PRS-7000

Integrated Monitoring System

Instruction Manual

CYG SUNRI CO., LTD.

Preface

Introduction

This guide and the relevant operating or service manual documentation for the equipment provide full information on safe handling, commissioning and testing of this equipment.

Documentation for equipment ordered from CYG SUNRI CO., LTD. is dispatched separately from manufactured goods and may not be received at the same time. Therefore this guide is provided to ensure that printed information normally present on equipment is fully understood by the recipient.

Before carrying out any work on the equipment, the user should be familiar with the contents of this manual and must read to the relevant chapters carefully.

This chapter describes the safety precautions recommended when using the equipment. Before installing and using the equipment, this chapter must be thoroughly read and understood.

Health and Safety

The information in this chapter of the equipment documentation is intended to ensure that equipment is properly installed and handled in order to maintain it in a safe condition.

When electrical equipment is in operation, dangerous voltages will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and equipment and cause personal injury or physical damage.

Before working in the terminal strip area, the equipment must be isolated.

Proper and safe operation of the equipment depends on appropriate shipping and handling, proper storage, installation and commissioning, and on careful operation, maintenance and servicing. For this reason, only qualified personnel may work on or operate the equipment.

Qualified personnel are individuals who:

- Are familiar with the installation, commissioning, and operation of the equipment and of the system to which it is being connected;
- Are able to safely perform switching operations in accordance with accepted safety engineering practices and are authorized to energize and de-energize equipment and to isolate, ground, and label it;
- Are trained in the care and use of safety apparatus in accordance with safety engineering practices;
- Are trained in emergency procedures (first aid).

Instructions and Warnings

The following indicators and standard definitions are used:

DANGER! means that death, severe personal injury and considerable equipment damage will occur if safety precautions are disregarded.

WARNING! means that death, severe personal and considerable equipment damage could occur if safety precautions are disregarded.

CAUTION! means that light personal injury or equipment damage may occur if safety precautions are disregarded.

NOTICE! is particularly applies to damage to device and to resulting damage of the protected equipment.

DANGER!

NEVER allow the current transformer (CT) secondary circuit connected to this equipment to be opened while the primary system is live. Opening the CT circuit will produce a dangerously high voltage.

WARNING!

ONLY qualified personnel should work on or in the vicinity of this device. This personnel **MUST** be familiar with all safety regulations and service procedures described in this manual. During operating of electrical device, certain part of the device is under high voltage. Severe personal injury and significant device damage could result from improper behavior.

WARNING!

Do **NOT** touch the exposed terminals of this device while the power supply is on. The generated high voltage causes death, injury, and device damage.

WARNING!

Thirty seconds is **NECESSARY** for discharging the voltage. Hazardous voltage can be present in the DC circuit just after switching off the DC power supply.

CAUTION!

- **Earthing**

  Securely earthed the earthing terminal of the device.

- **Operating environment**

  ONLY use the device within the range of ambient environment and in an environment free of abnormal vibration.

- **Ratings**

  Check the input ratings **BEFORE** applying AC voltage/current and power supply to the device.

- **Printed circuit board**

  Do **NOT** attach or remove printed circuit board if the device is powered on.

- **External circuit**

  Check the supply voltage used when connecting the device output contacts to external circuits, in order to prevent overheating.

- **Connection cable**

  Carefully handle connection cables without applying excessive force.

NOTICE!

The firmware may be upgraded to add new features or enhance/modify existing features, please **MAKE SURE** that the version of this manual is compatible with the product in your hand.

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1 Profile

1.1 Background description

PRS-7000 integrated monitoring system is a monitoring operating system self-designed and deeply-developed by CYG SUNRI based on SAS research achievements and field operating experience for many years. PRS-7000 is designed by integration of the advanced distributed-type network technology, object-oriented database technology and cross-platform visualization technology, fully complied with multiple international standards (IEC60870-5-103, IEC-61850 etc.). Adhere to the basic requirements for station information digitalization, communication platform networking and information sharing standardization, PRS-7000 can achieve unified access, storage and display of information in the whole station through system integration opimization. Besides, other functions can be realized, e.g. operational monitoring, operation and control, integrated analysis of information, record analysis, operating management, auxiliary application etc. PRS-7000 integrated monitoring system can also be applied to human-machine interface systems of general substation, digital substation, power plant etc.

PRS-7000 integrated monitoring system adopts distributed-type and extensible system frameworks, which can be applied to various system structures. The application program and database can be flexibly configured in each computer node, and no modification of application program is required. PRS-7000 integrated monitoring system can be installed in a computer with different operating systems, e.g. Linux, Windows, and Unix. The system is easy to be extended to user demands, which can meet requirements from users in aspects of system flexibility and extendibility to the greatest extent.

This product is suitable for:

- Electric system

Traditional substation, power station (hydropower station, thermal power plant and wind-power or PV new energy substation), and digital substation of different voltage levels;

- Other systems

Metro system, light rail system, electrified railway system;

Other industrial automation applications: mine, petrochemical industry, metallurgy etc.

1.2 Technical features

PRS-7000 integrated monitoring system provides a development platform which can meet various monitoring demands for intelligent substations. The main platform module includes data configuration (modeling) tool, database system supporting dynamic model, communication unit configuration tool, graphic configuration, communication protocol processing module, data bus module, system function redundant control module, statistical calculation, SCADA module, etc. which are designed crossing the Unix/Linux/Windows operating system platform.

Main technical features of the PRS-7000 integrated monitoring system are shown as follows:

1. The system is crossing multiple software and hardware platforms with great extendibility.
2. Based on the 64-bit system programming, multiple processes and multiple threading modes, the system reasonably utilizes the 64-bit system resources and dispatching model, and guarantees the reliability and timeliness of the monitoring system.
3. Unified data configuration modeling

- As a data platform applied to the substation, PRS-7000 integrated monitoring system adopts the dynamic modeling mode to conveniently build data models of various application in the system, and save in the commercial database by using the unified configuration tool. The real-time database adopts the method of resident memory, so each data object has an overall object index number, and the hierarchical index relation between objects is kept by each data object. All application programs at the platform can save the hierarchical relations between all data models and data objects through the unified data interface, so that all application data can be integrated seamlessly.
- The unified configuration tool can be used to configure different application information related to the various data sheets in the system database, including adding, deleting and modifying various data models, etc.
- The unified configuration tool can transform engineering data, and can transform engineering data of low version to the new system engineering data;
- On-line modification and easy maintenance for all data models and graphic pictures in the database can be realized.

4. Dynamically extensible communication protocol management

- The system communication management unit supports dynamic extension methods of communication protocol. For the new external communication unit, the new protocol analysis shall be opened, and the protocol configuration item shall be added to the database.
- The communication protocol management module is separated from the real-time monitoring module. The interactive interface of them is unified, which can prevent any unsafe information from violating the system; the extension of external communication protocol will not impact normal operation of the real-time monitoring module with its great extendibility.

5. Organic unification between IEC60870-5-103 and IEC61850

- IEC60870-5-103 is a main communication standard applied to most of the substations at present. IEC61850 is the latest seamless communication standard for substations, which will be the dominant communication standard in the future with its wide application, but the new and old equipment will be applied to the substation automation systems at the same time over a period of time.
- During the design and development of PRS-7000 integrated monitoring system, co-existence

of the aforementioned two standards is considered. Besides, supports of the two standards in aspects of database, communication management, signal processing are all realized.

6. Graphic system unrelated to application

- Based on MVC framework, the graphic interface subsystem separates the view display (V) and specific application model (M). The application controller (C) is applied to interpret all information and operating instructions of the system and control the output results displayed by the view, which can maintain the conformity between application model and view display and cut down differences between all kinds of application models (M). Separation between view and application business brings low coupling and high extensibility to the system, so the system can be conveniently applied to the thermal power plants, wind power plants, PV power plants, substations, etc.
- The graphic system supports some standard graphic formats (SVG, CIM/G, etc), with good interaction.

7. Integrated Anti-maloperation technology

- Based on the system control rule settings of the script engine, flexible and professional bay anti-maloperation configuration, and the built-in operating order management module, the system can realize integrated anti-maloperation blocking functions;
- The microcomputer anti-maloperation system and SCADA systems have the unified data bus. The anti-maloperation module acquires data from the same real-time database which provides data for other application modules in SCADA systems;
- The microcomputer anti-maloperation system and SCADA systems have the unified database configuration. The anti-maloperation data directly selects measuring points from automation data and edits anti-maloperation attributes, including close/open rule, operational terms, etc;
- The microcomputer anti-maloperation system and SCADA systems have the unified graph editing. The graphic picture of automation system can be directly used as that of anti-maloperation system;
- The microcomputer anti-maloperation system and the bay-layer measuring and control device share the rule base. Equipment on bay-layer can judge the blocking conditions of current interval, and realize mutually blocking between cross-bay equipment.

8. Protection management integrated technology

- The monitoring system and protection management system adopt the unified modeling tool, graphic configuration and database, achieving integration of configuration;
- Setting calling, setting modification, setting section switching, setting inspection and other functions are possessed by the monitoring host;
- The monitoring host realizes the fault record acquiring function. The acquired fault record is

stored in the data server to be provided for data gateway device;

- The monitoring hose realizes on/off function of the soft switch.

9. Load sharing and redundancy technology

61850 client adopts multiple backup redundancy mode. When fatal error occurs to the process providing 61850 client services and related service cannot be provided further, or the machine providing services are under high load for a long time, 61850 client in other machines will apply for providing primary services to the system management and service program. The primary services will select and set the suitable services to master server according to the queuing strategy. By overall consideration of system information of the work station, including system information, CPU usage information, memory usage information, disk usage information, disk occupancy information, network card usage information, etc, the work station under the lightest load will be selected to provide 61850 client primary services.

Based on the multiple backup redundancy, combined with rational consideration of load of workstations providing services, this technology can effectively avoid the overload condition of some workstations and guarantee the overall stability of the system.

10. Flexible networking mode

- The background networking mode of the system is flexible; the master-slave server mode and dual-single network mode can be selected as required; number of network nodes can be added or deleted flexibly; the specialized LAN management module and WAN WEB interface management module provide multiple system network functions;
- Data can be synchronized between multiple systems.
- The system background is designed with the soft-bus technology “SoftBus”, ensuring the stable access of each functional module.

11. Powerful script calculation function

- The powerful embedded script engine and operating machine are easy to use, which can achieve a variety of calculation signal expression and complex operating and control rules logic configuration;
- Analog quantity, status quantity and metering quantity can be calculated.

12. Complete simulation commissioning tool

- The system provides the specialized communication commissioning tool to simulate data generating tool, build internal diagnosis and maintenance module to maintain reliable operation of the monitoring system;
- The system contains complete communication message monitoring tool, which facilitates checking and positioning of communication problems and improves commissioning efficiency;
- The system provides the remote browsing and alarming direct transmission simulation master

station tools, which makes remote browsing and field commissioning of alarming direct transmission easy.

1.3 Technical index

The system indexes mainly contain the following aspects: system capacity, system response index, reliability index, load rate, working environment, power supply, etc, which all meet technical requirements for integrated monitoring system, as shown in the following table:

1.3.1 System capacity

Table 1.3.1 System Capacity Index

No.	Item		Unit	System Capacity
1	Capacity of real-time database	Analog quantity	Sample point	≥50000
		Status value	Sample point	≥100000
		Remote control	Sample point	≥10000
		Calculated quantity	Sample point	≥2000
2	Storage capacity of historical database	Historical curve sampling interval	min	1～30 (Adjustable)
		Historical trend curve, storage duration of daily report, monthly report and annual report	year	≥2
		Number of historical trend curves	PCS.	≥300
3	Synchronous vector storage	Continuous recording time	day	≥14

1.3.2 System response index

Table 1.3.2 System Response Index

No.	Item		Unit	System Capacity
1	Event sequence record resolution (SOE)	Station layer	ms	≤2
		bay layer measuring and control unit	ms	≤1
2	Over deadband transmission time of analog quantity (to station layer)		s	≤2
3	Status value change transmission time(to station layer)		s	≤1
4	Response time of analog information (from I/O input terminal to remote communication device output)		s	≤3
5	Status quantity change response time (from I/O input end to remote communication device outlet)		s	≤2
6	Time from generating to outputting of control execution command		s	≤1
7	Picture response		s	≤1
8	Image refreshing period		s	≤1
9	Scada master-slave switching time		S	≤10

1.3.3 Reliability index

Table 1.3.3 System Reliability Index

No.	Item		Unit	System Capacity
1	Measuring error of current, voltage		%	≤0.2
2	Measuring error of active power and reactive power		%	≤0.5
3	Measuring error of grid frequency		Hz	≤0.01
4	Over deadband transmission setting value of analog quantity		%	<0.1 rated value, each point can be adjusted
5	Availability ratio of dual-host system		%	≥99.9
6	Response ratio of remote signal		%	100
7	Accuracy of control operation		%	100
8	Mean time between failures (MTBF) in station layer		h	≥30000
9	Mean time between failures of bay level measure and control unit		h	≥30000
10	Mean load rate of CPU in each workstation	Under normal condition (within 30min)	%	≤30
11		Power system breakdown (within 10s)	%	≤50
12	Mean load rate of network	Under normal condition (within 30min)	%	≤20
13		Power system breakdown (within 10s)	%	≤40
14	Time from automatic switching to functional recovery of dual host		s	≤15
15	Accuracy of synchronous phase	Amplitude	%	≤0.2
16		Phase angle	°	≤0.2
17		Time synchronization	μs	≤1
18	Storage of synchronous phase	Continuous recording time	day	≥14

1.3.4 Load rate

CPU load rate and network mean load rate indexs of the computer are shown as follows:

Table 1.3.4 System Load Rate Index

No.	Item		Unit	System Capacity
1	CPU mean load rate of each workstation	Under normal condition (within 30min)	%	≤30
2		Power system breakdown (within 10s)	%	≤50
3	network average load factor	Under normal condition (within 30min)	%	≤20
4		Power system breakdown (within 10s)	%	≤40

1.3.5 Working environment and power supply

Table 1.3.5 System Working Environment and Power Supply Index

No.	Item	Unit	System Capacity
1	AC voltage	V	176V～264V AC
2	Cycle	HZ	48Hz～52Hz
3	Ground resistance	Ω	<0.5Ω
4	Temperature	℃	≤55℃
5	Related humidity	%	5%～95%
6	Ambient environment	None	No explosion hazards, no corrosive gas, no conducting dust, no severe mycete, no violent vibration and impulse source

1.3.6 Software version

Product Name	Software Name	Version
PRS-7000 Integrated Monitoring System	PRS-7000	V2.20

1.3.7 System Hardware Environment

The selection of each server in the PRS-7000 integrated monitoring system is based on the high-end selection in the industry, and the hardware parameters and performance indicators of the machine are not lower than the parameter indicators required for the server in the technical specifications for intelligent substation construction.

The hardware configuration description is as follows:

No.	Item	Capacity
1	Processor Word Length	≥ 64 bits
2	CPU	≥ 2 sockets (≥ 4 cores/socket)
3	CPU Speed	≥ 2 GHz
4	Memory	≥ 4 GB
5	Graphics Memory	≥ 1 GB
6	Hard Disk (SAS)	≥ 500 GB
7	Number of Ethernet	≥ 4
8	Network Speed	≥ 100/1000 Mbps adaptive
9	Operating System	LINUX or WINDOWS
10	Installation type	Rack-mounted
11	Graphics Cards	Dual Graphics Cards

1.3.8 System software environment

1.3.8.1 operating system

The PRS-7000 integrated monitoring system supports multiple operating systems, mainly including the following:

- Linux
- Window

1.3.8.2 System software

The database system can be designated by other commercial databases by the user. The system adopts an object-oriented programming method, adopts Visual C++, GCC, Qt, and JAVA development environments, and uses database configuration tools and reports to generate popular configuration interfaces for window screen output and graphical reports with both text and graphics. The system has excellent features such as modular structural design, flexible and convenient networking method, efficient database access operation, multi process and multi thread mode, etc., making it highly reliable, convenient human-machine interaction operation, high-quality image display, and good scalability.

2 Supervisory Control and Data Acquisition System (SCADA)

2.1 Profile

SCADA kernel is the data processing and function realization core of the whole integrated automation system. SCADA kernel has two working modes (main server SCADA and standby server) according to different topology and role during operation. During operation of SCADA kernel, the network processing layer is loaded to handle transmit-receive of real-time data message, and the configuration information is obtained from configuration database of data server system. In addition, SCADA can realize interaction with real-time database and historical database.

The real-time database describes the collection of monitoring points and management data points of the power automation system with the unit of variable (point). Based on that, PRS-7000 monitoring system real-time database is a collection of monitoring and management points (variables) organized in a certain form. The functions of running monitoring, operation and control, information comprehensive analysis, intelligent warning, auxiliary application, etc are based on the real-time database.

In Client/Server mode, the main server SCADA kernel handles real-time data of the 103/61850 direct-connecting secondary equipment and the front-endprocessor, updating the local real-time database, saving the historical database records into the data server and distributing synchronous data to all client ends and backup servers to main the conformity between real-time and historical data. The front-end processor uploads real-time data.

2.2 Data Acquisition

SCADA system collects grid steady, dynamic and transient data, and running status data of primary, secondary and auxiliary equipment. It can also send all kinds of control commands to IED and auxiliary systems within the station, supporting DL/T860 and accomplishing unified access of data.

2.2.1 Grid –Running Data Acquisition

2.2.1.1 Steady Data Acquisition

The main grid steady running data packages collected include:

Table 2.2.1 Grid Steady Running Data

No.	Item	Source
1	Status data acquisition	Positions of feeder, connecting line, bus-bar (section), breaker on side of transformer
		Positions of capacitor, reactor, breaker on side of transformer

		Positions of bus, feeder, connecting line, and disconnector of main transformer
		Positions of ground switch
		Positions of PT disconnector and bus ground switch
		Positions of main transformer tap, ground switch at neutral point, etc
2	Measurement data acquisition	Feeder, connecting line, bus-bar (section), current, voltage, active power, reactive power, and power factor on each side of transformer
		Bus voltage, zero-sequence voltage, frequency
		Current of breaker with the 2/3 wiring method
		Electric energy data: a. Active/reactive power on sides of the main transformer b. Active/reactive power of connecting line and transmission line c. Active/reactive power of by-pass switch d. Active/reactive power of feeder e. Reactive power of compensating capacitor and reactor in parallel f. Active/reactive power of transformer for station use
		Statistics, calculated data
3	Grid operating condition information is acquired by measuring and control device	The information source is a primary equipment auxiliary contact, which is directly connected to measuring and control device or intelligent terminal through the cables. The measuring and control device adopts the transmission mode of MMS message, and the intelligent terminal adopts the transmission mode of GOOSE message.
4	Grid operating measurement data is acquired by measuring and control device	The information source is the mutual inductor (output through merging unit)
5	Electric quantity data	The information source is the electric energy metering terminal or electronic watt-hour meter

2.2.1.2 Dynamic Data Acquisition

The grid dynamic operating data acquired is shown as follows:

Table 2.2.2 Grid Dynamic Operating Data

No.	Type	Contents
1	Range of information	Positive-sequence fundamental wave voltage phasor, positive-sequence fundamental wave current phasor of line and bus
		Frequency, change rate of frequency

No.	Type	Contents
		Active and reactive calculated quantity
2	Source of data	The dynamic data is acquired through PMU device; the information source is the mutual inductor (output through merging unit)
		The acquisition and transmission rate of dynamic data can be adjusted according to control command or grid operation event

2.2.1.3 Transient Data Acquisition

The grid transient operating data acquired is shown as follows:

Table 2.2.3 Grid Transient Operating Data

No.	Type	Contents
1	Range of information	Main-transformer protection wave recording data
		Line protection wave recording data
		Bus protection wave recording data
		Capacitor/reactor protection wave recording data
		Switch opening/closing wave recording data
		Abnormal measurement wave recording data
2	Source of data	The wave recording data is collected with fault recording device

2.2.2 Equipment Operation Information Acquisition

2.2.2.1 Primary Equipment Data Acquisition

On-line monitoring information of primary equipment acquired is shown as follows:

Table 2.2.4 On-line Monitoring Information of Primary Equipment

No.	Type	Contents
1	Range of information	Temperature of transformer oil, temperature of winding hot-spot, deformation of winding, oil level, grounding current of iron core, partial discharge data, etc.
		Gas content in the oil chromatography of transformer
		GIS, SF6 gas density (pressure) of breaker, partial discharge data, etc
		Stroke-time character of breaker, waveform of opening/closing coil current, working status of energy-storage motor, etc.
		Leakage current, resistance current and action times of arrester
		Other monitoring data

2	Source of data	The on-line monitoring device shall upload equipment status information and abnormal warning signal
		The primary equipment on-line monitoring device

2.2.2.2 Secondary Equipment Data Acquisition

Operating status information of secondary equipment acquired is shown as follows:

Table 2.2.5 Operating Status Information of Secondary Equipment

No.	Type	Contents
1	Range of information	Information about operating condition of device
		on/off signal of device soft switch
		Device self-check, blocking and time synchronization status, channel communication status monitoring and alarm signal
		Abnormal alarm signal of device SV/GOOSE/MMS link circuit
		Control, operating and blocking status signal of measuring and control device
		Setting value and current setting zone number of protective device
		Operating status and abnormal alarm signal of network communication equipment
		Health status diagnosis results and abnormal warning signals of secondary equipment
2	Source of data	Provided by equipment of station control layer, bay-layer equipment and process-layer equipment

2.2.3 Auxiliary Equipment Data Acquisition

Operating status information of auxiliary equipment acquired is shown as follows:

Table 2.2.6 Operating Status Information of Auxiliary Equipment

No.	Type	Contents	
1	Range of information	Measurement data of auxiliary equipment	Voltage of DC power supply bus, input voltage/current of battery charger, load current, etc.
			AC/DC input voltage and AC output voltage of inverter, etc.
			Ambient temperature, humidity, etc.
			density of oxygen or SF_6 in the switch gear room, etc.
		Status quantity information of auxiliary equipment	Positions of inlet/outlet switch of AC and DC power supply
			Working condition, abnormal and loss-of-power

No.	Type	Contents	
			alarm signal of equipment, etc.
			Security, fire protection, entrance guard alarm signals, etc.
			Abnormal alarm signals about environmental monitoring, etc.
2	Source of data	Provided by power supply, security, fire protection, video, entrance guard and environmental monitoring device, etc.	

2.3 Data Processing

SCADA system acquires and processes real-time grid operating data, primary and secondary equipment operating data, auxiliary equipment data in the station, and finally display the data to HMI.

2.3.1 Processing of Analog Quantity Data:

Processing of analog quantity data includes:

2.3.1.1 Conversion and Processing of Analog Quantity Raw Material:

The received original value of analog quantity data is converted and processed according to the scale, ratio and other parameters. Finally, the displayed actual value is in conformity with the actual quantity of engineering.

2.3.1.2 Analog Quantity Calculation:

The calculated quantity measurement measured value can be generated automatically according to related self-defined formula.

2.3.1.3 Manual Number-setting:

Manual number-setting for the analog quantity measured value can be performed. Under the manual number-setting status, the tab can be used to prompt. The analog will recover refreshing after relieving manual number-setting.

2.3.1.4 Zero-drifting Processing:

Zero-drifting range of each analog quantity can be set. When the measured value of analog quantity is within this range, the analog quantity will deem as zero.

2.3.1.5 Jumping Change Data Processing:

Table 2.3.1 Jumping Change Data Processing Mode

No.	Processing mode
1	The jumping change maximum increment of each analog quantity can be set. When the increment between the received measured value and the previous measured value exceeds the limit, current

No.	Processing mode
	measured value shall be abandoned.
2	When the measured value of analog quantity is out of the range of jumping change limit value, the post disturbance review will be triggered to record the data information before and after the jumping change; limit value of the jumping change can be set.

2.3.1.6 Judgment of Effectiveness and Rationality of Analog Quantity Data

Table 2.3.2 Judgment of Effectiveness and Rationality of Analog Quantity Data

No.	Judgment model	Criteria
1	Effectiveness	When communication between the secondary equipment and monitoring system interrupts, corresponding analog quantity status of the secondary equipment will be invalid; when the communication recovers, the analog quantity status will be valid.
		When the status is invalid, the tab shall be used to prompt.
2	Rationality	The minimum and maximum rational value of each analog quantity can be set. When the measured value is larger than the maximum value or smaller than the minimum value, the analog quantity status will be invalid, and the tab will be used to prompt; when the measured value recovers to the normal range, the status will be valid.
		When the analog quantity data does not refresh for a long time, the tab shall be used to prompt. The alarming differential value of not refreshing for a long time and the alarm delay can be set.

2.3.1.7 Analog Quantity Returns to Zero

When the status quantity information (for example position of breaker) is not corresponding to the analog quantity, alarm will work. For example, when the circuit breaker is open, but the circuit current and power are above zero, alarm signal will be given out.

2.3.1.8 Over limit Monitoring and Alarm of Analog Quantity

Table 2.3.3 Over limit Monitoring and Alarm of Analog Quantity

No.	Contents
1	Monitoring of analog quantity exceeding upper limit, extremely upper limit, lower limit or extremely lower limit. When the analog quantity exceeds the limit, the “over-limit” alarm will work with the alarm level of “over-limit”. The “over-limit” alarm records will be formed and saved into the historical database, can save at least 512 records.
2	The “over-limit” alarm records include name of analog quantity, “over-limit” type, “over-limit” setting value, measured value, time of “over-limit”. A “over-limit” recovery record will generate when the “over-limit” recovers.

3	The upper limit, extremely upper limit, lower limit and extremely lower limit of each analog quantity can be set.
4	The “over-limit” alarm should be set with time delay. The time delay can be set..
5	When it is over limit, the multiple-level alarm modes can be adopted: “over-limit” records display, audio alarm, voice alarm, pushing picture, etc.
6	Over-limit alarm inhibition can be realized.
7	Over-limit alarm blocking and relief can be realized.
8	Over-limit dead band of each analog quantity can be set to avoid frequent alarm around the over-limit value.

2.3.2 Status Quantity Data Processing

The status quantity data processing adopts event driven mode, that is to say when status quantity appears, it will be processed immediately. SCADA system mainly performs the following processing for status quantity data.

2.3.2.1 Judgment of Fault Trip

Judge whether it is the fault tripping or manual open according to total fault signal and breaker operation information. After the breaker trips, the SCADA system will judge whether the total fault signal exists within a certain time period before and after COS of breaker. If the total fault signal exists, the accident trip alarm will work.

2.3.2.2 Manual Statue-setting of Status Quantity Data

Table 2.3.4 Manual Statue-setting of Status Quantity Data

No.	Operating mode	Operational contents
1	Manual status-setting	Manual status-setting and manual negating can be performed to status quantity
		The tab can be used to prompt when manual status-setting is carried out.
		Recovery refreshing can be realized. Real-time status quantity can be adopted after recovery refreshing.
2	Manual labeling	Manual labeling can be performed to the primary equipment, including maintance signboard and grounding signboard.
		After the equipment is labeled, the behavior property of the signboard will be valid at once, e.g. “prohibit operation”, “prohibit alarm”, etc.
		After label of the equipment is removed, the behavior property of the signboard will be invalid at once .

2.3.2.3 Judgment of Effectiveness and Rationality of Status Quantity Data

Table 2.3.5 Judgment of Effectiveness and Rationality of Status Quantity Data

No.	Judgment model	Criteria
1	Effectiveness	When communication between the secondary equipment and monitoring system interrupts, status of the status quantity send by the secondary equipment will be invalid; when the communication recovers, the analog quantity status will be valid.
		When the status is invalid, the invalid tab will be used to prompt. If this status quantity is the position signals of primary equipment, e.g.breaker, disconnector, etc., the remote control of related primary equipment will be blocked.
2	Rationality	Check for the consistency of the dual-position status quantity of primary equipment. When the dual-position is not consistent, the status of status quantity will be under abnormal status. When the dual-position recovers, it will be under normal status.
		When it is under abnormal status, abnormal alarm will work, and remote control of related primary equipment will be blocked.

2.3.2.4 Logic Calculating and Processing of Status Quantity Data

Table 2.3.6 Logic Calculating and Processing of status quantity data

No.	Processing mode	Contents processed	
1	Calculation of status quantity	Calculation formula can be edited casually to achieve the calculation functions of status quantity signal.	
		The signal types involved in formula calculation can be status quantity or measured quantity.	
2	Negation	After setting the negation attribute, the status quantity will be negated according to the status quantity raw data, and the actual status quantity will be obtained.	
3	Signal synthesis	“And” logic	Through “And” logic, multiple signals will become new signal values
		“Or” logic	Through “Or” logic, multiple signals will become new signal values
		“Exclusive Or” logic	Through “Exclusive Or” logic, multiple signals will become new signal values
		“Not Exclusive Or” logic	Through “Not Exclusive Or” logic, multiple signals will become new signal values
		Single points synthesize to dual-point	Synthesize two single-point signals to a dual-point signal according to the sequence of “open position first, and then the closing”.

		Dual-point decomposes into open position	Extract the value of open position signal from the dual-point signal value, and the single-point open position signal will generate.
		Dual-point decomposes into closed position	Extract the value of closing position signal from the dual-point signal value.
		Synthesis of total fault signal	The t total fault signal can be obtained through switch closing and jumping signal calculation; or obtained through protective action signal and switch jumping signal.

2.3.2.5 Anti-maloperationAnti-maloperation Key Assignment

If the monitoring system is configured with integrated anti-maloperation, some primary equipment (e.g. ground wire) whose actual status cannot be collected, the status quantity can be assigned value by using the anti-maloperation key;

The original status of equipment with the value assigned by the anti-maloperation key can be set;

During actual operation, the status quantity of equipment can be refreshed according to the anti-maloperation steps. For example, if current status of the ground wire is open, after the ground wire is closed and the anti-maloperation operation orders have passed back to the monitoring system, the monitoring system will set the status of ground wire as “closed”.

2.3.2.6 Processing of Status Quantity Alarm

Table 2.3.7 Processing of Status Quantity Alarm

No.	Processing mode	Contents	
1	Alarm keeping	The status quantity alarm can be set as closed keeping or open keeping	
		When set as closed keeping	When the status quantity is from “open” to “closed”, the COS and SOE will alarm normally. The element will display normally.
			When the status quantity is from “closed” to “open”, COS and SOE will alarm normally, but the element will stay in closed position. Meanwhile, the tab is used to prompt that the current status is the closed keeping status.
			Under the closed keeping status, the closed keeping can be removed through operation. And the element will recover to the open position after removal of closed keeping.
		When set as open keeping	When the status quantity is from “closed” to “open”, the COS and SOE will alarm normally. The graphic element will display normally.

			When the status quantity is from “open” to “closed”, COS and SOE will alarm normally, but the element will stay in open position. Meanwhile, the tab is used to prompt that the current status is the open keeping status.
			Under the open keeping status, the open keeping can be removed through operation. And the graphic element will recover to the closed position after removal of openkeeping.
2	Alarm shielding	The COS or SOE alarm can be selected to shield. When the alarm is shielded, the COS or SOE will not be generated whether the status quantity is from “open” to “closed”, or from “closed” to “open”.	
3	Selection of alarm mode	Pushing picture	When alarm generates, the picture will jump to the pre-settingpicture, e.g. when fault occurs, the picture will jump to the sub diagram of the fault bay.
		Twinkling	When alarm generates, the graphic element related to this status quantity will twinkle
		Annunciator	When alarm generates, annunciator alarm can be available
4	Selection of alarm level	Alarm levels of status quantity can be divided into: fault alarm, abnormal alarm, COS alarm, notification alarm.	
5	Re-alarm	Re-alarm can be set for each status quantity. When the re-alarm is enabled and the status quantity alarm does not recover within the delayed time, re-alarm will work, and the re-alarm signs will be used to prompt .	
		“Open” or “closed” can be selected to start re-alarm.	
6	Calculation of alarm times	Calculation of alarm times can be set for status quantity alarm, e.g. calculation of breaker tripping times etc.	
7	Delayed alarm	Delayed alarm can be set for the status quantity. The alarm will generate after the delayed time from the status quantity signal acts. The delayed time can be set.	

2.3.2.7 Status Quantity Triggers Post Disturbance Review

1) When the post disturbance review function is enabled, and the total fault signal acts, the post disturbance review will be triggered automatically to record all signal status within a certain time period before and after the accident;

2) The time recorded by post disturbance review and the sampling cycle can be set;

3) The post disturbance review can display the picture status, primary equipment status, signal status saved before and after the fault in the form of picture broadcasting so that the fault is easy to trace. The post disturbance review broadcasting can be paused.

2.3.3 Processing of Electrical energy Data

The electrical energy mainly includes pulse electrical energy and micro-computer calculation electrical energy. Processing of electrical energy data is shown in the following table:

Table 2.3.8 Processing of Electrical energy Data

No.	Processing mode	Contents
1	Calculation of electrical energy	The calculated value can be obtained by using calculation formula, e.g. the total electrical energy can be calculated according to electrical energy of all lines.
2	Manual number-setting	Electrical energy value can be set manually
3	Judgment	When the communication between the electrical energy collection equipment and the monitoring system interrupts, the values of electrical energy collected by the equipment is invalid; the electrical energy will recover and be valid after the communication becomes normal.

2.4 Event Management

All information in a timed sequence during operation of the monitoring system will be classified into related alarm event management queue by SCADA.

2.4.1 Classification of Event Information

Event information mainly includes SOE event, COS event, protective operation event, self-check event, measurement over-limit event, operating command event, system information event, intelligent alarm information, etc. All the events will be distributed to the alarm window for real-time and dynamic display. All event information will be stored to the historical database for query.

All events have their own alarm levels. The alarming levels can be divided into: fault, abnormal, COS, over-limit and notification.

2.4.2 Event Alarm Modes

There are multiple display modes of event alarm, shown as follows:

Table 2.4.1 Event Alarming DisplayModes

No.	Display mode	Contents
1	Information display	Event information will be timely distributed to the alarm display window for display according to different types and levels.
2	Audio alarm	The event information can trigger audio alarm. Different audio documents can be selected according to event information of different types.
3	Voice alarm	The event information can trigger voice alarm. The voice alarm will broadcast specific contents of event. Male or female voice can be selected for voice alarm.

4	Automatic pushing picture	The event information can trigger pushing picture operation. The picture will automatically jump to the pre-setting picture after the event occurs.
5	Automatic printing of event	The event information can trigger automatic printing. The event information will drive the printer to print all the contents of event line-by-line.

2.5 Command Management

After receiving the operation from HMI, SCADA system will manage the commands and form related operating records. The operating records will be distributed to each HMI client. The main command management types are shown as follows:

Table 2.5.1 Types of Command Management

No.	Types of command management
1	Remote-control
2	Sequential control
3	Setting operation
4	Other commands: e.g. manual number-setting, manual negation, clear twinkling, labeling, label removing, VQC adjustment, etc.

2.6 Script Calculation

Table 2.6.1 Contents of Script Calculation

No.	Contents
1	The monitoring system can not only collect a number of actual measurements, signals and remote pulses, but also calculate and generate calculated quantity signal through script calculation, including calculating measurement, calculating signal and calculating remote pulse.
2	Whether calculating measurement, calculating signal or calculating remote pulse, the signals involved in script calculation can bemeasurement, signal, remote pulse, or system time, remote control (remote close/remote open), etc.
3	The logic symbols used for calculation can be “+”, “-”, “×”, “÷”, or “＞”, “＜” , “＝” , “≠” , “and”, “or” , “no”, etc.

2.7 Post Disturbance Review

Table 2.7.1 Contents of Post Disturbance Review

No.	Contents
1	When the post disturbance review function is enabled and the total fault signal acts, the post disturbance review will be triggered automatically to record all signal status within a certain time period before and after the fault, including analog quantity, status quantity, COS, SOE, protective operation event, protective self-check event, over-limit alarm, command operating records, etc.

No.	Contents
2	The time recorded by post disturbance review and the sampling cycle can be set.
3	Specific post disturbance review window is used to display the post disturbance review interface. Thepost disturbance review can display the picture status, primary equipment status, signal status etc. saved before and after the fault in the form of picture broadcasting so that the accident is easy to trace. The post disturbance review broadcasting can be paused.
4	The fault records can be invoked according to the storage list. After invoking specific faults from the records, the user can enter this fault interface to analyze them. he or she can check the signal and status value and review the operating and monitoring events occurred from the start time to the selected moment.
5	Fault recording name can be modified by user as required.

3 Database Configuration

Based on the lasted technology in computer field, PRS-7000 integrated monitoring system has been approved a lot in aspects of scalability, reducibleness, openness, standardization, object orientation and data sharing, thus ensuring that it can easily be expanded, maintained, connected with other systems and can be compatible with other commercial software.

The supporting platform subsystem of this system is mainly composed of database management system, database configuration, communication device configuration, graph configuration, data bus, external communication interface management module, etc.

3.1 Database management system

PRS-7000 integrated monitoring system has very high requirement for real-time performance. So, it has been configured with a set of rapid and complete database management system, so as to meet the requirement of various applications. The database management system has following functions:

- Rapid data access;
- Data organization
- Relation establishment between data;
- Establishment of grid data model;
- Standard access interface.

This system consists of commercial database management and real-time database management systems. The commercial one adopts the currently popular relational database with Client/Server mode. It is mainly used to establish database model, store historical data, save management information, check database consistency and ensure the consistency and completeness. The real-time one adopts the object-oriented design and includes Client/Server and Producer/Consumer modes. It has the extremely fast real-time responsiveness, so as to perfectly meet the requirement for real-time performance of power system. Meanwhile, it is also a network database management system, which can manage all distributed databases distributed on various nodes in network, thus ensuring the flexible configuration and random function combination of system as well as real-time synchronization of distributed databases on all network nodes. The real-time database is of hierarchical and relational structure, which provides clear structure and efficient access. The measuring point model of power grid is described by layer from plant station, to equipment (bay), then to measuring point, which is the typical tree structure. The real-time database still has many other trees and branches, which relate with each other in various forms and ask for extremely high requirement for real-time performance. Therefore, the database structure is designed mainly according to the main line of plant station - equipment - measuring point and in combination of other trees and some pure relational tables, so as to ensure good real-time performance, less disk space occupancy and convenient and efficient query.

These two kinds of databases are uniformly managed by system. They are organically combined together in system to provide the uniform access interface and human-machine interface to users. Besides, the system supports the consistent and complete data in database. In this way, all machines can access all data at any time and the consistent data can be viewed on all machines.

The commercial relational database mainly includes configuration database (basic configuration information & application configuration information) and historical database. The former one mainly stores the configuration data information of system and latter one stores various historical data produced during normal running of system, such as alarm record, operation record and sampling statistical data and so on.

The real-time database is mainly used to realize the real-time storing of real-time data collected by monitoring system, the value of which is updated consistently according to the variation of operational conditions, and always records the current operation status of monitored equipment.

The database can interface with other systems. Furthermore, it is featured with good expandability, thus facilitating the upgrade and update of system.

3.2 Database configuration tool

The database configuration tool, i.e., the database configuration software of PRS-7000 integrated monitoring system, also called as basic configuration tool, configures and establishes model for substation monitoring equipment and protection information in monitoring system. It is incorporated into the basic platform supporting module of monitoring system. Its main function is to provide the modeling tool for configuration and maintenance of monitoring system, thus rapidly and conveniently generating the engineering database required by monitoring system. This tool is featured with friendly configuration software interface, convenient operation, simple steps and user-friendly operation.

The database configuration tool adopts the modular configuration process according to the actual configuration procedure of substation. It strengthens the template concept, adopts simple and clear configuration for channel signal collection and is capable of copying bay, primary equipment and signals, thus avoiding the repetitive configuration. Since users are divided into different classes according to the authorization , this tool still can be used to separately configure the authorization of some user. What's more, it organizes the primary equipment and signals in station according to the hierarchical relation of plant station→ bay →equipment →signal. And this tool configures virtual signals and complex control logic rules through the operation expression. The modification content of engineering database will be saved into the memory if the modification is done before selecting "Save" and will be written into the engineering database after selecting "Save".

Because of the complete function of data check in configuration program, the probability of error database configuration is reduced to zero.

The interface of database configuration tool is as shown in following Figure 3.2.1.

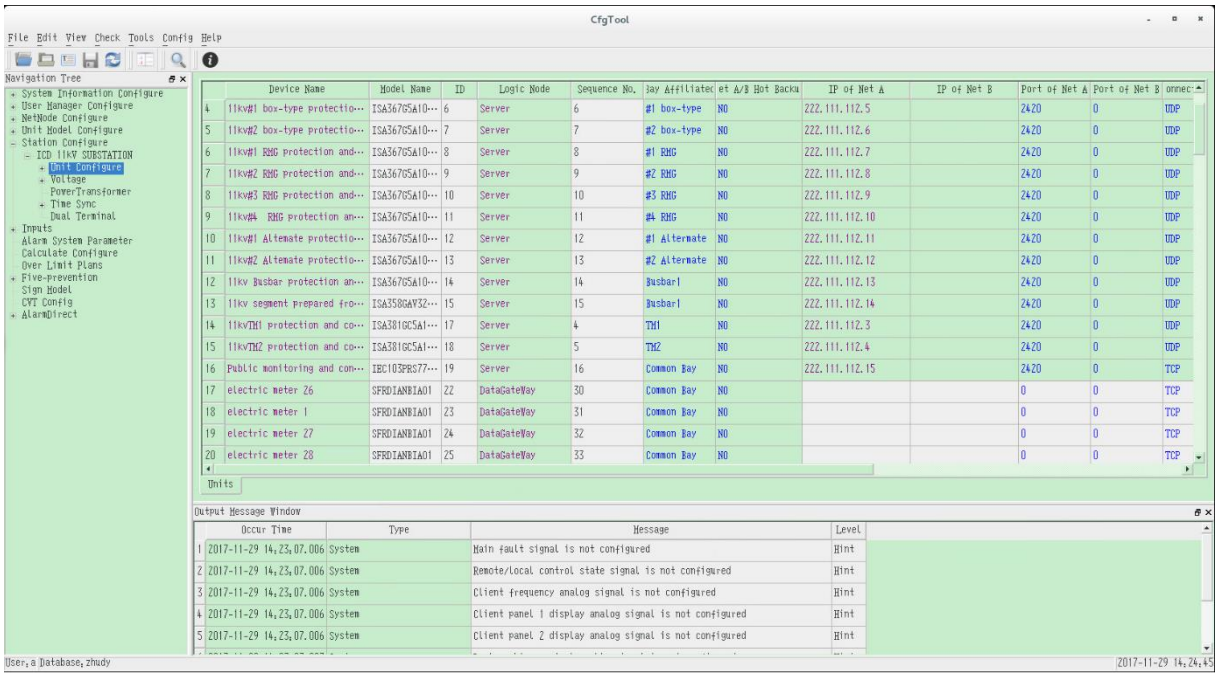


Figure 3.2.1 Database Configuration

3.2.1 User configuration strategy

1. The user configuration interface is as shown in Figure 3.2.2.

- Login users can be classified into two types as per their administration authority to user configuration, i.e., system administrator (including: system managers and super users) and non-system administrator (including: maintainers, operators and persons on duty);
- The system administrator can add and delete users and edit basic attributes of users, such as work ID, membership group, duty role, monitoring authorization and anti-maloperation authorization and so on;
- System managers and super users can delete themselves. Non-system administrators only can change their own password;
- All users of each group and duty role have corresponding default monitoring and anti-maloperation authorities. Users can also freely customize the related permission as required when created.

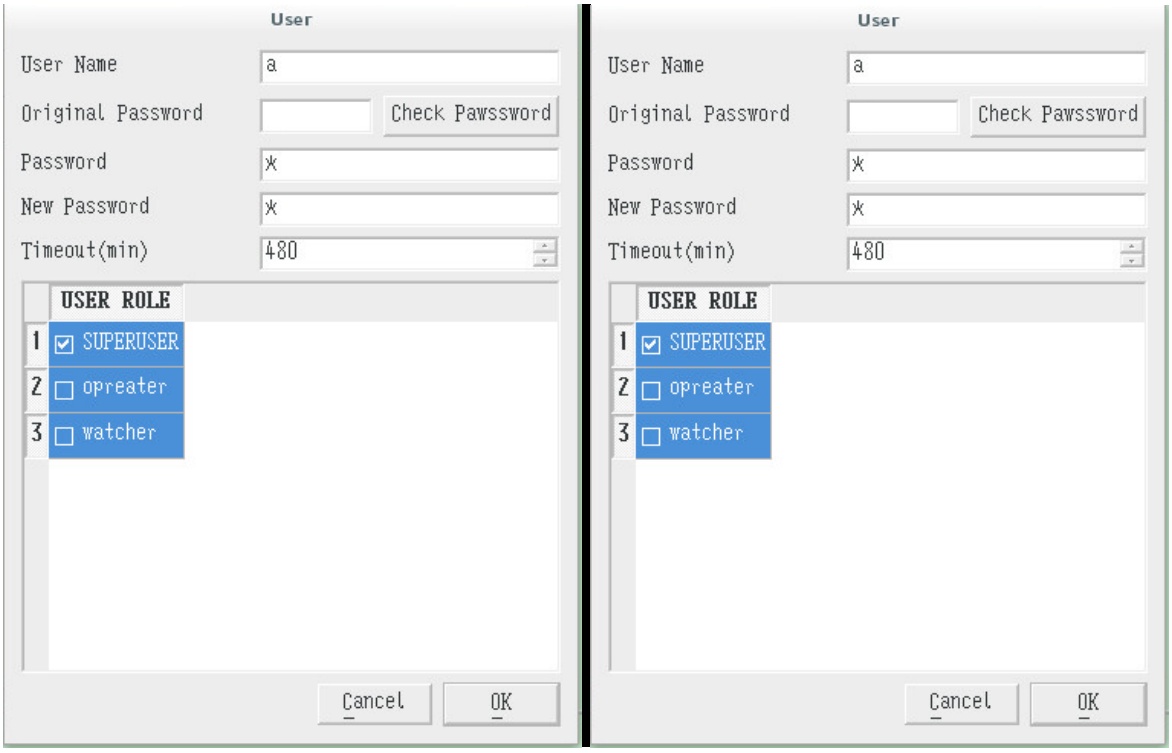


Figure 3.2.2 User Editing

2. The configuration of user authorization is described as follows:

1) The user authorization is configured according to following basic principles:

- Distinguish the authorization of equipment. Only specific persons are allowed to operate it;
- Different operators shall have different operation authorization .

2) Set different operation authorizations for operators according to different kinds of operation.

- The management of operation authorization includes: login authorization, check setting, change setting, view report, change report, view configuration, change configuration, inverting operation, manually set value, maintain & label, switch on/off, remote control authority of each voltage class, mal-operation authority, sequential control authority and alarm event confirmation, etc.
- Users with super authority can add or delete users and set the authority of other users.
- It is allowed to have multiple users with super authority in system at the same time.
- All users can modify their own password.
- Operators with operation authority can carry out control, manual value setting, labeling ,etc.
- The supervisory personnel shall monitor the control and operation carried out by operators and can enter his/her supervising password on same the machine or on the other one.
- User with protection setting authorization can modify the protection setting value.
- Users with report maintaining authorization can modify and generate reports.

- Users with database maintaining authorization can modify the definition of database.
- Users with operating maintaining authorization can modify the configuration of network node, node function and manually switch the master and slave hosts.
- All authorization modification shall be recorded in details, including modifier, modification time and authorization modified.
- All control operation needs password entering.
- At the time of online operation, related operators shall log in system. Otherwise, the corresponding operation menu will hide automatically and the operation on interface is also forbidden. Such operators also have to log out at the time of shift change.

3.2.2 Database configuration strategy

Users authorization to database configuration depends on users' authorization .

- In case the authorization “View Configuration” or "Change Configuration" is not configured, no database information will be loaded and the database operation function will be prohibited;
- If only “View Configuration” is configured, only database is loaded, the database operation function still prohibited;
- If "Change Configuration" is configured, all database operation prohibitedwill be available.

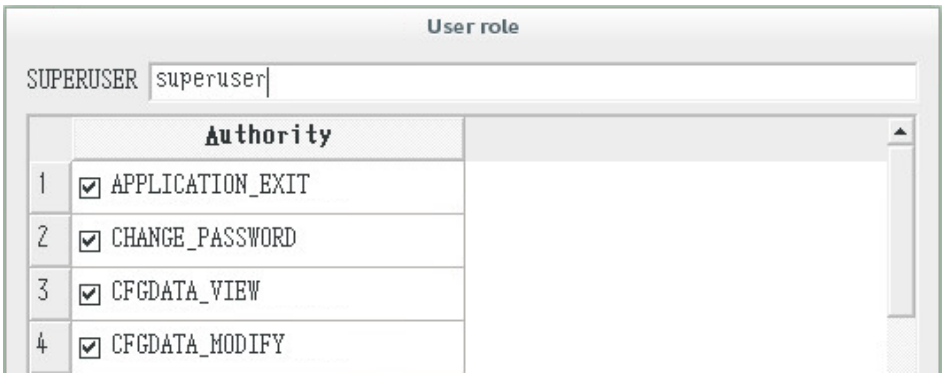


Figure 3.2.3 User Roles

In following instructions, it is assumed that the logged-in user has authorization to "Change Configure".

3.2.3 Configuration process

- The database of new project during installation and debugging is configured as follows:
- Obtain the template file of devices at bay level;
- Configure SCD;
- Generate the basic database of monitoring SCADA based on SCD;
- Configure users;

- Configure partial system parameters;
- Configure network nodes of system;
- Add secondary equipment;
- Add bay and primary equipment;
- Select points from the basic database to form remote measurement, remote signal, remote pulse and remote control library;
- Realize information layering and classification as well as data optimization;
- Configure advanced applications, such as anti-maloperation, sequential control, VQC, intelligent alarm, alarm direct transmission and remote browsing and so on;
- Configure communication device (configuration information needed by data gateway device);
- Configure graphics.

3.2.4 Configuration guidance

If 61850 monitoring station is configured for SCADA, it is necessary to create SCD. It is allowed to import ICD or CID files. The basic configuration tool can be used to import SCD (ICD or CID), 103 or TXT templates of device of other manufacturers.

Configuration process:

1) graphcfgtool (graphics configuration tool): based on the bay graphic element of the template → drawing the main diagram → create voltage levels → create bay and primary equipment;
2) basiccfgtool (basic configuration tool): import SCD to create secondary equipment automatically → carry out the correlation of secondary equipment and bay as well as the remote signal correlation of primary equipment;
3) graphcfgtool (graphics configuration tool): draw sub-diagrams → generate four types remote signals on interface → automatically generate the bay sub-diagram of the same type based on typical bay sub-diagram.

3.2.4.1 dbManager

The dbManager (database maintenance tool) is used to import, upgrade or back up databases.

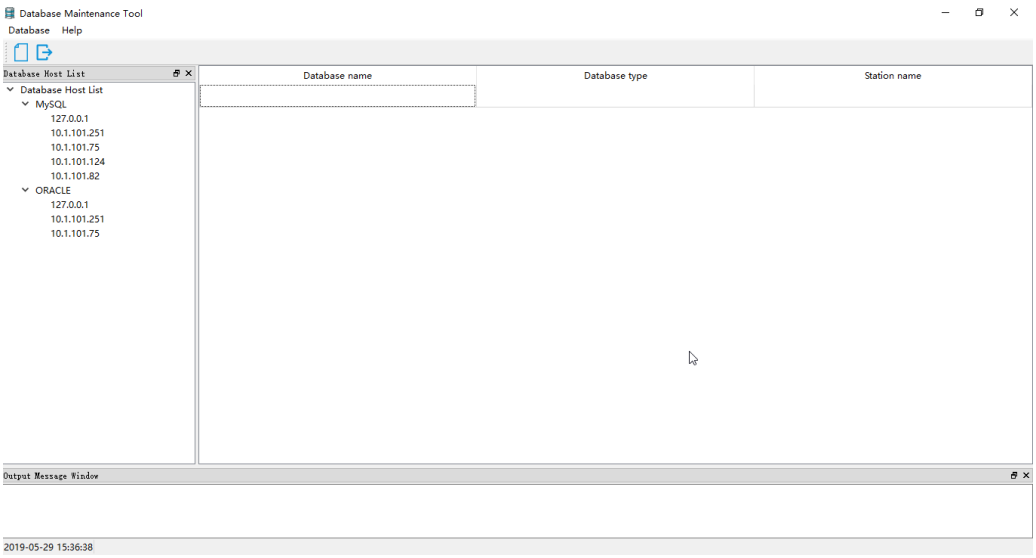


Figure 3.2.4 Interface of Database Maintenance Tool

Select the content to be imported into database from the IP list tree on the left side of above figure. The local host address is 127.0.0.1 and database type is mysql. Select 127.0.01 (mys) with mouse left key. Then, click the mouse right key and select "Open" to pop up the dialog of password entering, as shown in the following figure.

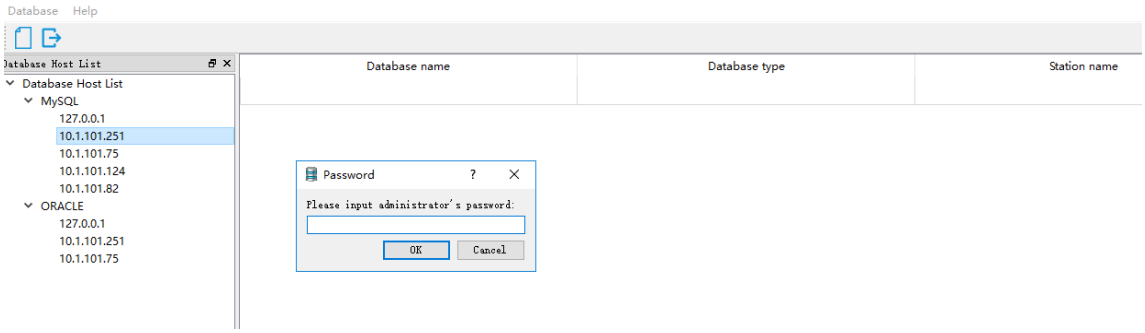


Figure 3.2.5 Login Interface of Database Maintenance Tool

The password to be entered is prs7000.sunroof. Enter the password to open the interface. Then, click the mouse right key again and select "Import database" to import prs7000cfg (configuration database) and prs7000his (historical database) in the path of bin\BaseDB\MySQL. under the SCADA installation directory. Upon the completion of importing, upgrade the database.

NOTICE!

Passwords for database importing and upgrading are both sa, which shall not be changed.

3.2.4.2 prs7000runset

The prs7000runset is used to set system parameters for server.

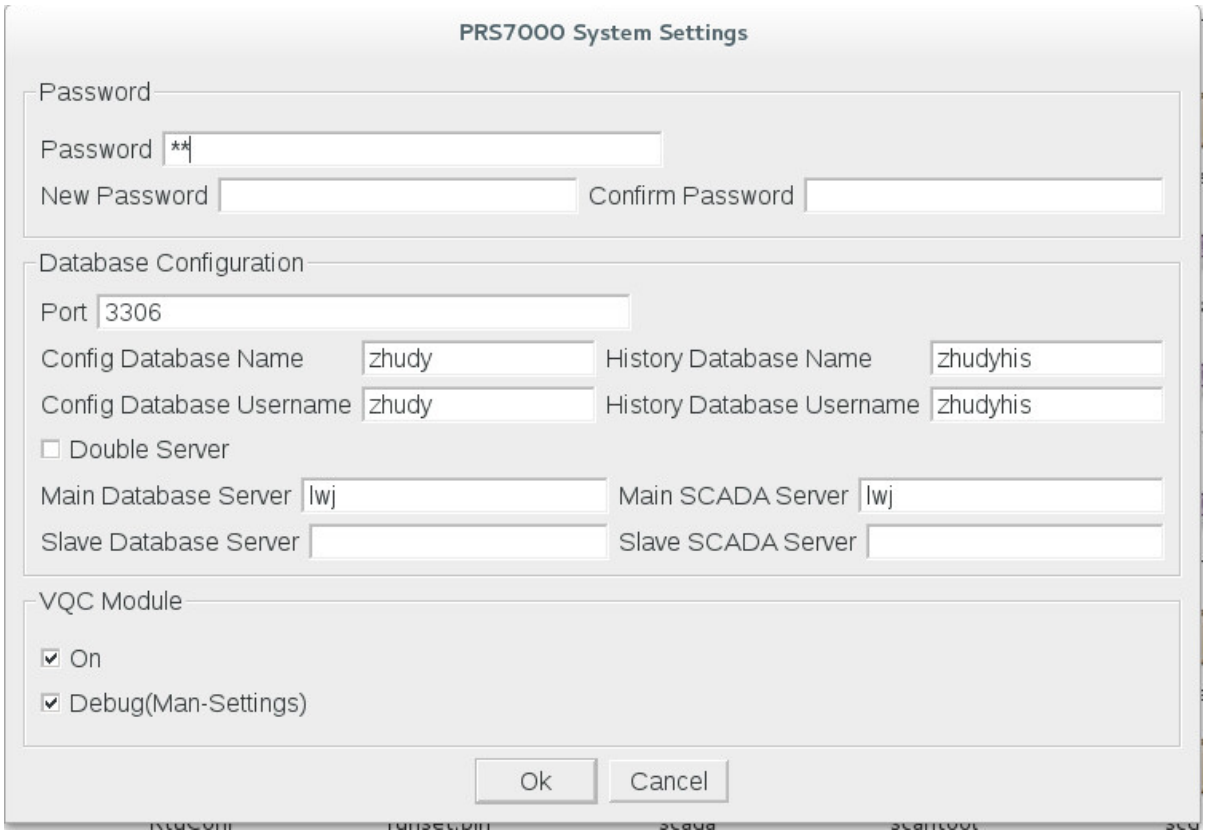


Figure 3.2.6 Window of System Parameter Setting

The Initial password is 0755isa; the new password must be changed to sa; the port number is fixed to 3306. The configuration database name is consistent with user name of configuration database. The historical database name is also consistent with user name of historical database. For the setting of master database server and master SCADA server, please fill in the server name of the local host. In case of master-slave redundancy host, please check (√) the space on the left side of dual-server, as shown in the following figure.

Figure 3.2.7 Dual-server Setting of System Parameters

For the setting of slave database server and slave SCADA server, please fill in the server name of salve host.

NOTICE!

all database names and user names are lowercase.

3.2.4.3 Graphic Element configuration tool - elementeditor

The graphic element configuration tool can be used to randomly edit elements. All elements are saved in the format of G file. In files, elements can be created, saved, deleted and imported or exported. All imported and exported elements are also in the format of G file. Therefore, if some

elements are multiplexed by several stations, they can be directly imported into other stations from one station.

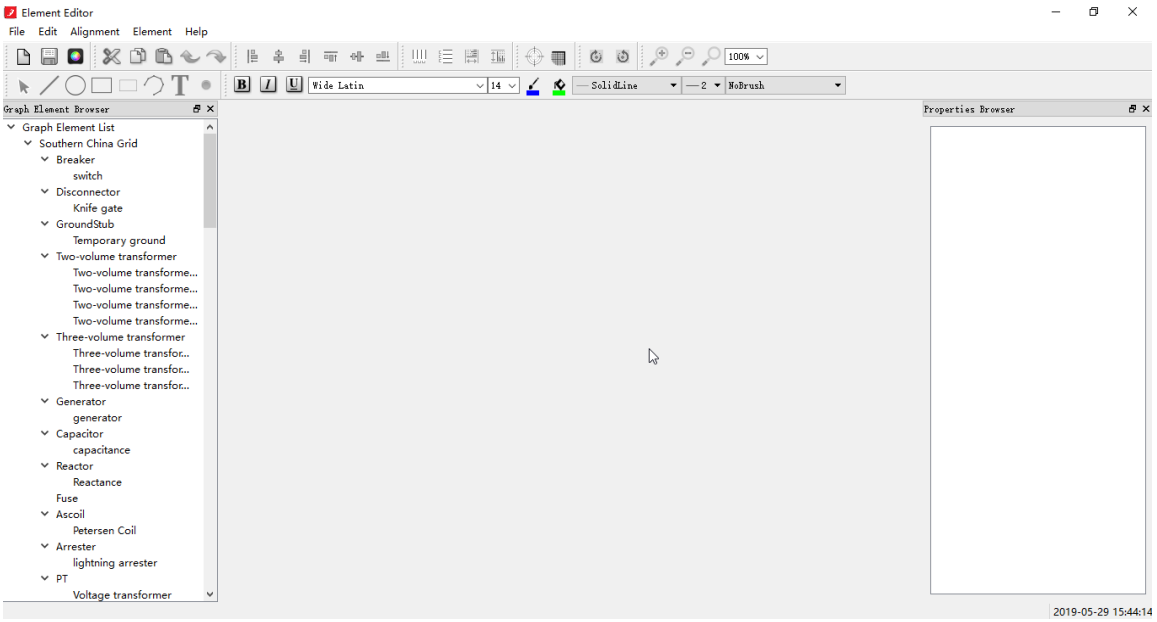


Figure 3.2.8 Graphic Element Configuration Tool

When creating new element, please select the height and width of new element. The state type number supports 1, 2, 3 and 4. Several kinds of status are set at the time of element drawing. So, the corresponding states also need to be drawn according to the selected type number. Select the element type from the left element list. If the space "Whether color" is checked, it means that the different state color will be displayed when the associated signal state changed. This option can be checked for state value. However, for the primary equipment with electrical attribute, it doesn't need to check this option. Because the coloring of primary equipment is determined by program. Depending on the related specification, different voltages are colored differently.

At the time of creating element, it is necessary to pay attention to the graphic element classification and note that the graphic element name cannot be repetitive.

For the monitoring graphics of new power plant (e.g., wind power plant and photovoltaic power station), the cubical transformer or the small switches of inverter may need to be drawn in the main diagram. In this case, it is feasible to add small switch element in state element and color the element according to field requirement.

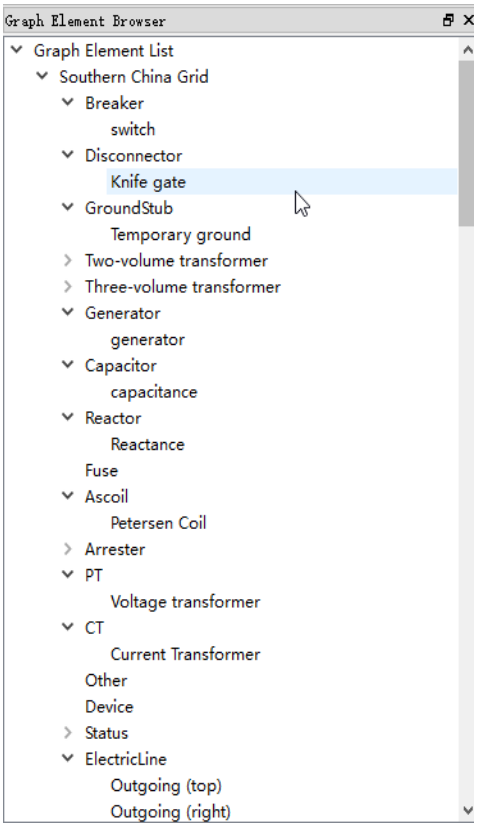


Figure 3.2.9 Graphic Element List

Graphic elements "Others", "Device", "State" and "Ground" can be interpreted as the state element. If the graphic element of primary equipment has to be added, please add the new one in the corresponding classification of primary equipment.

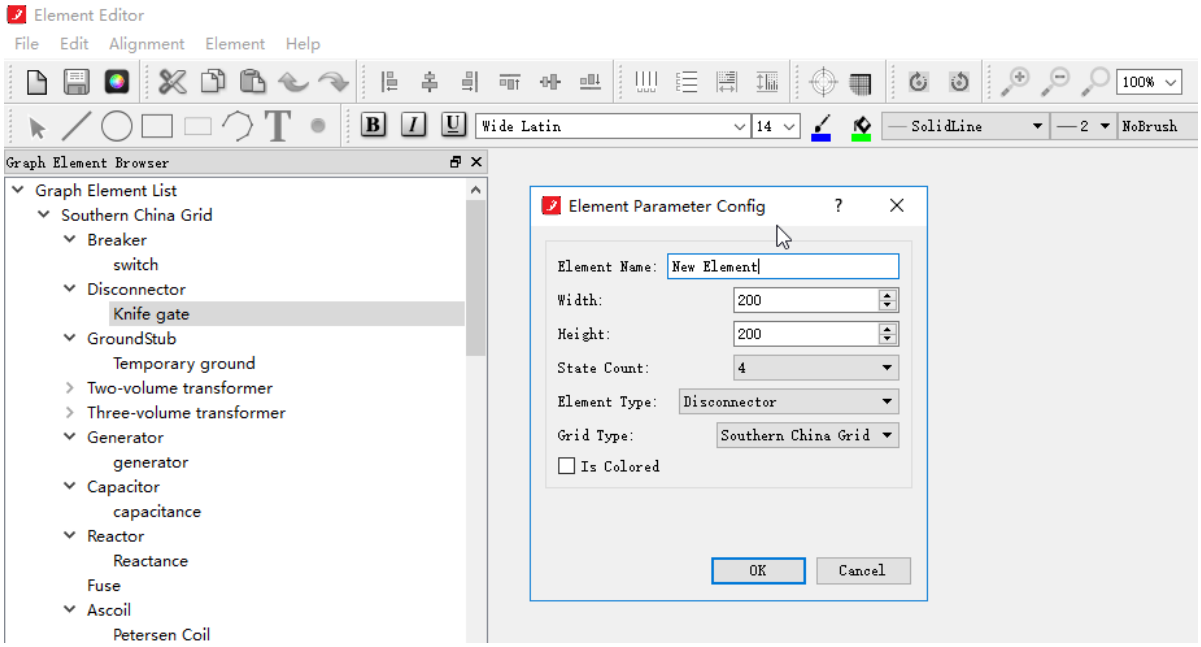


Figure 3.2.10 Configuration of graphic Element Parameters

As for the graphic element of non-primary equipment, if the remote control function has been

configured, it is necessary to change the remote signal sub-type correlated to the element to switch state and make the remote control signal correlate the corresponding remote signal.

3.2.5 Graphic configuration

3.2.5.1 Overview

The graphic configuration and connection configuration of PRS-7000 integrated monitoring system are realized through the graphic configuration software.

As the supporting platform module of monitoring system, this kind of software can provide a application construction platform for monitoring system, by means of which, users can rapidly and flexibly construct a visual application system with friendly interface in the form of “what you see is what you get”. Meanwhile, it expands the graphic element control (function unit) to continuously enhance the function and interface performance of system. It flexibly configures graphics (interface unit) to obtain various friendly interfaces, so as to meet the demand of different users. Furthermore, it provides a variety of normative interface templates for monitoring system to assist the engineering personnel to well finish the system configuration.

1) This graphic configuration tool provides following functions:

- Draw, copy and cut picture, including index diagram for sub-diagram, main diagram, index diagram for all annunciator, bay diagram, function diagram, system structure diagram, communication monitoring diagram, etc.
- Configure the correlation between signal and graphic element, so as to display the information correlation between primary and secondary equipment;
- Support various display modes, including bar graph, pie graph, trend curve, three-dimensional graph, photo and various indicating instruments, etc.;
- Can generate graphic files of standard SVG format.

2) Characteristics of this module:

- The software interface is of MDI style, through which, several pictures can be opened for design at the same time;
- Can add and delete controls in canvas ;
- Can edit controls in canvas , including editing the position (move), size (zoom), orientation (rotate), color, style and font of controls and copying and pasting controls;
- Can set the layout of controls in canvas , including alignment and positioning (forward and backward) of controls;
- Can set the attribute in each control through the dialog of attribute provided by each control itself;
- Provide the correlation function between control and monitoring data. In this way, the control can correlate to the monitoring data quantity;

- Can edit controls through mouse and keyboard;
- Can set the canvas size and provide scrolling function when the canvas size exceeds the main window;
- Can zoom in or out canvas for display or operation;
- Can set the SCADA color of canvas;
- Save the diagram configuration result in the form of binary data files;
- Can index diagrams and save the indexing information into files for the purpose of diagram searching at the time of perating monitoring system;
- Can print diagrams;
- Can compile the diagram configuration data and check its correctness and report the statistical information of configuration data;

3.2.5.2 Interface description

The interface of graphic configuration software is composed of title bar, menu, component bar, tool bar, drawing area, information output window, status bar and window list and so on, as shown in Figure 3.2.11.

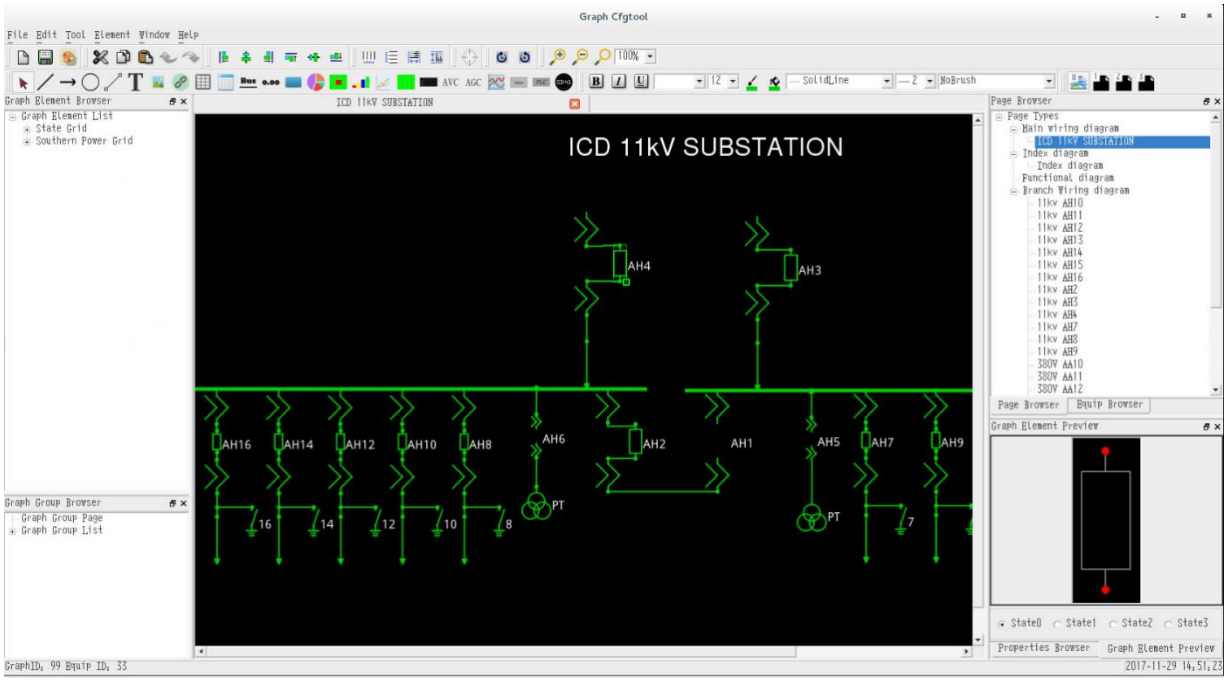


Figure 3.2.11 Main Menu Window of Configuration Graphics Editor

Table 3.2.1 Menu Description

Name	Description
Title bar	display the program module name - drawing configuration tool
Menu bar	when put the mouse is put onto this bar, the displayed

Name	Description
	drop-down box includes operable content
Tool bar	all tools used for graphic plotting, e.g., text, circle and pie graph
Drawing area	the working area of monitoring graphics, which can be used to draw various elements and controls and name of current monitoring picture
Element browser	the selection area of all equipment elements; can be directly dragged into the drawing area for use
Bay template browser	some commonly used bay templates, which facilitate rapid drawing
Drawing browser/equipment browser	the drawing browser displays all graphical interfaces; the equipment browser includes the primary and secondary equipment of all bays under each voltage class; these two browsers can be switched to each other
Attribute browser/element browser	display the specific attribute of all equipments in attribute browser after clicking all equipments; the element browser displays the element shape and status

3.2.5.3 Graphic configuration tool - graphcfgtool

This program is graphic configuration tool. The configuration of current graphic tool is graph-module integrated. That is to say, create the corresponding voltage class, bay and primary equipment during the creation of main diagram, as shown in the following figure.

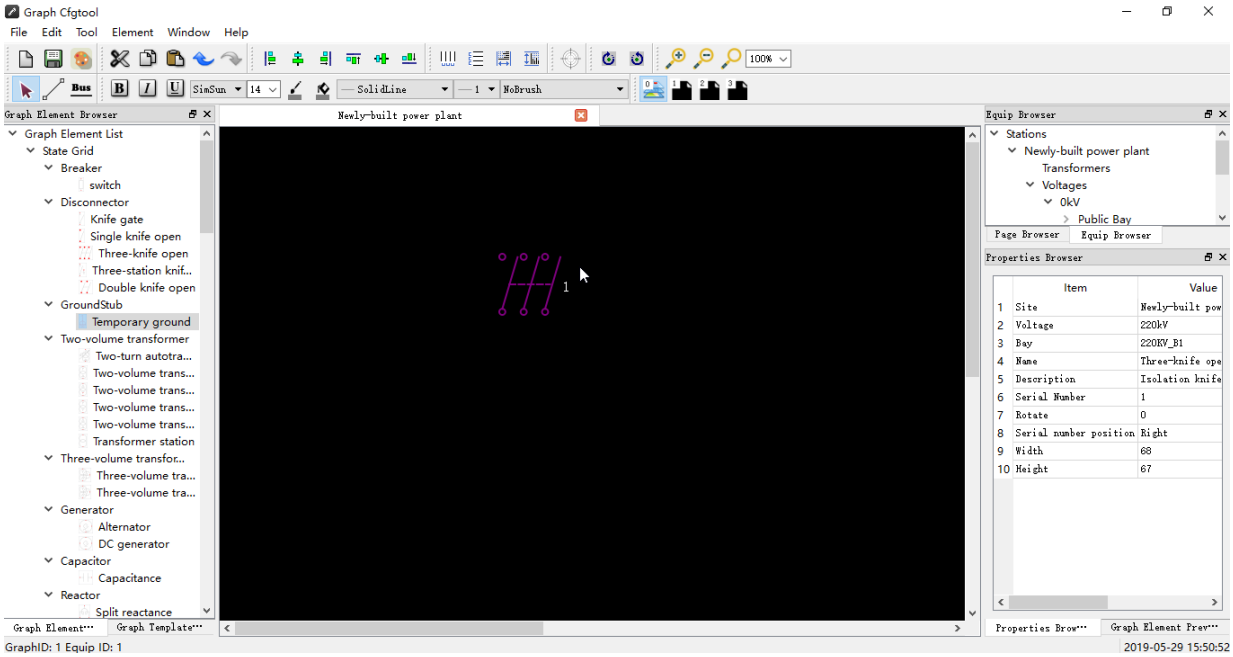


Figure 3.2.12 Window of Graphic Configuration Tool

For the newly create substation, it is feasible to carry out configuration according to the voltage class actually included by the station and manually create the bay under the voltage class node. If one substation has the bay of the same primary equipment, the bay temperate can be prepared to automatically generate multiple bays (see Configuration of Bay Template). When the substation,

voltage class and bay all have been created, please create the main diagram.

Figure 3.2.13 Diagram Dialogue of Station Information Adding

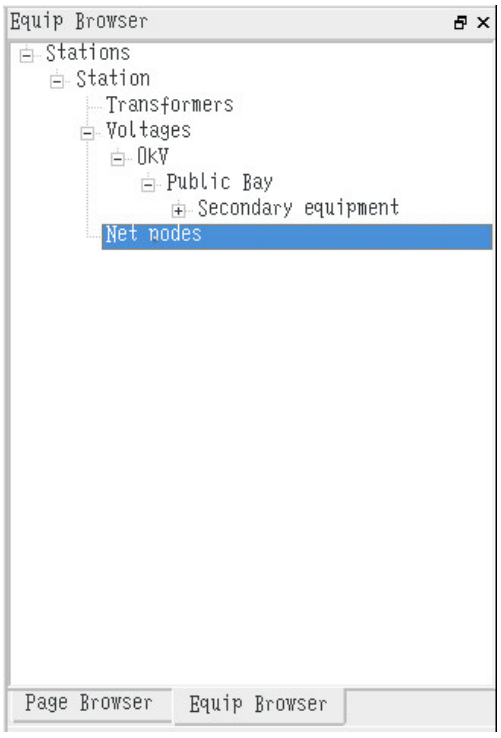


Figure 3.2.14 Introduction Interface of Equipment Browser

Draw the primary equipment element and create the actual primary equipment at the same time on the main diagram. For the equipment information, please select the voltage class and bay type under the voltage class; the equipment voltage defaults to the bay voltage class; the equipment name and number are filled in according to the actual name on field. The device ID will be

displayed directly around the primary equipment. Options include Up, Down, Left & Right. The primary equipment element will be automatically colored according to the corresponding equipment class voltage and related specifications.

Notes: when creating the bay of main transformer, it is defaulted to put this bay under the node of the highest voltage class and put the primary equipment at each side of main transformer into transformer bay. However, it is necessary to select the equipment voltage according to the actual voltage class at each side.

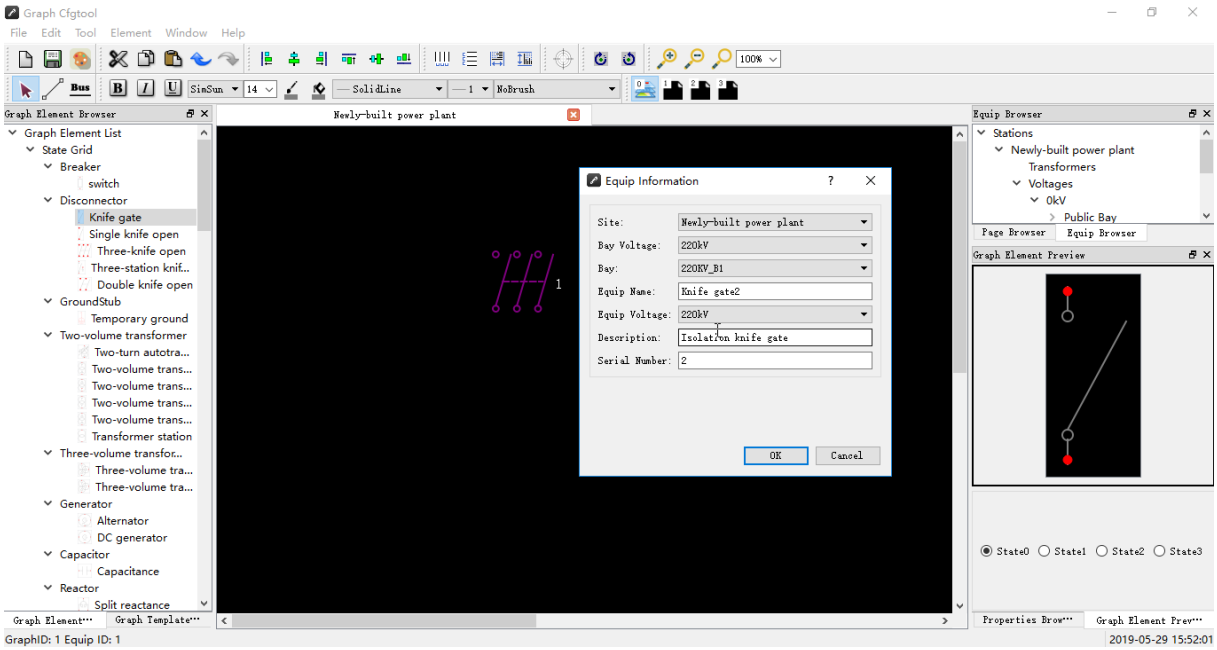


Figure 3.2.15 Equipment Information Diagram

New controls:

Figure 3.2.16 List of New Controls

 : arrow/straight line. The arrow shape can be selected in attribute browser.

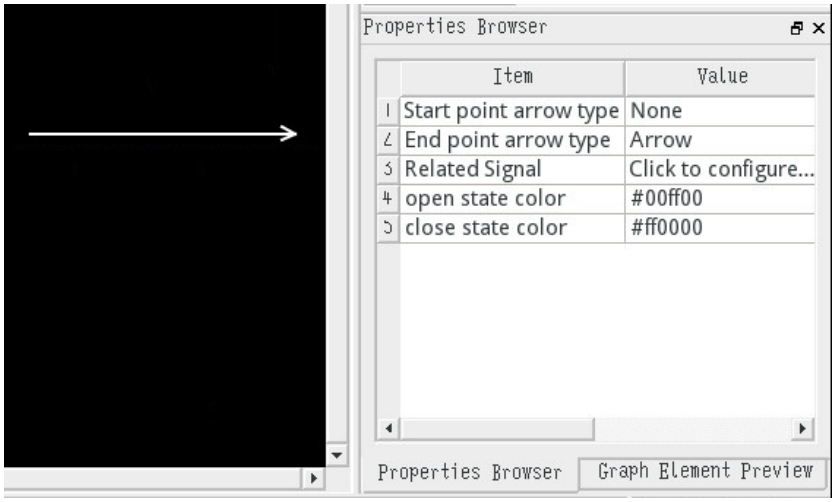


Figure 3.2.17 Arrow Line

 : connecting line. It is used to connect elements in picture. Each element has the connecting point. The connecting line only can connect the connecting point of each element. After using the connecting line, the connecting point (i.e., a red dot) between elements or between element and line can be seen;

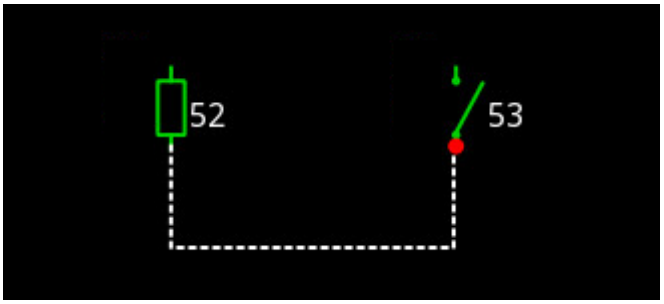


Figure 3.2.18 Connecting Line

When this red dot appears, click the mouse left key to finish the connecting operation. The random dragging of such elements will not result to their connection broken up. Finally, click "File - check topology" in the left upper corner to verify the correctness of connecting point of wiring diagram.

 : diagram linking button. It can be used to select the diagram to be linked. The overall remote signal list of annunciators defaults to read the correlated signal of annunciators of the bay diagram, excluding primary equipments, operating handle s and switch status, but supports the manual subscripted switch status and operating handles. The required signal can be configured as per user's requirement. If the remote siganl state changing occurs in the picture, it is feasible to trigger the overall annunciators diagram and display the corresponding color according to the actual alarm level.

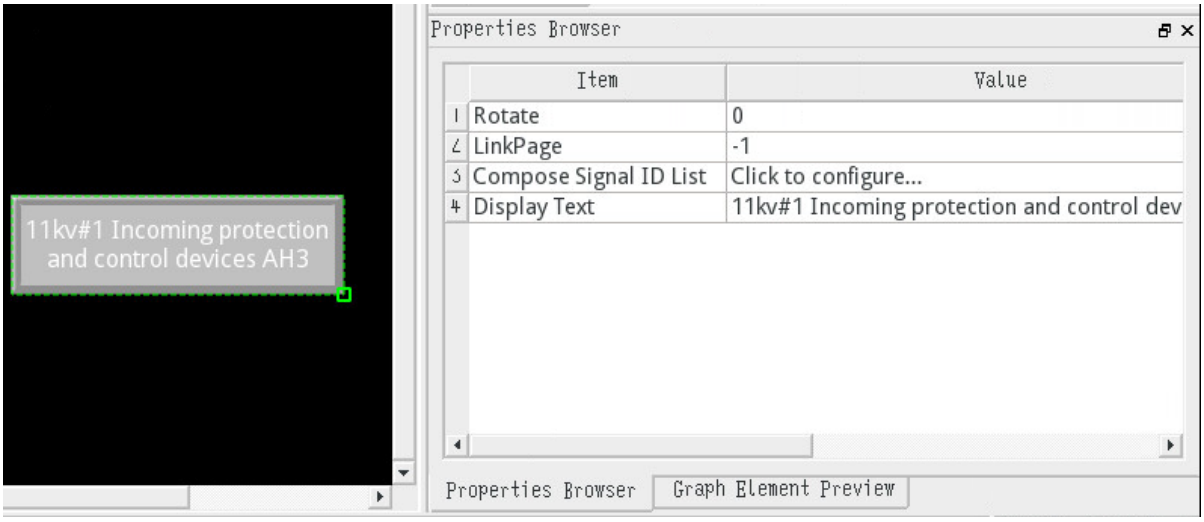


Figure 3.2.19 Diagram Linking Attribute

 : data table. This table displays remote measurment and remote signal.

: create the busbar primary equipment.

: dynamic text, which can be used to correlate the remote measurement and remote pulse.

 : function key, which can be used to correlate remote regulating, remote control, equipment status and remote signal.

 : pie graph, used to display the occupancy percentage of different data.

 : bar graph, used to display remote measurement and remote pulse in the form of bars.

 : curve graph, used to display the real-time changing curve of data.

 : VQC region graph, which can be set to standard 9-region graph, 15-region graph, 17-region graph and Shanghai 17-region graph.

 : word bit chart of VQC blocking information, which can be set to VQC general blocking information graph as well as blocking information graphs of low-voltage bus, medium-voltage bus, capacitor and main transformer.

 : GOOSE/SV table, which can be used to make GOOSE and SV two-dimensional tables rapidly. After the creation of sub-diagram, click this icon to pop up the following table. For the signal type, select the element to be displayed. Tags similar to Excel form in first row and first column are used to display the device name when dragging the scroll bar vertically or horizontally. The second row and second column display the name of device which can be correlated or be filled in by users themselves. Signals in two-dimensional table can be dragged from the signal list.

Each one correlates to three signals at most. The signal can be dragged out from the list to cancel the correlation. The signal can also be dragged into other space to modify the correlation.

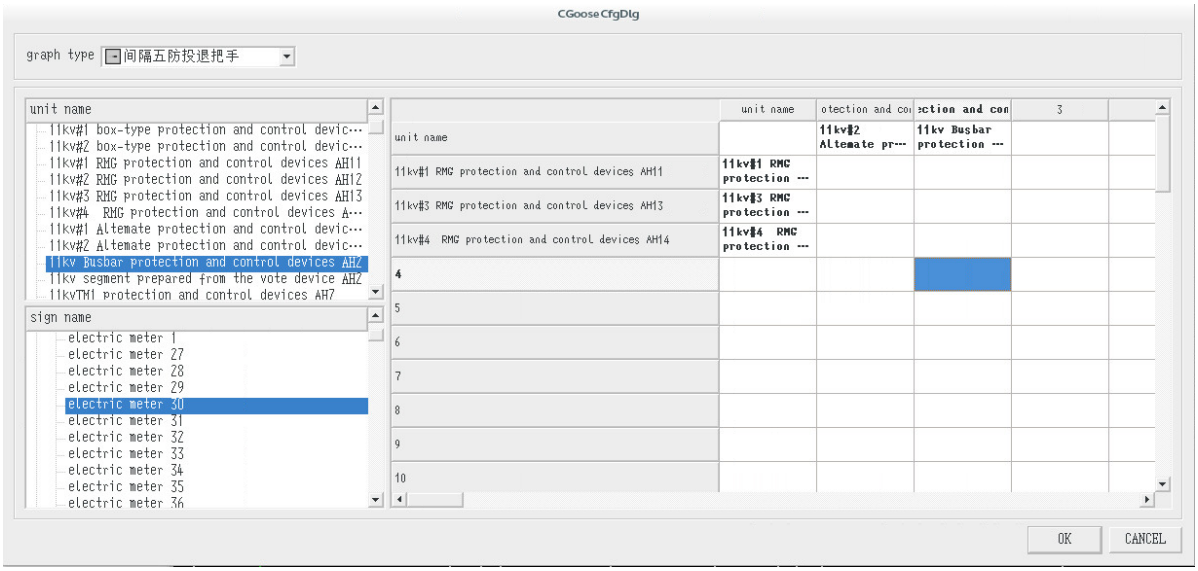


Figure 3.2.20 GOOSE/SV Table

- **Prepare bay template**

Click the template drawing to enter the corresponding interface. The standard template can be drawn according to the primary connection mode on field.

Figure 3.2.21 Bay Template Diagram

Select primary equipment. At the time of creation, for equipment name and equipment number, use @ to substitute different bay numbers of different places. For example, 220kV line has 4 bays. IDs of bay switches are 2201 - 2204 and those of disconnecting switches are 22011 - 22041. When creating the template, the equipment name and equipment ID are respectively @ switch and @. At the time of creating switch, the equipment name and equipment ID are respectively @1 switch and @1.

