FLEX 5000 Analog Isolated Current/Voltage/HART Input and Output Modules

Catalog Numbers 5094-IF8IH, 5094-IF8IHXT, 5094-OF8IH, 5094-OF8IHXT

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Chapter 6

Analog HART Output Module Features

Chapter 7

Common Features of HART Integration

Chapter 8

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Configure HART Devices

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Calibrate the Module

Appendix A

Troubleshoot Your Module

Notes:

About This Publication

This manual describes how to use FLEX 5000™ analog I/O modules in Logix 5000™ control systems.

Make sure that you are familiar with the following:

- Use of a controller in a Logix 5000 control system
- Use of an EtherNet/IP™ network, if the analog I/O modules are installed in a remote location from the controller that is accessible via the EtherNet/IP network
- Studio 5000 Logix Designer® environment

IMPORTANT Remember the following when you use FLEX 5000 Analog HART I/O Modules:

- You cannot use FLEX 5000 I/O modules with all Logix 5000 controllers. For example, you can use FLEX 5000 I/O modules with CompactLogix™ 5380 and ControlLogix® 5580 controllers but not with CompactLogix 5370 and ControlLogix 5570 controllers.
  For the most current information on the Logix 5000 controllers with which you can use FLEX 5000 I/O modules, see the product description at rok.auto/flex5000IO.
- You must use the Studio 5000 Logix Designer application, **version 32.02 or later**, to configure the FLEX 5000 analog HART I/O modules.
- You must use the Studio 5000 Logix Designer application, **version 33.00 or later**, to support ControlLogix 5580 High Availability controllers.

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Updated software version requirements	9
Added software and firmware compatibility	11
Reorganized common features	29
Updated firmware revision requirements	32
Added dedicated digital input point description	39
Added digital input point features chapter	49
Added points category description	78
Corrected Output Ch0x category descriptions	83
Added diagnostic assemblies chapter	133
Added PlantPAx HART instruction compatible device connection	throughout

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
FLEX 5000 Analog 8-channel Isolated Current/Voltage/HART Input Modules Installation Instructions, publication 5094-IN020	Describes how to install and wire the 5094-IF8IH and 5094-IF8IHXT analog input modules.
FLEX 5000 Analog 8-channel Isolated Current/Voltage/HART Output Modules Installation Instructions, publication 5094-IN021	Describes how to install and wire the 5094-OF8IH and 5094-OF8IHXT analog output modules.
FLEX 5000 Terminal Base Assembly Modules Installation Instructions, publication 5094-IN010	Describes how to install and wire the terminal base assemblies for the FLEX 5000 system.
FLEX 5000 Modules Specifications Technical Data, publication 5094-TD001	Provides specifications for FLEX 5000 EtherNet/IP adapters and FLEX 5000 modules.
CompactLogix 5380 Controllers User Manual, publication 5069-UM001	Describes how to configure, operate, and troubleshoot CompactLogix 5380 controllers.
ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication 1756-UM543.	Describes how to configure, operate, and troubleshoot ControlLogix 5580 and GuardLogix® 5580 controllers.
FLEX 5000 Digital I/O Modules User Manual, publication 5094-UM001	Describes how to configure, operate, and troubleshoot FLEX 5000 digital I/O modules.
FLEX 5000 Analog I/O Modules User Manual, publication 5094-UM002	Describes how to configure, operate, and troubleshoot FLEX 5000 analog I/O modules.
FLEX 5000 EtherNet/IP Adapter User Manual, publication 5094-UM005	Describes how to configure, operate, and troubleshoot FLEX 5000 EtherNet/IP adapters
FLEX 5000 High-speed Counter I/O Modules User Manual, publication 5094-UM003	Describes how to configure, operate, and troubleshoot FLEX 5000 high-speed counter modules.
EtherNet/IP Communication Modules in 5000 Series Control Systems User Manual, publication ENET-UM004	Describes how to configure, operate, and troubleshoot the FLEX 5000 EtherNet/IP adapters.
Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001	Describes how to use electronic keying in Logix 5000 control system applications.
EtherNet/IP Network Devices User Manual, ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley® industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

FLEX 5000 HART I/O Modules

Logix 5000 controllers use FLEX 5000 analog HART I/O modules to control devices in a control system. The controllers access the modules over an EtherNet/IP network. FLEX 5000 analog HART I/O modules use terminal base (TB) assemblies to connect field-side wiring.

