KINGSINE

KFA320 Protection Relay Test Set

User Manual

Version: 1.0

KINGSINE ELECTRIC AUTOMATION CO., LTD

File revision

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1 Introduction to Software Functions

✧ System Introduction

KINGSINE protection relay Test System is a new generation protection relay test system independently developed by KINGSINE Electric Automation Co., Ltd. Based on Linux platform, this next-generation testing software is designed to test various protection and automation devices produced by power plants, substations and protection manufacturers. It provides users with a simple, comprehensive and easy-to-use testing solution.

✧ System characterization

The system provides vector view, waveform view and characteristic plots such as differential, impedance and overcurrent. These rich graphics intuitively reflect current parameter settings and test status. It also supports complex operations such as zooming, panning and test point selection, providing high levels of usability and flexibility.

✧ Support setting verification and setting value input

The system supports setting verification modules and setting value input interfaces for related protection tests, including overcurrent, distance and differential. It allows convenient parameter entry during testing, eliminating the need for protection parameter settings. It also provides a one-click function to add parameters and test points for setting verification. Tailored to the testing habits of protection relay personnel, it offers user-friendly, targeted test modules for related protections. It also supports the saving, importing and exporting of test data, simplifying the configuration of different protection devices and increasing ease of use.

✧ Support for conventional and digital testers

The system supports both conventional and digital testers. Conventional testers can support multiple groups of voltage and current outputs, while digital testers are compatible with protocols such as IEC61850-9-1, IEC61850-9-2 SV, and Goose.

2 Hardware Introduction

2.1 Hardware Features

✧ Supports simultaneous output of analog signals (4-phase voltage, 6-phase current) and IEC61850 SMV messages.

✧ Equipped with a 10.1-inch true-color LCD screen, 1280×800 resolution, and capacitive touchscreen operation. It can work offline or be connected to a computer.

✧ Provides 4 pairs of LC optical ports, capable of transmitting and receiving 16 groups of IEC61850-9-1 and IEC61850-9-2 frame format Sample values. Includes optical power testing functionality.

✧ Can subscribe to and publish GOOSE information or output/receive switch signals to achieve closed-loop protection testing.

✧ Simulates IED to actively publish GOOSE and Sample value signals upon startup, eliminating the reset process of the tested device caused by link interruption after testing stops.

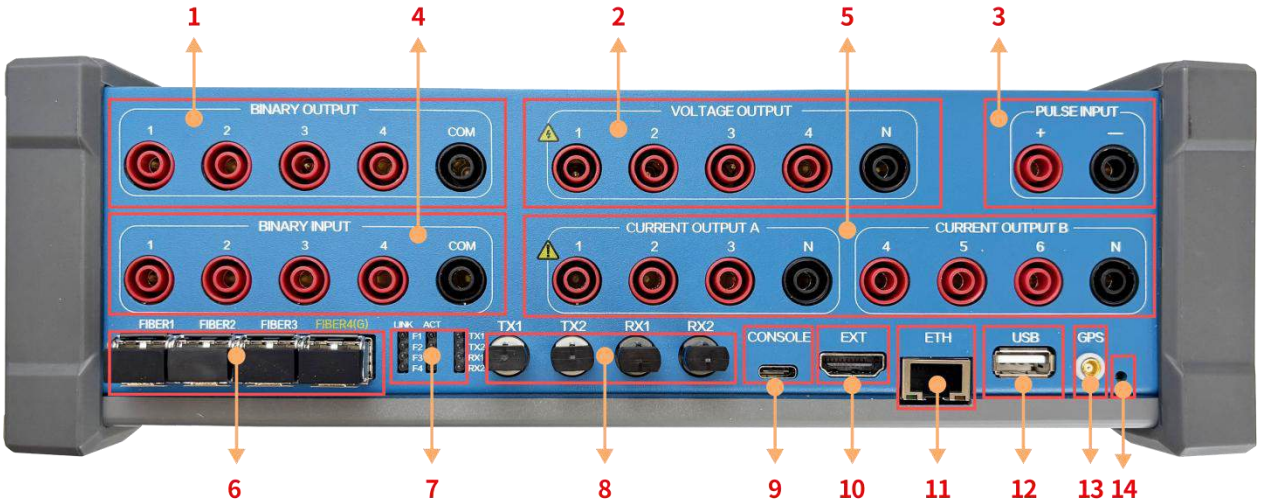
✧ Optical port output for Sample values or GOOSE can be freely defined. Can subscribe to/publish multiple different GOOSE control block information.

✧ Sample value channel functions and channel numbers can be freely configured, supporting up to 64 channels.

- ✧ Automatically parses SCL files (SCD, ICD, CID, NPI) to achieve automatic configuration of Sample values and GOOSE information. Sample value and GOOSE configuration information can be saved as one configuration file for convenient testing.
- ✧ Automatically detects optical digital signals from merging unit, protection devices, and intelligent control cabinet to achieve automatic configuration of Sample values and GOOSE information.
- ✧ Can simulate abnormal conditions (frame loss, out-of-sequence, quality anomalies, message retransmission, data anomalies, clock sync loss, etc.).
- ✧ The channel quality of output SV messages can be configured. Can simulate MU in maintenance, invalid, or operational states, and simulate dual-AD inconsistency tests.
- ✧ Built-in GPS/Beidou timing module with GPS and IRIG-B code synchronization functions.
- ✧ Comprehensive software testing modules, including AC, Sequence, Recloser, Distance, Overcurrent, Inverse Time Overcurrent, Zero Sequence, Ramp, Power Direction, Differential Bias and Harmonic restraint, Slip Frequency, Synchro, and more.
- ✧ Includes MU testing functionality, capable of testing MU accuracy, timing accuracy, and holdover accuracy. Supports data transmission and reception testing.
- ✧ Supports graphical display of SCD files. The instrument can graphically display IED device interconnection relationships and virtual terminal connections.
- ✧ Provides IRIG-B code transmission functionality. When synchronized with an external GPS, it can be used as a timing device.

2.2 Panel description

2.2.1 Top panel



No.	Interface Terminal	Detailed Description
1	4 pairs of Binary output channel	4 binary output with one common port
2	4 voltage output channels	Voltage output, common ground (AC: 0~300V/phase) 1,2,3,4 correspond to VA,VB,VC,V0 respectively.
3	1 pair of power pulse input	Used for energy meter calibration
4	4 pairs of Binary input	4 binary inputs with one common port

	channel	
5	6 current output channels	Current output (AC: 0~20A/per phase) 1,2,3,4,5,6 correspond to IA,IB,IC,IX,IY,IZ outputs respectively.
6	4 pairs of LC optical ports	Can be configured as 9-1/9-2 SMV transceiver or GOOSE transceiver.
7	Optical port indicator	Link light stays on when connected to LC optical module, ACT light blinks.
8	FT3 interface, 2 TX, 2 RX	TX for transmission, RX for reception. Can be configured as FT3 message transceiver or IRIG-B code/PPS pulse transceiver.
9	Type-C Console Port	Debug port (For KINGSINE engineer debugging or after-sales service diagnose only).
10	Extend port (HDMI-A type)	Private external expansion interface; Used for extend advance optional functions. It contains a communication bus and power supply.
11	RJ45 Ethernet port	Connecting to the host computer software
12	USB Type-A interface	USB 2.0, Used for external USB devices. Can be used to import SCD files, copy waveform files, copy test configurations, upgrade software, connect keyboard or mouse, etc.
13	GPS interface	Connect GPS antenna, for GPS timing synchronization and trigger.
14	GPS indicator	Red light blinking after connecting GPS, green light always on after successful connection

2.2.2 Right side panel

No.	interface terminal	Detailed description
1	Auxiliary DC Output Interface	Control and power supply for the external Auxiliary DC generate module (DC24V/1.8A max output)

2	Type-c charging Interface	Charging port for the tester (DC 20V/5.0A max input)
3	Charging Indicator	Red light when charging, green light when fully charged
4	Ground terminal	Grounding terminal for the tester during use.
5	power switch	Press and hold on for 3 seconds to Power on/off

2.3 Main technical parameters

2.3.1 Voltage and Current outputs

AC current source	
Output Amplitude	6×20A
Load capacity	180VA
Accuracy	<0.015%Rd+0.01%Rg Typ. <0.02%Rd+0.03%Rg Guar
Ascends/Descent response	<100us
DC Current source	
Output Amplitude	3×10A
Accuracy	<0.03%Rd+0.01%Rg Typ. <0.04%Rd+0.06%Rg Guar.
AC voltage source	
Output Amplitude	4× 300V
Load capacity	35VA
Accuracy	<0.015%Rd+0.005%Rg Typ. <0.02%Rd+0.03%Rg Guar.
Ascends/Descent response	<100us
DC Voltage source	
Output Amplitude	4×300V
Accuracy	<0.03%Rd+0.01%Rg Typ. <0.04%Rd+0.06%Rg Guar.

2.3.2 Binary inputs

Binary Input	
Input feature	0 V to 300 V (DC) or null contact (open-entry flip-flop potential can be set)
Sampling rate	10kHz
Time resolution	36us
Debounce Time	0ms to 25ms (software setting)
Electrical isolation	Separated in pairs, 1-2-3-4 co-located
Input impedance	5 kΩ...13 kΩ (empty contact)
Input feature	0 V to 300 V (DC) or null contact (open-entry flip-flop potential can be set)

Time measurement range	infinity
Time accuracy	±1ms (0.001s to 1s) ±0.1%(>1s)

2.3.3 Binary outputs

Binary Output (Relay Contacts)	
Binary Output Pairs	2 pairs（DO-1 and DO-2）
Type	Potential free relay contacts, software controlled
Break Capacity AC	Vmax: 380V(AC) / Imax: 8A / Pmax: 2000VA
Break Capacity DC	Vmax: 240V(DC) / Imax: 5A / Pmax: 150W
Response Time	≤10 ms
Binary Output (Fast eSSR)	
Binary Output Pairs	2 pairs (DO-3 and DO-4)
Circuit Breaker Simulate	Can be define as Open or Close status
Break Capacity AC	Vmax：250V(AC) / Imax: 0.2A
Break Capacity DC	Vmax：250V(DC) / Imax: 0.5A
Response Time	<100us
Contact Performance	Open the dry contact output using opto-coupler relay, the on-resistance is ≤ 6Ω, and the shut-off withstand voltage is ≥DC300V

2.3.4 Fiber ports for IEC61850 SV and GOOSE

Fiber Port	
Quantity	4 pairs LC
Type	multimode fiber
Cable model	62.5/125μm (or 50/125μm)
Wave length	1310nm or 850nm
Fiber Transmit Power and Receive Sensitivity	1310nm fiber: Transmit power range: -20dBm ～ -14dBm; Receive sensitivity range: ≥-31dBm～-14dBm 850nm fiber: Transmit power range: -19dBm ～ -10dBm; Receive sensitivity range: ≥-24dBm～-10dBm
Fiber Connector Type	LC interface
Number of FT3 interfaces	2×TX, 2×RX, ST type

2.3.5 Communication

Communication interface	
Ethernet	1× RJ45, 10/100M self-adaptive, used for software communication with the host computer and CDT communication.
Console port	1× Type C for debugging

USB	1× USB2
Wifi	Inbuilt WIFI DHCP service

2.3.6 Weight & Size

Weight & Size	
Chassis Size	288mm× 185mm× 95mm
Weight	<3.8kg
Display	10.1inch LCD, touch screen

2.3.7 Battery and AC/DC adapter

Battery and Charger	
Battery nominal voltage	10.8V
Battery rated capacity	4.4Ah x 2
Battery rated energy	95.04Wh
Maximum battery charge voltage	12.6V
Charge time (0-80%)	2h
Charge time (0-100%)	4h
Battery Storage environment	Temperature -20℃~+35℃ 65±20% humidity, no condensation
Rated power supply for Charger	100~240Vac,1-phase, 50/60Hz, 1.5A
Charger output	20V, 3.25A, 65W

2.3.8 Other interface

Other interface	
GPS	1× SMA Use for GPS antenna interface Support GPS and Beidou Satellite
Fiber IRIG-B	4× ST, 2 for transmission, 2 for receiving
Ext port Expansion	1× HDMI type A, for extend optional functions

2.3.9 Auxiliary DC output

Auxiliary DC Supply (optional external module)	
Output Amplitude	12~350V
Load capacity	40W max
Accuracy	±2V @12-100Vdc; ±2% @100-350Vdc

3 Battery Safety Instructions

3.1 Short-term Storage:

When lithium batteries are not used for a short period (e.g., within 3 months), store the batteries in their original charged state in a dry place, free from corrosive gases, with a temperature and humidity range of -20°C to 35°C and 65±20% humidity. Exceeding this temperature and humidity range may cause rusting of metal components or battery leakage.

3.2 Long-term Storage:

If lithium batteries are not used for an extended period (e.g., more than 6 months), charge them to 50%-70% capacity, remove them from the equipment, and store them in a cool, dry environment. Recharge the batteries every 3 months to avoid over-discharge due to self-discharge, which can lead to irreversible capacity loss.

The self-discharge rate of lithium batteries is affected by ambient temperature and humidity. High temperature and humidity accelerate self-discharge. It is recommended to store the batteries in an environment with a temperature of 20°C to 30°C and humidity of 65±20%.

3.3 Handling Extended Storage:

Generally, it is not recommended to store lithium batteries for more than one year, as the longer they are stored, the greater the capacity loss, leading to reduced equipment usage time.

By following the method described in Section 2 for long-term storage, batteries can typically be stored for up to one year. While there may be some capacity loss, other performance issues are unlikely. However, if installed in equipment, you may notice shorter charge and discharge times. If the usage time falls below the customer's requirements, the customer or user may classify the battery as defective or scrap it.

3.4 Storage Warehouse Requirements:

The warehouse should control temperature and humidity, ensure ventilation, and prevent direct sunlight from damaging stored materials. Windows and doors should be intact to protect materials from damage or moisture. If available, air conditioning or dehumidifiers should be used to avoid high-humidity environments.

The warehouse should be equipped with automatic fire suppression systems, emergency sprinklers, dry powder fire extinguishers, and firefighting sand (building sand is acceptable). Regular quarterly inspections should ensure functionality.

Batteries should not be stored in the same warehouse as flammable materials (e.g., packaging materials such as paper boxes). A separate warehouse is recommended.

3.5 Usage Precautions:

During transportation and use, batteries should be protected from severe vibrations, impacts, or compression, and from exposure to sunlight or rain.

Avoid using or storing batteries in high-temperature environments (e.g., direct sunlight or inside hot vehicles), as this can cause the battery to overheat, catch fire, or degrade, shortening its lifespan.

If a battery shows signs such as failure to fully charge, a sudden significant reduction in working time, difficulty assembling into devices, or visible deformation, immediately stop using the battery and isolate it in a safe area.

If a battery emits an odor, heats up, swells, deforms, changes color, or exhibits any other abnormal behavior, stop using it immediately. If the battery is in use or charging, remove it from the device or charger. Do not crush or puncture a swollen battery, and isolate it in a safe area.

If a battery is damaged, leaking electrolyte, or emitting a strange smell, stop using it immediately. Keep leaking batteries away from fire to prevent explosions and isolate them in a safe area.

Do not attempt to disassemble the battery in any way. Do not pierce, strike, throw, or step on the battery (lithium-ion batteries contain highly active materials that can react with water and oxygen in the air, releasing heat and potentially causing a fire).

Batteries that have undergone destructive or extreme performance testing (e.g., drop, impact, vibration, heat, immersion, high-temperature storage, short-circuit, low pressure, temperature cycling) should be managed as potentially abnormal or high-risk batteries. Stop using these batteries and do not store, transport, charge, or discharge them as normal batteries. Isolate them in a safe area.

Use only the specified charger for charging. Do not connect the battery directly to wall outlets or charging equipment that exceeds the specified charging conditions (voltage and current).

Do not charge the battery continuously for more than 12 hours.

Ensure the battery's positive and negative terminals are not reversed during use, and avoid contact with wires or other metal objects to prevent short circuits.

Do not submerge the battery in water or liquids. Protect it from moisture.

Keep the battery away from heat sources, such as fire or heaters. Do not throw the battery into fire or heat it.

Do not place the battery in a microwave oven or pressure vessel.

Do not dispose of batteries by burning, as this can cause explosions and other dangerous incidents.

3.6 Emergency Handling Methods:

Handling Rusted Batteries: Stop using the battery immediately and isolate it in a safe area (rusting can cause short circuits).

Handling Burning or Exploding Batteries: In case of a battery fire or explosion, it is extremely dangerous. People must evacuate the area. After ensuring proper protection, immediately cut off the power supply. For small-scale fires involving individual or a few batteries, cover the burning battery with sand or use a dry powder or CO2 fire extinguisher. For larger-scale fires, use a large amount of water to extinguish the fire, as water can cool the batteries.

Handling Overheated Batteries (above 80°C): Batteries generate heat during charging and discharging, with typical temperatures around 60°C. If the temperature rises to several hundred degrees due to internal or external short circuits, isolate the battery in a sand bucket and cover it with sand or submerge it in a bucket of saltwater (1%-10% concentration). Avoid direct contact with the battery to prevent burns. Once the battery cools to normal temperature, dispose of it as scrap.

Handling Swollen, Leaking, Deformed, or Damaged Batteries: Immediately stop using the battery and isolate it in a safe area. Have a dry powder or CO2 fire extinguisher ready. Once the battery is safe, hand it over to a qualified recycling company for disposal.

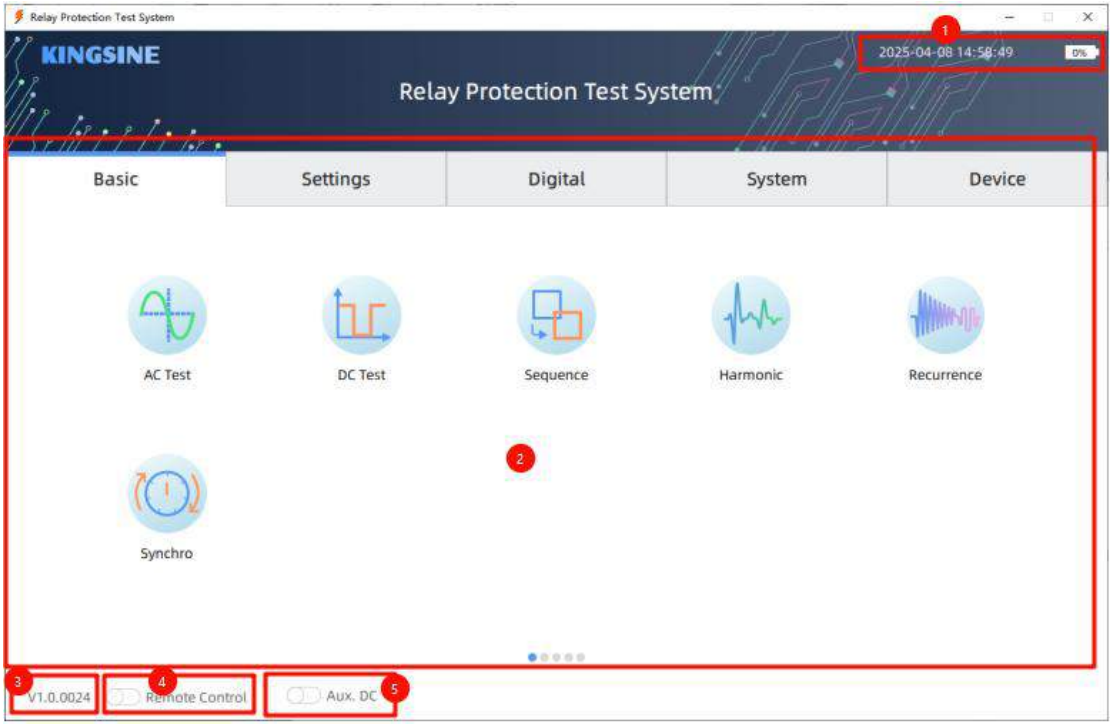
Handling Tested or Expired Batteries: Stop using the battery immediately. You can dispose of it by:

1) Isolating the battery in a safe area.
2) Handing the battery over to a qualified recycling company for disposal.

Handling Electrolyte Leaks in Eyes: If battery electrolyte leaks into the eyes, do not rub them. Rinse the eyes with clean running water and seek medical attention immediately. Failure to do so may result in eye damage or blindness.

4 General introduce of the software

4.1 The Start page



No.	Detailed description
1	Display the real time, and battery capacity, indicate battery charge/discharge status
2	Main function panel
3	Version of the software
4	Remote control button, used to connect with PC control software
5	Used to active the Auxiliary DC output.

4.2 Test modules interface

No.	Detailed description
1	Test module name
2	Display the real time, and battery capacity, indicate battery charge/discharge status; Real-time temperature monitoring of the CPU and internal power amplifier, as well as display of hardware alarm signals for the device, such as current open-circuit alarms, voltage fault-circuit alarms, etc. Click the alarm icon to view detailed alarm information.
3	Main operation panel
4	Status bar, Real-time display of the open and close states of the binary inputs and outputs.
5	Function buttons dock

4.2.1 Status bar

 Two status (ON/OFF) of the binary inputs and outputs.

Display the real-time status of all binary inputs and outputs.

The binary outputs in different modules can be controlled by the program to change their output status, and during testing, they can also be manually toggled by clicking the corresponding icons.

4.2.2 Function buttons dock

Some frequently used functions have been placed in the Dock area for quick access.

Button	Detailed description
Start	Start / Stop toggle
Binary	The settings for binary inputs and outputs can both be accessed here.
Settings	Additional setpoints or parameters required by some test modules can be found here. If a test module does not require extra parameters, this button will be unavailable.
IEC61850	This button is available when the IEC61850 SV output or GOOSE mapping is activated.
System	Provides quick access to system configuration options.
Parameter	You can save the parameter settings of the current test module and restore them from a document.
Report	You can view test reports and save the relevant documents.

4.2.3 Quick buttons

The Quick buttons will only be displayed when the cursor is in the parameter input boxes of the channels.

Rated Applies the global rated value to the current cursor position.

Equal Sets the values of other channels of the same type in the current group to be the same as the value at the current cursor position.

Zero Sets the value at the current cursor position to 0.

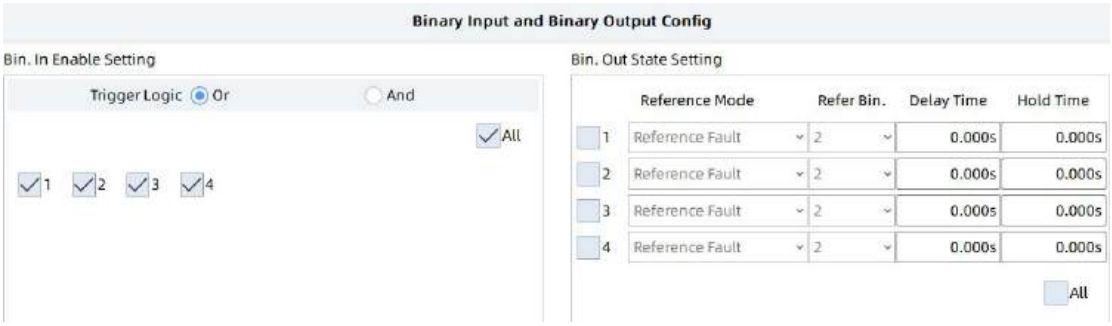
Max Sets the value at the current cursor position to the maximum available value.

Pos. Automatically adjusts the values of other channels of the same type in the current group to follow a positive phase sequence based on the setting at the current cursor position.

Neg. Automatically adjusts the values of other channels of the same type in the current group to follow a negative phase sequence based on the setting at the current cursor position.

4.2.3.1 Binary

Binary input and Binary output config:



4.2.3.1.1 Binary Inputs:

Trigger Logic

Or : If any enabled binary input meets the input condition, the software will record the action time of the corresponding binary input.

And: All enabled binary inputs must meet the conditions for the software to record the action time of the corresponding binary inputs.

All: Click the box before "All" to uniformly set the status of all binary inputs. Alternatively, you can individually set the status of each binary input.

The status of binary inputs configuration has four options:

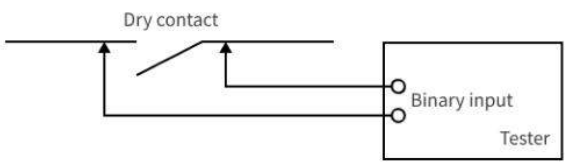
Both ascent edge and descent edge are valid (0-1 or 1-0).
automatically record the binary input state at the last fault state, and consider the binary input to be in action when the binary input state is inconsistent with the state at the last fault state.
This is also the most commonly used mode by default in the software.

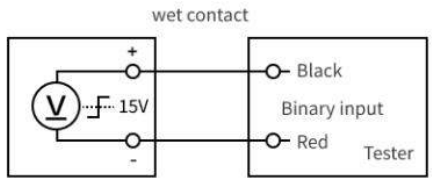
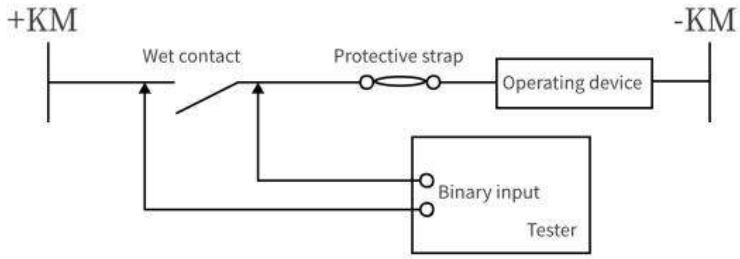
The binary input only responds to a change from OFF to ON (0-1).
when the binary input state is detected to change from open to closed, the binary input is considered to be in action.

The binary input only responds to a change from ON to OFF (1-0).
when the binary input state is detected to change from closed to open, the binary input is considered to be in action.

The binary input will not responds to any changes.
Disable the timer measurement in the binary input port.

All Binary inputs are compatible with both dry contacts (NO and NC), as well as wet contacts (<12V / 12~300Vdc), without polarity distinction.

1	

2		>12V: open <=12V: close
3		

Note:

During the testing process, to prevent grounding of the DC system which may cause the protective device to malfunction, it is prohibited to ground any terminal of the tester's binary input terminal.

4.2.3.1.2 Binary outputs

Used to preset the state (OFF or ON) of binary outputs during the output process. Binary outputs default to the OFF state.

Column	Descriptions
Init.	Used to activate the corresponding output options and set their initial states.
Reference Mode	**Reference Fault:** Set the flip moment of the binary output to the start moment of the fault. **Reference Prefault:** Set the flip moment of the binary output to the start moment of the Prefault. **Reference Binary Input:** Set the flip moment of the binary output to the moment when the corresponding Binary input receives the trigger signal.
Delay Time	After the binary output is confirmed to be valid at the flip moment, it will actually flip after this delay time. The default value is 0.
Hold Time	The hold time of the binary output after flipping. After the hold time expires, the binary output will return to its initial state. The default value is 0, meaning that it will remain in the flipped state until the end of the current test point, without returning to the initial state.

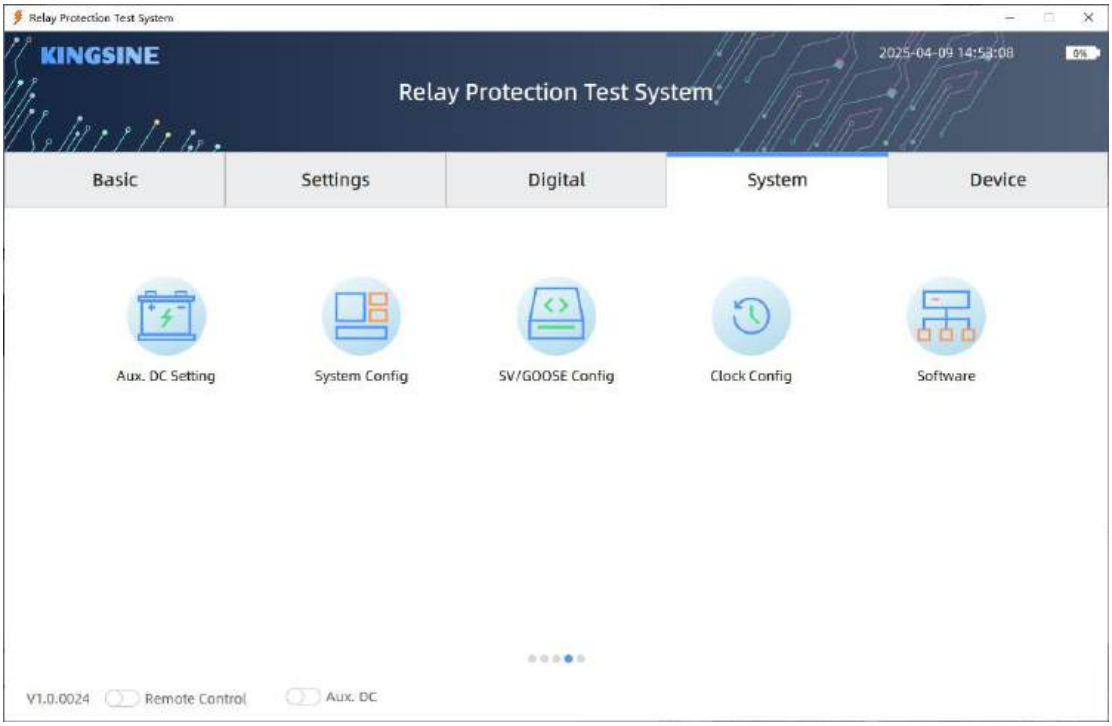
4.2.3.2 IEC61850

Access the IEC61850 interface. Reference to SV/GOOSE Config for the details.

4.2.3.3 System

Access the to the System Config.

5 System Settings

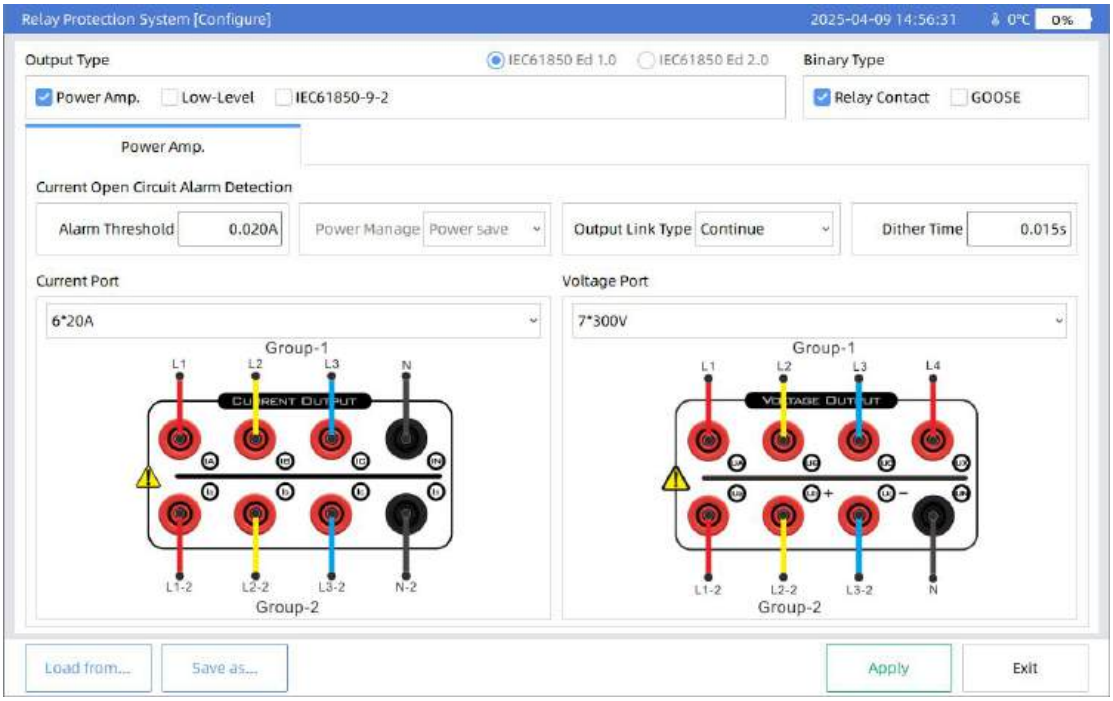


5.1 Aux.DC Setting

Conveniently select a preset amplitude or manually input the desired auxiliary DC amplitude by clicking the checkbox behind the voltage value, then click "OK" to start the output.

Note: The KFA320 device does not have a direct auxiliary DC output port. It must be used in conjunction with the Aux.DC adaptor accessory to achieve normal output.

5.2 System Config



5.2.1 Output Type:

5.2.1.1 Power Amp.:

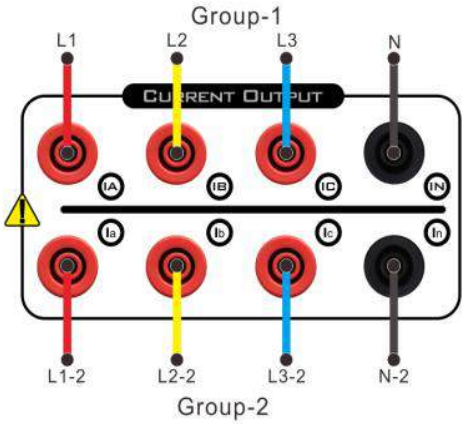
When selected, the amplifier output is enabled, and the tester outputs analog voltage and current after running.

Set the amplifier output mode and wiring method, as well as the current open circuit alarm threshold.

Current Open Circuit Alarm Detection: Set the alarm threshold. When the current output exceeds the threshold during an open circuit, the software generates a current open-circuit alarm. Otherwise, no alarm is generated (note that the alarm may be affected by induced virtual current but does not affect the actual output value).

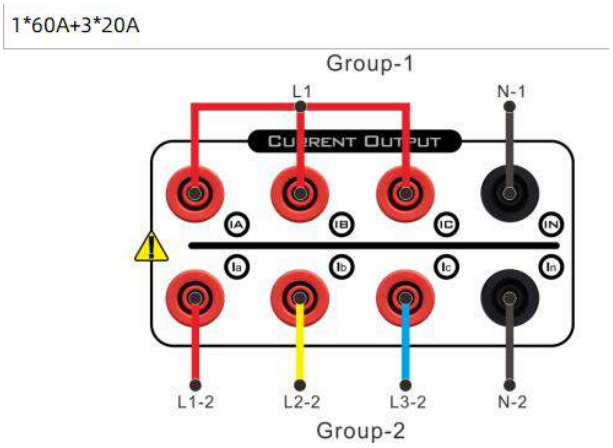
Current Port: Configure the current amplifier output (e.g., 20A per phase):

6*20A: The tester has 6 current output phases, each capable of outputting up to 20A independently.



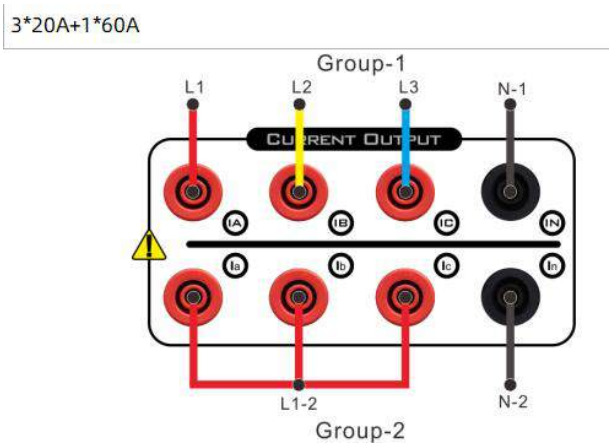
1*60A+3*20A: It means that IA,IB,IC three-phase current (group 1) outputs 60A in parallel, and the

other (group 2) single-phase outputs 20A in each phase, and the tester current output wiring can be referred to the following figure, which needs to be output by connecting IA,IB,IC in parallel.



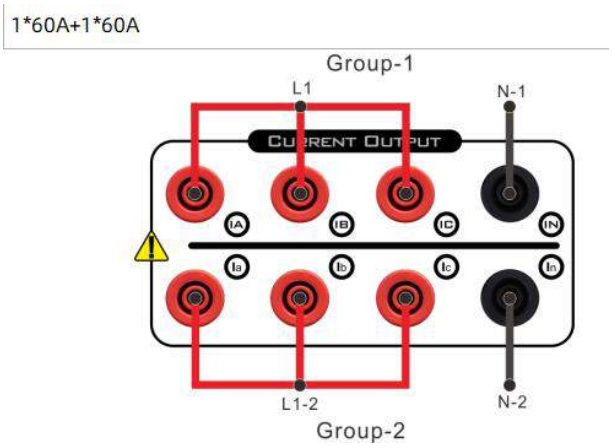
After setting according to the above figure and entering the AC test module of the software, the output and variables of the software interface become IA can be set, the maximum value is 60A, IB,IC can not be set, and the actual output is the three-phase average output of IA,IB,IC.

3*20A+1*60A: Group 1 outputs up to 20A per phase, while Group 2 outputs up to 60A in parallel.

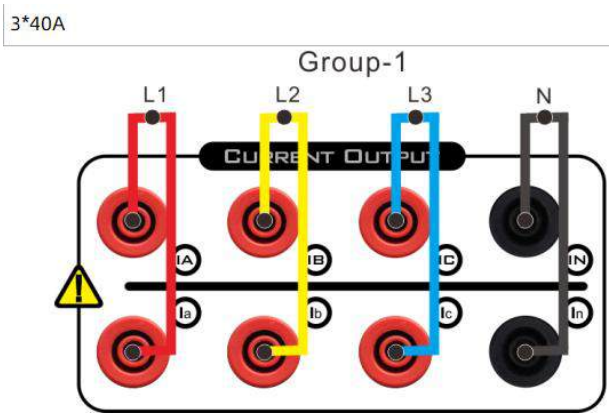


According to the above figure, after entering the AC test module of the software, the output and variable IX of the software interface can be set, the maximum value is 60A, IY, IZ cannot be set, and the actual output is the three-phase average output of IX, IY, IZ.

1*60A+1*60A: Both Group 1 and Group 2 output up to 60A in parallel.

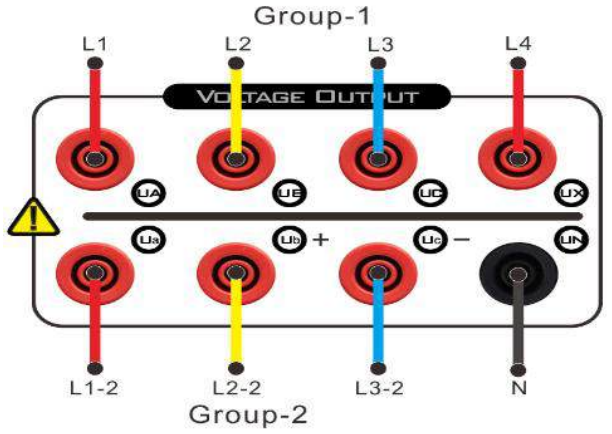


3*40A: The current outputs of Group 1 (IA, IB, IC) and Group 2 (IX, IY, IZ) are connected in parallel, doubling the output current.



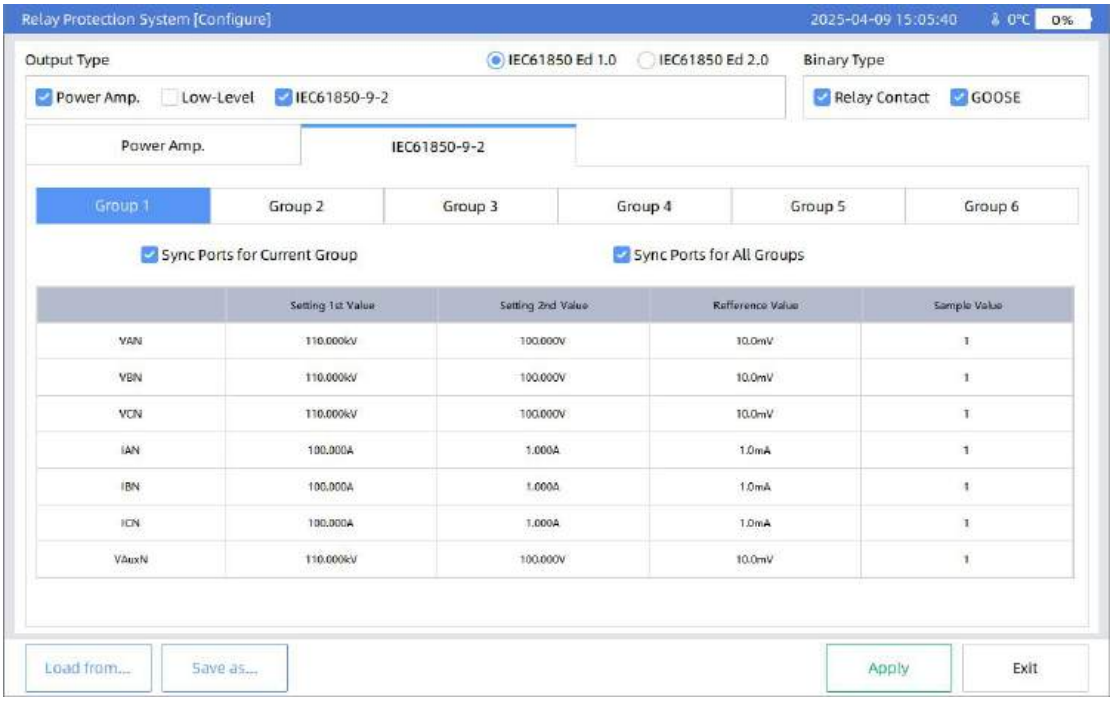
Voltage:

4*300V: Each phase outputs up to 300V independently.



5.2.1.2 IEC 61850-9-2

Configure digital output settings based on the protection device's ratio. Configure the output ratio and synchronization port settings for each group. After selecting IEC61850-9-2, click "SV/GOOSE" to enter the SV/GOOSE configuration interface.



Load from...: Import saved configuration files.

Save As...: Save the current configuration parameters as an .xml file. The default save path is the software directory.

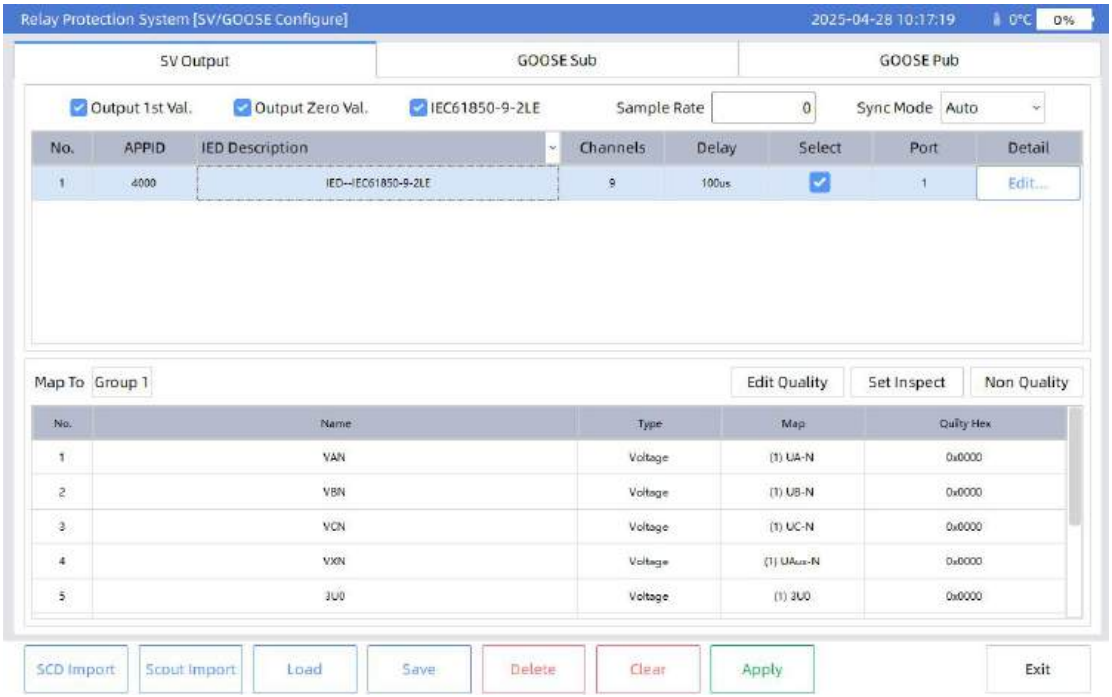
5.2.2 Binary Type:

Relay Contact: When selected, hard contact binary input and output functionality is enabled.

GOOSE: When selected, GOOSE publish and subscribe functionality is enabled.

5.3 SV/GOOSE Config

Note: Before configuring SV/GOOSE, ensure that "IEC61850-9-2" is selected under Output Type and "GOOSE" is selected under Binary Type in the System Configuration. Otherwise, SV/GOOSE configuration will be invalid.



Output Primary Val. After checking the box, the system will automatically convert the output to Primary Value based on the transformation ratio setting.

Output Zero Val. When selected, the tester continuously outputs zero values to the protection device when idle to prevent link disconnection.

Sample Rate Default is 80

Sync Mode Set to non-synchronized, synchronized, or auto-synchronized (default is auto-synchronized).

APPID Displays the current IED's APPID.

IED Description Displays the name of the current SV/GOOSE control block.

Channels Displays the total number of channels in the current control block.

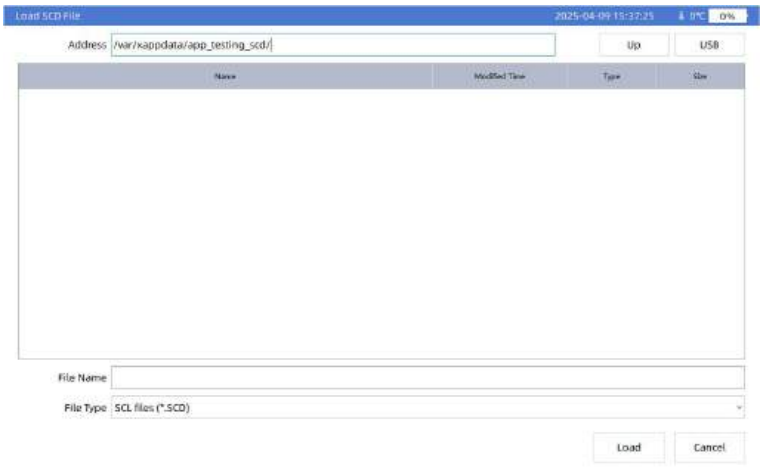
Delay Displays the delay time, which can be modified based on actual testing needs.

Select When checked, the control block is valid, and the tester outputs these parameters.

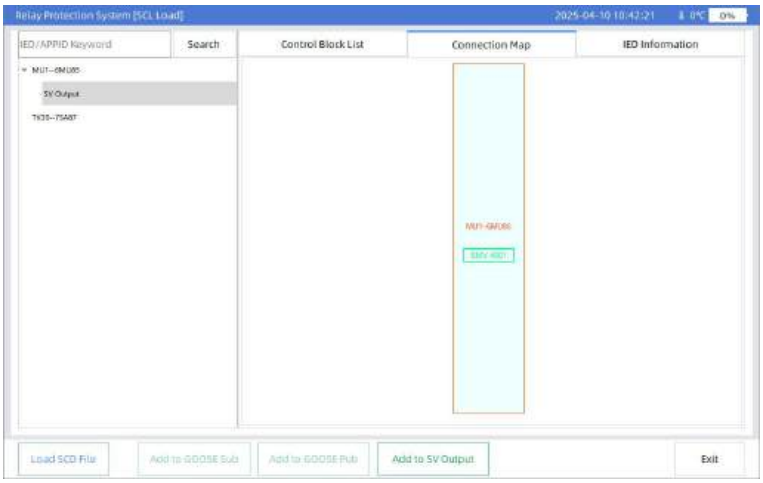
Port Select the optical output port for the control block (options: 1-4).

Detail Displays detailed control block information and enables configuration.

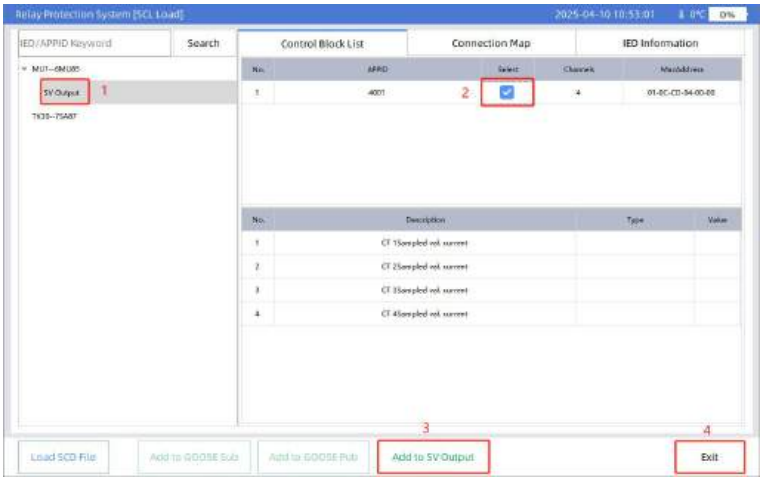
SCD Import Click to enter the SCD import interface. The default import path is the "app_testing_SCD" folder in the installation directory. Place the SCD file in this directory for easy import. After selecting the SCD file, click "Load."



