REXGEAR

*Your Power Solution Expert*


# 87660 High Performance 6-Channel Power Analyzer

## User Manual （V1.1）

# Table of Contents

# Section 1 Safety Rules

Read this manual carefully before operation of 87660 High Precision Multi Channel Power Analyzer and corresponding types, and follow the manual strictly!


Warning! prompting that the operation, application or conditions are dangerous, or even cause personnel death/injury. This sign shall be attached on the “Warning” positions listed in the manual.


Caution! prompting that the operation, application or conditions are dangerous or even damage to the analyzer, or the data stored in the instrument is lost. This sign shall be attached on the necessary positions noting “Caution” as listed in the manual.

- This manual will be changed following upgrading of performance and functions without prior notice.
- The pictures in this manual may differ from what appears on the screen of the instrument due to upgrading etc.
- We try our best ensure the accuracy of the contents of this manual. For any questions or errors, please contact REXGEAR company
- Without the permission of REXGEAR, it is strictly prohibited to copy or reproduce whole or part of the contents of this manual.
- To consult or ask for the latest manual, refer to the mailbox on homepage.

# Section 2 Technical Specifications

## I. Product Introduction

This 87660 series high-precision multi channel power analyzer adopts the latest FPGA+ARM parallel synchronous processing technology, IEC standard 3U compact chassis with exquisite appearance, widely used in energy efficiency testing etc. of three-phase electrical equipment, standard Ethernet-based TCP-MODBUS protocol, in line with engineering integration; LCD display, touch experience, waveform display of up to 6 channels simultaneously, CSV data export, effective Edit Range, synchronous cascading and other advanced functions.

## II. Features

1. High precision, wide frequency band: basic precision up to 0.05%, the minimum 100ms display data update cycle, AC/DC signal, power test bandwidth DC 0.5HZ-100kHz, meeting the requirements of various standard and non-standard sine wave load power tests.

2. Advanced motor measurement module and reserved motor sensor measurement interface, suitable for most motor sensor signal tests on the market; three-phase motor efficiency tested by a single machine to ensure signal synchronization and improve accuracy.

3. RS232/RS485, Ethernet interface; standard modbus, modbus/TCP and other optional protocols.

4. Mixed-frequency sampling, more accurate measurement of high frequency waveform.

5. LCD display, touch screen operation, simultaneous display of multiple waveforms.

## III. Main technical parameters of equipment

| | |
|---|---|
| Model | 87660 |
| Current specification | 20A |
| Wiring | 1P3W (single-phase 3-wire), 3P3W (three-phase 3-wire, 2-voltage and 2-current),<br>3V3A (three-phase 3-wire, 3-voltage and 3-current), 3P4W (three-phase 4-wire) |
| Input impedance of each phase | Voltage: about 2MΩ<br>Direct current input: about 10mΩ　　Current sensor input: about 100kΩ |
| Full-scale crest factor | 3 or 6 |
| Rated voltage range (Direct input) | 15/30/60/100/150/300/600/1000*[V]<br>* Crest factor of 1000V full-scale is 1.5 |
| Rated current range (Direct input) | 20A Current specification: 500m/1/2/5/10/20*[A]<br>Optional:<br>50A Current specification: 2/5/10/20/40/50*[A]<br>5A Current specification: 100m/200m/500m/1/2/5*[A]<br>1A Current specification: 20m/50m/100m/200m/500m/1*[A]<br>* Crest factor of 20A maximum scale full- scale is 1.5 |
| Rated current range (Sensor input) | 50m/100m/200m/500m/1/2/5/10[V] |
| Voltage/Current Precision scope | (1%～110%)× Range<br>* Accuracy of 1000V/20A range: (1%～100%) x scale |
| Range of power factor | ±(0.001 ～ 1.000) |
| Voltage measurement accuracy | DC　± (0.05%× indication +0.05%×range)<br>0.1Hz≤f＜66Hz　± (0.05%× indication +0.05%×range)<br>6 66Hz＜f≤1kHz　± (0.1%× indication +0.1%×range)<br>1kHz＜f≤10kHz　± ({0.1+0.05×(f-1)}%×indication+0.2%×range)<br>10kHz＜f≤100kHz　± ({0.5+0.04×(f-10)}%×indication+0.3%×range) |
| Current precision | DC　± (0.05%× indication +0.05%×range)<br>0.1Hz≤f＜66Hz　± (0.05%× indication +0.05%×range)<br>66Hz＜f≤1kHz　± (0.1%× indication +0.1%×range)<br>1kHz＜f≤10kHz　± ({0.1×f} %× indication+0.2%×range)<br>10kHz＜f≤100kHz　± ({1+0.08×(f-10)}%×indication+0.3%×range) |

| | |
|---|---|
| Active power measurement accuracy | DC ± (0.05%× indication +0.05%×range)<br>0.5Hz≤f＜45Hz ± (0.1%× indication +0.1%×range)<br>45Hz≤f≤66Hz ± (0.05%× indication +0.05%×range)<br>66Hz＜f≤1kHz ± ({0.2+0.1×(f-1)}%×indication+0.2%×range)<br>1kHz＜f≤10kHz ± ({0.2+0.1×(f-1)}%×indication+0.3%×range)<br>10kHz＜f≤100kHz ± ({5.1+0.18×(f-50)}%×indication+0.3%×range) |
| Active power measurement range | 4.4mW~4.4 kW/phase @220V，PF=0.001~1.000 |
| Active power resolution | 0.1mW |
| Frequency range | DC，0.5Hz ～ 100kHz |
| Frequency measurement accuracy | ±0.1%× indication |
| Harmonic measurement | 10Hz ~ 600Hz, 1~50th harmonic content, total distortion |
| Energy measurement range | 0～99999MWh (Resolution: 1mWh/0.01mAh) |
| Energy measurement accuracy | ±(0.1%× indication +0.1%×range) |
| Power meter | 99 hours 59 minutes 59 seconds |
| Filter | 500Hz, 5.5kHz voltage/current line and frequency filter |
| Voltage/current ratio | 1.0～ 50000.0 |
| External input ratio | 0.010~100.000 |
| Update cycle | 100m / 200m / 500m / 1/2/5/10[s] |
| Control interface | Standard RS-232, Ethernet;<br>Optional RS-485, motor measurement board (pulse torque rotation rate sensor) |
| Protocol | REXGEAR3.0，Modbus，TCP Modbus |
| Outline dimension | 426（W）× 132.5（H）× 443（D）mm |
| Size of opening | 426（W）× 132.5（H） mm |
| Foot height | 15 mm |
| Machine weight | About 4 kg |
| Power consumption of whole machine | About 60VA |

1. Temp.: 23±5℃; Humidity: 30%~75%RH; input wave: sine; common mode; voltage: 0V; LINE filter: OFF; frequency filter: ON under 440Hz; power factor λ: 1; crest factor: 3. After warming up. Connected, after resetting or changing the scale

2. The f in the measurement accuracy formula is the frequency in kHz.

3. When the update rate is 100ms, all accuracies are the value plus 0.05% of the reading.

4. Impact due to change to Temp. after resetting or changing the scale:

Plus 0.02% x scale/℃ for voltage DC accuracy, 500μA/℃ for current DC accuracy, 50μV/℃ for external sensor DC accuracy, product of voltage impact and current impact for power DC accuracy.

## VI. System Setting Influence on Accuracy

### 1. Line filter influence on measurement accuracy

The LINE filters are in the voltage/current measurement circuit. As the LINE filter is switched on, the measurement doesn't contain high frequency components, and the noise in the frequency converter, switching power supply or wave distortion will be eliminated, directly influencing the voltage, current and power measurement accuracy. As the LINE filter is switched on, the influence on measurement accuracy is as followed:

| Line filter | Voltage/Current | Power |
|---|---|---|

| | | |
|---|---|---|
| ON | For cutoff frequency of 500Hz,<br>45Hz~66Hz: plus 0.2% x reading<br>＜45Hz: plus 0.5% x reading<br>For cutoff frequency of 5.5kHz,<br>≤66Hz: plus 0.2% x reading<br>66Hz~500Hz: plus 0.5% x reading | For cutoff frequency of 500Hz,<br>45Hz~66Hz: plus 0.3% x reading<br>＜45Hz: plus 1% x reading<br>For cutoff frequency of 5.5kHz,<br>≤66Hz: plus 0.4% x reading<br>66Hz~500Hz: plus 1.2% x reading |

**2. Harmonics influence on measurement accuracy**

As harmonics measurement is ON, the measurement accuracy (reading error +scale error) is as following:

(1) As the LINE filter is ON (5.5kHz)

| Frequency | Voltage/Current | Power |
|---|---|---|
| 10Hz≤f＜45Hz | 0.4% x reading +0.35% x scale | 0.85% x reading +0.5% x scale |
| 45Hz≤f＜440Hz | 0.75% x reading +0.35% x scale | 1.5% x reading +0.5% x scale |
| 440Hz≤f＜1kHz | 1.2% x reading +0.35% x scale | 2.4% x reading +0.5% x scale |

(2) As the LINE filter is OFF

| Frequency | Voltage/Current | Power |
|---|---|---|
| 10Hz≤f＜45Hz | 0.15% x reading +0.35% x scale | 0.35% x reading +0.5% x scale |
| 45Hz≤f＜440Hz | 0.15% x reading +0.35% x scale | 0.25% x reading +0.5% x scale |
| 440Hz≤f＜1kHz | 0.2% x reading +0.35% x scale | 0.4% x reading +0.5% x scale |

**3. Calculation cycle and frequency measurement lower limit**

The frequency measurement range is different for different calculation cycle, as shown following:

| **Calculation cycle** | 0.1s | 0.25s | 0.5s |
|---|---|---|---|
| **Measurement frequency range** | 25Hz~100kHz | 10Hz~100kHz | 5Hz~100kHz |
| | 1s | 2s | 5s |
| | 2.5Hz~100kHz | 1.5Hz~50kHz | 0.5Hz~20kHz |

# V.Dimensions W×H×D

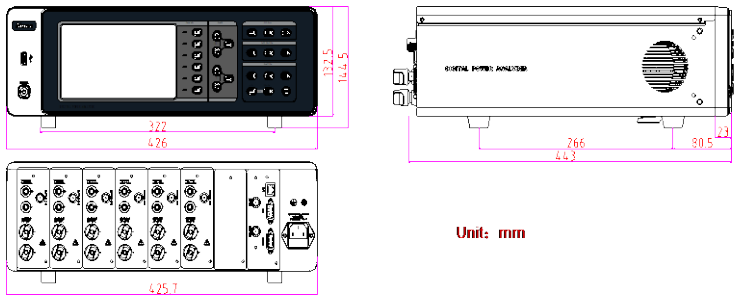



Figure 2-1 Outline dimension

# Section 3 Operation Manual

## I. Front Panel

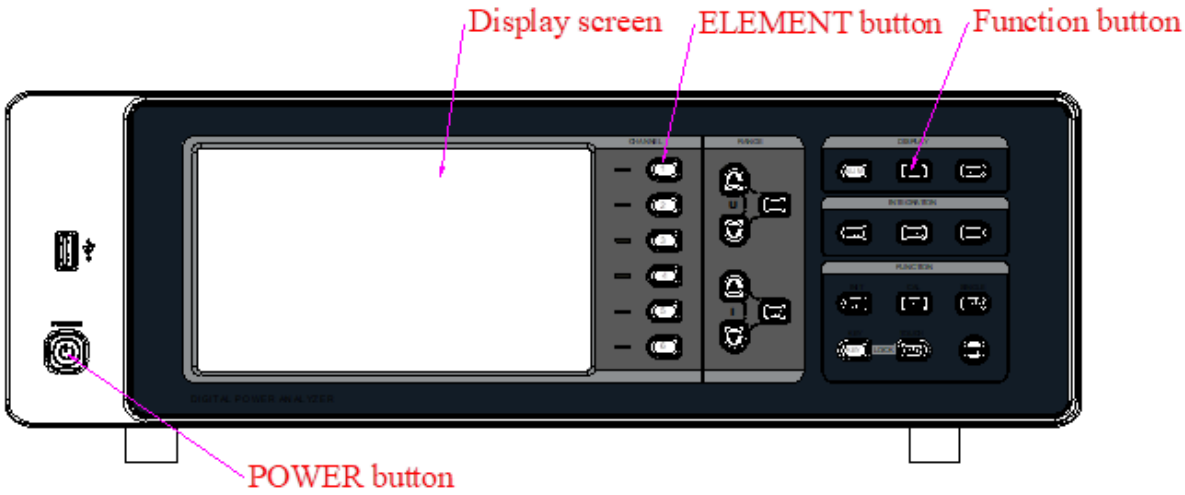



Figure 3-1 Front panel

### 1. Test Interface Description

- **Main interface**


Figure 3-2 Main screen

① OVER RANGE LED

② Function LED

③ WIRING

④ INTEG LED

⑤ Data display

⑥ ELEMENT area: including range, waveform color, scale, and filter ON/OFF state.

⑦ Data update: real-time display of current data collection times of each input element after the measurement is started.

⑧ U-disk plug/unplug LED

⑨ Communication connection indication

⑩ Current time

- **Numerical screen:**

For numerical data display, multiple measurements can be displayed, including 4, 8, 16 or All (all displayed) optional; in addition, each displayed item can be set separately, convenient for quick view of various parameters and improving measurement efficiency, as shown in the figure below:

Numerical display:

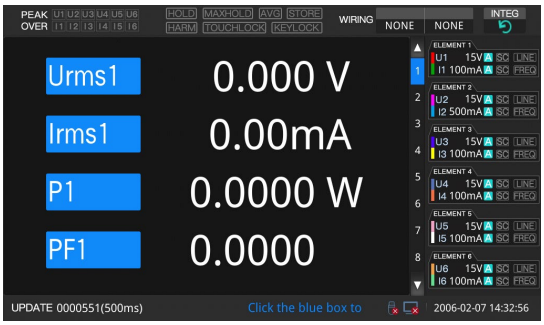



Figure 3-3 4-item display

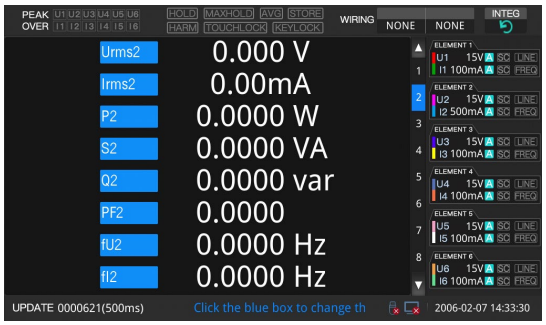



Figure 3-4 8-item display

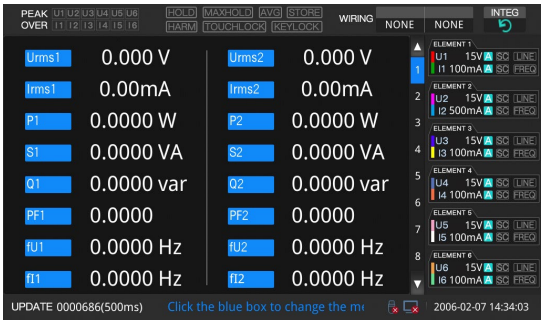



Figure 3-5 16-item display

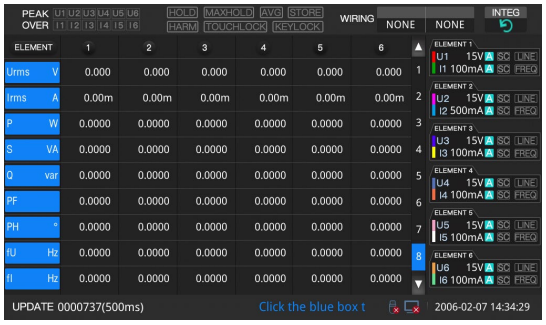



Figure 3-6 All value display

- **List (harmonic measurements)**

The harmonic module performs fast Fourier transform (DFT) processing on the original sampled points, and displays the voltage/current harmonic distortion, single harmonic content (up to 50th), single harmonic RMS and other parameters.