FLEX 5000 analog HART I/O modules connect a Logix controller to your process. HART input modules (5094-IF8IH, 5094-IF8IHXT) receive signals from process value transmitters and convert them to corresponding measurement values for use in the Logix controller (for example, temperature, flow, pressure, or pH). HART output modules (5094-OF8IH, 5094-OF8IHXT) provide current or voltage output signals that adjust the settings of valves and other devices in accord with desired process behavior.

Instruments that support the HART protocol allow several process parameters to be measured with one field device, provide status and diagnostics information, and allow remote configuration and troubleshooting.

FLEX 5000 analog HART I/O modules implement the Producer/Consumer network communication model for both the module itself and the HART devices that are attached to it. This communication is an intelligent data exchange between modules / HART devices and other system devices in which each module / HART device produces data without first being polled. You use the Studio 5000 Logix Designer application, version 32.02 or later, to configure the modules and HART devices.

Module and Software Compatibility

Controller and programming software compatibility requirements apply when you use FLEX 5000 standard and safety I/O modules. A module type and how it is used affect which requirements apply.

You must also consider Logix Designer application version requirements when you design your system. For example, you can use High Availability with only version 33 or greater of the Logix Designer application.

Firmware and Software Compatibility

- You must use the Studio 5000 Logix Designer application, version 32.02 or later, to configure the FLEX 5000 analog HART I/O modules.
- You must use the Studio 5000 Logix Designer application, version 33.00 or later, to support ControlLogix 5580 High Availability controllers.
- You must use module firmware 3.011 or later to support ControlLogix 5580 High Availability controller redundancy, and PlantPAx® HART instruction compatible device connection.

FLEX 5000 HART Module Feature Comparison

Table 1 describes the module firmware revision comparison for input modules.

Table 1 - FLEX 5000 HART Input Module Supported Features

FLEX 5000 HART Firmware Revision	Module	Supported features
2.0	5094-IF8IH, 5094-IF8IHXT	Analog input
		HART device connection
3.0	5094-IF8IH, 5094-IF8IHXT	Analog input
		HART device connection
		PlantPAx HART instruction compatible device connection
		Digital input (type 3 / type-3d support)
		ControlLogix 5580 High Availability controller

Table 2 describes the module firmware revision comparison for output modules.

Table 2 - FLEX 5000 HART Output Module Supported Features

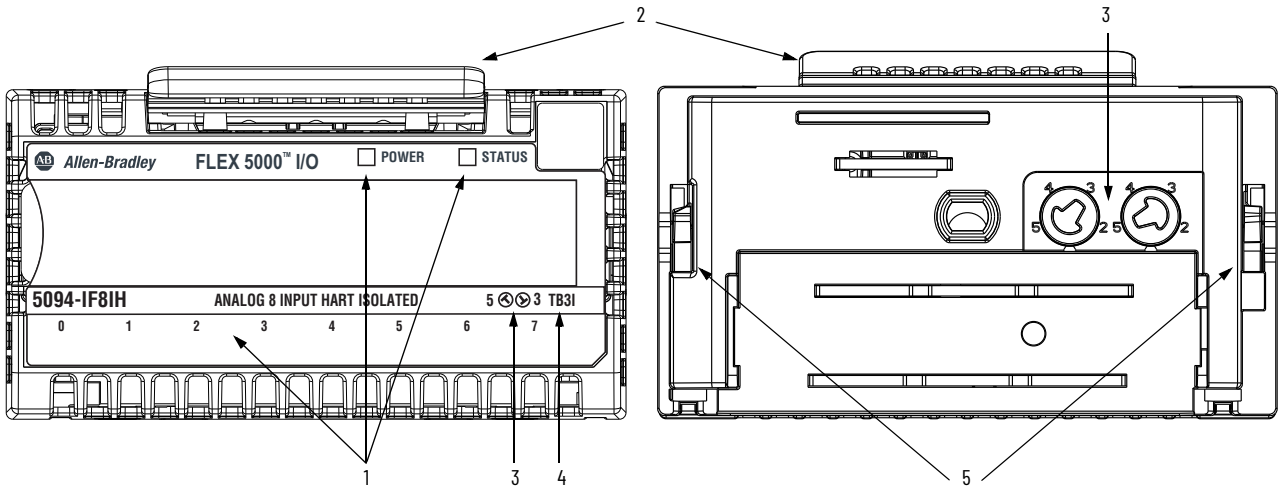
FLEX 5000 HART Firmware Revision	Module	Supported features
2.0	5094-OF8IH, 5094-OF8IHXT	Analog output
		HART device connection
3.0	5094-OF8IH, 5094-OF8IHXT	Analog output
		HART device connection
		PlantPAx HART instruction compatible device connection
		ControlLogix 5580 High Availability controller

