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PLX51-HART-4I / PLX51-HART-4O

HART Input/Output

Multidrop Field Devices

November 21, 2025

USER MANUAL

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PLX51-HART-4I/4O User Manual
For Public Use.

November 21, 2025

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Contents

1 Preface

1.1 Introduction to the PLX51-HART-4x

The PLX51-HART-4I and PLX51-HART-4O allows the user to interface up to four analog HART channels with either EtherNet/IP, Modbus TCP/IP, DNP3 TCP/UDP, or PCCC (AB-ETH) protocols. This includes 4 to 20 mA input and output devices with or without HART communications, as well as 0 to 20 mA devices without HART.

The PLX51-HART-4x is available in Input or Output variations:

1) **PLX51-HART-4I** for HART input devices (e.g. temperature sensor).
2) **PLX51-HART-4O** for HART output devices (e.g. valve positioners).

The PLX51-HART-4x supports multiple HART devices per channel (multidrop).

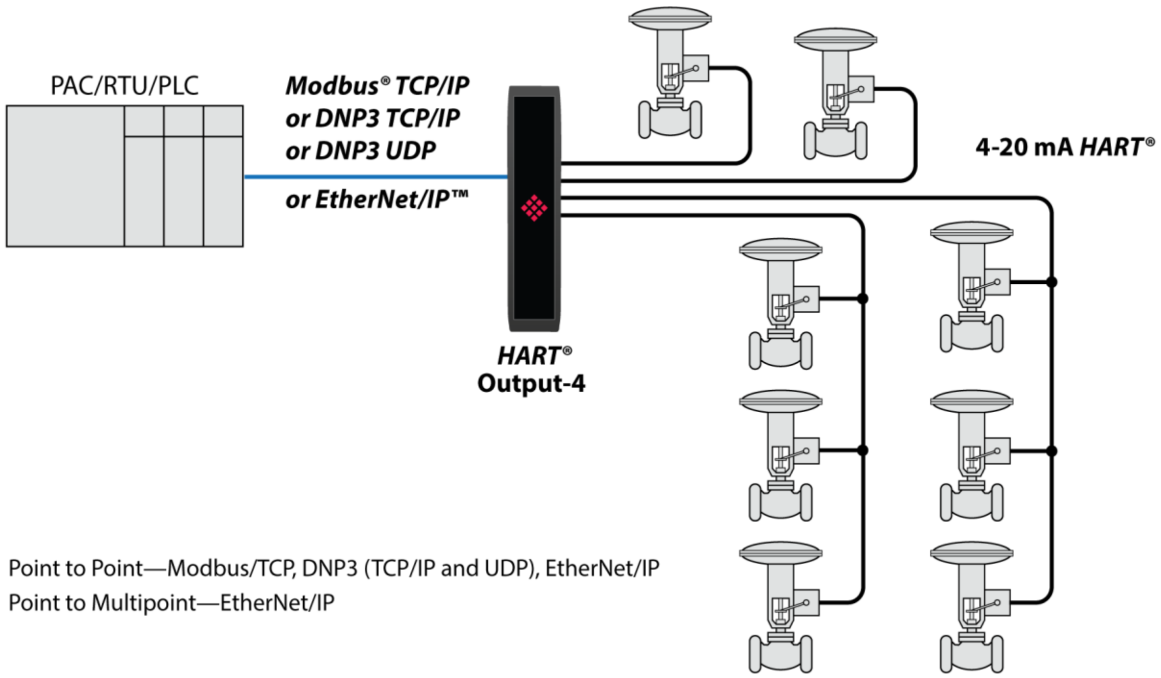


Figure 1.1 – PLX51-HART-4O multidrop typical architecture

1.2 Features

The PLX51-HART-4x can interface analog HART devices to either EtherNet/IP, Modbus TCP/IP, DNP3 TCP/UDP, PCCC (AB-ETH), or FTView systems.

The conversion to EtherNet/IP enables a HART device to be added directly into the IO tree of a Controller/PLC (e.g. Allen-Bradley Logix Controller).

The Modbus TCP/IP option enables a HART field device to be viewed as a Modbus Server, while the DNP3 option converts a HART field device into a DNP3 Outstation. The DNP3 option supports Secure Authentication, ensuring secure communications across the Ethernet network.

The PLX51-HART-4x supports PCCC (Allen Bradley legacy protocol – AB-ETH), which allows an SLC / MicroLogix / PLC5 to read data from HART field device and write data to HART field devices.

The PLX51-HART-4I or PLX51-HART-4O modules support direct access from a FTView SCADA or PanelView to read and display data without the need for an intermediate PLC or controller.

The PLX51-HART-4I or PLX51-HART-4O module also has automatic extraction and updating of multidrop HART devices which can be accessed via Modbus TCP/IP, FTView (using CIP parameter objects), or PCCC. When using an EtherNet/IP source, the user can select either the new or legacy tag format for updating Logix tags using direct-to-tag technology, where no PLC programming is required.

In addition, a rich collection of process and diagnostic information is provided directly into Logix, without the use of any explicit messaging. HART commands can also be relayed to the device using an EtherNet/IP message relay object.

The PLX51-HART-4x modules also allow the sending of custom HART messages using EtherNet/IP or Modbus TCP/IP. This will allow the user to read or write specific configured HART commands with custom data from the interface protocol (e.g. EtherNet/IP).

A DTM (Device Type Manager) is available for simplifying device configuration and management using an FDT frame.

A built-in webserver provides detailed diagnostics of system configuration and operation as well as field device specific diagnostics.

The PLX51-HART-4I or PLX51-HART-4O module is configured using the PLX50 Configuration Utility. This software can be downloaded from www.prosoft-technology.com free of charge.

Hereafter the PLX51-HART-4I or PLX51-HART-4O module will be referred to as the **module**.

1.3 Architecture

The figure below provides an example of the typical architecture for a PLX51-HART-4I interfacing to an EtherNet/IP device (e.g. Allen-Bradley Logix Controller).

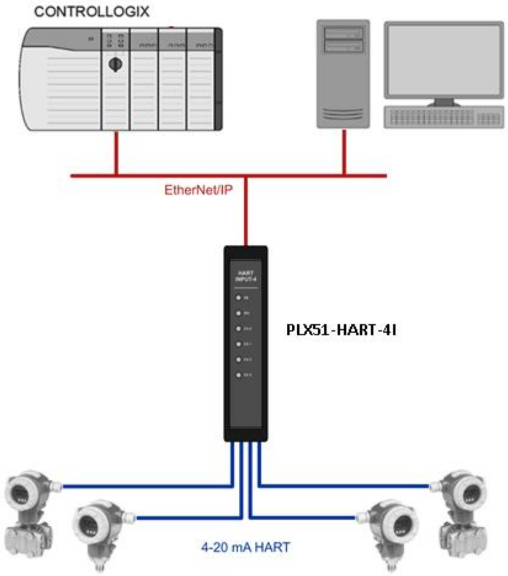


Figure 1.2 – PLX51-HART-4I EtherNet/IP typical architecture

The figure below provides an example of the typical architecture for a PLX51-HART-4x interfacing to a Modbus TCP/IP Client.

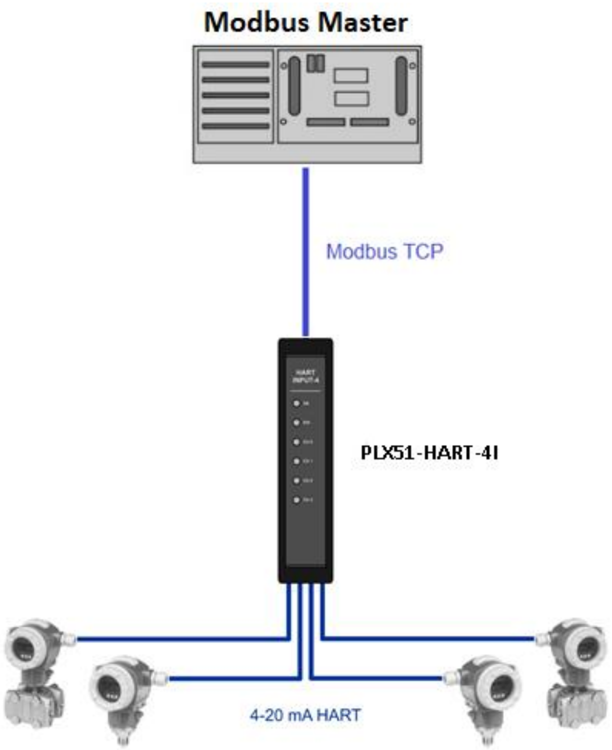


Figure 1.3 – PLX51-HART-4I Modbus TCP/IP typical architecture

The figure below provides an example of the typical architecture for a PLX51-HART-4I interfacing to a DNP3 Master SCADA.

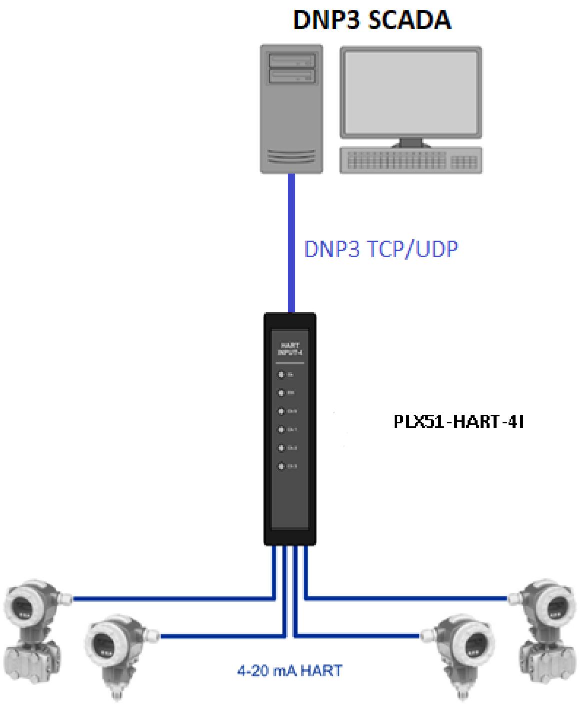


Figure 1.4 – PLX51-HART-4I DNP3 typical architecture

The figure below provides an example of the typical architecture for a PLX51-HART-4I interfacing to a SLC using PCCC.

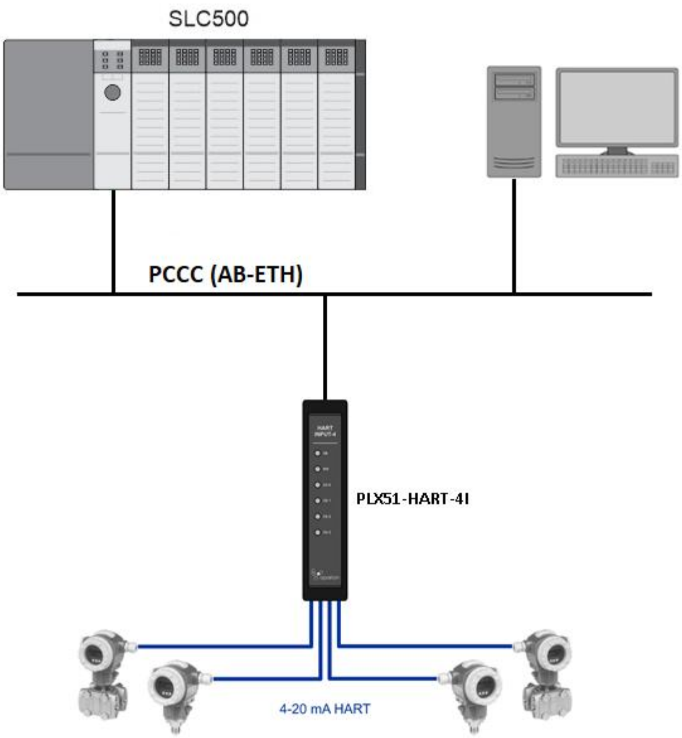


Figure 1.5 – PLX51-HART-4I PCCC interface architecture

The figure below provides an example of the typical architecture for a PLX51-HART-4I with multidrop HART devices.

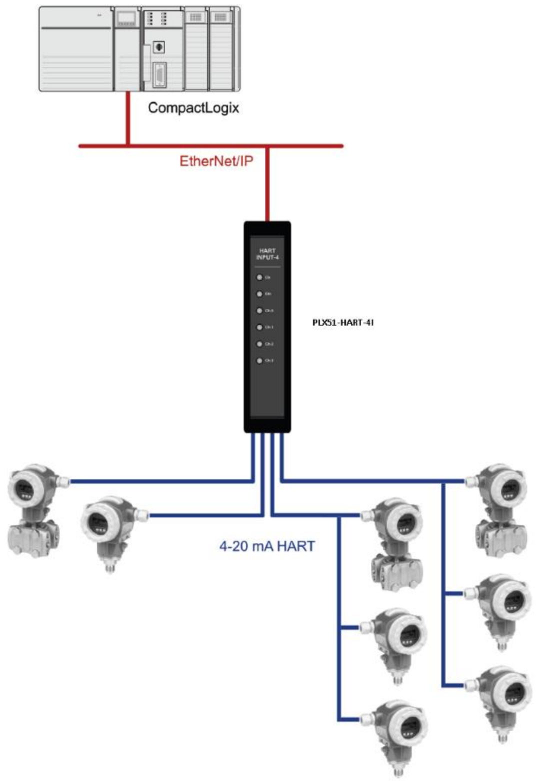


Figure 1.6 – PLX51-HART-4I multidrop architecture

1.4 Additional Information

The following documents contain additional information that can assist the user with the module installation and operation.

Table 1.1 - Additional Information

Resource	Link
PLX50 Configuration Utility Installation	https://www.prosoft-technology.com/
User Manual, Datasheet Example Code & UDTs	https://www.prosoft-technology.com/
Ethernet wiring standard	www.cisco.com/c/en/us/td/docs/video/cds/cde/cde205_220_420/installation/guide/cde205_220_420_hig/Connectors.html

1.5 References

Table 1.2 – References

Resource	Link
HART Communication Foundation	http://en.hartcomm.org/
DNP3	http://www.dnp.org
CIP Routing	The CIP Networks Library, Volume 1, Appendix C:Data Management
Modbus	http://www.modbus.org

1.6 Support

Technical support is provided via the Web (in the form of user manuals, FAQ, datasheets etc.) to assist with installation, operation, and diagnostics.

For additional support the user can use either of the following:

Table 1.3 – Support Details

Resource	Link
Contact Us link	https://www.prosoft-technology.com/
Support email	ps.support@belden.com

2 Installation

2.1 Module Layout

The module has six ports at the bottom of the enclosure as shown in the figure below. The ports are used for Ethernet, analog HART channels (4), and power. The power port uses a three-way connector for the DC power supply and the earth connection.

The Ethernet cable must be wired according to industry standards. See the additional information section of this document.

Figure 2.1 –Module side view

The module provides six diagnostic LEDs as shown in the front view figure below. These LEDs are used to provide status of the module system operation, the Ethernet interface, and the status of each of the four analog HART channels.

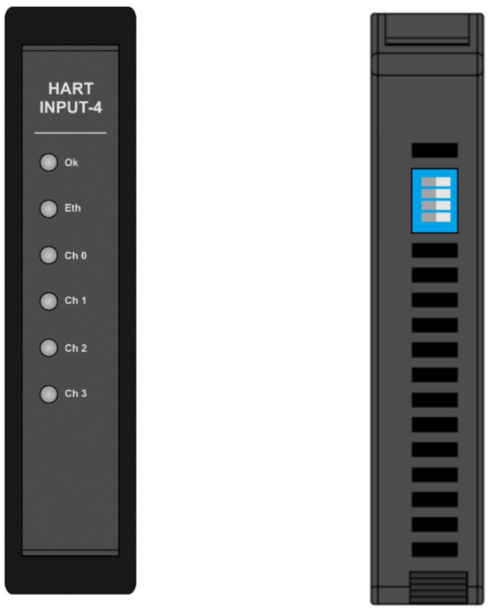


Figure 2.2 – PLX51-HART-4I front and top view

The module provides four DIP switches at the top of the enclosure as shown in the top view figure above.

Table 2.1 - DIP Switch Settings

DIP Switch	Description
DIP Switch 1	Used to force the module into Safe Mode. When in Safe Mode the module will not load the application firmware and will wait for new firmware to be downloaded. This should only be used on the rare occasion when a firmware update was interrupted at a critical stage.
DIP Switch 2	This will force the module into DHCP mode which is useful when the user has forgotten the IP address of the module.
DIP Switch 3	This DIP Switch is used to lock the configuration from being overwritten by the PLX50 Configuration Utility. When set the PLX50 Configuration Utility will not be able to download to the module.
DIP Switch 4	When this DIP Switch is set at bootup it will force the module Ethernet IP address to 192.168.1.100 and network mask 255.255.255.0. The user can then switch the DIP switch off and assign the module a static IP address if needed.

2.2 Module Mounting

The module provides a DIN rail clip to mount onto a 35mm DIN rail.

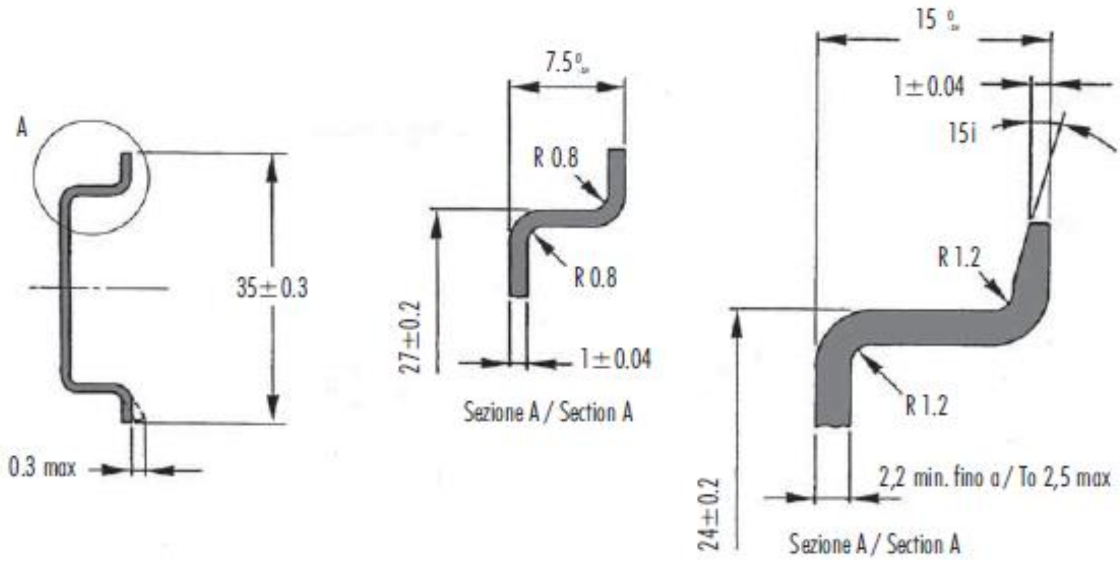


Figure 2.3 - DIN rail specification

The DIN rail clip is mounted on the bottom of the module at the back as shown in the figure below. Use a flat screwdriver to pull the clip downward. This will enable the user to mount the module onto the DIN rail. Once the module is mounted onto the DIN rail the clip must be pushed upwards to lock the module onto the DIN rail.

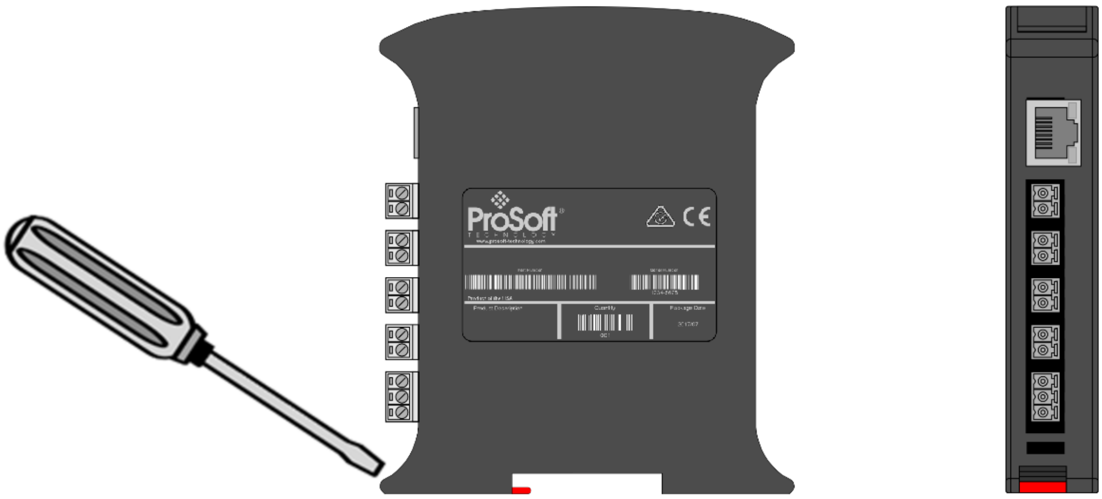


Figure 2.4 - DIN rail mouting

2.3 Power

A three-way power connector is used to connect Power+, Power– (ground), and earth. The module requires an input voltage of 10 – 28Vdc. Refer to the technical specifications section in this document.

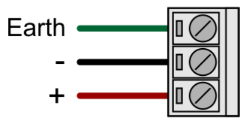


Figure 2.5 - Power connector

2.4 Analog (HART) – Single Device

The Analog HART channels are connected using a two-way connector. The input channels (PLX51-HART-4I) are internally loop powered and therefore can be connected directly to the field device signal terminals.

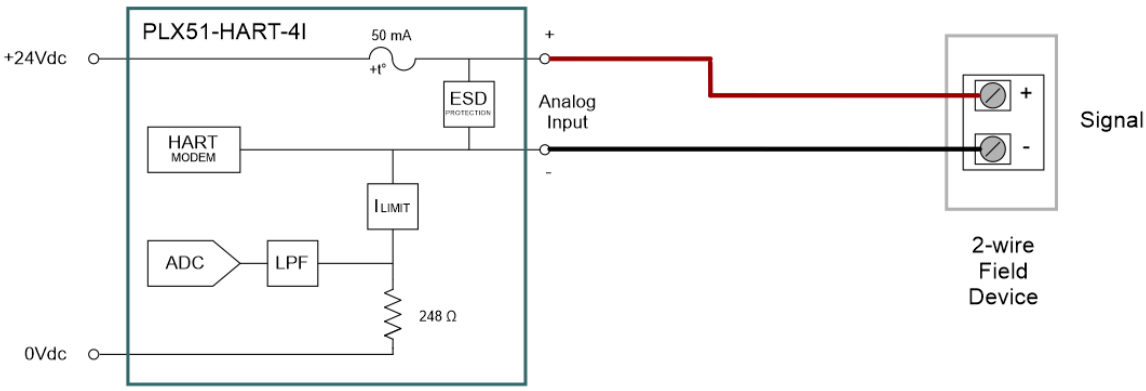


Figure 2.6 – PLX51-HART-4I Connection to Field Device (2-wire)

The output channels (PLX51-HART-4O) source the current directly and therefore can also be connected directly to the field device signal terminals. The input and output channels provide internal current limiting and electronic fuse protection.

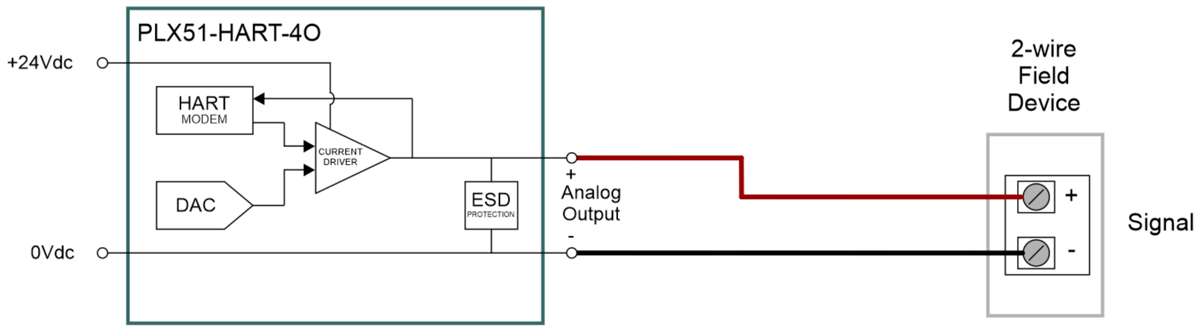


Figure 2.7 – PLX51-HART-4O Connection

The equivalent Analog Input and Output circuits are shown below.

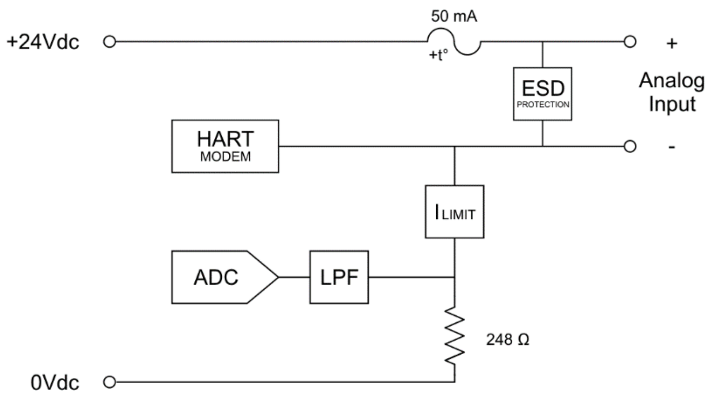


Figure 2.8 – Analog Input Equivalent Circuit

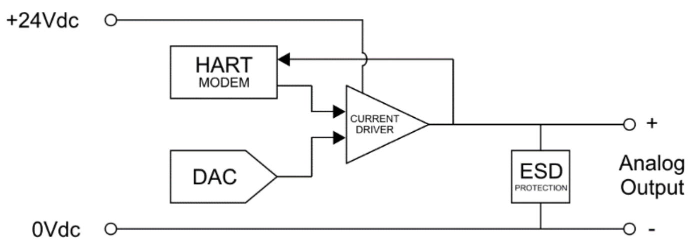


Figure 2.9 – Analog Output Equivalent Circuit

The PLX51-HART-4I module supports 2-wire (loop-powered) and 4-wire devices in various configurations as illustrated below.

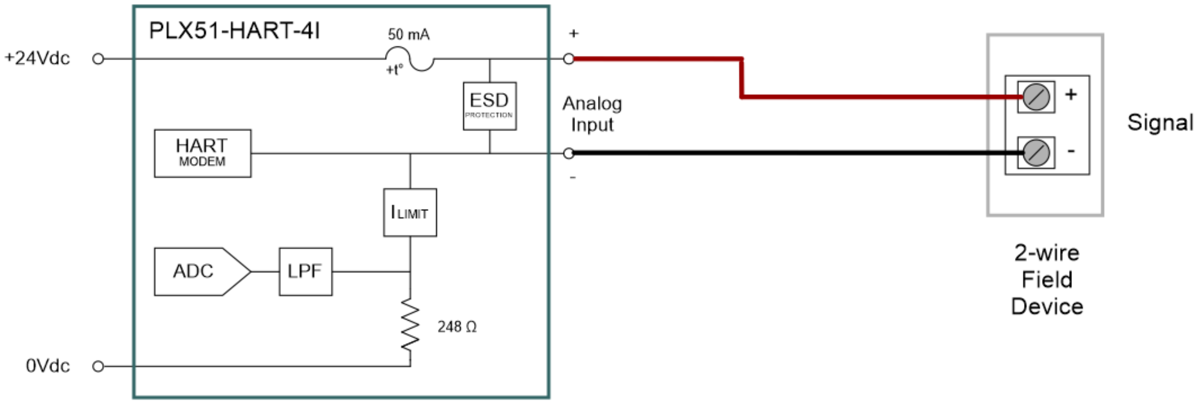


Figure 2.10 – Channel Connection - 2-wire – Module Powered

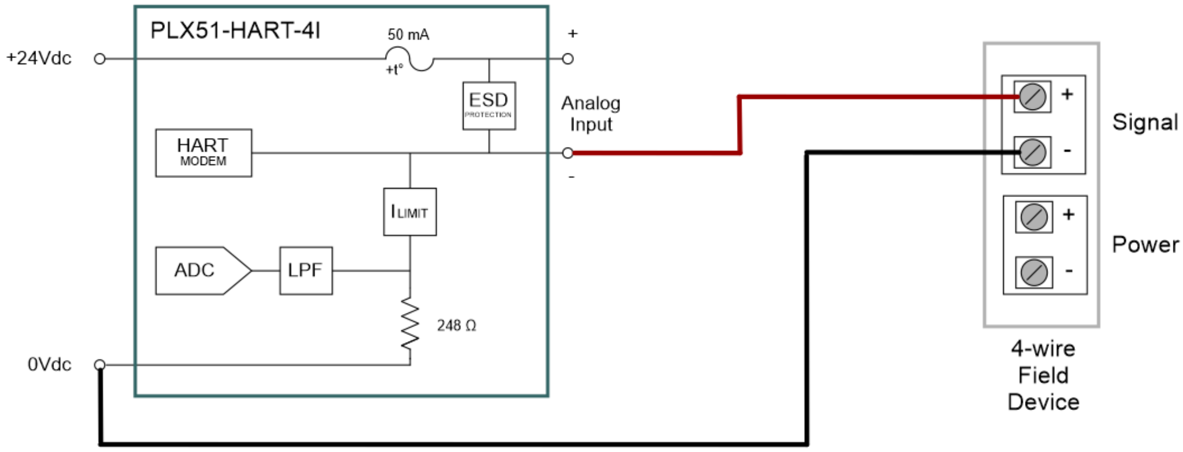


Figure 2.11 – Channel Connection - 4-wire – Device Powered

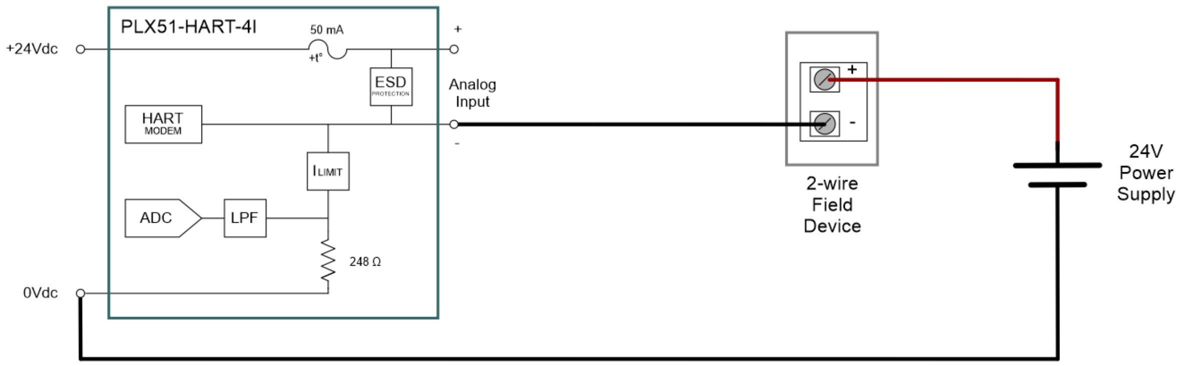


Figure 2.12 – Channel Connection - 2-wire – Externally Powered

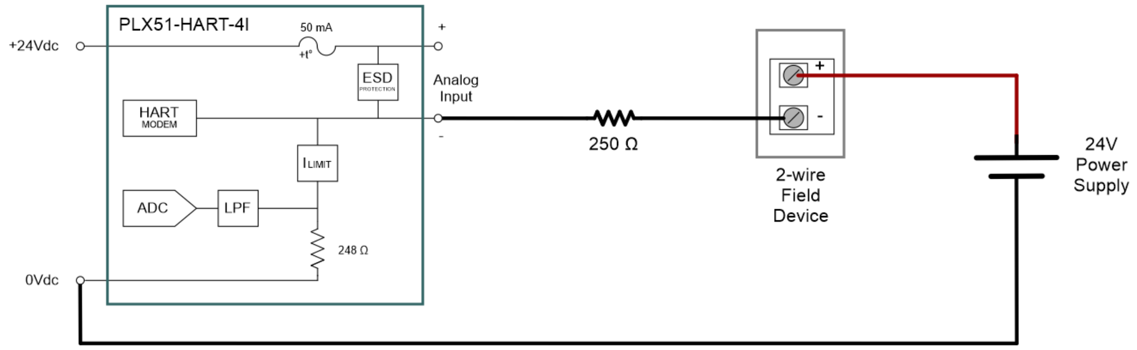


Figure 2.13 – Channel Connection - 2-wire – Externally Powered with External Resistor

2.5 Analog (HART) – Multidrop

In a multidrop setup the field devices can be connected in either a series or parallel configuration. The maximum number of devices that can be connected per channel is as follows:

Table 2.2 - Maximum Device Count

Connection Method	PLX51-HART-4I	PLX51-HART-4O
Series	2	2
Parallel	7	5*

Note: Output devices must be limited to 4 mA.

The above table should be considered as a maximum count; lower counts may be applicable for some field devices.

2.5.1 Series Configuration

The series connection method has the advantage of the (4-20 mA) current still being controlled by one of the devices, which may be required in some applications. The disadvantage is that the supply voltage is divided by the devices, so the maximum would typically be 2. (Assuming a typical minimum of 10V, and a supply of 24V).

This would apply to each channel of both the PLX51-HART-4O and the PLX51-HART-4I.

As indicated in the diagrams below, the PLX51-HART-4I can support multidrop devices in series with either module-powered or externally-powered configurations.

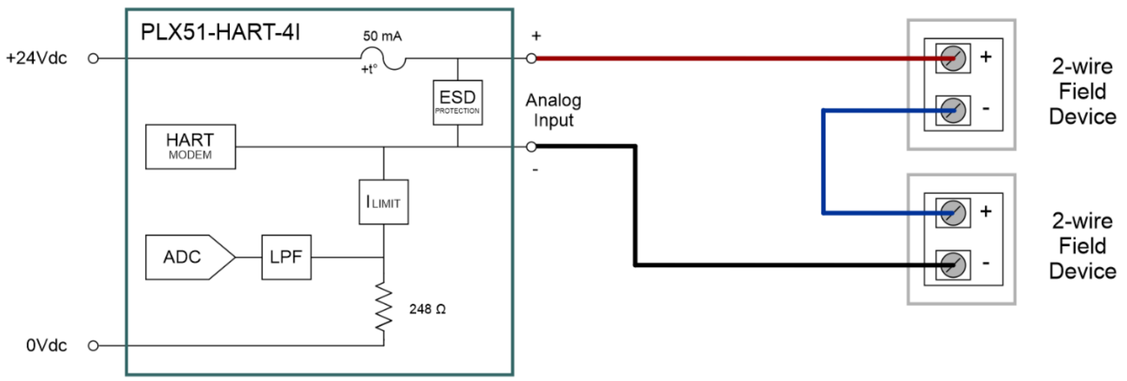


Figure 2.14 – PLX51-HART-4I - Multidrop Wiring – Series – Module Powered

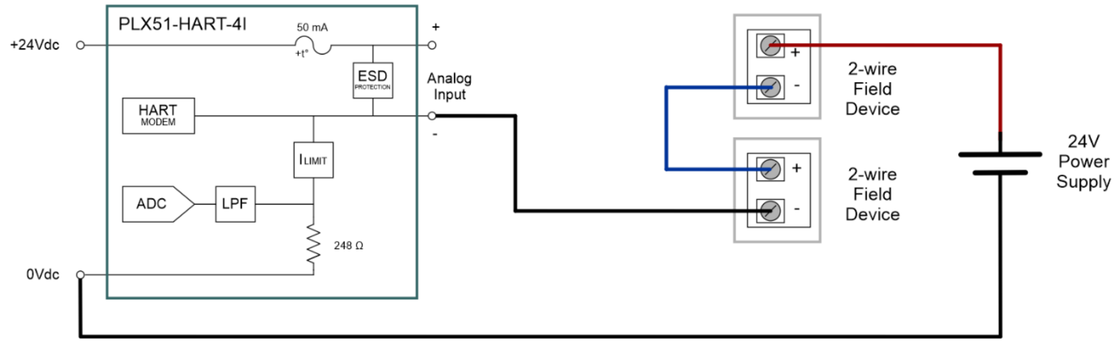


Figure 2.15 – PLX51-HART-4I - Multidrop Wiring – Series – Externally Powered

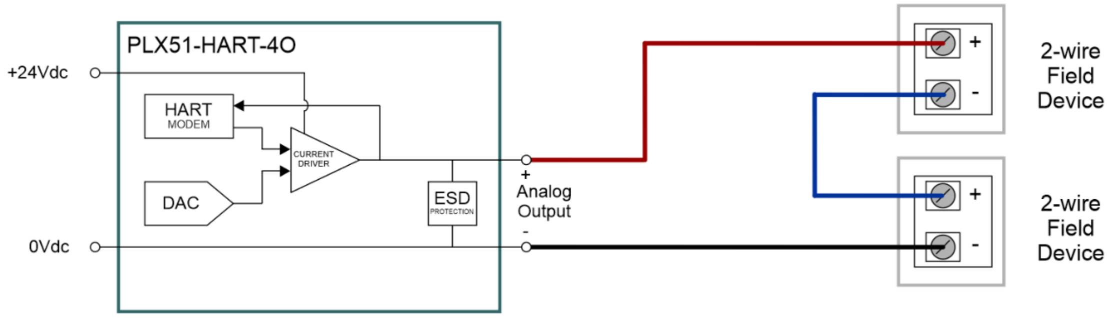


Figure 2.16 – PLX51-HART-4O - Multidrop Wiring – Series

Note: It is not recommended to multidrop 4-wire devices unless all devices make use of isolated power supplies.

2.5.2 Parallel Configuration

Connecting the field devices in parallel is more common although it has the disadvantage that the 4-20 mA cannot be controlled by any device. Here all of the field devices remain at 4 mA, and all share a common supply voltage.

The PLX51-HART-4O controls the current to a maximum of 20 mA, so using the same 4 mA per field device, the maximum number of devices is 5. It should be noted that this only applies to output devices (positioners etc.) that draw only 4 mA when placed in a non-current modulating mode.

In the case where output field devices attempt to draw more than 4 mA in this mode, the number of allowable multidrop devices reduces.

As indicated in the diagrams below, the PLX51-HART-4I can support multidrop devices in parallel with either module-powered or externally-powered configurations.

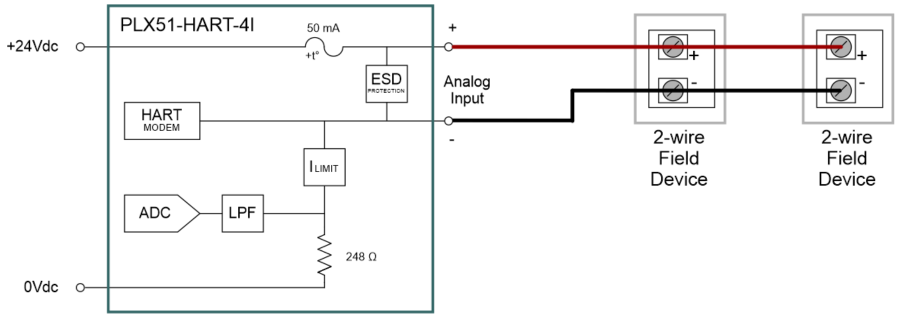


Figure 2.17 – PLX51-HART-4I - Multidrop Wiring – Parallel – Module Powered

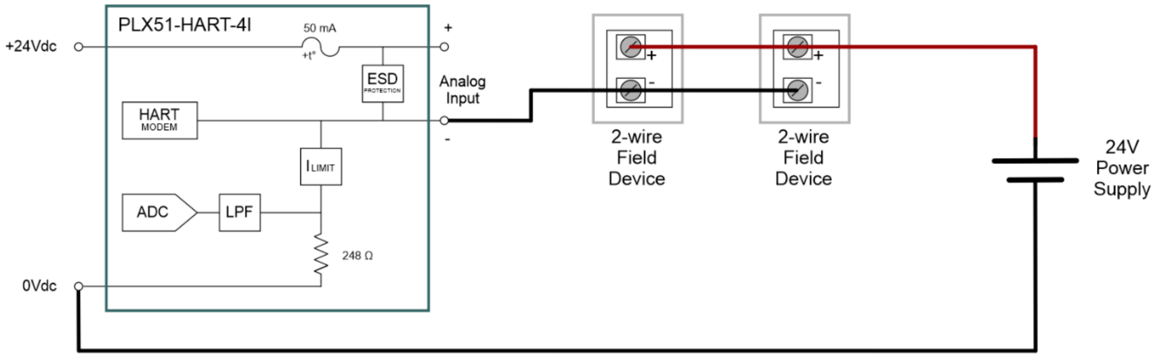


Figure 2.18 – PLX51-HART-4I - Multidrop Wiring – Parallel – Externally Powered

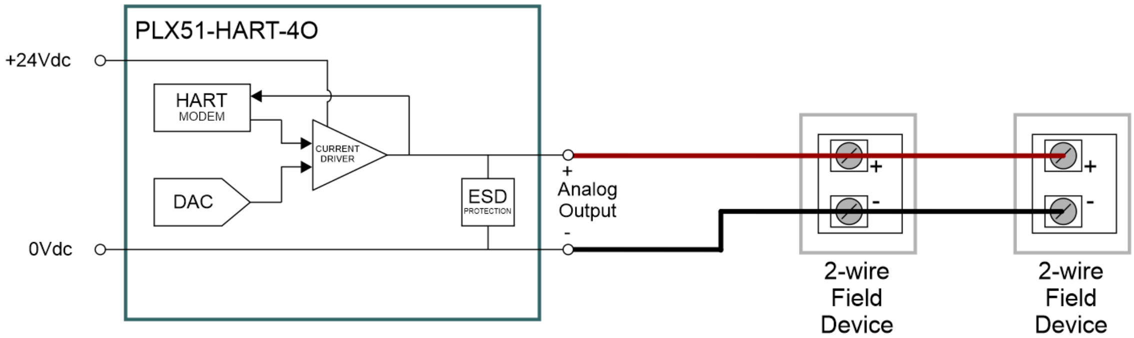


Figure 2.19 – PLX51-HART-4O - Multidrop Wiring – Parallel

Note: It is not recommended to multidrop 4-wire devices unless all devices make use of isolated power supplies.

