurement window is the frequency resolution. Take the 50 Hz input signal as an example, analyzing the harmonics with 10 cycles of signal length means the harmonic analysis has 5Hz frequency resolution as the figure shown below. In the spectrum, each harmonic is divided into 10 equal parts and the component of each part is called inter-harmonic while the component smaller than the fundamental wave is called sub-harmonic. The same 60 Hz signal, analyzing the harmonics with 12 cycles of signal length also means to have a 5Hz frequency resolution.





Anti-aliasing filter

The measurement circuit has anti-aliasing filter design in it with cutoff frequency about 60kHz. See the block diagram in Appendix C. When the A/D convertor is sampling the frequency component 0.5 times higher than the sampling rate, if the circuit has no anti-aliasing filter, the sampled signal will be a low frequency component which is called aliasing signal as shown in the figure below. The aliasing causes harmonic measurement error and the error of each harmonic angle, thus the design of anti-aliasing filter is very important for harmonic measurement. The anti-aliasing filter can make the filter more robust and flexible, also make the harmonic and power measurement functions more reliable.



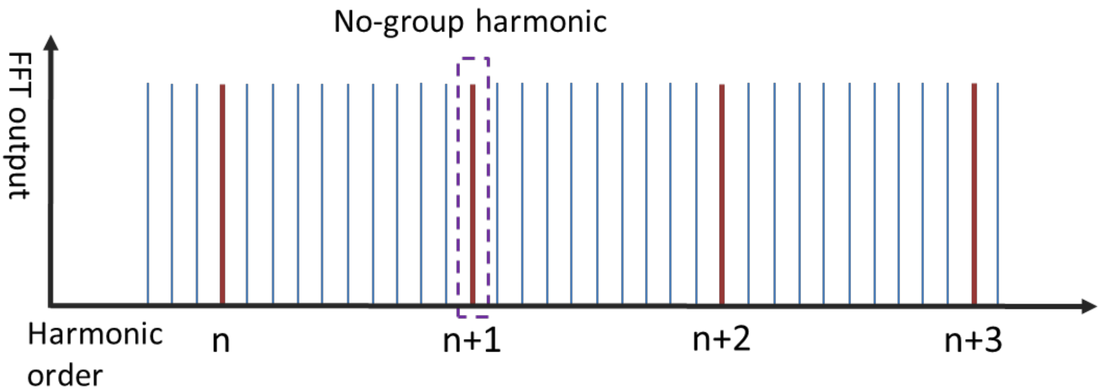
Definition of function

- **THD**
  The total harmonic distortion formula has Fundamental and Total two selections. Fundamental represents the formula using the fundamental wave as the denominator, and the THD may exceed 100%. Total represents the formula using the waveform total composition as the denominator, and the THD does not exceed 100%. The default is set to Fundamental.

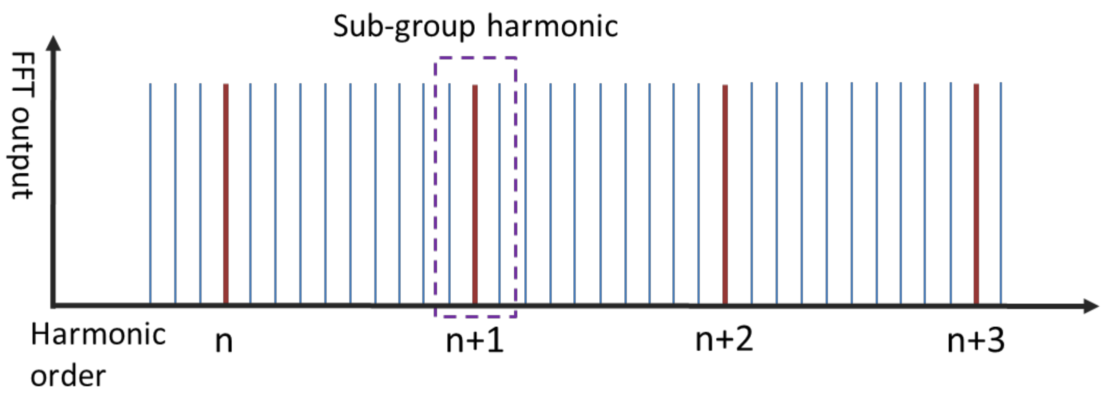
- **Order**
  It sets the upper limit of THD order. The range is 2~100, and the default is 40 orders.

- **Group**
  There are three types of groups for grouping the FFT analyzed components, which are OFF (no group), TYPE1 (sub-group) and TYPE2 (group) as described below.

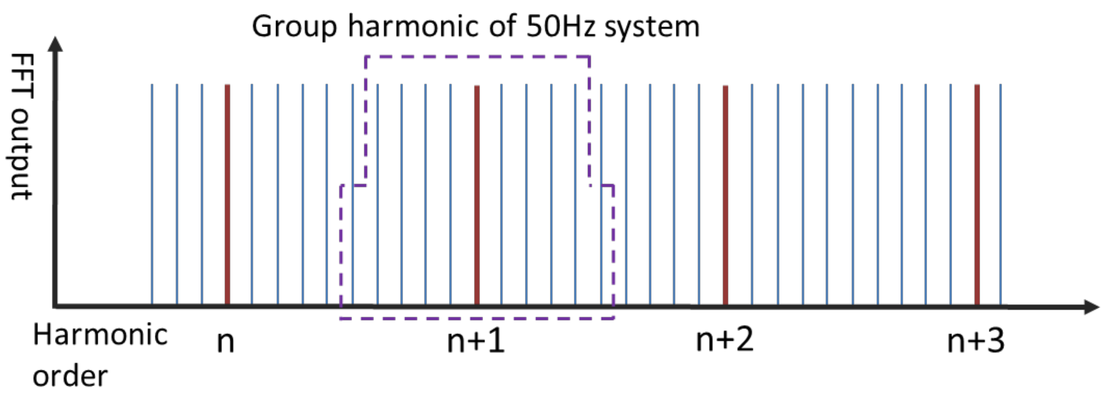
  - **OFF (No group)**
    The harmonics that are not grouped containing only the harmonics of fundamental wave integer multiple. Thus, the harmonic and subharmonic are not included. The total harmonic distortion is the ratio of the rms sum of harmonics of fundamental wave integer multiple to the fundamental wave rms.

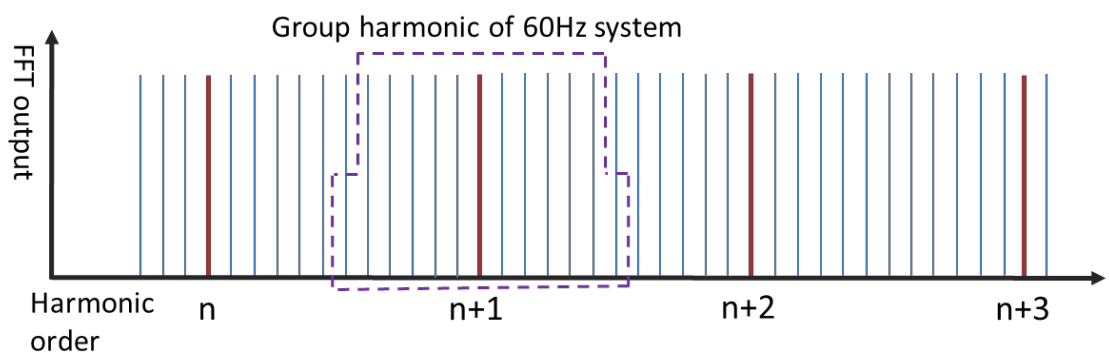


  - **TYPE1 (subgroup harmonic)**
    The subgroup harmonic is defined as the figure shown below. The subgroup harmonic rms is bigger than the no group harmonic. The total harmonic distortion is the ratio of subgroup harmonic rms total and subgroup fundamental wave rms.

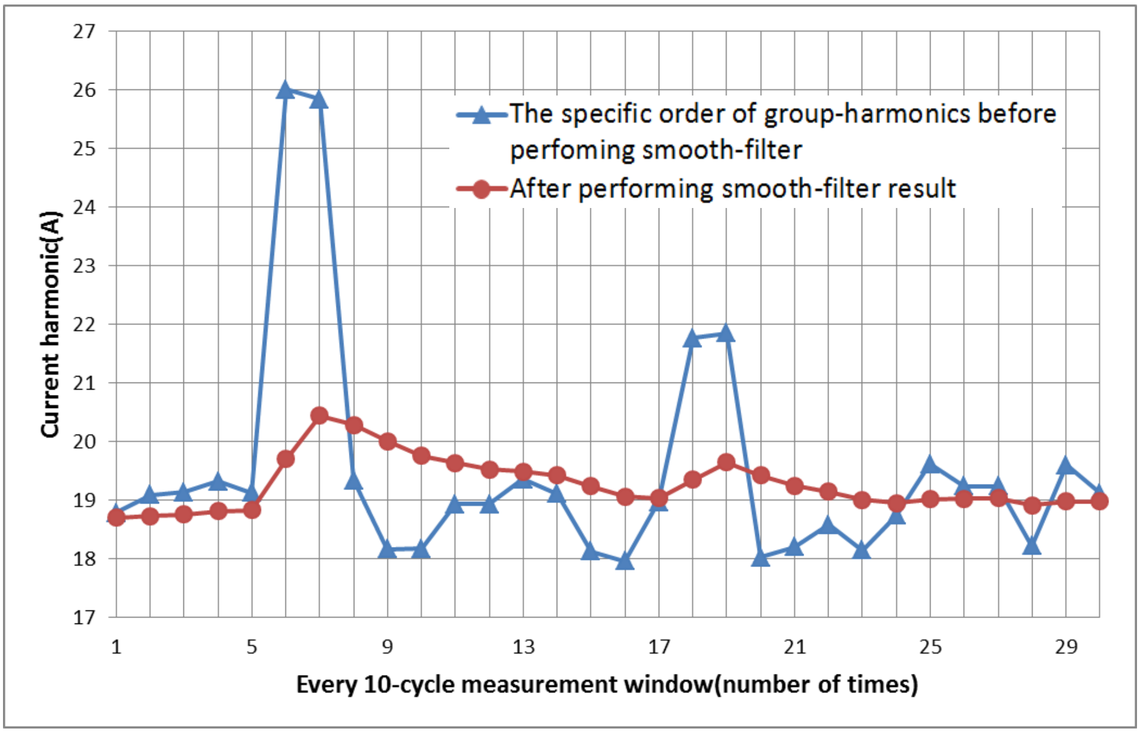


- **TYPE2 (group harmonic)**
  The definitions of group harmonic for different frequency power systems are slightly different as shown in the figure below. The rms of group harmonic is bigger than the no group harmonic and subgroup harmonic. The total harmonic distortion is the ratio of group harmonic rms total and group fundamental wave rms.





■ **Smooth**
A smoothing is performed over the rms 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. For example, a smoothing filter applies to the 30 measurement values of the certain group-harmonic (such as the third order), the result is shown the figure as below.



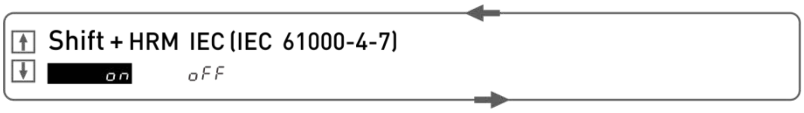
- **Display**

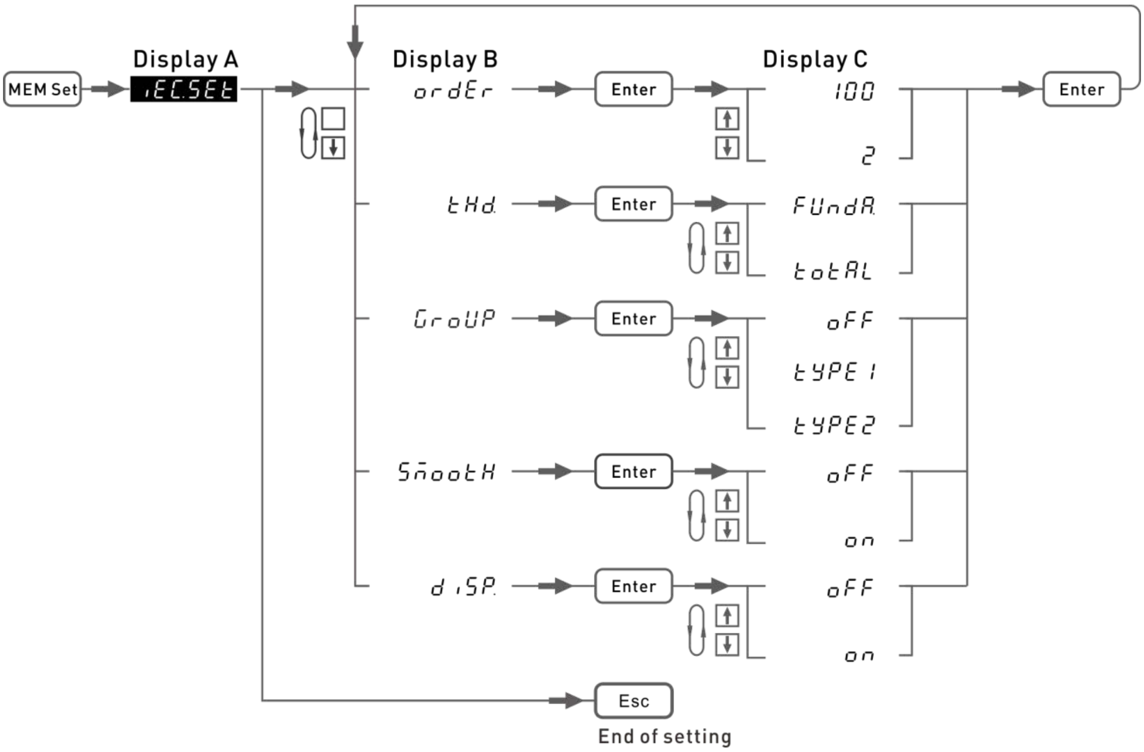
  When the display is set to ON, it can check the amplitude, angle and distortion percentage of each harmonic order. When the display is set to OFF, the V% and A% indicators indicate the THD of voltage and current. The rest indicators represent the rms of common measurement parameters.

Display on		
	Parameter	**Description**
Display A	-	The selected order.
Display B	V	The voltage rms of display A harmonic order.
	A	The current rms of display A harmonic order.
	W	The power rms of display A harmonic order.
	PF	The power factor of display A harmonic order.
	V °	The voltage angle of display A harmonic order that refers to the fundamental voltage angle.
	V%	The voltage distortion factor of display A harmonic order that refers to the fundamental voltage rms.
	A °	The current distortion factor of display A harmonic order that refers to the fundamental current angle.
	A%	The current distortion factor of display A harmonic order that refers to the fundamental current rms.
	W%	The power distortion factor of display A harmonic order that refers to the fundamental power rms.
Display C	V, A, W, var	Total RMS voltage, total RMS current, total active power and total reactive power.
Display D	V, A, W, var	Total RMS voltage, total RMS current and total active power.
	PF	Fundamental power factor.
	VHz	Voltage frequency.

	AHz	Current frequency.
	V%	Voltage total harmonic distortion rate.
	A%	Current total harmonic distortion rate.
	W%	Power total harmonic distortion rate.

Procedure





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 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.
3. The voltage and current total harmonic order need to be set at the same time. The 66205 Digital Power Meter does not provide the function to set them separately.

9.2 Normal Harmonic Measurement Mode

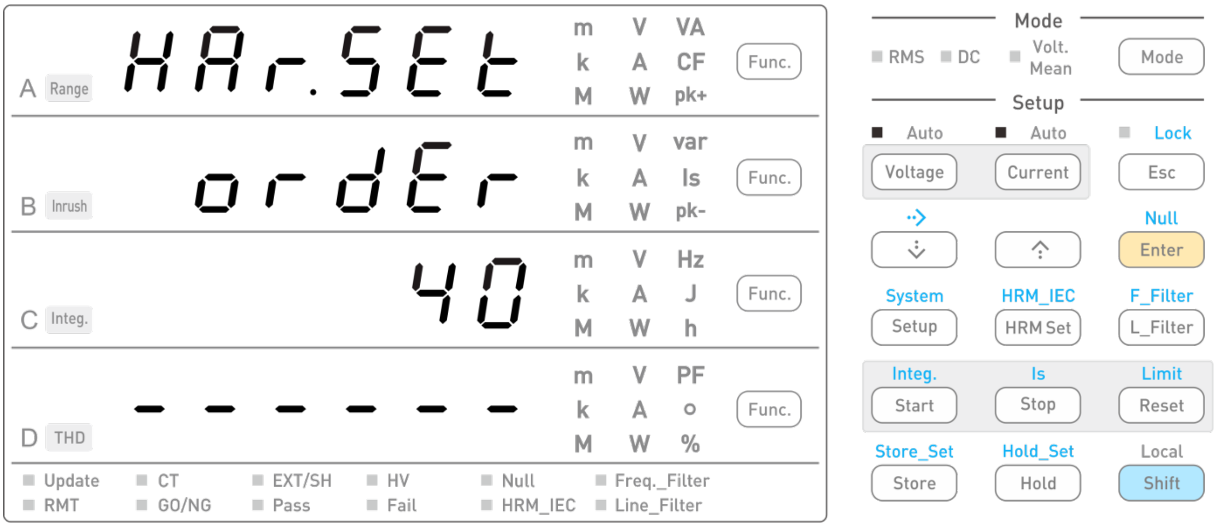


Figure 9-2 Normal Harmonic Measurement Setup Screen

The fundamental wave cycles of sync signal source defines the measurement window for measuring harmonic. The FFT uses rectangular window type to analyze the harmonic using the length of 4096 sampling points. The harmonic measurement in normal mode will trace the fundamental frequency change of sync signal to adjust the sample rate for integer cycle (rectangular window) analysis. The measured value of normal harmonic measurement is updated based on the display update rate. See section 5.3.2 Display Update Rate for the detailed information.

The fundamental frequency of sync signal source is obtained by the internal zero crossing circuit and the frequency calculation module. The digital signal processor (DSP) calculates the sampling rate and uses the analog / digital converter to get samples from the voltage or current signal. Send the sampled data back to DSP for FFT conversion to get the fundamental wave as well as the rms of every harmonic order and then calculate the THD.

However, since the speed of the extracted waveform sample rate is limited, the larger number of measurement cycles is required as the fundamental frequency increases. The figure shown below is the number of valid cycles relative to the fundamental frequency. If the number of cycles set is insufficient, the analysis mechanism will automatically adjust to the valid cycles to sustain 4096 sampling points rectangular window FFT analysis so that the harmonic measurement results will not go wrong.

