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**PCS-9785**

**Satellite-Synchronized Clock  
Instruction Manual**

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**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 be maintained in a safe condition.

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

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

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

Qualified personnel are individuals who:

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

## Instructions and Warnings

The following indicators and standard definitions are used:



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



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



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

**NOTICE!** is particularly applied to device damage and resulting damage of equipment.



### **DANGER!**

**NEVER** allow an open current transformer (CT) secondary circuit connected to this device while the primary system is live. Open CT circuit will produce a dangerously high voltage that causes death.



### **WARNING!**

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



### **WARNING!**

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



### **WARNING!**

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



### **CAUTION!**

- **Earthing**

Securely earth the device earthing terminal.

- **Operating environment**

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

- **Ratings**

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

- **Printed circuit board**

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

- **External circuit**

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

- **Connection cable**

Carefully handle connection cables without applying excessive force.

### **NOTICE!**

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

## **Documentation 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.

### **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, 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 Hardware**

Description of plug-in modules and definition of pins.

### **6 Settings**

Setting lists including system settings, communication settings and etc.

## **7 Human Machine Interface**

Description of the HMI panel, LCD display, menu tree and a detailed operating guide

## **8 Installation**

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

## **9 Commissioning**

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

## **10 Maintenance**

General maintenance policy.

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General decommissioning and disposal policy.

## **12 Appendix**

The demonstration of IRIG-B time code format.

## **13 Revisions History**

List of document modification and update history records.

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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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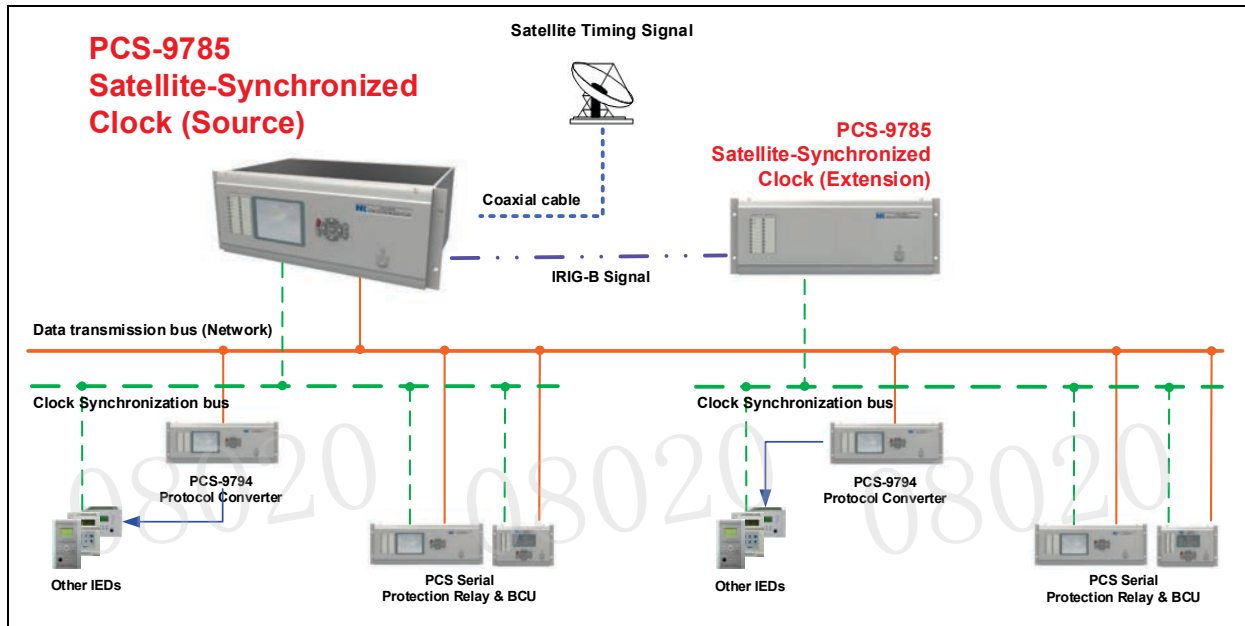
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## 1.1 Overview

The PCS-9785 satellite-synchronized clock is usually used in Substation Automation System (SAS) to satisfy the time unifying requirements of protection relay, disturbance fault recorder and other IEDs. Two kinds of PCS-9785 can be adopted to build a higher reliable and accuracy clock synchronization system in substation. The source clock can receive timing signals from its own GPS/BDS antenna (Master Mode), while the extension clock receives IRIG-B signals from another clock source (Slave Mode).



## 1.2 Features

- **Remote supervision**

This device supports local SCADA and remote control centre communication in using of protocols such as IEC 61850 Ed1.0 & Ed2.0 to realize the device running status supervision.

- **Time service**

This device supports GPS (Global Positioning System) and BDS (BeiDou Navigation Satellite System). In addition, it supports antenna transmission time delay compensation.

- **Signal reception**

This device provides several reception channels for IRIG-B signal via its optical port or RS-485/422 port. In addition, it supports link-based reception time delay compensation.

- **High accuracy**

The device accuracy is high in long term. The punctual error is less than 1μs per hour.

- **IEEE 1588 protocol**

This device supports the IEEE 1588 protocol (BC mode and OC mode) for clock synchronization in SNTP or PRP network.

- **SNTP/NTP protocol**

This device supports the SNTP/NTP protocol and can work as a network time server.

- **PRP/HSR**

This device supports the Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR) protocol.

- **Recording**

Automatically, this device stores all the self-diagnostic record, binary status change and service log in its internal storage.

- **Output clock synchronization signal**

The kinds of output clock synchronization signal is rich, including PPS (Pulse Per Second), PPM (Pulse Per Minute), PPH (Pulse Per Hour), IRIG-B signal, timing message (serial), SNTP/NTP timing message (network), IEEE 1588 signal, etc.

- **Output interface**

Various kinds of output interfaces are provided, including RS-484, RS-232, TTL, dry contact, AC modulation, optic fiber, RJ45, etc.

- **Dual power supplies redundancy**

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

- **Double devices redundancy strategy**

With a interconnection in using of IRIG-B signal, a set of two PCS-9785 can form the "dual device dual network" redundancy strategy to provide a higher reliable and accuracy clock synchronization system.

- **Output interface extension**

The output interface extension is very flexible. In addition, the enormous interfaces are isolated to each other.

- **Easy synchronization bus extension**

It is simple to extend the time synchronization bus by adding a new PCS-9785 extension device.

- **Human machine interface**

The friendly HMI provides large scale LCD and navigation keypad for the display of real time, satellite tracking status, IRIG-B inputting status, current clock source, etc.

## 2 Technical Data

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## **2 Technical Data**

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## 2.1 Electrical Specification

### 2.1.1 Power Supply

|                               |                                           |               |
|-------------------------------|-------------------------------------------|---------------|
| Standard                      | IEC 60255-26:2013                         |               |
| Rated voltage                 | 110Vdc/125Vdc, 220Vdc/250Vdc              | 110Vac/220Vac |
| Operating range               | 88~300Vdc                                 | 88~264Vac     |
| Permissible AC ripple voltage | Max. 15% of the nominal auxiliary voltage |               |
| Burden                        |                                           |               |
| Quiescent condition           | 28W                                       |               |
| Operating condition           | 30W                                       |               |

### 2.1.2 Binary Output for Block/Alarm

|                              |                                                                             |
|------------------------------|-----------------------------------------------------------------------------|
| Output mode                  | Potential free contact                                                      |
| Maximal system voltage       | 380Vac, 250Vdc                                                              |
| Voltage withstand            | 1000V RMS in 1min                                                           |
| Continuous carry             | 8A                                                                          |
| Short duration current       | 12A@3s, 15A@1s, 20A@0.5s, 30A@0.2s                                          |
| Breaking capacity (L/R=40ms) | 0.70A@48Vdc<br>0.40A@110Vdc<br>0.30A@125Vdc<br>0.20A@220Vdc<br>0.15A@250Vdc |
| Pickup time                  | 10ms                                                                        |
| Drop off time                | 6ms                                                                         |
| Durability                   | Min.10,000 operations                                                       |

## 2.2 Mechanical Specification

|                      |                                                          |
|----------------------|----------------------------------------------------------|
| Mounting Way         | Flush mounted                                            |
| Chassis color        | Silver grey                                              |
| Weight per device    | Approx. 8kg                                              |
| 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 60255-1:2009                                         |
| HMI side             | IP51                                                     |
| Terminal side        | IP30                                                     |
| Other sides          | IP50                                                     |

## 2.3 Ambient Temperature and Humidity Range

|          |                  |
|----------|------------------|
| Standard | IEC 60255-1:2009 |
|----------|------------------|

|                                         |                                                                     |
|-----------------------------------------|---------------------------------------------------------------------|
| Operating temperature                   | -25°C to +55°C (Readability of display may be impaired below -20°C) |
| Transport and storage temperature range | -40°C to +70°C                                                      |
| Permissible humidity                    | 5%-95%, without condensation                                        |
| Pollution degree                        | Class 2                                                             |
| Altitude                                | Max. 3000m                                                          |

## 2.4 Communication Port

### 2.4.1 Ethernet Port

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

### 2.4.2 SFP Interface

|                       |                                                  |
|-----------------------|--------------------------------------------------|
| Characteristic        | Glass optical fiber                              |
| Connector type        | LC                                               |
| Fiber type            | Multi-mode (62.5/125μm)                          |
| Transmission distance | Max. 2km                                         |
| Wave length           | 1310nm                                           |
| Transmission power    | Min. -23.0dBm (Avago)<br>Min. -19.0dBm (Yuguang) |
| Receiving power       | Min. -30.0dBm                                    |
| Margin                | Min. +3.0dB                                      |

## 2.5 Clock Synchronization Port

### 2.5.1 Input

#### 2.5.1.1 EIA-485 Port

|                       |                                                                             |
|-----------------------|-----------------------------------------------------------------------------|
| Baud rate             | 1200bps, 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps |
| Protocol              | IEC 60870-5-103:1997                                                        |
| Maximal capacity      | 32                                                                          |
| Transmission distance | Max. 500m                                                                   |
| Safety level          | Isolation to ELV level                                                      |
| Twisted pair          | Screened twisted pair cable                                                 |

#### 2.5.1.2 Optical Port

|                |                     |
|----------------|---------------------|
| Characteristic | Glass optical fiber |
|----------------|---------------------|

|                       |                         |
|-----------------------|-------------------------|
| Connector type        | ST                      |
| Fiber type            | Multi-mode (62.5/125µm) |
| Transmission distance | Max. 2km                |
| Wave length           | 850nm                   |
| Transmission power    | Min. -20.0dBm           |
| Receiving power       | Min. -24.0dBm           |
| Margin                | Min. +3.0dB             |

## 2.5.2 Output

### 2.5.2.1 RS-485/232 Port

|                       |                        |
|-----------------------|------------------------|
| Type                  | Differential           |
| Transmission distance | Max. 500m              |
| Maximal capacity      | 32                     |
| Timing standard       | IRIG-B                 |
| Safety level          | Isolation to ELV level |

### 2.5.2.2 Optical-coupled Contact

|                       |                        |
|-----------------------|------------------------|
| Operating voltage     | Max. 300Vdc            |
| Operating current     | Max. 125mA             |
| Transmission distance | Max. 200m              |
| Safety level          | Isolation to ELV level |

### 2.5.2.3 TTL

|                       |                        |
|-----------------------|------------------------|
| Output voltage        | 0~5V                   |
| Impedance             | 50Ω                    |
| Transmission distance | Max. 100m              |
| Safety level          | Isolation to ELV level |

### 2.5.2.4 AC Modulation

|                       |                        |
|-----------------------|------------------------|
| Connector type        | BNC-3                  |
| Impedance             | 600Ω                   |
| Transmission distance | Max. 2000m             |
| Safety level          | Isolation to ELV level |

### 2.5.2.5 Optical Port

|                 |                         |
|-----------------|-------------------------|
| Characteristic  | Glass optical fiber     |
| Connector type  | ST                      |
| Fibre type      | Multi-mode (62.5/125µm) |
| Wave length     | 850nm                   |
| Receiving power | Min. -25.0dBm           |
| Margin          | Min +3.0dB              |

## 2.6 Type Test

### 2.6.1 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 |

### 2.6.2 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 |

### 2.6.3 Insulation Test

|                       |                                    |
|-----------------------|------------------------------------|
| Standard              | IEC 60255-27-2013                  |
| Dielectric withstand  | 2.8kV, DC, 1min<br>2.0kV, AC, 1min |
| Impulse voltage       | 5kV                                |
| Overvoltage category  | Class III                          |
| Insulation resistance | Min.100MΩ @500Vdc                  |

### 2.6.4 Electromagnetic Compatibility

|                                         |                                                                                                                                     |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1MHz burst disturbance test             | IEC 60255-26-2013, Class III                                                                                                        |
|                                         | Common mode: 2.5kV<br>Differential mode: 1.0kV                                                                                      |
| Electrostatic discharge test            | IEC 60255-26-2013, Class IV                                                                                                         |
|                                         | For contact discharge: ±8kV<br>For air discharge: ±15kV                                                                             |
| Radio frequency interference tests      | IEC 60255-26-2013, Class III                                                                                                        |
|                                         | Frequency sweep<br>Radiated amplitude-modulated<br>10V/m (rms), f=80~1000MHz                                                        |
| Fast transient disturbance tests        | IEC 60255-26-2013, Class IV                                                                                                         |
|                                         | Power supply, I/O, Earth: ±4kV, 5kHz for 15ms, 100kHz for 0.75ms<br>Communication terminals: ±2kV, 5kHz for 15ms, 100kHz for 0.75ms |
| Surge immunity test                     | IEC 60255-26-2013, Class IV                                                                                                         |
|                                         | Power supply, AC input, I/O port: 1.2/50μs<br>Common mode: ±4kV<br>Differential mode: ±2kV                                          |
| Power frequency magnetic field immunity | IEC 61000-4-8:2009, Class V                                                                                                         |
|                                         | 100A/m for 1min, 1000A/m for 3s                                                                                                     |
| Pulse magnetic field immunity           | IEC 61000-4-9:2001, Class V                                                                                                         |

|                                               |                                                                                              |
|-----------------------------------------------|----------------------------------------------------------------------------------------------|
|                                               | 6.4/16 $\mu$ s, 1000A/m                                                                      |
| Conducted RF<br>electromagnetic disturbance   | IEC 60255-26-2013, Class III                                                                 |
|                                               | Power supply, AC, I/O, Comm. Terminal: 10Vrms, 150kHz~80MHz<br>Spot frequency, f=27MHz/68MHz |
| Power frequency immunity                      | IEC 60255-26-2013, Class A                                                                   |
|                                               | Common mode: 300V<br>Differential mode: 150V                                                 |
| Conducted emission                            | IEC 60255-26-2013, Class A                                                                   |
|                                               | f=0.15MHz~0.5MHz/0.5kHz~30MHz                                                                |
| Radiated emission                             | IEC 60255-26-2013, Class A                                                                   |
|                                               | f=30MHz~230MHz/230MHz~1000MHz                                                                |
| Damped oscillatory magnetic<br>field immunity | IEC 61000-4-10:2001, Class V                                                                 |
|                                               | 100kHz & 1MHz, 100A/m                                                                        |
| Power supply performance                      | IEC 60255-26-2013                                                                            |
| - Voltage dip                                 | Max. 200ms for dip to 40% (then recovery) of rated voltage (Un = 220Vdc)<br>without reset    |
| - Voltage short interruption                  | Max. 100ms for interruption of rated voltage (Un = 220Vdc) without reboot                    |

## 2.7 Clock Synchronization Specifications

### 2.7.1 PPS/PPM/PPH

|                    | RS-485   | TTL      | Contact   |
|--------------------|----------|----------|-----------|
| Rising edge (max.) | 50ns     | 50ns     | 200ns     |
| Accuracy (max.)    | 100ns    | 100ns    | 3 $\mu$ s |
| Pulse width        | 10~200ms | 10~200ms | 10~200ms  |

### 2.7.2 IRIG-B DC Code

|                    | RS-485                                                          | TTL   | Contact   |
|--------------------|-----------------------------------------------------------------|-------|-----------|
| Rising edge (max.) | 50ns                                                            | 50ns  | 200ns     |
| Accuracy (max.)    | 100ns                                                           | 100ns | 3 $\mu$ s |
| Format             | B000 (According to IEEE 1344:1995, add "Year" between P50~P58). |       |           |

### 2.7.3 IRIG-B AC Code

|                   |                                                                 |
|-------------------|-----------------------------------------------------------------|
| Carrier waveform  | Sinusoidal wave                                                 |
| Carrier frequency | 1kHz                                                            |
| Voltage magnitude | 0~10V (phase-phase), continuously adjustable                    |
| Modulation ratio  | 3:1                                                             |
| Accuracy          | Max. 15 $\mu$ s                                                 |
| Time code format  | B120 (According to IEEE 1344:1995, add "Year" between P50~P58). |

### 2.7.4 Serial Port Timing Message

|          |                                                                                |
|----------|--------------------------------------------------------------------------------|
| Baudrate | 1200bps, 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps,<br>115200bps |
|----------|--------------------------------------------------------------------------------|

|                     |                        |             |
|---------------------|------------------------|-------------|
| Data format         | Data bits              | 8           |
|                     | Stop bit               | 1           |
|                     | Parity                 | Odd or Even |
| Message format      | Motorola binary format |             |
| Transmission period | 1s                     |             |
| Accuracy            | Max. 1ms               |             |

### 2.7.5 Network

|          |            |
|----------|------------|
| SNTP/NTP | Max. 100μs |
| IEEE1588 | Max. 100ns |

### 2.7.6 GPS Receiver

|                         |                                         |                                                          |
|-------------------------|-----------------------------------------|----------------------------------------------------------|
| Frequency               | 1575.42MHz                              |                                                          |
| Sensitivity (max.)      | Tracking -163dBW<br>Acquisition -160dBW |                                                          |
| Satellites quantity     | Max.12                                  |                                                          |
| Acquisition time (max.) | TTFF-hot                                | 25s (with current almanac, position, time and ephemeris) |
|                         | TTFF-warm                               | 50s (with current almanac, position, and time)           |
|                         | TTFF-cold                               | 200s (no stored information)                             |
|                         | Reacquisition                           | 1s                                                       |
| Accuracy                | Max. 100ns                              |                                                          |

### 2.7.7 BDS Receiver

|                         |               |     |
|-------------------------|---------------|-----|
| Frequency               | 1561.098MHz   |     |
| Sensitivity             | Max. -133dBmW |     |
| Acquisition time (max.) | TTFF-hot      | 3s  |
|                         | TTFF-cold     | 33s |
|                         | Reacquisition | 1s  |
| Accuracy                | Max. 50ns     |     |

### 2.7.8 Time Frequency Measurement

|                 |                       |
|-----------------|-----------------------|
| Rated voltage   | 220Vac (grid voltage) |
| Operating range | 45.000Hz~55.000Hz     |
| Accuracy        | 0.001Hz               |
| Sampling period | 1s                    |

### 2.7.9 Internal Clock

|            |                                  |
|------------|----------------------------------|
| Inaccuracy | Max. $3 \times 10^{-10}$ (1μs/h) |
|------------|----------------------------------|

## 2.8 Certifications

- ISO9001:2008
- ISO14001:2004

- OHSAS18001:2007
- ISO10012:2003
- CMMI L5
- EMC: 2014/30/EU, EN60255-26:2013
- LVD: 2014/35/EU, EN60255-27:2014



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## 3 Operation Theory

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### 3.1 Overview

This device adopts modular design for its hardware and software. For hardware, MON module, CLK module and COM module are integrated. For software, reception function, time service function and output function are integrated.

The PCS-9785 receives standardized time signals, such as BDS, GPS, IRIG-B, via its built-in receiver. After a decode, it converts the source time into IRIG-B, PPS, PPM, PPH signals or timing message, and sends them via various output interfaces.

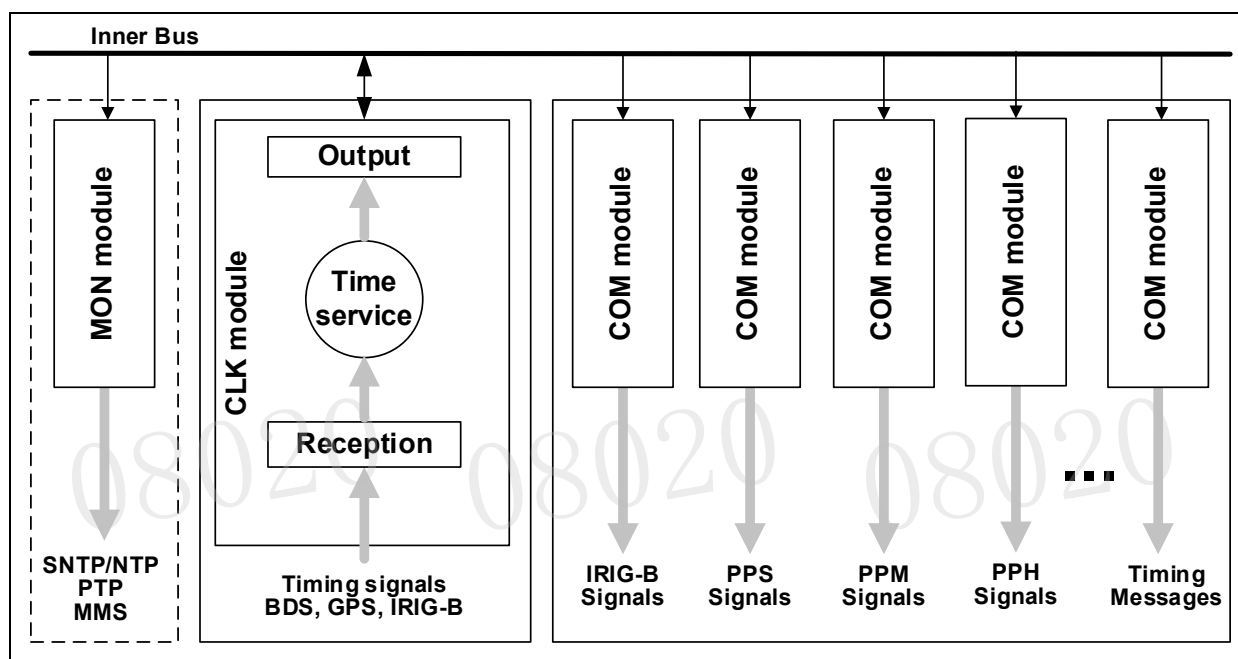


Figure 3.1-1 Operating sketch

#### 3.1.1 Reception Function

The reception function takes the received timing signal as its external time reference. Its main components include antenna, feeder line, low-noise amplifier, surge protector and BDS/GPS receiver.