IMPORTANT After upgrading your FLEX 5000 HART module firmware to the latest firmware revision, you need to wait 2 to 3 minutes before the channels reflect the upgrade and are ready to use.

Module Overview

Figure 1 shows the parts of an example FLEX 5000 analog HART I/O module.

Figure 1 - Example FLEX 5000 Analog HART I/O Module



Item	Description
1	**Status indicators** - Displays the status of communication, module health, and input/output devices. Indicators help with troubleshooting anomalies.
2	**Release lever** - Disengages the latching hooks to allow removal of the module from the terminal base assembly.
3	**Module keying** - Indicates the keying position the terminal base assembly must be configured to before installing the module.
4	**Terminal base** - Indicates the type of terminal base assembly to use with the module.
5	**Latching hooks** - Securely installs FLEX 5000 modules on the terminal base assembly.

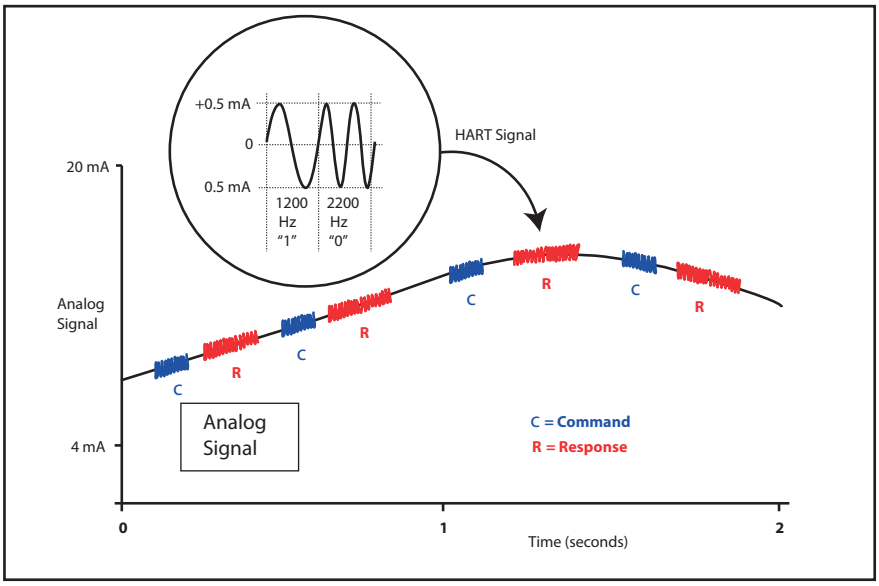
HART Communication

The HART field communication protocol is widely accepted in industry as a standard for digitally enhanced 4...20 mA communication with smart (microprocessor-based) field devices. A digital signal is superimposed on the 4...20 mA current loop to provide two means of communication from the device. The 4...20 mA analog channel lets the primary process variable be communicated at the fastest possible rate while the digital channel communicates multiple process variables, data quality, and device status. The HART protocol lets these simultaneous communication channels be used in a complementary fashion.