2.6 Ethernet Port

The Ethernet connector should be wired according to industry standards. Refer to the additional information section in this document for further details.

3 Setup

3.1 Install Configuration Software

The network setup and configuration of the module is achieved by means of the PLX50 Configuration Utility. This software can be downloaded from: https://www.prosoft-technology.com/.

Figure 3.1 - PLX50 Configuration Utility

3.2 Network Parameters

The module will have DHCP (Dynamic Host Configuration Protocol) enabled as factory default. Thus, a DHCP server must be used to provide the module with the required network parameters (IP address, subnet mask, etc.). There are several DHCP utilities available, however it is recommended that the DHCP server in the PLX50 Configuration Utility be used.

Note: When this DIP Switch is set at bootup, it will force the module's IP address to 192.168.1.100 and network mask 255.255.255.0. The user can then switch the DIP switch 'off' and assign the module a static IP address.

Within the PLX50 Configuration Utility, the DHCP server can be found under the Tools menu.

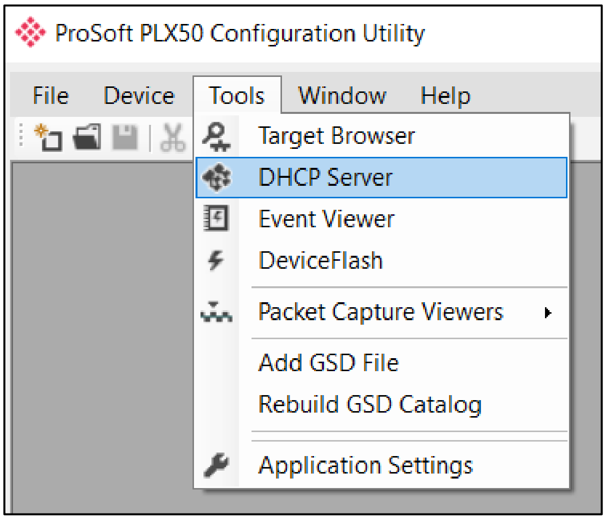


Figure 3.2 - Selecting DHCP Server

Once opened, the DHCP server will listen to all available network adapters for DHCP requests and display their corresponding MAC addresses.

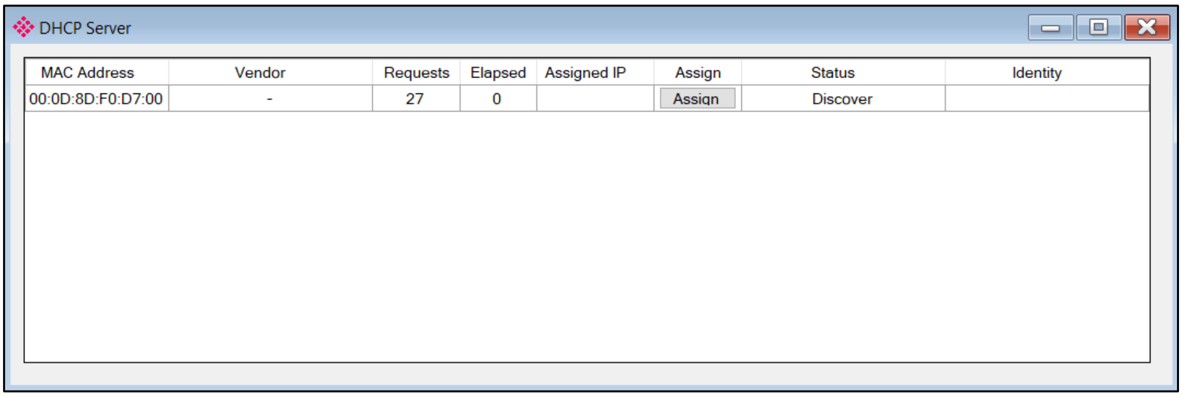


Figure 3.3 - DHCP Server

Note: If the DHCP requests are not displayed in the DHCP Server, it may be due to the local PC's firewall. During installation, the necessary firewall rules are automatically created for the Windows firewall. Another possibility is that another DHCP Server is operational on the network, and it has assigned the IP address.

To assign an IP address, click on the corresponding “Assign” button. The IP Address Assignment window will open.

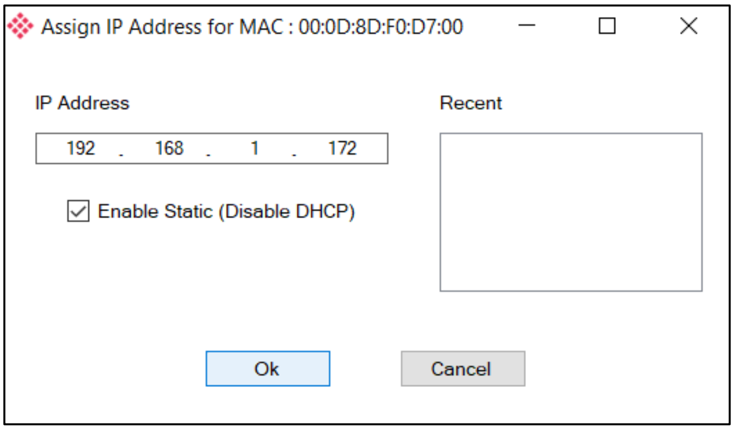


Figure 3.4 - Assigning IP Address

The required IP address can then be either entered, or a recently used IP address can be selected by clicking on an item in the Recent List. If the “Enable Static” checkbox is checked, then the IP address will be set to static after the IP assignment, thereby disabling future DHCP requests.

Once the IP address window has been accepted, the DHCP server will automatically assign the IP address to the module and then read the Identity Object Product name from the device.

The successful assignment of the IP address by the device is indicated by the green background of the associated row.

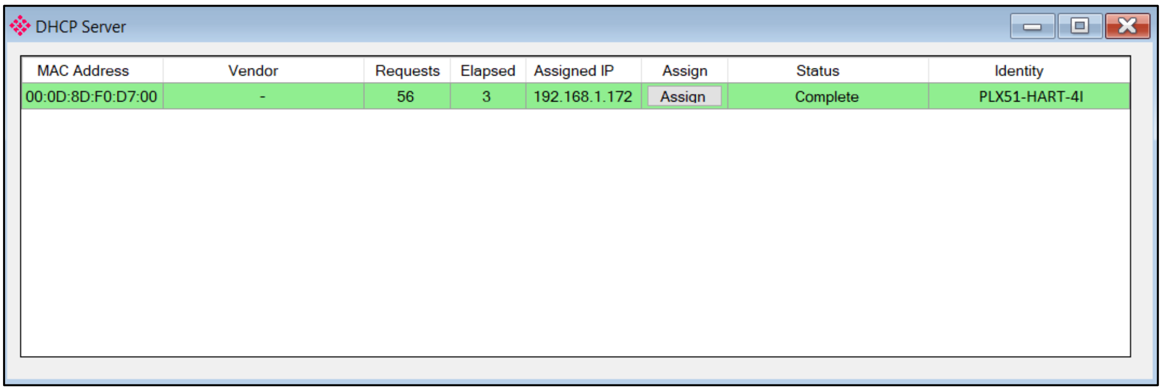


Figure 3.5 - Successful IP address assignment

It is possible to force the module back into DHCP mode by powering up the device with DIP switch 2 set to the On position.

A new IP address can then be assigned by repeating the previous steps.

Important: It is important to return DIP switch 2 back to Off position, to avoid the module returning to a DHCP mode after the power is cycled again.

In addition to setting the IP address, several other network parameters can be set during the DHCP process. These settings can be viewed and edited in the PLX50 Configuration Utility’s Application Settings, in the DHCP Server tab.

Once the DHCP process has been completed, the network settings can be set using the Ethernet Port Configuration via the Target Browser. The Target Browser can be accessed under the Tools menu.

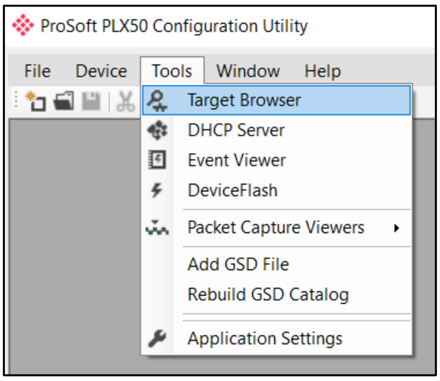


Figure 3.6 - Selecting the Target Browser

The Target Browser automatically scans the Ethernet network for EtherNet/IP devices.

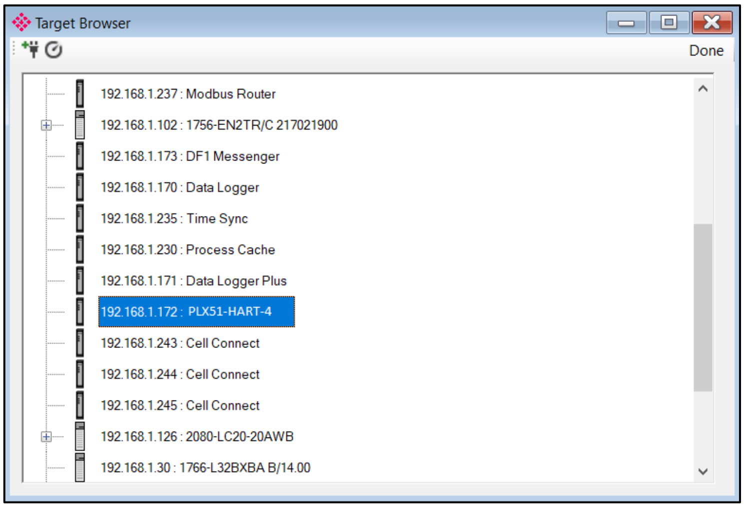


Figure 3.7 - Target Browser

Right-clicking on a device, reveals the context menu, including the Port Configuration option.

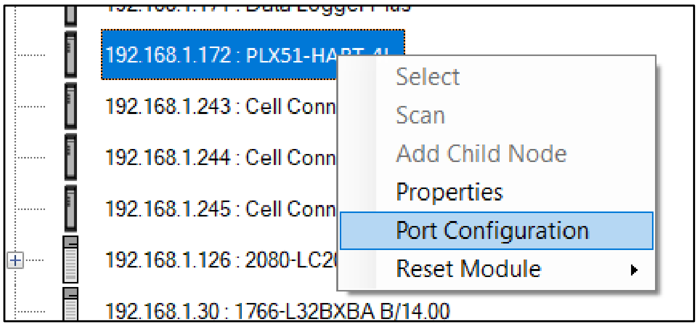


Figure 3.8 - Selecting Port Configuration

All the relevant Ethernet port configuration parameters can be modified using the Port Configuration window.

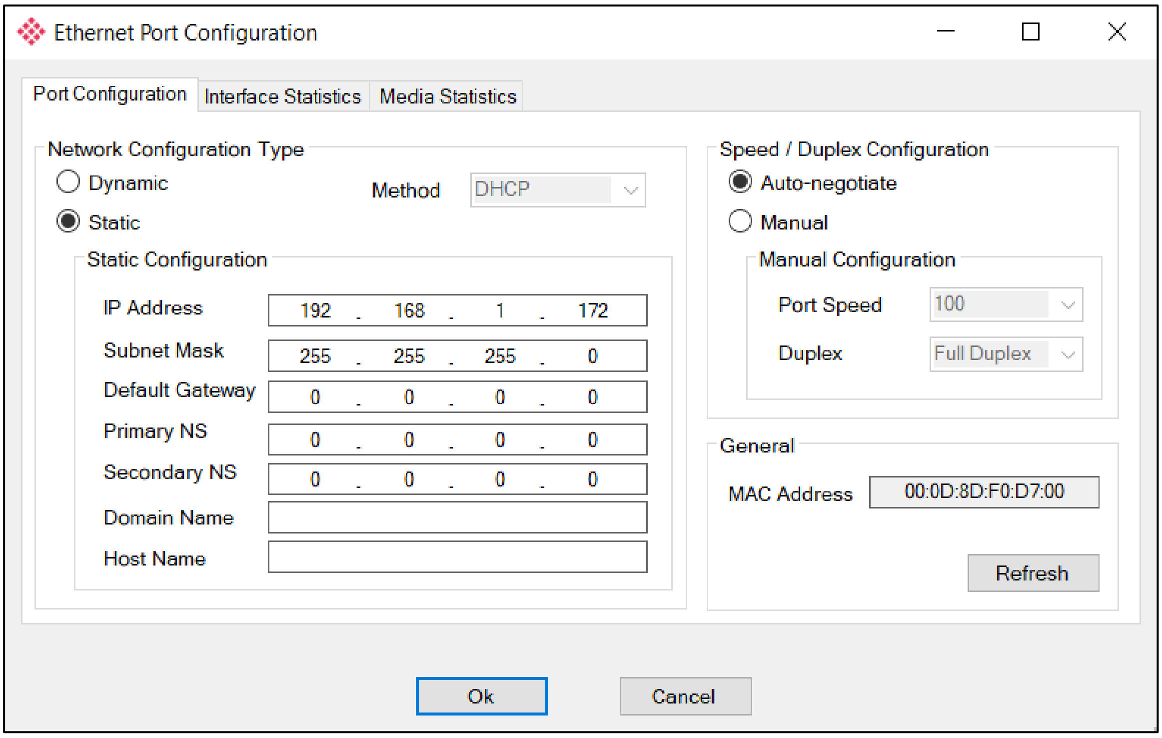


Figure 3.9 - Port Configuration

Alternatively, these parameters can be modified using Rockwell Automation's RSLinx software.

3.3 Creating a New Project

Before the user can configure the module, a new PLX50 Configuration Utility project must be created. Under the ***File*** menu, select ***New***.

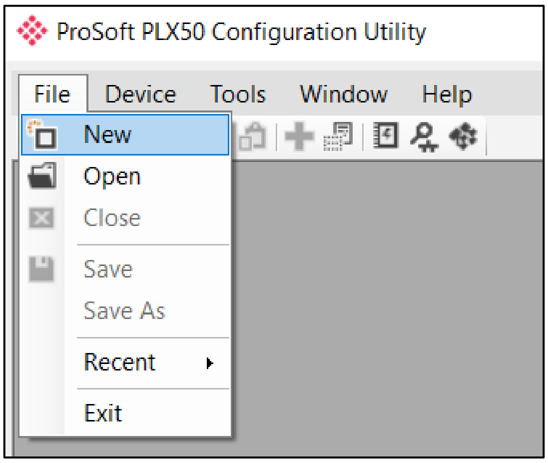


Figure 3.10 - Creating a new project

A PLX50 Configuration Utility project will be created, showing the Project Explorer tree view. To save the project use the ***Save*** option under the ***File*** menu. A new device can now be added by selecting ***Add*** under the ***Device*** menu.

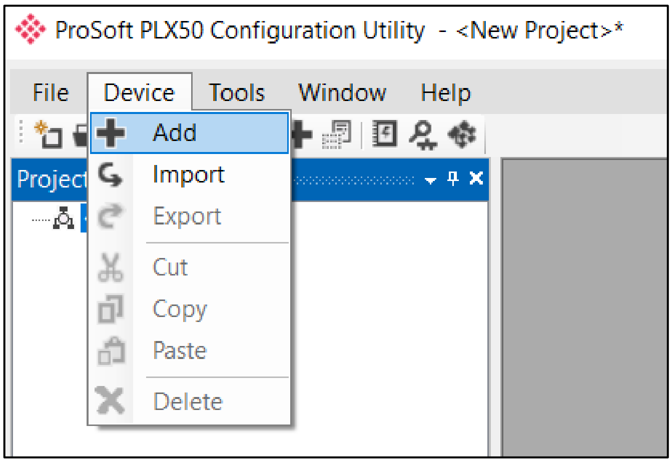


Figure 3.11 - Adding a new device

In the ***Add New Device*** window select the PLX51-HART-4I or PLX51-HART-4O and click the Ok button. The configuration of the PLX51-HART-4I or PLX51-HART-4O are almost identical.

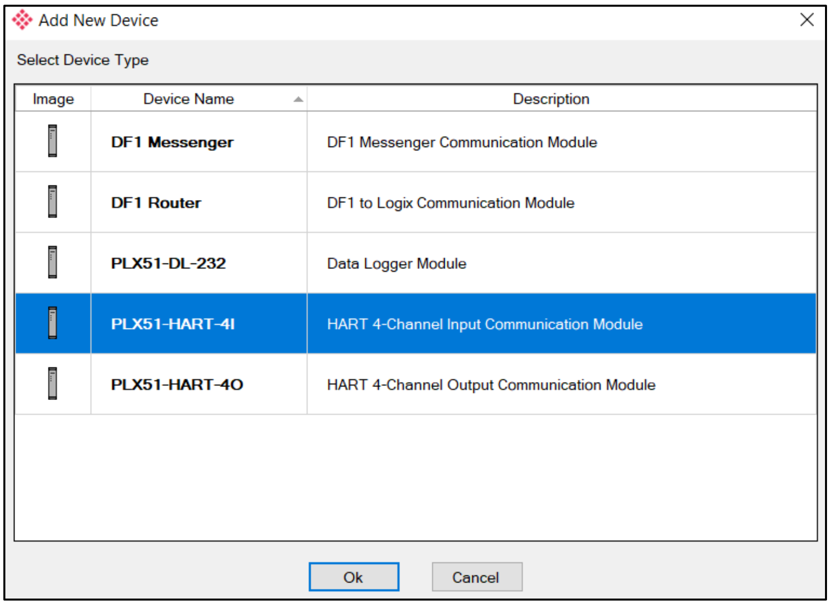


Figure 3.12 – Selecting a new module

The device will appear in the Project Explorer tree as shown below, and its configuration window opens. The device configuration window can be reopened by either double-clicking the module in the Project Explorer tree or right clicking the module and selecting ***Configuration***.

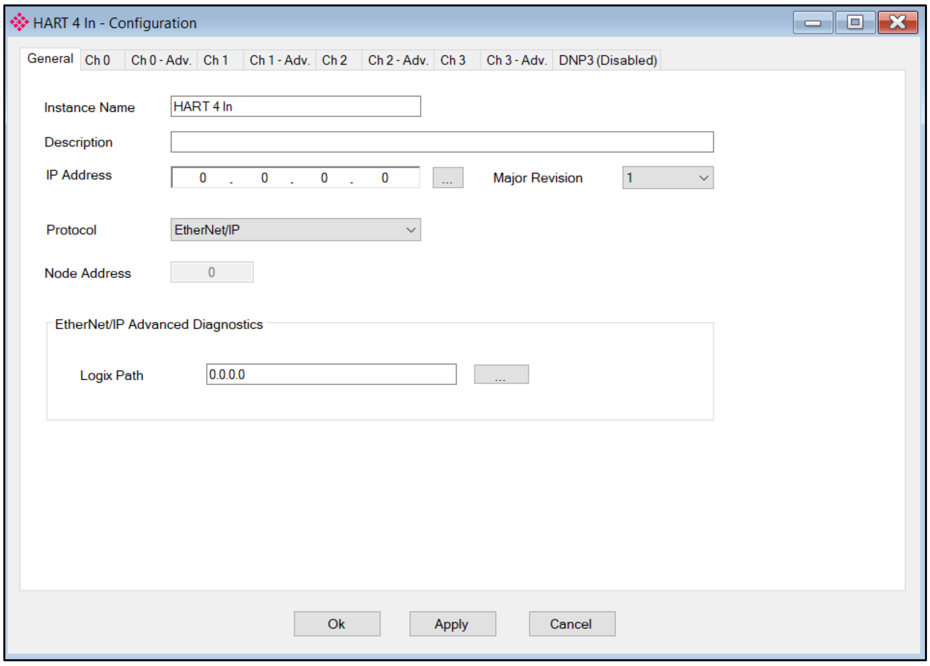


Figure 3.13 –Module configuration

Refer to the additional information section in this document for the PLX50 Configuration Utility's installation and operation documentation.

3.4 Module Parameters

The configuration form is divided into multiple tabs to configure the general, communication and channel specific parameters.

When downloading this configuration into the module it will be saved in non-volatile memory that persists when the module is powered down.

Important: When a firmware upgrade is performed the module will clear all configuration.

The general configuration is shown in the figure below. The general configuration window is opened by either double-clicking on the module in the tree, or right-clicking the module and selecting *Configuration*.

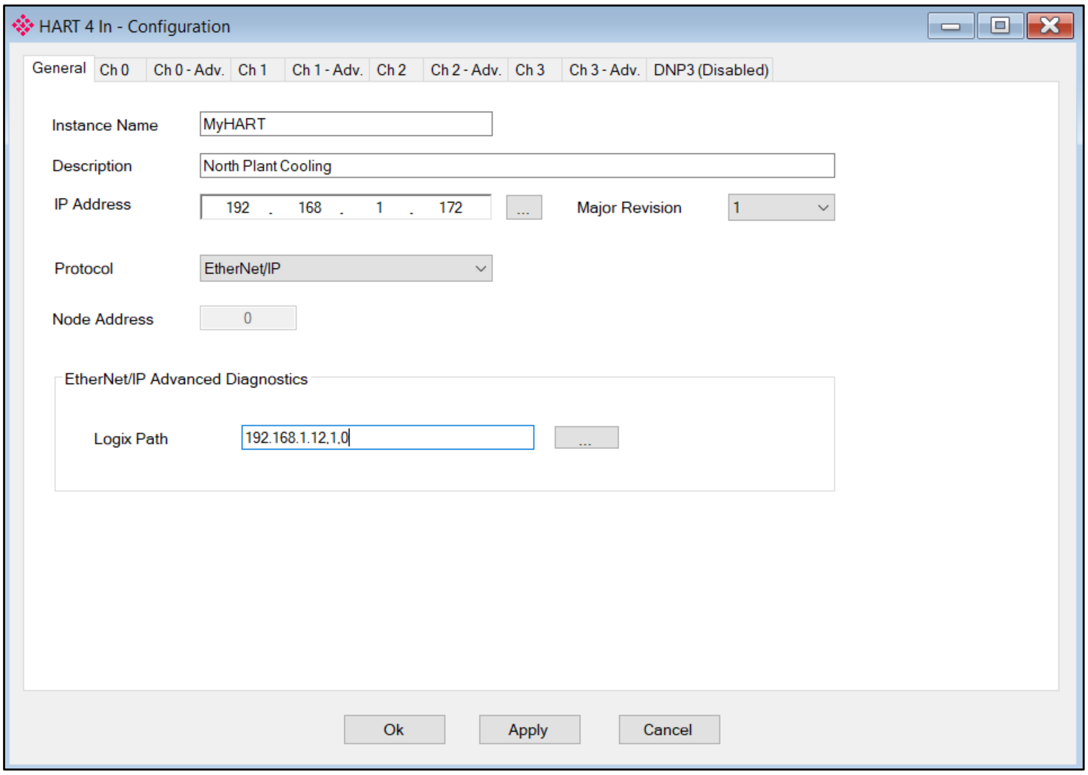


Figure 3.14 - General Configuration

The general configuration consists of the following parameters:

Table 3.1 - General configuration parameters

Parameter	Description
Instance Name	This parameter is a user defined name to identify between various modules.
Description	This parameter is used to provide a more detailed description of the application for the module.
IP Address	The IP address of the target module
Major Revision	The major revision of the module
Protocol	There are four protocols that can be selected for the module. **EtherNet/IP** This is the default setting and should be selected when the module is being used with the Rockwell Automation Logix family of controllers. **Modbus TCP/IP** When selected, the device will respond as a Modbus TCP/IP server. **DNP3 TCP** When selected, the device will respond as a DNP3 Outstation using a TCP. **DNP3 UDP** When selected, the device will respond as a DNP3 Outstation using a UDP. **SLC500 / MicroLogix / PLC5** When selected, the device will respond to PCCC (AB-ETH) SLC Reads and Writes.
Node Address	The Modbus/DNP3 node address of the device. Valid only when Modbus TCP/IP or DNP3 TCP/UDP protocol has been selected.
Logix Path	The destination Logix path to where the Advanced Mapping will be written.

The Channel (0) configuration is shown in the figure below. This window is opened by either double-clicking on the module in the tree or right clicking the module followed by selecting ***Configuration***. Once in the configuration window select the tab corresponding to the required channel.

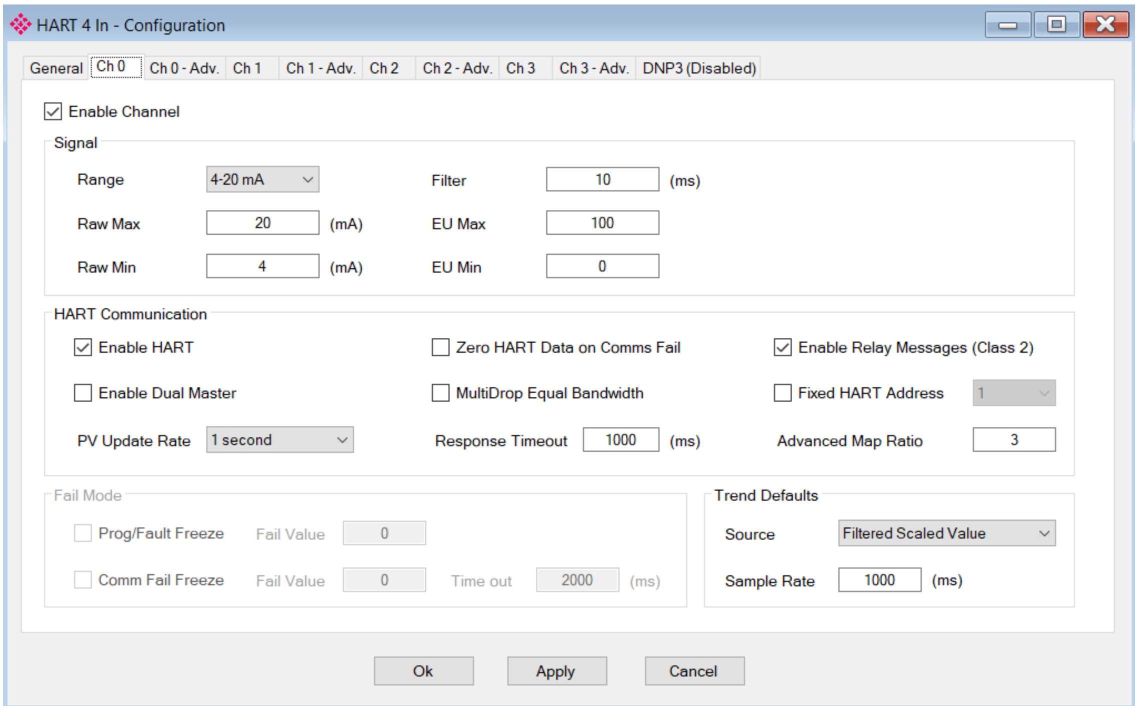


Figure 3.15 - Channel configuration (PLX51-HART-4I)

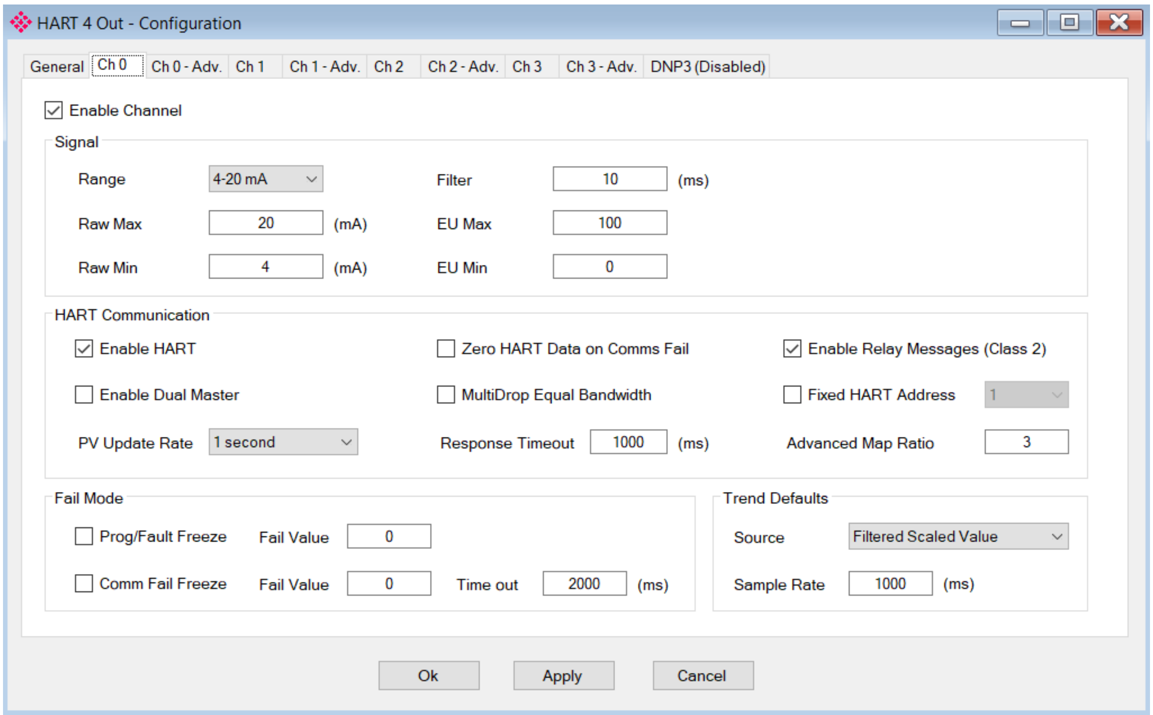


Figure 3.16 - Channel configuration (PLX51-HART-4O)

Each of the channel configuration tabs consist of the following parameters:

Table 3.2 - Channel configuration parameters

Parameter	Description
Enable Channel	Used to Enable or Disable the entire analog channel.
Signal	
Range	Select either 4-20 mA or 0-20 mA. Note that HART communication will be disabled if the 0-20 mA range has been selected.
Raw Max	The upper milliamp value to be used for the scaling to engineering units. The scaling to engineering units (EU) is calculated as follows: EU = EUMin + (RawValue – RawMin) * ((EUMax – EUMin) / (RawMax – RawMin))
Raw Min	The lower milliamp value to be used for the scaling to engineering units.
EU Max	The upper engineering value to be used for the scaling to engineering units. The scaled engineering value will equal this value when the current is equal to the Raw Max value.
EU Min	The lower engineering value to be used for the scaling to engineering units. The scaled engineering value will equal this value when the current is equal to the Raw Min value.
Filter	The time constant, in milliseconds, of the first order filter applied to the analog signal. A value of zero implies no filtering.
HART Communications	
Enable HART	Used to Enable or Disable the HART Communication. This should be disabled when using standard (non-HART) analog field devices.
Enable Dual Master	When this option is set, the PLX51-HART module (as the primary HART Master) will allow communication to be shared with a secondary HART Master (e.g., a handheld programmer or calibrator).

Parameter	Description
Zero HART Data on Comms Fail	When this parameter is set, the process variables of the HART device (PV, SV, TV, and FV as well as the units) will be made zero when communication to the HART device is lost.
MultiDrop Equal Bandwidth	When this parameter is set, the HART communication bandwidth will be equally shared between the “main” HART devices and the multidrop devices. The “main” HART device for the specific channel will use 50% of the HART communication bandwidth with this parameter cleared.
Response Timeout	The amount of time the PLX51-HART module will wait for a HART slave device to respond before the message transaction has been set to failed.
Enable Relay Messages	Used to enable or disable pass through (Class 2) messages, either from Logix (message blocks) or DTMs.
PV Update Rate	The rate at which the HART process variables (PV, SV, TV and FV) are updated. Select from: Fast (As fast as possible) ▪ 1 second ▪ 2 seconds ▪ 5 seconds ▪ 10 seconds Slowing this rate can enhance the performance of DTM communications. Care must be taken to not adversely affect primary control.
Adv. Diag. Ratio	The number of process variable updates between Advanced Diagnostic updates. **Note:** When MultiDrop Equal Bandwidth has been enabled, then this parameter is not applicable.
Fixed HART Address	The user can fix the address which the HART module will use to communicate with the attached field device. When this is not enabled, the HART module will search for the device from node address 0 to 63. **Note:** This is used with multidrop architecture.
Trend Defaults	
Source	The default source of the trend data can be one of the following: Raw Analog Current - The raw analog signal in milliamps. Filtered Scaled Value – The analog signal in engineering units. Digital Current – The current in milliamps reported by the field device (HART). PV – The Primary Variable in engineering units reported via HART. SV – The Secondary Variable in engineering units reported via HART. TV – The Third Variable in engineering units reported via HART. FV – The Fourth Variable in engineering units reported via HART.
Sample Rate	The period (milliseconds) between sample points. The trend data is a circular buffer of the latest 1000 points; therefore the total trend time is 1000 * Sample Rate.
Note: The following items apply only to the PLX51-HART-4O module. **Fail Mode**	
Prog / Fault Freeze	This configuration is used to determine the behaviour of the output analog signal when the Logix controller enters a faulted or program mode. Enabling this option freezes the output value to its last state, when a program or fault state is detected. Disabling this option forces the output value to the adjacent Fail Value, when a program or fault state is detected. This option is only valid when using the EtherNet/IP protocol.
Fail Value (Prog. / Fault)	The value, in engineering units, to be applied to the output when a program or fault state is detected, and the above Freeze option is disabled.

Parameter	Description
Comm Fail Freeze	This configuration is used to determine the behaviour of the output analog signal when communication from the source (EtherNet/IP, DNP3 or Modbus TCP/IP) is lost. Enabling this option freezes the output value to its last state, when communication is lost. Disabling this option forces the output value to the adjacent Fail Value when communication is lost.
Fail Value (Comm. Fail)	The value, in engineering units, to be applied to the output when communication from the source has been lost and the above Freeze option is disabled.
Time Out	The time, in milliseconds, since the last packet has been received from the source before the communication is deemed to have been lost.

3.5 Advanced Mapping

The module supports multidrop functionality on each channel (having multiple HART devices per channel), asynchronous reading of advanced diagnostic parameters (which are then written directly to Logix tags), and Custom HART messaging when using either EtherNet/IP or Modbus TCP/IP.

Note: Advanced Mapping is **NOT** supported for the DNP3 interface protocol.

Note: Diagnostics is supported **ONLY** for the EtherNet/IP interface protocol.

Note: Custom HART messaging is **NOT** supported by the DNP3 or PCCC interface protocol.

Note: A maximum of 50 Advanced Mapped Items is supported.

The Advanced Mapping configuration is shown in the figure below. The Advanced Mapping configuration window is opened by either double-clicking on the module in the tree, or right-clicking the module and selecting Ch 0 - *Adv*.

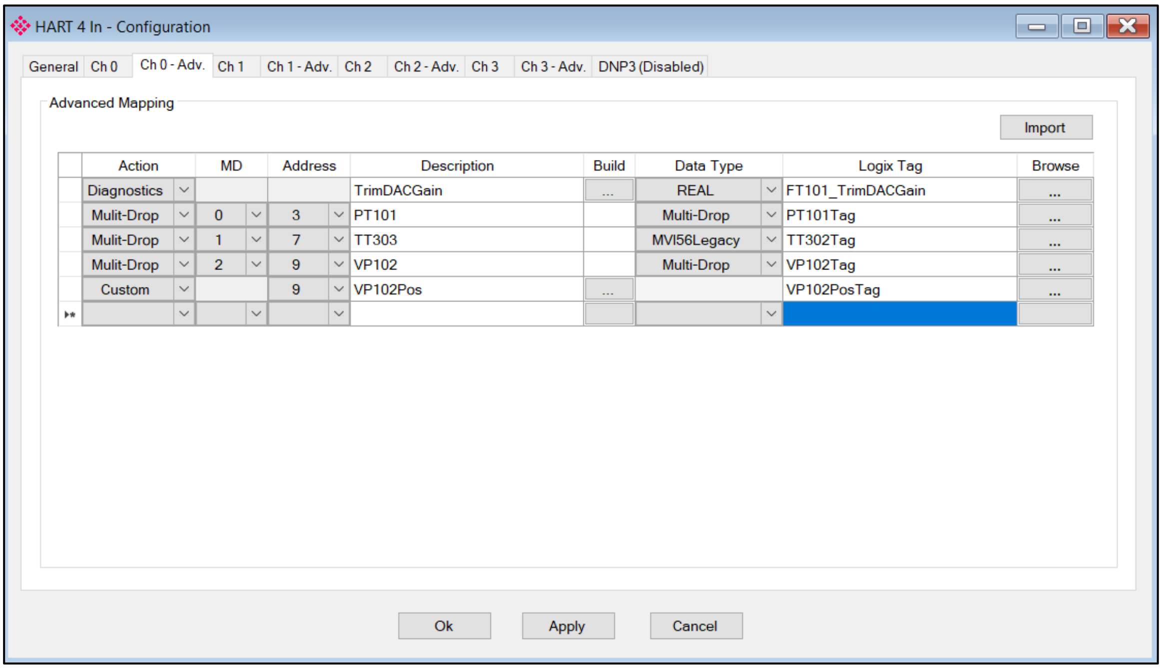


Figure 3.17 – Advanced Mapping Configuration

The Advanced Mapping configuration tab consists of the following parameters:

Table 3.3 – Advanced Diagnostics parameters

Parameter	Description
Action	**Important:** No Advanced Mapping items will send HART requests when Burst Mode is enabled on a specific HART device on that HART channel. **Diagnostics** When the ***Diagnostics*** option is selected, the user will be able to configure a specific HART command that must be sent to the “main” device (usually at the specified fixed address). The result will then be written to a configured Logix tag thus allowing the user to extract device specific diagnostics from a field device. **Multi-Drop** When the ***Multidrop*** option is selected the module will automatically extract all the required information from the device at the specified address (see below), allowing the user to have multiple HART devices on a single HART channel. **Custom** When the ***Custom*** option is selected a custom HART message can be built with data being read from and/or written to the protocol interface. Custom messages are supported by EtherNet/IP and Modbus TCP/IP. The user will need to select the HART device short address.
MD	This is the Multidrop Device Index for the specific HART device. There can be a maximum of 7 devices (0-6) per channel, and each Multidrop Device Index will specify the location where the multidrop data is stored and can be accessed by the various interface protocols (see the multidrop section for more details). **Applicable only for *Multi-Drop* Action.**
Address	This is the short node address of the HART device on the multidrop channel. The addresses can be found by using the Scan function in the Device List tab (see the Diagnostics and Multidrop sections for more details). **Important:** Connecting more than one device with the same short address will cause communication errors and prevent both devices from being detected during a scan. **Applicable only for *Multi-Drop* or *Custom* Action.**
Description	A user description for the device or diagnostic parameter.
Build	This button launches the HART Advanced Diagnostics Builder which is used to create the HART message required to extract the needed parameter. (See Advanced Diagnostic Builder below.) **Applicable only for EtherNet/IP interface protocol when using *Diagnostics* Action or EtherNet/IP and Modbus TCP/IP when using *Custom* Action.**
Data Type	**For Action – Diagnostics** The Logix tag data type required to accept the parameter. **For Action – Multi-Drop** The data type will specify if the UDT to be used must be of the legacy MVI56Legacy format or the new multi-drop format. **Important:** The user will need to ensure that the correct UDT is used for the Logix tag when using either new or legacy format for multi-drop operation. **Applicable only for EtherNet/IP interface protocol.**
Logix Tag	The Logix tag name mapped to receive the parameter. **Applicable only for EtherNet/IP interface protocol.**
Browse	This button launches the Tag Browser for the configured Logix controller. **Applicable only for EtherNet/IP interface protocol.**

3.5.1 Diagnostics

When using *Diagnostics* to create a new Advanced Diagnostic item, select the Build button. The HART Advanced Diagnostic Builder will open.

