PRS-7741

Bay Control Unit

Instruction Manual

CYG SUNRI CO., LTD

Preface

User's Guideline

This instruction manual contains full information of the equipment, including function descriptions, logic diagrams, input signals, output signals, setting parameters and technical parameters. It also list the operations on safe handling, commissioning and maintaining of this equipment. The instruction manual can be can be used as a technical reference during the whole product life cycle.

Documentation and manufactured equipments purchased from CYG SUNRI CO., LTD. are dispatched separately due to the necessary manufacturing period. Therefor, they sometimes may not reach the recipients at the same time. Therefore this manual is provided as a technical reference to commission the equipment.

The installation and commissioning personnel should read all relevant chapters carefully and get a thorough knowledge of the contents of this manual, before conducting any operation to the equipment. In this way, the personnel can get the required knowledge in handling electronic equipment.

This manual contains a security chapter which describes the safety precautions recommended when using the equipment. Before installing and using the equipment, this chapter is recommended to be thoroughly read and understood.

Personnel Security

The content in this chapter specifically describes to prevent and reduce the safety accidents in electric power production and construction procedures, to ensure the personal safety and health of employees in production activities and to ensure the power grids stable operation and reliable power supply.

Any kind of directly touching with the metal parts of the electrical equipment should be avoided when electrical equipment is on operation, because of the potential electric shock risk. Neglecting warning notices should be prevent because the improperly operation may damage the device, even cause personnel injury.

The good operating condition of the equipment depends on proper shipping and handling, proper storage, installation, commissioning and maintenance. Therefore, only qualified personnel should be allowed to operate the equipment. Intended personnel are individuals who:

- Have a thorough knowledge of protection systems, protection equipment, protection functions and the configured functional logic in the IEDs;
- Have a basic knowledge in the installation, commissioning, and operation of the equipment;
- Are familiar with the working field where it is being installed;

- Are able to safely perform operations in accordance with accepted safety engineering steps;
- Are authorized to energize and de-energize equipment, and to isolate, ground, and label it;
- Are trained in the maintanence and use of safety apparatus in accordance with safety engineering regulations;
- Have been trained in first aid if any emergency situations happen.

Warning Indications

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.

Documentation Outline

The manual provides a functional and technical description of this relay and a comprehensive set of instructions for the relay's use and application.

All contents provided by this manual are summarized as below:

1 Briefly Introduction

Briefly introduce the application scope, the selectable functions and product features about this equipment.

2 Technical Specifications

Introduce the technical specifications about this relay, including electrical specifications,

mechanical specifications, ambient temperature and humidity range, communication interface parameters, type tests, setting ranges and accuracy limits etc.

3 Operation Theory

Provide a comprehensive and detailed function description of all modules.

4 Supervision Functions

Introduce the automatic self-supervision function of this equipment.

5 Monitoring&Control

Introduce the measurement, controlling, signaling, recording and other functions of this relay.

6 IED Hardware

Introduce the main module functions of this relay and describe the definition of all terminals of each module.

7 Settings

List of all the settings and their ranges and step sizes, together with a brief explanation of each setting and some notices about the setting application.

8 Configuration Function

Introduce the configurable function (such as protection function configuration, LED configuration, binary input configuration and binary output configuration, analog quantities channels etc.) of this relay.

9 Communication Protocol

Introduce the communication interfaces and protocol that this relay contains. IEC60970-5-103 and IEC61850 protocols are introduced in details.

10 Commissioning

Introduce how to commission this relay, check the calibration and test all the function of this relay.

11 Installation

Recommend on unpacking, handling, inspection and storage of this relay. A guide to the mechanical installation and electrical wiring of this relay is also provided, including earthing recommendations. Some typical wiring connection is demonstrated in this manual manual as well.

12 Maintenance

A general maintenance steps for this device is outlined.

13 Decommissioning and Disposal

A general decommissioning and disposal steps for this relay is outlined.

14 Manual Version History

List the instruction manual versions and their corresponding modification history records.

CYG SUNRI CO., LTD.

Headquarters: No.13, Keji North 1st Road, North Area of Hi-tech Industral Park, Nanshan District, Shenzhen, China

Tel: +86-400-678-8099

Website: http://www.sznari.com

P/N: ZL_PRS-7741_X_Instruction Manual_EN_Overseas General_X

Version: 2.00

Table of Contents

1 Introduction

1.1 Application Scope

The PRS-7741 relay is a numerical Bay Control Unit (abbreviated as BCU) which can be used in various voltage level, ranging from 1000kV to 10kV.

PRS-7741 is specifically designed for monitoring and controlling all types of apparatus in power systems, including circuit breaker, disconnector, earthing switch, etc. Additionally, it is integrated with tap changer control functions for transformer and shunt reactor as well.

This relay can sample the analog values from the traditional instrument transformers, or receive the sampled values from the electronic current and voltage transformers (via a merging unit). The binary inputs and outputs of this relay can be configured according to the demands of a practical engineering through the PRS IED Studio configuration tool auxiliary software, which can meet some special requirements of protection and control functions.

PRS-7741 is suitable to be applied in Substation Automation System (abbreviated as SAS) using different kinds of communication protocol, including IEC-60870-5-103 protocol, IEC-61850 ED1 or ED2. It can also send/receive generic object oriented substation event (abbreviated as GOOSE) message in process level, which make it completely meet the demands of a modern digitalized substation.

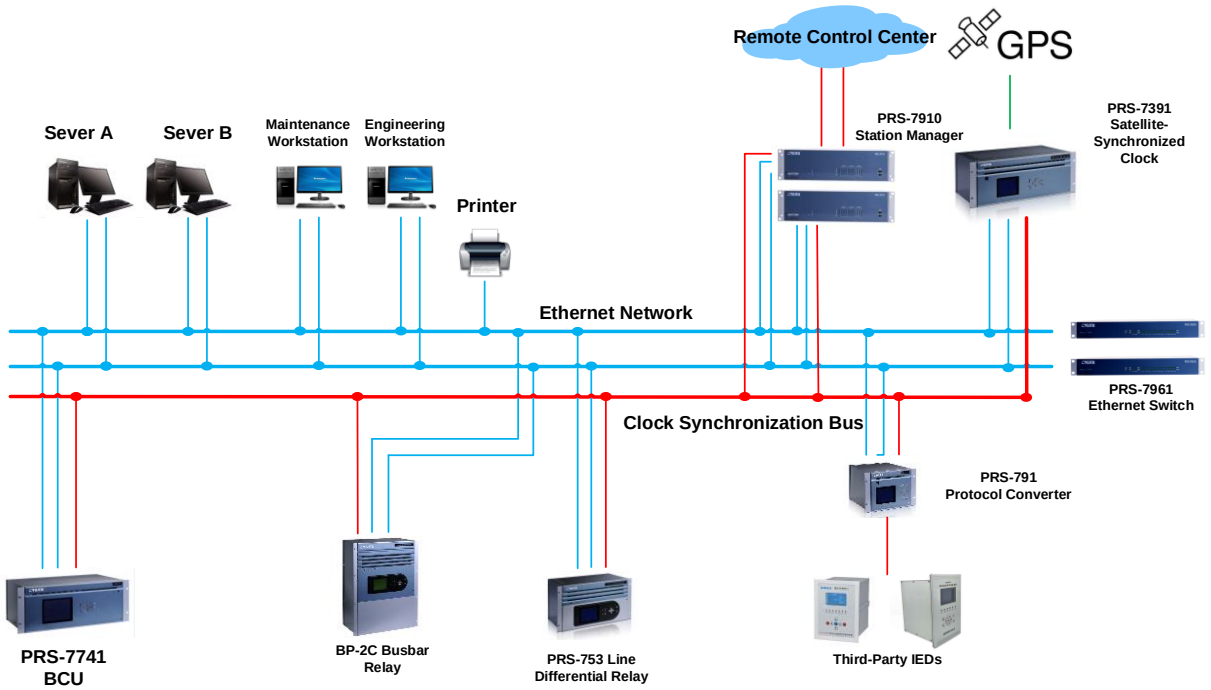


Figure 1.1.1 Typical Ethernet networking scheme

PRS-7741 can be used for both single and multiple bay arrangements in the following applications. Application diagrams of PRS-7741 are listed in the following figures.

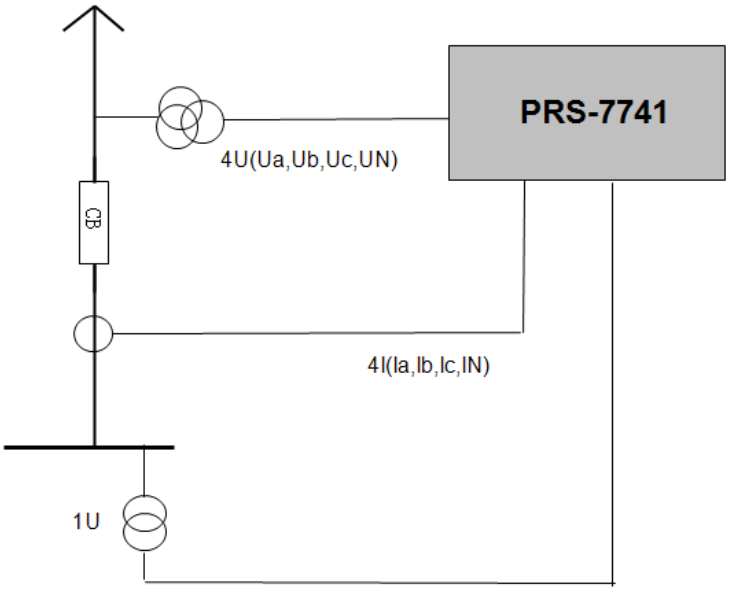


Figure 1.1.2 Typical application diagram of PRS-7741(Single bay, 4CT/5VT)

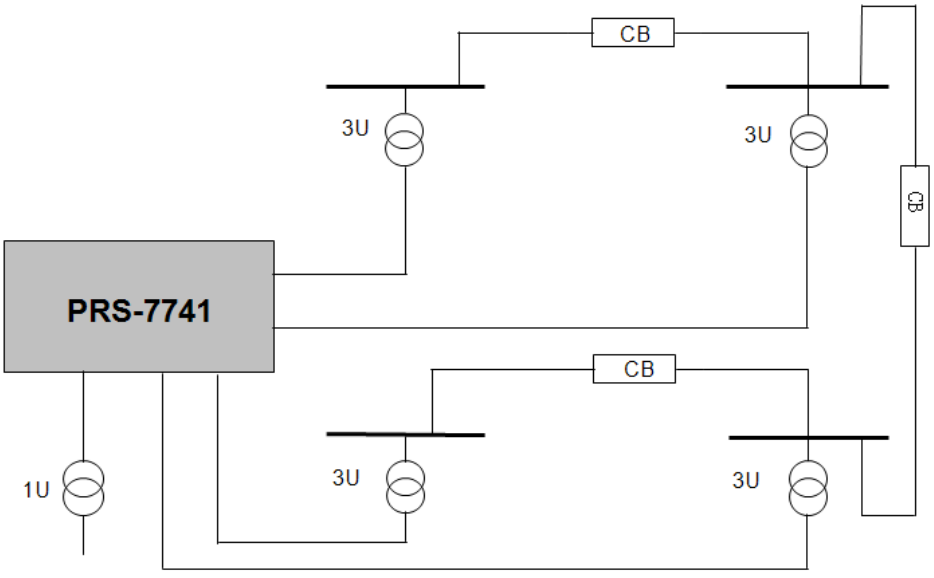


Figure 1.1.3 Typical application diagram 1 of PRS-7741(General, 13VT)

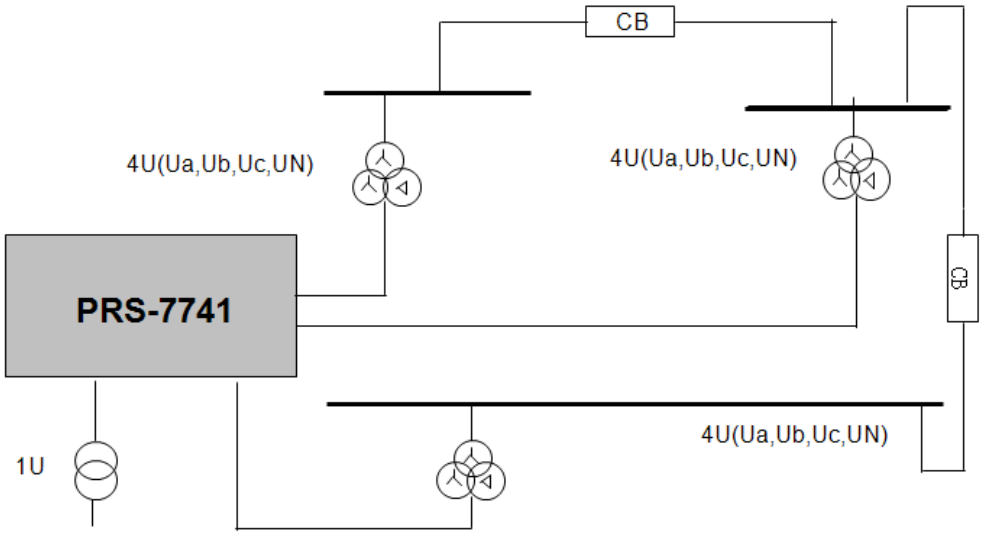


Figure 1.1.4 Typical application diagram 2 of PRS-7741(General, 13VT)

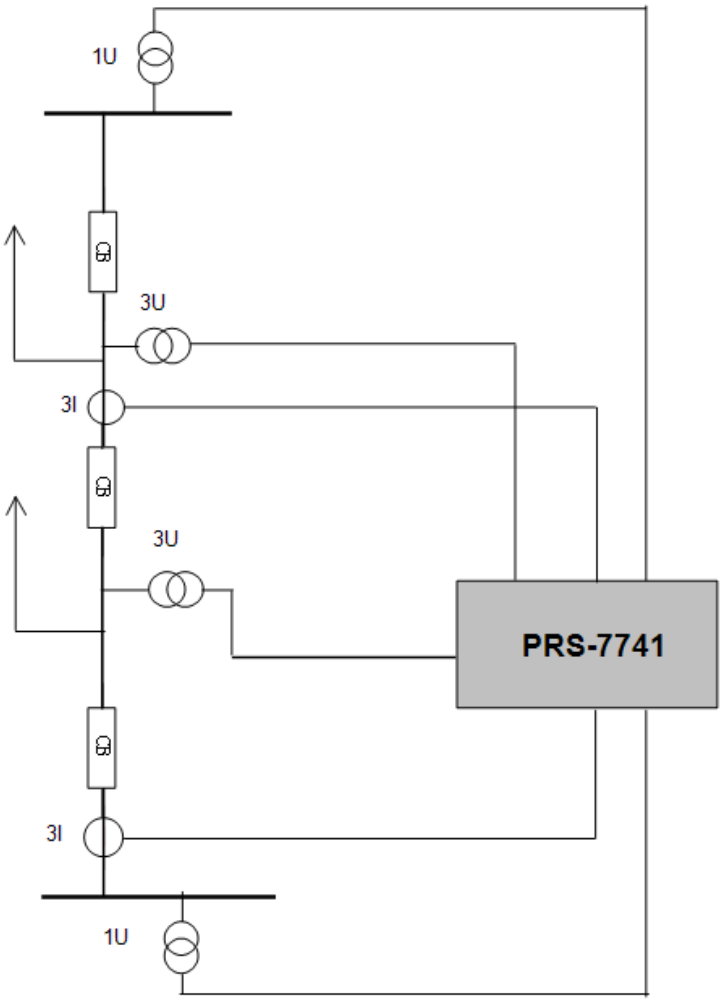


Figure 1.1.5 Typical application diagram of PRS-7741(Dual bays, 7CT/8VT)

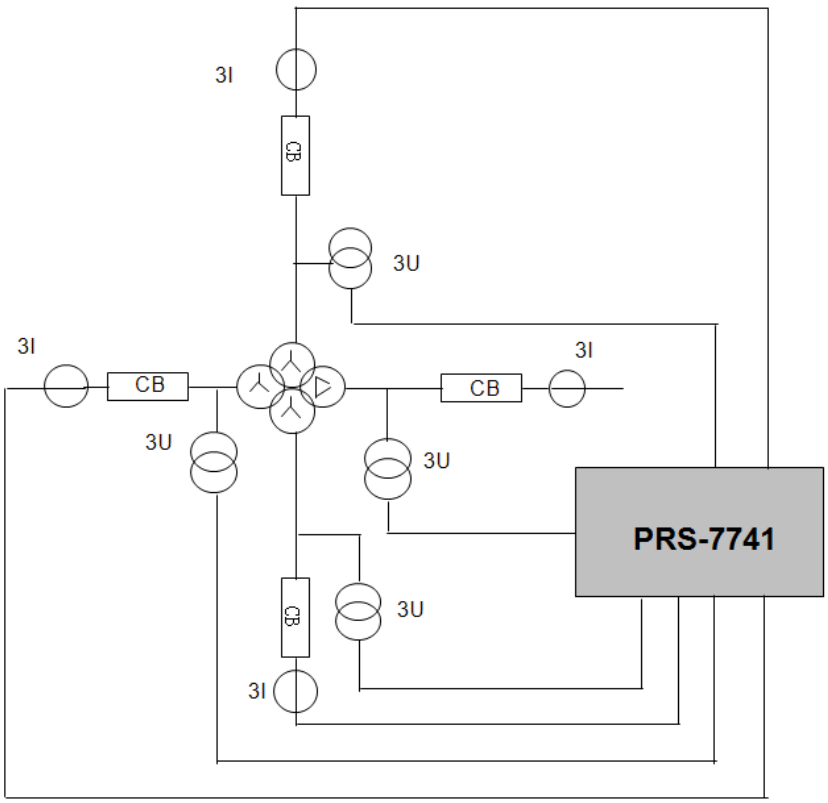


Figure 1.1.6 Typical application diagram of PRS-7741(Transformer Unit, 12CT/12VT)

"4U" is the Ua, Ub, Uc and external residual voltage input (UN).

"4I" is the Ia, Ib, Ic and external residual current input (IN).

"3U" is the Ua, Ub and Uc.

"3I" is the Ia, Ib and Ic.

"1U" is the Monophase voltage input.

1.2 Product Functions

NOTICE!

The I/O quantities listed in the following table are the maximal numbers. These I/O quantities will be influenced by each other.

Please consult the corresponding Manufacture Ordering Table or CYG SUNRI sales representative for specific I/O configuration.

Table 1.2-1 Maximal configuration of PRS-7741 (6U 19" rack)

Configuration	App 1	App 2	App 3	App 4	App 5
AC analog input (Conventional CT/VT)	4CT + 5VT	7CT + 8VT	13VT	24VT	12CT + 12VT

Configuration	App 1	App 2	App 3	App 4	App 5
DC analog input	Max. 18				
DC analog output	Max. 6				
Binary input	Max. 150				
Binary output	Max. 50 (25 groups)				
Supported CB number for closing synchronism check	1	N/A	2	N/A	1

Table 1.2-2 Maximal configuration of PRS-7741 (6U 9.5" rack)

Configuration	App 1	App 2
AC analog input (Conventional CT/VT)	4CT + 5VT	4CT + 8VT
DC analog input	N/A	Max. 6
DC analog output	N/A	
Binary input	Max. 90 configurable	Max. 80 configurable
Binary output	Max. 22 (11 groups) normally open contacts	
Supported CB number for closing synchronism check	1	N/A

1.2.1 Measurement

- Conventional CT/VT sampling method with AC AI module in using electrical cable
- Transducer input in DC for temperature, humidity, etc.

1.2.2 Configurable Function

- Programmable binary input
- Programmable binary output
- Programmable software & hardware interlocking logic output
- Programmable LED indicators

1.2.3 Miscellaneous Function

- Fuse Failure supervision
- Current circuit supervision
- Self-diagnostic
- Device power supply supervision
- Events Recorder including 1024 disturbance record, 1024 binary event, 1024 supervision events, 256 control logs and 1024 device logs
- Clock synchronization methods

- **Conventional**
  - PPS (RS-485): Pulse per second (PPS) via RS-485 differential level
  - IRIG-B (RS-485): IRIG-B via RS-485 differential level
  - PPM (DIN): Pulse per minute (PPM) via optical coupler
  - PPS (DIN): Pulse per second (PPS) via optical coupler
- **SAS**
  - SNTP (PTP): Unicast (point-to-point) SNTP mode via Ethernet network
  - SNTP (BC): Broadcast SNTP mode via Ethernet network
  - Message (IEC103): Clock messages through IEC103 protocol
- **Advanced**
  - IRIG-B (Fiber): IRIG-B via optical-fiber interface
  - PPS (Fiber): Pulse per second (PPS) via optical-fiber interface

1.2.4 Single Line Diagram

The main wiring diagram is showed on the device main interface.

- The single line diagram is showed on the device main interface. It contains the analog information collected by the device,as well as the position of the circuit breaker,disconnector and earthing blades.
- It can show single, double, 3/2 breaker arrangement of bays for line, transformer,bus coupler,shunt reactor and capacitor bank feeders.
- The front panel has push buttons for selection and operation of switchgear.

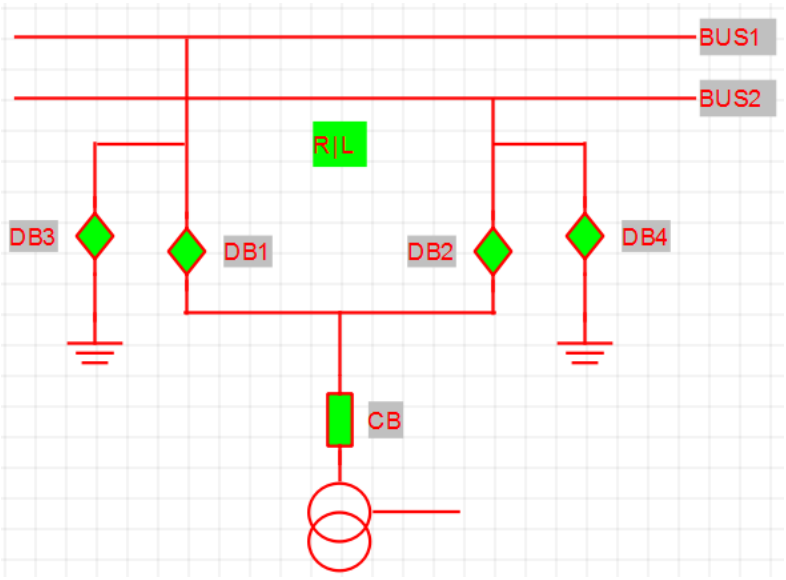


Figure 1.2.1 Device Main Interface

1.2.5 Communication

- RS-485 communication port conform to IEC 60870-5-103 protocol
- RS-485 differential port for clock synchronization
- Ethernet port via twisted-pair cable conform to SUNRI private 103 or IEC 61850 protocol over TCP/IP
- Ethernet port via optic fiber conform to SUNRI private 103 or IEC 61850 protocol over TCP/IP

1.3 Product Features

- This device is based on a 32-bit high performance dual-core processor, internal high speed bus and intelligent I/O ports, and the hardware is in modularized design and can be configured flexibly, featuring interchangeability and easy extension and maintenance.
- Modularized hardware design makes this relay be easily upgraded or repaired by a qualified service person. Various function optional modules can satisfy various situations according to the different requirements of the users..
- The adoption of 16-bit A/D converter and the dual-channel sampling technology can ensure the accuracy and reliability of protection sampling and the correctness of protection operation. It also provides dedicated current transformers for metering, and ensures the high accuracy of telemetering with 48-point high speed sampling rate per cycle.
- This device can sample the analog values from the traditional instrument transformers, or receive the sampled values from the electronic transformers. It can support the protocol IEC60044-8, IEC61850-9-2 and GOOSE.
- Various algorithms for protection and measurement have been completed in this device for the feature of electronic transformer sampling, such as the error prevention method of multi-algorithms data anomaly for the digital channels, to realize high accuracy and reliability under various conditions of network faults or communication interruption.
- This device has powerful GOOSE functions, and the connection and cooperation between some devices can be realized without using electrical cables, to facilitate the realization of such functions as simple bus differential protection, overload interlock shedding function and backup automatic transfer function etc.
- This device has fully realized the technology to integrate six functions into one device: protection, measurement, control, remote signaling, merging unit function and remote module functions, to improve the reliability.
- Various methods of GPS time synchronization are supported in this relay, including SNTP, pulse per second (PPS) and IRIG-B synchronization.
- The protection modules are completely separated from other modules, and are independent in both hardware and software. The protection functions do not depend on the communication network, so the failure of communication network will not affect the normal operation of the

protection functions.

- Mature protection configuration, fast speed and high security performance can meet the practical requirements. Each protective element is independent, so it is very convenient for whether adopting the selected protective element.
- This device constantly measures and calculates a large amount of analog quantities, such as phase voltage, phase-to-phase voltage, neutral voltage, phase current, neutral current, active power, reactive power, power factor and frequency etc.
- The human machine interface (HMI) with a small control module (a 240×128-dot LCD, a 9-key keypad and 20 LED indicators) on the front panel is very friendly and convenient to the user.
- This device can communicate with a SAS or RTU via different communication intermediates: Ethernet network, RS-485 serial ports. The communication protocol of this device is optional: IEC61850, IEC60870-5-103, DNP3.0 or ModBus.
- This device can detect the tripping circuit of the circuit breaker and monitor the operation (close or trip) time of a circuit breaker by checking the auxiliary contacts of the circuit breaker.
- Complete event recording function is provided: 64 latest protection operation reports, 1024 latest supervision records, 1024 latest control operation records, 1024 latest user operation records and 1024 latest records of time tagged sequence of event (SOE) can be recorded.
- Powerful fault and disturbance recording function is supported: 64 latest fault or disturbance waves, the duration of a wave recording is configurable.

