

# PROFIBUS Network Adapter

## RIO3-PBA User Manual



| <b>DOCUMENT CHANGE SUMMARY</b> |             |   |             |               |
|--------------------------------|-------------|---|-------------|---------------|
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## Content

|   |    |
|---|----|
| 1. Important Notes .....  | 5  |
| 1.1.1. Symbols .....  | 6  |
| 1.1.2. Safety Notes .....   | 6  |
| 1.1.3. Certification .....  | 6  |
| 2. Environment Specification .....                                      | 7  |
| 3. RIO3-PBA (PROFIBUS Network Adapter) .....                            | 8  |
| 3.1. RIO3-PBA Specification .....                                       | 8  |
| 3.2. RIO3-PBA Wiring Diagram .....                                      | 10 |
| 3.3. RIO3-PBA LED Indicator .....                                       | 11 |
| 3.3.1. LED Indicator .....  | 11 |
| 3.3.2. MOD (Module Status LED) .....                                    | 11 |
| 3.3.3. NET (Network Status LED).....                                    | 11 |
| 3.3.4. DIA (Diagnostic Status LED) .....                                | 12 |
| 3.3.5. IOS LED (Expansion Module Status LED).....                       | 12 |
| 3.3.6. Field-, System Power LED (Field-, System Power Status LED) ..... | 12 |
| 3.4. RIO3-PBA Electrical Interface .....                                | 13 |
| 3.4.1. PROFIBUS Connector .....   | 13 |
| 3.4.2. Dip Switch .....   | 13 |
| 3.4.3. RS232 Port for MODBUS/RTU, Touch Panel or IOGuide .....          | 14 |
| 3.5. I/O Process Image Map .....  | 14 |
| 3.5.1. Example of Input Process Image (Input Register) Map .....        | 15 |
| 3.5.2. Example of Output Process Image (Output Register) Map .....      | 16 |
| 4. Dimension .....  | 17 |
| 4.1. RIO3-PBA.....  | 17 |
| 5. Mechanical Set Up .....  | 18 |
| 5.1. Total Expansion .....  | 18 |
| 5.2. Plugging and Removal of the Components. ....                       | 18 |
| 5.3. G-Bus Pin Description .....  | 19 |
| 6. PROFIBUS Electrical Interface .....                                  | 20 |
| 6.1. G-Bus System .....   | 20 |
| 6.2. PROFIBUS Electrical Interface .....                                | 21 |
| 6.2.1. RIO3-PBA.....  | 21 |
| 6.2.2. Terminator Resistor.....   | 22 |
| 6.2.3. PROFIBUS Address Setup.....                                      | 23 |
| 6.2.4. Choice of PROFIBUS data transfer cable type .....                | 24 |
| 7. Parameter .....  | 25 |

|   |    |
|---|----|
| 7.1. RIO3-PBA.....  | 25 |
| 8. DPV1 Service.....  | 25 |
| 8.1. MSAC1 Read(PROFIBUS-DP Extensions to EN50170) .....                | 25 |
| 8.2. MSAC1 Write (PROFIBUS-DP Extensions to EN50170).....               | 26 |
| 8.3. Error Decode (PROFIBUS-DP Extensions to EN50170).....              | 27 |
| 8.4. Error_Code_1 (PROFIBUS-DP Extensions to EN50170).....              | 27 |
| 8.5. Diagnostics .....  | 28 |
| 9. MODBUS Interface.....  | 29 |
| 9.1. MODBUS Interface Register/Bit Map .....                            | 29 |
| 9.2. Supported MODBUS Function Codes .....                              | 29 |
| 9.2.1. 8(0x08) Diagnostics .....  | 31 |
| 9.2.2. Error Response.....  | 32 |
| 9.3. MODBUS Special Register Map .....                                  | 33 |
| 9.3.1. Adapter Identification Special Register (0x1000, 4096).....      | 33 |
| 9.3.2. Adapter Information Special Register (0x1100, 4352).....         | 34 |
| 9.3.3. Expansion Slot Information Special Resister (0x2000, 8192) ..... | 34 |
| 10. Troubleshooting .....   | 37 |
| 10.1. How to diagnose by LED indicator .....                            | 37 |
| 10.2. How to diagnose when device couldn't communicate network .....    | 38 |
| APPENDIX A.....   | 39 |
| A.1. Product List .....   | 39 |
| A.2. Glossary .....   | 39 |

## 1. Important Notes

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid-State Controls describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will HITACHI be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment. The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any installation, HITACHI cannot assume responsibility or liability for actual use based on the examples and diagrams.



### Warning!

- ✓ **If you don't follow the directions, it could cause a personal injury, damage to the equipment or explosion**
- Do not assemble the products and wire with power applied to the system. Else it may cause an electric arc, which can result into unexpected and potentially dangerous action by field devices. Arching is explosion risk in hazardous locations. Be sure that the area is non-hazardous or remove system power appropriately before assembling or wiring the modules.
- Do not touch any terminal blocks or IO modules when system is running. Else it may cause the unit to an electric shock or malfunction.
- Keep away from the strange metallic materials not related to the unit and wiring works should be controlled by the electric expert engineer. Else it may cause the unit to a fire, electric shock, or malfunction.


### Caution!

- ✓ **If you disobey the instructions, there may be possibility of personal injury, damage to equipment or explosion. Please follow below Instructions.**
- Check the rated voltage and terminal array before wiring. Avoid the circumstances over 55°C of temperature. Avoid placing it directly in the sunlight.
- Avoid the place under circumstances over 85% of humidity.
- Do not place Modules near by the inflammable material. Else it may cause a fire.
- Do not permit any vibration approaching it directly.
- Go through module specification carefully, ensure inputs, output connections are made with the specifications. Use standard cables for wiring.
- Use Product under pollution degree 2 environment.

### 1.1.1. Symbols

|   |   |
|---|---|
| <p><b>DANGER</b></p>     | <p>Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death property damage or economic loss.</p>                               |
| <p><b>IMPORTANT</b></p>   | <p>Identifies information that is critical for successful application and understanding of the product.</p>   |
| <p><b>ATTENTION</b></p>  | <p>Identifies information about practices or circumstances that can lead to personal injury, property damage, or economic loss.<br/>Attentions help you to identify a hazard, avoid a hazard, and recognize the consequences.</p> |

### 1.1.2. Safety Notes

|  |   |
|--|---|
| <p><b>DANGER</b></p>  | <p>The modules are equipped with electronic components that may be destroyed by electrostatic discharge. When handling the modules, ensure that the environment (persons, workplace, and packing) is well grounded. Avoid touching conductive components, e.g. G-BUS Pin.</p> |
|--|---|

### 1.1.3. Certification



## 2. Environment Specification

| <b>Environment Specification</b> |  |
|----------------------------------|--|
| Operating Temperature            | 60°C ~ 70°C : Power dissipation is limited to 0.8A<br>-40°C ~ 60°C : 1.5A full load is allowed |
| UL Temperature                   | -20°C~60°C   |
| Storage Temperature              | -40°C~85°C   |
| Relative Humidity                | 5% ~ 90% non-condensing  |
| Mounting                         | DIN rail   |
| <b>General Specification</b>     |  |
| Shock Operating                  | IEC 60068-2-27   |
| Vibration resistance             | Based on IEC 60068-2-6   |
| Industrial Emissions             | EN 61000-6-4/ALL : 2011  |
| Industrial Immunity              | EN 61000-6-2 : 2005  |
| Installation Position            | Vertical and horizontal installation is available.   |
| Product Certifications           | CE, UL, EAC  |

### 3. RIO3-PBA (PROFIBUS Network Adapter)

#### 3.1. RIO3-PBA Specification

| Interface Specification, RIO3-PBA     |  |
|---------------------------------------|--|
| Communication Interface Specification |  |
| Redundancy                            | Not supported  |
| Repeater Control Signal               | RS-485 Signal  |
| Freeze mode                           | Support  |
| Sync mode                             | Support  |
| Auto baudrate                         | Support  |
| Fail safe mode                        | Support  |
| Station type                          | Slave  |
| FMS support                           | Not supported  |
| Max. Network Node                     | 125 Nodes  |
| Max. Expansion Slot                   | 63 Slots   |
| I/O Data Size                         | Input : 244bytes / Output : 244bytes   |
| Indicators                            | 6 Status LEDs<br>1 Green/Red, Module Status (MOD)<br>1 Green/Red, Network Status (NET)<br>1 Red, Diagnostic Status (DIA)<br>1 Green/Red Expansion I/O Module Status (IOS)<br>1 Green, System Power Status<br>1 Green, Field Power Status |
| Communication Rate                    | 9.6K~12M(1.2Km~100m)   |
| Communication Speed                   | 9.6 ~12000Kbps (Auto baudrate selection)   |
| Bus Connection                        | 9 Pin D-Sub Connector  |
| Other Serial Port                     | RS232 for MODBUS/RTU, Touch Panel or IOGuide   |
| Serial Configuration (RS232)          | Node : 1 (Fixed)<br>Baud Rate : 115200 (Fixed)<br>Data bit : 8 (Fixed)<br>Parity bit : No parity (Fixed)<br>Stop bit : 1 (Fixed)   |
| Module Location                       | Starter module left side of HX-RIO3 Series System  |
| Field Power Detection                 | About 14Vdc  |
| General Specification                 |  |
| UL System Power                       | Supply voltage : 24Vdc Nominal, Class 2  |
| System Power                          | Supply voltage : 24Vdc nominal<br>Supply voltage range : 16~30Vdc<br>Protection : Output current limit (Min. 1.5A)<br>Reverse polarity protection  |
| Power Dissipation                     | 100mA @24Vdc   |
| Current for I/O Module                | 1.5A @5Vdc   |
| Isolation                             | System power to internal logic : Non-Isolation<br>System power I/O driver : Isolation  |
| UL Field Power                        | Supply voltage : 24Vdc nominal, Class 2  |
| Field Power                           | Supply voltage : 24Vdc typical (Max.30Vdc)   |