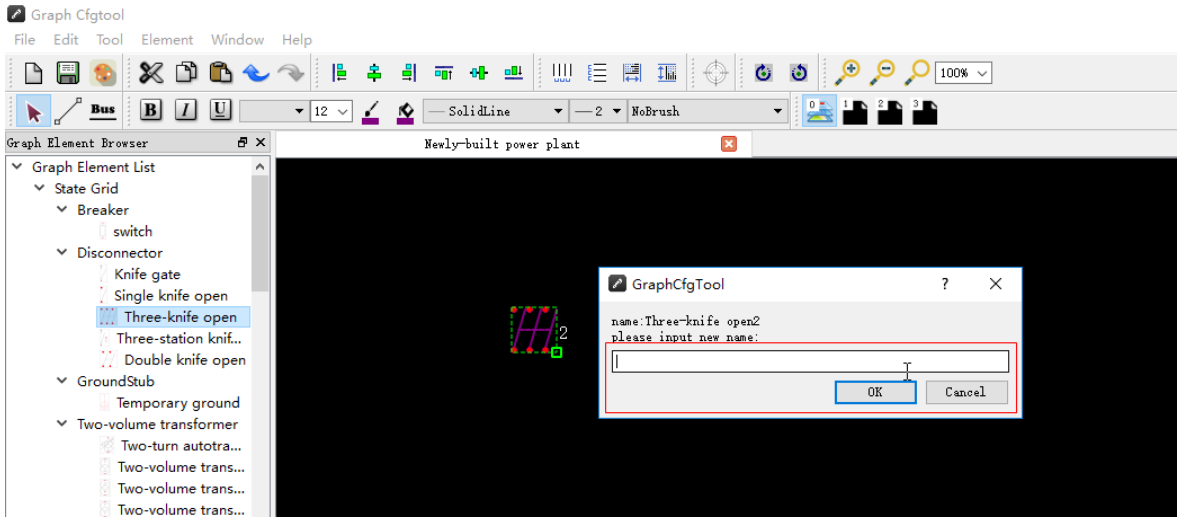


Figure 3.2.22 Creation of Switch Template

Upon the completion of template creation, select the right key "Generate bay template". If any modification is required, click the right key on the corresponding template list to modify bay template or equipment name. After modification, select the right key "Generate bay template" to cover the current template drawing or create a new template drawing.

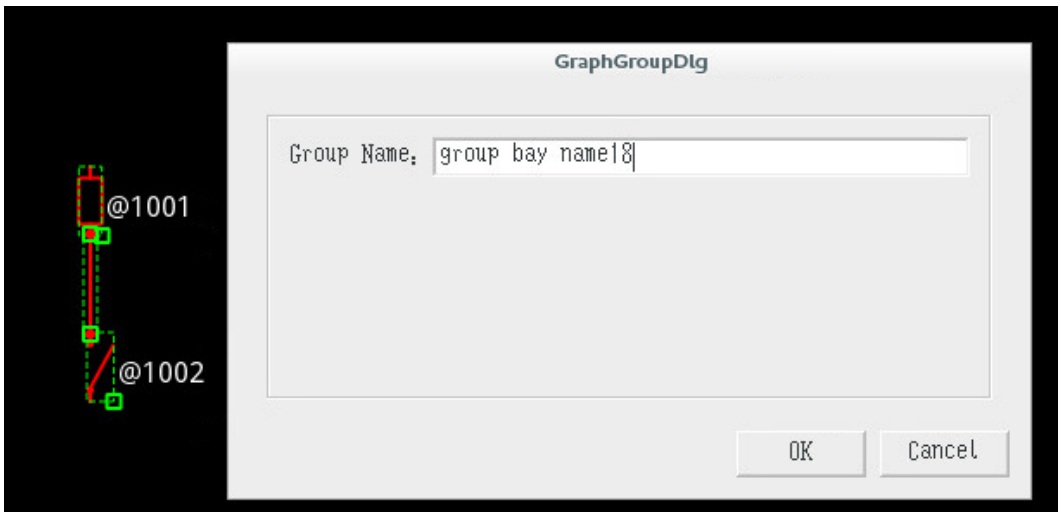


Figure 3.2.23 Naming of New Template

Use the bay template to generate bays in batches. Then, drag the bay template into the main diagram to pop up the following dialog, in which, the voltage class, bay name, starting bay ID and ending bay ID (to replace the character @ in template) of created bay. The sequence defaults to from left to right according to from starting bay ID to ending bay ID. The inverted sequence stands for reversed process.

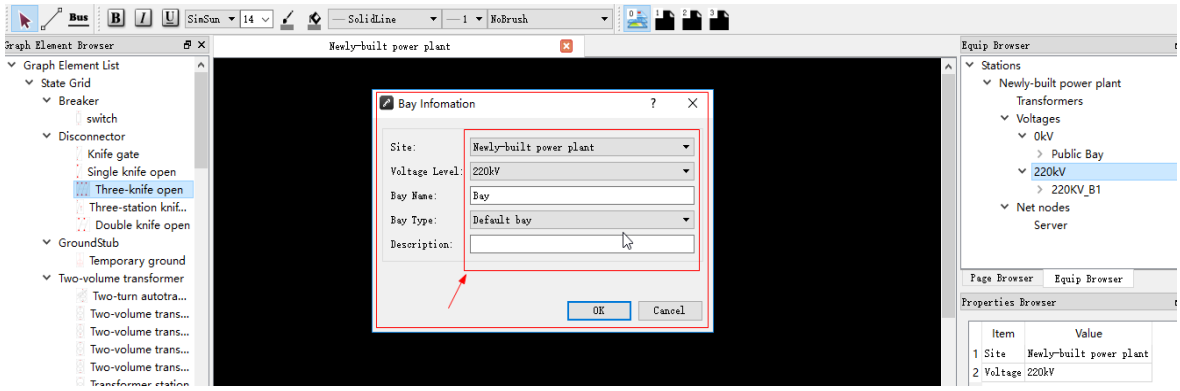


Figure 3.2.24 Bays Generated in Batches

After confirmation, fill in the bay name and bay number to be created and select bay creation. If there is no 2202 bay, please uncheck the select box in front of it. In case actual bays are 2201, 2203, 2205 and 2207, please modify the corresponding sequence numbers and bay IDs. Use the bay ID to replace the character @, which can only be digital and cannot be letter or other character. After confirmation, the required bay and primary equipment will be created automatically, with no need to modify the bay name and primary equipment name again.

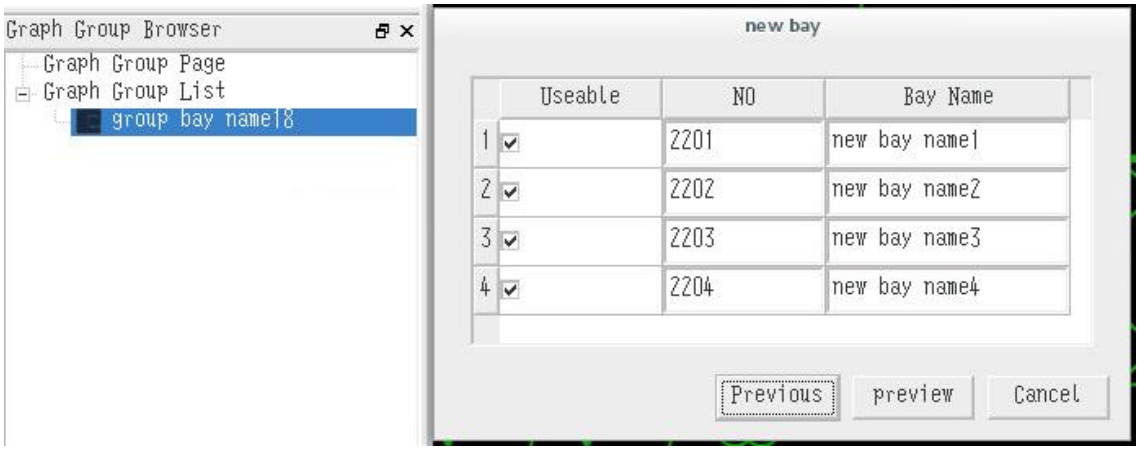


Figure 3.2.25 Naming of Bays Generated in Batches

➢ **Sub-diagram of connection**

Since the primary equipment element only can be generated in the main diagram, the primary equipment in sub-diagram can only be drawn through two methods.

1) After the creation of sub-diagram drawing, copy the primary equipment of the bay from the main diagram to the corresponding sub-diagram.

2) Then, find the bay sub-diagram to be generated on the main diagram and select any primary equipment of the bay. Click the right key "Generate the bay sub-diagram" to create the bay sub-diagram. In this way, the corresponding wiring diagram of primary equipment appears in the bay sub-diagram, as shown in the figure below.

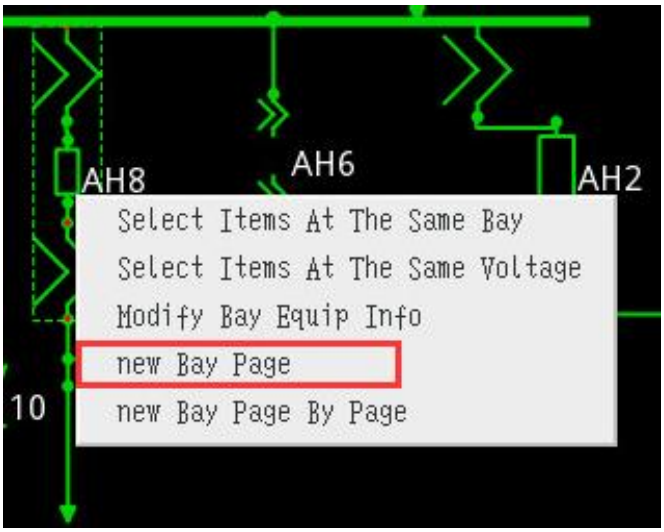


Figure 3.2.26 Generate Bay Sub-diagram

After the generation of sub-diagram, click the blank space in the sub-diagram with right key to generate state value, annunciator, measurement form and other related information, as shown in the figure below.

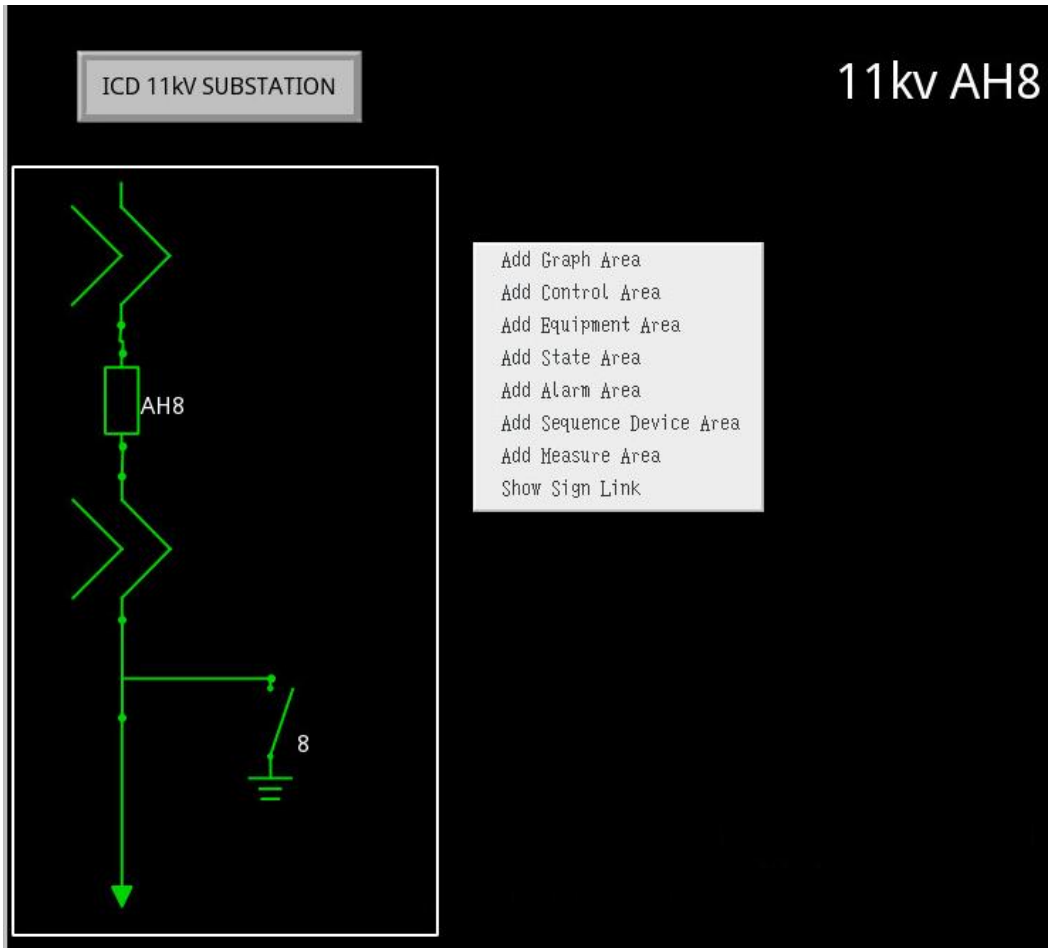


Figure 3.2.27 Add Bay Sub-diagram Information

1) Add wiring diagram: to be used to generate the wiring diagram of primary equipment for some

bay.

2) Add control quantity: not used for the time being.

3) Add equipment quantity: can be used to automatically generate the secondary equipment diagram and network communication state diagram under the bay.

4) Add State Value: can be used to generate the switch, signal light, handle and other state elements. Select the displayed element type. Select the bay to find its corresponding secondary equipment. Drag the signal into the right blank space to realize automatic generation. The column number to be generated can be selected.

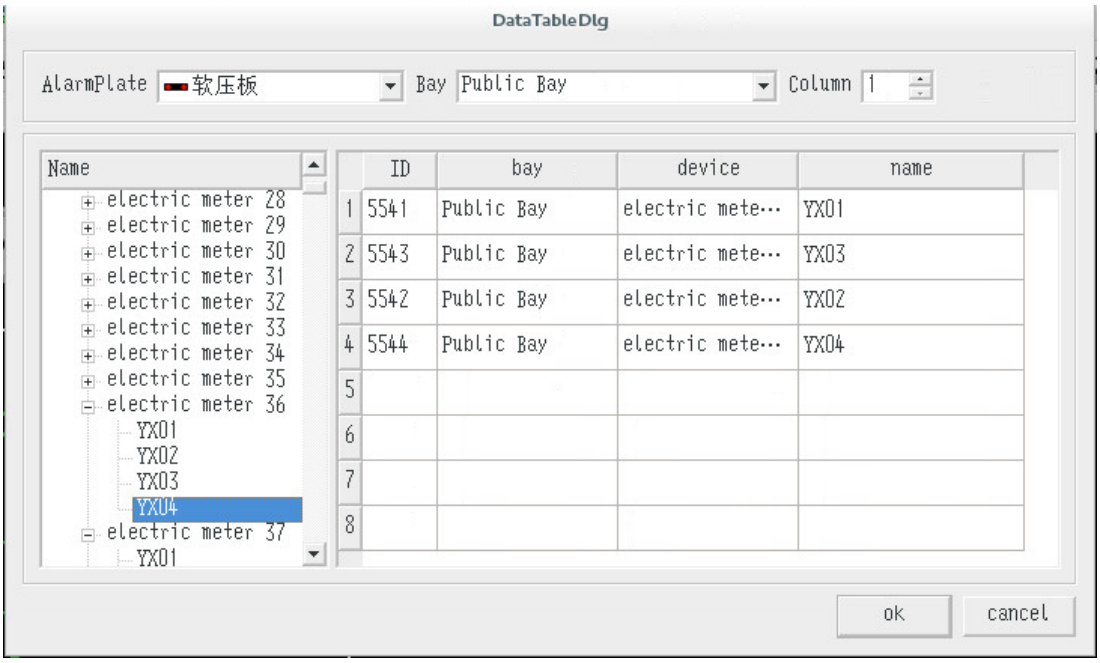


Figure 3.2.28 Add State Value Information

5) Add annunciator: can be used to generate annunciator automatically. Select the bay and column number of annunciator to be generated. Then, drag the required signal into the right blank space from left. In case of deletion required, select the corresponding one and click the right key to delete it, or drag the signal out from the right box.

6) Add sequential control area: to be used to automatically generate the device status of the bay corresponding to the sequential control operation, including operation, hot standby, cold standby and maintenance, etc.

7) Add quantity measurement: can be used to automatically generate the remote measurement or remote pulse forms. The remote measurement or remote pulse can be selected as data type. The title can be customized. Drag the required remote measurement to the right side to modify the signal description and unit. It also supports the generation of multi-dimensional table. The row number and column number are both selectable. Drag the required remote measurement into the corresponding table to modify the row name, column name and unit. The number of decimal can be 1-6.

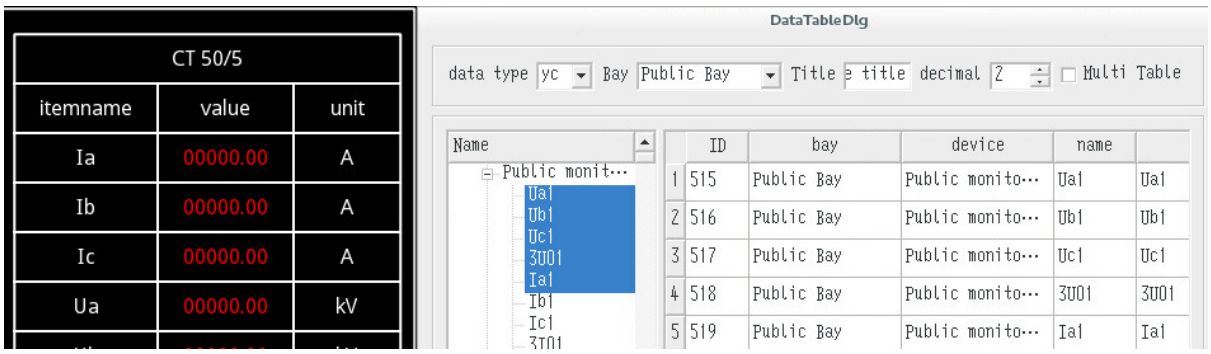


Figure 3.2.29 Add Quantity Measurement Information

After the form editing, move the mouse onto the form. Click the right key to select "Form modifying" to modify it.

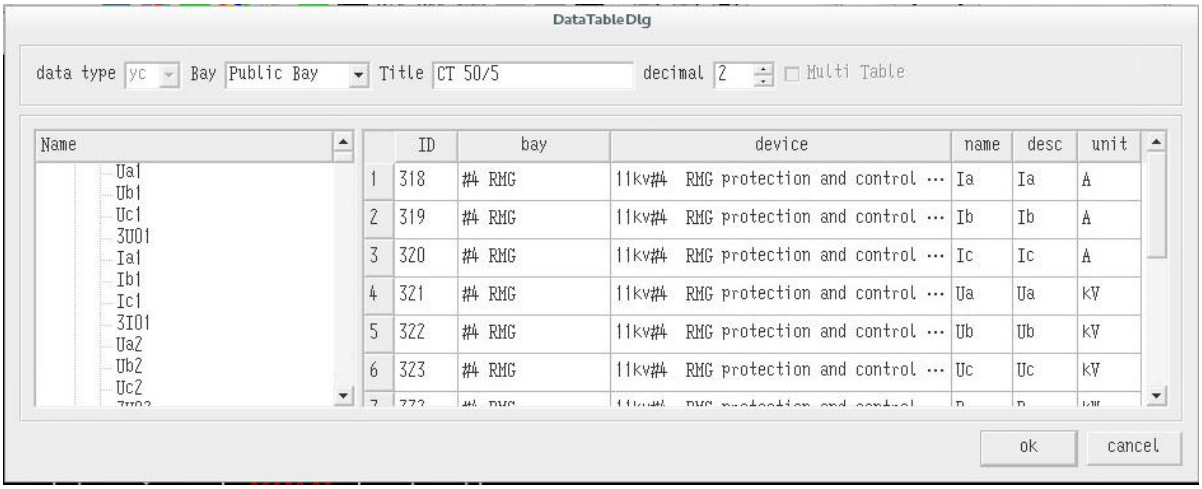


Figure 3.2.30 Modify Quantity Measurement Information

8) Element correlated information: can be used to view the primary equipment, State Value, annunciator as well as signal name and ID of quantity measurement. The remote signal correlated to the generated state value and annunciator can be viewed and modified in the attribute browser at right side.

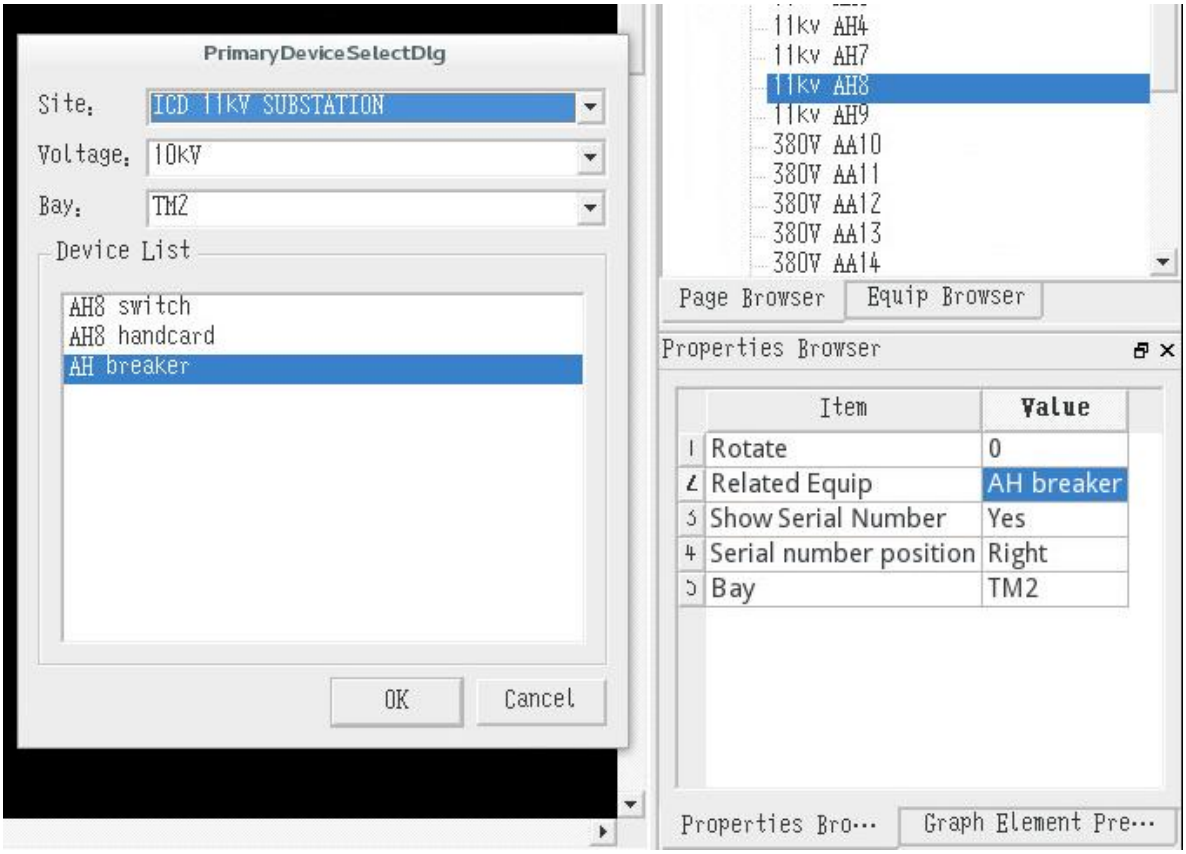


Figure 3.2.31 Modify Graphic Element Correlated Information

Upon the completion of one bay sub-diagram, Other bays of the same type can rapidly generate sub-diagrams of other bays based on the finished bay sub-diagram.

Take the following figure for example. The Bay of Changxing Line 1 includes two diagrams, i.e., one bay sub-diagram (including the connection diagram of bay primary equipment) and one protection sub-diagram. The sub-diagram of Changxing Line 2 can be directly generated according to the two finished sub-diagrams of Changxing Line 1. Find the primary equipment of Changxing Line 2 on the main diagram. Select it and click the right key "Generate the bay sub-diagram based on existing bay". Then, fill in the name of generated sub-diagram. After confirmation, select the bay sub-diagram template "Bay Sub-diagram of Changxing Line 1" or "Protection Sub-diagram of Changxing Line 1".

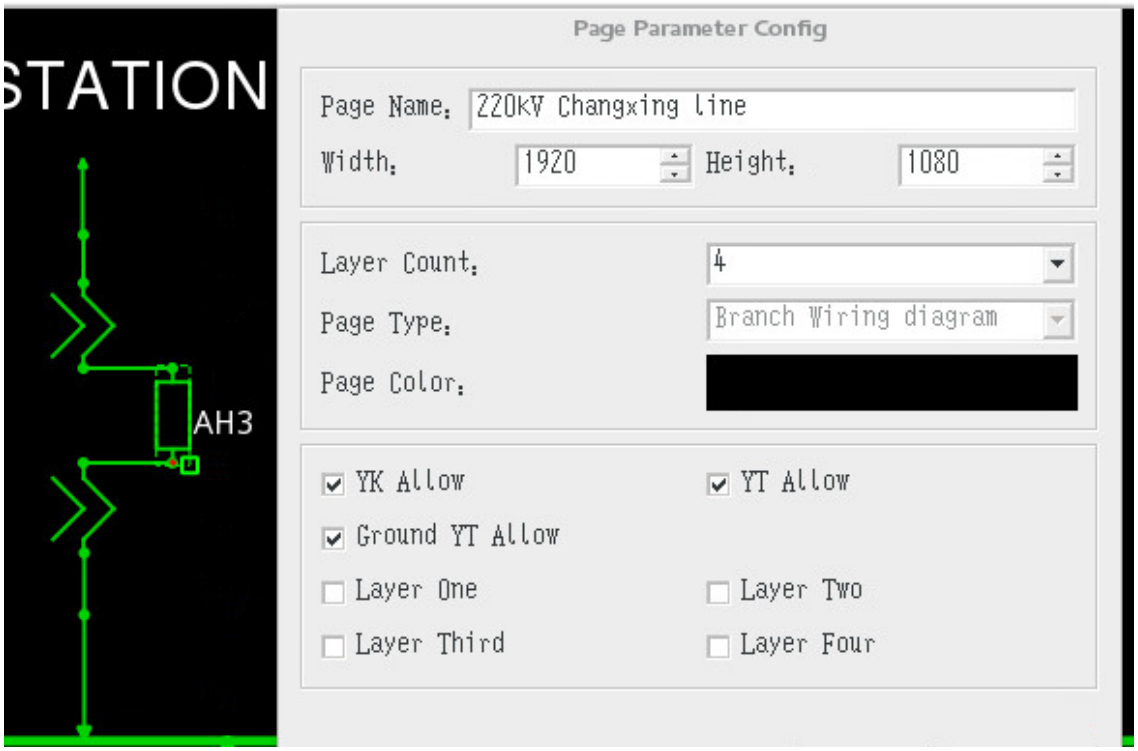


Figure 3.2.32 Interface Parameter Configuration Information

In case of the bay sub-diagram to be generated, check "Draw the primary connection diagram"; in case of the protection sub-diagram to be generated, uncheck this option. Then, the dialog of secondary equipment correlation will pop up. Generally, the program will automatically match the secondary equipment of the two bays respectively. However, if any non-corresponding conditions happen, the non-correspondence can be modified manually.

Figure 3.2.33 Mapping Relationship between Secondary Equipment of Target Bay and Template Bay

- **Functional diagram**

The network structure diagram can be generated automatically.

Select “drawing browser” and then “drawing type”. Then, click the left key to select "Function diagram". Next, click the right key to "Create picture" to pop up a dialog of "Picture parameter configuration", as shown in the following figure.

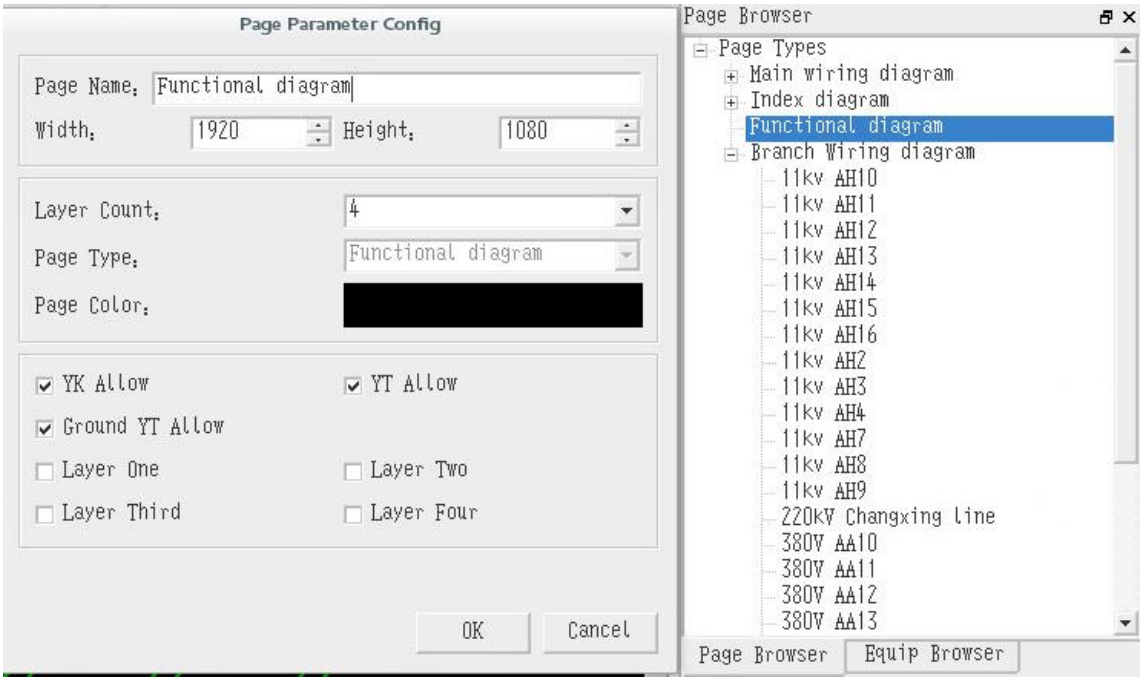


Figure 3.2.34 Generation of Functional Diagram

Click "OK" to enter the interface of function diagram. click the right key to select "Generate network structure diagram". Select the secondary equipment from the left list. The type of secondary equipment, including protection, measurement and control, can be edited through selecting basic configuration tool - secondary equipment - unit type in turns. The network structure diagram of secondary equipment dragged into the right list can be automatically generated, as shown in the following diagram.

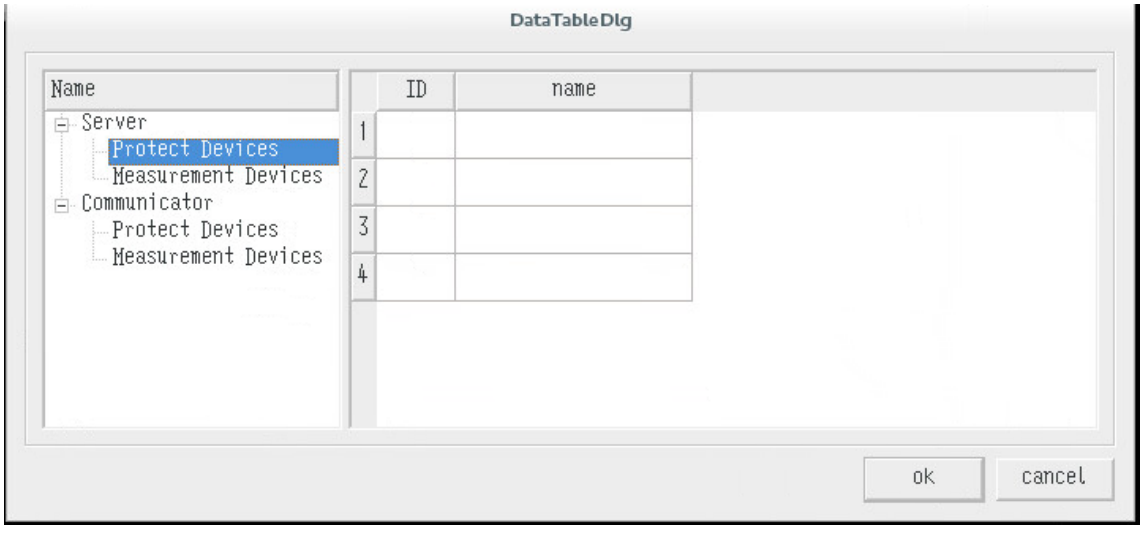


Figure 3.2.35 Equipment Selection of Network Structure Diagram

Click OK. Then, the network structure diagram generated automatically can be seen, the arrangement of which can be adjusted freely, as shown in the following diagram.

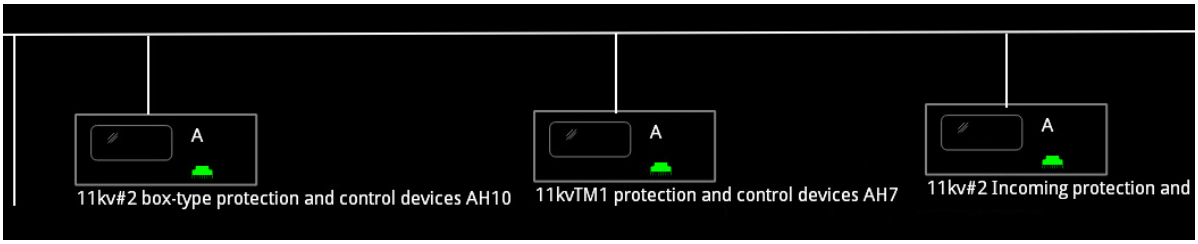


Figure 3.2.36 Generation of Network Structure Diagram

The device name and port element in secondary equipment can also be generated automatically. The setting of device element in element tool can be viewed.

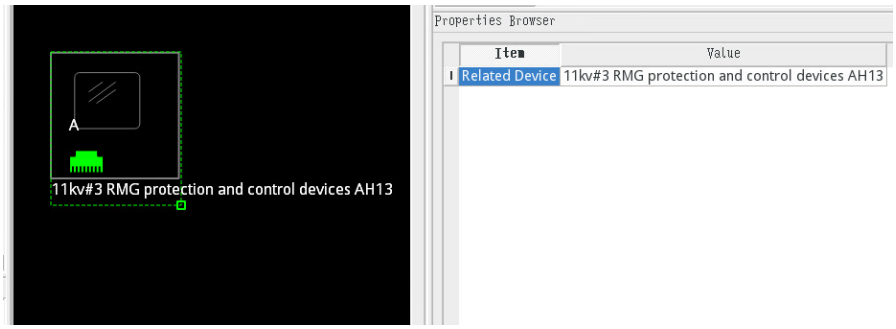


Figure 3.2.37 Diagram of port Status

➢ Index diagram

Select “drawing browser” and then “drawing type”. Then, click the left key to select "Index diagram". Next, click the right key to "Create picture" to pop up a dialog of "Canvas parameter configuration", as shown in the following figure.

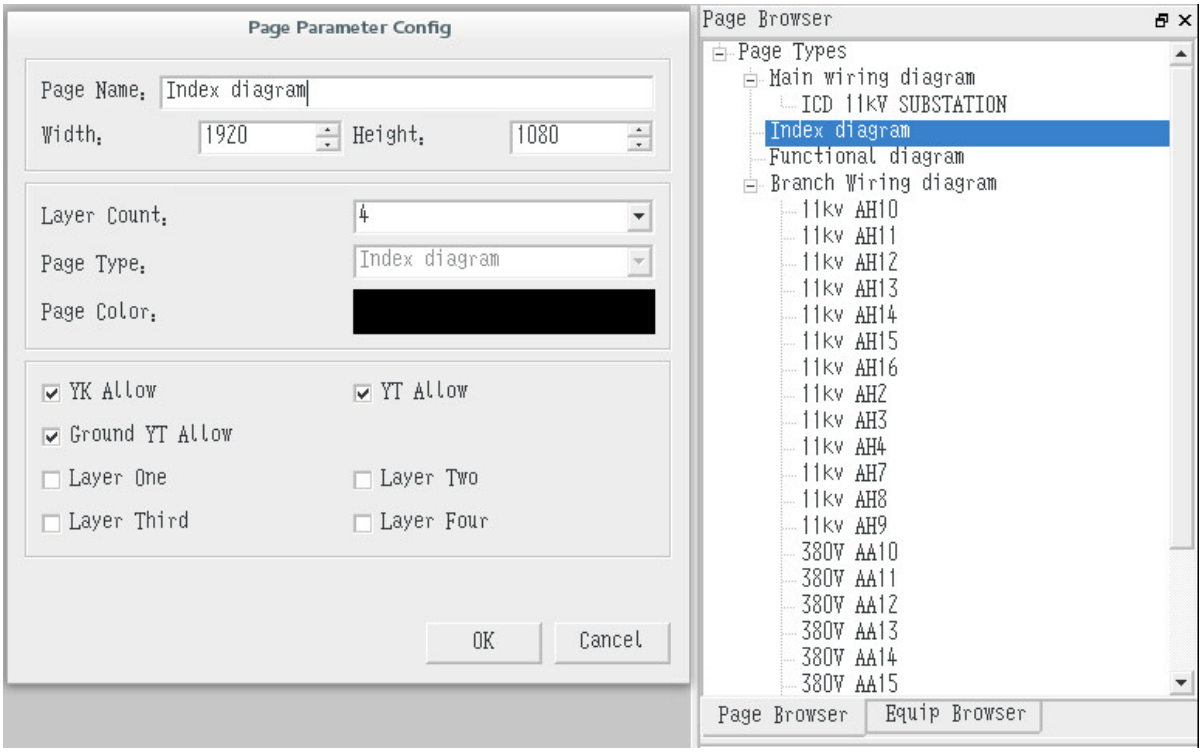


Figure 3.2.38 Generation of Index Diagram

Click "OK" to enter the interface of index diagram. Click the right key to select "Generation of index diagram". Then, linking buttons of all picture will be generated as diagram index, as shown in the figure below.

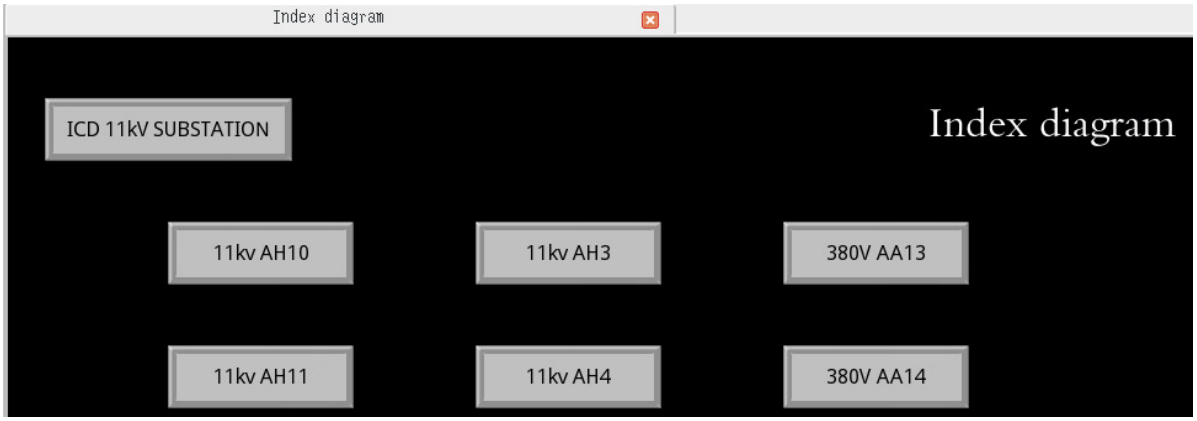


Figure 3.2.39 Generation of Index Diagram

- **Picture topological function**

This drawing tool has been configured with topological relation at the time of drawing. It is necessary to check whether the topological connection line is correct. The wrong connection line will be marked. Click the file in menu bar. Then, select "Check topology" in the popped-up drop-down menu.

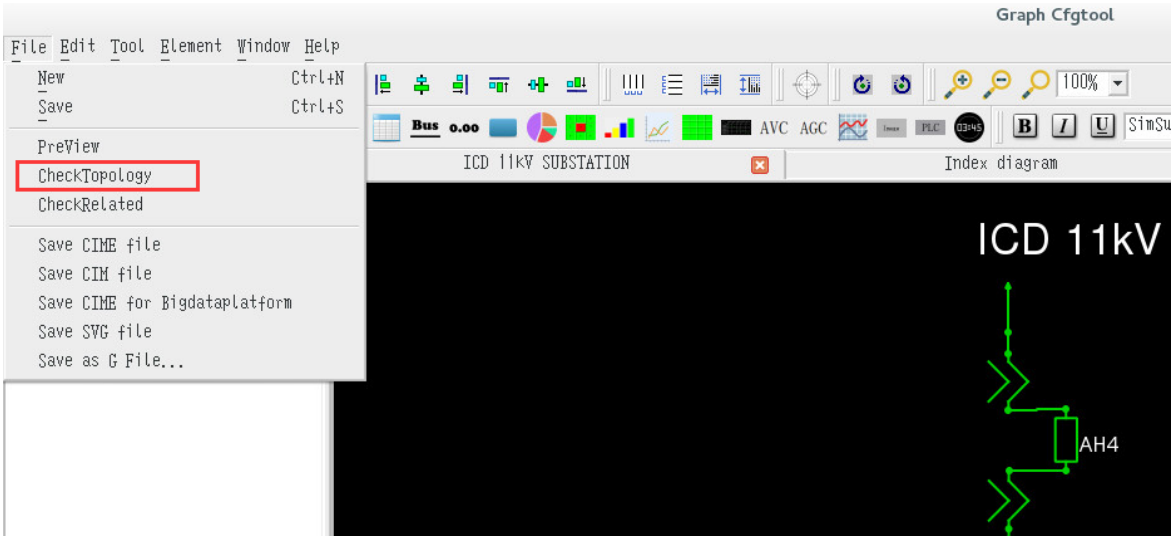


Figure 3.2.40 Check of Topology Diagram

Select the incoming line as the starting point of topology coloring. Set the starting mark of topology coloring of incoming line to "Yes" and correlate the voltage signal Ua of the line. In the HMI, select “configuration” – “operating parameter”, then check the picture coloring function in system setting. When Ua>0, color the primary equipment according to the breaker on/off position of the primary equipment and topological connection; when Ua<=0, all primary equipment is displayed with power-loss color (i.e., gray).

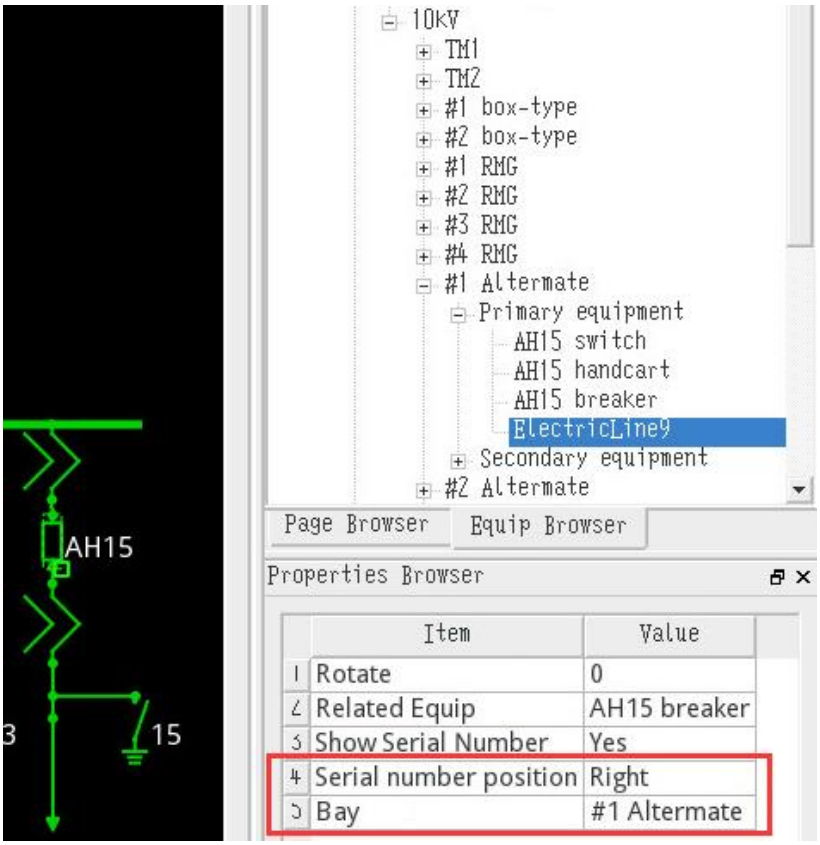


Figure 3.2.41 Setting of Topology Coloring

➢ **Tidal current diagram**

Click the right key to select "Generate tidal current diagram" on the main diagram. If the breaker is vertically installed, the icon is generated at the right side and the positive direction defaults to from top to bottom. If the breaker is horizontally installed, the icon is generated at the downside and the positive direction defaults to from left to right. The icon position can be adjusted through dragging. The correlation signal defaults to the remote measurement active power of the bay. If the bay doesn't have the active power character P, no signal is correlated and the tidal current icon is red. In this case, it is necessary to intervene the correlation signal manually. The correlation signal of tidal current is active power of the bay.

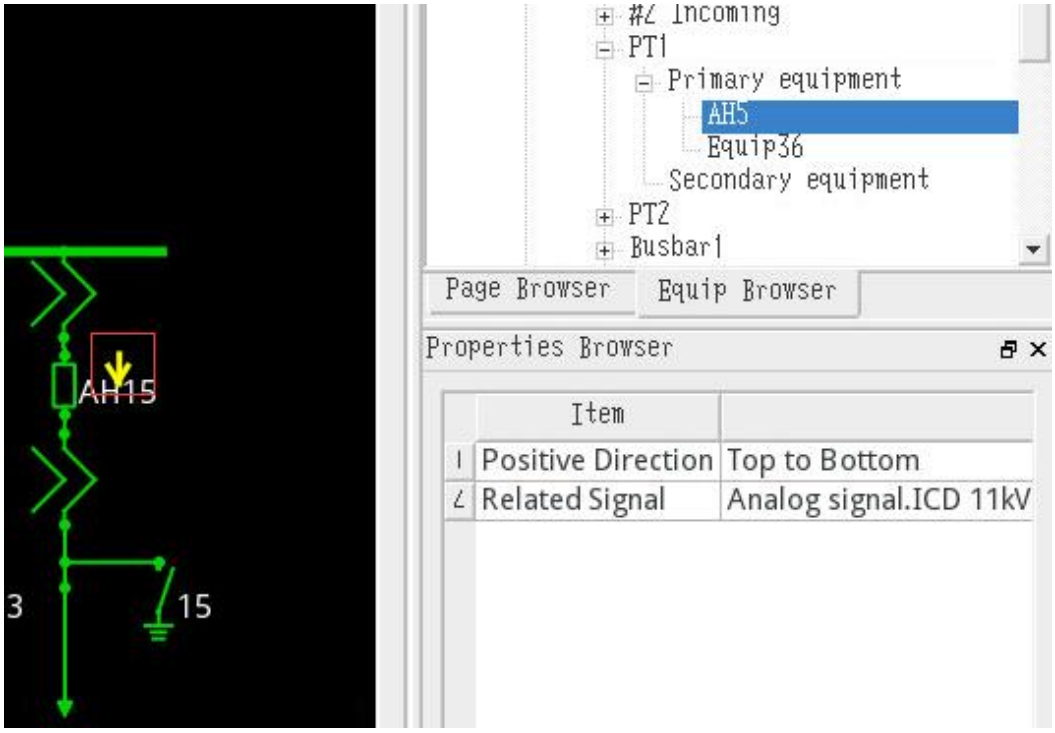


Figure 3.2.42 Generation of Tidal Current Diagram

3.2.6 Basic configuration tool - basiccfgtool

The basic configuration tool is mainly used to provide the configuration and modeling tool for configuration and maintenance of monitoring system, thus rapidly and conveniently generating the engineering database required by monitoring system. There are two kinds of method to open the basic configuration tool.

First method: click the mouse right key in the blank space of desktop to select "Open terminal". Then, enter basiccfgtool and press Enter to pop up the dialog “Login: basic configuration tool”.

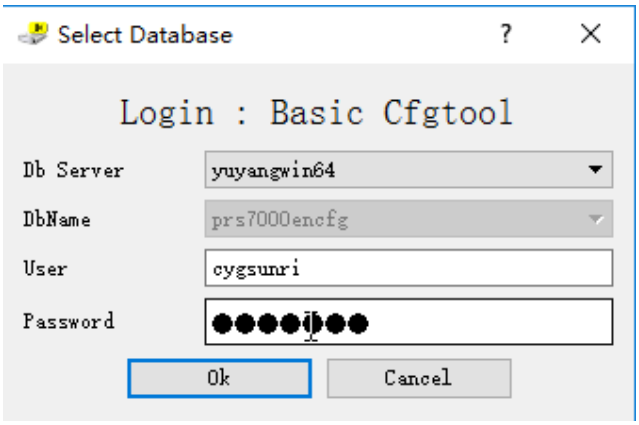


Figure 3.2.43 Login of Basic Configuration Tool

Database server: host name, i.e., server name;

Database: name of configuration database;

User: user name;

Password: password of corresponding user;

The interface of configuration tool will open after entering the user name and password.

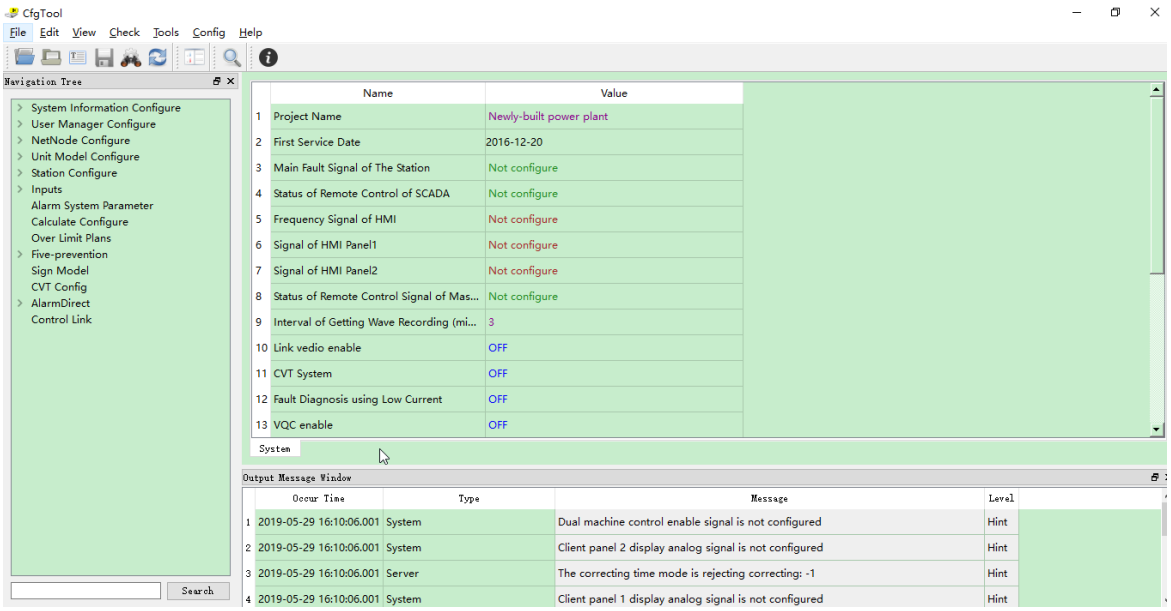


Figure 3.2.44 Introduction of Basic Configuration Tool

1) Menu bar: move mouse to the menu bar to display the specific application; then, select the corresponding application;

2) Tool bar: move mouse to the tool bar to display the specific application; then, select the corresponding application with left key;

3) Navigation tree: all applications of configuration tool are in the navigation tree. For details, please refer to Chapter 3.

4) System parameter: the content displayed by default after entering the configuration tool;

5) Display the current login user and configuration database;

6) System time: display current machine time;

Second method: under the path of /home/PRS7000/bin, double click the icon basiccfgtool, the enter user name and password and click "Log in".

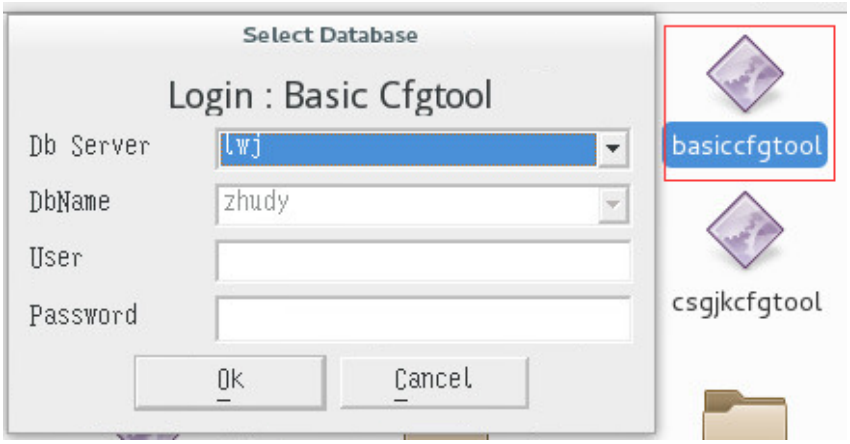


Figure 3.2.45 Login of Basic Configuration Tool

3.2.6.1 Model file import

At present, the basic configuration tool supports the import of SCD, ICD or TX module files. SCD has to be created in all 61850 monitoring stations. Besides, both IP and APPID of station level in SCD have to be filled in. The modification of signal name (if required) has to be finished in SCD before importing into SCADA. SCD shall be consistent with the database information in station. So, it is not recommended to modify the signal name separately in SCADA.

1) Import SCD files. Whether to check "Process level Goose information" means whether to analyze the secondary equipment of process level in SCD. Usually, it doesn't have to be checked. For the option “Delete IED undefined in SCD file from database”, if any 61850 device no longer exists in SCD newly imported into database, check this option to delete the device. The deletion of some 61850 IED usually occurs when updating SCD.

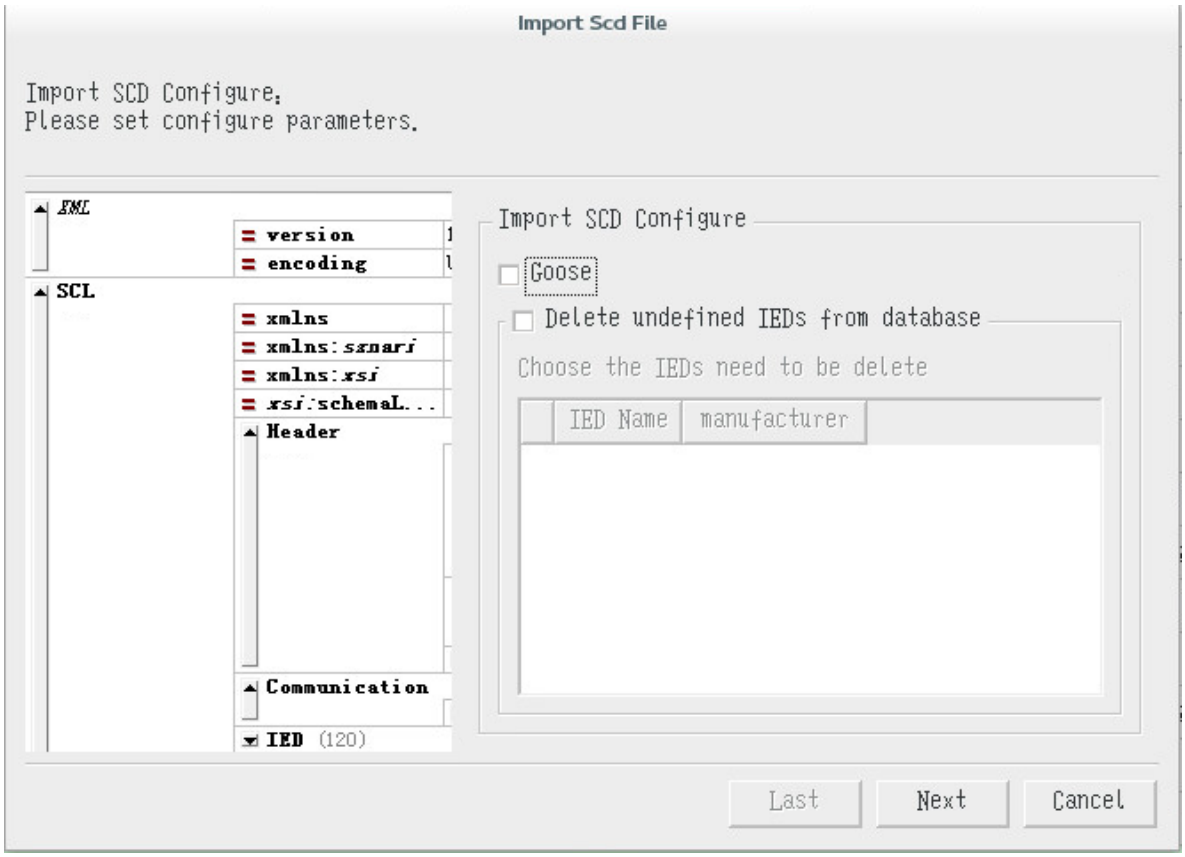


Figure 3.2.46 SCD Import Operation

Click "Next" to pop up the list of all secondary equipment in SCD, the defaulted selection is “select all”. The batch selection or canceling of several items at the same time is also supported.

NOTICE!

Notes: after SCD importing and secondary equipment creating, all subsequent SCD importing is updating operation. At the time of updating, the program will update the IED information as long as the IEDname is consistent.

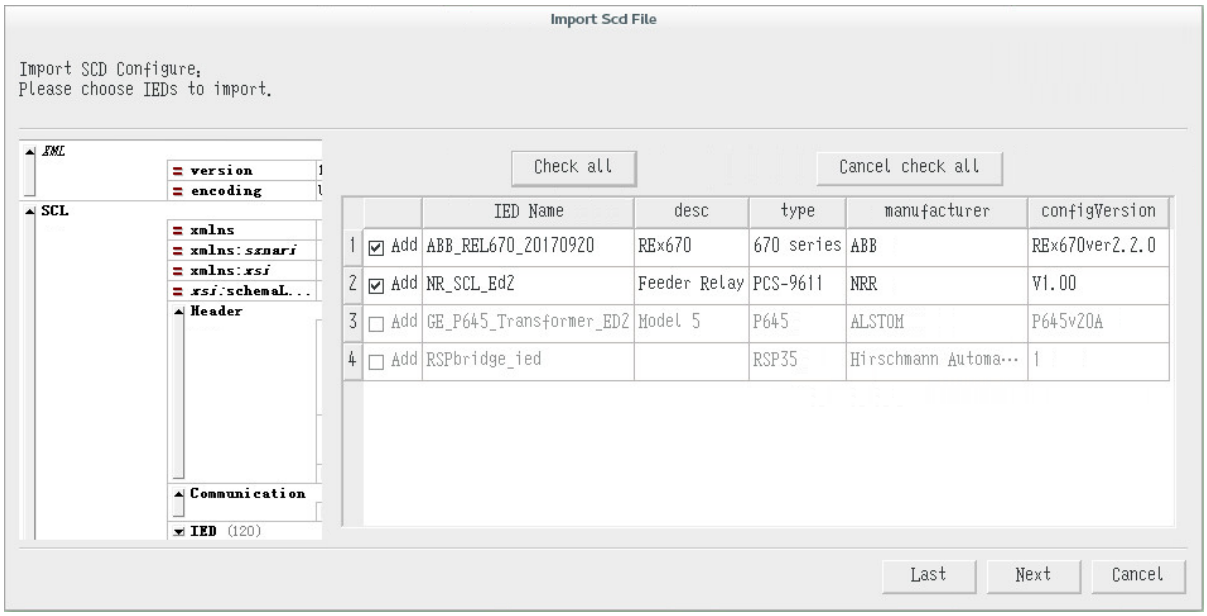


Figure 3.2.47 Selection of Imported SCD Equipment

Notes: Chinese characters are not allowed in neither SCD nor file path.

2) Import ICD files. Whether to check "Process level Goose information" means whether to analyze the secondary equipment of process level in ICD. Usually, it doesn't have to be checked. After ICD importing, the secondary equipment will be automatically generated as per configurations. If ICD is modified, click the ICD file with mouse right key and select "Update" in the popped-up menus.

NOTICE!

Chinese characters are not allowed in neither ICD nor file path.

3) For importing of TX template, import secondary equipment template firstly; then, create secondary equipment manually.

NOTICE!

TX temperate must be of utf8 code, which can be converted with UE or Notepad. The TX template name doesn't analysis Chinese characters again. It is forcibly represented with English letters.

3.2.6.2 System parameters

Operating parameters of SCADA server: the HMI display style is modified in these settings. The default selection is suggested. There is no need to carry out modification.

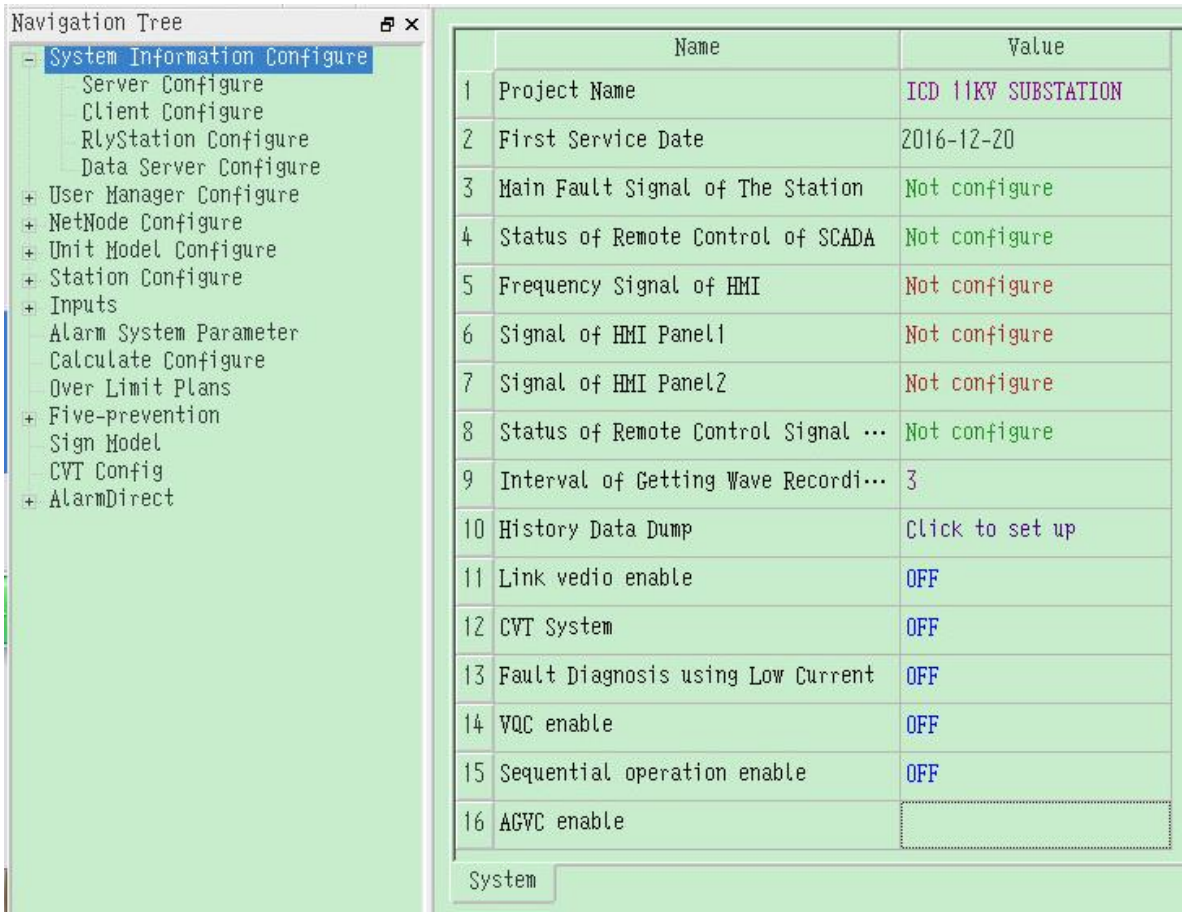


Figure 3.2.48 System Parameters

Operating parameters of SCADA server: selection of parameter configuration at the time of server running;

Operating parameters of SCADA client: referring to operating parameters of HMI, which subject to default configuration, with no need of modification;

Operating parameters of protection engineer station: subject to default configuration, with no need of modification;

Operating parameters of data server: subject to default configuration, with no need of modification;

3.2.6.3 Network configuration

Adding network node as per role is supported. The previous method, i.e., adding customized network node, is also OK.

Create role of monitoring host: fill in the name and IP of the host. If there are double servers, check "Dual Host". Select the client type according to the actual server configuration. In case the monitoring host doesn't integrate the mal-operation workstation, select the operating client as client type. If the monitoring host is integrated with the mal-operation workstation, select the the mal-operation client as client type.

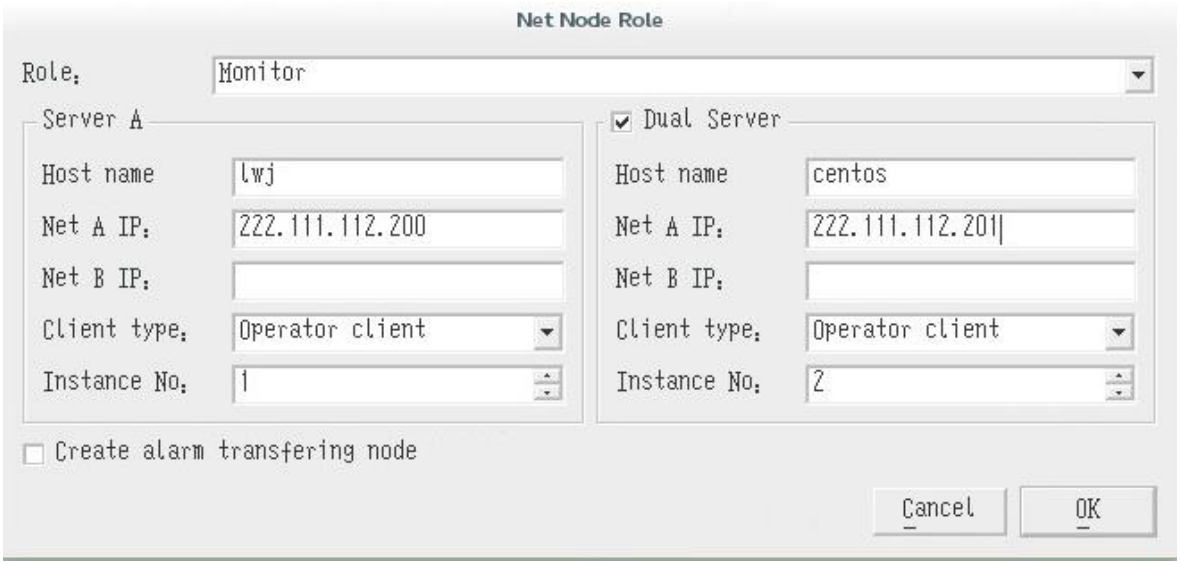


Figure 3.2.49 Role Creation of Monitoring Host

New operator station: the creation of this role only needs HMI and alarm window, both of which can be automatically generated after filling in IP. HIM type is operating client.

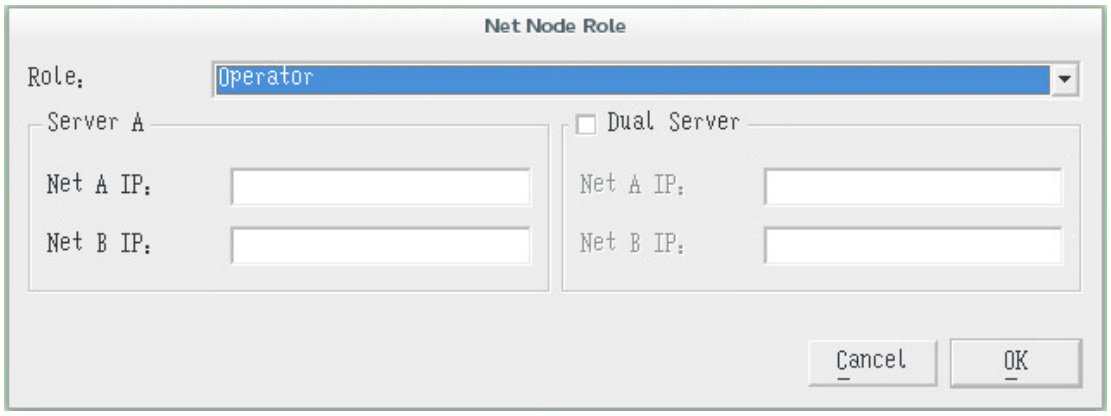


Figure 3.2.50 Role Creation of Operator Station

Create data gateway: only need to input name and IP of gateway device. "Dual computer" can be selected.

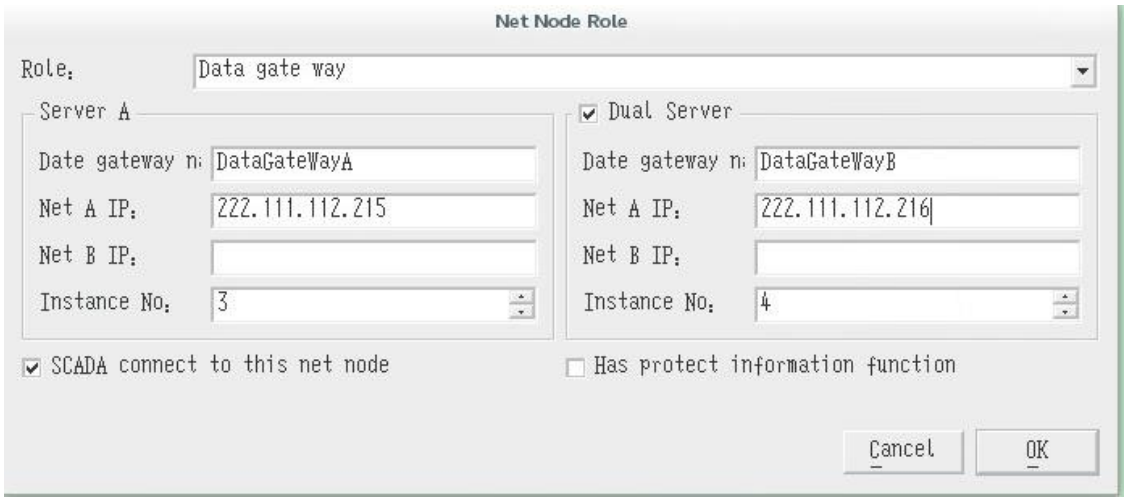


Figure 3.2.51 Role Creation of Station Gateway

Create protocol converter: multiple nodes of protocol converter can be created in batches. IP of protocol converter is subjected to auto increment.

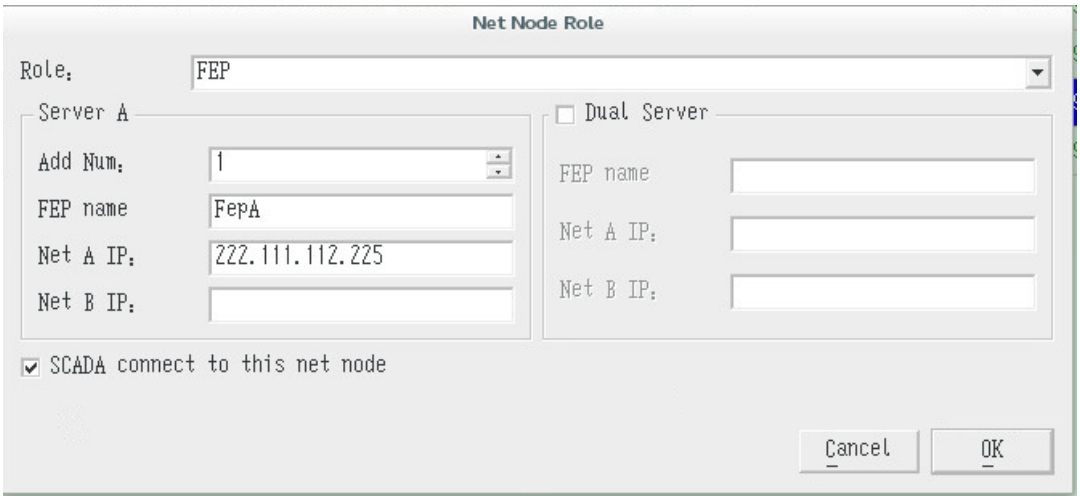


Figure 3.2.52 Role Creation of Protocol converter

At present, only protocol converter and data gateway device are reserved in network node type. The protocol converter communicates with equipment of other manufacturers and data gateway device communicates with master station.

3.2.6.4 Configuration of secondary equipment

The secondary equipment will be generated automatically after importing SCD or ICD. The difference is that the correlation between remote signal and remote control can be analyzed automatically according to 61850 template file. Check by default the status of remote signal equipment correlated with remote control. In case the actual secondary circuit on field doesn't correspond to the remote control and remote signal in 61850 modeling, please modify the remote signal correlated with remote control. If the secondary equipment template is 103 type or the secondary equipment is of other manufacturers, the correlation between remote control and remote signal cannot be analyzed. In this case, it is necessary to manually check the "Equipment Status" of remote signal and then correlate the remote control.

Modification of position remote signal correlated with remote control:

1) For 61850 model:

- The status signal correlated by default can be viewed in the remote control channel of secondary equipment. Select the remote signal to be changed; then, select the secondary equipment —— status signal in the attribute window at right side, and drag them to the required space.

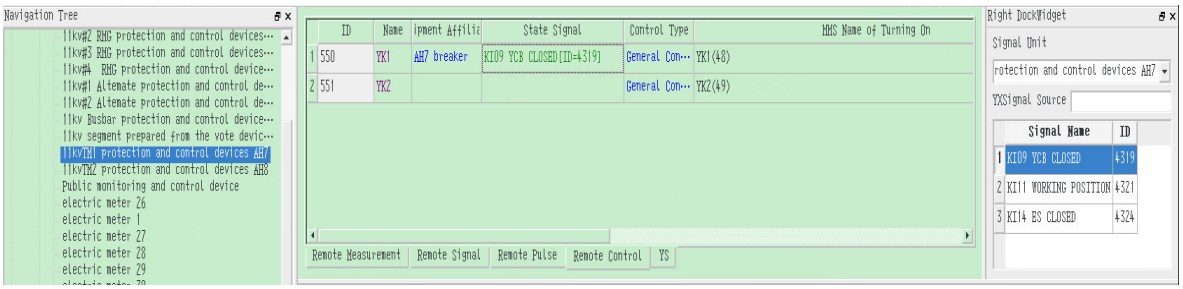


Figure 3.2.53 Modification of remote signal Correlated with 61850 Model remote control Channel

- The function of signal query is included in the right attribute window. Enter the related information in the secondary equipment query box. Then, the matched secondary equipment will be searched out.

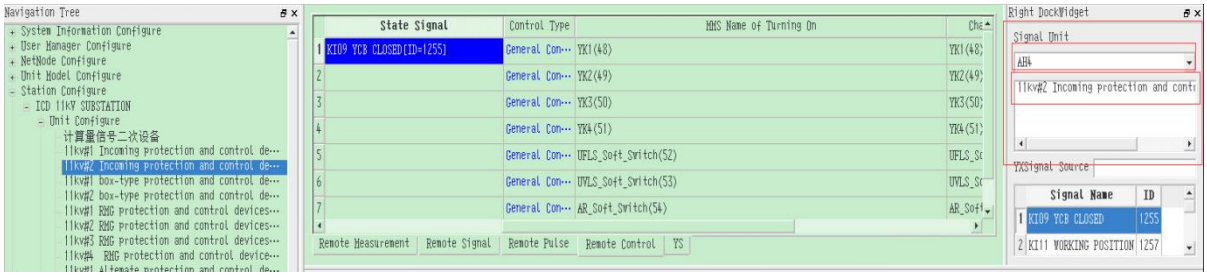


Figure 3.2.54 Query of Secondary Equipment

- Enter keywords in the remote signal query box. Then, the matched remote signal of the same keywords will be queried in the selected secondary equipment.

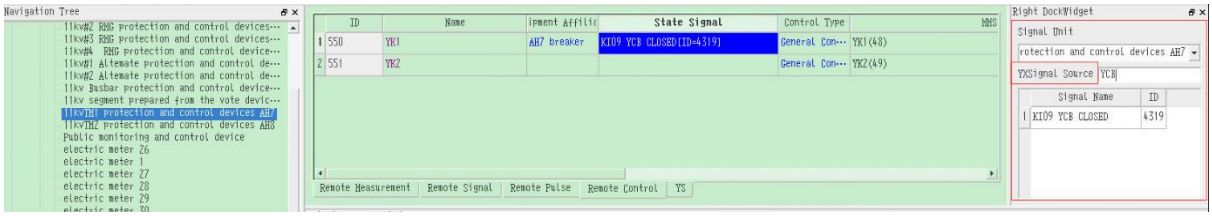


Figure 3.2.55 Query of Signal keywords

2) For 103 model:

- For the signal attribute of remote signal need to select the equipment status manually, It is feasible to select several ones and edit them in batches with right key.

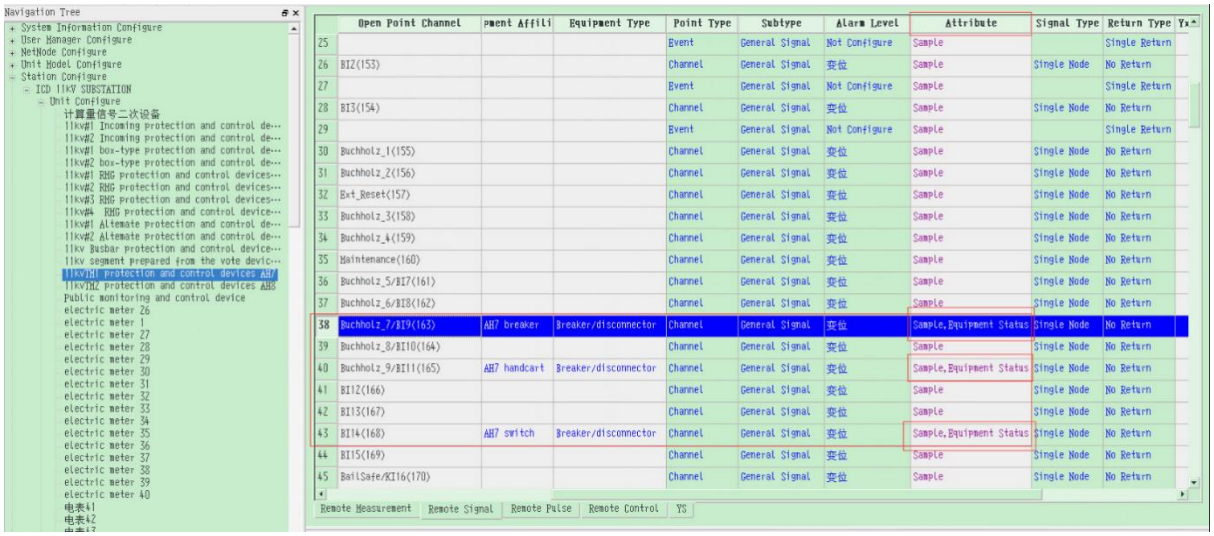


Figure 3.2.56 Remote signal Attribute of 103 Model

- Select the secondary equipment and status signal from the right attribute window; then, drag them into the corresponding remote control channel.

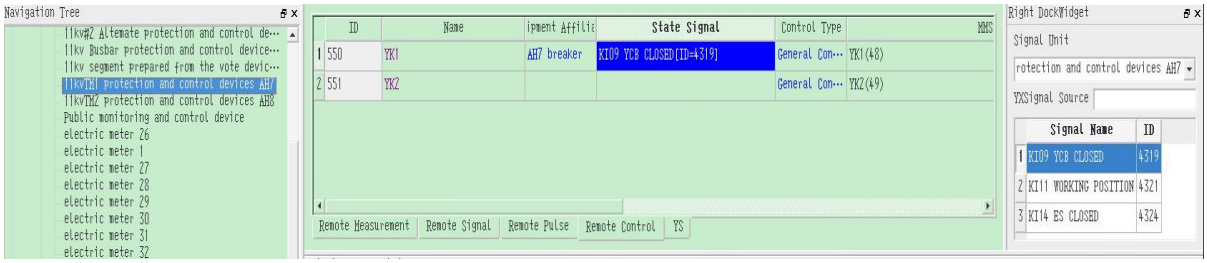


Figure 3.2.57 Remote Signal Correlated with 103 Model Remote Control Channel

- If 103 template is modified, click the template with right key to update it.

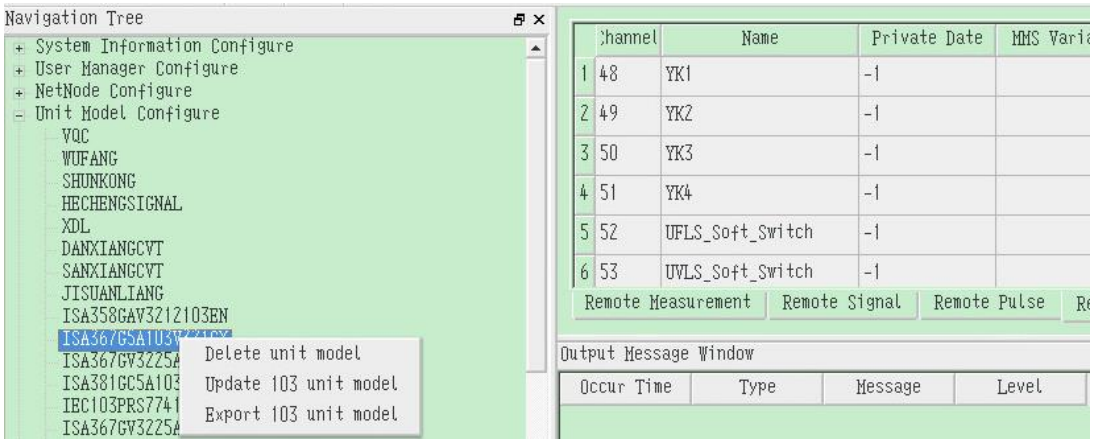


Figure 3.2.58 Update 103 Device Template

At present, an independent template (identified with 9) is used for calculation signals in SCADA. After importing this template, a secondary equipment with composite signal will be automatically created. All signal attributes belonged to the secondary equipment is of calculation.

The primary equipment is not more created for soft switch. So, if it is switch signal, the remote signal sub-type is analyzed to be switch status in SCADA. In this way, the remote control through HMI can be realized. The dispatching sign is no longer correlated with the primary equipment, but with remote control. Fill in the dispatching sign in the last column of remote control attribute, which will be used as the remote control ID at the time of HMI remote controlling.

3) Five-remote configuration duplication of secondary equipment: after configuring the five-remote attribute of one secondary equipment, it is feasible to copy the five-remote configuration for other devices with same template files.

Figure 3.2.59 Signal Duplication of The Secondary Equipment

Click the configured secondary equipment with right key. Then, select the corresponding option to duplicate the five-remote signal configuration. Next, click the corresponding secondary equipment with right key (pasting several equipment synchronously can also be achieved) to paste the five-remote signal configuration.

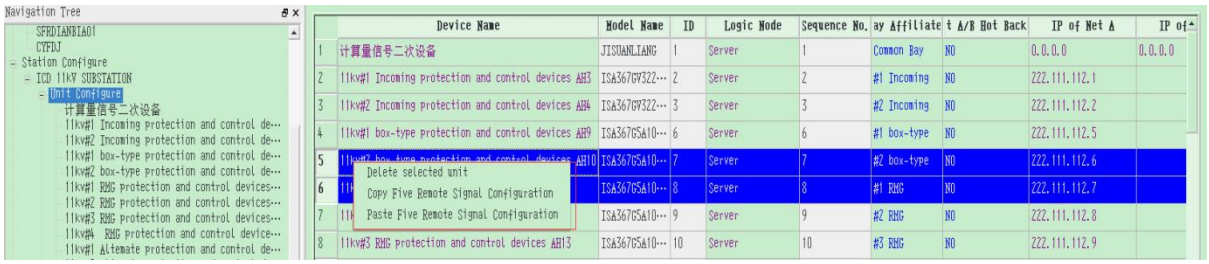


Figure 3.2.60 Duplicate and Paste Five-remote Signal Configuration

Select the five-remote attribute of the source secondary equipment to be pasted from the popped-up window, which includes the setting as shown in following figure. If major options as remote measurement, remote signal, remote pulse and remote control are checked, all sub-options under them will also be checked. The canceling of any sub-option will result in the unchecking of corresponding major option. It is defaulted that all sub-options are checked except for primary-secondary ratio. Click OK to paste into the target equipment.

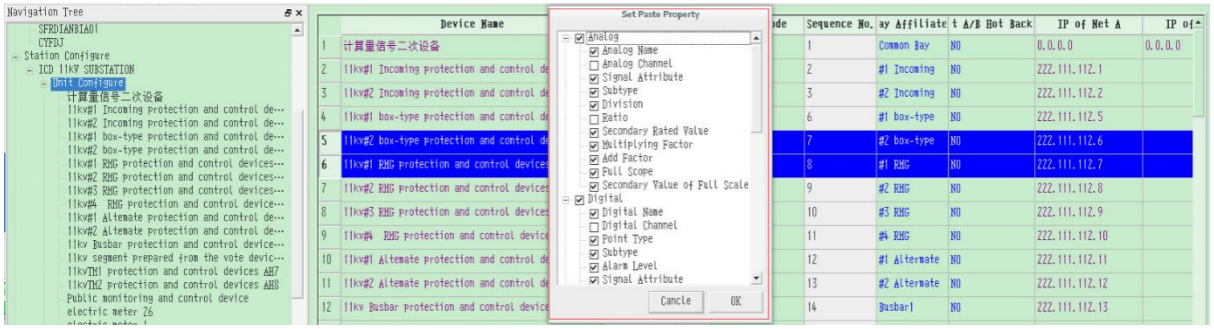


Figure 3.2.61 Set Pasted Attribute

The signal shielding means to shield remote signal state changing and soe event. The alarm description refers to on/off description in alarm configuration. All other attribute options can be found in the popped-up five-remote window.

4) Batch modification of four-remote attribute based on keywords: this function can be used to check repetitive signal attributes and adjust coefficients. Click the application above the basic configuration tool with mouse left key. Then, select the four-remote attribute based on keywords with left key for batch modification.

Figure 3.2.62 Batch Modification of Four-remote Attribute Based on keywords

Select the remote measurement, remote signal, remote pulse or remote control; enter the name keyword of secondary equipment to be queried in the corresponding box, such as protection device, measurement and control device and so on (can be defaulted; if defaulted, query within the range of all secondary equipment at the time of signal searching); enter the keyword of signal name in the signal query box, e.g., breaker and switch (also can be defaulted. If defaulted, all signals of queried secondary equipment will be searched); if both of them are defaulted, the search button will become gray, i.e., invalid when clicking; after entering the keyword, click Search to display the queried signal. Then, the signal attribute can be modified.

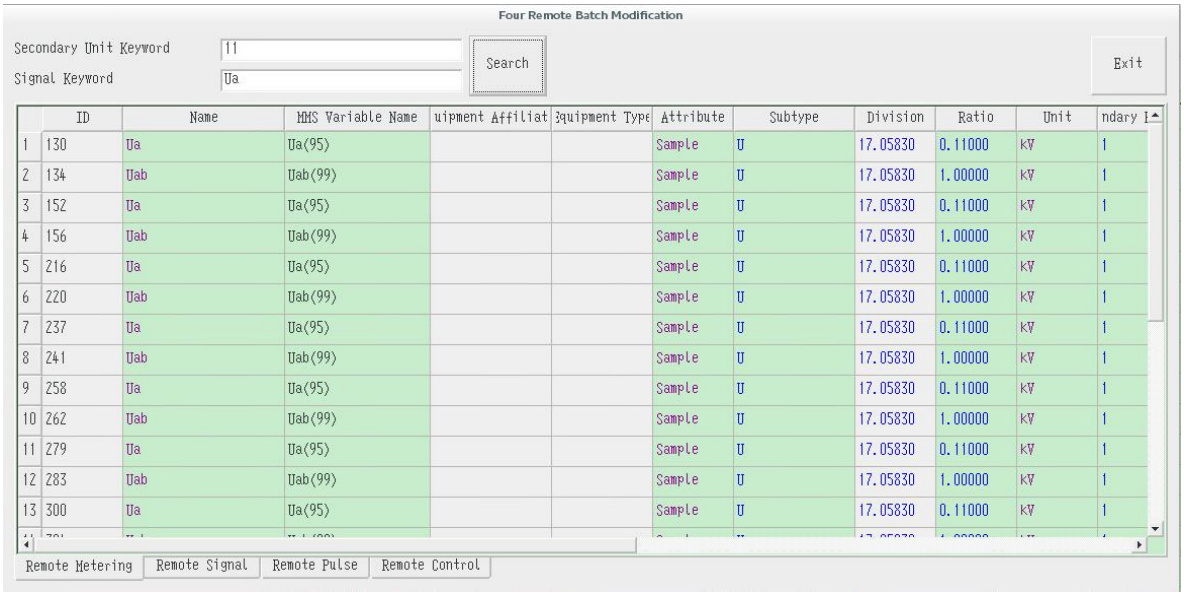


Figure 3.2.63 Batch Modification of Four-remote Attribute Based on Keywords

Select all the attributes to be modified. Then, click the right key to select Edit, entering the editing of multiple options. Then, modify listed signal attributes in batches.