2 Technical Specifications

2.1 Electrical Specifications

2.1.1 Current Transformer Ratings

Phase rotation		ABC or ACB, Configurable				
Rated frequency (fn)		50Hz, 60Hz				
Nominal frequency (fn)		50Hz, 60Hz				
Application object		For protection		For metering		For SEF
Rated current (In)		1A	5A	1A	5A	1A
Linear to		30×In	30×In	2×In	2×In	2×In
Thermal withstand capability	continuously	3×In	3×In	2×In	2×In	2×In
	for 10s	30×In	30×In	12×In	12×In	12×In
	for 1s	100×In	100×In	30×In	30×In	30×In
	for half a cycle	250×In	250×In	75×In	75×In	75×In
Burden (@ In, per phase)		< 0.15VA	< 0.25VA	< 0.20VA	< 0.40VA	< 0.20VA

2.1.2 Voltage Transformer Ratings

Phase rotation		ABC or ACB, Configurable
Rated frequency (fn)		50Hz, 60Hz
Nominal range		fn ± 10Hz
Rated voltage (Un)		100V ~ 220V (phase-to-phase voltage)
Linear to		300V
Thermal withstand capability	continuously	240V
	10s	360V
	1s	400V
Burden		< 0.10VA / phase@120V

2.1.3 Auxiliary Power Supply

Standard		IEC 60255-11:2008
Rated voltage		48VDC~250VDC、64V~250VAC
Variation		80% ~ 120%
Permissible AC ripple voltage		Max 15% of the rated voltage (DC power supply)
Burden	Traditional AC inputs	< 10W @ Quiescent condition; < 15W @ Operating condition

2.1.4 Binary Input

Binary input number	Up to 124					
Rated voltage	24V	30V	48V	110V	125V	220V	250V
Rated current	1.00mA	1.25mA	2.00mA	1.10mA	1.25mA	2.20mA	2.50mA
Pickup voltage	55% ~ 70% rated voltage						
“ON” value voltage	70% ~ 120% rated voltage						

“OFF” value voltage	< 55% rated voltage
Maximum permitted voltage	120% rated voltage
High voltage withstand	2000Vac, 2800Vdc
Resolving time for logic input	< 1ms

2.1.5 Binary Output

Item		Tripping output	Signal output
Binary output number		Up to 12	Up to 16
Output model		Potential-free contact	Potential-free contact
Max system voltage		380Vac, 250Vdc	380Vac, 250Vdc
Voltage across open contact		1000V RMS for 1min	1000V RMS for 1min
Continuous carry		2000VA, 240W	2000VA, 150W
Short duration current		6A for 3000ms; 15A for 500ms	6A for 3000ms; 15A for 500ms
Breaking capacity		1.00A @ 48Vdc, L/R=40ms 0.30A @ 110Vdc, L/R=40ms 0.20A @ 220Vdc, L/R=40ms	0.60A @ 48Vdc, L/R=40ms 0.10A @ 110Vdc, L/R=40ms 0.05A @ 220Vdc, L/R=40ms
Pickup time		< 8ms	< 10ms
Dropout time		< 5ms	< 8ms
Bounce time		1ms	1ms
Durability	loaded contact	10,000 operations minimum	10,000 operations minimum
	unloaded contact	20,000 operations minimum	20,000 operations minimum

2.2 Mechanical Specifications

Mounting Way	Flush mounted	
Weight per device	Approx. 8.0kg (fully equipped)	
Local control panel	Small control module: a 320×240-dot LCD, a 9-key keypad, 8 function keys, 20 LEDs and 9 function LEDs	
Display language	Optional: Chinese, English	
Housing material	Metallic plates, parts and screws: Steel Plastic parts: Polycarbonate	
Housing color	Silver grey	
Location of terminal	Rear panel of the device	
Protection class	IEC60225-1: 2009	Front side: IP52 Rear side, connection terminals: IP20 Other Sides: IP40

2.3 Ambient Temperature and Humidity Range

Standard	IEC 60255-1:2009
Operating temperature range	-40°C ~ +70°C (for the LCD -20°C ~ +70°C)
Transport and storage temperature range	-40°C ~ +70°C
Permissible humidity	5% ~ 95%, condensation not permissible
Altitude	<3000m

2.4 Communication Interfaces

2.4.1 Ethernet Port for RTU/SCADA

For Station Level			
Medium		**Parameters**	
Ethernet: Electrical OR Optical	Electrical	Port number	3
		Connector type	RJ-45
		Transmission rate	100Mbits/s
		Transmission standard	100Base-TX
		Transmission distance	≤ 100m
		Protocol	IEC60870-5-103:1997, IEC61850 etc.
		Safety level	Isolation to ELV level
	Optical	Port number	3
		Connector type	LC
		Transmission rate	100Mbits/s
		Transmission standard	100Base-FX
		Optical fiber type	Multi-mode
		Wavelength	1310nm
		Transmission distance	≤ 2000m
		Protocol	IEC60870-5-103:1997, IEC61850 etc.
For Process Level (If reqired)			
Medium		**Parameters**	
Optical		Port number	4
		Connector type	LC
		Transmission rate	100Mbits/s
		Transmission standard	100Base-FX
		Optical fiber type	Multi-mode
		Wavelength	1310nm
		Transmission distance	≤ 2000m

2.4.2 Serial Port for RTU/SCADA

Medium	**Parameters**	
RS-485 (EIA)	Port number	2
	Baud rate	4800 ~ 115200bps
	Transmission distance	≤ 500m @ 4800bps
	Maximal capacity	32
	Protocol	IEC60870-5-103:1997, DNP3.0 etc.
	Safety level	Isolation to ELV level

2.4.3 Time Synchronization

Medium	**Parameters**

RS-485 (EIA)	Port number	1
	Transmission distance	≤ 500m
	Maximal capacity	32
	Timing standard	IRIG-B
	Safety level	Isolation to ELV level
Optical Ethernet	Port number	1
	Transmission distance	≤ 2000m
	Timing standard	IRIG-B

2.4.4 Ethernet Port for Debugging

Medium	Parameters	
Electrical Ethernet (in front panel)	Port number	1
	Connector type	RJ-45
	Transmission rate	100Mbits/s
	Transmission standard	100Base-TX
	Transmission distance	≤ 100m
	Safety level	Isolation to ELV level

2.5 Type Tests

2.5.1 Environmental Tests

Dry cold test	IEC60068-2-1:2007, 16h at -40°C
Dry heat test	IEC60068-2-2: 2007, 16h at +70°C
Damp heat test	IEC60068-2-78: 2001, 6 days, 93%RH, +40°C
Cyclic temperature with humidity test	IEC60068-2-30: 2005, six (12+12hours) cycles, 95%RH, low temperature +25°C, high temperature +40°C

2.5.2 Mechanical Tests

Vibration test	IEC60255-21-1:1988, Class I
Shock test	IEC60255-21-2:1988, Class I
Bump test	IEC60255-21-2:1988, Class I
Seismic test	IEC60255-21-3:1988, Class I

2.5.3 Electrical Tests

Dielectric test	IEC60255-27:2013, test voltage: 2kV, 50Hz, 1min
Impulse voltage test	IEC60255-27:2013, test voltage: 5kV, unipolar impulses, waveform 1.2/50μs, source energy 0.5J
Insulation measurement	IEC60255-27:2013, insulation resistance >100MΩ @ 500Vdc
Overvoltage category	IEC60255-27:2013, Class III
Pollution degree	IEC60255-27:2013, Class II

2.5.4 Electromagnetic Compatibility

Slow damped oscillatory wave	IEC 61000-4-18

	Common mode: class Ⅲ 2.5kV
	Differential mode: class Ⅲ 1.0kV
Electrostatic discharge	IEC 61000-4-2 class Ⅳ
	For contact discharge: 8kV
	For air discharge: 15kV
Radiated radio-frequency electro-magnetic field	IEC 61000-4-3 class Ⅲ
	Frequency sweep Radiated amplitude-modulated 10V/m (rms), f=80~1000MHz, 1400~2700MHz
	Spot frequency Radiated amplitude-modulated 10V/m(rms), f=80MHz/160MHz/380MHz/450MHz/900MHz/1850MHz/2150MHz
Electrical fast transients	IEC 61000-4-4 class Ⅳ
	Power supply, I/O, Earth: class Ⅳ, 4kV, 5kHz, 5/50ns
	Communication port: class Ⅳ, 2kV, 5kHz, 5/50ns
Surge immunity	IEC 61000-4-5 class Ⅳ
	Power supply, AC input, I/O port: class Ⅳ, 1.2/50us Common mode: 4kV Differential mode: 2kV Communication port: class Ⅳ, 1.2/50us Common mode: 4kV
Conducted disturbance induced by radio-frequency field	IEC 61000-4-6 class Ⅲ
	Power supply, AC, I/O, Communication, Functional earth port: Class Ⅲ, 10Vrms, 150 kHz~80MHz
Power Frequency Magnetic Field Immunity	IEC 61000-4-8 class Ⅴ
	100A/m for 1min, 1000A/m for 3s
Pulse Magnetic Field Immunity	IEC 61000-4-9 class Ⅴ
	Class Ⅴ, 6.4/16μs, 1000A/m for 3s
Damped oscillatory magnetic field immunity	IEC 61000-4-10 class Ⅴ
	Class Ⅴ, 100kHz & 1MHz–100A/m
Power frequency	IEC 61000-4-16 class A
	Binary input port Common mode:300V Differential mode: 150V
Radiated emission	CISPR 11
	Enclosure port: the highest frequency of the internal sources of the EUT is less than 108MHz. 30MHz to 230MHz 40 dB(uV/m) quasi peak at 10m, 50 dB(uV/m) quasi peak at 3m 230MHz to 1000MHz 47 dB(uV/m) quasi peak at 10m, 57 dB(uV/m) quasi peak at 3m
Conducted emission	CISPR 22

	0.15 MHz to 0.50Mhz 79dB(uV) quasi peak, 66dB(uV) average 0.5MHz to 30Mhz 73dB(uV) quasi peak, 60dB(uV) average
Auxiliary power supply performance - Voltage dips -Voltage short interruptions	IEC 61000-4-11, IEC 61000-4-29 Up to 200ms for dips to 40% of rated voltage without reset 100ms for interruption without rebooting

2.6 Certifications

- ISO9001:2015
- ISO14001:2015
- OHSAS18001:2015
- ISO/IEC 20000:2016

2.7 Terminals

Connection Type	Wire Size
AC current	Screw terminals, 2.5mm^2 lead
AC voltage	Screw terminals, 1.5mm^2 lead
Power supply	Screw terminals, 1.0mm^2~2.5mm^2 lead
Contact I/O	Screw terminals, 1.0mm^2~2.5mm^2 lead
Grounding (Earthing) Connection	BVR type, 4.0mm^2~6.0mm^2 lead

2.8 Measurement Range and Accuracy

Metering Item	Range	Accuracy
Phase range	0° ~ 360°	≤ 0.5% or ±1°
Frequency	35.00Hz ~ 70.00Hz	≤ 0.01Hz
Currents from dedicated metering current transformers		
Current	0.05~1.40In	≤ 0.2% of rating
Voltage	0.05~1.20Un	≤ 0.2% of rating
Voltage under the limit temperature condition	0.05~1.20Un	≤ 0.4% of rating
Active power (W)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 0.5% of rating at unity power factor
Reactive power (Vars)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 0.5% of rating at zero power factor
Apparent power (VA)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 0.5% of rating
Energy (Wh)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 0.5% of rating at unity power factor
Energy (Varh)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 0.5% of rating at zero power factor
Currents from protection measurement current transformers		
Current	0.05~1.40In	≤ 0.2% of rating
Voltage	0.05~1.20Un	≤ 0.5% of rating
Active power (W)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 3.0% of rating at unity power factor

Reactive power (Vars)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 3.0% of rating at zero power factor
Apparent power (VA)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 3.0% of rating
Energy (Wh)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 3.0% of rating at unity power factor
Energy (Varh)	0.05 ~ 1.20×Un, 0.05 ~ 1.40×In	≤ 3.0% of rating at zero power factor

2.9 Management Function

2.9.1 Control Performance

Control mode	Local or remote
Accuracy of local control	≤ 1s
Accuracy of remote control	≤ 3s

2.9.2 Clock Performance

Real time clock accuracy	≤ 3s/day
Accuracy of GPS synchronization	≤ 1ms
External time synchronization	IRIG-B (200-98), PPS or SNTP protocol

2.9.3 Binary Input Signal

Resolution of binary input signal	≤ 1ms
Binary input mode	Potential-free contact
Resolution of SOE	≤ 1ms

3 Operation Theory

3.1 Overview

The PRS-7741 relay is a microprocessor based BCU which can provide mature monitoring and controlling functions for various primary equipments (busbars, transformers, transmission lines, etc.). The following sections detail the individual functions of this device.

3.2 AC Analog Input

3.2.1 Function Description

PRS-7741 Bay Control Unit is equipped with two AC modules at most which can collect four groups of AC analog. The calculation method of rated voltage, current class and power of each group of AC analog can be set independently. The device adopts high-conversion-precision components and algorithm, thus improving the collection and calculation precision, and the fine setting of amplitude and phase angle can be implemented through software.

Dead zone setting function is in the device; the dead zone value for each channel of voltage and current can be set.

PRS-7741 Bay Control Unit is designed with dual PT sampling. According to the disconnector positions between the double bus and line, the device can achieve the voltage from the selected busbar zone.

Parameter setting of AC measure quantity contains the following items:

Here is the calculation theory of measurement:

$$U = \sqrt{\frac{1}{N}\sum_{n=1}^{N} U^2(n)}$$

$$I = \sqrt{\frac{1}{N}\sum_{n=1}^{N} I^2(n)}$$

$$P = \frac{1}{N}[U_a(n)I_a(n) + U_b(n)I_b(n) + U_c(n)I_c(n)]$$

$$Q = \frac{1}{N}[U_a(n)I_a(n-\frac{3}{4}N) + U_b(n)I_b(n-\frac{3}{4}N) + U_c(n)I_c(n-\frac{3}{4}N)]$$

P , Q Active/Reactive power calculated by three-meter method

$$P = \frac{1}{N}[U_{ab}(n)I_a(n) + U_{cb}(n)I_c(n)]$$

$$Q=\frac{1}{N}\left[U_{ab}(n)I_a(n-\frac{3}{4}N)+U_{cb}(n)I_c(n-\frac{3}{4}N)\right]$$

P , Q Active/Reactive power calculated by two-meter method

N The sampling rate of measurement

$$\cos\Phi=\frac{P}{\sqrt{P^2+Q^2}}$$

3.2.2 Settings

Table 3.2-1 Parameter Setting of AC Measure Quantity

Name	Values (Range)	Unit	Stage	Default	Description
CT/PT primary rated value	1~1200KV, 1~9999A		~	1000A/110KV	CT/PT primary rated value
CT/PT secondary rated value	5A/100V,1A/100V,5A/115V,1A/115V,5A/220V and 1A/220V		~	1A/100V	CT/PT secondary rated value
Dead zone value	0~100%		~	0.2%	Dead zone value of U/I/P/Q/S/Cos
Power calculation method	Two-watt meter / three-watt meter.		~	three-watt meter	Power calculation method

3.3 DC Analog Input

3.3.1 Function Description

There are at most six DC sample channels in PRS-7741 Bay Control Unit. The input of DC quantity is usually 0~20mA or 0~5V, and can be provided with an external transmitter to collect the main transformer temperature, DC bus voltage and DC current.

Parameter setting of DC measure quantity contains the following items:

3.3.2 Settings

Table 3.3-1 Parameter Setting of DC Measure Quantity

Name	Values (Range)	Unit	Stage	Default	Description
Dead zone value	0~100%		~	0.2%	Dead zone value of DC

Name	Values (Range)	Unit	Stage	Default	Description
DC Transformer Coefficient	1~9999		~	930	DC Transformer Coefficient

3.4 Binary Input

3.4.1 Function Description

PRS-7741 Bay Control Unit can collect BI signals, and each BI shall generate reflection records after undergoing optoelectronic isolation and software impulse filtering.

Parameter setting of status signal quantity contains the following items:

After the filter circuit and debouncing algorithm processing, external interference can be filtered effectively. As shown in the following figure, a well-designed debouncing technique is adopted in this device. Binary input state change within "Debouncing time" (t0-t1 can be set 0~30s) will be ignored, in order to ensure the accuracy of the signal status. Once there is a confirmation of change status of signal (start from t1), a SOE record will be noted in the device.

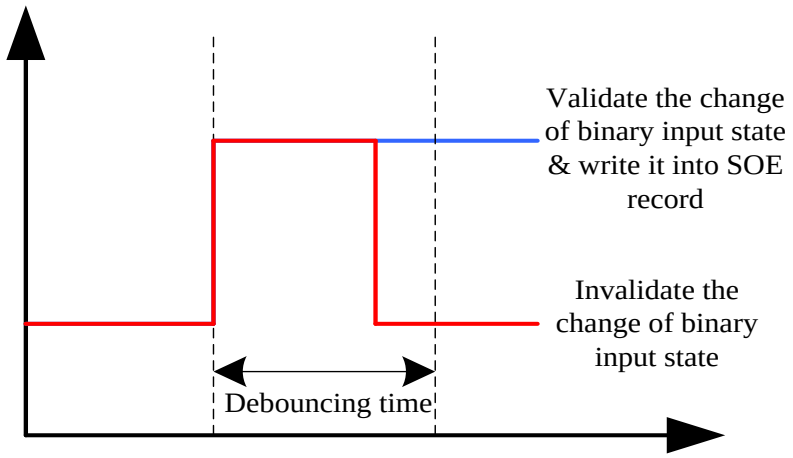


Figure 3.4.1 Debouncing technique for binary input

If any input changes more than a defined number of times (N) in a given period (P), then it shall be automatically suppressed and indication of this presented to the operator, corresponding LED alarm lights will be lit. when these fault inputs change less than N in new given period (P),then it shall be recuperative, corresponding LED alarm lights will be goes out. Selection of the variable N and P can be carried out during system configuration.

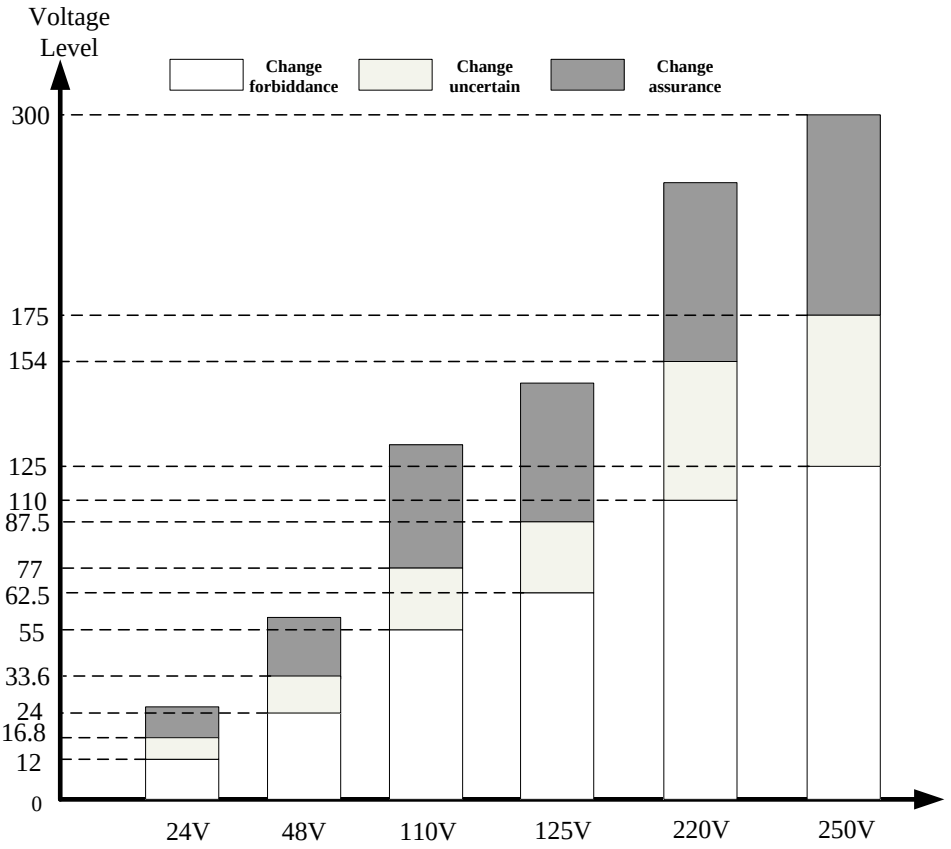
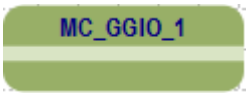


Figure 3.4.2 Voltage dependence for binary inputs

A double point status (DPS), which usually indicates primary switchgear status, can be derived from 2 ordinary binary inputs. The user-defined DPS is configurable through the auxiliary configuration software PRS-Explorer. The signification of a DPS is shown in the following table. For primary switchgear status, only the 2 status "01" and "10" indicates respectively the positions "Open" and "Close" are valid.

DPS	Bit0=0	Bit0=1
Bit1 = 0	DPS_INT	DPS_ON
Bit1 = 1	DPS_OFF	DPS_BAD

3.4.2 Function Block



	Data Item Name	Description	Attribute Name
1	dwOpenVal	dwOpenVal	stVal
2	dwCloseVal	dwCloseVal	stVal
3	dwDPosPinNO	dwDPosPinNO	stVal

3.4.3 I/O Signal

Table 3.4-1 Description of Binary Input

No.	Input Signal	Description
1	OpenVal	Double point of normally open

No.	Input Signal	Description
2	CloseVal	Double point of normally close
3	DPosPinNO	Double point

3.5 Binary Output

3.5.1 Function Description

The control output function performs execution to primary equipment, such as CB/DS/ES switching and tap position changer or for signaling purpose.

PRS-7741 Bay Control Unit has flexible remote control and interlock which are applicable to various service.

PRS-7741 Bay Control Unit contains 16 remote control outputs.

Remote control command selection time can be set; and remote control selection and remote control operation can be indicated by corresponding LED lights.

The interlock logic function of PRS-7741 Bay Control Unit is programmable. Through the visual logic configuration tool, the interlock logic configuration files can be modify based on the actual requirements.

To ensure more security of this function, each binary output consists of power relay, fault detector relay and output relay in series. An error of one relay will not cause any undesired output, to enhance the dependability. Furthermore, the circuit to block control is also available to prevent output by mistake during breakdown of hardware.

If the interlock logic is not fulfilled, the remote preset will fail. In the operation record, the failure reason of remote control can be viewed.

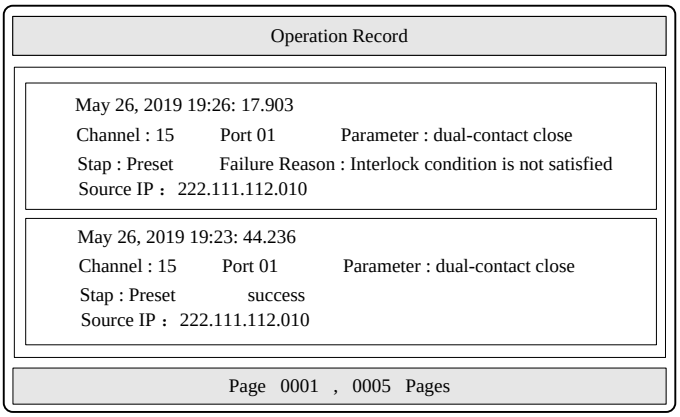
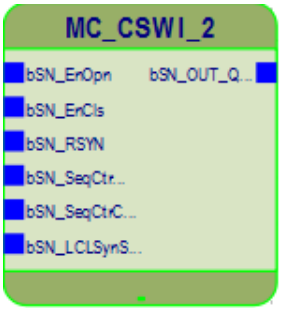


Figure 3.5.1 Operation Record

Parameter setting of remote control and blocking contains the following items:

3.5.2 Function Block



	Data Item Name	Description	Attribute Name
1	SetSN_PW_Opn	SetSN_PW_Opn	stVal
2	SetSN_PW_Cls	SetSN_PW_Cls	stVal
3	dwSetSN_SelTm	dwSetSN_SelTm	stVal
4	dwSetSN_ExecTm	dwSetSN_ExecTm	stVal
5	dwSetSN_DBlHoldTm	dwSetSN_DBlHoldTm	stVal
6	dwNorOpnVal	dwNorOpnVal	stVal
7	dwNorClsVal	dwNorClsVal	stVal
8	dwDPosPinNO	dwDPosPinNO	stVal
9	dwYFKOPinNO	dwYFKOPinNO	stVal
10	dwYHKOPinNO	dwYHKOPinNO	stVal
11	dwSYNCKOPinNO	dwSYNCKOPinNO	stVal

3.5.3 I/O Signal

Table 3.5-1 Description of Binary Output

No.	Input Signal	Description
1	bSN_EnOpn	Interlocking signal of remote open
2	bSN_EnCls	Interlocking signal of remote close
3	bSN_LCLSynStart	Signal of sync start
4	bSN_OUT_QDEnaSig	Signal of Starting the outlet switch

3.5.4 Settings

Table 3.5-2 Parameter Setting of Binary Output

Name	Values (Range)	Unit	Stage	Default	Description
SetSN_PW_Opn	0.1~60	S	0.01	0.2	remote-control trip pulse width
SetSN_PW_Cls	0.1~60	S	0.01	0.2	remote-control close pulse width
dwSetSN_SelTm	0.1~60	S	0.01	30	Time period of SBOw operation
dwSetSN_ExecTm	0.1~60	S	0.01	30	Time period of operate operation
dwSetSN_DBlHold Tm	0~10	S	0.01	0.02	Time period of debouncing

3.6 DC Analog Output

3.6.1 Function Description

There are at most six DC analog output channels in PRS-7741 Bay Control Unit. The output of DC quantity is usually 0~20mA. Regulation command from remote control center or local station control can be realized in sending DC analog output to regulate a control object such as the active/reactive power output of generator.

Technician can define the maximal and minimal values of the DC analog output (physical signification) to simply the visual understanding.

3.6.2 Settings

Table 3.6-1Parameter Settings of DC Analog Output

Name	Values (Range)	Unit	Stage	Default	Description
SetDCVal	0~2000	~	~	2000	Set the value of the output DC

- **DC Value**

DC Out value = SetDCVal / 100;

3.7 Interlocking Logic Output

3.7.1 Function Description

PRS-7741 Bay Control Unit has flexible remote control and interlock which are applicable to various service. In general, interlocking logic provides such kind of suitable scheme for operation of power system apparatus. Interlocking scheme of logic have function to block the switching control operation of primary equipment. The process of each IED has completed this logic function. For communication, IEC 61850-8-1 CODE is used as reference. The logic of interlocking scheme standard depend on the configuration and primary apparatus status. For modern standard requirements, interlocking logic scheme must have this flexibility to meet any specific condition.

Busbar wide interlocking for busbar earthing switches and closing of busbar isolators shall be arranged via the LAN between the BCUs. For security reasons, the position of the bus coupler and the bus bar earthing switchings shall be communicated from the bus coupler bay BCU to all other BCUs via hard bus wires. Also the position of the busbar isolators for closing of the busbar earth switches shall be communicated from all feeders to the bus coupler BCU via hard bus wires.

The interlocking logic scheme of function is easily enabled/disabled by setting parameters. Before a switching command, output is executed, the interlocking logic of the BCU will check whether the preprogrammed interlocking logic equations are met to permit the operation or not. The interlocking conditions depend on the circuit configuration and apparatus position status at switching commanding time. Some important technical terms of Interlocking functions are follow:

- PRS-7741 Bay Control Unit contains 16 remote control outputs.
- Remote control command time easily set w.r.to to any specific condition.
- Remote control selection and remote control operation can be indicated by corresponding LED lights.
- The interlock logic function of PRS-7741 Bay Control Unit is programmable. Through the visual logic configuration tool, the interlock logic configuration files can be modify based on the actual requirements.

However, any condition the logic scheme of interlocking is not fulfilled and the remote function preset will fail (not operated in due time). The failure reason of remote control can be viewed.

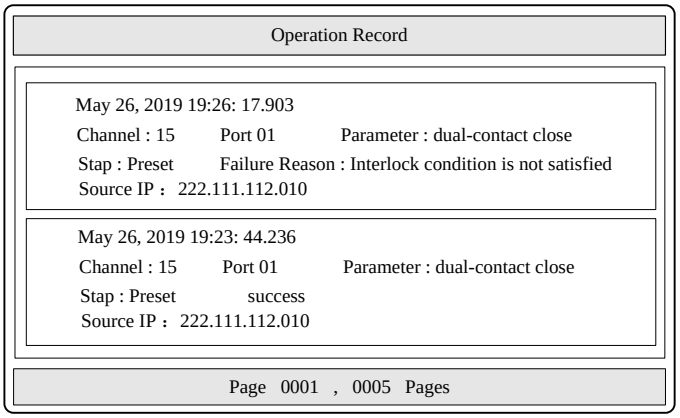
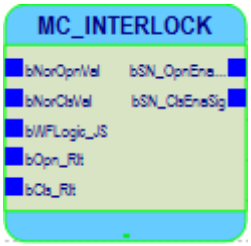


Figure 3.7.1 Block Diagram of Operation Recorded

3.7.2 Functional Block



	Data Item Name	Description	Attribute Name
1	dwYFYXPinNO	dwYFYXPinNO	stVal
2	dwYHYXPinNO	dwYHYXPinNO	stVal
3	dwBSKOPinNO	dwBSKOPinNO	stVal

Figure 3.7.2 Functional Block Diagram of Visual Logic Configuration Tool

3.7.3 I/O Signal

No.	Input Signal	Description
1	bNorOpnVal	Signal of normally open
2	bNorClsVal	Signal of normally close
3	bWFLogic_JS	Signal of unlock

No.	Input Signal	Description
4	bOpn_Rlt	Interlocking logic result of remote trip
5	bCls_Rlt	Interlocking logic result of remote close
6	bSN_OpnEnaSig	Output signal of allowing remote trip
7	bSN_ClsEnaSig	Output signal of allowing remote close

3.8 Tap Changer Control

3.8.1 Function Description

A tap changer is a connection point selection mechanism along a power transformer winding that allows a variable number of turns to be selected in discrete steps. A transformer with a variable turn's ratio is produced, enabling stepped voltage regulation of the output. The tap selection may be made via an automatic or manual tap changer mechanism.
If only one tap changer is required, manually operated tap points are usually made on the high voltage (primary) or lower current winding of the transformer to minimize the current handling requirements of the contacts. However, a transformer may include a tap changer on each winding if there are advantages to do so. For example, in power distribution networks, a large step-down transformer may have an off-load tap changer on the primary winding and an on-load automatic tap changer on the secondary winding.The high voltage tap is set to match long-term system profile on the high voltage network (typically supply voltage averages) and is rarely changed. The low voltage tap may be requested to change positions multiple times each day, without interrupting the power delivery, to follow loading conditions on the low-voltage (secondary winding) network.

The on-load design is also called on circuit tap changer or On Load Tap Changer (OLTC). For many power transformer applications, a supply interruption during a tap change is unacceptable, and the transformer is often fitted with a more expensive and complex OLTC mechanism electronic.

The control and supervision of OLTC is treated as a special kind of binary output in this device. This feature contains two functional modules:tap acquisition module and tap control module.The binary outputs "UpKOPinNO" and "DwnKOPinNO" are used to descend and rise respectively the tap position in comply with the principle SBO. During a tap changer control process, if "running tap" occurs, the tap position will be out of control (steps up or down continuously). An output contact "StpKOPinNO" is then provided to issue an emergency stop command to cut out the power supply of the tap position changer's motor mechanism.