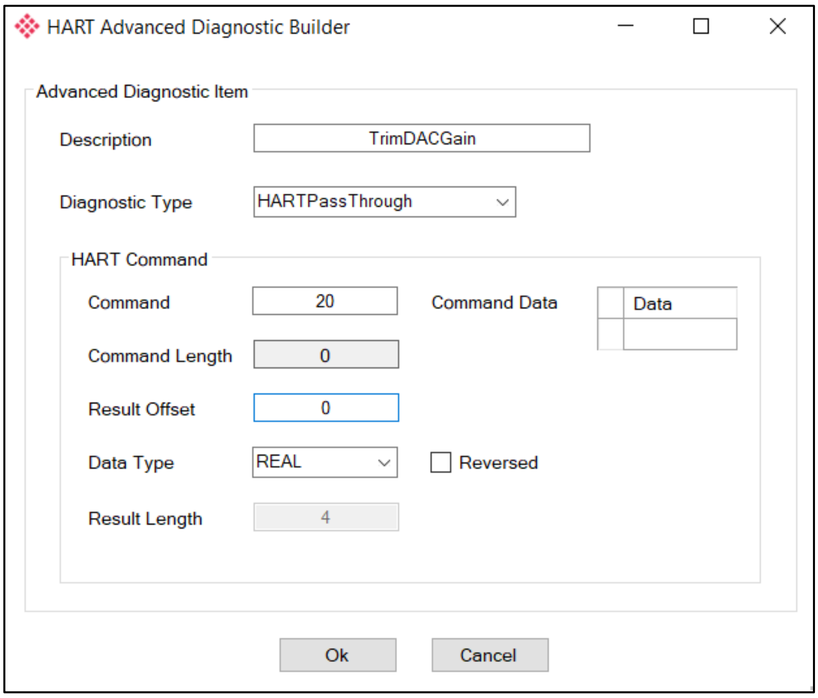


Figure 3.18 – Advanced Diagnostic Builder

The builder is used to generate the command, and to define the Data Type. The following parameters need to be configured:

Table 3.4 – Advanced Diagnostics Build parameters

Parameter	Description
Description	A user description for the advanced diagnostic parameter.
Diagnostic Type	Select ***HART Pass Through*** option.
HART Command	The HART command code (decimal).
Command Length	This is the length of the data that must be sent with the command.
Result Offset	The byte offset in the response where the required parameter starts.
Data Type	The Logix tag data type required to accept the parameter.
Response Length	This is the size of the data that must be copied to the Logix Tag. **Note:** This is only relevant for SINT Array Data Types.
Command Data	Additional request parameters required by the HART command.

Once accepted, the full command string will be built, and the current map item will be updated accordingly.

A Logix tag can now be associated with the Advanced Diagnostic parameter. This can be done by either entering the tag name or by using the Tag Browser to browse for a tag.

Important: It is important to ensure that the selected Logix tag type matches that of the expected HART command parameter. Failing to do so can cause unexpected results.

3.5.2 Multidrop

When using the Modbus TCP/IP or PCCC interface protocol, only Multidrop action is supported (see below). The data from each multidrop HART device will be placed at specific Modbus Registers or SLC File numbers (based on the Multidrop Device Index used). See the operational section for each protocol for the mapping of multidrop data.

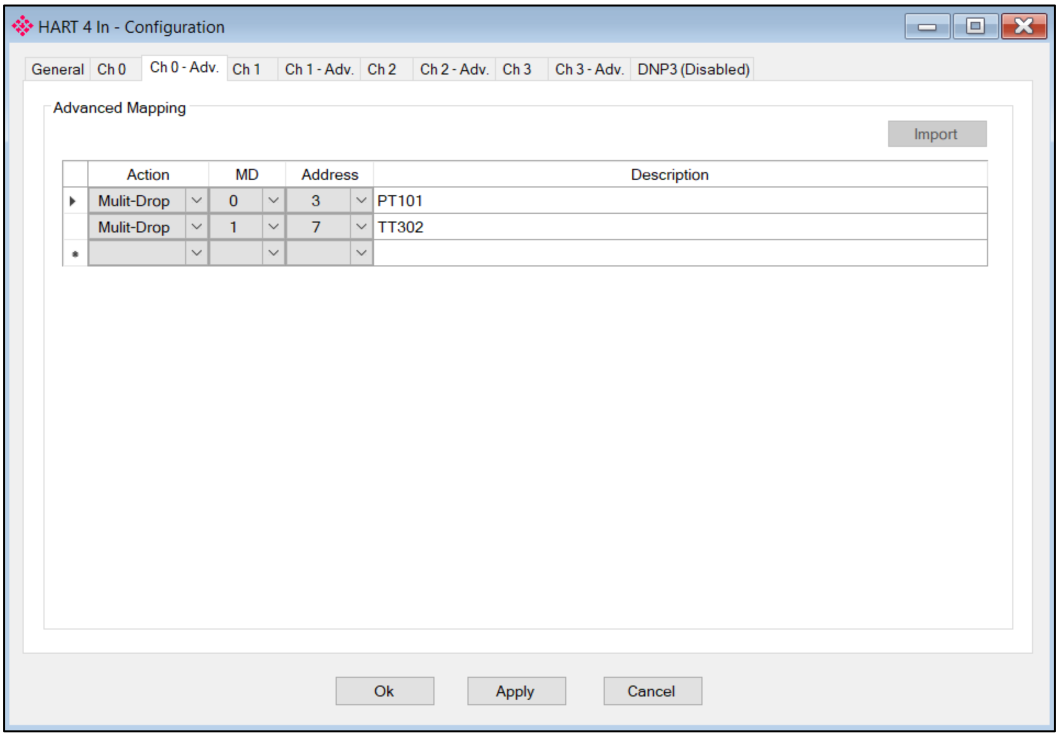


Figure 3.19 – Advanced Mapping (for Modbus TCP/IP or PCCC)

3.5.3 Custom

When using the *Custom* action, the user will need to create the custom HART command to send. To create a new Custom Command item, select the Build button. The HART Custom Builder will open.

Important: When adding a custom HART command, the user will need to also have the same device as either the main device or configured as one of the multidrop devices.

The following parameters are available in the HART Custom Command Item Builder:

Table 3.5 – Custom HART command common build parameters

Parameter	Description
HART Command	This is the HART command number that will be sent to the HART device.
Burst	This option will allow the user to receive specific Burst HART commands and map the data to a Logix tag or Modbus Holding Register. **Note:** Burst Mode will need to be activated for a specific HART command. This can be done using the Enable Burst Mode selection on the HART channel status page.
Auto-Trigger	This option will force the Custom HART command to be sent every time the Custom HART message trigger is checked. When this is enabled, the HART command will automatically send, and the user does not need to trigger it.
Send Reformat Option	The HART data being **sent** can be reformatted based on the endian and long/float requirements. The reformat options are below: 16 bit (BB AA) 32 bit (BB AA DD CC) 32 bit (DD CC BB AA) 32 bit (CC DD AA BB) 8 bit + 32 bit (BB AA DD CC) 8 bit + 32 bit (DD CC BB AA) 8 bit + 32 bit (CC DD AA BB) 8 bit + 16 bit (BB AA)
Receive Reformat Option	The HART data **received** can be reformatted based on the endian and long/float requirements. The reformat options are below: 16 bit (BB AA) 32 bit (BB AA DD CC) 32 bit (DD CC BB AA) 32 bit (CC DD AA BB) 8 bit + 32 bit (BB AA DD CC) 8 bit + 32 bit (DD CC BB AA) 8 bit + 32 bit (CC DD AA BB) 8 bit + 16 bit (BB AA)

EtherNet/IP

The required HART command will need to be entered into the builder window as shown below.

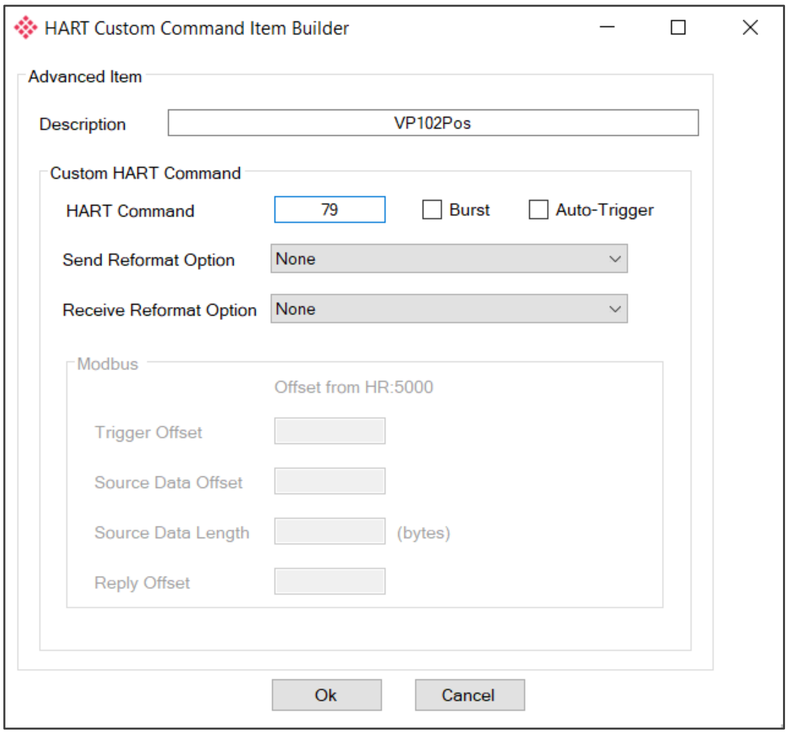


Figure 3.20 – Custom HART Command Builder Mapping (for EtherNet/IP)

The data to be sent and returned will be exchanged with the Logix tag specified. The Logix Tag UDT will have all the required parameters to trigger the message execution, provide the source data, and update the returned data.

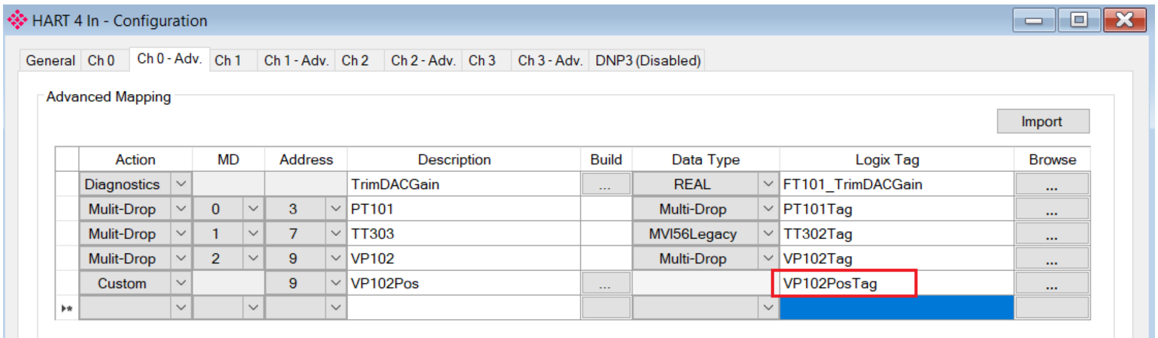


Figure 3.21 – Custom HART Command Logix Tag (for EtherNet/IP)

Important: It is important to ensure that the selected Logix tag type matches that of the expected HART custom command UDT type. Failing to do so can cause unexpected results.

Modbus TCP/IP

The required HART command and specific Modbus Offsets will need to be entered into the builder window as shown below.

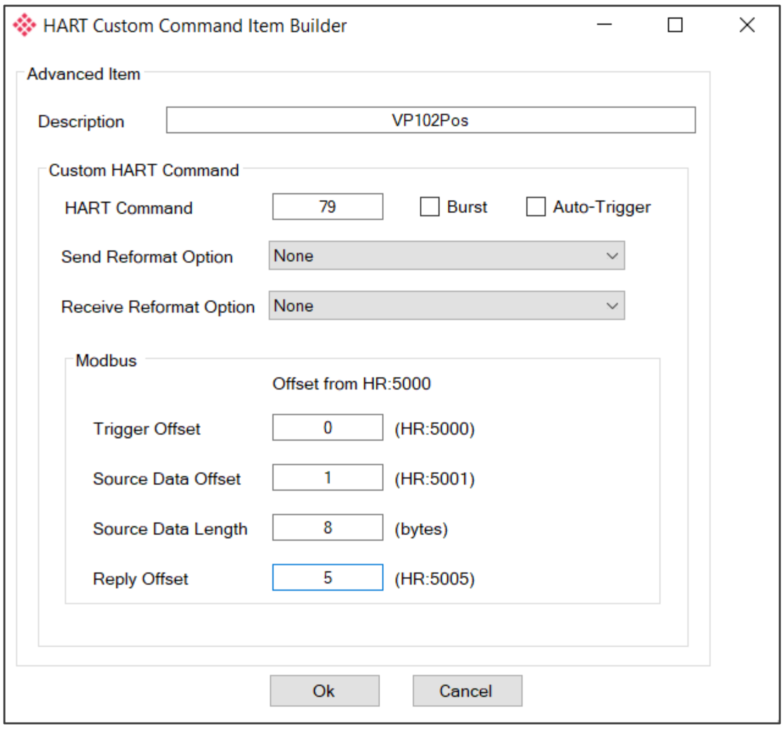


Figure 3.22 – Custom HART Command Builder Mapping (for Modbus TCP/IP)

Each HART channel is allowed up to 500 bytes of mapping data for custom HART commands. The custom HART command Modbus Holding Register range for each HART channel is shown below:

Table 3.6 – Custom HART Data Modbus Ranges

HART Channel	Modbus HR Range
0	HR 5000 – HR 5249
1	HR 5250 – HR 5499
2	HR 5500 – HR 5749
3	HR 5750 – HR 5999

Each Custom HART command requires four mapping parameters in addition to the HART command:

Table 3.7 – Custom HART command Modbus build parameters

Modbus Parameter	Description
Trigger Offset	The Trigger Offset parameter is the Modbus HR offset in the Modbus HR range (for the specific HART channel) for the trigger of the HART custom message. For example, if the trigger offset entered is 5 and the custom HART command is on HART channel 0, then the message trigger will be at Modbus HR 5005 (HR 5000 *for HART channel 0* + offset HR 5). If the trigger offset entered is 10 and the custom HART command is on HART channel 1, then the message trigger will be at Modbus HR 5260 (HR 5250 *for HART channel 1* + offset HR 10). The trigger parameter is used to trigger the start of the custom HART message execution. Each time the trigger Modbus HR is changed to a value different from the previous value, it will send the custom HART command.

Modbus Parameter	Description
	Note: Changing the trigger to value 0 will not trigger the custom HART command.
Source Data Offset	The source data offset parameter is the location in the Modbus HR range where the HART data to be sent is stored. For example, if the source data offset entered is 20 and the custom HART commands is on HART channel 0, then the HART message data to be sent will start at Modbus HR 5020 (HR 5000 *for HART channel 0* + offset HR 20).
Source Data Length	This is the length of the HART data to be sent in bytes. **Note:** A value of zero will result in no additional HART data being sent with the HART command.
Reply Offset	The reply offset parameter is the location in the Modbus HR range where the HART data returned (from the custom HART command) is stored. For example, if the reply offset entered is 40 and the custom HART commands is on HART channel 1, then the HART message data returned will start at Modbus HR 5290 (HR 5250 *for HART channel 1* + offset HR 40). See the Custom HART message operation section for details regarding the format of the reply data.

3.6 DNP3 Security

If one of the DNP3 protocols (DNP3 TCP or DNP3 UDP) have been selected, then the DNP3 Security tab will be enabled. This DNP3 Security configuration consists of the following parameters:

Table 3.8 – DNP3 configuration parameters

Parameter	Description
Enable Security	DNP3 Secure Authentication can be enabled or disabled. When enabled there will be no unsecured exchange of data (for critical functions).
Key Change Method	This setting determines the method by which security keys are exchanged between two devices. Currently the HART 4 only supports the Pre-Shared Key method. This method requires both devices to have update keys entered by means outside the DNP3 protocol, (i.e. using PLX50 Configuration Utility).
MAC Algorithm	The MAC algorithm is used to encrypt the challenge data for secure authentication. DNP3 allows for various encryption standards in different formats to be used for secure authentication: HMAC SHA-1 encryption (4 octets – serial) – for legacy support HMAC SHA-1 encryption (8 octets – serial) HMAC SHA-1 encryption (10 octets – networked) HMAC SHA-256 encryption (8 octets – serial) HMAC SHA-256 encryption (16 octets – networked) AES-GMAC (12 octets)
Key Wrap Algorithm	DNP3 uses various keys for secure authentication. The keys that are used for data exchange and called the session keys and these keys may be updated frequently. To exchange the session keys between two DNP3 devices the update key (refer to the Secure Authentication section for further detail) is used to encrypt the data and session keys before exchanging it between parties. DNP3 allows for two standards to encrypt the session keys: AES-128 Key Wrap AES-256 Key Wrap
Aggressive Mode	To reduce the bandwidth used for secure authentication the user can select aggressive mode which allows the message initiator to anticipate and provide the required authentication in the request message. From a network point of view there is a two-message exchange for secure authentication compared to the normal four message exchange for secure authentication.
Secure Optional Critical Functions	When secure authentication is enabled, there are various mandatory and optional application functions that must be authenticated before data can be exchanged. The optional functions can be selected in the box. Mandatory functions, e.g. Operate, are therefore not included in the options list.

Note: For further information regarding the security settings refer to the Security section.

The security configuration is shown in the figure below. The DNP3 Security configuration window is opened by either double-clicking on the module in the tree or right clicking the module and selecting *Configuration.* Once in the configuration window select the *DNP3* tab at the top.

Note: The actual pre-shared key cannot be included in the configuration. It can only be written to the module when online via the Status window.

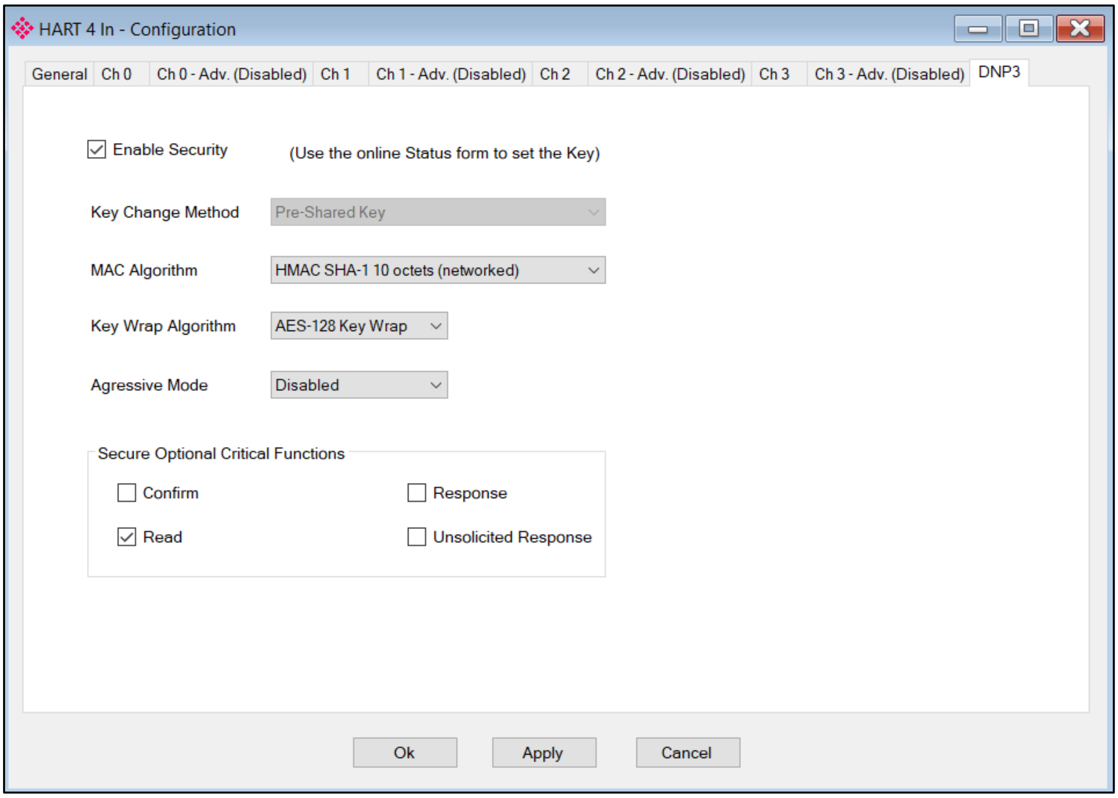


Figure 3.23 – DNP3 security configuration

3.7 MultiDrop

When using Multidrop and requiring a HART device at a specific address to be the "main" HART device (e.g. which will be populated in the Logix Input Assembly), then the ***Fixed HART Address*** parameter must be used (see below). This will ensure that the specified address is used as the main. Should this not be specified, then the PLX51-HART-4x will scan the specific HART channel and use the first HART device found as the "main" HART device.

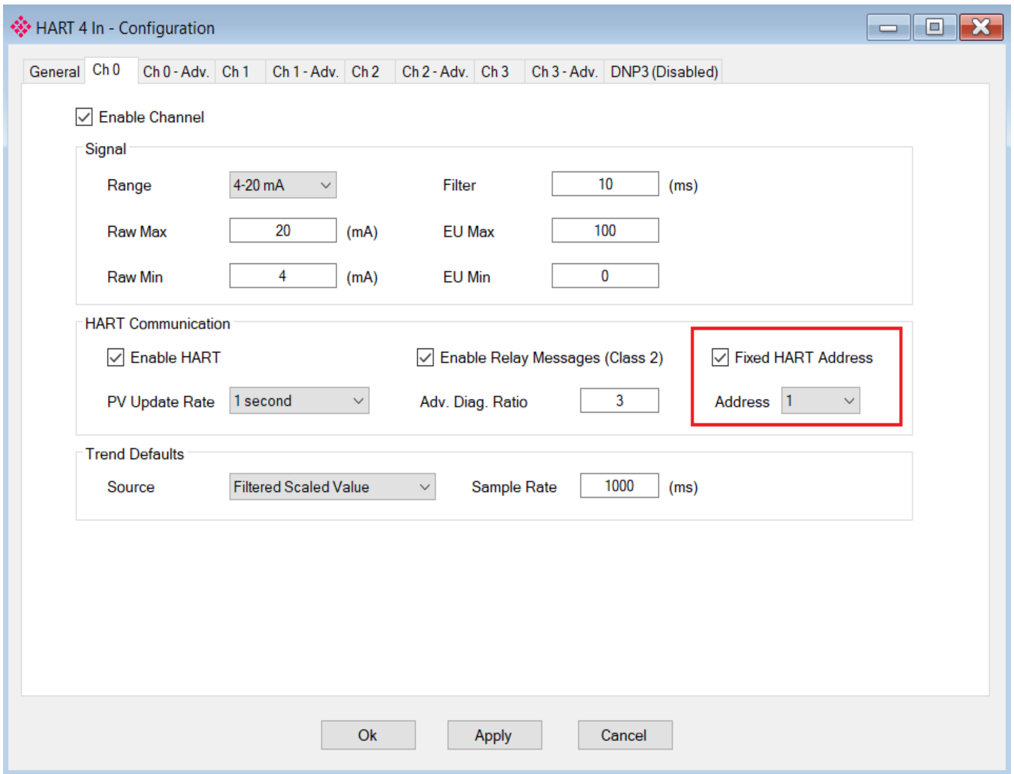


Figure 3.24 – Fixed HART address

The user will ensure that each field device on the drop has a unique node address. This can be verified by initiating a ***Device Scan*** and checking that each field device on the network has a unique address (as shown below):

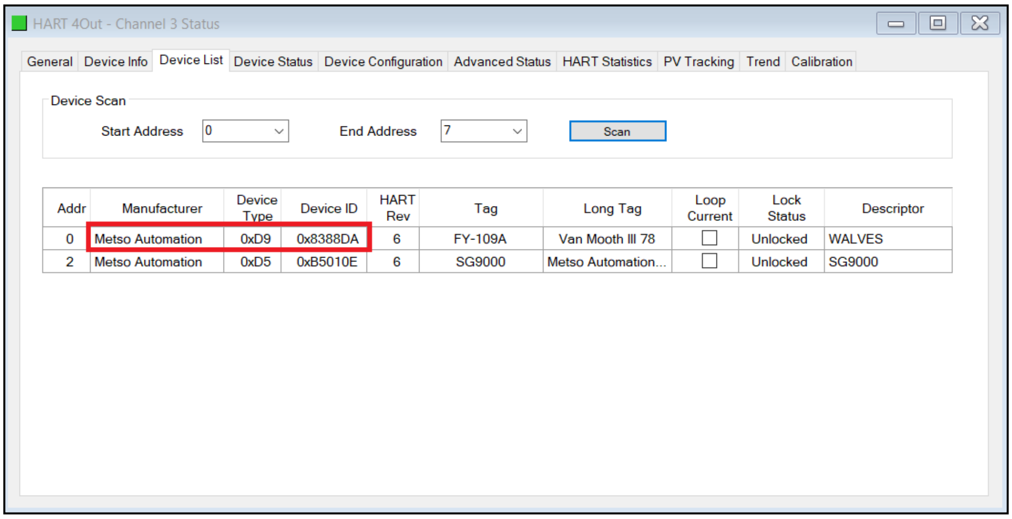


Figure 3.25 – HART Channel Scan

If needed, the user can set the node address of a module from the PLX50 Configuration Utility as shown below:

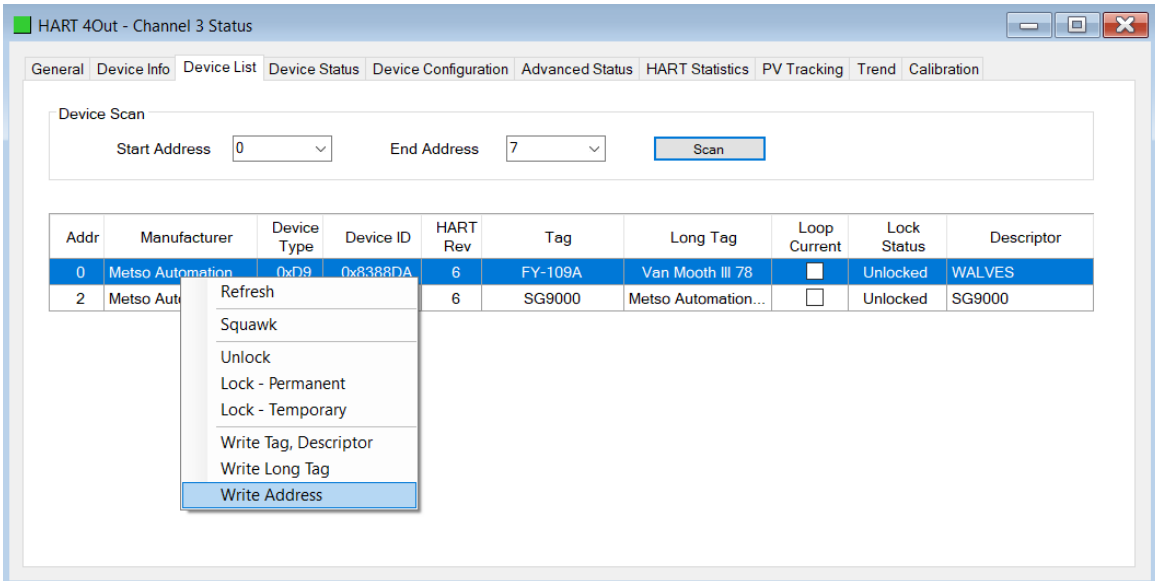


Figure 3.26 – Set Field Device Node Address

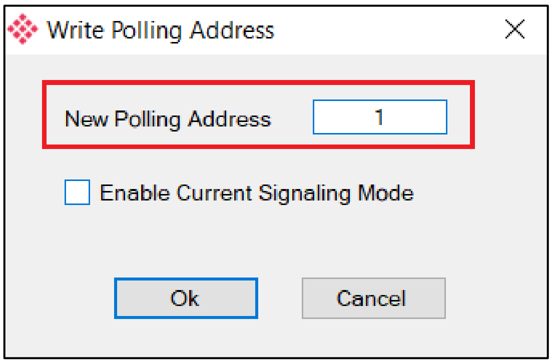


Figure 3.27 – Set Field Device Node Address

The user will also need to ensure that each field device on the drop has its loop current mode set to Multidrop and **NOT** Current Signaling Mode. This can be achieved by using the ***Write Address*** option (as shown above) and **unchecking** the loop current mode in the PLX50 Configuration Utility as shown below:

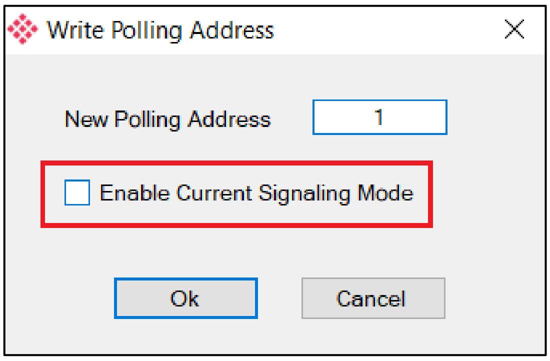


Figure 3.28 – Set Current Signalling Mode

3.8 Module Download

Once the module configuration has been completed, it must be downloaded to the module.

Before downloading the Connection Path of the module should be set. This path will automatically default to the IP address of the module, as set in the module configuration. It can however be modified if the module is not on a local network.

The Connection path can be set by right-clicking on the module and selecting the Connection Path option.

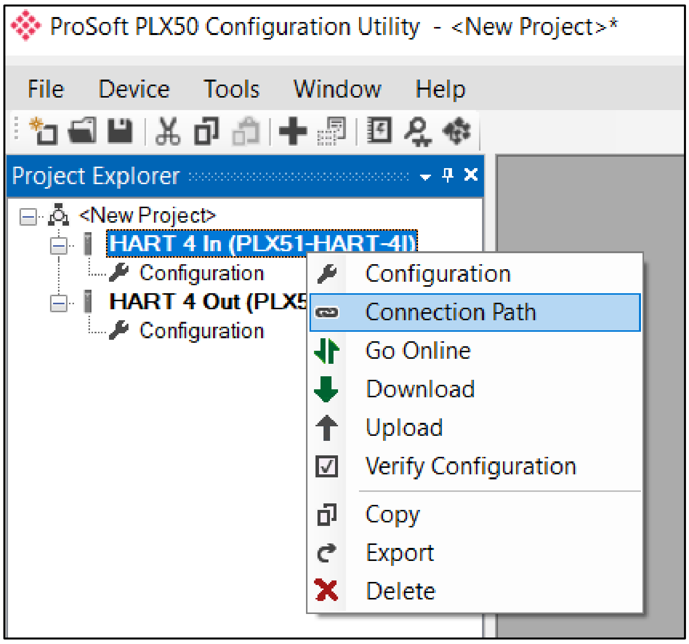


Figure 3.29 - Selecting Connection Path

The new connection path can then be either entered manually or selected by means of the Target Browser.

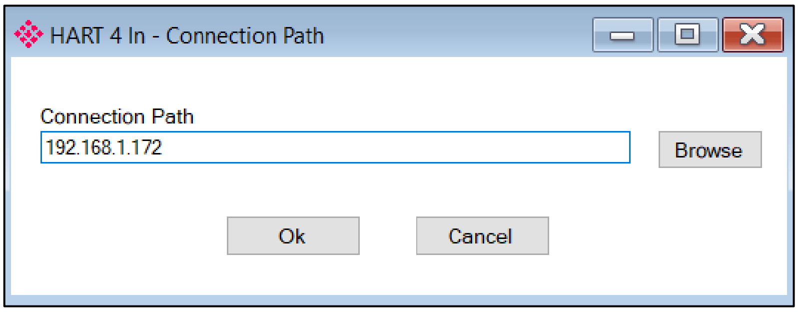


Figure 3.30 - Connection Path

To initiate the download, right-click on the module and select the Download option.

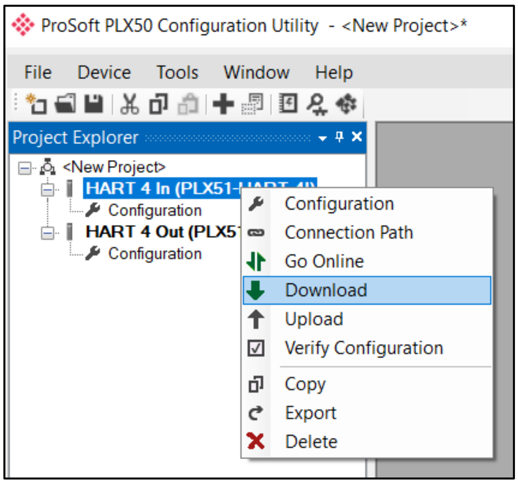


Figure 3.31 - Selecting Download

Once complete, the user will be notified that the download was successful.

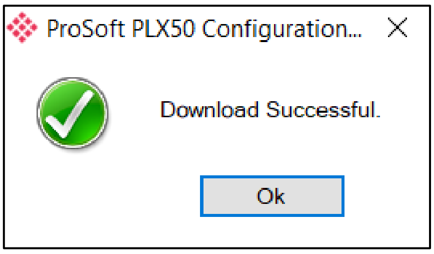


Figure 3.32 - Successful download

Within the PLX50 Configuration Utility environment the module will be in the **Online** state, indicated by the green circle around the module. The module is now configured and will start operating immediately.

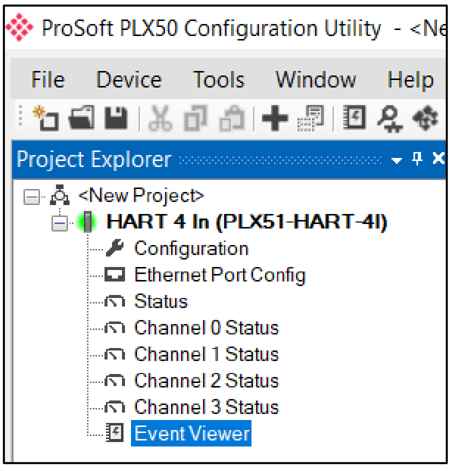


Figure 3.33 - Module online

3.9 Logix Integration

The Hart 4 modules can be easily integrated with Allen-Bradley Logix family of controllers. The module must be added using a Generic Profile which is described below.

3.9.1 Add Module to I/O Configuration

The module must be added to the RSLogix 5000 I/O tree as a generic Ethernet module. This is achieved by right clicking on the Ethernet Bridge in the RSLogix 5000 and selecting *New Module* after which the *ETHERNET-MODULE* is selected to be added as shown in the figure below.

Note: See the next section for importing the configuration (L5X).

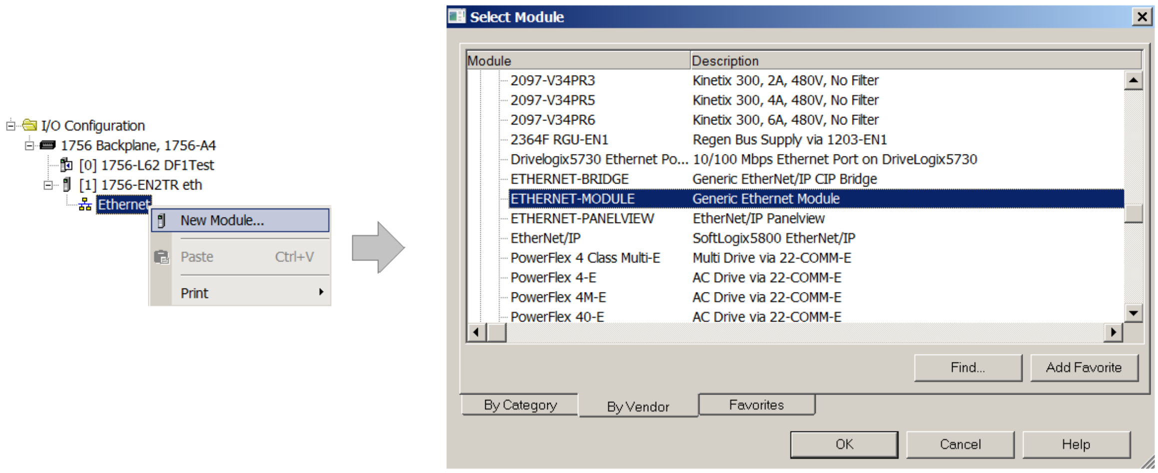


Figure 3.34 - Add a Generic Ethernet Module in RSLogix 5000

Important: The module configuration for the PLX51-HART-4I and PLX51-HART-4O modules are **NOT** identical.

The user must enter the IP address of the module that will be used. The assembly instance and size must also be added for the input, output, and configuration in the connection parameters section. The required connection parameters for the PLX51-HART-4I module are shown below:

Table 3.9 - RSLogix class 1 connection parameters for the PLX51-HART-4I module

Connection Parameter	Assembly Instance	Size
Input	113	119 (32-bit)
Output	116	1 (32-bit)
Configuration	102	0 (8-bit)

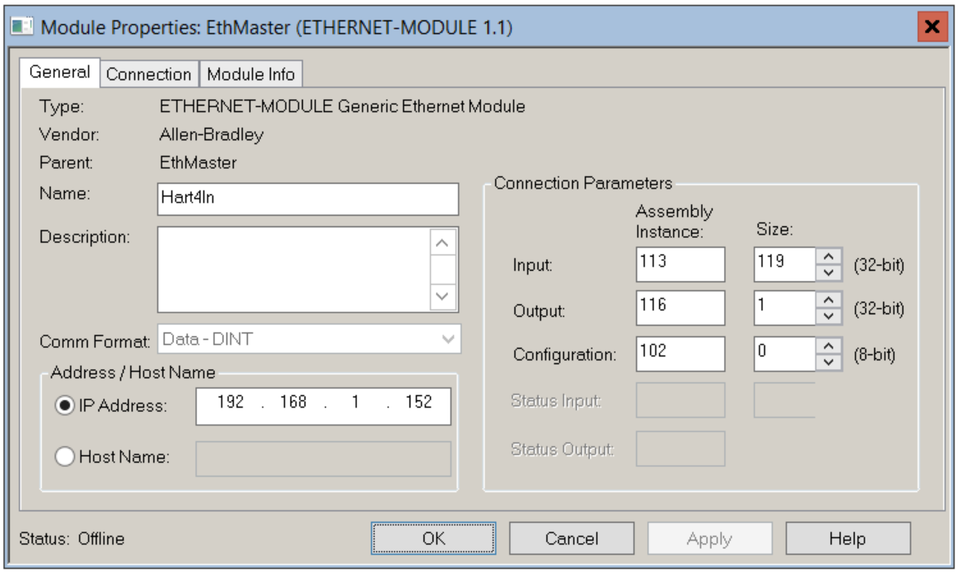


Figure 3.35 - RSLogix 5000 General module properties for **PLX51-HART-4I** module

The required connection parameters for the PLX51-HART-4O module are shown below:

Table 3.10 - RSLogix class 1 connection parameters for the **PLX51-HART-4O** module

Connection Parameter	Assembly Instance	Size
Input	113	119 (32-bit)
Output	115	4 (32-bit)
Configuration	102	0 (8-bit)

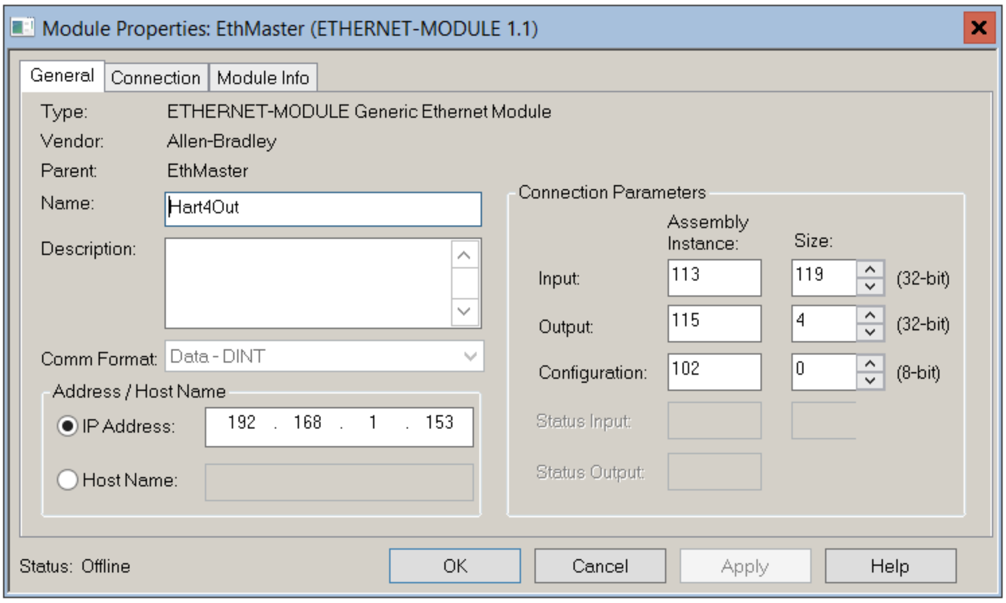


Figure 3.36 - RSLogix 5000 General module properties for **PLX51-HART-4O** module

Important: The user will need to enter the exact connection parameters before the module establishes a class 1 connection with the Logix controller.

Next, add the connection requested packet interval (RPI). This is the rate at which the input and output assemblies are exchanged. The recommended value is 200 ms. Refer to the technical specification section in this document for further details on the limits of the RPI.