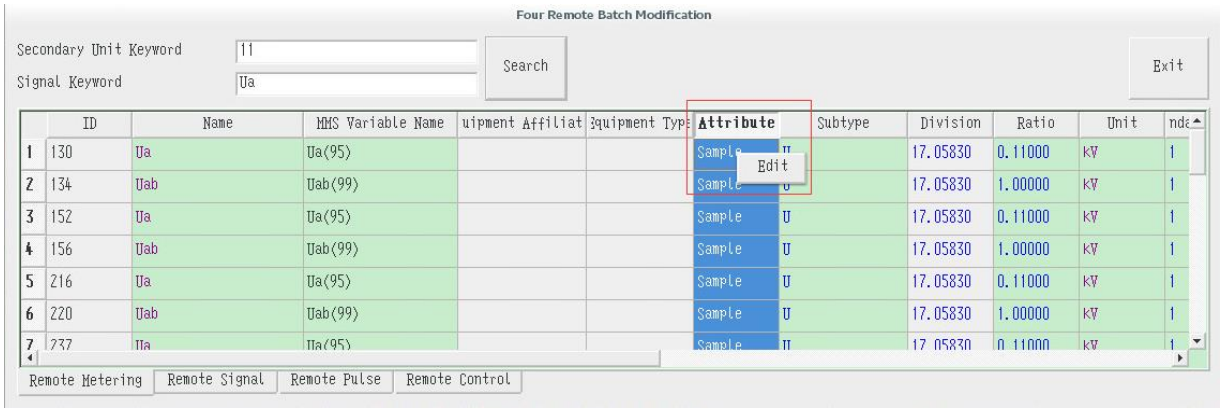


Figure 3.2.64 Batch Modification of Four-remote Attribute Based on Keywords

The operation of remote signal attribute which is not displayed (e.g., signal display shielding) is as shown in the figure below. Select several signals to be adjusted at the same time. Then, click them with right key to select Batch Modification of Remote Signal.

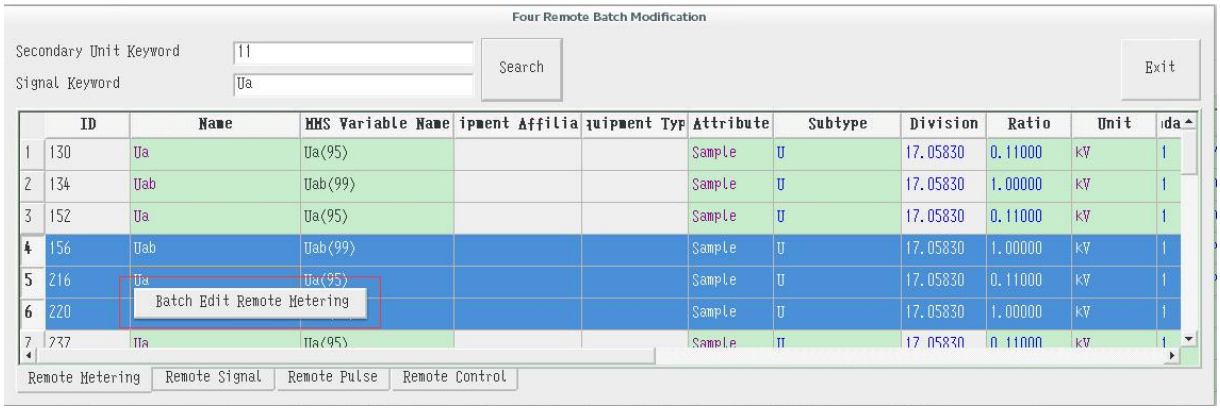


Figure 3.2.65 Batch Modification of Remote signal Attribute

Upon the completion of signal editing, click Quit to complete the batch modification of four-remote attribute.

5) Modification of remote signal attribute based on remote signal sub-type: when modifying the remote signal attribute, it is feasible to modify the description of a certain type of remote signal of same attribute in batches.

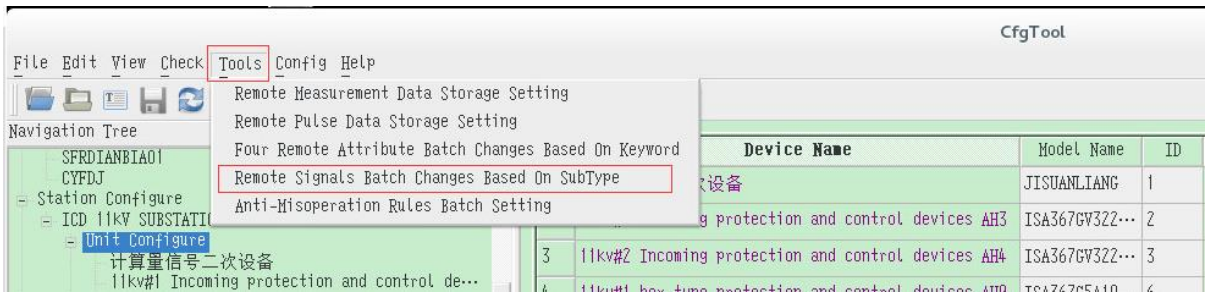


Figure 3.2.66 Modification of Remote signal Attribute Based on Remote signal sub-type

Click the corresponding application. Then, click Modification of Remote signal Attribute Based on Remote Signal Sub-type to pop up the window related to remote signal type selection.

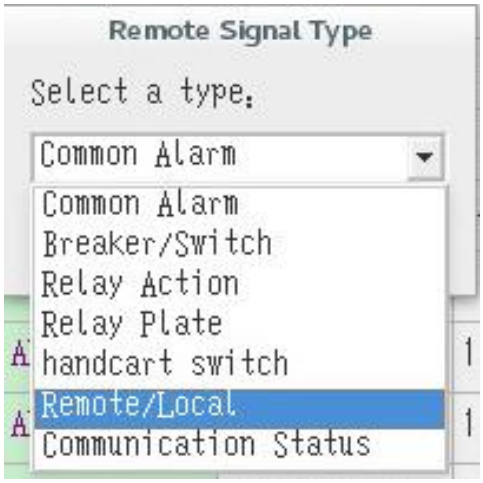


Figure 3.2.67 Signal Type Selection

Select the required type to pop up the corresponding interface. Then, modify its alarm description

and ON/OFF description in the interface.

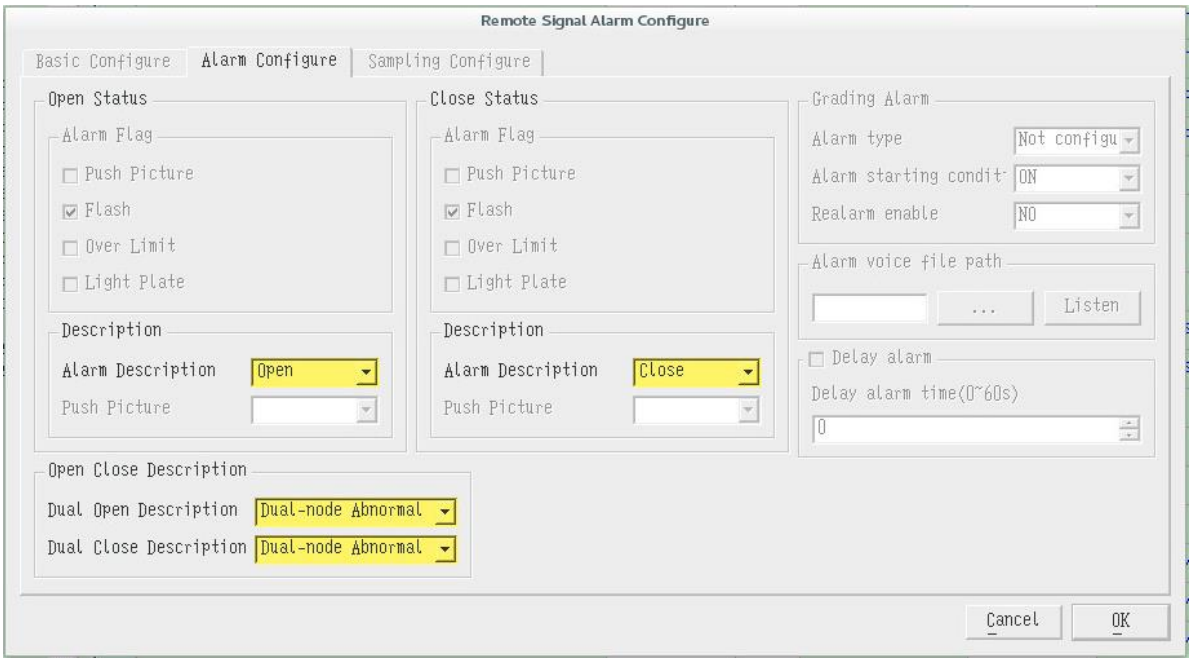


Figure 3.2.68 Modification of Remote signal ON/OFF Description

3.2.6.5 Correlation of bay and primary equipment

The voltage class, bay and primary equipment information all have been created in the drawing configuration tool. After importing SCD, it is necessary to finish the correlation of bay and secondary equipment. Select the bay. Then, select the uncorrelated secondary equipment from the right attribute window and drag it into "Correlated secondary equipment".

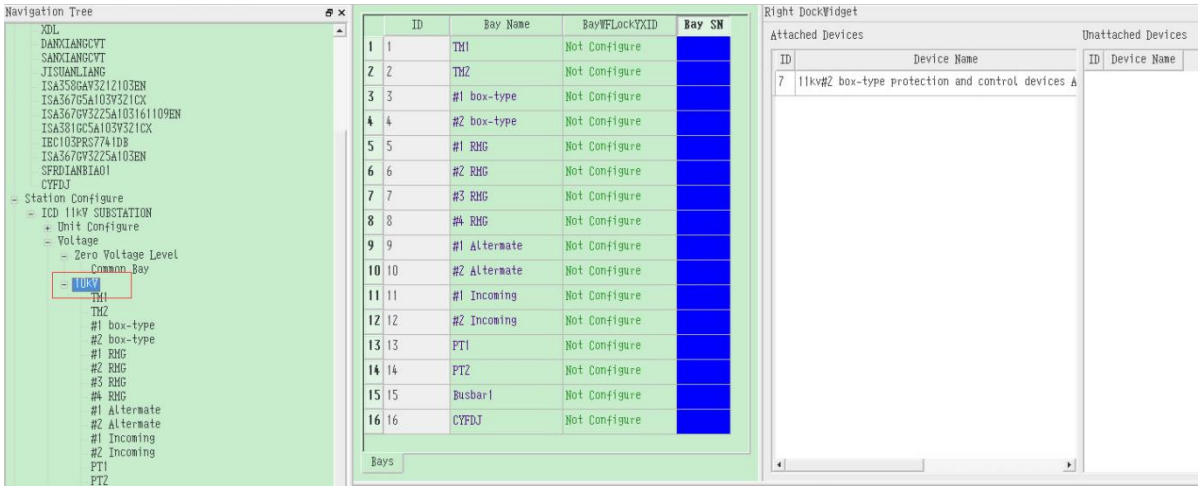


Figure 3.2.69 Signal Correlation of Secondary Equipment in Bay

The created primary equipment can be viewed in the main window of bay node. Then, make the primary equipment be correlated with remote signal or remote measurement.

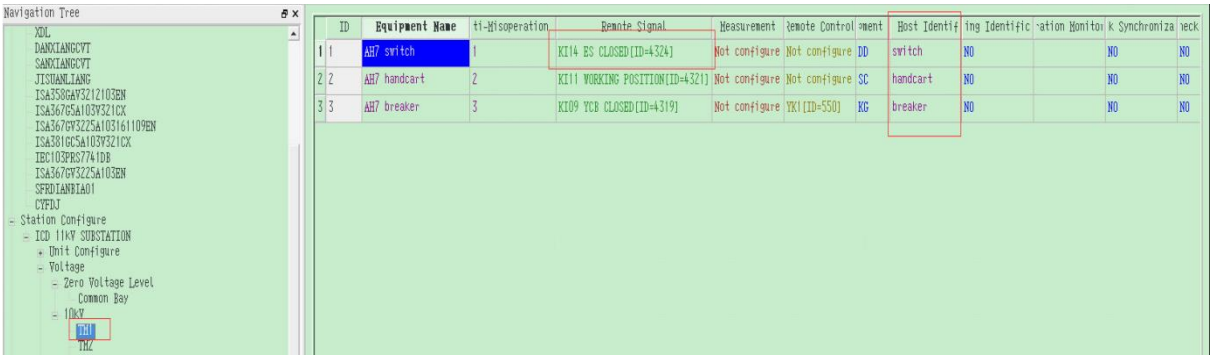


Figure 3.2.70 Remote signal Selection of Primary Equipment

Click "Correlate remote signal" to pop up the attribute window on the right side, which displays the secondary equipment of the bay. Select the corresponding secondary equipment. Then, the remote signal with "Equipment status" checked will be automatically screened out. Next, drag it to the corresponding space to finish the correlation. Since the correlation of remote control and remote signal has been finished at the four-remote place of secondary equipment, the correlated signal of remote control can be automatically read here. Upon the completion of remote signal correlation of primary equipment, the corresponding signal of primary equipment will exist in the HMI. Therefore, the graphic configuration has no need to correlate the primary equipment again.

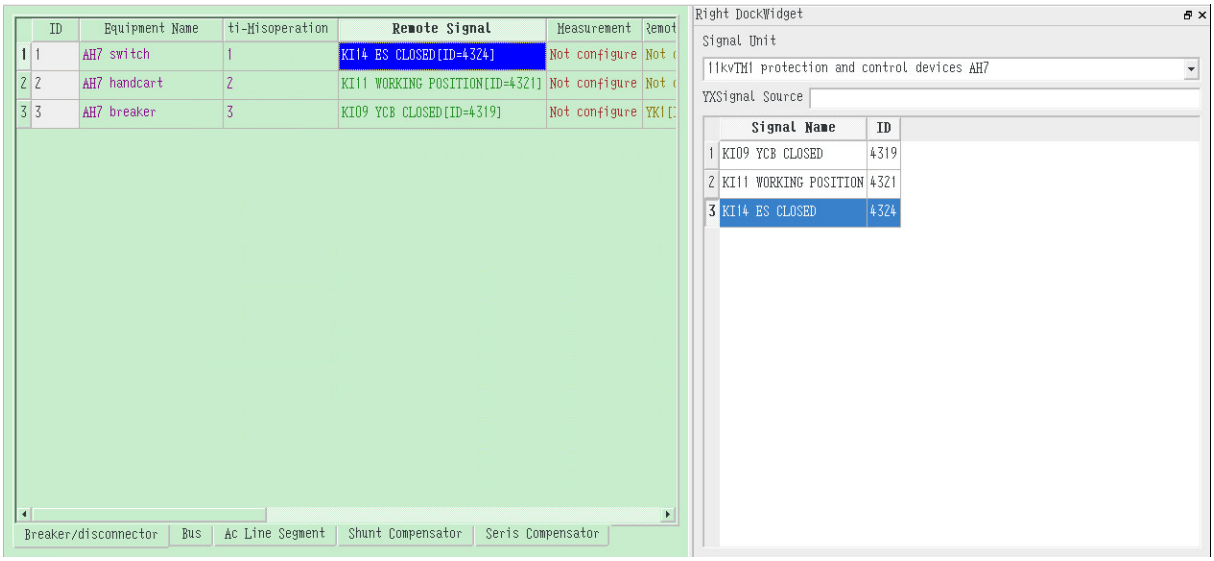


Figure 3.2.71 Remote signal Signal Correlation of Primary Equipment

Duplication of primary and secondary equipment correlation: for the bay with primary and secondary equipment correlation configured, it is feasible to duplicate its primary and secondary equipment correlation in other bays with same template files, so as to simplify the configuration.

Click the right key in the bay to pop up the duplication button of primary and secondary equipment correlation. Click this button to duplicate the correlation of the template bay. Then, click the bay which needs the duplicated with right key to pop up the button Paste. Click it to paste the correlation into the bay.

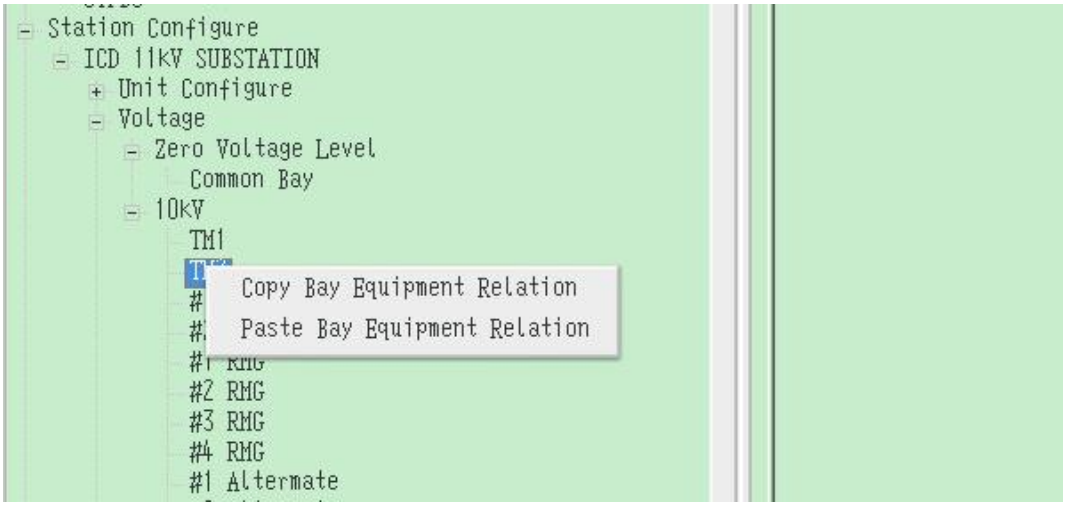


Figure 3.2.72 Correlation Duplication of Primary and Secondary Equipment

After pasting, the mapping relation of primary equipment between source bay and target bay will pop up firstly. Both source and target primary equipment are listed by default in a sequence of ID. After the completion of configuration, click OK to enter next step.

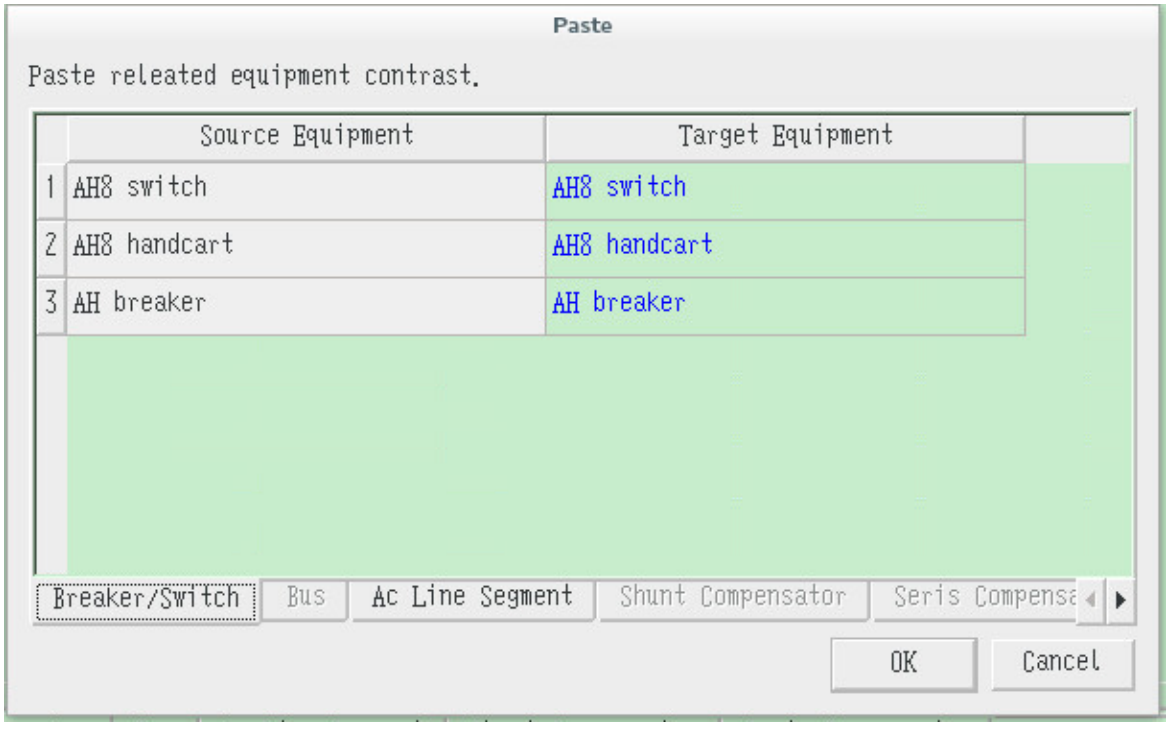


Figure 3.2.73 Target Configuration of Correlation Duplication of Primary and Secondary Equipment

Then, the selection window of source and target devices will pop up. The system has provided the fuzzy matching by default. Select the target device and click OK to paste the duplicated bay correlation into the target bay through matching the channel number. For bays of same type, only need to copy the correlation of source bay once and then paste it into different bays.

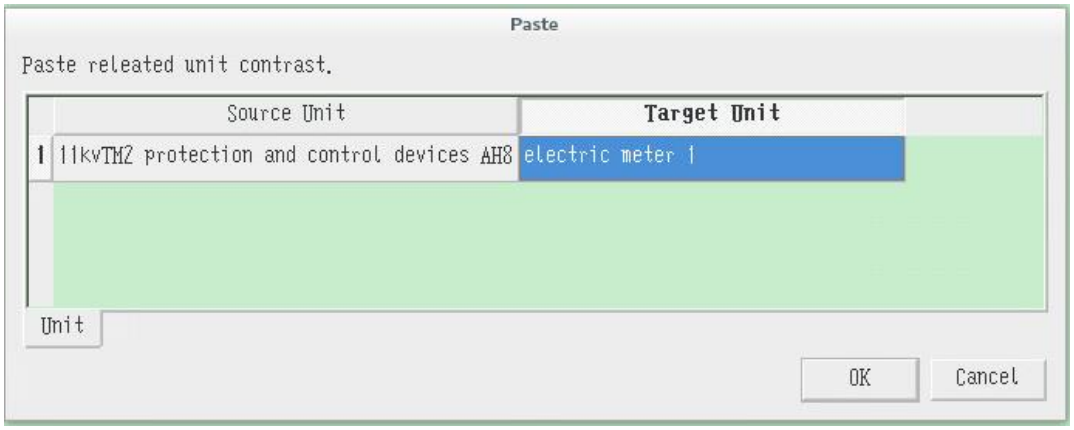


Figure 3.2.74 Target Selection of Correlation Duplication of Primary and Secondary Equipment

3.2.6.6 Update primary equipment

When configuring the database with basic configuration tool and graphic configuration tool both started, if the graphic configuration tool updates the primary equipment, the basic configuration tool can update synchronously only after it is restarted. Therefore, the function of updating primary equipment is added.

The button of updating primary equipment is located in the position shown in the figure below. Click it to reload the primary equipment in database, so as to update the primary equipment in basic configuration tool.

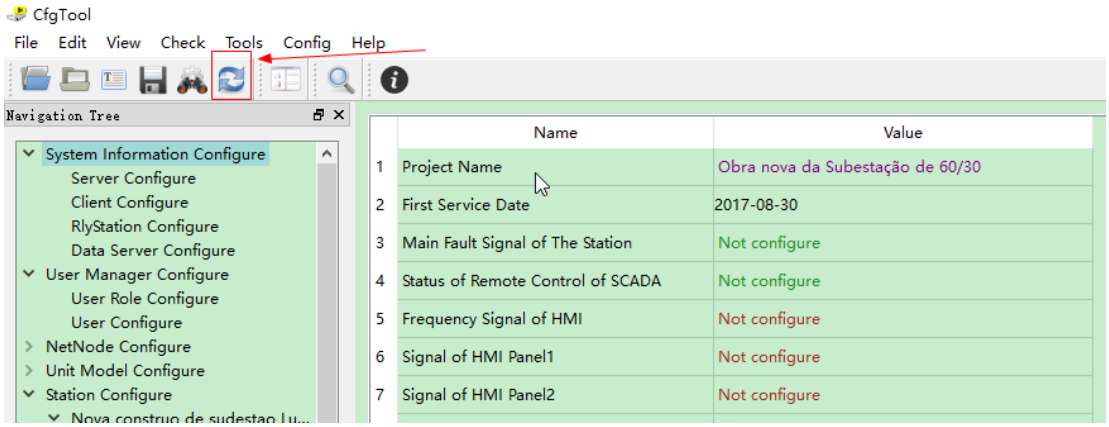


Figure 3.2.75 Primary Equipment Updating

3.2.6.7 Alarm configuration

Configuration of alarm level: can be used to configurate alarm name according to alarm level. Click Alarm Level Configuration in factory configuration to enter the corresponding configuration interface.

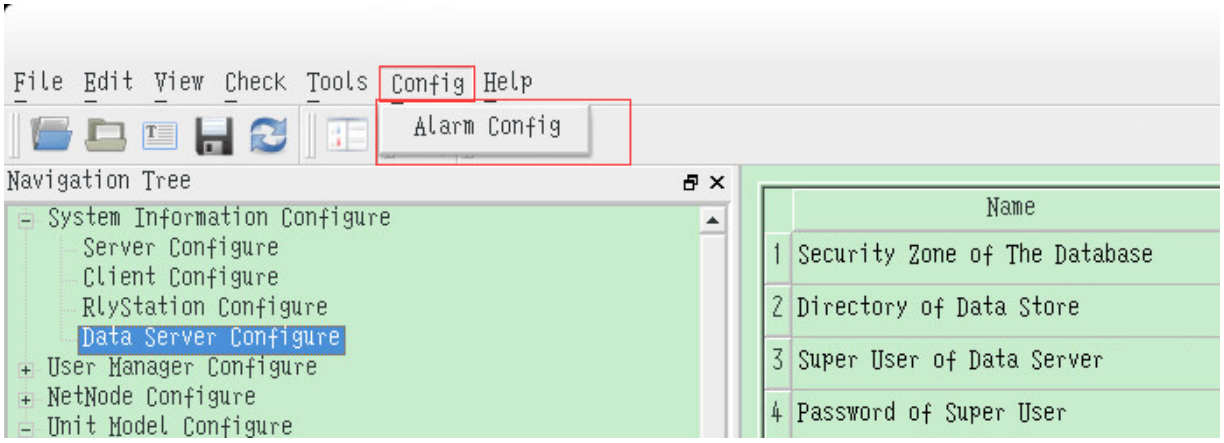


Figure 3.2.76 Configuration of Alarm Level

Customize the alarm name according to the alarm level, thus changing the signal attribute as well as the alarm name at alarm window. Four kinds of level are included by default, i.e., accident, abnormal, COS & report, all of which can be deleted with right key.

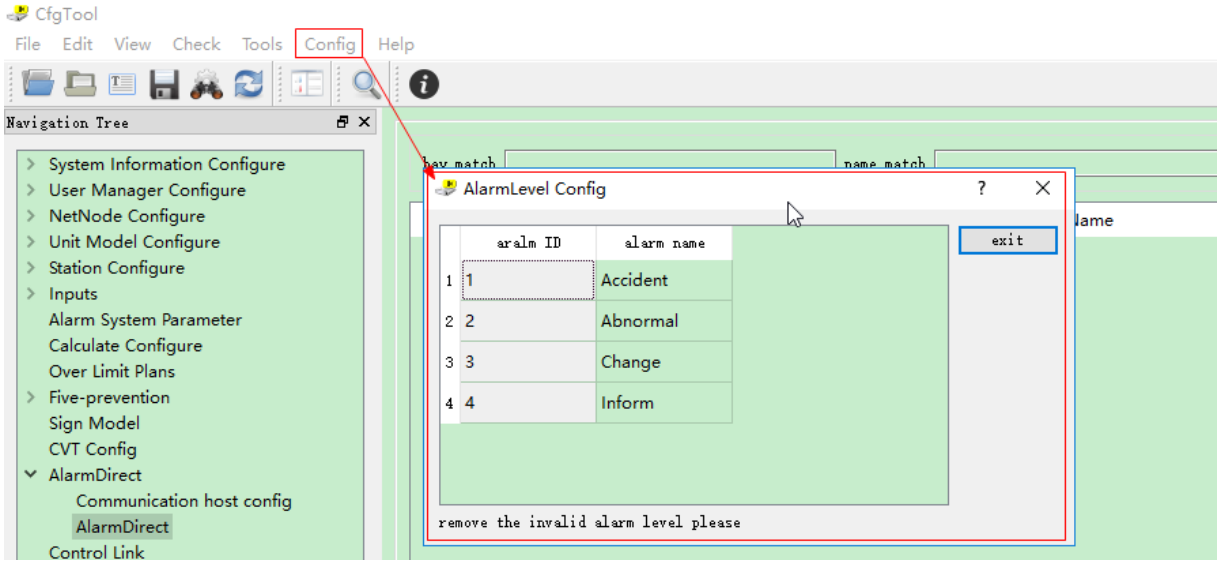


Figure 3.2.77 Deletion of Alarm Level

Alarm system parameter: can be configured, added or deleted as required. The re-alarm time refers to the duration from pausing refreshing the alarm configuration window to restoring refreshing. Click the option "Setting of alarm automatic confirmation" to pop up the right attribute window. Then, the number of automatically confirmed number of each event is determined in alarm configuration window. When the number reaches to the corresponding threshold value, the tag of such events will automatically confirm half of configured entries.

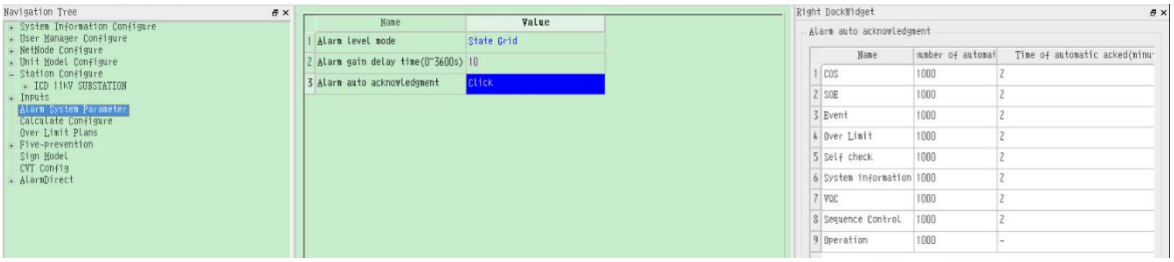


Figure 3.2.78 Parameter Setting of Alarm System

3.2.6.8 Configuration of statistics storage

The batch modification of storage attribute of remote measurement and remote pulse is supported. Select "Batch Modification of Remote measurement Storage Configuration" or "Batch Modification of Remote pulse Storage Configuration" in corresponding application. The remote measurement or remote pulse to be stored can be selected manually. Both storage cycle and value type can be modified. The storage cycle includes 30S, 1min, 2min, 3min, 4min, 5min, 6min, 10min, 12min, 15min, 30min & 60min.

Recommended configuration: the program defaults to recommend Ia, P and Q, which storage time is 3 minutes ;

Storage attribute: the storage cycle and value type can be set in batches.

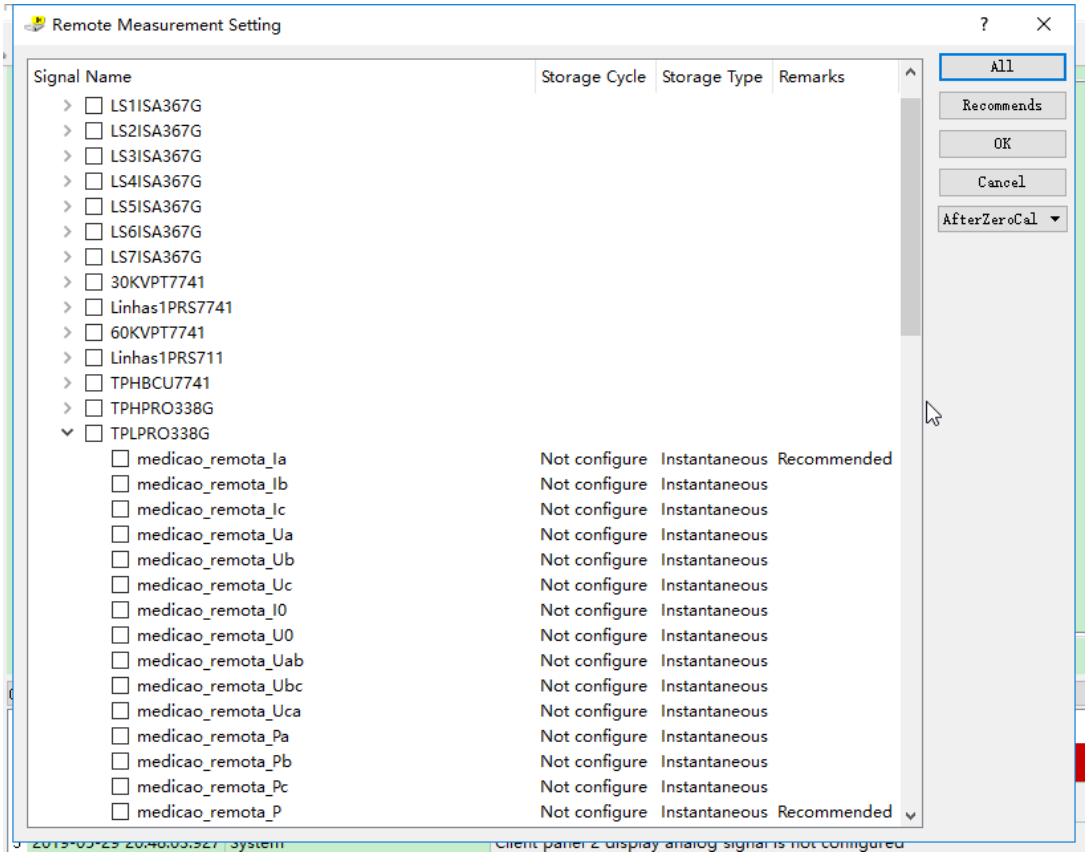


Figure 3.2.79 Setting of Storage Attribute

3.2.6.9 Over-limit alarm scheme

The remote measurement over-limit alarm is configured in the form of scheme. A new scheme has to be created when configuring the remote measurement over-limit alarm. The settable options includes "Out of lower limit ON", " Out of upper limit ON", " Out of lower lower limit ON" and " Out of upper upper limit ON".

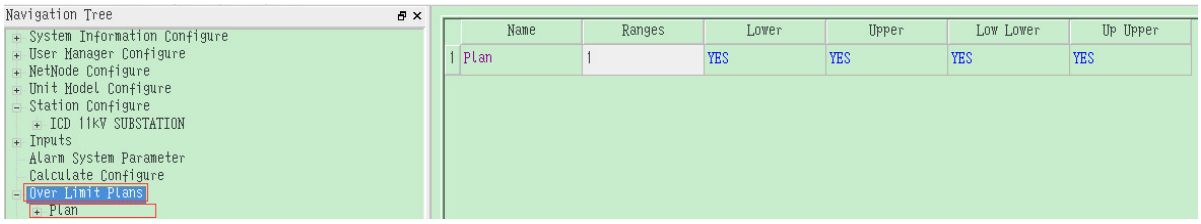


Figure 3.2.80 Setting of Over-limit Alarm

After the creation of new scheme, set the actived time period of the scheme and the setting of each limit.

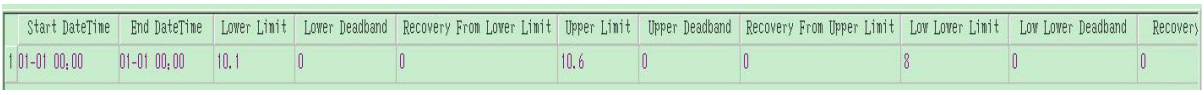


Figure 3.2.81 Setting of Over-limit Fixed Value

Select the remote measurement under scheme node. The configuration of remote measurement over-limit under the scheme is same.

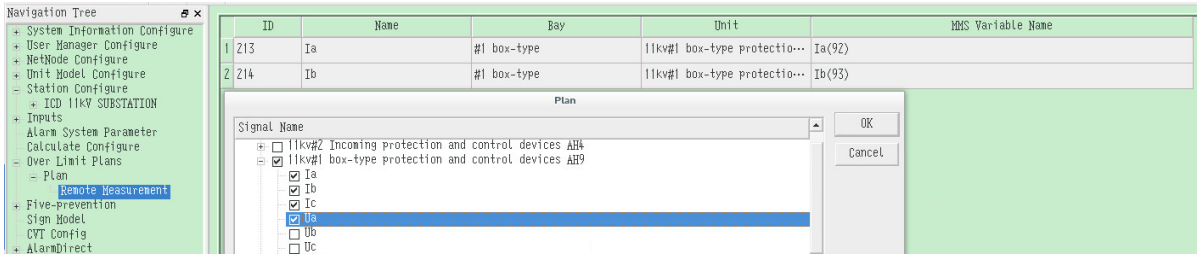


Figure 3.2.82 Configuration of Remote measurement Over-limit under Scheme Node

3.2.6.10 Mal-operation configuration

The configuration related to mal-operation is integrated into the mal-operation module of configuration tool, so as to facilitate the configuration at project site. Select the mode of mal-operation system according to the mode on site.

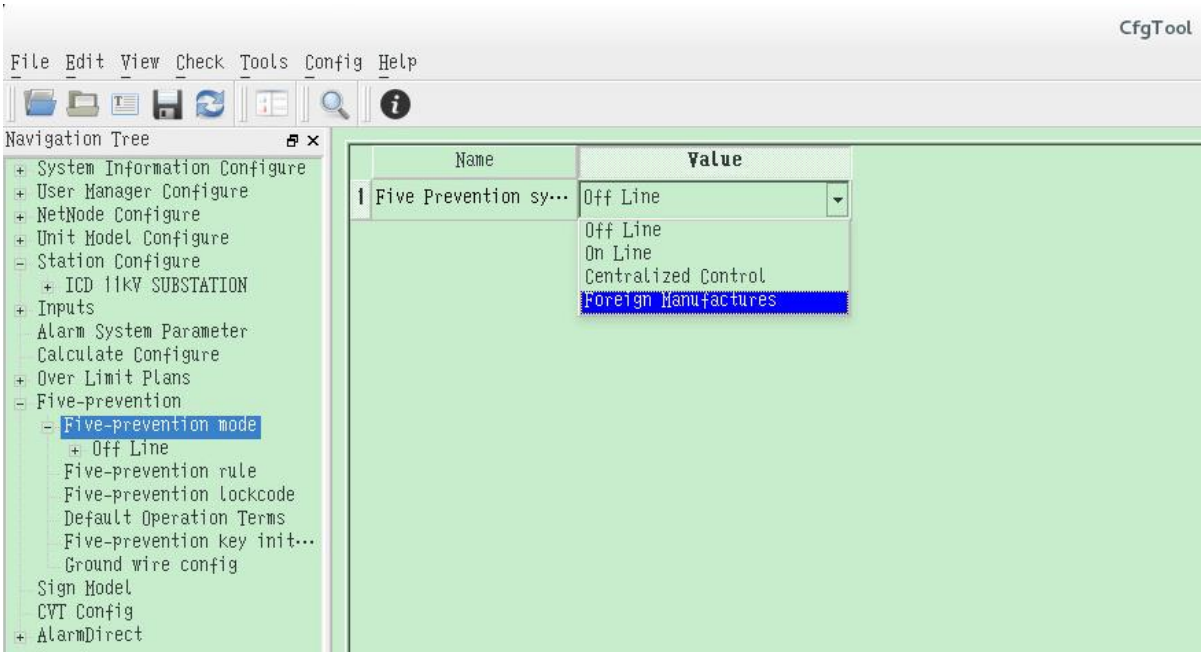


Figure 3.2.83 Selection of Mal-operation Mode

1) Mal-operation rules: all primary equipment will be listed here. Click the primary equipment which needs mal-operation configuration to pop up the Edit Bar of mal-operation rules. After edition of mal-operation rules, the content "Configured" will be displayed at the place of mal-operation rules. Besides, the customized operational term editing is supported for each primary equipment.

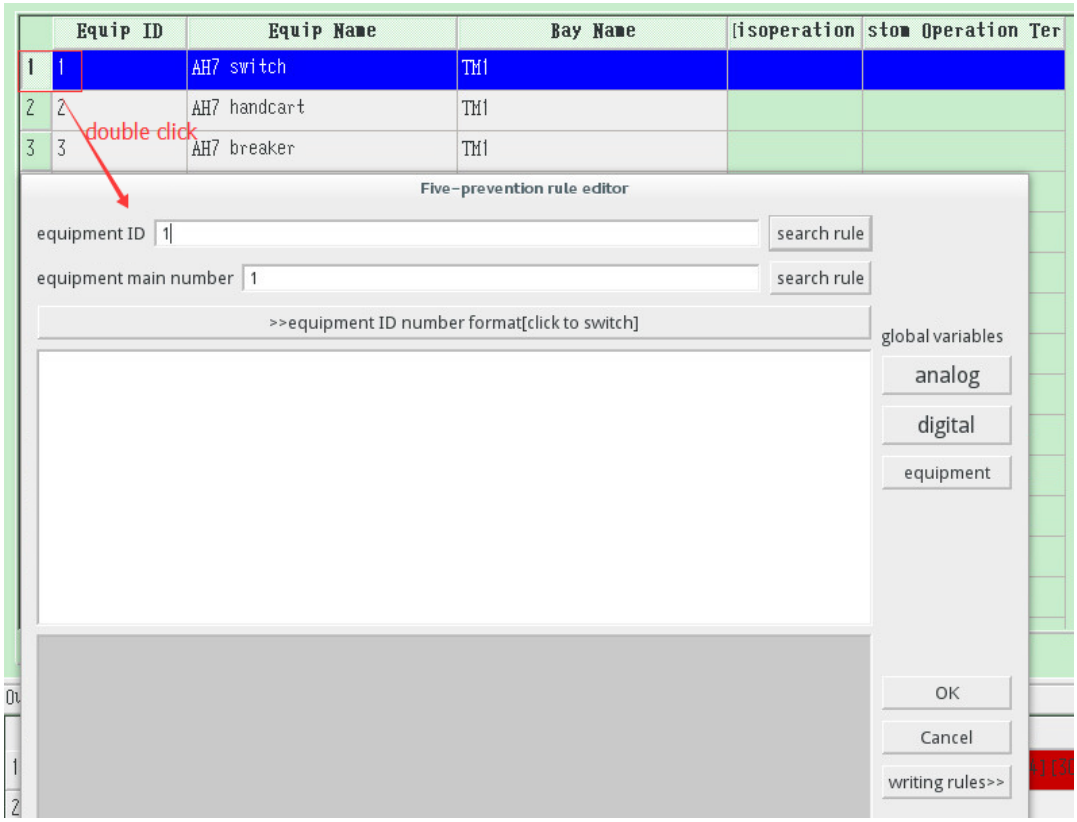


Figure 3.2.84 Configuration of Mal-operation Rules

2) Mal-operation encryption code: list all primary equipment. Click the place where needs the configuration of mal-operation encryption code to pop up the right attribute window. Then, add the mal-operation encryption code in the window. After configuration, the content "Configured" will be displayed at the place of mal-operation encryption code.

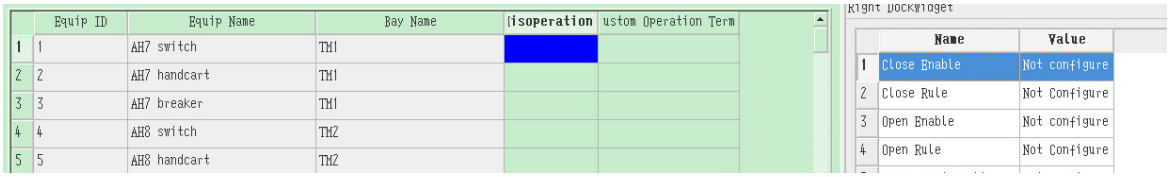


Figure 3.2.85 Configuration of Mal-operation Encryption Code

3) Default operational term: add the operational term according to the type of primary equipment.

4) Initialization file of mal-operation key: when there is mal-operation key installed under the integrated mal-operation, the initialization file of mal-operation key will be generated.

5) Status of ground wire library: switch on this function through selecting System Parameter —— Operating Parameter of SCADA Server —— Ground Wire Library Management. For the place of secondary equipment, it is necessary to create "Mal-operation virtual device".

Batch creation of equipment in ground wire library: select the batch creation of equipment in ground wire library with right key; then, fill in the number of ground wire libraries.

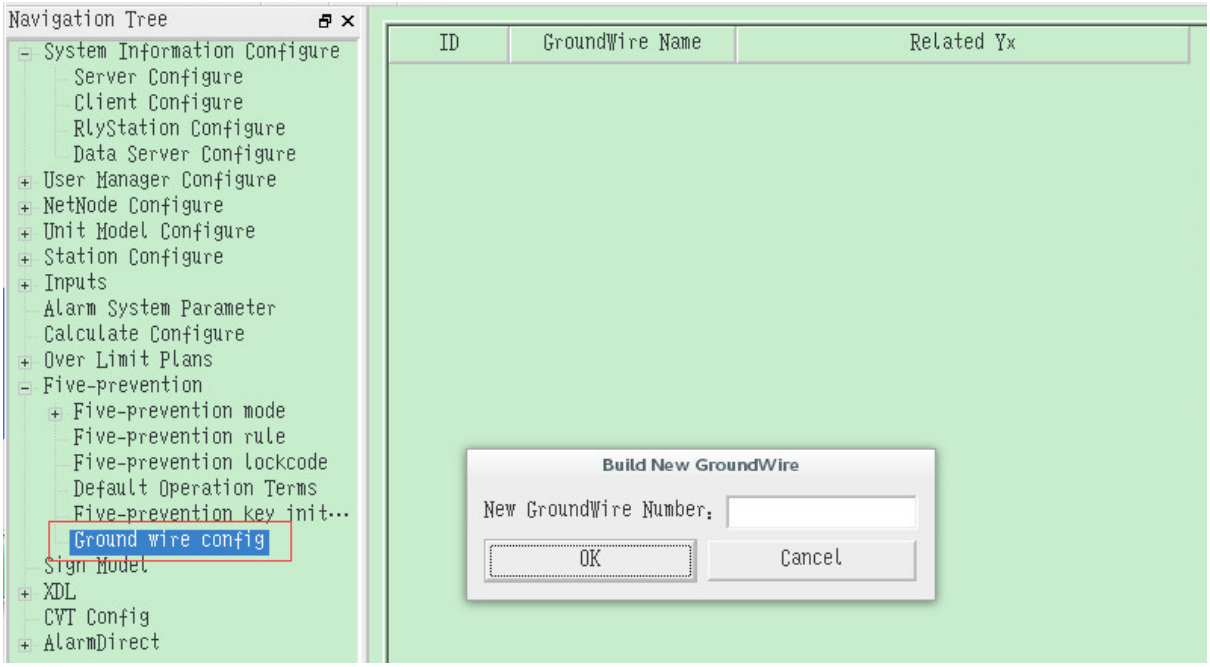


Figure 3.2.86 Create New Equipment in Ground Wire Library

After confirmation, the equipment in ground wire library will be generated automatically.

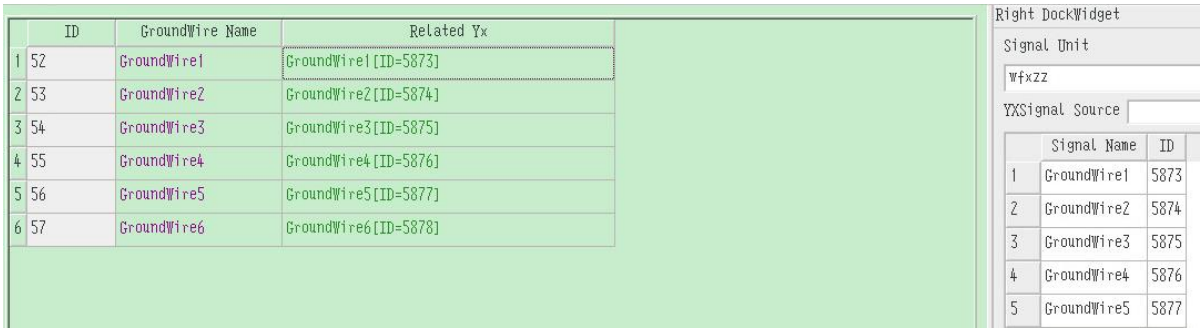


Figure 3.2.87 Generate New Equipment in Ground Wire Library

The correlated remote signal will automatically correlate the virtual remote signal in mal-operation virtual device. The name of virtual remote signal is consistent with that of ground wire library. Besides, both "Equipment Status" and "Mal-operation Key Value Set" in the signal attribute are checked.

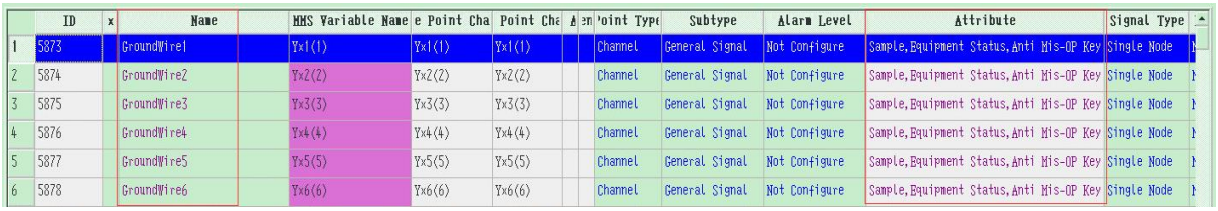


Figure 3.2.88 Automatic Correlation of Ground Wire Library Signal

6) Mal-operation configuration of bay: mal-operation rules of bay supports the batch import of remote control rules. Select “application” —— "Batch import of mal-operation rules", to pop up the following dialog. Click "Import rules" to generate all remote control mal-operation sharing rules.

If the interlock between bay mal-operation devices has to be realized through SCD connection, the option "Include program-controlled configuration information" has to be "On".

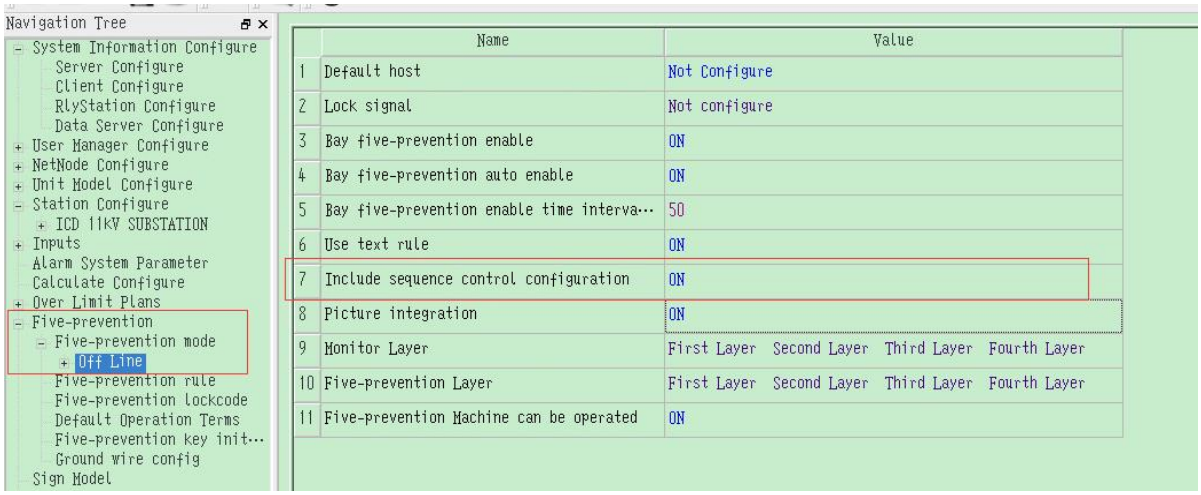


Figure 3.2.89 Bay Mal-operation Configuration On

Take the following figure as example. The interlocking double-point input 2 of CL2201 in SCD connection corresponds to the object 2 of CM2201.

Figure 3.2.90 Interlocking Signal Mapping of SCD Virtual Terminal

When configuring mal-operation rules, for mal-operation rules of primary equipment of CL2201 bay, if there is interlocking of CM2201 object 2, the related rules are as shown in Figure 3.2.91 and the judgment condition is subject to the positon of CM2201 object 2.

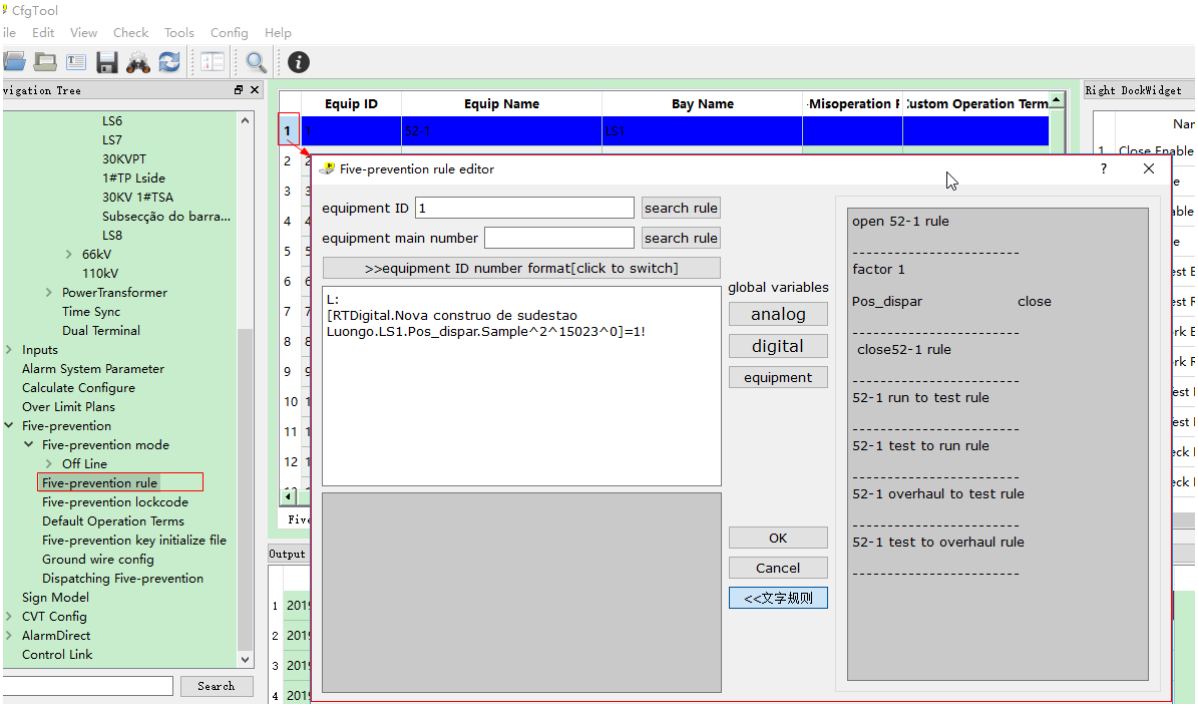


Figure 3.2.91 Rule Compiling of Station Control Layer

When it is required to convert to the mal-operation rule of bay level, please refer to Figure 3.2.92. It is defaulted to import all mal-operation rules of primary equipment remote control channel. Select "Batch import of mal-operation rules" in the drop-down box of menu bar "Application", as shown in figure below.

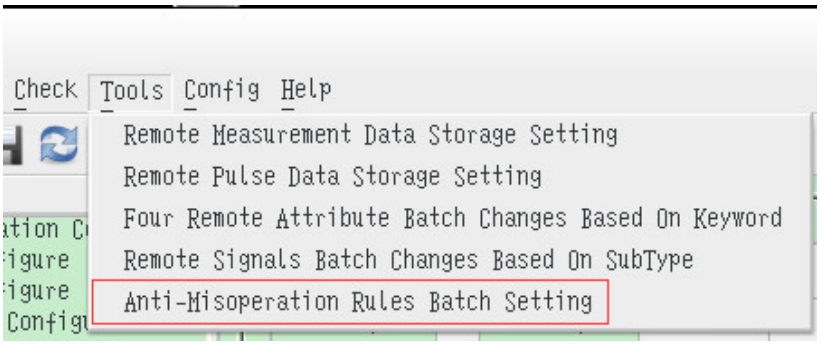


Figure 3.2.92 Batch Import of Mal-operation Rules

Click "Import rules". Then, the progress bar of 100% completion will be displayed.

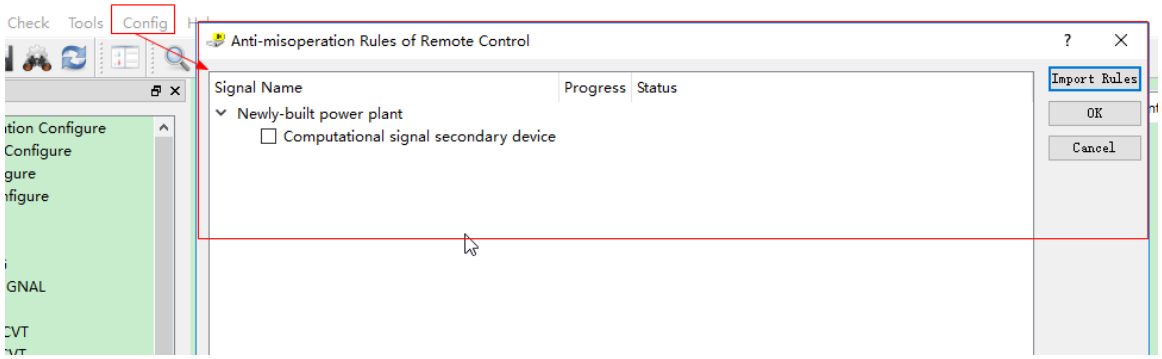


Figure 3.2.93 Mal-operation Rules Importing of Bay Level

For the generated bay mal-operation rules, please refer to Figure 3.2.94. It can be seen that the judgment condition of generated rules is their interlocking double-point input 2.

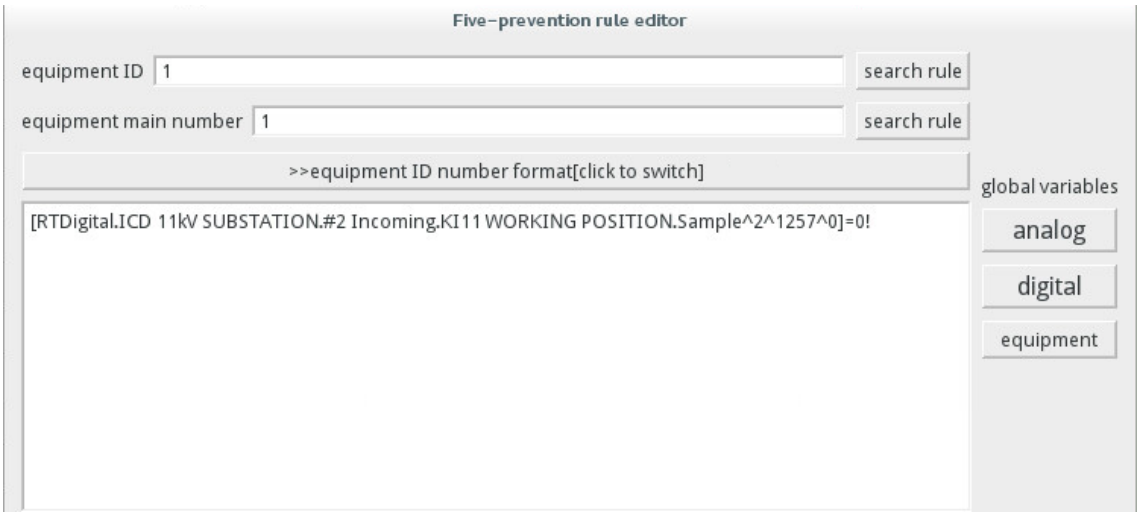


Figure 3.2.94 Generated Bay Mal-operation Rules

NOTICE!

Notes: The interlocking signal of current bay can be analyzed; besides, only need to directly import mal-operation rules of bay level into rules of station control layer.

In case the SCD connection involves interlocking remote measurement signal, it is necessary to configure the sub-type of interlocking floating remote measurement as per the remote measurement type of the corresponding bay.

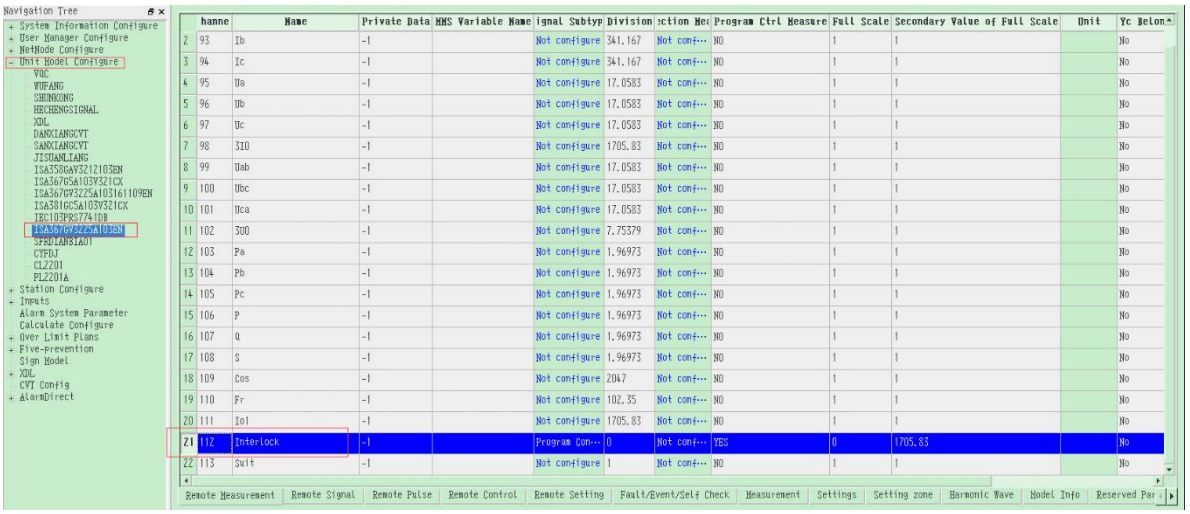


Figure 3.2.95 Configuration of SCD Connection Interlocking Remote measurement Signal

3.2.6.11 Time synchronization management

After the start of time synchronization management system, the six calculation remote signals related to time synchronization in SCADA will automatically be correlated from the secondary equipment of calculation, with no need to change signal name.

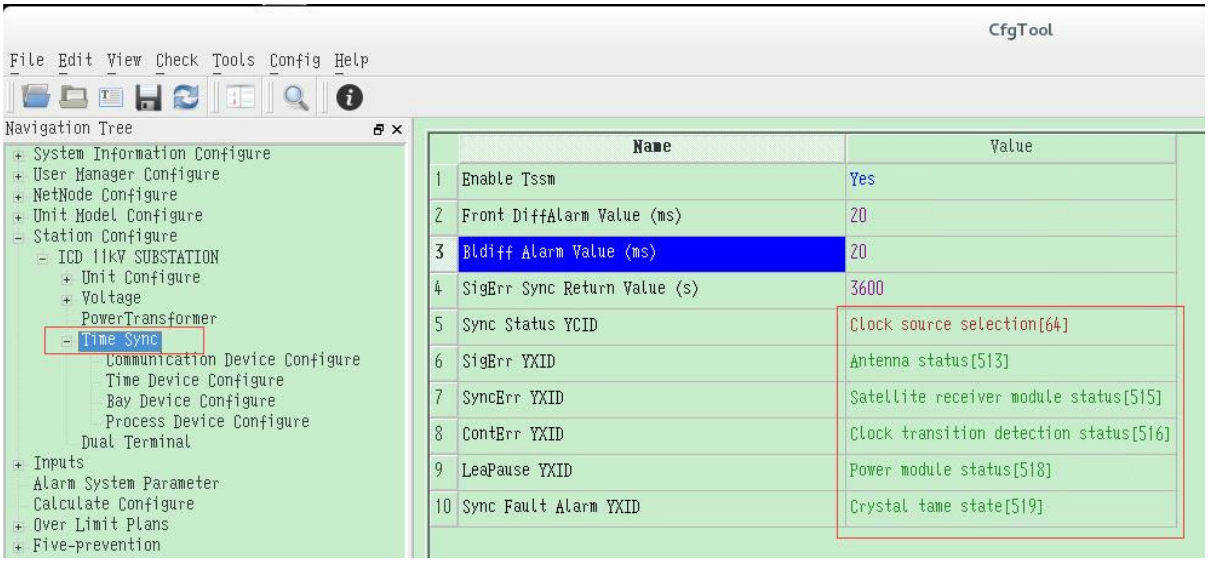


Figure 3.2.96 Start Time Synchronization System for Monitoring

1) Configuration of communication device: add the configuration of time synchronization management under communication device node. The calculation remote signal is automatically correlated from the secondary equipment of calculation.

Figure 3.2.97 Add Configuration of Time Synchronization Management under Communication Device Node

2) Configuration of synchronization device: add the time synchronization management configuration for synchronization device. The first eight signals are self-check signals in clock 61850 model. If it is required to be consistent with the signals in SCADA after modification of signal description in SCD, these signals can realize automatic correlation through matching character strings. The latter two are SCADA calculation signals, which will be correlated automatically by SCADA.

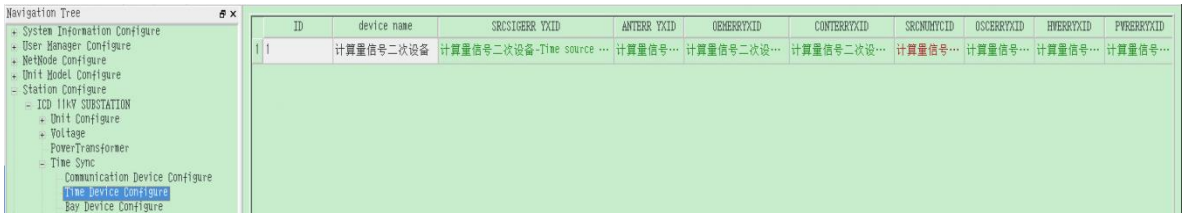


Figure 3.2.98 Configuration of Synchronization Device

3) Device configuration of at bay level: add the time synchronization management configuration for device at bay level. The first three signals are self-check signals of bay-level devices. If it is required to be consistent with the signals in SCADA after modification of signal description in SCD, these signals can realize automatic correlation through matching character strings. The measuring method of time difference defaults to “SCADA, NTP”. The latter five are calculation signals, which will be correlated automatically by SCADA.

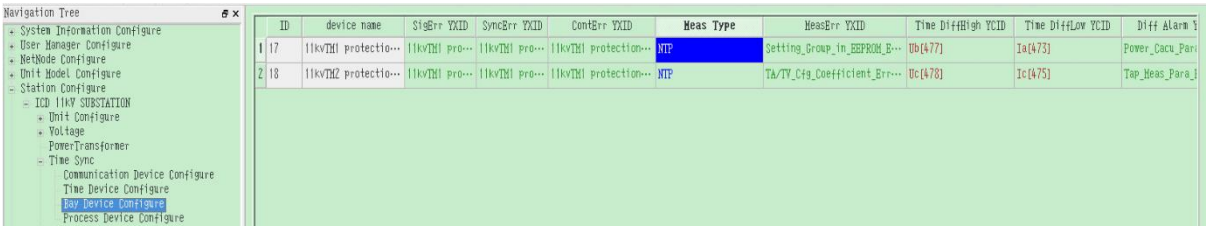


Figure 3.2.99 Device Configuration at Bay Level

4) Device configuration at process level: add the time synchronization management configuration for device at process level. Click the main window with right key and select "Add" , then select the number of devices at process level.

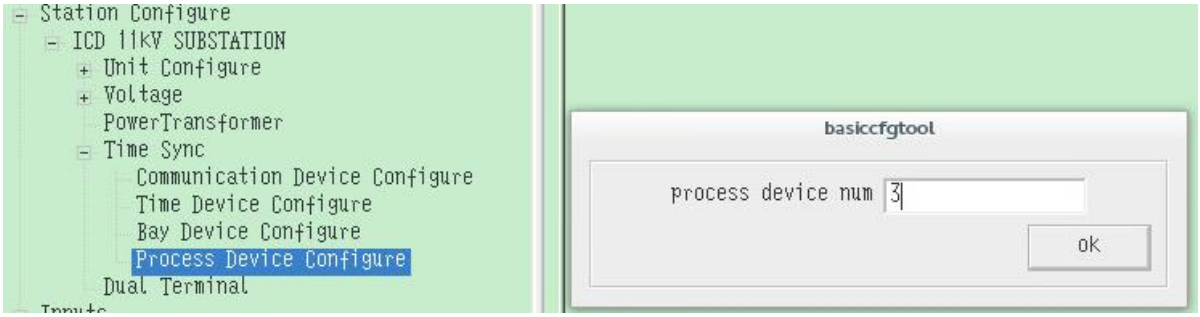


Figure 3.2.100 Device configuration at Process Level

Fill in the name of device at process level manually. Multiple devices can be selected to correlate the corresponding devices at process level.

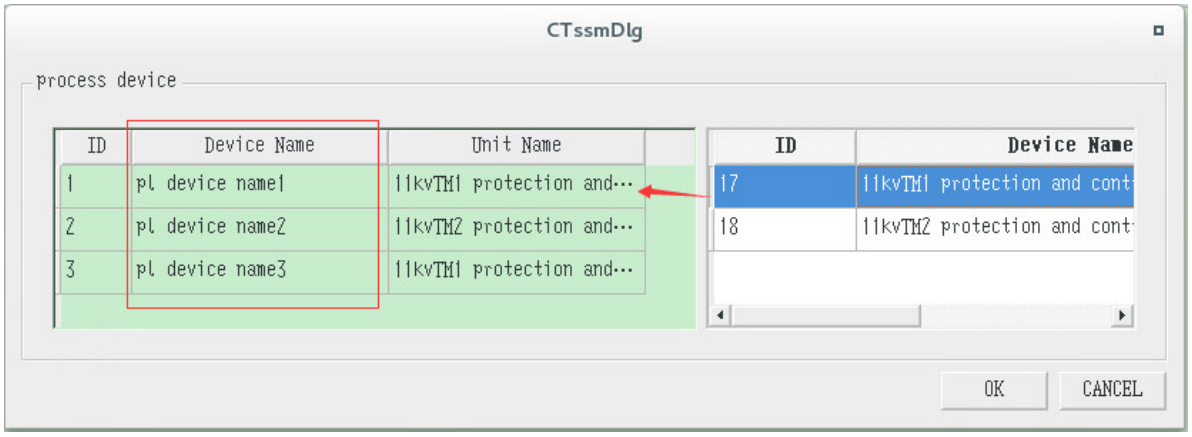


Figure 3.2.101 Matching Configuration of Devices at Process Level and Bay Level

The three signals “Time-synchronization signal status”, "Time-synchronization service status" and "Time-hopping detection status" are self-check signals of of process-level devices, which are transmitted to measurement and control device through goose. "Response status of time-synchronization measuring service", "Measured value (second) of time difference (remote measurement)", "Measured value (less than second) of time difference (remote measurement)" and "Alarm of accuracy abnormal" are signals generated when the measurement and control device measures process-level devices.

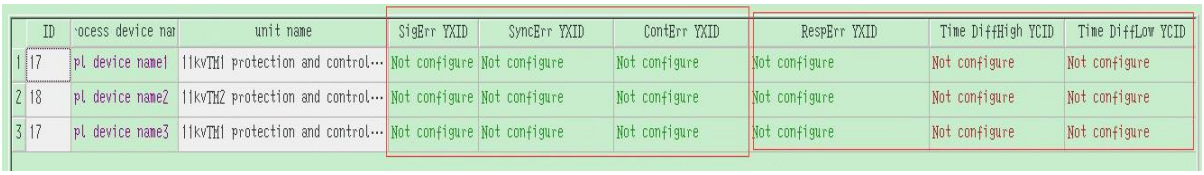


Figure 3.2.102 Device Signal configuration at Process Level

NOTICE!

rules for automatic matching of signals, change the signal name to “process-level device name + SCADA signal column heading name”.

For example, for time-synchronization signal status, time-synchronization service status and

Time-hopping detection status of set A merging unit of Changxing Line 1, when devices at process level have been created, corresponding signals can be correlated automatically.

3.2.6.12 CVT configuration

After the creation of CVT secondary equipment, the remote control channel will automatically correlate the corresponding remote signal signal, with on need of manual correlation.

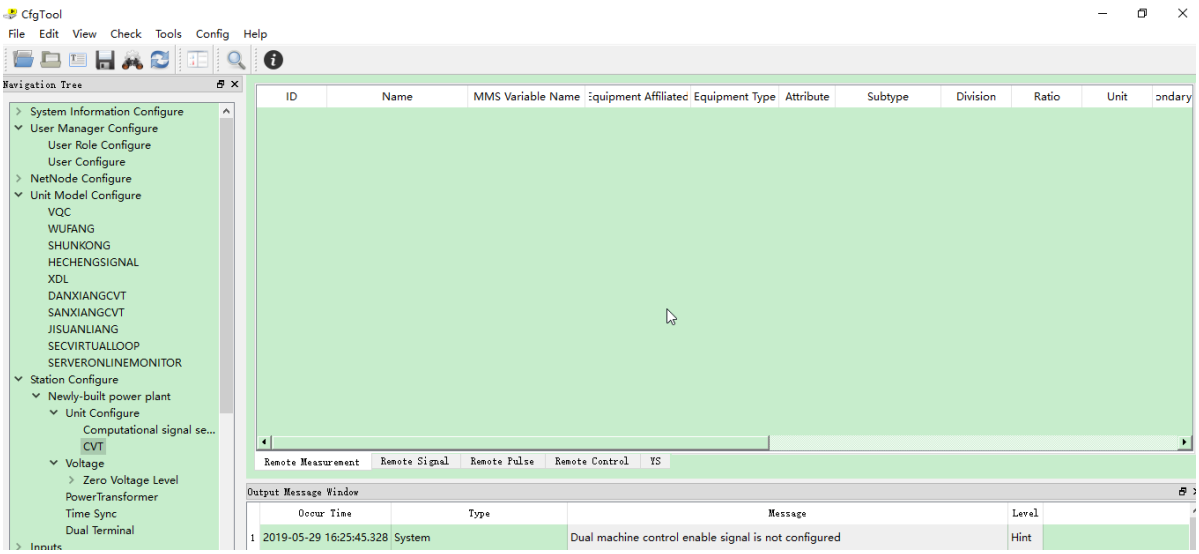


Figure 3.2.103 CVT Configuration

After “CVT function” starts in system parameters, the CVT correlated configuration node will be displayed and all CVT secondary equipment displayed under the node. Both high voltage and low voltage are common configurations of all signal CVT bays. Make the CVT of each bay correlated with "Phase A Voltage ", "Phase B Voltage", "Phase C Voltage" and "Zero-sequence Voltage". After configuration, if it is required to activate CVT process in real-time part, please enter "cvt" in terminal.

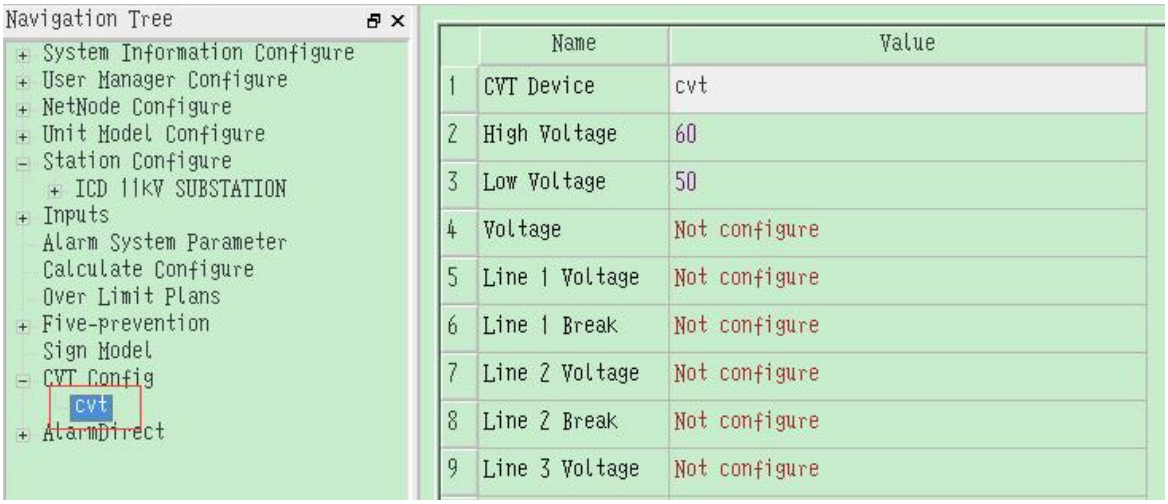


Figure 3.2.104 CVT Function Start

3.2.7 Configuration of communication device

3.2.7.1 Overview

1) Functions

This function is mainly used to configure the communication device and generate all configuration files required by normal operation of communication device. It also can generate the configuration of SCADA forwarding signal .

2) Role of communication device

The communication device can be configured as station gateway and protocol converter. Different roles are applied to different application cases. The configuration difference of such machines mainly lies in device communicating and signal forwarding. For details, please refer to the following table.

Table 3.2.2 User Editing

No.	Role	Model	Range of Application	Cooperation with SCADA
1	station gateway	PRS7910 Station Gateway	Be used for communication with in-station protection, BCU, status monitoring of power transmission and transformation equipment as well as information transmission to other master station systems.	The configuration required for operation is generated by the communication configuration tool at SCADA.
2	Protocol converter	PRS7910S Protocol Converter	Be used to connect the protection, BCU not of 61850 communication of other companies, but need to communicate with CYG SCADA.	The configuration required for operation is generated by the configuration tool of communication device at monitoring SCADA.

3) Configuration interface of communication tool

Figure 3.2.105 Configuration Interface of Communication tool

3.2.7.2 Hierarchical structure of communication device configuration

The hierarchical structure of communication device configuration is as shown in Figure 3.2.106.

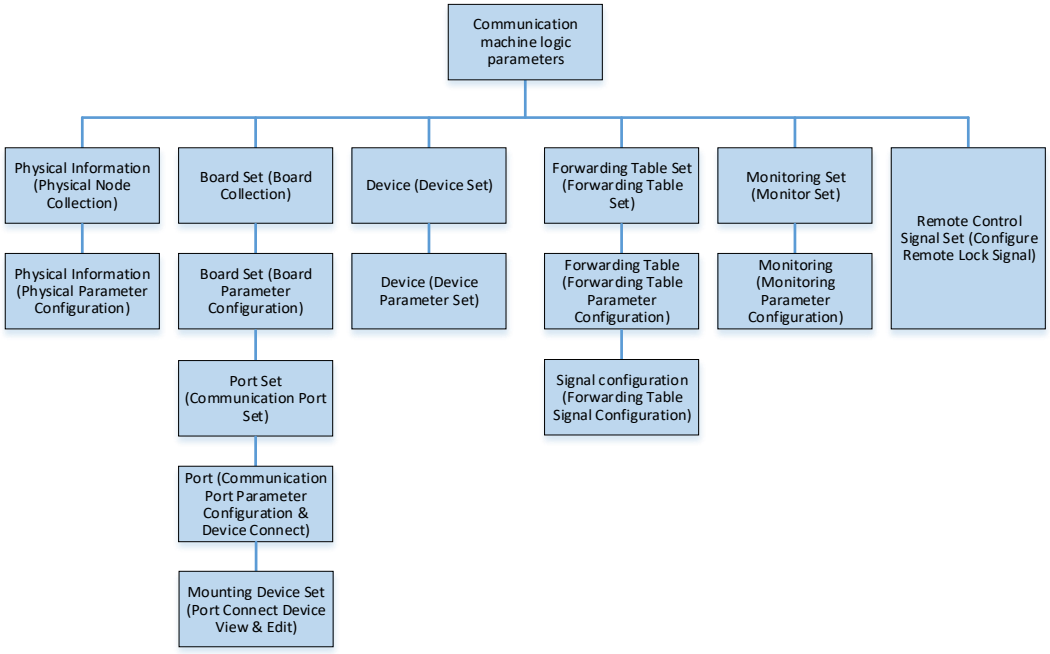


Figure 3.2.106 Hierarchical Structure of communication Device Configuration

3.2.7.3 Configuration tool of communication device - gatewaycfgtool

The configuration of communication tool during project implementation is finished by the service personnel of our company. The configuration has to be processed only when the transmitted dispatching signal changes.

The difference from previous version is that the current version only includes the station gateway group and only the logical node of data gateway machine exists under the node. Since the gateway device may be inconsistent with the protocol converter at site, the configuration file of communication device of current version is put under the node of station gateway group or protocol converter group. The configuration file is still selected from Files - Configuration File Version.

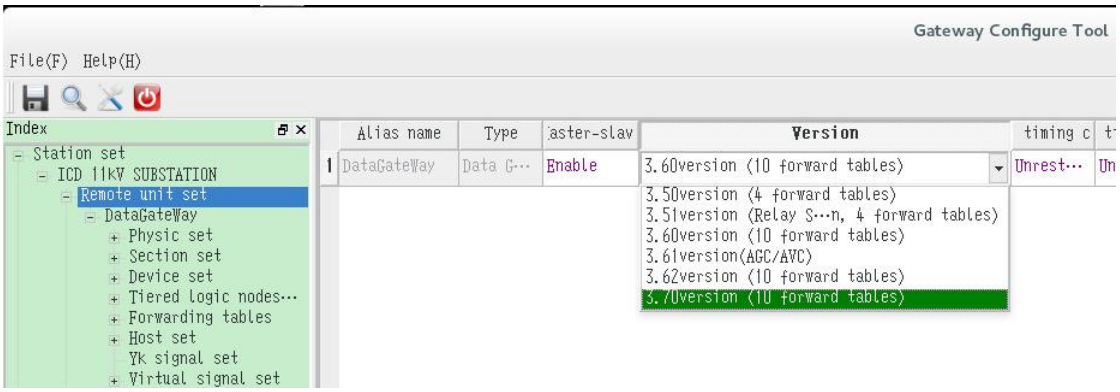


Figure 3.2.107 Configuration File Version Selection of communication Tools

In addition, the version 3.70 is added into the configuration file version. The newly added content shall be used with communication device 3.70, thus bringing about no influence on the configuration file of low version. New configuration items in forwarding table are only valid for the communication tool 3.70.

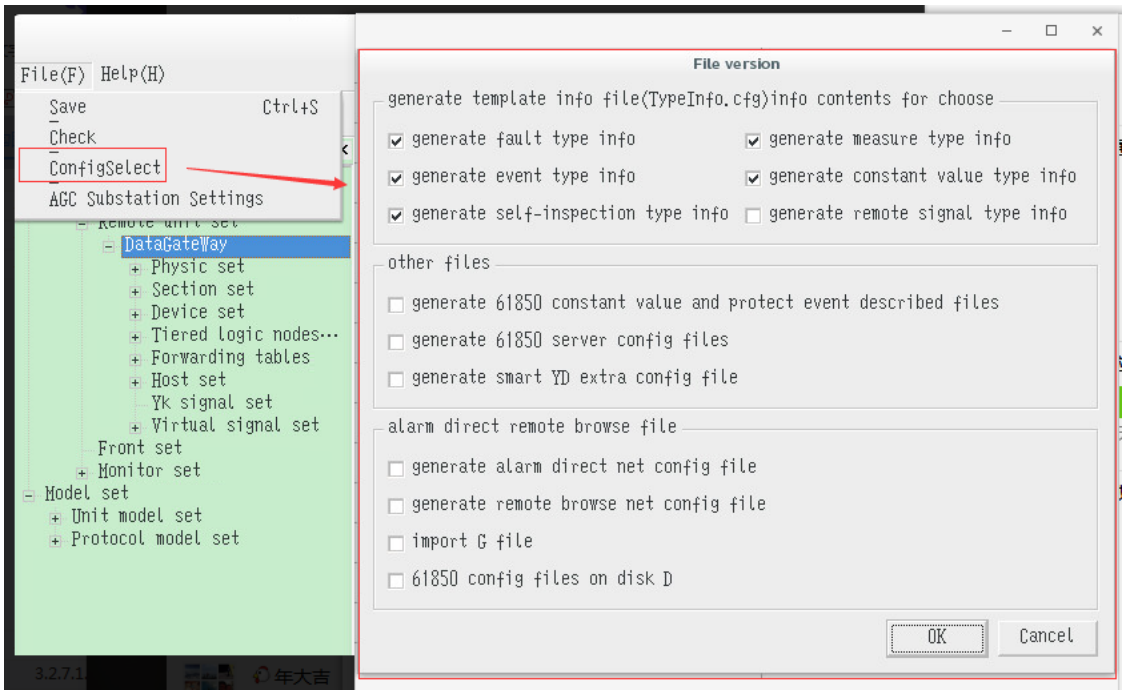


Figure 3.2.108 Configuration File Version Content Selection of communication tool

3.3 Data bus

The data bus operates based on independent process and communicates with other applications through message interface. It receives network data, transmits it to data demander. Other applications submit the required data to the network. Then, the network transmits such data. In this way, the network forms a independent system isolated with main system, so as to ensure that the system software will not be affected by the upgrade of network hardware. All other software of the whole system can operate in the new network environment with no need of any modification.

The data bus is responsible for the on-line synchronization of panoramic real-time data and synchronous storage of historical data (including file data) in the intelligent substation. When generating or modifying various system parameters on line, it transmits the related data to all nodes in network, ensuring the data consistency.

3.4 Management module of external communication interfaces

This interface is mainly used for communication with bay level protection, measurement & control device, and other intelligent substation equipment and auxiliary application systems (e.g., security, environment monitoring, on-line monitoring and video system). It supports various kinds of communication interfaces and protocols, thus meeting the communication access demand of various devices of intelligent substations.

The system mainly includes following external communication interfaces.

Table 3.4.1 Configuration Interface of Communication Devices

No.	Interface Type	Content
1	61850 communication interface	Be used for the communication access of 61850 devices
2	103 communication interface	Be used for the communication access of traditional 103 devices
3	103 communication interface	Be used for the communication access of in-station protocol converter, protection management host and other devices
4	Customized message interfaces required by other users	Can be freely expanded according to actual demands of users

4 On-line Operations

4.1 System console

4.1.1 Overview

System console provides visual interface to call other programs. Applications of PRS7000 integrated monitoring system can be preset in console, and can also be directly started from console.

As a main interface in real-time operation, PRS-7000 system console contains menu bar, toolbar and status bar. Status bar displays user login information, operating status of master and backup server, safe operation days, and current system time. Programs can be added into menu bar and tool bar in customized way, so that the monitoring process and configuration tool can be started by one-click.

4.1.2 Instructions

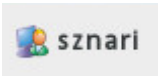
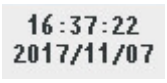
Figure 4.1.1 System Console

Real-time monitoring process starting: entering prs7000start in a terminal, the console and rtdb, scada, hmi, his_sync, htdata_cala process can be started. Entering prs7000stop or quitting console, all processes triggered by prs7000start can be exited. After the system console has been started, it will always appear on the bottom of the screen. At this time, programs should be started from console, so that the programs will not be sheltered by console.

Concrete meaning of menu bar is described as follows:

Table 4.1.1 Explanatory Table of Menu Bar of Console

Icon	Name	Description
	Main menu of console	Program group includes operation, configuration and maintenance, from which each program can be opened; settings contain system console setting, from which users can add, modify or delete menu or toolbar programs themselves; the permission is user login and logout; if the locking console is checked, the console cannot be moved. If not checked, the console can be moved freely. Quit means exiting from console. In this case, all real-time processes will be exited. It has the same action by entering prs7000stop in terminal.
	Operation toolbar	Operation includes process of realtime database (rtdb), human-machine interface (hmi), realtime alarm (AlarmWindow), historical information query (InfoQueryTool),

Icon	Name	Description
		report (report), curve (curve), AlarmDirect and remote view of alarm (AlarmDirect).
	Configuration toolbar	Configuration includes database configuration (basiccfgtool), gateway configuration (gatewaycfgtool), graph configuration (graphcfgtool), element configuration (elementeditor), VQC configuration (vqccfgtool), sequence control configuration (seqctrlcfgtool) and protection information modeling configuration (stationcfgtool).
	Maintenance toolbar	Maintenance includes process monitoring (pm_server), statistical calculation data browse (htdata_show) and wave recording analysis tool (faultanalyse).
	Sound alarm icon	When sound alarm occurs, click this icon to silence.
	Alarm window icon	When there is alarm, this icon becomes red. Click this icon to open alarm window.
	Login/logout	Login and logout of operator
	Local status	Display the master and slave status of server node.
	Safe operation days	Safe operation days of system, calculated since the plant is put into operation. The date can be set in the system parameters of database configuration tool.
	Time	Display the current time of server.
	Leftward icon	After touching the locking console tick in control menu, clicking this icon can lock console. 原文有问题吧

4.1.2.1 Program of system console

Main menu of console is shown as follows:

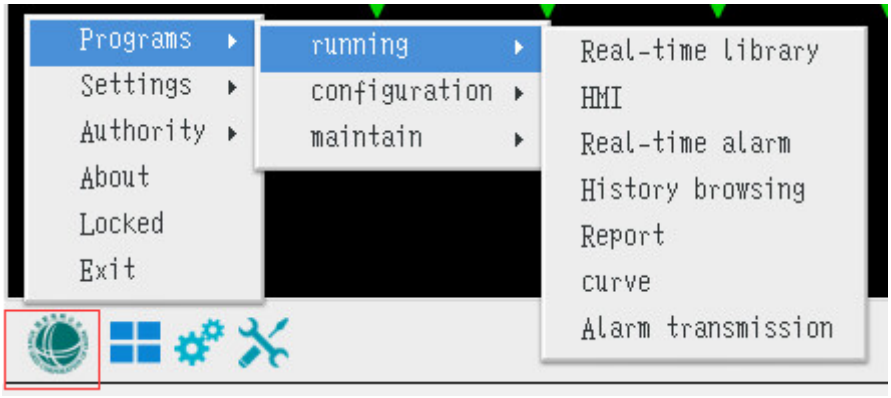


Figure 4.1.2 Main Menu of System Console

Left clicking the program under the corresponding program group, the program can be opened.