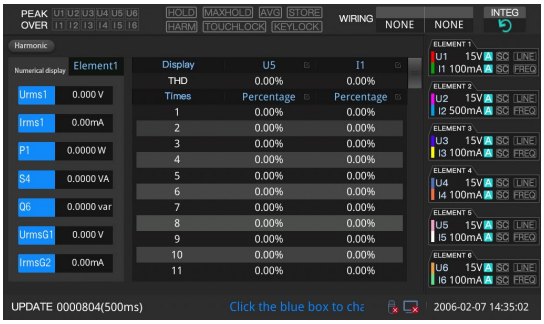



Figure 3-7 List

- **Waveform display**

To measure the waveform of voltage, current and other signals, view and analyze the voltage-current signal phase difference and waveform distortion. Multiple waveforms can be compared in the same group, and up to 6 waveforms can be displayed simultaneously.

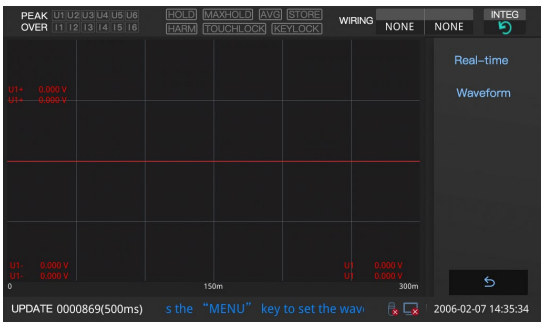



Figure 3-8 Waveform Display

Note: The setting of related screen is described in Section 4 Operation.

# II. Rear Panel

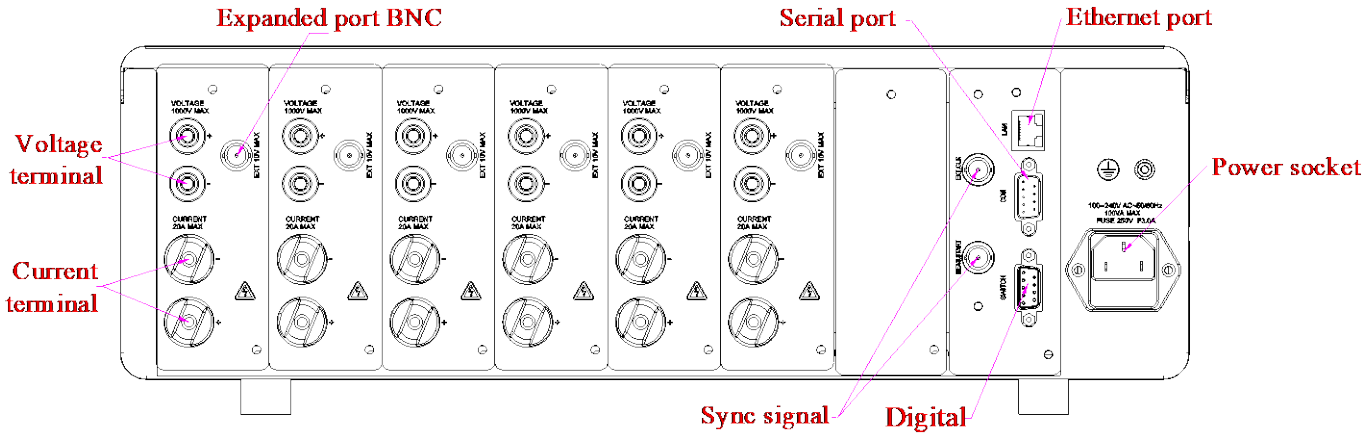



Figure 3-9 Rear panel

1. The rear panel consists of the following parts: power socket, voltage/current terminal, serial port, expanded port BNC, motor card/digital port, Ethernet port.

2. The power socket is set for the power input for the instrument. There is a fuse (250V/3A) under the socket.

3. The voltage/current terminal is the terminal for connecting the measurement circuit.

4. The serial port is standard RS232 or optional RS232/RS485.

5. The network port is RJ-45.

6. A standard BNC terminal is set for synchronized signals.

# III. Electrical wiring description

### 1. Voltage input terminal

The terminal is a Φ4mm safety banana jack.

Insert the safety plug (wire not exposed) into the voltage input terminal. A voltage measurement line with a safety plug and a measurement clip is accompanied.

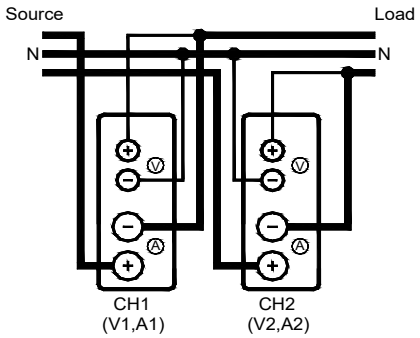
### 2. Current input terminal

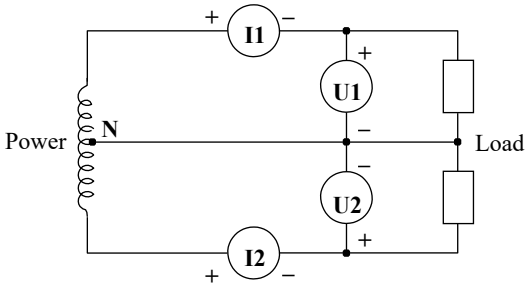
M8 stud terminal is used. It is recommended to use professional OT crimping terminals to pre-treat the measurement wire. Buckle the OT terminal to the stud, and then hold the terminal knob to tighten. No current measurement wire is provided with the box.

### 3. Configuration and wiring

The wiring of analyzer depends on the configuration of the measurement channel, including 1P3W, 3P3W, 3V3A, 3P4W, etc.

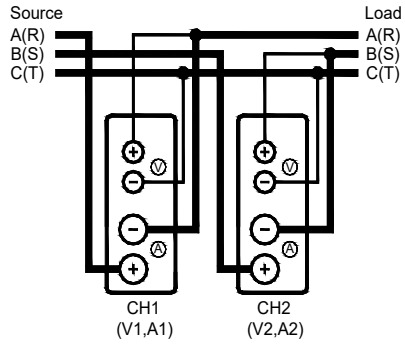
### 3.1 Single-phase 3-wire (1P3W) wiring

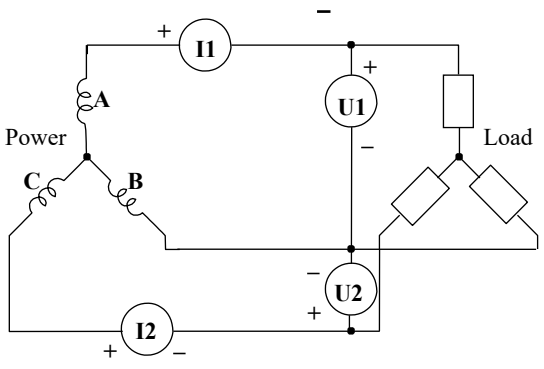


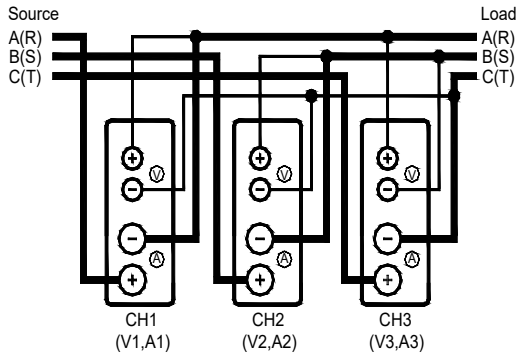

### 3.2 Three-phase 3-wire (3P3W) wiring

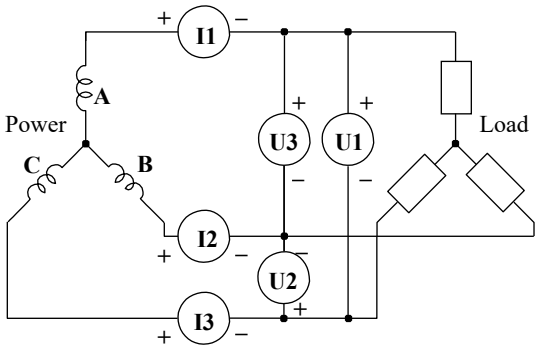
### 2 meters (2V2A) wiring



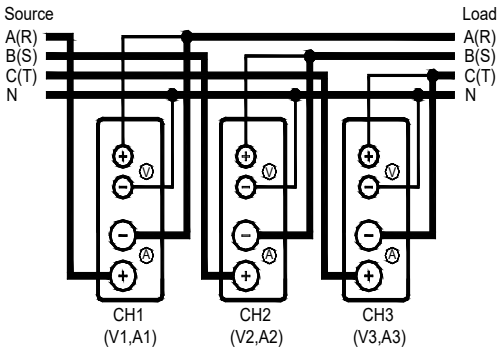



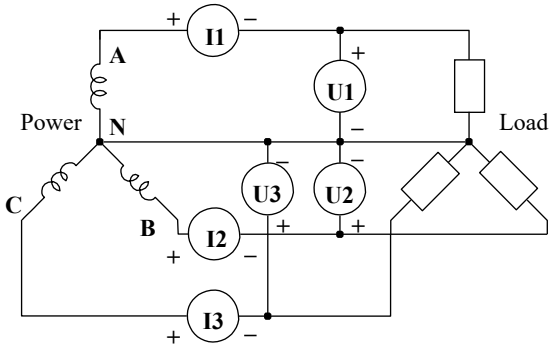
### 3.3 3 meters (3V3A) wiring




### 3.4 Three-phase 4-wire (3P4W) wiring




### 4. Wiring for verification using standard source

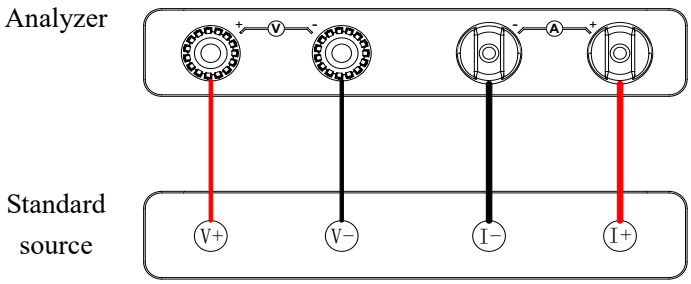



Figure 3-10 Wiring for verification using standard source

**5. Wiring for verification using standard meter**

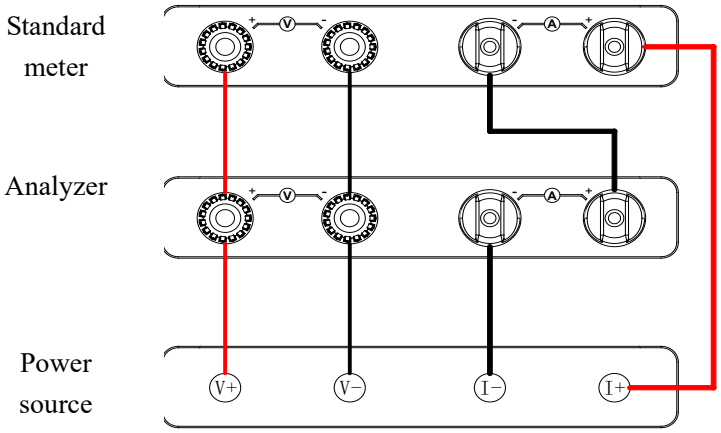



Figure 3-11 Wiring for verification using standard meter

**Caution**

- Press SHIFT+ESC before measuring to restore the initial settings (INIT).
- To perform current measurement, the voltage input terminal of the analyzer must have a voltage input of 60V or higher

**6. Section of Cable**

For carrying capacity of copper cable, see standard IEC 60364-5-523 IEC Electrical Installations of Buildings Part 5: Selection and Erection of Electrical Equipment - Section 523: Current-Carrying Capacities in Wiring Systems (1983). The maximum current measurement of the analyzer is 20A, it is recommended to use copper wires with section area≥4mm$^2$.

# Section 4 Operation

## I. Buttons

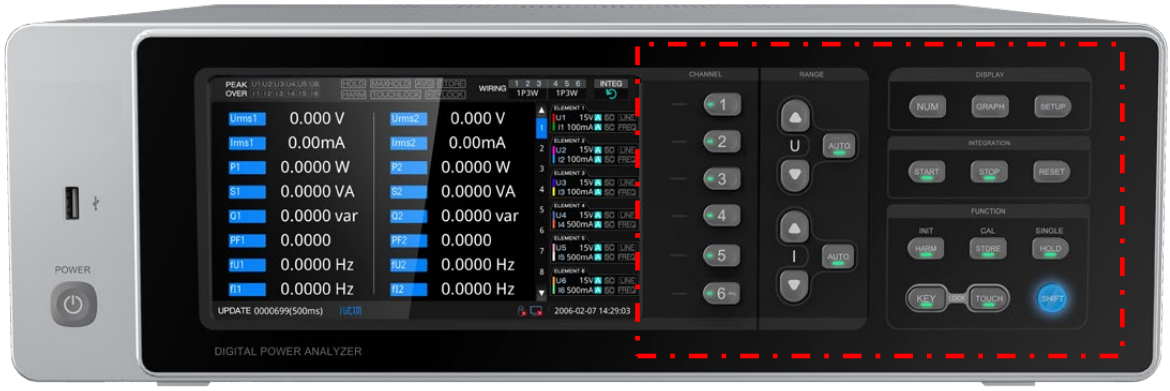



Figure 4.1 Keypad

### 1. General

The keypad is shown in the dashed frame in Figure 4.1, including range and page control, etc. Some buttons can be reused and switched via SHIFT.

### 2. Range area


Figure 4.2 Range area

Press the buttons in the range setting area (Figure 4.2) to control the voltage/current ranges. The steps are as follows:

(1) Enable the channel in ELEMENT area. For example, to set range of Channel 1, press button "1", the left channel LED will be on. At this time, you can switch the range for Channel 1, and multiple ranges can be switched;

(2) Adjust up/down ranges and auto range in RANGE area;

(3) After the setting is completed, click the button in ELEMENT area to disable the channel, and the left channel LED will go out.

### 3. PAGE area

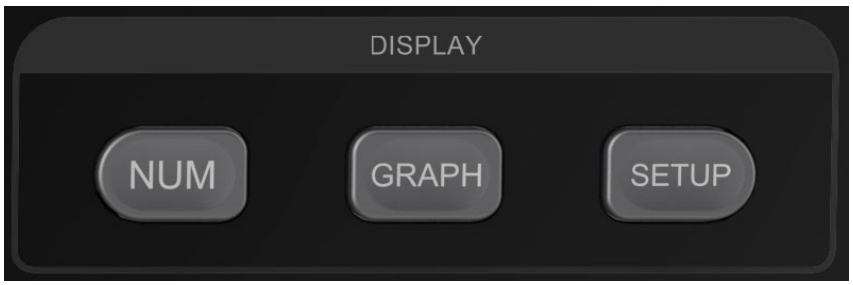



Figure 4.3 PAGE area

NUM: Press to switch to the numerical display screen; repeated presses toggle between numerical displays.

GRAPH: Press to switch to the waveform display screen.

SETUP: Press to enter the setup interface.

**4. Function operation area**


Figure 4.4 Function operation area

START: Integration start button, press to initiate integration.

STOP: Press to halt the integration.

RESET: Integration reset button.

**5. Setting area**

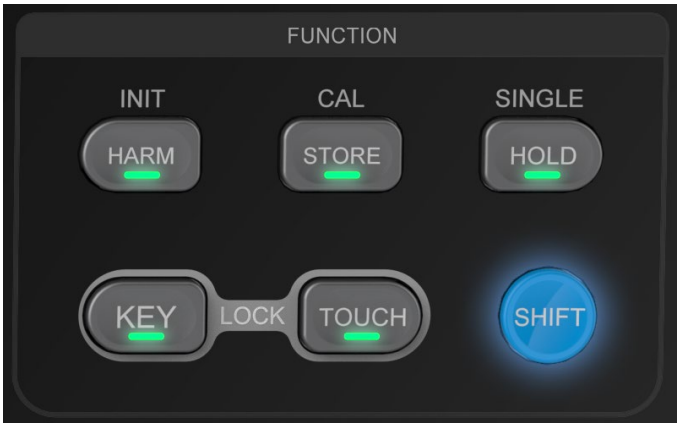



Figure 4.5 Function operation area

HARM: Press to activate the harmonic function.