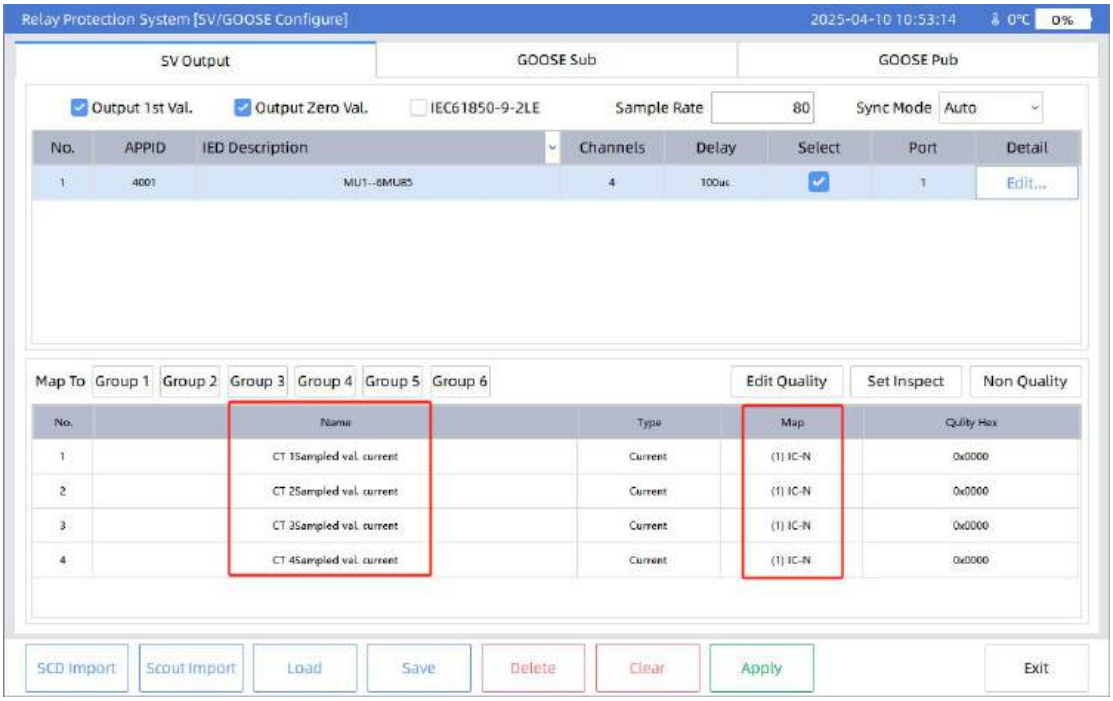
After loading, select the device to be tested and click "Connection Map" to view its connection relationships.



Once the SV control block is identified, switch back to the control block list page, select the corresponding SV control block, and click"Add to SV Output"



5.3.1 SV Channel Mapping:



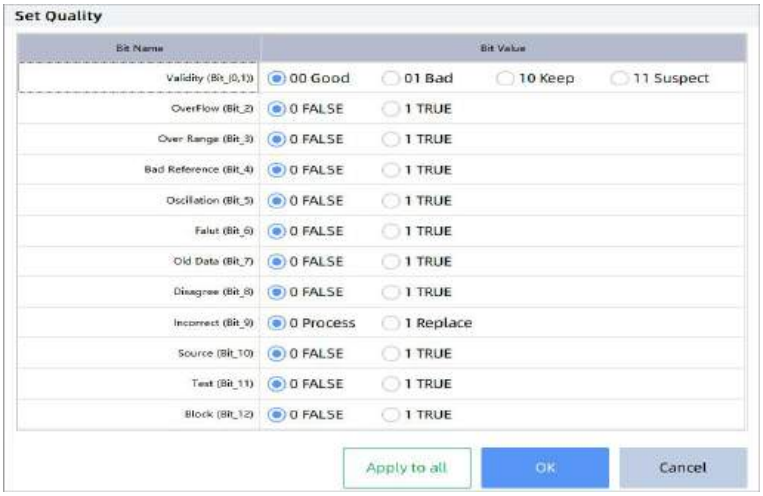
Name Indicates the channel name parsed by the software from the SCD file.

Type Indicates the type of the current channel, which is generally configured automatically but can also be manually configured. It can be set as delay, voltage, or current.

Map Maps the channels parsed from the SCD file to the output channels of the tester to apply signals to the protection device. The sequence number in front of the mapping column represents the current mapping output parameter group, which can be set as (Group 1 to Group 6).

Quality (Hex) Displays the quality information of the current channel.

Edit Quality Allows editing the quality of the currently selected channel.



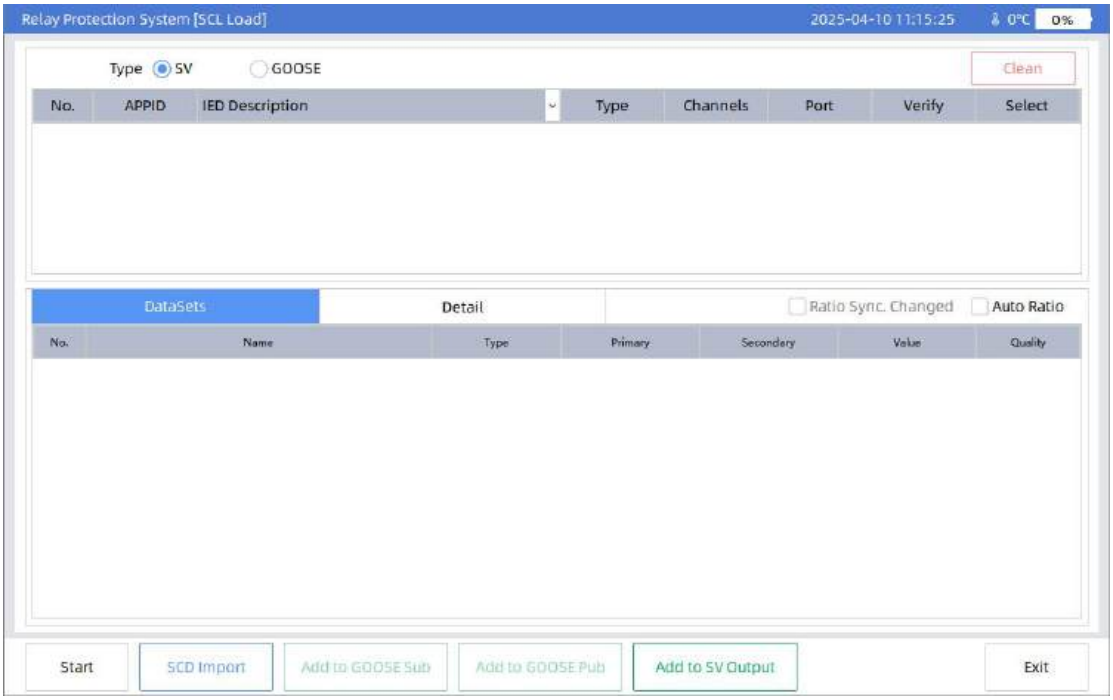
Set Inspect Click to set the test bit to true for all channels.

Non Quality Click to reset the quality bit of all channels to zero.

5.3.2 Scout Import

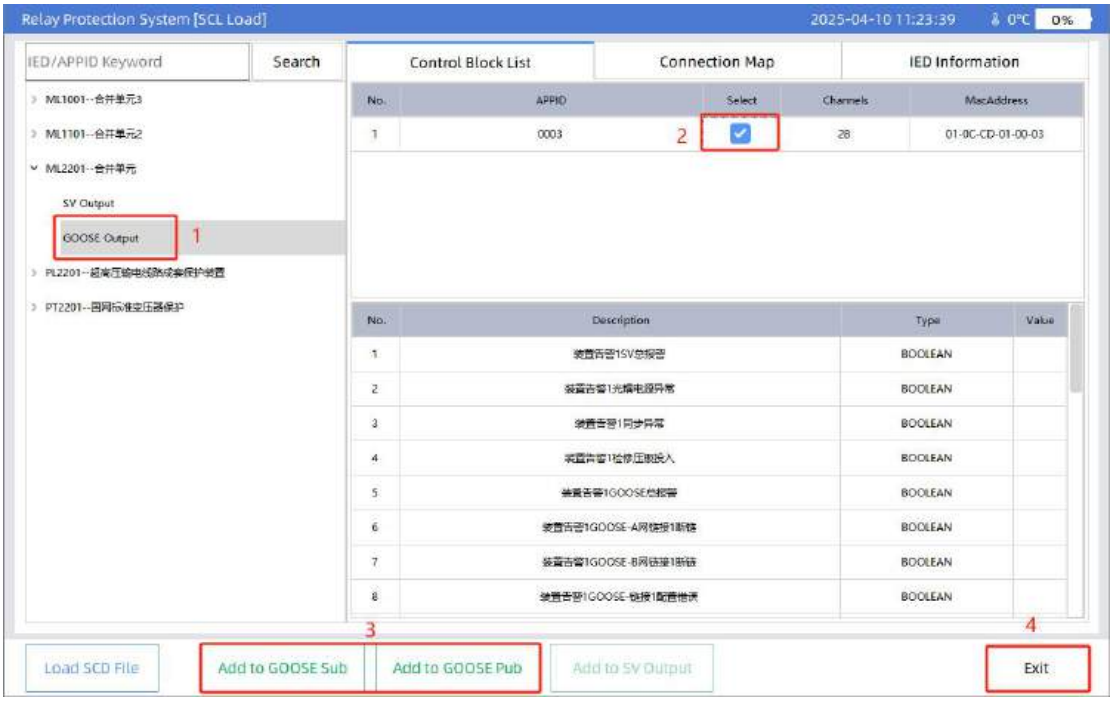
When no SCD file is available or when the control block to be selected is uncertain during testing, the scout import function can be used. Scout import can detect the SV/GOOSE control blocks sent by the protection device.

The detected data can be added directly to the test object for reference via the shortcut buttons at the bottom.



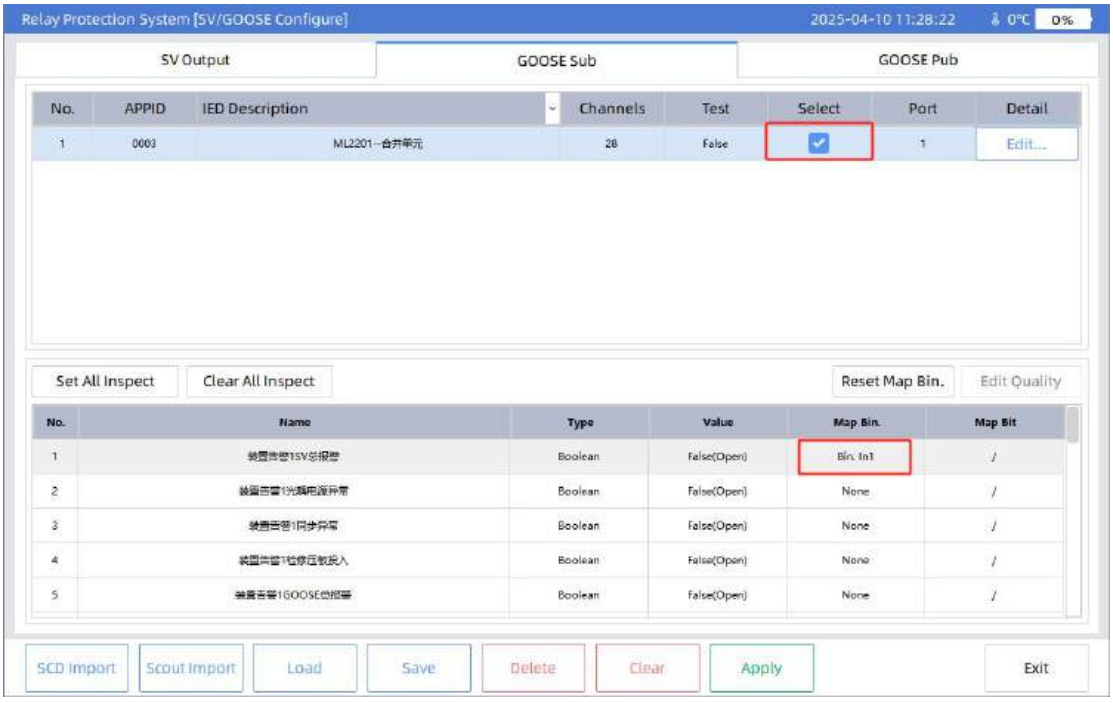
5.3.3 GOOSE Import Method

Select the GOOSE control block to be tested. When configuring the tester to receive action signals or other information from the protection device, add it to GOOSE Subscribe. When configuring the tester to send GOOSE change-of-state information to the protection device, add it to GOOSE Publish.



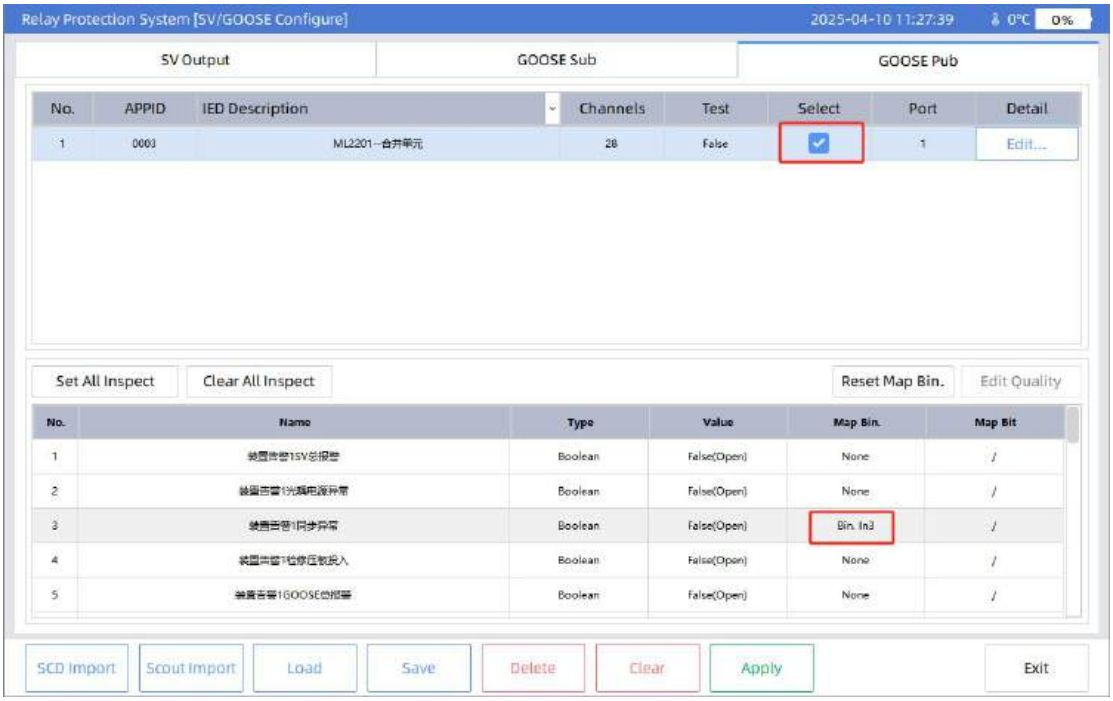
GOOSE Subscribe Input Mapping Configuration

Check the control block, select the binary output port, and map the input (e.g., the trip output of the protection device).



GOOSE Publish Output Mapping Configuration

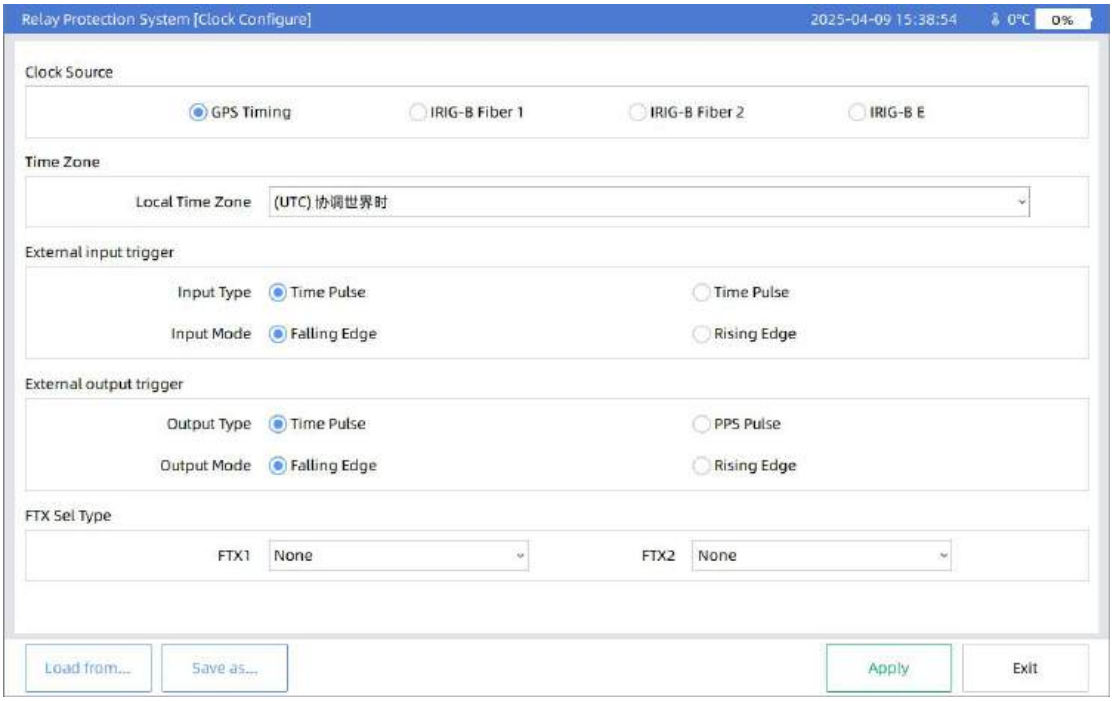
Select the control block, choose the optical port, and set the output (e.g., sending GOOSE trip signals to the protection device).



5.4 Clock Config

Configure the clock source signal, time zone, external trigger input type and method, and external trigger output type and method.

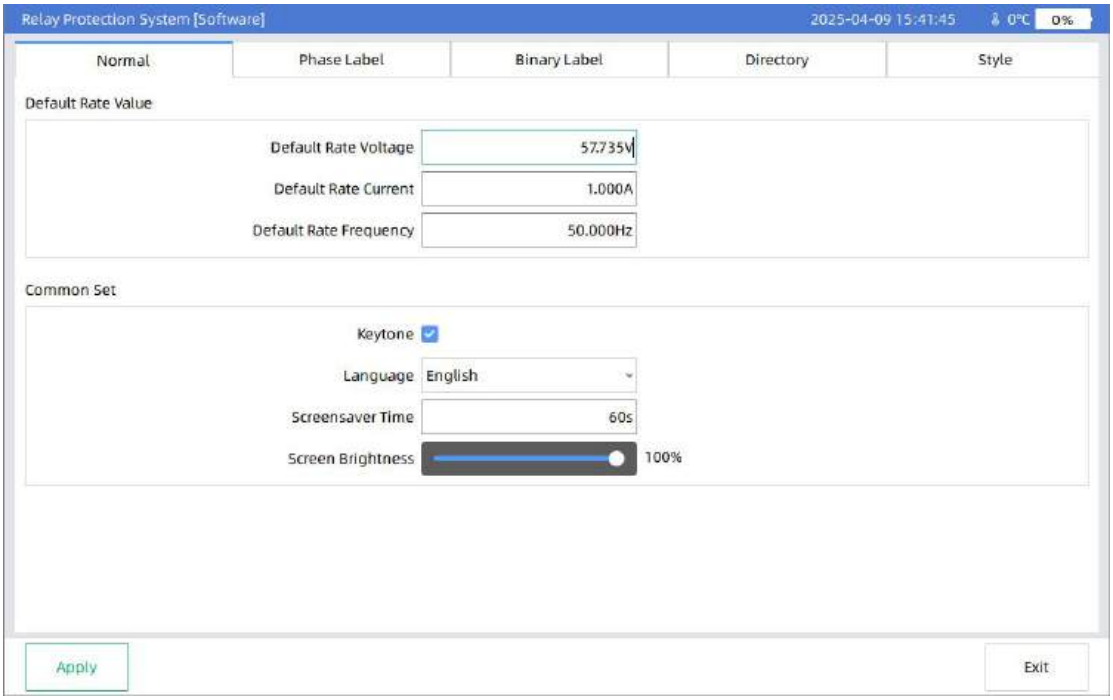
After synchronizing with the external clock source, the time displayed in the title bar will match the external clock source, and a synchronization status icon ( ) will be displayed.



Clock Source The synchronization clock source can be set to GPS, Optical IRIG-B code, or Electrical IRIG-B code.

Time Zone The local time zone can be set according to actual requirements.

5.5 Software

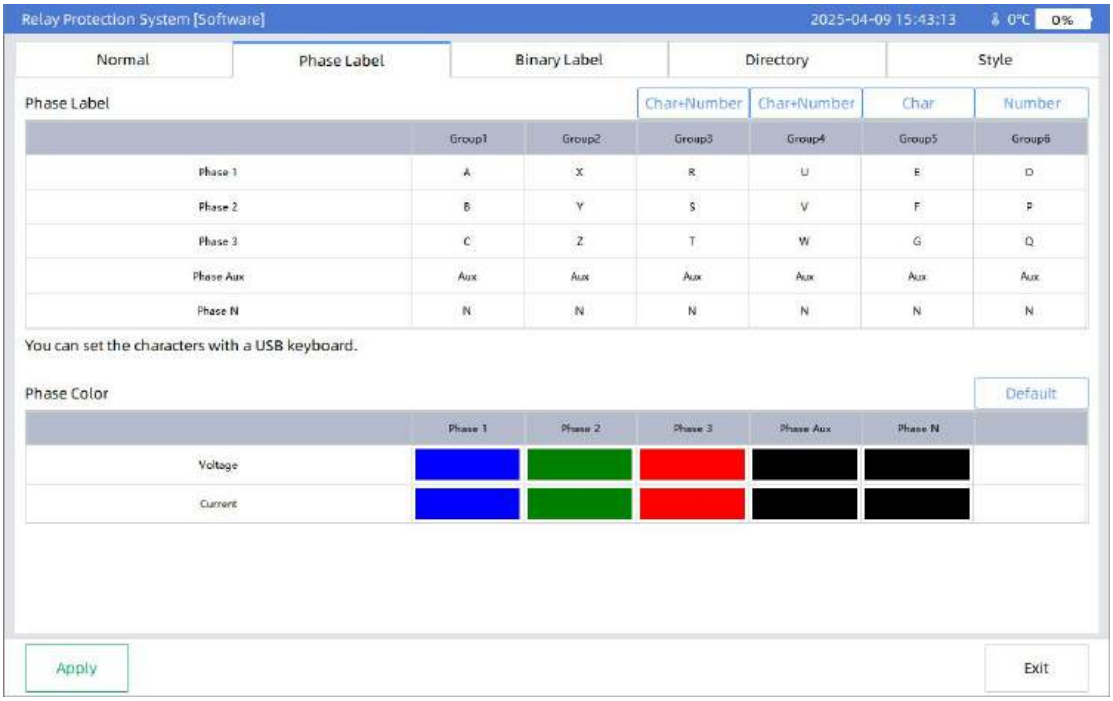


5.5.1 Normal

Default Rated Value Configure the default rated value of the tester, including the rated voltage, rated current, and rated frequency for a single phase. Click "Apply" after configuration.

Common Set **key Sound Enable:** When checked, clicking will produce a key sound effect.
Language: Switch to other languages.
Screensaver Time: Set the screen display time.
Screen Brightness: Adjust the screen brightness.

5.5.2 Phase Label

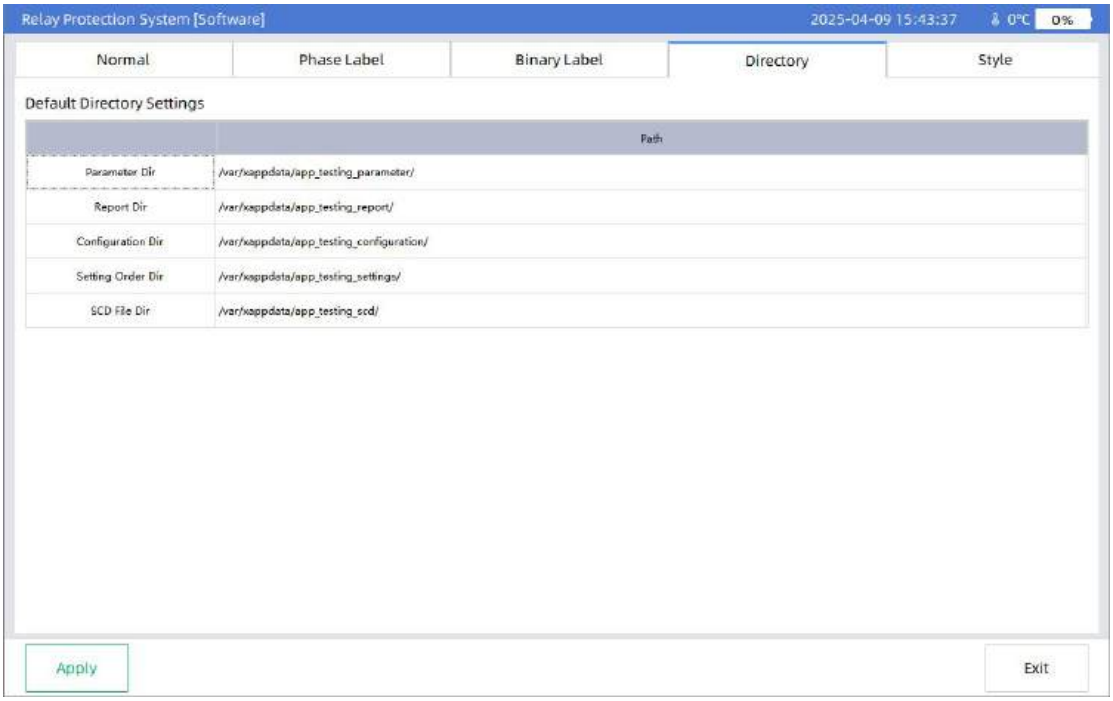


Modify the display identifiers for each group through phase label, including the display characters for each phase and the waveform display colors. Click "Apply" to save the changes.

5.5.3 Binary Label

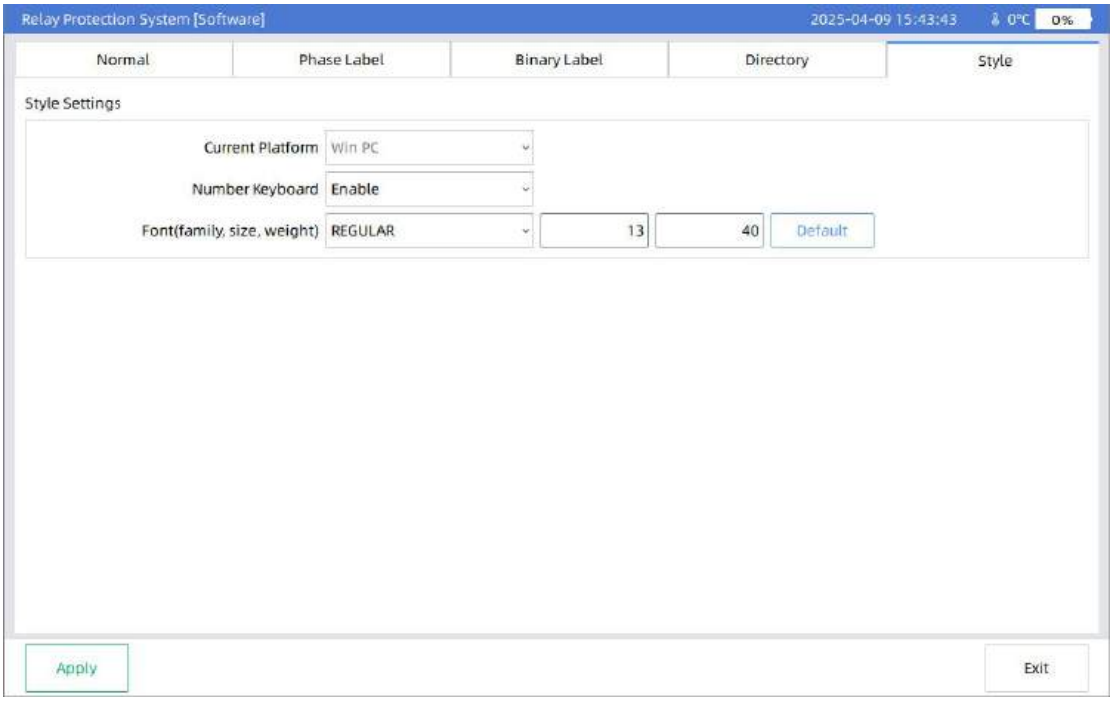
Modify the identification numbers of the binary inputs.

5.5.4 Directory



Set the directory path for various data.

5.5.5 Style

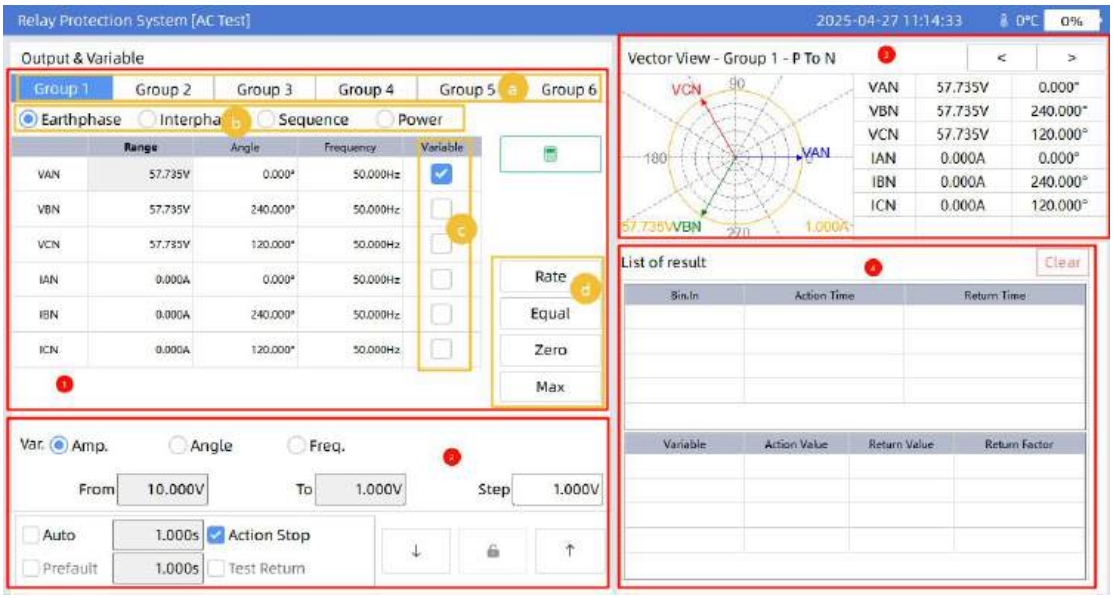


Set the inbuilt entry keyboard and modify the font display style of the software.

6 Basic Test Modules

6.1 AC test

Users can flexibly control the amplitude, phase, and frequency of the output for each voltage and current channel. They can also select the relevant variables as needed to perform manual or automatic tests. Additionally, four different perspectives output mode are provided, allowing users to switch between Earth-Phase, Interphase, Symmetrical, and Power modes.



The AC interface is equipped with a maximum of 6 groups of parameters output (two groups when amplifier output, 6 groups when IEC61850-9-2 output) , respectively, group 1, group 2, group 3, group 4, group 5, group 6 (group 1, 2 for analog/digital, group 3-6 output for digital output mode). Each group can be individually set output mode.

SN.	Detailed description
1.	The main parameter setting area allows users to independently set the amplitude, phase, and frequency of the output for all channels.
a.	Users can switch between different parameter groups, with each group consisting of three-phase voltage and three-phase current.
b.	Offers the ability to switch between four distinct output modes: Earth-Phase, Interphase, Symmetrical, and Power.
c.	The variable channel selection feature allows users to choose one or multiple phases as variable channels according to their needs, and vary them in the test according to the preset amplitude and direction.
d.	The quick buttons can modify the parameters of related channels based on the current cursor position.
2.	You can set the type of variable, its range of variation, as well as the variation mode and duration.
3.	The vector diagram display area shows the corresponding vector diagram based on the group selected in the main view. Users can also switch between different perspectives for viewing, including Earth-Phase, Interphase, Symmetrical, and Power.
4.	Test Result Display Area: After the test is completed, the action values and action times can be

	viewed in this area.

6.1.1 Introduction the function buttons

Auto Manual / Automatic test mode toggle.

Prefault Available only in automatic mode, it is used to output a Prefault state before the fault state set in the output interface. The Prefault state defaults to outputting positive-sequence rated voltage with zero current.

Action Stop When the "Action Stop" function is activated, the tester will immediately cease output upon receiving a trip signal; otherwise, the test output will continue.

Test Return: Only effective in automatic mode. When the "Test Return" function is activated, the tester will automatically initiate reverse variation upon receiving a trip signal, which is used to test the relay's drop-off characteristics. The "Test Return" and "Action Stop" functions cannot be used simultaneously.

① When a valid input signal is received, the output will change towards the initial value at the original step size, multiplied by 1.2 times the action value, until a valid input signal is received again or the initial value is reached and output stops. The software records the two action values and action times and calculates the return factor based on the action values;

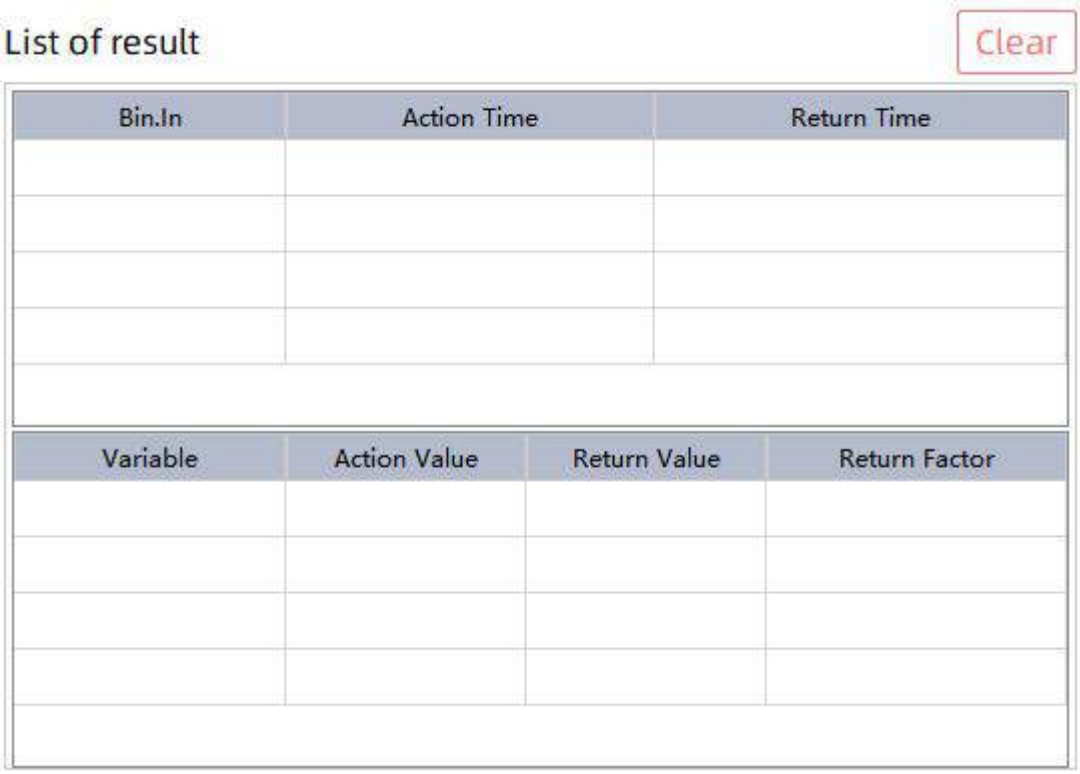
② If no input signal is received, the output will stop after reaching the final value from the initial value.

UP and DOWN arrow buttons: In manual mode, With each press, the output value of the selected variable channel will change by the step value of the variable, either increasing or decreasing.

Lock button: Effective during manual mode operation. When the “Lock” button is pressed, the current output value is locked and will not change. After releasing the button, the output will resume according to the interface settings. This feature is particularly useful when multiple parameter output values need to be changed simultaneously.

Fault calculation button: Currently, it only supports the auxiliary calculation of distance faults to help calculate fault values.
Reference to the Distance calculation model for the details.

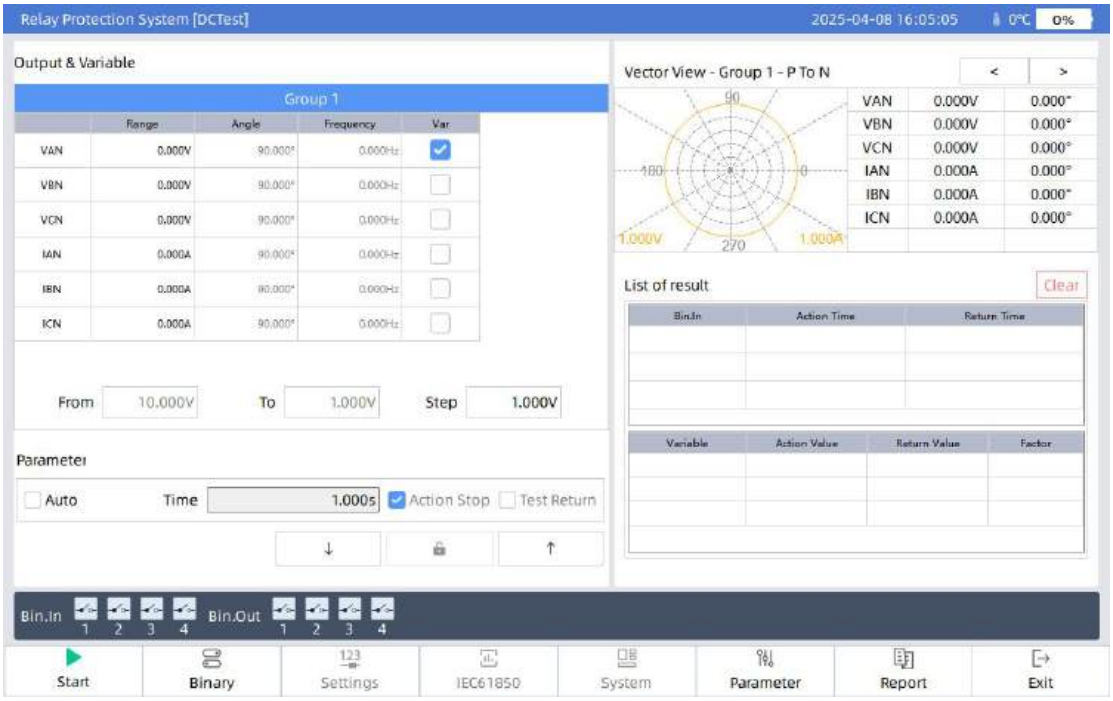
6.1.2 Test Results View



Column	Descriptions
Bin.In	Displays the sequence number of input actions (1-4 for hard contacts, 1-32 for GOOSE testing). When an input action occurs, the sequence number is recorded.
Action Time	Records the action time corresponding to the input action sequence number.
Return Time	Records the return time when the action returns during testing.
Variable	The variable channel and its type selected for the current test.
Action Value	Records the action value of each group's progression parameters during automatic ramping.
Return Value	Records the return action value when the action returns during testing.
Return Factor	The software automatically calculates the return coefficient based on the action value and return value. Return Factor = Return Value / Action Value.

6.2 DC test

Users can flexibly control the output DC amplitude of each voltage and current channel and select relevant variables for manual or automatic testing as needed.



6.2.1 Introduction the function buttons

Auto Manual / Automatic test mode toggle.

Action Stop When the "Action Stop" function is activated, the tester will immediately cease output upon receiving a trip signal; otherwise, the test output will continue.

Test Return: Only effective in automatic mode. When the "Test Return" function is activated, the tester will automatically initiate reverse variation upon receiving a trip signal, which is used to test the relay's drop-off characteristics. The "Test Return" and "Action Stop" functions cannot be used simultaneously.

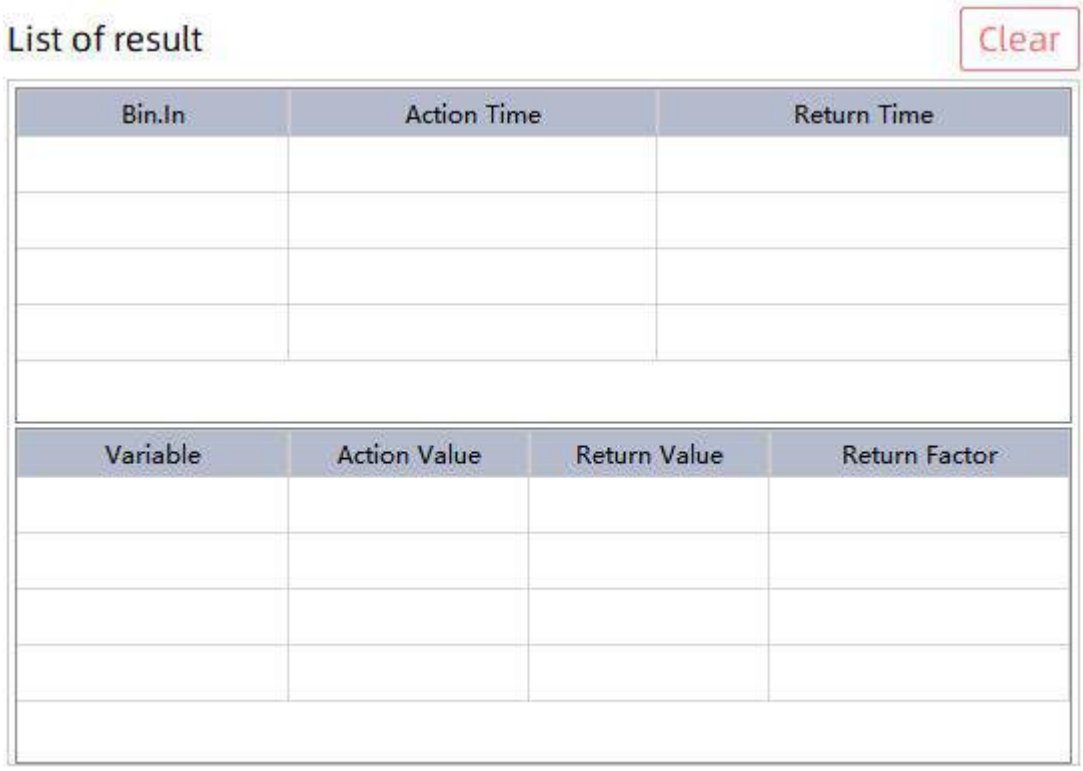
① When a valid input signal is received, the output will change towards the initial value at the original step size, multiplied by 1.2 times the action value, until a valid input signal is received again or the initial value is reached and output stops. The software records the two action values and action times and calculates the return factor based on the action values;

② If no input signal is received, the output will stop after reaching the final value from the initial value.

↓ ↑ UP and DOWN arrow buttons: In manual mode, With each press, the output value of the selected variable channel will change by the step value of the variable, either increasing or decreasing.

Lock button: Effective during manual mode operation. When the “Lock” button is pressed, the current output value is locked and will not change. After releasing the button, the output will resume according to the interface settings. This feature is particularly useful when multiple parameter output values need to be changed simultaneously.

6.2.2 Test Results View

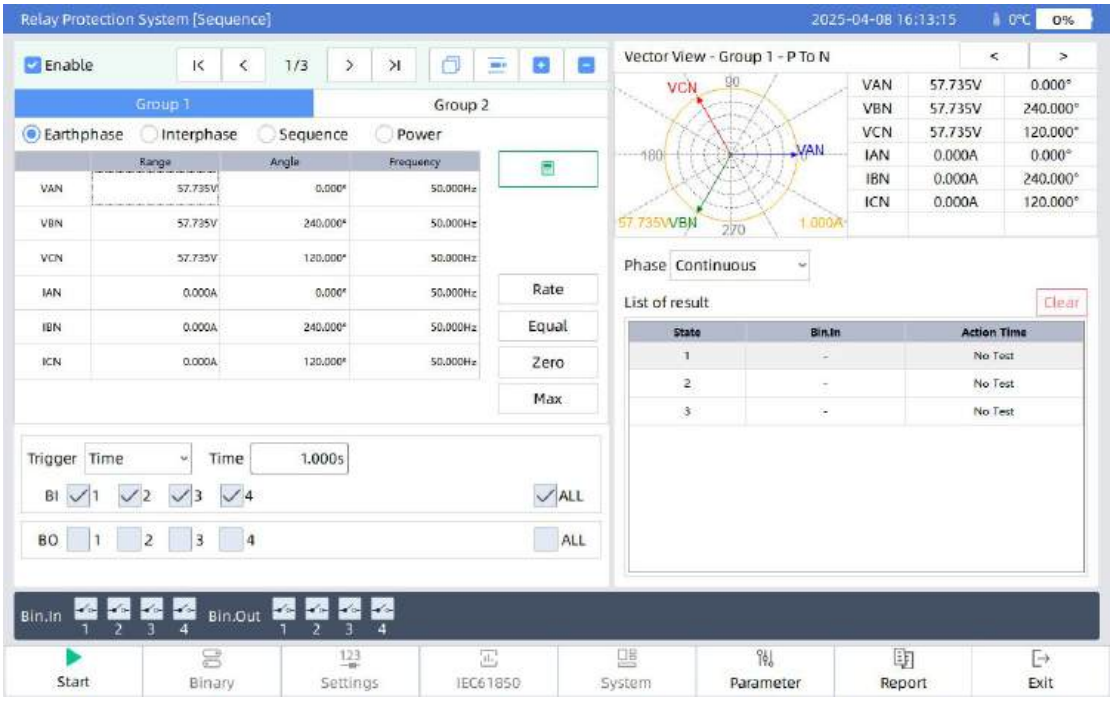


Column	Descriptions
Bin.In	Displays the sequence number of input actions (1-4 for hard contacts, 1-32 for GOOSE testing). When an input action occurs, the sequence number is recorded.
Action Time	Records the action time corresponding to the input action sequence number.
Return Time	Records the return time when the action returns during testing.
Variable	The variable channel and its type selected for the current test.
Action Value	Records the action value of each group's progression parameters during automatic ramping.
Return Value	Records the return action value when the action returns during testing.

Return Factor The software automatically calculates the return coefficient based on the action value and return value.
Return Factor = Return Value / Action Value.

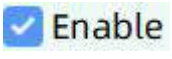
6.3 Sequence

Users can define a sequence of multiple states that are executed in order. The amplitude, phase, and frequency of each channel's output can be freely adjusted for each state. Additionally, different binary input and output rules can be defined for each state. The transition modes between states can also vary.



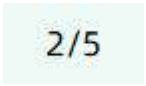
- Users can define no fewer than 32 states.
- Each state can independently set the amplitude, phase angle, and frequency of voltage and current.
- Each state can have a unique trigger condition to control state transitions.
- Each state can have a unique binary output control setting.
- The action time of each state is recorded separately.
- States are output in the defined order.
- Four different perspectives output mode are provided, allowing users to switch between Earth-Phase, Interphase, Symmetrical, and Power modes.
- The output of each state can be set to follow the defined absolute phase angle or maintain waveform continuity.

6.3.1 Function buttons



Each state is enabled by default after being added, but users can uncheck it to set it as disabled. During testing, disabled states will not produce output. This means that users can remove disabled states from the state sequence without deleting the current state

settings.



Displays the number of states and the current state sequence.
As shown in the figure, there are a total of 5 states, and the current state is the 2nd one.

Jump to the first state.

Move to the previous state.

Move to the next state.

Jump to the last state.

Duplicate the current state and insert it immediately after the current state.

Insert a new state before the current state.

Add a new state to the end of the sequence.

Delete the current state.

Assist for distance fault calculation.
Reference to Distance calculation model for the details.

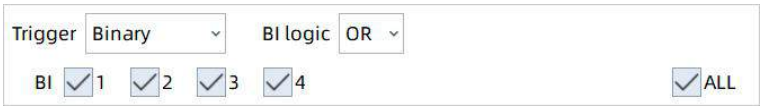
Absolute / **Continuous** output mode toggle:
Absolute: It means that when outputting, output according to the angle of the parameters set in the current state parameter interface;
Continuous: Indicates that when the output reaches the current state, the waveform is not output in accordance with the angle set in the interface, but continues the waveform of the previous state continuously.

6.3.2 Trigger settings

Time

Automatically transitions to the next state after the set duration has elapsed.

Binary



Automatically transitions to the next state when the activated binary input and corresponding logic conditions are met.

Binary + Time

Automatically transitions to the next state when the activated binary input and corresponding logic conditions are met, or the set duration has elapsed. Either of the two conditions being met is sufficient.

Keypress

A dialog box will pop up, and the system will wait for the user to press a key to confirm before transitioning to the next state.

GPS/IRIG-B

Users can set a specific trigger time, and the system will trigger and transition to the next state at the exact moment the time is reached. Before using this mode, synchronization with GPS or IRIG-B signals is required.

