I-7000/M-7000 Comprehensive Manual

Convering Setup, Wiring, and various SDK

V1.0, Mar. 2025

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Warranty

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Revision History

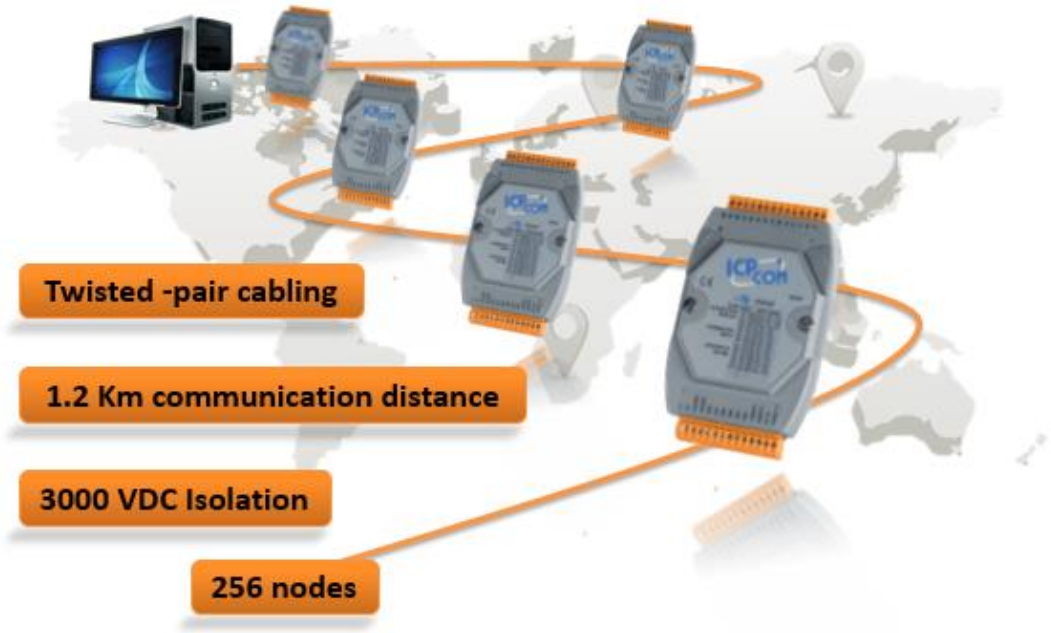
This chapter provides revision history information to this document.

The table below shows the revision history.

Revision	Date	Description
V1.0	2025, 02	Initial issue

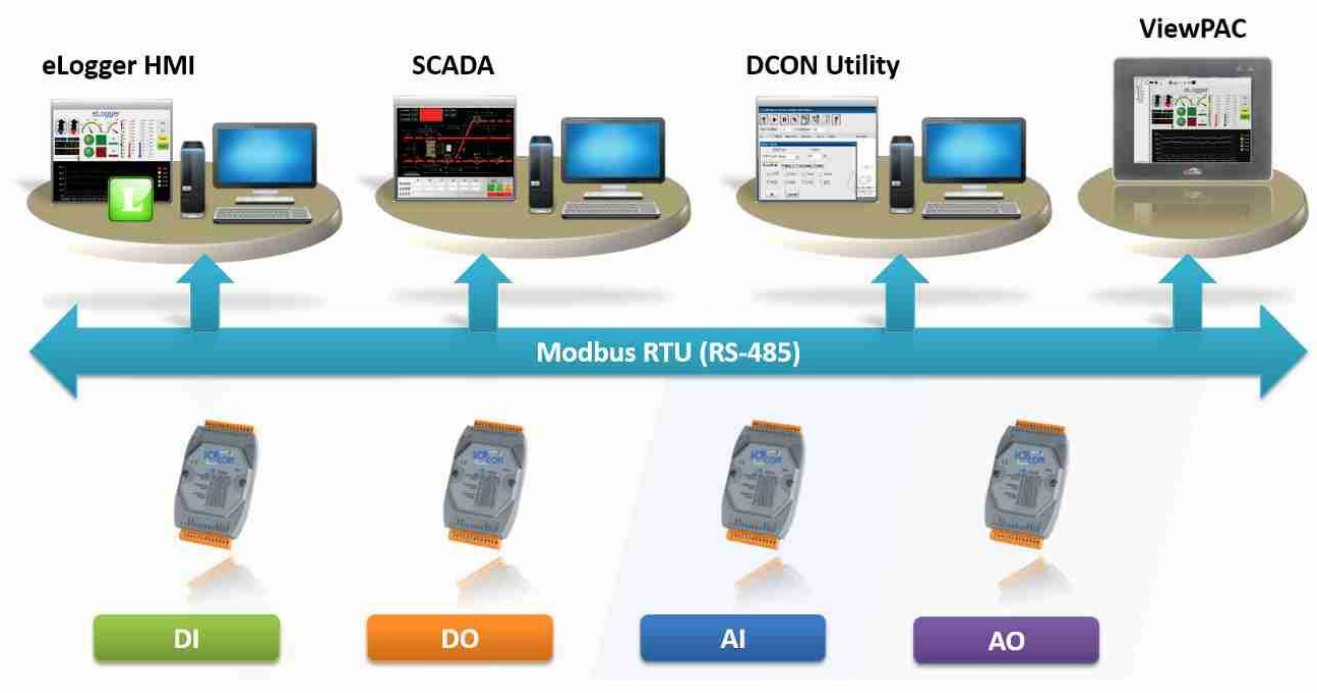
Content of Table

Chapter 1 Introduction



The I-7000 and M-7000 series remote I/O module provide cost-effective protection and conditioning for a wide range of valuable industrial control system. The product line includes sensor-to-computer, computer-to-sensor, digital I/O, timer/counter, RS-232 to RS-485 converter, USB to RS-485 converter, RS-485 repeater, RS-485 hub and RS-232/422/485 to Fiber Optics.

The I-7000 supports DCON protocol, and the M-7000 supports Modbus RTU and DCON protocols. Many SCADA/HMI software and PLCs that support the Modbus RTU protocol can easily integrate with M-7000 modules.

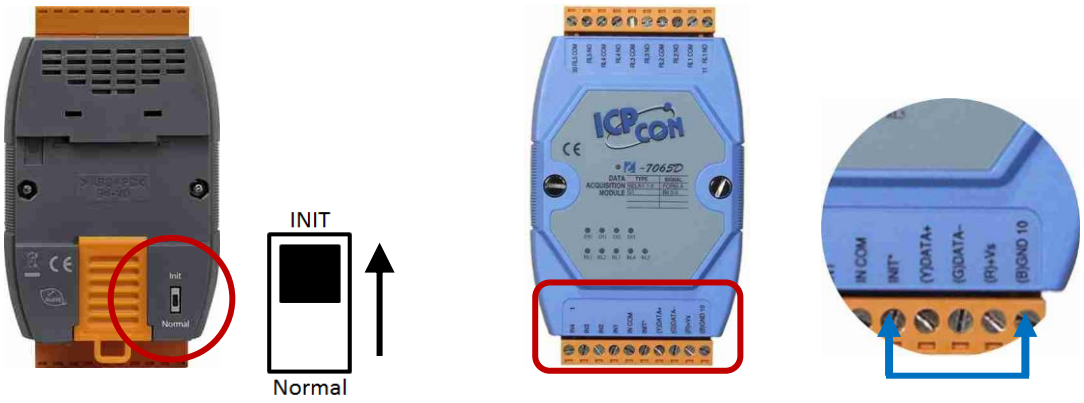


1.1 Getting Started

The I-7000 series only supports the DCON protocol, while the M-7000 series supports both DCON and Modbus protocols. When the module is set to DCON mode, communication parameters must be configured in Init mode. **Note: Only one module can be set at a time.**

Step 1: Power on in INT mode.

Set the DIP switch to "Init" (or connect the "INIT" pin to "GND") before powering up the module.

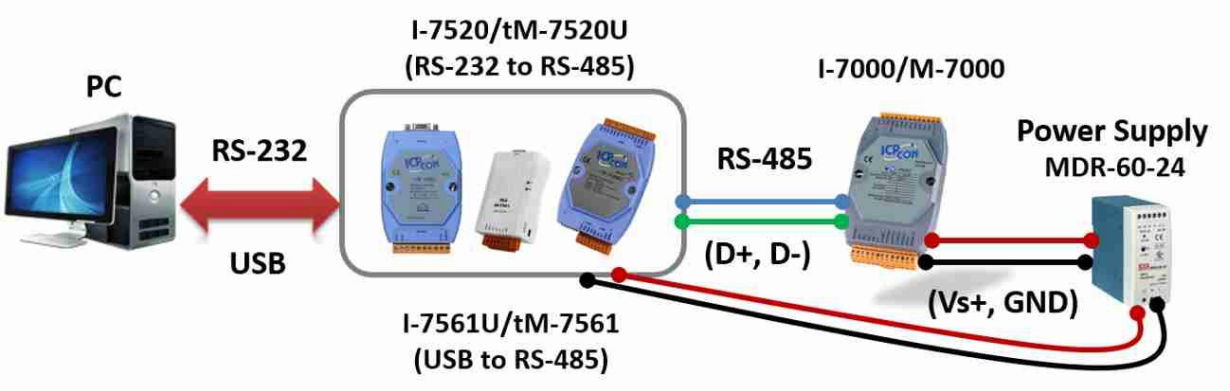


Communication Parameters:

Parameter / Model	Factory Default (Normal Mode)		In INIT mode, the initial value is fixed
	I-7000	M-7000	I-7000/M-7000
Protocol	DCON	Modbus RTU	DCON
Address	01		00
Baud Rate	9600		
Parity	N,8,1		

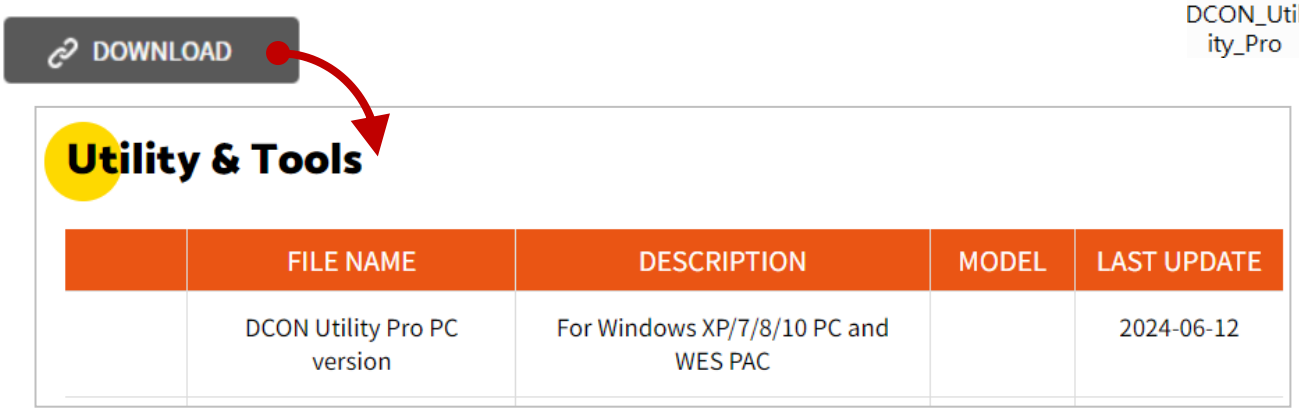
Step 2: Connect the module to a PC and power supply.

The I-7000/M-7000 series modules are equipped with an RS-485 port, which can be connected to a PC using an RS-232 (or USB) to RS-485 converter.

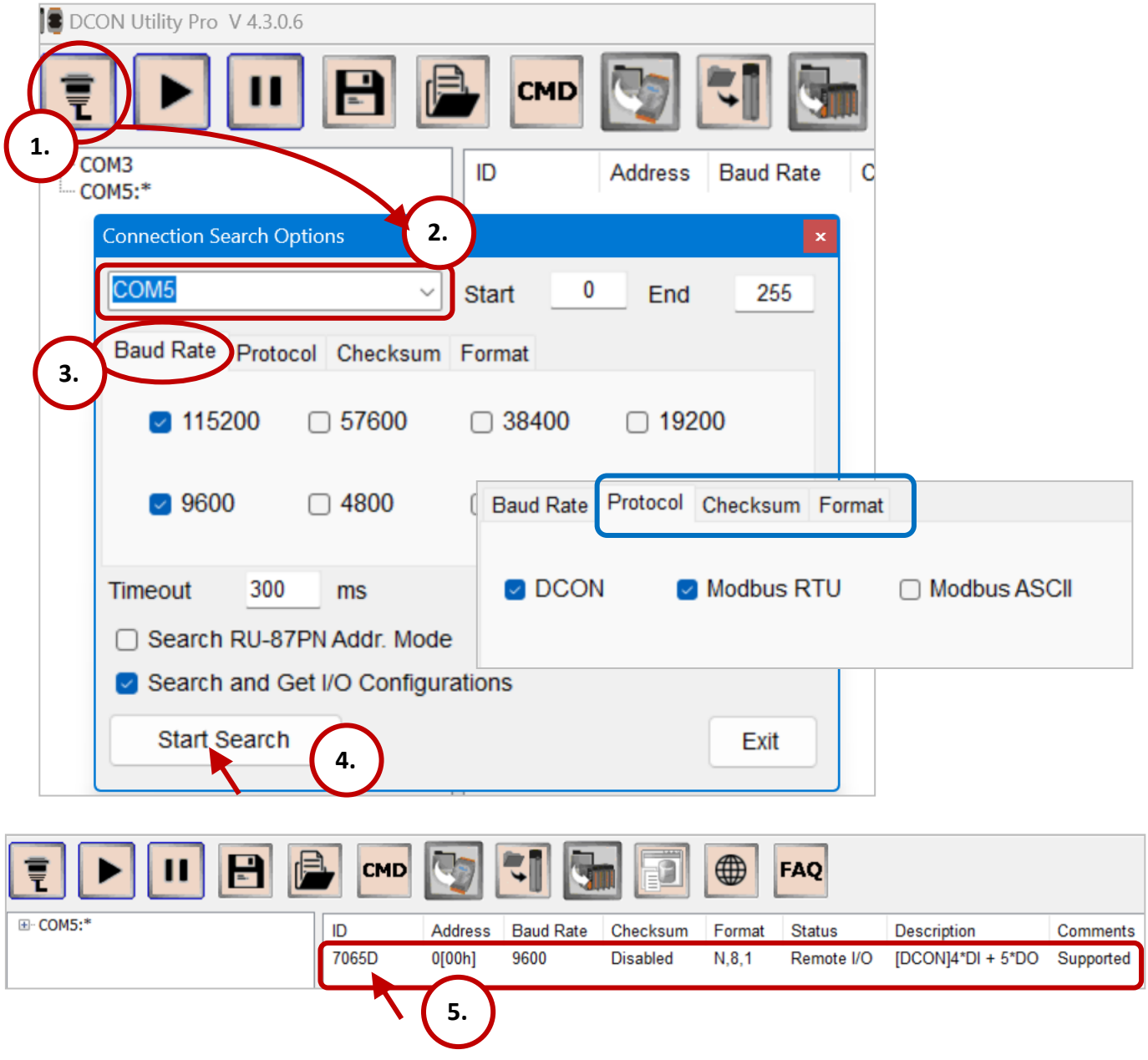


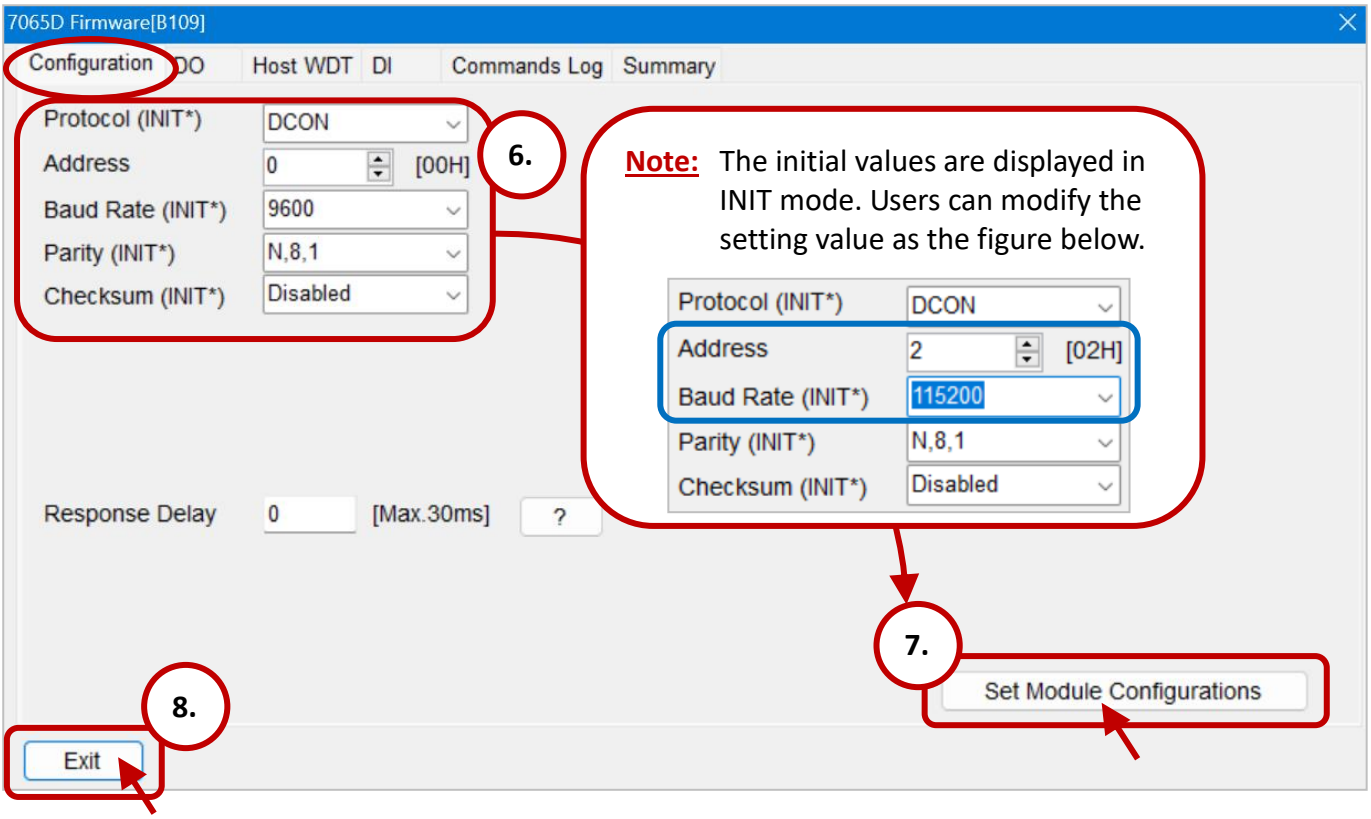
Step 3: Download and install the DCON Utility Pro.

https://www.icpdas.com/en/product/guide+Software+Utility_Driver+DCON__Utility__Pro



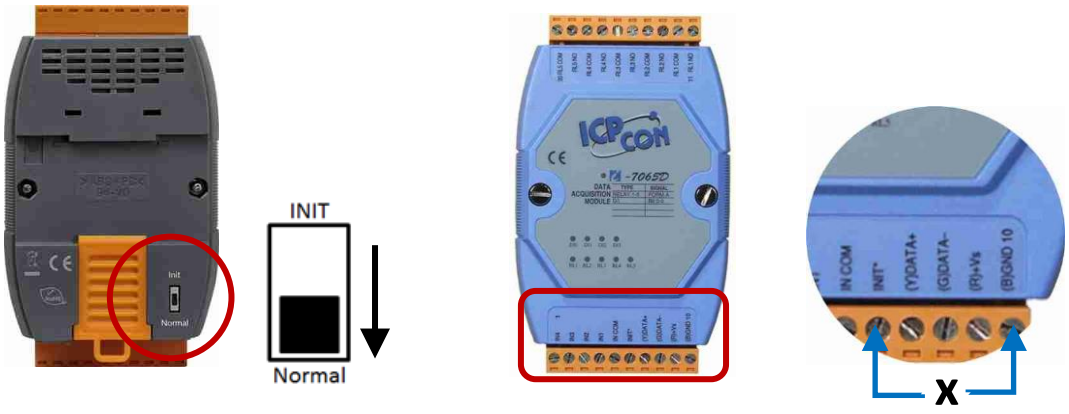
Step 4: Search for the module and configure the communication parameters.



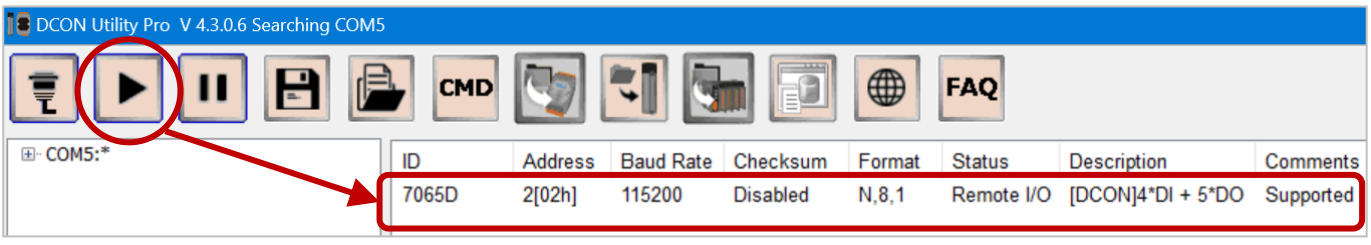


Step 5: Set the module to Normal mode and reboot.

Set the switch back to the "**Normal**" position (or disconnect the INIT and GND pins) and restart the module to apply the new settings.



Step 6: Search for the module again to ensure the new settings have taken effect.



1.2 Features

- **RS-485 Industrial Multi-Drop Network**

  The I-7000/M-7000 series modules use the industrial EIA RS-485 communication interface to transmit and receive data at high speeds over long distances. All modules are easy to integrate with standard computers and controllers. Internal surge protection circuitry is used on the data lines to protect the modules from voltage spikes.

- **I/O type and Range Programmable**

  The analog modules support various I/O types and data ranges, which can be configured remotely by issuing commands from the host.

- **Easy Mounting and Connection**

  Users can choose between DIN rail or piggyback mounting for installation of the module.

- **Dual Watchdog**

  The I-7000/M-7000 series modules feature both module and host watchdog functions to prevent errors and enhance the reliability and stability of the control system.

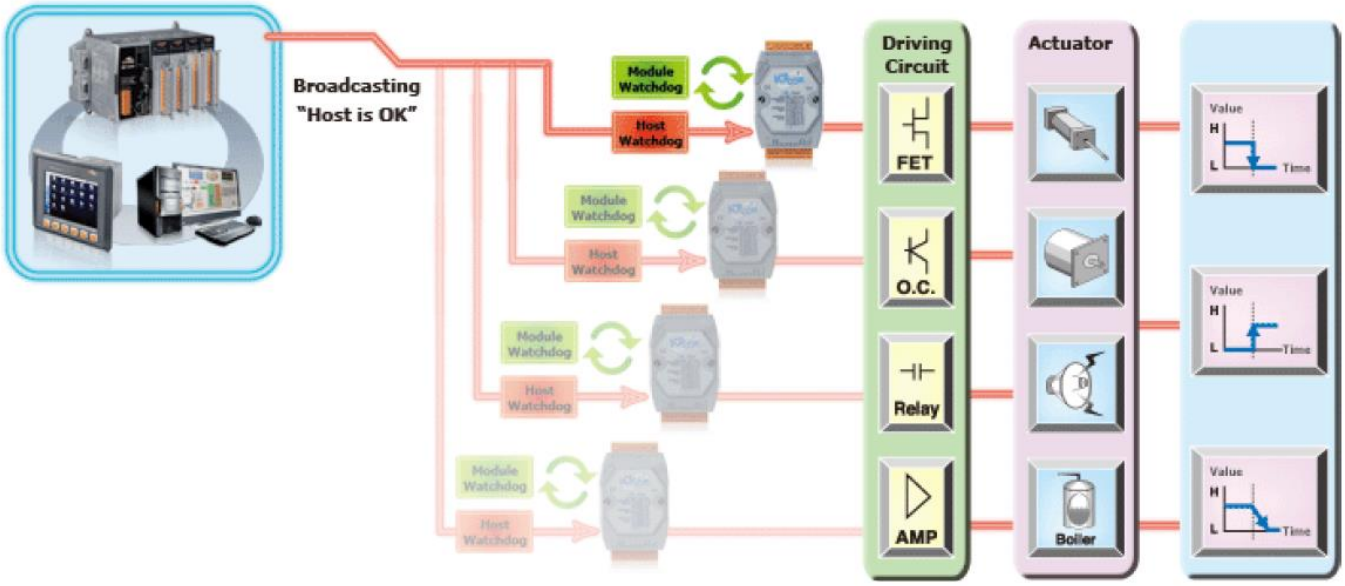
1) Module Watchdog:

The hardware watchdog is a circuit designed to monitor the operational status of the module. It uses a timer mechanism: during normal operation, the timer is periodically reset to zero and continues counting. If a timeout occurs, the module will automatically restart and load its default power-on values.

2) Host Watchdog:

The Host Watchdog is a software function designed to monitor the communication status between the host and the module. It uses the host's internal timer (e.g., PC, PLC, or PAC). Under normal operation, the host sends an "alive" signal to the module. If a timeout occurs, the module automatically loads the safe value. Once the timeout condition is cleared, the module restarts and loads the power-on value.

- **Programmable Power-on Value and Safe Value**



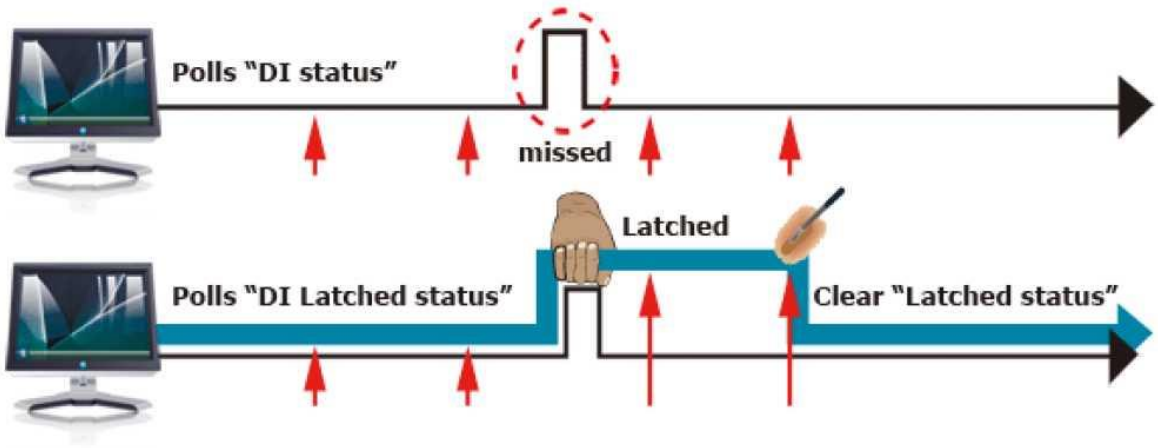
The DO and AO modules feature programmable power-on and safe values. When the host's watchdog mechanism is triggered, the DO or AO output will be set to its pre-configured safe value.

- **Advanced DI Functions**

The DI channel is not only used to read the digital input status but also provides several advanced functions.

DI Latch Function

All DI channels feature a latch function that retains high/low events in the module's internal registers. Typically, the host polls each module individually to obtain the DI status. However, there are occasional instances where a DI channel might generate a very brief pulse signal that could be missed if it occurs outside the polling period. With the latch function enabled, short-duration signals (≥5 ms) will no longer be lost.



Low Speed Counter

The DI module automatically counts the DI signal in the background and can detect and count signals up to 100Hz.

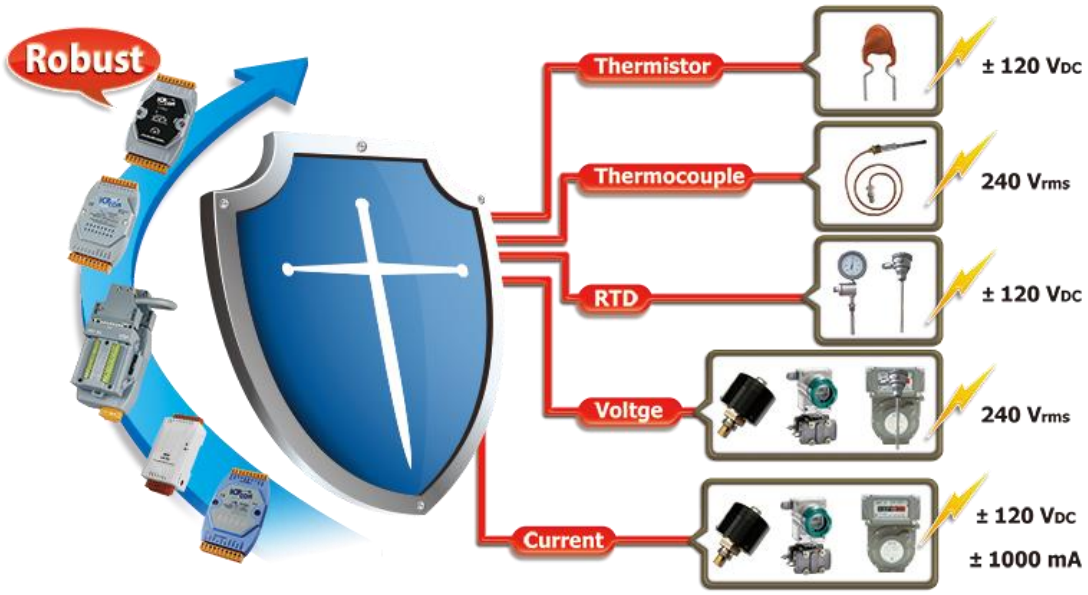
- **Overvoltage Protection**

Many of ICP DAS's analog input modules provide high overvoltage protection for the analog input channels. If the user accidentally connects the wrong line or a high voltage spike is applied to the analog input terminals, the module won't be damaged and will continue to provide accurate readings. This feature improves reliability, reduces maintenance needs, and makes the entire system more robust.

- **Over-current Protection**

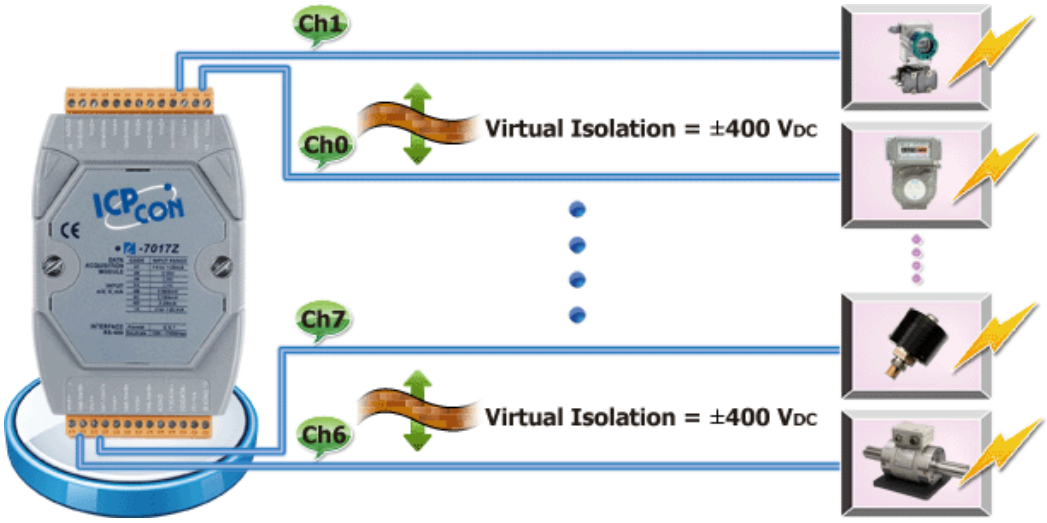
For the current measurement module, introducing high currents or voltages into the current loop could damage the module. ICP DAS has upgraded the protection to handle up to ±120 VDC and ±1000 mA. This improvement ensures that high currents or voltages in the loop won't damage the module, keeping the entire system running smoothly.

The "R" and "Z" versions of the I-7000/M-7000 provide continuous overvoltage and overcurrent protection, effectively safeguarding equipment from damage caused by pulses or surges.



- **Virtual Channel to Channel Isolation**

The “R” and “Z” versions of the analog input modules provide ±400 VDC virtual channel-to-channel isolation to prevent noise interference from adjacent channels in industrial environments. These modules include the I-7017R, I-7017Z, I-7018R, I-7018Z, I-7019R, and I-7019Z. While there is no physical channel-to-channel isolation, the leakage current between adjacent channels is only 1μA, resulting in minimal and negligible interference.



- **Physical Channel-to-Channel Isolation**

To achieve the **Channel-to-Channel Isolation** specification, **a communication module** (7000 series) must work in conjunction with **a signal conditioning module** (SG-300 series). This combination provides 3000VDC Channel-to-Channel Isolation protection.

M-2217CI X 1pcs = **M-7017** X 1pcs + **SG-3071** X 8pcs

Advantages of Channel-to-Channel Isolation Protection:

1. Saves installation space
2. Simplifies wiring
3. Reduces costs

Model	I/O	Channel-to-Channel Protection	Communication Interface
ET-2217CI ET-2217-4	8 AI 4 AI	3000VDC	2-Port Ethernet Protocol = Modbus TCP, Modbus UDP, MQTT, SNMP V2c
ET-2228CI ET-2224CI	8 AO 4 AO	3000VDC	
ET-2218CI ET-2218CI-4	8 TC 4 TC	3000VDC	
ET-2215CI ET-2215CI-4	8 RTD 4 RTD	3000VDC	
M-2217CI M-2217CI-4	8 AI 4 AI	3000VDC	RS-485 X 1 Protocol = Modbus RTU, DCON
M-2228CI M-2224CI	8 AO 4 AO	3000VDC	
M-2218CI M-2218CI-4	8 TC 4 TC	3000VDC	
M-2215CI M-2215CI-4	8 RTD 4 RTD	3000VDC	

In industrial field applications, using a module with channel-to-channel isolation protection improves system performance, ensures equipment safety, and enhances reliability by offering the following advantages:

1. **Improve System Stability and Reliability**

   - **Prevent Signal Interference**

     In industrial control systems, multiple signal sources and paths are common. Without proper isolation, crosstalk can occur, leading to signal distortion or increased noise. Using an isolated module prevents interference between signal channels, enhancing system stability.

   - **Reduce System Failures**

     Prevent a single channel issue, such as a short circuit or overload, from impacting other channels. This improves the system's fault tolerance and reliability.

2. **Improve Measurement Accuracy**

   - In industrial measurement applications such as temperature, pressure, and flow, channel isolation is crucial for maintaining accurate and reliable data. For example, in multi-channel data acquisition systems, a shared ground can introduce signal crosstalk, leading to distorted readings and inaccurate measurements. By implementing an isolated module, these interferences are eliminated, ensuring precise and stable signal acquisition for industrial control and monitoring systems.

3. **Enhanced equipment security**

   - **Preventing the spread of electrical faults:**
     Industrial fields often encounter high-voltage or high-current environments. Channel-to-channel isolation prevents electrical faults (e.g., over-voltage, short circuits) in one channel from affecting others or the overall system, ensuring the safety of both equipment and personnel.
   - **Prevent ground loop problems:**
     Inconsistent ground potentials between devices can cause ground loops, leading to noise, signal distortion, and potential damage to sensitive equipment. An isolated module effectively eliminates this issue, enhancing the overall system's safety and stability.

4. **Reduces noise and interference**

   - **Improved Electromagnetic Compatibility (EMC):**
     Industrial environments often contain strong sources of electromagnetic interference (EMI), such as large mechanical or high-power equipment. Channel-to-channel isolation minimizes noise propagation, enhancing equipment immunity and overall electromagnetic compatibility (EMC). This is crucial for ensuring the proper operation of sensitive devices, such as measurement instruments and communication equipment.
   - **Reduces the effect of external noise:**
     The isolation module can effectively reduce the influence of external electromagnetic noise or voltage fluctuations to ensure a clear and stable signal.

5. **Flexible system scalability**

   - In many industrial control systems, scalability becomes a key concern as the number of devices increases. Channel-to-channel isolated modules enable different equipment or control channels to operate independently, allowing system expansion or upgrades without disrupting other parts of the system.

6. **Improved signal quality and data transfer speeds**

   - In some high-speed data transmission applications, such as sensor data collection or remote control systems, channel-to-channel isolation helps to ensure signal quality and minimize data loss or transmission errors due to signal degradation or interference. This is important for industrial applications that require high precision control or real-time response.

7. **Reduce maintenance costs**

   - The isolated module limits the impact of faults, ensuring that a failure in one channel does not affect others. This reduces fault diagnosis and repair time. Maintenance personnel can quickly identify issues, minimizing downtime and lowering maintenance costs.

8. **Enhanced equipment longevity**

   - By minimizing interference and fault propagation between channels, systems with isolated modules operate more reliably, experience less wear and damage, and achieve a longer equipment lifespan.

Specific examples of industrial applications:

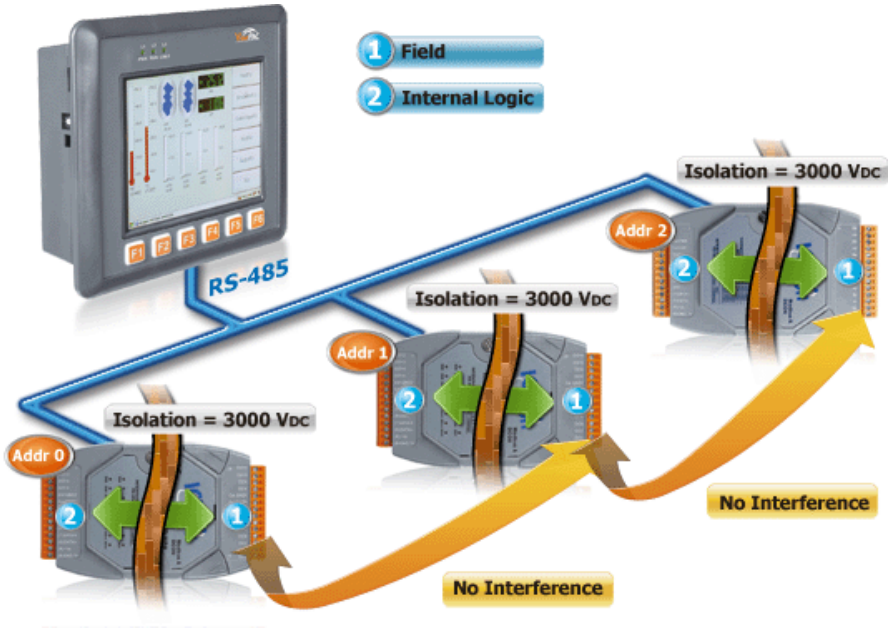
- **Power & Energy System:**
  Channel-to-channel isolation plays a crucial role in protecting low-voltage control systems from high-voltage faults, surges, or failures in other parts of a system. By electrically isolating the low-voltage and high-voltage channels, it prevents damage to sensitive components and minimizes the risk of system-wide failures. This isolation helps to ensure that any issues in the high-voltage side (such as a surge or fault) don't propagate into the low-voltage control circuitry, which could lead to equipment damage or malfunction.
- **Automation equipment:**
  In robotic control and production line automation, channel-to-channel isolation prevents signal interference between devices, ensuring more precise control.
- **Sensor and actuator systems:**
  In systems where multiple sensors and actuators are connected, isolated modules help ensure signal stability and prevent interference between channels.
- **Medical Equipment:**
  In the medical field, isolated modules protect patient vital sign monitoring devices from interference caused by other equipment. The application of isolated modules in medical devices is crucial, especially in safeguarding patient vital sign monitoring systems. Since medical equipment requires extremely high accuracy and stability, any electromagnetic interference or electrical faults from other devices may affect monitoring results and even compromise patient safety.

  Isolated modules effectively separate the electrical connections between different systems, preventing high-frequency noise or voltage spikes from other equipment from impacting vital sign monitoring devices. For example, electrocardiograms (ECG), blood pressure monitors, and oxygen saturation meters may display incorrect data or fail entirely if subjected to interference from other devices.
- **Telecommunications**:
  In telecommunications, maintaining isolation between communication channels is essential to prevent signal interference, ensuring clear and reliable transmission. This isolation minimizes crosstalk, where a signal transmitted on one circuit or channel creates an undesired effect in another, which can degrade the quality of the transmitted information. By implementing effective isolation strategies, telecommunications systems can maintain high-quality signal transmission, free from unwanted interference between channels.

In conclusion, the use of Channel-to-Channel Isolated modules in industrial field applications can effectively improve system stability, safety, signal quality and measurement accuracy, as well as reduce maintenance costs and the risk of failure, which is important for the normal operation of equipment, improve production efficiency and extend the life of equipment.

- **3000 VDC Isolation**

The I-7000 and M-7000 series have 3000 VDC isolation between the field and the internal logic circuit. This isolation prevents the noise from the field to the internal logic that can damage the module. Users are advised to utilize isolated modules on the RS-485 network to eliminate noise interference from adjacent modules.



- **Dual Communication Protocols (Request/Response)**

All I-7000 and M-7000 modules use a simple command /response protocol for communication. M-7000 also supports the industrial standard Modbus RTU protocol. The user can use high-level language, such as C, VB, Delphi, and others to write their application programs. Some famous software package can control I-7000 and M-7000 directly, such as LabView, Indusoft, Tracemode, EZ data logger, EZ Prog, etc.

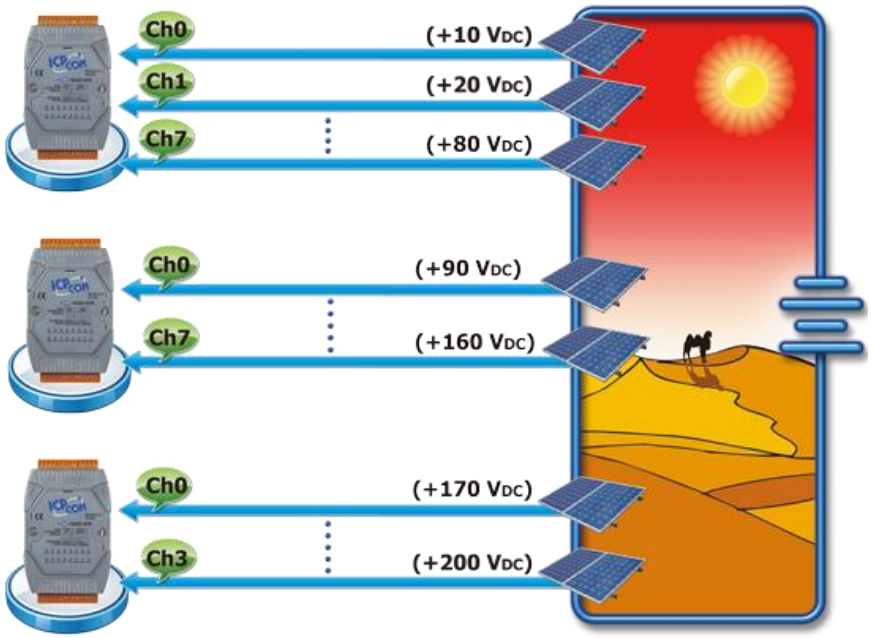
The I-700 series supports the DCON protocol
The M-7000 series supports the Modbus RTU and DCON protocols

- **Self-Tuner Inside**

"Self-Tuner" is a patented ASIC. It auto-tunes the baud rate and data format in whole RS-485 network, and auto handles the direction of the RS-485 communication line. Since the unique features of this ASIC, the user can implement a very flexible remote I/O configuration via the RS-485 network.

- **Common-mode Voltage Protection**

The typical application is to monitor the charging status of the batteries in series. The voltage of each battery is +10 VDC so the first battery is +10 VDC, the second battery is +20 VDC etc. The differential voltage of the 20th battery is only +10 VDC, while the common-mode voltage is around 200 VDC. If the common-mode voltage of the analog input module is not large enough, then it cannot measure the correct voltage of the battery in charging. ICP DAS analog input modules provide +/-200 VDC high common-mode voltage protection for industrial applications, which can effectively solve the measurement errors caused by insufficient common-mode voltage.

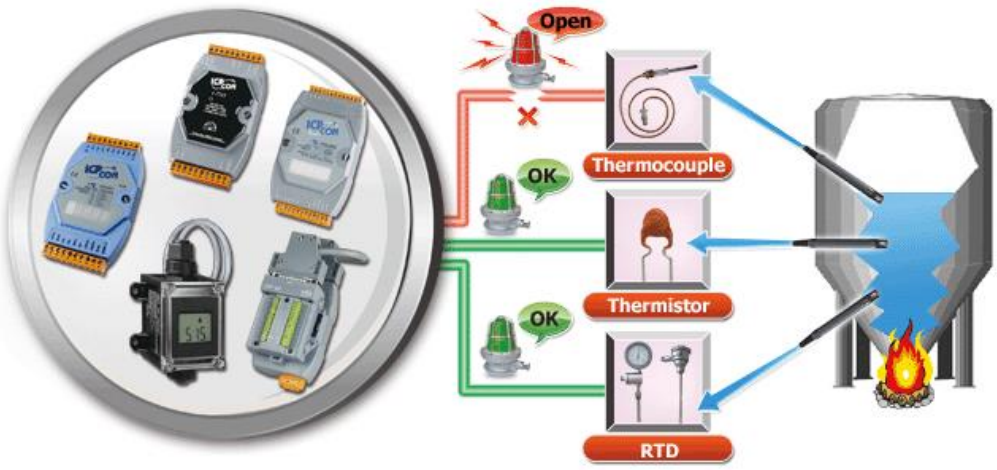


- **ESD Protection**

In the industrial environment, there are many noises, spike, electrostatic, etc. If the module is not strong enough, it is very easy to be damaged. The I-7K and M-7K modules all pass +/-4 KV ESD contact and +/-8 KV ESD air tests by static electricity gun in our laboratory. The test procedures follow the IEC 61000-4-2 standard. The components used in ICP DAS modules can suppress and withstand the high voltages defined by the IEC 61000-4-2 standard, thereby protecting the modules from the effects of electrostatic discharge.

- **Open Wire Detection**

The thermocouple, RTD and thermistor sensors are widely used in temperature control applications. If the system can not monitor the open wire status of the sensors, it may be very dangerous and cause large damage to life and property. When the wire of sensor is broken and the controller does not know the open wire status, the system may heat the boiler continuously and result in fire or explosion. Our thermocouple, RTD, thermistor modules provide open wire detection and make the system safer.

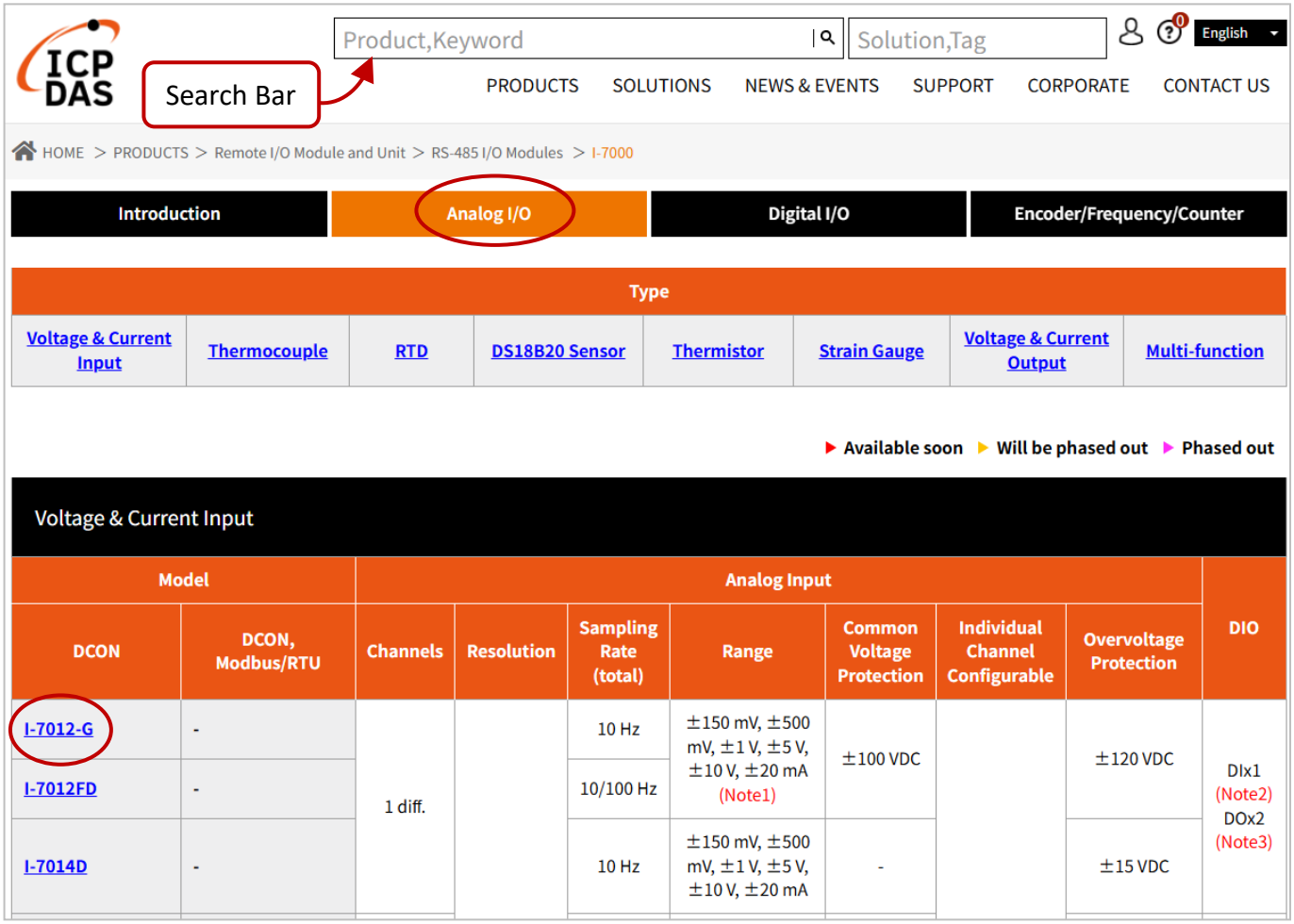


1.3 Product Information

Users can find the product page by entering the model number into the search box on the ICP DAS website. (https://www.icpdas.com/)

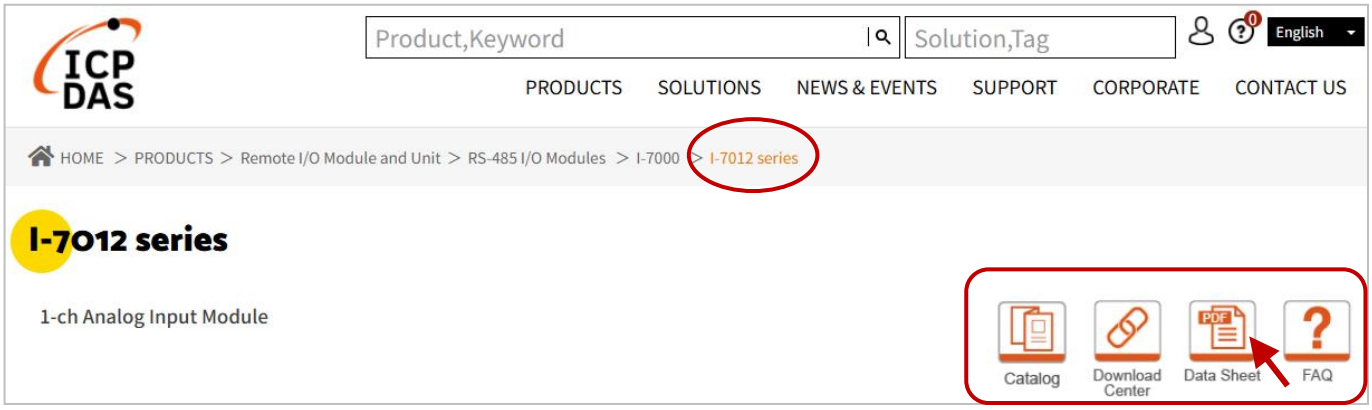
1.3.1 Selection Guide

Check the product selection guide to explore various I/O module types.
www.icpdas.com/en/product/guide+Remote__I_O__Module__and__Unit+RS-485__I_O__Modules+I-7000



1.3.2 Catalog/ Download Center/ Data Sheet / FAQ

On the product page, click the icon to access related files.

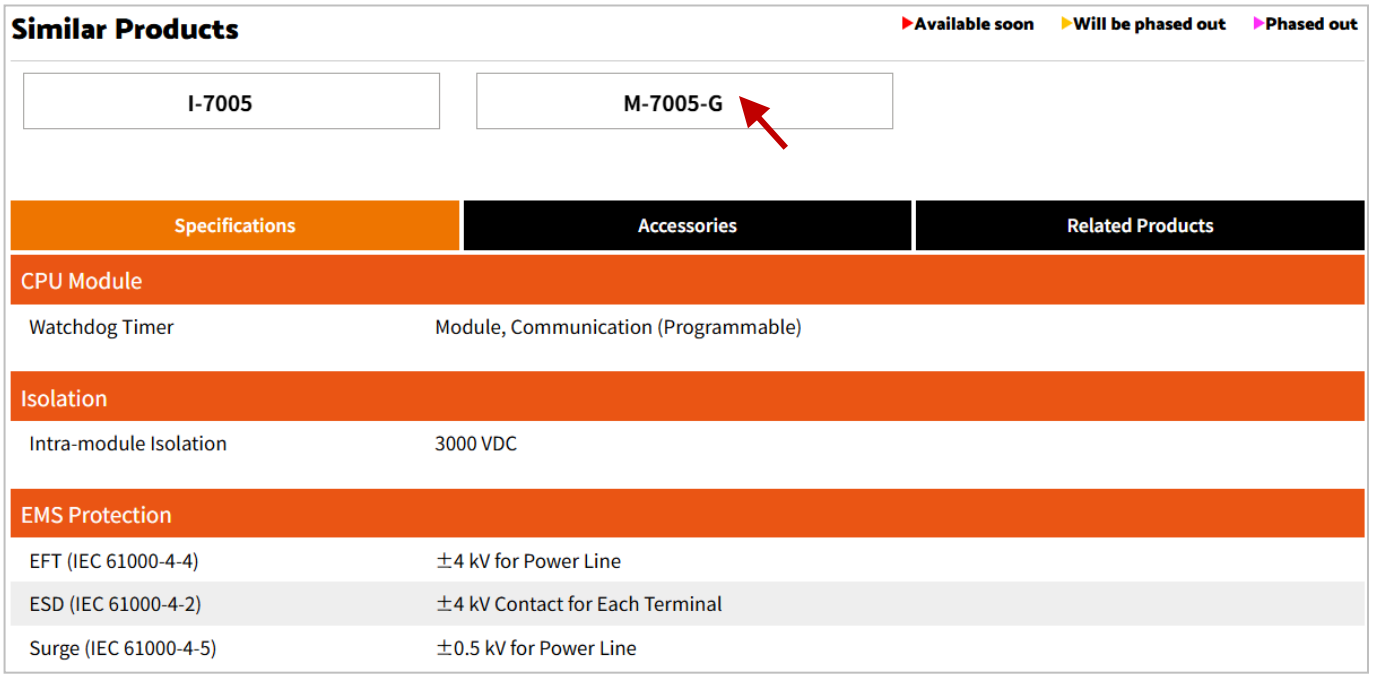


Description of icons:

Catalog	Users can download catalogs, flyers, or posters.
Download Center	Users can download the user manual, quick start guide, utility & tool, SDK, etc.
Data Sheet	Users can access module information, including pin assignments, wire connections, and internal I/O structure.
FAQ	Users can understand some issues with software development, product functionality, installation & configuration, and troubleshooting.

1.3.3 Specifications/ Similar Products

Users can click a similar model listed above the 'Specifications' section on the product page for more information.



Chapter 2 Hardware Installation

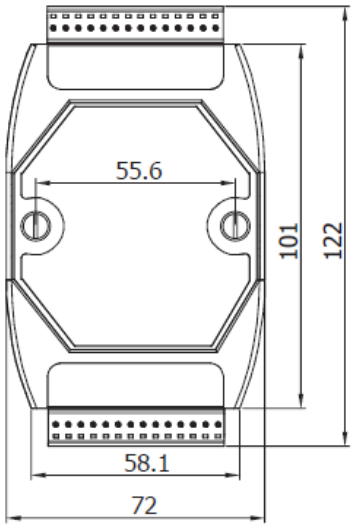
2.1 Installation

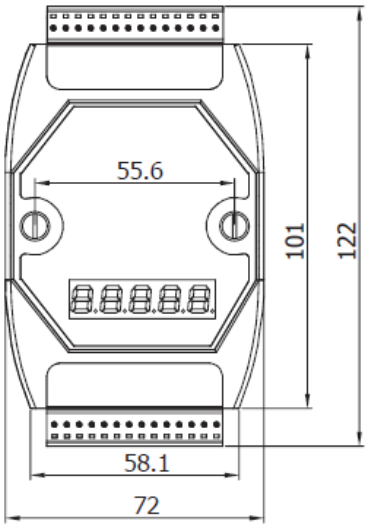
DIN-Rail Mounting

Piggyback Mounting

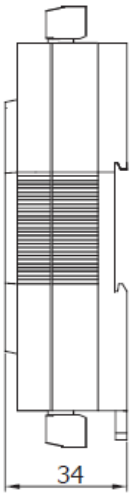
2.2 Dimensions (Units: mm)

Front View

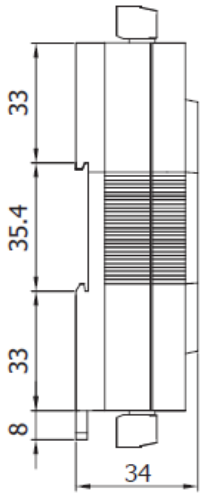




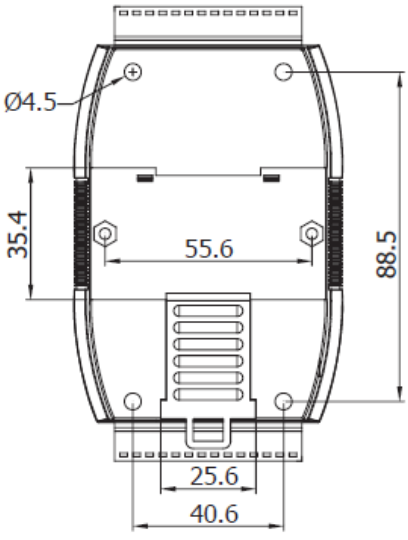
Left View

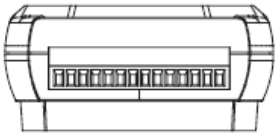


Right View



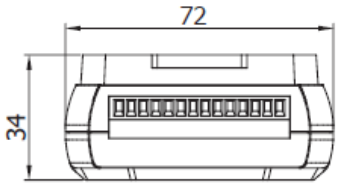
Rear View





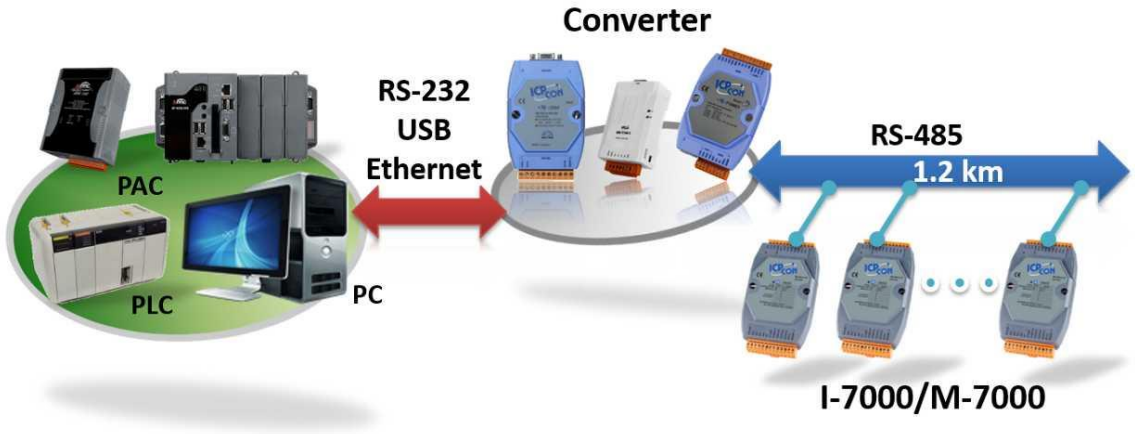
Top View

Button View



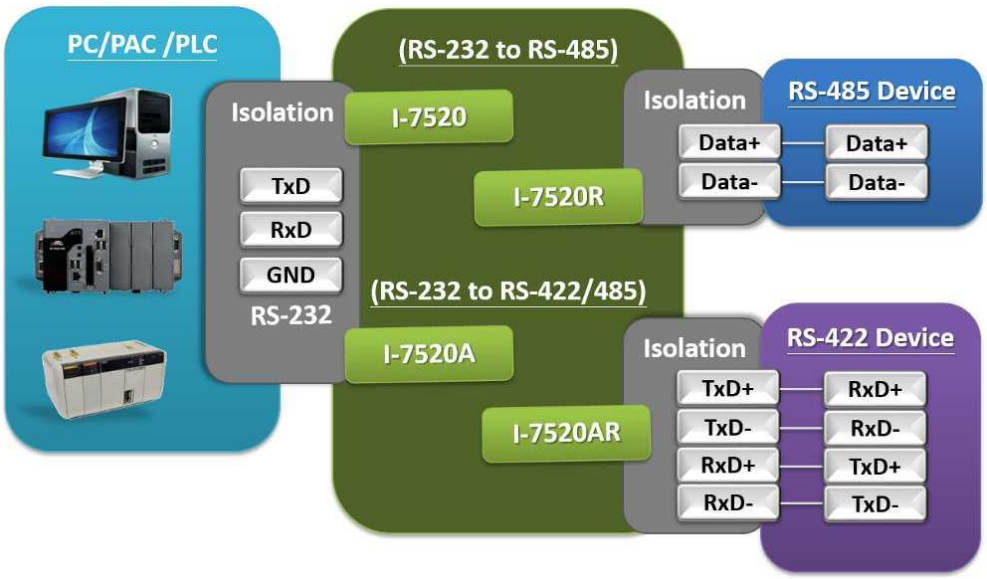
2.3 Connecting the I/O Module

2.3.1 System Architecture #1 (Bus Topology) - Converters

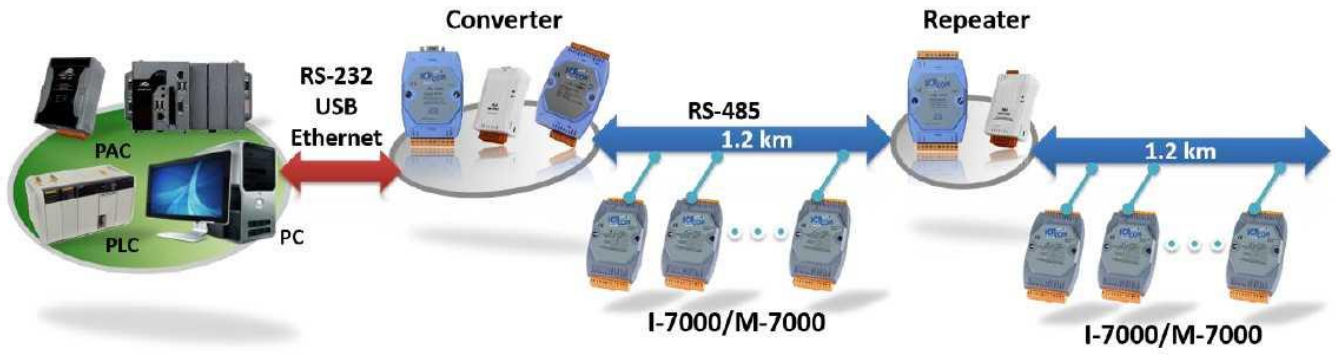


Converter	Input	Output	Power Input	Size	Driver
I-7520 series	RS-232	RS-422/485	10 ~ 30 VDC	Palm-size	N/A
tM-7520U		RS-485		Tiny size	N/A
I-7561 series	USB 2.0	RS-232/422/485	USB	Palm-size	Win7/8/10/11, Linux
tM-7561		RS-485		Tiny size	Win7/8/10/11, Linux
PDS-720	Ethernet	RS-232, RS-485	10 ~ 30 VDC	Palm-size	Win7/8/10/11
tDS-700 series			PoE or 12 ~ 48 VDC Jack	Tiny size	Win7/8/10/11

Note: The I-7520/A and I-7520R/AR feature isolation designs on different sides, allowing users to select the appropriate side for additional isolation protection, particularly for critical equipment. This design helps mitigate circuit damage caused by noise interference from the power input, enhancing overall system reliability.



2.3.2 System Architecture #2 (Bus Topology) - Repeater



The repeater is used to

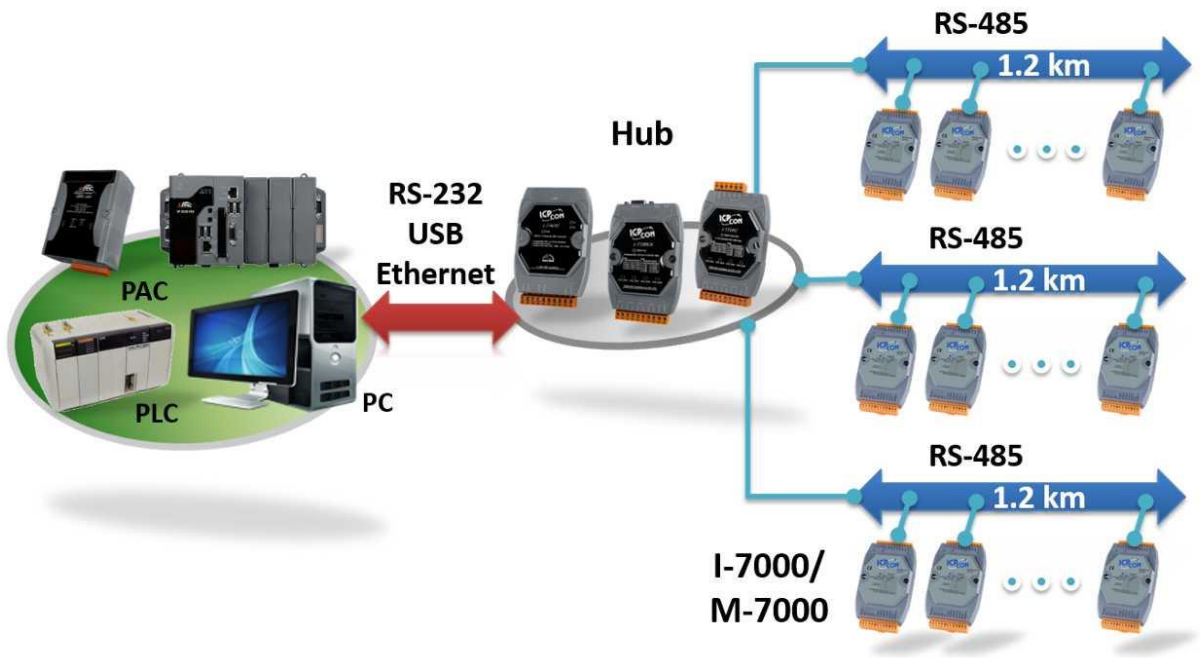
1. **Isolate two sides signal**

   If the signal gets worse on one side, it will not affect the other side.

2. **Extend the communication distance**

Repeater	Input	Output	Power Input	Size	Driver
I-7510 series	RS-485 or RS-422/485		10 ~ 30 VDC	Palm-size	N/A
tM-7510U	RS-485			Tiny size	

2.3.3 System Architecture #3 (Tree Topology) - Hub



- The best way to implement an RS-485 network that focuses on robustness and signal integrity is to use a daisy chain topology.
- In general, a tree topology cannot be realized with a "simple" RS-485.
- The reflections that would be caused by these long branches (connections between your main bus and the slave nodes) makes a reliable data transmission impossible.

> Traditionally, a 120 Ω terminating resistor is placed at the end of one RS-485 branch, which often results in better signals on one branch, but worse signals on the others.

Each port is equipped with an individual driver to avoid mutual interference.

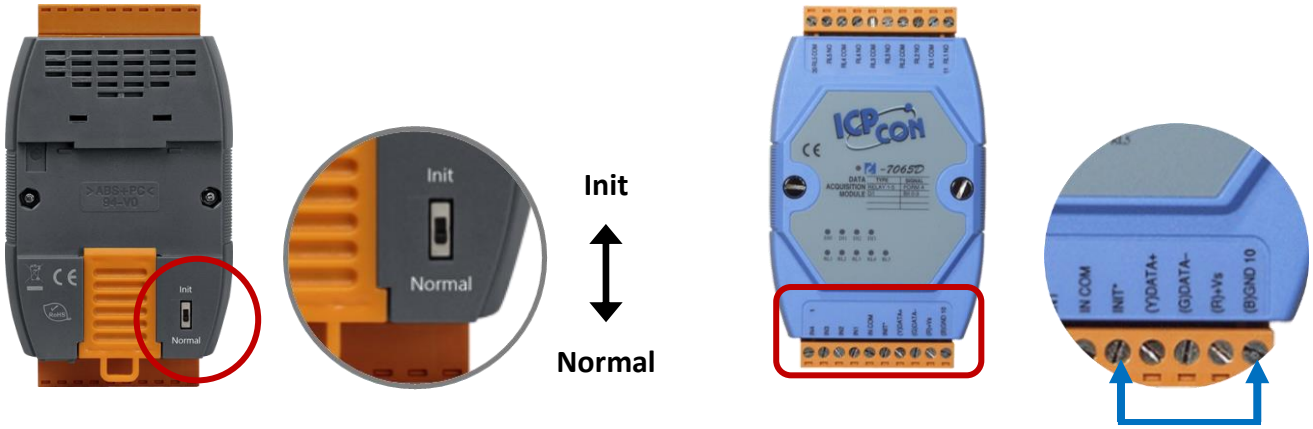
Hub	Input	Output	Power Input	Size	Driver
I-7520U4-G	RS-232	4-port RS-485	10 ~ 30VDC	Palm-size	N/A
I-7513-G	RS-485	3-port RS-485			N/A
I-7514U-G		4-port RS-485			N/A
I-7563-G	USB	3-port RS-485	USB		Win7/8/10/11, Linux
I-7563U-G					

Note: I-7563U speeds up to 921 kbps. others, speed up to 115 kbps

2.4 Operating Switch and Parameters

I-7000/M-7000 series provides two operating modes, Init Mode and Normal Mode, which can be set by sliding the switch on the rear side of the module. For some modules, users need to wire the INIT* pin to GND on the front of the module.

Operating Switch



Normal Mode:

Normally, the operating switch of I-7000/M-7000 series module is set to “Run”.

Init Mode:

If the communication parameters of the module are unknown, switch to the "Init" position and reboot the module. The settings are fixed and detailed in the following table:

Parameters	I-7K	M-7K
Protocol	DCON	
Address	0	
Baud Rate	9600 bps	
Parity	n,8,1-no parity	
Checksum	Disable	

Factory Defaults:

Parameters	I-7K	M-7K
Protocol	DCON	Modbus
Address	1	
The Baud Rate, Parity, and Checksum settings are the same as above table.		

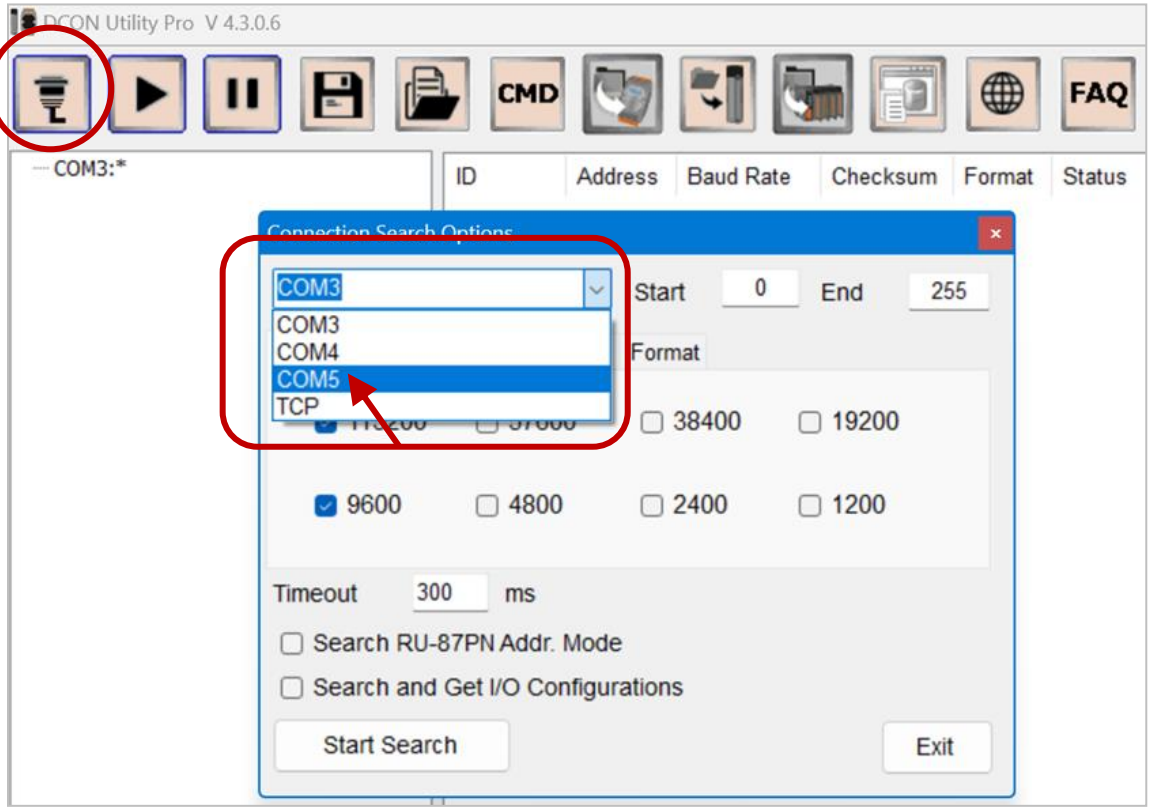
Chapter 3 Software Tool - DCON Utility Pro

Users can configure the communication parameters and I/O settings for each module by using DCON Utility Pro. Visit the website to download the software and the user manual.
http://www.icpdas.com/en/product/guide+Software+Utility_Driver+DCON__Utility__Pro

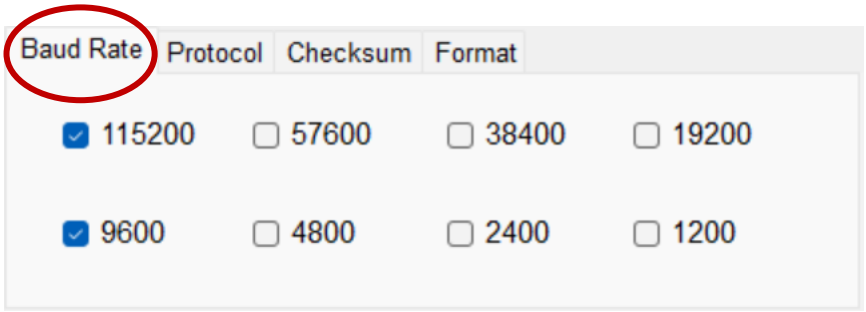
3.1 Search I/O Modules & Online Configuration Page

Ensure that the PC is connected to the I/O module and turn on the power supply. Afterward, launch the DCON Utility Pro.

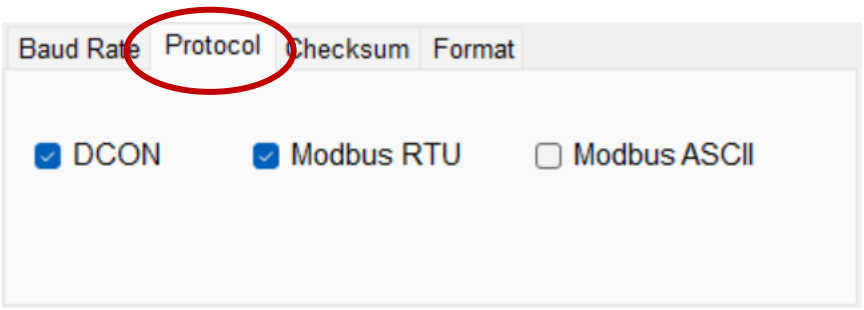
Step 1: Choose the PC's COM port and search options such as Baud Rate, Protocol, Checksum, and Format.



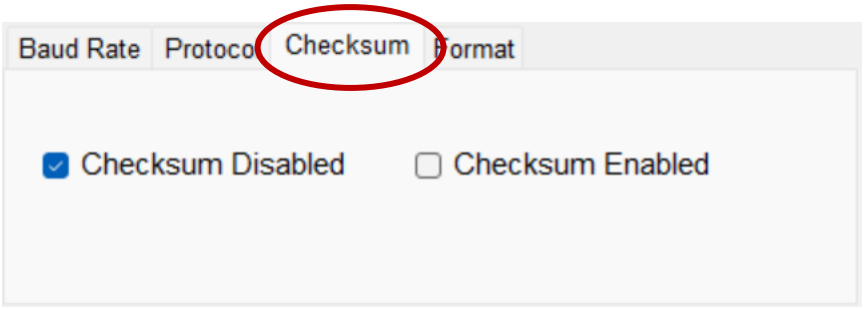
Baud Rate: The user can select multiple options. The default setting is 9600.



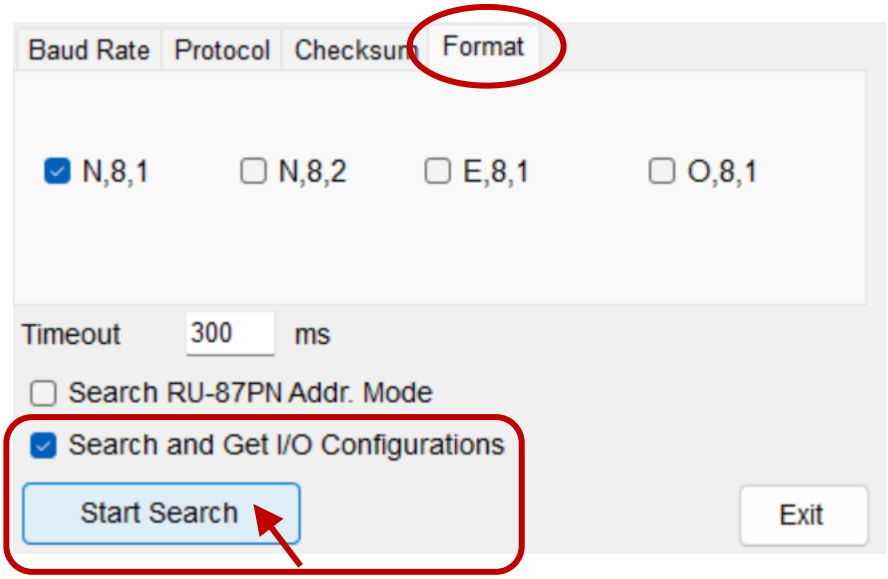
Protocol: The settings is fixed “DCON” if power on the module in Init mode.



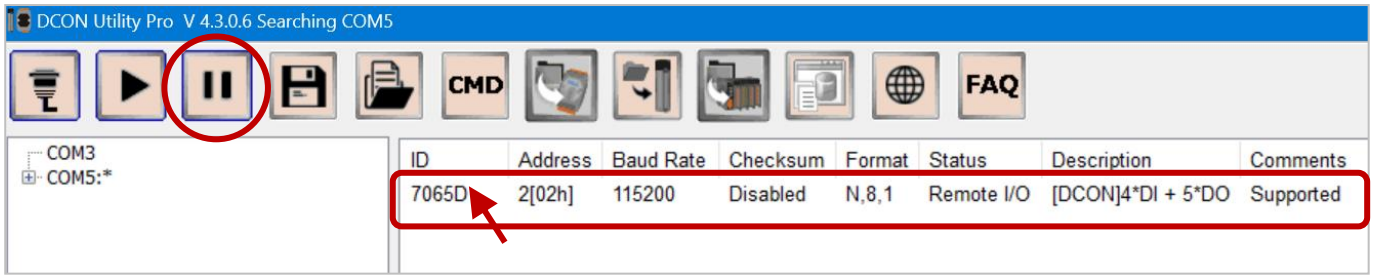
Checksum: The default setting is “Disabled”. ◦



Format: The default setting is “N,8,1”. After completing the settings, click “**Start Search**” to search for the I/O module.



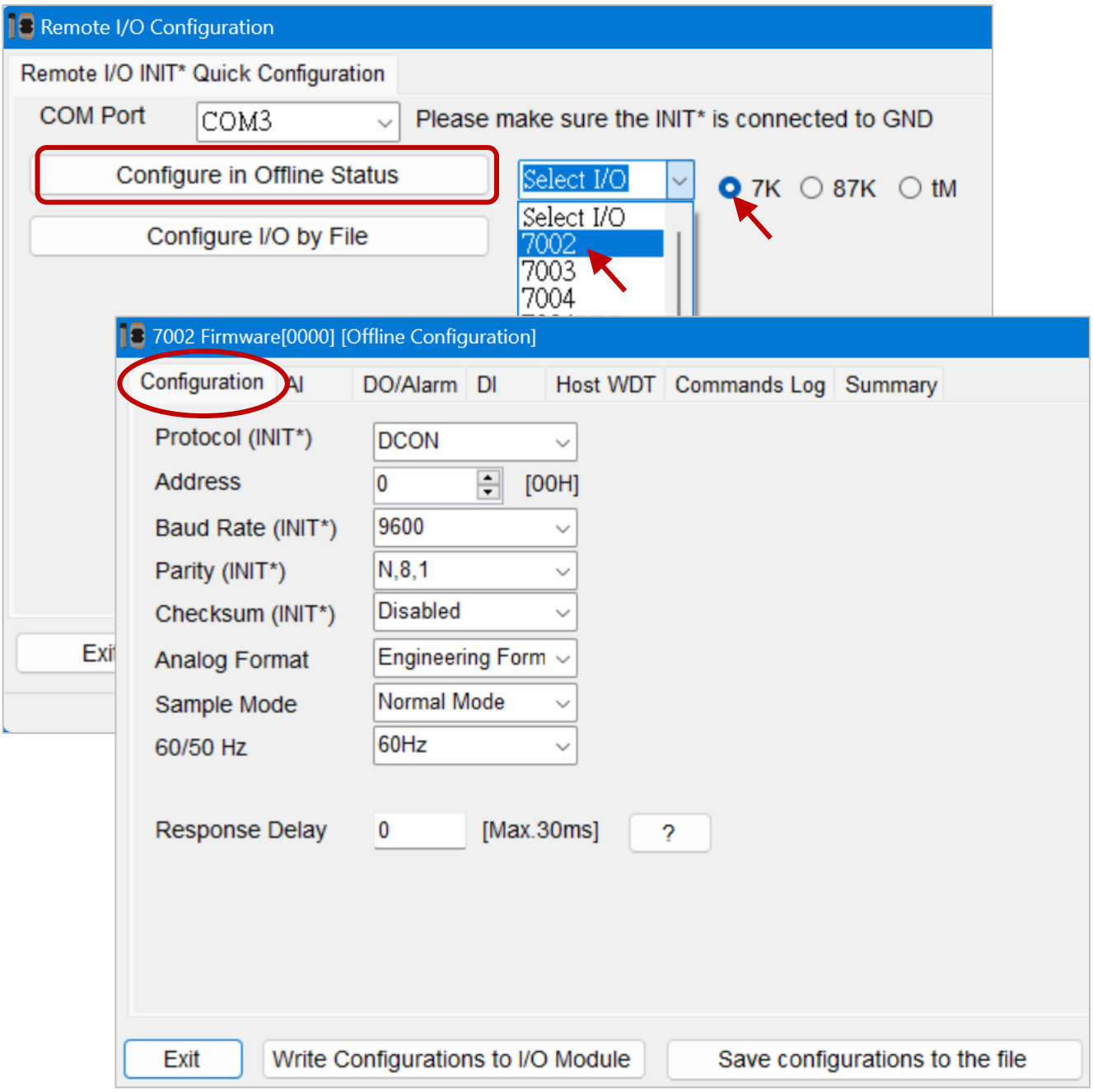
Step 2: After searching for a module, click **"Stop Search"** to end the search, then select the model (ID) to open the settings window.



3.2 Open the Offline Configuration Page

The **“Remote I/O INIT* Quick Configuration**” function in the DCON Utility Pro allows users to view the settings page for each I-7000/M-7000 module offline.

In the **"Remote I/O Configuration"** window, click **"Configure in Offline Status"**, select the **"7K"** option, and choose a model from the dropdown list to open its settings page.



3.3 Settings Page - Configuration

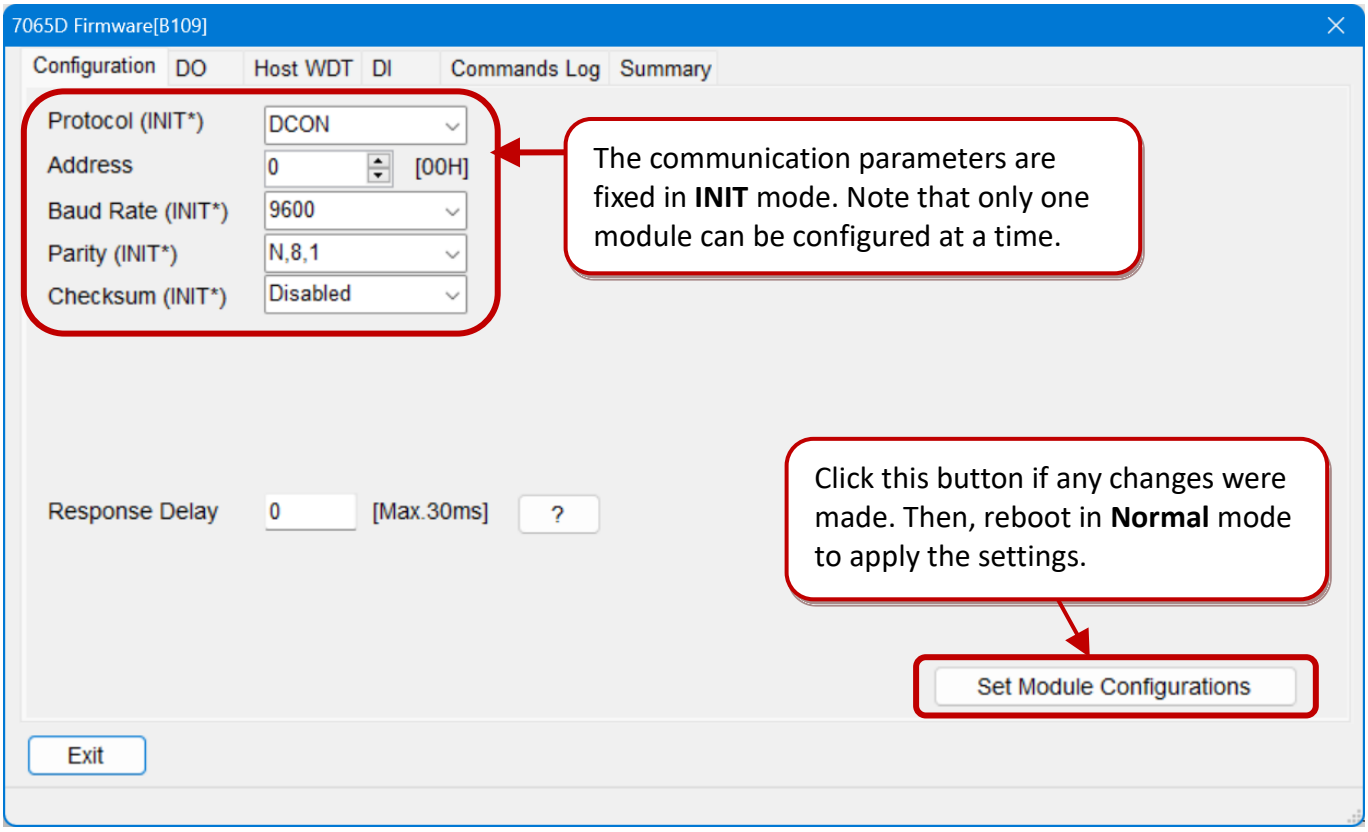
The **Configuration** page of DCON Utility Pro is used to configure the communication parameters of the I/O module, along with certain AI or AO parameters.

Note:

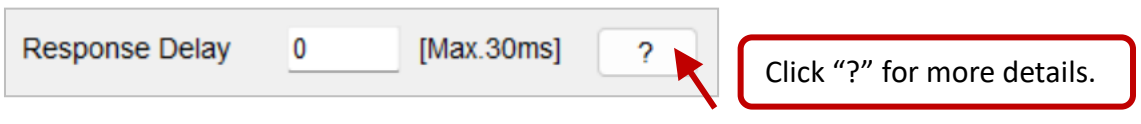
DCON Utility Pro support to open multiple settings windows of the I/O module since version 3 (or later).

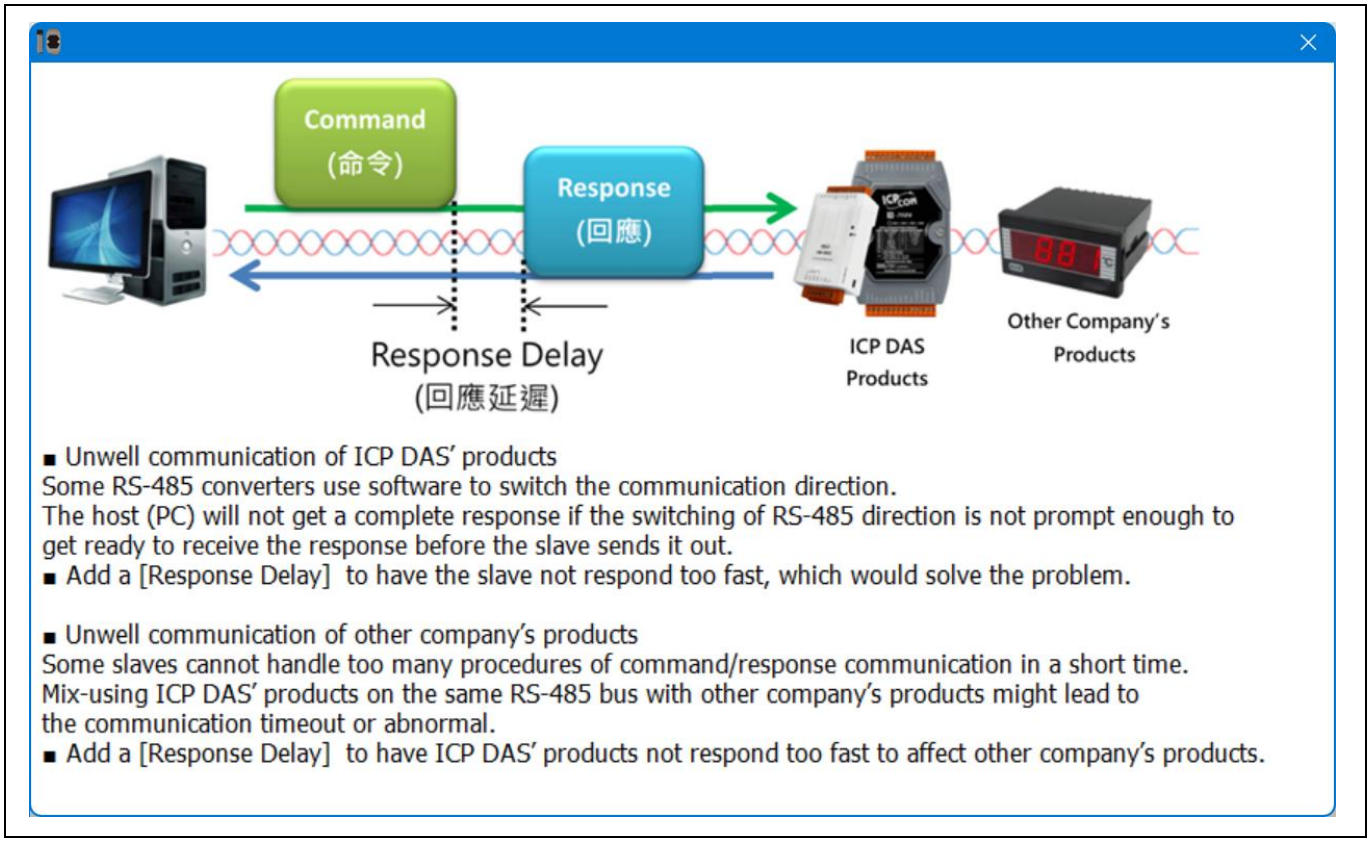
3.3.1 Common Settings for I-7000/M-7000 Modules

The communication parameters are fixed in **INIT** mode. Click the **Set Module Configurations** button if any changes were made. Then, reboot in **Normal** mode to apply the settings. Additionally, when the Protocol is set to **DCON**, items marked with "**INIT***" must be configured in INIT mode.