3.8.2 Tap acquisition

3.8.2.1 Function Block

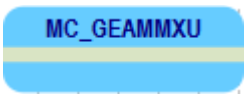


Figure 3.8.1 Block Diagram of Function Block

3.8.2.2 Settings

Table 4.7.1 Settings of Tap acquisition

No	Name	Default Value	Range	Description
1	SetSN_GEA_InType	BCD1	BCD1 BCD2 BCD3 LVDS	the access mode selection of the tap position of the transformer.
2	SetSN_TAP_Pos	39	1~39	The maximum number of transformer's tap position.
3	BIStartPin	BI01		First binary inputs used for Tap Position Indication.
4	BIEndPin	BI13		Last binary inputs used for Tap Position Indication.
5	AnaDCPin	DC01		DC input used for mode of "LVDS" selection of the tap position of the transformer

- **SetSN_GEA_InType**

This is the access mode selection of the tap position of the transformer.
There are 5 modes ("BCD1", "BCD2", "BCD3" ,"LVDS"and "GOCB") available.

- "BCD1:"This mode requires thirteen binary inputs, Users can choose thirteen consecutive binary inputs between "BIStartPin" and "BIEndPin". Binary input "BIStartPin" is the least significant bit however binary input "BIEndPin" is the most significant bit. The first bit, the second bit and the third bit represent ten ,twenty and thirty respectively. The last ten bits represent 0~9.
  Some examples are shown as follows:
  - If the transformer tap position is 5, then binary inputs "BIEndPin" to "BIEndPin" indicate as "0000100000 000".
  - If the transformer tap position is 15, then binary inputs "BIEndPin" to "BIEndPin" indicate as "0000100000 001".
  - If the transformer tap position is 25, then binary inputs "BIEndPin" to "BIEndPin" indicate as "0000100000 010".
  - If the transformer tap position is 35, then binary inputs "BIEndPin" to "BIEndPin" indicate as "0000100000 100".
- "BCD2:"This mode requires seven binary inputs, Users can choose seven consecutive binary inputs between "BIStartPin" and "BIEndPin". Binary input "BIStartPin" is the least significant bit however binary input "BIEndPin" is the most significant bit. The first 4 bits are for binary numbers while the 5th bit ,the 6th bit and the 7th bit represent ten and twenty respectively.
  Some examples are shown as follows:
  - If the transformer tap position is 5, then binary inputs "BIEndPin" to "BIEndPin" indicate as "000 0101".

- ✧ If the transformer tap position is 15, then binary inputs “BIEndPin” to “BIEndPin” indicate as "001 0101".
- ✧ If the transformer tap position is 25, then binary inputs “BIEndPin” to “BIEndPin” indicate as "010 0101".
- ✧ If the transformer tap position is 35, then binary inputs “BIEndPin” to “BIEndPin” indicate as "100 0101".

■ “BCD3:”This mode requires six binary inputs, Users can choose six consecutive binary inputs between “BIStartPin” and “BIEndPin”. Binary input “BIStartPin” is the least significant bit however binary input “BIEndPin” is the most significant bit. These 6 bits are for binary numbers.
Some examples are shown as follows:

- ✧ If the transformer tap position is 5, then binary inputs “BIEndPin” to “BIEndPin” indicate as "000101".
- ✧ If the transformer tap position is 15, then binary inputs “BIEndPin” to “BIEndPin” indicate as "001111".
- ✧ If the transformer tap position is 25, then binary inputs “BIEndPin” to “BIEndPin” indicate as "011001".
- ✧ If the transformer tap position is 35, then binary inputs “BIEndPin” to “BIEndPin” indicate as "100011".

■ “LVDS:” DC input used for mode of “LVDS” selection of the tap position of the transformer.

➢ **SetSN_TAP_Pos**

The maximum number of transformer’s tap position.If the tap value calculated by the module greater than “SetSN_TAP_Pos”, device prompts error messages.

3.8.3 Tap Control

3.8.3.1 Function Block

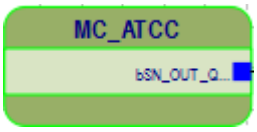


Figure 3.8.2 Block Diagram of Function Block

3.8.3.2 Settings

Table 4.7.2 Settings of Tap control

No	Name	Default Value	Range	Description
1	SetSN_PW_Up	0.2	0~10S	tap-control up pulse width
2	SetSN_PW_Dwn	0.2	0~10S	tap-control down pulse width
3	SetSN_PW_Stp	0.2	0~10S	tap-control stop pulse width
4	dwSetSN_SelTm	30	10~60S	Time period of SBOw operation

No	Name	Default Value	Range	Description
5	dwSetSN_ExecTm	30	10~60S	Time period of operate operation
6	dwSetSN_EmergStp_Ena	0	0/1	Enable/Disable the function to stop slip of TP immediately

- **dwSetSN_EmergStp_Ena**

Enable/Disable the function to stop slip of TP immediately. During tap changer control process, if "slip TP" occurs, the TP will be out of control, and it will step up or down continuously. An output contact "StpKOPinNO" is provided to issue an emergency stop command to block the power source of the motor of the TP changer.

3.9 Generic Object Oriented Substation Event (GOOSE)

3.9.1 Application

Generic Object Oriented Substation Event (GOOSE) is the mechanism defined in IEC 61850 standard used to satisfy fast message demand of SAS, and provides means of fast information transmission and exchange under network communication conditions. In case of any status change, Intelligent Electronic Device (abbreviated as IED) will use status change message to transmit binary objects in high speed. Information exchange among IEDs is realized by GOOSE.

This device can receive and send GOOSE signals in P2P mode or networking mode. For important application case, in order to ensure no loss of data during transmission, it is recommended to configure dual network mode, and duplicated GOOSE networks of process level are independent of the network of station level. The process level network is separated from station level network can ensure that important information, such as tripping signal, is not affected by data in MMS network.

In order to avoid network storm, ring network is not recommended for GOOSE network configuration. Duplicated protection configuration and their GOOSE networks shall be totally independent of each other, to ensure that in case of any network fault in one set of duplicated protection configuration, the other set will not be affected.

3.9.2 Function Description

IEC 61850 provides substation configuration language (SCL) based on XML, which has standardized description of substation systems and device configuration. There are four types of SCL files:

- SSD: Substation Specification Description
- SCD: Substation Configuration Description
- ICD: IED Capability Description
- CID: Configured IED Description

The manufacturers provide ICD file by its own IED configuration tool, which describes the data

model and ability of IED. SSD file is generated by system configuration tool, which includes single line diagram of primary system, logical node of primary device, type definition of logical node, etc. ICD file and SSD file are used as inputs of SCD file which is generated by SCD configuration tool, including a substation′ s primary system configuration (including related information configuration between primary system and secondary system), the secondary device configuration (including signals describe configuration, GOOSE connection configuration), communication network and parameters configuration. Each IED manufacturer exports its CID file after receiving SCD configuration model.

- **Sending GOOSE Message**

IED defines send data by defining GOOSE send dataset and GOOSE control block. GOOSE service is directly mapped to network data link layer. To ensure important information transmission priority, broadcast address is used for multi-channel transmission of information. GOOSE message allows high-speed transmission of tripping signals, which has high transmission success rate.

GOOSE message is not sent at fixed interval. When there is no GOOSE event, the sending interval of GOOSE message is fixed and relatively long. However, after an event occurs, the sending interval is set as shortest. GOOSE adopts continual retransmission to realize reliable transmission, and during this period, the sending interval will gradually increase, until the event status becomes stable. Finally, the sending interval of GOOSE message will be restored to fixed interval again. The whole process is shown as below:

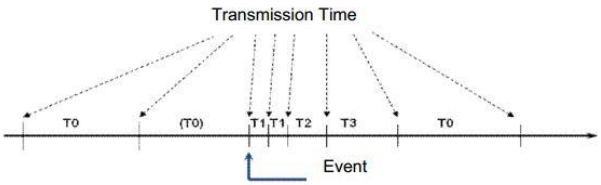


Figure 3.9.1 GOOSE sending mechanism

Where:

T0 is retransmission in stable conditions (no event for a long time), and it is configurable (typical value is 5000ms).

T1 is shortest retransmission time after the event, and it is configurable (typical value is 2ms).

T2 is retransmission times until achieving the stable conditions time, and it is fixed at 2T1.

T3 is retransmission times until achieving the stable conditions time, and it is fixed at 4T1.

GOOSE send adopts retransmission mechanism and has 4 transmission times: T0, T1, T2, and T3. After an event happens, a frame message will be sent, sending again after the time interval T1, and still sending after another time interval T1. Then, respectively sending again with the time interval T2 and T3. The sending will be continued at the time interval T0 again if no new event happens.

GOOSE can send not only binary quantities but also analog quantities without high real-time

requirement, such as, temperature and humidity.

➢ **Receiving GOOSE Message**

GOOSE receiving is controlled by GOOSE link of corresponding serial number, and provides corresponding alarm signal according to the same serial number. After receiving GOOSE data, the GOOSE data shall be processed accordingly, including presetting to 0, presetting to 1, maintaining if GOOSE data is invalid (refer to the following section).

➢ **Invalid GOOSE Data and GOOSE Data Link Disconnection**

In case of any of the following appears, GOOSE data will be considered as invalid.

- The next frame of GOOSE message is not received within 1.1 times maximum message survival time.
- GOOSE receive link is disabled.
- Version number is inconsistent or data configuration of dataset is mismatched.
- Device′ s test mode is inconsistent with the state of "Test" bit in the message.

NOTICE!

Each frame of GOOSE send data includes maximum message survival time, normally 2 times GOOSE heartbeat time (t0).

The state of "Test" bit in GOOSE message is set to 1 if the receiving control block receives message with "Test" bit, otherwise it is set to 0 if the message without "Test" bit is received.

If GOOSE message is not received within 2 times maximum message survival time, GOOSE data link disconnection will be issued. For example, GOOSE publisher sets heartbeat time (t0) to 5s, so that specified message survival time in send message is 10s. After receiving a frame of GOOSE message, GOOSE data will be considered as invalid if the next frame is not received within 11s. GOOSE data link disconnection will be issued if the next frame is still not received in 20s.

When adopting to disconnect network connection to test invalid data or data link disconnection, because disconnecting network connection occurs at any time between two groups of heartbeat messages, invalid GOOSE data is normally issued in 6s~11s and GOOSE data link disconnection is normally issued in 15s~20s after disconnecting network connection.

NOTICE!

Invalid GOOSE data is not synchronized with GOOSE data link disconnection in time. The former is issued when message is not received within 1.1 times maximum message survival time, while the latter is only issued when message is not received within 2 times maximum message survival time.

➢ **Maintenance Mechanism**

GOOSE message provides a parameter, "Test", and GOOSE can be set as maintenance status by the binary input [BI_Maintenance]. The publisher will compare the value of "Test" with that of the subscriber. If they are consistent, the corresponding operation will be executed, otherwise, invalid

GOOSE data will be issued, which eliminates mutual effect between the device in service and the device in maintenance.

Different from traditional contact signals, which can be enabled or disabled by corresponding logic links, this device adopts the following modes to enable and disable corresponding signals after applying GOOSE.

- Through comparing the value of "Test" in GOOSE message between the publisher and the subscriber, GOOSE data is valid when they are consistent, otherwise it is invalid.
- In "Test" state, the subscriber still has event recording and state display functions, to facilitate circuit check.
- GOOSE send link and GOOSE receive link are provided to fulfill the selective transmission of GOOSE signals and isolate the publisher from the subscriber.
- For the publisher, GOOSE will perform "AND" of data value and the state of GOOSE send link, according to whether the data is changed, and decide whether a new round of transmission is initiated.

3.9.3 Settings

Table 3.9-1 Settings of Generic Object Oriented Substation

No	Name	Default Value	Range	Description
1	GLink_SLRL_**	1	0 or 1	Enable/Disable the GOOSE channel message supervision in station layer.

NOTICE!

These links are aimed to avoid issuing disconnection alarms if the corresponding GOOSE channel is empty due to some situation such as the connected remote device is out of service.

3.10 Clock Management

➢ **Real-Time Clock**

The device has an inner real-time high-precision clock. This clock can last for one month even if the device is switched off. This real-time clock may also receive the clock synchronization from computer control system. In case of the device is powered off, the internal real-time clock can be automatically switched and powered by the internal lithium battery on the clock chip. If no short circuit and other abnormal situation occurred to the battery, the backup battery can last for no less than 10 years.

➢ **Clock Synchronization**

The clock synchronization function supports various synchronization signals, including differential IRIG-B, optical fiber IRIG-B, optical fiber PPS, differential PPS, free contact PPS/PPM, SNTP broadcast, SNTP peer-to-peer, received from a timing source device (E.g.: PRS-7391

Satellite-Synchronized Clock).

3.11 Synchrocheck 25SYN

3.11.1 25SYN Overview

This relay supports synchrocheck function. The synchrocheck can be used in a local control operation or remote control operation from a supervision and control system. Three check modes described below can be selected for the synchrocheck function.

3.11.2 25SYN Settings

Table 3.11-1 25SYN settings

NO	Name	Range	Unit	Step	Description
1	SetSN_Sync_NoChk	0 or 1			Enabling/disabling 25SYN without any check 0: disable 1: enable
2	SetSN_Sync_DBDL	0 or 1			Enabling/disabling dead line and dead bus (DLDB) check 0: disable 1: enable
3	SetSN_Sync_LBDL	0 or 1			Enabling/disabling dead line and live bus (DLLB) check 0: disable 1: enable
4	SetSN_Sync_DBLL	0 or 1			Enabling/disabling live line and dead bus (LLDB) check 0: disable 1: enable
5	SetSN_Sync_SYNCHK	0 or 1			Enabling/disabling synchronism check 0: disable 1: enable
6	SetSN_Sync_CLSLOOP	0 or 1			Enabling/disabling closing loop check 0: disable 1: enable
7	SetSN_Sync_SynForbidLoop	0 or 1			When synchronism check enable,it will disable closing loop check
8	SetSN_Sync_NoVolTDalay	0 .000~ 10.000	S	0.001	Dead check signal and exit delay parameters
9	SetSN_Sync_LoopTDelay	0 .000~ 10.000	S	0.001	Loop check signal and exit delay parameters

NO	Name	Range	Unit	Step	Description
10	SetSN_Sync_PHA	0 ~ 5			Set Sync Vol Choosen 0~2:UA/UB/UC 3~5:UAB/UBC/UCA
11	SetSN_Sync_SynOV	57.74~200.00	V	0.01	Threshold of over voltage for synchronism blocking
12	SetSN_Sync_SynUV	0.00~57.74	V	0.01	Threshold of under voltage for synchronism blocking
13	SetSN_Sync_SynOF	50~70	Hz	0.01	Threshold of over frequency for synchronism blocking
14	SetSN_Sync_SynUF	30~50	Hz	0.01	Threshold of under frequency for synchronism blocking
15	SetSN_Sync_LINU	0~100	V	0.01	Set Bus Side Rated Voltage Value
16	SetSN_Sync_SYNU	0~100	V	0.01	Set Line Side Rated Voltage Value
17	SetSN_Sync_SAMEFR	0~0.5	Hz	0.01	Frequency difference limit of same frequency system check
18	SetSN_Sync_NOVOL	0.01~120.00	V	0.01	Voltage threshold of dead check
19	SetSN_Sync_LINVOL	0.01~120.00	V	0.01	Voltage threshold of live check
20	SetSN_Sync_DA	1~ 180	deg	0.01	Phase difference limit of synchronism check
21	SetSN_Sync_DU	0.01~100.00	V	0.01	Voltage difference limit of synchronism check
22	SetSN_Sync_DF	0.00~2.00	Hz	0.01	Frequency difference limit of synchronism check
23	SetSN_Sync_DFDT	0.00~2.00	Hz/S	0.01	Frequency change rate of synchronism check
24	SetSN_Sync_CLOSETIME	0.000~5.000	S	0.001	Inherent Time-difference Value
25	SetSN_Sync_INHANG	0.00~180.00	deg	1	Inherent Angle-difference Value
26	SetSN_Sync_CLOSEANG	0.00~180.00	deg	1	Set Sync Closing-angle Value
27	SetSN_Sync_RESETIME	10.00~60.00	S	1	Max Time of Sync process

Commutation method

➢ Check Sync & Check Loop

1) Commutation method of Dif_Vol

Usys / Ulin	Phase	Line
UA/UB/UC	|Usys-Ulin| <[Dif_Vol]	|Usys-Ulin/1.732|<[Dif_Vol]
UAB/UBC/UCA	|Usys/1.732-Ulin|<[Dif_Vol]	|Usys-Ulin|<[Dif_Vol]*1.732

2) Commutation method of Sync_VolVal

Usys / Ulin	Phase	Line
UA/UB/UC	Usys> Sync_VolVal && Ulin> Sync_VolVal	Usys> Sync_VolVal && Ulin/1.732> Sync_VolVal
UAB/UBC/UCA	Usys/1.732>Sync_VolVal && Ulin> Sync_VolVal	Usys/1.732>Sync_VolVal &&Ulin/1.732>Sync_VolVal

3.11.3 25SYN Operation Principle

The function block of the protection is as below.

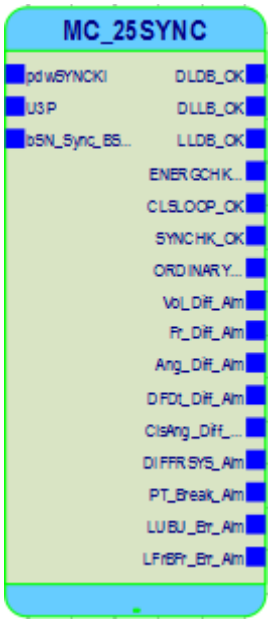


Figure 3.11.1 Function block

Input Signal	Function
bSN_Sync_BSFlg	Input signal of block Sync function(includes PT break)
pdwSYNCKI	Input signal of start Sync command
U3P	Voltage of system side and line side

Output Signal	Function

DBDL_OK	DBDL Condition is met
DLLB_OK	DLLB Condition is met
LLDB_OK	LLDB Condition is met
ENERGCHK_OK	ENERGCHK Condition is met
CLSLOOP_OK	CLSLOOP Condition is met
SYNCHK_OK	SYNCHK Condition is met
ORDINARY_OK	ORDINARY Condition is met
Vol_Diff_Alm	Alarm signal of voltage difference is not satisfied
Fr_Diff_Alm	Alarm signal of frequency difference is not satisfied
Ang_Diff_Alm	Alarm signal of angle difference is not satisfied
DfDt_Diff_Alm	Alarm signal of frequency change difference is not satisfied
ClsAng_Diff_Alm	Alarm signal of Closing angle is not satisfied
DIFFRSYS_Alm	Alarm signal of Non-co-frequency system
PT_Break_Alm	Alarm signal of PT break
LUBU_Err_Alm	Alarm signal of Synchronous voltage abnormal
LFrBFr_Err_Alm	Alarm signal of Synchronous frequency abnormal

➢ Energe Check

The voltage selection includes the selection of appropriate line and bus voltages depending on the type of system configuration. The module includes a fuse supervision feature which supervises the voltage transformer fuses for the selected voltage transformer.

The dead charge check conditions have three types:live-bus and dead-line check(LBDL),

dead-bus and live-line check(DBLL) and dead-bus and dead-line check(DBDL). The above three modes can be enabled and disabled by the corresponding logic settings. The device can calculate the measured bus voltage and line voltage at both sides of the circuit breaker and compare them with the settings. When the voltage is higher than Sync_LINVOL, the bus/line is regarded as live. When the voltage is lower than Sync_NOVOL, the bus/line is regarded as dead.

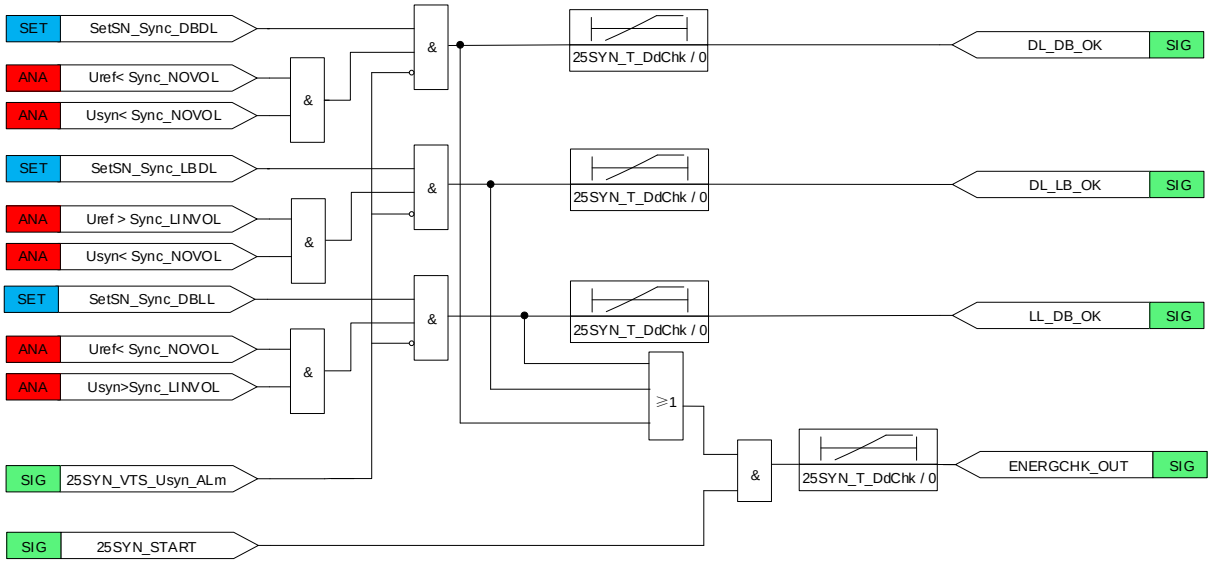


Figure 3.11.2 Logic diagram of **Energe Check** function

The main purpose of the **Energe Check** is to facilitate the controlled reconnection of the disconnected lines and buses to the energized lines and buses. The energizing function in the module is defined as a situation where a dead section of the network is connected to an energized one.

NOTICE!

If Usys < Sync_NOVOL, it means Ua< Sync_NOVOL, Ub< Sync_NOVOL ,Uc< Sync_NOVOL.

If Usys > Sync_LINVOL, it means Ua> Sync_LINVOL, Ub> Sync_LINVOL ,Uc> Sync_LINVOL.

➢ Check Sync

The **Check Sync** module measures the conditions across the circuit breaker. The module also determines the angle change occurring during the closing delay of the circuit breaker from the value of the measured slip frequency. The output is only given when all the measured conditions are simultaneously within their set limits. The issue of the output signal is timed to give closure at the optimal time including the time for the circuit breaker and the closing circuit.

The **Check Sync** module measures the amplitude, frequency and phase angle of the voltages on both sides of the circuit breaker and compares them to the threshold limit detectors. The voltage, frequency and phase angle difference values between the two sides of the circuit breaker are measured and available for evaluation before the synchronizing. If the available bus voltage is phase-to-phase and the line voltage is phase-to-neutral (or the opposite), a compensation is required. This is done with the voltage ratio, which scales up the line voltage to a level equal to the bus voltage.

SetSN_Sync_PHA is used for selection of measuring phase of the voltage for power system. The voltages can be single-phase (phase-to-neutral) or two-phase (phase-to-phase) voltage. If the SetSN_Sync_PHA value is from 0 to 2, the voltage is single-phase voltage (A/B/C) and SetSN_Sync_PHA value is from 3 to 5, the voltage is phase-to-phase voltage (AB, BC, CA). When sync phase is AB/BC/CA, bus dead-line condition: Ua/Ub/Uc< (Sync_Vol /1.732).

The frequency difference, voltage difference and Frequency changing rate difference(dFr/dt) of voltages from both sides of the circuit breaker are calculated in the device, they are used as input conditions of the synchronism check. When the synchronism check function is enabled and the voltages of both ends meet the requirements of the voltage difference, Frequency changing rate difference(dFr/dt), and frequency difference, and the measured bus voltage and line voltage for synchro-check should not exceed the overvoltage threshold SetSN_Sync_SynOV or lag the undervoltage threshold SetSN_Sync_SynUV, and the measured bus frequency and line frequency for synchro-check should not exceed the overfrequency threshold SetSN_Sync_SynOF or lag the underfrequency threshold SetSN_Sync_SynUF, it is regarded that the synchronism check conditions are met.

Considering the closing time of the circuit breaker, the calculation of phase angle difference should be according to the following formulas:

$$dA = \left| \Delta\varphi - \varphi_{dq} \right|$$

$$\varphi_{dq} = 2\pi\Delta f \times T_{dq} + \pi \frac{d\Delta f}{dt} \times T_{dq}^2 - \Delta\varphi_{\text{in}}$$

Where:

$\Delta\varphi$ is the phase angle difference between the line voltage and bus voltage;

φ_{dq} is the variation of phase angle within the operating time of the circuit breaker;

T_{dq} is the circuit breaker operating time, that is the value of Inherent time-diff, which is the time between activating the close command for the circuit breaker and CB reaching the closed position;

$\Delta\varphi_{\text{in}}$ is the angle compensation for the variation of phase angle, which is the value of Inherent angle-diff;

Δf is the frequency difference between the line voltage and bus voltage at the time of activating the close command for the circuit breaker;

The measured frequencies between the settings for the maximum and minimum frequency initiate the evaluation of the angle change to allow operation to be sent at the right moment, including the set value of closing time of the circuit breaker time. There is an internal phase angle[SetSN_Sync_CLOSEANG] released to block any incorrect closing pulses. The function also resets if the **Check Sync** conditions are not fulfilled within the set value of the

[SetSN_Sync_RESETIME] period. This then prevents the functions from being maintained in operation by mistake for a long time waiting for the conditions to be fulfilled.

The logic diagram of **Check Sync** is shown as below:

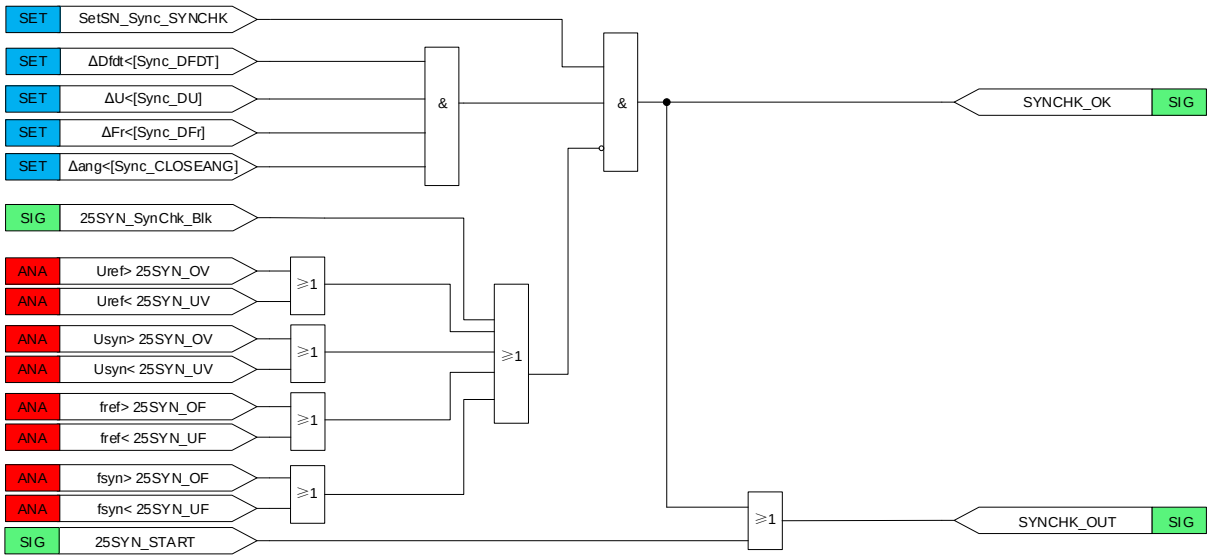


Figure 3.11.3 Logic diagram of the **Check Sync** function

➢ Close Loop

The **Close Loop** module is used for the controlled closing of a circuit breaker in an interconnected network. When used, the function gives an enabling signal at satisfying voltage, frequency and phase angle conditions across the breaker to be closed. The function can be used as a condition to be fulfilled before the breaker is closed.

The **Close Loop** module measures the amplitude, frequency and phase angle of the voltages on both sides of a circuit breaker and compares them to the threshold value of the limit detectors. The differences in voltage, frequency and phase angle values between the two sides of the circuit breaker are measured and available for evaluation before the synchronizing is done. If the available bus voltage is phase-to-phase and the line voltage is phase-to-neutral (or the opposite), a compensation is required. This is done with the voltage ratio, which scales up the line voltage to a level equal to the bus voltage. A typical example is to compensate for the voltage difference caused by connecting the bus voltage as phase-to-phase and the line voltage as phase-to-neutral, in which case the value of the voltage ratio is 1.732.

The **Close Loop** module starts the synchronizing check if the voltage at both sides of the breaker is above the set value of SetSN_Sync_SynUV and not exceed the overvoltage threshold SetSN_Sync_SynOV and the frequency at both sides of the breaker is above the set value of SetSN_Sync_SynUF and not exceed the overfrequency threshold SetSN_Sync_SynOF. When the values of the voltages and frequencies on both sides are fulfilled, the measured values are compared to the set value for phase angle and voltage difference, which are set using SetSN_Sync_DA and SetSN_Sync_DU settings. If a compensation factor is set due to the use of different voltages on the bus and line, the factor is deducted from the line voltage before the comparison is made for the phase angle values.

