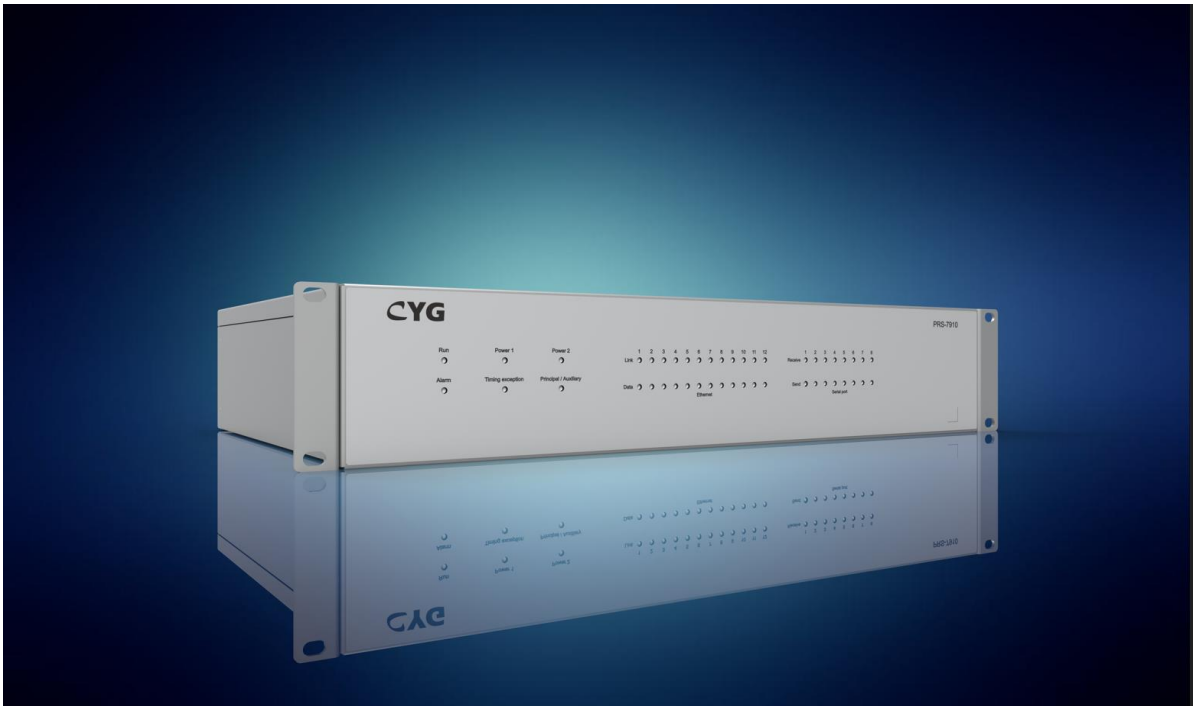


# PRS-7910

## Communication Gateway

### Instruction Manual



**CYG SUNRI CO., LTD.**



## **Preface**

### **Introduction**

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

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

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

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

### **Health and Safety**

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

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

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

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

Qualified personnel are individuals who:

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

### **Instructions and Warnings**

The following indicators and standard definitions are used:



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



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



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

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



**DANGER!**

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



**WARNING!**

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



**WARNING!**

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



**WARNING!**

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



**CAUTION!**

- **Earthing**

Securely earthed the earthing terminal of the device.

- **Operating environment**

**ONLY** use the device within the range of ambient environment and in an environment

free of abnormal vibration.

- **Ratings**

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

- **Printed circuit board**

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

- **External circuit**

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

- **Connection cable**

Carefully handle connection cables without applying excessive force.

**NOTICE!**

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

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The information in this manual is carefully checked periodically, and necessary corrections will be included in future editions. If nevertheless any errors are detected, suggestions for correction or improvement are greatly appreciated.

We reserve the rights to make technical improvements without notice.

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P/N: ZL\_PRS-7910\_X\_Instruction Manual\_EN\_Overseas General\_X

Version: 1.03

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## Documentation Structure

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 Introduction**

Briefly introduce the application, functions and features about this relay.

## **2 Technical Data**

Introduce the technical data about this relay, such as electrical specifications, mechanical specifications, ambient temperature and humidity range, communication port parameters, type tests, setting ranges and accuracy limits and the certifications that our products have passed.

## **3 Operation Theory**

Introduce a comprehensive and detailed functional description of all protective elements.

## **4 Supervision**

Introduce the automatic self-supervision function of this relay.

## **5 Management**

Introduce the management function (measurement and recording) of this relay.

## **6 Hardware**

Introduce the main function carried out by each module of this relay and providing the definition of pins 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 notes about the setting application.

## **8 Configurable Function**

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

## **9 Communication**

Introduce the communication port and protocol which this relay can support, IEC60970-5-103 and IEC61850 protocols are introduced in details.

## **10 Installation**

Introduce the recommendations on unpacking, handling, inspection and storage of this relay. A guide to the mechanical and electrical installation of this relay is also provided, incorporating earthing recommendations. A typical wiring connection to this relay is indicated.

## **11 Commissioning**

Introduce how to commission this relay, comprising checks on the calibration and functionality of

this relay.

## **12 Maintenance**

A general maintenance policy for this device is outlined.

## **13 Decommissioning and Disposal**

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

## **14 Manual Version History**

List the instruction manual version and the modification history records.





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# 1 Introduction

## 1.1 Application

The PRS-7910 is designed for the highest standards of performance, safety and reliability to meet requirements of a complex substation automation system (SAS). As the Communication Gateway of the SAS, it works as a station communication manager, which collects, stores and maps signals of relays, measurement units, control units and other IEDs in the substation to higher-level systems such as control center (CC) and distributed control system (DCS). AS the Protection Management of the SAS, it works as a station data protection manager, which acquires and stores events records, alarm records, protection analog, protection setting and connect to higher-level systems such as master protection management system (PMS).

The PRS-7910 supports several protocols, such as IEC 61850, IEC 60870-5-101/104, IEC 60870-5-103, Modbus and DNP3.0. Data can be transmitted to and received from analog channel, digital channel or network connected to CC, DCS, PMS or other system. The direct transmission mode and the device independent avoid any interaction or influence with the substation SCADA (Supervisory Control and Data Acquisition) system.

Furthermore, the PRS-7910 can run as a data acquisition and logic treatment platform and provides various and flexible advanced function extensions.

### **NOTICE!**

An additional protocol requirement besides the standard package can be customized, please declares the protocol requirement clearly in the technical agreement and the contract.

The PRS-7910 is applicable to:

- Power system

Conventional substation and digital substation of various voltage levels

New-build substation SAS implementation and old substation reconstruction or upgrade

- Industrial system

Industrial automation applications: mine, petrochemical industry, metallurgy, etc.

- Transport system

Subway, light-rail and electrified railway system

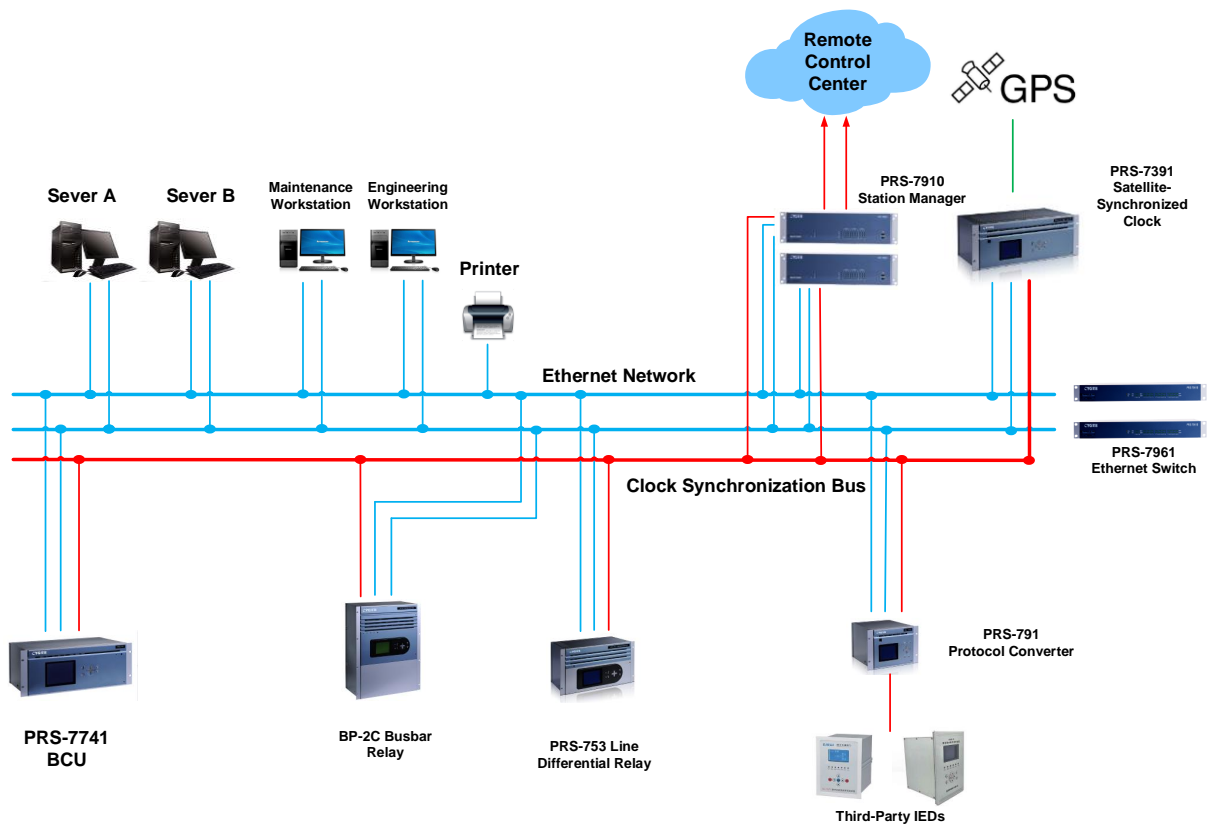


Figure 1.1.1 Typical Ethernet networking scheme



## 2 Technical Data

### 2.1 Power Supply

Standard	IEC 60870-2-1:1995
Rated voltage	110VDC/125VDC/220VDC, 220VAC
Operating range	85-265VDC, 85-265VAC
Frequency	50/60Hz

### 2.2 Communication interfaces

#### 2.2.1 Ethernet Port

For Station Level		
Medium	Parameters	
Ethernet Electrical	Port number	8
	Connector type	RJ-45
	Transmission rate	100Mbps/s
	Transmission standard	100Base-TX
	Transmission distance	≤ 100m
	Protocol	IEC60870-5-103, IEC61850, DNP 3.0 etc.
	Safety level	Isolation to ELV level

#### 2.2.2 Serial Port

Medium	Parameters	
RS-485 (EIA)	Port number	8
	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

#### 2.2.3 Time Synchronization

Medium	Parameters	
RS-485 (EIA)	Port number	1
	Transmission distance	≤ 500m
	Maximal capacity	32
	Timing standard	IRIG-B
	Accuracy	≤ 1ms
	Safety level	Isolation to ELV level
NTP	Accuracy	≤ 10ms
IEEE 1588	Accuracy	≤ 1ms

## 2.3 hardware configuration table

No.	Item	Parameter
1	CPU	Intel® Celeron® 2980U Processor (2 Cores, 2M Cache, 1.60 GHz)
2	Internal memory	4G DDR3L
3	Hard disk	128 GB or 256 GB SLC SATA electronic hard disk
4	Operating system	Linux debian 8.1 (kernel 3.16) or Ubuntu 16.04 (kernel 4.1)
5	Interface	3 USB2.0 interfaces. 6/12 RJ45, 10/100/1000M self-adaptive internet access. 8-channel RS232/485 serial port, in which, COM2-COM8 supports 232 parallel connection. 1-channel IEEE1588 time-check function and VGA interface.
6	Power supply	DC 110V/220V (85V-265V) . AC 220V (85-265V) , 50/60Hz.