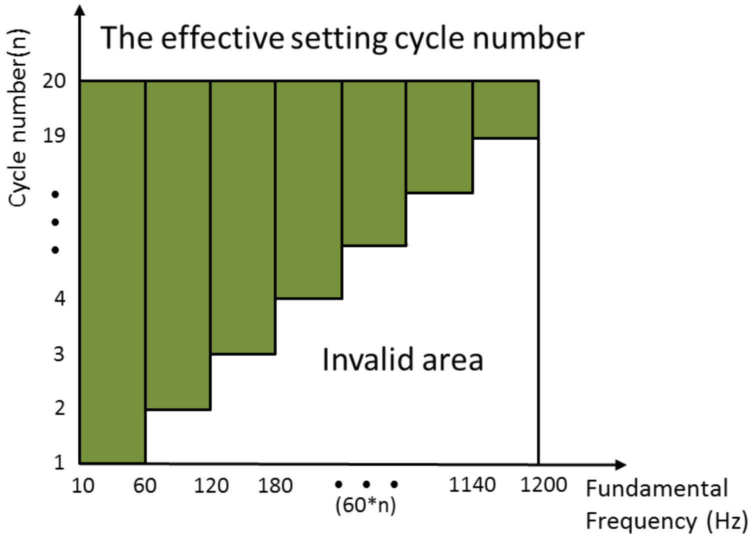
<table>
<tr><th colspan="5">Sample rate, window width, and upper limit of measured order</th></tr>
<tr><th rowspan="2">Fundamental Frequency (Hz)</th><th rowspan="2">Sample Rate (S/sec)</th><th rowspan="2">Measuring Window Width (cycle)</th><th colspan="2">Upper Limit of the Measured Order</th></tr>
<tr><th>Filter on</th><th>Filter off</th></tr>
<tr><td>10 to 60</td><td rowspan="9">(f×4096) / cycle</td><td rowspan="9">See the figure of the effective setting cycle number</td><td>100</td><td>100</td></tr>
<tr><td>60 to 120</td><td>50</td><td>80</td></tr>
<tr><td>120 to 180</td><td>37</td><td>50</td></tr>
<tr><td>180 to 240</td><td>28</td><td>40</td></tr>
<tr><td>240 to 300</td><td>22</td><td>30</td></tr>
<tr><td>300 to 360</td><td>17</td><td>25</td></tr>
<tr><td>360 to 480</td><td>14</td><td>20</td></tr>
<tr><td>480 to 720</td><td>9</td><td>10</td></tr>
<tr><td>720 to 1200</td><td>5</td><td>5</td></tr>
</table>

Definition of function

■ THD
The total harmonic distortion formula has Fundamental and Total two selections. Fundamental represents the formula using the fundamental wave as the denominator, and the THD may exceed 100%. Total represents the formula using the waveform total composition as the denominator, and the THD does not exceed 100%. The default is set to Fundamental.

■ Order
It sets the upper limit of THD order. The range is 2~100, and the default is 40 orders.

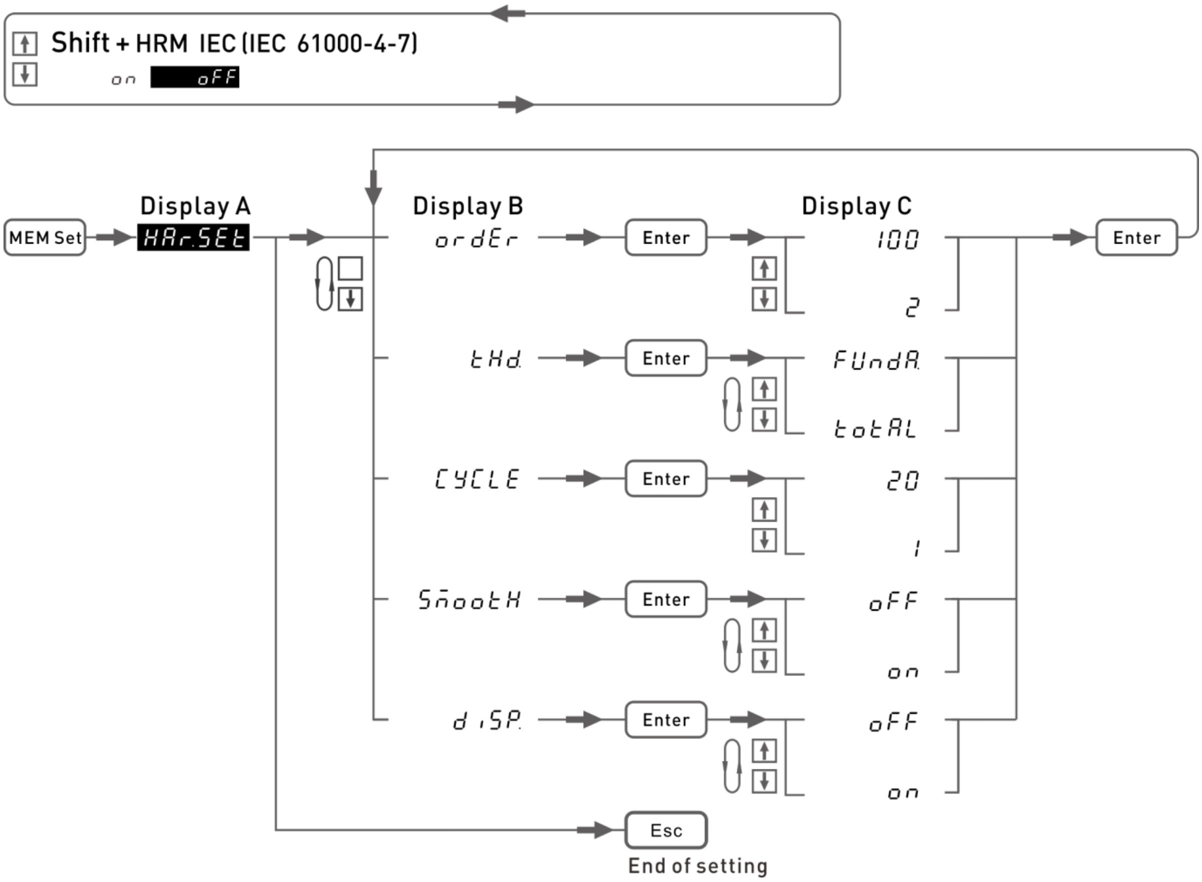
■ Cycle
When measuring fluctuating harmonic, it is suggested to use the standard IEC harmonic measurement mode compliant with IEC 61000-4-7 (10 cycles for 50Hz power system and 12 cycles for 60Hz power system). To speed up the measurement, it can use non-standard harmonic measurement mode to reduce the cycles of harmonic analysis. The cycles range for setting is 1~20 and the default is 1. The measurable harmonic order will decrease as the cycle increases. Detailed information is listed in the table below.



■ Smooth
Same as the Smooth function in standard harmonic measurement.

■ Display
Same as the Display function in standard harmonic measurement.

Procedure



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 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.
3. The voltage and current total harmonic order need to be set at the same time. The 66205 Digital Power Meter does not provide the function to set them separately.

10. Hold Function

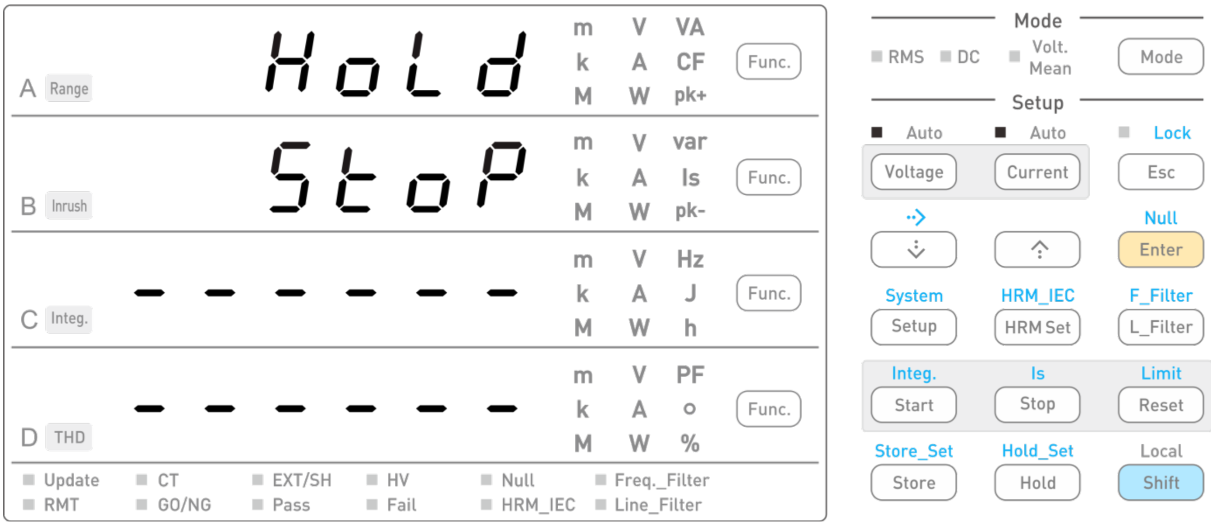


Figure 10-1 Hold Setup Screen

The Hold function instead of stops the measurement but freezes the measured value that displays on the main screen within the time set. It has Stop, Max and Min three functions available for use.

Definition of function

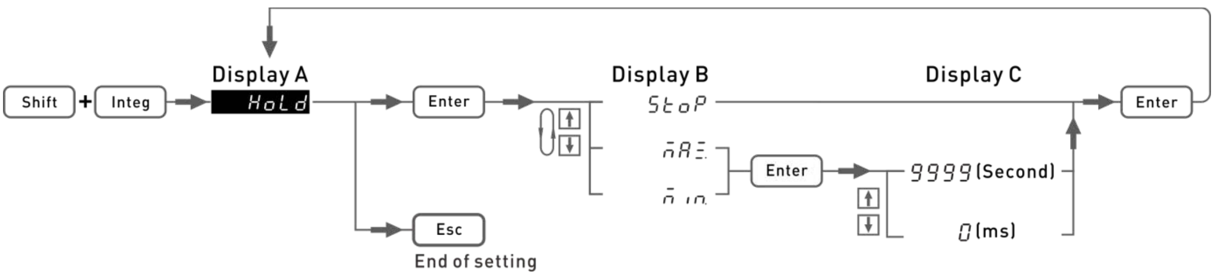
- Stop
  It immediately freezes the measured value on the main screen.

- Max
  It freezes the maximum measured value within the time set. The time range is 0s~9999s. The time is unlimited if set to 0.

- Min
  It freezes the minimum measured value within the time set. The time range is 0s~9999s. The time is unlimited if set to 0.

Procedure

- Setting parameter



- Operation
  - Trigger
    Press Hold to start hold function and the Hold key blinks.

- End
  When the upper limit of time count is met, the buzzer will beep once. The Hold stops blinking and keeps the light on indicating the Hold function is done.
- Reset
  When hold is done, press Hold key again to reset it. The Hold key light is off.

Notice When the harmonic measurement displays, only Stop can be used for Hold function, Max and Min are invalid.

11. Storing Measured Data

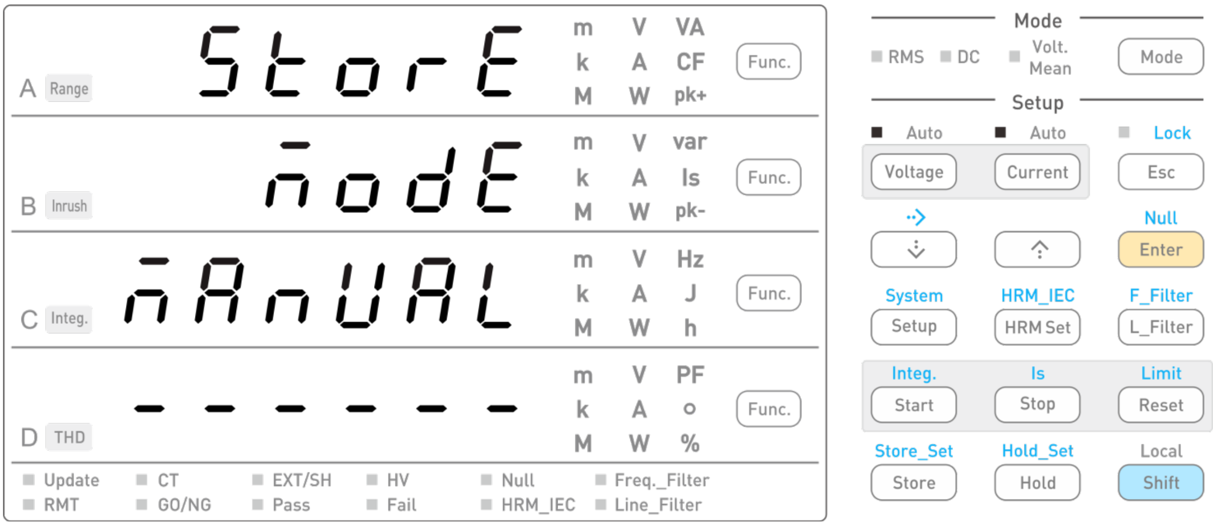
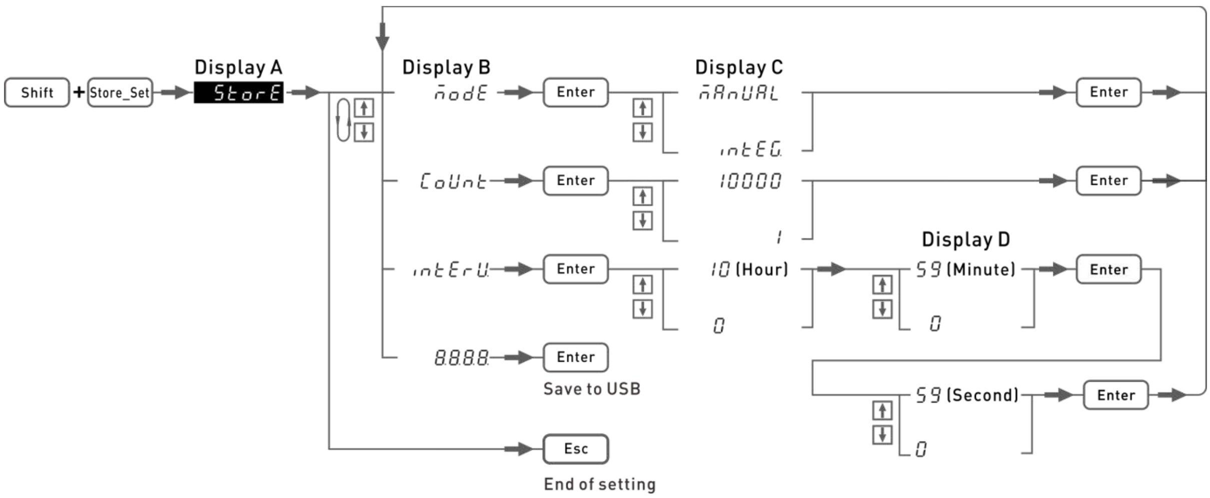


Figure 11-1 Store Setup Screen

The Store function allows the user to record the measured data. Press Shift+Store to enter into Store function for setting. The recording starts after performing several simple settings of store mode, store count and store interval.

Procedure



11.1 Store Mode

Select the following two modes to start or end the store operation.

Manual

It sets manual mode for use. When Store is pressed, the measured data will followed the defined time interval and number of times to record on the internal memory.

- Start: Press Store to begin recording data, and the key blinks.
- End:
  - When the store count is met.
  - Press Store again during storing process.

Integ Sync

It sets to integration sync mode for use. When Intec is pressed, the measured data will follow the defined integration interval (repeat mode) and number of times to record on the internal memory. Every integration value is simultaneously recorded.

- Standby: Press Store and the key in on.
- Start: Press Start to begin integration calculation. The Start and Store keys will blink indicating the integration is calculating and recording.
- End:
  - When the record count is met.
  - Press Shift+Reset.
  - Press Stop to end the data recording procedure. The Store key stops blinking. Even if pressing the Start key to continue the integration calculation, the data will not be recorded.

11.2 Store Item

The Store parameters are not valid for setting except numeric data. It does not support waveform storage either. The Store parameters are defined as below.

Manual mode

Store Parameter						
V	Vdc	Vmean	Vpk+	Vpk-	CF_V	Hz_V
I	Idc	Ipk+	Ipk-	CF_I	Hz_I	
P	Pdc	S	Q	PF	φ	
V(k)	I(k)	P(k)	S(k)	Q(k)	PF(k)	
φ(k)	Vhdf(k)	Ihdf(k)	Phdf(k)	Vdeg(k)	Ideg(k)	

Integ Sync mode

Store Parameter			
V	I	P	PF
Wh	Ah	-	-

11.3 Store Count and Store Interval

Setting store count
The store count setting range is 1~10000 and the default is 1.

- Integ sync:
  - Set the integration mode to normal: The setting of store count x store interval should be greater than the integration time or the actual record count will be less than the set count.

- Set the integration mode to continuous: The record stops when the record count met the set count.

Setting store interval
The store interval setting format is hh:mm:ss and the setting range is 10h:59m:59s. The default is 00h:00m:01s。

- Integ sync:
  - The store interval should be set greater than the integration time or the value cannot be recorded.
  - The store interval of V, I, P, PF will be replaced by integration time, while Wh and Ah follows the store interval setting for recording.

11.4 Save Data to USB

When the Store procedure ends, it is necessary to save the internal memory data to external USB device to prevent the data from being cleared when performing next store procedure. When saving the data, it will automatically create a folder on the external USB device and save the files in it.

Data and file format
- File folder: 66205_Store
- File format: .CSV
- File name: 66205_Integration_000.csv or 66205_Numeric.csv
- Data type: ASCII

Notice

1. The storage time for storing data to USB is related to the data 66205 recorded. When executing Save Data to USB, it will prompt the percentage of saving progress.
2. Do not remove the device while storing the data into the USB device. Otherwise, it may cause data loss or system malfunction.
3. The data in the internal memory will be cleared when performing Store next time.
4. The data stored to the internal memory cannot be retained by the internal lithium battery. The data in internal memory is lost when the meter is powered off.
5. The power supply for the USB port on the front panel is rated at 5V / 1.9A.

