MODBUS TCP/IP over Ethernet
Universal Analog Input Module

PPI
The Perfection Experts

AIME 4U / AIME 8U

4 / 8 Universal Analog Input Channels
DIN-Rail Mount
MODBUS over TCP/IP
Built-in Web Pages for Configuration & Settings

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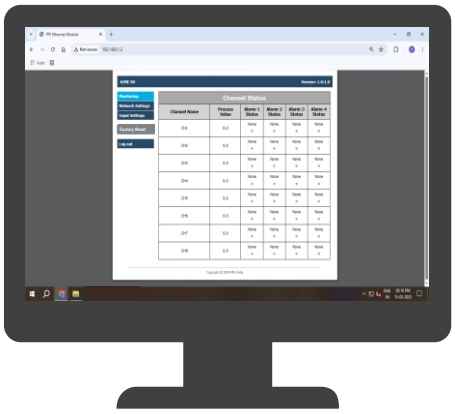
User Manual

Web Pages



CONTENTS

Section 1

PRODUCT OVERVIEW

The AIME series is a compact, high-performance Analog Input Module engineered for seamless integration with industrial control, monitoring, and data acquisition systems via the Ethernet interface using the industry-standard MODBUS TCP/IP protocol.

Available in 4-channel and 8-channel models, the AIME series is designed to meet diverse application requirements with flexible input configurations. The module ensures precise and stable measurements, featuring a 16-bit Sigma-Delta ADC, user-selectable channel update rates, built-in Cold Junction Compensation (CJC) for thermocouple inputs, Lead Resistance Compensation (LRC) for RTD inputs, and programmable scaling for DC voltage and current inputs.

To support easy system integration, the module supports both 16-bit signed integer and 32-bit floating-point process value outputs. Three-way isolation between the power supply, input channels, and Ethernet port ensures signal integrity and eliminates potential ground loop issues. Additionally, each channel also offers 4 programmable soft alarms with dedicated LED indicators, enhancing process reliability and safety.

The AIME module allows direct integration with MODBUS TCP/IP networks for real-time data sharing, making it ideal for networked process monitoring applications. It features integrated web pages that enable simple and intuitive network configuration, channel setup, and real-time data monitoring through any standard web browser.

Remote configuration capability via Ethernet reduces setup time and simplifies maintenance, offering users flexibility and convenience in system management. Additionally, Auto MDI/MDIX support ensures automatic detection and correction of straight-through or crossover Ethernet cables, eliminating the need for manual cable adjustments.

The AIME series is particularly well-suited for integration with SCADA, PLC, and HMI platforms, making it a reliable and flexible solution for system integrators working across diverse automation projects.

Whether for industrial monitoring, laboratory testing, or process automation, the AIME series provides a flexible and powerful solution for accurate analog signal measurement and reliable MODBUS TCP/IP communication.

Channel Specifications

Number of Channels	4 / 8		
Input Types	Thermocouples	:	J, K, T, R, S, B, N, E
	RTDs	:	2 / 3-Wire Pt100, Pt1000
	DC mV	:	0 to 80 mV, 0 to 160 mV
	DC Volts	:	0 to 1.25V, 0 to 5V, 1 to 5V, 0 to 10V
	DC mA	:	0 to 20 mA, 4 to 20 mA
Accuracy	**Thermocouples**	:	± 0.2% of reading for J, K, T, E (Excluding CJC) ± 0.4% of reading for R, S, B, N (Excluding CJC)
	CJC	:	± 1.5 °C (Specified over 18 to 37 °C)
	RTDs	:	± 0.2% of reading.
	Lead Resistance Compensation	:	Maximum 5Ω per Lead for 3-wire RTD
	DC Linear mV / V / mA	:	± 0.1% of reading

Thermal Drift	0.01% of Span per °C
Resolution	Thermocouples & RTDs : 0.1 °C DC Linear mV / V / mA : 0.001 / 0.01 / 0.1 / 1 Counts
Range	Thermocouple & RTDs : Refer Table-1 DC Linear mV / V / mA : -30000 to +30000 Counts
Zero Offset	User Adjustable over Full Range for Each Channel
ADC	16 Bit (± 32,768 Counts), Sigma-Delta (ΣΔ)
Sampling Time	User Settable as : • 45 mS per Channel (22 Samples per Second) • 79 mS per Channel (12 Samples per Second) • 146 mS per Channel (7 Samples per Second)
Input Resistance	> 1 MΩ for RTDs / Thermocouples / mV / V Input 249 Ω Precision Shunt for mA Input
Common Mode Rejection	> 100dB at 50/60 Hz
Input Protection	ESD : 8KV EFT : 2KV Surge : 1KV
Input Conditioning	First Order Analog R-C Low-Pass Filter + Programmable IIR Digital Filter

Alarms

Numbers	4, Independent for Each Channel with Front LED Indicators
Programmable Parameters	Type : Process Low, Process High Setpoint : Adjustable over Full Range Hysteresis : 1 to 3000 Unit Counts Inhibit : No, Yes

Ethernet Port

Interface	Ethernet 10/100 Base-T (Auto-sensing)
Connector	RJ45 with Integrated Magnetics & 1500V Galvanic Isolation
Auto MDI/MDIX	Supported (Automatic Detection & Correction for Straight-through or Crossover Cables)
Speed	10 Mbps / 100 Mbps, Auto-negotiation
Link / Activity Indicator	**Link LED**: Illuminates when a Valid Ethernet Connection is Established **ACT LED**: Blinks to Indicate Network Activity (Data Transmission or Reception)
Transmission Mode	Full Duplex / Half Duplex, Auto-negotiation
Protocol Support	**MODBUS TCP/IP** : Supports up to 2 Simultaneous MODBUS TCP Server Sockets **HTTP** : Built-in Web Server for Configuration and Real-time Monitoring

Power Supply & Isolation

Type	Switch Mode (SMPS)
Power Requirement	18 ~ 32 VDC, nominal 24 VDC @ **60mA Max.** **Note** : In case of looping multiple modules on one power source, make sure that the power source is capable of supplying minimum 60mA current per module.
Isolation	1500VAC for 1 second or 250VAC continuous Three-way Isolation between Power, Inputs & Ethernet Port

Physical

Mounting	DIN-Rail
Overall Dimensions	22.5(W) X 101(H) X 119(D), mm
Terminals	Screw Type, Pluggable
Weight	400 gm, Appx.

Environmental

Operating Ambient	0 to 55°C & 5 to 90%RH Non-condensing
Storage Temperature	-10 to +70°C
Atmospheres	Not Suitable for use in Corrosive or Explosive Atmospheres. The Panel in which the Instrument is Mounted must be free of Electrically Conductive Pollution.

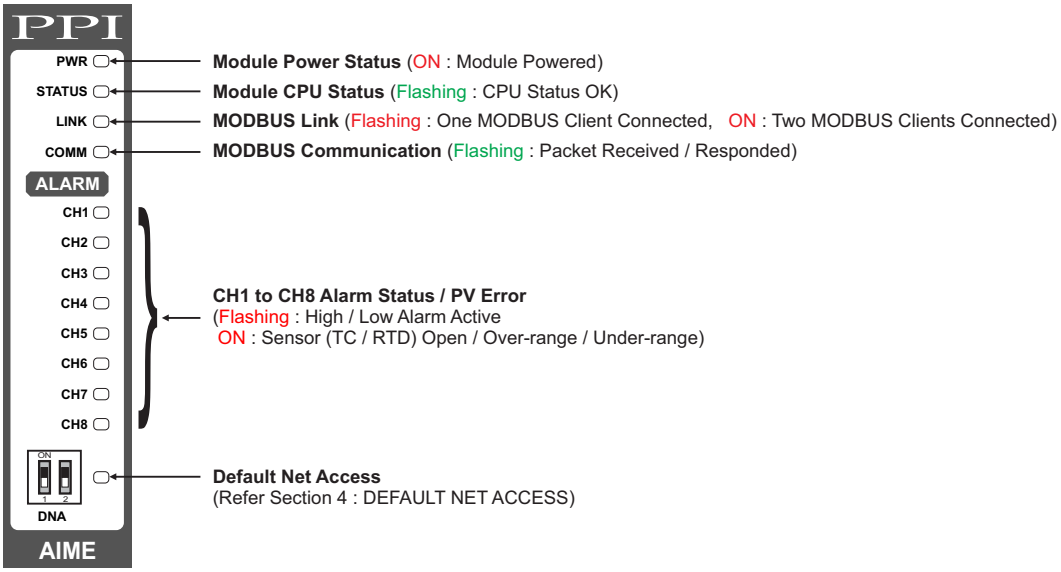
TABLE 1

Input Type	Range (Min. to Max.)
2 / 3-wire, RTD Pt100	-199.9 to +850.0 °C / -328.0 to +1562.0 °F
2 / 3-wire, RTD Pt1000	-199.9 to +850.0 °C / -328.0 to +1562.0 °F
Type J Thermocouple (Fe-K)	0.0 to +960.0°C / +32.0 to +1760.0°F
Type K Thermocouple (Cr-Al)	-200.0 to +1376.0°C / -328.0 to +2508.0°F
Type T Thermocouple (Cu-Con)	-200.0 to +387.0°C / -328.0 to +728.0°F
Type R Thermocouple (Pt / Pt-Rh13%)	0.0 to +1771.0°C / +32.0 to +3219.0°F
Type S Thermocouple (Pt / Pt-Rh10%)	0.0 to +1768.0°C / +32.0 to +3214.0°F
Type B Thermocouple (Pt-Rh6% / Pt-Rh30%)	0.0 to +1826.0°C / +32.0 to +3318.0°F
Type N Thermocouple (NiCrSi / NiSi)	0.0 to +1314.0°C / +32.0 to +2397.0°F
Type E Thermocouple (NiCr / Con)	-200.0 to +1000.0°C / -328.0 to +1832.0°F

