ET-7H16M Series
User Manual

Version 1.0.4, August 2024

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Warranty

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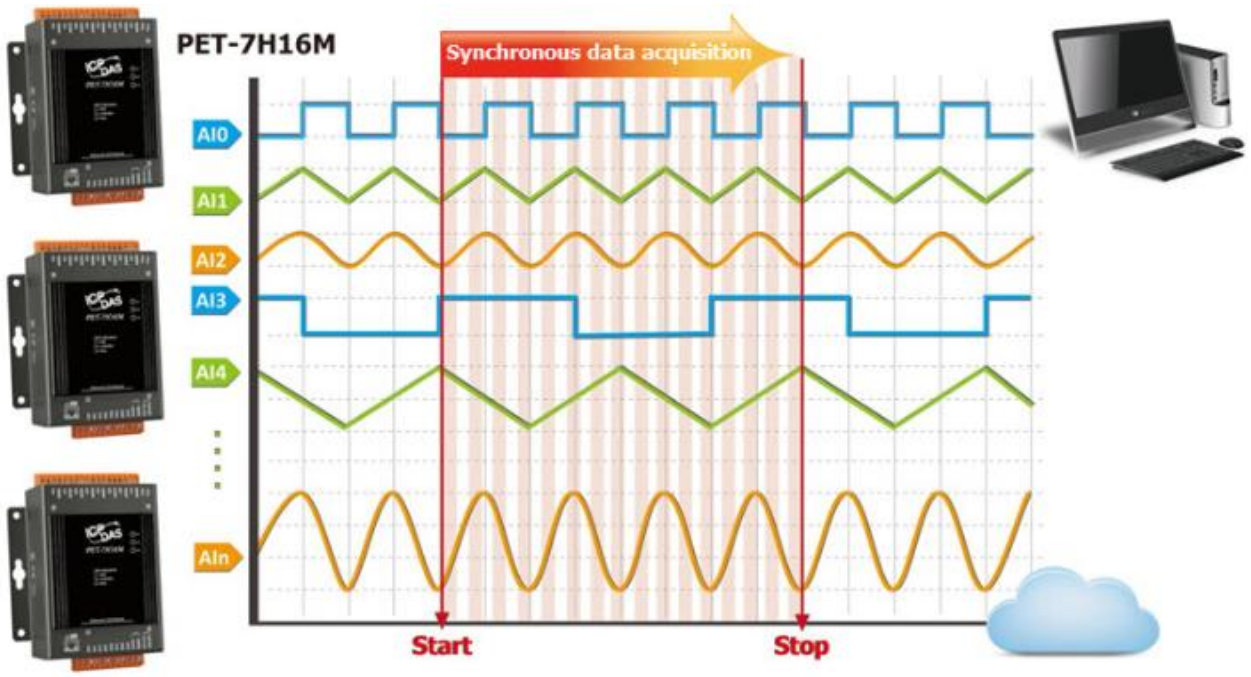
1. Introduction

The PET-7H16M is an high speed data acquisition devices built-in a Ethernet communication port for data transfer over the network and it includes eight high speed 16-bit single-ended analog inputs (200 KHz sample and hold for 8 channels), 4-channel digital inputs and 4-channel digital outputs. It provides programmable input range on all analog channels (±5 V and ±10 V), digital output can be set output with Short-circuit protection and overload protection. The counter value of 4-channel Low-speed DI counters and 1-channel High-speed counter are latched by ADC sampling time synchronously. PET-7H16M also has qualification for 4 kV ESD protection as well as 2500 VDC intra module isolation. In addition, the 16-bit ADC includes built-in anti-aliasing filtering to adjust the appropriate sampling rate and filter out modulator and signal noise. The PET-7H16M is not only suitable for a wide range of mobile/portable measurement applications, but also for precision signal measurement.



PET-7H16M supports more kinds of trigger modes for A/D conversion: software trigger, external clock trigger and external digital trigger (Post-trigger/Pre-trigger). The software trigger can acquire a sample whenever needed, while the internal pacer saves CPU loading by triggering the sampling at pre-programmed frequency. An external clock trigger can be used for triggering by external frequency source.

1.1. Features

The PET-7H16M series family offers the most comprehensive configuration to meet specific application requirements. The following list shows the features designed to simplify installation, configuration and application.

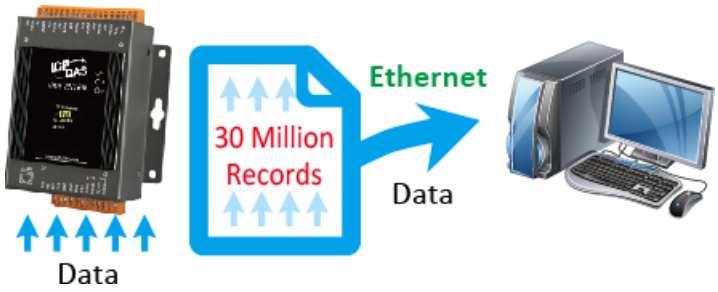
Data transmission mode

1. Continuous transmission (Maximum sampling rate of 30 kHz per channel)

After starting A/D acquisition, data is continuously transmitted to the Host PC.

Total simultaneous sampling channels	Maximum sampling rate per channel
8	30 KHz
7	34 KHz
6	40 KHz
5	48 KHz
4	60 KHz
3	80 KHz
2	120 KHz
1	200 KHz

2. After collecting N data samples, the data is transferred to the Host PC (Maximum sampling rate of 200 kHz per channel)



a. After starting A/D acquisition, the data will be temporarily stored in the memory on the PET-7H16M module, and wait until a command is received from the Host PC, before transferring the collected data to the Host PC.

b. The memory capacity allows temporary storage of up to 30 million data samples, Storage time:

(b1) 125 seconds at a sampling rate of 30 kHz

(b2) 19.6 seconds at a sampling rate of 200 kHz

Total simultaneous sampling channels	Maximum sampling rate per channel
1 ~ 8	200 KHz

A/D trigger mode

1. Software A/D Data Acquisition mode

The A/D acquisition parameters are configured via a command from the Host PC. The continuous A/D acquisition or the acquisition of N data samples begins after the command is triggered.

2. External Digital Signal Event Trigger mode

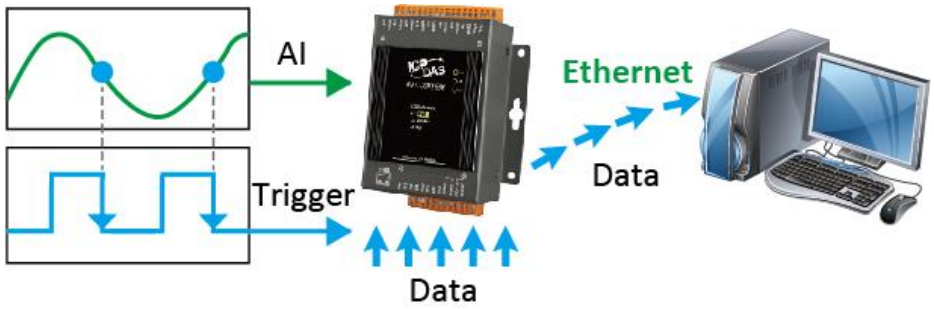
The A/D acquisition parameters are configured via a command from the Host PC, and then triggered via an external electrical signal. The A/D acquisition of the N data samples is then started.

3. Analog Threshold Trigger mode

The A/D acquisition parameters are configured via a command from the Host PC, When the analog input value is higher or lower than the set specific voltage value, the A/D acquisition of the N data is started.

4. External Clock Signal Synchronization A/D Conversion Data Acquisition mode

The speed of the A/D acquisition and the amount of data acquired are controlled by external electrical signals. A falling edge for each output waveform triggers an AD conversion

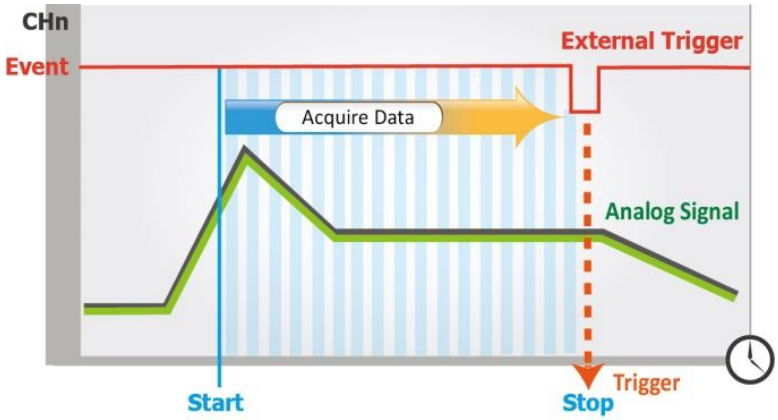


External Digital Signal Event Trigger Mode

A/D acquisition is performed in external digital event trigger mode (triggering the electrical signal is the falling edge trigger). The maximum sampling rate per channel is 200 kHz, and A/D acquisition of N data samples is performed. The acquisition mode can be categorized into two types.

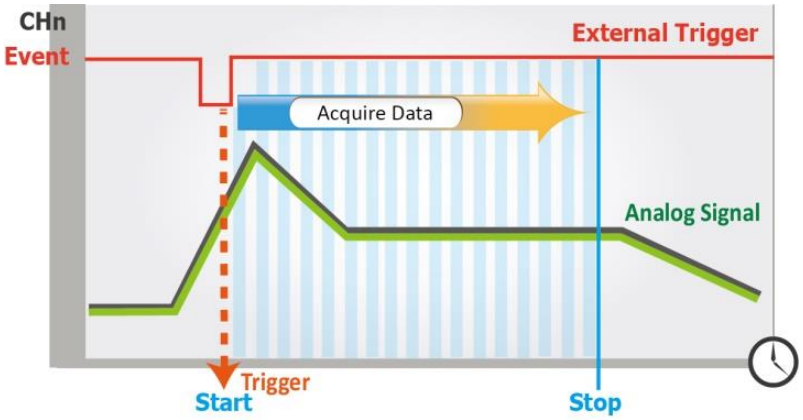
Pre-Trigger (acquisition of N data samples)

The A/D data is continually collected and is temporarily stored in the memory on the PET-7H16M until the trigger signal is received. Once the trigger signal is received, the collected N data samples are then transferred to the Host PC.



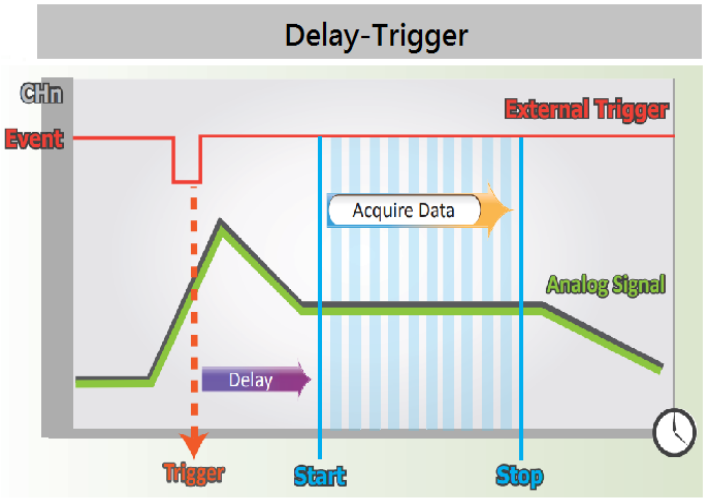
Post-Trigger (acquisition of N data samples)

In this mode, the A/D acquisition of the N data samples is started once the trigger signal is received.



Delay-Trigger (acquisition of N data samples)

The A/D acquisition of the N data samples is started once the programmed delay period from the trigger has elapsed.

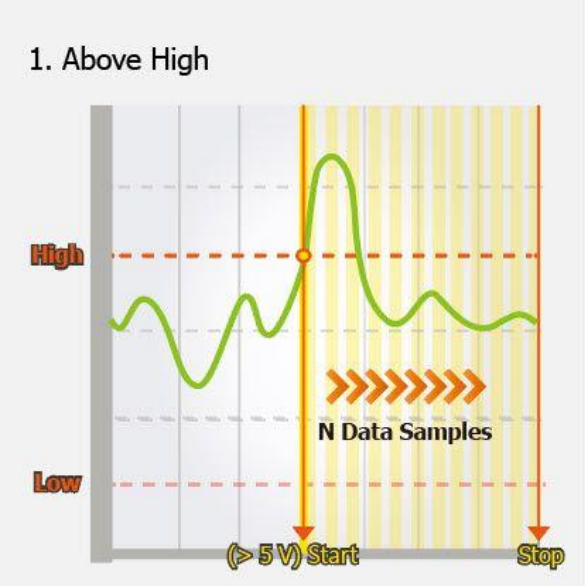


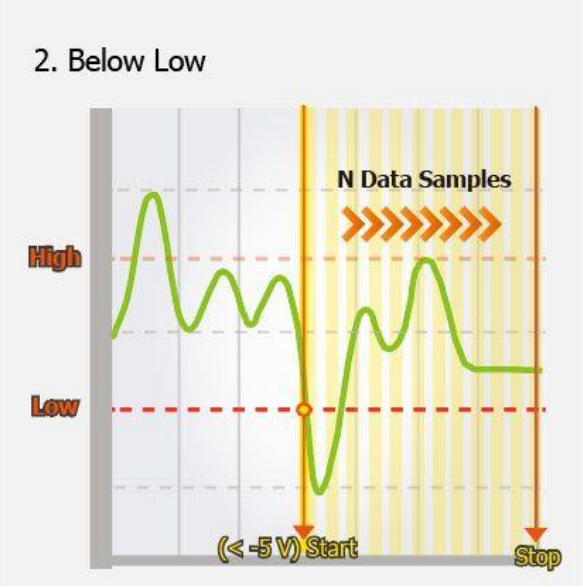
Analog Threshold Trigger Mode

Analog threshold Trigger is triggered when the voltage signal of the specified analog input channel is higher or lower than a certain voltage setting. In addition, the user can also specify the trigger voltage level range of the input signal. Once the signal leaves the high and low level region or the signal enters the high and low level region, it is triggered to start the acquisition.

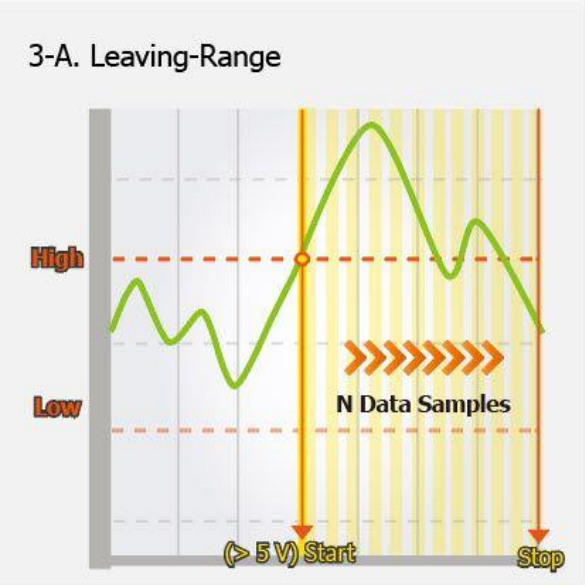
1. Above High: The signal is triggered above the high level and collects N data

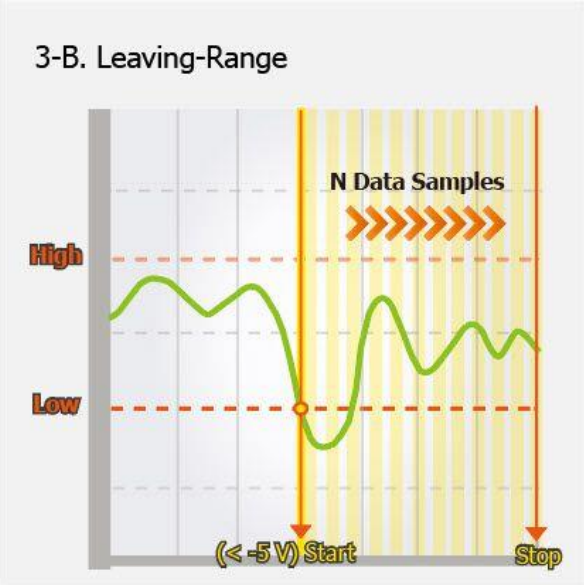
2. Below Low: The signal is triggered below the low level and collects N data



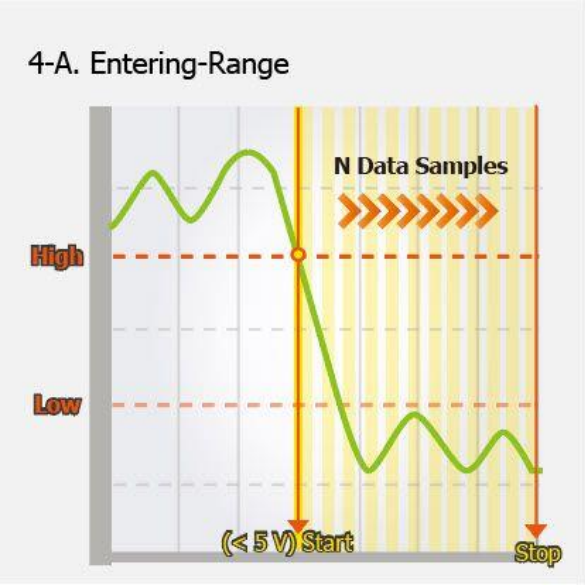


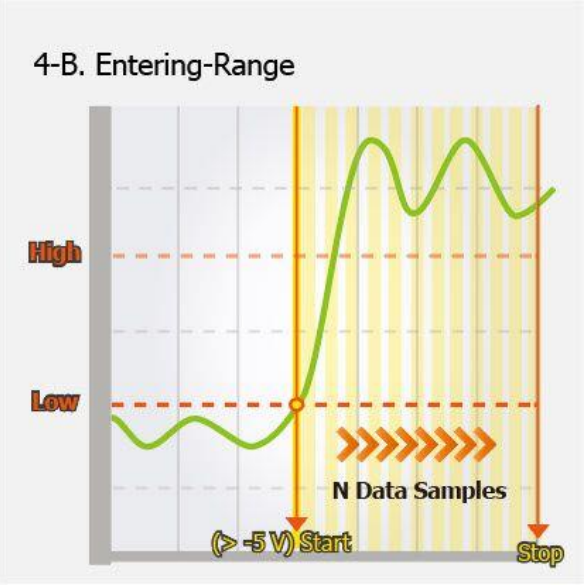
3. Leaving-Range: Trigger when the signal leaves the high and low level region, collect N data





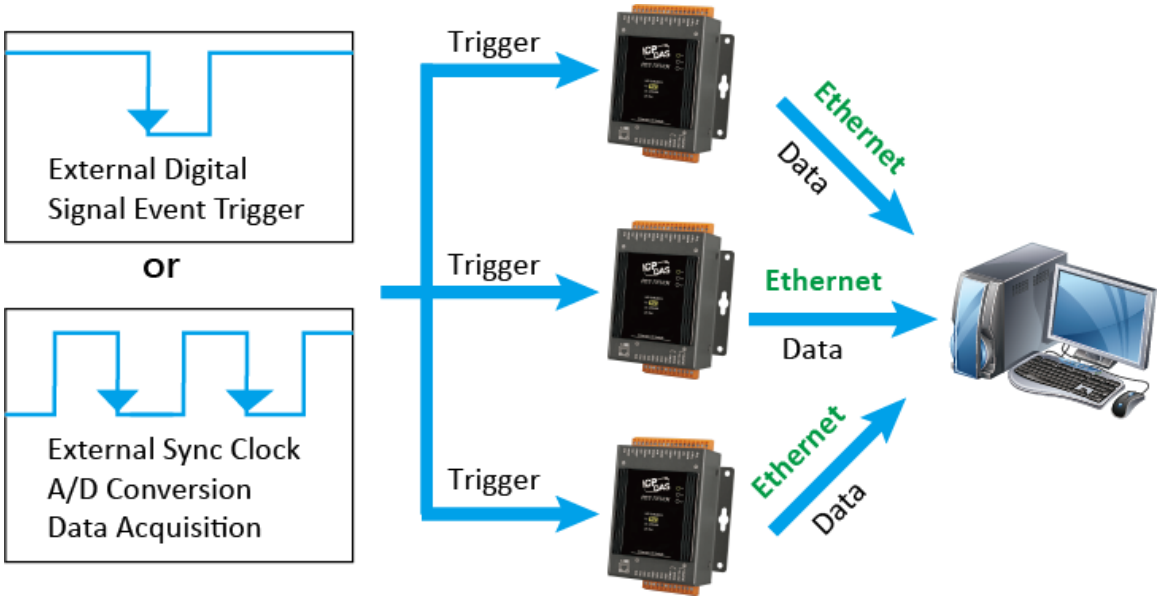
4. Entering-Range: Trigger when the signal enters the high and low level region, collect N data





A/D Sync Trigger between Multiple Modules

The A/D acquisition parameters are configured via a command from the Host PC, and are triggered by an external digital signal event, the A/D acquisition of N data samples, or A/D acquisition via the synchronization of an external clock signal.



Synchronous Counter Input

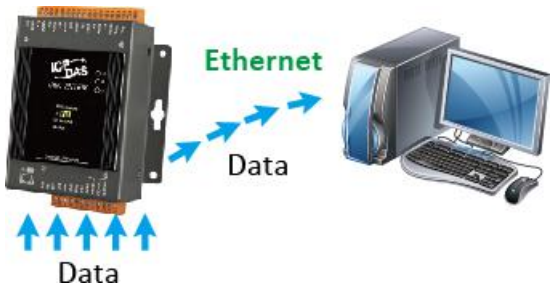
The PET-7h16M is equipped with 4-channel low-speed counters and 1-channel high-speed counter. It can be set to read the counter input synchronously with the A/D sampling time. The counter inputs can be read asynchronously by the software at any time and the counter inputs are also read synchronously with the analog input at the set sampling time. The high speed counter input is the same channel as the hardware trig + / trig- input. If the trig + / trig- input is set to the counter input. External digital signal event triggering and external clock A/D conversion data acquisition cannot be used.

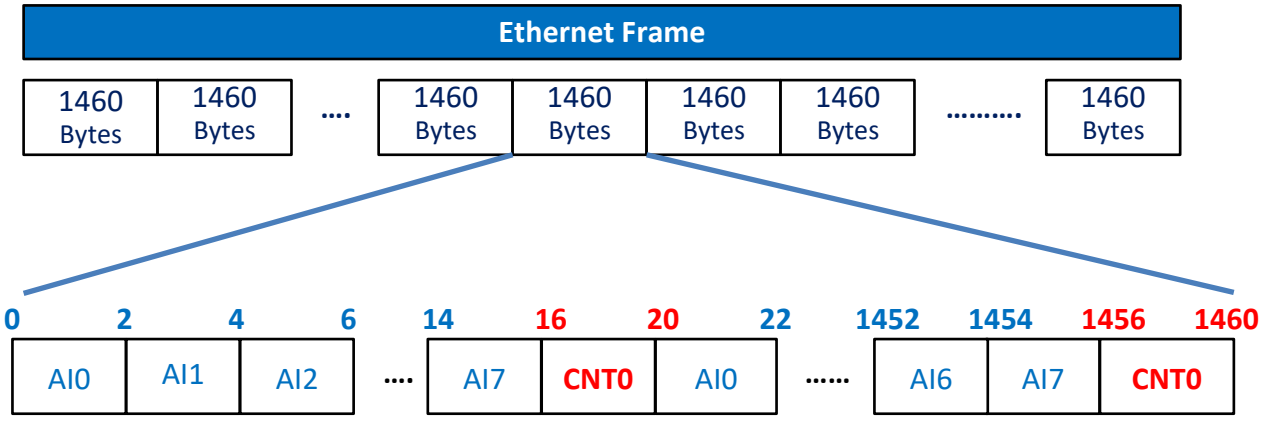
Synchronous Data Acquisition for Multiple Input Types

The features of the previous 1~4 are all about A/D high-speed acquisition, data transmission and trigger mode. In addition to the high-speed acquisition of the analog input, other digital input/digital output read-back and counter input can also be read simultaneously, and these acquisition data can also be transferred to the Host PC with the Analog input sampling data. It is flexibly to define different input types into the Ethernet data frame of synchronous input data acquisition. In synchronous input data acquisition, the sampling rate can be 2KHZ Max.

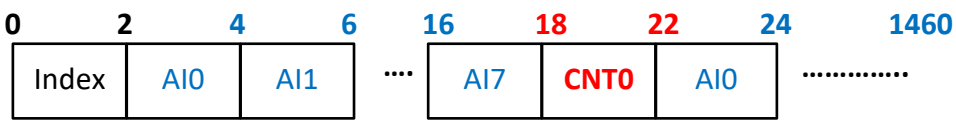
The Transmit packet of the synchronous input data acquisition is embedded in the Ethernet frame with user-defined data frames. Here are some examples below

1. The following user-defined frame consists of 8-channel AI value and 1-channel high-speed counter value.



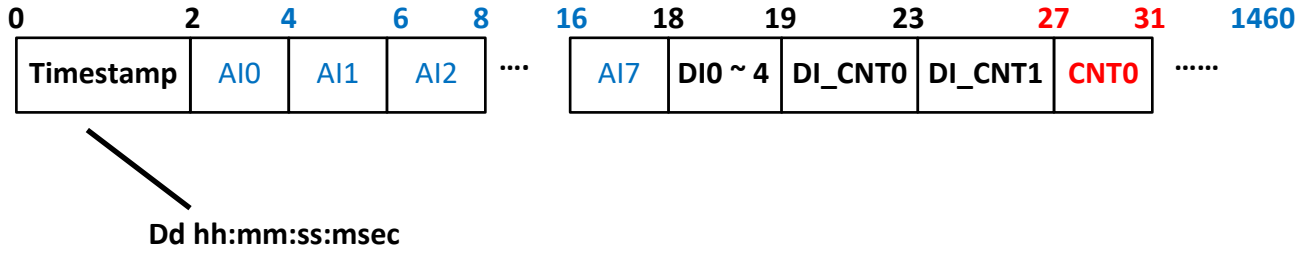


2. The following user-defined frame consists of the index header, 8-channel AI value and 1-channel high-speed counter value.



Index is a 16-bit integer serial number from 0 to 65535

3. The following user-defined frame consists of a timestamp header, an 8-channel AI value, a 4-channel DI value, a 2-channel low-speed counter value, and a 1-channel high-speed counter value.



Built-in Web Server

Each PET-7H16M module has a built-in web server that allows users to easily configure, monitor and control the module from a remote location using a regular web browser.

Communication Security

Account and password are required when logging into the PET-7H16M web server. An IP address filter is also included, which can be used to allow or deny connections with specific IP addresses.

Modbus/TCP Protocol

The Modbus/TCP slave function on the Ethernet port can be used to provide data to remote HMI/SCADA software built with Modbus/TCP driver.

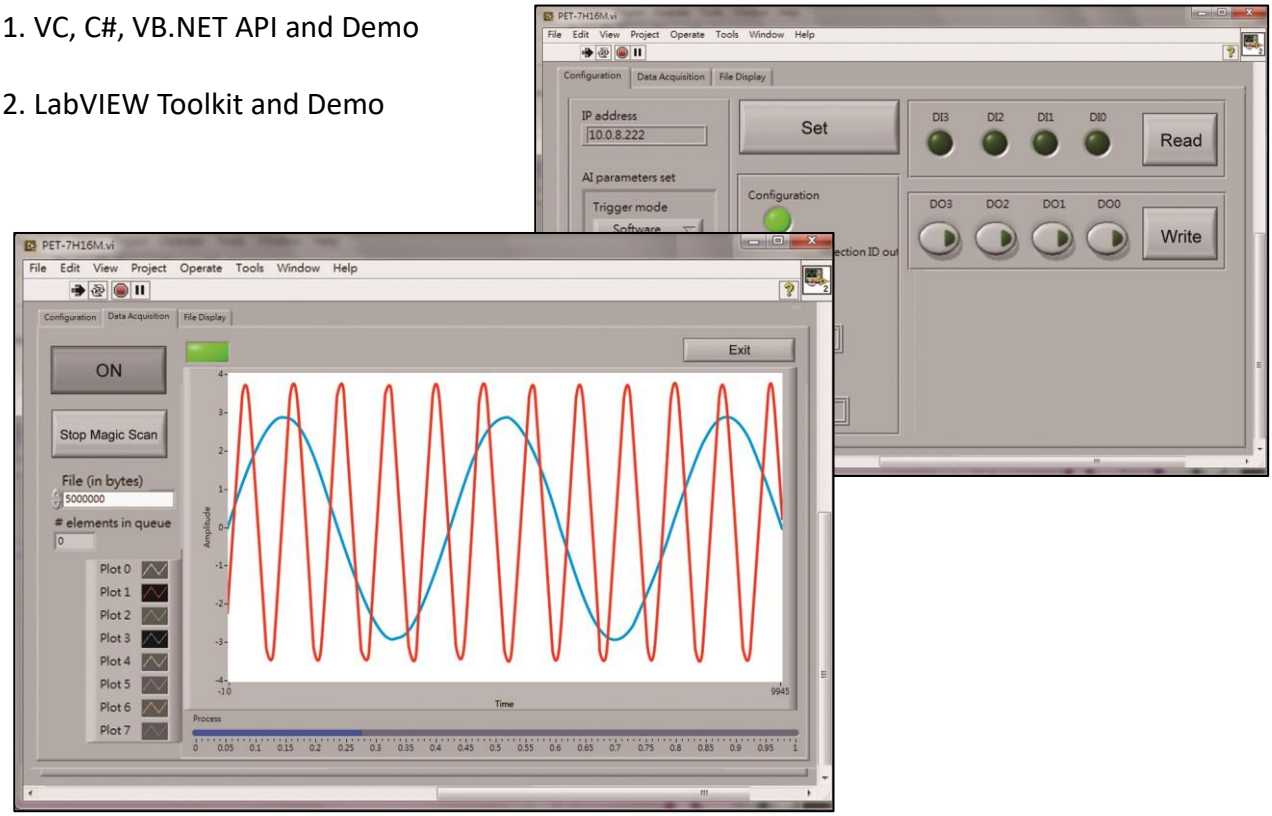
Automatic MDI/MDI-X Crossover for Plug-and-play

RJ-45 port supports automatic MDI/MDI-x that can automatically detect the type of connection to the Ethernet device without requiring special straight or crossover cables.

Software Support

1. VC, C#, VB.NET API and Demo

2. LabVIEW Toolkit and Demo



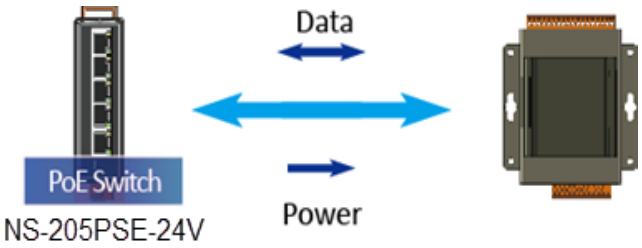
Highly Reliable Under Harsh Environment

PET-7H16M is housed in a metal shell/case with a column-like ventilator that helps to cool the working environment inside the shell/case.

- Operating Temperature: -25 ~ +75 °C
- Storage Temperature: -30 ~ +80 °C
- Humidity: 10 ~ 90% RH (non-condensing)

PoE

The PET-7H16M module has integrated Power-over-Ethernet (PoE), it allows power and data to be carried over a single Ethernet cable, so a device can operate solely from the power it receives through the data cable. This innovation allows greater flexibility in office design, higher efficiency in systems design, and faster turnaround time in set-up and implementation. The PET-7H16M module feature true IEEE 802.3af-compliant (classification, Class 2) Power over Ethernet (PoE) using both Ethernet pairs (Category 5 Ethernet cable). The PET-7H16M module can receive power from an auxiliary power sources like AC adapters and battery in addition to the PoE enabled network. This is a desirable feature when the total system power requirements exceed the PSE's(power sourcing equipment) load capacity. Furthermore, with the auxiliary power option, the PET-7H16M module can be used in a standard Ethernet (non-PoE) system.



When using PoE devices like PET-7H16M, you can choose ICP DAS “PoE” switch —”NS-205PSE” as the power source, NS-205PSE automatically detects the connected devices whether they are PoE devices or not. This mechanism ensures NS-205PSE to work with both PoE and non-PoE devices coordinately at the same time.

Being as a power source for PoE devices, NS-205PSE requires its power input ranging from +46 ~ +55VDC.

1.2. Specification

The table below summarizes the specifications of the PET-7H16M.