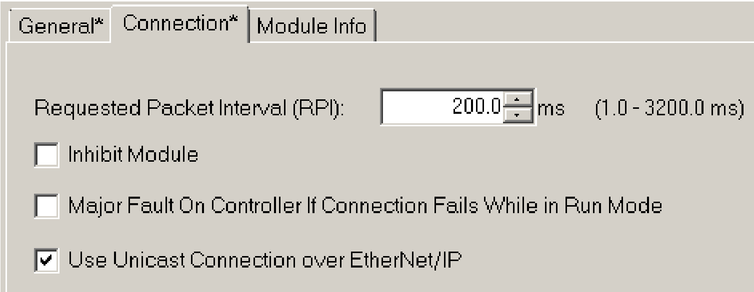


Figure 3.37 - Connection module properties in RSLogix 5000

Once the module has been added to the RSLogix 5000 I/O tree the user must assign the User Defined Types (UDTs) to the input and output assemblies. The user can import the required UDTs by right-clicking on *User-Defined* sub-folder in the *Data Types* folder of the I/O tree and selecting *Import Data Type*. The assemblies are then assigned to the UDTs with a ladder copy instruction (COP) as shown in the figure below.

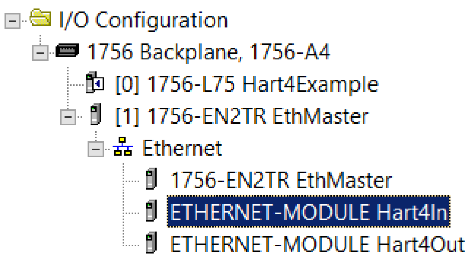


Figure 3.38 – RSLogix 5000 I/O module tree

3.9.2 Importing UDTs and Mapping Routines

To simplify the mapping of the input image, an RSLogix 5000 Routine Partial Import (.L5X) file is provided. This file can be imported by right-clicking on an empty rung in the MainRoutine and selecting the *Import Rungs* option.

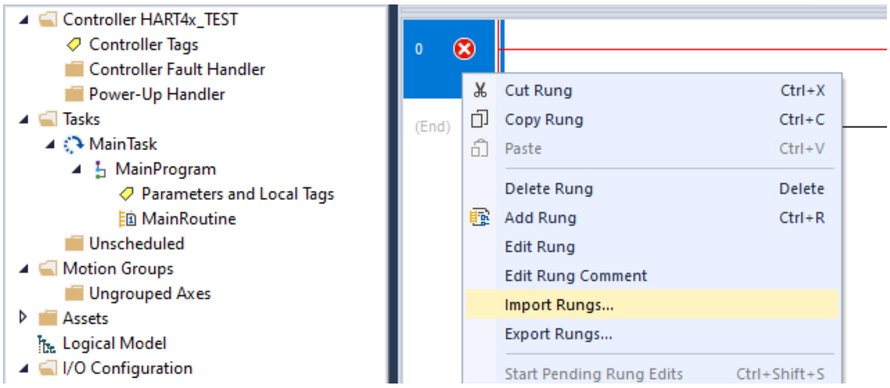


Figure 3.39 – RSLogix 5000 Importing module specific routine and UDTs

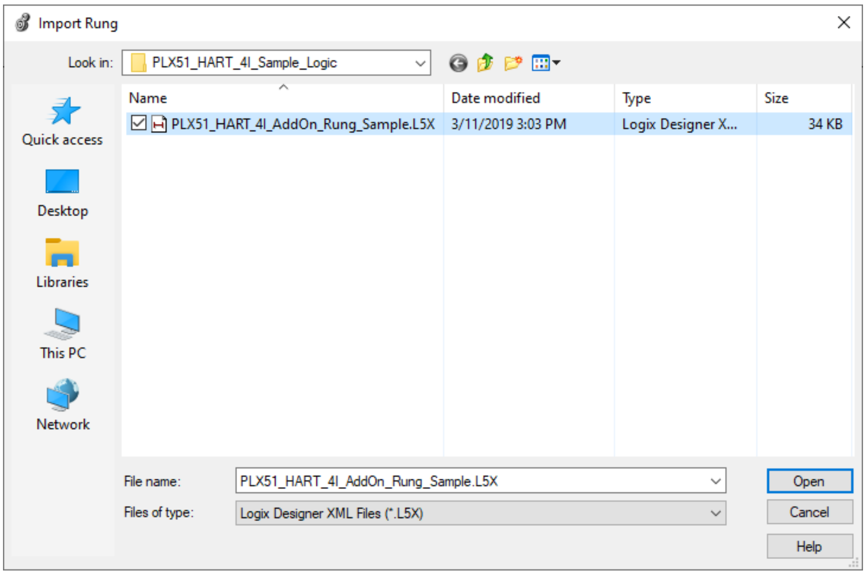


Figure 3.40 - Selecting partial import file for **PLX51-HART-4I** module

The import will create the following:

- The required UDTs (user defined data types)
- Controller tags representing the Input and Output assemblies.
- A routine mapping the PLX51-HART-4I and PLX51-HART-4O modules to the tags.

The user may need to change the routine to map to the correct module instance name and make sure that the mapping routine is called by the Program's Main Routine.

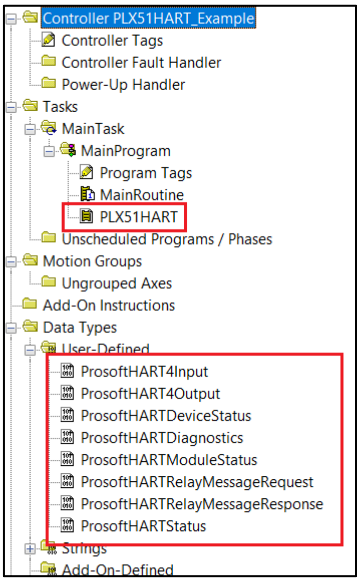


Figure 3.41 - Imported RSLogix 5000 objects

Refer to the additional information section of this document for an example RSLogix 5000 project as well as the required UDTs.

Name	Value	Style	Data Type
Hart4In_I	{...}		ProsoftHART4Input
Hart4In_I.Instance	'HART 4 In1'		ProsoftSTRING16
Hart4In_I.Status	{...}		ProsoftHARTModuleStatus
Hart4In_I.Temperature	48.276596	Float	REAL
Hart4In_I.Ch0_ManufacturerID	38	Decimal	SINT
Hart4In_I.Ch0_ManufacturerDeviceType	22	Decimal	SINT
Hart4In_I.Ch0_LiveList	2#0000_0000_0000_0000	Binary	INT
Hart4In_I.Ch0_DeviceID	0	Decimal	DINT
Hart4In_I.Ch0_Tag	' '		ProsoftSTRING8
Hart4In_I.Ch0_Descriptor	' '		ProsoftSTRING16
Hart4In_I.Ch0_DeviceStatus	{...}		ProsoftHARTDeviceStatus
Hart4In_I.Ch0_DeviceStatus.LoopOpen	0	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.CurrentUnderrange	0	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.CurrentOverrange	1	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.LoopShorted	1	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.CalibrationBusy	0	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.CalibrationFaulted	1	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.HARTCommsFault	0	Decimal	BOOL
Hart4In_I.Ch0_DeviceStatus.RelayMessagesInhibited	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus	{...}		ProsoftHARTStatus
Hart4In_I.Ch0_HARTStatus.ParityError	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.OverrunError	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.FramingError	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.ChecksumError	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.RxBufferOverflow	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.ValueTooLarge	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.ValueTooSmall	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.NotEnoughBytesInCommand	0	Decimal	BOOL
Hart4In_I.Ch0_HARTStatus.TransmitterSpecificCmdError	0	Decimal	BOOL

Figure 3.42 – UDT Input Assembly

4 Operation

Once the module has been configured, it will exchange HART information between the HART field device and an EtherNet/IP controller (e.g. Logix), DNP3 Master, Modbus TCP/IP client, or an SLC / MicroLogix / PLC5 using PCCC.

4.1 Logix 5000

When the module operates in a Logix "owned" mode the Logix controller will establish a class 1 cyclic communication connection with the module. An input and output assembly is exchanged at the configured (RPI) interval.

4.1.1 Input Assembly

The following parameters are used in the input assembly of the PLX51-HART-4I and PLX51-HART-4O modules.

Table 4.1 – Logix 5000 input assembly parameters

Parameter	Datatype	Description
Instance	STRING	The instance name of the module that was configured under the general module configuration in the PLX50 Configuration Utility.
Temperature	REAL	The internal temperature of the module in °C.
Module Status	DINT	Bit 0 – Configuration Valid Bit 1 – Channel 0 Enabled Bit 2 – Channel 1 Enabled Bit 3 – Channel 2 Enabled Bit 4 – Channel 3 Enabled Bit 5 – Channel 0 HART Enabled Bit 6 – Channel 1 HART Enabled Bit 7 – Channel 2 HART Enabled Bit 8 – Channel 3 HART Enabled
Channel Data The next section is repeated for each of the 4 channels. Where x represents channel number (0-3).		
Chx_ManufacturerID	SINT	The unique manufacturer identification code.
Chx_ManufacturerDeviceType	SINT	The device type code specified by the manufacturer.
Chx_LiveList	INT	When using Multidrop functionality this will indicate which of the configured devices are online. Note that each bit represents the configured Multidrop Device Index (see the Multidrop configuration in the Advanced Mapping section). Example: if bit 3 is set, then Multidrop device at MD 3 is online (for the specific channel).
Chx_DeviceID	DINT	The device identification code specified by the manufacturer.

Parameter	Datatype	Description
Chx_Tag	STRING8	Tag name of the field device.
Chx_Descriptor	STRING16	Descriptor of the field device.
Chx_DeviceStatus	SINT	Device Status comprising the following bits:
Chx_DeviceStatus.LoopOpen	BOOL	Loop open circuit detected. (Current < 3.6 mA)
Chx_DeviceStatus.CurrentUnderrange	BOOL	Loop current under range. (Current < 3.8 mA)
Chx_DeviceStatus.CurrentOverrange	BOOL	Loop current over range. (Current > 20.5 mA)
Chx_DeviceStatus.LoopShorted	BOOL	Loop short circuit detected. (Current > 21.0 mA)
Chx_DeviceStatus.CalibrationBusy	BOOL	Analog current calibration busy.
Chx_DeviceStatus.CalibrationFaulted	BOOL	Analog calibration failed.
Chx_DeviceStatus.HARTCommsFault	BOOL	HART communication failure.
Chx_DeviceStatus.RelayMessagesInhibited	BOOL	Relay HART messages inhibited, set in configuration. This prevents DTM and other class 2 communications.
Chx_HARTStatus	DINT	HART Status information as reported by field device.
Chx_HARTStatus.ParityError	BOOL	Parity error detected by field device.
Chx_HARTStatus.OverrunError	BOOL	Field device buffer overrun.
Chx_HARTStatus.FramingError	BOOL	HART Framing error detected by field device.
Chx_HARTStatus.ChecksumError	BOOL	Checksum error detected by field device.
Chx_HARTStatus.RxBufferOverflow	BOOL	Field device receive buffer overflow.
Chx_HARTStatus.ValueTooLarge	BOOL	Value too large in previous HART command.
Chx_HARTStatus.ValueTooSmall	BOOL	Value too small in previous HART command.
Chx_HARTStatus.NotEnoughBytesInCommand	BOOL	Insufficient bytes in previous HART command.
Chx_HARTStatus.TransmitterSpecificCmdError	BOOL	Specific error in previous HART command.
Chx_HARTStatus.InWriteProtectMode	BOOL	Previous command rejected due to field device being in Write-Protect mode.
Chx_HARTStatus.UpdateFailed	BOOL	Previous parameter update failed.
Chx_HARTStatus.AppliedProcessTooHigh	BOOL	Applied process too high or out of range.
Chx_HARTStatus.AppliedProcessTooLow	BOOL	Applied process too low or out of range.
Chx_HARTStatus.InMultidropMode	BOOL	Field device current in multidrop mode.
Chx_HARTStatus.InvalidUnitCode	BOOL	Invalid unit code received in command.
Chx_HARTStatus.BothRangeValuesOutOfLimits	BOOL	Configured range units out of range.
Chx_HARTStatus.PushedUpperRangeValueOverLimit	BOOL	Upper range out of limits.

Parameter	Datatype	Description
Chx_HARTStatus.AccessRestricted	BOOL	Access Restricted.
Chx_HARTStatus.DeviceBusy	BOOL	Device Busy.
Chx_HARTStatus.CommandNotImplemented	BOOL	Command not supported.
Chx_HARTStatus.DeviceMalfunction	BOOL	Device Malfunction.
Chx_HARTStatus.ConfigurationChanged	BOOL	Configuration changed.
Chx_HARTStatus.Coldstart	BOOL	Field device power failure or device reset.
Chx_HARTStatus.MoreStatusAvailable	BOOL	Additional status information is available.
Chx_HARTStatus.LoopCurrentFixed	BOOL	Loop Current is set at a fixed value and is not responding to process variations
Chx_HARTStatus.LoopCurrentSaturated	BOOL	Loop Current has reached its upper or lower limit.
Chx_HARTStatus.NonPrimaryVariableOutOFLimits	BOOL	A non-PV variable is beyond its operating limits.
Chx_HARTStatus.PrimaryVariableOutOfLimites	BOOL	The PV is beyond its operating limits.
Chx_RawCurrent	REAL	Raw analog current in mA.
Chx_ScaledValue	REAL	Scaled and filtered PV in engineering units.
Chx_DigitialCurrent	REAL	The field device’s target current.
Chx_PV	REAL	Primary Variable in engineering units.
Chx_SV	REAL	Secondary Variable in engineering units.
Chx_TV	REAL	Third Variable in engineering units.
Chx_FV	REAL	Fourth Variable in engineering units.
Chx_PVUnitCode	SINT	Primary Variable engineering units code.
Chx_SVUnitCode	SINT	Secondary Variable engineering units code.
Chx_TVUnitCode	SINT	Third Variable engineering units code.
Chx_FVUnitCode	SINT	Fourth Variable engineering units code.
Chx_Diagnostics.DeviceSpecificStatus0_0 - 5	SINTs	Additional device specific status information. Refer to the specific field device documentation.
Chx_ Diagnostics.OperationalModes_0 - 1	SINTs	Operation mode of the field device.
Chx_ Diagnostics.StandardizedStatus0	SINT	Standardized Status byte 0
Chx_ Diagnostics.StandardizedStatus1	SINT	Standardized Status byte 1
Chx_ Diagnostics.AnalogChannelSaturated	SINT	
Chx_ Diagnostics.StandardizedStatus2	SINT	Standardized Status byte 2
Chx_ Diagnostics.StandardizedStatus3	SINT	Standardized Status byte 3
Chx_ Diagnostics.AnalogChannelFixed	SINT	
Chx_ Diagnostics.DeviceSpecificStatus1_0 - 10	SINTs	Additional device specific status information. Refer to the specific field device documentation.

4.1.2 Output Assembly

The following parameters are used in the output assembly of the **PLX51-HART-4O** module.

Table 4.2 – PLX51-HART-4O Logix 5000 output assembly parameters

Parameter	Datatype	Description
Ch0_Data	REAL	Analog output value (in engineering units) for Channel 0.
Ch1_Data	REAL	Analog output value (in engineering units) for Channel 1.
Ch2_Data	REAL	Analog output value (in engineering units) for Channel 2.
Ch3_Data	REAL	Analog output value (in engineering units) for Channel 3.

4.1.3 HART Relay Message

The module supports the relaying of custom HART commands to the field device. This is achieved by building the HART command request and then sending it to the module using an explicit message instruction. An example of this is shown in the figure below.

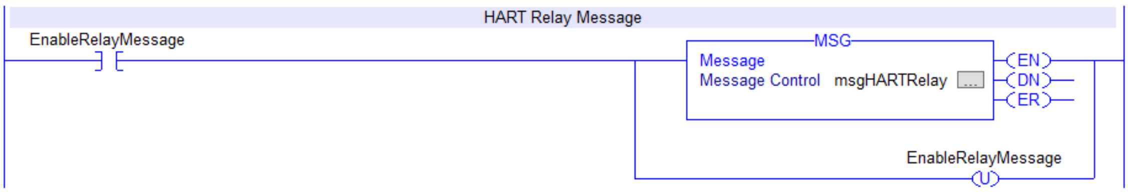


Figure 4.1 – Relay HART Message

The required attributes for the message instruction are as follows:

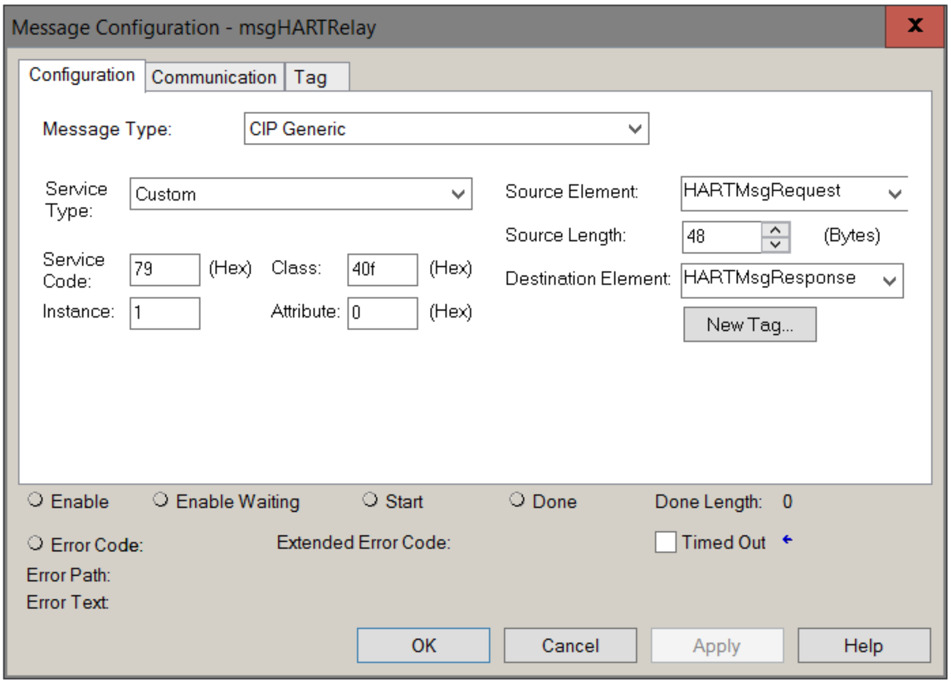


Figure 4.2 – Relay HART Message Configuration

Table 4.3 – Relay HART Message Parameters

Parameter	Value / Description
Message Type	CIP Generic
Service Type	Custom
Service Code	79 Hex (Relay HART Message service)
Class	40F Hex
Instance	Channel value + 1 1 for Channel 0 2 for Channel 1 3 for Channel 2 4 for Channel 3
Attribute	0
Source Element	Tag of type ProsoftHARTRelayMessageRequest
Source Length	48
Destination Element	Tag of type ProsoftHARTRelayMessageResponse

The required Request and Response HART Command structures are defined as follows:

Table 4.4 – Relay HART Message Request Structure

HART Command Request		
Byte Offset	**Data Type**	**Description**
0	INT	Request Length
2	SINT	Start Character (0x82 for Long Address)
3	SINT	Long Address 0 (0x80 + Manufacturer ID)
4	SINT	Long Address 1 (Device Type Code)
5	SINT	Long Address 2 (Device ID Byte 0)
6	SINT	Long Address 3 (Device ID Byte 1)
7	SINT	Long Address 4 (Device ID Byte 2)
8	SINT	Command Code
9	SINT	Command Data Length (in bytes)
10	SINT[]	Command Data (If required)

Table 4.5 – Relay HART Message Response Structure

HART Command Response		
Byte Offset	**Data Type**	**Description**
0	INT	Status (See table below)
2	INT	Packet Length
4	SINT	Start Character
5	SINT	Long Address 0
6	SINT	Long Address 1
7	SINT	Long Address 2
8	SINT	Long Address 3
9	SINT	Long Address 4
10	SINT	Command Code (Echoed)
11	SINT	Reply Data Length
12	INT	Status (Same as at byte 0 above).
14	SINT[]	Command Reply Data

HART Command Status Encoding

The Status code returned in the HART relay command are as follows:

Examine the value of the bit 7 in the first byte.

Table 4.6 - Status Decoding (when first byte bit 7 = 0)

If Byte 0 Bit 7 = 0 then:	
First Byte: Command Errors	
Value	Description
0	No error
1	(Undefined)
2	Invalid selection
3	Passed parameter too large
4	Passed parameter too small
5	Too few data bytes received
6	Transmitter specific error
7	In write-protect mode
8-15	Command specific error
16	Access restricted
32	Device is busy
64	Command not implemented
Second Byte: Device Status	
Bit	Description
0	PV out of limits
1	Variable (non-PV) out of limits
2	Analog output saturated
3	Output current fixed
4	(Undefined)
5	Cold Start
6	Configuration Changed

Table 4.7 - Status Decoding (when first byte bit 7 = 1)

If Byte 0 Bit 7 = 1 then:	
First Byte: Communication Errors	
Bit	Description
0	(Undefined)
1	Rx buffer overflow
2	(Undefined)
3	Checksum error
4	Framing error
5	Overrun error
6	Parity error
Second Byte: Not defined	
Value	Description
0	(Always zero)

HART Command Example

In the example below, a Logix message instruction is used to Read the Unique Identifier of the device. This makes use of the Universal Command #0. The field device is connected to channel 0, hence the Instance value set to 1.

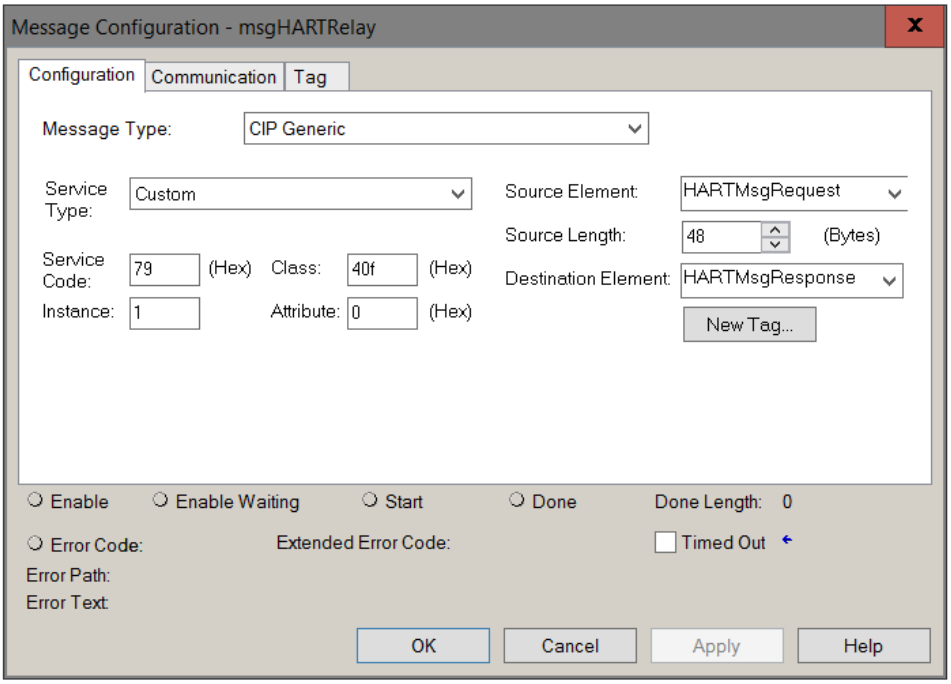


Figure 4.3 – Relay HART Message Example Configuration

HARTMsgRequest	{...}		AparianHARTRelayMessageRequest	
HARTMsgRequest.Length	8	Decimal	INT	Length = 8 bytes
HARTMsgRequest.StartCharacter	16#82	Hex	SINT	Start = 0x82 (Long Address)
HARTMsgRequest.AddressByte0	16#91	Hex	SINT	0x80 + ManufacturerID
HARTMsgRequest.AddressByte1	16#38	Hex	SINT	Device Type Code = 56 = 0x38
HARTMsgRequest.AddressByte2	16#79	Hex	SINT	DeviceID = 0xFF4F79
HARTMsgRequest.AddressByte3	16#4f	Hex	SINT	
HARTMsgRequest.AddressByte4	16#ff	Hex	SINT	
HARTMsgRequest.CommandData	{...}	Hex	SINT[40]	
HARTMsgRequest.CommandData[0]	16#00	Hex	SINT	Command = 0 Read Unique Identifier
HARTMsgRequest.CommandData[1]	16#00	Hex	SINT	Command Data Length = 0
HARTMsgRequest.CommandData[2]	16#00	Hex	SINT	Command Data (Not required for Cmd 0)
HARTMsgRequest.CommandData[3]	16#00	Hex	SINT	
HARTMsgRequest.CommandData[4]	16#00	Hex	SINT	
HARTMsgRequest.CommandData[5]	16#00	Hex	SINT	
HARTMsgRequest.CommandData[6]	16#00	Hex	SINT	

Figure 4.4 – Relay HART Command Example – Request

Name	Value	Style	Data Type	
HARTMsgResponse	{...}		AparianHARTRelayMessageResponse	
HARTMsgResponse.Status	16#4000	Hex	INT	Status = 0x4000
HARTMsgResponse.PacketLength	32	Decimal	INT	
HARTMsgResponse.StartCharacter	16#86	Hex	SINT	Long Address
HARTMsgResponse.AddressByte0	16#91	Hex	SINT	
HARTMsgResponse.AddressByte1	16#38	Hex	SINT	
HARTMsgResponse.AddressByte2	16#79	Hex	SINT	
HARTMsgResponse.AddressByte3	16#4f	Hex	SINT	
HARTMsgResponse.AddressByte4	16#ff	Hex	SINT	
HARTMsgResponse.Command	0	Decimal	SINT	Command Echo
HARTMsgResponse.ByteCount	24	Decimal	SINT	Reply Length = 24
HARTMsgResponse.Data	{...}	Hex	SINT[50]	
HARTMsgResponse.Data[0]	16#00	Hex	SINT	Status = 0x4000 (repeated)
HARTMsgResponse.Data[1]	16#40	Hex	SINT	
HARTMsgResponse.Data[2]	16#fe	Hex	SINT	Command 0 Reply Data: Format 254
HARTMsgResponse.Data[3]	16#11	Hex	SINT	ManufacturerID
HARTMsgResponse.Data[4]	16#38	Hex	SINT	Device Type Code
HARTMsgResponse.Data[5]	16#05	Hex	SINT	Number of Preambles
HARTMsgResponse.Data[6]	16#07	Hex	SINT	Universal Cmd Rev
HARTMsgResponse.Data[7]	16#03	Hex	SINT	Specific Cmd Rev
HARTMsgResponse.Data[8]	16#03	Hex	SINT	Software Rev
HARTMsgResponse.Data[9]	16#08	Hex	SINT	Hardware Rev

Figure 4.5 – Relay HART Command Example – Response

Note: The HART Long Address for a device is comprised of the Manufacturer ID, Device Type Code and Device ID. These values are displayed on the Channel Status screen in the PLX50 Configuration Utility when the device is Online.

4.1.4 Multidrop

When using Multidrop HART devices with Logix, the user must select the Logix Tag to be used to populate the HART device data. The user can either select to use the current Multidrop tag structure or the legacy MVI56Legacy tag structure.

The user will need to use either of the provided MultiDrop UDTs for each tag used for each HART multidrop device (as shown below):

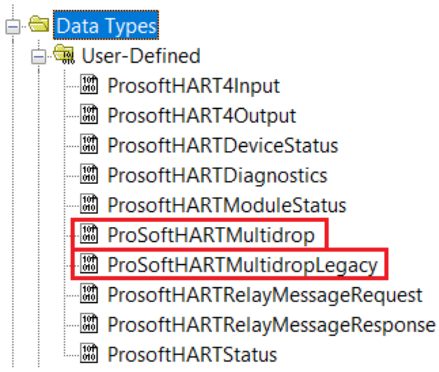


Figure 4.6 – Multidrop – new and legacy UDTs

Important: If the user does not use the provided UDTs it can result in unexpected behavior or no data updates.

Once the Logix tags for each multidrop HART device have been selected, the PLX51-HART-4x will automatically update the Logix tags with the data from each multidrop HART device on each HART channel.

MultiDrop UDT Structure

PT101	{...}		ProSoftHARTMultidrop
PT101.PollStatus	2#0000_0000	Binary	SINT
PT101.LastStatusByte	0	Decimal	SINT
PT101.LastSecond_StatusByte	0	Decimal	SINT
PT101.ManufactureIDCode	0	Decimal	SINT
PT101.DeviceTypeCode	0	Decimal	SINT
PT101.MinPreambles	0	Decimal	SINT
PT101.UniversalCMDMajor	0	Decimal	SINT
PT101.DeviceRevision	0	Decimal	SINT
PT101.SoftwareRevision	0	Decimal	SINT
PT101.HardwareRevision	0	Decimal	SINT
PT101.DeviceFlags	0	Decimal	SINT
PT101.DeviceID	0	Decimal	DINT
PT101.PreambleResponse	0	Decimal	SINT
PT101.MaxNumberDeviceVariables	0	Decimal	SINT
PT101.ConfigChangeCount	0	Decimal	INT
PT101.ExtDeviceStatus	0	Decimal	SINT
PT101.PVUnits	0	Decimal	SINT
PT101.SVUnits	0	Decimal	SINT
PT101.TVUnits	0	Decimal	SINT
PT101.FVUnits	0	Decimal	SINT
PT101.Tagname	''		ProsoftSTRING8
PT101.Descriptor	''		ProsoftSTRING16
PT101.TagDescriptorDate	''		ProsoftSTRING8
PT101.SerialNumber	0	Decimal	DINT
PT101.TransducerLimits	0	Decimal	SINT
PT101.PVAlarms	0	Decimal	SINT
PT101.PVTransfer	0	Decimal	SINT
PT101.PVURLLRV_Units	0	Decimal	SINT
PT101.WriteProtectionCode	0	Decimal	SINT
PT101.PrivateLabelCode	0	Decimal	SINT
PT101.PVAnalogChFlag	0	Decimal	SINT
PT101.PV	0.0	Float	REAL
PT101.SV	0.0	Float	REAL
PT101.TV	0.0	Float	REAL
PT101.FV	0.0	Float	REAL
PT101.UpperTransducerLimit	0.0	Float	REAL
PT101.LowerTransducerLimit	0.0	Float	REAL
PT101.MinimumSpan	0.0	Float	REAL
PT101.PVUpperRange	0.0	Float	REAL
PT101.PVLowerRange	0.0	Float	REAL
PT101.PVDamping	0.0	Float	REAL

Figure 4.7 – Multidrop – UDT

Table 4.8 – Multidrop UDT structure

Parameter	Datatype	Description
PollStatus	SINT	Bit 0 – When set this bit will indicate that the device is online
LastStatusByte	SINT	The first byte of the field device HART response status. See the HART section at the end of this document for details regarding the HART status.
LastSecond_StatusByte	SINT	The second byte of the field device HART response status. See the HART section at the end of this document for details regarding the HART status.
ManufactureIDCode	SINT	The unique manufacturer identification code.
DeviceTypeCode	SINT	The device type code specified by the manufacturer.
MinPreambles	SINT	Minimum Number of Preambles.
UniversalCMDMajor	SINT	Universal Command Major Revision Number.
DeviceRevision	SINT	Device Revision Number.

Parameter	Datatype	Description
SoftwareRevision	SINT	Software Revision Number.
HardwareRevision	SINT	Hardware Revision Number.
DeviceFlags	SINT	Device Function Flags. Bit 0 – Multi Sensor device Bit 1 – EEPROM control required Bit 2 – Protocol Bridge Device
DeviceID	DINT	Device Identification Number
PreambleResponse	SINT	Number of Preambles.
MaxNumberDeviceVariables	SINT	Maximum Number of Device Variables
ConfigChangeCount	INT	Configuration Change Number
ExtDeviceStatus	SINT	Extended Device Status
PVUnits	SINT	Primary Variable engineering units code.
SVUnits	SINT	Secondary Variable engineering units code.
TVUnits	SINT	Third Variable engineering units code.
FVUnits	SINT	Fourth Variable engineering units code.
Tagname	STRING8	Tag name of the field device.
Descriptor	STRING16	Descriptor of the field device.
TagDescriptorDate	STRING8	Date of the field device.
SerialNumber	DINT	Sensor Serial Number
TransducerLimits	SINT	Sensor Limits and Minimum Span Units Code.
PVAlarms	SINT	PV Alarm Selection Code
PVTransfer	SINT	PV Transfer Function Code
PVURLLRV_Units	SINT	PV Upper and Lower Range Values Units Code
WriteProtectionCode	SINT	Write Protection Code
PrivateLabelCode	SINT	Private Label Distributor Code
PVAnalogChFlag	SINT	PV Analog Channel Flags
PV	REAL	Primary Variable in engineering units.
SV	REAL	Secondary Variable in engineering units.
TV	REAL	Third Variable in engineering units.
FV	REAL	Fourth Variable in engineering units.
UpperTransducerLimit	REAL	Upper Transducer Limit
LowerTransducerLimit	REAL	Lower Transducer Limit
MinimumSpan	REAL	Minimum Span
PVUpperRange	REAL	PV Upper Rage Value
PVLowerRange	REAL	PV Lower Range Value
PVDamping	REAL	PV Damping Value (s)

MultiDrop Legacy (MVI56) UDT Structure

TT302	{...}		ProSoftHARTMultidropLegacy	
TT302.Auto_Poll_CMD_Status	2#0000_0000	Binary	SINT	Auto-Polling command status bits
TT302.Last_Status_Byte	0	Decimal	SINT	Last first status byte received from device
TT302.Last_Second_Status_Byte	0	Decimal	SINT	Last second status byte received from device
TT302.Manufacture_ID_Code	0	Decimal	SINT	Device's Manufacture ID Code
TT302.Device_Type_Code	0	Decimal	SINT	Device Type Code
TT302.Min_Preambles	0	Decimal	SINT	Minimum Number of Preambles
TT302.Universal_CMD_Major	0	Decimal	SINT	Universal Command Major Revision Number
TT302.Device_Rev_Level	0	Decimal	SINT	Device Revision Level
TT302.Software_Rev_Level	0	Decimal	SINT	Software Revision Level
TT302.Hardware_Rev_Level	0	Decimal	SINT	Hardware Revision Level
TT302.Device_Flags	0	Decimal	SINT	Device Flags
TT302.Device_ID	{...}	Decimal	SINT[3]	Device ID
TT302.Min_Preambles_Resp	0	Decimal	SINT	Minimum Preambles Count to Response
TT302.Max_Number_Devices	0	Decimal	SINT	Maximum Number of HART Devices in the Network
TT302.Config_Change_Count	0	Decimal	INT	Counter for Configuration Changes
TT302.Ext_Dev_Status	0	Decimal	SINT	Extended Field Device Status
TT302.Primary_Var_Units	0	Decimal	SINT	Primary Units Code
TT302.Secondary_Var_Units	0	Decimal	SINT	Secondary Units Code
TT302.Tertiary_Var_Units	0	Decimal	SINT	Tertiary Units Code
TT302.Quaternary_Var_Units	0	Decimal	SINT	Quaternary Units Code
TT302.Tag_Name	{...}	ASCII	SINT[8]	HART Device Tag Name
TT302.Descriptor	{...}	ASCII	SINT[16]	HART Device Descriptor
TT302.Tag_Descriptor_Date	{...}	ASCII	SINT[3]	HART Device Descriptor Date
TT302.Transd_Serial_Num	{...}	Decimal	SINT[3]	Transducer Serial Number
TT302.Transd_limits	0	Decimal	SINT	Transducer Limits
TT302.PV_Alarms	0	Decimal	SINT	PV Alarm Counter
TT302.PV_Transfer	0	Decimal	SINT	PV Transfer Counter
TT302.PV_URLLRV_Units	0	Decimal	SINT	PV Upper and Lower Value Limits
TT302.Write_Protection_Code	0	Decimal	SINT	Write Protection Code
TT302.Private_Label_Code	0	Decimal	SINT	Private Label Distributor Code
TT302.PV_Analog_Ch_Flag	0	Decimal	SINT	PV Analog Channel Flag
TT302.PV_value	0.0	Float	REAL	Primary Variable Value
TT302.SV_value	0.0	Float	REAL	Secondary Variable Value
TT302.TV_value	0.0	Float	REAL	Tertiary Variable Value
TT302.QV_value	0.0	Float	REAL	Quaternary Variable Value
TT302.U_trans_limit	0.0	Float	REAL	Upper Transducer Limit
TT302.L_trans_limit	0.0	Float	REAL	Lower Transducer Limit
TT302.Min_span	0.0	Float	REAL	Minimum Span
TT302.PV_URV	0.0	Float	REAL	PV Upper Range Value
TT302.PV_LRV	0.0	Float	REAL	PV Lower Range Value
TT302.PV_damp	0.0	Float	REAL	PV Damping Value

Figure 4.8 – Multidrop – Legacy UDT

Table 4.9 – Multidrop UDT structure

Parameter	Datatype	Description
Auto_Poll_CMD_Status	SINT	Bit 0 – When set this bit will indicate that the device is online
Last_Status_Byte	SINT	The first byte of the field device HART response status. See the HART section at the end of this document for details regarding the HART status.
Last_Second_Status_Byte	SINT	The second byte of the field device HART response status. See the HART section at the end of this document for details regarding the HART status.
Manufacture_ID_Code	SINT	The unique manufacturer identification code.
Device_Type_Code	SINT	The device type code specified by the manufacturer.
Min_Preambles	SINT	Minimum Number of Preambles.
Universal_CMD_Major	SINT	Universal Command Major Revision Number.
Device_Rev_Level	SINT	Device Revision Number.
Software_Rev_Level	SINT	Software Revision Number.
Hardware_Rev_Level	SINT	Hardware Revision Number.
Device_Flags	SINT	Device Function Flags. Bit 0 – Multi Sensor device

Parameter	Datatype	Description
		Bit 1 – EEPROM control required Bit 2 – Protocol Bridge Device
Device_ID	SINT[3]	Device Identification Number
Min_Preambles_Resp	SINT	Number of Preambles.
Max_Number_Devices	SINT	Maximum Number of Device Variables
Config_Change_Count	INT	Configuration Change Number
Ext_Dev_Status	SINT	Extended Device Status
Primary_Var_Units	SINT	Primary Variable engineering units code.
Secondary_Var_Units	SINT	Secondary Variable engineering units code.
Tertiary_Var_Units	SINT	Third Variable engineering units code.
Quaternary_Var_Units	SINT	Fourth Variable engineering units code.
Tag_Name	STRING8	Tag name of the field device.
Descriptor	STRING16	Descriptor of the field device.
Tag_Descriptor_Date	STRING8	Date of the field device.
Transd_Serial_Num	DINT	Sensor Serial Number
Transd_limits	SINT	Sensor Limits and Minimum Span Units Code.
PV_Alarms	SINT	PV Alarm Selection Code
PV_Transfer	SINT	PV Transfer Function Code
PV_URLLRV_Units	SINT	PV Upper and Lower Range Values Units Code
Write_Protection_Code	SINT	Write Protection Code
Private_Label_Code	SINT	Private Label Distributor Code
PV_Analog_Ch_Flag	SINT	PV Analog Channel Flags
PV_value	REAL	Primary Variable in engineering units.
SV_value	REAL	Secondary Variable in engineering units.
TV_value	REAL	Third Variable in engineering units.
QV_value	REAL	Fourth Variable in engineering units.
U_trans_limit	REAL	Upper Transducer Limit
L_trans_limit	REAL	Lower Transducer Limit
Min_span	REAL	Minimum Span
PV_URV	REAL	PV Upper Rage Value
PV_LRV	REAL	PV Lower Range Value
PV_damp	REAL	PV Damping Value (s)

4.1.5 HART Channel Command

The HART communication can dynamically be inhibited from the EtherNet/IP protocol interface. This is done by sending a Set Single Attribute to a specific CIP class, instance, and attribute. The data being sent is 8 bytes where the first byte is the HART channel command and the remaining 7 bytes are reserved. When the first byte is set to 1, then the HART Communication on the specific channel will be inhibited. The instance will determine the target HART channel.

Table 4.10 – HART Channel Command Parameters

Parameter	**Value / Description**
Message Type	CIP Generic
Service Type	Set Single Attribute
Service Code	10 Hex (Set Single Attribute)
Class	40F Hex
Instance	Channel value + 1 1 for Channel 0 2 for Channel 1 3 for Channel 2 4 for Channel 3
Attribute	14
Source Element	SINT[8] *SINT[0] – when set to 1 the HART communication will be inhibited.* *SINT[1] to SINT[7] – reserved.*
Source Length	8
Destination Element	None

4.1.6 HART Process Variable CIP Parameters

The module supports additional CIP attributes which will allow the EtherNet/IP device to read all 4 process variables (PV, SV, TV, and FV) from the "main" HART device as well as each multidrop HART device for each respective HART channel.