Figure 2[(1)] shows information about the HART protocol.

(1) This figure is from the HART Communication Protocol Specifications, April 2001, Revision 6.0, HART Communication Foundation. All Rights Reserved.

Figure 2 - HART Protocol



The Highway Addressable Remote Transducer (HART) protocol supports two-way digital communication, complements traditional 4...20 mA analog signals, and includes the following features:

- Predefined commands
  - Universal command
  - Common practice
  - Device specific
- Large installed base
- Worldwide support

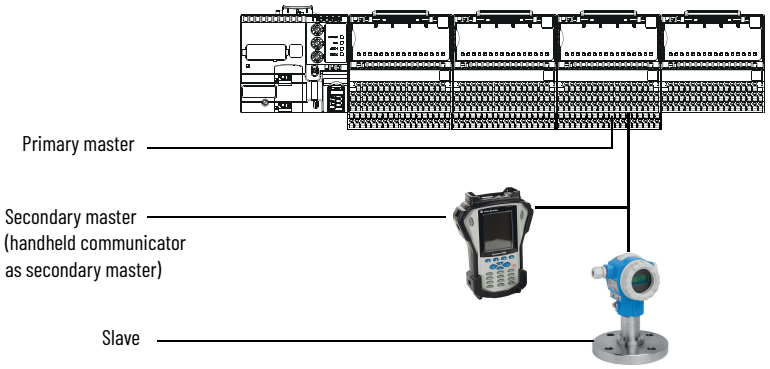
FLEX 5000 analog HART I/O modules support the HART protocol and perform these operations:

- Conversion of 4...20 mA analog signals to digital numeric values in engineering units (such as kg, m, or percent) that are used in the Logix controller.
- Conversion of digital numeric values in engineering units to 4...20 mA analog signals to control process devices.
- Producer/Consumer network communication model directly to each HART device.
- Automatic collection of dynamic process data from the connected HART device. For example, temperature, pressure, flow, or valve position.
- Automatic collection of device-specific variables from the connected HART device.
- Execution of commands through Studio 5000 Logix Designer using input and output tags.
- Facilitation of configuration and troubleshooting of the HART field device from your control room using FDT/DTM supported software.

With the FLEX 5000 analog HART I/O modules, both the controller and software for device maintenance and management can access field device data.

The FLEX 5000 analog HART I/O modules support command-response communication protocol in a point-to-point wiring architecture.

The FLEX 5000 analog HART I/O module is the primary master device and continuously obtains information from the connected HART devices. The secondary master can be used for device maintenance, for example a handheld communicator, as shown here.



Most 4...20 mA transmitters are available with a HART protocol interface. The type of data available depends on the type of instrument.

An example application is a HART enabled mass flowmeter. The standard mA signal from the flowmeter provides one primary measurement - flow. The mA signal with HART provides more process information. The mA signal that represents flow is still available. The HART configuration of the flowmeter can be set to communicate primary variable (PV), secondary variable (SV), tertiary variable (TV), and quaternary variable (QV). These values can represent mass flow, static pressure, temperature, total flow, and other conditions.

Dynamic variables, device-specific variables, device status, and command execution are all available through input and output controller tags in Studio 5000 Logix Designer.

Device status information is also provided through HART.

HART connectivity provides all this information with no changes to the existing 4...20 mA wiring.

FDT/DTM technology through HART connectivity is supported and also provides remote configuration and troubleshooting of HART devices through software.

HART-enabled I/O Modules

The FLEX 5000 analog HART I/O modules have built-in HART modems, so there is no need to install external HART multiplexers or clip-on HART modems. The 5094-IF8IH, 5094-OF8IHXT, 5094-OF8IH, and 5094-OF8IHXT modules have separate HART modems for each channel.

HART implementation in 5094 provides a connection between the controller and each HART device.