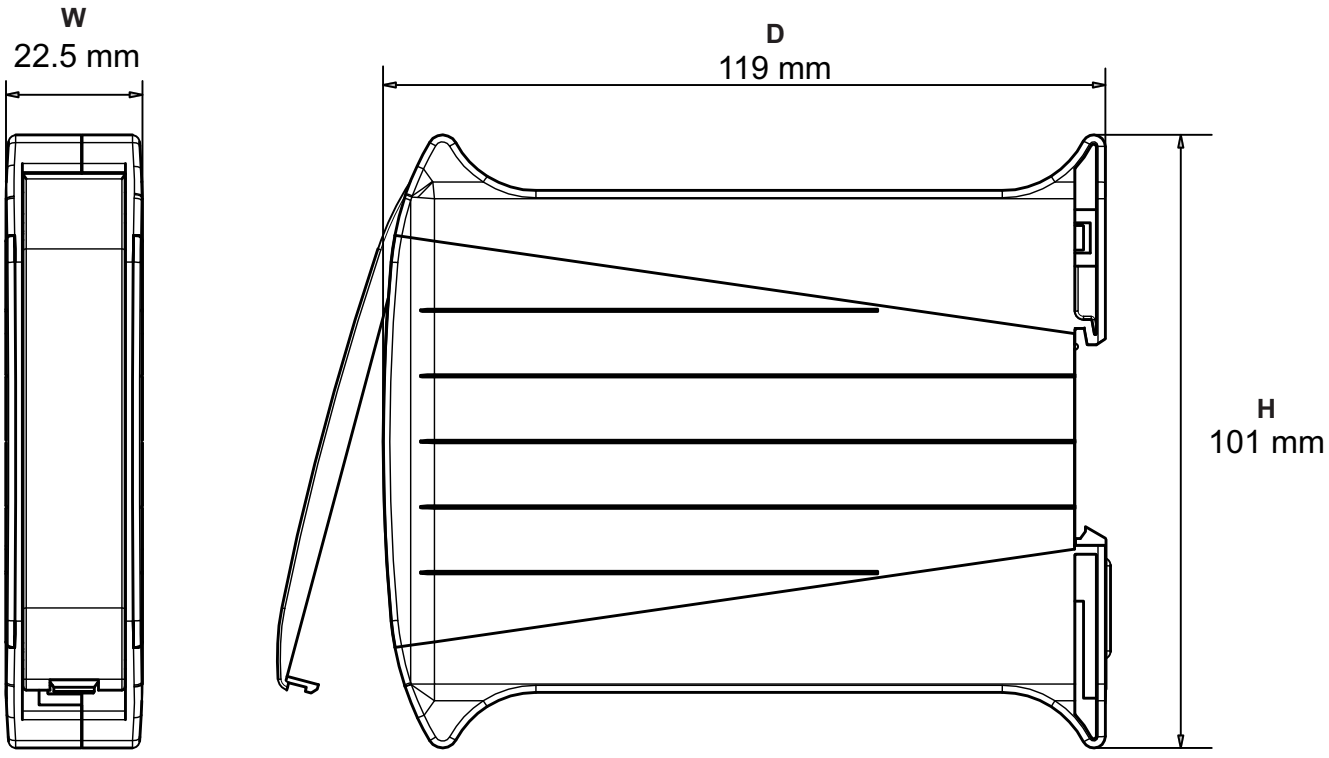
Section 2

HARDWARE OVERVIEW

FRONT PANEL



MECHANICAL DIMENSIONS

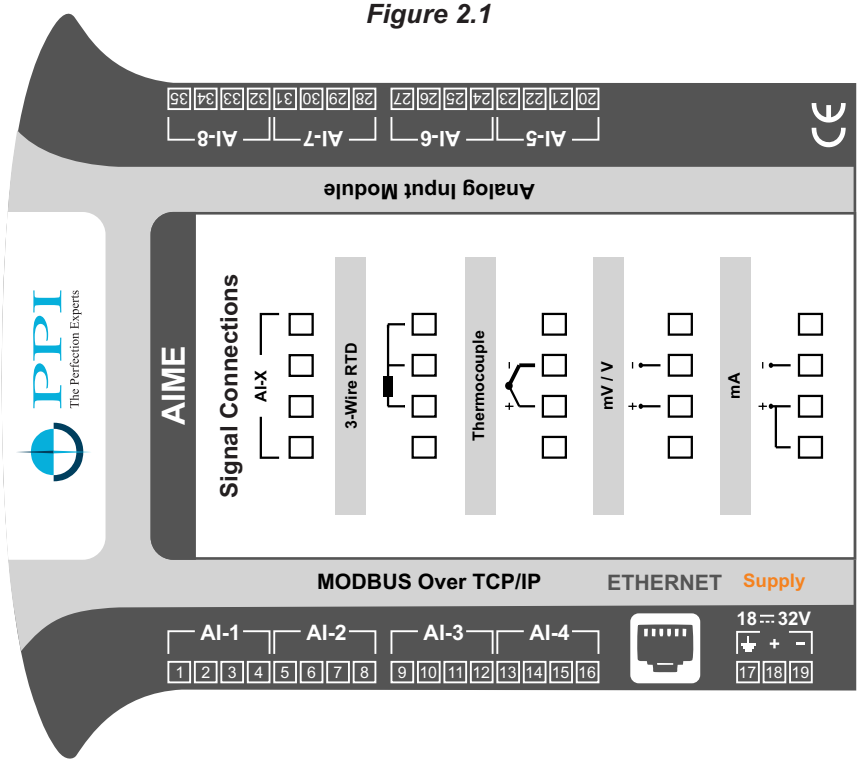


Overall Size (mm) : Width = 22.5, Height = 101.0, Depth = 119.0

CONNECTION DIAGRAM

The Figure 2.1 illustrates Electrical Connection Diagrams.

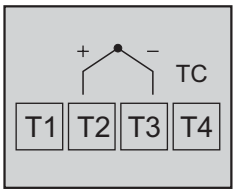
Figure 2.1



Analog Input Channel Connections (AI-1 to AI-8)

Each of the 4 (AI-1 to AI-4) / 8 (AI-1 to AI-8) analog input channels follows an identical wiring configuration. For clarity in wiring description, the four terminals associated with each channel are labeled T1, T2, T3 & T4.

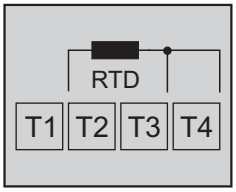
Figure 2.2(a)



Thermocouple (TC) Connections

- Connect the Thermocouple Positive (+) to T2 and Negative (-) to T3.
- Use the correct type of extension wires or compensating cables, ensuring polarity consistency.
- Avoid splicing or joining cables to prevent signal degradation.

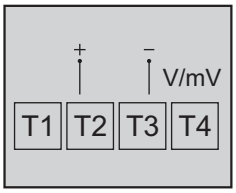
Figure 2.2(b)



RTD (Pt100 / Pt1000, 3-Wire) Connections

- Connect the single leaded end of the RTD sensor to T2.
- Connect the double leaded ends to T3 and T4 (interchangeable).
- Use copper conductors of low resistance, ensuring that all three leads are of the same gauge and length.

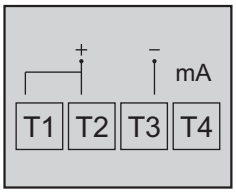
Figure 2.2(c)



DC Voltage (mV / V) Input

- Use shielded twisted-pair cables, with the shield grounded at the signal source.
- Connect common (-) to T3 and signal (+) to T2.

Figure 2.2(d)

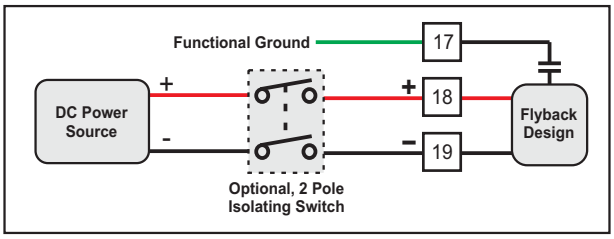


DC Current (mA) Input

- Use shielded twisted-pair cables, with the shield grounded at the signal source.
- Connect common (-) to T3 and signal (+) to T2. Short T1 & T2.

POWER SUPPLY (Terminals 18, 19)

Figure 2.3



The AIME module is designed to operate on a DC power supply voltage in the range of 18 to 32 VDC. The module's accuracy and performance remain unaffected within this specified voltage range. Refer the following wiring guidelines below.

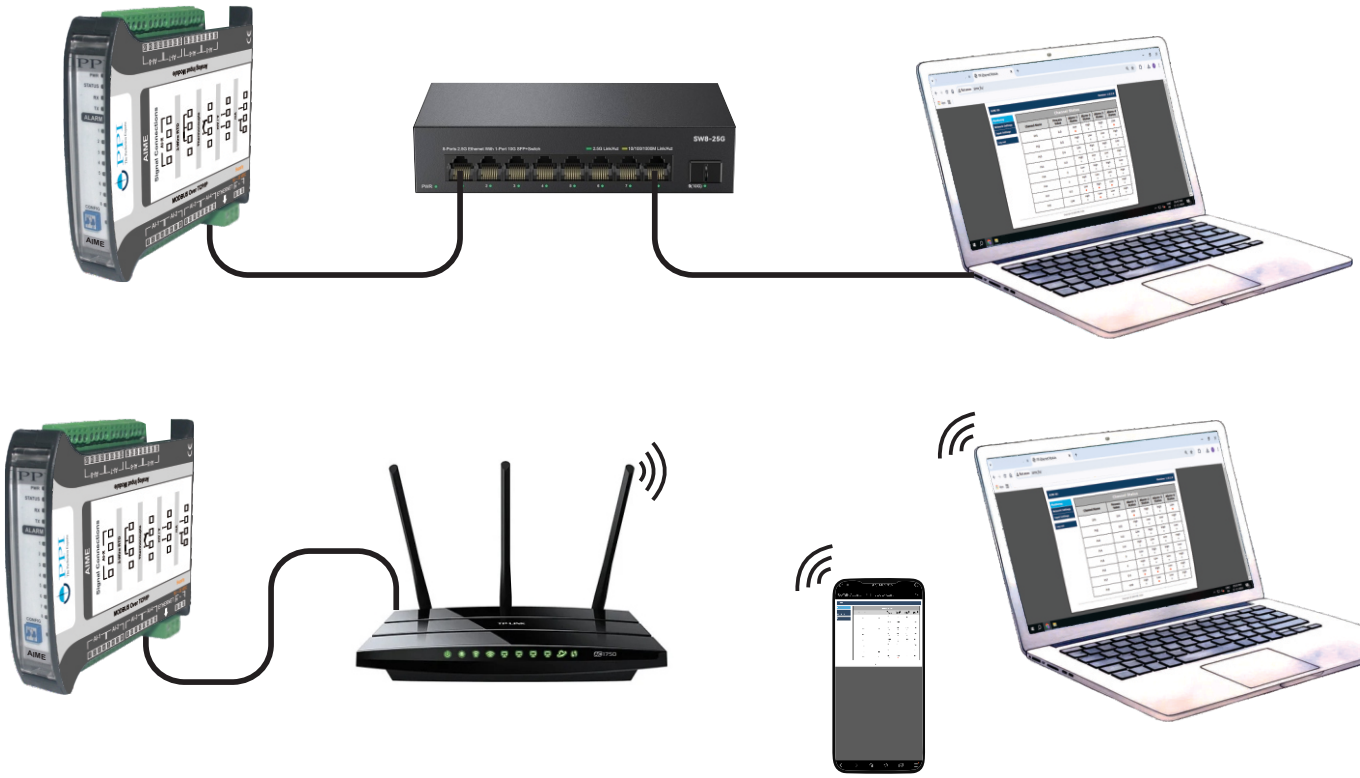
- Use well-insulated copper conductor wire, with a cross-sectional area not less than 0.5 mm², to ensure safe and reliable power connections.
- Observe correct polarity when connecting the DC power source, as illustrated in Figure 2.3.
- For improved safety and electrical noise immunity, it is strongly recommended to connect the functional ground (FG) or Earth terminal of the DC power source to Terminal 17 of the module.
- An optional 2-pole isolating switch may be installed in the power line to facilitate safe disconnection during maintenance or installation.

ETHERNET CONNECTIONS

1. Direct Connection to a PC :

- The module can be connected directly to a PC's Ethernet port.
- Auto-MDIX Support : The module automatically adjusts for the type of Ethernet cable used. Therefore, a standard "straight-through" cable can be used, eliminating the need for a "crossover" cable.

2. Connection via Network Infrastructure :



The module can be connected to a network using any of the following :

- Hub
- Switch
- Router (10/100 Base-T)
- Wireless (Wi-Fi) Router for accessing the module over a wireless network. When using a wireless router, the module can be accessed wirelessly from any PC or module connected to the same network.

Section 3

MODULE SET-UP

Overview

The AIME module is equipped with an intuitive web-based user interface, allowing for easy configuration and channel settings, including input type selection, display range/resolution, and alarm limits. For seamless integration with host modules like HMI, PLC, or PC, the module communicates using the industry-standard MODBUS TCP/IP protocol.

