ET5406A+/ET5407A+SingleChannel

Programmable DC Electronic Load

User Manual

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Product Basic Function

ET5406A+/ET5407A+ programmable DC electronic load provides 1mV/10mV, 1mA/10mA high resolution and precision with superior performance. It is equipped with 9 common modes and complete test functions, which can be widely used in charger, switching power supply, linear power supply, battery and other production line testing.

Key Features:

- User-friendly Design:
  - It adopts LCD screen with adjustable backlight;
  - The operation process is simple and convenient, and with visual interface display system, it is easy to get started.
  - Key lock function to prevent misoperation;
- High-performance load:
  - It provides CC, CV, CR, CP as basic measurement mode
  - It provides professional battery test;
  - The Tran test mode can test the dynamic output performance of the power supply;
  - The scan test mode can test the continuity of power output within a certain range
  - The list test mode can simulate a variety of loading status changes;
  - The short circuit test can be used to simulate load short circuit;
  - Support external trigger input;
  - Built-in buzzer alarm;
  - Maintain data storage in case of power failure;
  - Remote operation via USB, RS-232 (optional) or 485 (optional) interfaces;
- Multiple safety protection:
- It provides overcurrent, overvoltage, overpower, over temperature protection. The overvoltage and overcurrent parameters can be set flexibly, so as to effectively protect the load;
- It has intelligent fan speed control function, which can effectively reduce the fan noise when it is working.
  - With input polarity reverse prompt;

General technical specifications:

- Power supply voltage: 100Vac±10%~240Vac±10%，50/60Hz
  - Display: LCD screen with adjustable backlight
  - Operating temperature: 0℃ to 40℃
  - Storage temperature: -10℃ to 70℃
- Relative humidity: < 80%
- Interface: standard USB, optional RS232(or 485)
  - Size：75mm×155mm×240mm（W×H×D）

Standard accessories:

- Three-core power cord * 1
- Power fuse * 2
- User manual *

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1. Quick Start

1.1. Front Panel LCD Display

The segment codes on the front panel are displayed below:

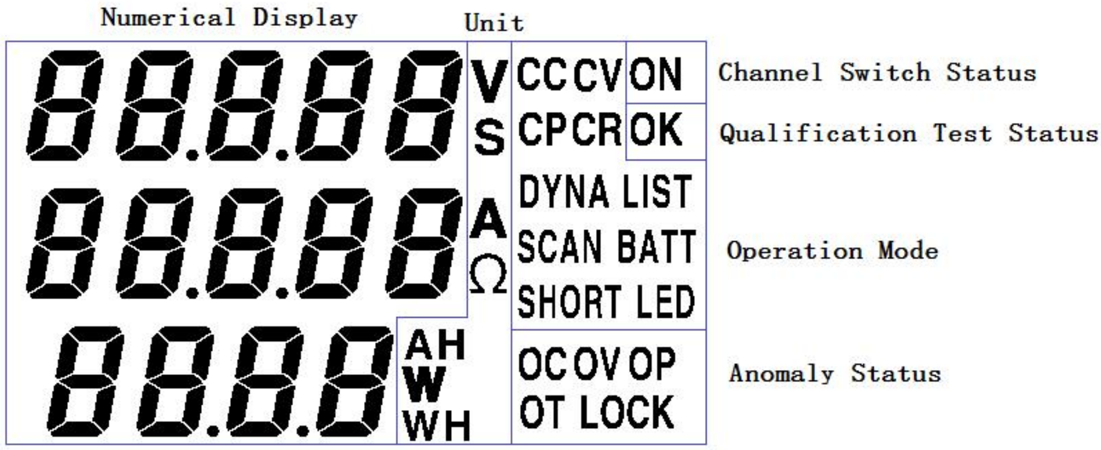


Fig. 1-1-1 Complete Segment Code Display

1.2. Buttons on the Front Panel

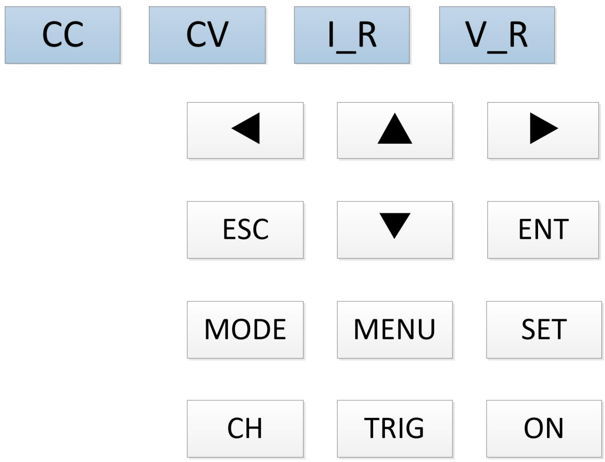


Fig. 1-2-1 Button Diagram

Button Descriptions

Below the display screen, there are 12 regular function buttons and 4 shortcut buttons, with the following specific operational functions.

Regular Function Buttons

◄: Cursor Left button; and Delete button within the Historical Record Recall Interface;

►: Cursor Right button; and Recall button within the Historical Record Recall Interface;

▲: Cursor Up button or Increment button;

▼: Cursor Down button or Decrement button;

ESC: Return button that is used to exit editing state or system setting state and return to the main display measurement interface;

ENT: OK button that is used to enter parameter settings for the current mode and confirm settings;

When the channel is active and parameters are being edited in CC/CV/CP/CR modes, it can be used to switch the display of voltage measurement values and current measurement values.

MODE: Mode Selection button that is used to enter the mode selection interface to choose one of the nine operation modes. This button is disabled within the system parameter setting interface;

MENU: System Menu button that is functional when the channel is closed and allows entry into system parameter settings;

SET: Parameter Setting button. In CC/CV/CP/CR modes, users can press this button to quickly enter the current/voltage/power/resistance value editing page. In other modes, it functions identically to the ENT button. This button is disabled in the system parameter setting interface;

CH: Channel Switching button, not activated;

TRIG: Trigger Key, functional in DYNA dynamic mode and LIST list mode. When the channel is active, each press generates a manual trigger signal. This button is disabled in the system parameter setting interface;

ON: Channel On/Off button, which is used to activate or deactivate the channel. This button is disabled in the system parameter setting interface;

Shortcuts

CC: CC Mode Shortcut, which switches to CC mode when pressed. This button is disabled in the system parameter setting interface;

CV: CV Mode Shortcut, which switches to CV mode when pressed. This button is disabled in the system parameter setting interface;

I_R: Current Range Shortcut. When the channel is inactive, users can press this button to switch between high and low current ranges. This button is disabled in the system parameter setting interface;

V_R: Voltage Range Shortcut. When the channel is inactive, users can press this button to switch between high and low voltage ranges. This button is disabled in the system parameter setting interface;

2. Functional Operations

To ensure stable and safe operation of the load and the power source to be tested, before testing the power source with the load, it is necessary to power on the load, properly connect the **positive (red) and negative (black) terminals** between the load and the power source, activate the output of the power source, and then press the ON button to activate the load channel.

Note!!! There must be a positive voltage between the red and black terminals. Any negative voltage input will prompt a reverse connection notification.

Reverse connection may result in damage to the instrument itself or the tested power source.

Note!!! Do not apply voltage to the input terminals until the instrument is powered on. When the instrument is powered on, the input terminals will undergo a 2-millisecond short-circuit self-check. Please wait until the instrument is powered on before applying voltage.

2.1. Mode Selection

Outside the system menu interface, press the [MODE] button to enter mode selection. Use either the knob or the arrow buttons [▲▼◄►] to navigate and select the mode, with the corresponding mode flashing. Press the [ENT] button to confirm the mode or press the [ESC] button to exit mode selection.