## 2.4 Signal transmission quantity parameter

Maximum number of Measurement signals	51200
Maximum number of remote signals	65000
Maximum number of remote control signals	25600
Maximum number of remote pulse signals	4096
Maximum number of remote set signals	4096

## 2.5 Related technical conditions

Operating temperature range	-20° C ~ +70° C
Permissible humidity	5% ~ 95%
Atmospheric pressure	70kPa ~ 106kPa
Transport and storage temperature range	-40° C ~ +70° C
Electrostatic discharge test	IEC 60255-26:2013 IEC 61000-4-4:2008
Anti fast transient disturbance performance	IEC 60255-26:2013 IEC 61000-4-4:2012
Anti surge (impact) disturbance performance	IEC 60255-26:2013 IEC 61000-4-5:2005
Immunity to Conducted Disturbances included by radio-frequency field	IEC 60255-26:2013 IEC 61000-4-6:2008
Immunity to power frequency magnetic field	IEC 60255-26:2013 IEC 61000-4-8:2009
Immunity to pulsed magnetic field	IEC 61000-4-9:2001
Anti high frequency electrical interference performance	IEC 60255-27:2013
Immunity to Shockwave	IEC 60255-21-2:1988

	IEC 60068-2-27:2008
Insulation and voltage resistance	IEC 60255-27:2013
Heat and humidity resistance	IEC 60068-2-30:2005

## 2.6 Functions

The PRS-7910 is a powerful device, which can meet various requirements of different substations. It contains a full series of basic functions focus on substation automation, as well as a variety of advanced functions, which enhance the information transmission and management.

- **Relay information acquisition**

Through serial or Ethernet port, this device can communicate with protection relays to gather their information such as SOE records, tripping signals, supervision alarms, etc.

- **Measurement & control IED information acquisition**

Through serial or Ethernet port, this device can communicate with measurement & control IEDs and intelligent meters to gather their information such as sampled values, binary status, energy metering signals, etc. Meanwhile, control and regulation operation could be done.

- **Auxiliary IED information acquisition**

In addition, this device can gather information of other auxiliary devices, such as energy meter, which is useful or crucial for substation.

- **Remote control center communication**

This device can realize the communication with multiple remote control centers with different protocols. The mapping transmission tables for different centers can be customized independently.

- **Signal synthesis**

The signal synthesis function is supported with the help of the configuration tool PRS-COMM. Logical and mathematic operation of data such as AND, OR, NOT, XOR, +, -, x and ^ can be proceed for the transmission to remote control center.

- **Command record and query**

This device records all the commands and operations, which include control selection, control execution, regulation, setting modification selection, setting modification execution, signal reset, etc. All these records can be viewed and queried with filter.

- **History event record**

This device automatically records the events during its service, which include self running state change, alarm from connected IED, communication failure alarm, etc.

- **Double device redundancy strategy**

Several device redundancy strategies are supported. The 2 devices are completely electrically independent. Their power supplies, communication ports and programs run independently.

The inter-device exchange is realized by network connection.

- **Time synchronization**

This device provides both reception and transmission RS-485 ports for IRIG-B signal in order to synchronize connected IEDs and to unify their clocks in one substation. It supports several time synchronization formats, including IRIG-B, IEEE 1588 (PPS), NTP, etc. It supports full calendar support (including leap year).

- **On-line maintenance and monitoring**

This powerful function enables the engineer to monitor the running status of this device through network, including running information print, message display of Ethernet port and serial port, on-field configuration, database view, virtual measurement, file transmission, remote rebooting, etc. With all these advanced functions, the substation upgrade becomes convenient.

- **Self-diagnostic**

During service, the device keeps a full supervision on its software and hardware, once an abnormality is found, the device will be self-blocked to ensure no maloperation is conducted, meanwhile, an alarm will be sent out both digitally and hardware output as alarm. If the device is dual equipped, at this time, if the abnormal device is on-duty then it will not only block itself but also activate the backup device to take over all the tasks to ensure the substation is still running normally. Meanwhile, the storage memory is checked regularly. If the storage memory minimum threshold is reached, legacy data delete strategy will proceed automatically.

## 2.7 Features

- **High performance hardware architecture**

Dual 1.60 GHz CPUs, 2GB RAM, optional 128 ~256 GB SATA SSD storage memory

CPU usage < 25% during normal service; CPU usage < 50% during massive data treatment

Non-rotating storage is adopted to avoid vibration

A fully closed chassis with a complete panel

Completely separated spaces for electronic and electrical systems

Designed with anti-interference measures to enhance the device EMC.

- **Power supply redundancy**

Dual power supply module is an option. The extra power supply module will be placed at the other side of the device rack and works independently.

- **Real-time database**

The database is compatible with data model IEC 61850 and IEC 103

Support of multiple models including primary/secondary equipment model, association model, primary schematic diagram model, etc.

Full modeling view and data information

Unified data acquisition and transmission.

- **History database**

Embedded history database

Optional capacity: 128 ~256 GB SLC SATA

Multiple data storage types including historical SOE records, operation reports, wave files, etc.

- **Multiple communication protocol support**

Standard package for server: IEC 60870-5-101/104, DNP, Modbus

Standard package for client: IEC 60870-5-101/104, IEC 60870-5-103, DNP3.0 Serial, DNP3.0 LAN/WAN, DNP secure, Modbus serial, Modbus TCP/IP

Advanced package: IEC 61850 server & client

Customized package: Other customized protocol

- **Real-time data transmission**

Internal SOE transmission delay <100ms

- **Response to control center**

The response success rate from device to control center > 99%

- **Single-port multi-protocol**

A network interface can support multiple different communication protocols. This design allows the device to handle various data transmission methods and communication protocols simultaneously on the same network interface without requiring additional hardware or multiple ports.

- **Unified substation model transmission**

The data model transmission between substation and control center is realized by using the SCD file.

Support of most international standard protocols including IEC 60870-5-101/104, IEC 60870-5-103, DNP, IEC 61850, etc.

- **Powerful auxiliary configuration tool**

Highly integrated configuration functions

Full substation configuration support including project implementation, running, maintenance, analysis, diagnostic and debugging.

- **System scale**

Up to 1024 IEDs

Up to 32 control centers

Database > 200,000 signals

## 2.8 Mechanical Specifications

Mounting Way	Flush mounted	
Weight per device	1/1 19" Case: Approx.4.5kg	
Merchanical size (width×high×depth)	1/1 19" Case: 425mm×280mm×88.1mm	
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: IP40 Rear side, connection terminals: IP20 Other Sides: IP40

### 3 Operation Theory

#### 3.1 Software Structure

The PRS-7910 Communication Gateway applies embedded Linux operation platform. The modularization software design provides high flexibility and applicability.

The software structure is shown in following figure:

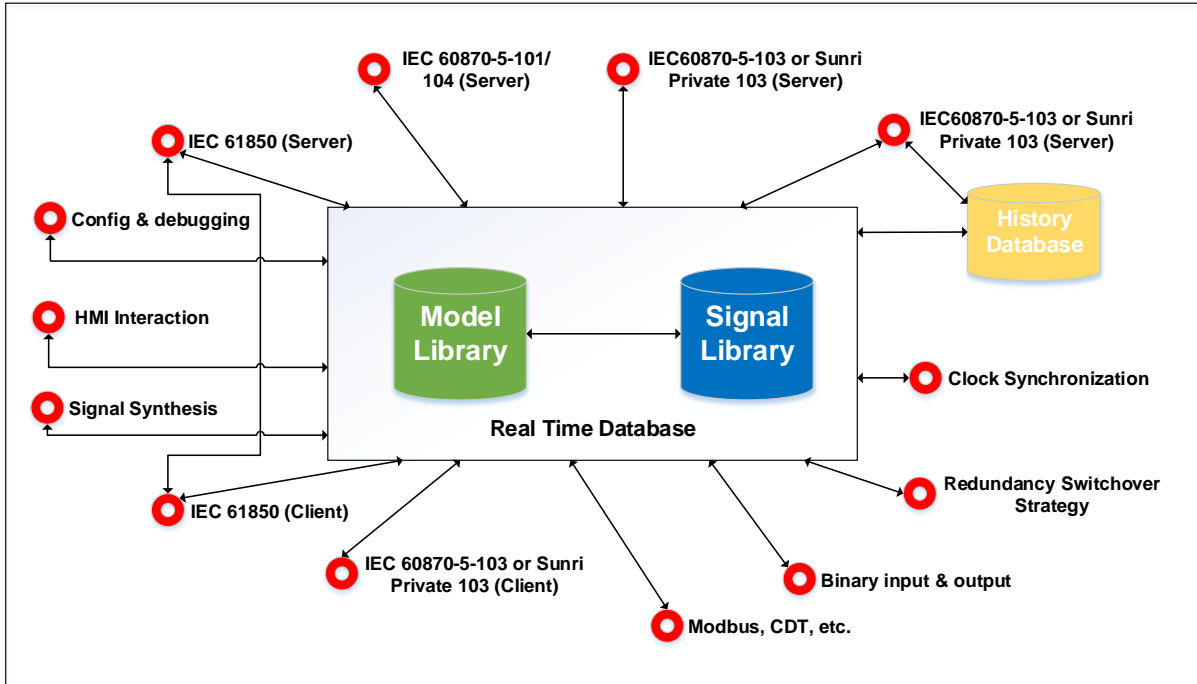


Figure 3.1.1 Software Module Design

#### 3.2 Software Module

Table 3.2.1 Software Module Description

Subsystem	Description
Real Time Database	For data acquisition (client) and transmission (server) Control/Regulation command from server will be stored inside.
History Database	For history data storage and query Periodic reading of the Real Time Database Could be the source of other application
Server Protocol	For communication to remote control center, distribution center, etc. Response to interrogation & Transmission of control command
Client Protocol	For communication to IED within the local substation Data acquisition from IED Processing of control command
Configuration & Debugging	Configuration offline & Debugging online with the help of PRS-COMM
HMI Interaction	For local manipulation, LCD display, LED indicators, to realize the supervision of running status, communication messages, parameters

Subsystem	Description
	& settings, project configuration, etc.
Binary input & output	For acquisition of binary input and programmable output contact
Time synchronization	For timing signal reception, decode and transmission
Signal Synthesis	For edition and analysis of synthesized signal
Redundancy Switchover Strategy	For device redundancy mode
Advanced Functions	For further advanced customized functions



## 4 Supervision

### 4.1 Overview

The PRS-7910 Communication Gateway is in quiescent state under normal conditions, and it is required to respond promptly for faults. When the device is in energizing process before the LED “HEALTHY” is on, the device need to be checked to ensure no abnormality. Therefore, the automatic supervision function, which checks the health of the protection system when startup and during normal operation, plays an important role.