#### 3.1.2 Time Service Function

The time service function will decode and convert the time reference. Depends on the "Multiple sources judgment" and "Optimization selection", it selects the optimizing external time reference, makes it to be the clock synchronization source, set the source in tracking and fixing status and compensates the transmission delay.

If all external time references are lost, the internal clock will enter the "Punctuality mode" to maintain its accuracy. After the recovery of any external time reference, the internal clock will quit the "Punctuality mode" and takes the "Tracking and fixing mode" again. In this period, there is no influence to the output function.

### 3.1.3 Output Function

The output function converts the internal clock information into various time codes, such as PPS/PPM/PPH, IRIG-B, serial code, SNTP/NTP, IEEE1588, etc. Then, it outputs these time codes via different interfaces, such as TTL, optical-coupled contact, RS-485/422, RS-232, optical fiber, AC modulation, RJ45, etc. for other IEDs.

## 3.2 Double Devices Redundancy Strategy

This device can work in the double devices mode with another one to ensure the time accuracy. The two devices are interconnected by two optical fibers in using of IRIG-B signal.

Normally, each device receives time signal from its own satellite receiver and decodes/converts the signal for output. If the satellite tracking of one of these two devices is lost, the lost will take the interconnection IRIG-B signal as its external time reference. Else if both the two have lost their satellite tracking, the internal clock of the device, which lost its tracking signal later, will be used as the time source.

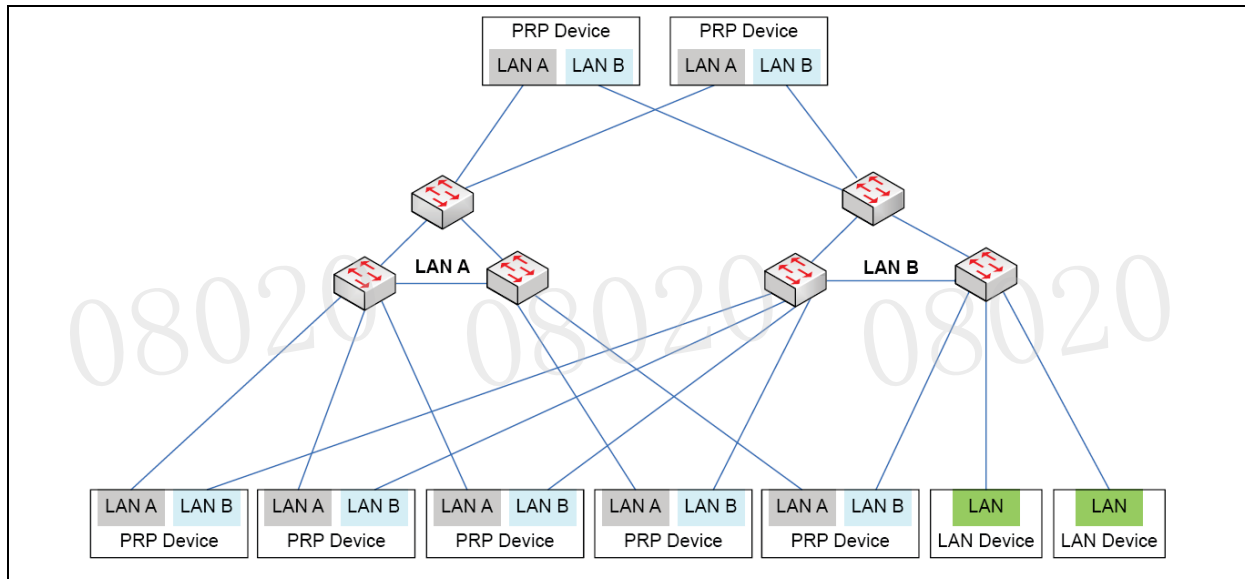
## 3.3 PRP/HSR

### 3.3.1 Parallel Redundancy Protocol (PRP)

#### 3.3.1.1 Network Mode

As same as dual star networks, PRP nodes connect to two completely independent parallel networks, and each node sends two copies of the same packet to LAN A and LAN B respectively, while receiving nodes accept the first packet and discard the second. Both LAN A and LAN B will transmit those messages to receiving nodes, and the receiving nodes will transmit data to application layer.

PRP nodes send two copies of the same packet via PRP network, two copies of the same packet are transmitted via dual switch networks, and receiving nodes make a redundant handling at the data link layer to realize redundant message receiving.

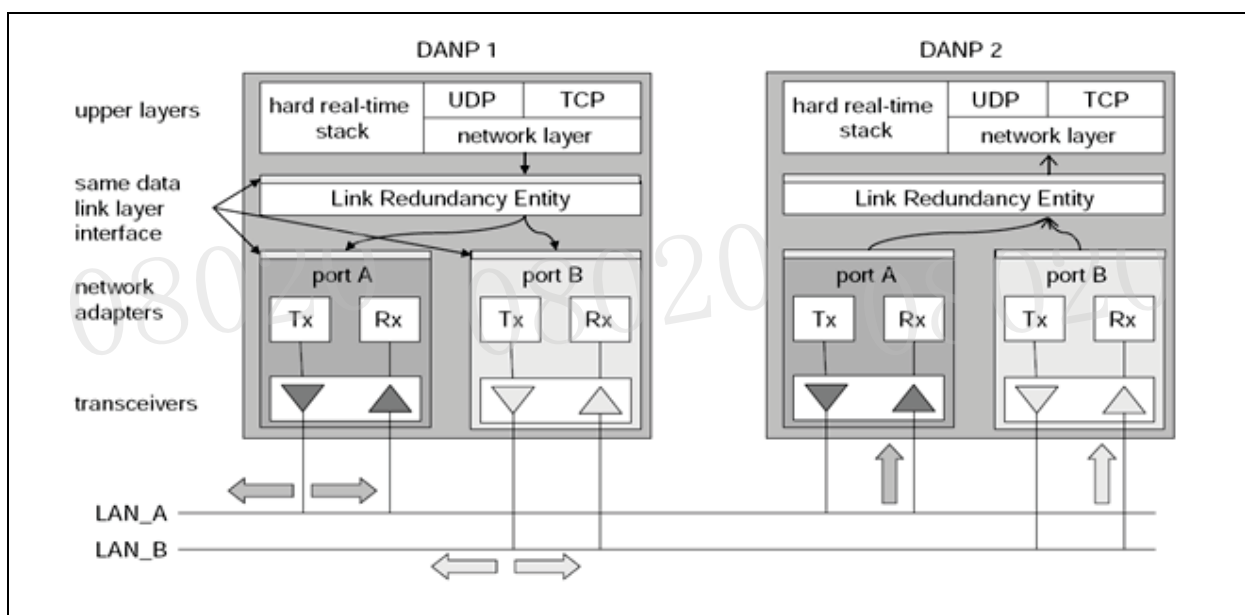


### 3.3.1.2 Receiving and Transmitting

Each node has two ports that operate in parallel and that are attached to the same upper layers of the communication stack through the Link Redundancy Entity (LRE). For the basic communication, the LRE presents toward its upper layers the same interface as a non-redundant network adapter, so the upper layers are unaware of redundancy.

When receiving a frame from the node's upper layers, the LRE appends to the frame a Redundancy Check Trailer (RCT) containing a sequence number and sends the frame through both its ports at nearly the same time. The two frames are nearly identical except for the LAN identifier (and the checksum).

When receiving frames from the network, the LRE forwards the first received frame of a pair to its node's upper layers and discards the duplicate frame (if it arrives). It removes the RCT if required.

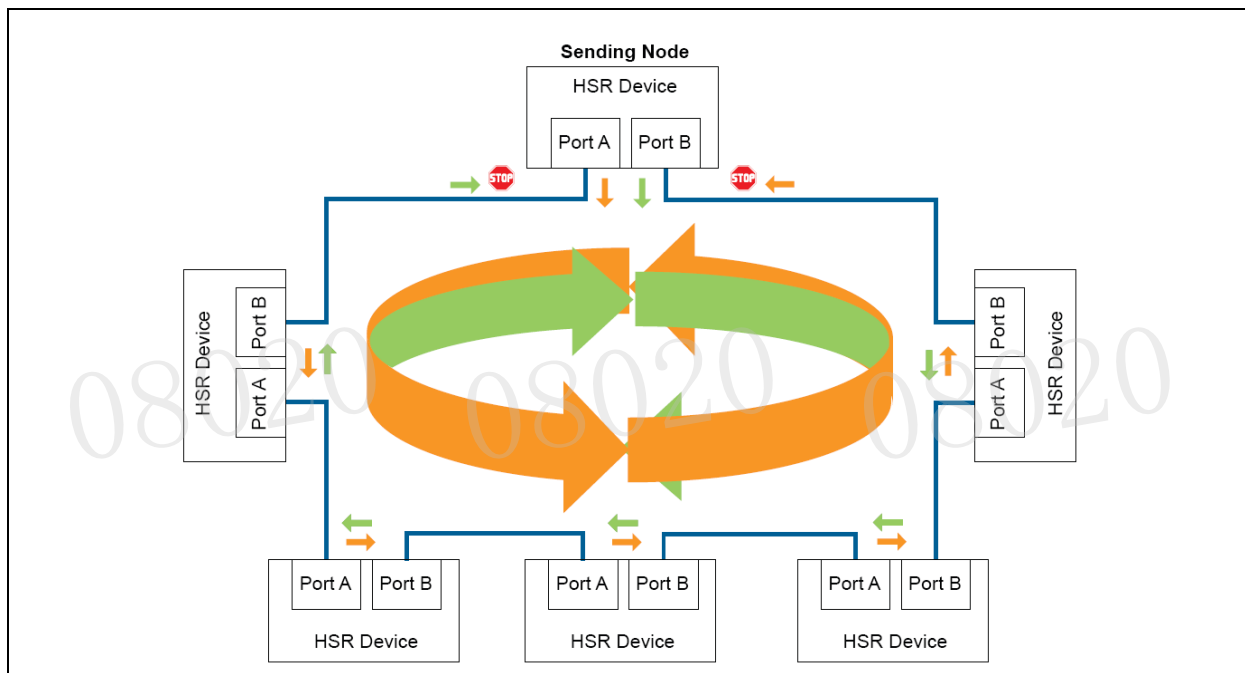


### 3.3.2 High-availability Seamless Redundancy (HSR)

HSR nodes send a copy of data to application layer. The data is copied at data link layer and is transmitted from Port A and Port B via different physical link.

HSR nodes have two identical interfaces arranged in a ring. Source nodes send packets over both ports. Each node relays unreceived frames from port A to port B and vice versa. The source node removes frames it receives that it injected into the ring.

HSR ring transmission through two-way link ensures the redundancy of data. When a link fails, a message can be transmitted to the receiving device from another loop, and there is no network reconstruction time. There is no switching network, and forwarding through the device. However, forwarding device has a forwarding delay time per level, so the total forwarding delay is great.



Each HSR node receives two copies of the same packet, and accepts the first packet and discards the second. The accepted packet is transmitted to application layer.

For P2P message (for example, TCP message), receiving node will stop transmitting after receiving the message. For multicast or broadcast message, if the message is from itself, receiving node will stop transmitting after receiving the message. If the message is from other node, receiving node will transmit it from another port after receiving the message, i.e., receiving message from Port A and transmitting message from Port B.

## 4 Supervision

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08020 08020 08020

08020 08020 08020

08020 08020 08020

## 4.1 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.

### NOTICE!

**ONLY** the master mode PCS-9785 clock source is equipped with a large scale LCD and the MON module for SAS communication. Thus the following alarms can be viewed locally from device LCD or remotely from SCADA.

### NOTICE!

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

**Table 4.1-1 Alarm description**

| No. | Item                | Description                                                                                                                     |
|-----|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 1   | Fail_Device         | The MON module fails. The device fails.                                                                                         |
| 2   | Alm_Initialization  | Error is found during device initialization process and there will be no time synchronization output.                           |
| 3   | Alm_Device          | The device is abnormal.<br>This signal will pick up if any other alarm picks up and it will drop off when all alarms drop off.  |
| 4   | Alm_DualDev         | The device working mode "Master" or "Slave" is wrong.<br>The CLK module type does not conform to the device configuration file. |
| 5   | Alm_Pwr1_Device     | The device power supply 1 fails.                                                                                                |
| 6   | Alm_Pwr2_Device     | The device power supply 2 fails.                                                                                                |
| 7   | Alm_Receiver_SatCh1 | The receiver of satellite channel 1 fails.                                                                                      |
| 8   | Alm_Receiver_SatCh2 | The receiver of satellite channel 2 fails.                                                                                      |
| 9   | Alm_SynLoss_SatCh1  | The synchronization of satellite channel 1 is lost.                                                                             |
| 10  | Alm_SynLoss_SatCh2  | The synchronization of satellite channel 2 is lost.                                                                             |
| 11  | Alm_Ant_SatCh1      | The antenna of satellite channel 1 fails.                                                                                       |
| 12  | Alm_Ant_SatCh2      | The antenna of satellite channel 2 fails.                                                                                       |
| 13  | Alm_Parity_IRIG-B1  | Error is found during the parity check of IRIG-B1                                                                               |

| No. | Item                     | Description                                                              |
|-----|--------------------------|--------------------------------------------------------------------------|
| 14  | Alm_Parity_IRIG-B2       | Error is found during the parity check of IRIG-B2                        |
| 15  | Alm_Recv_IRIG-B1         | The reception of IRIG-B1 is invalid                                      |
| 16  | Alm_Recv_IRIG-B2         | The reception of IRIG-B2 is invalid                                      |
| 17  | Alm_Send_IRIG-B          | The sending of IRIG-B signal is invalid.<br>The CLK module is failed.    |
| 18  | PTP1.Alm_Conflict_ID_Clk | An identical clock exists on the Precision Time Protocol (PTP) network1. |
| 19  | PTP2.Alm_Conflict_ID_Clk | An identical clock exists on the Precision Time Protocol (PTP) network2  |

Table 4.1-2 Troubleshooting

| No. | Item                     | Suggestion                                                                                                                                                                                                                             |
|-----|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Fail_Device              | Inform the service agency for repair.                                                                                                                                                                                                  |
| 2   | Alm_Initialization       | Check external time source if the initialization failure has lasted for a long period.                                                                                                                                                 |
| 3   | Alm_Device               | Eliminate all the other alarms firstly.                                                                                                                                                                                                |
| 4   | Alm_DualDev              | Verify the setting "Opt_DualDev" along with the device hardware.                                                                                                                                                                       |
| 5   | Alm_Pwr1_Device          | Check the rated input voltage and the PWR module 1.                                                                                                                                                                                    |
| 6   | Alm_Pwr2_Device          | Check the rated input voltage and the PWR module 2.                                                                                                                                                                                    |
| 7   | Alm_Receiver_SatCh1      | Inform the service agency for repair.                                                                                                                                                                                                  |
| 8   | Alm_Receiver_SatCh2      | Inform the service agency for repair.                                                                                                                                                                                                  |
| 9   | Alm_SynLoss_SatCh1       | Check the wiring between the antenna 1 and the CLK module.                                                                                                                                                                             |
| 10  | Alm_SynLoss_SatCh2       | Check the wiring between the antenna 2 and the CLK module.                                                                                                                                                                             |
| 11  | Alm_Ant_SatCh1           | Check the antenna 1 installation and its connection with the CLK module.                                                                                                                                                               |
| 12  | Alm_Ant_SatCh2           | Check the antenna 2 installation and its connection with the CLK module.                                                                                                                                                               |
| 13  | Alm_Parity_IRIG-B1       | Unify the parity check mode of both TX & RX for the IRIG-B1 link.                                                                                                                                                                      |
| 14  | Alm_Parity_IRIG-B2       | Unify the parity check mode of both TX & RX for the IRIG-B2 link.                                                                                                                                                                      |
| 15  | Alm_Recv_IRIG-B1         | Check the optical fiber connection for the IRIG-B1 reception link.                                                                                                                                                                     |
| 16  | Alm_Recv_IRIG-B2         | Check the optical fiber connection for the IRIG-B2 reception link.                                                                                                                                                                     |
| 17  | Alm_Send_IRIG-B          | Check the optical fiber connection for the IRIG-B sending link.<br>Check the CLK module.                                                                                                                                               |
| 18  | PTP1.Alm_Conflict_ID_Clk | Check the IDs of all the clocks who are on the same PTP network.<br>PTP1: the network connected to the second optical port from the bottom of the MON module<br>PTP2: the network connected to the last optical port of the MON module |
| 19  | PTP2.Alm_Conflict_ID_Clk |                                                                                                                                                                                                                                        |

## 5 Hardware

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## 5.1 Overview

This device consists several different modules. The application and terminal description of each module will be introduced in this chapter.

- **MON module** provides management functions like communication with SAS, event record, setting management etc.
- **CLK module** provides satellite signal receiver (BDS or GPS) and IRIG-B signal input channel.
- **COM module** provides different output interfaces with other IEDs.
- **PWR module** converts the power supply into various voltage levels for different modules and components in this device.
- **HMI module** is comprised of LCD, keypad, LED indicators and a multiplex RJ45 debugging port.

## 5.2 Module Configuration (for EXAMPLE only)

This section shows several examples of device terminal view and module arrangement.

### NOTICE!

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

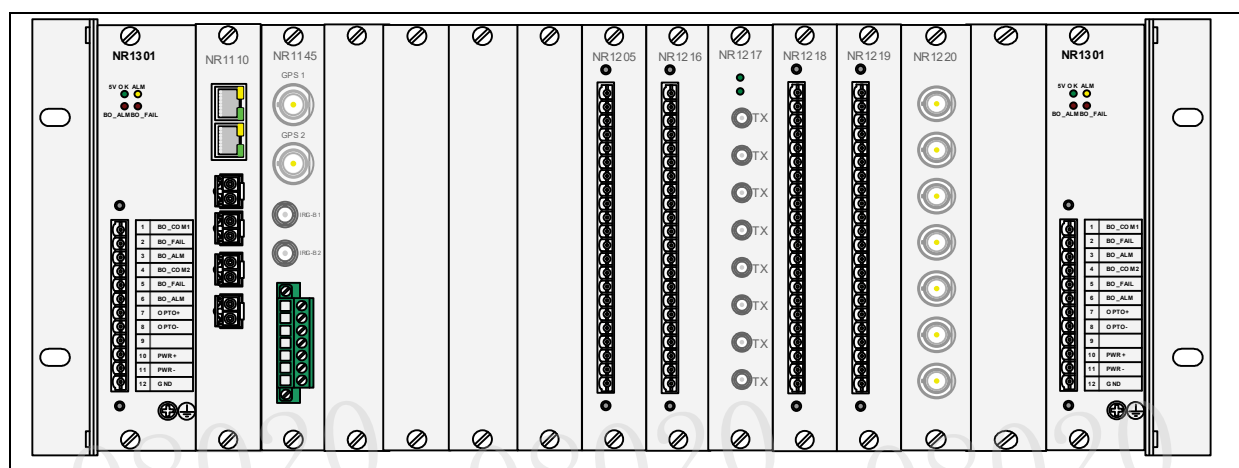


Figure 5.2-1 Terminal view example

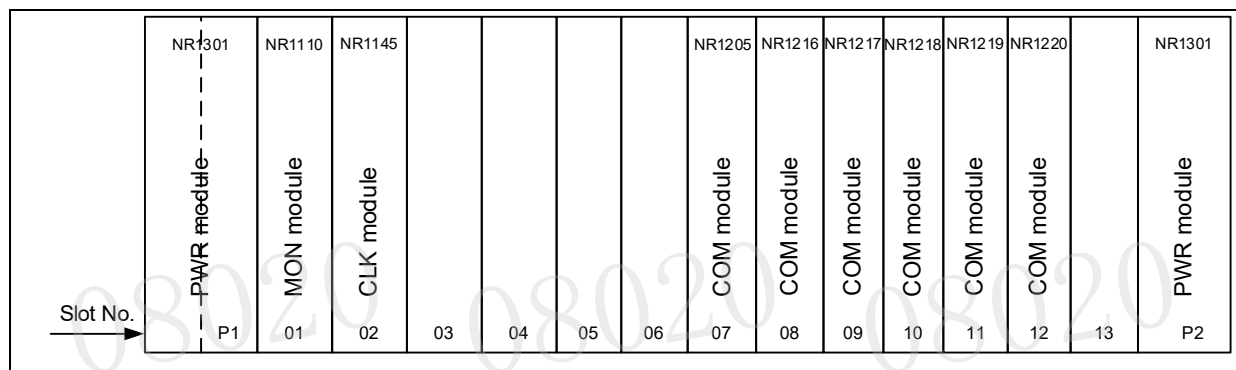


Figure 5.2-2 Module configuration example

Table 5.2-1 Module arrangement

| Symbol | Slot  | Type     | Interface                                                    | Remark                  |
|--------|-------|----------|--------------------------------------------------------------|-------------------------|
| MON    | 01    | NR1110D  | 2×RJ45 + 4×LC                                                | SOURCE<br>Obligatory    |
| CLK    | 02    | NR1145A  | 2×IRIG-B (ST or RS-485)                                      |                         |
|        |       | NR1145B  | 1×GPS + 2×IRIG-B (ST or RS-485)                              |                         |
|        |       | NR1145C  | 1×GPS + 1×BDS + 2×IRIG-B (ST or RS-485)                      |                         |
|        |       | NR1145D  | 2×GPS + 2×IRIG-B (ST or RS-485)                              |                         |
|        |       | NR1145I  | 1×GPS + 1×BDS + 1×Time Frequency Measurement + 2×IRIG-B (ST) |                         |
|        |       | NR1145J  | 1×GPS + 2×IRIG-B (TTL/RS-485)                                |                         |
|        |       | NR1145K  | 1×GPS + 1×Time Frequency Measurement + 2×IRIG-B (ST)         |                         |
| COM    | 03~13 | NR1141A  | 1×Debugging (RS-232) + 2×IRIG-B (ST or TTL/RS-485)           | EXTENSION<br>Obligatory |
|        |       | NR1205A  | 7×RS-485                                                     | Optional                |
|        |       | NR1216A  | 4×Optical-coupled contacts                                   |                         |
|        |       | NR1217A  | 8×ST connectors (TX)                                         |                         |
|        |       | NR1218A  | 7×RS-232                                                     |                         |
|        |       | NR1219A  | 8×TTL                                                        |                         |
| PWR    | P1    | NR1301TN | 110/125/220/250Vdc, 110/22Vac                                | At least one            |
|        | P2    |          |                                                              |                         |

### 5.3 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 LCD screen is a high-performance grand liquid crystal panel with back lighting, which has a user-friendly interface and an extensive display range.