A HART device that is configured in a 5094 I/O module supports a configurable connection that can include up to four Dynamic Variables, eight Device Variables, and four HART Commands.

Notes:

Analog HART I/O Module Operation in a Logix 5000 Control System

IMPORTANT Remember the following when you use FLEX 5000 Analog HART I/O Modules:

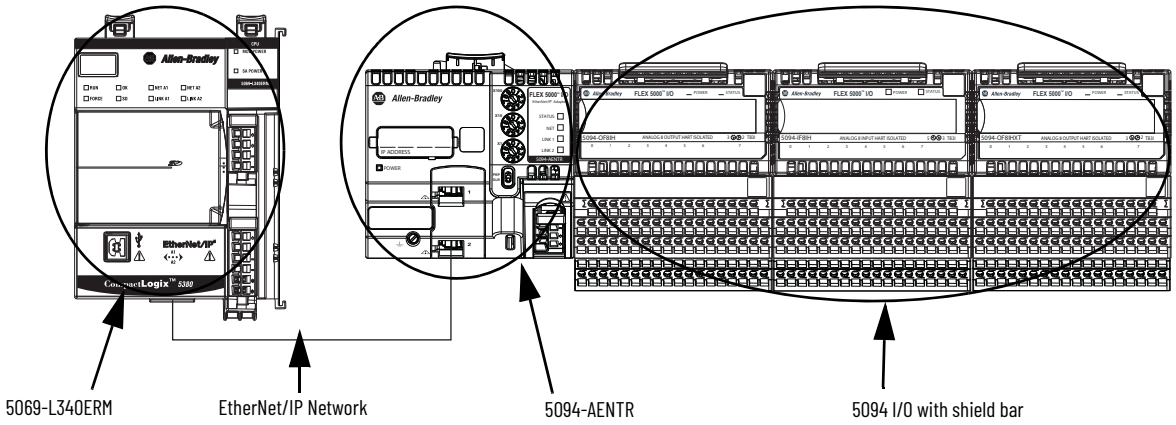
- You cannot use FLEX 5000 I/O modules with all Logix 5000 controllers. For example, you can use FLEX 5000 I/O modules with CompactLogix 5380 and ControlLogix 5580 controllers but not with CompactLogix 5370 and ControlLogix 5570 controllers.
  For the most current information on the Logix 5000 controllers with which you can use FLEX 5000 I/O modules, see the product description at rok.auto/flex5000IO.
- You must use the Studio 5000 Logix Designer application, **version 32.02 or later**, to configure the FLEX 5000 analog HART I/O modules.
- You must use the Studio 5000 Logix Designer application, **version 33.00 or later**, to support ControlLogix 5580 High Availability controllers.

Remote I/O Modules

You use FLEX 5000 analog HART I/O modules as remote I/O modules that are accessible via an EtherNet/IP network. The modules are installed to the right of a FLEX 5000 EtherNet/IP adapter.

Logix 5000 controllers can exchange data with the modules over the network.

Figure 3 - FLEX 5000 I/O Modules in a Logix 5000 Control System



Before You Begin

Before you use your analog HART I/O module, you must complete the following:

a. Install a FLEX 5000 EtherNet/IP adapter.
b. Install the FLEX 5000 I/O modules to the right of adapter.
c. Install an EtherNet/IP network.
d. Install the Logix 5000 controller that accesses the FLEX 5000 I/O modules via an EtherNet/IP network.

Make sure that you have enough FLEX 5000 terminal base (TB) assemblies to satisfy your application needs. For more information, see the FLEX 5000 Terminal Base Assembly Modules Installation Instructions, publication 5094-IN010.

IMPORTANT	TBs are not included with your module and are not available for purchase. TBs consist of a mounting base (MB) and removable terminal block (RTB). You must purchase MBs and RTBs separately and assemble them together.

Types of Analog I/O Modules

Table 3 describes the types of FLEX 5000 analog HART I/O modules.