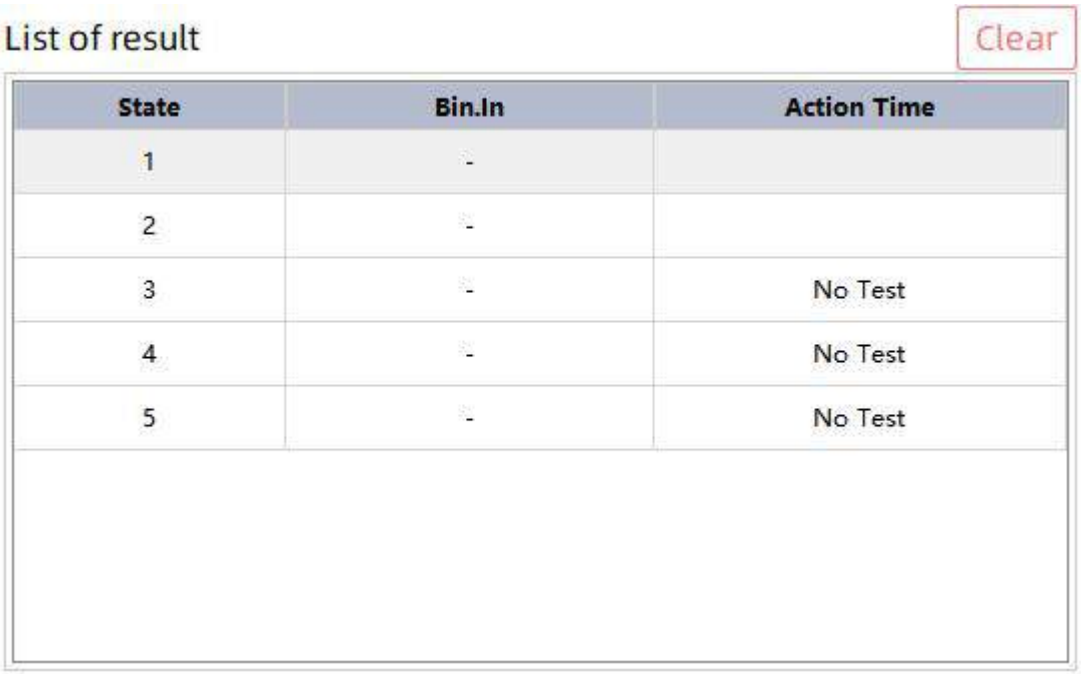
6.3.3 Binary output setting

User can independently set the output position of each Binary output for the current state.

Normally Open (NO): Indicates that the Binary output in the current state is in the normally open state.

Normally Closed (NC): Indicates that the Binary output in the current state is in the normally closed state.

6.3.4 Test Result View



The result view records the action contacts and action times of the binary inputs during the test.

Clear: Clear all action results.

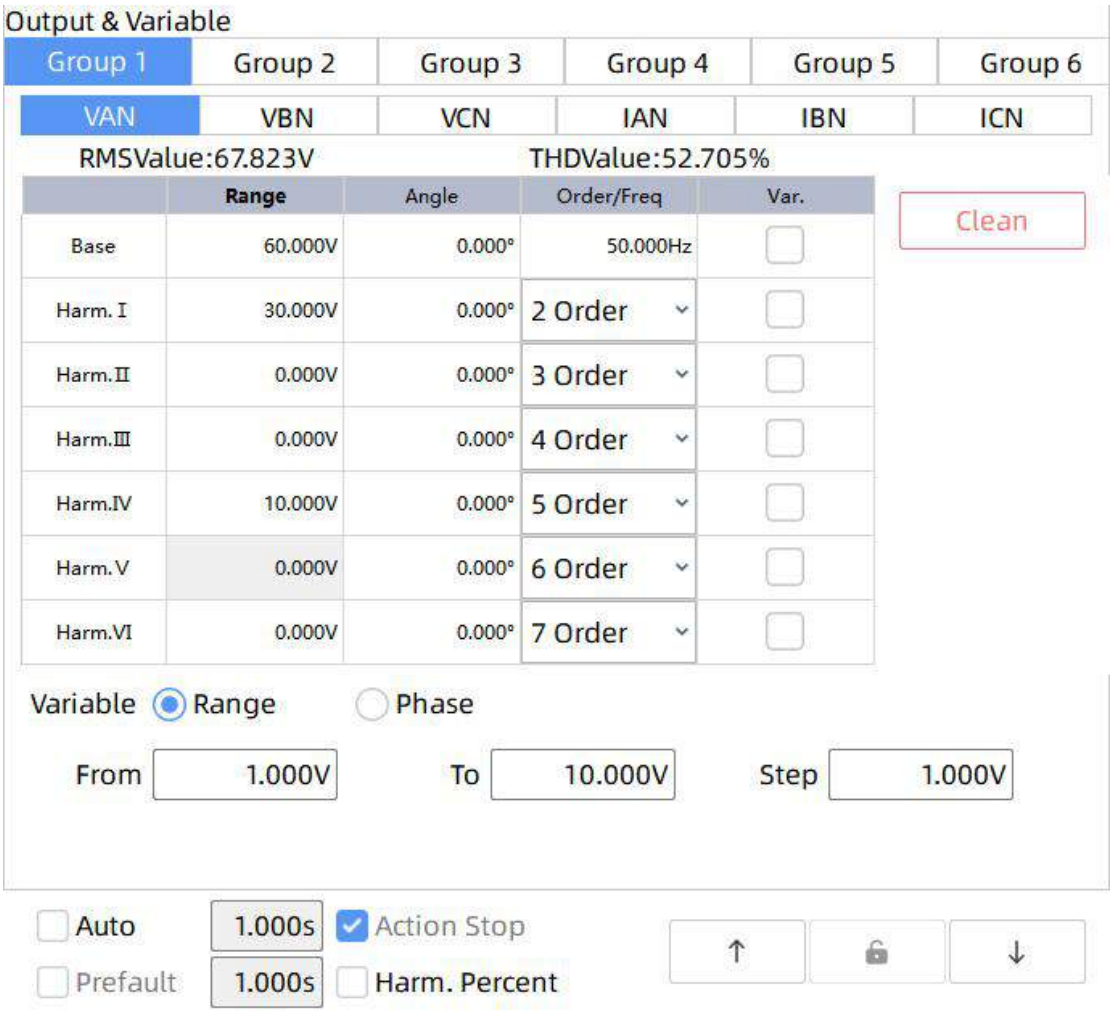
Bin.In: Displays the action sequence number of the binary input. The sequence number ranges from 1 to 4, corresponding to hardware digital input ports 1-4. When any of the digital inputs 1-4 is triggered, the sequence number will be recorded.

Action Time: Records the action time value when the digital input is triggered, corresponding to the digital input sequence number.

6.4 Harmonic

Harmonic test has 6 groups of parameters (2 groups for analog output, 6 groups for digital output) output, respectively group 1-6. Each group can be set to output fundamental wave and 6 harmonic single components individually, and the waveform graph can display the waveform graph after parameter setting, which is convenient to view the harmonic content waveform. After setting, all groups will be output at the same time, and the result list will show the result value and time.

6.4.1 Output & Variable setting



According to the test requirements, set the amplitude and angle output of the fundamental wave and single harmonics for each phase in each group.

RMS Value Displays the effective value calculated from the fundamental wave and single harmonic parameters on the current interface (the actual output amplitude of the tester).

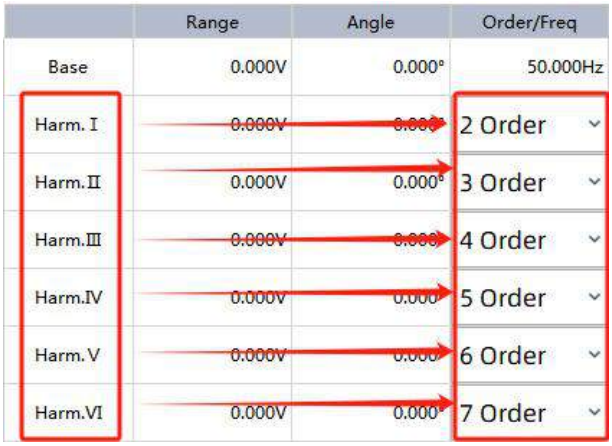
THD Value(THD%) Displays the total harmonic distortion calculated from the single harmonic parameters on the current interface.

Clean Clears the harmonics order setting of current channel.

Base Set the amplitude and angle of the fundamental wave for the current phase.

Harm I ~ VI Set the amplitude and angle of the particular harmonics order. The harmonic order can be freely defined in the frequency/order column. For example, set Harmonic I as the 2nd harmonic, Harmonic II as the 3rd harmonic, Harmonic III as the 4th harmonic, etc.

The order maximum can up to 32 times.



Range Set the amplitude of the fundamental wave and individual harmonics

Angle Set the phase of the fundamental wave and individual harmonics

Order/Freq Set the fundamental frequency (default: 50Hz) and individual harmonic orders, which can be configured from 2nd to 32nd order

Variable Range / Phase can be select.

1) Check the variable item in the Var. column.
2) Set the variable, which can be range or phase angle, based on actual test requirements.
3) Set the initial and final values of the variable (used for automatic stepping). During automatic stepping, the value will change from the initial to the final value according to the step size.
4) Set the step size for the variable amplitude. During automatic stepping, the value will change according to this step size.

Auto Manual / Automatic test mode toggle.

Prefault Available only in automatic mode, it is used to output a Prefault state before the fault state set in the output interface. The Prefault state defaults to outputting positive-sequence rated voltage with zero current.

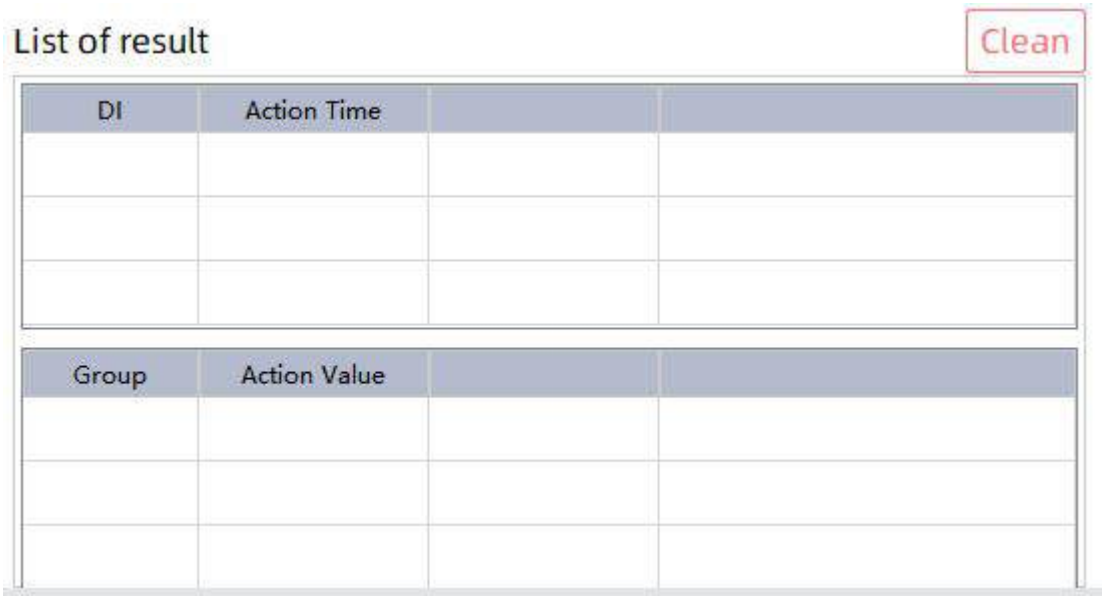
Action Stop When the "Action Stop" function is activated, the tester will immediately cease output upon receiving a trip signal; otherwise, the test output will continue.

Harm.Percent When checked, parameters will be displayed as harmonic percentages.

UP and DOWN arrow buttons: In manual mode, With each press, the output value of the selected variable channel will change by the step value of the variable, either increasing or decreasing.

Lock button: Effective during manual mode operation. When the “Lock” button is pressed, the current output value is locked and will not change. After releasing the button, the output will resume according to the interface settings. This feature is particularly useful when multiple parameter output values need to be changed simultaneously.

6.4.2 Test Result View



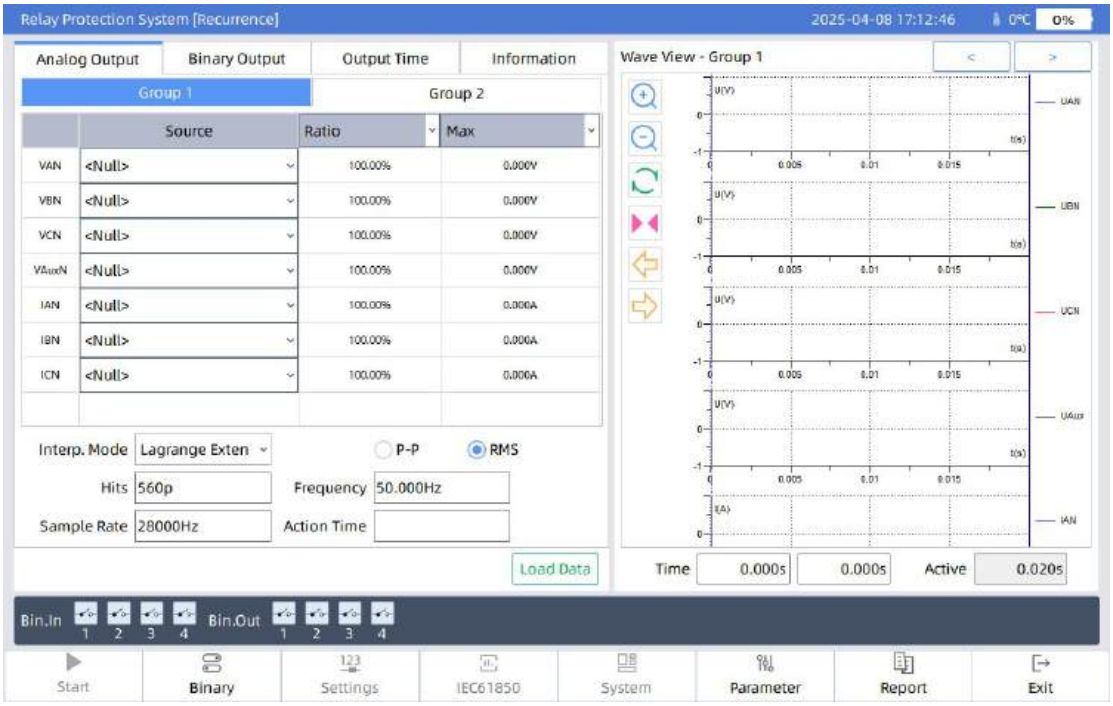
The list of result records the action values and action times when input actions occur during the test.

Clean Clear all action results.

DI Display the input action sequence numbers (1-4), corresponding to hardware input ports 1-4. When input actions 1-4 occur, the action

	sequence numbers will be recorded.
Action Time	Record the action time values corresponding to input actions 1-4.
Group	Group numbers. During automatic stepping, the action results of each group's stepping variables are displayed separately by group.
Action Value	Record the action values of each group's stepping parameters during automatic stepping.

6.5 Recurrence

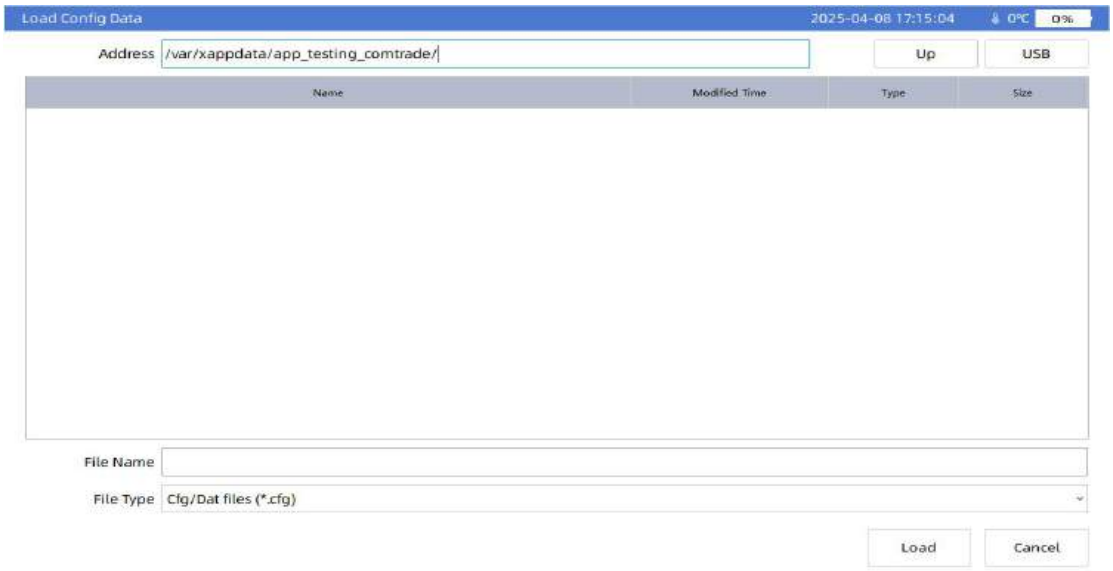


The Recurrence module has the following functions:

- Allow the user to import the Comtrade format transient data file and performs playback;
- With manual trigger, binary trigger, GPS trigger, etc;
- All data of any voltage or current channel are editable and superimposed;
- The output value of each current and voltage channel is adjusted proportionally and converted from the primary value to the secondary value;
- The data of the original record is interpolated and calculated;
- By setting the repetition start time, repeat the interval and repeat times, repeat a certain section of the waveform;
- Prolonging the output time of the normal state or repeating the output of a certain fault waveform;

6.5.1 Load Data

1. Place the .cfg and .dat comtrade files in a folder and copy them to the tester.
2. Click "Load Data," select the fault file, and then click "Load."



After clicking "Load," the software will display the loading progress next to the data loading button.

6.5.2 Analog output

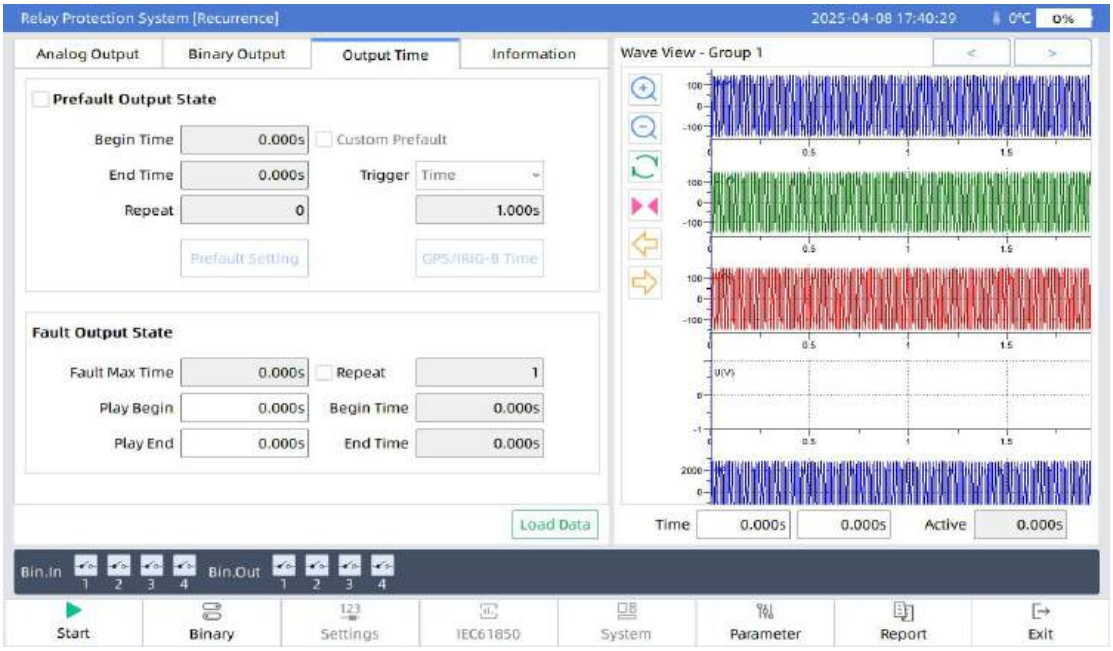
After loading the fault file, the software will automatically map the channel data in the fault file. In the analog output interface, you can see the voltage and current values to be output by the tester and modify the output parameters. According to the tester's channel configuration, a 6-phase tester has two groups of parameters (Group 1 and Group 2, where Group 1 is the first three phases of voltage and current, and Group 2 is the last three phases of voltage and current). A 3-phase tester has only one group of parameter settings.

Source	After the file is loaded, the software will automatically perform channel mapping. If necessary, users can manually adjust the channel mapping until they are satisfied.
Ratio/Ratio(=)	If the loaded file contains ratio information, the software will automatically use this information. If necessary, users can also manually adjust the ratio until they are satisfied. **Ratio**: Users can independently modify the ratio value for each channel without interfering with each other. **Ratio(=)**: When a user modifies the ratio value of a particular channel, the ratio values of other channels of the same type within the same group will also be updated simultaneously.
Max/Min	Display the minimum and maximum statistical values for each channel.
Interp.Mode	Select the interpolation algorithm used internally by the software. Can be set to Original, Not Insert, Newton, Lagrange, or Lagrange Exten.
Hits	Displays the number of hits based on the file.
Sample Rate	Displays the interpolated sampling rate.
Action Time	Displays the action time received by the binary input.

6.5.3 Binary output

Set custom binary output or choose to use the binary state from loaded file.

6.5.4 Output time



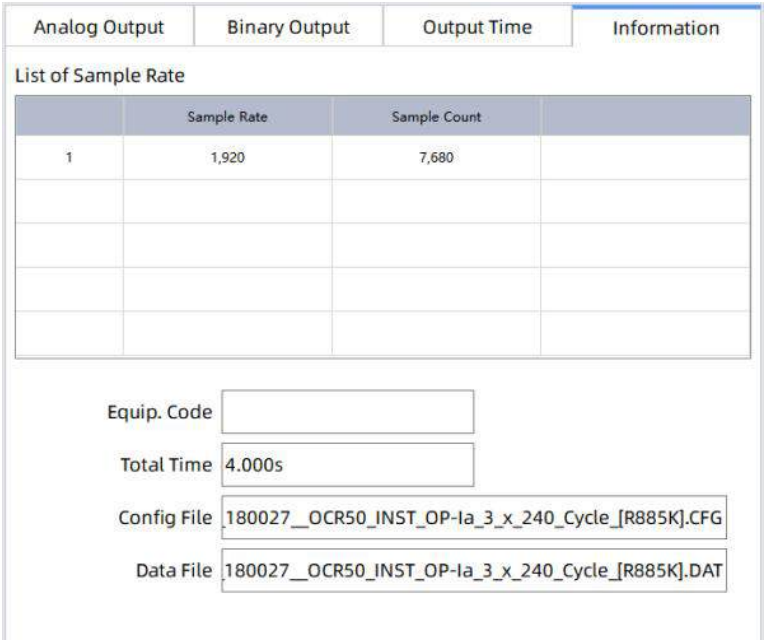
Set the prefault output begin time, i.e., output the rated voltage and zero current before outputting the fault waveform of the fault file, or customize the output voltage and current values according to actual needs. You can also set the switching method from the prefault state to the fault file output, including Time trigger, Binary input trigger, Binary input + Time trigger, GPS/IRIG-B code trigger, or Keypress trigger.

Preault Output State Output the rated voltage and zero current before outputting the fault waveform of the fault file, or customize the output voltage and current values according to actual needs. You can also set the toggle method from the prefault state to the fault file output, including Time trigger, Binary input trigger, Binary input + Time trigger, GPS/IRIG-B code trigger, or Keypress trigger.

Fault Output State Automatically reads the maximum output time of the fault file. You can modify the maximum output time as needed, set the fault playback begin and end times, and set the number of fault output repetitions, as well as the repetition begin and end times.

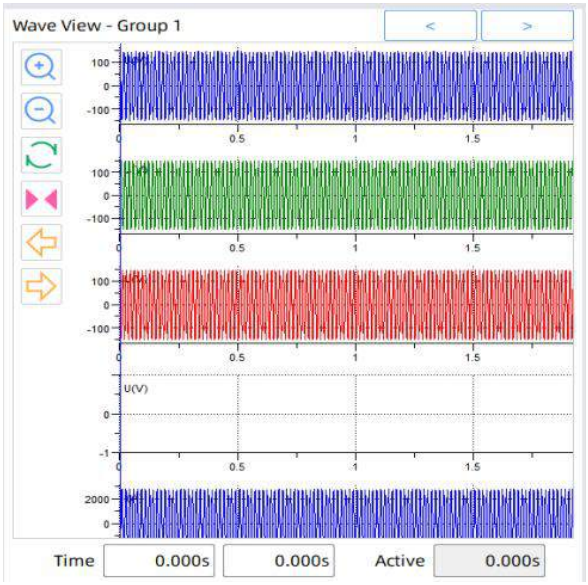
6.5.5 Information

Displays basic information about the fault file.



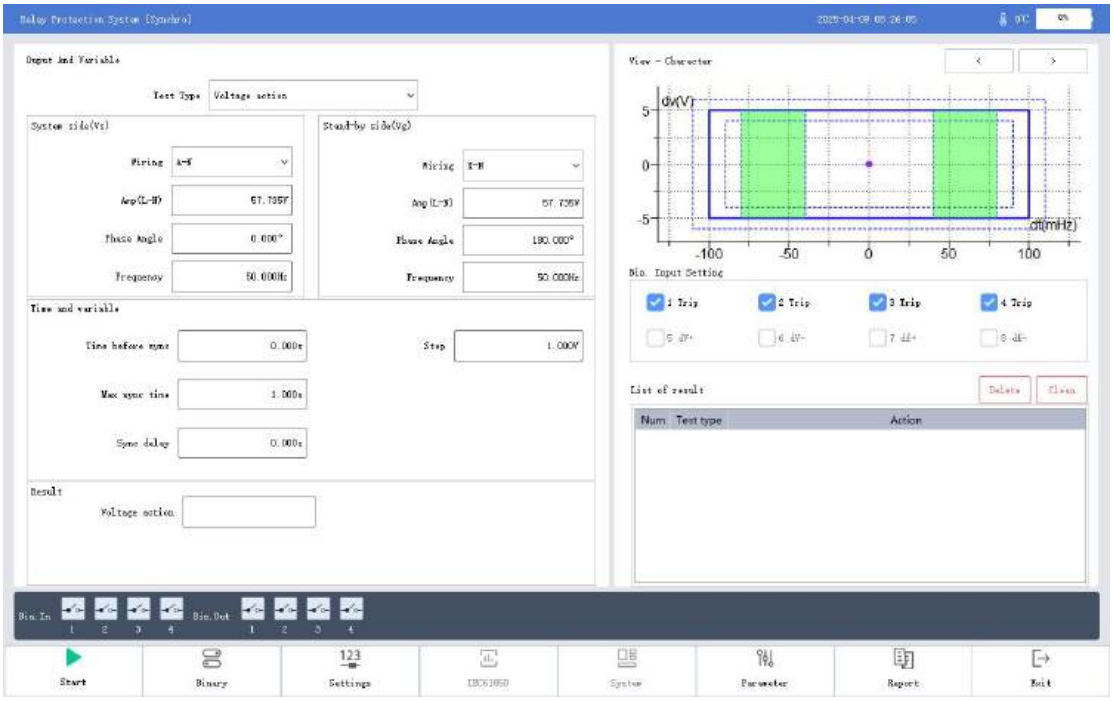
6.5.6 Wave View

Displays the output waveform after loading the fault data. You can zoom in, zoom out, shift left, and shift right to analyze the waveform and switch between groups for display.



6.6 Synchro

This module can test the voltage action value, frequency action value, leading angle and leading time, voltage adjustment pulse width, frequency adjustment pulse width, electrical zero position , automatic synchronization, and frequency acceleration of the synchronization device. It can also perform automatic adjustment tests for automatic synchronization devices.

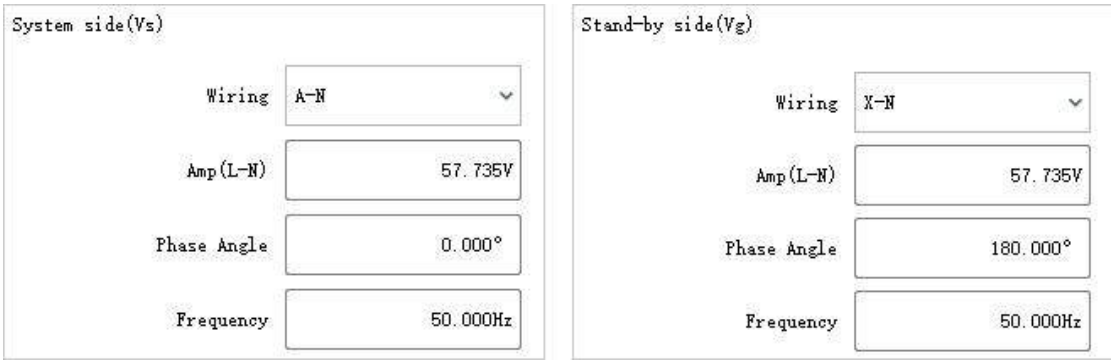


6.6.1 Test type:

Voltage Action	Used to test the synchronization voltage action value. The frequency remains unchanged, and the voltage is increased or decreased according to the set voltage step size until synchronization action occurs. Record the voltage amplitude of the side to be synchronized at this time. **Note**: The frequency difference between the system side and the side to be synchronized must be within the allowable frequency difference range.
Frequency Action	Used to test the synchronization frequency action value. The voltage amplitude remains unchanged, and the frequency is increased or decreased according to the set frequency step size until synchronization action occurs. Record the frequency of the side to be synchronized at this time. **Note**: The voltage difference between the system side and the side to be synchronized must be within the allowable voltage difference range.
Leading angle/time	Automatically adjust the frequency of the side to be synchronized. When the frequency difference just meets the requirements, record the lead angle and lead time at this time.
Electric Zero	Test the action angle and action time of the electrical zero point relay.
Volt Pulse Width	Measure the voltage adjustment pulse width.

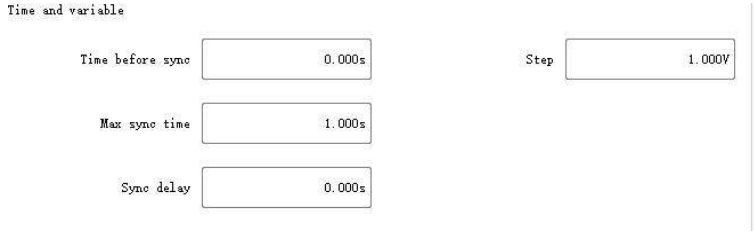
Freq Pulse Width	Measure the frequency adjustment pulse width.
Auto Synchro	When the frequency and voltage differences do not meet the synchronization conditions, adjust the voltage and frequency according to the synchronization device's frequency and voltage adjustment signals until the synchronization conditions are met and the synchronization device issues a synchronization signal. Record the lead angle and lead time at this time.
Frequency Acceleration	Test the frequency acceleration action value of the synchronization.

6.6.2 System side and stand-by side parameter settings



Wiring	Set the voltage wiring phases to test.
Amp(L-N)	Set the Earthphase voltage value of the system and stand-by side. The Interphase voltage can be calculated based on the Earthphase voltage VL-N * 1.732.
Phase Angle	Set the testing phase angle of both side voltage.
Frequency	Set the testing frequency of both side.

6.6.3 Time and variable



Time before sync	Rated output period, Defaults is 0s.
Max sync time	Set the maximum duration for the synchronization process. The tester will automatically stop the test once this time is reached, regardless of whether the synchronization test is completed.
Sync Delay	Set the output delay time, configurable based on the test function.

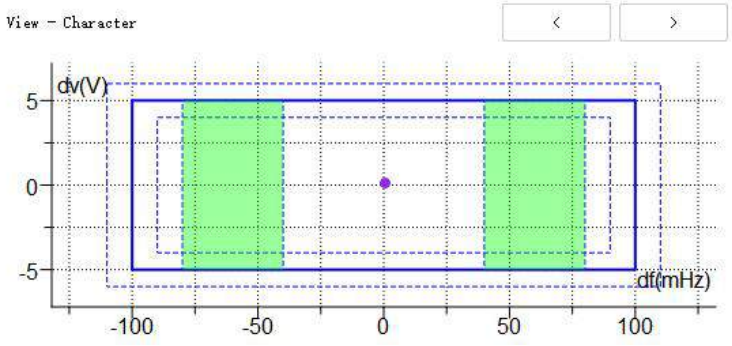
Step	Configurable based on the test function. The parameters of the side to be synchronized change according to this step size during the synchronization process. a. Voltage Step Size: The step size for voltage changes on the side to be synchronized during the synchronization process. The voltage increases or decreases according to this step size. b. Frequency Step Size: The step size for frequency changes on the side to be synchronized during the synchronization process. The frequency increases or decreases according to this step size.

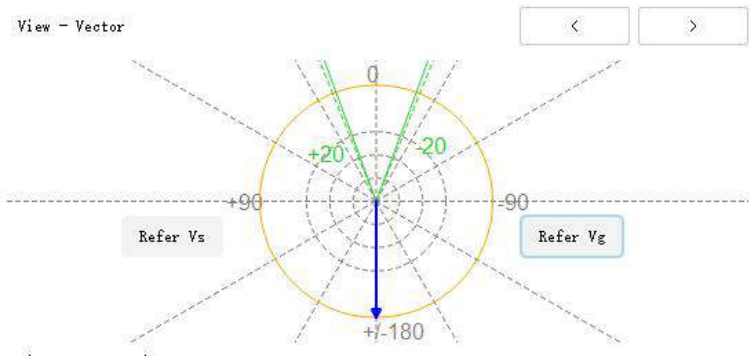
6.6.4 Binary input setting

Binary inputs: 1~4	CB tripping command from the synchronization relay
Binary input: 5	The voltage increase adjustment signal
Binary input: 6	The voltage decrease adjustment signal
Binary input: 7	The frequency increase adjustment signal
Binary input: 8	The frequency decrease adjustment signal

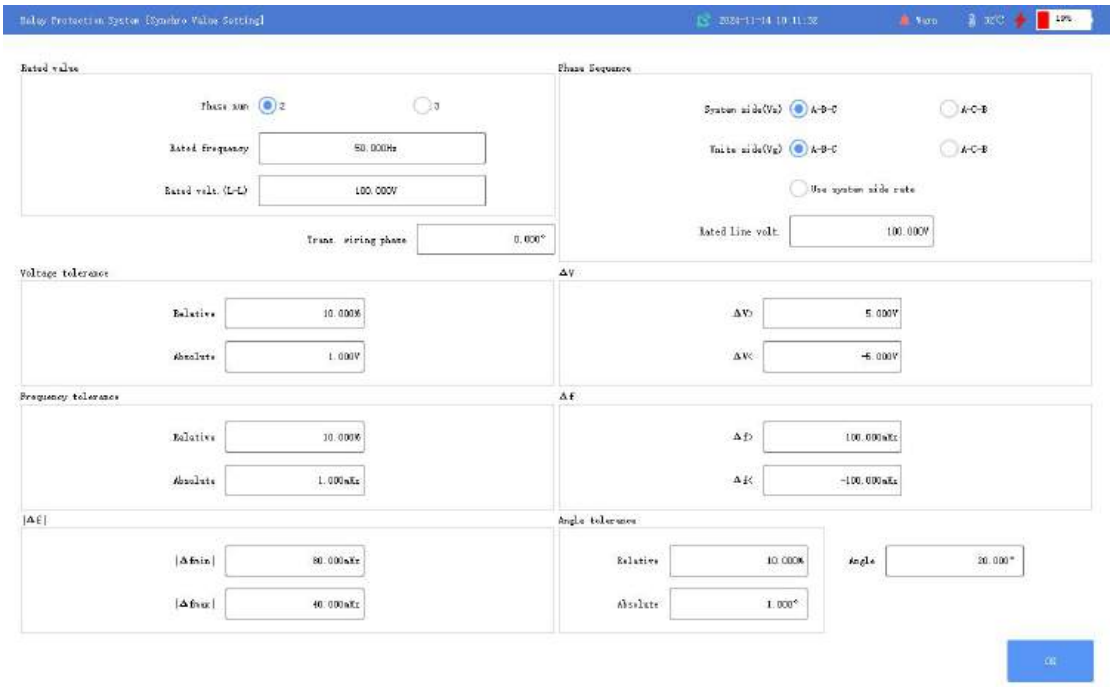
6.6.5 View Character / Vector

Displays the characteristic diagram / vector of voltage and frequency during the synchronization process.





6.6.6 Synchro object parameter Setting



Phase Sequence

Set the phase rotation of both system side and stand-by side.

Trans. Wiring phase

This value is defined by the characteristics of the coupling transformer, representing the inherent phase difference between the system side and the side awaiting synchronization.

Synchronizer Characteristic

Voltage tolerance △v	Set maximum tolerance of △v> and △v< , Obtain the maximum value between the relative and the absolute values.
Freq. tolerance △f	Set maximum tolerance of △f> and △f<, Obtain the maximum value between the relative and the absolute tolerances.
Angle tolerance	Determine the phase shift between the both sides through the circuit breaker closing delay and the coupling transformer, and ascertain their maximum

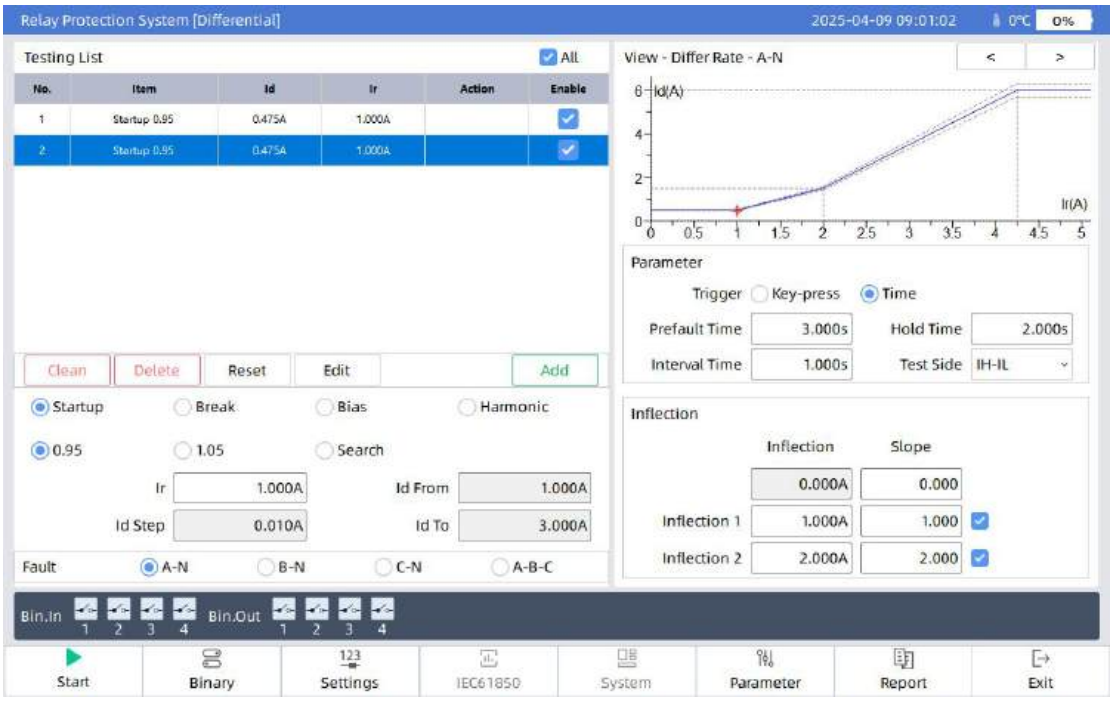
	allowable error; take the larger value between the relative tolerance and the absolute tolerance.
Dead Zones |△f|	The dead zone refers to the range within which a synchronizing relay does not output any voltage or frequency control commands.

6.6.7 Test list and Result view

Displays the contact action results after the synchronization function tested.

7 Advanced Test Modules

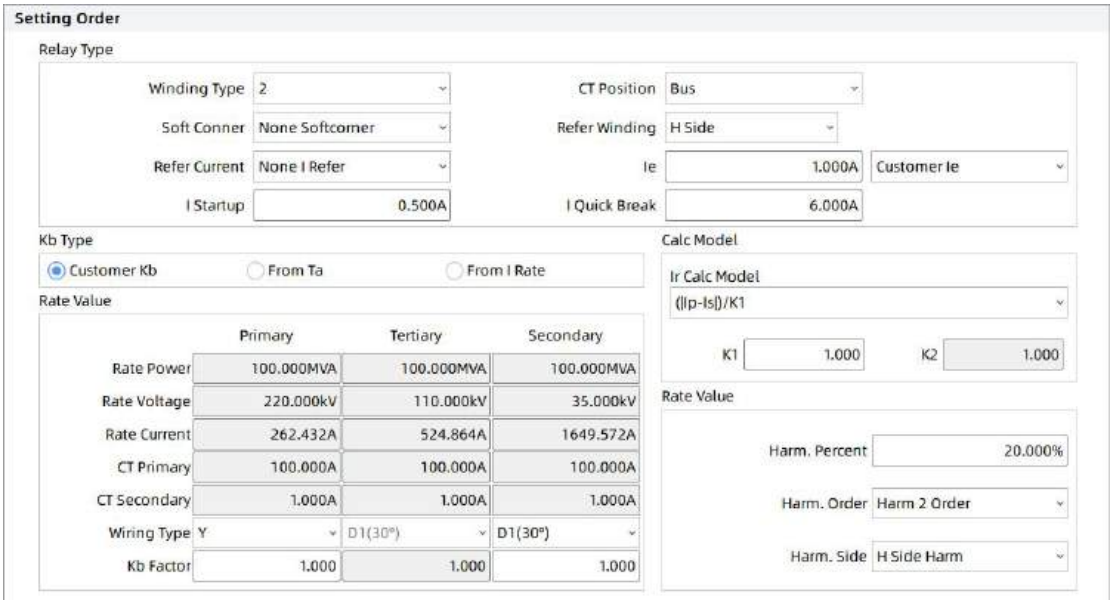
7.1 Differential



This module is primarily designed to simulate internal faults of differential protection devices. It can perform functions such as scanning of differential characteristic curves, scanning of differential harmonic restraint characteristics, and rapid scanning and verification of Idiff> and Idiff>>.

7.1.1 Differential object parameter setting

Before conducting the test, it is necessary use the “Settings” button to define the parameters of the test object.



Winding Type — Number of transformer windings: 2 or 3 winding.

Soft Conner — 1. For Y/Y transformer connections, both sides are in phase, and TA connections are generally Y/Y. Select "No Correction."
2. For Y/△ transformer connections, the two sides are out of phase. For microprocessor-based protection, TA connections are generally Y/Y. If the protection is designed for high-voltage side internal phase compensation, select "Y-side Correction." If the protection is designed for low-voltage side internal phase compensation (e.g., NARI RCS-978 protection), select "D-side Correction." If the protection is designed without internal phase compensation and relies on external TA wiring compensation, select "No Correction."

Refer Current — Per unit value or actual value. Most protection devices provide current values directly (e.g., differential threshold: 2A, unit: A). Some devices provide coefficients (e.g., differential threshold: 0.3Ie, unit: Ie). Convert per unit values to actual current values: Actual current = Per unit value × High-voltage side rated current.

CT position — If the differential protection currents on both sides flow into the transformer, the directions are opposite. If one side flows in and the other flows out, the directions are the same.

Refer Winding — Refer to the compensation method.

Ie — For per unit value Ie, the software provides three calculation methods:
1. Custom calculation: Calculated and entered by the user.
2. CT secondary current: Usually 1A or 5A.
3. Calculated from rated current: Ie = Rated power / (1.732 × Primary rated

	voltage × Primary rated current).
Idiff>	Differential protection starting current/threshold current, setting value.
Idiff>>	Differential protection quick-break current/threshold current, setting value.
Kb Type	**Customer Kb**: Manually calculate and input. Some protection devices use different methods for calculating balance coefficients. Users can manually calculate and input the balance coefficients for high and low voltage sides. **From TA**: Automatically calculated based on transformer capacity, rated voltage, and current. **From I rated**: Automatically calculated based on transformer rated current and primary/secondary current.
Ir Calc Model	Different protection devices from different manufacturers use different restraint current formulas. Refer to the protection device manual for details. **K1**: Restraint current formula coefficient. Refer to the protection device manual.
Rated Value	Input based on the actual environmental parameters and set values of the device under test.
Kb Factor	Indicates the conversion ratio relationship between each side winding and the reference winding.

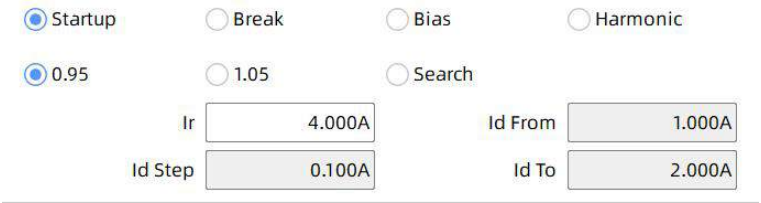
Reference for Restraint Current Formulas and Balance Coefficients of Various Manufacturers' Protections

Protection Model and Manufacturer	Compensation Method	Restraint Current Formula	Balance Coefficient
Beijing Sifang CSC-326EC	Y-side correction	Ir= | Imax'-ΣIi' | /2,Ii'≠Imax'	
Beijing Sifang CST-141B	Y-side correction	Ir=Max(| I1' | , | I2' |)	
Beijing Sifang CST-30A-Triple Winding Transformer	Y-side correction	Ir=Max(| I1' | , | I2' |)	
Beijing Sifang CST-30A-Double Winding Transformer	Y-side correction	Ir= | I1'-I2' | /2	
NARI Technology PST-1200	Y-side correction	Ir=Max(| I1' | , | I2' |)	HV side balance coefficient = 1, LV side balance coefficient = K2 = 1.732 * LV side primary PT * LV side primary CT / (HV side primary PT * HV side primary CT)
NARI Technology PST-600	Y-side correction	Ir=Max(| I1' | , | I2' |)	
NARI Technology PST-641	Y-side correction	Ir= | I1'-I2' | /2	Balancing factor on HV side = 1.732, Balancing factor on LV side = Ie on HV side / Ie on LV side

NARI Technology PST-621/622	Y-side correction	Ir=Max{|I1|, |I2|, |I3|}	HV side balance coefficient = 1.732, LV side balance coefficient = K2 = 1.732 * LV side primary PT * LV side primary CT / (HV side primary PT * HV side primary CT)
NARI Technology DGT-801	Y-side correction	Ir= √ (- | I1'× I2' |)*cos θ	
NR Electric RCS-9000	△Side correction; Missimum value	Ir=(| I1' | + | I2' |)/2	
NR Electric RCS-978	△Side correction; Missimum value	Ir=(| I1' | + | I2' |)/2	Balancing factor on the high voltage side = 1, balancing factor on the low voltage side = Ie on the high voltage side / Ie on the low voltage side
NR Electric RCS-985	△Side correction; Missimum value	Ir=(| I1' | + | I2' |)/2	Balancing factor on the high voltage side = 1, balancing factor on the low voltage side = Ie on the high voltage side / Ie on the low voltage side
NARI Technology RCS-9671	Y-side correction	Ir=|I1-I2|/2	HV side balance coefficient = 1, LV side balance coefficient = K2 = 1.732 * LV side primary PT * LV side primary CT / (HV side primary PT * HV side primary CT)
Shenzhen SR Electric ISA Series	Y-side correction	Ir = | Id- | I1' | - | I2' |	K1 = 1.732, K2 = 1.732 * d35
Shenzhen SR Electric BP-2B	Y-side correction	Ir = | Id- | I1' | - | I2' |	
XJ Electric WBZ-500	Y-side correction	Ir=Max(| I1' | , | I2' |)	
Beijing Sifang CST-141B, -200B Series	Y-side correction	Ir=|I1-I2|/2	HV side = 1, LV side = set value

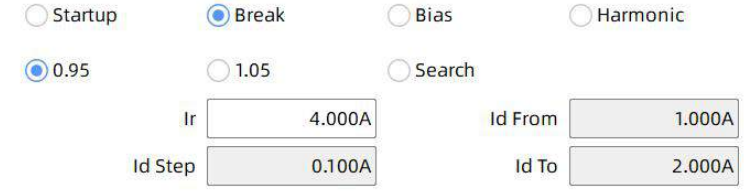
7.1.2 Main test content:

7.1.2.1 Idiff> check and Search



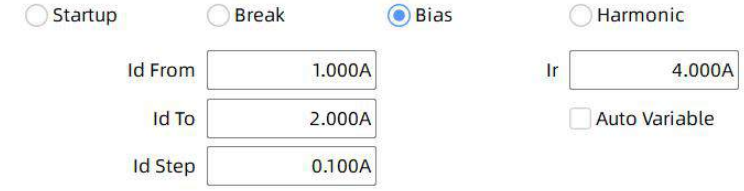
1. Verify the Idiff> current value of differential protection, such as 0.95 times or 1.05 times the Idiff> current.
2. Searching the Idiff> value. By fixing the I-bias and changing the I-diff, The program first outputs the initial values of the I-diff, Then, the I-diff changes from the start value to the end value in steps until the test device receives the differential relay action signal or the current reaches the end value.

7.1.2.2 Idiff>> check and Search



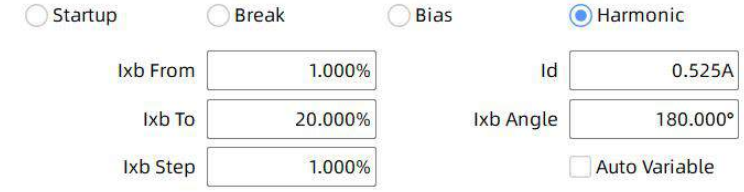
1. Verify the Idiff>> current value of differential protection, such as 0.95 times or 1.05 times the Idiff> current.
2. Searching the Idiff>> value. By fixing the I-bias and changing the I-diff, The program first outputs the initial values of the I-diff, Then, the I-diff changes from the start value to the end value in steps until the test device receives the differential relay action signal or the current reaches the end value.

7.1.2.3 Differential Curve Characteristic test



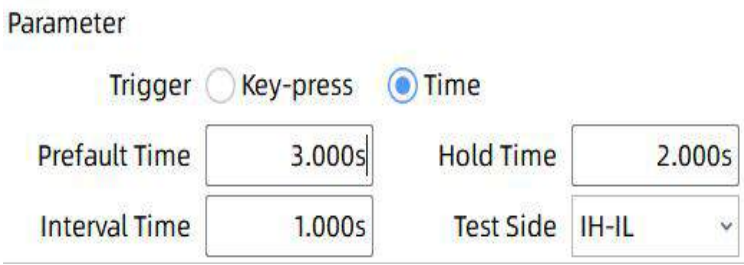
The differential characteristic curve can be verified and scanned.
The test range of I-diff can be either manually specified or automatically determined by the program.