STORE: Press to enable USB storage.

HOLD: Press to lock data refresh after activation.

KEYLOCK: Key lock, pressing the buttons will be disabled.

TOUCHLOCK: Screen lock, touch functionality will be disabled after pressing.

Multipurpose functions:

INIT: System settings initialization.

CAL: Used to initiate zero-point acquisition.

SINGLE: Press the Single key to perform a single measurement operation. When in the hold state, a single me asurement is executed based on the current data update rate before returning to the hold state.

# II. Setting display items

### 1. Setting Mode Description

In numerical display screen, the items on the current page can be customized and will not be lost after power off, convenient to set multiple groups for targeted data view. The setting is as follows:

① Press the measurement item button, as shown in the dashed frame

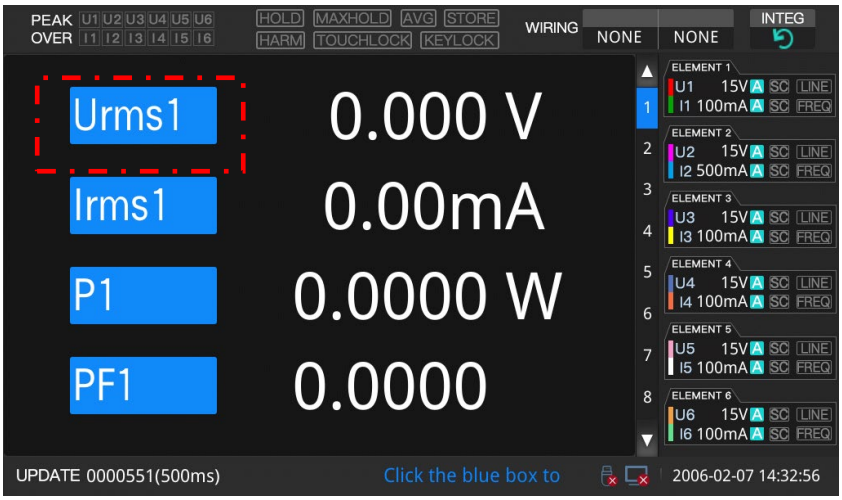



Figure 4.7 4-item display (before item change)

② The item selection box pops up. Select the measurement item and its channel to be displayed as shown in the figure below. Click OK to complete the setting. Click Cancel to exit the editing screen without saving.

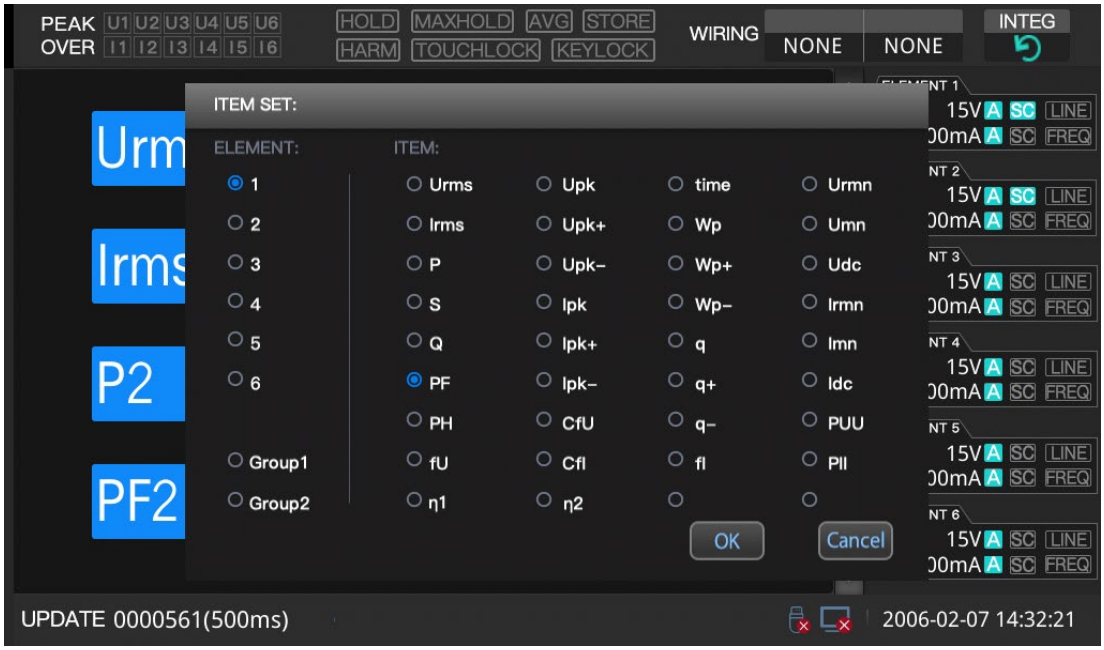



Figure 4.8 4-item option

③ The display item is set. The display in dashed frame area is changed from Urms1 to Irms1.


Figure 4.9 4-item display (after item change)

**2. Meaning of measurement items**

Table 4.1

| Symbol | Meaning |
|---|---|
| Urms | Voltage effective value |
| Irms | Current effective value |
| P | Active power |
| S | Apparent power |
| Q | Reactive power |
| PF | Power factor |
| PH | Phase angle |
| fU | Voltage frequency |
| fI | Current frequency |
| Upk | Peak voltage |
| Upk+ | Positive peak voltage |
| Upk- | Negative peak voltage |
| Ipk | Peak current |
| Ipk+ | Positive peak current |
| Ipk- | Negative peak current |
| CfU | Voltage crest factor |
| CfI | Current crest factor |
| time | Electric energy accumulation time |

| | |
|---|---|
| timeL | Electric energy accumulation time to reach current threshold |
| Wp | Sum of integral positive/negative electric energy |
| Wp+ | Accumulated positive electric energy |
| Wp- | Accumulated negative electric energy |
| q | Sum of integral positive/negative electricity |
| q+ | Accumulated positive electricity |
| q- | Accumulated negative electricity |
| Urmn | RMN of voltage |
| Umn | Mean of voltage |
| Udc | Voltage DC component (average) |
| Irmn | RMN of current |
| Imn | Mean of current |
| Idc | Current DC component (average) |
| PUU | Voltage phase angle |
| PII | Current phase angle |
| η1 | Efficiency 1 |
| η2 | Efficiency 2 |
| 1~6 | 1~6 channels |
| Group1 | Three-phase Group 1 (ELEMENT 1, 2, 3) |
| Group2 | Three-phase Group 2 (ELEMENT 4, 5, 6) |

## III. Set basic measurement conditions

### 1. Set wiring

1) Function introduction

To measure the power of various single-phase/three-phase modes, the 87660 high-precision power analyzer provides 4 multi-phase multi-wire wiring modes: single-phase 3-wire (1P3W), three-phase 3-wire (3P3W), three-phase 3-wire (3-voltage 3-ammeter, 3P3W (3V3A)) and three-phase 4-wire system (3P4W).

The 6 channels are divided into two groups: Channel 1~3 are three-phase Group 1, and channel 4~6 are three-phase Group 2.

2) Wiring switch

① Press the right MEASURE button, the Measure menu appears, as follows

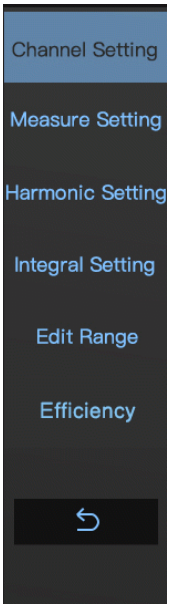



Figure 4.10 Measure Setting menu

② Click Measure Setting menu to enter Measure Setting screen.


Figure 4.11 Wiring setting

③ Set two sets of wiring respectively through the drop-down menu.

### 2. Set voltage/current range

There are two modes for range setting:

One:

Set the voltage/current range via the buttons in Range area (Figure 4.12):

(1) Enable the channel in ELEMENT area, for example, to set range of Channel 1, press button "1", the left channel LED is on;

(2) Switch to upper/lower range or AUTO range via buttons in RANGE area.

(3) After the setting is completed, click the button in ELEMENT area to disable the channel, and the left channel LED will go out.

Two:

(1) Press the button MEASURE on the keypad to enter Channel Setting screen.

(2) Set the range of Channel 1~6 via the pull-down menu in Range setting area, or press ALL to set all channels at the same time.

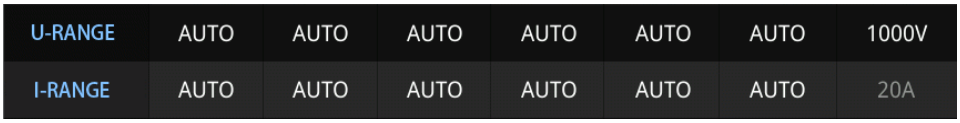



Figure 4.12 Range setting area

**3. Set external current sensor (BNC input)**

1) Function introduction

When the current measurement is greater than the meter range, different types of transformers and sensors may be chosen for measuring together with the power analyzer. Now different channel may be chosen as follows:

Table 4.2 Common current measurement methods

| External input device | Remark | Channel |
|---|---|---|
| **Shunt current transformer** | Also known as a shunt, it connects precision resistors with small impedance in series in the current signal circuit to be measured; when a current signal to be measured passes through the resistor, the voltage across the resistor can be measured, and the current to be measured can be calculated according to Ohm's law. | Current channel |
| **Split core type current transformer (Voltage output)** | Used for field testing without disassembling the tested circuit, easy to operate. It can transform the current into a magnetic field signal with a fixed function, and then transform the magnetic field signal into a voltage or current with a function relationship; thereby measuring the current. | BNC channel |
| **Split core type current transformer (current output)** | | Current channel |
| **CT (current transformer)** | Convert the primary current with large value into a secondary current with smaller value through a ratio for measurement | Mainly current channels, or BNC channel for some special specifications |

When using BNC channels, the current source needs to be set to BNC mode.

2) Operation

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② In Current Source area, you can set current source1~6 via pull-down menu. When using the BNC channel, set the current source to "BNC", as shown in the figure below, set channel 2 and 4 to BNC mode. You can select ALL to set all channels at the same time.


Figure 4.13 Current source setting area

**4. Set voltage/current ratio**

(1) Function introduction

The user can measure the signal through a voltage transformer or a current transformer, and then convert the voltage/current before voltage/current transformation. Among them, the current and the external input BNC

ratio need to be set separately.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② In Voltage ratio area, you can set the ratio of Channel 1~6 via the keyboard, as shown in the figure below. You can select ALL to set all channels at the same time.

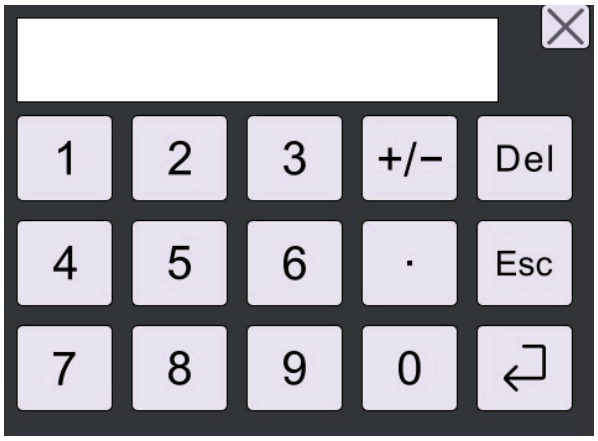



Figure 4.14 Keyboard

Set ranges of voltage, current and BNC ratios:

- Voltage ratio: 1~50000.0;
- Current ratio: 1~50000.0;
- BNC ratio: 0.01~100.000, mV/A;

For example, when a voltage output type current transformer with a voltage output of 10mV for 1A current measurement is used to measure 100A current, the output voltage is 10mV/A×100A = 1V, and the transformer ratio is 10mV/A.

**5. Set LINE filter and FREQ filter**

(1) Function introduction

Filters can be used to remove noise in the measurements. The LINE filter works in the voltage/current measurement circuit, and the FREQ filter works in the frequency measurement circuit.

The FREQ filter affects the frequency measurement in the frequency measurement circuit. Since this filter is not in the measurement circuit of voltage, current and power, even if the FREQ filter is turned on, the measurements will contain high frequency components.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② In LINE/FRREQ filter area, you can set the filter of Channel 1~6 via the keyboard, as shown in the figure below. You can select ALL to set all channels at the same time.


Figure 4.15 Filter setting area

Where the LINE filter can be set to 500Hz or 5.5kHz optional, and the FREQ filter is 500Hz after turn on.

**6. Set simultaneous source**

(1) Function introduction

The selection of simultaneous source affects the measurement interval. The simultaneous input signal (simultaneous source) passes from the initial point of the rising slope (or falling slope) that crosses the zero point (intermediate of amplitude) to the last point of the rising slope (or falling slope) that crosses the zero point (intermediate of amplitude) in the update cycle. If there is no or only one zero-crossing point in the update cycle, the entire update cycle is the measurement interval.

After selecting the input unit for the simultaneous source, select and set the simultaneous source from the following: U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, EXT (external) or None.

If improper simultaneous source is set, the measurement may be unstable or wrong.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② In Simultaneous Source area, you can set the simultaneous source of Channel 1~6 via the keyboard, as shown in the figure below. You can select ALL to set all channels at the same time.

(3) Precautions

① The simultaneous source is set to U1 by default. When Channel 1 works normally, the simultaneous source is U1.

② When the simultaneous source is set to external (EXT), the EXT CLK on the rear panel needs an external simultaneous signal, which is controlled at 2V~5V TTL. If it exceeds the range, the instrument may be burnt.

**7. Set crest factor**

Method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click Measure menu to enter Measure screen.

③ Click Crest Factor drop-down menu to select: CF3 or CF6 mode, as shown in the figure below.


Figure 4.16 Crest factor

**8. Set update cycle**

(1) Function introduction

The user needs to set the update cycle according to the measurement needs. With fast update, faster load changes in the power system can be obtained; with low update, sample data in several cycles of longer signal can be obtained.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click Measure menu to enter Measure screen.

③ Click Calculation cycle drop-down menu to select: 100ms~10s.

**9. Set efficiency formula**

(1) Function introduction

This instrument can measure two sets of efficiency simultaneously. The user can set the numerator and denominator of the efficiency formula as needed, and the efficiency can be read directly through display and/or

communication.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click the right Efficiency Calculation menu to enter Efficiency Formula screen.

③ Get the required efficiency value by clicking the adjustment formula.

**10. Set AVG (average)**

(1) Function introduction

When the power or load changes greatly or the input signal frequency is low, the value display is unstable and difficult to read. In this case, the average function can be enabled to obtain and display the mean of multiple measurements. If the input signal changes sharply, the response of measurement to the change will become slower.

(2) Average calculation

① Exponential average

The user can set the attenuation coefficient to exponentially average the effective value of voltage/current RMS and the instantaneous value of active power (sampled data) to remove the high-frequency components of measurements. The larger the attenuation coefficient, the better the noise removal effect; but the measurement delay will be correspondingly longer.

② Attenuation constant or average number

Users need to configure related parameters to use the averaging function. If the average type is Exp (exponential average), set the attenuation coefficient; if it is Lin (moving average), set the average number. For both the attenuation coefficient of exponential average or the average number of moving average, the larger the setting, the more stable the measurement, and the slower the response speed to input changes.