Table 3 - FLEX 5000 Analog HART I/O Modules

Cat. No.	Description
5094-IF8IH, 5094-IF8IHXT	8-channel isolated current/voltage/HART input module
5094-OF8IH, 5094-OF8IHXT	8-channel isolated current/voltage/HART output module

Power the Modules

FLEX 5000 analog HART I/O modules receive the following power types:

- System-side power that powers the system and lets modules transfer data and execute logic. System-side power is also known as Backplane power.
- Field-side power that powers field-side devices that are connected to some FLEX 5000 I/O modules. Field-side power is also known as SA power.

System-side power begins at the FLEX 5000 EtherNet/IP adapter and passes across the FLEX 5000 module internal circuitry via terminal base power bus, that is, Backplane power.

Field-side power, that is, SA power begins at the first terminal base assembly and can be daisy chained to the next terminal base assembly on the right. You can also install a separate field-side power source to each terminal base assembly.

For more information on how to power FLEX 5000 analog HART I/O modules, see the FLEX 5000 EtherNet/IP Adapter User Manual, publication 5094-UM005.

SA Power Requirements

Take note of the following when supplying SA power to your system:

- You must limit the SA field-side power source to 10 A, max, at 18...32V DC.
- Confirm that the external module power supply is adequately sized for the total module power bus current draw in the system.
- For example, if the total module power current draw, including current inrush requirements, is 5 A, you can use a module power supply that is limited to 5 A.
- You must use SELV-listed power supplies for module power if there are functional safety modules that are connected to the FLEX 5000 I/O family.
- Not all power supplies are certified for use in all applications, for example, nonhazardous and hazardous environments.
- Isolated source power of up to 25 mA available from the module to simplify the channel to channel isolation wiring for current sensors.

IMPORTANT We recommend that you use separate external power supplies for the adapter and the adjacent terminal base. This practice can prevent unintended consequences that can result if you use one supply.

Ownership

Every I/O module in a Logix 5000 control system must be owned by a controller, also known as the owner-controller. When the FLEX 5000 Analog HART I/O modules are used in a Logix 5000 control system, the owner-controller performs the following:

- Stores configuration data for every module that it owns.
- Can reside in a location that differs from the FLEX 5000 I/O modules.
- Sends the I/O module configuration data to define module behavior and begin operation in the control system.

Each FLEX 5000 Analog HART I/O module must continuously maintain communication with its owner-controller during normal operation.

FLEX 5000 Analog HART I/O modules are limited to one owner-controller.

Configure Analog HART I/O Modules

You must create a Studio 5000 Logix Designer application project for the Logix 5000 controller that owns the FLEX 5000 analog HART I/O modules and attached HART devices. The project includes module configuration data for the FLEX 5000 Analog HART I/O modules.

The Studio 5000 Logix Designer application transfers the project to the owner-controller during the program download. Data is then transferred to the FLEX 5000 analog HART I/O modules over the EtherNet/IP network.

The FLEX 5000 analog HART I/O modules can operate immediately after receiving the configuration data.

Connections

During module configuration, you must define the module. Among the Module Definition parameters, you must choose a connection type for the module. A connection is a real-time data transfer link between the owner-controller and the module that occupies the slot that the configuration references.

During HART device configuration, you must define the input and output tags for any connected HART device.

When you download module configuration to a controller, the controller attempts to establish a connection to each module in the configuration.

Because part of module configuration includes a slot in the FLEX 5000 I/O system, the owner-controller checks for the presence of a module or connected HART device there. If a module or HART device is detected, the owner-controller sends the configuration. One of the following occurs:

- If the configuration is appropriate to the module or HART device that is detected, a connection is made and operation begins.
- If the configuration is not appropriate to the module or HART device that is detected, the data is rejected and the Studio 5000 Logix Designer application indicates that an error occurred.

  The configuration can be inappropriate for many reasons. For example, a mismatch in electronic keying that helps prevents normal operation.

The owner-controller monitors its connection with a module and HART devices. Any break in the connection, for example, the loss of power to the FLEX 5000 I/O system, causes a fault. The Studio 5000 Logix Designer application monitors the fault status tags to indicate when a fault occurs on a module or HART device.