The frequency on both sides of the circuit breaker is also measured.It is also required that the difference in frequencies on both sides of the breaker must be below [Sync_SameFr].

The CLSLOOP_OK output are activated when the actual measured conditions match the set conditions. If the conditions do not persist for the specified time, the procedure is restarted until the conditions are fulfilled again. The circuit breaker closing is thus not permitted until the **Close Loop** situation has remained constant throughout the set delay time [SetSN_Sync_RESETIME].

The logic diagram of **Close Loop** is shown as below:

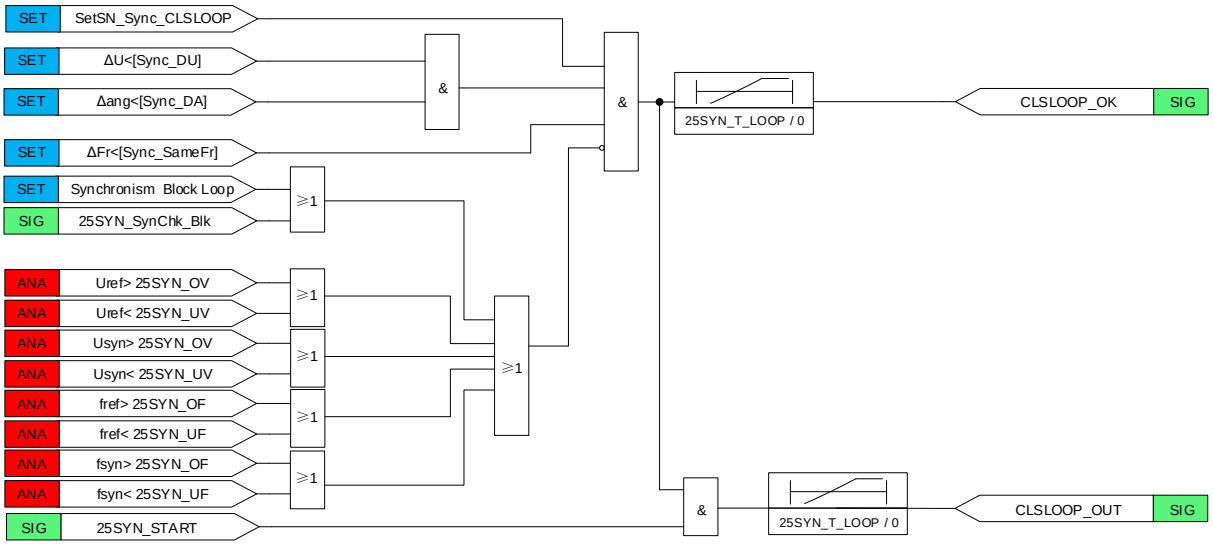


Figure 3.11.4 Logic diagram of the **Close Loop** function

3.11.4 25SYN Check Result

If the result of any check mode is right,synchrocheck result is right.

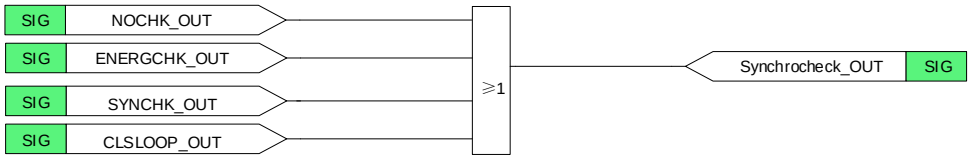


Figure 3.11.6 Logic diagram of the **Synchrocheck_OUT**

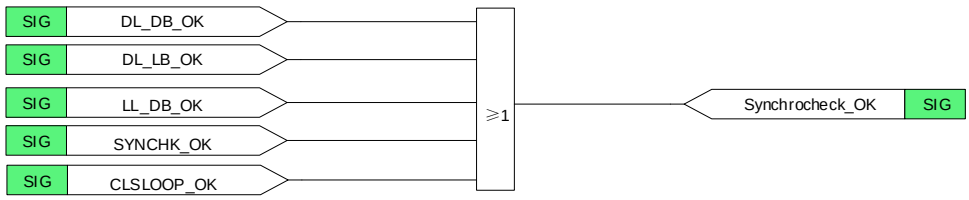


Figure 3.11.7 Logic diagram of the **Synchrocheck_OK**

NOTICE!

During the **Energe Check** or **Close Loop**,there is a special case that must be considered.If

the synchronization period is stated(Time period is **SetSN_Sync_RESETIME**),and the result is not satisfied in the time from **Treset** to **T1**.The condition is OK at the time of **T1**,but the remaining time **T1** is less than the exit delay time(**SetSN_Sync_TDelay**).In this case,when the time of **T1** is over,the device will stop the exit logic and the synchrocheck is failure.

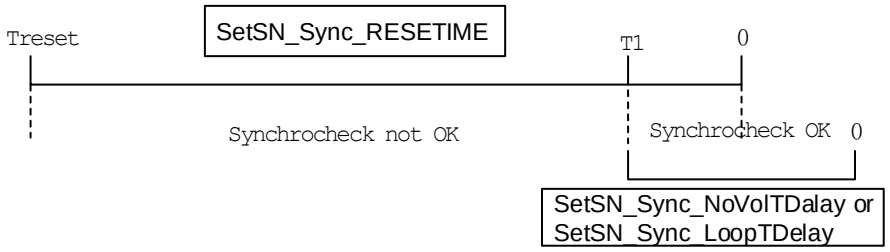


Figure 3.11.8 Logic diagram of the special case

3.11.5 25SYN Check Block

PT disconnection monitoring is to lock the synchronization function when the connection between the PT secondary circuit and the device fails, to prevent possible malfunction.

There are two main logics in this function:

1) System zero sequence voltage(U0) or negative sequence voltage(U2) is greater than 10%Un;

2) No voltage on the system side but current: Any system phase voltage(Ua、Ub、Uc) is less than 30%Un, system positive sequence voltage(U1) is less than 70%Un, and any system current(Ia, Ib, Ic) is greater than 0.5%In;

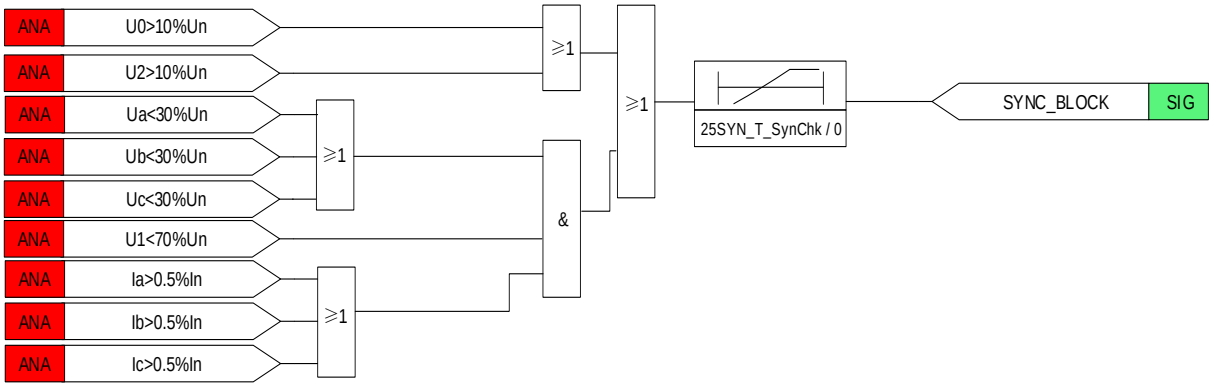


Figure 3.11.9 Logic diagram of the **25SYN Check Block** function

NOTICE!

During the **Synchrocheck**,if **SYNC_BLOCK** is established,the 25SYN function is blocked and the module considers the analog that device acquired is invalid.So 25SYN will no longer judge other synchronization logic and all logic results will be cleaned.

3.11.6 25SYN Application Scope

- **Energe Check**

Energizing check the subsystem of synchro check is to make easier the regulated or monitored

disconnected transmission lines or buses to connect again with energized transmission lines or buses as soon as possible. The main and important application of the energizing check module is to reconnect dead network of power system (T/L or buses) with energized or working network of power system.

➢ Check Sync

Synchronizing the subsystem of synchro check, the main purpose of using the synchronizing function is to check the operating values difference (Amplitude, frequency and angle of the operated voltages) between two operated asynchronous electrical power systems. If the synchronization condition is satisfied, then circuit breaker close command will issue to reconnect the two judged electrical power system. The big advantage this process is to prevent power system from any kind of trouble or damages.

The application of Synchronization module is:

- To reconnect different power generating systems
- To reconnect different operating distribution network or transmission lines
- In electrical power industry where precis and accurate automation is required

The synchronizing module provide a very accurate monitored date for synchronization operation of circuit breaker.

➢ Close Loop

The main and important purpose of implementation of Synchrocheck module is in power system to check the value of two unsynchronized systems for parallel operation. If the synchrocheck condition is satisfied, then IED system will issue the reconnect command signal for CB close or use autoreclosing function.

3.12 Metering

3.12.1 Pulse counter PCGGIO

Pulse counter (PCGGIO) function counts externally generated binary pulses, for instance pulses coming from an external energy meter, for calculation of energy consumption values. The pulses are captured by the BIO (binary input/output) module and then read by the PCGGIO function. A scaled service value is available over the station bus.

Pulse counter (PCGGIO) function in the IED supports unidirectional incremental counters. That means only positive values are possible. The counter uses a 32 bit format, that is, the reported value is a 32-bit, signed integer with a range 0...+2147483647. The counter value is stored in semiretain memory.

The transmission of the counter value can be done as a service value, that is, the value frozen in the last integration cycle is read by the station HMI from the database. PCGGIO updates the value in the database when an integration cycle is finished and activates the NEW_VAL signal in the function block. This signal can be time tagged, and transmitted to the station HMI. This time corresponds to the time when the value was frozen by the function.

3.12.2 Energy calculation and demand handling ETPMMTR

Outputs from the Measurements (CVMMXN) function can be used to calculate energy consumption. Active as well as reactive values are calculated in import and export direction. Values can be read or generated as pulses. Maximum demand power values are also calculated by the function.

Table 3.12-2 ETPMMTR settings

Name	*Type*	*Values*	*(Range)*	*Unit*
EAFACC	REAL	-	MWh	Accumulated forward active energy value
EARACC	REAL	-	MWh	Accumulated reverse active energy value
ERFACC	REAL	-	MVArh	Accumulated forward reactive energy value
ERRACC	REAL	-	MVArh	Accumulated reverse reactive energy value
MAXPAFD	REAL	-	MW	Maximum forward active power demand value for set interval
MAXPARD	REAL	-	MW	Maximum reverse active power demand value for set interval
MAXPRFD	REAL	-	MVar	Maximum forward reactive power demand value for set interval
MAXPRRD	REAL	-	MVar	Maximum reactive power demand value in reverse direction

The instantaneous output values of active and reactive power from the Measurements (CVMMXN) function block are used and integrated over a selected time tEnergy to measure the integrated energy. The energy values (in MWh and MVarh) are available as output signals and also as pulsed output which can be connected to a pulse counter. Outputs are available for forward as well as reverse direction. The accumulated energy values can be reset from the local HMI reset menu or with input signal RSTACC.

The maximum demand values for active and reactive power are calculated for the set time interval tEnergy. The maximum values are updated every minute and stored in a register available over communication and from outputs MAXPAFD, MAXPARD, MAXPRFD, MAXPRRD for the active and reactive power forward and reverse direction until reset with input signal RSTDMD or from the local HMI reset menu.

4 Supervision Functions

4.1 BCU Supervision Alarm

Hardware circuits and operating status of the device are self-supervised continuously. If any abnormality is detected, alarm information or report will be displayed on the device LCD and sent to local/remote control centre.

A minor abnormality may block a certain number of functions while the other functions can still work. However, if a severe hardware failure is detected, all functions will be blocked, the LED "HEALTHY" will be extinguished, and the output contact "Device Failure", which locates in the PWR module, will be electrified. Therefore, this device can no longer be in service and maintenance is required to eliminate the failure. The alarm signals and their corresponding troubleshooting suggestions are listed below.

NOTICE!

If the device is blocked or an alarm signal is issued, please find out its reason with the help of self-diagnostic record. If the reason cannot be found at site, please inform the local service or the manufacturer.

NOTICE!

"XXXX" is the function name substitution for bay identification such as "BayMMXU", "Bus1_MMXU", "Bay1_MMXU", "Sum_MMXU", etc.

Table 4.1-1 BCU supervision alarm

No.	Item	Description
Failure Signals (Device is blocked, "HEALTHY" LED is lit off, "ALARM" LED is lit on)		
1	Fai_Device	The device fails. This signal will pick up if any failure signal picks up and it will drop o^ when all failure signals drop off.
2	Fail_Sample_AD	Error is found during AD sampling.
3	Fail_Settings	Error is found during setting check.
4	Fail_Initialization	Error is found during device initialization process.
5	Fail_FPGA	FPGA chip in the MON module is damaged.
6	Fail_Ove rfl ow_AD	Receiving buffer overflow is found during AD sampling.
7	Fail_SampleSyn_AD	Receiving buffer error is found during AD sampling.
8	Alm_Self-Check	Error is found in device setting or the device is abnormal.
Alarm Signals (Device is not blocked, "HEALTHY" LED is lit on and "ALARM" LED is lit on)		
1	Alm_Device	The device is abnormal.
2	Alm_TimeSyn	Time synchronization abnormality alarm. This signal will pick up with a time delay of 60s and will drop off

No.	Item	Description
		instantaneously.
3	Alm_SamplSyn_FO	Synchronization error exists in the receiving buffer of NET-DSP module.
4	Alm_Overflow_FO	Received frames are beyond the capability of NET-DSP module.
5	Alm_SmplCRC_FO	Error is found in the CRC code received by NET-DSP module.
6	Alm_SmplCounter_FO	The frame counter of NET-DSP module is not consecutive.
7	Alm_RecvTimeout_FO	The data reception of NET-DSP module is time-out.
8	Alm_Quality_FO	The data quality bit received by NET-DSP is "Invalid".
9	B05.Alm_OptoDC	The powersupplyofBImoduleisabnormal. This signal will pick up with a time delay of 10s and will drop off with a time delay of 10s.
10	XXXXAlm_ROV	The [XXXX.UN_Pri] value (indicating residual voltage) is greater than [XXXX.UN_Al m_ROV]*[XXXX.U1n_VT_Measmt]. This signal will pick up with a time delay of 10s and will drop off with a time delay of 1s.
11	XXXX.Alm_VTS_Measmt	VT circuit fails. This signal will pick up with a time delay of 1.25s and will drop off with a time delay of 10s.
12	XXXX.Alm_UV	A primary phase voltage value is less than [XXXX.U_Alm_UV]*[XXXX.U1n_VT_Measmt]. This signal will pick up with a time delay of 10s and will drop off with a time delay of 1s.
13	XXXX.Alm_CTS	CT circuit fails. This signal will pick up with a time delay of 10s and will drop off with a time delay of 10s.
14	B**.Alm_Output	Hardware error is found in the BO module at slot XX.
15	DPOS.Alm	For a double position synthesis signal, which indicates CB/DS/ES status, both the normally open (abbreviated as NO) contact and the normally closed (abbreviated as NC) contact are opened or closed. This signal will pick up with a time delay of "[DPOS.t_DPU_**]+[DPOS.t_Alm]" and will drop off with a time delay of [DPOS.t_Alm].
16	Alm_Settings_RSYN	An incompatibility of the settings [25.Opt_Side_Measmt] and [25.Opt_Side_Syn] is found. This signal will pick up and drop off immediately.

Table 4.1-2 Troubleshooting for BCU supervision alarm

No.	Item	Description
Failure Signals (Device is blocked, "HEALTHY" LED is lit off, "ALARM" LED is lit on)		
1	Fail_Device	Eliminate all the other alarms firstly.
2	Fail_Sample_AD	Put the device out of service. Check the analog input module and the corresponding wiring connector. Reboot the device.
3	Fail_Settings	Inform the local technical support or the manufacturer.

No.	Item	Description
4	Fail_Initialization	Check whether the software version in LCD display is consistent with the one in the configuration file.
5	Fail_FPGA	Inform the local technical support or the manufacturer for replacement.
6	Fail_Overflow_AD	Put the device out of service. Check the analog input module and the corresponding wiring connector. Reboot the device.
7	Fail_SampleSyn_AD	
8	Alm_Self-Check	Check whether the software version in LCD display is consistent with the one in the configuration file. Check whether there is a fatal error in this device.
Failure Signals (Device is blocked, "HEALTHY" LED is lit on, "ALARM" LED is lit on)		
1	Alm_Device	Eliminate the other alarms firstly.
2	Alm_TimeSyn	Check clock synchronization mode and the clock synchronization source. Check wiring connection between the device and the source. Check the setting [Opt_TimeSyn]. If there is no clock synchronization, please set the setting to "No TimeSyn".
3	Alm_SamplSyn_FO	Check the communication channel and the compatibility between the device program version and the configuration file.
4	Alm_Overflow_FO	Check the communication channel and the transmission speed.
5	Alm_SmplCRC_FO	
6	Alm_SmplCounter_FO	
7	Alm_RecvTimeout_FO	
8	Alm_Quality_FO	Check the MU sending configuration and the compatibility between the device program version and the configuration file.
9	B05.Alm_OptoDC	Check the connection of binary input modules. Check whether the device power supply is in required range.
10	XXXX.Alm_ROV	Check the residual voltage input or the calculated residual voltage.
11	XXXX.Alm_VTS_Measmt	Check the measurement VT secondary circuit.
12	XXXX.Alm_UV	Check three-phase voltages.
13	XXXX.Alm_CTS	Please check the corresponding CT secondary circuit.
14	B**.Alm_Output	Check the corresponding BO module or PLC module at the slot AX
15	DPOS.Alm	Check the double point signals listed in the submenu "MainMenu" -> "Status" -> "Inputs" -> "DPS Inputs"). [DPOS**]="DPS_INT" : Intermediate-state; [DPOS**]="DPS_OFF" : Open; [DPOS**]="DPS_ON" : Close; [DPOS**]="DPS_BAD" : Bad state. If [DPOS**]="DPS_INT" or "DPS_BAD", check the state of corresponding CB/DS/ES.
16	Alm_Settings_RSYN	Change the values of [25.Opt_Side_Measmt] and [25.Opt_Side _Syn] (should be different) and save the modification.

4.2 GOOSE Alarm

If any GOOSE alarm signal is issued, the “ALARM” LED and the "HEALTHY” LED are both lit on. Th device is not blocked. When the GOOSE alarm signal disappears, the device will return to normal state, and the “ALARM” LED will be lit off automatically.

NOTICE!

"YYYY" refers to a link identification name that can be configured through the corresponding label setting (Access path: “MainMenu” -> “Settings” -> “Device Setup” -> “Label Settings”).

"**" is a communication link sequence number.

Table 4.2-1 GOOSE Alarm

No.	Item	Description
1	GAlm_AStorm_S L	Network storm exists in station level GOOSE network A.
2	GAlm_BStorm_SL	Network storm exists in station level GOOSE network B.
3	GAlm_CfgFile_SL	Error exists in station level GOOSE configuration file.
4	YYYY.GAlm_ADisc_SL_**	Station level GOOSE network A link** is disconnected.
5	YYYY.GAlm_BDisc_SL_**	Station level GOOSE network B link** is disconnected.
6	YYYY.GAlm_Cfg_SL_**	Mismatch is found between the GOOSE control blocks received via network and that defined in GOOSE configuration file in station level GOOSE network.

Table 4.2-2 Troubleshooting for GOOSE Alarm

No.	Item	Description
1	GAlm_AStorm_S L	Check Ethernet switches, ports, connections and GOOSE configuration file of station level GOOSE network.
2	GAlm_BStorm_SL	
3	GAlm_CfgFile_SL	
4	YYYY.GAlm_ADisc_SL_**	
5	YYYY.GAlm_BDisc_SL_**	
6	YYYY.GAlm_Cfg_SL_**	

5 Monitoring and Control

5.1 Event Recording

5.1.1 Overview

The device can store the latest 1024 supervision events, 1024 IO events, 1024 device logs, 256 control logs and 256 regulation logs. All the records are stored in non-volatile memory, and when the available space is exhausted, the latest one will automatically overwrite the oldest record.

5.1.2 Device Supervision Events

The device is under automatic supervision all the time. If there is any failure or abnormal condition detected (e.g. VT circuit failure), it will be stored and displayed.

5.1.3 Binary Status Change Events

When a binary input is energized or de-energized, i.e., its state has changed from "0" to "1" or from "1" to "0", it will be stored and displayed.

5.1.4 Device Logs

If an operator implements some operations on the device, such as reboot device, modify setting, etc., they will be stored and displayed.

5.1.5 Switch Control Logs

The total sequence of each attempt of control command will be stored and displayed, including object, source, remote/local mode, interlock condition, command (selection/execution, open/close, up/down) and result.

5.1.6 DC Regulation Logs

The total sequence of each attempt of regulation command will be stored and displayed, including object, source, remote/local mode, command (selection/execution), value and result.

6 IED Hardware

6.1 Overview

PRS-7741 Bay Control Unit measure & control device adopts 32-bit microchip processor as the control core for management and monitoring function, meanwhile, adopts high-speed digital signal processor DSP for calculation. 128 points are sampled in every cycle and parallel processing of sampled data can be realized in each sampling interval to ensure ultrahigh reliability and safety of the device.

This device is developed on the basis of the latest software and hardware platform, and this new platform provides high reliability, networking and great capability for anti-interference.

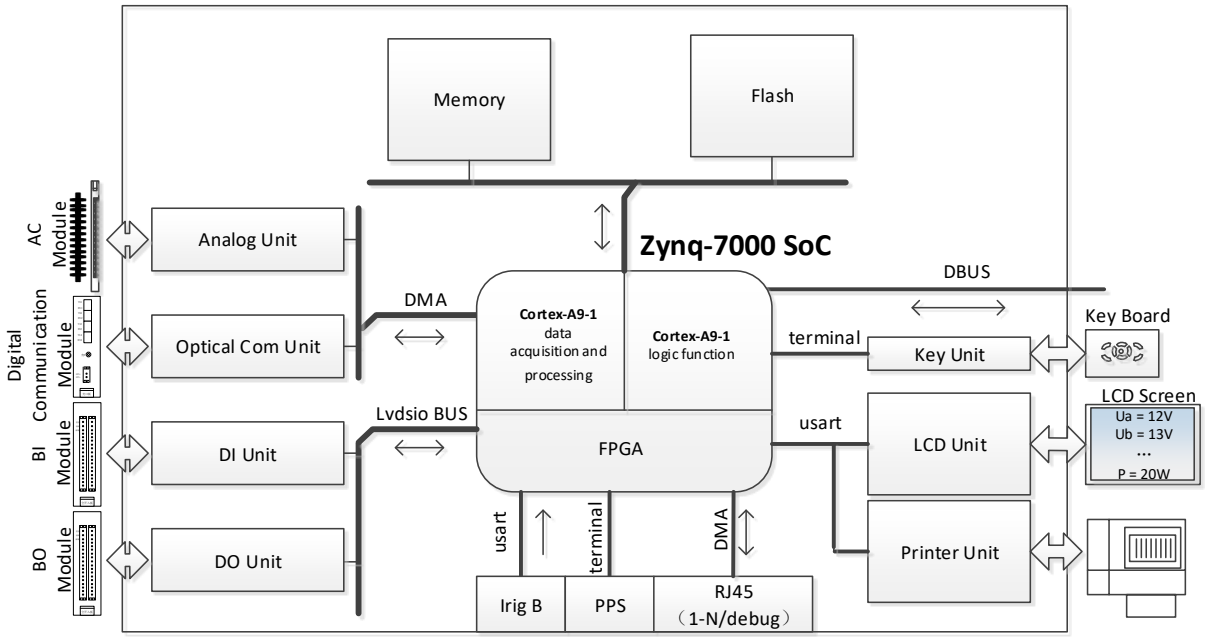


Figure 6.1.1 Hardware diagram

The working process of the device is shown in above figure: current and voltage from conventional CT/VT are converted into small voltage signal and sent to the FPGA in MON module after filtered and A/D conversion for calculation.

The standard configuration of device is made up of power module (Power), management module (MCPU), binary input/output module (BI/BO), communication receiving module (Comm) and bus backplane (panel)(Bus).

Table 7.1 Plug-in Function Table of Device

Board model	Board name	Function description
SR7601	Power module	Provide power supply, two device error signals, 9 binary outputs.

Board model	Board name	Function description
SR7341	BI&DC module	8 binary inputs, 6 DC outputs.
SR7340	BI&DC module	8 binary inputs, 6 DC inputs.
SR7330	BI module	18 binary inputs.
SR7310	BI&BO module	9 binary inputs, 7 binary outputs.
SR7300	BO module	14 binary outputs.
SR7160	AC module	Sampling of analog quantity.
SR7270	AD module	AD conversion(only for 1/1 19'' Edition 1)
SR7260/SR7267	CPU module	Used to connect to station-level network and upload device information.

The modules of BCU are designed to be pluggable. There are 10 or 20 slots in the bus board of the device. In addition to the fixed configuration of power module and management module, the binary input/output module, AC module and DC module can be selectively configured according to the facts of the situation. Each module is responsible for independent monitoring task. The design ensures the maintenance, modification or extension of components, modules and data transfer channels will not shutdown and the whole substation control system will run normally.

6.2 Module Configuration

NOTICE!

This section just shows several examples of device terminal view and module arrangement. The content including below doesn't mean the device can only be configured in this way.

The following figures should NOT be used as reference for device configuration or wiring design. For such purpose, please use the latest corresponding Manufacture Ordering Table and consult our design department.

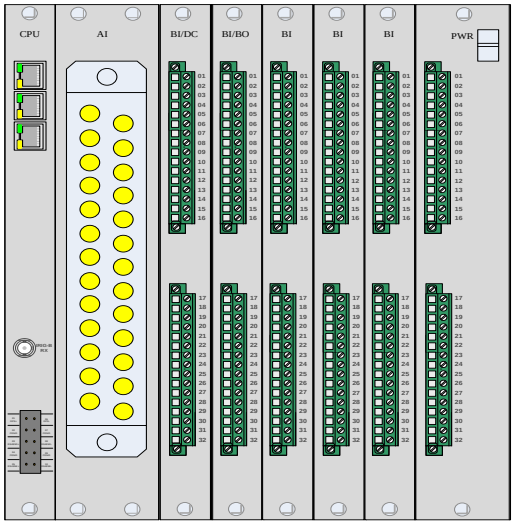


Figure 6.2.1 1/2 19" Terminal view and Module configuration example

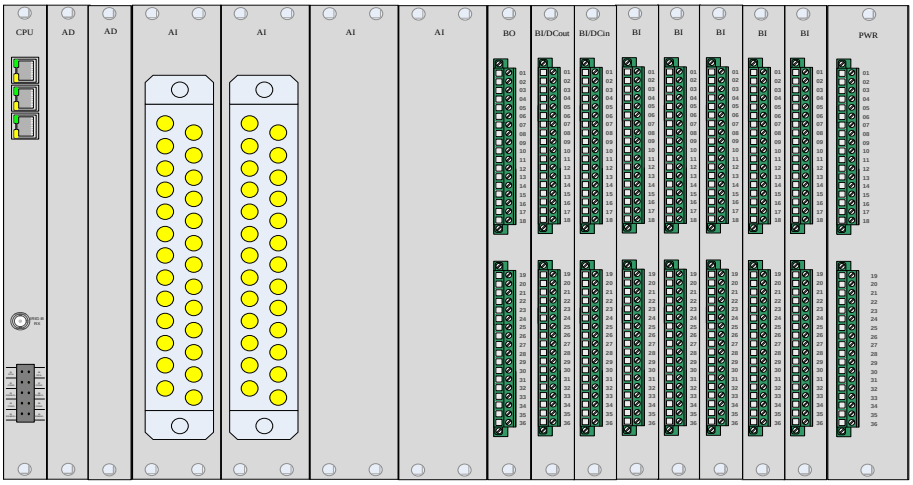


Figure 6.2.2 1/1 19" Terminal view and Module configuration example(Edition 1)

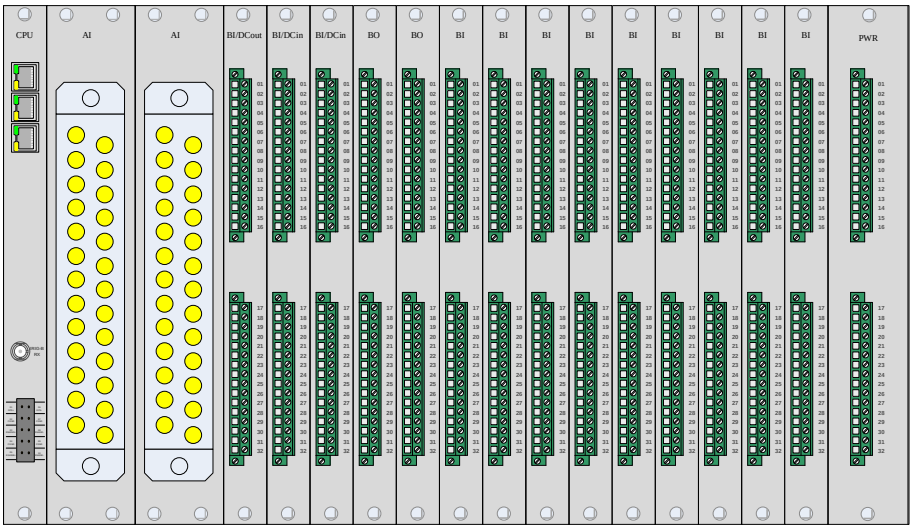


Figure 6.2.3 1/1 19" Terminal view and Module configuration example(Edition 2)

Table 7.2.1 Instruction of 1/2 19" panel configuration

NO.	#9	#8, #7	#6	#5	#4	#3	#2	#1
SIZE	20T	40T	20T	20T	20T	20T	20T	40T
NAME	CPU Module	AC Module	BI/BO Module	BI/DC Module	BI Module	BI Module	BI Module	Power Module
MODEL	SR7267	SR7160	SR7310	SR7340	SR7330	SR7330	SR7330	SR7601

This section just shows several examples of device terminal view and module arrangement. The content including below doesn't mean the device can only be configured in this way.