Software Specification

Software	
OS	Windows 7/8/10/11 and Linux
Software	Windows • Microsoft VC, C#, VB.NET SDK API and Demo • Python Demo • NI LabVIEW Toolkit and Demo Linux • C/C++ library and Demo • .NET library and Demo • Python Demo
Utility	Configuration, graphically display and data logging

System Specification

Communication	
Ethernet Port	1 x RJ-45, 10/100 Base-TX
PoE	IEEE 802.3af,class 2
Security	ID, Password and IP Filter
Protocol	TCP Streaming (Access data by SDK library) Modbus TCP
LED Indicators	
for System Running	Yes
for Ethernet Link/Act	Yes
for POE Power	Yes
2-Way Isolation	
I/O	2500 VDC
EMS Protection	
ESD (IEC 61000-4-2)	4 kV Contact for Each Terminal and 8 kV Air for Random Point
EFT (IEC 61000-4-4)	+/-4 kV for Power
Surge (IEC 61000-4-5)	+/-0.5 kV for Power

System Specification

Power	
Reverse Polarity Protection	Yes
Powered from Terminal Block	+12 ~ +48 VDC
Consumption	2.6 W
Mechanical	
Dimensions (W x L x H)	97 mm x 120 mm x 46.5 mm
Installation	DIN-Rail or Wall Mounting
Enclosures	Metal
Environment	
Operating Temperature	-25 ~ +75 °C
Storage Temperature	-30 ~ +80 °C
Humidity	10 ~ 90 % RH, Non-condensing

I/O Specification

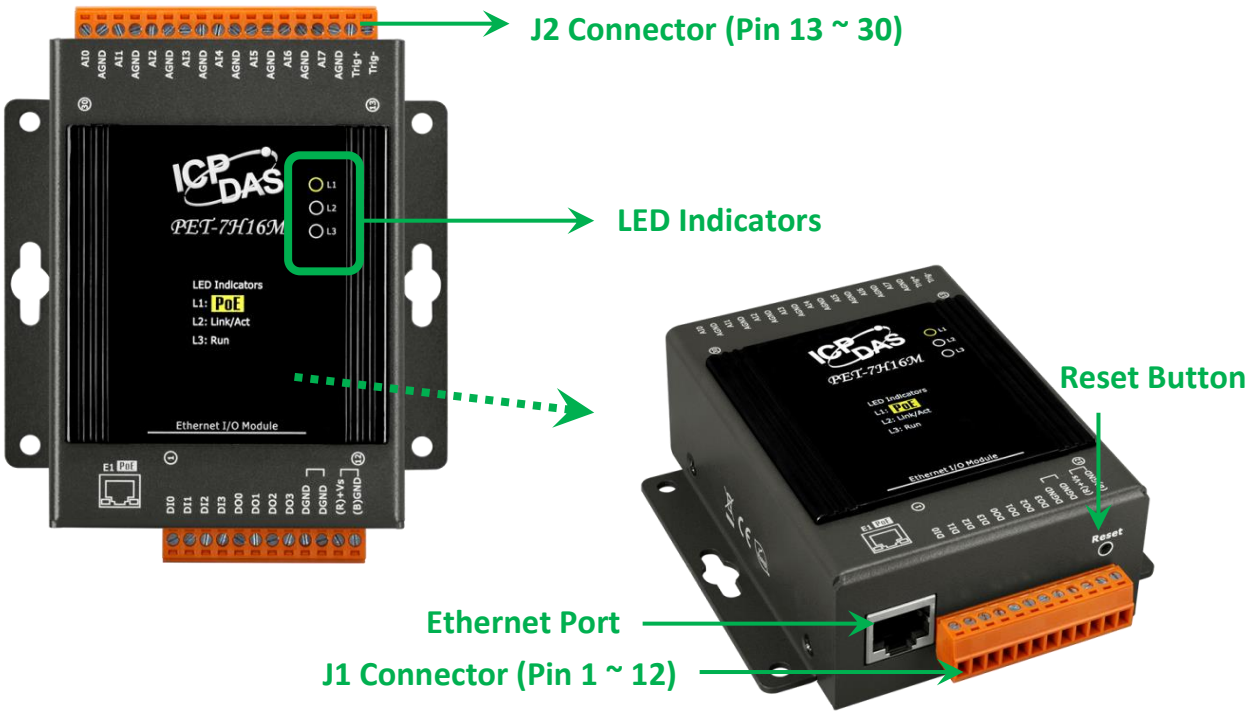
Analog Input		
Channels		8 Single-ended
Resolution		16-bit
Sampling Rate		200 KS/s (Each Channel)
Bipolar Input (Programmable)		+/- 10 V, +/- 5 V
FIFO Size		2 K Sample
Accuracy		0.05 % FSR @ ±10 V, ±5 V
AD Trigger Mode (Programmable)		Software/External clock trigger/Digital trigger (Post/Pre-trigger/Delay-trigger)，Analog Threshold trigger
Digital Input		
Channels		4
Contact		Wet Contact
Sink/Source (NPN/PNP)		Sink/Source
On Voltage Level		+5 VDC ~ 30 VDC
Off Voltage Level		1 VDC Max.
Counters	Max. Count	4,294,967,285 (32 bits)
	Max. Input Frequency	1KHz

I/O Specification

Digital Output		
Channels		4
Type		Isolated Open Collector
Sink/Source(NPN/PNP)		Sink
Load Voltage		+5 VDC ~ 30 VDC
Load Current		100 mA
Short-circuit Protection		Yes
Overload Protection		1.3A
External Clock Trigger		
Clock Rate		30KHz Max. (for continuous acquisition mode)
External Digital Trigger / Digital Trigger		
Trigger Pulse Width		1.5 µs Min.
Trigger Type		Falling edge
On Voltage Level		+5 VDC ~ 5.5 VDC @ 15 mA
Off Voltage Level		<0.8 VDC
External Digital Trigger / Digital Trigger		
Counters	Max. Count	4,294,967,285 (32 bits)
	Max. Input Frequency	30KHz

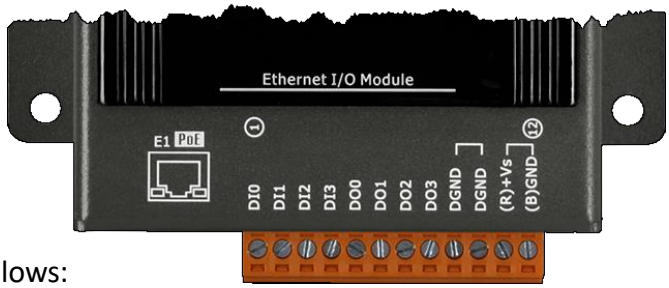
1.3. Overview

PET-7H16M is equipped with several interfaces and peripherals that can be integrated with external systems. Here is an overview of the components and its descriptions.



JP1 Connector

The JP1 connector has 12 pins arranged in 1 row. For more detailed information regarding the pin assignments of the J1 Connector, please refer to “1.2. Specification”

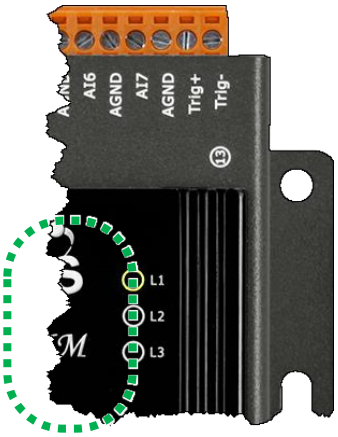


The pin assignments of the connector are as follows:

Signal	Direction	Description
DI0 ~ DI3	Input	Digital Input channels 0 to 3.
DO0 ~ DO3	Output	Digital Output channels 0 to 3.
DGND	-	Digital Ground.
(R) +Vs	(R) +Vs	Power Input (+12 ~ +48 VDC)
(B) GND	(B) GND	

LED Indicators

The PET-7H16M has 3 LED indicators shown as below.



LED Indicator		LED Action	Meaning
L1	PoE	ON	When unit power is supplied via PoE.
L2	Link/ACT	ON	Ethernet link detected
		OFF	No Ethernet link detected
		Flashing	Ethernet packet received
L3	RUN	Flashing	Firmware is running

Tips & Warnings

If the Run LED does not display the information as above, the following steps should be taken:

Step 1: Switch the power off

Step 2: Switch the power on and double-check the LED indicators

Ethernet Port

The PET-7H16M has an Ethernet port that can be connected to a computer or device via an Ethernet cable.

The L2 indicators display the status of the Ethernet port.

JP2 Connector

The JP2 connector has 18 pins arranged in 1 row. For more detailed information regarding the pin assignments of the J2 Connector, please refer to “1.2. Specification”

The pin assignments of the connector are as follows:

Signal	Direction	Description
AI0 ~ AI7	Input	Analog Input channels 0 to 7. For single-ended measurements, each signal is an Analog Input voltage channel.
AGND	-	Analog Input Ground. These terminals are reference point for single-ended AI measurements.
Trig+	Input	One external trigger(Support for external clock trigger/digital trigger)
Trig-		

Reset Button

The Reset button provides user with a quick and easy way to resort the default setting.

Press the Reset button continuously for 5 seconds, and then release it. The device will restore to factory default settings.

The table below lists the default settings after pressing reset button.

Network Settings

Data Item	Factory Default Settings
IP	192.168.255.1
Gateway	192.168.0.1
Mask	255.255.0.0
DHCP	Disable

Gain/offset value of AI calibration

Factory Default Setting
Original factory calibration value

Account Management

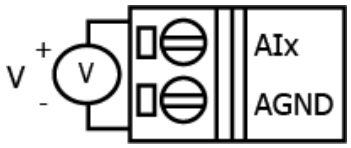
Factory Default Setting
A default user account consists of an account name “Admin” and a password “Admin”.

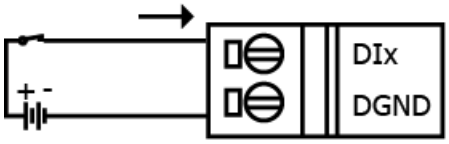
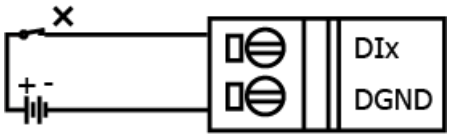
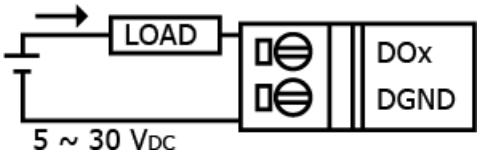
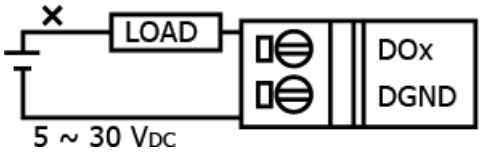
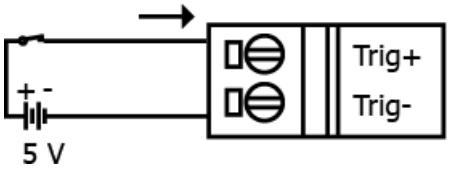
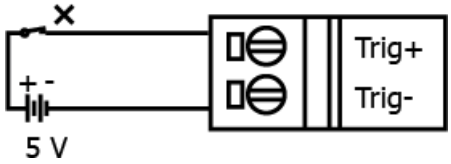
Accessible IP Settings

Factory Default Setting
Empty, there is no limit to allow any outgoing access.

1.4. Wiring Diagram

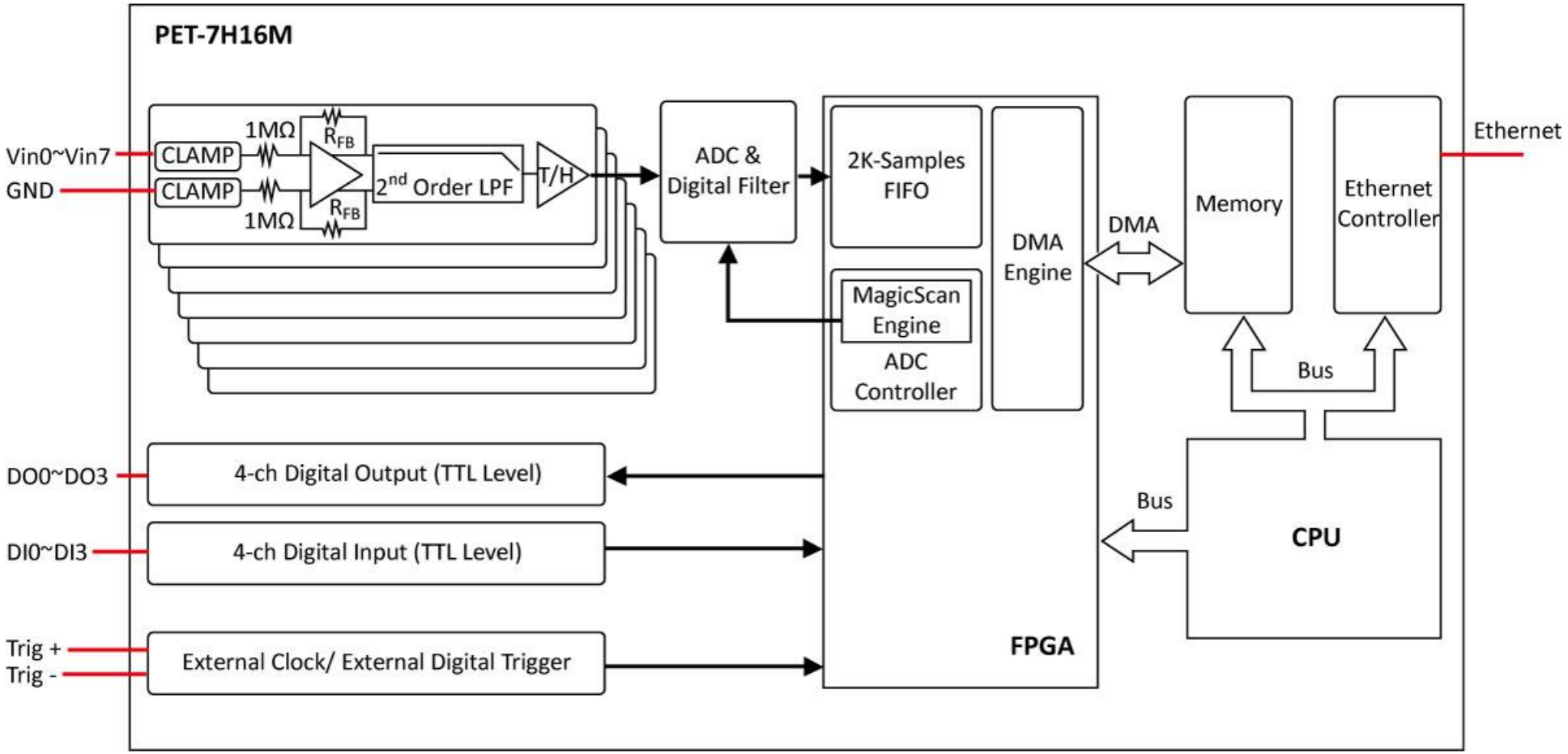
The wiring diagram of the PET-7H16M is illustrated on the following figure.

Analog Input (Voltage)


Digital Input/Counter	ON State Readback as 1	OFF State Readback as 0
Wet Contact (Sink)		
Digital Output	**ON State Readback as 1**	**OFF State Readback as 0**
Open Collector (Sink)		
External Clock Trigger/Digital Trigger	**ON State Readback as 1**	**OFF State Readback as 0**
Wet Contact (Sink)		

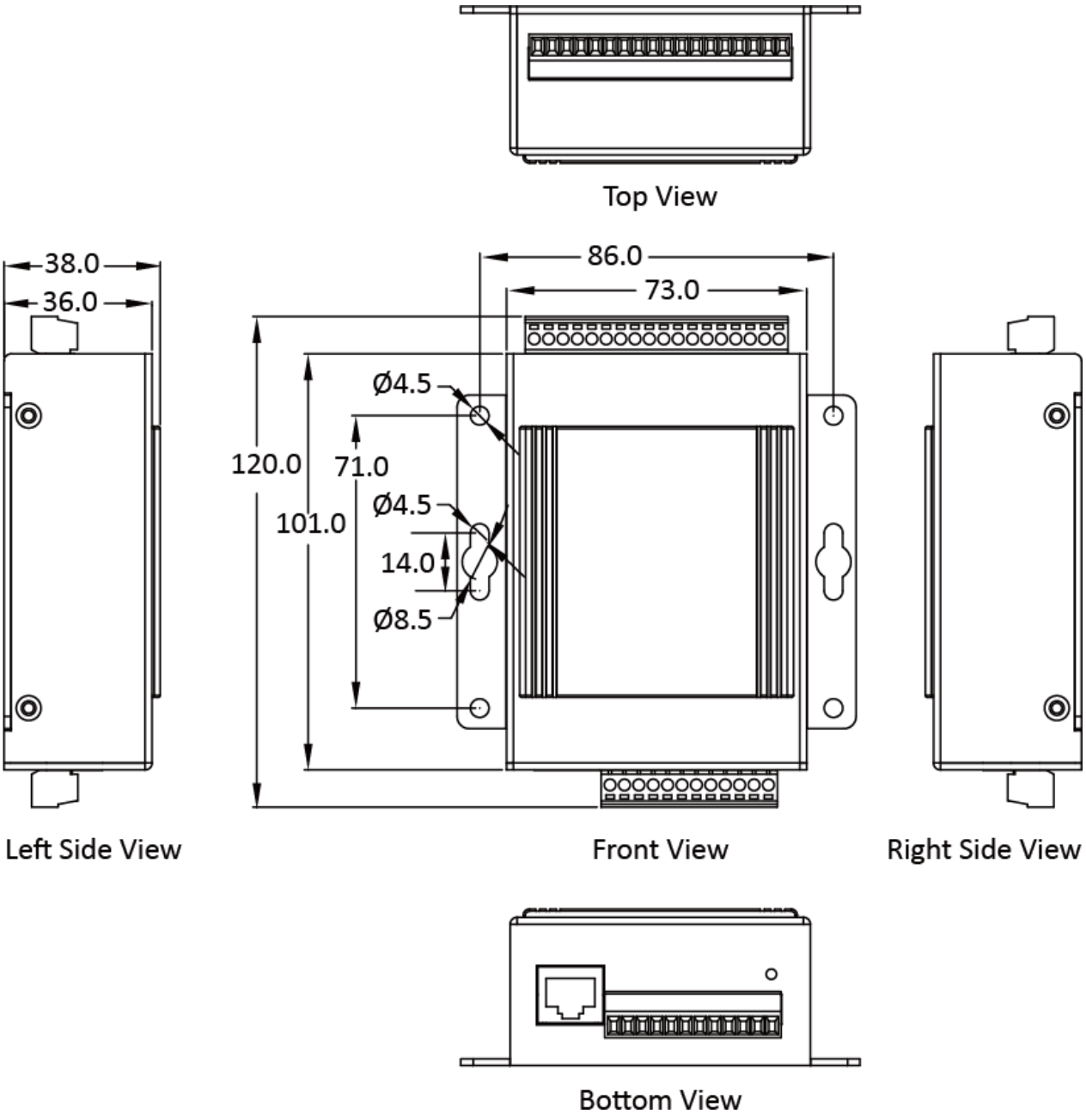
1.5. Block Diagram

PET-7H16M functions are illustrated in the block diagram shown here.



1.6. Dimension

The diagrams below provide the dimensions of the PET-7H16M to use in defining your enclosure specifications. All dimensions are in millimeters.



2. Getting Started

If you are a new user, begin with this chapter, it includes a guided tour that provides a basic overview of installing, configuring and using the PET-7H16M.

Before starting any task, please check the package contents. If any of the following package contents are missing or damaged, contact your dealer on distributor.

PET-7H16M

Quick Start Guide

2.4 mm Screw Driver

Before you work with the PET-7H16M, you should have a basic understanding of hardware specification, such as the dimensions, the usable input-voltage range of the power supply, and the type of communication interfaces.

For more information about the hardware details, please refer to “1.2. Specification”

For more information about the hardware dimensions, please refer to “1.6. Dimension”

2.1. Mounting the Hardware

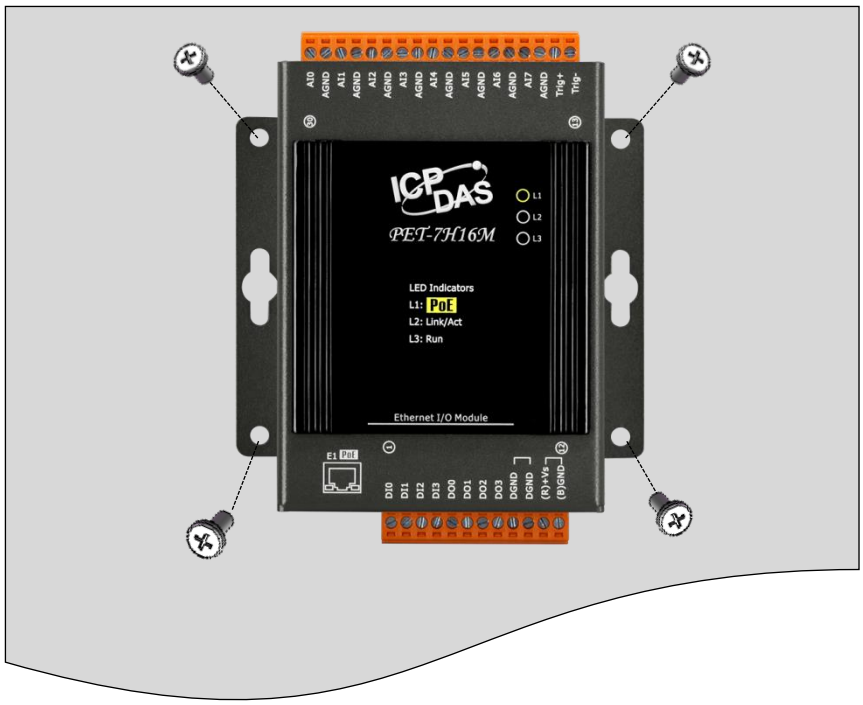
2.1.1. Mounting the PET-7H16M to a Wall/Panel

The PET-7H16M can be mounted either directly to a wall/panel.

Step 1: Use the included screwdriver to remote the DIN rail clip

Step 2: Use the included screws and a screw driver to attach the PET-7H16M to the wall/panel

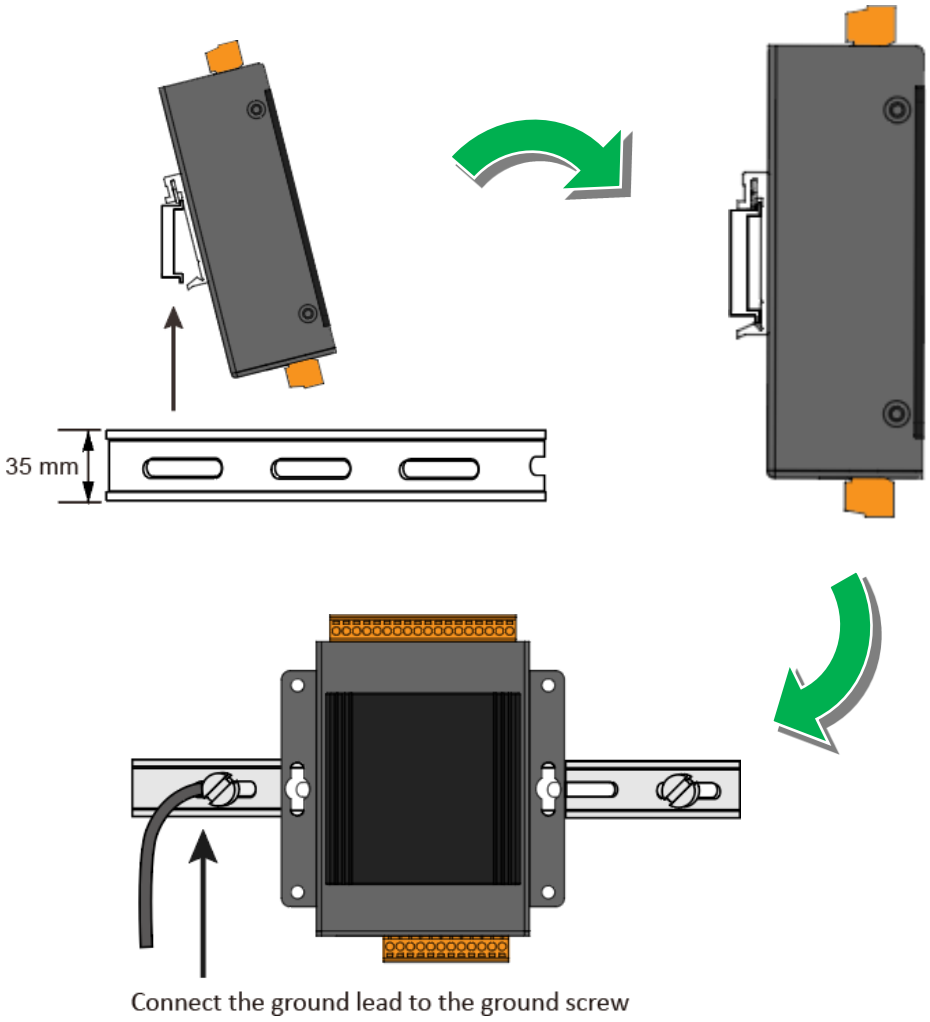
Step 3: Fasten the screws securely



2.1.2. Mounting/Removing PET-7H16M onto/from a DIN-Rail

The PET-7H16M has simple rail clips for mounting reliably on a standard 35 mm DIN rail.

To Mount the PET-7H16M onto a DIN-Rail



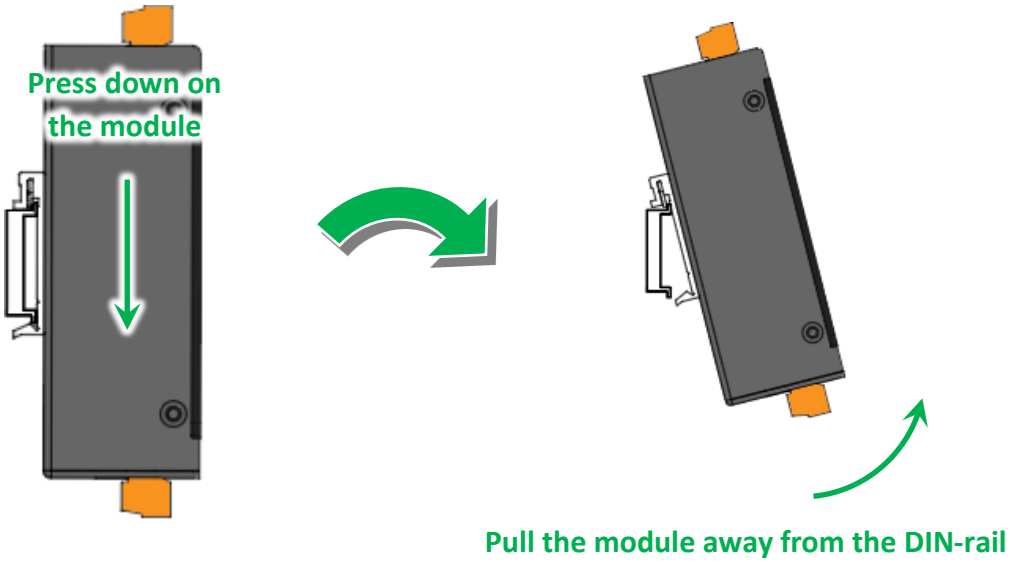
Tips & Warnings

A stainless steel DIN rail is recommended rather than an aluminum one in order to provide the most consistent earthling.

For more information on stainless steel DIN rail accessories series, please refer to https://www.icpdas.com/en/product/guide+Accessories+Others+DIN-Rail

To Remove the PET-7H16M form a DIN-Rail

Gently press down on the module and then pull the bottom of the module away from the DIN-rail clip to remove it.



2.2. Deploying a Basic PET-7H16M System

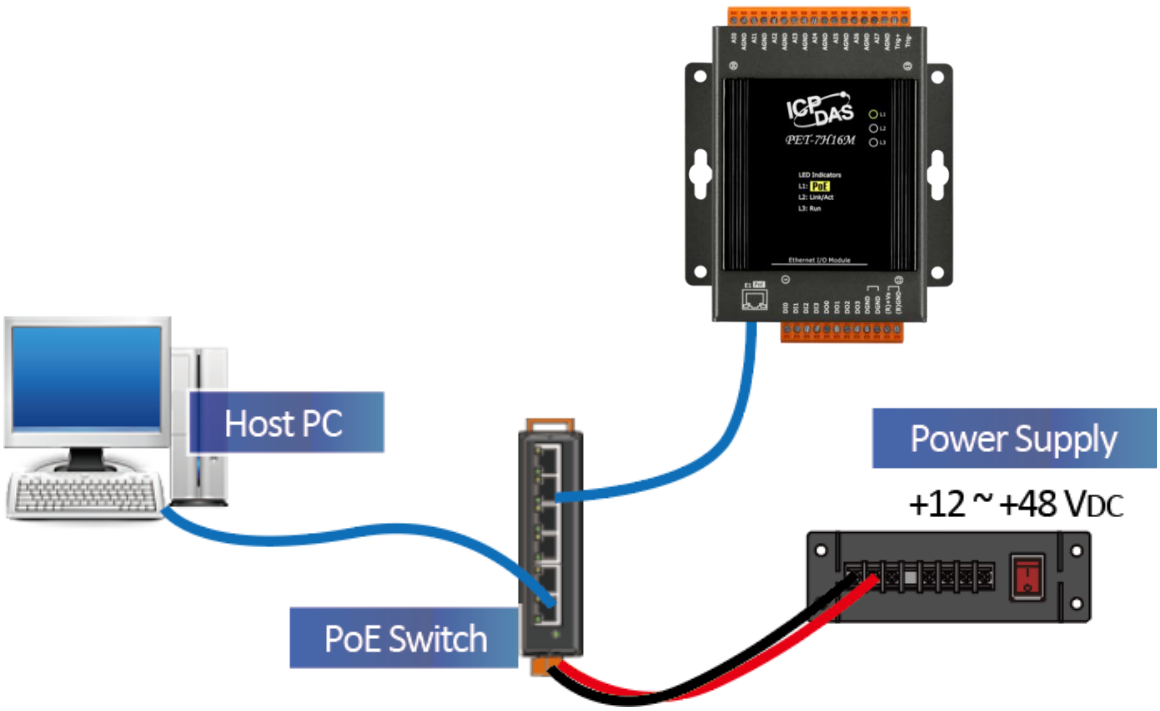
Here is a simple application for using the PET-7H16M that is shown below.

There are two ways for the PET-7H16M module getting the power. One is through Ethernet by a PoE switch; the other is as usual through wiring by an external power. External power should range from +12 VDC to 48 VDC. The reason we keep the second way is because it might be useful if someday or somehow you have different applications. PET-7H16M module is equipped with a LED, which indicates whether the power is supplied by a PoE switch.

PoE

i. Connect PC to the Ethernet port via the PoE switch.

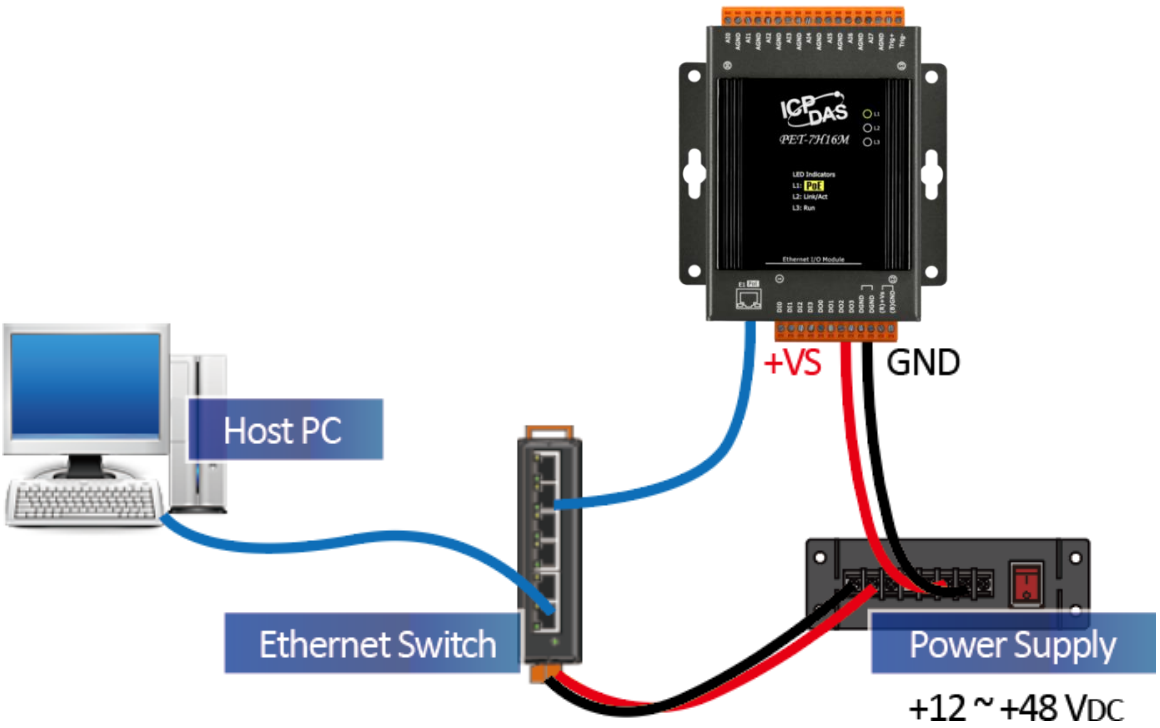
ii. Connect the power supply to the PoE switch, which supplies power to the PET-7H16M.



External Power supply

i. Connect PC to the Ethernet port via the Ethernet switch.

ii. Connect the power supply to the switch and PET-7H16M.



Tips & Warnings

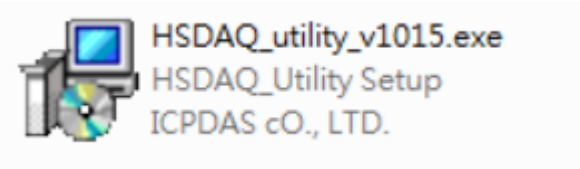
Network: connections with fewer switches between the PC and the HSDAQ device(s) can improve AI acquisition performance. It is recommended to connect the PC and the HSDAQ device(s) to the same switch/hub.

2.3. Installing the HSDAQ Utility

The HSDAQ Utility is a useful tool that provides a quick and easy way to update firmware, configure Ethernet settings, and download files to PET-7H16M from PC.

Refer to chapter 4.2. HSDAQUtility for more details.

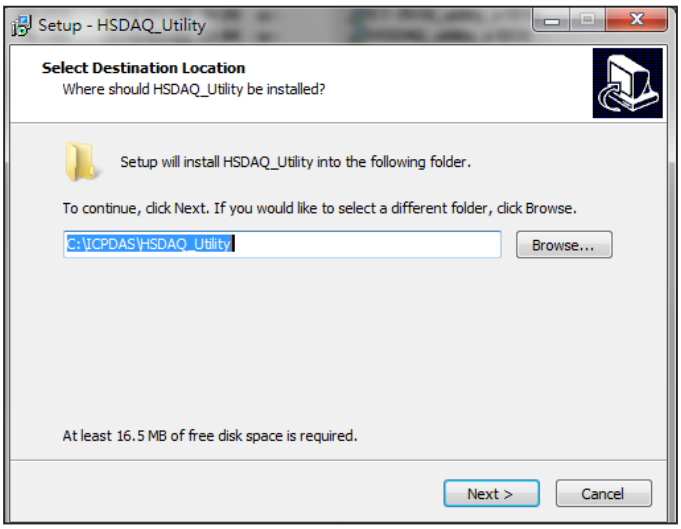
Step1: Get the HSDAQ Utility tool



The HSDAQ Utility can be obtained from our FTP site:
https://www.icpdas.com/en/download/show.php?num=2327

Step 2: Follow the prompts to complete the installation

After the installation has been completed, there will be a new short-cut for HSDAQ Utility on the desktop.



