

**PCS-9799**  
**Station Manager**  
**Instruction Manual**

**NR Electric 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 NR 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 chapter 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!**

It means that death, severe personal injury, or considerable equipment damage will occur if safety precautions are disregarded.



**WARNING!**

It means that death, severe personal, or considerable equipment damage could occur if safety precautions are disregarded.



**CAUTION!**

It means that light personal injury or equipment damage may occur if safety precautions are disregarded. This particularly applies to damage to the device and to resulting damage of the protected equipment.



**WARNING!**

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.



**WARNING!**

During operation of electrical equipment, certain parts of these devices are under high voltage. Severe personal injury or significant equipment damage could result from improper behavior.

Only qualified personnel should work on this equipment or in the vicinity of this equipment. These personnel must be familiar with all warnings and service procedures described in this manual, as well as safety regulations.

In particular, the general facility and safety regulations for work with high-voltage equipment must be observed. Noncompliance may result in death, injury, or significant equipment damage.



**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!**

- **Exposed terminals**

Do not touch the exposed terminals of this equipment while the power is on, as the high voltage generated is dangerous

- **Residual voltage**

Hazardous voltage can be present in the DC circuit just after switching off the DC power supply. It takes a few seconds for the voltage to discharge.

**CAUTION!**

- **Earth**

The earthing terminal of the equipment must be securely earthed.

- **Operating environment**

The equipment must only be used within the range of ambient environment detailed in the specification and in an environment free of abnormal vibration.

- **Ratings**

Before applying AC voltage and current or the DC power supply to the equipment, check that they conform to the equipment ratings.

- **Printed circuit board**

Do not attach and remove printed circuit boards when DC power to the equipment is on, as this may cause the equipment to malfunction.

- **External circuit**

When connecting the output contacts of the equipment to an external circuit, carefully check the supply voltage used in order to prevent the connected circuit from overheating.

- **Connection cable**

Carefully handle the connection cable without applying excessive force.

## Documentation Structure

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

All contents provided by this manual are summarized as below:

### 1 Introduction

Brief introduction of the application, functions and features

### 2 Technical Data

Lists of the technical data such as electrical specifications, mechanical specifications, ambient temperature and humidity range, communication port parameters, type tests and accuracy limits

### 3 Operation Theory

Comprehensive and detailed functional description

### 4 Supervision

Automatic self-supervision function of device

### 5 Management

Management function (measurement, recording, metering, etc.) of this device

### 6 Hardware

Description of plug-in modules and definition of pins

### 7 Settings

Setting lists including system settings, communication settings and etc.

### 8 Human Machine Interface

Description of the HMI panel, LCD display and menu tree

### 9 Configurable Function

Brief introduction of configurable functions and configuration software

### 10 Communication

Introduction of the supported communication protocols

### 11 Installation

Recommendation for unpacking, handling, inspection and storage with a guide to the mechanical and electrical installation

### 12 Commissioning

Commissioning recommendation for comprising checks on the calibration and functionality of device

## 13 Maintenance

General maintenance policy

## 14 Decommissioning and Disposal

General decommissioning and disposal policy

## 15 Manual Version History

List of instruction manual versions and history records of update.

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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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# 1 Introduction

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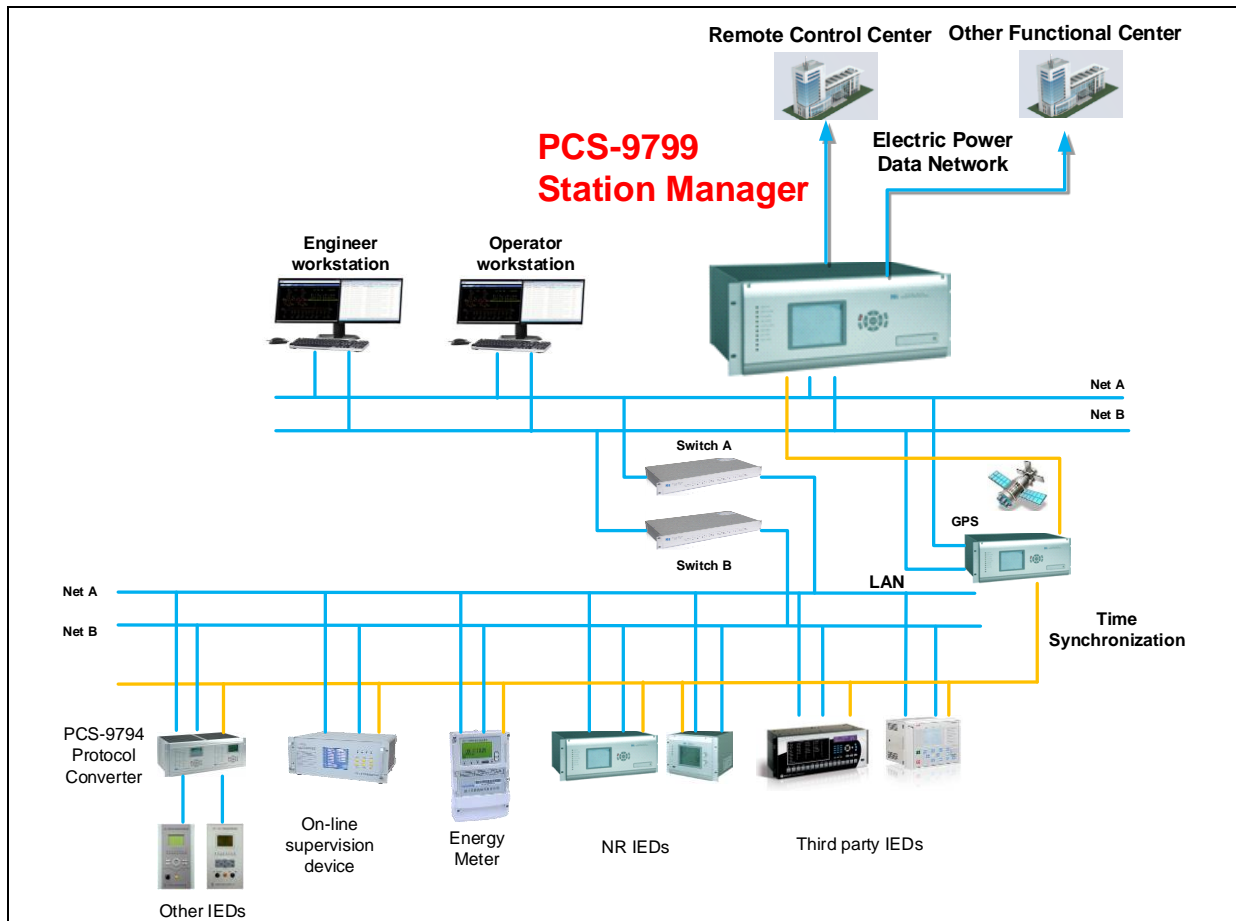


## 1.1 Overview

The PCS-9799 Station Manager is designed for the highest standards of performance, safety and reliability to meet requirements of a complex substation automation system (SAS). As a part of the SAS, it works as a station communication manager, which collects and maps signals of relays, measurement units, control units and other IEDs the substation to higher-level systems such as control centers (CC) or distributed control systems.

The PCS-9799 supports several protocols. In which, IEC 61850 client, IEC60870-5-101/104, NR private 103 (Ethernet port), IEC60870-5-103 (serial port) and CDT form a standard protocol package to satisfy most requirements. Data can be transmitted to and received from in analog channel, digital channel or network to CC, distributed control system or other system.

The direct transmission mode of the PCS-9799 allows an independent operation of this device. So as to avoid any interaction or influence with the HMI system to the substation's SCADA (Supervisory Control And Data Acquisition) system.



The PCS-9799 Station Manager is applicable to:

### 1. Power system

Conventional substation and digital substation of various voltage levels

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

## 2. Transport system

Subway, light-rail and electrified railway system

## 3. Industrial system

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



### Note!

The additional protocol requirement besides the standard package can be customized, please declare it clearly in the technical agreement and contract.

## 1.2 Functions

The PCS-9799 is a powerful device, which can meet various requirements of different substation. 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.

### 1. 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.

### 2. 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.

### 3. Auxiliary IED information acquisition

In addition, this device can gather information of other auxiliary devices, which are useful or crucial for the operation and safety of substation.

### 4. Remote control center communication

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

### 5. Synthetic signalization

The synthetic signalization is supported by this device with help of the configuration tool PCS-COMM. Logical and mathematic operation of data such as AND OR NOT XOR and + - × ÷ can be proceed for the transmission to remote control centers.

### 6. Remote command record and query

This device records all the commands and operations from the remote control source, 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.

## **7. Communication status check and supervision**

This device can automatically check and upload the communication status between itself and the devices connected. If an abnormality is detected, a corresponding alarm will be sent to the remote control center.

## **8. Time synchronization**

This device supports several time synchronization formats, including IRIG-B, network SNTP, time message, etc. It can also synchronize the connected IED with time message to unify the time in one substation.

## **9. 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.

## **10. Channel redundancy switching**

This mode based on 2 devices with the same communication configuration in one substation and enables the channel redundancy switching for the communication with different remote control centers (if one channel fails).

## **11. Binary inputs & outputs**

The IO module is equipped to provide 4 binary outputs (normally open contact) and 13 binary inputs (10 of which are configurable).

## **12. Self-diagnostic**

During the running time, 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.

# **1.3 Features**

## **1. High performance hardware architecture**

Dual CPU >1GHz, 2 GB RAM, optional 4G micro SD or 64G SSD

Capable for data management and communication of the SAS for the whole substation or power plant

Communication ports: up to 12 Ethernet ports, 15 serial ports (supporting RS-232, RS-485, RS-422 or MODEM)

Air cooling architecture is adopted to avoid the use of fan (motor and vibration)

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.

### 2. Real-time database

Compatible for 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

### 3. History database

Embedded history database

Optional capacity: 4GB micro SD or 64GB SSD (Solid State Drive)

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

### 4. Real-time data transmission

Internal SOE transmission delay <100ms

### 5. Unified substation model transmission

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

Support of most international standard protocols including IEC60870-5-101/104, NR private 103, IEC60870-5-103, IEC 61850 and CDT.

### 6. Powerful auxiliary configuration tool

Highly integrated configuration functions

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

### 7. System scale

Up to 300 IEDs

Up to 8 control centers

Database < 200,000 signals

## 2 Technical Data

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## 2.1 Electrical Specification

### 2.1.1 Power Supply

Standard	IEC 60255-11:2008
Rated voltage	110Vdc/125Vdc, 220Vdc/250Vdc
Operating range	88~300Vdc
Permissible AC ripple voltage	≤15% of the nominal auxiliary voltage
Power consumption	Classic < 45W

### 2.1.2 Binary Input

Rated voltage	24V	48V
Rated current	1.20mA	2.40mA
Pickup voltage	16.8-28.8Vdc	33.6-57.6Vdc
Drop-off voltage	<12Vdc	<24Vdc
Maximum permissible voltage	100Vdc	
Withstand voltage (continuu)	2000Vac, 2800Vdc	
Response time	≤1ms	

### 2.1.3 Binary Output

Contact Type	Parallel Connection	Single
Maximal system voltage	380Vac, 250Vdc	
Voltage withstand	1000V RMS in 1min	
Continuous carry	8A@380Vac 8A@250Vdc	5A@380Vac 5A@250Vdc
Short duration current	12A@3s 18A@1s 24A@0.5s 40A@0.2s	8A@3s 12A@1s 16A@0.5s 30A@0.2s
Breaking capacity (L/R=40ms)	0.65A@48Vdc 0.35A@110Vdc 0.30A@125Vdc 0.20A@220Vdc 0.15A@250Vdc	
Pickup time	< 8ms (typical 3ms)	
Drop off time	< 5ms	
Durability	10,000 operations minimum	

## 2.2 Mechanical Specification

Mounting Way	Flush mounted
Chassis color	Silver grey
Weight per device	Approx. 10kg
Chassis material	Aluminum alloy

Location of terminal	Rear panel of the device
Device structure	Plug-in modular type @ rear side, integrated front plate
Protection class	
Standard	IEC 60225-1:2009
HMI side	IP40
Terminal side	IP30
Other sides	IP20 (with ventilation hole)

## 2.3 Ambient Temperature and Humidity Range

Standard	IEC 60255-1:2009
Operating temperature	-10°C to +55°C
Transport and storage temperature range	-40°C to +70°C (Readability of display may be impaired below -20°C)
Permissible humidity	5%-95%, without condensation
Altitude	<3000m

## 2.4 Communication Port

### 2.4.1 EIA-485 Port

Baud rate	4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps
Protocol	IEC 60870-5-103:1997
Maximal capacity	32
Transmission distance	<500m
Safety level	Isolation to ELV level
Twisted pair	Screened twisted pair cable

### 2.4.2 Ethernet Port

Connector type	RJ-45
Transmission rate	100Mbps/s
Transmission standard	10Base-T/100Base-TX
Transmission distance	<100m
Protocol	IEC 60870-5-103:1997 or IEC 61850
Safety level	Isolation to ELV level

### 2.4.3 Clock Synchronization Port

Type	Differential RS-485
Transmission distance	<500m
Maximal capacity	32
Timing standard	IRIG-B
Safety level	Isolation to ELV level

### 2.4.4 Modem Port

Port number	Up to 9
Baud rate (Asynchronous)	300bps, 600bps, 1200bps
Center Frequency	1200Hz, 1350Hz, 1500Hz, 1700Hz, 2880Hz, 3000Hz
Frequency Offset	(±) 150Hz, 200Hz, 300Hz, 400Hz
Output Voltage	0dBm, -6dBm, -12dBm, -18dBm
Impedance	600Ω

## 2.5 Type Test

### 2.5.1 Environmental Test

Dry cold test	IEC 60068-2-1: 2007
Dry heat test	IEC 60068-2-2: 2007
Damp heat test, cyclic	IEC 60068-2-30: 2005
Steady heat test	IEC 60068-2-78: 2001

### 2.5.2 Mechanical Test

Vibration test	IEC 60255-21-1: 1988 Class I
Shock test	IEC 60255-21-2: 1988 Class I
Bump test	IEC 60255-21-2: 1988 Class I
Earthquake test	IEC 60255-21-3: 1993 Class I

### 2.5.3 Insulation Test

Insulation resistance	IEC 60255-5: 2000 > 100MΩ @500Vdc
Dielectric withstand	IEC 60255-27: 2005 2.8kV, DC, 1min 2.0kV, AC, 1min
Impulse voltage	IEC 60255-5: 2000 Rated insulation voltage > 63V, impulse voltage 5kV Rated insulation voltage < 63V, impulse voltage 1kV
Overvoltage category	IEC 60255-5: 2000 Class III
Pollution degree	IEC 60255-1:2009 Class II
Laser safety	Obvious warning sign

### 2.5.4 Electromagnetic Compatibility

1MHz burst disturbance test	IEC 60255-22-1:2007, Class III
	Common mode: 2.5kV Differential mode: 1.0kV
Electrostatic discharge test	IEC60255-22-2:2008 Class IV
	For contact discharge: ±8kV For air discharge: ±15kV
Radio frequency interference	IEC 60255-22-3:2007 Class III

tests	Frequency sweep Radiated amplitude-modulated 10V/m (rms), f=80~1000MHz
Fast transient disturbance tests	IEC 60255-22-4:2008, Class IV
	Power supply, I/O, Earth: $\pm 4\text{kV}$ , 5kHz for 15ms, 100kHz for 0.75ms Communication terminals: $\pm 2\text{kV}$ , 5kHz for 15ms, 100kHz for 0.75ms
Surge immunity test	IEC 60255-22-5:2008, Class IV
	Power supply, AC input, I/O port: 1.2/50 $\mu\text{s}$
	Common mode: $\pm 4\text{kV}$ Differential mode: $\pm 2\text{kV}$
Power frequency magnetic field immunity	IEC 61000-4-8:2001, Class V
	100A/m for 1min, 1000A/m for 3s
Pulse magnetic field immunity	IEC 61000-4-9:2001, Class V
	6.4/16 $\mu\text{s}$ , 1000A/m
Conducted RF electromagnetic disturbance	IEC 60255-22-6:2001, Class III
	Power supply, AC, I/O, Comm. Terminal: 10Vrms, 150kHz~80MHz Spot frequency, f=27MHz/68MHz
Power frequency immunity	IEC 60255-22-7:2003, Class A
	Common mode: 300V Differential mode: 150V
Conducted emission	IEC 60255-25:2000, Class A
	f=0.15MHz~0.5MHz/0.5kHz~30MHz
Radiated emission	IEC 60255-25:2000, Class A
	f=30MHz~230MHz/230MHz~1000MHz
Damped oscillatory magnetic field immunity	IEC 61000-4-10:2001, Class V
	100kHz & 1MHz, 100A/m
Auxiliary power supply performance - Voltage dips - Voltage short interruptions	IEC60255-11: 2008 Up to 200ms for dips to 40% of rated voltage without reset