Table 7.2.2 Instruction of 1/1 19" panel configuration(Edition 1)

NO.	#9	#8	#7	#6	#5	#4	#3	#2	#1
SIZE	20T	20T	20T	20T	20T	20T	20T	20T	40T
NAME	BO Module	BI/DCout Module	BI/DCin Module	BI Module	BI Module	BI Module	BI Module	BI Module	Power Module
MODEL	SR7300	SR7341	SR7340	SR7330	SR7330	SR7330	SR7330	SR7330	SR7601
NO.	#20	#19	#18	#17, #16	#15, #14	#13	#12	#11	#10
SIZE	20T	20T	20T	40T	40T	20T	20T	20T	20T
NAME	CPU Module	AD Module	AD Module	AC Module	AC Module				
MODEL	SR7267	SR7270	SR7270	SR7160	SR7160				

Table 7.2.3 Instruction of 1/1 19" panel configuration(Edition 2)

NO.	#9	#8	#7	#6	#5	#4	#3	#2	#1
SIZE	20T	20T	20T	20T	20T	20T	20T	20T	40T
NAME	BI Module	BI Module	BI Module	BI Module	BI Module	BI Module	BI Module	BI Module	Power Module
MODEL	SR7330	SR7330	SR7330	SR7330	SR7330	SR7330	SR7330	SR7330	SR7601
NO.	#20	#19, #18	#17, #16	#15	#14	#13	#12	#11	#10
SIZE	20T	40T	40T	20T	20T	20T	20T	20T	20T
NAME	CPU Module	AC Module	AC Module	BI/DCout Module	BI/DCin Module	BI/DCin Module	BO Module	BO Module	BI Module
MODEL	SR7267	SR7160	SR7160	SR7341	SR7340	SR7340	SR7300	SR7300	SR7330

NOTICE!

The two free AC modules can also be configured as BI or BO modules, up to four.

NOTICE!

There are two versions of the 1/1 19" device: Edition 1 and Edition 2. Edition 1 uses two SOC chips, and two special modules(SR7270) are required to provide AD conversion function; Edition 2 uses only one SOC chip, eliminating the need for conversion modules(SR7270). The current Edition 1 will be phased out, and Edition 2 will become the mainstream version. The introduction for Edition 1 is reserved here for easy access to its related information.

6.3 HMI Module

The HMI module consists of liquid crystal display module, keypad, LED, RJ-45 debugging port and ARM processor. The functions of ARM processor include display control of LCD, key operation

processing, and data exchange with the MON module through inner bus. RJ45 serial interface is provided for connecting a portable PC to the BCU, to enable local control and monitoring at the bay level in case the upper level of control has a failure or for downloading the bay module configuration files or for having an access to the maintenance dialogue with the equipment.

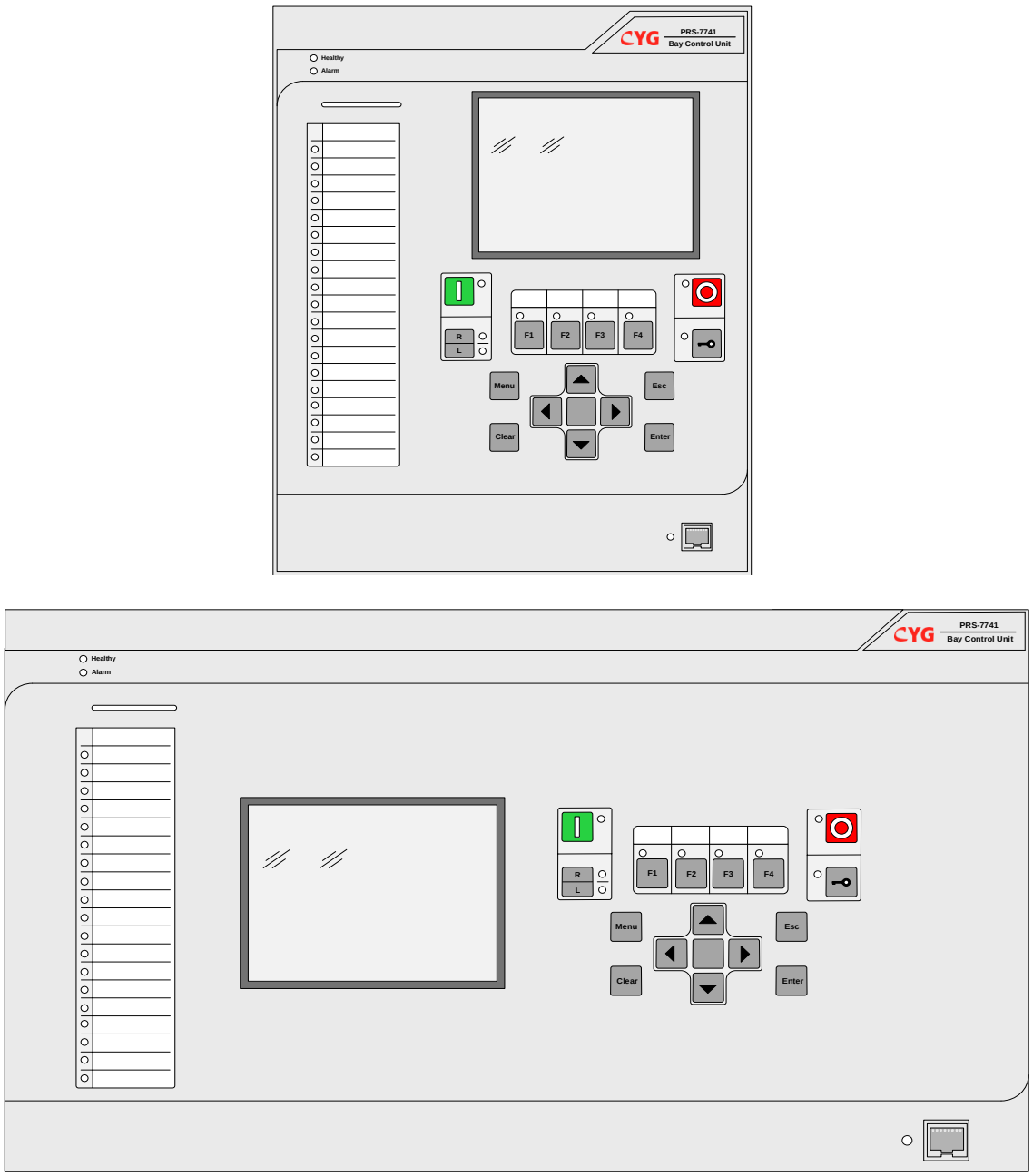
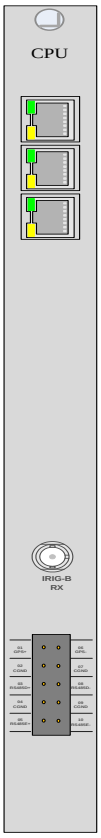


Figure 6.3.1 1/2 and 1/1 19" HMI view

6.4 Main CPU Module



The main CPU module is the central part of this equipment, and contains a powerful microchip processor and some necessary electronic elements. This powerful processor performs all of the functions for the relay: the protection functions, the communication management functions. There are several A/D conversion circuits on this module, which are used to convert the AC analog signals to corresponding DC signals for fulfilling the demand of the electrical level standard. A high-accuracy clock chip is contained in this module, it provide accurate current time for this relay.

The functional details of the main CPU module are listed as below:

- Protection calculations

  The main CPU module can calculate protective elements (such as overcurrent element, zero sequence overcurrent etc.) on the basis of the analog sampled values (voltages and currents) and binary inputs, and then decides whether the device needs to trip or close.

- Communication management

  The main CPU module can effectively manage all communication procedures, and reliably send out some useful information through its various communication interfaces. These interfaces are used to communicate with a SAS or a RTU. It also can communicate with the human machine interface module. If an event occurs (such as SOE, protective tripping event etc.), this module will send out the relevant event information through these interfaces, and make it be easily observed by the user.

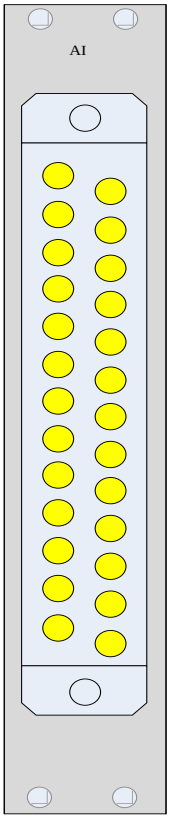
- Auxiliary calculations

  Based on the voltage and current inputs, the main CPU module also can calculate out the metering values, such as active power, reactive power and power factor etc. All these values can be sent to a SAS or a RTU through the communication interfaces.

- Time Synchronization

  This module has a local clock chip and an interface to receive time synchronized signals from external clock source. These signals include PPS (pulse per second) signal and IRIG-B signal. Basing on the timing message (from SAS or RTU) and the PPS signal, or basing on the IRIG-B signal, this module can synchronize local clock with the standard clock.

6.5 AC Module



The AC module is an analog input unit. It contains voltage transformers (VT) and current transformers (CT). It can transform these high AC input values to relevant low AC output value, which are suited to the analog inputs of the CPU module. It also can be thought as a bridge between the CPU module and the external analog signals that come into the BCU.

NOTICE!

There are 2 types of AC modules providing various numbers of **CT** and **VT** separately applicable to difference types of BCUs. The rated value of the input current transformer is optional: 1A or 5A. Please declare the rated value of the CT when placing order. It is necessary to check whether the rated values of the current transformer inputs are in

accordance with the demand of practical engineering before putting the device into operation.

NOTICE!

The width of AC AI module is doubled. One AC AI module occupies 2 slots.

Table 6.5-1 AC Module of Device(5U+4I)

left terminal	terminal instruction	right terminal	terminal instruction
01	Ua	02	Ub
03	Uc	04	Un
05	U1	06	U1-
07	U0	08	U0-
09		10	
11	Ia	12	Ia-
13	Ib	14	Ib-
15	Ic	16	Ic-
17	I0	18	I0-
19		20	
21		22	
23		24	
25		26	

Table 6.5-2 AC Module of Device(8U+4I)

left terminal	terminal instruction	right terminal	terminal instruction
01	Ua1	02	Ub1
03	Uc1	04	Un1
05	U01	06	U01-
07	Ua2	08	Ub2
09	Uc2	10	Un2
11	U02	12	U02-
13	Ia	14	Ia-
15	Ib	16	Ib-
17	Ic	18	Ic-
19	I0	20	I0-
21		22	
23		24	
25		26	

Table 6.5-3 AC Module of Device(4U+8I)

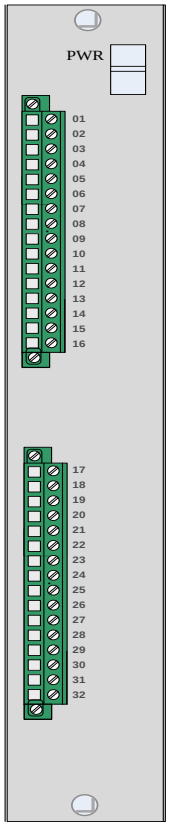
left terminal	terminal instruction	right terminal	terminal instruction
01	Ua	02	Ub
03	Uc	04	Un
05	U0	06	U0-

left terminal	terminal instruction	right terminal	terminal instruction
07	Ia1	08	Ia1-
09	Ib1	10	Ib1-
11	Ic1	12	Ic1-
13	I01	14	I01-
15	Ia2	16	Ia2-
17	Ib2	18	Ib2-
19	Ic2	20	Ic2-
21	I02	22	I02-
23		24	
25		26	

Table 6.5-4 AC Module of Device(12U)

left terminal	terminal instruction	right terminal	terminal instruction
01	Ua1	02	Ub1
03	Uc1	04	Un1
05	U01	06	U01-
07	Ua2	08	Ub2
09	Uc2	10	Un2
11	U02	12	U02-
13	Ua3	14	Ub3
15	Uc3	16	Un3
17	U03	18	U03-
19		20	
21		22	
23		24	
25		26	

6.6 Power Module



The Power module is a DC/DC converter with electrical insulation between its input and output. It provides DC power supply for the other modules of this device.

The use of an external miniature circuit breaker is recommended. The miniature circuit breaker must be in the on position when the device is in operation and in the off position when the device is in cold reserve.

NOTICE!

Several extra contacts (without fault detector element control) are provided by the PWR module. According to different applications, these contacts' configurations by default are different. Nevertheless, they can be customized through the auxiliary software PRS-softStudio.

Table 6.6-1 Power Module of Device

left terminal	terminal instruction	right terminal	terminal instruction
01	Power+	17	KO06 Open
02	Power-	18	KO07 Common
03	Device Err Common	19	KO07 Open
04	Device Err Close	20	KO07 Close
05	Device Err Open	21	KO08 Common

left terminal	terminal instruction	right terminal	terminal instruction
06	KO01 Common	22	KO08 Open
07	KO01 Open	23	KO08 Close
08	KO02 Common	24	KO09 Common
09	KO02 Open	25	KO09 Open
10	KO03 Common	26	KO09 Close
11	KO03 Open	27	
12	KO04 Common	28	
13	KO04 Open	29	
14	KO05 Common	30	
15	KO05 Open	31	
16	KO06 Common	32	

NOTICE!

The standard rated voltage of Power module is self-adaptive to 88~300Vdc. If the input voltage is out of range, an alarm signal (Fail_Device) will be issued. For a non-standard rated voltage Power module, please specify when placing order and check if the rated voltage is the same before putting the device into service.

NOTICE!

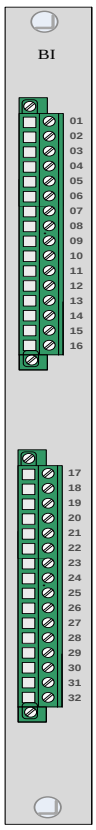
Effective grounding is the most important measure for a device to prevent EMI, so effective grounding must be ensured before the device is put into service.

The Power module provides the pin No.22 and a grounding screw for device grounding. The pin shall be connected to grounding screw and then connected to the earth copper bar of panel via dedicated grounding wire.

NOTICE!

This device, like almost all electronic equipments, contains electrolytic capacitors. These capacitors are well known to be subject to deterioration over time if voltage is not applied periodically. Deterioration can be avoided by powering the device up at least once a year.

6.7 BI Module



BI module is a binary input module used for the signaling of switching position. Every BI module has 18 optically isolated binary inputs. Each binary input is processed by a well-designed debouncing technique to avoid any hazardous behavior (multiple state changes during a given duration). A separate debounce and chatter time may be set for each of the binary input. All the binary inputs are included in the event-recording functions.

Binary inputs can be sent to SCADA or control center as states or as changes of state depending on the protocol.

NOTICE!

At least one BI module is obligatory in this device while the other BI modules are optional.

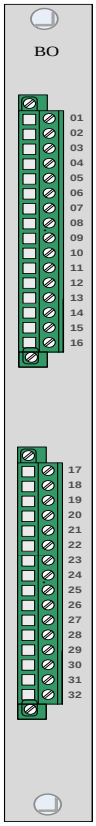
NOTICE!

Several rated voltages of BI module are optional, please declare the option when placing order. It is necessary to check whether the rated voltage of BI module meets the demand of engineering before putting the device into operation.

Table 6.7-1 BI Module of Device

left terminal	terminal instruction	right terminal	terminal instruction
01	KI01+	17	KI10+
02	KI02+	18	KI11+
03	KI01~KI02 Common	19	KI10~KI11 Common
04	KI03+	20	KI12+
05	KI04+	21	KI13+
06	KI03~KI03 Common	22	KI12~KI13 Common
07	KI05+	23	KI14+
08	KI05 Common	24	KI14 Common
09	KI06+	25	KI15+
10	KI06 Common	26	KI15 Common
11	KI07+	27	KI16+
12	KI07 Common	28	KI16 Common
13	KI08+	29	KI17+
14	KI08 Common	30	KI17 Common
15	KI09+	31	KI18+
16	KI09 Common	32	KI18 Common

6.8 BO Module



The BO module is a well-done binary output module used for tripping or closing output or for any signaling purpose. Up to 18 binary outputs are provided on each BO module for controlling up to 9

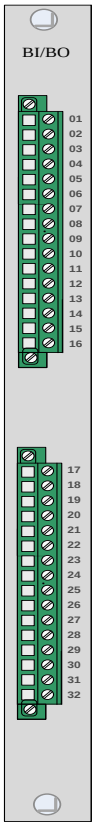
switchers or transformer tap changer positions.

Whenever any of the normal open contacts of the binary output relay is closed, the normal open contact remote operation signal of remote operation signal relay will close to issue a signal indicating that the BCU is undergoing a remote operation. If none of the normal open contact of the binary output relay is closed, the normal open contact remote operation signal keeps open state.

Table 6.8-1 BO Module of Device

left terminal	terminal instruction	right terminal	terminal instruction
01	KO01 Common	17	KO09 Common
02	KO01 Open	18	KO09 Open
03	KO02 Common	19	KO10 Common
04	KO02Open	20	KO10 Open
05	KO03 Common	21	KO11 Common
06	KO03 Open	22	KO11 Open
07	KO04 Common	23	KO11 Close
08	KO04 Open	24	KO12 Common
09	KO05 Common	25	KO12 Open
10	KO05 Open	26	KO12 Close
11	KO06 Common	27	KO13 Common
12	KO06 Open	28	KO13 Open
13	KO07 Common	29	KO13 Close
14	KO07 Open	30	KO14 Common
15	KO08 Common	31	KO14 Open
16	KO08 Open	32	KO14 Close

6.9 BI/BO Module

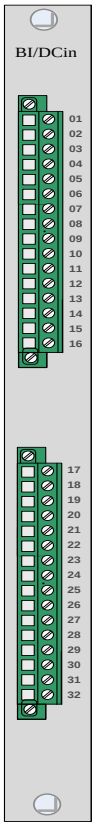


BI/BO module includes 9 optically isolated binary inputs and 7 binary outputs.

Table 6.9-1 BI/BO Module of Device

left terminal	terminal instruction	right terminal	terminal instruction
01	KI01+	17	KO01 Common
02	KI02+	18	KO01 Open
03	KI01~KI02 Common	19	KO02 Common
04	KI03+	20	KO02Open
05	KI04+	21	KO03 Common
06	KI03~KI03 Common	22	KO03 Open
07	KI05+	23	KO04 Common
08	KI05 Common	24	KO04 Open
09	KI06+	25	KO05 Common
10	KI06 Common	26	KO05 Open
11	KI07+	27	KO06 Common
12	KI07 Common	28	KO06 Open
13	KI08+	29	KO06 Close
14	KI08 Common	30	KO07 Common
15	KI09+	31	KO07 Open
16	KI09 Common	32	KO07 Close

6.10 BI/DC input Module

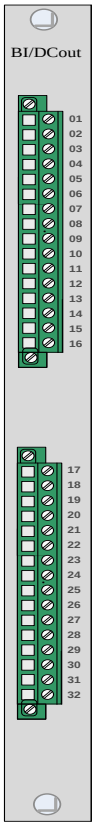


BI/DC module includes 9 optically isolated binary inputs and 6 DC inputs.

Table 6.10-1 BI/DC Module of Device

left terminal	terminal instruction	right terminal	terminal instruction
01	KI01+	17	DCIn01+
02	KI01 Common	18	DCIn01 Common
03	KI02+	19	DCIn02+
04	KI02 Common	20	DCIn02 Common
05	KI03+	21	DCIn03+
06	KI03 Common	22	DCIn03 Common
07	KI04+	23	DCIn04+
08	KI04 Common	24	DCIn04 Common
09	KI05+	25	DCIn05+
10	KI05 Common	26	DCIn05 Common
11	KI06+	27	DCIn06+
12	KI06 Common	28	DCIn06 Common
13	KI07+	29	
14	KI07 Common	30	
15	KI08+	31	
16	KI08 Common	32	

6.11 BI/DC Output Module



BI/DC module includes 9 optically isolated binary inputs and 6 DC outputs.

Table 6.11-1 BI/DC Module of Device

left terminal	terminal instruction	right terminal	terminal instruction
01	KI01+	17	DCOut01+
02	KI01 Common	18	DCOut01 Common
03	KI02+	19	DCOut02+
04	KI02 Common	20	DCOut02 Common
05	KI03+	21	DCOut03+
06	KI03 Common	22	DCOut03 Common
07	KI04+	23	DCOut04+
08	KI04 Common	24	DCOut04 Common
09	KI05+	25	DCOut05+
10	KI05 Common	26	DCOut05 Common
11	KI06+	27	DCOut06+
12	KI06 Common	28	DCOut06 Common
13	KI07+	29	
14	KI07 Common	30	
15	KI08+	31	

left terminal	terminal instruction	right terminal	terminal instruction
16	KI08 Common	32	

7 Settings

NOTICE!

According to different applications for different engineering requirements, settings may be different. This chapter describes as many settings as possible to make a reference for user.

7.1 System Settings

Access path: "MainMenu" -> "Set" -> "System Para"

Name	Values(Range)	Unit	Step	Default	Description
PT1 primary rated value	1~500	kV	1	500	Rated primary voltage of reference side VT1.
PT1 secondary rated value	100~220	V	120	220	Rated secondary voltage of reference side VT1.
Measure CT1 primary value	0~9999	A	1	9999	Rated primary current of three-phase CT1.
Measure CT1 secondary value	1~5	A	5	5	Rated secondary current of three-phase CT1.
PT2 primary rated value	1~500	kV	1	500	Rated primary voltage of reference side VT2.
PT2 secondary rated value	100~220	V	120	220	Rated secondary voltage of reference side VT2.
Measure CT2 primary value	0~9999	A	1	9999	Rated primary current of three-phase CT2.
Measure CT2 secondary value	1~5	A	5	5	Rated secondary current of three-phase CT2.
PT3 primary rated value	1~500	kV	1	500	Rated primary voltage of reference side VT3.
PT3 secondary rated value	100~220	V	120	220	Rated secondary voltage of reference side VT3.
Measure CT3 primary value	0~9999	A	1	9999	Rated primary current of three-phase CT3.
Measure CT3 secondary value	1~5	A	5	5	Rated secondary current of three-phase CT3.
PT4 primary rated value	1~500	kV	1	500	Rated primary voltage of reference side VT4.
PT4 secondary rated value	100~220	V	120	220	Rated secondary voltage of reference side VT4.
Measure CT4 primary value	0~9999	A	1	9999	Rated primary current of three-phase CT4.
Measure CT4 secondary value	1~5	A	5	5	Rated secondary current of three-phase CT4.

7.2 AC Analog Input

Table 7.2-1 Parameter Setting of AC Measure Quantity

Name	Values (Range)	Unit	Stage	Default	Description
CT/PT secondary rated value	5A/100V,1A/100V,5A/115V,1A/115V,5A/220V and 1A/220V		~	1A/100V	CT/PT secondary rated value
Analog Frequency	50Hz,60Hz		~	50Hz	rated frequency
Power calculation method	Two-watt meter / three-watt meter.		~	three-watt meter	Power calculation method

7.3 DC Analog Input

Table 8.3.1-1 Parameter Setting of DC Measure Quantity

Name	Values (Range)	Unit	Stage	Default	Description
Dead zone value	0~100%		~	0.2%	Dead zone value of DC
DC Transformer Coefficient	1~9999		~	930	DC Transformer Coefficient

7.4 Binary Output

Table 7.4.1 Parameter Setting Table of Binary Output

Name	Values (Range)	Unit	Stage	Default	Description
SetSN_PW_Opn	0.1~60	S	~	0.2	remote-control trip pulse width
SetSN_PW_Cls	0.1~60	S	~	0.2	remote-control close pulse width
dwSetSN_SelTm	0.1~60	S	~	30	Time period of SBOw operation
dwSetSN_ExecTm	0.1~60	S	~	30	Time period of operate operation
dwSetSN_DBIHoldTm	0~10	S	~	0.02	Time period of debouncing

7.5 DC Analog Output

Table 7.5.1 Parameter Settings of DC Analog Output

Name	Values (Range)	Unit	Stage	Default	Description
SetDCVal	400~2000	~	~	2000	Set the value of the output DC

7.6 Tap Changer Control

Table 7.66.1 Settings of Tap acquisition

No	Name	Default Value	Range	Description
1	SetSN_GEA_InType	BCD1	BCD1 BCD2 BCD3 LVDS	the access mode selection of the tap position of the transformer.
2	SetSN_TAP_Pos	39	1~39	The maximum number of transformer's tap position.
3	BIStartPin	BI01		First binary inputs used for Tap Position Indication.
4	BIEndPin	BI13		Last binary inputs used for Tap Position Indication.
5	AnaDCPin	DC01		DC input used for mode of "LVDS" selection of the tap position of the transformer

Table 8.6.2 Settings of Tap control

No	Name	Default Value	Range	Description
1	SetSN_PW_Up	0.2	0~10s	tap-control up pulse width
2	SetSN_PW_Dwn	0.2	0~10s	tap-control down pulse width
3	SetSN_PW_Stp	0.2	0~10s	tap-control stop pulse width
4	dwSetSN_SelTm	30	10~60s	Time period of SBOw operation
5	dwSetSN_ExecTm	30	10~60s	Time period of operate operation
6	dwSetSN_EmergStp_Ena	0	0/1	Enable/Disable the function to

No	Name	Default Value	Range	Description
				stop slip of TP immediately

7.7 Generic Object Oriented Substation Event (GOOSE)

Table 8.7.1 Settings of Generic Object Oriented Substation

No	Name	Default Value	Range	Description
1	GLink_SLRL_**	1	0 or 1	Enable/Disable the GOOSE channel message supervision in station layer.