7.1.2.4 Differential Harmonic Restrain test



The differential harmonic restrain can be verified and scanned.
The test range of Ixb can be either manually specified or automatically determined by the program.

7.1.2.5 Common parameter settings



Trigger Select the fault trigger mode. After the test starts, the output remains in the prefault state for a set duration before entering the fault state.

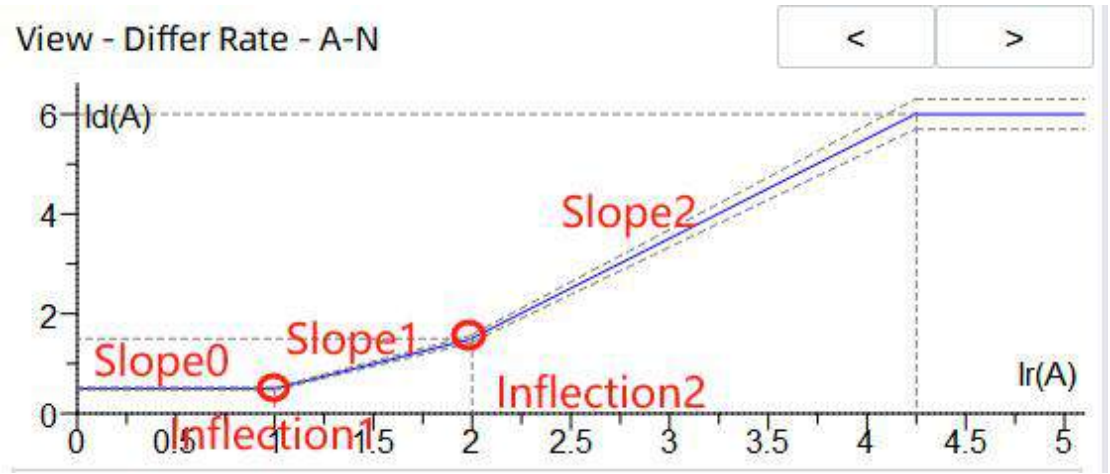
Prefault Time Valid when the time trigger mode is selected. Set the prefault output time.

Hold Time The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.

Interval Time After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output.

Test Output Process: Prefault → Fault state → Interval → Prefault → Fault state → Interval...

7.1.2.6 Inflection/Slope

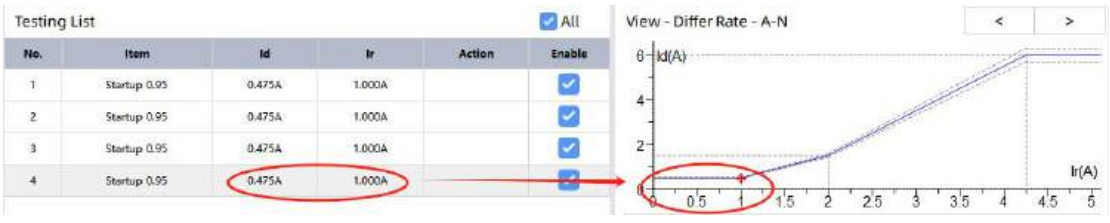


Inflection

	Inflection	Slope	
	0.000A	0.000	
Inflection 1	1.000A	1.000	☑
Inflection 2	2.000A	2.000	☑

The inflection point of the differential curve characteristic. These two parameters are protection setting values. The differential curve is plotted based on the inflection point and slope. For example, Slope 0 = 0.500, Slope 1 = 1.000, Slope 2 = 2.000, inflection point 1 = 1.000A, inflection point 2 = 2.000A.

7.1.2.7 Test List and Curve/Output View



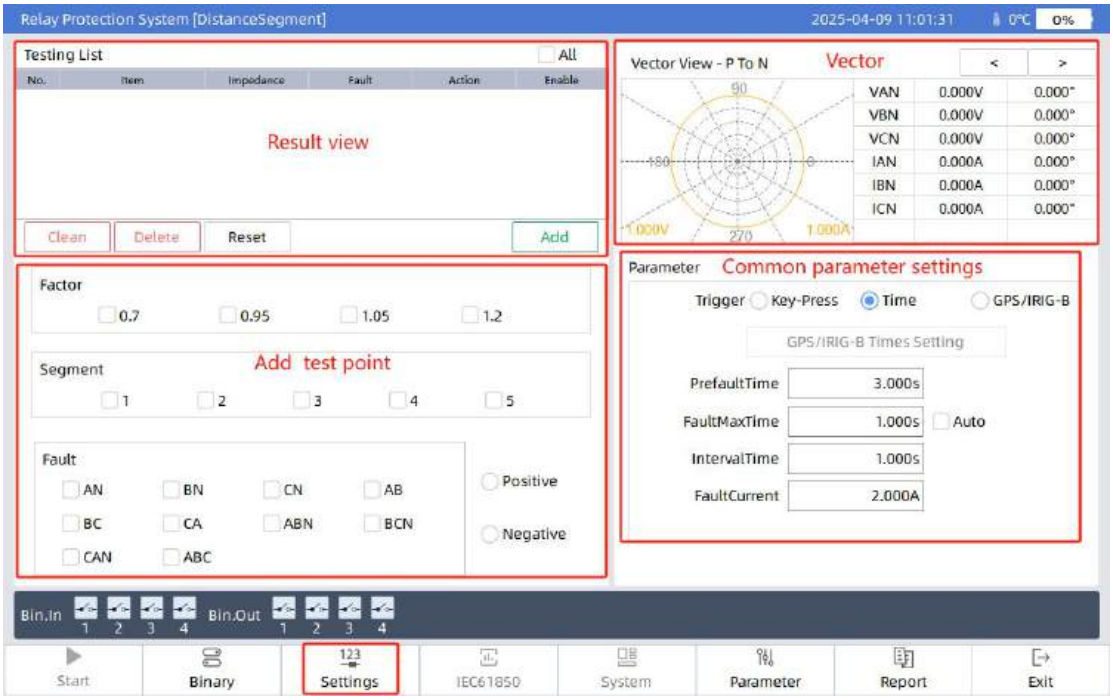
The curve/output view is displayed by a toggle slide button.

Idiff>, Idiff>>, curve characteristic, and harmonic restraint tests can all be added to the testing list, and the software will execute them in the order from top to bottom.

7.2 SttDistance (Distance Segment)

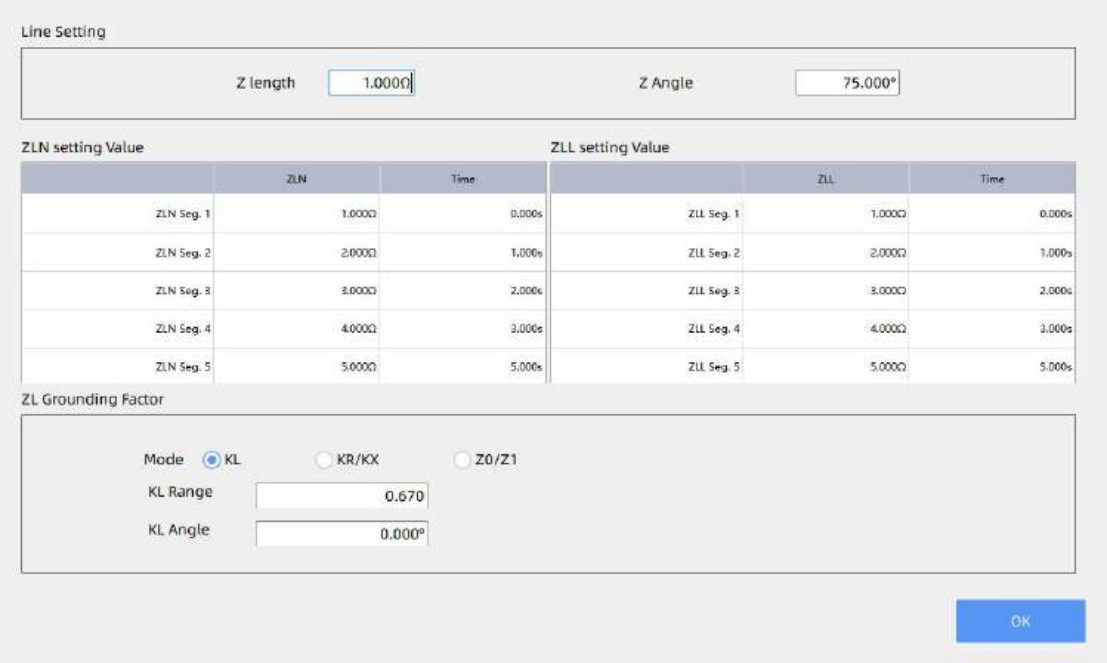
Used for distance protection setting value verification. It can complete multiple test points or a single test point at once, perform multi-section distance protection tests, simulate various L-N, L-L, L-L-L faults in the power system, and simulate directional fault tests for distance protection.

Interface Introduction:



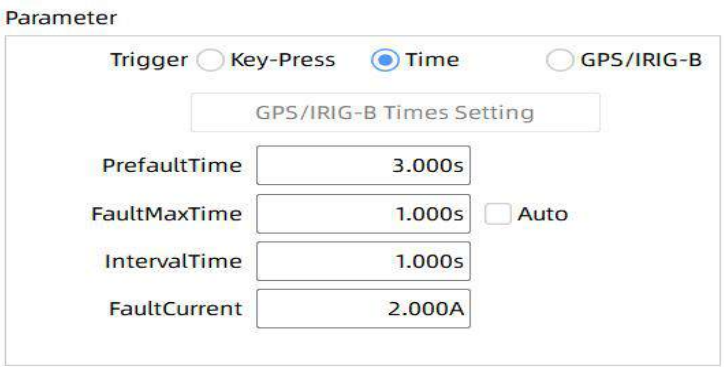
7.2.1 Distance Segment Object Parameter Setting

Before conducting the test, it is necessary use the “Settings” button to define the parameters of the test object.



Line setting	Set line length and line angle.
ZLN setting value	Grounding distance(L-N) zones 1~5 setting value and time
ZLL setting value	Interphase distance (L-L) zones 1~5 setting value and time
ZL Grounding Factor	Zero-sequence compensation coefficient. Different manufacturers use different compensation methods. For example, RCS900 and ISA300 series use KL compensation, while CSL, PSL, and WXB series use KR/KX. Select the appropriate zero-sequence compensation coefficient based on the protection model being tested.

7.2.2 Common parameter settings



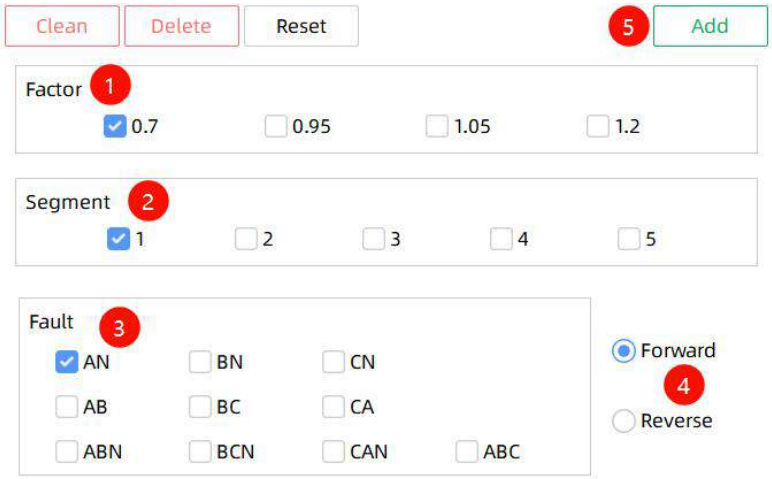
Trigger	Select the fault trigger mode. **Key-Press:** The test enters the fault state only after a key is pressed. Before the key is pressed, the output remains in the prefault state. **Time:** After the test starts, the output remains in the prefault state for a set duration before entering the fault state. **GPS/IRIG-B:** The software triggers synchronization via GPS or IRIG-B, typically

	used for line differential protection or fiber-optic differential protection coordination.
PrefaultTime	Valid when the time trigger mode is selected. Set the prefault output time.
FaultMaxTime	The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.
Auto	When checked, the software automatically adjusts the fault time output to the current distance section setting time.
IntervalTime	After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.
FaultCurrent	The fault test current for all points.

7.2.3 Adding test points

The add test point interface is used to edit and add test points to the test list. The steps are as follows:

1) Check the impedance factor: 0.7x, 0.95x, 1.05x, 1.2x.
2) Check the distance protection segment: I, II, III, IV, V.
3) Select the fault type:
   L-N fault: AN, BN, CN
   L-L-N fault: A-B-N, B-C-N, C-A-N
   L-L fault: AB, BC, CA
   L-L-L fault: ABC
4) Select the fault direction: Forward or Reverse.
5) Click "Add" to add the test point to the test list.



7.2.4 Test list and Result view

No.	Item	Impedance	Fault	Action	Enable
1	1*0.95	1.425Ω	A-N		☑
2	2*0.95	2.375Ω	A-N		☑

No. The sequence number of the current test point. When multiple test points are added, the software switches according to the sequence number.

Item Displays the current distance protection segment and impedance multiple.
For example, "2 * 0.95" indicates the 0.95 times impedance point of the distance protection zone 2 segment.

Impedance The impedance value of the current test point.
Impedance value = Current distance segment setting value × test factor.

Fault Displays the fault type of the current test point.
If the fault is followed by a "*" (e.g., A-N*), it indicates a negative direction. Otherwise, it indicates a positive direction.

Action The protection trip time received by the tester for the current test point.

Enable If checked, the current test point will be tested. If unchecked, the test point will be skipped. This feature is useful for retesting individual points with issues. Use the " All" checkbox to check or uncheck all test points.

7.3 DistanceZm

When a fault-circuit fault occurs in a power system, the fault-circuit current and voltage can be decomposed into prefault load state components and fault-generated components. Relays responding to power frequency variations only consider the fault components and are unaffected by the load state.

Protection Principle:

The power frequency variation distance relay measures the magnitude of the power frequency variation of the operating voltage. Its operating equation is:

$|\Delta Uop| > Uz$

For interphase faults: $UOP\Phi\Phi = U\Phi\Phi - I\Phi\Phi * Z_{ZD}$

$\Phi\Phi = AB, BC, CA$

For ground faults: $UOP\Phi = U\Phi - (I\Phi + K * 3I0) * Z_{ZD}$

$\Phi = A, B, C$

Z_{ZD} is the setting impedance, typically 0.8 to 0.85 times the line impedance.

U_Z is the operating threshold, taken as the memorized prefault operating voltage.

- The power frequency variation impedance relay is essentially an overvoltage relay.
- Due to the unique construction of its operating voltage ΔUop (reflecting both voltage and current changes at the protection installation point), it exhibits the same operating characteristics as an impedance relay.

Since the impedance characteristic boundary of the power frequency variation impedance relay is controlled

by the equivalent impedance Zs on the power supply side, it cannot be tested using conventional impedance relay methods. Instead, it should be treated as an overvoltage relay constructed from current variation$\Delta \dot{I}$

$$\left|\Delta \dot{U}_{op}\right| = m1.05U_N$$

Testing models:

$$\Delta \dot{U}_{op} = \Delta \dot{U} - \Delta \dot{I} \cdot Z_{set} = (\dot{U}_p - \dot{U}_N) - \Delta \dot{I} \cdot Z_{set}$$

Forward Ground Fault:

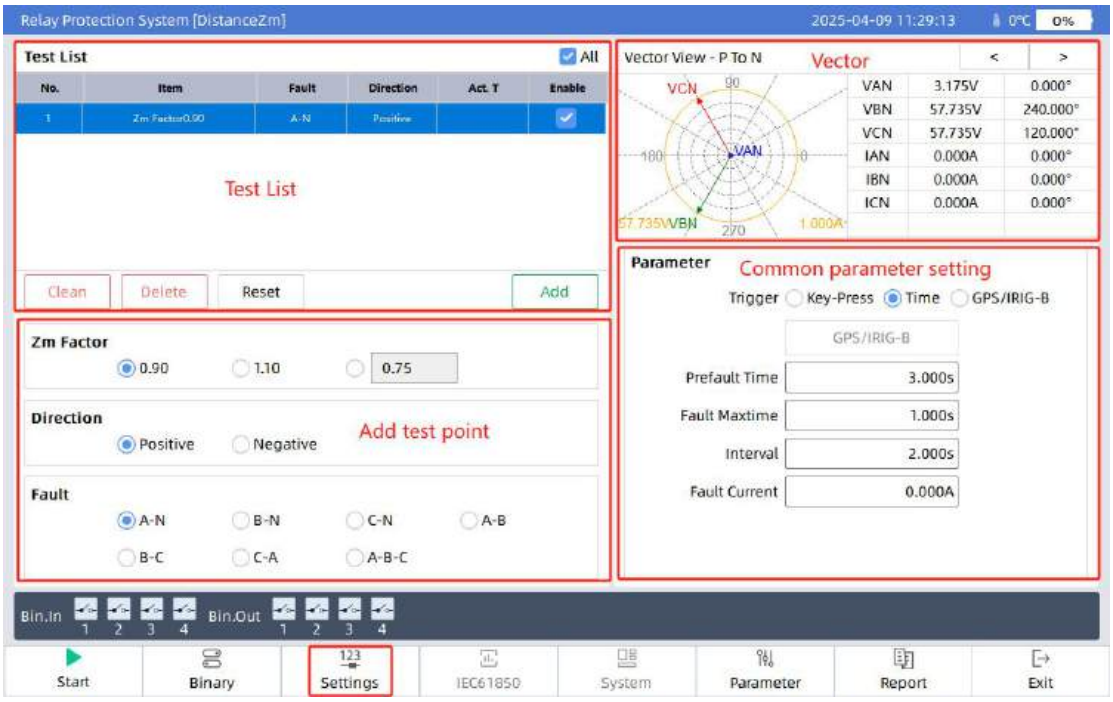
$$U_p = (1+K) \cdot \Delta I_p \cdot Z_{set} + (1-1.05m) * U_N$$

Forward Interphase Fault:

$$U_{pp} = \Delta I_{pp} * Z_{set} + (1-1.05m) * \sqrt{3} U_N$$

Reverse fault: Up, Upp = 0

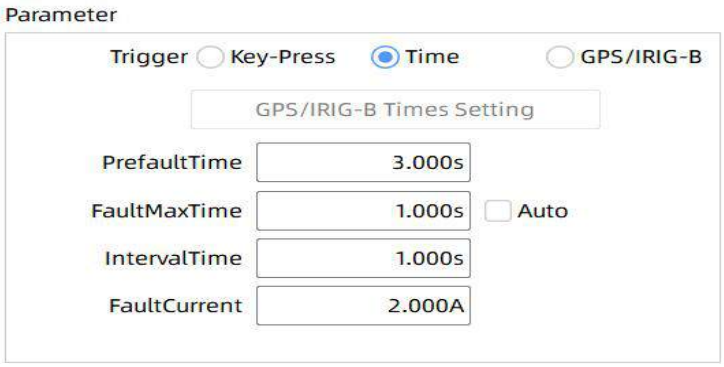
The power frequency variation impedance protection should operate reliably at m = 1.1, not operate at m = 0.9, and measure the operating time at m = 1.2.



7.3.1 DistanceZM Object Parameter Setting

Used for setting values in setting value verification.

7.3.2 Common parameter settings



Trigger Select the fault trigger mode.

Key-Press: The test enters the fault state only after a key is pressed. Before the key is pressed, the output remains in the prefault state.

Time: After the test starts, the output remains in the prefault state for a set duration before entering the fault state.

GPS/IRIG-B: Set the prefault trigger mode to GPS or IRIG B-code trigger. Before triggering, connect the tester to a clock source or GPS antenna for synchronization.

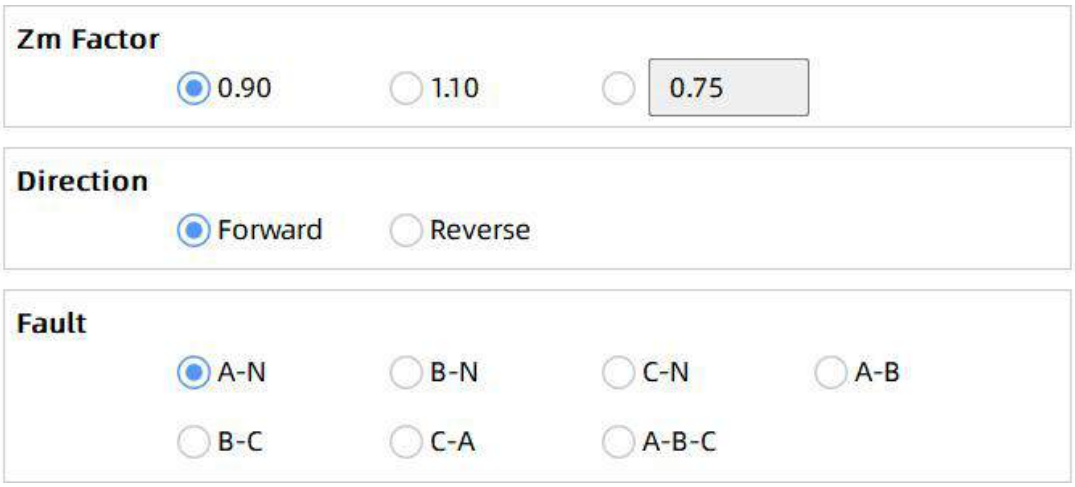
PrefaultTime Valid when the time trigger mode is selected. Set the prefault output time.

FaultMaxTime The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.

IntervalTime After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.

FaultCurrent The fault test current for all points.

7.3.3 Adding Test Points



1) Setting Values: Click "Settings" on the interface to enter the setting value configuration interface.

Note: The setting value names should be configured according to the protection device's setting parameters, used for fault calculation and test reference.

2) Zm factor: Set the power frequency factor multiple. Options include 0.9x, 1.1x, or any custom multiple.
3) Direction: Select the fault direction, either forward or reverse.
4) Fault: Select the fault type: A-N, B-N, C-N, A-B, B-C, C-A, or A-B-C.
5) Add Test Point: After setting the values, Zm factor, fault direction, and fault type, click "Add" to add the test parameters to the test list for testing.

7.3.4 Test list and Result view

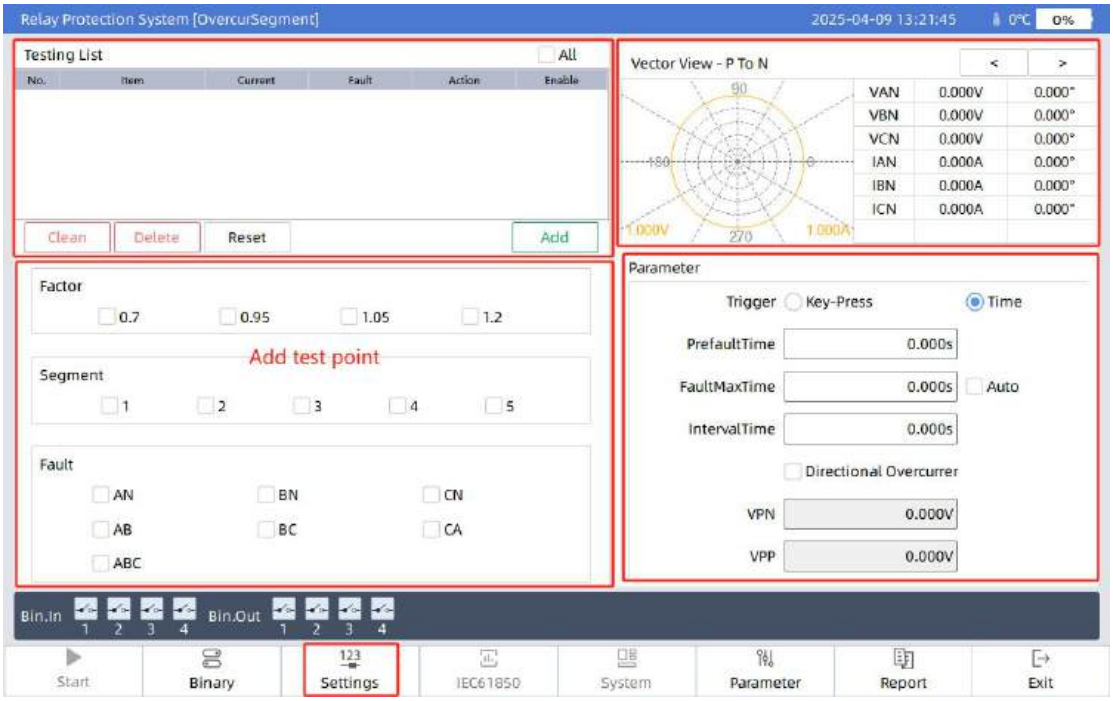
Displays the content of the currently added test points, including the test item (Zm factor), fault type, fault direction, test result action time, and test point checkbox (check "All" to test all points; uncheck to skip a point).

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

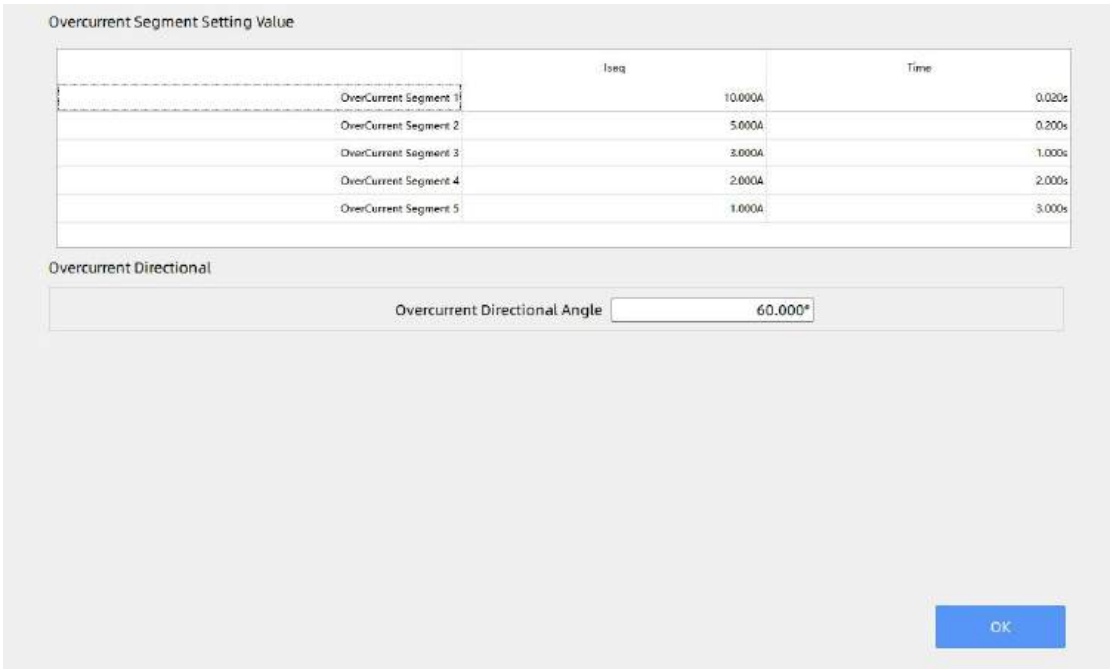
Clean	Clear all test points in the test list.
Delete	Delete the selected test point.
Reset	Clear the test results of the test points.
Add	Add test point(s) to the test list.

7.4 OvercurSegment

This module is a dedicated unit for verifying the setting values of overcurrent protection action values and action times. After setting the parameter values, fault types, overcurrent segment values, and multiples test points can be added with one click.



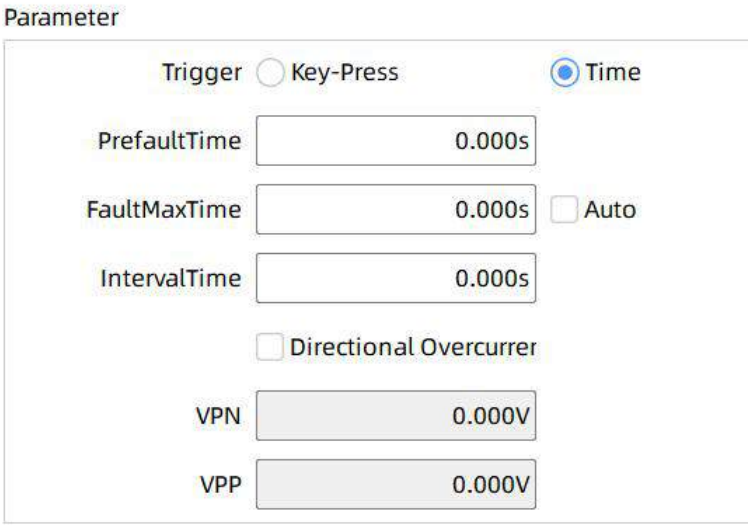
7.4.1 OvercurSegment Object Parameter Setting



Note: The setting values should be configured according to the actual setting values on the protection device. The software will calculate the actual output values and output time based on these setting values.

The setting values include operating current and delay time, also its directional angle.

7.4.2 Common parameter settings



Trigger Select the fault trigger mode.
Key-Press: The test enters the fault state only after a key is pressed. Before the key is pressed, the output remains in the prefault state.
Time: After the test starts, the output remains in the prefault state for a set duration before entering the fault state.

PrefaultTime Valid when the time trigger mode is selected. Set the prefault output time.

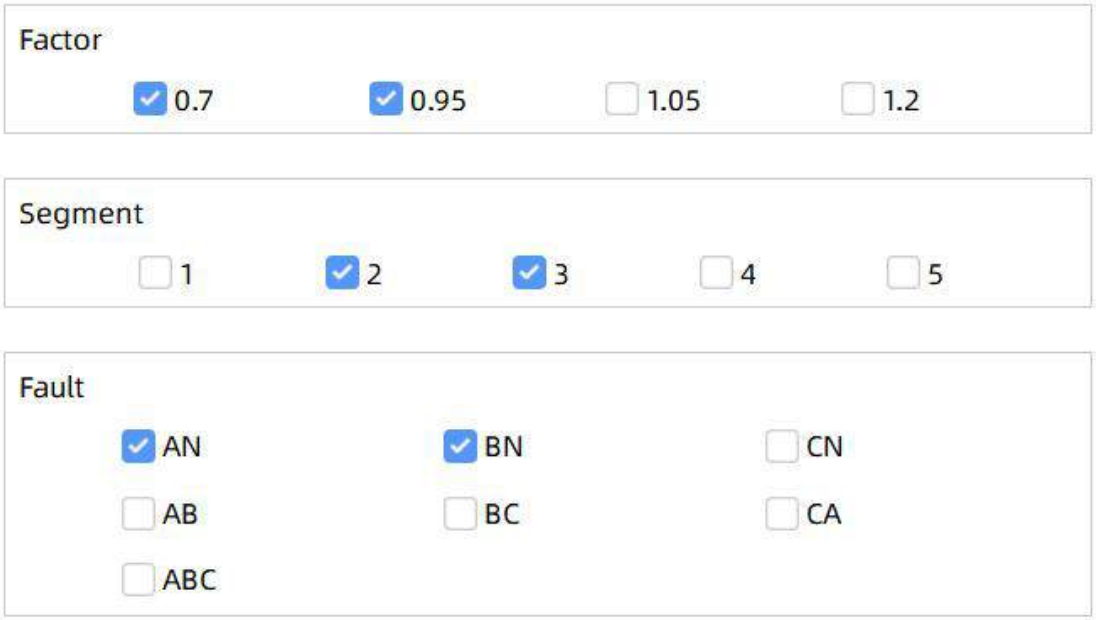
FaultMaxTime The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.

Auto When checked, the software automatically adjusts the fault time output to the current distance section setting time.

IntervalTime After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.

Directional Overcurrent While checked, allow to set the voltage for grounding fault(VPN) or interphase fault (VPP).

7.4.3 Adding Test Points

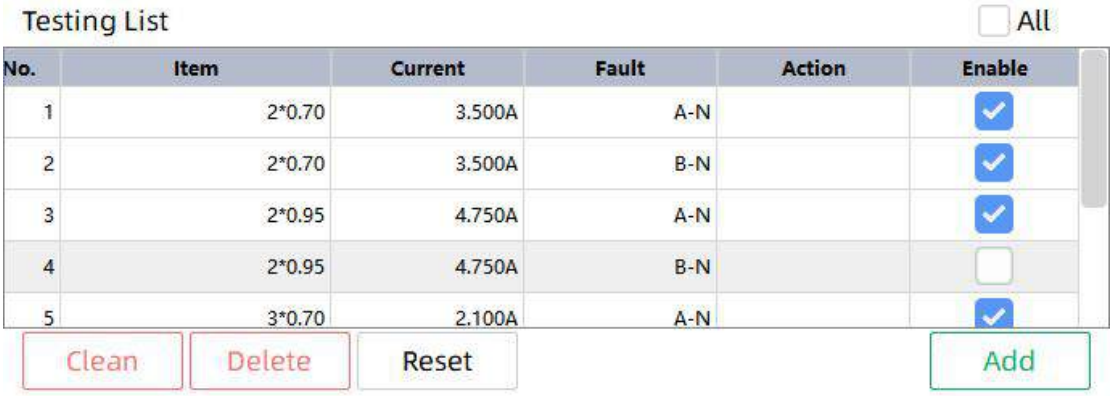


1) **Setting Values**: Click "Settings" on the interface to enter the setting value configuration interface.

Note: The setting value should be configured according to the protection device's setting parameters, used for fault calculation and test reference.

2) **Factor**: Select the overcurrent test factor multiple. Options include 0.7x, 0.95x, 1.05x, and 1.2x.
   0.7x: Outputs 0.7 times the overcurrent segment value, a non-operating point.
   0.95x: Outputs 0.95 times the overcurrent segment value, a reliable non-operating point.
   1.05x: Outputs 1.05 times the overcurrent segment value, a reliable operating point.
   1.2x: Outputs 1.2 times the overcurrent segment value, generally used to test the operating time.
3) **Overcurrent Segment:** Select the overcurrent segment test. A maximum of 5 sections can be tested. Sections can be added separately or selected multiple to add with one click.
4) **Fault:** Select the fault type: AN, BN, CN, AB, BC, CA or ABC. Single or multiple selections are allowed.
5) **Add:** After setting the values, factor, Segment, and fault type, click "Add" to add the test parameters to the test list for testing.

7.4.4 Test list and Result view



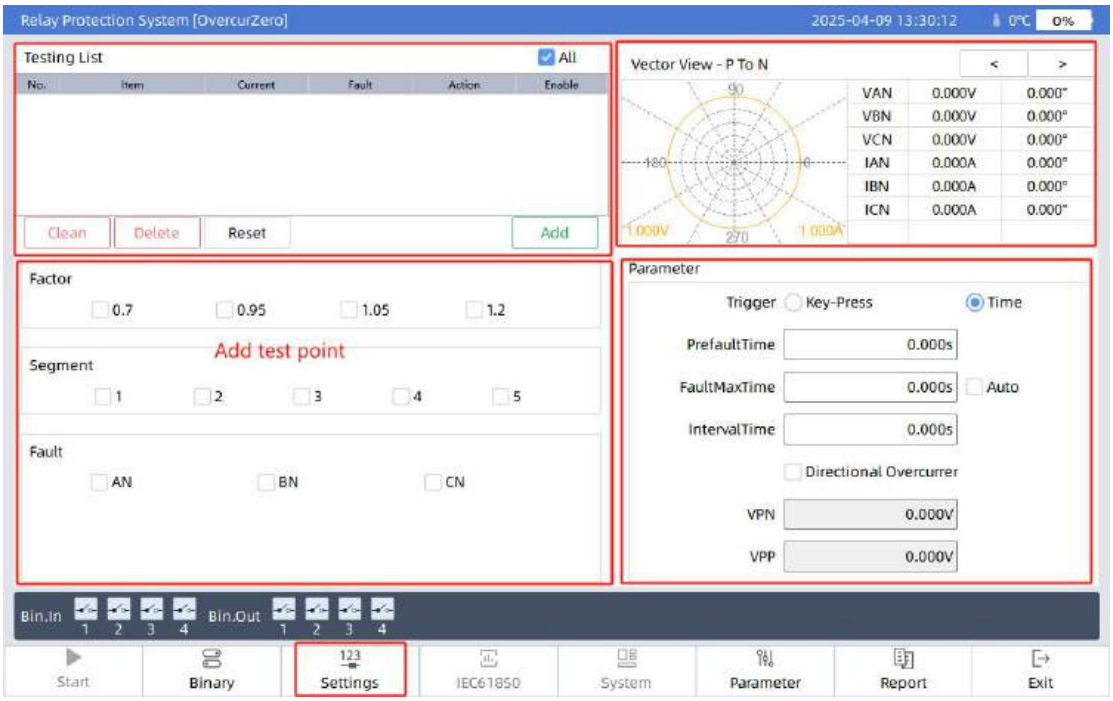
Displays the currently added test points, including the test item (segment and multiple), fault current value,

fault type, action value, and test point checkbox (check "All" to test all points; uncheck to skip a point).
After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

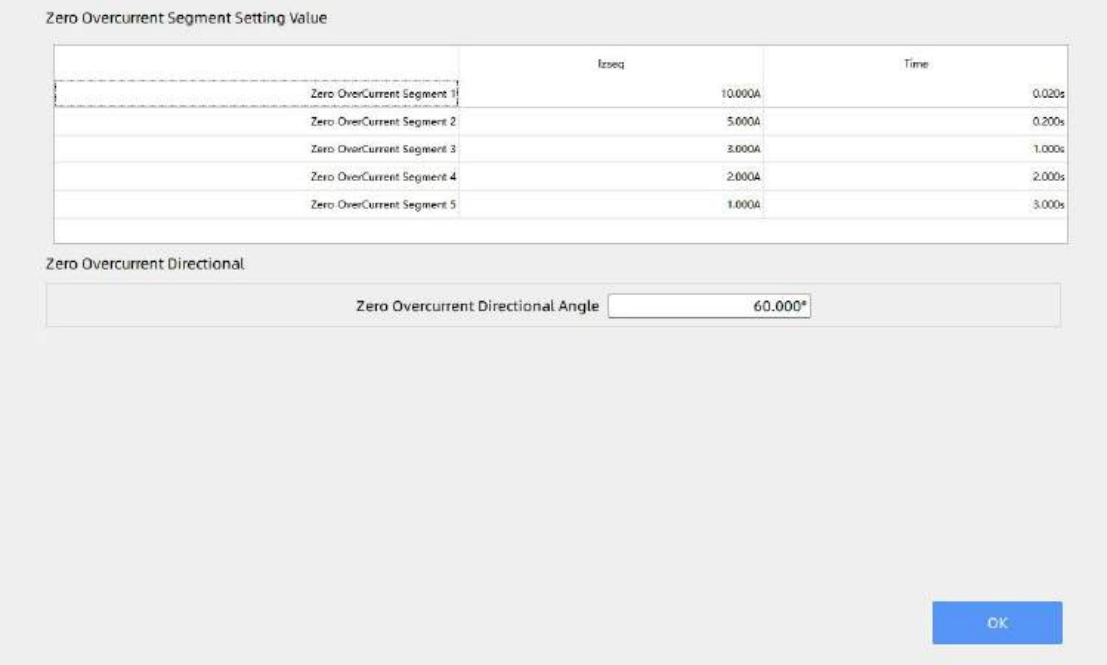
Clean	Clear all test points in the test list.
Delete	Delete the selected test point.
Reset	Clear the test results of the test points.
Add	Add test point(s) to the test list.

7.5 OvercurZero

This module is a dedicated unit for verifying the setting values of zero-sequence protection action values and action times. After setting the parameter values, fault types, zero-sequence section values, and test multiples can be added with one click.



7.5.1 OvercurZero Object Parameter Setting

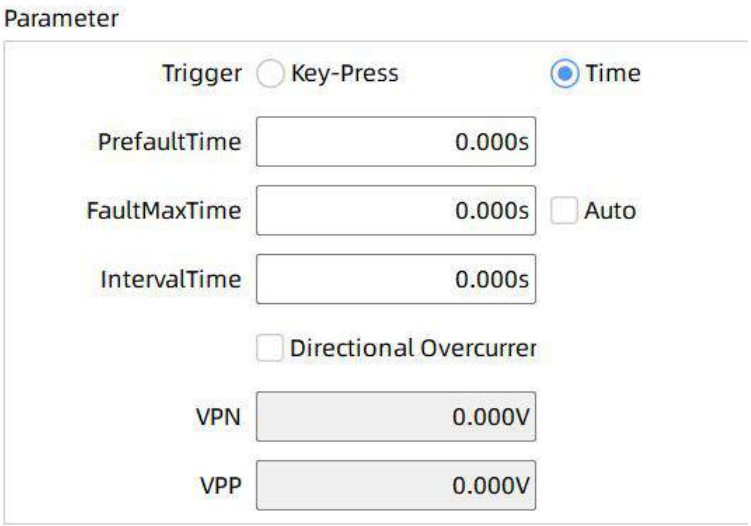


Click "Settings" on the bottom bar of module interface to enter the setting value configuration interface.

Note: The setting values should be configured according to the actual setting values on the protection device. The software will calculate the actual output values and output time based on these setting values.

The setting values include operating current and delay time, also its directional angle.

7.5.2 Common parameter settings



Trigger Select the fault trigger mode.

Key-Press: The test enters the fault state only after a key is pressed. Before the

	key is pressed, the output remains in the prefault state. **Time:** After the test starts, the output remains in the prefault state for a set duration before entering the fault state.
PrefaultTime	Valid when the time trigger mode is selected. Set the prefault output time.
FaultMaxTime	The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.
Auto	When checked, the software automatically adjusts the fault time output to the current distance section setting time.
IntervalTime	After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.
Directional Overcurrent	While checked, allow to set the voltage for grounding fault(VPN) or interphase fault (VPP).

7.5.3 Adding Test Points

1) Setting Values: Click "Settings" on the interface to enter the setting value configuration interface.

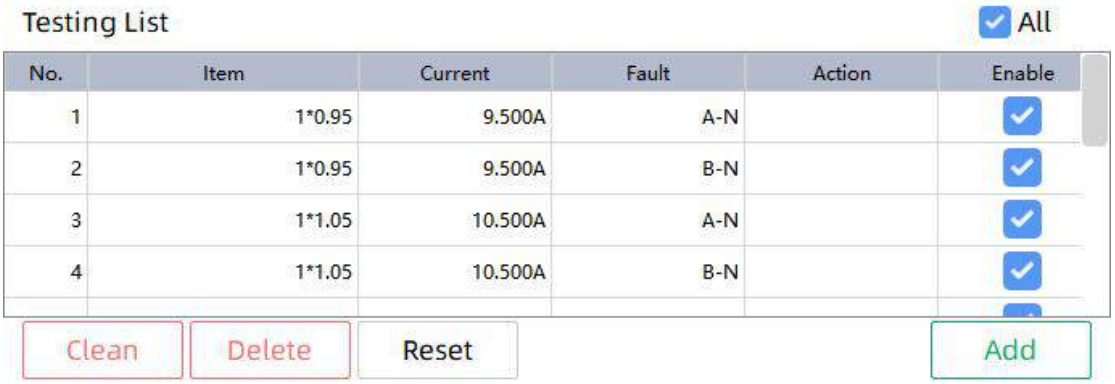
Note: The setting value should be configured according to the protection device's setting parameters, used for fault calculation and test reference.

2) Factor: Set the zero-sequence overcurrent test multiple. Options include 0.7x, 0.95x, 1.05x and 1.2x.
   0.7x: Outputs 0.7 times the zero-sequence overcurrent setting value, a non-operating point.
   0.95x: Outputs 0.95 times the zero-sequence overcurrent setting value, a reliable non-operating point.
   1.05x: Outputs 1.05 times the zero-sequence overcurrent setting value, a reliable operating point.
   1.2x: Outputs 1.2 times the zero-sequence overcurrent setting value, generally used to test the operating time.
3) Segment: Select the zero-overcurrent segment test. A maximum of 5 sections can be tested. Sections can be

added separately or selected multiple to add with one click.

4) Fault: Select the fault type: A-N, B-N, C-N.
5) Add Test Point: After setting the values, factor, segment, and fault type, click "Add" to add the test parameters to the test list for testing.

7.5.4 Test list and Result view



Displays the content of the currently added test points, including the test item, test current, fault type, test result action time, and test point checkbox (check "All" to test all points; uncheck to skip a point).

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

Clean Clear all test points in the test list.

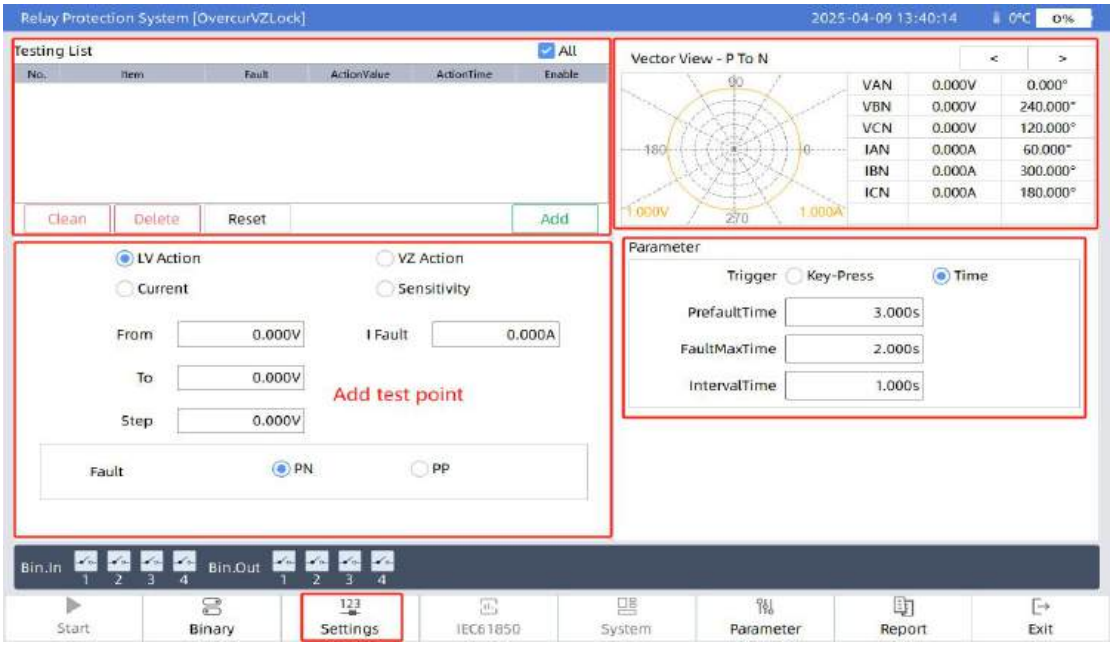
Delete Delete the selected test point.

Reset Clear the test results of the test points.

Add Add test point(s) to the test list.

7.6 OvercurVZLock

The overcurrent with voltage blocking protection function serves as a backup for feeder or transformer protection. It addresses the issue where, under maximum or minimum system operating conditions, the fault current at the line terminal during a two-phase fault-circuit (negative sequence blocking) or three-phase fault-circuit (under voltage blocking) does not reach the quick-break setting value, and the overcurrent delay time is too long. By introducing a composite voltage circuit, the overcurrent action value is reduced. This module can test overcurrent with voltage blocking: under voltage action value, negative sequence voltage action value, current action value, and maximum sensitivity angle.



7.6.1 OvercurVZLock Object Parameter Setting

Click "Settings" on the bottom bar of module interface to enter the setting value configuration interface.

Note: The setting values should be configured according to the actual setting values on the protection device. The software will calculate the actual output values and output time based on these setting values.

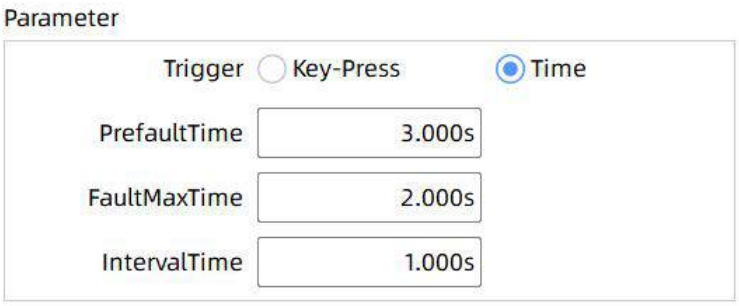
Ufseq Set the negative sequence voltage value for voltage blocking according to the protection device's setting values, used as a reference for test results.

Ulseq Set the low voltage value for voltage blocking according to the protection device's setting values, used as a reference for test results.

Ifseq Set the low current value for voltage blocking according to the protection device's setting values, used as a reference for test results.

Afseq Set the direction angle value for voltage blocking according to the protection device's setting values, used as a reference for test results.

7.6.2 Common parameter settings



Trigger Select the fault trigger mode.
Key-Press: The test enters the fault state only after a key is pressed. Before the key is pressed, the output remains in the prefault state.
Time: After the test starts, the output remains in the prefault state for a set duration before entering the fault state.

PrefaultTime Valid when the time trigger mode is selected. Set the prefault output time.

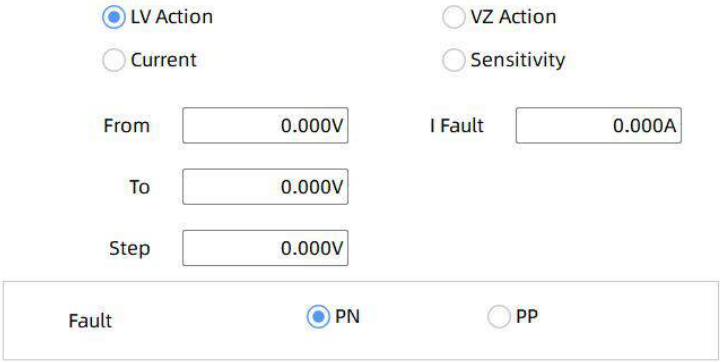
FaultMaxTime The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.