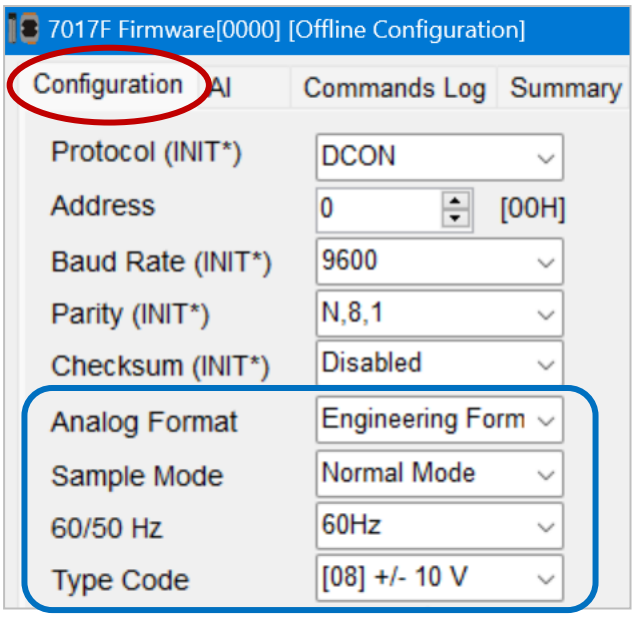
Protocol	Set the protocol, which can be DCON or Modbus RTU.
Address	Set a unique address for the module. (Range: 0-255)
Baud Rate	Set the baud rate, which can be 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200.
Parity	Set the parity, which can be [N,8,1], [N,8,2], [E,8,1], or [O,8,1].
Checksum	Set the checksum, which can be disabled or enabled.
Response Delay	Add a delay time for the response. (Default: 0 ms, Range: 0-30 ms)

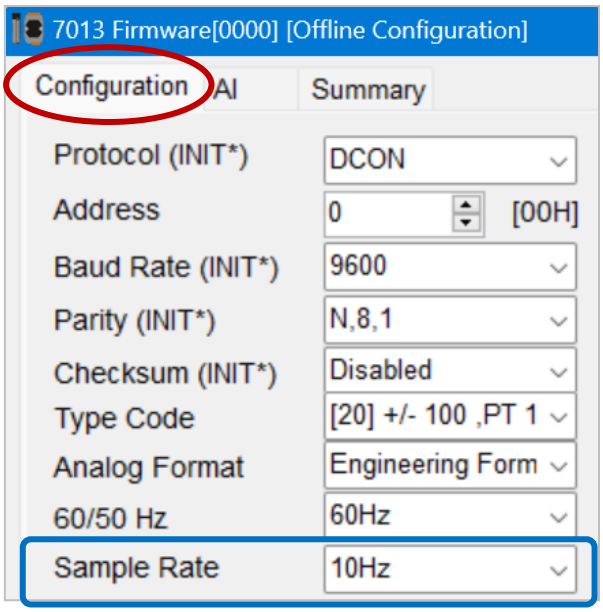




3.3.2 AI or AO Settings

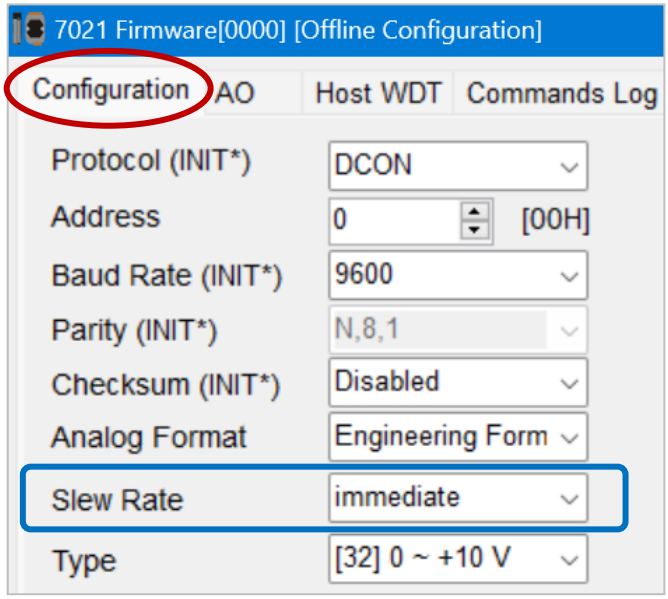
In addition to the common settings mentioned above, the **Configuration** page includes additional AI or AO settings depending on the model.

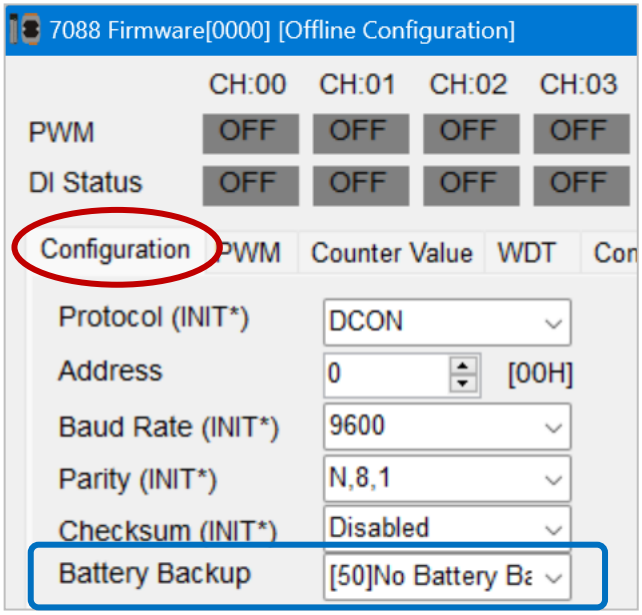




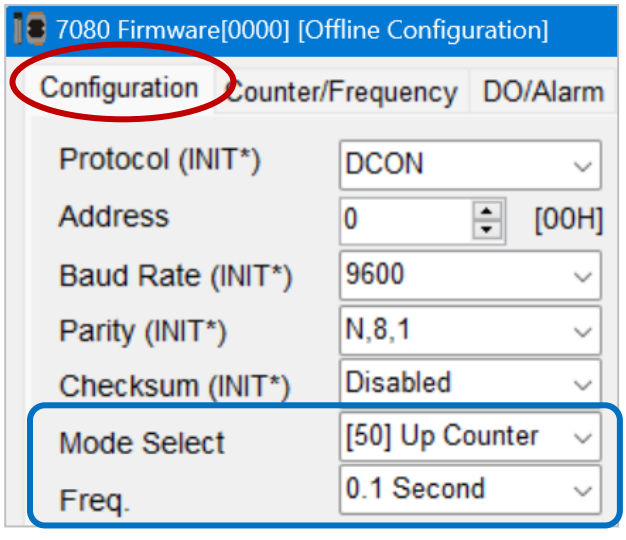
The following items will be displayed on the **Configuration** page based on the **AI** or **AO** module type.

Analog Format	Set the data format, which can be Engineering Format**,** Percent Format, 2's Complement Format, or Ω (Ohms)**.**
Sample Mode	Set the data sampling mode, which can be Normal Mode or Fast Mode.
Power Filter (60/50 Hz)	This function filters out **60/50 Hz** power noise to prevent signal distortion.
Type Code	Set the data type code and range, e.g., [08] +/-10V, [0D] +/-20mA.
Sample Rate	The sample rate of 7013(P)(D) series can be set to 10 Hz or 1 Hz.





Slew Rate	Set the rate of change for voltage or current (V/sec, mA/sec), which controls how quickly the module outputs a value when the AO value changes. The setting is available for the 7021/21P, 7024/24L/24R modules.
Battery Backup	If enabled, the data can be retained in case of power failure. The setting is available for the 7088(D) modules.



Mode Select	It can be set to either **Up Counter** or **Frequency** mode for the 7080(D) and 7080B(D) modules, with Battery Backup available for the 7080B(D).
Freq.	The time interval for measuring frequency can be set for the 7080(D) and 7080B(D) modules, with options of 0.1 or 1.0 second.

AI parameters on the Configuration page	Type Code	Analog Format	Sample Mode	60/50 Hz	Sample Rate	Response Delay	Slew Rate
Voltage & Current Input							
7012(F)(D)	o	o	o	o	-	-	-
7017	o	o	-	o	-	o	-
7017F/17C/17A5/17FC/17R/17RC	o	o	o	o	-	o	-
7017mC16	-	o	o	-	-	o	-
7017Z	-	o	o	o	-	o	-
Thermocouple Input							
7011(P)(D)	o	o	-	o	-	-	-
7018/18-16/18P/18R	o	o	-	o	-	o	-
7018Z/19/19R/19Z	-	o	-	o	-	o	-
Transmitter Input							
7014(D)	o	o	-	o	-	-	-
RTD Input							
7013(P)(D)	o	o	-	o	o	o	-
7015(P)	-	o	-	o	-	-	-
7033(D)	o	o	-	o	-	-	-
DS18B20 Sensor Input							
7004	-	-	-	-	-	o	-
Thermistor Input							
7005	-	o	-	-	-	o	-
Strain Gauge							
7016(P)(D)	o	o	-	o	-	-	-
Voltage & Current Output							
7021/21P	o	o	-	-	-	-	o
7022/22A	-	o	-	-	-	o	-
7024/24L/24R	o	o	-	-	-	o	o
7024U(D)/28(D)	-	o	-	-	-	o	-
Multi-Function							
7002/03/	-	o	o	o	-	o	-
7026	-	o	-	o	-	o	-

AI parameters	Type Code	Mode Select	Battery Backup	Freq.	Response Delay
Counter/Frequency Input					
7080(D)/80B(D)	-	o	-	o	o
7084	o	-	-	-	o
Counter Input/PWM Output					
7088(D)	-	-	o	-	o

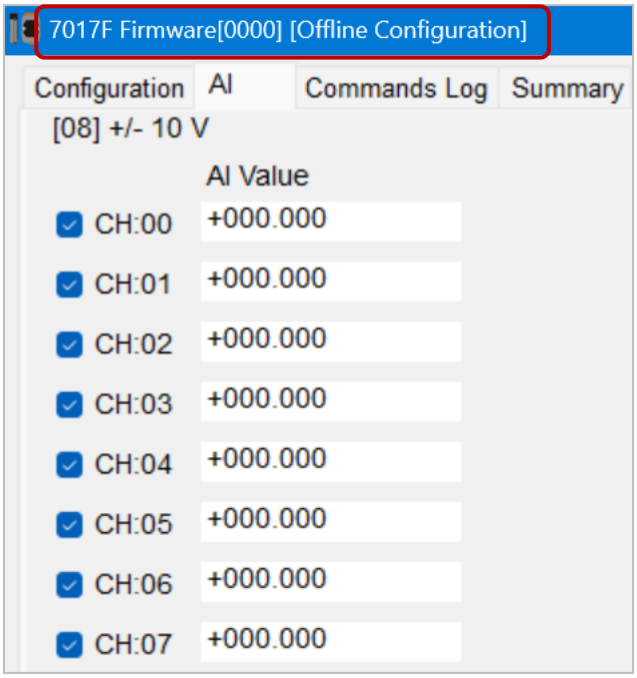
3.4 AI Settings Page

DCON Utility Pro offers several settings pages, with different items displayed depending on the model. The following describes the settings shown on the module's offline page.

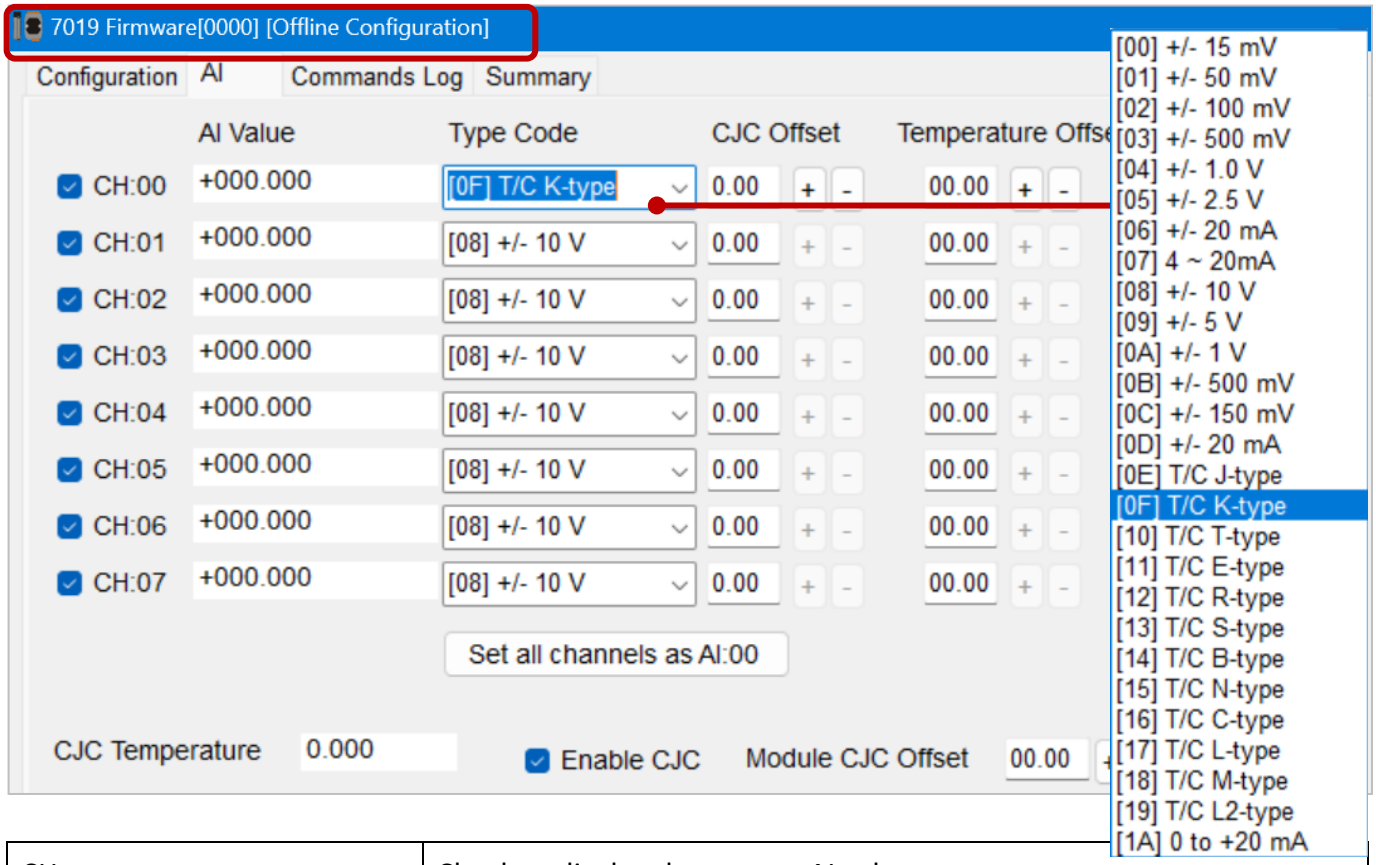
Refer to Section 3.2 to know how to open the offline page.

Note:

The available settings will vary depending on the model.



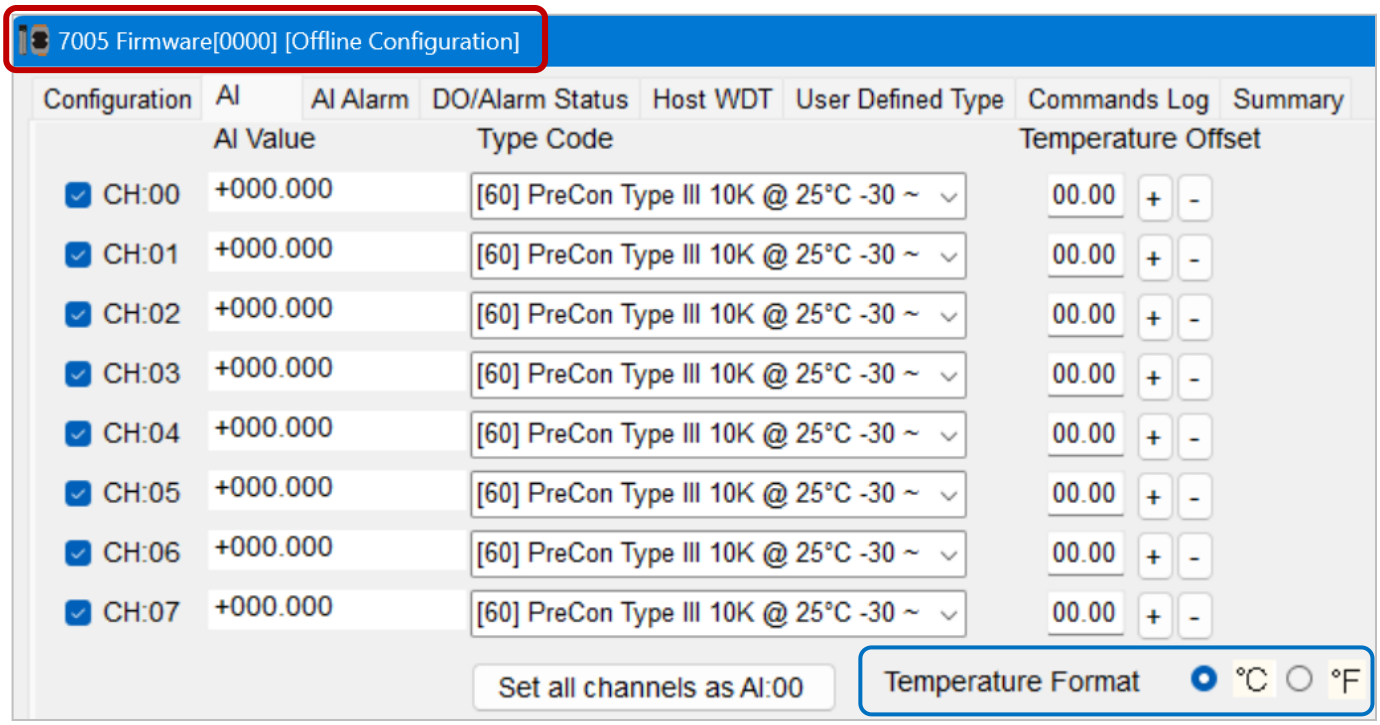
AI Page	Index of channel	Type Code (Defaults)	Individual Channel Configuration
7011/11D/11P/11PD	00	[05] +/-2.5V	-
7012/12D/12F/12FD		[08] +/-10V	
7013/13D/13P/13PD		[20] +/-100, Pt100 α=0.00385	
7014(D)		[08] +/-10V	
7016P/16PD	00	[05] +/-2.5V	
7016/16D	00 ~ 01		
7033(D)	00 ~ 02	[20] +/-100, Pt100 α=0.00385	
7002	00 ~ 03	[08] +/-10V	Yes
7015(P)	00 ~ 05	[20] +/-100, Pt100 α=0.00385	
7003	00 ~ 07	[08] +/-10V	
7005	00 ~ 07	[60] PreCon Type III 10K @ 25°C -30 ~ 240°F	
7017/17F	00 ~ 07	[08] +/-10V	-
7017A5		[1B] +/-150V	
7017C/7017FC/RC		[0D] +/-20mA	
7017R		[08] +/-10V	
7018/18P		[05] +/-2.5V	
7018R		[05] +/-2.5V	Yes
7019/19R		[08] +/-10V	
7018Z	00 ~ 09	[05] +/-2.5V	
7019Z		[08] +/-10V	
7017Z	00 ~ 09 or 00 ~ 19 (10 Differential or 20 Single-ended)	[08] +/-10V	
7017mC16	00 ~ 15	[07] 4 ~ 20mA	
7018-16	00 ~ 16	[05] +/-2.5V	-



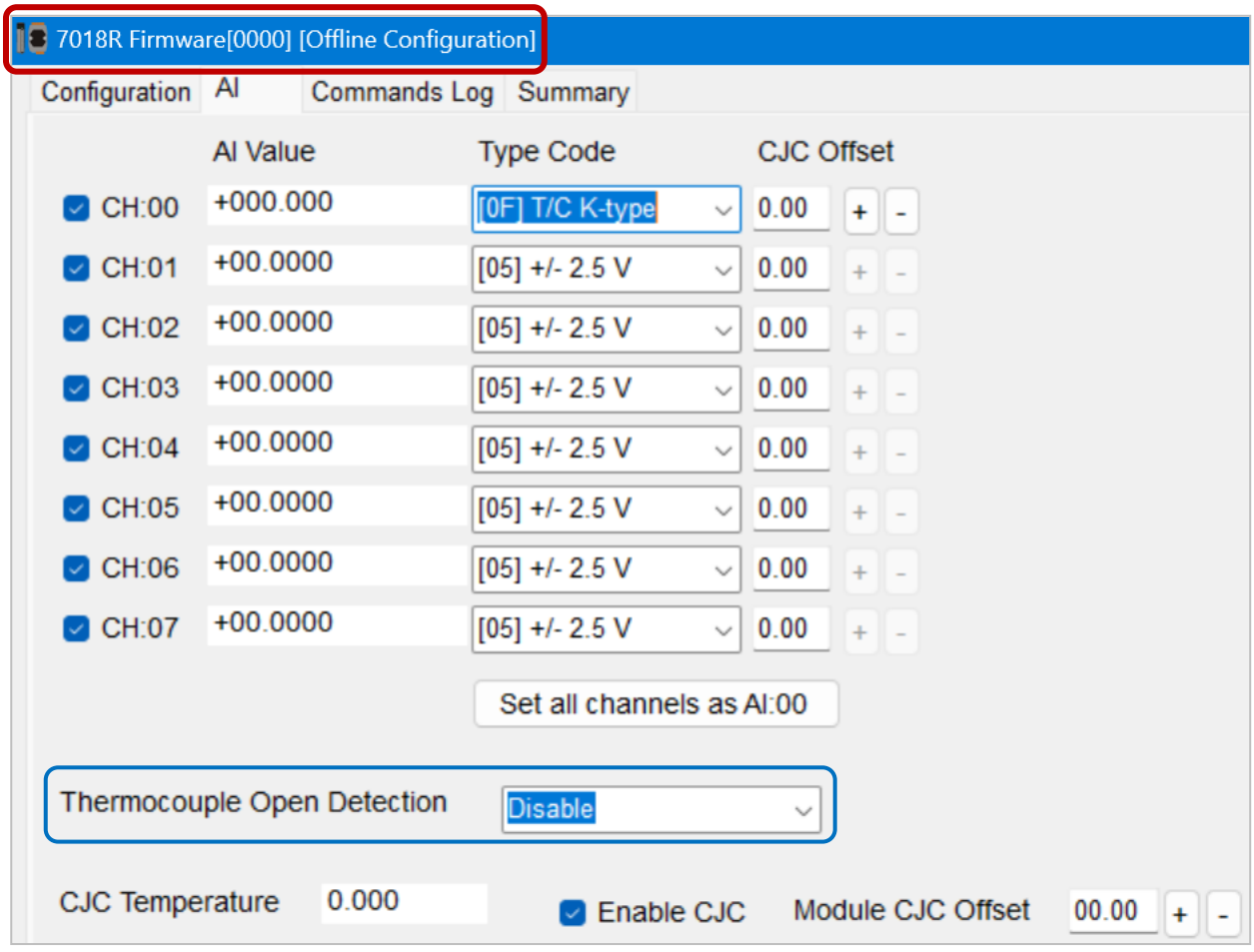
CH: xx	Check to display the current AI value.
Type Code	Set the data type code and range. The available options will vary depending on the model.
Set all channels as AI:00	Set the type code for all channels to be the same as channel 0.
CJC Offset	Set the CJC (Cold Junction Compensation) offset for each channel.
	It's available for the 7018/18-16/18P/18Z/18R/19/19R/19Z.
Temperature Offset	Set offset for each channel to adjuster the temperature readings.
	It's available for the 7005/15/15P/19/19R/19Z.
CJC Temperature	Read the module's CJC temperature.
	It's available for the 7011/11P/18/18-16/18P/18Z/18R/19/19R/19Z.
Enable CJC	This option is typically hidden and becomes available when the type code is set between [0E] and [19].
Module CJC Offset	Set the module's CJC offset
	It's available for the 7011/11P/18/18-16/18P/18Z/18R/19/19R/19Z.

These model's AI page includes the DIO and alarm settings. For more details, refer to Section 3.5: I/O Alarm Settings Page.

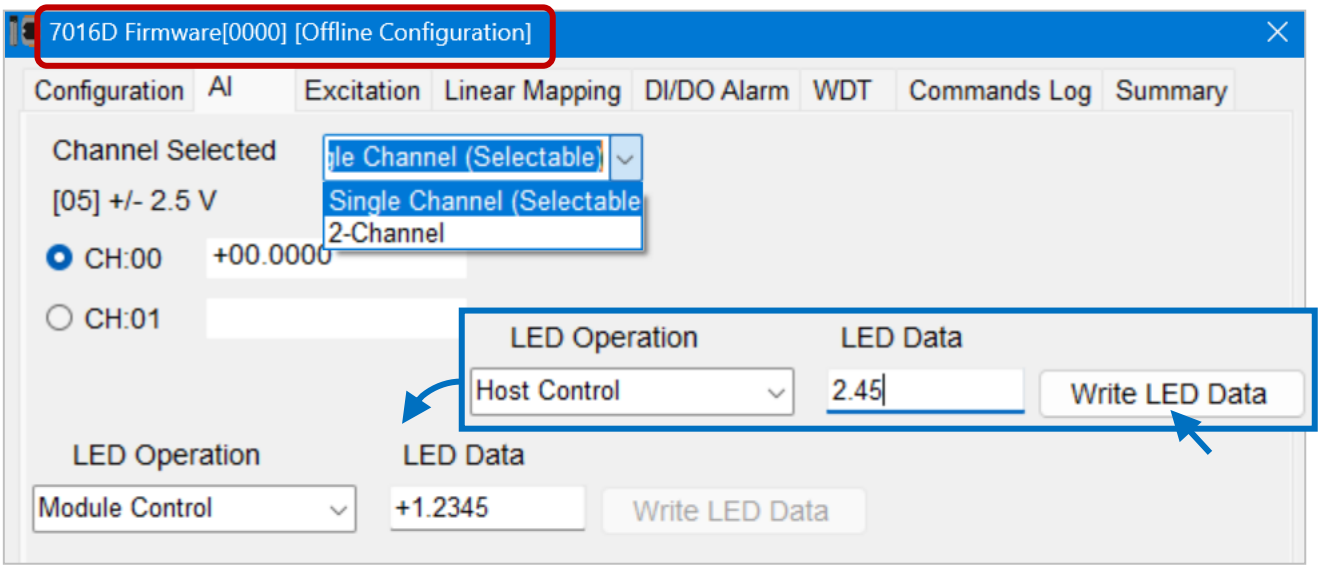
Model	AI Channel	DI Channel	DO Channel
7011(D)/11P(D)/12(D)/12F(D)/13P	1 (00)	1 (00)	2 (00 ~ 01)



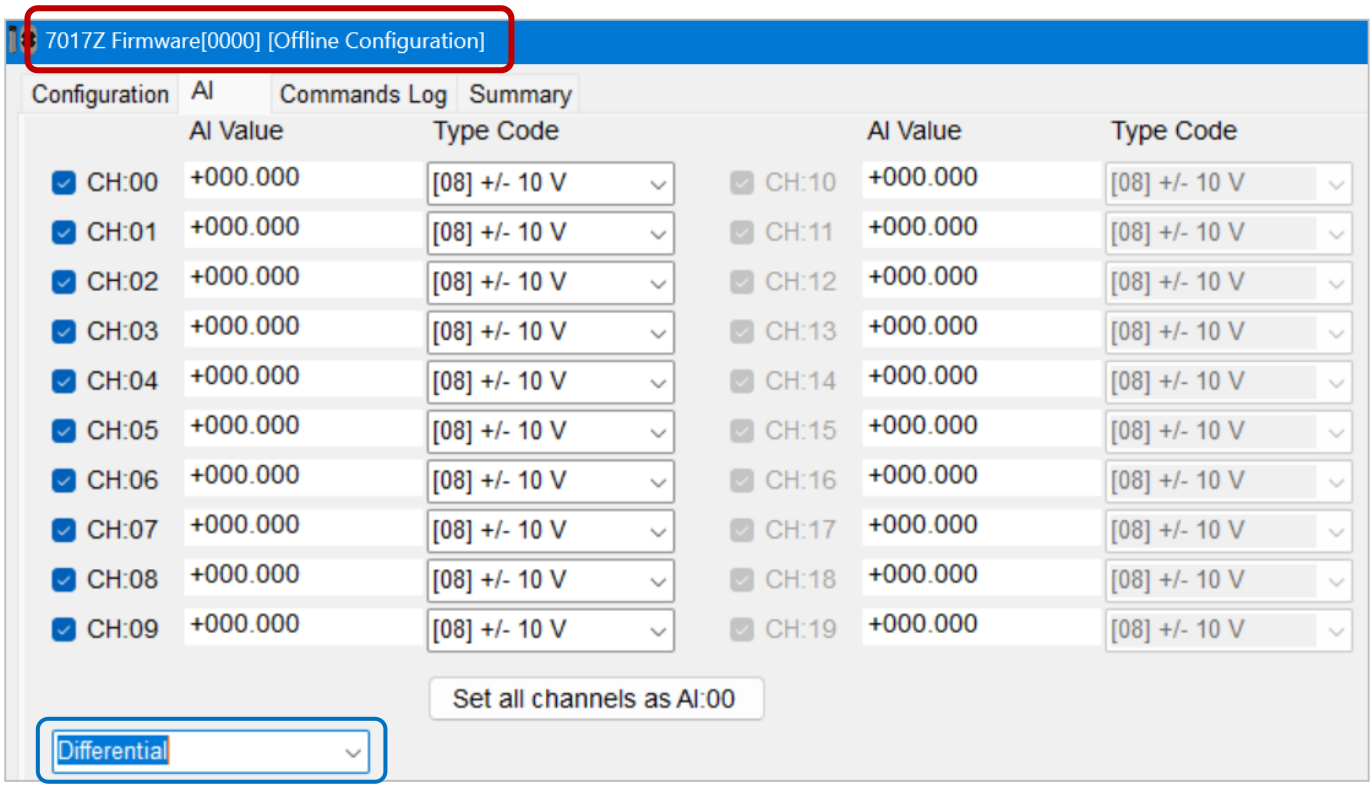
Temperature Format	The 7005 modules allow temperature unit settings in Celsius (°C, default) or Fahrenheit (°F).



Thermocouple Open Detection	The 7018R modules allow enabling or disabling the open-wire detection.



Channel Selected	The 7016(D) modules include two AI channels, while the older firmware supports only one channel. **Single Channel**: Indicates that either CH:00 or CH:01 can be used (one channel only). **2-Channel**: Indicates that both channels can be used.
	Note that the 7016**P**(D) modules include only one AI channel.
LED Operation	**Module Control**: Display the AI readings from the module. **Host Control**: Enter the value to be displayed on the LED and click “Write LED Data”.
	It’s available for the 7011D/11PD/12D/12FD/13D/13PD/16D/16PD.



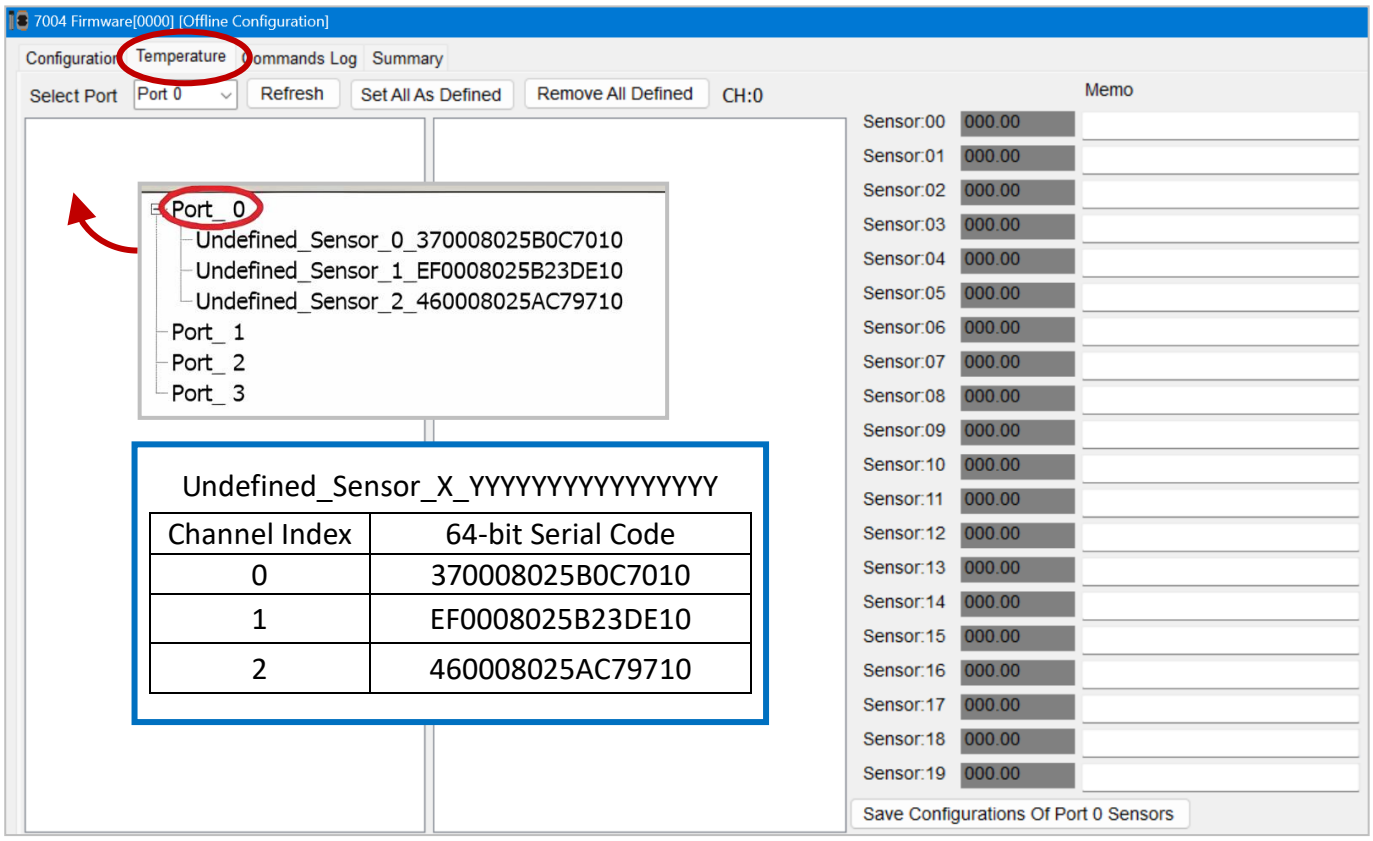
Differential/Single-ended	The 7017Z modules can be set to differential or single-ended mode. Differential mode: 10 channels ; Single-ended mode: 20 channels.

3.4.1 M-7004 Settings Page

Temperature Page	Ports	DS18B20 Sensor	Maximum Cable Length
M-7004	4	20 pcs per port	100 meters per port

The M-7004 provides 4 ports, with each port capable of connecting up to 20 DS18B20 sensors. Each DS18B20 sensor has a unique 64-bit serial number, represented by 16 hexadecimal characters. When using the M-7004 to read the temperature from the DS18B20 sensors, the user must know the serial number of each DS18B20 sensor and assign a unique channel index for each one.

Upon startup, the M-7004 scans all connected DS18B20 sensors on each port and checks if a channel index has been assigned to each sensor. If a sensor does not have a channel index assigned, it will be added to the "undefined" list. The user must assign a channel index to all items in the undefined list. This process only needs to be done once, as all data will be stored in non-volatile memory.

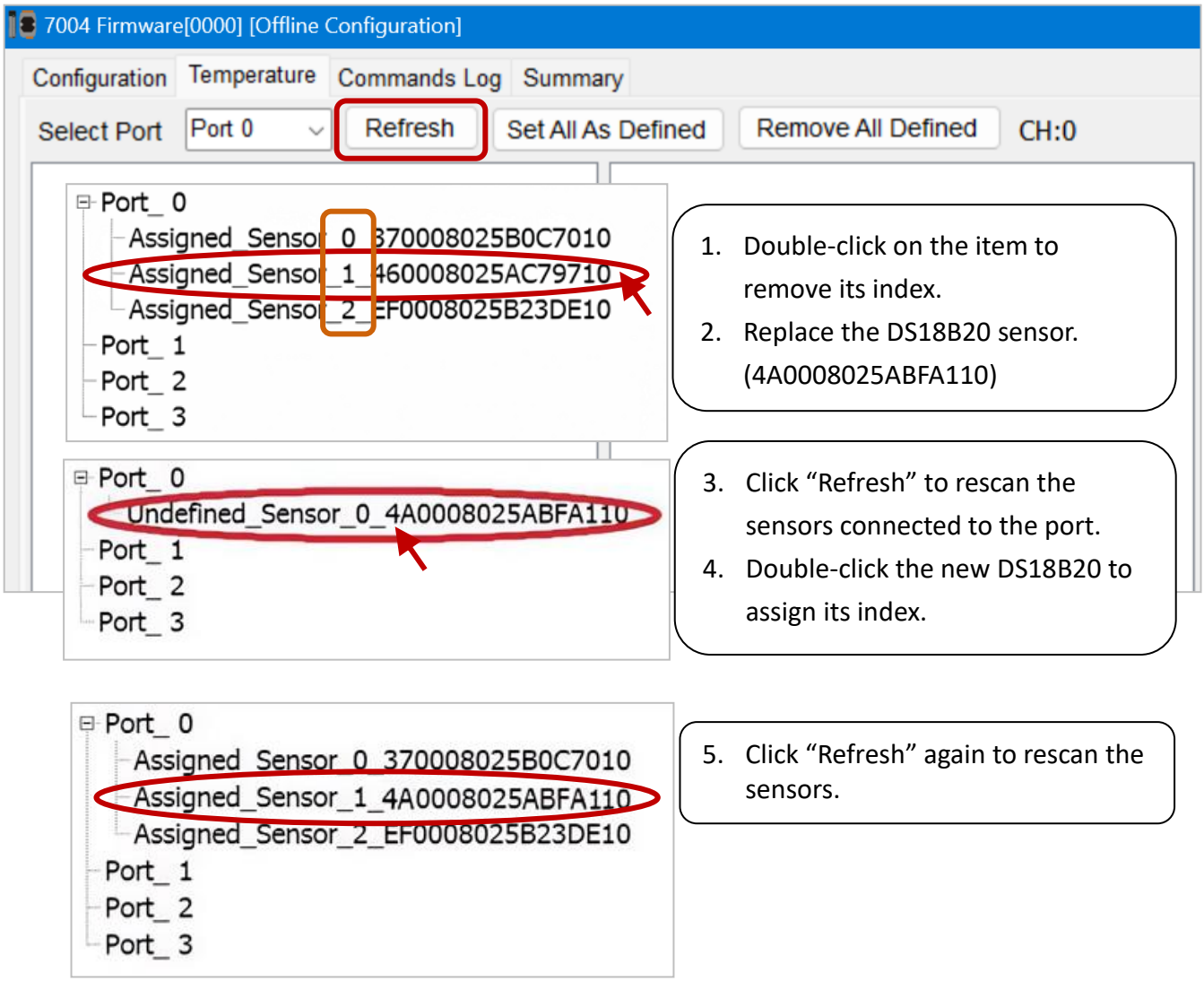


Undefined_Sensor_X_YYYYYYYYYYYYYYY

Channel Index	64-bit Serial Code
0	370008025B0C7010
1	EF0008025B23DE10
2	460008025AC79710

Select Port	Supports 4 Ports, Port 0 – 3.
Refresh	Rescan DS18B20 sensors connected to this port.
Set All As Defined	Set all channels to the last saved index value.
Remove All Defined	Clear all stored index values of all channels
Memo	Add notes for each Sensor
Save Configurations of Port x Sensors	Save the configuration of all sensors on port x

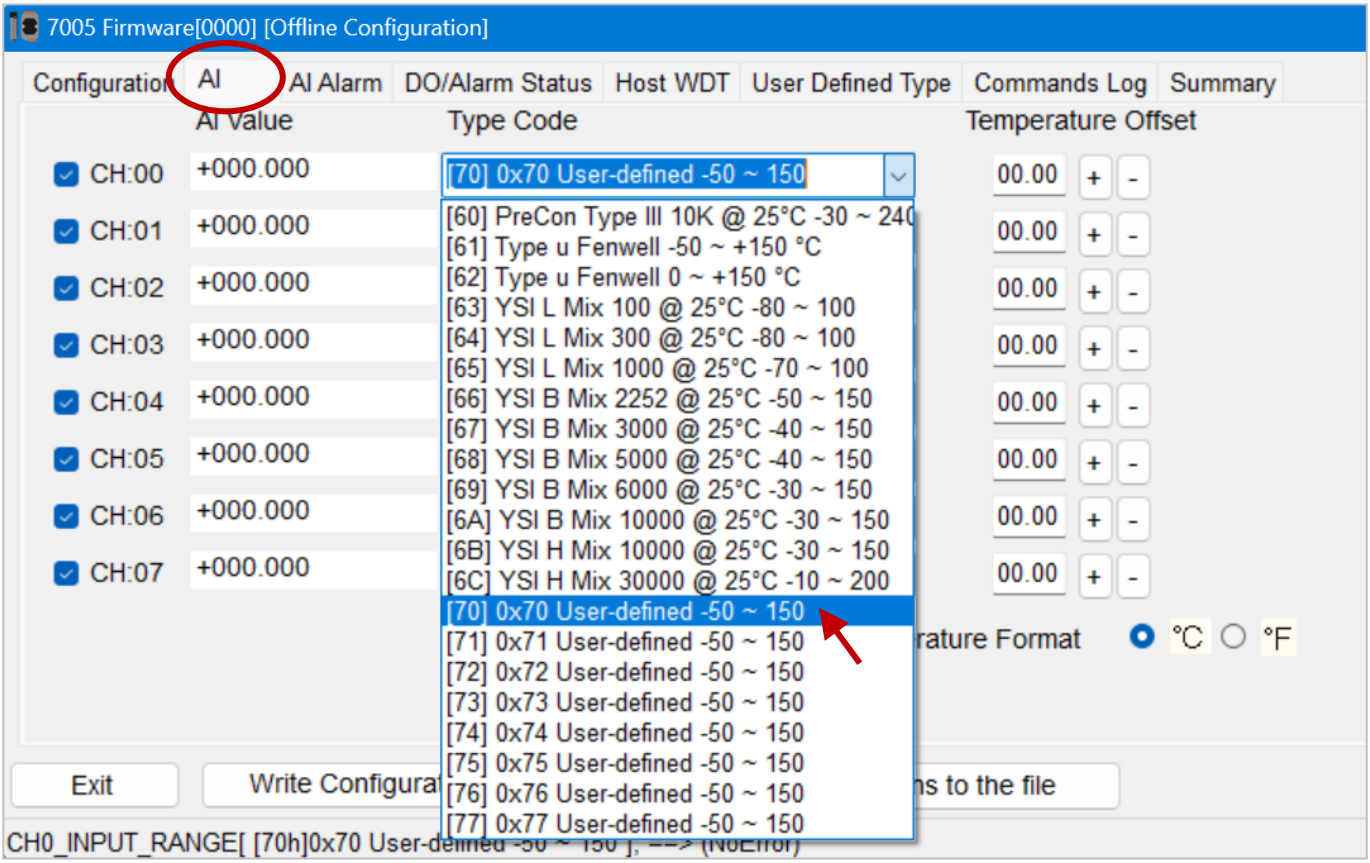
When the DS18B20 sensor is damaged and needs to be replaced, the index value of that channel must be removed. Then, click the 'Refresh' button to rescan the DS18B20 on the M-7004's port. The new DS18B20 will be found and listed in the undefined list. Double-click on the sensor and assign the original channel index to it.



3.4.2 Settings Page – User Defined Type (7005)

The **User Defined Type** page is available for the I-7005/M-7005 thermistor input modules only. The temperature-to-resistance tables for thermistors manufactured by different vendors may vary. Although the 7005 module already supports thermistors from several well-known brands, it still provides users the option to create their own conversion formulas to accommodate other thermistors.

First, go to the **AI** page to specify the channel and type code (e.g., Ch0, Type 70) to be used. Then, proceed to the **User Defined Type page** to configure the following settings.



Mode 1: The coefficient can be calculated using three sets of known data: (R1, T1), (R2, T2), and (R3, T3) from the temperature-to-resistance table provided by the thermistor manufacturer, as shown in the figure below.

5.1 Tabella valori temperatura resistenza sensore NTC 10K@25°C ß 3435

Temp.	Valore di Resistenza			Temp.	Valore di Resistenza			Temp.	Valore di Resistenza		
	Max.	Tipico	Min.		Max.	Tipico	Min.		Max.	Tipico	Min.
°C	KΩ	KΩ	KΩ	°C	KΩ	KΩ	KΩ	°C	KΩ	KΩ	KΩ
-50	344,60	329,50	314,90	1	26,65	26,13	25,62	56	3,50	3,43	3,35
-49	325,00	310,90	297,30	2	25,52	25,03	24,55	57	3,39	3,32	3,25
-48	306,60	293,50	280,90	3	24,44	23,99	23,54	58	3,28	3,22	3,15
-47	289,40	277,20	265,40	4	23,42	23,00	22,57	59	3,18	3,12	3,05
-46	273,40	262,00	251,00	5	22,45	22,05	21,66	60	3,09	3,02	2,95
-45	258,30	247,70	237,40	6	21,53	21,15	20,78	61	2,99	2,93	2,86
-44	244,20	234,30	224,70	7	20,64	20,30	19,95	62	2,90	2,84	2,77
-43	231,00	221,70	212,80	8	19,81	19,48	19,15	63	2,82	2,75	2,69
-42	218,60	209,90	201,60	9	19,01	18,70	18,39	64	2,73	2,67	2,61
-41	207,00	198,90	191,00	10	18,25	17,96	17,67	65	2,65	2,59	2,53

1. On the "**Set By Resistor and Temperature**" page, enter three sets of resistance values (R) and temperature values (°C), then click the "**Calculate**" button to compute the Steinhart coefficient.

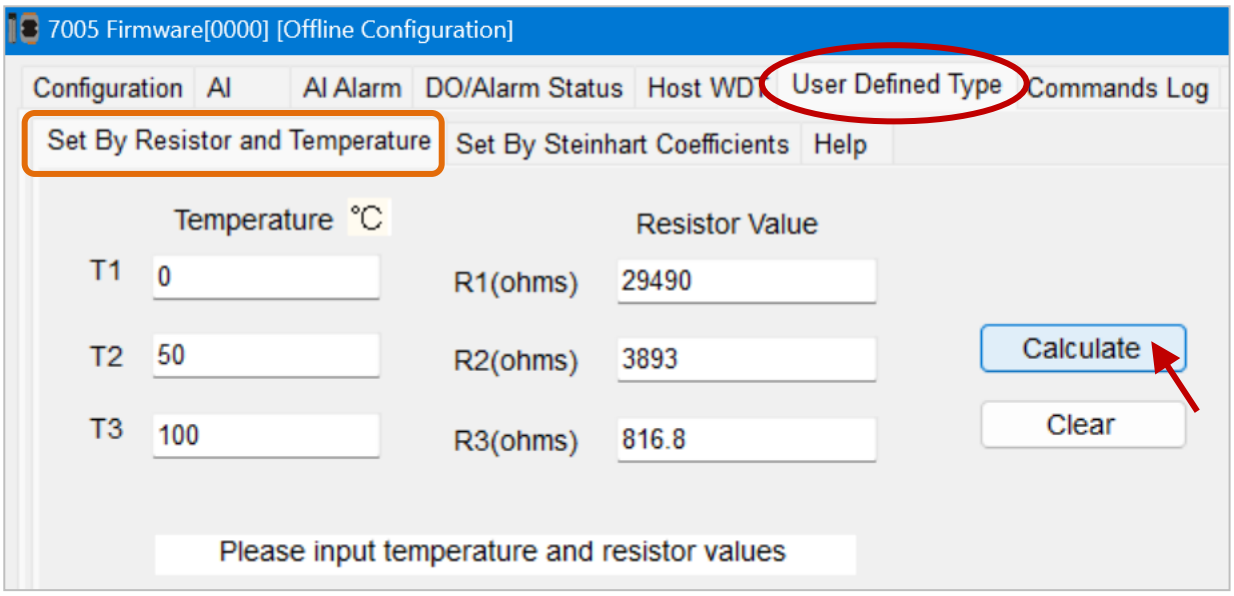
   It is recommended to follow the rule below to ensure accurate results.

   (1) -40°C ≦ **T1, T2, T3** ≦ 150°C (2) |**T2 - T1**| ≦ 50°C (3) |**T3 - T2**| ≦ 50°C

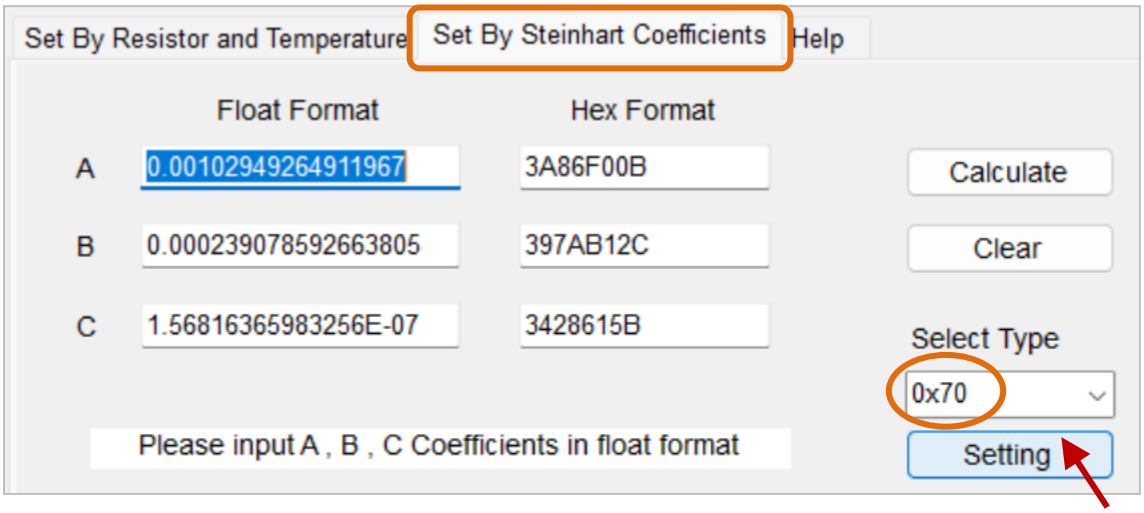
   For example,

Temperature (℃)	**Resistance (Ω)**
T1: 0	R1: 29490
T2: 50	R2: 3893
T3: 100	R3: 816.8

   Note: If the resistance value exceeds 204800 Ω, it is considered to be under range.



2. The **"Set By Steinhart Coefficients"** page will automatically appear, displaying the results. Click the **"Setting"** button to complete the configuration.



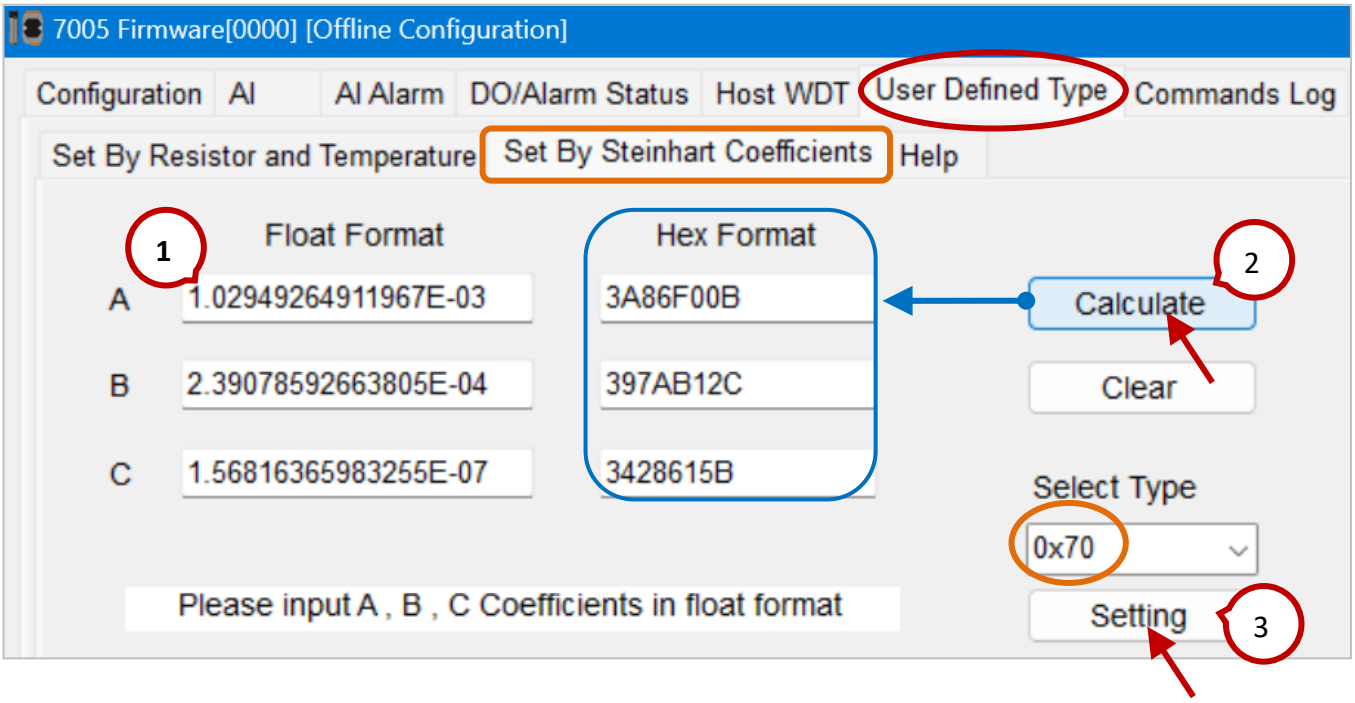
Mode 2: Typically, **Steinhart coefficients** for thermistors are provided by the manufacturers.

1. On the **"Set By Steinhart Coefficients"** page, enter the A, B, and C coefficients in **float** format.

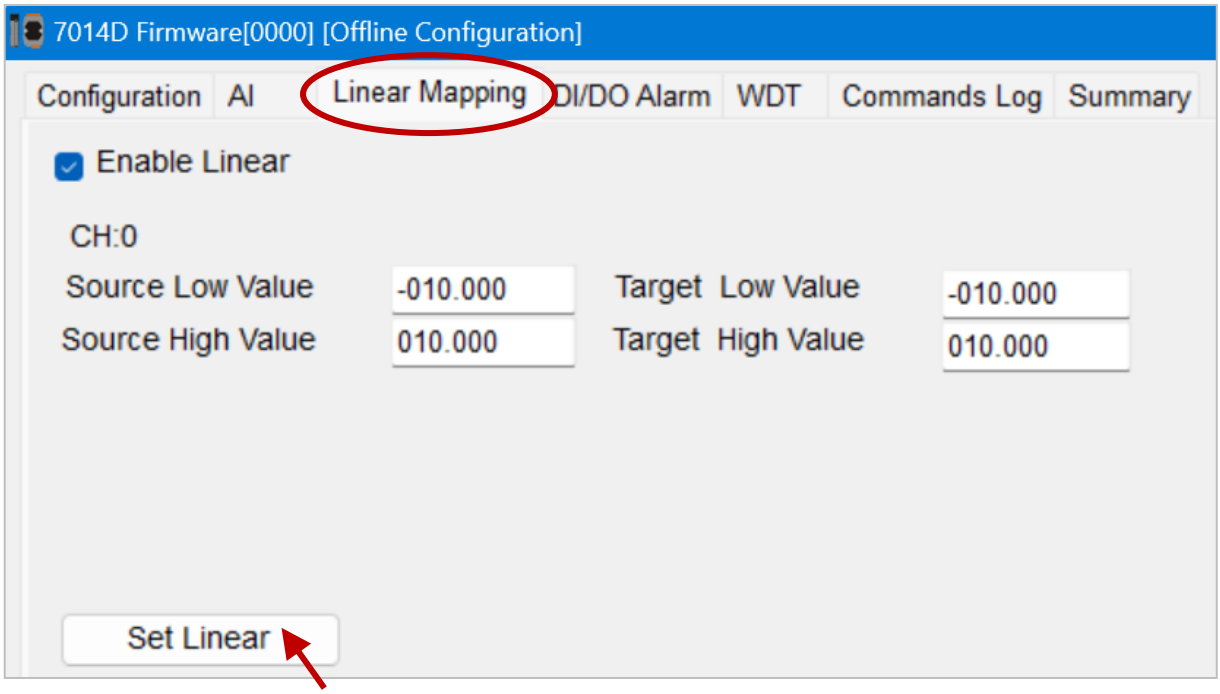
   Example: A thermistor with the component number **YSI H Mix 10000** has **Steinhart coefficients** as shown in the table below.

Coefficients	Float Format	Hexadecimal Format
A	1.02949264911967E-03	3A86F00B
B	2.39078592663805E-04	397AB12C
C	1.56816365983255E-07	3428615B

2. Click the **"Calculate"** button to display the coefficients in **hex format**. Then, click the **"Setting"** button to complete the configuration.



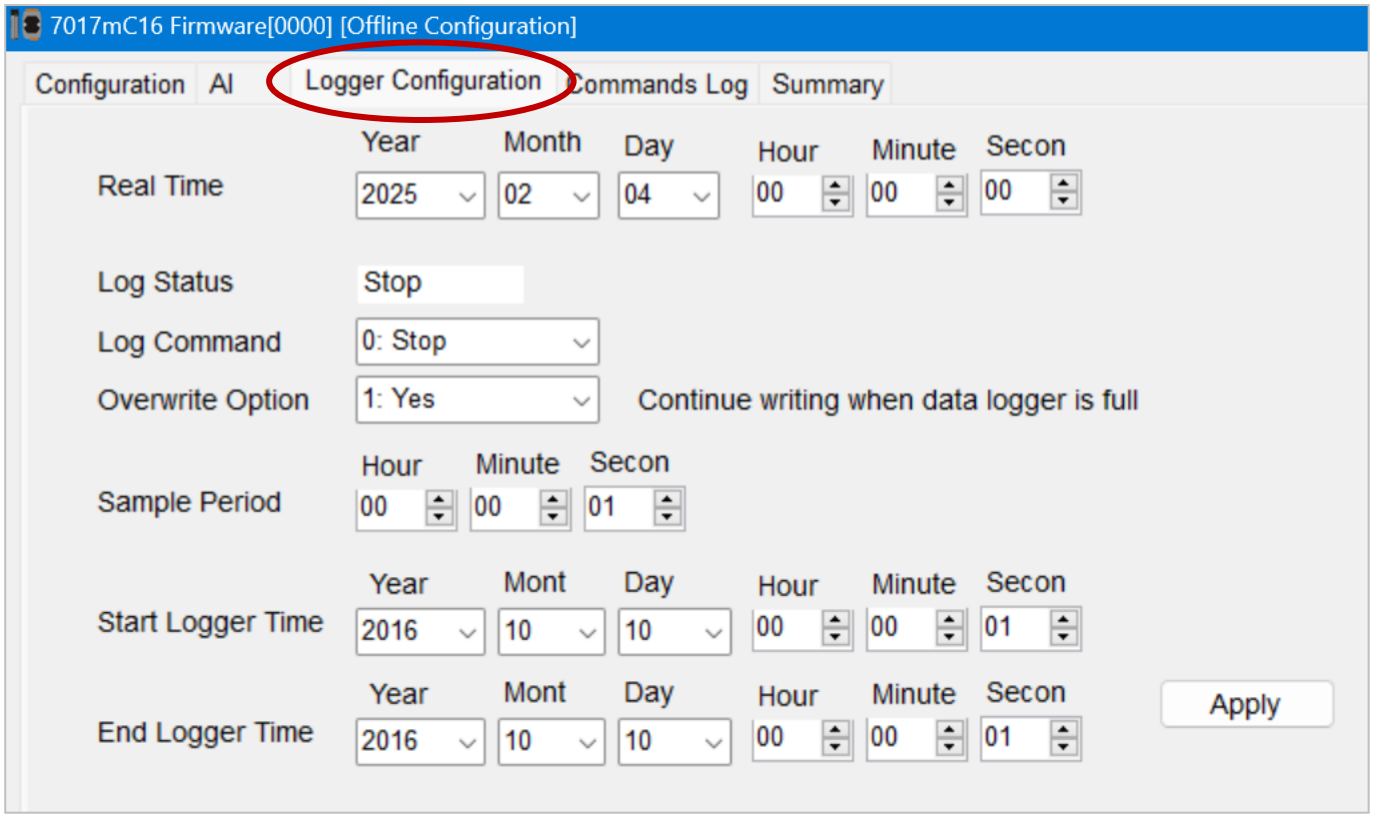
3.4.3 Settings Page - Linear Mapping



Source	Target	Check the **"Enable Linear"** option and specify the **Source Low/High** and **Target Low/High** values. Then, click **"Set Linear"** to apply the settings.
High/Low Value		
It's available for the 7014(D)/16(D)/16P(D)		

3.4.4 Settings Page – Logger Configuration (M-7017mC-16)

The **M-7017mC-16** is a 16-channel current input module with a built-in **data logger** capable of recording input values for all channels, including **date and time information**. It can store up to **100,000 records**, which can be downloaded.



Real Time	Set the current time. (Year/Month/Day/Hour/Minute/Second)
Log Status	Display the current logging status.
Log Command	Set the logging mode: • **0: Stop** – Stop logging. • **1: Run** – Start logging. • **2: Run in Period Mode** – Enables periodic logging.
Overwrite Option	Specifies whether to overwrite data: • **1: Yes** – If the storage is full, new data will overwrite old data. • **2: No** – Stop logging when storage is full.
Sample Period	Set the logging interval. (Hour/Minute/Second)
Start Logger Time	Set the start time for periodic logging. (Year/Month/Day/Hour/Minute/Second)
End Logger Time	Set the stop time for periodic logging. (Year/Month/Day/Hour/Minute/Second)
Apply	Click this button to apply all settings.

3.5 I/O Alarm Settings Page

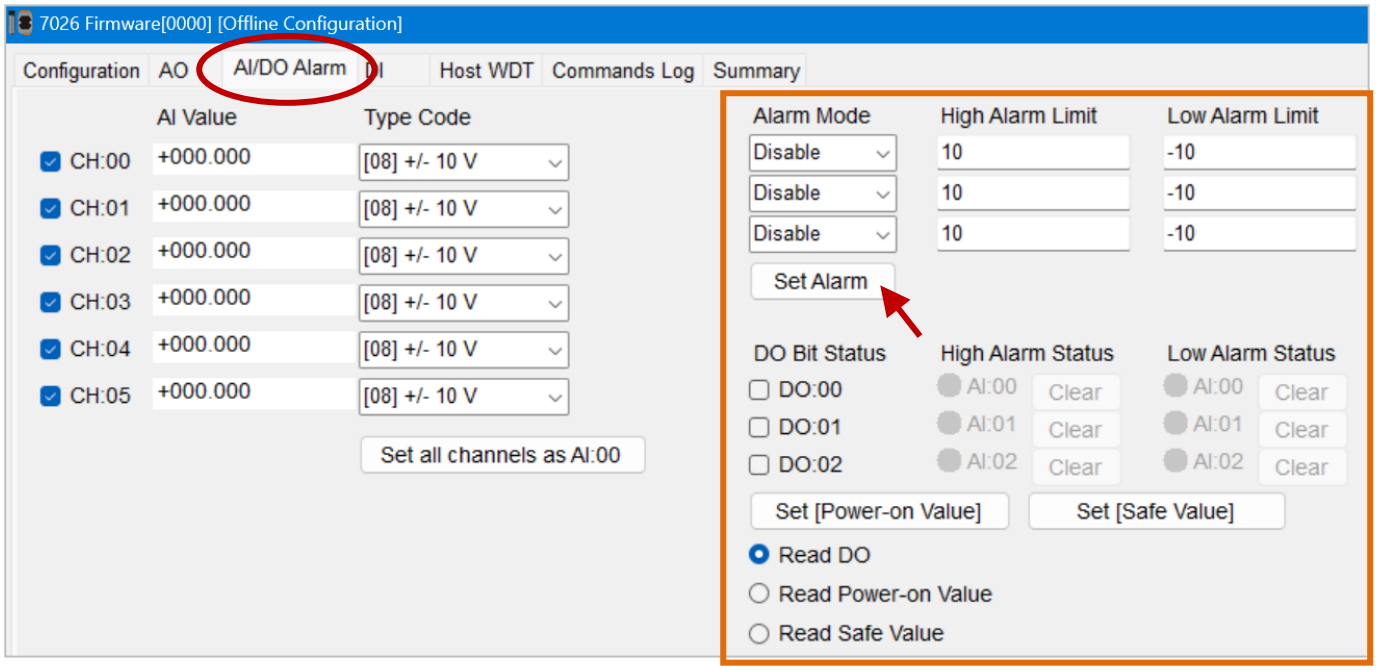
In addition to the I/O setting, the following models provide the “Alarm” function.

Settings Pages	Model
AI/DO Alarm	7026
DI/DO Alarm	7014(D)/16(D)/16P(D)
AI Alarm	7005
DO/Alarm (1)	7002, 7003
DO/Alarm (2)	7080(D)/80B(D)
DO/Alarm Status	7005

Note: The DI/DO/Alarm setting for the 7011(D)/11P(D)/12(D)/12F(D)/13P are listed on the AI page. Refer to the following description.

3.5.1 Settings Page - AI/DO Alarm

Model	AI Channel	AO Channel	DI Channel	DO Channel
7026	6	2	3	3



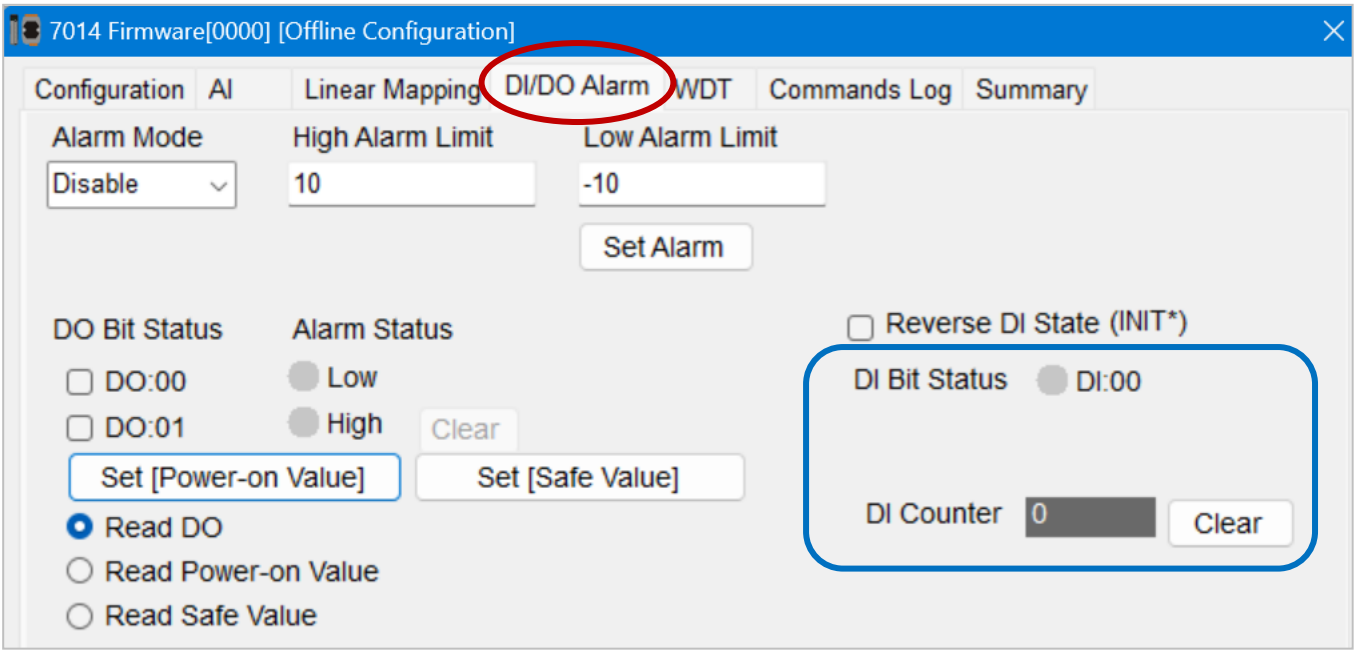
When **Alarm Mode = Disable**, **DO** can be configured.

Alarm Mode	• **Disable** – Alarm function is disabled. • **Momentary** – If the value exceeds the alarm limit, an alarm is triggered and remains active until the value returns to normal. • **Latch** – If the value exceeds the alarm limit, an alarm is triggered and remains active until manually cleared.
High Alarm Limit	Set the upper alarm threshold based on the **Type Code** setting.

Low Alarm Limit	Set the lower alarm threshold based on the **Type Code** setting.
Set Alarm	Click the **"Set Alarm"** button to apply all the above settings.
DO Bit Status	Set the DO value, Power-On Value, or Safe Value. Check **DO: xx** and click "Set Power-On/Safe Value" to configure its status. Otherwise, click "Read Power-On/Safe Value" to display its status.
High Alarm Status	Display or clear the alarm status 1) A red indicator lights up when the value exceeds the alarm threshold. 2) In Latch mode, click the "**Clear**" button to manually reset the alarm.
Low Alarm Status	

3.5.2 Settings Page - DI/DO Alarm

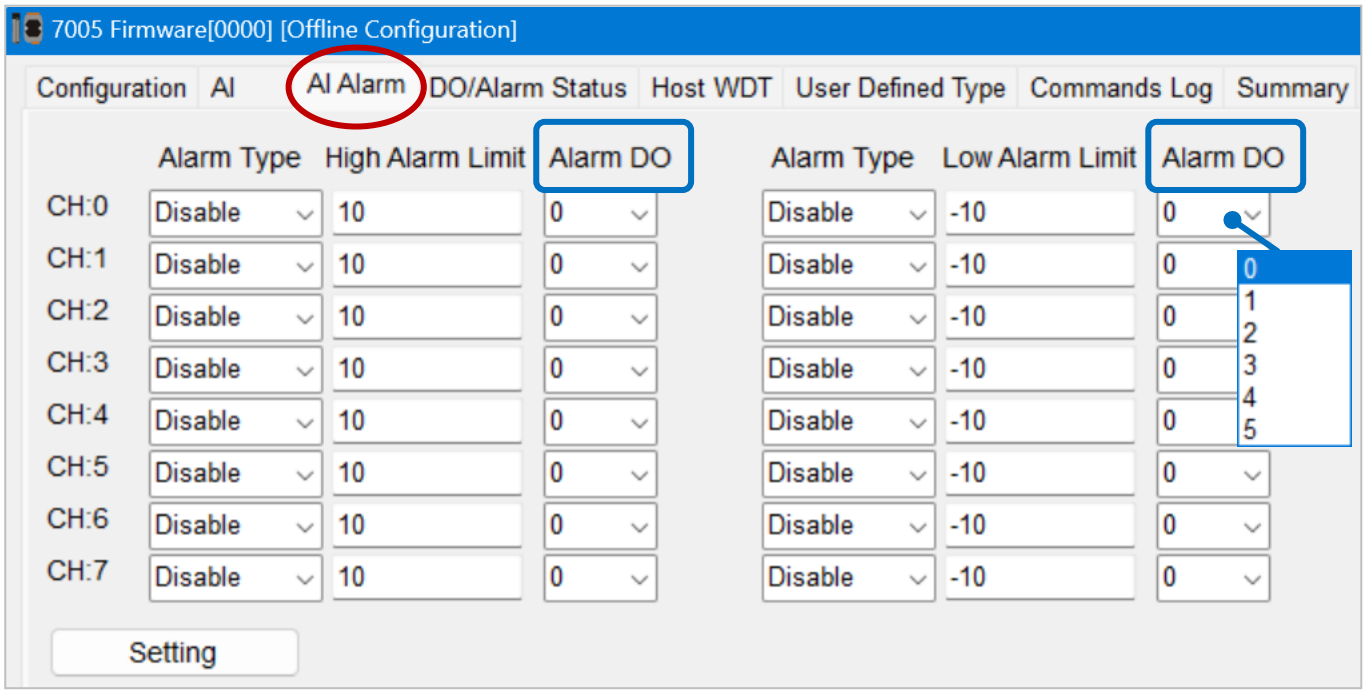
Model	AI Channel	AO Channel	DI Channel	DO Channel
7014(D)	1	-	1	2
7016P(D)	1	1	1	4
7016(D)	2			



For more details on related settings, refer to Section 3.5.1: Settings Page - AI/DO Alarm.

DI Bit Status	Display the status of DI0
DI Counter	When the DI is used as a counter, the count value can be displayed and cleared.

3.5.3 Settings Page - AI Alarm



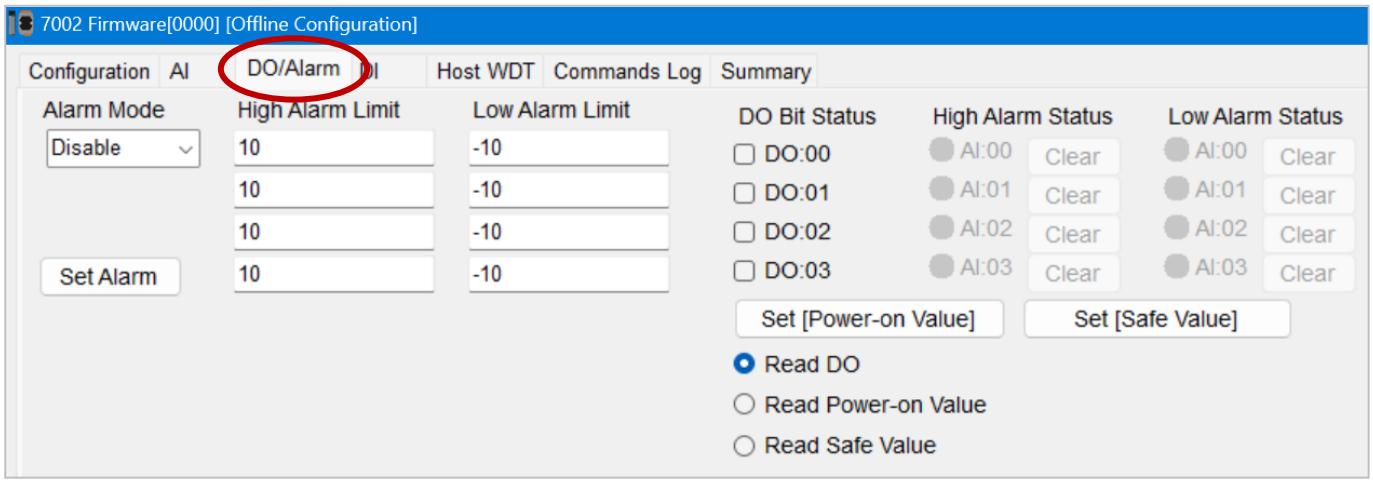
For more details on related settings, refer to Section 3.5.1: Settings Page - AI/DO Alarm.

Alarm DO	When the AI value exceeds the alarm threshold, the DOx alarm will be trigger.

3.5.4 Settings Page - DO/Alarm

For more details on related settings, refer to Section 3.5.1: Settings Page - AI/DO Alarm.

Model	AI Channel	DI Channel	DO Channel
7002	4	5	4
7003	8	-	4



3.5.5 Settings Page - DO/Alarm (/LED) (7080/80B)

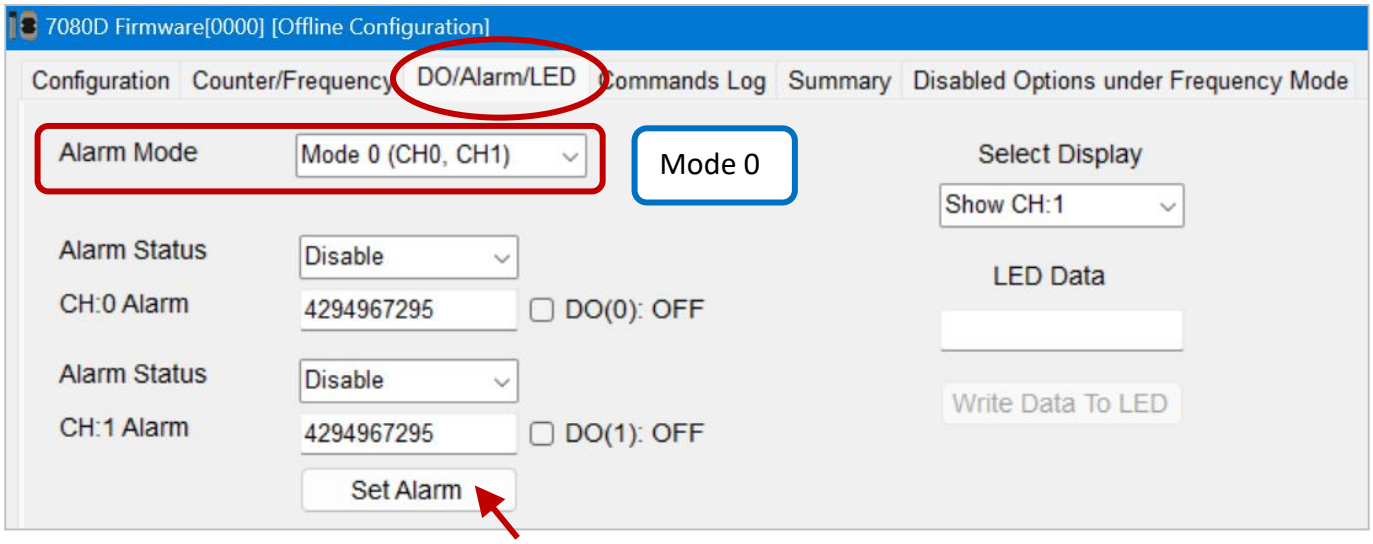
Model	Counter/Frequency Channel	DO Channel
7080(D), 7080B(D)	2	2

DO0 and DO1 can be used as general DO or alarm outputs in the following ways:

1. In **Frequency** mode, DO0/1 can function as general DO.
2. In **Counter** mode with Alarm disabled, DO0/1 can function as general DO.
3. In **Counter** mode with Alarm enabled, DO0/1 can function as an alarm output.

(Users can set the mode to **Up Counter** or **Frequency** on the "**Configuration**" page.)

Mode 0 (CH0, CH1)



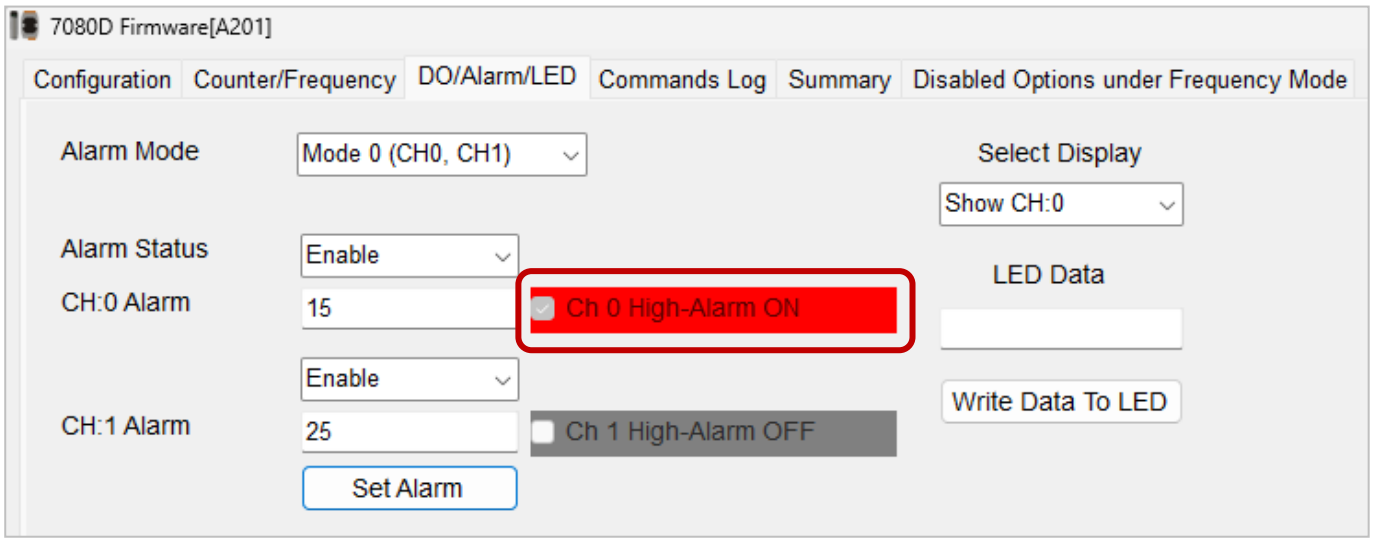
Alarm Mode	Set to Mode 0 or Mode 1
Mode 0 (CH0, CH1)	
Alarm Status	Enable or disable the alarm function.
DO(0), DO(1)	When Alarm Status is disabled, DO(0) and DO(1) can function as general DO. Checked: ON ; Unchecked: OFF
CH0, CH1 Alarm	Set the upper limit value of the alarm. (Default = 4294967295)

When **Alarm Status** = **Disable**, the DO status will display as follows:

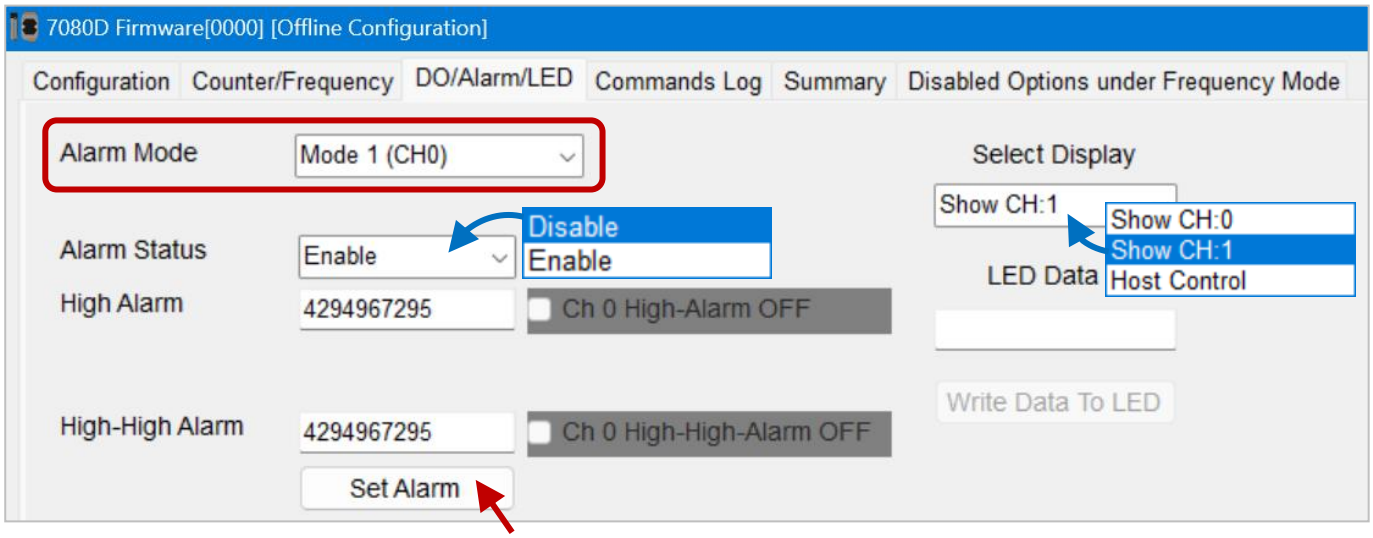
DI Counter (CH0, CH1)	[CH0 High Alarm]	[CH1 High Alarm]
	DO0	DO1
Counter 0/1 value < Alarm limits	OFF	OFF
Counter 0 value ≧ Alarm limits	ON	-
Counter 1 value ≧ Alarm limits	-	ON

Set Alarm	Click the "Set Alarm" button to apply the settings.

When **Alarm Status** (CH0, CH1) is enabled, and Counter 0 reaches or exceeds the alarm limit, the test result is displayed as shown in the figure below.



Mode 1 (CH0)

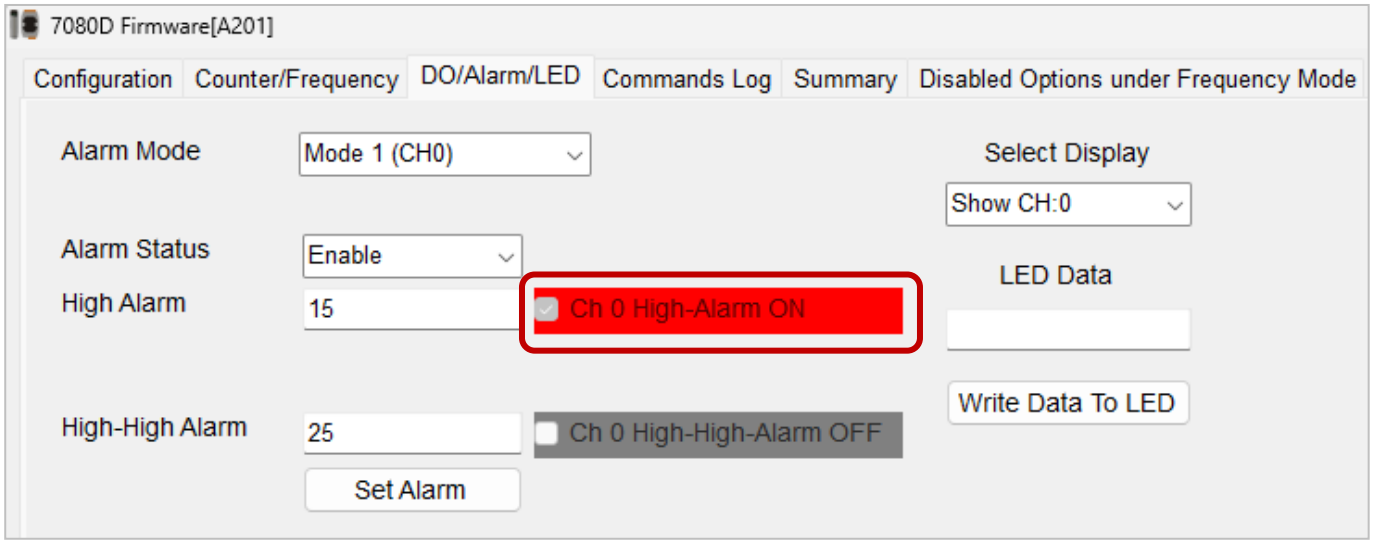


Alarm Mode	Set to Mode 0 or Mode 1
Mode 1 (CH0)	
Alarm Status	Enable or disable the alarm function.
DO(0), DO(1)	When Alarm Status is disabled, DO0 and DO1 can function as general DO. Checked: ON ; Unchecked: OFF
High Alarm	The **High-High Alarm** value must be set greater than the **High Alarm** value. (Default: 4,294,967,295)
High-High Alarm	
Set Alarm	Click the "**Set Alarm**" button to apply the settings.
Select Display	**Show CH:0/CH:1**: Display the DO0/DO1 status on the module's LED display. **Host Control:** The DO status is controlled by the host.
LED Data	When **Host Control** is selected, enter the value to be displayed on the module's LED, then click "**Write Data To LED**" to apply it.

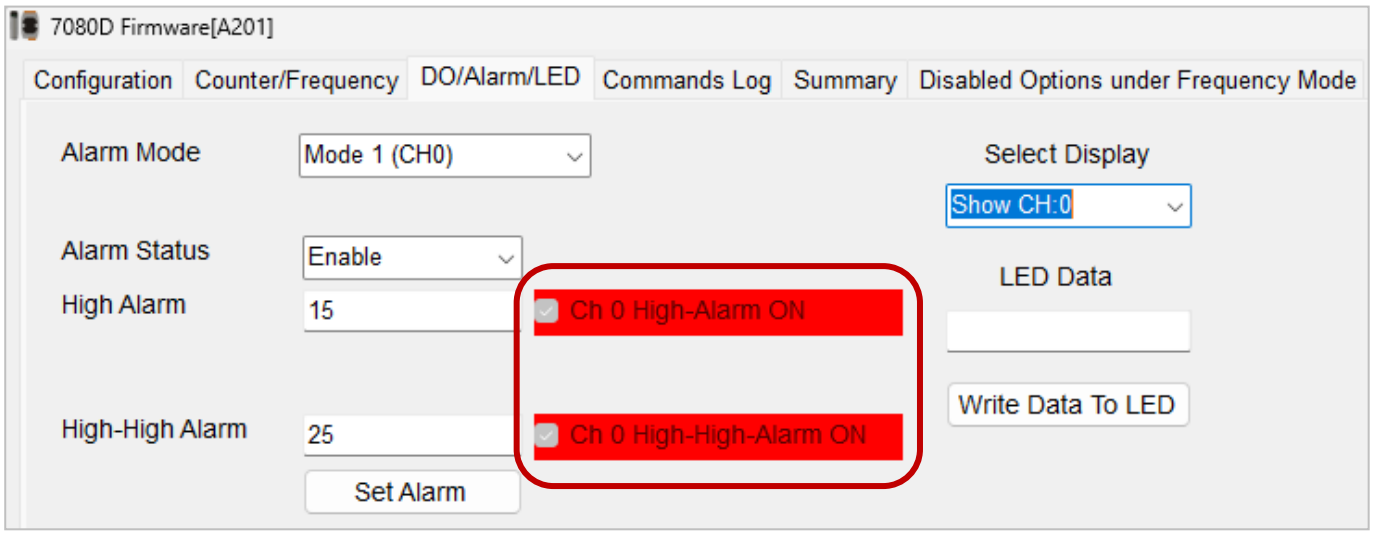
When **Alarm Status** = **Enable**, the DO status will display as follows:

DI Counter [CH0]	[CH0 High Alarm]	[CH0 High-High Alarm]
	DO0	DO1
Counter value < High Alarm value	OFF	OFF
High Alarm value ≤ Counter value < High-High Alarm value	ON	OFF
Counter value ≥ High-High Alarm value	ON	ON

When the **alarm state (CH0)** is enabled, and **Counter 0** exceeds the **High Alarm** value but is still less than the **High-High Alarm** value, the test result is displayed as follows.