7.8 Synchrocheck 25SYN

Table 8.8.1 25SYN settings

Name	Values(Range)	Unit	Step	Default	Description
Dead bus value	0.05 - 0.50	pu	0.01	0.40	Voltage low limit bus for energizing check
Dead line value	0.05 - 0.50	pu	0.01	0.40	Voltage low limit line for energizing check
Live bus value	0.40 - 1.20	pu	0.01	0.80	Voltage high limit bus for energizing check
Live line value	0.40 - 1.20	pu	0.01	0.80	Voltage high limit line for energizing check
Frequency deviation	1-5	Hz	1	5	Max allowed Frequency deviation from rated frequency
Difference voltage	0.02 - 0.50	pu	0.01	0.15	Voltage difference limit
Max energizing V	0.80 - 1.40	pu	0.01	1.15	Maximum voltage for energizing
Phase shift	-180-180	Deg	5	0	Phase shift
Voltage ratio	0.20 - 5.00	-	0.01	1.00	Voltage ratio
Live dead mode Auto	Off LLDB DLLB LLDB or DLLB			LLDB	Automatic energizing check mode
Dif phase angle Auto	5-90	Deg	1	25	Phase angle difference limit between bus and line Auto
Dif frequency Auto	0.003 - 1.000	Hz	0.001	0.010	Frequency difference limit between bus and line Auto
Energizing time Auto	0.000 - 60.000	s	0.001	0.100	Time delay for automatic energizing check
Syn Chk delay	0.000 - 60.000	s	0.001	0.100	Time delay output for

Name	Values(Range)	Unit	Step	Default	Description
Auto					synchrocheck Auto
Live dead mode Man	Off LLDB DLLB LLDB or DLLB			LLDB or DLLB	Manual energizing check mode
Dead bus line Man	Off On	-	-	Off	Manual dead bus, dead line energizing
Dif phase angle Man	5-90	Deg	1	25	Phase angle difference limit between bus and line Manual
Dif frequency Man	0.003 - 1.000	Hz	0.001	0.010	Frequency difference limit between bus and line Manual
Energizing time Man	0.000 - 60.000	s	0.001	0.100	Time delay for manual energizing check
Syn Chk delay Man	0.000 - 60.000	s	0.001	0.100	Time delay output for synchrocheck Manual
Synchrocheck mode	Off On	-	-	On	Operation for synchronism check function Off/On
Synchronizing mode	Off On	-	-	Off	Operation for synchronizing function Off/ On
Dif voltage Syn	0.02-0.50	pu	0.01	0.10	Voltage difference limit for synchronizing
Maximum Dif Hz Syn	0.050 - 0.250	Hz	0.001	0.200	Maximum frequency difference limit for synchronizing
Minimum Dif Hz Syn	0.003 - 0.250	Hz	0.001	0.010	Minimum frequency difference limit for synchronizing
Max Dif Hz rate Syn	0.000 - 0.500	Hz/s	0.001	0.300	Maximum allowed frequency rate of change
Minimum Syn time	0.000 - 60.000	s	0.001	2.000	Minimum time to accept synchronizing conditions
Wait Syn time	0.00 - 6000.00	s	0.01	600.00	Resets synch if no close has been made before set time
Operation	Off On	-	-	On	Operation Off / On
CB configuration	No voltage sel. Double bus 1 1/2 bus 1 CB 1 1/2 bus 2 CB Tie CB			No voltage sel.	Select CB configuration
Phase selection bus	phase1 phase2 phase3 phase1-phase2 phase2-phase3			phase1-phase2	Select phase for buses

Name	Values(Range)	Unit	Step	Default	Description
	phase3-phase1				
Phase selection line	phase1 phase2 phase3 phase1-phase2 phase2-phase3 phase3-phase1			phase1-phase2	Select phase for lines
Closing time of CB	0.000 - 60.000	s	0.001	0.080	Closing time of the breaker
Base value Sel phase	Phase Grp 1 Phase Grp 2 Phase Grp 3	-	-	Phase Grp 1	Base value selector, phase / phase-to- phase

7.9 Device Communication

Access path: "MainMenu" -> "Preset" -> " Communication "

No.	Item	Default Value	Range(Unit)
1	Bay No	1	0-255
2	IP0	222.111.112.003	000.000.000.000~255.255.255.255
3	NetMASK0	255.255.255.000	000.000.000.000~255.255.255.255
4	IP1	192.168.253.003	000.000.000.000~255.255.255.255
5	NetMASK1	255.255.255.000	000.000.000.000~255.255.255.255
6	IP2	192.168.002.003	000.000.000.000~255.255.255.255
7	NetMASK2	255.255.255.000	000.000.000.000~255.255.255.255

8 Configurable Function

BCU software adopts modular design, and each function is designed as an independent module. In the configuration tool, the user can select the target function module from the model library and set the corresponding input, output, parameter terminal. The advantage of the design is that the function configuration of the BCU is relatively independent and adjusted flexibly. If the function of BCU needs to be extended, it is only necessary to add a new function module to the configuration tool and import the configuration file into the device. The design shall be such that maintenance,modification or extension of components,modules and data transfer channels shall not require a shutdown of the whole substation control system.

8.1 General Description

The configurable function of this relay can be easy to realize the system configuration, the protection function configuration, the binary input configuration, the binary output configuration, the LED indicator configuration and the logic programming function in this relay through the PRS IED Studio configuration tool auxiliary software, which makes this relay can meet different practical requirements.

8.2 Introduction of PRS IED Studio Software

The PRS IED Studio software is developed in order to meet customer's demand on functions of the UAPC platform device, such as device configuration and programmable design. It selects substation as the core of data management and the device as fundamental unit, supporting one substation to govern many devices.

The software provides two kinds of operation modes: on-line mode and off-line mode. The on-line mode supports the Ethernet connection with the device through the standard IEC60870-5-103 and can be capable of uploading and downloading the configuration files through Ethernet net; the off-line mode supports the off-line setting configuration.

In addition, it also supports programmable logic to meet the demands of a practical engineering. Please see the PRS IED Studio online help brochure or the instruction manual of PRS IED Studio configuration tool auxiliary software for more details about the PRS IED Studio software.

The functions of the PRS IED Studio software:

- Programmable logic (off-line function)
- System configuration (off-line function)
- Function configuration (off-line function)
- LED indicators configuration (off-line function)

- Binary signals configuration (off-line function)
- Setting configuration (off-line & on-line function)
- Real-time display of analogue and digital quantity of device (on-line function)
- Display of sequence of report (SOE) (on-line function)
- Analysis of waveform (off-line & on-line function)
- File downloading/uploading (on-line function)

For more details about how to do a logic graph configuration, see the PRS IED Studio online help brochure or the instruction manual of PRS IED Studio configuration tool auxiliary software.

9 Communication Protocol

9.1 Overview

This section outlines the remote communications interfaces of CYG SUNRI Relays. The protective device supports a choice of three protocols via the rear communication interface (RS-485 or Ethernet), selected via the model number by setting. The protocol provided by the protective device is indicated in the menu "**Settings→Device Setup→Comm Settings**".

The rear EIA RS-485 interface is isolated and is suitable for permanent connection of whichever protocol is selected. The advantage of this type of connection is that up to 32 protective devices can be "daisy chained" together using a simple twisted pair electrical connection.

It should be noted that the descriptions contained within this section do not aim to fully detail the protocol itself. The relevant documentation for the protocol should be referred to for this information. This section serves to describe the specific implementation of the protocol in the relay.

9.2 Rear Communication Port Information

9.2.1 RS-485 Interface

This protective device provides two rear RS-485 communication ports, and each port has three terminals in the 12-terminal screw connector located on the back of the relay and each port has a ground terminal for the earth shield of the communication cable. The rear ports provide RS-485 serial data communication and are intended for use with a permanently wired connection to a remote control center.

9.2.1.1 EIA RS-485 Standardized Bus

The EIA RS-485 two-wire connection provides a half-duplex fully isolated serial connection to the product. The connection is polarized and whilst the product's connection diagrams indicate the polarization of the connection terminals it should be borne in mind that there is no agreed definition of which terminal is which. If the master is unable to communicate with the product, and the communication parameters match, then it is possible that the two-wire connection is reversed.

9.2.1.2 Bus Termination

The EIA RS-485 bus must have 120Ω (Ohm) ½ Watt terminating resistors fitted at either end across the signal wires. Some devices may be able to provide the bus terminating resistors by different connection or configuration arrangements, in which case separate external components will not be required. However, this product does not provide such a facility, so if it is located at the bus terminus then an external termination resistor will be required.

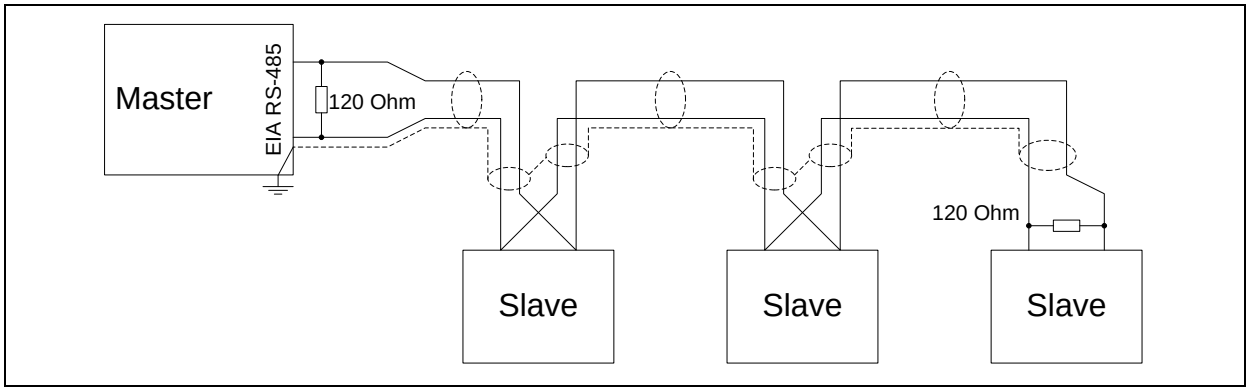


Figure 9.2.1 EIA RS-485 bus connection arrangements

9.2.1.3 Bus Connections & Topologies

The EIA RS-485 standard requires that each device is directly connected to the physical cable that is the communications bus. Stubs and tees are expressly forbidden, such as star topologies. Loop bus topologies are not part of the EIA RS-485 standard and are forbidden by it also.

Two-core screened cable is recommended. The specification of the cable will be dependent on the application, although a multi-strand 0.5mm^2 per core is normally adequate. Total cable length must not exceed 500m. The screen must be continuous and connected to ground at one end, normally at the master connection point; it is important to avoid circulating currents, especially when the cable runs between buildings, for both safety and noise reasons.

This product does not provide a signal ground connection. If a signal ground connection is present in the bus cable then it must be ignored, although it must have continuity for the benefit of other devices connected to the bus. At no stage must the signal ground be connected to the cables screen or to the product's chassis. This is for both safety and noise reasons.

9.2.1.4 Biasing

It may also be necessary to bias the signal wires to prevent jabber. Jabber occurs when the signal level has an indeterminate state because the bus is not being actively driven. This can occur when all the slaves are in receive mode and the master is slow to turn from receive mode to transmit mode. This may be because the master purposefully waits in receive mode, or even in a high impedance state, until it has something to transmit. Jabber causes the receiving device(s) to miss the first bits of the first character in the packet, which results in the slave rejecting the message and consequentially not responding. Symptoms of these are poor response times (due to retries), increasing message error counters, erratic communications, and even a complete failure to communicate.

Biasing requires that the signal lines be weakly pulled to a defined voltage level of about 1V. There should only be one bias point on the bus, which is best situated at the master connection point. The DC source used for the bias must be clean; otherwise noise will be injected. Note that some devices may (optionally) be able to provide the bus bias, in which case external components will not be required.

NOTICE!

It is extremely important that the 120Ω termination resistors are fitted. Failure to do so will result in an excessive bias voltage that may damage the devices connected to the bus.

As the field voltage is much higher than that required, SUNRI cannot assume responsibility for any damage that may occur to a device connected to the network as a result of incorrect application of this voltage.

Ensure that the field voltage is not being used for other purposes (i.e. powering logic inputs) as this may cause noise to be passed to the communication network.

9.2.2 Ethernet Interface

This protective device can provide four rear Ethernet interfaces (optional) and they are unattached each other. Parameters of each Ethernet port can be configured in the menu "**Settings→Device Setup→Comm Settings**".

9.2.2.1 Ethernet Standardized Communication Cable

It is recommended to use twisted screened eight-core cable as the communication cable. A picture is shown bellow.

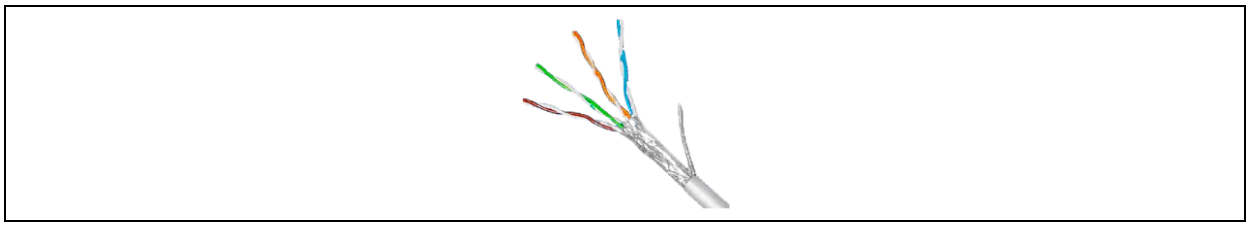


Figure 9.2.2 Ethernet communication cable

9.2.2.2 Connections and Topologies

Each equipment is connected with an exchanger via communication cable, and thereby it forms a star structure network. Dual-network is recommended in order to increase reliability. SCADA is also connected to the exchanger and will play a role of master station, so the every equipment which has been connected to the exchanger will play a role of slave unit.

9.2.3 IEC60870-5-103 Communication

The IEC specification IEC60870-5-103: Telecontrol Equipment and Systems, Part 5: Transmission Protocols Section 103 defines the use of standards IEC60870-5-1 to IEC60870-5-5 to perform communication with protective device. The standard configuration for the IEC60870-5-103 protocol is to use a twisted pair EIA RS-485 connection over distances up to 500m. It also supports to use an Ethernet connection. The relay operates as a slave in the system, responding to commands from a master station.

To use the rear port with IEC60870-5-103 communication, the relevant settings to the protective device must be configured.

9.2.4 DNP3.0 Communication

The DNP3.0 (Distributed Network Protocol) protocol can support the OSI/EPA model of the ISO (International Organization for Standards), and it includes four parts: application layer protocol, transport functions, data link layer protocol and data object library. The DNP3.0 protocol is recommended to use the Ethernet network. This relay operates as a slave in the system, responding to commands from a master station.

9.3 Network Topoloty

9.3.1 Star Topology

Each equipment is connected with an exchanger via communication cable, and thereby it forms a star structure network. Dual-network is recommended in order to increase reliability. SCADA is also connected to the exchanger and will play a role of master station, so the every equipment which has been connected to the exchanger will play a role of slave unit.

9.3.2 PRP Topology

This network topoloty is supported by the device.

9.3.3 RSTP Topology

This network topoloty is supported by the device.

9.4 IEC60870-5-103 Interface over Serial Port

The IEC60870-5-103 interface over serial port (RS-485) is a master/slave interface with the protective device as the slave device. It is properly developed by SUNRI.

The protective device conforms to compatibility level 3.

The following IEC60870-5-103 facilities are supported by this interface:

- Initialization (reset)
- Time synchronization
- Event record extraction
- General interrogation
- General commands
- Disturbance records

9.4.1 Physical Connection and Link Layer

Two EIA RS-485 standardized ports are available for IEC60870-5-103 in this protective device. The transmission speed is optional: 4800 bit/s, 9600 bit/s, 19200 bit/s or 38400 bit/s.

The link layer strictly abides by the rules defined in the IEC60870-5-103.

9.4.2 Initialization

Whenever the protective device has been powered up, or if the communication parameters have been changed, a reset command is required to initialize the communications. The protective device will respond to either of the two reset commands (Reset CU or Reset FCB), the difference is that the Reset CU will clear any unsent messages in the transmit buffer.

The protective device will respond to the reset command with an identification message ASDU 5, the COT (Cause Of Transmission) of this response will be either Reset CU or Reset FCB depending on the nature of the reset command.

9.4.3 Time Synchronization

The protective device time and date can be set using the time synchronization feature of the IEC60870-5-103 protocol. The protective device will correct for the transmission delay as specified in IEC60870-5-103. If the time synchronization message is sent as a send/confirm message then the protective device will respond with a confirmation. Whether the time-synchronization message is sent as a send confirmation or a broadcast (send/no reply) message, a time synchronization class 1 event will be generated/produced.

If the protective device clock is synchronized using the IRIG-B input then it will not be possible to set the protective device time using the IEC60870-5-103 interface. An attempt to set the time via the interface will cause the protective device to create an event with the current date and time taken from the IRIG-B synchronized internal clock.

9.4.4 Spontaneous Events

Events are categorized using the following information:

- Type identification (TYP)
- Function type (FUN)
- Information number (INF)

Messages sent to substation automation system are grouped according to IEC60870-5-103 protocol. Operating elements are sent by ASDU2 (time-tagged message with relative time), and status of binary signal and alarm element are sent by ASDU1 (time-tagged message). The cause of transmission (COT) of these responses is 1.

All spontaneous events can be gained by printing, implementing submenu “**IEC103 Info**” in the menu “**Print**”.

9.4.5 General Interrogation

The GI can be used to read the status of the relay, the function numbers, and information numbers that will be returned during the GI cycle. The GI cycle strictly abides by the rules defined in the IEC60870-5-103.

Refer the IEC60870-5-103 standard can get the enough details about general interrogation.

9.4.6 General Service

The generic functions can be used to read the setting and protection measurement of the protective device, and modify the setting. Two supported type identifications are ASDU 21 and ASDU 10. For more details about generic functions, see the IEC60870-5-103 standard.

All general classification service group numbers can be gained by printing, implementing submenu "**IEC103 Info**" in the menu "**Print**".

9.4.7 Disturbance Records

This protective device can store up to 32 disturbance records in its memory. A pickup of the fault detector or an operation of the relay can make the protective device store the disturbance records.

The disturbance records are stored in uncompressed format and can be extracted using the standard mechanisms described in IEC60870-5-103.

All channel numbers (ACC) of disturbance data can be gained by printing, implementing submenu "**IEC103 Info**" in the menu "**Print**".

9.5 Messages Description for IEC61850 Protocol

9.5.1 Overview

The IEC 61850 standard is the result of years of work by electric utilities and vendors of electronic equipment to produce standardized communications systems. IEC 61850 is a series of standards describing client/server and peer-to-peer communications, substation design and configuration, testing, environmental and project standards. The complete set includes:

- IEC 61850-1: Introduction and overview
- IEC 61850-2: Glossary
- IEC 61850-3: General requirements
- IEC 61850-4: System and project management
- IEC 61850-5: Communications and requirements for functions and device models
- IEC 61850-6: Configuration description language for communication in electrical substations related to IEDs
- IEC 61850-7-1: Basic communication structure for substation and feeder equipment–Principles and models
- IEC 61850-7-2: Basic communication structure for substation and feeder equipment - Abstract communication service interface (ACSI)
- IEC 61850-7-3: Basic communication structure for substation and feeder equipment–Common data classes
- IEC 61850-7-4: Basic communication structure for substation and feeder equipment–Compatible logical node classes and data classes

- IEC 61850-8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
- IEC 61850-9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link
- IEC 61850-9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3
- IEC 61850-10: Conformance testing

These documents can be obtained from the IEC (http://www.iec.ch). It is strongly recommended that all those involved with any IEC 61850 implementation obtain this document set.

9.5.2 Communication Profiles

The PRS-7000 series relay supports IEC 61850 server services over TCP/IP communication protocol stacks. The TCP/IP profile requires the PRS-7000 series to have an IP address to establish communications. These addresses are located in the menu "**Settings→Device Setup→Comm Settings**".

1. MMS protocol

IEC 61850 specifies the use of the Manufacturing Message Specification (MMS) at the upper (application) layer for transfer of real-time data. This protocol has been in existence for a number of years and provides a set of services suitable for the transfer of data within a substation LAN environment. IEC 61850-7-2 abstract services and objects are mapped to actual MMS protocol services in IEC61850-8-1.

2. Client/server

This is a connection-oriented type of communication. The connection is initiated by the client, and communication activity is controlled by the client. IEC61850 clients are often substation computers running HMI programs or SOE logging software. Servers are usually substation equipment such as protection relays, meters, RTUs, transformer, tap changers, or bay controllers.

3. Peer-to-peer

This is a non-connection-oriented, high speed type of communication usually between substation equipment, such as protection relays, intelligent terminal. GOOSE is the method of peer-to-peer communication.

4. Substation configuration language (SCL)

A substation configuration language is a number of files used to describe IED configurations and communication systems according to IEC 61850-5 and IEC 61850-7. Each configured device has an IED Capability Description (ICD) file and a Configured IED Description (CID) file. The substation single line information is stored in a System Specification Description (SSD) file. The entire substation configuration is stored in a Substation Configuration Description (SCD) file. The SCD file is the combination of the individual ICD files and the SSD file, moreover, add communication system parameters (MMS, GOOSE, control block, SV control block) and the

connection relationship of GOOSE and SV to SCD file.

9.5.3 MMS Communication Network Deployment

In order to enhance the stability and reliability of SAS, dual-MMS Ethernet is widely adopted. This section is applied to introduce the details of dual-MMS Ethernet technology. Generally, single-MMS Ethernet is recommended to be adopted in the SAS of 110kV and lower voltage levels, while dual-MMS Ethernet is recommended to be adopted in the SAS of voltage levels above 110kV.

Client-server mode is adopted: clients (SCADA, control center and etc.) communicate with the IEDs via MMS communication network, and the IEDs operate as the servers. IEDs are connected to clients passively, and they can interact with the clients according to the configuration and the issued command of the clients.

Three modes for dual-MMS Ethernet (abbreviated as dual-net) are provided as below.

NOTICE!

Hereinafter, the normal operation status of net means the physical link and TCP link are both ok. The abnormal operation status of net means physical link or TCP link is broken.

9.5.3.1 Dual-net Full Duplex Mode Sharing the Same RCB Instance

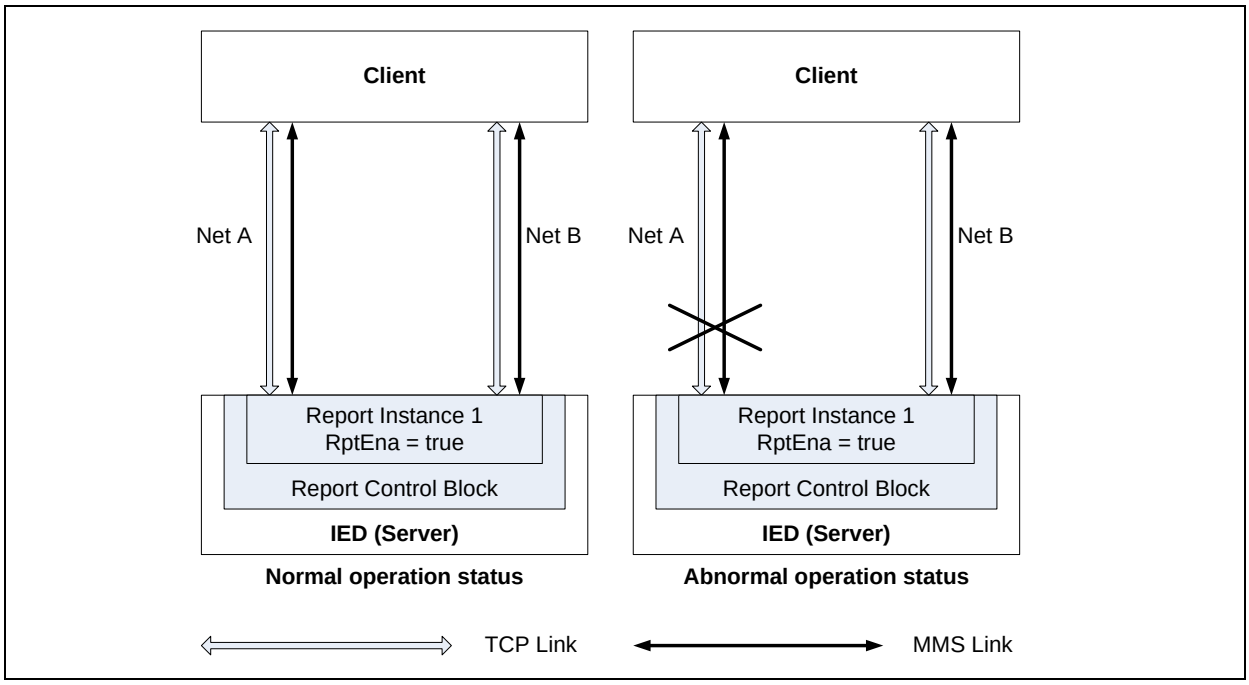


Figure 9.5.1 Dual-net full duplex mode sharing the RCB block instance

Net A and Net B share the same report control block (abbreviated as RCB) enabled by the client. IED sends undifferentiated date through dual-net to the clients. If one net is physically disconnected, the flag of RCB instance (i.e.: “RptEna” in above figure) is still “true”. Only when both Net A and Net B are disconnected, the flag of the RCB instance will automatically change to “false”.

In normal operation status of this mode, IED provides the same MMS service for Net A and Net B. If one net is physically disconnected (i.e.: “Abnormal operation status” in above figure), the working mode will switch to single-net mode seamlessly and immediately. Network communication supervision is unnecessary here, and Buffered Report Control Block (abbreviated as BRCB) need not to be used. On the other net, date alternation works normally. Therefore, MMS service can interact normally without interruption. This mode ensures no data loss during one net is in abnormal operation status.

In this mode, one report will be transmitted twice via dual nets for the same report instance, so the client needs to distinguish whether two reports are same according to corresponding EntryIDs.

9.5.3.2 Dual-net Hot-standby Mode Sharing the Same RCB Instance

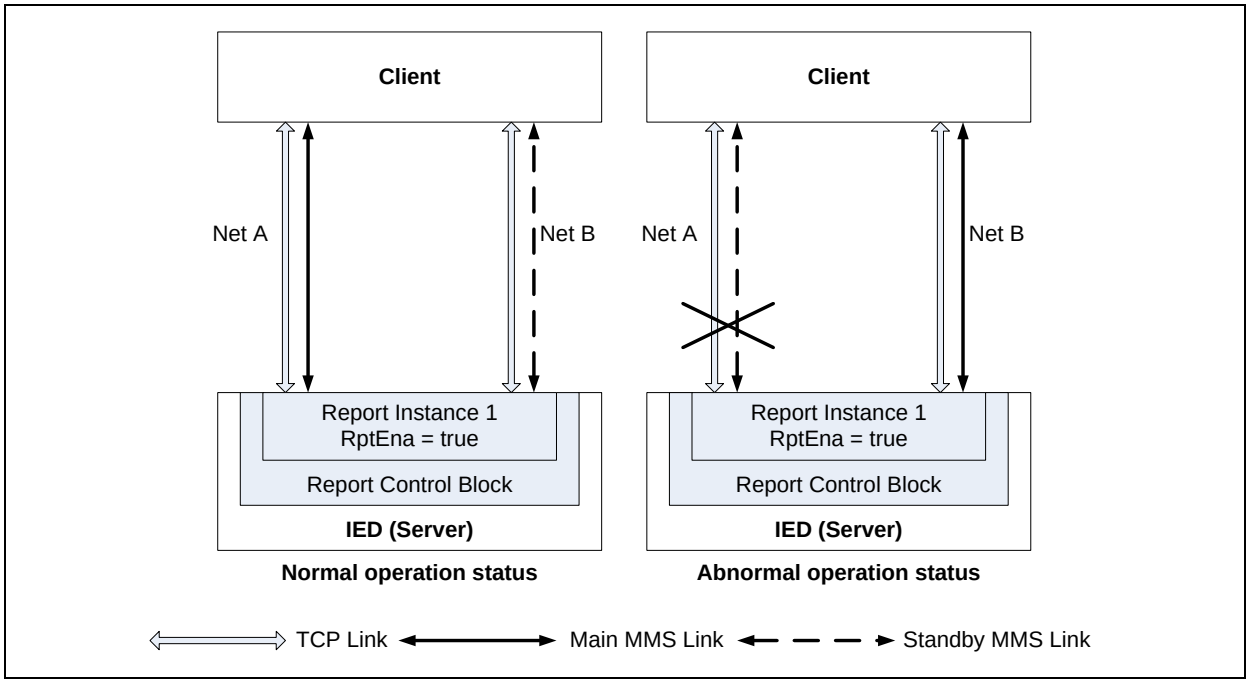


Figure 9.5.2 Dual-net hot-standby mode sharing the same RCB instance

In this mode, the MMS service is provided on main MMS link, no MMS service interacts on the standby MMS link. The definitions of two links are as follows:

- Main MMS Link: Physically connected, TCP level connected, MMS report service available.
- Standby MMS Link: Physically connected, TCP level connected, MMS report service not available.

If the main net fails to operate (i.e.: “Abnormal operation status” in the above figure), the IED will set “RptEna” to “false”. Meanwhile the client will detect the failure by heartbeat message or “keep-alive”, it will automatically enable the RCB instance by setting “RptEna” back to “true” through standby MMS link. By the buffer function of BRCB, the IED can provide uninterrupted MMS service on the standby net. However, the differences of BRCB standards among different manufacturers may cause data loss. Moreover, if duration of net switch is too long, the data loss is positively as the capacity of BRCB’s buffer function is limited.

NOTICE!

The first mode and second mode, Net A IED host address and Net B IED host address must be the same.

For example, if the subnet mask is “255.255.0.0”, network prefix of Net A is “198.120.0.0”, network prefix of Net B is “198.121.0.0”, Net A IP address of the IED is “198.120.1.2”, and then Net B IP address of the IED must be configured as “198.121.1.2”, i.e., Net A IED host address =1×256+2=258, Net B IED host address =1×256+2=258, Net A IED host address equals to Net B IED host address.