Table 4.11 – HART Process Variable CIP Parameters

Parameter	**Value / Description**
Message Type	CIP Generic
Service Type	Get Single Attribute
Service Code	0E Hex (Get Single Attribute)
Class	40F Hex
Instance	Channel value + 1 1 for Channel 0 2 for Channel 1 3 for Channel 2 4 for Channel 3
Attribute	25 – Main HART device 35 – Multidrop Device Index 0 45 – Multidrop Device Index 1 55 – Multidrop Device Index 2 65 – Multidrop Device Index 3 75 – Multidrop Device Index 4 85 – Multidrop Device Index 5 95 – Multidrop Device Index 6
Source Element	None
Source Length	8
Destination Element	REAL[4] *REAL[0] – HART Device PV.* *REAL[1] – HART Device SV.* *REAL[2] – HART Device TV.* *REAL[3] – HART Device FV.*

4.1.7 HART Custom Command

The module supports sending custom HART commands to a field device. See the *Advanced Mapping setup* section for more details regarding the Custom Command parameters. When adding a custom HART command (with a EtherNet/IP interface), a Logix tag will need to be selected with the correct Logix UDT type (*ProsoftHART4CustomCommand*). See the PLX51-HART Logix example code for the UDT.

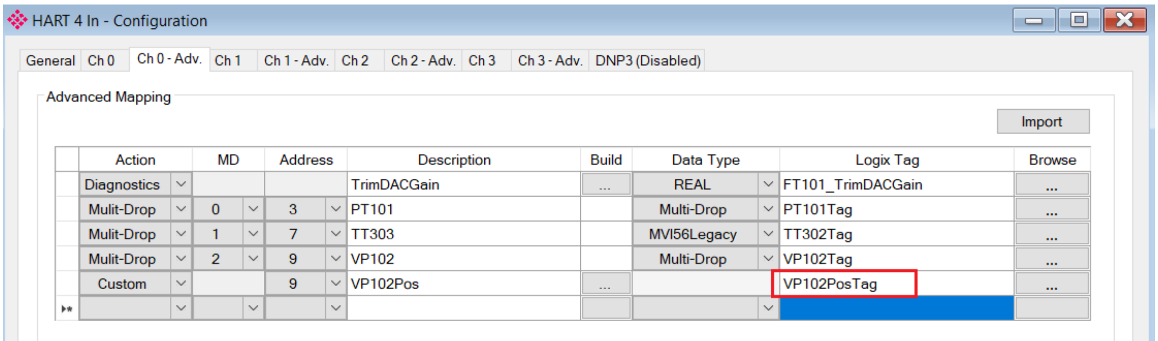


Figure 4.9 – Custom HART command selected Logix Tag

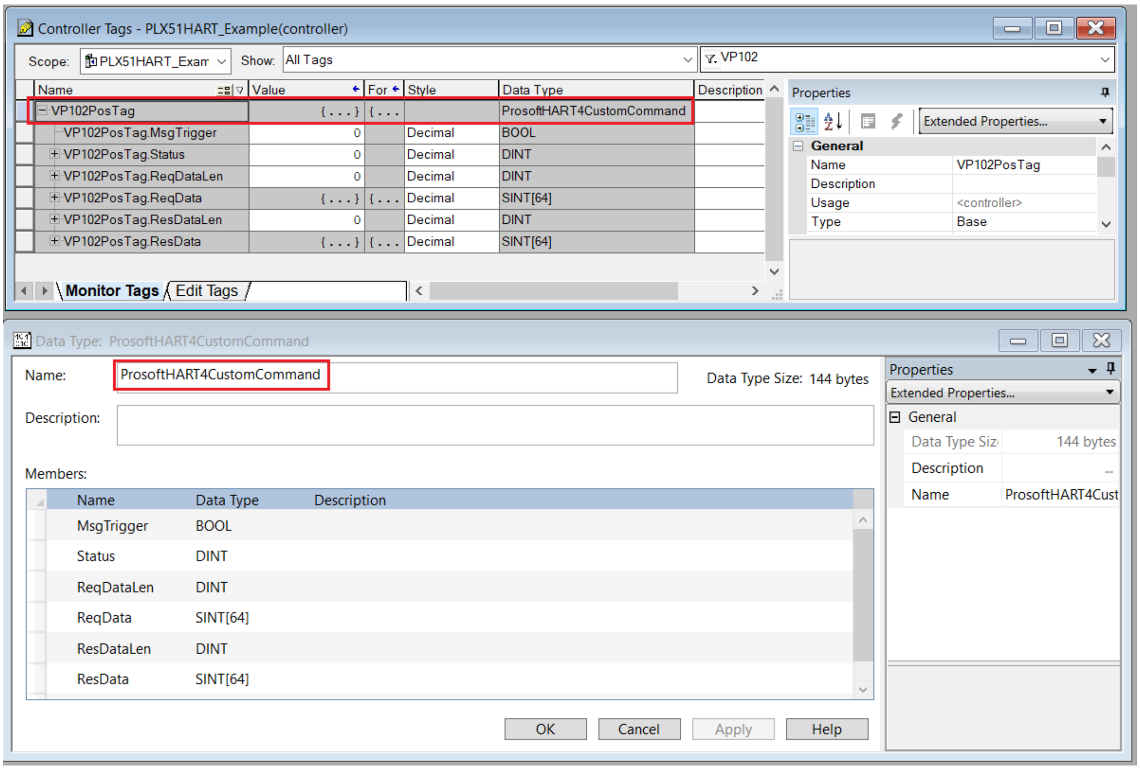


Figure 4.10 – Custom HART command Logix Tag

When the user wants to start the execution of the custom HART command, the MsgTrigger parameter must be set to 1. Once the message transaction has been completed, the MsgTrigger parameter will be cleared back to zero. Once the message has been completed, the status parameter will also be updated to indicate the status of the transaction.

Below is the description of the various parameters in the UDT.

Table 4.12 – Custom HART command UDT Parameters

Parameter	Description
MsgTrigger	This is the trigger to start the execution of the custom HART command. When this parameter is set to 1 it will start sending the custom HART message. Once complete this parameter will automatically be cleared back to zero.
Status	Once the custom HART message transaction has completed, it will update the status field in the UDT to indicate the status of the transaction. 0 – Success 1 – Response Timeout 2 – HART device offline 3 – No Multidrop Device configured
ReqDataLen	This parameter indicates the number of bytes to be sent in the custom HART command. If this parameter is made zero, then no additional HART data will be sent other than the HART command.
ReqData	This parameter is a SINT array allowing for up to 64 bytes to be sent. **Note**: It is the user's responsibility to ensure that the data to be sent is in the correct format based on the HART command.
ResDataLen	This parameter indicates the number of bytes received from the custom HART command. If this parameter is made zero, then no HART data was received.
ResData	This parameter is a SINT array allowing for up to 64 bytes to be returned.

4.2 DNP3 Operation

The DNP3 operation is enabled when the configuration protocol is set to either DNP3 TCP or DNP3 UDP. The module will then operate as a DNP3 Outstation supporting the following DNP3 objects.

Table 4.13 - DNP3 Object Implementation

Group:	**10 - Counters**					
Variation:	**5**					
Functions:	**Read**					
Parameter	Length	Item				
		General	Channel 0	Channel 1	Channel 2	Channel 3
Application Messages Received	1	0	-	-	-	-
Application Messages Sent	1	1	-	-	-	-
Critical Messages Received	1	2	-	-	-	-
Critical Messages Sent	1	3	-	-	-	-
Discarded Messages	1	4	-	-	-	-
Error Messages Sent	1	5	-	-	-	-
Error Messages Received	1	6	-	-	-	-
Checksum Error	1	7	-	-	-	-
HART Tx Count	1	-	20	30	40	50
HART Rx Count	1	-	21	31	41	51
Communication Errors	1	-	22	32	42	52
Command Errors	1	-	23	33	43	53
Time-Out Errors	1	-	24	34	44	54

Group:	**30 - Analog Inputs**					
Variation:	**1,2,3,4,5,6**					
Functions:	**Read**					
Parameter	Length	Item				
		General	Channel 0	Channel 1	Channel 2	Channel 3
Raw Current	1	-	10	20	30	40
Scaled Value	1	-	11	21	31	41
Digital Current	1	-	12	22	32	42
PV - Primary Value	1	-	13	23	33	43
SV - Secondary Value	1	-	14	24	34	44
TV - Tertiary Value	1	-	15	25	35	45
FV - Fourth Value	1	-	16	26	36	46

Group:	**41 - Analog Outputs**					
Variation:	**1,2,3,4**					
Functions:	**Select, Operate, Direct Operate, Direct Operate w/o Ack.**					
Parameter	Length	Item				
		General	Channel 0	Channel 1	Channel 2	Channel 3
Output Value	1	-	0	10	20	30

Group:	**102 - Unsigned 8-bit Integers**
Variation:	**1**

Functions:	**Read**					
Parameter	Length	Item				
		General	Channel 0	Channel 1	Channel 2	Channel 3
Module Status Bit 0 – Configuration Valid Bit 1 – Channel 0 Enabled Bit 2 – Channel 1 Enabled Bit 3 – Channel 2 Enabled Bit 4 – Channel 3 Enabled Bit 5 – Channel 0 HART Enabled Bit 6 – Channel 1 HART Enabled Bit 7 – Channel 2 HART Enabled Bit 8 – Channel 3 HART Enabled	1	0	-	-	-	-
PV Units Code	1	-	10	20	30	40
SV Units Code	1	-	11	21	31	41
TV Units Code	1	-	12	22	32	42
FV Units Code	1	-	13	23	33	43
Manufacturer ID	1	-	100	200	300	400
Manufacturer Device Type Code	1	-	101	201	301	401
Number of Preambles Required	1	-	102	202	302	402
Universal Command Rev	1	-	103	203	303	403
Specific Command Rev	1	-	104	204	304	404
Software Rev	1	-	105	205	305	405
Hardware Rev	1	-	106	206	306	406
Device Function Flags	1	-	107	207	307	407
Device ID Number	3	-	108	208	308	408
Pad Byte	1	-	109	209	309	409
Sensor Serial Number	3	-	112	212	312	412
Units Code for Sensor	1	-	115	215	315	415
Sensor Upper Limit	4	-	116	216	316	416
Sensor Lower Limit	4	-	120	220	320	420
Sensor Minimum Span	4	-	124	224	324	424
Tag	8	-	128	228	328	428
Descriptor	16	-	136	236	336	436
Date	3	-	152	252	352	452

Important: When using the Select, Operate, Direct Operate and Direct Operate without Acknowledge functions, only one item can be addressed at a time.

4.2.1 DNP3 Security

DNP3 offers Secure Authentication for links at risk of being attacked. There are various Key Change methods, Message Authentication Code (MAC) algorithms, and Authentication methods provided in the DNP3 protocol specification.

Various keys are used in DNP3 Secure Authentication. Session keys are used most frequently as it is used for Authentication of the requests. These keys are updated by the DNP3 master at a certain interval or every time there has been a message failure. The DNP3 master encrypts these keys before sending them across the wire using the Key Wrap Algorithm selected and the Update key. The Update Key can be updated in numerous ways (including sending it across the wire with another set of Keys encrypting that message).

The modules support DNP3 Secure Authentication 5, using the Pre-Shared Key method for Key Changes. Thus, the Update Key needs to be entered into each device by means outside of the DNP3 protocol.

In the PLX50 Configuration Utility the user can write the Update Key into the module using the Key tab in the Online Status window. The key entered must match the Key Wrap Algorithm selected. Thus, if AES-128 Key Wrap was selected the Update Key must be 128-bit (16 bytes) long. If AES-256 Key Wrap was selected the Update Key must be 256-bit (32 bytes) long. The user can either enter a predetermined hexadecimal code of create a new code in the PLX50 Configuration Utility as shown below. This key is encrypted and sent to the module where it is saved into the NV memory of the module.

Important: The Key update method in the PLX50 Configuration Utility is a **write-only** function. Once the key has been downloaded the user will not be able to view the key again. The user must make provision to document or save the key in a secure manner.

Important: The DNP3 master device must have the same Update Key and security configuration settings as that of the module. Failing to do this will result in failed data exchange for critical messages.

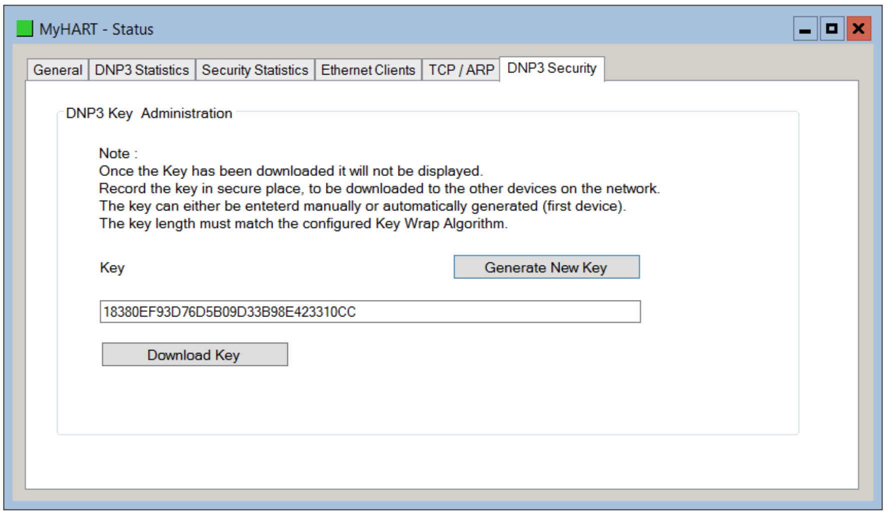


Figure 4.11 - HART 4 DNP3 key update method.

The module supports all DNP3 MAC algorithms and Key Wrap algorithms. The module also supports Aggressive Authentication mode which reduces the amount of traffic on the network (which could be required on busy networks or serial communication).

4.3 Modbus TCP/IP Operation

The Modbus TCP/IP operation is enabled when the configuration protocol is set to Modbus TCP/IP. The module will then operate as a Modbus TCP/IP Server supporting the following Modbus registers for the main device.

Table 4.14 - Modbus Register Map

Register Type:	**Holding Registers**						
Parameter	Byte Length	Date Type	Register				
			General	Channel 0	Channel 1	Channel 2	Channel 3
Module Status Bit 0 – Configuration Valid Bit 1 – Channel 0 Enabled Bit 2 – Channel 1 Enabled Bit 3 – Channel 2 Enabled Bit 4 – Channel 3 Enabled Bit 5 – Channel 0 HART Enabled Bit 6 – Channel 1 HART Enabled Bit 7 – Channel 2 HART Enabled Bit 8 – Channel 3 HART Enabled	2	INT	0	-	-	-	-
Channel 0 Live List When using Multidrop functionality this will indicate which of the configured devices are online. Note that each bit represents the configured Multidrop Device Index (see the Multidrop configuration in the Advanced Mapping section). Example: If bit 3 is set, then Multidrop device at MD 3 is online (for the specific channel).	2	INT	2	-	-	-	-
Channel 1 Live List When using Multidrop functionality this will indicate which of the configured devices are online. Note that each bit represents the configured Multidrop Device Index (see the Multidrop configuration in the Advanced Mapping section). Example: If bit 3 is set, then Multidrop device at MD 3 is online (for the specific channel).	2	INT	4	-	-	-	-

Channel 2 Live List When using Multidrop functionality this will indicate which of the configured devices are online. Note that each bit represents the configured Multidrop Device Index (see the Multidrop configuration in the Advanced Mapping section). Example: If bit 3 is set, then Multidrop device at MD 3 is online (for the specific channel).	2	INT	6	-	-	-	-
Channel 3 Live List When using Multidrop functionality this will indicate which of the configured devices are online. Note that each bit represents the configured Multidrop Device Index (see the Multidrop configuration in the Advanced Mapping section). Example: If bit 3 is set, then Multidrop device at MD 3 is online (for the specific channel).	2	INT	8	-	-	-	-
Modbus Statistics							
Rx Packet Count	4	DINT	20	-	-	-	-
Tx Packet Count	4	DINT	22	-	-	-	-
Checksum Errors	4	DINT	24	-	-	-	-
Timeouts	4	DINT	26	-	-	-	-
Device Info							
Manufacturer ID	1	BYTE	-	100	200	300	400
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	101	201	301	401
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	102	202	302	402
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	103	203	303	403
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	104	204	304	404
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	106	206	306	406
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	108	208	308	408
Sensor Lower Limit	4	REAL	-	110	210	310	410
Sensor Minimum Span	4	REAL	-	112	212	312	412
Tag	8	BYTE[8]	-	114	214	314	414
Descriptor	16	BYTE[16]	-	118	218	318	418

Date	3	BYTE[3]	-	126	226	326	426
HART Statistics							
HART Tx Count	4	DINT	-	500	550	600	650
HART Rx Count	4	DINT	-	502	552	602	652
Communication Errors	4	DINT	-	504	554	604	654
Command Errors	4	DINT	-	506	556	606	656
Parity Errors	4	DINT	-	508	558	608	658
Output Data - **Note: These are Write-Only Registers**							
Output Process Variable. Range: 1 to 100. This variable is in Engineering Units and the format is in Little Endian.	4	REAL	-	800	850	900	950
HART channel command - **Note: These are Write-Only Registers**							
HART communication inhibit. When set to 1 the HART communication on the specific channel will be inhibited.	2	INT	-	820	870	920	970

Register Type:	**Input Registers**						
Parameter	Byte Length	Date Type	Register				
			General	Channel 0	Channel 1	Channel 2	Channel 3
Device Process Variables							
Raw current	4	REAL	-	0	100	200	300
Scaled Value	4	REAL	-	2	102	202	302
Digital current	4	REAL	-	4	104	204	304
PV	4	REAL	-	6	106	206	306
SV	4	REAL	-	8	108	208	308
TV	4	REAL	-	10	110	210	310
FV	4	REAL	-	12	112	212	312
PV units code	1	SINT	-	14	114	214	314
SV units code	1	SINT	-				
TV units code	1	SINT	-	15	115	215	315
FV units code	1	SINT	-				
Device Status							

Device Status **Bit 0 – LoopOpen** Loop open circuit detected. (Current < 3.6 mA) **Bit 1 – CurrentUnderrange** Loop current under range. (Current < 3.8 mA) **Bit 2 – CurrentOverrange** Loop current over range. (Current > 20.5 mA) **Bit 3 – LoopShorted** Loop short circuit detected. (Current > 21.0 mA) **Bit 4 – CalibrationBusy** Analog current calibration busy. **Bit 5 – CalibrationFaulted** Analog calibration failed. **Bit 6 – HARTCommsFault** HART communication failure. **Bit 7 – RelayMessagesInhibited** Relay HART messages inhibited, set in configuration. This prevents DTM and other class 2 communications.	1	BYTE	-	400	500	600	700
Reserved	1	BYTE	-				
HART Status See section 7.2 HART Response Status for information regarding the HART Response Status	2	INT	-	401	501	601	701
Device Specific Status 0	6	BYTE[6]	-	402	502	602	702
Operational Modes	2	BYTE[2]	-	405	505	605	705
Standardized Status 0	1	BYTE	-	406	506	606	706
Standardized_status1	1	BYTE	-				
Analog channel saturated	1	BYTE	-	407	507	607	707
Standardized_status2	1	BYTE	-				
Standardized_status3	1	BYTE	-	408	508	608	708
Analog channel fixed	1	BYTE	-				
Device Specific Status 1	11	BYTE[11]	-	409	509	609	709

4.3.1 *Multidrop*

When multidrop is being used for HART devices the data from each device will automatically be updated to the specific Multidrop Device Index (MD). The table below indicates the Modbus location for the associated data.

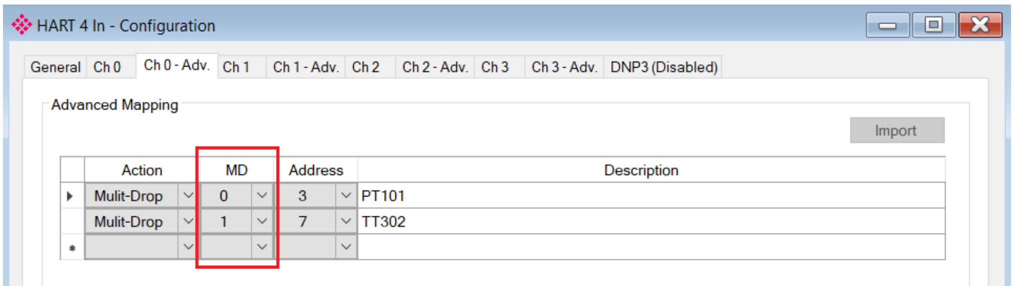


Figure 4.12 - Setting Multidrop Device Index

Table 4.15 - Modbus Multidrop Register Map

Register Type:	**Holding Registers**						
Parameter	Byte Length	Date Type	Register				
			General	Channel 0	Channel 1	Channel 2	Channel 3
Multidrop Device Index (MD) - 0							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1000	2000	3000	4000
Manufacturer ID	1	BYTE	-	1001	2001	3001	4001
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1002	2002	3002	4002
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1003	2003	3003	4003
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1004	2004	3004	4004
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	1005	2005	3005	4005
Pad Byte	1	BYTE	-				
Preamble Response	1	BYTE	-	1007	2007	3007	4007
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1008	2008	3008	4008
Extended Device Status	1	BYTE	-	1009	2009	3009	4009
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1010	2010	3010	4010
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1012	2012	3012	4012
Sensor Lower Limit	4	REAL	-	1014	2014	3014	4014
Sensor Minimum Span	4	REAL	-	1016	2016	3016	4016
Tag	8	BYTE[8]	-	1018	2018	3018	4018

Descriptor	16	BYTE[16]	-	1022	2022	3022	4022
Date	3	BYTE[3]	-	1030	2030	3030	4030
Multidrop Device Index (MD) - 1							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1100	2100	3100	4100
Manufacturer ID	1	BYTE	-	1101	2101	3101	4101
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1102	2102	3102	4102
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1103	2103	3103	4103
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1104	2104	3104	4104
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	1105	2105	3105	4105
Pad Byte	1	BYTE	-				
Preamble Response	1	BYTE	-	1107	2107	3107	4107
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1108	2108	3108	4108
Extended Device Status	1	BYTE	-	1109	2109	3109	4109
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1110	2110	3110	4110
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1112	2112	3112	4112
Sensor Lower Limit	4	REAL	-	1114	2114	3114	4114
Sensor Minimum Span	4	REAL	-	1116	2116	3116	4116
Tag	8	BYTE[8]	-	1118	2118	3118	4118
Descriptor	16	BYTE[16]	-	1122	2122	3122	4122
Date	3	BYTE[3]	-	1130	2130	3130	4130
Multidrop Device Index (MD) – 2							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1200	2200	3200	4200
Manufacturer ID	1	BYTE	-	1201	2201	3201	4201
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1202	2202	3202	4202
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1203	2203	3203	4203
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1204	2204	3204	4204
Device Function Flags	1	BYTE	-				

Device ID Number	3	BYTE[3]	-	1205	2205	3205	4205
Pad Byte	1	BYTE	-				
Preamble Response	1	BYTE	-	1207	2207	3207	4207
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1208	2208	3208	4208
Extended Device Status	1	BYTE	-	1209	2209	3209	4209
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1210	2210	3210	4210
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1212	2212	3212	4212
Sensor Lower Limit	4	REAL	-	1214	2214	3214	4214
Sensor Minimum Span	4	REAL	-	1216	2216	3216	4216
Tag	8	BYTE[8]	-	1218	2218	3218	4218
Descriptor	16	BYTE[16]	-	1222	2222	3222	4222
Date	3	BYTE[3]	-	1230	2230	3230	4230
Multidrop Device Index (MD) – 3							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1300	2300	3300	4300
Manufacturer ID	1	BYTE	-	1301	2301	3301	4301
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1302	2302	3302	4302
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1303	2303	3303	4303
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1304	2304	3304	4304
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	1305	2305	3305	4305
Pad Byte	1	BYTE	-				
Preamble Response	1	BYTE	-	1307	2307	3307	4307
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1308	2308	3308	4308
Extended Device Status	1	BYTE	-	1309	2309	3309	4309
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1310	2310	3310	4310
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1312	2312	3312	4312
Sensor Lower Limit	4	REAL	-	1314	2314	3314	4314
Sensor Minimum Span	4	REAL	-	1316	2316	3316	4316
Tag	8	BYTE[8]	-	1318	2318	3318	4318
Descriptor	16	BYTE[16]	-	1322	2322	3322	4322
Date	3	BYTE[3]	-	1330	2330	3330	4330

Multidrop Device Index (MD) – 4							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1400	2400	3400	4400
Manufacturer ID	1	BYTE	-	1401	2401	3401	4401
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1402	2402	3402	4402
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1403	2403	3403	4403
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1404	2404	3404	4404
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	1405	2405	3405	4405
Pad Byte	1	BYTE	-				
Preamble Response	1	BYTE	-	1407	2407	3407	4407
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1408	2408	3408	4408
Extended Device Status	1	BYTE	-	1409	2409	3409	4409
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1410	2410	3410	4410
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1412	2412	3412	4412
Sensor Lower Limit	4	REAL	-	1414	2414	3414	4414
Sensor Minimum Span	4	REAL	-	1416	2416	3416	4416
Tag	8	BYTE[8]	-	1418	2418	3418	4418
Descriptor	16	BYTE[16]	-	1422	2422	3422	4422
Date	3	BYTE[3]	-	1430	2430	3430	4430
Multidrop Device Index (MD) - 5							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1500	2500	3500	4500
Manufacturer ID	1	BYTE	-	1501	2501	3501	4501
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1502	2502	3502	4502
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1503	2503	3503	4503
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1504	2504	3504	4504
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	1505	2505	3505	4505
Pad Byte	1	BYTE	-				

Preamble Response	1	BYTE	-	1507	2507	3507	4507
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1508	2508	3508	4508
Extended Device Status	1	BYTE	-	1509	2509	3509	4509
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1510	2510	3510	4510
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1512	2512	3512	4512
Sensor Lower Limit	4	REAL	-	1514	2514	3514	4514
Sensor Minimum Span	4	REAL	-	1516	2516	3516	4516
Tag	8	BYTE[8]	-	1518	2518	3518	4518
Descriptor	16	BYTE[16]	-	1522	2522	3522	4522
Date	3	BYTE[3]	-	1530	2530	3530	4530
Multidrop Device Index (MD) – 6							
Poll Status **Bit 0 – Online** When set this bit will indicate that the device is online	2	INT		1600	2600	3600	4600
Manufacturer ID	1	BYTE	-	1601	2601	3601	4601
Mfg Device Type Code	1	BYTE	-				
Number of Preambles Required	1	BYTE	-	1602	2602	3602	4602
Universal Command Rev	1	BYTE	-				
Device Specific Command Rev	1	BYTE	-	1603	2603	3603	4603
Software Rev	1	BYTE	-				
Hardware Rev	1	BYTE	-	1604	2604	3604	4604
Device Function Flags	1	BYTE	-				
Device ID Number	3	BYTE[3]	-	1605	2605	3605	4605
Pad Byte	1	BYTE	-				
Preamble Response	1	BYTE	-	1607	2607	3607	4607
Max Number of Device Vars	1	BYTE	-				
Config Change Count	2	INT	-	1608	2608	3608	4608
Extended Device Status	1	BYTE	-	1609	2609	3609	4609
Pad Byte	1	BYTE	-				
Sensor Serial Number	3	BYTE[3]	-	1610	2610	3610	4610
Units Code for Sensor	1	BYTE	-				
Sensor Upper Limit	4	REAL	-	1612	2612	3612	4612
Sensor Lower Limit	4	REAL	-	1614	2614	3614	4614
Sensor Minimum Span	4	REAL	-	1616	2616	3616	4616
Tag	8	BYTE[8]	-	1618	2618	3618	4618
Descriptor	16	BYTE[16]	-	1622	2622	3622	4622
Date	3	BYTE[3]	-	1630	2630	3630	4630

Register Type:	**Input Registers**		
Parameter			Register

	Byte Length	Date Type	General	Channel 0	Channel 1	Channel 2	Channel 3
Multidrop Device Index (MD) - 0							
PV	4	REAL	-	1000	2000	3000	4000
SV	4	REAL	-	1002	2002	3002	4002
TV	4	REAL	-	1004	2004	3004	4004
FV	4	REAL	-	1006	2006	3006	4006
PV units code	1	SINT	-	1008	2008	3008	4008
SV units code	1	SINT	-				
TV units code	1	SINT	-	1009	2009	3009	4009
FV units code	1	SINT	-				
Multidrop Device Index (MD) - 1							
PV	4	REAL	-	1100	2100	3100	4100
SV	4	REAL	-	1102	2102	3102	4102
TV	4	REAL	-	1104	2104	3104	4104
FV	4	REAL	-	1106	2106	3106	4106
PV units code	1	SINT	-	1108	2108	3108	4108
SV units code	1	SINT	-				
TV units code	1	SINT	-	1109	2109	3109	4109
FV units code	1	SINT	-				
Multidrop Device Index (MD) - 2							
PV	4	REAL	-	1200	2200	3200	4200
SV	4	REAL	-	1202	2202	3202	4202
TV	4	REAL	-	1204	2204	3204	4204
FV	4	REAL	-	1206	2206	3206	4206
PV units code	1	SINT	-	1208	2208	3208	4208
SV units code	1	SINT	-				
TV units code	1	SINT	-	1209	2209	3209	4209
FV units code	1	SINT	-				
Multidrop Device Index (MD) - 3							
PV	4	REAL	-	1300	2300	3300	4300
SV	4	REAL	-	1302	2302	3302	4302
TV	4	REAL	-	1304	2304	3304	4304
FV	4	REAL	-	1306	2306	3306	4306
PV units code	1	SINT	-	1308	2308	3308	4308
SV units code	1	SINT	-				
TV units code	1	SINT	-	1309	2309	3309	4309
FV units code	1	SINT	-				
Multidrop Device Index (MD) - 4							
PV	4	REAL	-	1400	2400	3400	4400
SV	4	REAL	-	1402	2402	3402	4402
TV	4	REAL	-	1404	2404	3404	4404
FV	4	REAL	-	1406	2406	3406	4406
PV units code	1	SINT	-	1408	2408	3408	4408
SV units code	1	SINT	-				
TV units code	1	SINT	-	1409	2409	3409	4409

FV units code	1	SINT	-				
Multidrop Device Index (MD) - 5							
PV	4	REAL	-	1500	2500	3500	4500
SV	4	REAL	-	1502	2502	3502	4502
TV	4	REAL	-	1504	2504	3504	4504
FV	4	REAL	-	1506	2506	3506	4506
PV units code	1	SINT	-	1508	2508	3508	4508
SV units code	1	SINT	-				
TV units code	1	SINT	-	1509	2509	3509	4509
FV units code	1	SINT	-				
Multidrop Device Index (MD) - 6							
PV	4	REAL	-	1600	2600	3600	4600
SV	4	REAL	-	1602	2602	3602	4602
TV	4	REAL	-	1604	2604	3604	4604
FV	4	REAL	-	1606	2606	3606	4606
PV units code	1	SINT	-	1608	2608	3608	4608
SV units code	1	SINT	-				
TV units code	1	SINT	-	1609	2609	3609	4609
FV units code	1	SINT	-				

4.3.2 HART Custom Command

The module supports sending custom HART commands to a field device. See the *Advanced Mapping setup* section for more details regarding the Custom Command parameters. When adding a custom HART command (with a Modbus TCP/IP interface), offset parameters will need to be configured for the Modbus Holding Registers.

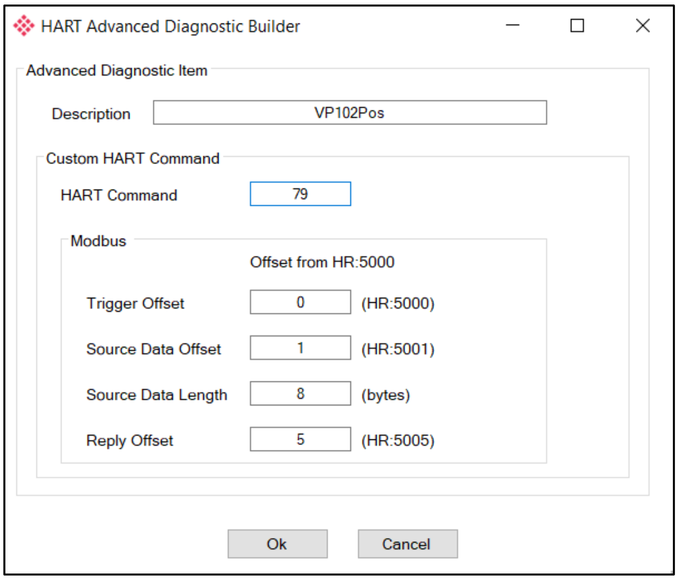


Figure 4.13 – Custom HART Command Builder Mapping (for Modbus TCP/IP)

Each HART channel is allowed up to 500 bytes of mapping data for custom HART commands. The custom HART command Modbus Holding Register range for each HART channel is shown below:

Table 4.16 – Custom HART Data Modbus Ranges

HART Channel	Modbus HR Range
0	HR 5000 – HR 5249
1	HR 5250 – HR 5499
2	HR 5500 – HR 5749
3	HR 5750 – HR 5999

Each Custom HART command requires four mapping parameters in addition to the HART command:

Table 4.17 – Custom HART command build parameters

Modbus Parameter	Description
Trigger Offset	The Trigger Offset parameter is the Modbus HR offset in the Modbus HR range (for the specific HART channel) for the trigger of the HART custom message. For example, if the trigger offset entered is 5 and the custom HART command is on HART channel 0, then the message trigger will be at Modbus HR 5005 (HR 5000 *for HART channel 0* + offset HR 5). If the trigger offset entered is 10 and the custom HART command is on HART channel 1, then the message trigger will be at Modbus HR 5260 (HR 5250 *for HART channel 1* + offset HR 10). The trigger parameter is used to trigger the start of the custom HART message execution. Each time the trigger Modbus HR is changed to a value different from the previous value, it will send the custom HART command. **Note:** Changing the trigger to value 0 will not trigger the custom HART command.

Source Data Offset	The source data offset parameter is the location in the Modbus HR range where the HART data to be sent is stored. For example, if the source data offset entered is 20 and the custom HART commands is on HART channel 0, then the HART message data to be sent will start at Modbus HR 5020 (HR 5000 *for HART channel 0* + offset HR 20).
Source Data Length	This is the length of the HART data to be sent in bytes.
Reply Offset	The reply offset parameter is the location in the Modbus HR range where the HART data returned (from the custom HART command) is stored. For example, if the reply offset entered is 40 and the custom HART commands are on HART channel 1, then the HART message data returned will start at Modbus HR 5290 (HR 5250 *for HART channel 1* + offset HR 40). See the Custom HART message operation section for details regarding the format of the reply data.

The reply data format (written to the Reply Offset Modbus Holding Register location) is shown below:

Table 4.18 – Modbus Custom HART command Reply format

Modbus Holding Register Offset	**Description**
Reply Offset + 0	**Status** Once the custom HART message transaction has completed, it will update the status field in the UDT to indicate the status of the transaction. 0 – Success 1 – Response Timeout 2 – HART device offline 3 – No Multidrop Device configured
Reply Offset + 1	**Last Trigger Value** This is the last trigger value (read back from the trigger register) that was updated when the message was executed. **Note**: When the trigger value is zero the message will **not** execute even though the last trigger value in this register will be updated.
Reply Offset + 2	**Replay Data Size** The number of bytes returned from the HART custom command.
Reply Offset + 3	**Reply Data** The reply data from the HART custom command. The number of bytes returned will equal the previous parameter *Reply Data Size*.

4.4 PCCC Operation

The PCCC operation is enabled when the configuration protocol is set to ***SLC 500 / MicroLogix / PLC5***. The module will then operate as a PCCC (AB-ETH) Slave allowing SLC500, MicroLogix, and PLC5 controllers to read and write data to the HART devices.

> **Important**: Only ***SLC Typed Read*** and ***SLC Typed Write*** commands are supported by the PLX51-HART-4x when operating in PCCC mode.

The following PLC Files are supported by the main device.

Table 4.19 – PLC File Map

Parameter	**Files**			
	Channel 0	**Channel 1**	**Channel 2**	**Channel 3**
Integers				
Device Status *Bit 0 - Loop Open/Current output fault* *Bit 1 - Current Underrange/reserved* *Bit 2 - Current Overrange/reserved* *Bit 3 - Loop Shorted/reserved* *Bit 4 - Calibration Busy* *Bit 5 - Calibration Failed* *Bit 6 - HART Comms Fault* *Bit 7 - Relay Message Inhibit*	N10:0	N11:0	N12:0	N13:0
HART Status *See the HART section at the end of the document for information regarding the HART status.*	N10:1	N11:1	N12:1	N13:1
Live List *When using Multidrop functionality this will indicate which of the devices that have been configured are online. Note that each bit represents the configured Multidrop Device Index (see the Multidrop configuration in the Advanced Mapping section).* *For example, if bit 3 is set, then Multidrop device at MD 3 is online (for the specific channel).*	N10:2	N11:2	N12:2	N13:2
Manufacturer ID	N10:3	N11:3	N12:3	N13:3
Device ID	N10:4	N11:4	N12:4	N13:4
PV Unit	N10:5	N11:5	N12:5	N13:5
SV Unit	N10:6	N11:6	N12:6	N13:6
TV Unit	N10:7	N11:7	N12:7	N13:7
FV Unit	N10:8	N11:8	N12:8	N13:8

HART Comms Inhibit *When set to 1 the HART communication for the specific HART channel will be inhibited.*	N10:59	N11:59	N12:59	N13:59
Floats				
PV Value	F20:0	F21:0	F22:0	F23:0
SV Value	F20:1	F21:1	F22:1	F23:1
TV Value	F20:2	F21:2	F22:2	F23:2
FV Value	F20:3	F21:3	F22:3	F23:3
Analog Value	F20:4	F21:4	F22:4	F23:4
Scaled Value	F20:5	F21:5	F22:5	F23:5
Digital Current	F20:6	F21:6	F22:6	F23:6

Note: With a HART output device (when using the PLX51-HART-4O), the user will need to write to the ***Scaled Value*** to update the analog signal being sent to the output HART device.

4.4.1 Multidrop

When multidrop is being used for HART devices the data from each device will automatically be updated to the specific Multidrop Device Index (MD). See below where the MD is set for each HART device for each HART channel.