This device based on the microprocessor operations is suitable for implementing this automatic supervision function of the system.

In case a defect is detected during initialization when power supply is provided to the device, the device will be blocked with indication and alarm of device out of service.

When a failure is detected by the automatic supervision, it is followed by a LCD message, LED indication and alarm contact outputs. The failure alarm is also recorded in event recording report and can be printed if required.

### 4.2 Supervision Alarms

Hardware circuit and operation status of the device are self-supervised continuously. If any abnormal condition is detected, information or report will be displayed and a corresponding alarm will be issued.

A minor abnormality may block a certain number of functions while the other functions can still work. However, if severe hardware failure or abnormality, such as PWR module failure, DC converter failure and so on, are detected, . The device then cannot work normally and maintenance is required to eliminate the failure. All the alarm signals and the corresponding handling suggestions are listed below.

**NOTICE!**

If the device is blocked or alarm signal is sent during operation, please do find out its reason with the help of self-diagnostic record. If the reason cannot be found at site, a trial recovery of the device by re-energization is suggested. Please contact the supplier if the device is still failure.

**Table 4.2.1 Front panel indicator**

Name	Definition	Colour
Run	After the device is powered on, the LED is lit. And the LED is turned off when the device is out of service or some functions don't work due to the hardware or software abnormality .	Green light
Power	After the device power supply 1 is powered on, the LED is lit. And the LED is turned off after	Green

supply 1	power failure.	light
Power supply 2	After the device power supply 2 is powered on, the LED is lit. And the LED is turned off after power failure.	Green light
Alarm	The LED will be lit when the hardware, software, or configuration is abnormal. It is turned off during normal operation, and the LED is not lit when the communication is interrupted and the timing is abnormal.	Red light
Time exception	When the service status is abnormal, the LED is lit, And when it is normal, it will be turned off.	Red light
Active and standby	the LED is lit when the device is used as a host. And the standby the LED is turned off.	Green light
Ethernet	When the link of the network port is normal, the corresponding link LED is lit. When there is a packet sending and receiving, the corresponding data LED flash.	Green light
Serial port	When a packet is received or sent, the receiving and sending LED of the corresponding serial port flash.	Green light

## 5 Management

### 5.1 Real Time Data Interrogation

This device can display the IO status, measurement & metering values, settings & parameters of the device itself and connected IEDs by the means of network interrogation.

#### 5.1.1 IO Status

Main Menu"-> "Database"->"Online"->"Status"

The status of binary inputs, output contacts, device alarms and network communication connection states can be interrogated and viewed in this category.

#### 5.1.2 Measurement

"MainMenu"-> "Database"->"Online"->"Measmt"

The measured values, including both AC & DC analog inputs, can be interrogated and viewed in this category.

#### 5.1.3 Tap Position

"MainMenu"-> "Database"->"Online"->"TP"

The transduced tap positions can be interrogated and viewed in this category.

#### 5.1.4 Metering

"MainMenu"-> "Database"->"Online"->"Metering"

The counted metering values can be interrogated and viewed in this category.

#### 5.1.5 IED Parameter

"MainMenu"-> "Database"->"Online"->"Grp No."

The setting group (especially for a protection relay) can be interrogated and viewed in this category.

#### 5.1.6 Setting Group

"MainMenu"-> "Database"->"Online"->"Grp No."

The setting group (especially for a protection relay) can be interrogated and viewed in this category.

#### 5.1.7 IED Setting

"MainMenu"-> "Database"->"Online"->"IED setting"

The settings can be interrogated and viewed in this category.

### 5.2 Event Recording

The device can store enormous SOE (Sequence of Events) records and device logs of this device itself and all the connected IED in its inner integrated history database. All the records are stored (separated by their different addresses and record groups) in non-volatile memory and follow the FIFO principle (First in First Out, when the available space is exhausted, the oldest record will be

automatically overwritten by the latest one).

### 5.2.1 SOE Records

#### ➤ IO Events

"MainMenu"-> "Database"->"Records"->"SOE Records"->"BI"

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.

#### ➤ Supervision Events

"MainMenu"-> "Database"->"Records"->"SOE Records"->"Alarm"

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

#### ➤ Disturbance Records

"MainMenu"-> "Database"->"Records"->"SOE Records"->"Op\_Element"

When any protection element operates or drops off, such as fault detector, distance protection, etc., they will be logged in disturbance records.

#### ➤ All the Records

"MainMenu"-> "Database"->"Records"->"SOE Records"->"All data types"

Select this item to view all the above records.

### 5.2.2 Operation Logs

"MainMenu"-> "Database"->"Records"->"Operation Logs"->"Control"

This menu contains all the manipulation logs of the connected IEDs, including control, regulation, setting modification, group number modification, virtual measurement/status, setting download, program download, configuration file download and miscellaneous event.

## 6 Security Features

- Integrated firewall
- Secure maintenance connection
- Secure SCADA protocol
- Port protocol filtering (enable/disable)

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## 7 Cyber Security

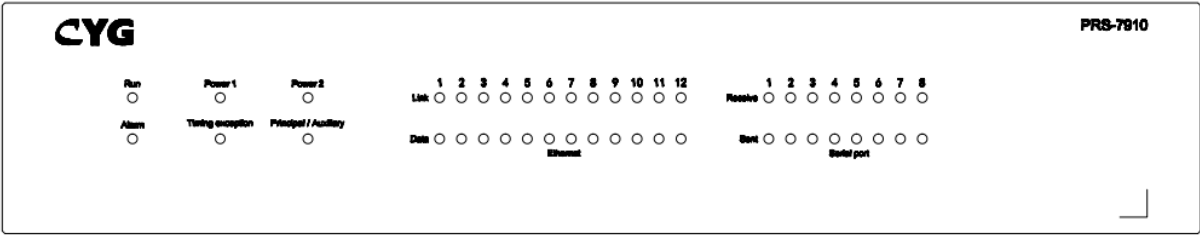
- Supports secure perimeter protected by encrypted communications
- User authorization
- Invalid password account lockout
- Secure SCADA communications and certificate-based authentication
- Signed firmware updates
- Malware protection
- Field-upgradable firmware to address technical and cybersecurity issues

# 8 Hardware

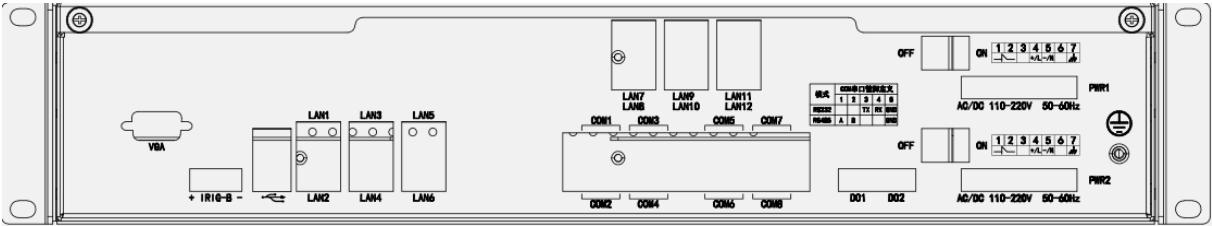
## 8.1 Overview

PRS-7910 communication unit comprises standard 2U half-level chassis. It adopts 32-bit dual-core high preference processor as its central unit for the communication management, database arrangement, advanced application, analysis and fault detection.

The PRS-7910 consists of high-performance built-in processor, FLASH, SRAM, SDRAM, Ethernet controller and other peripherals. Its functions include management of the complete device, human machine interface, communication and waveform recording, etc.



PRS-7910 Front Panel



PRS-7910 Back Panel

Mode	COM Serial Port Pin Definition				
	1	2	3	4	5
RS232			TX	RX	GND
RS485	A	B			GND

PRS-7910 Serial Port Definition

Figure 8.1.1 Terminal view example (2U 19" rack)

## 8.2 Human-Machine Interface

The device don't equip with LCD display. However, you use the specialized software Virtual LCD tool to connect to the device as shown below.

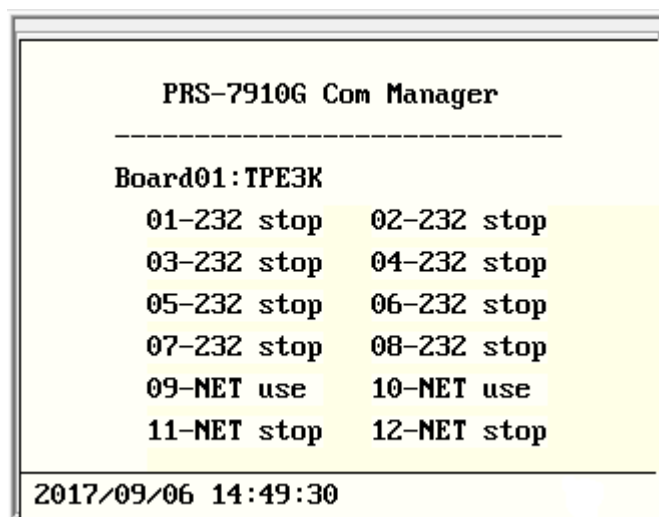


Figure 6.2.1 HMI view (Virtual LCD tool)

### 8.3 PWR Module (Power Supply)

The PWR module is a DC/DC or AC/DC converter with electrical insulation between the input and output. It has an input voltage range as described in the chapter 2. The tolerance of the output voltage for the electronic components is continuously monitored.

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. A 6-pin connector is fixed on the PWR module. The pin definition of the connector is described as below.

1	2	3	4	5	6	7
Power supply - normally closed			L/+	N/-		GND

Figure 6.3.1 PWR terminals

Table 6.3.1 Symbol description

Pin No.	Symbol	Description
01		Indication of power failure alarm 1
02		Indication of power failure alarm 2
03	NC	Not used
04	+/L	Positive pole of power supply for device/Live wire for AC power
05	-/N	Negative pole of power supply for device/Neutral line for AC power



Pin No.	Symbol	Description
06	NC	Not used
07	GND	Grounded connection of device

**NOTICE!**

The standard rated voltage of PWR module is 85~265VDC. For other non-standard rated voltage, please specify when placing order and check if the rated voltage of power supply module is the same as the voltage of power source before the device being put into service.

**NOTICE!**

The PWR module provides the terminal G and a grounding screw for device grounding. The terminal G shall be connected to grounding screw and then connected to the earth copper bar of panel via dedicated grounding wire.

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

**NOTICE!**

This device, like all electronic equipment's, 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 once a year.

**8.4 Interfaces**



**Figure 6.4.1 Interfaces**

➤ **Satellite Signal Receiver**

The CLK terminal receives and processes satellite signal. It converts satellite-timing signal into PPS or IRIG-B code and timing message and transmits them to the all modules via the internal bus.