IntervalTime After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.

7.6.3 Adding Test Points

7.6.3.1 LV Action

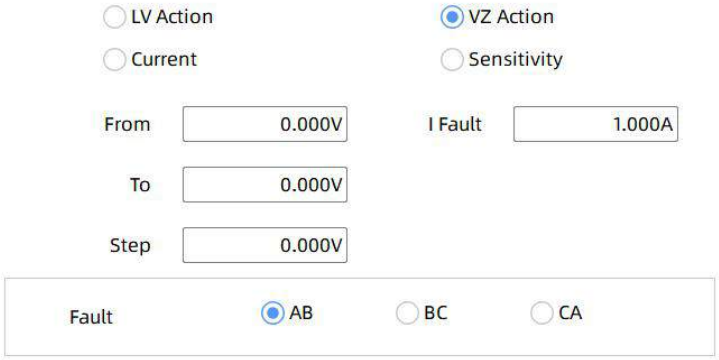
Test the under voltage blocking value for ground faults or Interphase faults using a step-by-step incremental method.



During testing, set the start value to the blocking voltage range and the end value to the non-blocking voltage value. Set the fault current to the fault current setting value or slightly higher. During testing, the software outputs the fault state, starting from the set start value and incrementing according to the set step size until the protection trips.

7.6.3.2 VZ Action

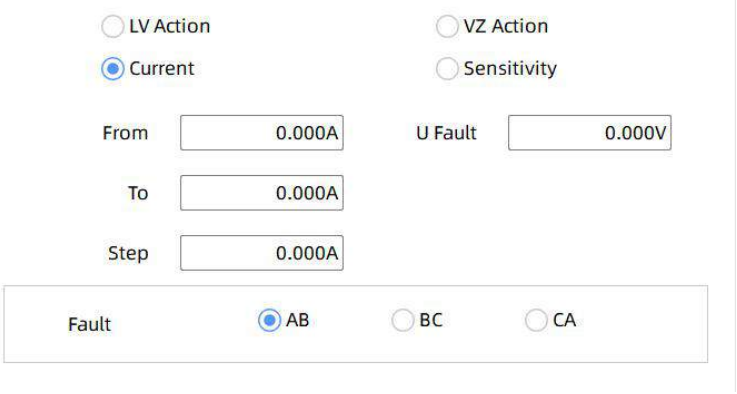
Test the negative sequence voltage action value for Interphase faults using a progressive step adjustment method.



During testing, set the start value to the blocking voltage range and the end value to the non-blocking voltage value. Set the fault current to the fault current setting value or slightly higher. During testing, the software outputs the fault state, starting from the set start value and incrementing according to the set step size until the protection trips.

7.6.3.3 Current

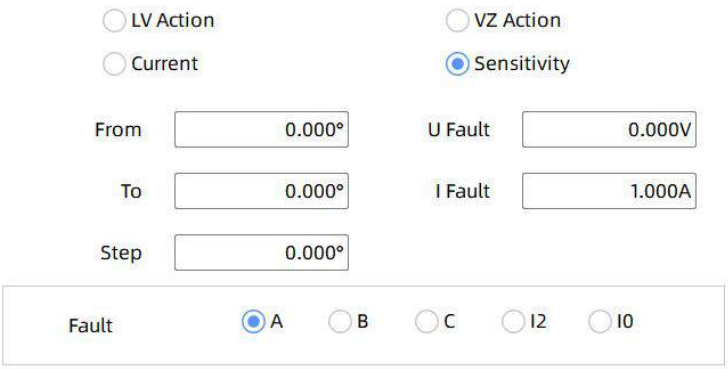
Test the overcurrent action value for Interphase faults using a progressive step adjustment method.



During testing, set the start value to a value below the overcurrent setting and the end value to a value above the overcurrent setting. Set the fault voltage according to the setting values. During testing, the software outputs the fault state, starting from the set start value and incrementing according to the set step size until the protection trips.

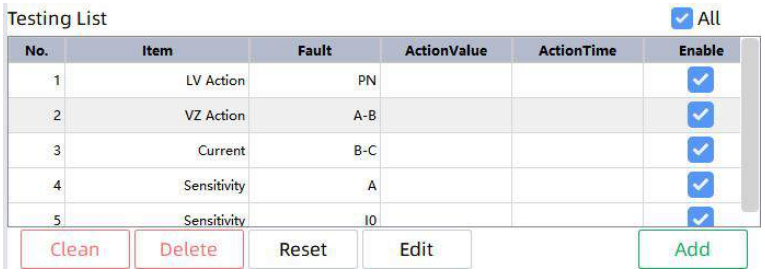
7.6.3.4 Sensitivity

Test the overcurrent voltage blocking action value and maximum sensitivity angle for phase faults using a progressive step adjustment method.



During testing, set the start value to the blocking phase range and the end value to the non-blocking phase value. Set the fault current to the fault current setting value or slightly higher. Set the fault voltage according to the setting values. During testing, the software outputs the fault state, starting from the set start value and incrementing according to the set step size until the protection trips.

7.6.4 Test list and Result view



Displays the currently added test points, including the test item, fault type, action value, action time, and test point checkbox (check "All" to test all points; uncheck to skip the current test point). After testing is completed, the test results will be displayed in the test list.

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

Clean Clear all test points in the test list.

Delete Delete the selected test point.

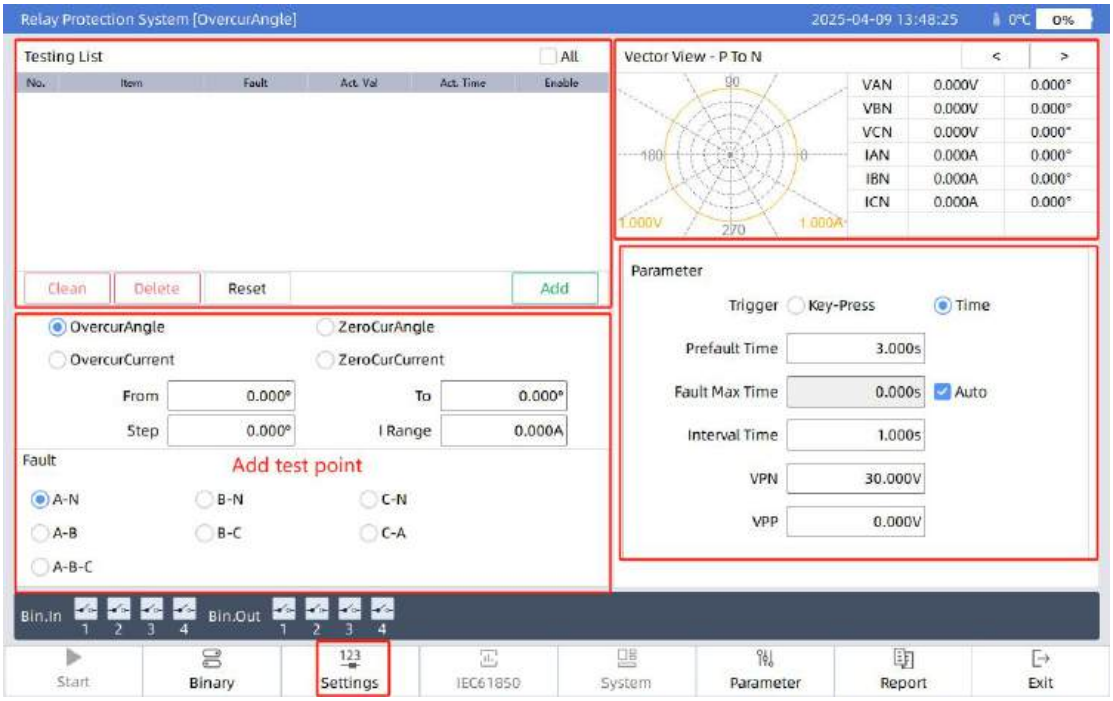
Reset Clear the test results of the test points.

Edit Edit the selected test point.

Add Add test point(s) to the test list.

7.7 OvercurAngle

Used for verifying the setting values of line overcurrent protection, including overcurrent direction angle, overcurrent magnitude, zero-sequence overcurrent angle, and zero-sequence overcurrent magnitude. By setting the start value, end value, and step size, the overcurrent direction angle, zero-sequence overcurrent direction angle, overcurrent magnitude, and zero-sequence overcurrent magnitude can be tested in a scanning manner. Multiple or single test points can be completed at once.



7.7.1 OvercurAngle Object Parameter Setting

Click "Settings" on the bottom bar of module interface to enter the setting value configuration interface.

Note: The setting values should be configured according to the actual setting values on the protection device. The software will calculate the actual output values and output time based on these setting values.

Idoc Set the overcurrent setting value according to the protection device's setting values, used as a reference for test results.

Tdoc Set the overcurrent delay time according to the protection device. When the maximum fault time is set to automatic, this time is used as the reference time for overcurrent test output + 100ms.

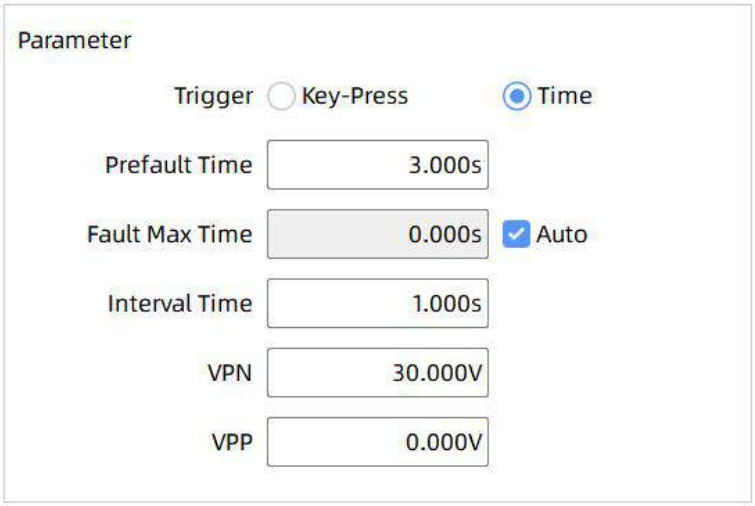
Adoc Set the overcurrent direction angle according to the protection device's setting values, used as a reference for test results.

Idzseq Set the zero-sequence current setting value according to the protection device's setting values, used as a reference for test results.

Tdzseq Set the zero-sequence overcurrent delay time according to the protection device. When the maximum fault time is set to automatic, this time is used as the reference time for zero-sequence test output + 100ms.

Adzseq Set the zero-sequence current setting value according to the protection device's setting values, used as a reference for test results.

7.7.2 Common parameter settings



Trigger Select the fault trigger mode.
Key-Press: The test enters the fault state only after a key is pressed. Before the key is pressed, the output remains in the prefault state.
Time: After the test starts, the output remains in the prefault state for a set duration before entering the fault state.

PrefaultTime Valid when the time trigger mode is selected. Set the prefault output time.

FaultMaxTime The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.

Auto When checked, the software automatically adjusts the fault time output to the current distance section setting time.

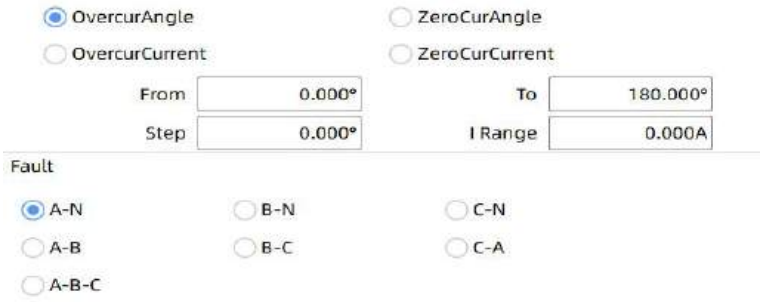
IntervalTime After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.

VPN & VPP The voltage for grounding fault(VPN) or interphase fault (VPP).

7.7.3 Adding Test Points

7.7.3.1 OvercurAngle

Test the overcurrent direction angle.



From Set the start value for overcurrent angle testing. The test process ensures the protection device transitions from non-operation to operation, so the start value is generally set to a non-operating point. The value is then incremented according to the step size until the protection trips.

To Generally set to the operating zone angle of the protection device. The tester outputs from the start value and increments according to the step size until the protection trips.

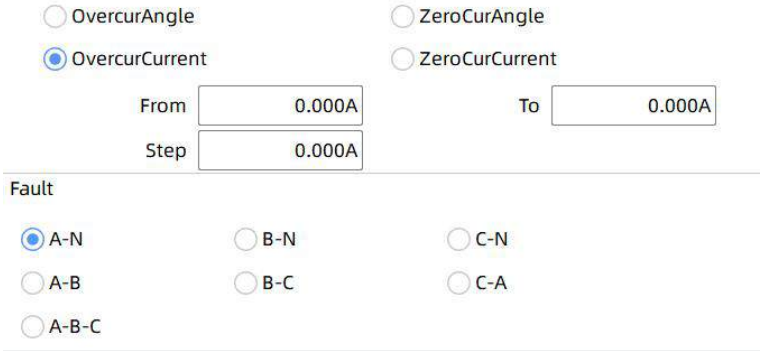
Step The angle step size for overcurrent direction scanning. A smaller value increases test accuracy but requires more time. Generally, the step size is set to 0.1°.

I Range Set to the fault-circuit fault current setting value of the protection device to ensure the overcurrent fault action is triggered.

Fault The fault type can be select.

7.7.3.2 OvercurCurrent

Test the overcurrent setting value.



From Set the start value for overcurrent testing. The test process ensures the protection device transitions from non-operation to operation, so the start value is generally set to a non-operating point. The value is then incremented according to the step size until the protection trips.

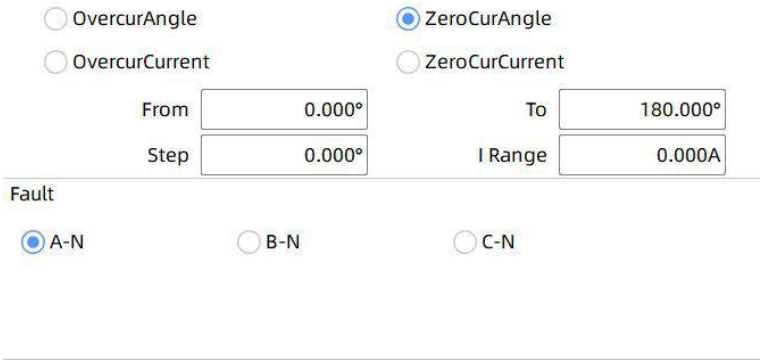
To Generally set to a value greater than the overcurrent setting value of the protection device. The tester outputs from the start value and increments according to the step size until the protection trips.

Step The current step size for overcurrent testing. A smaller value increases test accuracy but requires more time. Generally, the step size is set to 0.1A.

Fault The fault type can be select.

7.7.3.3 ZeroCurAngle

Test the zero-sequence overcurrent direction angle.



From Set the start value for zero-sequence overcurrent angle testing. The test process ensures the protection device transitions from non-operation to operation, so the start value is generally set to a non-operating point. The value is then incremented according to the step size until the protection trips.

To Generally set to the operating zone angle of the protection device. The tester outputs from the start value and increments according to the step size until the protection trips.

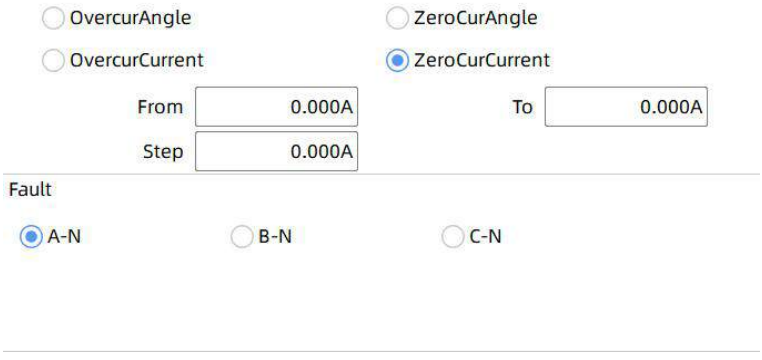
Step The angle step size for zero-sequence overcurrent direction scanning. A smaller value increases test accuracy but requires more time. Generally, the step size is set to 0.1°.

I Range Set to the fault-circuit zero-sequence overcurrent setting value of the protection device to ensure the overcurrent fault action is triggered.

Fault The fault type can be select.

7.7.3.4 ZeroCurCurrent

Test the zero-sequence overcurrent value.



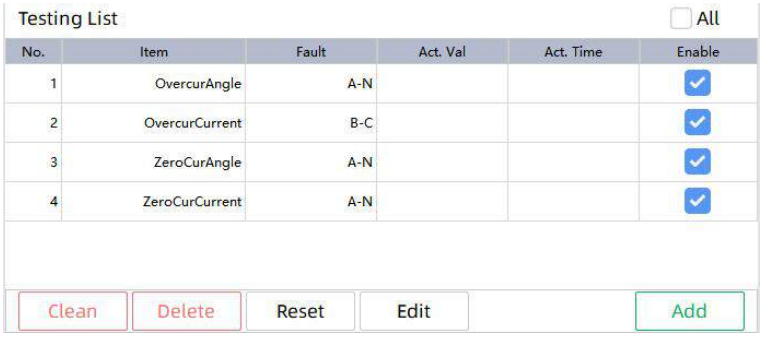
From Set the start value for zero-sequence overcurrent testing. The test process ensures the protection device transitions from non-operation to operation, so the start value is generally set to a non-operating point. The value is then incremented according to the step size until the protection trips.

To Generally set to a value greater than the zero-sequence overcurrent setting value of the protection device. The tester outputs from the start value and increments according to the step size until the protection trips.

Step The current step size for zero-sequence overcurrent testing. A smaller value increases test accuracy but requires more time. Generally, the step size is set to 0.1A.

Fault The fault type can be select.

7.7.4 Test list and Result view



Displays the currently added test points, including the test item, fault type, action value, action time, and test point checkbox (check "All" to test all points; uncheck to skip the current test point). After testing is completed, the test results will be displayed in the test list.

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

Clean Clear all test points in the test list.

Delete Delete the selected test point.

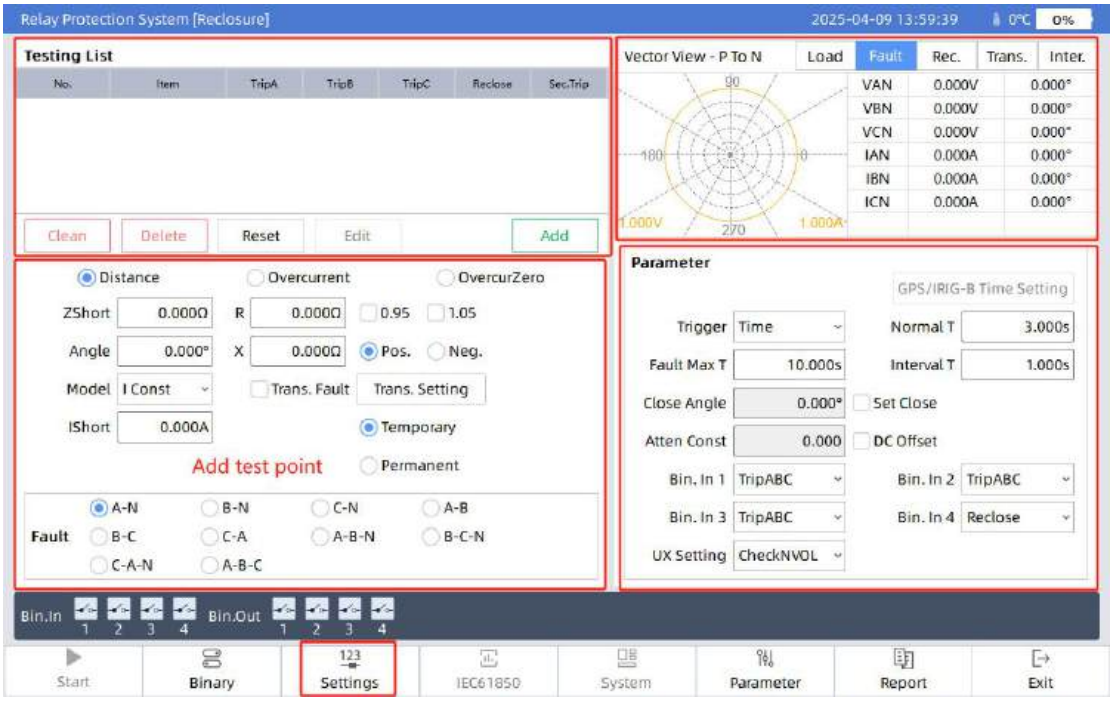
Reset Clear the test results of the test points.

Edit Edit the selected test point.

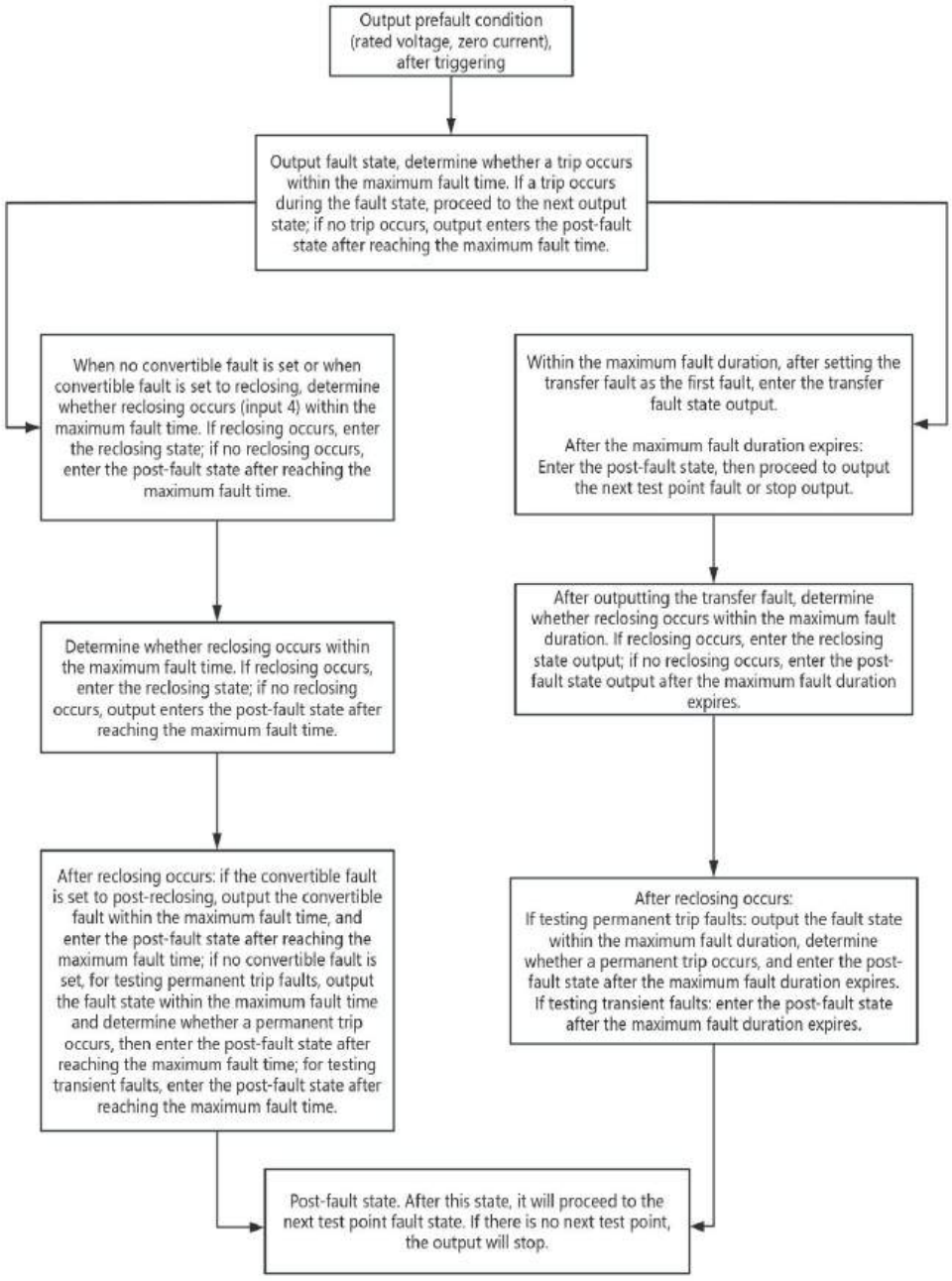
Add Add test point(s) to the test list.

7.8 Reclousure

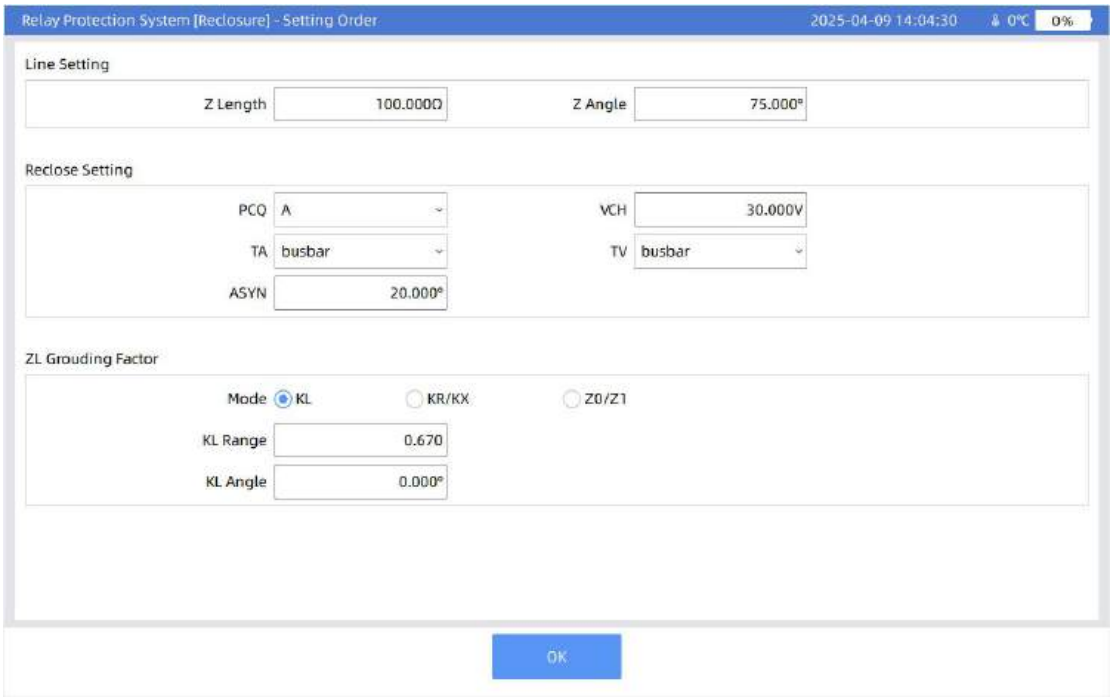
This test module is primarily used for integrated testing or setting value verification of overcurrent, distance, zero-sequence protection devices, and reclosing. It can control the closing angle during faults, superimpose a DC component that decays according to a time constant at the instant of the fault, and is used to test the transient overreach of measuring relays. It can also set the magnitude and phase of the line extraction voltage to verify the synchronization check or voltage check for line protection reclosing. Additionally, it can complete line-end coordination testing through GPS synchronization.



Software Testing Process:


Output prefault condition (rated voltage, zero current), after triggering
Output fault state, determine whether a trip occurs within the maximum fault time. If a trip occurs during the fault state, proceed to the next output state; if no trip occurs, output enters the post-fault state after reaching the maximum fault time.
When no convertible fault is set or when convertible fault is set to reclosing, determine whether reclosing occurs (input 4) within the maximum fault time. If reclosing occurs, enter the reclosing state; if no reclosing occurs, enter the post-fault state after reaching the maximum fault time.
Within the maximum fault duration, after setting the transfer fault as the first fault, enter the transfer fault state output.
After the maximum fault duration expires: Enter the post-fault state, then proceed to output the next test point fault or stop output.
Determine whether reclosing occurs within the maximum fault time. If reclosing occurs, enter the reclosing state; if no reclosing occurs, output enters the post-fault state after reaching the maximum fault time.
After outputting the transfer fault, determine whether reclosing occurs within the maximum fault duration. If reclosing occurs, enter the reclosing state output; if no reclosing occurs, enter the post-fault state output after the maximum fault duration expires.
After reclosing occurs: if the convertible fault is set to post-reclosing, output the convertible fault within the maximum fault time, and enter the post-fault state after reaching the maximum fault time; if no convertible fault is set, for testing permanent trip faults, output the fault state within the maximum fault time and determine whether a permanent trip occurs, then enter the post-fault state after reaching the maximum fault time; for testing transient faults, enter the post-fault state after reaching the maximum fault time.
After reclosing occurs:
If testing permanent trip faults: output the fault state within the maximum fault duration, determine whether a permanent trip occurs, and enter the post-fault state after the maximum fault duration expires.
If testing transient faults: enter the post-fault state after the maximum fault duration expires.
Post-fault state. After this state, it will proceed to the next test point fault state. If there is no next test point, the output will stop.

7.8.1 Reclosure Object Parameter Setting

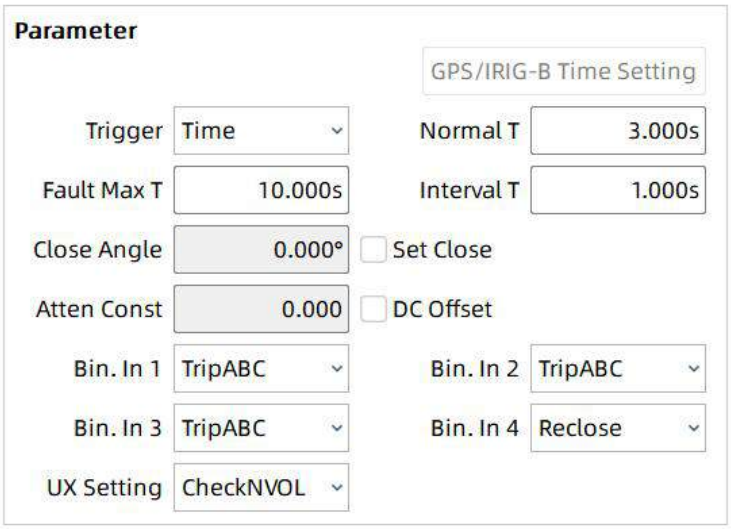


Click "Settings" on the bottom bar of module interface to enter the setting value configuration interface.

Note: The setting values should be configured according to the actual setting values on the protection device. The software will calculate the actual output values and output time based on these setting values.

Line Setting	Set Line Length and Line Impedance Angle, These parameters are used in the calculation of output values when testing distance protection with constant impedance.
Reclose Setting	**PCQ:** Can be set to A-phase, B-phase, or C-phase as the reference voltage. **VCH:** Set the voltage check setting value. **ASYN:** Set the synchronization check angle value. **TA Position:** Can be set to the line side or busbar side. When the TA is on the line side, IA, IB, and IC are the polarity terminals, and IN is the non-polarity terminal. When the TA is on the busbar side, IA, IB, and IC are the polarity terminals, and IN is the non-polarity terminal. **TV Position:** Can be set to the busbar side or line side. When the tester receives a trip signal, if the TV is installed on the busbar side, the tripped phase voltage returns to the normal value. If the TV is installed on the line side, the tripped phase has no voltage output.
ZL Grounding Factor	Three compensation methods can be set: **KL**: (KL amplitude, KL angle), **RX/KX**: (KR amplitude, KX amplitude), **Z0/Z1**: (Z0/Z1 amplitude, Z0/Z1 angle)

7.8.2 Common parameter settings



Trigger Select the fault trigger mode.

Key-Press: The test enters the fault state only after a key is pressed. Before the key is pressed, the output remains in the prefault state.

Time: After the test starts, the output remains in the prefault state for a set duration before entering the fault state.

GPS/IRIG-B: The software triggers synchronization via GPS or IRIG-B.

Normal T Valid when the time trigger mode is selected. Set the prefault output time.

Fault Max T The hold time for fault state output. If the tester receives a protection trip signal, it will end the fault state and transition to the next state. If no trip signal is received, the fault state will continue for the hold time.

Interval T After the fault state ends (either due to a protection trip or the hold time expiring), the output transitions to the Interval state, where the tester has no output, generally referring to the contact reset time.

Close Angle Set the closing angle while checked the "Set Closing" option.

The close angle is the phase angle of the reference phase voltage at the instant of the fault. It directly affects the initial value of the non-periodic voltage and current components. Since the three-phase voltages and currents are not in phase, the closing angle is related to the fault type. The selected voltage reference phase is as shown in the table below:

Fault type	Reference phase
A-N, AB-N, A-B-C	UA
B-N, BC-N	UB
C-N, CA-N	UC
A-B	UA-UB
B-C	UB-UC
C-A	UC-UA

Atten Const

set the value of the superimposed DC component while checked the “DC Offset” option.

When setting up a superimposed non-periodic component, there is an attenuated DC component superimposed on the sinusoidal signal at the instant of fault initiation. Where.

DC current component: $i_{DC}(t) = -I_{perm} Sin(\alpha - \varphi_k) e^{-\frac{t}{\tau}}$

DC voltage component: $v_{DC}(t) = i_{DC}(t) \cdot R_L (1 - \frac{\tau_L}{\tau})$

Formula : $$\tau = \frac{L_S + L_L}{R_L + R_S}$$

Iperm——— The maximum value of the steady-state short-circuit current

$\varphi_K = z(z = z_L + z_S)$ Impedance angle

$$\tau_L = \frac{L_L}{R_L}$$

α ——— Fault start angle (closing angle) (-90°-90°)

φK ——— Short-circuit current, phase angle between voltages

$Z_L = R_L + jX_L$ Short-circuit impedance

$Z_S = R_S + jX_S$ Impedance on the power supply (system) side

If the line impedance angle equals the system impedance angle, there is no decaying DC voltage component at this time. When the calculation mode is selected as constant voltage or constant current mode, there is also no DC voltage component. While the “DC Offset” option unchecked, since the current and voltage values are manually set, the influence of non-periodic components is not considered in the calculation. The initial magnitude of the non-periodic voltage and current components is related to the moment when the short circuit occurs, that is, related to the initial phase angle (close angle) of the power supply voltage when the short circuit occurs.

UX Setting

The working mode of UX can be set, and the options are: none, CheckNVOL, and CheckASYN.

Note: If the UX setting is selected as the no-voltage check mode, taking "CheckNVOL A" as an example, the output process of UX is as follows: before the fault until after the reclosing, UX outputs equal the UA voltage.

Bin.In 1

Can be set to trip A or trip ABC (selected for two-phase/three-phase faults), connected to the trip output contact of the protection device, compatible with dry contacts and 12...300V potential contacts.

Bin.In 2

Can be set to trip B or trip ABC (selected for two-phase/three-phase faults), connected to the trip output contact of the protection device, compatible with dry contacts and 12...300V potential contacts.

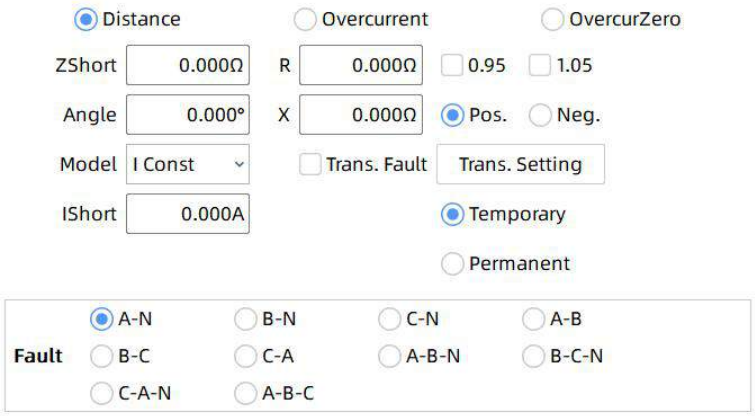
Bin.In 3 Can be set to trip C or trip ABC (selected for two-phase/three-phase faults), connected to the trip output contact of the protection device, compatible with dry contacts and 12...300V potential contacts.

Bin.In 4 Set as the reclosing output contact, connected to the reclosing output contact of the protection device.

GPS or IRIG-B time setting When the trigger mode is selected as GPS or IRIG-B code, this button is activated. After clicking, you can enter the setting interface. After the tester is synchronized, the trigger time point can be set. (This method requires the tester to be connected to a clock source for synchronization.)

7.8.3 Adding Test Points

7.8.3.1 Distance



For distance testing, the following parameters need to be set:

ZShort The R and X values can be determined by setting the |Z| value and angle, or the |Z| value and angle can be determined by setting the R and X values.

0.95 or 1.05 These are multiples for distance testing. 0.95 indicates reliable operation, and 1.05 indicates reliable non-operation.

Pos. Or Neg. Set the distance protection direction to forward or reverse based on the actual protection device configuration.

Model Includes constant current, constant voltage, and constant impedance.

a) **I Const (Commonly Used):** Set the constant fault current value. The fault voltage is calculated based on the constant current and impedance (zero-sequence compensation coefficient is required for single-phase ground distance calculation). If the calculated fault phase voltage exceeds 0.9 times the rated voltage, the software automatically reduces the fault-circuit current value.

b) **V Const:** Set the constant fault voltage value. The fault current is calculated based on the constant voltage and impedance (zero-sequence compensation coefficient is required for single-phase

ground distance calculation). If the calculated fault phase current exceeds the maximum current, the software automatically reduces the fault-circuit voltage value.

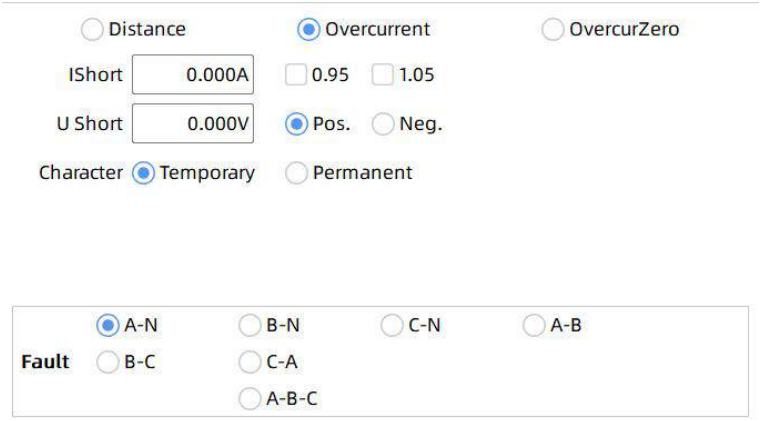
c) **Z Const (System):** Set the system impedance |Z| and angle, or R and X. The fault voltage and current are automatically calculated by the software based on the system impedance and fault-circuit impedance. If the calculated fault phase voltage exceeds 0.9 times the rated voltage or the calculated fault phase current exceeds the maximum current, the software automatically increases the system impedance.

Temporary When the protection trips, the fault disappears. If the protection recloses, the system returns to the pre-fault normal state, with phase voltages and currents equal to the pre-fault values.

Permanent When the protection trips, the fault persists. If the protection recloses, the system re-enters the fault state, with phase voltages and currents equal to the fault values. The protection will trip again (permanent trip), usually with accelerated tripping.

Fault Set the fault type. Distance protection includes fault types such as A-N, B-N, C-N, A-B, B-C, C-A, A-B-N, B-C-N, C-A-N, and A-B-C.

7.8.3.2 Overcurrent



Parameters to be set for overcurrent testing include:

IShort Set the protection current value based on the overcurrent protection setting of the protection device.

UShort Set the fault-circuit voltage value based on the protection device's fault-circuit voltage setting. If no fault voltage is required, this can be left unset.

0.95 or 1.05 Set the output multiple of the fault-circuit current. 0.95 indicates 0.95 times the fault-circuit current (reliable non-operation), and 1.05 indicates 1.05 times the fault-circuit current (reliable operation).

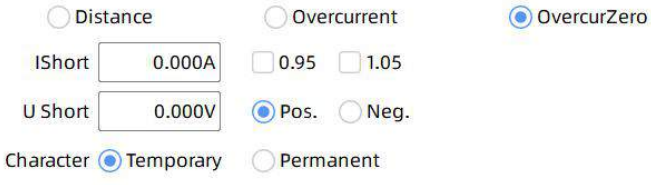
Pos. Or Neg. Set the protection direction to forward or reverse based on the actual protection

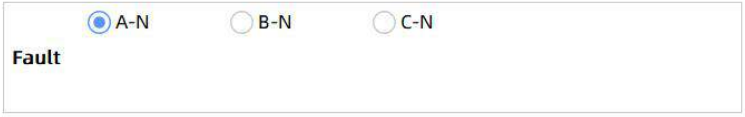
device configuration.

Character Temporary fault or permanent fault (used to test permanent trip time).

Fault Fault types include A-N, B-N, C-N, A-B, B-C, C-A, and A-B-C.

7.8.3.3 OvercurZero





Parameters to be set for zero-sequence testing include:

IShort Set the protection current value based on the overcurrent zero-sequence protection setting of the protection device.

UShort Set the fault-circuit voltage value based on the protection device's fault-circuit voltage setting. If no fault voltage is required, this can be left unset.

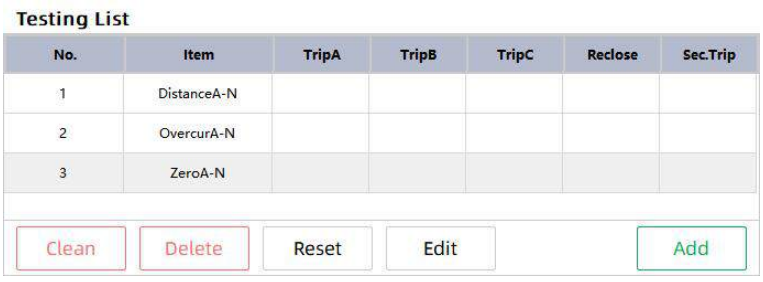
0.95 or 1.05 Set the output multiple of the fault-circuit current. 0.95 indicates 0.95 times the fault-circuit current (reliable non-operation), and 1.05 indicates 1.05 times the fault-circuit current (reliable operation).

Pos. Or Neg. Set the protection direction to forward or reverse based on the actual protection device configuration.

Character Temporary fault or permanent fault (used to test permanent trip time).

Fault Fault types include A-N, B-N, C-N.

7.8.4 Test list and Result view



Displays the currently added test points, including the test item, fault type, action time, and test point checkbox (check "All" to test all points; uncheck to skip the current test point). After testing is completed, the

test results will be displayed in the test list.

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

Clean	Clear all test points in the test list.
Delete	Delete the selected test point.
Reset	Clear the test results of the test points.
Edit	Edit the selected test point.
Add	Add test point(s) to the test list.

7.9 Slip Frequency

This module is mainly for frequency slip related tests.

For regular tests that involve only frequency amplitude as variables, please use the AC test or Ramping modules for testing.

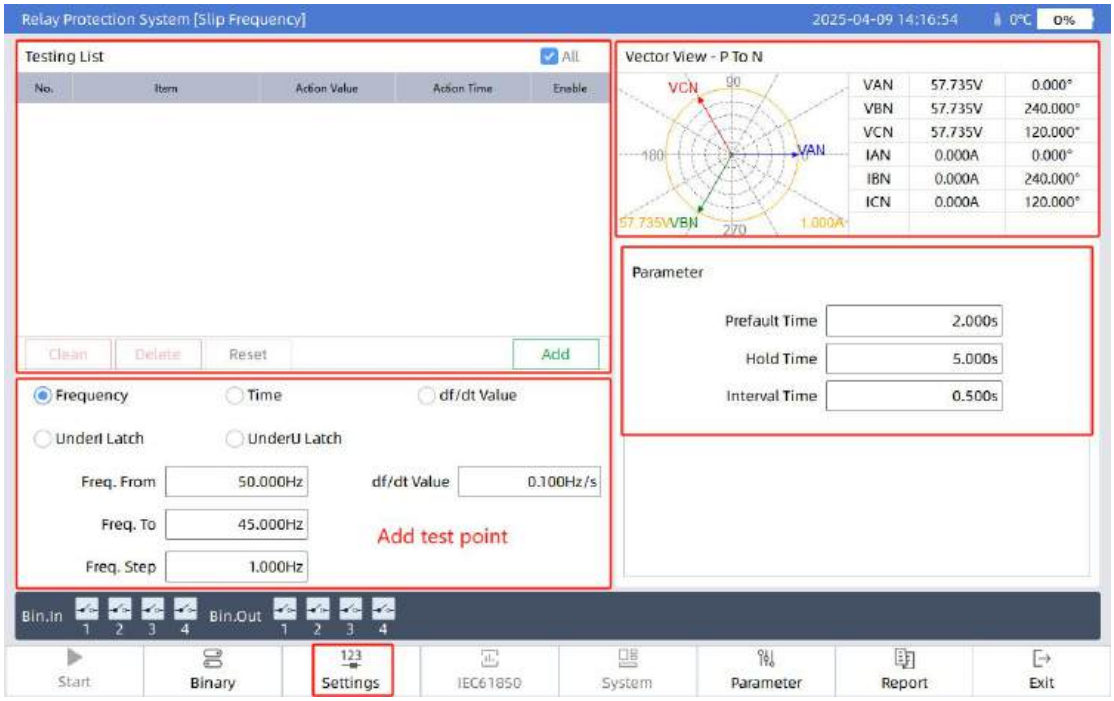
General:

Depending on the test item, there may be only one or multiple test cycles. In each test cycle, a prefault state, a hold state and a reset state are fixedly inserted;

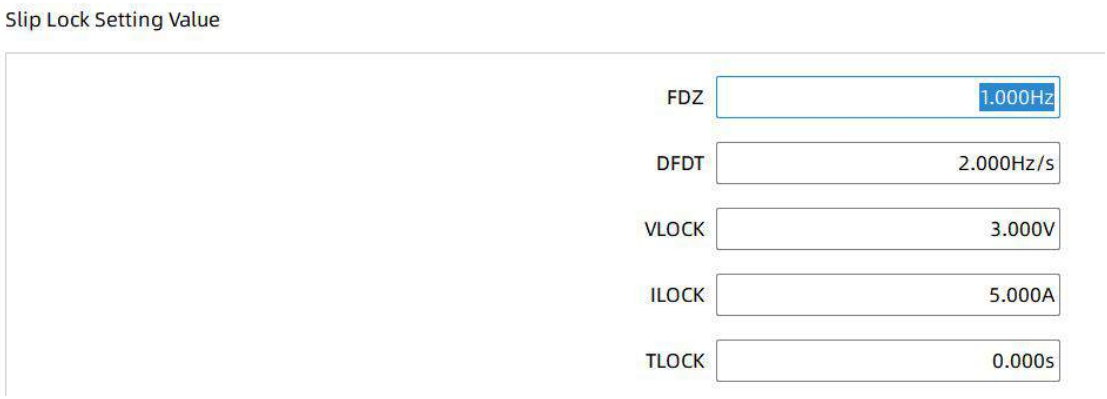
In the prefault state, the tester outputs the rated voltage and rated frequency with a current value of 0;

In the reset state(fault interval), the tester has no output.

The output value of the hold state is dynamic; in each test cycle, the output is fixedly maintained for a certain duration when the variable reaches its endpoint, and this period is referred to as the hold state. If the protective device has an action delay setting, then the duration of the hold state must be set longer than the action delay setting of the protective device.



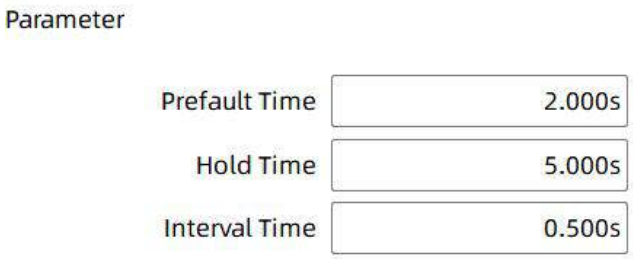
7.9.1 Slip Frequency Object Setting Value



Click to enter the setting value interface, where you can set the protection device's setting values to verify the test results.

7.9.2 Common Parameter setting

Common parameter



Prefault Time Define the duration of the prefault state.

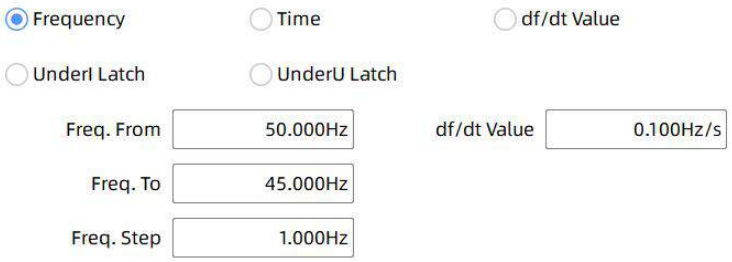
Hold Time Define the duration of the hold state.

Interval Time Define the duration of the fault interval state.

This parameters is globally valid in this module.

7.9.3 Test Item

7.9.3.1 Frequency



Test the frequency response at specific df/dt values.