2.4. Using HSDAQ Utility to Assign an IP address

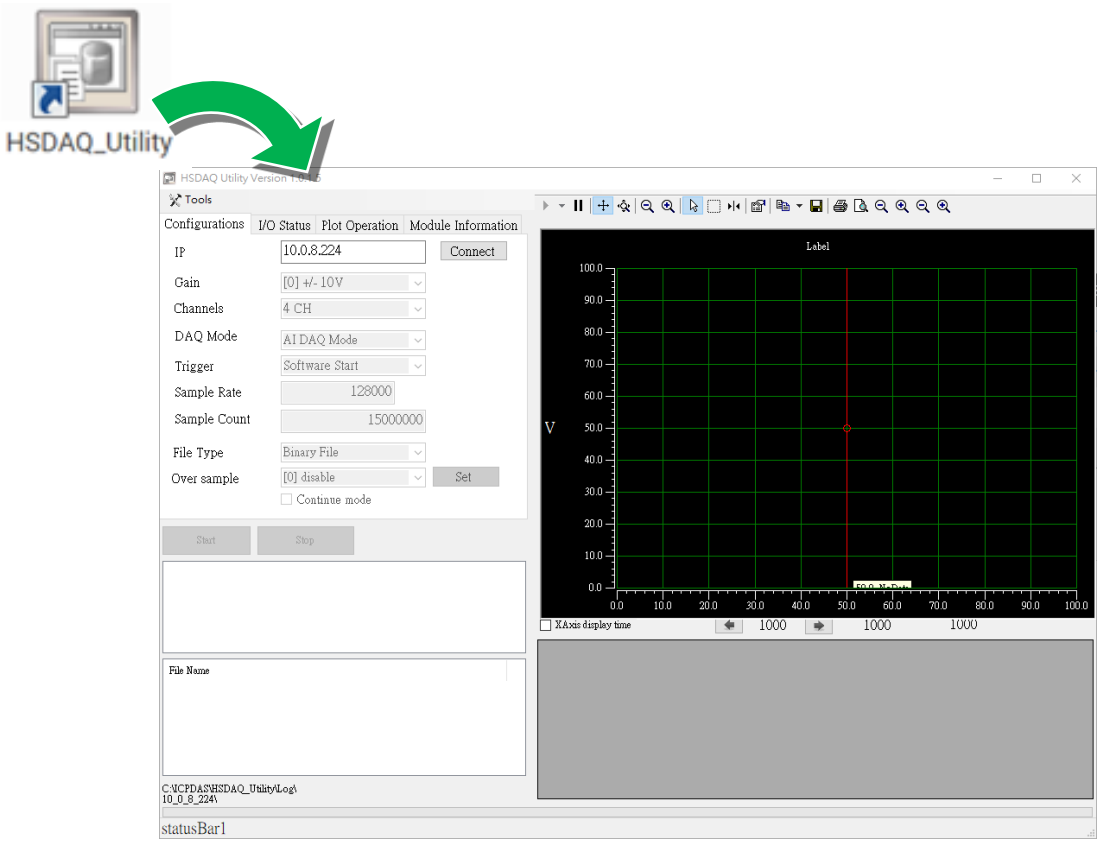
The PET-7H16M is an Ethernet device, which comes with a default IP address, therefore, you must first assign a new IP address to the PET-7H16M.

The factory default IP settings are as follows:

Item	Default
IP Address	192.168.255.1
Subnet Mask	255.255.0.0
Gateway	192.168.0.1

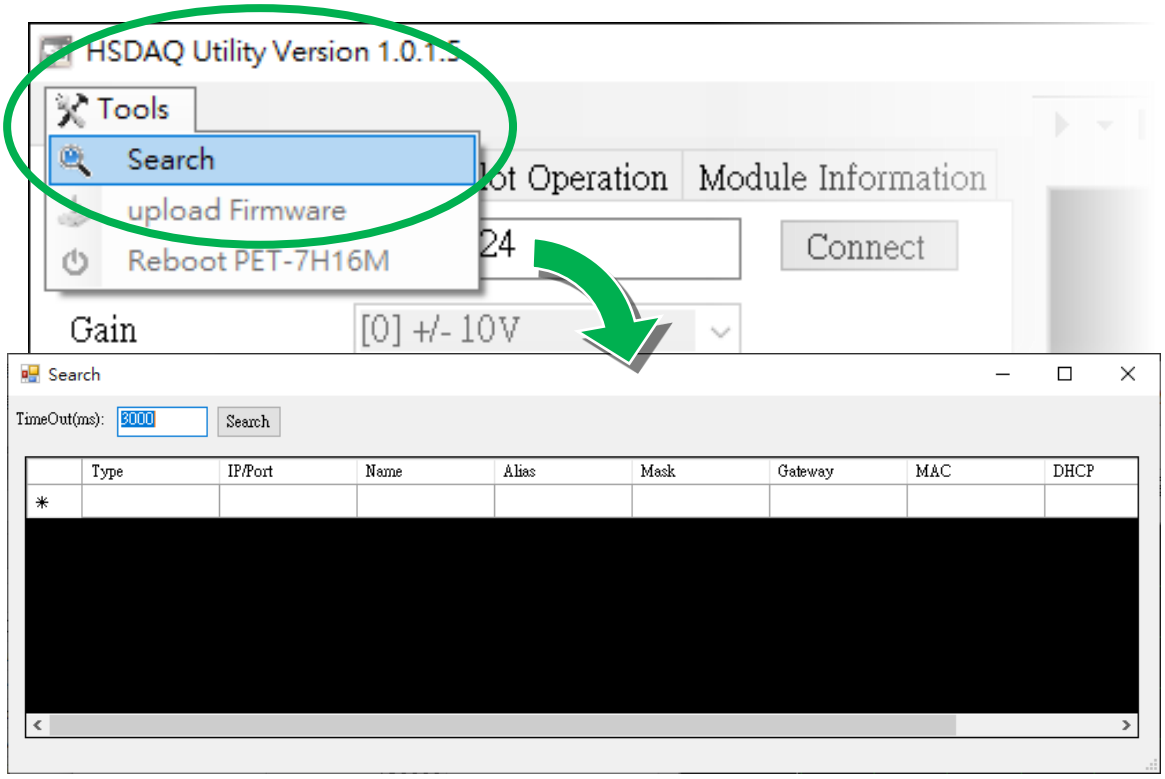
Step 1: Run the HSDAQ Utility

Double-click the HSDAQ Utility shortcut on your desktop.



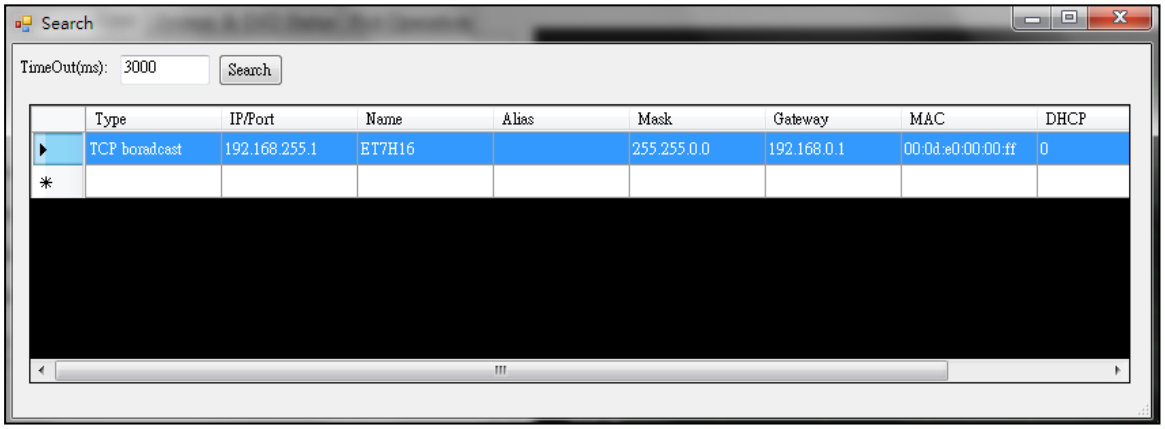
Step 2: Press choose “Search” from the “Tools” menu

After choosing Search from Tools menu, that will search all of the PET-7H16M modules on your network.



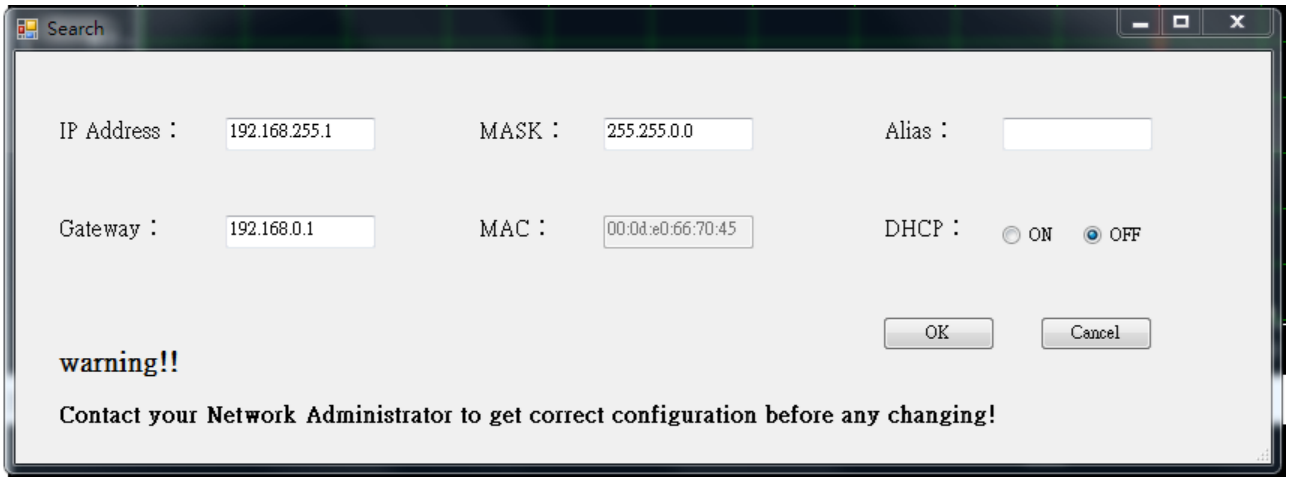
Step 3: Choose the field “192.168.255.1” and then choose “IP setting” from the toolbar

Choose default value “192.168.255.1” for fields in the list and double-click.



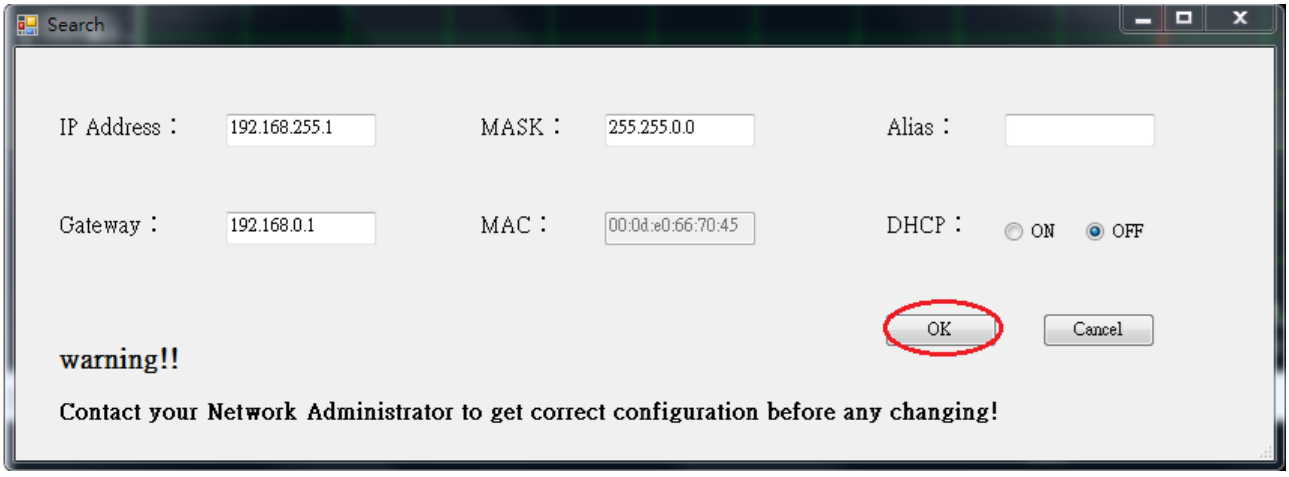
Step 4: Assign a new IP address and then choose “Set” button

You only can manually assign an IP address.



Step 5: Click “OK” button

When the setup is completed, click the "OK" button.



Step 6: Wait for PET-7H16M reboot

3. Operation

Once connected to the network, the PET-7H16M module can be remotely accessed and configured through software from anywhere on the network and the sampling data only can be acquired by software over Ethernet. So far, the device doesn't operate as a stand-along data logger. Only one TCP connection is allowed to get data from PET-7H16M at a time.

There are two different data acquisition modes and several trigger modes of analog input operation.

The following chart shows the acquisition and trigger modes and their operation frequency of each combination.

Acquisition / Trigger	Continuous	N Sample
Software AD	1 ~ 30 kHz	1 Hz ~ 200 kHz
External CLK AD	1 ~ 30 kHz	-
Analog Threshold Trigger	-	1 Hz ~ 200 kHz
Post-Trigger	-	1 Hz ~ 200 kHz
Pre-Trigger	-	1 Hz ~ 200 kHz
Delay-Trigger	-	1 Hz ~ 200 kHz
Synchronous	-	1 Hz ~ 2kHz

Tips & Warnings

Maximum 30,000,000 records in N Sample Mode

125 sec (30 kHz), 19.6 sec (200 kHz) of 30,000,000 records in software AD trigger.

3.1. Continuous Acquisition

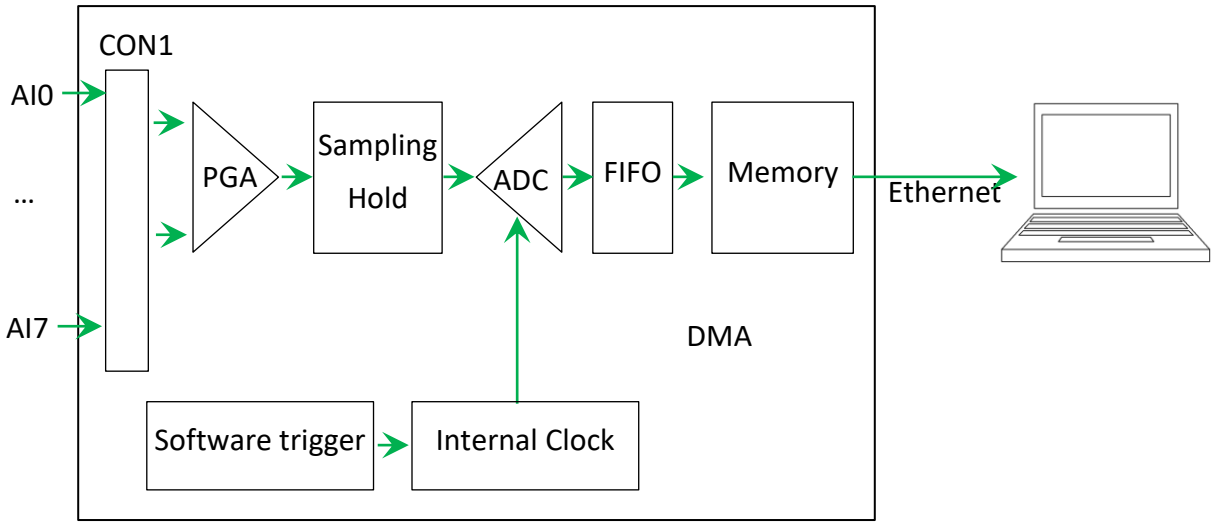
3.1.1. Software AD Trigger

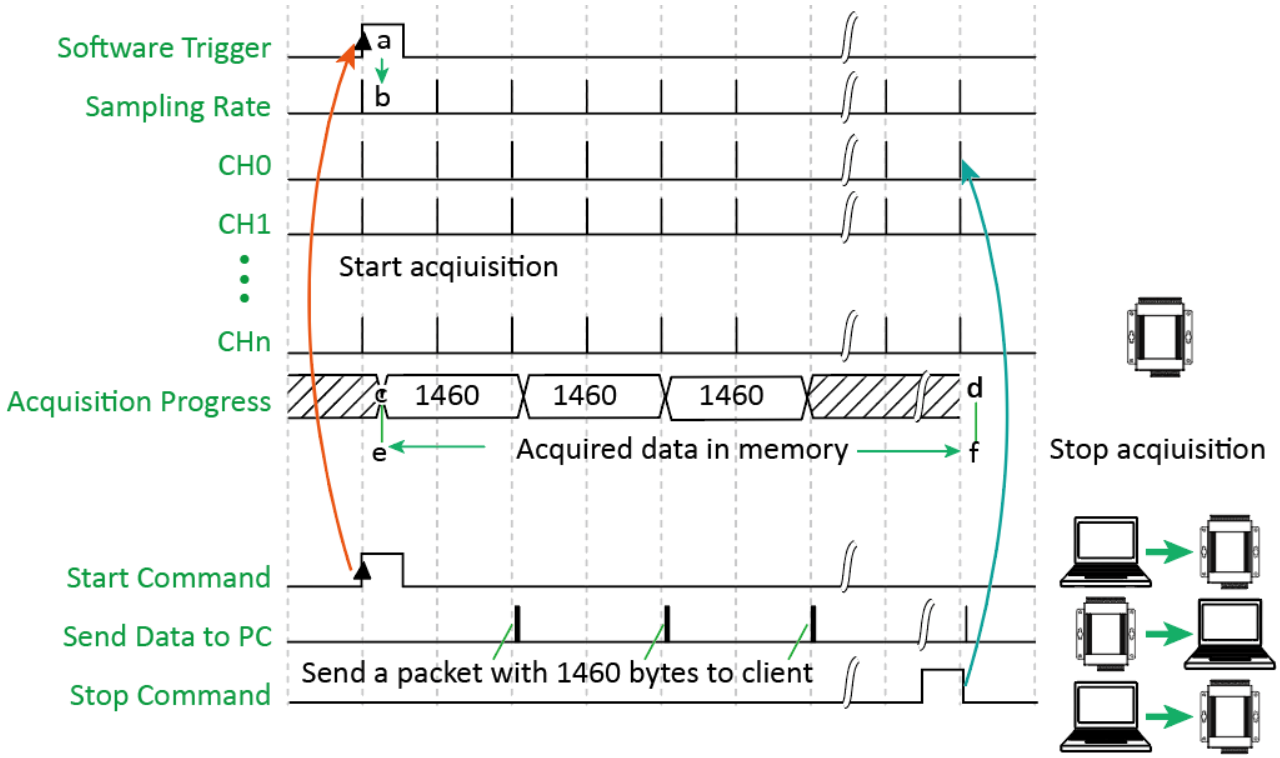
In continuous acquisition and software AD trigger, Send a start command from PC over the Ethernet to PET-7H16M to start the AD conversion. The analog input value is continuously acquired and converted to digital data. The data accumulated to a network packet size returns to the PC. The process of acquiring data is continuous until a stop command is sent over the Ethernet.

The sample rate can range from 1 to 30K Hz on local networks. (Lower over the Internet or wireless networks).

There are parameters below that need to be specified:

- Sampling rate (1~30KHz)
- Scan channels
- The trigger mode is software AD trigger




Software Trigger
Sampling Rate
CH0
CH1
CHn
Acquisition Progress
Start Command
Send Data to PC
Stop Command
a
b
Start acqiuisition
1460
1460
1460
c
d
e
f
Acquired data in memory
Stop acqiuisition
Send a packet with 1460 bytes to client

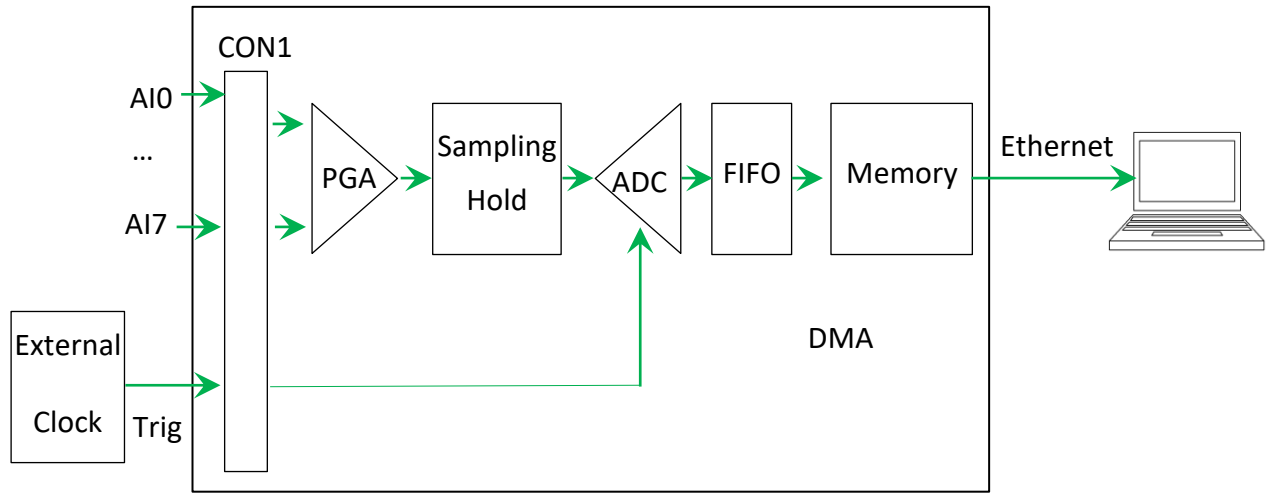
3.1.2. External clock AD trigger

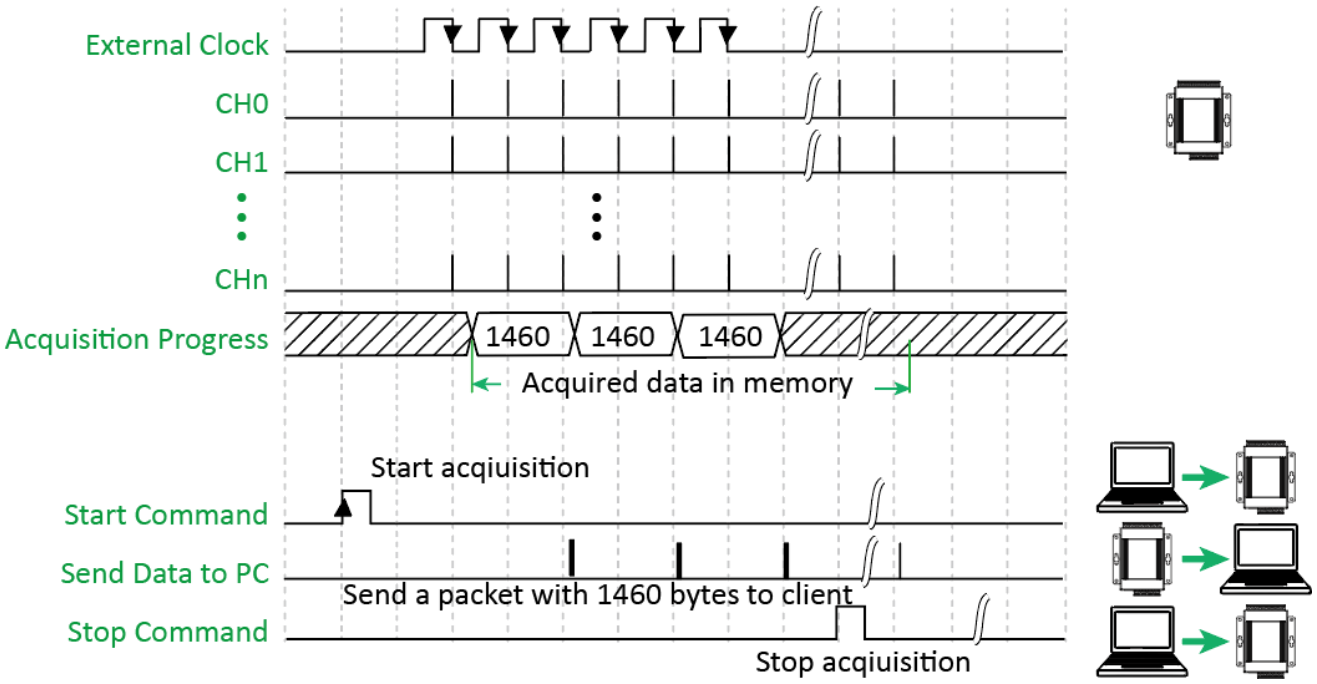
In this trigger, send a start command from PC over the Ethernet to PET-7H16M to start the acquisition. The A/D conversion is started actually when the external clock signal is input. The AI value converted to digital data followed the external clock sampling rate and the data accumulated to a network packet size returns to the PC. The process is stopped until a stop command is sent over the Ethernet.

The frequency of the external clock can range from 1~30K Hz.

There are parameters below that need to be specified:

- Scan channels
- The trigger mode is external clock AD trigger





3.2. N Sample Acquisition

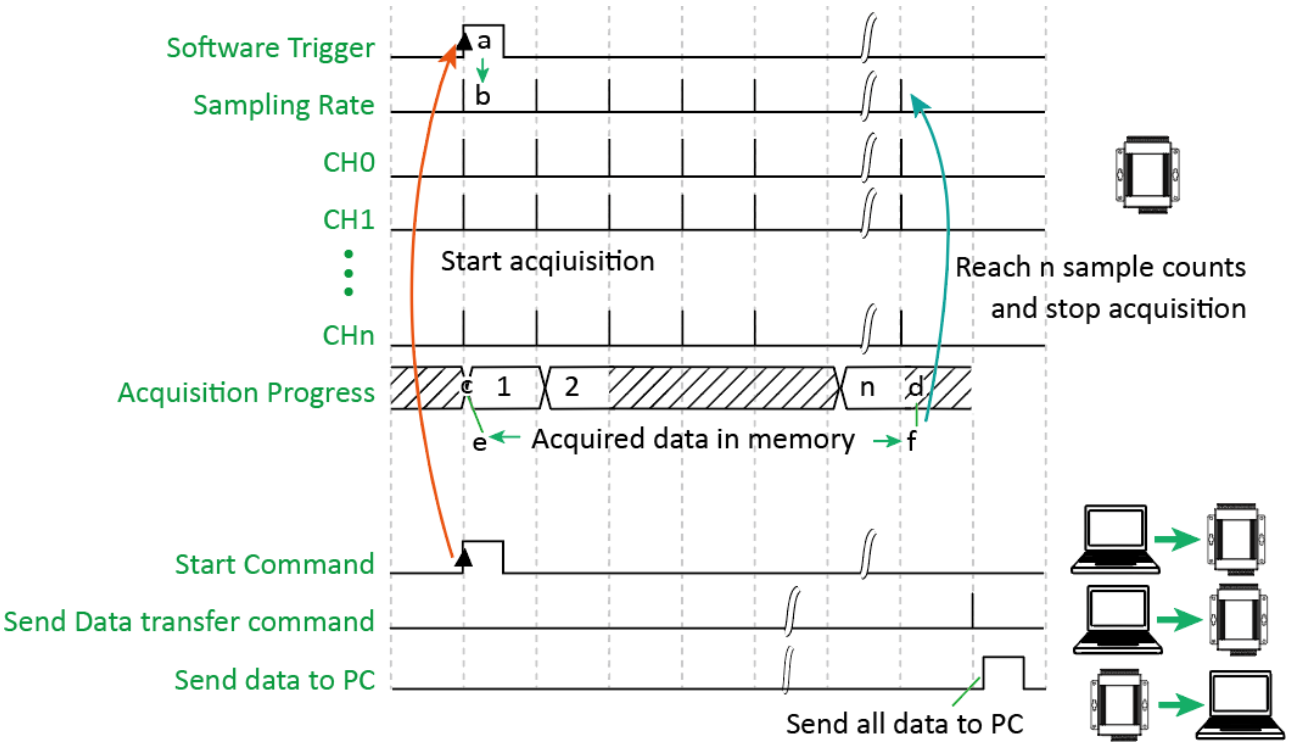
3.2.1. Software AD Trigger

In N sample acquisition and software AD trigger, Send a start command from PC over the Ethernet to PET-7H16M to start the AD conversion. The analog input value is continuously acquired and converted to digital data until the total number of samples reaches. Send a command to get the all acquisition data over the Ethernet.

The sample rate can range from 1 Hz to 200K Hz.

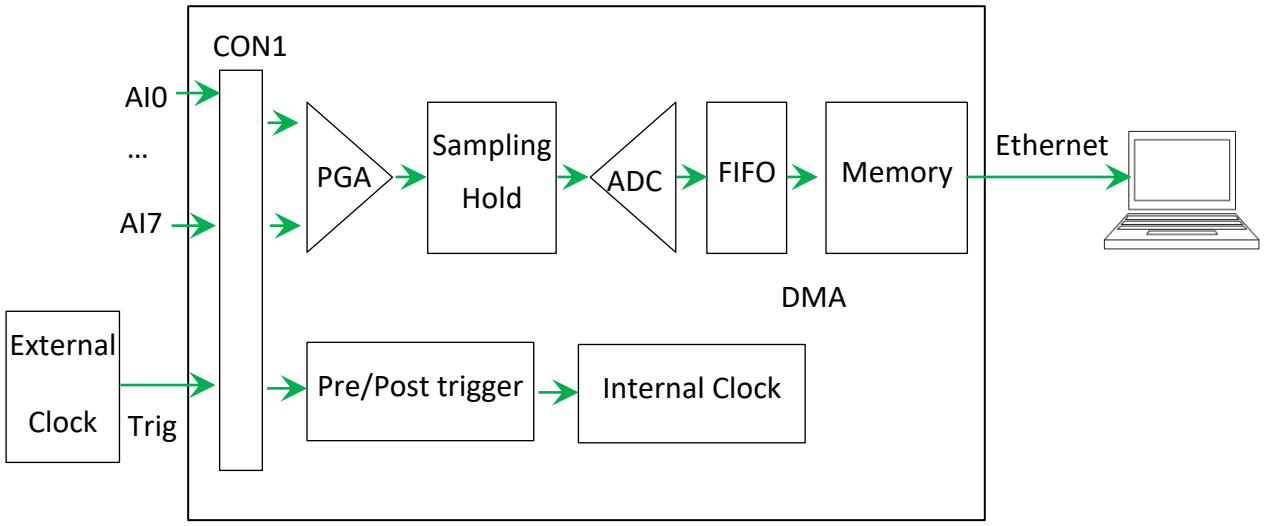
There are some parameters that need to be specified:

- Sampling rate
- Scan channels
- Sampling Count (Maximum 30,000,000 records)
- The trigger mode sets to the software AD trigger.



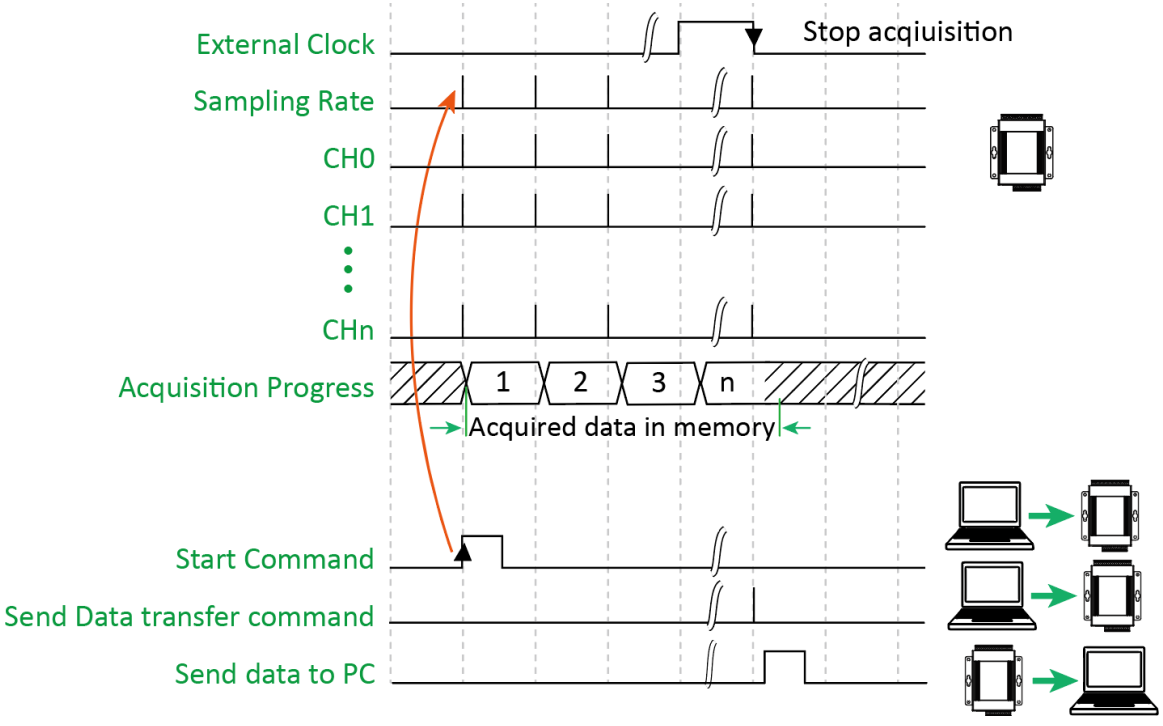
3.2.2. External Digital Trigger

There are two external digital trigger, Pre-trigger and Post-trigger.



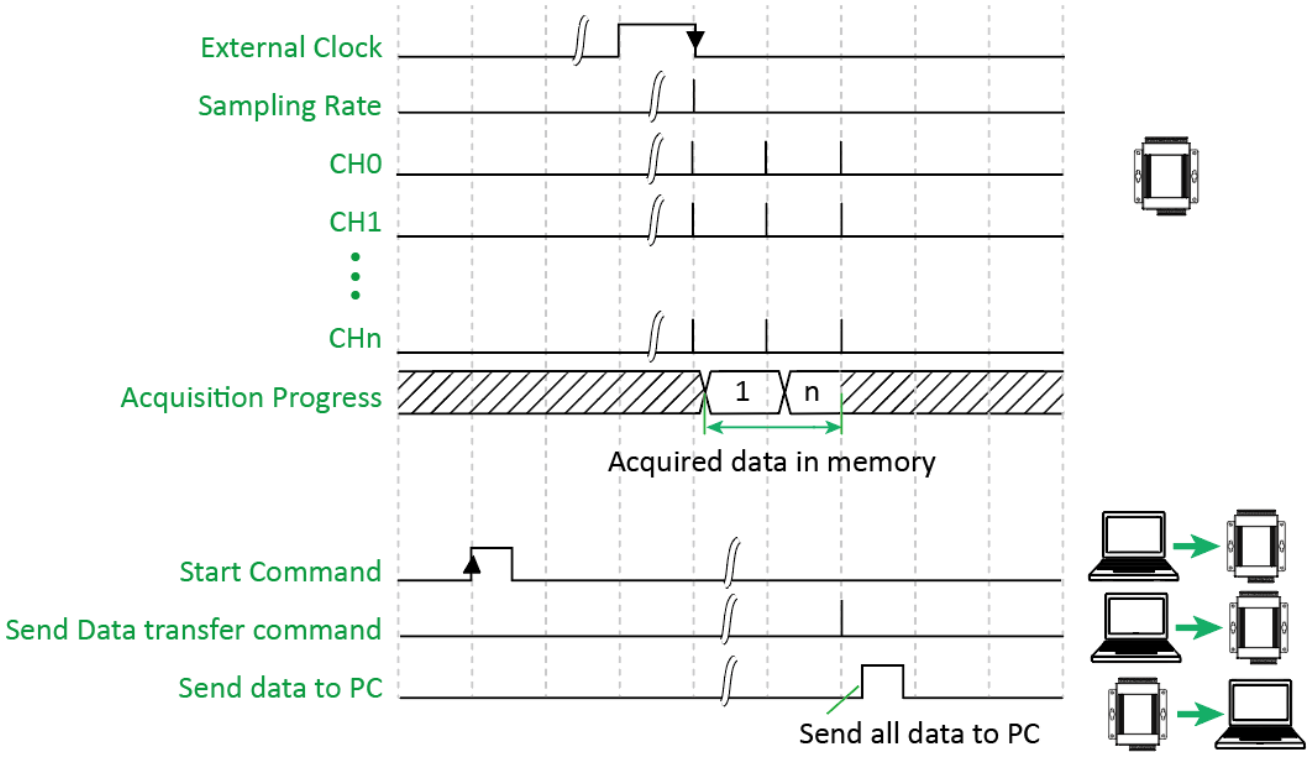
Pre-trigger

This trigger type is used when you want to collect data before an external trigger event. Send a start command from PC over the Ethernet to PET-7H16M to start the AD conversion. The analog input value is continuously acquired and converted to digital data. When the trigger event occurs, the AD conversion is stopped Send a command to get the specified sampling counts of data over the Ethernet.