③ Calculation formula

$$D_n = \left(M_{n-(m-1)} + M_{n-(m-2)} + \ldots + M_{n-2} + M_{n-1} + M_n\right)/m$$

Exponential average formula:

$$D_n = D_{n-1} + \left(M_n - D_{n-1}\right)/K$$

The variables are shown in the following table:

Table 4.3 Variables of average formula

| Symbol | Remark |
|---|---|
| $D_n$ | $n^{th}$ display |
| $M_n$ | $n^{th}$ measurement |
| $D_{n-1}$ | Display after n-$1^{th}$ exponential average |
| $M_{n-(m-1)}$ | Measurement that is m-1 time earlier than the $n^{th}$ measurement |
| $M_{n-(m-2)}$ | Measurement that is m-2 time earlier than the $n^{th}$ measurement |
| $M_{n-2}$ | Measurement that is 2 times earlier than the $n^{th}$ measurement |
| $M_{n-1}$ | Measurement that is 1 time earlier than the $n^{th}$ measurement |

| | |
|---|---|
| K | Average coefficient |
| m | Average coefficient |

④ Measurement with average function

Measurement with average function: U, I, P, S, and Q.

(3) Steps

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click Measure menu to enter Measure screen.

③ Set the average ON/OFF, calculation mode, and average coefficient by clicking.

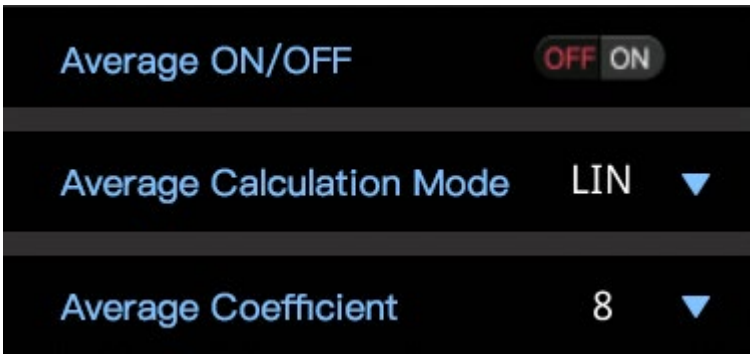



Figure 4.17 Average function

**11. Set master/slave synchronous measurement**

(1) Function introduction

The 87660 analyzer supports multi-machine cascading, one is the master and the other is the slave. Connect MEAN START terminals on the rear panel of the two analyzers using BNC cables to perform a synchronous measurement. When the master starts the measurement, the slave also starts the measurement. When the master machine stops, the slave machine also stops.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click Measure menu to enter Measure screen.

③ Select the master/slave by clicking, the default is Master mode in normal state.


Figure 4.18 Synchronous measurement

**12. Set MAXHOLD**

(1) Function introduction

The user can hold the maximum data with this function.

Valid for the following values:

Urms、Umn、Upk、Upk+、Upk-

Irms、Imn、Ipk、Ipk+、Ipk-

P、S、Q

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click Measure menu to enter Measure screen.

③ Switch MAXHOLD ON/OFF by clicking.


Figure 4.19 MAXHOLD

**13. HOLD and single measurement**

(1) Function introduction

The user can hold the data with this function. The single measurement is valid in HOLD state. After one measurement, it will re-enter HOLD state.

(2) Operation

HOLD ON: Press HOLD button in the button area to enter HOLD state.

Single sampling trigger: Press SHIFT in HOLD state, the SHIFT LED is on. Press HOLD at this time to trigger a single sampling (SINGLE).

Disable HOLD: Press HOLD in HOLD state to disable HOLD.

**14. Parameter initialization**

(1) Function introduction:

Initialize all measurement settings and system settings.

(2) Operation method

After pressing SHIFT button, the SHIFT LED is on. Press ESC at this time to initialize the parameters.

**15. Zeropoint acquisition**

(1) Function introduction

Resetting is required before measuring using the instrument. Resetting is to instruct the input signal in the internal circuit of high-precision power analyzer to be zero, thereby improving the accuracy of the instrument. There are two resetting methods: automatic and manual.

With automatic resetting, the instrument will automatically perform resetting after changing the measurement range and input filter. If the same measurement range and input filter are used for long time, the zero level of the power analyzer may change due to changes in the surrounding environment. In this case, manual resetting must be performed.

(2) Manual resetting

Press SHIFT button, the SHIFT LED is on. Press INTEG at this time to trigger a zeropoint acquisition.

**16. Set effective measurement range**

(1) Function introduction

The effective range of 87660 analyzer can be chosen. During the automatic shift, only the selected ranges are switched in cycle, and the unselected ranges are skipped, shortening the shifting time and improving the efficiency.

(2) Operation method

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click the right Edit Range menu to enter Edit Range screen.

③ Select the type (voltage/current) of the range to be changed.

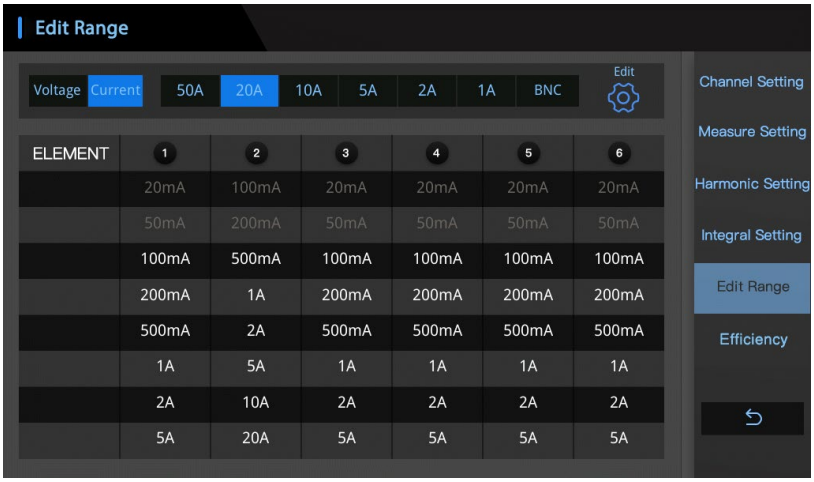



Figure 4.20 Edit Range screen

Select the model of board when selecting the current channel.

④ Click the right Edit after selecting the type and board to enter Edit Range screen, as shown below. Then enable the range to be used as needed, and click Exit to save after setting.

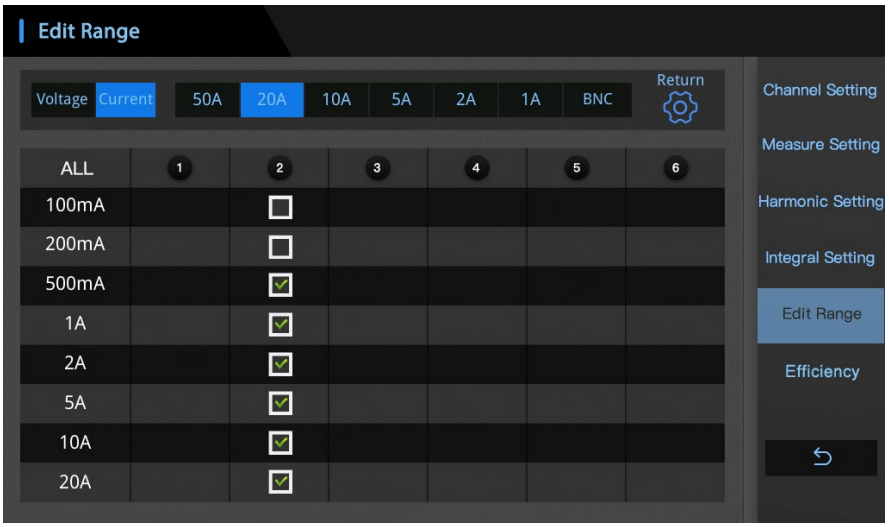



Figure 4.21 Edit Range area

**17. TOUCHLOCK and KEYLOCK**

(1) Function introduction:

Press TOUCHLOCK and KEYLOCK to lock touch and keys to prevent accidental touches on site.

(2) Operation method

KEYLOCK: Press SHIFT button, the SHIFT LED is on. Press PAGE UP at this time to trigger the KEYLOCK. At this time, the keys do not respond. Repeat to disable KEYLOCK.

TOUCHLOCK: Press SHIFT button, the SHIFT LED is on. Press PAGE DOWN at this time to trigger TOUCHLOCK. At this time, the touch screen does not respond. Repeat to disable TOUCHLOCK.

## VI. INTEG function

The power analyzer can integrate the power and current of single-phase/three-phase wiring groups.

(1) INTEG output parameters

Wp 、Wp+、Wp-

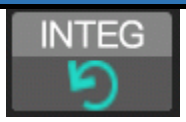
q、q+、q-

time、timeL

(2) INTEG state

The INTEG state can be obtained from the INTEG state icon on the upper part of numerical display, as shown in the following table:

Table 4.4 Energy INTEG state

| State | Remark | Icon |
|---|---|---|
| RESET | Reset or preparation: The integration value display and the integration time display are reset after integration reset. |  |
| START | Integration start: the integration is in progress |  |
| STOP | Integration stop: displayed when integration is interrupted |  |

(3) Setting of integral parameters

**Integration time**: to set the integration timing. If it is set to 0, it will not be timed, and the cyclic integration mode is invalid.

**Integration mode**: Configure the integration mode before using the integration function, including standard NOR mode and CONT cycle mode. The NOR integration mode stops after the set time ends or when it is manually stopped. The CONT integration mode resets and restarts after the set time ends, until the stop button is pressed.

**Restart INTEG state**: If the integration is in START state when shutting down, the set INTEG state will be displayed after restarting.

**Three-phase current threshold**: when the current three-phase current exceeds this value, the electric energy will be accumulated, and the default is 0.

(4) Parameter setting

① Press the button MEASURE on the keypad to enter Channel Setting screen.

② Click the right INTEG Setting menu to enter INTEG Setting screen.

③ Operate the corresponding parameters by clicking.


Figure 4.22 INTEG Setting area

(5) Manual INTEG mode

Press INTEG button in the function area to pop up the following menu, and operate by clicking.


Figure 4.23 INTEG menu

## V. HARM

(1) Function introduction

In HARM mode, the fundamental frequency within 600Hz can be measured up to the 50th harmonic. For specific parameters, see Section 2 Three. Technical Parameters.

The accuracy of conventional measurements will be slightly impacted in HARM mode. For details, see Section Two Four. Impact of System Settings on Measurement Accuracy.

(2) HARM display

The harmonics are displayed on the list screen as shown in the figure below:

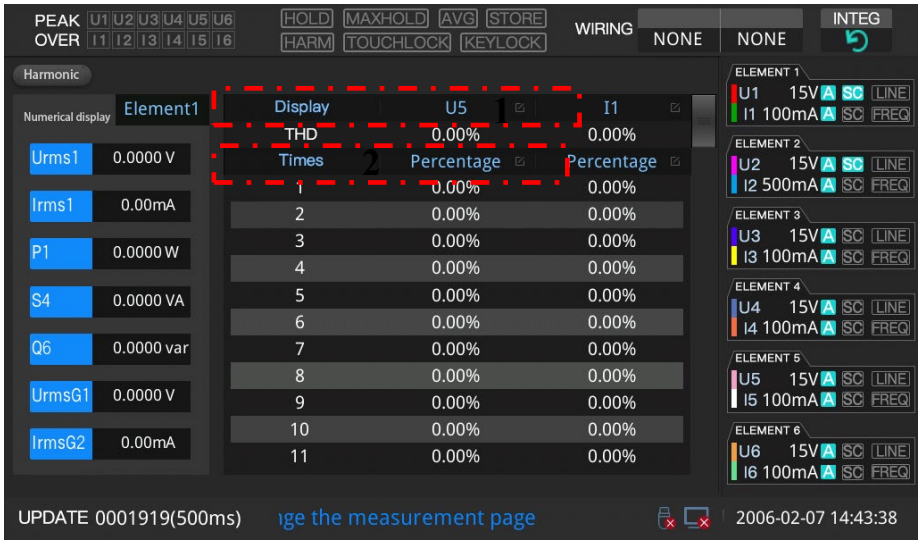



Figure 4.24 HARM display

The voltage/current total harmonic distortion and single harmonic parameters can be displayed simultaneously.

The display channel is set at the above icon marking (1), and the 50th harmonic content or the RMS of harmonic can be selected, marking (2). Control the display times of the current screen by sliding the right scroll bar.

(3) Set HARM measurement parameters

- Parameter description

**Select PLL source**

In HARM mode, the power analyzer uses PLL (Phase Locked Loop) to multiply the frequency of the input signal, and uses the multiplied output signal as the sampling clock of the A/D in the instrument for synchronous sampling. Therefore, the frequency of PLL source signal determines the A/D sampling clock in the instrument, and the quality of PLL source signal also affects the stability and accuracy of the sampled data. The 87660 power analyzer supports two independent PLL sources to measure two different signals at the same time. Channel 1~3 are in Group 1, and channel 4~6 are in Group 2.

**PLL source options**

The PLL source can be selected from the following options (depending on the installed number of input units): frequency of U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6 and other signal are used as the fundamental frequency for harmonic measurement. U1, I1, U2, I2, U3 or I3 can be set for Group 1, and U4, I4, U5, I5, U6 or I6 can be set for Group 2.

**Level of PLL source signal**

If the level of PLL source is too small compared with the range of the measured signals, the PLL will not be able to synchronize with the PLL source. For the power analyzer, the level of PLL source must exceed at least 50% of the range of measured signals.

**Change of PLL source frequency and measurement**

If the frequency of PLL source changes, the PLL circuit inside the instrument needs to re-check the frequency of PLL source, so the correct measurement may not be obtained immediately, and it will only be displayed 200ms~2s after change of the frequency.

**Harmonic order**

The user can specify the harmonic order, which mainly affects the times THD participates in the calculation.

**THD calculation mode**

The IEC mode is chosen to calculate the ratio of rms of 2~50th harmonic components to the fundamental rms;

The CSA mode is chosen to calculate the ratio of rms of 2~50th harmonic components to the 1st~50th harmonics;

IEC's THD calculation formula: $\frac{\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right]}{C_1}$ CSA's THD calculation formula: $\frac{\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right]}{\left[\sqrt{\sum_{k=1}^{n}(C_k)^2}\right]}$

- Parameter setting

① Press the button SETUP on the keypad to enter Channel Setting screen.

② Click the right HARM Setting menu to enter HARM Setting screen.

③ Operate the corresponding parameters by clicking.

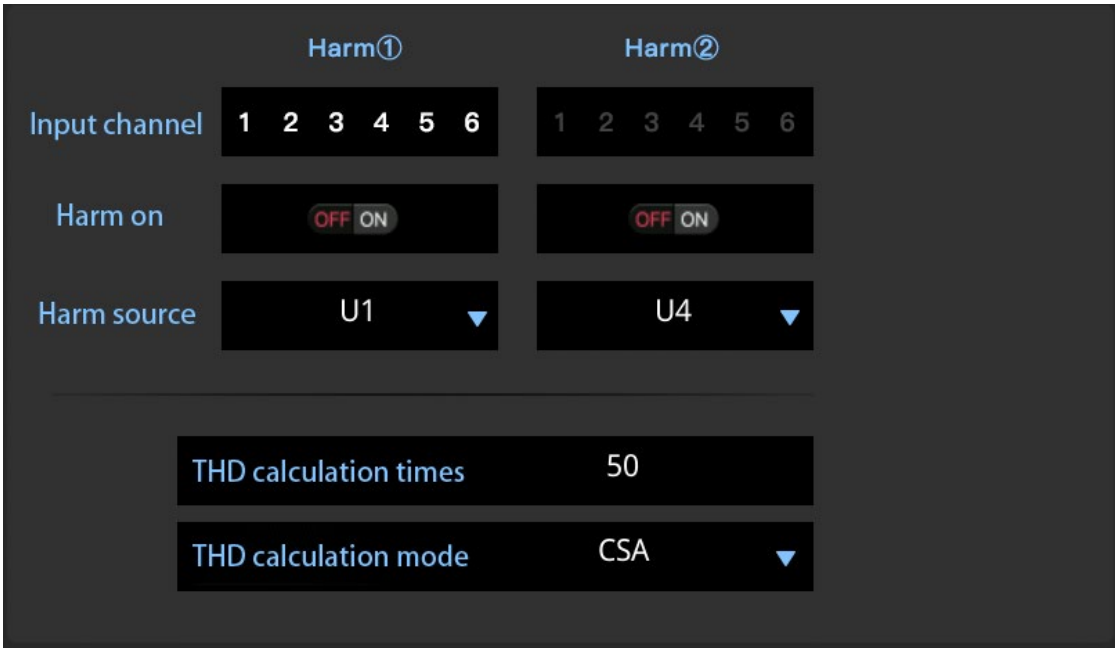



Figure 4.25 HARM Setting area

(4) HARM ON

The harmonic function of 87660 analyzer needs to be enabled manually. Click HARMONIC to enable/disable the harmonic measurement. If it is detected that the harmonic enable switch of neither Group 1 nor Group 2 are enabled, HARMONIC will automatically be disabled.