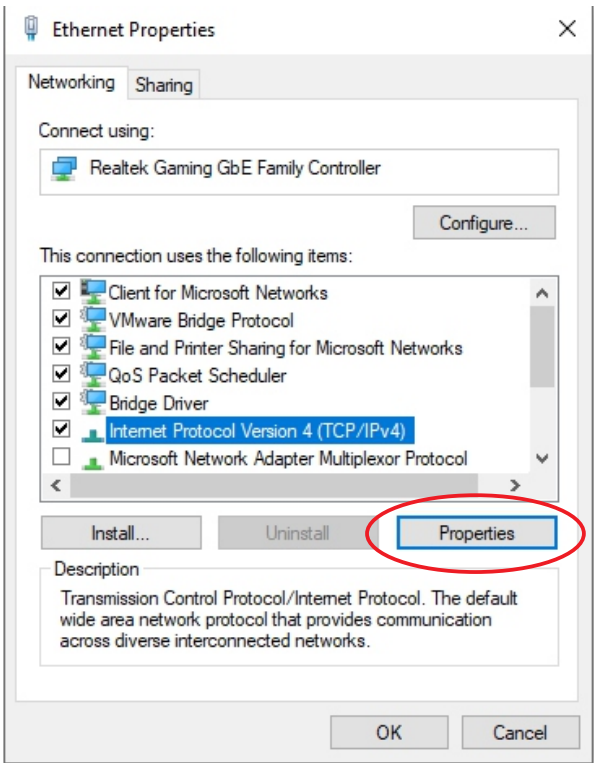
Initial Setup Procedure

The following steps outline how to prepare the module for its first use:

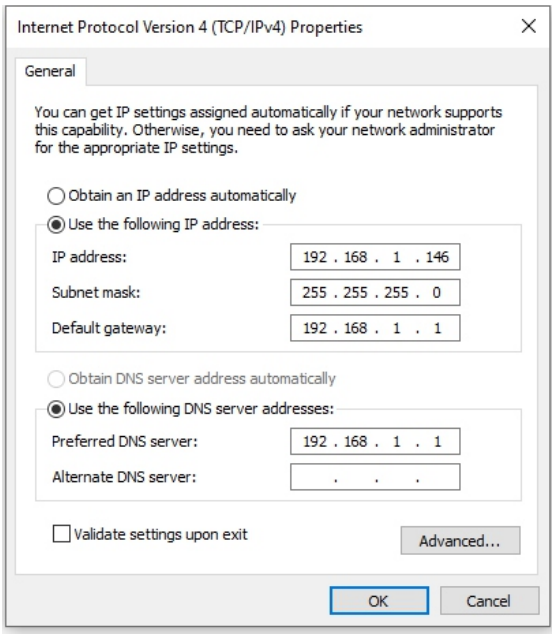
1. Power and Ethernet Connections
   - Connect the module's Ethernet port directly to a PC using a standard straight-through Ethernet cable or through a hub, switch, or router.
   - Ensure the module is powered on.

2. Default Network Settings
   The module is pre-configured with the following network parameters:
   - Static IP Address : 192.168.1.2
   - Gateway : 192.168.1.1
   - Subnet Mask : 255.255.255.0

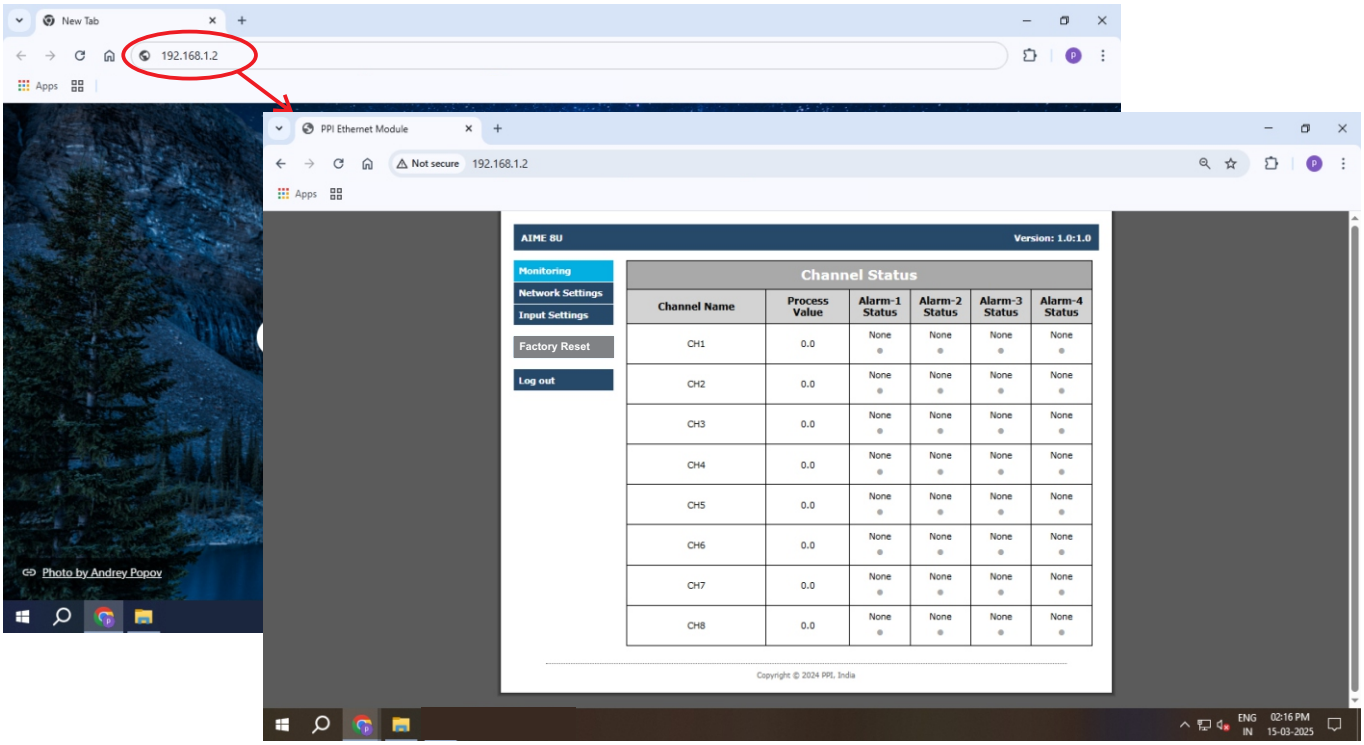
3. PC Network Configuration
   - On a Windows PC, navigate to:
     - *Control Panel > Network and Sharing Center > Change adapter settings.*
     - Right-click the active network adapter, click *Properties*.
     - Select *Internet Protocol Version 4 (TCP/IPv4)*, and click *Properties*.



- Modify the PC's network settings to match the module's default network parameters:
  - IP Address: Assign a compatible address in the range 192.168.1.x (e.g., 192.168.1.10), avoiding 192.168.1.2.
  - Subnet Mask: 255.255.255.0
  - Gateway: 192.168.1.1



4. Accessing the Web Interface
   - Open a web browser and enter the default IP address (192.168.1.2) in the address bar.
   - The module's home page (Monitoring) will load.



5. Configuring the module:
   - Navigate to the Network Settings page to customize the module's network parameters for integration into your existing network.
   - Proceed to the Input Settings page to configure individual channel parameters such as input type, display range, and alarms.

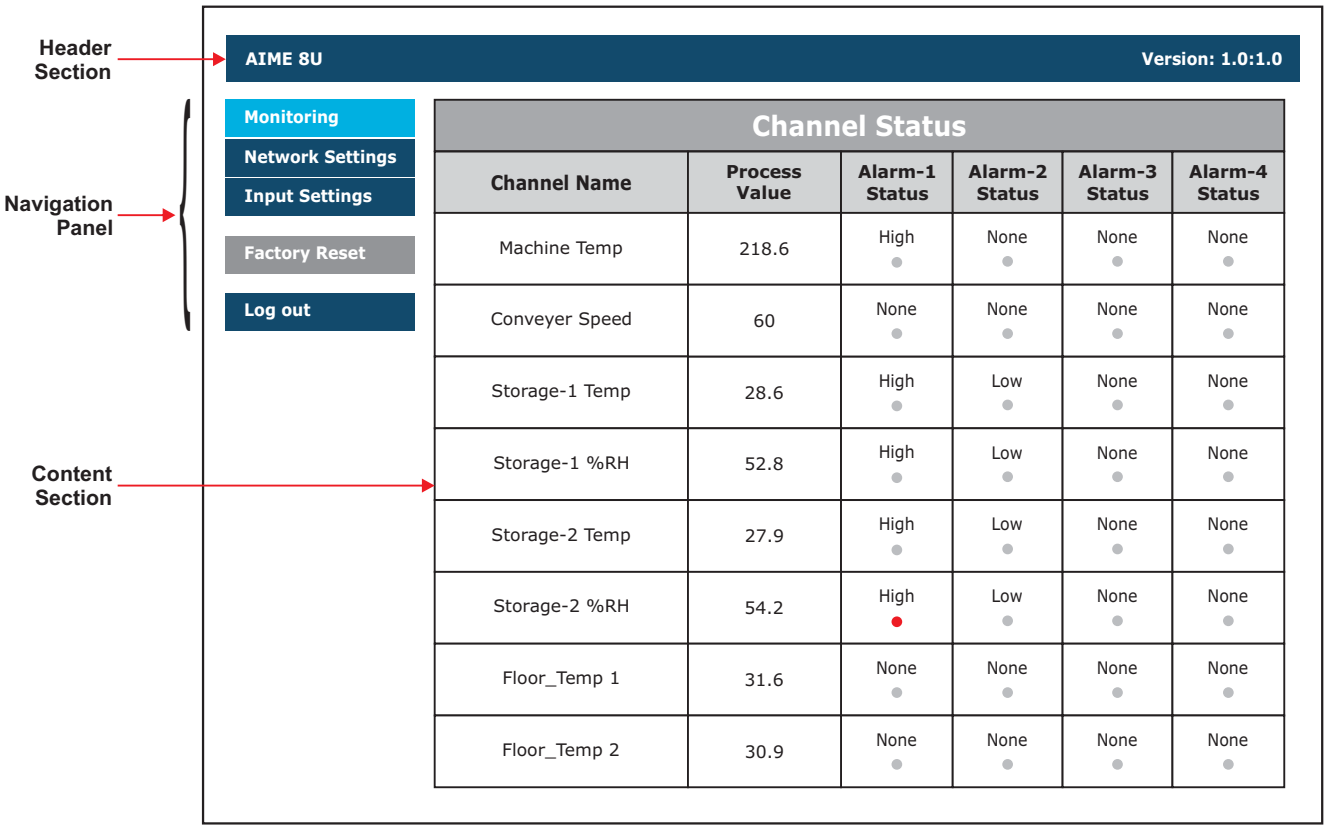
Next Steps

Once the module is successfully configured using the web interface, it can be seamlessly integrated with host modules such as HMI, PLC, or PC for data acquisition and factory automation applications.

The Sections 10 : **MODBUS MAPPING** details MODBUS register maps and communication settings to facilitate module interfacing.

Section 4

WEB PAGE : Monitoring



Overview

The **Monitoring** Page serves as the default landing page of the module's web interface. It provides a clear, real-time display of the process values (PVs) and alarm statuses for all 8 input channels.

Layout Description

1. **Header Section**
   Displays the module name, AIME 4U or AIME 8U, at the left and the firmware version (e.g., 1.0:1.0) at the right for easy identification and troubleshooting.