Post-trigger

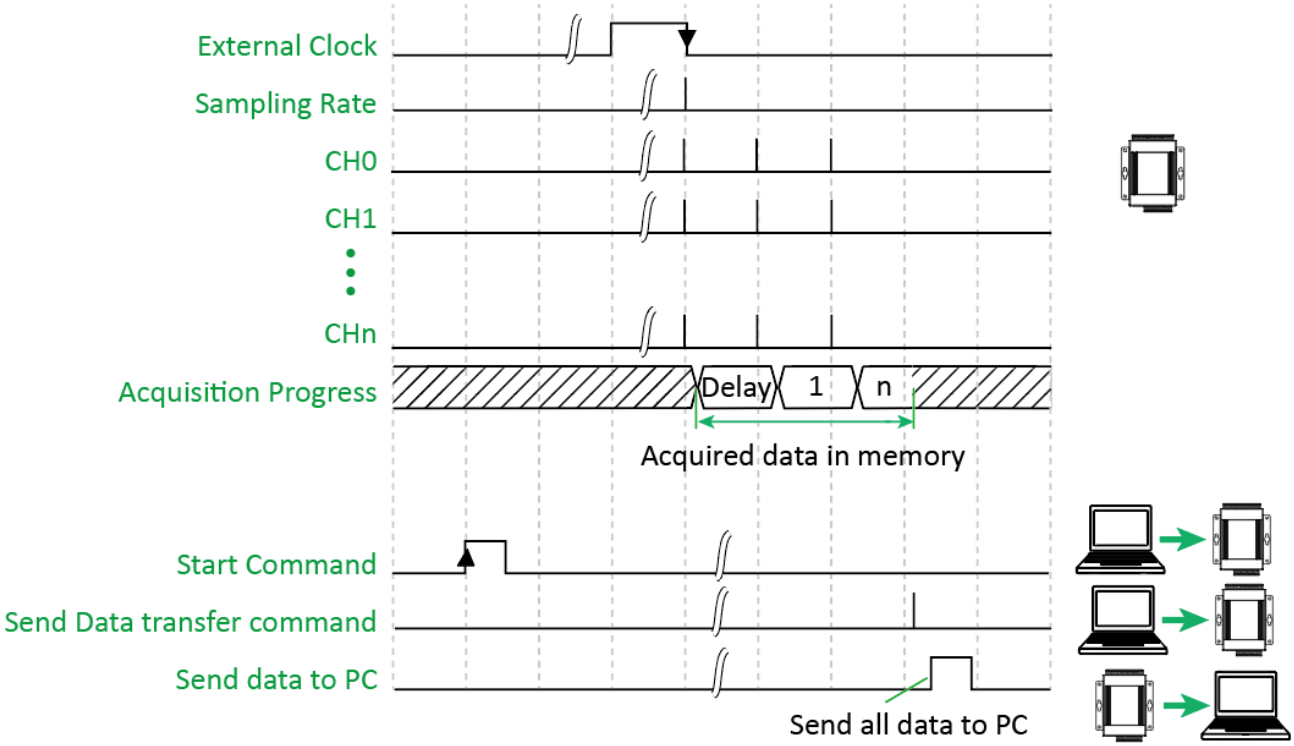
This trigger is used in application when you want to collect data after an external trigger event. Send a start command from PC over the Ethernet to PET-7H16M to start the acquisition. The A/D conversion is started actually when the external digital signal is input. The analog input value is continuously acquired and converted to digital data until the total number of samples reaches. Send a command to get the all acquisition data over the Ethernet.



Delay-trigger

After the external trigger is delayed, the data is collected after a period of time, which is suitable for this trigger mode. The PC sends a set parameter command (including delay time) to the PET-7H16M via the Ethernet network and sends a start command to start the acquisition. When an external trigger signal is input, wait until the set delay time has elapsed and start the A/D conversion. Continuously collect analog input values and convert them into digital data. When the total number of acquisitions reaches the set value, the acquisition is stopped.

Send a command to get all the collected data through Ethernet.



There are some parameters that need to be specified:

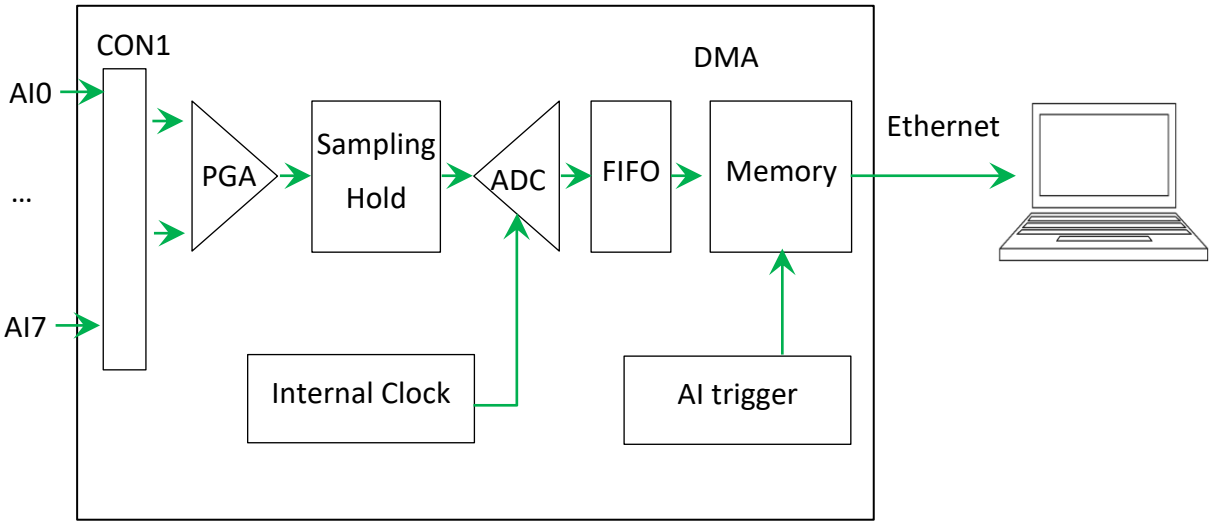
- Sampling rate (1 to 200K Hz)
- Scan channels
- Sampling Count (Maximum 30,000,000 records)
- Delay time (only for Delay-trigger)
- The trigger mode can be set to Post-trigger, Pre-trigger or Delay-trigger.
- The negative condition is allowed in digital trigger. It is used when a falling edge is detected on the digital signal. The negative condition is used when it triggers from high to low.

3.2.3. Analog Threshold Trigger

The analog threshold trigger is triggered when the input voltage signal is above or below a certain voltage setting. In addition, the analog trigger can be used to detect the instantaneous change in a continuous voltage signal. The user can specify the trigger voltage level range of the input signal. Once the range is exceeded or the voltage level is entered, the data is triggered to start collecting data.

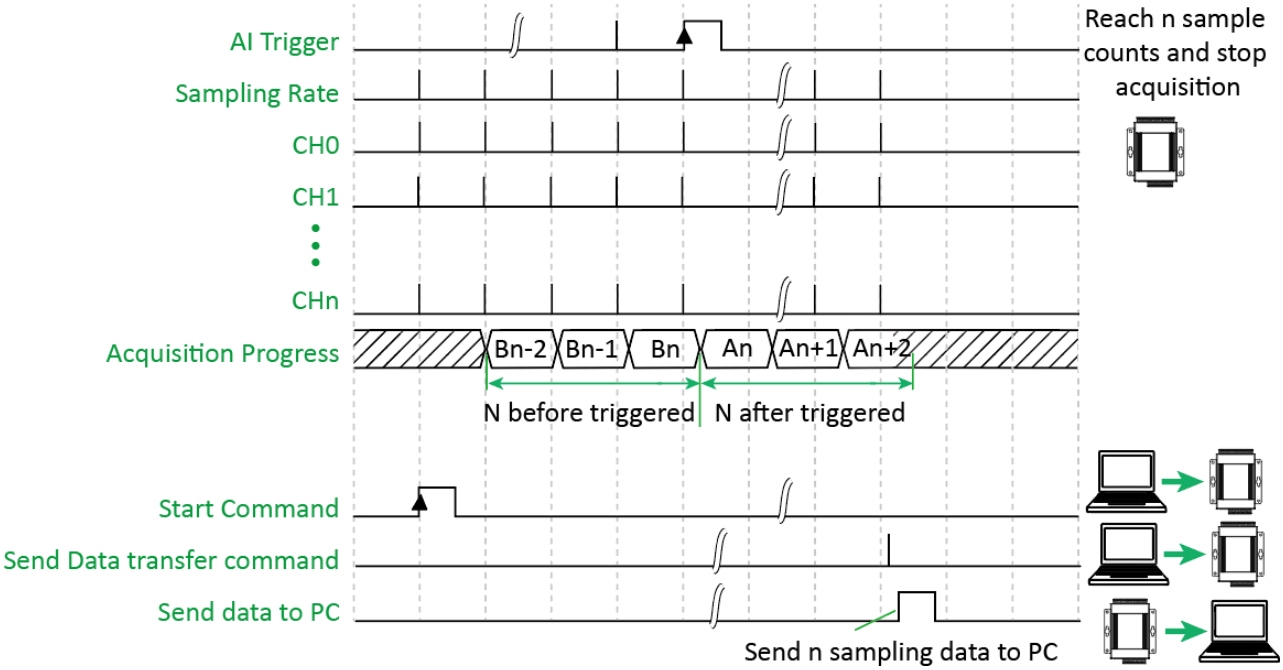
There are some conditions that to be followed.

- Higher than the value of the set voltage
- Lower than the value of the set voltage value
- Enter the range of the set voltage value
- Leave the range of the set voltage range



There are some parameters that need to be specified:

- Sampling rate (1~200KHz)
- Scan channels
- Sampling Count (Maximum 30,000,000 records)
- Set the high or low level voltage value
- Trigger mode set to analog threshold trigger
- Set the trigger conditions



3.3. Synchronous input data acquisition with flexible data frame

The synchronous input data acquisition can simultaneously read the digital input value/digital output read back value and the counter input value of the module, and then transmit the synchronously collected data to the host PC. Different input types can be flexibly defined into the

Ethernet data frame of the synchronous input data acquisition. This data network frame can also be added to a header definition. The header category is divided into two categories. The first type is the serial number of the network frame, and the first network frame number is 0. Then each network frame is sequentially added one. The second type is a timestamp.

In this acquisition mode, it is possible to set the low-speed counter (DI counter) and the high-speed counter of the module configuration to be read synchronously with the analog input.

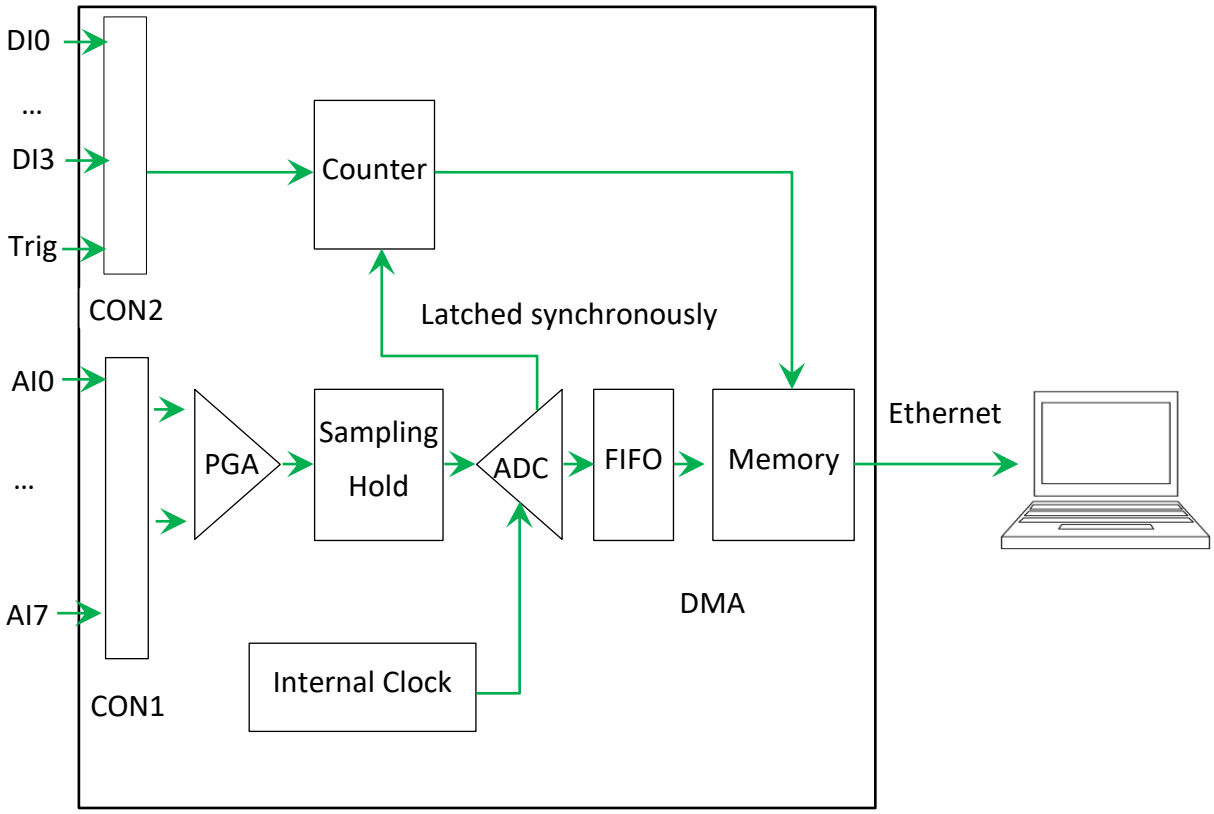
The sampling frequency is read synchronously with the sampling time set by the analog input. The high speed counter input is the same channel as the hardware trig + / trig- input. If the trig + / trig input is set to the counter input, the external signal trigger mode and external Clock Signal

Synchronization A/D Conversion Data Acquisition mode cannot be used.

In the Synchronous input data acquisition, the sampling rate can reach 2 kHz.

There are some parameters that need to be specified:

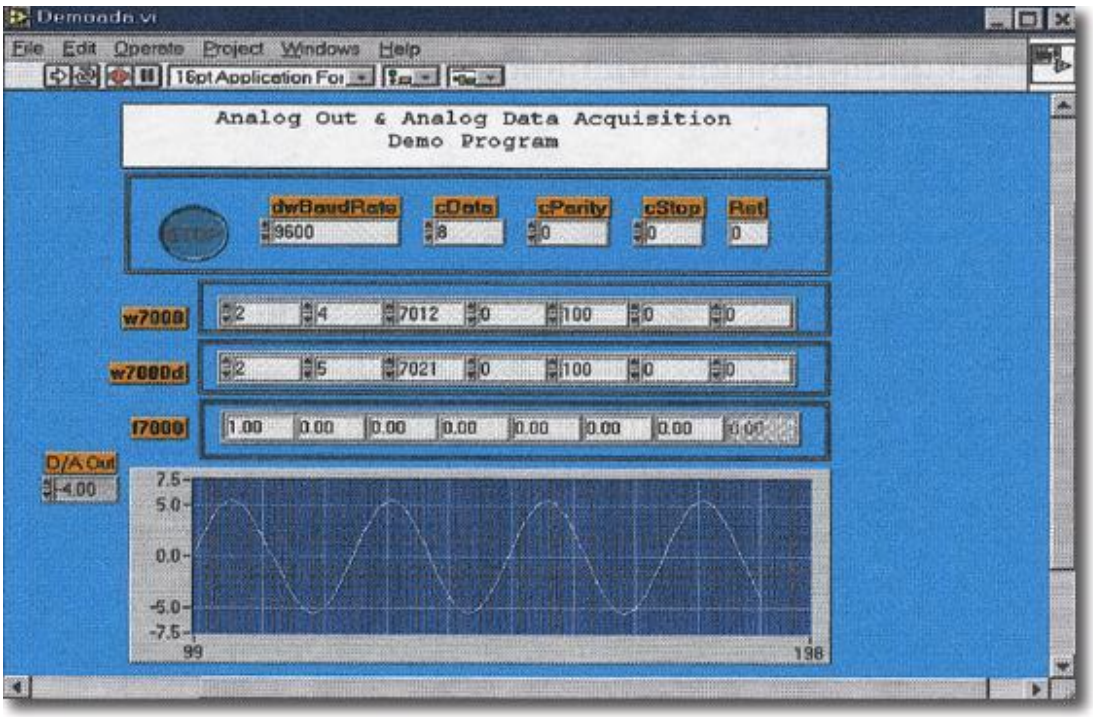
- Sampling rate (1 ~ 2 kHz)
- Specify the number of synchronous acquisition AI/DI/DO readback/Counter channels
- Trigger mode is set to software command trigger


DI0
...
DI3
Trig
CON2
Counter
Latched synchronously
AI0
...
AI7
CON1
PGA
Sampling
Hold
ADC
FIFO
Memory
DMA
Ethernet
Internal Clock

4. Tools and SDKs

PET-7H16M supports a number of external tools to aid in developing your applications.

4.1. LabVIEW



LabVIEW is the best way to acquire, analyze, and present data. LabVIEW delivers a graphical development environment that can be used to quickly build data acquisition quickly, instrumentation and control systems, boosting productivity and saving development time. With LabVIEW, it is possible to quickly create user interfaces that enable interactive control of software systems. To specify your system functionality, simply assemble block diagram – a natural design notation for scientists and engineers.

For more information on how to operate the PET-7H16M using LabVIEW via HSDAQ.dll, please refer to https://www.icpdas.com/en/download/show.php?num=2327

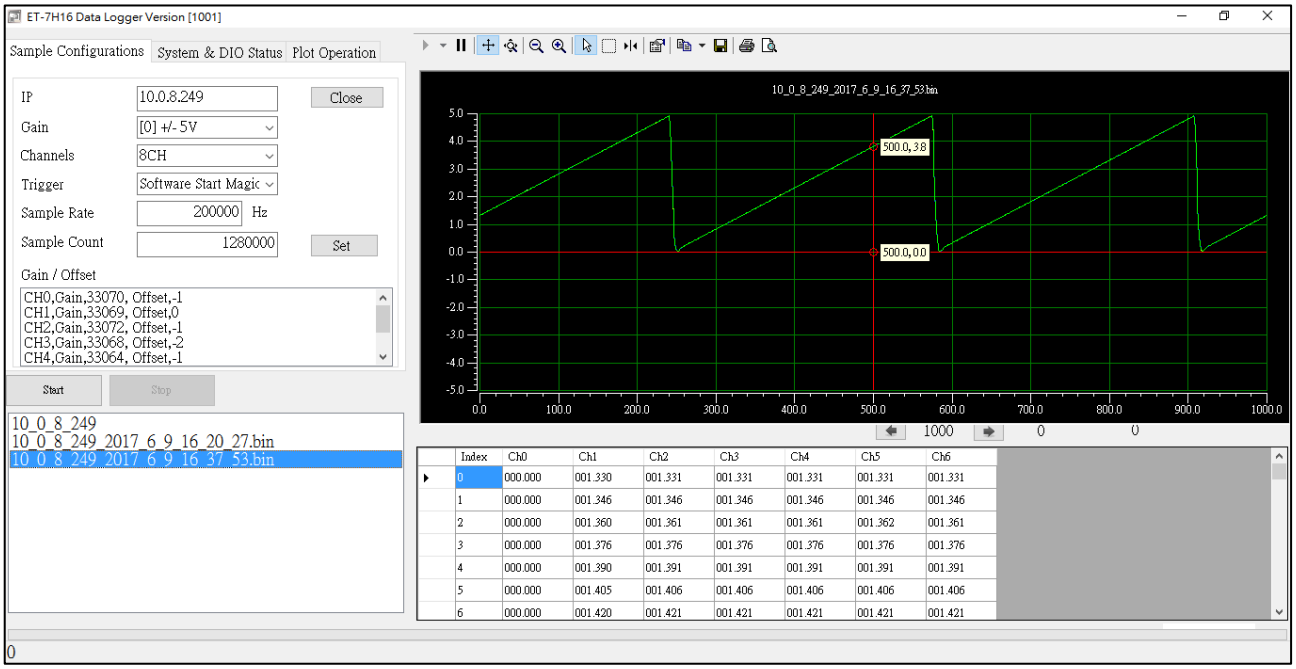
4.2. HSDAQ Utility

HSDAQ Utility is used to graphically display and easily data logging for ET-7H16 module.

HSDAQ Utility tool as ET-7H16 Data Logger

ET-7H16 Data Logger provides a single ET-7H16 connect as Data Logger function.

1. When connect to ET-7H16, it will get the parameters of gain and offset for calibration, they are used to calibrate the raw data from ET-7H16.
2. It also gets the configurations for sampling, set the new configurations for application then start, it will begin to get the sampling data from ET-7H16 and save the data to files.
3. After finish sampling data or stop data logger, it can show the sampling result as plot view.



System requirement

Minimum system requirements for HSDAQ Utility are given below:

- 266 MHz 32-bit(x86) or 64-bit (x64) processor
- 64 MB of system memory
- Support for Super VGA graphics
- At least 20 MB of available space (Need more)
- Microsoft Windows 7 or later(32-bit or 64-bit Windows Operating System)

Operating system of Windows requirement

- 32-bit(x86) 64-bit(x64)
- Microsoft Windows 2000
- Microsoft Windows 7 32-bit Microsoft Windows 7 64-bit
- Microsoft Windows 8 32-bit Microsoft Windows 2008 64-bit
- Microsoft Windows 10 32-bit Microsoft Windows 8 64-bit
- Microsoft Windows 11 64-bit

4.3. SDK API

This chapter provides a brief overview of HSDAQ APIs that have been designed for ET-7H16.

HSDAQ SDK library supports 32/64 bit Windows 7/8/10/11.

Get the latest version of HSDAQ SDK library at the location below.

The latest version of the installation package from FTP site listed as following FTP:

https://www.icpdas.com/en/download/show.php?num=2326

File	Description
HSDAQ.dll	Used for VC programs
HSDAQNet.dll	Used for .Net programs

Before using HSDAQ.dll & HSDAQNet.dll, you must install HSDAQ_SDK_package.exe to use the dll correctly. The program and SDK get the same path. Need to restart the computer after installation. For installation steps, please refer to " HSDAQ Standard API User Manual". For full usage information regarding the description, prototype and the arguments of the functions, please refer to the “HSDAQ Standard API User Manual”

https://www.icpdas.com/en/download/show.php?num=2599

The following API functions are used to access ET-7H16 module.

HSDAQ.dll Functions	HSDAQNet.dll Functions	Description
HS_Device_Create	Sys.HS_Device_Create	Create a connection to the device and initialize the device. This function is the driver entry.
HS_Device_Release	Sys.HS_Device_Release	Release the device from system.
HS_Reboot	Sys.Reboot	This function reboots the ET-7H16.
HS_GetFirmwareVersion	Sys.GetFirmwareVersion	Read the firmware version of ET-7H16
HS_GetSDKVersion	Sys.GetSDKVersion	This function retrieves the version number of the current HSDAQ.dll
	Sys.GeHSDAQNetVersion	This function retrieves the version number of the current HSDAQNet.dll
HS_ReadGainOffset	Config.HS_ReadGainOffset	Read the gain/offset values for application to calibrate each channel's analog data
HS_SetConfig	Config.HS_SetConfig	Set the configuration option for a device.
HS_SetConfigString	Config.HS_SetConfigString	Set the configuration option for a device with the string.
HS_GetConfig	Config.HS_GetConfig	Read the configuration option for a devcice.
HS_GetConfigString	Config.HS_GetConfigString	Read the configuration option for a device with the string.
HS_ReadAIALL	IO. ReadAIALL	Reads all the AI values of all channels in engineering-mode.
HS_ReadAI	IO. ReadAI	Reads the AI value of a channel in engineering-mode
HS_ReadDIO	IO. ReadDIO	Reads the DI and DO values
HS_WriteDO	IO. WriteDO	Writes the DO value
HS_WriteDOBit	IO. WriteDOBit	Writes a DO value to a channel
HS_GetAIScanParam	HSIO.HS_GetAIScanParam	Get the AI scan parameter from PET-7H16M regarding of the sampling rate, scan channels, pacer gain, trigger mode.
HS_SetAIScanParam	HSIO.HS_SetAIScanParam	Set the AI scan parameter for PET-7H16M regarding of the sampling rate, scan channels, pacer gain, trigger mode.

HSDAQ.dll Functions	HSDAQNet.dll Functions	Description
HS_StartAIScan	HSIO.HS_StartAIScan	Start data acquisition. The data is stored in memory and transfer to the data buffer on PC.
HS_StopAIScan	HSIO.HS_StopAIScan	Stop data acquisition.
HS_GetAIBuffer	HSIO.HS_GetAIBuffer	Get the floating-point value from data buffer on PC
HS_GetAIBufferHex	HSIO.HS_GetAIBufferHex	Get the binary data from data buffer on PC
HS_GetAIBufferStatus	HSIO.HS_GetAIBufferStatus	Get the status and data number from data buffer on PC.
HS_ClearAIBuffer	HSIO.HS_ClearAIBuffer	Clear the data buffer on PC
HS_GetTotalSamplingStatus	HSIO.HS_GetTotalSamplingStatus	Read the module status of ET-7H16 during data sampling
HS_TransmitDataCmd	HSIO.HS_TransmitDataCmd	Notify ET-7H16 module to send data to PC through TCP data port
HS_SetEventCallback	HSIO.HS_SetEventCallback	Bind the event condition to a user-defined callback function
HS_RemoveEventCallback	HSIO.HS_RemoveEventCallback	Disable the event condition and callback function.
HS_StartLogger	DATALOG.HS_StartLogger	Start the data logging and save data to the specified folder on storage disk of the host PC
HS_StartLoggerW		HS_StartLoggerW is a wide-character version of HS_StartLogger.The specified folder can included wild-character.
HS_StopLogger	DATALOG.HS_StopLogger	Stop the data logging.
HS_GetAllLogFiles	DATALOG.HS_GetAllLogFiles	Search all log files in the specified folder with the specified file type and return the total number of files
HS_LogFile_Open_byIndex	DATALOG.HS_LogFile_Open_byIndex	Open a data log file by the index number searched by HS_GetAllLogFiles
HS_LogFile_Open	DATALOG.HS_LogFile_Open	Open a data log file by the specified path and file name.
HS_LogFile_OpenW		HS_LogFile_OpenW is a wide-character version of HS_LogFile_Open.The specified folder and file name can be included wild-character.
HS_LogFile_Close	DATALOG.HS_LogFile_Close	Closes a data log file opened by HS_LogFile_Open.

HSDAQ.dll Functions	HSDAQNet.dll Functions	Description
HS_GetLogFileInfo HS_GetLogFile_AIScanConfigInfo	DATALOG.HS_GetLogFileInfo	Get the data log file information including the file version and file size.
	DATALOG.HS_GetLogFile_AIScanConfigInfo	Get the data log file information regarding of the sampling rate, scan channels, pacer gain and trigger mode.
HS_GetLogFile_GainOffset	DATALOG.HS_GetLogFile_GainOffset	Get the data log file information regarding of the gain/offset values for each AI channel.
HS_GetLogFile_AIScanSampleInfo	DATALOG.HS_GetLogFile_AIScanSampleInfo	Get the total sampling counts and the starting time of first triggered sampling data in the data log file
HS_GetLogFile_AIData	DATALOG.HS_GetLogFile_AIData	Reads AI input data from the text file
HS_GetLogFile_AIDataHex	DATALOG.HS_GetLogFile_AIDataHex	Read AI input data(Hex) from the binary file
HS_GetLastError	ErrHandling.GetLastError	Retrieves the last-error code value.
HS_SetLastError	ErrHandling.SetLastError	Sets the last-error code.
HS_GetLastErrorMessage	ErrHandling.GetErrorMessage	Retrieves a message string.
HS_ClearLastError	ErrHandling.ClearLastError	Clears the last-error code.

Visual C++ Samples

The ET-7H16 VC demo includes the following samples that demonstrate the use of the ET-7H16 Standard APIs in a Visual C++ language environment. The following samples can be found by downloading the latest version from ICP DAS web site.

For Visual C++ applications, these demo programs can be obtained from:

https://www.icpdas.com/en/download/show.php?num=2328

C# Samples

The ET-7H16 C# demo includes the following samples that demonstrate the use of the ET-7H16 Standard APIs in a C# language environment. The following samples can be found by downloading the latest version from ICP DAS web site.

For C# applications, these demo programs can be obtained from:

https://www.icpdas.com/en/download/show.php?num=2328

VB.net Samples

The ET-7H16 VB.net demo includes the following samples that demonstrate the use of the ET-7H16 Standard APIs in a VB.net language environment. The following samples can be found by downloading the latest version from ICP DAS web site.

For VB.net applications, these demo programs can be obtained from:

https://www.icpdas.com/en/download/show.php?num=2328

5. Web Applications

The PET-7H16M contains an advanced web configuration system that provides users with access PET-7H16M applications through a standard web browser.

Tips & Warnings

The web page function is only suitable for configuration settings. Do not enable this TCP communication when the module is acquitting the data via Ethernet.

Logging in to the PET-7H16M Web site

You can log in to the PET-7H16M web site from any computer that has Internet access.

Step 1 : Open a browser

In several browsers, Mozilla Firefox and Internet Explorer are both reliable and popular Internet browsers.

Step 2: Type the URL address of the PET-7H16M

If you haven't changed the default IP address of the PET-7H16M, please refer section "2.4. Using HSDAQ Utility to Assign an IP address" to configure it.

Step 3: Fill out the User name and Password

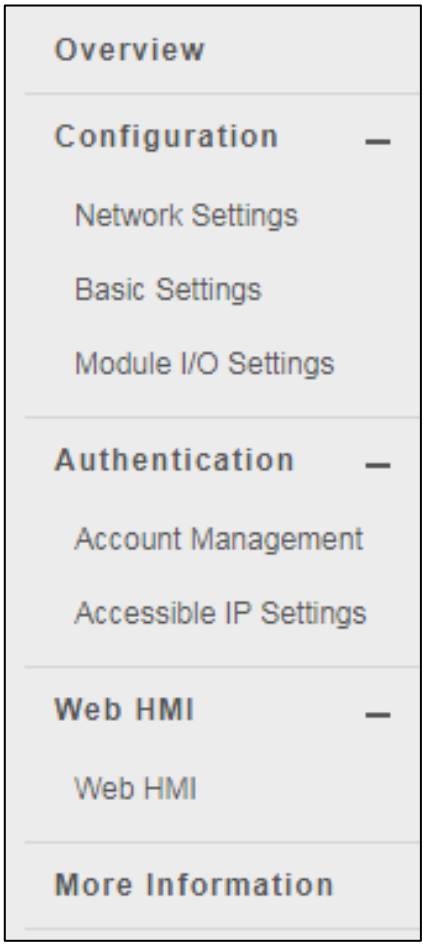
After entering the IP address, the login dialog box will appear and prompt you to enter your username and password.

The factory default user name and password are as follows:

Item	Default
User name	Admin
Password	Admin

Step 4: Welcome to PET-7H16M web site

After logging into the PET-7H16M web site, the welcome page will appear.

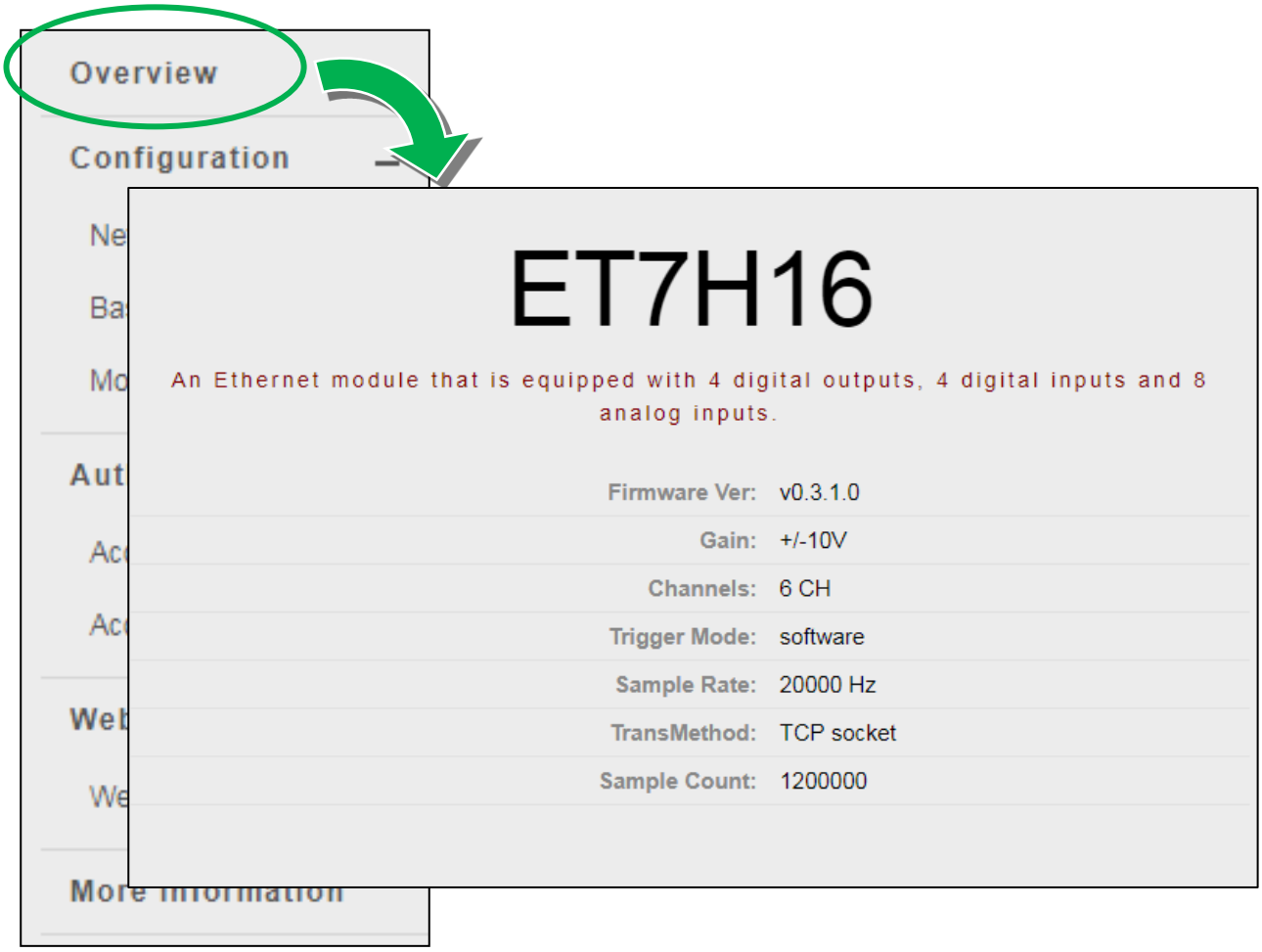


This site serves several functions. You can easily access these functions through the menu on the left side.