CC and CV are the two fundamental operation modes. Users can press the [CC] button to quickly switch to the CC mode, and press the [CV] button to quickly switch to the CV mode.

If the mode is switched when the channel is active, the channel output will be forcibly disabled after the mode is changed.

There are a total of nine modes: CC (Constant Current Discharge), CV (Constant Voltage Discharge), CP (Constant Power Discharge), CR (Constant Resistance Discharge), DYNA (Dynamic Mode), LIST (List Test), SCAN (Scan Mode), BATT (Battery Mode), SHORT (Short Circuit Mode).

Note: Although the segment code panel features the LED icon in the mode bar, this device does not support an LED mode.

2.2. Range Switching

Both current and voltage come with high and low ranges.

In the low range mode, the current and voltage can only be set up to 3A and 20V. If higher current or voltage is needed, users need to switch to the high range mode.

In the high range, 2 decimal places are displayed, whereas in the low range, 3 decimal places are displayed.

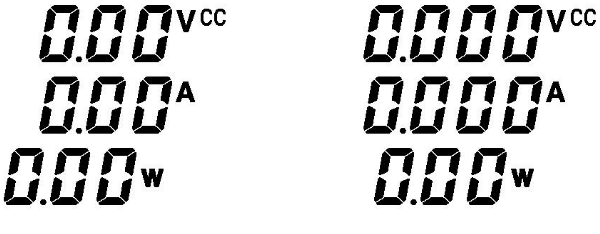


Fig. 2-2-1 Decimal Places for High and Low Ranges

When the channel is inactive, the range can be switched.

Press the [I_R] button to quickly switch between high and low current ranges.

Press the [V_R] button to quickly switch between high and low voltage ranges.

Alternatively, press the [MENU] button to enter system settings. Choose I rAn (i.e., I Range or current range) to switch current range and choose V rAn (i.e., V Range or voltage range) to switch voltage range.

During the switching of voltage range, the voltage limit will be reset to the maximum value allowed within the current range.

During the switching of current range, the current limit will be reset to the maximum value allowed within the current range.

During the switching from the high range to the low range, any associated settings that exceed the maximum value allowed within the low range will be capped at that maximum value.

2.3. Channel Switching

Press the [ON] button to activate or deactivate the channel.

When the channel is active, the "ON" character in the upper right corner of the interface will be displayed.

Once the channel is enabled, if it remains in an open circuit state (i.e., an input voltage of 0 or less than the startup voltage is detected, indicating that the load isn't functioning and remains in a high resistance state), the "ON" indicator will flash, indicating that the channel is in informal operation mode.

When the channel is disabled, the "ON" character in the upper right corner of the interface will not be displayed.

2.4. Remote/Local Switching Operation

Upon receiving a SCPI command, the load will detect the end character '\n' of the SCPI command and lock the buttons, with the LOCK icon displaying on the interface. At this point, all buttons except for the [ENT] are disabled. Press the [ENT] button to switch from remote to local, release the button lock status, and remove the LOCK icon.

2.5. System Setting Operation

When the channel is inactive, press the [MENU] button to enter the system menu interface on which [▲▼◄►] arrow buttons, [ENT] and [ESC] can be used to adjust system settings, while other buttons are disabled.

In the system menu interface, users can perform operations such as saving parameters, recalling parameters, trigger source selection, starting voltage, turn-off voltage, buzzer, backlight brightness, etc.

2.5.1. Saving Parameters

Within the system menu, the Save Parameter Interface is illustrated in Fig. 2-5-1-1. SavE PArA Set represents Save Parameter Setting.

Fig. 2-5-1-1 Save Parameter Interface

Press the [ENT] button to enter the parameter saving state, as shown in Fig. 2-5-1-2. The file name will be displayed in the second row and can be modified via the knob or cursor buttons. The file number will be displayed in the third row and it indicates the current entry number.

Fig. 2-5-1-2 Data Saving and File Name Editing

In this state, press the [ESC] button to exit the file name editing state.

In this state, press the [ENT] button to complete a parameter saving process. The file name in the second row can be edited and named repeatedly, while the file number in the third row is unique. The system supports saving up to 1600 entries of parameter configuration.

Once the maximum capacity of 1600 entries is reached, the system will loop back, deleting the oldest entry. Subsequently, all entries will be shifted forward by one slot, with the newest data saved in the 1600th slot.

The saved parameters include parameters configurable in various operation modes, system parameters in the system menu interface, and the current operation mode.

2.5.2. Load Parameters

Within the system menu, use the knob or cursor button to navigate to the Load Parameter Interface, as shown in Fig. 2-5-2-1 below. LoAd PArA Set refers to Load Parameter Setting.

Fig. 2-5-2-1 Load Parameter Interface

Press the [ENT] button to enter the Load Parameter Interface.

If there are no saved records, it will display "nonE," indicating no data.

If there are any saved records, use the knob button or press the [▲▼] button to switch and select a record.

Press the [ENT] or [►] button to load the selected record and return to the main display interface.

Press the [◄] button to delete the current record. Press and hold the [◄] button to delete all records.

2.5.3. Voltage Range

V rAn, there are two voltage ranges available. The high range, denoted as HIGH, displays voltage values with two decimal places; the low range, denoted as LoW, displays voltage values with three decimal places.

Within the non--system parameter setting interface, i.e., during operation mode, users can also swiftly switch between the high and low voltage ranges using the [V_R] button when the channel is inactive.

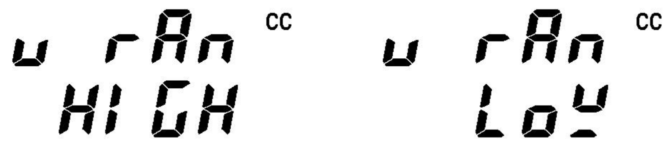


Fig. 2-5-3-1 High and Low Voltage Ranges

2.5.4. Current Range

I rAn, there are two current ranges available. The high range, denoted as HIGH, displays current values with two decimal places; the low range, denoted as LoW, displays current values with three decimal places.

Within the non--system parameter setting interface, i.e., during operation mode, users can also swiftly switch between the high and low current ranges using the [I_R] button when the channel is inactive.

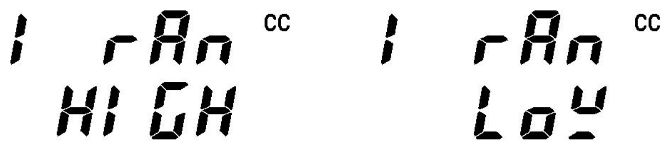


Fig. 2-5-4-1 High and Low Current Ranges

2.5.5. Voltage/Current/Power Limits

If the measured transient voltage exceeds the voltage limit for 20ms, over voltage protection will be triggered, and the "OV" and "LOCK" icons will be displayed on the interface, indicating an Over Voltage condition, button lockout, and forcible channel deactivation.

If the measured transient current exceeds the current limit for 20ms, over current protection will be triggered, and the "OC" and "LOCK" icons will be displayed on the interface, indicating an Over Current condition, button lockout, and forcible channel deactivation. Users can press the [ENT] button to release the abnormal state.

If the measured transient power exceeds the power limit for 20ms, over power protection will be triggered, and the "OP" and "LOCK" icons will be displayed on the interface, indicating an Over Power condition, button lockout, and forcible channel deactivation. Users can press the [ENT] button to release the abnormal state.

The voltage, current and power limits can be defined in the system settings, as shown in Fig. 2-5-5-1 below.

Fig. 2-5-5-1 Voltage/Current/Power Limits

The current voltage and current ranges will also affect the setting range of the limits.

In addition to the system settings, users can also set the voltage/current/power limits in the CC, CV, CP and CR modes.