Connection Types Available with FLEX 5000 Analog HART I/O Modules

When configuring an analog HART input or output module, you must define the module. Connection is a required parameter in the Module Definition. The choice determines what data is exchanged between the owner-controller and the module.

For more information on configuring the I/O modules, see Configure the Module on page 71.

Table 4 describes the connection types that you can use with FLEX 5000 analog HART I/O modules.

Table 4 - Connections - HART I/O Modules

Connection Type	Description	
	HART Input Modules	**HART Output Modules**
Data	The module returns the following to the owner-controller: General fault data Input data	The module returns the following to the owner-controller: General fault data Output data
Listen Only	When a Listen Only data connection is used, another controller owns the module. A controller that makes a Listen Only connection to the module does not write configuration for the module. It merely listens to the data exchanged with the owner-controller. **IMPORTANT**: If a controller uses a Listen Only connection, the connection must use the Multicast option. For more information on Listen Only connections, see Listen Only Mode on page 25. In this case, all other connections to the module, for example, the connection to the owner-controller must also use the Multicast option.	

Data Types Available with FLEX 5000 Analog HART I/O Modules

The Module Definition includes a Data parameter that matches the module type. Input modules use Input Data, and output modules use Output Data.

The available Data parameter choices are as follows:

- 5094-IF8IH and 5094-IF8IHXT – The Input Data choice is either Analog, Analog and Discrete, or Discrete.
- 5094-OF8IH and 5094-OF8IHXT – The Output Data choice is always Analog.

For more information on the Connection and Data parameter choices available with FLEX 5000 I/O modules, see the Studio 5000 Logix Designer application.

Requested Packet Interval

The Requested Packet Interval (RPI) is a configurable parameter that defines a specific rate at which data is exchanged between the owner-controller and the module.

You set the RPI value during initial module configuration and can adjust it as necessary after module operation has begun. Valid RPI values for analog HART I/O modules are 0.2...750 ms. Valid RPI values for HART devices are 500...9999.9 ms.

IMPORTANT If you change the RPI while the project is online, the connection to the module is closed and reopened in one of the following ways:

- You inhibit the connection to the module, change the RPI value, and uninhibit the connection.
- You change the RPI value. In this case, the connection is closed and reopened immediately after you apply the change to the module configuration.

For more information on guidelines for specifying RPI rates, see the Logix 5000 Controllers Design Considerations Reference Manual, publication 1756-RM094.

Connection Over an EtherNet/IP Network

During module and connected HART device configuration, you must configure the Connection over EtherNet/IP parameter. The configuration choice dictates how input data is broadcast over the network.

The FLEX 5000 analog HART I/O modules use one of the following methods to broadcast data:

- Multicast - Multicast connections deliver information from one sender to multiple receivers simultaneously.
  Copies of one transmission are passed to a selected subset of possible destinations.
- Unicast - Unicast connections are point-to-point transmissions between a source node and destination node on the network.
  A transmission is sent to one destination controller depending on the module configuration.

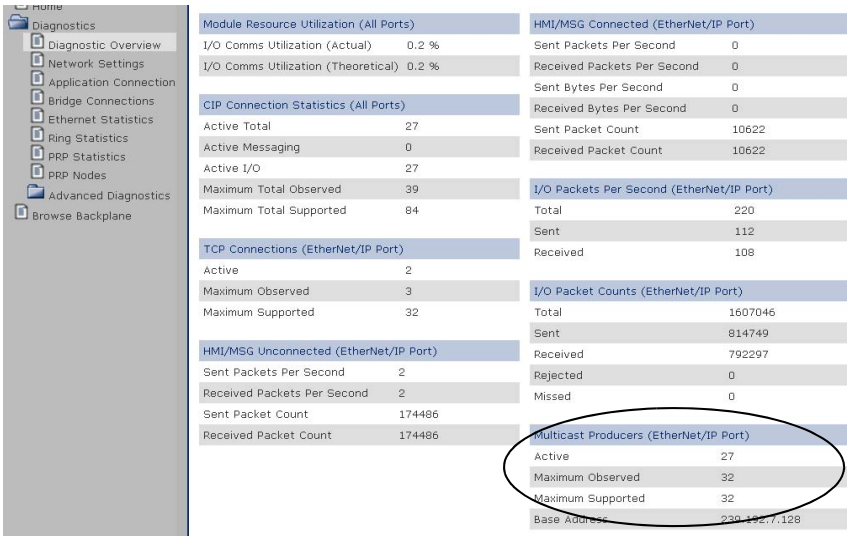
Unicast is the default setting. We recommend that you use Unicast because it reduces network bandwidth usage. However, if you are using a ControlLogix 5580 High Availability controller, you must use multicast.