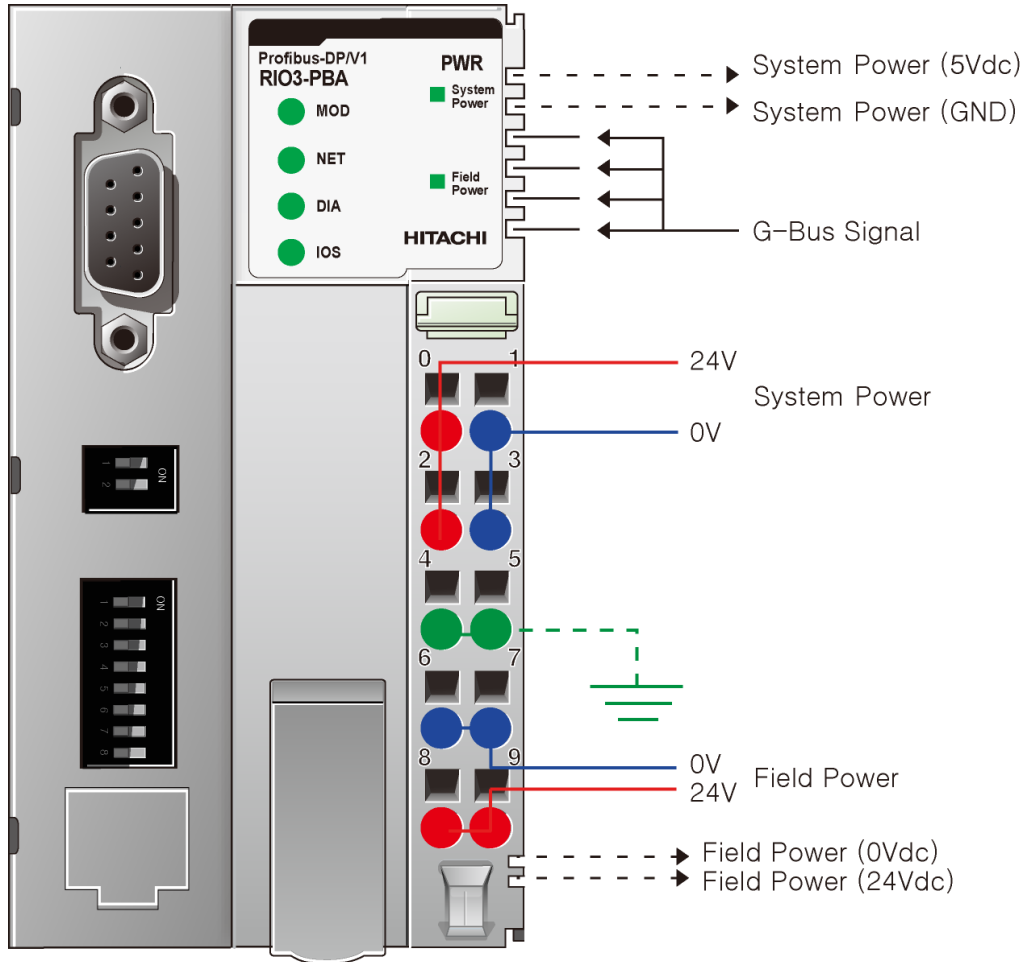


|                                  |  |
|----------------------------------|--|
|                                  | Field Power range is different depending on IO module series.<br>Refer to IO module's specification. |
| Max. Current Field Power Contact | DC 10A Max.  |
| Wiring                           | I/O Cable Max. 2.0mm <sup>2</sup> (AWG 14)   |
| Torque                           | 0.8Nm(7 lb-in)   |
| Weight                           | 163g   |
| Module Size                      | 54mm x 99mm x 70mm   |
| <b>Environment Condition</b>     | <b>Refer to 'Environment Specification'</b>  |

\* Operating temperature

- . -40 ~ 70 temperature range specification can be guaranteed°C under the following conditions.
- . Current for I/O Modules : 0.8A below.
- . Otherwise, temperature specification can be guaranteed with -40 ~ 60°C.

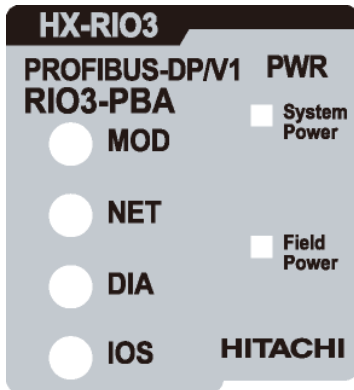
### 3.2. RIO3-PBA Wiring Diagram



| Pin No. | Signal Description  | Signal Description   | Pin No. |
|---------|---------------------|----------------------|---------|
| 0       | System Power, 24V   | System Power, Ground | 1       |
| 2       | System Power, 24V   | System Power, Ground | 3       |
| 4       | F.G                 | F.G                  | 5       |
| 6       | Field Power, Ground | Field Power, Ground  | 7       |
| 8       | Field Power, 24V    | Field Power, 24V     | 9       |

### 3.3. RIO3-PBA LED Indicator

#### 3.3.1. LED Indicator



| LED No.      | LED Function / Description | LED Colour |
|--------------|----------------------------|------------|
| MOD          | Module Status              | Green/Red  |
| NET          | Network Status             | Green/Red  |
| DIA          | Diagnostic Status          | Red        |
| IOS          | Extension Module Status    | Green/Red  |
| System Power | System Power Enable        | Green      |
| Field Power  | Field Power Enable         | Green      |

#### 3.3.2. MOD (Module Status LED)

| Status              | LED            | To indicate  |
|---------------------|----------------|--|
| Not Powered         | OFF            | power is not supplied to the unit.   |
| Normal, Operational | Green          | The unit is operating in normal condition.   |
| Device in Standby   | Flashing Green | The EEPROM parameter is not initialized yet.<br>Serial Number is zero value (0x00000000) |
| Minor Fault         | Flashing Red   | The unit has occurred recoverable fault in self-testing.<br>- EEPROM checksum fault.     |
| Unrecoverable Fault | Red            | The unit has occurred unrecoverable fault in self-testing.<br>- Firmware fault           |

#### 3.3.3. NET (Network Status LED)

| State                          | LED               | To indicate   |
|--------------------------------|-------------------|---|
| Not Powered<br>Not On-line     | OFF               | Device is not on-line or may not be powered   |
| On-line,<br>Not connected      | Flashing<br>Green | Device is on-line but has no connections in the established state.<br>- Not allocated to a master |
| On-line,<br>Connected          | Green             | Device is on-line and allocated to a master   |
| Connection Time-out            | Flashing Red      | One or more I/O connections are in the time-out state.  |
| Critical Communication Failure | Red               | Failed communication  |

### 3.3.4. DIA (Diagnostic Status LED)

| Status                 | LED          | To indicate :   |
|------------------------|--------------|---|
| Hardware Error         | Flashing Red | Device has hardware checking error.<br>(with MOD led is red.)   |
| Expansion Module Error | Flashing Red | Device has expansion module error.<br>(with IOS led is red.)  |
| IO Configuration Error | Flashing Red | Failed to initialize expansion module <ul style="list-style-type: none"> <li>- Overflow Input/Output size. (244bytes / 244bytes)</li> <li>- Overflow Configuration data size. (244bytes / 244bytes)</li> <li>- Too many expansion modules. (Max 63 slot)</li> <li>- Mismatch vendor code between adapter and expansion module.</li> </ul> |

### 3.3.5. IOS LED (Expansion Module Status LED)

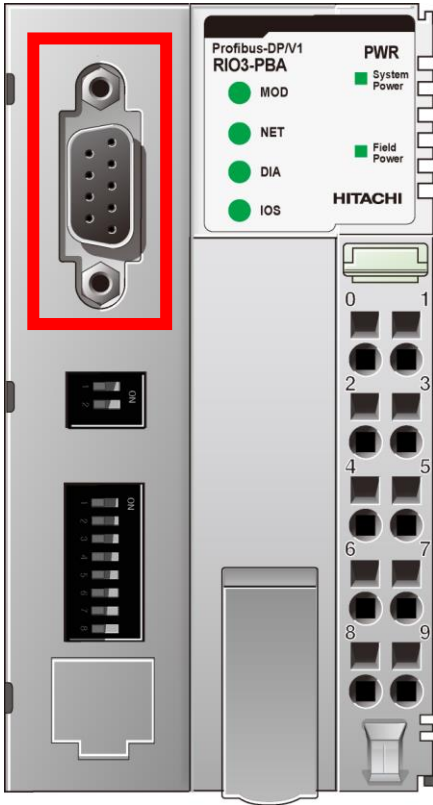
| State                                     | LED               | To indicate  |
|---|-------------------|--|
| Not Powered<br>No Expansion Module        | OFF               | Device has no expansion module or may not be powered.  |
| On-line,<br>Do not Exchanging I/O         | Flashing<br>Green | I/O Communication is normal but does not exchanging I/O data.<br>(Passed the expansion module confirmation)  |
| Connection,<br>Run Exchanging I/O         | Green             | Exchanging I/O data.   |
| Connection Fault during<br>Exchanging I/O | Red               | One or more expansion module occurred in fault state. <ul style="list-style-type: none"> <li>- Changed expansion module configuration.</li> <li>- Communication failure.</li> </ul>  |
| Expansion Configuration<br>Failed         | Flashing<br>Red   | Failed to initialize expansion module. <ul style="list-style-type: none"> <li>- Detect invalid expansion module ID.</li> <li>- Overflow Input/Output size. (244bytes/ 244bytes)</li> <li>- Too many expansion modules.</li> <li>- Initial protocol failure.</li> <li>- Mismatch vendor code between adapter and expansion module.</li> </ul> |

### 3.3.6. Field-, System Power LED (Field-, System Power Status LED)

| State                            | LED   | To indicate  |
|----------------------------------|-------|--|
| Not supplied field, system power | OFF   | Not supplied 24Vdc field power, 5Vdc system power. |
| Supplied field, system power     | Green | Supplied 24Vdc field power, 5Vdc system power.     |

### 3.4. RIO3-PBA Electrical Interface

#### 3.4.1. PROFIBUS Connector

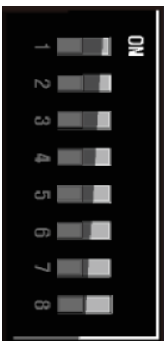


| Pin No. | Description |
|---------|-------------|
| 3       | RxD / TxD-P |
| 4       | CNTR-P      |
| 5       | DGND        |
| 6       | VP          |
| 8       | RXD / TxD-N |

#### 3.4.2. Dip Switch

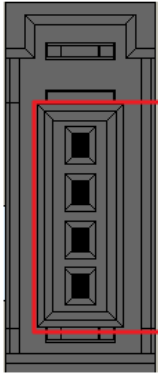


| Terminating Resistance | 1   | 2   |
|------------------------|-----|-----|
| Applied                | On  | On  |
| Not applied            | Off | Off |



| Node ID | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|
| 1       | On  | Off | Off | Off | Off | Off | Off | Off |
| 2       | Off | On  | Off | Off | Off | Off | Off | Off |
| ~       |     |     |     |     |     |     |     |     |
| 125     | On  | Off | On  | On  | On  | On  | On  | Off |