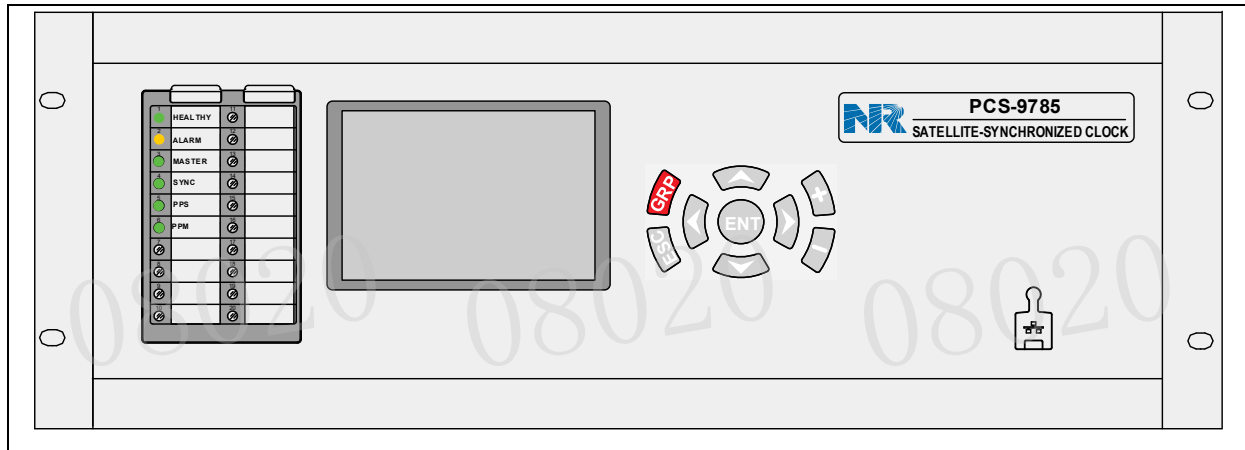


Figure 5.3-1 HMI view (Clock Source)

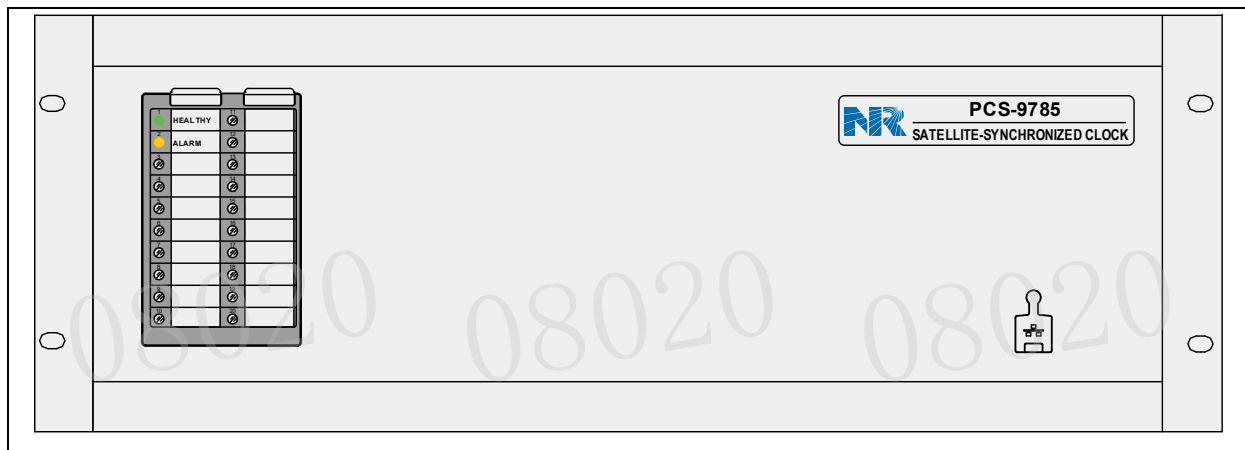


Figure 5.3-2 HMI view (Clock Extension)

## 5.4 MON Module (Monitoring & Communication)

### NOTICE!

**ONLY** the master mode PCS-9785 clock source is equipped with the MON module.

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, etc.

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

The MON module NR1110D provides two RJ45 ports and four SFP sockets. The two RJ45 ports are used for Ethernet network (MMS communication and SNTP/NTP time message). The four SFP sockets support the Precision Time Protocol network (IEEE 1588 protocol).



### CAUTION!

Do **NOT** look into the end of an optical fiber connected to an optical port.

Do **NOT** look into an optical port/connector.

A direct sight to laser light may cause temporary or permanent blindness.

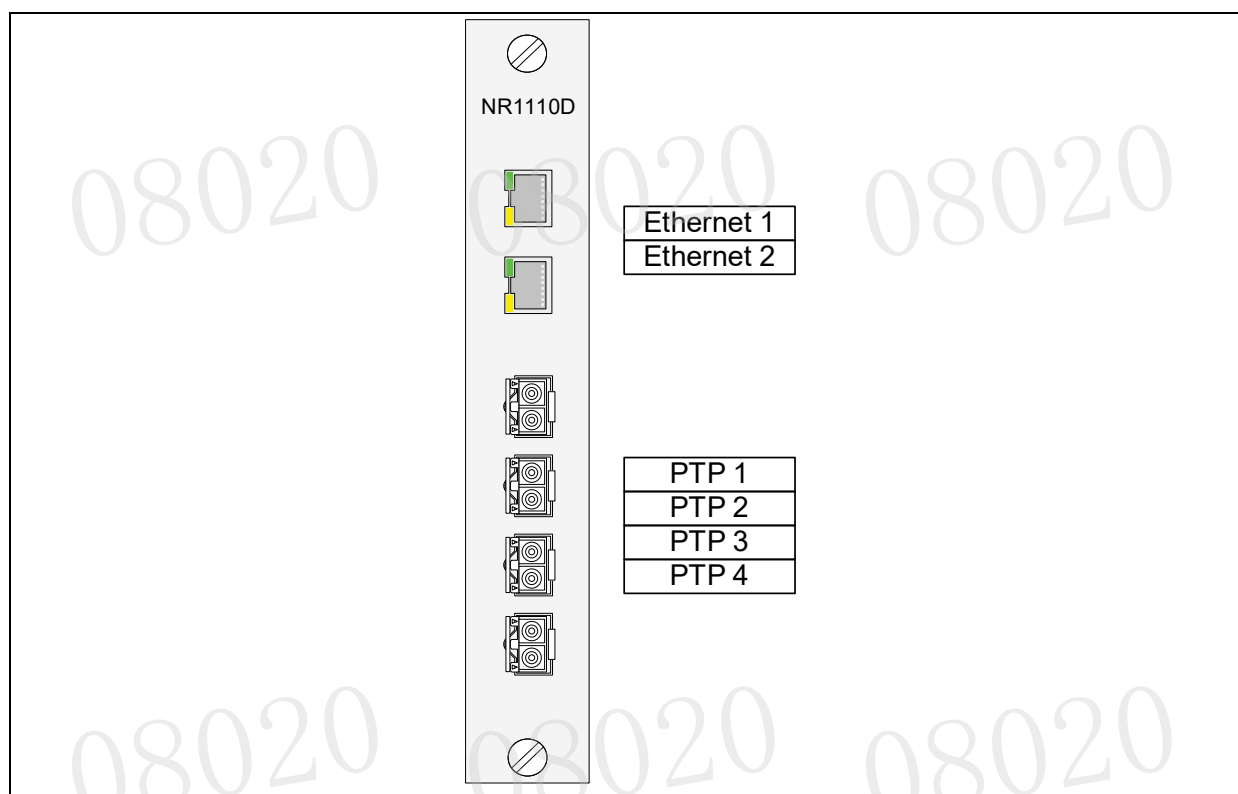


Figure 5.4-1 MON module

## 5.5 CLK Module (Satellite Signal Receiver)

The CLK module receives and processes satellite signal and external IRIG-B code. It converts them into PPS/PPM/PPH, IRIG-B code and timing message and transmits them to the MON module and COM modules via the internal bus.

### 5.5.1 NR1145 for Clock Source

Table 5.5-1 Sub models of NR1145

| Sub models                  |        | NR1145A | NR1145B | NR1145C | NR1145D | NR1145I | NR1145J | NR1145K |
|-----------------------------|--------|---------|---------|---------|---------|---------|---------|---------|
| Timing signal input channel |        |         |         |         |         |         |         |         |
| BDS                         |        | 0       | 0       | 1       | 0       | 1       | 0       | 0       |
| GPS                         |        | 0       | 1       | 1       | 2       | 1       | 1       | 1       |
| IRIG-B                      | ST     | 2       | 2       | 2       | 2       | 2       | 0       | 2       |
|                             | RS-485 |         |         |         |         | 0       |         | 0       |
|                             | TTL    | 0       | 0       | 0       | 0       | 0       | 2       | 0       |
| Time Freq. Measurement      |        | 0       | 0       | 0       | 0       | 1       | 0       | 1       |

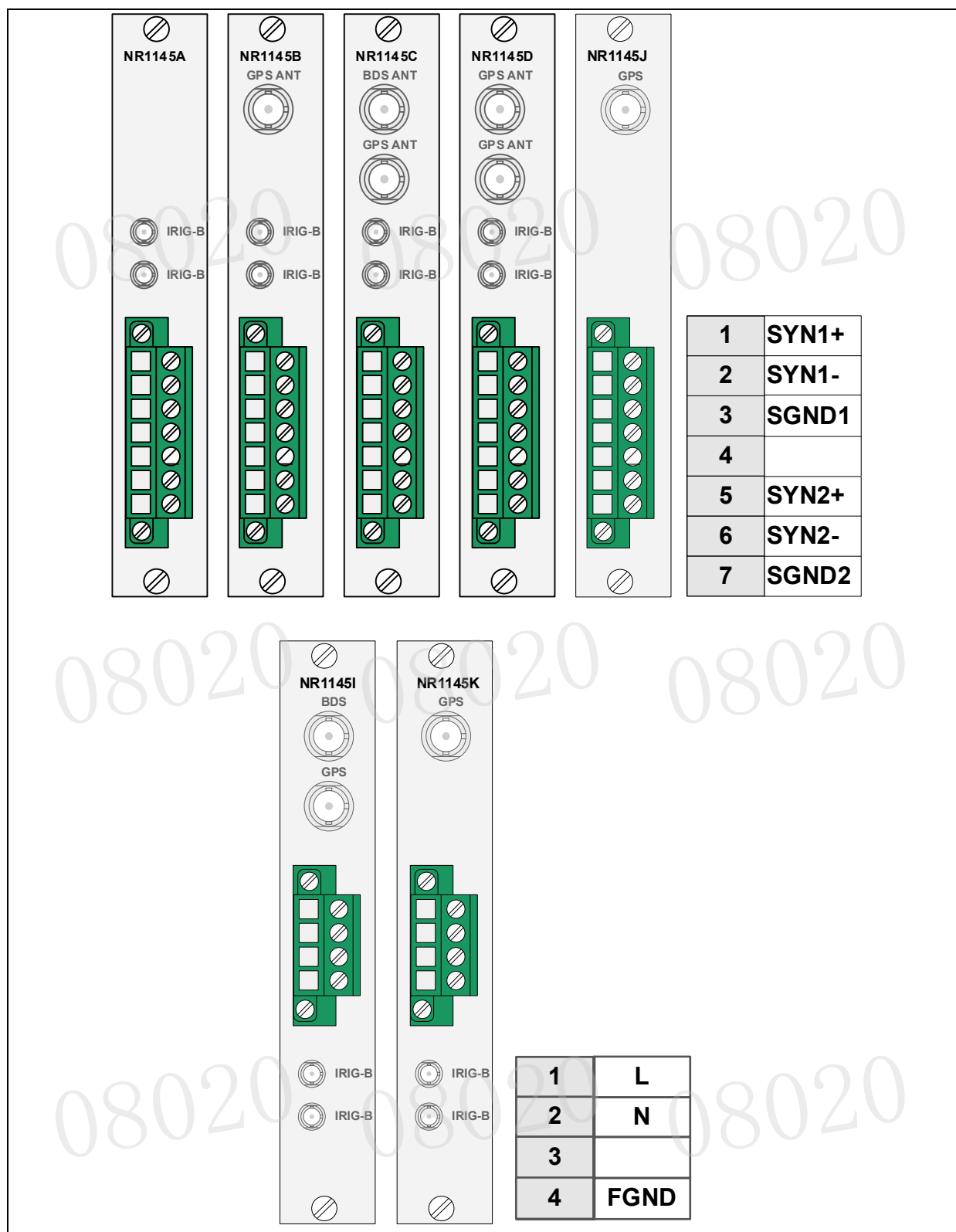


Figure 5.5-1 CLK module

**CAUTION!**

Do **NOT** look into the end of an optical fiber connected to an optical port.

Do **NOT** look into an optical port/connector.

A direct sight to laser light may cause temporary or permanent blindness.

### NOTICE!

Each IRIG-B input channel supports optic ST connector and RS-485 serial port.  
However, these two modes should be used exclusively.

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

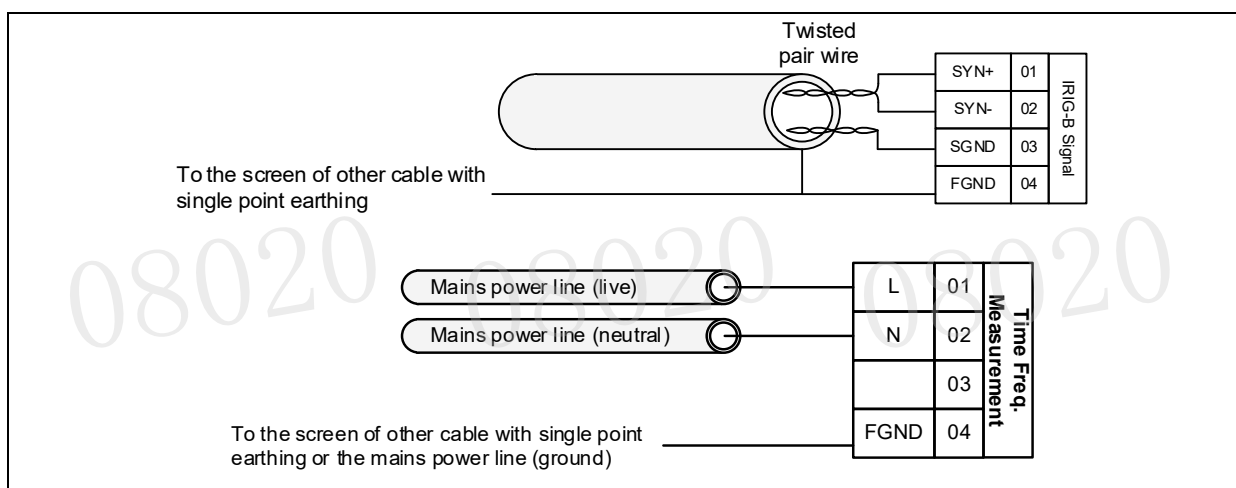


Figure 5.5-2 Wiring of synchronization port (CLK module NR1145)

For NR1145J, the reception mode of IRIG-B time synchronization signal could be selected by configuring the following 2 jumpers.

Table 5.5-2 Jumpers for IRIG-B signal reception mode

| Jumper                    | RS-485                    | TTL                       |
|---------------------------|---------------------------|---------------------------|
| J6 & J7 for serial port 1 |                           |                           |
| J8 & J9 for serial port 2 |                           |                           |
| Remark                    | Pin 1-2 ON<br>Pin 2-3 OFF | Pin 1-2 OFF<br>Pin 2-3 ON |

### 5.5.2 NR1141 for Clock Extension

The CLK module NR1145 receives and processes satellite signal and external IRIG-B code. It converts them into PPS/PPM/PPH, IRIG-B code and timing message and transmits them to the MON module and COM modules via the internal bus.

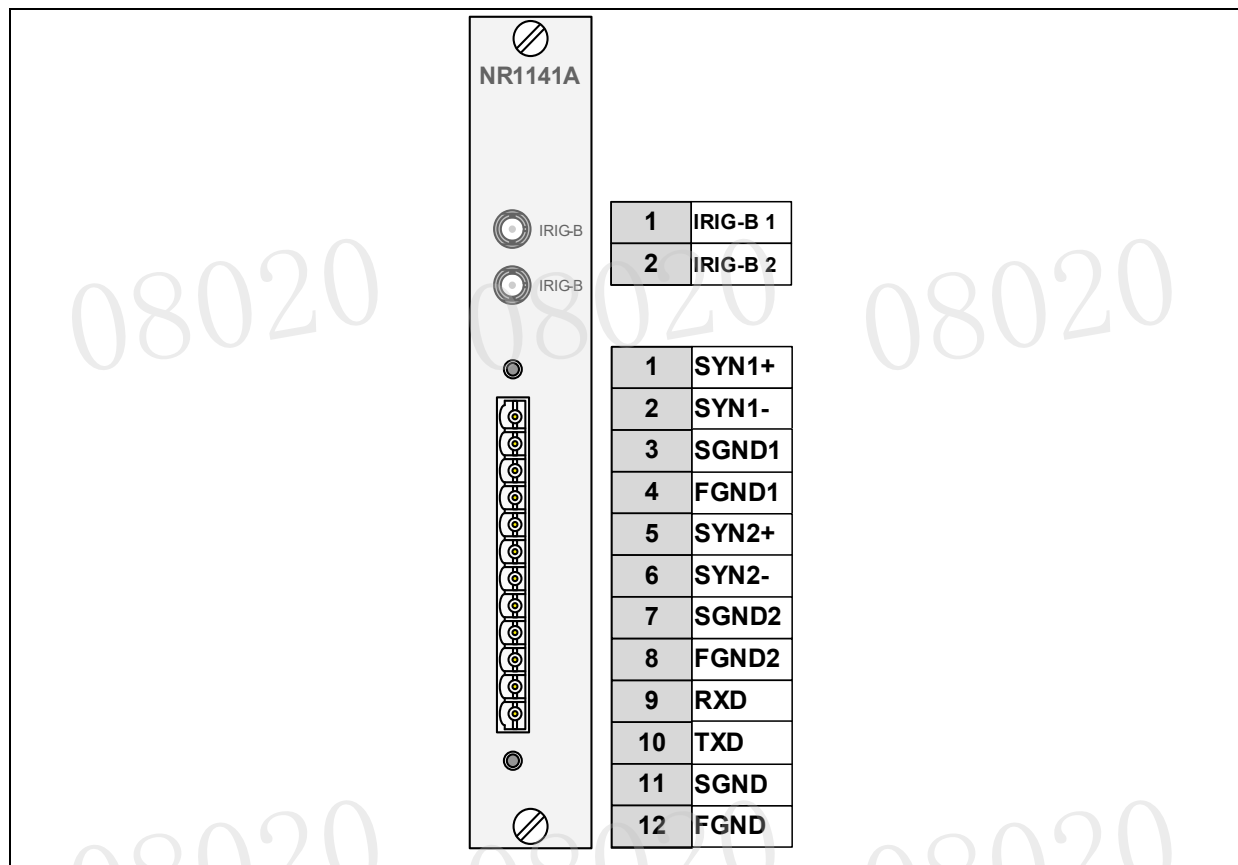


Figure 5.5-3 CLK module

**CAUTION!**

Do **NOT** look into the end of an optical fiber connected to an optical port.

Do **NOT** look into an optical port/connector.

A direct sight to laser light may cause temporary or permanent blindness.

**NOTICE!**

Each IRIG-B input channel supports optic ST connector and RS-485 serial port.

However, these two modes should be used exclusively.

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

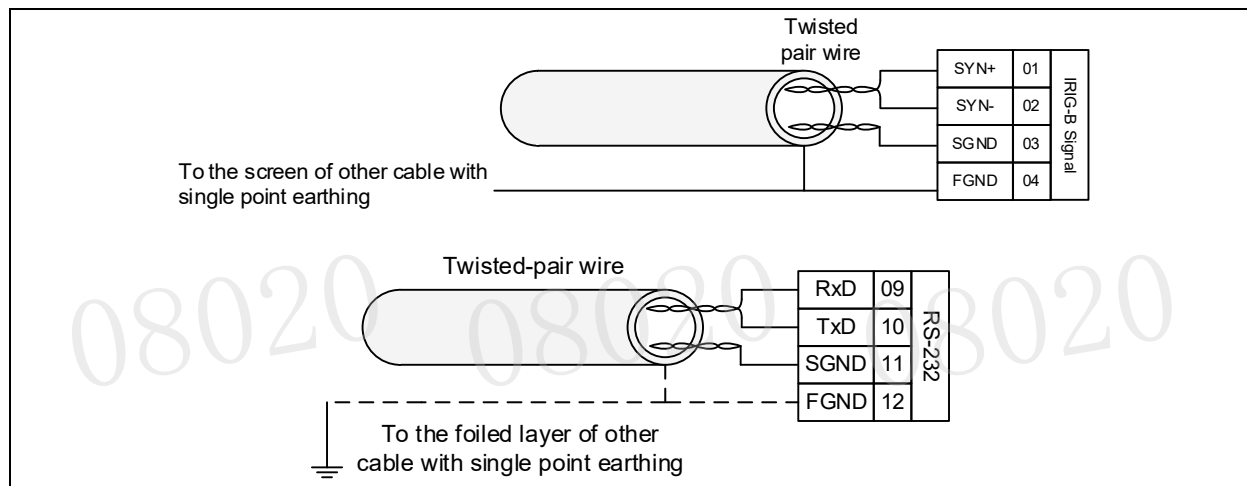


Figure 5.5-4 Wiring of synchronization port (CLK module NR1141)

## 5.6 COM Module

The COM module provides extension output interfaces for clock synchronization..

### 5.6.1 RS-485 (NR1205A)

The COM module NR1205A provides 7 RS-485 serial ports. The No.1~4 ports form the group 1 and the No.5~7 form the group 2.