12. Performing Auto-Null Procedure

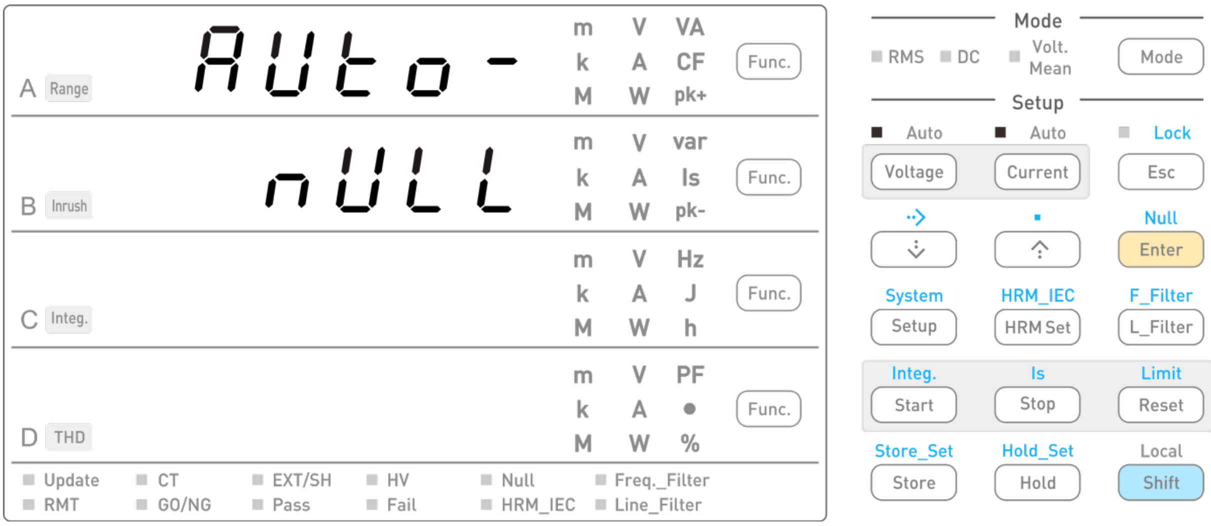


Figure 12-1 Auto-Null Procedure Setup Screen

When the current measurement circuit is disconnected and there is no current input to the 66205 current input terminal, the sampling data from A/D converter can get DC and AC components via Auto-Null function. When RMS, DC or VOLT.MEAN is set for current measurement, the calculation formula will deduct the Null data (DC or AC components) to zero the level before performing any testing. For the detailed of zero compensation operation, see section 5.3.7.

Procedure

- Step 1: Press Null (Shift + Enter) and Enter to enter into Auto-Null procedure.
- Step 2: Check if the input current signal (open circuit) has been removed. If yes, press Enter to continue.
- Step 3: Check if Auto-Null procedure is executing. Press Enter to start Auto-Null procedure.
- Step 4: Wait for Auto-Null procedure to complete. The Auto-Null progress is shown in percentage on Display D.
- Step 5: When the Display D shows Done, Auto-Null procedure is finished. Get the Null data and press Enter to return to the main screen.

Notice

1. When Auto-Null procedure is completed, the new Null data will override the previous compensation data.
2. The Null data is different from the model 66205 calibration data; therefore, it won't change the calibration data. Be sure to contact the distributor or service center of Chroma if calibration is required.
3. No other operation is allowed when performing Auto-Null procedure.
4. The internal Null data will not be cleared when the meter is powered off.

13. System Configuration

13.1 Checking Firmware, Digital Version and PCB Version

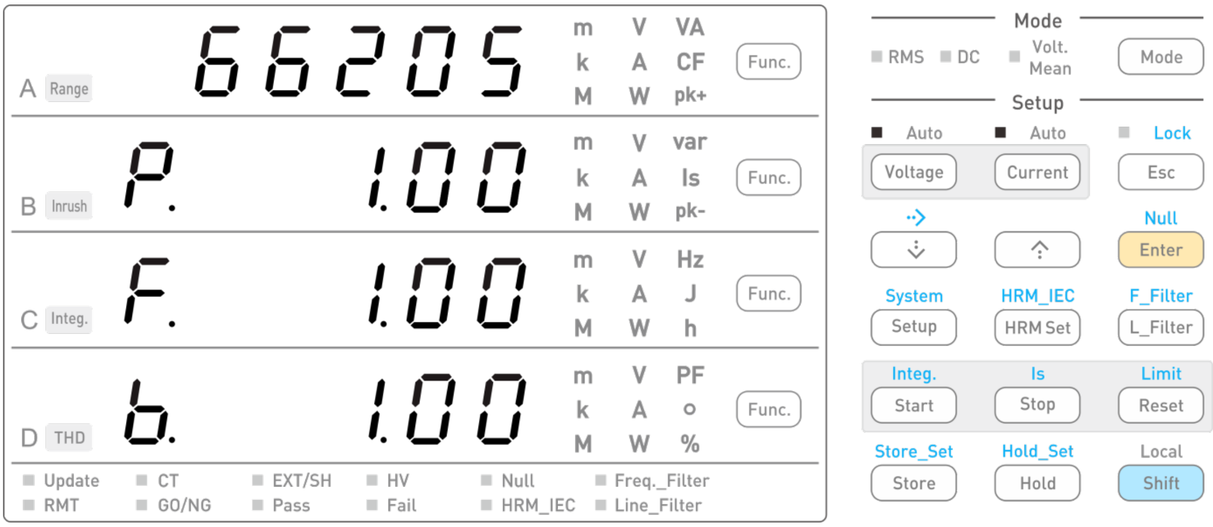
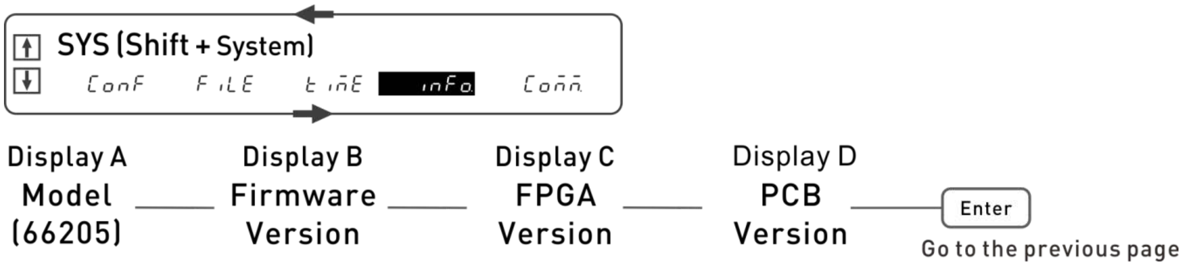


Figure 13-1 Firmware and Digital Version Check Screen

Procedure

- Press **System** (Shift + Setup) to enter system menu and select Info. It shows the firmware and digital program version (P for firmware version, F for digital version and PCB version.)
- Confirm the version and press **ESC** to return to the system menu for other configuration setting, or press **ESC** again to return to the measurement screen.



13.2 Setting Communication Address

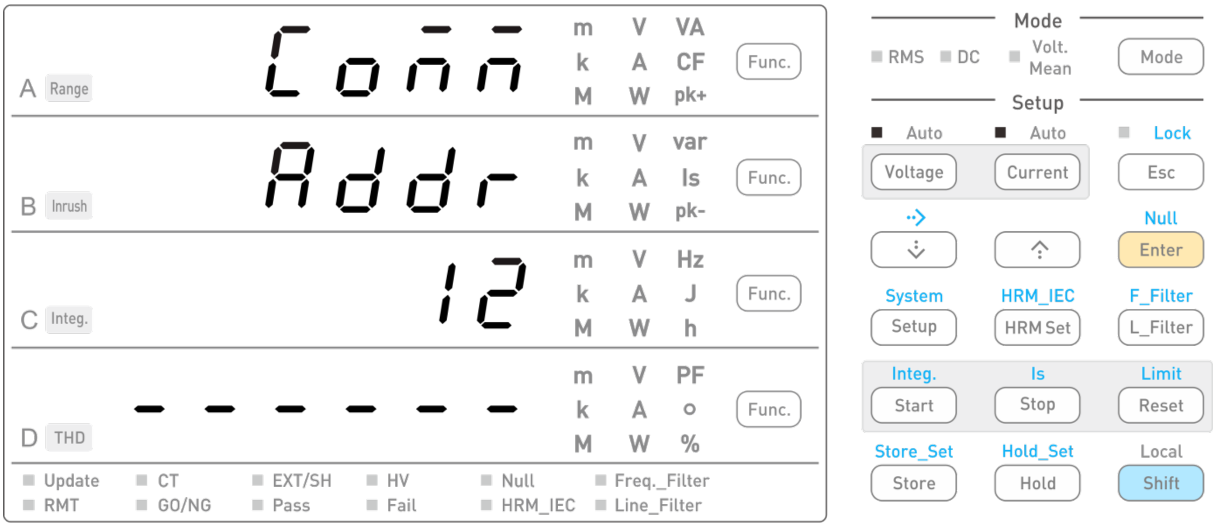
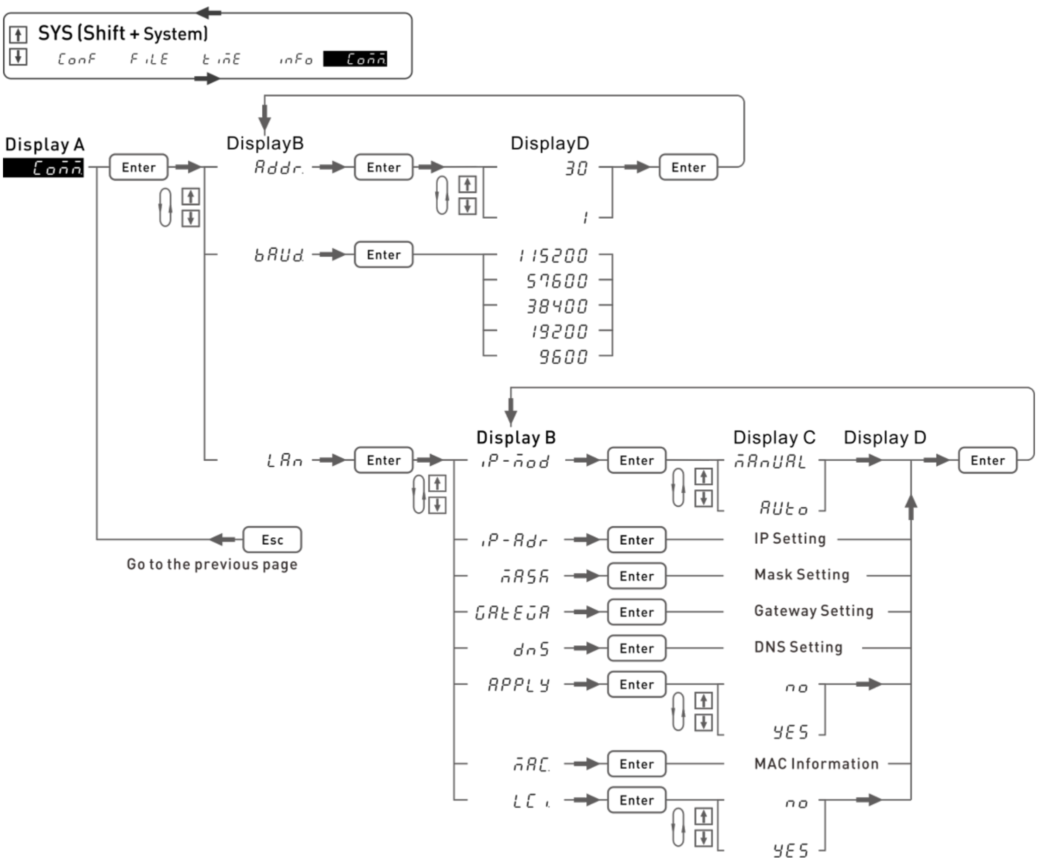


Figure 13-2 Communication Address Setup Screen

The model 66205 provides 4 kinds of communication interfaces which are GPIB, RS232, LAN and USB. The PC (host) can use these communication interfaces to remotely control the 66205 power meter.

Procedure

Press **Shift** + **Setup** to enter into the system menu and select Comm.



- Addr: It is GPIB address setting. Available setting range is 1 to 30. Default is setting
- Baud:
  - It is a baud rate setting of RS-232. There are five baud rate selections of 9600, 19200, 38400, 57600, 115200. The default setting is 19200.

  - Wire Connection: For RS-232 interface, only the signals of TxD and RxD are used for its transfer of data. The RS-232 connector is a 9-pin D subminiature male connector. The following table describes the pins and signals of RS-232 connector.

Pin Number	Description
1	-
2	RxD
3	TxD
4	-
5	GND
6	-
7	RTS
8	CTS
9	-

- LAN:
  - To use the Ethernet communication functions of the 66205, the IP address, mask, gateway, and DNS must be specified. Consult your system or network administrator when setting these parameters.

  - When MANUAL is set for IP MODE, the rest of the network settings will be applied. If AUTO is set for IP MODE, the rest of the network settings will be ignored. When the modifications are done, go to APPLY and choose YES to start updating the network configuration.

  - The LAN menu also shows the MAC address and LCI (LAN Configuration Initialize) settings. When YES is set for LCI, a confirmation screen will appear. Select YES again and the network settings will restore to default.

Notice The power connection of PC site (host) and the model 66205 (slave) is well grounded to avoid damaging the communication interface.

13.3 Setting Sound

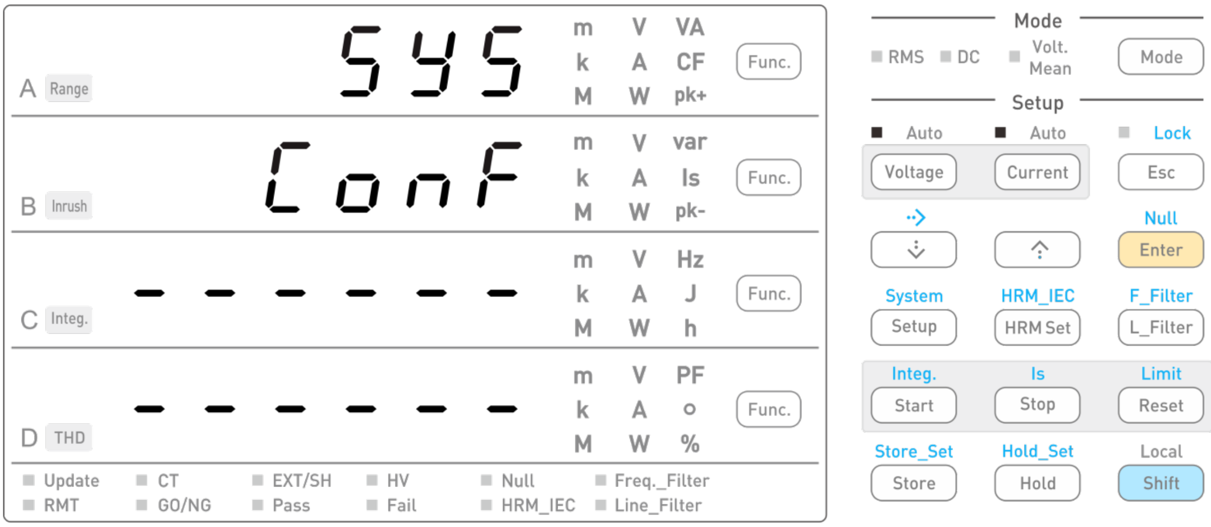
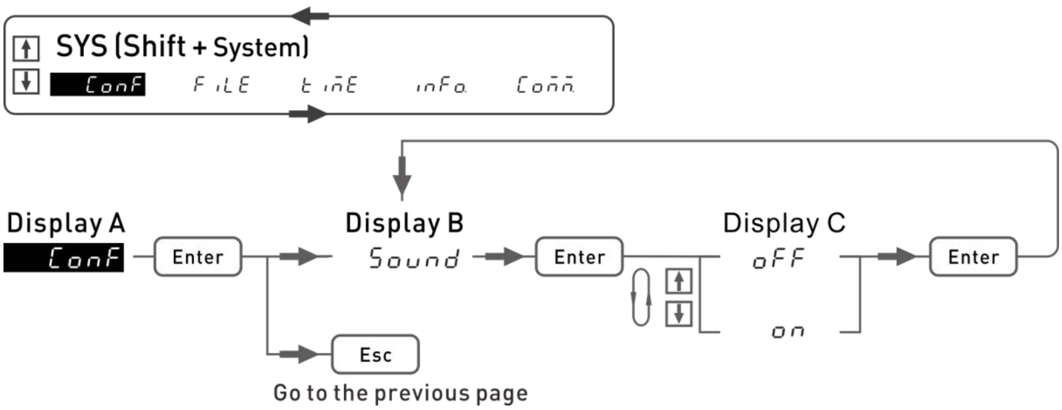


Figure 13-3 System Configuration Setup Screen

Procedure

- Press **Shift** + **Setup** to enter into the system menu and select ConF.
- Select Sound in the ConF. menu and use ↑, ↓ to set on or off and then press **Enter** to confirm it.
- Press **ESC** to return to the system menu for other configuration setting, or press **ESC** again to return to the measurement screen.