Testing Process **The F.scan is variable in this test module.**

The testing will be automatically conducted in multiple cycles. In each

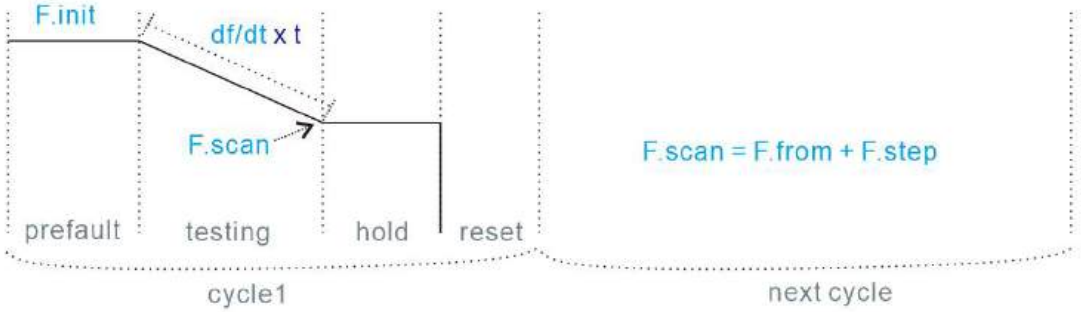
cycle, the frequency will smoothly transition from the initial frequency to the F.scan at a rate defined by df/dt until the protective device activates.

At the start of each test cycle, the initial frequency is set to the rated frequency value.

Within each test cycle, the F.scan will automatically change based on the definitions of Freq.From, Freq.To, and Freq.Step.

Thus, Freq.From must be set within the range where the protective device does not activate, while Freq.To must be set within the range where the protective device reliably activates. This will enable the determination of the frequency threshold for the protective device's activation.

It must also be ensured that the df/dt value does not cause the protective device to block.



Where the t is calculated by the software.

Frequency Trip Test Setting Parameters:

Freq.From , Freq.To Define the range of scanning frequency.

Freq.Step Define the increment or decrement of scanning frequency after each test cycle.

df/dt value: Define the sliding rate of frequency.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.9.3.2 Time

Test the operating time of the protection device at specific frequency df/dt and action values.

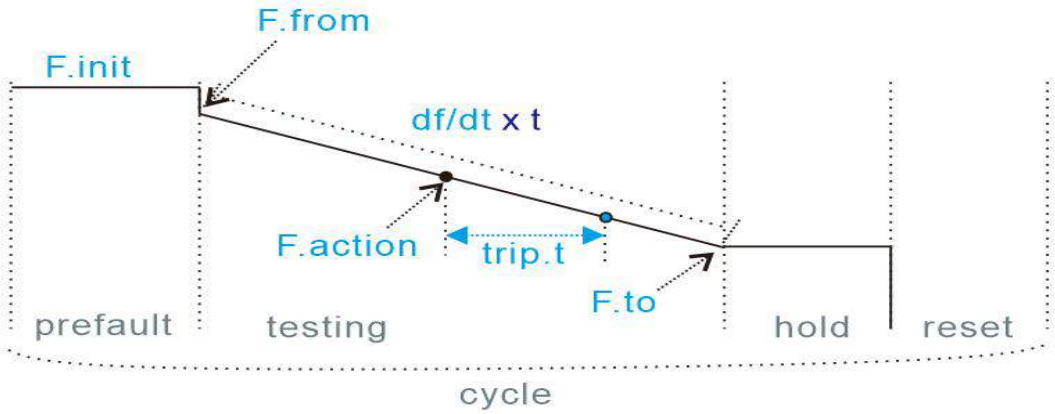
Testing Process The testing will be conducted in only one cycles.

After the Prefault is finished, the frequency will smoothly transition from Freq.From towards Freq.To at a rate determined by df/dt. Once the frequency reaches Clock Freq., the program starts the timer, After the protective device activates, the testing device calculates the time difference between F.Action and the tripping of the protective device.

The value of "Clock Freq." **needs to be measured first in the preceding Frequency test module.**

Thus, Freq.From must be set within the range where the protective device does not activate, while Freq.To must be set within the range where the protective device reliably activates.

It must also be ensured that the df/dt value does not cause the protective device to block.



Where the t is calculated by the software.

Time Test Setting Parameters

Freq.From , Freq.To Set the scan range of the test frequency.

df/dt: Define the sliding rate of frequency.

Clock Freq. Set the trip frequency value of the protective device as the timing frequency.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.9.3.3 df/dt Value

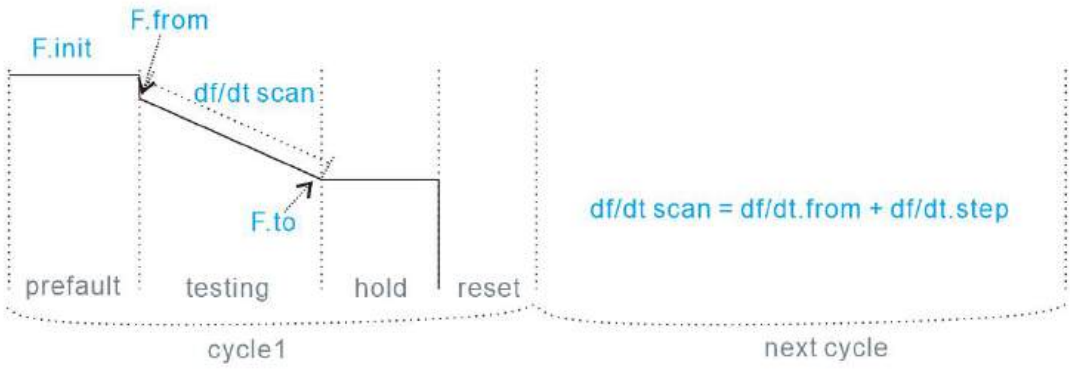
Testing the protective device's “df/dt” lockout value.

Testing Process The df/dt is the testing variable in this module.

The testing will be automatically conducted over multiple cycles.

In each testing cycle, the frequency will slide from "Freq.From" to "Freq.To" in the set direction at a rate of "df/dt scan" until the protective device operates.

After each testing cycle, the "df/dt scan" value will be automatically increased or decreased by the value of "df/dt Step". The "df/dt From" and "df/dt To" define the scanning range of "df/dt scan"; the protective device's setting "df/dt" threshold must be within this range to obtain the correct test results. The "df/dt From" should ensure that the protective device does not operate, while the "df/dt To" must ensure that the protective device can operate reliably.



Freq.From, Freq.To Set the range of the test frequency.

df/dt From,
df/dt To,
df/dt Step,

At the beginning of the test, "df/dt scan" is set to the value of "df/dt From". In the next testing cycle, the "df/dt scan" value will determine the direction based on the value of "df/dt To", and then automatically increase or decrease by the value of "df/dt Step" as the test parameter for the next cycle's "df/dt scan", and so on, until the protective device operates or until the "df/dt scan" equals the "df/dt To" value, at which point the test ends.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.9.3.4 Under-I Latch

Under-I Latch

When the frequency slides at a fixed rate of df/dt, test the low-current lockout value of the protective device.

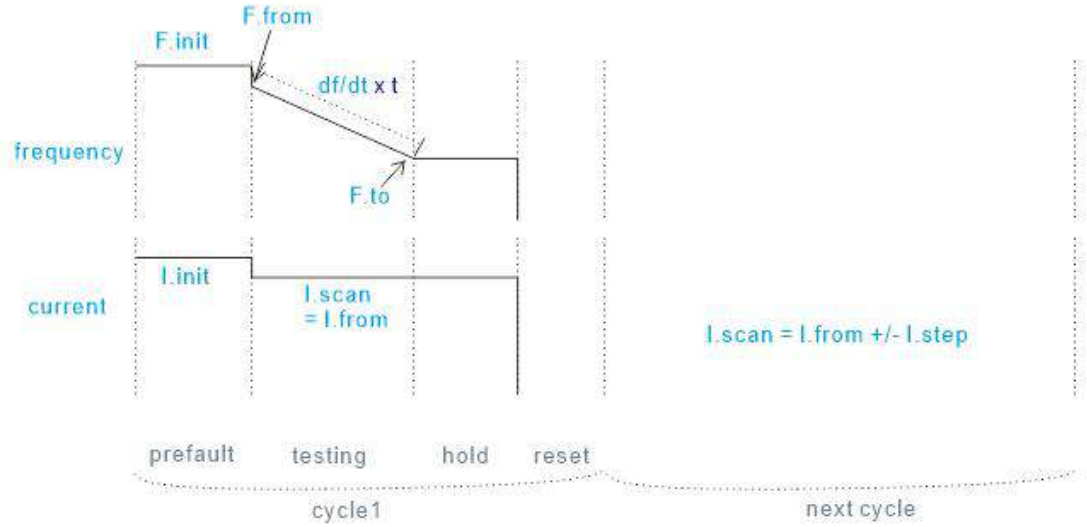
Testing Process

The current amplitude is variable of this module.

The testing will be automatically conducted over multiple cycles.

In each test cycle, the frequency will slide from Freq.From to Freq.To in the direction set by the df/dt rate.

At the same time, in each test cycle, a fixed current value (I.scan) is also applied to the protective device; at the start of the test, the I.scan value is set to I.From, and in the next test cycle, the I.scan is automatically increased or decreased by an I.Step value towards the direction of I.To, until the protective device operates or until it reaches the endpoint of I.To.



Freq.From, **Freq.To**, **df/dt**:

Define the range of frequency variation and the rate of change for each test cycle. Additionally, Freq.From must ensure that the protective device does not operate reliably, and the set values of Freq.To and df/dt must ensure that the protective device can operate reliably.

I.From, I.To, I Step

I.From and I.To define the scanning range of the test current I.scan, while I.Step is the increment or decrement of the test current after each test cycle. I.From must ensure that the protective device does not operate reliably, and I.To must ensure that the protective device can operate reliably.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.9.3.5 Under-U Latch

Under-U Latch

When the frequency slides at a fixed rate of df/dt, test the low-voltage lockout value of the protective device.

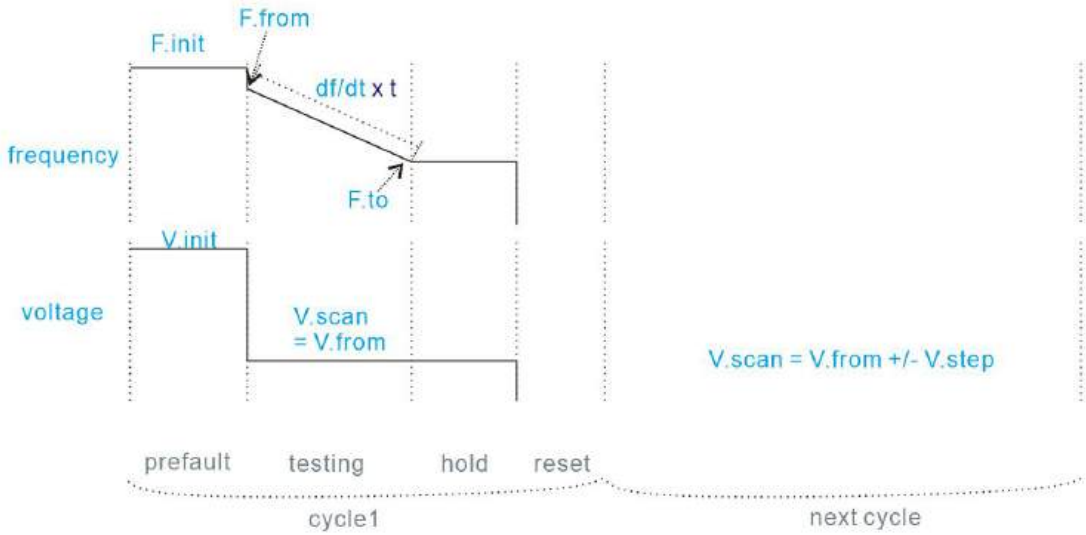
Testing Process

The voltage amplitude is variable of this test.

The testing will be automatically conducted over multiple cycles.

In each test cycle, the frequency will slide from Freq.From to Freq.To in the direction set by the df/dt rate.

At the same time, the amplitude of the output voltage is changing in each test cycle. at the start of the test, the voltage value(U.scan) is set to U.From, and in the next test cycle, the U.scan is automatically increased or decreased by an U.Step value towards the direction of U.To, until the protective device operates or until it reaches the endpoint of U.To.



Freq.From, **Freq.To**, **df/dt**:

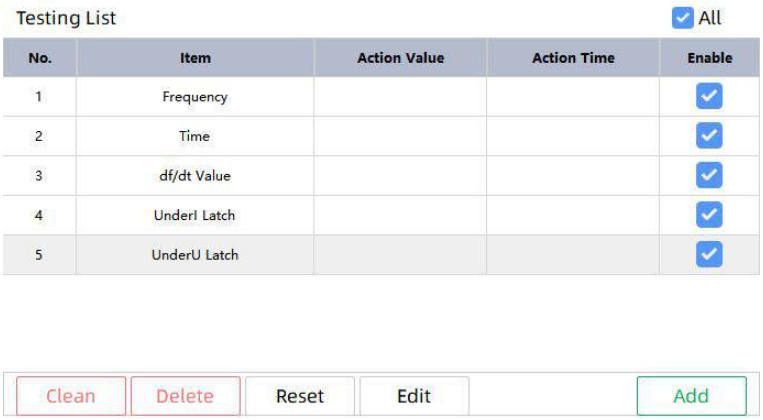
Define the range of frequency variation and the rate of change for each test cycle. Additionally, Freq.From must ensure that the protective device does not operate reliably, and the set values of Freq.To and df/dt must ensure that the protective device can operate reliably.

U.From, U.To, U Step

U.From and U.To define the scanning range of the test voltage, while U.Step is the increment or decrement of the test voltage after each test cycle. U.From must ensure that the protective device does not operate reliably, and U.To must ensure that the protective device can operate reliably.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.9.4 Testing List and Result View



Displays the currently added test points, including the test item, action value, action time, and test point checkbox (check "All" to test all points; uncheck to skip the current test point). After testing is completed, the test results will be displayed in the test list.

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

Clean Clear all test points in the test list.

Delete Delete the selected test point.

Reset Clear the test results of the test points.

Edit Edit the selected test point.

Add Add test point(s) to the test list.

7.10 Slip Voltage

This module is mainly for voltage slip related tests.

For regular tests that involve only voltage amplitude/angles as variables, please use the AC test or Ramping modules for testing.

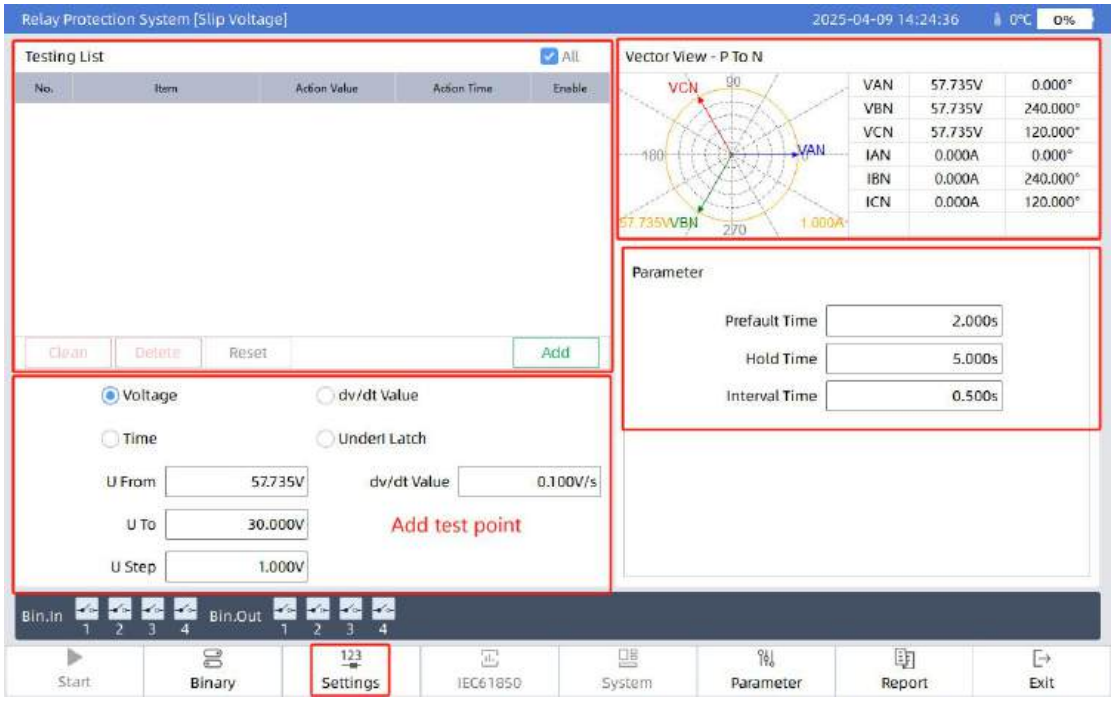
General:

Depending on the test item, there may be only one or multiple test cycles. In each test cycle, a prefault state, a hold state and a reset state are fixedly inserted;

In the prefault state, the tester outputs the rated voltage and rated frequency with a current value of 0;

In the reset state(fault interval), the tester has no output.

The output value of the hold state is dynamic; in each test cycle, the output is fixedly maintained for a certain duration when the variable reaches its endpoint, and this period is referred to as the hold state. If the protective device has an action delay setting, then the duration of the hold state must be set longer than the action delay setting of the protective device.

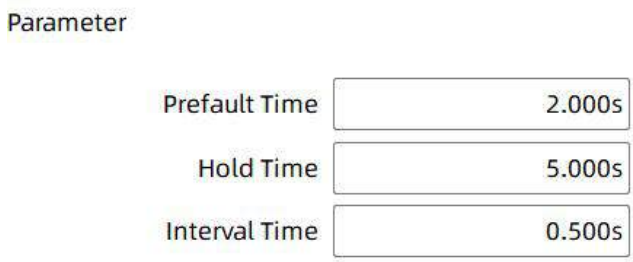


7.10.1 Slip Voltage Object Setting Value

Click to enter the setting value interface, where you can set the protection device's setting values to verify the test results.

7.10.2 Common Parameter setting

Common parameter



Prefault Time Define the duration of the prefault state.

Hold Time Define the duration of the hold state.

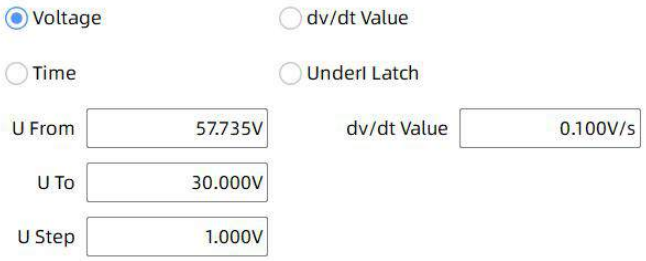
Interval Time Define the duration of the fault interval state.

This parameters is globally valid in this module.

7.10.3 Test Item

7.10.3.1 Voltage

Voltage



Test the voltage response at specific dv/dt values.

Testing Process

The V.scan is variable in this test module.

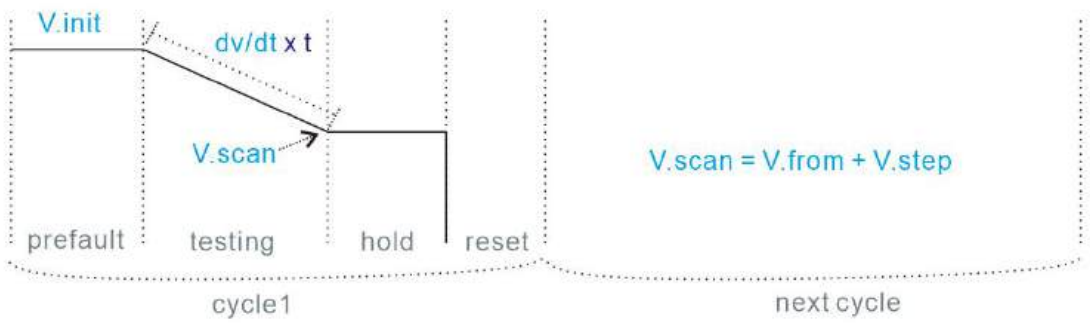
The testing will be automatically conducted in multiple cycles. In each cycle, the voltage will smoothly transition from the initial voltage to the scanning voltage(V.scan) at a rate defined by dv/dt until the protective device activates.

At the start of each test cycle, the initial voltage is set to the rated voltage value.

Within each test cycle, the V.scan will automatically change based on the definitions of U.From, U.To, and U.Step.

Thus, U.From must be set within the range where the protective device does not activate, while U.To must be set within the range where the protective device reliably activates. This will enable the determination of the voltage threshold for the protective device's activation.

It must also be ensured that the dv/dt value does not cause the protective device to block.



Set up parameters for action voltage test

U.From , U.To Define the scan range of V.scan;

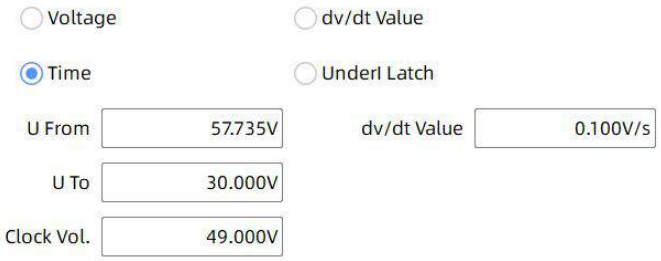
Freq.Step Define the increment or decrement of ending voltage after each test cycle.

dv/dt: Define the sliding rate of testing voltage.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.10.3.2 Time

Time



Test the operating time of the protection device at specific voltage dv/dt and action values.

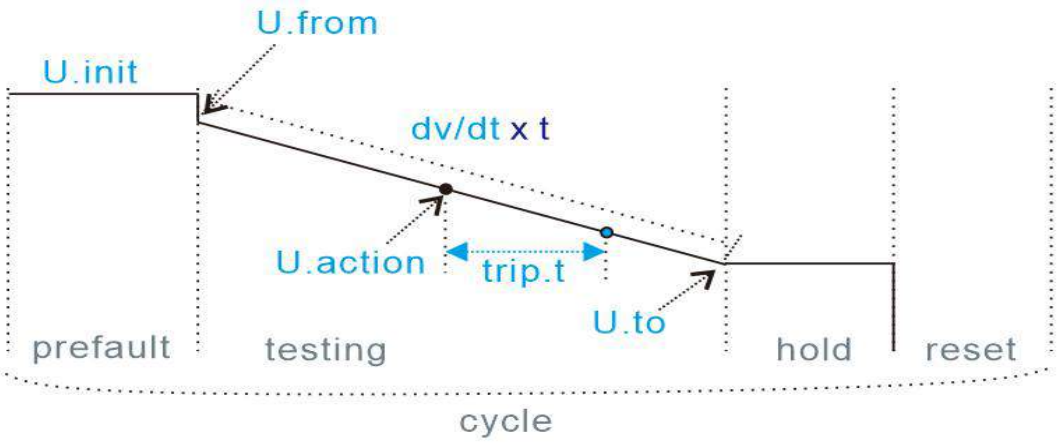
Testing Process The testing will be conducted in only one cycles.

After the Prefault is finished, the voltage will smoothly transition from U.From towards U.To at a rate determined by dv/dt. Once the voltage reaches U.Action, the program starts the timer, After the protective device activates, the testing device calculates the time difference between U.Action and the tripping of the protective device.

The value of U.action needs to be measured first in the preceding Voltage test module.

Thus, U.From must be set within the range where the protective device does not activate, while U.To must be set within the range where the protective device reliably activates.

It must also be ensured that the dv/dt value does not cause the protective device to block.



U.From , U.To Set the scan range of the test voltage.

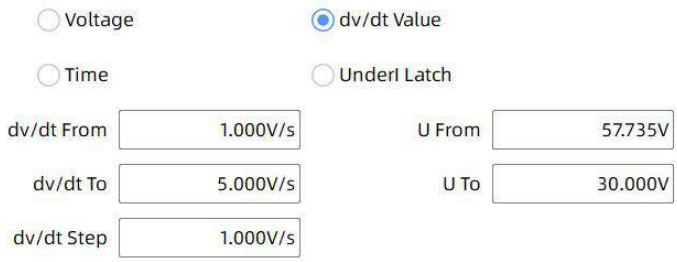
dv/dt: Define the sliding rate of voltage.

U.Action Set the trip voltage value of the protective device as the timing voltage.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.10.3.3 dv/dt

dv/dt



Testing the protective device's “dv/dt” lockout value.

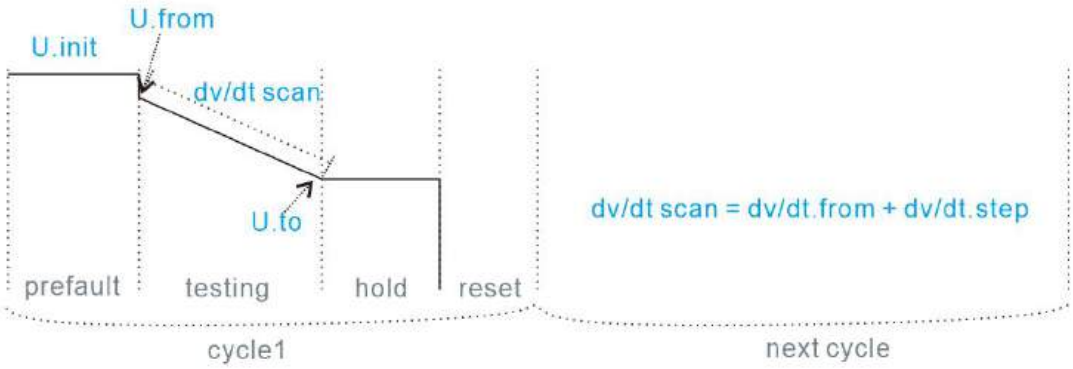
Testing Process **The dv/dt.scan is the testing variable in this module.**

The testing will be automatically conducted over multiple cycles.

In each testing cycle, the voltage will slide from "U.From" to "U.To" in the set direction at a rate of "dv/dt.scan" until the protective device operates.

After each testing cycle, the "dv/dt.scan" value will be automatically increased or decreased by the value of "dv/dt Step". The "dv/dt From" and "dv/dt To" define the scanning range of "dv/dt.scan"; the protective device's setting "dv/dt" threshold must be within this range to obtain the correct test results. The "dv/dt From" should ensure that

the protective device does not operate, while the "dv/dt To" must ensure that the protective device can operate reliably.

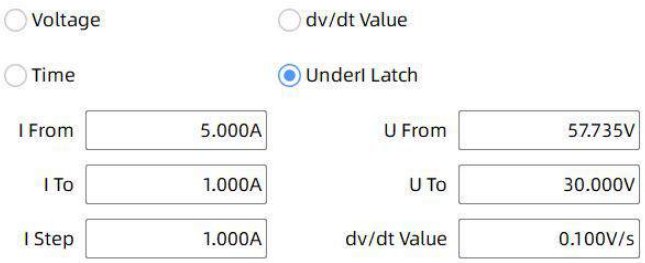


U.From, U.To Set the range of the test voltage.

dv/dt From, dv/dt To, dv/dt Step, At the beginning of the test, "dv/dt scan" is set to the value of "dv/dt From". In the next testing cycle, the "dv/dt scan" value will determine the direction based on the value of "dv/dt To", and then automatically increase or decrease by the value of "dv/dt Step" as the test parameter for the next cycle's "dv/dt scan", and so on, until the protective device operates or until the "dv/dt scan" equals the "dv/dt To" value, at which point the test ends.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.10.3.4 Under-I Latch



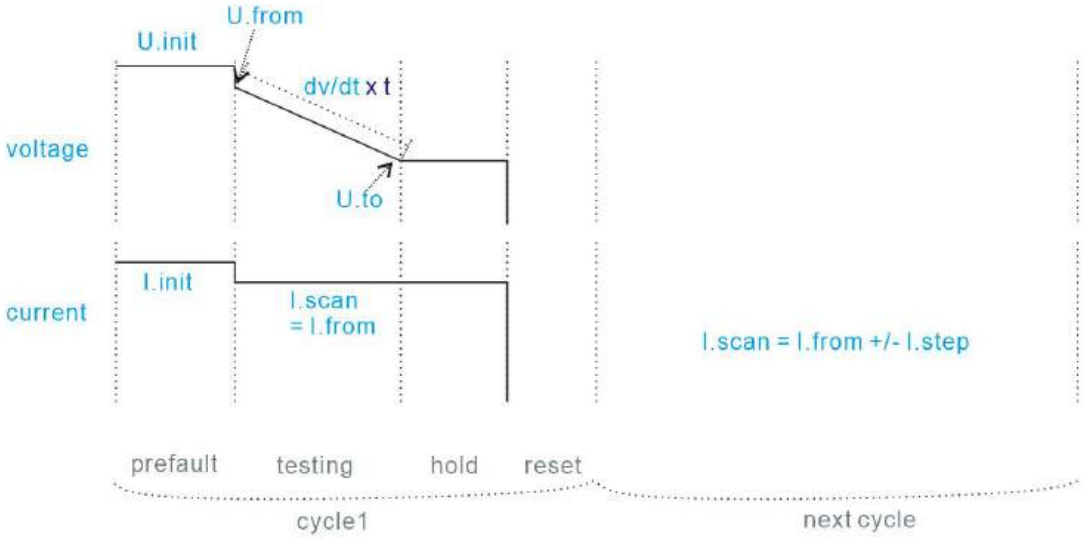
When the voltage slides at a fixed rate of dv/dt, test the low-current lockout value of the protective device.

Testing Process **The current amplitude is variable of this module.**

The testing will be automatically conducted over multiple cycles.

In each test cycle, the voltage will slide from U.From to U.To in the direction set by the dv/dt rate.

At the same time, in each test cycle, a fixed current value(I.scan) is also applied to the protective device; at the start of the test, the I.scan value is set to I.From, and in the next test cycle, the I.scan is automatically increased or decreased by an I.Step value towards the direction of I.To, until the protective device operates or until it reaches the endpoint of I.To.

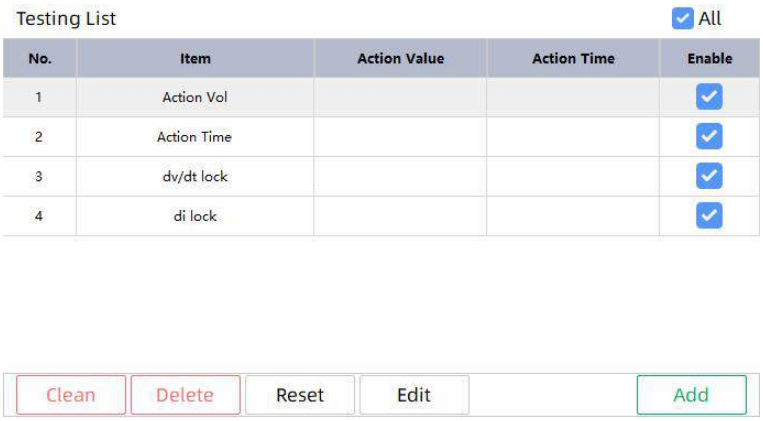


U.From, U.To, dv/dt: Define the range of voltage variation and the rate of change for each test cycle. Additionally, U.From must ensure that the protective device does not operate reliably, and the set values of U.To and dv/dt must ensure that the protective device can operate reliably.

I.From, I.To, I Step I.From and I.To define the scanning range of the test current, while I.Step is the increment or decrement of the test current after each test cycle. I.From must ensure that the protective device does not operate reliably, and I.To must ensure that the protective device can operate reliably.

After setting the parameters, click "Add" to add a test point, then start the operation and view the test results.

7.10.4 Testing List and Result View



Displays the currently added test points, including the test item, action value, action time, and test point checkbox (check "All" to test all points; uncheck to skip the current test point). After testing is completed, the test results will be displayed in the test list.

After adding a test point, select it to view the fault calculation values and vector relationships in the vector view.

Clean Clear all test points in the test list.

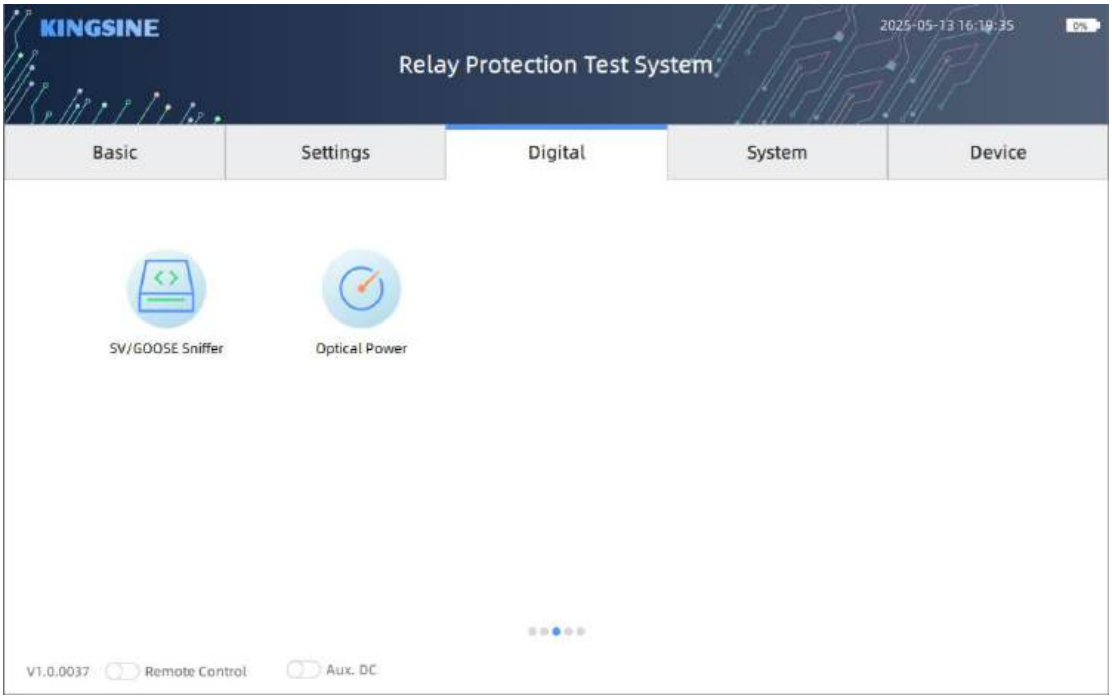
Delete Delete the selected test point.

Reset Clear the test results of the test points.

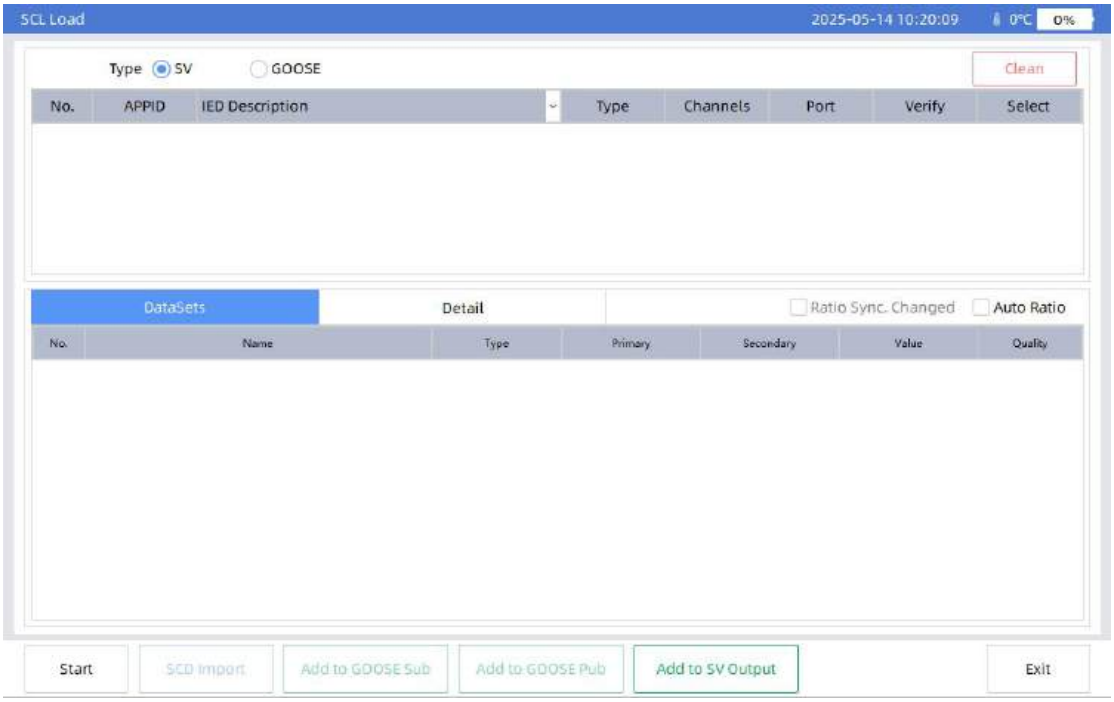
Edit Edit the selected test point.

Add Add test point(s) to the test list.

8 Digital Test Modules

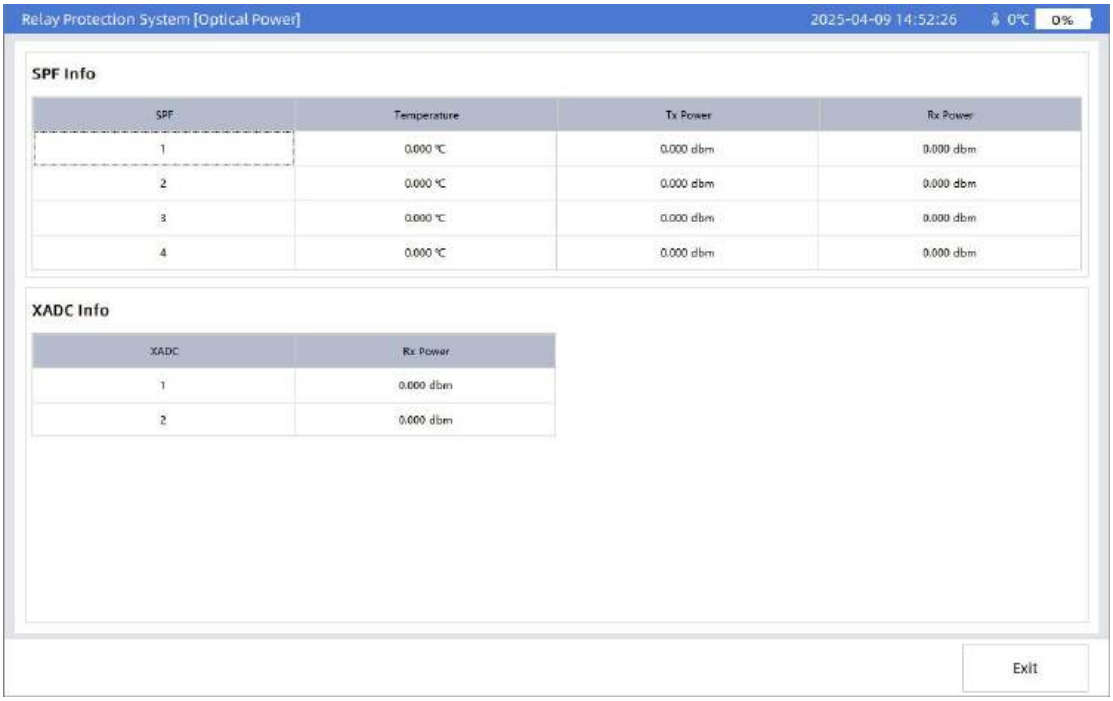


8.1 SV/GOOSE Sniffer



After connecting the fiber optic cable to the corresponding optical network port, select SV or GOOSE and click the “Start” button to begin detecting the message information on the corresponding port. The relevant Datasets will be displayed on the page. Users can click on the desired APPID and then use the “Add to...” button below to add it to the IEC 61850 configuration page for mapping settings.

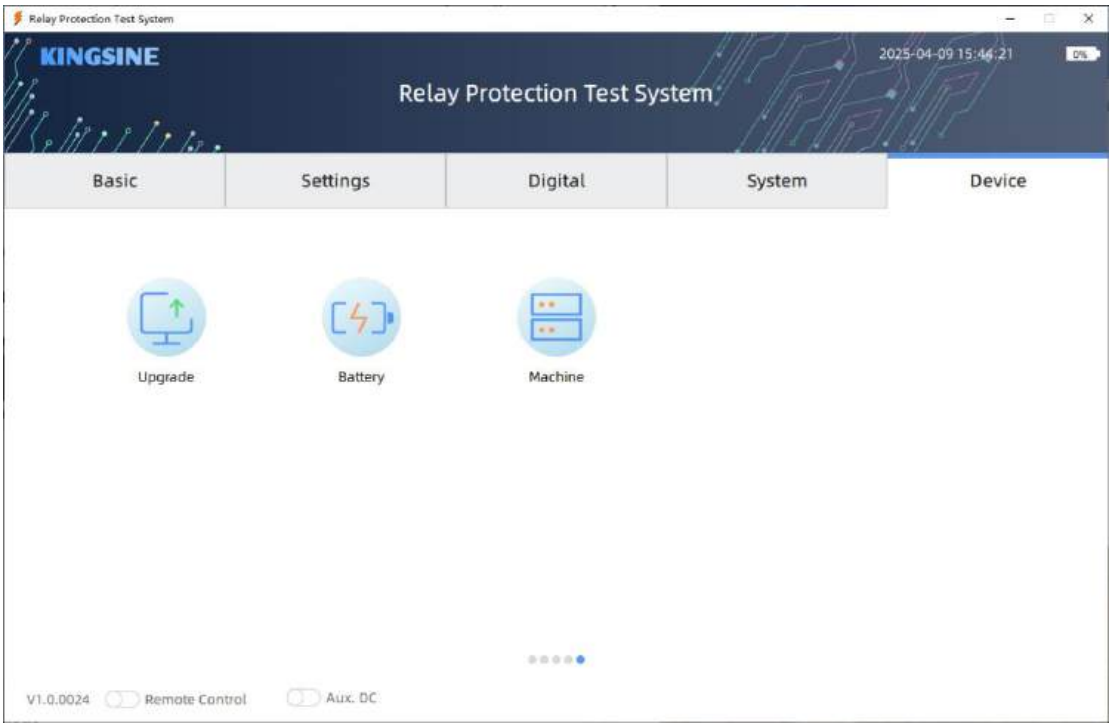
8.2 Optical Power



After connecting the optical fiber to the corresponding optical port, the system automatically measures and

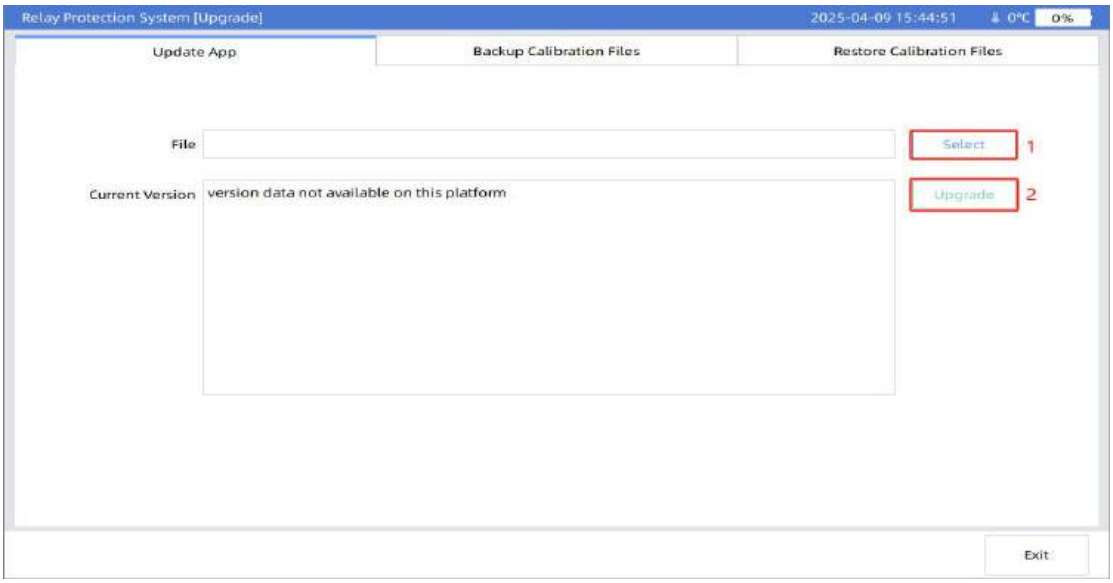
displays the optical power information. The diagram shows the current transmitted and received power, as well as the temperature of the optical network port.

9 Device Related



9.1 Upgrade

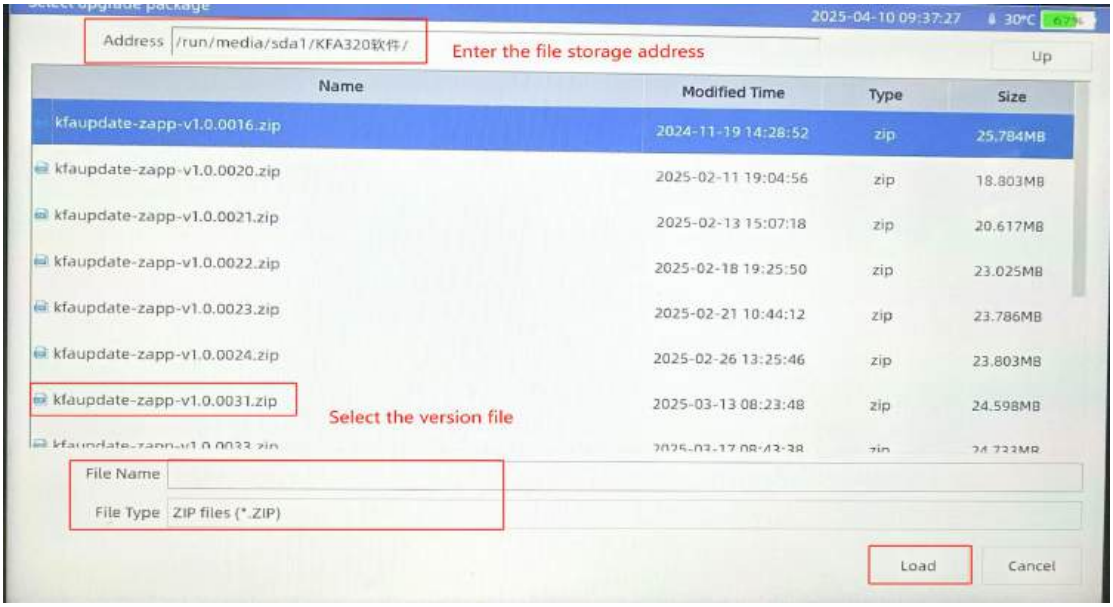
Click "Upgrade" to enter the software upgrade interface, used to upgrade the firmware and application software of the tester (available for handheld models). Copy the upgrade software to a USB drive, click "Select" on the software to choose the upgrade file, and then click "Upgrade." The firmware upgrade process takes about 10 minutes, and the tester must not be powered off during this time. After the upgrade, the tester will automatically reboot. Remove the USB drive before the reboot.



The figure above shows the interface of firmware upgrade.

Software Upgrade Steps:

Click "Select" next to the upgrade file to open the upgrade file selection.

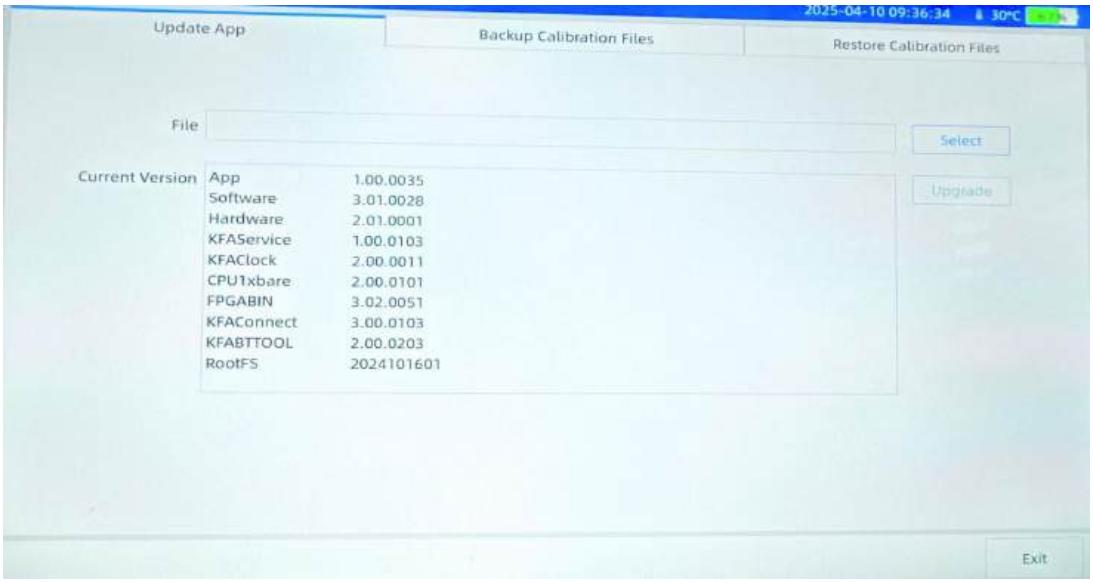


After selecting the upgrade file, click "Upgrade." The progress bar can be viewed during the upgrade process.

Do not power off the tester during the firmware upgrade. After the upgrade is complete, the software will automatically reconnect.