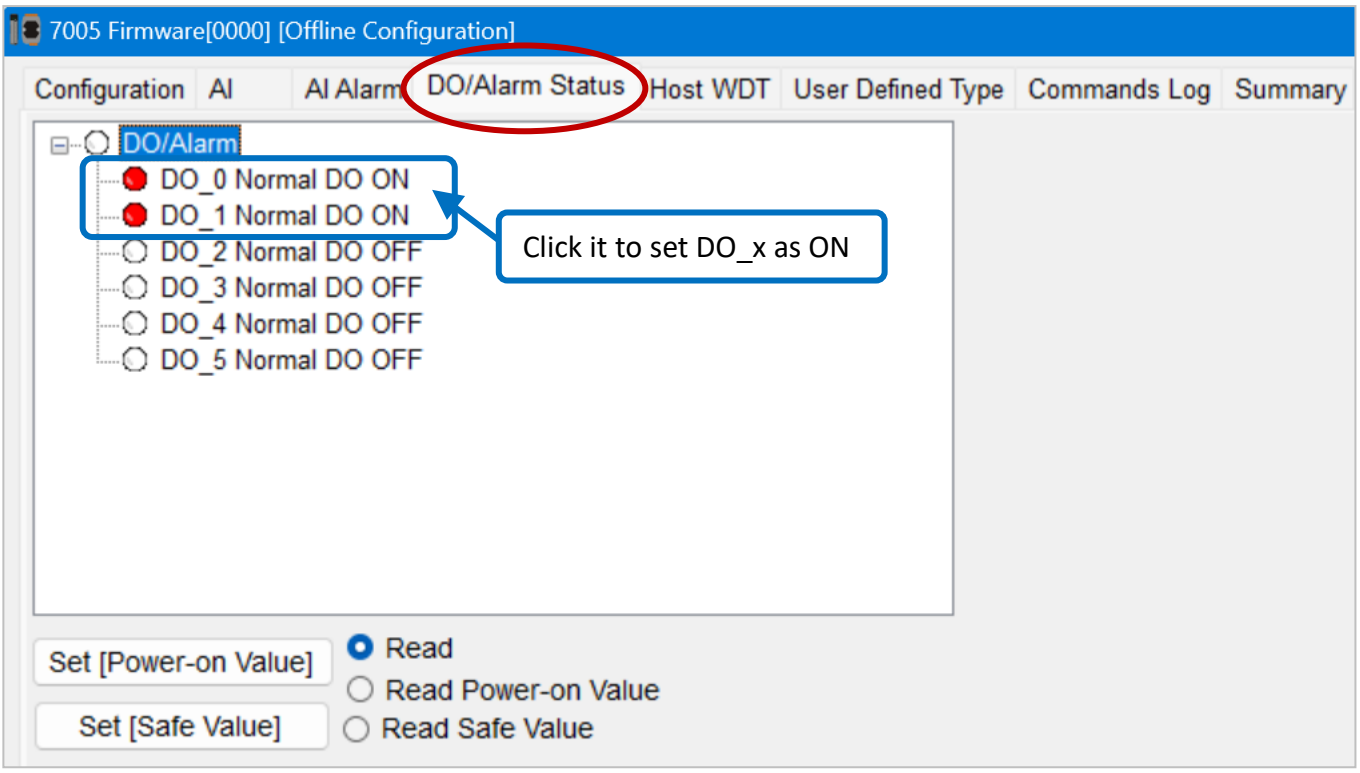


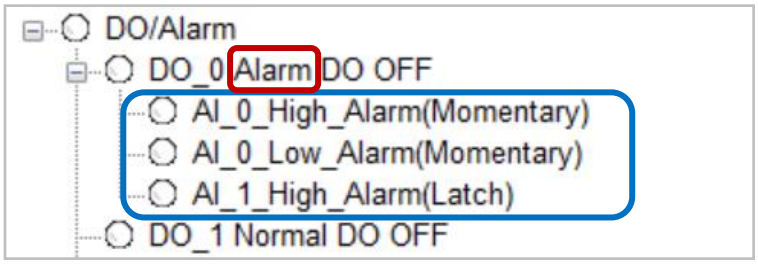
When the **alarm state (CH0)** is enabled, and **Counter 0** exceeds the **High-High Alarm** value, the test result is displayed as follows.



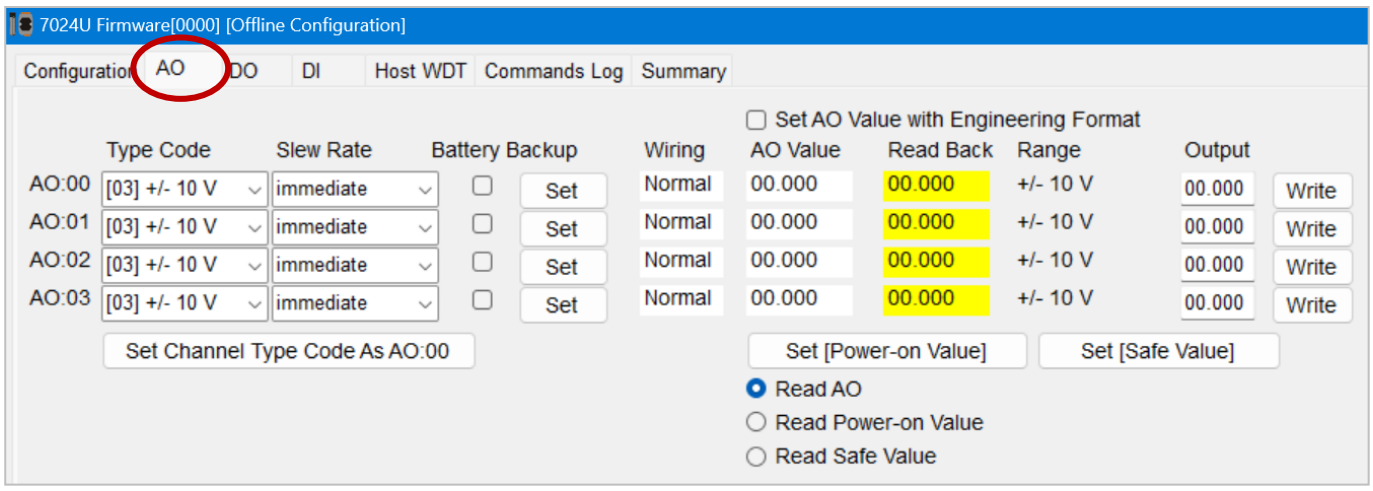
3.5.6 Settings Page - DO/Alarm Status (7005)

Model	AI Channel	DO Channel
7005	8	6



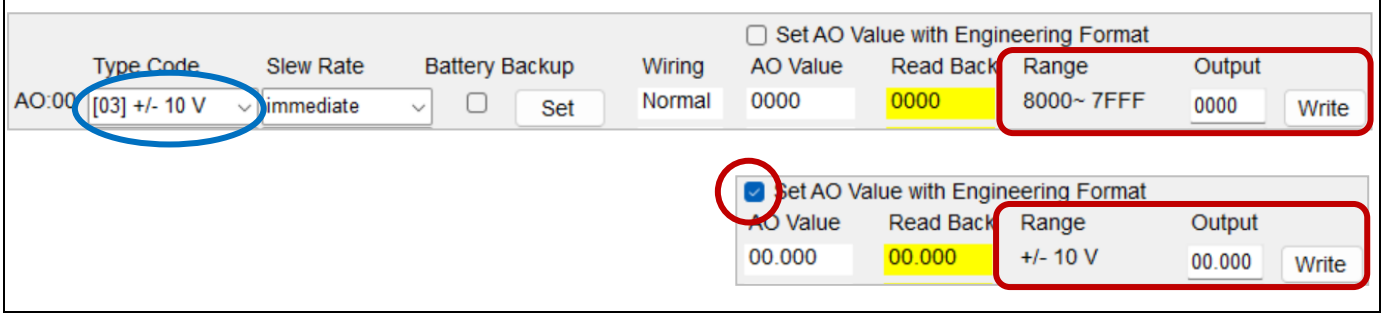
DO/Alarm Status	Set the DO Value, Power-On Value, or Safe Value: ● Select DO_x, then click Set [Power-On/Safe Value] to configure the value. ● To view the current setting, click Read [Power-On/Safe Value]. Typically, the **DO Status** is "**Normal**". It changes to **Alarm** when an alarm is triggered. Additionally, the **AI Alarm Status (Mode)** is displayed. 

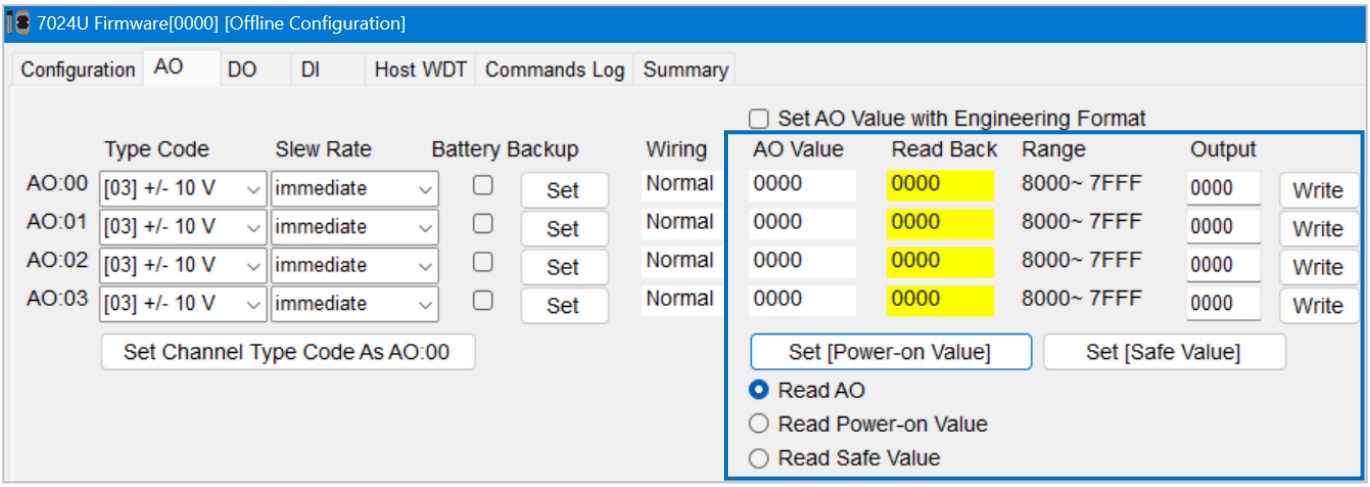
3.6 AO Settings Page



AO Page	Channel Index	Type Code (Default)	Slew Rate	Battery Backup	Wiring	Individual Channel Configuration
7021/21P	00	[32] 0 ~ +10V	Section 3.3.2	-	-	-
7022/22A	00 ~ 01	[02] 0 ~ +10V	o	-	-	o
7024/24L/24R	00 ~ 03	[33] +/-10V	Section 3.3.2	-	-	-
7024U(D)		[03] +/-10V	o	o	o	o
7028(D)	00 ~ 07		o	o	o	o
7026	00 ~ 01		o	-	-	o

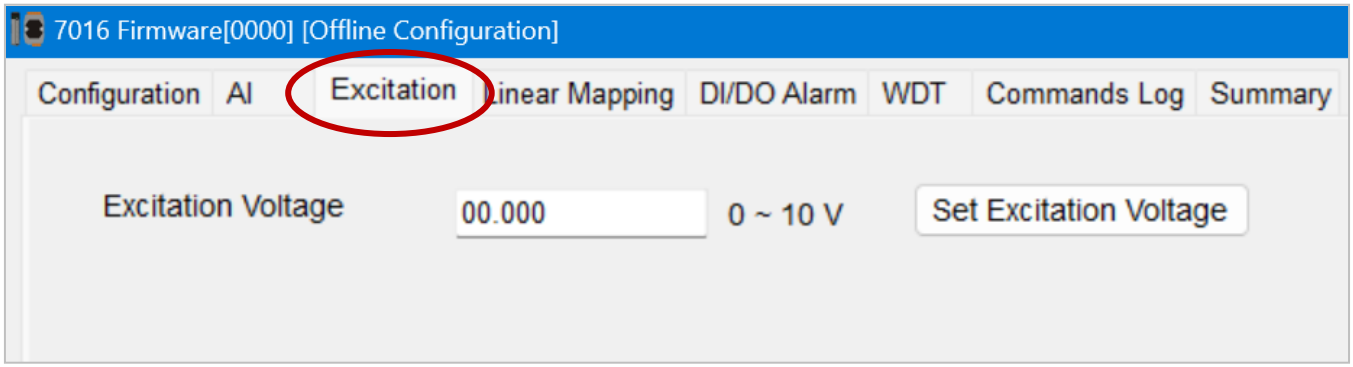
Type Code	Set the data type code and its range.
Slew Rate	Set the rate of change for voltage or current (V/sec, mA/sec) outputs. This setting is on the Configuration page of the 7021/21P, 7024/24L/24R.
Battery Backup	The output value of the 7024U(D) and 7028(D) can be retained in case of power failure.
Set	Click the **Set** button to apply the above settings.
Wiring	The 7024U(D) and 7028(D) provide the open-wire detection.
Set AO value with the Engineering format	Easily set the AO value. For example, when the **Type Code** is set to **±10V** and the **Analog Format** is **2's Complement**, the data range is **8000 to 7FFF**. Enabling this option lets users enter a value directly from **-10 to +10** (e.g., 2.5).





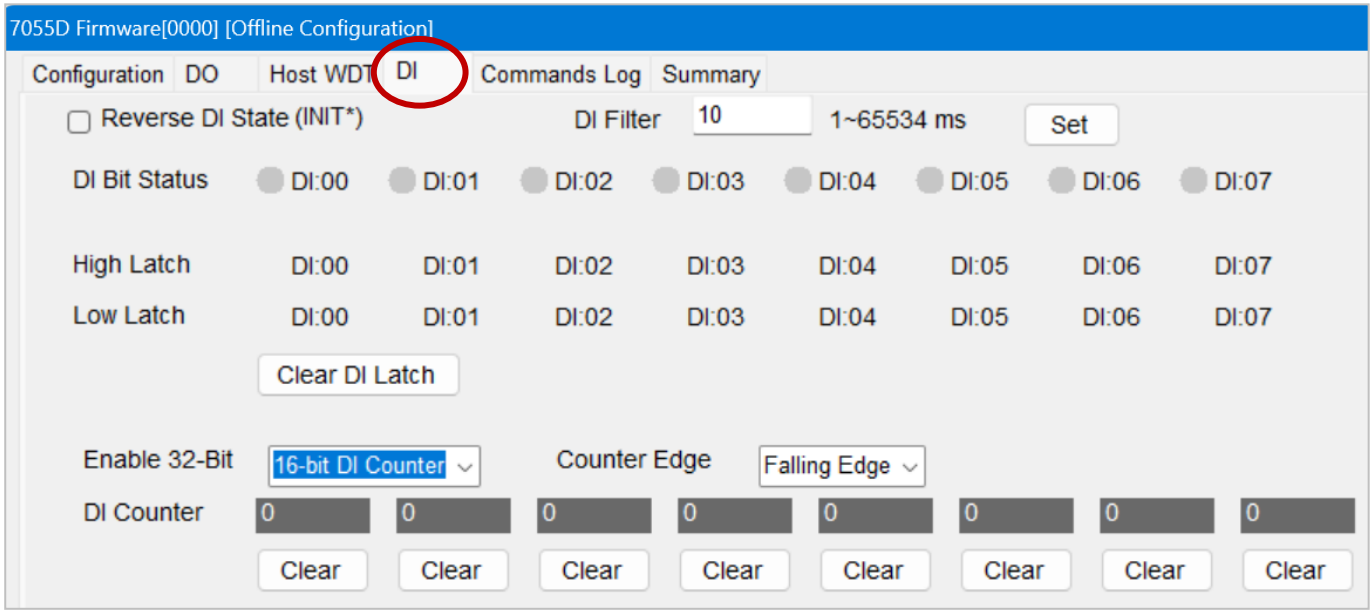
AO Value	Display the configured AO value, power-on value, or safe value.
Read Back	Display the current readback value of the analog output
Note: If the **Slew Rate** is set, the output value will not change immediately. As a result, the configured **AO Value** and the **Read Back** value may differ.	
Range	Display the valid output range. For example, when **Analog Format = 2's Complement**, the range is displayed as **8000 ~ 7FFF**.
Output / Write	Set the AO value, power-on value, or safe value. Enter a value in the **Output** field, then click **Write** to set the **AO Value**. Alternatively, click **Set Power-On Value** or **Set Safe Value** to configure those values. **Note:** Modules **7021/7021P** do not support reading the **Power-On Value**.
Read AO, Power-on Value, Safe Value	Upon selecting an item, the titles **AO Value** and **Read Back** will automatically update to reflect the selected item and show the readings.

3.6.1 Settings Page - Excitation



Excitation Voltage	Enter the desired output voltage value, then click the **Set Excitation Voltage** button to apply the setting.
	It's available for the 7016(D)/16P(D).

3.7 DI Settings Page

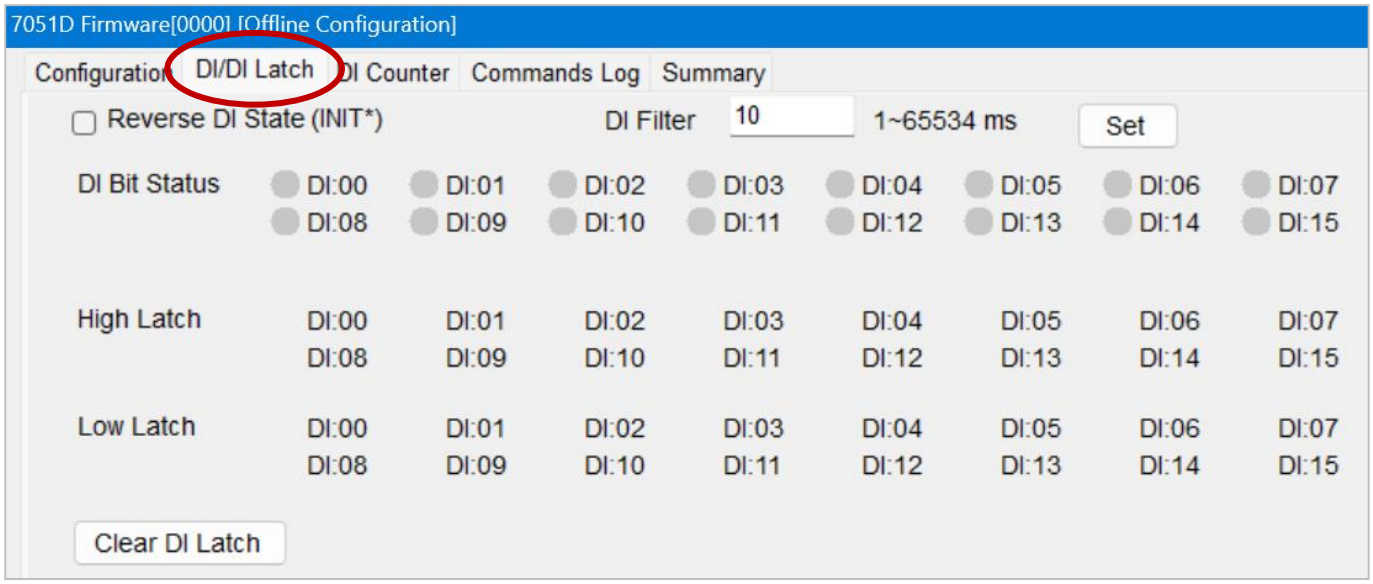


DI Page	Channel	DI Reverse	DI Filter	DI Bit Status	DI Latch	DI Counter	Enable 32-Bit	Counter Edge
7026	2	o	-	o	o	o	-	-
7024U(D)	4	o	-				-	-
7044(D)							o	o
7060(D)								o
7065(D)/65A(D)/65B(D)			o					o
7002	5	o	-				-	-
7024R		-						
7050(D)/50A(D)	7	o	-				o	o
7052(D)	8	-	o				o	o
7055(D)		o	o					
7058(D)/59(D)		-	-					
7063(D)/63A(D)/63B(D)		o	o					

Reverse DI State		Enables DI status inversion. Configuration is only allowed in INIT mode.
DI Filter		To prevent false triggering caused by high-frequency noise, users can specify a time (1 to 65534 ms), which defines how long a DI status change must persist before it is recognized as valid. Then, click **Set** to apply the setting.
DI Bit Status		Display the status (ON/OFF) of each DI channel.
DI Latch	High Latch	Display the high-level latch status of each DI channel.
	Low Latch	Display the Low-level latch status of each DI channel.
	Clear DI Latch	Clear the latch status of all DI channels.
DI Counter	Enable 32-Bit	Enable either **16-bit** or **32-bit** counter functionality.
	Counter Edge	Increment the counter by **1** when the DI signal transitions from **High to Low** or **Low to High**.
	Clear	Clear the counter value of each DI channel.

3.7.1 Settings Page - DI/DI Latch

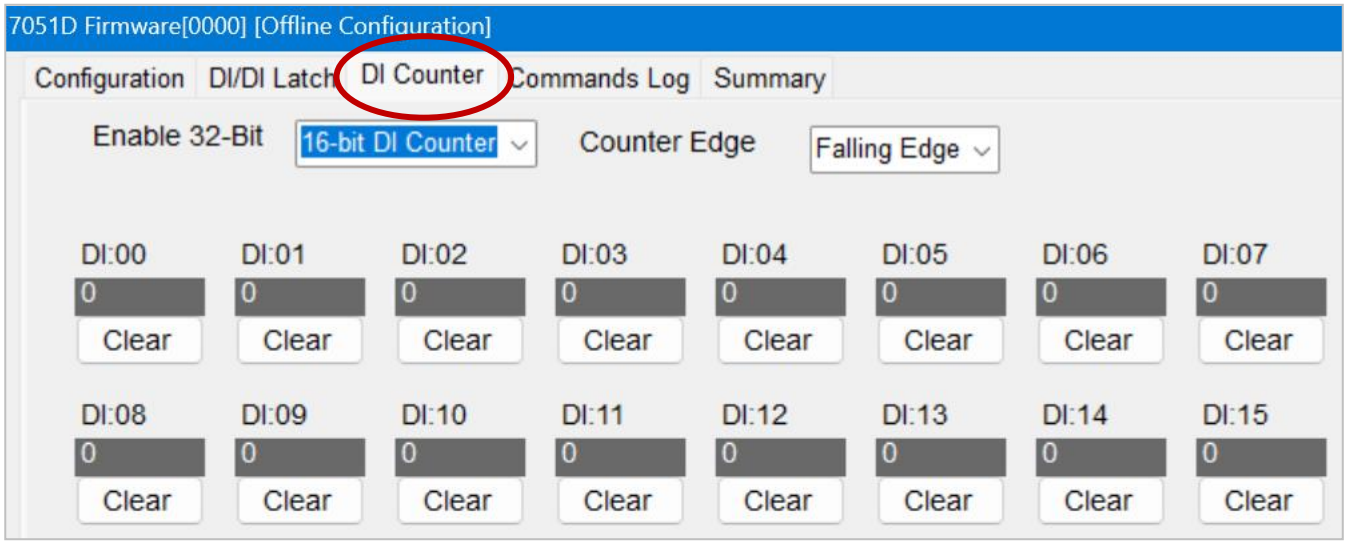
For more details on related settings, refer to Section 3.7: DI Settings Page.



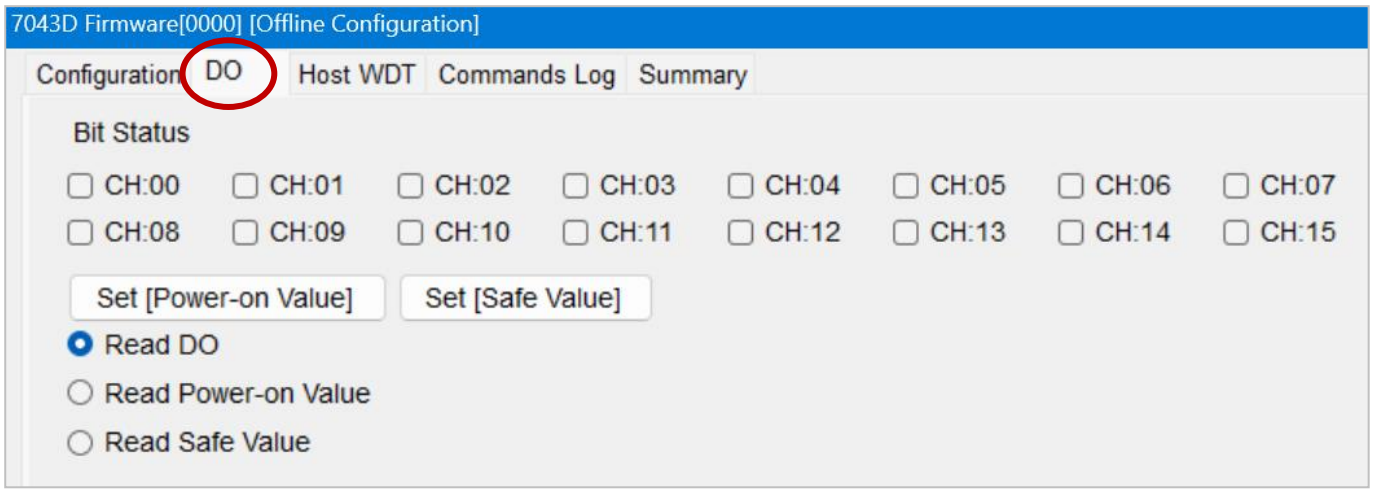
Page		DI/DI Latch				DI Counter	
Model	**Channel**	**DI Reverse**	**DI Filter**	**DI Bit Status**	**High/Low Latch**	**Enable 32-Bit**	**Counter Edge**
7041(D)	14	o	o	o	o	o	o
7046(D)	15	o	-				
7051(D)	16	o	o				
7053(D)			-				
7054(D)			-				
7054P(D)			-				
7058-16		-	-				

3.7.2 Settings Page - DI Counter

For more details on related settings, refer to Section 3.7: DI Settings Page.



3.8 DO Settings Page



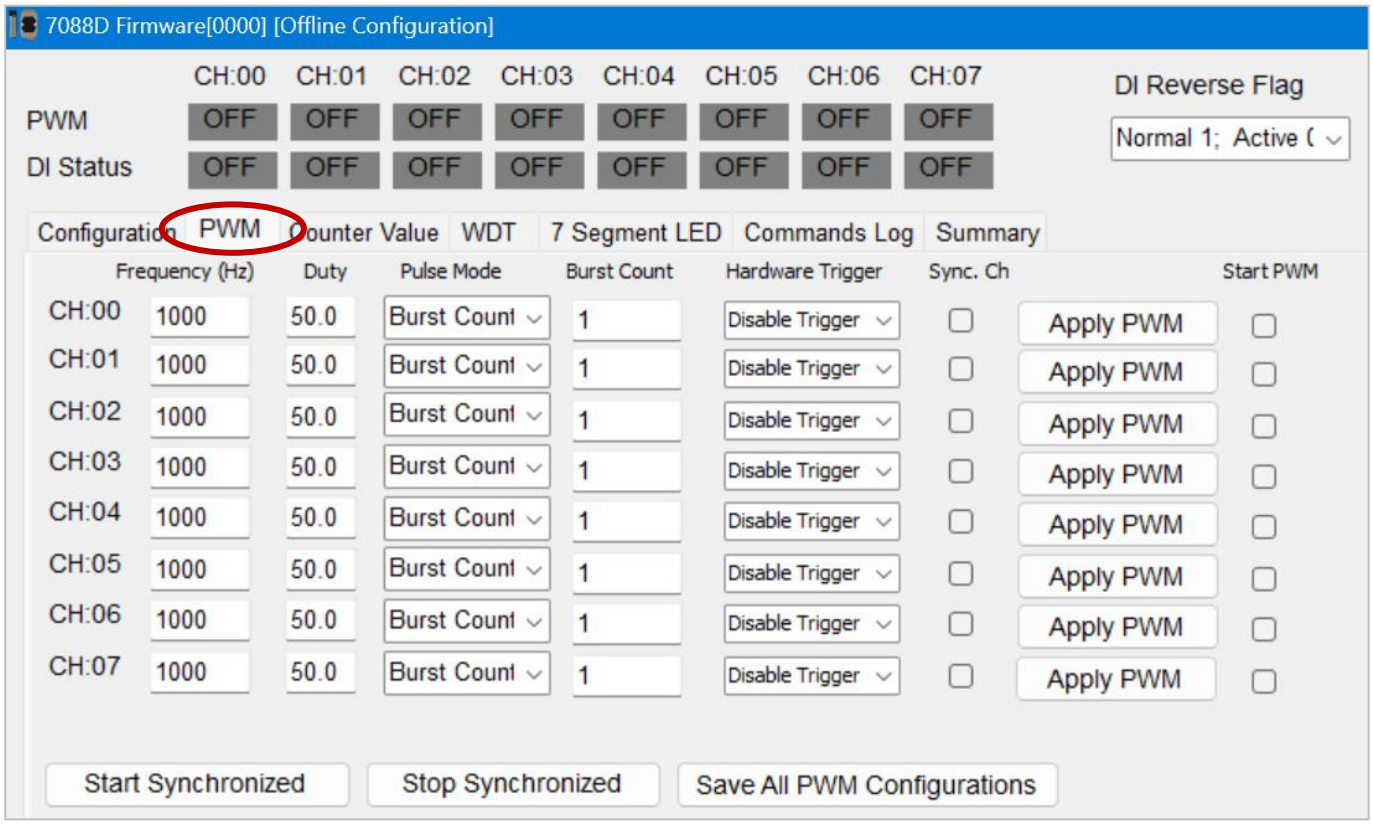
Bit Status	Set the status of DOx. - Checked: ON - Unchecked: OFF
Set [Power-on Value] Set [Safe Value]	Select the checkbox for **CH: xx**, then click the **Set Power-on Value** or **Set Safe Value** button to configure the respective value.
Read DO, Read Power-on Value, Read Safe Value	Select one of these options to view the current settings.

DO Page	Channel	Bit Status	Set/Read Power-on Value	Set/Read Safe Value
7058-16	2	o	o	o
7063(D)/63A(D)/63B(D)	3			
7024U(D)/60(D)	4			
7065(D)/65A(D)/65B(D)	5			
7066(D)/67(D)	7			
7044(D)/50(D)/50A(D)/55(D)/64(D)/68(D)/69(D)	8			
7061(D)	12			
7042(D)	13			
7043(D)/45(D)/54(D)/54P(D)	16			

3.9 Counter, Frequency, and Encoder

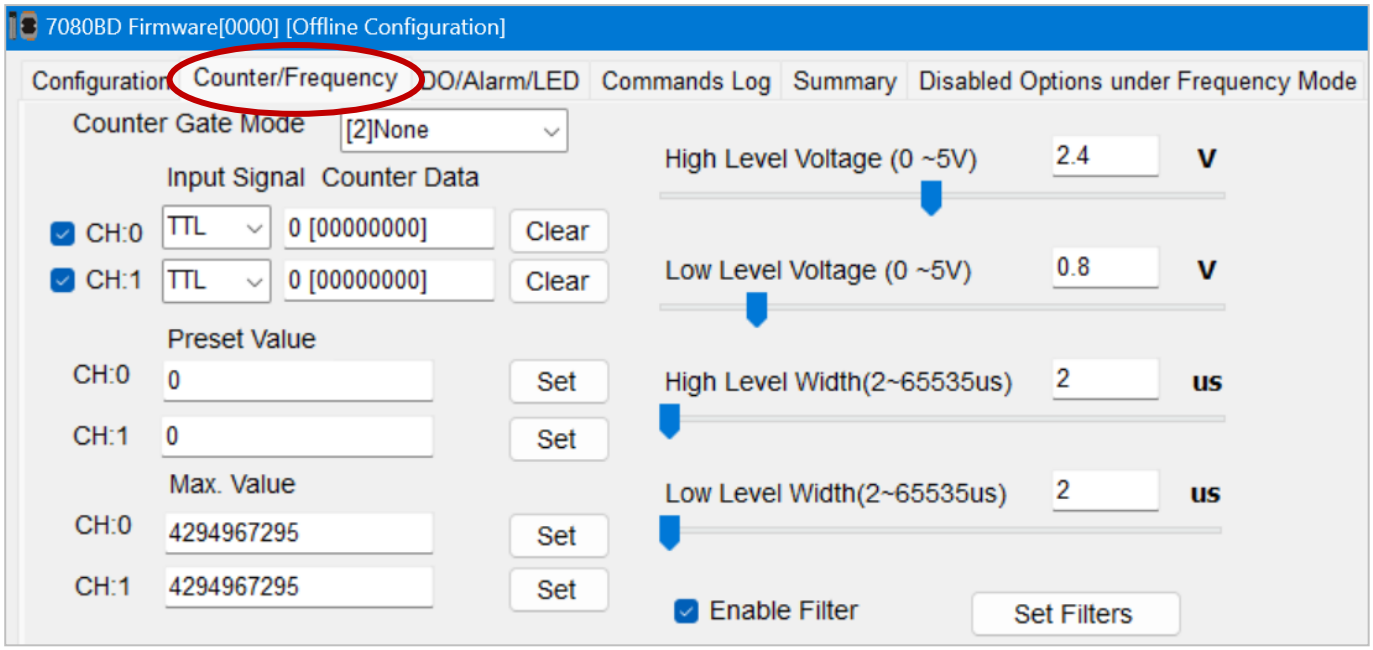
3.9.1 Settings Page - PWM

The PWM (Pulse Width Modulation) function outputs a waveform with an adjustable duty cycle and frequency through DO signals, allowing control of analog circuits such as motor position/speed, lamp brightness, and fan speed.



Frequency (Hz)	Set the frequency. (Range: 1 Hz to 500 KHz)
Duty	Set the duty cycle which represents the proportion of time the system remains "active" within a cycle. (Range: 0.1 ~ 99.9 %)
Pulse Mode	Set the pulse mode: **Burst Count** or **Continuous**.
Burst Count	Set the number of pulses in a burst. (Range: 1 ~ 65535)
Hardware Trigger	Set the trigger mode**:** ● **Disable Trigger** – Software trigger mode. ● **Trigger Start** – Activate hardware trigger. ● **Trigger Stop** – Deactivate hardware trigger.
Sync. Ch	Checked: Enable synchronized output. Unchecked: Output independently.
Apply PWM	Click this button to apply PWM settings.
Start PWM	Enable the PWM function when checked.
Start Synchronized	Click this button to activate synchronized PWM output.
Stop Synchronized	Click this button to deactivate synchronized PWM output.
Save All PWM Configurations	Click this button to save all PWM settings

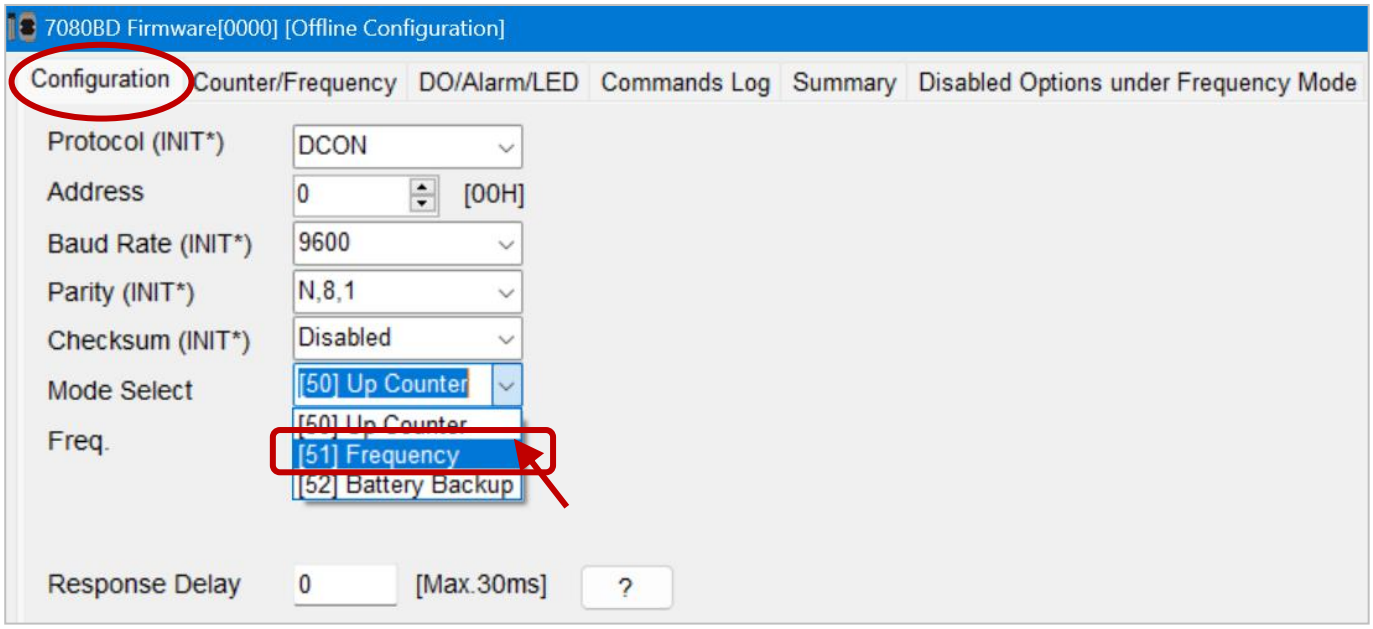
3.9.2 Settings Page – Counter/Frequency (7080/80B)



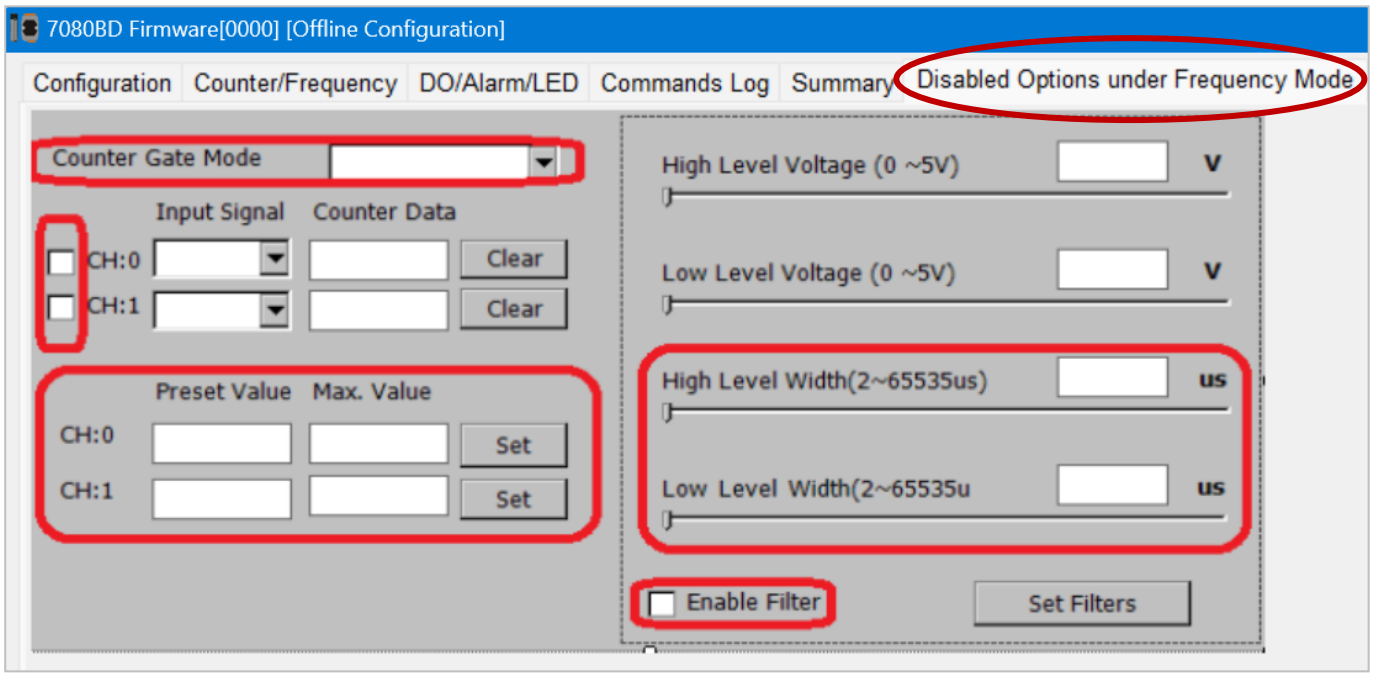
Counter Gate Mode	In **Frequency** mode, this setting is ignored. In **Counter** mode, the gate control function is disabled by default. [0] Low Active: The counter is enabled only when the gate input is Low. [1] High Active: The counter is enabled only when the gate input is High. [2] None: The counter is always enabled.
Input Signal	The input signal can be selected as either **TTL** (Transistor-Transistor Logic) or **Photo** (Isolated).
Counter Data	Display the current counter value.
Clear	Reset the counter to the initial value and clear the overflow flag.
Preset Value	Set the initial value of the counter, with a default of 0. This setting can be ignored in Frequency mode.
Max. Value	Set the maximum counter value.
Set	Click this button to apply the configured value.
High Level Voltage	Set the high-level trigger voltage (Default: 2.4V).
Low Level Voltage	Set the low-level trigger voltage (Default: 0.8V).
High Level Width	Set the minimum width of the input signal at high level. (Default: 2 µs).
Low Level Width	Set the minimum width of the input signal at low level. (Default: 2 µs).
Enable Filter	Check this box to enable the digital filter.
Set Filters	Click this button to apply the filter settings.

➢ Disable Options under Frequency Mode (7080/80B)

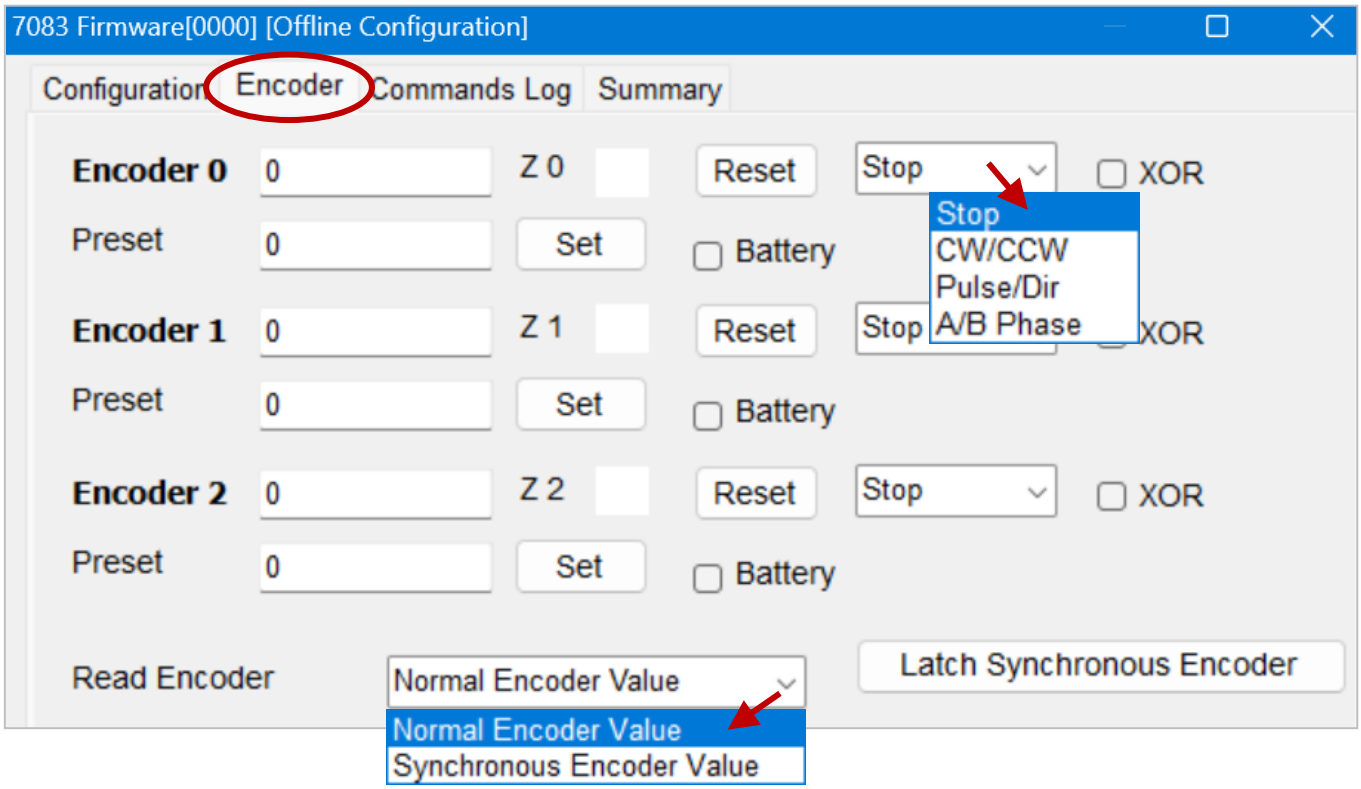
When the 7080(D)/80B(D) module is set to **Frequency** mode, certain settings on the **Count/Frequency** page will be disabled.



The following settings will be disabled in **Frequency** mode.



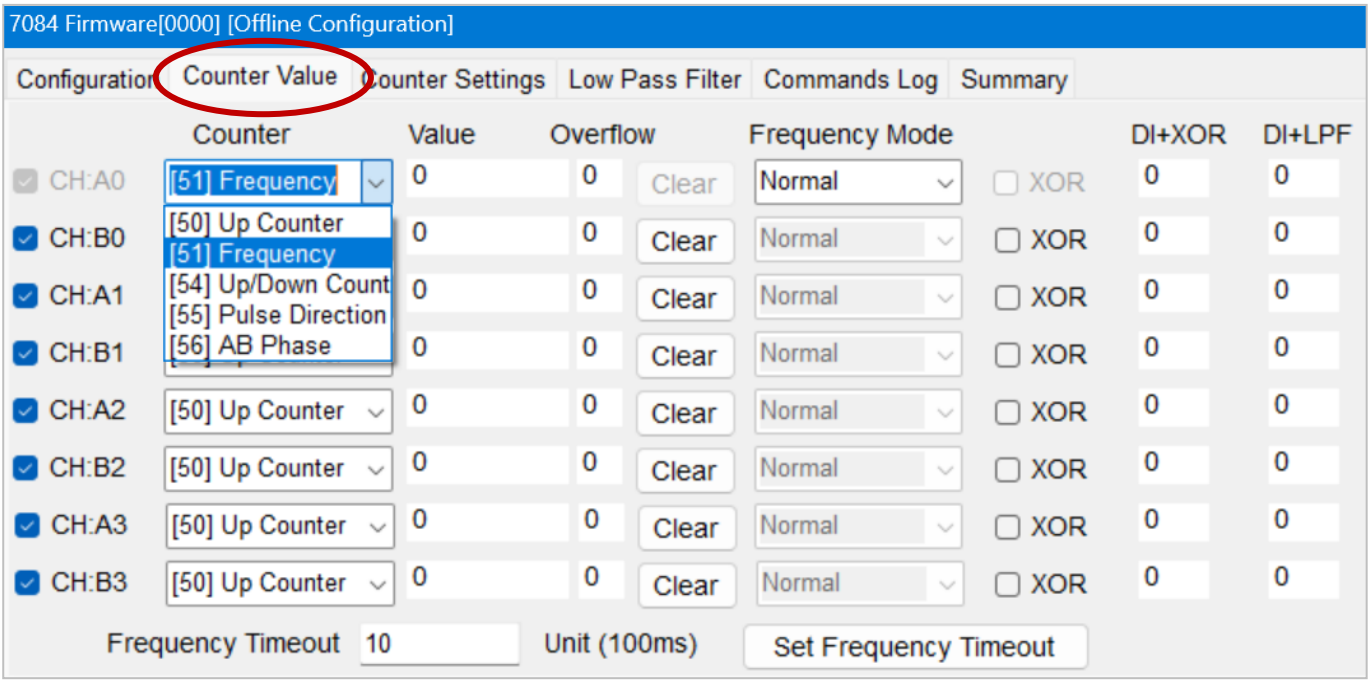
3.9.3 Settings Page - Encoder (I-7083, 7083B)



Encoder 0/1/2	Display the current value of Encoder 0, 1, or 2.
Preset	Enter the initial counting value, then click the **Set** button to apply the setting.
Z 0/1/2	Display the status of Z0, 1, or 2 as **Hi** or **Lo**.
Reset	Clear the encoder value.
Battery Backup	Enables value retention during power failure when checked.
Encoder Mode	Set the encoder mode to one of the following: - **Stop** - **CW/CCW** - **Pulse/Dir** - **A/B Phase**
XOR	Built-in XOR logic circuit; controls whether the encoder input triggers on **High Level** or **Low Level**.
Read Encoder	Normal Encode Value: Read the current encoder value. Synchronous Encoder Value: Read the synchronous encoder value.
Latch Synchronous Encoder	Synchronizes and latches encoder values from all I-7083 modules on the same RS-485 network.

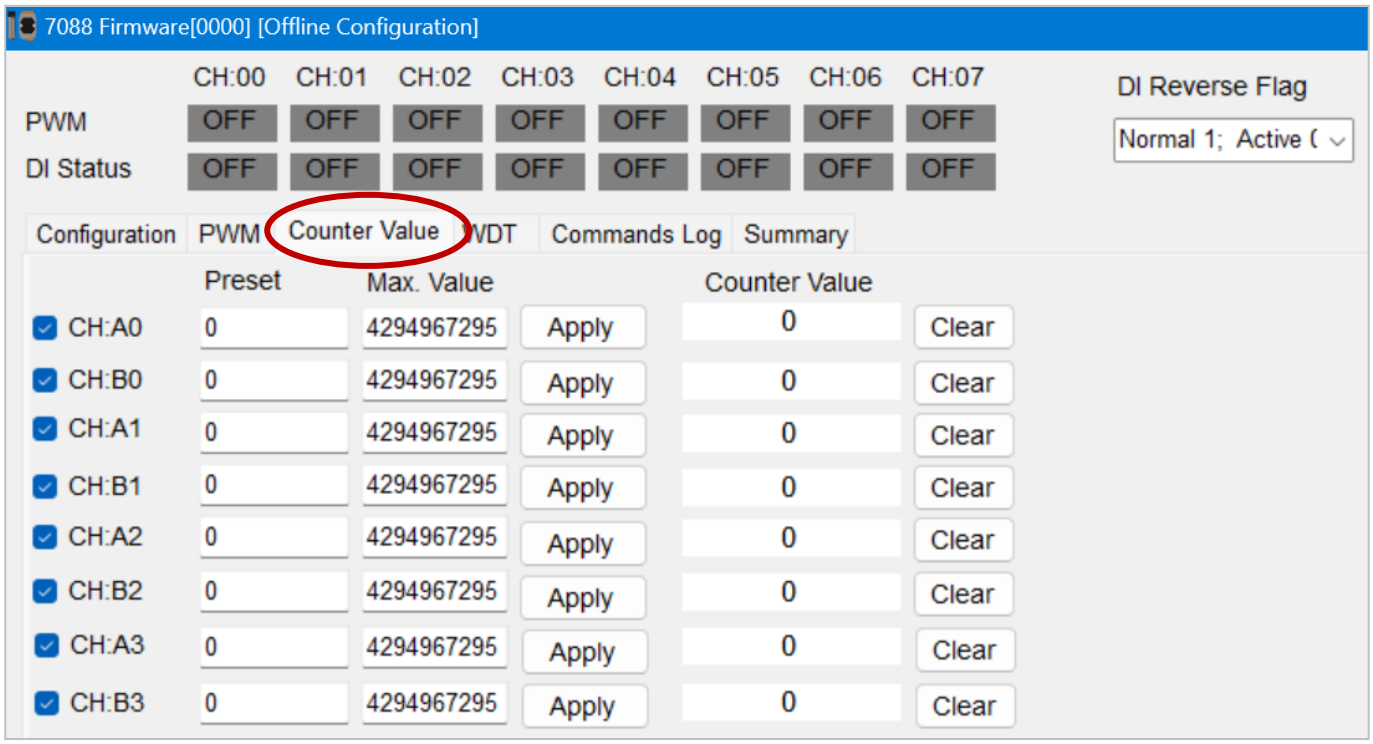
3.9.4 Settings Page - Counter Value (M-7084, 7088)

➢ **For the M-7084**



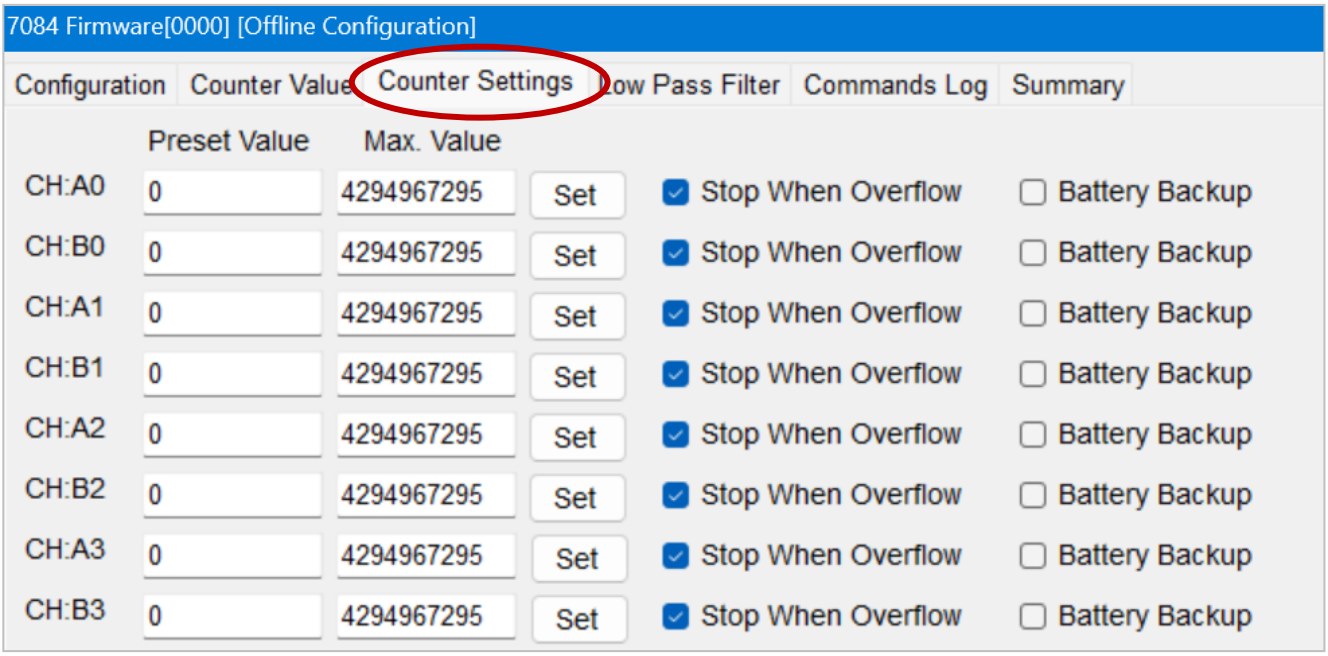
Counter	Counter Mode: [50] Up Counter, [54] Up/Down Counter Frequency Mode: [51] Frequency Encoder Mode: [55] Pulse Direction, [56] AB Phase
Value	Display the current counter value.
Overflow	In **Type Code [50]** mode, 0: No overflow；1: Overflow In **Type Code [54] – [56]** mode, 00: No overflow；01: Upper limit overflow； 10: Lower limit overflow；11: Not applicable
Clear	Resets the counter to the preset value and clear the overflow status flag.
Frequency Mode	In **Frequency Mode**, the measurement speed can be set to “Normal” or “High Speed”.
XOR	Check this option to enable XOR masking.
DI+XOR	Display the input status after applying XOR masking.
DI+LPF	Display the input status after applying a low-pass filter (LPF).
Frequency Timeout	Set the timeout period for frequency measurement (0.1 to 25.5 seconds).
Set Frequency Timeout	Click this button to apply the timeout setting .

➢ **For the 7088(D)**



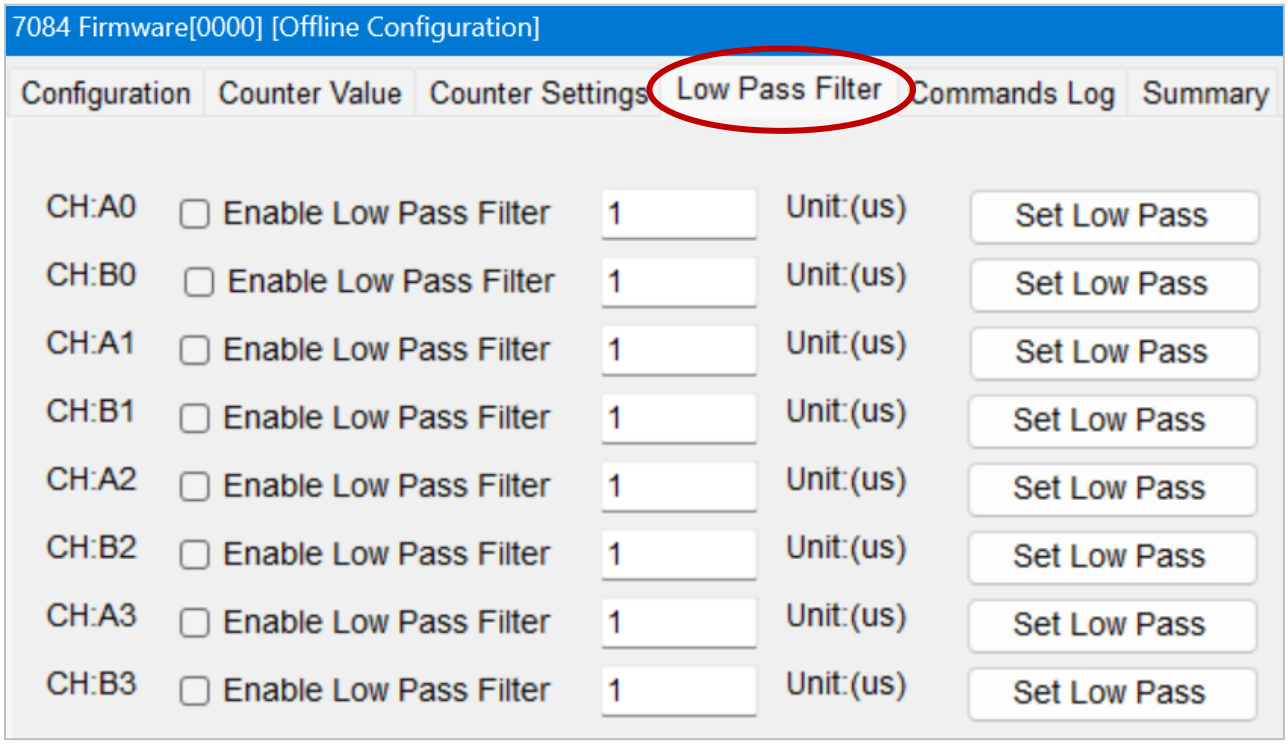
Preset	Set the initial counter value.
Max. Value	Set the maximum counter value.
Apply	Click this button to apply the settings.
Counter Value	Display the current counter value.
Clear	Reset the counter to the initial (preset) value.

3.9.5 Settings Page - Counter Settings (M-7084)



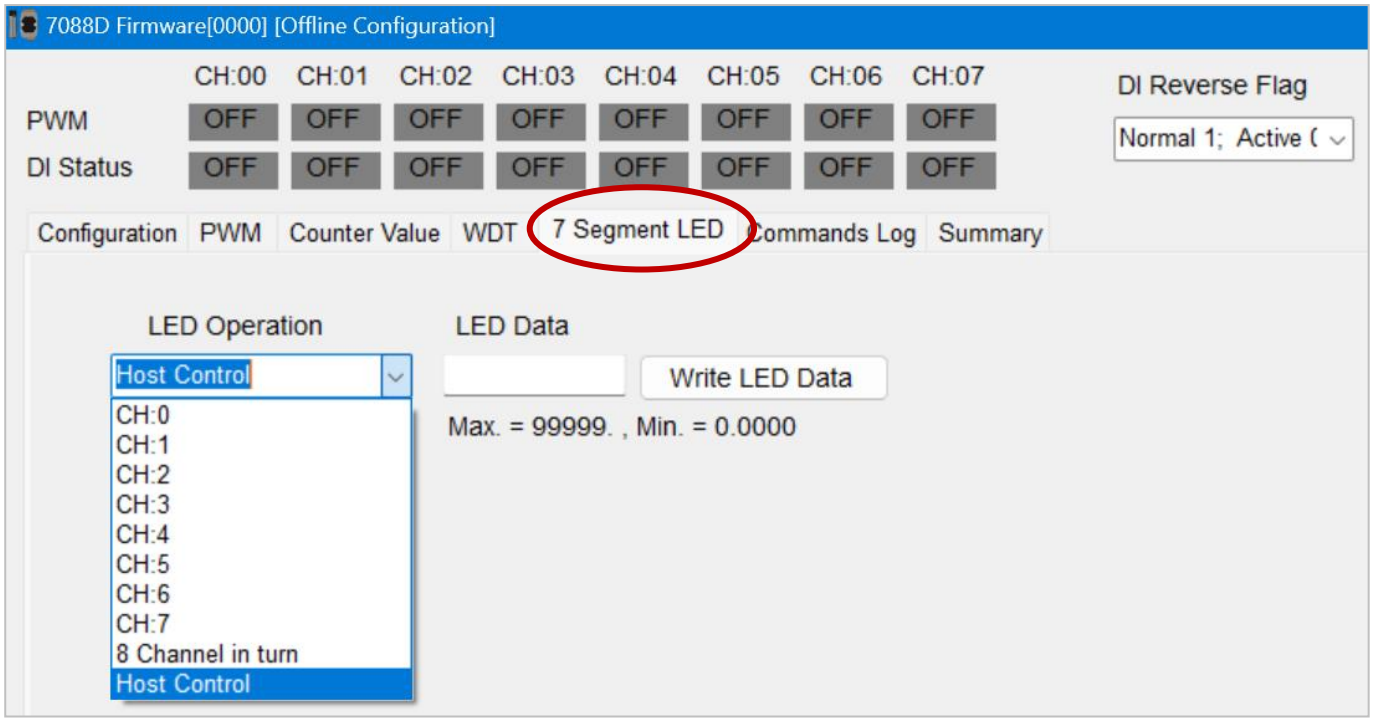
Preset Value	Set the initial counter value
Max. Value	Set the maximum counter value.
Set	Click this button to apply the settings.
Stop When Overflow	If checked, counting stops when an overflow occurs. (Applicable only to [50] Up Counter.)
Battery Backup	If checked, the counter value is retained during a power failure. (Not applicable to [51] Frequency mode.)

3.9.6 Settings Page - Low Pass Filter (M-7084)



Enable Low Pass Filter	Check this option to enable the low-pass filter.
Unit (µs)	Set the time constant of the low-pass filter. (Range: 1 to 32767 µs).
Set Low Pass	Click this button to apply the configured time constant.

3.9.7 Settings Page - 7 Segment LED (7088D)



LED Operation	**CH: 0 to 7:** Display the counter value of the specified channel on the LED display. **8 Channel in turn:** Sequentially displays the counter values of all 8 channels. **Host Control:** Display a custom value specified by the host/PC.
LED Data	When **Host Control** is selected, enter the desired value to display on the LED
Write LED Data	Click this button to write and display the entered value.

3.10 Settings Page – Host WDT

The **Host Watchdog** monitors whether the host is operational. A **Host Watchdog Timeout** occurs when the module does not receive a communication OK signal from the host. In this case, the module automatically outputs the **safe values** configured by the user on the **AO** or **DO** page.

The mechanisms for using the **Host Watchdog** differ between **DCON** and **Modbus RTU**, as follows:

Determining Whether Host Communication is Normal:

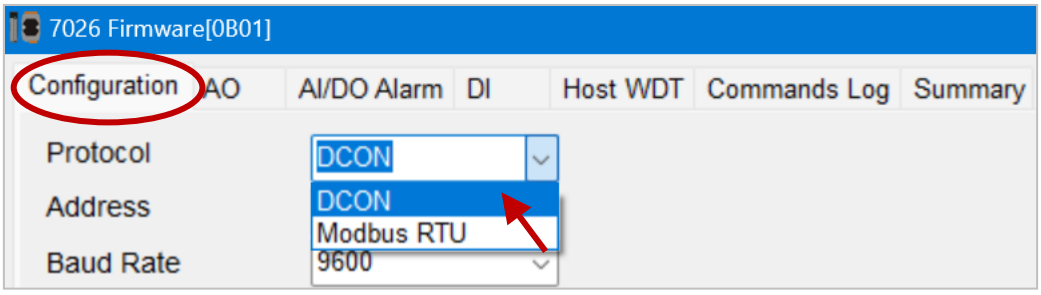
DCON: The host must send an additional broadcast command to all **I-7000 modules** on the same RS-485 network.

Modbus RTU: Only the module receives any valid Modbus RTU command.

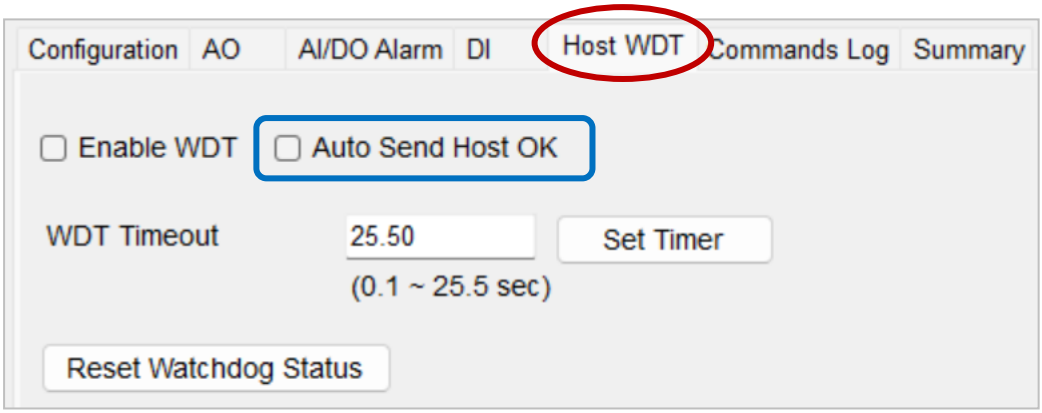
After a Host Timeout Occurs and the Host Recovers:

DCON: The host must send a specific command to each module individually to clear the timeout status before it can update **AO or DO** output values as usual.

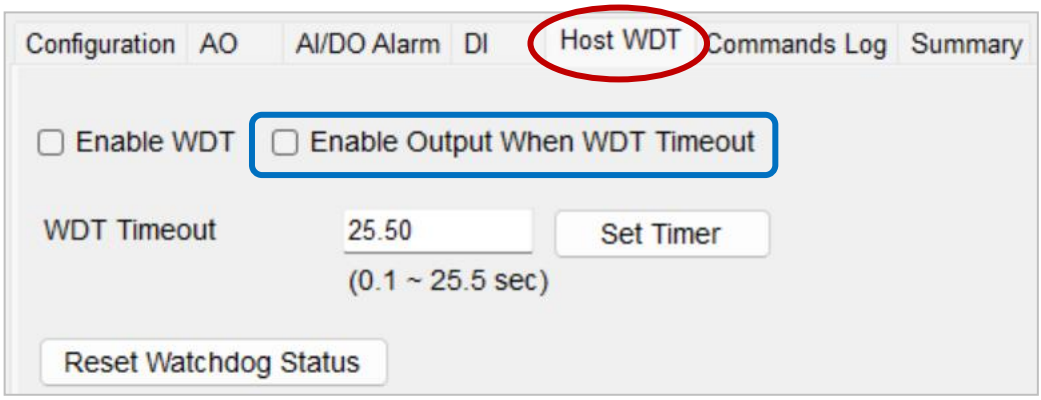
Modbus RTU: The host can ignore the module's timeout status and directly send Modbus RTU commands to update **AO or DO** output values.



DCON Protocol



Modbus RTU Protocol



Enable WDT	**Checked:** Enable the Watchdog function.
Auto Send Host OK	(Available only when Protocol is set to **DCON**) **Checked:** Simulate a "**Host OK**" signal in DCON Utility, preventing the safe value from being triggered. **Unchecked:** Simulate a "**Host Failed**" signal in DCON Utility. The safe value will be triggered after a timeout.
Enable Output When WDT Timeout	(Available only when Protocol is set to **Modbus RTU**) **Checked (Recommended):** Allow AO/DO values to be changed after a timeout occurs. **Unchecked:** Automatically output the safe value after a timeout. Users must clear the Timeout Status before changing output values.
WDT Timeout / Set Timer	Set the Watchdog timeout period and click the **Set Timer** button to apply the setting.
Reset Watchdog Status	Click this button to clear the Timeout Status. The Timeout Status must be cleared before changing AO/DO values. **Note:** Users can also clear the Timeout Status by writing **0** to **Modbus address 40492** or using the **DCON command ~AA1**.

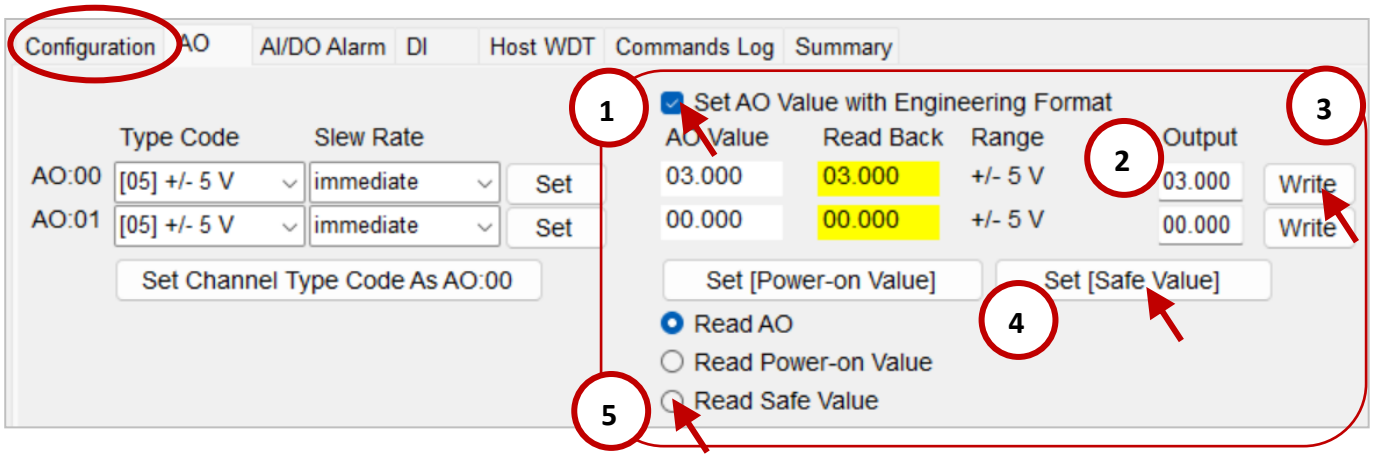
The supported number of AO and DO channels for the following models is shown in the table below.

Model	AO	DO
7021/21P	1	-
7022/22A	2	-
7011(D)/11P(D)/12(D)/12F(D)/13P/14(D)/58-16/80(D)/80B(D)	-	2
7026	2	3
7063(D)/63A(D)/63B(D)	-	3
7002/03/60(D)	-	4
7016(D)/16P(D)	1	4
7024U(D)	4	4
7024/24L/24R	4	-
7065(D)/65A(D)/65B(D)	-	5
7005	-	6
7066(D)/67(D)	-	7
7028(D)/88(D)	8	-
7044(D)/50(D)/50A(D)/55(D)/64(D)/68(D)/69(D)	-	8
7061(D)	-	12
7042(D)	-	13
7043(D)/45(D)/54(D)/54P(D)	-	16

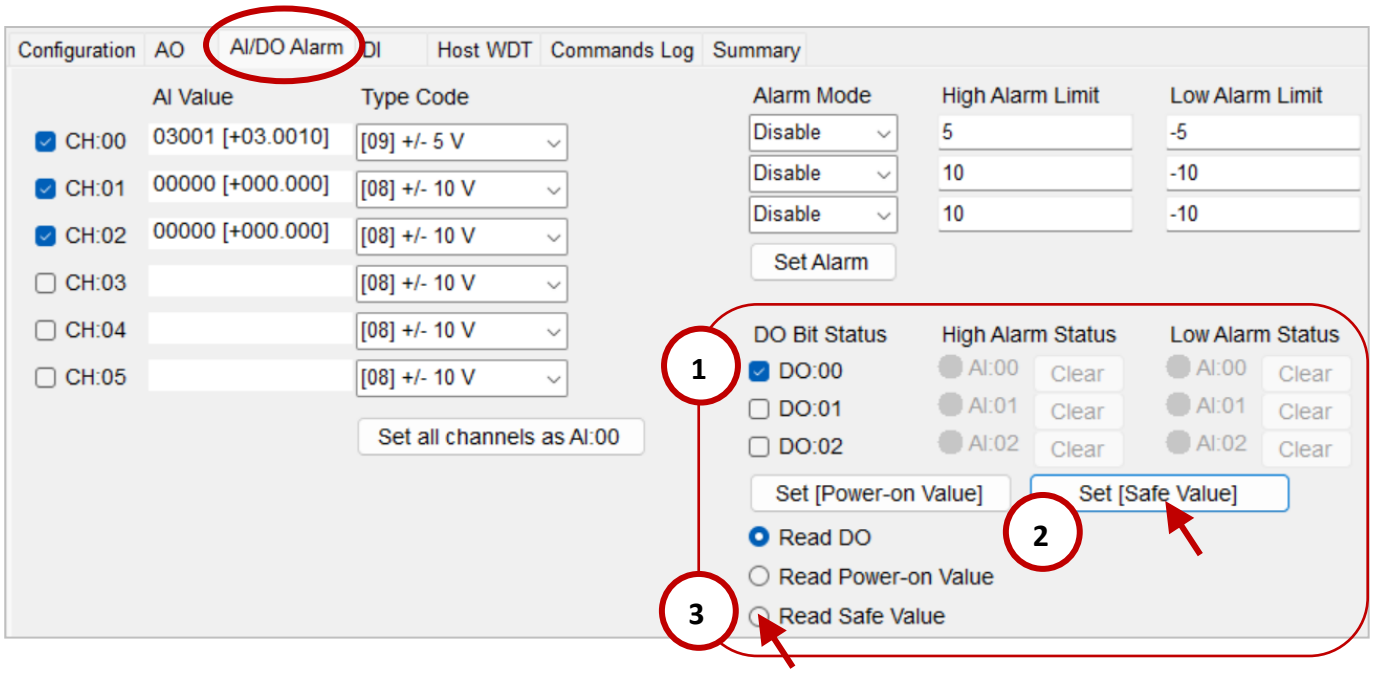
Follow the Steps to test the Function:

1. First, go to the **AO** or **DO** page to configure the power-on value and save value.

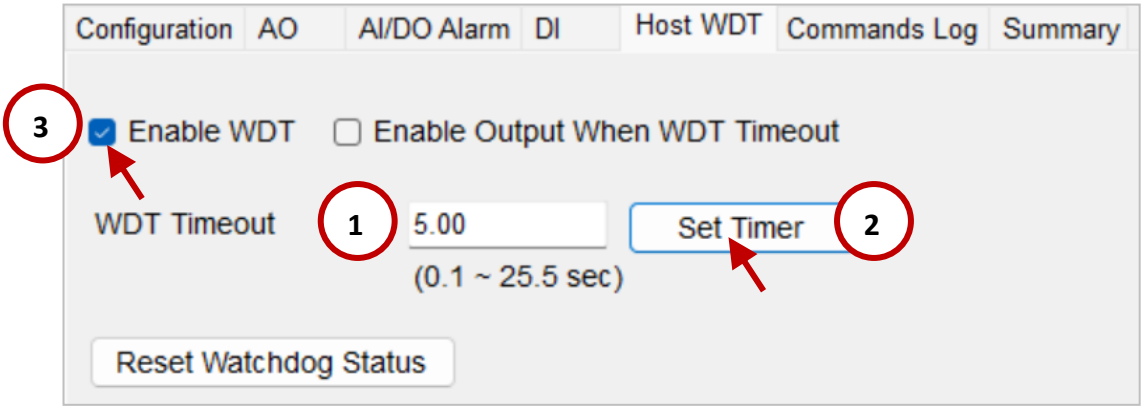
AO



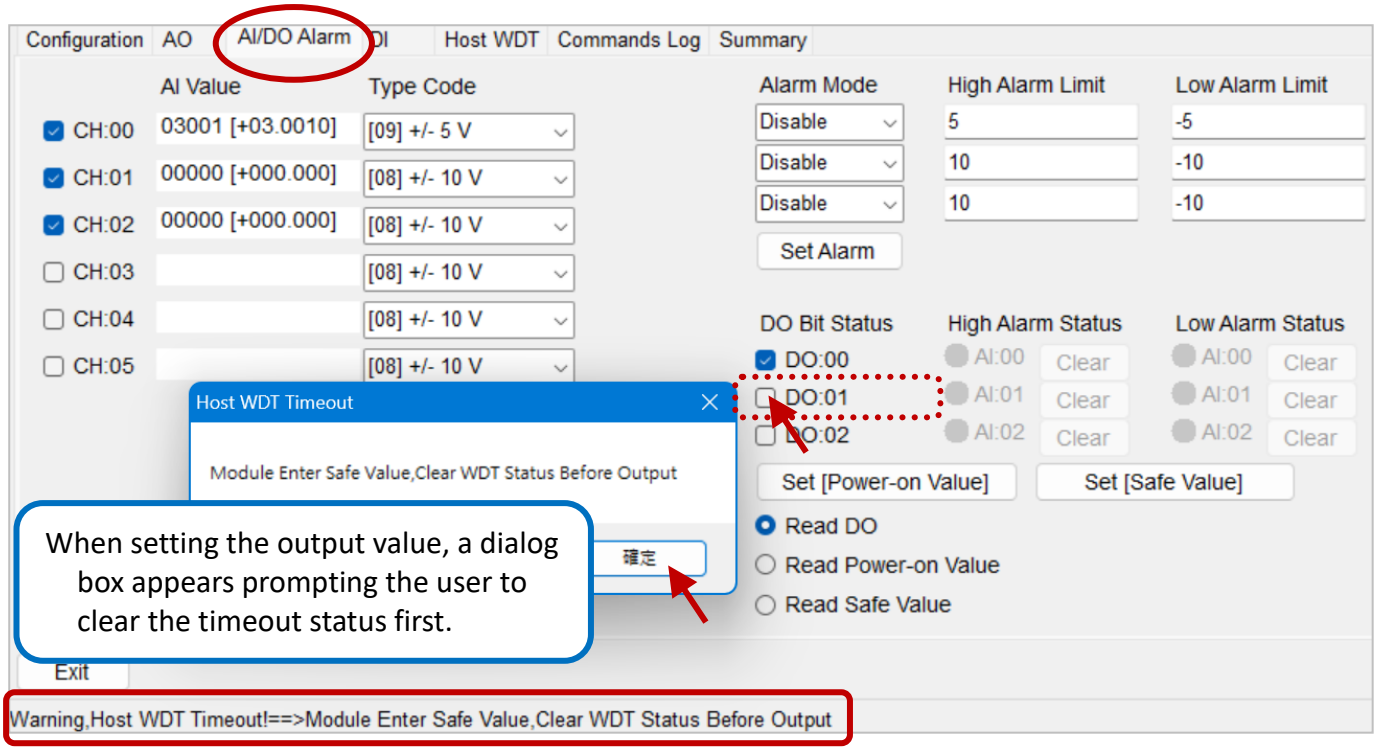
DO



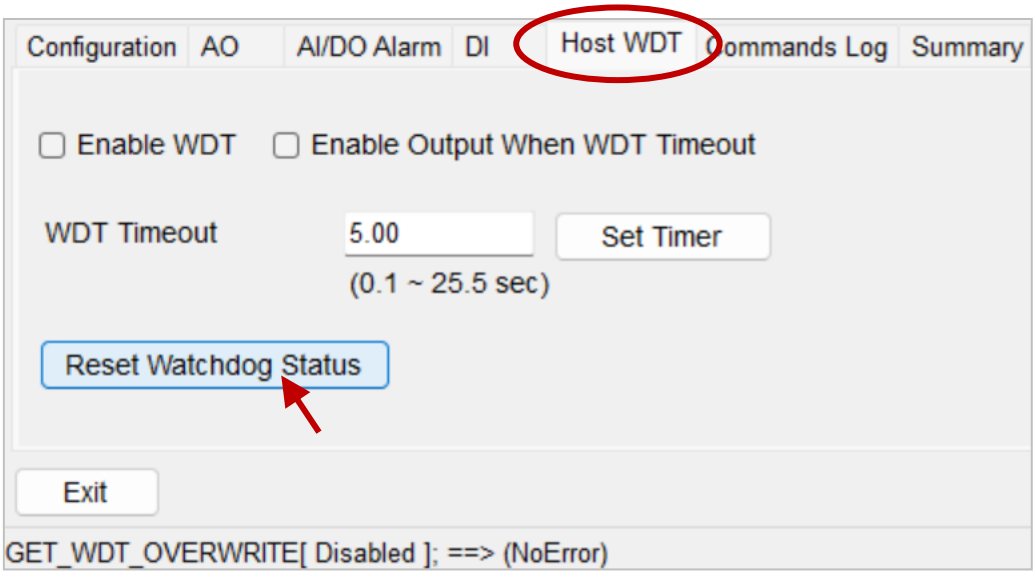
2. Set the "**WDT Timeout**" to "**5**" seconds and click the "Set Timer" button, then check the "Enable WDT" option.



3. Re-open the module window, wait for 5 seconds, the status bar will display the message "**Host WDT Timeout....**", then DO (or AO) will automatically output the safe value. In this case, users can try to change the DO value.



Next, click the "**Reset Watchdog Status**" button to clear the timeout status.



Note: Users can also clear the timeout status by writing '**0**' to Modbus address **40492** or using the DCON command "**~AA1**".

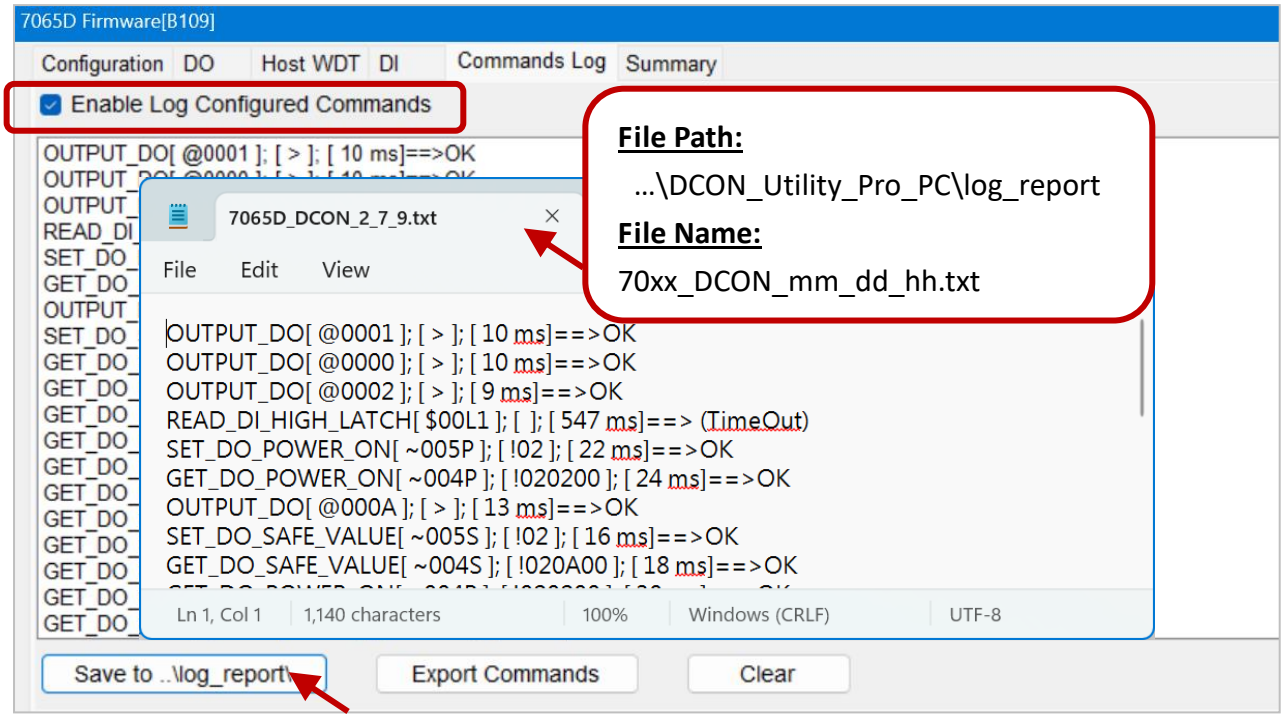
4. Upon reboot, the **DO (or AO)** will be set to the **Power-On Value**. If the **timeout status** is not cleared, the **DO (or AO)** will be set to the **Safe Value** after rebooting.

3.11 Settings Page - Commands Log

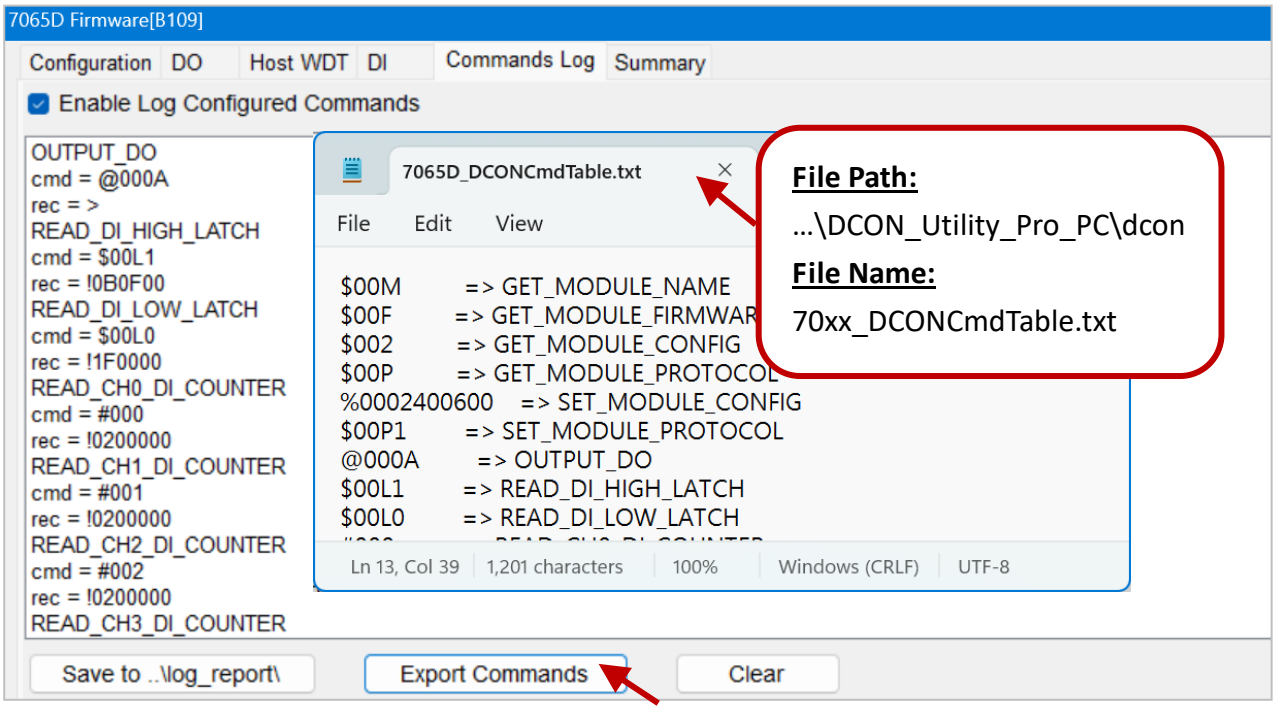
All models support this feature except the following:

Unsupported Model
7013(D)/13P(D)/15/15P/33(D)

When **"Enable Log Configured Commands"** is selected, the sent commands and response results will begin recording. Users can click the **"Save to …\log_report"** button to save the data as a **.txt** file.

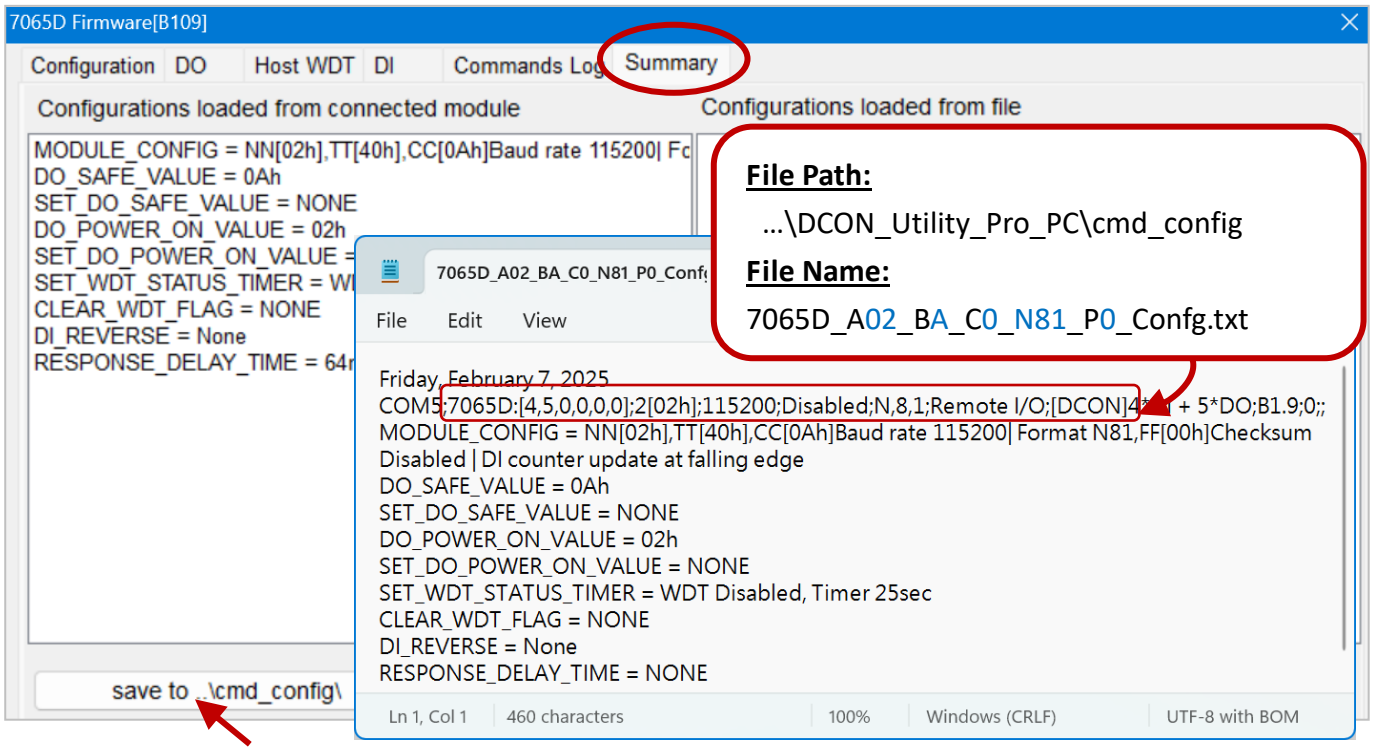


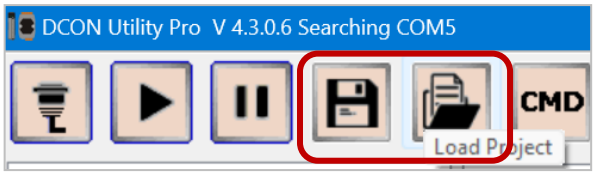
Click the "**Export Commands**" button to export the DCON commands related to the module. Otherwise, click the "**Clear**" button to clear the screen.