## 2.6 Management Functions

### 2.6.1 Clock Performance

Real time clock accuracy	$\leq 3\text{s/day}$
Accuracy of GPS synchronization	$\leq 1\text{ms}$
External time synchronization	IRIG-B (200-98)

### 2.6.2 Binary Input Signal

Resolution of binary input signal	$\leq 1\text{ms}$
Binary input mode	Potential-free contact
Resolution of SOE	$\leq 2\text{ms}$

## **2.7 Certifications**

1. ISO9001:2008
2. ISO14001:2004
3. OHSAS18001:2007
4. ISO10012:2003
5. CMMI L5
6. EMC: 2004/108/EC, EN50263:1999
7. Products safety (PS): 2006/95/EC, EN61010-1:2001



## 3 Operation Theory

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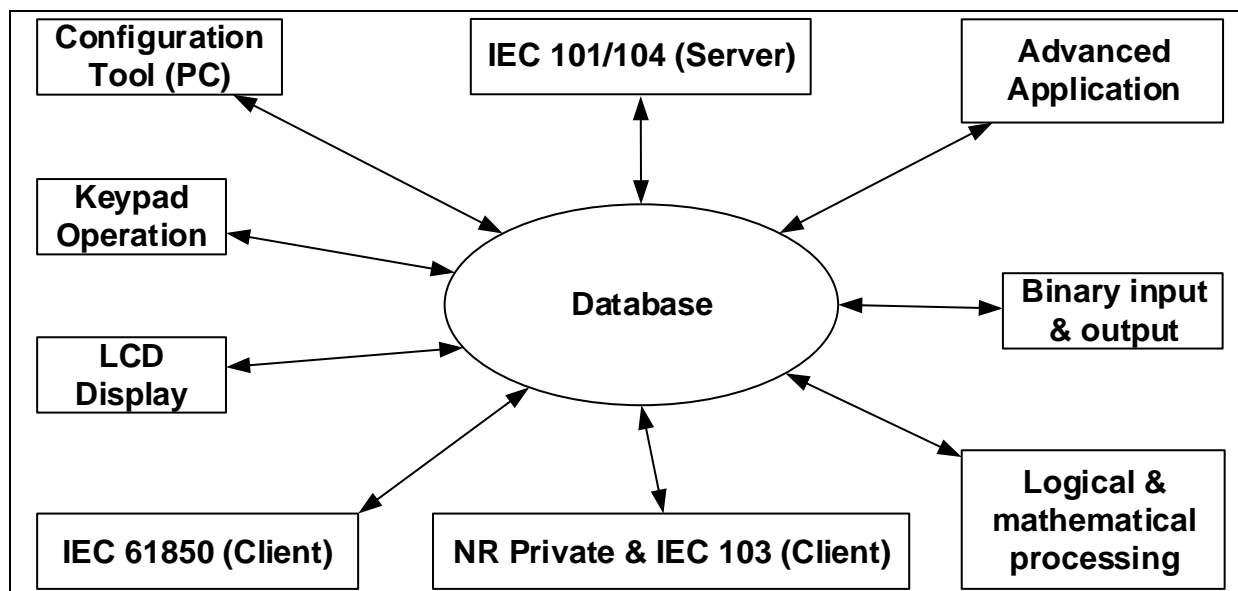




### 3.1 Software Structure

The PCS-9799 Station Manager applies embedded Linux software platform. The modularization software design provides high flexibility and applicability.

The software structure is shown in following figure:



### 3.2 Functions

No.	Subsystem	Description
1	Database	Data acquisition and management (server and client).
2	Server protocol	Communication to master station (control center, distribution center, etc.) Modeling of the whole substation Data transmission to master station via server protocol (IEC 101/104, CDT, etc.) Response to master station's interrogation Transmission of remote control command.
3	Client protocol	Communication to IED within the substation Data acquisition from IED via client protocol (IEC 61850/103, NR private 103, etc.) Processing of remote control command
4	Logical processing	Edition and analysis of synthesized signal Logical processing of control block logic
5	Binary input & output	Acquisition of binary input status Output contact based on device's states
6	Human-machine interaction	LCD display, LED indicators, keypad and configuration tool to realize the supervision of running status, communication messages, parameters & settings, project configuration, diagnostic & analysis
7	Advanced application	Advanced customized functions for special requirement.
8	Time synchronization	IRIG-B signal reception



## **4 Supervision**

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## 4.1 Overview

The PCS-9799 Station Manager 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 DC 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, all functions will be blocked and the LED “HEALTHY” will be extinguished. 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.



### Note!

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 Alarm description**

No.	Item	Description	Blocking Device
<b>Fail Signals</b>			
1	Alm_Brd_Overall	The signal is always issued when a certain hardware error is detected, the device will be blocked and all the functions are not available.	Blocked

Alarm Signals			
2	Alm_Process	The certain module of the program is abnormal.	Unblocked
3	Alm_Insuf_Disk	The ROM is not enough for the data storage.	Unblocked
4	Alm_RecvMON1	The data synchronization module1 is out of service.	Unblocked
5	Alm_RecvMON2	The data synchronization module2 is out of service.	Unblocked
6	Alm_RecvMON3	The data synchronization module3 is out of service.	Unblocked
7	Alm_RecvMON4	The data synchronization module4 is out of service.	Unblocked
8	Alm_Cfg_DualDev_Diff	When running in the dual-device mode, the configuration files of two devices are not consistent.	Unblocked
9	Alm_Cfg_Backup_Diff	The on-duty configuration file and the backup configuration files are not consistent (the time stamp of these two files are not same).	Unblocked
10	Alm_MON1_DualDev_Diff	When running in the dual-device mode, the programs running on the MON module 1 of the two devices are not consistent.	Unblocked
11	Alm_MON2/MON1_Diff	Within one device, the programs running on the MON module 2 and the one on MON module 1 are not consistent.	Unblocked
12	Alm_MON3/MON1_Diff	Within one device, the programs running on the MON module 3 and the one on MON module 1 are not consistent.	Unblocked
13	Alm_MON4/MON1_Diff	Within one device, the programs running on the MON module 4 and the one on MON module 1 are not consistent.	Unblocked
14	Alm_Pwr_Device	One of the power supply of device is in abnormal state. (available when the device is working in dual-power supply mode)	Unblocked
15	Alm_Cfg_Invalid	There is invalid configuration in the configuration database.	Unblocked

Table 4.2-2 Troubleshooting

No.	Item	Handling suggestion
Fail Signals		
1	Alm_Brd_Overall	The signal is always issued when a certain hardware error is detected, the device will be blocked and all the functions are not available, please check the hardware of the device (module misplaced, module loose etc.) and contact the manufacturer.
Alarm Signals		
2	Alm_Process	Generally it will recover automatically, if not, please contact the manufacturer.
3	Alm_Insuf_Disk	Generally it will recover automatically, if not, please contact the manufacturer.
4	Alm_RecvMON1	Generally it will recover automatically, if not, please contact the manufacturer.
5	Alm_RecvMON2	Generally it will recover automatically, if not, please contact the manufacturer.
6	Alm_RecvMON3	Generally it will recover automatically, if not, please contact the manufacturer.



7	Alm_RecvMON4	Generally it will recover automatically, if not, please contact the manufacturer.
8	Alm_Cfg_DualDev_Diff	Please check the configuration files or re-download the same file into the two devices.
9	Alm_Cfg_Backup_Diff	Please re-download the latest configuration file into the device and reboot.
10	Alm_MON1_DualDev_Diff	Please contact the manufacturer to update the program of the two devices.
11	Alm_MON2/MON1_Diff	Please contact the manufacturer to update the program of the device.
12	Alm_MON3/MON1_Diff	Please contact the manufacturer to update the program of the device.
13	Alm_MON4/MON1_Diff	Please contact the manufacturer to update the program of the device.
14	Alm_Pwr_Device	Please check the power supply of the device.
15	Alm_Cfg_Invalid	Please check the configuration database.





## 5 Management

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## 5.1 Real Time Data Interrogation

This device can display (with the optional LCD) the IO status, measurement & metering values, settings & parameters of the device itself or a connected IED by the means of network interrogation.

### 5.1.1 IO Status

**"MainMenu"-> "Database"->"Online"->"Datatype01"**

The device's or connected IED's status of the binary inputs, output contacts, certain device alarm and network communication connection state can be interrogated and viewed.

### 5.1.2 Measurement

**"MainMenu"-> "Database"->"Online"->"Datatype02"**

This device can perform continuous measurement of analogue input with optional AC AI module. It samples 80 points per cycle and calculates the RMS value in each interval. The optional LCD display is updated in every 0.5 second. The measurement data can also be transmitted to a local/remote PC via communication protocol.

The device's or connected IED's measured values, including both AC & DC analog inputs, can be interrogated and viewed.

### 5.1.3 Tap Position

**"MainMenu"-> "Database"->"Online"->"Datatype03"**

The device's or connected IED's transduced tap position can be interrogated and viewed.

### 5.1.4 Meterage

**"MainMenu"-> "Database"->"Online"->"Datatype04"**

The device's or connected IED's metering values can be interrogated and viewed.

### 5.1.5 Device Settings

**"MainMenu"-> "Database"->"Online"->"Datatype05"**

The device's or connected IED's device settings can be interrogated and viewed.

### 5.1.6 Setting Group

**"MainMenu"-> "Database"->"Online"->"Datatype06"**

A connected IED's (protection relay) setting group, including the active setting group and the editing setting group, can be interrogated and viewed.

### 5.1.7 Setting

**"MainMenu"-> "Database"->"Online"->"Datatype07"**

The device's or connected IED's parameter can be interrogated and viewed.

## 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 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

#### 1. IO Events

**"MainMenu"-> "Database"->"Records"->"SOE Records"->"Datatype01"**

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.

#### 2. Supervision Events

**"MainMenu"-> "Database"->"Records"->"SOE Records"->"Datatype02"**

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.

#### 3. Disturbance Records

**"MainMenu"-> "Database"->"Records"->"SOE Records"->"Datatype03"**

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

### 5.2.2 Operation Logs

#### 1. Control Logs

**"MainMenu"-> "Database"->"Records"->"Operation Logs"->"Datatype01"**

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.

## 6 Hardware

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## 6.1 Overview

PCS-9799 is designed based on the new generation of UAPC platform. 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. Meanwhile, it adopts DDR2 RAM to ensure the real-time and high-speed calculation. With the massive storage disk, the hardware is highly integrated which gives the device high extensibility and maintainability. The internal data bus is based on high-speed Ethernet, which makes sure the communication between each module is very efficient, enables the distribute computing, balances the system load and enhances the system extensibility.

This device consists of several different modules. The application and terminal description of each module are introduced below.

Slot No.	Module Type	Brief
01	NR1108	MON module, management and monitor module
12	NR1525	IO module, binary input and output module
13, 14, 15	NR1224, NR1225	COM module, extension serial ports and modem ports module for communication
P1	NR4304, NR4305	PWR module, power supply module
		HMI module, human-machine interface

- **MON module** provides functions like communication with SAS, event record, setting management etc. The medium of the Ethernet interface of the MON module is optional.
- **IO module** provides output contacts and binary inputs via opto-couplers.
- **COM module** provides up extension serial ports or modem ports for communication with other device or control system.
- **PWR module** converts the power supply into various DC voltage levels for different modules and components in the device.
- **HMI module** human-machine interface is comprised of LCD, keypad, LED indicators and a multiplex RJ45 port for debugging.



### Note!

In different engineering applications, the arrangement of equipped modules is different according to the actual requirements.

The following figures will show the example views of the device.