The Overview of the Main menu provides a brief introduction and explanation of this site.

5.1. Overview

The Overview links to the welcome page that provides functions to monitor necessary system information of PET-7016M. The information is the most important note of version control for upgrading system.

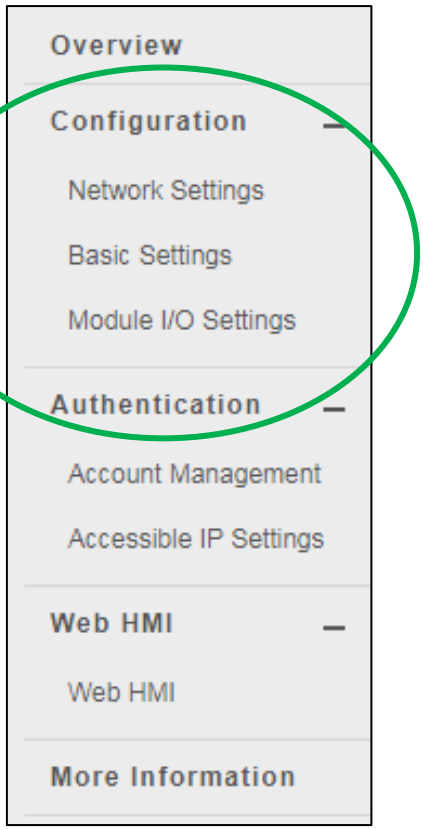


This page provides basic information about the PET-7H16M.

- Firmware Ver: Current firmware version
- Gain: Current input type
- Channels: Current trigger channels
- Trigger mode: Current trigger mode
- Sample Rate: Current sample rate
- TransMethod: Current transfer method
- Sample Count: Current sample count

5.2. Configuration

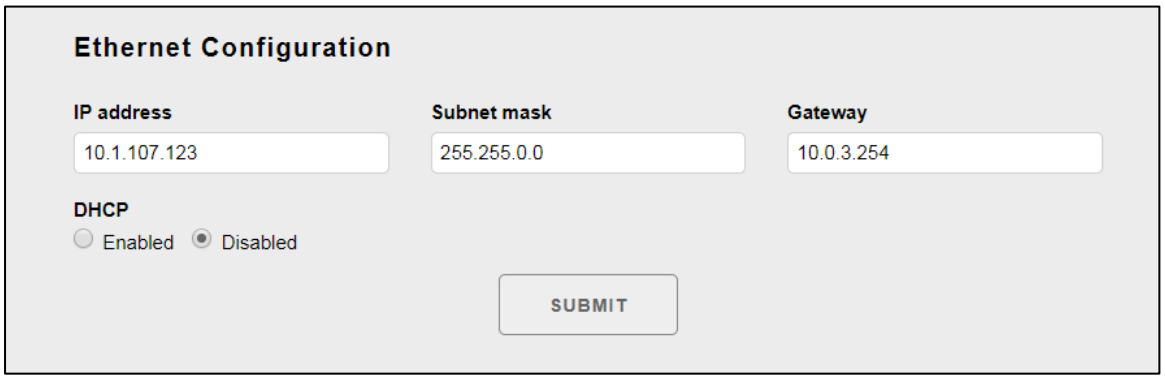
The **Configuration** menu consists of the following menu:



- **Network Settings**: This menu links to the Network Settings page that allows you to access the IP settings.
- **Basic Settings**: This menu links to the Basic Settings page that allows you to configure the basic information of this site.
- **Module I/O Settings**: This menu links to the Common Functions page that allows you to configure the settings of the Modbus

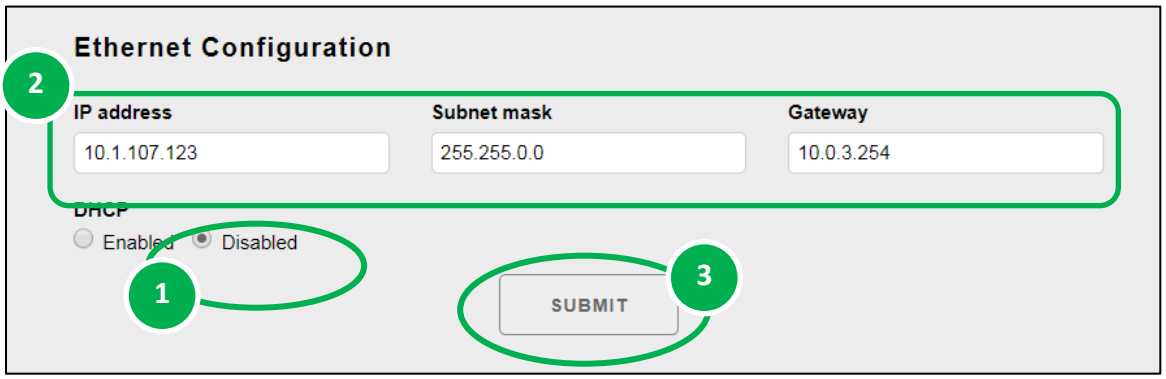
5.2.1. Network Settings

The Network Settings page provides functions to configure either DHCP (Roaming) or manually configured (Static) network settings.



Manually Configured Network Settings

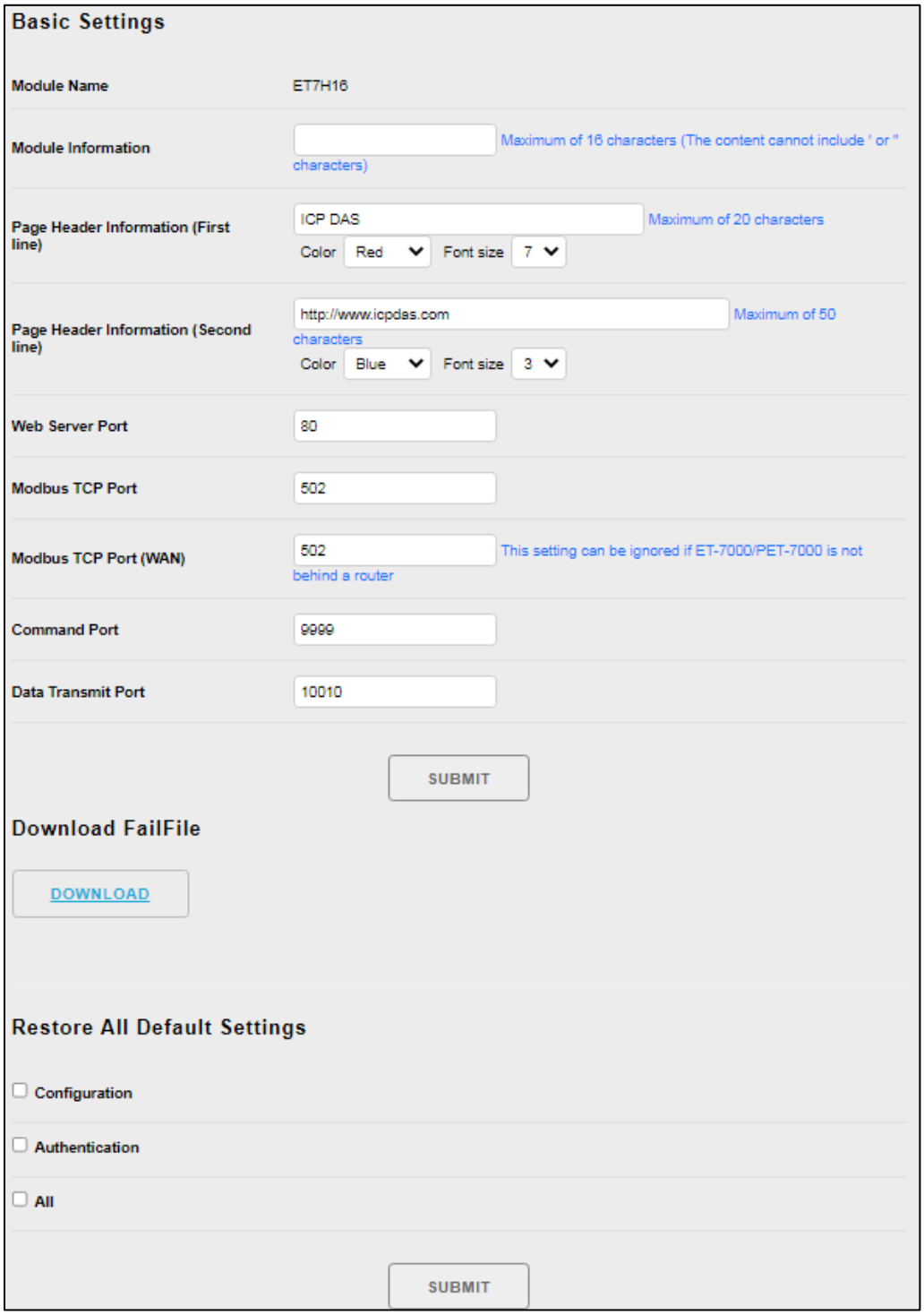
1. Disable the DHCP
2. Assign an IP address
3. Click SUBMIT to finished configuring the network settings



5.2.2. Basic Settings

The Basic Settings page provides the following functions:

- Configure the module information
- Configure the web site information
- Configure the command port and data transmit port
- Reset all settings to default



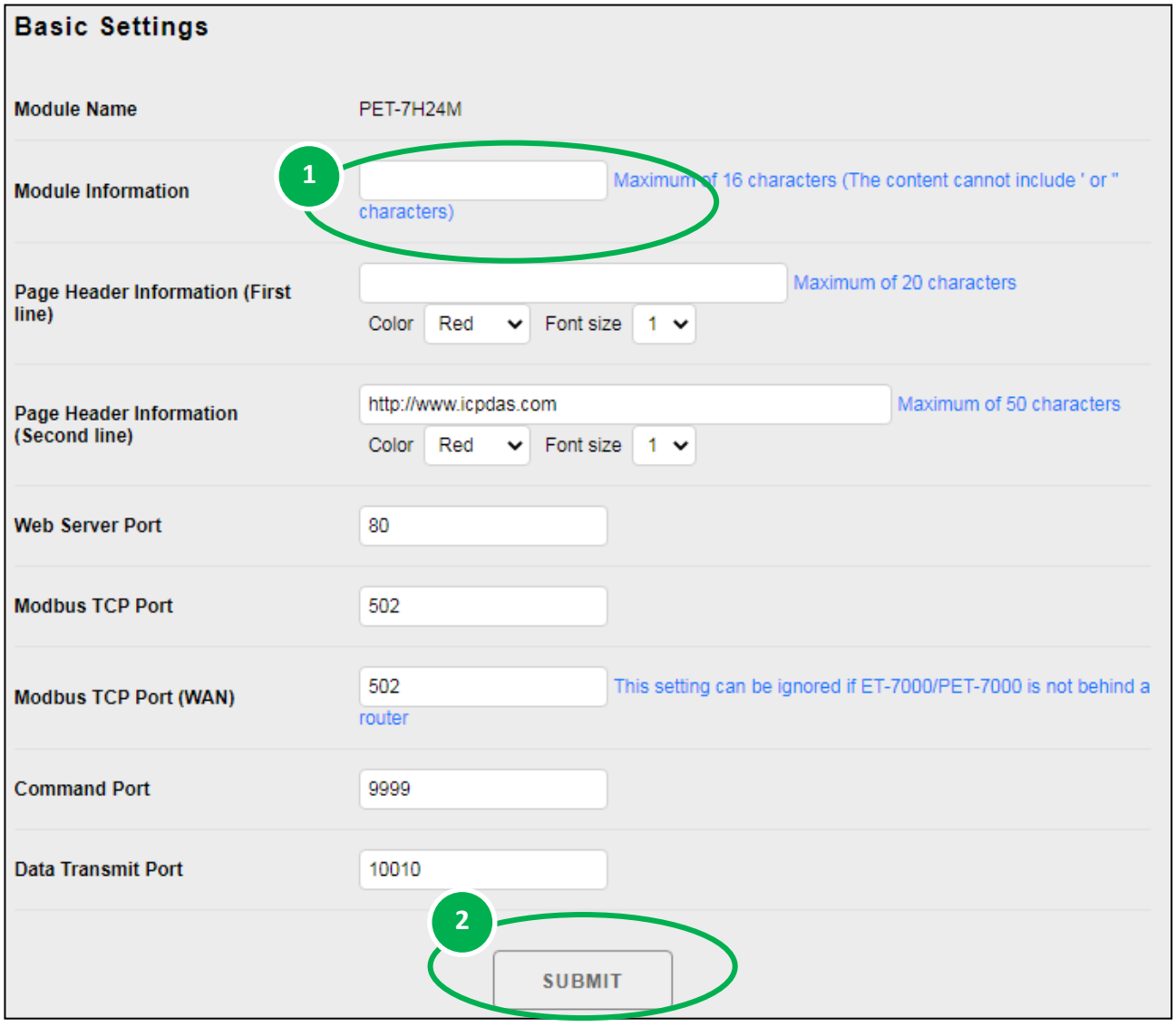
5.2.2.1. Configuring the Module Information

The module information includes the following data items:

- **Module Name**: The name of the module that can be modified. It has an initial value depending on the name of the module.
- **Module Information**: The module information indicates the name of the alias that is used to identify the module.

To configure the module information

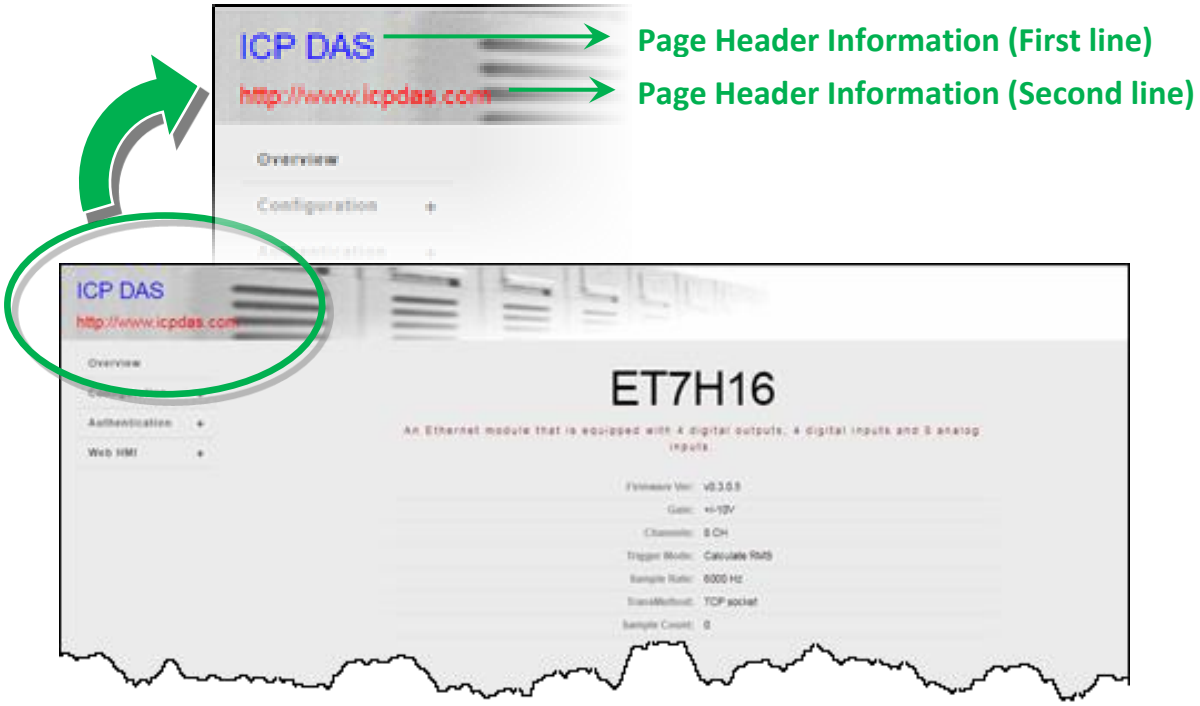
1. Enter the Module information
2. Click **SUBMIT** to finish configuring the module information



5.2.2.2. To Configuring the Web site Information

The module information includes the following data items:

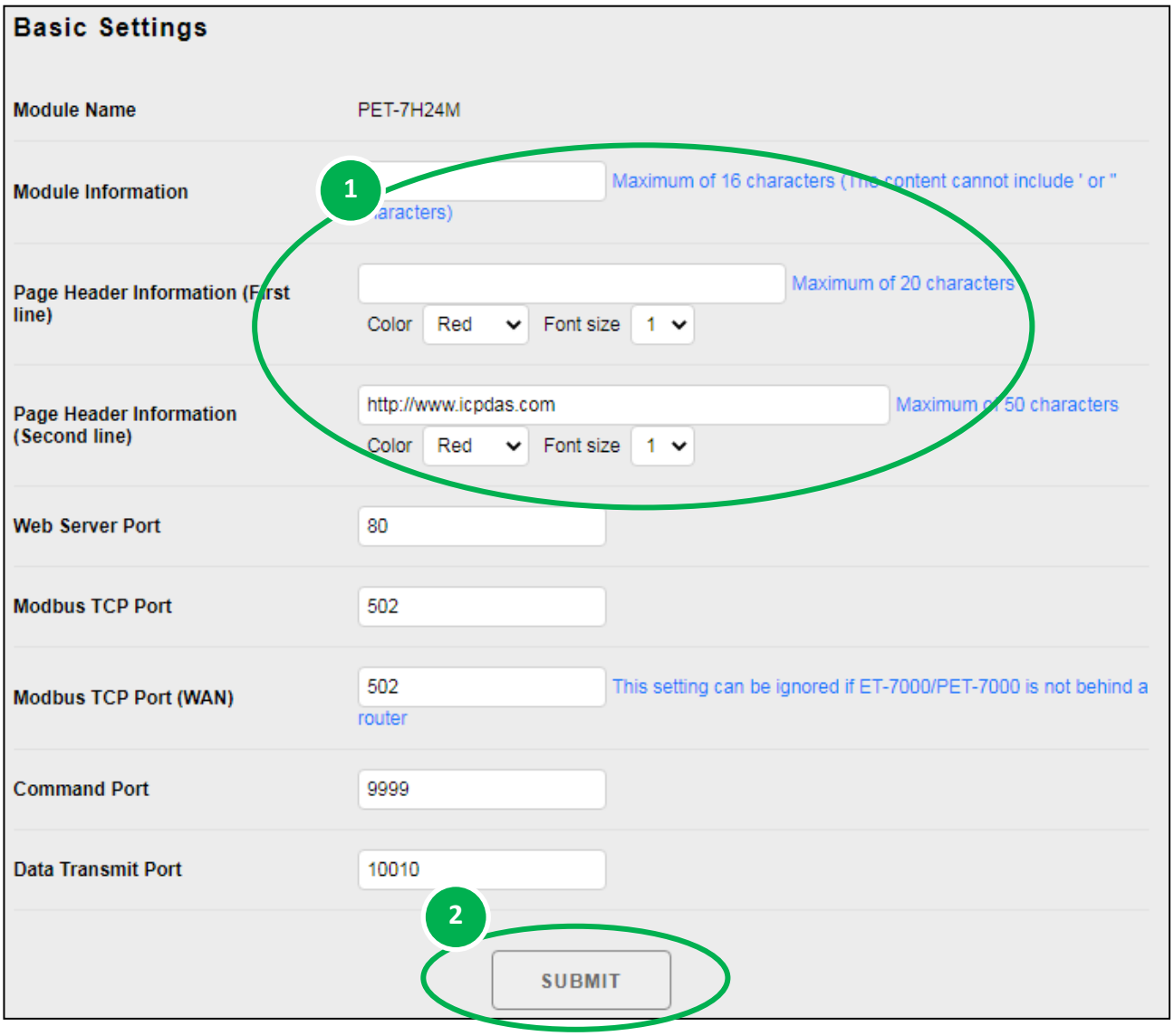
- **Page Header Information (First line)** and **Page Header Information (Second line)**: The title of the website that can be modified; you can view the title information in the top-left corner. The title information can be determined as follows:



- **Web Server TCP Port**: A port number of the TCP/IP port. By default, TCP/IP uses port 80.

To configure the web site information

1. Enter the web site information
2. Click **Submit** to finish configuring the module information

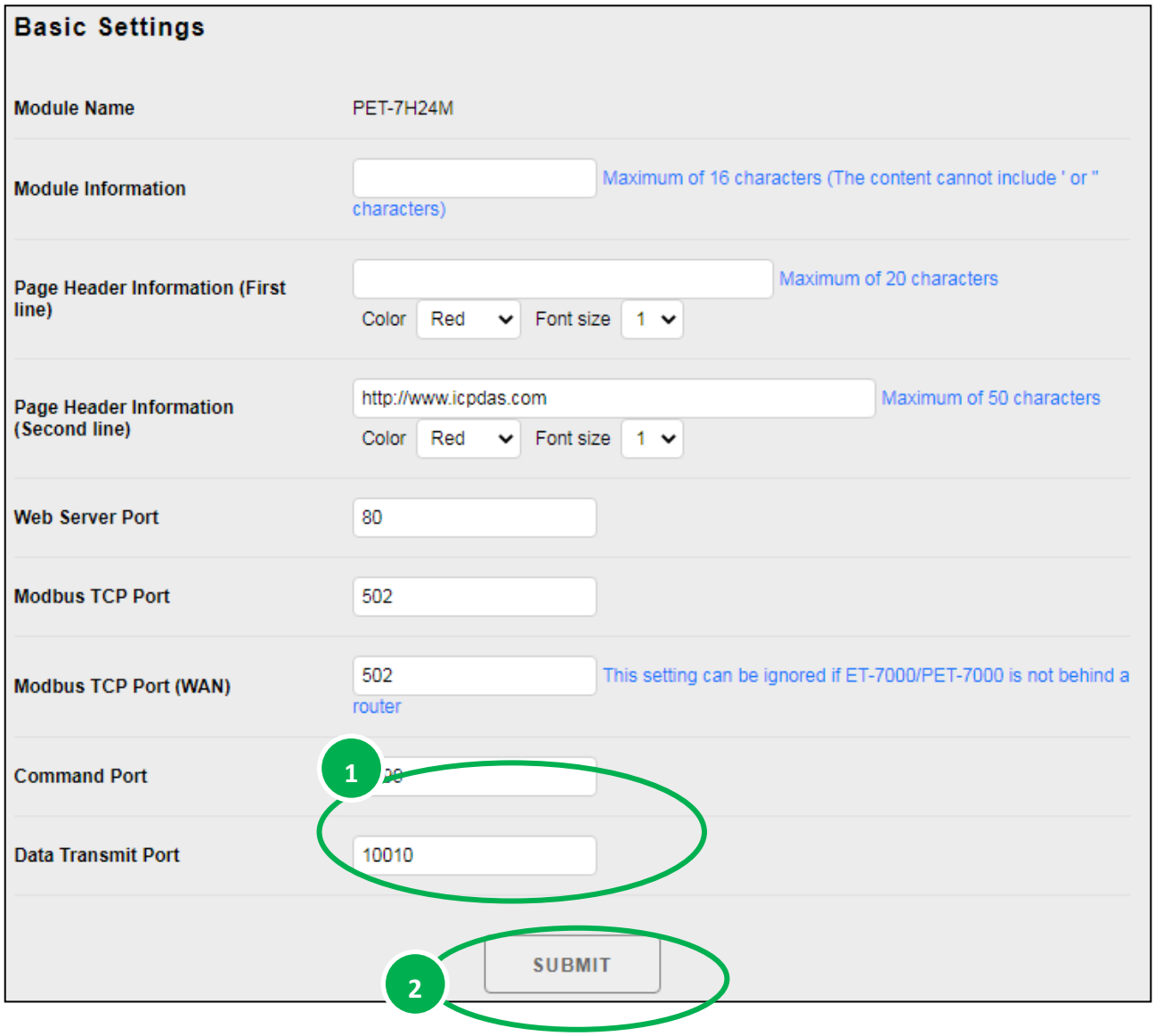


5.2.2.3. Command Port and Data Transmit Port

The user can change or check the currently used Command port and data transmit port.

- Command port default value is 9999
- Data Transmit port default value is 10010

If the ports 9999 and 10010 have been restricted by the firewall, they can be changed into the ports allowed by the firewall against the Basic Settings page.



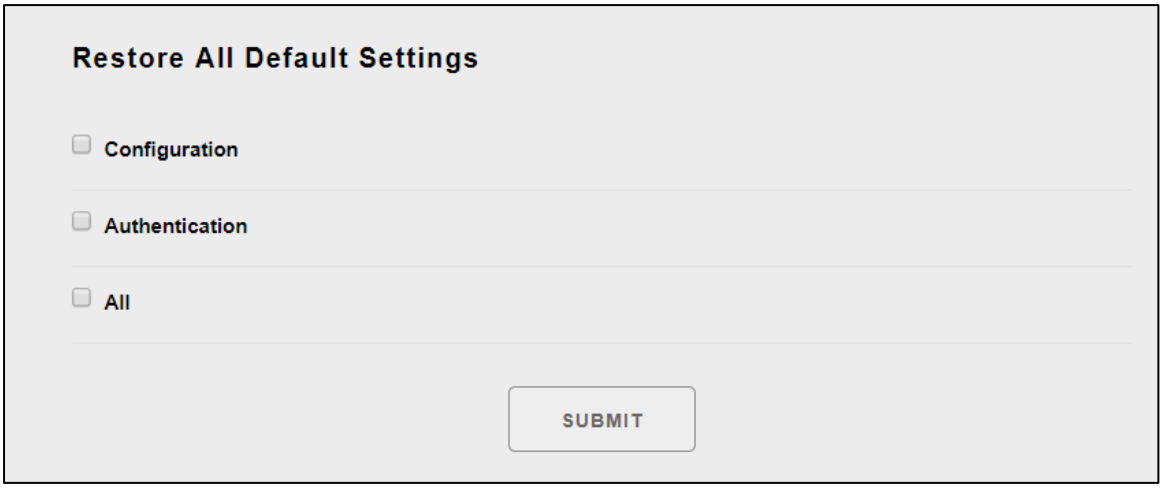
For the use of API after port replacement, please refer to the “HS_Device_Create()” section in the API manual linked below.

https://www.icpdas.com/en/download/show.php?num=2599

5.2.2.4. Resetting All Settings to the Factory Default

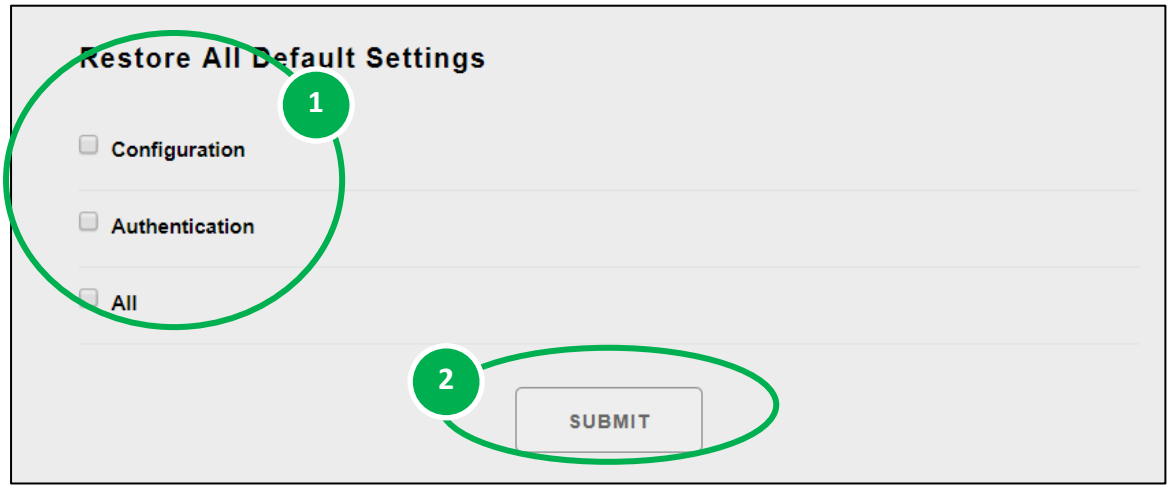
According to the menu selection of this web, the reset function can be divided into the following categories. You can use this function to reset the settings to their factory default.

- Configuration
- Authentication
- All



To reset the settings to their factory default

1. Enable the reset selection
2. Click **SUBMIT** to finish resetting the settings to their factory default



Factory Default Settings for Configuration Menu

The table below lists the factory default settings of the configuration menu.

Network Settings

Data Item	Factory Default Settings
IP	192.168.255.1
Gateway	192.168.0.1
Mask	255.255.0.0
DHCP	Disable

Basic Settings

Data Item	Factory Default Setting
Module Name	Depending on the module name
Module Information	Empty
Top page Information (First line)	ICP DAS
Top page Information (Second line)	http://www.icpdas.com
More Information URL	https://www.icpdas.com/en/product/PET-7H16M
Web Server TCP Port	80
Command Port	9999
Data Transmit Port	10010

Factory Default Settings for Authentication Menu

The table below lists the factory default settings of the Authentication menu.

Account Management

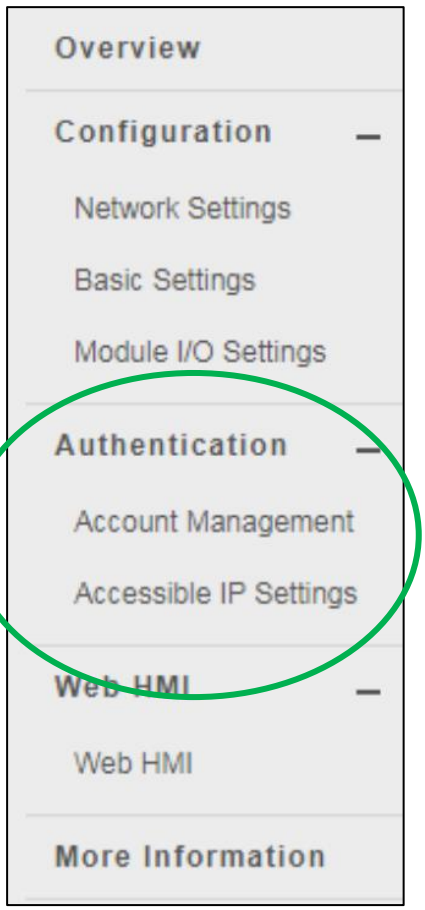
Factory Default Setting
A default user account consists of an account name “Admin” and a password “Admin”.

Accessible IP Settings

Factory Default Setting
Empty, there is no limit to allow any outgoing access.

5.3. Authentication

The **Authentication** menu consists of the following menu:

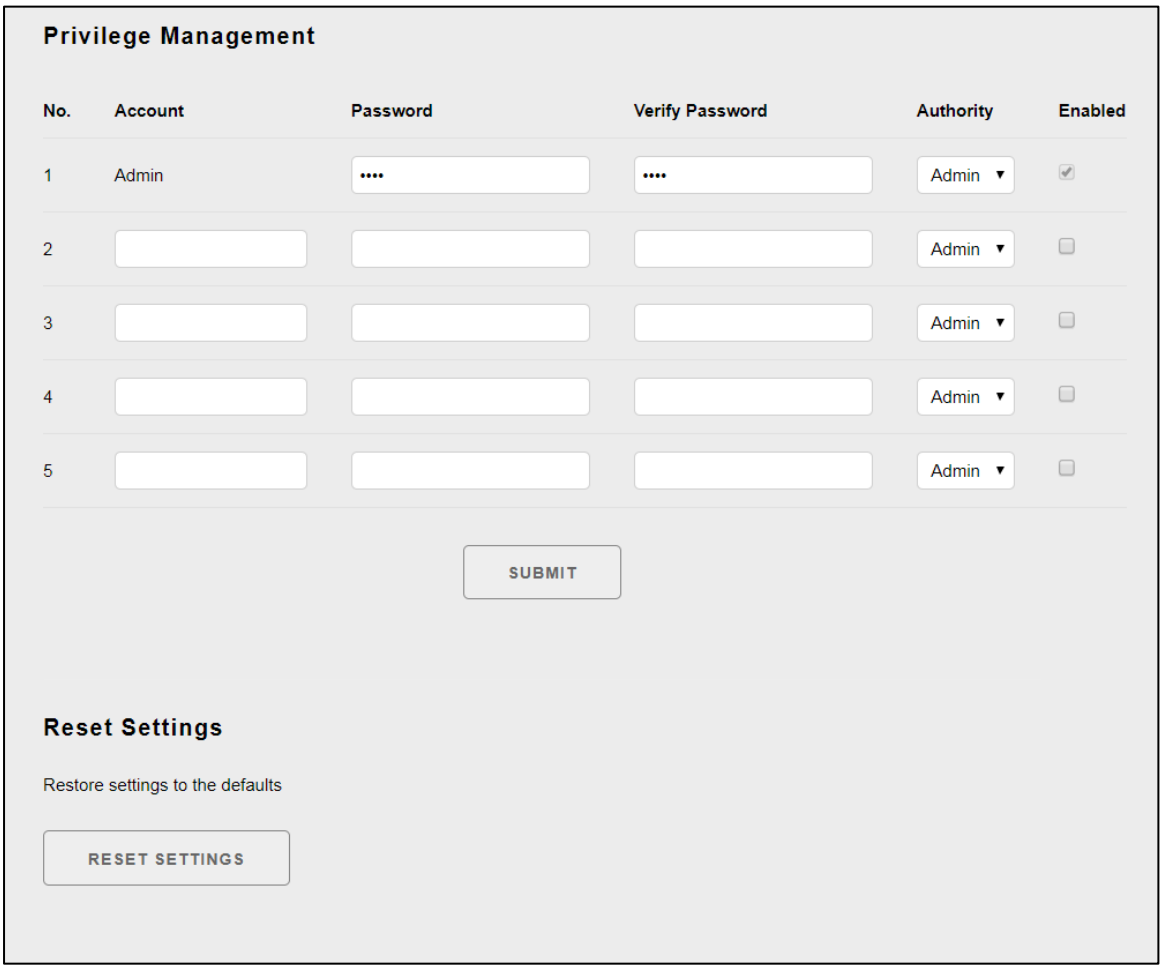


- **Account Management**: This menu links to the Privilege management page that allows you to manage the user accounts and their privileges.
- **Accessible IP Settings**: This menu links to the IP filter Settings page that allow you to control access to the web site

5.3.1. Account Management

The Basic Settings page provides the following functions:

- Configure the user accounts
- Load the factory default user account



5.3.1.1. Configuring the user accounts

The PET-7H16M web site supports up to 5 user accounts.