2. **Navigation Panel (Left Sidebar)**
   This panel contains various buttons to navigate through various web pages that provide module configuration and parameter settings. The following buttons exist.

   - Monitoring
     This page provides a real time view of process values and alarm statuses for all 4 / 8 channels.

   - Network Settings
     Allows users to configure network parameters (like IP address, subnet mask, gateway, etc.), enable/disable password protection, and TCP/IP settings.

   - Input Settings
     Used for configuring the analog input channels for sensor type, display scaling, alarm types and limits, etc.

- Factory Reset
  Used for re-setting all the analog input channels to their factory default values.

- Log Out
  Logs out the current user from the web interface securely.

3. Content Section

This section provides a tabular view of the live process values and alarm statuses for all 4 / 8 channels. The contents are dynamically refreshed every one second. The table comprises the following columns for each channel.

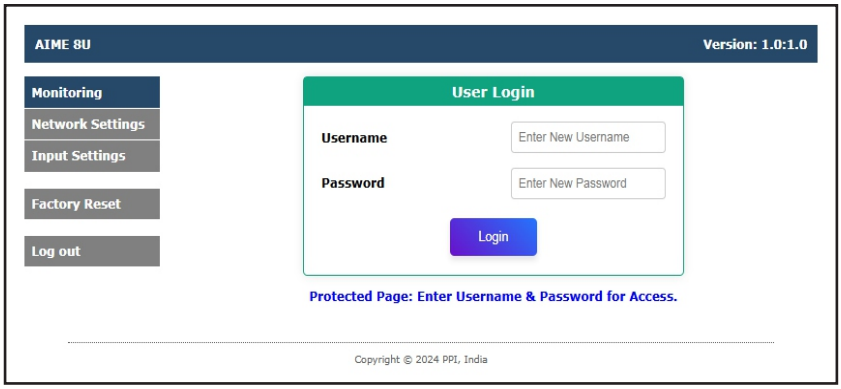
- Channel Name
  Displays the user assigned name for each analog input channel. The channel name is assigned on “Input Settings” web page.

- Process Value (PV)
  Displays the current value measured by the channel. The error conditions such as Under Range, Over Range, or (sensor) OPEN are displayed in red text for easy identification.

- Alarm Status Columns (Alarm-1 to Alarm-4):
  Displays the status of all the four alarms for each channel along with the type of the alarm (Low, High, None). The active alarms are indicated by Red dots while inactive alarms are indicated as Gray dots.

Section 5

WEB PAGE : User Login



Overview

The User Login page is displayed when access to the Network Settings and Input Settings web pages is restricted using password protection. This security feature ensures that only authorized users can modify network and channel settings.

Login Procedure

1. Enter the Username and Password in the respective fields.
2. Click the Login button to gain access to the restricted pages.

Default Credentials:

- **Username:** admin
- **Password:** admin

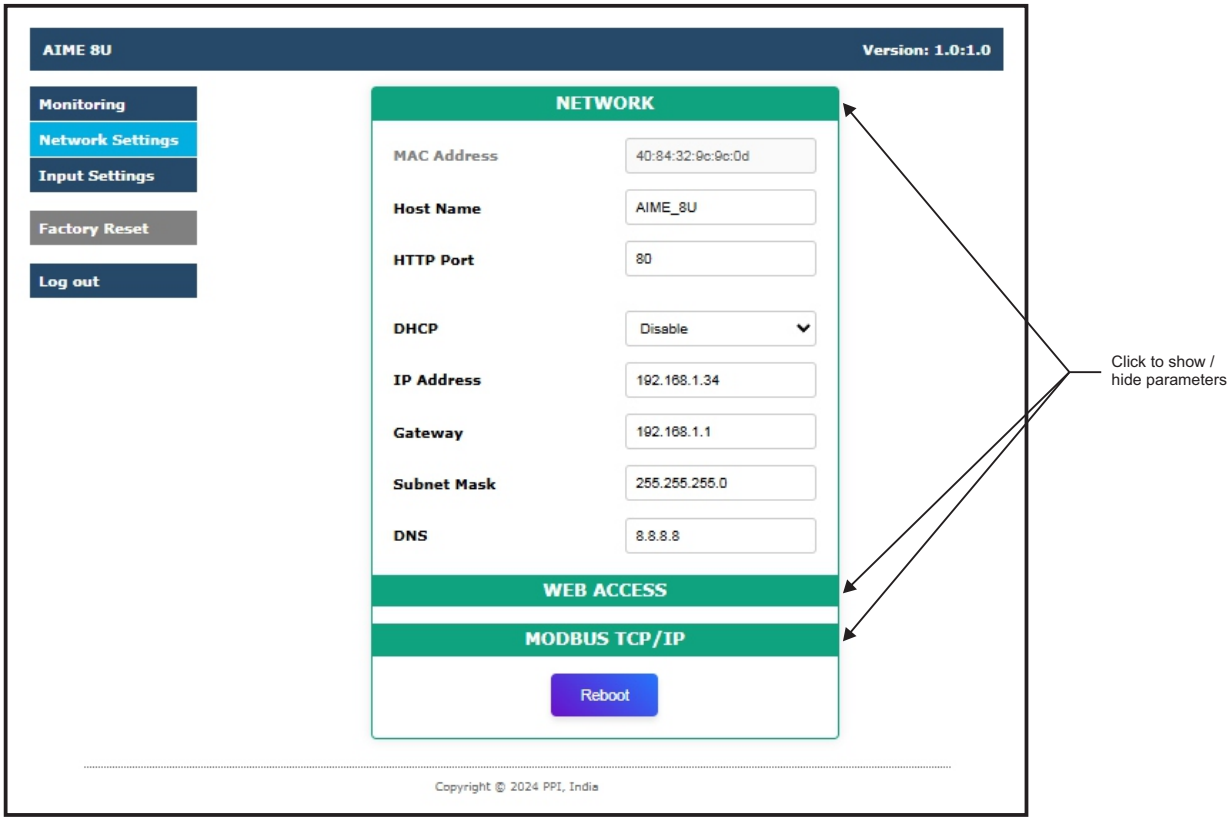
To enhance security, it is recommended to change the default credentials after the first login.

Managing Credentials

- The Username and Password can be updated on the Network Settings web page.
- Ensure that the new credentials are securely stored to prevent unauthorized access.
- If unrestricted access is required, password protection can be disabled by setting the Password Protection parameter to Disable on the Network Settings web page.

Section 6

WEB PAGE : Network Settings



Overview

The **Network Settings** page allows users to configure the module's network and communication parameters. It provides options to set network details, enable/disable password protection for access to 'Network Settings' & 'Input Settings' web pages, and configure MODBUS TCP/IP settings.

The page is structured into three collapsible sections for better organization: Network, Web Access, and MODBUS TCP/IP. Each section's title bar is clickable to expand (show) or collapse (hide) the parameters within, enabling easy navigation and parameter management. Each section with its parameters are described below.

Network

This section is for configuring basic network parameters.

1. **MAC Address**
   Displays the module's current Media Access Control (MAC) address. It is a read only parameter.

2. **Host Name**
   Allows users to assign a name to the module for network identification (e.g., "AIME8U_1"). Used when accessing the module via hostname instead of the IP address. The module supports Zeroconfig (Bonjour) and NBNS (NetBIOS Name Service).

   The default host name is **AIME** (case insensitive).

3. **HTTP Port**
   Configures the HTTP server port for the web interface. Default value is 80. Can be changed if another application requires port 80.

4. **DHCP**
   Dropdown menu to Enable or Disable DHCP (Dynamic Host Configuration Protocol).

   When enabled, the module obtains its network settings automatically from a DHCP server. When disabled, manual configuration of IP, Gateway, Subnet Mask, and DNS is required.

5. **IP Address**
   Specifies the module's static IP address if DHCP is disabled. Must be entered as a standard IPv4 address in the form xxx.xxx.xxx.xxx (e.g., 192.168.1.71), where xxx ranges from 0 to 255.

   Default: 192.168.1.2

6. **Gateway**
   Configures the gateway IP address for network routing. Typically, the IP address of the router. Must follow the IPv4 address format (e.g., 192.168.1.1).

   Default: 192.168.1.1

7. **Subnet Mask**
   Defines the subnet mask to determine the module's network segment. Must follow the IPv4 address format (e.g., 255.255.255.0).

   Default: 255.255.255.0

8. **DNS**
   Specifies the Domain Name System (DNS) server IP address for hostname resolution. Must follow the IPv4 address format (e.g., 8.8.8.8).

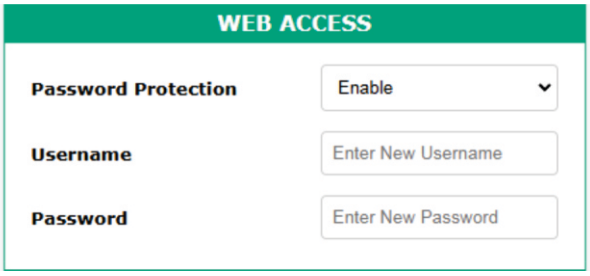
   Default: 8.8.8.8 (Google's public DNS server).

Web Access

This section manages access control for the web interface.

1. **Password Protection**
   Dropdown to Enable or Disable password protection.

   When enabled, users must provide a valid username and password to access the 'Network Settings' and 'Input Settings' web pages.



2. **Username**
   Input field to set or update the username for web access.

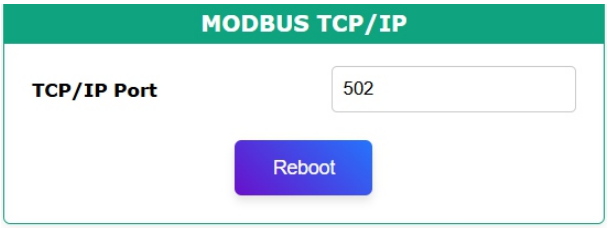
3. **Password**
   Input field to set or update the password for web access.

MODBUS TCP/IP

This section is for configuring MODBUS communication over TCP/IP. **Supports up to 2 Simultaneous MODBUS TCP Server Sockets.**

1. **TCP/IP Port**
   Specifies the TCP/IP port for MODBUS communication.

   Default: 502 (standard MODBUS port).