4.1.2.2 Setting of system console

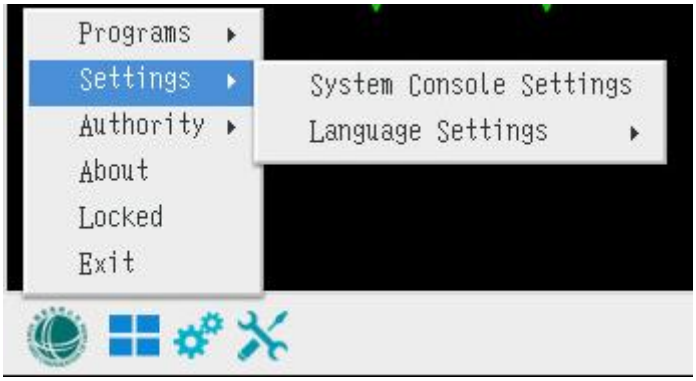


Figure 4.1.3 System Console Setting Entry

Selecting “Setting” --- “System console setting” by clicking left mouse button, the following diagram will pop up:

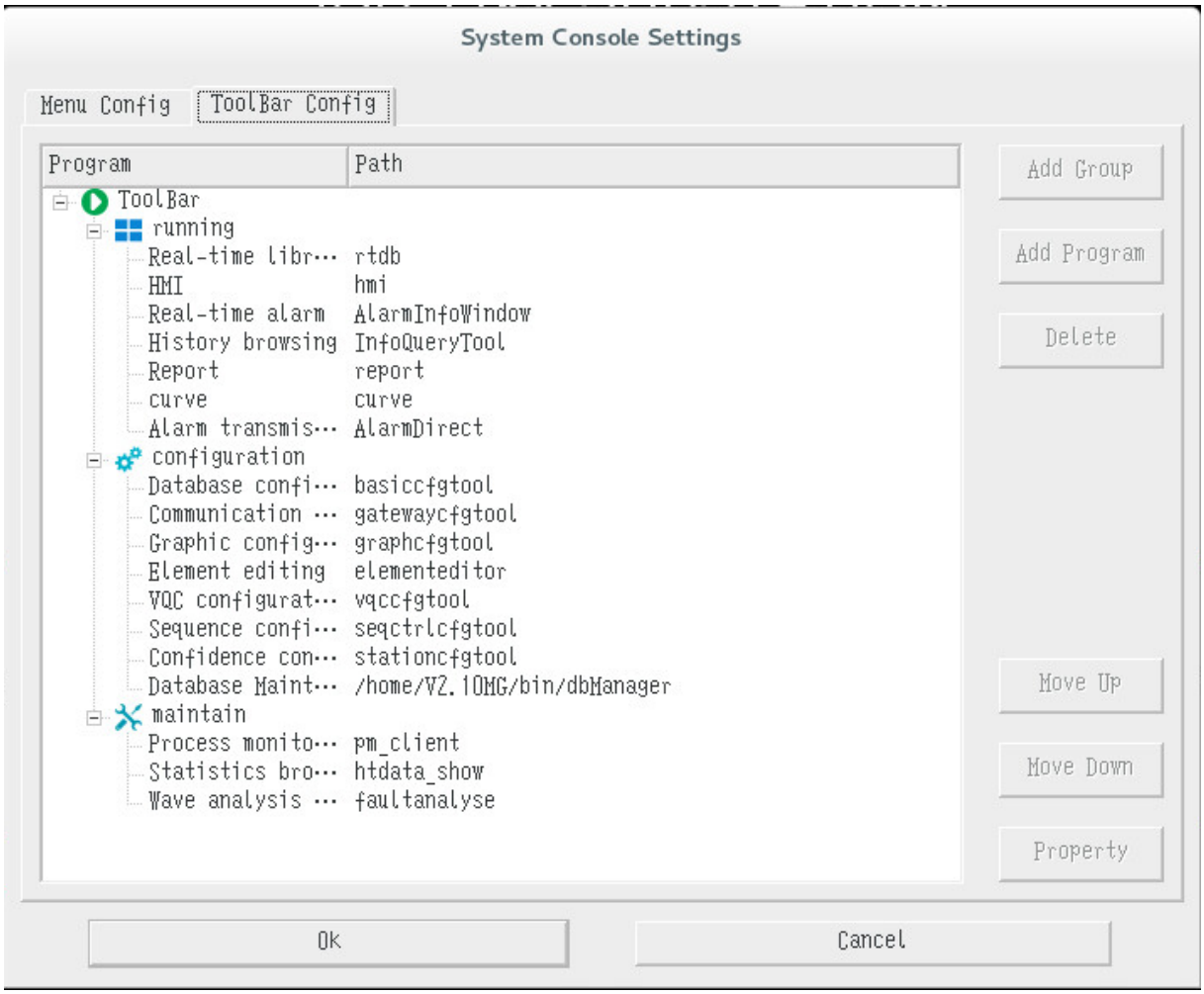


Figure 4.1.4 System Console Setting

In “system console setting” – “menu configuration” and “toolbar configuration”, the operations of program such as add, delete, move up and move down can be made.

Language setting graph is shown as below, where languages can be selected as required.

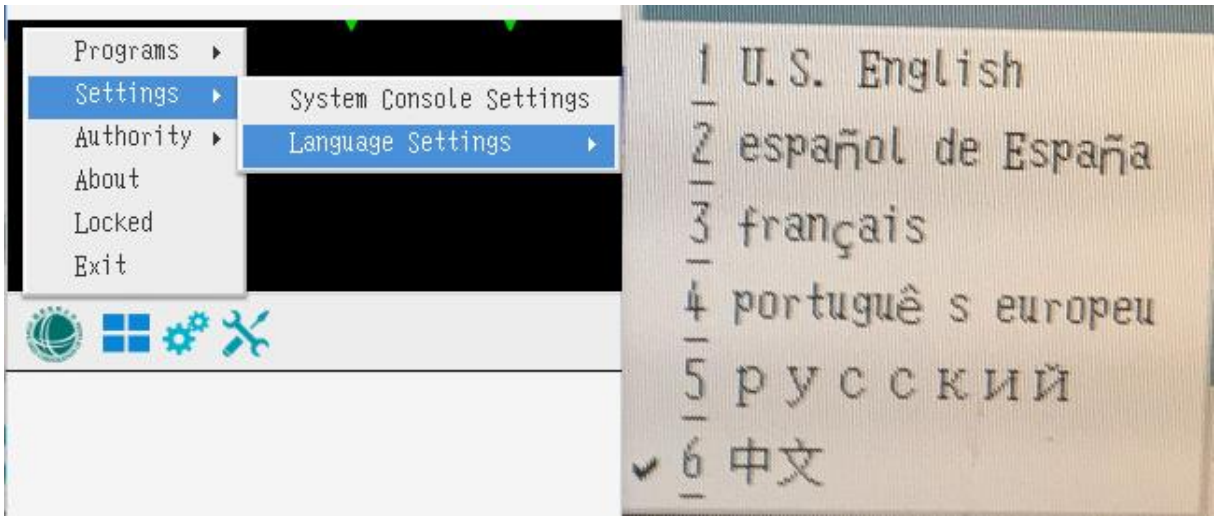


Figure 4.1.5 System Console Language Setting

4.1.2.3 Lock console

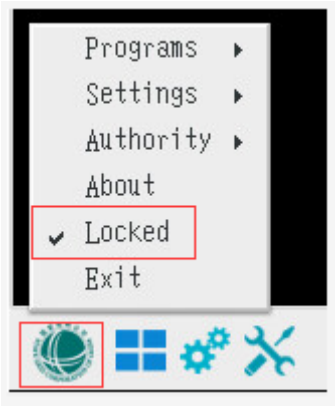


Figure 4.1.6 Lock System Console

If √ icon displays on the left, it means the console is locked and cannot be moved. Unchecking it by clicking, the console can be moved freely. Clicking “left” icon in toolbar, the console can be minimized.

4.2 HMI monitoring

4.2.1 Overview

Human-machine interface (HMI) of PRS-7000 system consists of status bar, window region and toolbar. Status bar displays the realtime network communication status, operation status of master/backup server, anti-maloperation status, station frequency, and event status. Window region shows main electrical wiring diagram, power flow distribution and flow direction, realtime status of primary devices (i.e. CB, disconnector etc.) and binary signal, distinguishes the electrification state of bus in different colors, provides manual setting interface and operation interface, and visually displays the historical information and comparison information of power flow in curve, bar graph and widget. Meanwhile, all command operations are initiated in HMI, such as remote control, remote regulation, anti-maloperation ticket, call/download protection setting etc.

4.2.2 Panoramic data display

HMI can show the panoramic data of automation system in the whole plant or station, mainly including data as follows:

- Display of network communication status between HMI and master server, operating status of master/standby server, anti-maloperation on/off status;
- Overview and classified display of event signals;
- Display of current system time and login users;
- Display of main electrical wiring diagram and sub-wiring diagram of plant;
- Overview and classified display of alarm records, different color are used for different priorities of alarms. Unacknowledged and acknowledged alarms also use different colors.
- Display of remote metering, remote signaling, remote pulse and protection event signals of

each bay in plant;

- Display of position of primary devices such as CB, disconnector, earthing disconnector and handcart;
- Display of power flow distribution & direction and topology coloring;
- Display of network structure diagram of secondary devices in the plant;
- Display of realtime and historical curve, bar graph and pie chart of each bay;
- Display of VQC operating & regulating information and blocking information;
- Display of procedural operation status of each bay;
- Display of setting of secondary devices in the plant.

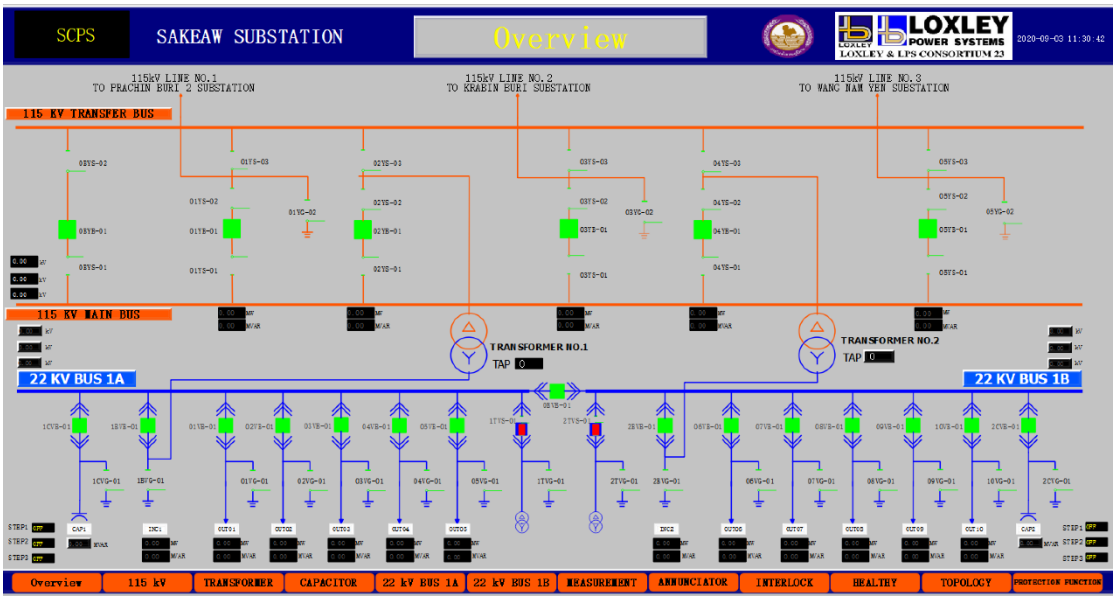


Figure 4.2.1 Human-machine Interface (HMI): Main Wiring Diagram

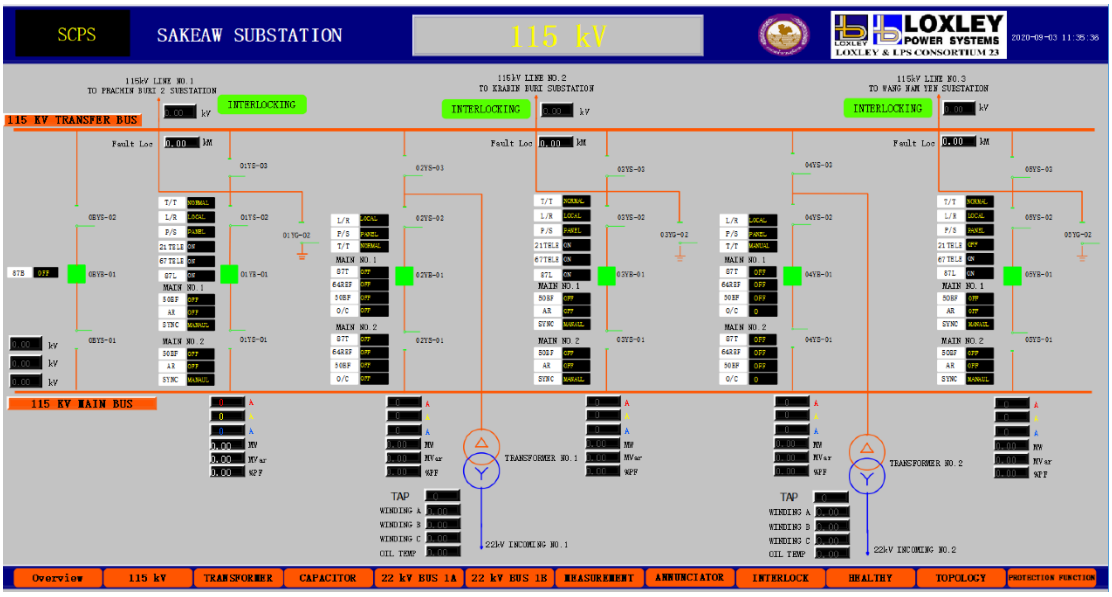


Figure 4.2.2 Human-machine Interface (HMI): Power Flow Direction and Distribution

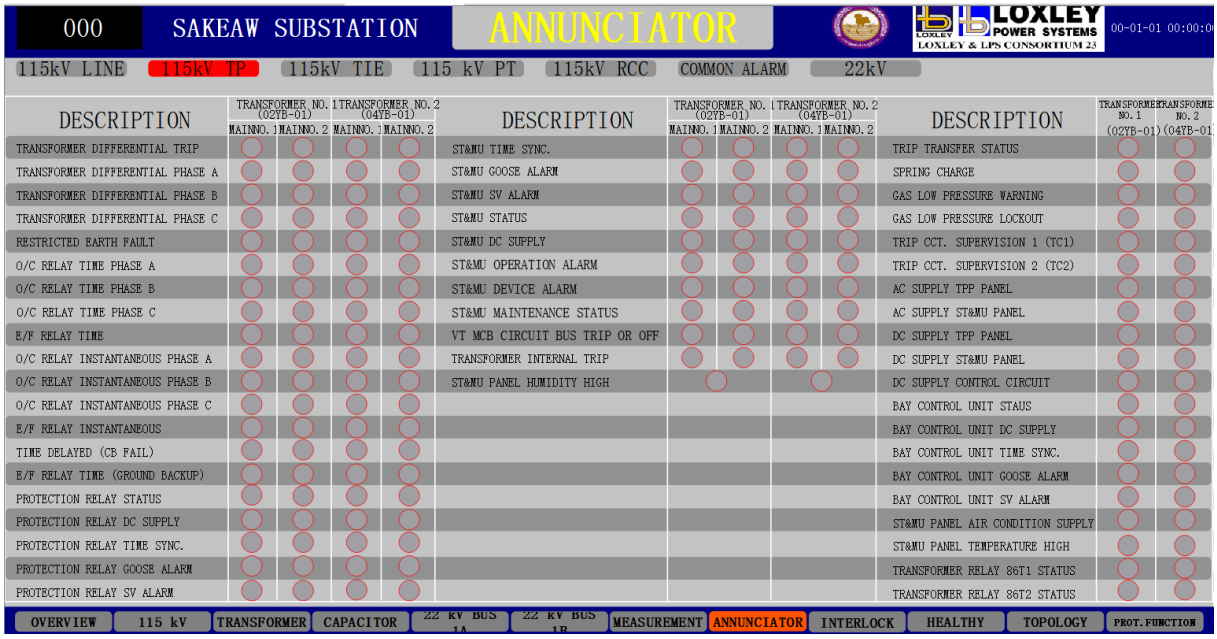


Figure 4.2.3 Human-machine Interface (HMI): Line Bay Detail

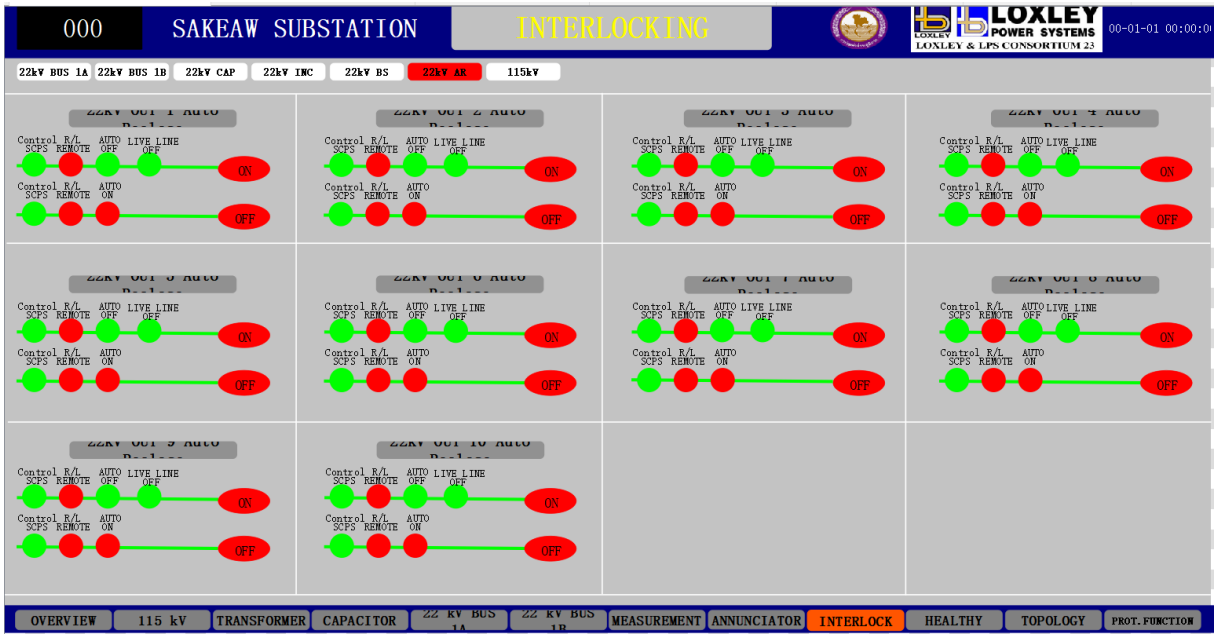


Figure 4.2.4 Human-machine Interface (HMI): INTERLOCKING

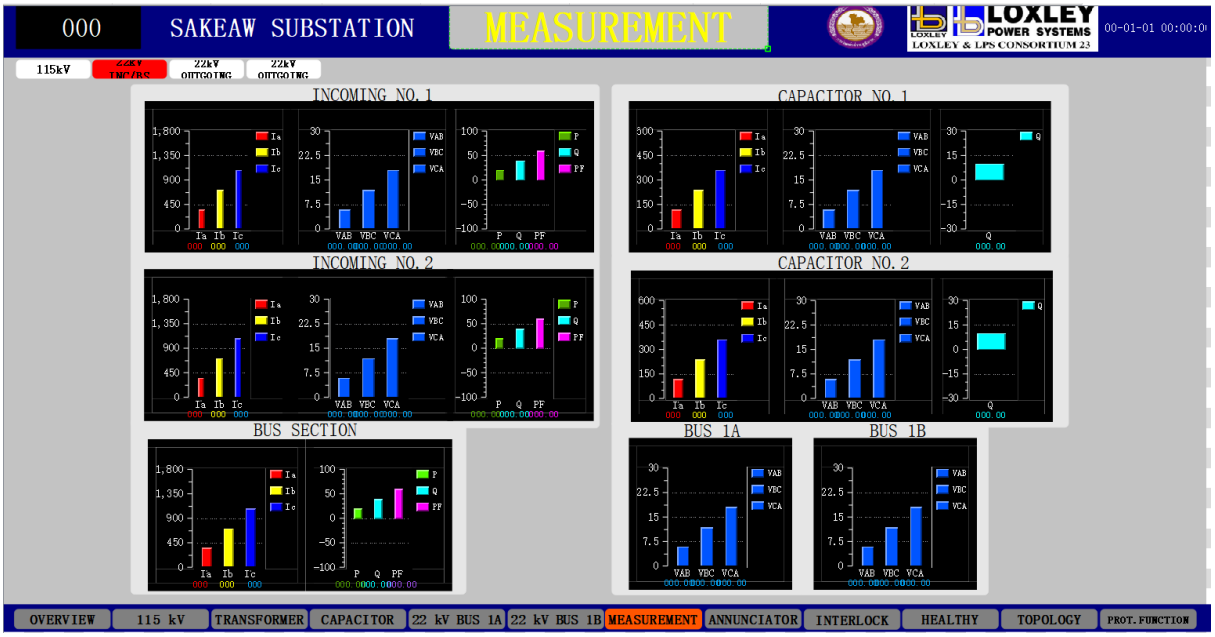


Figure 4.2.5 MEASUREMENT

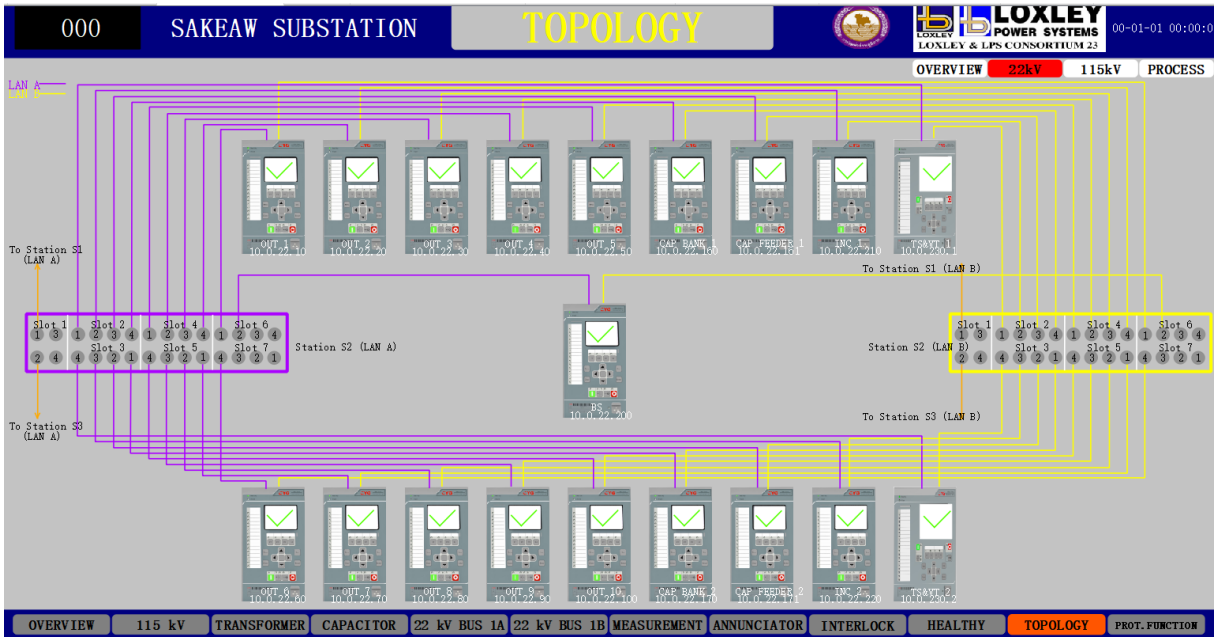


Figure 4.2.6 Human-machine Interface (HMI): System Network Diagram

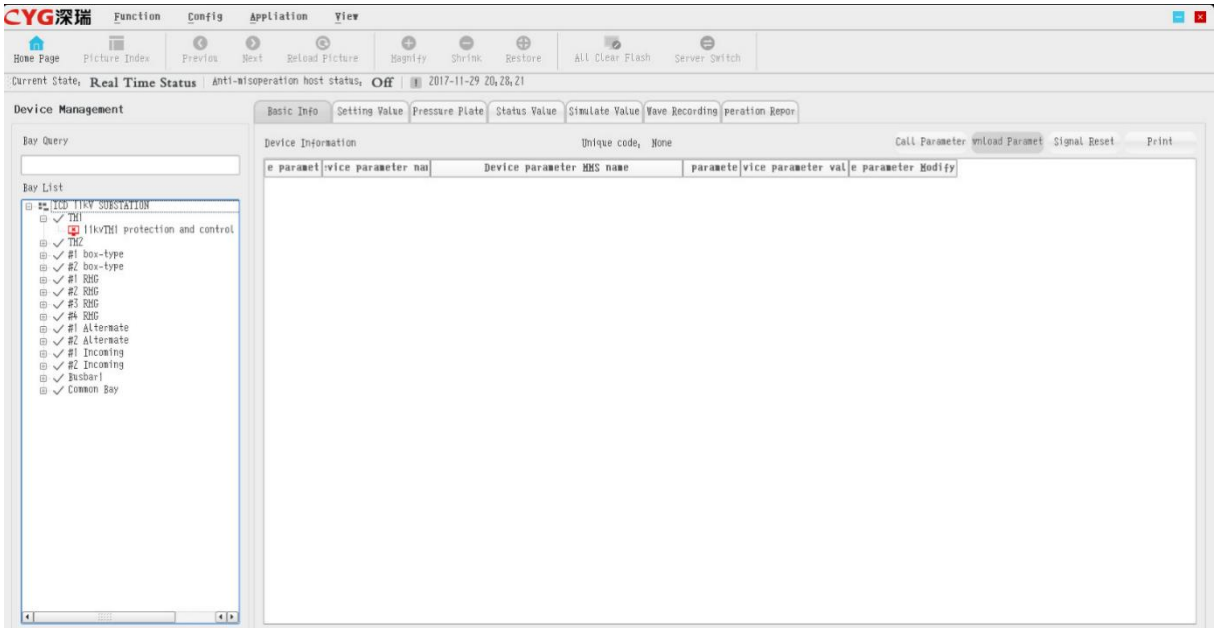


Figure 4.2.7 Human-machine Interface (HMI): Secondary Devices Management Detail

4.2.3 Instructions

4.2.3.1 Status bar

There is a status bar lying top of the human-machine interface, composed of safe operation days, current status, anti-maloperation serverstatus and alarm information.

Figure 4.2.8 Status Bar of Human-Machine Interface

The display of status is described as follows:

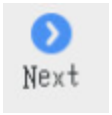
- Safe operation days: display the operation days of current host.
- Current status: the real-time status, indicating it is operating status now.
- Anti-maloperation serverstatus: On or Off, indicating the anti-maloperation serveris on or not.
- Alarm information: display the alarm information in current system, including alarm time, alarm contents.

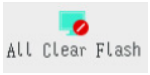
4.2.3.2 Tool bar

A tool bar lies above human-machine interface. The specific instructions are shown as Figure 4.2.9.

Figure 4.2.9 HMI Tool Bar

Table 4.2.1 Introduction of HMI Tool Bar

Icon	Name	Description
	Home	Switch HMI screen to home page set in HMI parameters;
	Screen Index	Pop up screen index box;
	Page Up	Go to previous screen of this screen;
	Page Down	Go to next screen of this screen;
	Reload screen	Re-load current screen;
	Zoom-in	Zoom in the current screen at certain magnification;

Icon	Name	Description
	Zoom-out	Zoom out the current screen at certain magnification;
	Restore	Restore current screen to original one (1:1);
	Clear all flicker	Stop all flickers on HMI;
	Dual-unit switchover	Switch between master and slave unit;
	Anti-maloperation serverlogin	When the current client node is configured as anti-maloperation serverclient, this button will display. After logs in, the corresponding anti-maloperation menu will pop up;

Only when the current client node is configured as anti-maloperation client, the anti-maloperation loging button can be displayed:

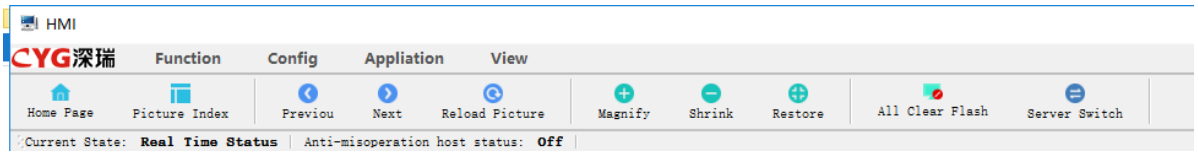


Figure 4.2.10 Anti-maloperation Login on HMI Tool Bar

After anti-maloperation login, the corresponding anti-maloperation menu will pop up. To quit it, click “Exit” button:

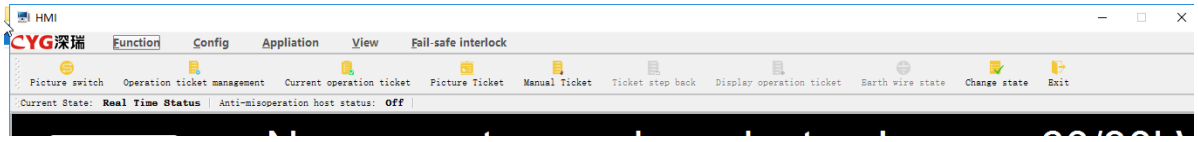


Figure 4.2.11 Change of Toolbar Before and After Anti-maloperation Login

4.2.3.3 Detailed operations

- **Exit HMI**

Clicking  button on the upper left corner, the following dialog box will display. Select a user, enter password to check authorization, and click OK to exit HMI.

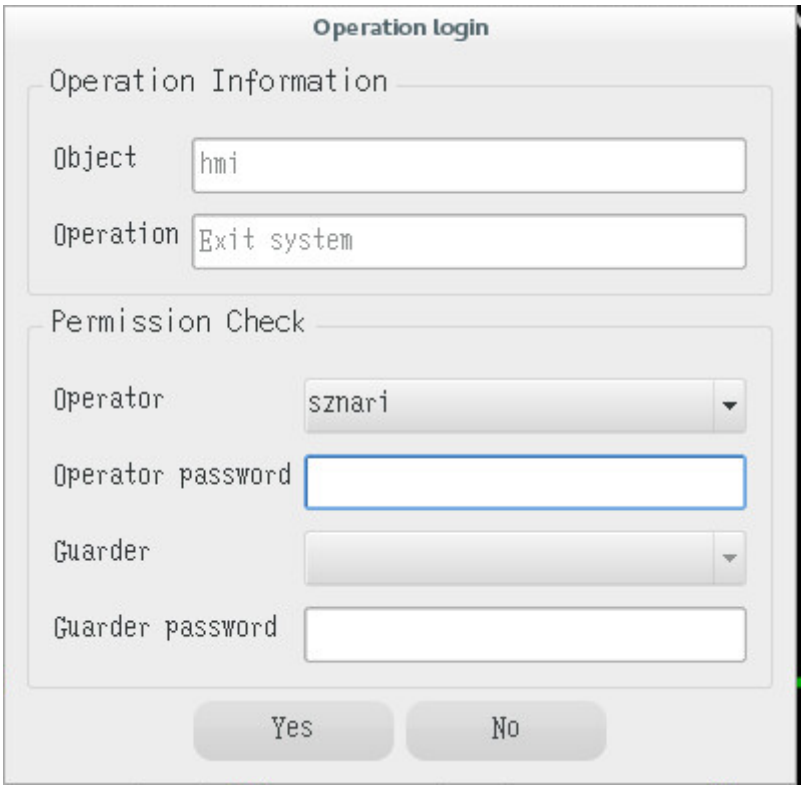


Figure 4.2.12 Exit HMI

- **User login**

When there is not user logged in the system, clicking the relevant element, the following prompt will display. Users shall go to console for login.

Figure 4.2.13 User Login Prompt

- **Remote control operation**

The closing or opening operation of primary equipment such as circuit breakers, disconnectors, earth disconnectors, etc. shall be supervised by the appropriate predefined interlocking.

Breaker: It functions as a regular breaker remote control, but the closing operation goes through the checking synchronous channel. Close By Pass: It is a bypass closing function that goes through the conventional channel. Recloser: It is a remote-controlled AR soft strap. Tag: It is a locked remote-controlled soft strap. By writing the soft strap's remote signal into the switch's Anti-maloperation rules, the remote control locking of the switch is achieved. Live Line: It also functions as a soft strap remote control, used for locking AR. When Live Line is closed, it indicates that there is human activity on the line. It allows remote control for locking reclosing but does not

lock the remote control. At the same time, a corresponding label is attached to the side of the switch.

When the 115kV line is in the Live Line state, the logic for locking the double AR is activated. This means that when the AR soft strap for this line is remotely controlled, the system will disable the AR remote control "Close" button, preventing users from initiating reclosing. However, the remote control for the "Trip" operation is not affected and can still be used normally.

Directly clicking primary element at anti-maloperation disabled status or make remote control by graphic ticketing at anti-maloperation status, the following diaglog box will pop up as Figure 4.2.14.

Figure 4.2.14 Remote Control Login

Select an operator and guardian, enter the password, check the device number, and click OK. After checkout, the monitoring system can provide with remote presetting. If the remote presetting is successful, the following dialog box will display as Figure 4.2.15. At this time, the remote control can continue. If clicking close, this operation will be exited.

Remote opening process is same to remote closing.

Figure 4.2.15 Remote Preset Succeeded

Clicking remote operation button, the remote command will be sent to secondary device. After the remote operation succeeds and the primary device changes position, the following dialog box will pop up as Figure 4.2.16.

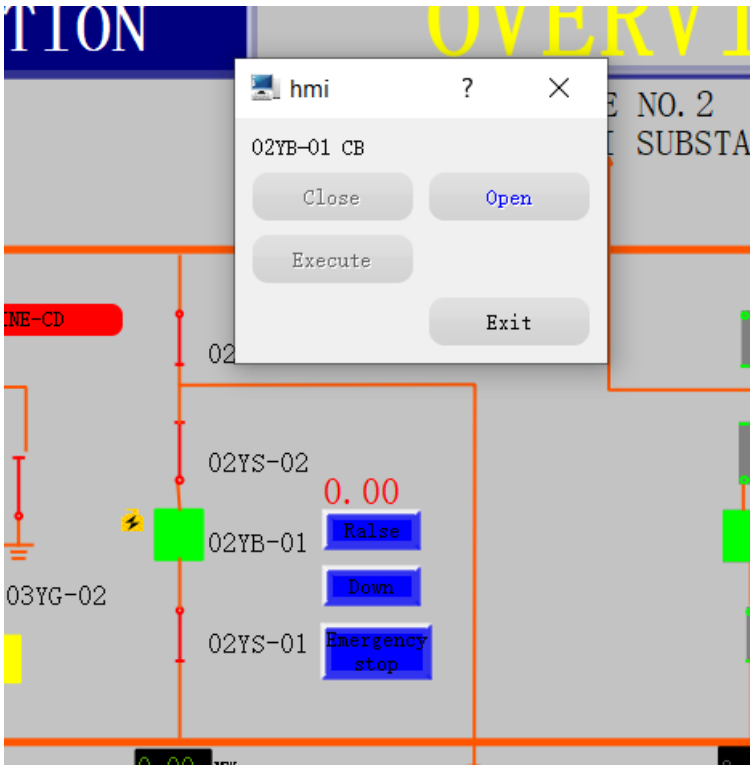


Figure 4.2.16 Remote Control Succeeded

If the remote operation command is sent successfully but the primary device doesn't change position correctly, the following dialog box will display as Figure 4.2.17.

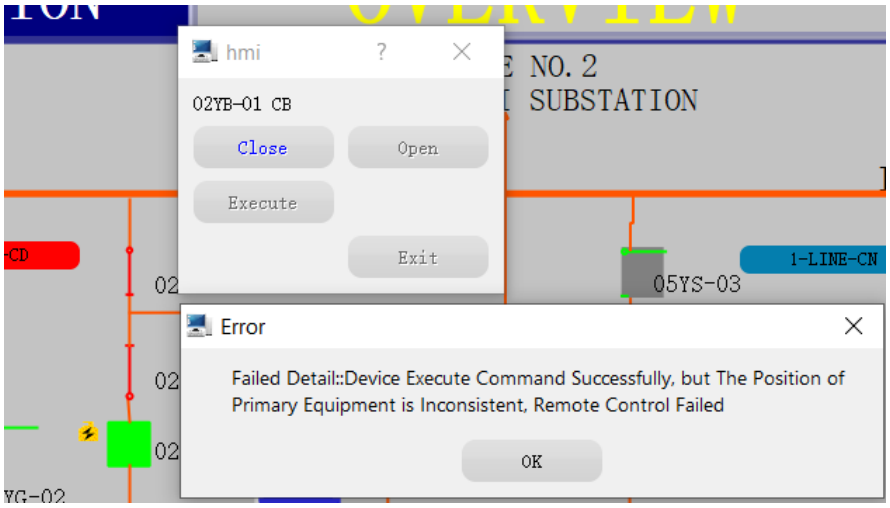


Figure 4.2.17 Remote Control Failed (with device implementing successfully)

- **Remote regulation operation**

For remote regulation of main transformer tap position: directly click Up/Down/Stop button on the screen to make corresponding operation as Figure 4.2.19.

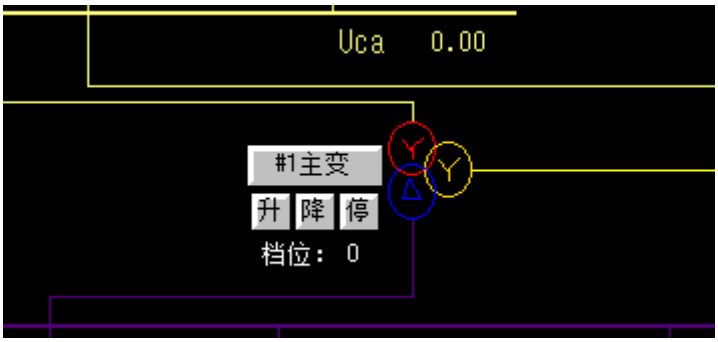


Figure 4.2.18 Up/Down/Stop Button for Remote Regulation

The remote regulation process is same to remote control.

- **Manual setting of analog quantity**

Right clicking the mouse on the remote metering element, the manual setting menu will pop up for option, as shown in Figure 4.2.20.

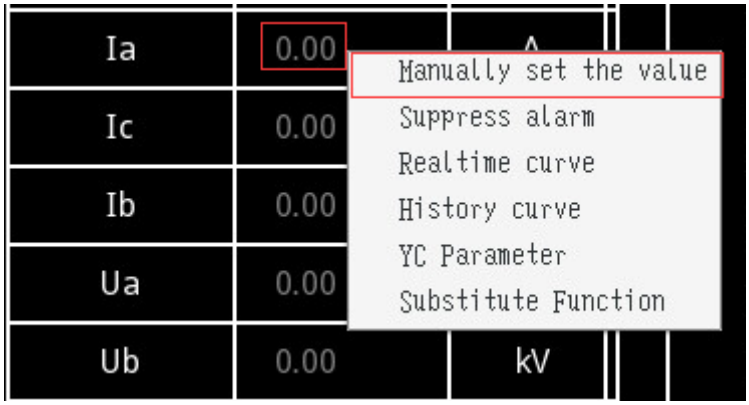


Figure 4.2.19 Manual Setting Menu

After clicking manual setting, the dialog box will pop up, on which the manual setting value can be entered as Figure 4.2.21.

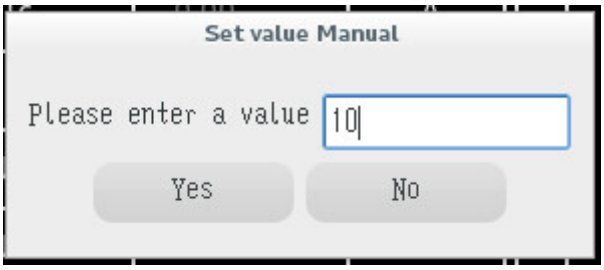


Figure 4.2.20 Manual Settings

After entering manual setting value and clicking OK, the remote metering will become in manual setting status, expressed in gray background and yellow font. Click cancel to undo manual setting.

At manual setting status, right click “restore refresh”, and restore manual setting to normal refresh status, as shown in Figure 4.2.22.

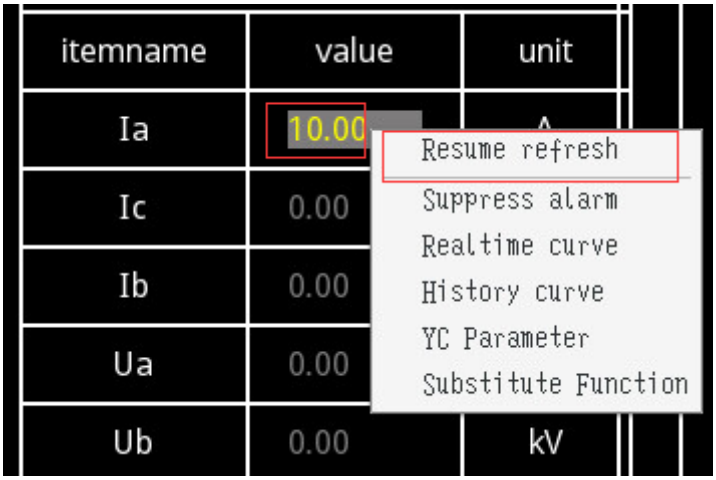


Figure 4.2.21 Restore Refresh

- **Manual negation of state value**

Right click “Manual Negation” on remote signaling element as shown in Figure 4.2.23.

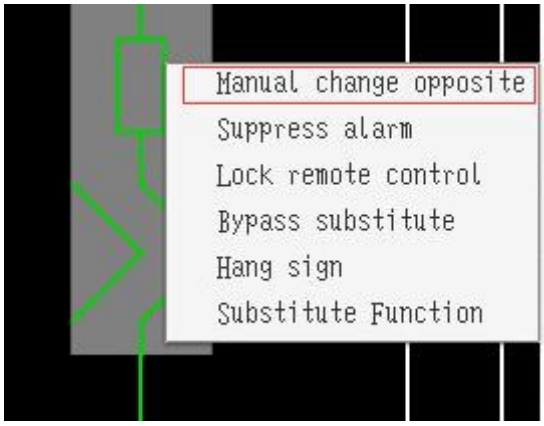


Figure 4.2.22 Manual Negation

After manual inversing operation, for instance, the CB position will be changed from opening to closing. Meanwhile, it will become gray background and have M marking aside to distinguish from normal state. At manual negation state  , if remote control is made, the following prompt will pop up as shown in Figure 4.2.24.

Figure 4.2.23 Manual Negation Blocking Remote Control

At manual inversing state, right click “Restore Refresh” and back to normal refresh state.

- **Inhibit alarm**

Put the cursor on the state value element such as CB, right click and select “Inhibit Alarm” as Figure 4.2.25.

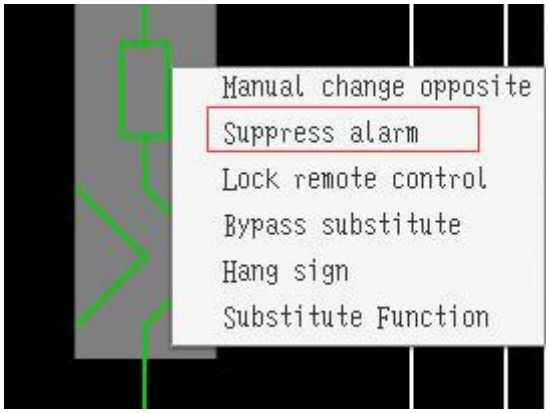


Figure 4.2.24 Inhibit Alarm

After selecting “inhibit alarm”,  sign will display on the element. At this state, when the signal acts, the position signal will not change, and event alarm such as COS or SOE will not occur. In this case, right click “Restore Alarm” and return to normal alarm state.

Inhibit alarm operation of analog quantity is same to that of state value.

- **Remote control lockout**

Put the cursor on the primary device element such as CB, and right click “Remote control lockout” as Figure 4.2.26.

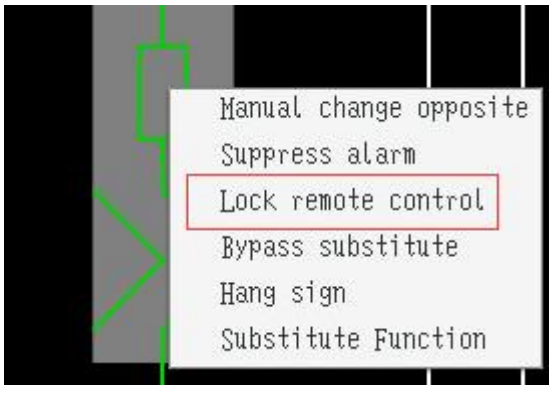


Figure 4.2.25 Remote Control Lockout

After selecting remote control lockout, this CB will be marked with  . If making remote control in this case, the following dialog box will pop up to remind of forbidding remote control, as shown in Figure 4.2.27.

Figure 4.2.26 Remote Control Locking

At remote control lockout state, right click “Remote Control Unblock” to release lock.

- **Labeling**

When the primary devices are under maintenance or other operations are needed, labelingoperation can be made in monitoring system. Put the cursor on the primary device element, and right click “labeling” as Figure 4.2.28.

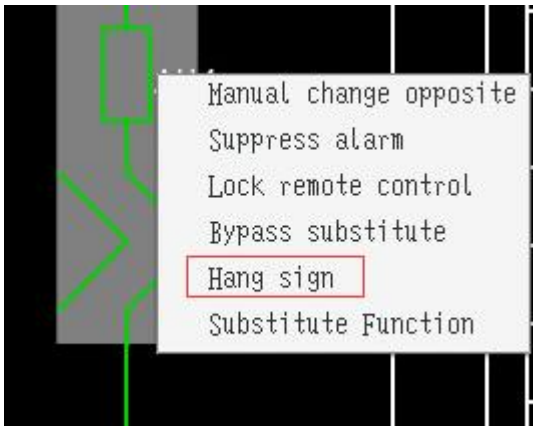


Figure 4.2.27 Labeling

After selecting “labeling”, the login diaglog box will pop up. After entering username and password, the user with authority can enter the following page:

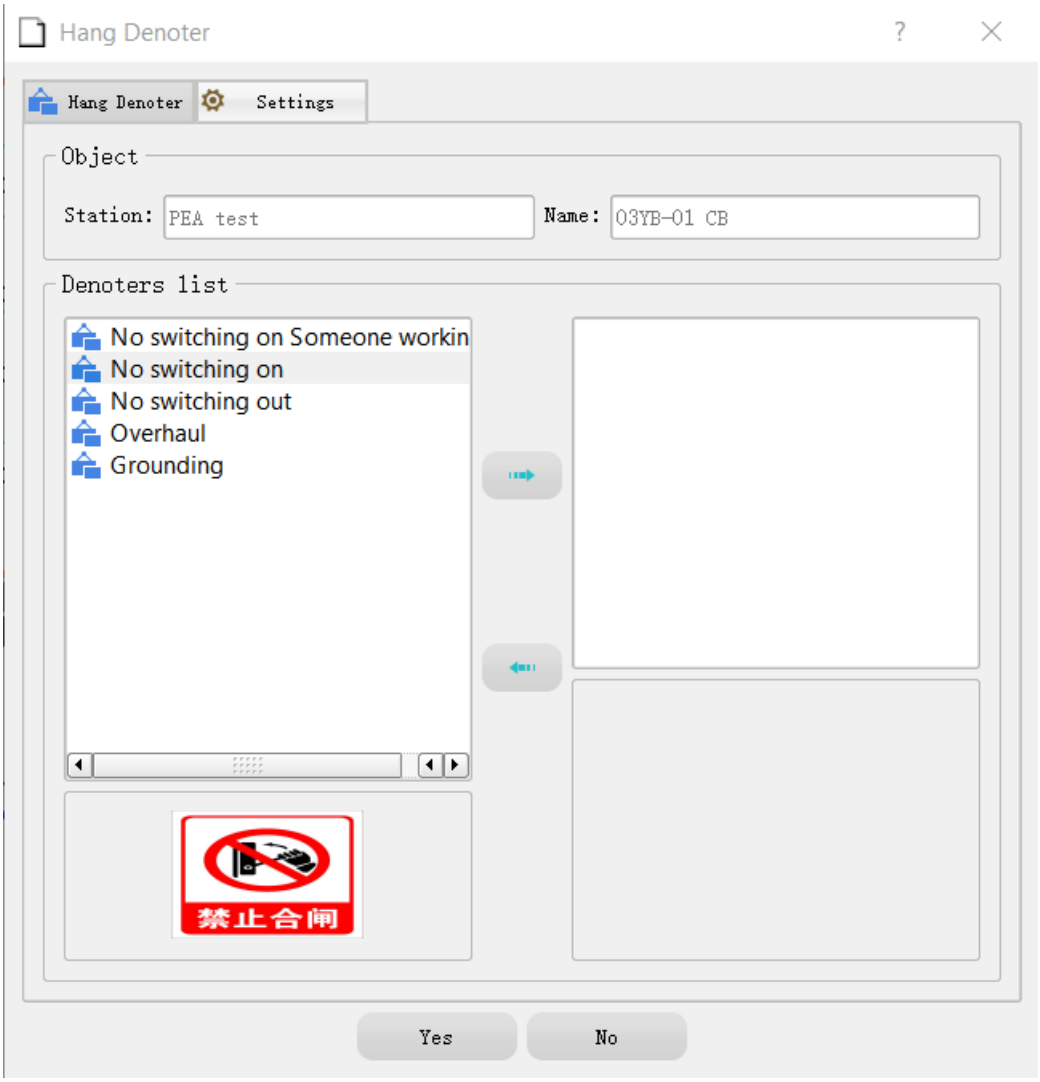


Figure 4.2.28 Dialog Box of Labeling

Select a suitable label in the list, click the rightward button to add a label, and click “Yes” to attach label successfully. The label will be strikingly displayed beside those primary devices.

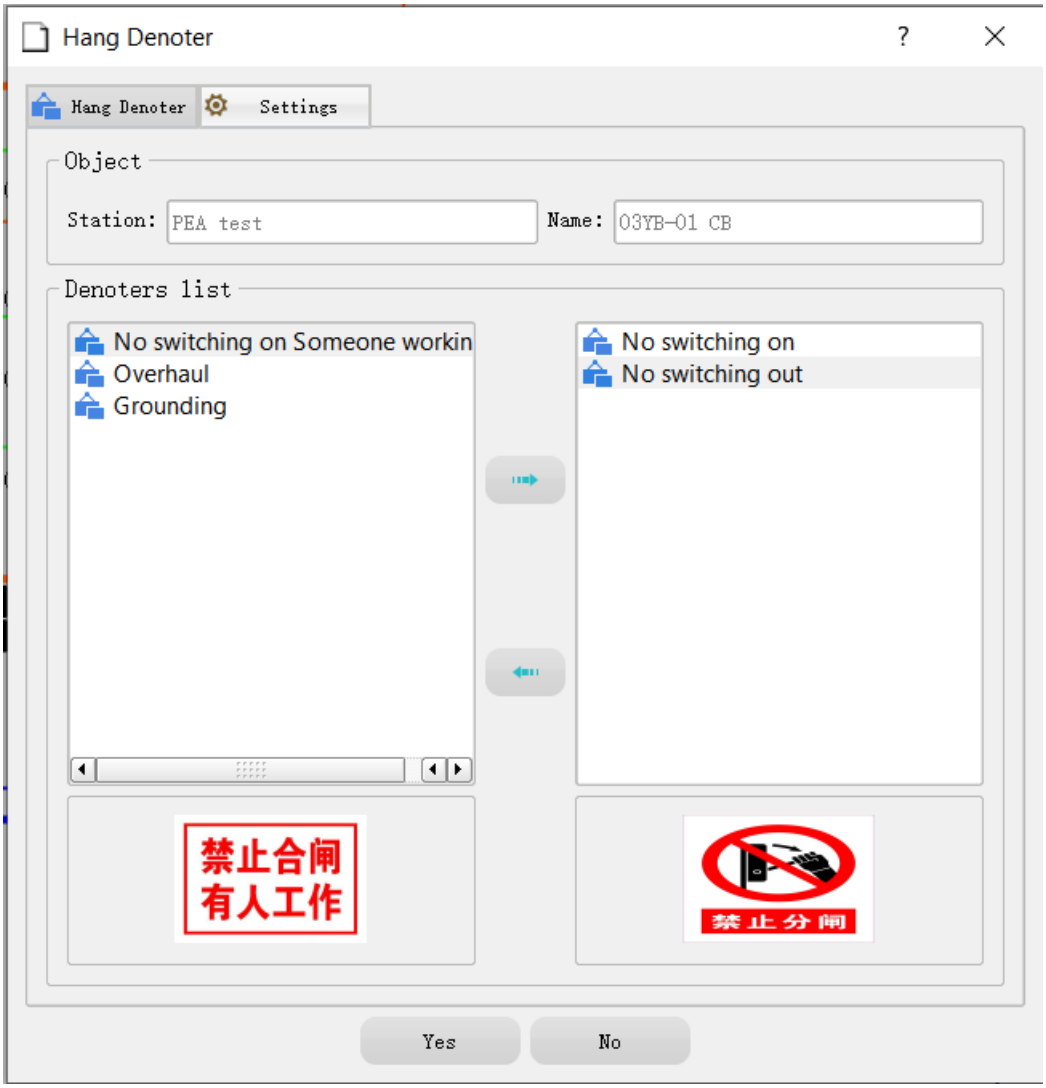


Figure 4.2.29 Labeling

Removing label is similar to attaching label. You only need to move the label on theh right list to the left.

Adding or removing tags will generate a log record.

- **Context menu operation in the blank space**

Right clicking the blank space in the screen, the following context menu will display as Figure 4.2.31.

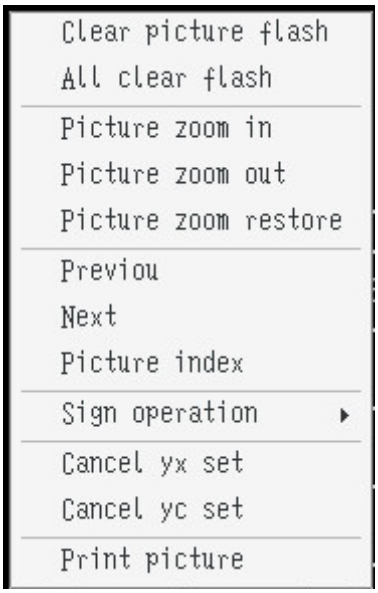


Figure 4.2.30 Context Menu

Name	Description
Clear flicker	Clear the element flicker in the current screen
Clear all flickers	Clear the element flicker in all screens
Zoom-in	Zoom in the current screen
Zoom-out	Zoom out the current screen
Restore original screen	Restore current screen to real size
Page up	Go to previous page
Page down	Go to next page
Screen index	After clicking screen index, you can go to sub-menu corresponding to the name, as shown in Figure 4.2.32
Labeling operation	Make configuration for label
Switch to anti-maloperation view	Switch to anti-maloperation graph layer in configuration tool
Undo remote signal manual setting of whole station	Cancel the remote signal manual setting of the whole station, and restore refresh
Undo remote metering manual setting of whole station	Cancel the remote metering manual setting in the whole station, and restore refresh
Print screen	Print the current screen

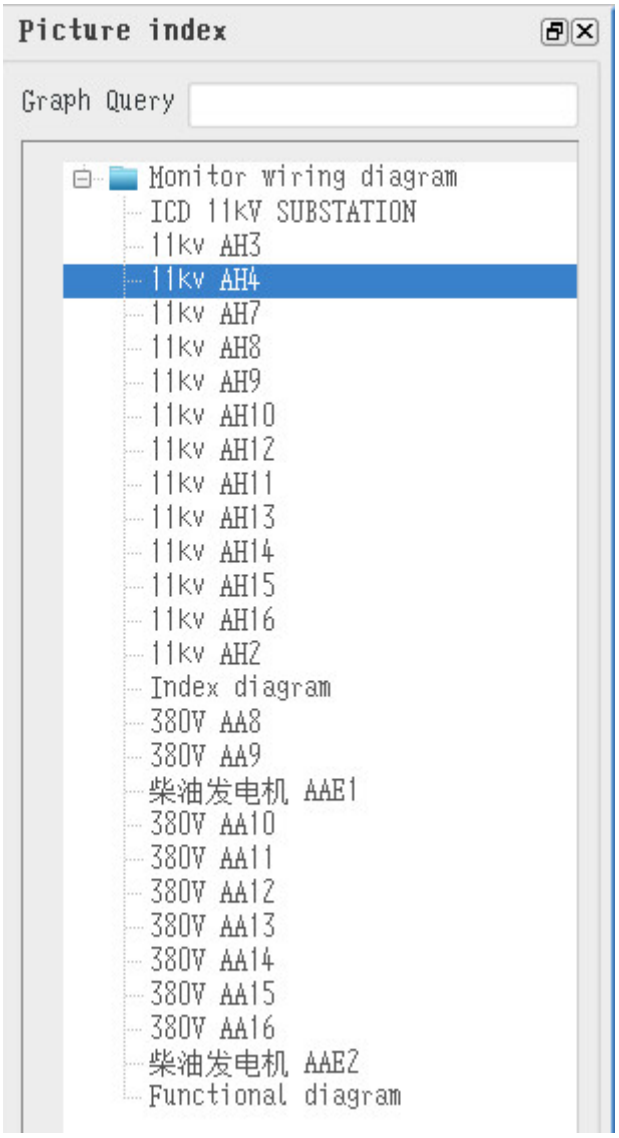


Figure 4.2.31 Screen Index

4.3 Curve tool

4.3.1 Overview

Curve tool is a new sub-module added in PRS-7000 integrated monitoring system. With this module, the hourly real-time curve as well as historical curve on a certain day, month and year can be displayed. Besides, it provides curve comparision, curve file storage and print functions.

4.3.2 Realization

Curve module is a online view tool, no need to configure any separate sub-curve. For the remote metering quantity stored in database configuration, by right click on HMI, the real-time curve and historical curve can be called, reading real-time curve from real-time database and reading historical curve from historical database. Curve tool can also be opened from system console, displayed by directly selecting remote metering quantity and curve type. There are several sub-types for curve, basically covering all users' demand.

4.3.3 Toolbar

Tool bar lies above curve tools as shown in Figure 4.3.1.

Figure 4.3.1 Curve Tool Bar

Table 4.3.1 Function Description of Curve Tool Bar

Icon	Name	Description
	Save	Save the current curve page to pdf file in local, and view and print it at any time.
	Clear	Clear the current signal and curve types.
	Background color	Background defaults to black. Current background color can be modified.
	Print	Print the current curve page. Print file storage path can be selected.
	Refresh	Refresh the current curve page. When it is real-time curve, refresh the current starting time, and re-make curve plotting.
	Search	Search the historical curve in self-defined time.

4.3.4 Curve type

Curve type includes hourly real-time curve, today real-time curve, one-day curve, self-defined historical curve, real-time & historical curve comparison, single-signal historical daily curve comparison, single-signal historical monthly curve comparison.

4.3.4.1 Hours real-time curve

Right click remote metering quantity stored in database configuration on HMI to select real-time curve. Such real-time curve defaults to be hourly real-time curve. It is defaulted that a point is plotted every 5s, and the time horizon of horizontal axis on displayed interface is 1 hour, the area in this hour can be magnified for view. The left-side signal list has given the remote metering quantity stored in database configuration. You can check the real-time signal curved to be displayed yourself. After every checking, as the current time has to be re-calculated, the hourly

real-time curve will be re-plotted.

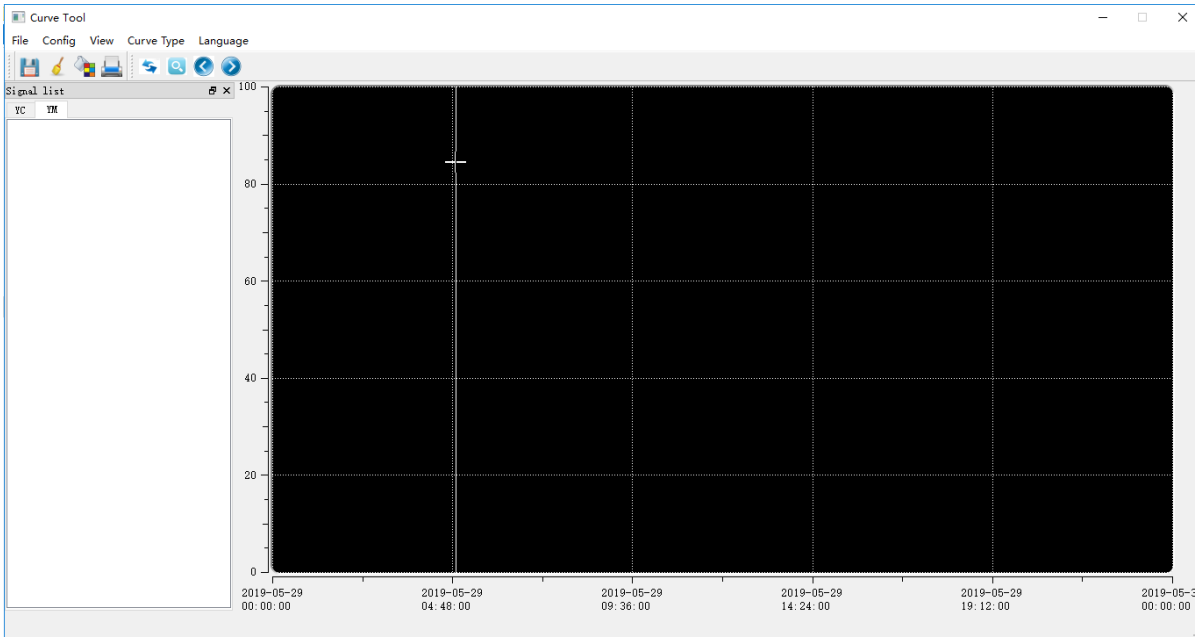


Figure 4.3.2 Hourly Real-time Curve

4.3.4.2 Today real-time curve

Selecting “Today Real-time Curve” in the curve types, the curve changing between the interval of 0:00-24:00 will be displayed. A point is plotted every 5s. It supports magnification display in this interval, and multiple-signal display. As the time horizon is fixed, the curve will not be re-plotted. The right side will show the meaning of signals expressed in different colors.

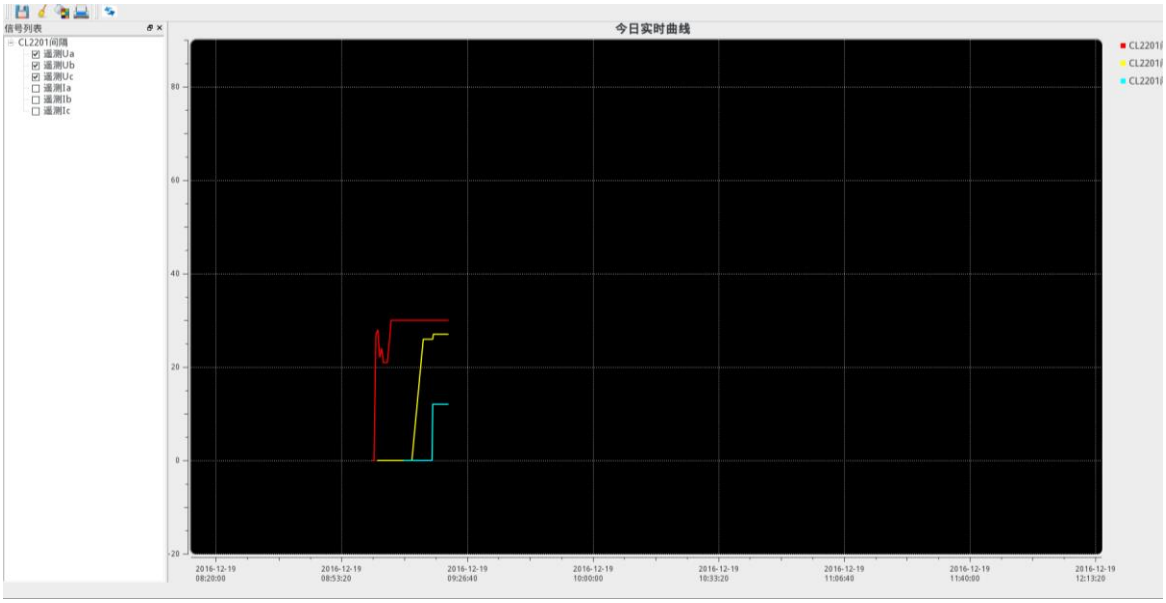


Figure 4.3.3 Today Real-time Curve

4.3.4.3 One-day historical curve

Selecting “one-day historical curve” in the curve type, it will pop up a time query dialog box. Selecting one day, the record of that day can be read out from historical database. When the one-day historical curve is selected, left and right button will be displayed on the top, which can be used to go to the curve of previous or next day quickly. The right side will show the meaning of signals expressed in different colors.

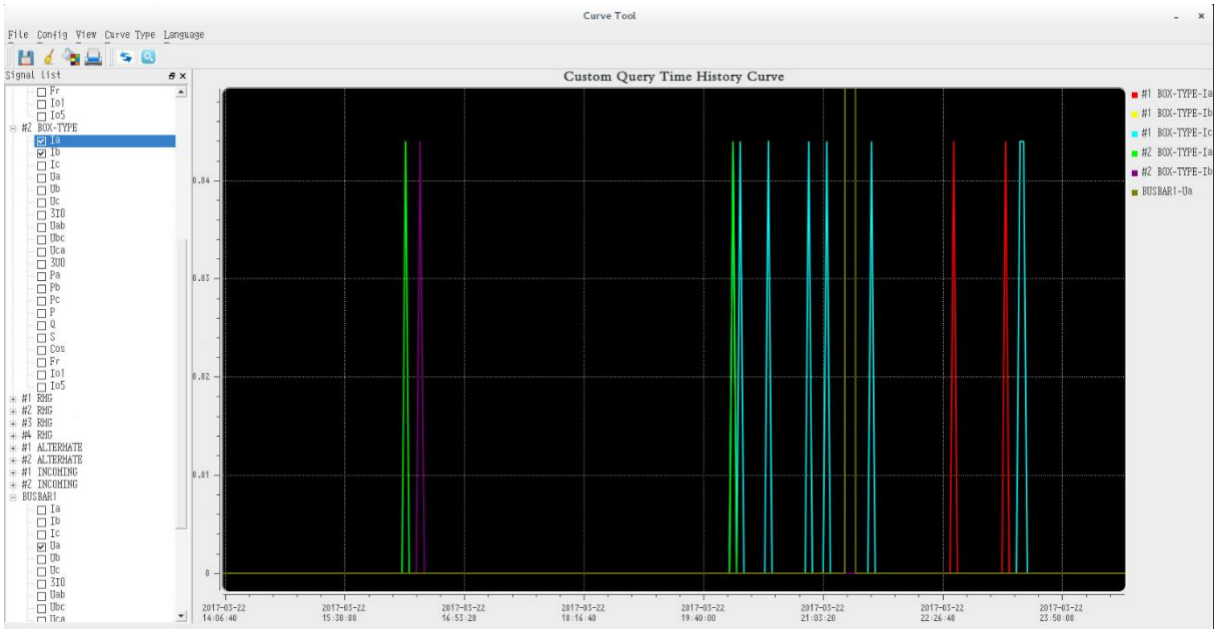


Figure 4.3.4 One-day Historical Curve

4.3.4.4 Self-defined historical curve

Selecting “self-defined historical curve” in the curve types, you can define a time range for query, but the ending time shall not be a future time.

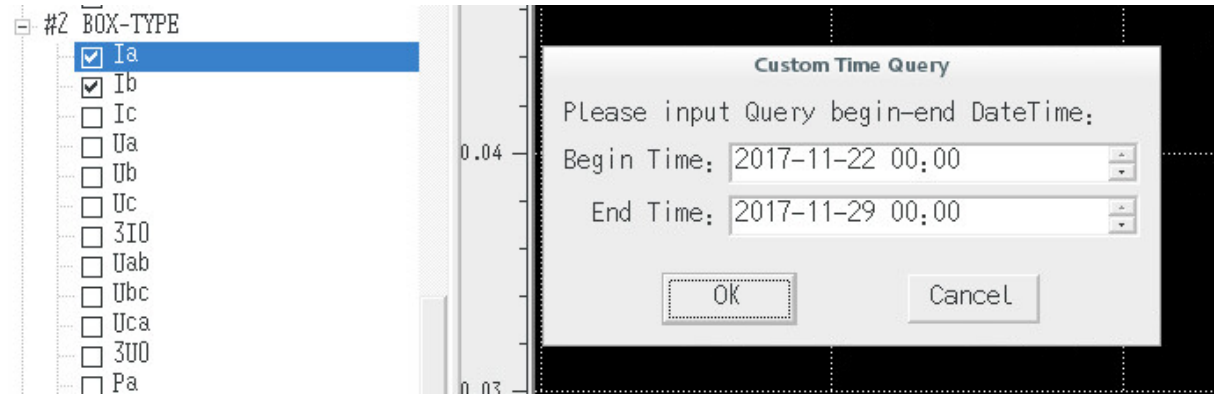


Figure 4.3.5 Self-defined Historical Curve Time Query

Zoom display in selected time range is available, but dragging screen is allowed only in this range.

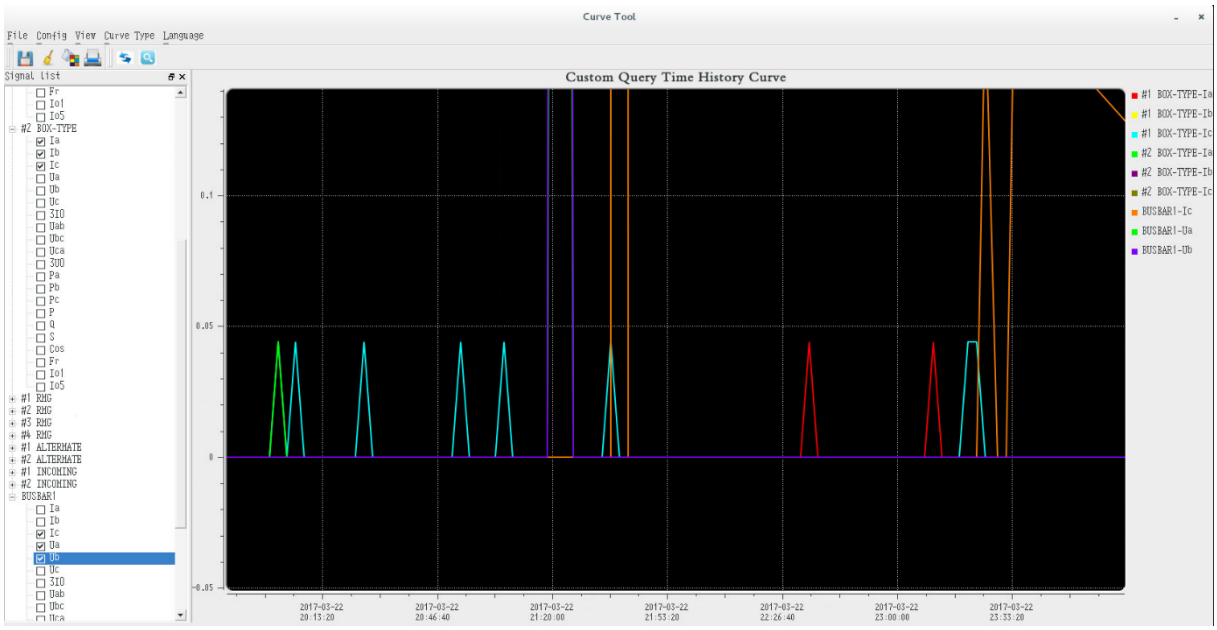


Figure 4.3.6 Self-defined Historical Curve Display

4.3.4.5 Real-time historical curve comparison

Selecting “real-time historical curve comparison” in the curve types, it will compare the real-time curve and historical curve of remote metering object on a certain day. No multiple points shall be selected. At present, it supports for comparison of real-time curve and 12-day historical curve at most. Zoom display is available in a selected time range, but dragging screen is allowed only in this range. The right side will show the meaning of signals expressed in different colors.

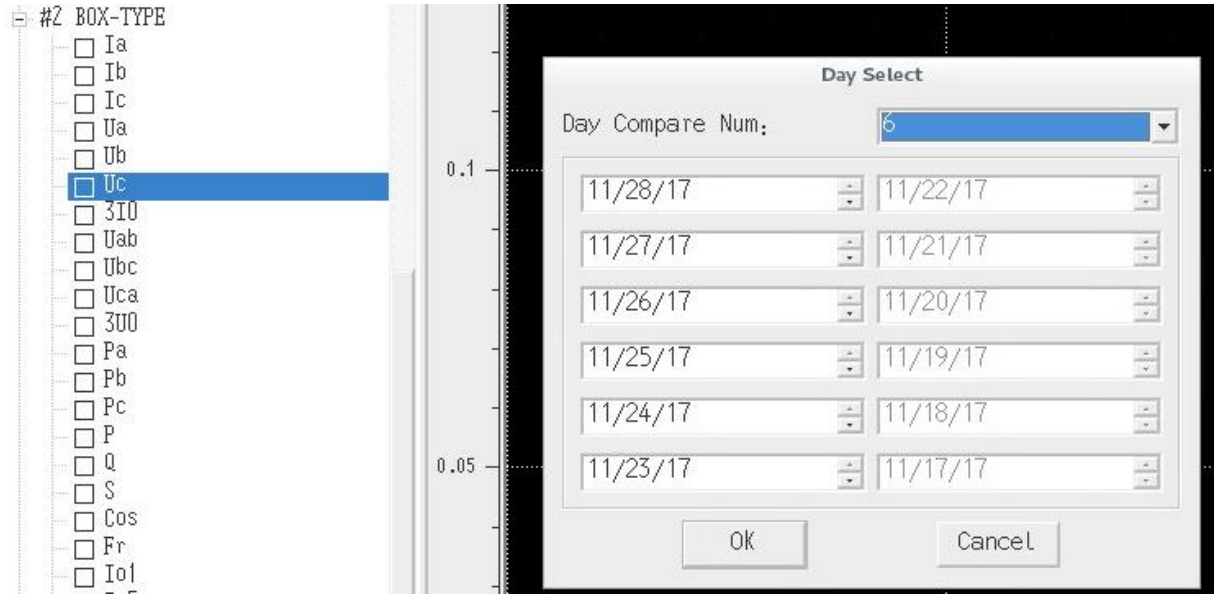


Figure 4.3.7 Selection of Comparison Date of historical & Real-time Curve

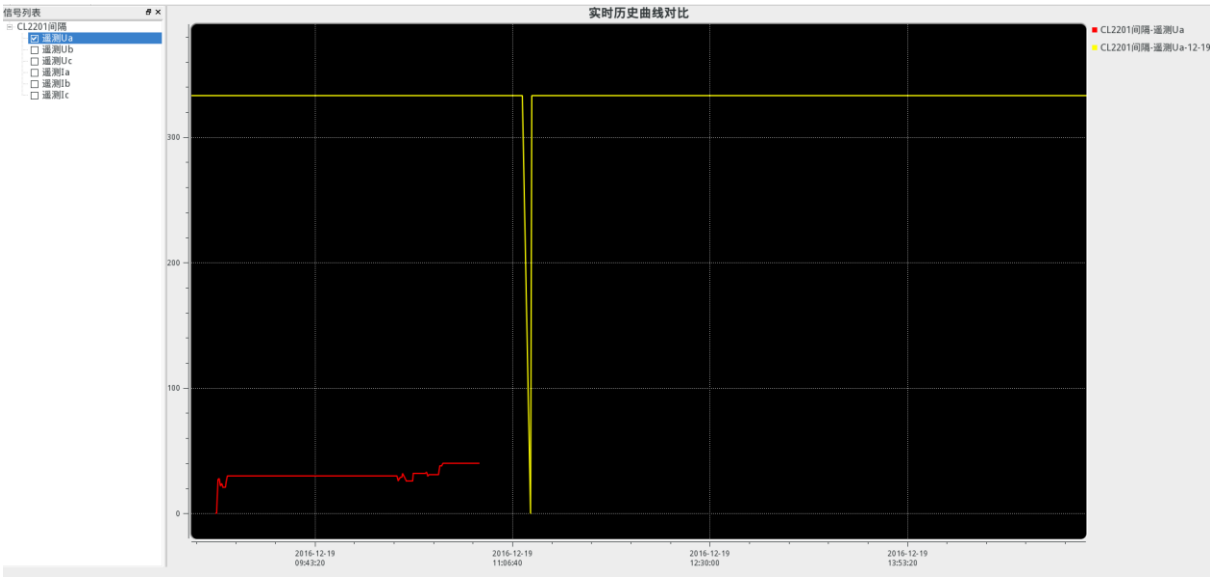


Figure 4.3.8 Single- signal Real-time & Historical Curve Comparison

4.3.4.6 Single-signal historical daily curve comparison

Selecting “single-signal historical daily curve comparison” in the curve types, the initial comparison day is 0, and it supports for comparison of 12 days of curves at most. Select comparison days, select comparison date, and click OK. Then, it will display the comparisons. Free scale is available in the time range on the selected day. The right side will show the meaning of signals expressed in different colors.

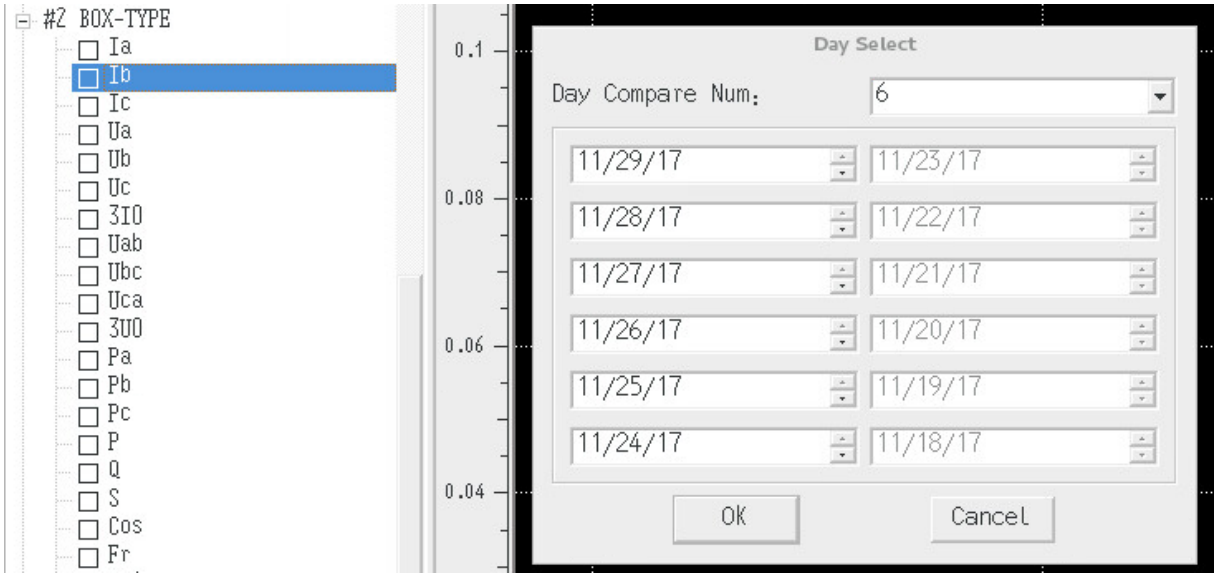


Figure 4.3.9 Date Choose for Single-signal Historical Daily Curve

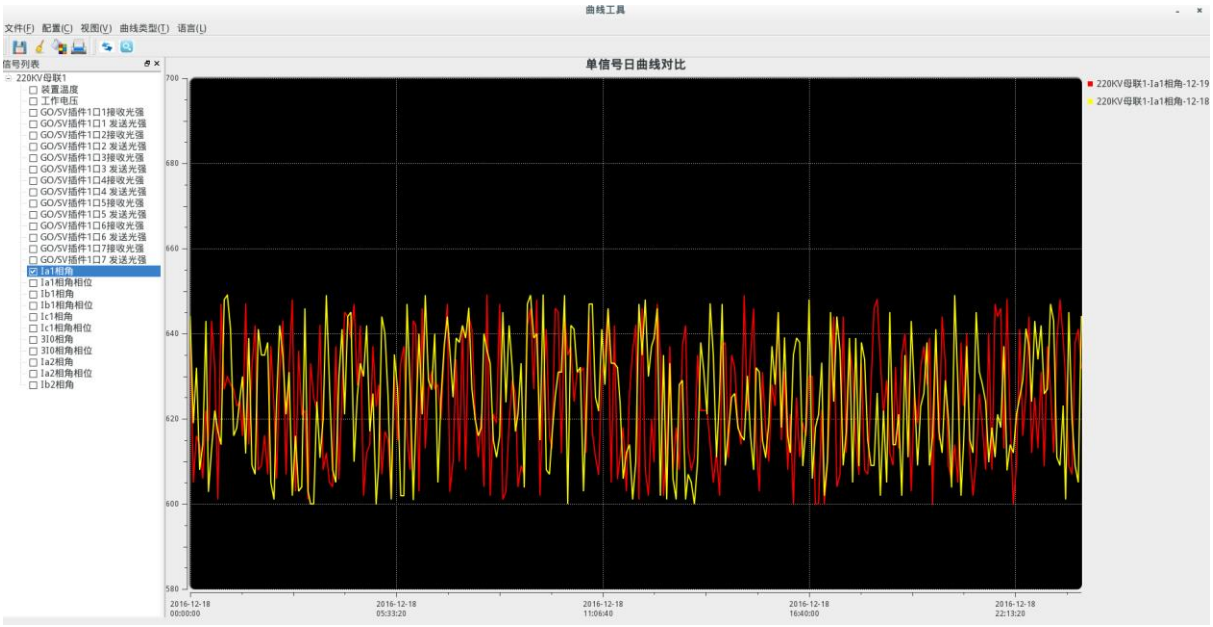


Figure 4.3.10 Single-signal Historical Daily Curve Comparison

4.3.4.7 Single-signal historical monthly curve comparison

Selecting “single-signal historical monthly curve comparison” in the curve types, the initial comparison month is 0, and it supports for comparison of 12 months of curves at most. Select comparison month number, select comparison month, and click OK. Then, it will display the comparisons. Free scale is available in the time range on the selected month. The right side will show the meaning of signals expressed in different colors.

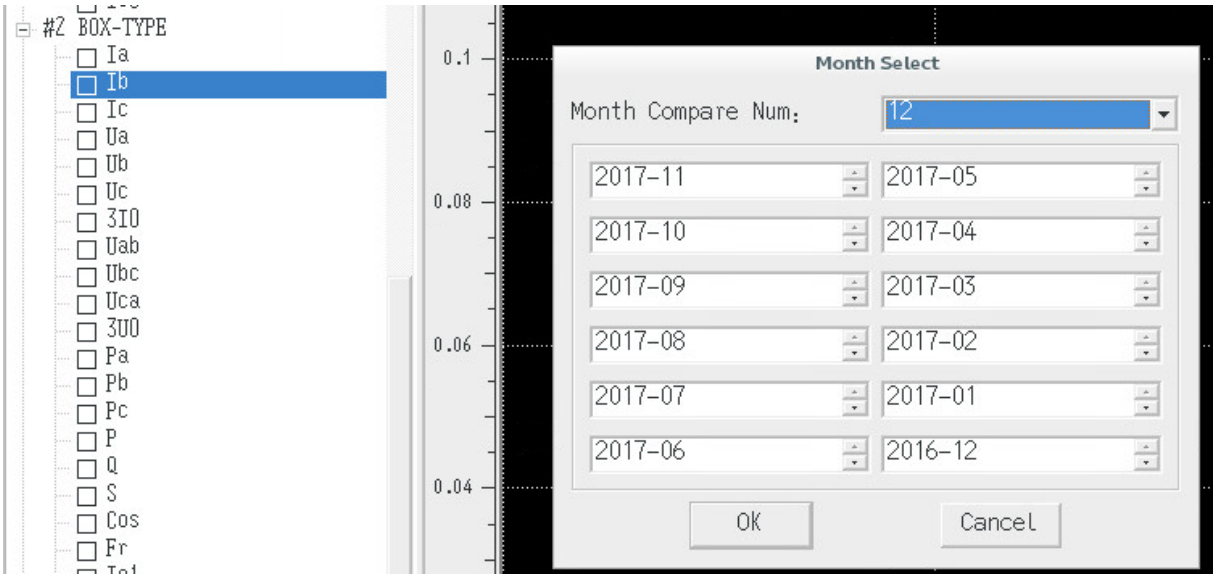


Figure 4.3.11 Selection of Single-signal Historical Monthly Curve

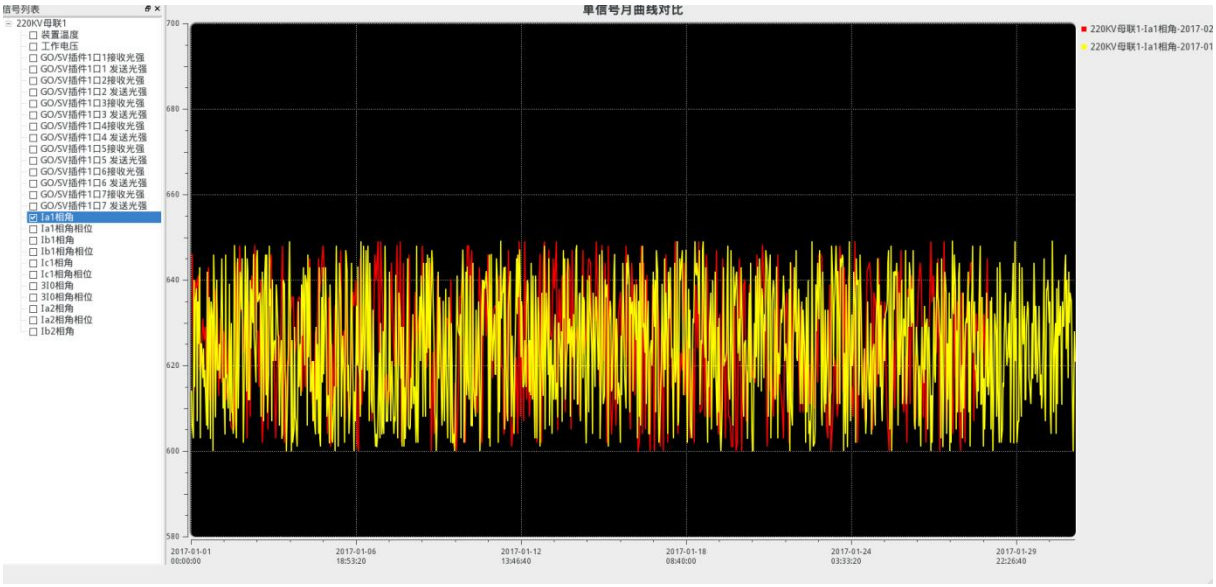


Figure 4.3.12 Single-signal Historical Monthly Curve Comparison

4.4 Report system

Report system is a sub-module of PRS-7000 integrated monitoring system. With this module, the historical data can be queried, displayed in self-defined form and printed out.

Report tool provides two operation modes: “edit state” and “operating state”. At edit state, the report can be set and configured for use by report designer; at operating state, the report can be queried and printed for use by general operators.

Report supports for normal and special types. Normal report is used for statistical and sampling data, while special report is used for event data. The two types of report can be divided into several sub-types, basically covering the users’ demands.

4.4.1 Report type

4.4.1.1 Sampling statistical report

Sampling statistical report is mainly specific to analog quantity and electric energy quantity. The common basic report consists of daily report, monthly report and annual report. Shift report, weekly report and quarterly report can be specially generated from basic report mentioned above. Statistic type of report are described as follows.

Table 4.4.1 Statistic Type of Daily Report

Report type	Signal type		Value type
Daily report	Analog quantity	Offset	value on the hour
		Statistics	Maximum
			Minimum
			Maximum moment
			Minimum moment
			Average value
	Electric energy	Offset	Energy metering on the hour

	quantity		Electric energy quantity of hour time
		Statistics	Daily cumulative electric energy quantity
			Electric energy quantity in daily peak period
			Electric energy quantity in daily valley period
			Electric energy quantity in daily mean period
			Daily load factor
			Maximum electric energy quantityof hour time
			Minimum electric energy quantity of hour time
			Maximum of hour time
			Minimum of hour time
			Average electric energy quantity of hour time

Table 4.4.2 Statistic Type of Monthly Report

Report type	Signal type		Value type
Monthly report	Analog quantity	Offset	Daily maximum
			Daily minimum
			Daily maximum moment
			Daily minimum moment
			Daily average
		Statistics	Monthly maximum
			Monthly minimum
			Monthly maximum moment
			Monthly minimum moment
			Monthly average
	Electric energy quantity	Offset	Daily cumulative electric energy quantity
			Maximum electric energy quantity of hour time
			Minimum electric energy quantity of hour time
			Maximum of hour time
			Minimum of hour time
			Average electric energy quantity of hour time
		Statistics	Monthly cumulative electric energy quantity
			Maximum daily electric energy quantity in a month
			Minimum daily electric energy quantity in a month
			Monthly maximum electric energy quantity day
			Monthly minimum electric energy quantity day
			Monthly average electric energy quantity

Table 4.4.3 Statistic Type of Annual Report

Report type	Signal type		Value type
Annual report	Analog quantity	Offset	Monthly maximum
			Monthly minimum
			Monthly maximum moment
			Monthly minimum moment
			Monthly average
		Statistics	Annual maximum
			Annual minimum
			Annual maximum moment
			Annual minimum moment
			Annual average
	Electric energy quantity	Offset	Monthly cumulative electric energy quantity
			Maximum daily electric energy quantity in a month
			Minimum daily electric energy quantity in a month
			Monthly average electric energy quantity
			Monthly maximum electric energy quantity day
			Monthly minimum electric energy quantity day
		Statistics	Annual cumulative electric energy quantity
			Maximum monthly electric energy quantity in a year
			Minimum monthly electric energy quantity in a year
			Average monthly electric energy quantity in a year
			Maximum electric energy quantity month in a year
			Minimum electric energy quantity month in a year

4.4.1.2 Event report

Table 4.4.4 Event Report Type

S/N	Special Report
1	Exceeding limit alarming report
2	SOE report
3	VQC regulation record
4	Protective action event report

5	Self-diagnosis report
6	Operation log
7	Equipment maintenance report
8	Setting modification report
9	Remote signal state change report
10	System information report

4.4.2 Report edit

Report format can be flexibly defined. By menu selection, the data association between report cells and database can be defined conveniently. Data of report is mainly sourced from historical data, self-defined data by users, constant, and all calculated results.