- A built-in administrator account
- The built-in Administrator is basically a setup and disaster recovery account that can be deleted. You can change the administrator account's password.
- Four user-defined accounts

Each user account consists of

- **An account name**: Specifies the name of This can be your name or another alias
- **A password**: The system will ask you to type this in twice to ensure it is correct.
- **The authority**: that determines what operations the user is allowed to perform.

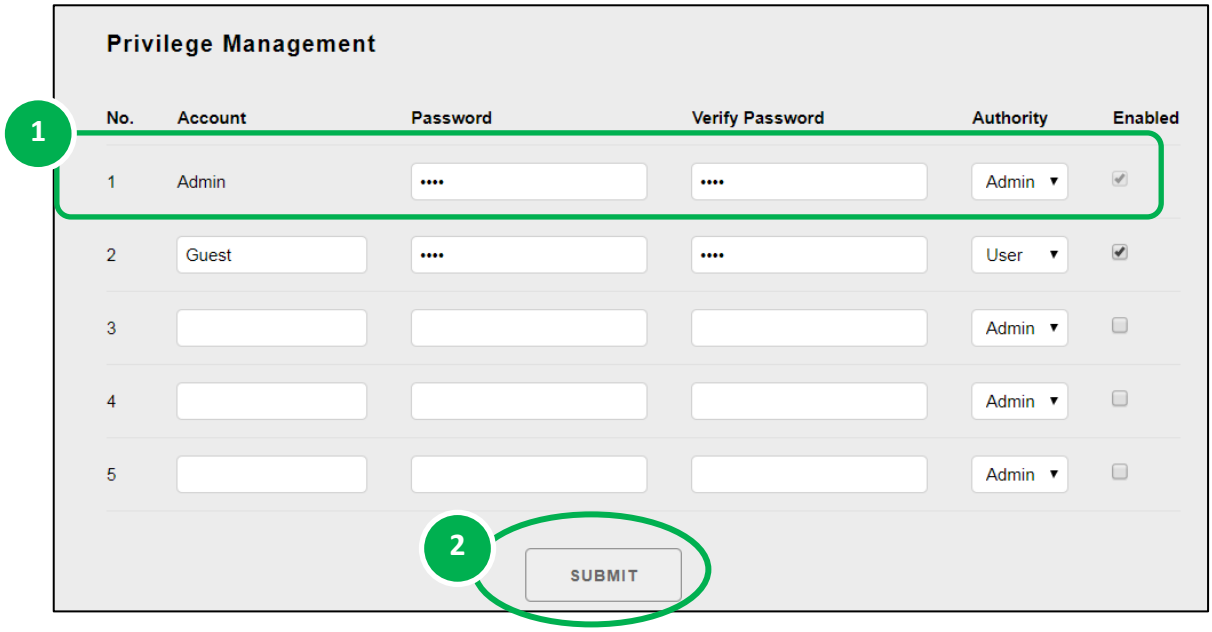
The authority has the following roles to determine what operations the user is allowed to perform.

- **Admin**: Enables access to all PET-7H16M website features, functions, and commands.
- **User**: Enables limited access to PET-7H16M website features, functions, and commands. In general, operators cannot change configuration settings.

To Create an User Account

When you create user accounts, you can Enable or Disable user accounts.

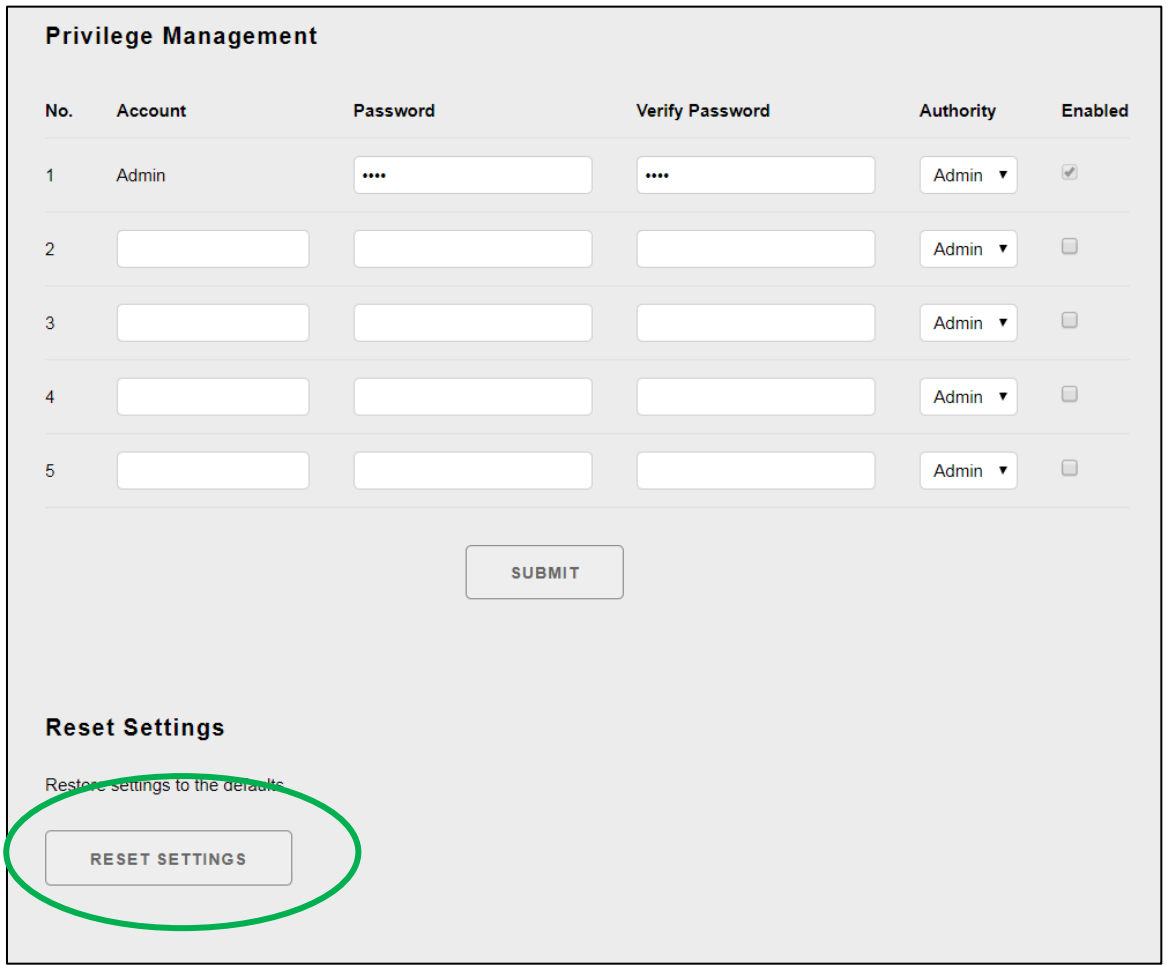
1. Enter the user account information, and then select the enable checkbox
2. Click **SUBMIT** to finish configuring the user accounts



5.3.1.2. Loading the factory default user accounts

The PET-7H16M has a built-in administrator account named Admin that is created when it is installed by default. The default account cannot be deleted.

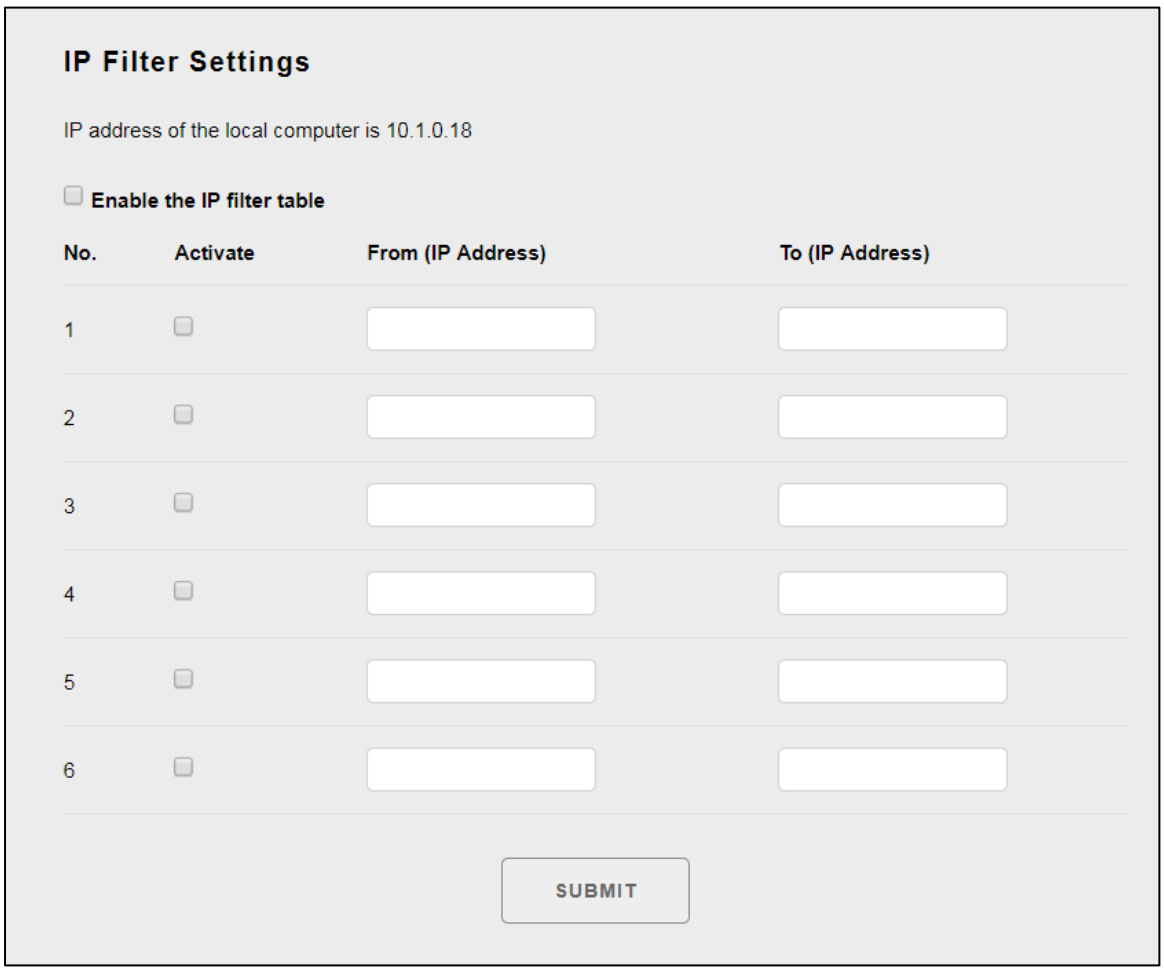
Click **RESET SETTINGS** to configure the user account to the factory default settings.



5.3.2. Accessible IP Settings

The IP filter Settings page provides the following functions:

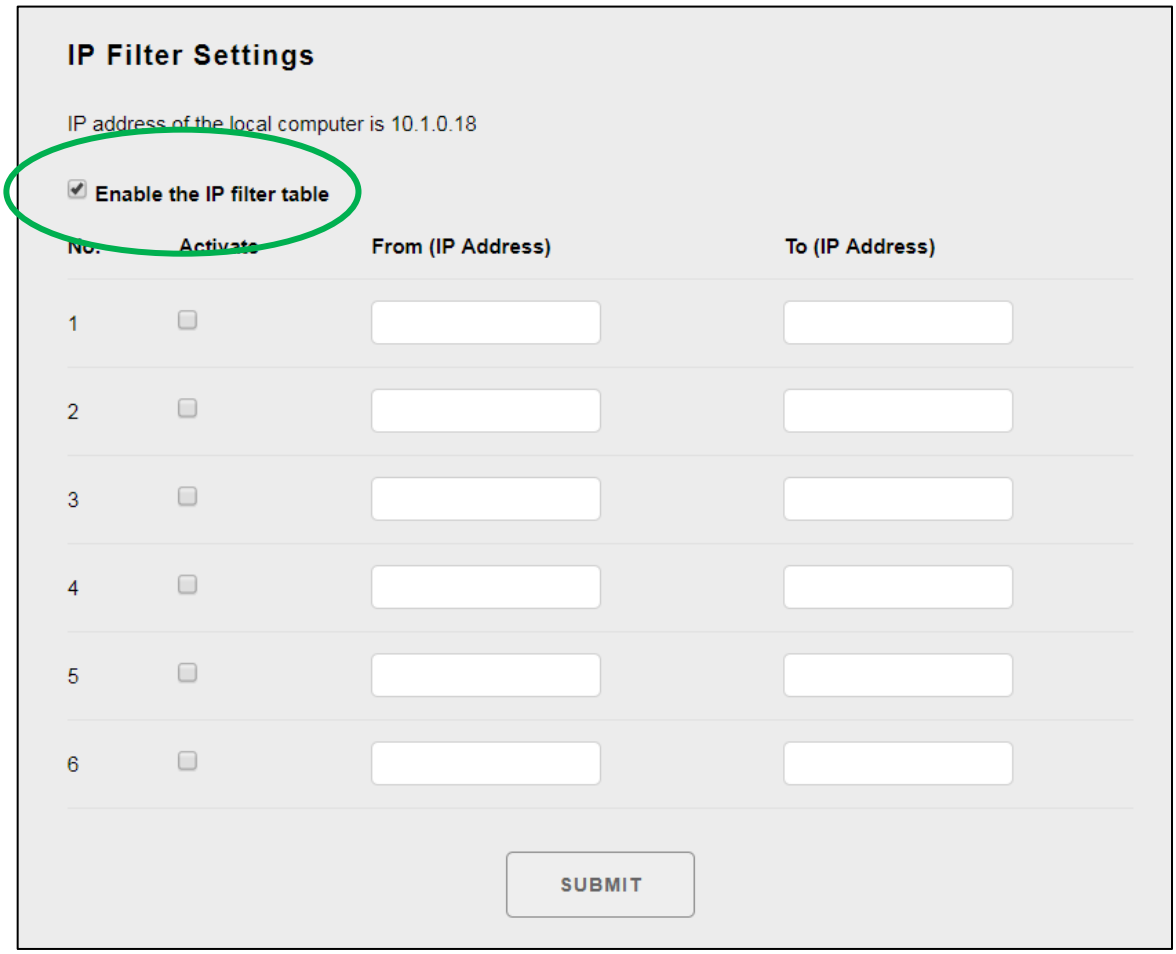
- Configure IP filtering



To Configure the IP filter

The PET-7H16M with an IP filter that enables you to restrict or grant user access based an IP filter list you create.

The filter can be enabled or disable by selecting the Enable the IP filter table checkbox



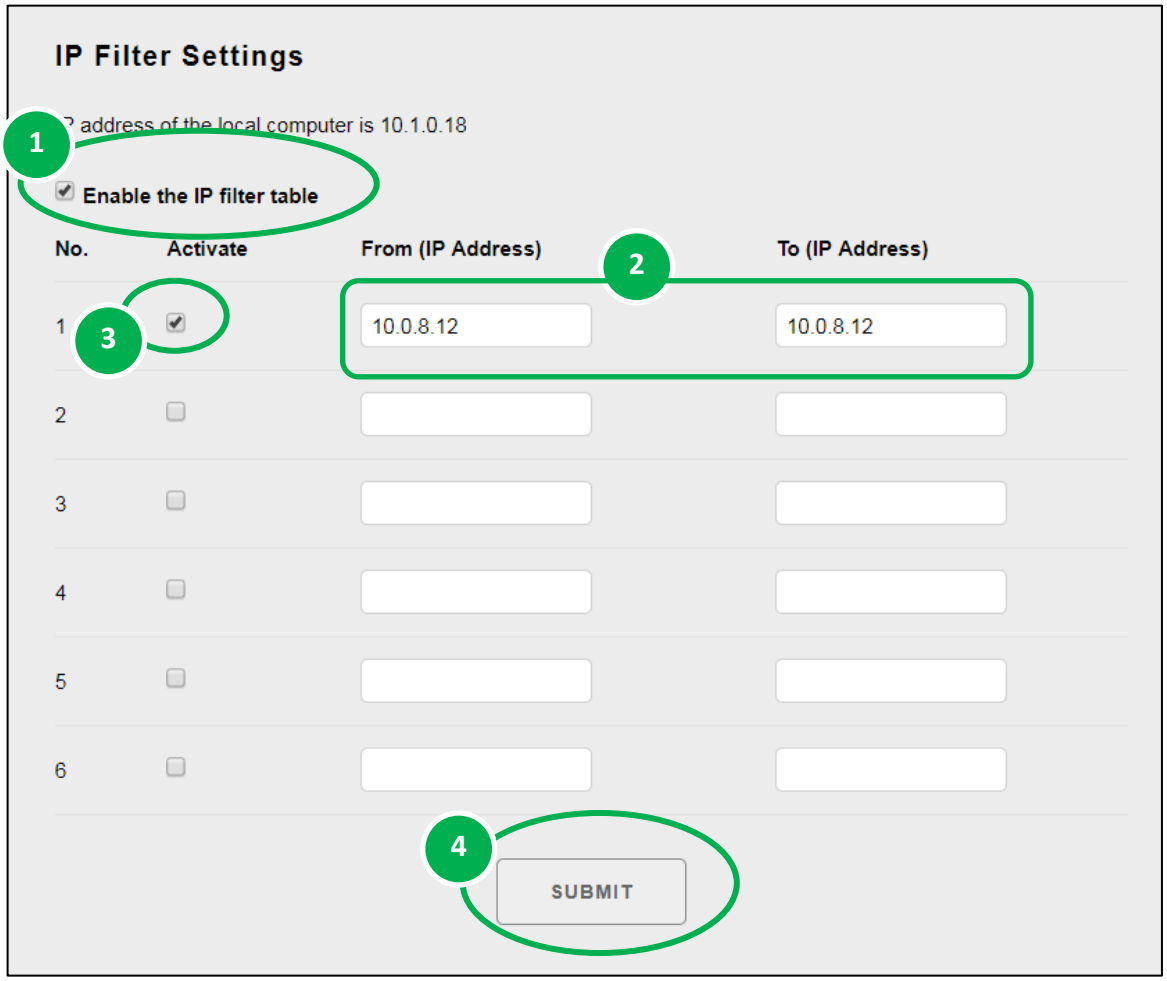
Tips & Warnings

By default, there is no limit to allow any outgoing access.

Here we provide two basic methods for configuring the IP filter.

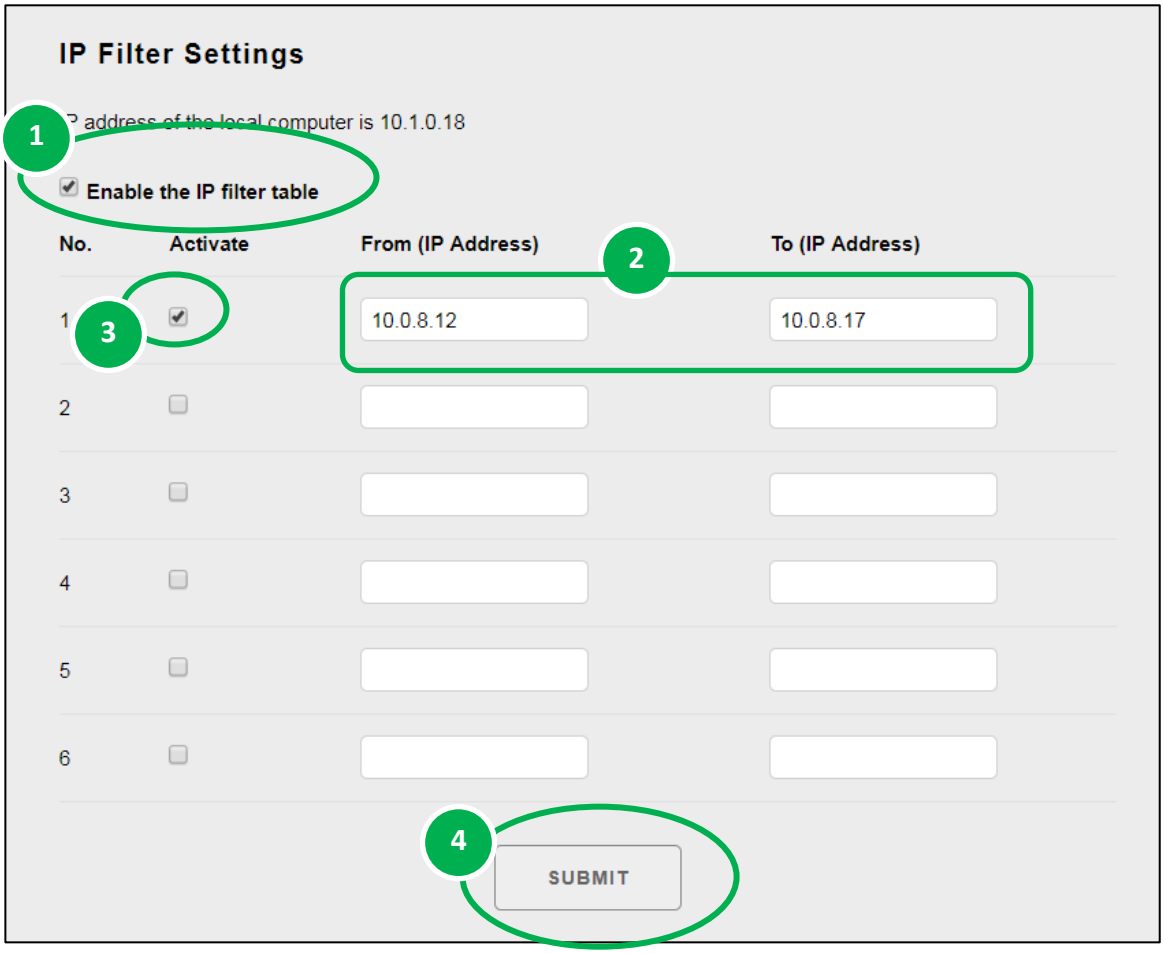
Method 1 : Allows access from a single IP address

1. Select the **Enable the IP filter table**
2. Enter the same IP address in the **From (IP Address)** and **To (IP Address)**
3. Select the **Active** the rule checkbox
    4. Click **SUBMIT** to finish configuring the list of IP filter

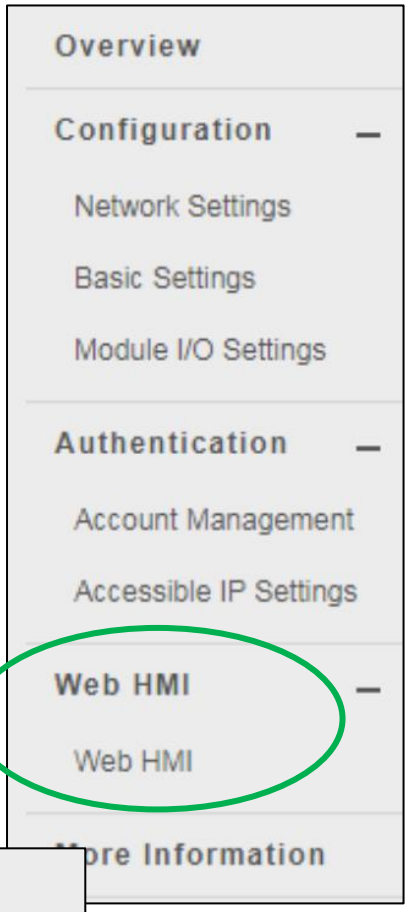


Method 2: Allow access from a group of IP addresses

1. Select the **Enable the IP filter table**
2. Enter a range of IP addresses in the **From (IP Address)** and **To (IP Address)**
3. Select the **Active** the rule checkbox
4. Click **SUBMIT** to finish configuring the IP filter list



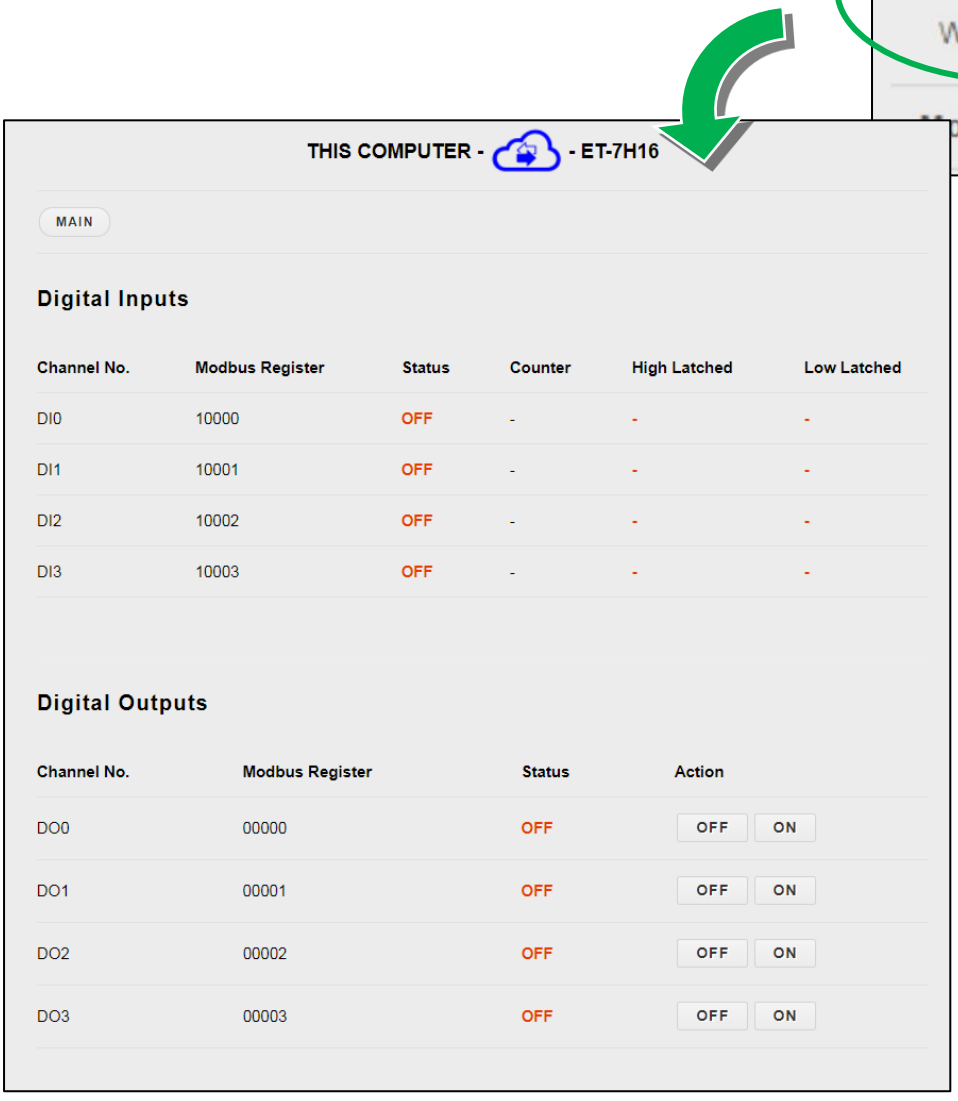
5.4. Web HMI



The **Web HMI** menu consists of the following menu:

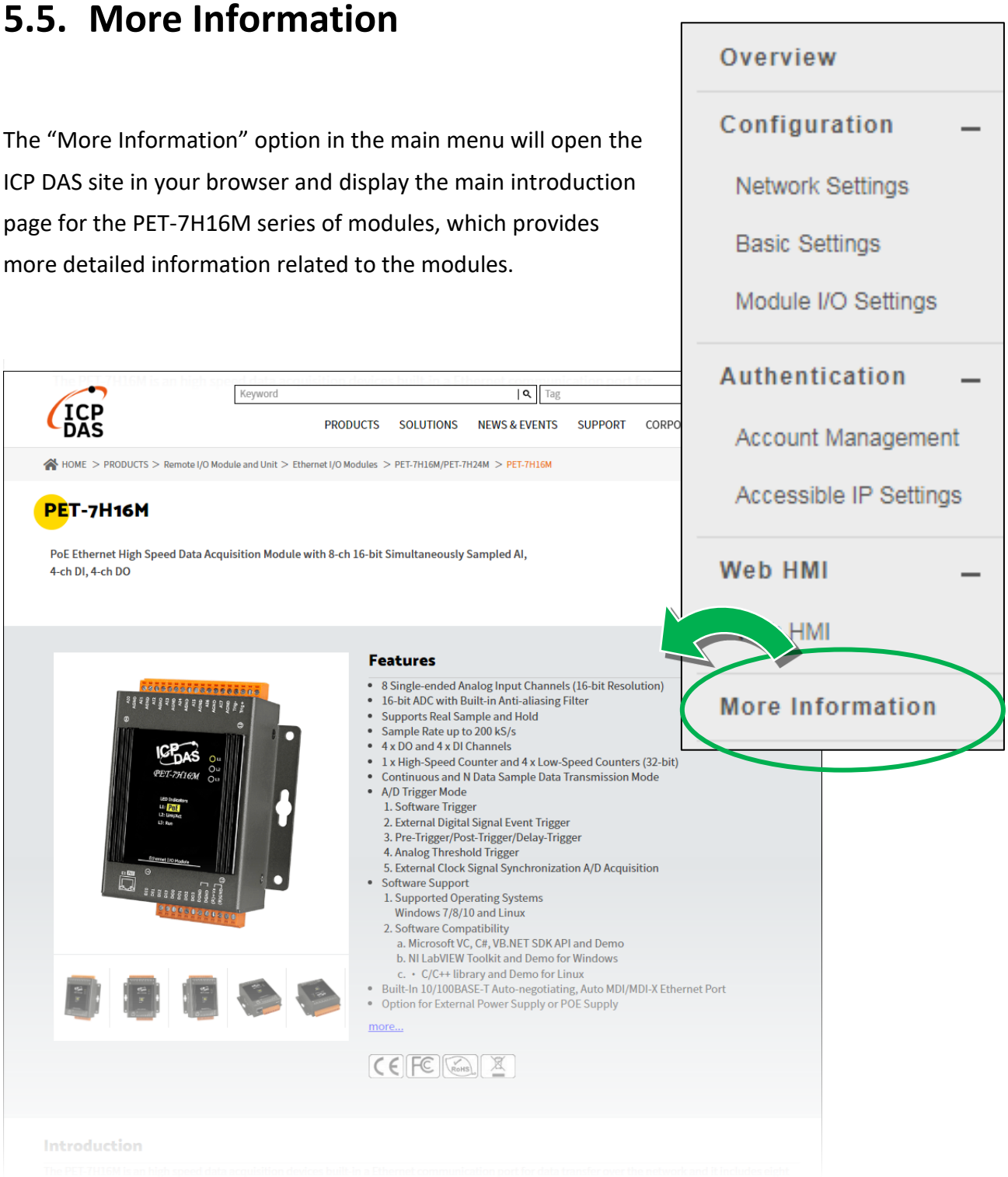
- **Web HMI:** This menu links to the I/O monitor page that allows you to monitor and control the I/O status on PET-7H16M module remotely.

By default, this page displays summary information about I/O channels that are classified according to the module type.



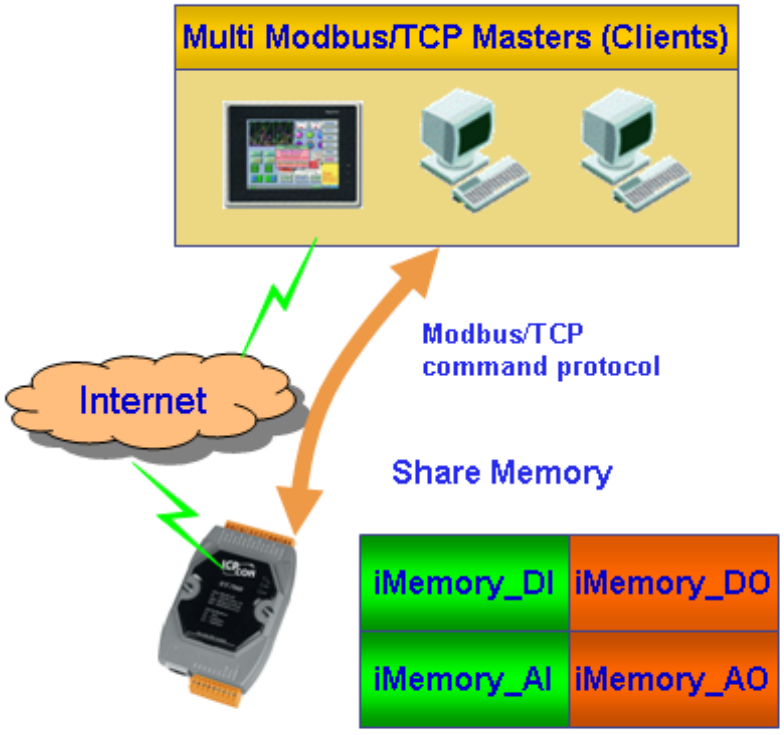
5.5. More Information

The “More Information” option in the main menu will open the ICP DAS site in your browser and display the main introduction page for the PET-7H16M series of modules, which provides more detailed information related to the modules.



6. Modbus Applications

The PET-7H16M is a Modbus device that allows you to access terminals data via Ethernet and communicates using a master-slave technique in which only one device (the master) can initiate transactions (called queries). The other devices (slaves) respond by supplying the requested data to the master, or by taking the action requested in the query.



Register Map

Modbus devices usually include a Register Map. Modbus functions operate on register map registers to monitor, configure, and control module I/O. The users should refer to the register map for the PET-7H16M to gain a better understanding of its operation.