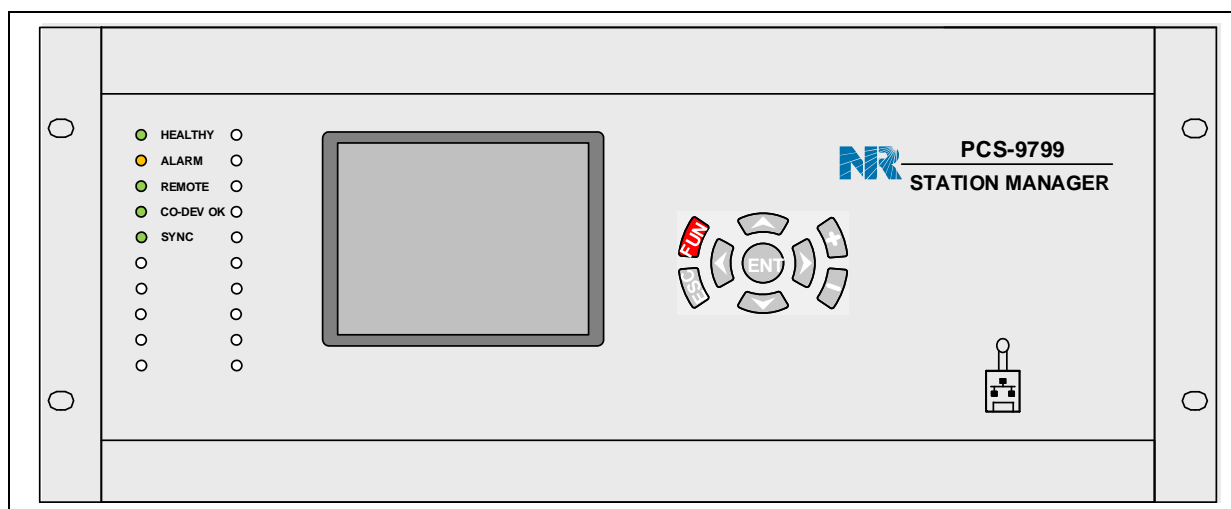


Figure 6.1-1 Front view

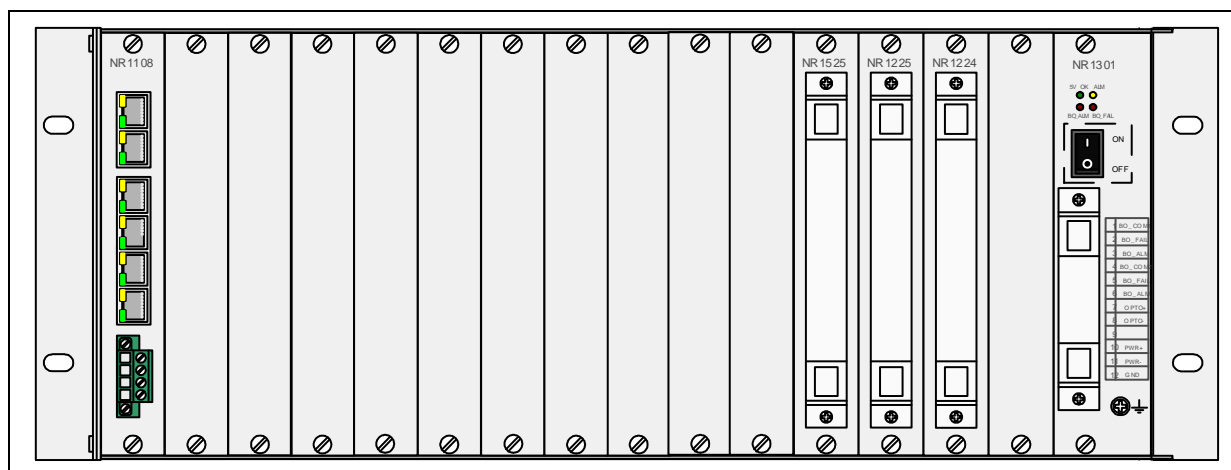


Figure 6.1-2 Rear view

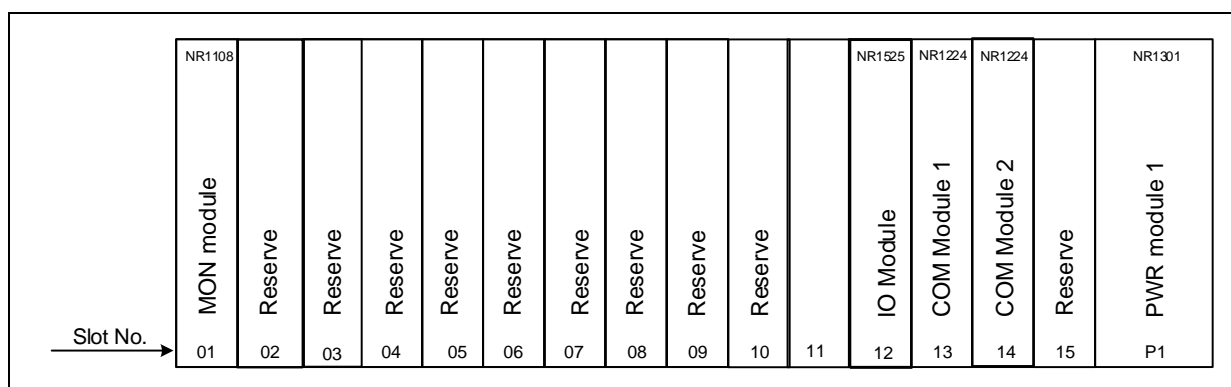


Figure 6.1-3 Module configuration

## 6.2 MON Module (Management & Monitoring)

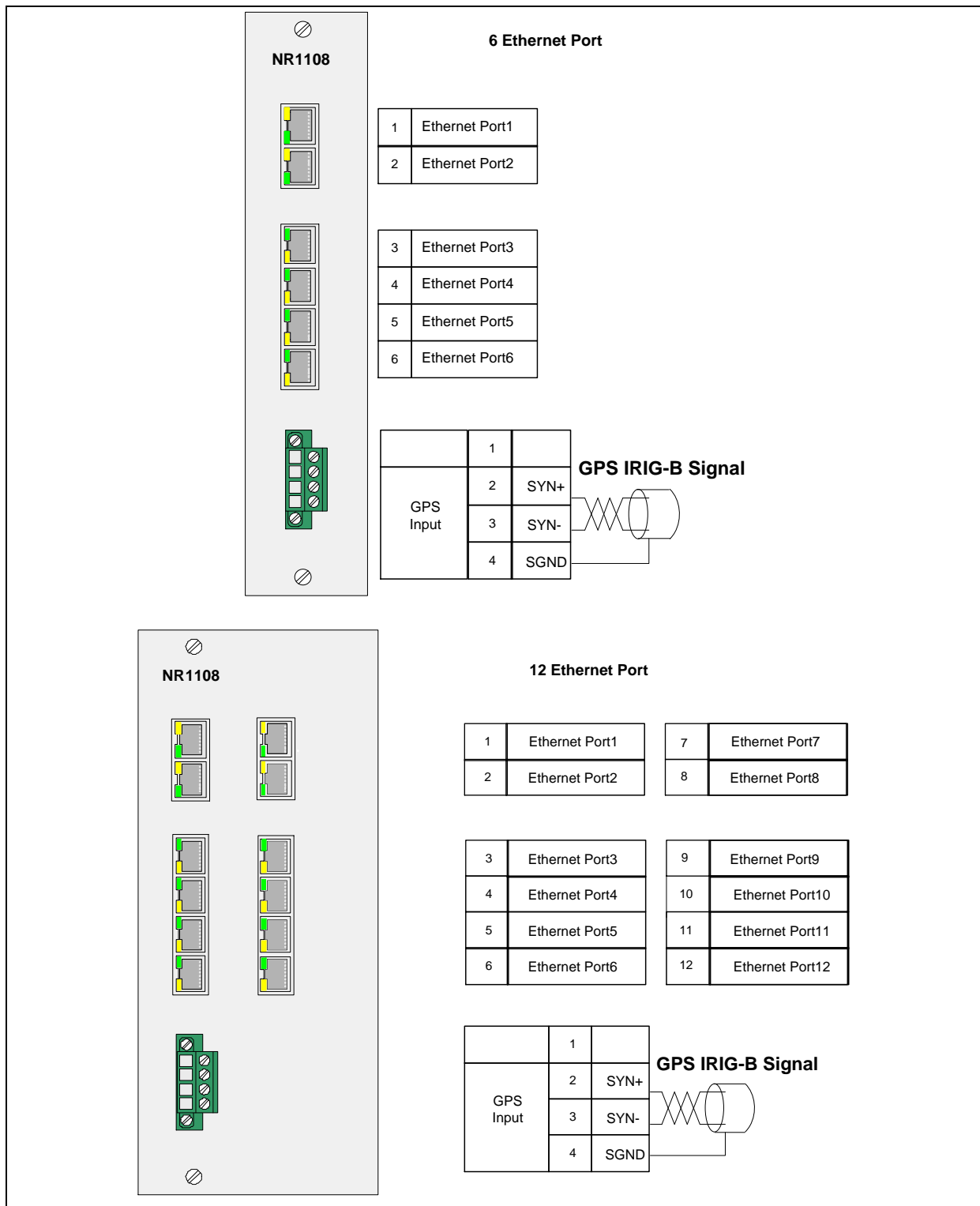
The MON module is obligatory and fixed at the first chassis slot 01.

The MON module 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.

The MON module uses the internal bus to receive data from other modules. It communicates with the LCD module by RS-485 bus.



**Figure 6.2-1 MON module**

Several different types of the MON module are optional:

Type	RAM	Storage	Ethernet Port
NR1108C	2G	4G	6
NR1108D	2G	4G	12
NR1108CD	2G	64G	6
NR1108DD	2G	64G	12

The correct wiring is shown in the following figure. Generally, the shielded cable with two pairs of twisted pairs inside shall be applied. One pair of the twisted pairs are respectively used to connect the "+" and "-" terminals of difference signal. The other pair of twisted pairs is used to connect the signal ground of the communication interface. The module reserves a free terminal for all the communication ports. The free terminal has no connection with any signal of the device, and it is used to connect the external shields of the cable when connecting multiple devices in series. The external shield of the cable shall be grounded at one of the ends only.

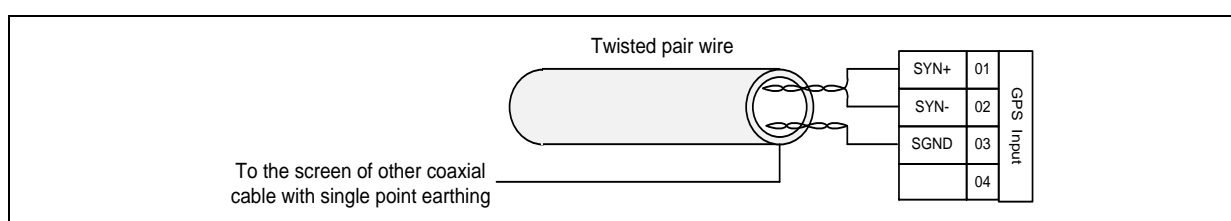


Figure 6.2-2 Wiring of synchronization port

### 6.3 IO Module (Binary Input and Output)

The IO module provides 4 output contacts and 13 binary inputs (10 of which are configurable).

The IO module NR1525 has a 22-pin connector.

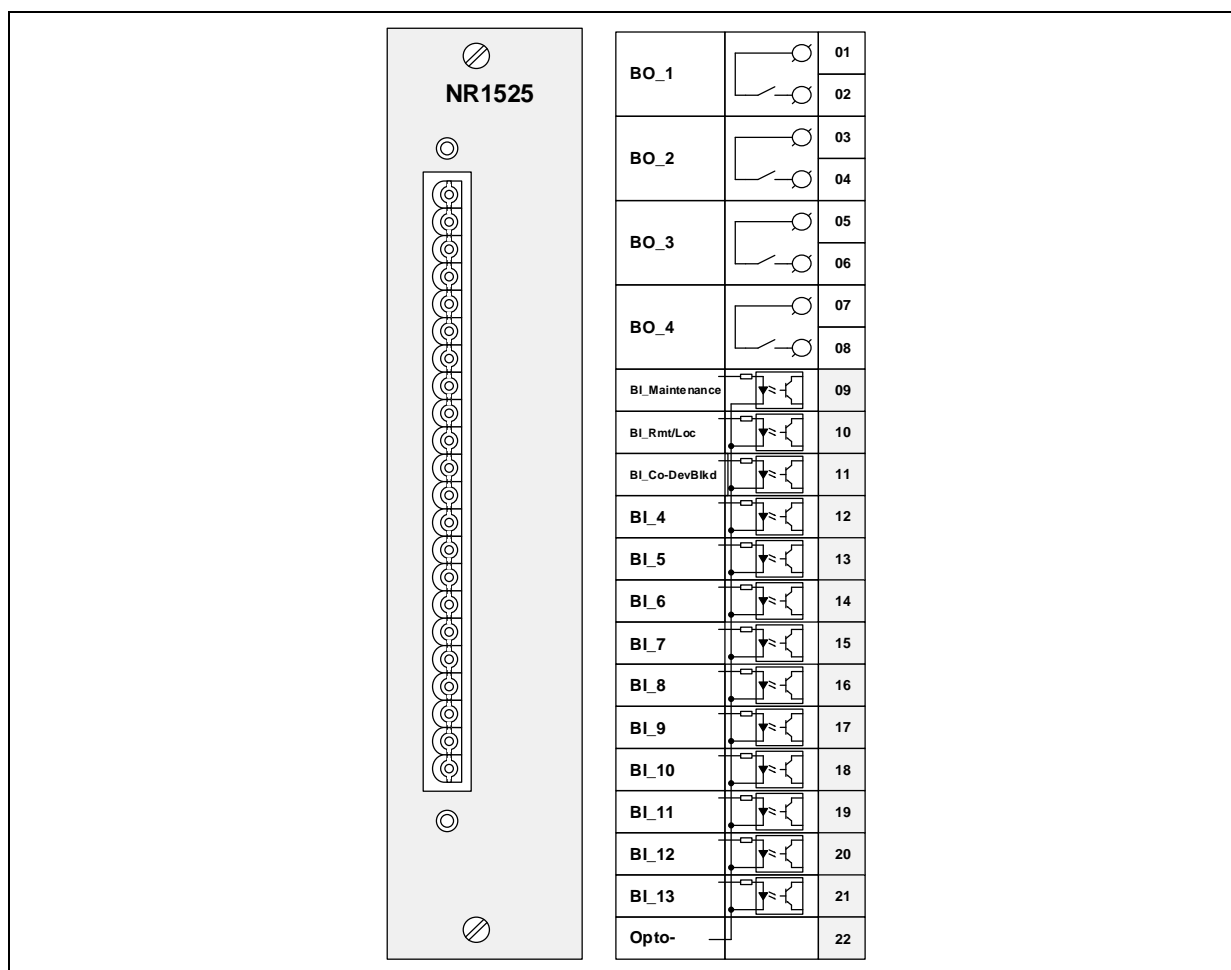


Figure 6.3-1 IO module

Pin No.	Symbol	Description
1	BO_1	Output contact 1 (NO)
2		
3	BO_2	Output contact 2 (NO)
4		
5	BO_3	Output contact 3 (NO)
6		
7	BO_4	Output contact 4 (NO)
8		
9	BI_Maintenance	Binary input for the indication of device maintenance state
10	BI_Rmt/Loc	Binary input to switch the remote/local control mode
11	BI_Co-DevBlkd	Binary input for the indication of co-operate device's block
12	BI_4	Configurable binary input
13	BI_5	
14	BI_6	
15	BI_7	
16	BI_8	

Pin No.	Symbol	Description
17	BI_9	
18	BI_10	
19	BI_11	
20	BI_12	
21	BI_13	
22	Opto-	Common negative pole of binary input.

### 1. Binary input: [BI\_Maintenance]

It is used to block communication export when this binary input is energized. During device maintenance or testing, this binary input is then energized not to send reports via communication port, local display and printing still work as usual. This binary input should be de-energized when the device is restored back to normal.

### 2. Binary input: [BI\_Rmt/Loc]

It is used to select the remote control or the local control.

If it is energized (the remote control), all the binary outputs can be remotely controlled by control center.

### 3. Binary input: [BI\_Co-DevBlkd]

It is used to identify that the cooperation device is blocked (when dual-device configuration is applied). This module can realize the inter-block between the on-duty device and backup device. The wiring is shown in following figure.

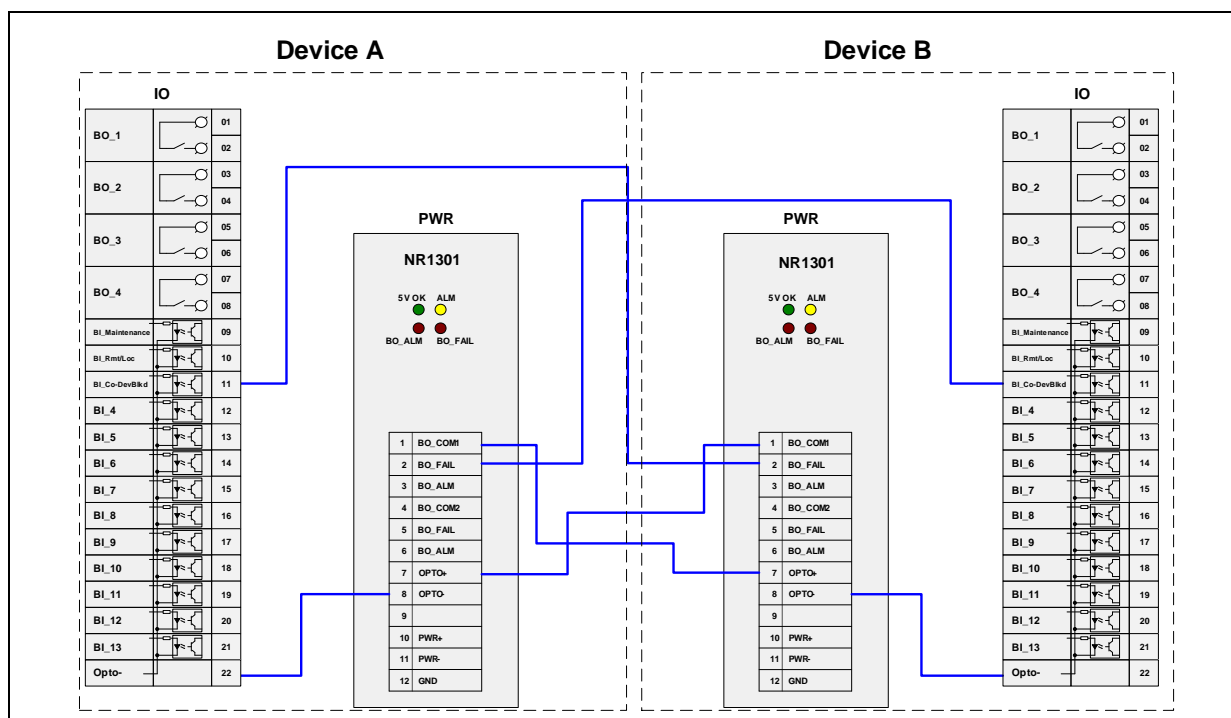


Figure 6.3-2 Wiring for dual device inter-block

## 6.4 COM Module (Extension Communication Ports)

The COM module provides several extension serial ports or modem ports



### Note!

The device supports at most 3 COM modules, the COM modules can be applied in slot 13, 14, 15.