13.4 Saving and Recalling File

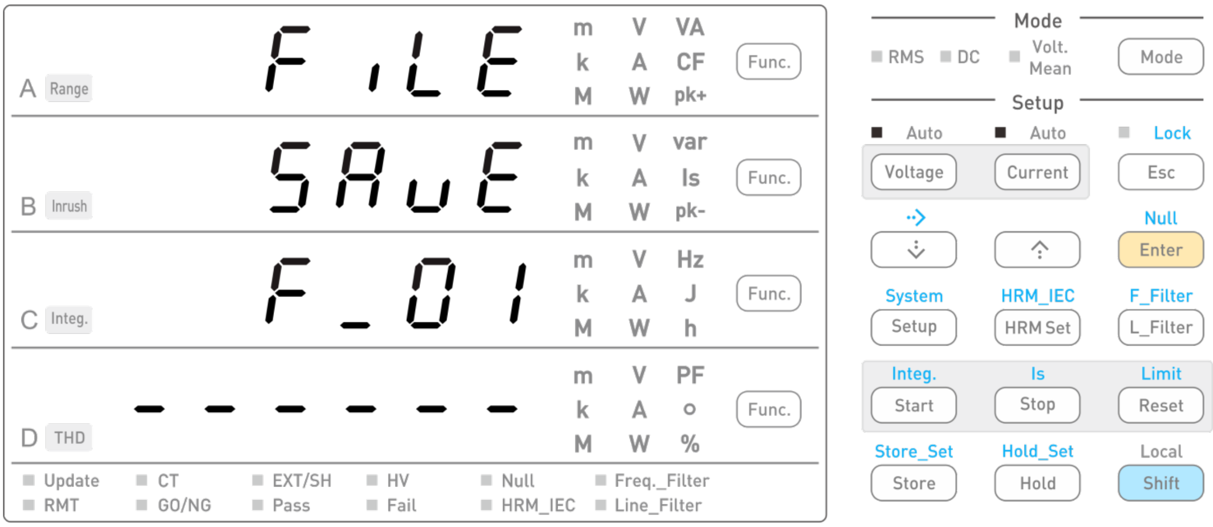
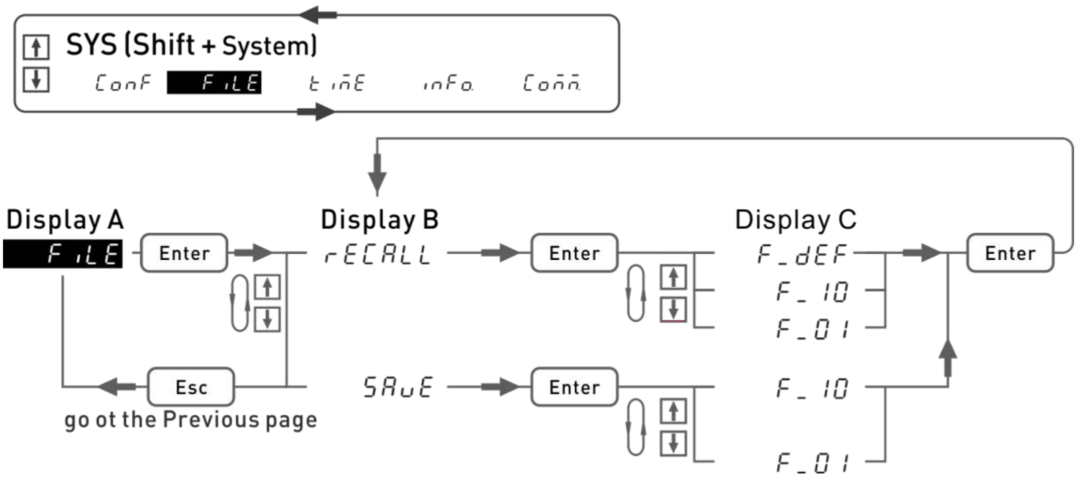


Figure 13-4 Save and Recall Setup Screen

The model 66205 provides 10 sets of Save and Recall for use. In addition F_def. can be recalled to return to default setting.

Procedure

- Press **Shift** + **Setup** to enter the system menu and select File to save and recall the file.
- Select Save in File menu and use ↑, ↓ to select one of F_01~F_10, and press **Enter** to save the setting. Press **ESC** to return to File menu, or press **ESC** again to return to the measurement screen.
- Select Recall in File menu and use ↑, ↓ to select one of F_01~F_10 or F_def., and press **Enter** to recall the setting and then return to the measurement screen.



13.5 Setting Time

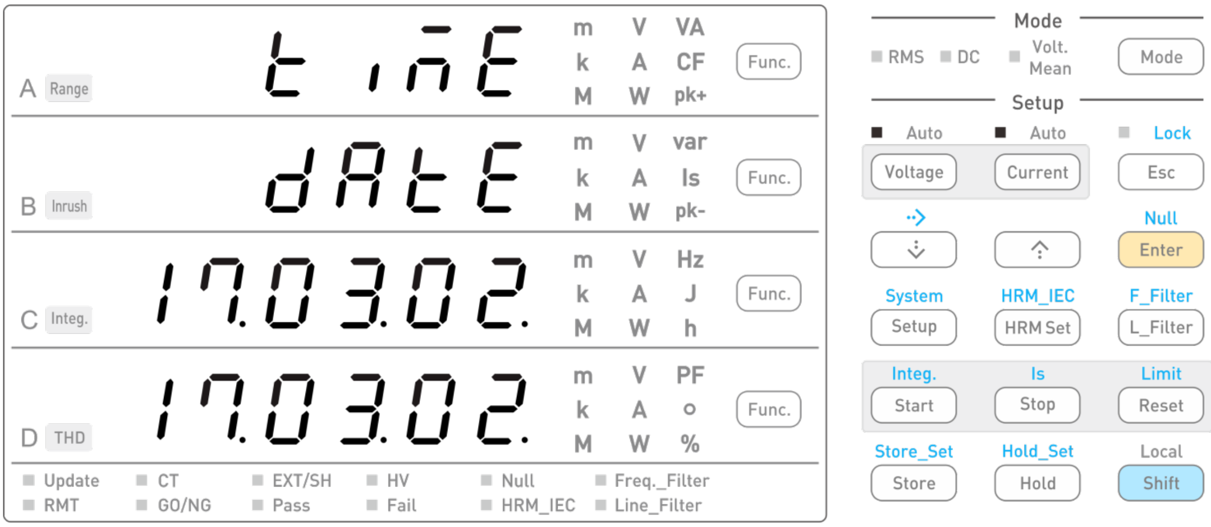
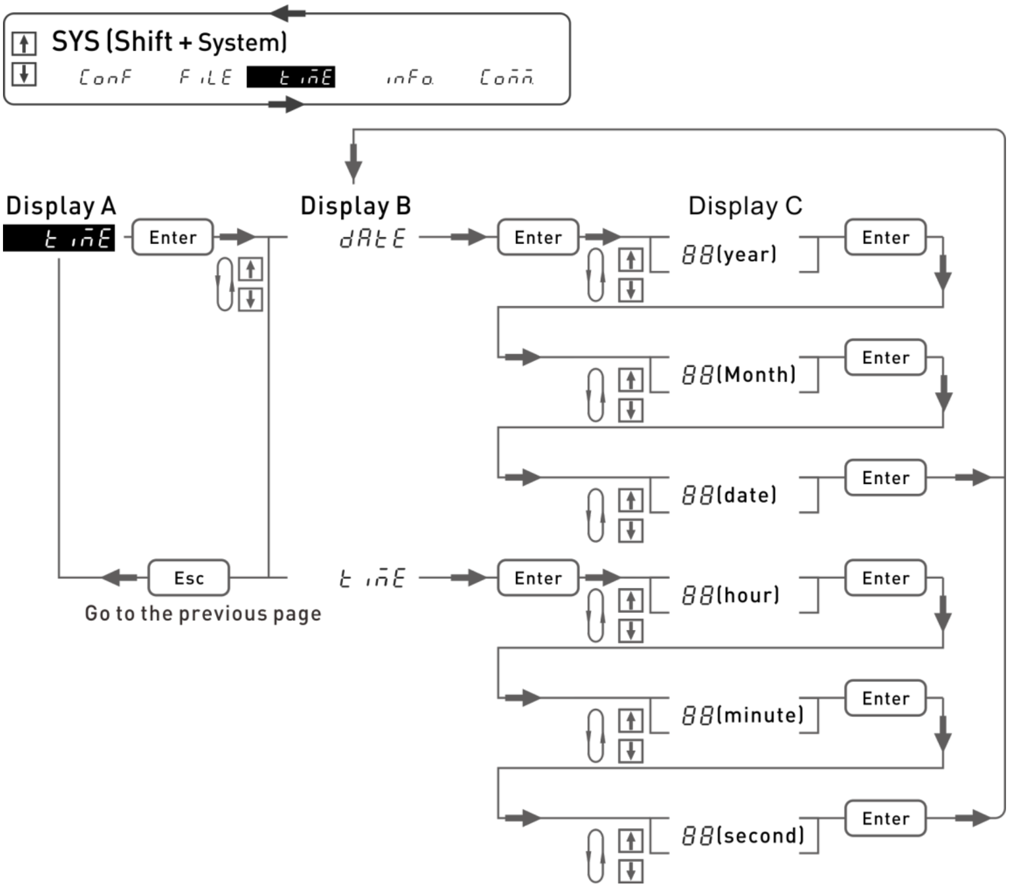


Figure 13-5 Time Setup Screen

Procedure

- Press **System** (Shift + Setup) to enter into the system menu and select Time for setting.
- Select Date in Time menu and set the date (yy:mm:dd). When done, it returns to Time menu.
- Select Time in Time menu and set the time (hh:mm:ss). When done, press **ESC** to return to the system menu for other configuration setting, or press **ESC** again to return to the measurement screen.



Notice

1. The date and time information is backed up with the lithium battery when the power is turned OFF.
2. The user cannot replace the battery. Contact the distributor or service center of Chroma to have the battery replaced.
3. The lithium battery specification: 3V nominal voltage; 225 mAh nominal capacity.

14. Using Remote Control

14.1 Overview

66205 provides GPIB, USB, Ethernet and RS232 four kinds of remote control interfaces and all functions of panel keys can be controlled by these four interfaces. The USB interface supports USB 2.0 / USB 1.1, while the GPIB interface is complied with IEEE-488 standard.

14.2 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 **66205** 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 **66205** 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

14.3 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

14.4 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.

14.4.1 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.

14.4.2 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 66205 Power Meter accepts the numerical data type listed in Table 14-1.

Table 14-1 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.

Arbitrary Block Data Format

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>

14.5 Basic Definition

14.5.1 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.

14.5.2 Program Headers

Program headers are key words that identify the command. They follow the syntax described in subsection 5.8 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.

Common Command and Query Headers:
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.

Instrument-Controlled Headers:
Instrument-controlled headers are used for all other instrument commands. Each of them has a long form and a short form. The 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 14.7.2 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.

14.5.3 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.

14.5.4 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

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

Example: ON;AUTO;110.01

Response Data Unit:
Example: ON or AUTO or 110.01 or 220.0 or VPK+

Response Data Unit Separator:
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; ...

Response Message Terminator (<RMT>):
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).

14.6 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.

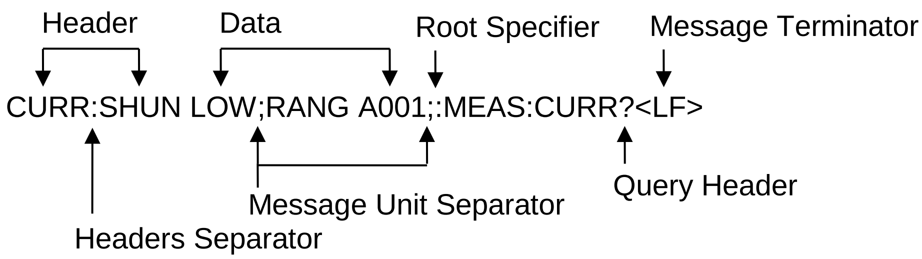


Figure 14-1 Structure of Program Message

14.7 Commands of the Power Meter

14.7.1 Standard Commands

***CLS**

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

***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.

Table 14-2 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
Query syntax: *ESE?<PMT>
Return parameters: <NR1>, 0 ~ 255
Header on: *ESE<space<NR1><RMT>
Header off: <NR1><RMT>
Example: *ESE 32
*ESE?

***ESR?**

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

***IDN?**

Description: This command queries manufacturer's name, model name, serial number and firmware version.
Setting syntax: none
Setting parameters: 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	66205
Serial number	66205A000066
F/W version	1.00
FPGA version	1.00
PCB version	1.00

Header on: <SRD><RMT>
Header off: <SRD><RMT>
Example: *IDN?

***RST**

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

***SRE**

Description: This command sets the service request enable register (SRER).
Setting syntax: *SRE<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 255
Query syntax: *SRE?<PMT>
Return parameters: <NR1>, 0 ~ 255
Header on: *SRE<space><NR1><RMT>
Header off: <NR1><RMT>
Example: *SRE 32
*SRE?

***STB?**

Description: This command queries the status byte register.

Table 14-3 Bit configuration of Status Byte Register

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

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

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

***TST?**

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

***SAV**

Description:	This command stores the present state of the configurtion in a specified memory location.
Setting syntax:	*SAV<space><NR1><PMT>
Setting parameters:	<NR1>, 1 ~ 10, 1~10: User define file
Query syntax:	none
Return parameters:	none
Example:	*SAV 2

***RCL**

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
Query syntax:	none
Return parameters:	none
Example:	*RCL 3

14.7.2 Instrument Commands

SYSTEM Sub-system

SYSTem:ERRor?

Description: This command queries the error string of this instrument.
Setting syntax: none
Setting parameters: none
Query syntax: SYSTem:ERRor?<PMT>
Return parameters: <SRD>,

0,No error	-200,Execution error	-277,Macro redefinition not allowed
-100,Command error	-201,Invalid while in local	-278,Macro header not found
-101,Invalid character	-202,Settings lost due to rtl	-280,Program error
-102,Syntax error	-203,Command protected	-281,Cannot create program
-103,Invalid separator	-210,Trigger error	-282,Illegal program name
-104,Data type error	-211,Trigger ignored	-283,Illegal variable name
-105,GET not allowed	-212,Arm ignored	-284,Program currently running
-108,Parameter not allowed	-213,Init ignored	-285,Program syntax error
-109,Missing parameter	-214,Trigger deadlock	-286,Program runtime error
-110,Command header error	-215,Arm deadlock	-290,Memory use error
-111,Header separator error	-220,Parameter error	-291,Out of memory
-112,Program mnemonic too long	-221,Settings conflict	-292,Referenced name does not exist
-113,Undefined header	-222,Data out of range	-293,Referenced name already exists
-114,Header suffix out of range	-223,Too much data	-294,Incompatible type
-115,Unexpected number of parameters	-224,Illegal parameter value	-300,Device-specific error
-120,Numeric data error	-225,Out of memory	-310,System error
-121,Invalid character in number	-226,Lists not same length	-311,Memory error
-123,Exponent too large	-230,Data corrupt or stale	-312,PUD memory lost
-124,Too many digits	-231,Data questionable	-313,Calibration memory lost
-128,Numeric data not allowed	-232,Invalid format	-314,Save/recall memory lost
-130,Suffix error	-233,Invalid version	-315,Configuration memory lost
-131,Invalid suffix	-240,Hardware error	-320,Storage fault
-134,Suffix too long	-241,Hardware missing	-321,Out of memory
-138,Suffix not allowed	-250,Mass storage error	-330,Self-test failed
-140,Character data error	-251,Missing mass storage	-340,Calibration failed
-141,Invalid character data	-252,Missing media	-350,Queue overflow
-144,Character data too long	-253,Corrupt media	-360,Communication error
-148,Character data not allowed	-254,Media full	-361,Parity error in program message
-150,String data error	-255,Directory full	-362,Framing error in program message
-151,Invalid string data	-256,File name not found	-363,Input buffer overrun
-158,String data not allowed	-257,File name error	-365,Time out error
-160,Block data error	-258,Media protected	-400,Query error
-161,Invalid block data	-260,Expression error	-410,Query INTERRUPTED
-168,Block data not allowed	-261,Math error in expression	-420,Query UNTERMINATED
-170,Expression error	-270,Macro error	-430,Query DEADLOCKED
-171,Invalid expression	-271,Macro syntax error	-440,Query UNTERMINATED after indefinite response
-178,Expression data not allowed	-272,Macro execution error	-500,Power on
-180,Macro error	-273,Illegal macro label	-600,User request
-181,Invalid outside macro definition	-274,Macro parameter error	-700,Request control
-183,Invalid inside macro definition	-275,Macro definition too long	-800,Operation complete
-184,Macro parameter error	-276,Macro recursion error	

Example: SYST:ERR?

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
Query syntax: SYSTem:HEADer?<PMT>
Return parameters: <CRD>, ON | OFF
Header on: :SYSTEM:HEADER<space><CRD><RMT>
Header off: <CRD><RMT>
Example: SYST:HEAD ON
SYST:HEAD?

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(;)
Query syntax: SYSTem:TRANsmit:SEParator?<PMT>
Return parameters: <NR1>, 0 ~ 1
Header on: :SYSTEM:TRANSMIT:SEPARATOR<space><NR1><RMT>
Header off: <NR1><RMT>
Example: SYST:TRAN:SEP 1
SYST:TRAN:SEP?

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
Query syntax: SYSTem:TRANsmit:TERMinator?<PMT>
Return parameters: <NR1>, 0 ~ 1
Header on: :SYSTEM:TRANSMIT:TERMINATOR<space><NR1><RMT>
Header off: <NR1><RMT>
Example: SYST:TRAN:TERM 0
SYST:TRAN:TERM?

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
Query syntax: SYSTem:VERsion?<PMT>
Return parameters: <NR2>, 1991.1
Header on: :SYSTEM:VERSION<space><NR2><RMT>
Header off: <NR2><RMT>
Example: SYST:VER?

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
Query syntax: none
Return parameters: none

Example: SYST:LOC

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 parameters: none
Query syntax: none
Return parameters: none
Example: SYST:REM

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
Query syntax: STATus:QUEStionable[:EVENt]?<PMT>
Return parameters: <NR1>, 0 ~ 65535
Example: STAT:QUES?

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
Query syntax: STATus:QUEStionable:CONDition?<PMT>
Return parameters: <NR1>, 0 ~ 65535
Example: STAT:QUES:COND?

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
Query syntax: STATus:QUEStionable:ENABle?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 65535
Example: STAT:QUES:ENAB 65535
STAT:QUES:ENAB?
STAT:QUES:ENAB? MAX

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.

Table 14-4 Bit Configuration of Questionable Status Register

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

OVR : Over voltage range.
OCR : Over current range.
OL : Over load.
Integrate RCE : Range change error when integrate mode running.
Inrush RCE : Range change error when inrush mode running.
FAN : Fan failure.

Setting syntax: STATus:QUEStionable:NTRansition<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 65535
Query syntax: STATus:QUEStionable:NTRansition?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 65535
Example: STAT:QUES:NTR 16383
STAT:QUES:NTR?
STAT:QUES:NTR? MAX

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
Query syntax: STATus:QUEStionable:PTRansition?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 65535
Example: STAT:QUES:PTR 255
STAT:QUES:PTR?
STAT:QUES:PTR? MAX

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
Query syntax: none
Return Parameters: none
Example: STAT:PRES

FETCH & MEASURE Sub-system

FETCh? {<CRD1>{,<CRD2>{, … {,<CRD18>}}}}}}
MEASure? {<CRD1>{,<CRD2>{, … {,<CRD18>}}}}}}

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、OL occur.

Setting syntax: none
Setting parameters: none
Query syntax:
FETCh?<PMT>
FETCh?<space><CRD>,<CRD>,…up to 18<PMT>
MEASure?<PMT>
MEASure?<space><CRD>,<CRD>,…up to 18<PMT>
Query parameters: <CRD>, V, VPK+, VPK-, THDV, I, IPK+, IPK-, IS, CFI, THDI, W, PF, VA, VAR, WH, FREQ, VDC, IDC, WDC, VMEAN, DEG, CFV, VHZ, IHZ, AH
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>;WH<space><NR2>;FREQ<space><NR2>;VDC<space><NR2>;IDC<space><NR2>;WDC<space><NR2>;VMEAN<space><NR2>;DEG<space><NR2>;CFV<space><NR2>;VHZ<space><NR2>;IHZ<space><NR2>;AH<space><NR2><RMT>

Header off:
<NR2>;<NR2>;<NR2>;<NR2>;<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>,<NR2>,<NR2>,<NR2>,<NR2><RMT>
Separator 1:
<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<NR2>;<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?
MEASure[:SCALar]:VOLTage:RMS?