## VI. Waveform display

(1) Function introduction

The power analyzer displays the waveform based on the sampled data, and you can choose to display/hide the voltage/current of each input unit. The Waveform Display screen includes a vertical axis and a horizontal axis.

Vertical axis (amplitude)

The display interval in the vertical axis direction is determined based on the specified range. The user can zoom in/out the waveform by setting the range of vertical axis.

Horizontal axis (time)

The horizontal axis of power analyzer is the time axis. The horizontal axis has 6 grids on one screen. The user can set the range of time axis to zoom in/out the waveform.

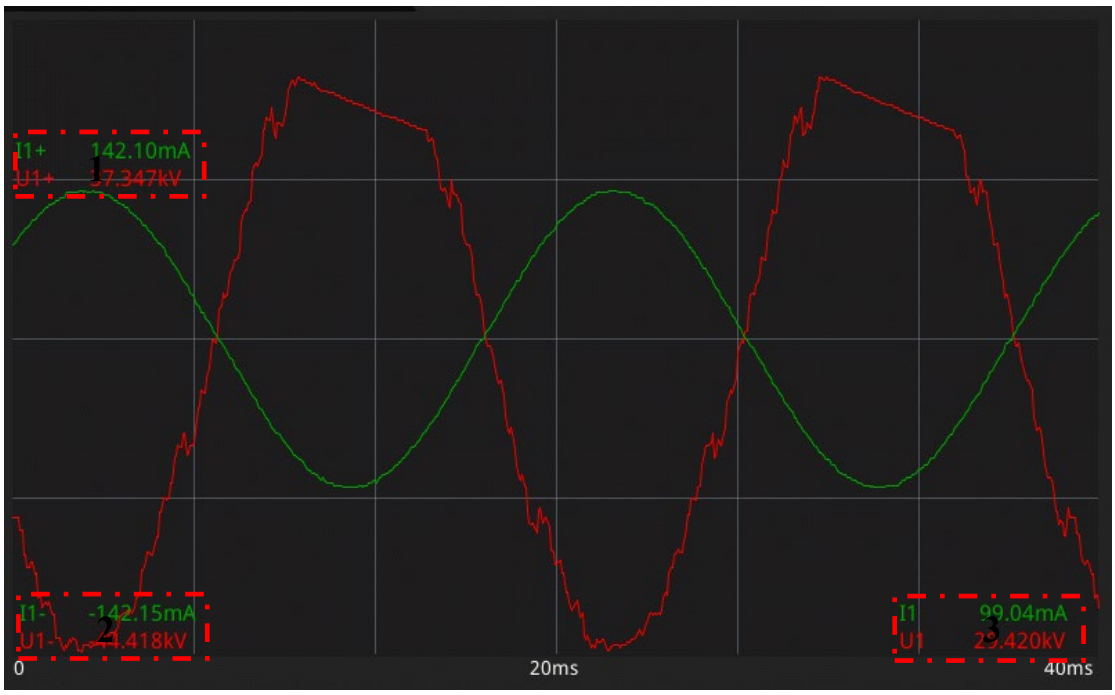



Figure 4.26 Waveform Display screen

Area 1 in the figure represents the positive peak of the signal

Area 2 in the figure represents the negative peak of the signal

Area 3 in the figure represents the RMS of the signal

Note: The waveform display is invalid when the harmonic function is ON.

(2) Set waveform display conditions

Curve accuracy: The 87660 analyzer has two modes: 2-curve and 6-curve. The 2-curve waveform has more data and are detailed. The 6-curve has less wave points than the 2-curve mode. To observe the details of the two curves, it is recommended to use the 2-curve mode. It is recommended to use the 6-curve mode when comparing trends and simultaneous characteristics of multiple curves.

X-axis range: There are 0.2 times, 0.6 times and 1 times the calculation cycle. For example, when the calculation period is set to 500ms and the X-axis range is selected as 0.2 times, the coordinate range of the horizontal axis is 0-100ms.

Y-axis range: There are 1.5 times, 2 times and 3 times range. For example, when the crest factor is fixed at 3 and the voltage range is set to "100Vrms", taking the input zero line as the center, the upper limit of display interval is 300Vpk (100Vrms× 3), the lower limit is -300Vpk (-100Vrms×3), and the waveform beyond this interval will be clipped.

Display mode: There are two display modes: full-screen and U/I split-screen. In full-screen display, the voltage/current are in one image. In U/I split-screen display mode, the voltage is displayed in the upper and the current is displayed in the lower.

Item Setting: select item ON and type.

(3) Setting steps

Press MENU button in Waveform Display screen, and click Wave Settings in the right pop-up menu to enter Waveform Setting screen.

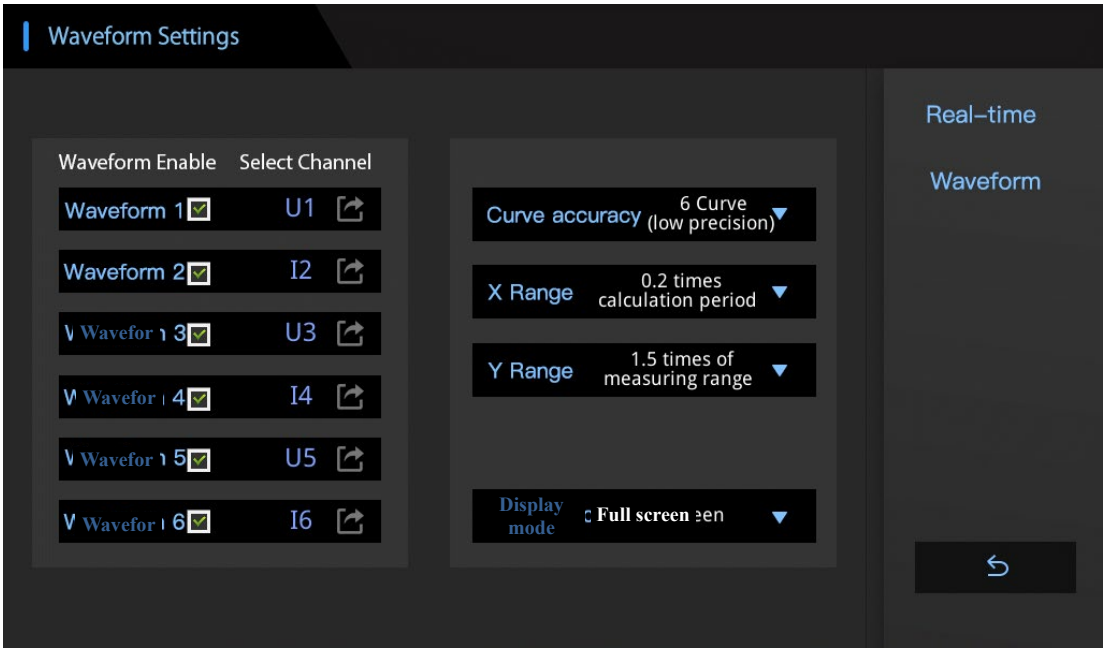



Figure 4.27 Waveform Setting screen

# VII. STORE

(1) Function introduction

The 87660 analyzer supports U-disk. The measurement parameters can be directly written into U-disk and stored in CSV format. The stored items can be edited, flexible and convenient.

(2) Storage setting

**Naming rules**: There are two file naming formats for storage: date (for example: 20210521) and date + time (for example: 20210521081022). For naming with date, the data stored on the day will be saved to the same file. The storage serial number will be re-accumulated for repeated storage. For naming with date + time, a new file will be created every time the storage is started.

**Storage item**: It is necessary to edit the storage item before storing, and the user can set it by himself.

**Storage mode:**

- Continuous storage mode: Store continuously after startup, up to 10W pieces of data can be stored.
- Store by time: timing starts after start storing, and stop storing after timing ends.
- Store by times: stop storing after reaching the designated storage times.

(3) Setting method

① Press the button SETUP on the keypad to enter System Setting screen.

② Click the right Store Setting menu to enter Store Setting screen.

③ Set the corresponding parameters by clicking.

(4) Storage format

| Model: | AN87660 | | | | | | |
|---|---|---|---|---|---|---|---|
| Version: | V0.38 | | | | | | |
| Date: | 20240226-17:02:14 | | | | | | |
| No. | Time | Urms[1](V) | Irms[1](mA) | Prms[1](W) | S[1](W) | Q[1](W) | Urms[2](V) |
| 1 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 20240226-17:02:14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 20240226-17:02:15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 20240226-17:02:16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 20240226-17:02:16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 20240226-17:02:16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 20240226-17:02:16 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure 4.28 Report format

(5) Start storage mode

Check whether the U-disk LED at the bottom of the screen is on after inserting the U-disk. After confirming that the U-disk is scanned successfully, press SHIFT button, the SHIFT LED is on. Press HARMONIC at this time to enable the storage (STORE). Press it again to stop the storage.

# VIII. Communication settings

(1) Function introduction

This machine supports serial port, network port, and optional GPIB conversion unit.

Support MOUBUS-RTU and MODBUS TCP protocol, and the SCPI protocol can be customized.

See Section VI Appendix to Protocol.

(2) Setting method

① Press the button SETUP on the keypad to enter System Setting screen.

② Click the right Communication Setting menu to enter Communication Setting screen.

③ Set the corresponding parameters by clicking.

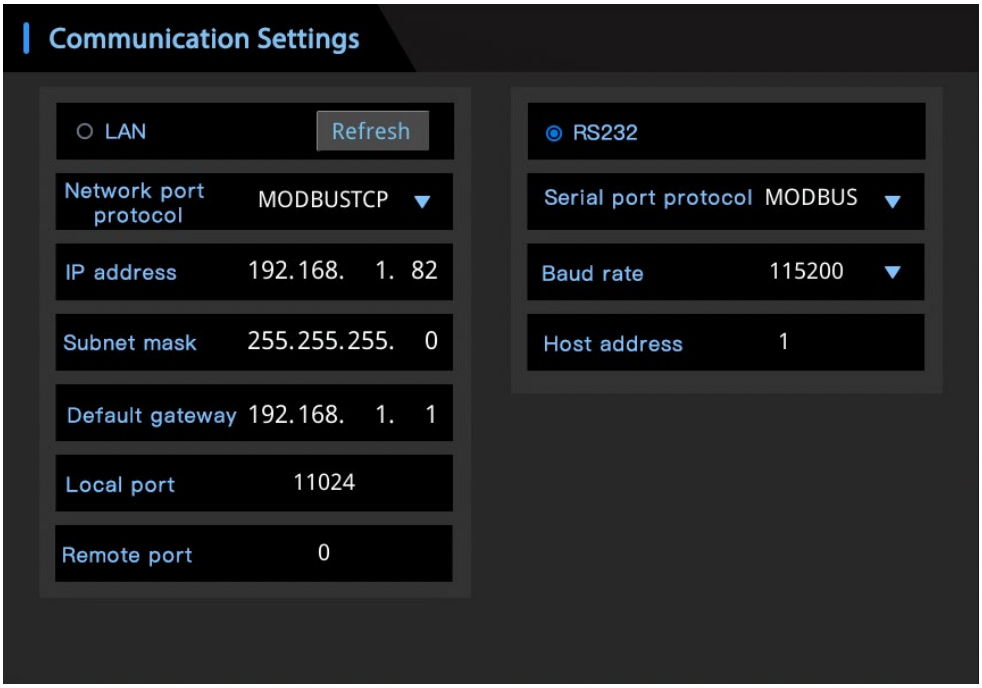



Figure 4.29 Communication Setting screen

Note: Click Refresh Network Port after any network port parameter is changed.

## IX Master settings

The software version can be viewed in the Master Setting screen, to perform self-check, language selection, system time setting, and screen brightness setting.

Setting method:

① Press the button SETUP on the keypad to enter System Setting screen.

② Click the right Master Setting menu to enter Master Setting screen.

③ Set the corresponding parameters by clicking.

## X. Operation Manual

The Product Instruction screen contains detail of main screen and detail of operations. For any problem found during the use of the instrument, read the corresponding instructions on this screen.

(1) Screen Introduction

Click Screen Introduction tab in the upper left corner to enter Screen Introduction screen. The meaning and function of each control of the measurement screen is described in a picture on this screen.

(2) FAQ

Click FAQ tab in the upper left corner of the screen to enter FAQ screen. This screen lists total 15 possible problems in daily use. Click the corresponding question, the operation steps will pop up on the right. Follow the steps to complete the corresponding operation.

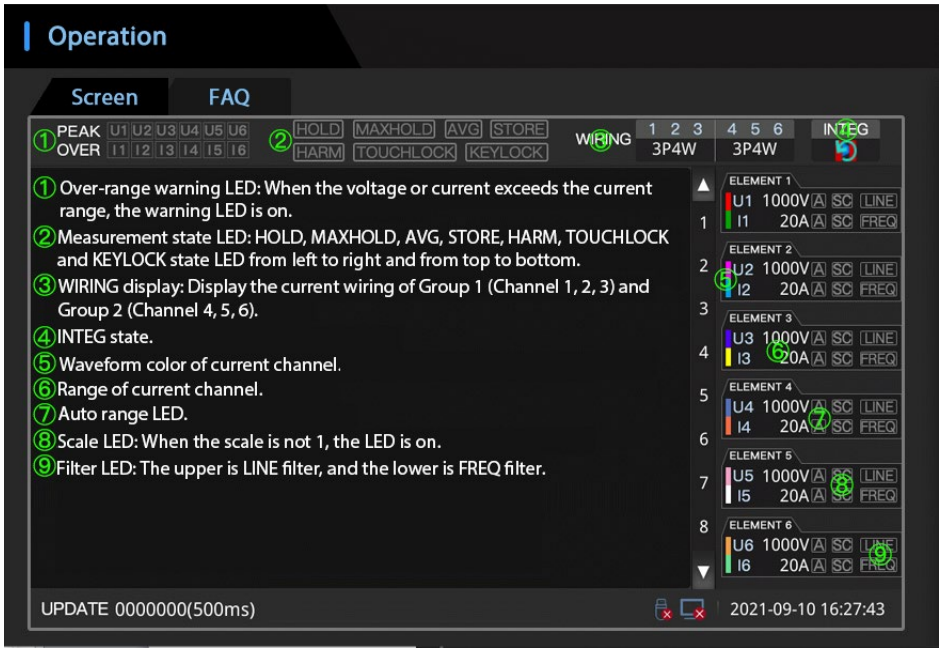



Figure 4.30 Instruction screen

# Section 5 External Interfaces

A 9-pin D-type port (male) is set on the rear panel of analyzer, providing RS-232 or RS-485 transmission and a LAN interface to provide network communication.

## I. RS-232/485 port

The analyzer is equipped with two serial ports: RS-232 and RS-485. The default port of 87660 analyzer is RS-232, and equipped with a standard RS-232 line. RS-485 line needs to be noted when ordering (dedicated RS-485 line will be delivered).