### 3.4.3. RS232 Port for MODBUS/RTU, Touch Panel or IOGuide

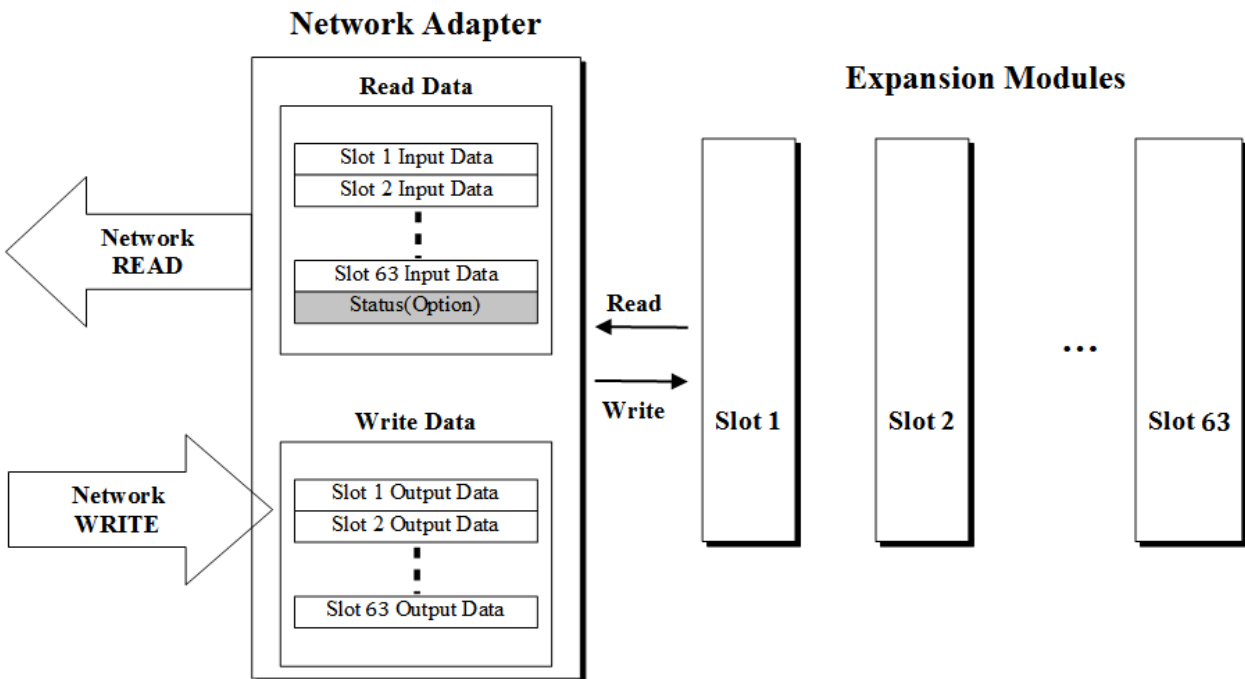


**Pin #1**  
**Pin #2**  
**Pin #3**  
**Pin #4**

| Pin# | Signal Name | Description |
|------|-------------|-------------|
| 1    | Reserved    | ----        |
| 2    | TXD         | RS232 TXD   |
| 3    | RXD         | RS232 RXD   |
| 4    | GND         | RS232 GND   |

### 3.5. I/O Process Image Map

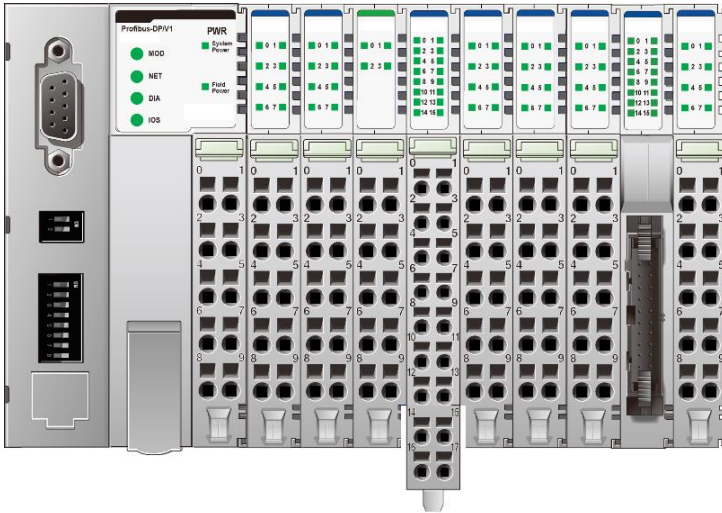
An expansion module may have 3 types of data as I/O data, configuration parameter and memory register. The data exchange between network adapter and expansion modules is done via an I/O process image data by HX-RIO3 Series Internal Bus protocol. The following figure shows the data flow of process image between network adapter and expansion modules.



### 3.5.1. Example of Input Process Image (Input Register) Map

Input image data depends on slot position and expansion slot data type. Input process image data is only ordered by expansion slot position.

• Example slot configuration



| Slot Address | Module Description |
|--------------|--------------------|
| #0           | PROFIBUS Adapter   |
| #1           | 8-discrete input   |
| #2           | 8-discrete input   |
| #3           | 4-analog input     |
| #4           | 16-discrete input  |
| #5           | 8-discrete input   |
| #6           | 8-discrete input   |
| #7           | 8-discrete input   |
| #8           | 16-discrete input  |
| #9           | 8-discrete input   |

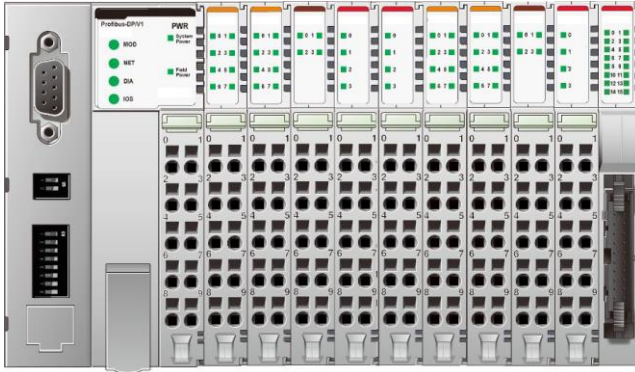
• Input Process Image

| Byte | Bit 7                               | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|------|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| 0    | Discrete Input 8 pts (Slot#1)       |       |       |       |       |       |       |       |
| 1    | Discrete Input 8 pts (Slot#2)       |       |       |       |       |       |       |       |
| 2    | Analog Input Ch0 low byte (Slot#3)  |       |       |       |       |       |       |       |
| 3    | Analog Input Ch0 high byte (Slot#3) |       |       |       |       |       |       |       |
| 4    | Analog Input Ch1 low byte (Slot#3)  |       |       |       |       |       |       |       |
| 5    | Analog Input Ch1 high byte (Slot#3) |       |       |       |       |       |       |       |
| 6    | Analog Input Ch2 low byte (Slot#3)  |       |       |       |       |       |       |       |
| 7    | Analog Input Ch2 high byte (Slot#3) |       |       |       |       |       |       |       |
| 8    | Analog Input Ch3 low byte (Slot#3)  |       |       |       |       |       |       |       |
| 9    | Analog Input Ch3 high byte (Slot#3) |       |       |       |       |       |       |       |
| 10   | Discrete Input 8 pts (Slot#4)       |       |       |       |       |       |       |       |
| 11   | Discrete Input 8 pts (Slot#4)       |       |       |       |       |       |       |       |
| 12   | Discrete Input 8 pts (Slot#5)       |       |       |       |       |       |       |       |
| 13   | Discrete Input 8 pts (Slot#6)       |       |       |       |       |       |       |       |
| 14   | Discrete Input 8 pts (Slot#7)       |       |       |       |       |       |       |       |
| 15   | Discrete Input 8 pts (Slot#8)       |       |       |       |       |       |       |       |
| 16   | Discrete Input 8 pts (Slot#8)       |       |       |       |       |       |       |       |
| 17   | Discrete Input 8 pts (Slot#9)       |       |       |       |       |       |       |       |

### 3.5.2. Example of Output Process Image (Output Register) Map

Output image data depends on slot position and expansion slot data type. Output process image data is only ordered by expansion slot position.

• Example slot configuration



| Slot Address | Module Description |
|--------------|--------------------|
| #0           | PROFIBUS Adapter   |
| #1           | 8-discrete output  |
| #2           | 8-discrete output  |
| #3           | 4-analog output    |
| #4           | 4-relay output     |
| #5           | 4-relay output     |
| #6           | 8-discrete output  |
| #7           | 8-discrete output  |
| #8           | 4-analog output    |
| #9           | 4-relay output     |
| #10          | 16-discrete output |