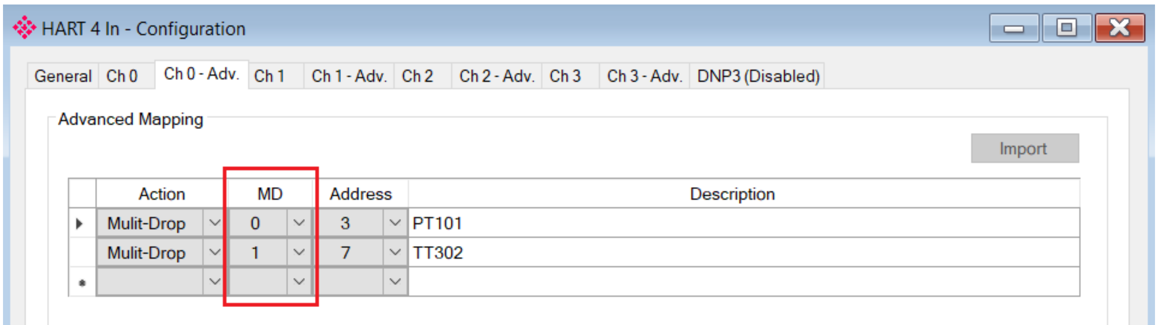


Figure 4.14 - Setting Multidrop Device Index

Table 4.20 – PLC File Map for Multidrop HART devices

Parameter	Files			
	Channel 0	**Channel 1**	**Channel 2**	**Channel 3**
Integers				
Multidrop Device Index (MD) - 0				
Poll Status Bit 0 – When set this bit will indicate that the device is online	N10:10	N11:10	N12:10	N13:10
Manufacturer ID	N10:11	N11:11	N12:11	N13:11
Device ID	N10:12	N11:12	N12:12	N13:12
PV Unit	N10:13	N11:13	N12:13	N13:13
SV Unit	N10:14	N11:14	N12:14	N13:14

TV Unit	N10:15	N11:15	N12:15	N13:15
FV Unit	N10:16	N11:16	N12:16	N13:16
Multidrop Device Index (MD) - 1				
Poll Status Bit 0 – When set this bit will indicate that the device is online	N10:17	N11:17	N12:17	N13:17
Manufacturer ID	N10:18	N11:18	N12:18	N13:18
Device ID	N10:19	N11:19	N12:19	N13:19
PV Unit	N10:20	N11:20	N12:20	N13:20
SV Unit	N10:21	N11:21	N12:21	N13:21
TV Unit	N10:22	N11:22	N12:22	N13:22
FV Unit	N10:23	N11:23	N12:23	N13:23
Multidrop Device Index (MD) - 2				
Poll Status *Bit 0 – When set this bit will indicate that the device is online*	N10:24	N11:24	N12:24	N13:24
Manufacturer ID	N10:25	N11:25	N12:25	N13:25
Device ID	N10:26	N11:26	N12:26	N13:26
PV Unit	N10:27	N11:27	N12:27	N13:27
SV Unit	N10:28	N11:28	N12:28	N13:28
TV Unit	N10:29	N11:29	N12:29	N13:29
FV Unit	N10:30	N11:30	N12:30	N13:30
Multidrop Device Index (MD) - 3				
Poll Status Bit 0 – When set this bit will indicate that the device is online	N10:31	N11:31	N12:31	N13:31
Manufacturer ID	N10:32	N11:32	N12:32	N13:32
Device ID	N10:33	N11:33	N12:33	N13:33
PV Unit	N10:34	N11:34	N12:34	N13:34
SV Unit	N10:35	N11:35	N12:35	N13:35
TV Unit	N10:36	N11:36	N12:36	N13:36
FV Unit	N10:37	N11:37	N12:37	N13:37
Multidrop Device Index (MD) - 4				
Poll Status Bit 0 – When set this bit will indicate that the device is online	N10:38	N11:38	N12:38	N13:38
Manufacturer ID	N10:39	N11:39	N12:39	N13:39
Device ID	N10:40	N11:40	N12:40	N13:40
PV Unit	N10:41	N11:41	N12:41	N13:41
SV Unit	N10:42	N11:42	N12:42	N13:42
TV Unit	N10:43	N11:43	N12:43	N13:43

FV Unit	N10:44	N11:44	N12:44	N13:44
Multidrop Device Index (MD) - 5				
Poll Status Bit 0 – When set this bit will indicate that the device is online	N10:45	N11:45	N12:45	N13:45
Manufacturer ID	N10:46	N11:46	N12:46	N13:46
Device ID	N10:47	N11:47	N12:47	N13:47
PV Unit	N10:48	N11:48	N12:48	N13:48
SV Unit	N10:49	N11:49	N12:49	N13:49
TV Unit	N10:50	N11:50	N12:50	N13:50
FV Unit	N10:51	N11:51	N12:51	N13:51
Multidrop Device Index (MD) - 6				
Poll Status Bit 0 – When set this bit will indicate that the device is online	N10:52	N11:52	N12:52	N13:52
Manufacturer ID	N10:53	N11:53	N12:53	N13:53
Device ID	N10:54	N11:54	N12:54	N13:54
PV Unit	N10:55	N11:55	N12:55	N13:55
SV Unit	N10:56	N11:56	N12:56	N13:56
TV Unit	N10:57	N11:57	N12:57	N13:57
FV Unit	N10:58	N11:58	N12:58	N13:58
Floats				
Multidrop Device Index (MD) - 0				
PV Value	F20:10	F21:10	F22:10	F23:10
SV Value	F20:11	F21:11	F22:11	F23:11
TV Value	F20:12	F21:12	F22:12	F23:12
FV Value	F20:13	F21:13	F22:13	F23:13
Multidrop Device Index (MD) - 1				
PV Value	F20:14	F21:14	F22:14	F23:14
SV Value	F20:15	F21:15	F22:15	F23:15
TV Value	F20:16	F21:16	F22:16	F23:16
FV Value	F20:17	F21:17	F22:17	F23:17
Multidrop Device Index (MD) - 2				
PV Value	F20:18	F21:18	F22:18	F23:18
SV Value	F20:19	F21:19	F22:19	F23:19
TV Value	F20:20	F21:20	F22:20	F23:20
FV Value	F20:21	F21:21	F22:21	F23:21
Multidrop Device Index (MD) – 3				
PV Value	F20:22	F21:22	F22:22	F23:22
SV Value	F20:23	F21:23	F22:23	F23:23
TV Value	F20:24	F21:24	F22:24	F23:24
FV Value	F20:25	F21:25	F22:25	F23:25

Multidrop Device Index (MD) - 4				
PV Value	F20:26	F21:26	F22:26	F23:26
SV Value	F20:27	F21:27	F22:27	F23:27
TV Value	F20:28	F21:28	F22:28	F23:28
FV Value	F20:29	F21:29	F22:29	F23:29
Multidrop Device Index (MD) - 5				
PV Value	F20:30	F21:30	F22:30	F23:30
SV Value	F20:31	F21:31	F22:31	F23:31
TV Value	F20:32	F21:32	F22:32	F23:32
FV Value	F20:33	F21:33	F22:33	F23:33
Multidrop Device Index (MD) - 6				
PV Value	F20:34	F21:34	F22:34	F23:34
SV Value	F20:35	F21:35	F22:35	F23:35
TV Value	F20:36	F21:36	F22:36	F23:36
FV Value	F20:37	F21:37	F22:37	F23:37

4.5 FTView Operation

The module supports direct EDS parameter access allowing FTView to directly read main and multidrop process variables.

4.5.1 Register EDS File

Before FTView can access the HART data from the module, the module's EDS file must be registered on that system.

There are multiple ways to achieve this. One of which is to right-click on the HART module in RSLinx Classic and select the ***Upload EDS file from device*** option.

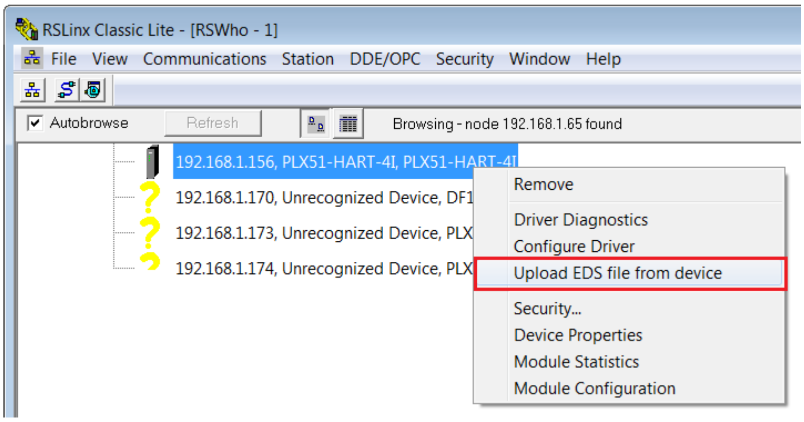


Figure 4.15 – Registering EDS file

This launches the Rockwell Automation EDS Wizard which will guide the user through the steps to complete the registration.

Figure 4.16 – EDS Registration wizard

4.5.2 Configure FTView Communication

Within the FTView environment, (either SE or ME,) using either a new or existing project ensures that the RSLinx Enterprise server has been added.

To add the RSLinx Enterprise communication server, right-click on the project server in the project tree and select the ***Add New Server*** option, and then the ***Rockwell Automation Device Server (RSLinx Enterprise)***.

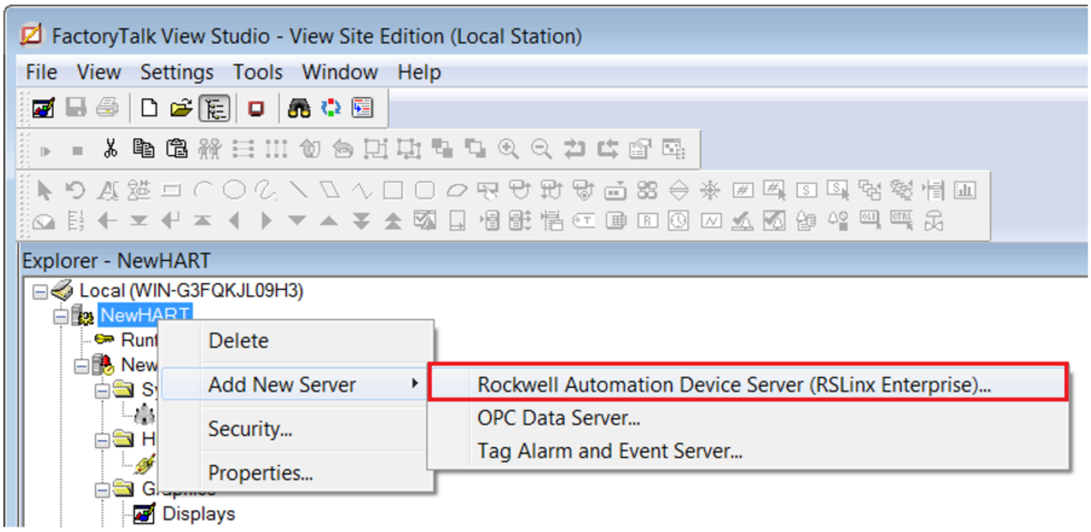


Figure 4.17 – Adding RSLinx Enterprise server

The ***RSLinx Enterprise Server Properties*** window will then open allowing additional configuration. All the default settings can be accepted.

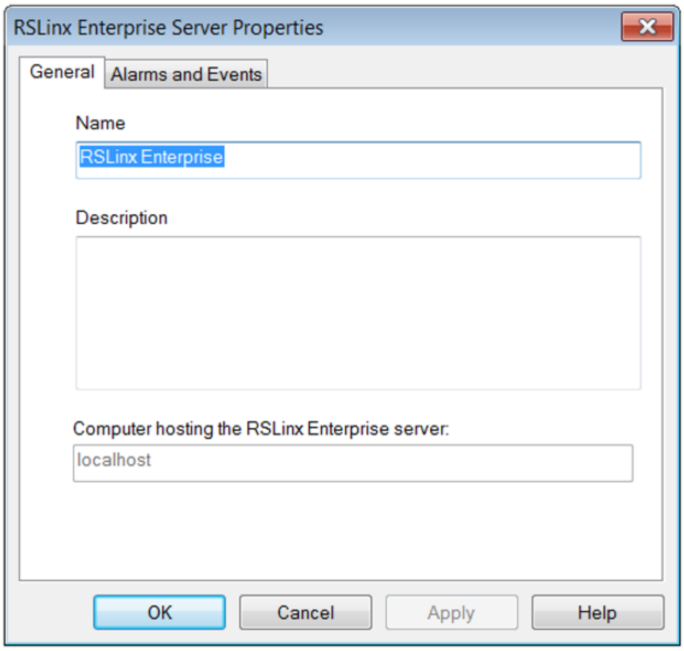


Figure 4.18 – Configuring RSLinx Enterprise

The ***RSLinx Enterprise*** item will then appear in the FTView project tree. Right-click on the ***Communication Setup*** option under this item.

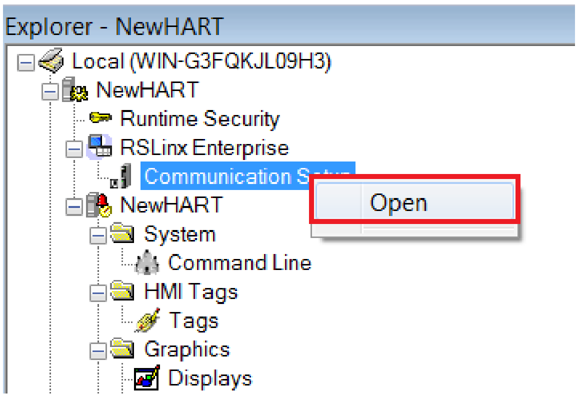


Figure 4.19 – Open Communication Setup

The ***Communication Setup*** window allows the user to associate a ***Device Shortcut*** to the physical module. This can be achieved by the following steps:

1 Under ***Device Shortcuts***, select the ***Add*** button.

2 Name the Device Shortcut, e.g. MyHART-4I

3 Set the Shortcut Type to EDS Parameter

4 On the right-hand side, navigate to, and select, the PLX51-HART module

5 Select the ***Apply*** button (under Device Shortcuts)

6 Select ***Ok***.

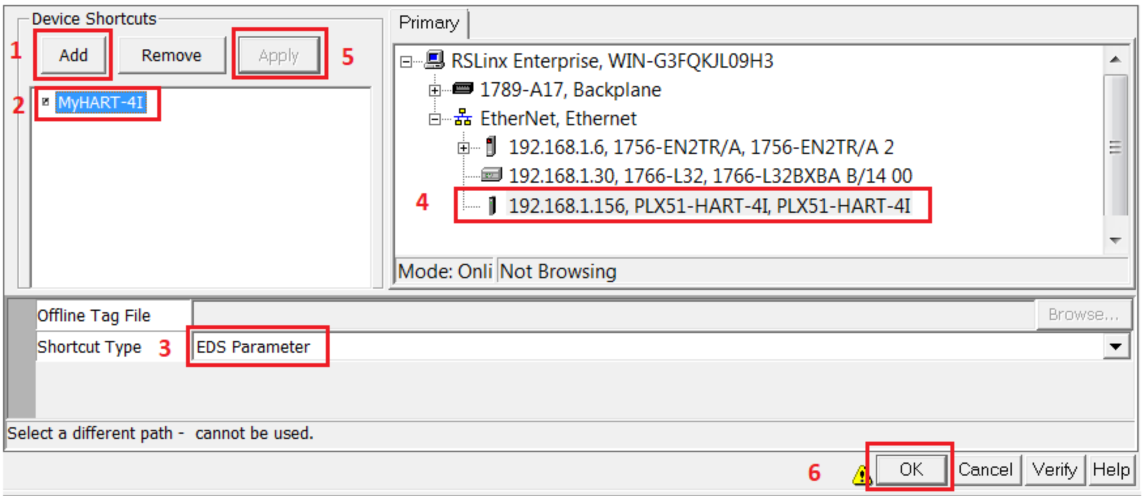


Figure 4.20 – Configuring communication shortcut

A warning, similar to the one below, will be shown. Select the ***Yes*** option to continue and accept the changes.

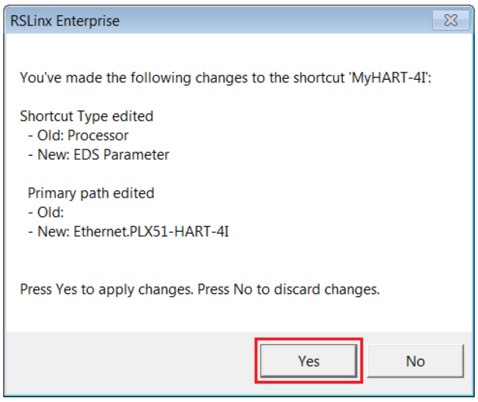


Figure 4.21 – Confirm RSLinx Enterprise shortcut

4.5.3 Displaying Process Variables

A ***Numeric Display*** can now be added to a FTView display to show a HART module parameter.

Open a new or existing display and using the menu or toolbar, add a ***Numeric Display*** object.

In the ***Numeric Display Properties*** window, select the ***Tags*** button.

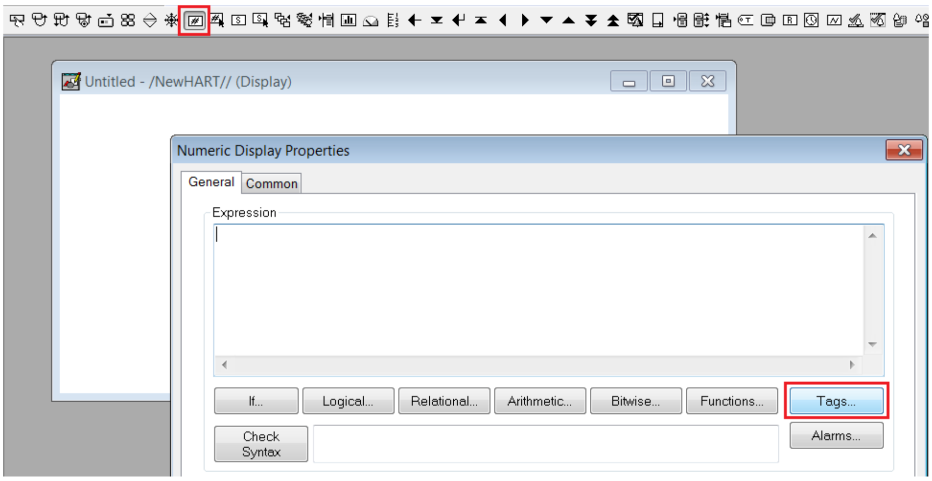


Figure 4.22 – Adding Numeric Display

The FTView ***Tag Browser*** will open. A refresh will be required the first time the ***Tag Browser*** is opened after any changes have been made to the communication setup. Right-click on the ***Folders*** tree on the left and select the ***Refresh All Folders*** option.

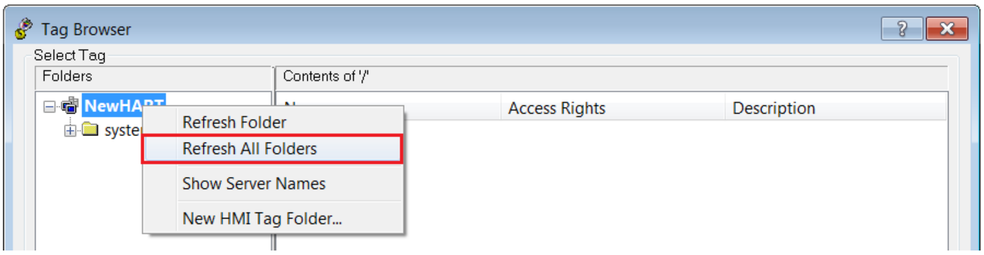


Figure 4.23 – Tag Browser – Refreshing All Folders

Once refreshed, all the HART module parameters will appear under the ***Offline*** section.

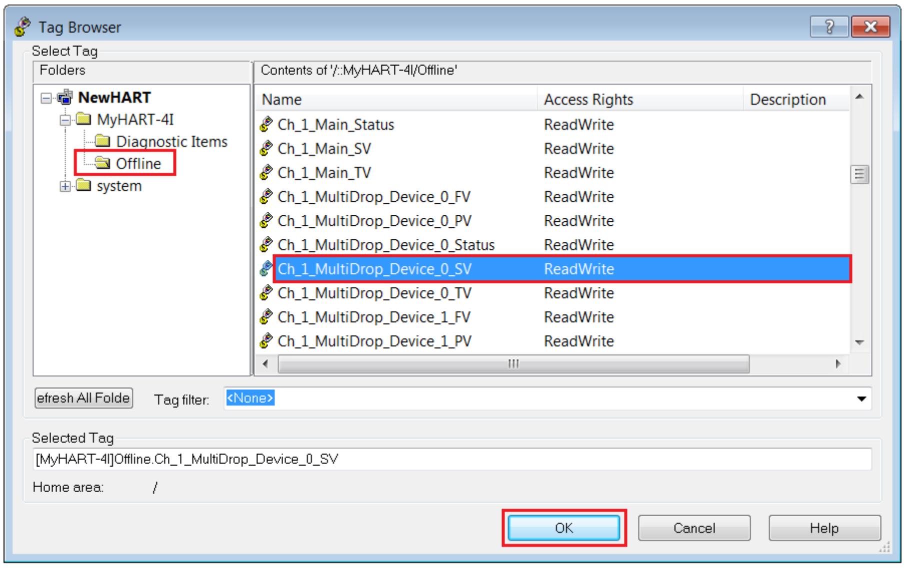


Figure 4.24 – Tag Browser – Select Tag

Select the required parameter (process variable or status) tag and press ***Ok***. The selected tag will appear in the Numeric Display's ***Expression*** textbox.

For a process variable, as in this example, it may be beneficial to set the format to ***Floating Point*** and select a suitable number of ***Decimal Places***.

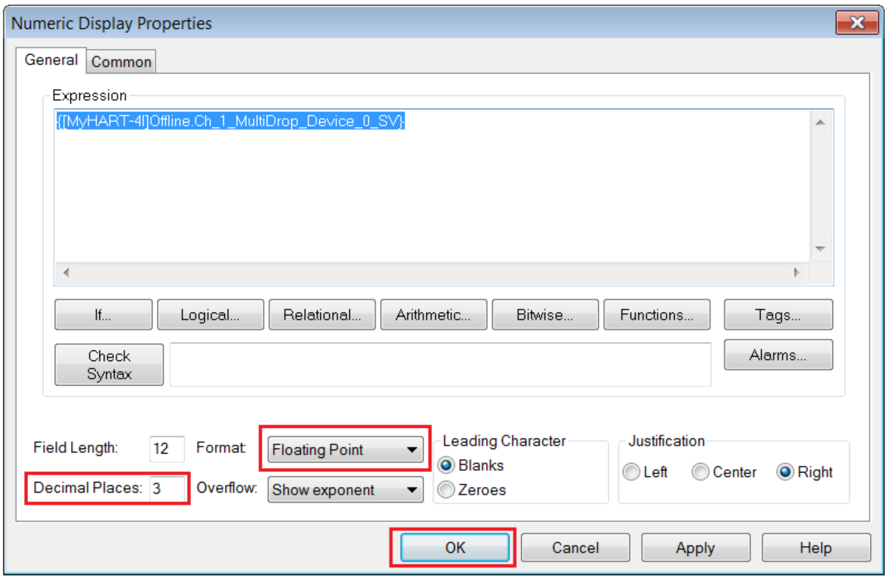


Figure 4.25 – Configure Numeric Display

The Numeric Display can be tested by using FTView's ***Test Display*** option. If the module is online and configured correctly, the selected parameter will be displayed.

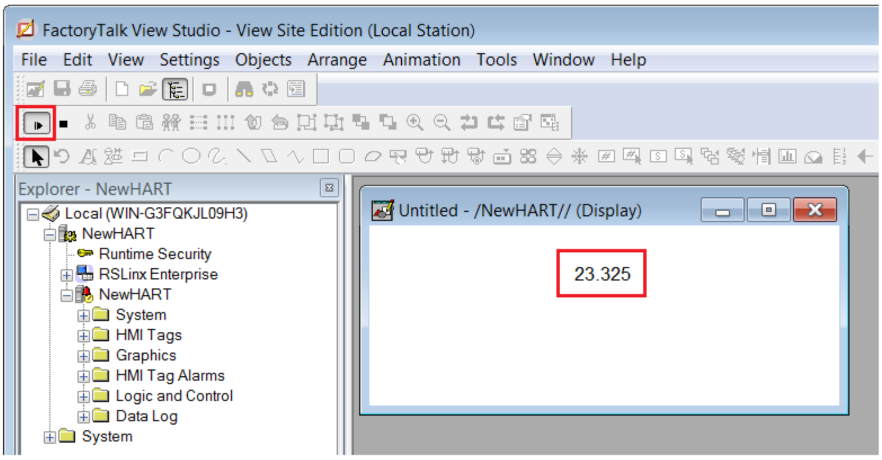


Figure 4.26 – Testing Display

5 Diagnostics

5.1 LEDs

The module provides six LEDs for diagnostics purposes as shown in the front view figure below.

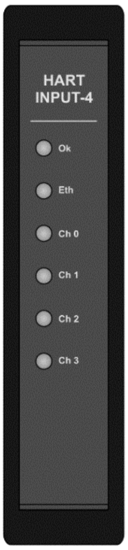


Figure 5.1 - Module front view

Table 5.1 - Module LED operation

LED	Description
Module	The module LED will provide information regarding the system-level operation of the module. Thus, if the LED is red then the module is not operating correctly. For example, if the module application firmware has been corrupted or there is a hardware fault the module will have a red Module LED. If the LED is green, then the module has booted and is running correctly.
Ethernet	The Ethernet LED will light up when an Ethernet link has been detected (by plugging in a connected Ethernet cable). The LED will flash when traffic is detected.
Channels (0-3)	Each channel LED represents the status of that specific analog channel. The LED will be green when the loop current is within the acceptable range (3.8 to 20.5 mA) and HART communication has been established to the field device. Otherwise, the LED will be red. The LED will flash green each time a HART response was received from the connected field device. If there was a HART communication error (e.g. checksum failure) then the LED will flash red. In a Multi-Drop Network, the LED will flash red when any HART device configured on that channel is no longer present. This is more visible when the main device (at the fixed address) is not connected, or when the fixed address for the main device entered does not correspond to any of the devices in the network.

5.2 Module Status Monitoring in the PLX50 Configuration Utility

The module can provide a range of statistics which can assist with module operation, maintenance, and fault finding. The statistics can be accessed in full by the PLX50 Configuration Utility or using the web server in the module.

To view the module's status in the PLX50 Configuration Utility environment, the module must be online. If the module is not already Online (following a recent configuration download), then right-click on the module and select the ***Go Online*** option.

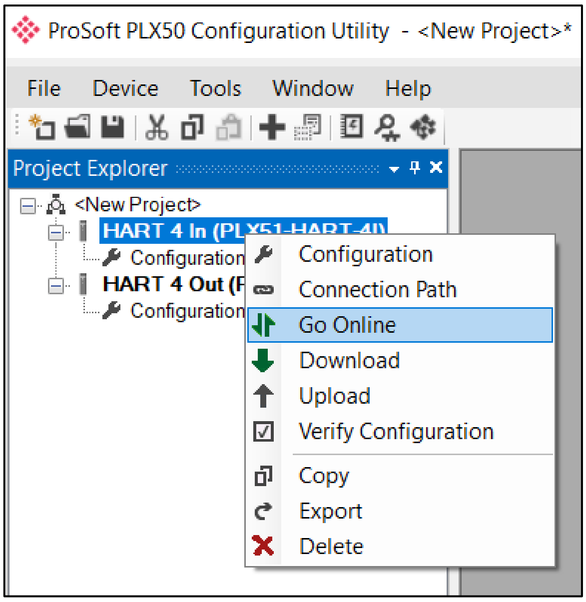


Figure 5.2 - Selecting to Go Online

The Online mode is indicated by the green circle behind the module in the ***Project Explorer*** tree.

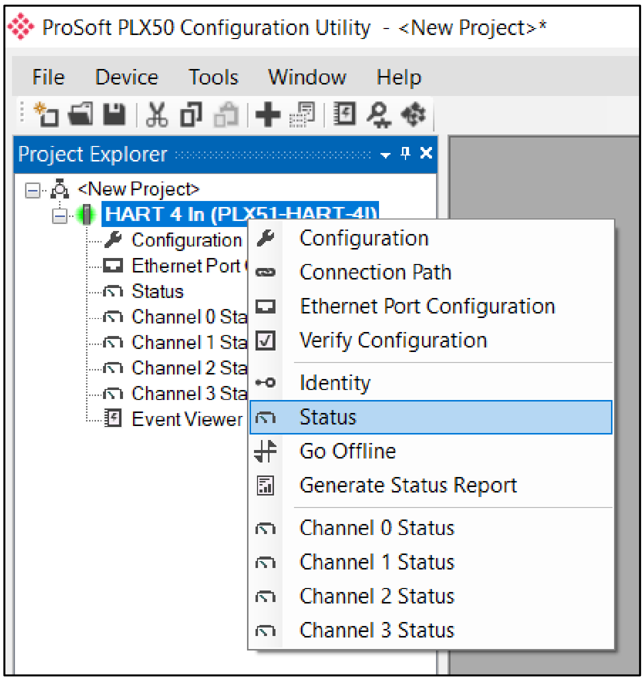


Figure 5.3 - Selecting online Status

The Status monitoring window can be opened by either double-clicking on the ***Status*** item in the ***Project Explorer*** tree, or by right-clicking on the module and selecting ***Status***.

The status window contains multiple tabs to display the status of the module. Most of these parameters in the status windows are self-explanatory or have been discussed in previous sections.

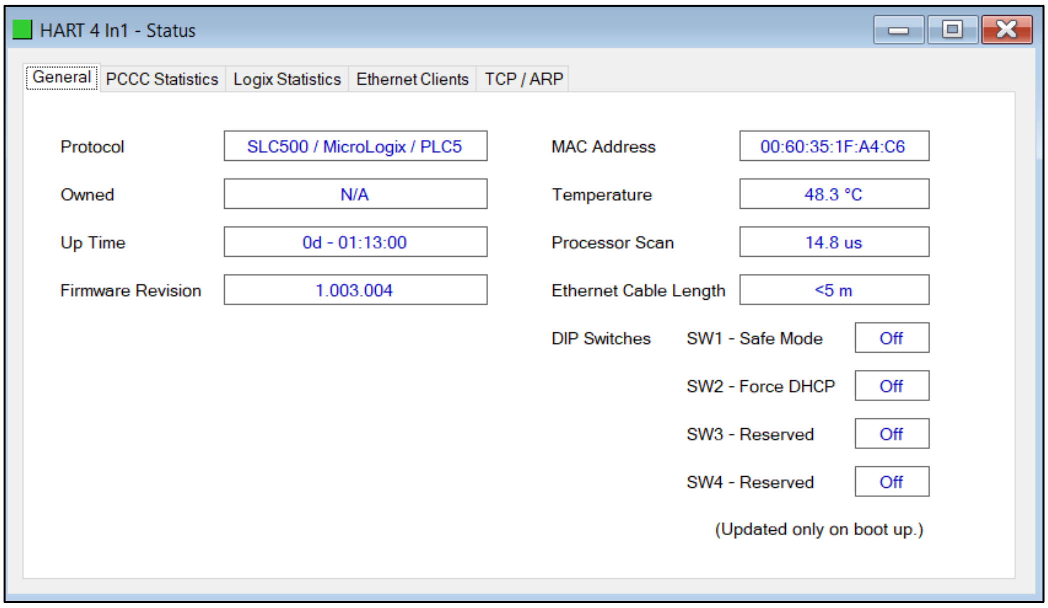


Figure 5.4 - Status monitoring – General

The General tab displays the following general parameters and can also be used to set the module time to the PC time:

Table 5.2 - Parameters displayed in the Status Monitoring – General Tab

Parameter	Description
Protocol	Indicates the current configured protocol: EtherNet/IP DNP3 TCP DNP3 UDP Modbus TCP/IP SLC500 / MicroLogix / PLC5 (PCCC)
Owned	Indicates whether the module is currently owned (Class 1) by a Logix controller.
Up Time	Indicates the elapsed time since the module was powered-up.
Firmware Revision	The current application firmware revision running.
MAC Address	Displays the module's unique Ethernet MAC address.
Temperature	The internal temperature of the module.
Processor Scan	The amount of time (microseconds) taken by the module's processor in the last scan.
Ethernet Cable Length	An estimate on the Ethernet cable length. (From the device to switch or media converter.) The accuracy is approximately 5m. A large discrepancy in this length may be indicative of an Ethernet cable issue.
DIP Switch Position	The status of the DIP switches when the module booted. Note that this status will not change if the DIP switches are altered when the module is running.

The subsequent Status tabs depend on the configured protocol.

5.2.1 EtherNet/IP Status

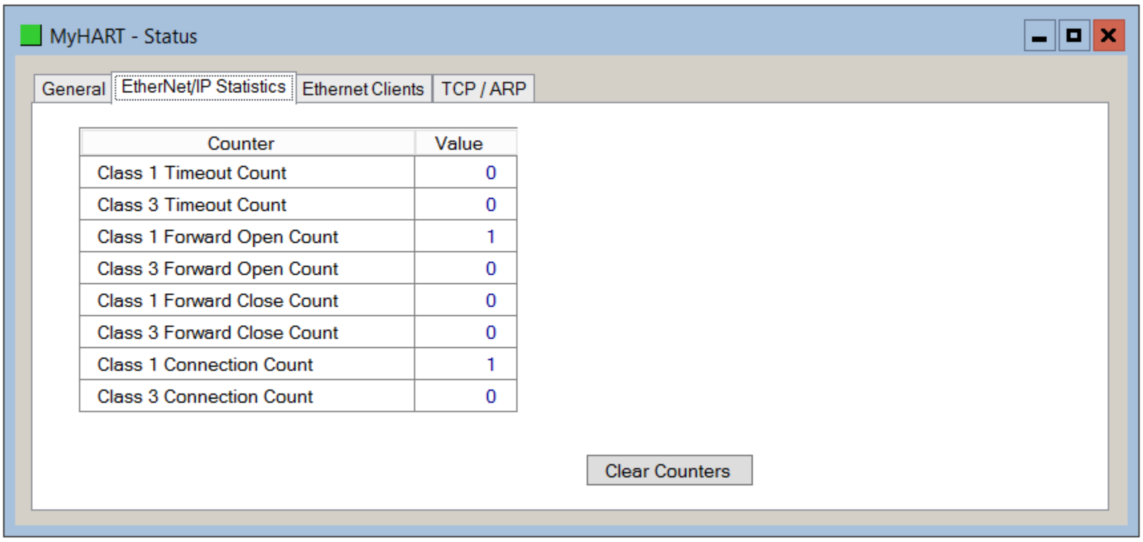


Figure 5.5 - EtherNet/IP Statistics

Table 5.3 - EtherNet/IP Statistics

Statistic	Description
Class 1 Timeout Count	The number of Class 1 connections closed due to Timeouts.
Class 3 Timeout Count	The number of Class 3 connections closed due to Timeouts.
Class 1 Forward Open Count	The number of Class 1 Forward Open (connection establishment) messages sent.
Class 3 Forward Open Count	The number of Class 3 Forward Open (connection establishment) messages sent.
Class 1 Forward Close Count	The number of Class 1 Forward Close (connection termination) messages sent.
Class 3 Forward Close Count	The number of Class 3 Forward Close (connection termination) messages sent.
Class 1 Connection Count	The current number of active Class 1 connections.
Class 3 Connection Count	The current number of active Class 3 connections.

5.2.2 Logix Statistics

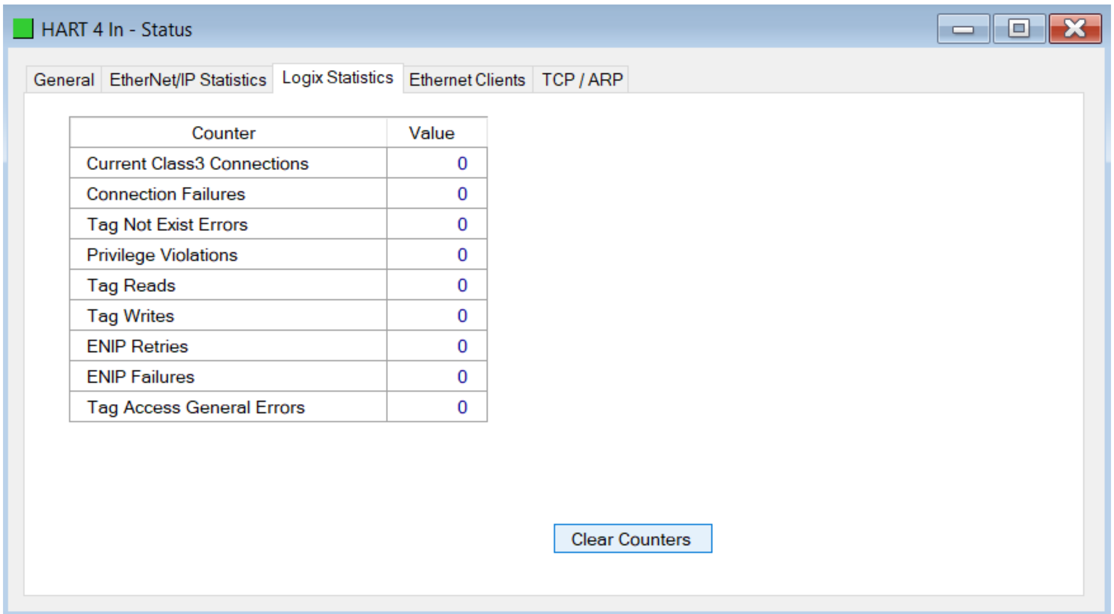


Figure 5.6 - Logix Statistics

Table 5.4 - Logix Statistics

Statistic	Description
Current Class 3 Connections	The number of current open class 3 connections.
Connection Failures	The number of failed attempts at establishing a class 3 connection with a Logix controller.
Tag Not Exist Errors	The number of tag read and tag write transactions that failed due to the destination tag not existing.
Privilege Violation Errors	The number of tag read and tag write transactions that failed due to a privilege violation error. This may be caused by the External Access property of the Logix tag being set to either None or Read Only.
Tag Reads	The number of tag read transactions executed by the PLX51-HART-4x module.
Tag Writes	The number of tag write transactions executed by the PLX51-HART-4x module.
CIP Timeout	This count increases when no response was received for the Tag Read/Write.
ENIP Retries	This count increases when no response was received from the Logix Controller by the time the ENIP timeout is reached.
ENIP Failures	This count increases when the ENIP Retry Limit is reached, and no response has been received from the Logix Controller.
Tag Access General Errors	This count increases when a tag cannot be accessed for any other reason not reported above.

5.2.3 DNP3 Statistics

The DNP3 Statistics will be displayed if either of the two DNP3 protocols have been configured.

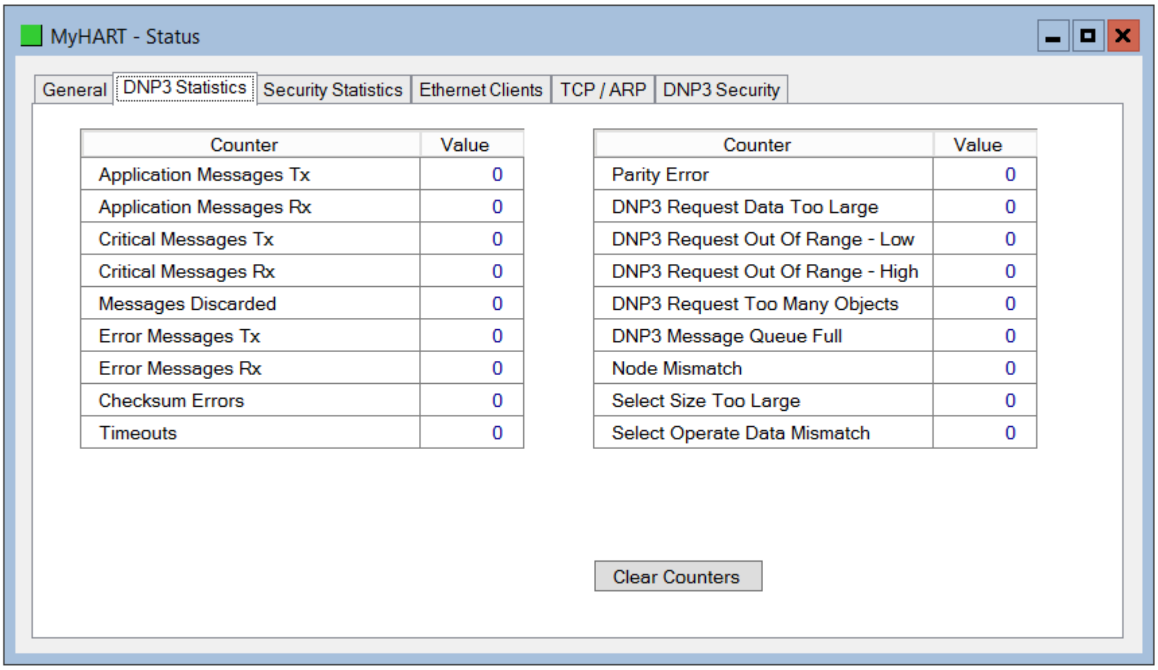


Figure 5.7 - DNP3 Statistics

Table 5.5 – DNP3 statistics

Statistic	Description
Application Messages Tx	The number of application DNP3 packets sent by the module.
Application Messages Rx	The number of application DNP3 packets received by the module.
Critical Messages Tx	The number of critical DNP3 packets sent by the module when security is enabled.
Critical Messages Rx	The number of critical DNP3 packets received by the module when security is enabled.
Messages Discarded	The number of DNP3 packets discarded by the module.
Error Messages Tx	The number of DNP3 error packets sent by the module.
Error Messages Rx	The number of DNP3 error packets received by the module.
Checksum errors	The number of corrupted DNP3 packets received by the module.
Timeouts	The number of message response timeouts the module has encountered.
Parity errors	The number of bytes with parity errors received by the module.
DNP3 Request Data Too Large	The request/response data is too big. The Hart 4 module allows for a maximum of 1000 bytes per transaction.
DNP3 Request Out of Range – Low	The DNP3 request has a range that is outside of the implemented DNP3 bounds for the specific group and variation. This error is specific to the range being lower than the implemented range.
DNP3 Request Out of Range – High	The DNP3 request has a range that is outside of the implemented DNP3 bounds for the specific group and variation. This error is specific to the range being higher than the implemented range.

Statistic	Description
DNP3 Request Too Many Objects	The Hart 4 module supports a maximum of 10 DNP3 objects in a single DNP3 request. This statistic indicates that more than 10 DNP3 objects were found in a single request.
DNP3 Message Queue Full	The Hart 4 module has received too many simultaneous messages to process.
Node Mismatch	The received message node number did not match the Hart 4 module configured node address.
Select Size Too Large	When the Select/Operate functionality is used the Hart 4 module supports a maximum of 255 bytes per transaction (or one full DNP3 message).
Select Operate Data Mismatch	The Select/Operate functionality requires that the response to the Select function matches the Select request.

5.2.4 Security Statistics

The DNP3 Security Statistics will be displayed if either of the two DNP3 protocols have been configured.