2.5.6. Trigger Source Selection

The load features a trigger (trIG) function, which is primarily used in DYNA and LIST tests to initiate the next conversion.

In DYNA and LIST test modes, once the channel is activated, a trigger signal will be generated and will result in a single change in the operation state.

There are three types of trigger signals: External trigger, manual trigger, and software trigger.

Users can select one of the four trigger sources, namely, ALL, E tEr, MAnUA and SoFt, or activate all of them.

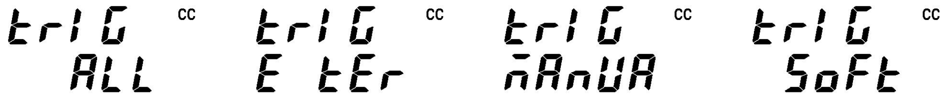


Fig. 2-5-6-1 Trigger Source Settings

E tEr: The external trigger terminal at the back of the instrument detects a Negative Edge with a low level lasting for more than 100ms, resulting in a trigger signal. For details, refer to section 12.2 "Functions of Communication Ports and External Interfaces."

Note: Although it is displayed as "E tEr," it is spelled out as "External," and the 'x' character is not displayed due to design reasons.

MAnUA: Press the [TRIG] button on the front panel to generate a trigger signal each time.

SoFt: It refers to triggering via the program-controlled command through the serial port. Each time the "*TRG\n" is sent, a trigger signal is generated.

2.5.7. Starting Voltage and Turn-off Voltage

Starting voltage, i.e. v on or voltage on, refers to the voltage at which the channel can be activated normally.

In the activated state, the channel will begin functioning only when the measured voltage exceeds the starting voltage. Otherwise, it will be in an open-circuit state, with the "ON" icon flashing.

Turn-off voltage, i.e. v oFF or voltage off, refers to the voltage at which the channel is deactivated and disconnected.

In the activated state, if the measured voltage falls below the turn-off voltage, the channel will be disconnected and switched to an open-circuit state, with the "ON" icon flashing.

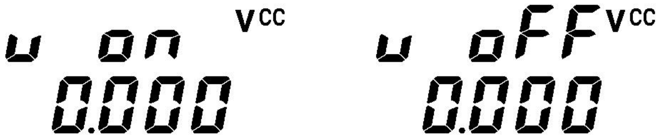


Fig. 2-5-7-1 Starting Voltage and Turn-off Voltage

Note: Starting Voltage≥Turn-off Voltage. If the starting voltage cannot be reduced during settings, please reduce the turn-off voltage first; if the turn-off voltage cannot be increased, please increase the starting voltage first.

2.5.8. Start Settings

Start Settings, i.e. StArt can be used to set the dEFAU or LASt.

dEFAU: default, each time the instrument is started, all parameters will be configured to their factory defaults.

LASt: last, each time the instrument is started, all parameters will be configured to settings from the previous shutdown.

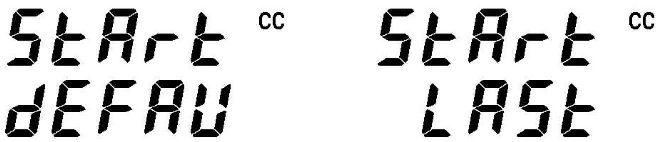
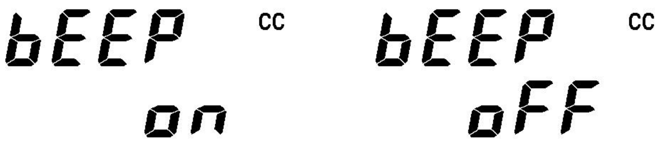


Fig. 2-5-8-1 Start Settings

Note: The channel is deactivated each time the instrument is restarted and the on/off status of the channel will not be stored. Additionally, in battery mode, measurement parameters (Ah, Wh, time) are continuously preserved in case of power loss, regardless of these settings.

2.5.9. Buzzer

The sound of the Buzzer (bEEP) can be turned on or off.



2-5-9-1 Buzzer Settings

2.5.10. Factory Reset

FACto is also called Factory reset. Upon pressing the [ENT] button, users will receive a "SURE" prompt. Press the [ENT] button once more to confirm and proceed with the factory reset to return all settings to their original factory defaults.

Fig. 2-5-10-1 Factory Reset

Note: After a factory reset, the "start settings" will return to default values (dEFAU). To preserve parameter settings during power-off, users need to configure the "start settings" as LASt.

2.5.11. Backlight Brightness

Backlight Brightness (LIGHt) refers to the backlight brightness of segment codes. It ranges from 0 to 10, with 0 indicating backlight off and 10 indicating maximum brightness.

Fig. 2-5-11-1 Backlight Brightness

2.5.12.RS485 Address

RS485 Address (485Ad or 485 Address) can be set from 0 to 31 and will function only when the communication mode is set as 485.

0 represents the broadcast address. In 485 mode, all instruments will respond to address 0.

Addresses 1 to 31 represent specific addresses. In multi-485 communication, each device must be assigned a unique address from 1 to 31.

Fig. 2-5-12-1 485 Address Setting

2.5.13. Baud Rate

Baud Rate (bUAd) can be set to 4800, 7200, 9600, 14400, 19200, 34800, 57600 or 115200.

Fig. 2-5-13-1 Baud Rate Setting

2.5.14. Communication Mode

Communication Mode (CoMMU or Communication) can be selected from USB, RS232 or RS485.

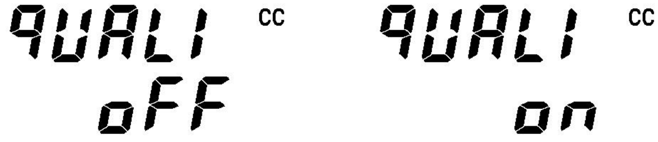
USB is standard, while RS232 and RS485 are optional.

RS485 communication protocol requires the addition of the string "M@Sxxx" at the beginning, whereas USB and RS232 do not. Refer to communication protocol details for more information.

2-5-14-1 Communication Mode Setting

2.5.15. Qualification Test and Its Limit

Qualification Test (qUALI or quality) can be enabled or disabled.

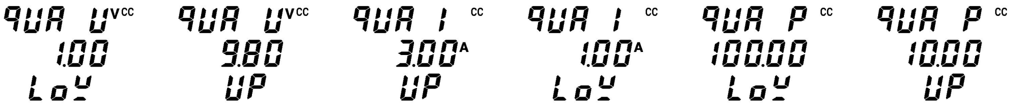


2-5-15-1 Qualification Test Setting

When the Qualification Test is enabled, the channel is active, and the tested voltage, current and power exceed the limits set for the test, the "OK" icon will flash, accompanied by a sounding Buzzer. If the tested voltage, current and power are within the specified limits, the "OK" icon will remain steady, and the Beep will remain silent.

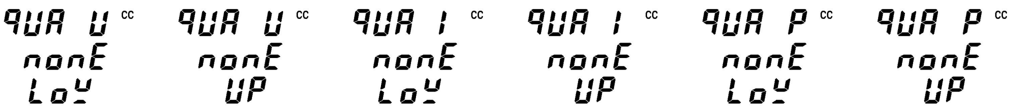
When the Qualification Test is enabled, upper and lower limits for voltage, current, and power can be edited.

Users can press the [ENT] button and use the arrow buttons and the knob to adjust the value.



2-5-15-2 Parameters Configurable When the Qualification Test Is Enabled

When the Qualification Test is disabled, these six values will appear as "NONE," indicating that they cannot be edited.