**1. Definition of RS-232 port**

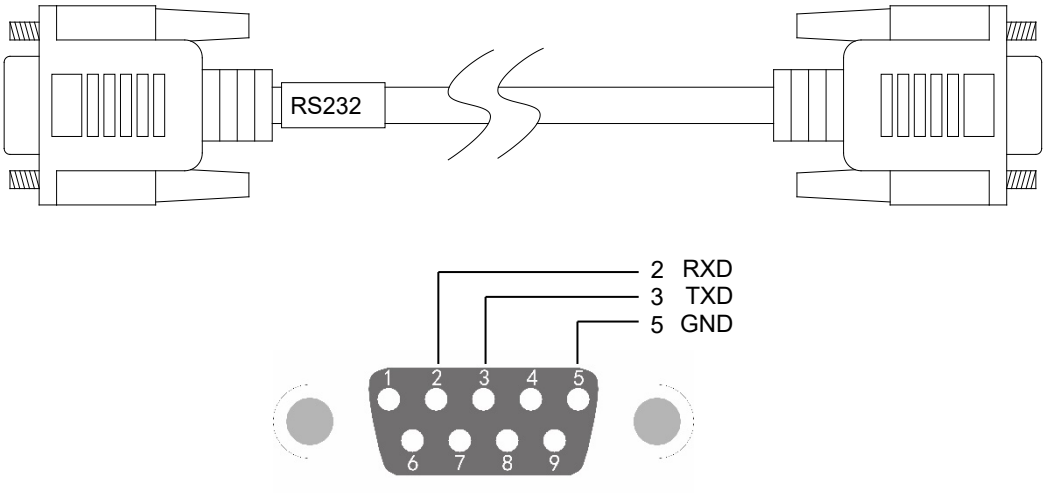
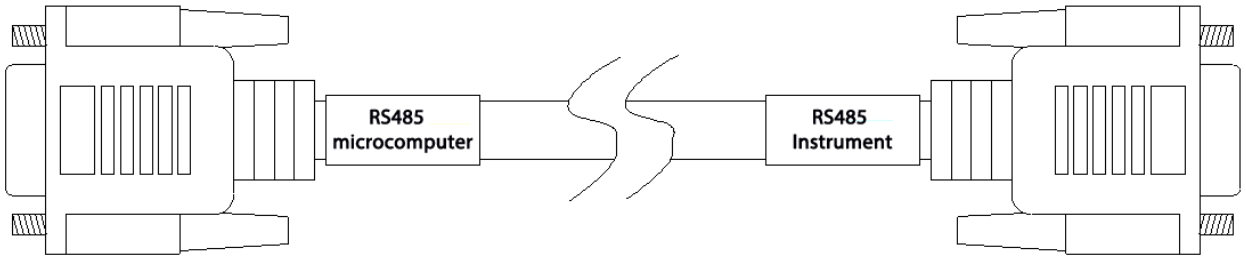



Figure 4-1 Definition of RS-232 port (same definition for computer side and instrument side)

| Computer (9-pin female) | Instrument (9-pin female) |
|---|---|
| 1 | 1 |
| 2 | 3 |
| 3 | 2 |
| 4 | 6 |
| 5 | 5 |
| 6 | 4 |
| 7 | 8 |
| 8 | 7 |
| 9 | 9 |
| Metal shell | Metal shell (connected with metal shielding layer) |

**2. Definition of RS-485 port**



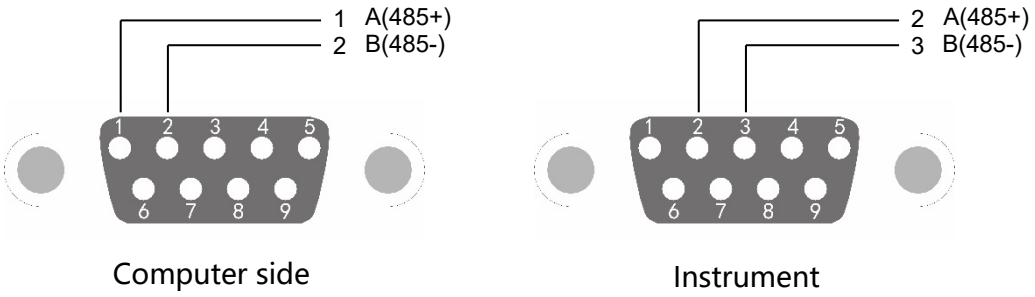



Figure 4-2 Definition of RS-485 port

| Computer (9-pin female) | Instrument (9-pin female) |
|---|---|
| 1 | 2 |
| 2 | 3 |
| Metal shell | Metal shell (connected with metal shielding layer) |

## II. Ethernet communication interface

| | |
|---|---|
| Interface | RJ-45 |
| Standard | IEEE802.3 |
| Protocol | TCP/IP |
| Baudrate | 10/100Mbps |

**Caution** The address and baud rate of the instrument should be consistent with the settings of the master computer. The analyzer supports Modbus protocol and Modbus/TCP protocol. Other protocols need to be customized.

# Section 6 Appendix to Protocol

## I. Modbus RTU protocol

### 1. Query

Note: (X in the protocol represents Channel 1-6 of the power analyzer. Not more than 100 bytes may be read each time, and only the parameters of each type can be read continuously. The harmonic content needs to be read separately, and the read measurements include voltage, current and BNC ratio)

### 1.1 Format of frame

1.1.1 Reading the contents of instrument register (03H). See Table 1:

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 2 | 03H | 03H | Function code(Query) |
| 3 | High byte of register start address | 11H | Register start address 1100H |
| 4 | Low byte of register start address | 00H | |
| 5 | High byte of register number | 00H | Register number 02H |
| 6 | Low byte of register number | 02H | |
| 7 | Low byte of CRC16 | C1H | CRC |
| 8 | High byte of CRC16 | 37H | |

Table 1

1.1.2 Frame returned by instrument (correct command), see Table 2:

| Sequence | Code | Description |
|---|---|---|
| 1 | Instrument address | Instrument communication address (01H-FFH, representing 1-255) |
| 2 | 03H | Function code(Query) |
| 3 | Return data byte (M) | |
| …… | Data of first register | |
| | Data of $n^{th}$ register | |
| M+4 | Low byte of CRC16 | |
| M+5 | High byte of CRC16 | |

Table 2

1.1.3 Content returned by instrument (wrong command), see Table 3:

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 2 | 83H | 83H | Function code(Query instruction error) |
| 3 | 02H | 02H | Error code |
| 4 | Low byte of CRC | C0H | |
| 5 | High byte of CRC | F1H | |

Table 3

Error code:

01H——Function code error

02H——Command length error

03H - Read register error

### 1.2 Register address

| No. | Register address Hex. | Data description | Data Format | Register Number | Number of bytes | Remarks | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 1X00H | Voltage effective value (V) | Float32 | 2 | 4 | Read only | Common parameters |
| 2 | 1X02H | Current effective value (mA) | Float32 | 2 | 4 | Read only | |
| 3 | 1X04H | Power (W) | Float32 | 2 | 4 | Read only | |
| 4 | 1X06H | Power factor | Float32 | 2 | 4 | Read only | |
| 5 | 1X08H | Apparent power (Va) | Float32 | 2 | 4 | Read only | |
| 6 | 1X0AH | Reactive power (Var) | Float32 | 2 | 4 | Read only | |
| 7 | 1X0CH | Voltage frequency (HZ) | Float32 | 2 | 4 | Read only | |
| 8 | 1X0EH | Current frequency (HZ) | Float32 | 2 | 4 | Read only | |
| 9 | 1X10H | Phase angle (°) | Float32 | 2 | 4 | Read only | |
| 10 | 1X12H | RMN of voltage (V) | Float32 | 2 | 4 | Read only | |
| 11 | 1X14H | Average of voltage (V) | Float32 | 2 | 4 | Read only | |
| 12 | 1X16H | Voltage peak high point (V) | Float32 | 2 | 4 | Read only | |
| 13 | 1X18H | Voltage peak low point (V) | Float32 | 2 | 4 | Read only | |
| 14 | 1X1AH | Peak voltage (V) | Float32 | 2 | 4 | Read only | |
| 15 | 1X1CH | RMN of current (mA) | Float32 | 2 | 4 | Read only | |
| 16 | 1X1EH | Average of current (mA) | Float32 | 2 | 4 | Read only | |
| 17 | 1X20H | Current peak high point (mA) | Float32 | 2 | 4 | Read only | |
| 18 | 1X22H | Current peak low point (mA) | Float32 | 2 | 4 | Read only | |
| 19 | 1X24H | Peak current (mA) | Float32 | 2 | 4 | Read only | |
| 20 | 1X26H | Electric energy running time-hours | Float32 | 2 | 4 | Read only | Electric energy parameters |
| 21 | 1X28H | Electric energy running time-minutes | Float32 | 2 | 4 | Read only | |
| 22 | 1X2AH | Electric energy running time-seconds | Float32 | 2 | 4 | Read only | |
| 23 | 1X2CH | Positive electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 24 | 1X2EH | Negative electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 25 | 1X30H | Electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 26 | 1X32H | Positive electricity (mAh) | Float32 | 2 | 4 | Read only | |
| 27 | 1X34H | Negative electricity (mAh) | Float32 | 2 | 4 | Read only | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 28 | 1X36H | Electricity (mAh) | Float32 | 2 | 4 | Read only | |
| 34 | 2X00H | RMS of current fundamental wave (mA) | Float32 | 2 | 4 | Read only | Harmonic parameters |
| 35 | 2X02H | RMS of voltage fundamental wave (V) | Float32 | 2 | 4 | Read only | |
| 36 | 2X04H | RMS of power fundamental wave (W) | Float32 | 2 | 4 | Read only | |
| 37 | 2X06H | Total current harmonic distortion (%) | Float32 | 2 | 4 | Read only | |
| 38 | 2X08H | Total voltage harmonic distortion (%) | Float32 | 2 | 4 | Read only | |
| 39 | 2X0AH | Total power harmonic distortion (%) | Float32 | 2 | 4 | Read only | |
| 40 | 2X0CH | Fundamental apparent power (VA) | Float32 | 2 | 4 | Read only | |
| 41 | 2X0EH | Fundamental reactive power (var) | Float32 | 2 | 4 | Read only | |
| 42 | 2X10H | Fundamental power factor | Float32 | 2 | 4 | Read only | |
| 43 | 2X12H | U1-U2 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 44 | 2X14H | U2-U3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 45 | 2X16H | U1-U3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 46 | 2X18H | U4-U5 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 47 | 2X1AH | U5-U6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 48 | 2X1CH | U4-U6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X1EH | I1-I2 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X20H | I2-I3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X22H | I1-I3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X24H | I4-I5 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X26H | I5-I6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X28H | I4-I6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 49 | 2X2A~8EH | Current harmonic content*100(%) (1~50$^{th}$, hex, read all at once, return 0BH, corresponding to 12, representing 0.12%) | int | 50 | 100 | Read only | |
| 50 | 2X8F~F3H | Voltage harmonic content*100(%) (1~50$^{th}$, hex, read all at once, return 0BH, corresponding to 12, representing 0.12%) | int | 50 | 100 | Read only | |
| 51 | 3000H | Group A (Channel 1~3) three-phase total voltage (V) | Float32 | 2 | 4 | Read only | Three-phase |
| 52 | 3002H | Group A three-phase total | Float32 | 2 | 4 | Read | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | current (mA) | | | | only | parameters |
| 53 | 3004H | Group A three-phase total power (W) | Float32 | 2 | 4 | Read only | |
| 54 | 3006H | Group A three-phase power factor | Float32 | 2 | 4 | Read only | |
| 55 | 3008H | Group A three-phase apparent power (VA) | Float32 | 2 | 4 | Read only | |
| 56 | 300AH | Group A three-phase reactive power (var) | Float32 | 2 | 4 | Read only | |
| | 300CH | Group A three-phase total electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| | 300EH | Group A three-phase total electricity (Ah) | Float32 | 2 | 4 | Read only | |
| | 3010H | Group B (Channel 4~6) three-phase total voltage (V) | Float32 | 2 | 4 | Read only | |
| | 3012H | Group B three-phase total current (mA) | Float32 | 2 | 4 | Read only | |
| | 3014H | Group B three-phase total power (W) | Float32 | 2 | 4 | Read only | |
| | 3016H | Group B three-phase power factor | Float32 | 2 | 4 | Read only | |
| | 3018H | Group B three-phase apparent power (VA) | Float32 | 2 | 4 | Read only | |
| | 301AH | Group B three-phase reactive power (var) | Float32 | 2 | 4 | Read only | |
| | 301CH | Group B three-phase total electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| | 301EH | Group B three-phase total electricity (Ah) | Float32 | 2 | 4 | Read only | |
| | 3020H | Efficiency 1 | Float32 | 2 | 4 | Read only | |
| | 3022H | Efficiency 2 | Float32 | 2 | 4 | Read only | |

### 1.3 Example of communication data (all data below are in hex)

(1) Read voltage of the instrument (Channel 1)

A. Send from master

| 01H | 03H | 11H | 00H | 00H | 02H | C1H | 37H |
|---|---|---|---|---|---|---|---|
| Instrument address | Command | High/low bytes of start register address | | High/low bytes of register number | | High/low bytes of CRC | |

B. Data returned by instrument: voltage=238.97V

| 01H | 03H | 04H | 43H | 6EH | F8H | A0H | CDH | D2H |
|---|---|---|---|---|---|---|---|---|
| Instrument address | Command | Number of bytes | 4-byte integer, high byte first | | | | CRC | |

(2) Read the voltage, current, and power of instrument

A. Send from master

| 01H | 03H | 11H | 00H | 00H | 06H | C0H | F4H |
|---|---|---|---|---|---|---|---|
| Instrument address | Command | High/low bytes of start register address | | High/low bytes of register number | | High/low bytes of CRC | |

B. Data returned by instrument: voltage=230.8V, current=4.089A, power=943.88W

| 01H | 03H | 0CH | 43,66,CD,C8-40,82,DD,6E-44,6B,F8,45 | 6FH | A2H |
|---|---|---|---|---|---|

| Instrument address | Command | Number of bytes | 4-byte integer, high byte first | CRC |
|---|---|---|---|---|

## 2. Setting class

### 2.1 Frame format

2.1.1 Set the content of instrument register (06H), see Table 4

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 2 | 06H | 06H | Function code(Settings) |
| 3 | High byte of register start address | 20H | Register address 2000H |
| 4 | Low byte of register start address | 00H | |
| 5 | Write high bytes of data | 00H | Write data 01H (write BNC ratio data bit is four bytes, CRC is shifted by two bytes) |
| 6 | Write low bytes of data | 01H | |
| 7 | Low byte of CRC16 | 43H | CRC |
| 8 | High byte of CRC16 | CAH | |

Table 4

2.1.2 Frame format returned by the instrument: If the writing is correct, the instrument returns the same frame format as Table 4.