The correct serial port wiring is shown in the following figure.

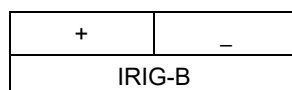
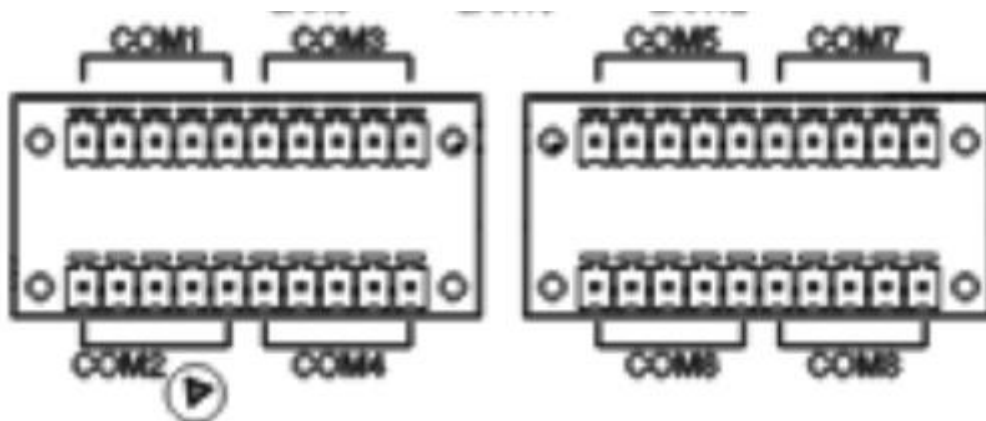


Figure 6.4.2 Wiring of synchronization port

➤ **Serial Ports**

The device provides several extension serial ports. The correct serial port wiring is shown in the following figure. Generally, a foiled cable with at least two pairs of twisted pairs shall be applied. One pair of the twisted pairs are respectively used to connect the transmission and reception terminals. The other pair of twisted pairs is used to connect the signal reference "SGND" of the communication interface. If there is a free terminal or a grounding terminal "FGND" for all the communication ports, it is suggested to connect the foiled layer of the cable when connecting multiple devices in series. The foiled layer connection of the cable shall be grounded at only one end.



Each serial port consists of 5 terminals, 2 terminals form 485 port, 3 terminals form 232 port, and it has adaptive serial port type function.

COM1					COM3					COM5					COM7				
485-	485-	232-	232-	GN	485-	485-	232-	232-	GN	485-	485-	232-	232-	GN	485-	485-	232-	232-	GN
A	B	TX	RX	D	a	b	TX	RX	D	a	b	TX	RX	D	a	b	TX	RX	D
485-	485-	232-	232-	GN	485-	485-	232-	232-	GN	485-	485-	232-	232-	GN	485-	485-	232-	232-	GN
a	b	TX	RX	D	a	b	TX	RX	D	a	b	TX	RX	D	a	b	TX	RX	D
COM2					COM4					COM6					COM8				

Table 6.4.3 Symbol & description (COM module)

### 8.5 Digital Output Ports

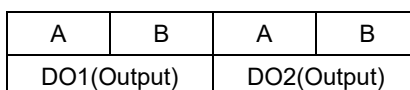
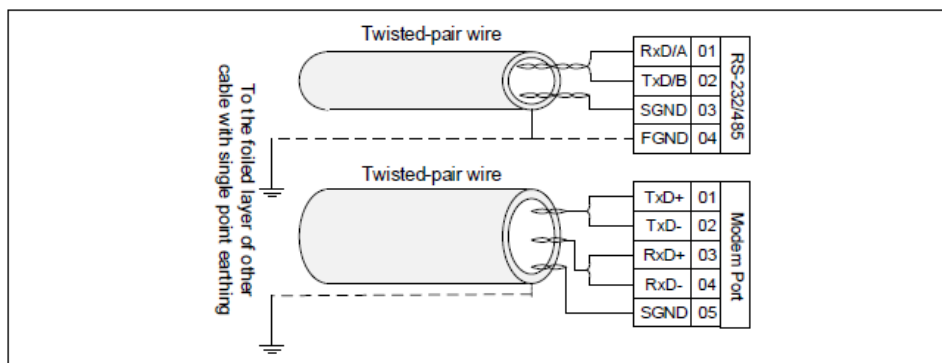


Figure 6.5.1 Output Ports

### 8.6 Optional Ports

The correct serial port wiring is shown in the following figure. Generally, a foiled cable with at least two pairs of twisted pairs shall be applied. One pair of the twisted pairs are respectively used to

connect the transmission and reception terminals. The other pair of twisted pairs is used to connect the signal reference "SGND" of the communication interface. If there is a free terminal or a grounding terminal "FGND" for all the communication ports, it is suggested to connect the foiled layer of the cable when connecting multiple devices in series. The foiled layer connection of the cable shall be grounded at only one end.



**Figure 6.6.1 Serial port wiring (MDM module)**

## 9 Settings

### 9.1 Overview

Setting configuration is an important function of device. The device normal operation depends in the correct setting configuration. Thus, only a qualified technician should be responsible for the configuration. Furthermore, if the device is operating abnormally, please check the setting configuration firstly.

#### **NOTICE!**

Setting configuration is an important function of device. The device normal operation depends in the correct setting configuration. Thus, only a qualified technician should be responsible for the configuration. Furthermore, if the device is operating abnormally, please check the setting configuration firstly.

### 9.2 Communication Settings

Access path: "Main Menu" -> "Settings" -> "Comm Settings" -> "IP"

No.	Item	Range	Description
1	Net** -IP**	000.000.000.000~255.255.255.255	The No.** IP address of No.** Ethernet port
2	Mask	000.000.000.000~255.255.255.255	The subnet mask of the corresponding Ethernet port

Access path: "Main Menu" -> "Settings" -> "Comm Settings" -> "MAC"

No.	Item	Range	Description
1	Net**	00:00:00:00:00:00~ff:ff:ff:ff:ff:ff	The hexadecimal Media Access Control Address of the corresponding Ethernet port

Access path: "Main Menu" -> "Settings" -> "Comm Settings" -> "Route"

No.	Item	Range	Description
1	Gateway	000.000.000.000~255.255.255.255	The IP address of local gateway
2	Destination	000.000.000.000~255.255.255.255	The destination network segment
3	Genmask	000.000.000.000~255.255.255.255	The opposite side's subnet mask

### 9.3 Identification Settings

Access path: "Main Menu" -> "Settings" -> "ID Settings"

No.	Item	Range	Description
1	Comm supervisor ID	0~999	The identification of this device in the network
2	Co-Dev ID	00 or 01	The identification of this device in dual-device mode

## 9.4 Password Settings

Access path: "Main Menu" -> "Settings" -> "ID Settings"

No.	Item	Range	Description
1	Password	0~999	The authority password of certain device critical manipulations.

## 10 Configurable Function

### 10.1 Overview

The PRS-COMM configuration and debugging tool is the auxiliary software designed for the PRS series communication devices (including remote terminal unit, communication gateway, protocol converter, and gateway) with offline configuration and online debugging functions.

The PRS series communication device is the new generation of communication device produced by CYG SUNRI on the research of integrated automation system and the site operation experience over years. The PRS-COMM configuration and debugging tool works as the associated auxiliary software is designed and developed on the basis of the object-oriented technology, the network-based database technology, the cross-platform visual technology and the latest industrial standards, which can fully support IEC60870-5-103, IEC61850 and other international standards and to meet the configuration and debugging demands of communication device in traditional substation, digitalized substation and power plant.

#### **NOTICE!**

For the detailed function instruction and operating procedure of the auxiliary software, please refer to "PRS-COMM Configuration and Debugging Tool Instruction Manual".

### 10.2 Function

The following functions are included:

- Configuration and management of IED in station: This tool can configure all the IEDs connected to the PRS series communication device. And in the same time, user can view the configurations of all the IED through this tool.
- Offline configuration function: The access and transfer rules of the PRS series communication device can be configured to meet the site requirements.
- Visual configuration of device: This graphical and symbolical tool is designed to facilitate the configuration of the PRS series communication device, most of the operations can be accomplished several clicks on the mouse.
- Online debugging function: This tool integrates the download and debugging functions. The configured scheme can be downloaded to the corresponding PRS series communication device, and the device status can be viewed and debugged online through the tool.

### 10.3 Application

The PRS-COMM configuration and debugging tool of the PRS series communication device is applicable to:

#### ➤ **Power system**

The integrated automation system of a new substation (traditional, digitalized, various voltage The renewal of integrated automation system of an existing substation (traditional, digitalized, various voltage levels)

➤ **Other systems**

The monitoring system of wind power station and photovoltaic power plant.

## **10.4 Event Recording**

### **10.4.1 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.

### **10.4.2 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.

### **10.4.3 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.

### **10.4.4 Device Logs**

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

### **10.4.5 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.

### **10.4.6 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.

# 11 Communication

## 11.1 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.

## 11.2 Rear Communication Port Information

### 11.2.1 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.

#### 11.2.1.1 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.

#### 11.2.1.2 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.



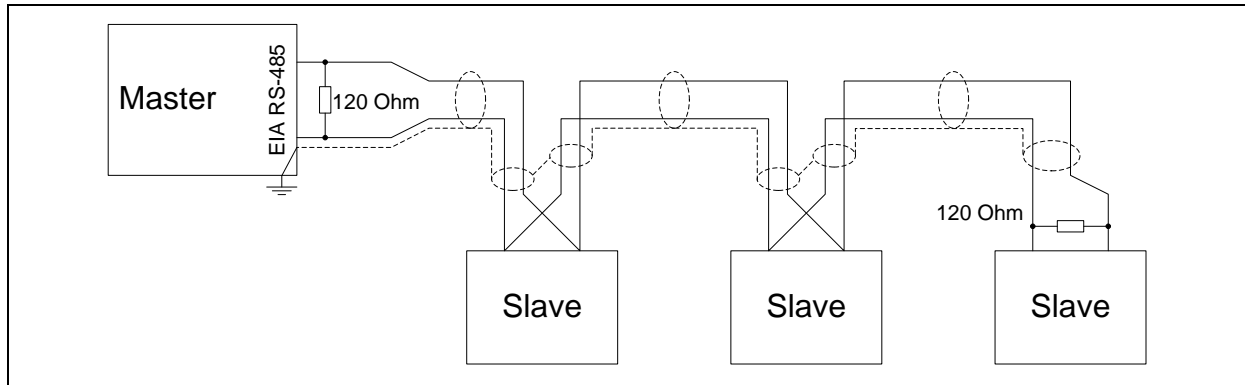


Figure 11.2.1 EIA RS-485 bus connection arrangements

### 11.2.1.3 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<sup>2</sup> 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.

### 11.2.1.4 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 120 $\Omega$  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, CYG 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.