The report supports many types of operations, operators, operating functions and function nest. Users may define calculations, but the expression reasonableness shall be inspected. Besides, some common formulas and functions shall be provided for calling.

Operands supported by the report include floating point number, integer number, characteri string, time variable etc.

Tabular data list can display various types of data. For character string, the data will not be processed, but directly displayed in final table. For real number and integer, the displayed length and position behind decimal point can be specified. Multiple forms of time can be displayed. A data may be concealed, which will not be displayed in the final table.

Three alignment ways can be selected in the table: align left, align center, and align right. Multiple display fonts are optional, line and row width can be adjusted conveniently, and the cell split and merge can be available. Provide table deletion and insertion function. Different types of border can be defined. It supports clipboard. Users can do cut, copy and paste operation conveniently. Relative reference and absolute reference are supported so that the the operational formual is correct after moving cell.

Report shall provide time loop function. Time loop is such a function that displays the value of a data point recorded by database discrete sampling in a series of continuous time. In this case, the user has to input the first data only. Report tool will provide loop iteration horizontally or vertically, automatically generating such data series.

The edit table can be previewed before print so that the print and display table are consistent. Report printing time can be defined freely.

Provide common table templates. Users can select required template as needed. Report can be online modified and self-synchronized. Report can be managed conveniencly.

4.4.3 Report display

Organize and display reports in Excel. Support running log, monthly, annual statistical and special statistical table.

The required report can be displayed conveniently. Provide data modification by manual. After modification, the corresponding manual setting place in database will be labeled to indicate

manual setting.

Select year, month and day, and query the historical report.

Report display interface is shown as Figure 4.4.1.

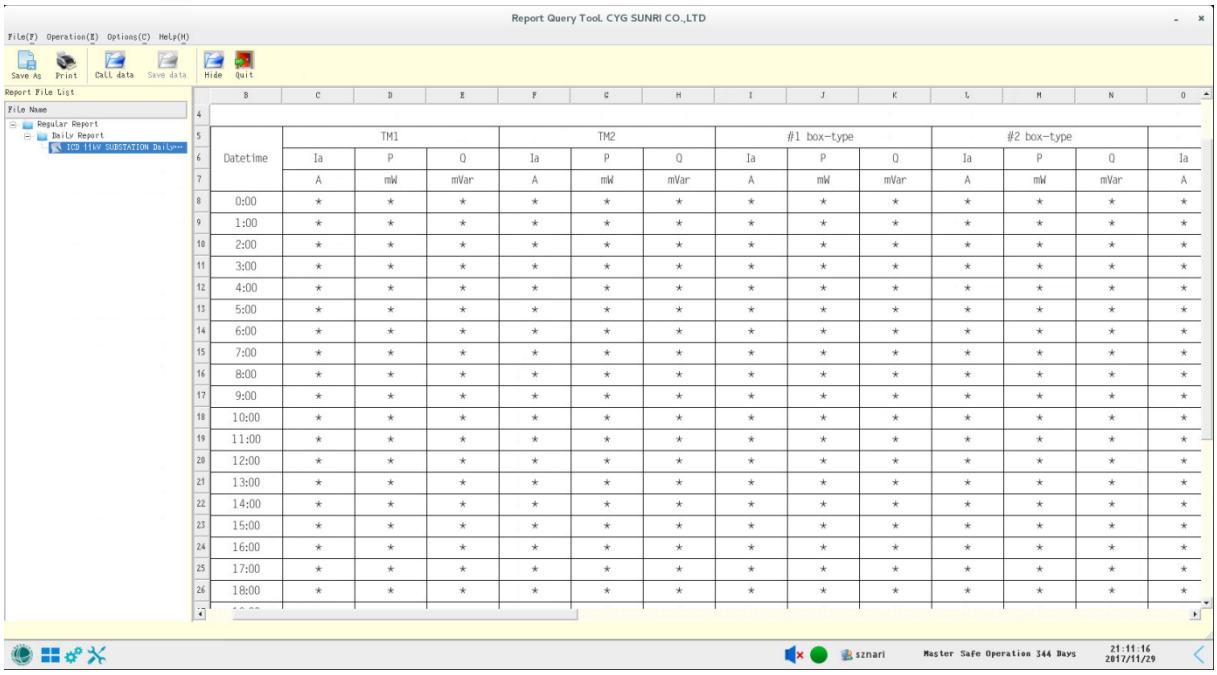


Figure 4.4.1 Report Display

4.4.4 Report print

Timed print: print required reports at defined time.

Call print: print existing reports by operator's calling on human-machine interface.

Click "Operate (E)" in the toolbar of report query tool, and then click "print" in the drop-down list:

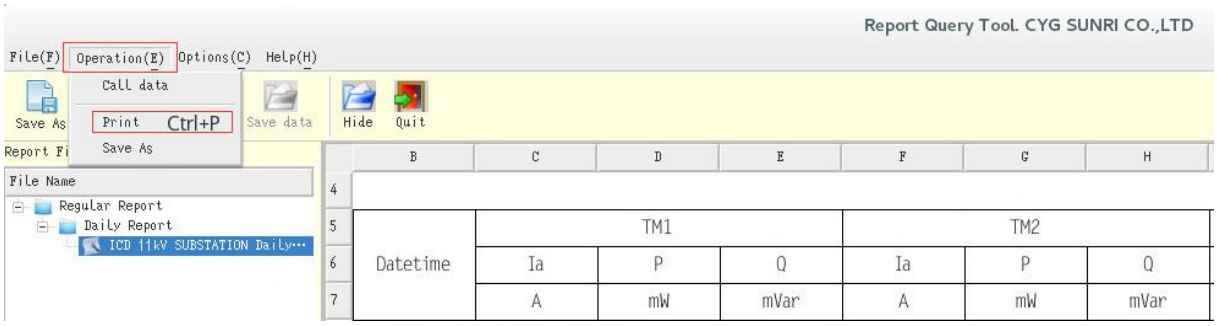


Figure 4.4.2 Report Print

4.5 Anti-maloperation blocking

4.5.1 Overview

PRS-7000 integrated monitoring system can realize anti-maloperation function by establishing communication with independent anti-maloperation host of other manufacturer. In addition, as the monitoring system has integrated integration anti-maloperation function, many integrated

anti-maloperation blocking proposal can be provided as demanded, so as to achieve safe and reliable anti-maloperation blocking function.

PRS-7000 integrated monitoring system not only provides integrated anti-maloperation blocking on station level, but also realizes anti-maloperation blocking on bay level, which strictly stops misoperation in the running of system.

4.5.2 Anti-maloperation blocking mode

4.5.2.1 Integrated anti-maloperation mode I

In this mode, the anti-maloperation host makes full use of monitoring system platform. In combination of computer key as well as its encryption technique and computer communication technology, the operation rules are introduced into monitoring system. By combining software and hardware, the anti-maloperation function is improved, which can strictly prohibit maloperation of operators possibly occurred in the operation.

Compared to traditional anti-maloperation host, the anti-maloperation host in this mode adopts a mode closely integrated with monitoring system. The integration is expressed in following aspects:

1) Microcomputer anti-maloperation system and background system have the consistent data bus; anti-maloperation modules and other SCADA application modules obtain data from the same real-time database;

2) Microcomputers anti-maloperation system and SCADA have the unified database configuration. Anti-maloperation data selecting measuring point and edits anti-maloperation properties (i.e. open-close rules, operational tips etc.) directly from SCADA;

3) Microcomputers anti-maloperation system and SCADA have the unified picture. The pictures of automation system can be directly used as proofing pictures, without re-making;

4) Microcomputer anti-maloperation system and measuring & control device of bay level share the operation rule base.

In a word, anti-maloperation system and SCADA have the unified data bus, unified database configuration and unified picture editing. Anti-maloperation system and measuring & control device of bay level share the operation rule base. Compared to traditional mode, this mode has eliminated repeated configuration, the system architecture is simpler, and maintenance is more convenient.

In this mode, the electrical operation process is: Simulated operation ticket issuing, simulates unlocking operation under blocking condition at rehearsal.

As it is seen, the whole electrical operation process is under the strict blocking condition of anti-maloperation host, computer key, anti-maloperation locks and measuring & control device of bay level. Operators are forced to make operation according to the operation sequence checked by anti-maloperation rule, so that the whole anti-maloperation system can realize all-around anti-maloperation blocking in software and hardware.

4.5.2.2 Integrated anti-maloperation mode II

Compared to integrated anti-maloperation mode, the largest difference from this pattern lies in local operating circuit blocking mechanism:

1) Not use anti-maloperation locks to make local operating blocking, not provide computer key;

2) Local operating blocking is realized by blocking node output from I/O BCU of bay level.

From the aspect of operating circuit, the difference from mode I is that removing “I/O blocking contact” to local operating circuit and substituting anti-maloperation lock with I/O BCU blocking contact of bay level to make local operation blocking.

Use difference from mode I: as the opening/closing of blocking contact of I/O BCU on bay level is judged in real-time according to rules, any unblocking operation is not required by manual in local operation (except abnormal operation).

To be noted that, as the computer key has no code matching function, if several devices of substation have no rules in local electrical operation or the rule of a certain time can be satisfied, the maloperation may be caused to the device. At this point, other methods can be used to meet requirements, for instance, strengthening electrical operation management of operators.

4.5.3 Independent anti-maloperation mode

Anti-maloperation system and SCADA are from different manufacturers. Our integrated monitoring system can match with independent anti-maloperation system by communication, and complete anti-maloperation blocking of station level. Communication protocol with independent anti-maloperation system can be extended so as to establish communication access with different anti-maloperation systems.

4.6 Setting operation management

SCADA provides functions of setting call, setting modification, setting zone switchover, and setting patrolling, and also realizes soft switch’s on and off, call and print of state value and analog quantity.

Click “Application” in the menu bar of HMI, and select “Secondary device management” in the drop-down list as following figure:

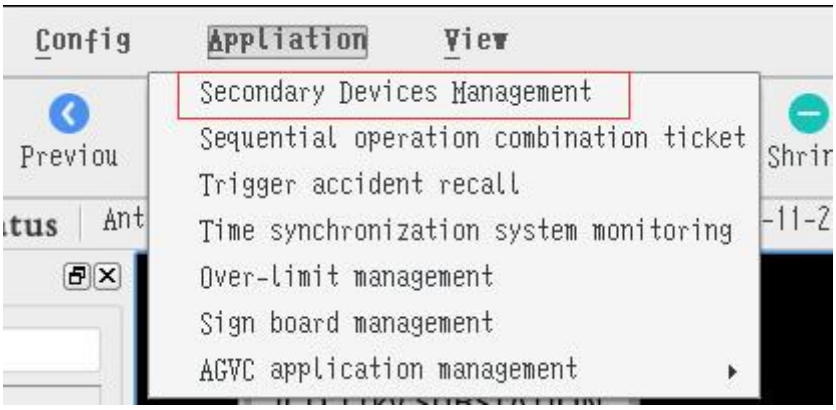


Figure 4.6.1Application

After clicking secondary device management, the following device management interface will display:

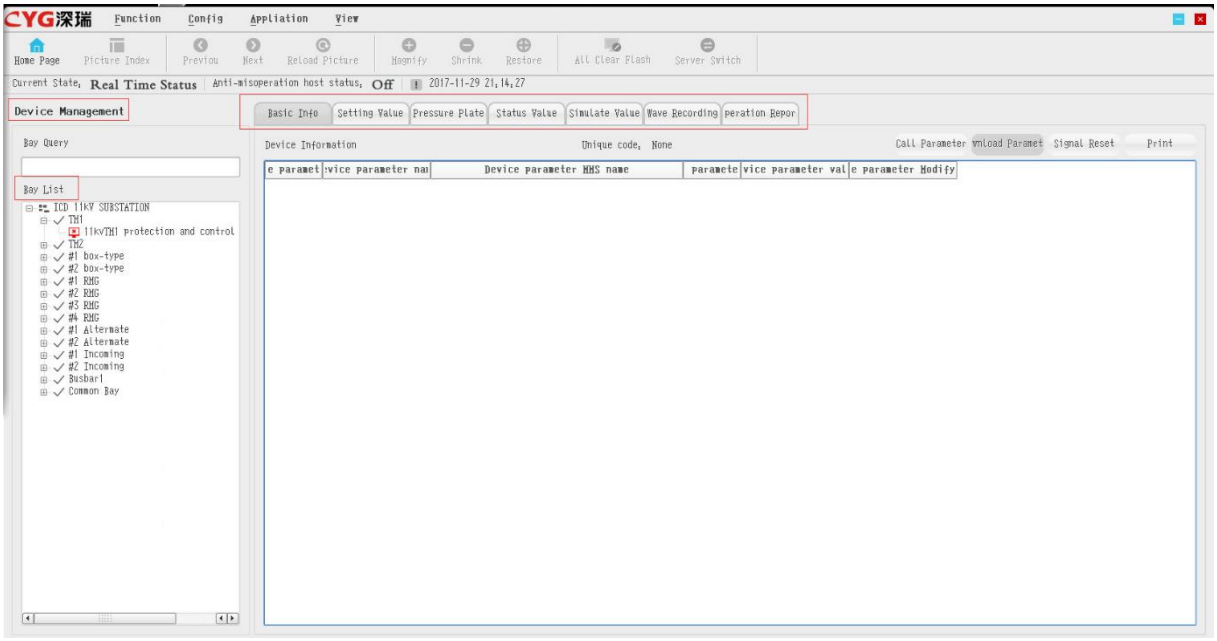


Figure 4.6.2 Secondary Device Management Interface

Left bay list: display all secondary devices in all bays. Left clicking means selection;

On the right side, the device parameter, setting, switch, state value and ananlog quantity can be selected successively;

1) Device parameter: retrieve the parameter information of protective, measuring and control device, download and print device parameters, and reset the signal of device, as shown in Figure 4.6.3.

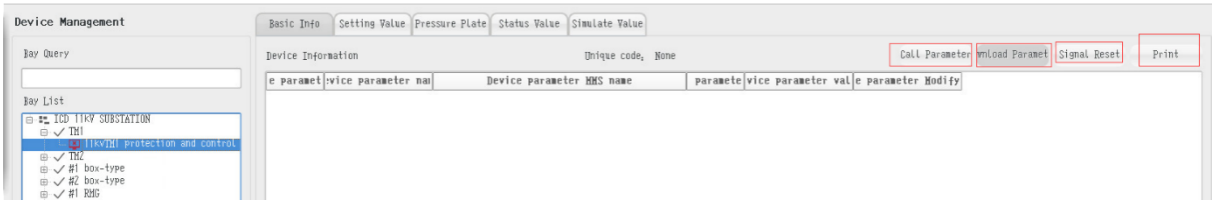


Figure 4.6.3 Device Parameter Management

2) Information management of setting zone: retrieve the setting zone information of protective device, switch the setting zone, output and print the information of setting zone as shown in Figure 4.6.4.

Figure 4.6.4 Setting Zone Information

3) Setting information management: call the setting of current zone and non-current zone, modify the setting, output and print the setting. The function are described as follows:

- Provide setting management function: setting call and modification etc.;
- Receive setting list;
- Provide protection verification at setting and modification display.
- See Figure 4.6.5.

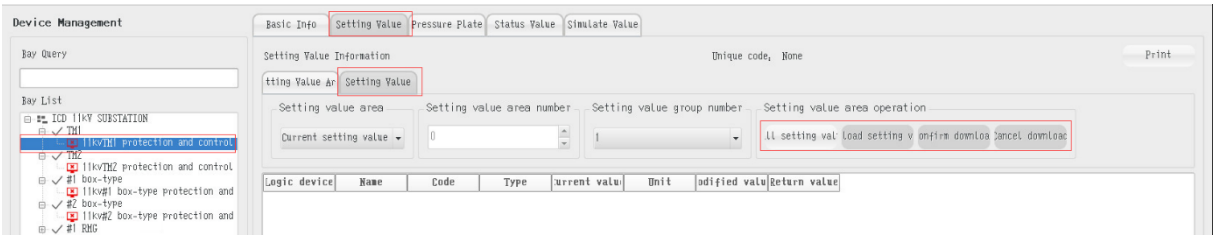


Figure 4.6.5 Constant Value Management

4) Provide switch state call and print function;

5) Provide retrieval of state value and analog quantity;

4.7 Control of voltage and reactive power

4.7.1 Overview

Voltage stability has great significance for national economic production and equipment life extension, while reducing reactive flow on line and power loss and realizing economic power supply is the target of every power supply sector. For this reason, with the load fluctuation, it is always very frequent that the substation has voltage and reactive regulation demands. If making regulation by manual intervention, one one hand, it will increase the burden of person on duty; on the other hand, it is hard to achieve regulation reasonableness by manual judgment.

With the improvement of integrated automation degree of substation, both sampling precision and signal response speed of system are greatly improved. The range of signals connected in different ways is greatly expanded than previous system. In the existing local monitoring system, the necessary conditions to realize automatic regulation of voltage and reactive power by software module control are theoretically fulfilled.

PRS-7000 integrated monitoring system provides reactive voltage control (VQC) function. The

VQC is integrated in the monitoring system, which realizes automatic regulation of voltage and reactive power in pure software. This software is applied to 10kV, 35kV, 110kV and 220kV substation, which can control 1~3 sets of two-winding transformer/three-winding transformer with same specification and 1~16 sets of shunt capacitive reactor, and realize integrated automation control for on-load voltage regulation and switching capative reactor banks.

VQC in monitoring system can automatically identify the primary wiring mode and operation mode of system, and take optimized measures according to system operation mode, working condition and specific site requirements so that the voltage and reactive power satisfy the setting range. In addition, the VQC has abundant blocking function to assure system safety. Users may flexibly set the corresponding remote signal as blocking signal as needed. For switching of capacitor banks, users can sefl-define the switchihng sequence.

4.7.2 Operating principle

The main method to regulate voltage and reactive power of substation is to regulate the main transformer tap and switched capative reactor bank. Regulation of tap and switched capative reactor has influcences on voltage and reactive power: up-regulation of tap, the voltage and reactive power will rise; down-regulation of tap, the voltage and reactive power will drop (it is positive for upshift and voltage rising, and opposite for upshift and voltage dropping); switching on capacitor, the reactive power will drop and the voltage will rise; switching off capacitor, the reactive power will rise and the voltage will drop; switching on reactor, the reactive power will rise and the voltage will drop; switching off reactor, the reactive power will drop and the voltage will rise (as the same operation to reactor and capacitor causes opposite result, the traditional capacitor will substitute reactor in following section).

As switching off capacitor is equivalent to switching on reactor, switching on capacitor is equivalent to switching off reactor. When the reactor and capacitor are on the same paralleled bus, in order to avoid repeating use, improve service life of device and save energy, the following rule will be used: if the capacitor has to be switched-on on the paralleled bus at a certain time, but the reactor has been operating on the bus, the reactor shall be switched off in priority. If disconnecting capacitor is required, the priority to remove capacity shall be given.

In the operation mode, the VQC considers that if any side of middle-voltage side or low-voltage side of main transformer is in paralleled operation and the main transformer switch correlated to paralleled bus is in operating, the main transformer will be in paralleling operation. In paralleling operation, the main transformer tap shall be kept on the same position. When regulating the main transformer tap, the regulation to main transformer shall be carried out simultaneously. All capative reactor banks related to paralleling main transformer can be regarded to connect to same bus and be switched on/off circularly.

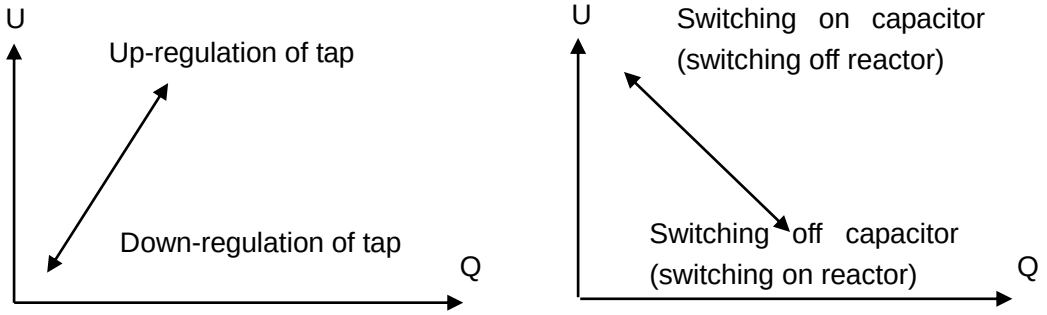


Figure 4.7.1 Influence of tap regulation and capacitor-reactor set switching on voltage and reactive power

VQC supports many control strategies. According to regional requirements, the control strategy can be divided into nine-zone graph method, fifteen-zone graph method and seventeen-zone graph method. Fifteen-zone and seventeen-zone graph method supports six patterns: consider voltage only, consider reactive power only, consider voltage in priority, consider reactive power in priority, comprehensive consideration and manual setting.

4.7.2.1 Nine-zone graph method

Nine-zone graph method means taking the corresponding control policy in nine zones. Nine-zone graph and relevant parameter definitions are as follows:

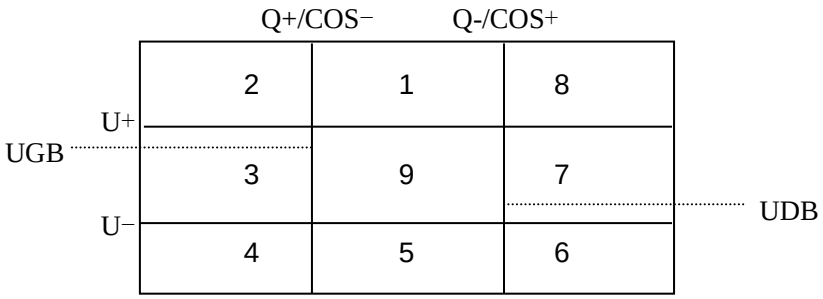


Figure 4.7.2 Nine-zone Graph

- **Voltage threshold-crossing**

1) U>U＋: voltage goes over upper limit

2) U<U－: voltage goes over lower limit

3) UGB=(U＋)－△Uq: voltage upper limit of zone-3 (△Uq is the maximum voltage change affected by switching on a set of capacitor)

4) UDB=(U－)＋△Uq: voltage lower limit of zone-7 (△Uq is the maximum voltage change affected by switching on a set of capacitor)

- **Reactive threshold-crossing**

Reactive threshold-crossing can judge based on reactive power or power factor. The upper limit value COS+ of power factor can be set to positive or negative: if positive, it is not allowed to compensate reactive power; if negative, it is allowed to compensate little reactive power.

1) Q>Q＋: reactive power goes over upper limit

2) Q<Q－: reactive power goes over lower limit

3) COS<COS－ and Q>0: power factor goes over lower limit

4) COS>COS＋ or Q<0: power factor goes over upper limit (COS＋ is positive)

5) COS<|COS＋| and Q<0: power factor goes over upper limit (COS＋ is negative)

➢ **Control strategy**

Control strategy of nine-zone graph is as following table (Number 1~9 corresponds to the position of represented bus of Figure 4.7.2 in nine-zone graph).

Table 4.7.1 Control Strategy of Nine-zone Graph

No.	Zone Description	Control Strategy
1	Voltage goes over upper limit. Reactive power/power factor is normal.	Normal mode: regulate down the tap. If the tap cannot be regulated, switch off the capacitor; Capacitor in priority mode: switch off the capacitor. If disconnecting capacitor will make reactive power/power factor over limit or there is no capacitor for disconnecting, then regulate the tap down. If the tap cannot be regulated, switch off the capacitor forcedly.
2	Voltage goes over upper limit. Reactive power goes over upper limit/power factor goes over lower limit.	Regulate the tap down. If the tap cannot be regulated, switch off the capacitor.
3	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	When voltage is less than UGB, switch on the capacitor. If no capacitor can be switched on, no operation will be made; When voltage is more than UGB, if there is regulable capacitor, regulate the tap down; or else no operation will be made.
4	Voltage goes over lower limit. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit in opposite direction or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
5	Voltage goes over lower limit. Reactive power/power factor is normal.	Normal mode: regulate up the tap. If the tap cannot be regulated, put on the capacitor; Capacitor in priority mode: switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
6	Voltage goes over lower limit. Reactive power goes over lower limit/power factor goes over upper limit.	Regulate the tap up. If the tap cannot be regulated, switch on the capacitor.
7	Voltage is normal. Reactive power goes over lower limit/power factor goes over upper limit.	When voltage is more than UDB, switch off the capacitor. If no capacitor can be switched off, no operation will be made; When voltage is less than UDB, if there is switchable capacitor, regulate the tap up; or else no operation will be made.
8	Voltage goes over upper limit. Reactive power goes over lower limit/power factor goes	Switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit in opposite direction or there is no capacitor for switching off, then regulate the tap up. If the tap cannot

	over upper limit.	be regulated, switch offthe capacitor forcedly.
9	Voltage is normal. Reactive power/power factor is normal.	If voltage on medium-voltage side goes over upper limit, regulate the tap down; If voltage on medium-voltage side goes over lower limit, regulate the tap up; If voltage on medium-voltage side is normal, no operation will be made.
Note: before implementing control strategy, this module will predict the regulation result based on given parameters. If reactive power/power factor on low-voltage side or voltage on low-voltage side goes over limit after regulation, the module will regulate action strategy or have no action.		

4.7.2.2 Fifteen-zone graph method

Fifteen-zone graph method means taking the corresponding control policy in fifteen zones. Fifteen-zone graph and relevant parameter definitions are as follows:

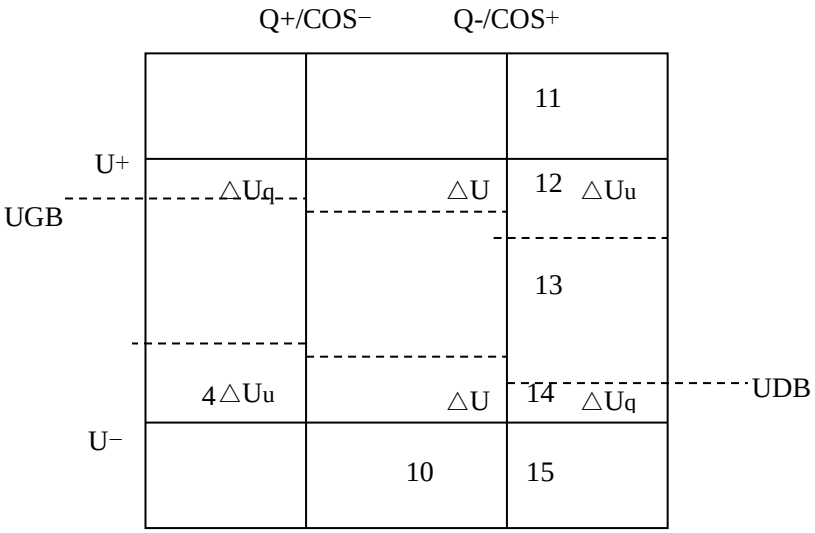


Figure 4.7.3 Fifteen-zone Graph

- **Voltage threshold-crossing**

1) U>U＋: voltage goes over upper limit

2) U<U－: voltage goes over lower limit

3) Uq: the maximum voltage change affected by switching on a set of capacitor

4) Uu: the maximum voltage change affected by regulating a gear of tap

5) U: the higher value of △Uq and △Uu

- **Reactive threshold-crossing**

Reactive threshold-crossing can judge based on reactive power or power factor. The upper limit

value COS+ of power factor can be set to positive or negative: if positive, it is not allowed to compensate reactive power; if negative, it is allowed to compensate little reactive power.

1) Q>Q＋: reactive power goes over upper limit

2) Q<Q－: reactive power goes over lower limit

3) COS<COS－ and Q>0: power factor goes over lower limit

4) COS>COS＋ or Q<0: power factor goes over upper limit(COS＋ is positive)

5) COS<|COS＋| and Q<0: power factor goes over upper limit (COS＋ is negative)

➢ **Control strategy**

Control strategy of fifteen-zone graph is as following table (Number 1~15 corresponds to the position of represented bus of Figure 4.7.3 in fifteen-zone graph).

When strategy 1 cannot be operated, adopt strategy 2. If manual setting of control strategy is selected, the control strategy can be set by manual.

Table 4.7.2 Control Strategy of Fifteen-zone Graph

Zone No.	Regulate voltage only		Regulate reactive power only		Voltage in priority		Reactive power in priority		Comprehensive consideration	
	Strategy 1	Strategy 2	Strategy 1	Strategy 2	Strategy 1	Strategy 2	Strategy 1	Strategy 2	Strategy 1	Strategy 2
1	Gear down	Switch off capacitor	Gear down	Switch on capacitor	Gear down	Switch off capacitor	Gear down	Switch on capacitor	Gear down	----
2	----	----	Switch on capacitor	Gear down	Gear down	----	Gear down	Switch on capacitor	Gear down	----
3	----	----	Switch on capacitor	----	Switch on capacitor	----	Switch on capacitor	----	Switch on capacitor	----
4	----	----	Switch on capacitor	----	Switch on capacitor	----	Switch on capacitor	----	Switch on capacitor	----
5	Switch off capacitor	Gear up	Switch on capacitor	----	Switch on capacitor	Gear up	Switch on capacitor	Gear up	Switch on capacitor	Gear up
6	Gear	Switch	----	----	Gear	Switch	Gear	Switch	Gear	Switch

	down	off capacitor			down	off capacitor	down	off capacitor	down	off capacitor
7	----	----	----	----	----	----	----	----	----	----
8	----	----	----	----	----	----	----	----	----	----
9	----	----	----	----	----	----	----	----	----	----
10	Gear up	Switch on capacitor	----	----	Gear up	Switch on capacitor	Gear up	Switch on capacitor	Gear up	Switch on capacitor
11	Switch off capacitor	Gear down	Switch off capacitor	----	Switch off capacitor	Gear down	Switch off capacitor	Gear down	Switch off capacitor	Gear down
12	----	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----
13	----	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----
14	----	----	Gear up	Switch off capacitor	Gear up	----	Gear up	Switch off capacitor	Gear up	----
15	Gear up	Switch on capacitor	Gear up	Switch off capacitor	Gear up	Switch on capacitor	Gear up	Switch off capacitor	Gear up	----

Elaboration of fifteen-zone voltage priority strategy is made as follows.

Table 4.7.3 Elaboration of Fifteen-zone Voltage Priority Control Strategy

Zone No.	Zone Description	Control Strategy
1	Voltage goes over upper limit. Reactive power goes over upper limit/power factor goes over lower limit.	Regulate the tap down. If the tap cannot be regulated, switch off the capacitor.
2	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	If there is regulable capacitor, regulate the tap down; or else no operation will be made.

3	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If there is no switchable capacitor, no operation will be made.
4	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If there is no switchable capacitor, no operation will be made.
5	Voltage goes over lower limit. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit in opposite direction or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
6	Voltage goes over upper limit. Reactive power/power factor is normal.	Normal mode: regulate down the tap. If the tap cannot be regulated, switch off the capacitor; Capacitor in priority mode: switch off the capacitor. If disconnecting capacitor will make reactive power/power factor over limit or there is no capacitor for disconnecting, then regulate the tap down. If the tap cannot be regulated, switch off the capacitor forcedly.
7	Voltage is normal. Reactive power/power factor is normal.	If voltage on medium-voltage side goes over upper limit, regulate the tap down; If voltage on medium-voltage side goes over lower limit, regulate the tap up; If voltage on medium-voltage side is normal, no operation will be made.
8	Voltage is normal. Reactive power/power factor is normal.	
9	Voltage is normal. Reactive power/power factor is normal.	
10	Voltage goes over lower limit. Reactive power/power factor is normal.	Normal mode: regulate up the tap. If the tap cannot be regulated, switch on the capacitor; Capacitor in priority mode: switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
11	Voltage goes over upper limit. Reactive power goes over lower limit/power factor goes over upper limit.	Switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit in opposite direction or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
12	Voltage is normal. Reactive power goes over lower limit/power factor goes over upper limit.	Switch off the capacitor. If there is no switchable capacitor, no operation will be made.
13	Voltage is normal. Reactive power goes over lower limit/power factor goes	Switch off the capacitor. If there is no switchable capacitor, no operation will be made.

	over upper limit.	
14	Voltage is normal. Reactive power goes over lower limit/power factor goes over upper limit.	If there is switchable capacitor, regulate the tap up; or else no operation will be made.
15	Voltage goes over lower limit. Reactive power goes over lower limit/power factor goes over upper limit.	Regulate the tap up. If the tap cannot be regulated, switch on the capacitor.
Note: before implementing control strategy, this module will predict the regulation result based on given parameters. If reactive power/power factor on low-voltage side or voltage on low-voltage side goes over limit after regulation, the module will regulate action strategy or have no action.		

4.7.2.3 Seventeen-zone graph method

Seventeen-zone graph method means taking the corresponding control strategy in seventeen zones. Seventeen-zone graph and relevant parameter definitions are as follows:

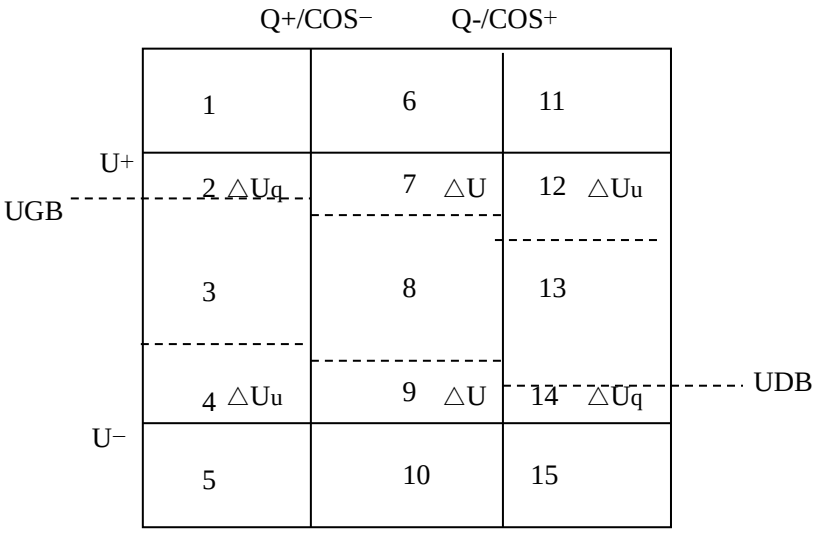


Figure 4.7.4 Seventeen-zone Graph

- **Voltage threshold-crossing**

1) U>U＋: voltage goes over upper limit

2) U<U－: voltage goes over lower limit

3) Uq: the maximum voltage change affected by putting on a set of capacitor

4) Uu: the maximum voltage change affected by regulating a gear of tap

- **Reactive threshold-crossing**

Reactive threshold-crossing can judge based on reactive power or power factor. The upper limit value COS+ of power factor can be set to positive or negative: if positive, it is not allowed to

compensate reactive power; if negative, it is allowed to compensate little reactive power.

1) Q>Q＋: reactive power goes over upper limit

2) Q<Q－: reactive power goes over lower limit

3) △Qq: the maximum reactive power change caused by switching on/off a set of capacitor, i.e. the largest capacity of capacitor

4) △Qu: the maximum reactive power change caused by regulating a gear of main transformer

5) COS<COS－ and Q>0: power factor goes over lower limit

6) COS>COS＋ or Q<0: power factor goes over upper limit (COS＋ is positive)

7) COS<|COS＋| and Q<0: power factor goes over upper limit (COS＋ is negative)

➢ **Control strategy**

Control strategy of seventeen-zone graph is as following table (Number corresponds to the position of represented bus of Figure 4.7.4 in seventeen-zone graph).

When strategy 1 cannot be operated, adopt strategy 2. If manual setting of control strategy is selected, the control strategy can be set by manual.

Table 4.7.4 Control Strategy of Seventeen-zone Graph

Action zone	Regulate voltage only		Regulate reactive power only		Voltage in priority		Reactive power in priority		Comprehensive consideration	
	Strategy 1	Strategy 2	Strategy 1	Strategy 2	Strategy 1	Strategy 1	Strategy 2	Strategy 1	Strategy 2	Strategy 1
1	Gear down	Switch off capacitor	----	----	Gear down	Switch off capacitor	Gear down	Switch off capacitor	Gear down	Switch off capacitor
10	Gear down	Switch off capacitor	----	----	Gear down	Switch off capacitor	Gear down	----	Gear down	----
11	Switch off capacitor	Gear down	----	----	Switch off capacitor	Gear down	Switch off capacitor	----	Switch off capacitor	----
2	Gear down	Switch off capacitor	Gear down	Switch on capacitor	Gear down	Switch off capacitor	Gear down	Switch on capacitor	Gear down	----
3	----	----	Switch	----	Switch	----	Switch	----	Switch	----

			on capacitor		on capacitor		on capacitor		on capacitor	
30	----	----	Switch on capacitor	Gear down	Gear down	----	Gear down	Switch on capacitor	Gear down	----
31	----	----	Switch on capacitor	----	Switch on capacitor	----	Switch on capacitor	----	Switch on capacitor	----
4	Switch on capacitor	Gear up	Switch on capacitor	----	Switch on capacitor	Gear up	Switch on capacitor	Gear up	Switch on capacitor	Gear up
5	Gear up	Switch on capacitor	----	----	Gear up	Switch on capacitor	Gear up	Switch on capacitor	Gear up	Switch on capacitor
50	Gear up	Switch on capacitor	----	----	Gear up	Switch on capacitor	Gear up	----	Gear up	----
51	Switch on capacitor	Gear up	----	----	Switch on capacitor	Gear up	Switch on capacitor	----	Switch on capacitor	----
6	Gear up	Switch on capacitor	Gear up	Switch off capacitor	Gear up	Switch on capacitor	Gear up	Switch off capacitor	Gear up	----
7	----	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----
70	----	----	Gear up	Switch off capacitor	Gear up	----	Gear up	Switch off capacitor	Gear up	----
71	----	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----	Switch off capacitor	----
8	Switch	Gear	Switch	----	Switch	Gear	Switch	Gear	Switch	Gear

	off capacitor	down	off capacitor		off capacitor	down	off capacitor	down	off capacitor	down
9	----	----	----	----	----	----	----	----	----	----

Elaboration of seventeen-zone voltage priority strategy is made as follows.

Table 4.7.5 Elaboration of Seventeen -zone Voltage Priority Control Strategy

Zone No.	Zone Description	Control Strategy
1	Voltage goes over upper limit. Reactive power/power factor is normal.	Normal mode: regulate down the tap. If the tap cannot be regulated, switch off the capacitor; Capacitor in priority mode: switch off the capacitor. If disconnecting capacitor will make reactive power/power factor over limit or there is no capacitor for disconnecting, then regulate the tap down. If the tap cannot be regulated, switch off the capacitor forcedly.
10	Voltage goes over upper limit. Reactive power/power factor is normal.	Regulate the tap down. If the tap cannot be regulated, switch off the capacitor.
11	Voltage goes over upper limit. Reactive power/power factor is normal.	Switch off the capacitor. If disconnecting capacitor will make reactive power/power factor over limit or there is no capacitor for disconnecting, then regulate the tap down. If the tap cannot be regulated, switch off the capacitor forcedly.
2	Voltage goes over upper limit. Reactive power goes over upper limit/power factor goes over lower limit.	Regulate the tap down. If the tap cannot be regulated, switch off the capacitor.
3	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If there is no switchable capacitor, no operation will be made.
30	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	If there is regulable capacitor, regulate the tap down; or else no operation will be made.
31	Voltage is normal. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If there is no switchable capacitor, no operation will be made.
4	Voltage goes over lower limit. Reactive power goes over upper limit/power factor goes over lower limit.	Switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit in opposite direction or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
5	Voltage goes over lower limit.	Normal mode: regulate up the tap. If the tap cannot be regulated,

	Reactive power/power factor is normal.	switch on the capacitor; Capacitor in priority mode: switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
50	Voltage goes over lower limit. Reactive power/power factor is normal.	Regulate up the tap. If the tap cannot be regulated, switch on the capacitor;
51	Voltage goes over lower limit. Reactive power/power factor is normal.	Switch on the capacitor. If connecting capacitor will make reactive power/power factor over limit or there is no capacitor for connecting, then regulate the tap up. If the tap cannot be regulated, switch on the capacitor forcedly.
6	Voltage goes over lower limit. Reactive power goes over lower limit/power factor goes over upper limit.	Regulate the tap up. If the tap cannot be regulated, switch on the capacitor.
7	Voltage is normal. Reactive power goes over lower limit/power factor goes over upper limit.	Switch off the capacitor. If there is no switchable capacitor, no operation will be made.
70	Voltage is normal. Reactive power goes over lower limit/power factor goes over upper limit.	If there is capacitor, for disconnecting, regulate the tap up; or else no operation will be made.
71	Voltage is normal. Reactive power goes over lower limit/power factor goes over upper limit.	Switch off the capacitor. If there is no switchable capacitor, no operation will be made.
8	Voltage goes over upper limit. Reactive power goes over lower limit/power factor goes over upper limit.	Switch off the capacitor. If disconnecting capacitor will make reactive power/power factor over limit in opposite direction or there is no capacitor for disconnecting, then regulate the tap down. If the tap cannot be regulated, switch off the capacitor forcedly.
9	Voltage is normal. Reactive power/power factor is normal.	If voltage on medium-voltage side goes over upper limit, regulate the tap down; If voltage on medium-voltage side goes over lower limit, regulate the tap up; If voltage on medium-voltage side is normal, no operation will be made.
Note: before implementing control strategy, this module will predict the regulation result based on given parameters. If reactive power/power factor on low-voltage side or voltage on low-voltage side goes over limit after regulation, the module will regulate action strategy or have no action.		

4.7.2.4 Blocking logic

- **Low-voltage bus blocking**

Low-voltage bus blocking will block the VQC regulation of whole bus, including regulation of main transformer and switching on/off of capacitor. If any section of parallel bus is blocked, other bus sections will also be blocked. When the medium-voltage side requires regulation, if there is blocking on the correlated low-voltage bus, the medium-voltage side shall not be regulated.

- Bit 01, configuration error blocking (modify configuration and reset): in the configuration of low-voltage bus, the signal is not configured or the signal has been deleted.
- Bit 03, remote signal blocking (auto reset): for blocking remote signal in the corresponding low-voltage bus, the auto reset remote signal meets blocking condition.
- Bit 04, remote signal blocking (manual reset): for blocking remote signal in the corresponding low-voltage bus, the manuual reset remote signal meets blocking condition.
- Bit 05, zero-sequence voltage blocking (auto reset): the zero-sequence voltage blocking of low-voltage bus is enabled, and zero-sequence voltage goes over limit.
- Bit 06, over-voltage and under-voltage blocking (auto reset): the voltage of low-voltage bus goes over limit.
- Bit 07, reactive threshold-crossing (auto reset): the reactive power of main transformer on the low-voltage bus goes over limit.
- Bit 08, no operating main transformer (auto reset): there is no main transformer operating in parallel bus.
- Bit 10, differential voltage blocking (auto reset): the voltage difference between maximum and minimum of parallel low-voltage bus exceeds the differential voltage constant.
- Bit 11, regulation failure blocking (manual reset): if the main transformer on parallel bus has been successfully regulated for three times, the capacitor has been successfully regulated for one time, and the change of voltage or reactive power is less than the minimum of voltage or reactive power on low-voltage side when regulating gear and switching on/off capacitor, the first section of parallel bus will be set as regulation failure blocking.

If the blocking information is converted to binary bit string, the meaning is described as follows (the least significant bit is the first bit):

Table 4.7.6 Low-voltage Bus Blocking Logic

Device	Bit	Meaning	Bit	Meaning	Remark
Low-voltage bus	1	Configuration error blocking	2		If any section of bus in several paralleled lines is blocked, the whole paralleled bus will be blocked.
	3	Remote signal blocking (auto reset)	4	Remote signal blocking (manual reset)	
	5	Zero-sequence voltage blocking	6	Overvoltage-undervoltageblocking	
	7	Reactive threshold-crossing	8	No operating main transformer	

	9		10	Differential voltage blocking	
	11	Regulation failure blocking (manual reset)	12		

➢ **Medium-voltage bus blocking**

Medium-voltage bus blocking will block the VQC regulation of whole bus, including regulation of main transformer and switching on/off of capacitor on related low-voltage bus of main transformer. If any section of parallel bus is blocked, other bus sections will also be blocked. When the low-voltage side requires regulation, if there is blocking on the correlated medium-voltage bus, the low-voltage side shall not be regulated.

- Bit 01, configuration error blocking (modify configuration and reset): in the configuration of medium-voltage bus, the signal is not configured or the signal has been deleted.
- Bit 03, remote signal blocking (auto reset): for blocking remote signal in the corresponding medium-voltage bus , the auto reset remote signal meets blocking condition.
- Bit 04, telecomand blocking (manual reset): for blocking remote signal in the corresponding medium-voltage bus, the manuual reset remote signal meets blocking condition.
- Bit 06, over-voltage and under-voltage blocking (auto reset): the voltage of medium-voltage bus goes over limit.
- Bit 08, no operating main transformer (auto reset): there is no main transformer operating in parallel medium-voltage bus.
- Bit 10, differential voltage blocking (auto reset): the voltage difference between maximum and minimum of parallel low-voltage bus exceeds the differential voltage constant.
- Bit 11, regulation failure blocking (manual reset): if the main transformer on parallel bus has been successfully regulated for three times, the capacitor has been successfully regulated for one time, and the change of voltage or reactive power is less than the minimum of voltage or reactive power on medium-voltage side when regulating gear and switching on/off capacitor, the first section of parallel bus will be set as regulation failure blocking.

If the blocking information is converted to binary bit string, the meaning is described as follows (the least significant bit is the first bit):

Table 4.7.7 Medium-voltage Bus Blocking Logic

Device	Bit	Meaning	Bit	Meaning	Remark
Medium-voltage bus	1	Configuration error blocking	2		If any section of bus in several paralleled lines is blocked, the whole paralleled bus will be blocked.
	3	Remote signal blocking (auto reset)	4	Remote signal blocking (manual reset)	
	5		6	Overvoltage-undervoltageblocking	

	7		8	No operating main transformer	
	9		10	Differential voltage blocking	
	11	Regulation failure blocking (manual reset)	12		

➢ **Main transformer blocking**

Main transformer blocking only blocks the regulation of main transformer. If any transformer in paralleled transformer is blocked, other main transformers will also be blocked.

- Bit 01, configuration error blocking (modify configuration and reset): in the configuration of main transformer, the signal is not configured or the signal has been deleted.
- Bit 03, remote signal blocking (auto reset): for blocking remote signal in the corresponding main transformer, the auto reset remote signal meets blocking condition.
- Bit 04, remote signal blocking (manual reset): for blocking remote signal in the corresponding main transformer, the manuual reset remote signal meets blocking condition.
- Bit 05, abnormal operation blocking (manual reset): when the main transformer regulation is on and VQC control is not made, the gears of main transformer have change.
- Bit 06, regulating times blocking (auto reset): the daily regulating times reach the maximum.
- Bit 07, reactive threshold-crossing (auto reset): the reactive power of main transformer goes over limit.
- Bit 08, disable blocking (auto reset): when the main transformer is deactivated, the medium-voltage side and low-voltage side are all deactivated.
- Bit 09. Overload/under-load (auto reset): the current of main transformer exceeds limited value.
- Bit 11, refusing operation blocking (manual reset): if the main transformer has been successfully regulated for three times (the device has implemented recheck) and the gear has no change, it is judged that the main transformer refuses operation.
- Bit 12, gear slipping blocking (manual reset): the main transformer has been successfully regulated, but the gear changes more than one.
- Bit 13, gear missing blocking: the gear between main transformers in parallel exceeds one gear per time.
- Bit 14, abnormal CB position of main transformer.
- Bit 15, the gears of main transformer reach limitation and cannot be regulated: the main transformer gears to be regulated have reached the limitation of regulation direction.
- Bit 16, regulation interval not reached: when the related main transformer and busbar group

meets regulation conditions, there is no other blocking and the regulation interval has not reached. Then the bit turn to 1.

If the blocking information is converted to binary bit string, the meaning is described as follows (the least significant bit is the first bit):

Table 4.7.8 Main Transformer Blocking Logic

Device	Bit	Meaning	Bit	Meaning	Remark
Main transformer	1	Configuration error blocking (restart, reset)	2		If any main transformer in several paralleled transformers is blocked, the other transformers correlated will be blocked. Abnormal operation means the action of controlled object not caused by VQC regulation.
	3	Remote signal blocking (auto reset)	4	Remote signal blocking (manual reset)	
	5	Abnormal operation blocking (manual reset)	6	Regulating times blocking	
	7	Reactive threshold-crossing	8	Disable blocking	
	9	Overload/under-load	10		
	11	Refusing operation blocking	12	Gear slipping blocking	
	13	Gear missing blocking	14	Abnormal CB position of main transformer	
	15	Gears of main transformer reach limitation and cannot be regulated	16	regulation interval not reached	

➢ **Capacitor blocking**

Capacitor blocking will only block the corresponding capacitor group.

- Bit 01, configuration error blocking (modify configuration and reset): in the configuration of capacitor, the signal is not configured or the signal has been deleted.
- Bit 03, remote signal blocking (auto reset): for blocking remote signal in the corresponding capacitor, the auto reset remote signal meets blocking condition.
- Bit 04, remote signal blocking (manual reset): for blocking remote signal in the corresponding capacitor, the manuual reset remote signal meets blocking condition.
- Bit 05, abnormal operation blocking (manual reset): when the capacitor regulation is on and VQC control is not made, the capacitor state has change.
- Bit 06, switching times blocking: the daily regulating times reach the maximum.
- Bit 11, refusing operation blocking (manual reset): if the switching operation has been successfully implemented (the device has implemented recheck) and the state has no change, it is judged that the capacitor refuses operation.
- Bit 12, abnormal CB position of capacitor.

If the blocking information is converted to binary bit string, the meaning is described as follows (the

least significant bit is the first bit):

Table 4.7.9 Capacitor Blocking Logic

Device	Bit	Meaning	Bit	Meaning	Remark
Capacitor	1	Configuration error blocking (restart, reset)	2		Abnormal operation means the action of controlled object not caused by VQC regulation.
	3	Remote signal blocking (auto reset)	4	Remote signal blocking (manual reset)	
	5	Abnormal operation blocking (manual reset)	6	Switching times blocking	
	7		8		
	9		10		
	11	Refusing operation blocking	12	Abnormal CB position of capacitor	

4.7.3 VQC configuration tool vqccfgtool

4.7.3.1 Function ON/OFF and Preset Commissioning

For operating VQC in the monitoring system, it shall make configuration in “VQC module” of “PRS7000 system setting” as shown in following figure:

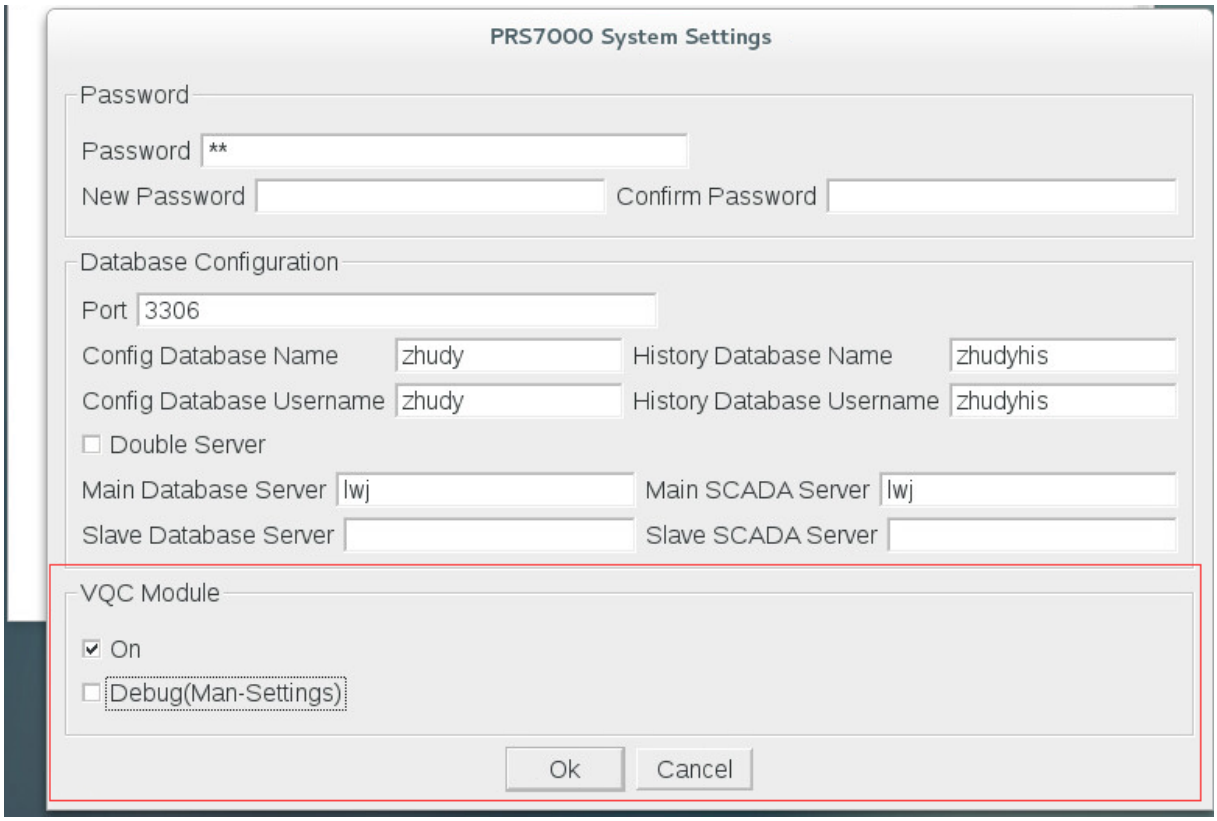


Figure 4.7.5 VQC module ON in system setting

There are two configurations related to background VQC.

1) ON. Only this option is selection, the VQC module in monitoring system will be put into

operation.

2) Commissioning (manual setting). Upon selecting this option, the VQC module in monitoring system will preferentially adopt manual setting as reactive regulation criterion. This option is generally used in commissioning or test. At VQC commissioning state, the return time of remote metering out-of-limit blocking will be reduced from 30s to 5s, and the return time of remote signal out-of-limit blocking will be reduced from 45s to 10s.

4.7.3.2 Monitoring signal configuration

There are several configurations related to monitoring system VQC module as follows:

1) Import the VQC template (VQC-V3.0.txt).

2) Configure the VQC device. The logic node shall be configured to server, and the direct connection property on the right can be freely configured but shall not conflict with existing direct connection device as shown in following Figure 4.7.6:

3) Configure the required four remotes of monitoring system in the bay configuration, such as blocking remote metering, current setting, bus operation section, remote control on/off etc.

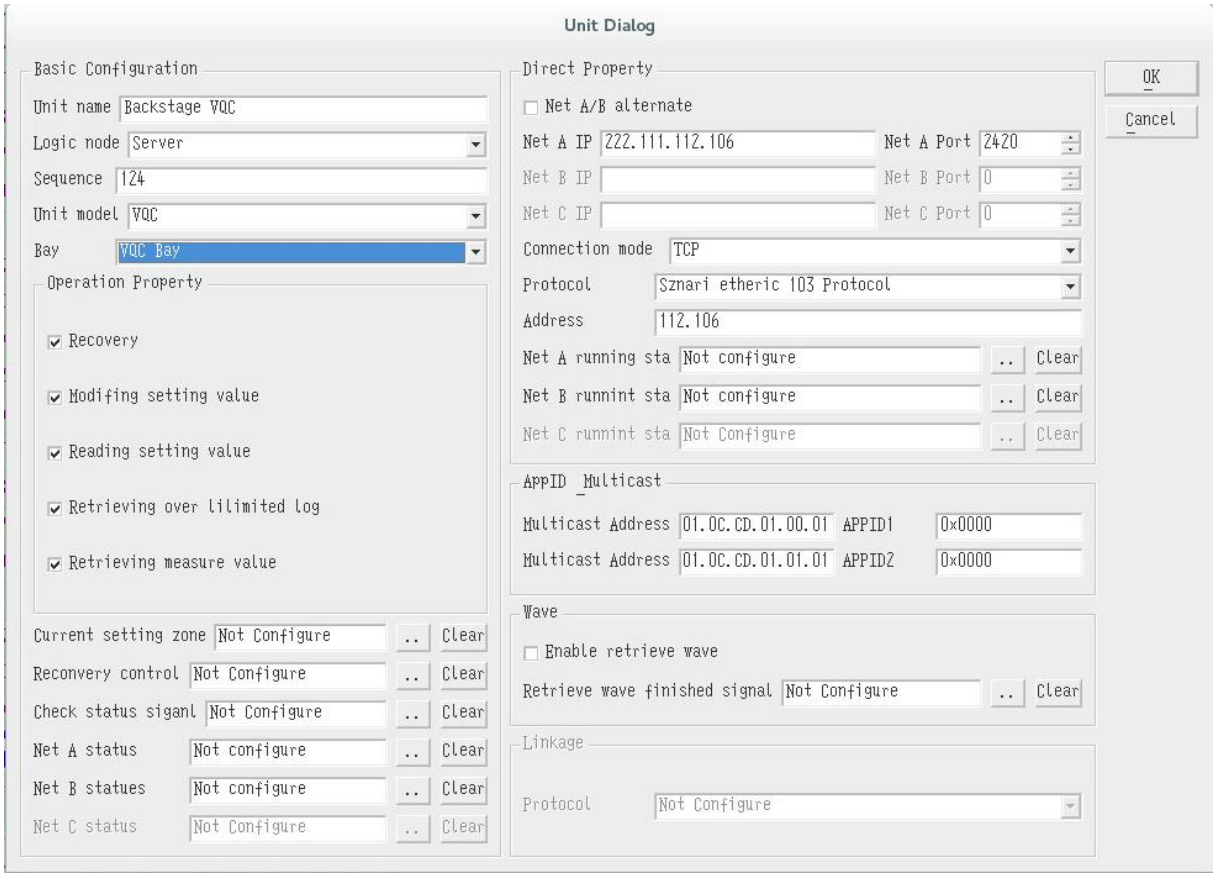


Figure 4.7.6 Configuration of VQC Secondary Devices

4.7.3.3 VQC parameter configuration

- **Monitoring System VQC Configuration**

Double clicking vqccfgtool icon under /home/PRS7000/bin, the following login dialog box will pop up:

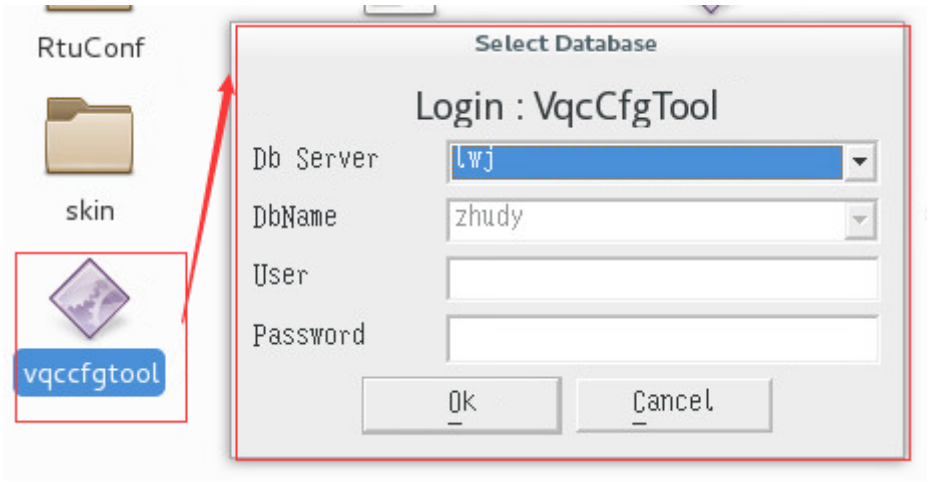


Figure 4.7.7 VQC Login

Enter username and password, and click login as shown in Figure 4.7.7:

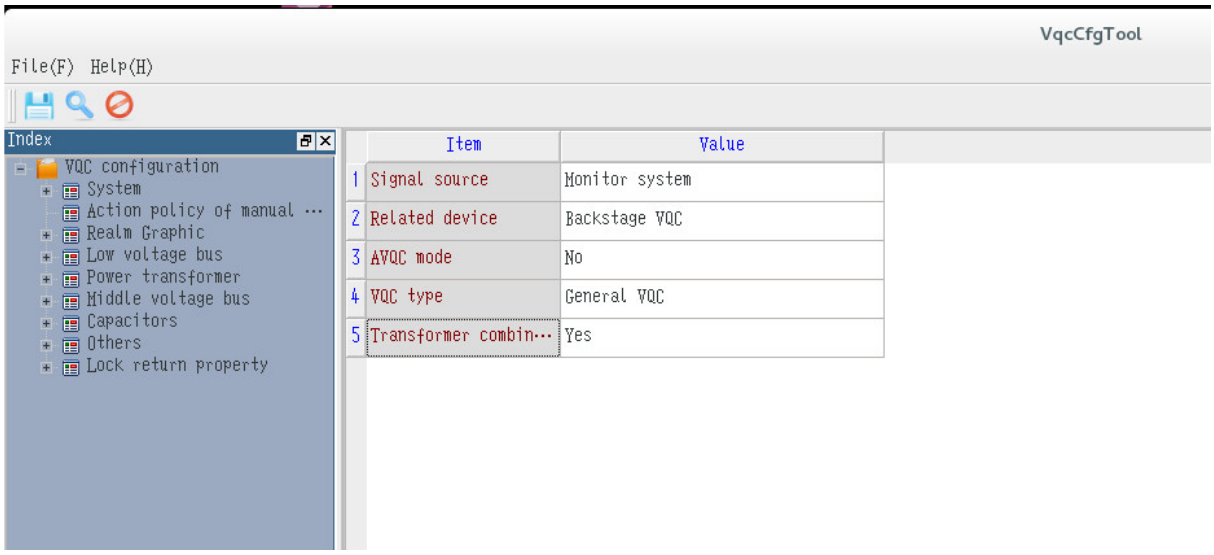


Figure 4.7.8 Configuration of VQC Signal Source and Correlated Device

Signal source: select “monitoring system” and determine the signal source of monitoring system VQC;

Correlated device: select VQC device configured in database configuration tool;

AVQC mode or not:

VQC type: select normal VQC or other VQC mode;

Joint commissioning of main transformer: provide joint commissioning of main transformer or not. If with main transformer, select “Yes”; otherwise, select “No”;

Toolbar is shown as follows:

Figure 4.7.9 Toolbar

 Save configuration: save all modified configurations;

 Check configuration: with this function, the VQC parameters can be provided with routine check, and the check result will be output in information prompt box;

 Close tool: clicking it, a prompt box will pop up. Selecting “Yes”, it will exit from VQC configuration tool;

VQC parameter configuration shall observe the following rules:

1) The signal source of VQC configuration node shall not be “None”;

2) Correlated device shall be VQC device, i.e. shall not be “none”. Module unit identification must be “VQC unit”;

3) The number of main transformer and bus shall be correct and consistent (1-1, 2-2, 3-3, 3-4);

4) When 3U0 blocking is on, the zero-sequence voltage on low-voltage bus must be configured;

5) In the order of switching on/off capacitor, the serial number of capacitor shall not exceed that of configured capacitor;

6) The capacitance sum of bus sections shall not exceed the maximum quantity of capacitor;

7) In the configuration of bus, the signals configuration shall have the consistent number as bus, and the signals configuration shall be integrated;

8) In the configuration of main transformer, the signals configuration shall have the consistent number as main transformer, and the signals configuration shall be integrated;

9) If the main transformer has medium-voltage side, the voltage and CB on medium-voltage side must be configured;

10) If the main transformer has dual branches, the parameter signal on each branch must be configured;

11) In the configuration of capacitance, the signals configuration shall have the consistent number as capacitor, and the signals configuration shall be integrated;

12) Medium-voltage bus configuration check depends on medium-voltage side. If there is

medium-voltage side, the corresponding signal on medium-voltage side shall be completelely configured;

13) A suspension time shall be configured in the zone graph parameter configuration. If the reactive power is judged as Cos, the range of Cos shall be correct;

- **System parameter setting**

System parameter settings contain the following items as shown in Figure 4.7.10:

1) Low-voltage bus number: the number of bus on low-voltage side of main transformer; the maximum number is four;

2) Main transformer number: the quantity of main transformer; the maximum number is three. The system will decide the primary system wiring mode based on the number of bus and main transformer (the wiring method applied to standard configuration is shown in Appendix, and the expansion may also be made according to project);

3) Reactive criterion: reactive/power factor. It means judging the reactive threshold-crossing, corresponding zone graph setting and parameter matching based on reactive power or power factor;

4) Main transformer gear mode: the way of influencing on voltage caused by transformer gear shift, including gear-up voltage-rising/gear-down voltage-rising;

5) Zone type: nine-zne, fifteen-zone and seventeen-zone are optional;

6) Priority mode: the operation object in priority when it is nine-zone, including capacitor priority/normal mode;

7) Control strategy: when it is fifteen-zone and seventeen-zone, it includes considering voltage only, considering reactive only, voltage priority, reactive priority, comprehensive consideration and manual setting;

8) The blocking switch of main transformer in parallel: not block/only block main transformer/block main transformer and capacitor. If only blocking main transformer is selected, it only blocks the main transformer regulation when main transformer is in parallel, and the capacitor can also be switched on/off. If blocking main transformer and capacitor is selected, the paralleled main transformer and related capacitor will not be provided with VQC regulation;

9) 3U0 blocking on/off: if it is on, the inspection on zero-sequence voltage of bus will be started. If the zero-sequence voltage threshold is exceeded, VQC regulation of bus will be blocked;

10) Zero-sequence over-voltage threshold on low-voltage side: the primary value of zero-sequence voltage threshold of bus, which can be self-defined as needed;

11) Over-voltage threshold on low-voltage side: when the bus voltage exceeds the value, it will block VQC regulation of bus;

12) Under-voltage threshold on low-voltage side: when the bus voltage is less than the value, it will block VQC regulation of bus;

13) Upper limit of reactive blocking: when the reactive power of main transformer exceeds this value, it will block VQC regulation of related bus;

14) Lower limit of reactive blocking: when the reactive power of main transformer is less than this value, it will block VQC regulation of related bus;

15) The maximum voltage variation on low-voltage side when regulating a gear of main transformer (△Uu): the maximum influence value caused to voltage of low-voltage side when regulating a gear of main transformer tap;

16) The maximum reactive variation when regulating a gear of main transformer (△Qu): the maximum influence value caused to reactive power of low-voltage side when regulating a gear of main transformer tap;

17) The maximum voltage variation on low-voltage side when switching on/off capacitor once (△Uq): the maximum influence value caused to voltage of low-voltage side when switching on/off capacitor once;

18) The maximum reactive variation when switching on/off capacitor once (△Qq): the maximum influence value caused to reactive power of low-voltage side when switching on/off capacitor once; this value shall be properly increased based on actual maximum capacity of capacitor (primary);

19) The maximum voltage variation on medium-voltage side when regulating a gear of main transformer: the maximum influence value caused to voltage of medium-voltage side when regulating a gear of main transformer tap;

20) The maximum voltage variation on medium-voltage side when switching on/off capacitor once: the maximum influence value caused to voltage of medium-voltage side when switching on/off capacitor once;

21) Daily gearshift times: the maximum that VQC shifts gears of each main transformer every day. If the daily shifting times of a main transformer exceed this value, it will block the daily VQC regulation of this main transformer. Generally the value is 10, and can also be set as necessary;

22) Daily switching times: the maximum that VQC makes switching to each capacitor bank every day. If the daily switching times of a capacitor bank exceed this value, it will block the daily VQC regulation of this capacitor bank. Generally the value is 10, and can also be set as necessary;

23) Remote metering confirmation time (s): it means the time required for confirming remote metering when deciding VQC operation region, used to avoid fluctuation of remote metering data. Generally the value is 30s;

24) Regulation interval (minute): the interval between any two regulations of a main transformer and busbar group, including interval between main transformers, capacitors and between capacitor and main transformer. The interval is suggested to above 5 minutes;

25) Gearshifting interval of main transformer (minute): the interval between two regulations of a main transformer and busbar group. If the main transformer regulation is required and the interval time is not reached, the action will not be made temporarily. The interval is suggested to be 15 minutes;

26) Switching interval of capacitor (minute): the interval between two switchings of capacitor in a main transformer and busbar group. If the capacitor switching is required and the interval time is not reached, the action will not be made temporarily. The interval is suggested to be 15 minutes;

27) Reverse gearshifting interval (minute): the interval of reverse regulation of main transformer in a main transformer and busbar group. It shall be bigger than gearshifting interval of main transformer. The interval is suggested to be 20 minutes;

28) Reverse switching interval (minute): the interval between two switchings of capacitor in a main transformer and busbar group. It shall be bigger than switching interval of capacitor. The interval is suggested to be 20 minutes;

29) The minimum voltage variation on low-voltage side caused by gearshifting/switching: the minimum voltage change on the low-voltage side of bus when regulating a gear of main transformer tap or swiching a capacitor bank. If the voltage variation of bus before and after VQC regulation (consecutively shift gear of main transformer for three times, and switch capacitor once) is less than set value, it is considered that the bus regulation is failed, and it will block VQC regulation of bus. It is mainly used to prevent constant VQC regulation due that the acquisition of bus voltage is wrong;

30) The minimum voltage variation on medium-voltage side caused by gearshifting/switching: the minimum voltage change on the medium-voltage side of bus when regulating a gear of main transformer tap or swiching a capacitor bank. If the voltage variation of bus before and after VQC regulation (consecutively shift gear of main transformer for three times, and switch capacitor once) is less than set value, it is considered that the bus regulation is failed.

31) The minimum reactive variation caused by gearshifting/switching: the minimum reactive change when regulating a gear of main transformer tap or swiching a capacitor bank. If the reactive variation before and after VQC regulation (consecutively shift gear of main transformer for three times, and switch capacitor once) is less than set value, it is considered that the bus regulation is failed, and it will block VQC regulation of bus. It is mainly used to prevent constant VQC regulation due that the acquisition of reactive power of main transformer is wrong;

32) Capacitor switching sequence: the sequence of cycled switching of capacitor. When the bus has to switch capacitor bank, it will select switchable capacitors in switching sequence for operation. If the number of capacitor is N, the first N capacitor shall be set only.

33) Is there medium-voltage side: main transformer has medium-voltage side or not. If there is medium-voltage side but the voltage control is not required, it can be set to “None”;

34) Medium-voltage side blocking low-voltage side: if the control policy adopted to met

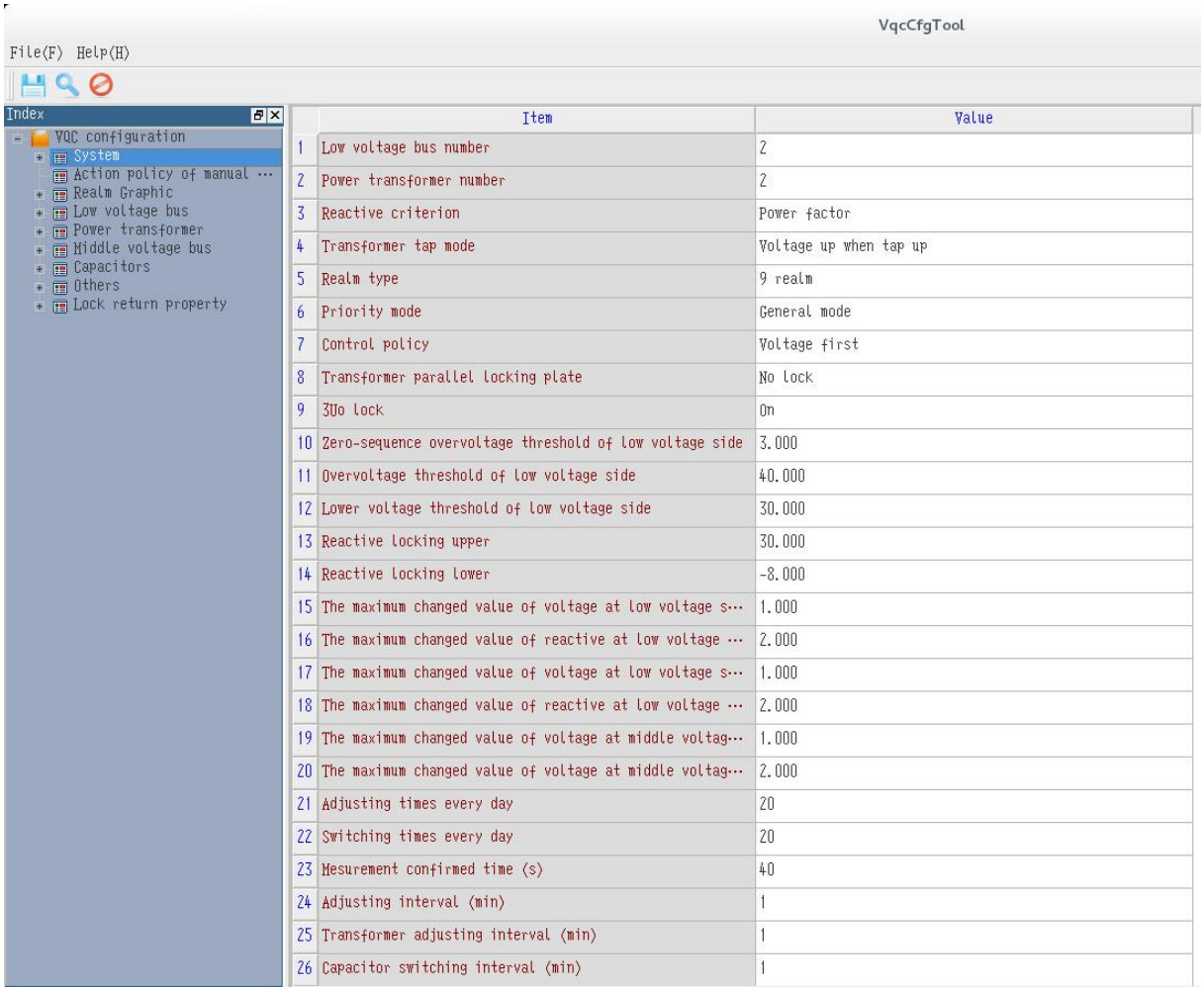
requirements of low-voltage side will cause over-voltage or under-voltage on medium-voltage side, the device will select other control policies or will not have action;

35) Over-voltage threshold on medium-voltage side: if the bus voltage is more than this value, it will block VQC regulation of bus;

36) Under-voltage threshold on medium-voltage side: if the bus voltage is less than this value, it will block VQC regulation of bus;

37) Regulation of medium-voltage side: when the low-voltage side falls in normal range, the main transformer tap can be regulated so that the medium-voltage side meets requirement;

38) Low/medium dropout blocking threshold: when the voltage difference of paralleled bus is larger than this value, it will block VQC regulation of bus.



	Item	Value
1	Low voltage bus number	2
2	Power transformer number	2
3	Reactive criterion	Power factor
4	Transformer tap mode	Voltage up when tap up
5	Realm type	9 realm
6	Priority mode	General mode
7	Control policy	Voltage first
8	Transformer parallel locking plate	No lock
9	3Uo lock	On
10	Zero-sequence overvoltage threshold of low voltage side	3.000
11	Overvoltage threshold of low voltage side	40.000
12	Lower voltage threshold of low voltage side	30.000
13	Reactive locking upper	30.000
14	Reactive locking lower	-8.000
15	The maximum changed value of voltage at low voltage s···	1.000
16	The maximum changed value of reactive at low voltage ···	2.000
17	The maximum changed value of voltage at low voltage s···	1.000
18	The maximum changed value of reactive at low voltage ···	2.000
19	The maximum changed value of voltage at middle voltag···	1.000
20	The maximum changed value of voltage at middle voltag···	2.000
21	Adjusting times every day	20
22	Switching times every day	20
23	Mesurement confirmed time (s)	40
24	Adjusting interval (min)	1
25	Transformer adjusting interval (min)	1
26	Capacitor switching interval (min)	1

Figure 4.7.10 System Parameter Setting

- **Configuration of manual setting of action strategy**

When “control strategy” in system parameter is “manual setting”, the manual setting configuration node of corresponding zone will display under operation strategy manual configuration nodes as Figure 4.7.11:

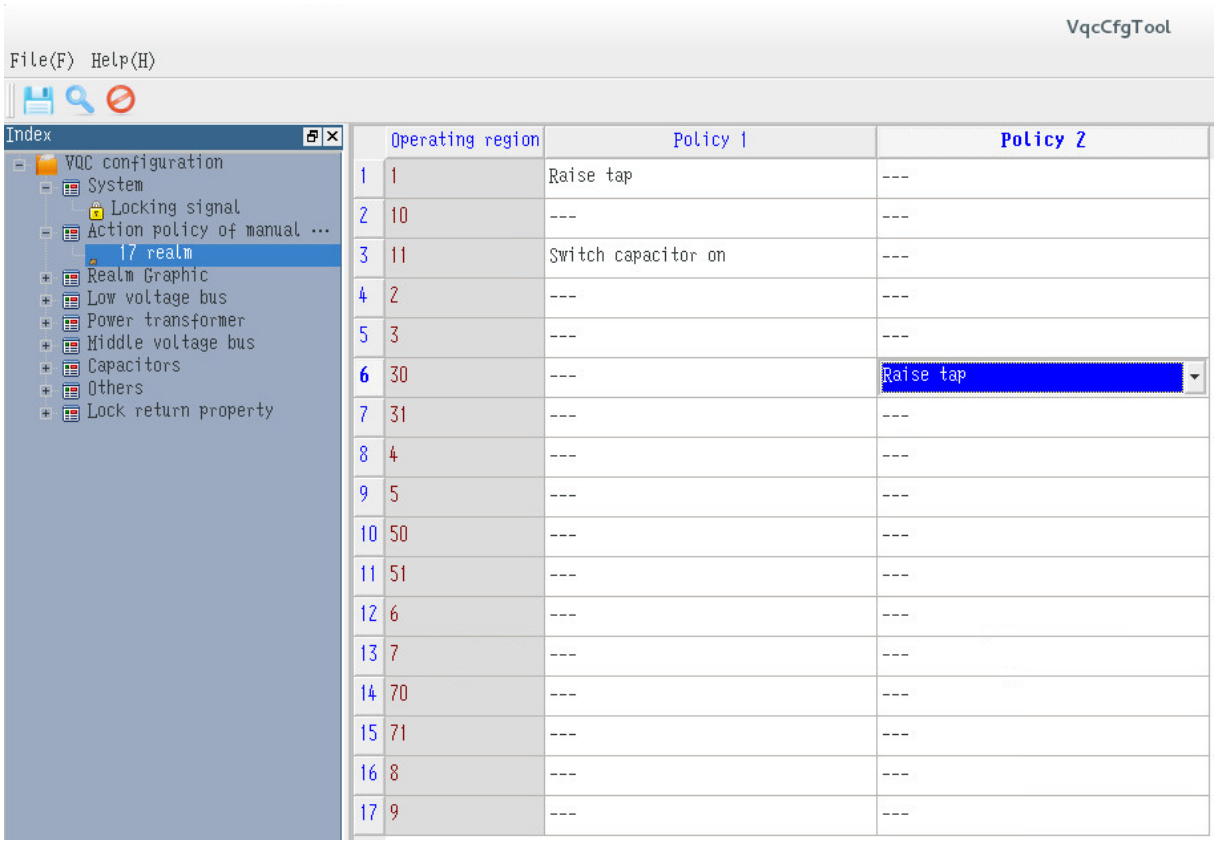


Figure 4.7.11 Configuration of Manual Setting of Operation Strategy

➢ Zone graph configuration

Zone graph parameters are all primary value. There are 48 groups. Each group corresponds to a time range. User can set the ending time of time range of each group. The starting time is the ending time of previous group as shown in Figure 4.7.11:

1) Voltage upper limit on low-voltage side (U+), voltage lower limit on low-voltage side (U-): it can be self-defnied as necessary, but the maximum upper limit of voltage cannot exceed over-voltage threshold of low-voltage side, and the minimum lower limit of voltage cannot be less than under-voltage threshold of low-voltage side;

2) Cos-/Q+, Cos+/Q-: it refers to reactive crossing upper limit/power factor lower limit and reactive crossing lower limit/power factor upper limit respectively. The upper limit of power factor can be negative, indicating compensating reactive is allowed. If the reactive criterion is reactive, it shall be consistent with the unit of reactive signal in the main transformer configuration;

3) Voltage upper limit on medium-voltage side (U+), voltage lower limit on medium-voltage side (U-): it can be self-defnied as necessary, but the maximum upper limit of voltage cannot exceed over-voltage threshold of medium-voltage side, and the minimum lower limit of voltage cannot be less than under-voltage threshold of medium-voltage side;

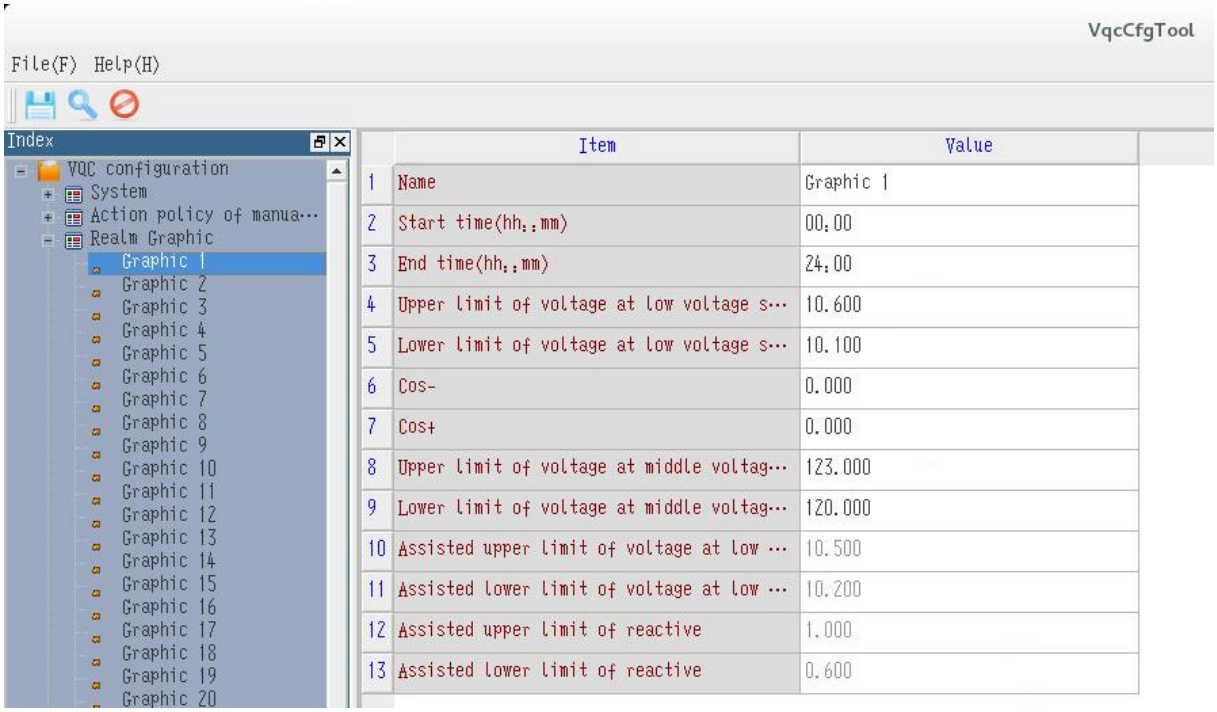


Figure 4.7.12 Zone Graph Configuration

- **Low-voltage bus configuration**

Bus configuration is started from bus 1. If there are N buses only, the parameter configuration of bus 1~N is only required as Figure 4.7.13. Parallels caused by buscouple connecting among bus and main transformer paralleling are called as bus paralleling.

1) Number of capacitor bank: the controllable actual capacitor banks on this bus;

2) Bus voltage: the actual record after dragging is the corresponding remote metering table ID of remote metering signal of busbar voltage in SCADA system database configuration tool;

3) Zero-sequence voltage: the configuration is same to busbar voltage;

4) Buscouple CB: the actual record after dragging is the corresponding remote signal table ID of remote signal of buscouple CB in SCADA system database configuration tool;

5) Buscouple disconnector 1: the actual record after dragging is the corresponding remote signal table ID of remote signal of buscouple disconnector 1 in SCADA system database configuration tool;

6) Buscouple disconnector 2: the actual record after dragging is the corresponding remote signal table ID of remote signal of buscouple disconnector 2 in SCADA system database configuration tool;

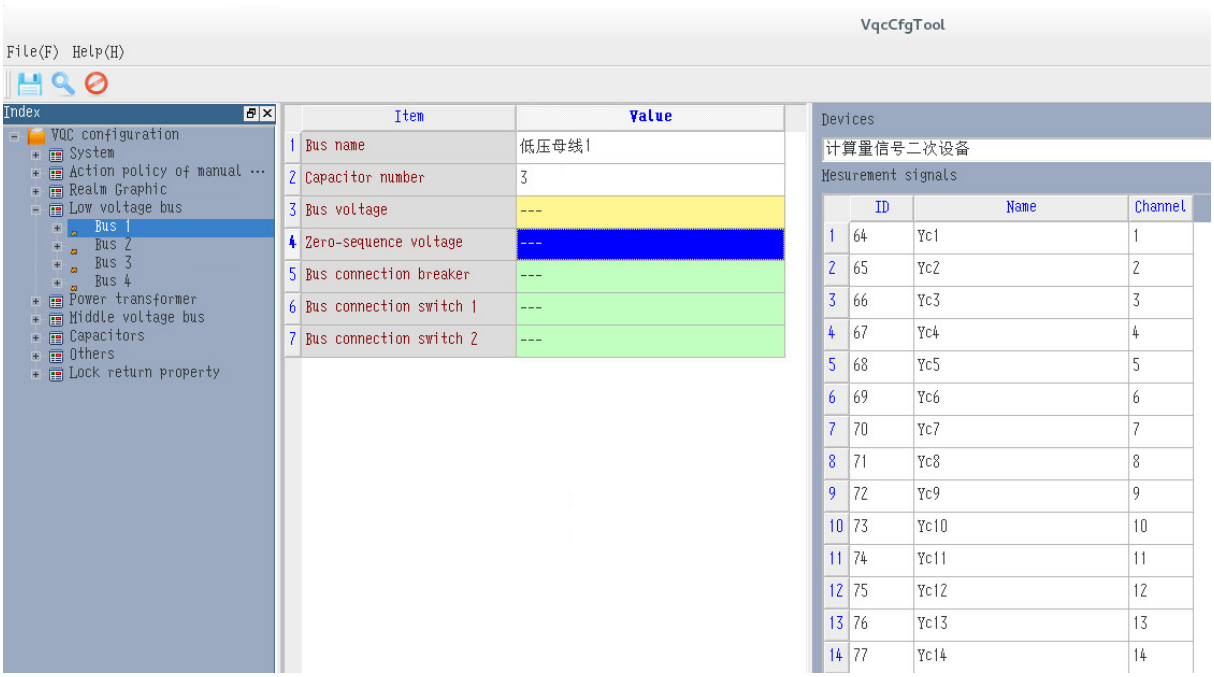


Figure 4.7.13 Bus Configuration

- **Medium-voltage bus configuration**

Bus configuration is started from bus 1. If there are N buses only, the parameter configuration of bus 1~N is only required as Figure 4.7.14. Parallels caused by buscouple connecting among bus and main transformer paralleling are called as bus paralleling.