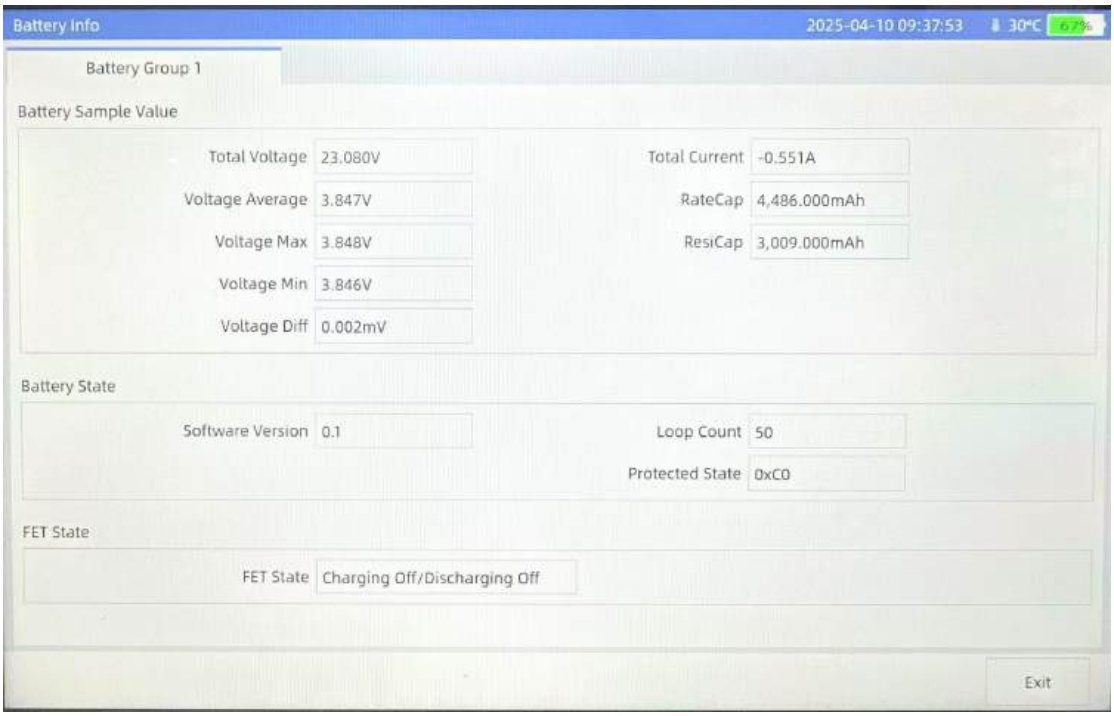
Once the automatic reconnection is complete, the software upgrade is successful.

After a successful upgrade and reconnection, check Current Version to check the upgraded software version and confirm if it has been upgraded to the intended version.

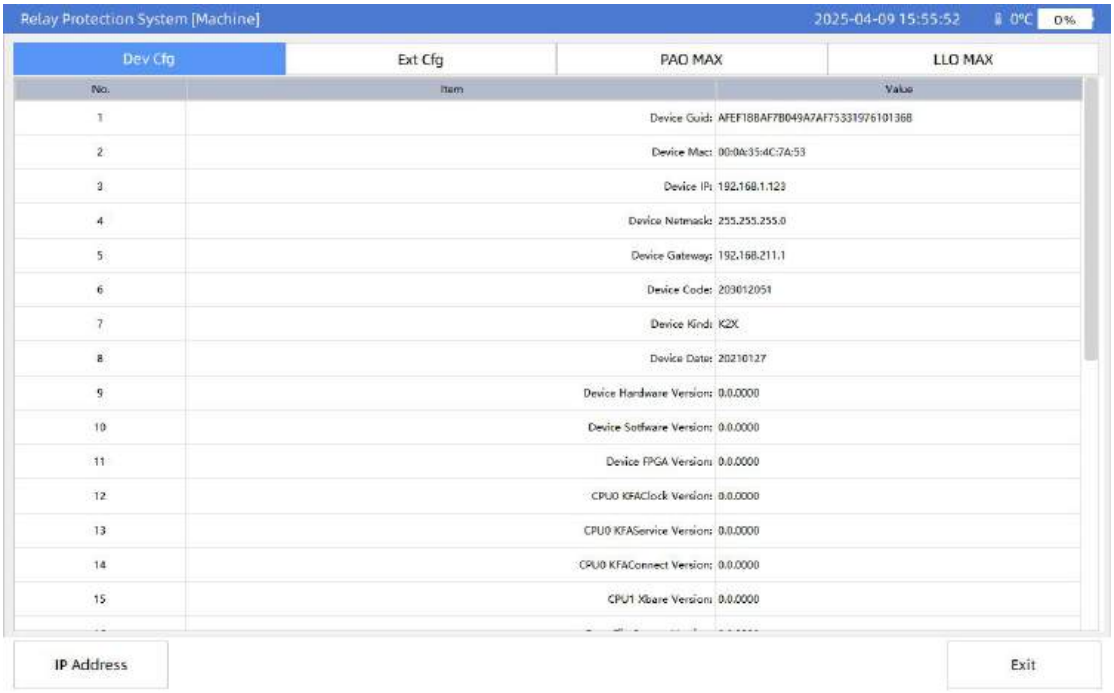


9.2 Battery

Displays the information of the inbuilt battery.



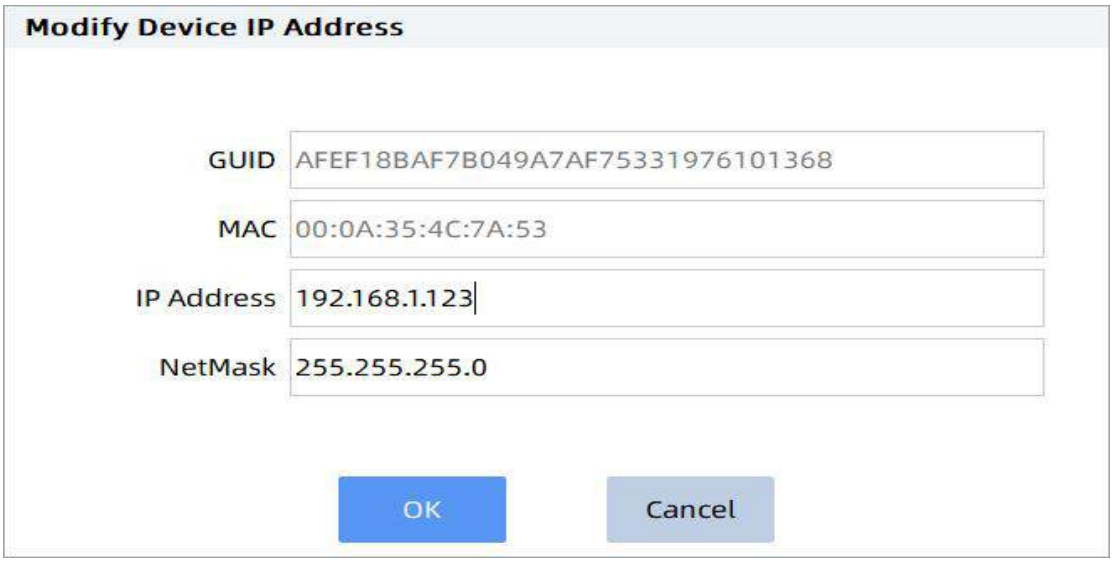
9.3 Machine



Displays the internal parameters of the currently connected device, which cannot be modified by the user.

IP Address: Modify the IP address of the tester. The factory IP address of the tester is 192.168.1.123. When connecting the tester to a local area network (LAN) or a computer on a different subnet, you can modify the tester's IP address here to match the LAN or computer's IP address. For example, if the LAN's IP address is 192.168.5.xxx, you can change the tester's address to 192.168.5.xxx.

Note: The last three digits (XXX) of the tester's IP address should not be the same as any other IP address in the LAN or on the computer.



10 Protection Test Examples

10.1 Line protection

10.1.1 Overcurrent Segment Protection

10.1.1.1 Test example: Overcurrent Segment Protection Test for RCS-9612A Microprocessor-Based Line Protection Device

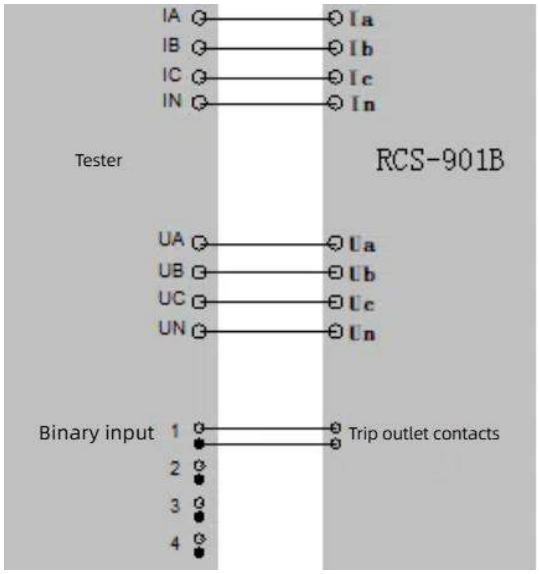
1) Test Purpose

Verify the sensitivity and reliability of the overcurrent protection sections of the RCS-9612A line protection device. Specifically, ensure that the protection reliably operates at 1.05 times the setting value, does not operate at 0.95 times the setting value, and measures the operating time at 1.2 times the setting value.

2) Test wiring

a) Connect the three-phase voltage and three-phase current output terminals of the tester to the corresponding voltage and current input terminals of the protection device.

b) Connect the trip output contacts of the protection device to the input contact 1 of the tester.



3) Protection Setting Configuration

Protection Enable/Disable: Enable Overcurrent Protection Section I, Section II, and Section III. If there is a hard enable switch for overcurrent protection, ensure it is enabled. Disable all other unrelated protections.

4) Setting Values:

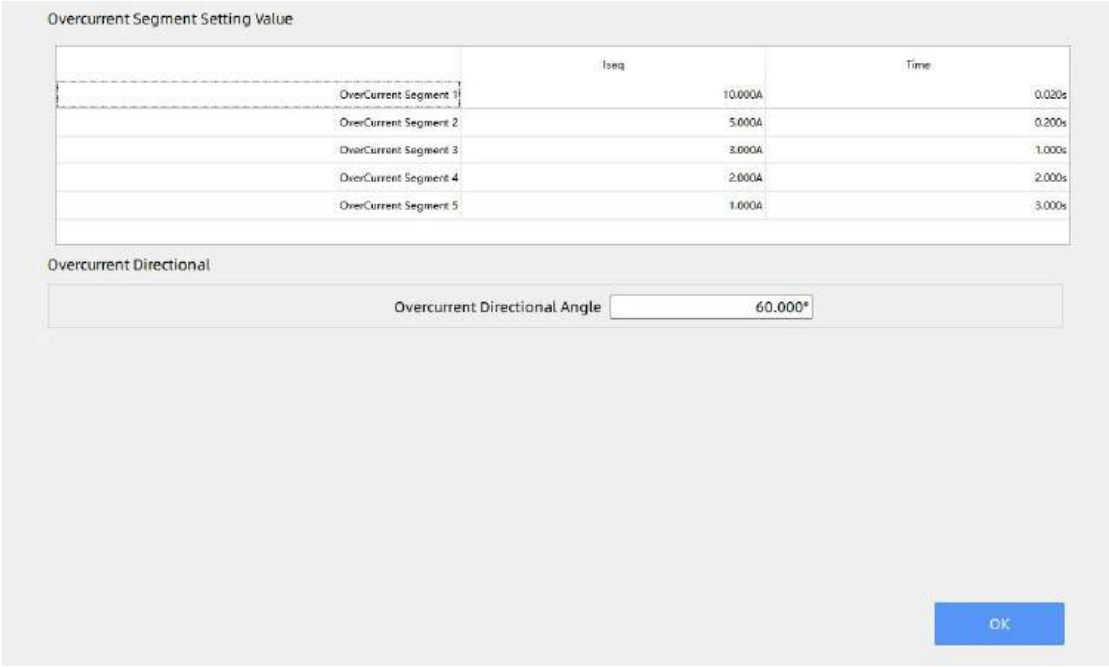
Overcurrent Protection Section I: 10A, 0s.

Overcurrent Protection Section II: 5A, 0.5s.

Overcurrent Protection Section III: 3A, 1s.

5) Parameter Settings

a) Setting Value Parameters:Click "Settings" in the software to enter the setting value parameter interface.



Set the protection settings parameters according to the specified values, as shown in the figure above. Configure the settings and time delays for Overcurrent Segment Ⅰ, Overcurrent Ⅱ, and Overcurrent Ⅲ. Other irrelevant parameters can be set arbitrarily.

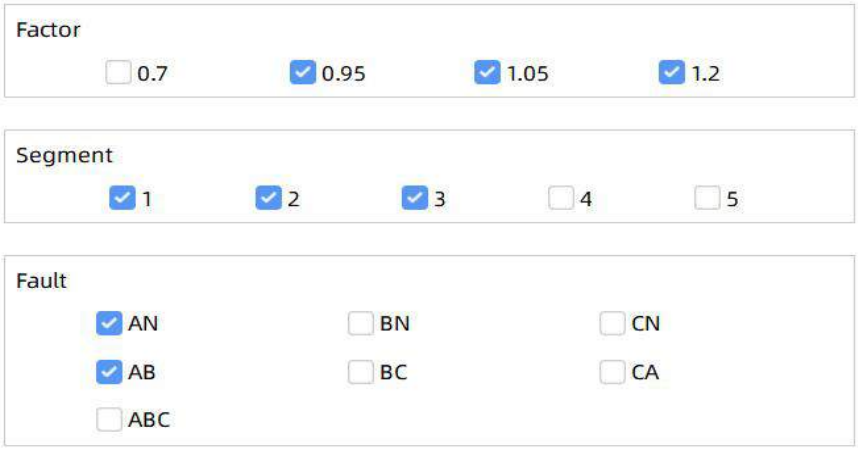
b) Select the factor for each overcurrent segment :

1.05 times the setting value: Ensure reliable operation.

0.95 times the setting value: Ensure reliable non-operation.

1.2 times the setting value: Test the protection’s operating time.

Select the test segments (Ⅰ,Ⅱ,Ⅲ), check the fault types AN and AB (other fault types can be added as needed for testing), and then click "Add".



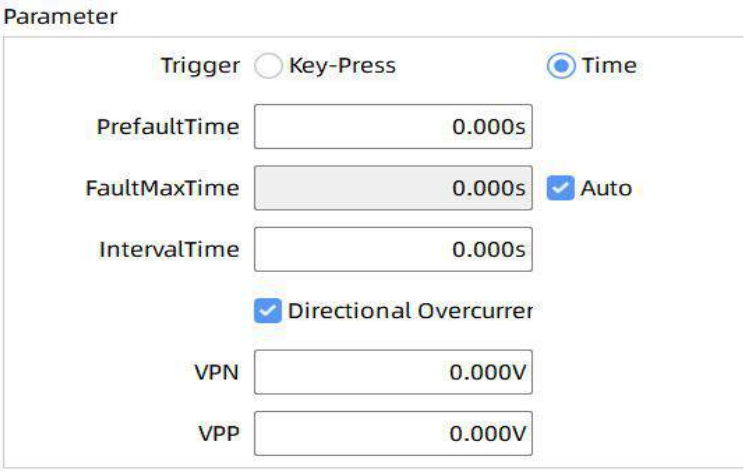
c) Common Parameter:

Trigger Mode AS "Key-Press" After running, wait for the protection device functions to reset, then click "OK" to trigger.

Check "FaultMaxTime" as automatic. The software will test according to the time settings in the values.

Set the Interval time to 1s (greater than the contact reset time).

Check the overcurrent direction based on actual test requirements.



6) Click "Start" to test each test point, view and save the test results, and generate a test report.

10.1.2 Slip Frequency

10.1.2.1 Test Example 1: Action Frequency of Slip Frequency Test

1) Test Purpose

Test the low-frequency operating characteristics of the ISA-351F protection device and observe whether the frequency setting value matches the actual action frequency.

2) Protection Wiring

Disconnect the ISA-351F protection device from the current and voltage transformer connection plates. Disconnect the circuit breaker trip connection plate on the protection panel.

Connect the tester's three-phase AC voltage outputs (UA, UB, UC) to the corresponding voltage ports on the ISA-351F protection device's AC module.

Connect the ISA-351F trip output signal to the trip input point of the simulated circuit breaker. Then connect the trip output contact of the simulated circuit breaker to the input port of the tester's switch input (if no simulated circuit breaker is used, connect the trip output contact of the protection device directly to the tester's input contact 1).

3) Protection Settings

(The following operations are performed on the ISA-351F microprocessor-based protection device.)

On the ISA-351F, select Settings, and under the Low-Frequency Protection option in the 6th column:

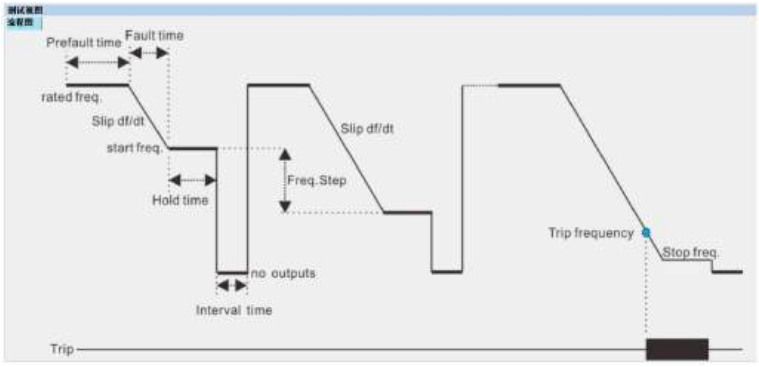
Set "Low Frequency Protection without df/dt Blocking" to Enabled.

Check its operating frequency setting value as 47Hz and the operating time setting as 2.5s.

Disable all other unrelated test functions.

4) Test Parameter Settings

a) View Time Action Characteristics Diagram (Reference):



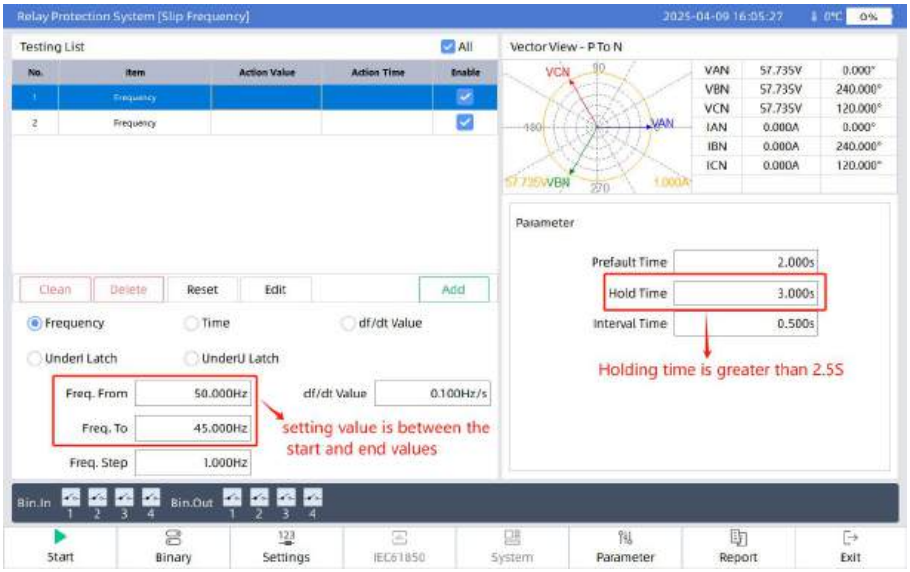
Note:

Start freq.: Corresponds to the initial frequency value in the parameter settings.

Stop freq.: Corresponds to the final frequency value in the parameter settings.

Slip df/dt: Corresponds to the frequency rate of change in the parameter settings.

b) Parameter Settings (Refer to the figure below):



Hold Time: Set to 3s (must be greater than the setting time of 2.5s to ensure the tester can receive the protection device's trip output contact).

The range from the initial frequency to the final frequency must include the setting value of 47Hz.

Since the protection device is set to operate without rate of change blocking, the frequency rate of change value can be ignored (set to 0.1Hz/s here).

Freq.Step: Set to 1Hz/s (the step size should allow the initial value to reach the operating setting value; smaller step sizes improve test accuracy).

After setting, click "Add" to add the test parameters to the test list.

c) Experimental results reference

10.1.2.2 Test Example 2: Action Time

1) Test Purpose

Test the under-frequency operating characteristics of the ISA-351F protection device and observe the operating time of the frequency protection.

2) Protection Wiring

Disconnect the ISA-351F protection device from the current and voltage transformer connection plates. Disconnect the circuit breaker trip connection plate on the protection panel.

Connect the tester's three-phase AC voltage outputs (UA, UB, UC) to the corresponding voltage ports on the ISA-351F protection device's AC module.

Connect the ISA-351F trip output signal to the trip input point of the simulated circuit breaker. Then connect the trip output contact of the simulated circuit breaker to the input port 1 of the tester (if no simulated circuit breaker is used, connect the trip output contact of the protection device directly to the tester's input contact).

3) Check the Setting Parameters of the ISA-351F Protection Device

(The following operations are performed on the ISA-351F protection device.)

On the ISA-351F, select Settings, and under the Low-Frequency Protection option in the 6th column:

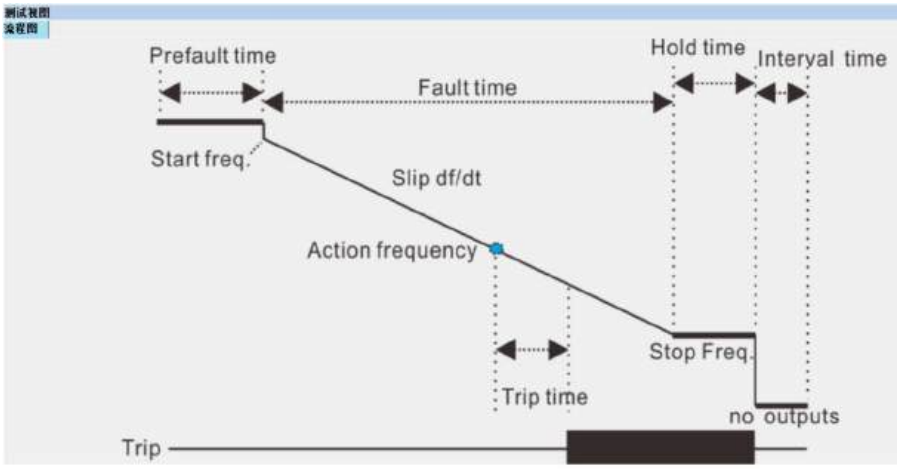
Set "under-Frequency Protection without df/dt Blocking" to Enabled.

Check its operating frequency setting value as 47Hz and the operating time setting as 2.5s.

Disable all other unrelated test functions.

4) Experimental Parameter Settings

a) View Time Operating Characteristics Diagram (Reference):



b) Parameter Settings:

Note: The default known operating frequency is 47Hz. Test the operating time under this condition.

Freq.From: 50Hz

Freq.To: 45Hz

Clock Freq.: 47Hz (set to the protection device's operating frequency setting).

df/dt Value: 0.5Hz/s (no precise requirement for this value since there is no rate of change blocking).

Prefault Time: 2s (generally, the pre-fault time should be greater than the PT disconnection recovery time and protection contact reset time; here, it is set to 2s).

Hold Time: 3s (this time ensures the protection device's trip output and should be greater than the setting time).

After setting, click "Add" to add the test parameters to the test list.

c) Experimental results reference

10.1.2.3 Test Example 3: Rate of Change (Slip) Blocking Frequency Protection

1) Purpose of the test

The test yields a slip blocking value for the ISA-351F protective device that is consistent with the calibration.

2) Protection Wiring

Disconnect the ISA-351F protection device from the current and voltage transformer connection plates. Disconnect the circuit breaker trip connection plate on the protection panel.

Connect the tester’s three-phase AC voltage outputs (UA, UB, UC) to the corresponding voltage ports on the ISA-351F protection device's AC module.

Connect the ISA-351F trip output signal to the trip input point of the simulated circuit breaker. Then connect the trip output contact of the simulated circuit breaker to the input port 1 of the tester.

3) Protection Settings

(The following operations are performed on the ISA-351F microprocessor-based protection device.)

On the ISA-351F, select Settings, and under the under-Frequency Protection option in the 6th column:

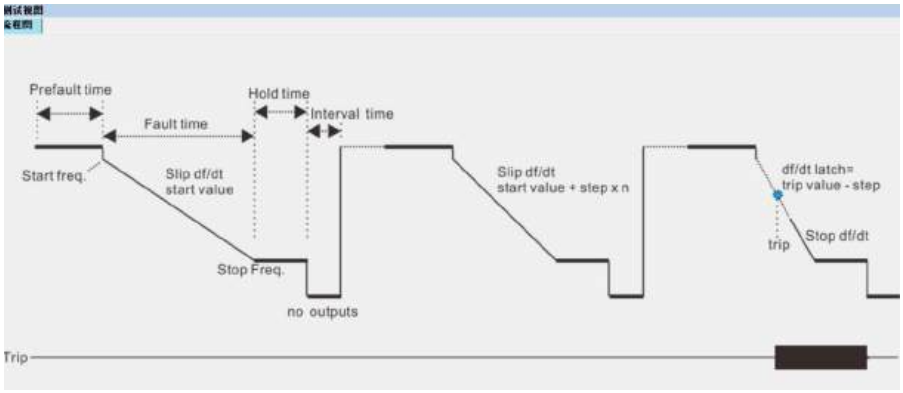
Set "under-Frequency Protection with df/dt Blocking" to Enabled.

Disable all other protections that may interfere.

Check its action value as 47Hz, the rate of change (df/dt) blocking value as 2Hz/s, and the action time setting as 2.5s.

4) Experimental Parameter Settings

a) View Rate of Change (Slip) Blocking action Characteristics Diagram (Reference):



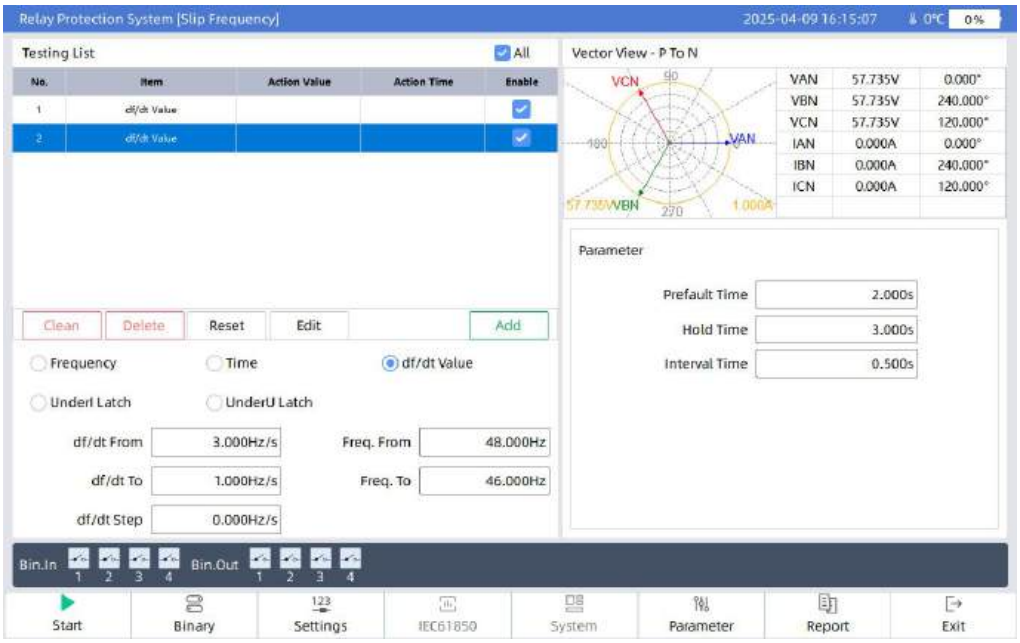
Note:

Start Freq.: Corresponds to the initial frequency value in the parameter settings.

Stop Freq.: Corresponds to the final frequency value in the parameter settings.

Slip df/dt: Corresponds to the frequency rate of change in the parameter settings.

b) Parameter Settings:



Freq.From: 48Hz

Freq.To: 46Hz

df/dt From: 3Hz/s

df/dt To: 1Hz/s

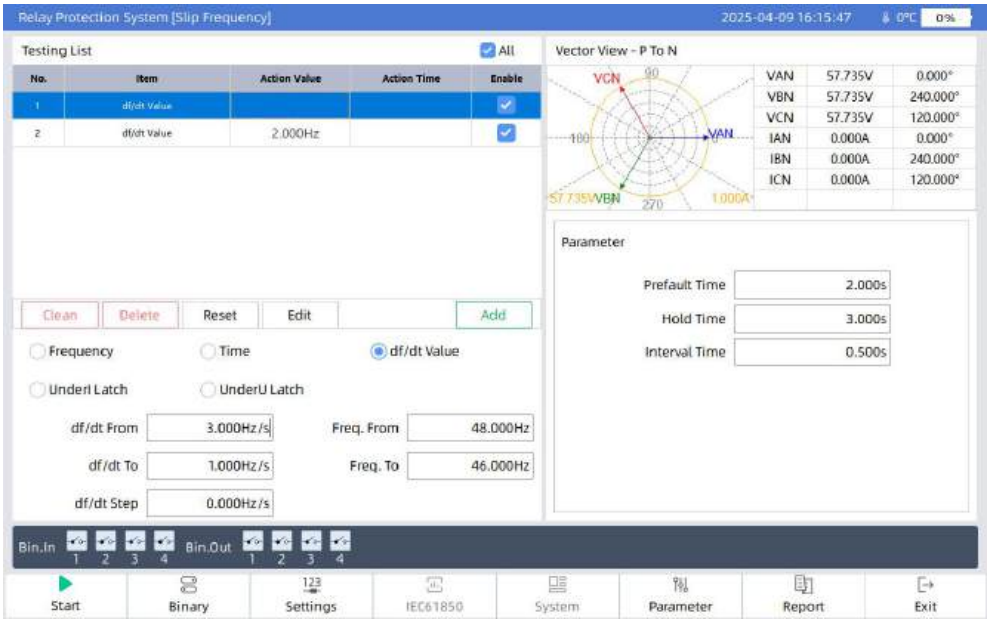
df/dt Step: 0.1Hz/s (smaller step sizes improve test accuracy but require more time).

Prefault Time: 2s (generally, the prefault time should be greater than the PT disconnection recovery time and protection contact reset time; here, it is set to 2s).

Hold Time: 3s (this time ensures the protection device's trip output and should be greater than the setting time).

After setting, click "Add" to add the test parameters to the test list.

c) Experimental Results Reference:



10.1.2.4 Test Example 4: under-Current Blocking Frequency Protection

1) Test Purpose

Test whether the under-current blocking value of the ISA-351F protection device matches the setting value.

2) Protective wiring

Disconnect the ISA-351F protection device from the current and voltage transformer connection plates. Disconnect the circuit breaker trip connection plate on the protection panel.

Connect the KF86 three-phase AC current outputs (IA, IB, IC) and three-phase AC voltage outputs (UA, UB, UC) to the corresponding ports on the ISA-351F protection device's AC module.

Connect the ISA-351F trip output signal to the trip input point of the simulated circuit breaker. Then connect the trip output contact of the simulated circuit breaker to the input port 1 of the tester.

3) Protection settings

(The following operations are performed on the ISA-351F microprocessor-based protection device.)

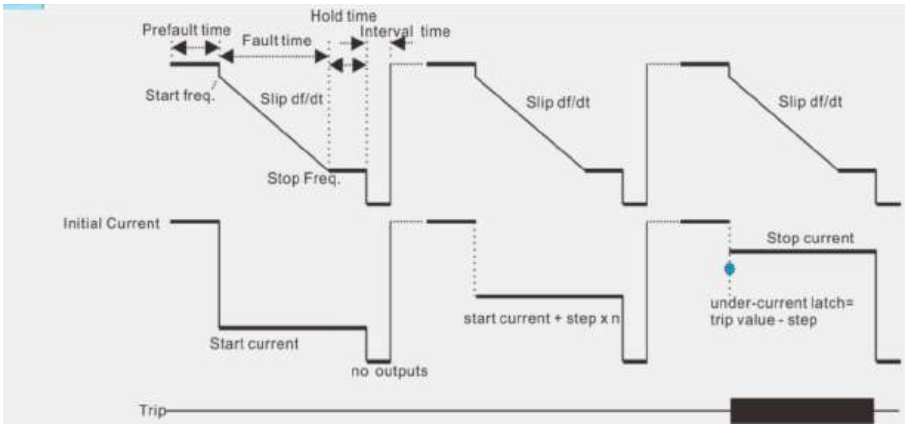
On the ISA-351F, select Settings, and under the under-Frequency Protection option in the 6th column:

Set "Under-Frequency Protection without df/dt Blocking" and "Under-Current Blocking Under-Frequency Protection" to Enabled.

Check its operating setting value as 47Hz, the current blocking value as 1.6A, and the operating time setting as 2.5s.

4) Experimental Parameter Settings

a) View Under-I Latch action characteristics diagram (Reference):



b) Parameter Settings:

Freq.From: 48Hz

Freq.To: 46Hz

df/dt Value: 0.5Hz/s

I From: 1A

I To: 3A

I Step: 0.1A (smaller step sizes improve test accuracy but require more time).

Prefault Time: 2s (generally, the prefault time should be greater than the PT disconnection recovery time and protection contact reset time; here, it is set to 2s).

Hold Time: 3s (this time ensures the protection device's trip output and should be greater than the setting time).

After setting, click "Add" to add the test parameters to the test list.

c) Experimental Results Reference:

10.1.3 Slip Voltage

10.1.3.1 Test example 1: Action Value Test for CSC-161A Digital Line Protection Device

Test Item: Slip Voltage Action Value Test

Protection Device: CSC-161A Digital Line Protection Device

Protection Settings:

a. The slip voltage setting is based on line voltage.

b. The slip rate-of-change (dU/dt) blocking is based on the rate of change of line voltage.

c. Voltage setting: 70V

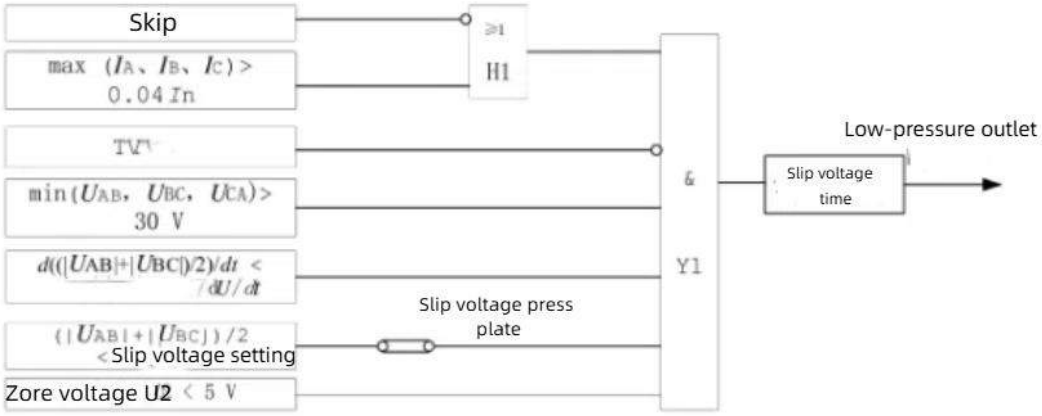
d. Rate-of-change blocking: 5V/s

Protection Enable/Disable:

a. Enable the slip voltage hardwire (panel) setting.

b. Enable the slip voltafe software control word.

Protection Operation Logic:

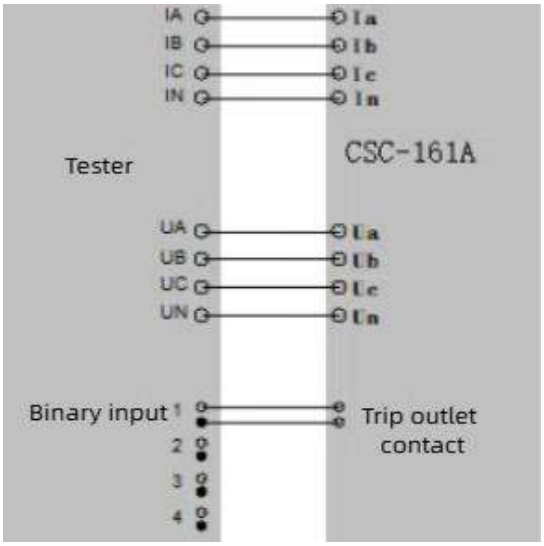


1) Test Wiring

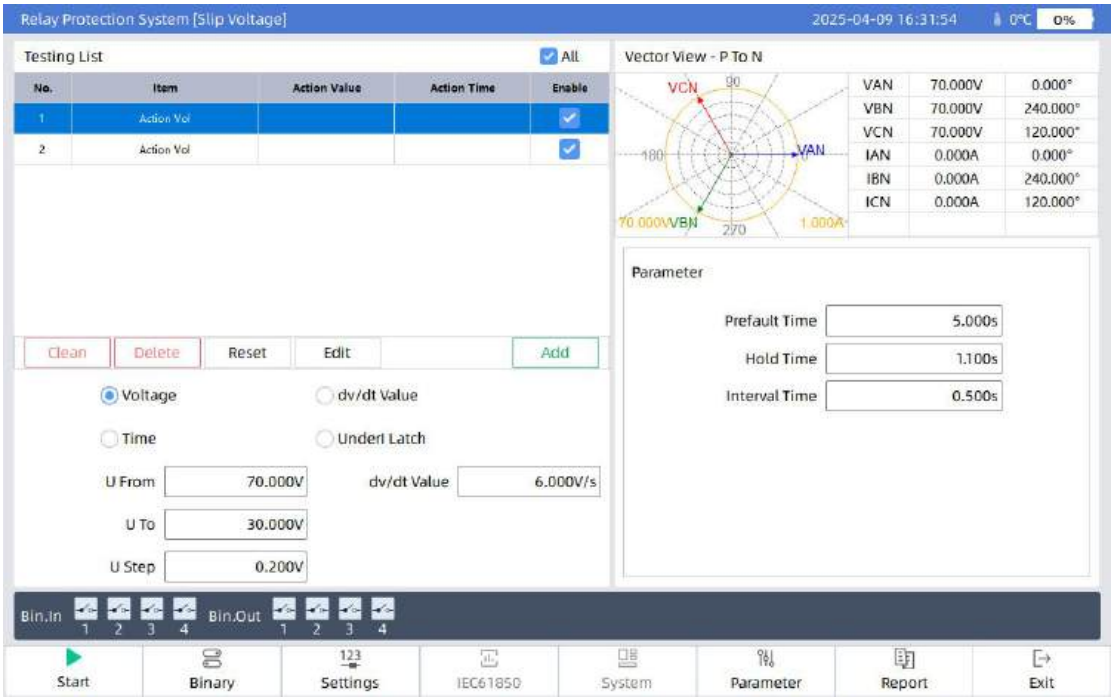
Connect the tester's voltage outputs (UA, UB, UC, UN) to the corresponding voltage terminals of the protection device.

Connect the tester's current outputs (IA, IB, IC, IN) to the corresponding current terminals of the protection device.

Connect the protection device's trip output contact to the input contact 1 of the tester, as shown in the figure below.



2) Parameter settings



U From: 70V

U TO: 30V

dv/dt Value: 6V/s

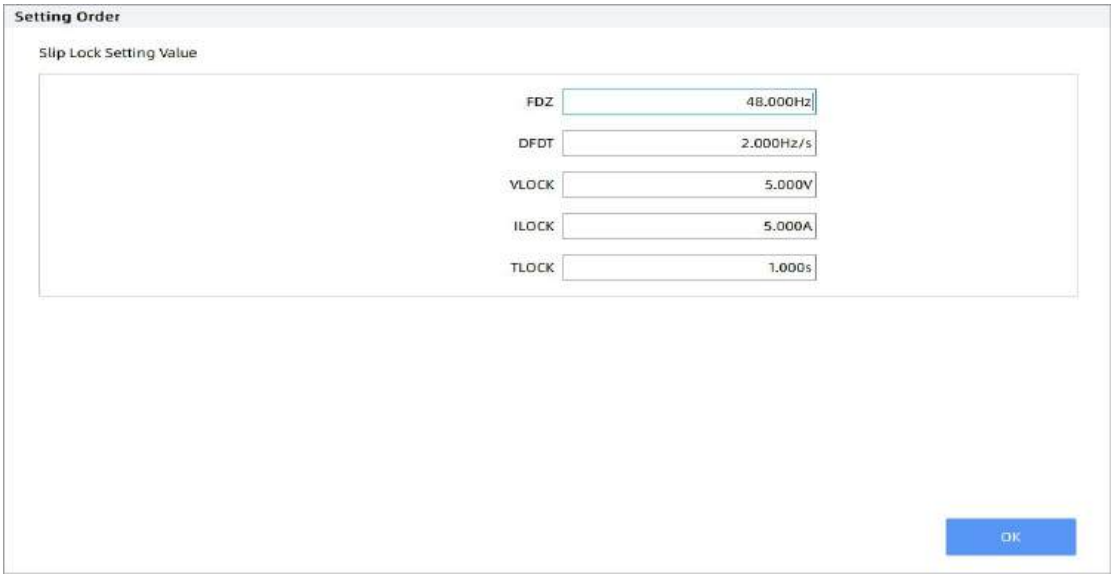
U Step: 0.2V (smaller step sizes improve test accuracy but require more time).

Prefault Time: 5s (generally, the prefault time should be greater than the PT disconnection recovery time and protection contact reset time; here, it is set to 5s).

Hold Time: 1.1s (this time ensures the protection device's trip output and should be greater than the setting time).

After setting, click "Add" to add the test parameters to the test list.

3) Settings



10.1.4 Power Frequency Variation Protection

10.1.4.1 Test example: Setting Verification of Power Frequency Variation Impedance Element for RCS-931 Series Ultra-High Voltage Line Protection Device

Test Item: Setting Verification of Power Frequency Variation Impedance Element

Protection Device: RCS-931 Series Ultra-High Voltage Line Protection Device

Protection Settings: Power Frequency Variation Impedance 1

Protection Enable/Disable: Enable distance protection, disable zero-sequence protection, disable reclosing.

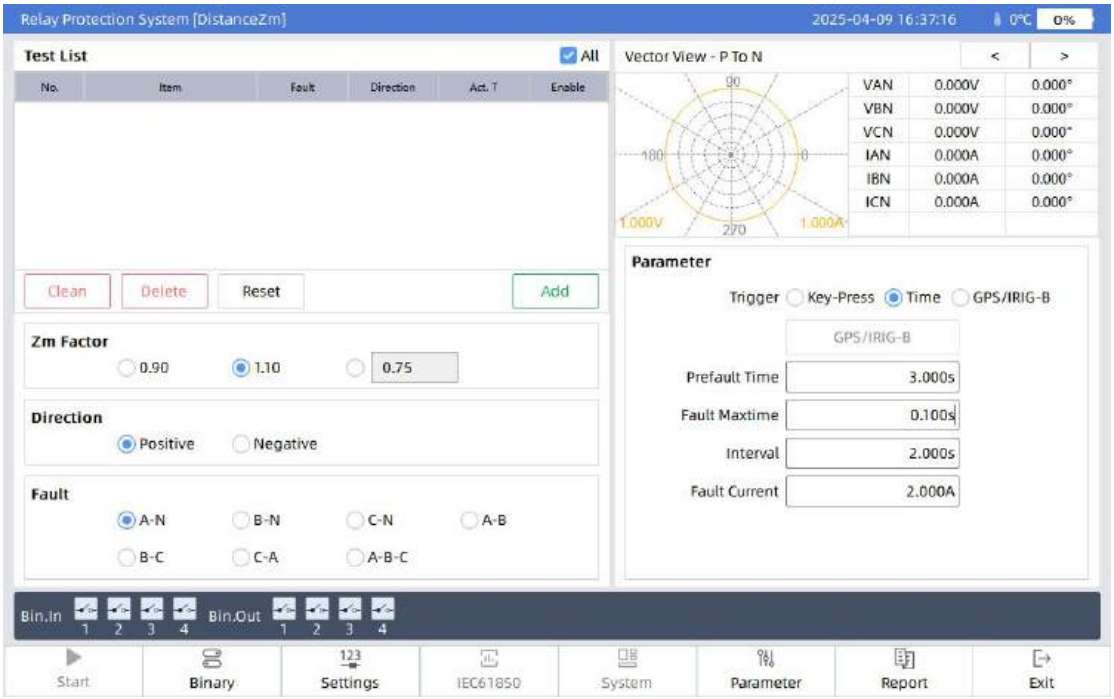
Control Word Settings: Enable power frequency variation distance.

1) Test wiring

a. Connect the three-phase voltage and three-phase current output terminals of the tester to the corresponding voltage and current input terminals of the protection device.

b. Connect the trip output contact of the protection device to the input contact 1 of the tester.

2) Parameter Settings



3) **Set Zm Factor:**

0.9 times for reliable non-operation.

1.1 times for reliable operation.

Alternatively, freely set the power frequency coefficient to 1.2 times to test the protection operating time.

Select the fault direction as positive and the fault type as A-N fault.

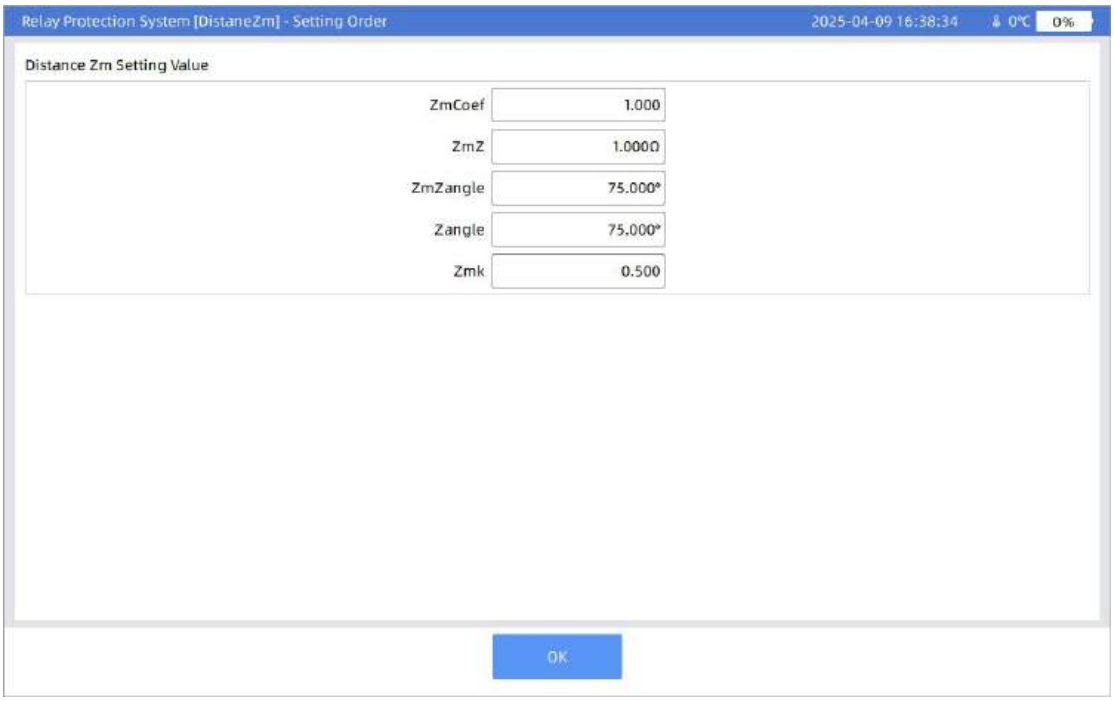
4) **Set Common Parameter:**

Set the trigger mode to "Key-Press."

Set the Fault Maxtime to 0.1s (greater than the power frequency variation trip time setting of 0s).

Set the fault current to 2A.

5) **Settings**

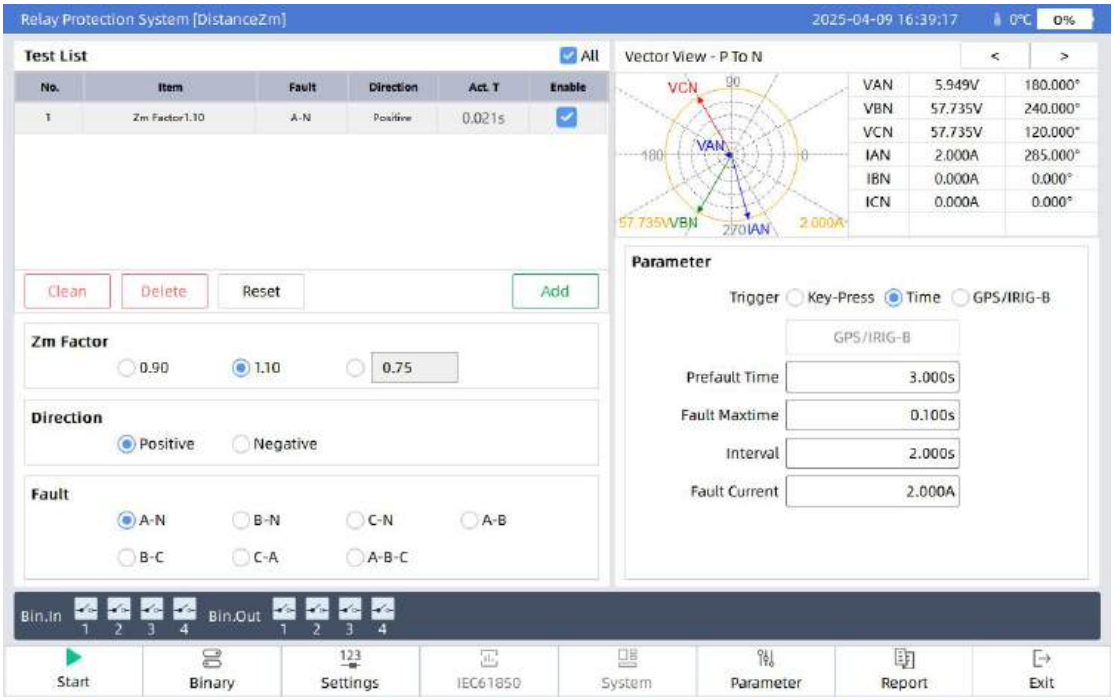


Set the ZmCoef (M value), ZmZ (1 Ω), ZmZangle, Zangle and Zmk.