2-5-15-3 When the Qualification Test Is Disabled, No Parameters Can Be Modified

2.5.16. System Information

System Information (InFo or Information) is for display only and cannot be edited. It shows the current software version and serial number, with the software version displayed on the second line and the serial number on the third line.

2-5-16-1 System Information

3. Basic Mode Operations

The electronic load features four basic operating modes:

Constant Current (CC), Constant Voltage (CV), Constant Resistance (CR), and Constant Power (CP).

These four modes are considered the basic operation modes. After the channel is activated, all parameters other than the turn-off delay time can be edited and take immediate effect.

3.1. Constant Current (CC)

In CC mode, the electronic load consumes a constant current, regardless of input voltage changes.

3.1.1. Main Display Interface

As shown in Fig. 3-1-1-1, the Main Display Interface displays the measured voltage n the first line, the measured current on the second line, and power on the third line. The "CC" on the top right indicates the CC mode.

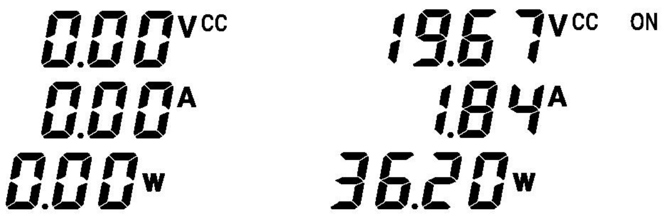


Fig. 3-1-1-1 Main Display Interface in CC Mode

3.1.2. Parameter Editing

Press the [ENT] button on the Main Display Interface to enter Parameter Editing interface. Use the arrow buttons [▲ ▼◄ ►] or knob to select the parameter to be edited.

Press the [ENT] button to edit the selected parameter and use the arrow buttons [▲ ▼◄ ►] or knob to adjust the selected parameter.

In CC mode, the following five parameters can be edited.

Current Setting: Constant current to be consumed in CC mode.

Fig. 3-1-2-1 Editing and Setting Current

Turn-off Delay Value: After the channel is activated, a countdown begins, and the channel will be deactivated when the countdown reaches zero.

Fig. 3-1-2-1 Editing Turn-off Delay Value

Current, Voltage and Power Limits: They are typically set to their maximum values. If these maximum values are exceeded, the channel will be forcibly deactivated and the buttons will be locked, with OC, OV and OP prompted.

Each time the voltage or current range is switched, the corresponding voltage or current limits will be reset to their maximum values.

Fig. 3-1-4 Editing Current, Voltage and Power Limits

Press the [SET] button to quickly enter the current editing interface.

Press [ESC] repeatedly to exit the parameter editing state and return to the main display interface.

3.1.3. Operation Status

Press the [ON] button to activate the channel. It will display the current measured values: measured voltage on the first line, measured current on the second line, and measured power on the third line.

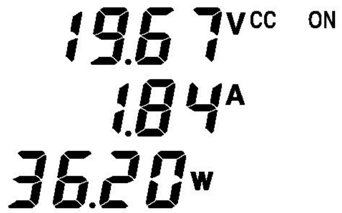


Fig. 3-1-3-1 When the Channel Is Activated，the Measured Values Will Be Displayed

In CC, CV, CR and CP modes, when the channel is activated, parameters can also be edited.

When the channel is activated, users can edit current parameters, with the current values to be edited displayed on the second line, measured voltage and current displayed alternatively on the first line, and power value displayed on the third line, as shown in Fig. 3-1-3-2.

When editing current values, users can press the [ENT] button to constantly or alternatively display the measured voltage or current on the first line.

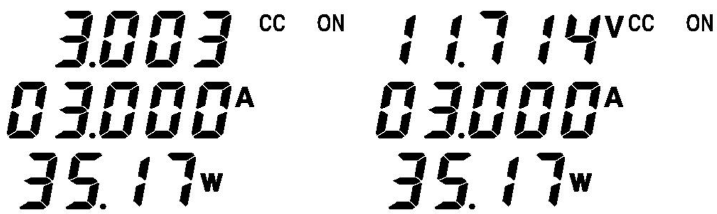


Fig. 3-1-3-2 Editing Current Value When the Channel Is Activated in CC Mode

In terms of editing delay time, voltage limit, current limit and power limit when the channel is activated, the parameters are displayed in a normal editing mode without showing the currently measured voltage, current and power.

3.2. Constant Voltage (CV)

In CV mode, the electronic load will consume enough current to maintain the input voltage at the set voltage value.

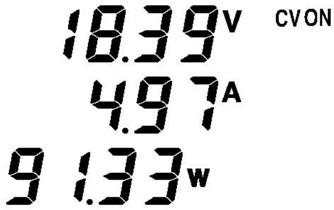


Fig. 3-2-1 Basic Display Interface When the Channel Is Activated in CV Mode

Basic button operations and interface switching and display are the same with those in CC mode.

In CV mode, users can edit 5 parameters: setting voltage value, turn-off delay value, current, voltage, and power limit.

Compared to CC mode, the only difference is that the setting value is changed into the voltage value, while the other four values remain the same.

In CV mode, press the [SET] button on the main display interface to quickly enter the voltage editing interface.

3.3. Constant Power (CP)

In constant power mode, the load consumes a constant power. When the input voltage changes, the load will adjust the current accordingly to maintain power consumption at the set power value.

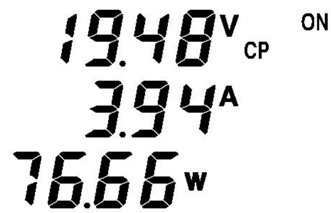


Fig. 3-3-1 Basic Display Interface When the Channel Is Activated in CP Mode

Basic button operations and interface switching and display are the same with those in CC mode.

In CP mode, users can edit 5 parameters: setting power value, turn-off delay value, current, voltage, and power limit.

Compared to CC mode, the only difference is that the setting value is changed into the power value, while the other four values remain the same.

In CP mode, press the [SET] button on the main display interface to quickly enter the power editing interface.

3.4. Constant Resistance (CR)

In constant resistance mode, the load is held at a constant resistance. When the input voltage changes, the load will adjust the current accordingly to maintain the load at the set resistance value.

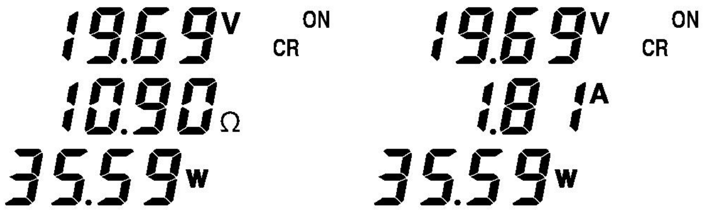


Fig. 3-4-1 Basic Display Interface When the Channel Is Activated in CR Mode

After the channel is activated, users can press the arrow buttons [▲ ▼◄ ►] to select whether to display resistance and current alternately on the second line, or to display only current or resistance.

Other basic button operations and interface switching and display are the same with those in CC mode.

In CR mode, users can edit 5 parameters: setting resistance value, turn-off delay value, current, voltage, and power limit.

Compared to CC mode, the only difference is that the setting value is changed into the resistance value, while the other four values remain the same.

In CR mode, press the [SET] button on the main display interface to quickly enter the resistance editing interface.

4. Dynamic Test Operation (DYNA)

Dynamic test operation allows for the repeated switching between two set currents or voltages in the load, enabling the examination of the power source's dynamic characteristics. Before initiating dynamic testing operation, it's necessary to configure the relevant parameters for dynamic testing.

4.1. Main Display Interface

The main display interface in the dynamic mode displays voltage, current, and power.

Fig. 4-1-1 Main Display Interface in the Dynamic Mode

4.2. Parameter Editing

Parameters cannot be edited when the channel is activated and can only be edited when the channel is deactivated.