1) Bus voltage: the actual record after dragging is the corresponding remote metering table ID ofremote signal of busbar voltage in SCADA system database configuration tool;

2) Buscouple CB: the actual record after dragging is the corresponding remote signal table ID of remote signal of buscouple CB in SCADA system database configuration tool;

3) Buscouple disconnector 1: the actual record after dragging is the corresponding remote signal table ID of remote signal of buscouple disconnector 1 in SCADA system database configuration tool;

4) Buscouple disconnector 2: the actual record after dragging is the corresponding remote signal table ID of remote signal of buscouple disconnector 2 in SCADA system database configuration tool;

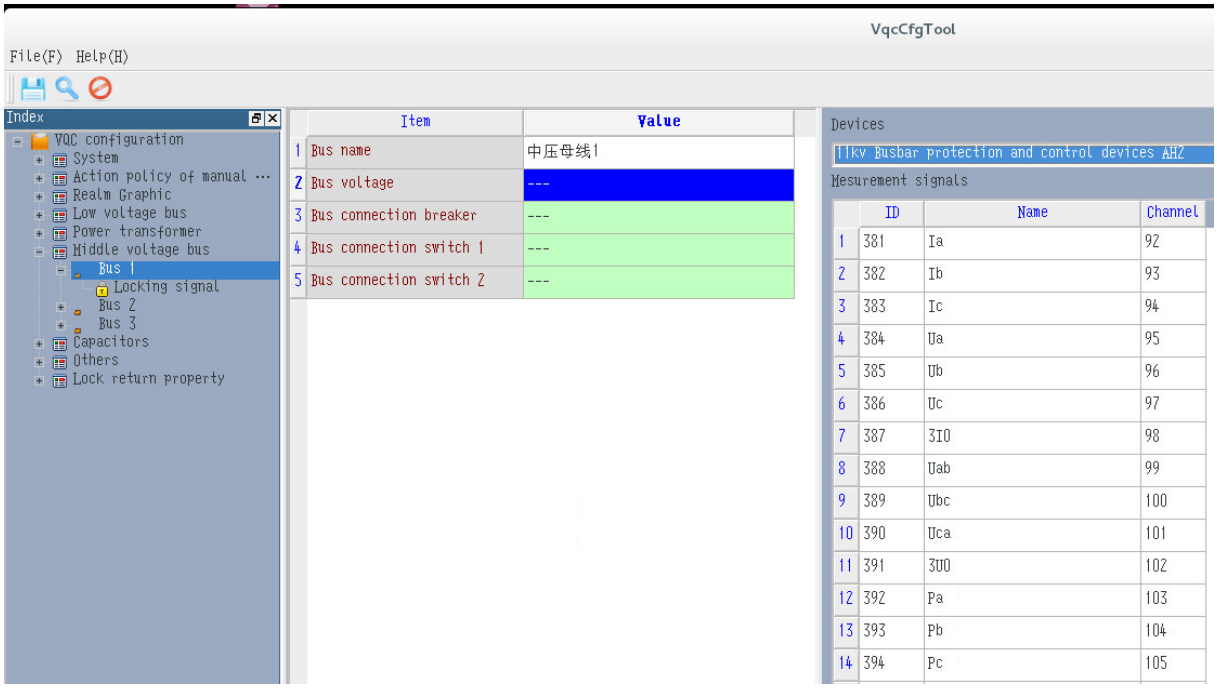


Figure 4.7.14 Bus Configuration

➢ Transformer configuration

Transformer configuration is started from transformer 1. If there are N transformers only, the parameter configuration of transformer 1~N is only required as Figure 4.7.15. If there is main transformer operating on any bus section of medium-voltage side or low-voltage side of main transformer and running in parallel by buscouple CB, it is called as main transformer in parallel.

1) Transformer current signal: the position of current flowing through transformer in remote metering database (ID number);

2) Transformer gear signal: the position of telemetering quantity of transformer gear in remote metering database (ID number);

3) Tap remote control signal: the position of corresponding remote regulating quantity of transformer in remote control database (ID number);

4) There is medium-voltage side or not: the transformer has medium-voltage bus or not.

5) High, low and medium side CB signal of transformer: the position of high, low and medium side CB as well as disconnector closing signal in remote signal database (ID number). The device will judge the main transformer is operating or not according to high and low side transformer signal. If the high or low side transformer signal is at opening position, it is considered that the main transformer is out of operation, and the regulation of main transformer will be blocked. medium side transformer signal is used to judge the medium-voltage side is operating or not. If the medium side transformer signal is in opening position, the voltage on medium-voltage side will not be regulated;

6) There is emergency stop or not: Yes/No. If the main transformer is not connected to

emergency control contact, it shall select “No”. In this case, if the main transformer has voltage-regulation and gear-shift, the emergency stop command will not be sent, so that other switches will not be controlled incorrectly;

7) Number of branch: if there are two branches, and active, reactive and power factor are respectively from two branches, then the number of branch will be 2. The device will calculate the active, reactive and power factor of main transformer based on reactive and active power of two branches. If the control targets to high side transformer reactive power or there is only a branch on low-voltage side, then the number of branch will be 1;

8) Active 1, active 2, reactive 1, reactive 2, Cos1, Cos2 signal of main transformer: refer to the number of remote metering quantity on two branches. If the branch number is 1, then the active 2, reactive 2 and Cos2 signal of transformer cannot be set;

9) Action detection time: the time that the system detects position change of main transformer after sending gearshift command. If the gear has no change within the time, it is considered that the change of position is failed. If the position changes more than one gear, it is considered that the gear is slipped. It is suggested that the time will be maximum time required for changing a position on site plus a certain margin.

10) Lowest/highest position: the actual lowest/highest position of main transformer. It is a basiss to judge the regulation of main transformer available or not;

11) Maximum/minimum operating current: the maximum operating current means the maximum current on the high-voltage side of transformer. If the operating current of transformer exceeds this value, it is considered to over-load, and it will block the VQC regulation of relevant main transformer. The minimum operating current means the minimum current on the high-voltage side of transformer. If the operating current of transformer is less than this value, it is considered to under-load, and it will block the VQC regulation of relevant main transformer. Settings may be self-defined as necessary.

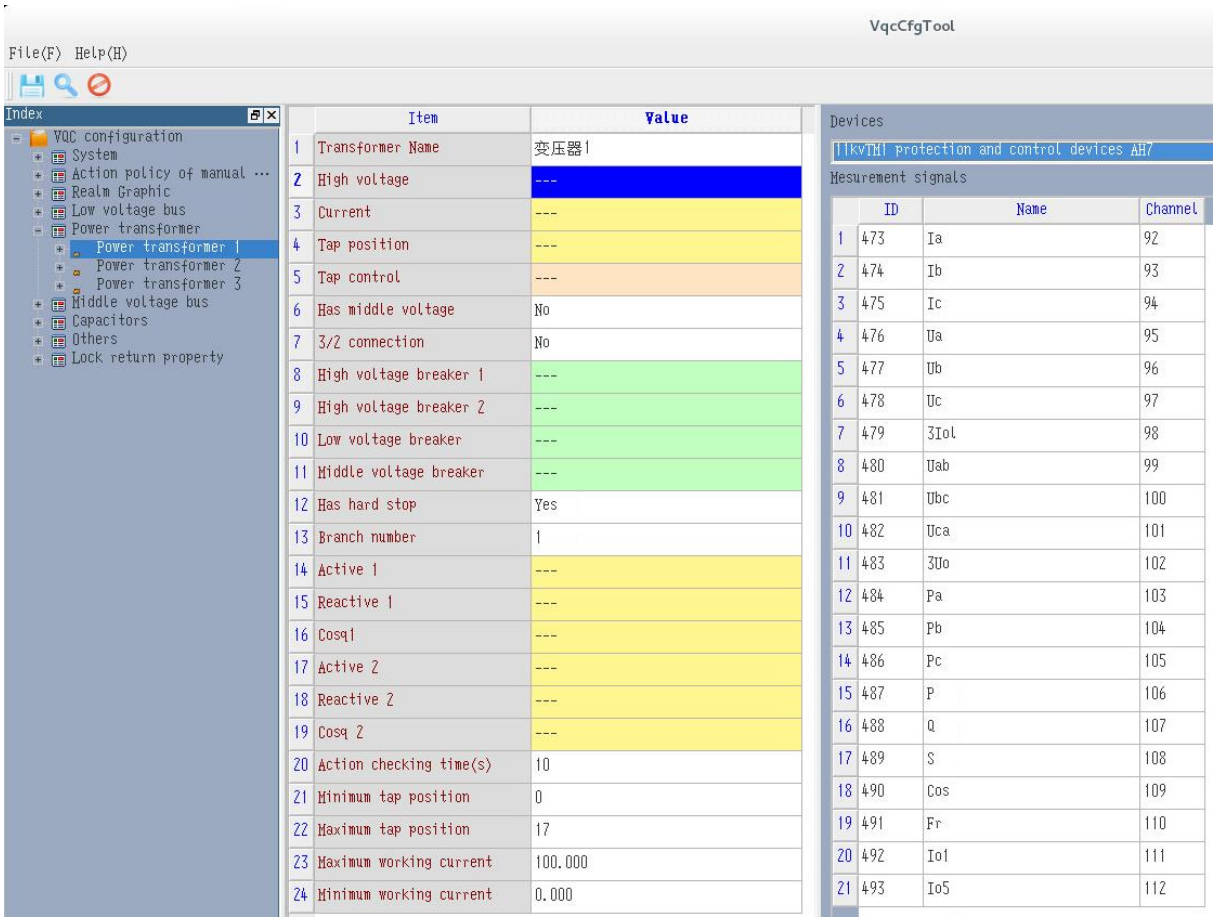


Figure 4.7.15 Transformer Configuration

- **Capacitor Configuration**

The capacitor to be configured will be numbered from 1 in the order of bus. The number will be the sum of all busbar capacitors continuously, as shown in Figure 4.7.16:

CB signal of capacitor: the position of closing signal of corresponding CB of capacitor in the remote signal database (ID number)

Remote control signal of capacitor: the position of remote control signal of corresponding CB of capacitor in the remote control database (ID number)

Rules of capacitor switching-on:

1) If a reactor can be removed, it shall disconnect reactor in priority;

2) Re-arrange the capacitor and reactor according to adequate capacity, small capacity and capacity out-of-limit. Each line will be divided into three sub-lines;

3) Sequence the capacitor and reactor queue with adequate capacity, small capacity and capacity out-of-limit based on daily switching times. Arrange the one with fewer switching in front, and form a final queue;

4) In this case, there are six queues. Under the condition that the capacitor is not forcedly switched on, find the first capacitor or reactor in the queue with adequate capacity and small

capacity. Under the forced switching on/off condition, incorporate the queue with capacity out-of-limit into options;

5) After the capacitor refuses action for the first time, if the operation condition is not changed, this capacitor will be operated again until operation is refused.

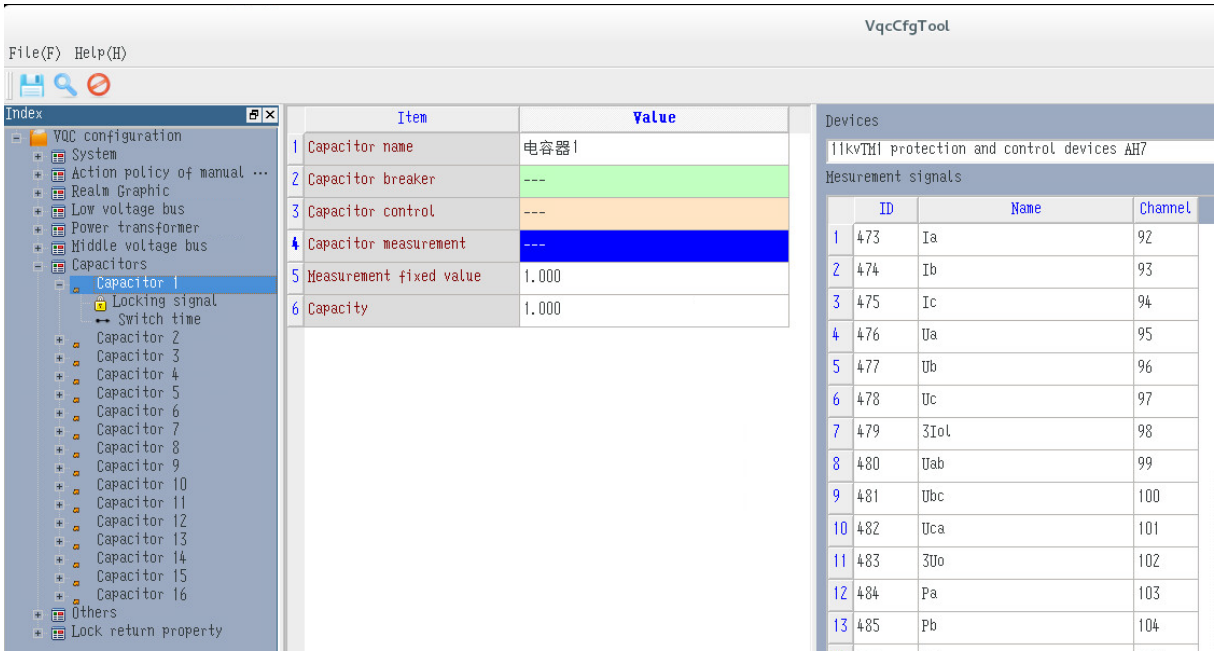


Figure 4.7.16 Capacitor Configuration

➢ **Blocking remote signal configuration**

Each object (system parameter, bus, main transformer, and capacitor) can be configured with 12 remote signals as blocking signal. Wherein, the blocking generated from first six signals will be auto reset after returning, and the blocking generated from later six signal must be manually reset, as shown in Figure 4.7.17:

1) Relative signal: the position of blocking signal in remote signal database (ID);

2) Blocking value: closing/opening position, referring to the state value when the blocking signal has effect. Opening position means the signal is blocked at opening state; closing position means the signal is blocked at closing state;

Description of blocking remote signal type:

1) Total blocking signal will block all VQC operations. Accident total signal can be served as total blocking signal.

2) Bus blocking signal will block all VQC operations on the whole busbar. It is suggested to use bus protection action signal, communication failure signal of bus & relative main transformer and capacitor acquisition device as bus blocking signal.

3) Main transformer blocking signal will block the current main transformer or paralleled main transformer. It is suggested to use disconnector closing position on both sides of main transformer

switch, protective action signal of main transformer, local operation signal of remote regulating as the blocking signal of main transformer.

4) Capacitor blocking signal will only block the current capacitor. It is suggested to use disconnector closing position on both sides of capacitor CB, local/remote signal of capacitor switch and protective action signal of capacitor as the blocking signal of capacitor bank.

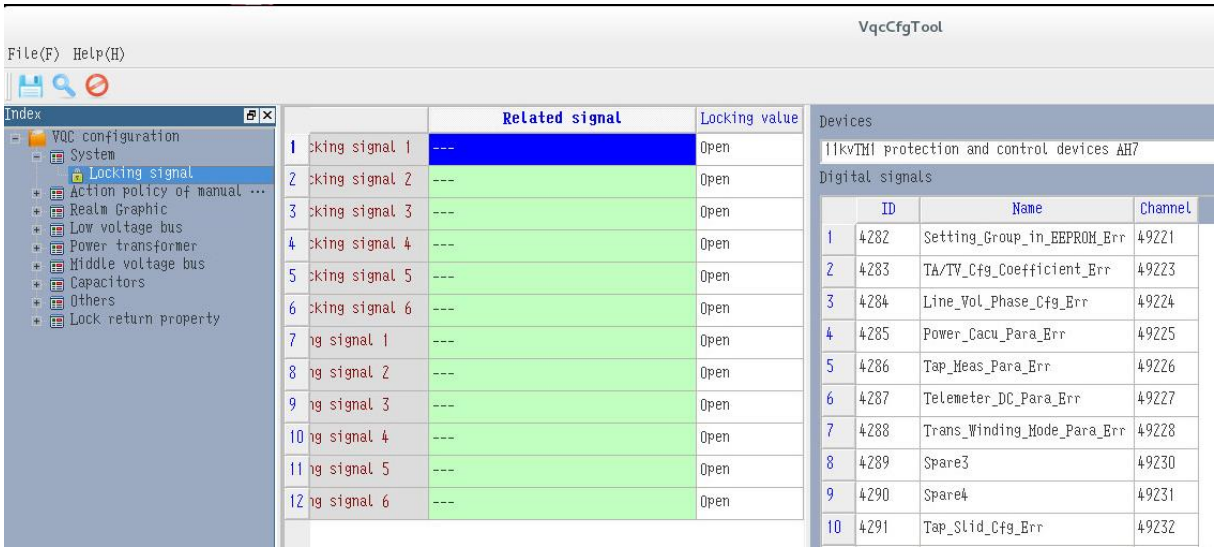


Figure 4.7.17 Blockign Remote Signal Configuration

➢ Control Switch Configuration

On this interface, the general VQC function can be switched on or off, and the VQC regulation of single device can also be separately switched on or off. In the real-time operation, the device on/off parameters will be written into database in real-time manner as shown in Figure 4.7.18:

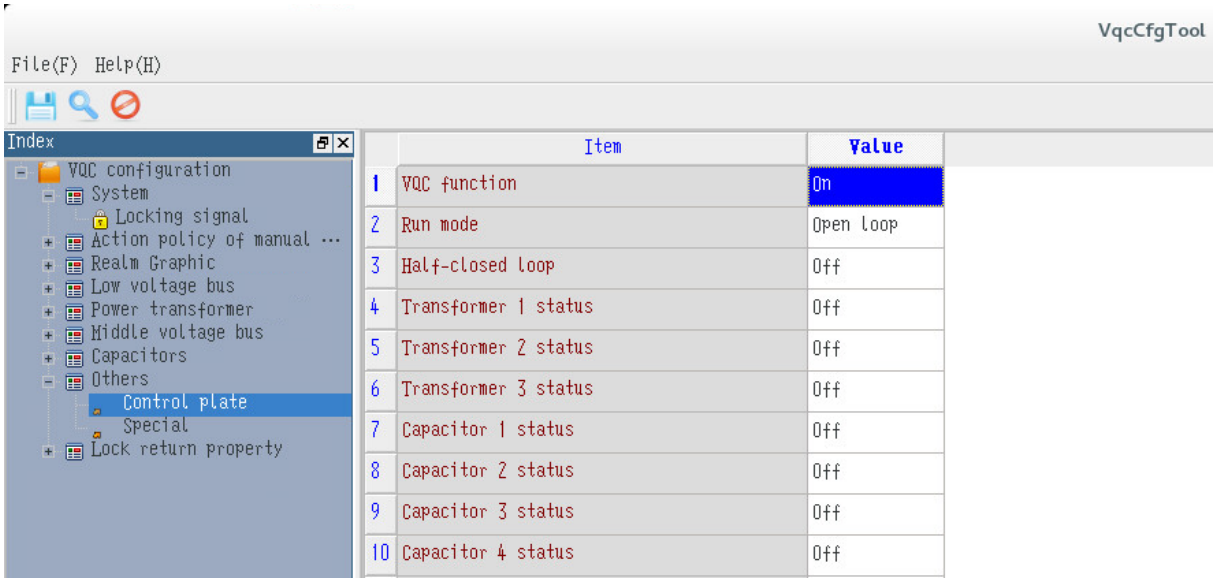


Figure 4.7.18 VQC Control Soft Switch

➢ Special configurations

VQC switching on/off hard soft switch: selecting “Yes”, the hide items of “VQC switching on/off soft switch signal” and “hard switch use mode” will pop up; selecting “No”, the above two options will be hidden.

VQC switching on/off hard switch signal: the position of VQC switching on/off hard switch signal in the remote signal database (database signal ID).

Hard switch use mode: if the hard switch is in normal mode, VQC module will decide VQC on/off based on soft switch and hard switch. They have AND relationship. If any one is not switched on, VQC will not make automatic control. Disconnection of hard switch will cause total blocking. If the hard switch is in Shaoxing mode, the hide item of “Local/remote control switching signal” will display;

Local/remote control switching signal: the position of local/remote control switching signal in the remote signal database (database signal ID). If it is 0, that is to say at local control state, VQC switching on/off absolutely depends on hard switch state, and users cannot make remote switching on/off. If the local/remote control switching state is 1, that is to say at remote control state, the hard switch position has nothing to do with VQC switching on/off, and users can make remote control of VQC state.

See details in Figure 4.7.19:

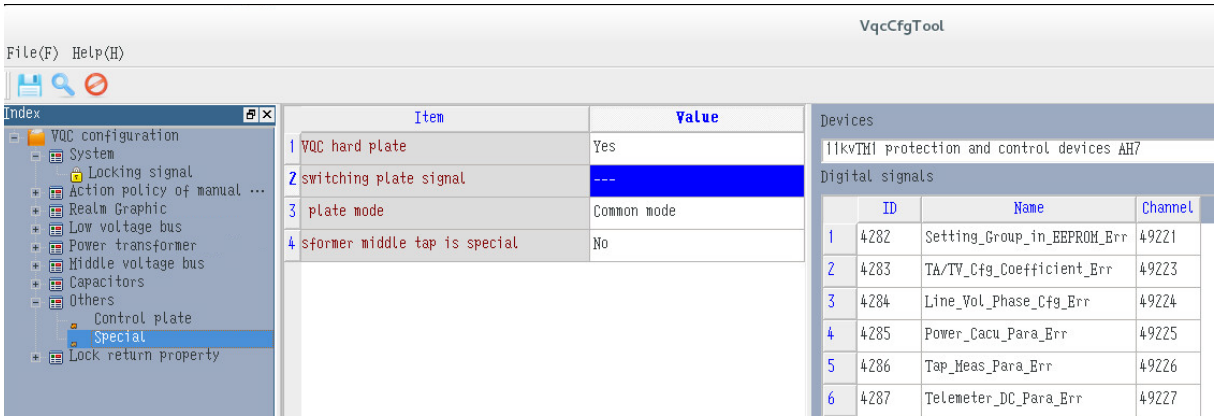


Figure 4.7.19 VQC Control Switch

4.7.3.4 Monitoring system VQC graph configuration

Make configuraiton of VQC graph interface in the graph configuration tool in flexible manner. For those VQCs configured to local database, the relevant information can be displayed on HMI, and the configuraiton personnel can draw graphics according to actual demands:

Remote control: VQC on/off, main transformer capacitor on/off, open/close loop control, manual blocking and clear remote control can be configured in normal way;

Remote signal and remote metering: various types of remote signal and remote metering generated from VQC, including blocking information, nine-zone graph information and blocking remote signal, can be configured on the interface. The blocking information and nine-zone graph information of compoenents can be displayed by utilization of nine-zone graph element and bitmap space.

4.7.4 Setting value and parameter list

➢ System parameters

Table 4.7.10 System Parameters

Number of low-voltage busbar	
Number of main transformer	
Reactive power criteria	□Reactive □Power factor
Main transformer tap position mode	□Gear-up voltage-rising □ Gear-down voltage-rising
Zone type	□Nine-zone □Fifteen-zone □Seventeen-zone □Shanghai Seventeen-zone
Priority mode	□Common mode □ Capacitor in priority
Control strategy	□Consider voltage only □Consider reactive only □Voltage in priority □Reactive in priority □Comprehensive consideration □Manual setting
Paralleling blocking of main transformer	□Not block □Block main transformer only □Block main transformer and capacitor
3U0 blocking on/off	□On □Off
Zero-sequence over-voltage threshold on low-voltage side (V)	
Over-voltage threshold on low-voltage side (V)	
Under-voltage threshold on low-voltage side (V)	
Reactive power blocking upper limit (VA)	
Reactive power blocking lower limit (VA)	
Maximum voltage variation on low-voltage side when the main transformer changes a tap position (ΔUu)	
Maximum reactive power variation when the main transformer changes a tap position (ΔQu)	
Maximum voltage variation on low-voltage side when the capacitor switches once (ΔUu)	
Maximum reactive variation when the capacitor switches once (ΔQu)	
Maximum voltage variation on medium-voltage side when the main transformer changes a tap position	
Maximum voltage variation on medium-voltage side when the capacitor switches once	
Daily tap-shifting times	
Daily switching times	
Measurement confirmation time (s)	
VQC regulation interval (minute)	
Main transformer tap-shifting interval (minute)	
Capacitor switching interval (minute)	
Reverse tap-shifting interval (minute)	
Reverse switching interval (minute)	

Minimum voltage variation on low-voltage side when the main transformer changes a tap position	
Minimum voltage variation on low-voltage side when the capacitor switches once	
Minimum voltage variation on medium-voltage side when the main transformer changes a tap position	
Minimum voltage variation on medium-voltage side when the capacitor switches once	
Mininum reactive changes due to gear shift	
Minimum reactive changes due to switching	
Capacitor closing sequence	1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16
Capacitor opening sequence	1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16
Is there medium-voltage side?	□Yes □No
Medium-voltage blocking switch of low-voltage side	□On □Off
Over-voltage threshold on medium-voltage side (V)	
Under-voltage threshold on medium-voltage side (V)	
Regulating switch on medium-voltage side	□On □Off
Differential voltage blocking threshold on low-voltage side (V)	
Differential voltage blocking threshold on medium-voltage side (V)	
main transformer tap-shifting times for blocking	
capactior action times for blocking	
Refusal operation times of main transformer	
Refusal operation times of capacitor	

- **Zone graph parameters**

Table 4.7.11 Zone Graph Parameter

Starting time（hh：mm）	
Ending time（hh：mm）	
Voltage upper limit of low-voltage side U+	
Voltage lower limit of low-voltage side U-	
Cos-/Q+	
Cos+/Q-	
Voltage upper limit of medium-voltage side U+	
Voltage lower limit of medium-voltage side U-	
Auxiliary voltage upper limit of low-voltage side	
Auxiliary voltage lower limit of low-voltage side	
Auxiliary reactive power upper limit	
Auxiliary reactive power lower limit	

NOTICE!

48 time buckets of zone graph parameters can be set at most.

➢ Busbar parameters

Table 4.7.12 Busbar Parameter

Number of capacitor bank	

➢ Main transformer parameters

Table 4.7.13 Main Transformer Parameter

Is there medium-voltage side?	□Yes □No
Is there 3/2 wiring?	□Yes □No
Is there emergency stop?	□Yes □No
Branch number	
Maximum working current (over-load current)	
Minimum working current (under-load current)	
Lowest tap position	
Highest tap position	
Tap-shifting detection time (s)	

➢ Capacitor parameter

Table 4.7.14 Capacitor Parameter

Setting measurement value of capacitor	
Capacitor capacity	The capacitance is positive, and the reactance is negative.

➢ Control switch

Table 4.7.15 Control Switch

VQC total on/off	□On □Off
Working mode	□Open loop □Closed loop
Semi-closed loop on/off	□On □Off
Main transformer on/off (main transformer 1~3)	□On □Off
Capacitor on/off (capacitor 1~16)	□On □Off
On-load voltage regulation of main transformer, and capacitor comprehensive control (main transformer 1~2)	□On □Off
On-load voltage regulation auto control of main transformer, capacitor disabled (main transformer 1~2)	□On □Off
On-load voltage regulation auto control of main transformer, timed control of capacitor (main transformer 1~2)	□On □Off
On-load voltage regulation manual control of main transformer, timed control of capacitor (main transformer 1~2)	□On □Off

➢ **Blocking signal**

Table 4.7.16 Blocking Signal

S/N	Blocking state value	Blocking signal name
1	Close□ Open□	
2	Close□ Open□	
3	Close□ Open□	
4	Close□ Open□	
5	Close□ Open□	
6	Close□ Open□	
7	Close□ Open□	
8	Close□ Open□	
9	Close□ Open□	
10	Close□ Open□	
11	Close□ Open□	
12	Close□ Open□	

NOTICE!

Blocking signal shall be separately set against total blocking, each section of bus, each main transformer and each capacitor bank. The first six signals are auto reset, and the latter six signals are manual reset.

➢ **Protective events**

Monitoring host VQC has detailed VQC action record and pre-/post-regulation working condition records. Event type codes are listed in following table.

Table 4.7.17 Protective Events

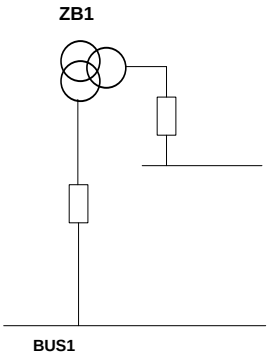
Action type code	Meaning	Action type code	Meaning
170	Voltage regulation of 1# bus failed	171	1# main transformer tap-slipped
172	Voltage regulation of 2# bus failed	173	2# main transformer tap-slipped
174	Voltage regulation of 3# bus failed	175	3# main transformer tap-slipped
176	Voltage regulation of 4# bus failed	177	Voltage regulation of 1# medium-voltage bus failed
178	Voltage regulation of 2# medium-voltage bus failed	179	Voltage regulation of 3# medium-voltage bus failed
220	1# main transformer VQC refusal operation	221	1# main transformer VQC tap up
222	1# main transformer VQC tap down	223	2# main transformer VQC refusal operation
224	2# main transformer VQC tap up	225	2# main transformer VQC tap down
226	3# main transformer VQC refusal operation	227	3# main transformer VQC tap up

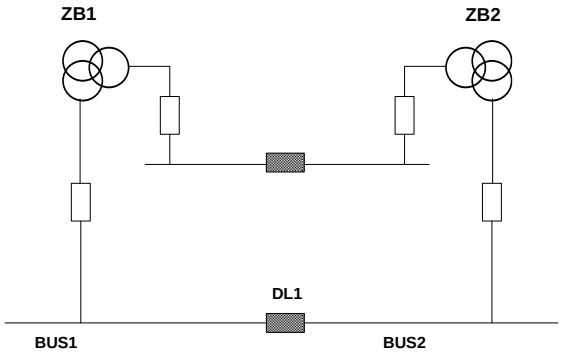
228	3# main transformer VQC tap down	229	1# capacitor VQC refusal operation
230	1# capacitor VQC close	231	1# capacitor VQC open
232	2# capacitor VQC refusal operation	233	2# capacitor VQC closed
234	2# capacitor VQC open	235	3# capacitor VQC refusal operation
236	3# capacitor VQC close	237	3# capacitor VQC open
180	4# capacitorVQC refusal operation	181	4# capacitor VQC close
182	4# capacitor VQC open	183	5# capacitor VQC refusal operation
184	5# capacitor VQC close	185	5# capacitor VQC open
186	6# capacitor VQC refusal operation	187	6# capacitor VQC close
188	6# capacitor VQC open	189	7# capacitor VQC refusal operation
190	7# capacitor VQC close	191	7# capacitor VQC open
192	8# capacitor VQC refusal operation	193	8# capacitor VQC close
194	8# capacitor VQC open		
300	Abnormal action of 1# main transformer	301	Abnormal action of 2# main transformer
302	Abnormal action of 3# main transformer	303	Abnormal action of 1# capacitor
304	Abnormal action of 2# capacitor	305	Abnormal action of 3# capacitor
306	Abnormal action of 4# capacitor	307	Abnormal action of 5# capacitor
308	Abnormal action of 6# capacitor	309	Abnormal action of 7# capacitor
310	Abnormal action of 8# capacitor		
195	9# capacitor VQC refusal operation	196	9# capacitor VQC close
197	9# capacitor VQC open	198	10# capacitor VQC refusal operation
199	10# capacitor VQC close	200	10# capacitor VQC open
201	11# capacitor VQC refusal operation	202	11# capacitor VQC close
203	11# capacitor VQC open	204	12# capacitor VQC refusal operation
205	12# capacitor VQC close	206	12# capacitor VQC open
207	13# capacitor VQC refusal operation	208	13# capacitor VQC close
209	13# capacitor VQC open	210	14# capacitor VQC refusal operation

211	14# capacitor VQC close	212	14# capacitor VQC open
213	15# capacitor VQC refusal operation	214	15# capacitor VQC close
215	15# capacitor VQC open	216	16# capacitor VQC refusal operation
217	16# capacitor VQC close	218	16# capacitor VQC open
311	Abnormal action of 9# capacitor	312	Abnormal action of 10# capacitor
313	Abnormal action of 11# capacitor	314	Abnormal action of 12# capacitor
315	Abnormal action of 13# capacitor	316	Abnormal action of 14# capacitor
317	Abnormal action of 15# capacitor	318	Abnormal action of 16# capacitor

4.7.5 Mode of connection

The following four connection modes apply to monitoring host VQC standard configuration (adjustment can be made according to different demands of project):





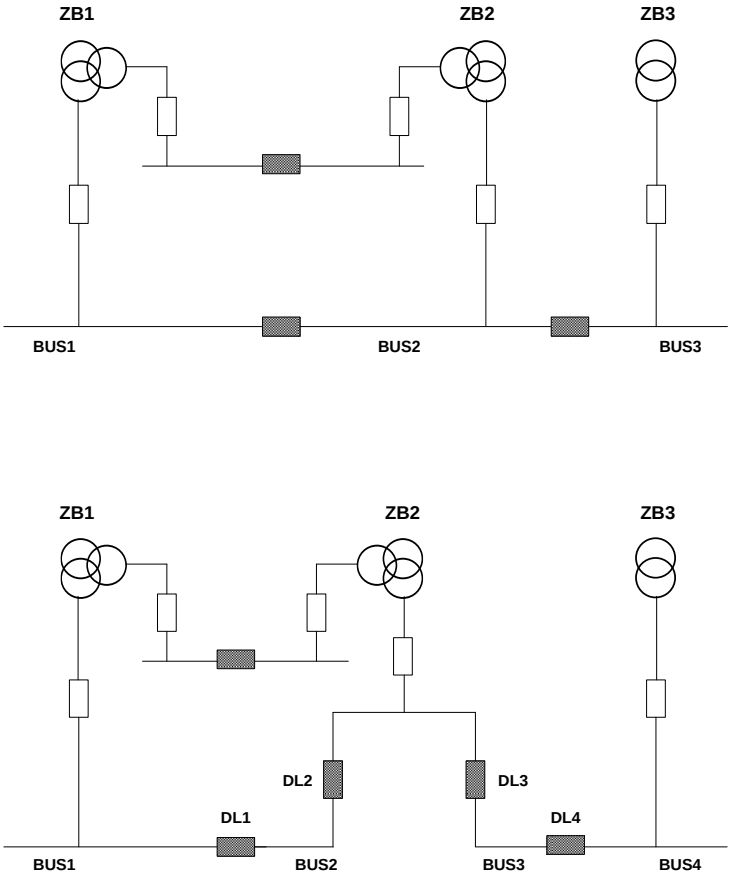


Figure 4.7.20 Connection Mode for Standard Configuration

4.8 Alarm window application

4.8.1 Overview

Nowadays, all signals of devices in substation have been acquired by automation system. The information is abundant in quantity, but no further processing is made. At present, there is a common problem. After collection by monitoring system, all real-time data are displayed according to time order. Hierarchical processing, analysis and optimization are not made to data. Various types of signals have frequent actions. As the monitoring tasks are heavy for watchkeeper, some important alarm signals may be omitted. As soon as there is a fault, it is not convenient for watchkeeper to quickly monitor failure equipment, accurately judge fault and handle it timely, directly leading to increased difficulty in power grid operation monitoring and increased quantity of maintenance.

Based on abovereasons, PRS-7000 integrated monitoring system provides alarm window application and history search function, signal screening by substations and bays, and signal shielding by substations and bays, greatly making up for deficiencies due to different technical levels of watchkeeper. Alarm signal can be processed by classification in the alarm window, and its bay location can be found for comprehensive reasoning and analysis. Besides, the specific analysis can be printed out and shall be able to be exported to pdf and/or excel file formats. The synthetic information analysis and alarm window module of PRS-7000 integrated monitoring system has important significance for reducing the workload of substation watchkeeper, improving

fault/exception handling accuracy and rapidity, and safeguarding safe running of power grid.

Alarm window application can realize the following functions:

1) Alarm information classification and sequential display. Watchkeeper can judge the severity level of alarm according to alarm information classification;

2) Make real-time analysis and judgment of rationality and accuracy of real-time data, and give alarm for abnormal data timely;

3) Provide functions of screening signal and shielding signal by substationssubstations and bays, and realize quick search of required information;

4) Provide history search interface to retrieve any historical information at any time.

5) Only one (1) alarm shall be shown for a point. An old message for a point shall be deleted when a new alarm is generated for that point.

6) The time field shall flash for unacknowledged alarms

4.8.2 Main functions

4.8.2.1 Alarm classification

Alarm information is classified by types into SOE, COS, protection event, self-check event, VQC event, sequential control record, command record, maintenance information, intelligent alarm information etc.;

Alarm information is classified by significance into faultinformation, abnormal information, change-of-state information, over-limit information and notification information.

Alarm information can be comprehensively displayed by classifications orlevels. Watchkeeper can accurately judge the alarm severity based on alarm informationlevel, so as to fastly detect abnormal message of power grid and provide faultpre-warning of power grid.

4.8.2.2 Alarm information display

Alarm signal can be labeled with alarm level according to the significance. Alarm information can be screened and displayed by bays and substations. The historical alarm information can be searched by substations, bays, devices and time.

The real-time display window of alarm information consists of several pages, at least including SOE information, protection event information, change-of-state information, notification information, over-limit information, maintenance information, intelligent alarm information, sequential operation record, command record etc. Main tag pages of alarm window have meanings as follows:

1) Timing sequence information: display all alarms according to time order.

2) Fault information: the signals of breaker tripping (including tripping not operated by manual), protection device tripping & closing due to grid fault and device fault, as well as other signals affecting safe operation of the whole substation. Such information is important and needs real-time

monitoring and immediate handling.

3) Abnormal information: abnormal information is the alarm signal reflecting abnormal situation of device and the signal affecting remote control operation of device, which directly threats grid safety and device running and is important needing real-time monitoring and immediate handling.

4) Change-of-state information: change-of-state information refers to the message regarding state change (closing, opening) of switching devices. Such information directly reflects the change of operation mode of power grid, and is important needing real-time monitoring.

5) Notification information: notification information generally reflects the operationg condition and state monitoring of devices in power grid, mainly including disconnector, earthing switch position signal, tap position of transformer, and related signals in normal operation of device (i.e. protection switch on/off, start signal and abrnomal disapperarance signal of protective device, fault record and transceiver, measuring & control device local/remote signal etc.). Such kind of information neesds regular query.

6) SOE: when the unconfirmed SOE events exist in the operating system, the annunciator will blink. Clicking annunciator, the recent SOE events will be displayed.

7) COS: when the unconfirmed COS events exist in the operating system, the annunciator will blink. Clicking annunciator, the recent COS events will be displayed.

8) Over-limit alarm: over-limit information reflects that some important measurement quantity goes over alarm limit. Those important measurement quantities mainly include active power, reactive power, current, voltage, oil temperature of transformer, section tidal current etc. It is important information needing real-time monitoring and immediate handling.

9) Device self-check: when the unconfirmedself-check events exist in the operating system, the annunciator will blink. Clicking annunciator, the recent slef-check events will be displayed.

10) Protection event: when the unconfirmed protection events exist in the operating system, the annunciator will blink. Clicking annunciator, the recent protection events will be displayed.

11) System information: when the unconfirmed system events exist in the operating system, the annunciator will blink. Clicking annunciator, the recent system events will be displayed.

12) Command information: record information of other operations in monitoring host. When the uncompleted operation commands exist in the operating system, the annunciator will blink. Clicking annunciator, the recent operation information will be displayed.

13) VQC information: when the unconfirmed VQC events exist in the operating system, the annunciator will blink. Clicking annunciator, the recent VQC events will be displayed.

14) Sequential control information: mainly referring to sequential control records, including single-step control information, whole sequential control information etc.

15) Maintenance information: after a device is in “maintenance” state, all signals of this device

will be displayed on maintenance page.

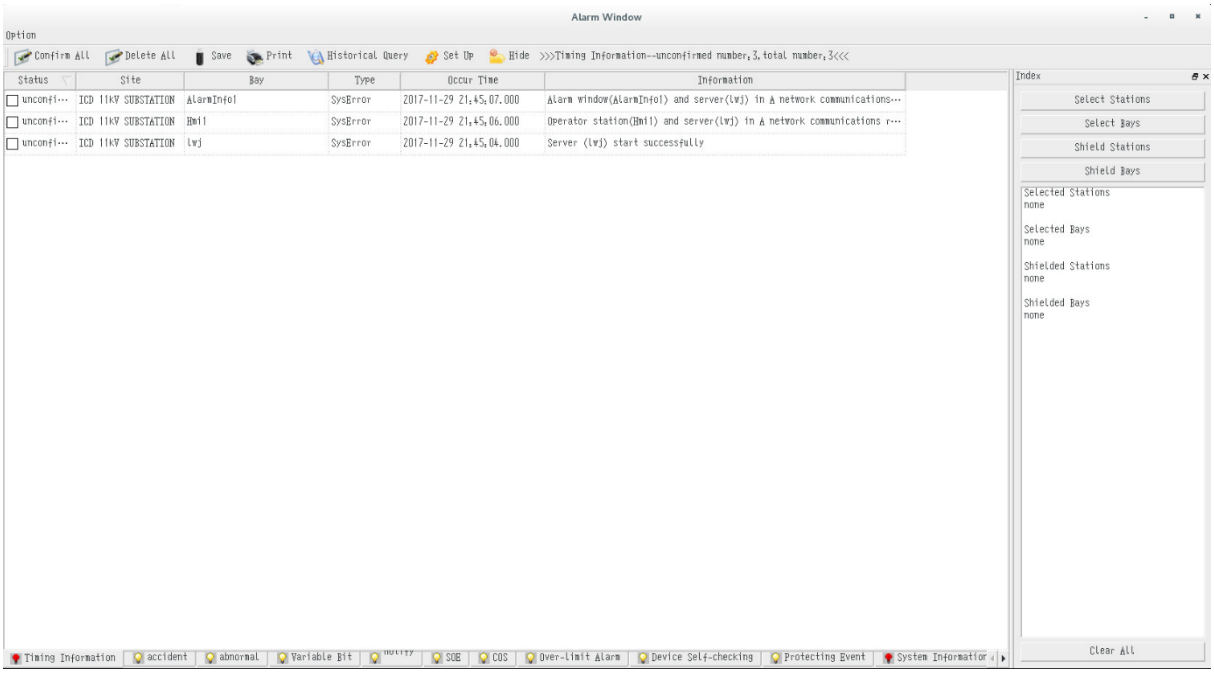


Figure 4.8.1 Main Interface of Alarm Window

4.8.2.3 Information query

In order to quickly search information and eliminate other irrelated interference factors, the function of screening and shielding signals by substations and bays is provided. You can select query of information by substations or bays in the index as shown in following figure:

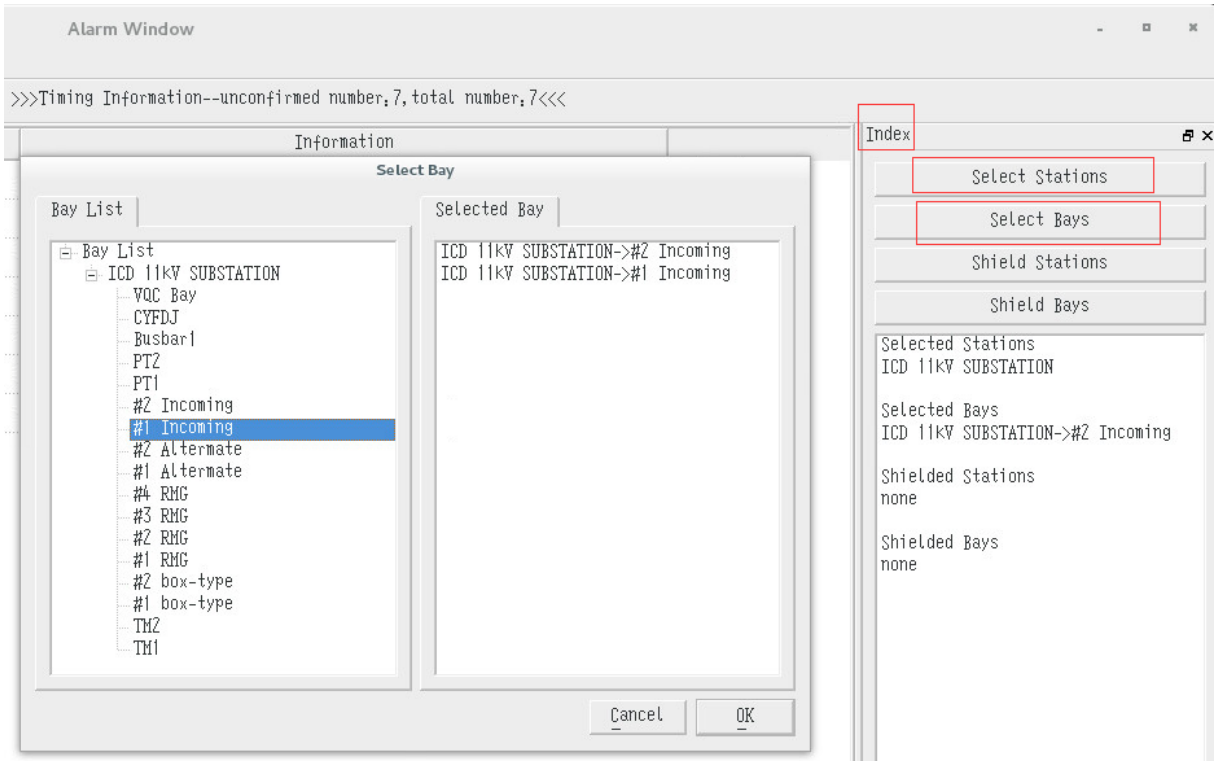


Figure 4.8.2 Information Query Interface

Screen out the desired bay signals.

4.8.2.4 Information confirmation and deletion

Alarm window information can be confirmed here. After confirmation, a red flag will be labeledas confirmed information. When an alarm is acknowledged, its visual representation shall no longer flash. Confirmed information can also be deleted so as to greatly simplify information quanity as shown in the following figure:

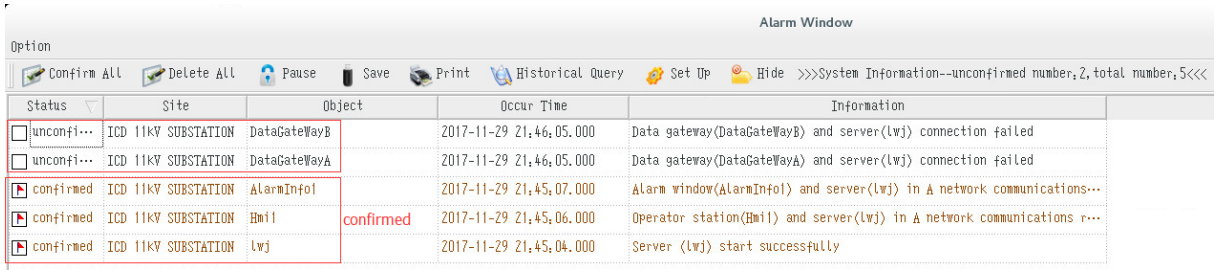


Figure 4.8.3 Alarm Information Confirmation and Deletion

4.8.2.5 History query in time order

Clicking the history information query button in the title bar of alarm window, the previous historical information can be searched. Not only the alarm information can be searched, the measurement or electric quantity saved by sampling can also besearched. It provides powerful evidence for previous problems and is also very convenient for user:

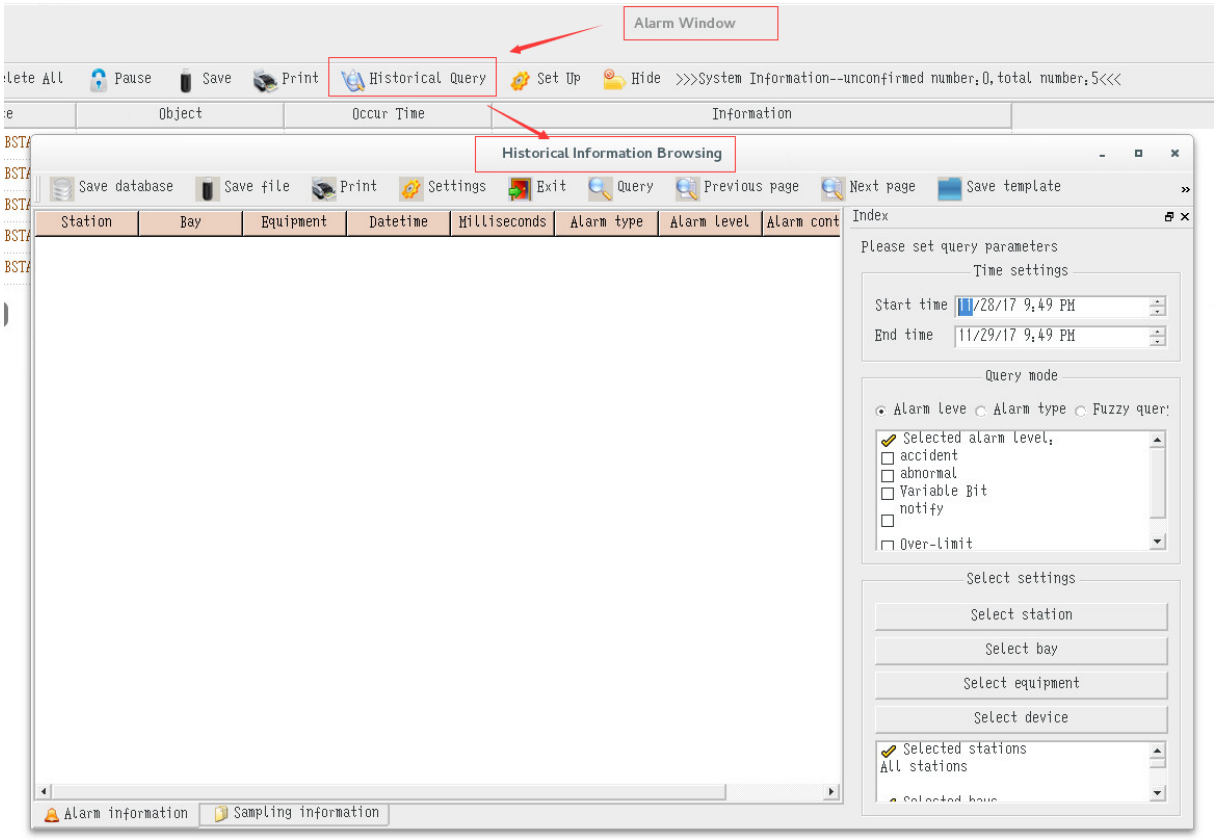


Figure 4.8.4 History Query in Chronological Order

4.8.2.6 Alarm window setting

Personalized setting of alarm window can be made, including font size and styles etc. Besides, the displayed color of alarm information can also be set according to different types of alarm information. Audio alarm and voice alarm can also be set for different informations. In addition, the relevant information can be printed according to time.

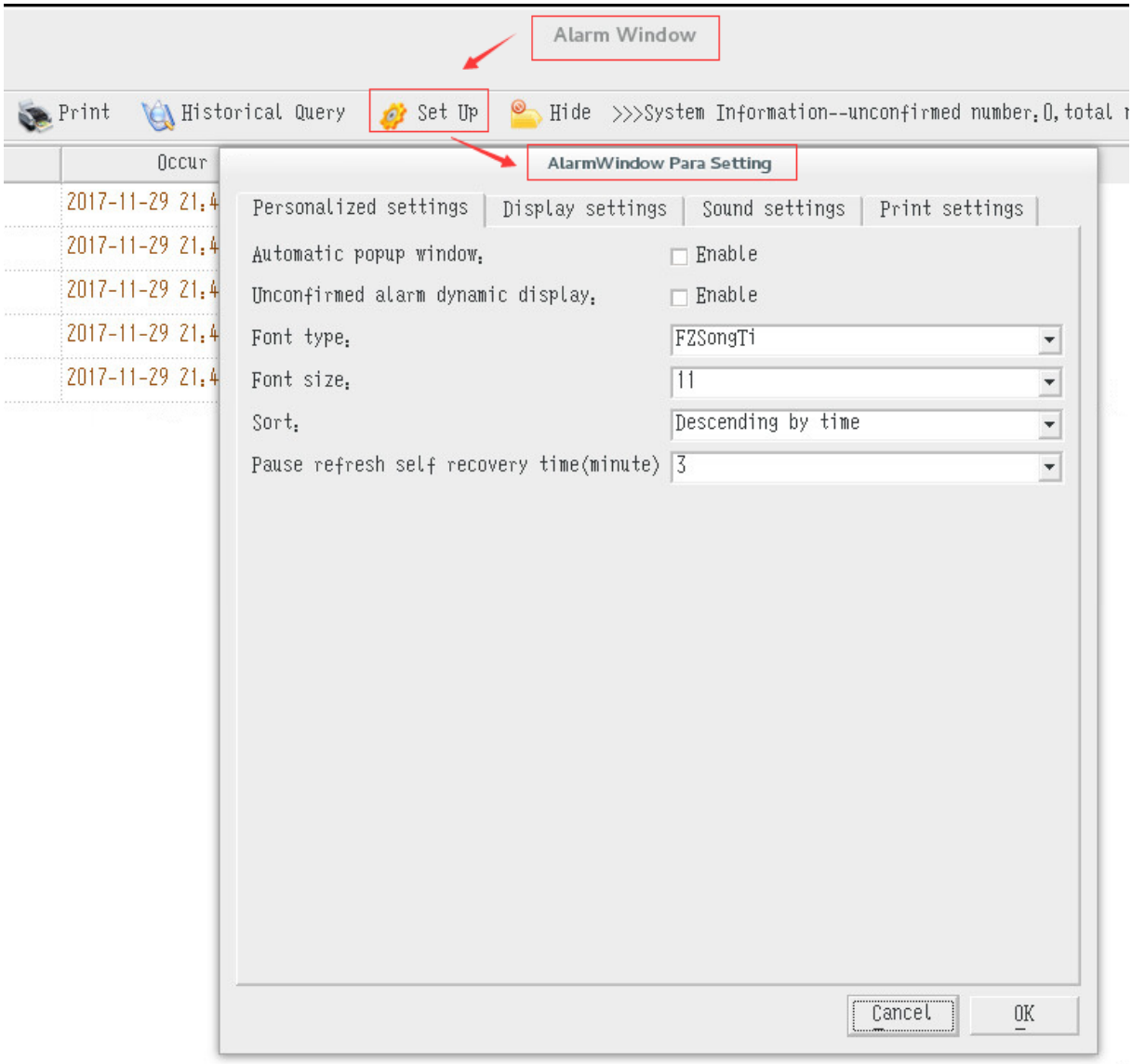


Figure 4.8.5 Alarm Window Parameter Setting

4.9 Description of fault analysis software

4.9.1 Overview

Monitoring host of PRS-7000 integrated monitoring system realizes fault record callingfunction. The called fault record will be saved under the path of /PRS7000/bin/61850wave in local system.

Acquisition of fault record data: when the protection operates and recording completes, the monitoring host will send signals based on recording, and call the fault record data in triggered way. Patrol inspection can also be used to call record list information of protection device at fixed time. When the new record is detected, it will call the newly-generated recording data.

4.9.2 Analysis function

Various protections in substation have great responsibilities. Either failure in operation or mis-operation will lead to serious consequence or severe fault. Microcomputer protection device generally provides auxiliary functions, such as event record, fault record etc. These information

will record the startup, operationand reset of protection units, as well as sampling data in a period time, so as to analyze the action behavior of protectionunits after accidents, find causes and specify the fault responsibility.

PRS-7000 integrated monitoring system has integrated recording view and analysis function, by which the fault recording file can be viewed in waveform conveniently, and the problem can be detected in timely manner.

4.9.2.1 Software function

Waveform display: analyze the recording data; display the waveform of analog channel and switching channel in sequence in the same window, with horizontal direction as time axis and vertical direction as amplitude axis. Support for recording data display. At default display mode, the horizontal and vertical display scale of waveform shall be appropriate. When the waveforms are many and long, the vertical and horizontal scrolling is available. The waveform and names of channels will be respectively displayed in different colors by phases.

Instantaneous value display: if users click different horizontal axis position in waveform window, the time and value of signal quanity of each channel at corresponding position will be displayed.

Zoom-in/zoom-out: the waveform curve and horizontal/vertical direction can be zoomed-in or zoomed-out. With this function, the local waveform can be specifically observed.

4.9.2.2 Software instructions

- **Waveform display**

Open the program, click “maintenance” icon on console, and select “recording analysis tool” in the dialog box. Left click it to open it:

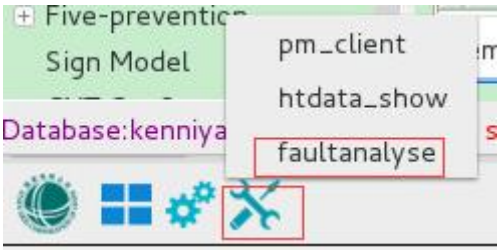


Figure 4.9.1 Open recording analysis tool

Click “File—Open” or  icon on the toolbar to open the recording file tree as shown in Figure 4.9.2.

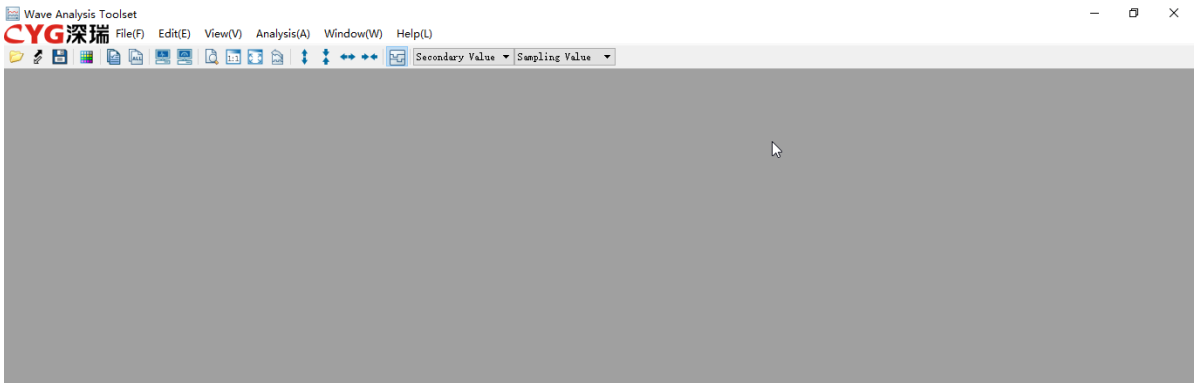


Figure 4.9.2 Starting Interface of Recording File Analysis Tool

If the recording file is actively called by protection engineer station, it will be displayed in 61860wave folder by bays and devices. If the recording file is called by protection management substation, it will be displayed in comtrade folder by bays and devices. The opening interface of recording file is shown as Figure 4.9.3.

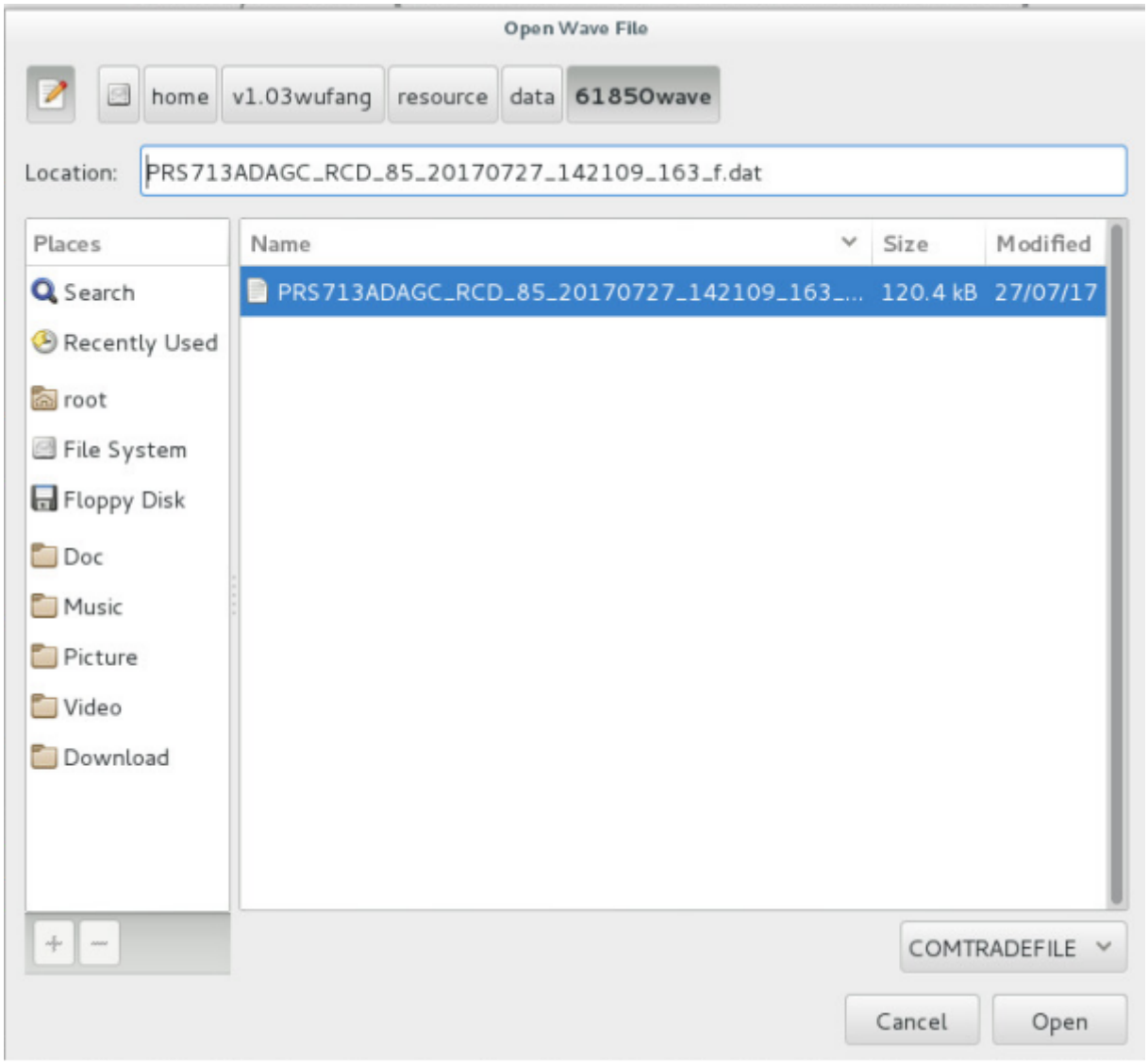


Figure 4.9.3 Open recording file

Double click the waveform file to display and open it. If the waveform file is large, you have to wait for a while. The waveform file is shown as Figure 4.9.4.

Figure 4.9.4 Reading Interface of Recording File

To exit from current waveform and view other waveforms, click “File-Open” again for operation.

- **Instantaneous value display**

Clicking waveform window, the instantaneous value of all waveforms at the clicking position will be displayed as Figure 4.9.5.

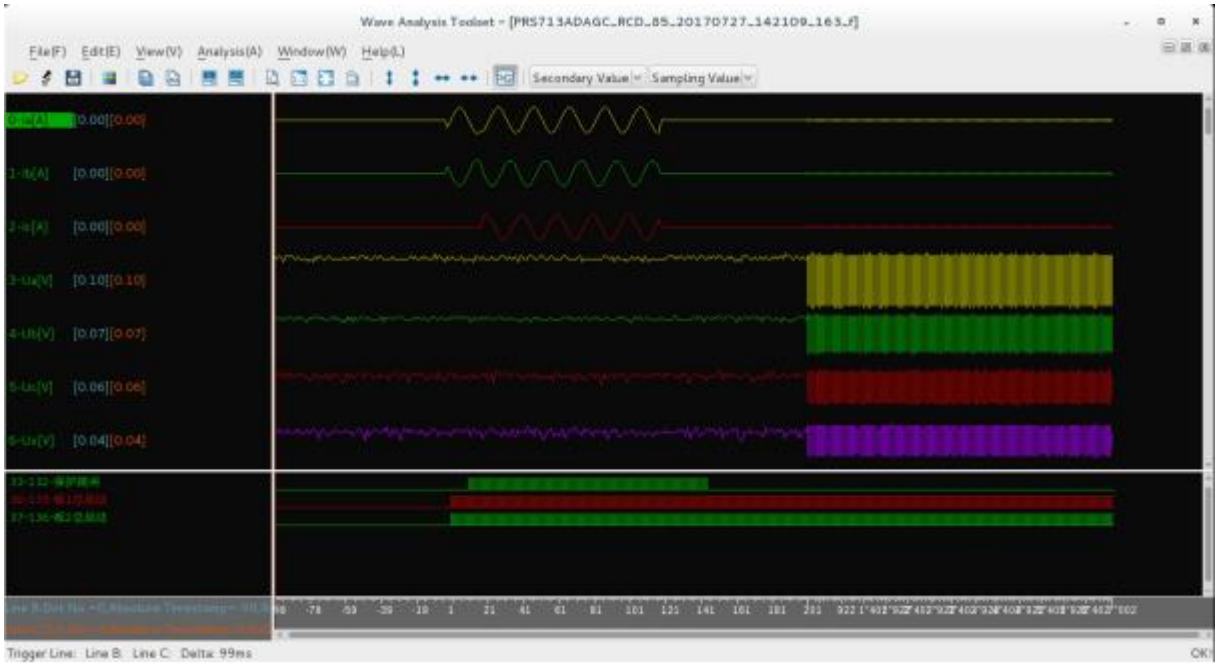


Figure 4.9.5 Display All Instantaneous Values

- **Zoom-in and zoom-out**

Click  icon in the toolbar to make zoom-in/zoom-out of curve horizontally and vertically as shown in Figure 4.9.6 and Figure 4.9.7.

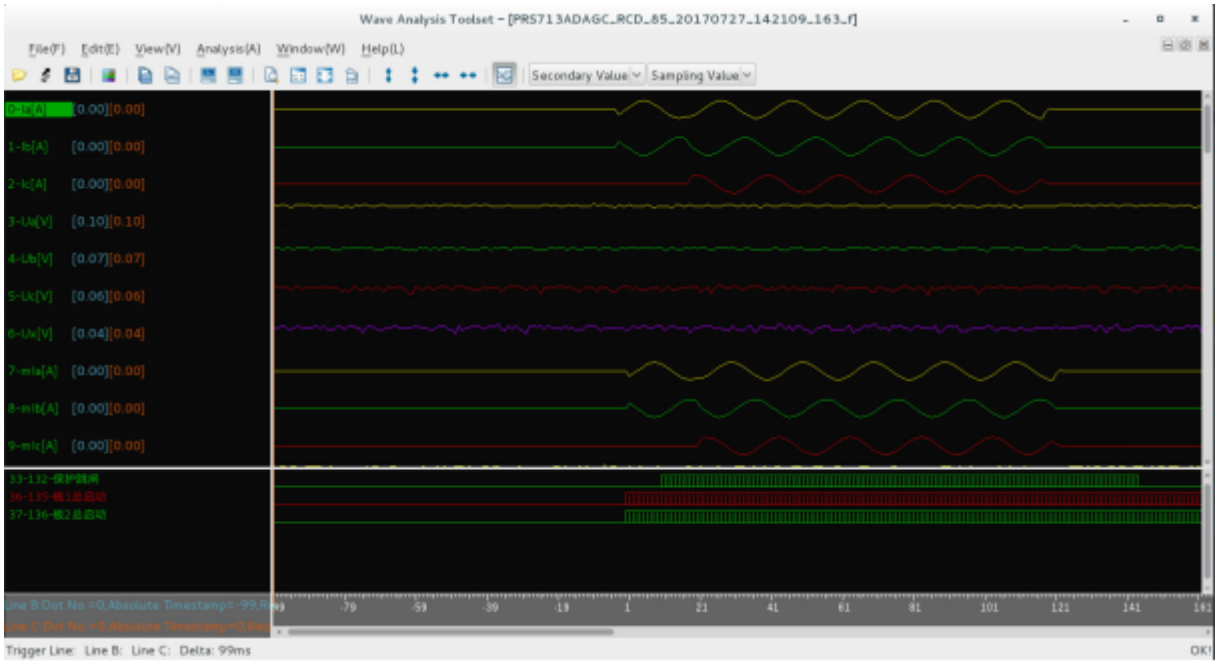


Figure 4.9.6 Lateral Magnification of Curve

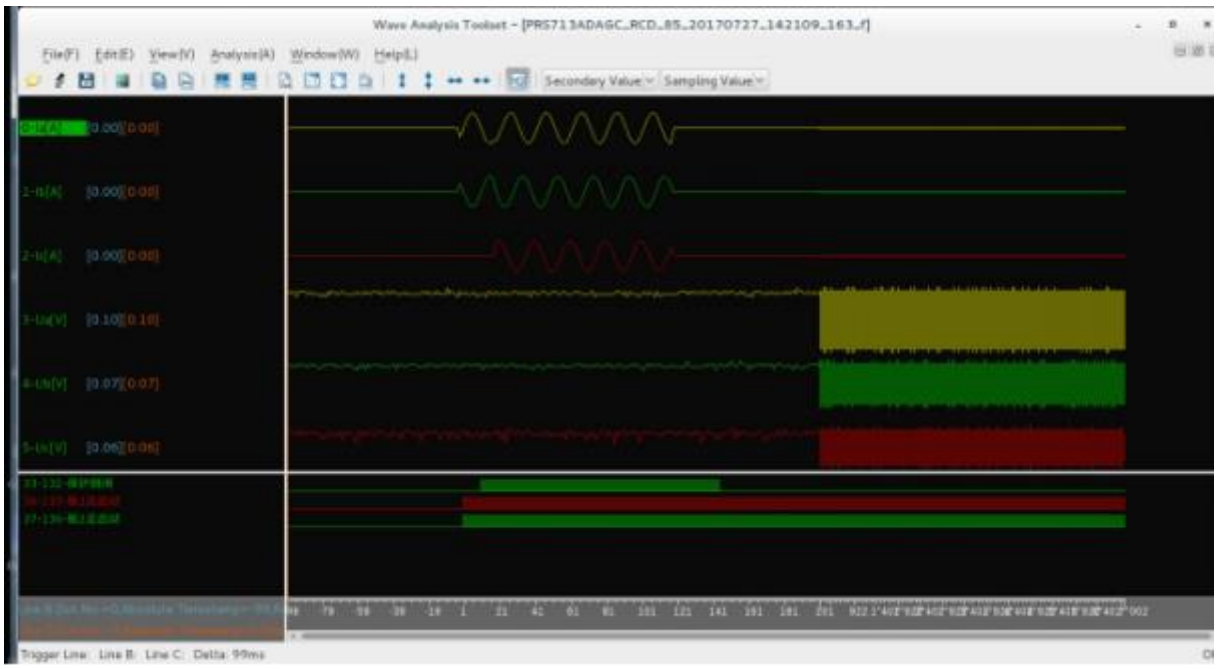


Figure 4.9.7 Longitudinal Magnification of Curve

➢ **Print**

Clicking “file” in the menu bar, and selecting printer setting in the dropdown list, the dialog box of “waveform print setting” will pop up, where the analog quantity and state quantity for printing, printing range, color and direction can be selected. Besides, the printer can also be set as shown

in Figure 4.9.8.

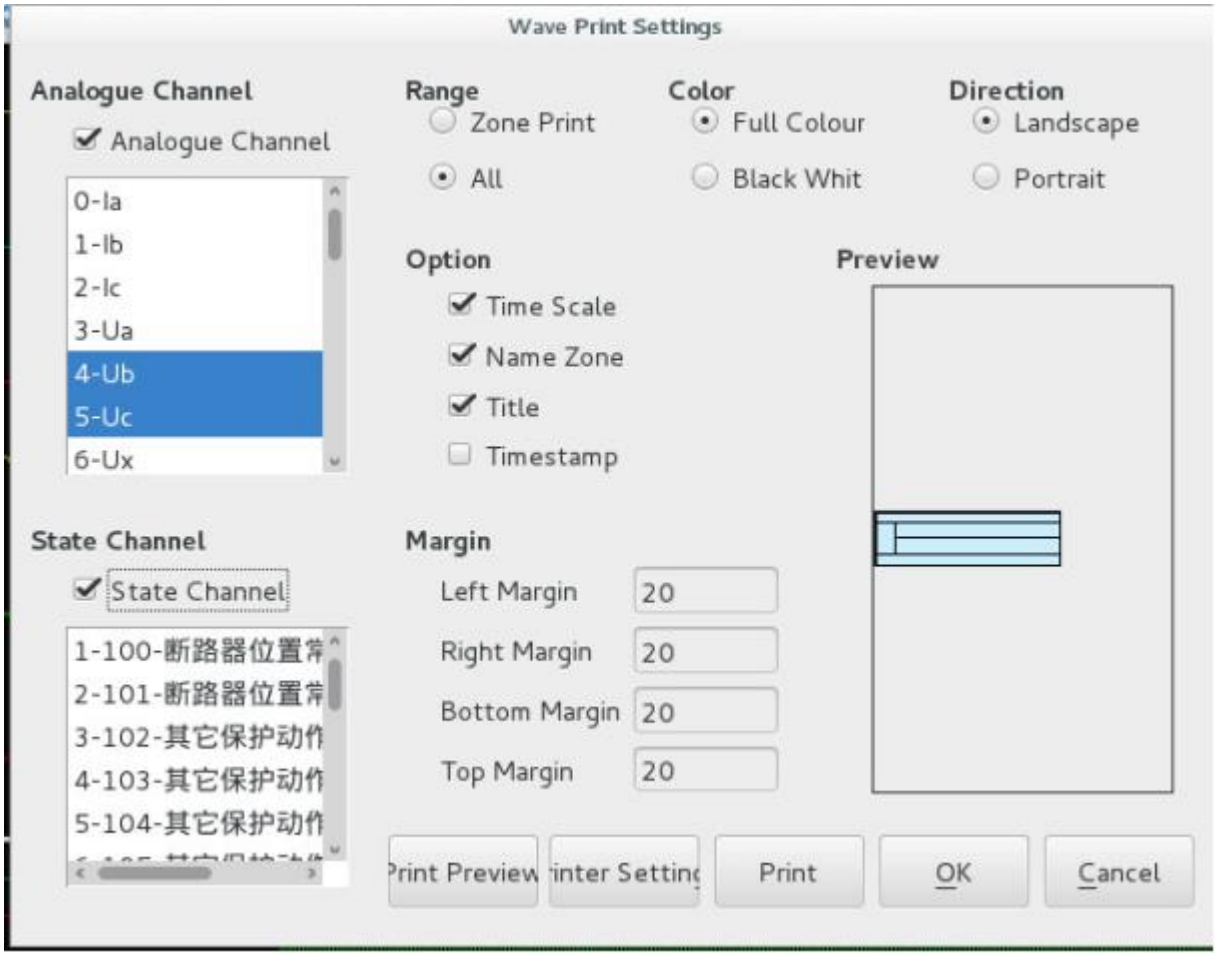


Figure 4.9.8 Waveform Print Setting

Selecting the analog or state quanity to be printed and clicking “printer setting”, the dialog box for printer setting will pop up as shohwn in Figure 4.9.9.

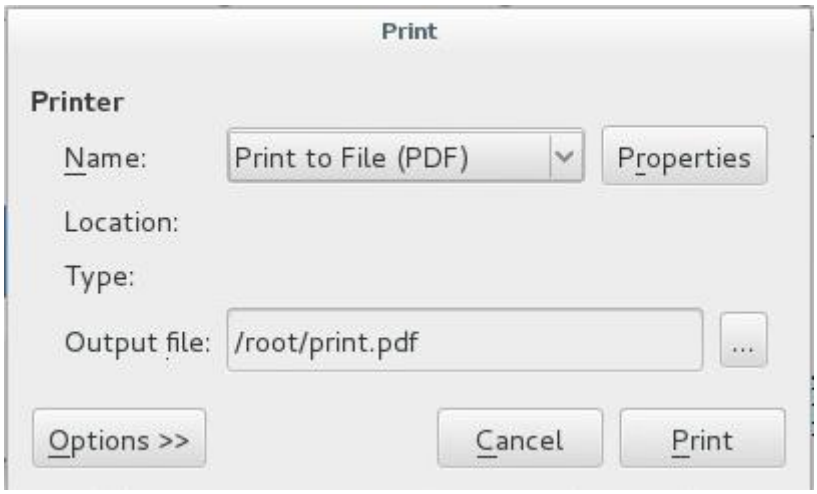


Figure 4.9.9 Printer Setting

If the printer has been connected correctly, the default configuration will be used. Click “Print” to

make printing directly. The printing effect is shown as Figure 4.9.10. If preview is required, “Print Preview” can be selected from printer setting window.

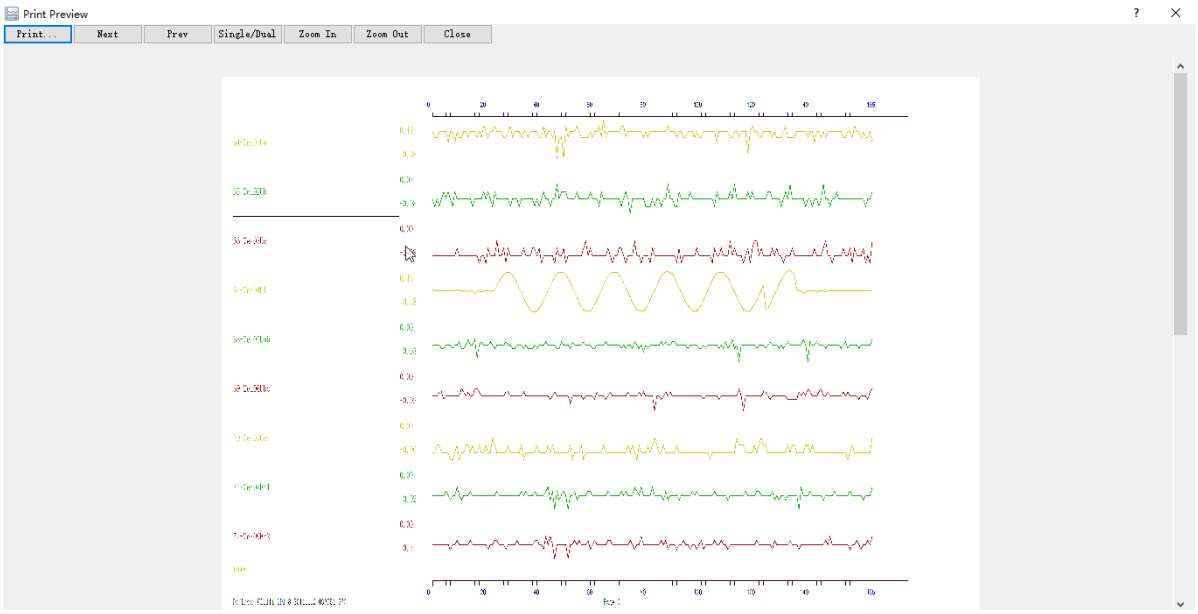


Figure 4.9.10 Preview of Printing Effect

4.9.3 Security mechanism

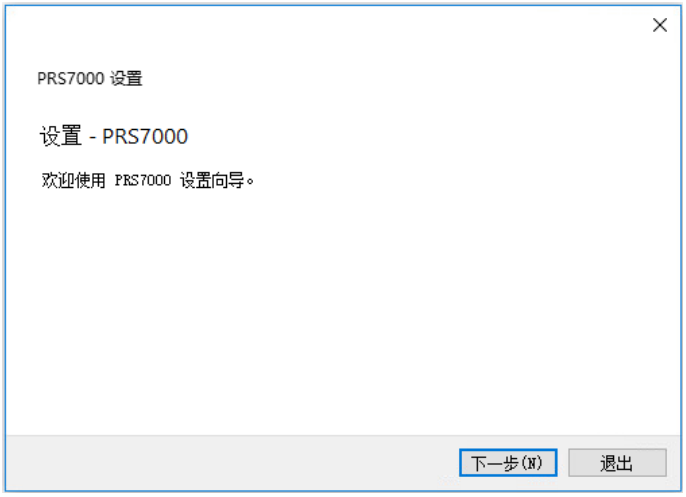
PRS-7000 integrated monitoring system provides strict security mechanism for signal reset, setting modification, setting zone switching in the relay protection and fault information management module.

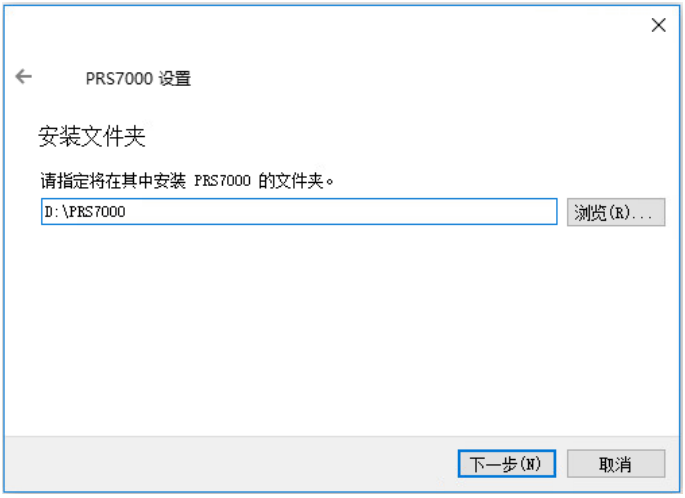
Operator and scrutineer must have different and corresponding rights, and shall operate with password checking. In addition, operating time, operation obeject, operating type, operator, scrutineer and operating result will be fully recorded and saved into historical database to review responsibilities. Besides, every login will have time limit. As soon as time up, the user will automatically log out. Limit time cal be set.

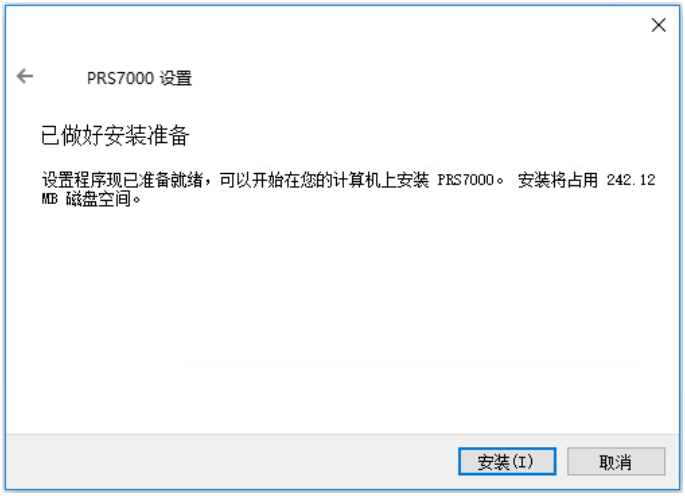
5 Installation

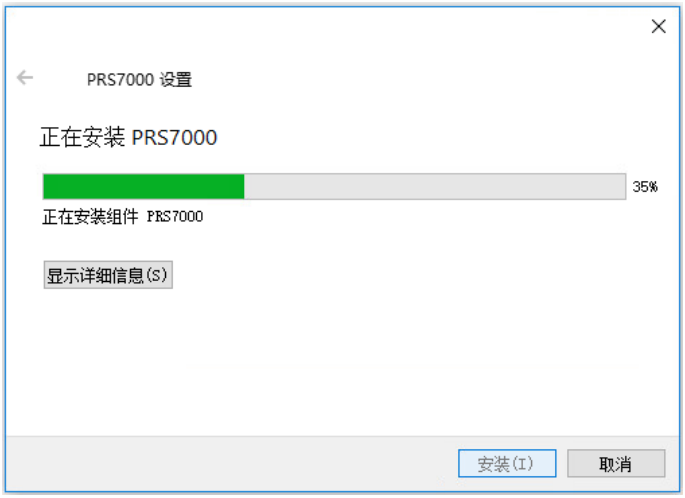
5.1 Installation steps

Double click on the application software to configure it by default throughout the entire process









5.2 Configuration Check

After restoring the relevant configuration, check whether the configuration tools are opened normally, and check whether the following configurations are normal, to ensure that the database configuration is correct after the upgrade.

6 Common Configuration Maintenance

The section of common configuration maintenance provides handling methods of frequently asked questions and some problem solutions, and aims at providing convenience for system maintainers. Detailed information is shown in below:

6.1 How to Add New bays?

6.1.1 Database Backup

When modifying any database of the operating stations, the database should be backuped to prevent from errors of modification. With the backup information, the database will be restored at any time. Meanwhile, it is also the basic operational quality of power system maintainers.

1) Creat a new folder under the root directory and name it as “database backup”; for example, under the home route of linux system, click the right button->new folder, and name it as “database backup”:

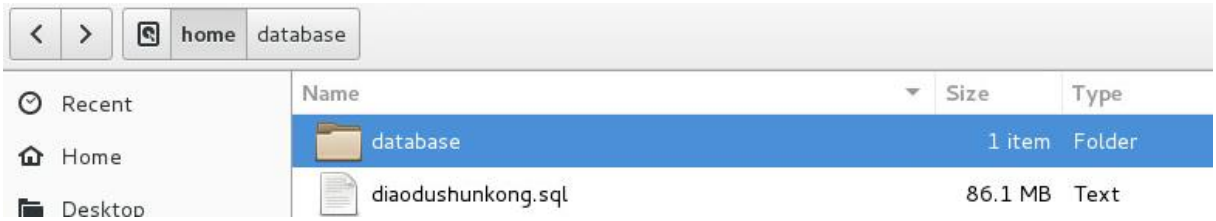


Figure 6.1.1 New Folder under Root Directory

Then double click the left mouse button to open the database backup folder, click the right button->new folder and name it with “year-month-date” as per the modification time of the day. For example:

Figure 6.1.2 Name the New Folder

2) Click “configuration icon” on consolesonsole and select “database maintenance tools”:

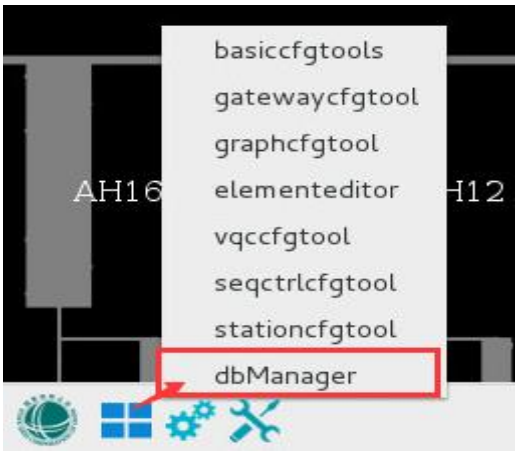


Figure 6.1.3 Database Maintenance Tools

Click the left mouse button and the dialog box of database maintenance tools will pop up:

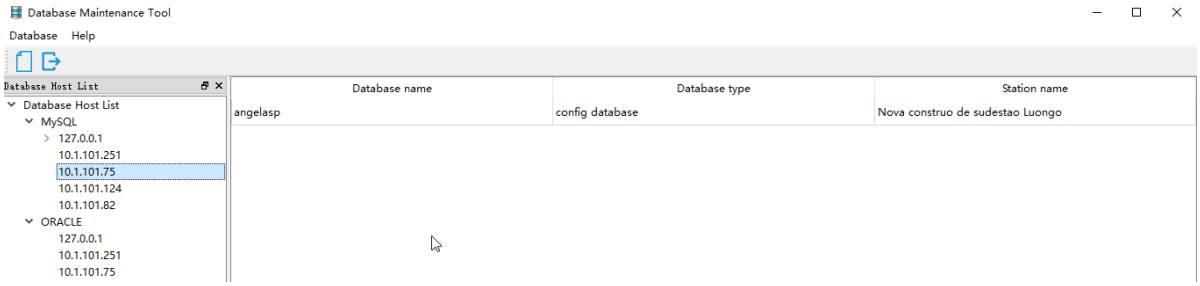


Figure 6.1.4 Open Database Maintenance Tools

Click the left mouse button to select 127.0.0.1(MySQL), then click the right button->open.

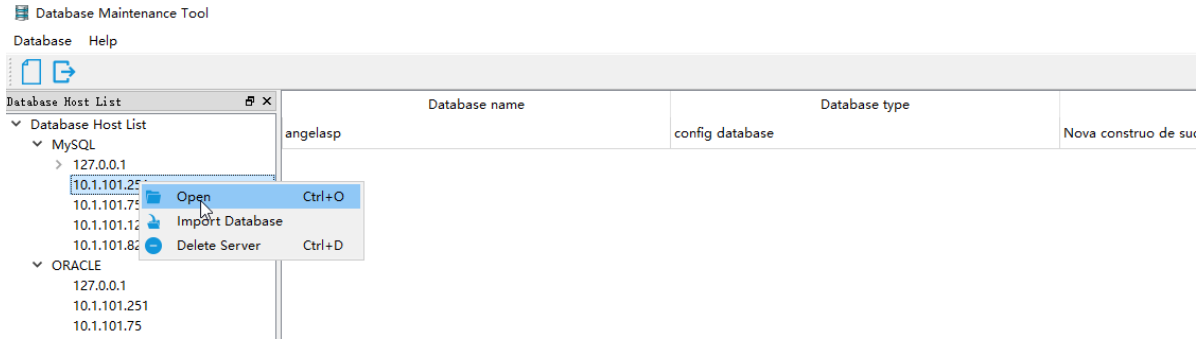


Figure 6.1.5 Open Database

The dialog for entering password will pop up.

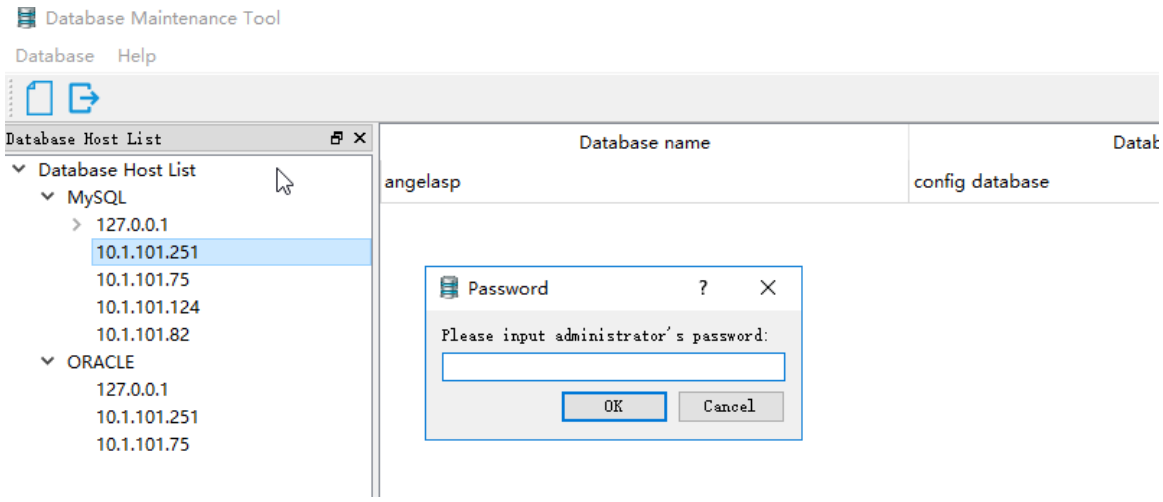


Figure 6.1.6 Dialog Box for Inputting Password

After entering the password of prs7000.sunri, click Yes and the drop-down box under 127.0.0.1(MySQL) with all database imported from database maintenance tools will pop up.