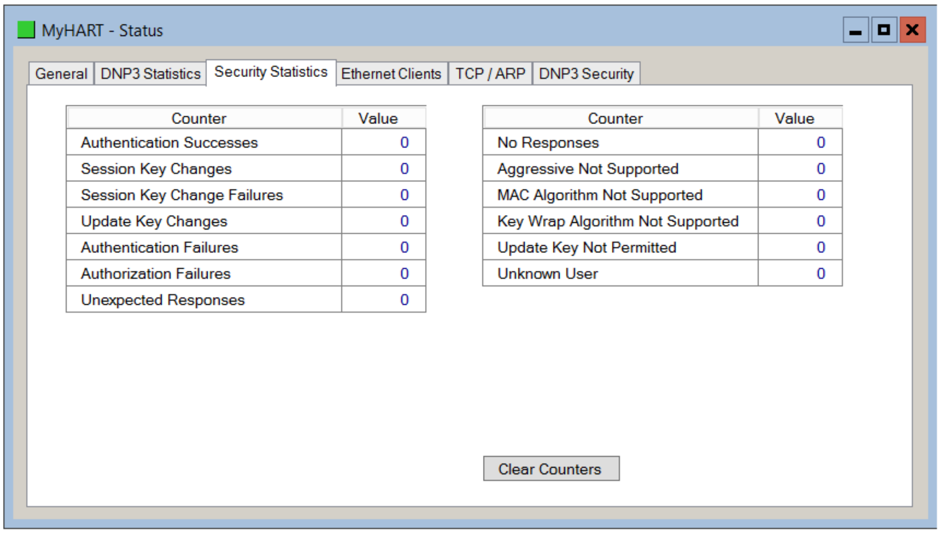


Figure 5.8 - DNP3 Security Statistics

Table 5.6 – DNP3 Security statistics

Statistic	**Description**
Authentication Successes	Increases every time the device successfully authenticates a message.
Session Key Changes	When the session keys have been successfully updated.
Session Key Change Failures	When the session keys have failed to update.
Update Key Changes	The Update Key has changed.
Authentication Failures	The other device has provided invalid authentication information such as an incorrect MAC.
Authorization Failures	Increases when a user is not authorized to perform a requested operation.
Unexpected Responses	The other device has responded with a message that was not expected during the authentication process.
No Responses	The other device has not replied during the authentication process.
Aggressive Not Supported	When Aggressive Mode Authentication is not supported this will increase.
MAC Algorithm Not Supported	The MAC algorithm requested is not supported
Key Wrap Algorithm Not Supported	The Key Wrap algorithm requested is not supported.
Update Key Not Permitted	Updating of a key was not permitted.
Unknown User	The user used for authentication was unknown. The default user (1) is the only user supported.

5.2.5 Modbus

The Modbus Statistics will be displayed if the Modbus TCP/IP protocol has been configured.

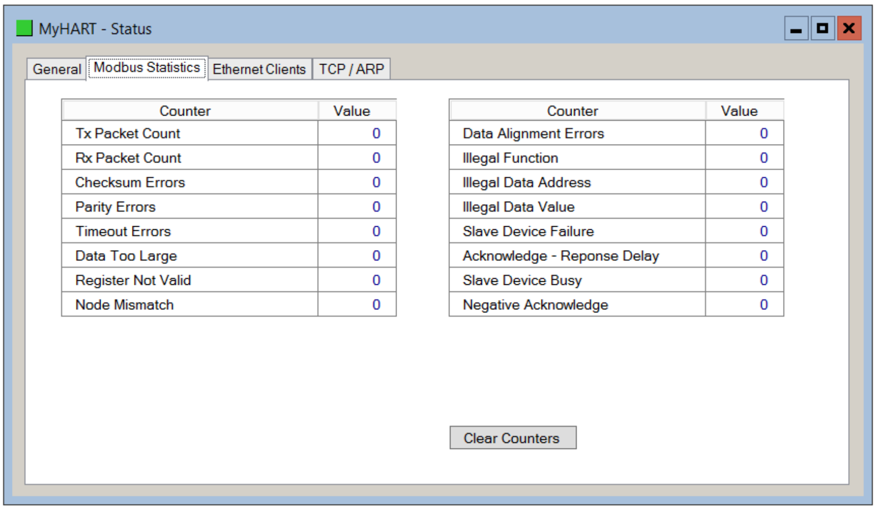


Figure 5.9 - Modbus Statistics

Table 5.7 – Modbus statistics

Statistic	Description
Tx Packet Count	The number of Modbus packets sent by the module.
Rx Packet Count	The number of Modbus packets received by the module.
Checksum errors	The number of corrupted Modbus packets received by the module.
Parity errors	The number of bytes with parity errors received by the module.
Timeout Errors	The number of message response timeouts the module has encountered.
Data Too Large	The number of Modbus requests or responses where the data was too large to process.
Register Not Valid	A request was received for a register which is not defined.
Node Mismatch	The received Modbus request did not match the module's Modbus node address.
Data Alignment Errors	The Modbus request and associated mapped item is not byte aligned with the destination.
Illegal Function	The number of times the Modbus device responded with an Illegal Function exception.
Illegal Data Address	The number of times the Modbus device responded with an Illegal Data Address exception.
Illegal Data Value	The number of times the Modbus device responded with an Illegal Data Value exception.
Slave Device Failure	The number of times the Modbus device responded with a Device Failure exception.
Acknowledge –Response Delay	The number of times the Modbus device responded with an Acknowledge exception.
Slave Device Busy	The number of times the Modbus device responded with a Slave Busy exception.
Negative Acknowledge	The number of times the Modbus device responded with a Negative Acknowledge exception.
Memory Parity Error	The number of times the Modbus device responded with a Memory Parity exception.

5.2.6 PCCC

The PCCC Statistics will be displayed if the PCCC protocol has been configured.

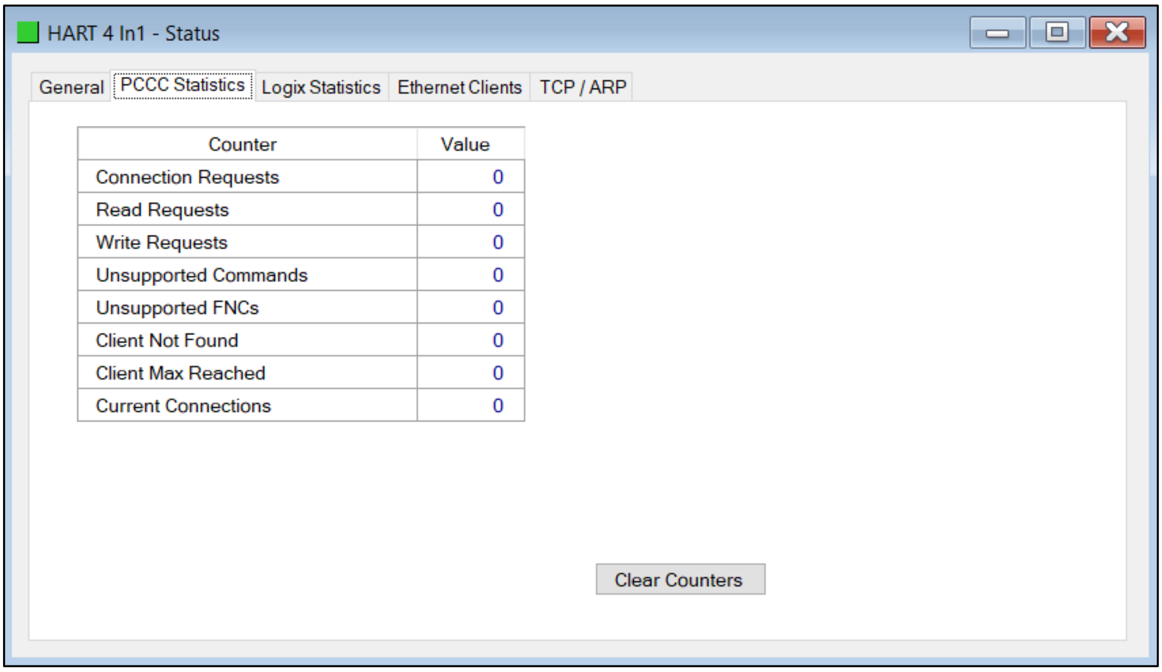


Figure 5.10 - PCCC Statistics

Table 5.8 – PCCC statistics

Statistic	Description
Connection Requests	The number of PCCC connection establishment requests received.
Read Requests	The number of Read requests received.
Write Requests	The number of Write requests received.
Unsupported Commands	The number of requests rejected due to an unsupported command.
Unsupported FNC Code	The number of requests rejected due to an unsupported function code.
Client Not Found	The number of rejected requests due to no matching connection.
Client Max Reached	The number of connection request rejections due to maximum connection count reached.
File Not Found	The number of rejected requests due to an unsupported PLC file number.
Current Connections	The current number of active connections.

5.3 Channel Status

The status of a specific channel can be monitored by double-clicking on the ***Channel x Status*** in the tree, or by right-clicking on the device and selecting the ***Channel x Status*** item.

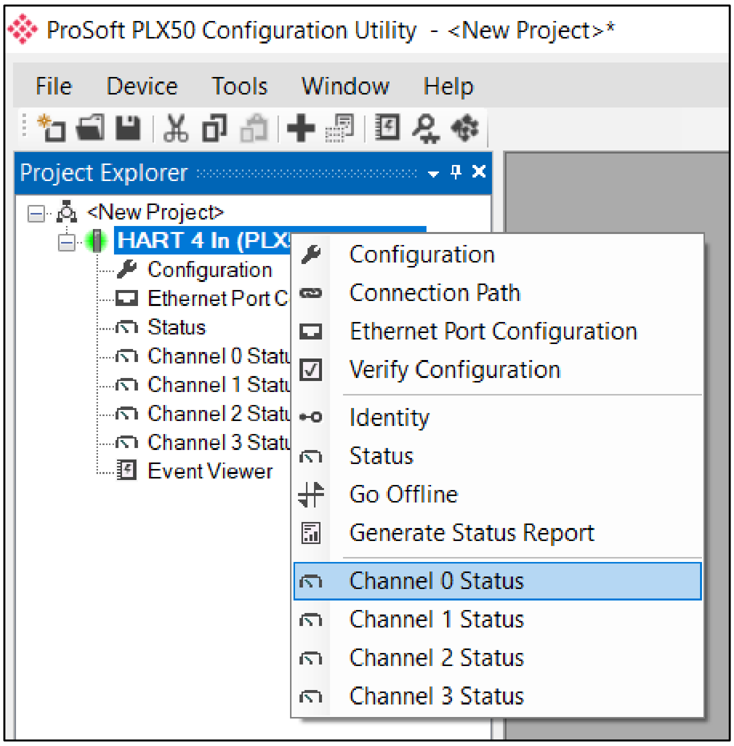


Figure 5.11 - Select Online Channel Status

The Channel Status window contains multiple tabs to display the status of that specific channel. The General tab displays a summary of the common HART parameters.

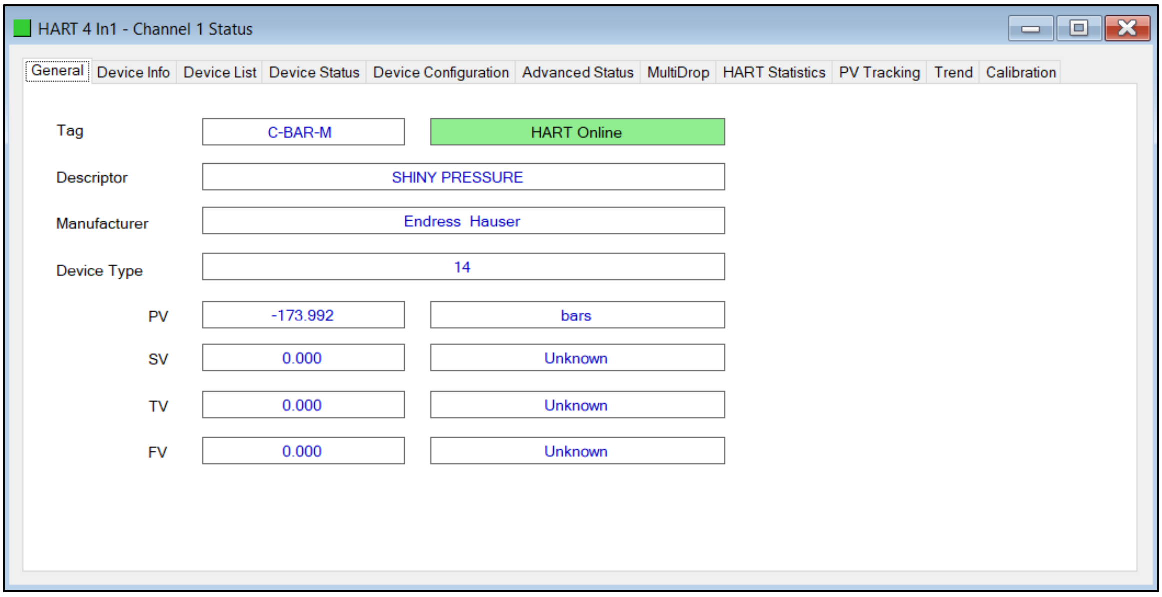


Figure 5.12 - Channel Status – General

Table 5.9 - Channel Status Parameters – General

Parameter	Description
Tag	The user tag name configured in the field device. (8 characters)
Status	The status of the HART communication.
Descriptor	The user descriptor configured in the field device. (16 characters)
Manufacturer	The field device manufacturer.
Device Type	The device type code assigned by the manufacturer.
PV (and Units)	The displayed primary variable in engineering units, with the engineering unit enumeration.
SV (and Units)	The displayed secondary variable in engineering units, with the engineering unit enumeration.
TV (and Units)	The third variable displayed in engineering units, with the engineering unit enumeration.
FV (and Units)	The fourth variable displayed in engineering units, with the engineering unit enumeration.

The Device Info tab displays detailed information of the field device.

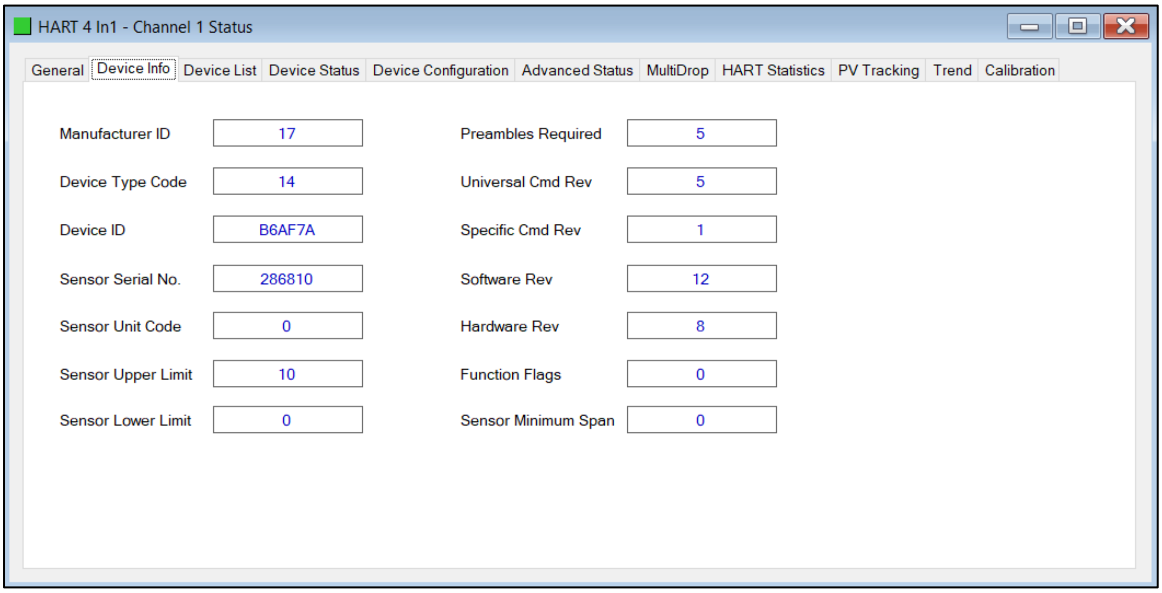


Figure 5.13 - Channel Status – Device Info

Table 5.10 - Channel Status Parameters – Device Info

Parameter	Description
Manufacturer ID	The field device manufacturer unique identification code.
Device Type Code	The device type code assigned by the manufacturer.
Device ID	The device identification code assigned by the manufacturer.
Sensor Serial Number	The serial number of the field device sensor.
Sensor Unit Code	The engineering unit code used for the sensor limits.
Sensor Upper Limit	The upper limit of the sensor in the engineering units.
Sensor Lower Limit	The lower limit of the sensor in the engineering units.
Preambles Required	The minimum number of preambles required by the field device to process a HART request.
Universal Command Revision	The universal command revision supported by the field device.
Specific Command Revision	The specific command revision supported by the field device.

Parameter	Description
Software Revision	The software revision of the field device.
Hardware Revision	The hardware revision of the field device electronics.
Function Flags	The Device Function Flags as reported by the field device.
Sensor Minimum Span	The minimum span allowed by the sensor.

The Device Status tab displays the status of the analog and HART interaction with the module.

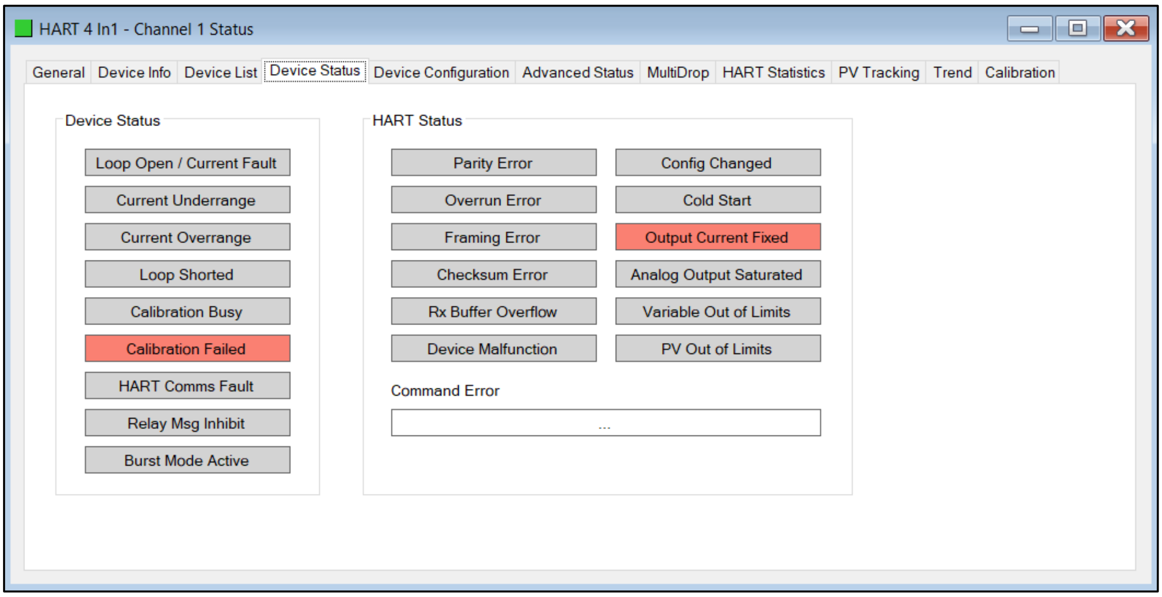


Figure 5.14 - Channel Status – Device Status

Table 5.11 - Channel Status Parameters – Device Status

Parameter	Description
Loop Open / Current Fault	Flagged if the current loop is either below 3.6mA or above 21.0 mA.
Current Under-range	Flagged if the current is below 3.8mA.
Current Over-range	Flagged if the current is above 20.5 mA.
Loop Shorted	Flagged if a loop short is detected.
Calibration Busy	Flagged when the module is busy being calibrated.
Calibration Failed	Flagged if the calibration data is invalid or corrupt.
HART Comms Fault	Flagged if HART communication is enabled but not active.
Relay Message Inhibit	Flagged when Class 2 HART relay messages have been disabled in the configuration.
Burst Mode Active	Flagged if the field device is operating in Burst Mode.
Parity Error	Flagged if the field device received a message with a parity error
Overrun Error	Flagged if the field device receive buffer is overrun.
Framing Error	Flagged if the field device receives a message with an invalid stop delimiter.
Checksum Error	Flagged if the field device receives a message with an invalid checksum.
Rx Buffer Overflow	Flagged if the field device receives a message too long for the receive buffer.
Device Malfunction	Flagged if the field device has detected an error or suffered some hardware failure.

Parameter	Description
Config Changed	Flagged if an operation resulted in the configuration changing.
Cold Start	Flagged if the field device has experienced a power failure or reset.
Output Current Fixed	Flagged if the loop current is set at a fixed value and is not responding to process variations
Analog Output Saturated	Flagged if the Loop Current has reached its upper or lower limit
Variable Out of Limits	Flagged if a variable other than the PV is beyond its operating limits.
PV Out of Limits	Flagged if the PV is beyond its operating limits.
Command Error	An enumerated error in response to the last command issued.

The Device Configuration tab provides the facility to display and modify common HART parameters in the field device.

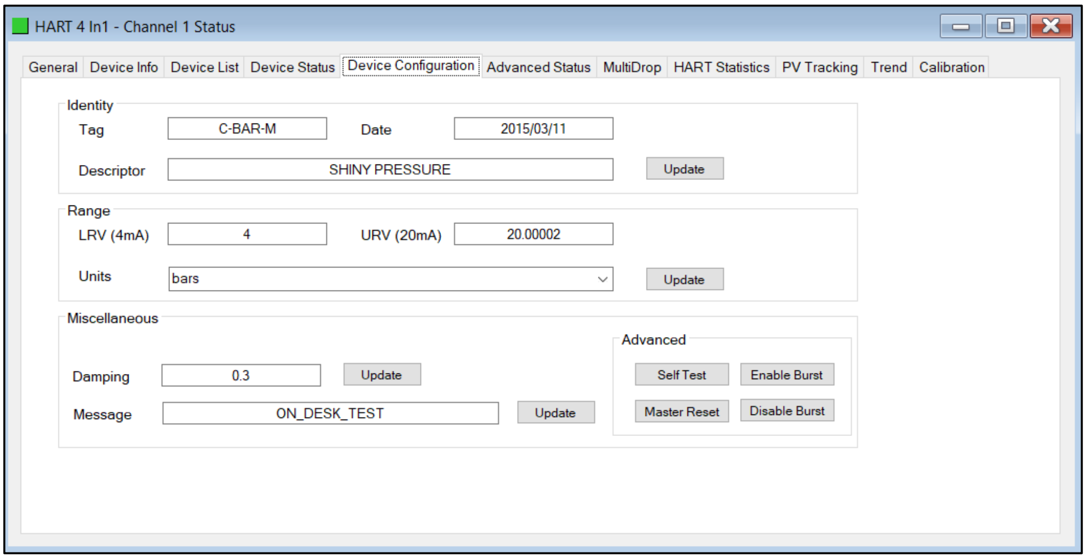


Figure 5.15 - Channel Status – Device Configuration

Table 5.12 - Channel Status Parameters – Device Configuration

Parameter	Description
Tag	The user tag name configured in the field device. (8 characters). **Note:** The Tag, Descriptor and Date are updated together.
Descriptor	The user descriptor configured in the field device. (16 characters). **Note:** The Tag, Descriptor and Date are updated together.
Date	The date when the tag and descriptor configuration was last modified. **Note:** The Tag, Descriptor and Date are updated together.
LRV	The Lower Range Value in engineering units represented by the 4 mA analog signal. **Note:** The LRV, URV and Range Units are updated together.
URV	The Upper Range Value in engineering units represented by the 20 mA analog signal. **Note:** The LRV, URV and Range Units are updated together.
Range Units	The engineering units in which the LRV and URV values are specified. **Note:** The LRV, URV and Range Units are updated together.
Damping	The damping value specified in seconds. Damping refers to the digital filtering of process variables to remove transient and potentially erroneous deviations from the actual measure variable.
Message	A user defined 32-character message stored in the field device.

Master Reset	Resets the field device
Enable Burst Mode	This instructs the field device to enter Burst Mode. The user will need to enter the HART command that must be sent using Burst Responses. **Note:** The user will need to verify which HART commands are supported by the specific HART device for Burst responses.
Disable Burst Mode	This instructs the field device to exit Burst Mode.

A parameter can be modified by entering the new value into the appropriate text box and clicking the adjacent Update button. When the parameter is pending, that is, edited but not yet committed, then the text box will be shaded yellow. Once the value has been written (updated) the value will be written to the field device and then re-read from the field device, after which the parameter background will return to normal.

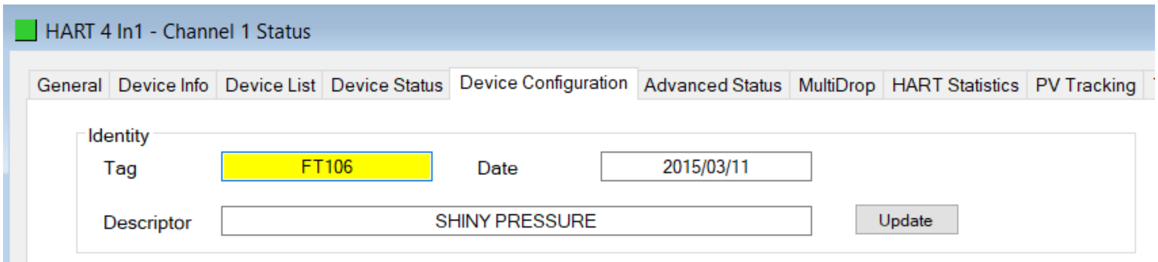


Figure 5.16 - Updating Device Parameters

The Advanced Status tab displays the advanced and device specific status information of the field device. Due to the manufacturer specific encoding of these parameters, consult the field device manufacturer’s documentation for more information.

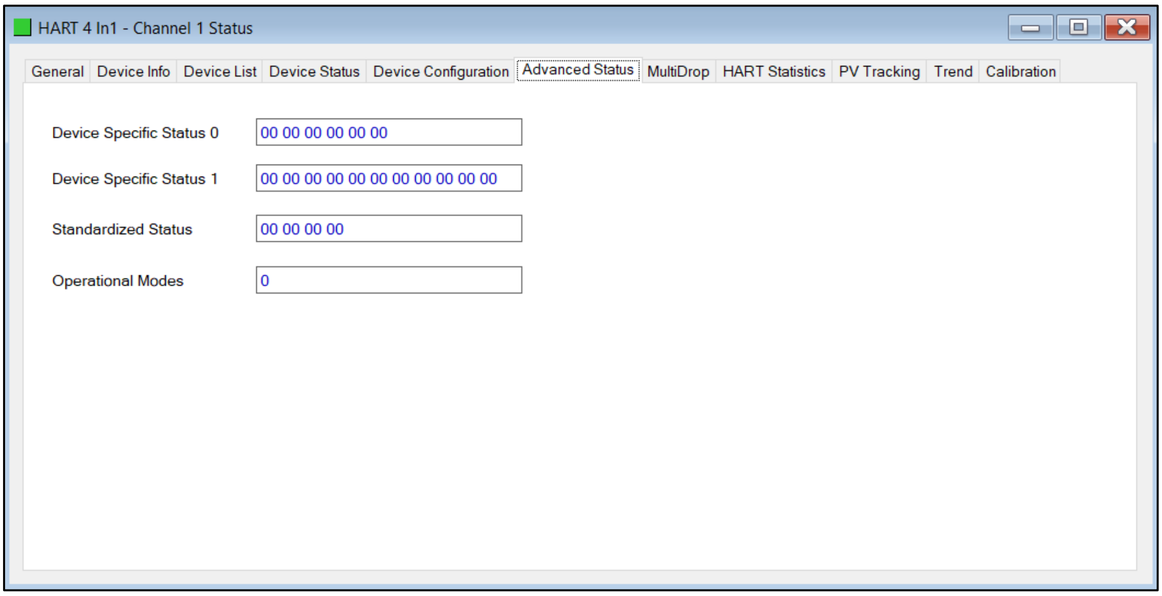


Figure 5.17 - Channel Status – Advanced Status

The HART Statistics tab displays communication statistics.

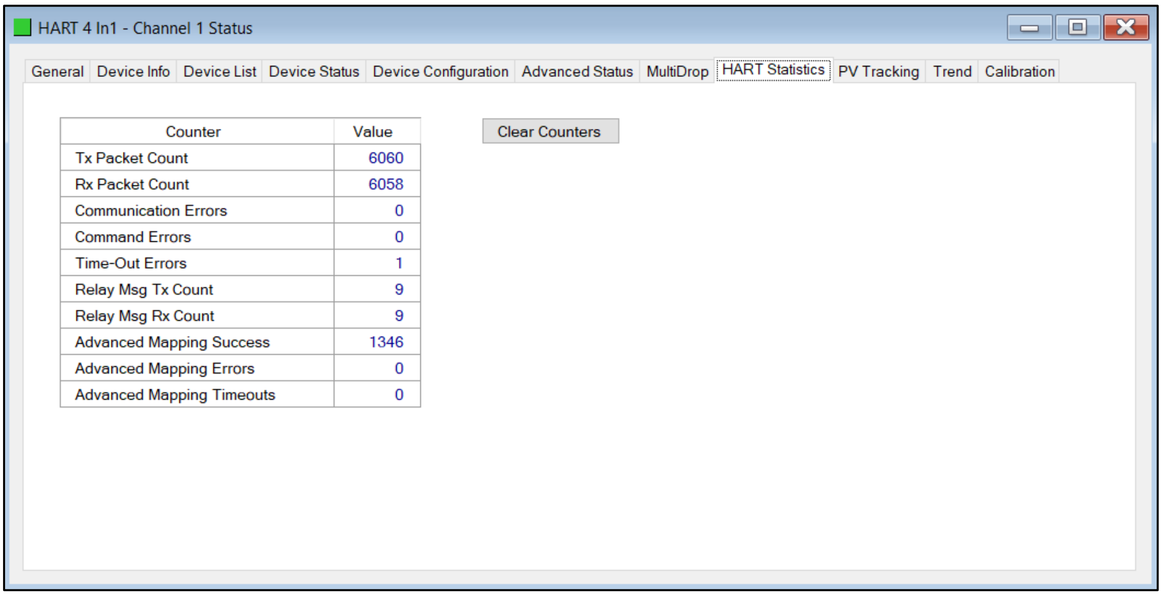


Figure 5.18 - Channel Status – HART Communication Statistics

Table 5.13 - Channel Status Parameters HART Communication Statistics

Parameter	Description
Tx Packet Count	The number of HART packets sent.
Rx Packet Count	The number of HART packets received.
Communication Errors	The number of communication errors experienced.
Command Errors	The number of command errors experienced.
Time-Out Errors	The number of HART time-out errors experienced.
Relay Message Tx Count	The number of HART packets sent via relay (Class 2) messages (DTMs etc.)
Relay Message Rx Count	The number of HART packets received for relay (Class 2) messages (DTMs etc.)
Advanced Mapping Success	The number of successful advanced mapping reads.
Advanced Mapping Errors	The number of advanced mapping reads that failed. (Illegal HART command etc.)
Advanced Mapping Timeouts	The number of advanced mapping reads where no reply was received.

The PV Tracking Status tab displays the current, minimum and maximum value of the common process variables. The Reset button can be used to reset the maximum and minimum values.

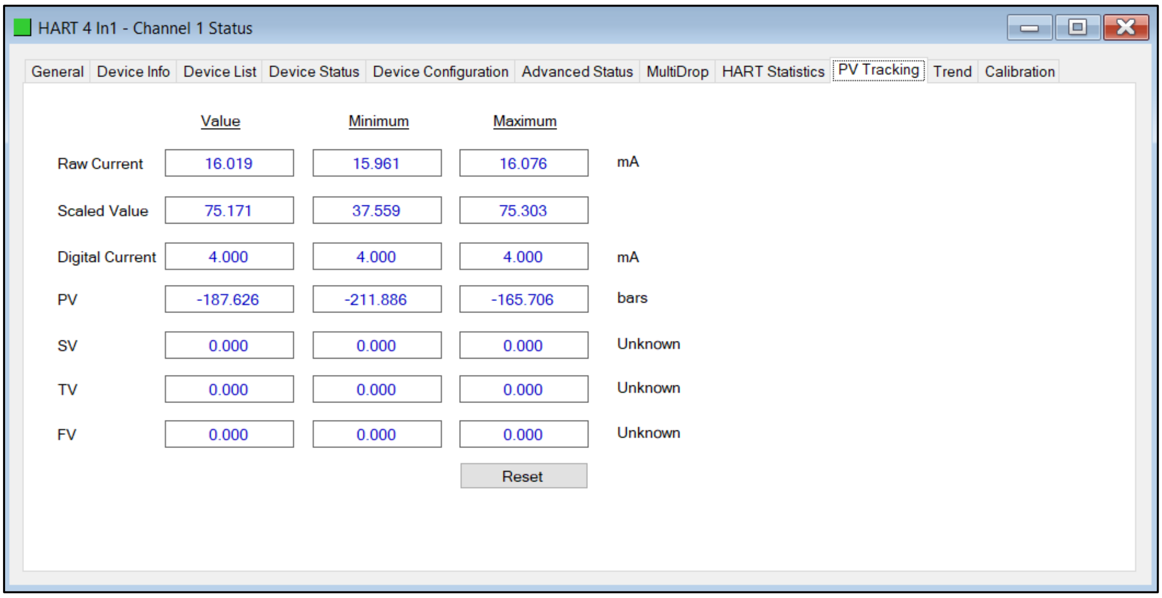


Figure 5.19 - Channel Status – PV Tracking

The Trend tab displays the status of the analog and HART interaction with the module.

The module can store up to 1000 trend points which are sampled at a user-configurable interval. The user can choose between one of the following sources:

- Raw Analog Current (4-20 mA)
- Filtered Scaled Value
- Digital Current
- Primary Variable (PV)
- Secondary Variable (SV)
- Third Variable (TV)
- Fourth Variable (FV)

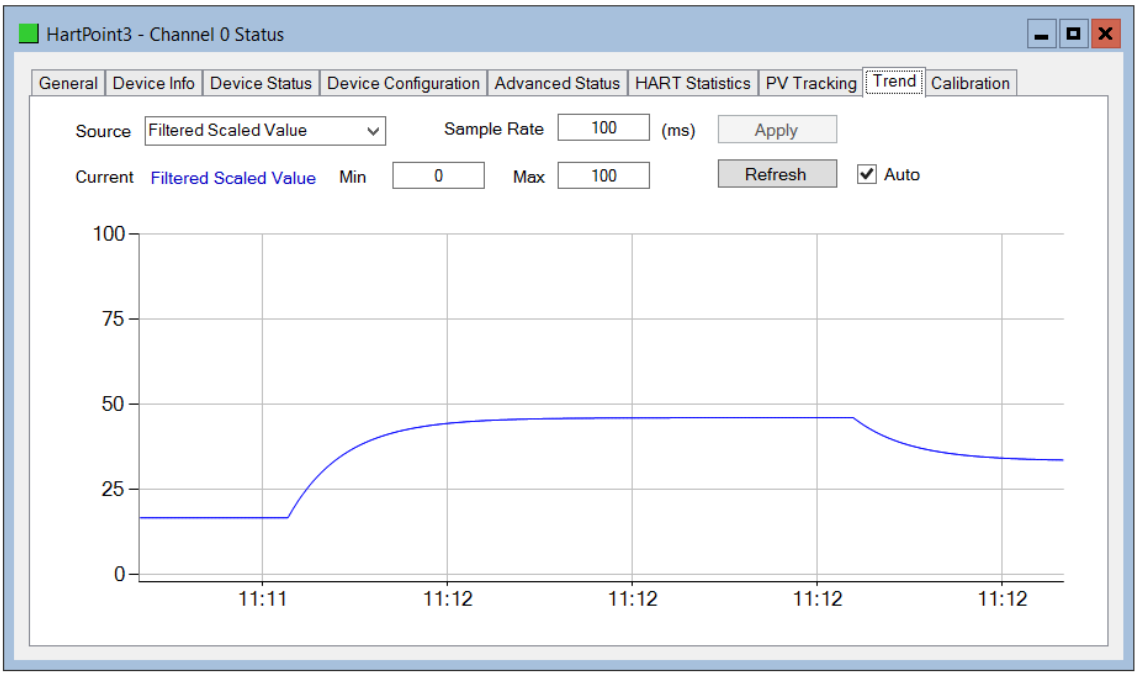


Figure 5.20 - Channel Status – Trend

Once the source or sample rate has been modified, the *Apply* button must be clicked for the changes to take effect. This will also result in the existing trend data being cleared. The Y axis scale can be modified by adjusting the *Min* and *Max* value and clicking the *Refresh* button. To automatically update the trend every second, the *Auto* check box can be selected.

5.4 Device List

The module supports scanning a channel to determine at which short address the field device(s) are. The user can select the start and end address to minimize the scan time. Once the scan is completed and a device is found the device's details will be displayed in the list as shown below. When the user is using multiple devices on a single channel, more than one device will be displayed in this list.

Important: When multiple devices are used on a single channel then the user must ensure that each device is at a unique address. The user can change the short node address in the options by right-clicking on the device and selecting ***Write Address***.

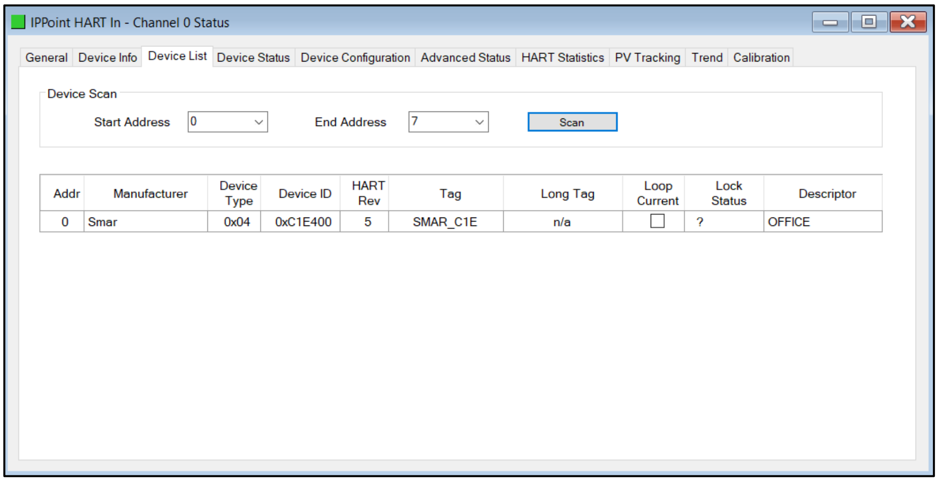


Figure 5.21 – Device List

There are various options the user can execute per device found in the device list. Some of the options will only be relevant depending on the HART Revision (e.g. the Long Tag is only supported by HART Revision 6 and above).

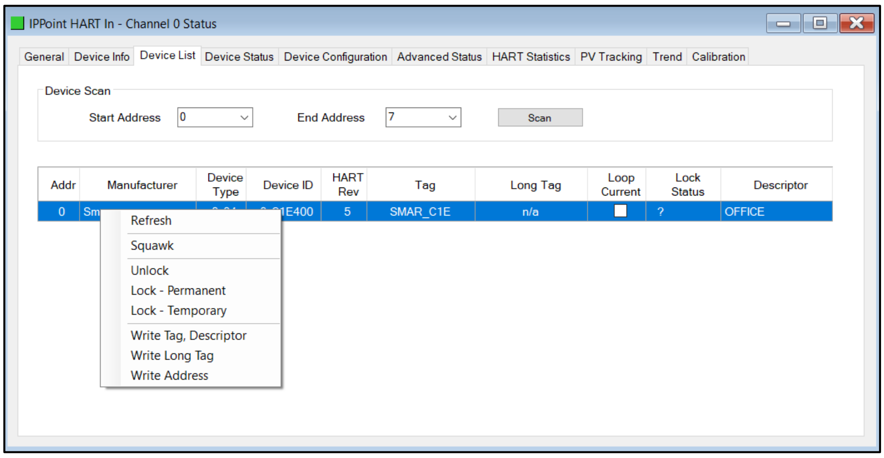


Figure 5.22 – Device List Options

5.5 MultiDrop

The ***MultiDrop*** tab will have all the configured multidrop devices, their Status, as well as the four process variables for each multidrop HART device.

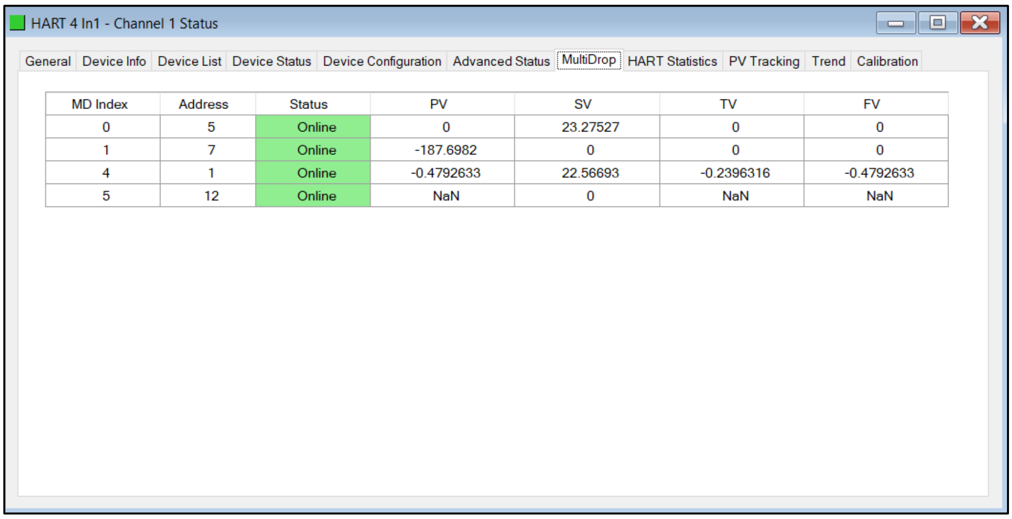


Figure 5.23 – Channel Status – MultiDrop

5.6 Calibration

The Calibration tab in the Channel status monitoring form, can be used to display and modify the calibration parameters.