Press the [ENT] button to enter the parameter setting interface, and select the parameter to be edited using the knob or arrow buttons. After the selection, press the [ENT] button again to edit the selected parameter. The following parameters can be edited.

After setting the parameters, press the [ESC] button repeatedly to return to the main display interface.

Dynamic Mode: There are 3 modes, Cont (Continuous), PULS (Pulse) and trIG (Trigger).

Fig. 4-2-1 Dynamic Mode

Dynamic Load State: There are two kinds of load state, CC or CV, indicating either constant current discharge or constant voltage

discharge.

Fig. 4-2-2 Dynamic Load State

Value A: Current value in CC load state, voltage value in CV load state.

Fig. 4-2-3 Value A in Different Kinds of Load State

Value B: Current value in CC load state, voltage value in CV load state.

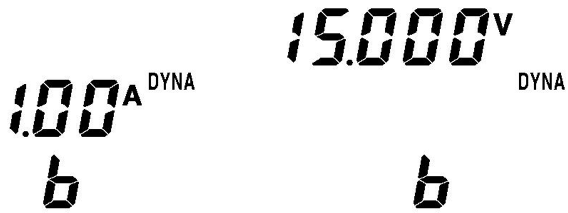


Fig. 4-2-4 Value B in Different Kinds of Load State

Value A Pulse Width Time: Duration of value A.

Value B Pulse Width Time: Duration of value B.

Fig. 4-2-5 A and B Pulse Width Time

4.3. Operation State

After users press the [ON] button to activate the channel, it will exhibit different operation behaviors based on the specified settings.

Continuous Mode (Cont): In this mode, after the test is initiated, the load can continuously switch between values A and B.

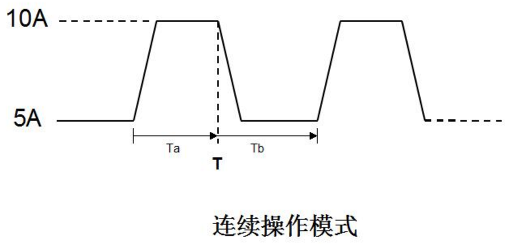


Fig. 4-3-1 Continuous Mode

Pulse Mode (PULS): In this mode, after the test is initiated, the load switches from value A to value B upon receiving each trigger signal. After maintaining value B for the pulse width time, it reverts back to value A.

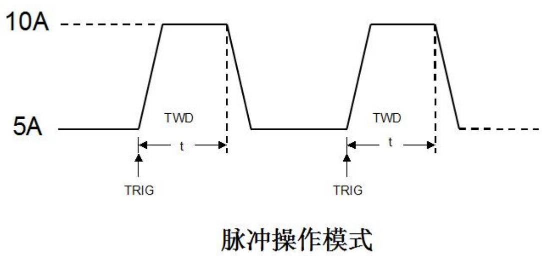


Fig. 4-3-2 Pulse Mode

Trigger Mode (trIG): In this mode, after the test is initiated, the load switches between values A and B upon receiving each trigger signal. In this mode, pulse width settings will not take effect.

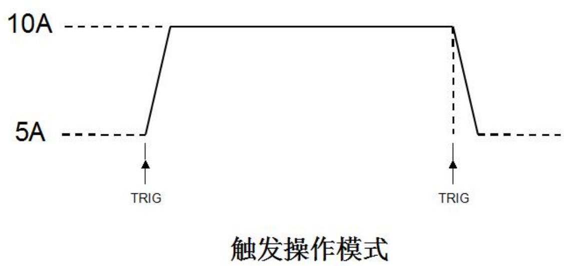


Fig. 4-3-3 Trigger Mode

5. LIST Test Operations

The LIST test feature streamlines the testing of the device under test across various load conditions, promoting automation in production line testing. By pre-configuring the steps of the

LIST test, the testing procedures and parameters for the device under test can be organized into a list and executed in sequence. Specific setting parameters include: defining the number of steps, step mode, loop switch, load mode for each step, load magnitude, delay time, comparison switch, upper limit, and lower limit.

5.1. Main Display Interface

When the channel is deactivated, it can display basic electrical parameters (voltage, current, power), or the 10 list settings (excluding delay settings) or test results from the previous LIST setting test. Use the arrow buttons [▲ ▼◄ ►] to switch between the displayed interfaces.

Fig. 5-1-1 Basic LIST Electrical Parameters and LIST Test Results

Refer to section 5.3 for details on the LIST settings interface.

When the channel is activated, voltage will be displayed on the first line, with current, resistance or current LIST steps on the second line and power on the third line. Users can use the arrow buttons [▲ ▼◄ ►] to select whether to display the parameters alternatively or to display a specific parameter permanently on the second line.

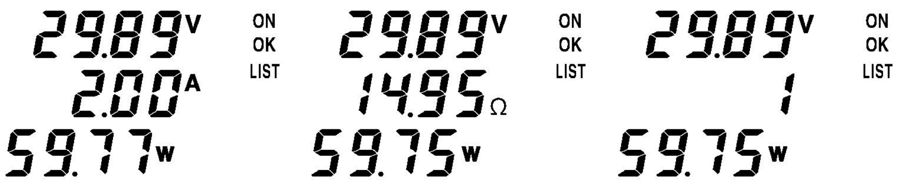


Fig. 5-1-2 LIST Test When the Channel Is Activated

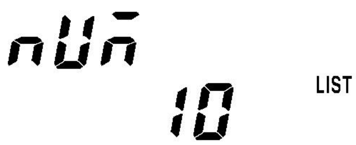
5.2. Parameter Editing

Parameters cannot be edited while the channel is activated; editing is only possible when the channel is deactivated.

Press the [ENT] button to enter the parameter setting interface and select parameters to be edited by using the knob or arrow buttons. After the selection, press the [ENT] button again to edit the selected parameter. The following parameters can be edited.

After setting parameters, press the [ESC] button repeatedly to return to the main display interface.

Test Steps: Set the number of test items, ranging from 1 to 10.



5-2-1 Test Steps

Step Mode: Continuous/Trigger. Set the step mode for test items.

Continuous: Perform tasks sequentially and sustain the delay time in the current mode.

Trigger: Enter the next mode upon receiving a trigger signal.

5-2-2 Test Steps

Looping: Enabled/Disabled. Set whether the entire test will be performed repeatedly.

When the looping mode is disabled, operation starts from the mode 1. Upon the completion of the final mode, the channel is automatically deactivated, thus concluding the operation.

When the looping mode is enabled, operation starts from mode 1 and, upon the completion of the final mode, loops back to mode 1 to start over again.

5-2-3 Looping Mode

Modes: The following 6 modes are available.

CC (Constant Current), CV (Constant Voltage), CP (Constant Power), CR (Constant Resistance), oPEn (Open Circuit) and SHort (Short Circuit).

5-2-4 Functional Modes

Setting Values: Correspond to the test setting values for the respective test items.

In CC mode, current can be set; in CV mode, voltage can be set; in CP mode, power can be set; in CR mode, resistance can be set.

In oPEn or SHort mode, settings are unavailable, with nonE being displayed.

5-2-4 Setting Values in Different Modes

Note: When the mode is changed, the setting value will be limited to the maximum setting within the current range. For instance, if the initial setting in CV mode is 100V, when the CV mode is switched to the CC mode, the low current range will be capped at 3A, with the high current range limited to the maximum current setting.

Delay: Runtime setting for this specific test item.

5-2-5 Settings in Different Modes

Comparison: Whether to compare the values from the current channel with the preset upper and lower limits after the test is initiated. Users can choose OFF (disabled), CUrr (current), voLt (voltage), PoWEr (power), and rES (resistance).