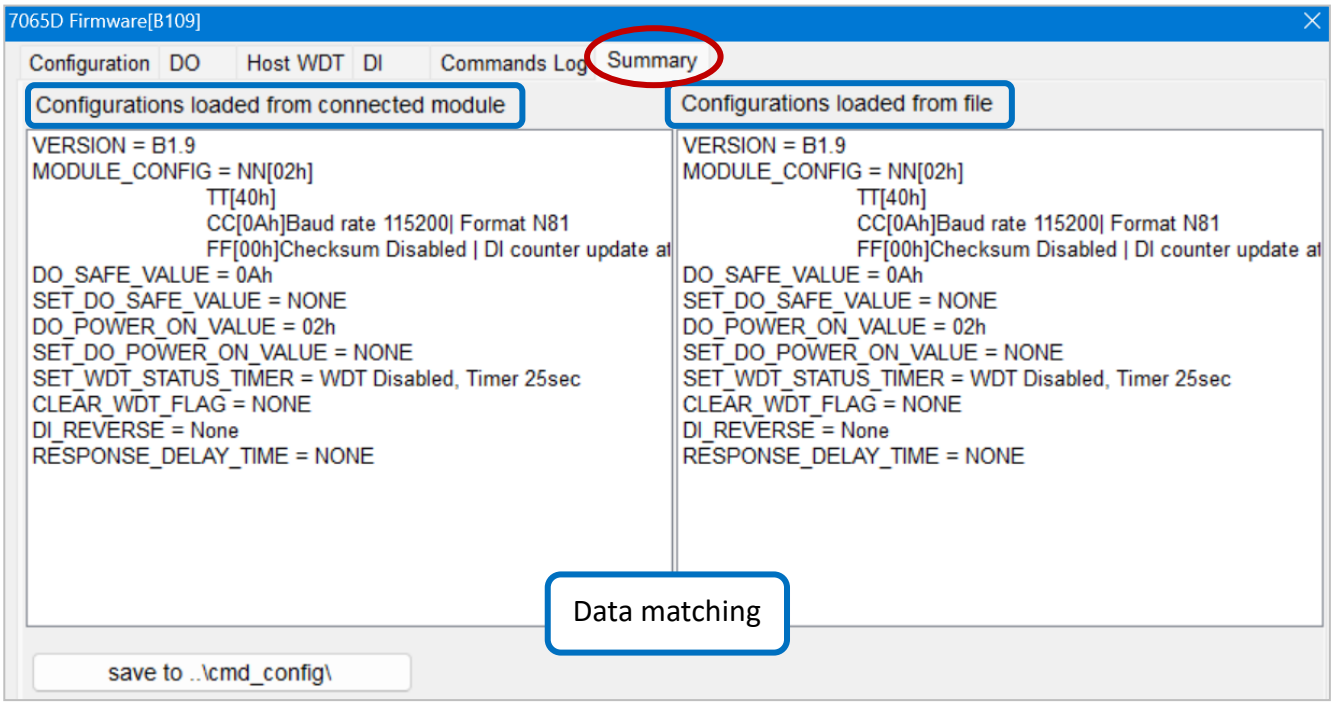
3.12 Settings Page - Summary

The I-7000/M-7000 series modules support the "**Summary**" page. The left pane of this page displays the module settings read by DCON Utility Pro**.** Users can click the **"Save to …\cmd_config"** button to save the data as a **.txt** file.





If the user has saved a configuration file using the "Save/Load Project" function (see Appendix A - FAQ _01_002), they can verify the contents of the connection module and the loaded file in the window.



Chapter 4 DCON/Modbus Commands

Visit the Selection Guide webpage for more information about products.

The manuals for specific models are listed below. '**70xx**' in the table indicates support for both **I-70xx** and **M-70xx** series.

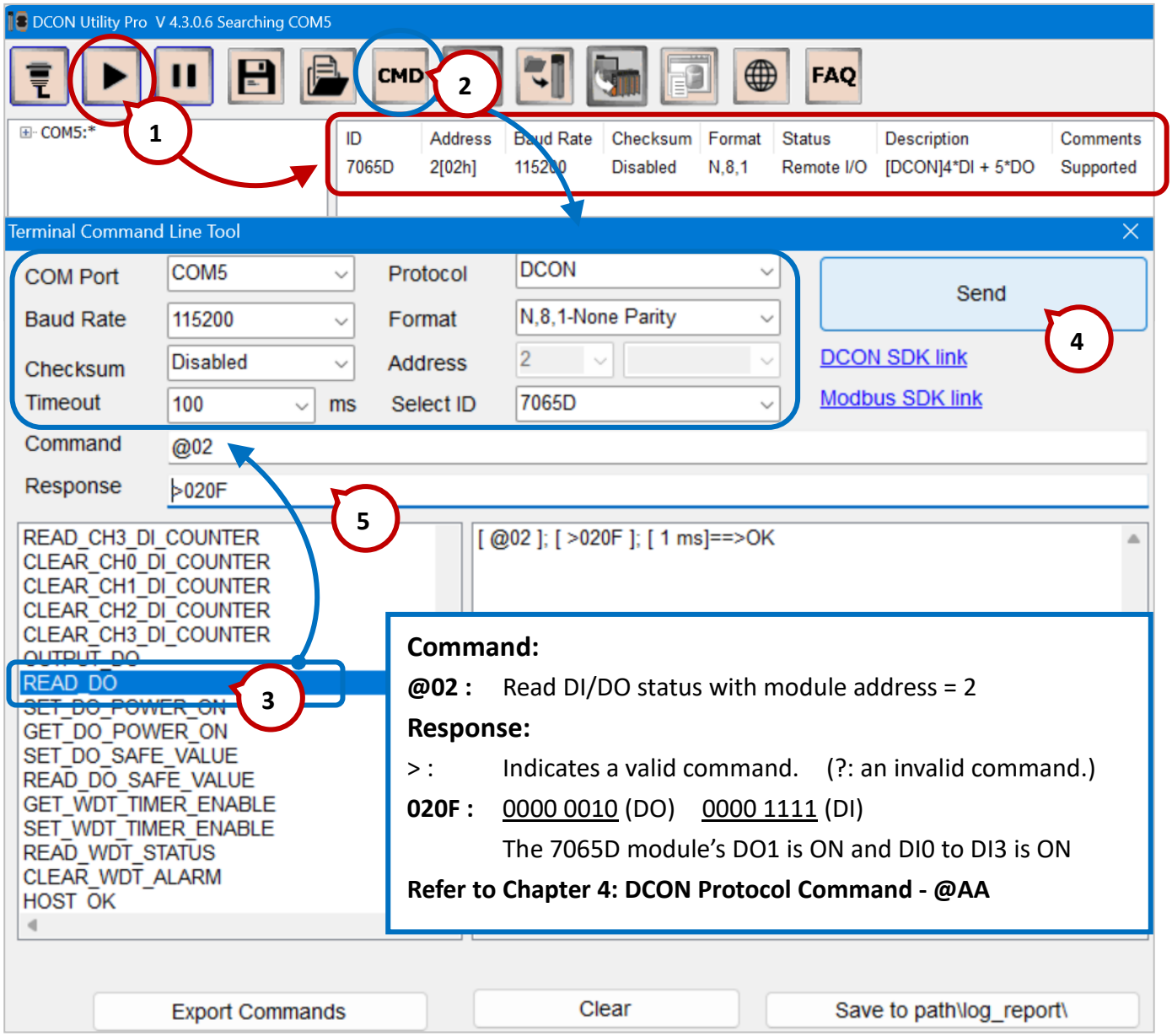
Analog I/O			
https://www.icpdas.com/en/product/guide+Remote__I_O__Module__and__Unit+RS-485__I_O__Modules+I-7000#461			
1	Voltage & Current Input	I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf	Link
2		I-7017_I-7018_I-7019_M-7017_M-7018_M-7019_en.pdf	Link
3		I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf	Link
-	Transmitter Input: I-7014D Thermocouple Input: 7018/18R/18Z/19R, I-7018P, M-7018-16/19Z		
4	Thermistor Input	I-7005_M-7005_en.pdf	Link
5	DS18B20 Sensor	M-7004_M-2004_en.pdf	Link
6	RTD Input	I-7013_I-7015_I-7033_M-7015_M-7033_en.pdf	Link
7	Strain Gauge	I-7016(D)_I-7016P(D)_en.pdf	Link
8	Voltage & Current Output	I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_ M-7024_M-7024L_M-7024R_M-7024U(D)_M-7028_en.pdf	Link
-	Multi-function	AI/DI: M-7002_en.pdf	Link
		AI/DO: M-7003_en.pdf	Link
		AI/AO/DI/DO: M-7026_en.pdf	Link
Encoder/Frequency /Counter			
https://www.icpdas.com/en/product/guide+Remote__I_O__Module__and__Unit+RS-485__I_O__Modules+I-7000#464			
9	Counter/Frequency Input	I-7080(D)_I-7080B(D)_en.pdf	Link
10	Encoder/Counter Input	I-7083(D)_I-7083B(D)_en.pdf	Link
11	Counter/Frequency/Encoder Input	M-7084_en.pdf	Link
12	Counter Input & PWM Output	I-7088(D)_M-7088(D)_en.pdf	Link
Digital I/O			
https://www.icpdas.com/en/product/guide+Remote__I_O__Module__and__Unit+RS-485__I_O__Modules+I-7000#462			
13	Digital Input/Output	I-7000_M-7000_DIO_en.pdf (7041 ~ 7069)	Link

4.1 Command Line Tool

The **"Command Line"** function in DCON Utility Pro can be used to test and debug I/O modules. It supports both DCON and Modbus protocol commands.

Note: Only one module should be configured at a time.

1. Search the I/O module and then click the "**CMD**" button to open the settings window.
2. In the "**Terminal Command Line Tool**" window, the module settings will automatically be loaded. Simply click the desired default commands and click the **Send** button.



Export Commands	Export all supported commands for this module. "… \DCON_Utility_Pro_NoFAQ\dcon**70xx_DCONCmdTable.txt**"
Clear	Clear the command response Window.
Save to \logger_report\	Click this button to automatically save testing commands. "…\DCON Utility Pro\logger_report\ Command_Line_Result_Log_**m_dd_xx**.txt"

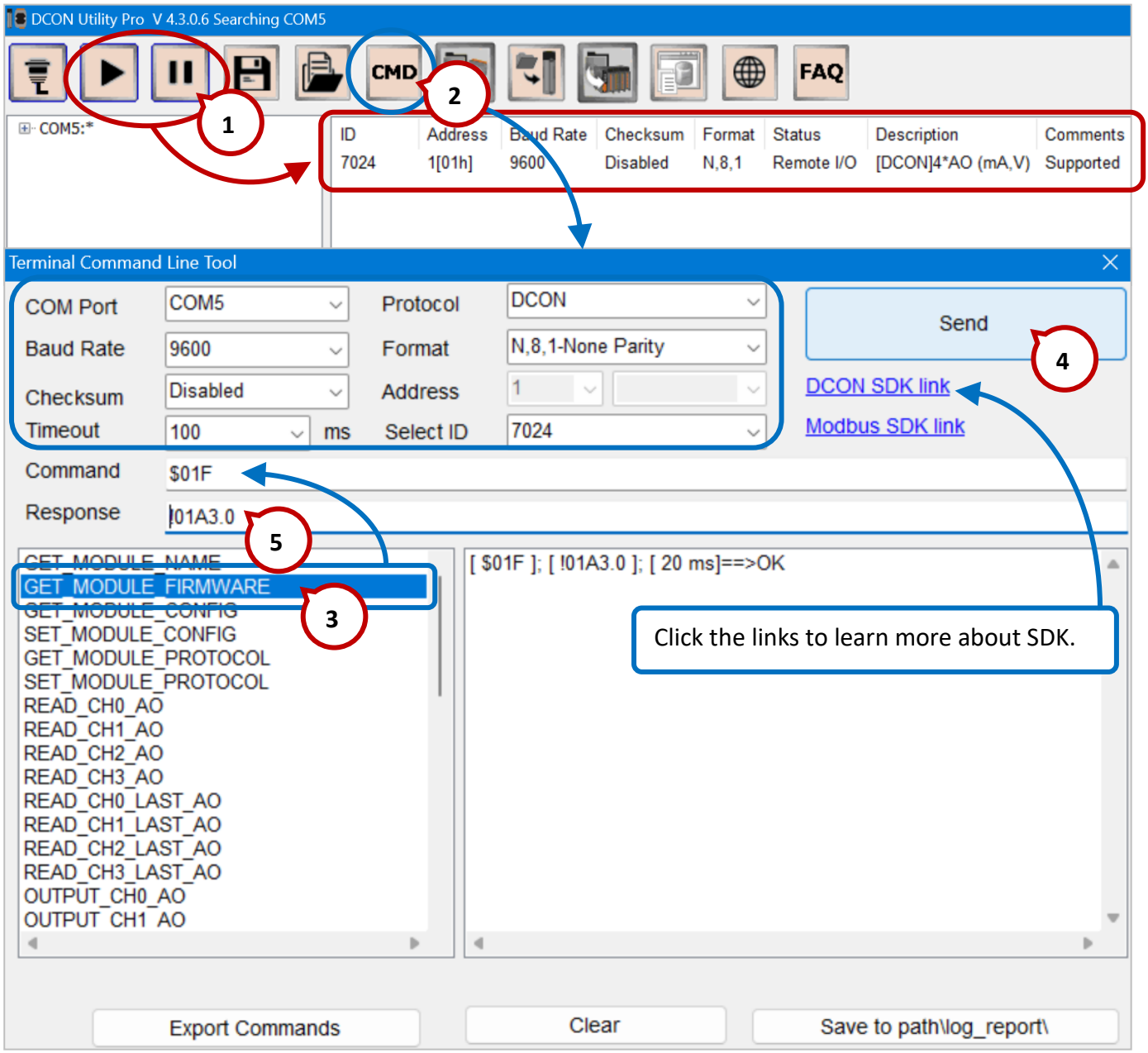
Chapter 5 Software Development of I-7000 series

5.1 Using DCON Commands

The **"Command Line"** function in DCON Utility Pro provides commonly used DCON/Modbus commands (see Section 4.1 for reference) based on the detected I-7000/M-7000 modules. Users can also click the links on the window to learn more about the available software development kits (SDKs).

DCON Utility Pro:
https://www.icpdas.com/en/product/guide+Software+Utility_Driver+DCON__Utility__Pro

Download DCON Utility Pro (PC):
https://www.icpdas.com/en/download/show.php?num=1046



Users can refer to Chapter 4: DCON/Modbus Protocol Commands in the module-specific manual to view detailed DCON commands. For example, the **#AAN** command is used to read the analog input value from a specified channel.

2.4 #AAN

Description : Read Analog Input from channel N

Syntax : **#AAN[CHK](cr)**

#	delimiter character
AA	address of reading module (00 to FF)
N	channel to read, from 0 to 7

Response : Valid Command : **>(Data)[CHK](cr)**

Invalid Command : **?AA[CHK](cr)**

Syntax error or communication error may get no response.

>	delimiter for valid command
?	delimiter for invalid command
AA	address of response module (00 to FF)
(Data)	analog input value, reference *Sec.1.10* for its format

Example :

Command : #032 Receive : >+02.513

Read address 03 channel 2, get data successfully.

Command : #029 Receive : ?02

Read address 02 channel 9, return error channel number.

Related Command :

Sec.2.1 %AANNTTCCFF, *Sec.2.7* $AA2

Related Topics :

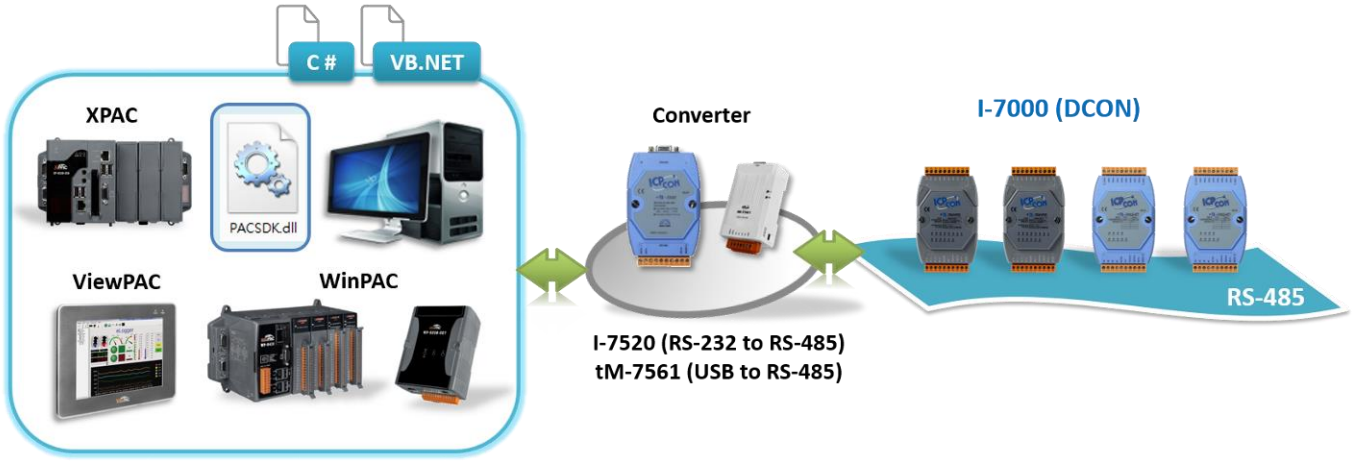
Sec.1.10 Configuration Tables

Note : The command is for I-7017/17F only

5.2 Using PACSDK

PACSDK are software development toolkits that can be used on a PC or PAC (e.g., XPAC, WinPAC, and ViewPAC series). PACSDK includes header files, libraries, documentation, and tools that can be used to develop VC/C#/VB.net applications to access I/O data of I-7000 series module.

Note: PACSDK only supports the DCON protocol.



PACSDK

Items		PACSDK	Items
Header file		PACSDK.h	Using libraries when developing VC applications on Windows PC or PAC.
Library files		PACSDK.lib	
DLL files	For C program	PACSDK.dll	Loading libraries when executing VC applications on PC or PAC.
	For .NET program (i.e., C#, VB)	PACNET.dll	1) Using management libraries when developing .NET applications 2) Load libraries when executing .NET applications on PC or PAC.

Download Files:

1) PACSDK:

Users can download SDK according to the development platform (i.e., PC or PAC).
When using the following development platform **– PC, XP-8000-WES7, XP-9000-IoT, iPPC (IoT/WES7),** copy PACSDK.dll and PACNET.dll to the folder where the applications (.exe file) is located after downloading.

For PC	
https://www.icpdas.com/en/product/guide+Software+Development__Tools+PAC__SDK	
SDK & Demo	X86: https://www.icpdas.com/en/download/show.php?num=1050 X64: https://www.icpdas.com/en/download/show.php?num=1846

XP-8000-WES7、XP-9000-IoT、iPPC (IoT/WES7)
https://www.icpdas.com/en/download/show.php?num=2540

When developing applications on **XPAC (CE6), WinPAC (CE5),** or **WinPAC/ViewPAC (CE7)** platforms, visit the webpage to download and install the necessary files.

Development Tools: Visual Studio 2008 Professional or earlier version

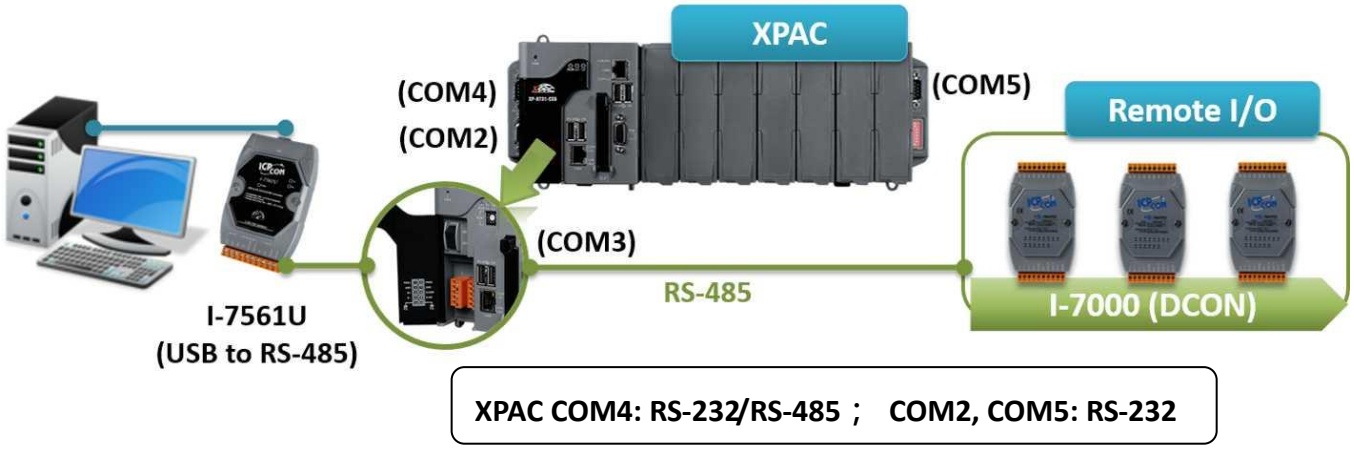
WinPAC/ViewPAC (CE7)
WinCE7.0 PACs/ViewPACs without I/O Slot(s) https://www.icpdas.com/en/download/show.php?num=2409 WinCE7.0 PACs/ViewPACs with I/O Slot(s) https://www.icpdas.com/en/download/show.php?num=2348
XPAC (CE6)
WinCE6.0 PACs https://www.icpdas.com/en/download/show.php?num=2473
WinPAC (CE5)
WinCE5.0 PACs without I/O Slot(s) https://www.icpdas.com/en/download/show.php?num=2594 WinCE5.0 PACs with I/O Slot(s) https://www.icpdas.com/en/download/show.php?num=2593

2) The PAC API Manual:

To learn about PACSDK installation, development environment settings, and PAC_IO API functions, refer to the manual (pac_standard_api_manual_x.x.x.pdf).

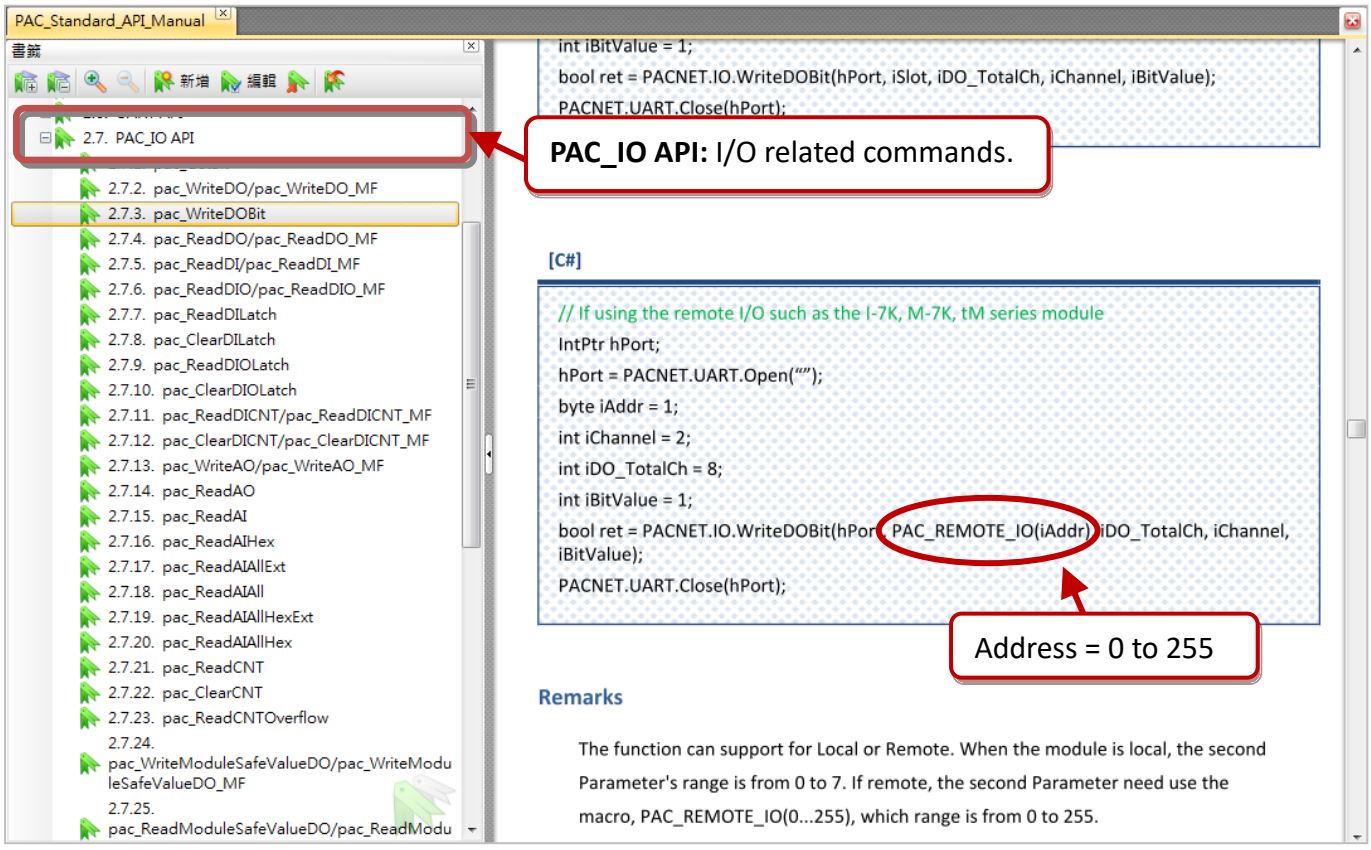
The manuals for each platform are listed in the table below.

PC	https://www.icpdas.com/en/download/show.php?num=1049
PAC (WES/IoT)	https://www.icpdas.com/en/download/show.php?num=2527
PAC (WinCE)	https://www.icpdas.com/en/download/show.php?num=2407

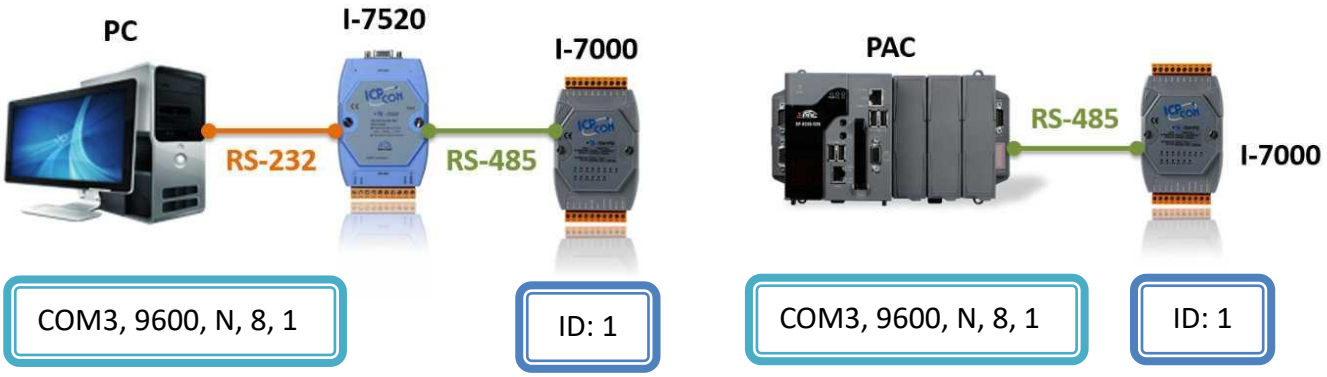


The following API manuals are available for **XPAC** usage.

https://www.icpdas.com/web/product/download/pac/wince/document/api/pac_standard_api_manual_en.pdf



Demo Program:



Example Code in C# Language:

```
hPort = PACNET.UART.Open ("COM3,9600,N,8,1”);
        // Open COM3 port with baud rate 9600 bps and data format N, 8, 1
        if (hPort == (IntPtr)(-1))
        {
            return 0;
            // Exit the program if the COM port fails to open.
        }
int iAddr=1;    // In this example, the module’s ID is set to 1.

float fValue;
  PACNET.PAC_IO.ReadAI (hPort, PACNET.PAC_IO.PAC_REMOTE_IO(iAddr), 1, 4, ref fValue);
  // This I-7000 module includes 4 AI channels. Read the AI value from channel 1 and store it in the
  fValue variable.

  PACNET.PAC_IO.WriteAO (hPort, PACNET.PAC_IO.PAC_REMOTE_IO(iAddr), 1, 2, 2.0);
  // This I-7000 module includes 2 AO channels. Outputs a value of “2.0” to channel 1.

  PACNET.PAC_IO.ReadDI (hPort, PACNET.PAC_IO.PAC_REMOTE_IO(iAddr), 4, ref DiValue);
  // This I-7000 module includes 4 DI channels. Read all DI values and store them in the DiValue variable.

  PACNET.PAC_IO.WriteDO (hPort, PACNET.PAC_IO.PAC_REMOTE_IO(iAddr), 4, 3);
  //This I-7000 module includes 4 DO channels. Outputs a value of "3", which sets DO0 and DO1 to ON,
  and DO2 and DO3 to OFF. Each bit represents the status of a channel; bit 0 represents the first channel,
  bit 1 represents the second channel, and so on.

PACNET.UART.Close(hPort);
// Close the COM port and terminate communication.
```

Example Code in C Language:

```
HANDLE hPort = uart_Open("COM3,9600,N,8,1”);
                    // Open COM3 port with baud rate 9600 bps and data format N, 8, 1
          if(hPort == INVALID_HANDLE_VALUE)
          {
                    printf("Open COM port Error…”);
                    return 0;
                   // Exit the program if the COM port fails to open.
          }
int iAddr=1;    // In this example, the module’s ID is set to 1

float fAI_Value;
    pac_ReadAI (hPort, PAC_REMOTE_IO(iAddr), 1 , 4, &fAI_Value);
    // This I-7000 module includes 4 AI channels. Read the AI value from channel 1 and store it in the
    &fAI_Value variable.

    pac_WriteAO (hPort, PAC_REMOTE_IO(iAddr), 1 , 2, 2.0);
    //This I-7000 module includes 2 AO channels.
    Outputs a value of “2.0” to channel 1.
```

Refer to Section 2.7.13 ,**pac_WriteAO,** in the API manual.

C++ for pac_WriteAO

```
BOOL pac_WriteAO(
  HANDLE hPort,
  int slot,
  int iChannel,
  int iAO_TotalCh,
  float fValue
);
```

Address

```
DWORD lDI_Value ;
    pac_ReadDI (hPort, PAC_REMOTE_IO(iAddr), 4, &lDI_Val);
    // This I-7000 module includes 4 DI channels. Read all DI values and store them in the lDI_Val variable.
```

[C]

```
BYTE bit3;
BYTE iSlot = 2;
int iDI_TotalCh = 8;
DWORD lDI_Value;
HANDLE hPort;
hPort = uart_Open(“”);
BOOL iRet = pac_ReadDI(hPort, iSlot, iDI_TotalCh, &lDI_Value);
bit3 = pac_GetBit(lDI_Value, 3);
uart_Close(hPort);
```

Refer to Section 2.7.1**, pac_GetBit,** in the API manual.

Address

```
    pac_WriteDOBit (hPort,PAC_REMOTE_IO(iAddr),4 ,3, 1);
    //This function can control one DO channel at a time. This module
    includes 4 DO and the DO3 is set to ON.

uart_Close(hPort);
// Close the COM port and
terminate communication.
```

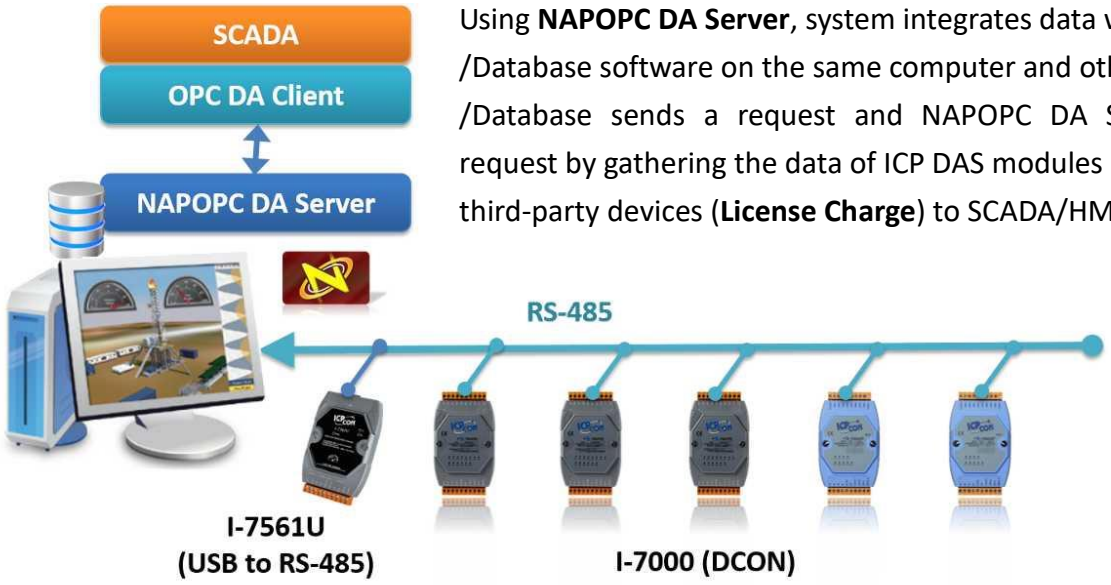
Refer to Section 2.7.3 **,pac_WriteDOBit,** in the API manual.

C++

```
BOOL pac_WriteDOBit(
  HANDLE hPort,
  int slot,
  int iDO_TotalCh,
  int iChannel,
  int iBitValue
);
```

Address

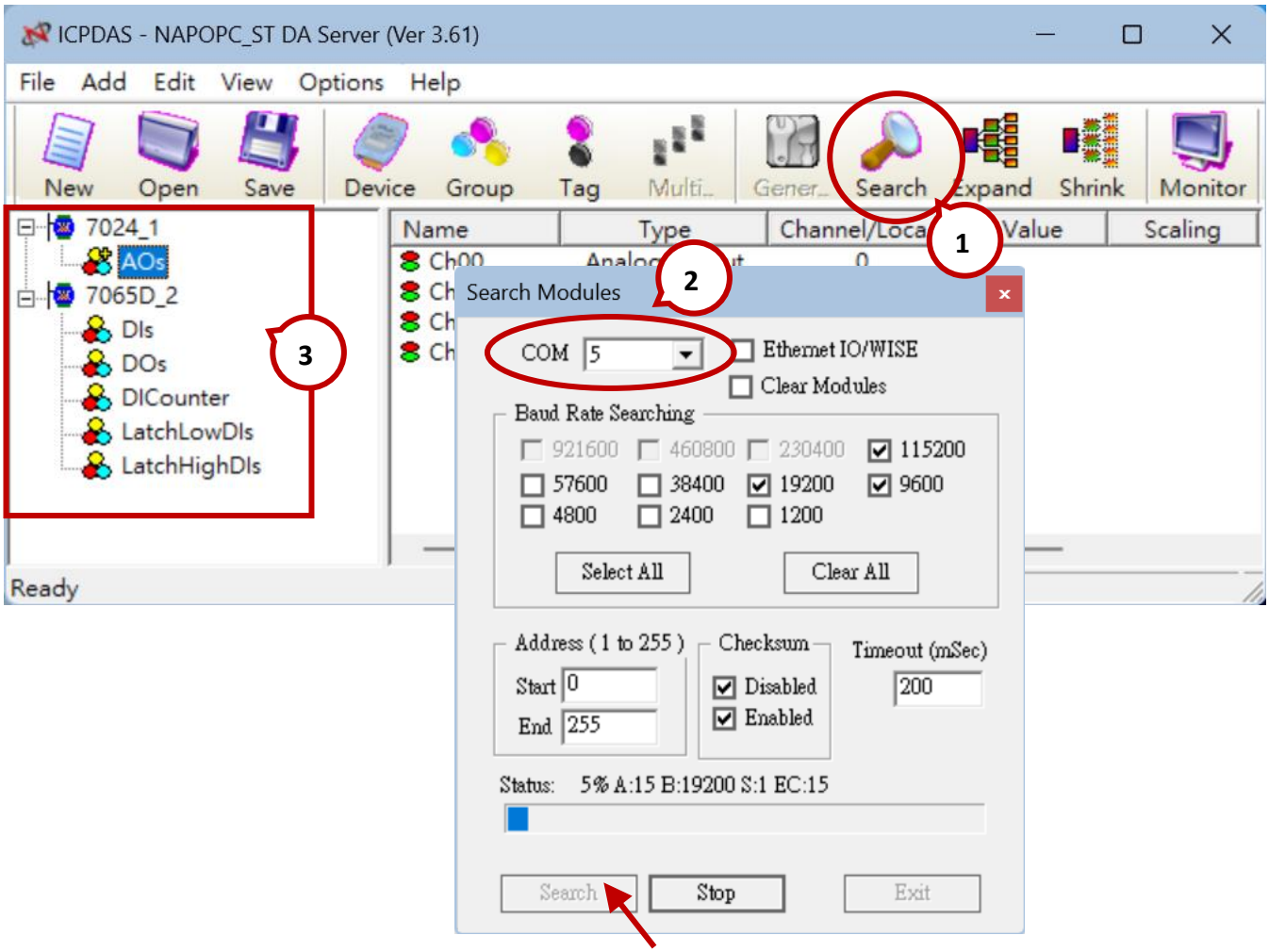
5.3 Using OPC DA Server



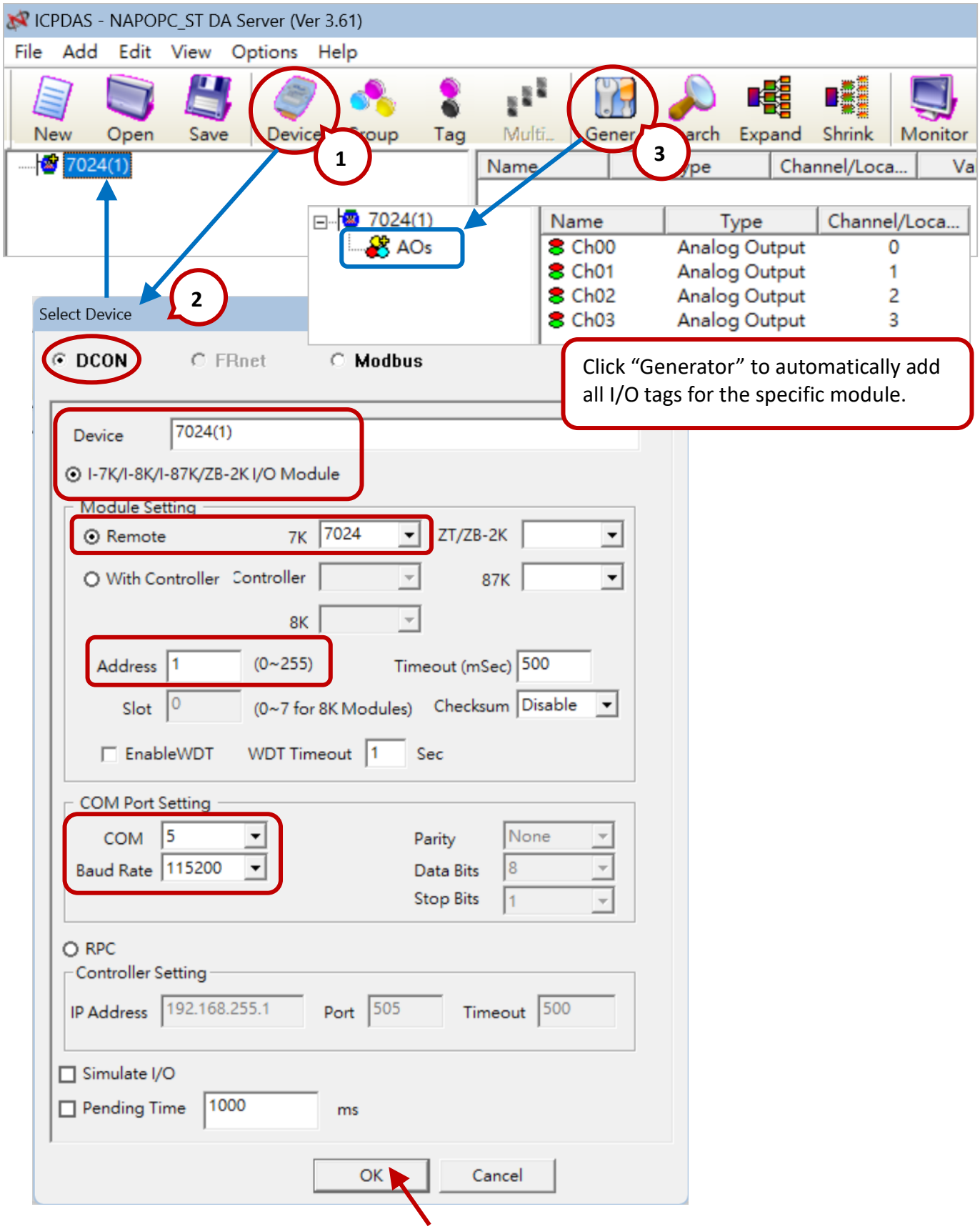
Using **NAPOPC DA Server**, system integrates data with SCADA/HMI /Database software on the same computer and others. SCADA/HMI /Database sends a request and NAPOPC DA Server fulfills the request by gathering the data of ICP DAS modules (**License Free**) and third-party devices (**License Charge**) to SCADA/HMI/Database.

The Product Page:
https://www.icpdas.com/en/product/guide+Software+Applications+NAPOPC__DA__Server

Download the NAPOPC DA Server (ST):
https://www.icpdas.com/en/download/show.php?num=3293



In addition to using the search method, users can also create their own Device and I/O Tag.



5.4 Using LabVIEW (DCON)

LabVIEW (**Lab**oratory **V**irtual **I**nstrumentation **E**ngineering **W**orkbench) is a system-design platform and development environment for a visual programming language from National Instruments. LabVIEW provides an easy-to-use graphical interface and supports a variety of hardware drivers and software analysis tools that help users to speed up the amount of time to develop applications. LabVIEW has been widely used for the test, measurement, and automated control in various laboratories or industries.

Visit the **LabVIEW** webpage for more information:
https://www.icpdas.com/en/product/guide+Software+Development__Tools+LabVIEW__Tools#3089

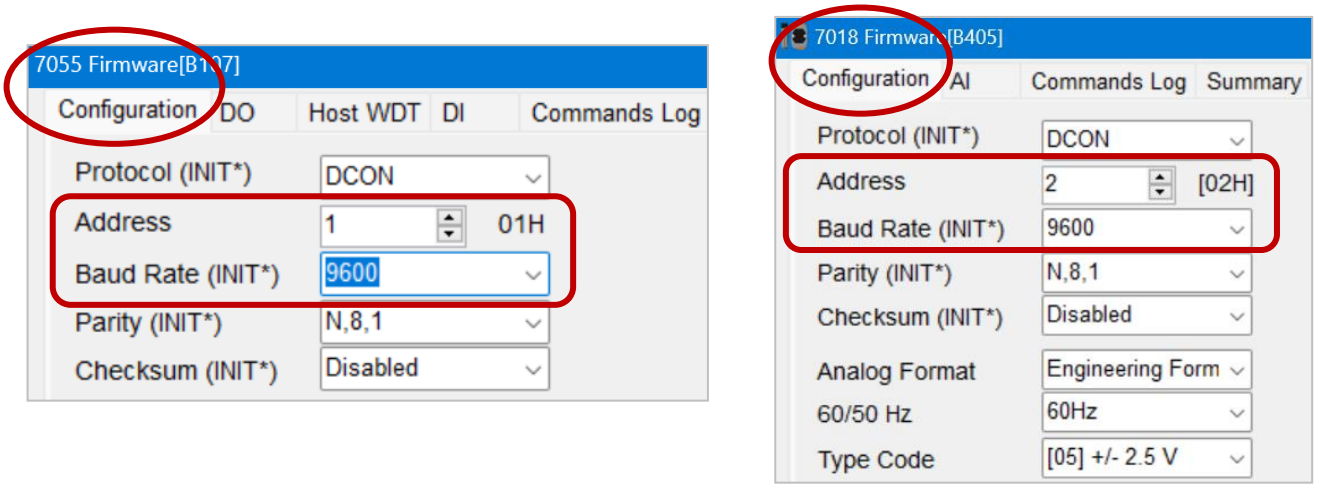
Note: Before the PC communicates with I-7000 series module, refer to Chapter 3: Settings Page - Configurations to configure the parameters (e.g., Address, Baud Rate).

Download demo programs (For DCON module, I-7000 series)
https://www.icpdas.com/en/download/show.php?num=1845

PAC SDK on Windows PC					
This tool is used to access remote I/O modules with DCON protocol. Version: LabVIEW 8.5 and later					
Download	**Applied Products**				
					
	I-7000/M-7000	tM series	M-2000	M-6000	I-8k/I-87k modules in DCON based IO Expansion Unit (RU-87Pn, I-87Kn, USB-87Pn)

5.5 Using Win-GRAF (DCON)

Win-GRAF supports the **DCON** protocol for connecting to I-7000 series modules. Unlike M-7000 series modules, **I-7000 series** modules allow certain I/O parameters to be configured directly in Win-GRAF Workbench (e.g., enabling the DI Counter, setting the analog type for AI/AO modules, etc.). However, the module's **Address** and **Baud Rate** must be configured using **DCON Utility Pro**. The following example demonstrates how to use an **XP-8xxx-CE6** PAC to connect to **I-7055** (8 DI, 8 DO) and **I-7018** (8 AI) I/O modules via **COM3**.



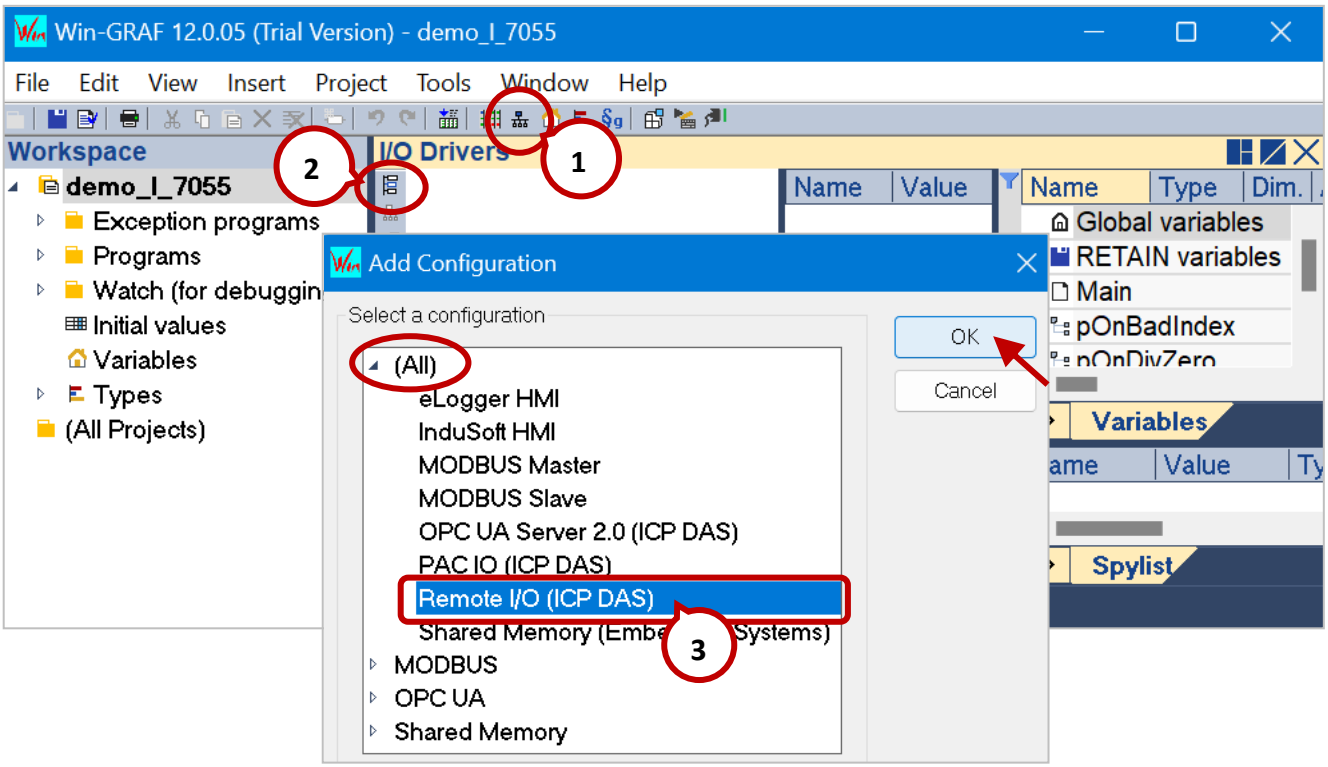
Visit the Win-GRAF Workbench webpage for more information:

Web: https://www.icpdas.com/en/product/guide+Software+Development__Tools+Win-GRAF

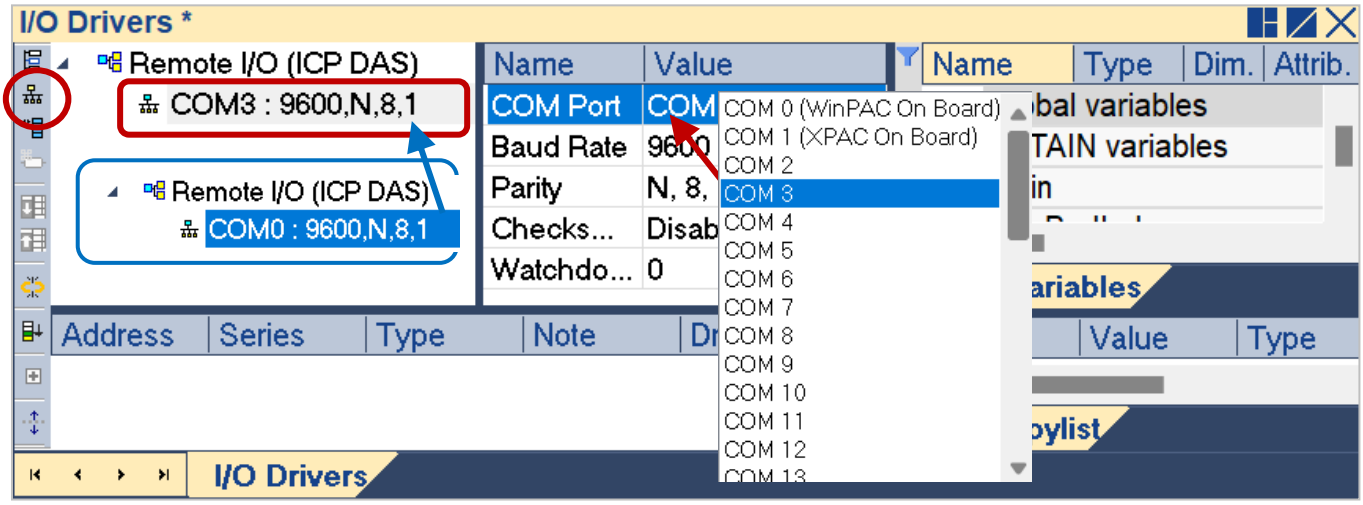
Manual: https://www.icpdas.com/en/download/show.php?num=8110

Configuration Instructions:

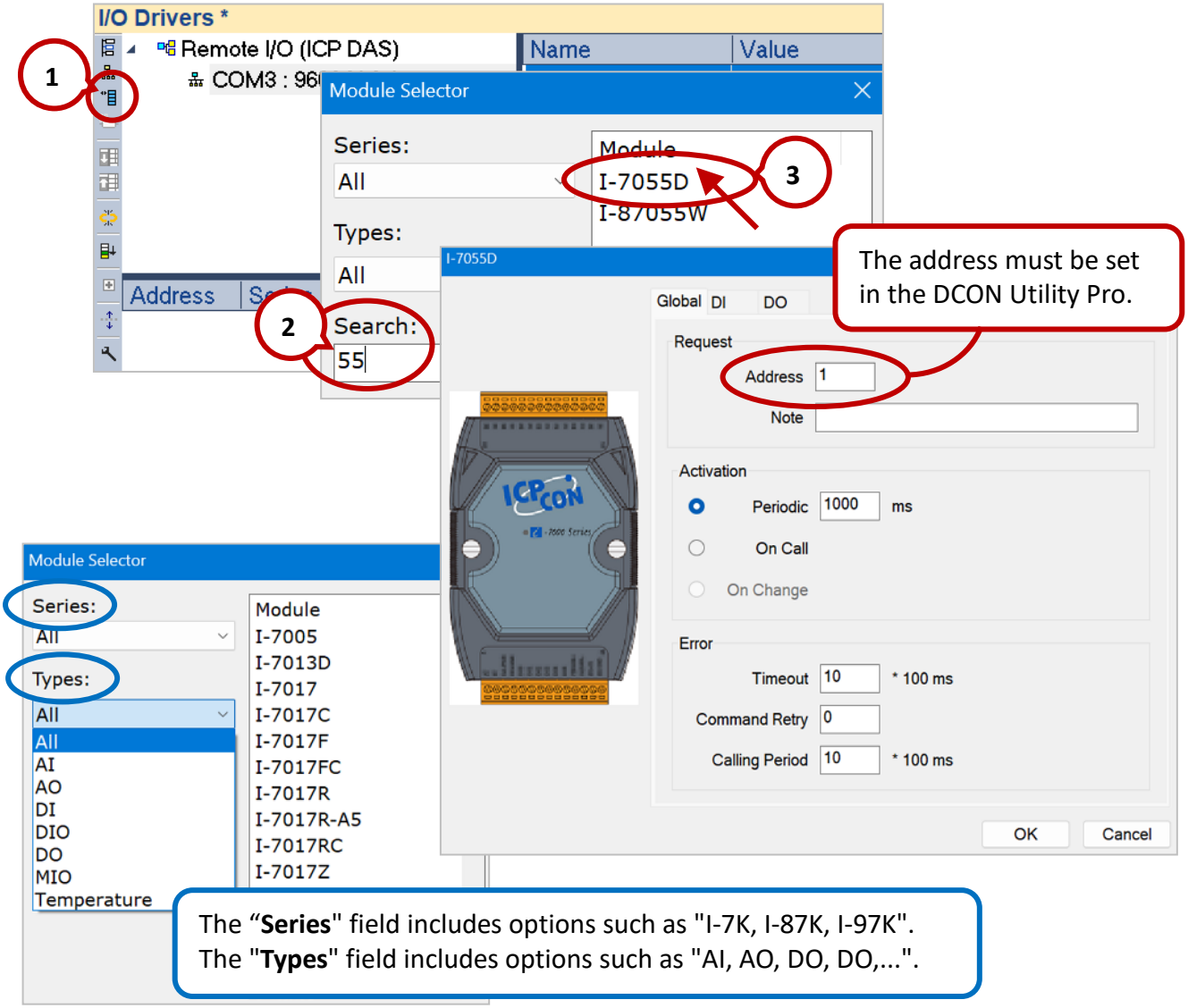
1. Click the "**Open Fieldbus Configuration**" button to open the "**I/O Drivers**" window.
2. Click the "**Insert Configuration**" button, expand the "**All**" category, select "**Remote I/O (ICP DAS)**", and then click **OK**.



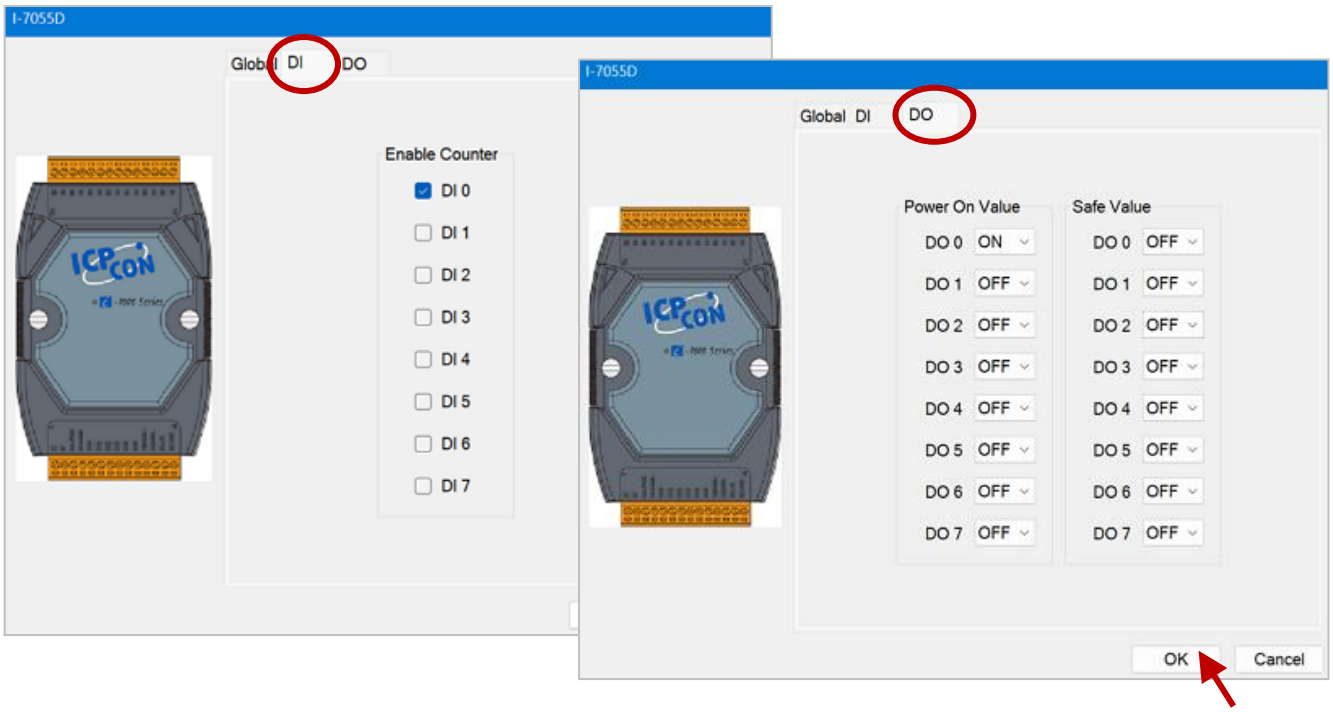
3. Click the "**Insert Master/Port**" button and the default settings **COM0:9600,N,8,1** will be displayed. Double-click the **Value** field to modify the settings (e.g., **COM3:9600,N,8,1**).



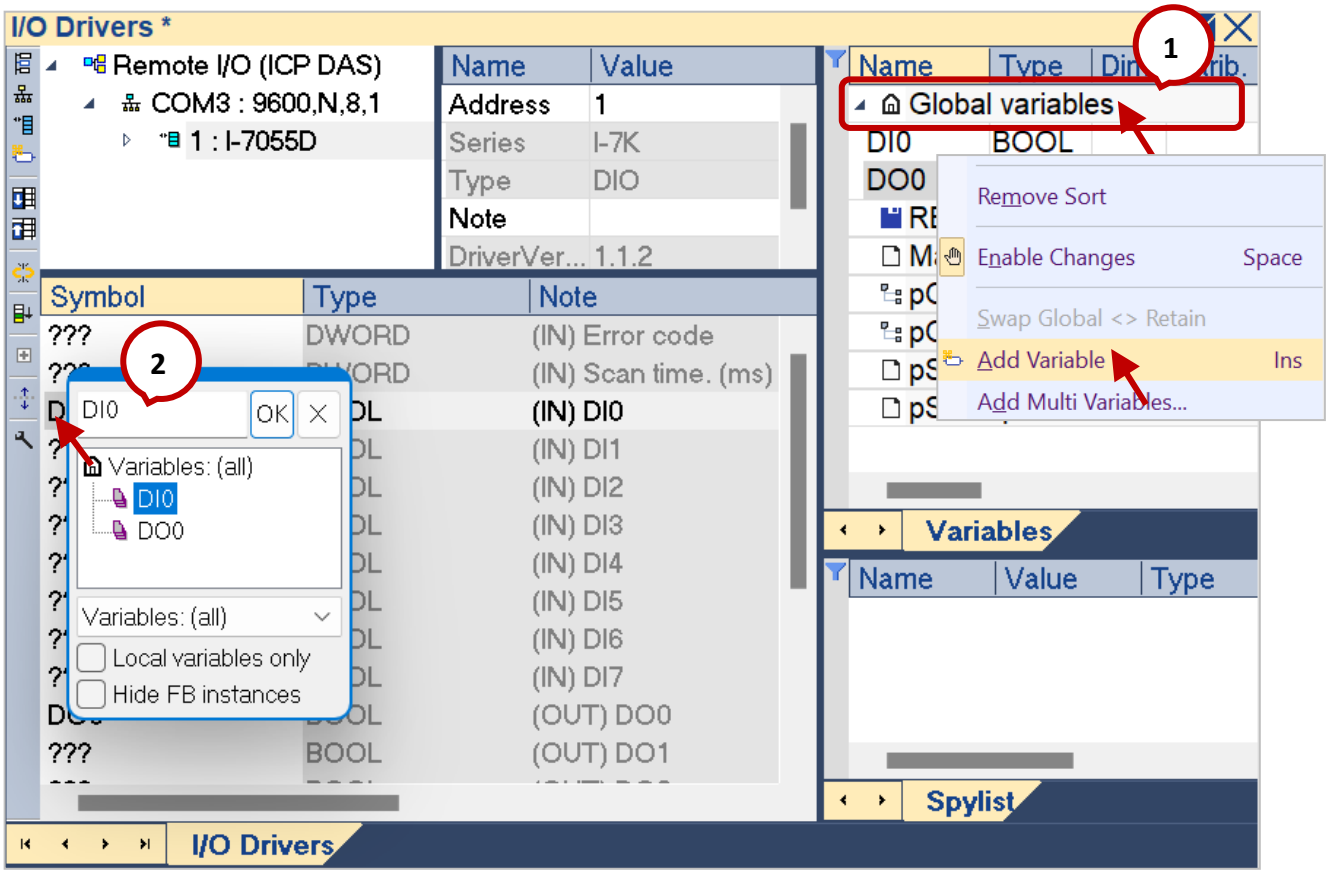
4. Click the "**Insert Slave/Data Block**" button to open the **Module Select** window. Enter the model number in the "**Srarch**" field to quickly locate the module. Double-click "**I-7055D**" to open the settings window.



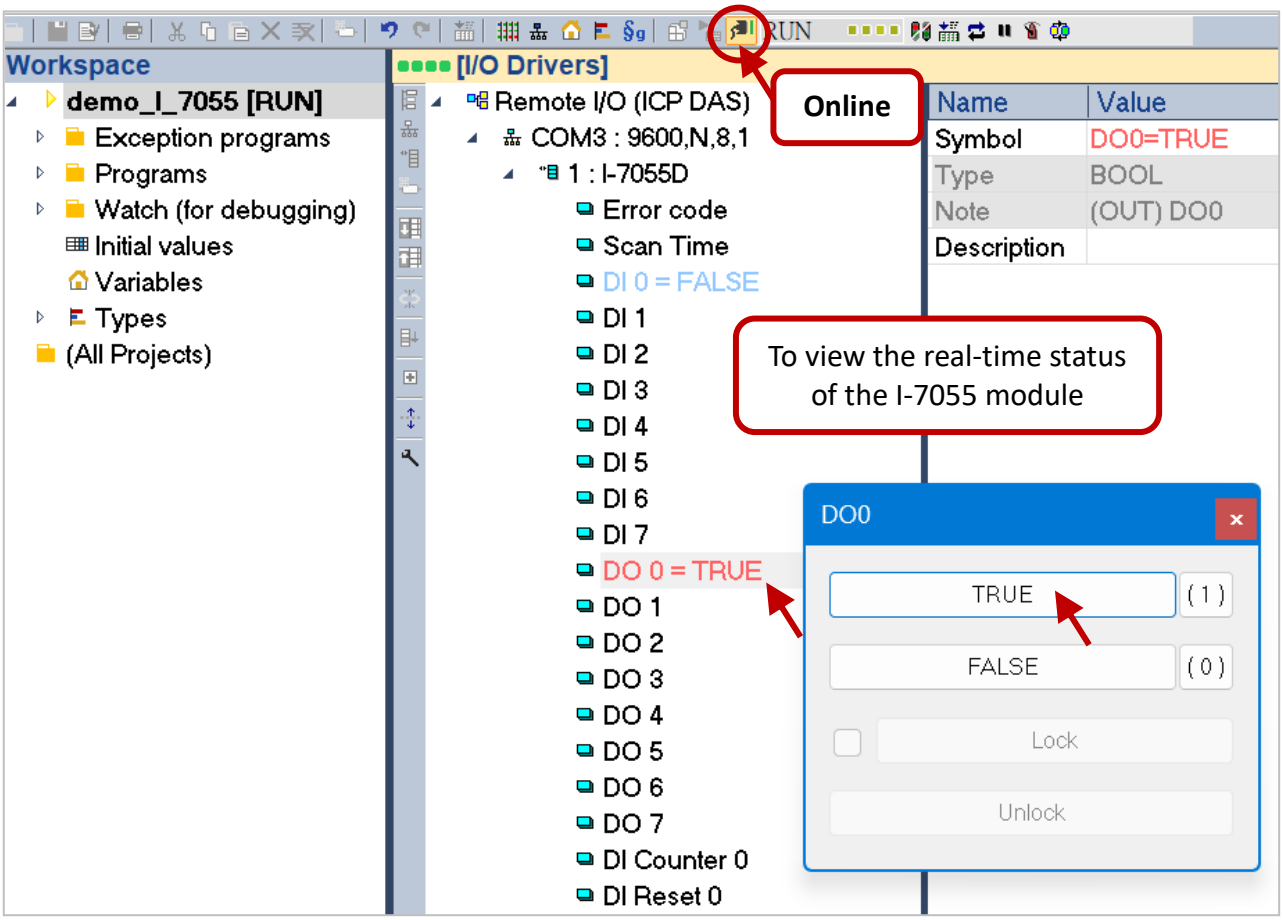
The available tab may vary depending on the model. The **DI Counter** function can be enabled in the **DI** tab, while the **Power-On Value** and **Safe Value** can be set in the **DO** tab. After completing the configuration, click **OK** to apply the settings.



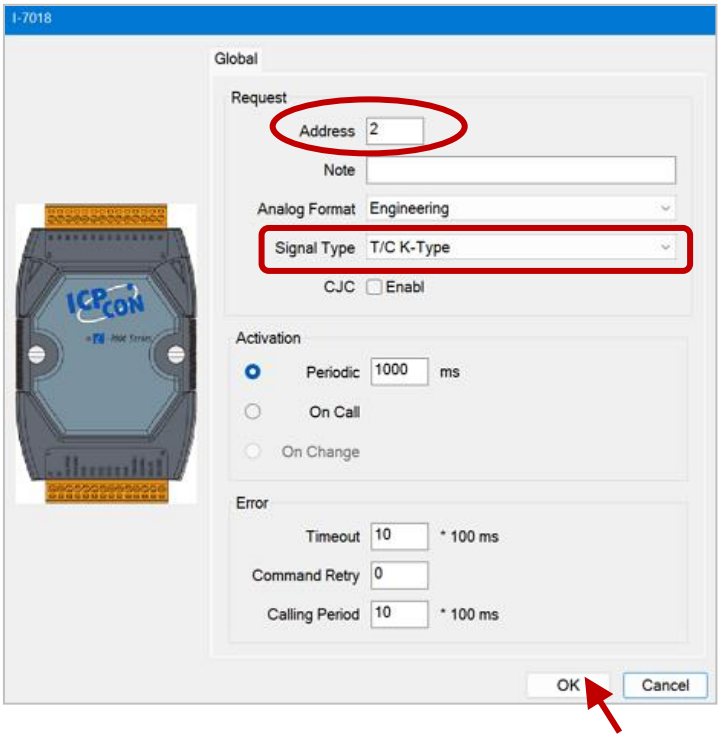
5. After adding the module, the corresponding I/O types for the I-7055D will be automatically displayed. To add a variable, enter the name in the **Symbol** field. Alternatively, right-click on **Global Variables** and select **Add Variable** (or press the Insert key) to add the DI0 and DO0 variables (BOOL), and then choose the variable name in the **Symbol** field.

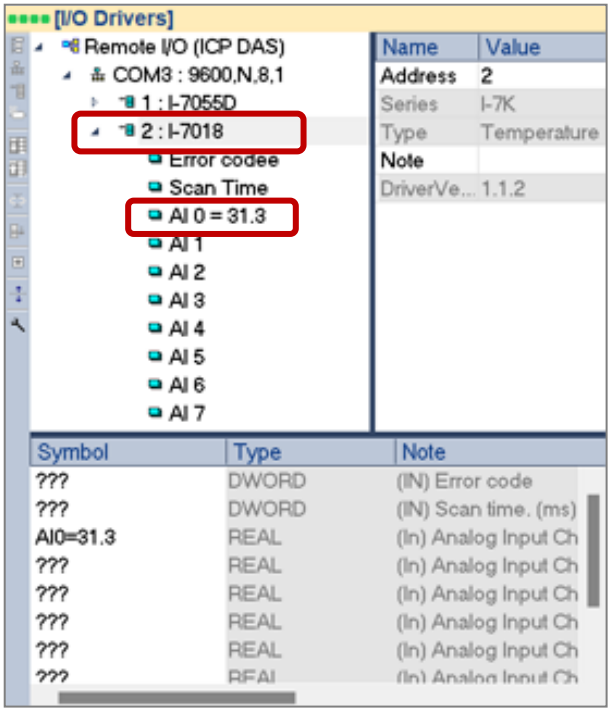


6. Click the **"Online"** button to connect to the PAC and download the demo program. Afterward, users can view the I-7055's I/O status. Additionally, double-click on a **DO** to change its status.



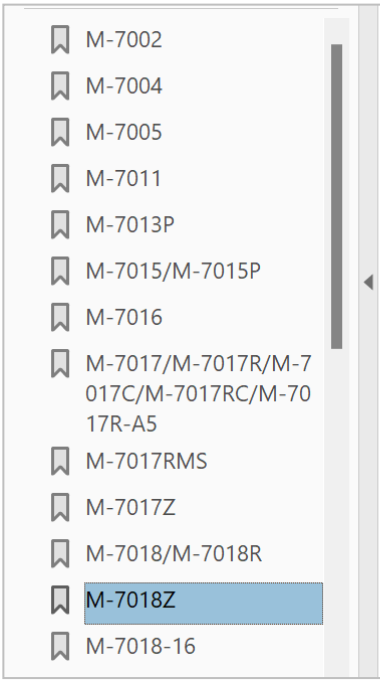
Users can follow Step 4 to add an **I-7018** data block. Ensure that the module is configured with **Address=2** and **Baud Rate=9600** in **DCON Utility Pro**. In the **Global** tab, set the **Signal Type** to **T/C K-Type**. After downloading the program, users will see the current temperature displayed as **31.3°C**.





Chapter 6 Software Development of M-7000 series

Modbus Mapping Table: https://www.icpdas.com/en/download/show.php?num=9270



M-7018Z

Address	Description	Attribute
30001 ~ 30010 40001 ~ 40010	Analog input value of channel 0 to 9	R
30129 40129	CJC temperature in 0.01°C	R
40257 ~ 40266	Type code of channel 0 to 9	R/W
40353 ~ 40362	CJC offset of channel 0 to 9 in 0.1°C. 1 for 0.1, 127 for 12.7, 255 for –0.1, 128 for –12.8	R/W
40481	Firmware version (low word)	R
40482	Firmware version (high word)	R
40483	Module name (low word)	R
40484	Module name (high word)	R
40485	Module address, valid range: 1 ~ 247	R/W
40486	Bits 5:0 Baud rate, 0x03 ~ 0x0A Code 0x03 0x04 0x05 0x06 Baud 1200 2400 4800 9600 Code 0x07 0x08 0x09 0x0A Baud 19200 38400 57600 115200 Bits 7:6	R/W

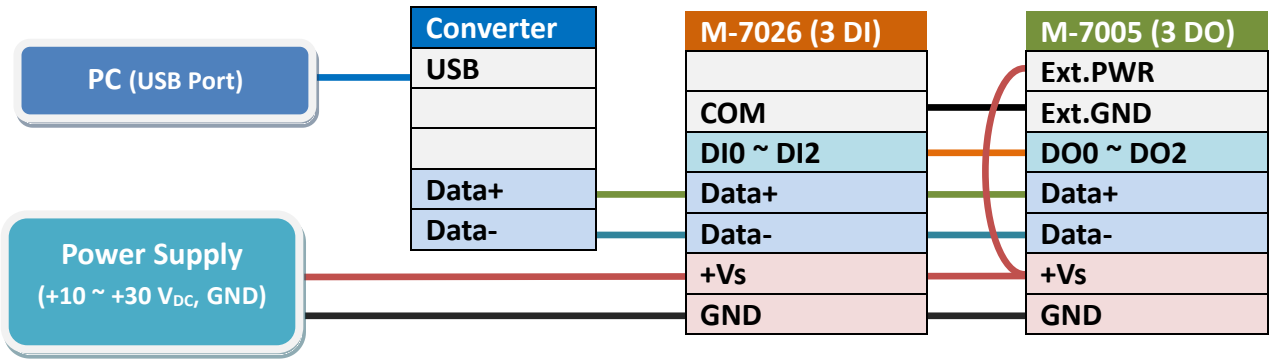
6.1 Using Modbus Master Tool

Modbus Master Tool supports Modbus RTU/ASCII protocol that can be used to simulate and test I/O modules on a PC (or PAC). The download URL are as follows.

Web: http://www.icpdas.com/en/product/guide+Software+Development__Tools+Modbus__Tool#674

Tool: http://www.icpdas.com/en/download/show.php?num=1026 (PC or WinCE)

Hardware Wiring (For testing)：



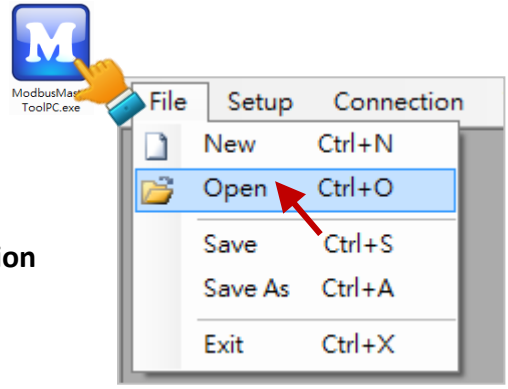
In this example, the M-7000 series DI and DO modules will be used. Please follow the steps below to complete the configuration.

Model	I/O	Slave ID	Baud Rate	Protocol	Modbus Address (Base 1)
M-7026	3 DI	1	9600	Modbus RTU	10033 ~ 10035 (Read DI)
M-7005	3 DO	2			00001 ~ 00003 (Read /Write DO)

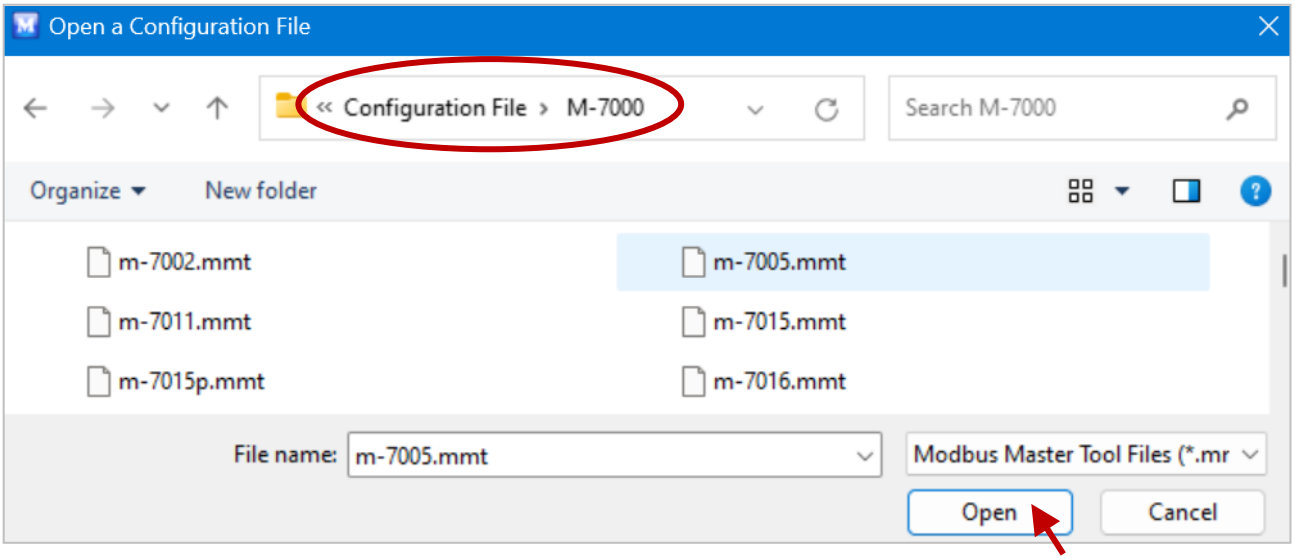
Step1: Open the Modbus Master Tool software

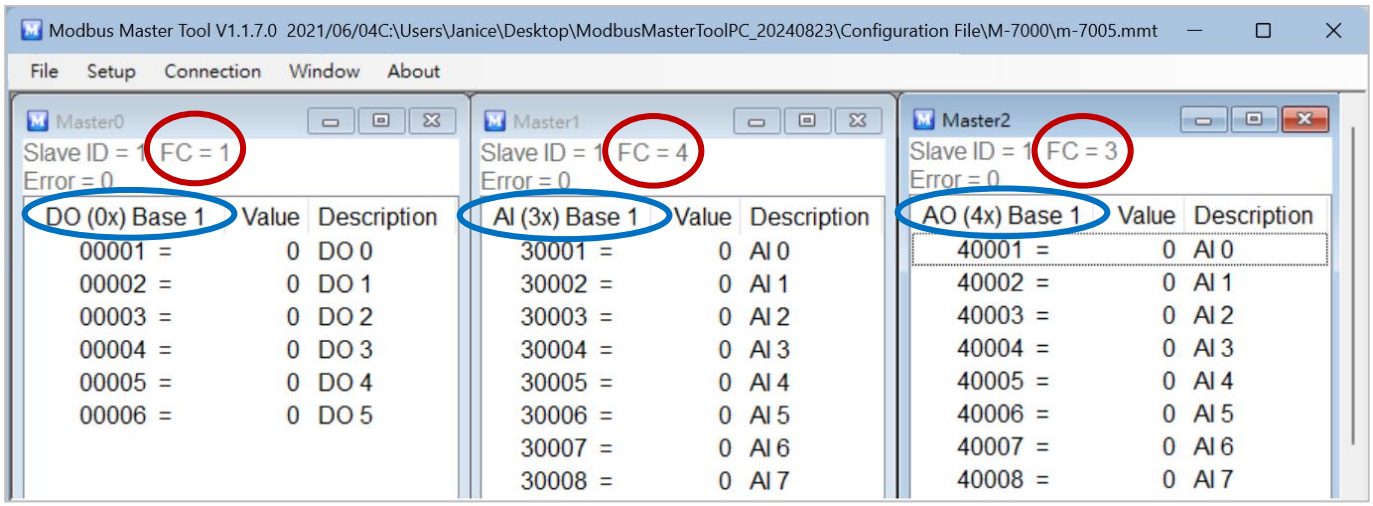
Method 1: Open a Configuration File

Note: When using this method, all function windows supported by the specific model will be opened. If only a single function needs to be configured, refer to Method 2.



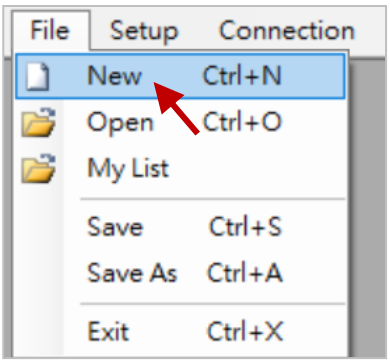
Click "**Open**" in the "**File**" menu, navigate to the **…/Configuration File/M-7000** folder, select the required model, and then click "**Open**" to load the configuration file with address base 1.



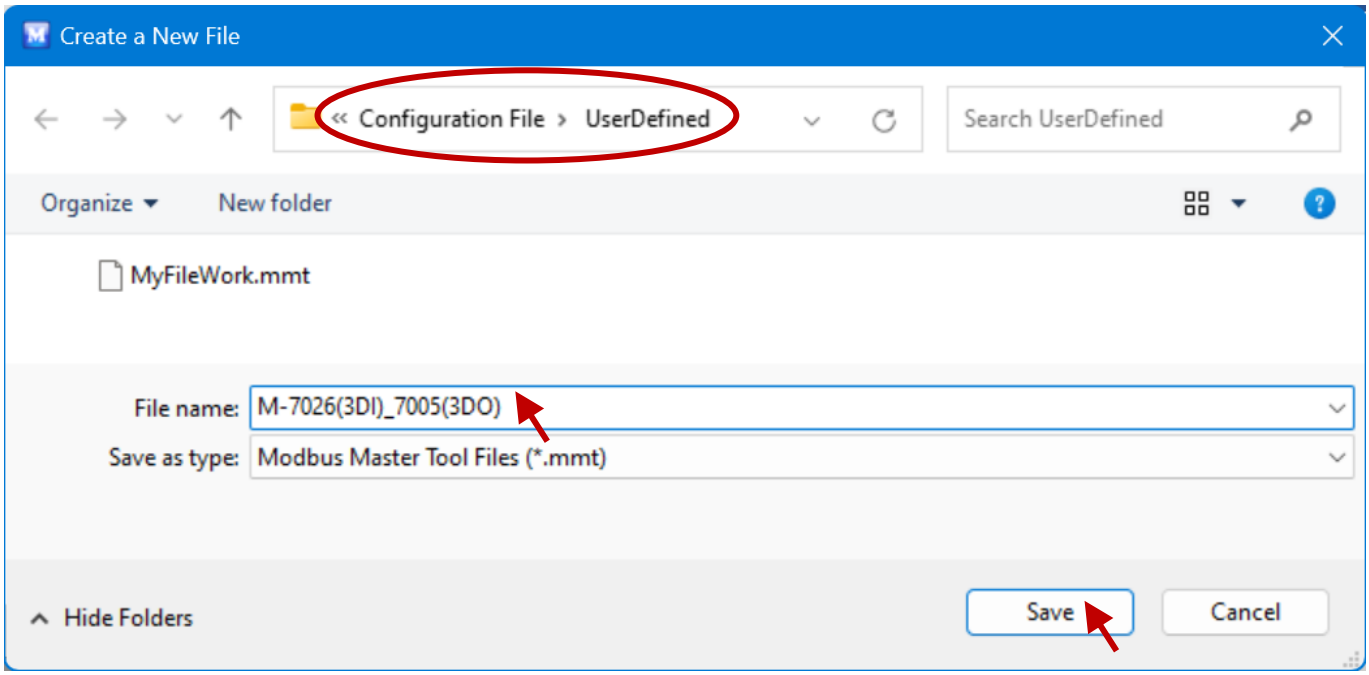


Method 2: Create a Configuration File

Click "**New**" in the "**File**" menu to add a configuration file and then save it.



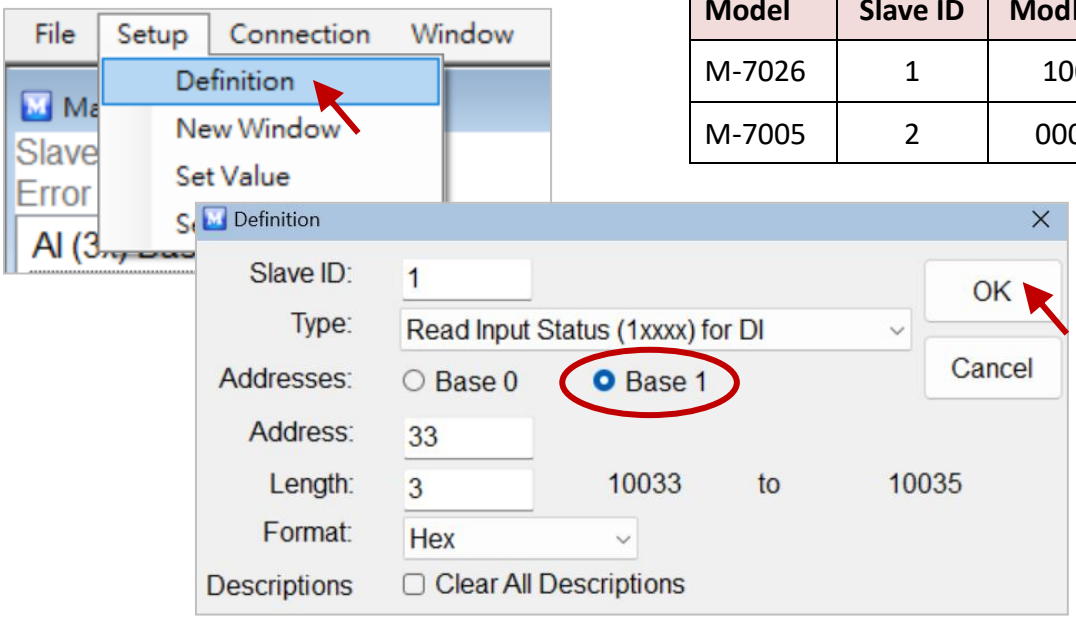
Under the **…/Configuration File/UserDefined** folder, enter a file name, and click the "**Save**" button to save the file.



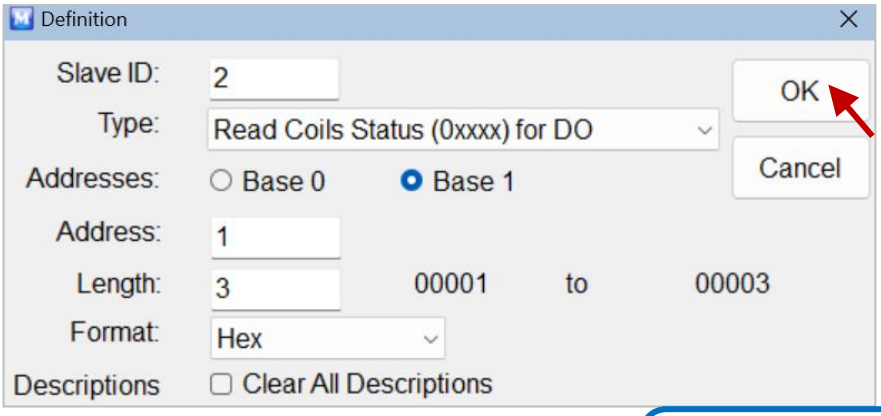
Step 2: Set DI and DO Configurations

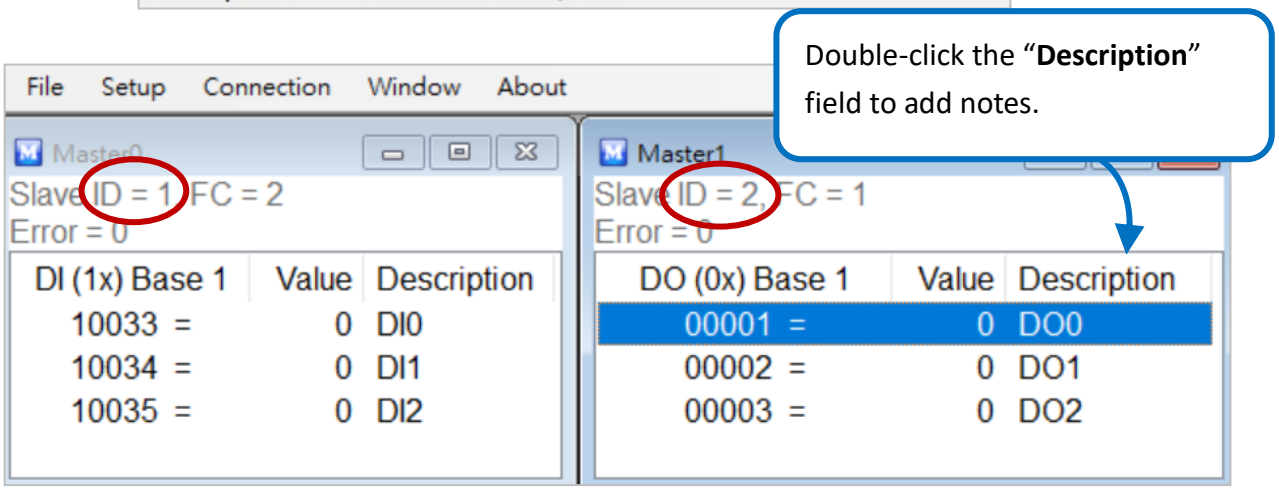
Click "**Definition**" in the "**Setup**" menu to set DI configurations, and click OK.