#### ● NR1224

This module provides 5 serial ports (RS-232/RS-485), besides, the No.5 port can be set as RS-422.

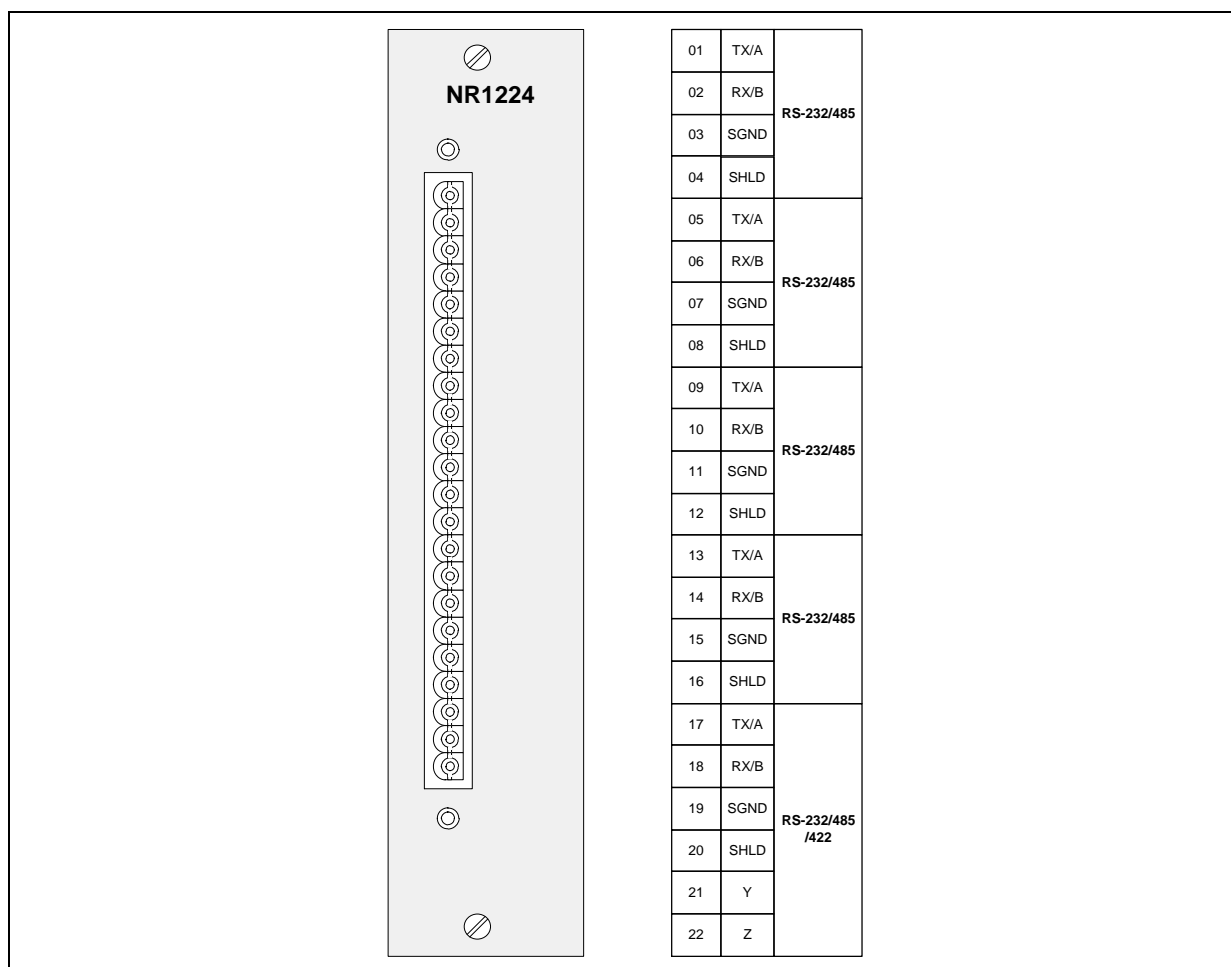


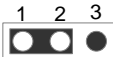



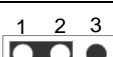
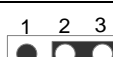



Figure 6.4-1 COM Module (NR1224)

Pin No.	Symbol	Description	Port No.
01	TX/A	RS-232: TX (Send) RS-485: A	Serial port 1
02	RX/B	RS-232: RX (Receive) RS-485: B	
03	SGND	Signal ground	
04	SHLD	Shielded layer	

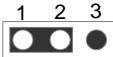
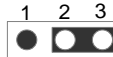



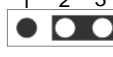



Pin No.	Symbol	Description	Port No.
05	TX/A	RS-232: TX (Send) RS-485: A	Serial port 2
06	RX/B	RS-232: RX (Receive) RS-485: B	
07	SGND	Signal ground	
08	SHLD	Shielded layer	
09	TX/A	RS-232: TX (Send) RS-485: A	Serial port 3
10	RX/B	RS-232: RX (Receive) RS-485: B	
11	SGND	Signal ground	
12	SHLD	Shielded layer	
13	TX/A	RS-232: TX (Send) RS-485: A	Serial port 4
14	RX/B	RS-232: RX (Receive) RS-485: B	
15	SGND	Signal ground	
16	SHLD	Shielded layer	
17	TX/A	RS-232: TX (Send) RS-485,RS-422: A	Serial port 5
18	RX/B	RS-232: RX (Receive) RS-485,RS-422: B	
19	SGND	Signal ground	
20	SHLD	Shielded layer	
21	Y	RS-422: Y	
22	Z	RS-422: Z	

The mode option of each serial port is realized by the corresponding jumpers which locate on the COM module. The configuration detail of each port is listed in the following tables (the black background means connected pins by the jumper).

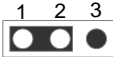


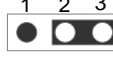

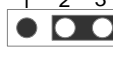



➤ Serial port 1

Jumper	RS-485	RS-232
P7		
P8		
P9		
P5		
		

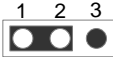

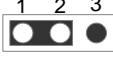

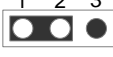




## ➤ Serial port 2

Jumper	RS-485	RS-232
P12		
P13		
P14		
P10		
		

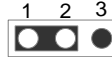
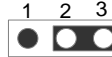
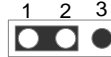
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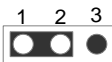
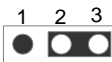
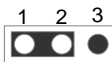
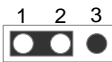
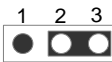
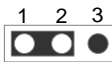

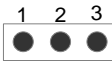
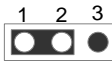














Jumper	RS-485	RS-232
P17		
P18		
P19		
P15		
		

## ➤ Serial port 4

Jumper	RS-485	RS-232
P22		
P23		
P24		
P20		
		

## ➤ Serial port 5

Jumper	RS-485	RS-232	RS-422
P27			

Jumper	RS-485	RS-232	RS-422
P28			
P29			
P30			
P31			
P32			
P25			
			
P33			
			

**Note!**

When the port 1 is used as RS-485 port, the P5 is used as matched resistance. Normally the jumper is not necessary. If the communication quality is not good enough, users can use P5 to enhance the quality. Similar principles are adopted for the other ports.

Port 2 as RS-485: P10 as matched resistance

Port 3 as RS-485: P15 as matched resistance

Port 4 as RS-485: P25 as matched resistance

Port 5 as RS-422: P33 as matched resistance

- NR1225

This module provides 2 serial ports (RS-232/RS-485) and 3 modem ports.



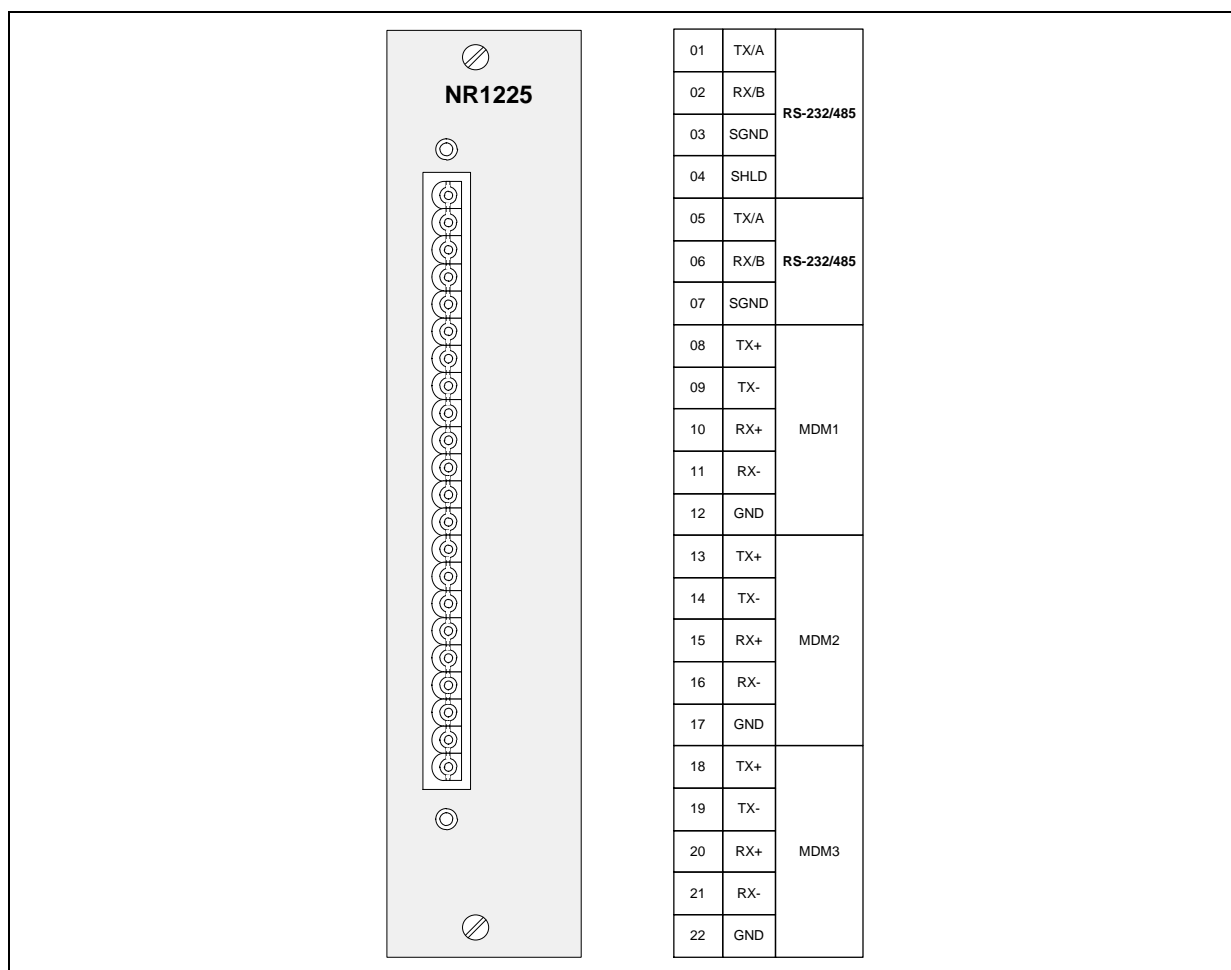
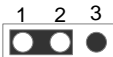



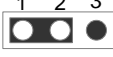
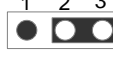





Figure 6.4-2 COM Module (NR1225)

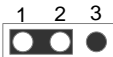



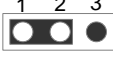




Pin No.	Symbol	Description	Port No.
01	TX/A	RS-232: TX (Send) RS-485: A	Serial port 1
02	RX/B	RS-232: RX (Receive) RS-485: B	
03	SGND	RS-232/RS-485 signal ground	
04	SHLD	RS-232/RS-485 shield layer	
05	TX/A	RS-232: TX(Send) RS-485: A	Serial port 2
06	RX/B	RS-232: RX(Receive) RS-485: B	
07	SGND	RS-232/RS-485 signal ground	
08	TX+	Modem Send +	Modem port 1
09	TX-	Modem Send -	
10	RX+	Modem Receive +	
11	RX-	Modem Receive -	
12	GND	Modem signal ground	
13	TX+	Modem Send +	Modem port 2

Pin No.	Symbol	Description	Port No.
14	TX-	Modem Send -	
15	RX+	Modem Receive +	
16	RX-	Modem Receive -	
17	GND	Modem signal ground	
18	TX+	Modem Send +	Modem port 3
19	TX-	Modem Send -	
20	RX+	Modem Receive +	
21	RX-	Modem Receive -	
22	GND	Modem signal ground	

➤ Serial port 1

Jumper	RS-485	RS-232
P7		
P8		
P9		
P5		
		

➤ Serial port 2

Jumper	RS-485	RS-232
P12		
P13		
P14		
P10		
		



**Note!**

When the port 1 is used as RS-485 port, the P6 is used as matched resistance. Normally the jumper is not necessary. If the communication quality is not good enough, users can use P5 to enhance the quality. Similar principle is adopted for the other port.

Port 2 as RS-485: P11 as matched resistance

## 6.5 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 12-pin connector is fixed on the PWR module at the slot P1. The pin definition of the connector is described as below.

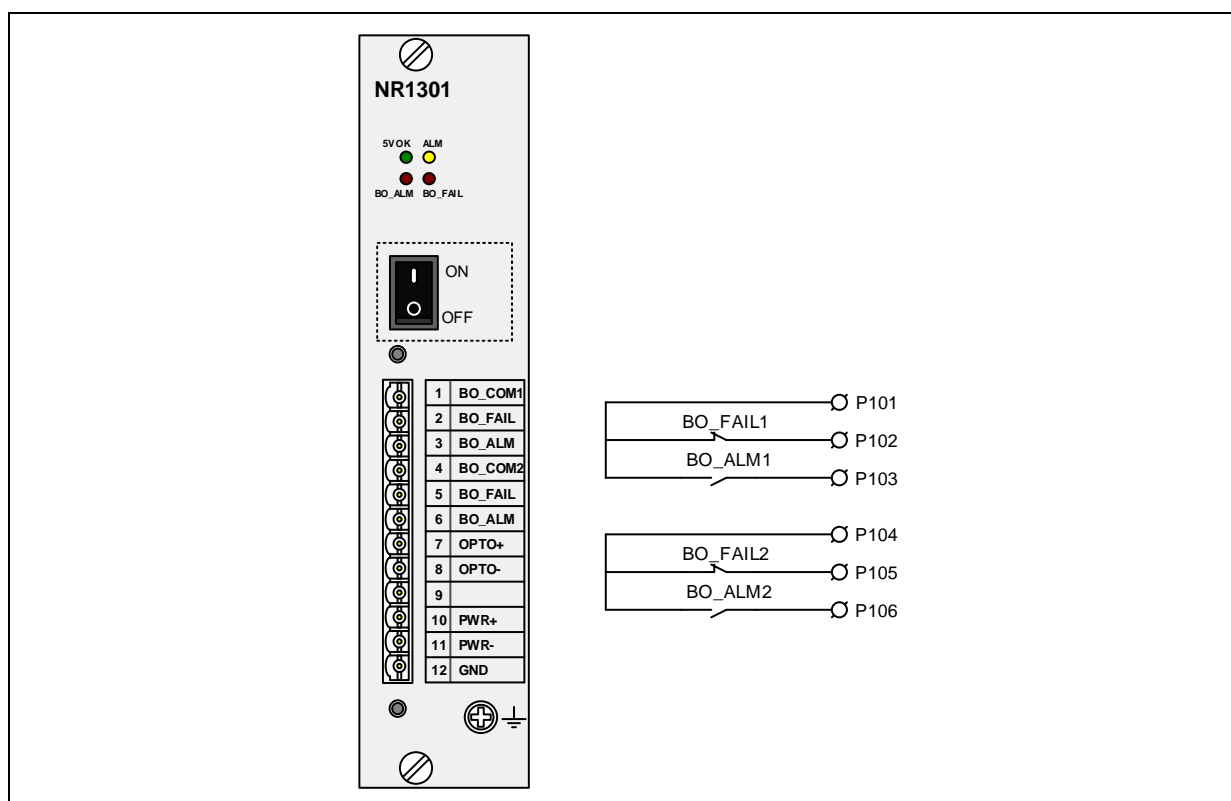


Figure 6.5-1 PWR module

Pin No.	Symbol	Description
01	BO_COM1	Common terminal 1
02	BO_FAIL	Indication of device failure 1 (01-02, NC)
03	BO_ALM	Indication of device abnormality alarm 1 (01-03, NO)
04	BO_COM2	Common terminal 2
05	BO_FAIL	Indication of device failure 2 (04-05, NC)
06	BO_ALM	Indication of device abnormality alarm 2 (04-06, NO)
07	OPTO+	Positive pole of power supply for low-voltage opto-coupler (24V)
08	OPTO-	Negative pole of power supply for low-voltage opto-coupler (24V)

Pin No.	Symbol	Description
09		Not used
10	PWR+	Positive pole of power supply for device
11	PWR-	Negative pole of power supply for device
12	GND	Grounded connection of device

**Note!**

The standard rated voltage of PWR module is self-adaptive to 88~300Vdc. For non-standard rated voltage power supply module, 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.