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[:SCALar]:VOLTage:RMS?<PMT>
MEASure[:SCALar]:VOLTage:RMS?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:RMS<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:VOLT:RMS?
MEAS:VOLT:RMS?

FETCh[:SCALar]:VOLTage:PEAK+?
MEASure[:SCALar]:VOLTage:PEAK+?

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[:SCALar]:VOLTage:PEAK+?<PMT>
MEASure[:SCALar]:VOLTage:PEAK+?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:PEAK+<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:VOLT:PEAK+?
MEAS:VOLT:PEAK+?

FETCh[:SCALar]:VOLTage:PEAK-?
MEASure[:SCALar]:VOLTage:PEAK-?

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[:SCALar]:VOLTage:PEAK-?<PMT>
MEASure[:SCALar]:VOLTage:PEAK-?<PMT>
Query parameters: none
Return parameters: <NR2>

Header on: :FETCH:VOLTAGE:PEAK-<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:VOLT:PEAK-?
MEAS:VOLT:PEAK-?

FETCh[:SCALar]:VOLTage:DC?
MEASure[:SCALar]:VOLTage:DC?

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[:SCALar]:VOLTage:DC?<PMT>
MEASure[:SCALar]:VOLTage:DC?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:DC<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:VOLT:DC?
MEAS:VOLT:DC?

FETCh[:SCALar]:VOLTage:CREStfactor?
MEASure[:SCALar]:VOLTage:CREStfactor?

Description: These queries return the crest factor of voltage. The return could be -3 or <NR2>.
-3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:VOLTage:CREStfactor?<PMT>
MEASure[:SCALar]:VOLTage:CREStfactor?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:CRESTFACTOR<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:VOLT:CRES?
MEAS:VOLT:CRES?

FETCh[:SCALar]:VOLTage:MEAN?
MEASure[:SCALar]:VOLTage:MEAN?

Description: These queries return the voltage mean. The return could be -3 or <NR2>.
-3: Invalid data when OVR occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:VOLTage:MEAN?<PMT>
MEASure[:SCALar]:VOLTage:MEAN?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:VOLTAGE:MEAN<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:VOLT:MEAN?
MEAS:VOLT:MEAN?

FETCh[:SCALar]:VOLTage:THD?
MEASure[:SCALar]:VOLTage:THD?

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[:SCALar]:VOLTage:THD?<PMT> MEASure[:SCALar]:VOLTage:THD?<PMT>
Query parameters:	none
Return parameters:	<NR2>
Header on:	:FETCH:VOLTAGE:THD<space><NR2><RMT>
Header off:	<NR2><RMT>
Example:	FETC:VOLT:THD? MEAS:VOLT:THD?

FETCh[:SCALar]:VOLTage:FREQuency?
MEASure[:SCALar]:VOLTage:FREQuency?

Description:	These queries return the frequency of voltage signal in Hertz.
Setting syntax:	none
Setting parameters:	none
Query syntax:	FETCh[:SCALar]:VOLTage:FREQuency?<PMT> MEASure[:SCALar]:VOLTage:FREQuency?<PMT>
Query parameters:	none
Return parameters:	<NR2>
Header on:	:FETCH:VOLTAGE:FREQUENCY<space><NR2><RMT>
Header off:	<NR2><RMT>
Example:	FETC:VOLT:FREQ? MEAS:VOLT:FREQ?

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

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, OL occur.
Setting syntax:	none
Setting parameters:	none
Query syntax:	FETCh[:SCALar]:CURRent:RMS?<PMT> MEASure[:SCALar]:CURRent:RMS?<PMT>
Query parameters:	none
Return parameters:	<NR2>
Header on:	:FETCH:CURRENT:RMS<space><NR2><RMT>
Header off:	<NR2><RMT>
Example:	FETC:CURR:RMS? MEAS:CURR:RMS?

FETCh[:SCALar]:CURRent:PEAK+?
MEASure[:SCALar]:CURRent:PEAK+?

Description:	These queries return the plus value of peak current. The return could be -3 or <NR2>. -3: Invalid data when OCR、OL occur.
Setting syntax:	none
Setting parameters:	none
Query syntax:	FETCh[:SCALar]:CURRent:PEAK+?<PMT>

MEASure[:SCALar]:CURRent:PEAK+?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:PEAK+<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:PEAK+?
MEAS:CURR:PEAK+?

FETCh[:SCALar]:CURRent:PEAK-?
MEASure[:SCALar]:CURRent:PEAK-?

Description: These queries return the minus value of peak current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:PEAK-?<PMT>
MEASure[:SCALar]:CURRent:PEAK-?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:PEAK-<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:PEAK-?
MEAS:CURR:PEAK-?

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

Description: These queries return the DC current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:DC?<PMT>
MEASure[:SCALar]:CURRent:DC?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:DC<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:DC?
MEAS:CURR:DC?

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

Description: These queries return the inrush current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:INRush?<PMT>
MEASure[:SCALar]:CURRent:INRush?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:INRUSH<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:INR?
MEAS:CURR:INR?

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

Description: These queries return the crest factor of current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:CREStfactor?<PMT>
MEASure[:SCALar]:CURRent:CREStfactor?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:CRESTFACTOR<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:CRES?
MEAS:CURR:CRES?

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

Description: These queries return the total harmonic distortion of current. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:THD?<PMT>
MEASure[:SCALar]:CURRent:THD?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:THD<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:THD?
MEAS:CURR:THD?

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

Description: These queries return the frequency of current signal in Hertz.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:FREQuency?<PMT>
MEASure[:SCALar]:CURRent:FREQuency?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:CURRENT:FREQUENCY<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:CURR:FREQ?
MEAS:CURR:FREQ?

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

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、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:POWer:REAL?<PMT>
MEASure[:SCALar]:POWer:REAL?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:POWER:REAL<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:POW:REAL?
MEAS:POW:REAL?

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

Description: These queries return the power factor. The return could be -3 or <NR2>.
-3: Invalid data when OVR, OCR, OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:POWer:PFACtor?<PMT>
MEASure[:SCALar]:POWer:PFACtor?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:POWER:PFACTOR<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:POW:PFAC?
MEAS:POW:PFAC?

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

Description: These queries return the apparent power. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:POWer:APParent?<PMT>
MEASure[:SCALar]:POWer:APParent?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:POWER:APPARENT<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:POW:APP?
MEAS:POW:APP?

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

Description: These queries return the reactive power. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:POWer:REACtive?<PMT>
MEASure[:SCALar]:POWer:REACtive?<PMT>
Query parameters: none

Return parameters: <NR2>
Header on: :FETCH:POWER:REACTIVE<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:POW:REAC?
MEAS:POW:REAC?

FETCh[:SCALar]:POWer:DC?
MEASure[:SCALar]:POWer:DC?

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、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:POWer:DC?<PMT>
MEASure[:SCALar]:POWer:DC?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:POWER:DC<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:POW:DC?
MEAS:POW:DC?

FETCh[:SCALar]:ENERgy:WH?
MEASure[:SCALar]:ENERgy:WH?

Description: These queries return the energy in watt hour. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OL occur.
Setting syntax : none
Setting parameters: none
Query syntax: FETCh[:SCALar]:ENERgy:WH?<PMT>
MEASure[:SCALar]:ENERgy:WH?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:ENERGY:WH<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:ENER:WH?
MEAS:ENER:WH?

FETCh[:SCALar]:ENERgy:AH?
MEASure[:SCALar]:ENERgy:AH?

Description: These queries return the energy in ampere hour. The return could be -3 or <NR2>.
-3: Invalid data when OVR、OCR、OL occur.
Setting syntax : none
Setting parameters: none
Query syntax: FETCh[:SCALar]:ENERgy:AH?<PMT>
MEASure[:SCALar]:ENERgy:AH?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:ENERGY:AH<space><NR2><RMT>

Header off: <NR2><RMT>
Example: FETC:ENER:AH?
MEAS:ENER:AH?

FETCh[:SCALar]:FREQuency?
MEASure[:SCALar]:FREQuency?

Description: These queries return the frequency of signal in Hertz.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:FREQuency?<PMT>
MEASure[:SCALar]:FREQuency?<PMT>
Query parameters: none
Return parameters: <NR2>
Header on: :FETCH:FREQUENCY<space><NR2><RMT>
Header off: <NR2><RMT>
Example: FETC:FREQ?
MEAS:FREQ?

FETCh[:SCALar]:VOLTage:HARMonic:ARRay? <CRD>
MEASure[:SCALar]:VOLTage:HARMonic:ARRay? <CRD>

Description: These queries return the amplitude or percentage or degree 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[:SCALar]:VOLTage:HARMonic:ARRay?<space><CRD><PMT>
MEASure[:SCALar]:VOLTage:HARMonic:ARRay?<space><CRD><PMT>
Query parameters: <CRD>, VALUE | PERCENT | PHASE
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: FETC:VOLT:HARM:ARR? VALUE
MEAS:VOLT:HARM:ARR? PERCENT
FETC:VOLT:HARM:ARR? PHASE

FETCh[:SCALar]:CURRent:HARMonic:ARRay? <CRD>
MEASure[:SCALar]:CURRent:HARMonic:ARRay? <CRD>

Description: These queries return the amplitude or percentage or degree of all the harmonic order. The return could be -3 or <NR2>.
-3: Invalid data when OCR、OL occur.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh[:SCALar]:CURRent:HARMonic:ARRay?<space><CRD><PMT>
MEASure[:SCALar]:CURRent:HARMonic:ARRay?<space><CRD><PMT>
Query parameters: <CRD>, VALUE | PERCENT | PHASE
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: FETC:CURR:HARM:ARR? PERCENT
MEAS:CURR:HARM:ARR? VALUE
FETC:CURR:HARM:ARR? PHASE

FETCh[:SCALar]:HARMonic:ARRay?
MEASure[:SCALar]:HARMonic:ARRay?

Description: These queries return the total parameters of harmonic meaurement.
Setting syntax: none
Setting parameters: none
Query syntax: FETCh:HARMonic:ARRay?<PMT>
MEASure:HARMonic:ARRay?<PMT>
Query parameters: none
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

Description: This command sets the GPIB address.
Setting syntax: [COMMunicate:]ADDRess:GPIB<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 30
Query syntax: [COMMunicate:]ADDRess:GPIB?<PMT>
Return parameters: <NR1>, 1 ~ 30
Header on: :ADDRESS:GPIB<space><NR1><RMT>
Header off: <NR1><RMT>
Example: ADDR:GPIB 8
ADDR:GPIB?

[COMMunicate:]BAUDrate:ASRL

Description: This command sets the baudrate of ASRL.
Setting syntax: [COMMunicate:]BAUDrate:ASRL<space><NR1><PMT>

Setting parameters: <NR1>, 9600 | 19200 | 38400 | 57600 | 115200
Query syntax: [COMMunicate:]BAUDrate:ASRL?<PMT>
Return parameters: <NR1>, 9600 | 19200 | 38400 | 57600 | 115200
    Header on: :BAUDRATE:ASRL<space><NR1><RMT>
    Header off: <NR1><RMT>
Example: BAUD:ASRL 38400
    BAUD:ASRL?

CONFIGURE Sub-system

[CONFigure:]VOLTage:RANGe

Description: This command sets the voltage range of measure.
Setting syntax: [CONFigure:]VOLTage:RANGe<space><CRD><PMT>
Setting parameters: <CRD>, AUTO | V600 | V300 | V150 | V60 | V30 | V15
Query syntax: [CONFigure:]VOLTage:RANGe?<PMT>
Return parameters: <CRD>, V600 | V300 | V150 | V60 | V30 | V15
    Header on: :VOLTAGE:RANGE<space><CRD><RMT>
    Header off: <CRD><RMT>
Example: VOLT:RANG V150
    VOLT:RANG?

[CONFigure:]CURRent:RANGe

Description: This command sets the current range of measure.
Setting syntax: [CONFigure:]CURRent:RANGe<space><CRD><PMT>
Setting parameters: <CRD>
    External shunt off:
        AUTO | A30 | A20 | A5 | A2 | A05 | A03 | A02 | A005 | A002 | A0005
    External shunt on:
        AUTO | E015 | E01 | E005 | E0025 | E001
Query syntax: [CONFigure:]CURRent:RANGe?<PMT>
Return parameters: <CRD>,
    External shunt off: A30 | A20 | A5 | A2 | A05 | A03 | A02 | A005 | A002 | A0005
    External shunt on: E015 | E01 | E005 | E0025 | E001
    Header on: :CURRENT:RANGE<space><CRD><RMT>
    Header off: <CRD><RMT>
Example: CURR:RANG A2
    CURR:RANG?

[CONFigure:]MEASure:MODE

Description: This command sets the mode of measurement.
Setting syntax: [CONFigure:]MEASure:MODE<space><CRD><PMT>
Setting parameters: <CRD>, RMS | DC | VMEAN
Query syntax: [CONFigure:]MEASure:MODE?<PMT>
Return parameters: <CRD>, RMS | DC | VMEAN
    Header on: :MEASURE:MODE<space><CRD><RMT>
    Header off: <CRD><RMT>
Example: MEAS:MODE RMS
    MEAS:MODE?

[CONFigure:]MEASure:AVERage

Description: This command sets the number of measurements over which the average calculation is to be performed.
Setting syntax: [CONFigure:]MEASure:AVERage<space><NR1><PMT>

Setting parameters: <NR1>, 1 | 4 | 8 | 16 | 32 | 64
Query syntax: [CONFigure:]MEASure:AVERage?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 | 4 | 8 | 16 | 32 | 64
Header on: :MEASURE:AVERAGE<space><NR1><RMT>
Header off: <NR1><RMT>
Example: MEAS:AVER 16
MEAS:AVER?
MEAS:AVER? MAX

[CONFigure:]MEASure:UPDate

Description: This command sets the time of measure in second over which the data calculation is to be performed.
Setting syntax: [CONFigure:]MEASure:UPDate<space><NR2><PMT>
Setting parameters: <NR2>, 0.05 | 0.1 | 0.25 | 0.5 | 1 | 2 | 5 | 10
Query syntax: [CONFigure:]MEASure:UPDate?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 0.05 | 0.1 | 0.25 | 0.5 | 1 | 2 | 5 | 10
Header on: :MEASURE:UPDATE<space><NR2><RMT>
Header off: <NR2><RMT>
Example: MEAS:UPD 0.5
MEAS:UPD?
MEAS:UPD? MAX

[CONFigure:]FILTer[:LINE]

Description: This command is used to select bandwidth of digital low pass filter on input signal path.
Setting syntax: [CONFigure:]FILTer[:LINE]<space><CRD><PMT>
Setting parameters: <CRD>, OFF | BW500 | BW5500
Query syntax: [CONFigure:]FILTer[:LINE]?<PMT>
Return parameters: <CRD>, OFF | BW500 | BW5500
Header on: :FILTER<space><CRD><RMT>
Header off: <CRD><RMT>
Example: FILT BW5500
FILT?

[CONFigure:]FILTer:FREQuency

Description: This command is used to switch low pass filter on the path of frequency detect.
Setting syntax: [CONFigure:]FILTer:FREQuency<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]FILTer:FREQuency?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :FILTER:FREQUENCY<space><CRD><RMT>
Header off: <CRD><RMT>
Example: FILT:FREQ ON
FILT:FREQ?

[CONFigure:]SYNChronous:SOURce

Description: This command is used to select the source of frequency detect.
Setting syntax: [CONFigure:]SYNChronous:SOURce<space><CRD><PMT>
Setting parameters: <CRD>, VOLT | CURR | OFF
Query syntax: [CONFigure:]SYNChronous:SOURce?<PMT>
Return parameters: <CRD>, VOLT | CURR | OFF
Header on: :SYNCHRONOUS:SOURCE<space><CRD><RMT>
Header off: <CRD><RMT>

Example: SYNC:SOUR VOLT
SYNC:SOUR?

[CONFigure:]INPut:CT

Description: This command is used to switch the CT function.
Setting syntax: [CONFigure:]INPut:CT<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]INPut:CT?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INPUT:CT<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INP:CT ON
INP:CT?

[CONFigure:]INPut:CT:RATio

Description: This command sets the CT ratio.
Setting syntax: [CONFigure:]INPut:CT:RATio<space><NR2><PMT>
Setting parameters: <NR2>, 1.0 ~ 9999.9 , resolution 0.1
Query syntax: [CONFigure:]INPut:CT:RATio?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 1.0 ~ 9999.9
Header on: :INPUT:CT:RATIO<space><NR2><RMT>
Header off: <NR2><RMT>
Example: INP:CT:RAT 100.1
INP:CT:RAT?
INP:CT:RAT? MAX

[CONFigure:]INPut:HV

Description: This command is used to switch the HV function.
Setting syntax: [CONFigure:]INPut:HV<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]INPut:HV?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INPUT:HV<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INP:HV ON
INP:HV?

[CONFigure:]INPut:SHUNt

Description: This command is used to switch the external shunt function.
Setting syntax: [CONFigure:]INPut:SHUNt<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]INPut:SHUNt?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INPUT:SHUNT<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INP:SHUN ON
INP:SHUN?

[CONFigure:]INPut:SHUNt:RESistance

Description: This command sets the external shunt resistance.
Setting syntax: [CONFigure:]INPut:SHUNt:RESistance<space><NR2><PMT>
Setting parameters: <NR2>, 0.0000001 ~ 99.9999999, resolution 0.0000001
Query syntax: [CONFigure:]INPut:SHUNt:RESistance?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, 0.0000001 ~ 99.9999999

Header on: :INPUT:SHUNT:RESISTANCE<space><NR2><RMT>
Header off: <NR2><RMT>
Example: INP:SHUN:RES 23.456
INP:SHUN:RES?
INP:SHUN:RES? MAX

[CONFigure:]CURRent:NULL[:STATe]

Description: This command is used to enable or disable the null measurements function when measuring current.
Setting syntax: [CONFigure:]CURRent:NULL[:STATe]<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]CURRent:NULL[:STATe]?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :CURRENT:NULL<space><CRD><RMT>
Header off: <CRD><RMT>
Example: CURR:NULL ON
CURR:NULL?

[CONFigure:]INTEGrate

Description: This command is used to switch the integration function.
Setting syntax: [CONFigure:]INTEGrate<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]INTEGrate?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INTEGRATE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INTEG ON
INTEG?