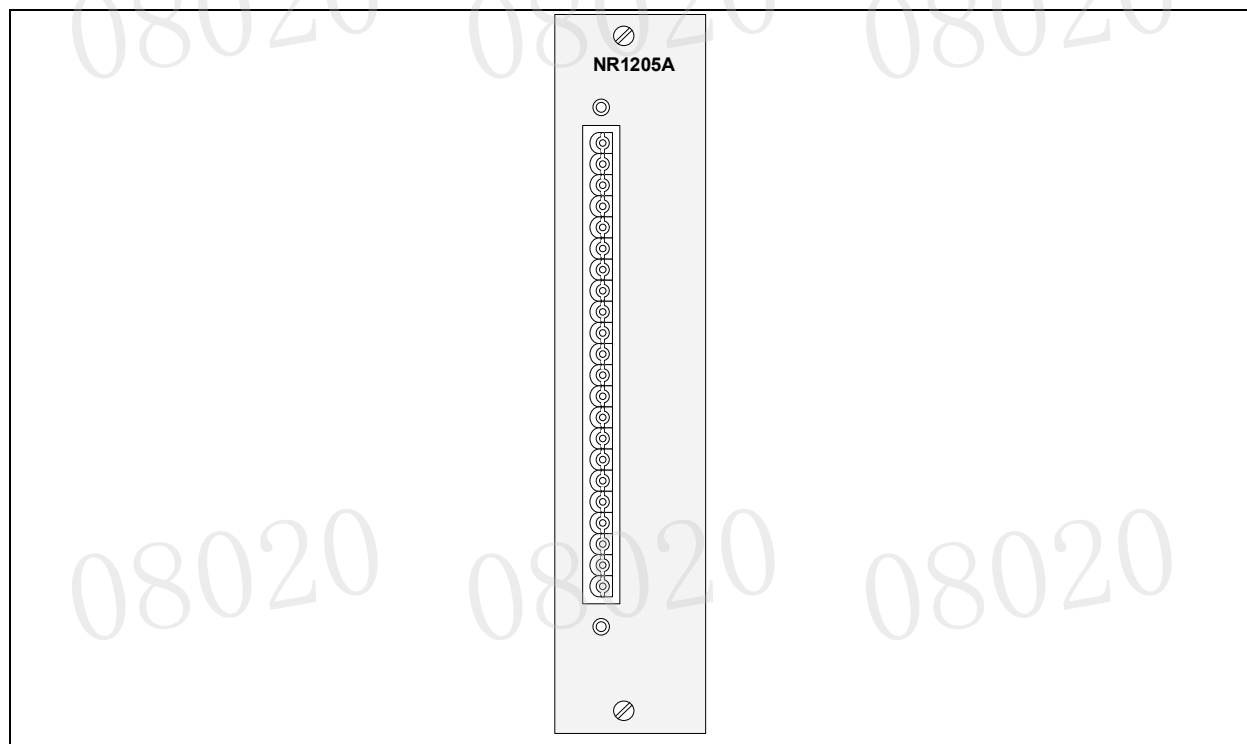


Figure 5.6-1 COM Module (NR1205A)

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

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

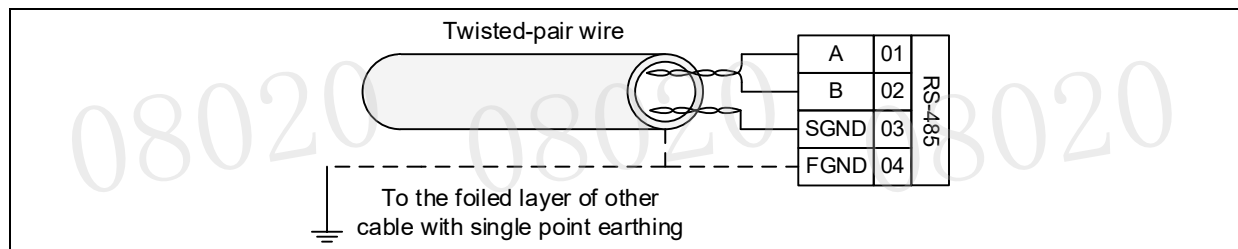


Figure 5.6-2 Serial port wiring of NR1205A

Table 5.6-1 Pin definition of NR1205A

| Pin No. | Symbol   | Description      | Port No.      |
|---------|----------|------------------|---------------|
| 01      | 1A       | RS-485: A        | Serial port 1 |
| 02      | 1B       | RS-485: B        |               |
| 03      | 1/2 SGND | Signal reference |               |
| 04      | 1/2 FGND | Foiled layer     |               |
| 05      | 2A       | RS-485: A        | Serial port 2 |
| 06      | 2B       | RS-485: B        |               |
| 07      | 3A       | RS-485: A        | Serial port 3 |
| 08      | 3B       | RS-485: B        |               |
| 09      | 3/4 SGND | Signal reference |               |
| 10      | 3/4 FGND | Foiled layer     |               |
| 11      | 4A       | RS-485: A        | Serial port 4 |
| 12      | 4B       | RS-485: B        |               |
| 13      | 5A       | RS-485: A        | Serial port 5 |
| 14      | 5B       | RS-485: B        |               |
| 15      | 5/6 SGND | Signal reference |               |
| 16      | 5/6 FGND | Foiled layer     |               |
| 17      | 6A       | RS-485: A        | Serial port 6 |
| 18      | 6B       | RS-485: B        |               |
| 19      | 7A       | RS-485: A        | Serial port 7 |
| 20      | 7B       | RS-485: B        |               |
| 21      | 7 SGND   | Signal reference |               |
| 22      | 7 FGND   | Foiled layer     |               |

The output polarity mode and the output signal mode can be selected by setting the corresponding jumpers on the module.

Table 5.6-2 Output polarity mode of NR1205A

| Jumper       | Output polarity                                                                   |                                                                                    |
|--------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|              | Positive                                                                          | Negative                                                                           |
| J1 (Group 1) |  |  |
| J2 (Group 2) |  |  |

Table 5.6-3 Output signal mode of NR1205A

| Signal mode                     | Group 1 (Jumper "ON") | Group 2 (Jumper "ON") |
|---------------------------------|-----------------------|-----------------------|
| PPS                             | JP20                  | JP9                   |
| PPM                             | JP21                  | JP10                  |
| IRIG-B                          | JP22                  | JP11                  |
| PPH                             | JP23                  | JP12                  |
| Timing message<br>(serial port) | JP24                  | JP13                  |

**NOTICE!**

The jumpers JP1~JP7 correspond to the match resistance of the No.1~7 RS-485 output channels. Set "ON" to connect a 120Ω match resistance in parallel.

**5.6.2 Optical-Coupled Contact (NR1216A)**

The COM module NR1216A provides 8 optical-coupled contacts. The No.1~4 contacts form the group 1 and the No.5~8 form the group 2.

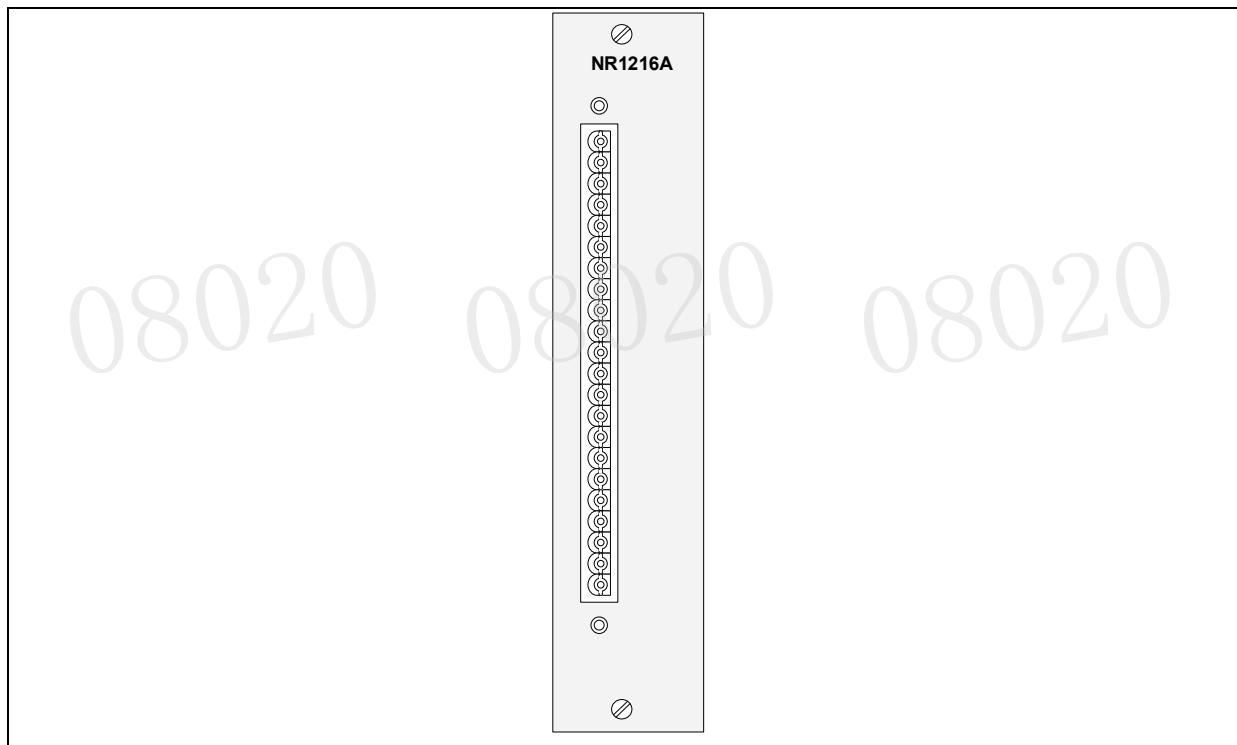


Figure 5.6-3 COM Module (NR1216A)

Table 5.6-4 Pin definition of NR1216A

| Pin No. | Symbol | Description                                  |
|---------|--------|----------------------------------------------|
| 01      | OUT1+  | The positive pole of the No.1 output contact |
| 02      | OUT1-  | The negative pole of the No.1 output contact |
| 03      | GND    | The ground for shielding                     |
| 04      | OUT2+  | The positive pole of the No.2 output contact |
| 05      | OUT2-  | The negative pole of the No.2 output contact |
| 06      | OUT3+  | The positive pole of the No.3 output contact |
| 07      | OUT3-  | The negative pole of the No.3 output contact |
| 08      | GND    | The ground for shielding                     |
| 09      | OUT4+  | The positive pole of the No.4 output contact |
| 10      | OUT4-  | The negative pole of the No.4 output contact |
| 11      | OUT5+  | The positive pole of the No.5 output contact |
| 12      | OUT5-  | The negative pole of the No.5 output contact |
| 13      | GND    | The ground for shielding                     |
| 14      | OUT6+  | The positive pole of the No.6 output contact |
| 15      | OUT6-  | The negative pole of the No.6 output contact |
| 16      | OUT7+  | The positive pole of the No.7 output contact |
| 17      | OUT7-  | The negative pole of the No.7 output contact |
| 18      | GND    | The ground for shielding                     |
| 19      | OUT8+  | The positive pole of the No.8 output contact |
| 20      | OUT8-  | The negative pole of the No.8 output contact |

| Pin No. | Symbol | Description |
|---------|--------|-------------|
| 21      |        | Empty       |
| 22      |        | Empty       |

The output polarity mode and the output signal mode can be selected by setting the corresponding jumpers on the module.

Table 5.6-5 Output signal mode of NR1216A

| Signal mode | Group 1 (Jumper "ON") | Group 2 (Jumper "ON") |
|-------------|-----------------------|-----------------------|
| PPS         | JP20                  | JP9                   |
| PPM         | JP21                  | JP10                  |
| IRIG-B      | JP22                  | JP11                  |
| PPH         | JP23                  | JP12                  |

#### NOTICE!

The jumpers JP1~JP8 correspond to the current-limiting resistance of the No.1~8 output contacts. Set "OFF" to connect a 7500Ω current-limiting resistance in serial.

#### 5.6.3 ST Connector (NR1217A)

The COM module NR1217A provides 8 optical ports (ST connector). The No.1~4 ports form the group 1 and the No.5~8 form the group 2.

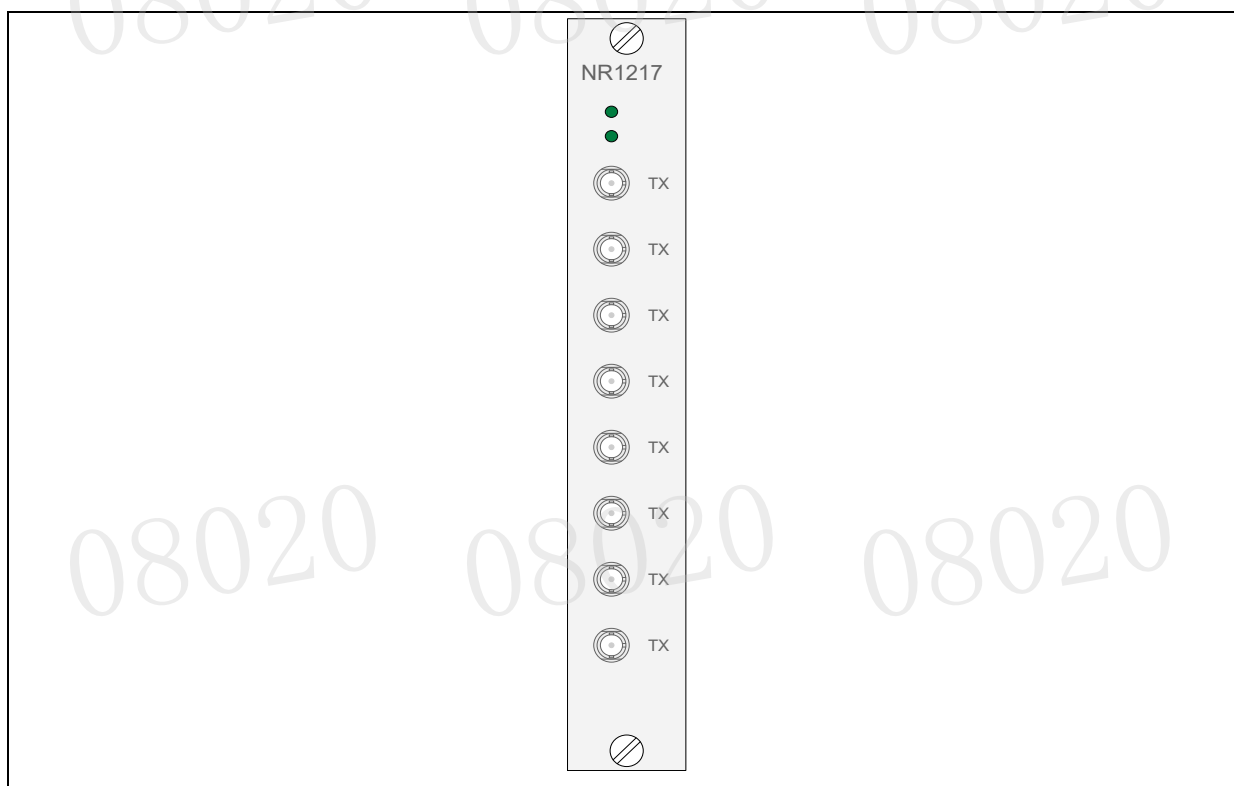


Figure 5.6-4 COM Module (NR1217A)

**CAUTION!**

Do **NOT** look into the end of an optical fiber connected to an optical port.

Do **NOT** look into an optical port/connector.

A direct sight to laser light may cause temporary or permanent blindness.

The working mode for idle and the output signal mode can be selected by setting the corresponding jumpers on the module.

**Table 5.6-6 Working mode of NR1217A**

| Port No. | Jumper | Working Mode (for idle) |            |
|----------|--------|-------------------------|------------|
|          |        | Without light           | With light |
| 1        | J1     |                         |            |
| 2        | J2     |                         |            |
| 3        | J3     |                         |            |
| 4        | J4     |                         |            |
| 5        | J5     |                         |            |
| 6        | J6     |                         |            |
| 7        | J7     |                         |            |
| 8        | J8     |                         |            |

**Table 5.6-7 Output signal mode of NR1217A**

| Signal mode    | Group 1 (Jumper "ON") | Group 2 (Jumper "ON") |
|----------------|-----------------------|-----------------------|
| PPS            | JP20                  | JP9                   |
| PPM            | JP21                  | JP10                  |
| IRIG-B         | JP22                  | JP11                  |
| PPH            | JP23                  | JP12                  |
| Timing message | JP24                  | JP13                  |

#### 5.6.4 RS-232 (NR1218A)

The COM module NR1218A provides 7 RS-232 serial ports. The No.1~4 ports form the group 1 and the No.5~7 form the group 2.

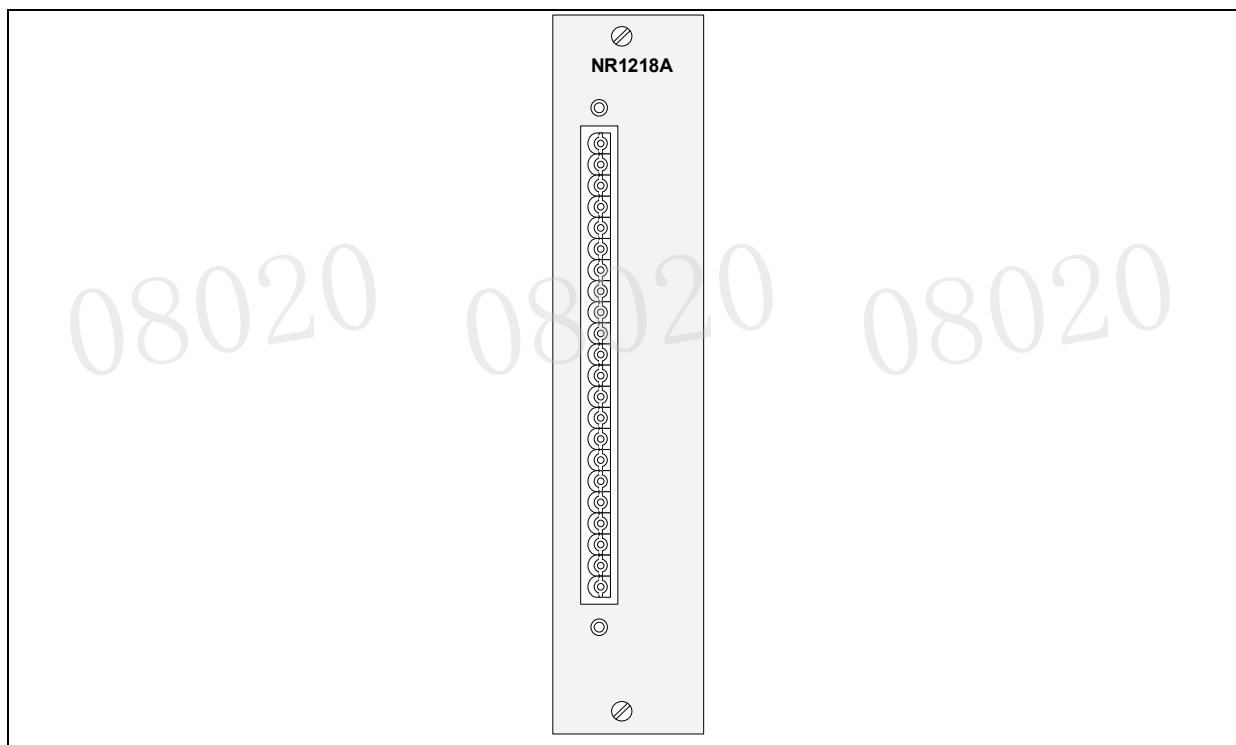


Figure 5.6-5 COM Module (NR1218A)

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

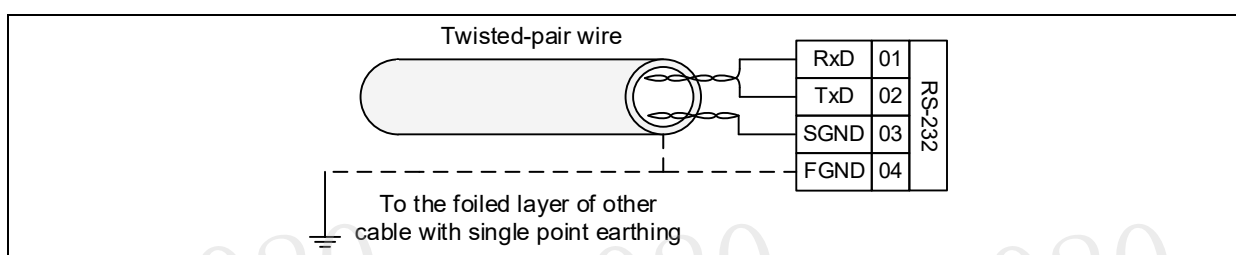


Figure 5.6-6 Serial port wiring of NR1218A

Table 5.6-8 Pin definition of NR1218A

| Pin No. | Symbol   | Description      | Port No.      |
|---------|----------|------------------|---------------|
| 01      | 1 RxD    | RS-232: RxD      | Serial port 1 |
| 02      | 1 TxD    | RS-232: TxD      |               |
| 03      | 1/2 SGND | Signal reference |               |
| 04      | 1/2 FGND | Foiled layer     |               |
| 05      | 2 RxD    | RS-232: RxD      | Serial port 2 |

| Pin No. | Symbol   | Description      | Port No.      |
|---------|----------|------------------|---------------|
| 06      | 2 TXD    | RS-232: TXD      | Serial port 3 |
| 07      | 3 RXD    | RS-232: RXD      |               |
| 08      | 3 TXD    | RS-232: TXD      |               |
| 09      | 3/4 SGND | Signal reference |               |
| 10      | 3/4 FGND | Foiled layer     |               |
| 11      | 4 RXD    | RS-232: RXD      | Serial port 4 |
| 12      | 4 TXD    | RS-232: TXD      |               |
| 13      | 5 RXD    | RS-232: RXD      | Serial port 5 |
| 14      | 5 TXD    | RS-232: TXD      |               |
| 15      | 5/6 SGND | Signal reference |               |
| 16      | 5/6 FGND | Foiled layer     |               |
| 17      | 6 RXD    | RS-232: RXD      | Serial port 6 |
| 18      | 6 TXD    | RS-232: TXD      |               |
| 19      | 7 RXD    | RS-232: RXD      | Serial port 7 |
| 20      | 7 TXD    | RS-232: TXD      |               |
| 21      | 7 SGND   | Signal reference |               |
| 22      | 7 FGND   | Foiled layer     |               |

**NOTICE!**

The jumpers JP22 (for the group 1) and JP27 (for the group 2) should be "**ON**" while the other jumpers should be "**OFF**" to set the port in timing message output mode.