5-2-6 Comparison Value Mode

Upper Limit: The maximum allowable value for this test when [Comparison] is set to Current, Voltage, Power or Resistance.

When [Comparison] is set to OFF, it becomes uneditable, with nonE being displayed.

5-2-7 Upper Limit for Comparison

Lower Limit: The minimum allowable value for this test when [Comparison] is set to Current, Voltage, Power or Resistance.

When [Comparison] is set to OFF, it becomes uneditable, with nonE being displayed.

5-2-8 Lower Limit for Comparison

5.3. Operation Status

Press the [ON] button to activate the channel. Once the channel is activated, parameters cannot be edited.

Operation commences from step 1 and proceeds to the specified steps. In Auto mode, after a delay, it automatically moves to the next step. In Trigger mode, it requires a trigger signal to proceed to the next step.

Once the final step is completed, if the looping mode is disabled, a round of LIST test comes to an end; if the looping mode is enabled, the test restarts from step 1.

During the LIST test, the Qualification Test settings within the system settings will be deactivated because within each step of the list, comparison values can be set, allowing for qualification test for specific electrical parameters within the current step of the test. Additionally, the test results at the end of each step can be recorded. There are three results: PASS, FAIL and NONE. Test results can be viewed after the test is completed and the channel is deactivated.

5-3-1 Comparison Results

The effect of the comparison value is similar to that of the Qualification Test. If the value falls within the specified range, the "OK" icon remains steady; if it exceeds the range, the "OK" icon flashes and the Buzzer sounds.

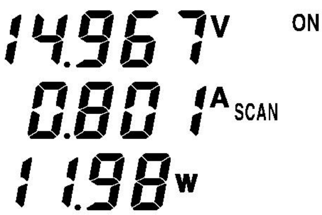
6. Scan Test Operation (SCAN)

Scan Test enables the examination of the continuous operation status of the device under test within a specified range, facilitating the capture of critical parameters such as protective current and breakover voltage. Users can customize parameters including start and end points for scanning, step size, step delay, threshold type and comparison type. Upon completion of the Scan Test, a qualified or failed test result, along with the measured voltage and current from the most recent 255 points (less than or equal to 255 points) will be displayed.

6.1. Main Display Interface

When the channel is deactivated, this interface will display basic electrical parameters (voltage, current and power), captured voltage/current/power, comparison status, and scanned voltage/current from up to 255 points.

When the channel is activated, this interface will display basic electrical parameters (voltage, current and power).



6-1-1 Basic Electrical Parameters

6.2. Parameter Editing

Parameters cannot be edited while the channel is activated; editing is only possible when the channel is deactivated.

Press the [ENT] button to enter the parameter setting interface, and select the parameter to be edited using the knob or arrow buttons. After the selection, press the [ENT] button again to edit the selected parameter. The following parameters can be edited.

After setting the parameters, press the [ENT] button repeatedly to return to the main display interface.

Scan Type: CC (Constant Current) / CV (Constant Voltage) / CP (Constant Power). Set the continuous operation type of the device under test within a certain range.

6-2-1 Scan Type

For CC scan type, start value, end value, and step value are current values;
For CV scan type, start value, end value, and step value are voltage values;
For CP scan type, start value, end value, and step value are power values.

Start Value: The initial setting value for the scan.

6-2-2 Scan Start Value

End Value: The ending setting value for the scan.

6-2-3 Scan End Value

Step Size: Set the increased step value for each step between the scan start point and scan end point.

6-2-4 Scan Step Value

Step Delay: Set the time taken for each step between the scan start point and the scan end point.

6-2-5 Scan Step Delay Value

Threshold Types: Minimum Voltage/Voltage Transition/ Drop.

Minimum Voltage: MIn. When the voltage of the load during operation is less than the threshold setting value of the minimum voltage, the voltage, current, and power values of the load will be captured, and displayed on the measurement display interface;

Voltage Transition: dELtA. When the amplitude of voltage transition during operation exceeds the threshold setting value, the voltage, current, and power values of the load will be captured, and displayed on the measurement display interface;

Drop: droP. When the voltage suddenly drops significantly close to 0 during operation, i.e., the previous scan value, the voltage, current, and power values of the load will be captured, and displayed on the measurement display interface.

6-2-6 Scan Threshold Types (Minimum Voltage, Voltage Transition and Drop)

Comparison types: During the scanning process, comparisons can be configured for current (CUrr), voltage (voLt), power (PoWEr), or none (nonE).

After the parameters for comparison are selected, whether the measured value exceeds the upper or lower limits will be examined during the scanning process. If so, the result will display as "FAIL"; otherwise, it will indicate "PASS".

6-2-7 Scan Comparison Types (Minimum Voltage, Voltage Transition and Drop)

Note: The comparison feature only yields resultant values upon the completion of the scan. Throughout the scanning process, the comparison feature will not trigger the display of the "OK" icon or the activation of the Buzzer.

Upper Limit for Comparison: It refers to the upper limit corresponding to the comparison type. The display varies according to different comparison types.

6-2-8 Upper Limit for Scan Comparison

Lower Limit for Comparison: It refers to the lower limit corresponding to the comparison type. The display varies according to different comparison types.

6-2-9 Lower Limit for Scan Comparison

6.3. Operation Status

Press the [ON] button to activate the channel, and it will operate according to the setting values. It starts from the initial setting value and progresses through the changes in the step size at specified intervals of the step delay until reaching the end value. After the scan is completed, the channel will be automatically deactivated.

After completing the test, users can select and observe various results from the scan using the knob or arrow buttons.

If the threshold detection is triggered during the scanning process, the captured voltage, current, and power values can also be viewed.

6-3-1 Captured Values of the Voltage Threshold

The Scan Test also comes with the comparison setting and the output of the comparison results.

6-3-2 Comparison Results

During scanning, voltage and current data can be recorded. The total number of recorded data points is limited to 255 or fewer. If the total number of scanned points exceeds 255, only the most recent 255 data points can be observed.

6-3-3 Data Recorded from the Scan

7. Battery Test Operation (BATT)

The battery test feature is commonly used to detect battery discharge performance. The electronic load can operate in constant current or constant resistance mode, and the available cut-off conditions for load operation include voltage, operation time, discharge capacity, and discharge energy. Upon being activated, the load will automatically begin to measure the battery's discharge capacity and discharge energy, which will be displayed on the measurement display interface.

7.1. Main Display Interface

When the channel is deactivated, users can use the knob and arrow buttons [▲ ▼◄ ►] to switch the display among basic electrical parameters (voltage, current, power), ampere-hour, watt-hour, and the time of the last battery measurement.

Fig. 7-1-1 Basic Electrical Parameters

Fig. 7-1-2 Capacity AH and Energy WH Recorded from Last Measurement

The recording time consists of hours on the first line, minutes on the second line and seconds on the third line.

Fig. 7-1-3 Time Value from Last Record

When the channel is activated, users can use the knob and arrow buttons [▲ ▼◀ ▶] to switch the display among basic electrical parameters (voltage, current, power), ampere-hour, watt-hour, the time of the last battery measurement and the resistance value.

Fig. 7-1-4 Display of Various Parameters When the Channel Is Activated

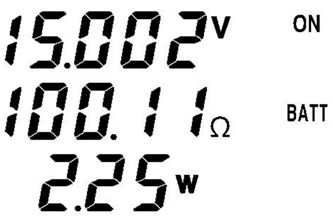


Fig. 7-1-5 Display of Resistance Value

7.2. Parameter Editing

Parameters cannot be edited while the channel is activated; editing is only possible when the channel is deactivated.

Press the [ENT] button to enter the parameter setting interface, and select the parameter to be edited using the knob or arrow buttons. After the selection, press the [ENT] button again to edit the selected parameter. The following parameters can be edited.