- **0xxxx address table**

Begin address	Points	Description	Registers per Point	Range	Access Type
0	4	Digital Out	1	0 = off 1 = on	R/W
34	1	The data order of long value to Modbus register	1	0: low byte, high byte 1: high byte, low byte	R/W
36	1	Reset the I/O settings to the factory default state	1	1: Reset	W (Pulse)
37	1	Reset the web settings to the factory default state	1	1: Reset	W (Pulse)
40	1	Set the AI Data format	1	0: 2's comp Hex 1: Engineering unit	R/W
112	1	Reboot the module	1	1: Reboot	W (Pulse)

- **1xxxx address table**

Begin address	Points	Description	Registers per Point	Range	Access Type
0	4	Digital input value	1	0 = off 1 = on	R

- **3xxxx address table**

Begin address	Points	Description	Registers per Point	Range	Access Type
0	8	Analog Input	word	-32768 ~ +32767	R
16	8	Use Channel Gain Value	word	0 ~ 65535	R
32	8	Use Channel Offset Value	word	-32768 ~ +32767	R
80	1	Number of the DI channel	word	0 ~ 65535	R
81	1	Number of the DO channel	word	0 ~ 65535	R
82	1	Number of the AI channel	word	0 ~ 65535	R
90	1	OS image version	word	0 ~ 65535	R
91	1	Firmware version	word	0 ~ 65535	R
92	1	ET7H16 Library version	word	0 ~ 65535	R
94	1	TCP library version	word	0 ~ 65535	R
95	1	Web server library version	word	0 ~ 65535	R
100	1	Read module name	word	0 ~ 65535	R

- **4xxxx address table**

Begin address	Points	Description	Registers per Point	Range	Access Type
32	1	Set AI type	word	0: +/- 5V 1: +/- 10V	R/W/E
50	1	Read the boot count of the module	word		R/W/E
60	1	Read the module Modbus NetID The factory default value is 0 when the settings are set to the factory default values	word	0 ~ 65535	R/W/E

7. Updates

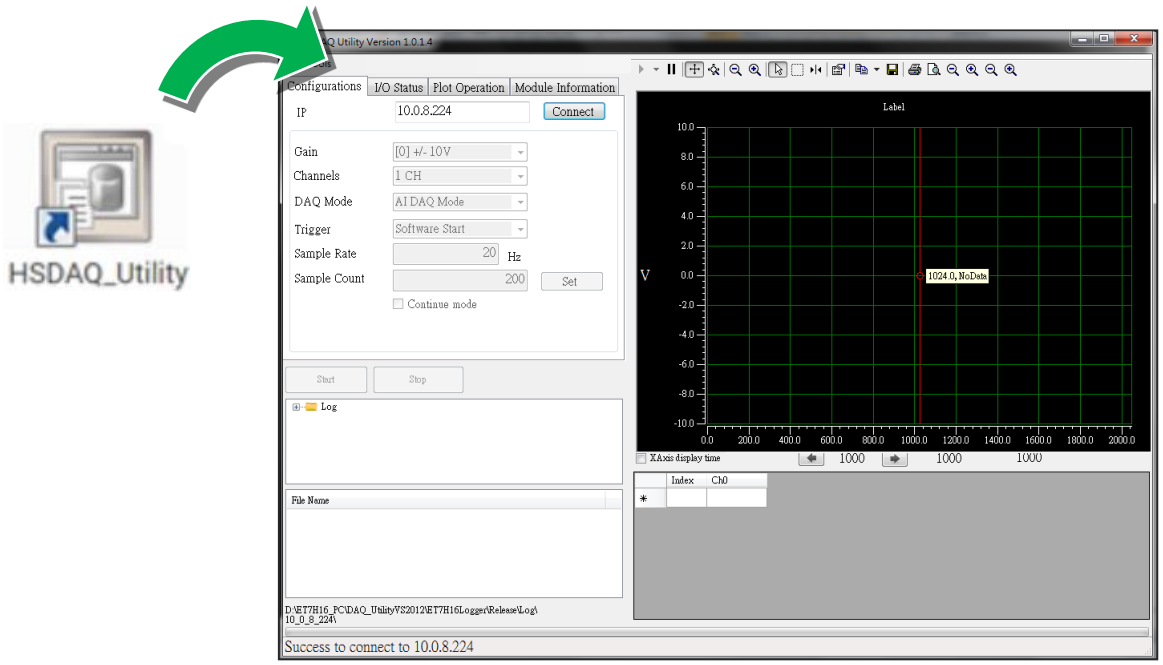
The firmware is stored in flash memory and can be updated to fix functionality issues or add additional features, so we advise you to periodically check the ICP DAS web site for the latest updates.

Step 1: Get the latest version of the firmware and the autoexec.bat file

The latest version of the PET-7H16M firmware and autoexec.bat file can be obtained from: https://www.icpdas.com/en/download/show.php?num=2325

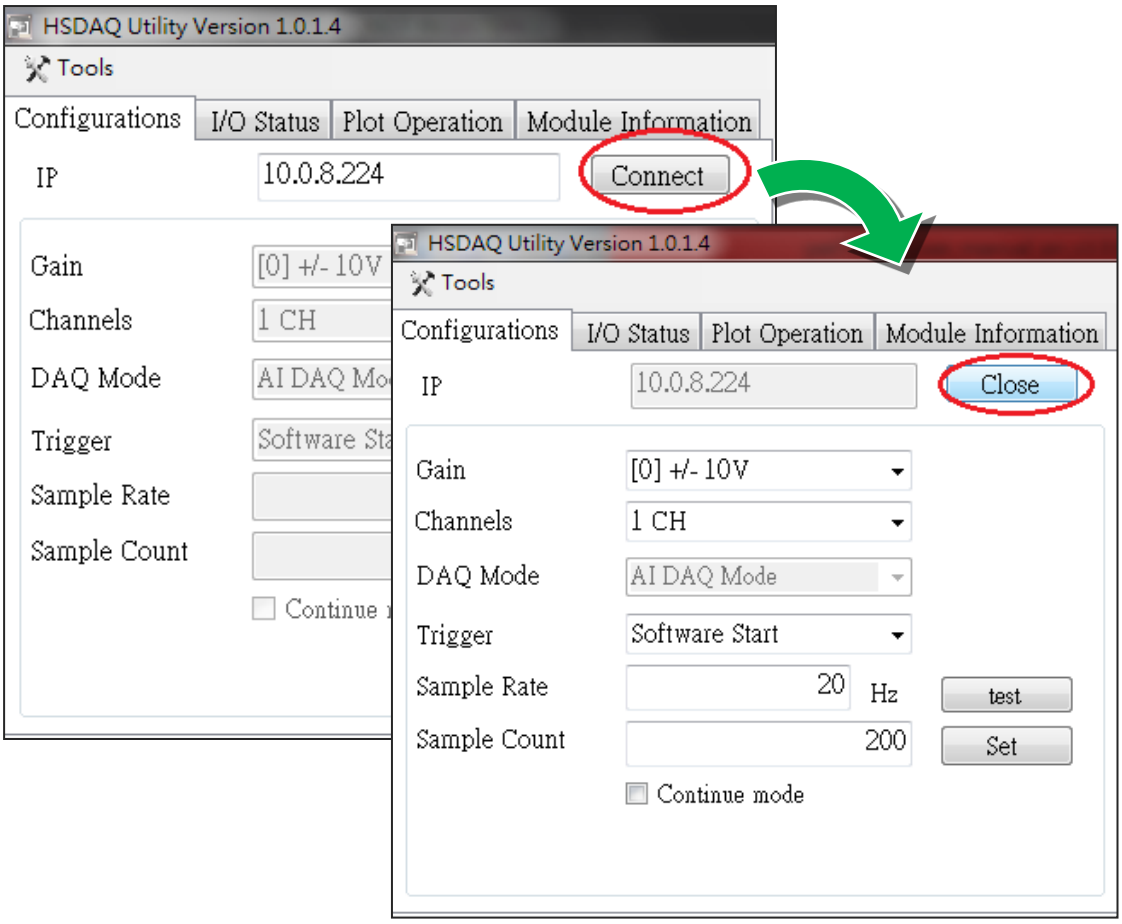
Step 2: Run the HSDAQ Utility

Double-click the HSDAQ Utility shortcut on your desktop.



Step 3: Establish a connection to PET-7H16M

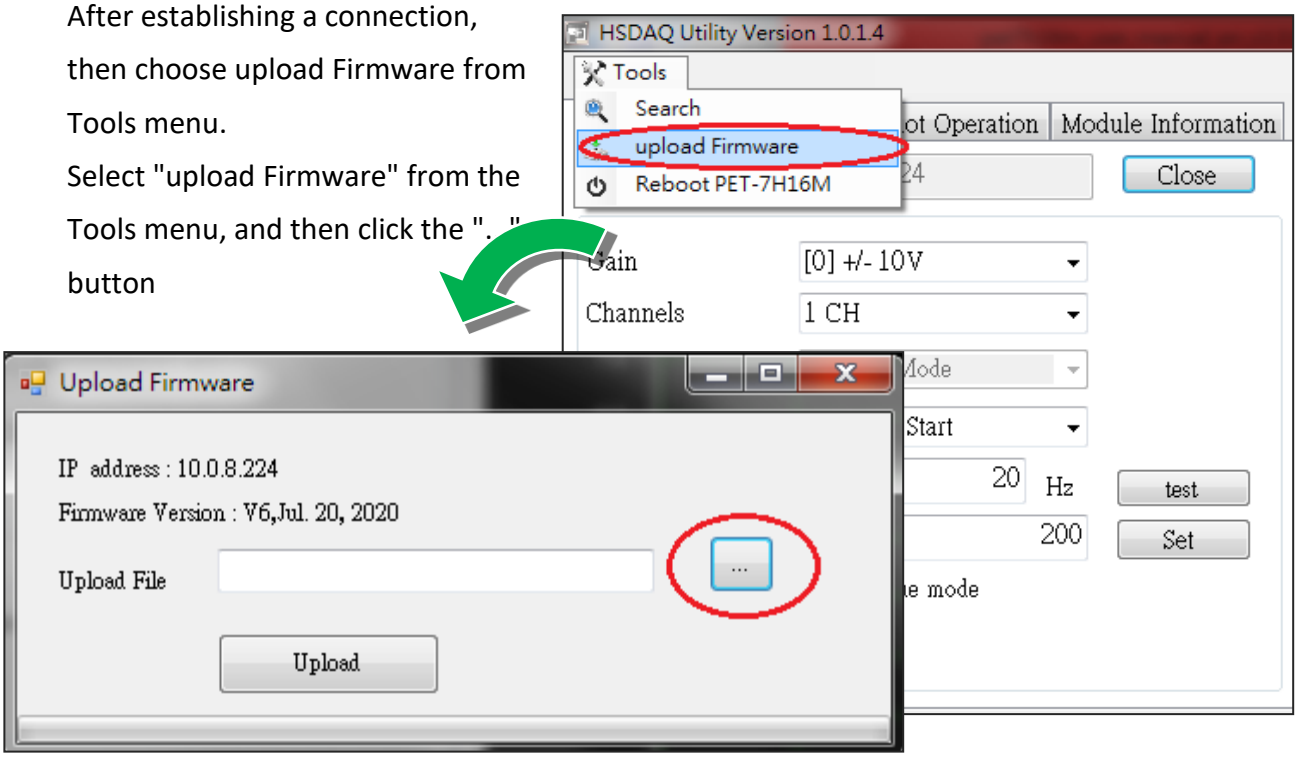
Click “Connect” button



Step 4: Choose “Erase Disk” from the “Command” menu

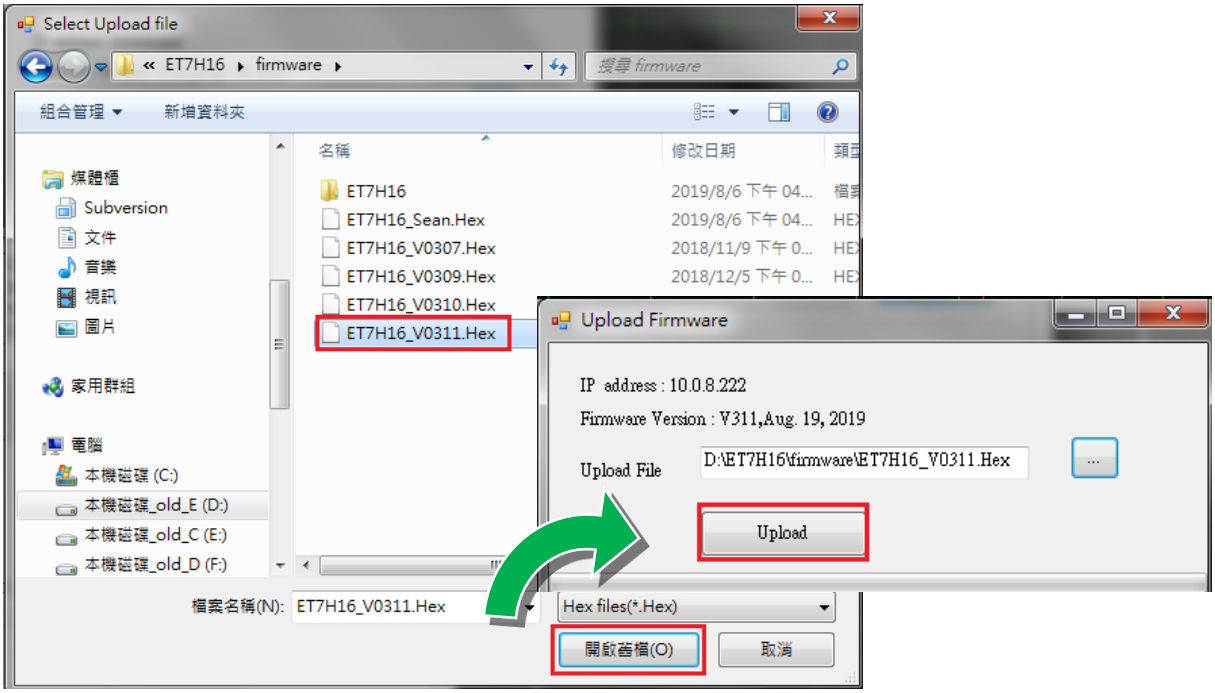
After establishing a connection, then choose upload Firmware from Tools menu.

Select "upload Firmware" from the Tools menu, and then click the ". . ." button



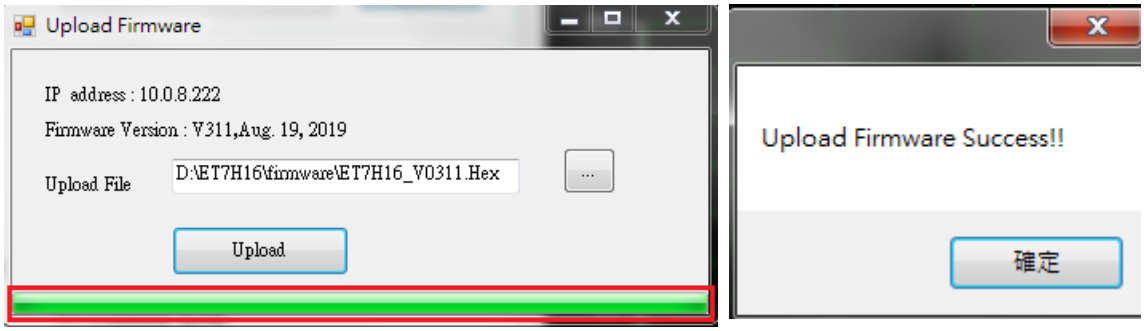
Step 5: Choose the PET7H16M_VXXXX.hex to upload

Select PET7H16M_VXXXX.hex to upload, then click "Open File" and then click "Upload".



Step 6: End of upload

After uploading the file, the progress bar will be as shown below.



Tips & Warnings

You have to reboot the PET-7H16M after uploading the firmware.

8. Calibration

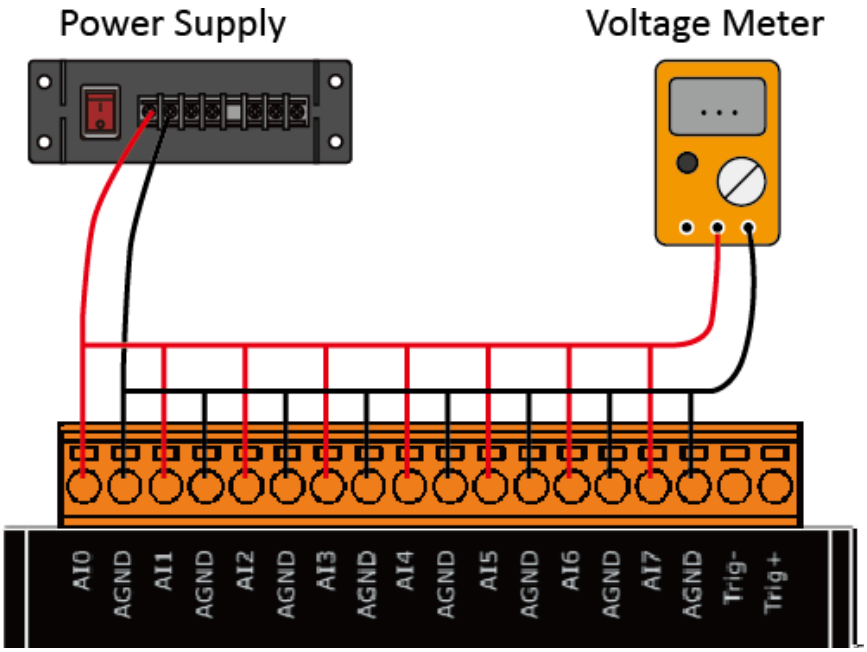
When shipped from the factory, PET-7H16M is already fully calibrated, including the calibration coefficients that are stored in the onboard EEPROM. For a more precise application of voltages in the field, the procedure described below provides a method that allows the board installed in a specific system to be calibrated so that the correct voltages can be achieved for the field connection. This calibration allows the effects of voltage drops caused by IR loss in the cable and/or the connector to be eliminated.

At first the user has to prepare the equipment for calibration

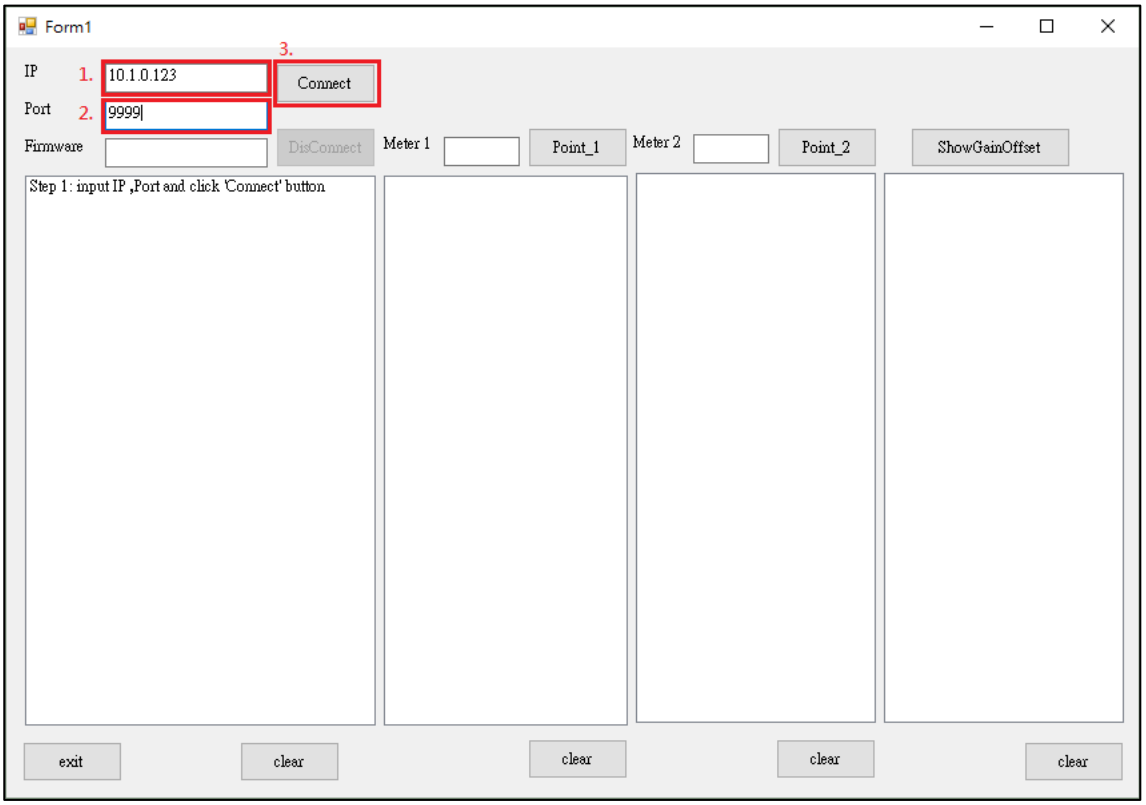
- Precise multi-meter (The more precise meter is better)
- Stable power supply

The calibration procedure will be described in detail in the following.

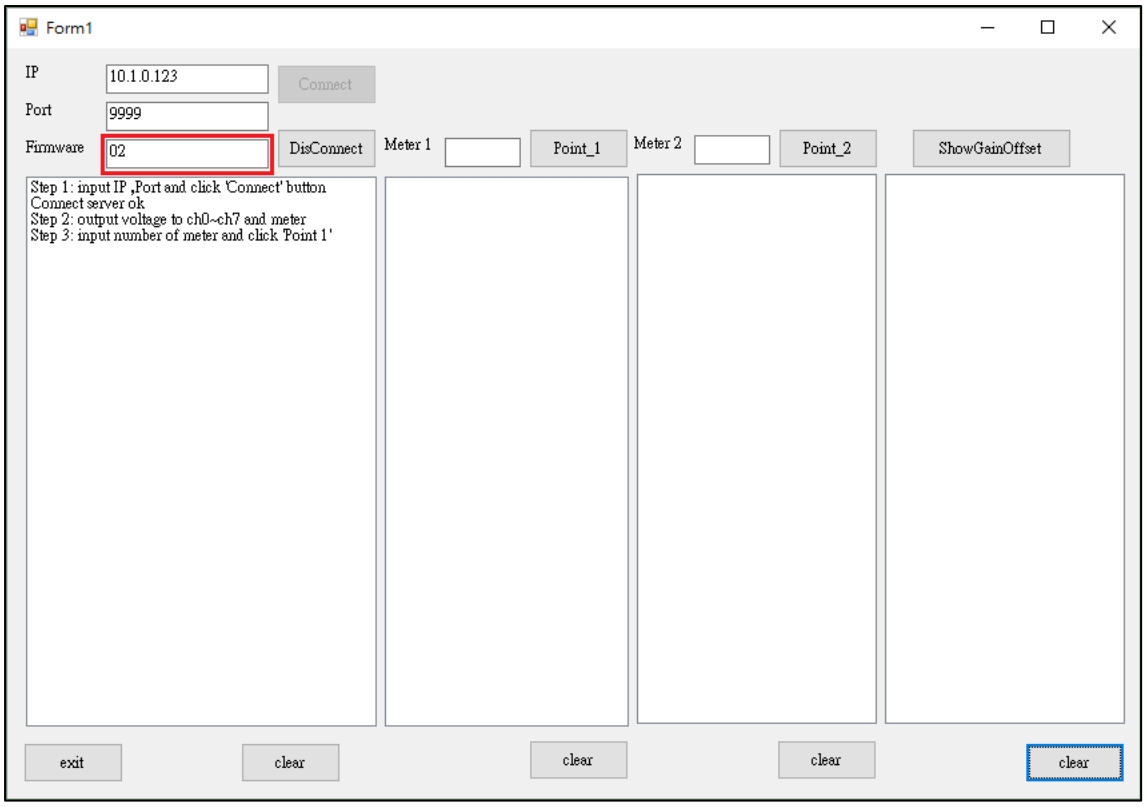
Connect the AI channels to the meter and power supply, as shown below:



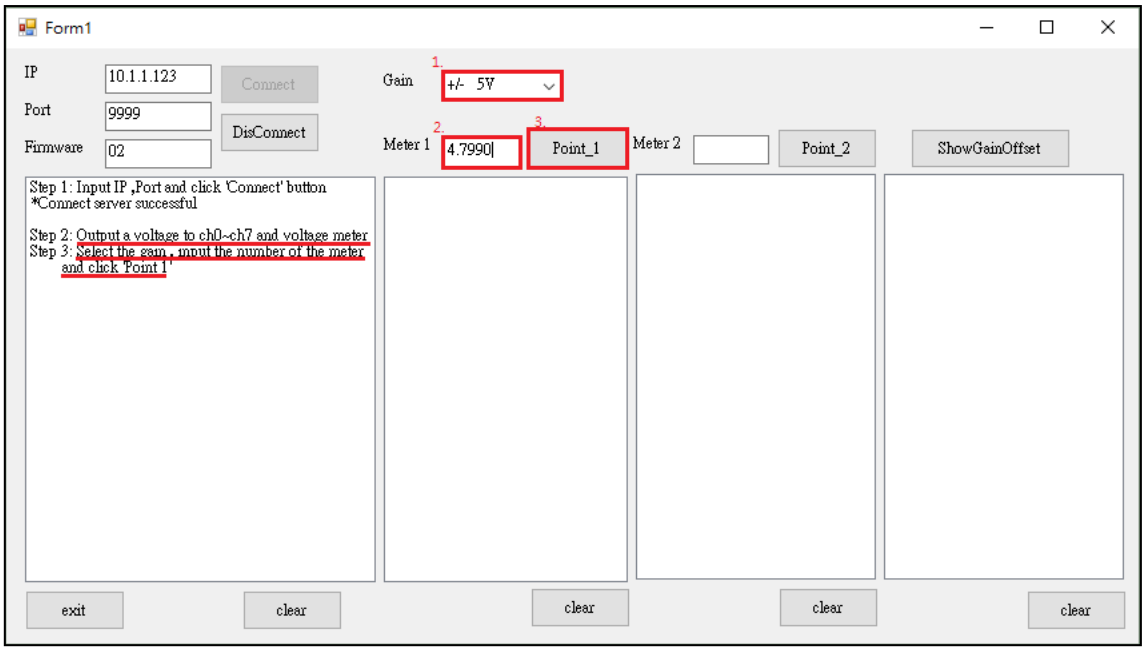
Step 1: Entering the IP and Port, and click Connect



After the connection is successful, the firmware version will be read back.



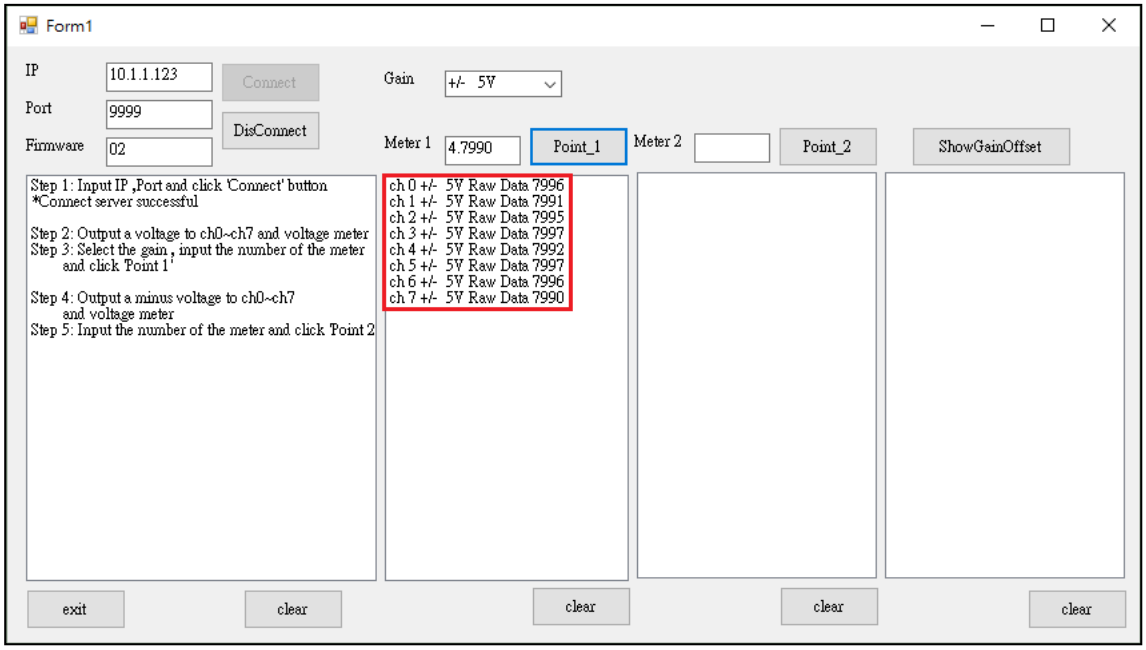
Step 2：Output voltage 4.8V to ch0 ~ ch7 and the meter, and select +/-5V in Gain combo box. Enter the value reading from the meter in Meter 1 textbox (the following example is 4.7990)



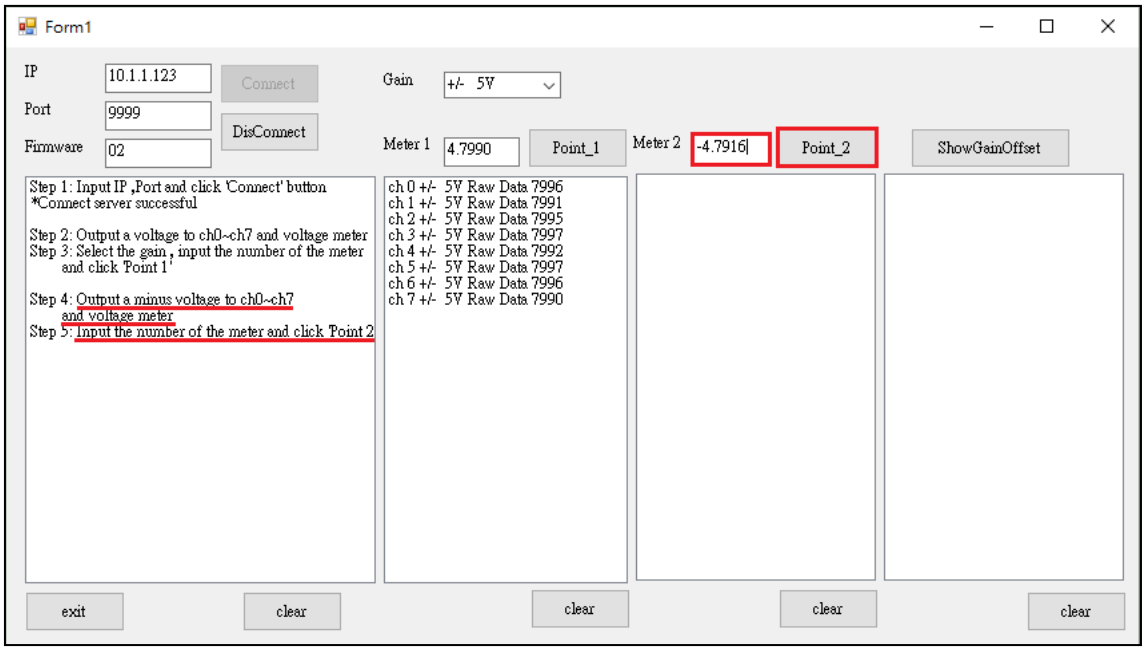
Tips & Warnings

The range of output voltage is 5V~0V and it's better to output voltage value near to 5V.