The PWR module provides the terminal 12 and grounding screw for device grounding. The terminal 12 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.

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

## 6.6 HMI Module (Human-Machine Interface)

The HMI module consists of liquid crystal display screen, keypad, LED indicators and RJ-45 debugging port. The contained ARM processor works for display controlling of LCD, keypad processing, and exchanging data with the MON module. The optional LCD screen is a high-performance grand liquid crystal panel with back lighting, which has a user-friendly interface and an extensive display range.

## 7 Settings

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<b>7.3 Identification Settings.....</b>	<b>7-1</b>



## 7.1 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.



### Note!

According to different applications in different engineering requirements, displayed settings may be different.

## 7.2 Communication Settings

Access path: "MainMenu" -> "Settings" -> "Comm Settings" -> "IP"

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

Access path: "MainMenu" -> "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: "MainMenu" -> "Settings" -> "Comm Settings" -> "Route"

No.	Item	Range	Description
1	Local router	000.000.000.000~255.255.255.255	The IP address of local router
2	Remote segment	000.000.000.000~255.255.255.255	The router's network segment (opposite side)
3	Remote mask	000.000.000.000~255.255.255.255	The router's subnet mask (opposite side)

## 7.3 Identification Settings

Access path: "MainMenu" -> "Settings" -> "ID Settings"

No.	Item	Range	Description
1	Manager 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

### 1. Manager ID

This setting should be different with the other communication management device (i.e. PCS-9794 Protocol Converter, RCS-9698 Gateway) in the same network.

**2. Co-Dev ID**

This setting is only valid if the dual-device mode is applied. The 2 devices should share the same "Manager ID" in the same network and have different "Co-Dev ID".



## 8 Human Machine Interface

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## 8.1 Overview

Operator can access the device from the HMI panel. Local communication with the device is possible in using a computer via the multiplex RJ45 port on the HMI panel. Furthermore, remote communication is also possible in using a PC with the SCADA via a RS485 port or a Ethernet port on the MON module.

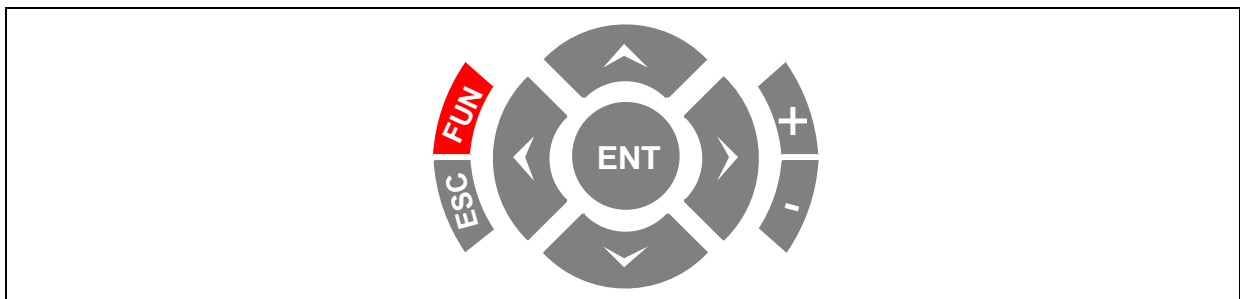
This chapter describes the human machine interface (HMI), and gives out an instruction about how to display or print event report, setting and so on through HMI menu tree and display metering value, including r.m.s. current, voltage and frequency etc. through LCD. Procedure to change active setting group or a settable parameter value through keypad is also described in details.

### 8.1.1 Design

The human-machine interface (HMI) module which allows a communication to be as simple as possible for the user. The HMI module helps to draw your attention to something that has occurred which may activate an LED or a report displayed on the LCD. Operator can locate the data of interest by navigating the keypad.

No.	Item	Description
1	LCD	A 320×240 dot matrix backlight LCD display is visible in dim lighting conditions. The corresponding messages are displayed when any operation implemented.
2	LED	20 status indication LEDs in which the first 5 are fixed.
3	Keypad	Navigation keypad and 9 keys
4	Communication port	A multiplex RJ45 port for debugging

### 8.1.2 Keypad



#### 1. "ESC"

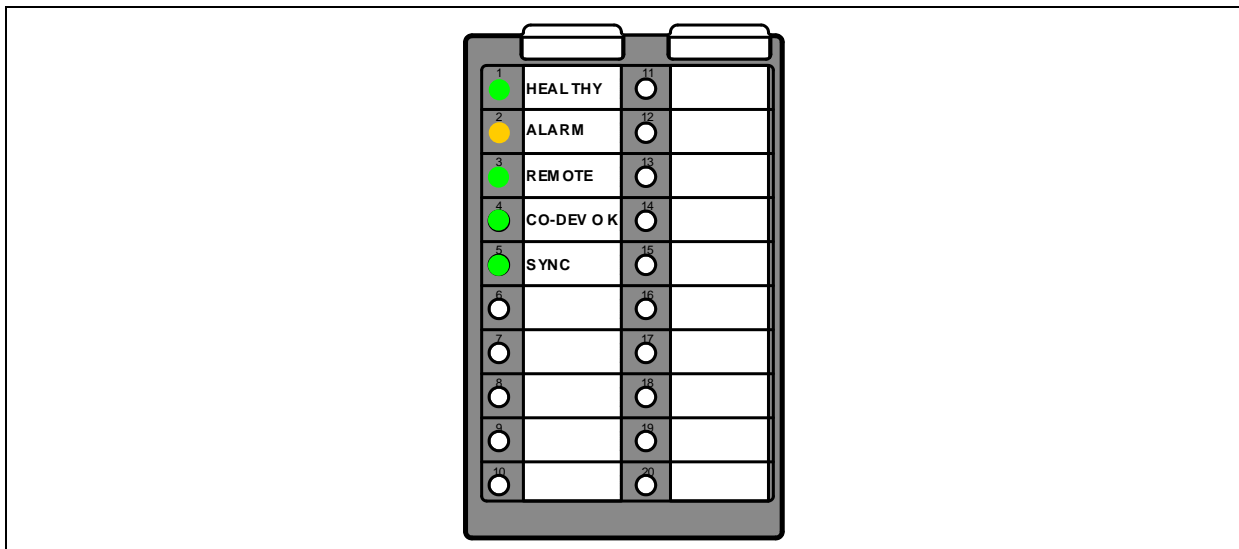
- Cancel the operation
- Quit the current menu

#### 2. "ENT"

- Execute the operation
- Confirm the interface

3. "FUN"
  - Activate the switching function
4. "◀" and "▶"
  - Move the cursor horizontally
  - Enter the next menu or return to the previous menu
5. "▲" and "▼"
  - Move the cursor vertically
  - Select command menu within the same level of menu
6. "+" and "-"
  - Modify the value
  - Modify and display the message number
  - Page up/down

### 8.1.3 LED Indicator



A brief explanation has been made as below.

LED	Display	Description
HEALTHY	Off	The device is out of service or any hardware error is detected during self-check.
	Green	The device is in service and ready for operation.
ALARM	Off	The device is in normal operating condition.
	Yellow	An abnormal alarm is issued.
REMOTE	Off	This device is in local control.

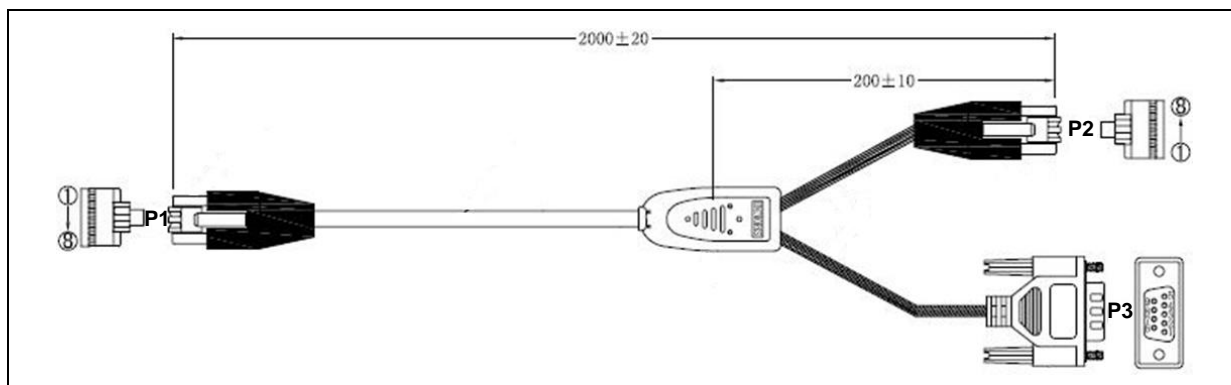
LED	Display	Description
	Green	This device can be controlled remotely.
CO-DEV OK	Off	The co-operating device is blocked or the communication between the two station managers is abnormal.
	Green	The two station managers are co-operating.
SYNC	Off	None synchronization signal is received.
	Green	The device is successfully synchronized with the time source.

**Note!**

1. "HEALTHY" LED can only be litted on by energizing the device without any detection of abnormality.
2. "ALARM" LED is litted on as long as a alarm exists. When all alarms disappear, it will be turned off.

### 8.1.4 Front Debugging Port

There is a multiplex RJ45 port on the front panel. This port can be used as an RS-232 serial port as well as a twisted-pair Ethernet port. As shown in the following figure, a customized cable is applied for debugging via this multiplex RJ45 port.



P1: To connect the multiplex RJ45 port. An 8-core cable is applied here.

P2: To connect the twisted-pair Ethernet port of the computer.

P3: To connect the RS-232 serial port of the computer.

The definition of the 8-core cable in the above figure is introduced in the following table.

Terminal No.	Core color	Function	Device side (Left)	Computer side (Right)
1	Orange & white	TX+ of the Ethernet port	P1-1	P2-1
2	Orange	TX- of the Ethernet port	P1-2	P2-2
3	Green & white	RX+ of the Ethernet port	P1-3	P2-3

Terminal No.	Core color	Function	Device side (Left)	Computer side (Right)
4	Blue	TXD of the RS-232 serial port	P1-4	P3-2
5	Brown & white	RXD of the RS-232 serial port	P1-5	P3-3
6	Green	RX- for the Ethernet port	P1-6	P2-6
7	Blue & white	The ground connection of the RS-232 port.	P1-7	P3-5
8	Brown		P1-8	

### 8.1.5 Ethernet Port Setup

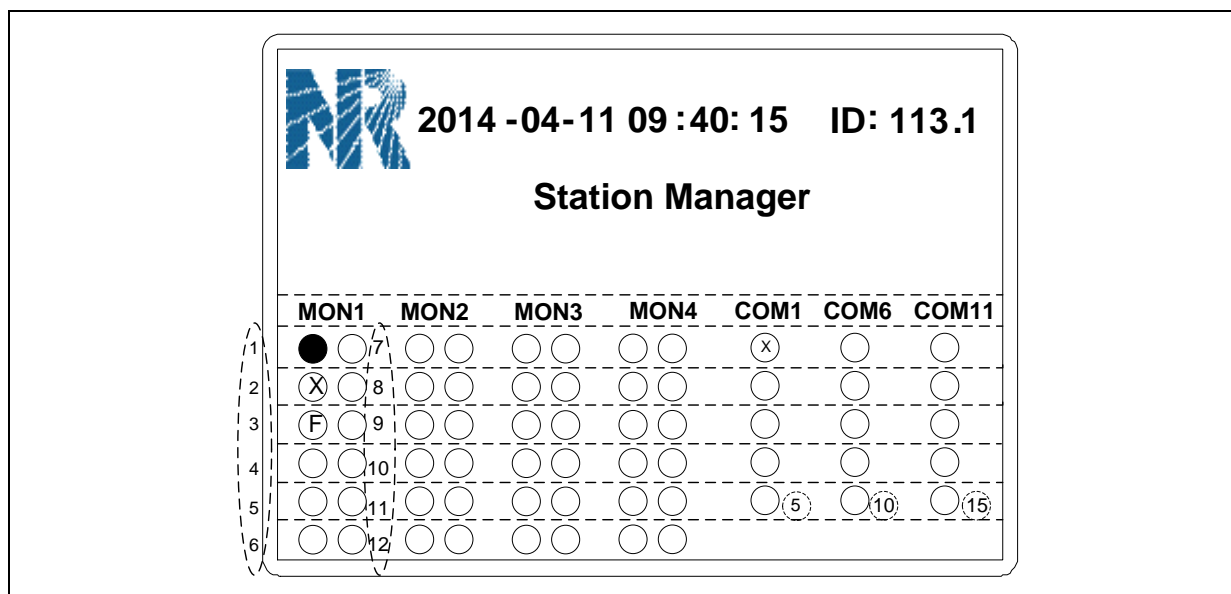
MON plug-in module is equipped with two or four 100Base-TX Ethernet interface. Take NR4106MB as an example, its rear view and the definition of terminals are shown in the following figure.

The Ethernet port can be used to communication with PC via auxiliary software (PCS-Explorer) after connecting the device with PC, so as to fulfill on-line function (please refer to the instruction manual of PCS-Explorer). At first, the connection between the device and PC must be established. Through setting the IP address and subnet mask of corresponding Ethernet interface in the menu "**Settings -> Comm Settings -> IP**", it should be ensured that the device and PC are in the same network segment. For example, setting the IP address and subnet mask of network A. (using network A to connect with PC)

PC: IP address is set as "198.87.96.102", subnet mask is set as "255.255.255.0"

The IP address and subnet mask of device should be [IP\_LAN1] = 198.87.96.XXX, [Mask\_LAN1] = 255.255.255.0, [En\_LAN1] = 1. (XXX can be any value from 0 to 255 except 102)

## 8.2 LCD Display



This is the normal display of the LCD, each circle on the LCD represents the communication state of each port. The "MON" represents the MON module where the 12 circles represent the 12

Ethernet ports. The "COM" represents the COM module of which each has 5 serial or modem ports.

The meaning of the circles:

●: This port is enabled and the communication is ok.

⊗: This port is enabled but the communication is abnormal.

Ⓢ: This port is enabled, but the physical connection is abnormal.

○: This port is disabled.