[CONFigure:]INTEGrate:MODE

Description: This command sets the mode of execution in integration function.
Setting syntax: [CONFigure:]INTEGrate:MODE<space><CRD><PMT>
Setting parameters: <CRD>, NORMAL | CONTINUE
Query syntax: [CONFigure:]INTEGrate:MODE?<PMT>
Return parameters: <CRD>, NORMAL | CONTINUE
Header on: :INTEGRATE:MODE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INTEG:MODE CONTINUE
INTEG:MODE?

[CONFigure:]INTEGrate:TIME

Description: This command sets the time of integration in Second.
Setting syntax: [CONFigure:]INTEGrate:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 35999999
Query syntax: [CONFigure:]INTEGrate:TIME?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 35999999
Header on: :INTEGRATE:TIME<space><NR1><RMT>
Header off: <NR1><RMT>
Example: INTEG:TIME 60
INTEG:TIME?
INTEG:TIME? MAX

[CONFigure:]INTEGrate:SMARt

Description: This command is used to switch the smart range function in integration

mode.
Setting syntax: [CONFigure:]INTEGrate:SMARt<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]INTEGrate:SMARt?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :INTEGRATE:SMART<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INTEG:SMAR ON
INTEG:SMAR?

[CONFigure:]INTEGrate:SMARt:RANGe

Description: This command sets the range of smart measure in integration mode.
Setting syntax: [CONFigure:]INTEGrate:SMARt:RANGe<space><CRD><PMT>
Setting parameters: <CRD>
External shunt off:
AUTO | A30 | A20 | A5 | A2 | A05
External shunt on:
AUTO | E015 | E01 | E005 | E0025 | E001
Query syntax: [CONFigure:]INTEGrate:SMARt:RANGe?<PMT>
Return parameters: <CRD>,
External shunt off: A30 | A20 | A5 | A2 | A05
External shunt on: E015 | E01 | E005 | E0025 | E001
Header on: :INTEGRATE:SMART:RANGE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: INTEG:SMAR:RANG AUTO
INTEG:SMAR:RANG?

[CONFigure:]CURRent:INRush

Description: This command is used to switch the inrush function.
Setting syntax: [CONFigure:]CURRent:INRush<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]CURRent:INRush?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :CURRENT:INRUSH<space><CRD><RMT>
Header off: <CRD><RMT>
Example: CURR:INR ON
CURR:INR?

[CONFigure:]CURRent:INRush:LEVel

Description: This command sets the level of trigger of inrush current in Ampere.
Setting syntax: [CONFigure:]CURRent:INRush:LEVel<space><NR2><PMT>
Setting parameters: <NR2>, 0.1 ~ 9999.9
Query syntax: [CONFigure:]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: CURR:INR:LEV 11.5
CURR:INR:LEV?
CURR:INR:LEV? MAX

[CONFigure:]CURRent:INRush:TIME

Description: This command sets the time of measure of inrush current in Millisecond.
Setting syntax: [CONFigure:]CURRent:INRush:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 9999

Query syntax: [CONFigure:]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: CURR:INR:TIME 100
CURR:INR:TIME?
CURR:INR:TIME? MAX

[CONFigure:]CURRent:INRush:DELay

Description: This command sets the delay of measure of inrush current in Millisecond.
Setting syntax: [CONFigure:]CURRent:INRush:DELay<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 9999
Query syntax: [CONFigure:]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: CURR:INR:DEL 15
CURR:INR:DEL?
CURR:INR:DEL? MAX

[CONFigure:]HARMonic:THD

Description: This command sets the method of THD calculate in harmonic calculation.
Setting syntax: [CONFigure:]HARMonic:THD<space><CRD><PMT>
Setting parameters: <CRD>, FUNDAMENTAL | TOTAL
Query syntax: [CONFigure:]HARMonic:THD?<PMT>
Return parameters: <CRD>, FUNDAMENTAL | TOTAL
Header on: :HARMONIC:THD<space><CRD><RMT>
Header off: <CRD><RMT>
Example: HARM:THD TOTAL
HARM:THD?

[CONFigure:]HARMonic:ORDer

Description: This command sets how many harmonic order of THD calculation in harmonic measure.
Setting syntax: [CONFigure:]HARMonic:ORDer<space><NR1><PMT>
Setting parameters: <NR1>, 2 ~ 100
Query syntax: [CONFigure:]HARMonic:ORDer?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 2 ~ 100
Header on: :HARMONIC:ORDER<space><NR1><RMT>
Header off: <NR1><RMT>
Example: HARM:ORD 40
HARM:ORD?
HARM:ORD? MAX

[CONFigure:]HARMonic:CYCLe

Description: This command sets the cycle of harmonic measure.
Setting syntax: [CONFigure:]HARMonic:CYCLe<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 20
Query syntax: [CONFigure:]HARMonic:CYCLe?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 ~ 20
Header on: :HARMONIC:CYCLE<space><NR1><RMT>
Header off: <NR1><RMT>
Example: HARM:CYCL 10
HARM:CYCL?

HARM:CYCL? MAX

[CONFigure:]HARMonic:SMOothing

Description: This command sets the state of smoothing filter in harmonic calculation.
Setting syntax: [CONFigure:]HARMonic:SMOothing<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]HARMonic:SMOothing?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :HARMONIC:SMOOTHING<space><CRD><RMT>
Header off: <CRD><RMT>
Example: HARM:SMO ON
HARM:SMO?

[CONFigure:]HARMonic:DISPlay

Description: This command sets the state of harmonic display function in harmonic calculation.
Setting syntax: [CONFigure:]HARMonic:DISPlay<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]HARMonic:DISPlay?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :HARMONIC:DISPLAY<space><CRD><RMT>
Header off: <CRD><RMT>
Example: HARM:DISP ON
HARM:DISP?

[CONFigure:]HARMonic:DISPlay:ORDer

Description: This command sets the order of harmonic display function.
Setting syntax: [CONFigure:]HARMonic:DISPlay:ORDer<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 100
Query syntax: [CONFigure:]HARMonic:DISPlay:ORDer?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 ~ 100
Header on: :HARMONIC:DISPLAY:ORDER<space><NR1><RMT>
Header off: <NR1><RMT>
Example: HARM:DISP:ORD 40
HARM:DISP:ORD?
HARM:DISP:ORD? MAX

[CONFigure:]IEC

Description: This command is used to switch the IEC 61000-4-7 harmonic function.
Setting syntax: [CONFigure:]IEC<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]IEC?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :IEC<space><CRD><RMT>
Header off: <CRD><RMT>
Example: IEC ON
IEC?

[CONFigure:]IEC:THD

Description: This command sets the method of THD calculation in IEC 61000-4-7 harmonic calculation.
Setting syntax: [CONFigure:]IEC:THD<space><CRD><PMT>
Setting parameters: <CRD>, FUNDAMENTAL | TOTAL
Query syntax: [CONFigure:]IEC:THD?<PMT>

Return parameters: <CRD>, FUNDAMENTAL | TOTAL
Header on: :IEC:THD<space><CRD><RMT>
Header off: <CRD><RMT>
Example: IEC:THD TOTAL
IEC:THD?

[CONFigure:]IEC:ORDer

Description: This command sets how many harmonic order of THD calculation in IEC 61000-4-7 harmonic measure.
Setting syntax: [CONFigure:]IEC:ORDer<space><NR1><PMT>
Setting parameters: <NR1>, 2 ~ 100
Query syntax: [CONFigure:]IEC:ORDer?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 2 ~ 100
Header on: :IEC:ORDER<space><NR1><RMT>
Header off: <NR1><RMT>
Example: IEC:ORD 40
IEC:ORD?
IEC:ORD? MAX

[CONFigure:]IEC:GROup

Description: This command sets the mode of group function in IEC 61000-4-7 harmonic calculation.
Setting syntax: [CONFigure:]IEC:GROup<space><CRD><PMT>
Setting parameters: <CRD>, OFF | TYPE1 | TYPE2
Query syntax: [CONFigure:]IEC:GROup?<PMT>
Return parameters: <CRD>, OFF | TYPE1 | TYPE2
Header on: :IEC:GROUP<space><CRD><RMT>
Header off: <CRD><RMT>
Example: IEC:GRO TYPE1
IEC:GRO?

[CONFigure:]IEC:SMOothing

Description: This command sets the state of smoothing filter in IEC 61000-4-7 harmonic calculation.
Setting syntax: [CONFigure:]IEC:SMOothing<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]IEC:SMOothing?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :IEC:SMOOTHING<space><CRD><RMT>
Header off: <CRD><RMT>
Example: IEC:SMO ON
IEC:SMO?

[CONFigure:]IEC:DISPlay

Description: This command sets the state of harmonic display function in IEC 61000-4-7 harmonic calculation.
Setting syntax: [CONFigure:]IEC:DISPlay<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]IEC:DISPlay?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :IEC:DISPLAY<space><CRD><RMT>
Header off: <CRD><RMT>
Example: IEC:DISP ON
IEC:DISP?

[CONFigure:]HOLD

Description: This command is used to switch the hold function.
Setting syntax: [CONFigure:]HOLD<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]HOLD?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :HOLD<space><CRD><RMT>
Header off: <CRD><RMT>
Example: HOLD ON
HOLD?

[CONFigure:]HOLD:MODE

Description: This command sets the mode of hold function.
Setting syntax: [CONFigure:]HOLD:MODE<space><CRD><PMT>
Setting parameters: <CRD>, STOP | MAX | MIN
Query syntax: [CONFigure:]HOLD:MODE?<PMT>
Return parameters: <CRD>, STOP | MAX | MIN
Header on: :HOLD:MODE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: HOLD:MODE MIN
HOLD:MODE?

[CONFigure:]HOLD:TIME

Description: This command sets the time of hold function in Second.
Setting syntax: [CONFigure:]HOLD:TIME<space><NR1><PMT>
Setting parameters: <NR1>, 0 ~ 9999
Query syntax: [CONFigure:]HOLD:TIME?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 0 ~ 9999
Header on: :HOLD:TIME<space><NR1><RMT>
Header off: <NR1><RMT>
Example: HOLD:TIME 30
HOLD:TIME?
HOLD:TIME? MAX

[CONFigure:]STORe

Description: This command is used to switch the store function.
Setting syntax: [CONFigure:]STORe<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]STORe?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :STORE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: STOR ON
STOR?

[CONFigure:]STORe:MODE

Description: This command sets the mode of store function.
Setting syntax: [CONFigure:]STORe:MODE<space><CRD><PMT>
Setting parameters: <CRD>, MANUAL | INTEGRATION
Query syntax: [CONFigure:]STORe:MODE?<PMT>
Return parameters: <CRD>, MANUAL | INTEGRATION
Header on: :STORE:MODE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: STOR:MODE MANUAL

STOR:MODE?

[CONFigure:]STORe:COUNt

Description: This command sets amount of record in store function.
Setting syntax: [CONFigure:]STORe:COUNt<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 10000
Query syntax: [CONFigure:]STORe:COUNt?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 ~ 10000
Header on: :STORE:COUNT<space><NR1><RMT>
Header off: <NR1><RMT>
Example: STOR:COUN 50
STOR:COUN?

[CONFigure:]STORe:TINTerval

Description: This command sets interval time of recording in store function.
Setting syntax: [CONFigure:]STORe:TINTerval<space><NR1><PMT>
Setting parameters: <NR1>, 1 ~ 39599
Query syntax: [CONFigure:]STORe:TINTerval?[<space><MAX | MIN>]<PMT>
Return parameters: <NR1>, 1 ~ 39599
Header on: :STORE:TINTERVAL<space><NR1><RMT>
Header off: <NR1><RMT>
Example: STOR:TINT 1
STOR:TINT?

[CONFigure:]SOUNd

Description: This command sets the sound of keypad.
Setting syntax: [CONFigure:]SOUNd<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: [CONFigure:]SOUNd?<PMT>
Return parameters: <CRD>, OFF | ON
Header on: :SOUND<space><CRD><RMT>
Header off: <CRD><RMT>
Example: SOUN ON
SOUN?

[CONFigure:]DATE

Description: This command sets the date of this system.
Setting syntax: [CONFigure:]DATE<space><arg1>,<arg2>,<arg3><PMT>
Setting parameters: <arg1> year: <NR1>, 1999 ~ 2099
<arg2> month: <NR1>, 1 ~ 12
<arg3> day: <NR1>, 1 ~ 31
Query syntax: [CONFigure:]DATE?<PMT>
Return parameters: <SRD>, example “2016/8/30”
Header on: :DATE<space><CRD><RMT>
Header off: <CRD><RMT>
Example: DATE 2016,8,30
DATE?

[CONFigure:]TIME

Description: This command sets the time of this system with 24H format.
Setting syntax: [CONFigure:]TIME<space><arg1>,<arg2>,<arg3><PMT>
Setting parameters: <arg1> hour: <NR1>, 0 ~ 23
<arg2> minute: <NR1>, 0 ~ 59
<arg3> second: <NR1>, 0 ~ 59

Query syntax: [CONFigure:]TIME?<PMT>
Return parameters: <SRD>, example "19:07:30"
  Header on: :TIME<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: TIME 19,7,30
  TIME?

[CONFigure:]FORMat:WARNing

Description: This command sets the format of warning message.
Setting syntax: [CONFigure:]FORMat:WARNiing<space><CRD><PMT>
Setting parameters: <CRD>, NUMBER | STRING
  NUMBER message : -1, -2, -3, -4
  STRING message : E1, E2, E3, E4
Query syntax: [CONFigure:]FORMat:WARNing?<PMT>
Return parameters: <CRD>, NUMBER | STRING
  Header on: :FORMAT:WARNING<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: FORM:WARN NUMBER
  FORM:WARN?

TRIGger

Description: Three different modes, LIMIT(GONG), INRUSH and ENERGY, are triggered by this command.
Setting syntax: TRIGger<space><CRD><PMT>
Setting parameters: <CRD>, OFF | ON
Query syntax: TRIGger?<RMT>
Return parameters: <CRD>, STOP | FINISH | RUNNING
  Header on: :TRIGGER<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: TRIG ON
  TRIG?

TRIGger:MODE

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

PROTection:CLEar

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

PROTection?

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

Bit position	15	14~6	5	4	3	2	1	0
Condition	FAN	-	-	Inrush RCE	Integrate RCE	OL	OCR	OVR
Bit weight	32768	-	-	16	8	4	2	1

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

WAVeform:CAPture?

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: WAV:CAP?

WAVeform:DATA?

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<byte1><byte2><byte3><byte4><byte5><byte6><byte7><byte8>...

Point #1 *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: WAV:DATA? V
WAV:DATA? I

SHOW Sub-system

SHOW[:DISPlay]:ITEM

Description: This command is used to select which item of measure will be displayed.
Setting syntax: SHOW[:DISPlay]: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, VA, VPK+, IPK+, VPK-, IPK-
	arg2: V, I, W, PF, DEG, THDV, THDI, IS
	arg3: V, I, W, VAR, CFV, CFI, AH, WH
	arg4: V, I, W, PF, VHZ, IHZ, THDV, THDI
Query syntax:	none
Return parameters:	none
Example:	SHOW:ITEM V,I,W,PF

CALCULATE Sub-system

[CALCulate:]COMParator

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 Limit function.
Setting syntax:	[CALCulate:]COMParator<space><CRD><PMT>
Setting parameters:	<CRD>, ON | OFF
Query syntax:	[CALCulate:]COMParator?<PMT>
Return parameters:	<CRD>, ON | OFF
Header on:	:COMPARATOR<space><CRD><RMT>
Header off:	<CRD><RMT>
Example:	COMP ON COMP?

[CALCulate:]COMParator:TIME

Description:	Programming "COMP:TIME" decides the dwelling time of Limit function. The unit of Setting Parameter is second.
Setting syntax:	[CALCulate:]COMParator:TIME<space><NR1><PMT>
Setting parameters:	<NR1>, 0 ~ 9999
Query syntax:	[CALCulate:]COMParator:TIME?[<space><MAX | MIN>]<PMT>
Return parameters:	<NR1>, 0 ~ 9999
Header on:	:COMPARATOR:TIME<space><NR1><RMT>
Header off:	<NR1><RMT>
Example:	COMP:TIME 30 COMP:TIME? COMP:TIME MAX

[CALCulate:]COMParator:RESult?

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

[CALCulate:]COMParator:FAIL?

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: [CALCulate:]COMParator:FAIL?<PMT>
Return parameters: <CRD>, NONE, V, VPK+, VPK-, I, IPK+, IPK-, W, PF, VA, VAR, CFV, CFI, THDV, THDI, VHZ, IHZ, VDC, IDC, WDC, VMEAN, DEG
    Header on: :COMPARATOR:FAIL<space><CRD>,<CRD>,...<RMT>
    Header off: <CRD>,<CRD>,...<RMT>
    Separator 0: <CRD>,<CRD>,...<RMT>
    Separator 1: <CRD>;<CRD>;...<RMT>
Example: COMP:FAIL?

[CALCulate:]COMParator:ITEM

Description: This command is used to select measured items as comparison items in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:ITEM<space><CRD>,<CRD>,…<PMT>
Setting parameters: <CRD>, NONE, V, VPK+, VPK-, I, IPK+, IPK-, W, PF, VA, VAR, CFV, CFI, THDV, THDI, VHZ, IHZ, VDC, IDC, WDC, VMEAN, DEG
Query syntax: [CALCulate:]COMParator:ITEM?<PMT>
Return parameters: <CRD>, NONE, V, VPK+, VPK-, I, IPK+, IPK-, W, PF, VA, VAR, CFV, CFI, THDV, THDI, VHZ, IHZ, VDC, IDC, WDC, VMEAN, DEG
    Header on: :COMPARATOR:ITEM<space><CRD>,<CRD>,…<RMT>
    Header off: <CRD>,<CRD>,…<RMT>
    Separator 0: <CRD>,<CRD>,…<RMT>
    Separator 1: <CRD>;<CRD>;…<RMT>
Example: COMP:ITEM V,I,W
COMP:ITEM?