Model	Slave ID	Modbus Address (Base 1)
M-7026	1	10033 ~ 10035 (3 DI)
M-7005	2	00001 ~ 00003 (3 DO)



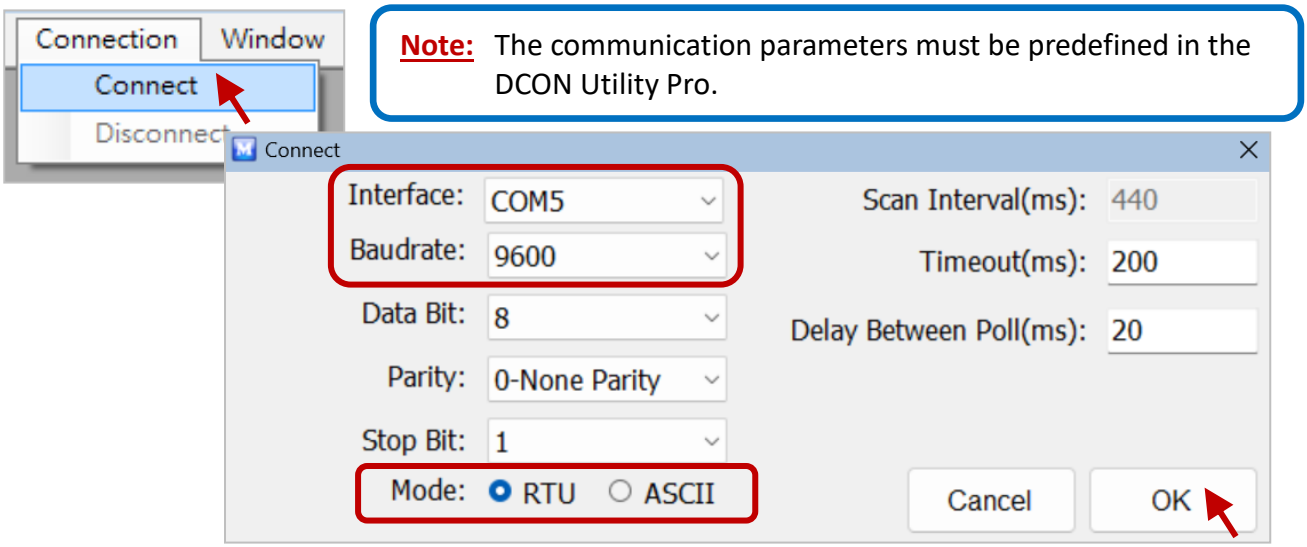
Click "**New Window**" in the "**Setup**" menu to set DO configurations, and click OK.





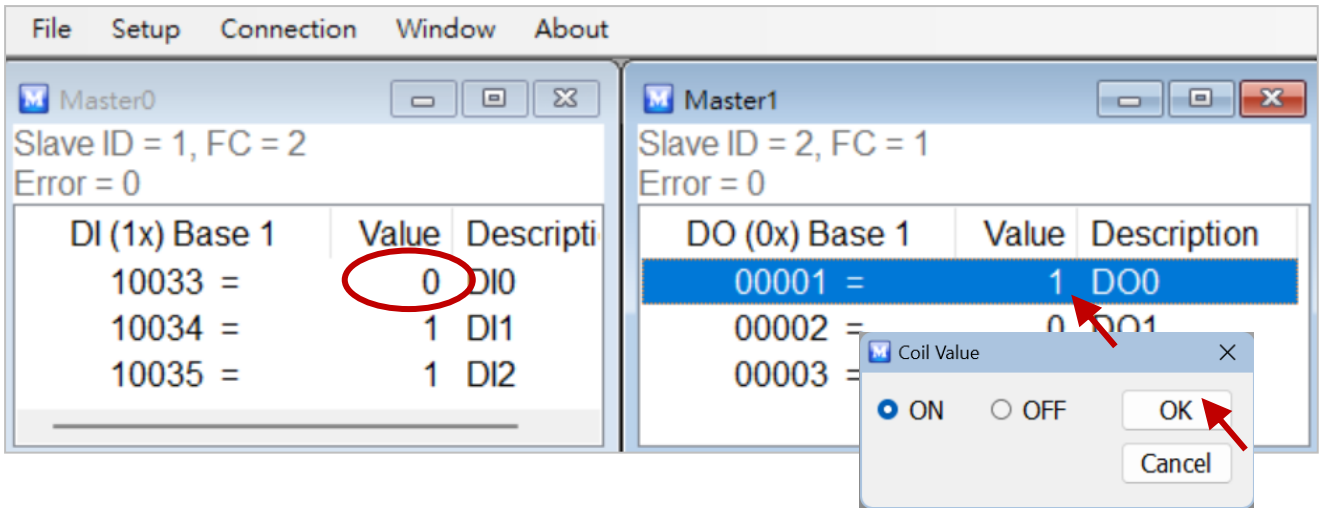
Step 3: Establish a Serial Port Connection

Click "**Connect**" in the "**Connection**" menu. In this example, the M-7000 module communicates with the PC's COM5 port via the Modbus RTU protocol. Configure the parameters as shown and click "**OK**".



Step 4: Test the DI and DO Modules

The M-7005 is preset to invert the DI status. When the DO is set to ON (1), the DI will change from ON (1) to OFF (0). Note that users can click **"Disconnect"** in the **"Connection"** to cancel the connection.



6.2 Using Linux Modbus SDK

ICP DAS LinPAC family is embedded with flexible and open source Linux system which can be used to control M-7000 series module via DCON or Modbus protocols. The following describes three kinds of Modbus tools that for users to develop various applications.

Modbus Development Tools	Download
C Programming Language	
★ LinPAC SDK ★ libmodbus	Go to the LinPAC product page to download the LinPAC SDK. Go to the libmodbus website to download the libmodbus library.
Python Programming Language	
★ modbus-tk	Go to the Python website to download the Modbus tool
Perl Programming Language	
★ Device-Modbus	Go to Perl website to download Modbus tool.

Visit the website for more information:
https://www.icpdas.com/en/product/guide+Software+Development__Tools+Modbus__Tool#2844

6.3 Using nModbus

nModbus is a C# 3.0 implementation of the Modbus protocol. It is developed and maintained on a voluntary basis and provided free of charge. ICP DAS verified and improved the DLL based on the official released NModbus_net-2.0_1.11.0.0-source.zip.

Programmers can use the DLL released by ICP DAS to develop a Modbus application for regular Windows based PCs, PAC, or WinCE based devices.

Users can download files on the nModbus webpage:
http://www.icpdas.com/en/product/guide+Software+Development__Tools+Modbus__Tool

nModbus API Manual:
https://www.icpdas.com/en/download/show.php?num=1024

Download the Demo Program:
https://www.icpdas.com/en/download/show.php?num=1025

- **PC version**:

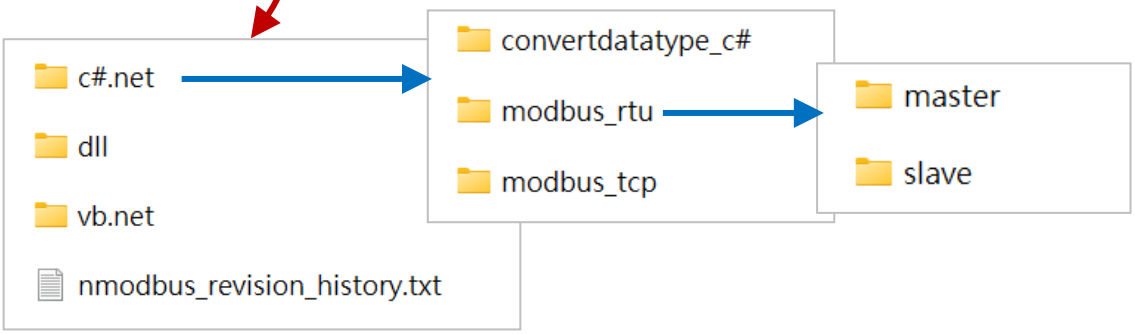
  DLL: log4net.dll, nmodbuspc.dll

- **WinCE version**:

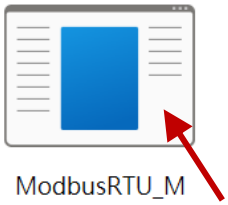
  DLL: cabc.dll, fc19.dll, nmodbusce.dll

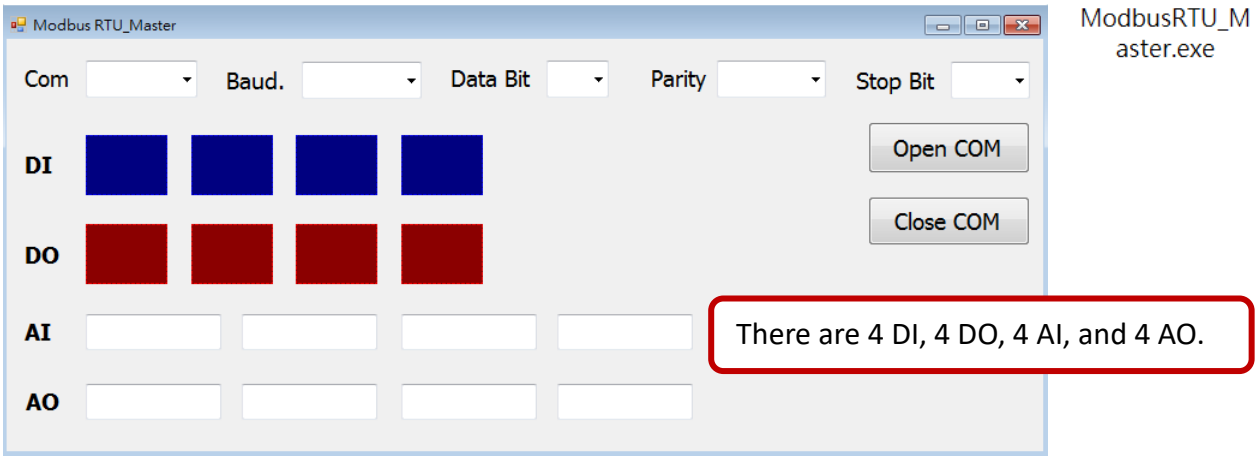
The user can download the demo program for either the WinForm or WinCE version and unzip the file.

FILE NAME	VERSION	FILE DATE	SIZE	NOTE	
nModbus_demo_WinForm.zip	v1.13.0.0	2024-09-06	2.4 MB	PC windows version including WES/IoT PAC	
nModbus_demo_WinCE.zip	v1.13.0.0	2024-09-11	1.6 MB	WinCE version	
nModbus revision history		2024-09-06	4 KB		



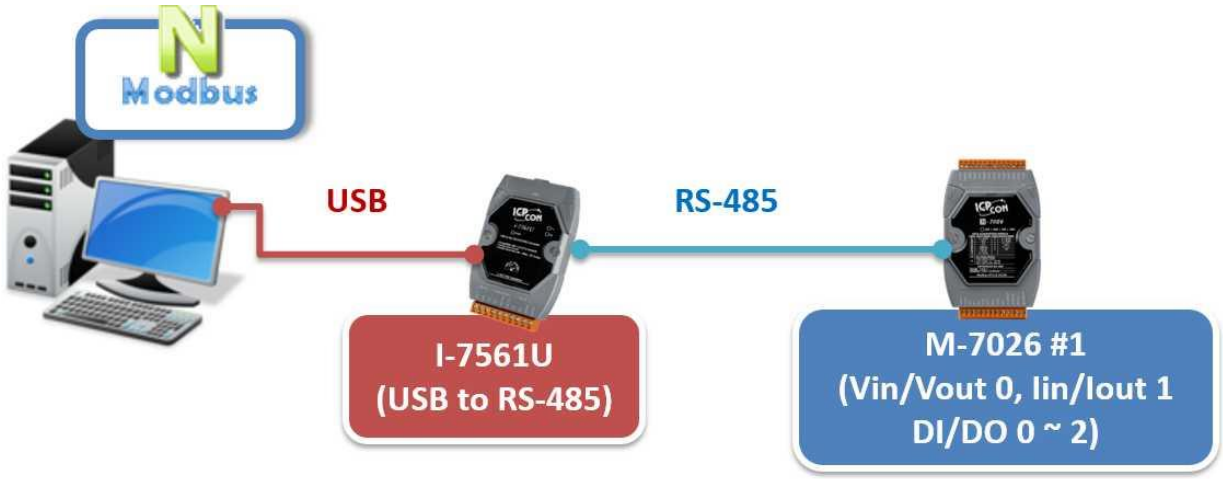
After downloading the **WinForm** demo program, open the "**ModbusRTU_Master.exe**" in the folder. For example, .../nModbus_demo_WinForm**c#.net**\modbus_rtu\master\ModbusRTU_Master\ModbusRTU_Master\bin\Release





The Modbus address (Base 0 or Base1) and the number of I/O tags may vary depending on the module. The user can modify the program to suit the specific model. In this example, the M-7026 is used, with the address in the program starting from "0." All the APIs used are listed in the table below.

I/O	Address (Base 0)	nModbus API
DO0 - DO2	0 - 2 (starting address: 0, reading length: 3)	ReadCoils, WriteSingleCoil
DI0 - DI2	32 - 34 (starting address: 32, reading length: 3)	ReadInputs
AI0 - AI5	0 - 5 (starting address: 0, reading length: 6)	ReadInputRegisters
AO0 - AO1	32 - 33 (starting address: 32, reading length: 2)	ReadHoldingRegisters, WriteSingleRegister



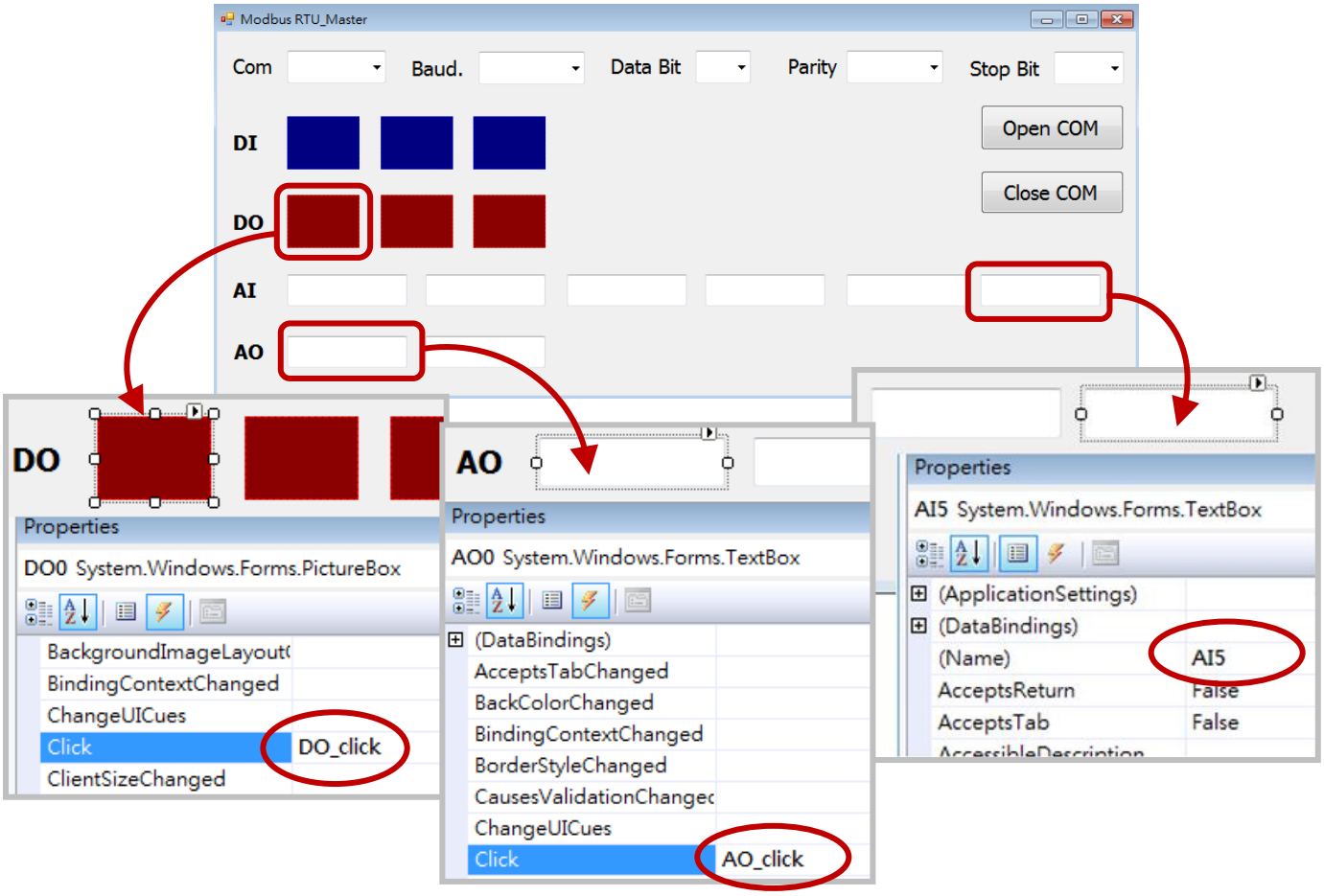
The following steps describe how to modify the Modbus RTU Master demo program (in C# and VB) to match the M-7026's Modbus address (Base1) and I/O quantity.

Click the link to view the M-7026's Modbus address (Base1) mapping table.
https://www.icpdas.com/web/product/download/io_and_unit/rs-485/document/manual/7000/M-7000_address_mapping_table.pdf

I/O	Modbus Address (Base1)
DO0 - DO2	00001 - 00003
DI0 - DI2	10033 - 10035
AI0 - AI5	30001 - 30006
AO0 - AO1	40033 - 40034

6.3.1 Modify the Form

First, modify the number of I/O objects in the form. For example, the M-7026 includes 3 DI, 3 DO, 6 AI, and 2 AO. In the "**Properties**" window, configure the "**Name**" fields and set the "**Click**" fields for the AO/DO objects.



6.3.2 Modify C# Code

In this example, the module's address is set to "**1**". If the address is "2", all instances of "**slaveID**" in the program must be assigned the value "**2**"

```
byte slaveID = 1;  →  byte slaveID = 2;
```

Configure the I/O Tags

Before modifying

```
private void Form1_Load(object sender, EventArgs e)
{
    foreach (string s in SerialPort.GetPortNames())
        comcmb.Items.Add(s);
    comcmb.SelectedIndex = 0;
    baudcmb.SelectedIndex = 0;
    dbcmb.SelectedIndex = 0;
    ptycmb.SelectedIndex = 0;
    sbcmb.SelectedIndex = 0;

    listDI.Add(DI0);
    listDI.Add(DI1);
    listDI.Add(DI2);
    listDI.Add(DI3);

    listDO.Add(DO0);
    listDO.Add(DO1);
    listDO.Add(DO2);
    listDO.Add(DO3);

    listAI.Add(AI0);
    listAI.Add(AI1);
    listAI.Add(AI2);
    listAI.Add(AI3);

    listAO.Add(AO0);
    listAO.Add(AO1);
    listAO.Add(AO2);
    listAO.Add(AO3);

    openbtn.Enabled = true;
    closebtn.Enabled = false;
}
```

The original example includes 4 DI, 4 DO, 4 AI, and 4 AO

After modifying

```
private void Form1_Load(object sender, EventArgs e)
{
    foreach (string s in SerialPort.GetPortNames())
        comcmb.Items.Add(s);
    comcmb.SelectedIndex = 0;
    baudcmb.SelectedIndex = 0;
    dbcmb.SelectedIndex = 0;
    ptycmb.SelectedIndex = 0;
    sbcmb.SelectedIndex = 0;

    listDI.Add(DI0);
    listDI.Add(DI1);
    listDI.Add(DI2);

    listDO.Add(DO0);
    listDO.Add(DO1);
    listDO.Add(DO2);

    listAI.Add(AI0);
    listAI.Add(AI1);
    listAI.Add(AI2);
    listAI.Add(AI3);
    listAI.Add(AI4);
    listAI.Add(AI5);

    listAO.Add(AO0);
    listAO.Add(AO1);

    openbtn.Enabled = true;
    closebtn.Enabled = false;
}
```

M-7026 includes 3 DI, 3 DO, 6 AI , and 2 AO

Read the starting address of the I/O (Base 0)

Before modifying

```
private void timer1_Tick(object sender, EventArgs e)
{
    try
    {
        byte slaveID = 1;
        ushort startAddress = 0;
        ushort numofPoints = 4;
```

After modifying

M-7026		Address (Base0)
DI0 ~ DI2	3	10032 ~ 10034
DO0 ~ DO2	3	00000 ~ 00002
AI0 ~ AI5	6	30000 ~ 30005
AO0 ~ AO1	2	40032 ~ 40033

```
private void timer1_Tick(object sender, EventArgs e)
{
    try
    {
        byte slaveID = 1;
        ushort startAddress_DI = 32, startAddress_DO = 0, startAddress_AI = 0, startAddress_AO = 32;
        ushort numofPoints_DI = 3, numofPoints_DO = 3, numofPoints_AI = 6, numofPoints_AO = 2;
```

Read DI Tags (Base 0)

Before modifying

```
//read DI(1xxxx)
bool[] status = master.ReadInputs(slaveID, startAddress, numofPoints);
for (int i = 0; i < numofPoints; i++)
{
    if (status[i] == true)
        listDI[i].BackColor = Color.DodgerBlue;
    else
        listDI[i].BackColor = Color.Navy;
}
```

After modifying

```
//read DI(1xxxx)
bool[] status = master.ReadInputs(slaveID, startAddress_DI, numofPoints_DI);
for (int i = 0; i < numofPoints_DI; i++)
{
    if (status[i] == true)
        listDI[i].BackColor = Color.DodgerBlue;
    else
        listDI[i].BackColor = Color.Navy;
}
```

Read DO Tags (Base 0)

Before modifying

```
//read DO(0xxxx)
bool[] coilstatus = master.ReadCoils(slaveID, startAddress, numofPoints);
for (int i = 0; i < numofPoints; i++)
{
    if (coilstatus[i] == true)
        listDO[i].BackColor = Color.Red;
    else
        listDO[i].BackColor = Color.DarkRed;
}
```

After modifying

```
//read DO(0xxxx)
bool[] coilstatus = master.ReadCoils(slaveID, startAddress_DO, numofPoints_DO);
for (int i = 0; i < numofPoints_DO; i++)
{
    if (coilstatus[i] == true)
        listDO[i].BackColor = Color.Red;
    else
        listDO[i].BackColor = Color.DarkRed;
}
```

If users need to convert AI/AO values for display in a specific unit, refer to **Appendix B:** Type Code for AI Values (Modbus Protocol)

Read AI Tags (Base 0)

Before modifying

```
//read AI(3xxxx)
ushort[] register = master.ReadInputRegisters(slaveID, startAddress, numofPoints);
for (int i = 0; i < numofPoints; i++)
{
    listAI[i].Text = register[i].ToString();

    //If you need to show the value with other unit, you have to caculate the gain and offset
    //eq. 0 to 0kg, 32767 to 1000kg
    //0 (kg) = gain * 0 + offset
    //1000 (kg) = gain *32767 + offset
    //=> gain=1000/32767, offset=0
    //double value = (double)register[i] * 10.0 / 32767;
    //listAI[i].Text = value.ToString("0.00");
}
```

After modifying

```
//read AI(3xxxx)
ushort[] register = master.ReadInputRegisters(slaveID, startAddress_AI, numofPoints_AI);
for (int i = 0; i < numofPoints_AI; i++)
{
    listAI[i].Text = register[i].ToString();

    //If you need to show the value with other unit, you have to caculate the gain and offset
    //eq. 0 to 0kg, 32767 to 1000kg
    //0 (kg) = gain * 0 + offset
    //1000 (kg) = gain *32767 + offset
    //=> gain=1000/32767, offset=0
    //double value = (double)register[i] * 10.0 / 32767;
    //listAI[i].Text = value.ToString("0.00");
}
```

Read AO Tags (Base 0)

Before modifying

```
//read AO(4xxxx)
ushort[] holdingregister = master.ReadHoldingRegisters(slaveID, startAddress, numofPoints);
for (int i = 0; i < numofPoints; i++)
{
    listAO[i].Text = holdingregister[i].ToString();

    //If you need to show the value with other unit, you have to caculate the gain and offset
    //eq. 0 to 0 mA, 32767 to 20 mA
    //0 (mA) = gain * 0 + offset
    //20 (mA) = gain *32767 + offset
    //=> gain=20/32767, offset=0
    //double holdvalue = (double)holdingregister[i] * 20.0 / 32767;
    //listAO[i].Text = holdvalue.ToString("0.00");
}
```

After modifying

```
//read AO(4xxxx)
ushort[] holdingregister = master.ReadHoldingRegisters(slaveID, startAddress_AO, numofPoints_AO);
for (int i = 0; i < numofPoints_AO; i++)
{
    listAO[i].Text = holdingregister[i].ToString();

    //If you need to show the value with other unit, you have to caculate the gain and offset
    //eq. 0 to 0 mA, 32767 to 20 mA
    //0 (mA) = gain * 0 + offset
    //20 (mA) = gain *32767 + offset
    //=> gain=20/32767, offset=0
    //double holdvalue = (double)holdingregister[i] * 20.0 / 32767;
    //listAO[i].Text = holdvalue.ToString("0.00");
}
```

Write AO Tags (Base 0)

Before modifying

```
        //set AO
        private void AO_click(object sender, EventArgs e)
        {
            byte slaveID = 1;
            frmInputValue inputvalue = new frmInputValue();
            if (serialPort.IsOpen == true)
            {
                ushort index = ushort.Parse(((TextBox)sender).Tag.ToString());
                inputvalue.StringValue = ((TextBox)sender).Text;
                inputvalue.ShowDialog();
                if (inputvalue.DialogResult == DialogResult.OK)
                {
                    double value = inputvalue.Value;
                    ushort aovalue = (ushort)value;

                    //use gain=20/32767, offset=0
                    //ushort aovalue = (ushort)(value * 32767 / 20.0);
                    master.WriteSingleRegister(slaveID, index, aovalue);
                }
            }
        }
```

After modifying

```
//set AO
private void AO_click(object sender, EventArgs e)
{
    byte slaveID = 1;
    frmInputValue inputvalue = new frmInputValue();
    if (serialPort.IsOpen == true)
    {
        ushort index = ushort.Parse((Convert.ToInt16(((TextBox)sender).Tag.ToString()) + 32).ToString());
        inputvalue.StringValue = ((TextBox)sender).Text;
        inputvalue.ShowDialog();
        if (inputvalue.DialogResult == DialogResult.OK)
        {
            double value = inputvalue.Value;
            ushort aovalue = (ushort)value;

            //use gain=20/32767, offset=0
            //ushort aovalue = (ushort)(value * 32767 / 20.0);
            master.WriteSingleRegister(slaveID, index, aovalue);
        }
    }
}
```

6.3.3 Modify VB Code

In this example, the module's address is set to "**1**". If the address is "2", all instances of "**slaveID**" in the program must be assigned the value "**2**".

```
Dim slaveID As Byte = 1
```

```
Dim slaveID As Byte = 2
```

Configure the I/O Tags

Before modifying

```
Private Sub Form1_Load(ByVal sender As System.Object,
    For Each s As String In serialPort.GetPortNames()
        cmbcom.Items.Add(s)
    Next
    cmbcom.SelectedIndex = 0
    cmbbaud.SelectedIndex = 0
    cmbdb.SelectedIndex = 0
    cmbpty.SelectedIndex = 0
    cmbsb.SelectedIndex = 0

    listDI.Add(DI0)
    listDI.Add(DI1)
    listDI.Add(DI2)
    listDI.Add(DI3)

    listDO.Add(DO0)
    listDO.Add(DO1)
    listDO.Add(DO2)
    listDO.Add(DO3)

    listAI.Add(AI0)
    listAI.Add(AI1)
    listAI.Add(AI2)
    listAI.Add(AI3)

    listAO.Add(AO0)
    listAO.Add(AO1)
    listAO.Add(AO2)
    listAO.Add(AO3)
    btnOpen.Enabled = True
    btnClose.Enabled = False

End Sub
```

The original example includes 4 DI, 4 DO, 4 AI, and 4 AO.

After modifying

```
Private Sub Form1_Load(ByVal sender As System.Object,
    For Each s As String In serialPort.GetPortNames()
        cmbcom.Items.Add(s)
    Next
    cmbcom.SelectedIndex = 0
    cmbbaud.SelectedIndex = 0
    cmbdb.SelectedIndex = 0
    cmbpty.SelectedIndex = 0
    cmbsb.SelectedIndex = 0

    listDI.Add(DI0)
    listDI.Add(DI1)
    listDI.Add(DI2)

    listDO.Add(DO0)
    listDO.Add(DO1)
    listDO.Add(DO2)

    listAI.Add(AI0)
    listAI.Add(AI1)
    listAI.Add(AI2)
    listAI.Add(AI3)
    listAI.Add(AI4)
    listAI.Add(AI5)

    listAO.Add(AO0)
    listAO.Add(AO1)
    btnOpen.Enabled = True
    btnClose.Enabled = False

End Sub
```

M-7026 includes 3 DI, 3 DO, 6 AI, and 2 AO.

Read the starting address of the I/O (Base 0)

Before modifying

```
Private Sub Timer1_Tick(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Timer1.Tick
    Dim slaveID As Byte = 1
    Dim startAddress As UShort = 0
    Dim numOfPoints As UShort = 4
```

After modifying

```
Private Sub Timer1_Tick(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Timer1.Tick
    Dim slaveID As Byte = 1
    Dim startAddress_DI As UShort = 32
    Dim startAddress_DO As UShort = 0
    Dim startAddress_AI As UShort = 0
    Dim startAddress_AO As UShort = 32
    Dim numOfPoints_DI As UShort = 3
    Dim numOfPoints_DO As UShort = 3
    Dim numOfPoints_AI As UShort = 6
    Dim numOfPoints_AO As UShort = 2
```

M-7026		Address (Base0)
DI0 ~ DI2	3	10032 ~ 10034
DO0 ~ DO2	3	00000 ~ 00002
AI0 ~ AI5	6	30000 ~ 30005
AO0 ~ AO1	2	40032 ~ 40033

Read DI Tags (Base 0)

Before modifying

```
Try
    'read DI(1xxxx)
    Dim status() As Boolean = master.ReadInputs(slaveID, startAddress, numOfPoints)
    For i As Integer = 0 To numOfPoints - 1
        If status(i) = True Then
            listDI(i).BackColor = Color.DodgerBlue
        Else
            listDI(i).BackColor = Color.Navy
        End If
    Next
```

After modifying

```
Try
    'read DI(1xxxx)
    Dim status() As Boolean = master.ReadInputs(slaveID, startAddress_DI, numOfPoints_DI)
    For i As Integer = 0 To numOfPoints_DI - 1
        If status(i) = True Then
            listDI(i).BackColor = Color.DodgerBlue
        Else
            listDI(i).BackColor = Color.Navy
        End If
    Next
```

Read DO Tags (Base 0)

Before modifying

```
'read DO(0xxxx)
Dim coils() As Boolean = master.ReadCoils(slaveID, startAddress, numOfPoints)
For i As Integer = 0 To numOfPoints - 1
    If coils(i) = True Then
        listDO(i).BackColor = Color.Red
    Else
        listDO(i).BackColor = Color.DarkRed
    End If
Next
```

After modifying

```
'read DO(0xxxx)
Dim coils() As Boolean = master.ReadCoils(slaveID, startAddress_DO, numOfPoints_DO)
For i As Integer = 0 To numOfPoints_DO - 1
    If coils(i) = True Then
        listDO(i).BackColor = Color.Red
    Else
        listDO(i).BackColor = Color.DarkRed
    End If
Next
```

If users need to convert AI/AO values for display in a specific unit, refer to **Appendix B:** Type Code for AI Values (Modbus Protocol)

Read AI Tags (Base 0)

Before modifying

```
'read AI(3xxxx)
Dim register() As UShort = master.ReadInputRegisters(slaveID, startAddress, numOfPoints)
For i As Integer = 0 To numOfPoints - 1
    'If you need to show the value with other unit, you have to caculate the gain and offset
    'eq. 0 to 0kg, 32767 to 1000kg
    '0 (kg) = gain * 0 + offset
    '1000 (kg) = gain *32767 + offset
    '=> gain=1000/32767, offset=0
    'Dim value As Double = CDbl(register(i) * 1000.0 / 32767)
    'listAI(i).Text = value.ToString("0.00")
    listAI(i).Text = register(i).ToString()
Next
```

After modifying

```
'read AI(3xxxx)
Dim register() As UShort = master.ReadInputRegisters(slaveID, startAddress_AI, numOfPoints_AI)
For i As Integer = 0 To numOfPoints_AI - 1
    'If you need to show the value with other unit, you have to caculate the gain and offset
    'eq. 0 to 0kg, 32767 to 1000kg
    '0 (kg) = gain * 0 + offset
    '1000 (kg) = gain *32767 + offset
    '=> gain=1000/32767, offset=0
    'Dim value As Double = CDbl(register(i) * 1000.0 / 32767)
    'listAI(i).Text = value.ToString("0.00")
    listAI(i).Text = register(i).ToString()
Next
```

Read AO Tags (Base 0)

Before modifying

```
'read AO(4xxxx)
Dim holding_register() As UShort = master.ReadHoldingRegisters(slaveID, startAddress, numOfPoints)
For i As Integer = 0 To numOfPoints - 1
    'If you need to show the value with other unit, you have to caculate the gain and offset
    'eq. 0 to 0 mA, 32767 to 20 mA
    '0 (mA) = gain * 0 + offset
    '20 (mA) = gain *32767 + offset
    '=> gain=20/32767, offset=0
    'Dim value As Double = CDbl(holding_register(i) * 20.0 / 32767)
    'listAO(i).Text = value.ToString("0.00")
    listAO(i).Text = holding_register(i).ToString()
Next
```

After modifying

```
'read AO(4xxxx)
Dim holding_register() As UShort = master.ReadHoldingRegisters(slaveID, startAddress_AO, numOfPoints_AO)
For i As Integer = 0 To numOfPoints_AO - 1
    'If you need to show the value with other unit, you have to caculate the gain and offset
    'eq. 0 to 0 mA, 32767 to 20 mA
    '0 (mA) = gain * 0 + offset
    '20 (mA) = gain *32767 + offset
    '=> gain=20/32767, offset=0
    'Dim value As Double = CDbl(holding_register(i) * 20.0 / 32767)
    'listAO(i).Text = value.ToString("0.00")
    listAO(i).Text = holding_register(i).ToString()
Next
```

Write AO Tags (Base 0)

Before modifying

```
'set ao
Private Sub AO_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles AO0.Click, AO3.Click, AO2.Click, AO1.Click
    Dim slaveID As Byte = 1
    Dim txt As TextBox = CType(sender, TextBox)
    Dim inputvalue As New frmInputValue()
    If serialPort.IsOpen = True Then
        Dim index As UShort = UShort.Parse(txt.Tag.ToString())
        inputvalue.StringValue = txt.Text
        inputvalue.ShowDialog()
        If inputvalue.DialogResult = Windows.Forms.DialogResult.OK Then
            Dim value As Double = inputvalue.Value
            Dim aovalue As UShort = CUShort(value)

            'use gain=20/32767, offset=0
            'Dim aovalue As UShort = CUShort(value * 32767 / 20.0)
            master.WriteSingleRegister(slaveID, index, aovalue)
        End If
    End If
End Sub
```

```
If serialPort.IsOpen = True Then
    Dim index As UShort = UShort.Parse(txt.Tag.ToString())
    inputvalue.StringValue = txt.Text
    inputvalue.ShowDialog()
```

After modifying

```
'set ao
Private Sub AO_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles AO0.Click, AO1.Click
    Dim slaveID As Byte = 1
    Dim txt As TextBox = CType(sender, TextBox)
    Dim inputvalue As New frmInputValue()
    If serialPort.IsOpen = True Then
        Dim index As UShort = UShort.Parse(Convert.ToInt16(txt.Tag.ToString()) + 32)
        inputvalue.StringValue = txt.Text
        inputvalue.ShowDialog()
        If inputvalue.DialogResult = Windows.Forms.DialogResult.OK Then
            Dim value As Double = inputvalue.Value
            Dim aovalue As UShort = CUShort(value)

            'use gain=20/32767, offset=0
            'Dim aovalue As UShort = CUShort(value * 32767 / 20.0)
            master.WriteSingleRegister(slaveID, index, aovalue)
        End If
    End If
End Sub
```

```
If serialPort.IsOpen = True Then
    Dim index As UShort = UShort.Parse(Convert.ToInt16(txt.Tag.ToString()) + 32)
    inputvalue.StringValue = txt.Text
    inputvalue.ShowDialog()
```

6.3.4 Test the Demo Program (WinForm, C#)

1. Before using the M-7026 module, refer chapter 3 to configure the following parameters by using DCON Utility Pro.

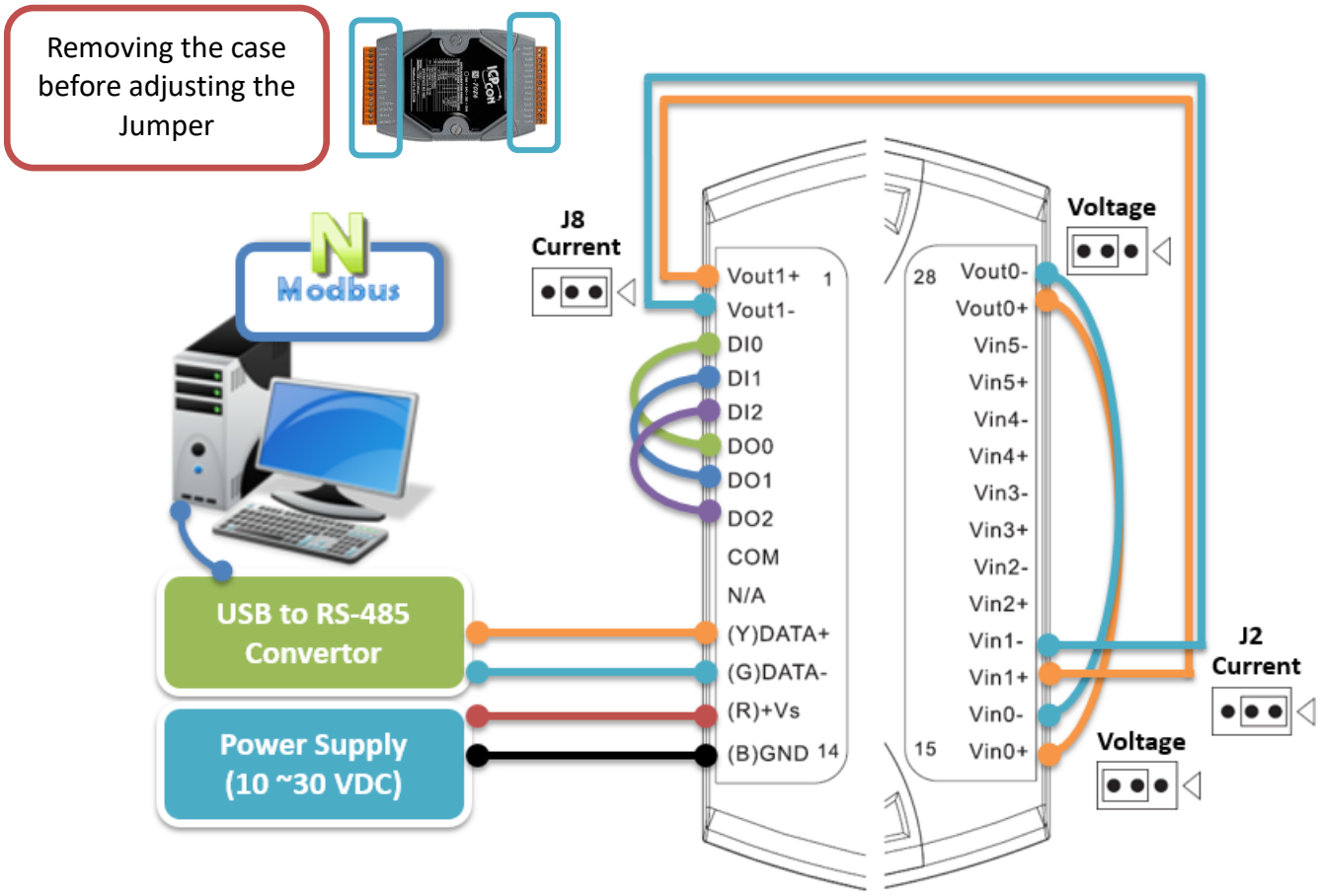
M-7026	The "Configuration" Page
Protocol	**Modbus RTU**
Address	**1**
Baud Rate = 9600、Parity= N,8,1、Analog Format= Engineering	

M-7026	The "AO" Page	The "AI/DO Alarm" Page
Type Code	**Vout0** = [08] +/-10V **Vout1** = [00] 0 ~ +20 mA	**Vin0** = [08] +/-10V **Vin1** = [1A] 0 ~ +20 mA

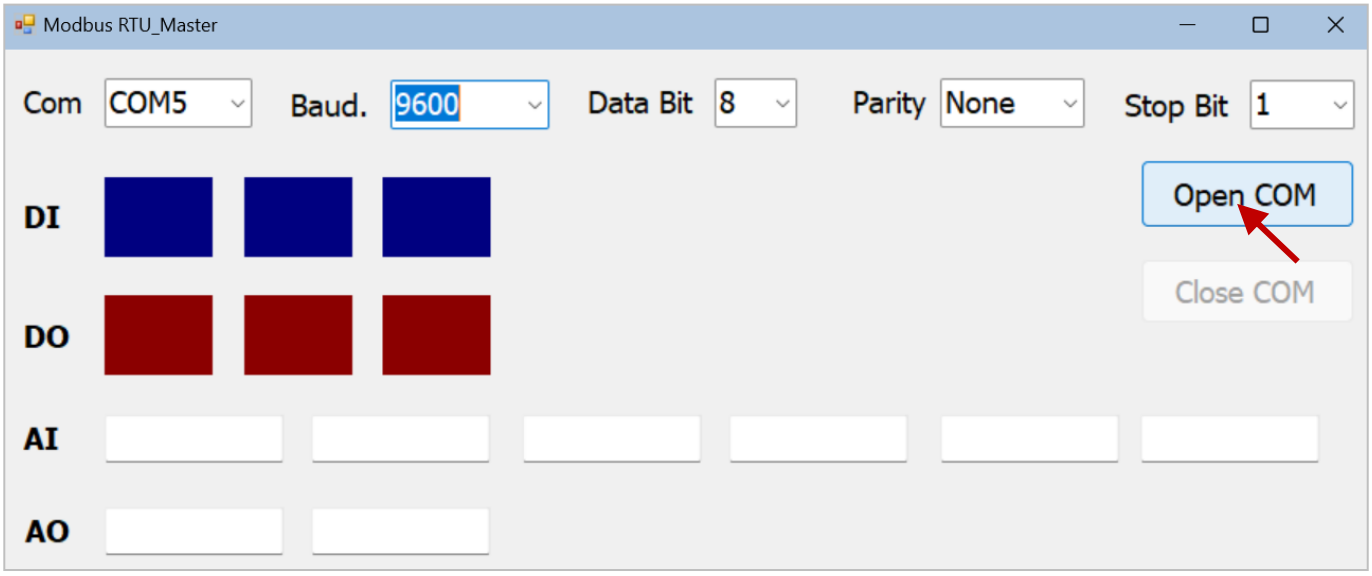
Hardware Wiring (For testing)：

In this example, an M-7026 module is used to test DI, DO, AI, and AO statuses. Connect all devices as shown in the wiring diagram below. The M-7000 module includes an internal jumper that allows users to select between voltage or current measurement. To configure **M-7026#1** for current measurement on **Vin1/Vout1**, adjust the **J2** and **J8** jumpers accordingly. For detailed instructions, refer to Page 3 of the M-7026 Data Sheet.

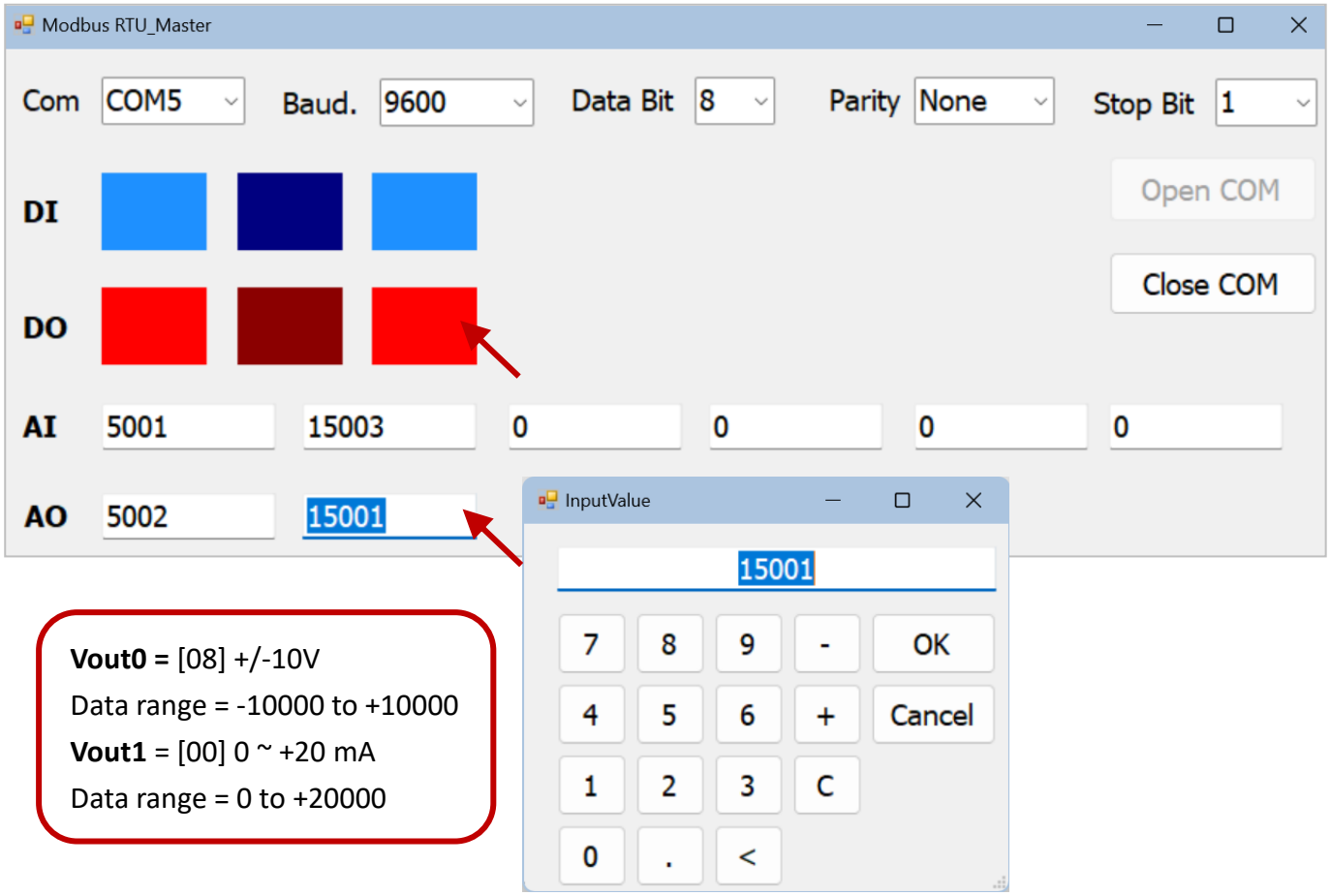
www.icpdas.com/web/product/download/io_and_unit/rs-485/document/data_sheet/M-7026_en.pdf



Double-click **ModbusRTU_Master.exe** to open the window. Configure the PC's COM port and the baud rate setting, then click "**Open COM**" to establish communication.



If the communication is successful, users can test the demo by clicking the "DO" button to turn the DI "ON" or the "AO" button to output a value to the AI.



Vout0 = [08] +/-10V
Data range = -10000 to +10000
Vout1 = [00] 0 ~ +20 mA
Data range = 0 to +20000

6.4 Using LabVIEW (Modbus)

LabVIEW (**Lab**oratory **V**irtual **I**nstrumentation **E**ngineering **W**orkbench) is a system-design platform and development environment for a visual programming language from National Instruments. LabVIEW provides an easy-to-use graphical interface and supports a variety of hardware drivers and software analysis tools that help users to speed up the amount of time to develop applications. LabVIEW has been widely used for the test, measurement, and automated control in various laboratories or industries.

Visit the **LabVIEW** webpage for more information:
https://www.icpdas.com/en/product/guide+Software+Development__Tools+LabVIEW__Tools#3089

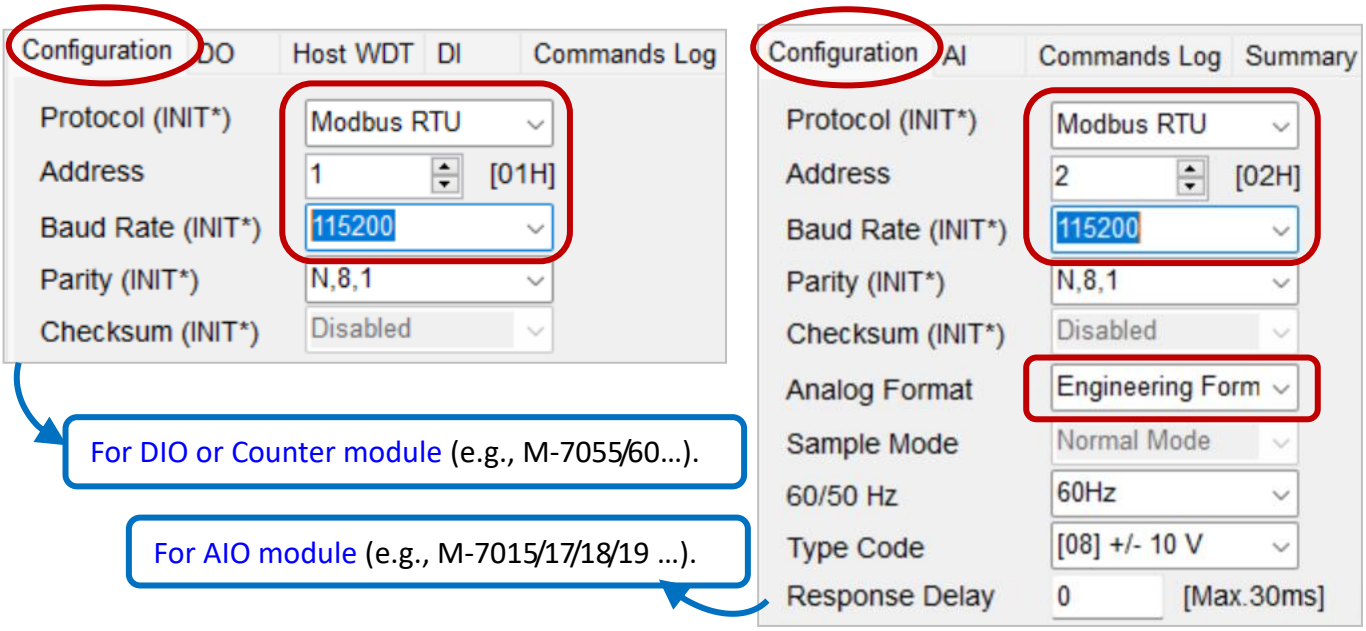
Note: Before communicating with M-7000 series module, refer to Chapter 3: Settings Page - Configurations to configure the parameters (e.g., Address, Baud Rate).

Download demo programs (For Modbus module, M-7000 series)
https://www.icpdas.com/en/download/show.php?num=1029

Modbus Tool					
This tool is used to access remote I/O modules with Modbus protocol. Version: LabVIEW 8.5 and later					
Download	**Applied Products**				
					
	tET/tPET Series	ET-7000/ET-7200	ET-2200	I-8k/I-87k modules in Modbus based IO Expansion Unit (ET-8KPn-MTCP, iP-8x41-MTCP, iP-8x11-MRTU)	
					
	M-7000	M-2000	M-6000	USB-4018HS	

6.5 Using Win-GRAF (Modbus)

Before using the M-7000 series module, refer to Chapter 3: Settings Page - Configurations to configure the parameters. Ensure that the "**Analog Format**" field is set to "**Engineering Format**".



Win-GRAF supports the **Modbus RTU** protocol for connecting to **M-7000** series modules. It includes built-in Modbus commands, allowing users to select the model and the desired read/write functions, thereby eliminating the need to manually reference tables and configure settings.

The following example demonstrates how to use an **XP-8xxx-CE6** PAC to connect to **M-7055** (8 DI, 8 DO) to read from or write to I/O modules via **COM3**. It also covers the procedure for downloading the program to the PAC, checking the module's status, and adding an additional module (**M-7017**).

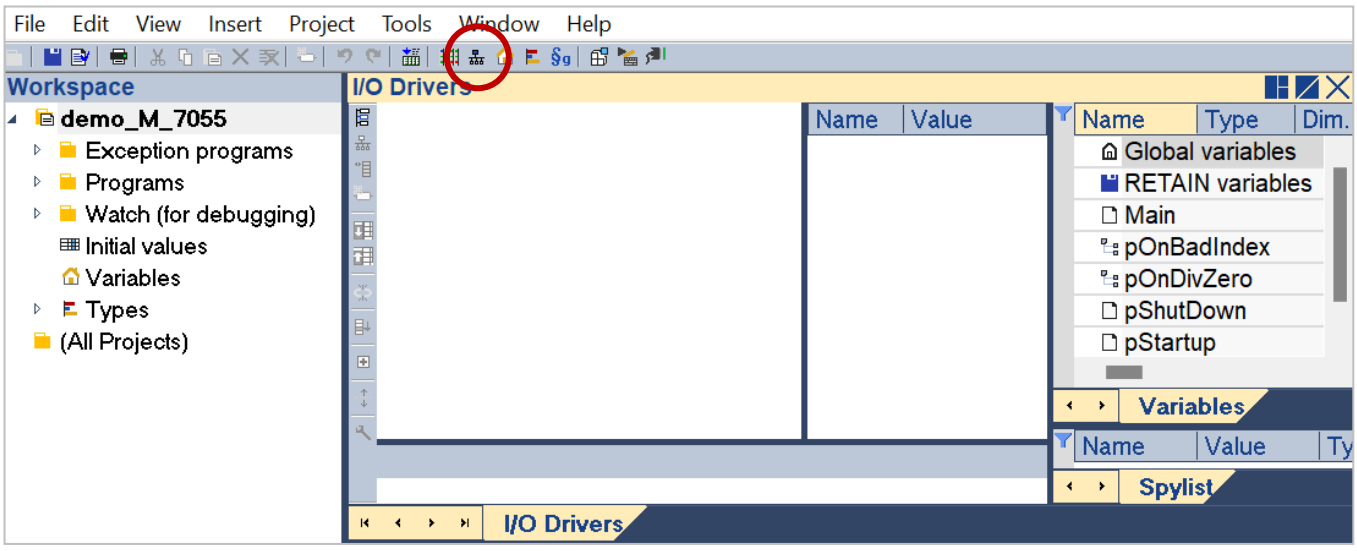
Visit the Win-GRAF Workbench webpage for more information:

Web: https://www.icpdas.com/en/product/guide+Software+Development__Tools+Win-GRAF

Manual: https://www.icpdas.com/en/download/show.php?num=8110

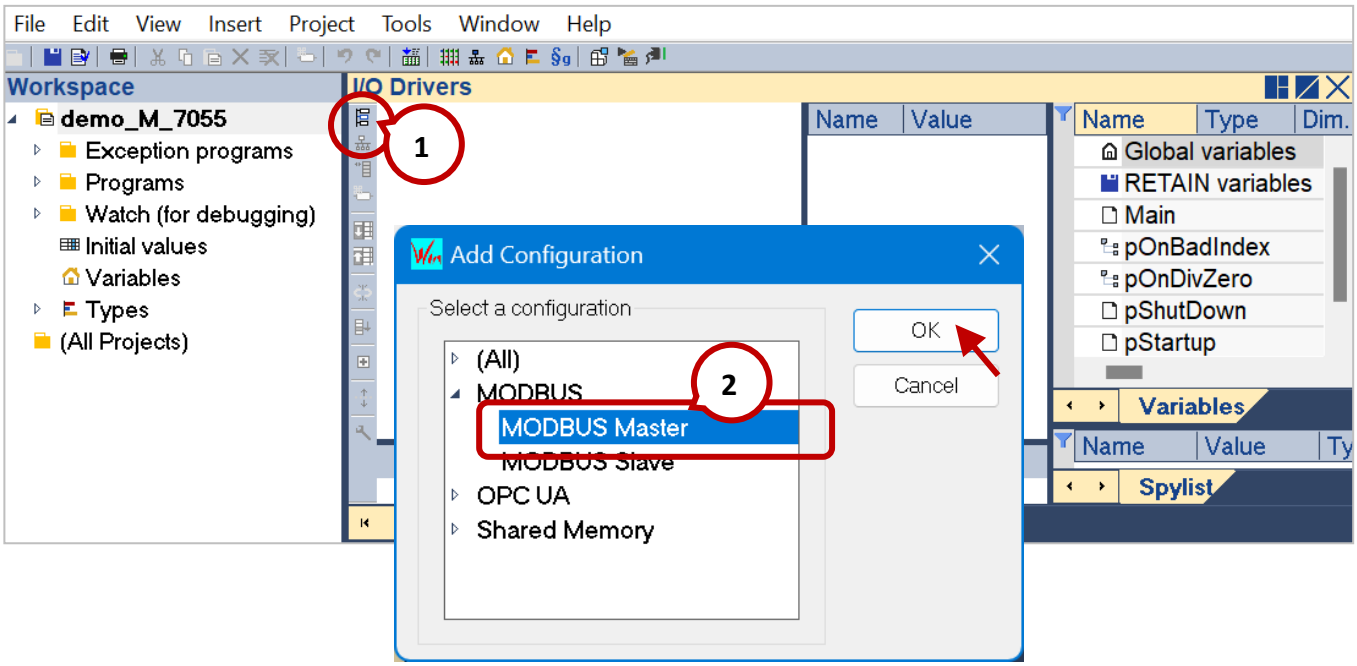
Configuration Instructions:

1. **Open Fieldbus:** Click the "**Open Fieldbus Configuration**" button to open the "**I/O Drivers**" window.



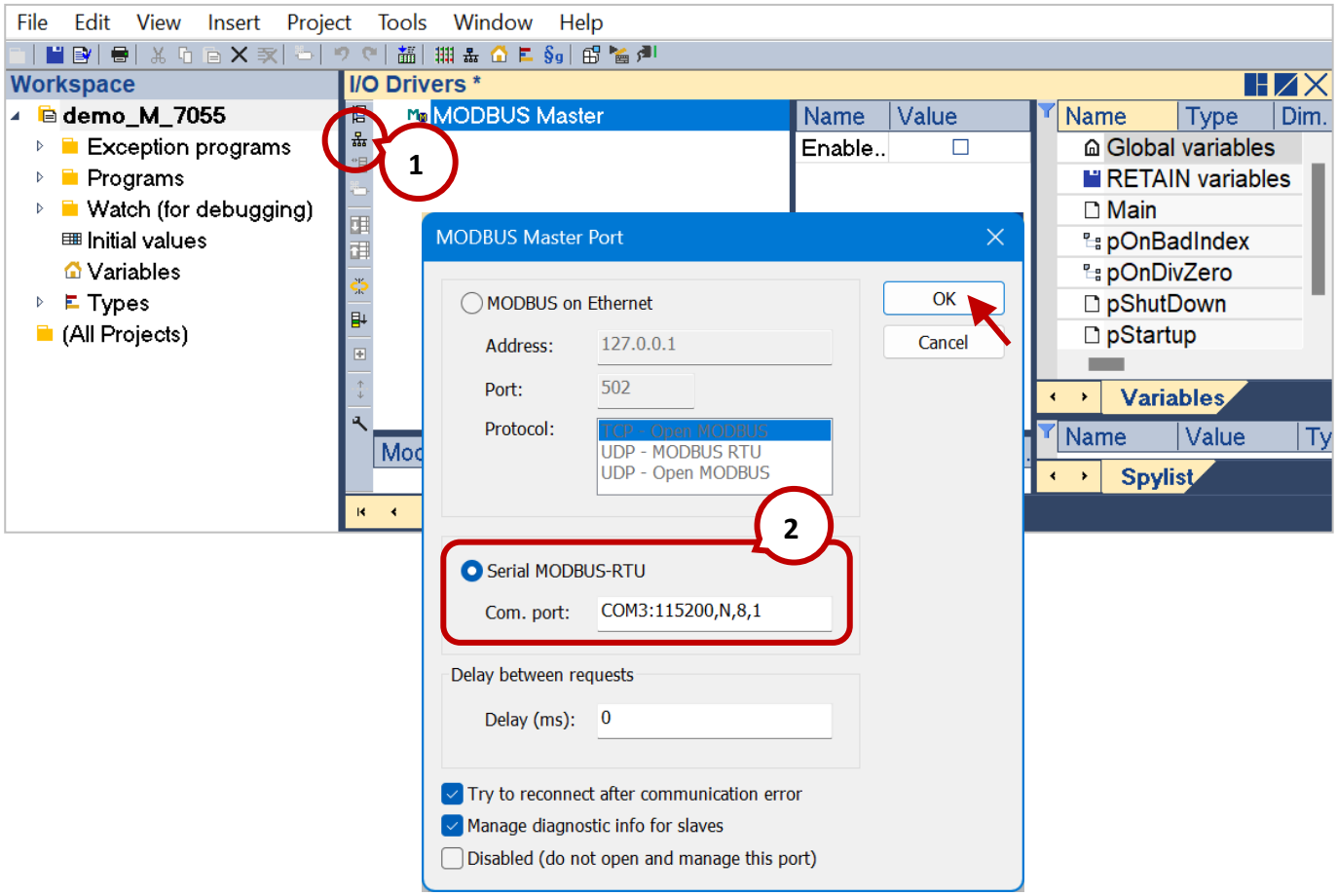
2. Add the MODBUS Master

Click the "**Insert Configuration**" button and select " **MODBUS Master**", and then click **OK**.



3. Select the MODBUS-RTU

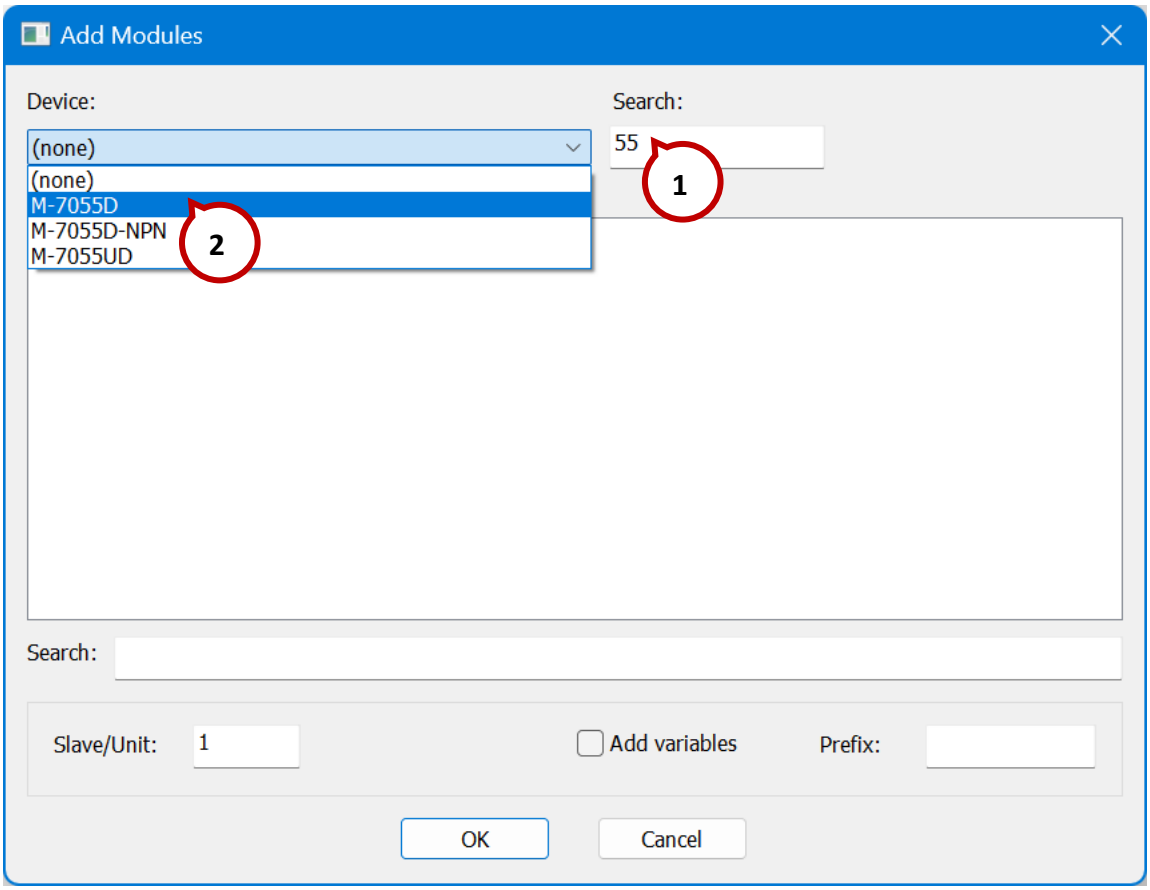
Click the **"Insert Master/Port"** button and select **"Serial MODBUS-RTU"**. Enter **COM3:115200,N,8,1** in the **"Com. Port"** field and click the **OK** button. Note that the COM settings should be configured according to the application requirements.



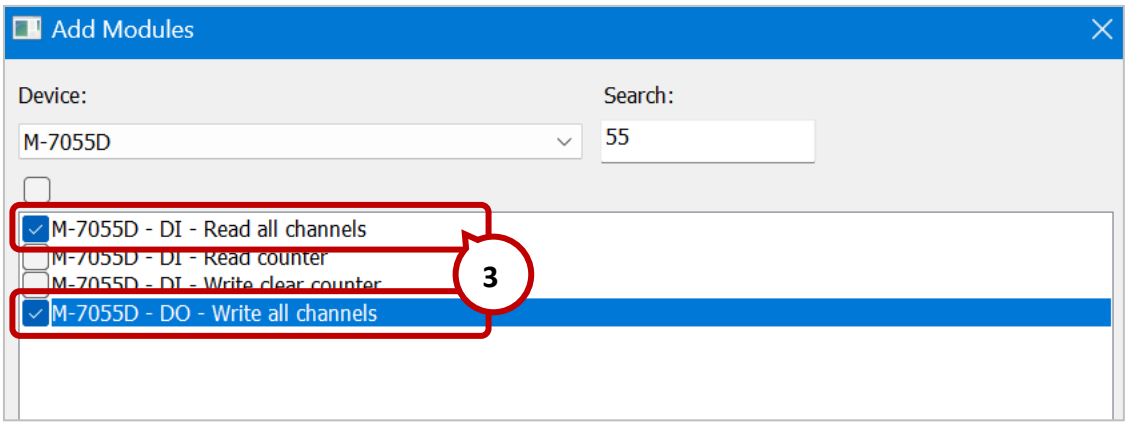
4. Add the Modbue and Select the Function

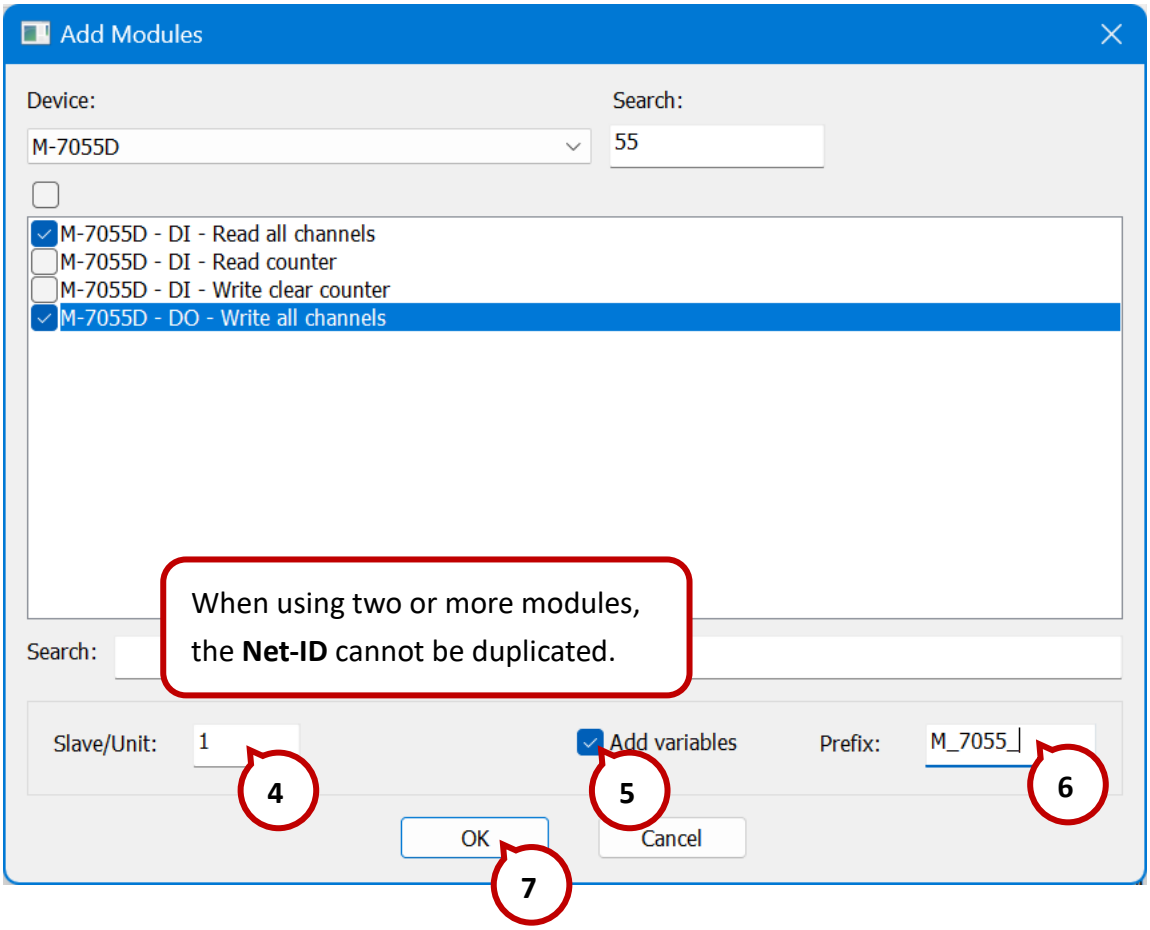
Follow the steps to add the **M-7055** module in the "**ADD Modules**" window.

- Enter the model number in the "**Srarch**" field to quickly locate the module.
- Select the desired module in the **"Device"** field.



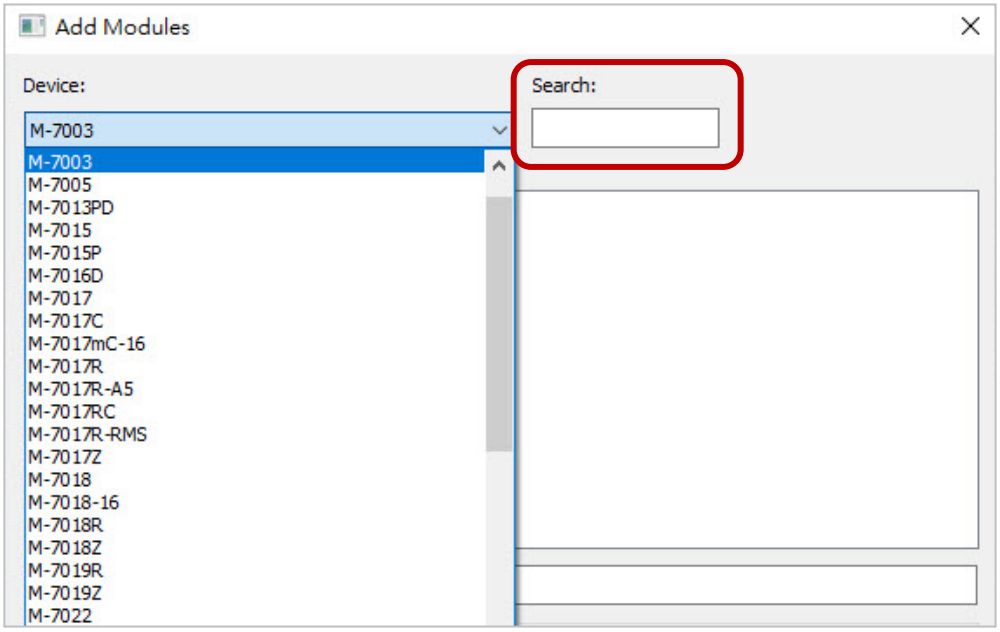
- After selecting the model, all supported I/O functions will be automatically displayed. In this example, select the "M-7055D – **DI – Read all channels**" and "M-7055D – **DO – Write all channels**".





- Enter the module's Net-ID in the "**Slave/Unit**" field. Note that the **Net-ID** must be unique and cannot be duplicated.
- Select "**Add variables**" to automatically add variables. If unchecked, the user will need to add new variables manually.
- Enter the variable prefix in the "**Prefix**" field (e.g., **M_7055_** , where the variable name can be **M_7055_**DI_R_00).
- Click "**OK**".

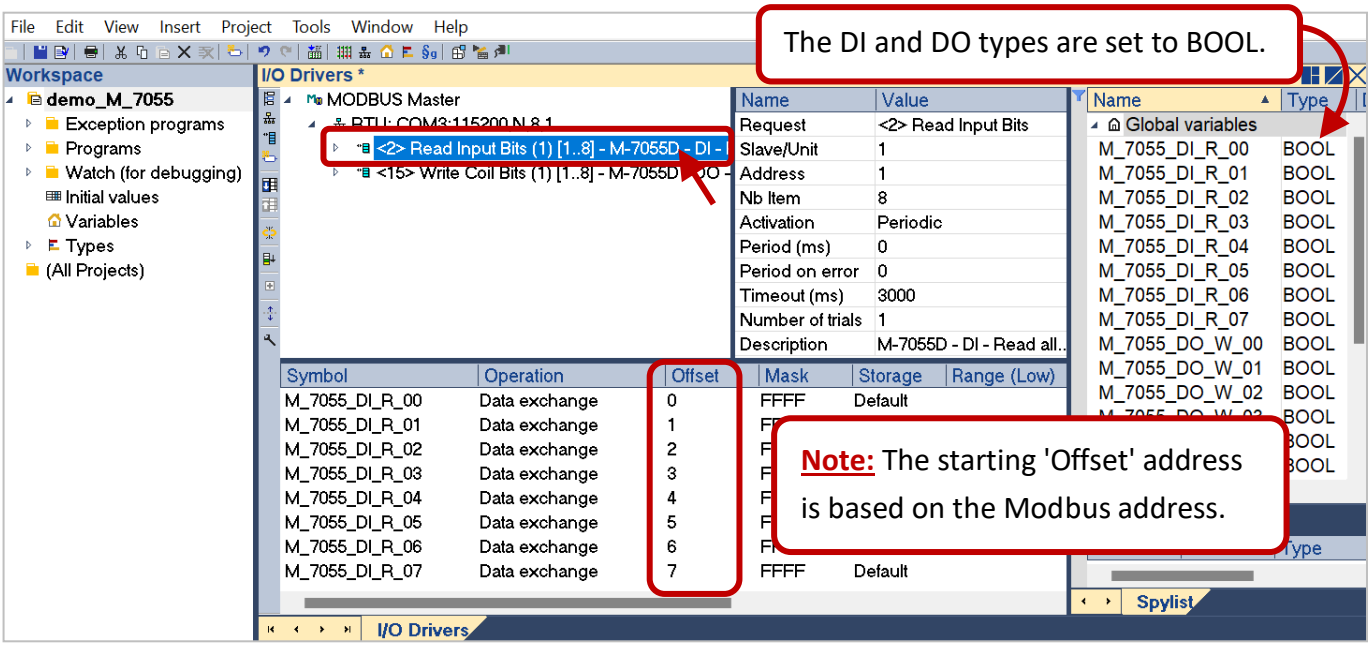
The **M-7000** series offers a wide range of modules. Users can quickly locate the desired model using the search function.



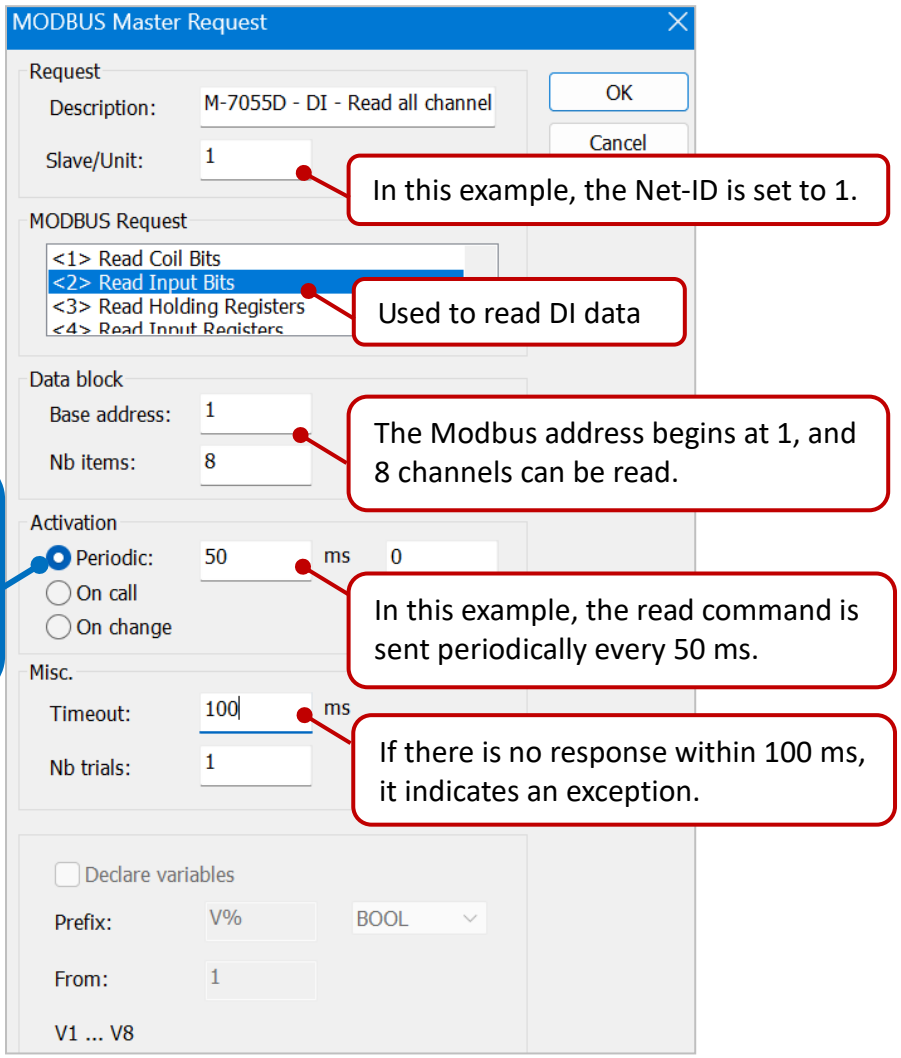
The selected items have automatically created two data blocks: one for reading 8 DI data and one for writing 8 DO data.

5. Configure the DI MODBUS Request Address

Double-click the first data block (i.e., **<2> Read Input Bits**), which is used to read 8 DI with Modbus addresses 1 to 8 (Base1). Therefore, the **Offset** address should be set from 0 to 7.



Advanced Settings:

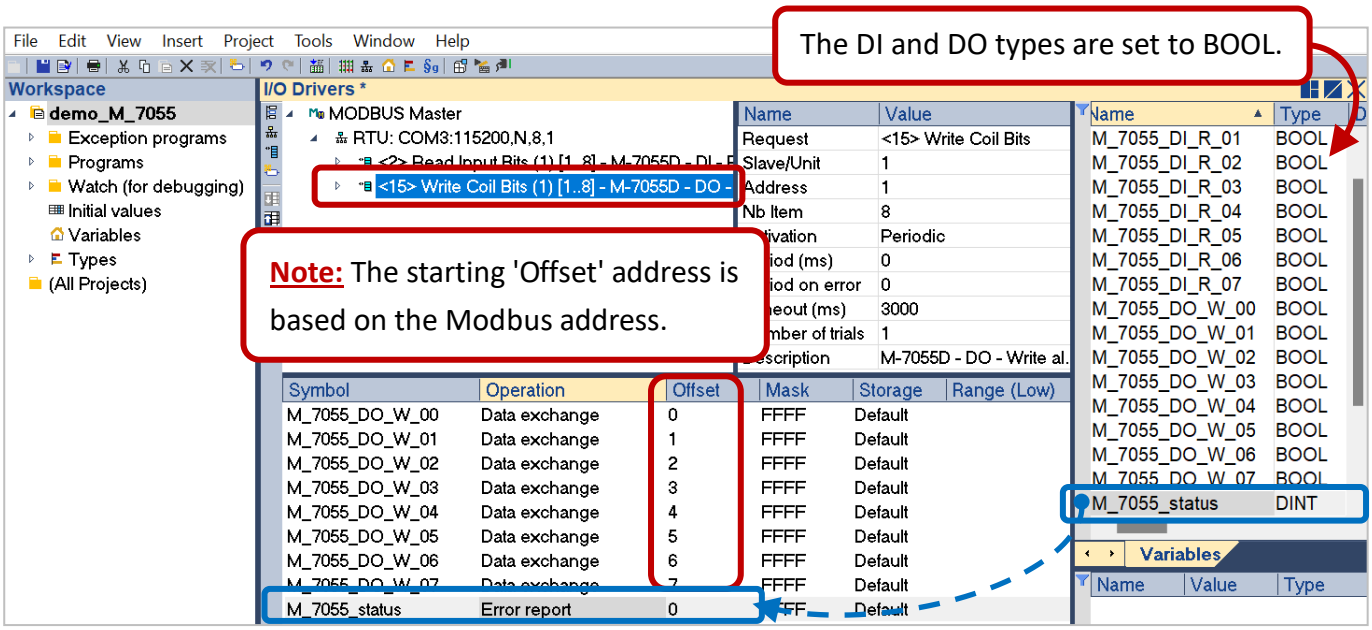


Tip:

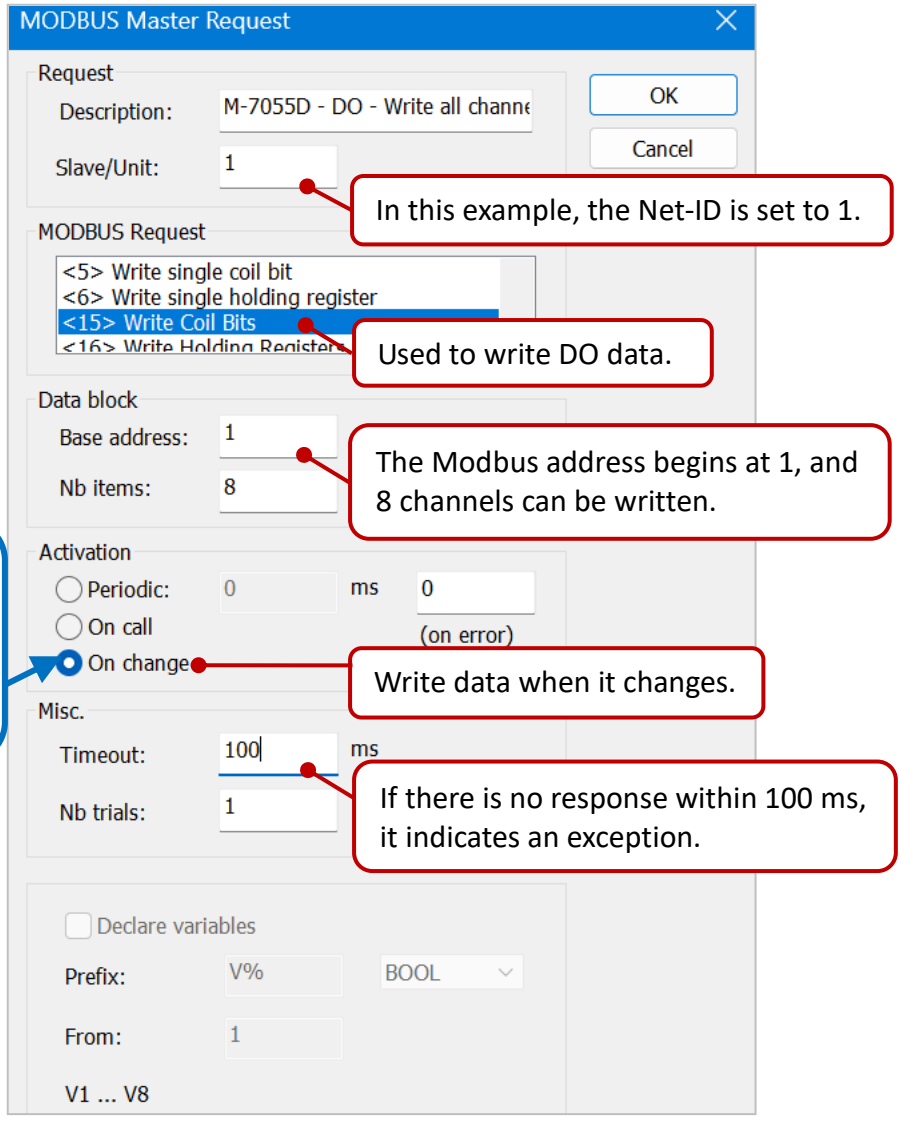
Select the **Periodic** option when reading the AI, DI, or Counter values.

6. Configure the DO MODBUS Request Address

Double-click the second data block (i.e., **<15> Write Coil Bits**), which is used to write 8 DO with Modbus addresses 1 to 8 (Base 1). Therefore, the **Offset** address should be set from 0 to 7. If the **Operation** field is set to "**Error report**", the **Offset** address should be set to "**0**", and the variable type should be set to "**DINT**".



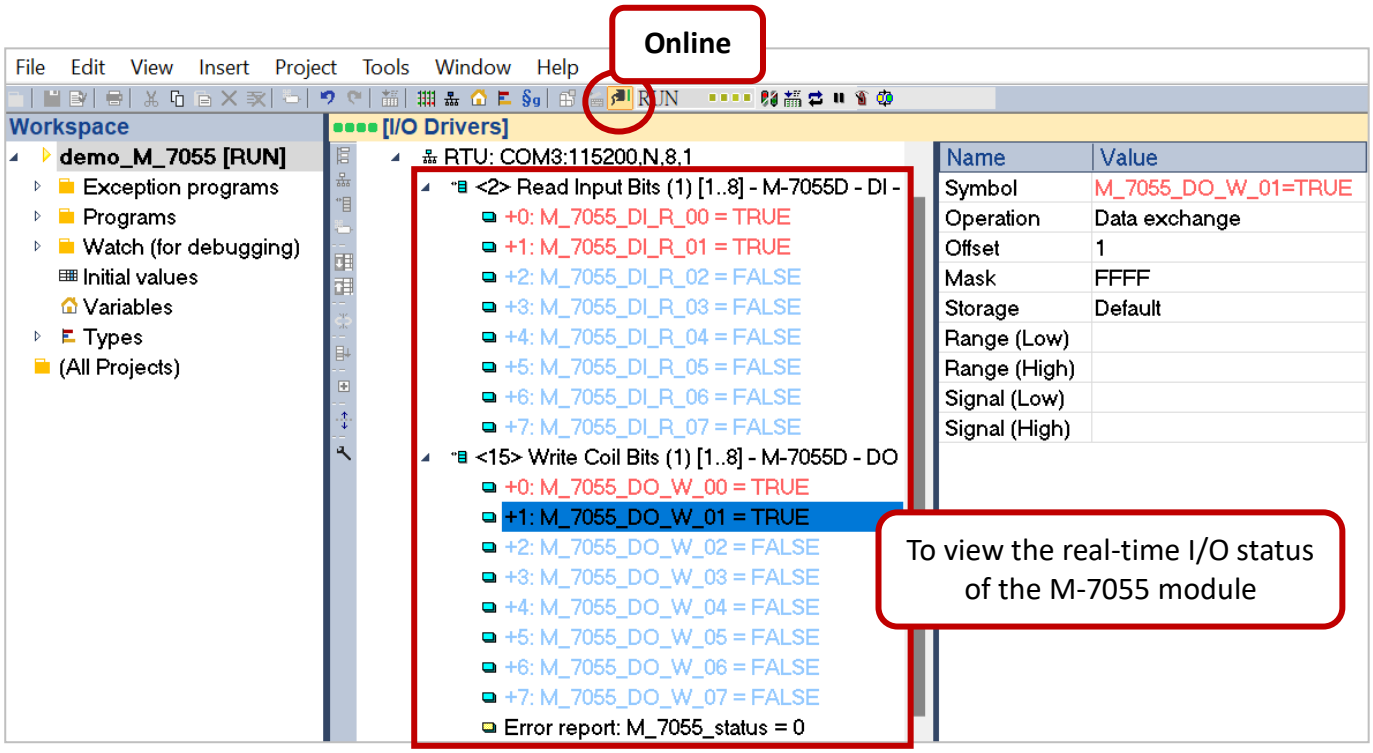
Advanced Settings:



Tip:
The **On change** option applies when writing AO and DO values or clearing the Counter.

7. Download the Demo Program and Test the I/O Module

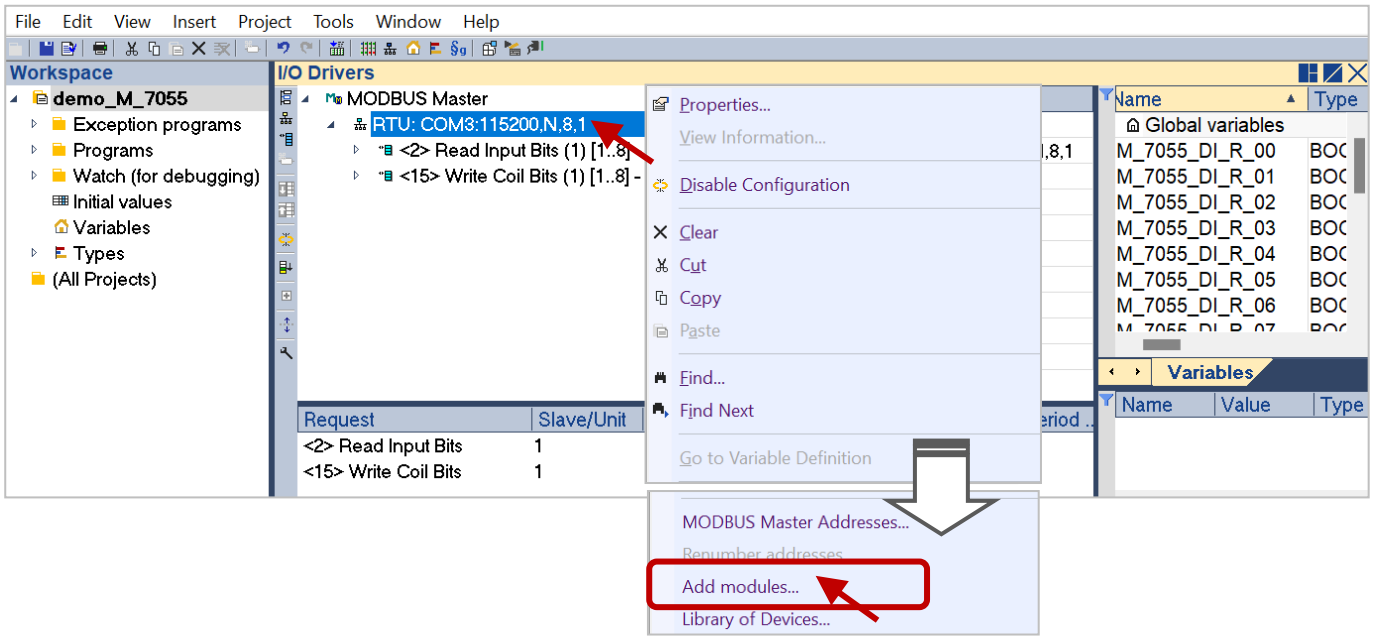
Click the "**Online**" button to connect to the PAC and download the demo program. Afterward, users can view the M-7055's I/O status.