## 8.3 Menu Tree



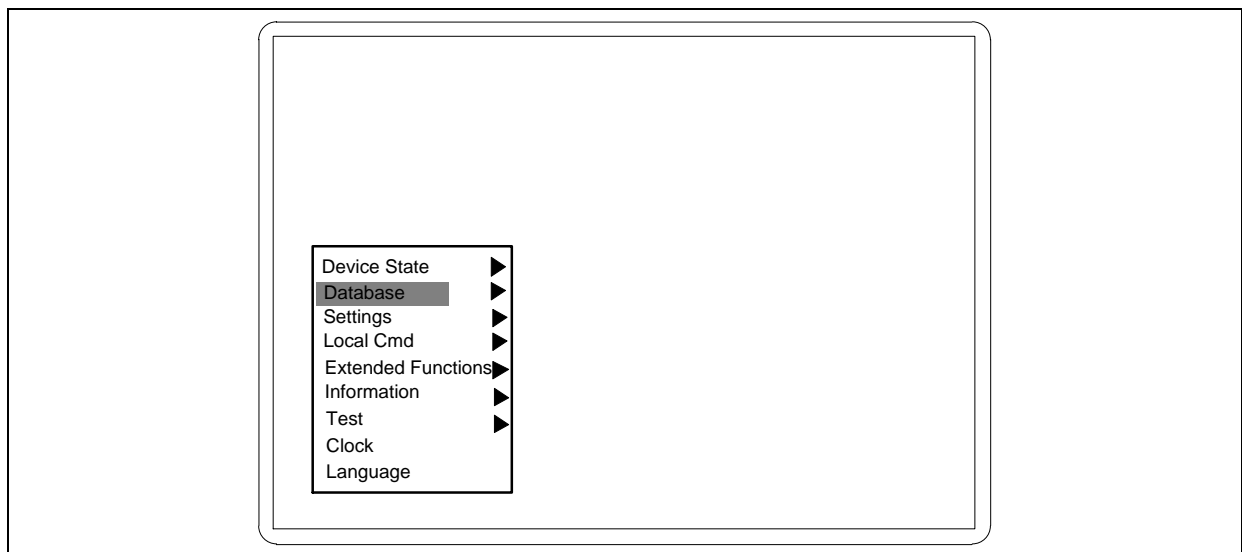
### Note!

According to different applications in different engineering requirements, display of menu in HMI may be different.

The descriptions about menu are based on the maximized configuration, for a specific project, if some function is not available, the corresponding submenu will be hidden.

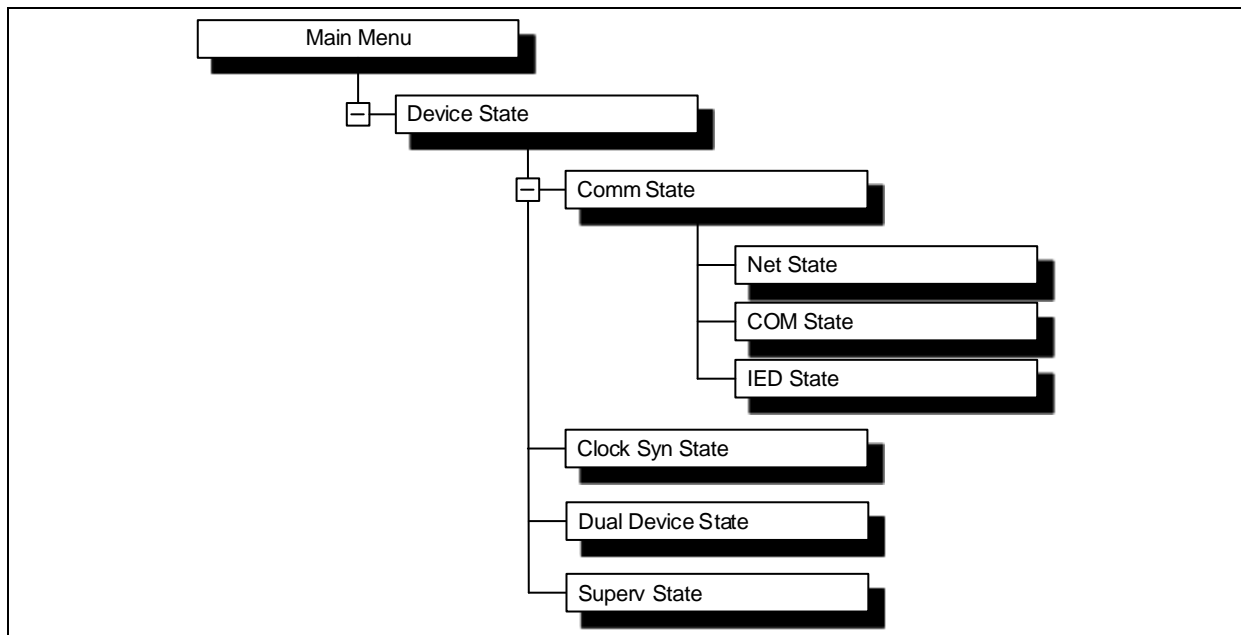
### 8.3.1 Main Menu

Press "▲" of any running interface and enter the main menu. Select different submenu by "▲" and "▼". Enter the selected submenu by pressing "ENT" or "▶". Press "◀" and return to the previous menu. Press "ESC" back to main menu directly.



The menu of this device is organized into main menu and submenus, much like a PC directory structure. The menu of this device is divided into several sections.

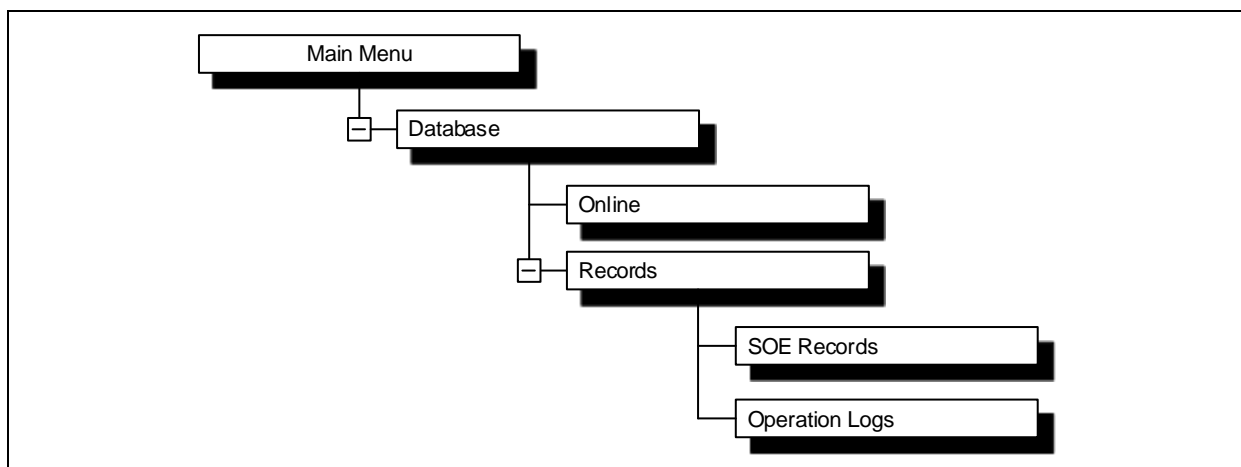
### 8.3.2 Device State



This menu is mainly used to display some real-time states, including communication state, co-operated device state and self-supervision states.

No.	Item	Function description	
1	Comm State	To display the states of the communication with IEDs connected to this device.	
		Net State	The communication states of the Ethernet ports.
		COM State	The communication states of the serial ports and modem ports.
		IED State	The communication states of the connected IEDs.
2	Clock Syn State	To display the state of the clock synchronization.	
3	Dual Device State	To display the state of the co-operated device.	
4	Superv State	To display the alarms of self-supervision.	

### 8.3.3 Database

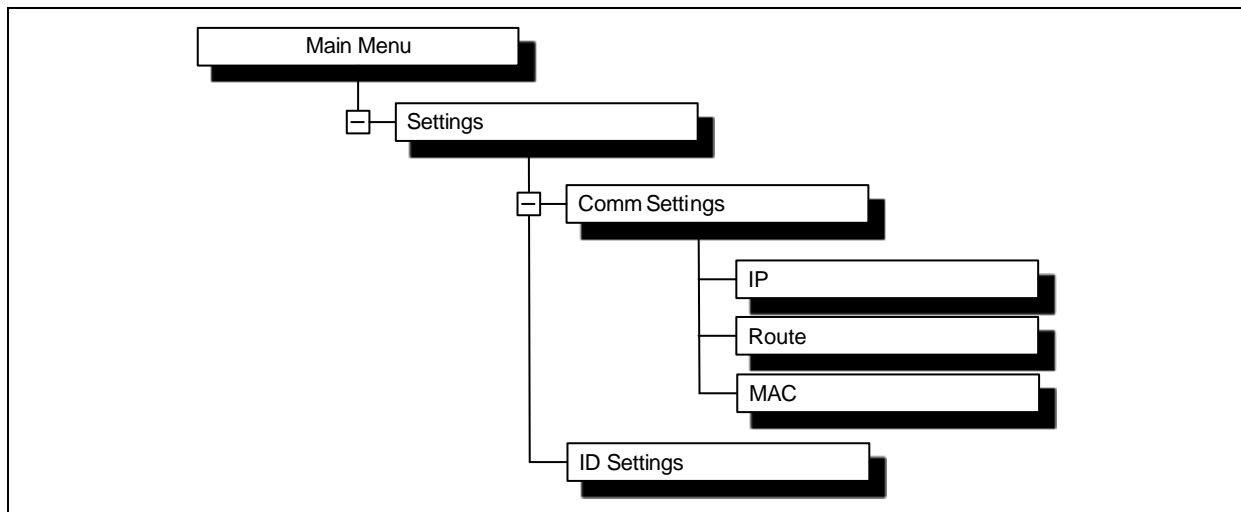




This menu is mainly used to display the state of the real-time and historical data.

No.	Item	Function description	
1	Online	To display all the real-time data including the binary inputs, the measurements, the tap positions, the metering data, the settings, parameters and etc.	
2	Records	To display all the historical data, including SOE reports and operation reports.	
		SOE Records	To display the SOE (sequence of event) reports.
		Operation Logs	To display the operation logs.

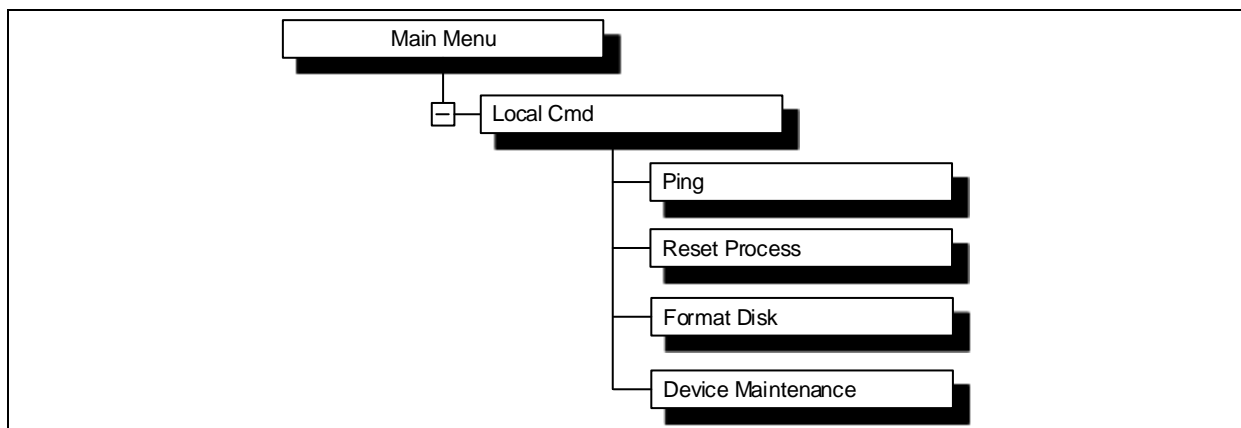
### 8.3.4 Settings



This menu is used to configure the parameters of the device, which include the device address, ID, IP address, MAC address, the route table etc.

No.	Item	Function description	
1	Comm Settings	To display and set and set the IP, MAC address and the route table.	
		IP	To display and set IP address.
		Route	To display and set the route table.
		MAC	To display MAC address.
2	ID Settings	To display and set and set the device's identification in the network.	

### 8.3.5 Local Command



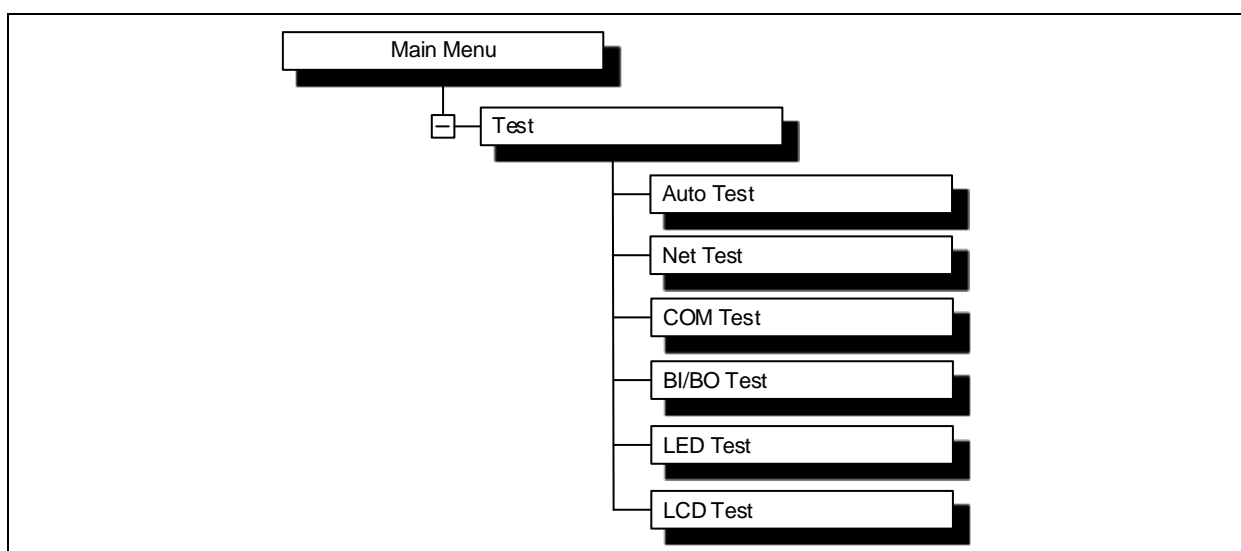
This menu is used to do certain operation locally via HMI.

No.	Item	Function description
1	Ping	To start an Ethernet ping test of the specified ranged addresses.
2	Reset Process	To reset the progress of a selected application.
3	Format Disk	To format the storage disk of this device.
4	Device Maintenance	To indicate the maintenance state of the device in communication.

### 8.3.6 Information

This menu is mainly used to display the version of the firmware, the version of the configuration and the time of downloading the configuration.

### 8.3.7 Test



This menu is used to self-test the device.

No.	Item	Function description
1	Auto Test	To entirely start all the above tests automatically.

No.	Item	Function description
2	Net Test	To start the communication test of the Ethernet ports.
3	COM Test	To start the communication test of the serial ports and modem ports.
4	BI/BO Test	To start the contact test of the IO module.
5	LED Test	To start the light test of the LED indicators.
6	LCD Test	To start the pixel check of the LCD display.

### 8.3.8 Clock

This menu is mainly used to view and modify the current time of the internal clock in this device.

### 8.3.9 Language

This menu is used to set the LCD display language with "+" or "-".



## **9 Configurable Function**

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## 9.1 Overview

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

The PCS series communication device is the new generation of communication device produced by NR Electric on the research of integrated automation system and the site operation experience over years. The PCS-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.



### Note!

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

## 9.2 Function

The following functions are included:

- Configuration and management of IED in station: This tool can configure all the IEDs connected to the PCS 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 PCS 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 PCS 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 PCS series communication device, and the device status can be viewed and debugged online through the tool.

## 9.3 Application

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

- Power system

The integrated automation system of a new substation (traditional, digitalized, various voltage



levels)

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 Communication

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## 10.1 Overview

This section outlines the remote communications interfaces of this device. This device supports several protocols (server & client) via the rear communication interfaces. The standard protocols provided by the device are instructed in this chapter.