**5.6.5 TTL (NR1219A)**

The COM module NR1219A provides 8 TTL output ports. The No.1~4 ports form the group 1 and the No.5~8 form the group 2.

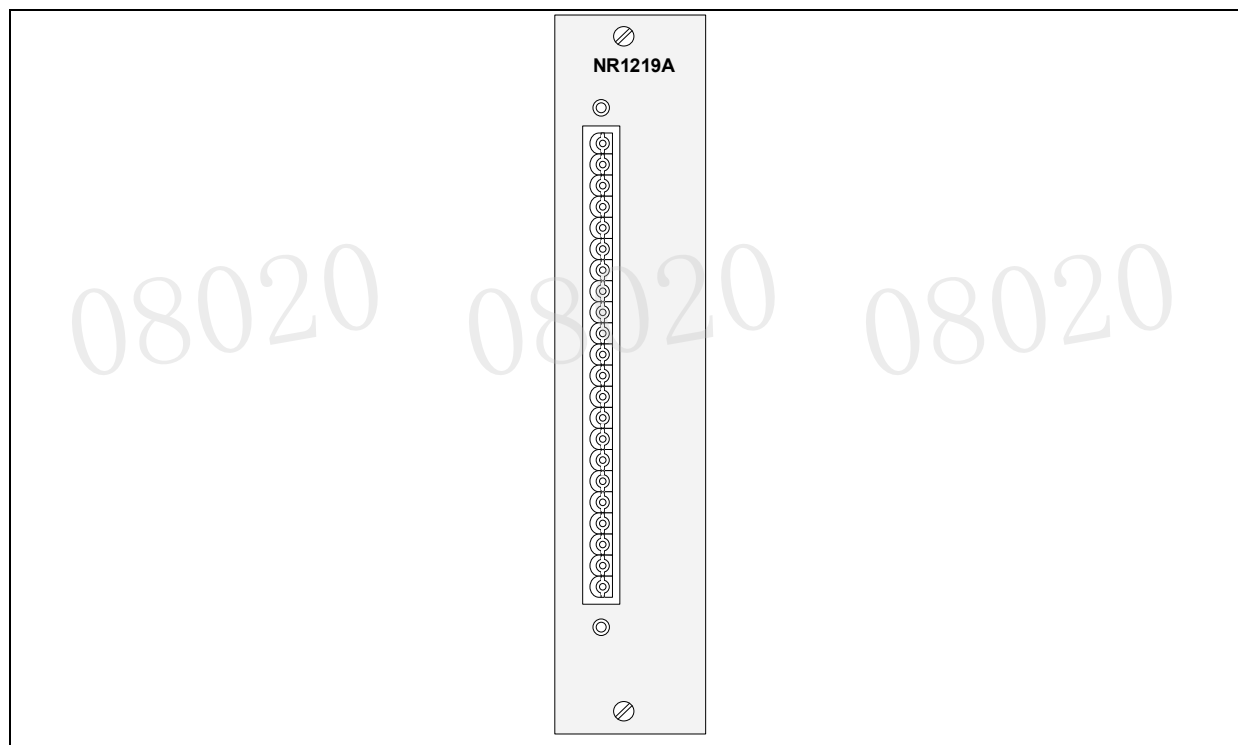


Figure 5.6-7 COM Module (NR1219A)

Table 5.6-9 Pin definition of NR1219A

| Pin No. | Symbol | Description                              |
|---------|--------|------------------------------------------|
| 01      | OUT1+  | The positive pole of the No.1 TTL output |
| 02      | OUT1-  | The negative pole of the No.1 TTL output |
| 03      | GND    | The ground for shielding                 |
| 04      | OUT2+  | The positive pole of the No.2 TTL output |
| 05      | OUT2-  | The negative pole of the No.2 TTL output |
| 06      | OUT3+  | The positive pole of the No.3 TTL output |
| 07      | OUT3-  | The negative pole of the No.3 TTL output |
| 08      | GND    | The ground for shielding                 |
| 09      | OUT4+  | The positive pole of the No.4 TTL output |
| 10      | OUT4-  | The negative pole of the No.4 TTL output |
| 11      | OUT5+  | The positive pole of the No.5 TTL output |
| 12      | OUT5-  | The negative pole of the No.5 TTL output |
| 13      | GND    | The ground for shielding                 |
| 14      | OUT6+  | The positive pole of the No.6 TTL output |
| 15      | OUT6-  | The negative pole of the No.6 TTL output |
| 16      | OUT7+  | The positive pole of the No.7 TTL output |
| 17      | OUT7-  | The negative pole of the No.7 TTL output |
| 18      | GND    | The ground for shielding                 |
| 19      | OUT8+  | The positive pole of the No.8 TTL output |
| 20      | OUT8-  | The negative pole of the No.8 TTL output |

| Pin No. | Symbol | Description |
|---------|--------|-------------|
| 21      |        | Empty       |
| 22      |        | Empty       |

The output polarity mode and the output signal mode can be selected by setting the corresponding jumpers on the module.

Table 5.6-10 Output polarity mode of NR1219A

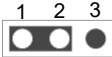
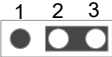
| Jumper       | Output polarity                                                                   |                                                                                    |
|--------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|              | Positive                                                                          | Negative                                                                           |
| J1 (Group 1) |  |  |
| J2 (Group 2) |  |  |

Table 5.6-11 Output signal mode of NR1219A

| Signal mode | Group 1 (Jumper "ON") | Group 2 (Jumper "ON") |
|-------------|-----------------------|-----------------------|
| PPS         | JP4                   | JP1                   |
| PPM         | JP5                   | JP2                   |
| IRIG-B      | JP6                   | JP3                   |

### 5.6.6 AC Modulation (NR1220A)

The COM module NR1220A provides 7 BNC ports to output AC modulated (1kHz sinusoid) IRIG-B code.

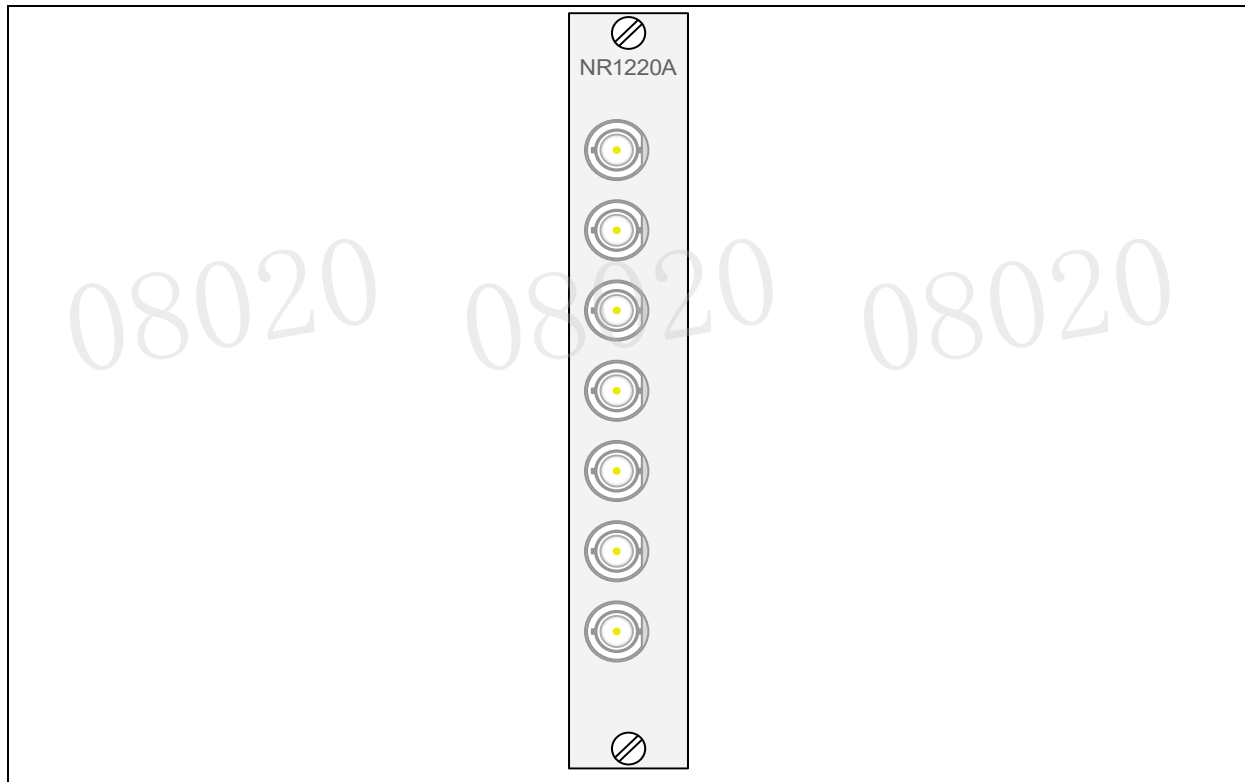


Figure 5.6-8 COM Module (NR1220A)

## 5.7 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. The pin definition of the connector is described as below.

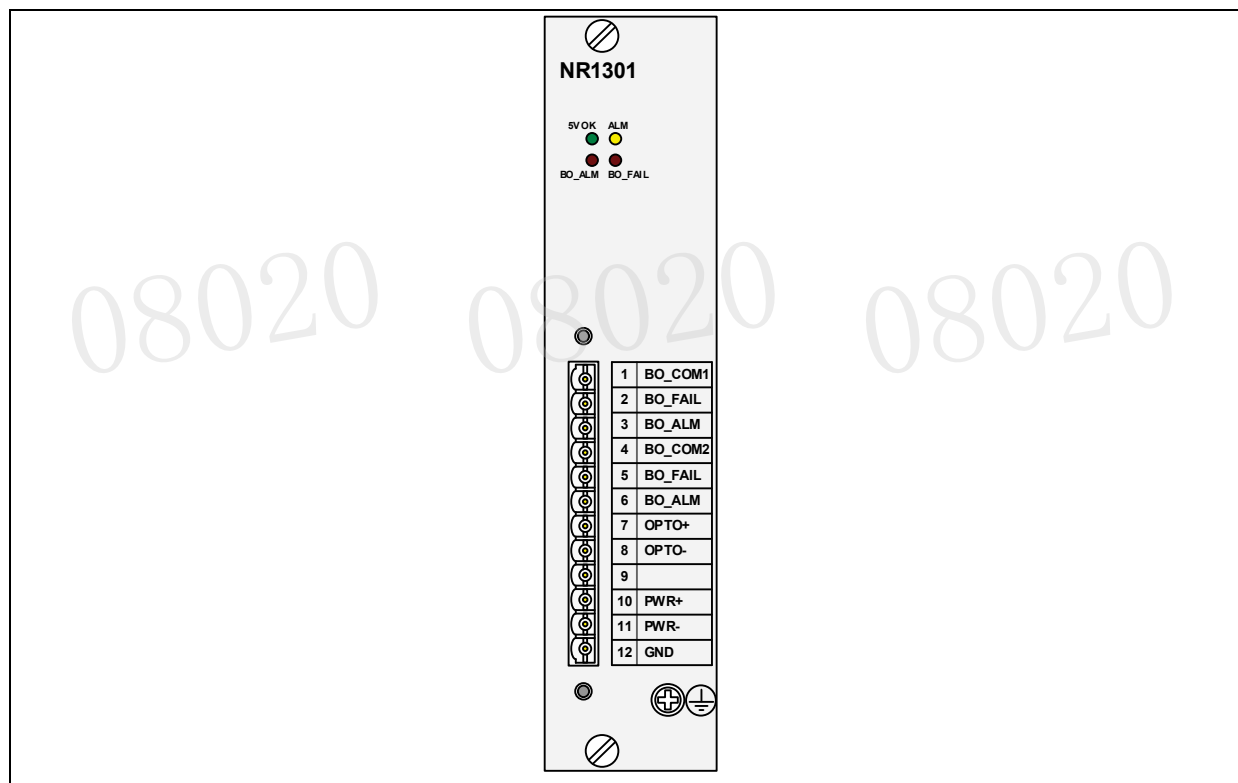


Figure 5.7-1 PWR module

| 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) |
| 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                                    |

**NOTICE!**

The standard rated voltage of PWR module is self-adaptive to 88~300Vdc. For other non-standard rated voltage, please specify when placing order and check if the rated voltage of power supply module is the same as the voltage of power source before the device being put into service.

**NOTICE!**

The PWR module provides the terminal 12 and a 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.

**NOTICE!**

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 Settings

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08020 08020 08020

08020 08020 08020

08020 08020 08020

## 6.1 Overview

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

### NOTICE!

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

## 6.2 For PCS-9785 Clock Source

### 6.2.1 Device Settings

| No. | Item                   | Range(Unit)          | Default Value |
|-----|------------------------|----------------------|---------------|
| 1   | Opt_DualDev            | Slave or Master      | Master        |
| 2   | Opt_Src_InitClk        | Internal or External | External      |
| 3   | Opt_Parity_Send_IRIG-B | Odd or Even          | Odd           |
| 4   | t_PW_Send_Pulse        | 10~200(ms)           | 200           |
| 5   | En_Meas_f_Grid         | Disable or Enable    | Disable       |
| 6   | En_MDisk               | Disable or Enable    | Enable        |

- **Opt\_DualDev**

This is the device clock service mode option for the dual device redundancy strategy. It should be "Slave" if the MON module NR1145A is selected. Otherwise, it should be "Master".

- **Opt\_Src\_InitClk**

This is the device initialization mode option.

External                      The device is initialized by external timing source. There will be no output before the completion of initialization.

Internal                      The device is initialized by its internal clock.

- **Opt\_Parity\_Send\_IRIG-B**

The parity check mode option for IRIG-B output signal.

- **t\_PW\_Send\_Pulse**

The pulse width setting for output signal PPS/PPM/PPH.

- **En\_Meas\_f\_Grid**

Logic enabling setting for time frequency measurement.

If this setting is enabled, the device LCD displays the measured grid frequency (under 220Vac)

with the accuracy up to 0.001Hz.

- **En\_MDisk**

Moveable disk implemented on the MON plug-in module can be used to backup and restore program, settings and configuration.

1 Use moveable disk to realize backup and recovery function.

0 Disable the use of moveable disk.

## 6.2.2 TimeZone Settings

### NOTICE!

Any modification confirmation of time zone settings will automatically reboot the device.

| No. | Item                  | Range(Unit)                                                    | Default Value |
|-----|-----------------------|----------------------------------------------------------------|---------------|
| 1   | OffsetHour_UTC        | -12~12                                                         | 8             |
| 2   | OffsetMinute_UTC      | 0~60                                                           | 0             |
| 3   | DST.En                | Disable or Enable                                              | Disable       |
| 4   | DST.OffsetMinute      | 0~60                                                           | 60            |
| 5   | DST.MonthInYear_Start | Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec     | Feb           |
| 6   | DST.WeekInMonth_Start | 1st, 2nd, 3rd, 4th, Last                                       | Last          |
| 7   | DST.DayInWeek_Start   | Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday | Sunday        |
| 8   | DST.HourInDay_Start   | 0~23                                                           | 3             |
| 9   | DST.MonthInYear_End   | Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec     | Sep           |
| 10  | DST.WeekInMonth_End   | 1st, 2nd, 3rd, 4th, Last                                       | Last          |
| 11  | DST.DayinWeek_End     | Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday | Sunday        |
| 12  | DST.HourInDay_End     | 0~23                                                           | 3             |

- **OffsetHour\_UTC, OffsetMinute\_UTC**

These settings are used to set the time offset of the current time zone to the GMT (Greenwich Mean Time) zone.

| Time zone | GMT zone       | East 1st | East 2nd | East 3rd | East 4th  | East 5th  |
|-----------|----------------|----------|----------|----------|-----------|-----------|
| Setting   | 0              | 1        | 2        | 3        | 4         | 5         |
| Time zone | East 6th       | East 7th | East 8th | East 9th | East 10th | East 11th |
| Setting   | 6              | 7        | 8        | 9        | 10        | 11        |
| Time zone | East/West 12th | West 1st | West 2nd | West 3rd | West 4th  | West 5th  |
| Setting   | 12/-12         | -1       | -2       | -3       | -4        | -5        |
| Time zone | West 6th       | West 7th | West 8th | West 9th | West 10th | West 11th |
| Setting   | -6             | -7       | -8       | -9       | -10       | -11       |

- **DST.En**

Enable/Disable the Daylight Saving Time (DST) function.

### 6.2.3 ClkSrc Settings

| No. | Item                    | Range(Unit)                                | Default Value | Description                                                               |
|-----|-------------------------|--------------------------------------------|---------------|---------------------------------------------------------------------------|
| 1   | En_SatCh1               | Disable or Enable                          | Enable        | Enable/Disable the satellite channel 1                                    |
| 2   | En_SatCh2               | Disable or Enable                          | Enable        | Enable/Disable the satellite channel 2                                    |
| 3   | t_Comp_SatCh1           | 0~1,000,000,000(ns)                        | 0             | Delay compensation for the satellite channel 1                            |
| 4   | t_Comp_SatCh2           | 0~1,000,000,000(ns)                        | 0             | Delay compensation for the satellite channel 2                            |
| 5   | t_Comp_Recv_IRIG-B1     | 0~1,000,000,000(ns)                        | 0             | Delay compensation for the IRIG-B reception channel 1                     |
| 6   | t_Comp_Recv_IRIG-B2     | 0~1,000,000,000(ns)                        | 0             | Delay compensation for the IRIG-B reception channel 2                     |
| 7   | Opt_Recv_IRIG-B1        | Disable, RS485, TTL, IdleLitOn, IdleLitOff | IdleLitOn     | Reception mode of the IRIG-B reception channel 1                          |
| 8   | Opt_Recv_IRIG-B2        | Disable, RS485, TTL, IdleLitOn, IdleLitOff | IdleLitOn     | Reception mode of the IRIG-B reception channel 2                          |
| 9   | Opt_Parity_Recv_IRIG-B1 | Odd or Even                                | Odd           | Parity check mode of the IRIG-B reception channel 1                       |
| 10  | Opt_Parity_Recv_IRIG-B2 | Odd or Even                                | Odd           | Parity check mode of the IRIG-B reception channel 2                       |
| 11  | En_Alm_SynLoss_SatCh1   | Disable or Enable                          | Enable        | Enable/Disable the synchronization loss alarm for the satellite channel 1 |
| 12  | En_Alm_Ant_SatCh1       | Disable or Enable                          | Enable        | Enable/Disable the antenna alarm for the satellite channel 1              |
| 13  | En_Alm_SynLoss_SatCh2   | Disable or Enable                          | Enable        | Enable/Disable the synchronization loss alarm for the satellite channel 2 |
| 14  | En_Alm_Ant_SatCh2       | Disable or Enable                          | Enable        | Enable/Disable the antenna alarm for the satellite channel 2              |
| 15  | Opt_Priority_SatCh      | SatCh1 or SatCh2                           | SatCh1        | The higher priority selection in the satellite channels                   |
| 16  | DefaultYear_SatCh       | 2000~3000(1)                               | 2018          | Reset to this year if there is a synchronization error                    |

### 6.2.4 NTP Settings

| No. | Item           | Range(Unit)       | Default Value | Description             |
|-----|----------------|-------------------|---------------|-------------------------|
| 1   | En_Unicast_NTP | Disable or Enable | Enable        | Enable/Disable SNTP/NTP |

| No. | Item                 | Range(Unit)                                                 | Default Value | Description                            |
|-----|----------------------|-------------------------------------------------------------|---------------|----------------------------------------|
|     |                      |                                                             |               | unicast mode                           |
| 2   | En_Broadcast_NTP     | Disable or Enable                                           | Enable        | Enable/Disable SNTP/NTP broadcast mode |
| 3   | Period_Broadcast_NTP | 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384(s) | 64            | The broadcast period for SNTP/NTP      |
| 4   | t_Comp_NTP           | -65535~65535(μs)                                            | 0             | Delay compensation of SNTP/NTP network |

### 6.2.5 PTP Settings

| No. | Item              | Range(Unit)                          | Default Value | Description                           |
|-----|-------------------|--------------------------------------|---------------|---------------------------------------|
| 1   | PTP1.En           | Disable or Enable                    | Enable        | Enable/Disable the PTP port 1         |
| 2   | PTP2.En           | Disable or Enable                    | Enable        | Enable/Disable the PTP port 2         |
| 3   | PTP3.En           | Disable or Enable                    | Enable        | Enable/Disable the PTP port 3         |
| 4   | PTP4.En           | Disable or Enable                    | Enable        | Enable/Disable the PTP port 4         |
| 5   | PTP1.Opt_Protocol | Standard, C37.238-2011, C37.238-2017 | Standard      | Protocol option for PTP network 1     |
| 6   | PTP2.Opt_Protocol | Standard, C37.238-2011, C37.238-2017 | Standard      | Protocol option for PTP network 2     |
| 7   | PTP3.Opt_Protocol | Standard, C37.238-2011, C37.238-2017 | Standard      | Protocol option for PTP network 3     |
| 8   | PTP4.Opt_Protocol | Standard, C37.238-2011, C37.238-2017 | Standard      | Protocol option for PTP network 4     |
| 9   | PTP1.ID_Clk       | 0~255                                | 1             | Clock identification in PTP network 1 |
| 10  | PTP2.ID_Clk       | 0~255                                | 1             | Clock identification in PTP network 2 |
| 11  | PTP3.ID_Clk       | 0~255                                | 1             | Clock identification in PTP network 3 |
| 12  | PTP4.ID_Clk       | 0~255                                | 1             | Clock identification in PTP network 4 |
| 13  | PTP1.DomainNo.    | 0~255                                | 0             | Device domain number in PTP network 1 |
| 14  | PTP2.DomainNo.    | 0~255                                | 0             | Device domain number in PTP network 2 |
| 15  | PTP3.DomainNo.    | 0~255                                | 0             | Device domain number in PTP network 3 |
| 16  | PTP4.DomainNo.    | 0~255                                | 0             | Device domain number in PTP network 4 |