**Output Process Image Mode#0** (Uncompressed Input Processing Data), **default output image**

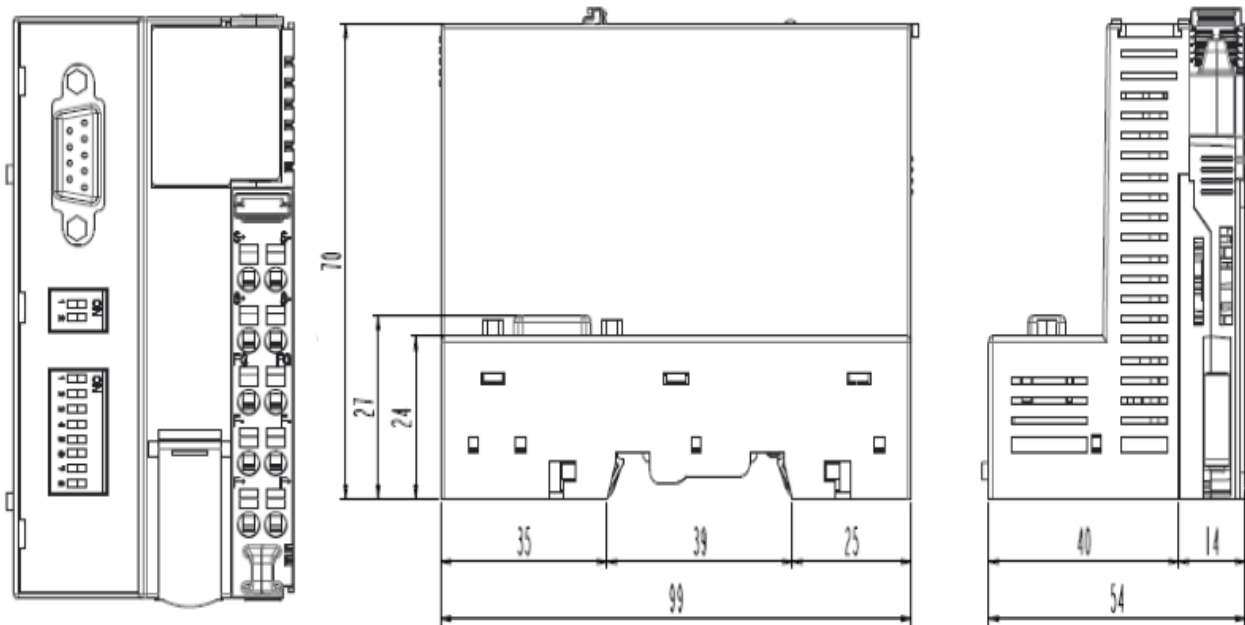
| Byte | Bit 7                               | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|------|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| 0    | Discrete Output 8 pts(Slot#1)       |       |       |       |       |       |       |       |
| 1    | Discrete Output 8 pts(Slot#2)       |       |       |       |       |       |       |       |
| 2    | Analog Output Ch0 low byte(Slot#3)  |       |       |       |       |       |       |       |
| 3    | Analog Output Ch0 high byte(Slot#3) |       |       |       |       |       |       |       |
| 4    | Analog Output Ch1 low byte(Slot#3)  |       |       |       |       |       |       |       |
| 5    | Analog Output Ch1 high byte(Slot#3) |       |       |       |       |       |       |       |
| 6    | Analog Output Ch2 low byte(Slot#3)  |       |       |       |       |       |       |       |
| 7    | Analog Output Ch2 high byte(Slot#3) |       |       |       |       |       |       |       |
| 8    | Analog Output Ch3 low byte(Slot#3)  |       |       |       |       |       |       |       |
| 9    | Analog Output Ch3 high byte(Slot#3) |       |       |       |       |       |       |       |
| 10   | Discrete Output low 4 pts(Slot#4)   |       |       |       |       |       |       |       |
| 12   | Discrete Output low 4 pts(Slot#5)   |       |       |       |       |       |       |       |
| 13   | Discrete Output low 8 pts(Slot#6)   |       |       |       |       |       |       |       |
| 14   | Discrete Output low 8 pts(Slot#7)   |       |       |       |       |       |       |       |
| 15   | Analog Output Ch0 low byte(Slot#8)  |       |       |       |       |       |       |       |
| 16   | Analog Output Ch0 high byte(Slot#8) |       |       |       |       |       |       |       |
| 17   | Analog Output Ch1 low byte(Slot#8)  |       |       |       |       |       |       |       |
| 18   | Analog Output Ch1 high byte(Slot#8) |       |       |       |       |       |       |       |
| 19   | Analog Output Ch2 low byte(Slot#8)  |       |       |       |       |       |       |       |
| 20   | Analog Output Ch2 high byte(Slot#8) |       |       |       |       |       |       |       |
| 21   | Analog Output Ch3 low byte(Slot#8)  |       |       |       |       |       |       |       |
| 22   | Analog Output Ch3 high byte(Slot#8) |       |       |       |       |       |       |       |
| 24   | Discrete output low 8 pts(Slot#9)   |       |       |       |       |       |       |       |
| 25   | Discrete output low 8 pts(Slot#10)  |       |       |       |       |       |       |       |
| 26   | Discrete output low 8 pts(Slot#10)  |       |       |       |       |       |       |       |



## 4. Dimension

### 4.1. RIO3-PBA

(mm)



## 5. Mechanical Set Up

### 5.1. Total Expansion

The number of the module assembly that can be connected is 63. The maximum length is 426mm  
Exception.

### 5.2. Plugging and Removal of the Components.



As above figure to safeguard the RIO3 module from jamming, it should be fixed onto the DIN rail with locking level. To do so, fold on the upper of the locking lever. To pull out the RIO3 module, unfold the locking lever.

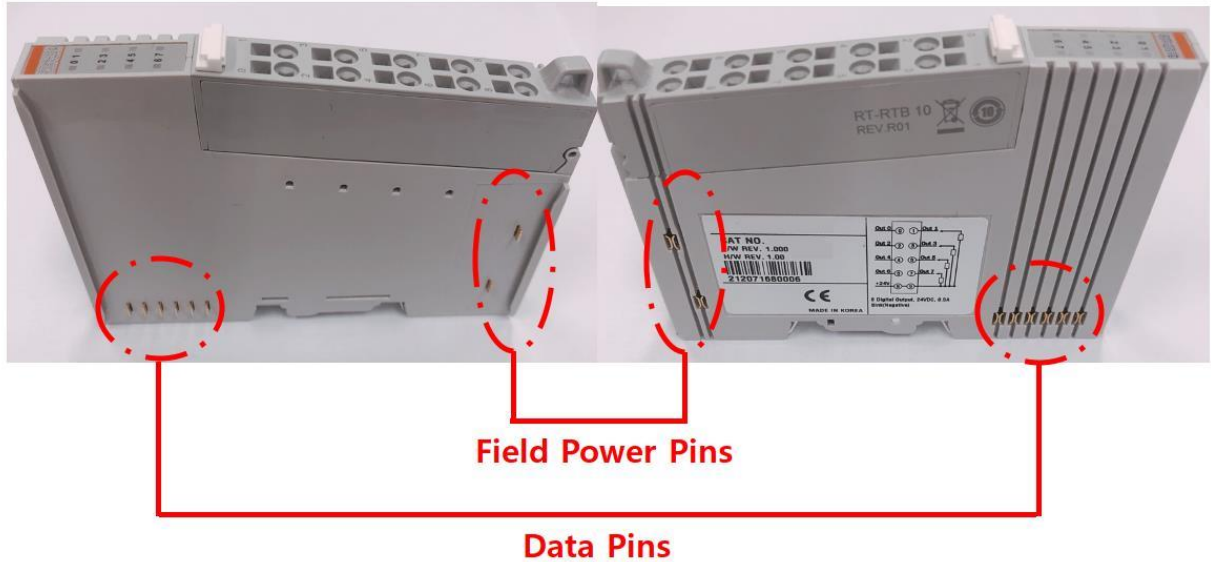
**DANGER**



Before work is done on the components, the voltage supply must be turned off.

### 5.3. G-Bus Pin Description

Communication between the RIO3 series and the expansion module as well as system / field power supply of the bus modules is carried out via the internal bus. It is comprised of 6 data pin and 2 field power pins.

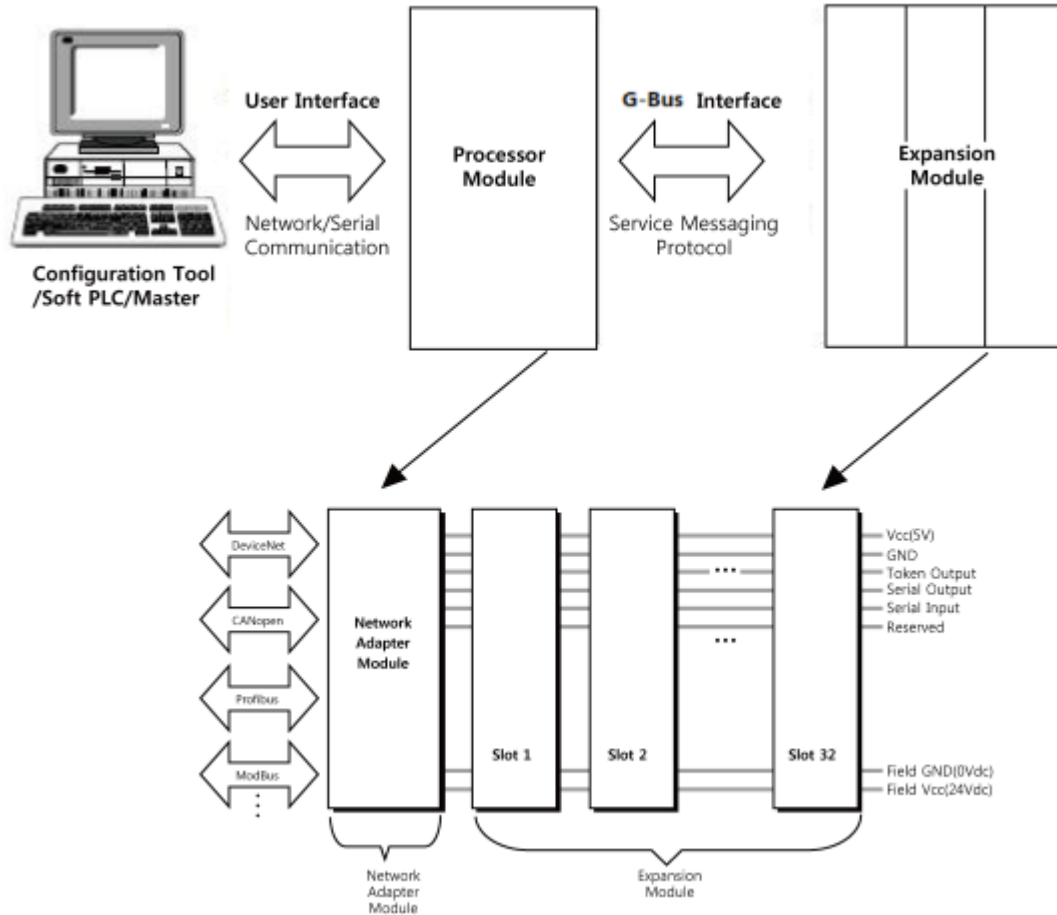


| No. | Name          | Description                                  |
|-----|---------------|--|
| 1   | Vcc           | System supply voltage (5V dc).               |
| 2   | GND           | System Ground.                               |
| 3   | Token Output  | Token output port of Processor module.       |
| 4   | Serial Output | Transmitter output port of Processor module. |
| 5   | Serial Input  | Receiver input port of Processor module.     |
| 6   | Reserved      | Reserved for bypass Token.                   |
| 7   | Field GND     | Field Ground.                                |
| 8   | Field Vcc     | Field supply voltage (24Vdc).                |

|                      |   |
|----------------------|---|
| <p><b>DANGER</b></p> | <p>Do not touch data and field power pins to avoid soiling and damage by ESD noise.</p> |
|----------------------|---|

## 6.PROFIBUS Electrical Interface

### 6.1. G-Bus System



- **Network Adapter Module**

The Network Adapter Module forms the link between the field bus and the field devices with the Expansion Modules.

The connection to different field bus systems can be established by each of the corresponding Network Adapter Module, e.g. for SyncNet, PROFIBUS, CANopen, DeviceNet, Ethernet/IP, CC-Link, MODBUS/Serial, MODBUS/TCP etc.

- **Expansion Module**

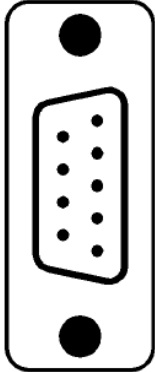
The Expansion Modules are supported a variety of input and output field devices. There are digital and analog input/output modules and special function modules.