Reboot

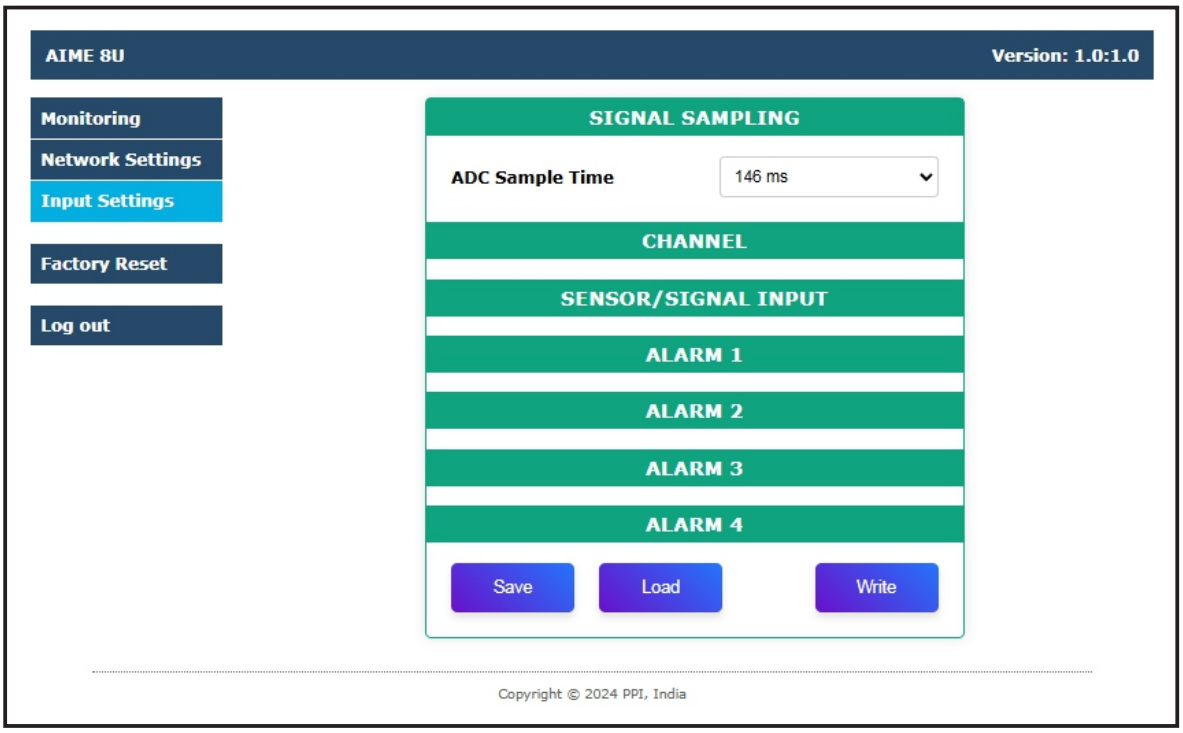
Clicking this button applies any changes made on the page and reboots the module to activate the updated settings.

Before applying the changes, pressing the Reboot button triggers a validation process. This process ensures that all entered addresses, such as the IP Address, Gateway, Subnet Mask, and DNS, conform to their required formats: If any address is found to be invalid, the page automatically scrolls to the top, and an error message is displayed prominently (e.g., “Incorrect IP Address Formatting!”). The wrong value is also shown in red. This feature prevents the submission of incorrect configurations, ensuring reliable network connectivity and functionality.

Note: Users must correct the highlighted errors and press the Reboot button again to apply the changes.

Section 7

WEB PAGE : Input Settings



Overview

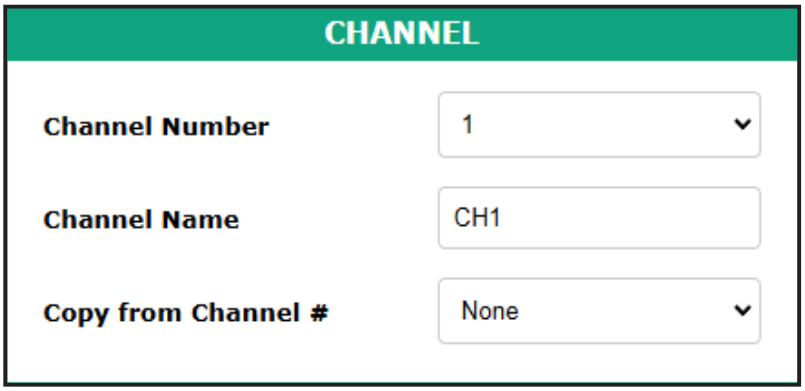
The **Input Settings** page is designed for configuring parameters specific to each analog input channel of the module. This page provides users with full flexibility to customize input types, display resolutions, units, and related signal conditioning parameters.

The page is structured into several collapsible sections for better organization: Signal Sampling, Channel, Sensor / Signal Input, Alarm 1, Alarm 2, Alarm 3, and Alarm 4. Each section's title bar is clickable to expand (show) or collapse (hide) the parameters within, enabling easy navigation and parameter management. Each section with its parameters are described below.

Signal Sampling

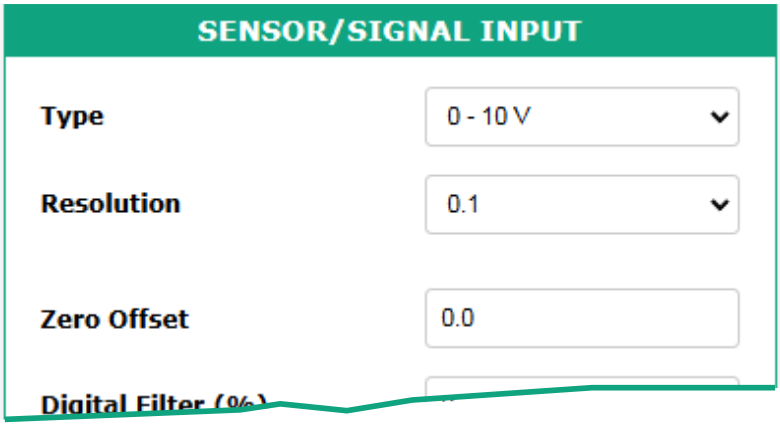
This section allows adjusting the time interval for sampling the analog input channels. For detailed description refer MODBUS parameter table.

Channel



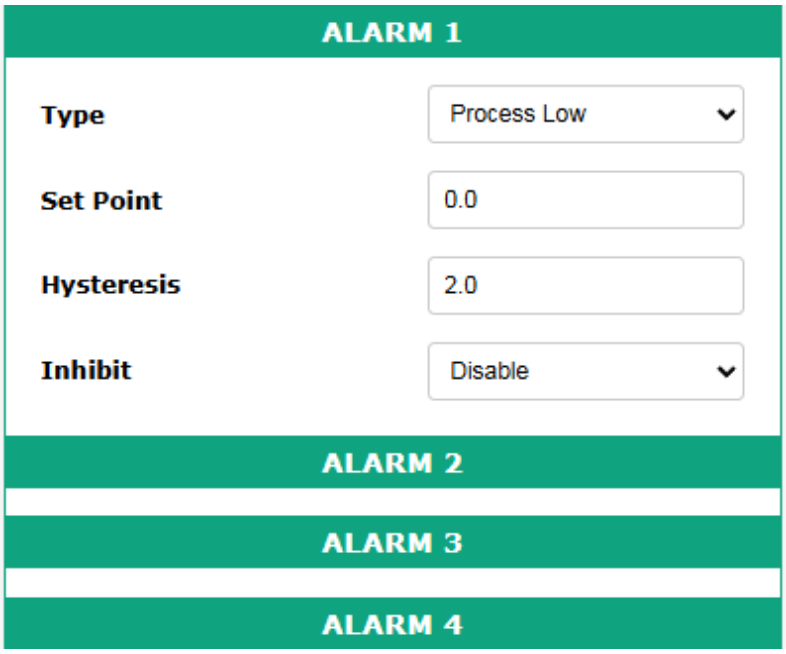
- All parameters are organized per channel, allowing independent customization for each input.
- Users can select the desired Channel Number (1 to 4 or 8) from a dropdown menu to configure specific settings for that channel.
- The Channel Name field allows assigning a unique, descriptive name to the selected channel for easy identification (e.g., “Temperature”, “Pressure”).
- The Copy from Channel # option enables quick replication of settings from any other configured channel. Select the channel number from the dropdown menu whose parameter settings are to be replicate to the selected channel.

Sensor/Signal Input



- This collapsible section provides controls to define input-specific parameters such as Type, Resolution, Units, Zero Offset, and Digital Filter (%).
- Users can configure these parameters to match the type of input sensor connected to the channel (e.g., voltage, current, RTD, thermocouple).
- Refer Section 10 : **MODBUS MAPPING** for parameter description.

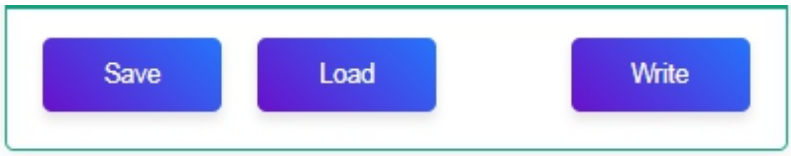
Alarm 1, Alarm 2, Alarm 3 & Alarm 4



- There are four collapsible Alarm sections labeled ALARM 1, ALARM 2, ALARM 3, and ALARM 4.
- These sections allow users to define alarm thresholds and settings for each channel to monitor critical conditions.

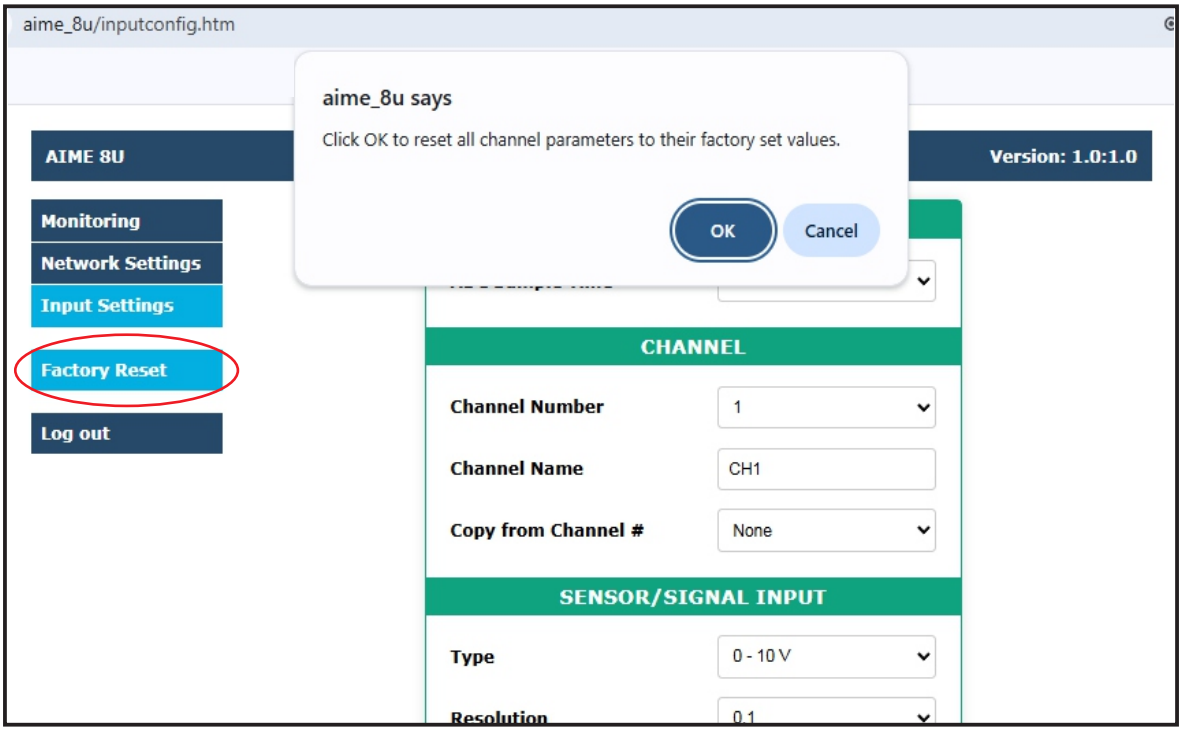
Action Buttons

- Located at the bottom of the page:
  - **Save**
    Saves the current configuration of all 4 / 8 channels to a file for backup or transfer.
  - **Load**
    Restores settings for all 4 / 8 channels from a previously saved configuration file.
  - **Write**
    Applies the configured settings for all 4 / 8 channels directly to the module, ensuring they take effect immediately.



Section 8

FACTORY RESET



Overview

The Factory Reset feature allows users to restore all channel parameters to their default factory settings. This function is useful for troubleshooting, starting fresh configurations, or reverting to the original setup.