After setting the parameters, press the [ENT] button repeatedly to return to the main display interface.

Discharge Modes: In Battery mode, there are two discharge modes, CC (constant current discharge) or Cr (constant resistance discharge).

Fig. 7-2-1 Discharge Modes

Cut-off Conditions: In Battery mode, there are four cut-off conditions, voltage (voLt), time (tIME), capacity (AH) and energy (WH).

Fig. 7-2-2 Cut-off Conditions

Cut-off Enable:

In the constant current (CC) discharge mode with voltage (voLt) as the cut-off condition, users can select settings from 1 to 3, adjusting the discharge current and cut-off voltage within this range.

In other scenarios, the setting is limited to 1.

Fig. 7-2-3 Cut-off Enable

Discharge Setting Value: In the CC discharge mode, it is set to current; in the Cr discharge mode, it is set to resistance.

Fig. 7-2-4 Discharge Setting Value

In the CC discharge mode with voLt as the cut-off condition, the number of discharge setting values that can be configured is equal to the cut-off enable value.

Cut-off Voltage: Set the cut-off value when voltage is selected as the cut-off condition.

In the CC discharge mode with voLt as the cut-off condition, the number of cut-off voltage values that can be configured is equal to the cut-off enable value.

For example, if the cut-off enable is set to 3, there are 3 cut-off voltage values that can be configured.

If the instrument operates at this time, it will check if the measured voltage is less than cut-off voltage 1;

If so, it will determine if the measured voltage is less than cut-off voltage 2;

If so, it will determine if the measured voltage is less than cut-off voltage 3;

If so, the channel will be automatically deactivated and the battery measurement will be completed.

In general, cut-off voltage 1 > cut-off voltage 2 > cut-off voltage 3. If set as shown in Figure 7-2-5, the measured voltage will be less than 8V, and will be definitely less than 12V and 10V, making the conditions for the latter two cut-off voltages ineffective.

Fig. 7-2-5 Cut-off Voltage

Under other conditions, the cut-off enable can only be set to 1, and if the measured voltage is less than cut-off voltage 1, the channel will be automatically deactivated and the battery measurement will be completed.

Cut-off Time: Set the cut-off value when time is selected as the cut-off condition. After the channel operates based on the cut-off time value, it will be automatically deactivated and the battery measurement will be completed.

Cut-off Capacity: Set the cut-off value when capacity is selected as the cut-off condition. After the capacity value accumulates to the cut-off level, the channel will be automatically deactivated and the battery measurement will be completed.

Cut-off Energy: Set the cut-off value when energy is selected as the cut-off condition. After the energy value accumulates to the cut-off level, the channel will be automatically deactivated and the battery measurement will be completed.

7.3. Operation Status

After setting the parameters, press the ON button to start the battery test.

Once the cut-off condition is met, the channel will be automatically deactivated. Energy, capacity, and time values will be saved even after power outage, ensuring that the values from the last measurement are preserved. In battery mode, each time the channel is activated for measurement, the calculation of energy, capacity, and time values will be restarted.

7.3.1. Example: CC Discharge with Voltage Selected as the Cut-off Condition

This is the most common method, typically used for discharging lithium batteries.

As shown below, CC discharge is selected as the discharge condition, with voltage as the cut-off condition.

Fig. 7-1-1 CC Discharge with Voltage Selected as the Cut-off Condition

At this time, the cut-off enable can be set from 1 to 3, allowing for a maximum of 3 sets of discharge current and cut-off voltage configurations.

For example, discharging a 5-cell lithium battery with a capacity of 3000mAh.

For a single-cell lithium battery, the full charge voltage is typically 4.2V, with the cutoff voltage usually set at 3V (specific to the lithium battery type; cutoff voltages may vary for different types).

For a 5-cell lithium battery, the full charge voltage is 4.2 * 5 = 21V, and the cutoff voltage is 3 * 5 = 15V.

3000mAh means that the battery can be discharged at 3A for 1 hour. Here, if discharged at 1C, the battery can be discharged at 3A according to its capacity of 3000mAh. Alternatively, a common used discharge rate is 0.2C, meaning 0.2 * 3000 = 600mA. The specific discharge rate depends on the user's usage.

At this time, the cutoff enable can be set to 1, the discharge current to 3A and the cutoff voltage to 15V.

With these settings, when the instrument detects an input voltage below 15V, it will automatically deactivate the channel and terminate the measurement.

Fig. 7-3-1-1 Battery Discharge Settings

As the battery discharges, its internal resistance increases and output voltage decreases. Therefore, users can use a lower current for discharge when the battery voltage decreases.

Therefore, users can set the cutoff enable to 3.

Set discharge current 1 to 3A and cutoff voltage 1 to 17V;

Set discharge current 2 to 1.5A and cutoff voltage 2 to 16V;

Set discharge current 3 to 0.5A and cutoff voltage 3 to 15V.

Discharge current 1 > Discharge current 2 > Discharge current 3; Cutoff voltage 1 > Cutoff voltage 3 > Cutoff voltage 3.

With these settings, when detecting an input voltage below 17V, the instrument will discharge at 1.5A; when detecting an input voltage below 16V, it will discharge at 0.5A; and when detecting an input voltage below 15V, it will automatically deactivate the channel and terminate the measurement.

8. Short Circuit Test Operation (SHORT)

The load can simulate a short-circuit circuit at the input terminal.

Press the ON button to activate the channel, and the two input terminals of the instrument will be short-circuited.

During the short circuit test, the actual current consumed by the load short circuit depends on the maximum output of the power supply. The short circuit current should not exceed the device's current limit, otherwise, it will trigger over-current protection.

Basic button operations and interface switching and display are the same as those in constant current mode (CC).

Current, voltage, and power limits can be edited.

9. Protection/Prompt Feature

The load provides over current protection, over voltage protection, over power protection, over temperature protection and reverse polarity prompt.

When in a protective or prompting state, the buttons will be locked. Users need to press the [ENT] button briefly to unlock the buttons.

Equipment Protection/Prompt Descriptions:

Protection Type	Type Description	Protection/Prompt Reasons
OC	Over Current Protection	Input current exceeds the current limit (detected for over 20ms)
OV	Over Voltage Protection	Input voltage exceeds the voltage limit (detected for over 20ms)

OP	Over Power Protection	Input power exceeds the power limit (detected for over 20ms)
OT	Over Temperature Protection	The temperature of the heatsink exceeds 85°
RV	Reverse Polarity Prompt	Input polarity is reversed

Note: There's only a prompt for reverse polarity, without any protection.

10. Qualification Test Operation

The Qualification Test operates in non-list mode. Once this feature is enabled, it can continuously monitor whether the current test is within the set limit range on the main interface in basic measurement mode.
If the test is within the range, the "OK" icon will be displayed continuously, indicating that the data is qualified.
If the test exceeds the range, the "OK" icon will flash and the Buzzer will sound, indicating that the data is not qualified.
Note: When the Buzzer is deactivated in the system settings, it will not sound even if the data is not qualified.

11. Other System Settings

11.1. Keyboard Lock Feature

Once the protection/prompt feature is triggered or the newline character ('\n', i.e. 0x0A) is received from the SCPI command, the "LOCK" icon will be displayed on the interface, indicating that the keyboard is locked. Press the [ENT] button briefly to unlock the keyboard.

11.2. Communication Port and External Interface Feature

The USB communication port comes as standard, with RS232 and RS485 as optional features (Users can choose either one).

The back panel of the device is provided with a USB communication port and a 6P 3.81mm pluggable terminal, as defined in the figure below.