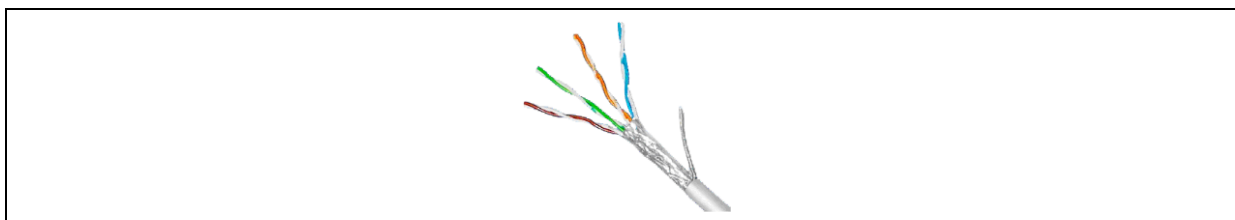
Ensure that the field voltage is not being used for other purposes (i.e. powering logic inputs) as this may cause noise to be passed to the communication network.

**11.2.2 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**”.

**11.2.2.1 Ethernet Standardized Communication Cable**

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



**Figure 11.2.2 Ethernet communication cable**

**11.2.2.2 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.

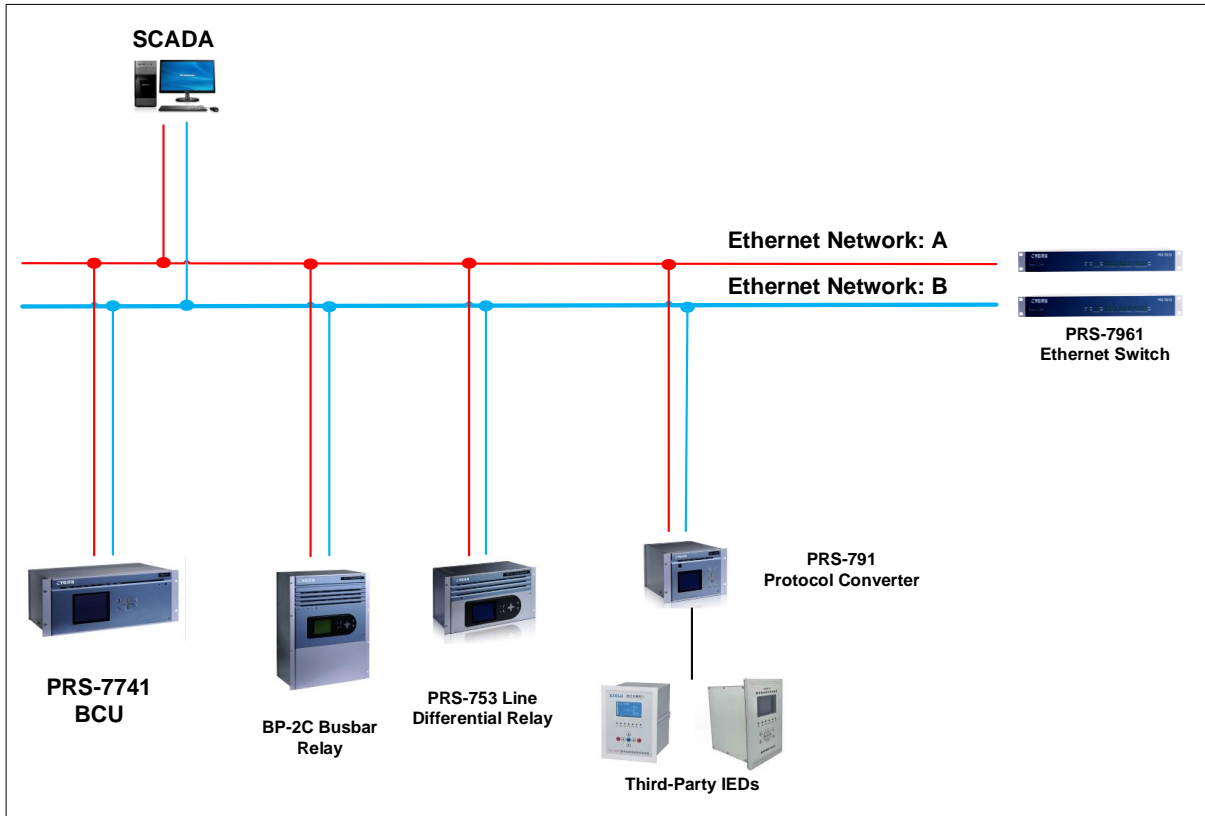


Figure 11.2.3 Ethernet communication structure

### 11.2.3 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.

### 11.2.4 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 supports serial and Ethernet network communication. This relay operates as a slave in the system, responding to commands from a master station.

### 11.2.5 IEC60870-5-101 Communication

The IEC specification IEC60870-5-101: Telecontrol equipment and systems Part 5: Transmission statute. Companion standard for basic telecontrol tasks. The standard configuration for the IEC60870-5-101 protocol is to use an RS-232 connection.

### 11.2.6 IEC60870-5-104 Communication

The IEC specification IEC60870-5-104: Telecontrol devices and systems Part 5: Transmission statute IEC 60870-5-101 network access using the standard set of transmission statutes. IEC60870-5-104 protocol uses Ethernet communication and supports TCP/IP protocol.

### 11.2.7 MODBUS Communication

MODBUS protocol supports serial and Ethernet communication. Serial communication uses RS-485 port connection, Ethernet communication uses TCP/IP protocol.

## 11.3 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

### 11.3.1 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.

### 11.3.2 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.

### 11.3.3 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.

#### 11.3.4 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"**.

#### 11.3.5 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.

#### 11.3.6 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"**.

#### 11.3.7 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**”.

## 11.4 Messages Description for IEC61850 Protocol

### 11.4.1 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.

### 11.4.2 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.

## 11.4.3 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.

### 11.4.3.1 Dual-net Full Duplex Mode Sharing the Same RCB Instance

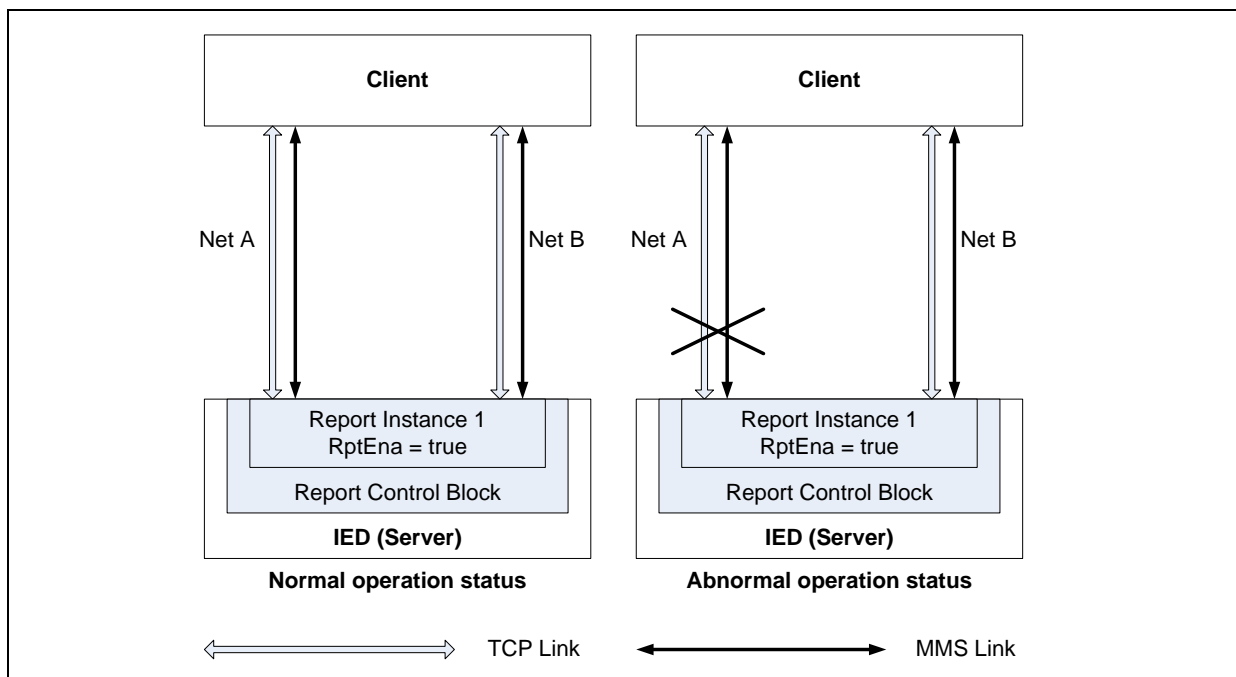


Figure 11.4.1 Dual-net full duplex mode sharing the RCB block instance

Net A and Net B share the same report control block (abbreviated as RCB) enabled by the client. IED sends undifferentiated data 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, data 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.



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

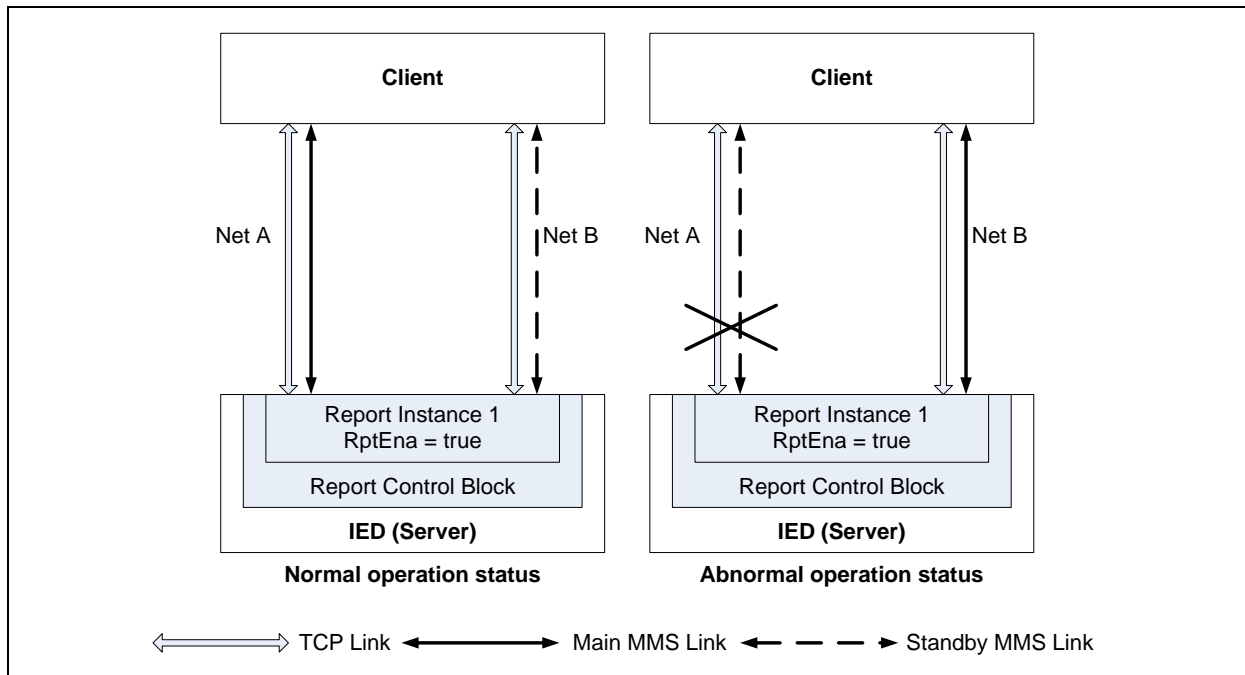


Figure 11.4.2 Dual-net hot-standby mode sharing the same RCB instance

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 =  $1 \times 256 + 2 = 258$ , Net B IED host address =  $1 \times 256 + 2 = 258$ , Net A IED host address equals to Net B IED host address.