To add other module settings with the same communication settings (COM3:115200,N,8,1), follow these steps:

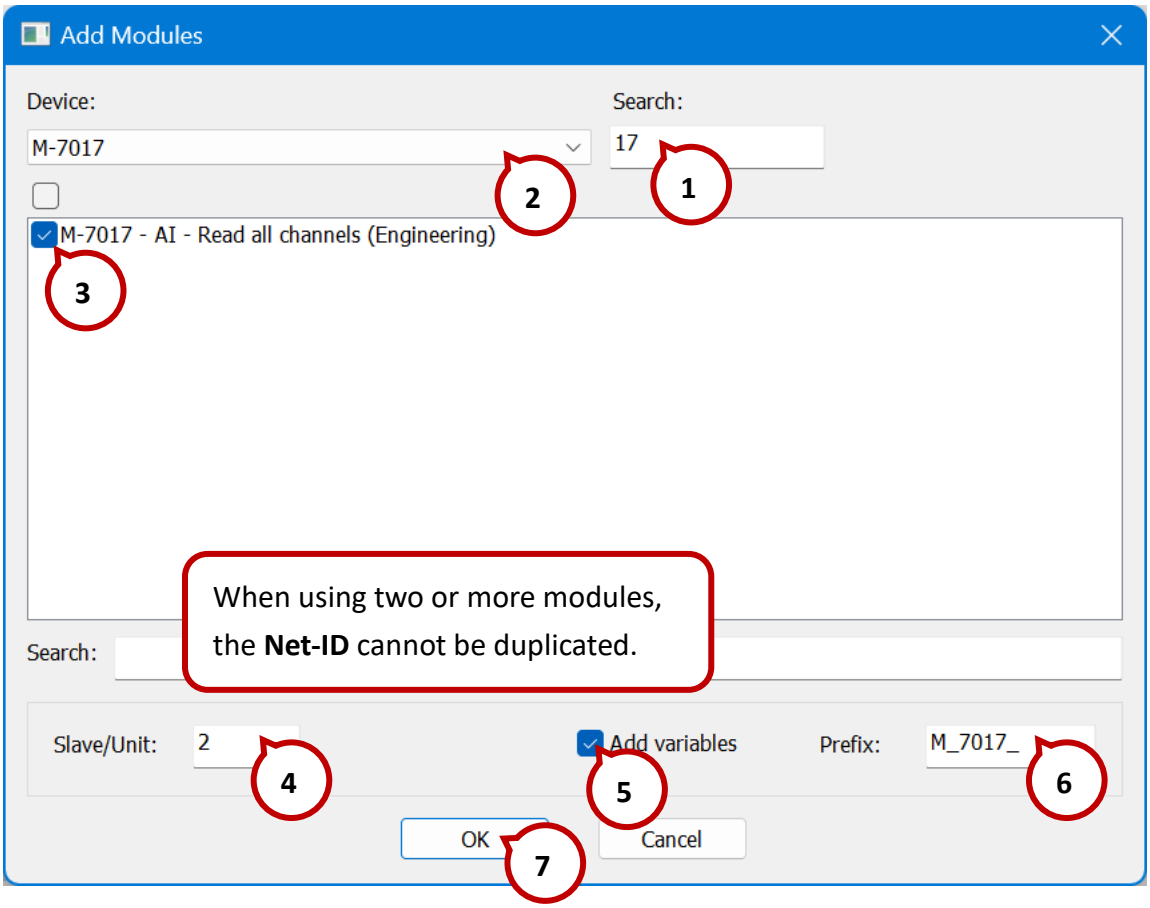
1. Select the "ADD Modules"

Right-click the "**RTU: COM3:115200,N,8,1**" and select the "**ADD Modules**".



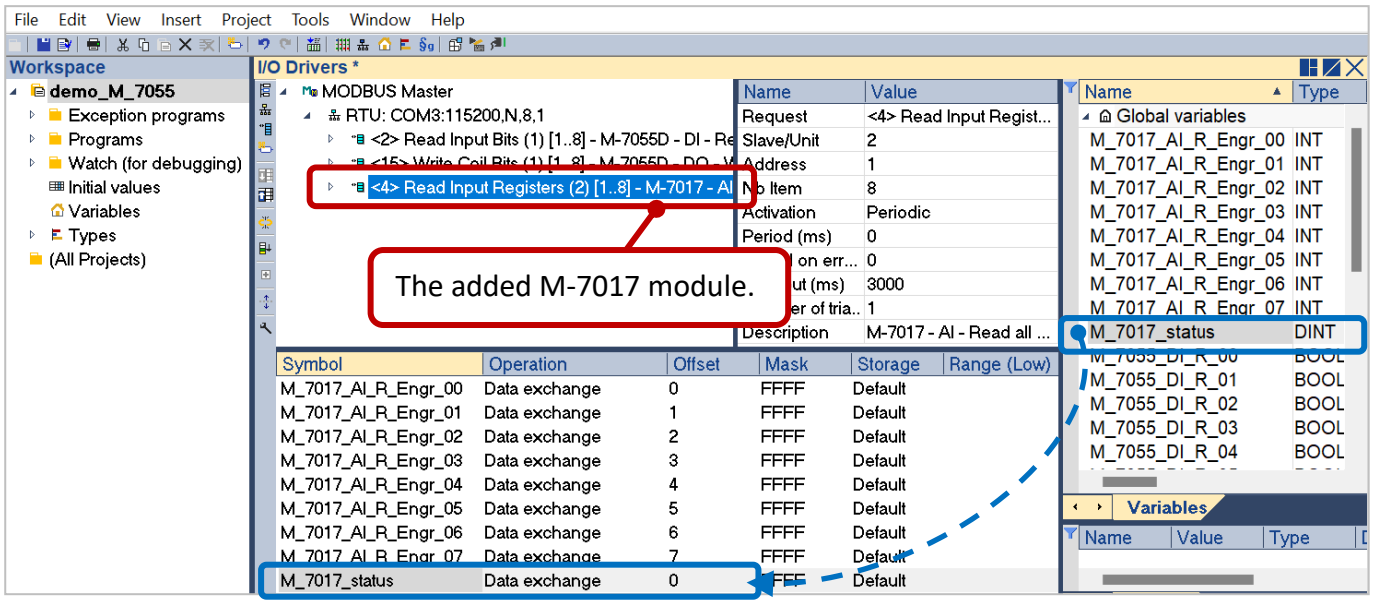
2. Add the Modbue and Select the Function

Select the desired model (e.g., M-7017) and I/O function in the "**ADD Modules**" window.



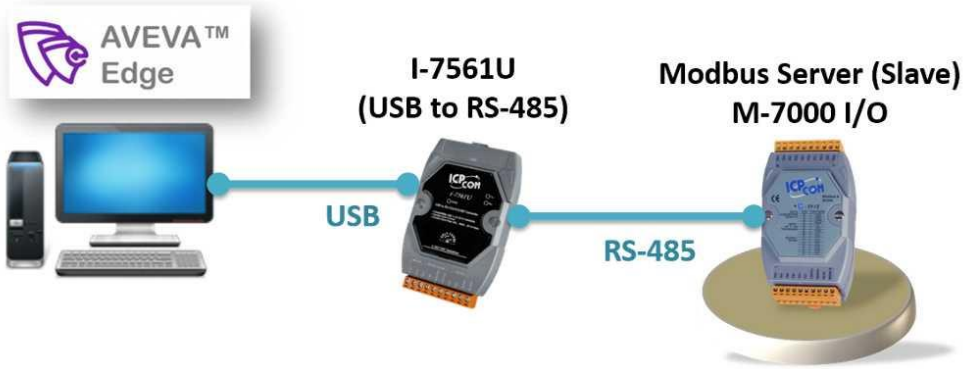
3. The Module Settings are Complete

Users can verify that the M-7017 Data Block has been successfully added to the MODBUS-RTU communication settings.



6.6 AVEVA Edge

Before using the module, download the **DCON Utility Pro** software to configure the basic parameters of the **M-7000**.



6.6.1 Example1: M-7018 Configuration Setup

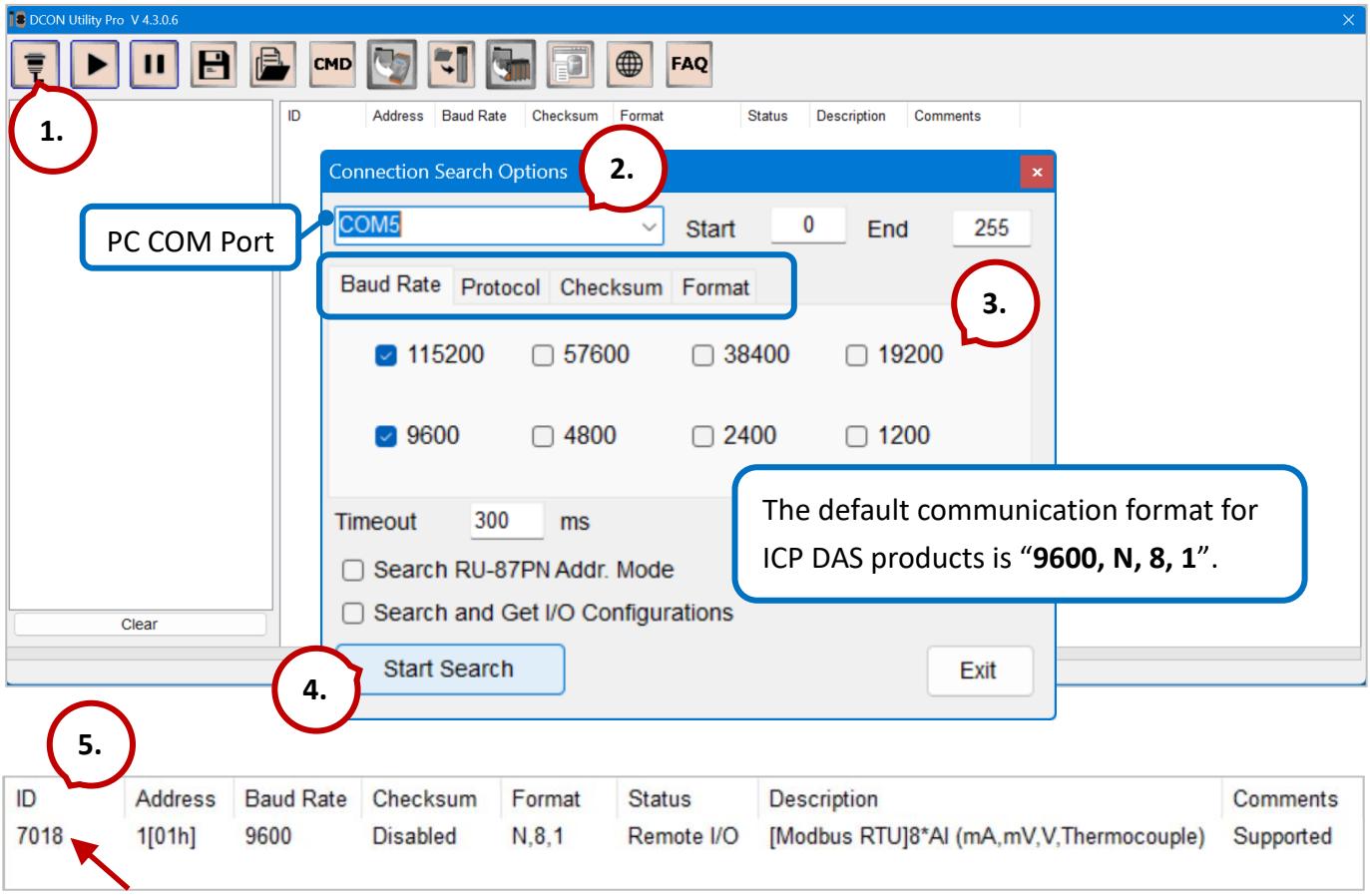
This section explains how to use AVEVA Edge to read from and write to the M-7018-G module via the Modbus RTU protocol. In this example, a simple screen will be created to display the thermocouple temperature readings, along with a button of the Symbols function.

➢ **The M-7018 Webpage and Download Files**

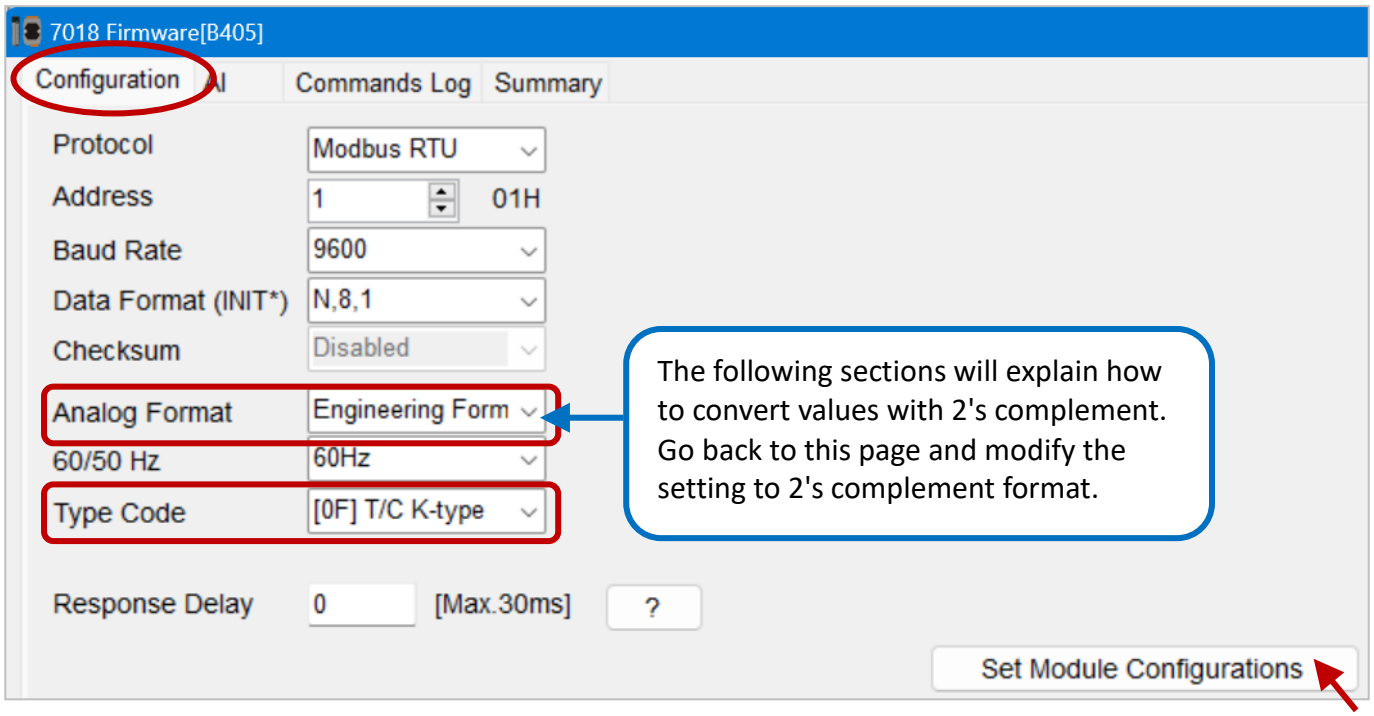
The **M-7018-G** is an 8-channel thermocouple input module developed by **ICP DAS**. Click the **Download Center** button on the **M-7018-G** webpage to download the user manual and Tools.
(https://www.icpdas.com/en/product/M-7018-G)

➢ Configure M-7018 Parameters (DCON Utility Pro)

Once the software is launched, click the **Connection Options** button in the toolbar, select the PC's COM port, verify the search parameters, and click **Start Search**. When the module is detected, double-click on **7018** to access the **Configuration** page.



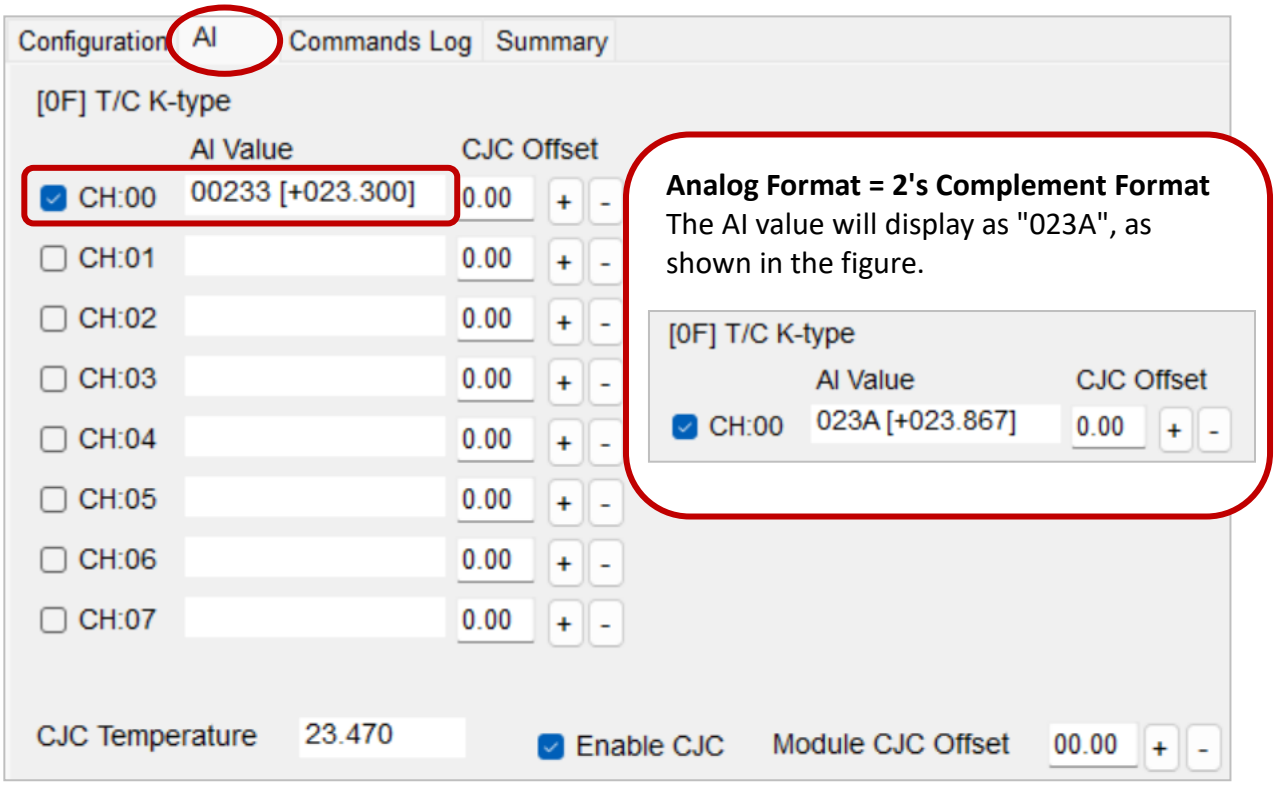
Set the analog format to **Engineering Format**, the type code to **Thermocouple K-type**, and then click the **Set Module Configurations** button.



➢ Engineering or 2's Complement AI Values

On the **AI** tab, channels that are checked are enabled, and real-time AI values will be displayed. The table below shows the values in different formats, and the following sections will guide you on how to convert the software readings into actual temperature values.

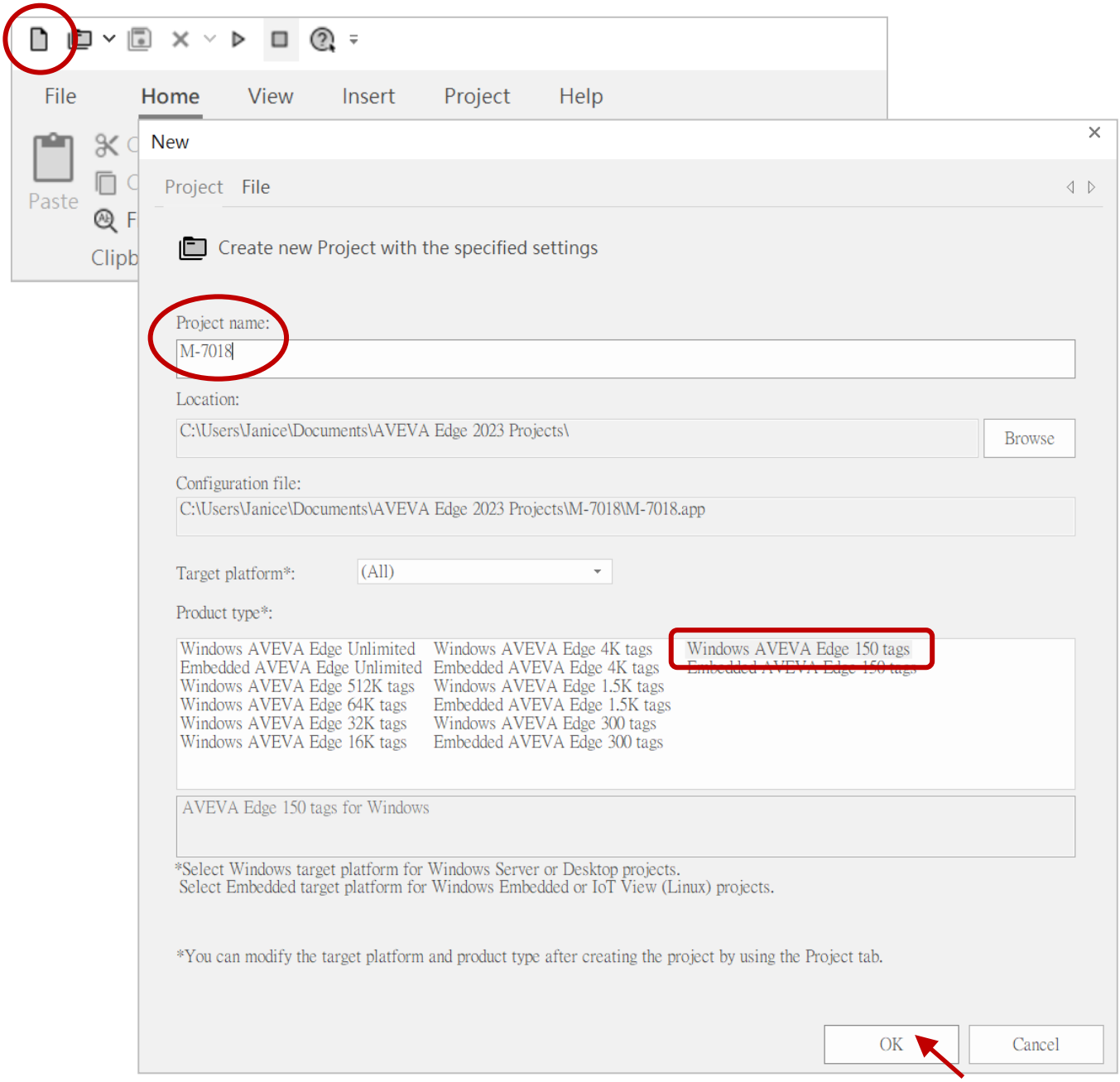
Analog Format	AI0 value	The temperature detected on the channel
Engineering Format	**00302**	30.200°C
2's Complement Format	**02DB**	30.608°C



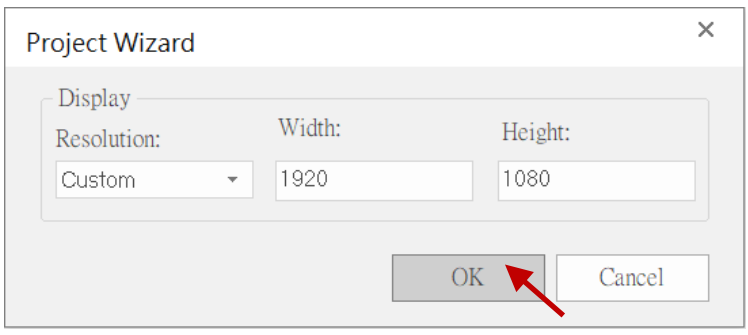
6.6.2 Example1: AVEVA Edge and the M-7018 Module

➢ **Create the Project and Tags**

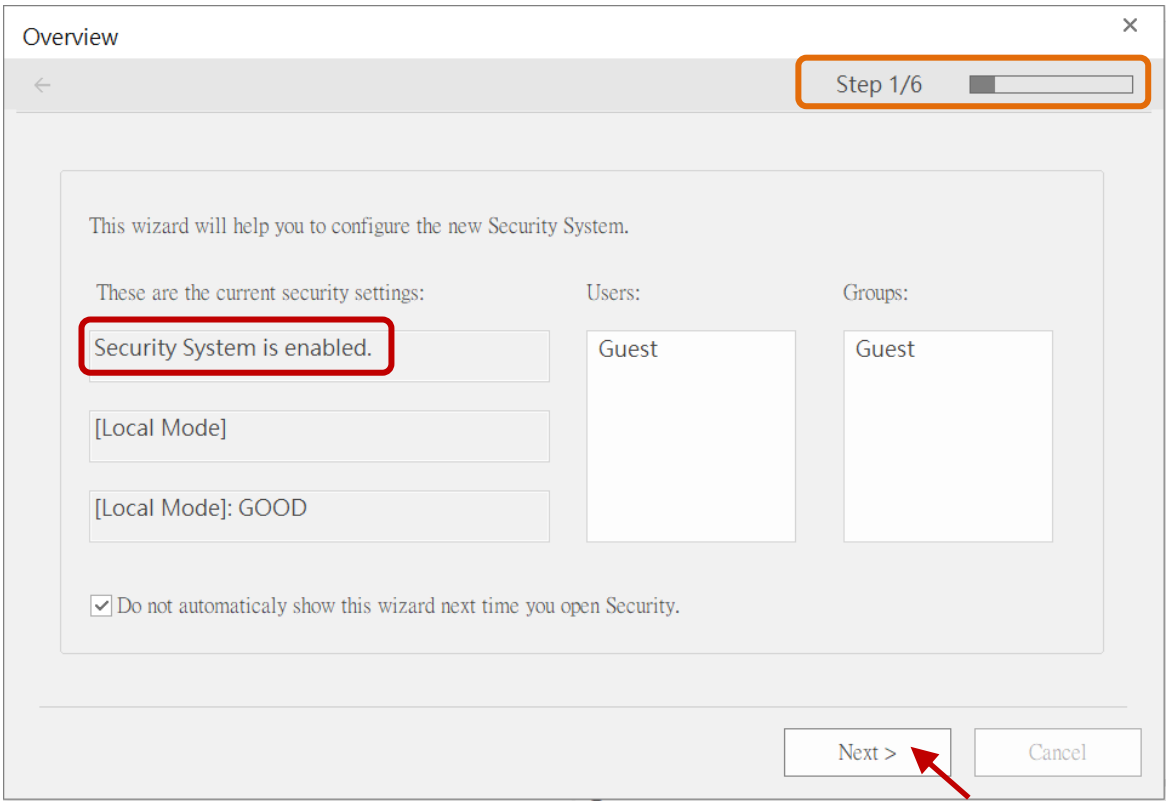
Click the "**New**" shortcut icon, name the project "**M-7018**", choose the platform and the number of tags, then click "**OK**".



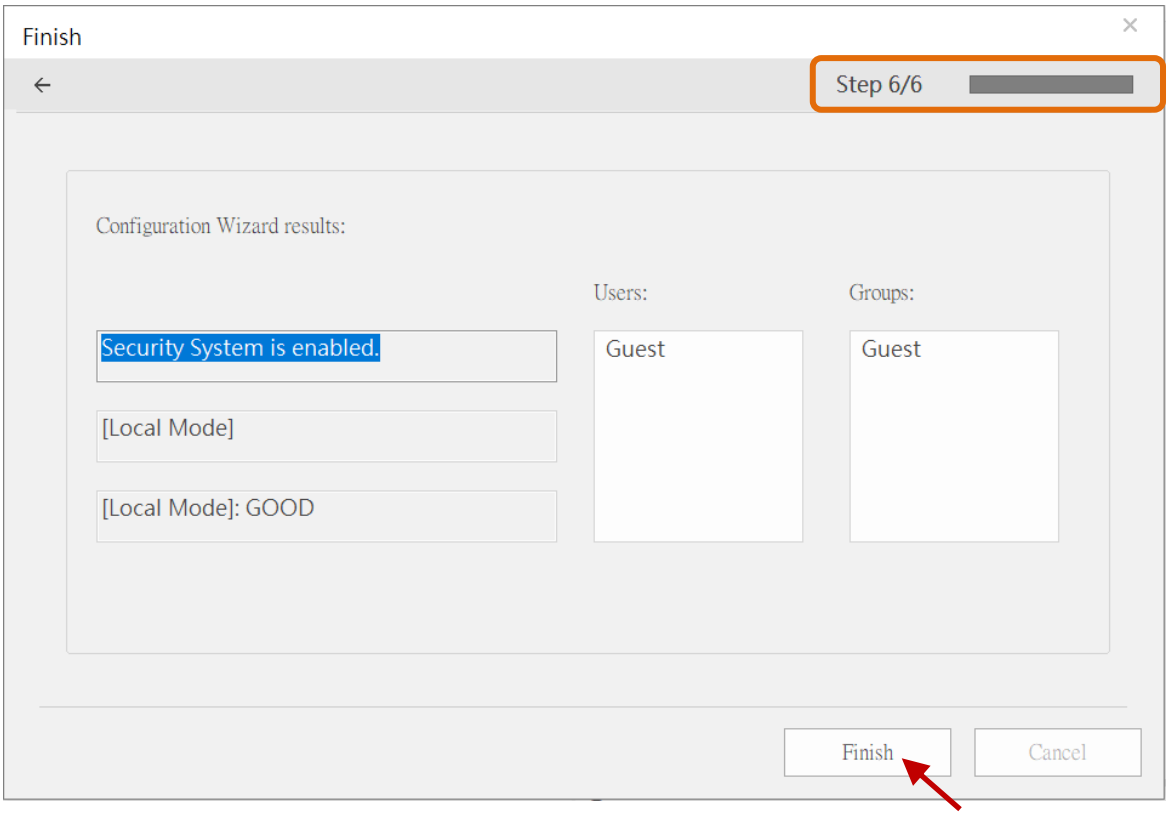
Set the resolution to **1920 × 1080** in the project wizard, then click "**OK**".



The **Overview** window displays the current security settings. Simply click the **Next** button to proceed through the setup. In Steps 2 to 6, the user can set the primary password, configure security settings, and create user groups.

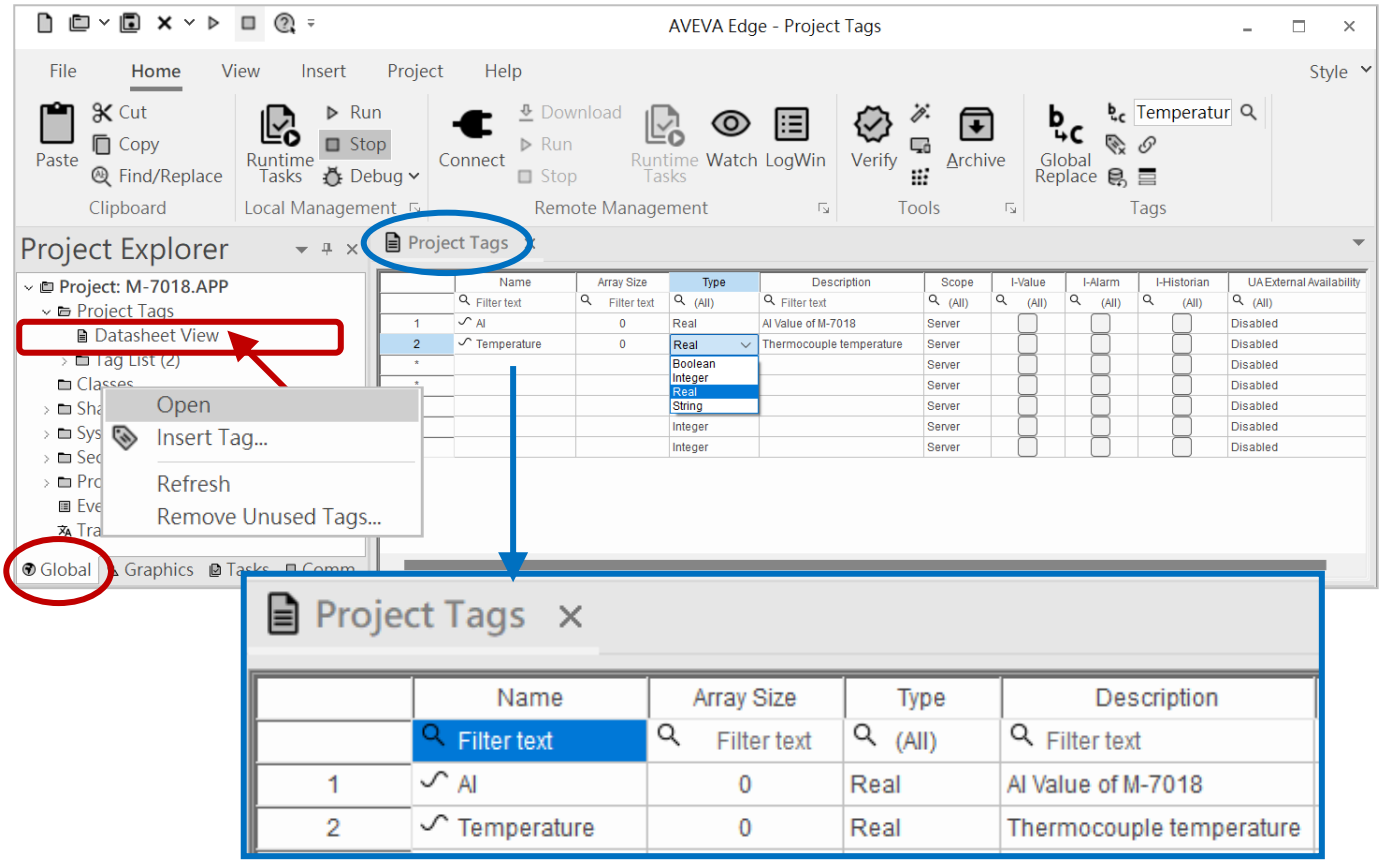


This example uses the default settings. Once done, click the **Finish** button to complete the setup.



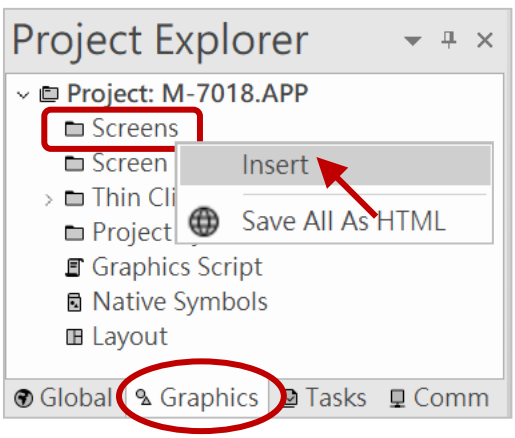
Click the **Global** tab in the **Project Explorer** panel. Right-click on **Datasheet View** and select **Open** to display the **Project Tags** page. Then, follow the table to add tags.

Name	Array Size	Type	Description
AI	0	Real	AI Value of M-7018
Temperature	0	Real	Thermocouple temperature

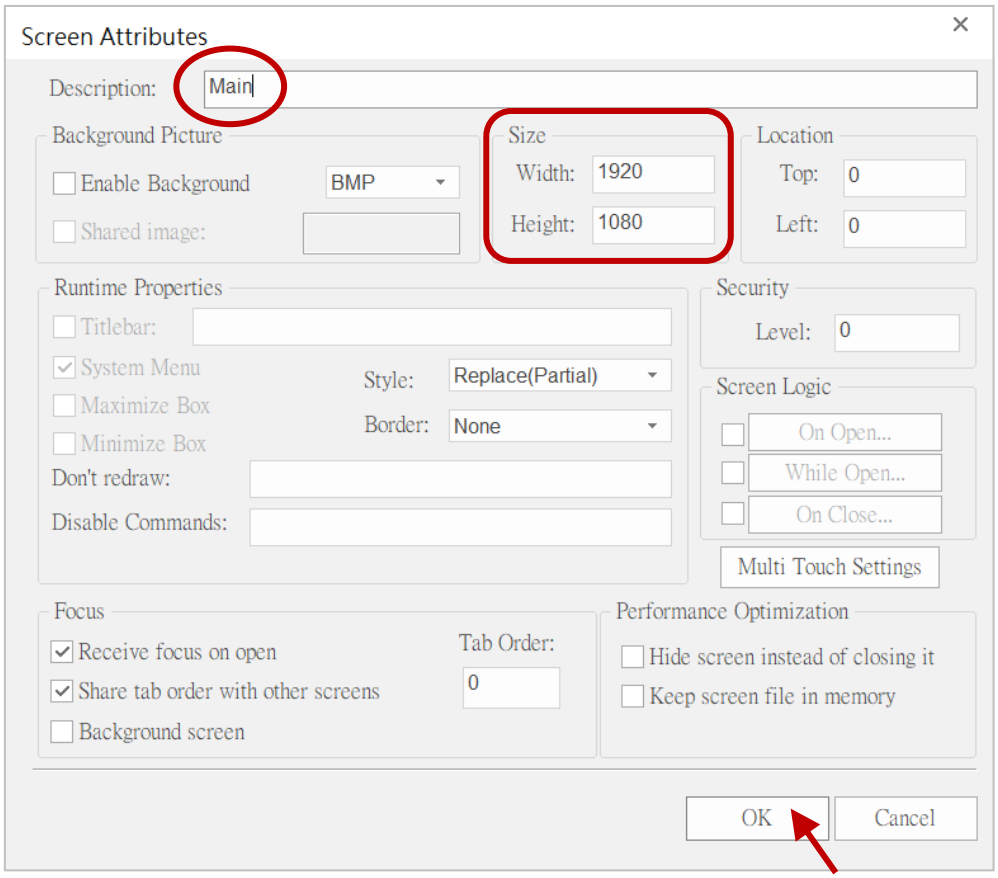


➢ Add the Screen

Click the **Graphics** tab in the **Project Explorer** panel. Right-click on **Screens** and select the **Insert** to display the **Screen Attributes** window.

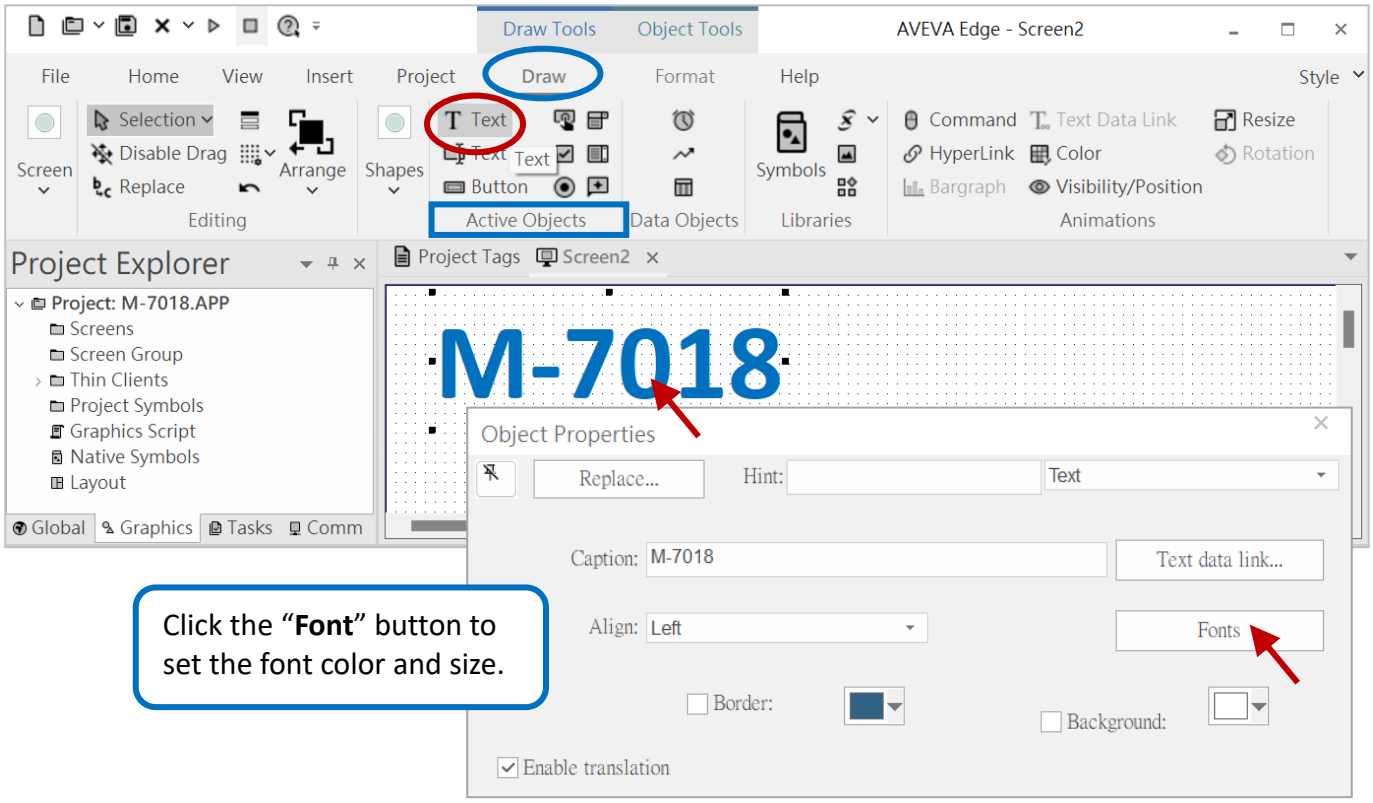


The user can adjust the resolution (e.g., 1920 x 1080) in this window. Click **OK** to add the screen.

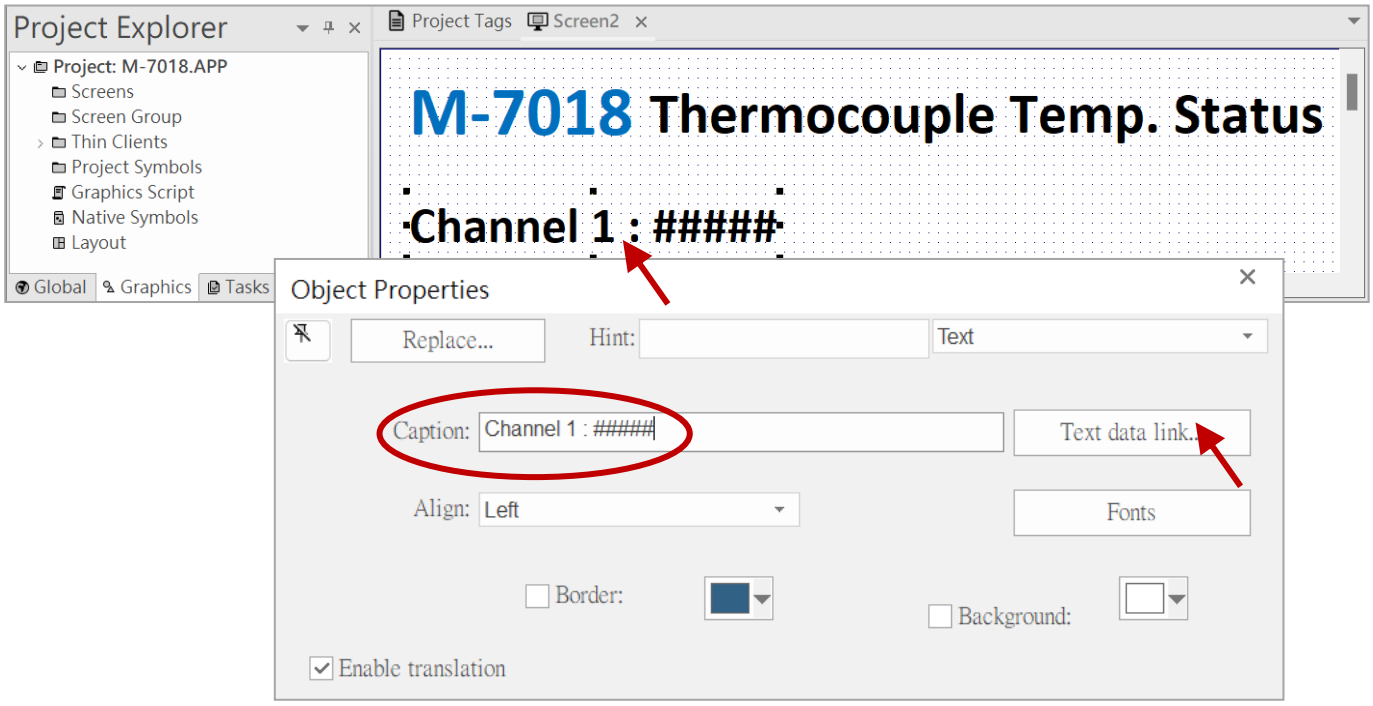


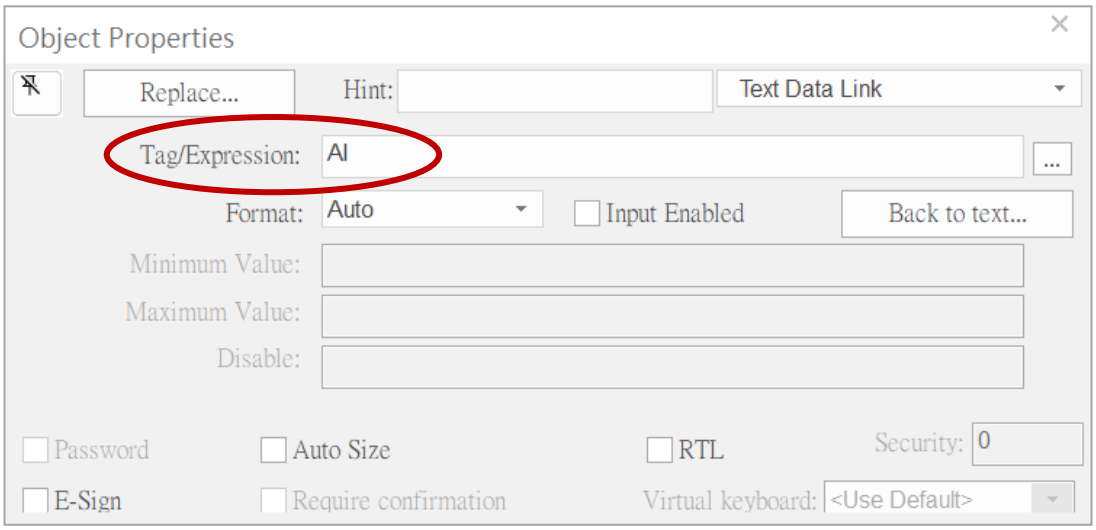
➢ Add the Text Object

The **Draw** ribbon appears only after creating a screen. To add a text object from the **Active Objects** group, click on the screen to input the text, then double-click the object to open the **Objects Properties** Window and adjust the font.



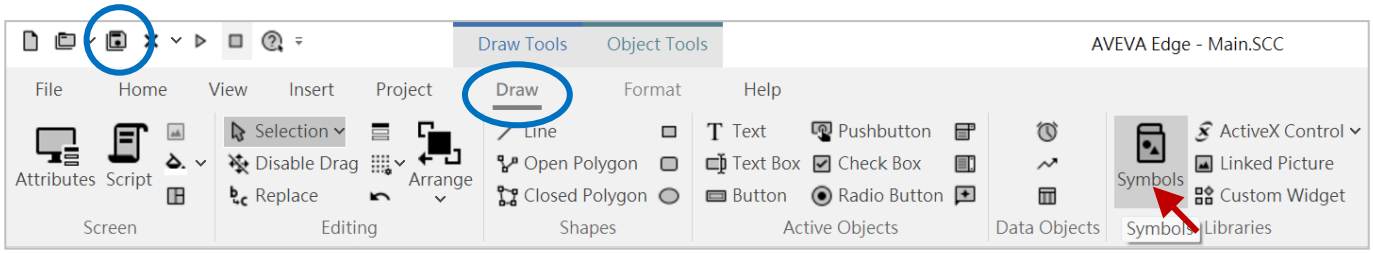
Add two text objects to the screen. Set their captions as "**Thermocouple Temp. Status**" and "**Channel 1: #####**". The number of "#" indicates the length of the displayed data, including the decimal point. Double-click "**Channel 1: #####**" to open the **Object Properties** Window, then click the **Text Data Link** button and input "**AI**" in the **Tags/Expression** field.



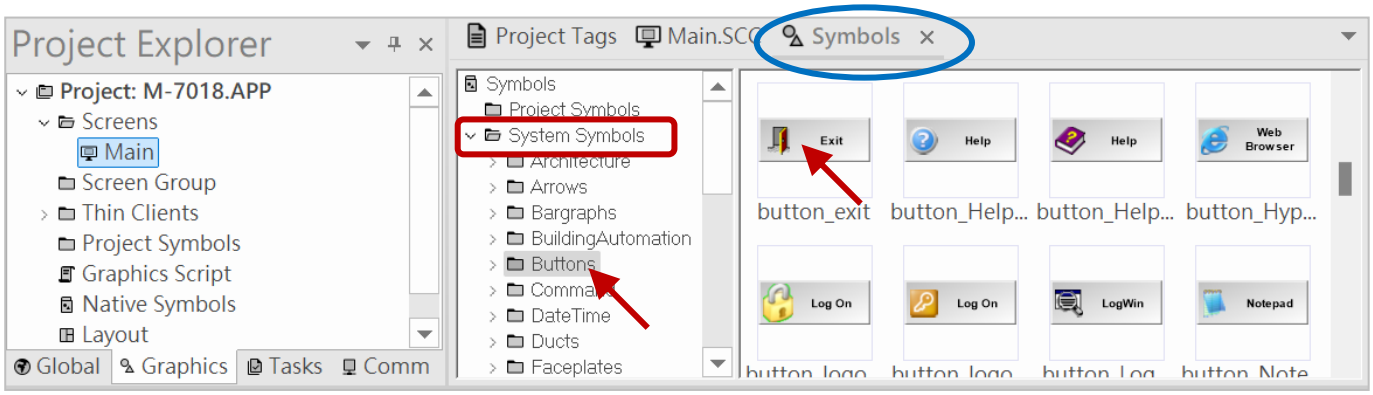


➢ Add a System Symbol

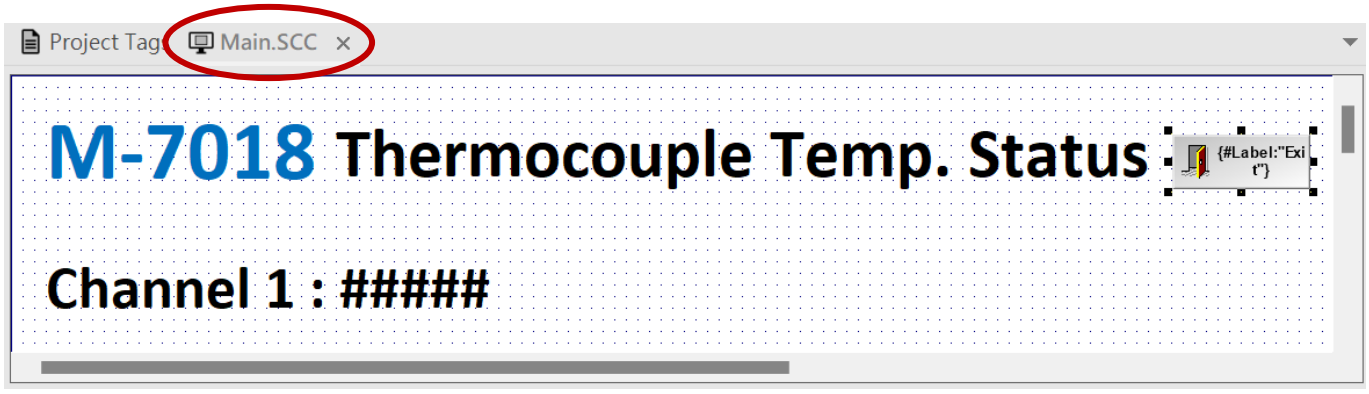
In this example, an **Exit** button is added from the system symbols to terminate the run-time task. Clicking the **Symbols** object on the **Draw** ribbon brings up the **Symbols** window. **Note:** Users can save the screen as "**Main.SCC**" by clicking the "**Save All**" button in the upper-left corner of the window.



Expand the **System Symbols** folder and navigate to the **Buttons** sub-folder. Double-click the **button_exit** object to automatically close the Symbols page. Then, click on the Screen page to position the object.



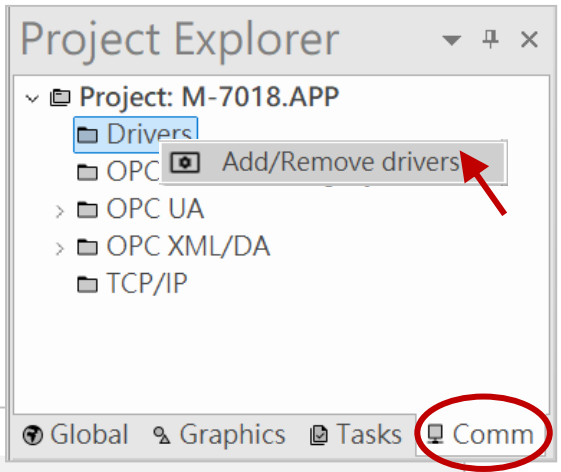
Then, click on the "Main.SCC" page to position the object. Once completed, the screen will appear as shown below.



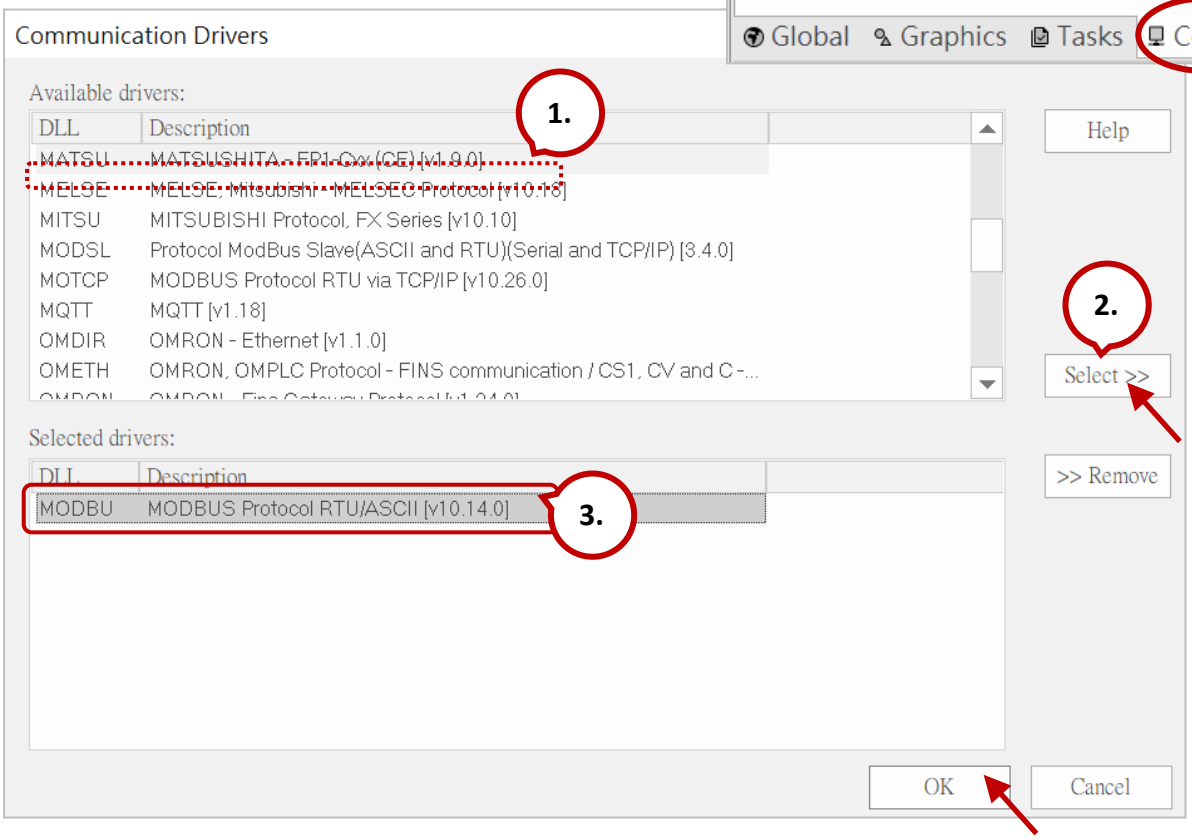
➢ Add the MODBU (Modbus RTU) Communication Driver

Adding a driver sheet is simple. AVEVA Edge supports various drivers, and this project uses the MODBUS Driver (Modbus RTU) along with the ICP DAS M-7018-G module for testing.

Click the **Comm** tab in the **Project Explorer** panel. Right-click on **Drivers** and select **Add/Remove drivers**.

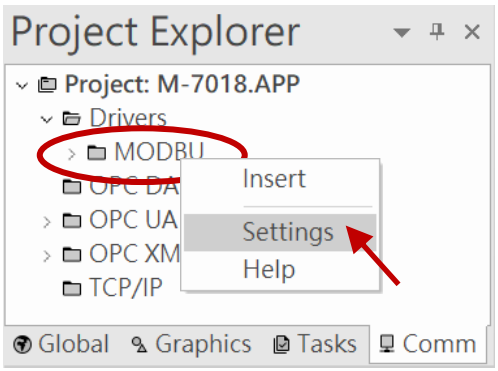


Once the **MODBU** driver is found, click the "**Select >>**" button to add it to the **Selected Drivers** list. Afterward, click the **OK** button to close the window.

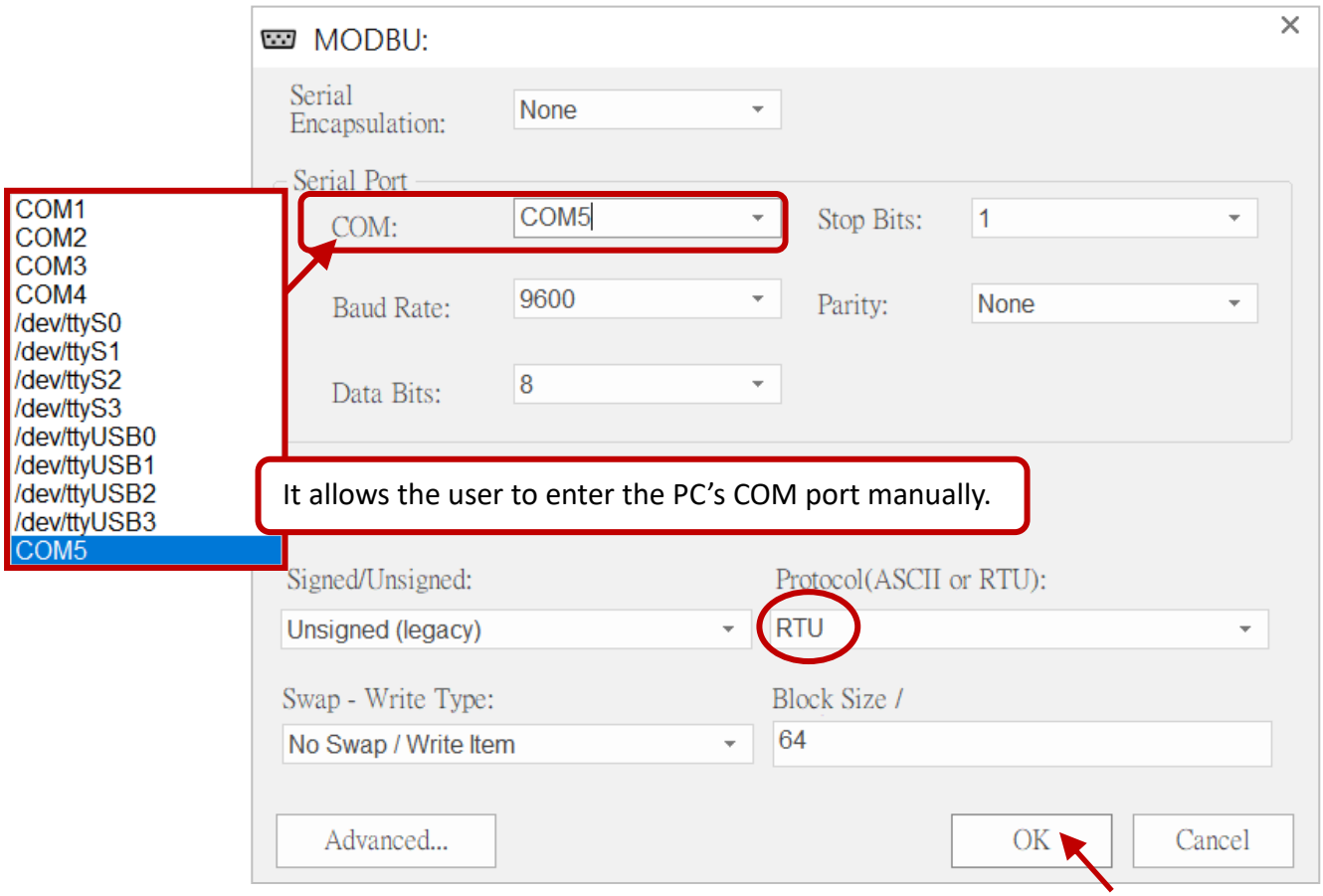


Next, right-click the added **MODBU** driver and select "**Settings**" to open the settings window.

If the user has any questions about the settings, click "**Help**" to access the relevant driver manual.

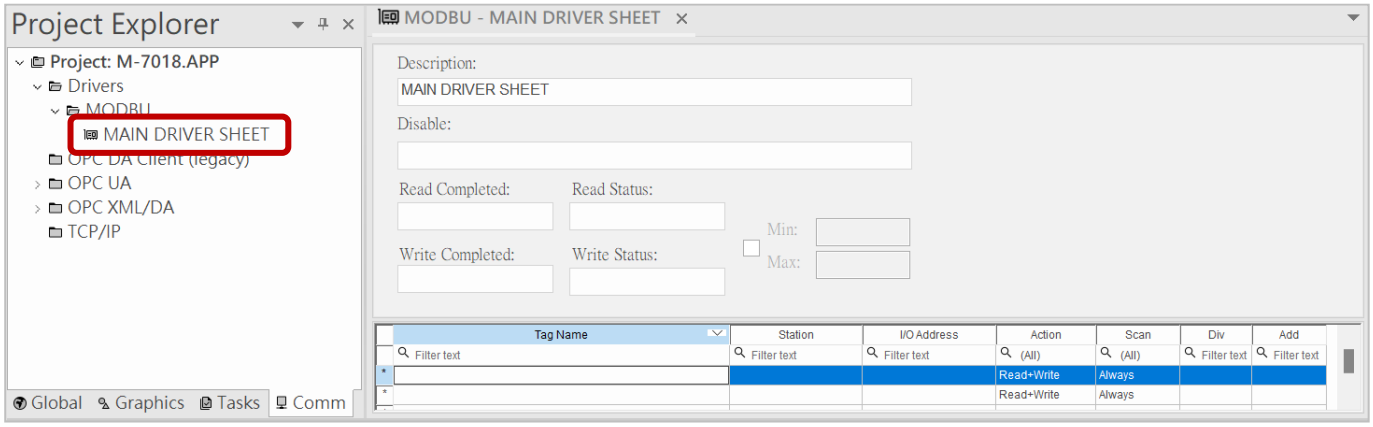


In the **MODBU** window, select the correct COM port (which can be entered manually, e.g., COM5) and the predefined parameters (e.g., Baud Rate: 9600, Data Bits: 8, Stop Bits: 1, Parity: None). Make sure **RTU** is selected in the Protocol field, then click **OK**.



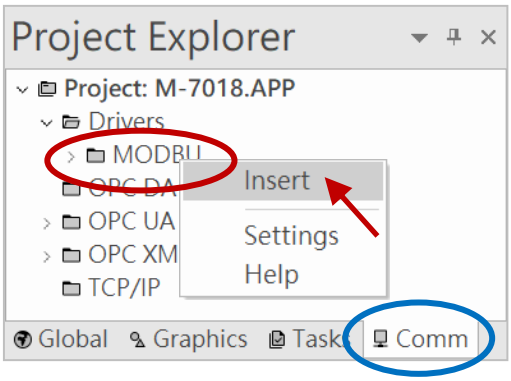
Note:

After the **MODBU** driver is added, the **MAIN DRIVER SHEET** will be automatically created. Generally, the user can add tags in this sheet. However, if the system becomes large and there are many tags to add, which could overload the communication. **It is recommended that the user add tags in a separate sheet to ensure the stability of data communication**, as will be explained later.



➢ Add a Driver Worksheet for Analog Inputs (Engineering)

Click the **Comm** tab in the **Project Explorer** panel. Right-click on the **MODBU** driver and select **Insert** to add a standard Modbus RTU worksheet.

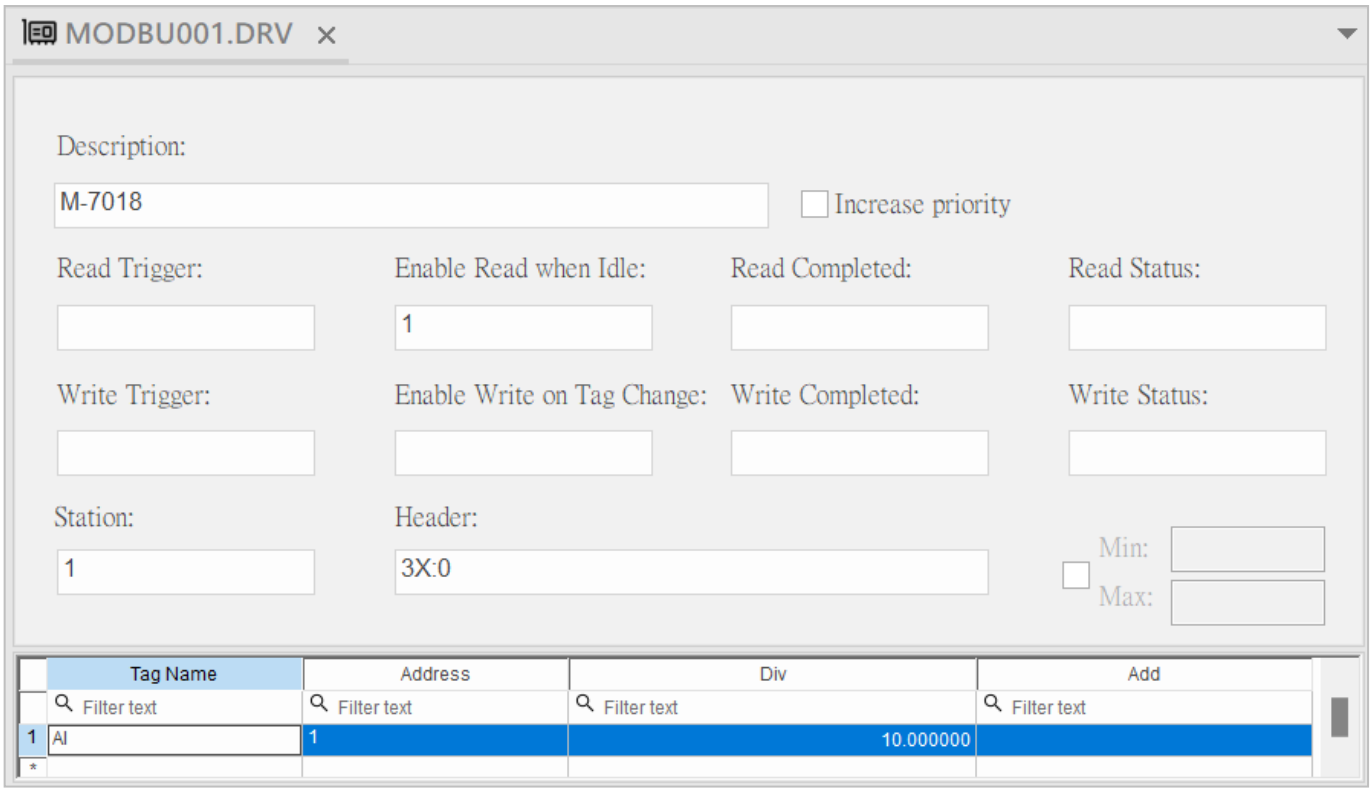


In this example, the type code of the M-7018 module is set to Thermocouple K-type, with a data range of -2700 to 13720, representing -270°C to 1372°C. For more details, refer to Appendix B.

Input the following settings in the MODBU worksheet.

Field Name	Settings
Description	M-7018
Enable Read when Idle	1
Station	1
Header	3X:0

No.	Tag Name	Address	Div	Add
1	AI	1	10	-



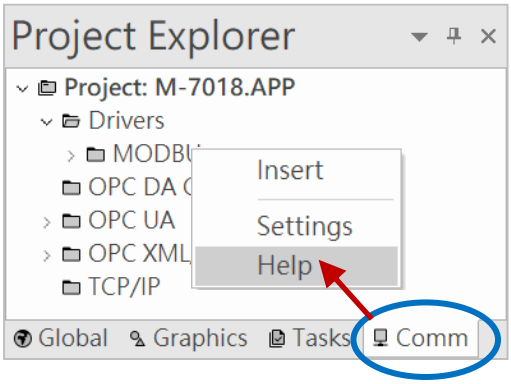
The table below outlines the fields to be configured in Example 1:

Description	Enter a brief description to identify the worksheet
Enable Read when Idle	Enter a tag name (Boolean) or a constant value. If the value exceeds 0, the module data will be read automatically and continuously. In this example, the value is set to 1.

Station	Enter the Net-ID (ranging from 0 to 255) assigned to the module on the Modbus network. In this example, the ID is set to 1.
Header	In this example, the header is set to "3X:0" to read the analog input values from the module.

The following are commonly used examples. Users can also click on "**Help**" to view the Driver's Manual.

Example	Description
0X:0	Coil status
1X:0	Input status
STA:0	Exception Status
3X:0	Input register
4X:0	Holding register
FP3:0	Input register (Floating-point value)
FP:0	Holding Register (Floating-point value)
DW3:0	Input register (Dword value)
DW:0	Holding Register (Dword value)
ST:0	Holding Register (String value)



Tag Name	Enter the tag name for reading or writing data. In this example, the tag name is set to "AI" (Real).
Address	Enter the Modbus address (or offset address). For this example, the address is set to "1".

Click the link to view the M-7018's Modbus address (Base1) mapping table.
https://www.icpdas.com/web/product/download/io_and_unit/rs-485/document/manual/7000/M-7000_address_mapping_table.pdf

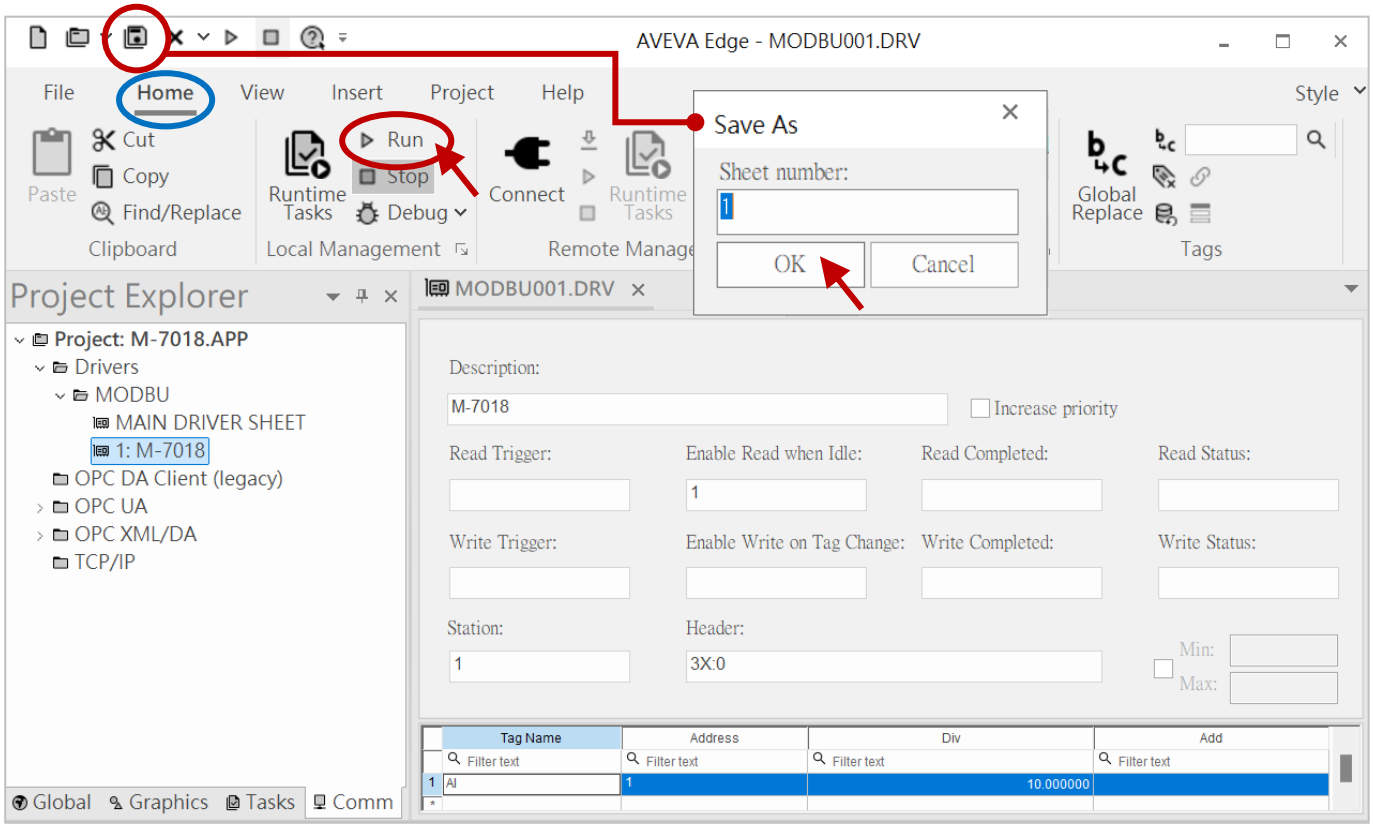
Modbus function	Modbus Address	Notes (M-7018)
3X	30001 to 30008	To read AI0 to AI7

Div	The user can set a divisor to scale the displayed value. In this example, the divisor is set to 10. **Note:** Do not use this field if the "**Min**" and "**Max**" fields are enabled.

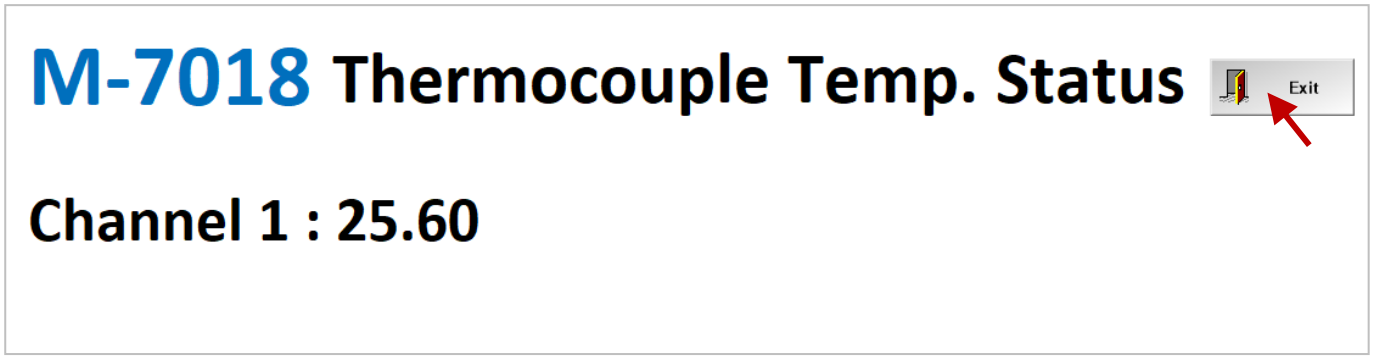
Users can refer to Appendix B for the module's type code. This module is set to K-type, and its value range can be adjusted to display from -270°C to 1372°C after dividing by 10.

Type Code	Input Range	Data Format	Min.	Max.
0x0F	K-type Thermocouple -270 to 1372°C	Engineering unit	-2700	13720

Click the "**Save All**" button in the upper-left corner. A "**Save As**" dialog box will appear; click "OK." Then, click "**Run**" on the **Home** ribbon to start the run-time task.



The user can see that the current temperature is 25.60°C. Click the "**Exit**" button to exit the runtime screen.



The run-time screen

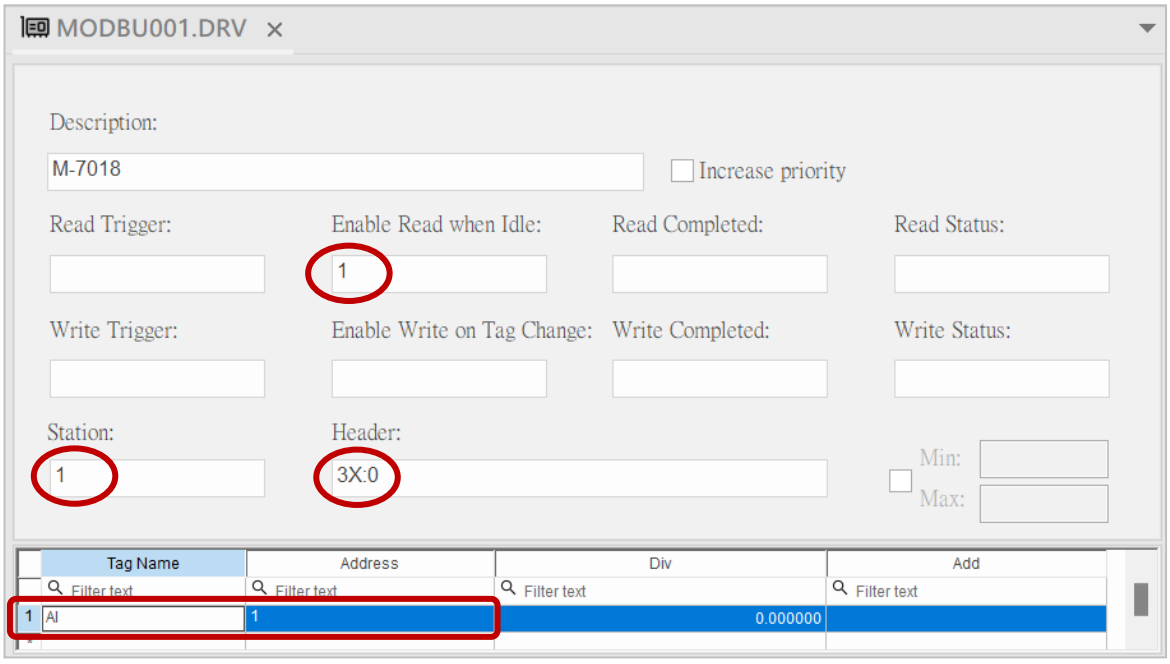
➢ Add a Driver Worksheet for Analog Inputs (2's Complement)

If the module's analog format is set to **2's Complement** using DCON Utility Pro, the data will be in hexadecimal. The K-type thermocouple's data range is from E6D0 to 7FFF (see Appendix B). In this example, a formula is used to convert the reading to the actual temperature. A simpler conversion method is shown in Example 2.

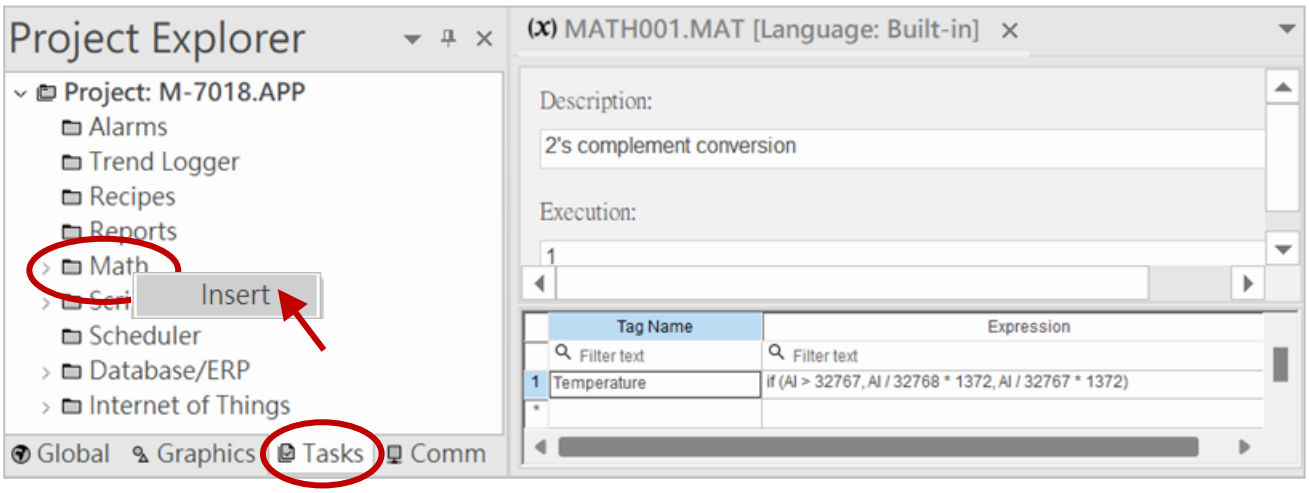
Input the following settings in the MODBU worksheet.

Field Name	Settings
Description	M-7018
Read Trigger	1
Station	1
Header	3X:0

No.	Tag Name	Address	Div	Add
1	AI	1	-	-



Click the **Tasks** tab in the **Project Explorer** panel. Right-click on **Math** and select **Insert** to add a sheet for performing the 2's complement conversion.



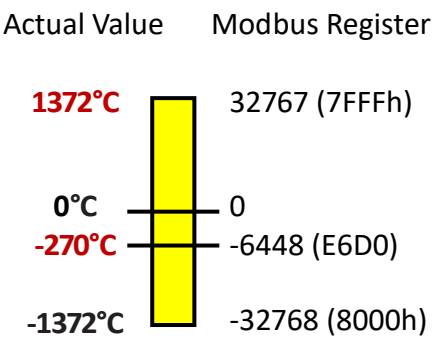
The settings are listed in the table below.

Field Name	Settings
Description	2's complement conversion
Execution	1
Tag Name	Temperature
Expression	if (AI > 32767, AI / 32768 * 1372, AI / 32767 * 1372)

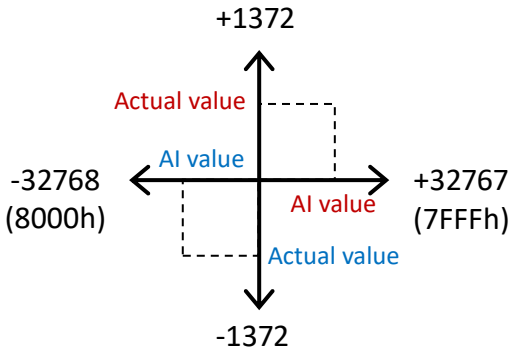
Users can refer to Appendix B for the module's type code. The M-7018 module is set to K-type with temperature range of -270 to 1372 (°C).

Type Code	Input Range	Data Format	Min.	Max.
0x0F	Type K Thermocouple **-270 ~ 1372°C**	Engineering unit	-2700	13720
		2's complement HEX	E6D0	7FFF

The data range for a 16-bit signed value spans from -32,768 to 32,767. In this example, the module's data is represented in 2's complement format in hexadecimal. To obtain the corresponding temperature value, we need to convert this data accordingly.

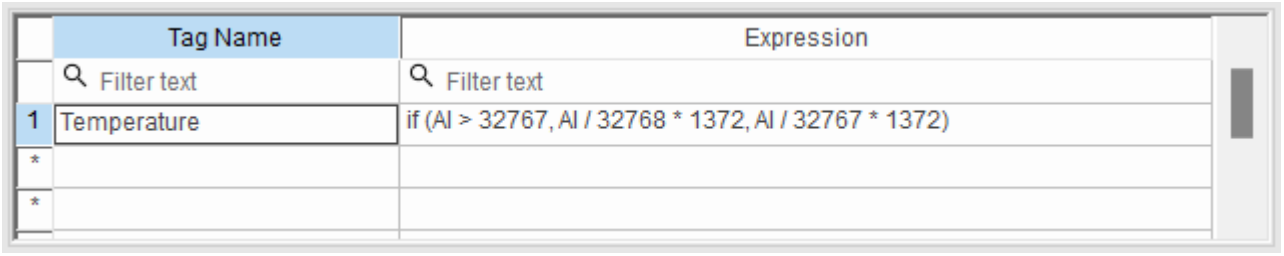


Positive value: Actual Value = AI/32767*1372
Negative value: Actual Value = AI/32768*1372

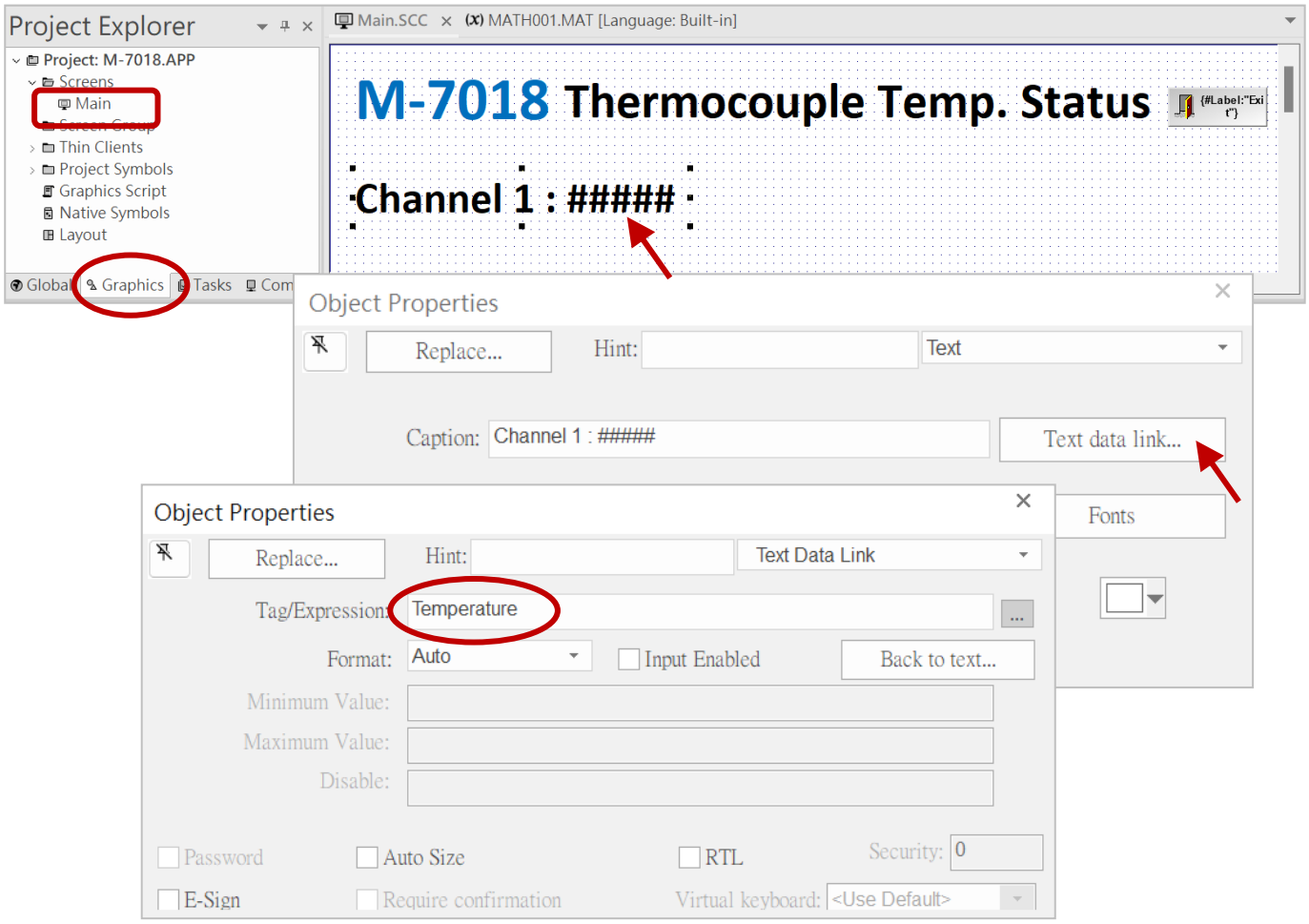


If the data exceeds the maximum range of a signed 16-bit value (32,767), it is treated as a negative value. Therefore, the expression is defined as:

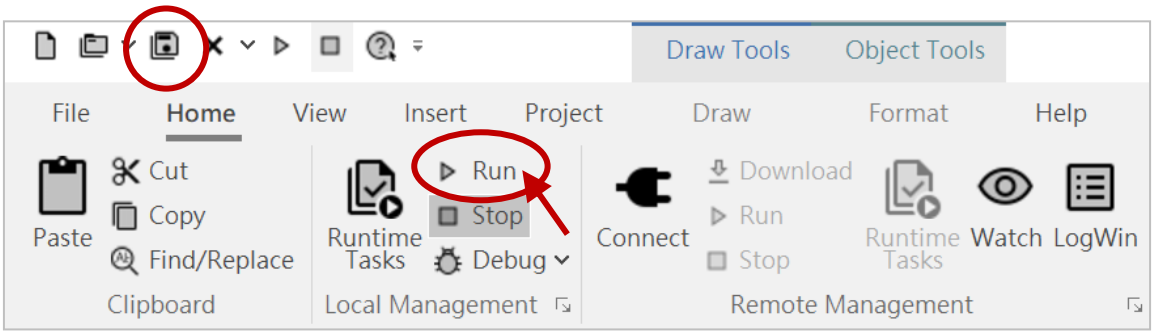
if (AI > 32767, AI / 32768 * 1372, AI / 32767 * 1372)

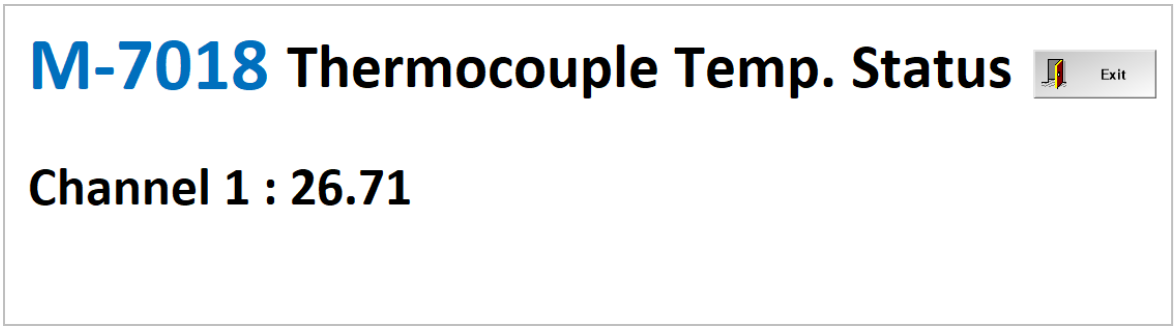


Double-click on **Channel 1 : #####** to open the **Object Properties** window. Then, click the **Text data link** button and enter **Temperature** in the **Tag/Expression** field.