[CALCulate:]COMParator:LIMit:V

Description: This command sets upper and lower boundaries of voltage (r.m.s) in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:V<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: [CALCulate:]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: COMP:LIM:V 130.0,80.0
COMP:LIM:V?
COMP:LIM:V? MAX

[CALCulate:]COMParator:LIMit:VPK+

Description: This command sets upper and lower boundaries of positive peak voltage in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:VPK+<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: [CALCulate:]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: COMP:LIM:VPK+ 160.0,150.0

COMP:LIM:VPK+?
COMP:LIM:VPK+? MAX

[CALCulate:]COMParator:LIMit:VPK-

Description: This command sets upper and lower boundaries of negative peak voltage in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:VPK-<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:VPK- 160.0,150.0
COMP:LIM:VPK-?
COMP:LIM:VPK-? MAX

[CALCulate:]COMParator:LIMit:I

Description: This command sets upper and lower boundaries of current (r.m.s.) in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:I<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:I 12.0,10.0
COMP:LIM:I?
COMP:LIM:I? MAX

[CALCulate:]COMParator:LIMit:IPK+

Description: This command sets upper and lower boundaries of positive peak current in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:IPK+<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:IPK+ 15.0,13.0
COMP:LIM:IPK+?
COMP:LIM:IPK+? MAX

[CALCulate:]COMParator:LIMit:IPK-

Description: This command sets upper and lower boundaries of negative peak current in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:IPK-<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:IPK- 15.0,13.0
COMP:LIM:IPK-?
COMP:LIM:IPK-? MAX

[CALCulate:]COMParator:LIMit:W

Description: This command sets upper and lower boundaries of power in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:W<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: [CALCulate:]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: COMP:LIM:W 100.0,90.0
COMP:LIM:W?
COMP:LIM:W? MAX

[CALCulate:]COMParator:LIMit:PF

Description: This command sets upper and lower boundaries of power factor in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:PF<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9.999, -1 denote don’t care.
Query syntax: [CALCulate:]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: COMP:LIM:PF 0.9,0.7
COMP:LIM:PF?
COMP:LIM:PF? MAX

[CALCulate:]COMParator:LIMit:VA

Description: This command sets upper and lower boundaries of apparent power in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:VA<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don’t care.
Query syntax: [CALCulate:]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: COMP:LIM:VA 1500.0,1300.0
COMP:LIM:VA?
COMP:LIM:VA? MAX

[CALCulate:]COMParator:LIMit:VAR

Description: This command sets upper and lower boundaries of reactive power in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:VAR<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:VAR 100.0,90.0
COMP:LIM:VAR?
COMP:LIM:VAR? MAX

[CALCulate:]COMParator:LIMit:CFV

Description: This command sets upper and lower boundaries of voltage crest factor in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:CFV<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:CFV?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99.99
Header on: :COMPARATOR:LIMIT:CFV<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:CFV 2.5,1.5
COMP:LIM:CFV?
COMP:LIM:CFV? MAX

[CALCulate:]COMParator:LIMit:CFI

Description: This command sets upper and lower boundaries of current crest factor in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:CFI<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:CFI 3.5,2.5
COMP:LIM:CFI?
COMP:LIM:CFI? MAX

[CALCulate:]COMParator:LIMit:THDV

Description: This command sets upper and lower boundaries of total harmonic distortion of voltage in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:THDV<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:THDV 50,40
COMP:LIM:THDV?
COMP:LIM:THDV? MAX

[CALCulate:]COMParator:LIMit:THDI

Description: This command sets upper and lower boundaries of total harmonic distortion of current in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:THDI<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99.99, -1 denote don't care.
Query syntax: [CALCulate:]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: COMP:LIM:THDI 30.0,20.0
COMP:LIM:THDI?
COMP:LIM:THDI? MAX

[CALCulate:]COMParator:LIMit:VHZ

Description: This command sets upper and lower boundaries of frequency of voltage in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:VHZ<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:VHZ?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:VHZ<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:VHZ 70.0,40.0
COMP:LIM:VHZ?
COMP:LIM:VHZ? MAX

[CALCulate:]COMParator:LIMit:IHZ

Description: This command sets upper and lower boundaries of frequency of current in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:IHZ<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:IHZ?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:IHZ<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:IHZ 70.0,40.0
COMP:LIM:IHZ?
COMP:LIM:IHZ? MAX

[CALCulate:]COMParator:LIMit:VDC

Description: This command sets upper and lower boundaries of DC voltage in LIMIT mode.

Setting syntax: [CALCulate:]COMParator:LIMit:VDC<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:VDC?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:VDC<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:VDC 10.0,5.0
COMP:LIM:VDC?
COMP:LIM:VDC? MAX

[CALCulate:]COMParator:LIMit:IDC

Description: This command sets upper and lower boundaries of DC current in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:IDC<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9999.99999, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:IDC?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2>, -1 ~ 9999.99999
Header on: :COMPARATOR:LIMIT:IDC<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:IDC 12.0,10.0
COMP:LIM:IDC?
COMP:LIM:IDC? MAX

[CALCulate:]COMParator:LIMit:WDC

Description: This command sets upper and lower boundaries of DC power in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:WDC<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:WDC?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:WDC<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:WDC 100.0,90.0
COMP:LIM:WDC?
COMP:LIM:WDC? MAX

[CALCulate:]COMParator:LIMit:VMEAN

Description: This command sets upper and lower boundaries of voltage-mean in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:VMEAN<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 99999.9999, -1 denote don't care.
Query syntax: [CALCulate:]COMParator:LIMit:VMEAN?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 99999.9999
Header on: :COMPARATOR:LIMIT:VMEAN<space><NR2>,<NR2><RMT>
Header off: <NR2>,<NR2><RMT>
Separator 0: <NR2>,<NR2><RMT>
Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:VMEAN 10.0,5.0

COMP:LIM:VMEAN?
COMP:LIM:VMEAN? MAX

[CALCulate:]COMParator:LIMit:DEG

Description: This command sets upper and lower boundaries of V-I phase in LIMIT mode.
Setting syntax: [CALCulate:]COMParator:LIMit:DEG<space><NR2>,<NR2><PMT>
Setting parameters: <NR2>, -1 ~ 9.999, -1 denote don’t care.
Query syntax: [CALCulate:]COMParator:LIMit:DEG?[<space><MAX | MIN>]<PMT>
Return parameters: <NR2> , -1 ~ 9.999
  Header on: :COMPARATOR:LIMIT:DEG<space><NR2>,<NR2><RMT>
  Header off: <NR2>,<NR2><RMT>
  Separator 0: <NR2>,<NR2><RMT>
  Separator 1: <NR2>;<NR2><RMT>
Example: COMP:LIM:DEG 0.9,0.7
COMP:LIM:DEG?
COMP:LIM:DEG? MAX

CALIBRATION Sub-system

CALibration:ZERO:AUTO

Description: The command is used to force 66205 to autozeroing calibration. If ambient temperature variation is too much, user may program this command to improve the accuracy.
Setting syntax: CALibration:ZERO:AUTO<PMT>
Setting parameters: none
Query syntax: CALibration:ZERO:AUTO?<PMT>,
Query parameters: none
Return parameters: <CRD>, OK | WAIT | FAIL
  Header on: :CALIBRATION:ZERO:AUTO<space><CRD><RMT>
  Header off: <CRD><RMT>
Example: CAL:ZERO:AUTO
CAL:ZERO:AUTO?

15. Status Reporting

15.1 Introduction

This chapter explains the status data structure of Chroma 66200 Series power meter 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 power meter.

15.2 Register Information in Common

■ ***Condition register***

The condition register represents the present status of power meter signals. Reading the condition register does not change the state of its bits. Only changes in power meter 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 power meter. An event becomes true when the associated condition makes one of the following device-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 Standard Event Status register.

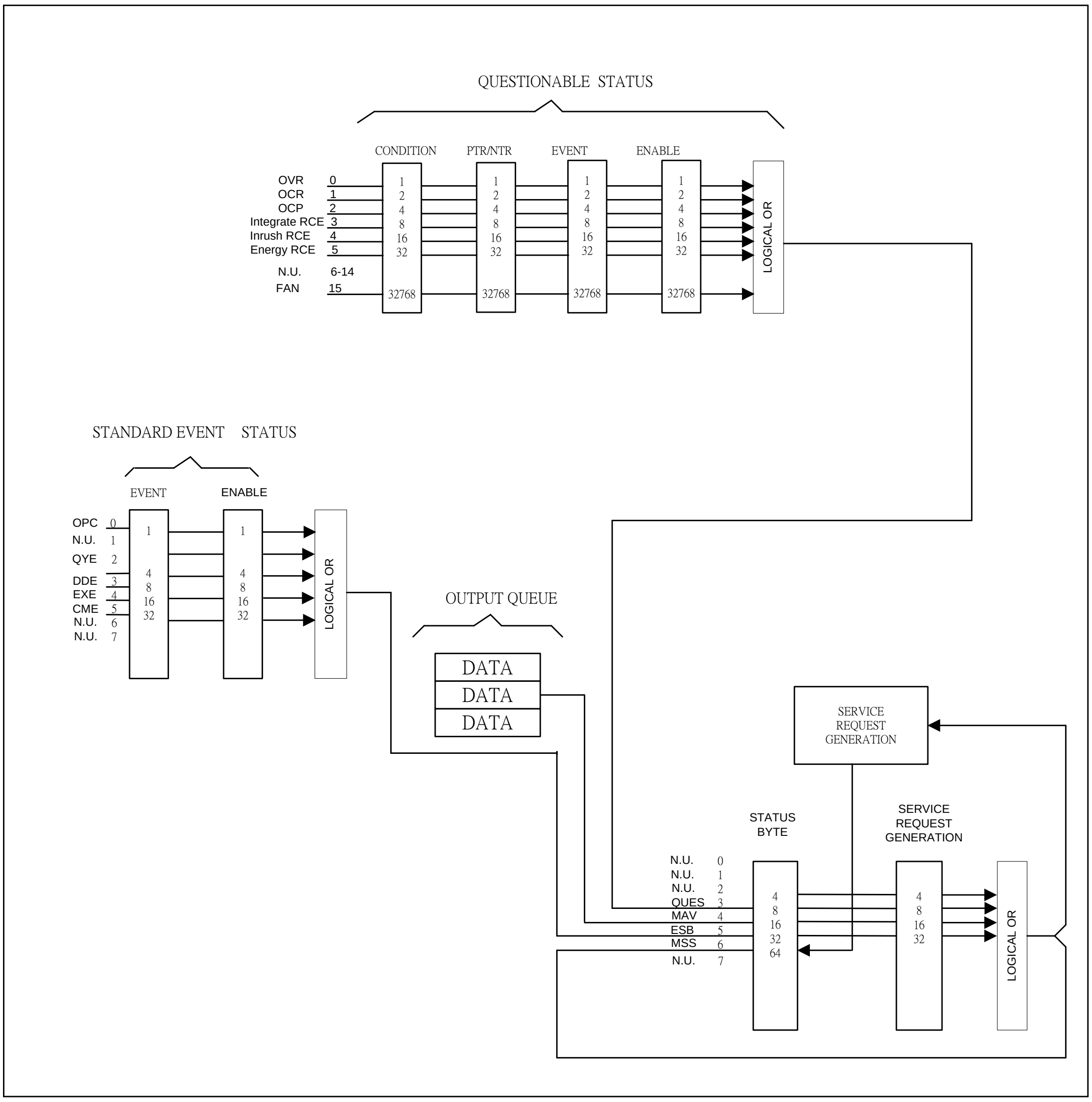


Figure 15-1 Status Registers of 66205

15.2.1 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 15-1 lists the questionable status conditions that are applied to the instrument.
- 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 15-1 Bit Description of Questionable 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.
OL	2	4	*Over load*. 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.

15.2.2 Output Queue

- The Output Queue stores output messages until they are read from the instrument.
- 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.

15.2.3 Standard Event Status

- All programming errors that have occurred will set one or more error bits in the Standard Event Status register. Table 15-2 describes the standard events that apply to the instrument.
- 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 15-2 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 instrument'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 instrument has received a <GET> message from program.

15.2.4 Status Byte Register

- The Status Byte register summarizes all of the status events for all status registers. Table 15-3 describes the status events that are applied to the instrument.
- 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 instrument 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 15-3 Bit Description of Status Byte

Mnemonic	Bit	Value	Meaning
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.

15.2.5 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 66205 Digital Power Meter has a 15-pin D-type terminal for external trigger signal and external Pass/Fail display. The table below lists the pin definition:

I/O Port (DB-15, Male Connector)								
Pin	Definition	Input/Output/Power	Pin	Definition	Input/Output/Power	Pin	Definition	Input/Output/Power
1	Reserved	-	6	/Stop	Input	11	Reserved	-
2	/Start	Input	7	GND	Power	12	Reserved	-
3	Reserved	-	8	Reserved	-	13	/Reset	Input
4	Reserved	-	9	Reserved	-	14	Fail+	Output(dry contact)
5	Pass-	Output(dry contact)	10	Pass+	Output(dry contact)	15	Fail-	Output(dry contact)

/Start, /Stop and /Reset

The /Start, /Stop and /Reset of I/O port can replace the Trigger, Stop and Reset functions on the front panel. Before using the I/O port, be sure to enable the integration calculation, inrush current measurement or limit functions first. The figure below is the internal wiring diagram of /Start, /Stop and /Reset which are defined as lower edge trigger actions.

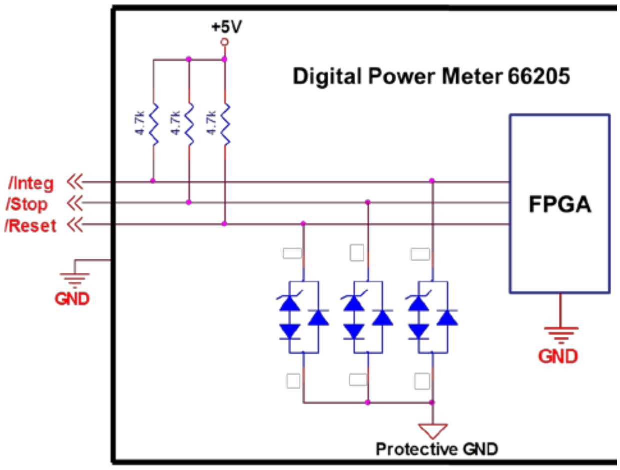


Figure A-1 /Start, /Stop, and /Reset Internal Wiring Diagram

Wiring for Pass + / Pass –

The internal wiring diagram of Pass + / Pass – is shown as below. 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.

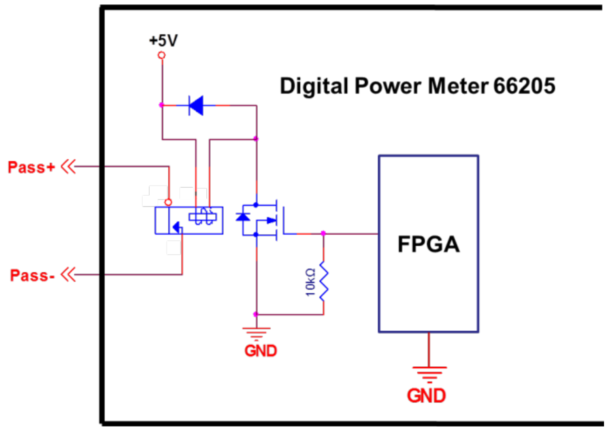


Figure A-2 Pass + / Pass – Internal Wiring Diagram

Wiring for Fail + / Fail –

The internal wiring diagram of Fail + / Fail – is shown as below. 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.

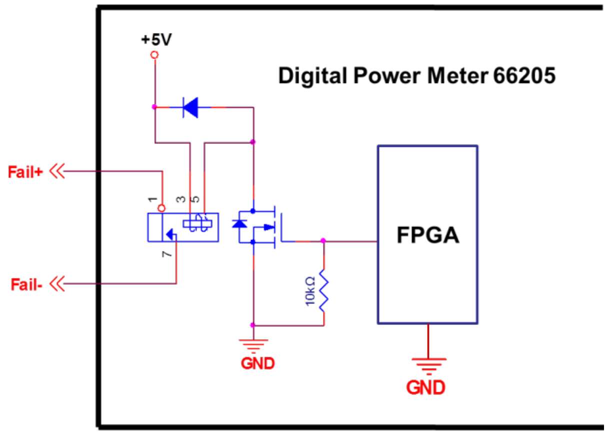


Figure A-3 Fail + / Fail – Internal Wiring Diagram

Appendix B Computing Equation for Measurement Parameter

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

The 66205 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 rms volts and rms 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 66205 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 rms 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 66205 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 them 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 Chapter 9.

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.

Table B-1 Normal Measurement Parameter

Measurement parameter	Computing equation
True rms value	
V_{rms}	$\sqrt{\frac{1}{N}\sum_{n=1}^{N} v(n)^2}$
I_{rms}	$\sqrt{\frac{1}{N}\sum_{n=1}^{N} i(n)^2}$
W	$\frac{1}{N}\sum_{n=1}^{N} v(n)\cdot i(n)$
VAR	$\sqrt{VA^2 - W^2}$
VA	$V_{rms}\cdot I_{rms}$
PF	$\frac{W}{VA}$
DC value	
V_{dc}	$\frac{1}{N}\sum_{n=1}^{N} v(n)$
I_{dc}	$\frac{1}{N}\sum_{n=1}^{N} i(n)$
W_{dc}	$V_{dc}\cdot I_{dc}$
Peak value	
V_{PK+}	The maximum sampling value of the positive half wave of $v(t)$ during data update interval.
V_{PK-}	Absolute value of the maximum sampling value of the negative half wave of $v(t)$ data update interval.
I_{PK+}	The maximum sampling value of the positive half wave of $i(t)$ during data update interval.
I_{PK-}	Absolute value of the maximum value of the negative half wave of $i(t)$ during data update interval.
Crest Factor	
CFv	$\frac{\max imum\ of\ (I_{pk+}, I_{pk-})}{I_{rms}}$
CFi	$\frac{\max imum\ of\ (I_{pk+}, I_{pk-})}{I_{rms}}$
Integration	
Power Integration(W)	

	$\frac{1}{N}\sum_{n=1}^{N} v(n)\cdot i(n)$
Watt-hour [Wh]	$\frac{1}{N}\sum_{n=1}^{N} v(n) * i(n)\cdot Time$
Ampere-hour [Ah]	$\frac{1}{N}\sum_{n=1}^{N} i(n)\cdot Time$
Frequency	
F	Zero crossing detection

Table B-2 Harmonic Measurement Parameter

Measurement Functions during Harmonic Measurement (normal mode and no-group of IEC mode)	**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 $\mathrm{P(k)}=\mathrm{V(k)}\bullet I(k)\bullet\cos\varphi(k)$		$P=\sum_{k=1}^{\max} P(k)$
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()[˚]	Vdeg(k) = Phase different of V(k) with respect to V(1)			
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 (normal mode and no-group of IEC mode)	**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	$\frac{\sqrt{\sum_{k=2}^{\max} V(k)^2}}{V(1)} \cdot 100$ or $\frac{\sqrt{\sum_{k=2}^{\max} V(k)^2}}{V(total)} \cdot 100$ See Harmonic measurement function for detailed setting.
Total harmonic distortion of current Ithd[%] or THDI	$\frac{\sqrt{\sum_{k=2}^{\max} I(k)^2}}{I(1)} \cdot 100$ or $\frac{\sqrt{\sum_{k=2}^{\max} V(k)^2}}{I(total)} \cdot 100$ See Harmonic measurement function for detailed setting.
Total harmonic distortion of power Pthd[%]	$\left\lvert\frac{\sum_{k=2}^{\max} P(k)}{P(1)}\right\rvert \cdot 100$ or $\frac{\sqrt{\sum_{k=2}^{\max} V(k)^2}}{P(total)} \cdot 100$

IEC Mode Measurement(TYPE 1)		
Measurement Function	Method of Determination, Equation	
	When the frequency of the measured item is 50Hz	When the frequency of the measured item is 60Hz
Rms value of the harmonic subgroup of the current U()[V]	$\sqrt{\sum_{i=-1}^{1} U(k+i)^2}$	
Rms value of the harmonic subgroup of the current I()[A]	$\sqrt{\sum_{i=-1}^{1} I(k+i)^2}$	
Total subgroup harmonic distortion of voltage Uthdsg[%]	$\frac{\sqrt{\sum_{k=2}^{max} U_{sg}(k)^2}}{U_{sg}(1)}$	
Total subgroup harmonic distortion of current Ithdsg[%]	$\frac{\sqrt{\sum_{k=2}^{max} I_{sg}(k)^2}}{I_{sg}(1)}$	

IEC Mode Measurement(TYPE 2)		
Measurement Function	Method of Determination, Equation	
	When the frequency of the measured item is 50Hz system	When the frequency of the measured item is 60Hz system
Rms value of the harmonic subgroup of the current U()[V]	$\sqrt{\frac{U(k-5)^2}{2}+\sum_{i=-4}^{4}U(k+i)^2+\frac{U(k+5)^2}{2}}$	$\sqrt{\frac{U(k-6)^2}{2}+\sum_{i=-5}^{5}U(k+i)^2+\frac{U(k+6)^2}{2}}$
Rms value of the harmonic subgroup of the current I()[A]	$\sqrt{\frac{I(k-5)^2}{2}+\sum_{i=-4}^{4}I(k+i)^2+\frac{I(k+5)^2}{2}}$	$\sqrt{\frac{I(k-6)^2}{2}+\sum_{i=-5}^{5}I(k+i)^2+\frac{I(k+6)^2}{2}}$
Total group harmonic distortion of voltage Uthdg[%]	$\frac{\sqrt{\sum_{k=2}^{max}U_g(k)^2}}{U_g(1)}$	
Total group harmonic distortion of current Ithdg[%]	$\frac{\sqrt{\sum_{k=2}^{max}I_g(k)^2}}{I_g(1)}$	

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.