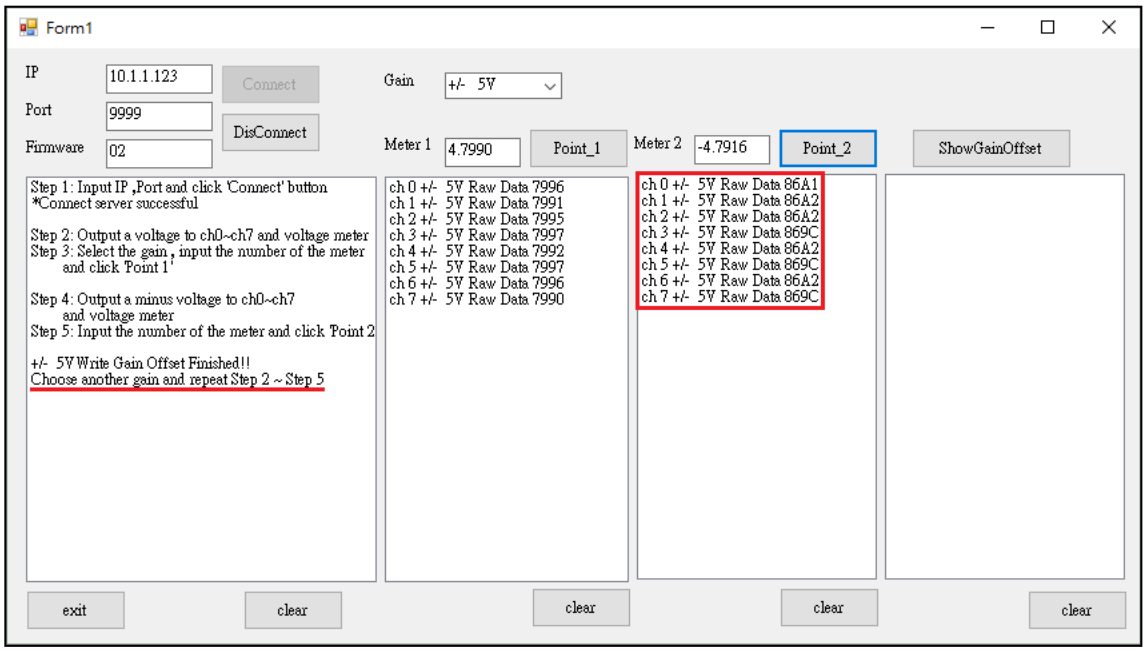
Step 3: Click Point_1 button and get the raw data of each channel as following



Step 4：Output a voltage, -4.8V to ch0 ~ ch7 and the meter, enter the value reading from meter in Meter 2 textbox (the following example is -4.7916)



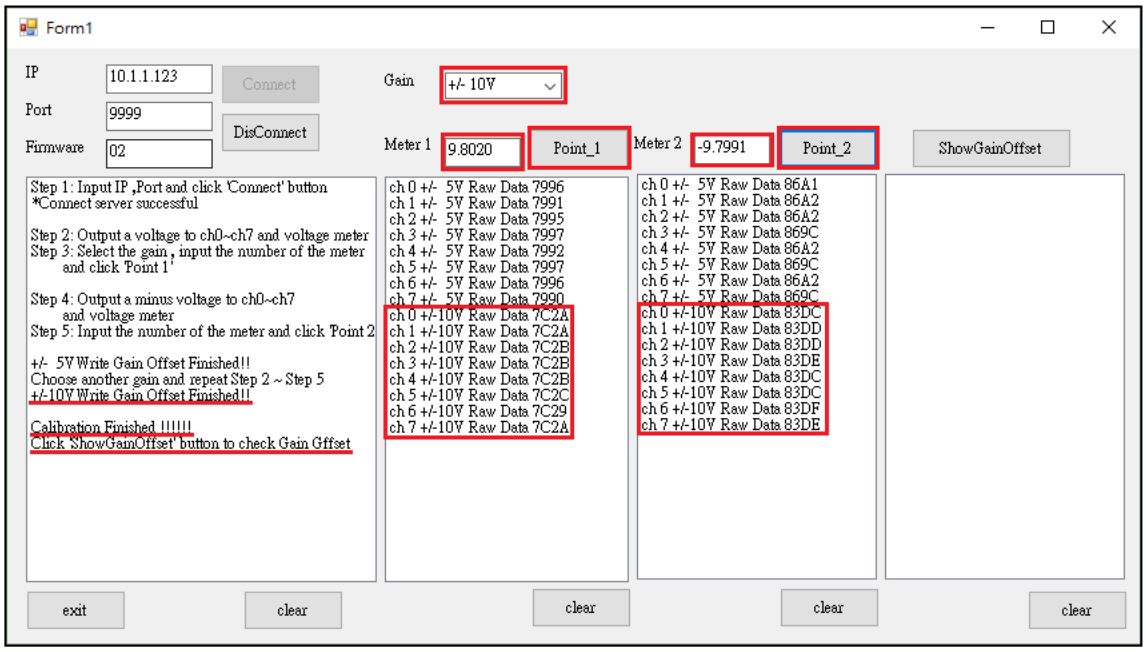
Step 5: Click Point_2 button and get the raw data of each channel as following



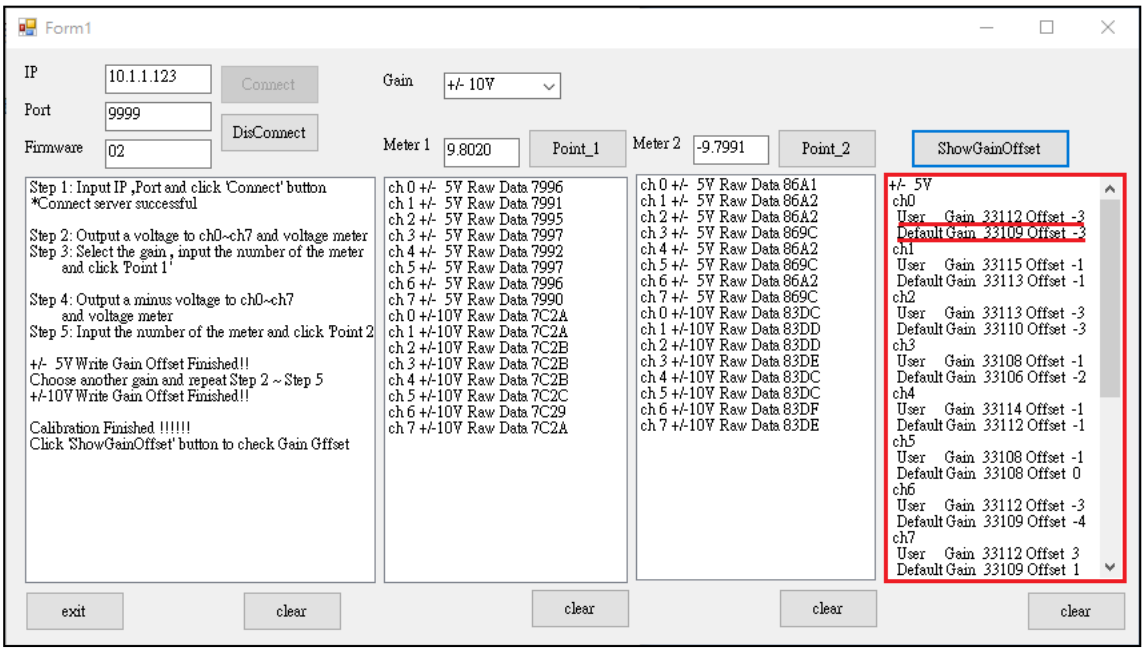
Step 6: Select +/- 10V in Gain combo box

Step 7: Repeat the Step 2 ~ Step 5, and the upper limit voltage outputs 9.8V in Step 2 and the lower limit voltage outputs -9.8V in Step 5

The calculated Gain Offset will be stored in the EEPROM. The calibration is completed after the message appears “Calibration Finished!!!”



Step 8: After completing the calibration, click on ShowGainOffset button to read Gain and Offset value



Appendix

1A. What is Modbus TCP/IP?

Modbus is a communication protocol that was developed by Modicon Inc. in 1979, and was originally designed for use with Modicon controllers. Detailed information regarding the Modbus protocol can be found at: http://www.modbus.org.

The different versions of the Modbus protocol used today include Modbus RTU, which is based on serial communication interfaces such as RS-485 and RS-232, Modbus ASCII and Modbus TCP, which uses the Modbus RTU protocol embedded into TCP packets.

Modbus TCP is an internet protocol. The protocol embeds a Modbus frame into a TCP frame so that a connection oriented approach is obtained, thereby making it more reliable. The master queries the slave and the slave responds with a reply. The protocol is open and, hence, highly scalable.

Modbus Message Structure

Modbus devices communicate using a master-slave (client-server) technique in which only one device (the master/client) can initiate transactions (called queries). The other devices (slaves/servers) respond by either supplying the requested data to the master, or by taking the action requested in the query.

A query from a master will consist of a slave address (or broadcast address), a function code defining the requested action, any required data, and an error checking field. A response from a slave consists of fields confirming the action taken, any data to be returned, and an error checking field.

☑ **The Modbus/TCP Message Structure**

Bytes 00-05	Bytes 06-11
6-byte header	RT

☑ **The Leading 6 bytes of a Modbus/TCP Protocol Query**

Byte 00	Byte 01	Byte 02	Byte 03	Byte 04	Byte 05
Transaction identifier		Protocol identifier		Length Field (upper byte)	Length Field (lower byte)

- Transaction identifier = Assigned by the Modbus/TCP master (client)
- Protocol identifier = 0
- Length field (upper byte) = 0 (since all messages are smaller than 256)
- Length field (lower byte) = The number of following RTU data bytes

☑ **RTU Data Structure**

Byte 06	Byte 07	Bytes 08-09	Bytes 10-11
Net ID (Station Number)	Function Code	Data Field	
		Reference Number (Address Mapping)	Number of Points

- Net ID specifies the address of the receiver (Modbus/TCP slave).
- Function Code specifies the message type.
- Data Field is the data block.

A.1. Net ID (Station Number)

The first byte in the frame structure of a Modbus RTU query is the receiver's address. Availed address is in the range of 0 to 247. Address 0 is used for general broadcast, while addresses 1 to 247 are given to individual Modbus devices.

A.2. Function Codes

The second byte in the frame structure of a Modbus RTU query is the function code, which describes what the slave device is required to do. Valid function codes are between 1 and 255. To answer the query, the slave device uses the same function code as contained in the request. The highest bit of the function code will only be set to '1' if an error occurs in the system. In this way, the master will know whether the message has been transmitted correctly or not.

Code	Function	Reference
01 (0x01)	Read the Status of the Coils (Readback DOs)	0xxxx
02 (0x02)	Read the Status of the Input(Reads DIs)	1xxxx
03 (0x03)	Read the Holding Registers (Readback AOs)	4xxxx
04 (0x04)	Read the Input Registers (Reads AIs)	3xxxx
05 (0x05)	Force a Single Coil (Writes DO)	0xxxx
06 (0x06)	Preset a Single Register (Writes AO)	4xxxx
15 (0x0F)	Force Multiple Coils (Writes DOs)	0xxxx
16 (0x10)	Preset Multiple Registers (Writes AOs)	4xxxx

A.3. Data Field

Data is transmitted in 8-, 16- and 32-bit format. The data for 16-bit registers is transmitted in high-byte first format. For example: 0x0A0B ==> 0x0A, 0x0B. The data for 32-bit registers is transmitted as two 16-bit registers, and is low-word first. For example: 0x0A0B0C0D ==> 0x0C, 0x0D, 0x0A, 0x0B.

The data field of messages sent between a master and a slave contains additional information about the action to be taken by the master or any information requested by the slave. If the master does not require this information, the data field can be empty.

Reference (Address)	Description
0xxxx	Read/Write Discrete Outputs or Coils. A 0x reference address is used to output device data to a digital output channel.
1xxxx	Read Discrete Inputs. The ON/OFF status of a 1x reference address is controlled by the corresponding digital input channel.
3xxxx	Read Input Registers. A 3x reference register contains a 16-bit number received from an external source, e.g. an analog signal.
4xxxx	Read/Write Output or Holding Registers. A 4x register is used to store 16bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.

B. Analog Input Type and Data Format Table

Type Code	Input Range	Data Format	+F.S	-F.S
02	-10 to +10V	Engineering Unit	+10000	-10000
		2's comp HEX	7FFF	8000
01	-5 to +5V	Engineering Unit	+5000	-5000
		2's comp HEX	7FFF	8000

- **Engineering:**

  The value gets from the software is 1000 times of the real value.

- **2's Complement (Hex):**

  The value usually displayed as hexadecimal format on the document or the software.

C. Troubleshooting

A number of common problems are easy to diagnose and fix if you know the cause.

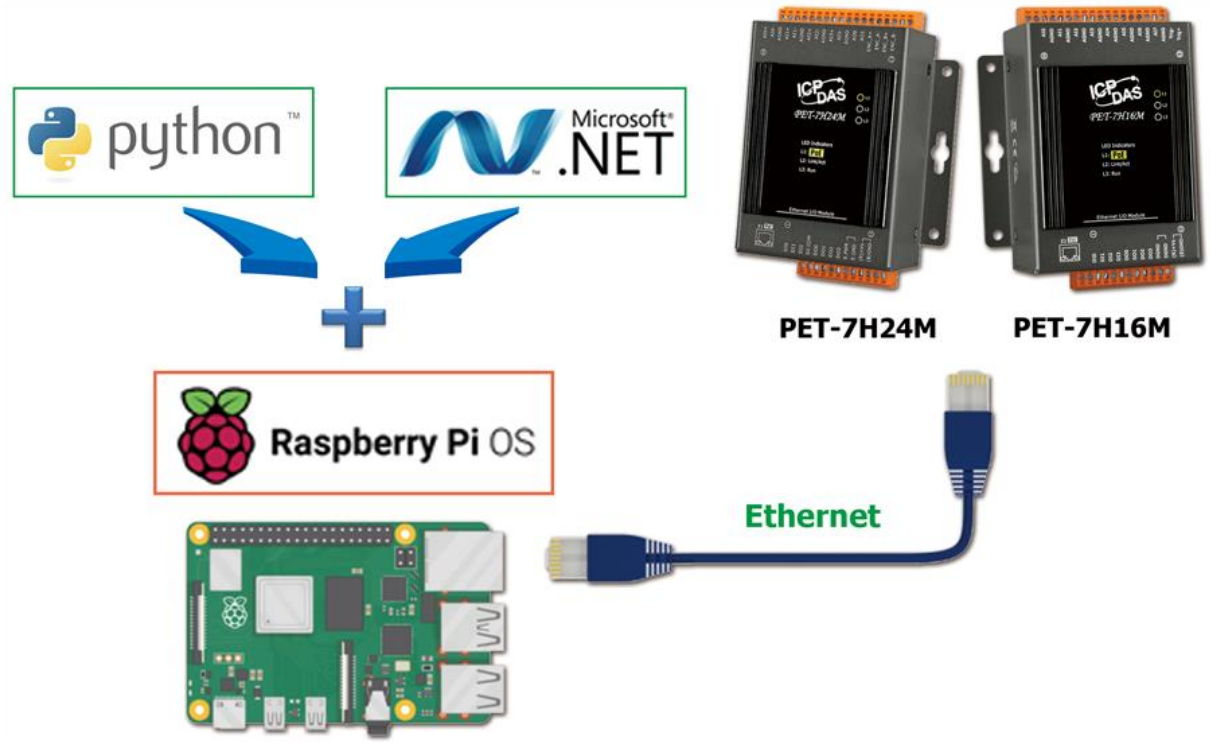
Symptom/Problem	Possible cause	Solution
The Run LED doesn't light	Internal power has failed	Return the module for repair.
The Run LED indicator is ON (light), but not flashing.	The module has possibly crashed.	Reboot the module
Cannot communicate via the Ethernet port, but the PET-7H16M is still operating.	The IP/Mask/Gateway address isn't within the IP address range of the LAN.	Change the IP/Mask/Gateway address to match the LAN, or ask the MIS administrator for assistance.
	The IP address has restricted by the IP filter settings	Check the IP filter setting using the Web configuration.
	There are more than 30 TCP/IP connections.	Reboot the module.
Able to explore the web page through port 80 using a web browser, but Modbus/TCP program cannot access the module through port 502.	Port 502 has been restricted by the firewall.	Consult your MIS administrator for assistance.
Modbus/TCP program can access the module through port 502, but Web browser cannot explore the web page through port 80 using a web browser.	The Port 502 has restricted by the firewall.	Consult your MIS administrator for assistance.
	The Web Configuration function has been disabled. (Shown on the Basic Settings page)	Enable the Web Configuration function using either the SMMI or the console.
	The Web server TCP port has been changed from port 80 (Shown on the Basic Settings page)	Change the TCP port to 80 or reconnect the PET-7H16M using the specific TCP port.

D. Applications

D.1. Raspberry Pi application

The Raspberry Pi open hardware creates diversified and customized applications in the age of Internet of Things. With python (the most popular development tool for the IoT) or Microsoft's cross-platform development tool .Net, it can provide products and various services more quickly.

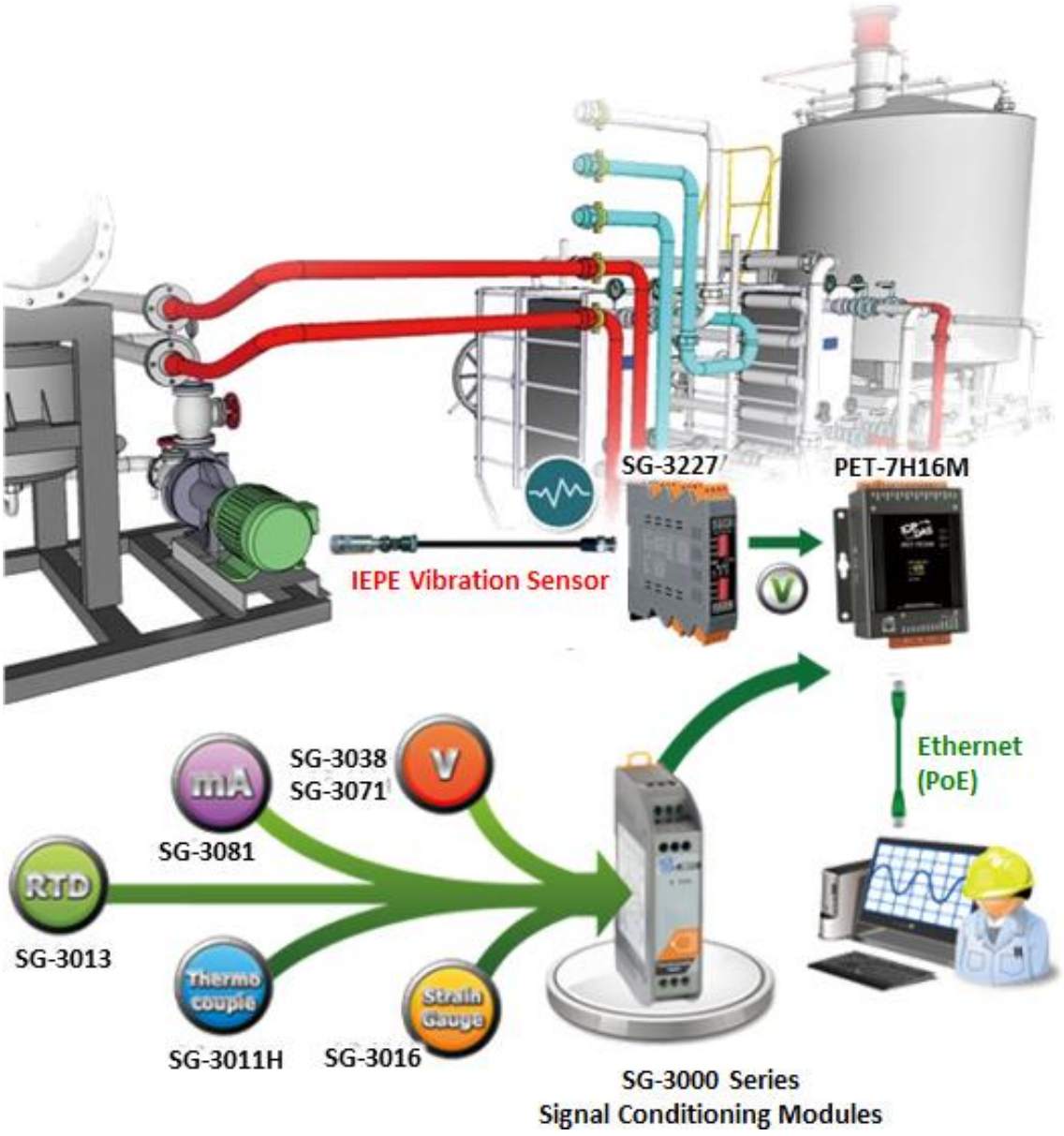
Raspberry Pi users use the python/.Net library and sample programs provided by the ICP DAS high-speed data acquisition module platform to connect to the PET-7H16M/PET-7H24M to collect high-speed data for data analysis and IoT applications.



D.2. Temperature, Vibration, Strain High Speed Measurement Application

The SG-3000 Series Signal Conditioning Module can be connected to a variety of sensors for current, voltage, thermocouple, resistance temperature sensor (RTD), strain gauge (Strain Gauge), accelerometer Different input signals such as (IEPE Accelerometer) are filtered, isolated, amplified, and converted into an analog voltage or current output in the general measurement range.

PET-7H16M/PET-7H24M plus SG-3000 series signal conditioning module will not only monitor voltage, current, temperature, strain, vibration and other diversified signals, but also collect real-time data from different regions and transmit it to the central management system via Ethernet.



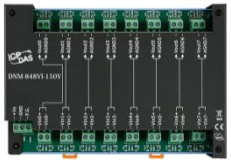
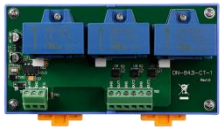
Models	SG-3011/H	SG-3013	SG-3016	SG-3227
Input				
Channels	1		2	
Signal	Thermocouple	RTD	Strain Gauge	IEPE Signal Conditioner
Type	J, K, T, E, R, S, B, N, C, L, M, L2	Pt100 Ni120 Pt100	±10 mV, ±20 mV, ±30 mV, ±50mV, ±100mV	IEPE Current: 2 mA, 4 mA, 6 mA, 10 mA ± 5% AC Signal Gain: 1, 10, 100 ± 2% High Pass Filter: 10 Hz Low Pass Filter: x1, x10 : 80 kHz; x100 : 50 kHz
Output				
Channels	1		2	
Signal	0 ~ 10 V, 0 ~ 20 mA	0 ~ 5 V, 0 ~ 10 V, 0 ~ 20 mA, 4 ~ 20 mA	±5 V, ±10 V, 0 ~ 5 V, 0 ~ 10 V, 0 ~ 20 mA	AC Couple: ±10 V, DC Couple: 1~28 V
Others				
Applications	• HVAC/Air conditioning control • Petrochemical industry • Electronic/semiconductor equipment • Water treatment equipment • Pot/heating industry • Hot pressing mold	• VOC Combustion control • Corrosive temperature measurement • Air/oil pressure machine • Solar production equipment Desalination equipment	• Vehicle material research • Equipment construction • Boat, bridge structure • Building structure monitoring	• Building structure • Equipment safety detection • Mechanical vibration measurement • Structural vibration analysis measurement • Vibration reduction test • Machine rigidity test

For more information, please click the link to the right. SG-3000 Series

D.3. High Voltage and High Current High Speed Measurement Application

DN-800 series is a Voltage Attenuator and Current Transformer designed for used in high-voltage and high-current applications. The high-voltage and high-current can be converted into ±10 Vpp attenuated signal, and PET-7H16M/PET-7H24M is able to read the ±10 VDC signals via DN-800 series. By using DN-800 series and PET-7H16M/PET-7H24M, the power data of all kinds of machines and AC/DC motors can be high-speed measured and retrieved, and then the analyzed data can be quickly used to develop a model to build a failure warning system.

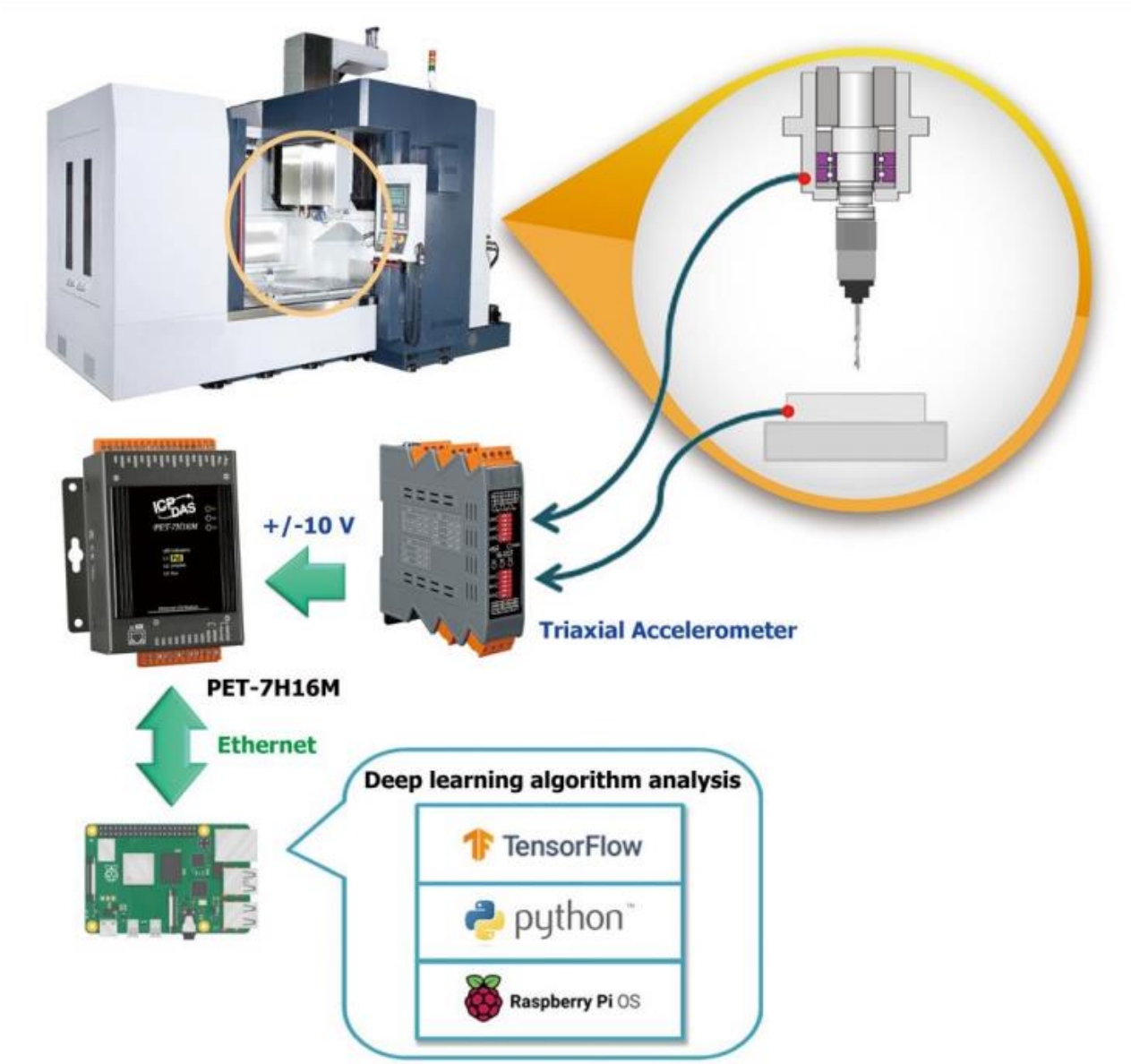
Models		Input Channel	Input Type	Input Range	CT Type	Cable	Output
	DNM-831I-100V-50A	1 x Voltage, 1 x Current	AC/DC	±100 Vpp, ±50 A	Clip-on Ø21 mm	1.5 m	±10 Vpp
	DNM-831I-100V-200A			±100 Vpp, ±200 A			
	DNM-831I-100V-500A			±100 Vpp, ±500 A			
	DNM-831I-100V-1000A			±100 Vpp, ±1000 A	Clip-on Ø40.5 mm		
	DNM-831I-100V-2000A			±100 Vpp, ±2000 A			
	DNM-844-50A	4 x Current		±50 A	Clip-on Ø21 mm		
	DNM-844-200A			±200 A			
	DNM-844-500A			±500 A			
	DNM-844-1000A			±1000 A	Clip-on Ø40.5 mm		
	DNM-844-2000A			±2000 A			

Models		Input Channel	Input Type	Input Range	CT Type	Cable	Output
	DNM-843VI-600V	3 x Voltage	AC/DC	±600 Vpp	N/A	N/A	±10 Vpp
	DNM-843VI-800V			±800 Vpp			
	DNM-848VI-10V	8 x Voltage		±10 Vpp			
	DNM-848VI-80V			±80 Vpp			
	DNM-848VI-150V			±150 Vpp			
	DN-843I-CT-1	3 x Current		±1 A	Solid Core (closed)		±1.6 Vpp
	DN-843I-CT-10			±10 A			±10 Vpp
	DN-843I-CT-20			±20 A			±10 Vpp
	DN-843I-CT-50			±50 A			±4 Vpp

For more information, please click the link to the right. DNM-800 Series

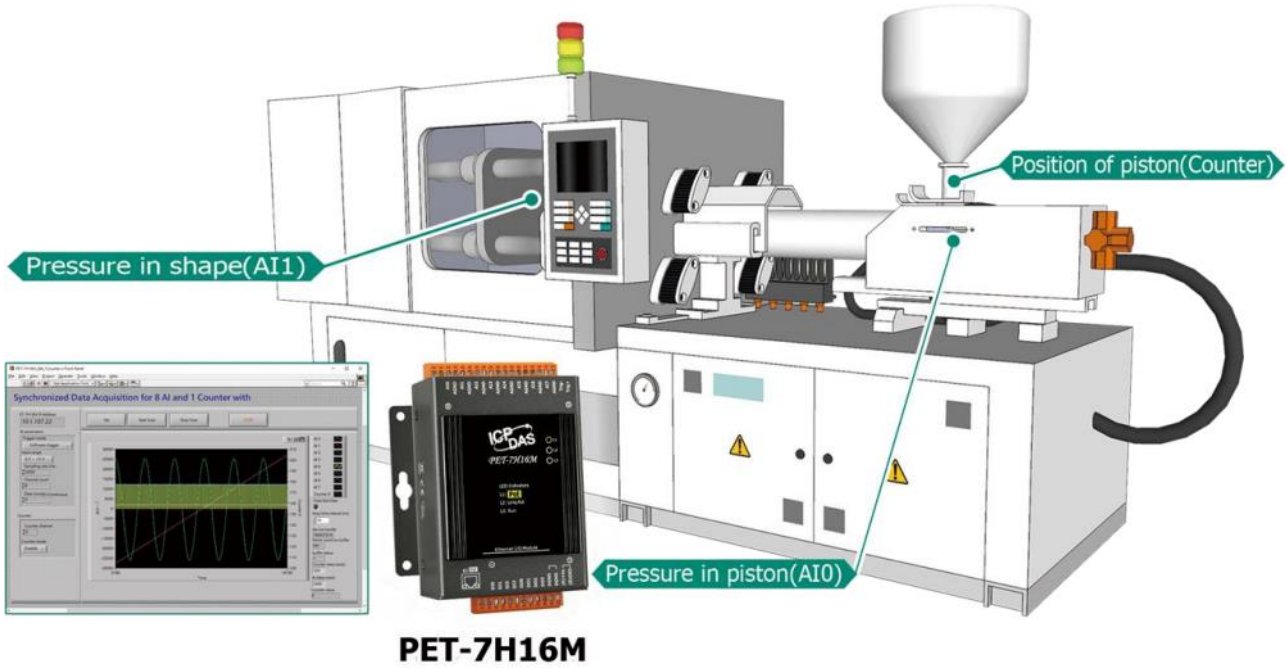
D.3.1. Tool Wear Monitoring and Life Prediction

PET-7H16M with Raspberry Pi hardware is used to collect a large number of vibration signal data from the spindle and platform of the processing machine, with tool wear data, and use Tensor Flow deep learning to analyze the tool wear prediction during the cutting process. The purpose is to estimate the tool wear in the future through random and short-term measurement of vibration signals. It is used to predict whether to replace unhealthy or unsafe cutting tool before the important material cutting process.



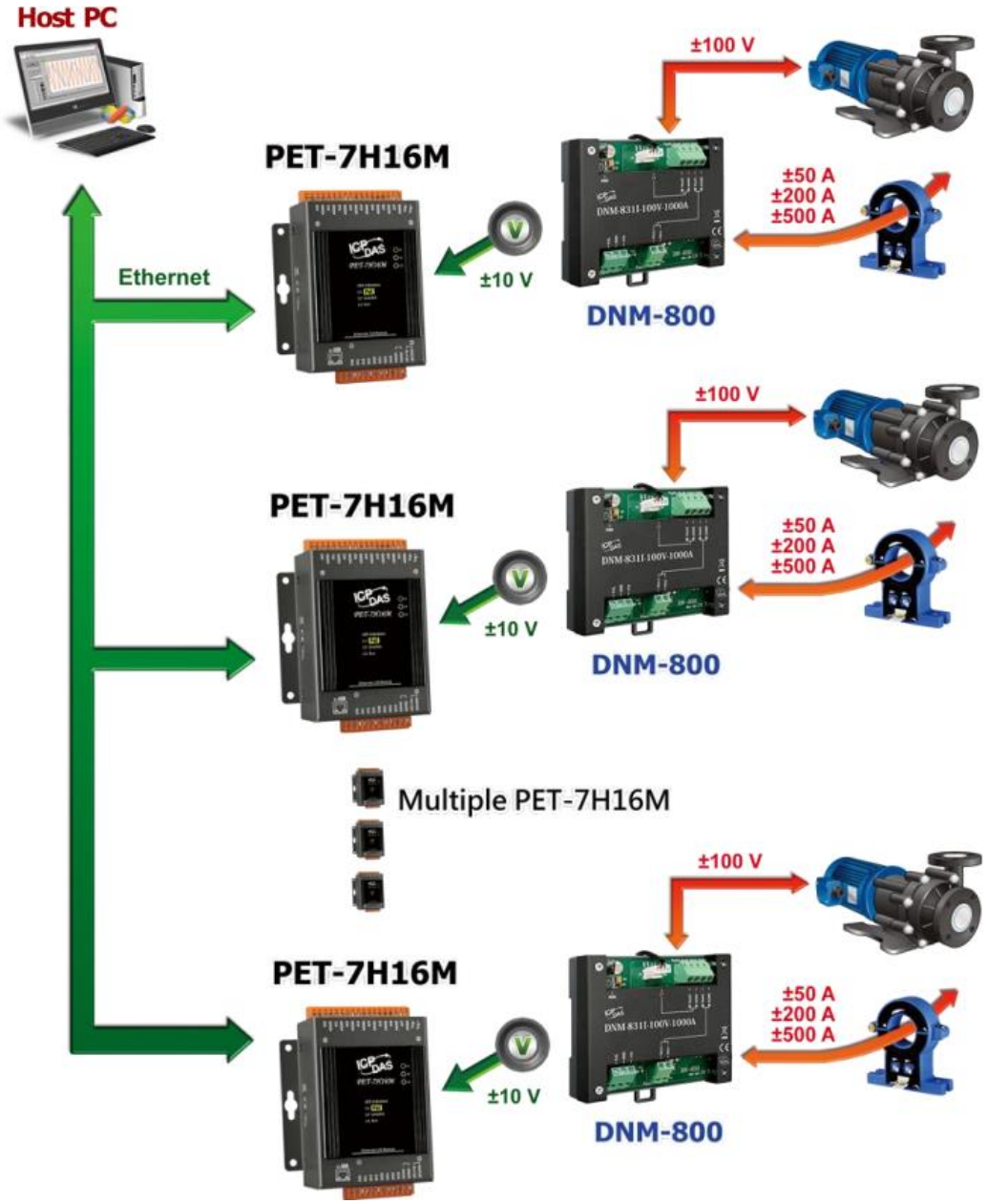
D.4. Casting Machine Monitoring Application

The aluminum casting machine pumps the hot aluminum into the mold through its piston. The customer wants to measure the pressure value of the mold and piston pressurization in the die. The piston moves at a very high speed, and its pressure also changes at a high speed. A comparison chart of the relationship between piston position and pressure is established. The two pressure sensors are converted into voltage values and input to the two AI channels of PET-7H16M. The obtained AI value is converted into a pressure value. The position of the piston is linear coded. Connect this linear encoder to trig + / trig- input to the high-speed counter. The position of the piston is obtained from the value of the counter. The counter input and analog input of PET-7H16M can be read simultaneously. The counter input value and the analog input value are read synchronously at the set sampling time. The AI sampling rate of this application is up to 2k Hz.



D.4.1. Motor Monitoring Application

PET-7H16M is equipped with a voltage attenuator and current transformer module (DNM-800) to collect the voltage and current signals of the motor and convert them into analog voltages in the general measurement range. The signals are converted into digital data via the PET-7H16M and transmitted back to the host PC via Ethernet. . On the PC side, the voltage, current, frequency, energy consumption, harmonics and health status of the motor in operation are calculated through algorithms, and the data results are displayed on the HMI to help customers monitor the energy consumption and health status of the motor at all times. It is currently used in a technology company, deploying 9 sets of PET-7H16M to monitor 9 sets of motor equipment. The AI sampling rate of each channel of this application is 2k~10k Hz.



E. Revision History

This chapter provides revision history information to this document.

The table below shows the revision history.

Revision	Date	Description
1.0.1	January 2019	Initial issue
1.0.2	October 2019	1. Modify chapter 4.3 SDK API 2. Add Analog threshold Trigger function 3. Add Delay-trigger function
1.0.3	July 2021	1. Modify the ET-7H16 utility name to HSDAQ utility 2. Update links in the manual 3. Add HSDAQ SDK package description 4. Add application note appendix
1.0.4	August 2024	1. Modify Appendix A. What is Modbus TCP/IP? 2. Modify System Specification – Communication 3. Add Software Specification 4. Add Appendix B . Analog Input Type and Data Format Table 5. Update Modbus Register Map