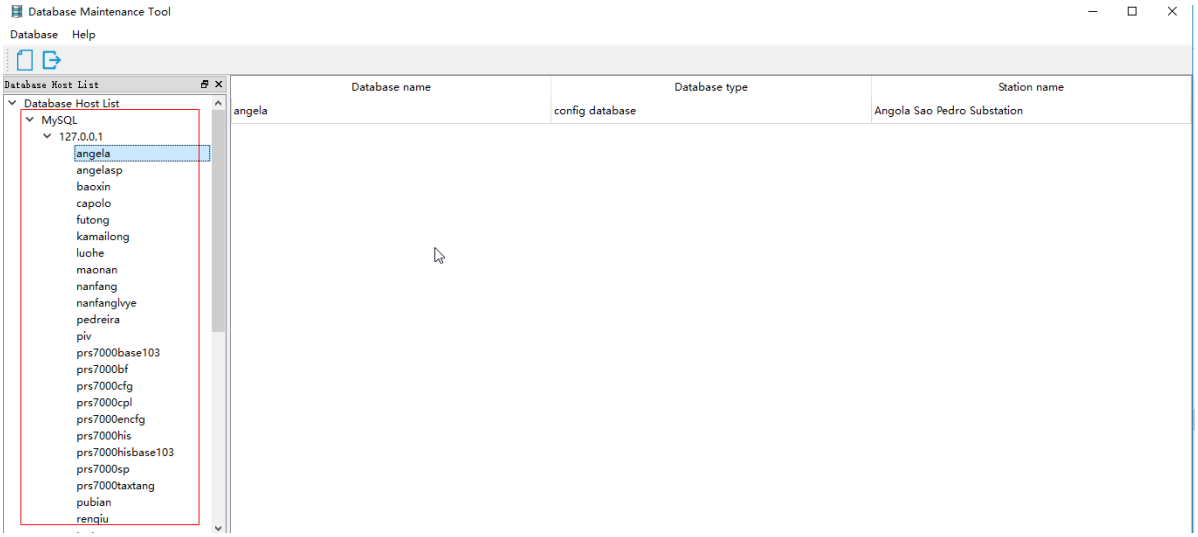


Figure 6.1.7 Interface of Imported Database

Click the left mouse button to select the database of the machine, then click the right button->export database.

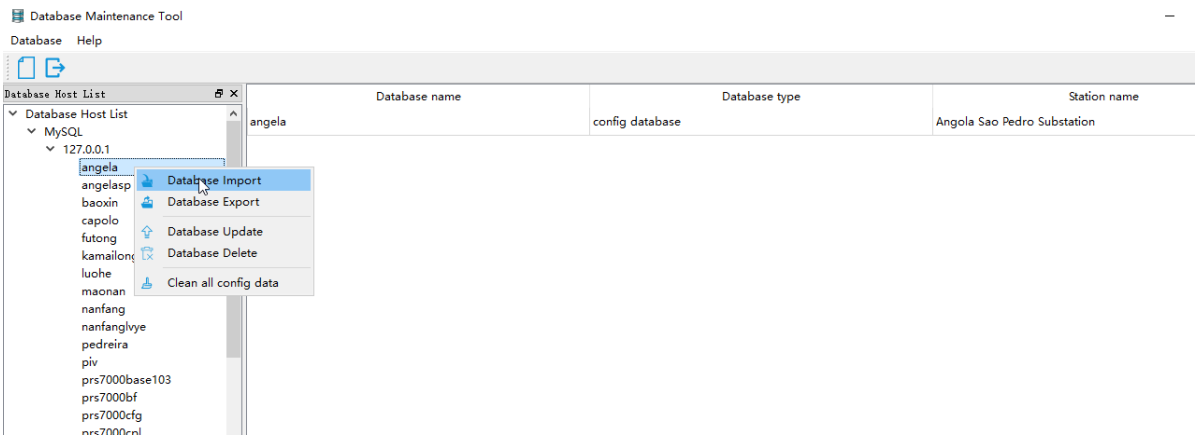


Figure 6.1.8 Export Database

The dialog box requiring for saving will pop up. Select the new route: /home/database backup/2017-11-13 and click “Save”.

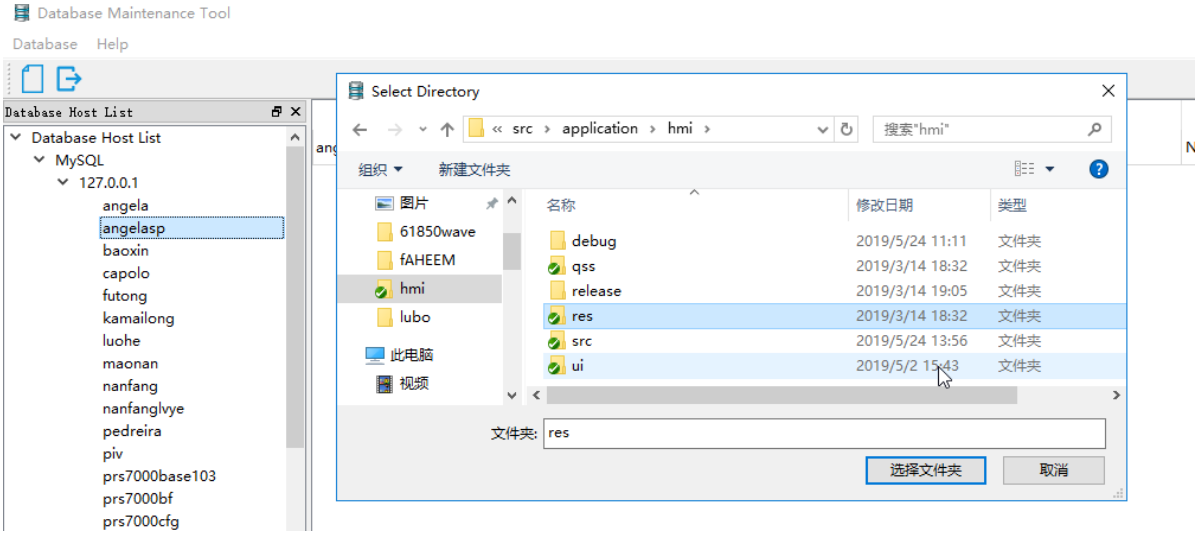


Figure 6.1.9 Selection of Database Exporting Route

When the blank reminding column under the maintenance tool displays “order execution is over”, it means that configuration database has been successfully exported:

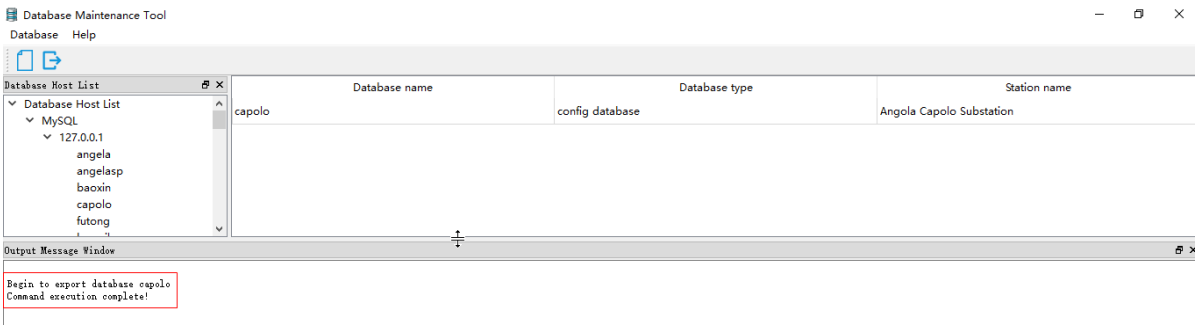


Figure 6.1.10 Database is Successfully Exported

At this time, find the route of previous new folder and open it, then we will see the ceshi.sql file is

stored under the route:

Figure 6.1.11 Exported Databae File

This is the configuration database that we just backuped.

3) Backup the historical database in the same way. As shown in below, backup ceshihis.sql and finish the backup process:

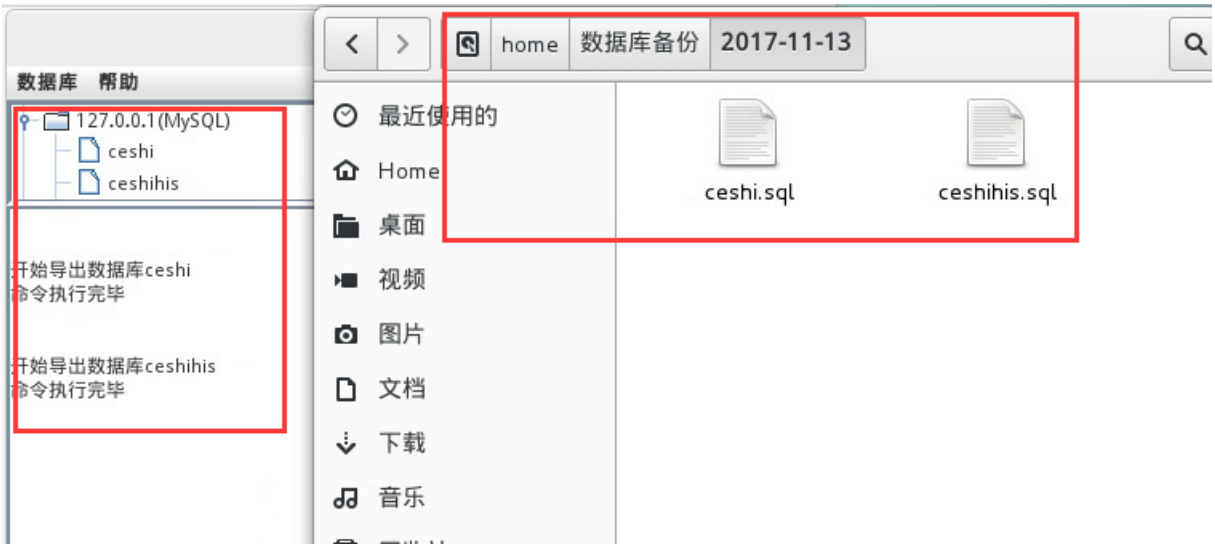


Figure 6.1.12 Exported Database and Historical Database Files

Remarks: Differences between the configuration database and the historical database are explained as below. Whenprogramed, configuration database and historical database are seprated and also corresponding. The most distinct difference can be seen from the naming rules. Name of historical database = configuration database name +his. Detailed information is as shown in the following figure:

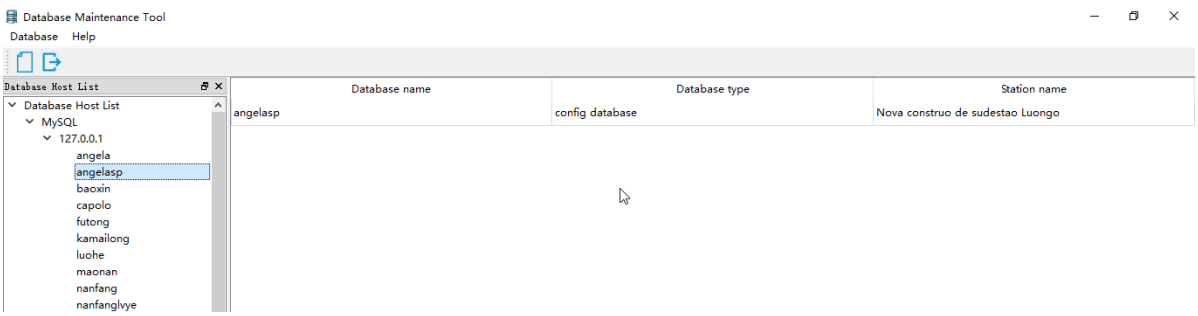


Figure 6.1.13 Differences between Database and Historical Database

A completed database backup means to backup configuration database and historical database into our local catalog.

6.1.2 Modification of Graph Configuration

1) Click “configuration icon” on the consoleconsole and select “graph configuration”:

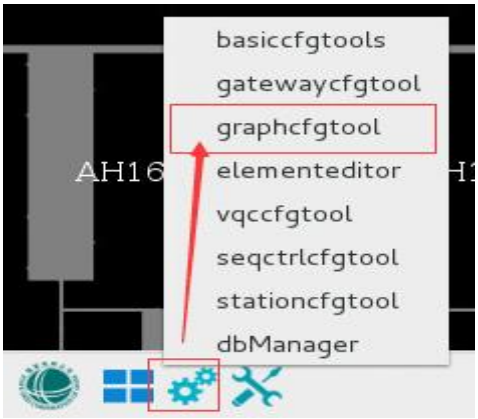


Figure 6.1.14 Select Graph Configuration Tools

Log-in dialogof graph configuration tool will pop up:

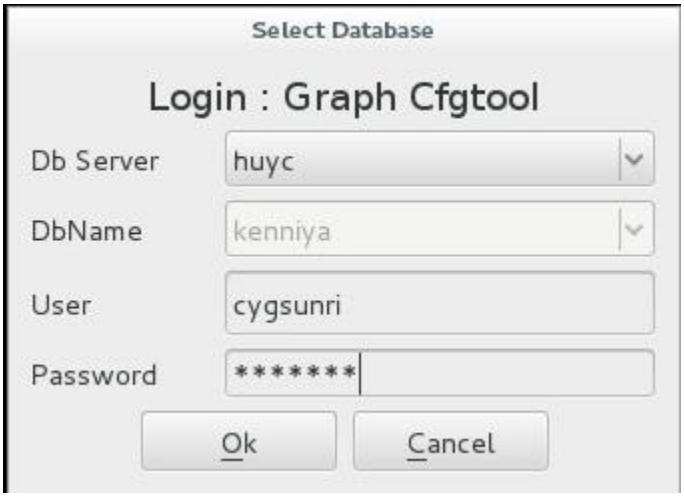


Figure 6.1.15 Log-in Graph Configuration Tools

Database server: Machine name, which means the server name;

Database: Name of configuration database;

User: User name;

Password: Password of the corresponding user;

2) EnterEnter the user name and password to enter the interface of graph configuration tools:

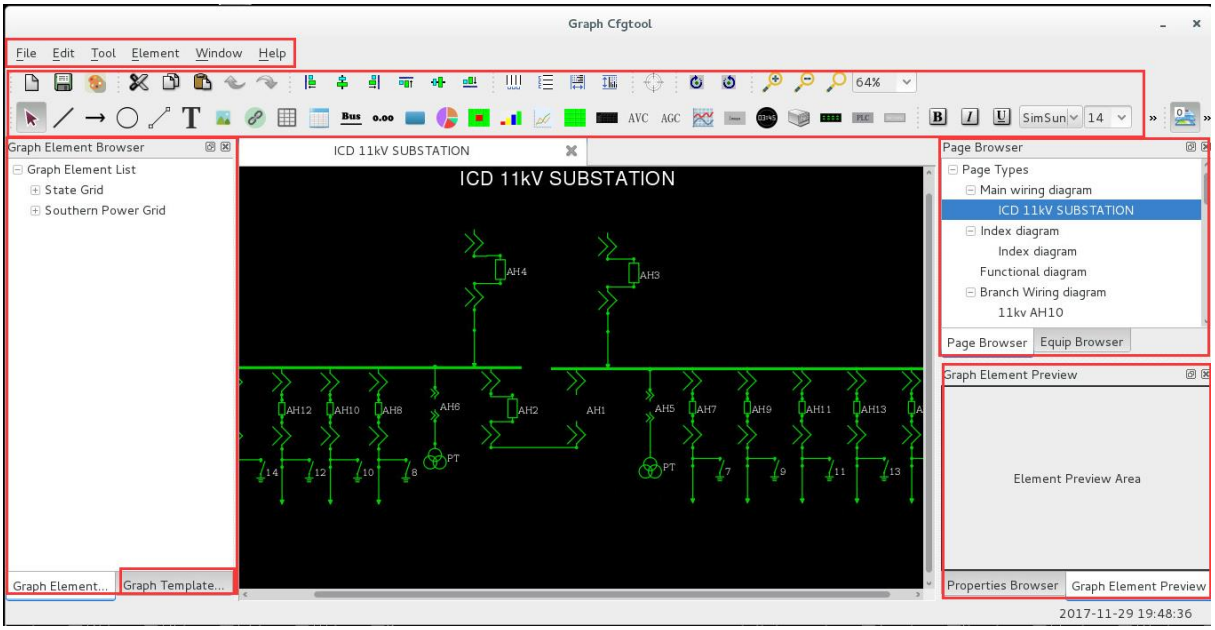


Figure 6.1.16 Interface of Graph Configuration Tools

It mainly includes 7 parts:

- Menu bar: Each menu of the menu bar has an option of drop-down box for realizing functions of saving and previewing, etc.;
- Tool bar: All graphing tools can be selected in the tool bar;
- Metafile browser: For the selection area of the primary equipment which have been put into storage, metafile can be directly dragged into the graphing area;
- Graphing area: The ultimate graphing display area. Arbitrary metafile combination of primary equipment can be performed in this area;
- Graph paper browser/equipment browser: Graph paper browser and equipment browser can be randomly switched. Graph paper browser displays all graphical interfaces. Double click the left mouse button to switch among graphical interfaces; Equipment browser includes bays of main transformers and various voltage classes of substation, primary equipment and secondary equipment of bays, and configuration information of network nodes, etc;
- Bay template browser: It provides some frequently used bay templates, which can be directly utilized;
- Property browser/metafile browser: Property browser and metafile browser can be randomly switched. Property browser displays property information of certain primary equipment in the

graphing area; metafile browser displays layer information of certain primary equipment;

3) Click the right button->equipment browser. Select the appropriate voltage class in the drow-down options of voltage class. Click the right button->create a new bay. Detailed information is as shown in the following figure:

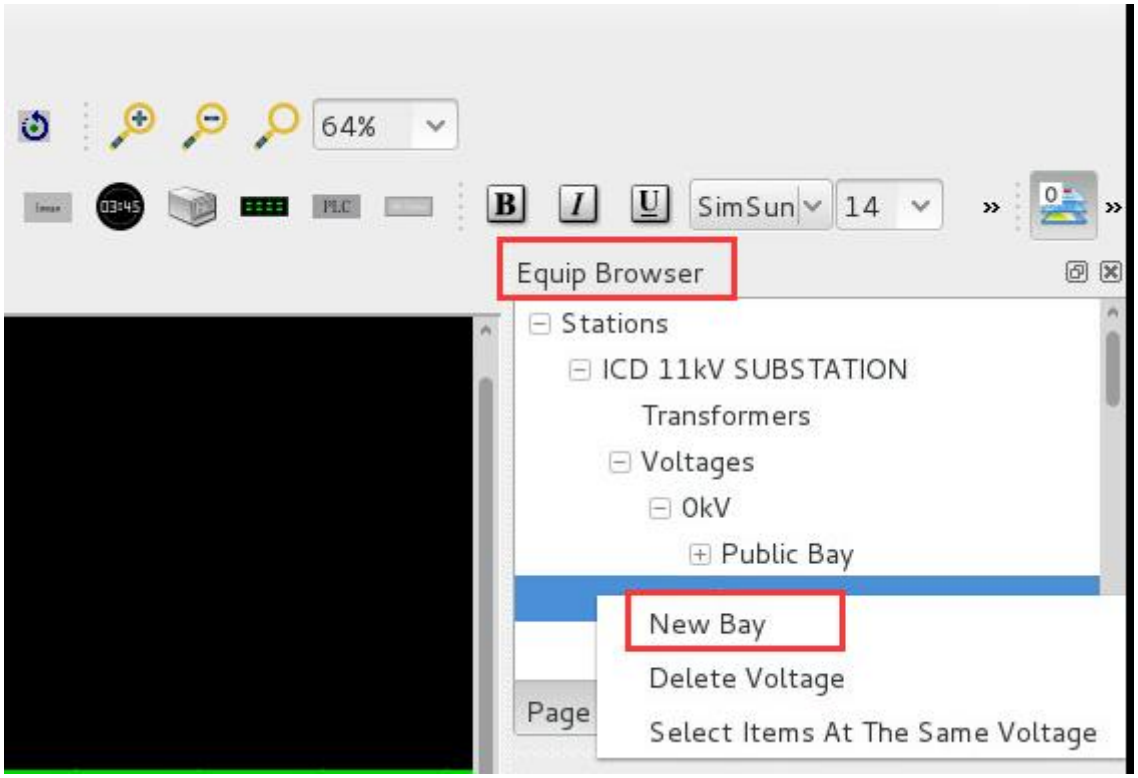


Figure 6.1.17 Interface of Create New Bays

The blockdiagram of bay information will pop up:

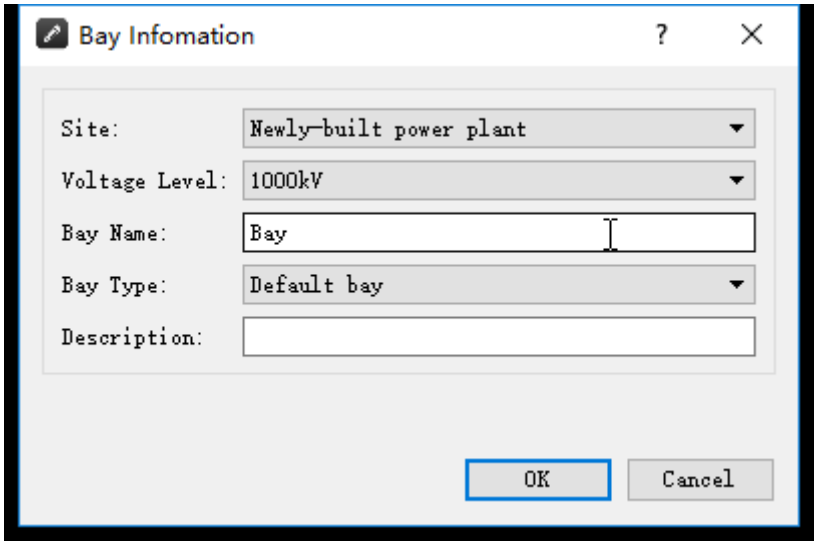


Figure 6.1.18 Bay Information Interface

Substation and voltage class are confirmed. Manually enter the bay name, such as “999 test bay”. Common options of the bay types can be selected in the drow-down box. Here we can select the “feeder outgoing line bay”. Description means the introduction to the bay and is generally the same with the bay name. In the current situation, the description is “999 test bay”. Deatailed information is as shown in the following figure:

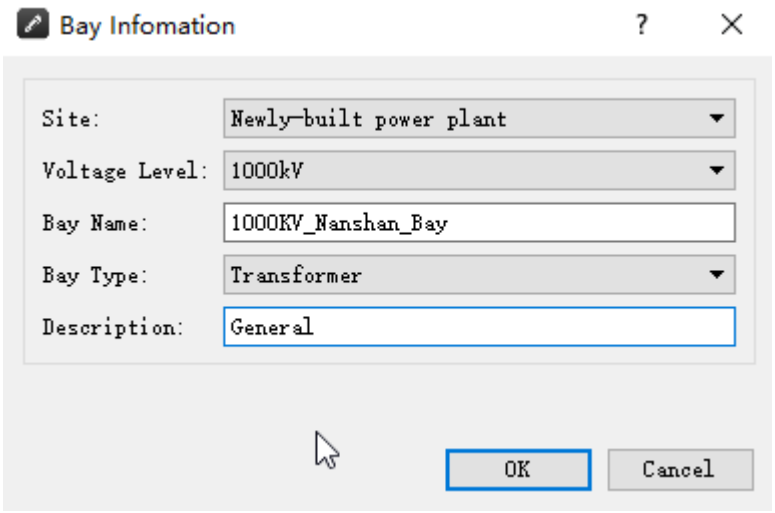


Figure 6.1.19 Filling Bay Information

Afterwards, click “confirm” button to creat “999 test bay” under voltage class of 35kV with corresponding primary equipment and secondary equipment:

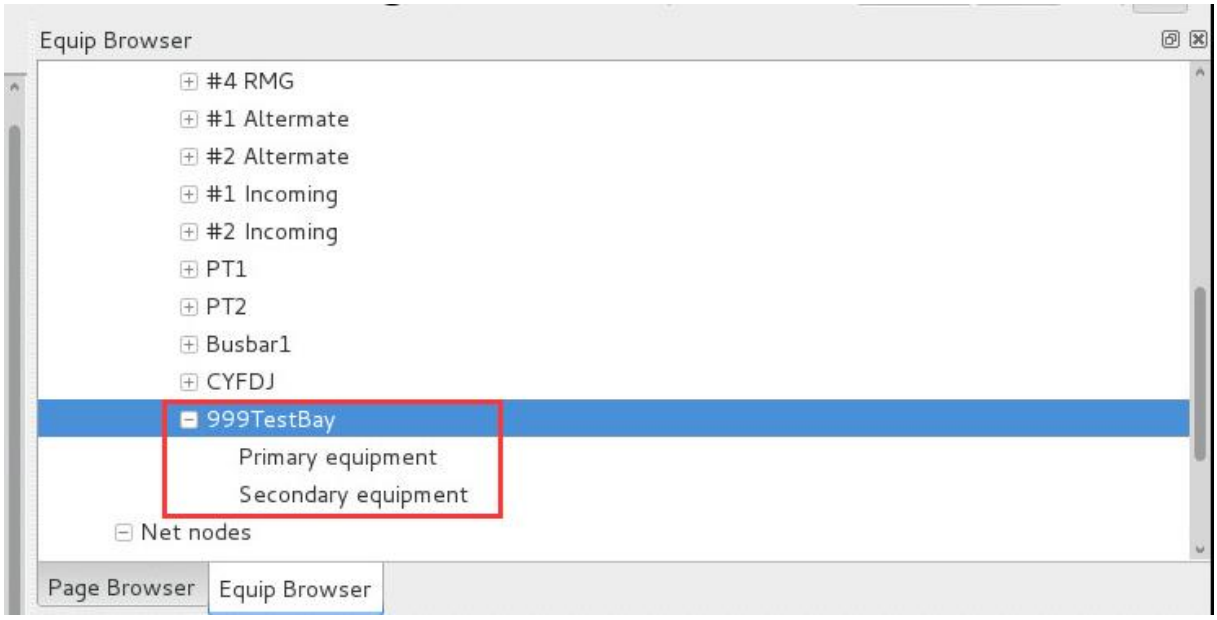


Figure 6.1.20 Create New Bays under the Corresponding Voltage Class

4) Select the graph paper browser, then select the main wiring diagram in graph types, double click the drop-down options of the main wiring diagram to display the main wiring diagram of the overall substation:

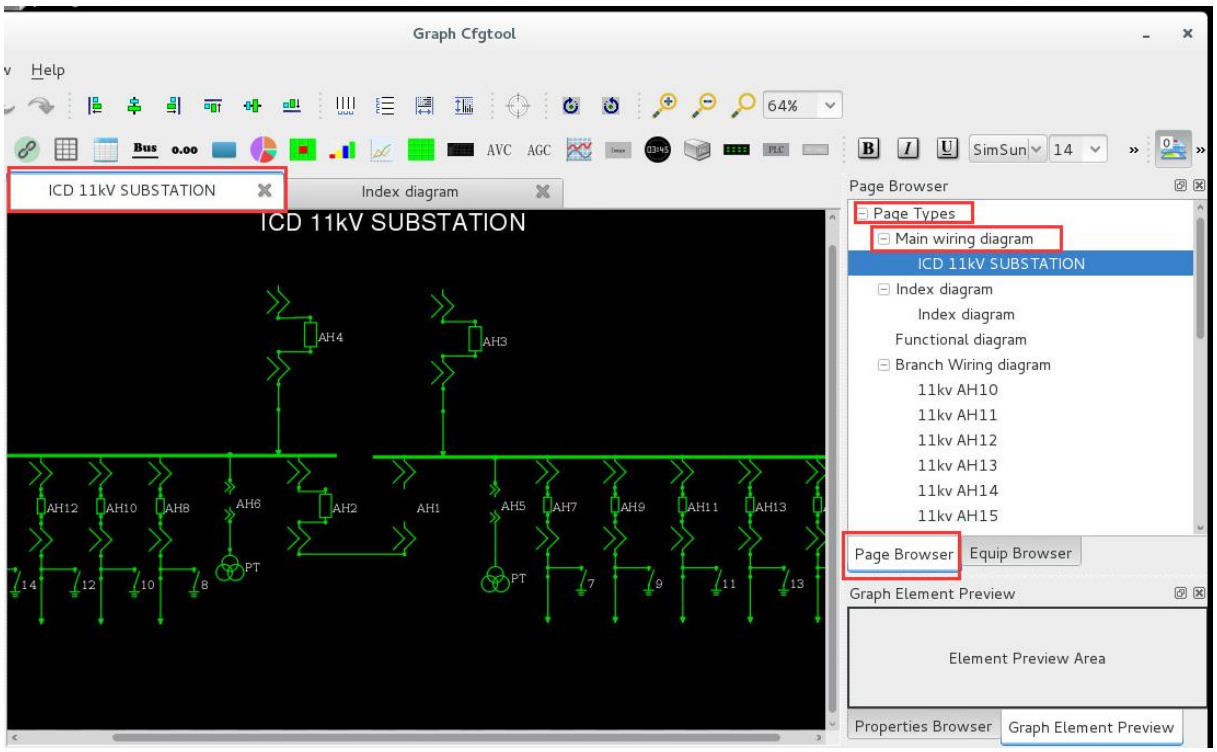


Figure 6.1.21 Main Wiring Diagram

5) Find the position of the new bay as per the main electric wiring diagram and confirm the primary equipment in the new bay. For example, “999 test bay” is on the letter I with one switch, one handcart and one earthing knife-switch. Then it is on the left side of the graph configuration tool. Find the corresponding metafile in the metafile browser and drag it to the corresponding position of main wiring diagram:

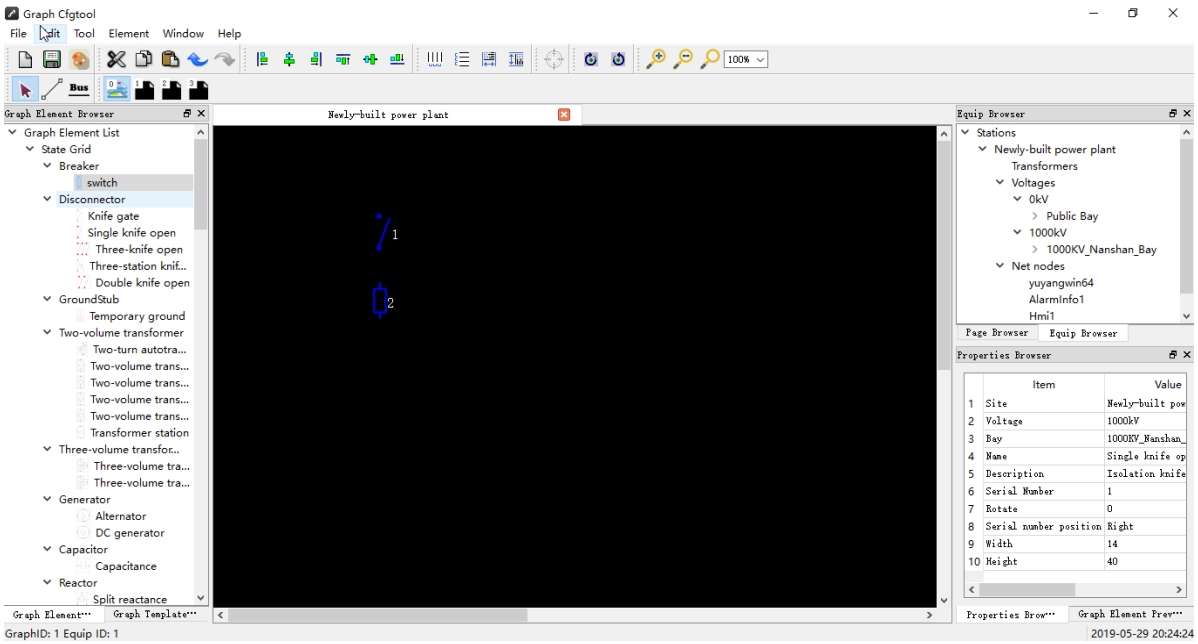


Figure 6.1.22 Metafile Browser

6) Click the switch button in metafile list with the left mouse button and drag the switch icon to the corresponding position of the graphing area. Then the dialog box of “equipment information” will pop up:

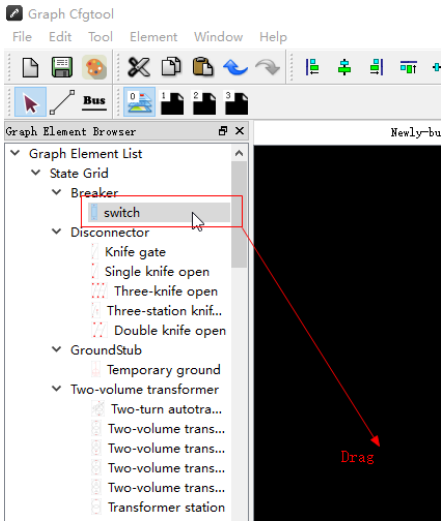


Figure 6.1.23 Creat Primary Equipment

Substation: It displays the substation that the equipment belongs to. Normally it is set by default;

Voltage: Select the voltage class of the equipment. As the voltage class of the new 999 bay bay is 110kV, we need to select 110kV;

Select bays: Select the bays of the equipment. In the current situation, we need to select 999 test bay;

Equipment name: Enter as per names on the electric diagram. For example, we can enter 999 switch;

Equipment voltage: It means the voltage class of electrified equipment. In the current situation, it is 110kV;

Description: It describes types of primary equipment;

Equipment number: The unique number of the primary equipment on the main electric wiring diagram;

Detailed information is as shown in the following figure:

Figure 6.1.24 Information of New Primary Equipment

After verification, click the confirm button and an actual switch icon will be displayed on the position which is originally used to place switch. The color of the icon is confirmed in accordance with electric standards after selecting voltage clasee:

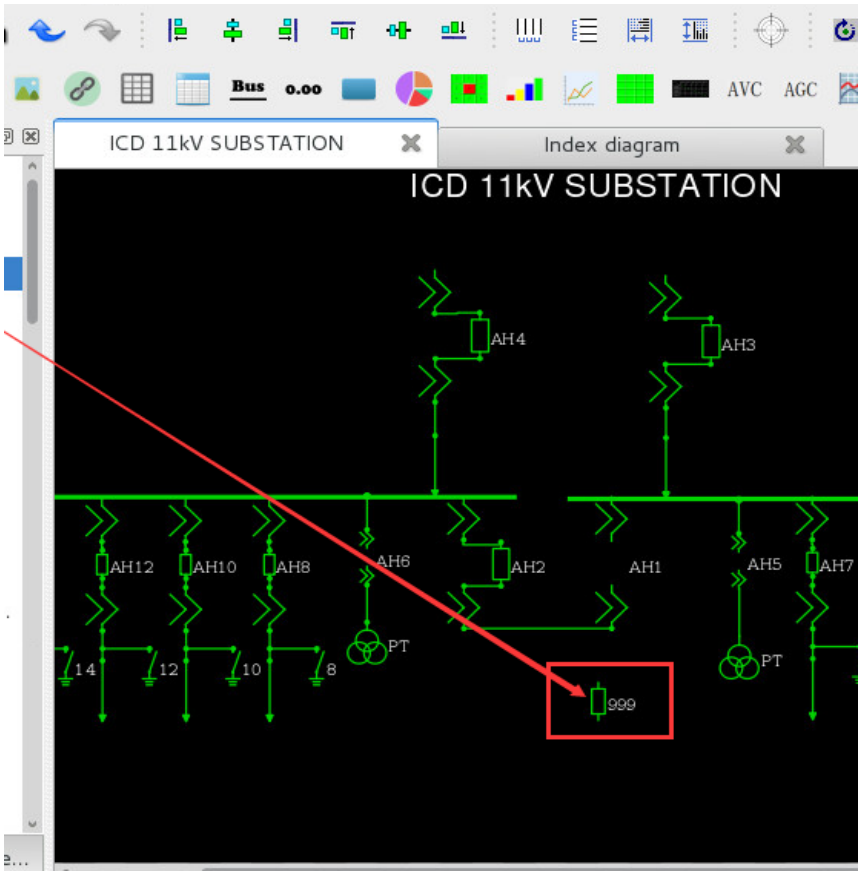


Figure 6.1.25 Creation of Primary Equipment is Finished

Click the swtich with the left mouse button and the corresponding properties will be displayed in the propery browser at the bottom right of graph configuration tools:

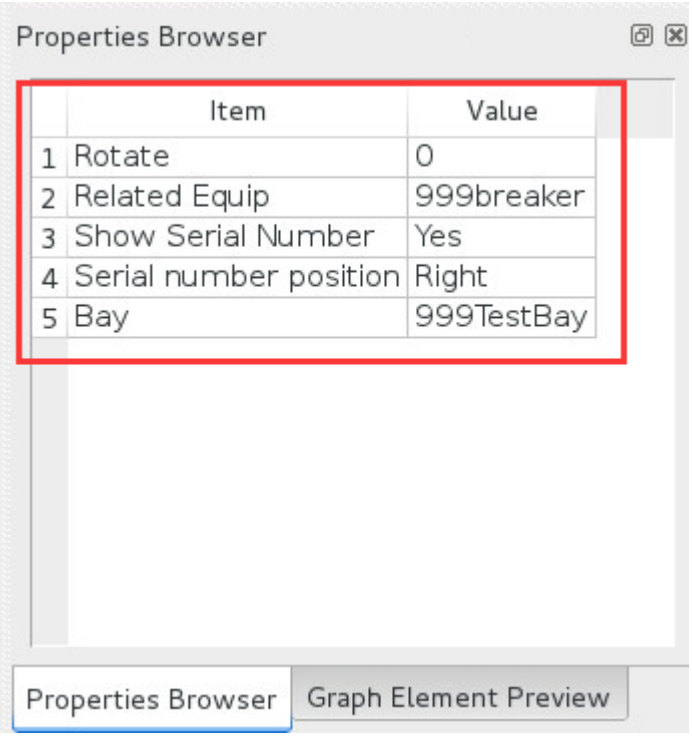


Figure 6.1.26 Property Browser

Rotation angle: It means the rotation angle of the primary equipment;

Associated equipment: It means name of the equipment;

Display number: Select No, then the number of primary equipment will not be displayed;

Number position: Positions of up, down, left and right can be selected;

Bay: It means the belonging bay;

Select the left metafile browser to check the metafile status of the switch: In the following figure, one can see that the switch belongs to the four-state equipment.

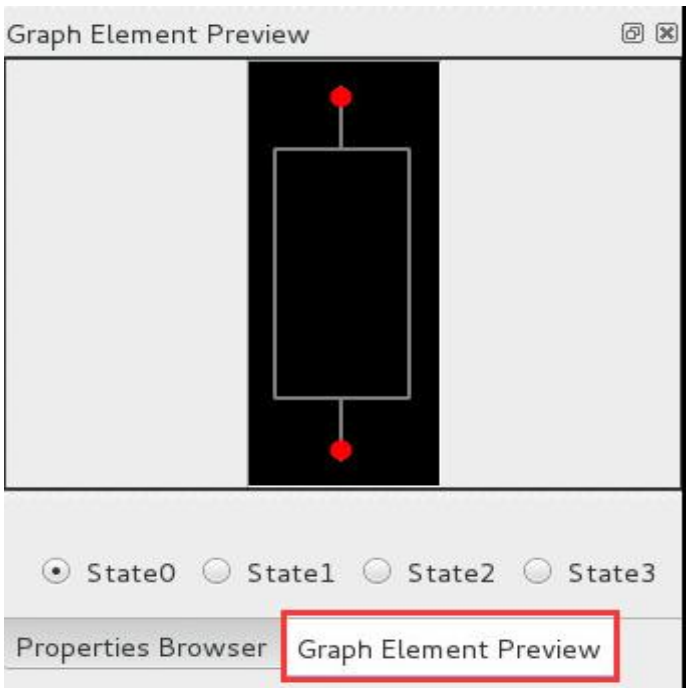


Figure 6.1.27Metafile Browser

Remarks:

- If the breaker name is wrong, double click the breaker with the left mouse button and the dialog box for modifying name will pop up. Click confirm button after modification:

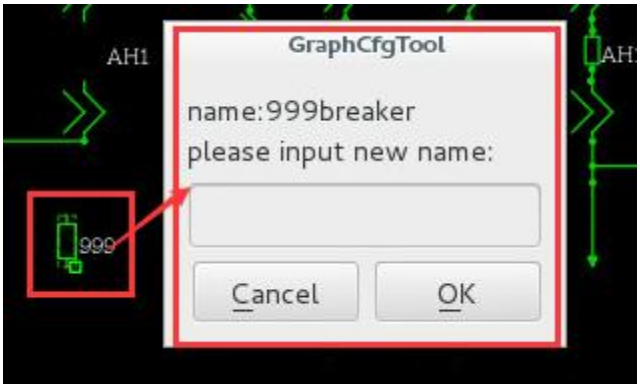


Figure 6.1.28 Rename Primary Equipment

- Size of breaker is adjustable. Click the left mouse button to select the small rectangle on the bottom right of switch to adjust its size;

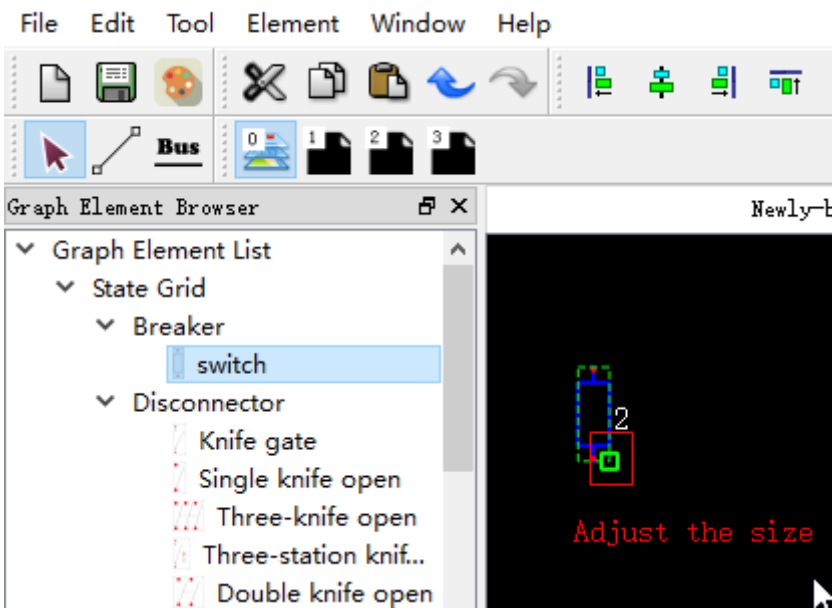


Figure 6.1.29 Adjust Size of Primary Equipment

7) Successively add the handcart, earthing knife-switch and AC outgoing line with the above mentioned method. Detailed information is as shown in the following figure:

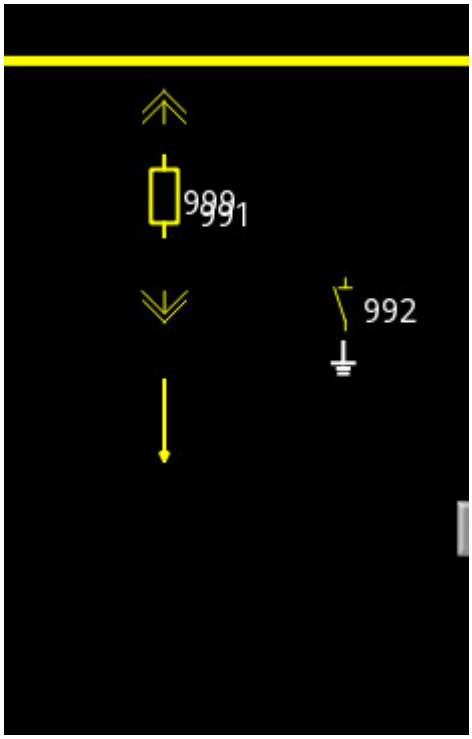


Figure 6.1.30 Adding Primary Equipment is Finished

It means all the primary equipment added in the 999 test bay;

8) Select the connecting line (the straight line with small circles on both ends) in the tool bar on top left corner of the graph configuration tools. After moving the mouse to the corresponding position, there will be relevant illustrations about tools in the tool bar being displayed.

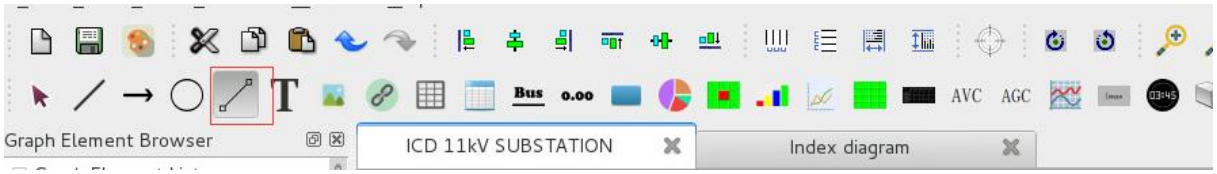


Figure 6.1.31 Tool Bar Illustration

Connect the primary equipment with connecting lines. For example, connecting the outgoing line and handcart with a connecting line. Click the connecting line with left mouse button and move the mouse to the connection point, and then a red attachment point will be displayed.

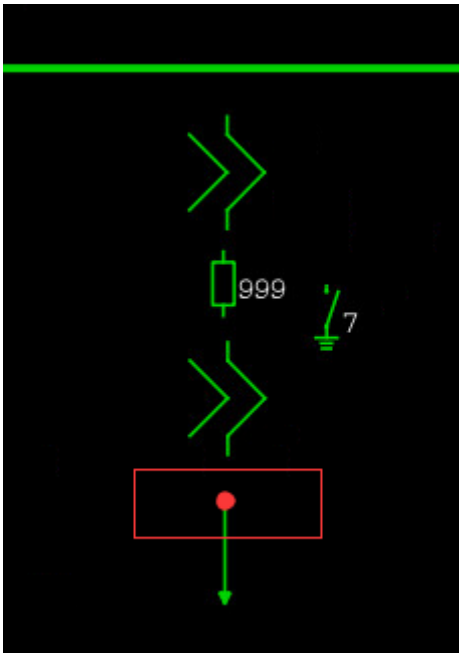


Figure 6.1.32 Starting Point of Primary Equipment Connection Line

Then move the mouse to the attachment point of handcart and a red point will be displayed:

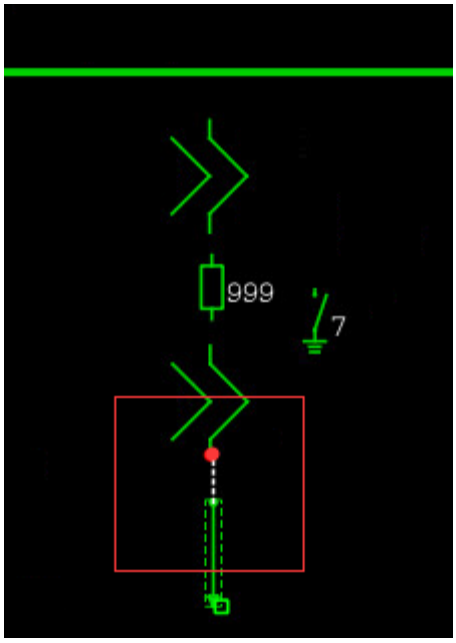


Figure 6.1.33 Ending Point of Primary Equipment Connection Line

Click the left mouse button and the outgoing line and handcart will be connected.

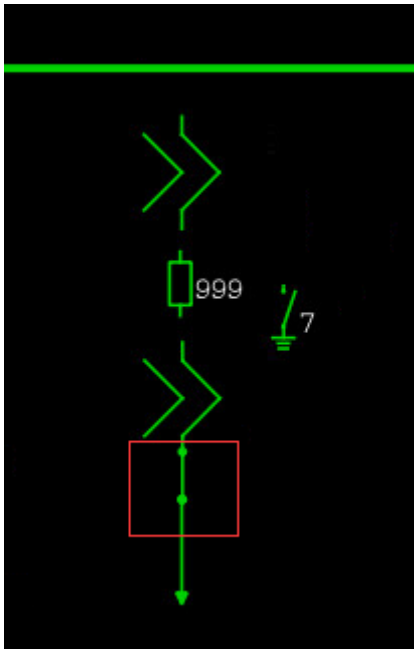


Figure 6.1.34 Primary Equipment is Sussefully Connected

All primary equipments are connected with the connection lines. Adopt the same method to connect all the primary equipments. Then a completed new bay graph will be displayed on the main connection diagram. Detailed information is as shown in the following figure:

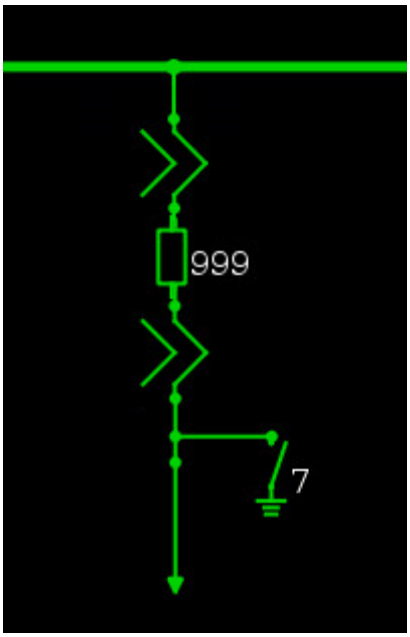


Figure 6.1.35 Graphing of New Bay is Finished

9) Click the “breaker” icon with the left mouse button. Then click the right mouse button and a box will be displayed:

Figure 6.1.36 Generate Detailed Drawing of Bay on Basis of Primary Equipment

After clicking the button of “generate detailed drawing of the bay”, a dialog box of “graphics parameter configuration” will pop up:

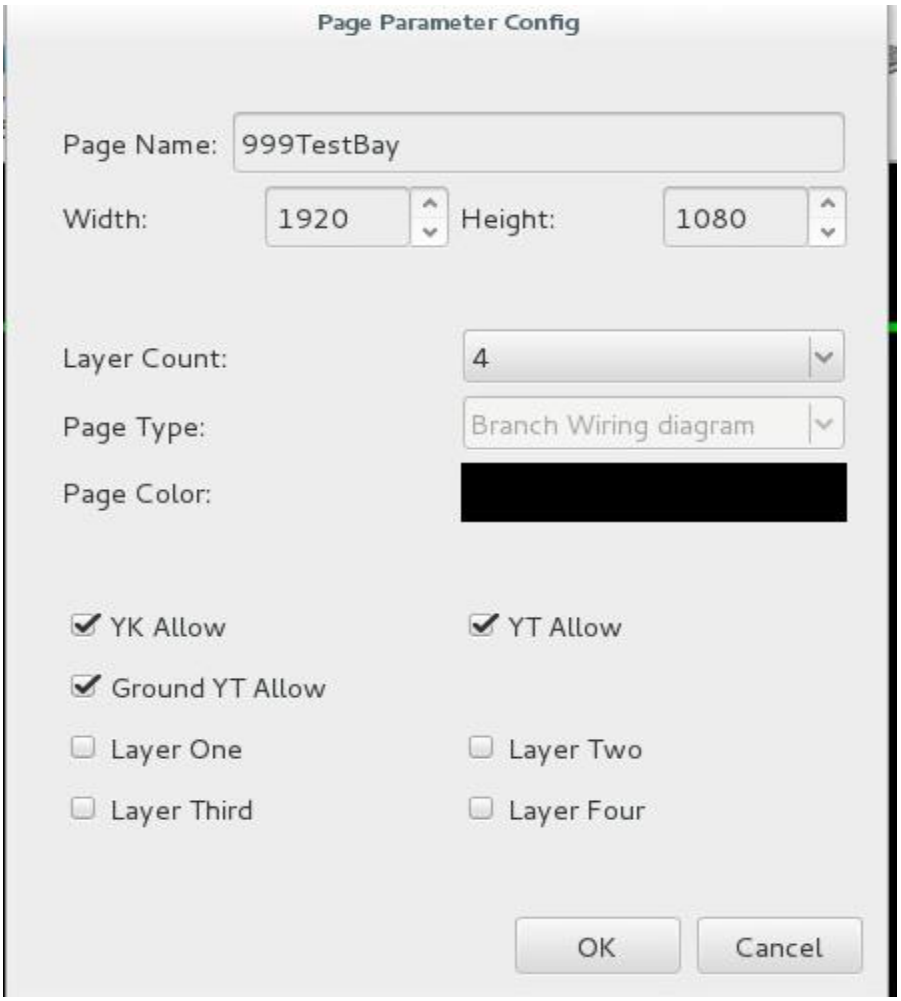


Figure 6.1.37 Graphics Parameter Configuration

After clicking the “confirm” button, a detailed drawing of 999 test bay will be automatically generated which includes all primary equipment of the bay. Detailed information is as shown in the following figure:

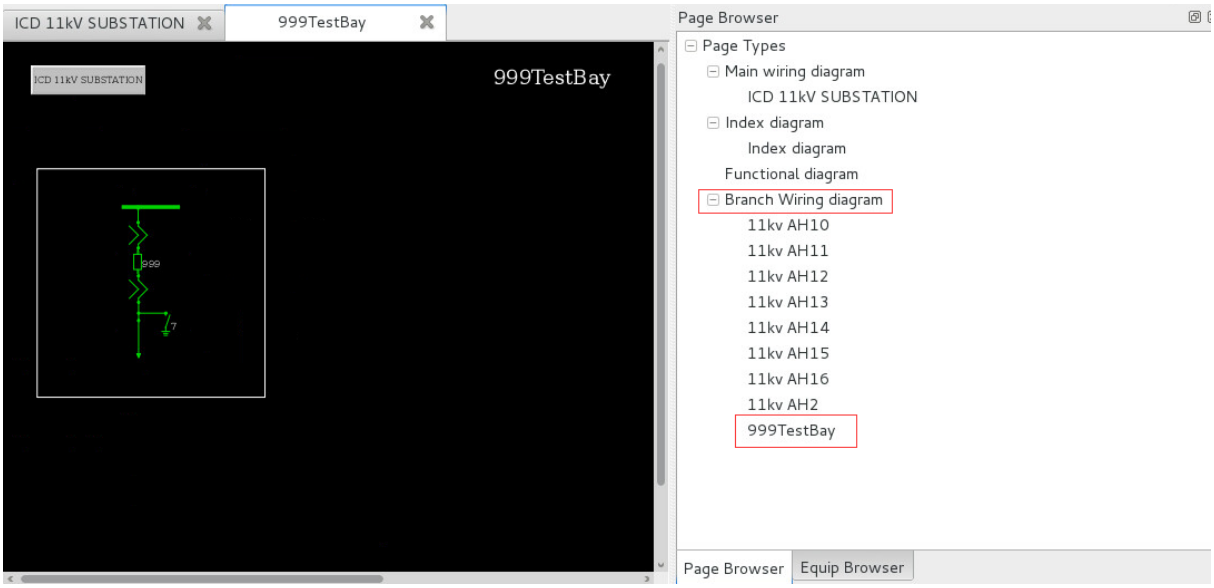


Figure 6.1.38 Generation of Bay Detailed Drawing is Finished

10) All open graph lists will be displayed in the graphing area. Detailed information is as shown in the following figure:

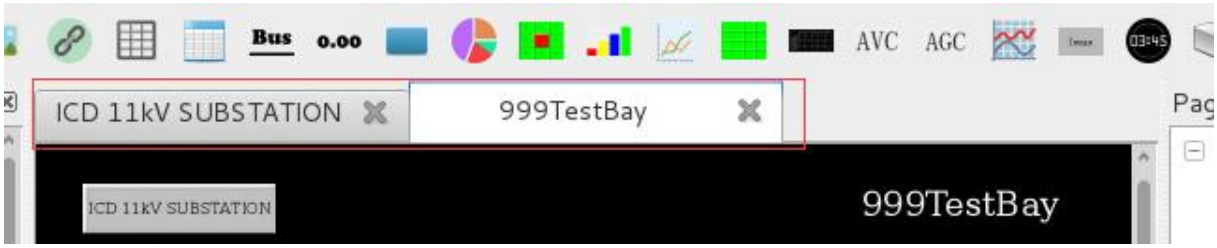


Figure 6.1.39 Graph List

Left-click the “main wiring diagram” button to return to the interface of main wiring diagram.

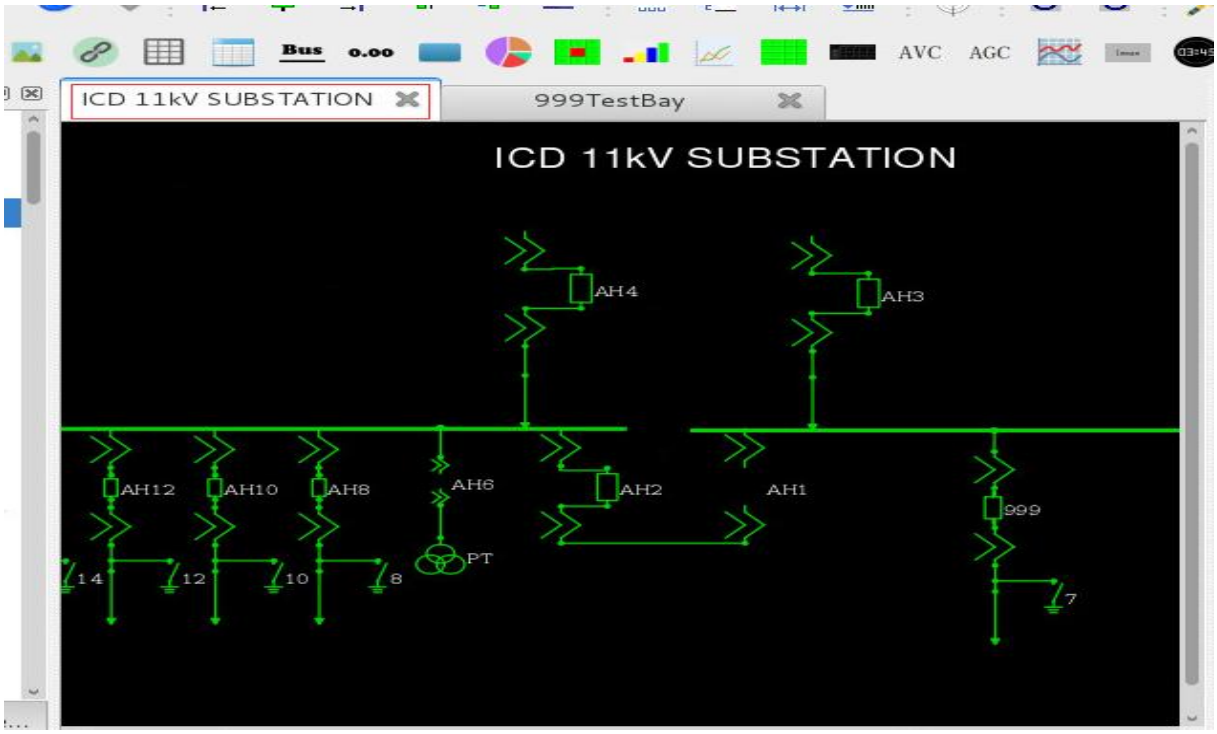


Figure 6.1.40 Main Wiring Diagram

11) Click the “interlinking (P)” in tool bar with the left mouse button. Then click the left mouse button under the new bay graph to draw a rectangle. Then click the left mouse button to have it relased. Detailed information is as shown in the following figure:

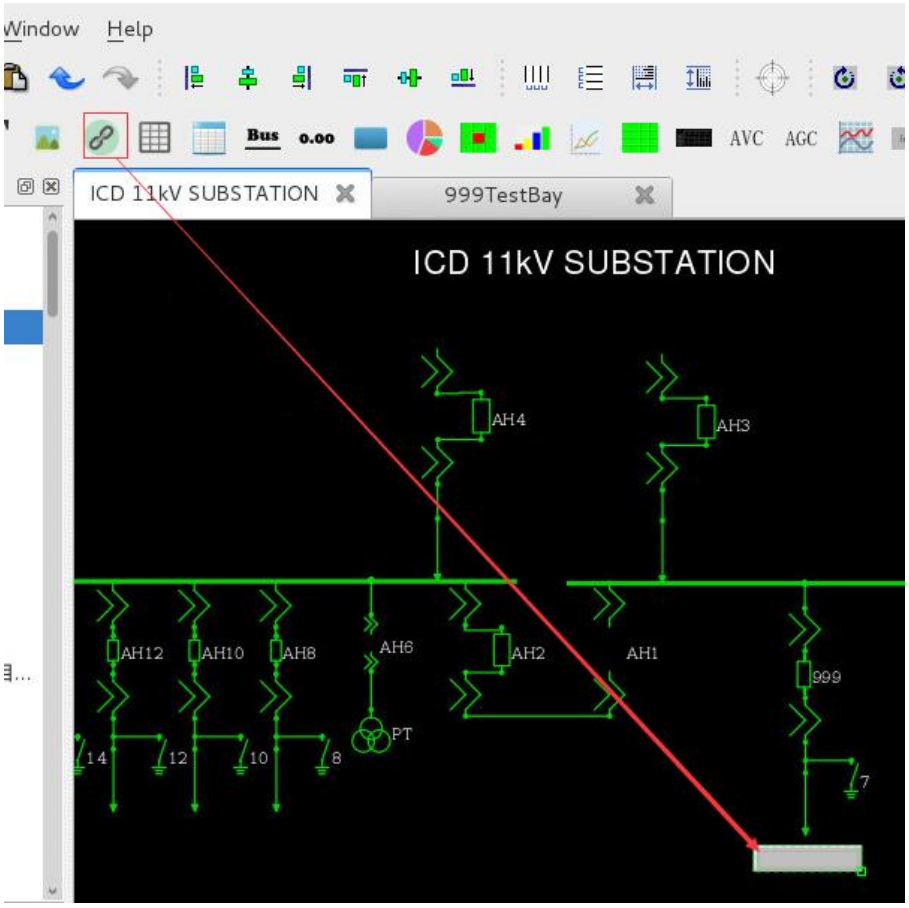


Figure 6.1.41 Interlinking Figure of Added Bay

Click the rectangle which was just finished and click the button of “connection interface” in the property browser. A drop-down box will pop up. Then select the newly created “999 test bay”:

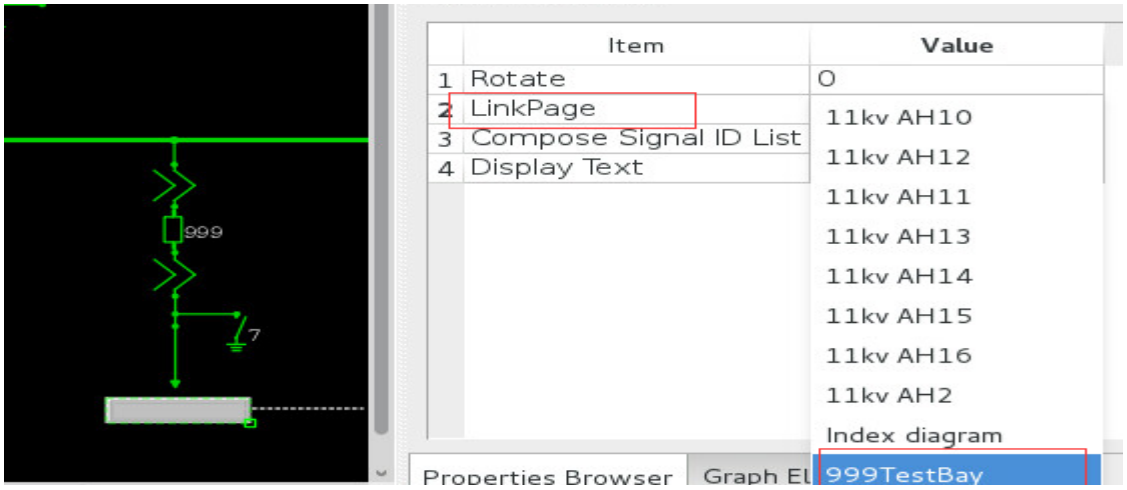


Figure 6.1.42 Interface Association of Bay Interlinking Metafile

Then the text of “999 test bay” will be displayed on the interlinking metafile. It will establish the association relationship between the extension diagram and interlinking metafile. While operating, click the interlinking metafile to directly access the sub-interface of “999 test bay”:

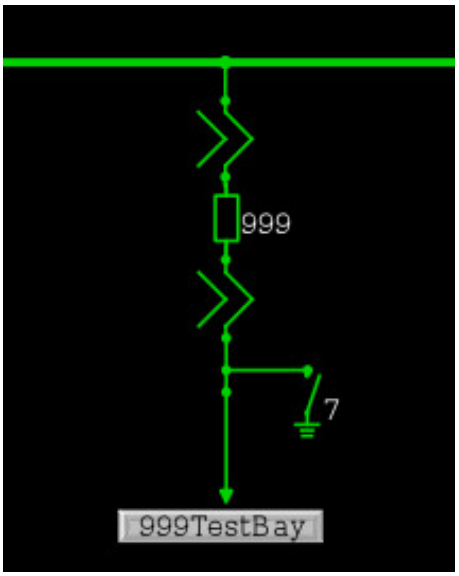


Figure 6.1.43 Graphing of Bay Interlinking Metafile

At present, all works on the mian wiring diagram have been finished. Click the “save” button on top left corner to save all modifications (it is suggested to save after finishing each step, then save all information after finishing the overall process):

Figure 6.1.44 Save Modifications

After clicking the “save” button, a dialog box of “check associated information” will pop up. Click “No”:

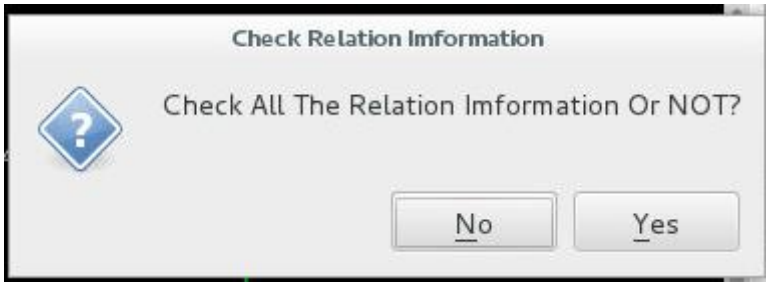


Figure 6.1.45 Ceck Associated Information

Then a dialog box of “save” will pop up. Click “confirm”:

Figure 6.1.46 Save Database

Click the “X” button on top right coner of the “graph paper configuration tools” to close the graph paper configuration tools.

6.1.3 Modification of Basic Configuration Tools

1) Click “configuration icon” on the console and select “database configuration”:

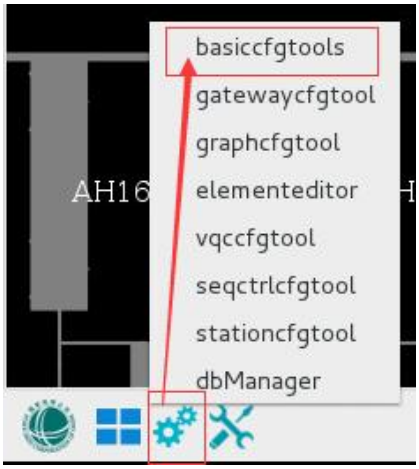


Figure 6.1.47 Database Configuration Selection

Click “database configuration” with the left mouse button and a dialog box of “log in: basic configuration tools” will pop up:

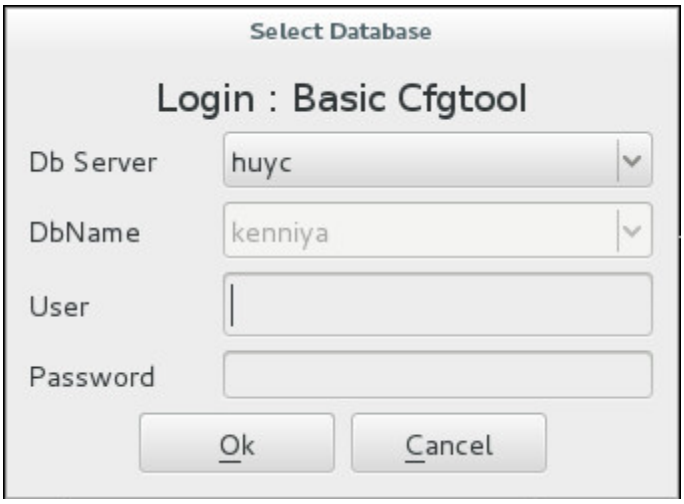


Figure 6.1.48 Log in Database Configuration

Database server: Machine name, which means the server name;

Database: Name of configuration database;

User: User name;

Password: Password of the corresponding user;

2) Enter the user name and password to enter the interface of configuration tools:

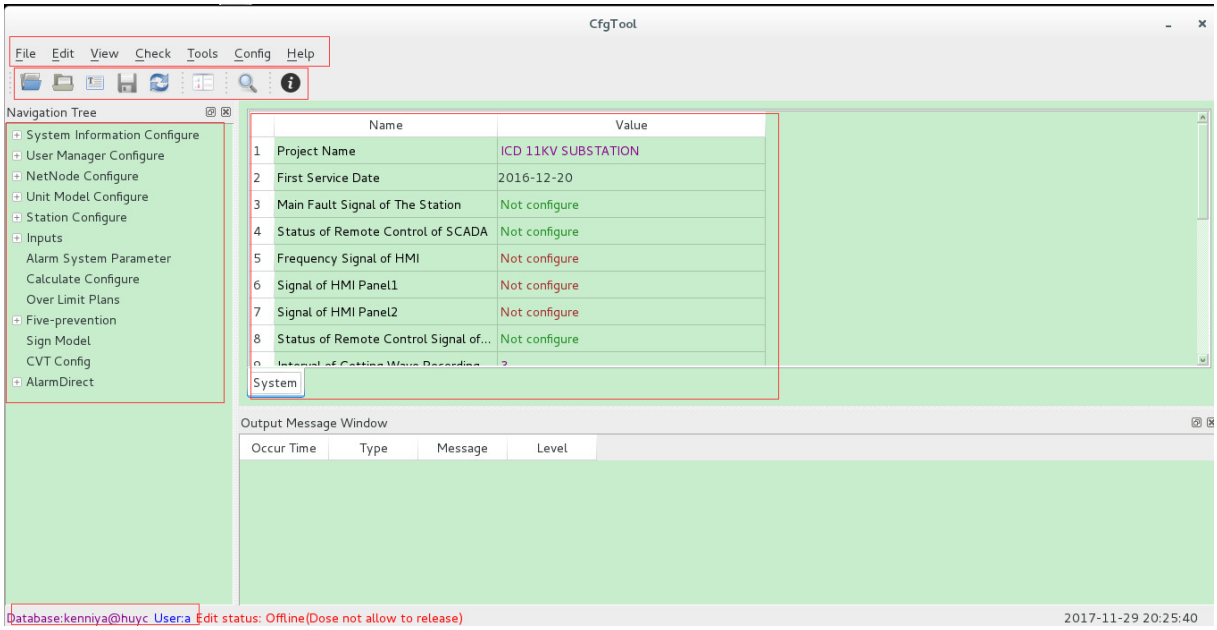


Figure 6.1.49 Introduction of Database Configuration Interface

- Menu bar: Move the mouse to the menu bar and the corresponding application will be displayed. Then click and select the application;
- Tool bar: Move the mouse to the tools and the cooresponding application will be displayed. Click the left mouse button to select.

- Navigation tree: All applications of configuration tools are included in the navigation tree. See detailed information in Chapter3;
- System parameter: Default content after accessing the configuration tools;
- Display the current log-in user and configuration database;
- System time: It displays the current machine time;

3) Click navigation tree--->configuration of secondary equipment template. Click the "+" icon on the right side with the left mouse button and all imported templates of the station will be displayed:

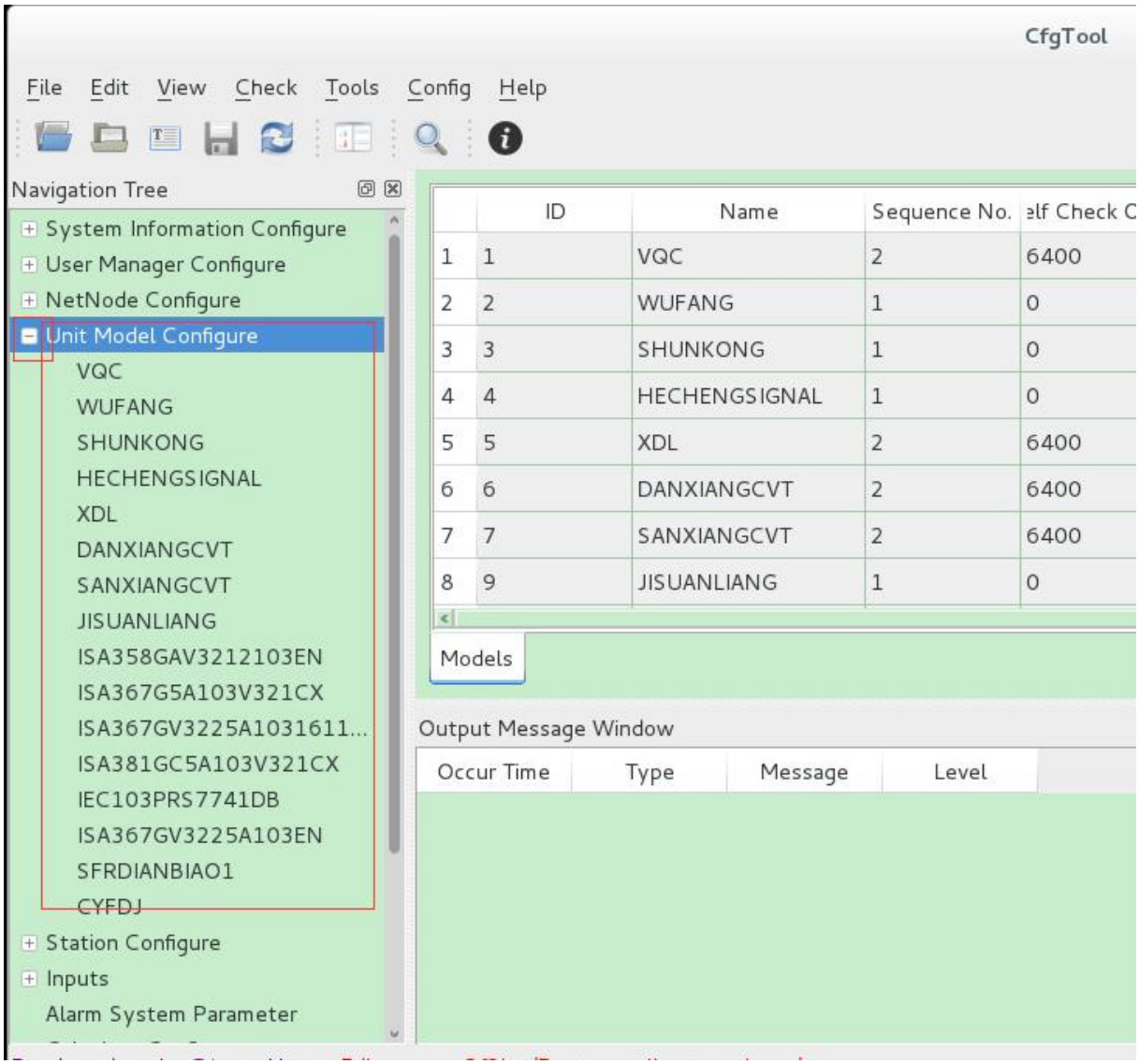


Figure 6.1.50 Secondary Equipment Configuration

Click the right mouse button on the "secondary equipment templatec onfiguration" and a choice box will be displayed:

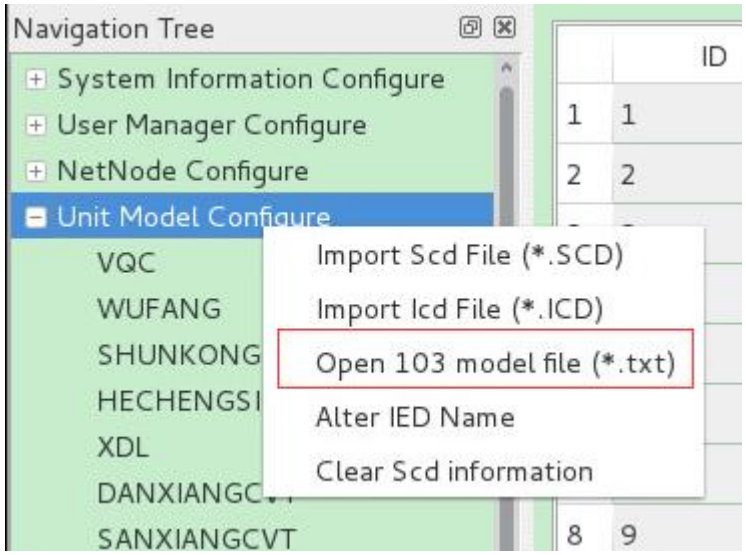


Figure 6.1.51 Import 103 Template

If the new bay equipment is 103 communication, select “import 103 template file (*.tx)”;

If the new bay equipment is 61850 communication, select “impot Scd file (*.SCD)” or “import ICD file (*.ICD)”;

Taking the 103 template of “999 new bay” as an example, select “import 103 template file (*.tx)” and the choice box of “import 103 equipment template file” will pop up:

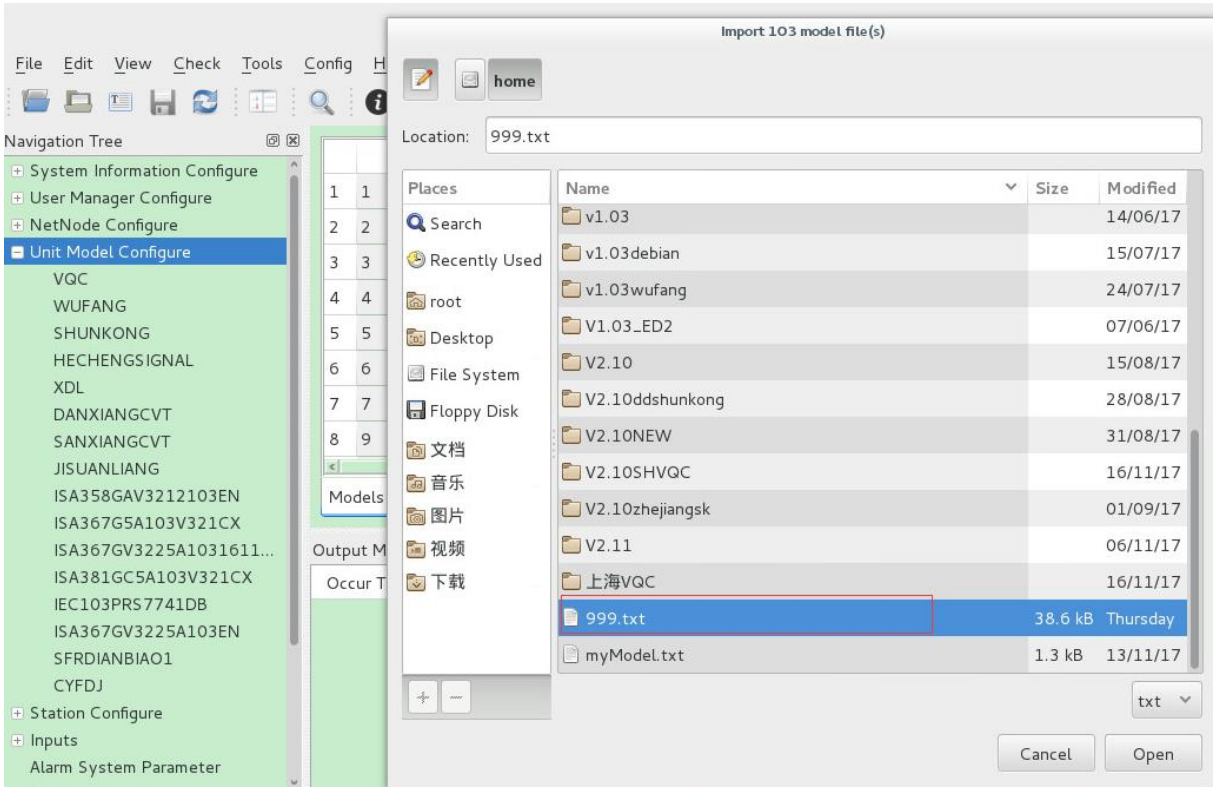


Figure 6.1.52103 Template Selection

Select the template file under the corresponding route, click to open it, and the “999” template will

be impoted in the drop-down menu of “secondary equipment template configuration”.