Appendix C Circuit Diagram

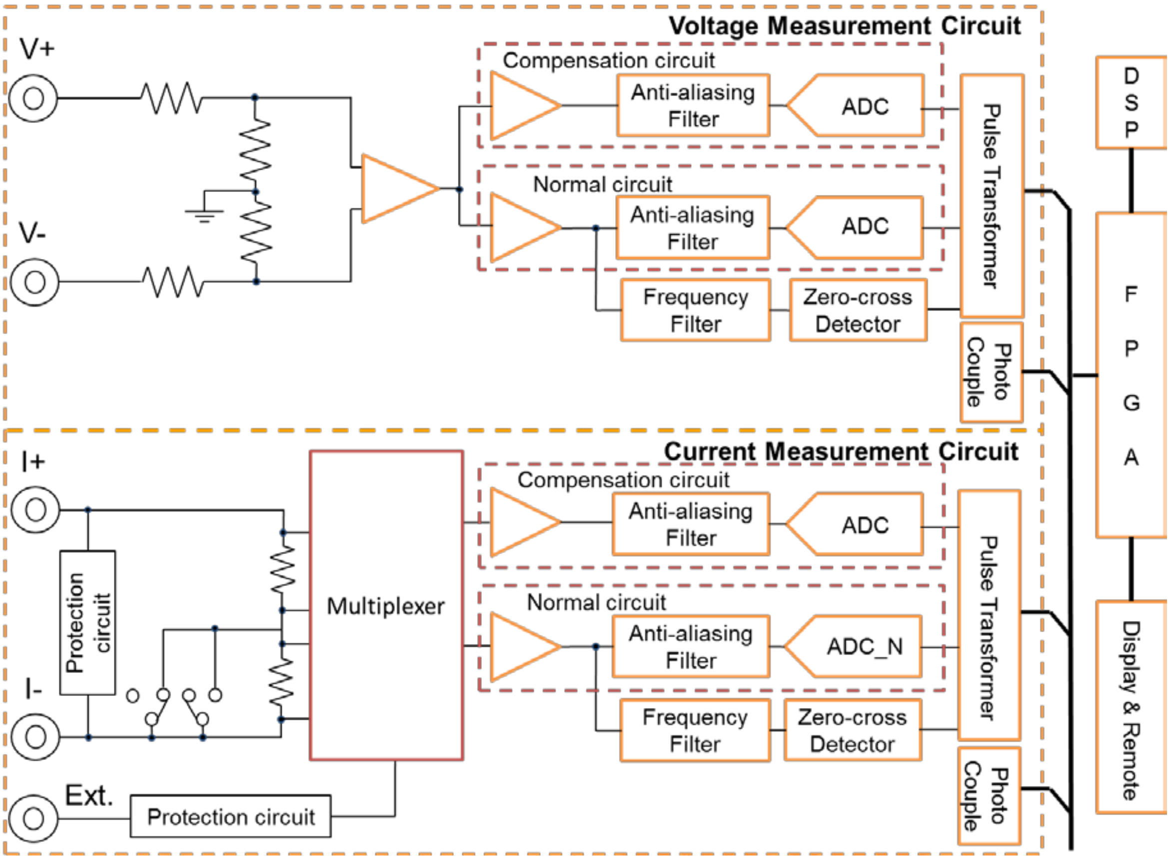


Figure C-1 Circuit Diagram

The 66205 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 30A), an external sensor can be used instead.

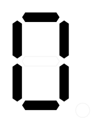
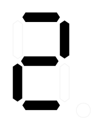
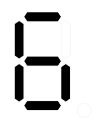
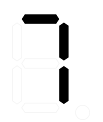
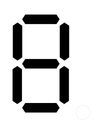
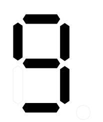
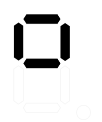
Similarly, after the voltage input terminal is inputted with the voltage signal, the signal will be attenuated and sensed. After the sensing signal is processed by amplifier and filter, the A/D converter will get the sampling data and send to FPGA for simple calculation and then send to DSP for further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

The A/D converter gets the samples of voltage and current signals simultaneously. The sampling rate is not 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.

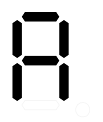
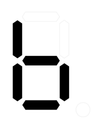
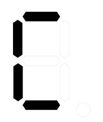
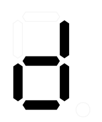
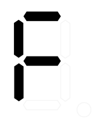
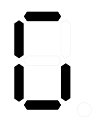
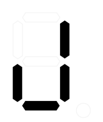
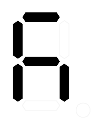
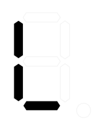
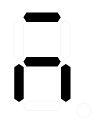
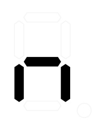
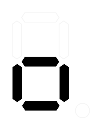
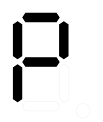
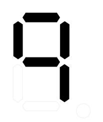
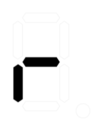
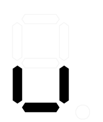
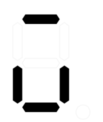
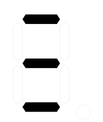
Appendix D Mapping Table for Displayed Letters

The numbers and English letters shown on the 7-segment display of model 66205 power meter panel are listed in the tables below.

Numbers:

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

English letters:

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 E Troubleshooting

This appendix introduces the error messages displayed by the 66205 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.001	SDRAM checked error	The system hardware SDRAM error, contact Chroma's dealer for service matter.
Err.002	Program code error	The system F/W program error, contact Chroma's dealer for service matter.
ERR.031 ~ 037 and ERR.131 ~ 137 and ERR.061 ~ 067 and ERR.161 ~ 167	Voltage calibration data error	Contact Chroma's dealer for service matter.
ERR.041 ~ 047 and ERR.141 ~ 147 and ERR.071 ~ 077 and ERR.171 ~ 177	Current calibration data error	Contact Chroma's dealer for service matter.
ERR.051 ~ 057 and ERR.151~ 157 and ERR.081 ~ 087 and ERR.181~ 187	Calibration data error of the external shunt measurement function.	Contact Chroma's dealer for service matter.
Err.099	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.
-OL-	Over Load	Input voltage or current exceeds measurement range of 66205. Operation in over-rated frequently may damage the internal circuit.
-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. Please contact Chroma or its distributor for repair and services.

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 F Specification Verification Procedure

This appendix describes the procedure of specification verification for verifying the functions of 66205 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 5520A or Fluke 5502A
Current Source	0~20Arms output	Fluke 5520A or Fluke 5502A
Test Wire	Withstand voltage 600Vrms, Withstand current 20Arms	

Configuring Test Wires

Connect the Fluke 5520A voltage output Hi/Lo to the 66205 Digital Power Meter's rear panel V+/V- and the Fluke 5520A current output to the 66205 Digital Power Meter's rear panel I+/I- with test wires as Figure shown below. Once the instruments are configured, power on the Fluke 5520A and the 66205 Digital Power Meter.

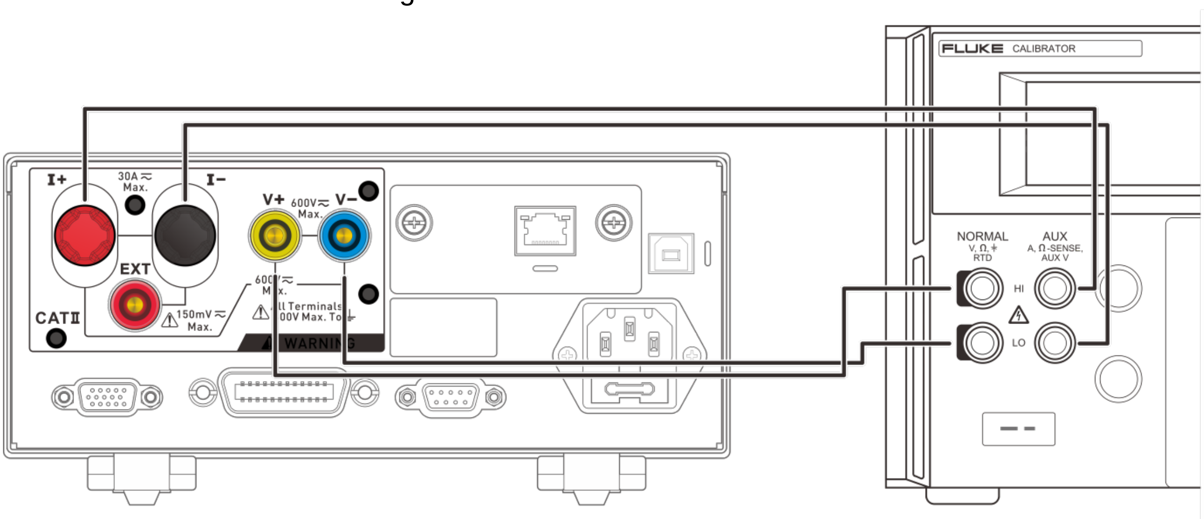


Figure F-1

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 66205 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 5520A.
3. Set the Fluke 5520A to begin output.
4. Log the voltage RMS showed on the display panel of 66205 Digital Power Meter.
5. Set the 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 5520A output to Standby.

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

The test result of each voltage range for 66205 Digital Power Meter:

600V Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Voltage 480Vrms, 60Hz	Vrms	479.22		480.78
Low Voltage 60Vrms, 60Hz	Vrms	59.640		60.360

300V Range				
Fluke Calibrator	**Parameter**	**Max. Spec.**	**Measured Result**	**Min. Spec.**
High Voltage 240Vrms, 55Hz	Vrms	239.61		240.39
Low Voltage 30Vrms, 55Hz	Vrms	29.820		30.180

150V Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Voltage 120Vrms, 55Hz	Vrms	119.80		120.19
Low Voltage 15Vrms, 55Hz	Vrms	14.910		15.090

60V Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Voltage 48Vrms, 55Hz	Vrms	47.922		48.078
Low Voltage 6Vrms, 55Hz	Vrms	5.9640		6.0360

30V Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Voltage 24Vrms, 55Hz	Vrms	23.961		24.039
Low Voltage 3Vrms, 55Hz	Vrms	2.9820		3.0180

15V Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Voltage 12Vrms, 55Hz	Vrms	11.980		12.019
Low Voltage 1.5Vrms, 55Hz	Vrms	1.4910		1.5090

Current Specification Verification

Steps:

1. Follow the test table to set current measurement range of 66205 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 5520A.
3. Set the Fluke 5520A to begin output.
4. Log the current RMS showed on the display panel of 66205 Digital Power Meter.
5. Set the 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 5520A output to Standby.

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

The test result of each current range for the 66205 Digital Power Meter:

30A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/20Arms, 55Hz	Irms	19.965		20.035
Low Current 100V/3Arms, 55Hz	Irms	2.9820		3.0180

20A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/16Arms, 55Hz	Irms	15.974		16.026
Low Current 100V/2Arms, 55Hz	Irms	1.988		2.012

5A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/4Arms, 55Hz	Irms	3.9935		4.0065
Low Current 100V/0.5Arms, 55Hz	Irms	497.00m		503.00m

2A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/1.6Arms, 55Hz	Irms	1.5974		1.6026
Low Current 100V/0.2Arms, 55Hz	Irms	198.80m		201.20m

0.5A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/0.4Arms, 55Hz	Irms	399.35m		400.65m
Low Current 100V/50mArms, 55Hz	Irms	49.700m		50.300m

0.3A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/0.24Arms, 55Hz	Irms	239.61m		240.39m
Low Current 100V/30mArms, 55Hz	Irms	29.820m		30.180m

0.2A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/0.16Arms, 55Hz	Irms	159.74m		160.26m
Low Current 100V/20mArms, 55Hz	Irms	19.880m		20.120m

0.05A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/40mArms, 55Hz	Irms	39.935m		40.065m
Low Current 100V/5mArms, 55Hz	Irms	4.9700m		5.0300m

0.02A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/16mArms, 55Hz	Irms	15.974m		16.026m
Low Current 100V/2mArms, 55Hz	Irms	1.9880m		2.0120m

0.005A Range				
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
High Current 100V/4mArms, 55Hz	Irms	3.9940m		4.0070m
Low Current 100V/0.5mArms, 55Hz	Irms	0.4970m		0.5030m

Frequency Specification Verification

Steps:
1. Follow the test table to set the voltage measurement range of 66205 Digital Power Meter , the parameter indicator is set to VHz or AHz.
2. Follow the test table to set the voltage, frequency output of Fluke 5520A.
3. Set the Fluke 5520A to begin output.
4. Log the voltage frequency showed on the display panel of 66205 Digital Power Meter.
5. Set the 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 5520A output to Standby.

The test result of frequency measurement for 66205 Digital Power Meter:

66205			Fluke Calibrator	Min. Spec.	Measured Result	Max. Spec.
Measurement Range	**Sync. Source**	**Frequency Filter**				
300V	Voltage	OFF	240V / 50Hz	49.970		50.030
150V	Voltage	ON	120V / 60Hz	59.964		60.036
15V	Voltage	OFF	1.5V / 400Hz	399.76		400.24
5A	Current	ON	500mA / 50Hz	49.970		50.030
0.5A	Current	OFF	50mA / 60Hz	59.964		60.036
50mA	Current	ON	5mA / 10Hz	9.9940		10.006

Power Specification Verification

Steps:
1. Follow the test table to set the voltage range and current range of 66205 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 5520A.
3. Set the Fluke 5520A to begin output.
4. Log the active power, PF readings showed on the display of 66205 Power Meter.
5. Set the Fluke 5520A 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 5520A output to Standby.

The test result of power measurement:

66205 Range		**600V Range**		**30A Range**
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
480Vrms 20Arms 55Hz PF = 1	W	9.5814k		9.6186k
	PF	1		0.9981
66205 Range		**600V Range**		**20A Range**
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
480Vrms 16Arms 55Hz PF = 1	W	7.6663k		7.6936k
	PF	1		0.9981
66205 Range		**300V Range**		**5A Range**
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
240Vrms 4Arms 55Hz PF = 1	W	958.29		961.71
	PF	1		PF
66205 Range		**150V Range**		**2A Range**
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
120Vrms 1.6Arms 55Hz PF = 1	W	191.65		192.34
	PF	1		PF
66205 Range		**60V Range**		**0.5A Range**
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
48Vrms 0.4Arms 55Hz PF = 1	W	19.165		19.234
	PF	1		PF

66205 Range		60V Range	0.3A Range	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
48Vrms 0.24Arms 55Hz PF = 1	W	11.499		11.540
	PF	1		0.9981
66205 Range		**30V Range**	**0.2A Range**	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
24Vrms 160mArms 55Hz PF = 1	W	3.8331		3.8468
	PF	1		0.9981
66205 Range		**15V Range**	**0.05A Range**	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
12Vrms 40mArms 55Hz PF = 1	W	479.14m		480.85m
	PF	1		0.9981
66205 Range		**300V Range**	**0.02A Range**	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
230Vrms 20mArms 55Hz PF = 1	W	4.5924		4.6076
	PF	1		0.9981
66205 Range		**150V Range**	**0.005A Range**	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
115Vrms 5mArms 55Hz PF = 1	W	574.05m		575.95m
	PF	1		0.9981
66205 Range		**300V Range**	**0.02A Range**	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
230Vrms 20mArms 55Hz PF = 0.8	W	3.6733		3.6866
	PF	0.8021		0.7979
66205 Range		**150V Range**	**0.005A Range**	
Fluke Calibrator	**Parameter**	**Min. Spec.**	**Measured Result**	**Max. Spec.**
115Vrms 5mArms 55Hz PF = 0.5	W	286.83m		288.16m
	PF	0.5028		0.4972

Chroma's Continuous Quality Process
User Manual Customer Feedback

Chroma welcomes all comments and recommendations to improve this publication in the future editions. Please scan the QR code below or click the URL http://www.chromaate.com/survey?n=793ce6db-17ef-4cd3-b0de-8bbd09aa38e0 to fill in the customer feedback form. Thank you!

CHROMA ATE INC.
致茂電子股份有限公司
66 Huaya 1st Road, Guishan,
Taoyuan 33383, Taiwan
台灣桃園市 33383 龜山區
華亞一路 66 號
T +886-3-327-9999
F +886-3-327-8898
Mail: info@chromaate.com
http://www.chromaate.com