- **PTP1.DomainNo., PTP2.DomainNo.**

Domain number for this PTP device communicating with others as defined by the protocol

| Domain No. | Definition           |
|------------|----------------------|
| 0          | Default domain       |
| 1          | Alternate domain 1   |
| 2          | Alternate domain 2   |
| 3          | Alternate domain 3   |
| 4~127      | User-defined domains |
| 128~255    | Reserved             |

### 6.2.6 SerialPort Settings

| No. | Item                  | Range(Unit)                                               | Default Value | Description                            |
|-----|-----------------------|-----------------------------------------------------------|---------------|----------------------------------------|
| 1   | Opt_Fmt_SerialPort    | M12, DLT                                                  | DLT           | Sending message format for serial port |
| 2   | Opt_Parity_SerialPort | None, Odd, Even                                           | Even          | Parity check mode for serial port      |
| 3   | Opt_Baud_SerialPort   | 1200, 2400, 4800,<br>9600, 19200, 38400,<br>57600, 115200 | 9600          | Baud rate for serial port              |

### 6.2.7 Comm Settings

| No. | Item              | Range(Unit)                     | Default Value   |
|-----|-------------------|---------------------------------|-----------------|
| 1   | IP_LAN1           | 000.000.000.000~255.255.255.255 | 198.120.000.020 |
| 2   | Mask_LAN1         | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 3   | IP_LAN2           | 000.000.000.000~255.255.255.255 | 198.121.000.020 |
| 4   | Mask_LAN2         | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 5   | En_LAN2           | 0 or 1                          | 1               |
| 6   | IP_LAN3           | 000.000.000.000~255.255.255.255 | 198.122.000.020 |
| 7   | Mask_LAN3         | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 8   | En_LAN3           | 0 or 1                          | 1               |
| 9   | IP_LAN4           | 000.000.000.000~255.255.255.255 | 198.123.000.020 |
| 10  | Mask_LAN4         | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 11  | En_LAN4           | 0 or 1                          | 1               |
| 12  | Opt_NetMode       | Normal, PRP, HSR, RSTP          | Normal          |
| 13  | Cfg_RingNet1      | 0, 3, 5, 6, 9, 10, 12           | 0               |
| 14  | Cfg_RingNet2      | 0, 3, 5, 6, 9, 10, 12           | 0               |
| 15  | Cfg_NetPorts_Bond | 0, 3, 5, 6, 9, 10, 12           | 0               |
| 16  | Gateway           | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 17  | Destination_1     | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 18  | Genmask_1         | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 19  | Gateway_1         | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 20  | Destination_2     | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 21  | Genmask_2         | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 22  | Gateway_2         | 000.000.000.000~255.255.255.255 | 000.000.000.000 |

| No. | Item                   | Range(Unit)                     | Default Value   |
|-----|------------------------|---------------------------------|-----------------|
| 23  | Destination_3          | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 24  | Genmask_3              | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 25  | Gateway_3              | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 26  | Destination_4          | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 27  | Genmask_4              | 000.000.000.000~255.255.255.255 | 255.255.255.000 |
| 28  | Gateway_4              | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 29  | IP_FE1                 | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 30  | IP_FE2                 | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 31  | IP_FE3                 | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 32  | IP_FE4                 | 000.000.000.000~255.255.255.255 | 000.000.000.000 |
| 33  | Port_UDP_Meas_f_Grid   | 0~65535                         | 7500            |
| 34  | t_Send_UDP_Meas_f_Grid | 1~60(s)                         | 1(s)            |

- **IP\_LAN1, IP\_LAN2, IP\_LAN3, IP\_LAN4**

IP address of Ethernet port 1, 2, 3 or 4.

- **Mask\_LAN1, Mask\_LAN2, Mask\_LAN3, Mask\_LAN4**

Subnet mask of Ethernet port 1, 2, 3 or 4.

- **En\_LAN2, En\_LAN3, En\_LAN4**

Enable/Disable Ethernet port 2, 3 or 4.

The Ethernet port 1 is always in service.

- **Opt\_NetMode**

Network mode option

Normal: Normal network (not ring)

PRP: Parallel Redundancy Protocol

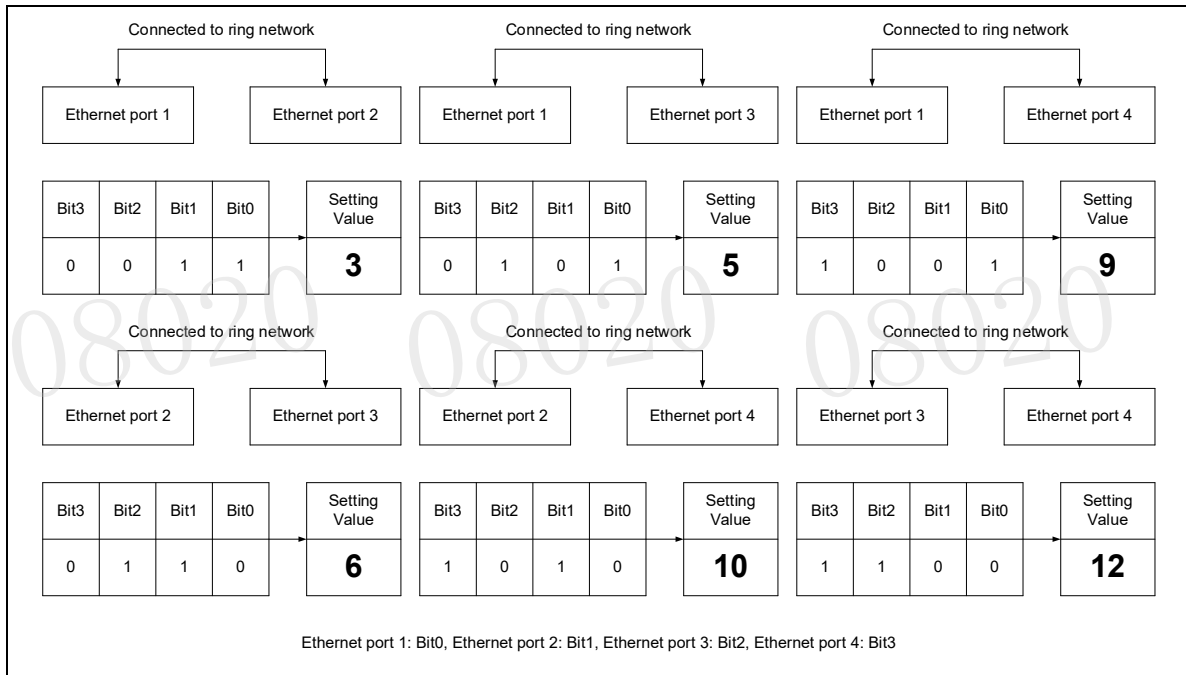
HSR: High-availability Seamless Redundancy

RSTP: Rapid Spanning Tree Protocol

- **Cfg\_RingNet1, Cfg\_RingNet2**

Use these settings to set two Ethernet ports in station level ring network.

The value of these settings represents a 4-bits binary number. Each bit represents a corresponding Ethernet port's ring-network status. Use the following map to decide the specific setting value. Additionally, the default value "0" means the ring network mode is deactivated. This device works in STP mode.

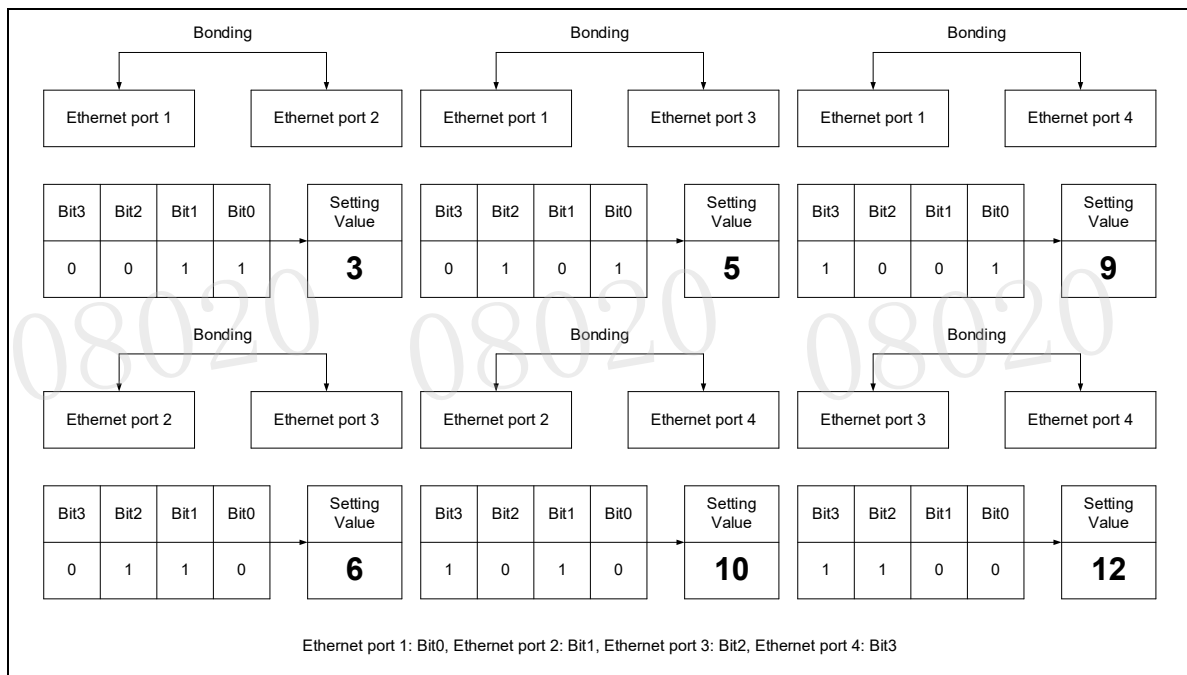


### ● Cfg\_NetPorts\_Bond

Use this setting to set the channel bonding arrangement of two Ethernet ports in station level communication.

For redundancy or increased throughput of the communication, dual network structure may be adopted along with channel bonding technology. These two bonded interfaces, who share the identical IP address and MAC address, work in Active-Standby mode. If the link via active interface fails, the link via original standby interface will be activated automatically to ensure a reliable communication.

The value of this setting represents a 4-bits binary number. Each bit represents a corresponding Ethernet port's bonding status. Use the following map to decide the specific setting value. Additionally, the default value "0" means the channel bonding function is deactivated.



The Active-Standby mode switching logic is:

Take the device Ethernet ports 1 & 2 for example and assume that P1 is connected to NET1 while P2 is connected to NET2.

- After the device is powered on, only P1 is activated when both NET1 and NET2 are normal.
- If NET1 is abnormal, P2 will be activated if NET2 is normal.
- If NET1 is abnormal, P2 cannot be activated if NET2 is also abnormal. The device will keep trying on P1.
- If P2 is working, the device will maintain this state even if NET1 has been restored to normal. It will be switched to P1 only if NET2 is abnormal.

- **Gateway**

IP address of local gateway (router)

- **Destination\_1, Destination\_2, Destination\_3, Destination\_4**

Network segment of opposite router 1, 2, 3, 4

- **Genmask\_1, Genmask\_2, Genmask\_3, Genmask\_4**

Subnet mask of local router 1, 2, 3, 4

- **Gateway\_1, Gateway\_2, Gateway\_3, Gateway\_4**

IP address of local gateway (router) 1, 2, 3, 4

- **IP\_FE1, IP\_FE2, IP\_FE3, IP\_FE4**

IP address of front-end 1, 2, 3, 4 in Substation Automation System (SAS)

- **Port\_UDP\_Meas\_f\_Grid, t\_Send\_UDP\_Meas\_f\_Grid**

Port number and sending period of UDP messages transmission in SAS

Device messages are sent to Supervisory Control And Data Acquisition (SCADA) system by UDP. The time frequency measurement message format is:

| Byte number | Description                             | Contents                                                                                                                                                            | Range   |
|-------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 1           | Frame header                            | <%>                                                                                                                                                                 | '%'     |
| 2-19        | Reserved                                | '0'                                                                                                                                                                 |         |
| 20          | Frequency header                        | <*>                                                                                                                                                                 | '*'     |
| 21          | Tens digit of power frequency           | ASCII code                                                                                                                                                          | '4'~'6' |
| 22          | Ones digit of power frequency           | ASCII code                                                                                                                                                          | '0'~'9' |
| 23          | Tenth digit of power frequency          | ASCII code                                                                                                                                                          | '0'~'9' |
| 24          | Hundredth digit of power frequency      | ASCII code                                                                                                                                                          | '0'~'9' |
| 25          | Thousandth digit of power frequency     | ASCII code                                                                                                                                                          | '0'~'9' |
| 26          | Ten-thousandth digit of power frequency | ASCII code                                                                                                                                                          | '0'~'9' |
| 27-32       | Reserved                                | '0'                                                                                                                                                                 |         |
| 33          | Check byte (upper)                      | Bytes 1-32 are checked byte by byte in exclusive-OR logic, and the upper and lower hexadecimal digits of the check byte are respectively represented by ASCII code. | '0'~'9' |
| 34          | Check byte (lower)                      |                                                                                                                                                                     | 'A'~'F' |
| 35          | End mark                                | CR                                                                                                                                                                  | 0DH     |
| 36          | End mark                                | LF                                                                                                                                                                  | 0AH     |

## 6.3 For PCS-9785 Clock Extension

### 6.3.1 Overview

User can use the RS-232 debugging port on the CLK module to download program and configure settings. The modified settings will be saved immediately and valid instantly.

| Parameter  | Value |
|------------|-------|
| Start Bit  | 1     |
| Data Bit   | 8     |
| Stop Bit   | 1     |
| Check Mode | None  |

Use a serial commissioning software to send debugging command via the port. If a command is executed successfully, the device will return **"OK"**.

#### **NOTICE!**

It is necessary to disconnect the input channels and restart the device before any configuration.

### 6.3.2 Current Year

The information about "Current Year" is not included in the standard IRIG-B code. Thus, an initial value of current year (default value: 2005) must be manually set for correct output of timing message. In later operation, the device will automatically update "current year" based on the setting value.

- Command format: TDDDD

|      |                                |
|------|--------------------------------|
| T    | The command key word           |
| DDDD | ASCII code of the current year |

Example: "T2006" means to set the current year as 2006.

- Command format: T?

To query the current value of "Current Year".

### 6.3.3 Internal Clock Current Time

Use the following command to set current time of the internal clock.

- Command format: TYYYYMMDDhhmmss

|      |                      |
|------|----------------------|
| T    | The command key word |
| YYYY | ASCII code of year   |
| MM   | ASCII code of month  |
| DD   | ASCII code of day    |
| hh   | ASCII code of hour   |
| mm   | ASCII code of minute |
| ss   | ASCII code of second |

Example: "T20060817195342" means to set the internal clock time as 2006-08-17 19:53:42.

### 6.3.4 Optical Inputs Reception Mode

The two optical inputs on the CLK module are used to receive IRIG-B signal from another clock synchronization source. The reception mode of each input is optional between idle-light-on (default) and idle-light-off.

- Command format: FDD

|          |                                                                                 |
|----------|---------------------------------------------------------------------------------|
| F        | The command key word                                                            |
| First D  | Reception mode of the first optical input, 1: idle-light-on; 0: idle-light-off  |
| Second D | Reception mode of the second optical input, 1: idle-light-on; 0: idle-light-off |

Example: "F10" means the first is idle-light-on, the second is idle-light-off.

- Command format: F?

To query the current value of optical inputs reception mode.

#### **NOTICE!**

For a IRIG-B signal input channel, the optical or electrical input working mode is optional. To use the optical mode, the relevant electrical input must be unconnected and its input mode should be TTL

### **6.3.5 Electrical Inputs Reception Mode**

The two electrical inputs on the CLK module are used to receive IRIG-B signal from other clock synchronization source. The reception mode of each input is optional between TTL (default) and RS-485.

- Command format: EDD

E                                      The command key word

First D                                Reception mode of the first electrical input, 1: TTL; 0: RS-485

Second D                            Reception mode of the second electrical input, 1: TTL; 0: RS-485

Example: "E01" means the first is RS-485, the second TTL.

- Command format: E?

To query the current value of electrical inputs reception mode.

#### **NOTICE!**

For a IRIG-B signal input channel, the optical or electrical input working mode is optional. To use the electrical mode, the relevant optical input must be unconnected and its input mode should be idle-light-on.

### **6.3.6 Input Cable Length**

To reduce the time delay due to signal transmission from clock source to this device, it is necessary to consider the transmission cable length. This device can compensate the delay based on the length so as to minimize the error in time synchronization.

- Command format: ADDDD or BDDDD

A or B                                The command key word, A signifies the first input while B signifies the second

DDDD                                Length of input cable (default value = 0), Unit: meter; Range: 1~9999; Step: 1

Example: A0030 means the first input cable length is 30m

- Command format: A? or B?

To query the current value of input cable length.

### 6.3.7 Internal Clock Operation Mode

If the operation mode of internal clock is "ON" (default) and there is no IRIG-B signal input, the time synchronization source will be the internal clock. Then, if one of the two inputs has received IRIG-B signal, the time source will be switched automatically. Additionally, the internal clock will be synchronized every minute.

If the operation mode of internal clock is "OFF" and there is no IRIG-B signal input, there will be no time synchronization output from this device.

- Command format: CD

C                                      The command key word

D                                      Internal clock operation mode, 1: ON; 0: OFF

Example: C1 means the operation mode is ON.

- Command format: C?

To query the current internal clock operation mode.

### 6.3.8 Input Channel Alarm Mode

The two IRIG-B signal inputs can be adopted together or separately. The input channel alarm mode should be set according to the real adoption situation.

- Command format: WD

W                                      The command key word

D                                      Input channel alarm mode

0: alarm while one input channel is disconnected

1: alarm while one input channel is disconnected or the time source is asynchronous (default)

2: alarm while both input channels are disconnected

- Command format: W?

To query the current input channel alarm mode.

## 7 Human Machine Interface

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08020 08020 08020

08020 08020 08020

08020 08020 08020

## 7.1 Overview

### NOTICE!

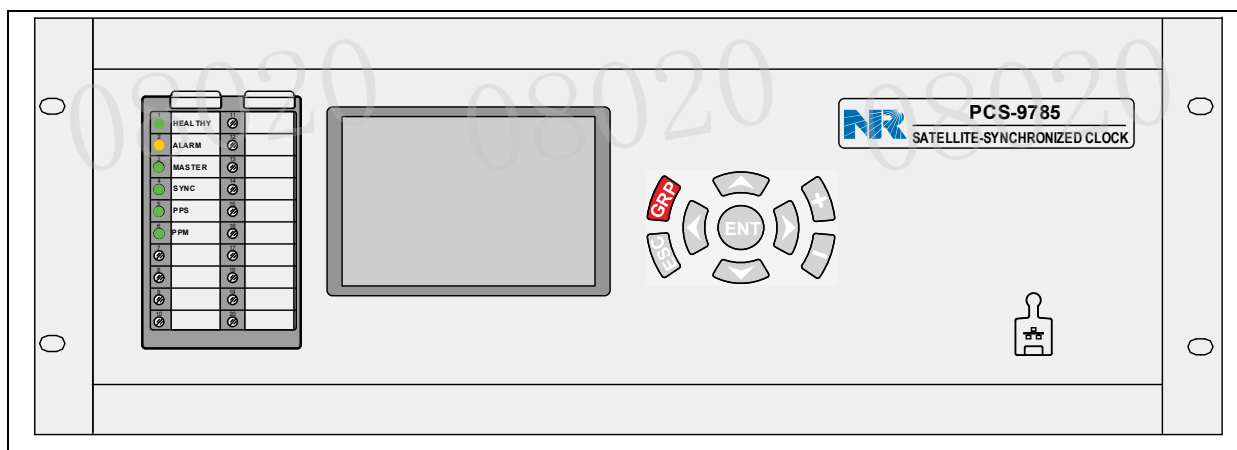
**ONLY** the master mode PCS-9785 clock source is equipped with the following HMI for local operation.

Operator can access this device from the HMI panel. Local communication with the device is possible in using a computer via the multiplex RJ-45 debugging port. Furthermore, remote communication is also possible in using the SAS via communication ports in the MON module.

This chapter describes the human machine interface (HMI), and gives operator an instruction about how to display and modify status, settings, etc. through LCD.

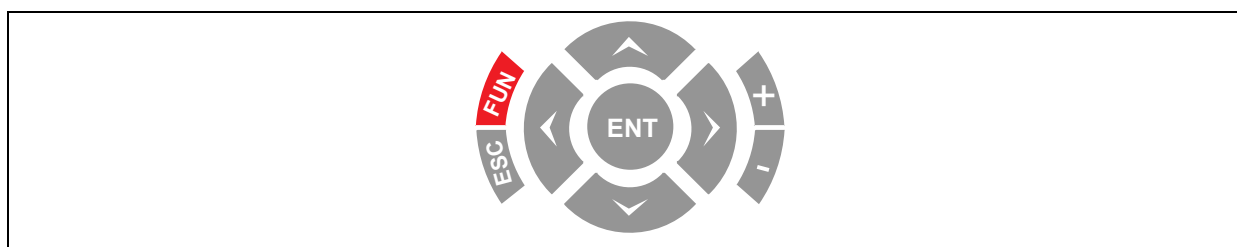
### 7.1.1 Design

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.