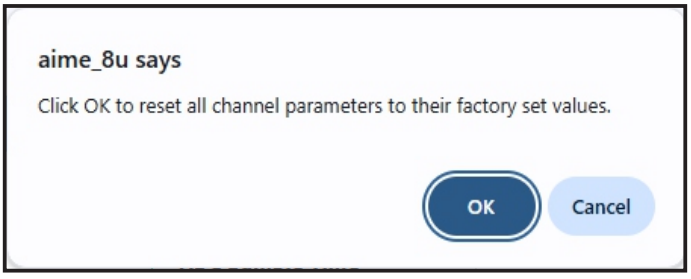
The Factory Reset button becomes active only when the Input Settings web page is selected.

Factory Reset Procedure

1. Navigate to the Input Settings web page.

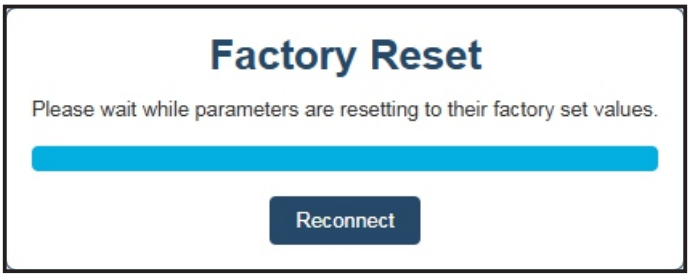
2. Click the Factory Reset button.

3. An alert window will appear asking for confirmation.



- Click OK to proceed with the reset.
- Click Cancel to return to the Input Settings page without making changes.

4. If OK is selected, a new page will appear showing a progress bar indicating that the module is resetting all parameters.



5. Wait until the progress bar completes.

6. Once the reset process finishes, click Reconnect to reopen the Input Settings page with all parameters restored to their factory defaults.

Reference

For the list of default parameter values, refer to the MODBUS Mapping section of the manual.

Section 9

DEFAULT NET ACCESS

Overview

The module is equipped with a 2-way DIP switch to enable Default Network Access (DNA Mode). This mode allows users to access the web interface using factory default network settings, which is especially useful if the previously configured network settings are lost or unknown.

Table 9.1

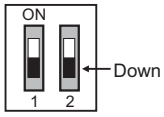
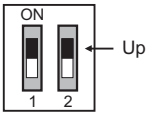
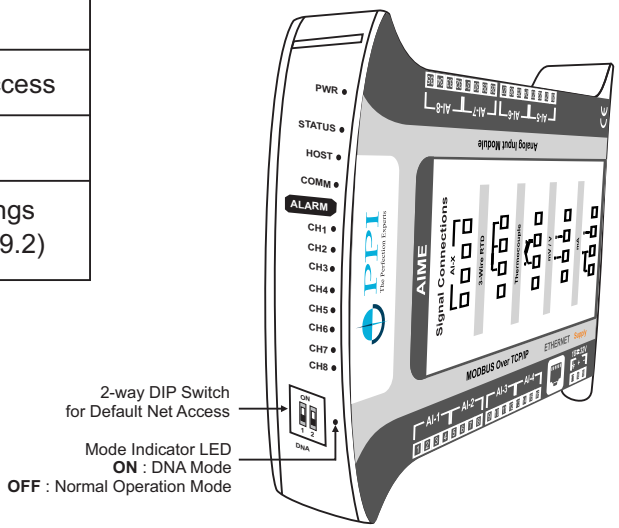
Switch Position		
Operation Mode	Normal	Default Net Access
Mode Indicator	OFF	ON
Network Access Settings	User-Configured Settings	Default Settings (Refer Table 9.2)

Table 9.2

Parameter	Default Value
Static IP Address	192.168.1.2
Gateway	192.168.1.1
Subnet Mask	255.255.255.0

Figure 9.1



How to Access Web Pages in DNA Mode

Follow the steps below to place the module in DNA Mode and access the web interface:

1. Ensure the module is powered off.

2. Set both DIP switches to the ON position.

3. Connect the module's Ethernet port to a PC using a standard Ethernet cable, or through a hub, switch, or router.

4. Power on the module. The module will boot using the default network settings. The Mode Indicator LED turns ON.

5. Modify the PC's network settings to match the module's default network parameters. Open a web browser and enter the default IP address: 192.168.1.2.

6. Log in using the default credentials. Username: admin, Password: admin.

7. The Network Settings page will display the current stored network and TCP/IP settings. Edit the settings as desired and save by clicking the Reboot button. The username and password can also be updated from this page.

8. Navigate to the Input Settings page to view and modify channel parameters as required.

Exiting DNA Mode

To return to normal operation with user-configured network parameters:

1. Log out from the web application.

2. Power off the module.

3. Move both DIP switches to the OFF position.

4. Power on the module. The module will now operate with the user-configured network settings.

Section 10

MODBUS MAPPING

Overview

This section provides a comprehensive description of the MODBUS register mappings & parameter descriptions for the analog input channels. It explains data types, address allocations, and parameter handling for seamless integration into SCADA or PLC systems.

1. MODBUS DATA TYPES

Type	Description	Range	Remark
INT16	16-bit signed integer (1 word)	-32768 to 32767	MSB first
UINT16	16-bit unsigned integer (1 word)	0 to 65535	MSB first
FLOAT32	32-bit value (2 words)	-3.4028E+38 to 3.4028E+38	FLOAT32 is a 32-bit data type that represents a single-precision floating-point number. It is a binary representation of a decimal number, consisting of: • 1 sign bit (indicating positive or negative) • 8 exponent bits (representing the power of 2) • 23 fraction bits (representing the fractional part) FLOAT32 is commonly used to represent real numbers. It is compliant with the IEEE 754 floating-point standard.
BIT	Boolean value	0 or 1	Used for coil or discrete input status monitoring
BITMAP16	16-bit field (1 word)	Each bit value : 0 or 1	Represents a collection of 16 individual bits, with bit positions ranging from 0 (LSB) to 15 (MSB). Each bit can have a value of 0 or 1, allowing for a compact representation of binary data.
ENUM16	16-bit field (1 word)	0 to predefined numeric integer	ENUM (Enumeration) represents a predefined set of named values, typically stored in a 16-bit unsigned Modbus register. This register can hold a value between 0 and 65535, but in the context of ENUM, it is restricted to a specific set of discrete values. **For example**: ENUM (None = 0, Process Low Alarm = 1, Process High Alarm = 2) In this example, the ENUM data type is represented as an unsigned 16-bit integer (UINT16), with a predefined set of named values: None, Process Low Alarm, Process High Alarm.

2. RESOLUTION BASED PARAMETERS

MODBUS protocol utilizes 16-bit signed integer registers (Input and Holding Registers) to store data. These registers accommodate values within the range -32,767 to 32,768. However, many process parameters require values with decimal precision. Since MODBUS registers inherently do not support floating-point values, decimal handling is achieved through scaling techniques.

This section describes how **Fixed** and **Programmable** decimal point parameters are stored and retrieved using MODBUS registers.

Handling Fixed Decimal Point Values

For parameters with a fixed decimal resolution, the integer values written to the MODBUS register are automatically converted by the device. However, when reading values, users must convert the retrieved integer values back to their corresponding decimal representations by dividing them by the appropriate power of 10.

Example: Fixed Decimal Resolution of 0.01

- Parameter Range: -12.34 to 20.00
- Scaling Factor: 100 (since 0.01 = 10^(-2))
- Writing a Value: To set a parameter to 34.82, write 34.82 × 100 = 3482 into the register.
- Reading a Value: If the register contains 3482, the actual value is 3482 ÷ 100 = 34.82.

This method ensures consistency in handling values with fixed decimal precision across MODBUS communication.

Handling Programmable Decimal Point Values

For parameters with a programmable decimal resolution, the number of decimal places is stored in a separate parameter named Resolution (or PV Resolution). The resolution value determines the scaling factor applied when storing and retrieving values in MODBUS registers.

Resolution Parameter Definition

The resolution parameter is stored as an integer value corresponding to the decimal precision:

Resolution Value	Decimal Precision	Scaling Factor
0	1 (No Decimals)	10^0=1
1	0.1	10^1=10
2	0.01	10^2=100
3	0.001	10^3=1000
4	0.0001	10^4=10000

Example: Programmable Decimal Resolution

- Resolution Parameter Value: 3 (corresponding to 0.001 resolution)
- Writing a Value: To set the parameter to 27.651, use Scaling Factor 1000 (corresponding to Resolution value 3) to convert the decimal value to integer value : 27.651 × 1000 = 27651 and write to the MODBUS register.
- Reading a Value: If the register contains 27651, divide by 1000 (10^3) to get 27.651.

Using this method, MODBUS allows flexible handling of parameters where decimal precision may need to be adjusted dynamically.

3. PROCESS VALUE (PV) AS FLOAT32 DATA TYPE

The module supports reading process values for all channels in 32-bit Single Precision Floating-Point (FLOAT32) format via MODBUS communication. This allows direct access to real-time measured values with decimal precision for easy integration into SCADA, PLC, and monitoring systems.

Data Representation

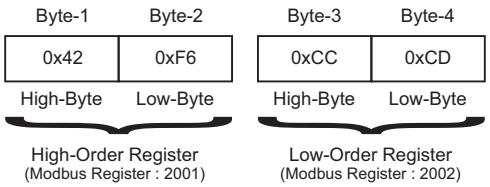
- The process values are represented in IEEE 754 single precision floating-point format.
- The FLOAT32 data occupies two consecutive 16-bit MODBUS registers, with the high-order register at an odd address.
  Example :
  The MODBUS address for Channel-1 float value is 2001and it occupies two registers; 2001(high register) & 2002 (low register).
- The byte order follows standard MODBUS RTU convention:
  - High-order byte first, followed by low-order byte within each 16-bit register.

Byte and Register Sequence Example

Let's consider an example of a process value reading for Channel 1:

- Process Value: 123.4
- Hexadecimal FLOAT32 Representation: 0x42F6CCCD

Register allocation and byte order:



The MODBUS frame will transmit these bytes in sequence:

Byte-1 → Byte-2 → Byte-3 → Byte-4 (0x42, 0xF6, 0xCC, 0xCD)

Resolution Details

- For Thermocouple and RTD Pt100 inputs, the FLOAT32 process values are communicated with a fixed 0.1 resolution.
- For DC Linear inputs (mV / V / mA), the resolution depends on the DC Resolution parameter, which can be set from 0 to 4.
  Example : If DC Resolution = 2 (0.01 resolution) and the measured integer count is 12345, the FLOAT32 value will be transmitted as 123.45 (i.e., 12345 ÷ 100).

PV Errors

The following constant counts indicate PV Errors.

Value	PV Error Type
-32768	Under Range
+32752	Over Range
+32767	Sensor Open

4. MODBUS FUNCTIONS SUPPORTED

Description	Function Code
Read Input Registers	04
Read Holding Registers	03
Write Single Holding Register	06
Write Multiple Holding Registers	16

Description	Function Code
Read Discrete Inputs	02
Read Coils	01
Write Single Coil	05
Write Multiple Coils	15

5. PARAMETER DESCRIPTIONS

Note :
In the following parameter descriptions, the MODBUS addresses are mentioned for 8 channels. For 4 channel module, only the first four addresses are valid. Similarly for BITMAP16 data type, ignore bit positions 4 to 7 for 4 channel module.

Process Value (PV)

MODBUS
The process values for all channels can be monitored as both INT16 and FLOAT32 data types.

- Data Type : Input Register, Read-only, INT16
  Address : 1561 (CH1) to 1568 (CH8)
  Remark : Values require scaling as per resolution settings.
  PV errors are indicated as the following constant integer values.