Click **Save All** to save the project. Then, click **Run** on the **Home** ribbon to start the run-time task and view the current temperature value.





6.6.3 Example 2: M-7026 Configuration Setup

This section provides a brief overview of using AVEVA Edge to read from and write to the M-7026-G module through the Modbus RTU protocol. A PC can be connected to the M-7026-G using the I-7561 (USB to RS-485) converter.

➢ The M-7026 Webpage and Download Files

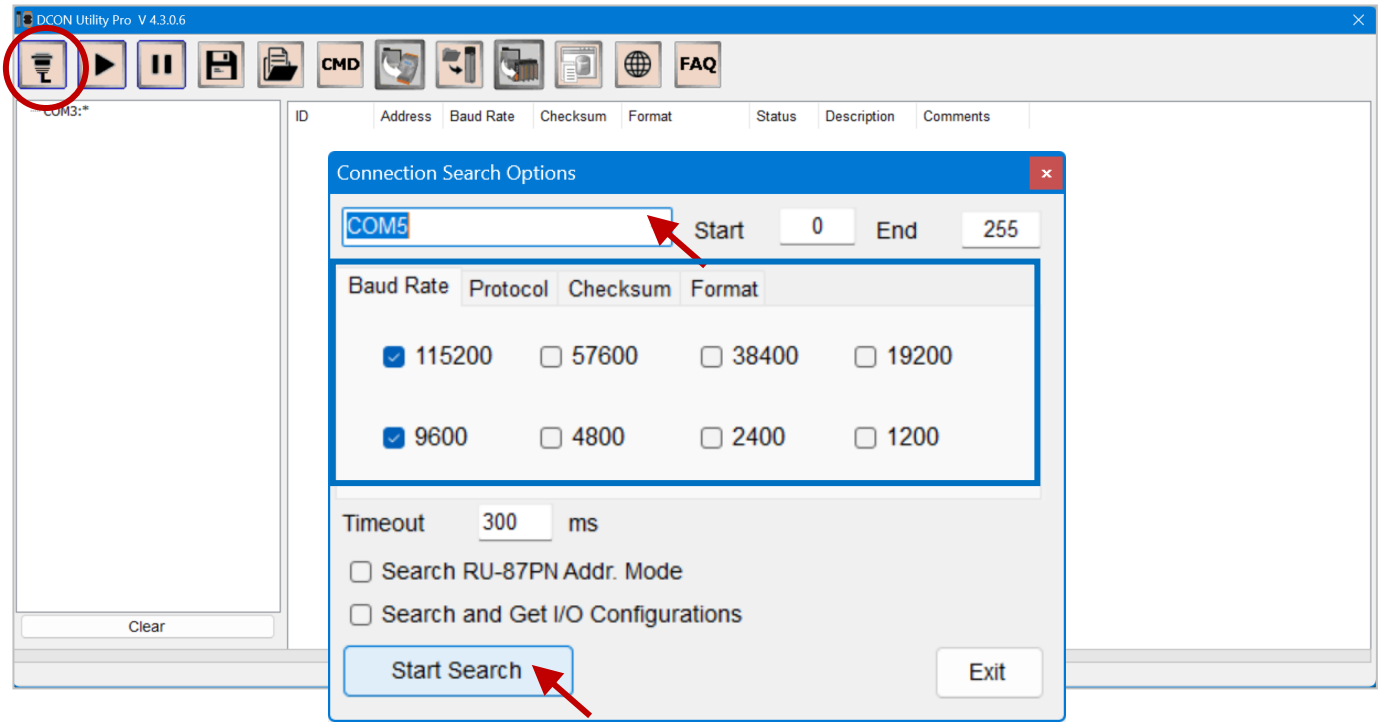
The M-7026-G, developed by ICP DAS, is a module featuring 6 analog inputs, 2 analog outputs, 3 digital inputs, and 3 digital outputs.

Webpage: M-7026-G (https://www.icpdas.com/en/product/M-7026-G).
Download files: https://www.icpdas.com/en/download/index.php?model=M-7026-G

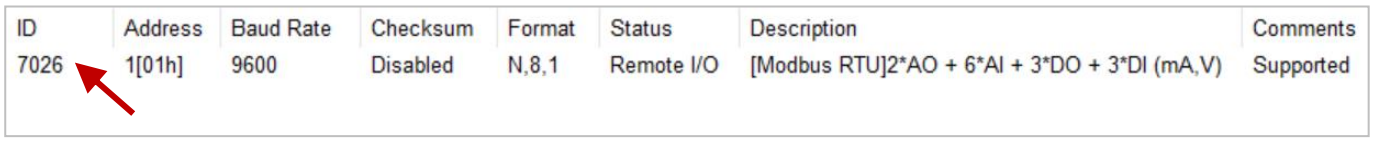
Note:
Before using the module, download the **DCON Utility Pro** software to configure the basic parameters of the M-7026-G.

➢ Configure M-7026 Parameters (DCON Utility Pro)

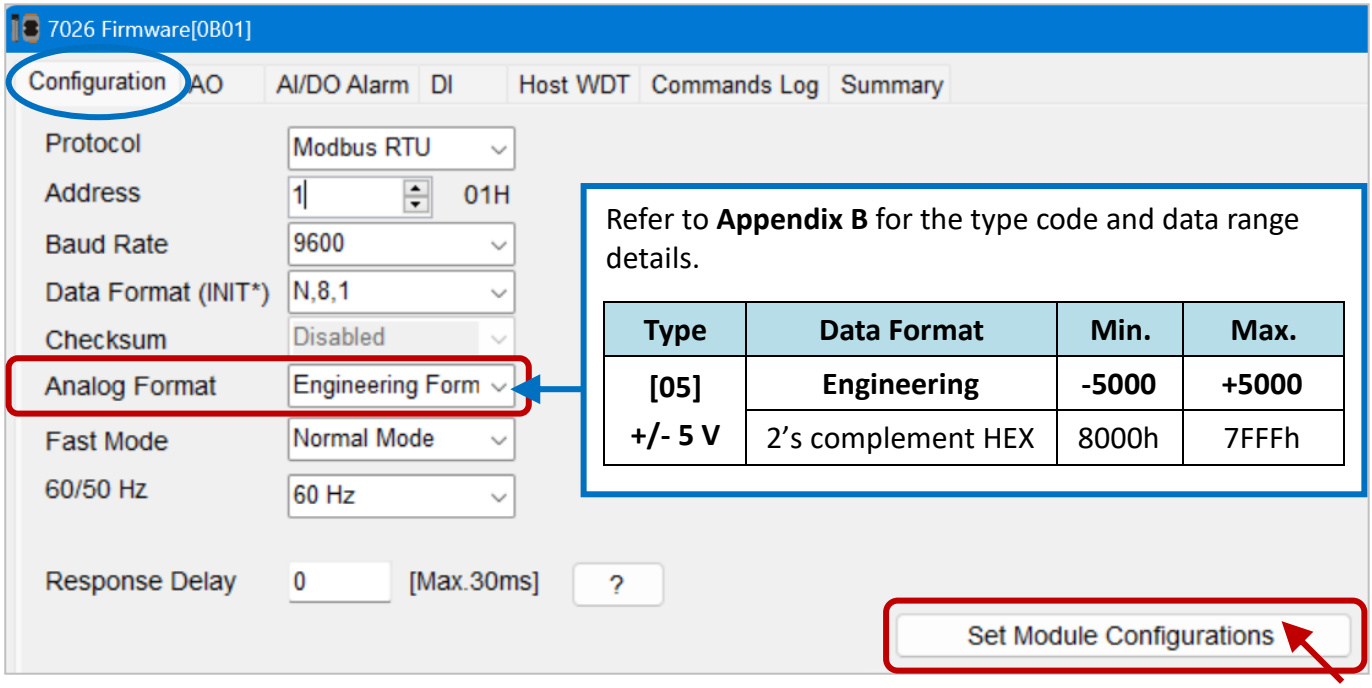
Once the software is launched, click the **Connection Options** button in the toolbar, select the PC's COM port, check the search parameters (e.g., Baud Rate, Protocol, and so on), and click **Start Search**.



When the module is detected, double-click on **7026** to access the **Configuration** page.

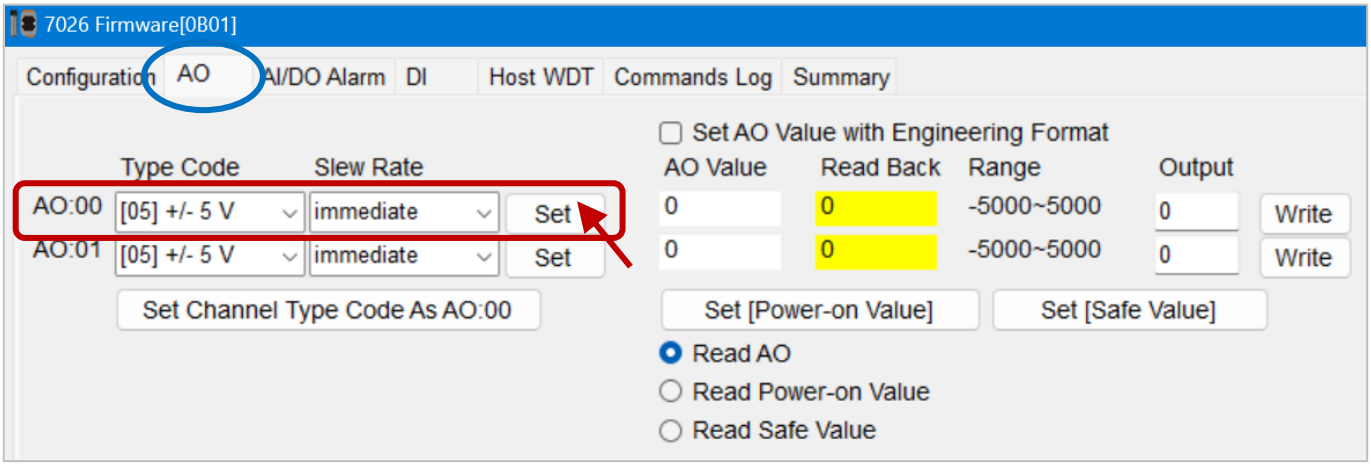


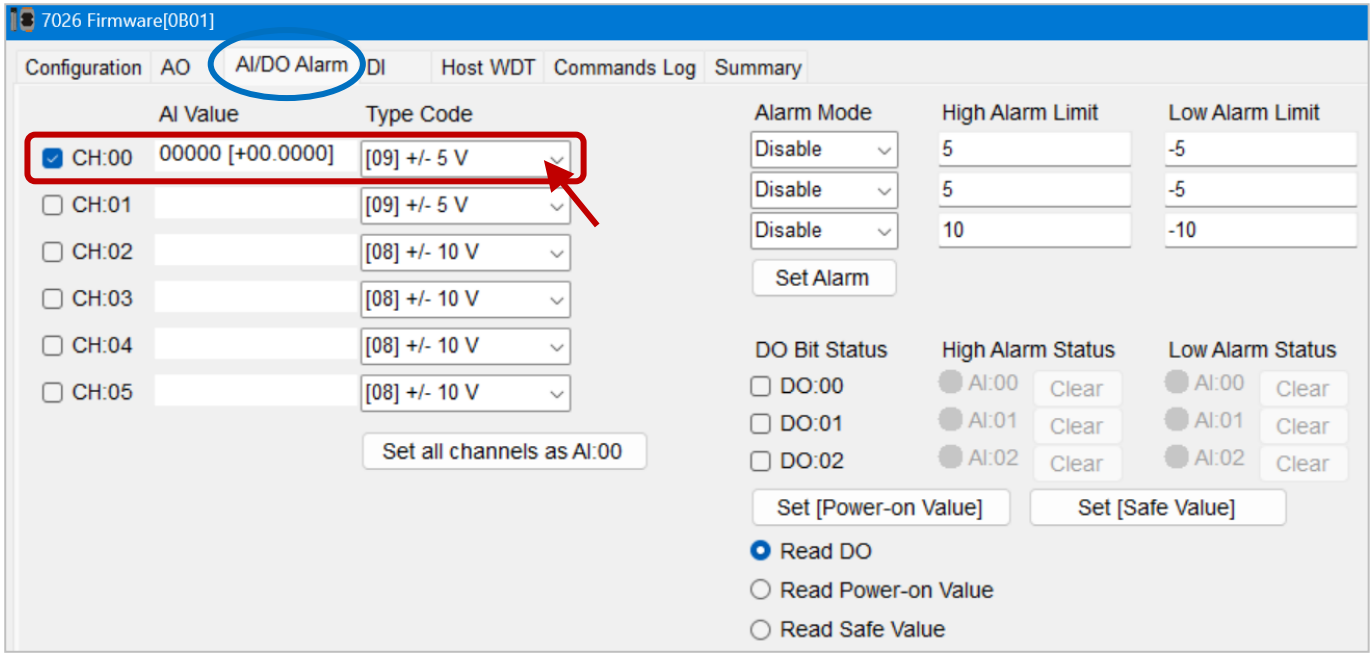
The analog format of the M-7026 module can be configured as either **Engineering Format** or **2's Complement Format**. After setting the type code to **±5V** on both the **AO** and **AI** pages, click the **Set Module Configurations** button.



Refer to **Appendix B** for the type code and data range details.

Type	Data Format	Min.	Max.
[05]	**Engineering**	**-5000**	**+5000**
+/- 5 V	2's complement HEX	8000h	7FFFh

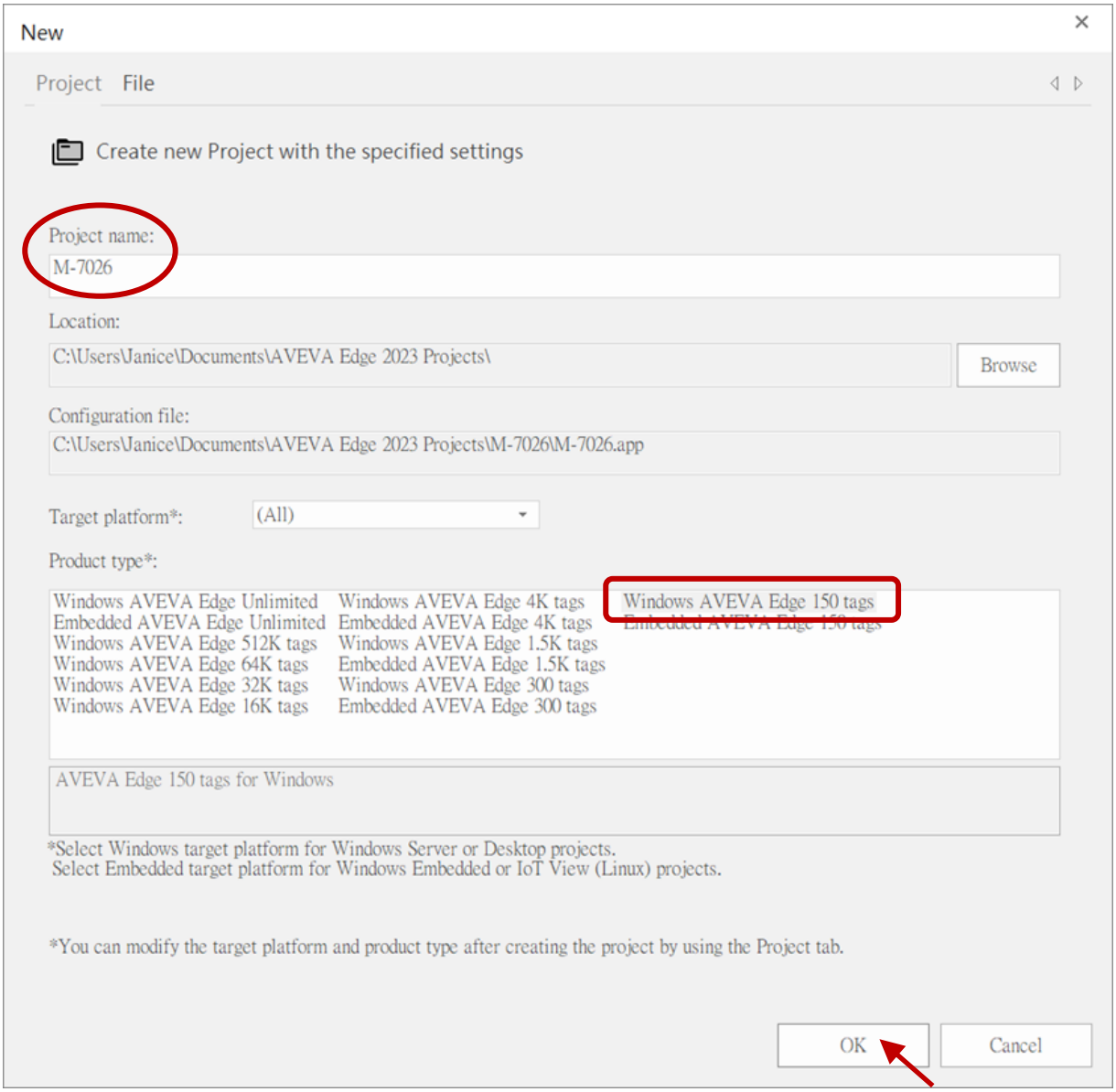




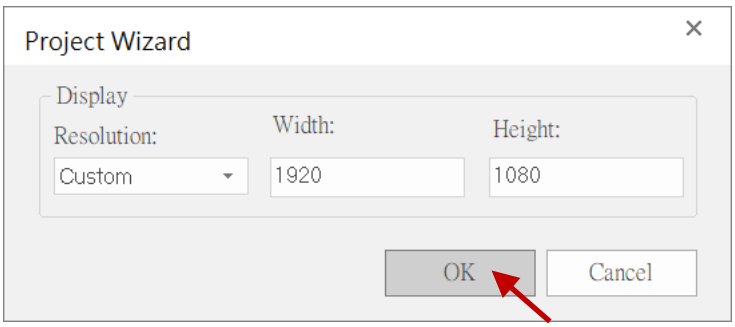
6.6.4 Example2: AVEVA Edge and the M-7026 Module

➢ **Create the Project and Tags**

Create a project named **M-7026**, select **"Windows AVEVA Edge 150 tags"**, and click **OK**.



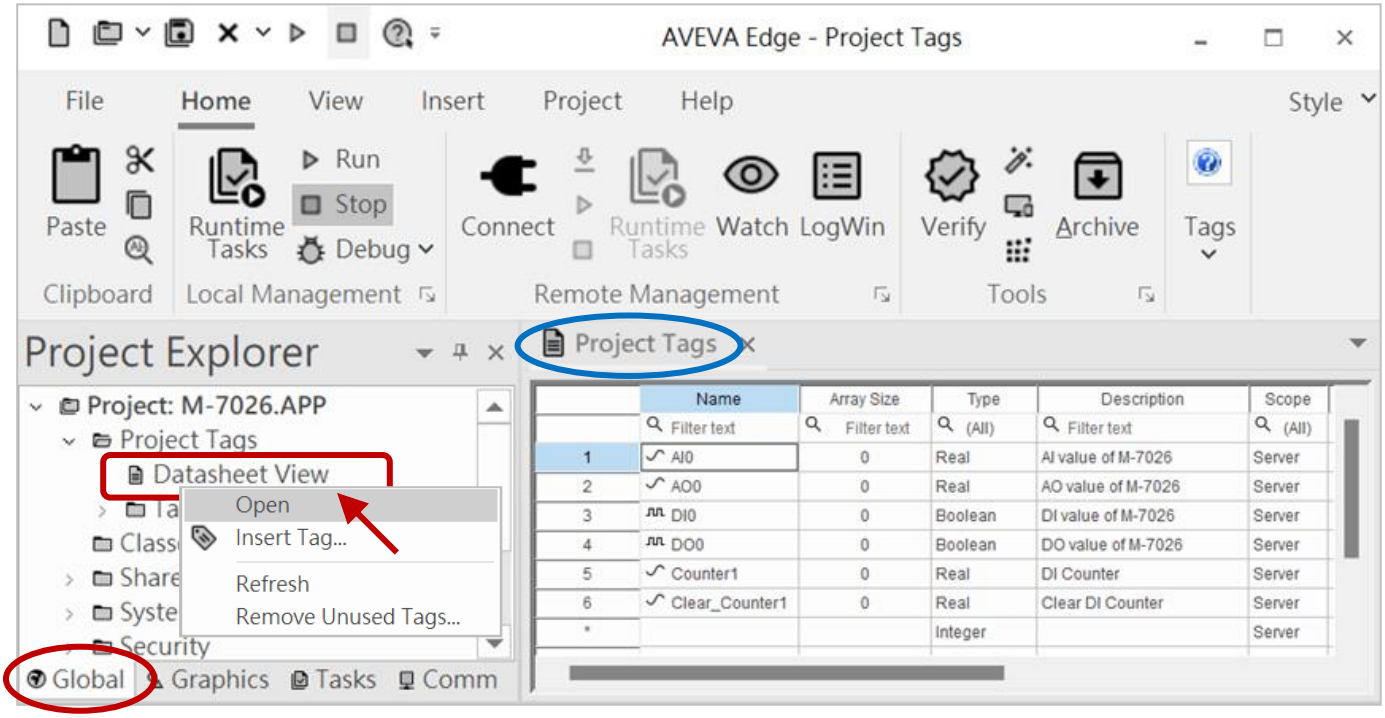
(Set the resolution to **1920 × 1080**.)



Note: In the following "**Overview**" window, keep the default settings. Users can directly click the **Next** button to complete the setup. In this example, the Tags listed in the table below need to be added.

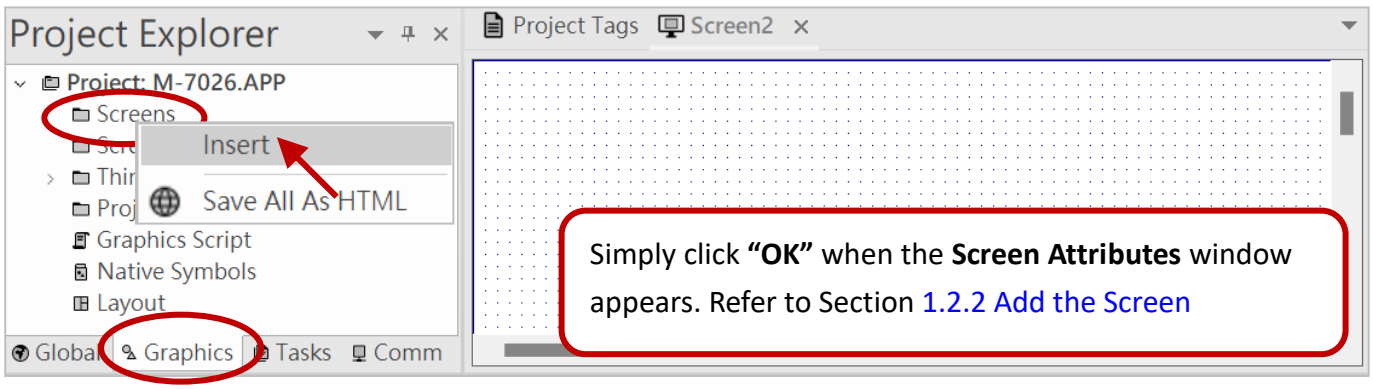
Click the **Global** tab in the Project Explorer, right-click on **Datasheet View**, and select **Open** to display the **Project Tags** window.

Tag Name	Array Size	Type	Description
AI0	0	Real	AI value of M-7026
AO0	0	Real	AO value of M-7026
DI0	0	Boolean	DI value of M-7026
DO0	0	Boolean	DO value of M-7026
Counter1	0	Integer	DI Counter
Clear_Counter1	0	Integer	Clear DI Counter



➢ Add the Screen

Click the **Graphics** tab in the **Project Explorer** panel，Right-click on the **Screens** and select **Insert**.



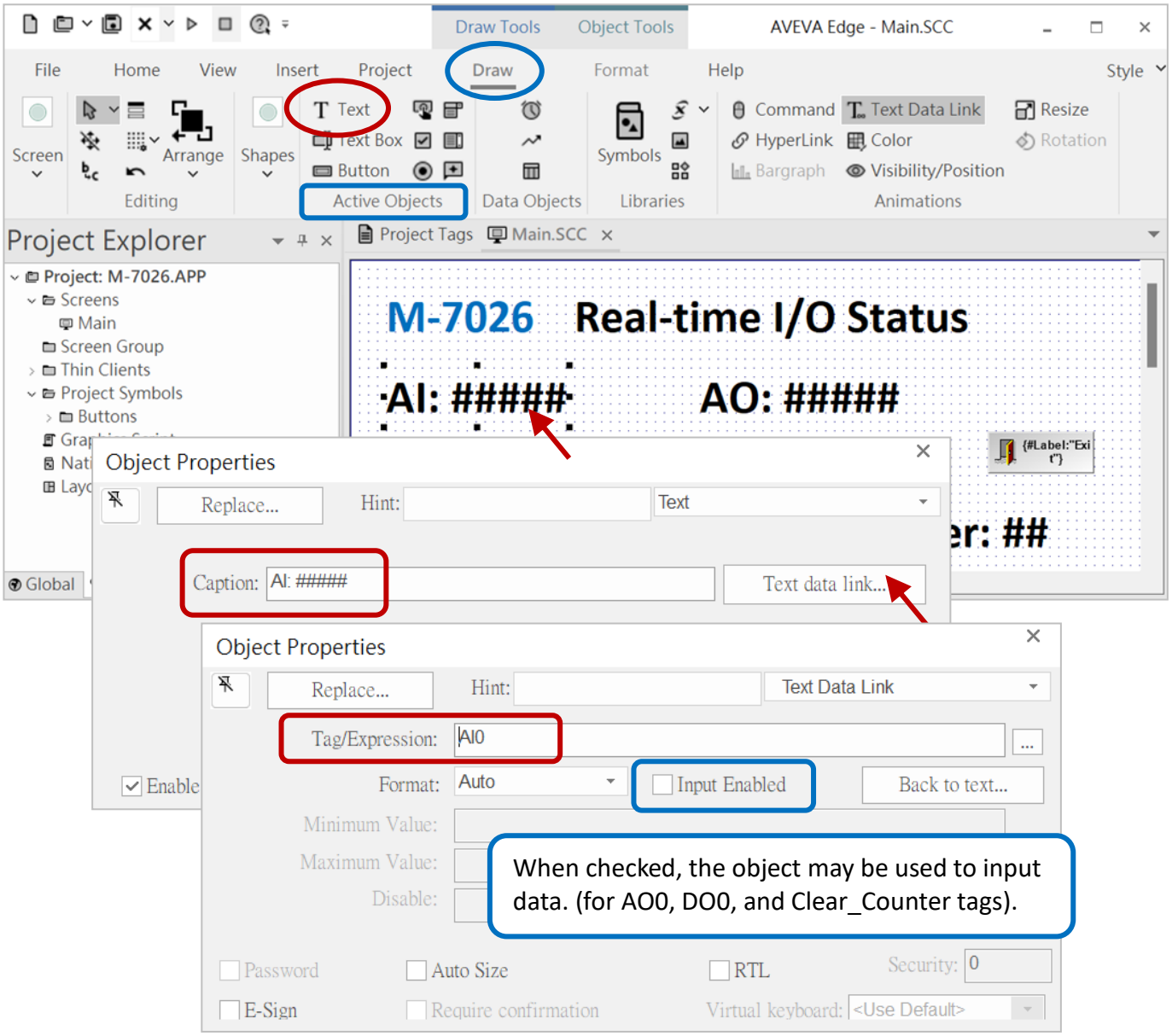
➢ Add the Text Object and Assign the Tag

The **Draw** ribbon appears only after creating a screen. Click the **Text** object in the **Active Objects** group to create the objects listed in the table below. The number of "**#**" symbols represents the length of the data to be displayed (including the decimal point).

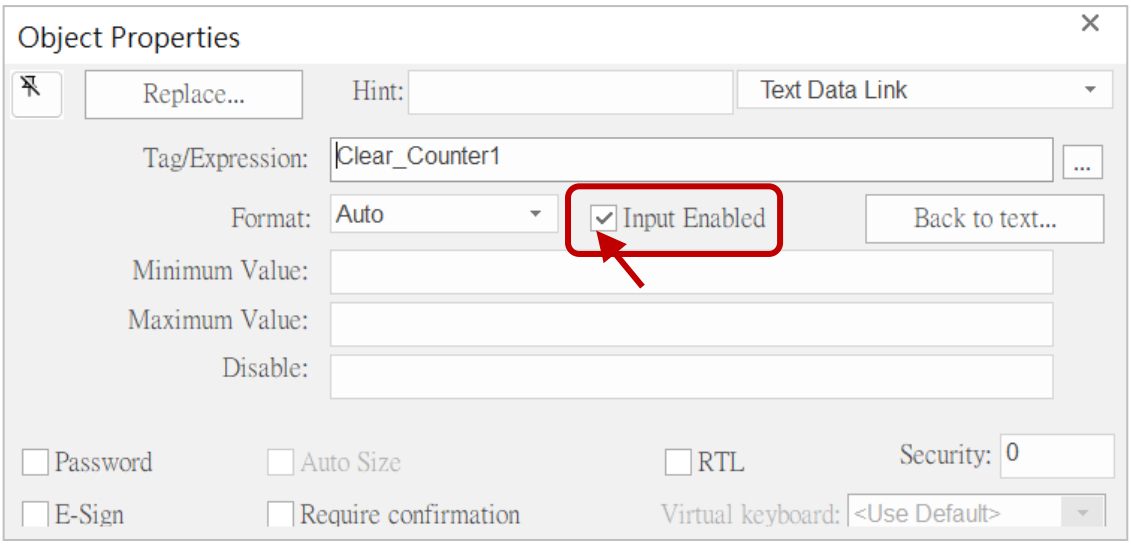
Caption	Tag/Expression
M-7026	-
AI: #####	AI0
DI: ####	DI0
Counter: ##	Counter1

Caption	Tag/Expression	Input Enabled
Real-time I/O Status	-	-
AO: #####	AO0	☑
DO: ####	DO0	☑
Clear_Counter: ##	Clear_Counter1	☑

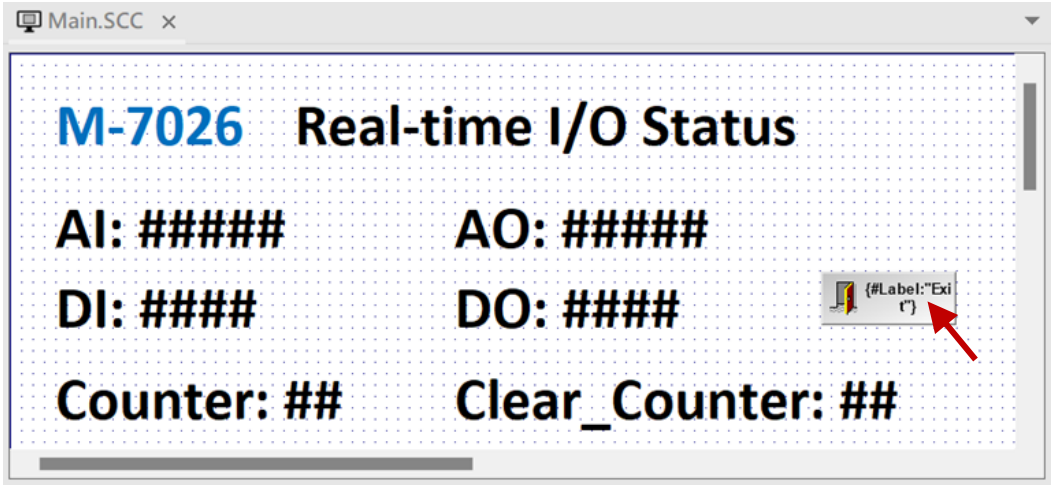
Double-click on the **Text** object to open the **Object Properties** window, and configure the settings as specified in the table.



For AO0, DO0, and Clear_Counter1 tags, check the **Input Enabled** item.



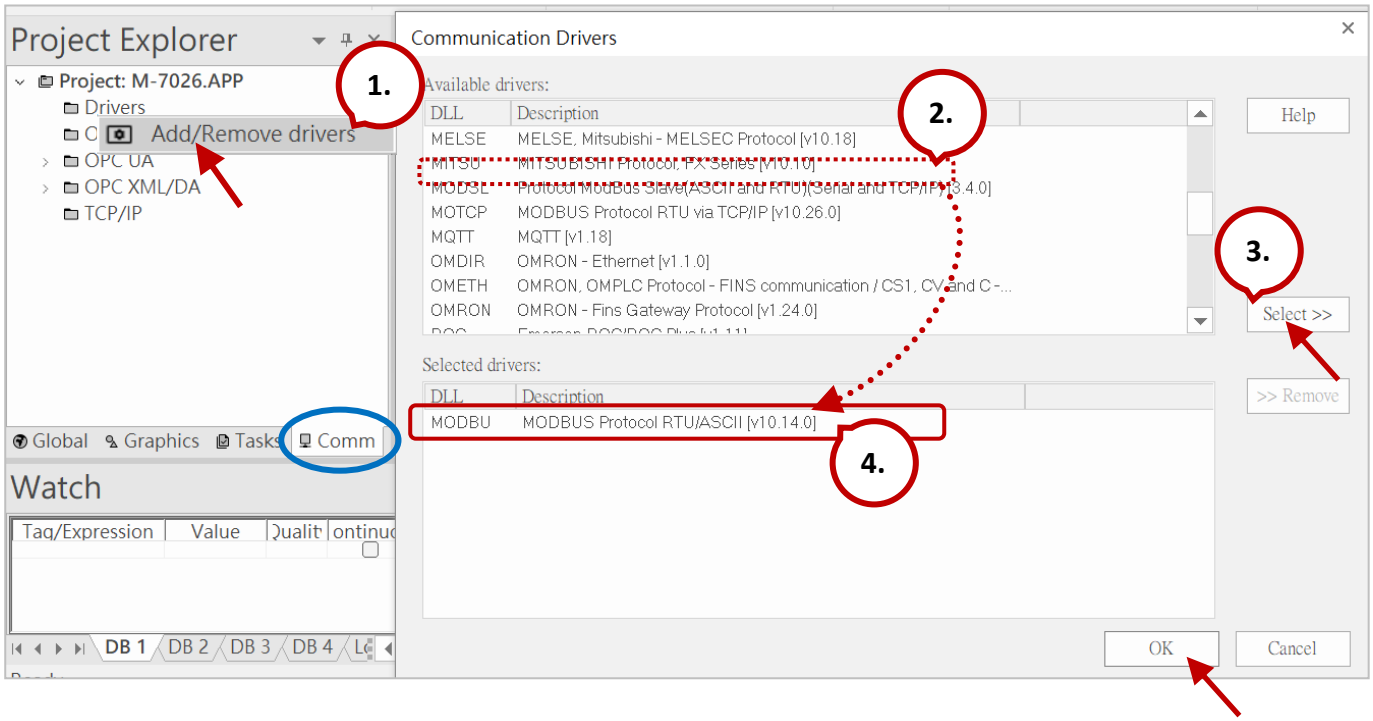
Once completed, the screen will appear as shown below.



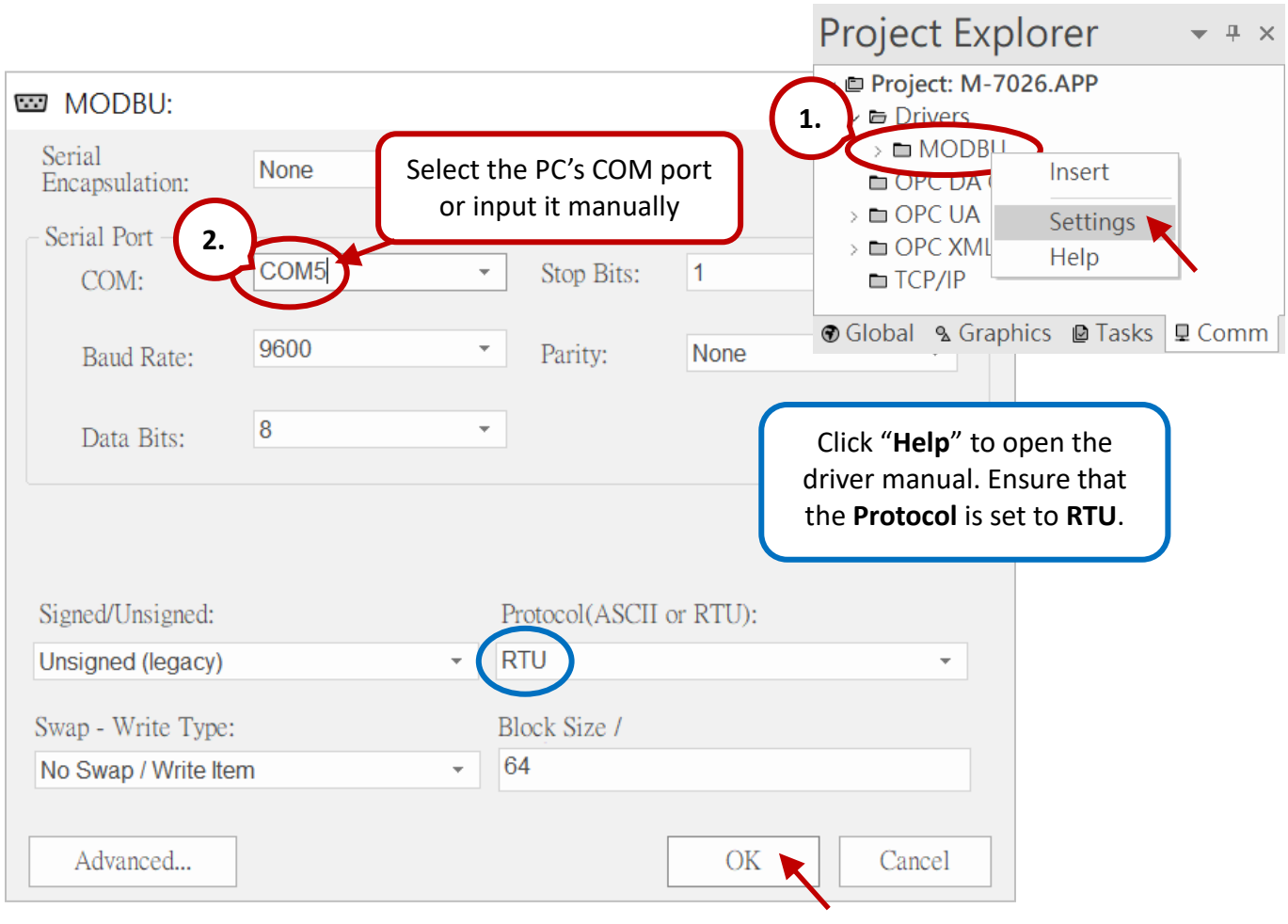
Note: Refer to Example 1 - Add a System Symbol to add an "**Exit**" button, which is used to exit the run-time task.

➢ Add the MODBU (Modbus RTU) Communication Driver

Right-click on **Drivers** and select **Add/Remove drivers** in the Comm tab. After the **MODBU** is selected, click OK.

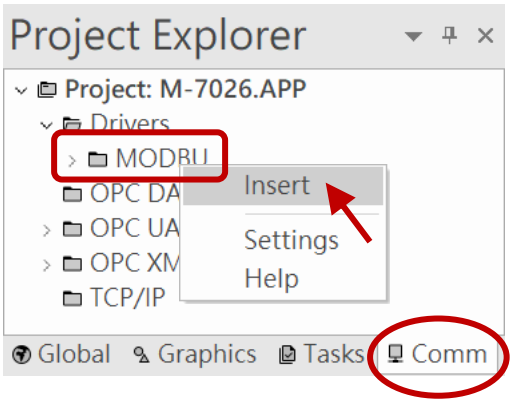


Right-click on the **MODBU** driver and select "**Settings**" to open the window. Then, configure the parameters according to the M-7026 module's configurations.



➢ Add a Driver Worksheet for I/O (Engineering)

Click the **Comm** tab in the **Project Explorer** panel. Right-click on the **MODBU** driver and select **Insert** to add a standard Modbus RTU worksheet.



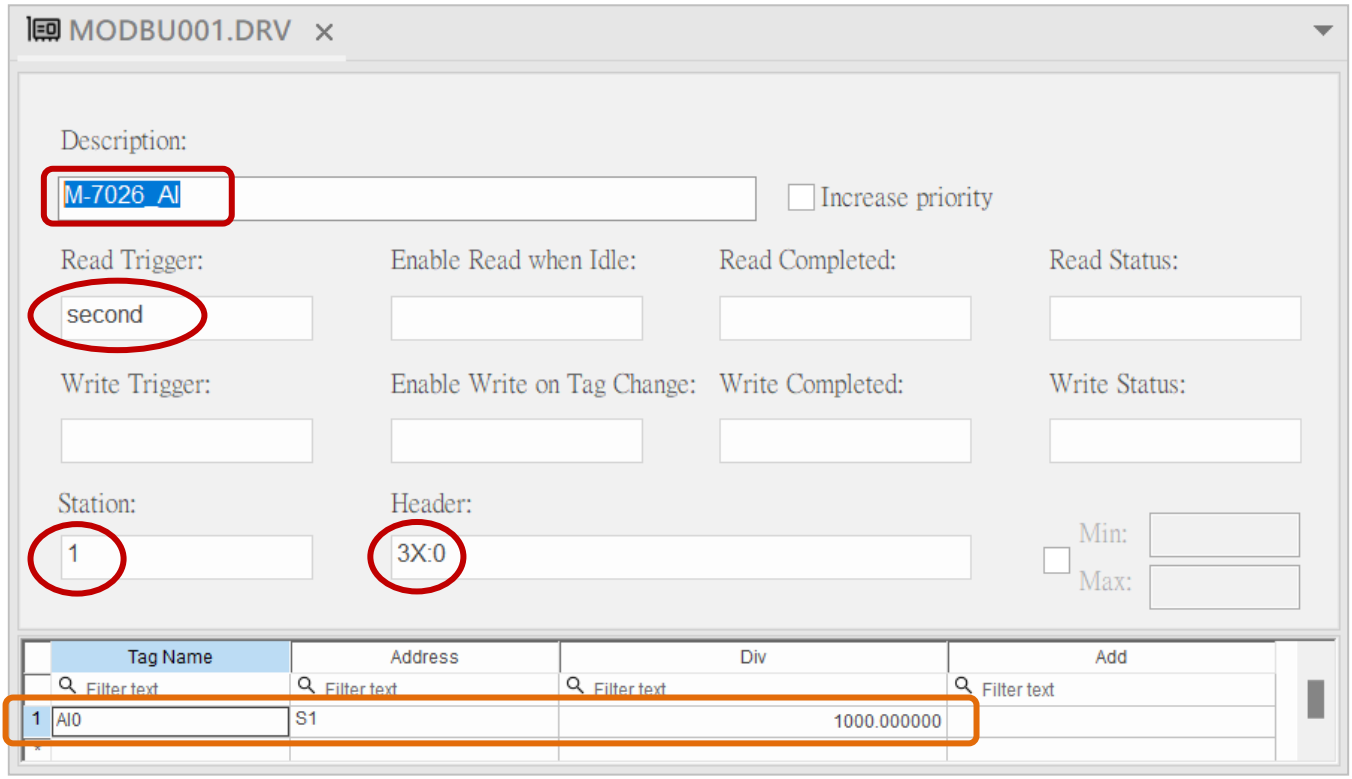
Note:
After adding the **MODBU** driver, the **MAIN DRIVER SHEET** is automatically created. Users can typically add tags there, but if the system becomes large with too many tags, it could overload communication. **To ensure stable data communication, it's recommended to add tags in a separate sheet**, as will be explained later.

In this example, 6 new Modbus RTU worksheet will be added. Please input the data for the first "M-7026_AI" worksheet first.

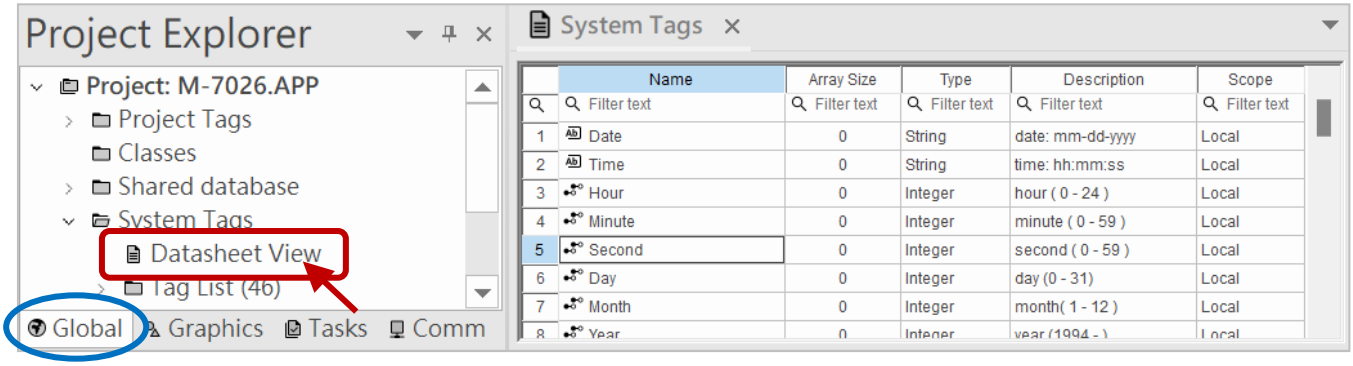
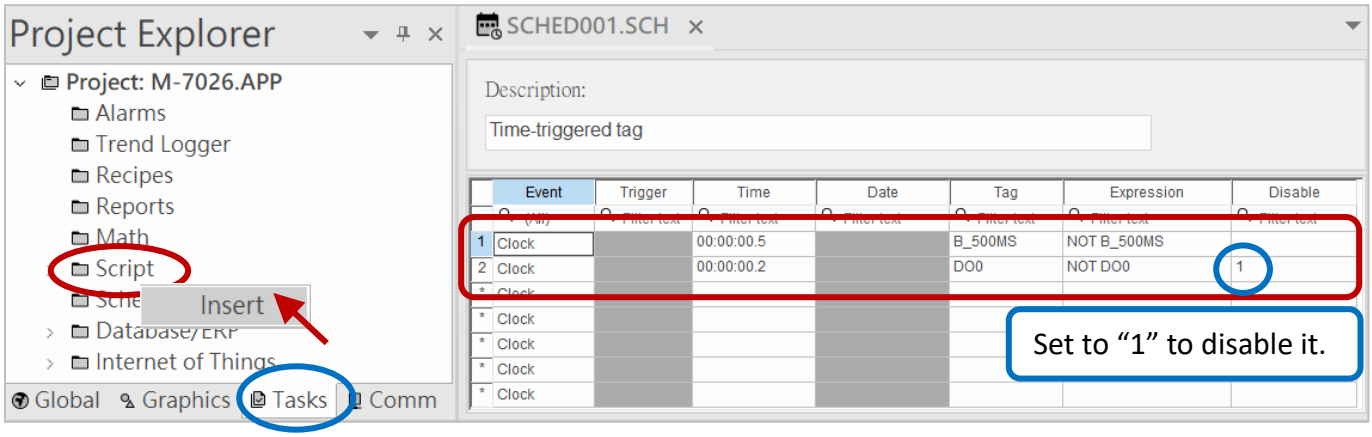
Field Name	AI
Description	M-7026_AI
Read Trigger	second
Station	1
Header	3X:0

NO.	Tag Name	Address	Div	Add
1	AI0	S1	1000	-

Note:
Add "**S**" before the address for **Signed**, or leave it out for Unsigned. See the explanation below.



The table below outlines the fields to be configured in Example 2.

Read Trigger
Enter a tag name. The module's data will be read once when the value changes. In this example, this field in the AI, AO, DI, and DO worksheet will be set to the system variable "**Second**" to read data every second. Users can double-click "**Datasheet View**" under **System Tags** on the **Global** page to view all system variables.      Users can insert a schedule on the "**Tasks**" tab and set the tag status to change every 0.5 seconds to trigger a read action (Time: 00:00 :00.5, Tag: B_500MS, Expression: NOT B_500MS).   
Enable Read when Idle
Enter a tag name (Boolean) or "1". If the value is greater than **0**, data will be automatically read continuously. In this example, enter **"1"** in this field for both the **DI_Counter** and **Clear_Counter** worksheet. **Note:** To read **AI**, **DI**, or **Counter** tags, configure the **"Read Trigger"** or **"Enable Read When Idle"** field. For **AO**, **DO**, and **Clear Counter** tags, configure the **"Write on Tag Change"** field as well.

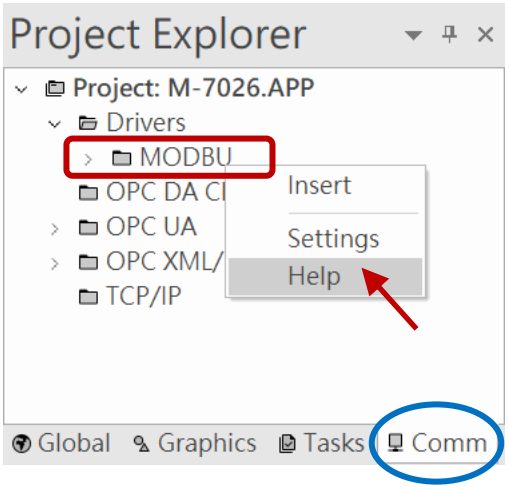
Enable Write on Tag Change

Enter a tag name or a constant value (greater than 0). When the tag data in the worksheet changes, it will automatically be written to the on-site equipment. In this example, enter "**1**" in this field for the AO, DO, and Clear Counter worksheets.

Header

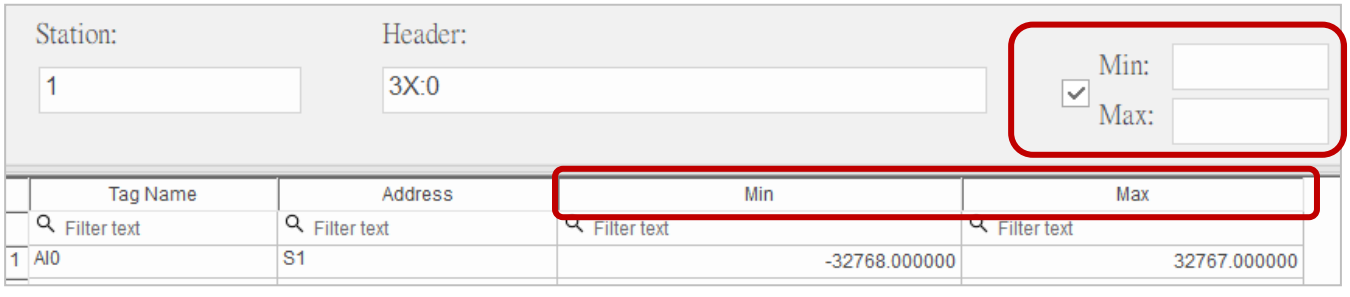
Specify the data type and start address to read/write the module data. Users can click "**Help**" to view the driver manual. Commonly used examples are listed in the table.

Example	Description
0X:0	Coil status
1X:0	Input status
STA:0	Exception Status
3X:0	Input register
4X:0	Holding register
FP3:0	Input register (Floating-point value)
FP:0	Holding Register (Floating-point value)
DW3:0	Input register (Dword value)
DW:0	Holding Register (Dword value)
ST:0	Holding Register (String value)



Min/Max

This function will be used for the 2's complement conversion, as explained in the next section. After selecting the checkbox, the entered values will apply to all tags in the table, and the column names **"Div"** and **"Add"** will change to **"Min"** and **"Max"**. It is recommended to enter values individually for each tag.



Tag Name

Enter a tag name to read/write data.

Address

Enter the Modbus address of the unit.

Example	Description
S1, S33	"S" indicates that the data is a signed value
1, U33, 33	"U" (or no symbol) indicates that the data is an unsigned value

Click the link to view the M-7026's Modbus address (Base1) mapping table.
https://www.icpdas.com/web/product/download/io_and_unit/rs-485/document/manual/7000/M-7000_address_mapping_table.pdf

Modbus Function	Modbus Register	Notes (M-7026)
3X	30001 ~ 30006	Read the AI 0 to 5
4X	40033 ~ 40034	Read/Write the AO 0 to 1
1X	10033 ~ 10035	Read the DI 0 to 2
0X	00001 ~ 00003	Read/Write the DO 0 to 3
3X	30129 ~ 30131	Read the DI Counter 0 to 2
0X	00513 ~ 00515	Clear the Counter 0 to 2

Note: In the "**Header**" field, the sum of the start address and the address must be greater than 0. For example,

Modbus Register	Header (Data Type: start Address)	Address
0**1020**	0x:**1000**	**20**
1000**1**	1x:**1**	**0**
3**1020**	3x:**1000**	**20**
3000**1**	3x:**1**	**0**
3001**0**	3x:**0**	**10**
4000**1**	4x:**1**	**0**
4001**0** (bit**2**)	4x:**0**	**10.2**
4000**1** and 40002	DW:**1**	**0**
4001**3** and 40014	DW:**0**	**13**

Div

The user can set a divisor to scale the displayed value. Do not use this field if the 'Min' and 'Max' fields are enabled. In this example, the data range of M-7026 is as follows (refer to Appendix B.5): divide the reading value by 1000 to display a range of -5 to +5 V.

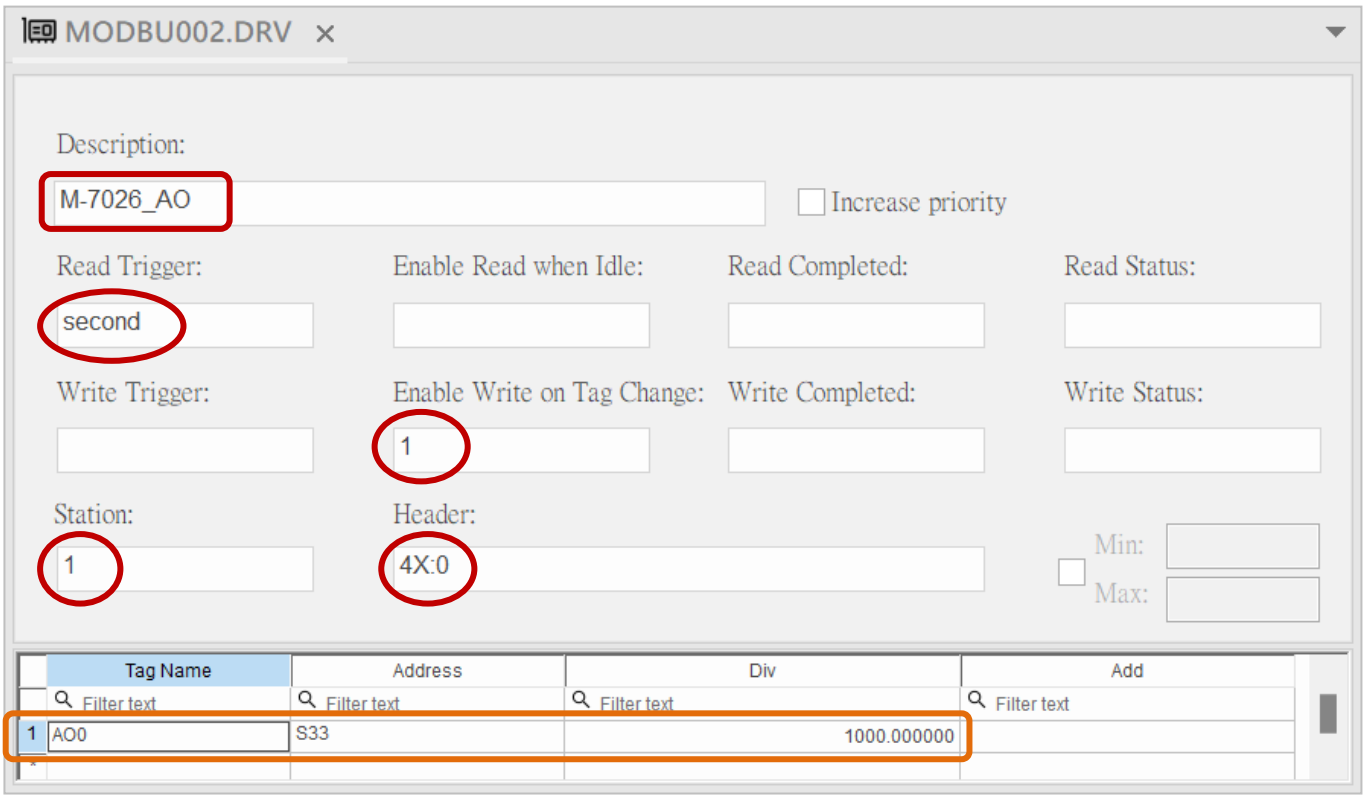
Type Code	Input Range	Data Format	Min.	Max.
0x05	+/-5 V	Engineering	-5000	+5000

Refer to the table below to add other worksheets.

Field Name	AO	DI	DO	Counter	Clear_Counter
Description	M-7026_AO	M-7026_DI	M-7026_DO	M-7026_DI_Counter	M-7026_Clear_Counter
Read Trigger	second	second	second	-	-
Enable Read when Idle	-	-	-	1	1
Enable Write on Tag Change	1	-	1	-	1
Station	1	1	1	1	1
Header	4X:0	1X:0	0X:0	3X:0	0X:0
Tag Name	AO0	DI0	DO0	Counter1	Clear_Counter1
Address	S33	33	1	130	514
Div	1000	-	-	-	-

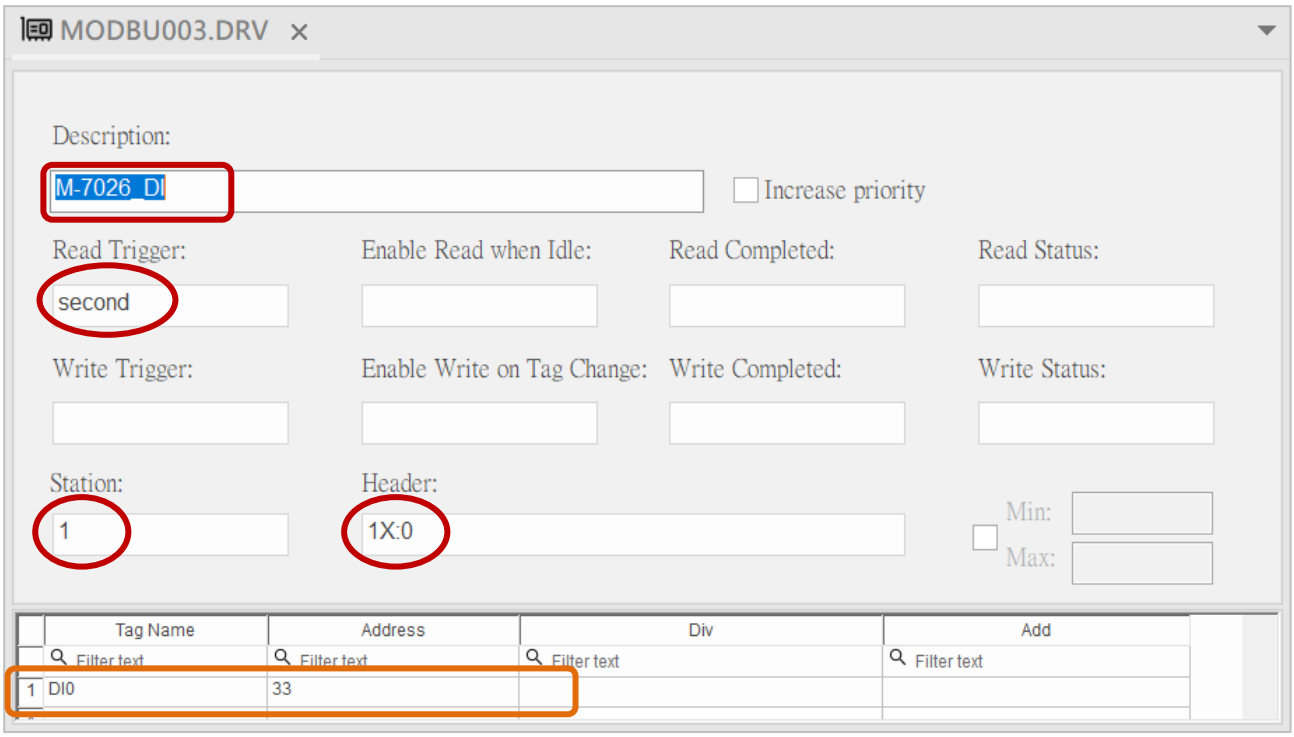
M-7026_AO:

Read Trigger	Enable Write on Tag Change	Station	Header	Tag Name	Address	Div
second	1	1	4X:0	AO0	S33	1000



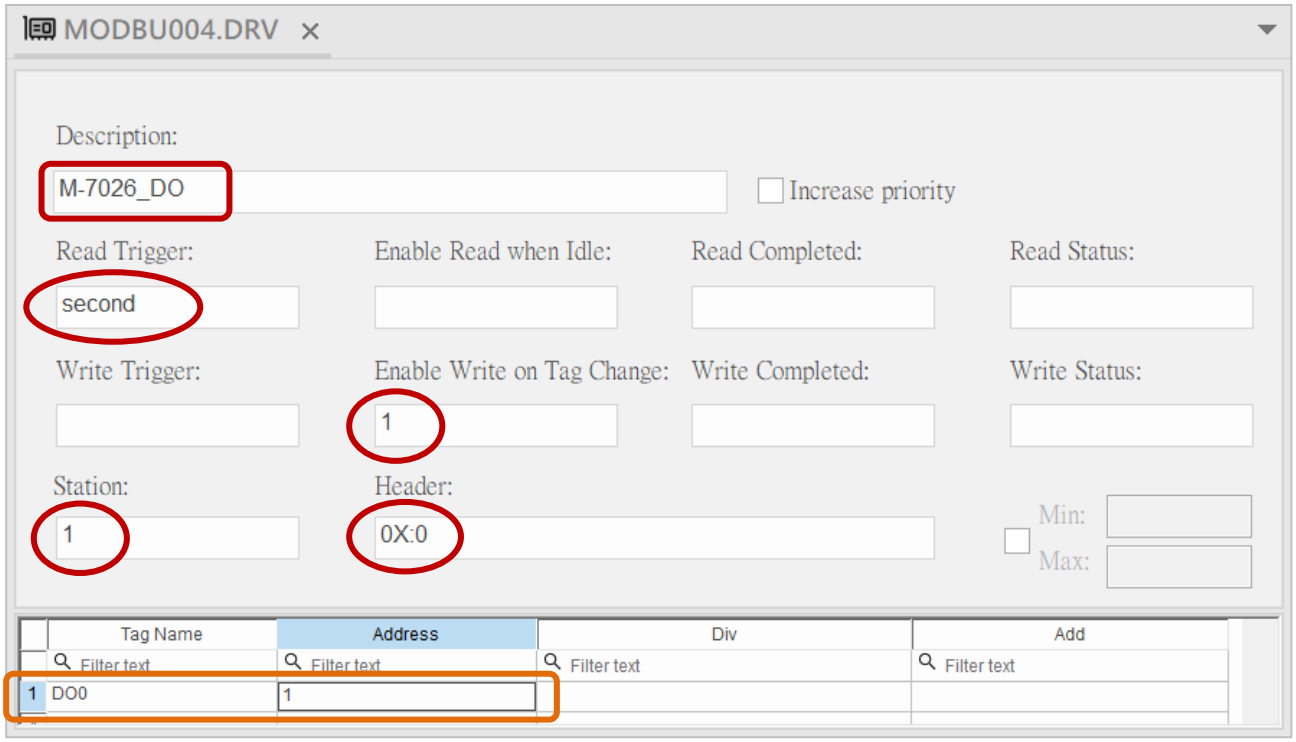
M-7026_DI:

Read Trigger	Station	Header	Tag Name	Address
second	1	1X:0	DI0	33



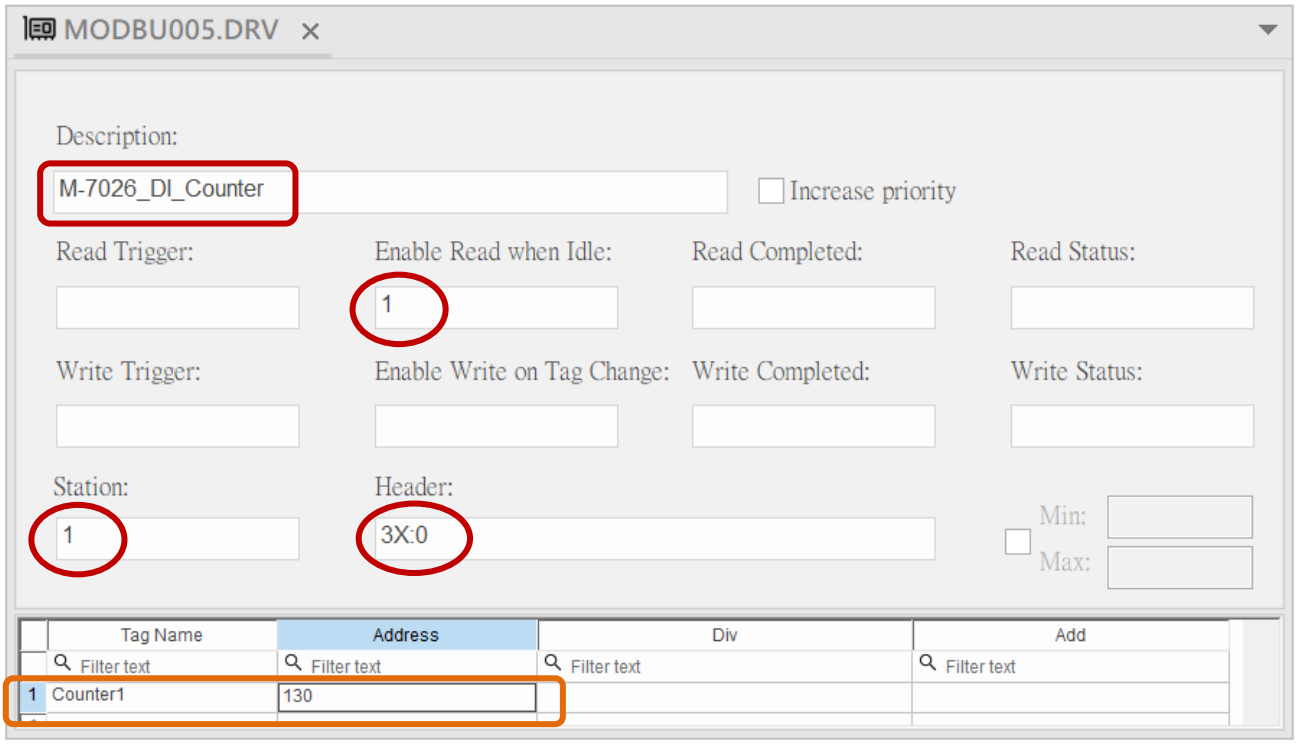
M-7026_DO:

Read Trigger	Enable Write on Tag Change	Station	Header	Tag Name	Address
second	1	1	0X:0	DO0	1



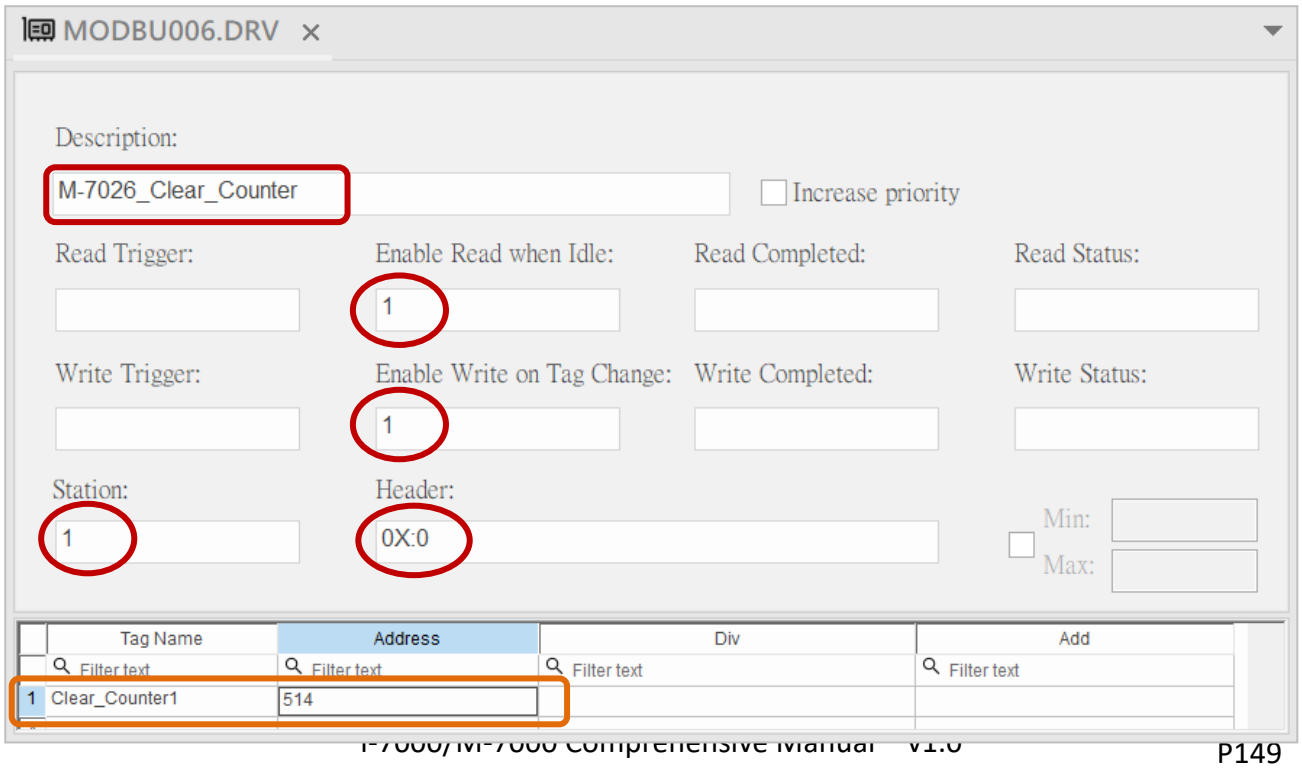
M-7026_DI_Counter:

Enable Read when Idle	Station	Header	Tag Name	Address
1	1	3X:0	Counter1	130

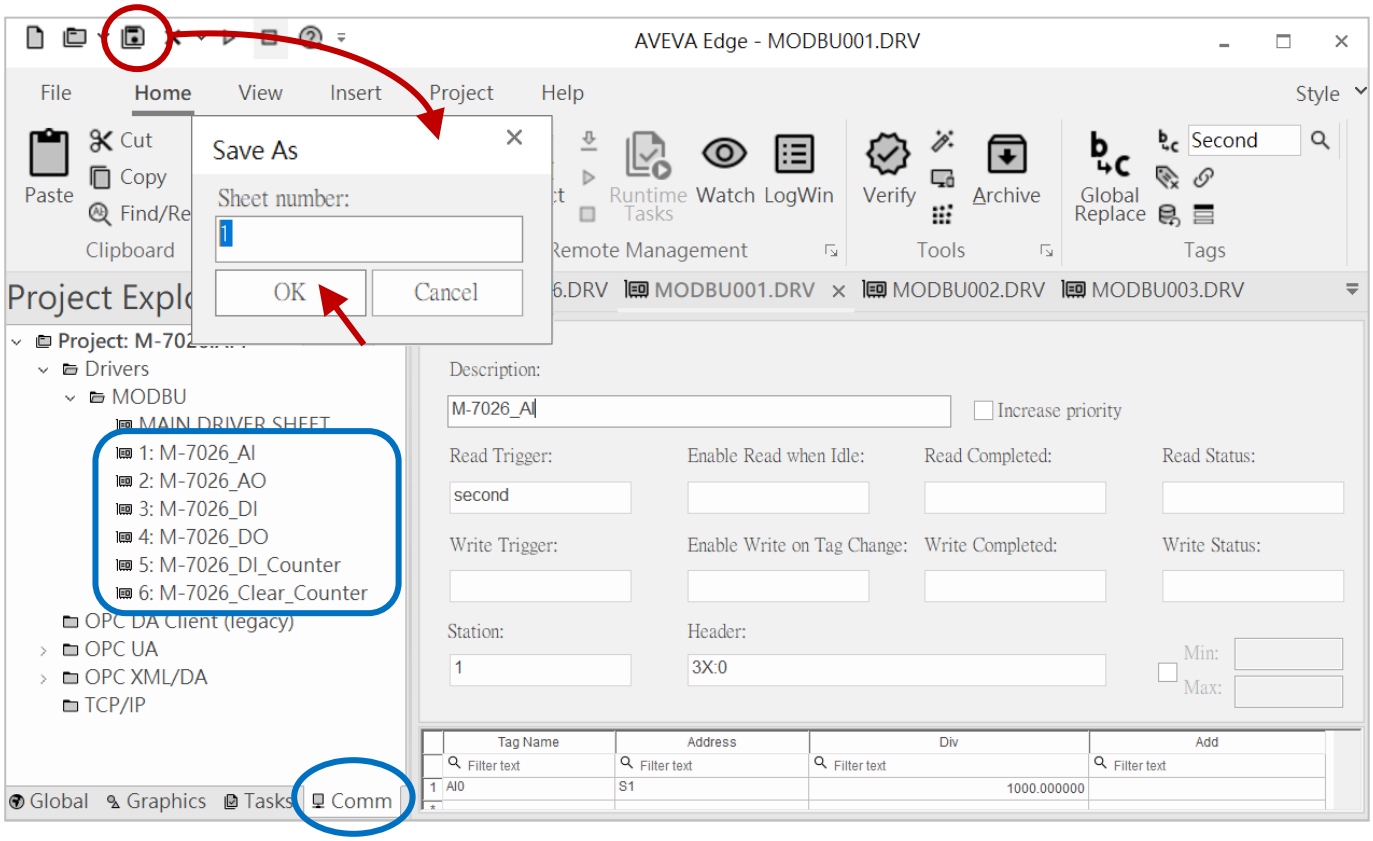


M-7026_Clear_Counter:

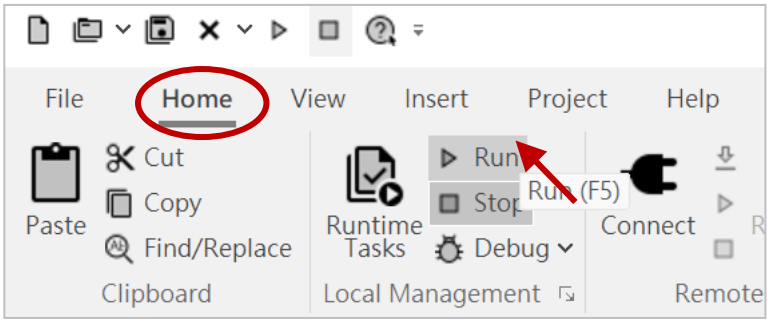
Enable Read when Idle	Enable Write on Tag Change	Station	Header	Tag Name	Address
1	1	1	0X:0	Clear_Counter1	514



After clicking "**Save All**" in the upper-left corner, the "**Save As**" dialog box appears. Simply click **OK** several times to save worksheet 1 to 6.

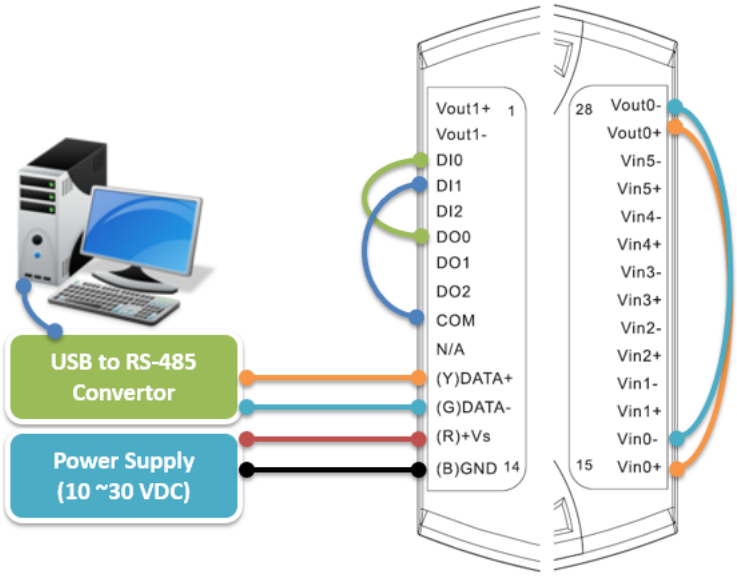


Click **Run** on the **Home** ribbon.



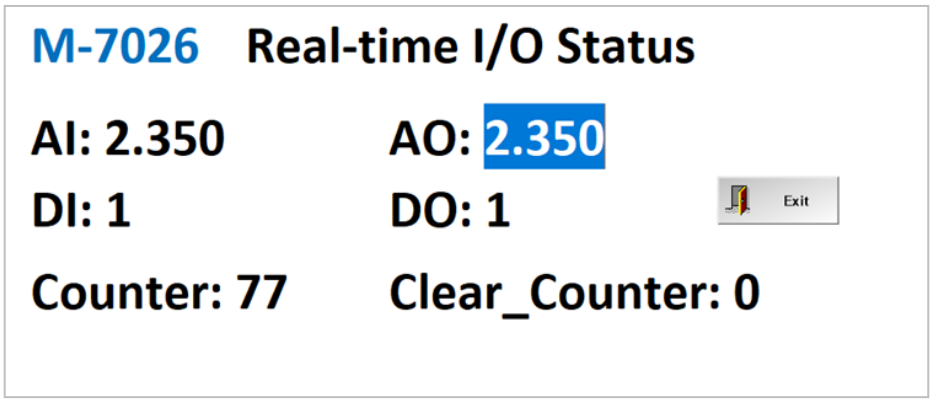
The hardware wiring of the M-7026 module in this example.

1. The Vin0+ is connected to the Vout0+
2. The Vin0- is connected to the Vout0-
3. The DI0 is connected to the DO0
4. If the DI1 is connected to the COM, the counter value will increase by 1.



Testing steps:

1. If the analog format is set to Engineering, set the AO value to 2.35 and press Enter; the AI value will display 2.350.
2. Set the DO to “1”, and the DI will change to “1”.
3. If the DI1 pin is connected to the COM pin, the counter value will increase by 1. If the Clear_Counter is set to “1”, the counter value will reset to “0”.



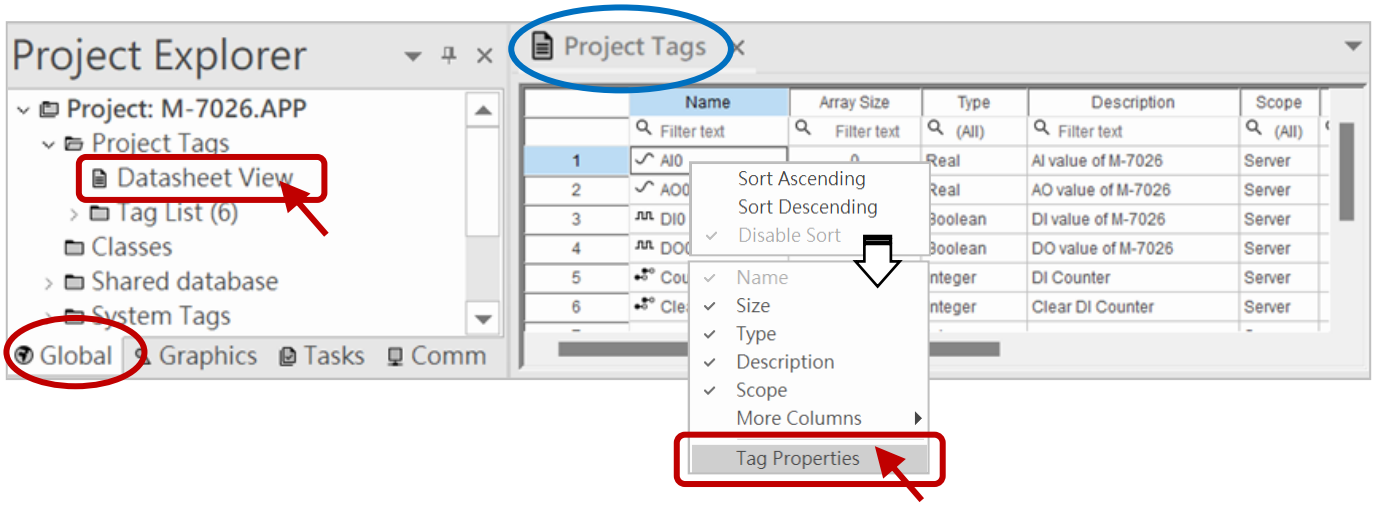
Note: Click the “**Exit**” button or press **Alt + Tab** to return to the software interface, then click “**Stop**” on the **Home** ribbon.

➢ Add a Driver Worksheet for I/O (2's Complement)

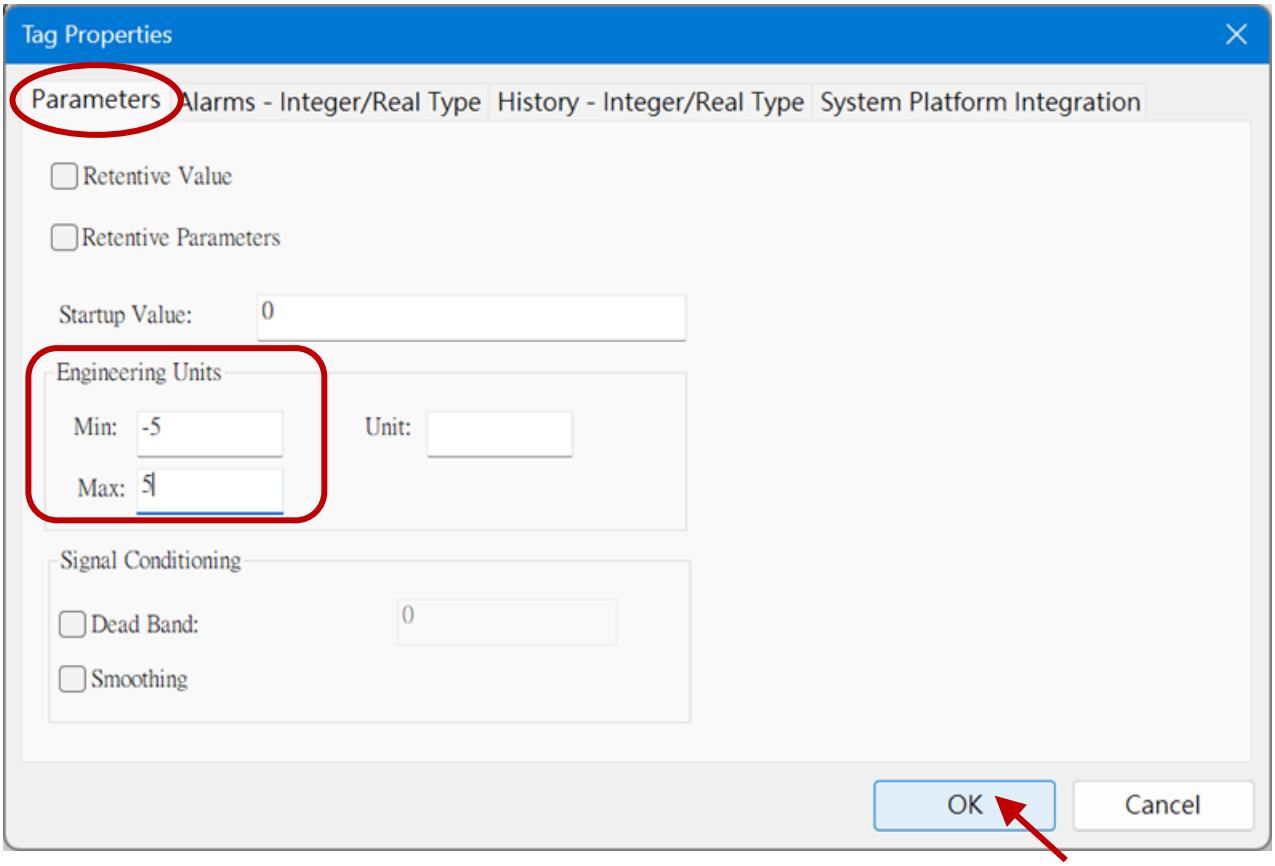
If the M-7026 module's analog format is set to **2's Complement** using DCON Utility Pro, the data will be in hexadecimal as shown in the table (see Appendix B.5). Therefore, it is necessary to convert the readings to actual values by means of engineering unit conversion.

Type Code	Input Range	Data Format	Min.	Max.
0x05	**+/-5 V**	2's complement HEX	**8000h**	**7FFFh**

Double-click **Datasheet View** to display the **Project Tags** page. Right-click on **AI0** and select **Tag Properties** to open the window.



On the **Parameters** tab, enter a minimum value of **-5** and a maximum value of **5** in the **Engineering Units** area. Also, set the AO tag in the same way.



Refer to the table below to set the AI and AO worksheets. (The DI and DO worksheets are the same as described in the previous section.)

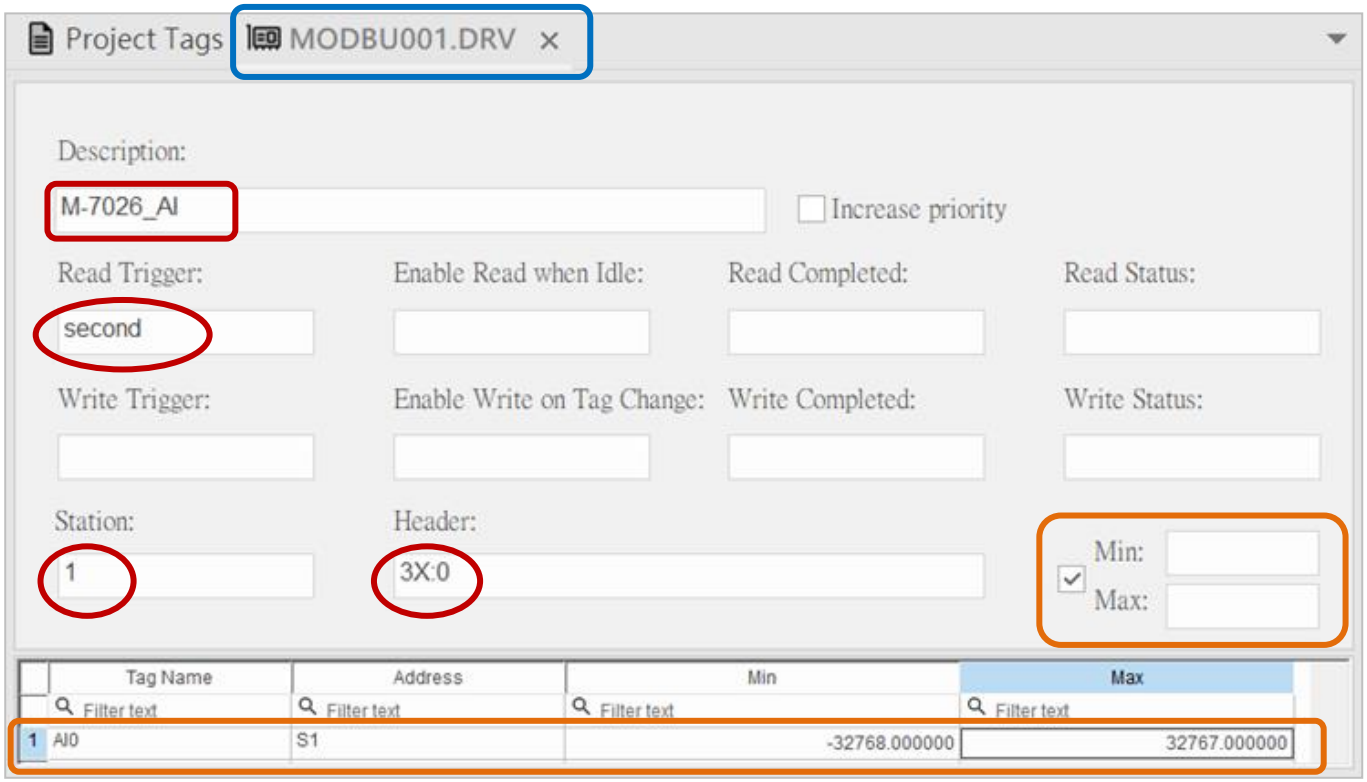
M-7026_AI:

Read Trigger	Station	Header	Min/Max
second	1	3X:0	Checked

Note:

If the Min/Max field is filled in, all tags in the MODBU001 worksheet will be converted based on that value. To convert each tag individually, leave the field empty. When the Min/Max option is selected, the field name will automatically change to Min/Max. Set the parameters as shown in the table below.

Tag Name	Address	Min	Max
AI0	S1	-32768	32767

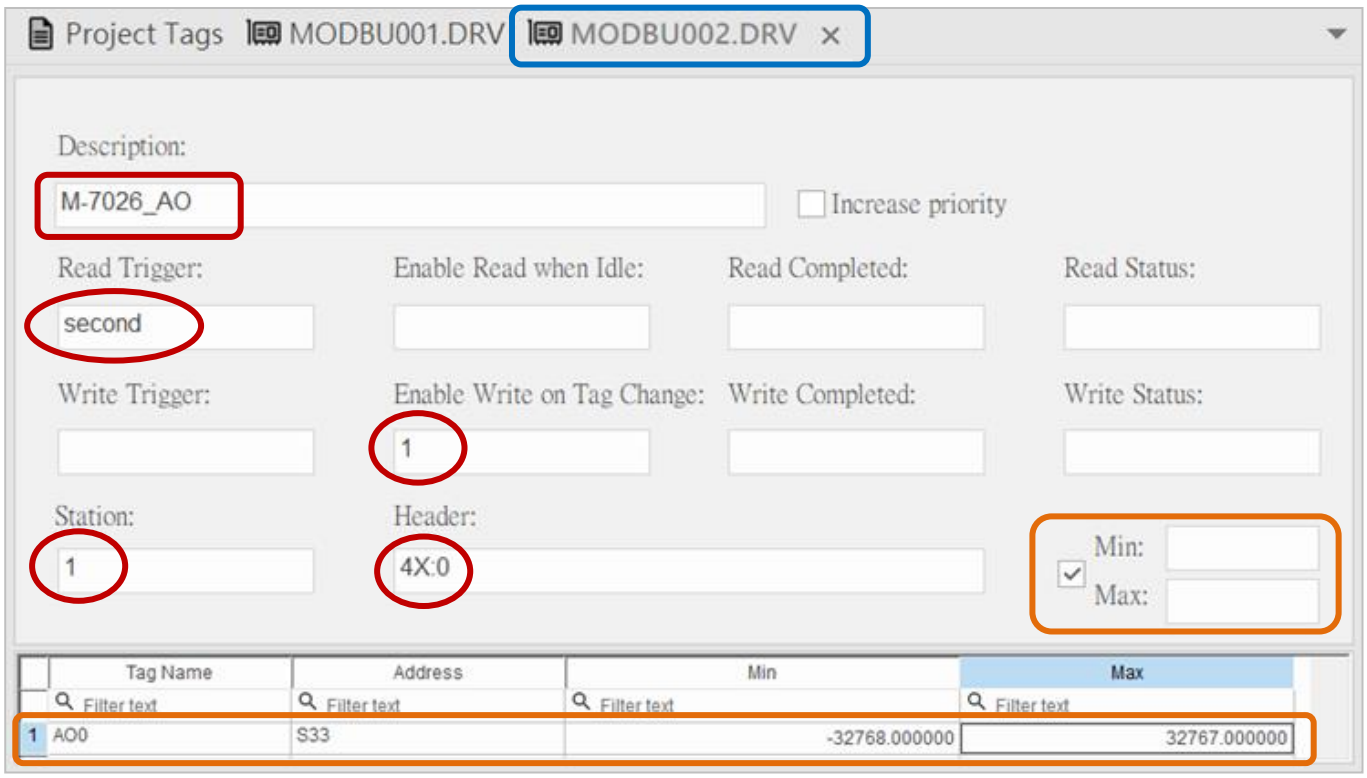


M-7026_AO:

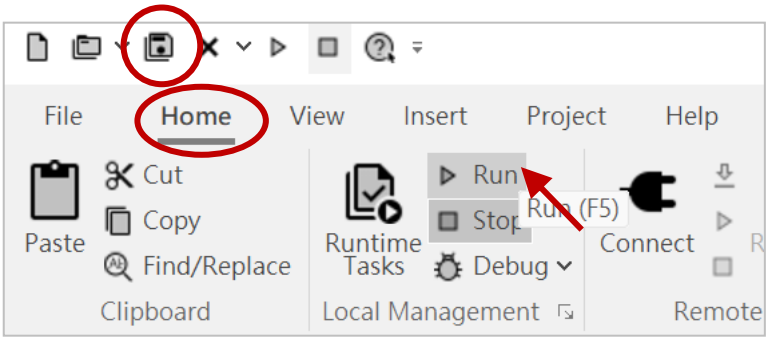
Set the parameters as shown in the table below.