### 11.4.3.3 Dual-net Full Duplex Mode with 2 Independent RCB Instances

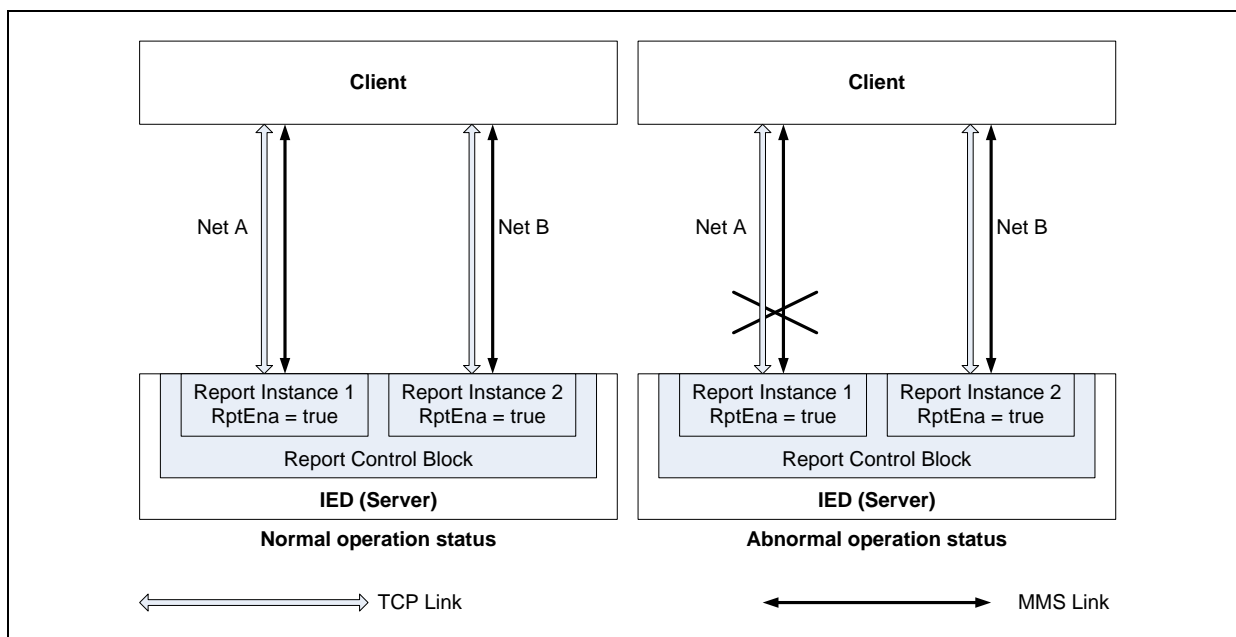


Figure 11.4.3 Dual-net full duplex mode with 2 independent RCB instances

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. Two 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 operate normally. To ensure no repeated data is saved into the 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.

### 11.4.4 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.

#### 11.4.4.1 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.

#### 11.4.4.2 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:

#### 11.4.4.3 Protection Logical Nodes

The following list describes the protection elements for PRS-7910 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.

#### 11.4.4.4 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:

## 11.4.5 Server Features and Configuration

### 11.4.5.1 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.**

### 11.4.5.2 File Transfer

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

### 11.4.5.3 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.

**11.4.5.4 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.

**11.4.5.5 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.

**11.4.6 ACSI Conformance**

**11.4.6.1 ACSI Basic Conformance Statement**

**Table 11.4.1 ACSI Basic Conformance Statement**

Services		Client	Server	PRS-7000 Series
<b>Client-Server Roles</b>				
<b>B11</b>	Server side (of Two-party Application-Association)	—	C1	Y
<b>B12</b>	Client side (of Two-party Application-Association)	C1	—	N
<b>SCSMS Supported</b>				
<b>B21</b>	SCSM: IEC 61850-8-1 used	Y	Y	Y

<b>B22</b>	SCSM: IEC 61850-9-1 used	N	N	N
<b>B23</b>	SCSM: IEC 61850-9-2 used	Y	N	Y
<b>B24</b>	SCSM: other	N	N	N
<b>Generic Substation Event Model (GSE)</b>				
<b>B31</b>	Publisher side	—	O	Y
<b>B32</b>	Subscriber side	O	—	Y
<b>Transmission Of Sampled Value Model (SVC)</b>				
<b>B41</b>	Publisher side	—	O	N
<b>B42</b>	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

#### 11.4.6.2 ACSI Models Conformance Statement

Table 11.4.2 ACSI Models Conformance Statement

Services		Client	Server	PRS-7000 Series
<b>M1</b>	Logical device	C2	C2	Y
<b>M2</b>	Logical node	C3	C3	Y
<b>M3</b>	Data	C4	C4	Y
<b>M4</b>	Data set	C5	C5	Y
<b>M5</b>	Substitution	O	O	Y
<b>M6</b>	Setting group control	O	O	Y
<b>Reporting</b>				
<b>M7</b>	Buffered report control	O	O	Y
<b>M7-1</b>	sequence-number	Y	Y	Y
<b>M7-2</b>	report-time-stamp	Y	Y	Y
<b>M7-3</b>	reason-for-inclusion	Y	Y	Y
<b>M7-4</b>	data-set-name	Y	Y	Y
<b>M7-5</b>	data-reference	Y	Y	Y
<b>M7-6</b>	buffer-overflow	Y	Y	N
<b>M7-7</b>	entryID	Y	Y	Y
<b>M7-8</b>	BufTm	N	N	N
<b>M7-9</b>	IntgPd	Y	Y	Y
<b>M7-10</b>	GI	Y	Y	Y
<b>M8</b>	Unbuffered report control	M	M	Y
<b>M8-1</b>	sequence-number	Y	Y	Y

<b>M8-2</b>	report-time-stamp	Y	Y	Y
<b>M8-3</b>	reason-for-inclusion	Y	Y	Y
<b>M8-4</b>	data-set-name	Y	Y	Y
<b>M8-5</b>	data-reference	Y	Y	Y
<b>M8-6</b>	BufTm	N	N	N
<b>M8-7</b>	IntgPd	N	Y	Y
<b>Logging</b>				
<b>M9</b>	Log control	O	O	N
<b>M9-1</b>	IntgPd	N	N	N
<b>M10</b>	Log	O	O	N
<b>GSE</b>				
<b>M12</b>	GOOSE	O	O	Y
<b>M13</b>	GSSE	O	O	N
<b>M14</b>	Multicast SVC	O	O	N
<b>M15</b>	Unicast SVC	O	O	N
<b>M16</b>	Time	M	M	Y
<b>M17</b>	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

**11.4.6.3 ACSI Services Conformance Statement**

**Table 11.4.3 ACSI Services Conformance Statement**

Services		Server/Publisher	PRS-7910
<b>Server</b>			
<b>S1</b>	ServerDirectory	M	Y
<b>Application association</b>			
<b>S2</b>	Associate	M	Y
<b>S3</b>	Abort	M	Y
<b>S4</b>	Release	M	Y
<b>Logical device</b>			
<b>S5</b>	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			
<b>S32</b>	QueryLogByTime	O	N
<b>S33</b>	QueryLogAfter	O	N
<b>S34</b>	GetLogStatusValues	O	N
Generic substation event model (GSE)			
GOOSE control block			
<b>S35</b>	SendGOOSEMessage	M	Y
<b>S36</b>	GetGoReference	O	Y
<b>S37</b>	GetGOOSEElementNumber	O	N
<b>S38</b>	GetGoCBValues	M	Y
<b>S39</b>	SetGoCBValuess	M	N
Control			
<b>S51</b>	Select	O	N
<b>S52</b>	SelectWithValue	M	Y
<b>S53</b>	Cancel	M	Y
<b>S54</b>	Operate	M	Y
<b>S55</b>	Command-Termination	O	Y
<b>S56</b>	TimeActivated-Operate	O	N
File transfer			
<b>S57</b>	GetFile	M/O	Y
<b>S58</b>	SetFile	O	N
<b>S59</b>	DeleteFile	O	N
<b>S60</b>	GetFileAttributeValues	M/O	Y
Time			
	SNTP	M	Y

### 11.4.7 Logical Nodes

#### 11.4.7.1 Logical Nodes Table

The PRS-7910 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.

## 11.5 DNP3.0 Interface

### 11.5.1 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.

### 11.5.2 Link Layer Functions

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

### 11.5.3 Transport Functions

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

### 11.5.4 Application Layer Functions

#### 11.5.4.1 Function Code

Table 11.5.1 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

#### 11.5.4.2 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

#### 11.5.4.3 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.

**11.5.4.4 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”.

**11.5.4.5 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 11.5.2 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.

**11.5.4.6 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).

#### **11.5.4.7 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).

#### **11.5.5 Cyber Security Capabilities**

Conforming to DNP3 Secure Authentication Specification Version 5 as specified in IEEE Std 1815 TM -2012

## 12 Commissioning

### 1.1 General

This relay is fully numerical in their design, implementing all protection and non-protection functions in software. The relay employs a high degree of self-checking and in the unlikely event of a failure, will give an alarm. As a result of this, the commissioning test does not need to be as extensive as with non-numeric electronic or electro-mechanical relays.

To commission numerical relays, it is only necessary to verify that the hardware is functioning correctly and the application-specific software settings have been applied to the relay.

Blank commissioning test and setting records are provided at the end of this manual for completion as required.

Before carrying out any work on the equipment, the user should be familiar with the contents of the safety and technical data sections and the ratings on the equipment's rating label.

### 12.1 Safety Instructions

#### **NOTICE!**

Current transformer secondary circuits **MUST** be short-circuited **BEFORE** the current leads to the device are disconnected.

Only qualified personnel should work on or in the vicinity of this device. The 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.

Particular attention must be drawn to the following:

- The earthing screw of the device must be connected solidly to the protective earth conductor before any other electrical connection is made.
- Hazardous voltages can be present on all circuits and components connected to the supply voltage or to the measuring and test quantities.
- Hazardous voltages can be present in the device even after disconnection of the supply voltage (storage capacitors!)
- The limit values stated in the technical data must not be exceeded at all, not even during testing and commissioning.
- When testing the device with secondary test equipment, make sure that no other measurement quantities are connected. Take also into consideration that the trip circuits and maybe also close commands to the circuit breakers and other primary switches are disconnected from the device unless expressly stated.

## 12.2 Commission Tools

Minimum equipment required:

- Multifunctional dynamic current and voltage injection test set with interval timer.
- Multimeter with suitable AC current range and AC/DC voltage ranges of 0~440V and 0~250V respectively.
- Continuity tester (if not included in the multimeter).
- Phase angle meter.
- Phase rotation meter.

### **NOTICE!**

Modern test set may contain many of the above features in one unit.