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 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 device.



### Note!

A special demand besides the standard protocols described in this chapter must be declared obviously and clearly in the technic sheet and the contract. Please pay attention and provide detailed protocol demand when ordering.

## 10.2 Rear Communication Port

### 10.2.1 RS-485 Interface

This device provides several rear RS-485 communication ports, and each port has three terminals in the connector located on the back of the device 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.

#### 10.2.1.1 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.

#### 10.2.1.2 Bus Termination

The EIA RS-485 bus must have 120Ω (Ohm) ½ Watt terminating resistors fitted at either end across the signal wires (refer to the following figure). 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.

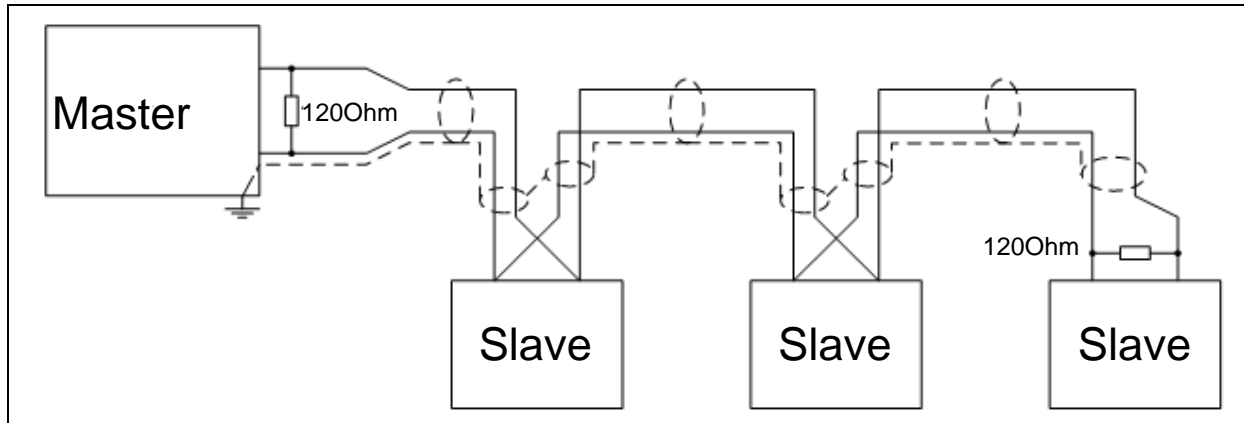


Figure 10.2-1 EIA RS-485 bus connection arrangements

### 10.2.1.3 Bus Connections & Topologies

The EIA RS-485 standard requires that each device be 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.

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.

### 10.2.1.4 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.

**Note!**

It is extremely important that the 120Ω termination resistors be 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, NR cannot assume responsibility for any damage that may occur to a device connected to the network because 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.

### 10.2.2 Ethernet Interface

This 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**".

#### 10.2.2.1 Ethernet Standardized Communication Cable

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

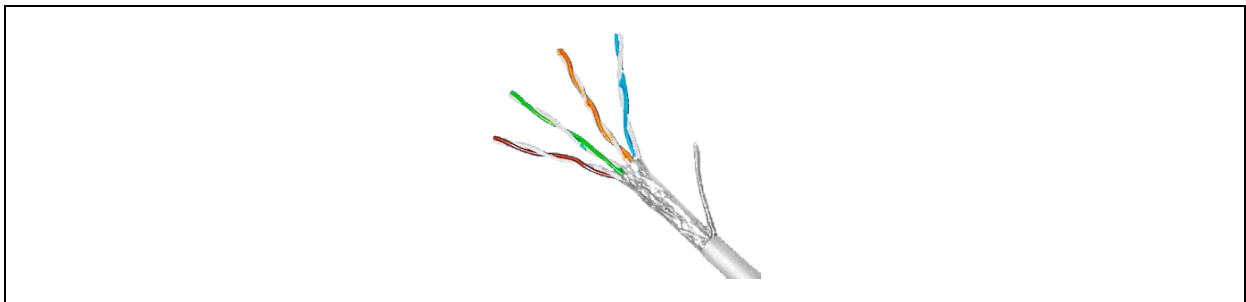


Figure 10.2-2 Ethernet communication cable

#### 10.2.2.2 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 connected to the exchanger and will play a role as master station, other equipment connected to the exchanger will play a role as slave unit.

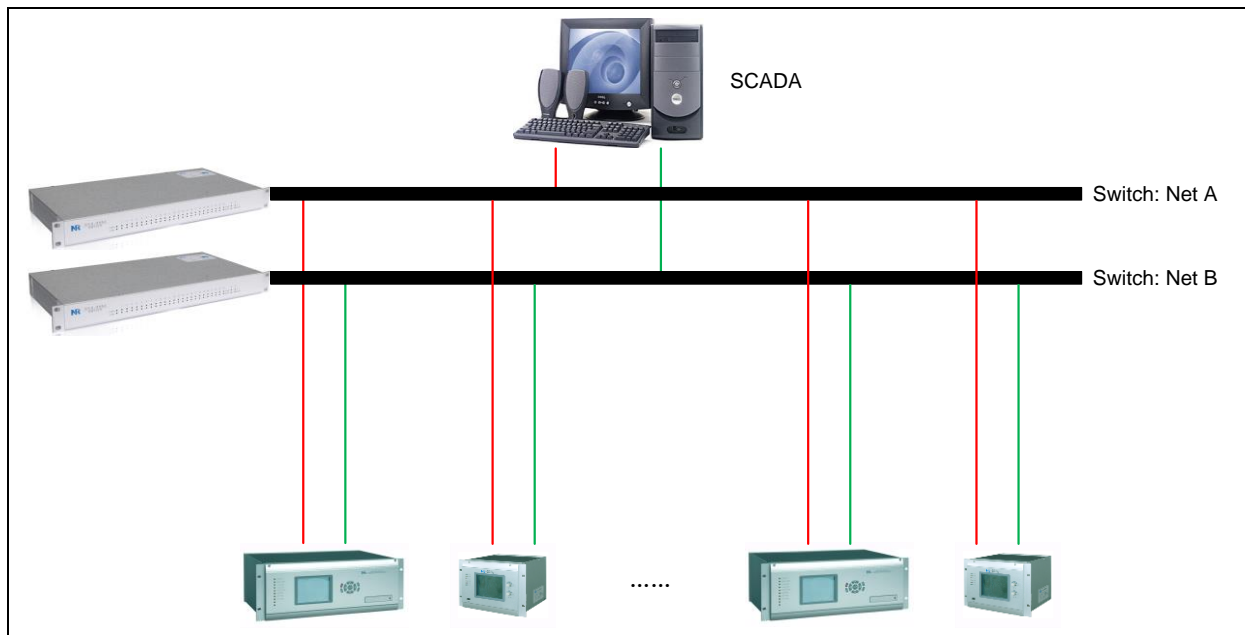


Figure 10.2-3 Ethernet communication structure

### 10.3 IEC60870-5-103 Interface over Serial Port

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

The device conforms to compatibility level 3.

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

1. Initialization (reset)
2. Time synchronization
3. Event record extraction
4. General interrogation
5. General commands
6. Disturbance records

#### 10.3.1 Physical Connection and Link Layer

Two EIA RS-485 standardized ports are available for IEC60870-5-103 in this 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.

#### 10.3.2 Initialization

Whenever the device has been powered up, or if the communication parameters have been changed, a reset command is required to initialize the communications. The 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 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.

### 10.3.3 Time Synchronization

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

### 10.3.4 Spontaneous Events

Events are categorized using the following information:

1. Type identification (TYP)
2. Function type (FUN)
3. 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.

### 10.3.5 General Interrogation

The GI can be used to read the status of the device, 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.

### 10.3.6 General Service

The generic functions can be used to read the setting and measurement of the 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.

### 10.3.7 Disturbance Records

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

## 10.4 Brief of IEC 61850 Protocol

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:

1. IEC 61850-1: Introduction and overview
2. IEC 61850-2: Glossary
3. IEC 61850-3: General requirements
4. IEC 61850-4: System and project management
5. IEC 61850-5: Communications and requirements for functions and device models
6. IEC 61850-6: Configuration description language for communication in electrical substations related to IEDs
7. IEC 61850-7-1: Basic communication structure for substation and feeder equipment—Principles and models
8. IEC 61850-7-2: Basic communication structure for substation and feeder equipment - Abstract communication service interface (ACSI)
9. IEC 61850-7-3: Basic communication structure for substation and feeder equipment—Common data classes
10. IEC 61850-7-4: Basic communication structure for substation and feeder equipment—Compatible logical node classes and data classes
11. 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
12. IEC 61850-9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link
13. IEC 61850-9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3
14. 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.

## 10.5 Brief of IEC 60870-5-101 Protocol

IEC 60870-5-101 is a standard for power system monitoring, control & associated communications for telecontrol, teleprotection, and associated telecommunications for electric power systems. This



is completely compatible with IEC 60870-5-1 to IEC 60870-5-5 standards and uses standard asynchronous serial tele-control channel interface between DTE (Data Terminal Equipment) and DCE (Data Circuit-terminating Equipment). The standard is suitable for multiple configurations like point-to-point, star, multidropped etc.

### 10.5.1 Features

- Supports unbalanced (only master initiated message) & balanced (can be master/slave initiated) modes of data transfer.
- Link address and ASDU (Application Service Data Unit) addresses are provided for classifying the end station and different segments under the same.
- Data is classified into different information objects and each information object is provided with a specific address.
- Facility to classify the data into high priority (class-1) and low priority (class-2) and transfer the same using separate mechanisms.
- Possibility of classifying the data into different groups (1-16) to get the data according to the group by issuing specific group interrogation commands from the master & obtaining data under all the groups by issuing a general interrogation.
- Cyclic & Spontaneous data updating schemes are provided.
- Facility for time synchronization
- Schemes for transfer of files-Example: IED's will store disturbance recorder file in the memory, When electrical disturbance is occurred in the field. This file can be retrieved through IEC104 protocol for fault analysis

### 10.5.2 Frame Format

Character format of IEC 101 uses 1 start bit, 1 stop bit, 1 parity bit & 8 data bits. FT1.2 (defined in IEC 60870-5-1) is used for frame format of IEC 101 which is suitable for asynchronous communication with hamming distance of 4. This uses 3 types of frame formats - Frame with variable length ASDU, Frame with fixed length & single character. Single character is used for acknowledgments, fixed length frames are used for commands & variable lengths are used for sending data.

### 10.5.3 Types supported

- Single indication without / with 24 / with 56 bit timestamps.
- Double indication without / with 24 / with 56 bit timestamps.
- Step position information without / with 24 / with 56 bit timestamps.
- Measured value – normalized, scaled, short floating point without / with timestamps.
- Bitstring of 32 bit without / with timestamps.
- Integrated totals (counters) without / with timestamps.

- Packed events (start & tripping ) of protection equipments
- Single commands
- Double commands
- Regulating step command
- Set point commands of various data formats
- Bitstring commands
- Interrogation commands
- Clock synchronization & delay acquisition commands
- Test & reset commands

## 10.6 Brief of IEC 60870-5-104 Protocol

IEC 60870-5-104 protocol is an extension of IEC101 protocol with the changes in transport, network, link & physical layer services to suit the complete network access. The standard uses an open TCP/IP interface to network to have connectivity to the LAN (Local Area Network) and routers with different facility (ISDN, X.25, Frame relay etc.) can be used to connect to the WAN (Wide Area Network). Application layer of IEC 104 is preserved same as that of IEC101 with some of the data types and facilities not used. There are two separate link layers defined in the standard, which is suitable for data transfer over Ethernet & serial line (P2P Point-to-Point Protocol). The control field data of IEC104 contains various types of mechanisms for effective handling of network data synchronization.

# 11 Installation

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## 11.1 Overview

The device must be shipped, stored and installed with the greatest care.

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

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

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

## 11.2 Safety Information

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.



### **DANGER!**

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



### **WARNING!**

Only insert or withdraw other modules while the power supply is switched off.



### **WARNING!**

The modules may only be inserted in the slots designated in *Section 6.2*. Components can be damaged or destroyed by inserting boards in the wrong slots.



### **DANGER!**

Improper handling of the equipment can cause damage or an incorrect response of the equipment itself or the primary plant.



### **WARNING!**

Industry packs and ribbon cables may only be replaced or the positions of jumpers be changed on a workbench appropriately designed for working on electronic equipment.

The modules, bus backplanes are sensitive to electrostatic discharge when not in the unit's housing.

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

1. Should boards have to be removed from this device installed in a grounded cubicle in an HV switchgear installation, please discharge yourself by touching station ground (the cubicle) beforehand.
2. Only hold electronic boards at the edges, taking care not to touch the components.
3. Only works on the board which has 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.
4. Always store and ship the electronic boards in their original packing. Place electronic parts in electrostatic screened packing materials.

### 11.3 Check Shipment

Check that the consignment is complete immediately upon receipt. Notify the nearest NR 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 NR 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 *Chapter "Technical Data"*.

### 11.4 Material and Tools Required

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

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

### 11.5 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. Surge voltages of high amplitude and short rise time, extreme changes of temperature, high levels of humidity, severe vibration and strong induced magnetic fields should be avoided as far as possible.
3. Air must not 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).



### WARNING!

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

## 11.6 Mechanical Installation

This device is made of single layer 4U chassis. The following figures show the dimensions and cut-out size in the cubicle for reference in mounting.

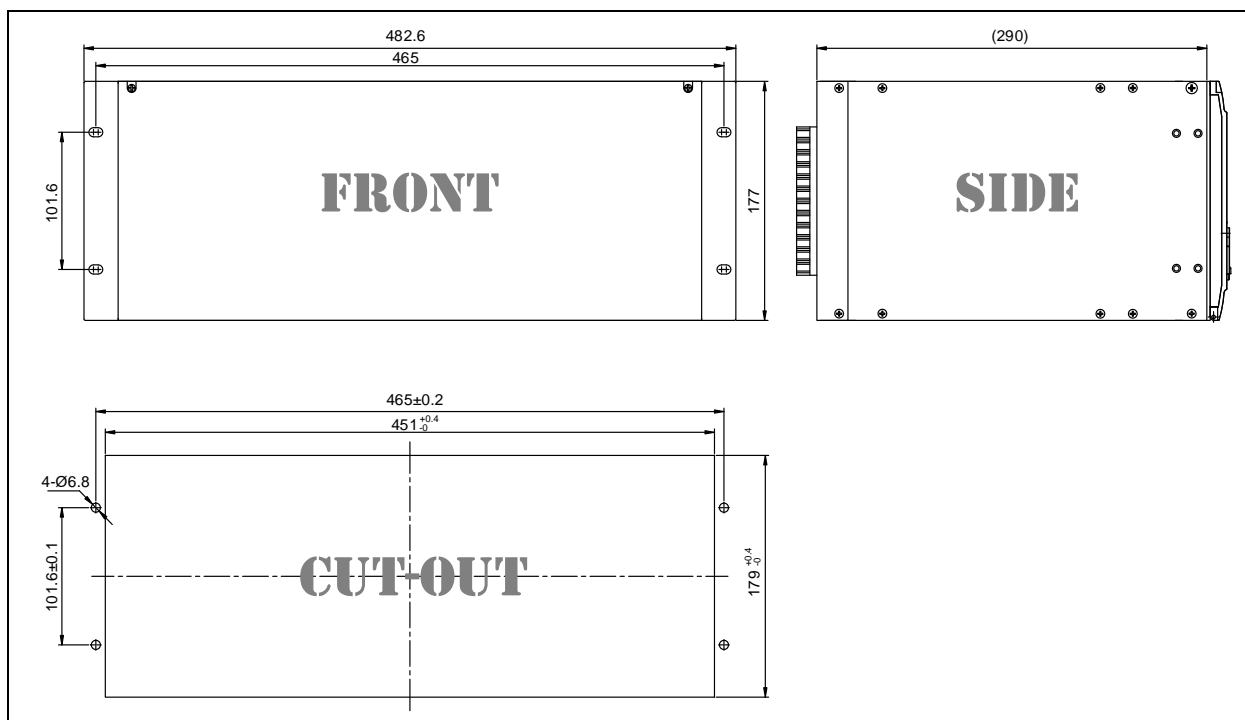


Figure 11.6-1 Dimensions (full-width chassis, rear wiring, unit: mm)



### Note!

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

The following figure shows the installation way of a module being plugged into a corresponding slot.