9.5.3.3 Dual-net Full Duplex Mode with 2 Independent RCB Instances

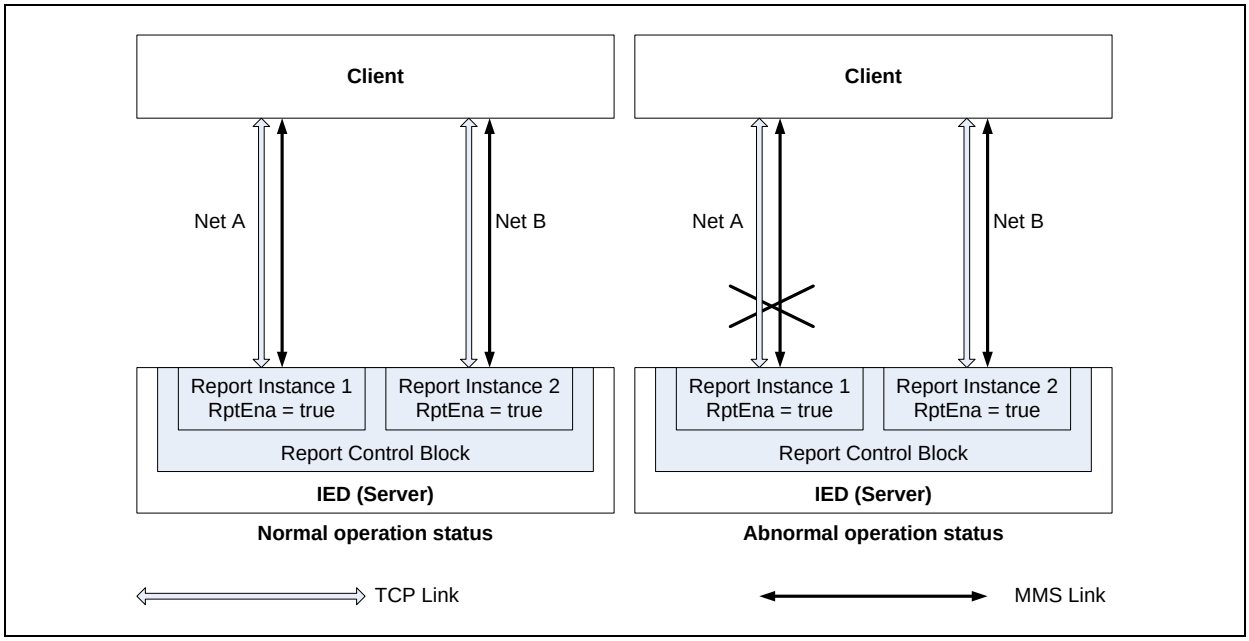


Figure 9.5.3 Dual-net full duplex mode with 2 independent RCB instances

In this mode, IED provides 2 report instances for each RCB, Net A and Net B work independently from each other, failures of any net will not affect the other net at all. Tow report instances are required for each client. Therefore, the IED may be unable to provide enough report instances if there are too many clients.

Net A and Net B send the same report separately when they operates normally, To ensure no repeated data is saved into database, massive calculation is required for the client.

Moreover, accurate clock synchronization of the IED is required to distinguish whether 2 reports are the same report according to the timestamps. Clock synchronization error of the IED may lead to report loss/redundancy.

As a conclusion, for the second mode, it’s difficult to realize seamless switchover between dual nets, however, for the third mode, the IED may be unable to provide enough report instances if too many clients are applied on site. Considering client treatment and IED implementation, the first mode (Dual-net full duplex mode sharing the same report instance) is recommended for MMS communication network deployment.

9.5.4 Server Data Organization

IEC61850 defines an object-oriented approach to data and services. An IEC61850 physical device can contain one or more logical device(s) (for proxy). Each logical device can contain many logical nodes. Each logical node can contain many data objects. Each data object is composed of data attributes and data attribute components. Services are available at each level for performing various functions, such as reading, writing, control commands, and reporting.

Each IED represents one IEC61850 physical device. The physical device contains one or more logical device(s), and the logical device contains many logical nodes. The logical node LPHD contains information about the IED physical device. The logical node LLN0 contains common information about the IED logical device.

9.5.4.1 Digital Status Values

The GGIO logical node is available in the PRS-7000 series relays to provide access to digital status points (including general I/O inputs and warnings) and associated timestamps and quality flags. The data content must be configured before the data can be used. GGIO provides digital status points for access by clients. It is intended that clients use GGIO in order to access digital status values from the PRS-7000 series relays. Clients can utilize the IEC61850 buffered reporting features available from GGIO in order to build sequence of events (SOE) logs and HMI display screens. Buffered reporting should generally be used for SOE logs since the buffering capability reduces the chances of missing data state changes. All needed status data objects are transmitted to HMI clients via buffered reporting, and the corresponding buffered reporting control block (BRCB) is defined in LLN0.

9.5.4.2 Analog Values

Most of analog measured values are available through the MMXU logical nodes, and metering values in MMTR, the else in MMXN, MSQI and so on. Each MMXU logical node provides data from a IED current/voltage “source”. There is one MMXU available for each configurable source. MMXU1 provides data from CT/VT source 1(usually for protection purpose), and MMXU2 provides data from CT/VT source 2 (usually for monitor and display purpose). All these analog data objects are transmitted to HMI clients via unbuffered reporting periodically, and the corresponding unbuffered reporting control block (URCB) is defined in LLN0. MMXUx logical nodes provide the following data for each source:

9.5.4.3 Protection Logical Nodes

The following list describes the protection elements for PRS-7741 series relays. The specified relay will contain a subset of protection elements from this list.

The protection elements listed above contain start (pickup) and operate flags, instead of any element has its own start (pickup) flag separately, all the elements share a common start (pickup) flags “PTRC.ST.Str.general”. The operate flag for _PTOC1 is “_PTOC1.ST.Op.general”. For PRS-7000 series relays protection elements, these flags take their values from related module for the corresponding element. Similar to digital status values, the protection trip information is reported via BRCB, and BRCB also locates in LLN0.

9.5.4.4 LLN0 and Other Logical Nodes

Logical node LLN0 is essential for an IEC61850 based IED. This LN shall be used to address common issues for Logical Devices. Most of the public services, the common settings, control values and some device oriented data objects are available here. The public services may be BRCB, URCB and GSE control blocks and similar global defines for the whole device; the common settings include all the setting items of communication settings, system settings and some of the protection setting items, which can be configured to two or more protection elements (logical nodes). In LLN0, the item Loc is a device control object, this Do item indicates the local operation for complete logical device, when it is true, all the remote control commands to the IED will be blocked and those commands make effective until the item Loc is changed to false. In PRS-7000 series relays, besides the logical nodes we describe above, there are some other logical nodes below in the IEDs:

9.5.5 Server Features and Configuration

9.5.5.1 Buffered/unbuffered Reporting

IEC61850 buffered and unbuffered reporting control blocks locate in LLN0, they can be configured to transmit information of protection trip information (in the Protection logical nodes), binary status values (in GGIO) and analog measured/calculated values (in MMXU, MMTR and MSQI). The reporting control blocks can be configured in CID files, and then be sent to the IED via an IEC61850 client. The following items can be configured.

- **TrgOps: Trigger options.**

The following bits are supported by the PRS-7000 series relays:

- Bit 1: Data-change
- Bit 4: Integrity
- Bit 5: General interrogation

- **OptFlds: Option Fields.**

The following bits are supported by the PRS-7000 series relays:

- Bit 1: Sequence-number
- Bit 2: Report-time-stamp
- Bit 3: Reason-for-inclusion
- Bit 4: Data-set-name
- Bit 5: Data-reference
- Bit 7: EntryID (for buffered reports only)
- Bit 8: Conf-revision
- Bit 9: Segmentation

- **IntgPd: Integrity period.**

9.5.5.2 File Transfer

MMS file services are supported to allow transfer of oscillography, event record or other files from a PRS-7000 series relay.

9.5.5.3 Timestamps

The Universal Time Coordinated(UTC for short) timestamp associated with all IEC61850 data items represents the latest change time of either the value or quality flags of the data item.

9.5.5.4 Logical Node Name Prefixes

IEC61850 specifies that each logical node can have a name with a total length of 11 characters. The name is composed of:

- **A five or six-character name prefix.**
- **A four-character standard name (for example, MMXU, GGIO, PIOC, etc.).**
- **A one or two-character instantiation index.**

Complete names are of the form xxxxxx_PTOC1, where the xxxxxx character string is configurable. Details regarding the logical node naming rules are given in IEC61850 parts 6 and 7-2. It is recommended that a consistent naming convention be used for an entire substation project.

9.5.5.5 GOOSE Services

IEC61850 specifies the type of broadcast data transfer services: Generic Object Oriented Substation Events (GOOSE). IEC61850 GOOSE services provide virtual LAN (VLAN) support, Ethernet priority tagging, and Ether-type Application ID configuration. The support for VLANs and priority tagging allows for the optimization of Ethernet network traffic. GOOSE messages can be given a higher priority than standard Ethernet traffic, and they can be separated onto specific VLANs. Devices that transmit GOOSE messages also function as servers. Each GOOSE publisher contains a “GOOSE control block” to configure and control the transmission.

The GOOSE transmission (including subscribing and publishing) is controlled by GOOSE logic link settings in device.

The PRS-7000 series relays support IEC61850 Generic Object Oriented Substation Event (GOOSE) communication. All GOOSE messages contain IEC61850 data collected into a dataset. It is this dataset that is transferred using GOOSE message services. The GOOSE related dataset is configured in the CID file and it is recommended that the fixed GOOSE be used for implementations that require GOOSE data transfer between PRS-7000 series relays.

IEC61850 GOOSE messaging contains a number of configurable parameters, all of which must be correct to achieve the successful transfer of data. It is critical that the configured datasets at the transmission and reception devices are an exact match in terms of data structure, and that the GOOSE addresses and name strings match exactly.

9.5.6 ACSI Conformance

9.5.6.1 ACSI Basic Conformance Statement

Table 9.5-1 ACSI Basic Conformance Statement

Services		Client	Server	PRS-7000 Series
Client-Server Roles				
B11	Server side (of Two-party Application-Association)	—	C1	Y
B12	Client side (of Two-party Application-Association)	C1	—	N
SCSMS Supported				
B21	SCSM: IEC 61850-8-1 used	Y	Y	Y
B22	SCSM: IEC 61850-9-1 used	N	N	N
B23	SCSM: IEC 61850-9-2 used	Y	N	Y
B24	SCSM: other	N	N	N
Generic Substation Event Model (GSE)				
B31	Publisher side	—	O	Y
B32	Subscriber side	O	—	Y
Transmission Of Sampled Value Model (SVC)				
B41	Publisher side	—	O	N
B42	Subscriber side	O	—	N

Where:

C1: Shall be "M" if support for LOGICAL-DEVICE model has been declared

O: Optional

M: Mandatory

Y: Supported by PRS-7000 series relays

N: Currently not supported by PRS-7000 series relays

9.5.6.2 ACSI Models Conformance Statement

Table 9.5-2 ACSI Models Conformance Statement

Services		Client	Server	PRS-7000 Series
M1	Logical device	C2	C2	Y
M2	Logical node	C3	C3	Y
M3	Data	C4	C4	Y
M4	Data set	C5	C5	Y
M5	Substitution	O	O	Y
M6	Setting group control	O	O	Y
Reporting				
M7	Buffered report control	O	O	Y
M7-1	sequence-number	Y	Y	Y
M7-2	report-time-stamp	Y	Y	Y

M7-3	reason-for-inclusion	Y	Y	Y
M7-4	data-set-name	Y	Y	Y
M7-5	data-reference	Y	Y	Y
M7-6	buffer-overflow	Y	Y	N
M7-7	entryID	Y	Y	Y
M7-8	BufTm	N	N	N
M7-9	IntgPd	Y	Y	Y
M7-10	GI	Y	Y	Y
M8	Unbuffered report control	M	M	Y
M8-1	sequence-number	Y	Y	Y
M8-2	report-time-stamp	Y	Y	Y
M8-3	reason-for-inclusion	Y	Y	Y
M8-4	data-set-name	Y	Y	Y
M8-5	data-reference	Y	Y	Y
M8-6	BufTm	N	N	N
M8-7	IntgPd	N	Y	Y
Logging				
M9	Log control	O	O	N
M9-1	IntgPd	N	N	N
M10	Log	O	O	N
GSE				
M12	GOOSE	O	O	Y
M13	GSSE	O	O	N
M14	Multicast SVC	O	O	N
M15	Unicast SVC	O	O	N
M16	Time	M	M	Y
M17	File transfer	O	O	Y

Where:

C2: Shall be "M" if support for LOGICAL-NODE model has been declared

C3: Shall be "M" if support for DATA model has been declared

C4: Shall be "M" if support for DATA-SET, Substitution, Report, Log Control, or Time models has been declared

C5: Shall be "M" if support for Report, GSE, or SMV models has been declared

M: Mandatory

Y: Supported by PRS-7000 series relays

N: Currently not supported by PRS-7000 series relays

9.5.6.3 ACSI Services Conformance Statement

Table 9.5-3 ACSI Services Conformance Statement

Services		Server/Publisher	PRS-7741
Server			
S1	ServerDirectory	M	Y
Application association			
S2	Associate	M	Y
S3	Abort	M	Y
S4	Release	M	Y
Logical device			
S5	LogicalDeviceDirectory	M	Y
Logical node			
S6	LogicalNodeDirectory	M	Y
S7	GetAllDataValues	M	Y
Data			
S8	GetDataValues	M	Y
S9	SetDataValues	M	Y
S10	GetDataDirectory	M	Y
S11	GetDataDefinition	M	Y
Data set			
S12	GetDataSetValues	M	Y
S13	SetDataSetValues	O	Y
S14	CreateDataSet	O	N
S15	DeleteDataSet	O	N
S16	GetDataSetDirectory	M	Y
Substitution			
S17	SetDataValues	M	Y
Setting group control			
S18	SelectActiveSG	M/O	Y
S19	SelectEditSG	M/O	Y
S20	SetSGValuess	M/O	Y
S21	ConfirmEditSGValues	M/O	Y
S22	GetSGValues	M/O	Y
S23	GetSGCBValues	M/O	Y
Reporting			
Buffered report control block			
S24	Report	M	Y
S24-1	data-change	M	Y
S24-2	qchg-change	M	N
S24-3	data-update	M	N
S25	GetBRCBValues	M	Y

S26	SetBRCBValues	M	Y
Unbuffered report control block			
S27	Report	M	Y
S27-1	data-change	M	Y
S27-2	qchg-change	M	N
S27-3	data-update	M	N
S28	GetURCBValues	M	Y
S29	SetURCBValues	M	Y
Logging			
Log control block			
S30	GetLCBValues	O	N
S31	SetLCBValues	O	N
Log			
S32	QueryLogByTime	O	N
S33	QueryLogAfter	O	N
S34	GetLogStatusValues	O	N
Generic substation event model (GSE)			
GOOSE control block			
S35	SendGOOSEMessage	M	Y
S36	GetGoReference	O	Y
S37	GetGOOSEElementNumber	O	N
S38	GetGoCBValues	M	Y
S39	SetGoCBValuess	M	N
Control			
S51	Select	O	N
S52	SelectWithValue	M	Y
S53	Cancel	M	Y
S54	Operate	M	Y
S55	Command-Termination	O	Y
S56	TimeActivated-Operate	O	N
File transfer			
S57	GetFile	M/O	Y
S58	SetFile	O	N
S59	DeleteFile	O	N
S60	GetFileAttributeValues	M/O	Y
Time			
	SNTP	M	Y

9.5.7 Logical Nodes

9.5.7.1 Logical Nodes Table

The PRS-7741 series relays support IEC61850 logical nodes as indicated in the following table. Note that the actual instantiation of each logical node is determined by the product order code.

9.6 DNP3.0 Interface

9.6.1 Overview

The descriptions given here are intended to accompany this relay. The DNP3.0 protocol is not described here; please refer to the DNP3.0 protocol standard for the details about the DNP3.0 implementation. This manual only specifies which objects, variations and qualifiers are supported in this relay, and also specifies what data is available from this relay via DNP3.0.

The relay operates as a DNP3.0 slave and supports subset level 3 of the protocol, plus some of the features from level 4. The DNP3.0 communication uses the Ethernet ports (electrical or optical) at the rear side of this relay.

9.6.2 Link Layer Functions

Please see the DNP3.0 protocol standard for the details about the linker layer functions.

9.6.3 Transport Functions

Please see the DNP3.0 protocol standard for the details about the transport functions.

9.6.4 Application Layer Functions

9.6.4.1 Function Code

Table 9.6-1 Function Code

Function Code	Function
0 (0x00)	Confirm
1 (0x01)	Read
2 (0x02)	Write
3 (0x03)	Select
4 (0x04)	Operate
5 (0x05)	Direct Operate
6 (0x06)	Direct Operate No Acknowledgment
13 (0x0D)	Cold Restart
14 (0x0E)	Warm Restart
20 (0x14)	Enable Unsolicited Responses
21 (0x15)	Disable Unsolicited Responses
22 (0x16)	Assign Class
23 (0x17)	Delay Measurement

9.6.4.2 Supported Object List

The supported object groups and object variations are show in the following table.

Request: Master may issue/Outstation shall parse

Function code: decimalism

Qualifier code: hexadecimal

Response: Master shall parse\Outstation may issue

Function code: decimalism

Qualifier code: hexadecimal

9.6.4.3 Communication Table Configuration

This relay now supports 4 Ethernet clients and 2 serial port clients. Each client can be set the DNP related communication parameters respectively and be selected the user-defined communication table. This relay supports a default communication table and 4 user-defined communication tables, and the default communication table is fixed by the manufacturer and not permitted to configure by the user.

The user can configure the user-defined communication table through the PRS IED Studio configuration tool auxiliary software. The object groups “Binary Input”, “Binary Output”, “Analog Input” and “Analog Output” can be configured according to the practical engineering demand.

9.6.4.4 Analog Input and Output Configuration

To the analog inputs, the attributes “deadband” and “factor” of each analog input can be configured independently. To the analog outputs, only the attribute “factor” of each analog output needs to be configured. If the integer mode is adopted for the data formats of analog values (to “Analog Input”, “Object Variation” is 1, 2 and 3; to “Analog Output”, “Object Variation” is 1 and 2.), the analog values will be multiplied by the “factor” respectively to ensure their accuracy. And if the float mode is adopted for the data formats of analog values, the actual float analog values will be sent directly.

The judgment method of the analog input change is as below: Calculate the difference between the current new value and the stored history value and make the difference value multiply by the “factor”, then compare the result with the “deadband” value. If the result is greater than the “deadband” value, then an event message of corresponding analog input change will be created. In normal communication process, the master can online read or modify a “deadband” value by reading or modifying the variation in “Group34”.

9.6.4.5 Binary Output Configuration

The remote control signals, logic links and external extended output commands can be configured into the “Binary Output” group. The supported control functions are listed as below.

Table 9.6-2 control functions

Information Point	Pulse On/Null	Pulse On/Close	Pulse On/Trip	Latch On/Null	Latch Off/Null
Remote Control	Not supported	Close	Trip	Close	Trip
Logic Link	Not supported	Set	Clear	Set	Clear
Extended Output	See following description				

To an extended output command, if a selected command is controlled remotely, this command point will output a high ~ level pulse. The pulse width can be decided by the “On ~ time” in the related “Binary Command” which is from the DNP3.0 master. If the “On ~ time” is set as “0”, the default pulse width is 500ms.

9.6.4.6 Unsolicited Messages

This relay does not transmit the unsolicited messages if the related logic setting is set as “0”. If the unsolicited messages want to be transmitted, the related logic setting should be set as “1” or the DNP3.0 master will transmit “Enable Unsolicited” command to this relay through “Function Code 20” (Enable Unsolicited Messages). If the “Binary Input” state changes or the difference value of the “Analog Input” is greater than the “deadband” value, this device will transmit unsolicited messages. If the DNP3.0 master needs not to receive the unsolicited messages, it should forbid this relay to transmit the unsolicited messages by setting the related logic setting as “0” or through the “Function Code 21” (Disable Unsolicited Messages).

9.6.4.7 Class Configuration

If the DNP3.0 master calls the Class0 data, this relay will transmit all actual values of the “Analog Input”, “Binary Input” and “Analog Output”. The classes of the “Analog Input” and “Binary Input” can be defined by modifying relevant settings. In communication process, the DNP3.0 master can online modify the class of an “Analog Input” or a “Binary Input” through “Function Code 22” (Assign Class).

9.7 IEEE 1588-2008 Protocol

9.7.1 Overview

The Precision Time Protocol (PTP) is a protocol used to synchronize clocks throughout LAN. On a local area network, it achieves clock accuracy in the sub-microsecond range, making it suitable for measurement and control systems.

9.7.2 Time Synchronization

Time synchronization of the device support IEEE 1588-2008 Protocol via ethernet interface or optical interface.

10 Commissioning

10.1 General

This part contains a brief description about how to verify the function, including functional verification items, functional verification methods and more.

With high degree of self-checking, any fault with the internal hardware and software can be diagnosed by the device itself. So for the commissioning, only hardware interface and the application-specific software function are necessary to verify.

Before carrying out commissioning, users should pay close attention to the safety, technical data and the ratings on the front panel label.

10.2 Safety Instructions

This section contains some safety information, some of which are given warning signs to avoid personal injury or equipment damage, to prompt the user to be careful.

10.2.1 Safety Identification


Electrical warning icon indicating a danger of electric shock.


Notice icon, indicating important information or warnings involved in the article. This icon may indicate a danger of software, equipment or property damage.


Information icons alert readers to important facts or conditions.


Prompt staff not to forget the dangers of static electricity and make prevention.


Forbid to energize the device while not grounded, to avoid endangering the personal safety due to electrical insulation damage!

Although these markings warn of the danger, it is important to note that operating damaged equipment under certain operating conditions can result in reduced process performance and may result in death or personal injury. Therefore, be sure to fully comply with all warnings and cautions.

10.2.2 Safety Identification Examples

For the various safety instructions given in the previous section, the following are examples

10.2.2.1 Warning Signs


Do not touch the circuit during operation. There may be fatal voltage and current.
Strict compliance with safety regulations. Work in high voltage environment need to be serious to avoid personal injury or equipment damage.


When measuring signals in an open circuit, remember to use a properly isolated test clamp that can have fatal voltages and currents.


During normal operation, never disconnect or connect the wires or connectors connected with the terminals. It may cause deadly dangerous voltage and current, may also interrupt the operation of the equipment, damage the terminals and the measuring circuit.


Never disconnect the secondary winding of the current transformer. Current transformers that operate when the secondary windings are open will create strong potentials that may damage the transformers and may cause personal injury.


When the protective device is energized, never plug the module. Hot plug may damage the protection device and measuring circuit, may also result in injury.

10.2.2.2 Caution Signs

Do not connect the protective shell to the live wire, charging the shell may damage the internal circuit.


During installation and commissioning, be careful not to get an electric shock if you touch the leads and connecting terminals

10.2.2.3 Notice Signs


Do not modify the settings in the running protection device. After modify the setting, verify it according to the rules.

10.2.2.4 Anti-static Signs


Remember to avoid touching circuits, including electronic circuits, and the device may be damaged if subjected to static electricity. Electronic circuits may also contain deadly high voltages.


Remember to use a certified conductive bag when transporting the module. Remember to connect the anti-static wristband to the ground when handling the module and remember to operate it on a suitable anti-static surface. Static electricity discharge may cause damage to the module.


Remember to wear the anti-static wristband connected to the ground when replace the module, Static electricity discharge may damage the module and protection device.

10.2.2.5 Earthing Signs


Regardless of operating conditions, remember to connect the protective device to the earth, also needed for special occasions such as testing, demonstrating and off-line configuration on the desk. Operation of the protective device without proper earthing may damage the protective device and the measuring circuit and may also cause an injuring accident.

10.2.2.6 Information Signs

Effective value and step of settings explanation: The protection setting supports as much as 6 significant figures, of which the decimal point occupies one digit (the highest digit can not be a decimal point). The minimum setting step is 0.01.

10.3 Commission Tools

10.3.1 Instrumentation and Meters Notice:

- Instruments, meters must pass the inspection, and within the validity of the inspection
- instruments, meters should be accurate level higher than the seized equipment related indicators 2 to 4 levels.

10.3.2 Tools Requirement:

- Relay protection testing devices: Multifunctional dynamic current and voltage injection test set with interval timer.
- Regulative DC power: DC output can be adjustable within 0 ~ 240V.
- Accuracy meter: support three-phase voltage, three-phase current output.
- Tong-type ammeter
- Multifunction phase meter
- Multimeter
- Megger
- Laptop: with appropriate software
- Network cable
- Optical power meter
- EIA RS-485 to EIA RS-232 converter

10.4 Commission Preparation

10.4.1 Basic Knowledge

When commissioning this device for the first time, sufficient time should be allowed to become familiar with the manual to understand the basic operation, protection principles, and related basic performance of the devices as much as possible. If find any doubt in the process, consult the manufacturer's field service personnel or technical support staff of our company.

Alternatively, if a laptop is available together with suitable setting software (such as PRS IED Studio software), the menu can be viewed one page at a time to display a full column of data and text. This PC software also allows settings to be entered more easily, saved to a file on disk for future reference or printed to produce a setting record. Refer to the PRS IED Studio Instruction

manual for details.

If the application-specific settings have been applied to the relay prior to commissioning, it is advisable to make a copy of the settings so as to allow them restoration later. This could be done by extracting the settings from the relay itself via printer or manually creating a setting record.

10.4.2 Operation Preparation

Check the printer wiring is normal, the print paper is ample, in order to print the test settings, version, and a variety of experiment data.

Attention! The device should be checked before power on. The appearance should be no damage. The module is plugged and fastened, and the insulation of the DC voltage circuit meets the specified requirements. The indicators can refer to the commissioning record of the device.

Attention! Disconnect the external AC circuit of the cubicle before the test to avoid causing a safety accident, which will cause serious damage to the construction workers on site.

Attention! When you need to plug and unplug the device module, you should ensure the device is powered off and make the anti-static measures to prevent the module damage or performance degradation.

Attention! Temporarily open or shorted terminals should be well documented for reliable recovery after the end of the test.

If it has been necessary to disconnect any of the external wiring from the protection in order to perform any of the following tests, it should be ensured that all connections are replaced in accordance with the relevant external connection or scheme diagram. Confirm current and voltage transformer wiring.

10.5 Product Checks

These product checks cover all aspects of the relay which should be checked to ensure that it has not been physically damaged prior to commissioning, is functioning correctly and all input quantity measurements are within the stated tolerances.

10.5.1 Document Check

Document acceptance check include: protection inspection and factory test reports, certificates, drawings, technical manual of related equipment.

10.5.2 Appearance Inspection

Check the the front and back of the cubicle of various electrical components, terminal blocks, hard-switch. All should be marked with the number, name, application and operating position. The marked handwriting should be clear, neat, and not easy to bleach.

The device mark inspection shall include the product type, name, manufacturer's name and trademark, date of manufacture and serial number, safety mark, etc., the mark and installation

location shall be consistent with the design drawings.

Inspect the surface of the device. There shall not be scratches, bumps, groove marks, rust, deformation and other defects that affect the quality and appearance;

Check the device panel keyboard is complete, flexible operation, the LCD is clear, the indicator shows normal;

Uncharged metal part of the device should be connected as one, and reliable grounding;

Check the cubicle shell of the device must be grounded reliably;

10.5.3 Insulation Check

Disconnect the weak electric link with other devices and short circuit the AC voltage circuit terminal, AC current circuit terminal, DC circuit terminal and signal circuit terminal inside the cubicle terminal block, and measure the insulation resistance value using the tester whose open circuit voltage is 500V. Insulation should meet the following requirements:

Device independent circuit and exposed conductive parts, 500V megger insulation resistance measured value should be no less than 100MΩ;

Between electrically disconnected independent circuits, 500V megger insulation resistance measured value should be no less than 100MΩ;

After the insulation test is completed, make sure that all external wiring is properly connected.

10.5.4 External Wiring Check

External protection wiring should be consistent with the design drawings; Internal and external wiring on the terminal block and cable marking on it is correct, complete, and consistent with the drawings; Secondary circuit wiring should be neat and beautiful, solid and reliable;

All secondary cables and terminal blocks wiring connection should be solid. Cable mark should be complete, correct and clear;

The correct mark should be attached to the optical fiber (including optical cable, pigtail, jumper) and both ends of the device port. Such fiber-optic annotation should include the optical fiber number, destination. The starting point of the fiber should indicate the cubicle number. The content of the port mark should include the port number and destination. The starting point of the port should include the cubicle number, switch number and port number.

10.5.5 Test Category

The following tests are necessary to ensure the normal operation of the equipment before it is first put into service.

These tests are performed for the following hardware to ensure that there is no hardware defect. Defects of hardware circuits other than the following can be detected by self-monitoring when the power supply is energized.

- User interfaces test

- Binary input circuits and output circuits test
- AC input circuits test
- Function tests

These tests are performed for the following functions that are fully software-based. Tests of the protection schemes and fault locator require a dynamic test set.

- Measuring elements test
- Timers test
- Metering and recording test
- Conjunctive tests

The tests are performed after the relay is connected with the primary equipment and other external equipment.

- On load test.
- Phase sequence check and polarity check.

10.6 With the Relay Energized

Check that the input range of the external power supply should meet the power requirements of the "technical data" section within the permissible power supply input voltage range.

Attention! All external circuits connected to the unit must be checked to ensure correct installation before the unit is powered on or the test procedure started.

10.6.1 LCD Display Check

After the device is powered on, the LCD will be lit. After the device is initialized, if the device is in normal operation, the LCD displays the status of the main single line diagram.