Optional equipment:

- An electronic or brushless insulation tester with a DC output not exceeding 500V (for insulation resistance test when required).
- A portable PC, with appropriate software (this enables the rear communications port to be tested, if this is to be used, and will also save considerable time during commissioning).
- EIA RS-485 to EIA RS-232 converter (if EIA RS-485 IEC60870-5-103 port is being tested).

## 12.3 Setting Familiarization

When commissioning this device for the first time, sufficient time should be allowed to become familiar with the method by which the settings are applied. A detailed description of the menu structure of this relay is contained in this manual.

With the front cover in place all keys are accessible. All menu cells can be read. The LED indicators and alarms can be reset. Protection or configuration settings can be changed, or fault and event records cleared. However, menu cells will require the appropriate password to be entered before changes can be made.

Alternatively, if a portable PC 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 PC software user manual for details. If the software is being used for the first time, allow sufficient time to become familiar with its operation.

## 12.4 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.

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.

This relay is fully numerical and the hardware is continuously monitored. Commissioning tests can be kept to a minimum and need only include hardware tests and conjunctive tests. The function tests are carried out according to user's correlative regulations.

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

#### Hardware tests

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.

### **12.4.1 With the Relay De-energized**

#### **12.4.1.1 Visual Inspection**

After unpacking the product, check for any damage to the relay case. If there is any damage, the internal module might also have been affected, contact the vendor. The following listed items are necessary.

- Protection panel

Carefully examine the protection panel, protection equipment inside and other parts inside to see that no physical damage has occurred since installation.

The rated information of other auxiliary protections should be checked to ensure it is correct for the particular installation.

- Panel wiring

Check the conducting wire which is used in the panel to assure that their cross section meeting the requirement.

Carefully examine the wiring to see that they are no connection failure exists.

- Label

Check all the isolator binary inputs, terminal blocks, indicators, switches and push buttons to make sure that their labels meet the requirements of this project.

- Equipment plug-in modules

Check each plug-in module of the equipment on the panel to make sure that they are well installed into the equipment without any screw loosened.

- Earthing cable

Check whether the earthing cable from the panel terminal block is safely screwed to the panel steel sheet.

- Switch, keypad, isolator binary inputs and push button

Check whether all the switches, equipment keypad, isolator binary inputs and push buttons work normally and smoothly.

#### **12.4.1.2 Insulation Test (if required)**

Insulation resistance tests are only necessary during commissioning if it is required for them to be done and they have not been performed during installation.

Isolate all wiring from the earth and test the isolation with an electronic or brushless insulation tester at a DC voltage not exceeding 500V, The circuits need to be tested should include:

- Voltage transformer circuits
- Current transformer circuits
- DC power supply
- Optic-isolated binary inputs
- Binary output contacts
- Electrical communication ports

The insulation resistance should be greater than 100MQ at 500V.

Test method:



To unplug all the terminals sockets of this relay, and do the insulation resistance test for each circuit above with an electronic or brushless insulation tester.

On completion of the insulation resistance tests, ensure all external wiring is correctly reconnected to the protection.

#### **12.4.1.3 External Wiring**

Check that the external wiring is correct to the relevant relay diagram and scheme diagram. Ensure as far as practical that phasing/phase rotation appears to be as expected.

Check the wiring against the schematic diagram for the installation to ensure compliance with the customer's normal practice.

#### **12.4.1.4 Auxiliary Power Supply**

The relay only can be operated under the auxiliary power supply depending on the relay's nominal power supply rating.

The incoming voltage must be within the operating range specified above, before energizing the relay, measure the auxiliary supply to ensure it within the operating range.

Other requirements to the auxiliary power supply are specified above. See this section for further details about the parameters of the power supply.

#### **NOTICE!**

Energize this relay only when the power supply is within the specified operating ranges.

### **12.4.2 With the Relay Energized**

The following groups of checks verify that the relay hardware and software is functioning correctly and should be carried out with the auxiliary supply applied to the relay.

The current and voltage transformer connections must remain isolated from the relay for these checks. The trip circuit should also remain isolated to prevent accidental operation of the associated circuit breaker.

#### **12.4.2.1 Front Panel LCD Display temperatures.**

For this purpose, this relay has an automatic "LCD contrast" adjusting feature, which is capable to adjust LCD contrast automatically according to the ambient brightness.

Connect the relay to DC power supply correctly and turn the relay on. Check program version and forming time displayed in command menu to ensure that are corresponding to what ordered.

#### **12.4.2.2 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".

In the event of the auxiliary supply failing, with a super capacitor (ultra capacitor) fitted on CPU

board, the time and date will be maintained. Therefore when the auxiliary supply is restored the time and date will be correct and not need to set again.

To test this, remove the auxiliary supply from the relay for approximately 30s. After being re-energized, the time and date should be correct.

**12.4.2.3 Light Emitting Diodes (LEDs)**

On power up, the green LED “HEALTHY” should have illuminated and stayed on indicating that the relay is healthy.

The relay has latched signal relays which remember the state of the trip, auto-reclose when the relay was last energized from an auxiliary supply. Therefore these indicators may also illuminate when the auxiliary supply is applied. If any of these LEDs are on then they should be reset before proceeding with further testing. If the LED successfully reset, the LED goes out. There is no testing required for that that LED because it is known to be operational.

It is likely that alarms related to voltage transformer supervision will not reset at this stage.

**12.4.2.4 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.

**12.4.2.5 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.

**12.4.2.6 Test the AC Current Inputs**

This test verifies that the accuracy of current measurement is within the acceptable tolerances. Apply current equal to the current transformer secondary winding rating to each current transformer input of the corresponding rating in turn, see the following table or external connection diagram for appropriate terminal numbers, checking its magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the relays menu.

The current measurement accuracy of the relay is  $\pm 2.5\%$ . However an additional allowance must be made for the accuracy of the test equipment being used.

Current channel linearity and precision checkout

**Table 12.4.1 Current channel checkout**

Item	Practical Input	Measurement (on LCD)	Error
la			

Item	Practical Input	Measurement (on LCD)	Error
lb			
lc			
I01			
I02			
I0s			

**12.4.2.7 Test the AC Voltage Inputs**

This test verifies that the accuracy of voltage measurement is within the acceptable tolerances.

Apply rated voltage to each voltage transformer input in turn; checking its magnitude using a multimeter/test set readout. The corresponding reading can then be checked in the relays menu.

The voltage measurement accuracy of the relay is  $\pm 0.5\%$ . However an additional allowance must be made for the accuracy of the test equipment being used.

Voltage channel linearity and precision checkout

**Table 12.4.2 Voltage channel checkout**

Item	Practical Input	Measurement (on LCD)	Error
Ua			
Ub			
Uc			
U0			
Ux			

**12.4.2.8 Test the Binary Inputs**

This test checks that all the binary inputs on the relay are functioning correctly.

The binary inputs should be energized one at a time, see external connection diagrams for terminal numbers.

Ensure that the voltage applied on the binary input must be within the operating range.

The status of each binary input can be viewed using the submenu “Contact Inputs” and “Prot Inputs”.

Binary inputs testing checkout

Table 12.4.3 Binary inputs checkout

BI Name	State without energized	State with energized	Correct?

### 12.4.3 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.

However, these checks can only be carried out if there are no restrictions preventing the tenderization of the plant being protected.

Remove all test leads, temporary shorting leads, etc. and replace any external wiring that has been removed to allow testing.

If it has been necessary to disconnect any of the external wiring from the protection in order to perform any of the foregoing 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.

#### 12.4.3.1 Final Checks

After the above tests are completed, remove all test or temporary shorting leads, etc. If it has been necessary to disconnect any of the external wiring from the protection in order to perform the wiring verification tests, it should be ensured that all connections are replaced in accordance with the relevant external connection or scheme diagram.

Ensure that the protection has been restored to service.

If the protection is in a new installation or the circuit breaker has just been maintained, the circuit breaker maintenance and current counters should be zero. 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.

## 13 Installation

### 13.1 General

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.

### 13.2 Safety Instructions

Modules and units may only be replaced by correspondingly trained personnel. Always observe the basic precautions to avoid damage due to electrostatic discharge when handling the equipment.

In certain cases, the settings have to be configured according to the demands of the engineering configuration after replacement. It is therefore assumed that the personnel who replace modules and units are familiar with the use of the operator program on the service PC.



#### **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.

#### **NOTICE!**

Industry packs and ribbon cables may **ONLY** be replaced on a workbench for electronic equipment. Electronic components are sensitive to electrostatic discharge when not in the unit's housing.

#### **NOTICE!**

Jumper links may **ONLY** be changed on a workbench for electronic equipment. Electronic components are sensitive to electrostatic discharge when not in the unit's housing.

#### **NOTICE!**

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. Do not wear a grounded wristband, however, while inserting or withdrawing units.
- Always store and ship the electronic boards in their original packing. Place electronic parts in electrostatic screened packing materials.

### 13.3 Checking the Shipment

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.

If the equipment is not going to be installed immediately, store all the parts in their original packing in a clean dry place at a moderate temperature. The humidity at a maximum temperature and the permissible storage temperature range in dry air are listed in Section 2.1.3.

### 13.4 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).

### 13.5 Device Location and Ambient Conditions

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.

Since every piece of technical equipment can be damaged or destroyed by inadmissible ambient conditions, such as:

1. The location should not be exposed to excessive air pollution (dust, aggressive substances).
2. Severe vibration, extreme changes of temperature, high levels of humidity, surge voltages of high amplitude and short rise time and strong induced magnetic fields should be avoided as far as possible.
3. Air must be allowed to circulate freely around the equipment.

The equipment can in principle be mounted in any attitude, but it is normally mounted vertically (visibility of markings).

**NOTICE!**

Excessively high temperature can appreciably reduce the operating life of this device.

**13.6 Mechanical Installation**

This relay is made of a single layer 2U height 19" chassis with 8 connectors on its rear panel. The following figure shows the dimensions of this relay for reference in mounting.