- **Two types of RIO3 Bus Message**

- Service Messaging
- I/O Messaging

## 6.2. PROFIBUS Electrical Interface

### 6.2.1. RIO3-PBA



| Dsub 9 (Female) | Signal Name | Description  |
|-----------------|-------------|--|
| 1               | -           |  |
| 2               |             |  |
| 3               | RXD/TXD-P   | Receive/Transmit data-plus(B wire)                     |
| 4               | CNTR-P      | Repeater control signal(direction control), RTS signal |
| 5               | DGND        | Data ground(reference potential for VP)                |
| 6               | VP          | Supply voltage-Plus(P5V)                               |
| 7               | -           |  |
| 8               | RXD/TXD-N   | Receive/Transmit data-minus(A-wire)                    |
| 9               | CNTR-N      | Repeater Control Signal(direction control)             |

All fieldbus devices which use a standard 9-pin Sub-D connector should provide the VP and DGND signals on the bus connector in addition to the receive and transmit signals. With all other connector types, only the receive and transmit signals need to be connected. Make sure that the connector type used is suitable for the selected baud rate. If optional signal is provided, they must also comply with EN50170 Volume 2 and they must be correctly described in the respective GSD file. To prevent EMC interface from entering the device, the cable shield should be connected to the functional ground of the device (generally the electrically conductive case). This is done by connecting the cable shield to the metal case of the Sub-D connector and the functional ground over a larger area. The bus connector must have a low-impedance connection to the cable shield.

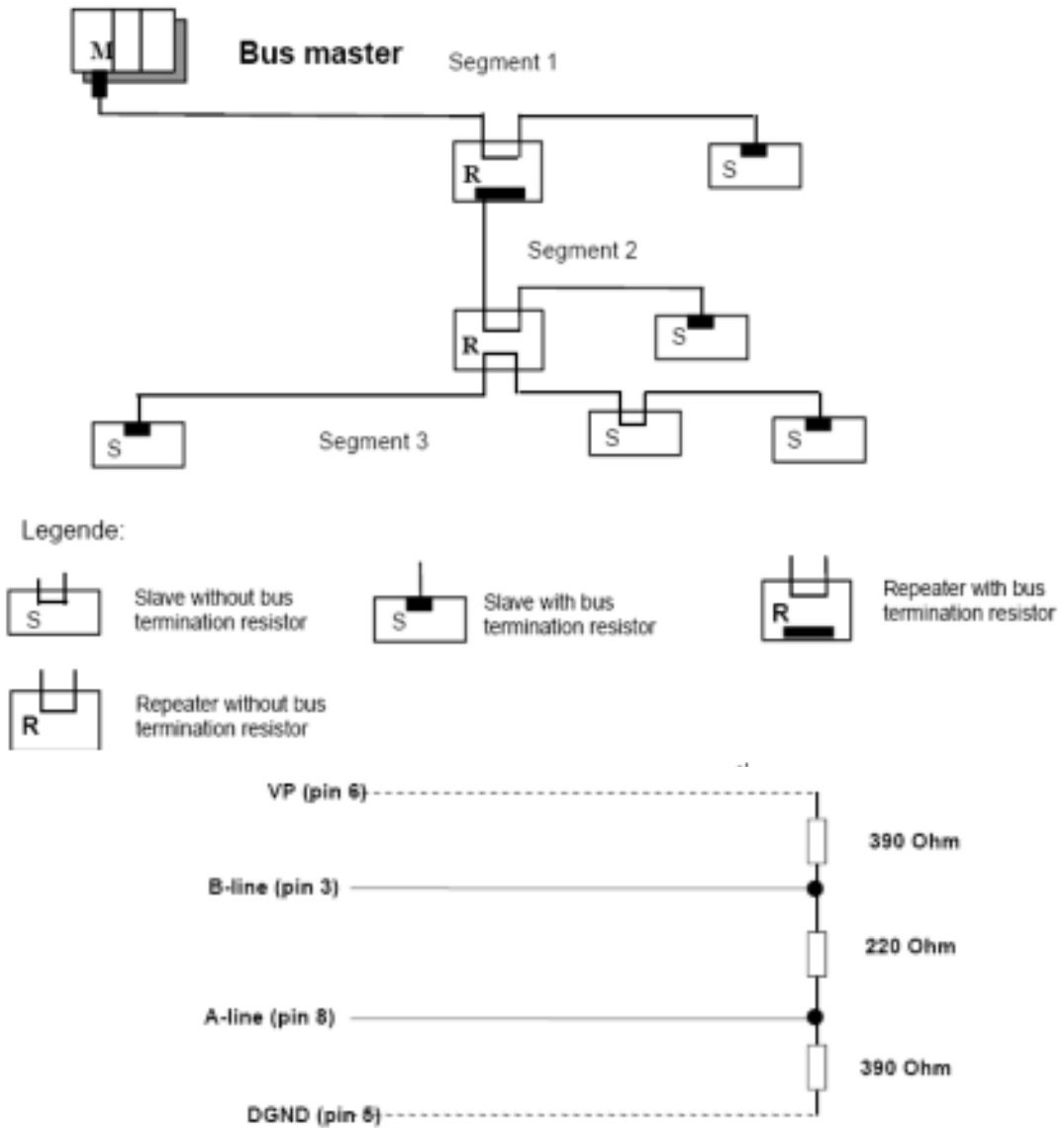
The data transfer technology of the serial bus system, which uses a shielded twisted pair data cable, is described in the specification of the interface-immune RS 485 interface standard. To allow correct bus termination, each station must connect the signals DGND and VP (5V) to pins 5 and 6 of the connectors, respectively. The 5V supply for the terminating resistors (VP) should have a minimum current rating of 10mA (the current load can increase to 12mA if a NULL signal is sent through the bus). The current rating should be increased to app. 90mA if you need to be able to supply other types of devices on the bus such as bus terminals and optical fibre cable drivers. Due to the capacitive load of the station and the resulting cable reflections, bus connectors should be provided with built-in series inductors as shown below.

#### ATTENTION



The use of an incorrect supply voltage or frequency can cause severe damage to the component.

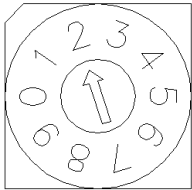
### 6.2.2. Terminator Resistor



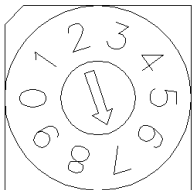
To minimize cable reflections and ensure a defined noise level on the data lines, the data transfer cable must be terminated at both ends with a terminating resistor combination as follows.

### 6.2.3. PROFIBUS Address Setup

Each PROFIBUS Adapter could have a unique address (from 1 to 99) so that it can be addressed independently from other nodes. The address 0 is reserved to identify a broadcast exchange. No response is returned to broadcast requests sent by the master.



X 10 (MSD)



X 1 (LSD)

The above figure shows MAC ID 27(=2\*10 + 7\*1) of a slave node.

#### ◆ Communication Speed Setting

- See Master Module Setting about communication speed setting.

#### ATTENTION



MAC ID addresses must be unique throughout the entire interconnected network.

## 6.2.4. Choice of PROFIBUS data transfer cable type

Depending on the application, the user can choose between electrical and optical fibre data transfer cables. The following types of electrical data cables can be used:

- **Standard bus cable**
- **Standard bus cable with halogen-free sheath (type FRNC)**
- **Cable with PE Sheath** for use in the food and manufacturing industries. ( it differs from the standard bus cable solely in the cable sheath).
- **Direct buried cable** with additional protective sheath for laying in the ground.
- **Trailing cable** ( this is a special cable type which is used where parts of the machine move occasionally or continuously).
- **Festooned cable**. Compared to a trailing cable, a festooned cable has an additional strain relief element.

The bus cable is specified in EN 50170 part 8-2 as " Cable Type A" and should comply with the parameters in the following table. Cable Type B, which is also described in EN 50170, is outdated, and should no longer be used.

**Table 1. show the parameters for standard type A bus cables.**

| Parameter                              | Cable type A                          |
|--|---------------------------------------|
| Characteristic impedance in $\Omega$   | 135..165 at a frequency of (3..20MHz) |
| Operating capacity(pF/m)               | < 30                                  |
| Loop resistance ( $\Omega/\text{km}$ ) | $\leq 110$                            |
| Core diameter (mm)                     | $> 0.64^*$                            |
| Cora cross-section (mm)                | $> 0.34^*$                            |

\* The cable cross-sections used should be compatible with the mechanical specifications of the bus interface connector

The cable parameters specified for standard Type A bus cables result in the maximum length of each bus segment for the respective data transfer rate shown in Table 2.

**Table 2 : Maximum cable lengths per segment**

| Baudrate                      | 9.6  | 19.2 | 45.45 | 93.75 | 187.5 | 500 | 1500 | 3000 | 6000 | 12000 |
|-------------------------------|------|------|-------|-------|-------|-----|------|------|------|-------|
| Max. segment Length in 'm'(m) | 1200 | 1200 | 1200  | 1200  | 1000  | 400 | 200  | 100  | 100  | 100   |

**Important :** In a PROFIBUS-DP/FMS installation, you must choose a data transfer rate which is supported by all devices connected to the bus. The chosen data transfer rate then determines the maximum segment lengths as shown above.

The maximum admissible distance between two bus stations in each PROFIBUS network can be calculated as follows:

### **(NO\_REP+1)\*Segment length**

NO\_REP=The maximum number of repeaters connected in series(depends on repeater type).