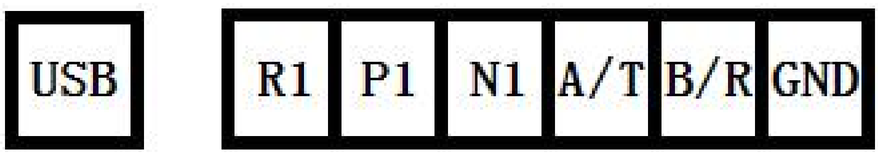


Fig. 11-2-1 Communication Port and External Interface

USB: A square-ended USB for Type-B socket. It can be recognized by the computer as a COM port and need to be provided with a CH340 driver.

R1: Run1, OC output port, requires external pull-up resistor and pull-up level, with a level range of 0-50V.

In LIST mode, if the test is in progress, the level is low; otherwise, the level is high.

P1: Pass1, OC output port, requires external pull-up resistor and pull-up level, with a level range of 0-50V.

If the LIST test result or the result of the qualification test is deemed satisfactory, the level is low; otherwise, the level is high.

N1: When an external trigger is input, the Negative Edge 1 is triggered, with the low level being effective and maintained for more than 100ms.

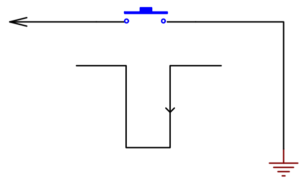


Fig. 11-2-2 External Trigger Signal

B/R: In RS485 mode, it is Terminal B for 485; in RS232 mode, it is RXD, a receiving terminal.

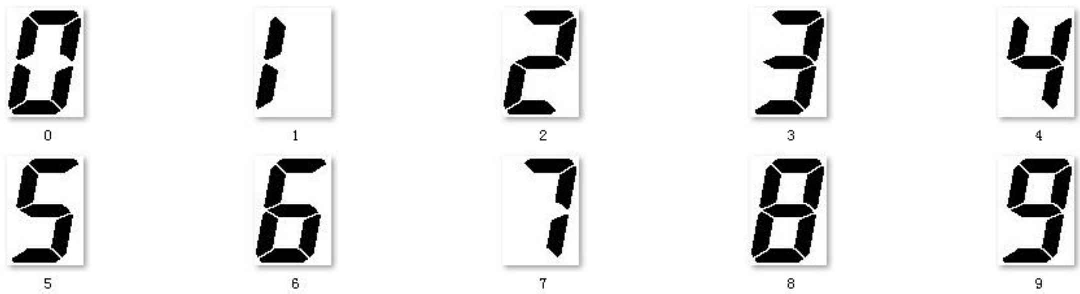
A/T: In RS485 mode, it is Terminal A for 485; in RS232 mode, it is TXD, a transmitting terminal.

GND: Ground for expansion port signals and communication ports.

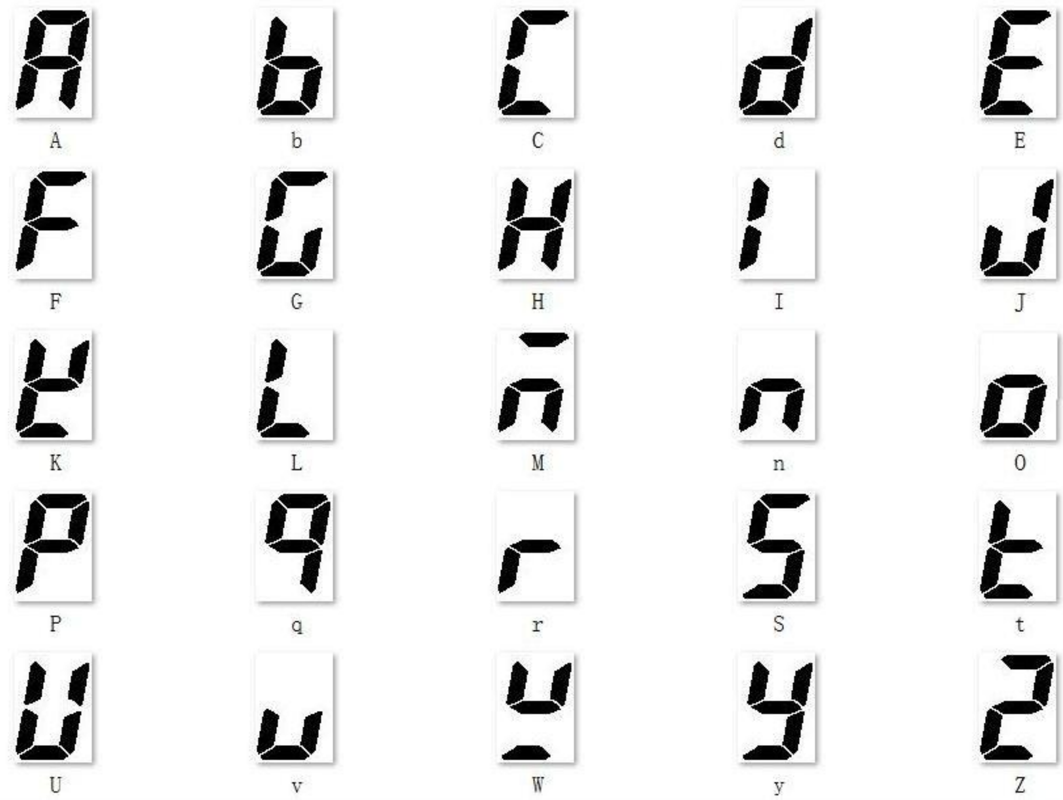
Note: The B/R and A/T terminals for the Communication Port are optional features that need to be selected during the ordering process for normal operation.

Appendix:

Digits 0 to 9



Letters A to Z (excluding X)



Technical Index:

MODEL		**ET5406A+**	**ET5407A+**
Rated input	Power	200W	200W
	Input voltage	0-120V	0-180V
	Input current	0-20A	0-30A
CV mode	Range	0.1~19.999V,0.1~120.00V	0.1~19.999V,0.1~180.00V
	Resolution	1mV,10mV	
	Accuracy	±（0.05%+0.02%FS）	
CC mode	Range	0~3.000A,0~20.00A	0~3.000A,0~30.00A
	Resolution	1mA,10mA	
	Accuracy	±（0.05%+0.05%FS）	±（0.05%+0.05%FS）
CR mode	Range	0.05Ω~4.50kΩ	
	Resolution	10mΩ，1Ω	
	Accuracy	±（0.1%+0.5%FS）	
CP mode	Range	0~200W	0~200W
	Resolution	10mW	
	Accuracy	±（0.1%+0.5%FS）	
Tran Test	Mode	CC，CV	
	T1&T2	0.05s~99.999s	
Battery Test	Discharge mode	CC，CR	
	Maximum discharge	9999Ah	

	capacity		
	Resolution	1mA，10mA，10mΩ，1Ω	
Range of measurement			
Voltage read-back value	Range	0~19.999V,0 ~120.00V	0~19.999V,0~180.00V
	Resolution	1mV,10mV	
	Accuracy	±（0.05%+0.1%FS）	
Current read-back value	Range	0~3.000A,0~20.00A	0~3.000A,0~30.00A
	Resolution	1mA,10mA	
	Accuracy	±（0.05%+0.1%FS）	±（0.05%+0.1%FS）
Power read-back value	Range	200W	
	Resolution	10mW	
	Accuracy	±（0.1%+0.5%FS）	
Scope of protection			
Over Voltage Protection(OV)		＞21V OR ＞125V over voltage protection	＞21V OR ＞185V over voltage protection
Over Current Protection(OC)		＞3.1 or ＞21A over current protection	＞3.1 or ＞31A over current protection
Over Power Protection(OP)		210W	
Over Temperature Protection		85℃	

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