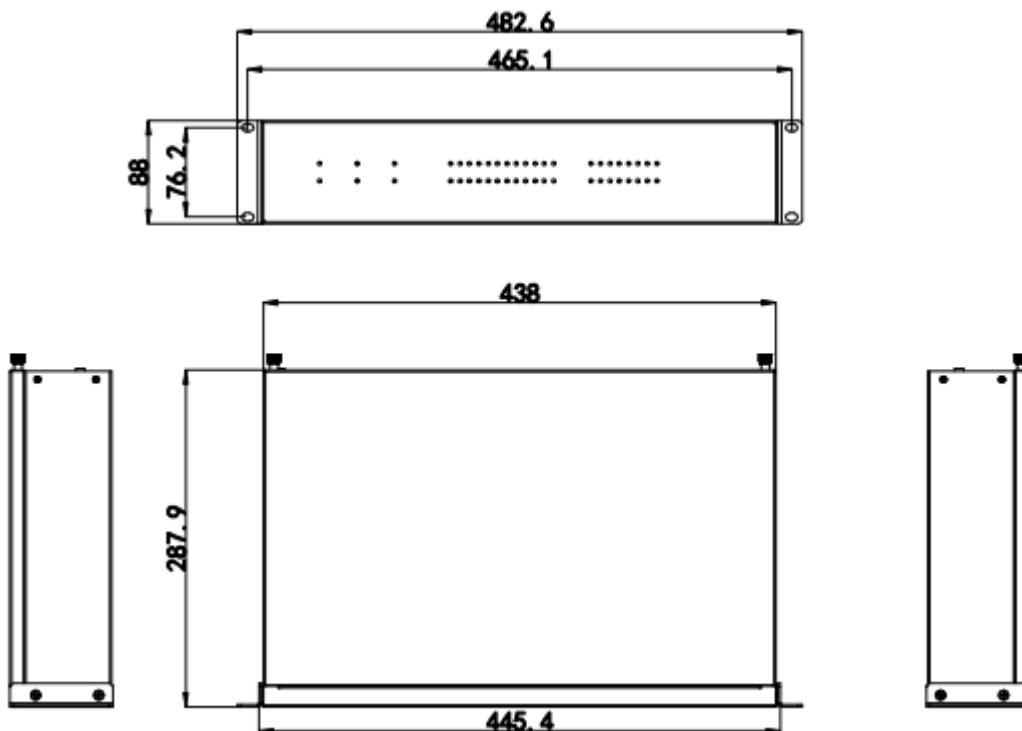


Figure 13.6.1 Dimensions of this relay (2U 19" rack) and the cut-out in the cubicle (unit: mm)

**NOTICE!**

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

As mentioned in Chapter 6, up to eight modules are installed in the enclosure of this relay, and these modules must be plugged into the proper slots of this relay respectively. The safety instructions must be abided by when installing the boards, please see Section 11.2 for the details.

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.

## 13.7 Electrical Installation and Wiring

### 13.7.1 Grounding Guidelines

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.

Switching operations in HV installations generate transient over voltages on control signal cables. There is also a background of electromagnetic RF fields in electrical installations that can induce spurious currents in the devices themselves or the leads connected to them.

All these influences can influence the operation of electronic apparatus.

On the other hand, electronic apparatus can transmit interference that can disrupt the operation of other apparatus.

In order to minimize these influences as far as possible, certain standards have to be observed with respect to grounding, wiring and screening.

#### **NOTICE!**

All these precautions can only be effective if the station ground is of good quality.

### 13.7.2 Cubicle Grounding

The cubicle must be designed and fitted out such that the impedance for RF interference of the ground path from the electronic device to the cubicle ground terminal is as low as possible.

Metal accessories such as side plates, blanking plates etc., must be effectively connected surface-to-surface to the grounded frame to ensure a low-impedance path to ground for RF interference. The contact surfaces must not only conduct well, they must also be non-corroding.

#### **NOTICE!**

If the above conditions are not fulfilled, there is a possibility of the cubicle or parts of it forming a resonant circuit at certain frequencies that would amplify the transmission of interference by the devices installed and also reduce their immunity to induced interference.

Movable parts of the cubicle such as doors (front and back) or hinged equipment frames must be effectively grounded to the frame by three braided copper strips (see Figure below).

The metal parts of the cubicle housing and the ground rail are interconnected electrically conducting and corrosion proof. The contact surfaces shall be as large as possible.

#### **NOTICE!**

For metallic connections please observe the voltage difference of both materials according to the electrochemical code.

The cubicle ground rail must be effectively connected to the station ground rail by a grounding strip (braided copper).



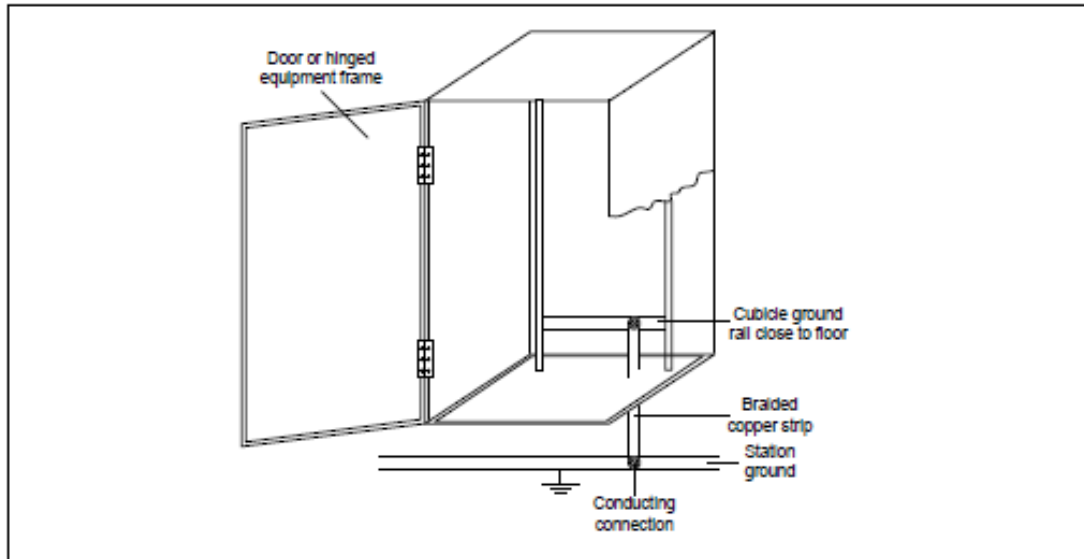


Figure 13.7.1 MD\_SOPT settings

### 13.7.3 Ground Connection on the Device

There is a ground terminal on the rear panel, and the ground braided copper strip can be connected with it. Take care that the grounding strip is always as short as possible. The main thing is that the device is only grounded at one point. Grounding loops from unit to unit are not allowed.

There are some ground terminals on some connectors of this relay, and the sign is "GND". All the ground terminals are connected in the cabinet of this relay.

### 13.7.4 Grounding Strips and their Installation

High frequency currents are produced by interference in the ground connections and because of skin effect at these frequencies, only the surface region of the grounding strips is of consequence.

The grounding strips must therefore be of (preferably tinned) braided copper and not round copper conductors, as the cross-section of round copper would have to be too large.

Proper terminations must be fitted to both ends (press/pinch fit and tinned) with a hole for bolting them firmly to the items to be connected.

The surfaces to which the grounding strips are bolted must be electrically conducting and non-corroding.

The following figure shows the ground strip and termination.

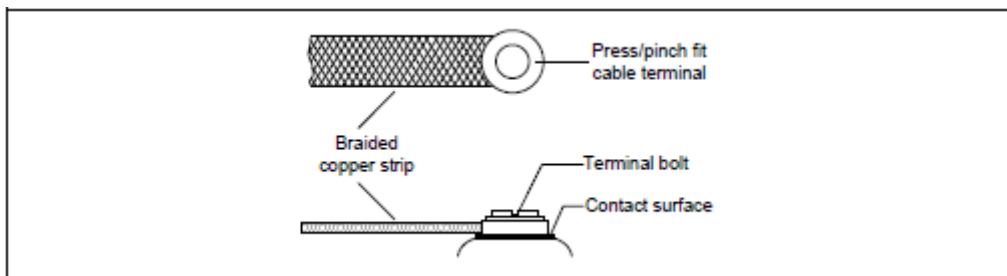


Figure 13.7.2 Ground strip and termination

### 13.7.5 Guidelines for Wiring

There are several types of cables that are used in the connection of this relay: braided copper cable, serial communication cable etc. Recommendation of each cable:

- Grounding: braided copper cable, 2.5mm<sup>2</sup> ~ 6.0mm<sup>2</sup>
- Power supply, binary inputs & outputs: stranded conductor, 1.0mm<sup>2</sup> ~ 2.5mm<sup>2</sup>
- AC voltage inputs: stranded conductor, 1.5mm<sup>2</sup>
- AC current inputs: stranded conductor, 2.5mm<sup>2</sup> ~ 4.0mm<sup>2</sup>. If the 4.0mm<sup>2</sup> lead is selected, only the dedicated terminal cable lug provided by SUNRI can be adopted.
- Serial communication: 4-core shielded braided cable
- Ethernet communication: 4-pair screened twisted category 5E cable

### 13.7.6 Wiring for Electrical Cables

A female connector is used for connecting the wires with it, and then a female connector plugs into a corresponding male connector that is in the front of one board.



**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.

## **14 Maintenance**

### **14.1 Maintenance Schedule**

It is recommended that products supplied by CYG receive periodic monitoring after installation. In view of the critical nature of protective relays and their infrequent operation, it is desirable to confirm that they are operating correctly at regular intervals.

This relay is self-supervised and so requires less maintenance than earlier designs of relay. Most problems will result in an alarm so that remedial action can be taken. However, some periodic tests should be done to ensure that the relay is functioning correctly and the external wiring is intact.

### **14.2 Regular Testing**

The relay is almost completely self-supervised. The circuits which can not be supervised are binary input, output circuits and human machine interfaces. Therefore regular testing can be minimized to checking the unsupervised circuits.

### **14.3 Failure Tracing and Repair**

Failures will be detected by automatic supervision or regular testing.

When a failure is detected by supervision, a remote alarm is issued and the failure is indicated on the front panel with LED indicators and LCD display. It is also recorded in the alarm record. Failures detected by supervision are traced by checking the history alarm reports through the HMI. See Section 8.3.2 for the details of the alarm events.

When a failure is detected during regular testing, confirm the following:

- Test circuit connections are correct
- Modules are securely inserted in position
- Correct DC power voltage is applied
- Correct AC inputs are applied
- Test procedures comply with those stated in the manual

### **14.4 Replace Failed Modules**

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

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

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. And

the replaced analog input module and power supply module should have the same ratings.

**NOTICE!**

After replacing modules, be sure to check that the same configuration is set as before the replacement. If this is not the case, there is a danger of the unintended operation of switchgear taking place or of protections not functioning correctly. Persons may also be put in danger.

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

When handling a module, take anti-static measures such as wearing an earthed wrist band and placing modules on an earthed conductive mat. Otherwise, many of the electronic components could suffer damage. After replacing the main CPU module, check the settings.

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## 15 Decommissioning and Disposal

### 15.1 Decommissioning

#### 15.1.1 Switching off

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

#### 15.1.2 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.

#### 15.1.3 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.

### 15.2 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.

## 16 Manual Version History

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

**Table 15.2.1 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	<p>Step value changed from 0.05 to 0.01 for [Time Multiplier] setting.</p> <p>Update the number of the binary inputs and binary outputs.</p> <p>Step value changed from 0.05 to 0.01 for [Time Multiplier] setting.</p> <p>Add the binary input hardware demo diagrams in the binary input tables.</p> <p>Update the description of IEC61850 dual-MMS Ethernet.</p>
1.01	1.02	1.02	2016-01-24	<p>Add parameters of fault location function.</p> <p>Output TEMP_RL is added Internal improvements.</p> <p>Update the configurable signals.</p>
1.02	1.03	1.03	2016-8-16	<p>Update the communication description.</p> <p>Update the mechanical specifications.</p> <p>Update the main CPU module picture.</p> <p>Update the setting list.</p>
1.05	1.05	1.05	2018-8-20	<p>Add hardware configuration table</p> <p>Add Signal transmission quantity parameter</p>
1.05	1.05	1.05	2018-8-24	Motify model PRS-7910G to PRS-7910