**Example :** The repeater manufacture specifications allow nine repeaters to be connected in series. The maximum distance between two bus stations at a data transfer rate of 1500 kbit/s is then as follow:

$$(9+1)*200\text{m}=2000 \text{ m}$$



## 7. Parameter

### 7.1. RIO3-PBA

- Parameter length: 3 bytes
- Parameter Data:

| Offset | Access | Decimal Bit | Description  | Default Value |
|--------|--------|-------------|--|---------------|
| 3      | R/W    | 00-01       | Word Data Format<br>0 : Little-Endian (INTEL)<br>1 : Big-Endian (MOTOROLA)   | 1 (Motorola)  |
|        |        | 02-07       | Reserved   | 0             |
| 4      | R/W    | 00-04       | Reserved   | 0             |
|        |        | 05          | PROFIBUS Disconnection<br>0: Fault values are switched<br>1: Hold last state | 1             |
|        |        | 06-07       | Reserved   | 0             |
| 5      | R/W    | 00-07       | IO Scan Rate (Unit : us) <sup>1)</sup>                                       | 1000 (us)     |

1) IO Scan Rate is changed by IO data size(In + Output data). refer to below, the fastest IO scan rate for each case.

|         |                       |                        |
|---------|-----------------------|------------------------|
| example | 10byte ▶ about 40us   | 100byte ▶ about 60us   |
|         | 500byte ▶ about 160us | 1000byte ▶ about 260us |

## 8. DPV1 Service

### 8.1. MSAC1 Read(PROFIBUS-DP Extensions to EN50170)

#### ■ MSAC1 Read request

| Parameter      | Description  |
|----------------|--|
| Remote Address | Slave Address (0~99)   |
| Slot Number    | Slot Number : 0(RIO3-PBA)  |
| Index          | 253 : FW revision (Data size : 4bytes)<br>254 : Vendor code (Data size : 1 byte) |
| Length         | 1~128  |

#### ■ MSAC1 Read Confirm(+)

| Parameter      | Description          |
|----------------|----------------------|
| Remote Address | Slave Address (0~99) |
| Length         | 1~128                |
| Data           | User Data            |

#### ■ MSAC1 Read Confirm(-)

| Parameter      | Description          |
|----------------|----------------------|
| Remote Address | Slave Address (0~99) |
| Error Decode   | -                    |
| Error code 1   | -                    |
| Error code 2   | Reserved             |

## 8.2. MSAC1 Write (PROFIBUS-DP Extensions to EN50170)

### MSAC1 Write Request

| Parameter      | Description  |
|----------------|--|
| Remote Address | Slave Address (0~99)   |
| Slot Number    | Slot Number : 0(RIO3-PBA)  |
| Index          | 254 : Vendor code (Data size : 5 bytes)  |
| Length         | 1~128  |
| Data           | Vendor ( <b>Don't mention this to the User manual</b> )<br>- Data[0] : 0xAE<br>- Data[1] : 0xBE<br>- Data[2] : 0xCE<br>- Data[3] : 0xDE<br>- Vendor code |

### MSAC1 Write Confirm (+)

| Parameter      | Description          |
|----------------|----------------------|
| Remote Address | Slave Address (0~99) |
| Length         | 1~128                |

### MSAC1 Write Confirm (-)

| Parameter      | Description          |
|----------------|----------------------|
| Remote Address | Slave Address (0~99) |
| Error Decode   | -                    |
| Error code 1   | -                    |
| Error code 2   | Reserved             |

| Parameter    | Description             |
|--------------|-------------------------|
| C_Ref        | Communication-Reference |
| Error Decode | -                       |
| Error code 1 | -                       |
| Error code 2 | Reserved                |

### 8.3. Error Decode (PROFIBUS-DP Extensions to EN50170)

- ▶ 0~127 : Reserved
- ▶ 128 : DPV1
- ▶ 129~253 : Reserved
- ▶ 254 : FMS
- ▶ 255 : HART

### 8.4. Error\_Code\_1 (PROFIBUS-DP Extensions to EN50170)

| Bit | 7  | 6 | 5 | 4 | 3  | 2 | 1 | 0 |
|-----|--|---|---|---|--|---|---|---|
| 1   | Error Class<br>0xA : Application class       |   |   |   | Error code<br>0 : Read Error<br>1 : Write Error<br>2 : Module Failure<br>3 ~7 : Reserved<br>8 : Version conflict<br>9 : Feature not supported<br>10~15 : User specific   |   |   |   |
| 2   | Error Class<br>0xB : Access class            |   |   |   | Error code<br>0 : Invalid index<br>1 : Write length error<br>2 : Invalid slot<br>3 : Type conflict<br>4 : Invalid area<br>5 : state conflict<br>6 : access denied<br>7 : invalid range<br>8 : invalid parameter<br>9 : invalid type<br>10~15 : User specific |   |   |   |
| 3   | Error Class<br>0xC : Resource class          |   |   |   | Error code<br>0 : read constrain conflict<br>1 : Write constrain conflict<br>2 : Resource busy<br>3 : Resource unavailable<br>4 ~7 : Reserved<br>8~15 : User specific  |   |   |   |
| 4   | Error Class<br>0xD : RIO3-PBA Specific Class |   |   |   | Error code<br>1 : Slot Parameter write error<br>2 : Read memory error<br>3 : Write memory error  |   |   |   |

## 8.5. Diagnostics

| Byte | Item                  | Description                  |
|------|-----------------------|------------------------------|
| 0    | Station status 1      | PROFIBUS Standard Diagnostic |
| 1    | Station status 2      |                              |
| 2    | Station status 3      |                              |
| 3    | Master Address        |                              |
| 4    | PNO Ident Number High |                              |
| 5    | PNO Ident Number Low  |                              |

### • Station Status 1~3

| Station status |         |                 |   |
|----------------|---------|-----------------|---|
| 1              | Bit 7   | Master_Lock     | Slave is parameterized by another master                      |
|                | Bit 6   | Prm_Fault       | Last parameter telegram faulty                                |
|                | Bit 5   | Inv._Sl_Res.    | Inplausible response of the slave                             |
|                | Bit 4   | Not_Supp.       | Unknown command detected by the slave                         |
|                | Bit 3   | Ext_Diag        | The area Ext_Diag is used for extended diagnostic             |
|                | Bit 2   | Cfg_Fault       | Slave is wrong parameterized                                  |
|                | Bit 1   | Sta._Not_Rdy    | Slave not ready   |
|                | Bit 0   | Sta._Non_Exist. | Slave not responding  |
| 2              | Bit 7   | Deactivated     | Slave not projected   |
|                | Bit 6   | Reserved        | Reserved  |
|                | Bit 5   | Sync_Mode       | Sync-command active   |
|                | Bit 4   | Freeze_Mode     | Freeze-command active   |
|                | Bit 3   | WD_On           | Watchdog activated  |
|                | Bit 2   | 1               | Always 1  |
|                | Bit 1   | Stat_Diag       | Get diagnostic from slave, till bit is released               |
|                | Bit 0   | Prm_            | Slave must be parameterized                                   |
| 3              | Bit 7   | Ext_Diag_Ovfl.  | The slave has more diagnostic data available than it can send |
| -              | Bit 6~0 | Reserved        | Reserved  |

## 9. MODBUS Interface

### 9.1. MODBUS Interface Register/Bit Map

#### • Register Map

| Start Address | Read/Write | Description   | Func. Code  |
|---------------|------------|---|-------------|
| 0x0000 ~      | Read       | Process input image registers (Real Input Register)   | 3,4,23      |
| 0x0800 ~      | Read/Write | Process output image registers (Real Output Register) | 3,16,23     |
|               |            |   |             |
| 0x1000 *      | Read       | Adapter Identification special registers.             | 3,4,23      |
| 0x1020 *      | Read/Write | Adapter Watchdog, other time special register.        | 3,4,6,16,23 |
| 0x1100 *      | Read/Write | Adapter Information special registers.                | 3,4,6,16,23 |
| 0x2000 *      | Read/Write | Expansion Slot Information special registers.         | 3,4,6,16,23 |

\* The special register map must be accessed by read/write of each address (one address).

#### • Register Map

| Start Address | Read/Write | Description  | Func. Code |
|---------------|------------|--|------------|
| 0x0000 ~      | Read       | Process input image bits<br>All input registers areas are addressable by bit address.<br>Size of input image bit is size of input image register * 16.     | 2          |
| 0x1000 ~      | Read/Write | Process output image bits<br>All output registers areas are addressable by bit address.<br>Size of output image bit is size of output image register * 16. | 1,5,15     |

### 9.2. Supported MODBUS Function Codes

| Function Code | Function                                 | Description   |
|---------------|--|---|
| 1(0x01)       | Read Coils<br>(Read output bit)          | This function code is used to read from 1 to 2000 contiguous status of coils in a remote device. The Request PDU specifies the starting address, i.e. the address of the first coil specified, and the number of coils. In the PDU Coils are addressed starting at zero. Therefore, coils numbered 1-16 are addressed as 0-15. The coils in the response message are packed as one coil per bit of the data field. Status is indicated as 1= ON and 0= OFF.   |
| 2(0x02)       | Read Discrete Inputs<br>(Read input bit) | This function code is used to read from 1 to 2000 contiguous status of discrete inputs in a remote device. The Request PDU specifies the starting address, i.e. the address of the first input specified, and the number of inputs. In the PDU Discrete Inputs are addressed starting at zero. Therefore, Discrete inputs numbered 1-16 are addressed as 0-15. The discrete inputs in the response message are packed as one input per bit of the data field. Status is indicated as 1= ON; 0= OFF. |

|          |   |  |
|----------|---|--|
| 3(0x03)  | Read Holding Registers<br>(Read output word)  | This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request PDU specifies the starting register address and the number of registers. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.  |
| 4(0x04)  | Read Input Registers<br>(Read input word)   | This function code is used to read from 1 to approx. 125 contiguous input registers in a remote device. The Request PDU specifies the starting register address and the number of registers. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.   |
| 5(0x05)  | Write Single Coil<br>(Write one-bit output)   | This function code is used to write a single output to either ON or OFF in a remote device. The requested ON/OFF state is specified by a constant in the request data field. A value of FF 00 hex requests the output to be ON. A value of 00 00 requests it to be OFF. All other values are illegal and will not affect the output.   |
| 6(0x06)  | Write Single Register<br>(Write one-word output)  | This function code is used to write a single holding register in a remote device. Therefore, register numbered 1 is addressed as 0. The normal response is an echo of the request, returned after the register contents have been written.   |
| 8(0x08)  | Diagnostics<br>(Read diagnostic register)<br>*Refer to the 6.2.1                                | MODBUS function code 08 provides a series of tests for checking the communication system between a client ( Master) device and a server ( Slave), or for checking various internal error conditions within a server. The function uses a two-byte sub-function code field in the query to define the type of test to be performed. The server echoes both the function code and subfunction code in a normal response. Some of the diagnostics cause data to be returned from the remote device in the data field of a normal response.  |
| 15(0x0F) | Write Multiple Coils<br>(Write a number of output bits)   | This function code is used to force each coil in a sequence of coils to either ON or OFF in a remote device. The Request PDU specifies the coil references to be forced. Coils are addressed starting at zero. A logical '1' in a bit position of the field requests the corresponding output to be ON. A logical '0' requests it to be OFF. The normal response returns the function code, starting address, and quantity of coils forced.  |
| 16(0x10) | Write Multiple registers<br>(Write a number of output words)                                    | This function code is used to write a block of contiguous registers (1 to approx. 120 registers) in a remote device. The requested written values are specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.   |
| 23(0x17) | Read/Write Multiple registers<br>(Read a number of input words /Write a number of output words) | Read a number of input words /Write a number of output words This function code performs a combination of one read operation, and one write operation in a single MODBUS transaction. The write operation is performed before the read. The request specifies the starting address and number of holding registers to be read as well as the starting address, number of holding registers, and the data to be written. The byte count specifies the number of bytes to follow in the write data field. The normal response contains the data from the group of registers that were read. The byte count field specifies the quantity of bytes to follow in the read data field. |