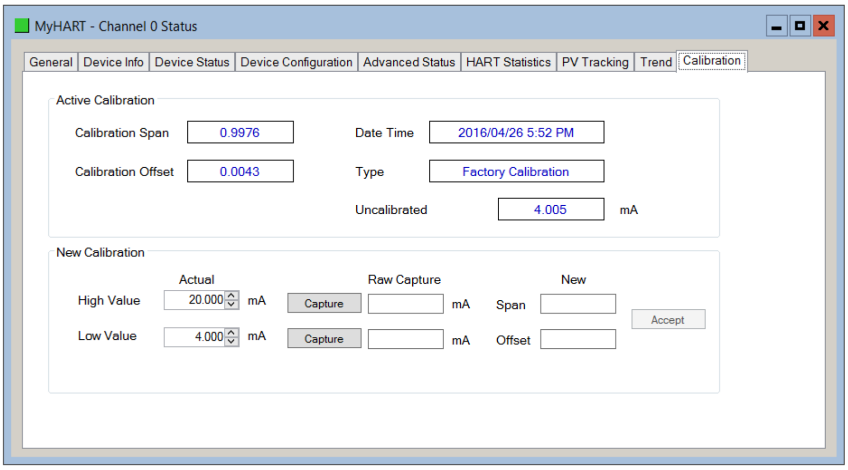


Figure 5.24 – Channel Status – Input Calibration

The module is Factory Calibrated and should not require any further calibration before use. To re-calibrate the module, the User Calibration methods described below can be implemented.

5.6.1 PLX51-HART-4I Calibration:

To re-calibrate a PLX51-HART-4I module,

1. Using an external milliamp source, adjust the current to 4 mA, or as close as possible to 4 mA.
2. Enter the exact milliamp value, read from an external meter, into the ***Low Value Actual*** numeric inputs.
3. Press the ***Low Value*** (4 mA) ***Capture*** button, to capture the current (un-calibrated value) into the ***Raw Capture*** field.
4. Using the external milliamp source, adjust the current to 20 mA, or as close as possible to 20 mA.
5. Enter the exact milliamp value, read from an external meter, into the ***High Value Actual*** numeric inputs.
6. Press the ***High Value*** (20 mA) ***Capture*** button, to capture the current (un-calibrated value) into the ***Raw Capture*** field.
7. The new ***Span*** and ***Offset*** calibration settings will be automatically calculated. (See figure below).
8. Press ***Accept*** to write these new calibration figures to the module.
9. The Calibration Type will then change to User Calibration, to reflect the changes.

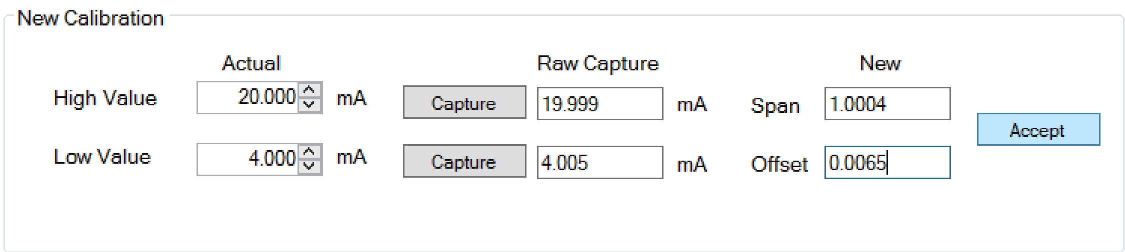


Figure 5.25 – User Calibration – Input

Important: Before commencing with input calibration ensure that it is safe to do so. The simulated current values could translate to extreme process variables in the connected control system which may cause unexpected results. Failure to do so could result in severe equipment damage and personal injury.

5.6.2 PLX51-HART-4O Calibration:

To re-calibrate a PLX51-HART-4O module:

1. Ensure the channel configuration has both the ***Prog/Fault Freeze*** and ***Comm Fail Freeze*** options checked, and that the module is disconnected from the EtherNet/IP (Logix), DNP3 or Modbus source.
2. Click the ***Set 4 mA*** button. The output current will change to 4 mA.
3. Using an external meter, measure the actual loop current and enter the milliamp value in the ***Low Value*** (4 mA) ***Actual Measured*** textbox.
4. Click the ***Set 20 mA*** button. The output current will change to 20 mA.
5. Using an external meter, measure the actual loop current and enter the milliamp value in the ***High Value*** (20 mA) ***Actual Measured*** textbox.
6. The new ***Span*** and ***Offset*** calibration settings will be automatically calculated. (See figure below).
7. Press ***Accept*** to write these new calibration figures to the module.
8. The Calibration Type will then change to User Calibration, to reflect the changes.

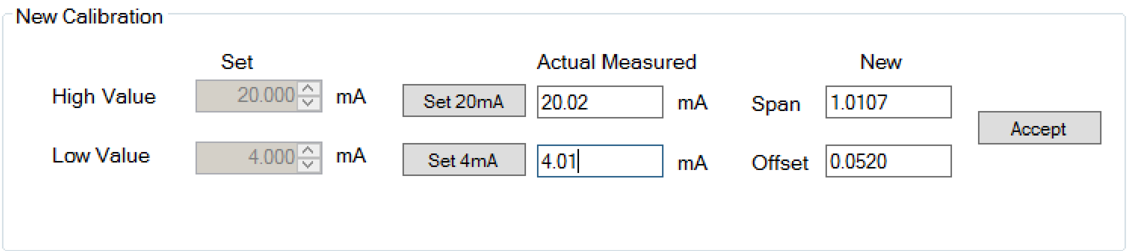


Figure 5.26 – User Calibration - Output

Important: Before commencing with output calibration ensure that it is safe to do so. The field device should be either isolated from the process mechanically or the process be in such a state that variations in the output signal cannot cause a disruption to the process. Failure to do so could result in severe equipment damage and personal injury.

Important: The ***Set 20 mA*** and ***Set 4 mA*** buttons will be disabled if the configuration has either the ***Prog/Fault Freeze*** or ***Comm Fail Freeze*** options not checked.

Important: If the module's data source (EtherNet/IP (Logix), DNP3 or Modbus) is not disconnected or disabled, then the simulated milliamp value will be constantly over-written negating the calibration procedure.

5.7 Module Event Log

The module logs various diagnostic records to an internal event log. These logs are stored in non-volatile memory and can be displayed using the PLX50 Configuration Utility or via the web interface.

To view them in the PLX50 Configuration Utility, select the Event Viewer option in the Project Explorer tree.

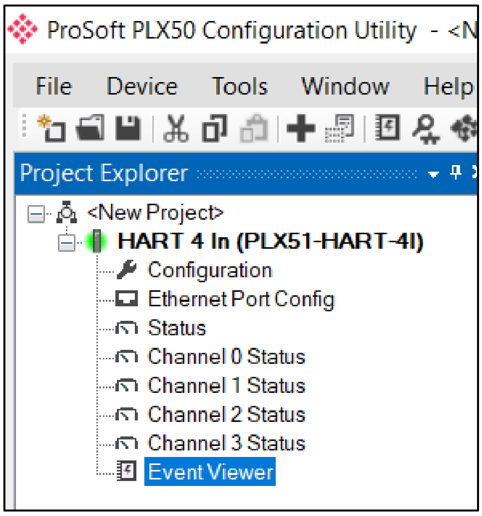


Figure 5.27 - Selecting the module Event Log

The Event Log window will open and automatically read all the events from the module. The log entries are displayed with the latest record at the top. Custom sorting is achieved by double-clicking on the column headings.

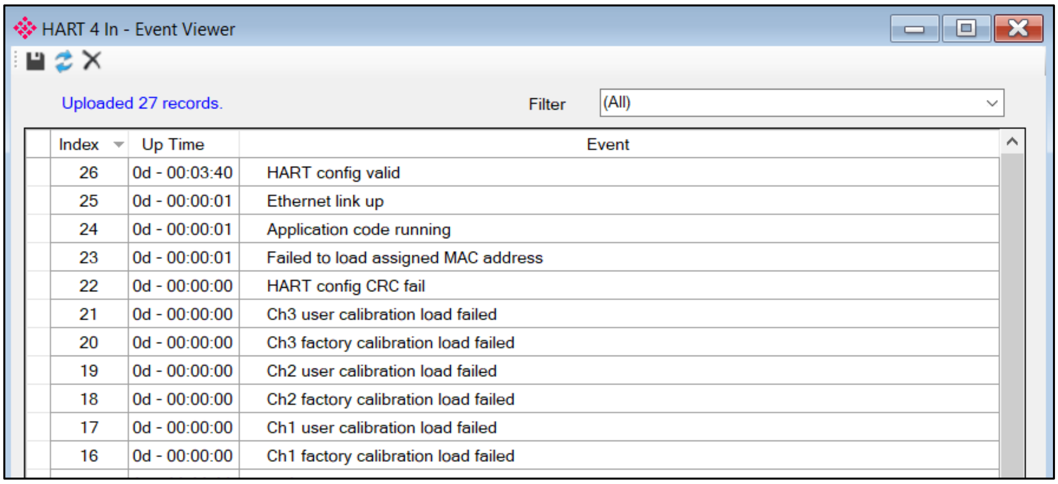


Figure 5.28 – Module Event Log

The log can also be stored to a file for future analysis, by selecting the Save button in the tool menu. To view previously saved files, use the Event Log Viewer option under the Tools menu.

5.8 Web Server

The module provides a web server allowing a user without the PLX50 Configuration Utility or RSLogix 5000 to view various diagnostics of the module. This includes Ethernet parameters, system event log, advanced diagnostics, and application diagnostics.

> **Note:** The web server is read-only. No parameters or configuration can be altered from the web interface.

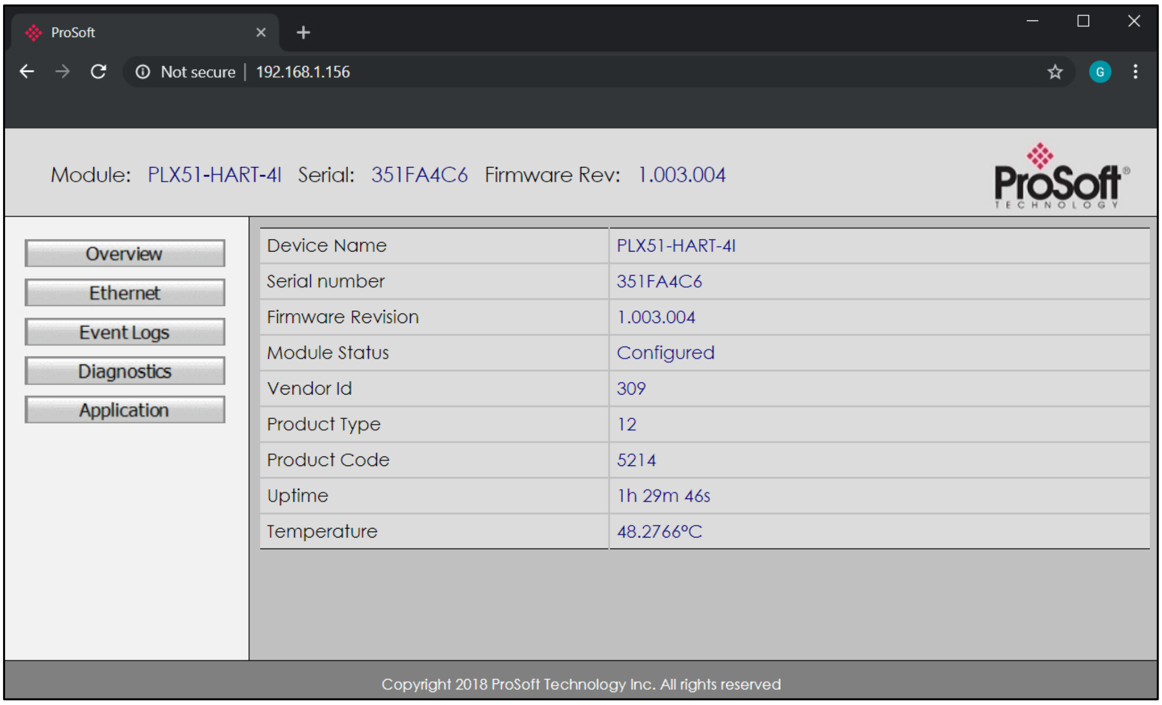


Figure 5.29 - Web interface

5.9 HART Packet Capture

The PLX51-HART-4x module provides the capability to capture the HART traffic for analysis. This will assist you and the support team to diagnose any possible issues. To invoke the capture of the module, right-click on the module (when online in PLX50CU) and select the HART Packet Capture item.

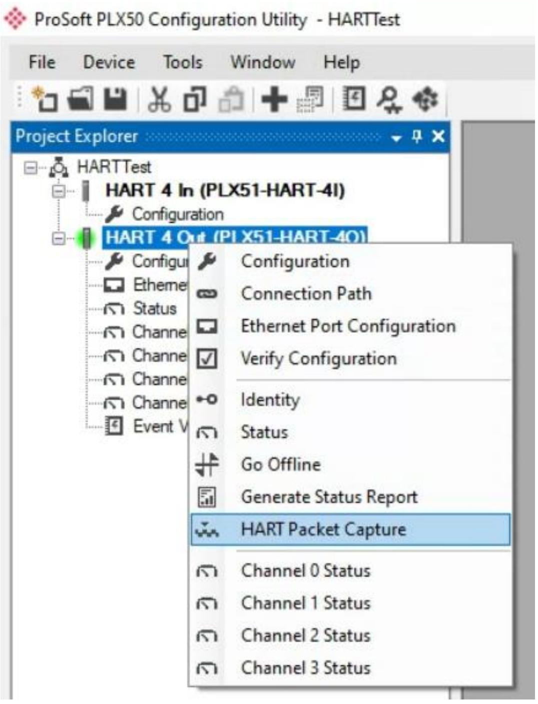


Figure 5.30 - Selecting HART Packet Capture

The HART Packet Capture window will open and automatically start capturing all HART packets.

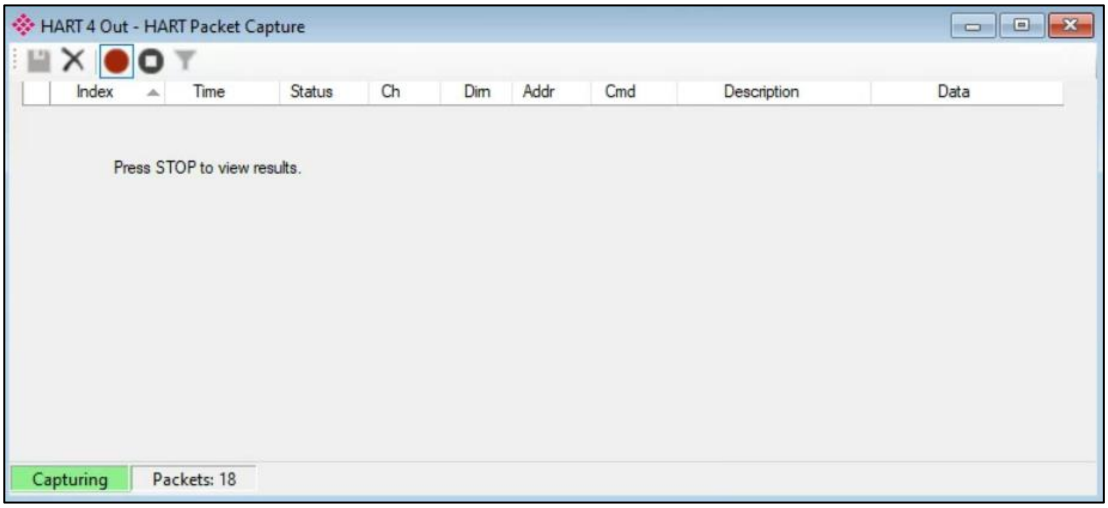


Figure 5.31 – HART Packet Capture

To display the captured HART packets, the capture process must first be stopped, by pressing the ***Stop*** button.

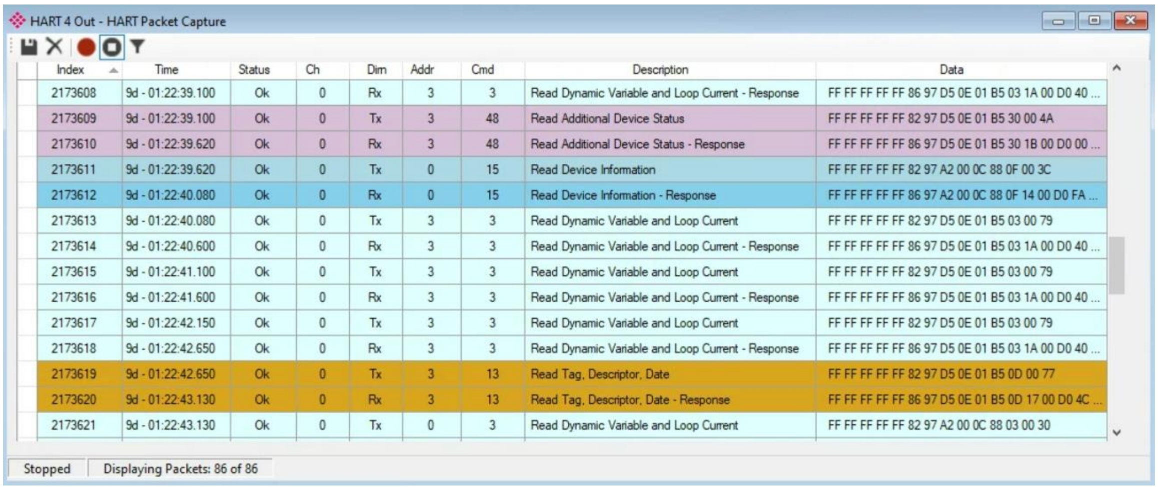


Figure 5.32 – HART Packet Capture complete

The captured HART packets are tabulated as follows:

Table 5.14 – HART Packet Capture fields

Statistic	Description
Index	The packet index, incremented for each packet sent or received.
Time	The elapsed time since the module powered up.
Status	The status of the packet. Received packets are checked for valid HART constructs and valid checksums.
Ch	The HART channel where the packet was captured.
Dirn	The direction of the packet, either transmitted (Tx) or received (Rx).
Addr	The HART slave device short address.
Cmd	The HART command sent or received
Description	A basic description of the captured packet. If the user double-clicks on the description, it will provide a more detailed description.
Data	The raw HART data.

The packet capture can be saved to a file for further analysis, by selecting the ***Save*** button on the toolbar. Previously saved HART Packet Capture files can be viewed by selecting the HART ***Packet Capture Viewer*** option in the ***Tools*** menu.

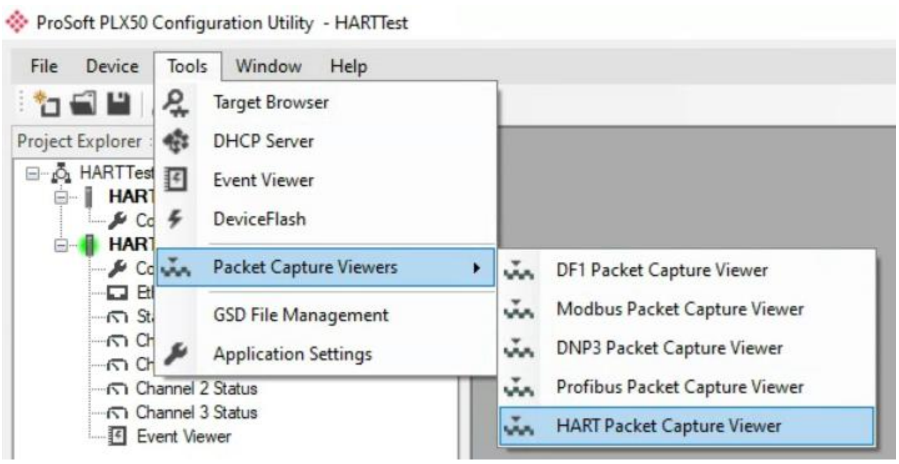


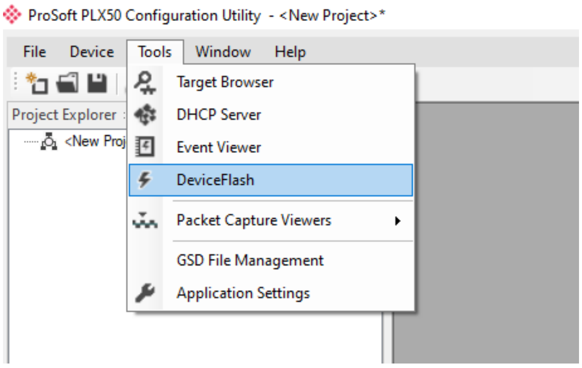
Figure 5.33 - Selecting the HART Packet Capture Viewer

5.10 Firmware

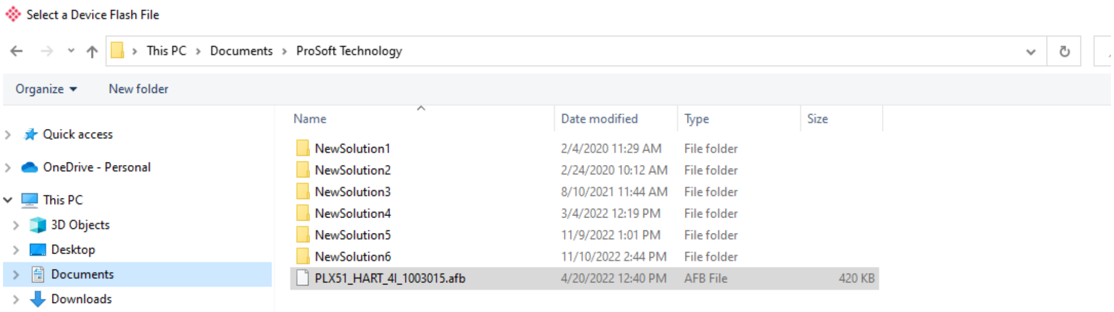
The PLX51-HART-4I/4O gateway firmware can be upgraded or downgraded by using the PLX50 Configuration Utility.

5.10.1 Firmware Upgrade/Downgrade

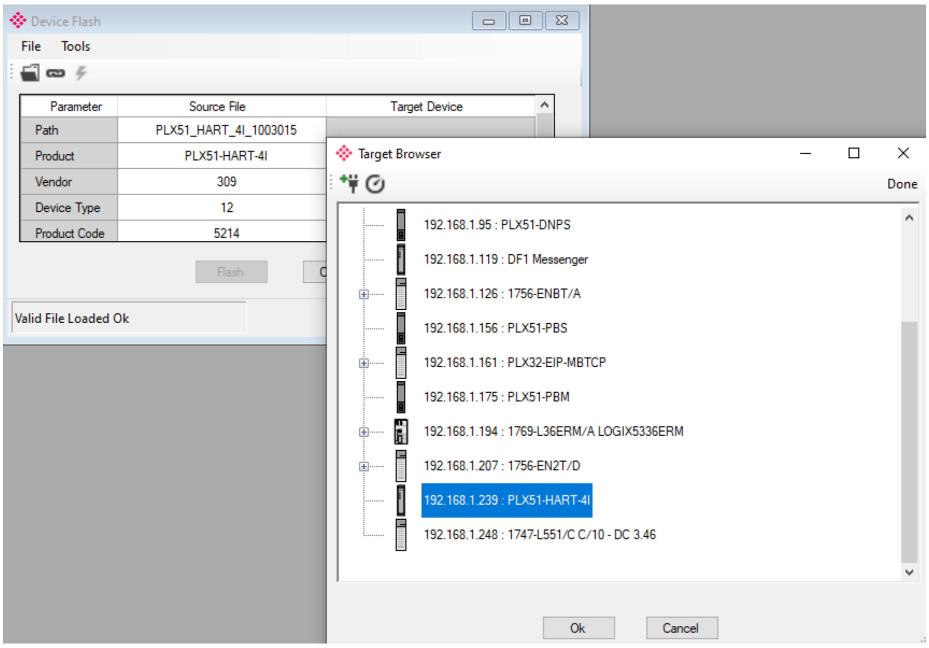
1 In the PLX50 Configuration Utility, navigate to the **TOOLS** > **DEVICEFLASH** option.



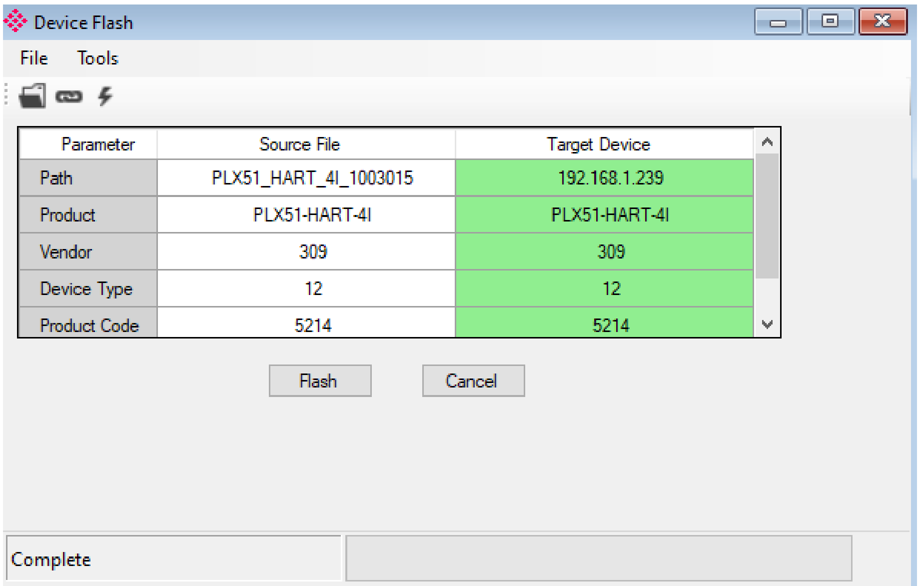
2 In the *Select a Device Flash File* dialog, select the firmware file.



3 In the *Target Browser* dialog, select the desired PLX51-HART-4I/4O gateway.



4 In the *Device Flash* dialog, verify the *Source File* and *Target Device* information is correct. Then click the **FLASH** button.



5.10.2 Firmware Downgrade for PLX51-HART-4I Without "HB" Designation

Note: Downgrading below v1.003.017 on hardware without the "HB" designation on the F/W REV product label will require the module to be placed in Safe Mode prior to flashing. This is due to v1.003.017 being signed.

Note: For PLX51-HART-4I only - The minimum firmware required to run on hardware with the "HB" designation is v1.003.017.

To downgrade from the gateway's v1.003.017 firmware:

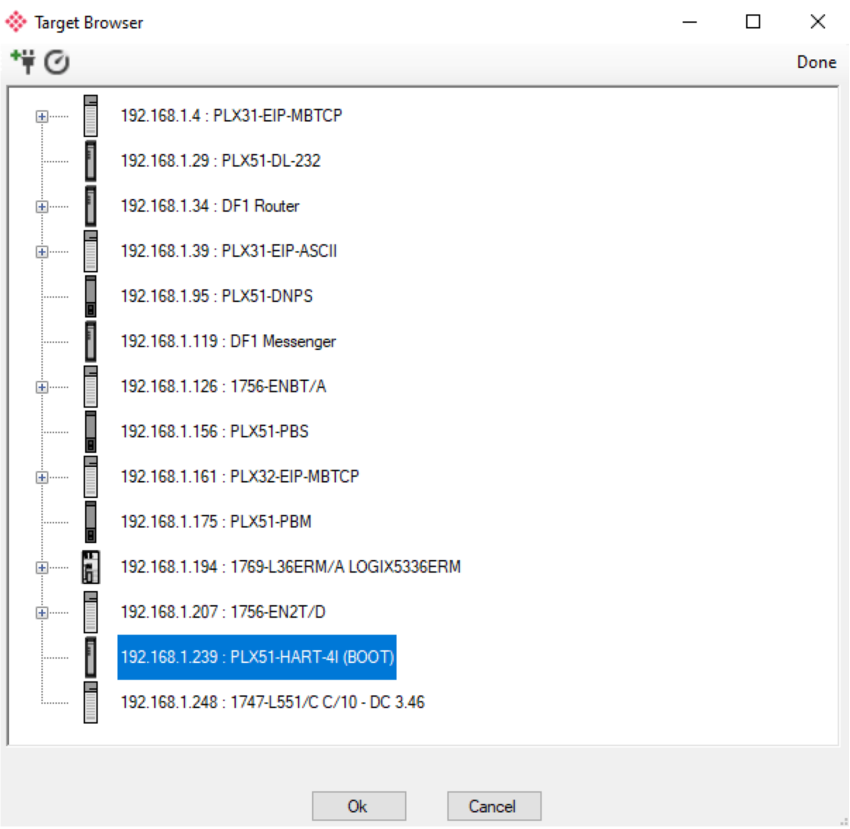
1 Power down the PLX51-HART-4I gateway.

2 Set the gateway's DIP Switch 1 to **On** (Safe Mode). See *Module Layout* on page 11 for more DIP switch information.

3 Power up the PLX51-HART-4I gateway.

4 Once the gateway is powered up, set DIP Switch 1 to **Off**.

5 In the PLX50 Configuration Utility, navigate to **TOOLS** > **TARGET BROWSER**. The gateway will display "BOOT" if it is in Safe Mode.



6 Using the same download process as in the *Firmware Upgrade/Downgrade* section on page 119, flash the module to the desired firmware.

6 Asset Management FDT – DTM Technology

The PLX51-HART-4I/4O module supports FDT / DTM technology, allowing the user to configure any field device using its DTM (Device Type Manager) in any standard FDT Frame (Field Device Tool).

To use a field device DTM with the module, the following Prosoft DTMs will need to first be installed:

- EtherNet/IP CommDTM (Communication DTM)
- PLX51-HART-4I/4O (Gateway DTM)

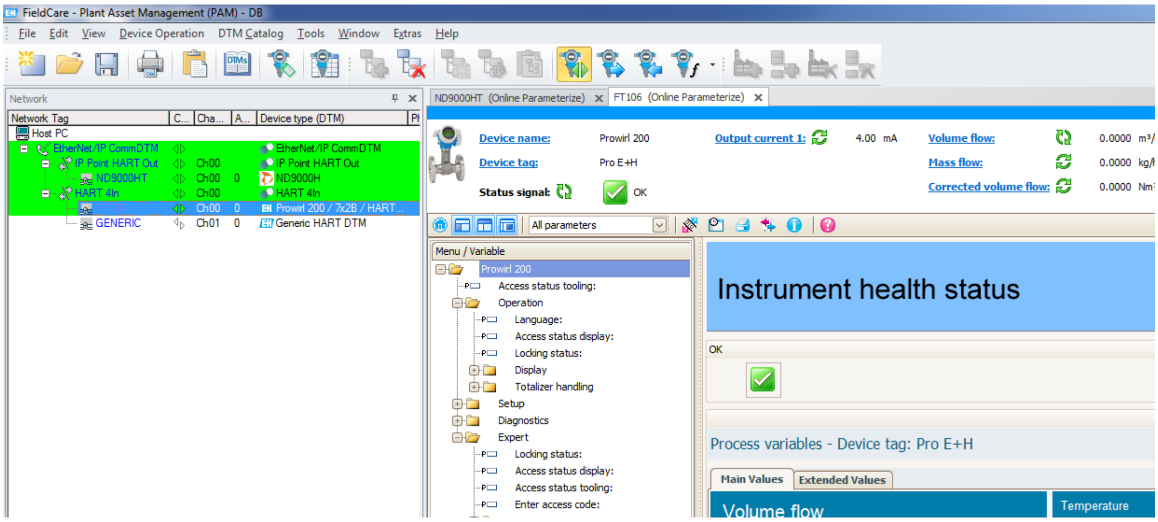


Figure 6.1 – FDT / DTM Example

7 What is HART?

7.1 Introduction to HART

HART is an acronym for Highway Addressable Remote Transducer. HART is able to transfer digital information across a standard 4-20 mA loop, by superimposing the digital data on the analog signal using Frequency Shift Keying (FSK). As the name implies FSK changes the frequency of the carrier to represent the binary data 0 or 1. A frequency of 1200 Hz represents a logical 1 and a frequency of 2200 Hz represents a logic 0. Therefore, HART has a maximum transfer rate of 1200 bits per second (bps).

The amplitude of the FSK modulation is typically 1mA. Due to the relatively high frequency in comparison to changes of the analog signal, a low pass filter can be employed to prevent the modulation from affecting the analog signal.

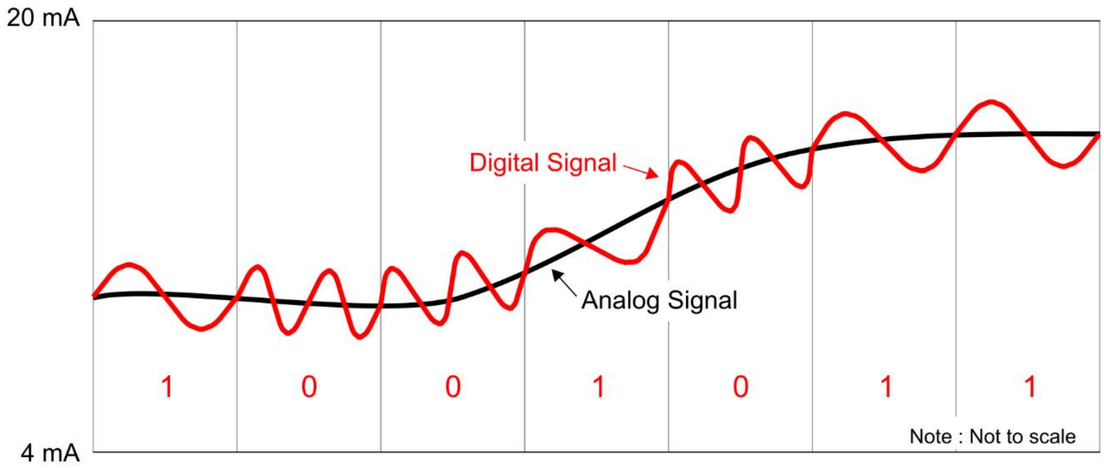


Figure 7.1. – HART FSK Modulation

7.2 HART Response Status

Table 7.1 - Status Decoding (when first byte bit 7 = 0)

If Byte 0 Bit 7 = 0 then:	
First Byte : Command Errors	
Value	Description
0	No error
1	(Undefined)
2	Invalid selection
3	Passed parameter too large
4	Passed parameter too small
5	Too few data bytes received
6	Transmitter specific error
7	In write-protect mode
8-15	Command specific error
16	Access restricted
32	Device is busy
64	Command not implemented
Second Byte : Device Status	
Bit	Description
0	PV out of limits
1	Variable (non-PV) out of limits
2	Analog output saturated
3	Output current fixed
4	(Undefined)
5	Cold Start
6	Configuration Changed

Table 7.2 - Status Decoding (when first byte bit 7 = 1)

If Byte 0 Bit 7 = 1 then:	
First Byte : Communication Errors	
Bit	Description
0	(Undefined)
1	Rx buffer overflow
2	(Undefined)
3	Checksum error
4	Framing error
5	Overrun error
6	Parity error
Second Byte : Not defined	
Value	Description
0	(Always zero)

8 Technical Specifications

8.1 Dimensions

Below are the enclosure dimensions as well as the required DIN rail dimensions. All dimensions are in millimeters.

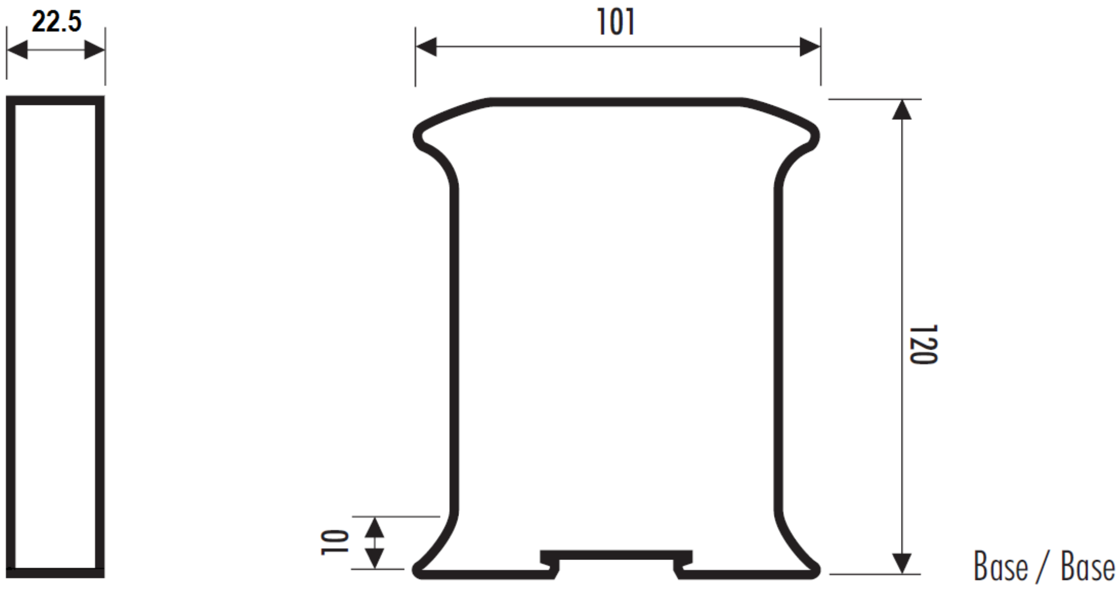


Figure 8.1 – Module enclosure dimensions

8.2 Electrical

Table 8.1 - Electrical specification

Specification	Rating
Power requirements	Input: 10 – 28V DC, 35mA @ 24 VDC – With no field devices attached. 130mA @ 24 VDC - With 4 field devices at 22mA each. 64 mA @12 VDC - With no field devices attached. 160mA @ 12 VDC - With 4 field devices at 22mA each.
Power consumption	0.9 W – With no field devices attached. 3.1 W – With 4 field devices at 22mA each. 4.3 W – With input channels shorted. (PLX51-HART-4I)
Connector (Power)	3-way terminal
Connector (Analog)	2-way terminal
Conductors	24 – 18 AWG
Enclosure rating	IP20, NEMA/UL Open Type
Temperature	-20 – 70 °C
Earth connection	Yes, terminal based
Emissions	IEC61000-6-4
ESD Immunity	EN 61000-4-2
Radiated RF Immunity	IEC 61000-4-3
EFT/B Immunity	EFT: IEC 61000-4-4
Surge Immunity	Surge: IEC 61000-4-5
Conducted RF Immunity	IEC 61000-4-6

8.3 Ethernet

Table 8.2 - Ethernet specification

Specification	Rating
Connector	RJ45
Conductors	CAT5 STP/UTP
ARP connections	Max 20
TCP connections	Max 20
CIP connections	Max 10
Communication rate	10/100Mbps
Duplex mode	Full/Half
Auto-MDIX support	Yes

8.4 Analog Input Channel (PLX51-HART-4I)

Table 8.3 - Analog Input channel specification

Specification	Rating
Number of channels	4
ADC resolution	12 bit
Input impedance	247.5 Ω
Accuracy (calibrated 25°C)	< 0.15 %
Accuracy (uncalibrated)	< 0.30 %
Range	0 – 22 mA
Current limit	34 mA

8.5 Analog Output Channel (PLX51-HART-4O)

Table 8.4 - Analog Output channel specification

Specification	Rating
Number of channels	4
DAC resolution	16 bit
Drive	50 – 1170 Ω Resistive < 50 mH Inductive
Accuracy (calibrated 25°C)	< 0.15 %
Accuracy (uncalibrated)	< 0.30 %
Range	0 – 22 mA

8.6 Certifications

Please visit our website: www.prosoft-technology.com.

9 Support, Service & Warranty

9.1 Contacting Technical Support

ProSoft Technology, Inc. is committed to providing the most efficient and effective support possible. Before calling, please gather the following information to assist in expediting this process:

1. Product Version Number
2. System architecture
3. Network details

If the issue is hardware related, we will also need information regarding:

1. Module configuration and associated ladder files, if any
2. Module operation and any unusual behavior
3. Configuration/Debug status information
4. LED patterns
5. Details about the interfaced serial, Ethernet or Fieldbus devices

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Latin America Regional Office	**Asia Pacific Regional Office**
Phone: +52.222.264.1814 ps.latinam@belden.com Languages spoken: English, Spanish, Portuguese REGIONAL TECH SUPPORT ps.support.la@belden.com	Phone: +60.3.2247.1898 ps.asiapc@belden.com Languages spoken: Bahasa, Chinese, English, Hindi, Japanese, Korean, Malay REGIONAL TECH SUPPORT ps.support.ap@belden.com

For additional ProSoft Technology contacts in your area, please see: www.prosoft-technology.com/About-Us/Contact-Us

9.2 Warranty Information

For details regarding ProSoft Technology's legal terms and conditions, please see: www.prosoft-technology.com/ProSoft-Technology-Legal-Terms-and-Conditions

For Return Material Authorization information, please see: www.prosoft-technology.com/Services-Support/Return-Material-Instructions