Value	PV Error Type
-32768	Under Range
+32752	Over Range
+32767	Sensor Open

- Data Type : 2x Input Register, Read-only, FLOAT32
  Address : 2001 (CH1) to 2015 (CH8)
  Remark : Direct representation of measured PV (°C / °F for TC/RTD or scaled counts for mV/mA inputs).

Description
The PV represents the measured temperature or scaled counts for each channel based on the input type. Refer below tables.

Thermocouples & RTDs	
Input Type	**Range (Min. to Max.)**
Type J	0 to +960.0°C / +32.0 to +1760.0°F
Type K	-200.0 to +1376.0°C / -328.0 to +2508.0°F
Type T	-200.0 to +387.0°C / -328.0 to +728.0°F
Type R	0 to +1771.0°C / +32.0 to +3219.0°F
Type S	0 to +1768.0°C / +32.0 to +3214.0°F
Type B	0 to +1826.0°C / +32.0 to +3318.0°F
Type N	0 to +1314.0°C / +32.0 to +2397.0°F
Type E	-200 to +1000.0°C / -328.0 to +1832.0°F
RTD Pt100	-199.0 to +850.0°C / -328.0 to +1562.0°F
RTD Pt1000	

DC Signals	
Input Type	**Range (Min. to Max.)**
0 to 20 mA	-30000 to 30000 units Settable Resolution: 1 0.1 0.01 0.001 0.0001 Units
4 to 20 mA	
0 to 80 mV	
0 to 160 mV	
0 to 1.25 V	
0 to 5.0 V	
0 to 10.0 V	
1 to 5.0 V	

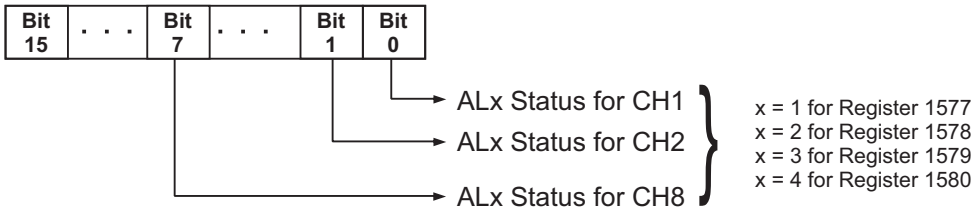
Alarm Status

MODBUS

The status for each of the 4 alarms (AL1 to AL4) across 8 channels (CH1 to CH8) can be monitored as both BIT and BITMAP16 data types.

- Data Type : Discrete Input, Read-only, BIT
  Address : 1 to 8 (AL1 Status for CH1 to CH8)
  17 to 24 (AL2 Status for CH1 to CH8)
  33 to 40 (AL3 Status for CH1 to CH8)
  49 to 56 (AL4 Status for CH1 to CH8)
  Remark : 0 = Alarm Off, 1 = Alarm On

- Data Type : Input Register, Read-only, BITMAP16
  Address : 1577 (AL1 Status for CH1 to CH8), 1578 (AL2 Status for CH1 to CH8)
  1579 (AL3 Status for CH1 to CH8),1580 (AL4 Status for CH1 to CH8)
  Remark : Each bit : 0 = Alarm Off, 1 = Alarm On



- **Description**

Alarm status for each of the 4 alarms (AL1 to AL4) across 8 channels (CH1 to CH8).

Ambient Temperature

MODBUS

- Data Type : Input Register, Read-only, INT16
  Address : 82
  Remark : Resolution based parameter

Description

- Represents the ambience temperature surrounding the module.
- Measured in °C with 0.1°C resolution.
- Used for cold junction compensation for thermocouple inputs.

ADC Sample Time

MODBUS

- Data Type : Holding Register, Read / Write, ENUM16
  Address : 1557
  Remark : 146 mS = 0, 79 mS = 1, 45 mS = 2 (Default : 146 mS)

Description

- Sets the interval between consecutive channel conversions.
- Can be used to optimize the performance of the system and achieve the desired balance between conversion speed and accuracy.
- The slower the speed, the higher the accuracy and vice-a-versa.

Digital Filter

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 1612 (CH1) to 1619 (CH8)
  Remark : —

Description

- Applies an IIR (Infinite Impulse Response) filter to the measured Process Value (PV) to minimize signal noise and fluctuations.
- Adjustable filter strength from 0% to 90%.
- Setting 0% disables the filter.
- Higher values provide greater noise reduction but result in a slower response time.
- Lower values allow faster response but with less noise suppression.

Input Type

MODBUS

- Data Type : Holding Register, Read / Write, ENUM16
  Address : 83 (CH1) to 90 (CH8)
  Remark : Type J = 0, Type K = 1, Type T = 2, Type R = 3, Type S = 4, Type B = 5, Type N = 6, Type E = 7
  RTD Pt100 = 8, RTD Pt1000 = 21
  0 to 20 mA = 9, 4 to 20 mA = 10
  0 to 80 mV = 11, 0 to 160 mV = 17
  0 to 1.25 V = 13, 0 to 5 V = 14, 0 to 10 V = 15, 1 to 5 V = 16 (Default : 0 to 10 V)

Description

- Defines the type of input signal the addressed channel will process.
- Sensor Inputs : Thermocouples & RTDs.
- Transmitter Signal : mV / V / mA.

Temperature Units

MODBUS

- Data Type : Holding Register, Read / Write, ENUM16
  Address : 99 (CH1) to 106 (CH8)
  Remark : °C = 0, °F = 1 (Default : °C)

Description

- Defines the units for converting the measured temperature.
- Applicable for Thermocouples & RTDs only.

PV Resolution

MODBUS

- Data Type : Holding Register, Read / Write, ENUM16
  Address : 115 (CH1) to 122 (CH8)
  Remark : 1 count = 0, 0.1 count = 1, 0.01 count = 2, 0.001 count = 3, 0.0001 count = 4
  (Default : 1 Unit for DC Linear input & 0.1 for Thermocouple & RTD)

Description

- Determines the decimal point position for the measured PV.
- Thermocouples & RTDs always follow fixed 0.1 °C / °F resolution. This parameter value is ignored.
- Parameters such as alarm limits, hysteresis, etc. follow the set resolution setting.

Signal Low

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 501 (CH1) to 508 (CH8)
  Remark : Resolution based parameter. Refer table below for input type v/s settable range.

Input Type	Settings	Default
0 to 20 mA	0.00 to Signal High	0.00
4 to 20 mA	4.00 to Signal High	4.00
0 to 80 mV	0.00 to Signal High	0.00
0 to 160 mV	0.0 to Signal High	0.0
0 to 1.25 V	0.000 to Signal High	0.000
0 to 5 V	0.000 to Signal High	0.000
0 to 10 V	0.00 to Signal High	0.00
1 to 5 V	1.000 to Signal High	1.000

Description

- Applicable to mV / V / mA input signals.
- Helps in scaling transmitter signals to match the desired measured PV range.
- Defines the input signal value corresponding to the **low end** of the PV range.
- Refer *Appendix-A : DC Linear Signal Interface* for details.

Signal High

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 517 (CH1) to 524 (CH8)
  Remark : Resolution based parameter. Refer table below for input type v/s settable range.

Input Type	Settings	Default
0 to 20 mA	Signal Low to 20.00	20.00
4 to 20 mA	Signal Low to 20.00	20.00
0 to 80 mV	Signal Low to 80.00	80.00
0 to 160 mV	Signal Low to 160.0	160.0
0 to 1.25 V	Signal Low to 1.250	1.250
0 to 5 V	Signal Low to 5.000	5.000
0 to 10 V	Signal Low to 10.00	10.00
1 to 5 V	Signal Low to 5.000	5.000

Description
- Applicable to mV / V / mA input signals.
- Helps in scaling transmitter signals to match the desired measured PV range.
- Defines the input signal value corresponding to the **high end** of the PV range.
- Refer *Appendix-A : DC Linear Signal Interface* for details.

PV Range Low

MODBUS
- Data Type : Holding Register, Read / Write, INT16
  Address : 131 (CH1) to 138 (CH8)
  Remark : Resolution based parameter.
  Settable Range : -30000 to 30000 (Default : 0)

Description
- Applicable to mV / V / mA input signals.
- Helps in signal-to-value mapping for transmitter signal inputs.
- Defines the process value that corresponds to the **Signal Low** input.
- Refer *Appendix-A : DC Linear Signal Interface* for details.

PV Range High

MODBUS
- Data Type : Holding Register, Read / Write, INT16
  Address : 147 (CH1) to 154 (CH8)
  Remark : Resolution based parameter.
  Settable Range : -30000 to 30000 (Default : 1000)

Description
- Applicable to mV / V / mA input signals.
- Helps in signal-to-value mapping for transmitter signal inputs.
- Defines the process value that corresponds to the **Signal High** input.
- Refer *Appendix-A : DC Linear Signal Interface* for details.

PV Zero-offset

MODBUS
- Data Type : Holding Register, Read / Write, INT16
  Address : 163 (CH1) to 170 (CH8)
  Remark : Resolution based parameter.
  Settable Range : -30000 to 30000 (Default : 0)

Description
- Compensates for sensor zero-offset or thermal gradient errors.
- The set value is algebraically added to the measured Process Value (PV) to correct deviations.
- Final PV = Measured PV + Zero-offset.

Alarm Type

MODBUS

- Data Type : Holding Register, Read / Write, ENUM16
  Address : 179 to 186 (AL1 Type for CH1 to CH8), 243 to 250 (AL2 Type for CH1 to CH8)
  307 to 314 (AL3 Type for CH1 to CH8), 371 to 378 (AL4 Type for CH1 to CH8)
  Remark : None = 0, Process Low = 1, Process High = 2 (Default : None).

Description

Defines the alarm condition for the addressed alarm number.

- *None* : Disables the alarm.
- *Process Low* : Triggers an alarm when PV drops below the set low limit.
- *Process High* : Triggers an alarm when PV exceeds the set high limit.

Alarm Setpoint

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 195 to 202 (AL1 SP for CH1 to CH8), 259 to 266 (AL2 SP for CH1 to CH8)
  323 to 330 (AL3 SP for CH1 to CH8), 387 to 394 (AL4 SP for CH1 to CH8)
  Remark : Resolution based parameter.
  Min. to Max. Range specified for the selected Input Type.
  Default : Min Range for Alarm Low type & Max Range for Alarm High type.

Description

- Defines the alarm limit for the addressed alarm number and channel number.
- Sets the low limit if the alarm type is Process Low.
- Sets the high limit if the alarm type is Process High.

Alarm Hysteresis

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 211 to 218 (AL1 Hyst for CH1 to CH8), 275 to 282 (AL2 Hyst for CH1 to CH8)
  339 to 346 (AL3 Hyst for CH1 to CH8), 403 to 410 (AL4 Hyst for CH1 to CH8)
  Remark : Resolution based parameter. 1 to 30000 (Default : 20)

Description

- Specifies the hysteresis value for the addressed alarm number and channel number.
- Introduces a dead band between the ON and OFF states to prevent rapid switching.

Alarm Inhibit

MODBUS

The alarm inhibit for each of the 4 alarms (AL1 to AL4) across 8 channels (CH1 to CH8) can be accessed as both BIT and UINT16 data types.