Read Trigger	Enable Write on Tag Change	Station	Header	Min/Max
second	1	1	4X:0	Checked

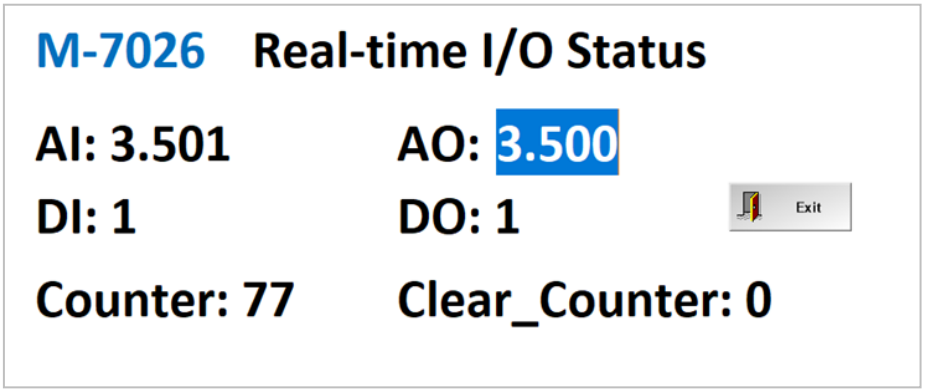
Tag Name	Address	Min	Max
AO0	S33	-32768	32767



Click "**Save All**" in the upper-left corner, then click "**Run**" on the **Home** ribbon to start the runtime task.



The user can enter an AO value, set the DO to '**1**' (ON), or set the Clear_Counter to '**1**' to view the data change.



Note: Click the "**Exit**" button or press **Alt + Tab** to return to the software interface, then click "**Stop**" on the **Home** ribbon.

Chapter 7 Application Notes

7.1 Common Descriptions

7.1.1 Module Output Status

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf
3: I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf
7: I-7016(D)_I-7016P(D)_en.pdf
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L_ M-7024R_M-7024U(D)_M-7028_en.pdf

A "**power-on reboot**" or a "**module watchdog reboot**" will reset all outputs to their predefined **Power-on Values**. At this point, the module can receive commands from the host to change the output values. However, if a "**host watchdog timeout**" occurs, a flag will be set, and all outputs will be set to the Safe Values. In this state, the module will ignore output commands, and the LED on the module will blink.

Users can use the command **~AA0** to read the module status, where **04** indicates that the "host watchdog timeout" status has been set. The command **~AA1** can be used to clear the "host watchdog timeout" status, allowing the module to accept output commands again.

7.1.2 Reset Status

Index of the Manual (Ch4)
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L _M-7024R_M-7024U(D)_M-7028_en.pdf
11: M-7084_en.pdf
12: I-7088(D)_M-7088(D)_en.pdf
13: I-7000_M-7000_DIO_en.pdf (7041 ~ 7069)

When the module powers on or reboots due to the module watchdog mechanism, the reset status flag will be set. This status will be cleared after responding to the **$AA5** command (if it is the first time the reset status is detected). This can be used to check whether the module has rebooted. If the $AA5 command response indicates that the reset status is cleared, it means the module has not rebooted since the last $AA5 command was sent.

If the $AA5 command response indicates that the reset status is set, and it is not the first time the $AA5 command has been sent after power-on, this means the module has rebooted due to the "module watchdog mechanism," and the output values have been reset to the Power-on Values.

7.1.3 Dual Watchdog Operation

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf
2: I-7017_I-7018_I-7019_M-7017_M-7018_M-7019_en.pdf
3: I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf
4: I-7005_M-7005_en.pdf
6: I-7013_I-7015_I-7033_M-7015_M-7033_en.pdf
7: I-7016(D)_I-7016P(D)_en.pdf
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L_ M-7024R_M-7024U(D)_M-7028_en.pdf
11: M-7084_en.pdf
12: I-7088(D)_M-7088(D)_en.pdf
13: I-7000_M-7000_DIO_en.pdf (7041 ~ 7069)

Dual Watchdog = Module Watchdog + Host Watchdog

The module **watchdog** is a hardware reset circuit designed to monitor the module's operating status. In harsh or high-noise environments, the module may be affected by external signals and stop functioning. This circuit ensures that the module continues to operate without interruption.

The **host watchdog** is a software feature used to monitor the host's operating status. Its purpose is to prevent issues caused by network/communication errors or host failures. When a host watchdog timeout occurs, the module switches all outputs to Safe Values to prevent any unexpected conditions in the controlled devices.

The **I-7000/M-7000 series modules** are equipped with a dual watchdog mechanism, enhancing the stability and reliability of the control system.

7.1.4 Frame Ground (F.G.)

Index of the Manual (Ch4)
2: I-7017_I-7018_I-7019_M-7017_M-7018_M-7019_en.pdf
4: I-7005_M-7005_en.pdf
6: I-7013_I-7015_I-7033_M-7015_M-7033_en.pdf
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L_ M-7024R_M-7024U(D)_M-7028_en.pdf
11: M-7084_en.pdf
12: I-7088(D)_M-7088(D)_en.pdf
13: I-7000_M-7000_DIO_en.pdf (7041 ~ 7069)

Electronic circuits are highly susceptible to electrostatic discharge (ESD), especially in continental climate regions where the impact is more severe. Some I-7000 modules and all M-7000 modules adopt a frame grounding design. This design provides a bypass path for electrostatic discharge, effectively enhancing ESD protection and improving the reliability of the modules.

Either of the following methods can enhance the protection of the module:

1. If the module is installed on a DIN rail, ensure that the DIN rail is grounded, as it will be in contact with the upper frame ground (F.G.). (See the diagram on the right.)
2. Connect a wire to the lower frame ground (F.G.) terminal and ground the wire.

ICP DAS offers DIN rails that can be easily connected to a grounding terminal. Each model is made of stainless steel, which is more durable than aluminum. As shown in the diagram, one end features a screw and includes a ring terminal.

Visit the website for more information about the “DIN rail” product.
https://www.icpdas.com/en/product/guide+Accessories+Others+DIN-Rail

Model	Description
DRS-125	125mm Length, Stainless 35mm DIN-Rail
DRS-240	240mm Length, Stainless 35mm DIN-Rail
DRS-360	360mm Length, Stainless 35mm DIN-Rail

7.2 Descriptions of AI and AO

7.2.1 Hexadecimal Data Conversion

Index of the Manual (Ch4)
2: I-7017_I-7018_I-7019_M-7017_M-7018_M-7019_en.pdf

There are two types of **hexadecimal conversions**: one for **4 ~ 20mA** and **0 ~ 20mA** data ranges, and another for other data ranges (e.g., **±10V, ±20mA**).

1) 4 ~ 20mA and 0 ~ 20mA Data Ranges

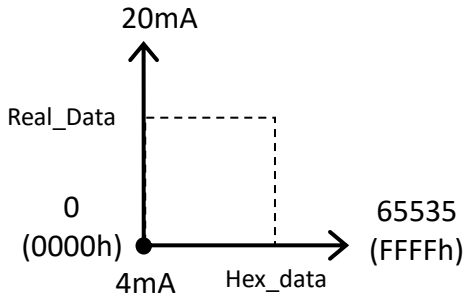
0000h corresponds to the **minimum value**, and **FFFFh** corresponds to the **maximum value**.

The formula for data conversion is:

$$\text{Real\_Data} = \frac{\text{Hex\_Data} \times (\text{Maximum} - \text{Minimum})}{65535} + \text{Minimum}$$

For example, for a **4 ~ 20mA** data range, the formula is:

$$\text{Real\_Data} = \frac{\text{Hex\_Data} \times (20.0 - 4.0)}{65535} + \text{Minimum}$$



2) Other Data Ranges

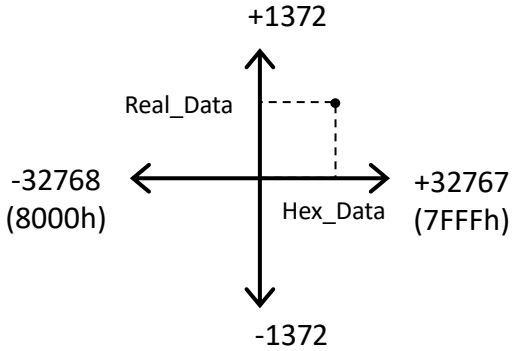
8000h (-32768) corresponds to **-Max**, **0000h (0)** corresponds to **0**, **7FFFh (32767)** corresponds to **+MAX**, where **Max** is the absolute value of the minimum or maximum range, whichever is greater.

The formula for data conversion is:

```
If Hex_Data >= 0 then
  Real_Data = Hex_Data * MAX / 32767
else
  Real_Data = Hex_Data * MAX / 32768
```

For example, for a thermocouple K Type of -270 ~ 1372°C, **MAX = 1372**, the formula is:

```
If Hex_Data >= 0 then
  Real_Data = Hex_Data * 1372.0 / 32767
else
  Real_Data = Hex_Data * 1372.0 / 32768
```



7.2.2 High/Low Alarm

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf 3: I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf 7: I-7016(D)_I-7016P(D)_en.pdf

Some analog input modules (e.g., I-7012) include an upper/lower limit alarm function. When this function is enabled, DO0 serves as the lower limit alarm, and DO1 as the upper limit alarm. As a result, DO commands to change the DO status will be ignored. The alarm function compares the AI value against the specified upper and lower alarm limits. The two types of alarms are described below.

Momentary Alarm：

When the AI value exceeds the alarm limit, the alarm is triggered. If the AI value returns within the specified range, the alarm is automatically deactivated.

If AI value > upper alarm value, DO1 (upper limit alarm) turns ON ; otherwise, DO1 remains OFF.
If AI value < lower alarm value, DO0 (lower limit alarm) turns ON; otherwise, DO0 remains OFF.

Latch Alarm：

When the AI value exceeds the alarm limit, the alarm is triggered. The alarm remains latched even if the AI value returns to normal. A manual reset or command is required to deactivate the alarm.

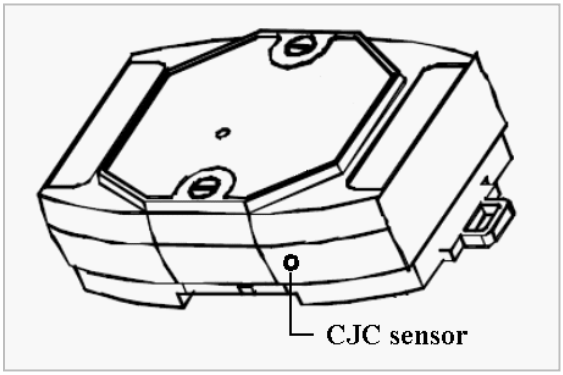
If AI value > upper alarm value, (upper limit alarm) turns ON.
If AI value < lower alarm value, DO0 (lower limit alarm) turns ON.

7.2.3 Thermocouple

Index of the Manual (Ch4)
2: I-7017_I-7018_I-7019_M-7017_M-7018_M-7019_en.pdf 3: I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf

When two wires composed of dissimilar homogeneous metals are joined at one end, a thermoelectric electromotive force (emf) appears that depends only on the metals and the junction temperature. This is called the Seebeck effect. A pair of different metals with a fixed junction at one end constitutes a **thermocouple**. For small changes in temperature, the emf is linearly proportional to the temperature. This implies that the temperature reading can be obtained by measuring the emf.

We cannot measure the emf, V_1, directly because when a voltmeter is connected to the thermocouple, another emf, V_2, is created at the (cold) junction of the thermocouple and the voltmeter. The cold junction compensation method is used to resolve the problem. Using another sensor, e.g. a thermistor, to measure the cold junction temperature, T_2, we can calculate the emf, V_2, which corresponds to T_2. The thermocouple emf, V_1, can be obtained by adding V_2 to that measured by the voltmeter and then the temperature.



7.2.4 Resistance Measurement

Index of the Manual (Ch4)
4: I-7005_M-7005_en.pdf
6: I-7013_I-7015_I-7033_M-7015_M-7033_en.pdf

The I-7005, M-7005, I-7013(D), M-7013(D), I-7015/15P, M-7015/15P, I-7033(D), and M-7033(D) modules support resistance measurement. Before measuring the resistance, check the thermistor wiring in the Data Sheet for these modules. Then, set the Analog Format to "**Ω**" on the "Configuration" page of the DCON Utility Pro, or send %AANNTTCCFF command to the module to change the data format. (refer to manuals No. 4 & 6).

For I-7005, M-7005:

For firmware version A2.3 (or older), the maximum resistance that can be measured is 180,000 Ω.
For firmware version A3.7 (or later), the maximum resistance that can be measured is 204800 Ω.

When the Analog Format is set to "**Ω**", the maximum measurable resistance for type codes 71 to 77 is as follows:

Type Code	Maximum Resistance
71	3200 Ω
72	6400 Ω

Type Code	Maximum Resistance
73	12800 Ω
74	25600 Ω
75	51200 Ω
76	102400 Ω
77	204800 Ω

For M-7015/15P and M-7033(D) modules with firmware version B2.9 or older, it has to be switched to DCON protocol for resistance measurement.

For I-7013(D), M-7013P(D):

Type Code	Maximum Resistance	Firmware Version
82	200 Ω	Only available for B1.5 (or later)
20 ~ 29	375 Ω	-
2A	3200 Ω	Only available for B1.3 (or later)

For I-7033(D), M-7033(D):

Type Code	Maximum Resistance	Firmware Version
82	200 Ω	Only available for B1.5 (or later)
20 ~ 29	375 Ω	-
2A	3200 Ω	-

For I-7015/15P、M-7015/15P :

Type Code	Maximum Resistance	Firmware Version
2B, 2C	160 Ω	Only available for A2.9 (or older)
20 ~ 29	320 Ω	
2A, 2D	3000 Ω	

Type Code	Maximum Resistance	Firmware Version
2B, 2C	200 Ω	Only available for B1.9 (or later)
20 ~ 29	375 Ω	
2A, 2D	3200 Ω	

7.2.5 Transmitter

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf

A **transmitter** is an instrument that converts a sensor signal into a **4 - 20mA** or **0 - 5V** output signal. Transmitters may include driving or compensation circuits for the sensor, with an output that has been linearized and amplified.

- **2-wire transmitter** – Typically outputs a 4 - 20mA current signal. One wire is for power input, and the other is for signal output.
- **3-wire transmitter** – Typically outputs a 0 - 5V voltage signal. One pair of wires is for power input and ground, while the third wire is for signal output.

7.2.6 Linear Mapping

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf
7: I-7016(D)_I-7016P(D)_en.pdf

The linear mapping function converts an input value into a desired output value. It is a mechanism that transforms an analog input value into a physical quantity.

Linear mapping uses the following reference values:

- **Source Low Value (SL) → Target Low Value (TL)**
- **Source High Value (SH) → Target High Value (TH)**

For an **input value (AI)**, the output value is calculated as:

```
if AI < SL, output value = -19999. (under limit)
    else if AI > SH, output value = +19999. (over limit)
        else output value = (AI-SL)/(SH-SL) * (TH-TL) + TL
```

Suppose a **temperature sensor** is connected to an **I-7014D** module, where the sensor outputs 4mA at 0°C and 20mA at 100°C**.** To read the temperature directly, we have the source value **4 to 20 mA** and target value **0 to 100°C**. Additionally, assume the **I-7014D module** is configured to address = 01, baud rate = 9600 bps, and checksum disabled.

1. Set the I-7014D to read ±20 mA type.
   See Chapter 4: Commands Manual - **%AANNTTCCFF**
   Command: **%01010D0600** Response: !01

2. Set the Source Low Value (SL) to “4” and Source High Value (SH) to “20”.
   See Chapter 4: Commands Manual - **$AA6(SL)(SH)**
   Command: **$016+04.000+20.000** Response: !01

3. Set the Target Low Value (TL) to “0” and Target High Value (TH) to “100”.
   See Chapter 4: Commands Manual - **$AA7(TL)(TH)**
   Command: **$017+000.00+100.00** Response: !01

4. Enable the linear mapping function.
   See Chapter 4: Commands Manual - **$AAAV**
   Command: **$01A1** Response: !01

5. Using the **#01** command to read the temperature value of I-7014D directly.
   See Chapter 4: Commands Manual - **#AA**

7.2.7 Analog Output

Index of the Manual (Ch4)
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L_ M-7024R_M-7024U(D)_M-7028_en.pdf

Besides being set by analog output commands, the analog outputs can also be controlled under two additional conditions. When the host watchdog is enabled and a host watchdog timeout **(host WDT**) occurs, the system loads the **safe value** into the analog output ports. The ***analog output commands*** have no effect on the analog output ports until the **host WDT status** is cleared.

The host WDT status is stored in the EEPROM and remains unchanged even after a power-on reset. Users can clear this status through the Host **WDT** setting page in DCON Utility Pro or the **~AA1** command (see Chapter 4 of the command manual for details).

When the module is powered on, If the host WDT status is cleared, the system loads the **power-on value** into the analog output ports. If It is not cleared, the **safe value** is loaded instead.

Users can configure the **power-on value** and **safe value** through the AO setting page in DCON Utility Pro or the following commands.

Model	Set “Safe Value” Command
I-7021, I-7021P	~AA5
I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024L, M-7024R, M-7024U, M-7028	~AA5N

Model	Set “Power-on Value” Command
I-7021, I-7021P	$AA4
I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024L, M-7024R, M-7024U, M-7028	$AA4N

When the module receives the analog output command - #AA(data) or #AAN(data),

- If the Host WDT status is not cleared, the module will respond with **"!"**, indicating that the command is ignored due to the WDT status.
- If the Host WDT status is cleared, the module will respond with **">"**, confirming that the command was successful and the analog output has been processed.
- If the specified output value exceeds the upper limit of the acceptable range, the module will respond with **"?"**, indicating that the value is out of range. In this case, the analog output will be set to the lower limit as a safeguard.

7.2.8 Slew Rate Control

Index of the Manual (Ch4)
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L_ M-7024R_M-7024U(D)_M-7028_en.pdf

Usually, the output of an analog output module changes instantaneously. That is, when the module receives an output command, its output changes to the specified value immediately. However, it may require that the output change to the specified value gradually in some applications. The slew rate control is to adjust the output change rate.

The I-7021, I-7021P, I-7022, M-7022, I-7024, M-7024, M-7024L, I-7024R, M-7024R, M-7024U, and M-7028 modules support programmable slew rate control. When an analog output command is received, the analog output will change to the new value in the specified slew rate automatically. These modules update the analog output every 10 ms. The analog output is updated smoothly until it reaches the specified output value.

7.2.9 Analog Output Read-back

Index of the Manual (Ch4)
8: I-7021_I-7021P(D)_I-7022_I-7024_I-7024R_M-7022_M-7024_M-7024L_ M-7024R_M-7024U(D)_M-7028_en.pdf

The I-7021/21P, I-7022, and M-7022 modules have the analog-to-digital converter that can be used to monitor the analog output signal and provide the analog output read- back. If the difference between the specified analog output value and the analog output read-back value is large, then it could be improper wire connection or load.

In contrast, the I-7024, M-7024, M-7024L, I-7024R, M-7024R, M-7024U, and M-7028 modules do not have the analog-to- digital converter to monitor the analog output signal. However, they can respond the value that is set to the digital-to-analog converter. This value cannot be used to check improper wire connection and load.

7.3 Descriptions of DI and DO

7.3.1 Digital Input and Event Counter

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf 3: I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf 7: I-7016(D)_I-7016P(D)_en.pdf

The digital input DI0 can function as an event counter. The counter increments when the input transitions from a high level to a low level. It is 16 bits wide, making it suitable for low-speed counting, with a frequency of less than 50 Hz.

7.3.2 Digital Output

Index of the Manual (Ch4)
1: I-7012(D)_I-7012F(D)_I-7014D_I-7017_I-7017F_en.pdf 3: I-7011(D)_I-7011P(D)_I-7018_I-7018P_en.pdf 7: I-7016(D)_I-7016P(D)_en.pdf

When the module powers on, it first checks the **host watchdog timeout status.** If the status is set, the digital outputs (DO0 and DO1) are set to Safe Value. If the status is clear, the digital outputs are set to the **Power-On Value**. If the host watchdog timeout status is set, the module will ignore the digital output command @AADO(Data).

7.3.3 Safe Value and Power-on Value of Digital Output

Index of the Manual (Ch4)
13: I-7000_M-7000_DIO_en.pdf (7041 ~ 7069)

Besides being set by DO commands, the digital outputs can also be controlled under two additional conditions. When the host watchdog is enabled and a host watchdog timeout **(host WDT**) occurs, the system loads the **safe value** into the DO ports. The **DO commands** have no effect on the DO ports until the **host WDT status** is cleared.

The host WDT status is stored in the EEPROM and remains unchanged even after a power-on reset. Users can clear this status through the Host **WDT** setting page in DCON Utility Pro or the **~AA1** command (see Chapter 4 of the command manual for details). When the module is powered on, if the host WDT status is cleared, the system loads the **power-on value** into the DO ports. If It is not cleared, the **safe value** is loaded instead. Users can configure the power-on value and safe value through the DO setting page in DCON Utility Pro or the **~AA5V** commands.

7.3.4 D/O Operation Principle

Index of the Manual (Ch4)
9: I-7080(D)_I-7080B(D)_en.pdf

1. Description of DO Usage
   DO0 or DO1 can function as a digital output (DO) or alarm output as follows:
   - In Frequency mode, it functions as a standard digital output.
   - In Counter mode, when the alarm is disabled (using the @AADA or @AADAN command), it functions as a standard digital output.
   - In Counter mode, when the alarm is enabled (using the @AAEAT or @AAEAN command), it functions as an alarm output.

Mode	DO 0	DO 1
Frequency Mode	DO 0	DO 1
Counter Mode & Alarm Disabled	DO 0	DO 1
Counter Mode & Alarm Enabled (**Alarm Mode 1**, ~AAA1)	High-alarm on Counter 0	High-High alarm on Counter 0
Counter Mode & Alarm Enabled (**Alarm Mode 0**, ~AAA0；Enable ch**0** @AAEA0)	Alarm on Counter 0	DO 1 or Alarm on Counter 1
Counter Mode & Alarm Enabled (**Alarm Mode 0**, ~AAA0；Enable ch**1** @AAEA1)	DO 0 or Alarm on Counter 0	Alarm on Counter 1

2. The DO status of the I-7080 and I-7080D modules is off when powered on for the first time.

3. The DO will change to the desired status upon receiving the “@AADO” command. Once set, all the DOs will remain in the same state until the next “@AADO” command is received.

4. If the host watchdog is activated, the DOs will not change, and the module status will be set to '04'. In this case, the “@AADO” command sent from the host will be ignored, and the module will return '!' as a warning. The host can use the “~AA1” command to clear the module status to 0, after which the I-7080 and I-7080D modules will be able to accept the '@AADO' command again.

5. If the DO is configured as alarm output, the module will control the ON/OFF state automatically. Therefore, the “@AADO” command will be ignored in this condition.

7.4 Descriptions of Counter, Frequency, and Encoder

7.4.1 Counter/Frequency Input Mode Selection

Index of the Manual (Ch4)
9: I-7080(D)_I-7080B(D)_en.pdf

The counter/frequency input can be configured as either an isolated or non-isolated signal, and Channels 0 and 1 can be set independently. There are four different input modes available for both the I-7080 and I-7080D modules, as described below.

Input Mode	Command	Channel 0	Channel 1
Input mode 0	$AAB0	Non-isolated	Non-isolated
Input mode 1	$AAB1	Isolated	Isolated
Input mode 2	$AAB2	Non-isolated	Isolated
Input mode 3	$AAB3	Isolated	Non-isolated

7.4.2 Frequency Measurement

Index of the Manual (Ch4)
11: M-7084_en.pdf

Frequency is usually measured in one of two ways:

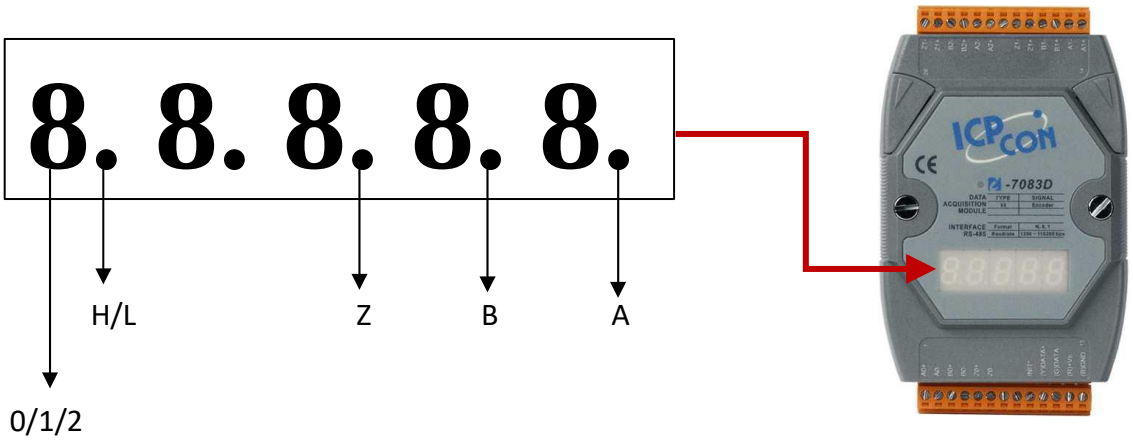
1. by counting the number of signal pulses over a known time interval (gate time).
2. **by counting the number of pulses in the reference clock over the signal period.**

The M-7084 uses the second method for frequency measurement, which counts the number of reference clock pulses during one signal period. The drawback of this method is that its resolution decreases as the frequency increases. To improve resolution, the M-7084 offers a high-frequency measurement mode that counts 11 signal periods instead of just one. The high-frequency measurement mode can be enabled using the **@AAFHVV** command. Refer to the Ch4 commands manual or the Ch3 Settings Page - Counter Value.

The side effects of the high-frequency measurement mode are longer measurement times and the potential for counting overflow when the signal frequency is very low. The M-7084 can switch to automatic frequency measurement mode using the **@AAFAVV** command. (Refer to the Ch4 commands manual). In automatic frequency measurement mode, the channel automatically switches to the high-frequency measurement mode when the signal frequency is high, and to the low-frequency measurement mode when the signal frequency is low.

7.4.3 LED Display Format

Index of the Manual (Ch4)
10: I-7083(D)_I-7083B(D)_en.pdf



The 5-digit 7-segment display will sequentially show the values of encoder 0/1/2, which are 8-byte hexadecimal values. The value will be displayed in two parts: the first display shows **0.** (decimal point on) **+ Bytes 8 to 5** of the value, and the second display shows **0** (decimal point off) **+ Bytes 4 to 1** of the value. As shown below:

Encoder **0**	Step 1：0.+ Byte 8 + Byte 7 + Byte 6 + Byte 5
	Step 2：0 + Byte 4 + Byte 3 + Byte 2 + Byte 1
Encoder **1**	Step 3：1. + Byte 8 + Byte 7 + Byte 6 + Byte 5
	Step 4：1 + Byte 4 + Byte 3 + Byte 2 + Byte 1
Encoder **2**	Step 5：2. + Byte 8 + Byte 7 + Byte 6 + Byte 5
	Step 6：2 + Byte 4 + Byte 3 + Byte 2 + Byte 1

The last 3-digit with the decimal point are used to represent the Hi/Lo status of Z, B, and A, respectively. For example: Ch0 = 1234ABCD, B = Hi.

Channel		Encoder Value				
			-	Z	B	A
Encoder **0**	0.	Bytes 8 to 5	1	2	3.	4
	0	Bytes 4 to 1	A	B	C.	D

Index of the Manual (Ch4)
For the following subjects: 10: I-7083(D)_I-7083B(D)_en.pdf

7.4.4 Encoder & Synchronous Encoder

The encoder will continuously count until it receives the next **#**** command, at which point the synchronized encoder will latch the data. The user must read the encoder and synchronized encoder one by one. Therefore, there will be a time delay between each read operation. When the host computer sends the #** command to the RS-485 network, all 7083/7083B devices in the network will latch their synchronized encoders simultaneously. Then, the host computer can read these synchronized encoders one by one. Refer to the Ch4 commands manual or the Ch3 Settings Page - Encoder.

7.4.5 Preset Value of Encoder

The **@AAPN(data)** can be used to set the preset value of encoder. The value is saved in the EEPROM. When the power is turned on, the preset value will be loaded from the EEPROM and set as the encoder's starting value.

For the 7083**B** module, the current encoder value will be stored as the preset value in EEPROM when the power is turned OFF. When the next time the power is turned ON, the preset value will be reloaded from EEPROM. That is to say, the encoder value will not be lost (nonvolatile) even if the power is turned OFF. The 7083B can use the **$AADNM** command to set the L-bit to 0 to disable the function of retaining data during a power failure. Refer to the Ch4 commands manual or the Ch3 Settings Page - Encoder.

For the 7083 module, this function is not supported, so the starting value of the encoder is always the same as the preset value in the EEPROM, and the L-bit has no effect.

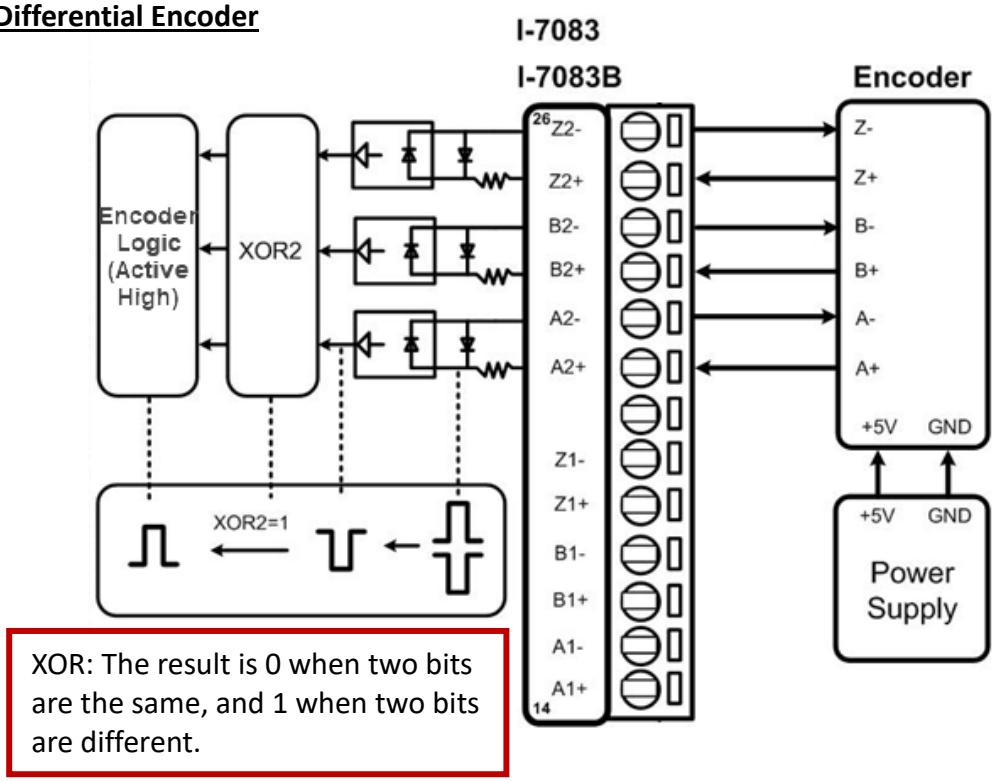
7.4.6 Encoder Counting Sequence

The encoder is a 32-bit up/down counter with no overflow. If counting down (-), receiving 0x00000000 will change it to 0xffffffff. If counting up (+), receiving 0xffffffff will change it to 0x00000000. There is no overflow condition.

7.4.7 XOR Control Bit Setting

The module's internal logic is designed for active-high operation. Therefore, the XOR control bit should be set to "**1**" in most applications.

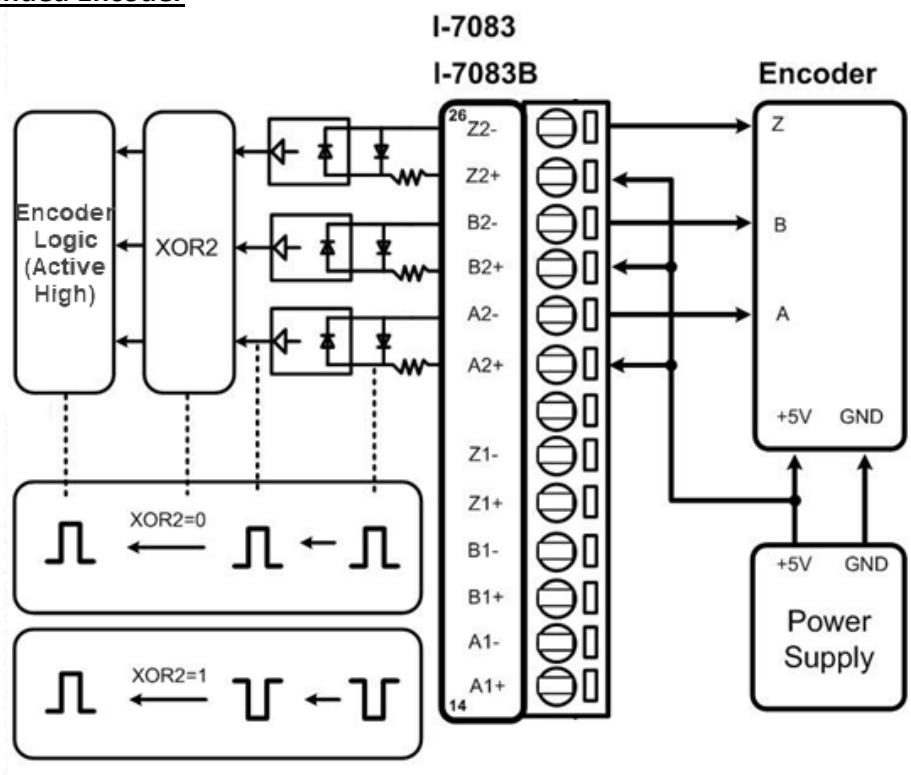
5V Differential Encoder



XOR: The result is 0 when two bits are the same, and 1 when two bits are different.

If the input signal is **single-ended and active-high**, the XOR control bit must be set to "**0**" for proper operation.

5V Single-ended Encoder



If the XOR bit is set incorrectly, the encoded value may exhibit the following errors.

- The counting direction will be **reversed**.
- The encoder value will have an **error count of 1**.
- The **Z signal** will be **inverted**.

The user can use **$AASN** command to check the status of A, B, Z. All **A, B,** and **Z** signals are expected to be **Low** in the normal state and **High** in the active state. The check sequences are as follows:

Step	Command	Response
1	$01S0	!01M0
2	$01S1	!01M0
3	$01S2	!01M0

M= Mode

For example,

Command	Response
$01S0	!0150

01 (hex) indicates the module's Net-ID **50** (hex) can be represented as 0101 0000 (binary)

L	X	C	C	0	Z	B	A
0	1	0	1	0	**0**	**0**	**0**

L = 0: Do not update the preset value
1: Update the preset value
(Refer to Section 7.4.5 – Preset Value of Encoder)

X = XOR Control bit = 0 or 1

CC = Counting mode
00: Stop counting
01: Up/Down (CW/CCW) Counting Mode
10: Pulse/Direction Counting
11: AB phase (Quadrant) counting mode

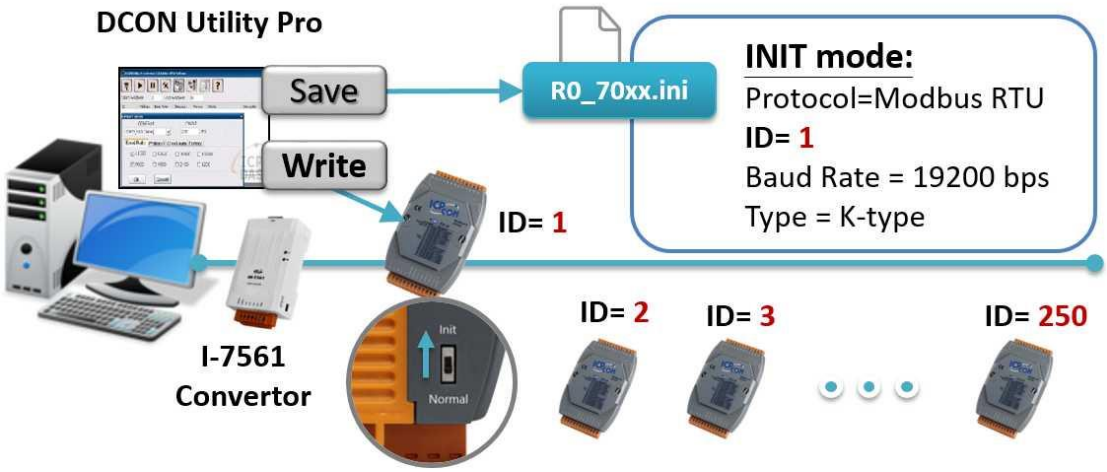
Z、B、A = 0: Low；1: High

Appendix A DCON Utility Pro – FAQ

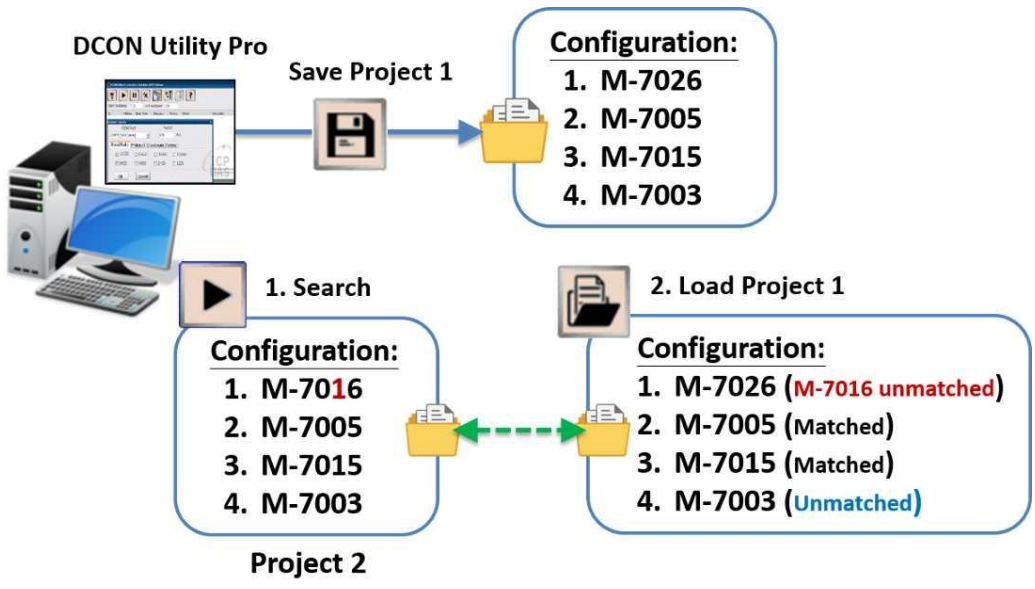
Users can click the “FAQ” button in DCON Utility Pro to view descriptions of the functions.

Visit the ICP FAS website to view the latest FAQ:
https://www.icpdas.com/en/product/guide+Software+Utility_Driver+DCON__Utility__Pro#1243

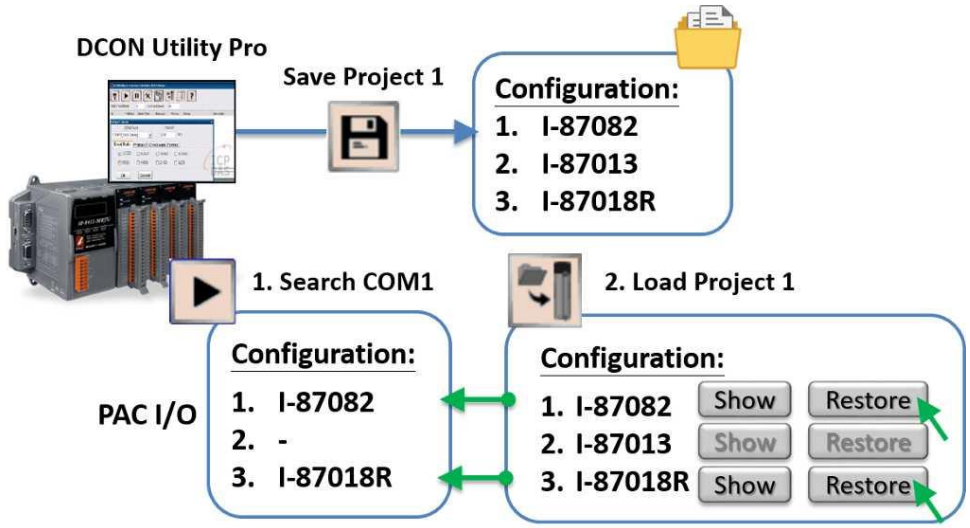
Usage	
DCON_01_001	How to configure a large amount of remote io in INIT state?



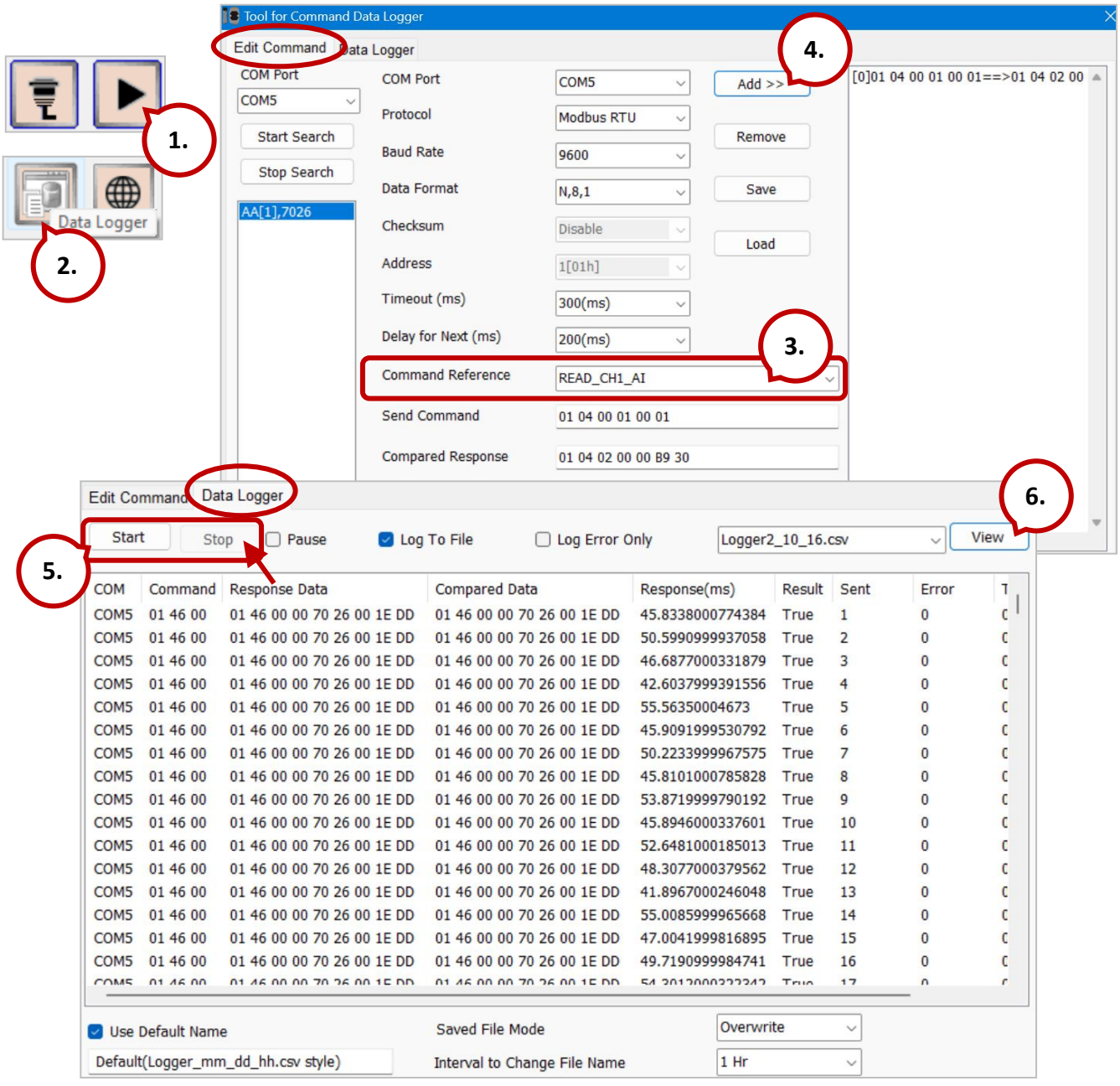
DCON_01_002	How to manage and maintain all configured modules by using Save/Load project function?

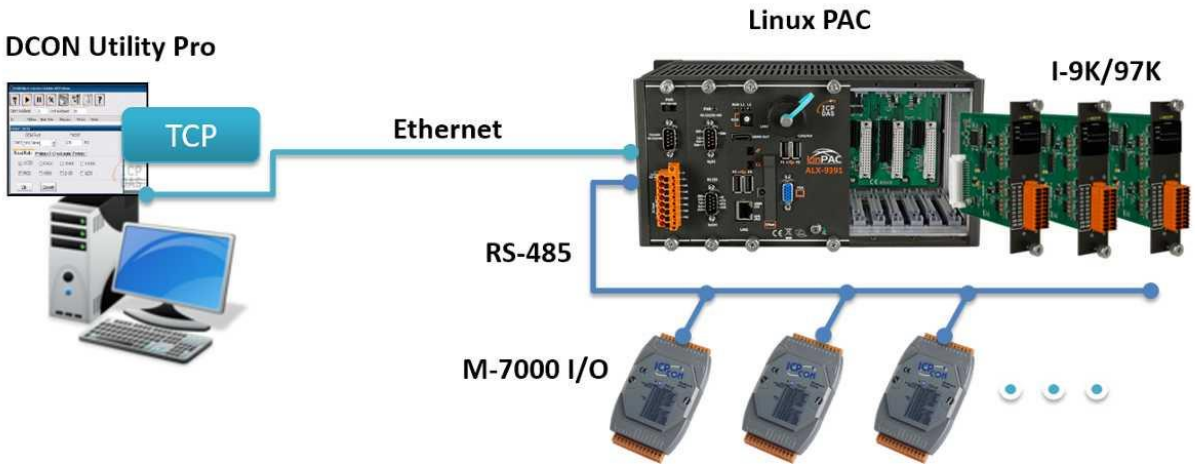


DCON_01_003	How to backup and restore the I-87K module on PAC system?



DCON_01_004	How to use Data Logger function?



DCON_01_005	How to query the commands used by the module through DCON Utility Pro?
DCON_01_006	How to use multi-language?
DCON_01_007	How to use DCON_Utility Pro to configure modules on Linux PAC platform?
	
DCON_02_001	How to establish a reliable and safety system by using Safe Value and Host Watchdog?
DCON_02_002	How to catch the DI module ON OFF signal of distributed system?
DCON_02_003	How to map GPS receiver module data to Google_Map?
DCON_02_004	How to configure the network settings for module with hardware configuration dip switch?
DCON_02_005	How to set the User define type for NTC thermistor thermometer?
DCON_02_006	What are the differences between I-87KN, RU-87PN, USB-87PN and ET-87PN settings?
DCON_02_007	How to upgrade from I-87KN to RU-87PN?
Troubleshooting	
DCON_03_001	How to solve the problem of NET Framework causing the PC fail to run DCON Utility Pro?
DCON_03_002	How to solve the problem that the RS-485 network cannot find the modules?

Appendix B Type Code for AI Values (Modbus Protocol)

When using the DCON or Modbus protocol, the data range for conversion may vary, even for the same type code. Refer to the table to determine the correct data range based on the selected protocol.

B.1 M-7013P, M-7013PD

Type Code	RTD Type	Data Format	Min.	Max.
0x20	Platinum 100 α = 0.00385 -100 ~ 100°C	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x21	Platinum 100 α = 0.00385 0 ~ 100°C	Engineering unit	0	10000
		2's complement HEX	0000	7FFF
0x22	Platinum 100 α = 0.00385 0 ~ 200°C	Engineering unit	0	20000
		2's complement HEX	0000	7FFF
0x23	Platinum 100 α = 0.00385 0 ~ 600°C	Engineering unit	0	6000
		2's complement HEX	0000	7FFF
0x24	Platinum 100 α = 0.003916 -100 ~ 100°C	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x25	Platinum 100 α = 0.003916 0 ~ 100°C	Engineering unit	0	10000
		2's complement HEX	0000	7FFF
0x26	Platinum 100 α = 0.003916 0 ~ 200°C	Engineering unit	0	20000
		2's complement HEX	0000	7FFF
0x27	Platinum 100 α = 0.003916 0 ~ 600°C	Engineering unit	0	6000
		2's complement HEX	0000	7FFF
0x28	Nickel 120 -80 ~ 100°C	Engineering unit	-8000	10000
		2's complement HEX	999A	7FFF
0x29	Nickel 120 0 ~ 100°C	Engineering unit	0	10000
		2's complement HEX	0000	7FFF
0x2A	Platinum 1000 α = 0.00385 -200 ~ 600°C	Engineering unit	-2000	6000
		2's complement HEX	D556	7FFF

Type Code	RTD Type	Data Format	Min.	Max.
0x2E	Platinum 100 α = 0.00385 -200 ~ 200°C	Engineering unit	-20000	20000
		2's complement HEX	8000	7FFF
0x2F	Platinum 100 α = 0.003916 -200 ~ 200°C	Engineering unit	-20000	20000
		2's complement HEX	8000	7FFF
0x80	Platinum 100 α = 0.00385 -200 ~ 600°C	Engineering unit	-2000	6000
		2's complement HEX	D556	7FFF
0x81	Platinum 100 α = 0.003916 -200 ~ 600°C	Engineering unit	-2000	6000
		2's complement HEX	D556	7FFF

Under/Over Range Reading

Data Format	Under Range	Over Range
Engineering Unit	-32768	+32767
2's complement HEX	8000	7FFF

B.2 M-7015, M-7015P

The Modbus protocol's Engineering data format is available for the M-7015/15P with firmware version B202 or later, as shown in the table below.

Type Code	RTD Type	Data Format	Min.	Max.
0x20	Platinum 100 α = 0.00385 -100 ~ 100°C	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x21	Platinum 100 α = 0.00385 0 ~ 100°C	Engineering unit	0	10000
		2's complement HEX	0000	7FFF
0x22	Platinum 100 α = 0.00385 0 ~ 200°C	Engineering unit	0	20000
		2's complement HEX	0000	7FFF
0x23	Platinum 100 α = 0.00385 0 ~ 600°C	Engineering unit	0	6000
		2's complement HEX	0000	7FFF
0x24	Platinum 100 α = 0.003916 -100 ~ 100°C	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x25	Platinum 100 α = 0.003916 0 ~ 100°C	Engineering unit	0	10000
		2's complement HEX	0000	7FFF
0x26	Platinum 100 α = 0.003916 0 ~ 200°C	Engineering unit	0	20000
		2's complement HEX	0000	7FFF
0x27	Platinum 100 α = 0.003916 0 ~ 600°C	Engineering unit	0	6000
		2's complement HEX	0000	7FFF
0x28	Nickel 120 -80 ~ 100°C	Engineering unit	-8000	10000
		2's complement HEX	999A	7FFF
0x29	Nickel 120 0 ~ 100°C	Engineering unit	0	10000
		2's complement HEX	0000	7FFF
0x2A	Platinum 1000 α = 0.00385 -200 ~ 600°C	Engineering unit	-2000	6000
		2's complement HEX	D556	7FFF

Type Code	RTD Type	Data Format	Min.	Max.
0x2B	Cu 100 α = 0.00421 -20 ~ 150°C	Engineering unit	-2000	15000
		2's complement HEX	EEEF	7FFF
0x2C	Cu 100 α = 0.00427 0 ~ 200°C	Engineering unit	0	20000
		2's complement HEX	0000	7FFF
0x2D	Cu 1000 α = 0.00421 -20 ~ 150°C	Engineering unit	-2000	15000
		2's complement HEX	EEEF	7FFF
0x2E	Platinum 100 α = 0.00385 -200 ~ 200°C	Engineering unit	-20000	20000
		2's complement HEX	8000	7FFF
0x2F	Platinum 100 α = 0.003916 -200 ~ 200°C	Engineering unit	-20000	20000
		2's complement HEX	8000	7FFF
0x80	Platinum 100 α = 0.00385 -200 ~ 600°C	Engineering unit	-2000	6000
		2's complement HEX	D556	7FFF
0x81	Platinum 100 α = 0.003916 -200 ~ 600°C	Engineering unit	-2000	6000
		2's complement HEX	D556	7FFF
0x82	Cu 50 -50 ~ 150°C	Engineering unit	-5000	15000
		2's complement HEX	D556	7FFF
0x83	Nickel 100 -60 ~ 180°C	Engineering unit	-6000	18000
		2's complement HEX	D556	7FFF
0x84	Nickel 120 -80 ~ 150°C	Engineering unit	-8000	15000
		2's complement HEX	BBBC	7FFF
0x85	Cu 100 α = 0.00428 0 ~ 150°C	Engineering unit	0	15000
		2's complement HEX	0000	7FFF

Under/Over Range Reading

Data Format	Under Range	Over Range
Engineering Unit	-32768	+32767
2's complement HEX	8000	7FFF

B.3 M-7017/18/19 Series

The table below allows users to quickly review the supported type codes for each model.

Type	M-7017, M-7017R M-7017C, M-7017RC M-7017mC-16 M-7017RMS	M-7017R-A5	M-7018	M-7018R	M-7018Z	M-7019R M-7019Z
0x00 +/-15mV	-	-	●	●	●	●
0x01 +/-50mV	-	-	●	●	●	●
0x02 +/-100mV	-	-	●	●	●	●
0x03 +/-500mV	-	-	●	●	●	●
0x04 +/-1V	-	-	●	●	●	●
0x05 +/-2.5V	-	-	●	●	●	●
0x06 +/-20mA	-	-	●	●	●	●
0x07 4 ~ 20mA	B2.2 (*)	-	-	-	●	B2.7(*)
0x08 +/-10V	●	-	-	-	-	●
0x09 +/-5V	●	-	-	-	-	●
0x0A +/-1V	●	-	-	-	-	●
0x0B +/-500mV	●	-	-	-	-	●
0x0C +/-150mV	●	-	-	-	-	●
0x0D +/-20mA	● (*)	-		-	-	●
0x0E Type J	-	-	●	●	●	●
0x0F Type K	-	-	●	●	●	●
0x10 Type T	-	-	●	●	●	●
0x11 Type E	-	-	●	●	●	●
0x12 Type R	-	-	●	●	●	●
0x13 Type S	-	-	●	●	●	●
0x14 Type B	-	-	●	●	●	●
0x15 Type N	-	-	●	●	●	●
0x16 Type C	-	-	●	●	●	●
0x17 Type L	-	-	-	●	●	●
0x18 Type M	-	-	-	●	●	●
0x19 Type L2	-	-	-	●	●	●
0x1A 0 ~ 20mA	B2.2 (*)	-	-	-	●	B2.7 (*)
0x1B +/-150V	-	●	-	-	-	-
0x1C +/-50V	-	●	-	-	-	-

Note:

1. "B2.x" indicates the firmware version required for the supported type.
2. Type codes **07, 0D, and 1A** are not available for **M-7017RMS**.

Type Code	Input Range	Data Format	Min.	Max.
0x00	-15 ~ +15 mV	Engineering unit	-15000	15000
		2's complement HEX	8000	7FFF
0x01	-50 ~ +50 mV	Engineering unit	-5000	5000
		2's complement HEX	8000	7FFF
0x02	-100 ~ +100 mV	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x03	-500 ~ +500 mV	Engineering unit	-5000	5000
		2's complement HEX	8000	7FFF
0x04	-1 ~ +1 V	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x05	-2.5 ~ +2.5 V	Engineering unit	-25000	25000
		2's complement HEX	8000	7FFF
0x06	-20 ~ +20 mA	Engineering unit	-20000	20000
		2's complement HEX	8000	7FFF
0x07	+4 ~ +20 mA	Engineering unit	4000	20000
		2's complement HEX	0000	FFFF
0x08	-10 ~ +10 V	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x09	-5 ~ +5 V	Engineering unit	-5000	5000
		2's complement HEX	8000	7FFF
0x0A	-1 ~ +1 V	Engineering unit	-10000	10000
		2's complement HEX	8000	7FFF
0x0B	-500 ~ +500 mV	Engineering unit	-5000	5000
		2's complement HEX	8000	7FFF
0x0C	-150 ~ +150 mV	Engineering unit	-15000	15000
		2's complement HEX	8000	7FFF
0x0D	-20 ~ +20 mA	Engineering unit	-20000	20000
		2's complement HEX	8000	7FFF

Type Code	Input Range	Data Format	Min.	Max.
0x0E	Type J Thermocouple -210 ~ 760°C	Engineering unit	-2100	7600
		2's complement HEX	DCA2	7FFF
0x0F	Type K Thermocouple -270 ~ 1372°C	Engineering unit	-2700	13720
		2's complement HEX	E6D0	7FFF
0x10	Type T Thermocouple -270 ~ 400°C	Engineering unit	-2700	4000
		2's complement HEX	A99A	7FFF
0x11	Type E Thermocouple -270 ~ 1000°C	Engineering unit	-2700	10000
		2's complement HEX	DD71	7FFF
0x12	Type R Thermocouple 0 ~ 1768°C	Engineering unit	0	17680
		2's complement HEX	0000	7FFF
0x13	Type S Thermocouple 0 ~ 1768°C	Engineering unit	0	17680
		2's complement HEX	0000	7FFF
0x14	Type B Thermocouple 0 ~ 1820°C	Engineering unit	0	18200
		2's complement HEX	0000	7FFF
0x15	Type N Thermocouple -270 ~ 1300°C	Engineering unit	-2700	13000
		2's complement HEX	E56B	7FFF
0x16	Type C Thermocouple 0 ~ 2320°C	Engineering unit	0	23200
		2's complement HEX	0000	7FFF
0x17	Type L Thermocouple -200 ~ 800°C	Engineering unit	-2000	8000
		2's complement HEX	E000	7FFF
0x18	Type M Thermocouple -200 ~ 100°C	Engineering unit	-20000	10000
		2's complement HEX	8000	4000
0x19	Type L DIN43710 Thermocouple -200 ~ 900°C	Engineering unit	-2000	9000
		2's complement HEX	E38E	7FFF

Type Code	Input Range	Data Format	Min.	Max.
0x1A	0 ~ +20 mA	Engineering unit	0	20000
		2's complement HEX	0000	FFFF
0x1B	-150 ~ +150 V	Engineering unit	-15000	15000
		2's complement HEX	8000	7FFF
0x1C	-50 ~ +50 V	Engineering unit	-5000	5000
		2's complement HEX	8000	7FFF

Under/Over Range Reading

Data Format	Under Range	Over Range
Engineering Unit	-32768	+32767
2's complement HEX	8000	7FFF

B.4 M-7024, M-7024R, M-7024L

Type Code	Output Range	Data Format	Min.	Max.
0x30	0 ~ 20 mA	Engineering	0	20000
		2's complement HEX	0000h	3FFFh
0x31	4 ~ 20 mA	Engineering	4000	20000
		2's complement HEX	0000h	3FFFh
0x32	0 ~ 10 V	Engineering	0	10000
		2's complement HEX	0000h	3FFFh
0x33	-10 ~ 10 V	Engineering	-10000	10000
		2's complement HEX	C000h	3FFFh
0x34	0 ~ 5 V	Engineering	0	5000
		2's complement HEX	0000h	3FFFh
0x35	-5 ~ 5 V	Engineering	-5000	5000
		2's complement HEX	C000h	3FFFh

B.5 M-7024U, M-7026, M-7028

Type Code	Range	Data Format	Min.	Max.
0x00	0 mA ~ +20 mA	Engineering	0	+20000
		2's complement HEX	0000h	FFFFh
0x01	+4 mA ~+20 mA	Engineering	+4000	+20000
		2's complement HEX	0000h	FFFFh
0x02	0V ~ +10 V	Engineering	0	+10000
		2's complement HEX	0000h	FFFFh
0x03	+/-10 V	Engineering	-10000	+10000
		2's complement HEX	8000h	7FFFh
0x04	0 V ~ +5 V	Engineering	0	+5000
		2's complement HEX	0000h	FFFFh
0x05	+/-5 V	Engineering	-5000	+5000
		2's complement HEX	8000h	7FFFh

B.6 M-7084

Type Code	Counter Type	Data Format	Min.	Max.
0x50	Up Counter	Hexadecimal	00000000	FFFFFFFF
0x51	Frequency	The data format can be set by using a Modbus address - 00269. (0: Hex. 1: Float)		
0x54	Up/Down Counter	Hexadecimal	80000000	7FFFFFFF
0x55	Pulse/Direction Counter	Hexadecimal	80000000	7FFFFFFF
0x56	Quadrature Counter	Hexadecimal	80000000	7FFFFFFF

Appendix C Type Code for AI Values (DCON Protocol)

When using the DCON or Modbus protocol, the data range for conversion may vary, even for the same type code. Refer to the table to determine the correct data range based on the selected protocol.

C.1 7005 (Thermistor)

I-7005, M-7005

Type Code	Thermistor Range	Data Format	-F.S.	+F.S.
0x60	PreCon Type III 10K @ 25°C -30 ~ 240°F	Engineering unit	-030.00	+240.00
		% of FSR	-012.50	+100.00
		2's complement HEX	F000	7FFF
		Ohms	+173600.0	+000539.4
0x61	Fenwell U 2K @ 25°C -50 ~ 150°C	Engineering unit	-050.00	+150.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+134020.0	+000037.2
0x62	Fenwell U 2K @ 25°C 0 ~ 150°C	Engineering unit	+000.00	+150.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+006530.0	+000037.2
0x63	YSI L Mix 100 @ 25°C -80 ~ 100°C	Engineering unit	-080.00	+100.00
		% of FSR	-080.00	+100.00
		2's complement HEX	999A	7FFF
		Ohms	+014470.0	+000014.3
0x64	YSI L Mix 300 @ 25°C -80 ~ 100°C	Engineering unit	-080.00	+100.00
		% of FSR	-080.00	+100.00
		2's complement HEX	999A	7FFF
		Ohms	+067660.0	+000035.8
0x65	YSI L Mix 1000 @ 25°C -70 ~ 100°C	Engineering unit	-070.00	+100.00
		% of FSR	-070.00	+100.00
		2's complement HEX	A667	7FFF
		Ohms	+132600.0	+000106.4
0x66	YSI B Mix 2252 @ 25°C -50 ~ 150°C	Engineering unit	-050.00	+150.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+151000.0	+000041.8

Type Code	Thermistor Range	Data Format	-F.S.	+F.S.
0x67	YSI B Mix 3000 @ 25°C -40 ~ 150°C	Engineering unit	-040.00	+150.00
		% of FSR	-026.67	+100.00
		2's complement HEX	DDDE	7FFF
		Ohms	+101000.0	+000055.6
0x68	YSI B Mix 5000 @ 25°C -40 ~ 150°C	Engineering unit	-040.00	+150.00
		% of FSR	-026.67	+100.00
		2's complement HEX	DDDE	7FFF
		Ohms	+168300.0	+000092.7
0x69	YSI B Mix 6000 @ 25°C -30 ~ 150°C	Engineering unit	-030.00	+150.00
		% of FSR	-020.00	+100.00
		2's complement HEX	E667	7FFF
		Ohms	+106200.0	+000111.5
0x6A	YSI B Mix 10K @ 25°C -30 ~ 150°C	Engineering unit	-030.00	+150.00
		% of FSR	-020.00	+100.00
		2's complement HEX	E667	7FFF
		Ohms	+177000.0	+000185.9
0x6B	YSI H Mix 10K @ 25°C -30 ~ 150°C	Engineering unit	-030.00	+150.00
		% of FSR	-020.00	+100.00
		2's complement HEX	E667	7FFF
		Ohms	+135200.0	+000237.0
0x6C	YSI H Mix 30K @ 25°C -10 ~ 200°C	Engineering unit	-010.00	+200.00
		% of FSR	-005.00	+100.00
		2's complement HEX	F99A	7FFF
		Ohms	+158000.0	+000186.7
0x70 ~ 0x77	User-defined -50 ~ 150°C	Engineering unit	-050.00	+150.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+000000.0	+000000.0

Note:

For the user-defined type, a resistance value greater than 180,000 Ω is considered out of the under-range. For firmware version A3.7 or later, this threshold is 204,800 Ω.

Under/Over Range Reading

I-7005, M-7005

Data Format	Under Range	Over Range
Engineering Unit	-9999.9	+9999.9
% of FSR	-999.99	+999.99
2's Complement HEX	8000	7FFF

M-7005: Using Modbus RTU Protocol

Under Range	Over Range
8000h	7FFFh

C.2 I-7011

7011(D), I-7011P(D)

Type Code	Input Range	Data Format	-F.S.	Zero	+F.S.
0x00	-15 ~ +15 mV	Engineer Unit	-15.000	+00.000	+15.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x01	-50 ~ +50 mV	Engineer Unit	-50.000	+00.000	+50.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x02	-100 ~ +100 mV	Engineer Unit	-100.00	+000.00	+100.00
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x03	-500 ~ +500 mV	Engineer Unit	-500.00	+000.00	+500.00
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x04	-1 ~ +1 V	Engineer Unit	-1.0000	+0.0000	+1.0000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x05	-2.5 ~ +2.5 V	Engineer Unit	-2.5000	+0.0000	+2.5000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x06	-20 ~ +20 mA	Engineer Unit	-20.000	+00.000	+20.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x0E	J Type -210 ~ 760 degree Celsius	Engineer Unit	-210.00	+00.000	+760.00
		% of FSR	-027.63	+000.00	+100.00
		2's complement HEX	DCA2	0000	7FFF
0x0F	K Type -270 ~ 1372 degree Celsius	Engineer Unit	-0270.0	+00.000	+1372.0
		% of FSR	-019.68	+000.00	+100.00
		2's complement HEX	E6D0	0000	7FFF
0x10	T Type -270 ~ 400 degree Celsius	Engineer Unit	-270.00	+000.00	+400.00
		% of FSR	-067.50	+000.00	+100.00
		2's complement HEX	A99A	0000	7FFF

Type Code	Input Range	Data Format	-F.S.	Zero	+F.S.
0x11	E Type -270 ~ 1000 degree Celsius	Engineer Unit	-0270.0	+000.00	+1000.0
		% of FSR	-027.00	+000.00	+100.00
		2's complement HEX	DD71	0000	7FFF
0x12	R Type 0 ~ 1768 degree Celsius	Engineer Unit	+0000.0	+0000.0	+1768.0
		% of FSR	+0000.0	+0000.0	+100.00
		2's complement HEX	0000	0000	7FFF
0x13	S Type 0 ~ 1768 degree Celsius	Engineer Unit	+0000.0	+0.0000	+1786.0
		% of FSR	+0000.0	+000.00	+100.00
		2's complement HEX	0000	0000	7FFF
0x14	B Type 0 ~ 1820 degree Celsius	Engineer Unit	+0000.0	+00.000	+1820.0
		% of FSR	+0000.0	+000.00	+100.00
		2's complement HEX	0000	0000	7FFF
0x15	N Type -270 ~ 1300 degree Celsius	Engineer Unit	-0270.0	+00.000	+1300.0
		% of FSR	-20.77	+000.00	+100.00
		2's complement HEX	E56B	0000	7FFF
0x16	C Type 0 ~ 2320 degree Celsius	Engineer Unit	+00.000	+00.000	+2320.0
		% of FSR	+000.00	+000.00	+100.00
		2's complement HEX	0000	0000	7FFF
0x17*1	L Type -200 ~ 800 degree Celsius	Engineer Unit	-200.00	+00.000	+800.00
		% of FSR	-025.00	+000.00	+100.00
		2's complement HEX	E000	0000	7FFF
0x18*1	M Type -200 ~ 100 degree Celsius	Engineer Unit	-200.00	+000.00	+100.00
		% of FSR	-100.00	+000.00	+050.00
		2's complement HEX	8000	0000	4000
*1: Type codes '17, 18' are available for the I-7011P and I-7011PD.					

C.3 I-7012/14 Series (AI)

I-7012/12D/12F/12FD, I-7014D

Type Code	Input Range	Data Format	-F.S.	Zero	+F.S.
0x08	-10 ~ +10 V	Engineer Unit	-10.000	+00.000	+10.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x09	-5 ~ +5 V	Engineer Unit	-5.0000	+0.0000	+5.0000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x0A	-1 ~ +1 V	Engineer Unit	-1.0000	+0.0000	+1.0000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x0B	-500 ~ +500 mV	Engineer Unit	-500.00	+000.00	+500.00
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x0C	-150 ~ +150 mV	Engineer Unit	-150.00	+000.00	+150.00
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x0D	-20 ~ +20 mA	Engineer Unit	-20.000	+00.000	+20.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF

C.4 7013/15/33 Series (RTD)

I-7013/13D, M-7013P/13PD ; I-7015/15P, M-7015/15P ; I-7033/33D, M-7033/33D

Type Code	RTD Range	Data Format	-F.S.	+F.S.
0x20	Platinum 100 α = 0.00385 -100 ~ 100°C	Engineering unit	-100.00	+100.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
		Ohms	+060.25	+138.50
0x21	Platinum 100 α = 0.00385 0 ~ 100°C	Engineering unit	+000.00	+100.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+138.50
0x22	Platinum 100 α = 0.00385 0 ~ 200°C	Engineering unit	+000.00	+200.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+175.84
0x23	Platinum 100 α = 0.00385 0 ~ 600°C	Engineering unit	+000.00	+600.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+313.59
0x24	Platinum 100 α = 0.003916 -100 ~ 100°C	Engineering unit	-100.00	+100.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
		Ohms	+059.57	+139.16
0x25	Platinum 100 α = 0.003916 0 ~ 100°C	Engineering unit	+000.00	+100.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+139.16
0x26	Platinum 100 α = 0.003916 0 ~ 200°C	Engineering unit	+000.00	+200.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+177.14
0x27	Platinum 100 α = 0.003916 0 ~ 600°C	Engineering unit	+000.00	+600.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+317.28

Type Code	RTD Range	Data Format	-F.S.	+F.S.
0x28	Nickel 120 -80 ~ 100°C	Engineering unit	-080.00	+100.00
		% of FSR	-080.00	+100.00
		2's complement HEX	999A	7FFF
		Ohms	+066.60	+200.64
0x29	Nickel 120 0 ~ 100°C	Engineering unit	+000.00	+100.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+120.00	+200.64
0x2A*	Platinum 1000 α = 0.00385 -200 ~ 600°C	Engineering unit	-200.00	+600.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+0185.2	+3137.1
Type Codes '2A' is available for the I-7013/13D with firmware B2.2 or later.				
0x2B*	Cu 100 α = 0.00421 -20 ~ 150°C	Engineering unit	-020.00	+150.00
		% of FSR	-013.33	+100.00
		2's complement HEX	EEEF	7FFF
		Ohms	+091.56	+163.17
0x2C*	Cu 100 α = 0.00427 0 ~ 200°C	Engineering unit	+000.00	+200.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+090.34	+167.75
0x2D*	Cu 1000 α = 0.00421 -20 ~ 150°C	Engineering unit	-020.00	+150.00
		% of FSR	-013.33	+100.00
		2's complement HEX	EEEF	7FFF
		Ohms	+0915.6	+1631.7
Type Codes '2B, 2C, 2D' are available for the I-7015/15P and M-7015/15P.				
0x2E*	Platinum 100 α = 0.00385 -200 ~ 200°C	Engineering unit	-200.00	+200.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
		Ohms	+018.49	+175.84
0x2F*	Platinum 100 α = 0.003916 -200 ~ 200°C	Engineering unit	-200.00	+200.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
		Ohms	+017.14	+177.14

Type Code	RTD Range	Data Format	-F.S.	+F.S.
0x80*	Platinum 100 α = 0.00385 -200 ~ 600°C	Engineering unit	-200.00	+600.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+018.49	+313.59
0x81*	Platinum 100 α = 0.003916 -200 ~ 600°C	Engineering unit	-200.00	+600.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+017.14	+317.28
Type Codes '2E, 2F, 80, 81' are available for the I-7013/13D and I-7033/33D with firmware B1.3 or later. Type Codes '2E, 2F, 80, 81' are available for the I-7015 with firmware B1.1 or later.				
0x82*	Cu 50 -50 ~ 150°C	Engineering unit	-050.00	+150.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+039.24	+082.13
Type Code '82' is available for the I-7013/13D and I-7033/33D with firmware B1.5 or later. Type Code '82' is available for the I-7015 and M-7015 with firmware A2.3 or later.				
0x83*	Nickel 100 -60 ~ 180°C	Engineering unit	-060.00	+180.00
		% of FSR	-033.33	+100.00
		2's complement HEX	D556	7FFF
		Ohms	+069.50	+223.10
Type Code '83' is only available for the I-7015/15P and M-7015/15P. Type Code '83' is available for the I-7015 and M-7015 with firmware A2.9 or later.				
0x84*	Nickel 120 -80 ~ 150°C	Engineering unit	-080.00	+150.00
		% of FSR	-053.33	+100.00
		2's complement HEX	BBBC	7FFF
		Ohms	+066.60	+248.95
0x85*	Cu 100 α = 0.00428 0 ~ 150°C	Engineering unit	+000.00	+150.00
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
		Ohms	+100.00	+164.16
Type Codes '84, 85' are only available for the I-7015/15P and M-7015/15P with firmware B2.9 or later.				

Under/Over Range Reading

I-7013/13D, M-7013P/13PD, I-7033/33D, M-7033/33D (Firmware version: B1.2 or later)

Data Format	Under Range	Over Range
Engineering Unit	-0000	+9999
% of FSR	-0000	+9999
2's Complement HEX	8000	7FFF

I-7013, I-7033/33D (Firmware version: B1.3 or later),
I-7015/M-7015 (Firmware version: B2.1 or later),
M-7013P/13PD, I-7015P, M-7015P, M-7033/33D

Note: The under/over range readings can be set by using the ~AADVV command.

Data Format	Under Range	Over Range
Engineering Unit	-9999.9	+9999.9
% of FSR	-999.99	+999.99
2's Complement HEX	8000	7FFF

M-7013P/13PD, M-7015/15P, M-7033/33D: Using Modbus RTU Protocol

Under Range	Over Range
8000	7FFF

C.5 7016 Series

I-7016/16D/16P/16PD, M-7016/16D

Type Code	Input Range	Data Format	-F.S.	Zero	+F.S.
0x00	-15 ~ +15 mV	Engineer Unit	-15.000	+00.000	+15.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x01	-50 ~ +50 mV	Engineer Unit	-50.000	+00.000	+50.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x02	-100 ~ +100 mV	Engineer Unit	-100.00	+000.00	+100.00
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x03	-500 ~ +500 mV	Engineer Unit	-500.00	+000.00	+500.00
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x04	-1 ~ +1 V	Engineer Unit	-1.0000	+0.0000	+1.0000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x05	-2.5 ~ +2.5 V	Engineer Unit	-2.5000	+0.0000	+2.5000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF
0x06	-20 ~ +20 mA	Engineer Unit	-20.000	+00.000	+20.000
		% of FSR	-100.00	+000.00	+100.00
		2's complement HEX	8000	0000	7FFF

C.6 7017/18/19 Series

I-7017/17C/17F/17FC/17R/17R-A5/17RC/17Z,
M-7017/17C/17mC-16/17R/17R-A5/17RC/17RMS/17Z
I-7018/18P/18R, M-7018/18P/18R, M-7018-16
I-7019R, M-7019R/19Z

The table below allows users to quickly review the supported type codes for each model.

Type	I-7017, M-7017 I-7017F I-7017R, M-7017R M-7017RMS	I-7017C, M-7017C I-7017RC, M-7017RC M-7017mC-16	I-7017R-A5 M-7017R-A5	I-7018 M-7018
0x00 +/-15mV	-	-	-	●
0x01 +/-50mV	-	-	-	●
0x02 +/-100mV	-	-	-	●
0x03 +/-500mV	-	-	-	●
0x04 +/-1V	-	-	-	●
0x05 +/-2.5V	-	-	-	●
0x06 +/-20mA	-	-	-	●
0x07 4 ~ 20mA	B2.2 (*)	B2.2 (*)	-	-
0x08 +/-10V	●	-	-	-
0x09 +/-5V	●	-	-	-
0x0A +/-1V	●	-	-	-
0x0B +/-500mV	●	-	-	-
0x0C +/-150mV	●	-	-	-
0x0D +/-20mA	● (*)	●	-	-
0x0E Type J	-	-	-	●
0x0F Type K	-	-	-	●
0x10 Type T	-	-	-	●
0x11 Type E	-	-	-	●
0x12 Type R	-	-	-	●
0x13 Type S	-	-	-	●
0x14 Type B	-	-	-	●
0x15 Type N	-	-	-	●
0x16 Type C	-	-	-	●
0x17 Type L	-	-	-	-
0x18 Type M	-	-	-	-
0x19 Type L2	-	-	-	-
0x1A 0 ~ 20mA	B2.2 (*)	B2.2 (*)	-	-

0x1B +/-150V	-	-	●	-
0x1C +/-50V	-	-	●	-

Note:

3. "B2.2" indicates the firmware version required for the supported type.
4. Type codes **07, 0D, and 1A** are not available for the **M-7017RMS**.

Type	I-7018P	I-7018R M-7018R	I-7018Z M-7018Z	I-7019R M-7019R M-7019Z
0x00 +/-15mV	●	●	●	●
0x01 +/-50mV	●	●	●	●
0x02 +/-100mV	●	●	●	●
0x03 +/-500mV	●	●	●	●
0x04 +/-1V	●	●	●	●
0x05 +/-2.5V	●	●	●	●
0x06 +/-20mA	●	●	●	●
0x07 4 ~ 20mA	-	-	●	B2.7 (*)
0x08 +/-10V	-	-	-	●
0x09 +/-5V	-	-	-	●
0x0A +/-1V	-	-	-	●
0x0B +/-500mV	-	-	-	●
0x0C +/-150mV	-	-	-	●
0x0D +/-20mA	-	-	-	●
0x0E Type J	●	●	●	●
0x0F Type K	●	●	●	●
0x10 Type T	●	●	●	●
0x11 Type E	●	●	●	●
0x12 Type R	●	●	●	●
0x13 Type S	●	●	●	●
0x14 Type B	●	●	●	●
0x15 Type N	●	●	●	●
0x16 Type C	●	●	●	●
0x17 Type L	●	●	●	●
0x18 Type M	●	●	●	●
0x19 Type L2	-	●	●	●
0x1A 0 ~ 20mA	-	-	●	B2.7 (*)
0x1B +/-150V	-	-	-	-
0x1C +/-50V	-	-	-	-

Note: "B2.7" indicates the firmware version required for the supported type.

C.6.1 7017 Series

Type Code	Input Range	Data Format	-F.S.	+F.S
0x07*	+4 ~ +20 mA	Engineering unit	+04.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
Type Code '07' is only available for I-7017 and M-7017 with firmware B2.2 or later, but not on M-7017RMS.				
0x08	-10 ~ +10 V	Engineering unit	-10.000	+10.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x09	-5 ~ +5 V	Engineering unit	-5.0000	+5.0000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0A	-1 ~ +1 V	Engineering unit	-1.0000	+1.0000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0B	-500 ~ +500 mV	Engineering unit	-500.00	+500.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0C	-150 ~ +150 mV	Engineering unit	-150.00	+150.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0D*	-20 ~ +20 mA	Engineering unit	-20.000	+20.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
Type Code '0D' is NOT available for the M-7017RMS.				
0x1A*	0 ~ +20 mA	Engineering unit	+00.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
Type Code '1A' is only available for I-7017 and M-7017 with firmware B2.2 or later, but not on M-7017RMS.				
0x1B*	-150 ~ +150 V	Engineering unit	-150.00	+150.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x1C*	-50 ~ +50 V	Engineering unit	-50.000	+50.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
Type Codes '1B, 1C' are only available for the I-7017R-A5 and M-7017R-A5.				

C.6.2 7018 Series

Type Code	Input Range	Data Format	-F.S.	+F.S
0x00	-15 ~ +15 mV	Engineering unit	-15.000	+15.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x01	-50 ~ +50 mV	Engineering unit	-50.000	+50.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x02	-100 ~ +100 mV	Engineering unit	-100.00	+100.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x03	-500 ~ +500 mV	Engineering unit	-500.00	+500.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x04	-1 ~ +1 V	Engineering unit	-1.0000	+1.0000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x05	-2.5 ~ +2.5 V	Engineering unit	-2.5000	+2.5000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x06	-20 ~ +20 mA	Engineering unit	-20.000	+20.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x07*	+4 ~ +20 mA	Engineering unit	+04.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
Type Code '07' is only available for the I-7018Z and M-7018Z.				
0x0E	Type J Thermocouple -210 ~ 760°C	Engineering unit	-210.00	+760.00
		% of FSR	-027.63	+100.00
		2's complement HEX	DCA2	7FFF
0x0F	Type K Thermocouple -270 ~ 1372°C	Engineering unit	-0270.0	+1372.0
		% of FSR	-019.68	+100.00
		2's complement HEX	E6D0	7FFF
0x10	Type T Thermocouple -270 ~ 400°C	Engineering unit	-270.00	+400.00
		% of FSR	-067.50	+100.00
		2's complement HEX	A99A	7FFF

Type Code	Input Range	Data Format	-F.S.	+F.S
0x11	Type E Thermocouple -270 ~ 1000°C	Engineering unit	-0270.0	+1000.0
		% of FSR	-027.00	+100.00
		2's complement HEX	DD71	7FFF
0x12	Type R Thermocouple 0 ~ 1768°C	Engineering unit	+0000.0	+1768.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x13	Type S Thermocouple 0 ~ 1768°C	Engineering unit	+0000.0	+1768.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x14	Type B Thermocouple 0 ~ 1820°C	Engineering unit	+0000.0	+1820.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x15	Type N Thermocouple -270 ~ 1300°C	Engineering unit	-0270.0	+1300.0
		% of FSR	-020.77	+100.00
		2's complement HEX	E56B	7FFF
0x16	Type C Thermocouple 0 ~ 2320°C	Engineering unit	+0000.0	+2320.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x17*	Type L Thermocouple -200 ~ 800°C	Engineering unit	-200.00	+800.00
		% of FSR	-025.00	+100.00
		2's complement HEX	E000	7FFF
0x18*	Type M Thermocouple -200 ~ 100°C	Engineering unit	-200.00	+100.00
		% of FSR	-100.00	+050.00
		2's complement HEX	8000	4000
Type Codes '17, 18' are only available for the I-7018P, I-7018R, M-7018R, I-7018Z, and M-7018Z.				
0x19*	Type L DIN43710 Thermocouple -200 ~ 900°C	Engineering unit	-200.00	+900.00
		% of FSR	-022.22	+100.00
		2's complement HEX	E38E	7FFF
Type Code '19' is only available for the I-7018R, M-7018R, I-7018Z, and M-7018Z.				
0x1A*	0 ~ +20 mA	Engineering unit	+00.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
Type Code '1A' is only available for the I-7018Z and M-7018Z.				

C.6.3 7019 Series

Type Code	Input Range	Data Format	-F.S.	+F.S
0x00	-15 ~ +15 mV	Engineering unit	-15.000	+15.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x01	-50 ~ +50 mV	Engineering unit	-50.000	+50.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x02	-100 ~ +100 mV	Engineering unit	-100.00	+100.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x03	-500 ~ +500 mV	Engineering unit	-500.00	+500.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x04	-1 ~ +1 V	Engineering unit	-1.0000	+1.0000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x05	-2.5 ~ +2.5 V	Engineering unit	-2.5000	+2.5000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x06	-20 ~ +20 mA	Engineering unit	-20.000	+20.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x07*	+4 ~ +20 mA	Engineering unit	+04.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
Type Code '07' is only available for the I-7019R, M-7019R, and M-7019Z with firmware B2.7 or later.				
0x08	-10 ~ +10 V	Engineering unit	-10.000	+10.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x09	-5 ~ +5 V	Engineering unit	-5.0000	+5.0000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0A	-1 ~ +1 V	Engineering unit	-1.0000	+1.0000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF

Type Code	Input Range	Data Format	-F.S.	+F.S
0x0B	-500 ~ +500 mV	Engineering unit	-500.00	+500.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0C	-150 ~ +150 mV	Engineering unit	-150.00	+150.00
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0D	-20 ~ +20 mA	Engineering unit	-20.000	+20.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x0E	Type J Thermocouple -210 ~ 760°C	Engineering unit	-210.00	+760.00
		% of FSR	-027.63	+100.00
		2's complement HEX	DCA2	7FFF
0x0F	Type K Thermocouple -270 ~ 1372°C	Engineering unit	-0270.0	+1372.0
		% of FSR	-019.68	+100.00
		2's complement HEX	E6D0	7FFF
0x10	Type T Thermocouple -270 ~ 400°C	Engineering unit	-270.00	+400.00
		% of FSR	-067.50	+100.00
		2's complement HEX	A99A	7FFF
0x11	Type E Thermocouple -270 ~ 1000°C	Engineering unit	-0270.0	+1000.0
		% of FSR	-027.00	+100.00
		2's complement HEX	DD71	7FFF
0x12	Type R Thermocouple 0 ~ 1768°C	Engineering unit	+0000.0	+1768.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x13	Type S Thermocouple 0 ~ 1768°C	Engineering unit	+0000.0	+1768.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x14	Type B Thermocouple 0 ~ 1820°C	Engineering unit	+0000.0	+1820.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF
0x15	Type N Thermocouple -270 ~ 1300°C	Engineering unit	-0270.0	+1300.0
		% of FSR	-020.77	+100.00
		2's complement HEX	E56B	7FFF
0x16	Type C Thermocouple 0 ~ 2320°C	Engineering unit	+0000.0	+2320.0
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	7FFF

Type Code	Input Range	Data Format	-F.S.	+F.S
0x17*	Type L Thermocouple -200 ~ 800°C	Engineering unit	-200.00	+800.00
		% of FSR	-025.00	+100.00
		2's complement HEX	E000	7FFF
0x18*	Type M Thermocouple -200 ~ 100°C	Engineering unit	-200.00	+100.00
		% of FSR	-100.00	+050.00
		2's complement HEX	8000	4000
0x19*	Type L DIN43710 Thermocouple -200 ~ 900°C	Engineering unit	-200.00	+900.00
		% of FSR	-022.22	+100.00
		2's complement HEX	E38E	7FFF
Type Codes '17, 18, 19' are only available for the I-7019R, M-7019R, and M-7019Z.				
0x1A*	0 ~ +20 mA	Engineering unit	+00.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
Type Code '1A' is only available for the I-7019R, M-7019R, and M-7019Z with firmware B2.7 or later.				

Under/Over Range Reading

I-7018 series (Firmware version: B1.4 or older)

Data Format	Under Range	Over Range
Engineering Unit	-0000	+9999
% of FSR		
2's Complement HEX		

I-7018 series (Firmware version: B1.5 or later)**, I-7019, M-7018, M-7019 series**

Data Format	Under Range	Over Range
Engineering Unit	-9999.9	+9999.9
% of FSR	-999.99	+999.99
2's Complement HEX	8000	7FFF

M-7018, M-7019 series: Using Modbus RTU Protocol

Under Range	Over Range
8000	7FFF

4 ~ 20 mA Under Range Reading

Data Format	Modbus RTU	DCON
Engineering Unit	-32768	-9999.9
% of FSR	-	-999.99
2's Complement HEX	0000h	0000

C.7 7021/22/24/28 Series

I-7021/21P/22/24/24R, M-7022/24/24R/24L/24U(D)/28(D)

C.7.1 I-7021 and I-7021P

Type Code	Output Range	Data Format	Min.	Max.
0x30	0 ~ +20 mA	Engineering unit	00.000	20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF
0x31	+4 ~ +20 mA	Engineering unit	04.000	20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF
0x32	0 ~ 10 V	Engineering unit	00.000	10.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF

C.7.2 I-7022 and M-7022

Type Code	Output Range	Data Format	Min.	Max.
0x00	0 ~ 20 mA	Engineering unit	00.000	20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF
0x01	4 ~ 20 mA	Engineering unit	04.000	20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF
0x02	0 ~ 10 V	Engineering unit	00.000	10.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF
0x04*	0 ~ 5 V	Engineering unit	00.000	05.000
		% of FSR	+000.00	+100.00
		2's complement HEX	000	FFF
Note: Type Code 4 is supported on firmware version B1.2 or later.				

C.7.3 7024, 7024R, and M-7024L

Type Code	Output Range	Data Format	Min.	Max.
0x30	0 ~ +20 mA	Engineering unit	+00.000	+20.000
0x31	+4 ~ +20 mA	Engineering unit	+04.000	+20.000
0x32	0 ~ +10 V	Engineering unit	+00.000	+10.000
0x33	-10 ~ +10 V	Engineering unit	-10.000	+10.000
0x34	0 ~ +5 V	Engineering unit	+00.000	+05.000
0x35	-5 V ~ +5 V	Engineering unit	-05.000	+05.000

C.7.4 M-7024U and M-7028

Type Code	Output Range	Data Format	Min.	Max.
0x00	0 ~ +20 mA	Engineering unit	+00.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
0x01	+4 ~ +20 mA	Engineering unit	+04.000	+20.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
0x02	0 ~ +10 V	Engineering unit	+00.000	+10.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
0x03	-10 ~ +10V	Engineering unit	-10.000	+10.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF
0x04	0 ~ +5 V	Engineering unit	+00.000	+05.000
		% of FSR	+000.00	+100.00
		2's complement HEX	0000	FFFF
0x05	-5 ~ +5 V	Engineering unit	-05.000	+05.000
		% of FSR	-100.00	+100.00
		2's complement HEX	8000	7FFF