2.1.3 The setting command is wrong, and the content returned by the instrument is shown in Table 5:

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 2 | 86H | 86H | Function code(Wrong setting instruction) |
| 3 | 03H | 03H | Error code |
| 4 | High byte of CRC | 02H | |
| 5 | Low byte of CRC | 61H | |

Table 5

Error code:

01H——Function code error

02H——Command length error

03H - Read register error

04H-Setting out of range error

### 2.2 Register address

| No. | Register address Hex. | Data description | Data Format | Register Number | Number of bytes | Remarks | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 4000H | Integration time (minute: 0-2880, 48 hours) | int32 | 1 | 2 | Write only | |
| 2 | 4001H | Integral state (6 channels controlled simultaneously) (0-2: 0-Clear, 1-Start, 2-Stop) | int32 | 1 | 2 | Write only | |
| 3 | 4002H | Channel 1, 2, 3 load type (range: 0-3, 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | int32 | 1 | 2 | Write only | |
| | 4003H | Channel 4, 5, 6 load type (range: 0-3: 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | int32 | 1 | 2 | Write only | |
| 4 | 4004H | Calculation cycle (0-6: 0-0.1s, 1-0.2s, 2-0.5s, 3-1s, 4-2s, 5-5s, 6-10s) | int32 | 1 | 2 | Write only | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 4005H | Synchronous measure master/slave selection (0-1: 0-Master, 1-Slave) | int32 | 1 | 2 | Write only | |
| 5 | 4006H | Channel 1 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range). 0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 400BH | Channel 6 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range). 0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | int32 | 1 | 2 | Write only | |
| 6 | 400CH | Channel 1 current range (0-7: 8 ranges of current (more than 7 means auto range).) | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 4011H | Channel 6 current range (0-7: 8 ranges of current (more than 7 means auto range).) | | | | | |
| 7 | 4012H | Channel 1 current source (0-1: 0-BNC input, 1-Direct input) | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 4017H | Channel 6 current source (0-1: 0-BNC input, 1-Direct input) | int32 | 1 | 2 | Write only | |
| 8 | 4018H | Channel 1 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 401DH | Channel 6 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | int32 | 1 | 2 | Write only | |
| 9 | 401FH | Channel 1~3 harmonic source ((0-5: 0-U1, 1-I1, ~5-I3) | int32 | 1 | 2 | Write only | |
| | 4020H | Channel 4~6 harmonic source (6-11: 6-U3, 7-I3, ~11-I6) | int32 | 1 | 2 | Write only | |
| 10 | 4021H | Group 1 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | int32 | 1 | 2 | Write only | |
| | 4022H | Group 2 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | int32 | 1 | 2 | Write only | |
| 11 | 4023H | Channel 1 FREQ filter (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 4028H | Channel 6 FREQ filter (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only | |
| 12 | 4029H | Channel 1 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 402EH | Channel 6 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | int32 | 1 | 2 | Write only | |
| 13 | 402FH | Channel 1 voltage ratio (10-500000: 1~50000.0) | int32 | 1 | 4 | Write only | |
| | | | int32 | 1 | 4 | Write only | |
| | 4034H | Channel 6 voltage ratio (10-500000: 1~50000.0) | int32 | 1 | 4 | Write only | |
| 14 | 4035H | Channel 1 current ratio (10~50000: 1~50000.0) | int32 | 1 | 4 | Write only | |
| | | | int32 | 1 | 4 | Write only | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 403AH | Channel 6 current ratio (10~50000: 1~50000.0) | int32 | 1 | 4 | Write only | |
| 15 | 403BH | Channel 1 BNC ratio (10-100000: 0.01~100.000) | int32 | 1 | 4 | Write only | |
| | | | int32 | 1 | 4 | Write only | |
| | 4040H | Channel 6 BNC ratio (10-100000: 0.01~100.000) | int32 | 1 | 4 | Write only | |
| 16 | 4041H | Average state (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only | |
| 17 | 4042H | Average calculation method (0-1: 0-Linear, 1-Exp) | int32 | 1 | 2 | Write only | |
| 18 | 4043H | Total number of mean calculation (0-3: 0-8, 1-16, 2-32, 3-64) | int32 | 1 | 2 | Write only | |
| 19 | 4044H | MAXHOLD (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only | |
| 20 | 4045H | HOLD (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only | |
| 21 | 4046H | THD mode (0-1: 0-IEC, 1-CSA) | int32 | 1 | 2 | Write only | |
| 22 | 4047H | Maximum number of THD calculations (0-50) | int32 | 1 | 2 | Write only | |
| 23 | 4048H | Peak factor(Range 0-1,0-3,1-6) | int32 | 1 | 2 | Write only | |

Setting class (read only)

| No. | Register address Hex. | Data description | Data Format | Register Number | Number of bytes | Remarks | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 5000H | Integration time (minute: 0-2880, 48 hours) | Float 32 | 2 | 4 | Read only | |
| 2 | 5002H | Integral state (6 channels controlled simultaneously)<br>(0-2: 0-Clear, 1-Start, 2-Stop) | Float 32 | 2 | 4 | Read only | |
| 3 | 5004H | Channel 1, 2, 3 load type (range: 0-3, 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | Float 32 | 2 | 4 | Read only | |
| | 5006H | Channel 4, 5, 6 load type (range: 0-3: 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | Float 32 | 2 | 4 | Read only | |
| 4 | 5008H | Calculation cycle (0-6: 0-0.1s, 1-0.2s, 2-0.5s, 3-1s, 4-2s, 5-5s, 6-10s) | Float 32 | 2 | 4 | Read only | |
| 5 | 500AH | Synchronous measure master/slave selection (0-1: 0-Master, 1-Slave) | Float 32 | 2 | 4 | Read only | |
| 6 | 500CH | Channel 1 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range).<br>0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | Float 32 | 2 | 4 | Read only | |
| | ~ | | | | | | |
| | 5016H | Channel 6 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range).<br>0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | Float 32 | 2 | 4 | Read only | |
| 7 | 5018H | Channel 1 current range (0-7: 8 ranges of current (more than 7 means auto range).) | Float 32 | 2 | 4 | Read only | |
| | ~ | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 5024H | Channel 6 current range (0-7: 8 ranges of current (more than 7 means auto range).) | Float 32 | 2 | 4 | Read only |
| 8 | 5026H | Channel 1 current source (0-1: 0-BNC input, 1-Direct input) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5030H | Channel 6 current source (0-1: 0-BNC input, 1-Direct input) | Float 32 | 2 | 4 | Read only |
| 9 | 5032H | Channel 1 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 503CH | Channel 6 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | Float 32 | 2 | 4 | Read only |
| 10 | 503EH | Channel 1~3 harmonic source ((0-5: 0-U1, 1-I1, ~5-I3) | Float 32 | 2 | 4 | Read only |
| | 5040H | Channel 4~6 harmonic source (6-11: 6-U3, 7-I3, ~11-I6) | Float 32 | 2 | 4 | Read only |
| 11 | 5042H | Group 1 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | Float 32 | 2 | 4 | Read only |
| | 5044H | Group 2 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | Float 32 | 2 | 4 | Read only |
| 12 | 5046H | Channel 1 FREQ filter (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5050H | Channel 6 FREQ filter (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 13 | 5052H | Channel 1 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 505CH | Channel 6 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | Float 32 | 2 | 4 | Read only |
| 14 | 505EH | Channel 1 voltage ratio (1.0-5000.0) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5068H | Channel 6 voltage ratio (1.0-5000.0) | Float 32 | 2 | 4 | Read only |
| 15 | 506AH | Channel 1 current ratio (1.0~5000.0) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5074H | Channel 6 current ratio (1~50000.0) | Float 32 | 2 | 4 | Read only |
| 16 | 5076H | Channel 1 BNC ratio (0.01~100.00) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5080H | Channel 6 BNC ratio (0.01~100.00) | Float 32 | 2 | 4 | Read only |
| 17 | 5082H | Average state (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 18 | 5084H | Mean calculation method (0-1: 0-Linear, 1-Exp) | Float 32 | 2 | 4 | Read only |
| 19 | 5086H | Total number of mean calculation (0-3: 0-8, 1-16, 2-32, 3-64) | Float 32 | 2 | 4 | Read only |
| 20 | 5088H | MAXHOLD (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 21 | 508AH | HOLD (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 22 | 508CH | THD mode (0-1: 0-IEC, 1-CSA) | Float | 2 | 4 | Read |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 32 | | | only |
| 23 | 508EH | Maximum number of THD calculations (0-50) | Float 32 | 2 | 4 | Read only |
| 24 | 5090H | Peak factor(Range 0-1,0-3,1-6) | Float 32 | 2 | 4 | Read only |

### 2.3 Example of communication data (all data below are in hex)

(1) Set type of load for Channel 1, 2, 3

Send by master: set to 1P3W

| 01H | 06H | 40H | 02H | 00H | 01H | FCH | 0AH |
|---|---|---|---|---|---|---|---|
| Instrument address | Command | High/low bytes of start register address | | 2-byte data bit | | High/low bytes of CRC | |

(2) Set voltage range

Send by master: set to 30V

| 01H | 06H | 40H | 04H | 00H | 01H | 1CH | 0BH |
|---|---|---|---|---|---|---|---|
| Instrument address | Command | High/low bytes of start register address | | 2-byte data bit | | High/low bytes of CRC | |

# II. ModbusTCP protocol

### 1. Query

Note: (X in the protocol represents Channel 1-6 of the power analyzer. Not more than 100 bytes may be read each time, and only the parameters of each type can be read continuously. The harmonic content needs to be read separately, and the read measurements include voltage, current and BNC ratio)

### 1.1 Format of frame

1.1.1 Reading the contents of instrument register (03H). See Table 1:

| Sequence (bytes) | Code | Example | Description |
|---|---|---|---|
| 1 | Transaction identifier High type | 00H | Identification of Modbus request response/response transaction (generated by client, original value returned by server) |
| 2 | Low byte of transaction identifier | 01H | |
| 3 | High byte of protocol identifier | 00H | 0000 h = the Modbus Protocol |
| 4 | Low byte of protocol identifier | 00H | |
| 5 | Data frame length High type | 00H | Calculate the length from the 7th byte |
| 6 | Low byte of data frame length | 06H | |
| 7 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 8 | Function code | 03H | Function code(Query) |
| 9 | High byte of register start address | 11H | Register start address 1100H |
| 10 | Low byte of register start address | 00H | |
| 11 | High byte of register number | 00H | Register number 02H |
| 12 | Low byte of register number | 02H | |

Table 1

1.1.2 Frame returned by instrument (correct command), see Table 2:

| Sequence (bytes) | Code | Description |
|---|---|---|
| 1 | Transaction identifier High type | Identification of Modbus request response/response transaction (generated by client, original value returned by server) |
| 2 | Low byte of transaction identifier | |
| 3 | High byte of protocol identifier | 0000 h = the Modbus Protocol |
| 4 | Low byte of protocol identifier | |
| 5 | Data frame length High type | Calculate the length from the 7th byte |

| | | |
|---|---|---|
| 6 | Low byte of data frame length | |
| 7 | Instrument address | Instrument communication address (01H-FFH, representing 1-255) |
| 8 | 03H | Function code(Query) |
| 9 | Return data byte (M) | |
| …… | Data of first register | |
| M+9 | Data of $n^{th}$ register | |

Table 2

1.1.3 Content returned by instrument (wrong command), see Table 3:

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Transaction identifier High type | 00H | Identification of Modbus request response/response transaction (generated by client, original value returned by server) |
| 2 | Low byte of transaction identifier | 01H | |
| 3 | High byte of protocol identifier | 00H | 0000 h = the Modbus Protocol |
| 4 | Low byte of protocol identifier | 00H | |
| 5 | Data frame length High type | 00H | Calculate the length from the $7^{th}$ byte |
| 6 | Low byte of data frame length | 03H | |
| 7 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 8 | 83H | 83H | Function code(Query instruction error) |
| 9 | 02H | 02H | Error code |

Table 3

Error code:

01H——Function code error

02H——Command length error

03H - Read register error

## 1.2 Register address

| No. | Register address Hex. | Data description | Data Format | Register Number | Number of bytes | Remarks | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 1X00H | Voltage effective value (V) | Float32 | 2 | 4 | Read only | Common parameters |
| 2 | 1X02H | Current effective value (mA) | Float32 | 2 | 4 | Read only | |
| 3 | 1X04H | Power (W) | Float32 | 2 | 4 | Read only | |
| 4 | 1X06H | Power factor | Float32 | 2 | 4 | Read only | |
| 5 | 1X08H | Apparent power (Va) | Float32 | 2 | 4 | Read only | |
| 6 | 1X0AH | Reactive power (Var) | Float32 | 2 | 4 | Read only | |
| 7 | 1X0CH | Voltage frequency (HZ) | Float32 | 2 | 4 | Read only | |
| 8 | 1X0EH | Current frequency (HZ) | Float32 | 2 | 4 | Read only | |
| 9 | 1X10H | Phase angle (°) | Float32 | 2 | 4 | Read only | |
| 10 | 1X12H | RMN of voltage (V) | Float32 | 2 | 4 | Read only | |
| 11 | 1X14H | Average of voltage (V) | Float32 | 2 | 4 | Read | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | only | |
| 12 | 1X16H | Voltage peak high point (V) | Float32 | 2 | 4 | Read only | |
| 13 | 1X18H | Voltage peak low point (V) | Float32 | 2 | 4 | Read only | |
| 14 | 1X1AH | Peak voltage (V) | Float32 | 2 | 4 | Read only | |
| 15 | 1X1CH | RMN of current (mA) | Float32 | 2 | 4 | Read only | |
| 16 | 1X1EH | Average of current (mA) | Float32 | 2 | 4 | Read only | |
| 17 | 1X20H | Current peak high point (mA) | Float32 | 2 | 4 | Read only | |
| 18 | 1X22H | Current peak low point (mA) | Float32 | 2 | 4 | Read only | |
| 19 | 1X24H | Peak current (mA) | Float32 | 2 | 4 | Read only | |
| 20 | 1X26H | Electric energy running time-hours | Float32 | 2 | 4 | Read only | Electric energy parameters |
| 21 | 1X28H | Electric energy running time-minutes | Float32 | 2 | 4 | Read only | |
| 22 | 1X2AH | Electric energy running time-seconds | Float32 | 2 | 4 | Read only | |
| 23 | 1X2CH | Positive electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 24 | 1X2EH | Negative electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 25 | 1X30H | Electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 26 | 1X32H | Positive electricity (mAh) | Float32 | 2 | 4 | Read only | |
| 27 | 1X34H | Negative electricity (mAh) | Float32 | 2 | 4 | Read only | |
| 28 | 1X36H | Electricity (mAh) | Float32 | 2 | 4 | Read only | |
| 34 | 2X00H | RMS of current fundamental wave (mA) | Float32 | 2 | 4 | Read only | Harmonic parameters |
| 35 | 2X02H | RMS of voltage fundamental wave (V) | Float32 | 2 | 4 | Read only | |
| 36 | 2X04H | RMS of power fundamental wave (W) | Float32 | 2 | 4 | Read only | |
| 37 | 2X06H | Total current harmonic distortion (%) | Float32 | 2 | 4 | Read only | |
| 38 | 2X08H | Total voltage harmonic distortion (%) | Float32 | 2 | 4 | Read only | |
| 39 | 2X0AH | Total power harmonic distortion (%) | Float32 | 2 | 4 | Read only | |
| 40 | 2X0CH | Fundamental apparent power (VA) | Float32 | 2 | 4 | Read only | |
| 41 | 2X0EH | Fundamental reactive power (var) | Float32 | 2 | 4 | Read only | |
| 42 | 2X10H | Fundamental power factor | Float32 | 2 | 4 | Read only | |
| 43 | 2X12H | U1-U2 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 44 | 2X14H | U2-U3 phase angle (°) | Float32 | 2 | 4 | Read only | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 45 | 2X16H | U1-U3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 46 | 2X18H | U4-U5 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 47 | 2X1AH | U5-U6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 48 | 2X1CH | U4-U6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X1EH | I1-I2 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X20H | I2-I3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X22H | I1-I3 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X24H | I4-I5 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X26H | I5-I6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| | 2X28H | I4-I6 phase angle (°) | Float32 | 2 | 4 | Read only | |
| 49 | 2X2A~8EH | Current harmonic content*100(%) (1~50$^{th}$, hex, return 0BH, corresponding to 12, representing 0.12%) | int | 50 | 100 | Read only | |
| 50 | 2X8F~F3H | Voltage harmonic content*100(%) (1~50 $^{th}$, hex, return 0BH, corresponding to 12, representing 0.12%) | int | 50 | 100 | Read only | |
| 51 | 3000H | Group A (Channel 1~3) three-phase total voltage (V) | Float32 | 2 | 4 | Read only | Three-phase parameters |
| 52 | 3002H | Group A three-phase total current (mA) | Float32 | 2 | 4 | Read only | |
| 53 | 3004H | Group A three-phase total power (W) | Float32 | 2 | 4 | Read only | |
| 54 | 3006H | Group A three-phase power factor | Float32 | 2 | 4 | Read only | |
| 55 | 3008H | Group A three-phase apparent power (VA) | Float32 | 2 | 4 | Read only | |
| 56 | 300AH | Group A three-phase reactive power (var) | Float32 | 2 | 4 | Read only | |
| 57 | 300CH | Group A three-phase total electric energy (Wh) | Float32 | 2 | 4 | Read only | |
| 58 | 300EH | Group A three-phase total electricity (Ah) | Float32 | 2 | 4 | Read only | |
| 59 | 3010H | Group B (Channel 4~6) three-phase total voltage (V) | Float32 | 2 | 4 | Read only | |
| 60 | 3012H | Group B three-phase total current (mA) | Float32 | 2 | 4 | Read only | |
| 61 | 3014H | Group B three-phase total power (W) | Float32 | 2 | 4 | Read only | |
| 62 | 3016H | Group B three-phase power factor | Float32 | 2 | 4 | Read only | |
| 63 | 3018H | Group B three-phase apparent power (VA) | Float32 | 2 | 4 | Read only | |
| 64 | 301AH | Group B three-phase reactive power (var) | Float32 | 2 | 4 | Read only | |
| 65 | 301CH | Group B three-phase total | Float32 | 2 | 4 | Read | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | electric energy (Wh) | | | | only | |
| 66 | 301EH | Group B three-phase total electricity (Ah) | Float32 | 2 | 4 | Read only | |
| 67 | 3020H | Efficiency 1 | Float32 | 2 | 4 | Read only | |
| 68 | 3022H | Efficiency 2 | Float32 | 2 | 4 | Read only | |