**Figure 11.6-2 Demonstration of module insertion**

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.

## 11.7 Electrical Installation and Wiring

### 11.7.1 Grounding Guidelines

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.



**Note!**

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

### 11.7.2 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.



**Note!**

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 11.7-1*).

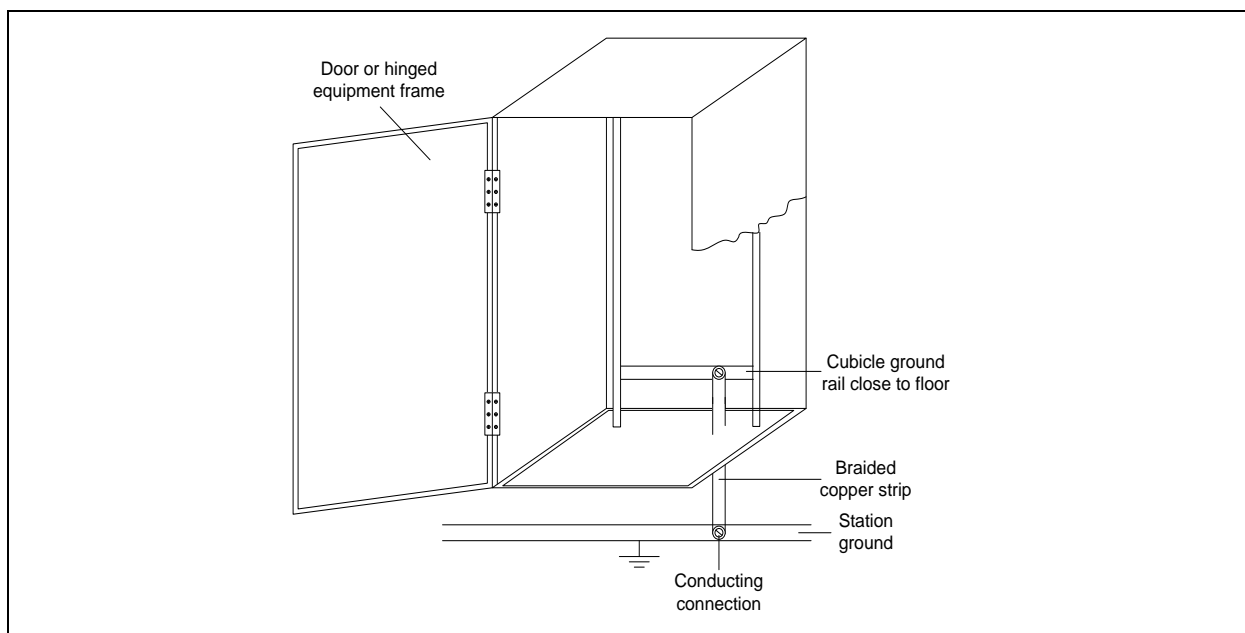
The metal parts of the cubicle housing and the ground rail are interconnected electrically conducting and corrosion proof. The contact surfaces shall be as large as possible.



**Note!**

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 11.7-1 Cubicle grounding system**

### 11.7.3 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 device, and the sign is “GND”. All the ground terminals are connected in the cabinet of this device. Therefore, the ground terminal on the rear panel (see *Figure 11.7-2*) is the only ground terminal of this device.



Figure 11.7-2 Ground terminal of this device

### 11.7.4 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.

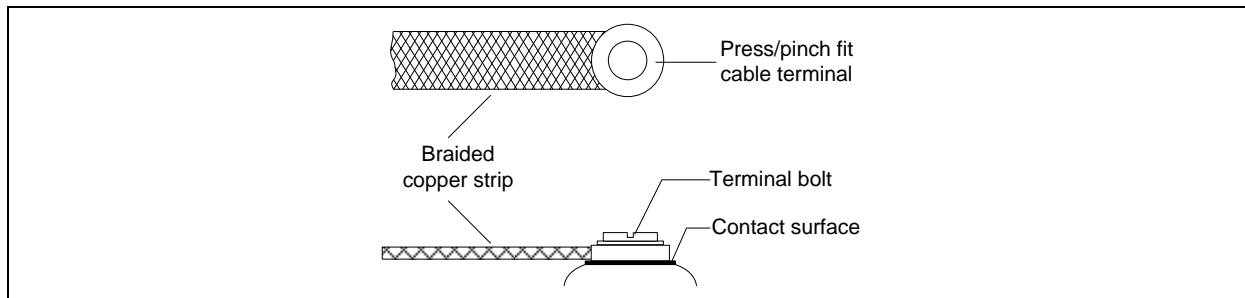


Figure 11.7-3 Ground strip and termination

### 11.7.5 Guidelines for Wiring

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

1. Grounding: braided copper cable,  $2.5\text{mm}^2 \sim 6.0\text{mm}^2$
2. Power supply, binary inputs & outputs: braided copper cable,  $1.0\text{mm}^2 \sim 2.5\text{mm}^2$
3. AC voltage inputs: braided copper cable,  $1.0\text{mm}^2 \sim 2.5\text{mm}^2$
4. AC current inputs: braided copper cable,  $1.5\text{mm}^2 \sim 4.0\text{mm}^2$
5. Serial communication: 4-core shielded braided cable
6. Ethernet communication: 4-pair shielded twisted category 5E cable

## 12 Commissioning

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## 12.1 Overview

This device is numerical in their design, implementing all functions in software. The device employs a high degree self-checking so in the unlikely event of a failure, it will give an alarm.

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.

## 12.2 Safety Instruction



### WARNING!

Hazardous voltages are present in this electrical equipment during operation. Non-observance of the safety rules can result in severe personal injury or property damage.



### WARNING!

Only the qualified personnel shall work on and around this equipment after becoming thoroughly familiar with all warnings and safety notices of this manual as well as with the applicable safety regulations.

Particular attention must be drawn to the following:

1. The earthing screw of the device must be connected solidly to the protective earth conductor before any other electrical connection is made.
2. Hazardous voltages can be present on all circuits and components connected to the supply voltage or to the measuring and test quantities.
3. Hazardous voltages can be present in the device even after disconnection of the supply voltage (storage capacitors!)
4. The limit values stated in the *Chapter "Technical Data"* must not be exceeded at all, not even during testing and commissioning.
5. 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 may be close commands to the circuit breakers and other primary switches are disconnected from the device unless expressly stated.



### DANGER!

Current transformer secondary circuits must have been short-circuited before the current leads to the device are disconnected.

**WARNING!**

Primary test may only be carried out by qualified personnel, who are familiar with the commissioning of the system, the operation of the plant and safety rules and regulations (switching, earthing, etc.).

## 12.3 Commission Tool

**Minimum equipment required:**

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

**Note!**

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

**Optional equipment:**

1. An electronic or brushless insulation tester with a DC output not exceeding 500V (for insulation resistance test when required).
2. 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).
3. EIA RS-485 to EIA RS-232 converter (if EIA RS-485 IEC60870-5-103 port is being tested).
4. Tester: HELP-9000.

## 12.4 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 device is contained in *Chapter "Operation Theory" and Chapter "Settings"*.

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 PCS-9700 HMI 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.

## 12.5 Product Check

These product checks cover all aspects of the device 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 device 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 device itself via printer or manually creating a setting record.

### 12.5.1 With the Device De-energized

This device 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.

#### 1. 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 DC power is supplied.

2. User interfaces test
3. Binary input circuits and output circuits test
4. AC input circuits test
5. Function tests

These tests are performed for the following functions that are fully software-based.

1. Measuring elements test
2. Timers test
3. Conjunctive tests

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

1. On load test.
2. Phase sequence check and polarity check.

#### 12.5.1.1 Visual Inspection

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

1. Device panel

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

### 2. 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.

### 3. Device 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.

### 4. Earthing cable

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

### 5. 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.

#### 12.5.1.2 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:

1. Voltage transformer circuits
2. Current transformer circuits
3. DC power supply
4. Optic-isolated control inputs
5. Output contacts
6. Communication ports

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

#### Test method:

To unplug all the terminals sockets of this device, 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 device.



### 12.5.1.3 External Wiring

Check that the external wiring is correct to the relevant device 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.

### 12.5.1.4 Auxiliary Power Supply

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

The incoming voltage must be within the operating range specified in *Chapter "Technical Data"*, before energizing the device, measure the auxiliary supply to ensure it within the operating range.

Other requirements to the auxiliary power supply are specified in *Chapter "Technical Data"*. See this section for further details about the parameters of the power supply.



#### **WARNING!**

Energize this device only if the power supply is within the specified operating ranges in *Chapter "Technical Data"*.

## 12.5.2 With the Device Energized

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

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

### 12.5.2.1 Front Panel LCD Display

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

### 12.5.2.2 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 battery 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 device for approximately 30s. After being re-energized, the time and date should be correct.

### 12.5.2.3 Light Emitting Diode (LED)

On power up, the green LED "**HEALTHY**" should have illuminated and stayed on indicating that the device is healthy.

The device has latched signal devices which remember the state of the trip, auto-reclose when the device 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.

### 12.5.2.4 LED Test

1. Apply the rated DC 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 the equipment find serious errors in it.
2. Produce one of the abnormal conditions listed in *Chapter "Supervision"*, the "**ALARM**" LED will light in yellow. When abnormal condition reset, the "**ALARM**" LED extinguishes.
3. Switch the remote/local control mode of the device to verify it will not transmit any remote control command if the "**REMOTE**" LED is off.
4. The "**CO-DEV OK**" LED is lighting in green if the dual-device mode is applied. Switch of the other device to check if the LED is off.
5. The "**SYNC**" LED is lighting in green if a time synchronization source is connected to the device and the signal is normal. The LED will be off if there is no signal or the signal is abnormal.

### 12.5.2.5 Binary status change test

This test verifies the correctness and the transmission response time of remote signalisation of binary status' change.

#### Steps of test:

1. Select the device to test.
2. According to the terminal arrangement of the device, produce certain change of binary status (0->1 or 1->0).
3. Register the data and compare it to the display of SCADA and gateway.
4. Verify the response time of SCADA and gateway.



#### Note!

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 its operating range.

Cabinet name		Cabinet No.	Contact No.	Device type	Device address	
No.	Real status	Device display	SCADA		Gateway	
			Display	response time	Display	response time
1						
2						
3						
.....						

### 12.5.2.6 Remote control test

This test verifies the sequence and correctness of remote control.

#### Steps of test:

1. Select the the primary switchgear to control.
2. Send a remote control command from Dispatching Centre or SCADA or local control device.
3. Verify the result of remote control.
4. Verify the response time of SCADA and gateway in using a multimeter on the output contact.



#### Note!

See the external connection diagram for the position of output contact.

No.	Device type	Device address	Control object	Open	Close	Response time
1						
2						
3						
.....						

### 12.5.2.7 SOE record test

This test verifies the correctness and response time of SOE record.

#### Steps of test:

1. Select the three devices to test.
2. For each device, connect 10 binary inputs in parallel and produce a change of status together
3. Verify and compare the recording time of SCADA and the local device.

Cabinet name	Cabinet No.	Contact No.	Device type	Device address

No.	Real status	SOE recording time	
		Device	SCADA
1			
2			
3			
.....			

### 12.5.3 On-load Check

The objectives of the on-load checks are:

1. Confirm the external wiring to the current and voltage inputs is correct.
2. Measure the magnitude of on-load current and voltage (if applicable).
3. 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 device 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.

### 12.6 Final Check

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 device 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 device has been restored to service.

If the device 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 device is put into service.

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



## 13 Maintenance

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This device is designed to require no special maintenance. All measurement and signal processing circuit are fully solid state. All input modules are also fully solid state. The output relays are hermetically sealed.

Since the device is almost completely self-monitored, from the measuring inputs to the output relays, hardware and software defects are automatically detected and reported. The self-monitoring ensures the high availability of the device and generally allows for a corrective rather than preventive maintenance strategy. Therefore, maintenance checks in short intervals are not required.

Operation of the device is automatically blocked when a hardware failure is detected. If a problem is detected in the external measuring circuits, the device normally only provides alarm messages.

### 13.1 Appearance Check

1. The device case should be clean without any dust stratification. Case cover should be sealed well. No component has any mechanical damage and distortion, and they should be firmly fixed in the case. Device terminals should be in good condition. The keys on the front panel with very good feeling can be operated flexibly.
2. It is only allowed to plug or withdraw device board when the supply is reliably switched off. Never allow the CT secondary circuit connected to this equipment to be opened while the primary system is live when withdrawing an AC module. Never try to insert or withdraw the device board when it is unnecessary.
3. Check weld spots on PCB whether they are well soldered without any rosin joint. All dual inline components must be well plugged.

### 13.2 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 event record. Failures detected by supervision are traced by checking the “**Superv State**” screen on the LCD.

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

1. Test circuit connections are correct
2. Modules are securely inserted in position
3. Correct DC power voltage is applied
4. Correct AC inputs are applied
5. Test procedures comply with those stated in the manual

### 13.3 Module Replacement

If the failure is identified to be in the device module and the user has spare modules, the user can

recover the device 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 (AI, PWR, MON, BI, BO, etc.) and hardware type-form as the removed module. Furthermore, the MON module replaced should have the same software version. In addition, the AI and PWR module replaced should have the same ratings.

The module name is indicated on the top front of the module. The software version is indicated in LCD menu "**Information**"->"**Version Info**".



### Caution!

When handling a module, take anti-static measures such as wearing an earthed wristband and placing modules on an earthed conductive mat. Otherwise, many of the electronic components could suffer damage.

#### 1. Replacing a module

- 1) Switch off the DC power supply
- 2) Disconnect the trip outputs
- 3) Short circuit all AC current inputs and disconnect all AC voltage inputs
- 4) Unscrew the module connector
- 5) Unplug the connector from the target module.
- 6) Unscrew the module.
- 7) Pull out the module
- 8) Inset the replacement module in the reverser procedure.
- 9) After replacing the MON module, input the application-specific setting values again.



### Warning!

Hazardous voltage can be present in the DC circuit just after switching off the DC power supply. It takes approximately 30 seconds for the voltage to discharge.

#### 2. Replacing the Human Machine Interface Module (front panel)

- 1) Open the device front panel
- 2) Unplug the ribbon cable on the front panel by pushing the catch outside.
- 3) Detach the HMI module from the device
- 4) Attach the replacement module in the reverse procedure.



**Warning!**

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.

**Warning!**

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

**Danger!**

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 devices not functioning correctly. Persons may also be put in danger.

## 13.4 Cleaning

Before cleaning the device, ensure that all AC/DC supplies, current transformer connections are isolated to prevent any chance of an electric shock whilst cleaning. Use a smooth cloth to clean the front panel. Do not use abrasive material or detergent chemicals.

## 13.5 Storage

The spare device or module should be stored in a dry and clean room. Based on IEC standard 60255-1 the storage temperature should be from -40°C to +70°C, but the temperature of from 0°C to +40°C is recommended for long-term storage.





## 14 Decommissioning and Disposal

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## 14.1 Decommissioning

### 1. Switching off

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

### 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 PWR module of this device, 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 CTs and VTs, make sure that the circuit breaker for the primary CTs and VTs is switched off.

### 3. Dismantling

The device rack 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.

## 14.2 Disposal

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



**Note!**

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





## 15 Manual Version History

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

### Manual version and modification history records

Manual Version		Software Version	Date	Description of change
Source	New			
	R1.00	R1.00	2015-03-31	Form the original manual.