After setting, click "Add" to add the test parameters to the test list.

6) **Start the Test:**

Click "Start" to begin the test. View and save the test results/report.



10.1.5 Distance Protection

10.1.5.1 Test Example 1: Setting Verification of Distance Protection for GE Multilin-L90 Line Differential Protection Device

Test Task: Complete the setting verification and operating time test for ground distance and Interphase distance in one go.

Protection Device: GE Multilin-L90 Line Differential Protection Device.

Protection Settings

Interphase Distance:

Section I: 1 Ω

Section II: 2 Ω, 0.5s

Section III: 3 Ω, 1s

Ground Distance:

Section I: 1 Ω

Section II: 2 Ω, 0.5s

Section III: 3 Ω, 1s

Zero-Sequence Compensation Coefficient: KL = 0

Protection Enable/Disable: Enable distance protection, disable zero-sequence protection, disable reclosing, disable power frequency variation distance.

1) Test Wiring

a. Connect the voltage and current output terminals of the testing device to the corresponding voltage and current input terminals of the protection device using test leads.

b. Connect the trip output contact of the protection device to the input contact 1 of the tester, as shown in the figure below.

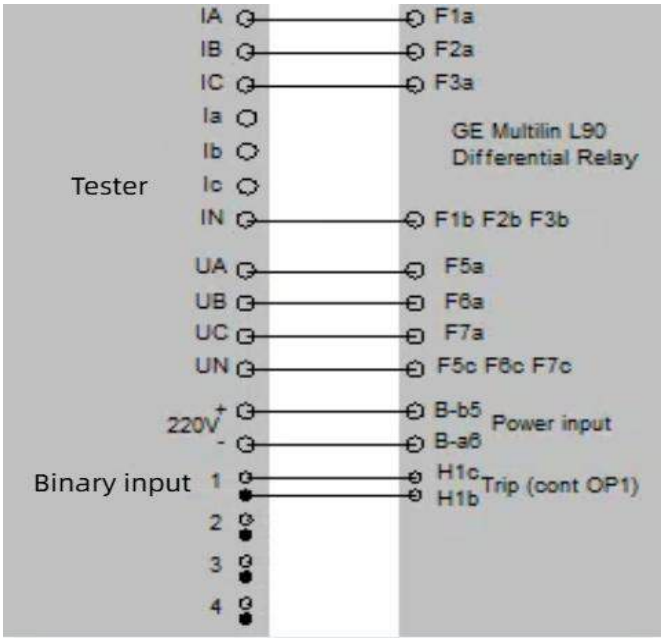
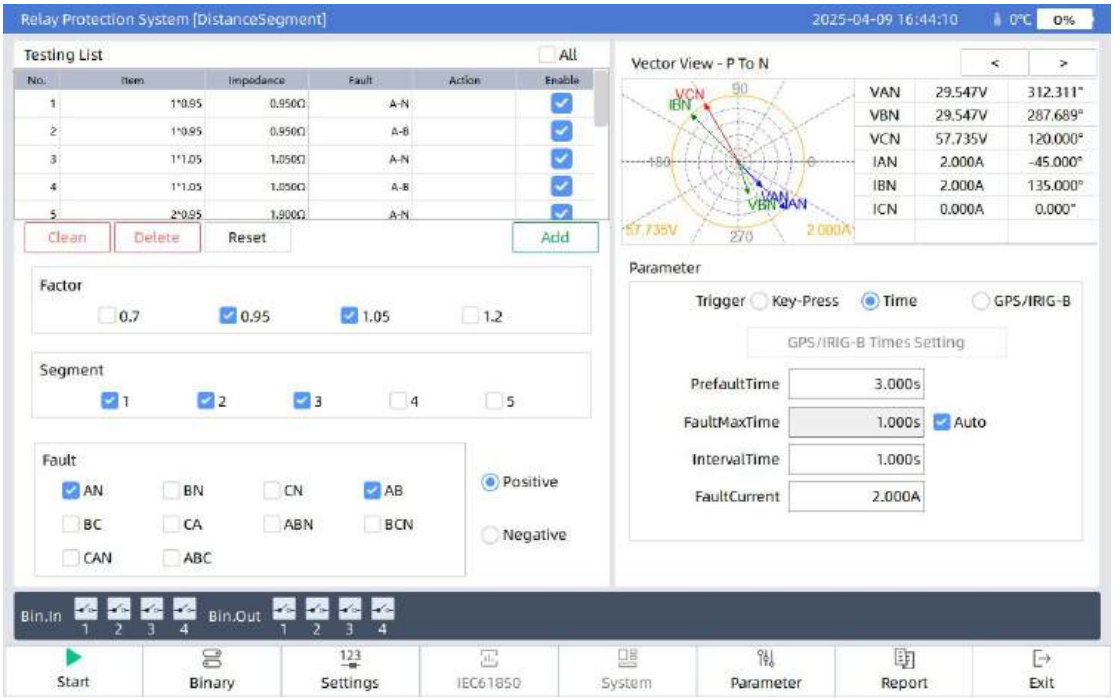


Figure 4.10-2 Test Wiring Diagram

2) Parameter Settings



a. **Set the factor for distance current value**

0.7 times to test the operating time.

0.95 times for reliable operation.

1.05 times for reliable non-operation.

1.2 times for non-operation.

Select the fault direction as positive.

Check the sections: Select Section I, Section II, and Section III.

Select fault types: A-N, A-B. If other fault types need to be tested, check them as well. After setting, click "Add" to add the test points to the test list.

b. Common Parameter Settings

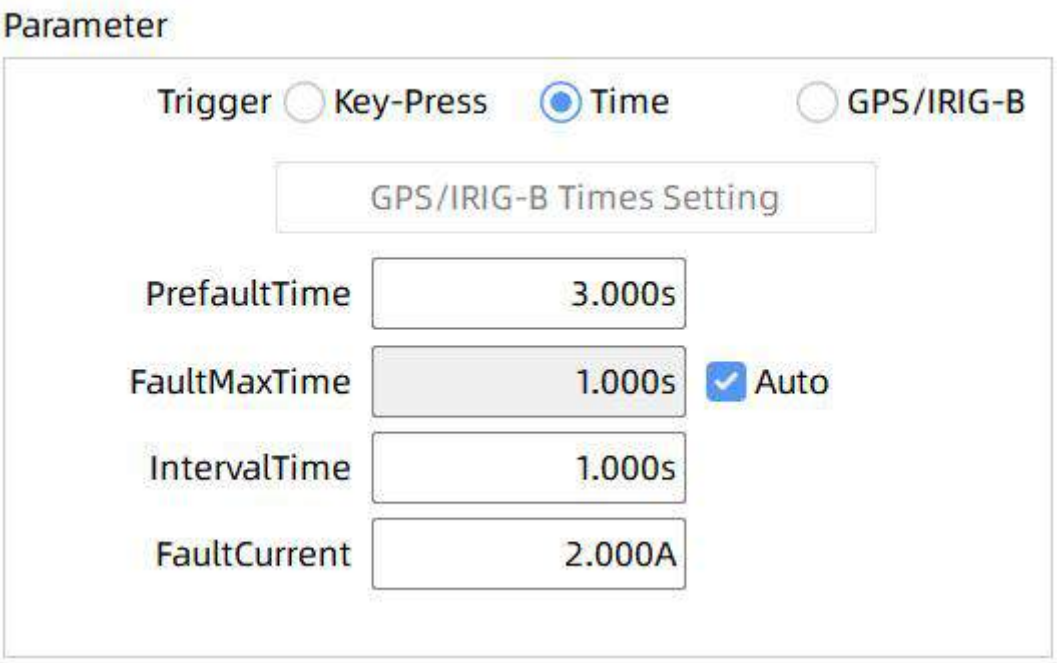
Set the trigger mode to "Time."

Set the prefault time to 3s (prefault time should consider PT disconnection recovery, typically 20-25s; here, it is set to 3s as PT disconnection recovery is not considered).

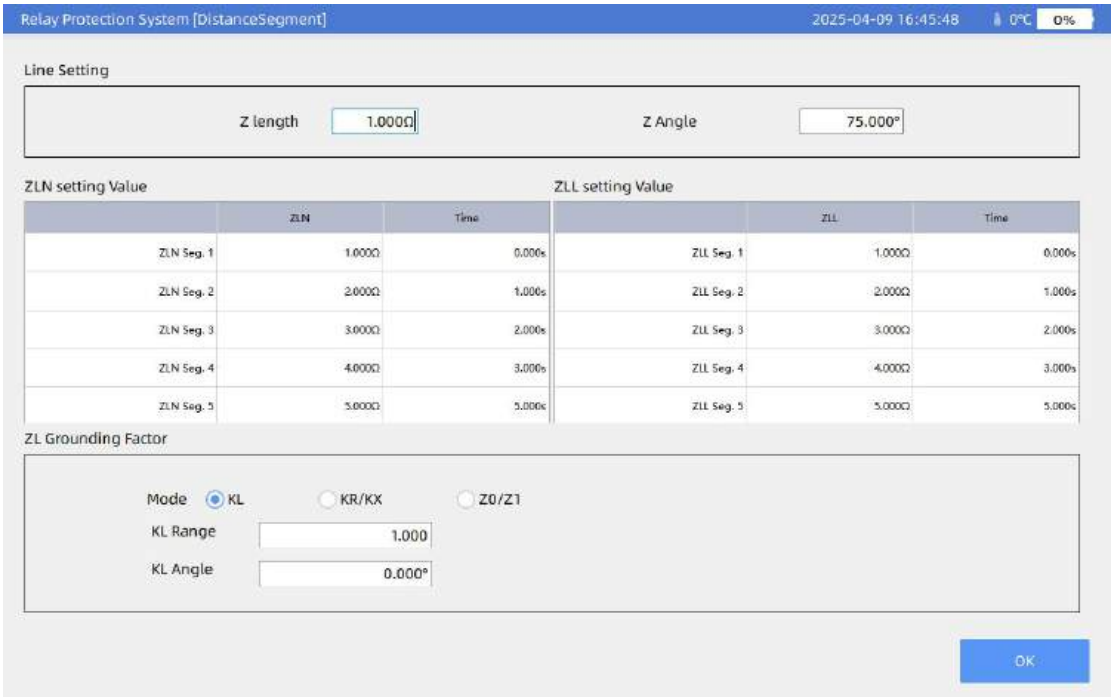
Check "FaultMaxTime" as automatic. The software will automatically read the output setting time for each section.

Set the interval time to 1s (generally, the interval time should be greater than the contact reset time).

Set the fault-circuit current to 2A (generally, it should be greater than the fault current setting).



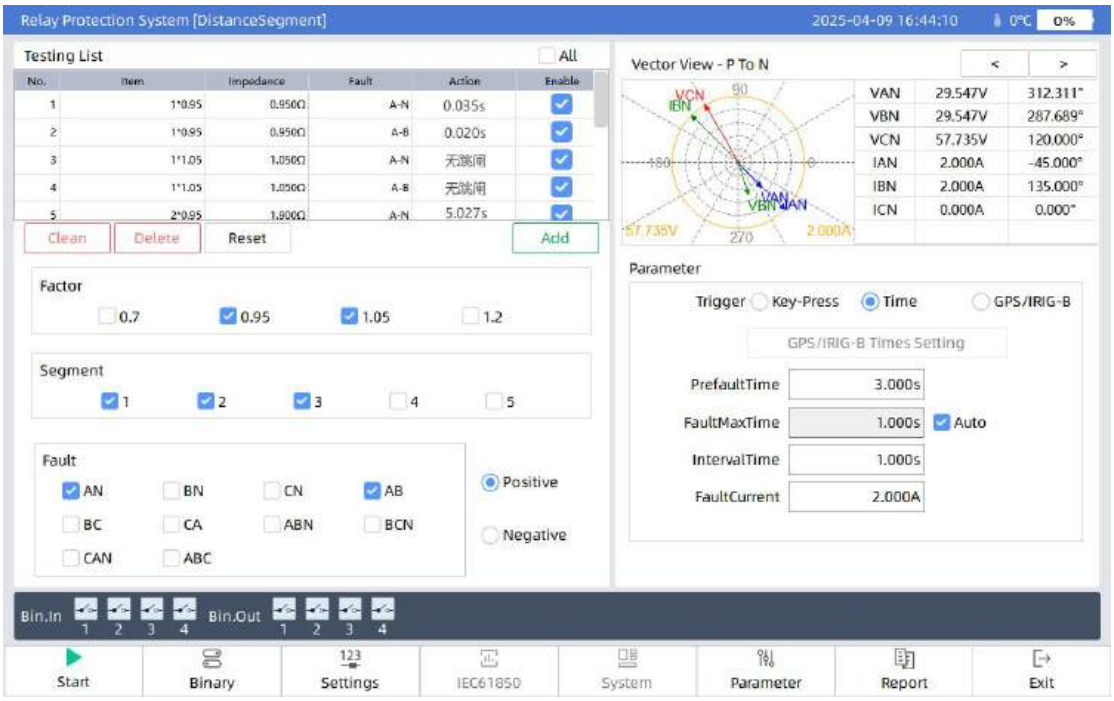
3) Settings



Based on the protection device's settings, configure the impedance and time settings for Section I, Section II, and Section III for both ground faults and Interphase faults. Set the line positive sequence impedance angle and the zero-sequence compensation coefficient KL (magnitude: 1, angle: 0).

4) Starting the test

Click the "Start" button, and the software will begin testing according to the set test point parameters. View and save the test report.



10.1.6 Zero-Sequence Current Protection

10.1.6.1 Test Example 1: Setting Verification of Zero-Sequence Protection for RCS-901B Line Protection Device

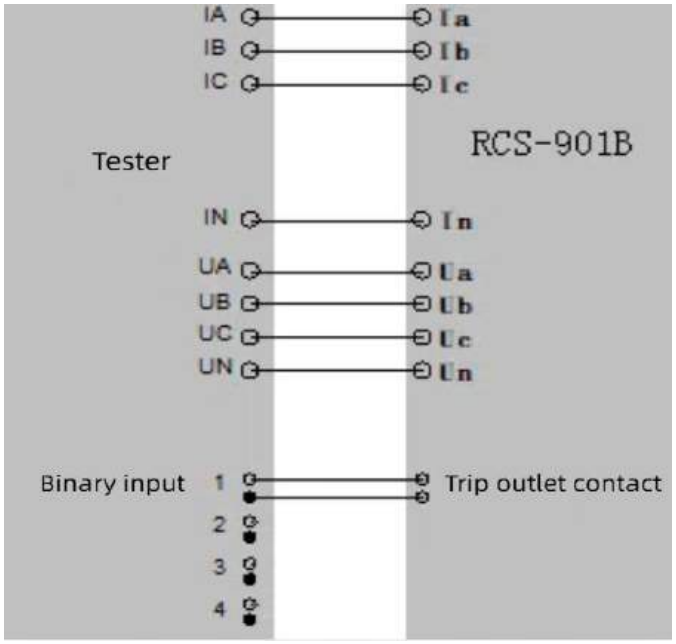
1) Test Purpose

Verify the sensitivity and reliability of the overcurrent protection sections of the RCS-9612A line protection device. Specifically, ensure that the protection reliably operates at 1.05 times the setting value, does not operate at 0.95 times the setting value, and measures the operating time at 1.2 times the setting value.

2) Test wiring

a. Connect the three-phase voltage and three-phase current output terminals of the tester to the corresponding voltage and current input terminals of the protection device.

b. Connect the trip output contact of the protection device to the input contact 1 of the tester.



3) Protection Setting Configuration

a. Protection Enable/Disable:

Enable Zero-Sequence Overcurrent Protection Section I, Section II, Section III, and Section IV (set the relevant control words to 1).

Enable the zero-sequence overcurrent hardware and software switches (set the control words to 1).

Disable all other unrelated protections (set the control words to 0).

b. Setting Values:

Zero-Sequence Overcurrent Protection Section I: 5A, 0s.

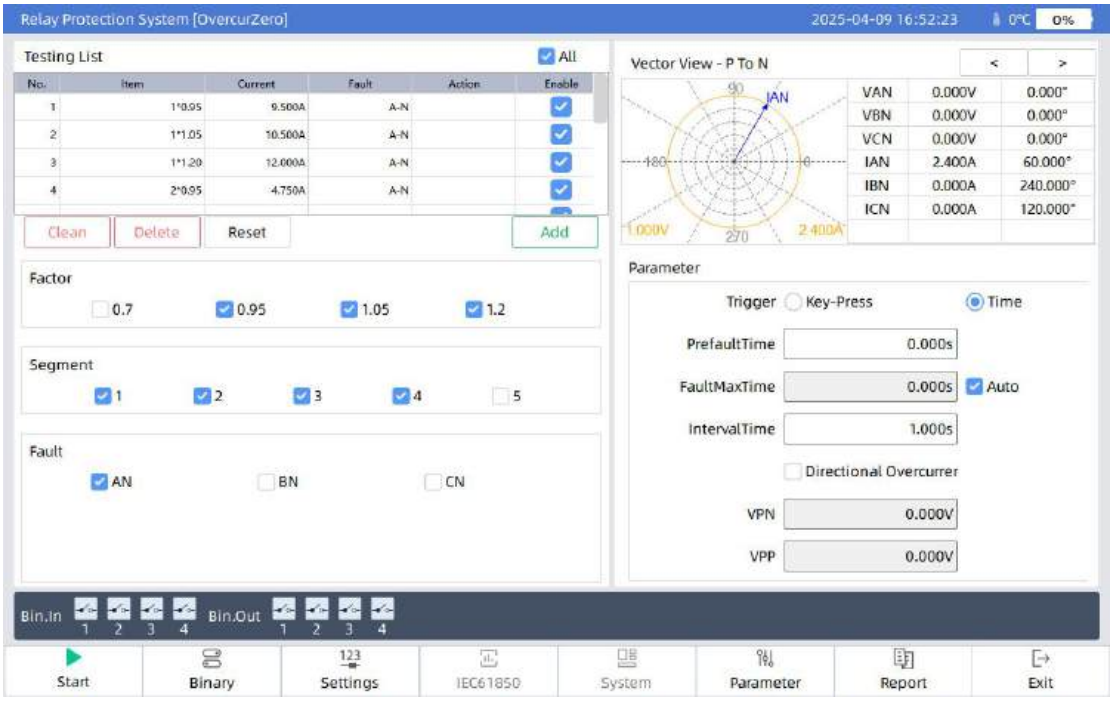
Zero-Sequence Overcurrent Protection Section II: 3A, 0.5s.

Zero-Sequence Overcurrent Protection Section III: 2A, 1s.

Zero-Sequence Overcurrent Protection Section IV: 1A, 1.5s.

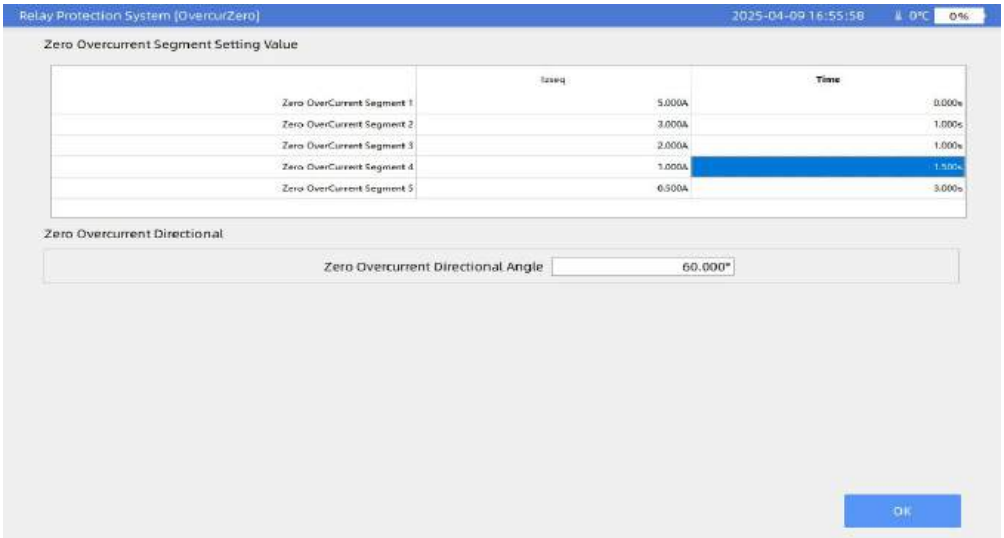
4) Software Parameter Settings

Enter the zero-sequence overcurrent sectional module to set the parameters.



a. **Set Setting Value Parameters Based on Protection Device Settings:**

Click "Settings" in the software interface to enter the setting value parameter configuration.



Set the values and times for Zero-Sequence Overcurrent Sections I, II, III, and IV based on the setting values.

b. **Select Test Multiples for Each Section:**

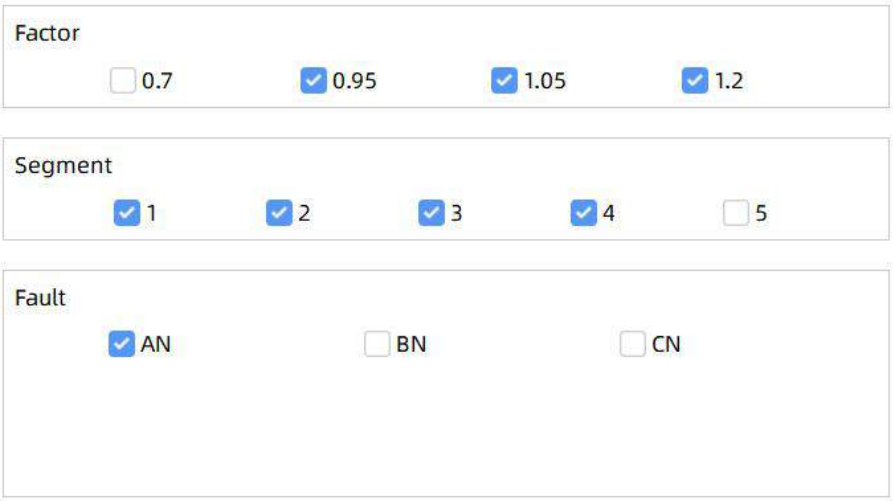
1.05 times the setting value for reliable operation.

0.95 times the setting value for reliable non-operation.

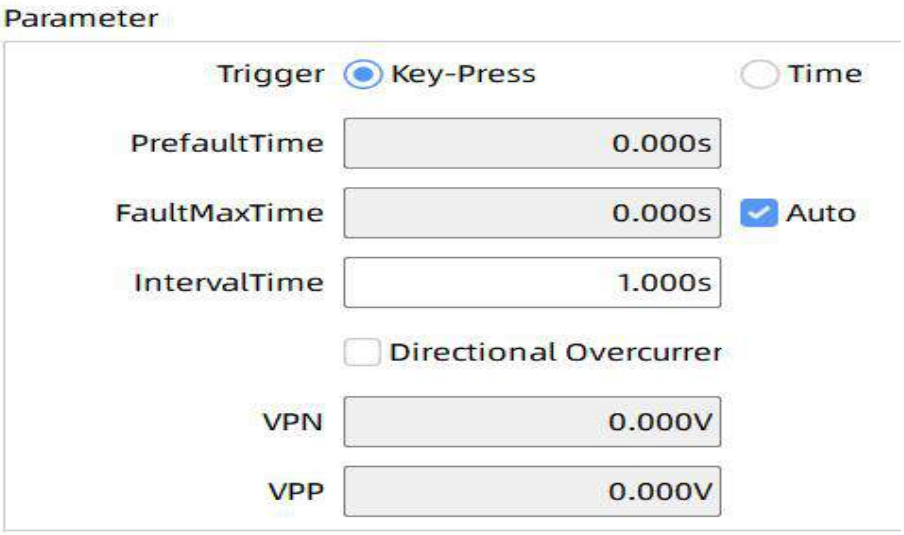
1.2 times the setting value to measure the protection operating time.

Select test sections: Sections I, II, III, and IV.

Check the fault type A-N (other fault types can be added as needed). Then click "Add to Test List."



c. Time Parameter Settings:



Set the trigger mode to "Key-Press." After running, wait for the protection device functions to reset, then click "OK" to trigger.

Check "FaultMaxTime" as automatic. The software will test according to the time settings in the values.

Set the interval time to 1s (greater than the contact reset time).

Check the overcurrent direction based on actual test requirements.

5) Start Testing： Click "Start" to test each test point, view and save the test results, and generate a test report.

10.1.7 Zero-Sequence Overcurrent Directional Protection

10.1.7.1 Test example 1: Zero-Sequence Overcurrent Directional Protection Test for PSL 602G Digital Line Protection Device

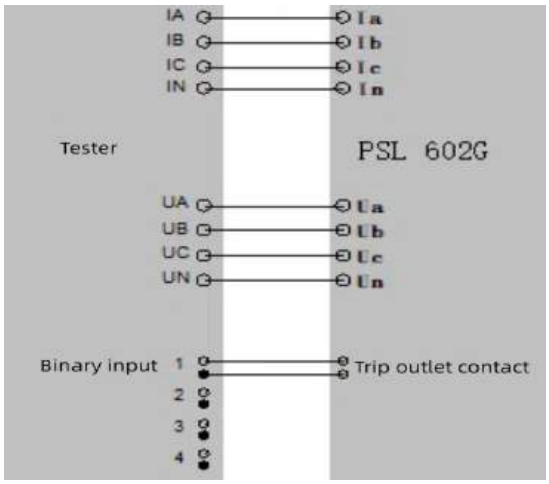
1) Test Purpose

Verify the operating boundary value of the zero-sequence overcurrent directional protection for the PSL 602G digital line protection device.

2) Test Wiring

a. Connect the three-phase voltage and three-phase current output terminals of the tester to the corresponding voltage and current input terminals of the protection device.

b. Connect the trip output contact of the protection device to the input contact 1 of the tester.



3) Protection Setting Configuration

a. PSL 602G Digital Line Protection Device Zero-Sequence Directional Settings:

The zero-sequence directional protection includes positive and negative directional elements. The sensitivity of the negative element is higher than that of the positive element.

The relationship between the positive zero-sequence current setting and the negative current setting is:

$$: \Gamma^{+}_{0ZD} > \Gamma_{0ZD}$$

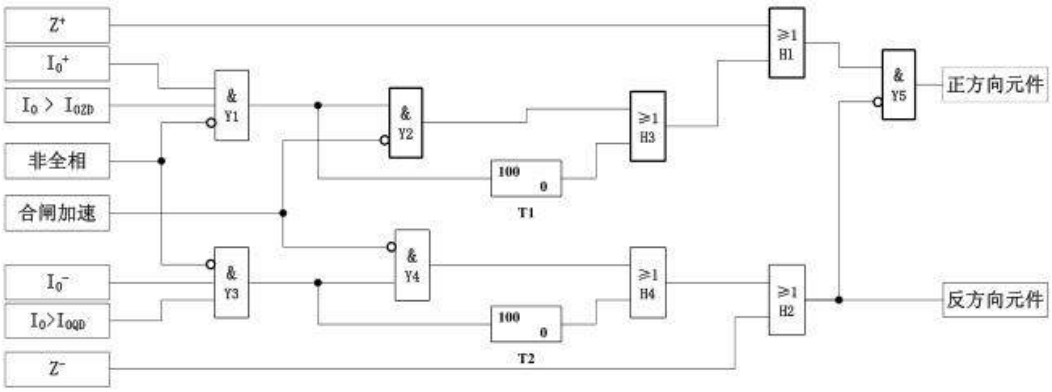
Γ^{+}_{0ZD} = Longitudinal zero sequence current rating

Γ_{0ZD} = Zero sequence current fixing

The voltage threshold of the zero sequence directional element is taken as a fixed threshold (0.5V) plus a floating threshold. The floating threshold is calculated based on the zero sequence voltage during normal operation. The sensitivity angle of the zero sequence directional element is -110° and the range of operation is as follows:

$$175^{\circ} \leq \arg \frac{3\dot{U}_0}{3\dot{I}_0} \leq 325^{\circ}$$

a) Directional Element Configuration:



b) Set Zero-Sequence Overcurrent Setting Section I to 5A, time to 0s.

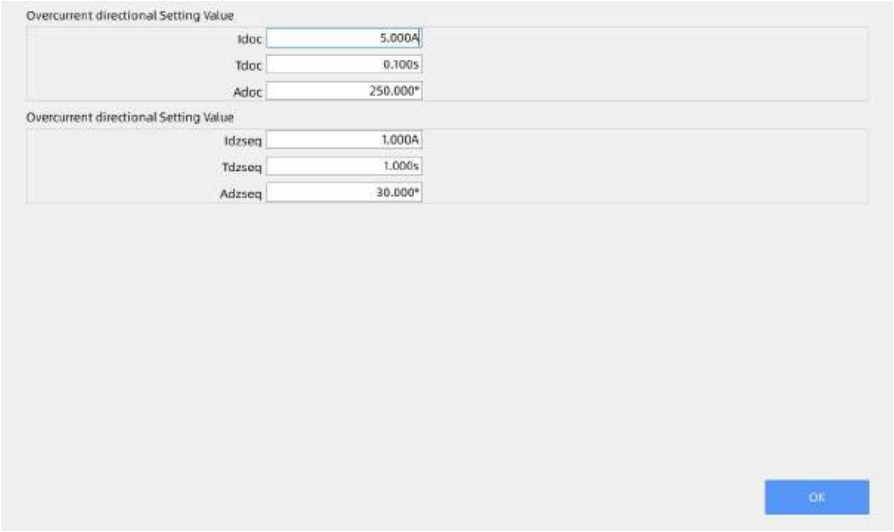
c) Enable Zero-Sequence Directional Overcurrent Section I, enable the zero-sequence protection hardware and software switches (set the relevant control words to 1), and disable other protection switches and control words (set the relevant control words to 0).

4) Parameter Settings

Click the overcurrent directional module and select the zero-sequence overcurrent angle to set the test parameters.

a. Click "Settings" to Enter the Setting Interface:

b. **Set the zero-sequence overcurrent operating value** to 5A, the zero-sequence overcurrent delay time to 0.1s, and the zero-sequence sensitivity angle to 250°. Other unrelated parameters can be set arbitrarily.

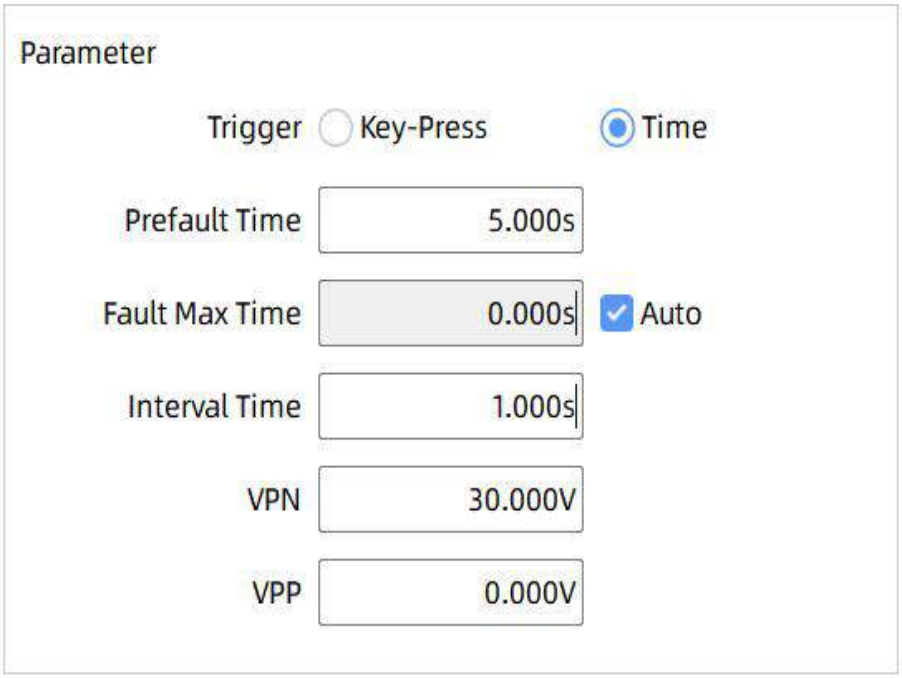


a) Select Zero-Sequence Overcurrent Angle:

Set the initial value to 170°, the final value to 330°, and the step size to 1°. Set the fault type to A-N, then add to the test list.

Set the initial value to 330°, the final value to 170°, and the step size to 1°. Set the fault type to A-N, then add to the test list.

Set the trigger mode to "Time," the pre-fault time to 5s, the Interval time to 1s (contact reset), and the Earthphase fault voltage to 30V. Set other unrelated parameters to 0.



5) Click "Start":

The software begins testing according to the set parameters. The test process includes:

Pre-fault state.

Fault state (initial value).

Fault interval.

Fault state (initial value + 1 step).

Fault interval.

Fault state (initial value + 2 steps).

...

Until the protection operates, then proceed to the next test point:

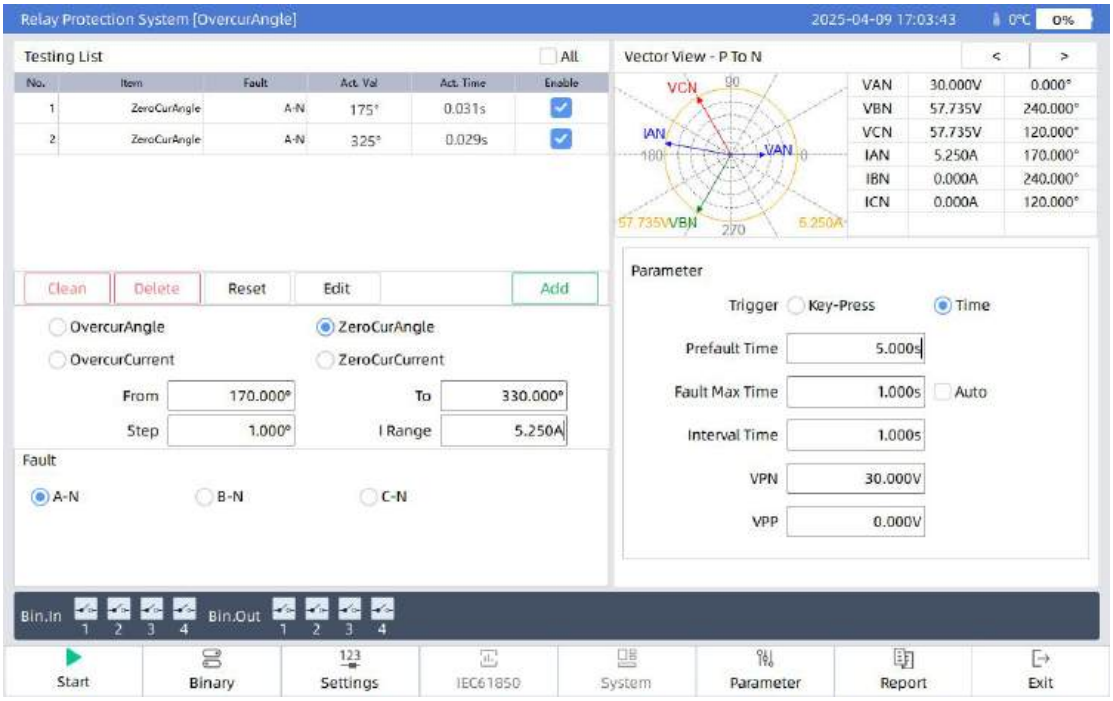
Fault state (initial value).

Fault interval.

...

Until the protection operates.

View and save the test results.



10.1.8 Automatic Reclosing

10.1.8.1 Test Example 1: Automatic Reclosing and Permanent Trip Test for GE Multilin-L90 Line Differential Protection Device

Test Task: Simulated test for the entire group of ground distance protection Section I, including trip time, reclosing time, and permanent trip time.

Protection Device: GE Multilin-L90 Line Differential Protection Device

Protection Settings:

Ground Distance Section I Setting: 1Ω, direction 75°, time setting 0s.

Zero-Sequence Compensation Method: Z0/Z1 compensation, Z0/Z1 = 1, angle 0°.

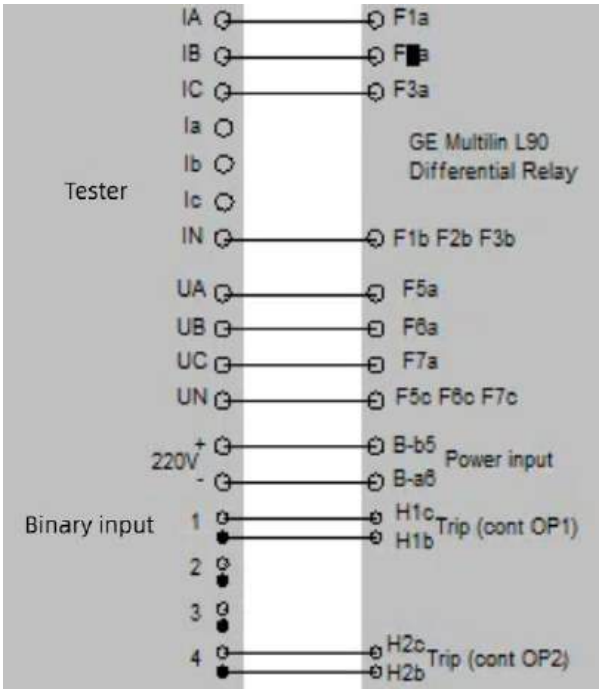
Reclosing charging time: 10s, reclosing trip time: 0.8s.

Protection Enable/Disable: Enable ground distance protection Section I and automatic reclosing.

1) Test Wiring

a. Connect the voltage and current output terminals of the tester to the corresponding voltage and current input terminals of the protection device.

b. Connect the trip output contact of the protection device to the input contact 1 of the tester, and the reclosing output contact to the input contact 4 of the tester, as shown in the figure below.



2) Parameter Settings

a. Based on the Protection Device Settings:

Set the impedance value to |1 Ω |, angle 75° , check 0.95 times (reliable operation), and set the direction to positive.

Set the calculation model to constant current, fault-circuit current to 2A, permanent fault, and fault type to A-N.

a) Trigger Mode Settings:

Set the trigger mode to "Time."

Set the prefault time to 15s (the prefault time generally needs to consider the reclosing charging time, PT disconnection recovery time, and contact reset time; set it to a value greater than the maximum of these, typically 20-25s).

Set the FaultMaxTime to 10s (the maximum fault time includes the trip time,

reclosing time, and permanent trip time; it should be set greater than the sum of these times).

Set the Interval time to 1s (for multiple test points, the Interval time should be set greater than the contact reset time).

b) Input Settings:

Set Input 1 to Trip A.

Set Input 2 to Trip B.

Set Input 3 to Trip C.

Set Input 4 to Reclose.

c) Set UX Output:

Since the protection reclosing does not check for no-voltage or synchronization, this can be set arbitrarily.

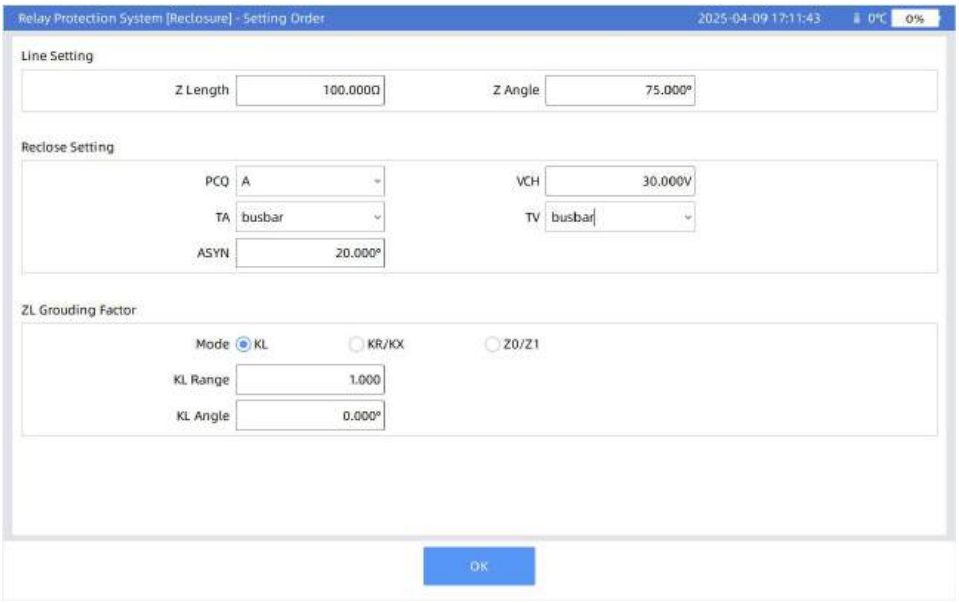
d) Setting Value Parameters:

Set zero-sequence compensation to Z0/Z1, with Z0/Z1 magnitude as 1 and angle as 0°.

Set the TA position to the line side and the TV position to the busbar side.

Set the line impedance angle to 75°. Other unrelated parameters can be set arbitrarily.

e) Fixed value parameter setting



Set the zero sequence compensation as Z0/Z1, Z0/Z1 amplitude as 1, angle as 0°, TA position as line side, TV as busbar side, line impedance angle as 75°. Other irrelevant parameters are set arbitrarily.

3) Start the Test

The process of this test is as follows: Prefault → Fault → Reclosing → Permanent Trip.

a. Click the 

button.

b. The tester sequentially simulates and outputs the voltage and current for the four states: pre-fault (3s), fault, reclosing, and permanent trip (total 10s). It records the trip

time, reclosing time, and permanent trip time.

c. After the test ends, save the test report.

d. Save the test parameters.

10.2 Transformer Protection

10.2.1 Differential Ratio & Restraint

10.2.1.1 Test example 1： Differential Ratio Restraint Test for PCS-978 Transformer Protection

Test Device: PCS-978

Test Item: High-Low Side Differential Ratio Restraint Test for PCS-978 Transformer Protection.

Setting Values:

Differential Quick Trip Setting: 5Ie

Differential Protection Start Setting: 0.5Ie

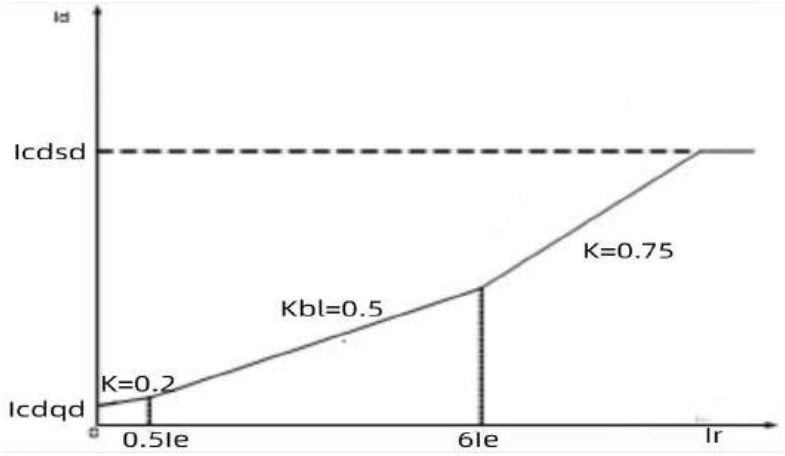


Figure 5.2.1-1: PCS-978 Manual - Steady-State Ratio Differential Protection Operating Characteristics

Step 1: Parameter Configuration:

Configure SV sampled value message parameters. Map the high-voltage side to the first group

of variables and the low-voltage side to the second group of variables. Set the transformation ratios for the first and second groups.

Configure GOOSE subscription: Map In1 to trip the high-voltage side.

Step 2: Setting Value Configuration:

Some setting values are obtained from the steady-state ratio differential protection operating characteristics diagram in the protection manual.

Ratio Restraint Characteristic Knee Point 1 Current: 0.5Ie

Ratio Restraint Characteristic Knee Point 2 Current: 6Ie

Start Current Slope: 0.2

Fundamental Ratio Restraint Characteristic Slope 1: 0.5

Fundamental Ratio Restraint Characteristic Slope 2: 0.75

Balance Coefficients for Each Side: Automatically calculated (requires input of rated capacity, rated voltage for each side, and CT ratios for each side).

High-Voltage Side Winding Connection Type: Set according to the actual field conditions.

Low-Voltage Side Winding Connection Type: Set according to the actual field conditions.

Correction Selection: △ Side Correction (PCS-978 uses △→Y side transformation to adjust the differential current, so select △ side correction).

Restraint Equation: Ir = (|I1| + |I2| * K2) / K1

K1: 2

K2: 1

Balance Coefficient Calculation: Ignore winding connection types.

Step 3: [Test Parameter] setting:

Prefault Time: 2 seconds;

Interval Fault time: 0.5 seconds;

Test winding: high - low (this test through the "high - low" on both sides of the differential calibration);

Low-voltage side wiring method Number of clock points: 11 points (adjusted according to the fixed value list);

TA positive polarity: internal transformer fault;

Primary side ratio and delay: first set of ratios and delays;

Secondary side ratio and delay: second set of ratios and delays;

Step 4: Adjust the test point position:

Adjust manually by touching the "Differential Ratio Braking Characteristics Graph" or automatically by pressing the "Search Line Sorting Position Organizer".

Step 5: Start the test:

Press the "Start" button to start the test, the test is completed automatically end, "Test Report" to view the test results.

10.2.1.2 Test example 2: CSC-326 transformer protection differential ratio braking test

Test Set: CSC-326

Test item: CSC-326 transformer protection high - low side differential ratio braking test

Setting value: Differential speed limit value Setting value: 6Ie

Differential protection start-up value: 0.5Ie

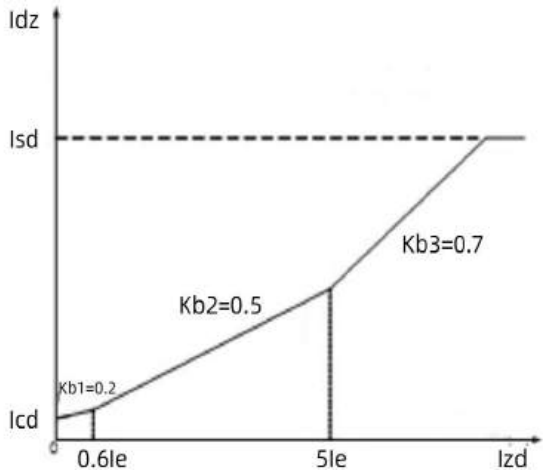


Figure 5.3.1-2 CSC-326 Instruction Manual - Steady State Ratio Differential Protection Operating Characteristics

Step 1: Parameter Configuration:

The high voltage side maps the first set of variables and the low voltage side maps to the second set of variables, setting the first and second set of variable ratios;

Step 2: [Rectified value] setting:

Some of the fixed values are obtained by looking at the operating characteristic diagram of the steady state ratio differential protection through the protection manual.

Ratio braking characteristic inflection point 1 current: 0.6Ie;

Ratio braking characteristic inflection point 2 current: 5Ie;

Starting current slope: 0.2;

Base wave ratio braking characteristic slope 1: 0.5;

Base wave ratio braking characteristic slope 2: 0.7;

Balancing factor of each side: automatic calculation (need to input rated capacity, rated voltage of each side and CT ratio of each side);

High-voltage side winding wiring type: set according to the actual situation on site;

Low-voltage side winding wiring type: set according to the actual situation on site;

Calibration selection: Y-side calibration (the CSC- 326 unit performs phase correction on the Y-side, so Y-side calibration is selected);

Braking equation: Ir=(|I1-I2|)/K1 or Ir=(|I1+I2|)/K1;

K1: 2;

K2: 1;

Calculation of balance coefficients: Winding wiring type is not taken into account;

Step 3: Test Parameter Settings:

PreFault Time: 2 seconds

Interval Time: 0.5 seconds

Test Winding: High-Low (this test verifies the differential protection between the high and low sides).

Low-Voltage Side Connection Clock Number: 11 (set according to the setting sheet).

TA Polarity: Internal transformer fault.

Primary Side Transformation Ratio and Delay: First group transformation ratio and delay.

Secondary Side Transformation Ratio and Delay: Second group transformation ratio and delay.

Step 4: Adjust Test Point Positions:

Manually adjust by touching the "Differential Ratio Restraint Characteristic Curve" or automatically adjust by clicking "Search Line Sorting Position Adjustment."

Step 5:Start the Test:

Click "Start" to begin the test. The test will automatically end upon completion. View the test results in the "Test Report."

11 Appendix: Software Functional Test Modules

	Protection relay Type	Test content	Recommended software modules
Line protection	Overcurrent Zone Segmentation	overcurrent verification	AC test, OvercurSegment
	Over (Under) Voltage	voltage verification	AC Test
	Frequency Protection	frequency verification	frequency protection
	Directional Power Protection	Power verification	AC Test
	Circuit Breaker Protection	circuit breaker performance test	AC Test, Sequence
	Reclosing, Acceleration	Reclosing Relay Test	Reclosure, Sequence
	Distance, zero sequence	Distance Relay Calibration	SttDistance, OvercurZero
	Power Frequency Variation Distance	Power Frequency Protection Test	DistanceZm
	Voltage-Controlled Overcurrent	Voltage-Restrained Overcurrent Test	OvercurVZlock
	Under Frequency, Slip Voltage	Under frequency Protection Test	Slip Frequency, Slip Voltage
Transformer protection	Generator, transformer differential protection	Differential Protection Verification	Differential

Dear Customer

Thank you for using KINGSINE's protection relay test system. I hope this manual will enable you to provide as detailed technical information and helpful information as possible for the use and operation of KINGSINE Electric products. All readers provide valuable comments. If you need business consulting or technical support services, please call or visit the company's website.

Attached:

Please pay close attention to the latest news on the company's website in order to obtain the latest and most helpful first-hand information for your work.

The functions and pictures mentioned in this manual are subject to the actual released product.

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