### 1.3 Example of communication data (all data below are in hex)

(1) Read voltage of the instrument (Channel 1)

A. Send from master

| 0001H | 0000H | 0006H | 01H | 03H | 11H | 00H | 00H | 02H |
|---|---|---|---|---|---|---|---|---|
| Transaction identifier | Modbus Protocol | Data frame length | Instrument address | Command | High/low bytes of start register address | | High/low bytes of register number | |

B. Data returned by instrument: voltage=238.97V

| 0001H | 0000H | 0007H | 01H | 03H | 04H | 43H | 6EH | F8H | A0H |
|---|---|---|---|---|---|---|---|---|---|
| Transaction identifier | Modbus Protocol | Data frame length | Instrument address | Command | Number of bytes | 4-byte integer, high byte first | | | |

(2) Read the voltage, current, and power of instrument

A. Send from master

| 0001H | 0000H | 0006H | 01H | 03H | 11H | 00H | 00H | 06H |
|---|---|---|---|---|---|---|---|---|
| Transaction identifier | Modbus Protocol | Data frame length | Instrument address | Command | High/low bytes of start register address | | High/low bytes of register number | |

B. Data returned by instrument: voltage=230.8V, current=4.089A, power=943.88W

| 0001H | 0000H | 000FH | 01H | 03H | 0CH | 43,66,CD,C8-40,82,DD,6E-44,6B,F8,45 |
|---|---|---|---|---|---|---|
| Transaction identifier | Modbus Protocol | Data frame length | Instrument address | Command | Number of bytes | 4-byte integer, high byte first |

## 2. Setting class

### 2.1 Frame format

2.1.1 Set the content of instrument register (06H), see Table 4

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Transaction identifier High type | 00H | Identification of Modbus request response/response transaction (generated by client, original value returned by server) |
| 2 | Low byte of transaction identifier | 01H | |
| 3 | High byte of protocol identifier | 00H | 0000 h = the Modbus Protocol |
| 4 | Low byte of protocol identifier | 00H | |
| 5 | Data frame length High type | 00H | Calculate the length from the 7th byte |
| 6 | Low byte of data frame length | 06H | |
| 7 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 8 | 06H | 06H | Function code(Settings) |
| 9 | High byte of register start address | 20H | Register address 2000H |
| 10 | Low byte of register start address | 00H | |
| 11 | Write high bytes of data | 00H | Write data 01H |
| 12 | Write low bytes of data | 01H | |

Table 4

2.1.2 Frame format returned by the instrument: If the writing is correct, the instrument returns the same frame format as Table 4.

2.1.3 The setting command is wrong, and the content returned by the instrument is shown in Table 5:

| Sequence | Code | Example | Description |
|---|---|---|---|
| 1 | Transaction identifier High type | 00H | Identification of Modbus request response/response transaction (generated by client, original value returned by server) |
| 2 | Low byte of transaction identifier | 01H | |
| 3 | High byte of protocol identifier | 00H | 0000 h = the Modbus Protocol |
| 4 | Low byte of protocol identifier | 00H | |
| 5 | Data frame length High type | 00H | Calculate the length from the 7th byte |
| 6 | Low byte of data frame length | 03H | |
| 7 | Instrument address | 01H | Instrument communication address (01H-FFH, representing 1-255) |
| 8 | 86H | 86H | Function code(Wrong setting instruction) |
| 9 | 03H | 03H | Error code |

Table 5

Error code:

01H——Function code error

02H——Command length error

03H - Read register error

04H-Setting out of range error

**2.2 Register address**

| No. | Register address Hex. | Data description | Data Format | Register Number | Number of bytes | Remarks | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 4000H | Integration time (minute: 0-2880, 48 hours) | int32 | 1 | 2 | Write only | |
| 2 | 4001H | Integral state (6 channels controlled simultaneously) (0-2: 0-Clear, 1-Start, 2-Stop) | int32 | 1 | 2 | Write only | |
| 3 | 4002H | Channel 1, 2, 3 load type (range: 0-3, 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | int32 | 1 | 2 | Write only | |
| | 4003H | Channel 4, 5, 6 load type (range: 0-3: 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | int32 | 1 | 2 | Write only | |
| 4 | 4004H | Calculation cycle (0-6: 0-0.1s, 1-0.2s, 2-0.5s, 3-1s, 4-2s, 5-5s, 6-10s) | int32 | 1 | 2 | Write only | |
| | 4005H | Synchronous measure master/slave selection (0-1: 0-Master, 1-Slave) | int32 | 1 | 2 | Write only | |
| 5 | 4006H | Channel 1 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range). 0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |
| | 400BH | Channel 6 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range). 0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | int32 | 1 | 2 | Write only | |
| 6 | 400CH | Channel 1 current range (0-7: 8 ranges of current (more than 7 means auto range).) | int32 | 1 | 2 | Write only | |
| | ~ | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 4011H | Channel 6 current range (0-7: 8 ranges of current (more than 7 means auto range).) | | | | |
| 7 | 4012H | Channel 1 current source (0-1: 0-BNC input, 1-Direct input) | int32 | 1 | 2 | Write only |
| | ~ | | | | | |
| | 4017H | Channel 6 current source (0-1: 0-BNC input, 1-Direct input) | int32 | 1 | 2 | Write only |
| 8 | 4018H | Channel 1 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | int32 | 1 | 2 | Write only |
| | ~ | | | | | |
| | 401DH | Channel 6 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | int32 | 1 | 2 | Write only |
| 9 | 401FH | Channel 1~3 harmonic source ((0-5: 0-U1, 1-I1, ~5-I3) | int32 | 1 | 2 | Write only |
| | 4020H | Channel 4~6 harmonic source (6-11: 6-U3, 7-I3, ~11-I6) | int32 | 1 | 2 | Write only |
| 10 | 4021H | Group 1 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | int32 | 1 | 2 | Write only |
| | 4022H | Group 2 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | int32 | 1 | 2 | Write only |
| 11 | 4023H | Channel 1 FREQ filter (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only |
| | ~ | | | | | |
| | 4028H | Channel 6 FREQ filter (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only |
| 12 | 4029H | Channel 1 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | int32 | 1 | 2 | Write only |
| | ~ | | | | | |
| | 402EH | Channel 6 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | int32 | 1 | 2 | Write only |
| 13 | 402FH | Channel 1 voltage ratio (10-500000: 1~50000.0) | int32 | 1 | 4 | Write only |
| | | | int32 | 1 | 4 | Write only |
| | 4034H | Channel 6 voltage ratio (10-5000000: 1~50000.0) | int32 | 1 | 4 | Write only |
| 14 | 4035H | Channel 1 current ratio (10~50000: 1~50000.0) | int32 | 1 | 4 | Write only |
| | | | int32 | 1 | 4 | Write only |
| | 403AH | Channel 6 current ratio (10~50000: 1~50000.0) | int32 | 1 | 4 | Write only |
| 15 | 403BH | Channel 1 BNC ratio (10-100000: 0.01~100.000) | int32 | 1 | 4 | Write only |
| | | | int32 | 1 | 4 | Write only |
| | 4040H | Channel 6 BNC ratio (10-100000: 0.01~100.000) | int32 | 1 | 4 | Write only |
| 16 | 4041H | Average state (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only |
| 17 | 4042H | Average calculation method (0-1: 0-Linear, 1-Exp) | int32 | 1 | 2 | Write only |
| 18 | 4043H | Total number of mean calculation (0-3: 0-8, 1-16, 2-32, 3-64) | int32 | 1 | 2 | Write only |
| 19 | 4044H | MAXHOLD (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20 | 4045H | HOLD (0-1: 0-OFF, 1-ON) | int32 | 1 | 2 | Write only | |
| 21 | 4046H | THD mode (0-1: 0-IEC, 1-CSA) | int32 | 1 | 2 | Write only | |
| 22 | 4047H | Maximum number of THD calculations (0-50) | int32 | 1 | 2 | Write only | |
| 23 | 4048H | Peak factor(Range 0-1,0-3,1-6) | int32 | 1 | 2 | Write only | |

Setting class (read only)

| No. | Register address Hex. | Data description | Data Format | Register Number | Number of bytes | Remarks | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 5000H | Integration time (minute: 0-2880, 48 hours) | Float 32 | 2 | 4 | Read only | |
| 2 | 5002H | Integral state (6 channels controlled simultaneously)<br>(0-2: 0-Clear, 1-Start, 2-Stop) | Float 32 | 2 | 4 | Read only | |
| 3 | 5004H | Channel 1, 2, 3 load type (range: 0-3, 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | Float 32 | 2 | 4 | Read only | |
| | 5006H | Channel 4, 5, 6 load type (range: 0-3: 0-1P3W, 1-3P3W, 2-3P4W, 3-3V3A) | Float 32 | 2 | 4 | Read only | |
| 4 | 5008H | Calculation cycle (0-6: 0-0.1s, 1-0.2s, 2-0.5s, 3-1s, 4-2s, 5-5s, 6-10s) | Float 32 | 2 | 4 | Read only | |
| 5 | 500AH | Synchronous measure master/slave selection (0-1: 0-Master, 1-Slave) | Float 32 | 2 | 4 | Read only | |
| 6 | 500CH | Channel 1 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range).<br>0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6— 600 V，7—1000 V） | Float 32 | 2 | 4 | Read only | |
| | ~ | | | | | | |
| | 5016H | Channel 6 voltage range (0-7: 8 ranges of voltage (more than 7 means auto range).<br>0—15V，1—30 V，2—60 V，3—100 V，4—150 V，5—300 V，6—600 V，7—1000 V） | Float 32 | 2 | 4 | Read only | |
| 7 | 5018H | Channel 1 current range (0-7: 8 ranges of current (more than 7 means auto range).) | Float 32 | 2 | 4 | Read only | |
| | ~ | | | | | | |
| | 5024H | Channel 6 current range (0-7: 8 ranges of current (more than 7 means auto range).) | Float 32 | 2 | 4 | Read only | |
| 8 | 5026H | Channel 1 current source (0-1: 0-BNC input, 1-Direct input) | Float 32 | 2 | 4 | Read only | |
| | ~ | | | | | | |
| | 5030H | Channel 6 current source (0-1: 0-BNC input, 1-Direct input) | Float 32 | 2 | 4 | Read only | |
| 9 | 5032H | Channel 1 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | Float 32 | 2 | 4 | Read only | |
| | ~ | | | | | | |
| | 503CH | Channel 6 simultaneous source (0-17: 0-U1, 1-I1…U6-10, I6-11, 16-EXT, 17-NULL) | Float 32 | 2 | 4 | Read only | |
| 10 | 503EH | Channel 1~3 harmonic source ((0-5: 0-U1, 1-I1, ~5-I3) | Float 32 | 2 | 4 | Read only | |
| | 5040H | Channel 4~6 harmonic source (6-11: 6-U3, 7-I3, | Float | 2 | 4 | Read | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | ~11-I6) | 32 | | | only |
| 11 | 5042H | Group 1 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | Float 32 | 2 | 4 | Read only |
| | 5044H | Group 2 harmonic ON/OFF (0-1: 0-OFF (normal measurement), 1-ON (harmonic measurement)) | Float 32 | 2 | 4 | Read only |
| 12 | 5046H | Channel 1 FREQ filter (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5050H | Channel 6 FREQ filter (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 13 | 5052H | Channel 1 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 505CH | Channel 6 LINE filter (0-1: 0-OFF, 1-500Hz, 2-5.5kHz) | Float 32 | 2 | 4 | Read only |
| 14 | 505EH | Channel 1 voltage ratio (1.0-5000.0) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5068H | Channel 6 voltage ratio (1.0-5000.0) | Float 32 | 2 | 4 | Read only |
| 15 | 506AH | Channel 1 current ratio (1.0~5000.0) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5074H | Channel 6 current ratio (1.0~5000.0) | Float 32 | 2 | 4 | Read only |
| 16 | 5076H | Channel 1 BNC ratio (0.01~100.00) | Float 32 | 2 | 4 | Read only |
| | ~ | | | | | |
| | 5080H | Channel 6 BNC ratio (0.01~100.00) | Float 32 | 2 | 4 | Read only |
| 17 | 5082H | Average state (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 18 | 5084H | Mean calculation method (0-1: 0-Linear, 1-Exp) | Float 32 | 2 | 4 | Read only |
| 19 | 5086H | Total number of mean calculation (0-3: 0-8, 1-16, 2-32, 3-64) | | | | |
| 20 | 5088H | MAXHOLD (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 21 | 508AH | HOLD (0-1: 0-OFF, 1-ON) | Float 32 | 2 | 4 | Read only |
| 22 | 508CH | THD mode (0-1: 0-IEC, 1-CSA) | Float 32 | 2 | 4 | Read only |
| 23 | 508EH | Maximum number of THD calculations (0-50) | Float 32 | 2 | 4 | Read only |
| 24 | 5090H | Peak factor(Range 0-1,0-3,1-6) | Float 32 | 2 | 4 | Read only |

**2.3 Example of communication data (all data below are in hex)**

(1) Set type of load for Channel 1, 2, 3

Send by master: set to 1P3W

| 0001H | 0000H | 0006H | 01H | 06H | 40H | 01H | 00H | 00H |
|---|---|---|---|---|---|---|---|---|
| Transaction identifier | Modbus Protocol | Data frame length | Instrument address | Command | High/low bytes of start register address | | 2-byte data bit | |

(2) Set voltage range (Channel 1)

Send by master: set to 30V

| 0001H | 0000H | 0006H | 01H | 06H | 40H | 04H | 00H | 01H |
|---|---|---|---|---|---|---|---|---|
| Transaction identifier | Modbus Protocol | Data frame length | Instrument address | Comm and | High/low bytes of start register address | | 2-byte data bit | |

# Section 7 Maintenance

## I. Maintenance and Care

### 1. Regular Maintenance

◆ Check the analyzer, power line, communication line and accessories every year at least, to ensure safety of operators and accuracy of the instrument. If the analyzer works in production place or other severe environment, check them carefully every half year.

◆ Power on at regular basis (every month in general) for at least 30 Min. to ensure accuracy after long time storage of the analyzer.

◆ Calibrate the instrument every year or more frequent to guarantee accuracy and reliability.

### 2. Daily Maintenance

◆ Never keep the analyzer operates over-range for long time. The allowed amplitude of impact signal shall not exceed 1.6 times of normal signal. If the analyzer is not used, pull off the power line.

◆ Keep the analyzer in dry place free of dust or serious vibration for long time storage.

◆ Warm up for 30 Min. before using the analyzer after long term storage.

## II. Troubleshooting


**Analysis meter must be repaired or maintained by an experienced professional. Otherwise, personnel injury or death may occur.**

| Faults | Measures |
|---|---|
| There is no display after the analyzer is turned on | 1) Check connection of power line;<br>2) Check the fuse. Any blown one shall be replaced with one of same size;<br>3) Re-start. |
| The current/power is zero during normal measuring | 1) Check the load;<br>2) Check the wiring. |
| Large error between the measurement and the actual value | 1) Check the load;<br>2) Check settings of voltage/current transformer ratio;<br>3) Check the wiring of load. |

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V1.1