- Data Type : Coil, Read / Write, BIT
  Address : 65 to 72 (AL1 Inhibit for CH1 to CH8), 81 to 88 (AL2 Inhibit for CH1 to CH8)
  97 to 104 (AL3 Inhibit for CH1 to CH8), 113 to 120 (AL4 Inhibit for CH1 to CH8)
  Remark : 0 = Disable, 1 = Enable (Default : Disable)

- Data Type : Holding Register, Read / Write, UINT16
  Address : 227 to 234 (AL1 Inhibit for CH1 to CH8), 291 to 298 (AL2 Inhibit for CH1 to CH8)
  355 to 362 (AL3 Inhibit for CH1 to CH8), 419 to 426 (AL4 Inhibit for CH1 to CH8)
  Remark : 0 = Disable, 1 = Enable (Default : Disable)

Description

Decides whether alarm monitoring starts immediately after power-up.

Yes

Alarm monitoring begins only after the PV crosses the limit once:

- Above the low limit for Process Low alarms.
- Below the high limit for Process High alarms.

No

The alarm monitors PV immediately after power-up.

Enable Bottom Clipping

MODBUS

- Data Type : Holding Register, Read / Write, UINT16
  Address : 435 (CH1) to 442 (CH8)
  Remark : 0 = Disable, 1 = Enable (Default : Disable)

Description

- Applicable for mV / V / mA inputs.
- Refer Appendix-B.

Bottom Clip Value

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 451 (CH1) to 458 (CH8)
  Remark : Resolution based parameter. Settable Range : -30000 to 30000 (Default : 0)

Description

- Applicable for mV / V / mA inputs.
- Refer Appendix-B.

Enable Top Clipping

MODBUS

- Data Type : Holding Register, Read / Write, UINT16
  Address : 467 (CH1) to 474 (CH8)
  Remark : 0 = Disable, 1 = Enable (Default : Disable)

Description

- Applicable for mV / V / mA inputs.
- Refer Appendix-B.

Top Clip Value

MODBUS

- Data Type : Holding Register, Read / Write, INT16
  Address : 483 (CH1) to 490 (CH8)
  Remark : Resolution based parameter. Settable Range : -30000 to 30000 (Default : 1000)

Description

- Applicable for mV / V / mA inputs.
- Refer Appendix-B.

APPENDIX A

DC LINEAR SIGNAL INTERFACE

Overview

Various transmitters generate different signal types, such as mV, V, or mA, with distinct signal ranges. To ensure compatibility with a wide range of transmitters, PPI products offer configurable Signal Type and Range settings.

Common industry-standard signal ranges include:

- 0 to 80 mV, 0 to 160 mV
- 0 to 5 V, 1 to 5 V, 0 to 10 V
- 0 to 20 mA, 4 to 20 mA

Additionally, since transmitters output different signal ranges corresponding to specific process values (e.g., a 1 to 4.5 V signal may represent 5% to 95% RH), PPI products allow users to configure the process value range and resolution.

Required Parameters for Linear Transmitter Interface

For interfacing linear transmitters, the following six parameters must be configured:

Parameter	Definition	Example
Input Type	Defines the standard DC signal type in which the transmitter signal range falls.	4 to 20 mA
Signal Low	The minimum signal value corresponding to the lowest process value.	4.00 mA
Signal High	The maximum signal value corresponding to the highest process value.	20.00 mA
PV Resolution	Defines the smallest measurable unit for the process value.	0.01 psi
Range Low	The process value corresponding to Signal Low.	0.00 psi
Range High	The process value corresponding to Signal High.	5.00 psi

Mathematical Representation

The relationship between transmitter signal values and the corresponding process values follows a straight-line equation:

$$Y = mX + C$$

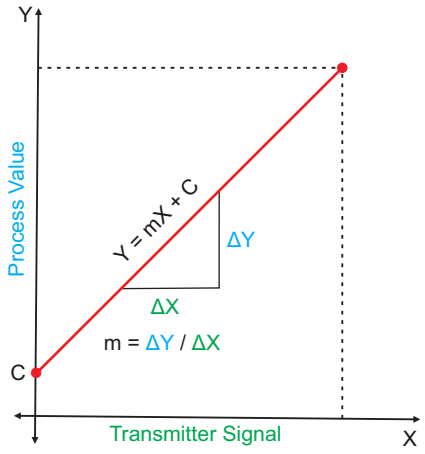
Where;

X : Signal Value from Transmitter

Y : Process Value Corresponding to X

C : Process Value Corresponding to X = 0 (Y-intercept)

m : Slope (Change in Process Value per unit Change in Signal Value)

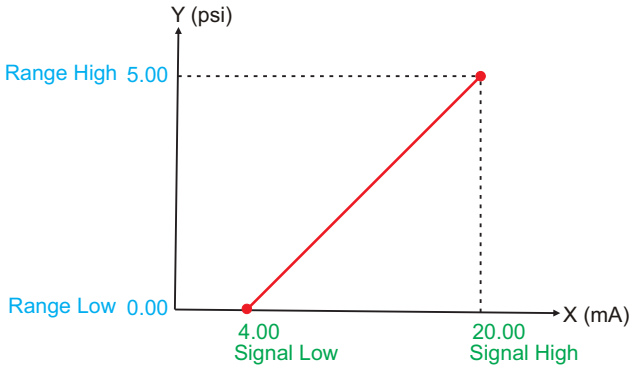


Examples of Transmitter Configurations

Example 1:

Pressure Transmitter (**4 to 20 mA** corresponding to **0 to 5 psi**)

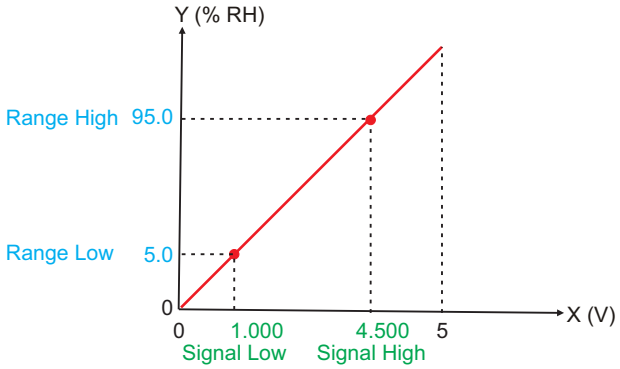
Input Type	:	4-20 mA
Signal Low	:	4.00 mA
Signal High	:	20.00 mA
PV Resolution	:	0.01
Range Low	:	0.00
Range High	:	5.00



Example 2

Humidity Transmitter (**1 to 4.5 V** corresponding to **5 to 95 %RH**)

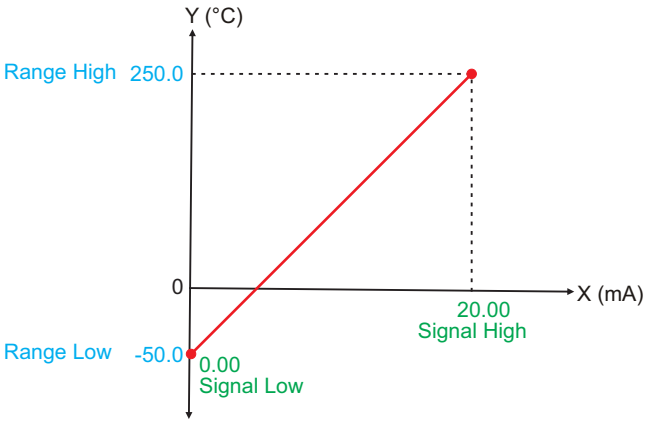
Input Type	:	0-5 V
Signal Low	:	1.000 V
Signal High	:	4.500 V
PV Resolution	:	0.1
Range Low	:	5.0
Range High	:	95.0



Example 3

Temperature Transmitter (**0 to 20 mA** corresponding to **-50 to 250 °C**)

Input Type	:	0-20 mA
Signal Low	:	0.00 mA
Signal High	:	20.00 mA
PV Resolution	:	0.1
Range Low	:	-50.0
Range High	:	250.0



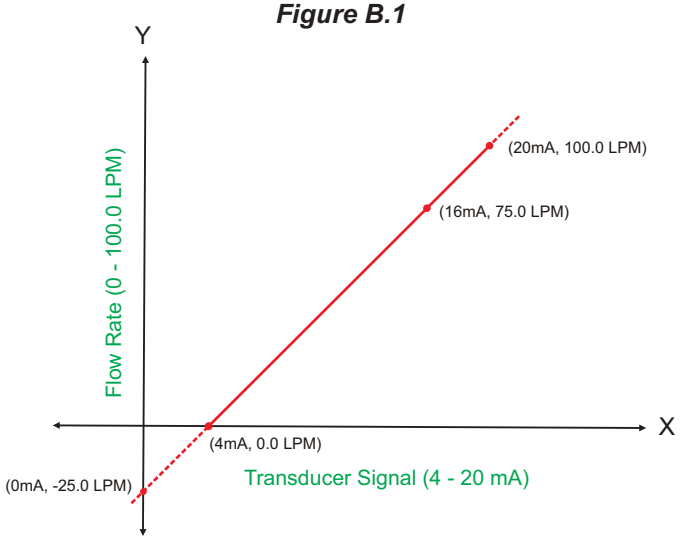
APPENDIX B

LOW / HIGH CLIPPINGS

Overview

For mA, mV, or V inputs, the measured process value (PV) is calculated based on the configured Signal Low and Signal High values, which correspond to the PV Range Low and PV Range High settings. Low and High Clipping allows users to restrict PV values within a specific operational range to suppress unwanted out-of-range values.

Figure B.1



Example: Flow Rate Measurement

A flow transmitter outputs a signal between 4 to 20 mA, corresponding to a flow rate of 0.0 to 100.0 LPM (Liters per Minute). However, if the system is designed for a maximum flow rate of 75.0 LPM, then only the signal range 4 to 16 mA is relevant. Without clipping, any signal value outside this range would result in incorrect process values.

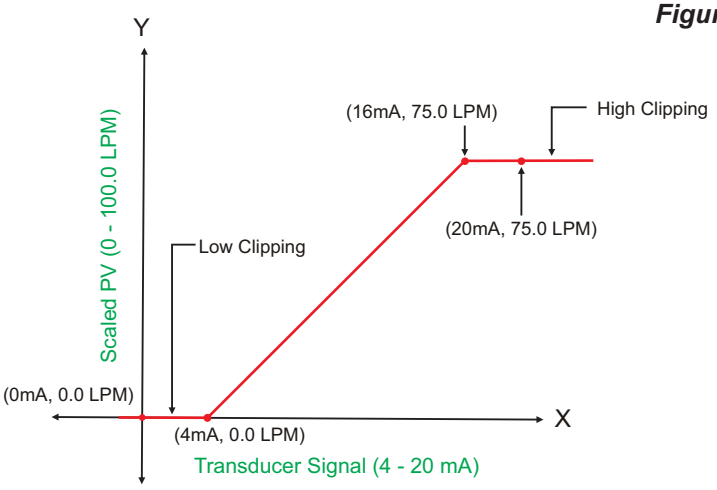
Low & High Clipping Implementation

To prevent out-of-range readings:

- Enable Low Clipping: Suppresses PV values below the Signal Low threshold.
- Enable High Clipping: Restricts PV values exceeding the Signal High threshold.

Example Parameter Configuration for Clipping

Figure B.2



PV Range Low	: 0.0
PV Range High	: 100.0
Enable Low Clipping	: Yes
Low Clip Value	: 0.0
Enable High Clipping	: Yes
High Clip Value	: 75.0

Summary

- Low Clipping ensures that the PV does not drop below the defined minimum.
- High Clipping ensures that the PV does not exceed the defined maximum.
- This feature is useful for applications where operating limits are predefined and must be strictly followed.

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