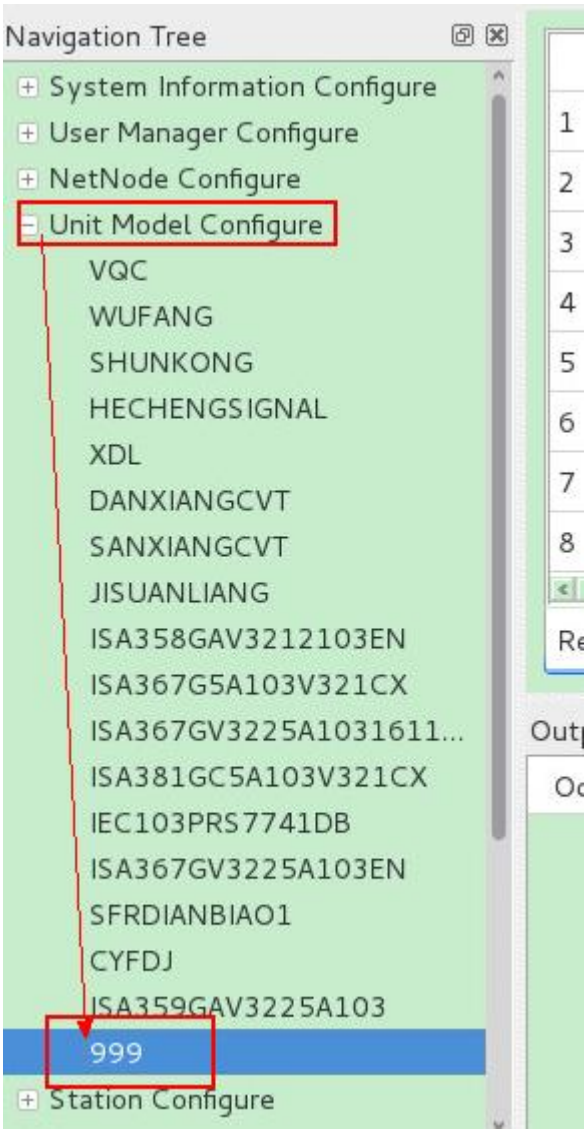


Figure 6.1.53 Importation of 103 Template is Finished

4) Click navigation tree----->substation configuration----->secondary equipment configuration. Click the right mouse button and a choice box will pop up:

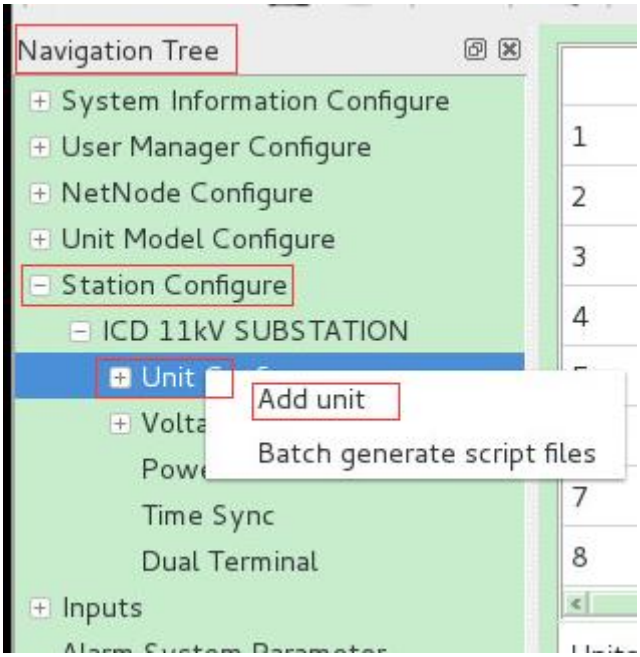


Figure 6.1.54 Create Seondary Equipment

A“unit configuration dialog box” will pop up after selecting the “creat secondary equipment”:

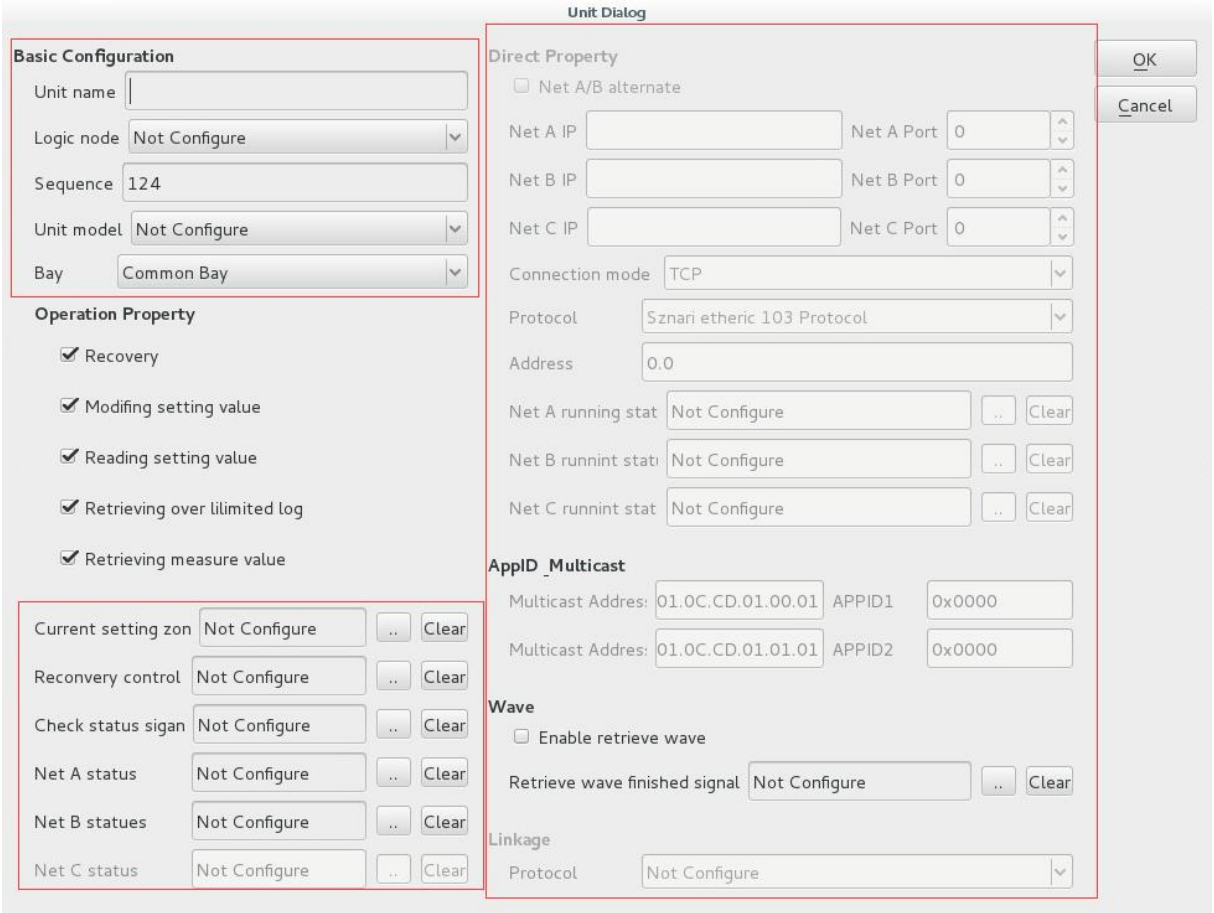


Figure 6.1.55 Configuration Dialog Box of Secondary Equipment

a, Among all the basic properties:

- Unit name: It means the name of secondary equipment. In the current situation, we should fill in “35kV feeder protection and measurement equipment ISA-999” according to standards (voltage class+function+equipment name);
- Logical node: Select the logical node of secondary equipment. In case of direct communication with monitoring host, select “server”; in case of oursourcing equipment, select “protocol converter” or “DataGateWay”. In the current situation, we assume it as the direct communication with monitoring host and select “server”;
- Internal node sequence: Automatically distributed by program;
- Unit template: The matching equipment template of secondary equipment. In the current situation, it means the previously imported “999” template;
- Bay: Select the belonging bay of secondary equipment, that is to say, “999 test bay”;

b, Operational property: Select all by default;
c, Among all the direct connection properties:

- AB networks are mutual standby: If the station is equipped with AB dual networks, then select it; if the station is in unit, then don’t select it;
- A network IP: Fill in the IP distributed to the equipment, such as 222.111.112.99;
- A network port: Always fill in 2420
- Connection type: Select TCP;
- Communication protocol: Select according to per actual conditions. In case of 103 communication equipment, select “Shenzhen Nari Ethernet 103 protocol”;
- Communication address: Fill in the last two number of A network IP. In the current situation, fill in 112.99;
- Related remote signal for A/B networks: Automatical correlation without filling in;

d, AppID and multicast:

- Multicast address 1/2; no need to fill in;
- APPID1/2: Fill in the last two numbers as the last number of A network IP. In the current situation, it is 0x0099;

e, Record: No need to fill in;
f, Hitchedcommunication equipment: No need to fill in;
g, Current setting zone and setting items: Automatically filling in, and no need to fill in manually;

5) Click “confirm” button after finishing the overall process. Then click the secondary equipment to check the corresponding signals of remote signal, measurement, remote control and regulating (all signals in the default template will be automatically imported);

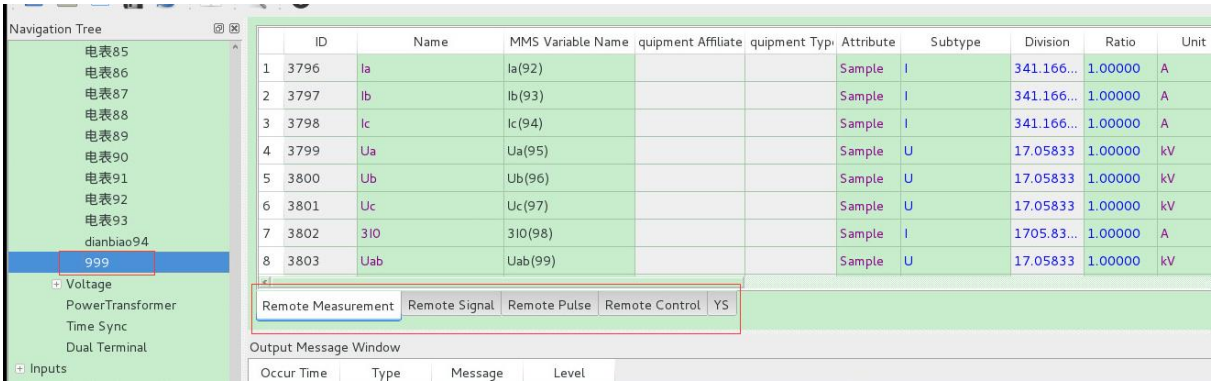


Figure 6.1.56 Signals of Telemetering, Remote Signal, Remote Control and Regulating of the Secondary Equipment

6) In the remote signal list:

Modify signal names as per the electric installation drawing. For example, remote signal 01 refers to the switch position, remote signal 02 refers to the handcart position, remore signal 03 refers to the earthing knife-switch position, etc;

Modification of signal properties. Signal properties of all primary equipment must be selected as equipment status, that is to say, click the right mouse button—>edit. Select equipment status in the pop-up choice box;

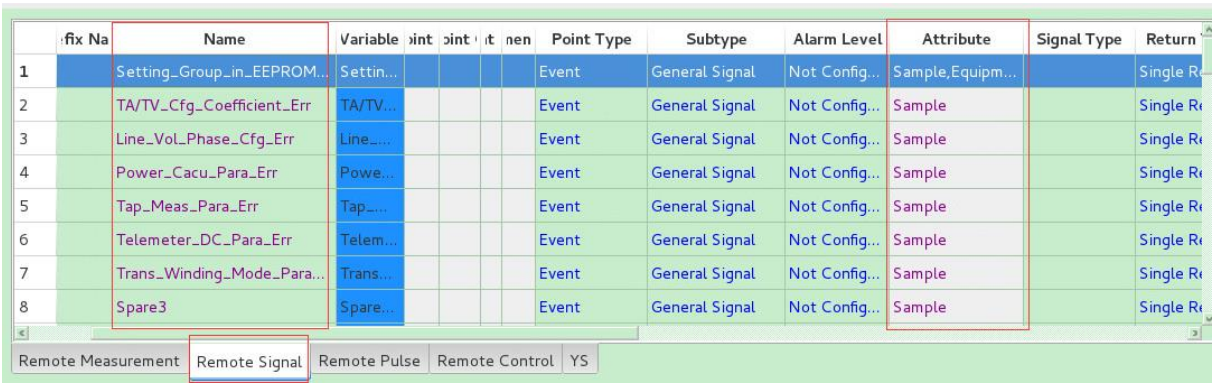


Figure 6.1.57 Configuration of Secondary Equipment Remote Signaling Property

7) Then select remote control property. Modify the remote control name as per the electric installation drawing of secondary equipment. For example, set the remote open1 outlet /remot close 1 outlet as remot switch control:

Figure 6.1.58 Modification of Remote Controlling Name

8) Click navigation tree------>voltage class------>35kV and select the new “999 test bay”. Select “switch/disconnecting link” option (display the primary equipment of all new bays in graph tools). Detailed information is as shown in the following figure:

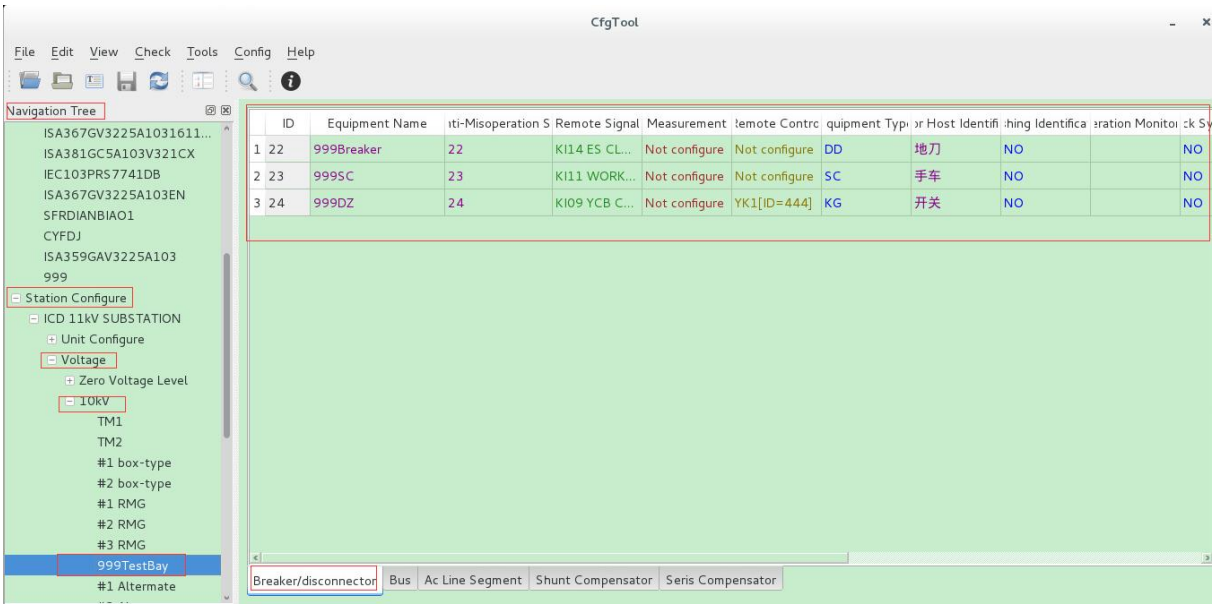


Figure 6.1.59 Primary Equipment Selection

Associate remote position signal of each equipment. Click the remote position signal of switch and a property window will pop up:

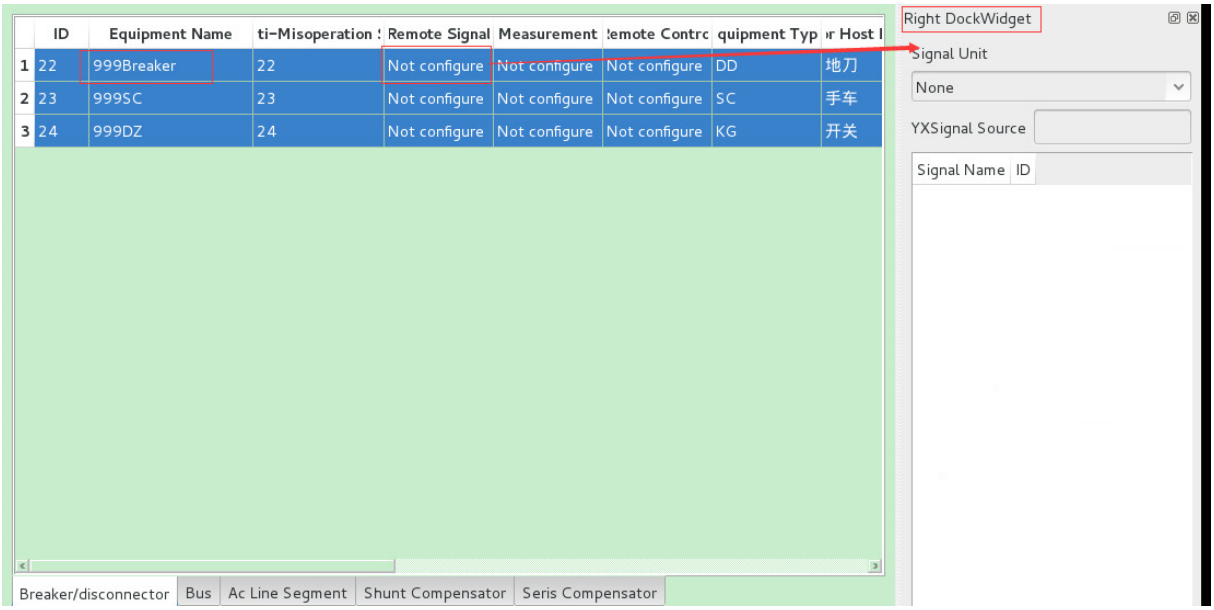


Figure 6.1.60 Selection of Primary Equipment Remote Position Signal

Click the property window to display drop-down box of secondary equipment. Select the added “35kV feeder protection and measurement equipment ISA-999” and the remote signal of properties of all selected “equipment status” will be displayed:

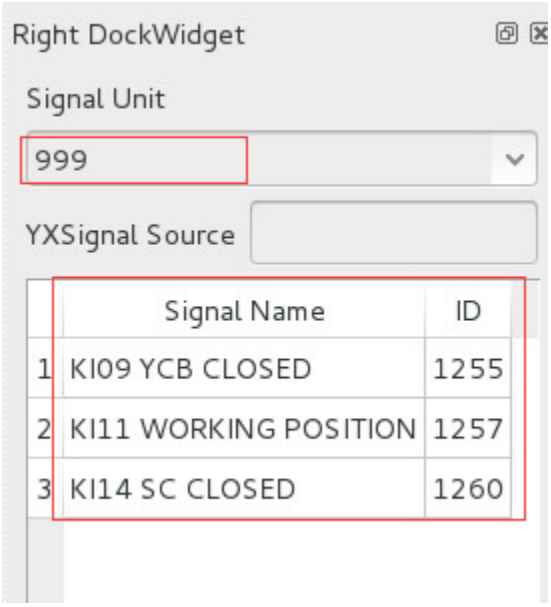


Figure 6.1.61 Display Remote Signling of Primary Equipment

Click the left mouse button to select signals. Click the signal and drag it to the remote position signal box to automatically associate primary equipment and remote signals:

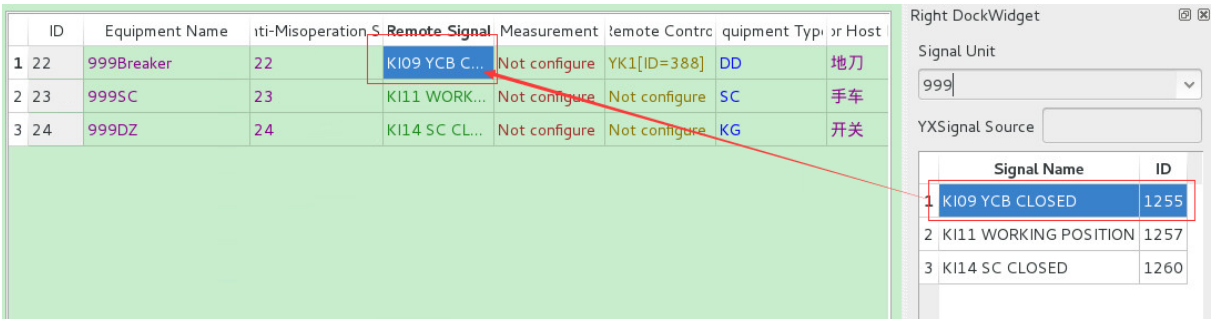


Figure 6.1.62 Associaion of Primary Equipment and Remote Position Signaling

9) Click the save button on top left corner and a choice box will pop up. Click confirm button to save the modifications (it is suggested to save once after finishing each step):

Figure 6.1.63 Save Configuration

When the pop-up progress bar of data saving reaches 100%, the data is saved successfully;

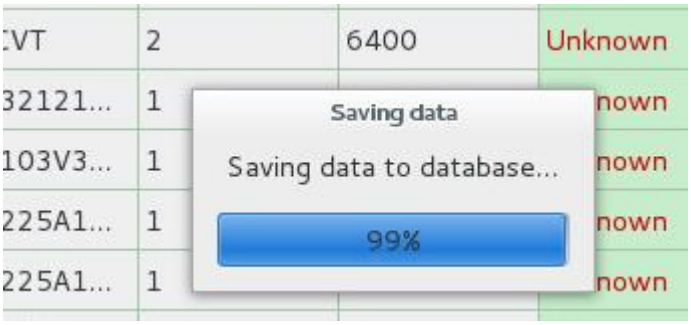


Figure 6.1.64 Save Data

Then the save button will turn to gray and all information will be saved. Detailed information is as shown in the following figure:

Figure 6.1.65 Save Data in Progress

10) So far, all works about basic configuration tools have been finished. Click the “X” button on top right corner and select “Yes (Y)” in the pop-up dialog box to exit configuration tools.

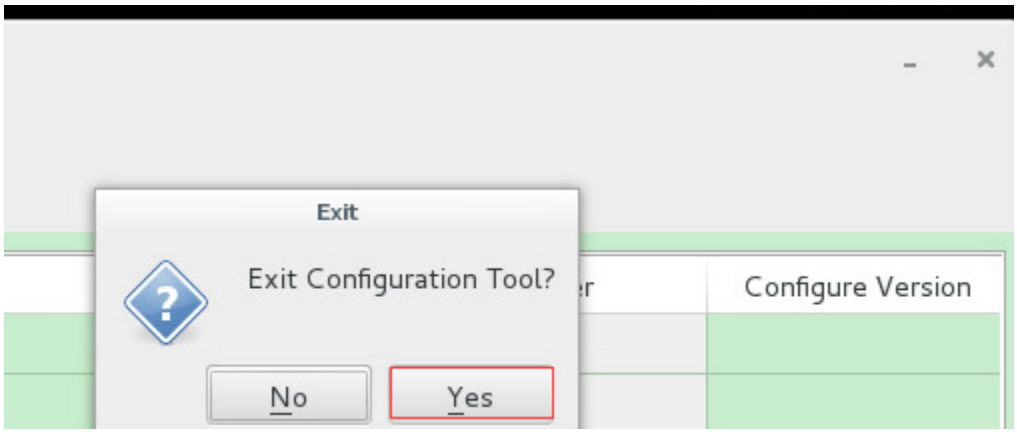


Figure 6.1.66 Exit Configuration Tools

6.1.4 Once-Again Modification on Graph Configuration

Open the graph configuration tools in accordance with the method metioned in 5.1.2.1 (detailed steps have been illustrated in previous chapters, so there will be no more detailed description here); graph paper browser-----> sub diagram, open “999 test bay”. Detailed information is as shown in the following figure:

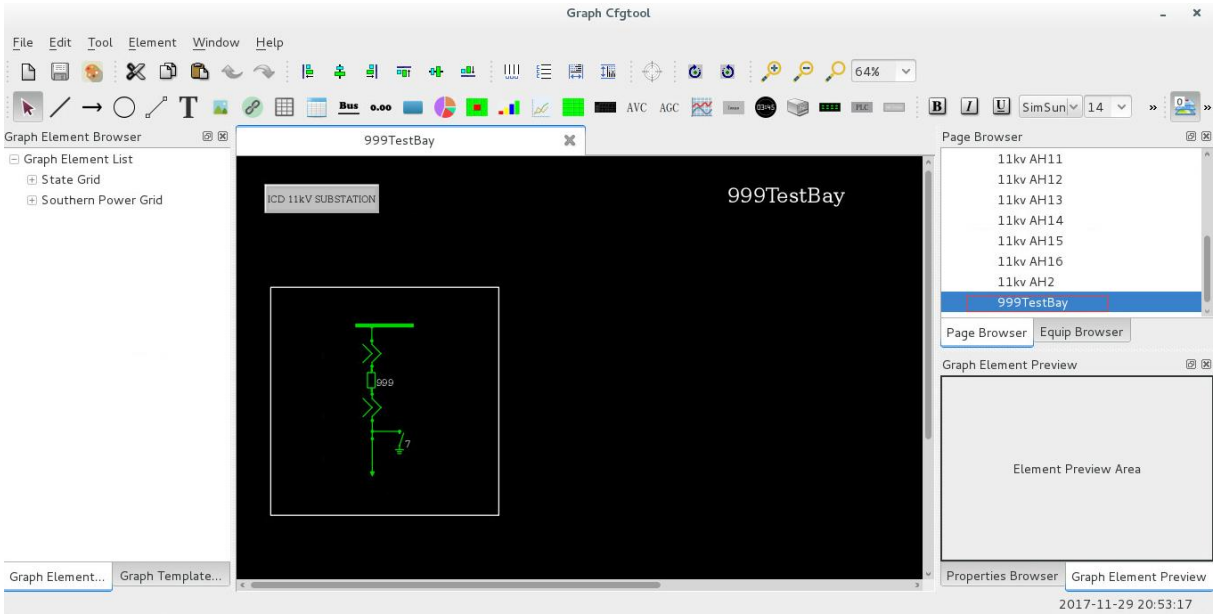


Figure 6.1.67 Open New Bay Interface

It can be seen that there is only one automatically generated detail drawing of the primary equipment in the graphing area without any information about the associated soft switchs, handles, measurement or alarm windows. Further perfection in steps is shown in the following paragraphs:

1) Add measurement information as required. Click the right mouse button in the blank of graphing area and a choice window will pop up:

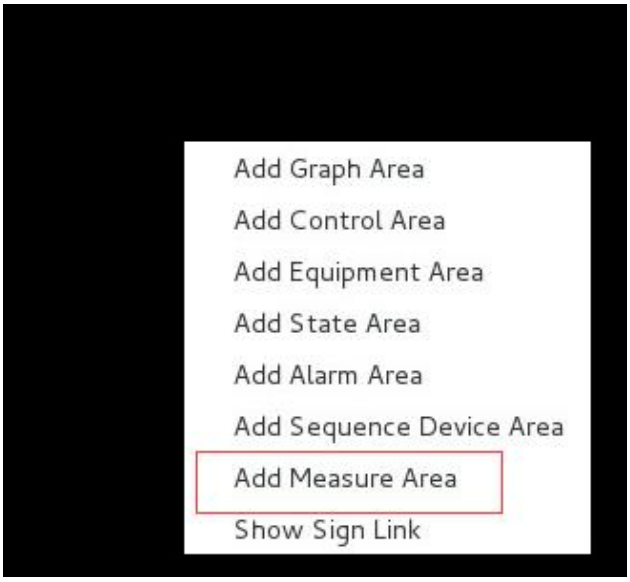


Figure 6.1.68 Increment Measurement

Click and select “increment measurement” with the left mouse button and a database dialog box will pop up:

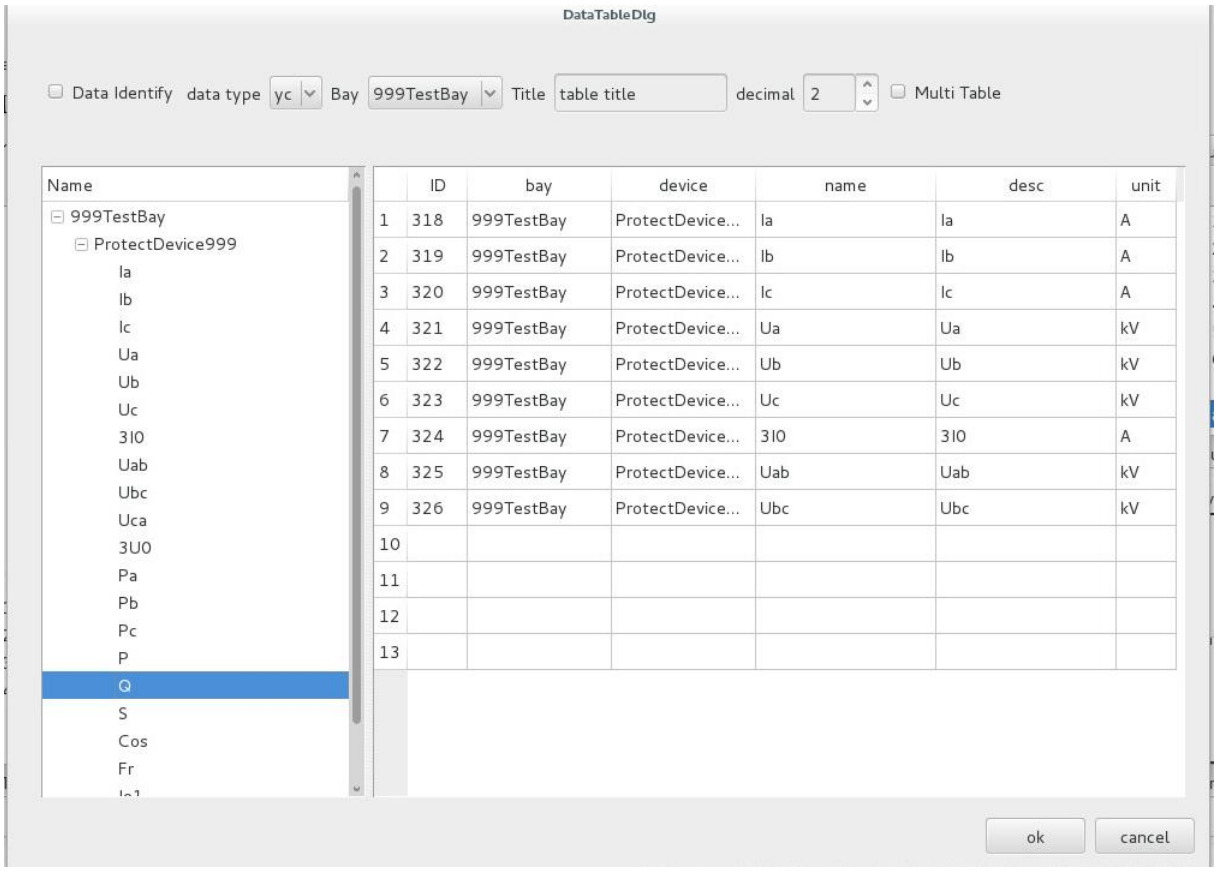


Figure 6.1.69 Selection of Increment Measurement

Data type: Telemetering;

Bay: Select the new bay. In the current situation, select “999 test bay”;

Title: Double click to have it modified. In the current situation, modify it as measurement quantity;

Decimalnumber: Fill in as required;

Name: Name all measurement signals of new bays;

Drag the necessary measurement quantity to the right table. Click “confirm” button to automatically create a measurement table. Detailed information is as shown in the following figure:

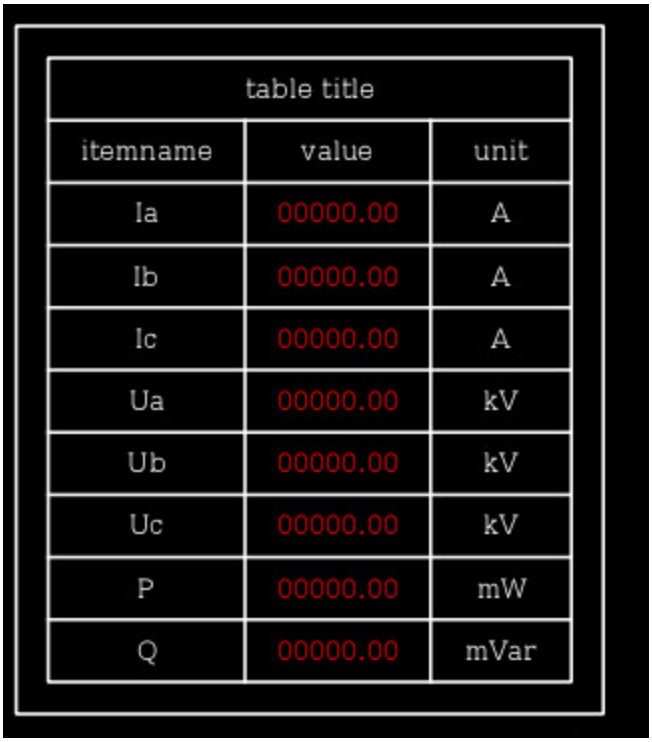


Figure 6.1.70 Create Measurement Quantity Table

2) Add the information about annunciator as required. Click the right mouse button in the blank of graphing area and a choice window will pop up:

Figure 6.1.71 Add Annunciator

Click and select “ annunciator” and a database dialog box will pop up:

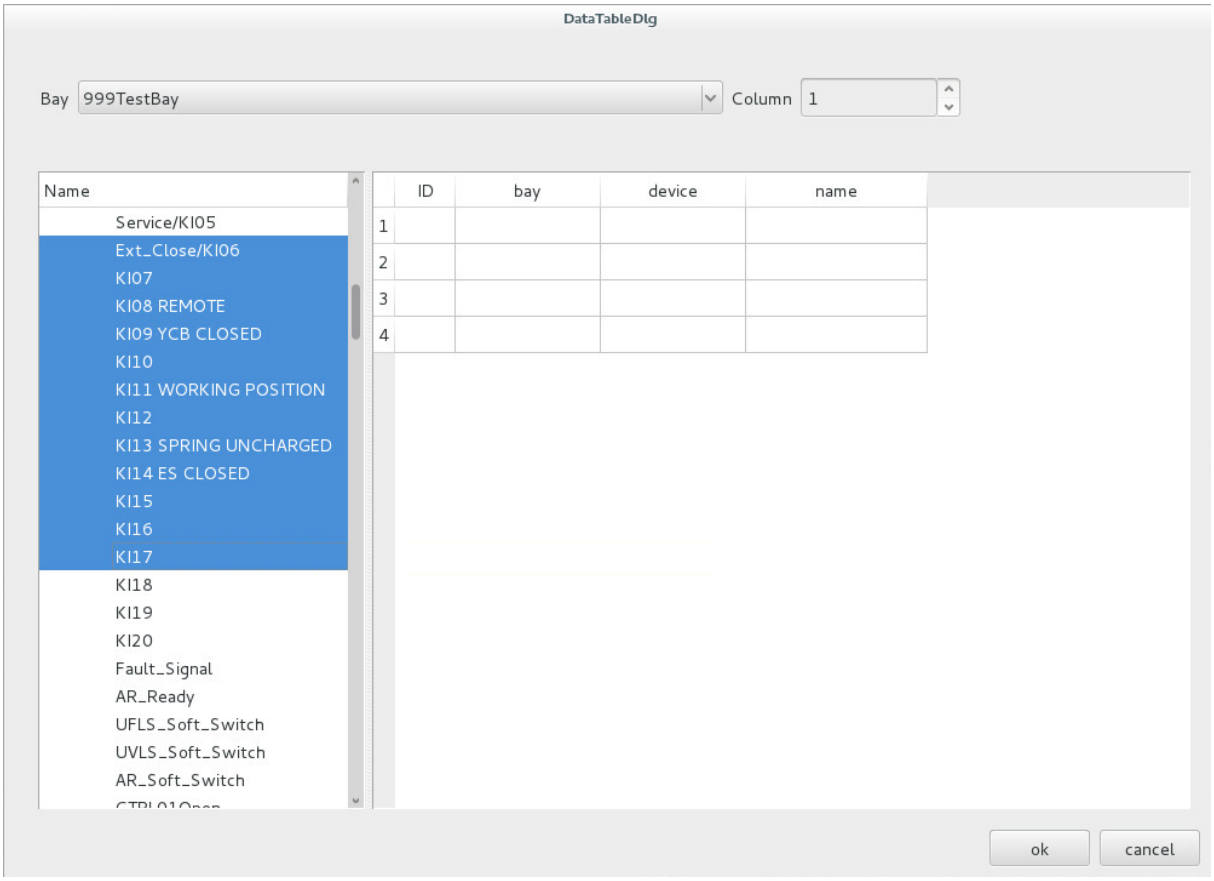


Figure 6.1.72 Annunciator Signal Selection

Bay: Select the new bay. In the current situation, select “999 test bay”;

Column number: It means the configuration of annunciator column number. In the current situation, set it as 2;

Remote signal in the left signal list can be dragged into the right table one by one. Or one can click one signal and then press shift button to drag multiple signals to the right side. Detailed information is as shown in the following figure:

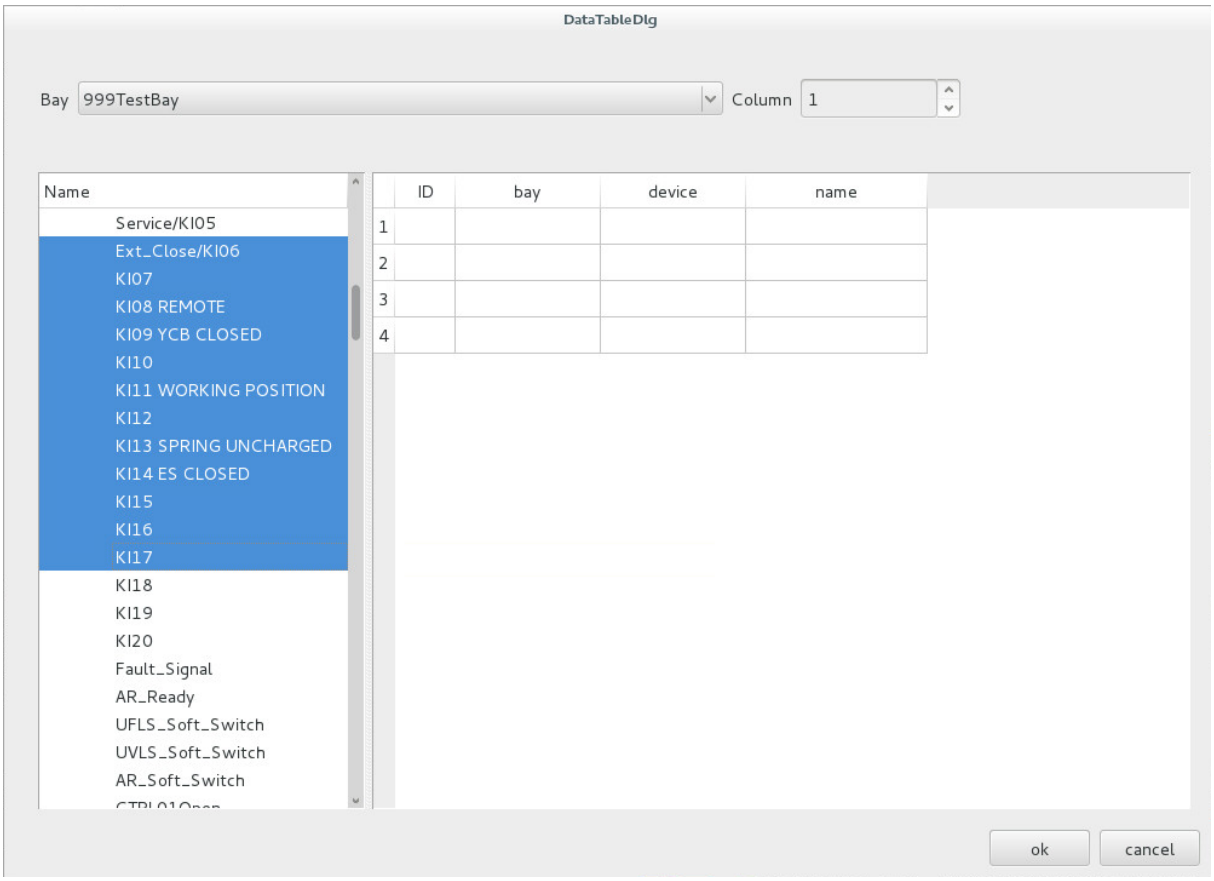


Figure 6.1.73 Batch Selection of Annunciator Signals

Click confirm button to create the annunciator table:

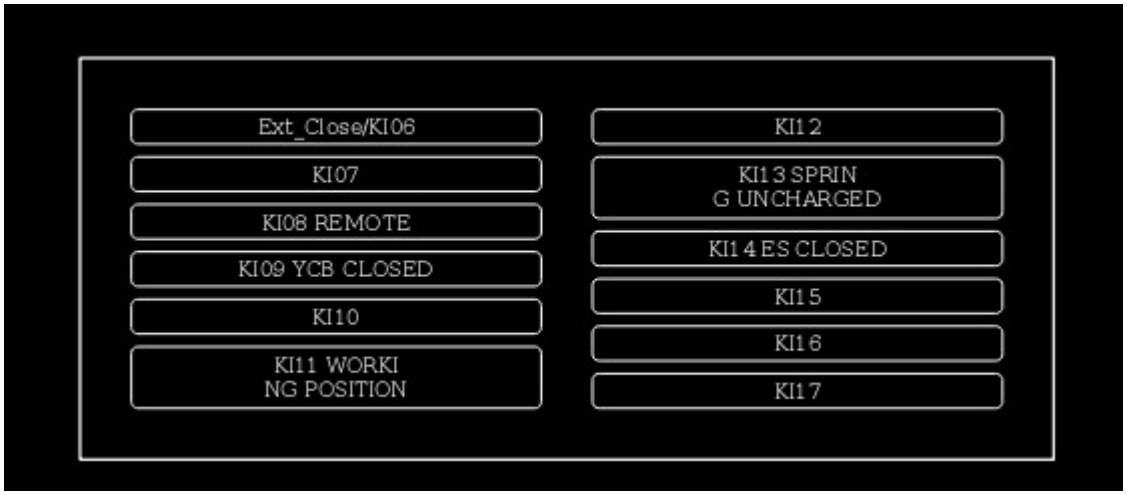


Figure 6.1.74 Creation of Annunciator is Finished

Select text button in the tool bar,

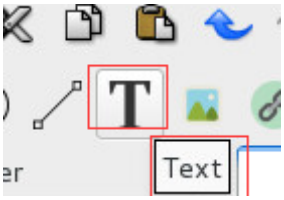


Figure 6.1.75 Text Selection

Click the left mouse button in the blank of graphing area to drag a rectangle, and a typeface will be displayed,

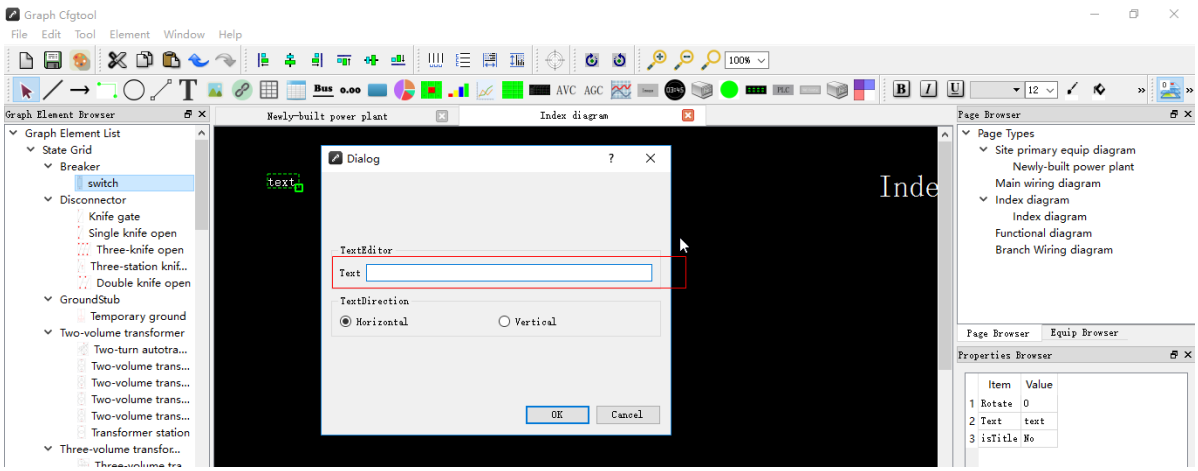


Figure 6.1.76 Text writing

Double click to pop up a dialog box of text property so as to modify it into any desired descriptions. For example, it can be modified as “ annunciator”. Text arrangement mode can also be adjusted into horizontal and vertical arrangement:

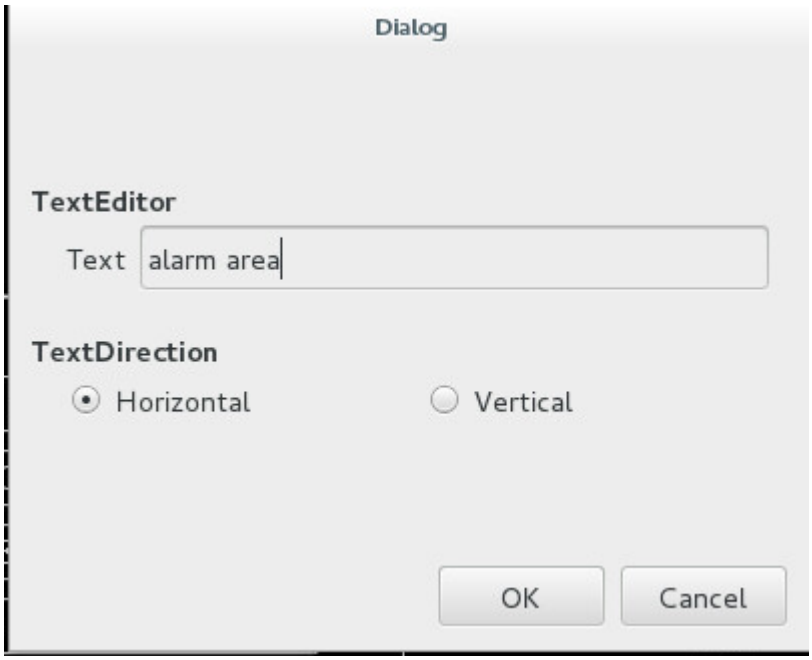


Figure 6.1.77 Configuration of Text Property

After clicking confirm button, the original text will turn to “ annunciator”:

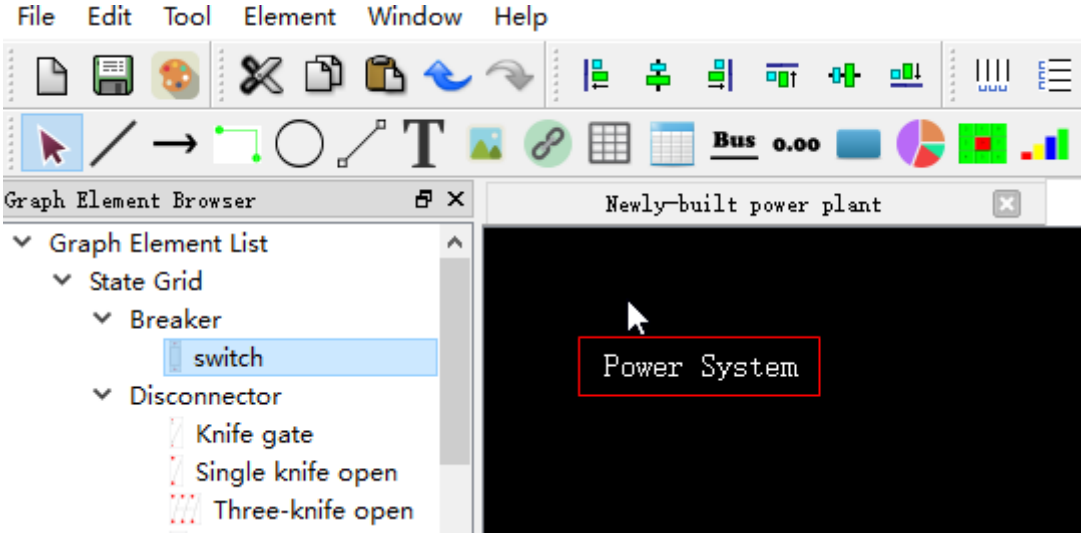


Figure 6.1.78 writing is completed

Click the text with the left mouse button and drag it to the newly added annunciator list or any position. Detailed information is as shown in the following figure:

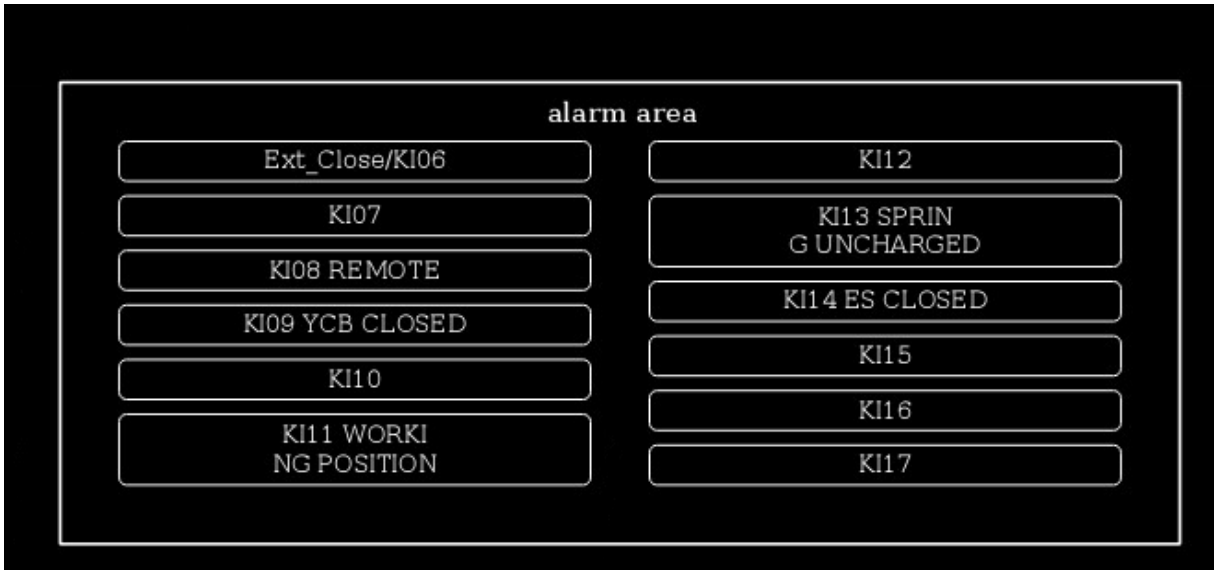


Figure 6.1.79 Text Adition is Successfully Finished

3) Add the net communication status display of equipment as required: Select the net metafile in “net communication status display ”, press the left mouse button and drag it to the blank of graphing area on the right side:

Figure 6.1.80 Status Display Selection of Net Access Port Communication

Click the icon. Click the “remote signal quantity.measured value” of associated signals in the property browser on bottom right corner, and a signal choice box will pop up:

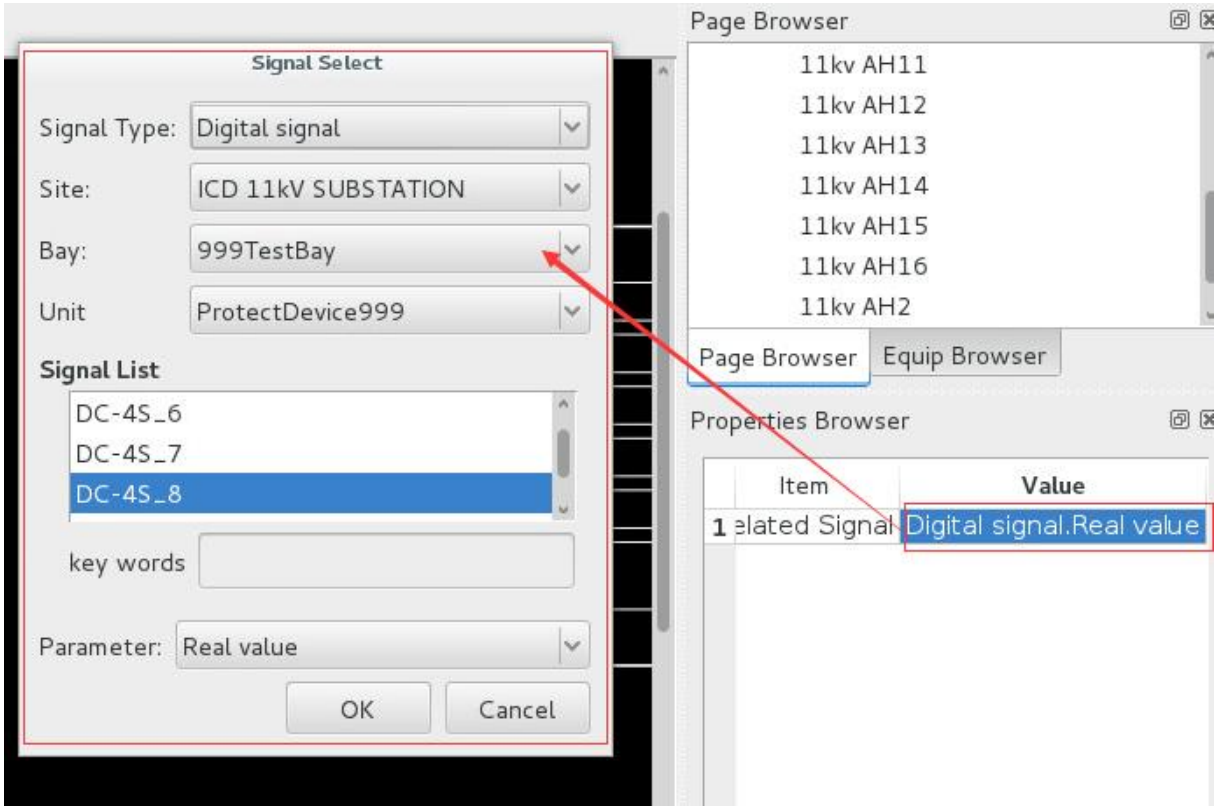


Figure 6.1.81 Display Signal Association of Internet Access Port Communication

- Signal type: Remote signal
- Substation：Default
- Bay: Select the new bay. In the current situation, select “999 test bay”;
- Equipment:The belonging equipment of the remote signal. In the current situation, select “35kV feeder protection and measurement equipment ISA-999”;
- Measure point: It means the detailed signal names. Select “A network channel failure”; in case of B network, select “B network channel failure”;

Click confirm button to finish the association works of the added equipment and signals. Then add texts on right side of icon to provide detailed descriptions (there will be no more detailed information about how to add texts). Detailed information is as shown in the following figure:

Figure 6.1.82 Create Status Display of Network Access Port Communication

NOTICE!

There is a shortcut to automatically create status information of network access port. In the blank of graphing area, click the right mouse button---->add equipment quantity. Click the left mouse button to display the following figure:

Figure 6.1.83 Automatic Creation of Network Access Port Communication

4) Add status information about control handles, soft switchs and signal lights. Click the blank space with the right mouse button--->add status quantity, and a block diagram of “data table dialog box” will pop up:

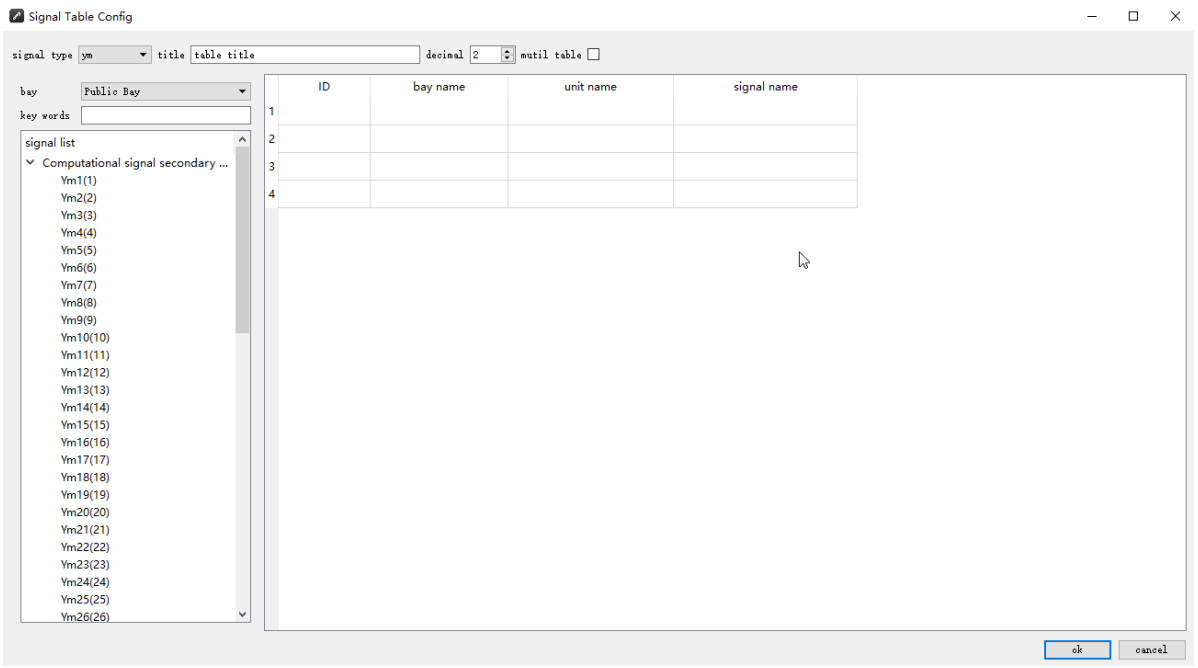


Figure 6.1.84 Add Signals of Status Quantity

- Display type: Status information can be selected, for example, control handles and switchs, etc;
- Bay: Select new bay. In the current situation, select “999 test bay”;
- Name:All remote signal information;

In case of selecting the handle as display type and signal name as remote signal 06, it means the handle is associated with remote signal 06 to realize correspondence of metafile status and signal status. Detailed information is as shown in the following figure:

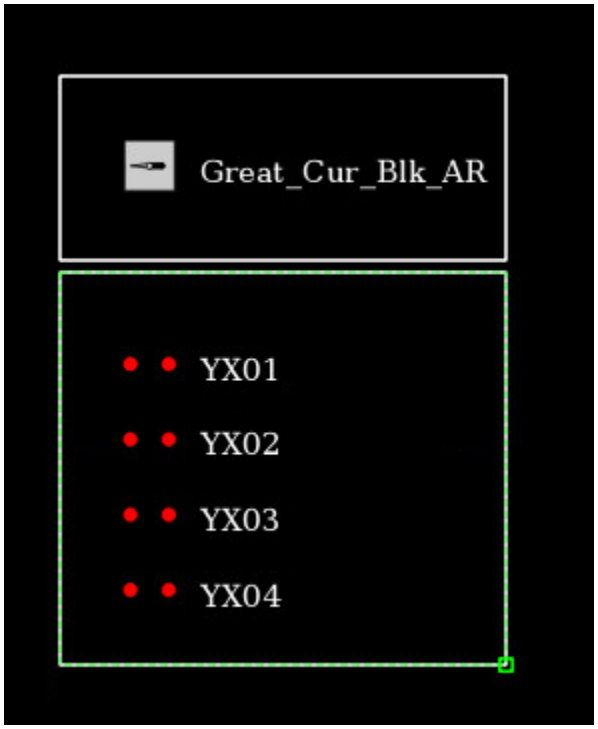


Figure 6.1.85 Creation of Handle and Soft Switch

So far, the detail drawing of new bays has been finished. Detailed information is as shown in the following figure:

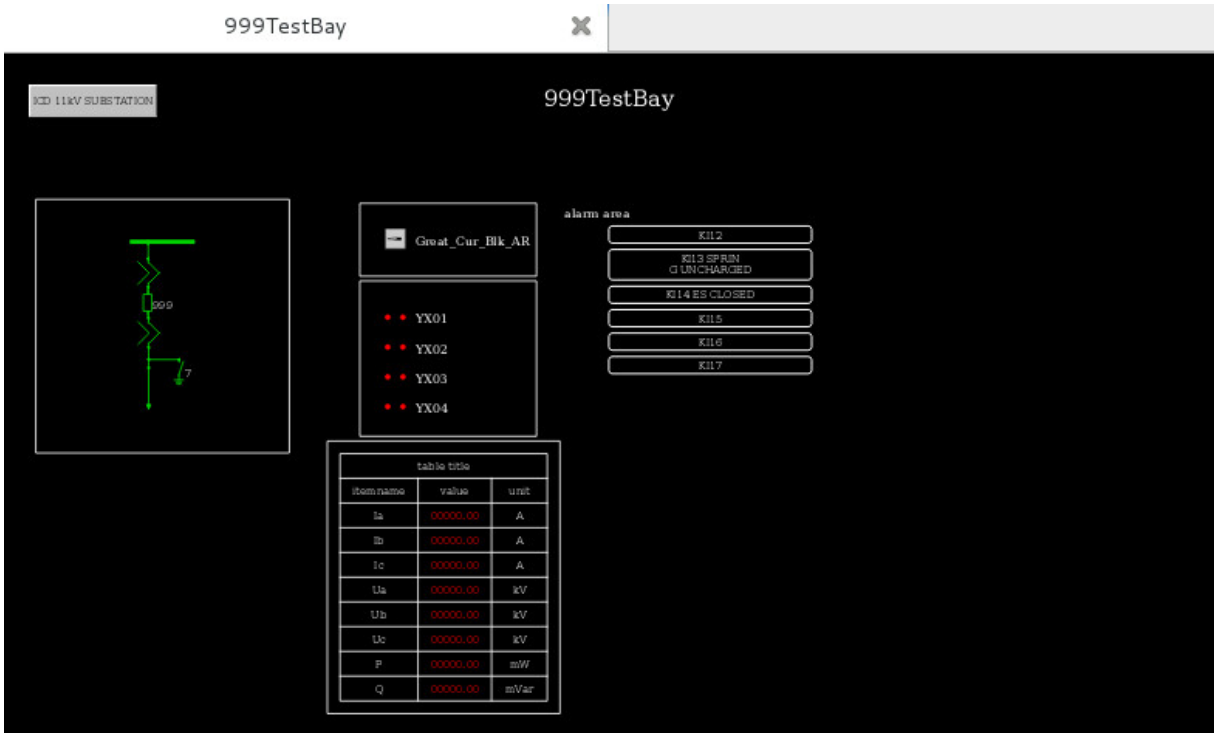


Figure 6.1.86 Detail Drawing of New Bay is Finished

5) Click save button on top left corner of the tool bar and a window of “check association information” will pop up. Select No:

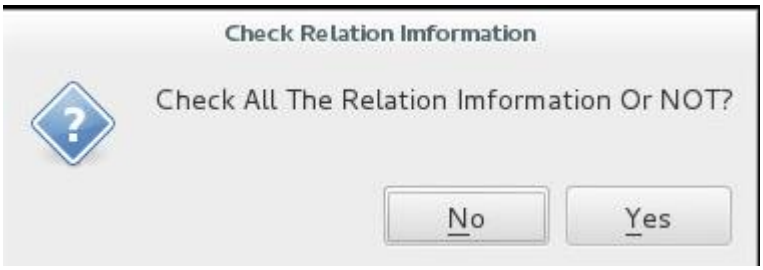


Figure 6.1.87 Check Association Information

Then the “save” window will pop up. Click confirm button:

Figure 6.1.88 Save Data

Click the “X” button on top right corner of “graph paper configuration tools” to close graph paper configuration tools;

In case of adding other metafiles or operations, perform the same procedure as mentoned above. There will be no detailed information listed here.

6.1.5 Exit the Monitoring System

When creating new bays or performing other modifications, it is normally required to exit the monitoring system. It is very simple to exit the monitoring system. Detailed information about the console is as shown in the following figure:

Click the power grid icon on the left-most of the console and a dialog box will pop up:

Figure 6.1.89 Exit Monitoring Software

Select exit. Enter the user name and password, then click confirm button and the information about closing progress will be displayed on the terminal:

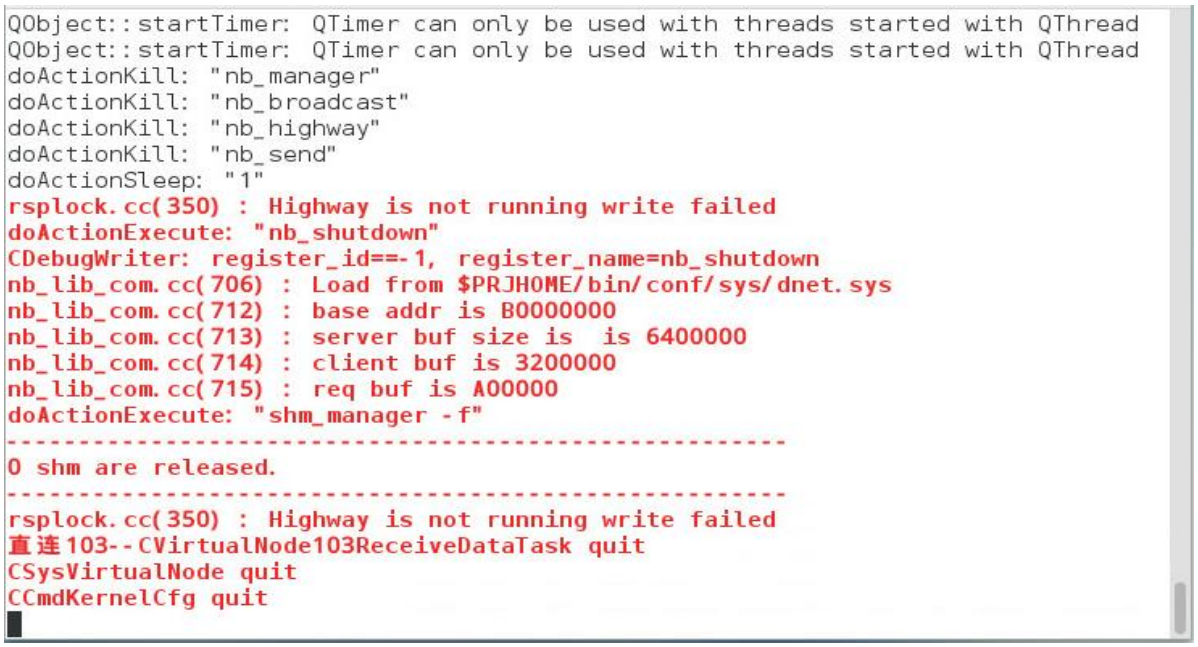


Figure 6.1.90 Exiting of Monitoring Software is finished

Click the X button on the top right corner to close the terminal. Then all the monitoring progress will be closed.

6.1.6 Restart Monitoring Program

In the blank space, click the right mouse button----->open the terminal, enter prs7000start and press enter button. After a while, relevant progress about monitoring program will be displayed. All the modification information can be checked on HMI interface!

The modification results are as shown in the following figure:

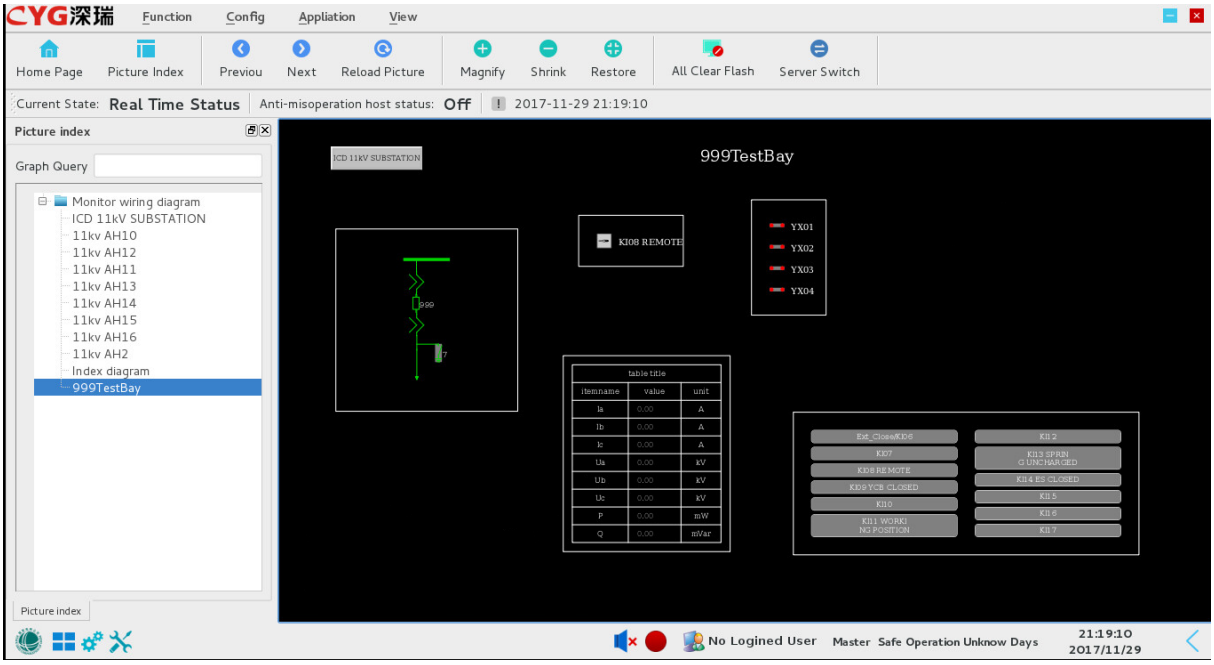


Figure 6.1.91 Display New Bay

6.2 How to Modify Bay Names and CT Ratio?

Modifications of bay names and CT ratio of bays also mean the modification on database. Therefore, exit the monitoring program and backup database before modification. Monitoring program exiting procedure has been illustrated in 5.1.1, and database backup has been illustrated in 5.1.2,so there will be no detailed information here.

6.2.1 odification of Bay Names

1) Click “configuration icon” on the console and select “graph configuration”:

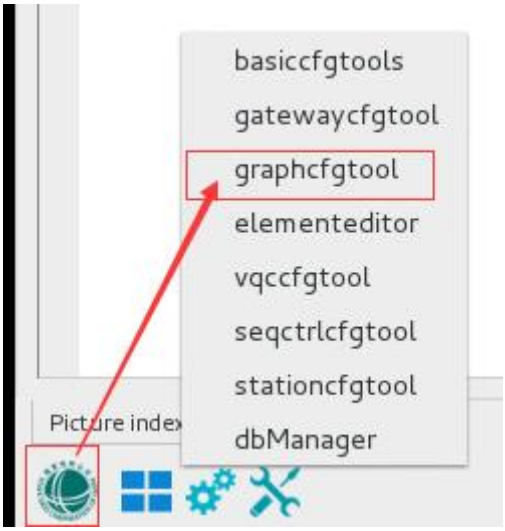


Figure 6.2.1 Graph Configuration Tools Selection

Alog-in box of graph paper configuration tools will pop up:

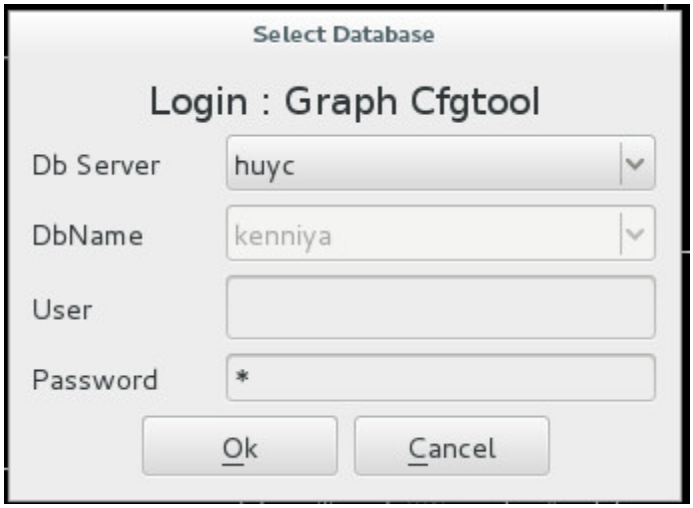


Figure 6.2.2 Log-in Graph Configuration Tools

- Database server: Machine name, which means the server name;
- Database: Name of configuration database;
- User: User name;
- Password: Password of the corresponding user;

2) Enter the user name and password to enter the interface of grapg configuration tools. It is the same as step 2 in 5.1.2;

3) Find the bay, name of which needs to be modified, in the equipment browser on the right side. For example, in case of modifying the name of “999 new bay” as “999 feeder outgoing line”. Click “999 test bay” with the left mouse button in the drop-down menu of 35kV and relevant information will be displayed in the property browser.

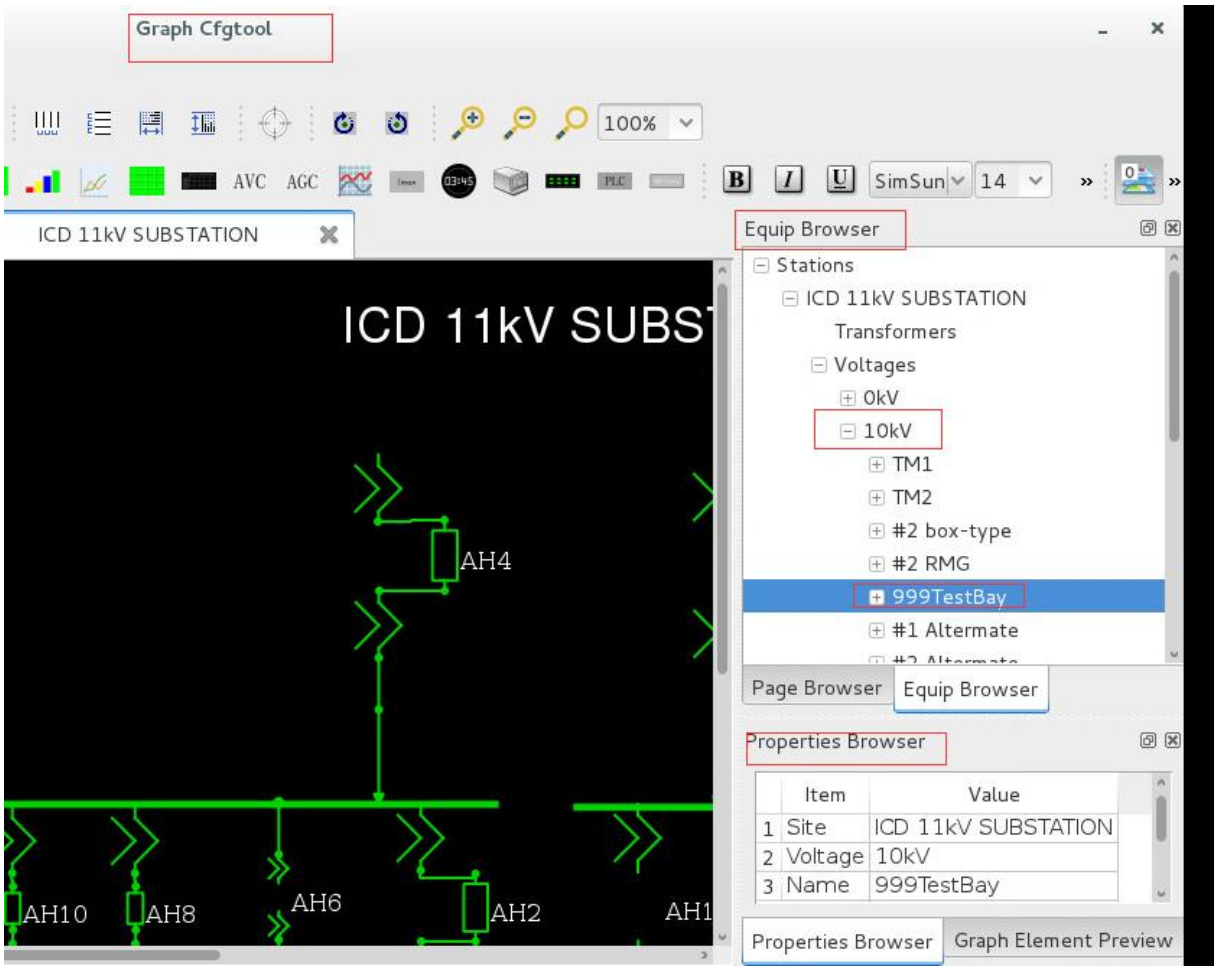


Figure 6.2.3 Find the Bay that Needs to be Modified

4) In the “property browser”:

- Double click the editable box on the right side of “name” and enter name of the new bay as “999 feeder outgoing line”. Then click the blank on the right side and the name will be modified as “999 feeder outgoing line”;
- Double click the editable box on right side of “description” and enter name of the new bay as “999 feeder outgoing line”. Then click the blank on the right side and the content of “description” will be changed as “999 feeder outgoing line”;

Detailed information is as shown in the following figure:

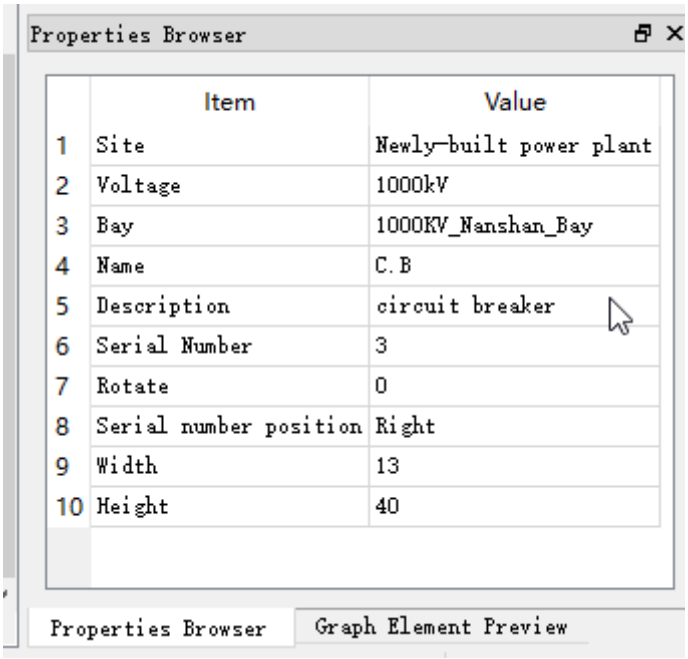


Figure 6.2.4 Modify Bay Name and Description

5) Click “drop-down menu of sub diagram” in graph paper browser. Then click “999 test bay” with the left mouse button. Click the right mouse button to pop up the choice box:

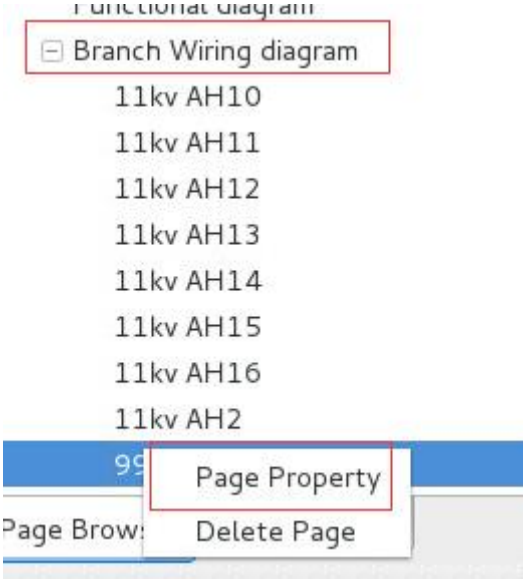


Figure 6.2.5 Selection of Graph Property

Click the graph property to pop up the dialog box of “graphics parameter configuration”. Modify “graph name” as “999 feeder outgoing line”:

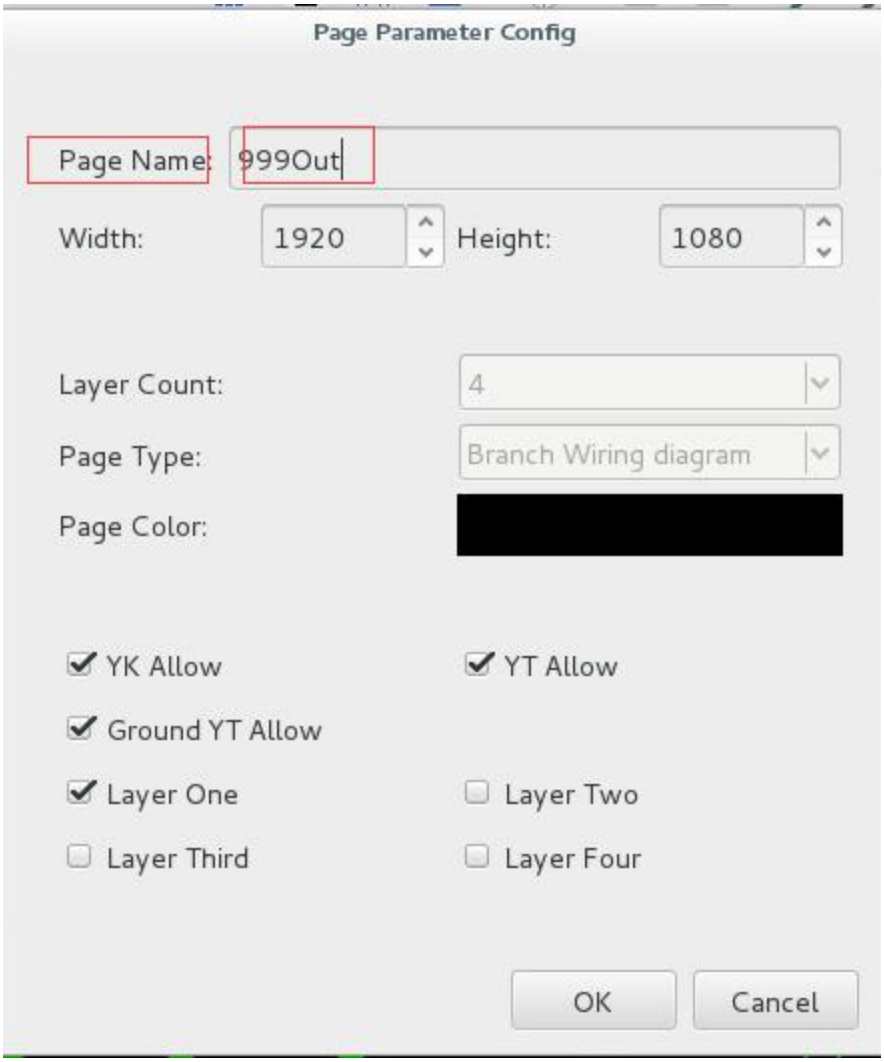


Figure 6.2.6 Graphics Parameter Configuration

Click “confirm” button and the graph name in the drop-down manue of extension diagram will be modified as name of the new bay:

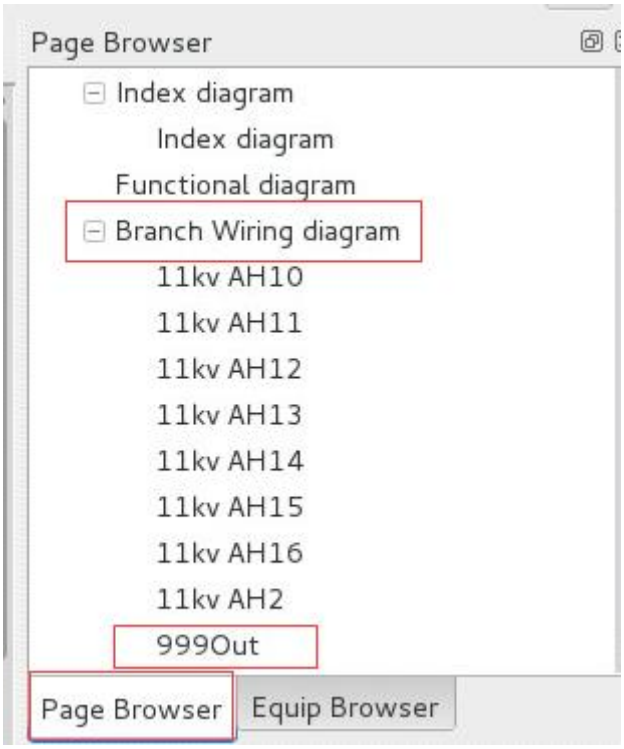


Figure 6.2.7 Graph Paper Browser is Successfully Modified

6) Open the main wiring diagram in graph paper browser. Select and click the bay button under the bay modification with the left mouse button, and relevant information will be displayed in the property browser:

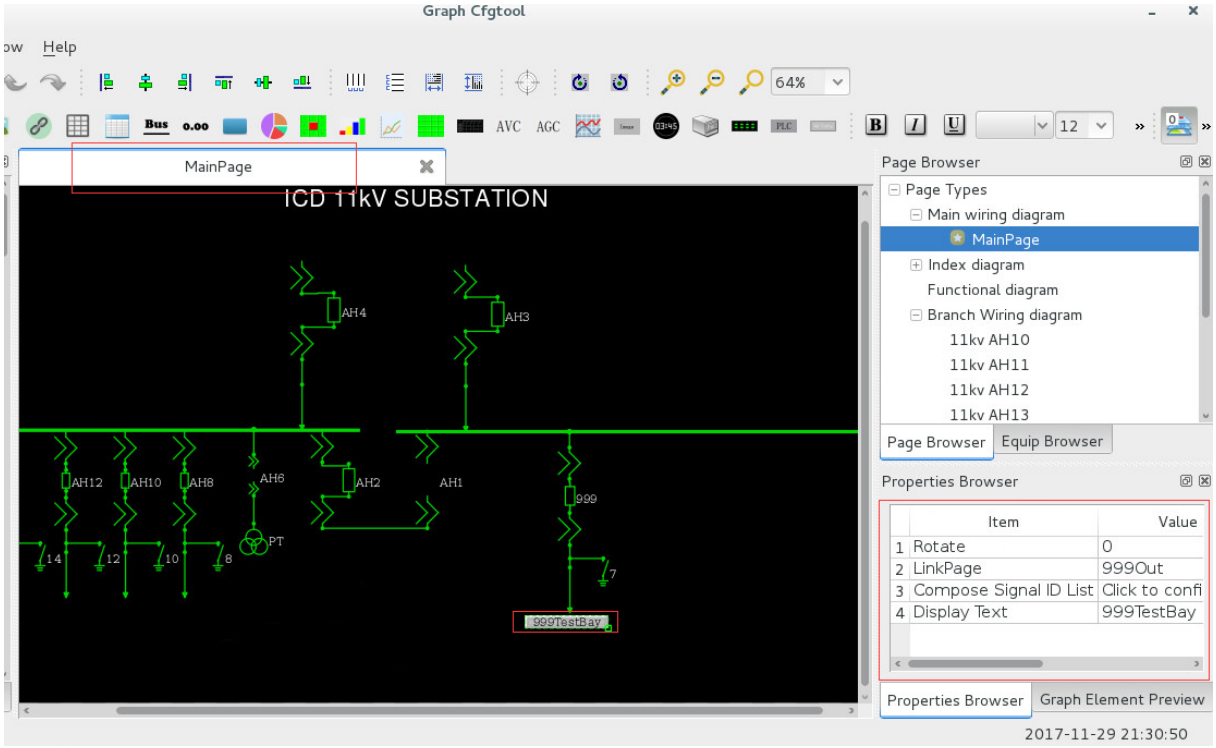


Figure 6.2.8 Check Graph Interlinkage Property

7) Double click the editable box on the right side of “text display” in the property browser, and

modify the name of bay as “999 feeder outgoing line”. Then click the blank on the right side and the text of “999 feeder outgoing line” will be displayed. Meanwhile, the left button will be automatically changed into name of the new bay:

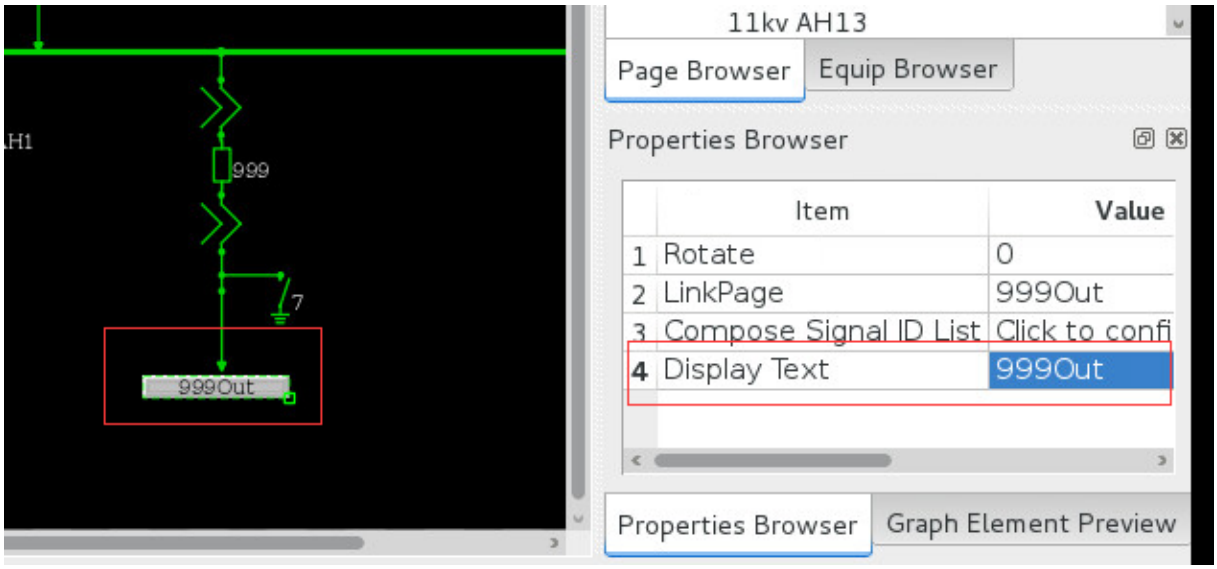


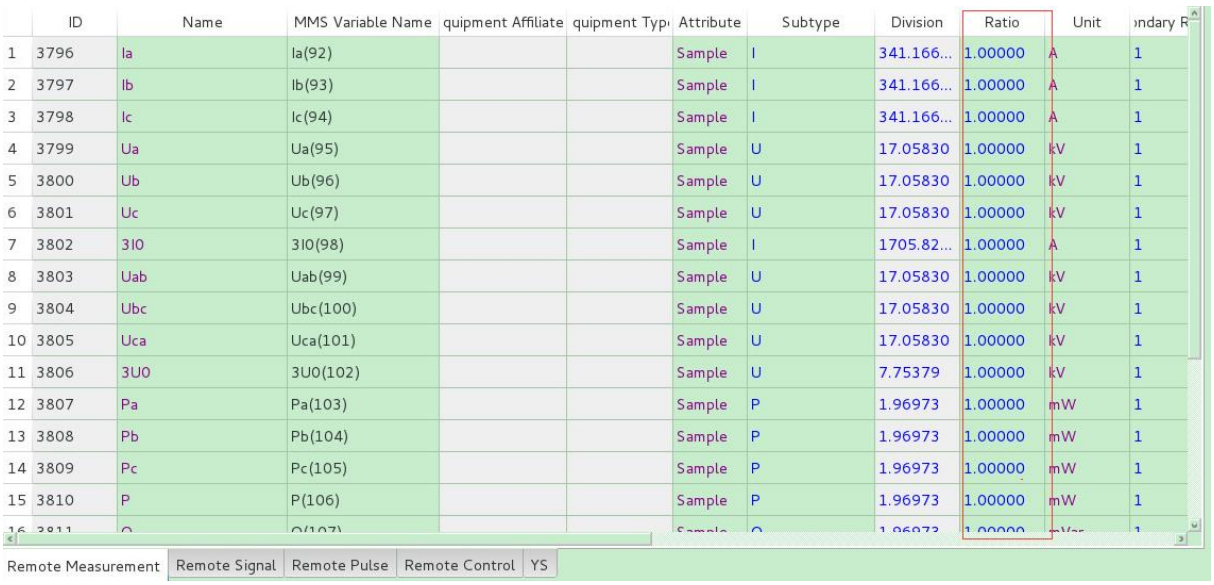
Figure 6.2.9 Modificaiton of Graph Interlinkage Property

Click save button to exit “graph configuration tools”. So far, all works about modifying bay names have been finished;

8) Restart the monitoring host and perform the same procedure as described in 5.1.6 and the modification result will be displayed.

6.2.2 Modification of CT Ratio

1) Perform the same procedure as described in the first step of 5.1.3. Open the basic configuration tools, then click navigation tree------>substation configuration------>secondary equipment configuration, and select the secondary equipment that is related with the equipment. For example, select “35kV feeder protection and measurement equipment ISA-999” and the information about remote signal, measurement, remote control and regulating will be displayed on the rigt box:



	ID	Name	MMS Variable Name	quipment Affiliate	quipment Typ	Attribute	Subtype	Division	Ratio	Unit	ondary R
1	3796	Ia	Ia(92)			Sample	I	341.166...	1.00000	A	1
2	3797	Ib	Ib(93)			Sample	I	341.166...	1.00000	A	1
3	3798	Ic	Ic(94)			Sample	I	341.166...	1.00000	A	1
4	3799	Ua	Ua(95)			Sample	U	17.05830	1.00000	kV	1
5	3800	Ub	Ub(96)			Sample	U	17.05830	1.00000	kV	1
6	3801	Uc	Uc(97)			Sample	U	17.05830	1.00000	kV	1
7	3802	3I0	3I0(98)			Sample	I	1705.82...	1.00000	A	1
8	3803	Uab	Uab(99)			Sample	U	17.05830	1.00000	kV	1
9	3804	Ubc	Ubc(100)			Sample	U	17.05830	1.00000	kV	1
10	3805	Uca	Uca(101)			Sample	U	17.05830	1.00000	kV	1
11	3806	3U0	3U0(102)			Sample	U	7.75379	1.00000	kV	1
12	3807	Pa	Pa(103)			Sample	P	1.96973	1.00000	mW	1
13	3808	Pb	Pb(104)			Sample	P	1.96973	1.00000	mW	1
14	3809	Pc	Pc(105)			Sample	P	1.96973	1.00000	mW	1
15	3810	P	P(106)			Sample	P	1.96973	1.00000	mW	1

Remote Measurement | Remote Signal | Remote Pulse | Remote Control | YS

Figure 6.2.10 Select to Modify Bays

2) Click “measurement” and select the column of “ratio” tomodify it. For example, modify the ratio of Ua as 100, detailed information is as shown in the following figure:

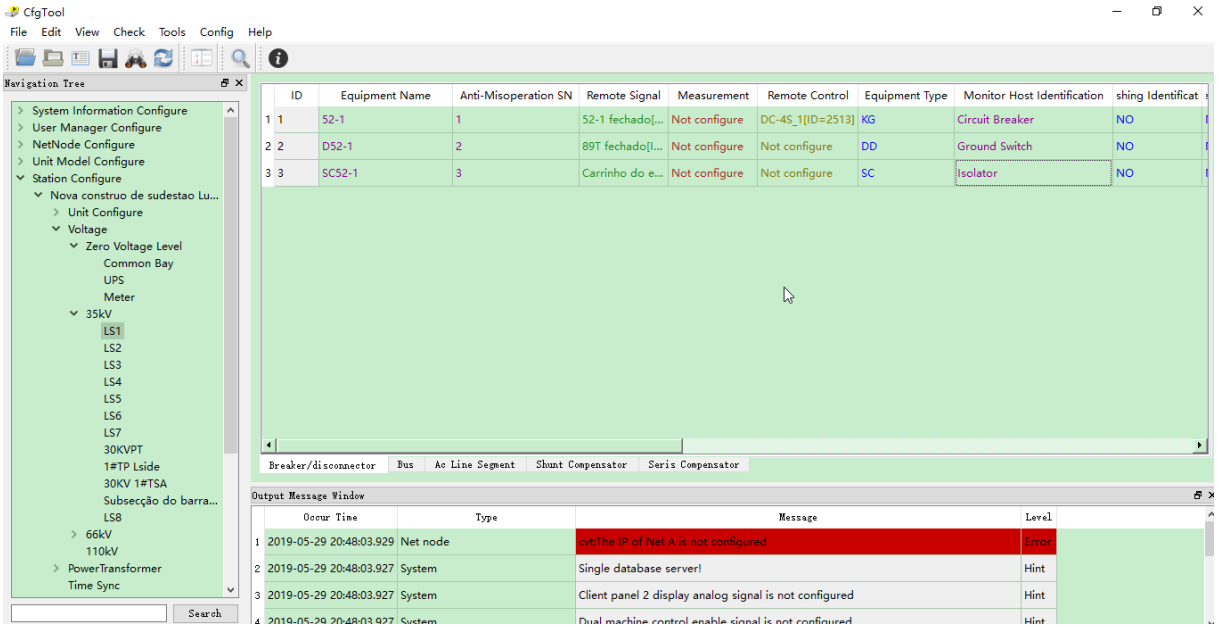


Figure 6.2.11 measurement detailed information

Double click the ratio of measurement signals to modify it as actual values. Then click the save button on the top left corner and exit configuration tools; so far, work about modifying CT no-load voltage ratio has been finished.

3) Restart the monitoring host and perform the same procedure as described in 5.1.6. Then the modification results will be displayed in the sub-interface of bay modification.

6.3 Where to Save “PrtScn” Screen Shot Files

Directly press the “PrtScn” to capture screens. However, many people may not know the place for storing screen shot files. In fact, all the screen shot files are stored in the “picture” file. For example, for the root user, screen shots are stored in “/root/picture/”.

In addiction, one can click “application program”-“tools”-“screen shot” to capture screens with more functions.

7 Appendix

List of key words is as shown below:

8 Manual Version History

In the current version of the instruction manual, several descriptions on existing features have been modified.

Table 8-1 Manual version and modification history records

Manual Version		Software Version	Date	Description of change
Source	New			
Beta	1.00	1.00	2014-04-15	Form the original manual.
1.01	1.02	1.02	2015-05-21	Updata the number of the binary inputs and binary outputs. Update the description of IEC61850 dual-MMS Ethernet.
1.02	1.03	2.00	2017-12-6	Update the description of IEC61850-ED2 MMS Ethernet. Update all the format.