- Refer to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1a

## 9.2.1. 8(0x08) Diagnostics

### Sub-function 0x0000(0) Return Query Data

The data passed in the request data field is to be returned (looped back) in the response. The entire response message should be identical to the request.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|--------------|----------------------|-----------------------|-------------|
| 0x0000(0)    | Any                  | Echo Request Data     |             |

### Sub-function 0x0001(1) Restart Communications Option

The remote device could be initialized and restarted, and all of its communications event counters are cleared. Especially, data field 0x55AA make the remote device to restart with factory default setup of EEPROM.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|--------------|----------------------|-----------------------|-------------|
| 0x0001(1)    | 0x0000, 0xFF00       | Echo Request Data     | Reset Only  |

### Sub-function 0x000A(10) Clear Counters and Diagnostic Register

The goal is to clear all counters and the diagnostic register. Counters are also cleared upon power-up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|--------------|----------------------|-----------------------|-------------|
| 0x000A(10)   | 0x0000               | Echo Request Data     |             |

### Sub-function 0x000B(11) Return Bus Message Count

The response data field returns the quantity of messages that the remote device has detected on the communications system since its last restart, clear counters operation, or power-up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|--------------|----------------------|-----------------------|-------------|
| 0x000B(11)   | 0x0000               | Total Message Count   |             |

### Sub-function 0x000D(13) Return Bus Exception Error Count

The response data field returns the quantity of MODBUS exception responses returned by the remote device since its last restart, clear counters operation, or power-up.

Exception responses are described and listed in section 3.2.11.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|--------------|----------------------|-----------------------|-------------|
| 0x000D(13)   | 0x0000               | Exception Error Count |             |

### Sub-function 0x000E(14) Return Slave Message Count

The response data field returns the quantity of messages addressed to the remote device, or broadcast, that the remote device has processed since its last restart, clear counters operation, or power-up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|--------------|----------------------|-----------------------|-------------|
| 0x000E(14)   | 0x0000               | Slave Message Count   |             |

### Sub-function 0x000F(15) Return Slave No Response Count

The response data field returns the quantity of messages addressed to the remote device for which it has returned no response (neither a normal response nor an exception response), since its last restart, clear counters operation, or power-up.

| Sub-function | Data Field (Request) | Data Field (Response)   | Description |
|--------------|----------------------|-------------------------|-------------|
| 0x000F(15)   | 0x0000               | Slave No Response Count |             |

### Sub-function 0x0064(100) Return Slave ModBus, Expansion Module Status

The response data field returns the status of ModBus and expansion module addressed to the remote device. This status values are identical with status 1 word of input process image. Refer to 2.4.2.

| Sub-function | Data Field (Request) | Data Field (Response) | Description           |
|--------------|----------------------|-----------------------|-----------------------|
| 0x0064(100)  | 0x0000               | ModBus, RBUS Status   | Same as status 1 word |

## 9.2.2. Error Response

In an exception response, the server sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response.

### • Exception Codes

| Exception Code | Name                     | Description  |
|----------------|--------------------------|--|
| 01             | Illegal Function         | The function code received in the query is not an allowable action for the server (or slave).  |
| 02             | Illegal Data Address     | The data address received in the query is not an allowable address for the server (or slave).  |
| 03             | Illegal Data Value       | A value contained in the query data field is not an allowable value for server (or slave).   |
| 04             | Slave Device Failure     | An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.  |
| 05             | Acknowledge              | The server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so.  |
| 06             | Slave Device Busy        | Specialized use in conjunction with programming commands. The server (or slave) is engaged in processing a long-duration program command. The client (or master) should retransmit the message later when the server (or slave) is free. |
| 08             | Memory Parity Error      | The server (or slave) attempted to read record file but detected a parity error in the memory. The client (or master) can retry the request, but service may be required on the server (or slave) device.                                |
| 0A             | Gateway Path Unavailable | Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request.  |



### 9.3. MODBUS Special Register Map

The special register map can be accessed by function code 3, 4, 6 and 16. Also the special register map must be accessed by read/write of each address (one address).

#### 9.3.1. Adapter Identification Special Register (0x1000, 4096)

| Address      | Access | Type, Size  | Description  |
|--------------|--------|---|--|
| 0x1000(4096) | Read   | 1word   | Vendor ID = 0x029D(669), HITACHI   |
| 0x1001(4097) | Read   | 1word   | Device type = 0x000C, Network Adapter  |
| 0x1002(4098) | Read   | 1word   | Product Code = 0x9040  |
| 0x1003(4099) | Read   | 1word   | Firmware revision, if 0x0100, revision 1.00  |
| 0x1004(4100) | Read   | 2word   | Product unique serial number   |
| 0x1005(4101) | Read   | String<br>up to 34byte  | Product name string (ASCII)<br>"RIO3-PBA_Profibus,HX-RIO3 Series"  |
| 0x1006(4102) | Read   | 1word   | Sum check of EEPROM  |
| 0x1010(4112) | Read   | 2word   | Firmware release date  |
| 0x101E(4126) | Read   | 7word<br>- 1word<br>- 1word<br>- 1word<br>- 1word<br>- 1word<br>- 2word | Composite Id of following address<br>0x1100(4352), Modbus Node. (Fixed 0x0001)<br>0x1000(4096), Vendor ID<br>0x1001(4097), Device type<br>0x1002(4098), Product code<br>0x1003(4099), Firmware revision<br>0x1004(4100), Product serial number |

- String Type consists of valid string length (first 1word) and array of characters

### 9.3.2. Adapter Information Special Register (0x1100, 4352)

| Address      | Access | Type, Size   | Description   |
|--------------|--------|--------------|---|
| 0x1102(4354) | Read   | 1word        | Start address of input image word register. =0x0000   |
| 0x1103(4355) | Read   | 1word        | Start address of output image word register. =0x0800  |
| 0x1104(4356) | Read   | 1word        | Size of input image word register.  |
| 0x1105(4357) | Read   | 1word        | Size of output image word register.   |
| 0x1106(4358) | Read   | 1word        | Start address of input image bit. = 0x0000  |
| 0x1107(4359) | Read   | 1word        | Start address of output image bit. =0x1000  |
| 0x1108(4360) | Read   | 1word        | Size of input image bit.  |
| 0x1109(4361) | Read   | 1word        | Size of output image bit.   |
| 0x110D(4365) | Read   | 1word        | Field Power & Node ID Dip Switch State.<br>ex) Field Power ON, Dip SW On = 10000000 11111111          |
| 0x110E(4366) | Read   | Up to 33word | Expansion slot's RIO3-number including GN<br>First 1word is adapter's number, if GN-9289, then 0x9289 |
| 0x1110(4368) | Read   | 1word        | Number of expansion slot  |
| 0x1113(4371) | Read   | Up to 33word | Expansion slot Module Id. Refer to Appendix A.1 Product List.<br>First 1word is adapter's module id.  |
| 0x1119(4377) | Read   | 1word        | Hi byte is ModBus status, low byte is internal status.<br>Zero value means 'no error'.                |
| 0x111D(4381) | Read   | 1word        | Adapter HX-RIO3 Series Revision. If 0x013C, HX-RIO3 Series<br>Revision is 1.60                        |

\*\* After the system is reset, the new "Set Value" action is applied.

\*\* If the slot location is changed, set default value automatically (all expansion slot is live).

### 9.3.3. Expansion Slot Information Special Resister (0x2000, 8192)

Each expansion slot has 0x20(32) address offset and same information structure.

|                                   |                                   |
|-----------------------------------|-----------------------------------|
| Slot#1 0x2000(8192)~0x201F(8223)  | Slot#2 0x2020(8224)~0x203F(8255)  |
| Slot#3 0x2040(8256)~0x205F(8287)  | Slot#4 0x2060(8288)~0x207F(8319)  |
| Slot#5 0x2080(8320)~0x209F(8351)  | Slot#6 0x20A0(8352)~0x20BF(8383)  |
| Slot#7 0x20C0(8384)~0x20DF(8415)  | Slot#8 0x20E0(8416)~0x20FF(8447)  |
| Slot#9 0x2100(8448)~0x211F(8479)  | Slot#10 0x2120(8480)~0x213F(8511) |
| Slot#11 0x2140(8512)~0x215F(8543) | Slot#12 0x2160(8544)~0x217F(8575) |
| Slot#13 0x2180(8576)~0x219F(8607) | Slot#14 0x21A0(8608)~0x21BF(8639) |
| Slot#15 0x21C0(8640)~0x21DF(8671) | Slot#16 0x21E0(8672)~0x21FF(8703) |
| Slot#17 0x2200(8704)~0x221F(8735) | Slot#18 0x2220(8736)~0x223F(8767) |
| Slot#19 0x2240(8768)~0x225F(8799) | Slot#20 0x2260(8800)~0x227F(8831) |
| Slot#21 0x2280(8832)~0x229F(8863) | Slot#22 0x22A0(8864)~0x22BF(8895) |
| Slot#23 0x22C0(8896)~0x22DF(8927) | Slot#24 0x22E0(8928)~0x22FF(8959) |
| Slot#25 0x2300(8960)~0x231F(8991) | Slot#26 0x2320(8992)~0x233F(9023) |
| Slot#27 0x2340(9024)~0x235F(9055) | Slot#28 0x2360(9056)~0x237F(9087) |
| Slot#29 0x2380(9088)~0x239F(9119) | Slot#30 0x23A0(9120)~0x23BF(9151) |
| Slot#31 0x23C0(9152)~0x23DF(9183) | Slot#32 0x23E0(9184)~0x23FF(9215) |
| Slot#33 0x2400(9216)~0x241F(9247) | Slot#34 0x2420(9248)~0x243F(9279) |

.....