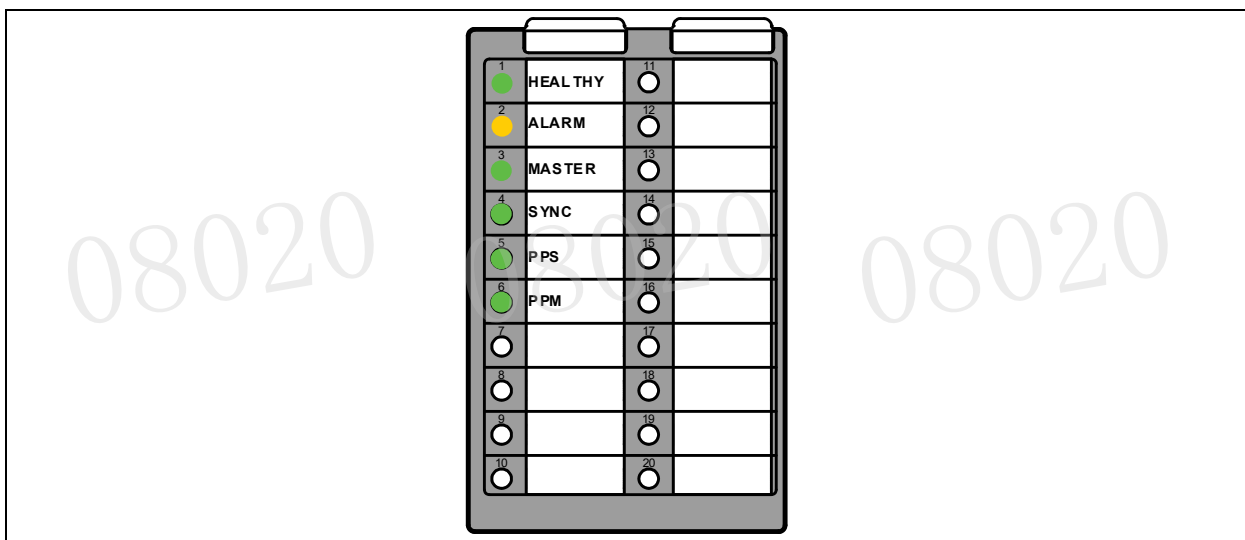
| No. | Item               | Description                                                                                                                                                |
|-----|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 6 are fixed.                                                                                                  |
| 3   | Keypad             | Navigation keypad and 9 keys                                                                                                                               |
| 4   | Communication port | A multiplex RJ45 port for debugging                                                                                                                        |

### 7.1.2 Keypad



- "ESC"
  - Cancel the operation
  - Quit the current menu
- "ENT"
  - Execute the operation
  - Confirm the interface
- "GRP"
  - Reserved
- "◀" and "▶"
  - Move the cursor horizontally
  - Enter the next menu or return to the previous menu
- "▲" and "▼"
  - Move the cursor vertically
  - Select command menu within the same level of menu
- "+" and "-"
  - Modify the value
  - Modify and display the message number
  - Page up/down

### 7.1.3 LED Indicator



A brief explanation has been made as below.

| LED            | Display       | Description                                                                             |
|----------------|---------------|-----------------------------------------------------------------------------------------|
| <b>HEALTHY</b> | Off           | The device is out of service or any hardware error is detected during self-check.       |
|                | Steady green  | The device is in service and ready for operation.                                       |
| <b>ALARM</b>   | Off           | The device is in normal operating condition.                                            |
|                | Steady yellow | An abnormal alarm is issued.                                                            |
| <b>MASTER</b>  | Off           | The device is the slave in dual device redundancy strategy                              |
|                | Steady green  | The device is the master in dual device redundancy strategy                             |
| <b>SYNC</b>    | Off           | None synchronization signal is received.                                                |
|                | Steady green  | The device is successfully synchronized with at least one of the external time sources. |
| <b>PPS</b>     | Off           | None pulse output                                                                       |
|                | Flash green   | The device is outputting pulse per second                                               |
| <b>PPM</b>     | Off           | None pulse output                                                                       |
|                | Flash green   | The device is outputting pulse per minute                                               |

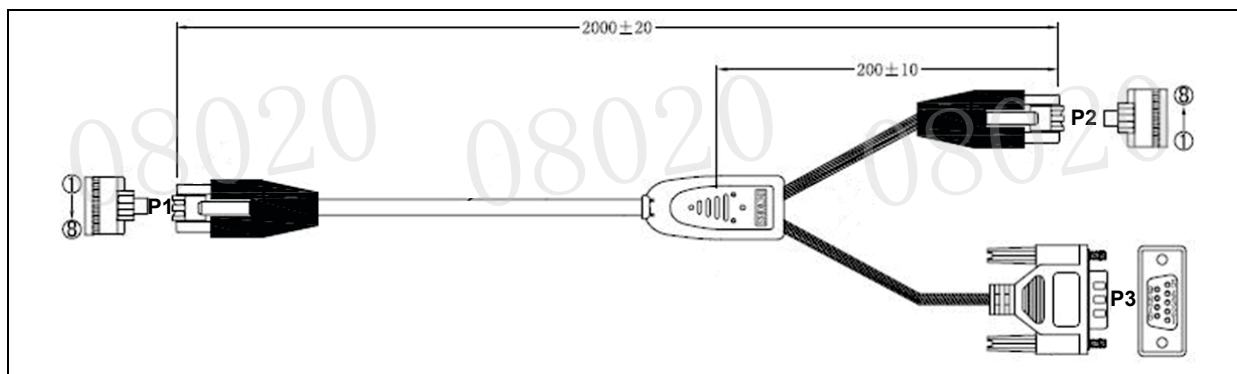
**NOTICE!**

"**HEALTHY**" LED can only be turned on by energizing the device and no abnormality detected.

"**ALARM**" LED is turned on as long as alarm exists. When all alarm signals disappear, it will be turned off.

**7.1.4 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.

| No. | Core color     | Function                                  | Device side<br>(Left) | Computer side<br>(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                     |
| 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                  |                          |

### 7.1.5 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)

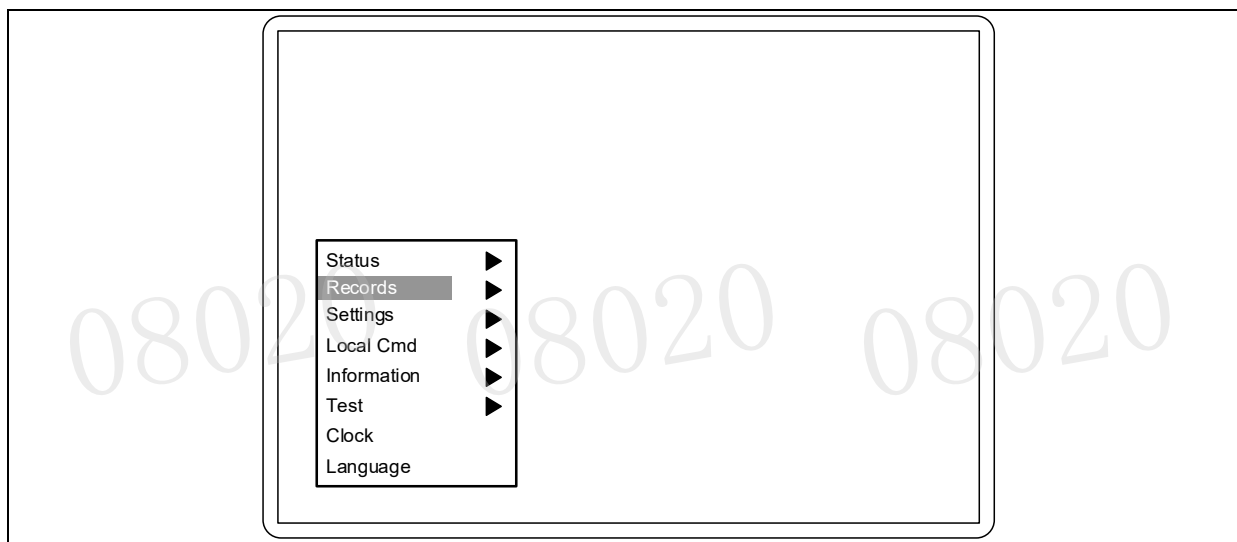
## 7.2 Menu Tree

### NOTICE!

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

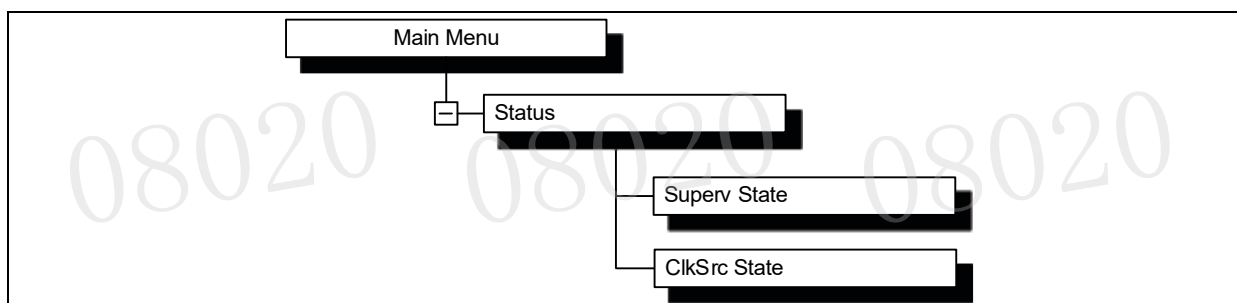
### 7.2.1 Main Menu

Press "▲" in the normal display 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.

### 7.2.2 Status



This menu is mainly used to display some real-time states, including self-supervision and clock sources states.

#### NOTICE!

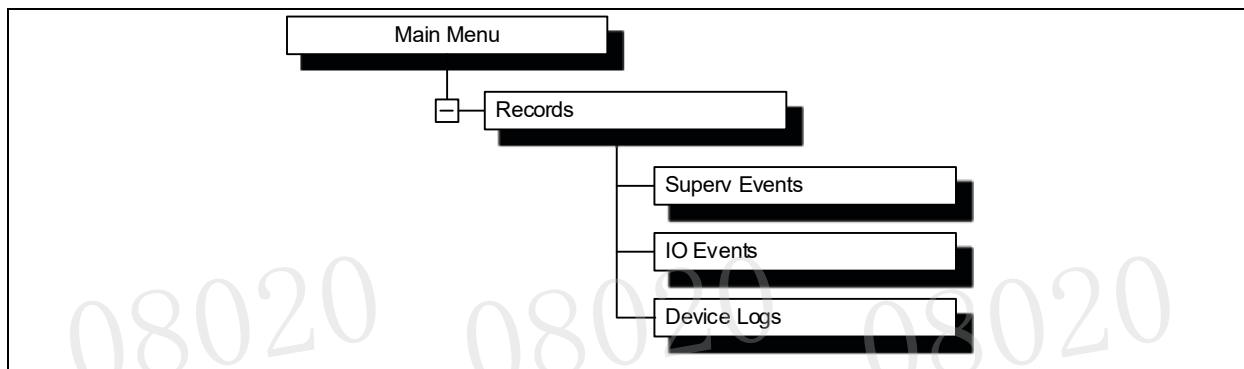
Please refer to the chapter "*Supervision*" for the detail of all self-supervision states.

**Table 7.2-1 Item description of "ClkSrc State"**

| No. | Item                  | Description                                                                                 |
|-----|-----------------------|---------------------------------------------------------------------------------------------|
| 1   | State_Syn_SatCh1      | Synchronization state of the satellite channel 1 (Invalid, Valid, Not Available)            |
| 2   | State_Ant_SatCh1      | Antenna state of the satellite channel 1 (OK, OverCurrent, UnderCurrent)                    |
| 3   | State_Receiver_SatCh1 | Receiver state of the satellite channel 1 (Invalid, Valid, Not Available)                   |
| 4   | N_Satellite_SatCh1    | Connected satellite number of the satellite channel 1                                       |
| 5   | t_Diff_SatCh1         | Time difference, between the time source and the internal clock, of the satellite channel 1 |
| 6   | State_Syn_SatCh2      | Synchronization state of the satellite channel 2 (Invalid, Valid, Not Available)            |
| 7   | State_Ant_SatCh2      | Antenna state of the satellite channel 2 (OK, OverCurrent, UnderCurrent)                    |
| 8   | State_Receiver_SatCh2 | Receiver state of the satellite channel 2 (Invalid, Valid, Not Available)                   |
| 9   | N_Satellite_SatCh2    | Connected satellite number of the satellite channel 2                                       |

| No. | Item                   | Description                                                                                 |
|-----|------------------------|---------------------------------------------------------------------------------------------|
| 10  | t_Diff_SatCh2          | Time difference, between the time source and the internal clock, of the satellite channel 2 |
| 11  | State_Syn_Recv_IRIG-B1 | Synchronization state of the IRIG-B channel 1 (Invalid, Valid, Not Available)               |
| 12  | Quality_Recv_IRIG-B1   | Quality bit of the IRIG-B channel 1                                                         |
| 13  | t_Diff_Recv_IRIG-B1    | Time difference, between the time source and the internal clock, of the IRIG-B channel 1    |
| 14  | State_Syn_Recv_IRIG-B2 | Synchronization state of the IRIG-B channel 2 (Invalid, Valid, Not Available)               |
| 15  | Quality_Recv_IRIG-B2   | Quality bit of the IRIG-B channel 2                                                         |
| 16  | t_Diff_Recv_IRIG-B2    | Time difference, between the time source and the internal clock, of the IRIG-B channel 2    |

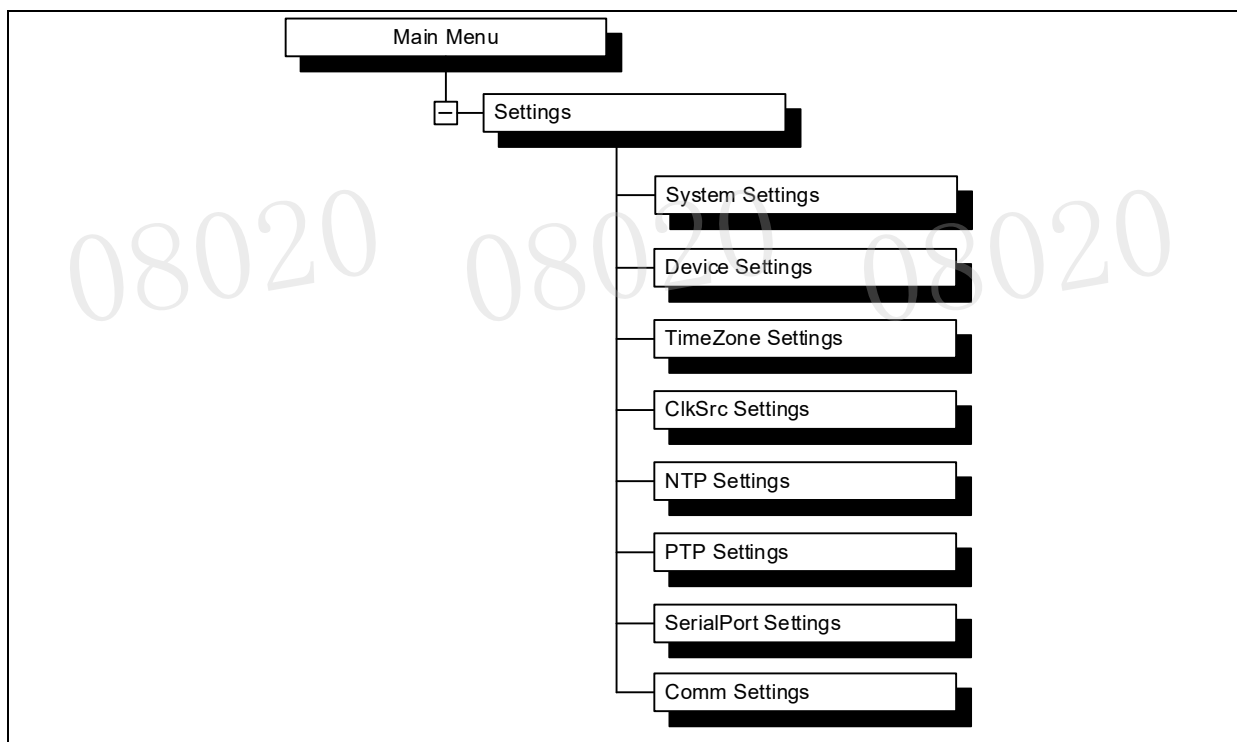
### 7.2.3 Records



This menu is used to display all kinds of records, so that the operator can load to view and use as the reference for accident analyzing and device repairing. All records are stored in non-volatile memory. The device can still stock them even if it loses its power.

| No. | Item          | Description                 |
|-----|---------------|-----------------------------|
| 1   | Superv Events | Self-supervision alarm      |
| 2   | IO Events     | Binary signal change record |
| 3   | Device Logs   | Device operation log        |

## 7.2.4 Settings

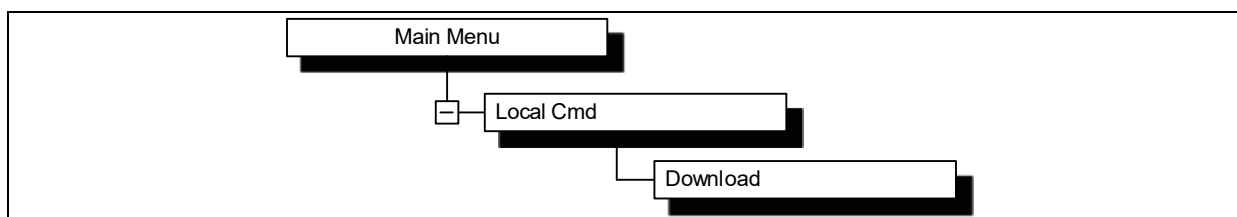


This menu is used to configure the parameters of the device.

### NOTICE!

Please refer to the chapter "Settings" for the detail of all settings.

## 7.2.5 Local Command



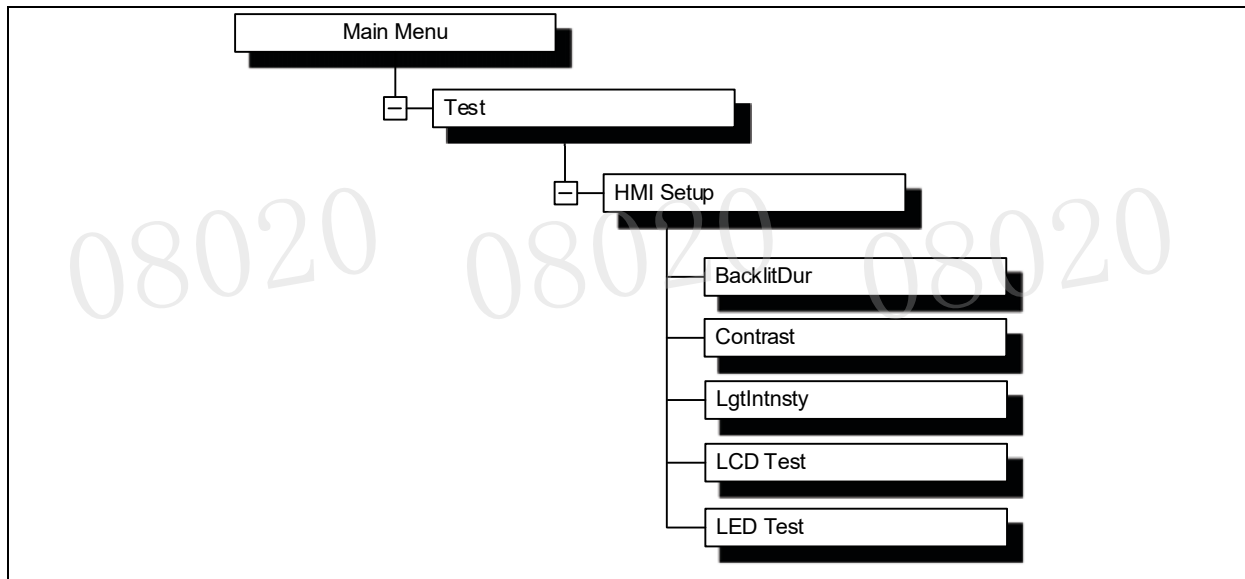
This menu is used to do certain operation locally via LCD.

| No. | Item     | Function description                       |
|-----|----------|--------------------------------------------|
| 1   | Download | Send out the request of a program download |

## 7.2.6 Information

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

### 7.2.7 Test



This menu is used to self-test the device.

| No. | Item      | Function description |                                                    |
|-----|-----------|----------------------|----------------------------------------------------|
| 1   | HMI Setup | BacklitDur           | To change the duration of LCD backlight            |
|     |           | Contrast             | To adjust de contrast of LCD display               |
|     |           | LgtIntnsty           | To adjust the light intensity of the LCD backlight |
|     |           | LCD Test             | To start the pixel check of the LCD display.       |
|     |           | LED Test             | To start the light test of the LED indicators.     |

### 7.2.8 Clock

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

### 7.2.9 Language

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

## 8 Installation

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## 8.1 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.

## 8.2 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.



### **WARNING!**

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

### **NOTICE!**

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

### **NOTICE!**

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

### **NOTICE!**

A module can **ONLY** be inserted in the slot designated in the chapter 5. Components can be damaged or destroyed by inserting module in a wrong slot.

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

- Should boards have to be removed from this device installed in a grounded cubicle in an HV switchgear installation, please discharge yourself by touching station ground (the cubicle) beforehand.

- Only hold electronic boards at the edges, taking care not to touch the components.
- Only works on the board that 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.
- Always store and ship the electronic boards in their original packing. Place electronic parts in electrostatic screened packing materials.

### 8.3 Shipment Checking

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"*.

### 8.4 Required Material and Tools

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).

### 8.5 Device Location and Ambient Conditions

#### **NOTICE!**

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

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:

- The location should not be exposed to excessive air pollution (dust, aggressive substances).
- 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.

- 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).

## 8.6 Mechanical Installation

### NOTICE!

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

This device is made of a single layer 4U chassis. Following figure shows the dimensions and cutout size in the cubicle of this device for reference in mounting.