Attention! If the device is in the alarm state after power-on, the LCD displays the alarm status information. At this point you can refer to the "Supervision" section to analyze the cause of the alarm and treatment.

10.6.2 Date and Time

If the time and date is not being maintained by substation automation system, the date and time should be set manually.

Set the date and time to the correct local time and date using menu item “Clock”.

For devices using IRIG-B (DC) time code and SNTP, IEEE 1588 time synchronization, you can verify the timing accuracy by modifying the clock setting of the device. For PPM, PPS time synchronization system, through the time synchronization binary input check.

10.6.3 Light Emitting Diodes (LEDs)

The device has two lights that can not be defined. the two lights are as follows:

"Healthy": indicates that the device is in normal operation, no software, hardware failure. When the "healthy" light goes out, it indicates a serious problem with the device, resulting in the device not functioning properly.

"Alarm": indicates that there are some alarm events on the device. On this condition, you can analyze the cause of the alarm and how to handle it by checking the "supervision" section of the manual.

The rest of the indicators are configurable indicators.

If the indicator of the device is set to the self-retaining state, if the signal is not reset before the latest power-off, the signal will continue to be triggered when the device is powered on again, and the indicator can be reset by resetting operation. It is likely that alarms related to voltage transformer supervision will not reset at this stage.

10.6.3.1 Test the HEALTHY and ALARM LEDs

Apply the rated power supply and check that the “HEALTHY” LED is lighting in green. We need to emphasize that the “HEALTHY” LED is always lighting in operation course except that this device finds serious errors in it.

Produce one of the abnormal conditions listed in Chapter 4, the “ALARM” LED will light in yellow. When abnormal condition reset, the “ALARM” LED extinguishes.

10.6.3.2 Test the Other LEDs

Test the other LEDs according to the configuration of the LEDs (through the PRS IED Studio software). If the conditions which can turn on the selected LED are satisfied, the selected LED will be on.

10.6.4 Test the AC Current Circuit

Attention! The wiring must be checked in strict accordance with the AC current connection drawings provided.

The purpose of this test is to check whether the wiring of the AC circuit in the cubicle is correct and whether the sampling precision meets the requirements. The sampling accuracy and polarity of the device can be checked through sourcing rated AC current at the AC current input terminal on the back of the cubicle .

Protection current measurement accuracy requirement shall be no higher than 1% or 0.02In. However an additional allowance must be made for the accuracy of the test equipment being used.

Apply current equal to the current transformer secondary winding rating to each current transformer input in turn, see the following table, checking the magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the relays menu.

Table 10.6-1 Current channel checkout

Group No.	Item	Input Value	Input Angle	Display Value	Display Angle
Three-phase current 1	Ia				
	Ib				
	Ic				
Three-phase current 2	Ia				
	Ib				
	Ic				
Three-phase current …	Ia				
	Ib				
	Ic				
Residual current 1	3I0				
Residual current 2	3I0				
Residual current …	3I0				

10.6.5 Test the AC Voltage Inputs

Attention! The wiring must be checked in strict accordance with the AC voltage connection drawings provided.

The purpose of this test is to check whether the wiring of the AC voltage in the cubicle is correct and whether the sampling precision meets the requirements. The sampling accuracy and polarity of the device can be checked through sourcing rated AC voltage at the AC voltage input terminal on the back of the cubicle .

Protection voltage measurement accuracy requirement shall be no higher than 1% or 0.02In. However an additional allowance must be made for the accuracy of the test equipment being used.

Apply voltage equal to the voltage transformer secondary winding rating to each voltagetransformer input in turn, see the following table, checking the magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the relays menu.

Table 10.6-2 Voltage channel checkout

Group No.	Item	Input Value	Input Angle	Display Value	Display Angle
Three-phase voltage 1	Ua				
	Ub				
	Uc				
Three-phase voltage 2	Ua				
	Ub				
	Uc				
Three-phase voltage …	Ua				
	Ub				
	Uc				
Residual voltage 1	3U0				

Group No.	Item	Input Value	Input Angle	Display Value	Display Angle
Residual voltage 2	3U0				
Residual voltage …	3U0				

10.6.6 Test the Binary Inputs

The purpose of this test is to check whether the connection of binary input circuit is correct. During the test, the voltage applied to the binary input terminal must be within the allowable operating range.

Each binary input status can be checked by the device LCD panel, and the status "1" indicates that the binary input has been applied with an input voltage, and the opening status becomes "0" when the input voltage disappears.

Table 10.6-3 Binary inputs checkout

Teminal NO.	Signal Name	States on LCD	Correct?

10.6.7 Test the Binary Outputs

The purpose of this test is to check whether the binary output circuit connection is correct. According to the protection logic of the device and various kinds of signal output logic, stimulate a fault condition. The corresponding relay contact of the device shall be operated with the corresponding action or alarm signal.

10.6.8 Protection Function Checks

The purpose of this experiment is to verify the correctness of the protection logic. Protection function tests generally include the following types:

- Impedance protection test
- Current protection test
- Voltage protection test
- Frequency protection test
- Secondary system supervision function test

For details on how to implement the protection logic function, refer to "Operation Theory"

10.6.9 Printing Function Checks

Check the printer cable is connected properly before printing, printing paper is complete. Printing method can be set to "automatic" or "manual". When set to automatic printing, the device will print protection action event, self- checking information and other records initiatively in real time.

10.6.10 On-load Checks

The objectives of the on-load checks are:

- Confirm the external wiring to the current and voltage inputs is correct.
- Measure the magnitude of on-load current and voltage (if applicable).
- Check the polarity of each current transformer.

10.6.11 Final Checks

After the above tests are completed, remove all test or temporary shorting leads, etc. Restore the original correct wiring. Tighten the secondary circuit terminals, especially for the current terminals, circuit breaker closing and opening, operating power supply circuit.

If a test block is installed, remove the test plug and replace the cover so that the protection is put into service.

Ensure that all event records, fault records, disturbance records and alarms have been cleared and LED's has been reset before leaving the protection.

Ensure that the protection has been restored to service.

11 Installation

11.1 General

Design and installation chapter is suit for design, installation, commissioning and maintenance staff. Designers must have a wealth of experience in electrical design. The installer must have the basic knowledge of electronic equipment and cubicle drawing reading. Commissioning and maintenance personnel must have extensive experience in operating protective equipment and test equipment.The equipment must be shipped, stored and installed with the greatest care.

Choose the place of installation such that the communication interface and the controls on the front of the device are easily accessible.

Air must circulate freely around the equipment. Observe all the requirements regarding place of installation and ambient conditions given in this instruction manual.

Take care that the external wiring is properly brought into the equipment and terminated correctly and pay special attention to grounding. Strictly observe the corresponding guidelines contained in this section.

11.2 Safety Instructions

Warning! Only insert or withdraw a module while the device power supply is switched off. To this end, disconnect the power supply cable that connects with the power supply module.

Attention! A module can only be inserted in the reserved slot. Components can be damaged or destroyed by inserting module in a wrong slot.

The basic precautions to guard against electrostatic discharge are as follows:

- Should boards have to be removed from this relay installed in a grounded cubicle in an HV switchgear installation, please discharge yourself by touching station ground (the cubicle) beforehand.
- Only hold electronic boards at the edges, taking care not to touch the components.
- Only works on boards that have been removed from the cubicle on a workbench designed for electronic equipment and wear a grounded wristband.
- Always store and ship the electronic boards in their original packing. Place electronic parts in electrostatic screened packing materials.

11.3 Checking the Shipment

Vehicles, trains, ships and all other means of transport are available, but to prevent snow and rain,

shock, impact and collision, to ensure product packaging integrity.

Check that the consignment is complete immediately upon receipt. Notify the nearest CYG SUNRI CO., LTD. Company or agent, should departures from the delivery note, the shipping papers or the order be found.

Visually inspect all the material when unpacking it. When there is evidence of transport damage, lodge a claim immediately in writing with the last carrier and notify the nearest CYG SUNRI CO., LTD.Company or agent.

- **Unpacking and checking procedures**

1. Remove the shipping package.
2. Before unpacking, you should first check the equipment packaging intact, whether there are signs of serious collision and phenomenons that equipment in the box may be damaged. If found abnormal, it is recommended to take pictures as a record, confirm and contact with the manufacturer at first time.
3. When unpacking, you should use a claw, and pull out the nails, and then pry off the box lid; If the crowbar is used, never take the device as a fulcrum, and it is forbidden to stick into the wooden box carelessly with the crowbar. Open the box with the greatest care and avoid excessive vibration.
4. Check the appearance of the device is intact.
5. Check the delivery list. Check the device certificate of competency, supporting documents, attachments, spare parts, etc. are consistent with the order requirements, whether the packing list and the type, name, quantity, etc. are consistent and complete. If correct, sign the confirmation.
6. Manufacturer documents and spare parts should be assigned to personal keeping and registration.
7. If any abnormalities occur during unpacking, feedback CYG SUNRI CO., LTD. Company or agent at the first time, so as to avoid the follow-up of unclear responsibilities.

If the equipment is not going to be installed and commissioned immediately, store all the parts in their original packing in a clean dry place and keep air circulation. And to prevent the intrusion of various harmful gases, non-corrosive items stored in the same place.

11.4 Material and Tools Required

The necessary mounting kits will be provided, including screws, pincers and assembly instructions.

A suitable drill and spanners are required to secure the cubicles to the floor using the plugs provided (if this relay is mounted in cubicles).

11.5 Device Location and Ambient Conditions

The mechanical and electrical environmental conditions at the installation site must comply with the requirements of "Chapter 2 Technical Data". Avoid adverse conditions caused by the environment:

- Avoid installing in wet, dark and other places likely to cause damp and rust. If in unavoidable rainy area, install the device in a higher position;
- If the area is an earthquake prone area, fix the protection device tightly;
- If there is a lot of dust in the installation place, clean it before installing.

The place of installation should permit easy access especially to front of the device, i.e. to the human machine interface of the equipment. There should also be free access at the rear of the equipment for additions and replacement of electronic boards.

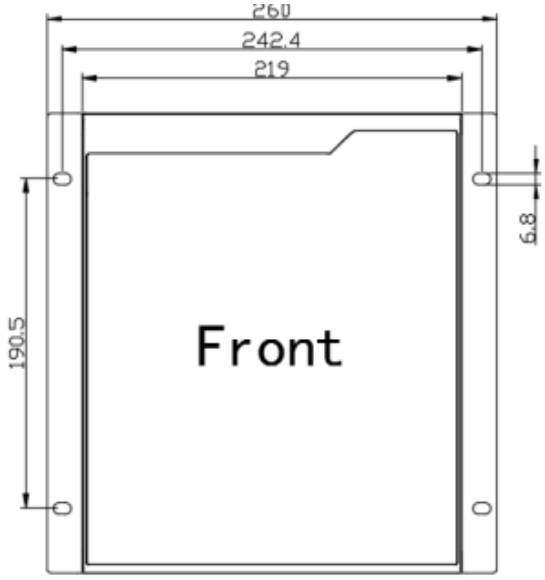
11.6 Mechanical Installation

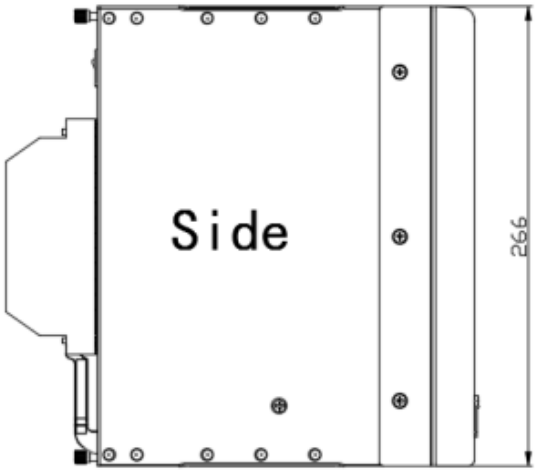
In the case of equipment supplied in cubicles, place the cubicles on the foundations that have been prepared. Take care while doing so not to jam or otherwise damage any of the cables that have already been installed. Secure the cubicles to the foundations.

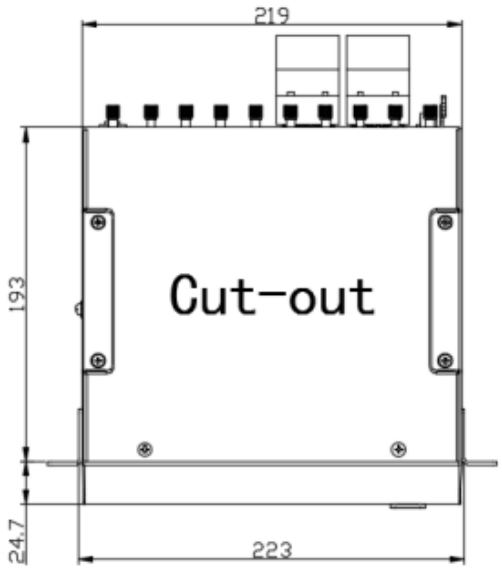
The device should be firmly fixed in the cubicle(cabinet), and the connecting screws should be tightened. The grounding wire of each device should be connected with the copper grounding busbar inside the cubicle, and reliably connected with the secondary grounding network. Device wiring should be consistent with the wiring diagram requirements.

The device features a 6U height, 1/1 19 "or 1/2 19" width chassis, integral panel and pluggable functional modules with lock. The device is designed conforming to IEC 60297-3. Embedded Installation as a whole, rear wiring. The current/ voltage connector structure are in the same size, and can be expanded, combined flexibly. Installation hole size as below.

Attention! It is necessary to leave enough space top and bottom of the cut-out in the cubicle for heat emission of this relay.


260
242.4
219
6.8
190.5
Front


Side
266


219
193
Cut-out
24.7
223

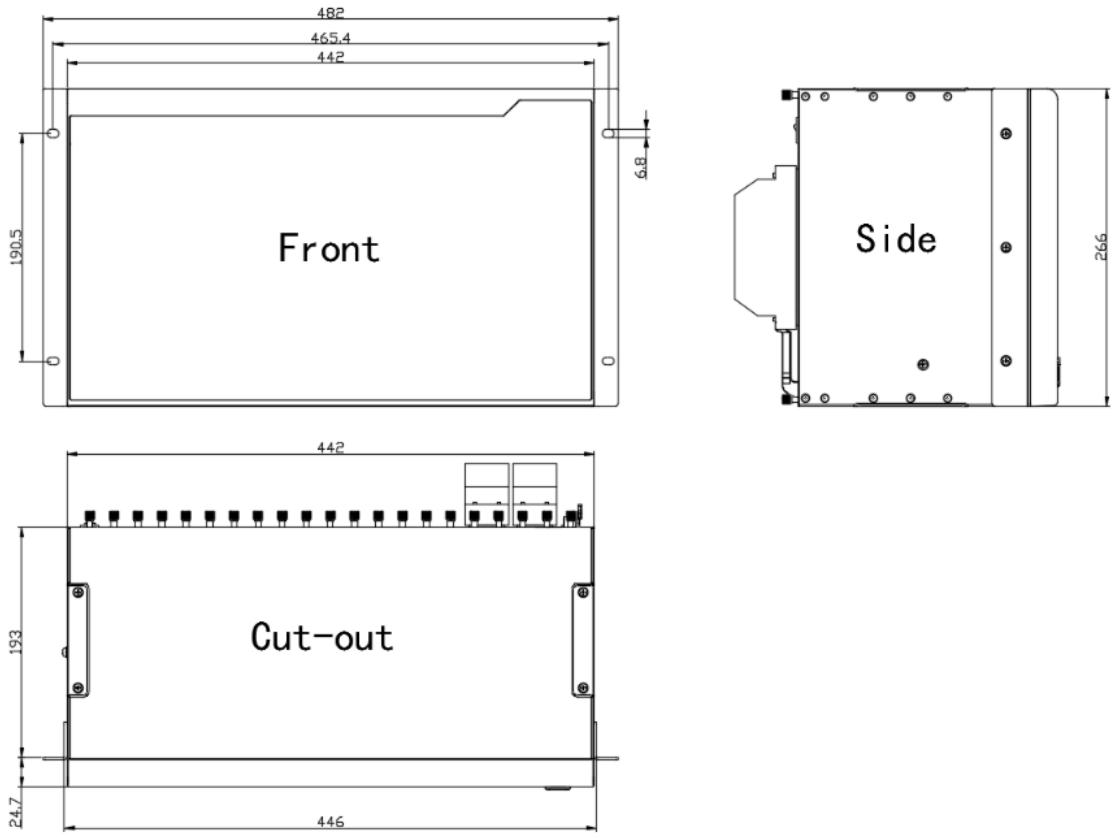


Figure 11.6.1 Dimensions of this relay and the cut-out in the cubicle (unit: mm)

11.7 Electrical Installation and Wiring

11.7.1 TA Circuit Connection

According to the wiring diagram of the device, connect the terminal block of rear AC module with the CT loop using multiple wires, of which the cross-sectional area should be 2.5 ~ 4.0mm^2.

11.7.2 Power Supply, TV, BI and BO, Signal Wiring

According to the wiring diagram of the device, connect the AC, Phoenix terminal of module and the terminal block in the cubicle side with multiple wires.

DC voltage power supply wiring power +, power - should be distinguish in different colors, for example power + (brown), power - (blue).

Power supply, binary inputs & outputs: stranded conductor, 1.0mm^2 ~ 2.5mm^2.

AC voltage inputs: stranded conductor, 1.5mm^2.

Grounding: braided copper cable, 2.5mm^2 ~ 6.0mm^2.

For wires connected to two points, there should be no joint in the middle, and the wire core should not be damaged. If the wire length is not enough during the process of wiring or rewiring, the worker must replace it. There should be no excess wire in the slot. If it is required to remove the wire, the whole wire must be completely removed.

When wiring the AC terminal of module, current and voltage wires must adopt 12mm size cable lug, to avoid loose contact. Strictly prohibit electric screwdriver, so as to avoid terminals damage.

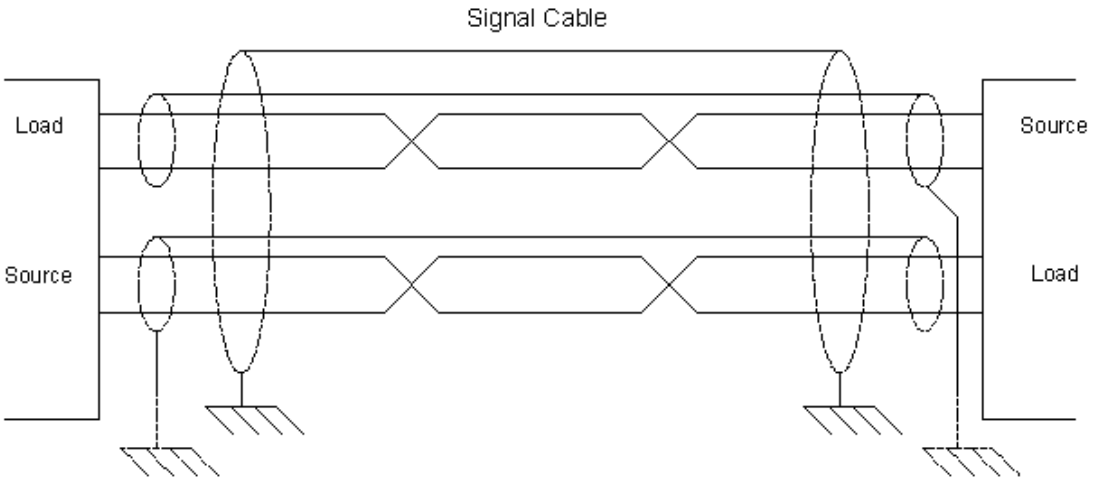
Attention! Never allow the current transformer (CT) secondary circuit connected to this equipment to be opened while the primary system is live. Opening the CT circuit will produce a dangerously high voltage.

11.7.3 Grounding

Use a yellow-green multi-core cable with a cross-section of at least 2.5 mm^2 to connect the grounded copper bars. The cubicle should reliably connected to the secondary ground network.

11.7.4 Shielded cable connection

When using a shielded cable, connect the shielded cable to ground and follow the engineering application method. This includes checking of the appropriate grounding point near the device, such as the grounding point inside the cubicle and the grounding point near the measurement source. Ensure a single shield connection a suitable short cross-sectional wire (maximum 10CM) for ground connection.



11.7.5 Install the optical cable

Care should be taken to handle the cable without substantial bending. The minimum curvature radius of the plastic optical fiber is 15 cm and the glass optical fiber is 25 cm. To use the cable clamp, a loose buffer sleeve should be used.

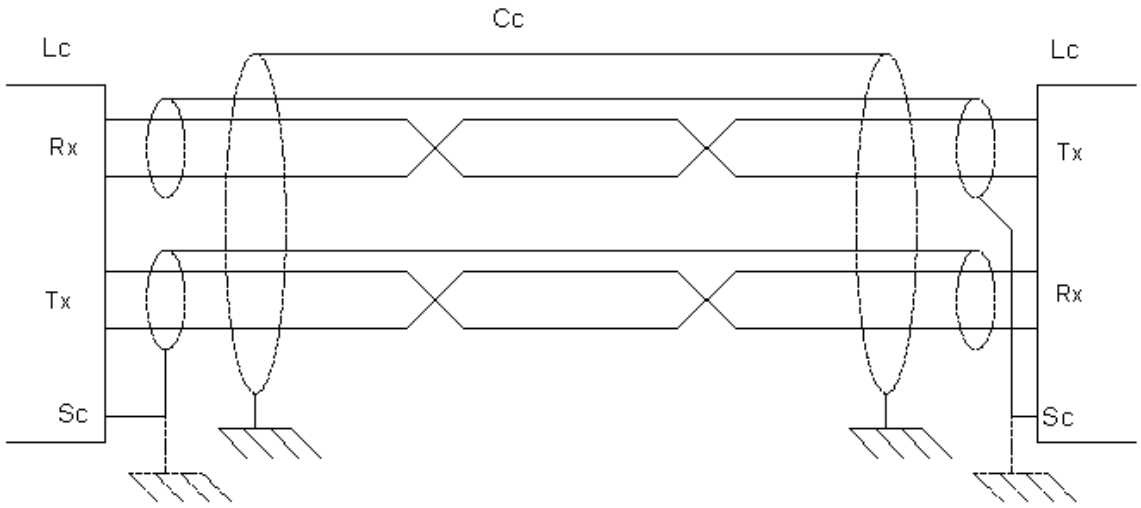
When connecting or removing the optical fiber, please take hold of the connection ends. Do not take the cable. Do not twist, stretch, bend the cable. Invisible damage can increase the attenuation of the fiber and can destroy the communication.

11.7.6 Install the communication cable

When using electrical connections between the protection device and the communication device, or point-to-point electrical connections between the two protection devices, it is important to install the cables carefully. Due to the low electrical level of communication signals, the factors

susceptible to noise interference must be considered.

The best way is to use shielded twisted pair(STP), one for each twisted pair and the other for the all twisted pairs for surround shielding. Each signal uses the twisted pair shown in the following figure to shield each individual twisted-pair cable by connecting its internal shielded cable to the device's ground connection or, alternatively, to a device near the signal transmitter Connected, at the receiving end, shielded line let it hang in the air, not connected with the ground. The outer shield surrounding all twisted pairs is physically connected near each end of the equipment.



Cc: communication cable

Lc: line connector

Rx: receive signal input

Tx: transmit signal output

Sc: shielded (grounding) connection

11.8 Installation check

11.8.1 Check the installation

Check that all terminal screws with external wiring are tightened, the wiring is neat, and all wiring labels are clearly defined.

11.8.2 Confirm the hardware and software version

Hardware and software version information is available on the device label. After the device is powered on, the software version can also be checked through the LCD interface.

11.8.3 Device start

if confirm that the wiring is correct during the installation check, you can supply device with power and start it.

Configuration file needs to read during device startup process. It needs a certain period of time for the startup process. The startup time is related to the size of configuration file. In general, the startup time is less than 1 minute.

The "HEALTHY" indicator lights up when the unit starts up normally. If a fault is detected during the startup procedure, the "ALARM" indicator is lit and the internal fault code, alarm information can be checked via LEDs.

12 Maintenance

12.1 Maintenance General

A strict and detailed laboratory test is carried out in the development and design of the relay device. All the relay devices are strictly tested according to national or international standards.

The relay device has powerful real-time self-check capability. However, during the long time running of the relay device, there is no real time supervision for the input terminals and output circuits. Therefore, some periodic tests should be done to ensure that the relay is functioning correctly and the external wiring is intact.

The maintenance of the relay device mainly includes the following two conditions:

- Regular testing;
- Failure maintenance

12.2 Regular Testing

Regular testing is to test the normal relay devices in a certain period of time, so as to find potential defects or failures and eliminate hidden dangers to ensure the healthy operation of the devices.

The regular testing cycle depends on a number of factors, such as the environment conditions, the complexity, etc. Advices of CYG are as the following:

- The relay device must be tested for the first time in the first year of operation, mainly including protection logic, AC circuit, tripping circuit and power supply circuit.
- A partial test should be carried out every 3 years, mainly including the inspection of the AC circuit and the tripping circuit.
- An overall test should be carried out every 6 year, mainly including the protection function logic, the AC circuit, the tripping and closing circuit, the power supply circuit.

12.3 Failure Maintenance

Failure maintenance refers to the maintenance of a faulty relay device.

12.3.1 Hardware Failure

1) Check whether the hardware is in trouble or not according to the device alarm signal.
2) visual check of the device
   - Check whether the device has obvious physical fault
   - If you can find a clear physical fault point of the device, please contact CYG for repair or replacement
3) Confirm the scope of the fault

- Check whether this fault is caused by an external circuit.
- Carry out the input and output test for the relay device by test instrument.
- If it is determined that the fault belongs to the relay device, please contact CYG for repair or replacement

12.3.2 Software Failure

1) Check whether the hardware is in trouble or not according to the device alarm signal.
2) Try to restart the device and check if the fault is recoverable if possible.
3) If the fault is not recoverable, please contact CYG for repair or replacement

12.4 Replace Failed Modules

If the failure is identified to be in the relay module and the user has spare modules, the user can replace the failed modules to recover the protection device.

Repair at the site should be limited to module replacement. Maintenance at the component level is not recommended.

Before replacement, the user should check that the replacement module has an identical module name and hardware type-form as the removed module. Furthermore, the replaced module should have the same software version. For the replaced analog input module and power supply module, it should be confirmed of the same ratings.

NOTICE!

After replacing modules, it must be checked that the same configuration is set before and after the replacement. If it is not the case, there is a danger of the unintended operation of switchgear taking place or of relay device not running correctly. Persons may also be in danger.

Units and modules must only be replaced while the power supply is switched off and only by appropriately trained and qualified personnel. Strictly observe the basic precautions to guard against electrostatic discharge.

Take anti-static measures such as wearing an earthed wrist band and placing modules on an earthed conductive mat when handling a module. Otherwise, the electronic components may suffer damage. After replacing the main CPU module, check the settings and configurations.

13 Decommissioning and Disposal

13.1 Decommissioning

13.1.1 Switching off

To switch off this relay, switch off the external miniature circuit breaker of the power supply.

13.1.2 Disconnecting cables

Disconnect the cables in accordance with the rules and recommendations made by relational department.

DANGER!

Before disconnecting the power supply cables that connected with the power supply module of this relay, make sure that the external miniature circuit breaker of the power supply is switched off.

DANGER!

Before disconnecting the cables that are used to connect analog input module with the primary CT and VT, make sure that the circuit breaker for the primary CT and VT is switched off.

13.1.3 Dismantling

The rack of this relay may now be removed from the system cubicle, after which the cubicles may also be removed.

DANGER!

When the station is in operation, make sure that there is an adequate safety distance to live parts, especially as dismantling is often performed by unskilled personnel.

13.2 Disposal

In every country there are companies specialized in the proper disposal of electronic waste.

NOTICE!

Strictly observe all local and national regulations when disposing of the device.

14 Manual Version History

In the current version of the instruction manual, several descriptions on existing features have been modified.

Table 13.2-1 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.
1.00	1.01	1.01	2015-05-21	Step value changed from 0.05 to 0.01 for [Time Multiplier] setting. Update the number of the binary inputs and binary outputs. Step value changed from 0.05 to 0.01 for [Time Multiplier] setting. Add the binary input hardware demo diagrams in the binary input tables. Update the description of IEC61850 dual-MMS Ethernet.
1.01	1.02	1.02	2016-01-24	Add parameters of fault location function. Output TEMP_RL is added Internal improvements. Update the configurable signals.
1.02	1.03	1.03	2016-8-16	Update the communication description. Update the mechanical specifications. Update the main CPU module picture. Update the setting list.
1.03	2.00	2.00	2017-12-6	Update the operation functions. Update Description of module configuration. Update AC module. Change the number of the binary inputs, binary outputs, DC inputs and DC output from 18 to 16. Update the picture of 1/1 19'' Terminal view and Module configuration example. Update the Instruction of 1/1 19'' panel configuration