Slot#63 0x27C0(10176)~0x27DF(10207)

| Address Offset | Expansion Slot#1 | Expansion Slot#2 | Expansion Slot#3 | Expansion Slot#4 | ..... | Expansion Slot#63 |
|----------------|------------------|------------------|------------------|------------------|-------|-------------------|
| + 0x00(+0)     | 0x2000(8192)     | 0x2020(8224)     | 0x2040(8256)     | 0x2060(8288)     | ..... | 0x27C0(10176)     |
| + 0x01(+1)     | 0x2001(8193)     | 0x2021(8225)     | 0x2041(8257)     | 0x2061(8289)     |       | 0x27C1(10177)     |
| + 0x02(+2)     | 0x2002(8194)     | 0x2022(8226)     | 0x2042(8258)     | 0x2062(8290)     |       | 0x27C2(10178)     |
| + 0x03(+3)     | 0x2003(8195)     | 0x2023(8227)     | 0x2043(8259)     | 0x2063(8291)     |       | 0x27C3(10179)     |
| + 0x04(+4)     | 0x2004(8196)     | 0x2024(8228)     | 0x2044(8260)     | 0x2064(8292)     |       | 0x27C4(10180)     |
| + 0x05(+5)     | 0x2005(8197)     | 0x2025(8229)     | 0x2045(8261)     | 0x2065(8293)     |       | 0x27C5(10181)     |
| + 0x06(+6)     | 0x2006(8198)     | 0x2026(8230)     | 0x2046(8262)     | 0x2066(8294)     |       | 0x27C6(10182)     |
| + 0x07(+7)     | 0x2007(8199)     | 0x2027(8231)     | 0x2047(8263)     | 0x2067(8295)     |       | 0x27C7(10183)     |
| + 0x08(+8)     | 0x2008(8200)     | 0x2028(8232)     | 0x2048(8264)     | 0x2068(8296)     |       | 0x27C8(10184)     |
| + 0x09(+9)     | 0x2009(8201)     | 0x2029(8233)     | 0x2049(8265)     | 0x2069(8297)     |       | 0x27C9(10185)     |
| + 0x0A(+10)    | 0x200A(8202)     | 0x202A(8234)     | 0x204A(8266)     | 0x206A(8298)     |       | 0x27CA(10186)     |
| + 0x0B(+11)    | 0x200B(8203)     | 0x202B(8235)     | 0x204B(8267)     | 0x206B(8299)     |       | 0x27CB(10187)     |
| + 0x0C(+12)    | 0x200C(8204)     | 0x202C(8236)     | 0x204C(8268)     | 0x206C(8300)     |       | 0x27CC(10188)     |
| + 0x0D(+13)    | 0x200D(8205)     | 0x202D(8237)     | 0x204D(8269)     | 0x206D(8301)     |       | 0x27CD(10189)     |
| + 0x0E(+14)    | 0x200E(8206)     | 0x202E(8238)     | 0x204E(8270)     | 0x206E(8302)     |       | 0x27CE(10190)     |
| + 0x0F(+15)    | 0x200F(8207)     | 0x202F(8239)     | 0x204F(8271)     | 0x206F(8303)     |       | 0x27CF(10191)     |
| + 0x10(+16)    | 0x2010(8208)     | 0x2030(8240)     | 0x2050(8272)     | 0x2070(8304)     |       | 0x27D0(10192)     |
| + 0x11(+17)    | 0x2011(8209)     | 0x2031(8241)     | 0x2051(8273)     | 0x2071(8305)     |       | 0x27D1(10193)     |
| + 0x12(+18)    | 0x2012(8210)     | 0x2032(8242)     | 0x2052(8274)     | 0x2072(8306)     |       | 0x27D2(10194)     |
| + 0x13(+19)    | 0x2013(8211)     | 0x2033(8243)     | 0x2053(8275)     | 0x2073(8307)     |       | 0x27D3(10195)     |
| + 0x14(+20)    | 0x2014(8212)     | 0x2034(8244)     | 0x2054(8276)     | 0x2074(8308)     |       | 0x27D4(10196)     |
| + 0x15(+21)    | 0x2015(8213)     | 0x2035(8245)     | 0x2055(8277)     | 0x2075(8309)     |       | 0x27D5(10197)     |
| + 0x16(+22)    | 0x2016(8214)     | 0x2036(8246)     | 0x2056(8278)     | 0x2076(8310)     |       | 0x27D6(10198)     |
| + 0x17(+23)    | 0x2017(8215)     | 0x2037(8247)     | 0x2057(8279)     | 0x2077(8311)     |       | 0x27D7(10199)     |
| + 0x18(+24)    | 0x2018(8216)     | 0x2038(8248)     | 0x2058(8280)     | 0x2078(8312)     |       | 0x27D8(10200)     |
| + 0x19(+25)    | 0x2019(8217)     | 0x2039(8249)     | 0x2059(8281)     | 0x2079(8313)     |       | 0x27D9(10201)     |
| + 0x1A(+26)    | 0x201A(8218)     | 0x203A(8250)     | 0x205A(8282)     | 0x207A(8314)     |       | 0x27DA(10202)     |
| + 0x1B(+27)    | 0x201B(8219)     | 0x203B(8251)     | 0x205B(8283)     | 0x207B(8315)     |       | 0x27DB(10203)     |
| + 0x1C(+28)    | 0x201C(8220)     | 0x203C(8252)     | 0x205C(8284)     | 0x207C(8316)     |       | 0x27D8C(10204)    |
| + 0x1D(+29)    | 0x201D(8221)     | 0x203D(8253)     | 0x205D(8285)     | 0x207D(8317)     |       | 0x27DD(10205)     |
| + 0x1E(+30)    | 0x201E(8222)     | 0x203E(8254)     | 0x205E(8286)     | 0x207E(8318)     |       | 0x27DE(10206)     |
| + 0x1F(+31)    | 0x201F(8223)     | 0x203F(8255)     | 0x205F(8287)     | 0x207F(8319)     |       | 0x27DF(10207)     |

| Address Offset | Access | Type, Size | Description   |
|----------------|--------|------------|---|
| + 0x02(+2) **  | Read   | 1word      | Input start register address of input image word this slot.   |
| + 0x03(+3) **  | Read   | 1word      | Input word's bit offset of input image word this slot.        |
| + 0x04(+4) **  | Read   | 1word      | Output start register address of output image word this slot. |
| + 0x05(+5) **  | Read   | 1word      | Output word's bit offset of output image word this slot.      |
| + 0x06(+6) **  | Read   | 1word      | Input bit start address of input image bit this slot.         |
| + 0x07(+7) **  | Read   | 1word      | Output bit start address of output image bit this slot.       |
| + 0x08(+8) **  | Read   | 1word      | Size of input bit this slot                                   |
| + 0x09(+9) **  | Read   | 1word      | Size of output bit this slot                                  |
| + 0x0A(+10) ** | Read   | n word     | Read input data this slot                                     |

|                |            |                           |  |
|----------------|------------|---------------------------|--|
| + 0x0B(+11) ** | Read/Write | n word                    | Read/write output data this slot   |
| + 0x0E(+14)    | Read       | 1word                     | RT-number, if RT-1238, returns 0x1238  |
| + 0x0F(+15)    | Read       | String<br>up to<br>74byte | First 1word is length of valid character string.<br>If RT-1238, returns<br>"00 1E 52 54 2D 31 32 33 38 2C 20 38 44 49 2C 20 32 34 56 64 63<br>2C 20 55 6E 69 76 65 72 73 61 6C 00 00"<br>Valid character size = 0x001E =30 characters,<br>"RT-1238, 8DI, 24Vdc, Universal" |
| + 0x10(+16)    | Read       | 1word                     | Size of configuration parameter byte   |
| + 0x11(+17) ** | Read/Write | n word                    | Read/write Configuration parameter data, up to 8byte. Refer to A.2<br>***  |
| + 0x17(+23) ** | Read/Write | 2word                     | Firmware Revision  |
| + 0x19(+25) ** | Read/Write | 2word                     | Firmware release date.   |

\*\* After the system is reset, the new "Set Value" action is applied.

\*\*\* Nothing of output, input, memory, or configuration parameter corresponding slot returns Exception 02.

## 10. Troubleshooting

### 10.1. How to diagnose by LED indicator

| LED Status                           | Cause  | Action  |
|--------------------------------------|--|---|
| All LED turns off                    | - No power   | - Check main power Cable  |
| MOD LED is red                       | - Occurrence critical error in firmware  | - Contact Sales team and send module for repair.  |
| NET LED turns off                    | Failure of communication with Master   | Check main power for master and communication cable.  |
| NET LED flashed green                | Failure of exchanging data with master   | Check status in software for Master configuration.  |
| NET LED is red                       | Failed communication   | - Contact Sales team and send module for repair.  |
| DIA Flashing Red with MOD led is red | Device has hardware checking error.  | - Contact Sales team and send module for repair.  |
| DIA Flashing Red with IOS led is red | Device has expansion module error.   | - Contact Sales team and send module for repair.  |
| DIA Flashing Red                     | Failed to initialize expansion module<br>- Overflow Input/Output size. (244bytes / 244bytes)<br>- Overflow Configuration data size. (244bytes / 244bytes)<br>- Too many expansion modules. (Max 63 slot)<br>- Mismatch vendor code between adapter and expansion module.   | - Use expansion slot up to 63.<br>- Compose that IO total size is not excess.<br>- Check status of expansion IO connection.<br>- Check the vendor code of module. |
| IOS LED turns off                    | - Device may not be powered.   | - Check main power Cable  |
| IOS LED flashes red                  | - Adapter has no expansion module  | - Add one or more expansion modules.  |
| IOS LED is red                       | One or more expansion module occurred in fault state.<br>- Detected invalid expansion module ID.<br>- Overflowed Input/Output Size<br>- Too many expansion module<br>- Initialization failure<br>- Communication failure.<br>- Changed expansion module configuration.<br>- Mismatch vendor code between adapter and expansion module. | - Use expansion slot up to 63.<br>- Compose that IO total size is not excess.<br>- Check status of expansion IO connection.<br>- Check the vendor code of module. |
| Field Power LED turns off            | - Field power is not supplied.   | - Check main power Cable<br>- Contact Sales team and send module for repair.  |
| System Power LED turns off           | - System power is not supplied.  | - Check main power Cable<br>- Contact Sales team and send module for repair.  |

## 10.2. How to diagnose when device couldn't communicate network

### Inspection of wrong or omission cable connection.

- Check status of cable connection for each node.
- Check that all colour matches between connector and cable.
- Check wire omission.

### Terminator resistor

- If terminator resistor is not installed, install terminator resistor
- Check location of terminator resistor

### Configuration of Node address

- Check duplication node address.

### Configuration of Master

- Check configuration of master
- Check whether to do download or don't
- Check composition is right
  - Configuration of communication baud rate
  - I/O size
  - Configuration of each nodes

### Ground and environment

- Check ground is contacted
- Check environment factor(temperature, humidity, etc) is in less than regular limit

## APPENDIX A

### A.1. Product List

Please refer the separate HX-RIO3 product list document

### A.2. Glossary

- System Power : The power for starting up CPU.
- Field Power : The power for input and output line.
- Terminator Resistor : Resistor for prevention reflected wave.
- EDS : Electronic Data Sheet.
- Sink : The method of in/output power supply if a device has no power source.
- Source : The method of in/output power supply if a device has the power source.