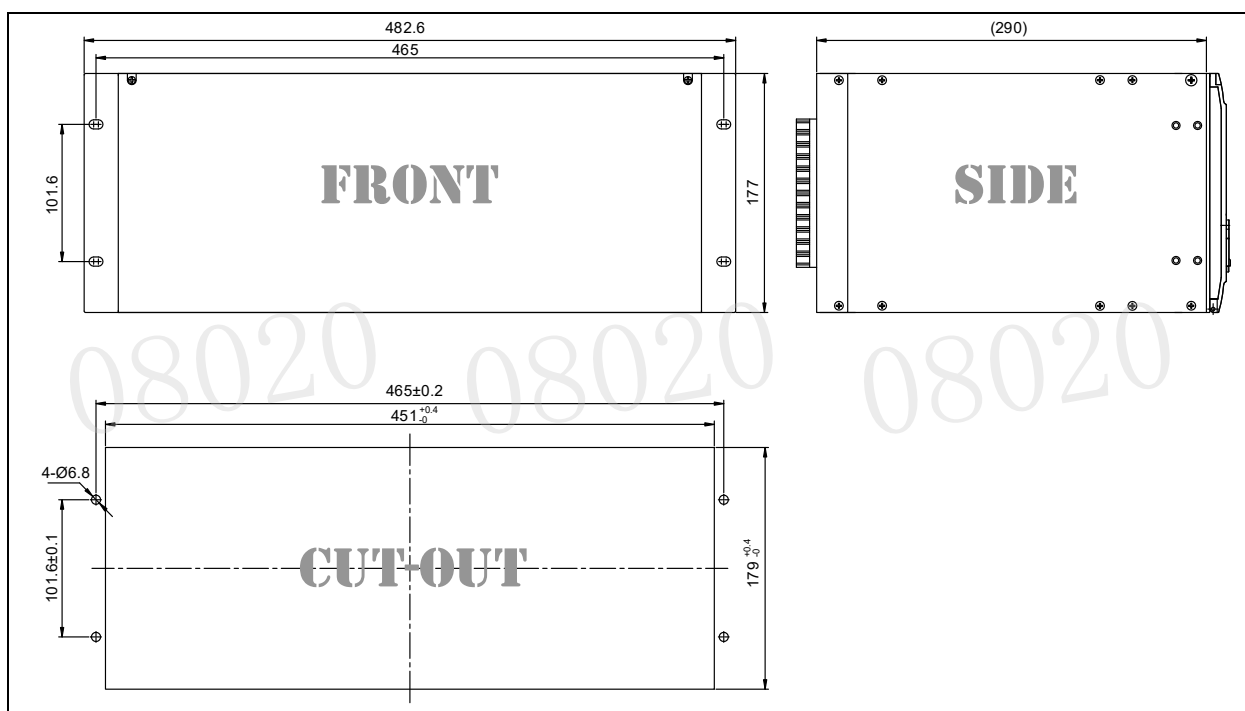


Figure 8.6-1 Dimensions (unit: mm, 4U 19" rack)

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



**Figure 8.6-2 Demonstration of module plugging**

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.

## **8.7 Electrical Installation and Wiring**

### **8.7.1 Grounding Guidelines**

#### **NOTICE!**

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

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.

### **8.7.2 Cubicle Grounding**

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

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

#### **NOTICE!**

If the above conditions are not fulfilled, there is a possibility of the cubicle or parts of it forming a resonant circuit at certain frequencies that would amplify the transmission of interference by the devices installed and 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 8.7-1*).

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.

**NOTICE!**

For metallic connection, 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).

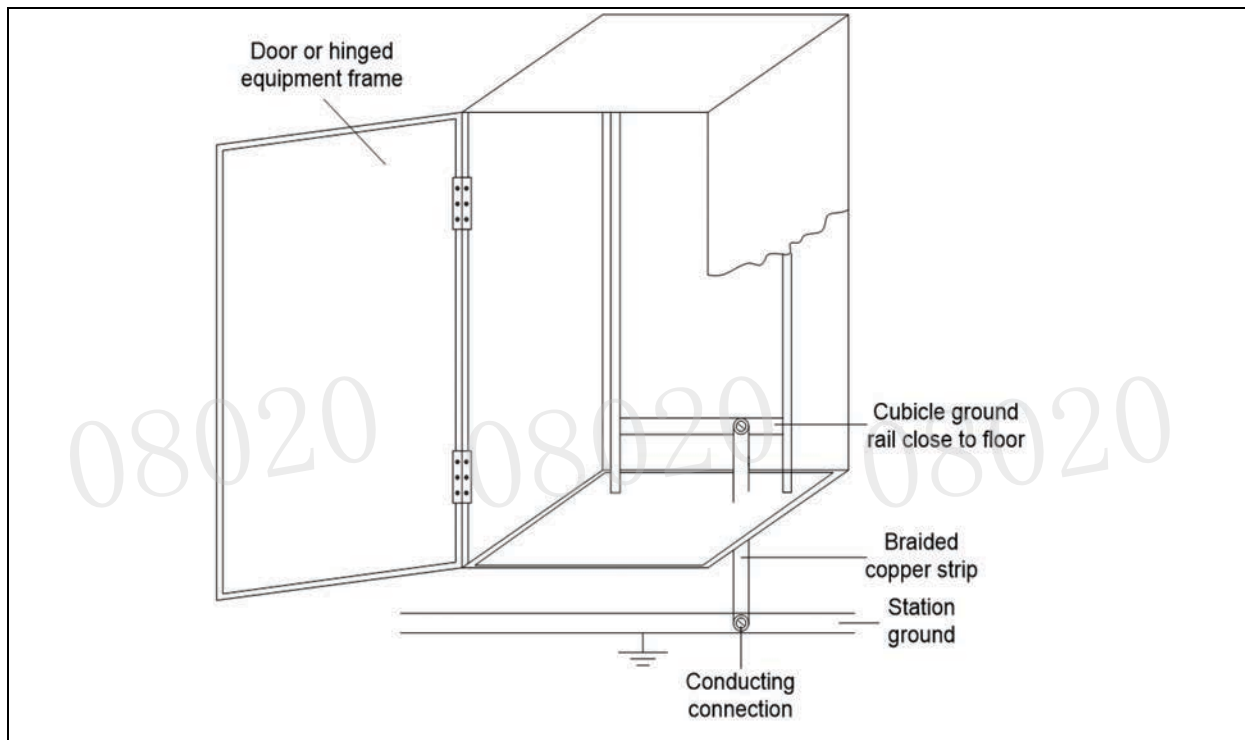


**Figure 8.7-1 Cubicle grounding system**

### 8.7.3 Device Ground Connection

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 8.7-2*) is the only ground terminal of this device.



Figure 8.7-2 Device ground terminal

#### 8.7.4 Grounding Strips

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.

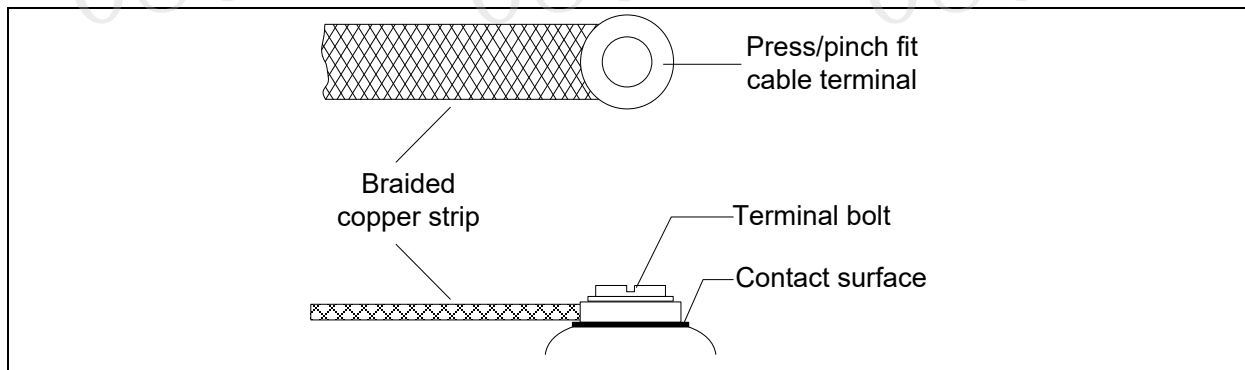


Figure 8.7-3 Ground strip and termination

#### 8.7.5 Wiring Guideline

There are several types of cables that are used for connection of this device. Recommendation of cable is:

- Grounding: braided copper cable,  $2.5\text{mm}^2 \sim 6.0\text{mm}^2$
- Power supply, binary inputs & outputs: stranded conductor,  $1.0\text{mm}^2 \sim 2.5\text{mm}^2$
- Serial communication: 4-core shielded cable
- Ethernet communication: 4-pair twisted shielded cable (category 5E)

### 8.7.6 Antenna Installation

The active receiving antenna includes three parts: the head, the feeder and the support. The diameter of the mushroom-shaped head is 96mm and the height is 126mm. The length of the feeder is 30m (should be declared if there is other requirement). The longer the feeder is, the more serious the signal attenuation will be. Thus, a feeder longer than 60m should be sectioned by amplifier.

To realize a good reception of satellite signal, the antenna head should be installed outdoor with as large reception range as possible.

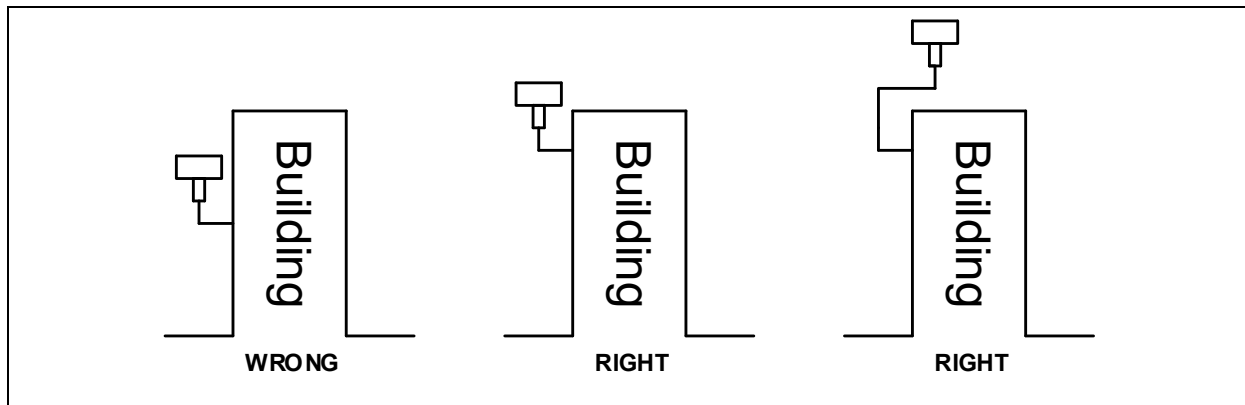


Figure 8.7-4 Antenna head installation

#### **NOTICE!**

The antenna may be installed in an open space if it is impossible to be installed on the top of a building. Make sure that there is no roof on the top and the installation height is no lower than the surrounding obstacles.

#### **NOTICE!**

It is possible to cover a glass or plastic shield over the antenna head. Make sure that there is no metallic component in the shield.

#### **NOTICE!**

This antenna has a great anti-interference capability, while if the interference signal is too strong, there will still be influence. So it is suggested to install the antenna as far as possible to avoid any other transmission or reception antenna.

#### **NOTICE!**

The low-loss coaxial cable feeder is one of the keys in signal transmission. It is suggested to use the cable pipe while wiring in case of animal bit or corrosion.

#### **NOTICE!**

Because of outdoors installation, a surge arrestor is obligatory. The arrestor should be installed between the antenna and the device. It also should be directly and independently grounded.

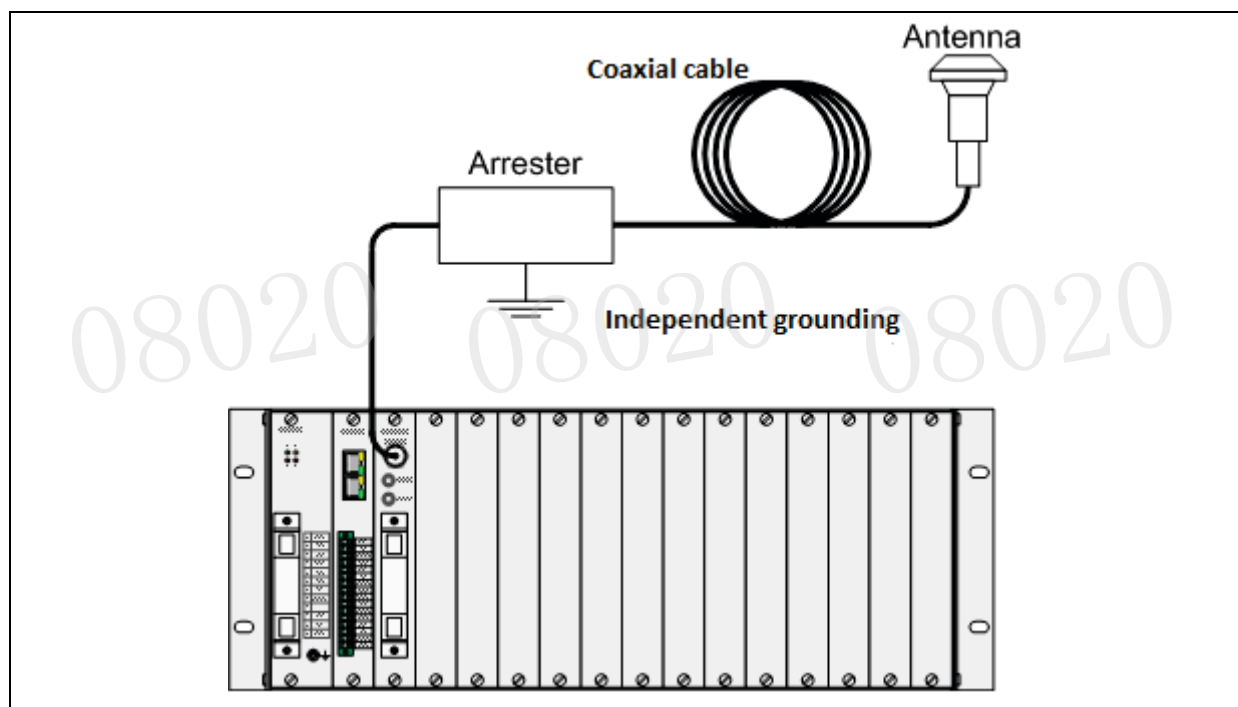


Figure 8.7-5 Arrester installation

## 9 Commissioning

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## 9.1 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.

## 9.2 Safety Instructions



### WARNING!

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

Particular attention must be drawn to the following:

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

## 9.3 Commission Tools

### NOTICE!

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

- Minimum required equipment
  - Multimeter with suitable current range and voltage ranges.
  - Continuity tester (if not included in the multimeter).

- Optional equipment
  - A portable PC, with appropriate software (this enables the rear communications port to be tested, if this is to be used, and will save considerable time during commissioning).
  - EIA RS-485 to EIA RS-232 converter
  - Tester: HELP-9000

## 9.4 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.

## 9.5 Product Checks

These product checks cover all aspects of the device that 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 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.

### 9.5.1 With the Device De-energized

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

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

- Hardware tests

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

- User interfaces test
- Binary input circuits and output circuits test
- Function tests

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

- Conjunctive tests

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

- On load test

#### 9.5.1.1 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.

- Device panel

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

- Panel wiring

Check the conducting wire that 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.

- 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.

- Earthing cable

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

- Switch, keypad, isolator binary inputs and push button

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

#### 9.5.1.2 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:

- Voltage transformer circuits
- Current transformer circuits
- DC power supply
- Optic-isolated control inputs
- Output contacts
- 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.

#### 9.5.1.3 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.

#### 9.5.1.4 Power Supply



#### WARNING!

Energize this device **ONLY** if the power supply is within the specified operating range in the chapter "*Technical Data*".

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 the 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 the chapter "*Technical Data*". See this section for further details about the parameters of the power supply.

#### 9.5.2 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.

### 9.5.2.1 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.

### 9.5.2.2 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.

### 9.5.2.3 Light Emitting Diode

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 that 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.

- 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.
- 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.

## 9.6 Final Checks

After the above tests are completed, remove all test or temporary shorting leads, etc. If it has been necessary to disconnect any of the external wiring from the 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.

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## 10 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.

## 10.1 Appearance Check

- 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.
- 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.
- Check weld spots on PCB whether they are well soldered without any rosin joint. All dual inline components must be well plugged.

## 10.2 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:

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

## 10.3 Failed Module Replacement



### WARNING!

Module can **ONLY** be replaced while the device power supply is switched off.

**ONLY** appropriately, trained and qualified personnel can perform the replacement by strictly observing the precautions against electrostatic discharge.



### WARNING!

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



### CAUTION!

Take anti-static measures such as wearing an earthed wristband and placing modules on an earthed conductive mat when handling a module. Otherwise, electronic components could be damaged.



### CAUTION!

Check the device configuration after a replacement of module. Unintended operation of device may occur.

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**".

- To replace 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.
- To replace the Human Machine Interface Module (HMI 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.

## 10.4 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.

## 10.5 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.

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# 11 Decommissioning and Disposal

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## 11.1 Decommissioning



### **WARNING!**

Switch **OFF** the external miniature circuit breaker of device power supply **BEFORE** disconnecting the power supply cable connected to the PWR module.



### **WARNING!**

**KEEP** an adequate safety distance to live parts of the power substation.

#### 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.

#### 3. Dismantling

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

## 11.2 Disposal

### **NOTICE!**

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

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## 12 Appendix

As demonstrated in the following figure, This device adopts the IRIG-B code which is complied to the IRIG Standard 200-04 and, according to IEEE C 37.118-2005, adds information about "Year" and "Signal quality".

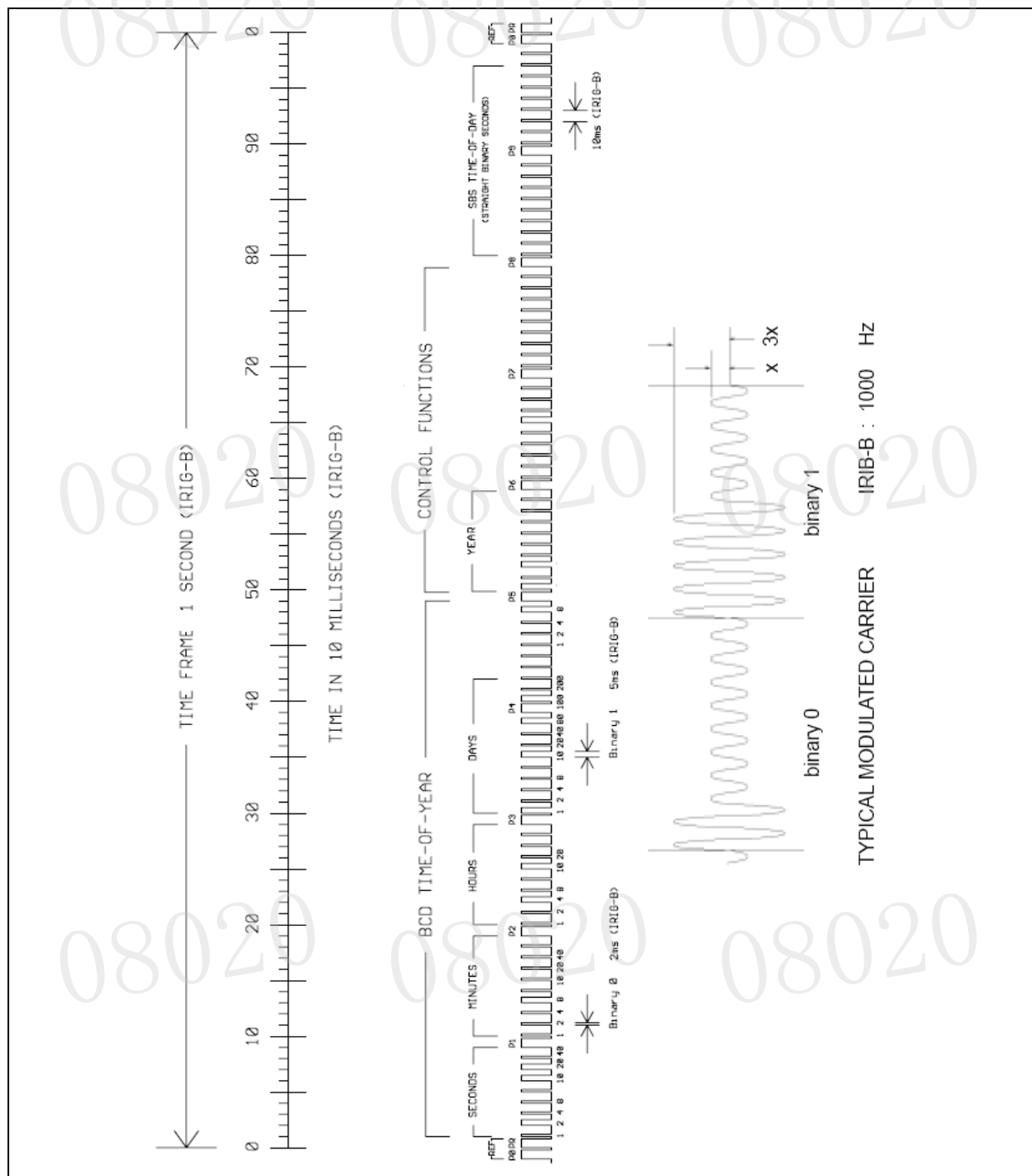


Figure 12-1 Time code format of IRIG-B

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## 13 Revisions History

| Document Version | Firmware Version | Release Date | Description of change                                                                                                                                                                                                                            |
|------------------|------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R1.00            | R1.00            | 2016-05-30   | Form the original manual.                                                                                                                                                                                                                        |
| R1.01            | R1.00            | 2016-07-18   | Update communication settings.                                                                                                                                                                                                                   |
| R1.02            | R1.00            | 2016-10-17   | <ul style="list-style-type: none"> <li>● Update maximum &amp; minimum values description ;</li> <li>● Update certifications ;</li> <li>● Optimize serial ports wiring instructions in different modules.</li> </ul>                              |
| R1.10            | R1.03            | 2017-07-19   | <ul style="list-style-type: none"> <li>● Add PCS-9785 Clock Extension with relevant hardware configuration, setting method ;</li> <li>● Update alarm list ;</li> <li>● Update device menu ;</li> <li>● Update communication settings.</li> </ul> |
| R1.11            | R1.07            | 2018-03-15   | <ul style="list-style-type: none"> <li>● Update time zone settings ;</li> <li>● Update Daylight Saving Time settings ;</li> <li>● Update communication settings.</li> </ul>                                                                      |
| R1.12            | R1.08            | 2018-05-22   | <ul style="list-style-type: none"> <li>● Add PRP/HSR and IEEE 1588 descriptions ;</li> <li>● Update DST settings names ;</li> <li>● Update the setting "Opt_NetMode" ;</li> <li>● Update setting structure ;</li> </ul>                          |
| R1.13            | R1.09            | 2018-10-20   | <ul style="list-style-type: none"> <li>● Update MON module port arrangement ;</li> <li>● Update setting structure.</li> </ul>                                                                                                                    |
| R1.20            | R1.11            | 2019-07-05   | <ul style="list-style-type: none"> <li>● Addition of NR1145I, NR1145J &amp; NR1145K;</li> <li>● Addition of technical data and settings for time frequency measurement.</li> </ul>                                                               |

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