Multicast is more efficient than sending multiple unicast streams to multiple notes. Use multicast in the following situations:

- FLEX 5000 I/O is used in a Redundancy application
- Communication is with multiple destinations

IMPORTANT When using a ControlLogix 5580 High Availability controller, a HART modules occupies 1 multicast connection and HART devices occupy up to 4 multicast connections. These connections total a maximum of 5 connections per HART module and limits the adapter to a maximum of 6 HART modules.

You can verify how many multicast connections are on your network by looking at your adapter Diagnostic Overview web page.



Input Module Operation

Logix 5000 controllers do not poll the FLEX 5000 analog input modules for input data. Instead, the input modules send their input data, that is channel and status data, at the RPI.

At the RPI, not only does the module send input data to the controller, but also the controller sends data to the module inputs. For example, the controller sends data to command the module to unlatch alarms or enable alarms.

FLEX 5000 analog input modules reside in a FLEX 5000 I/O system that is accessible to a Logix 5000 controller over an EtherNet/IP network. A FLEX 5000 EtherNet/IP adapter is the first component in a FLEX 5000 I/O system and connects the system to the EtherNet/IP network.

FLEX 5000 analog input modules communicate input data to the FLEX 5000 EtherNet/IP adapter at the defined RPI. The input data consists of channel and status data.

At the RPI, the following events occur.

1. The remote analog input module scans its channels for input data.
2. The module sends the data to the FLEX 5000 EtherNet/IP adapter.
3. The FLEX 5000 EtherNet/IP adapter in the FLEX 5000 I/O system sends the data over the EtherNet/IP network.
4. One of the following:
   - If the controller is directly connected to the EtherNet/IP network, it receives the input data immediately.
   - If the controller is connected to the EtherNet/IP network through another communication module, the module sends the data to its backplane and the controller receives it.

Output Module Operation

The controller sends data to an output module at the RPI or after an Immediate Output (IOT) instruction is executed.

The RPI defines when the controller sends data to the FLEX 5000 analog output module and when the output module reads back data. The controller sends data to an output module only at the RPI.

At the RPI, not only does the controller send data to the output module, but also the output module sends data to the controller. For example, the output module sends an indication of the channel data quality.

FLEX 5000 analog input modules reside in a FLEX 5000 I/O system that is accessible to a Logix 5000 controller over an EtherNet/IP network. A FLEX 5000 EtherNet/IP adapter is the first component in a FLEX 5000 I/O system and connects the system to the EtherNet/IP network.

FLEX 5000 analog output modules receive output data from a controller. The output module also sends data to the controller.

Controller to Remote Analog Output Module Data Transmission

The controller broadcasts data to its local backplane at one of the following:

- RPI
- An IOT instruction is executed.

IMPORTANT An IOT instruction sends data to all output modules in the system immediately, and resets the RPI timer.

Based on the RPI rate and the length of the controller program scan, the output module can receive and readback data multiple times during one program scan.

When the RPI is less than the program scan length, the output channels can change values multiple times during a program scan. The owner-controller does not depend on the program scan to complete to send data.

These events occur when the controller sends data to a FLEX 5000 output module.

1. Data is sent in one of the following ways:
   - If the controller is directly connected to the EtherNet/IP network, it broadcasts data to the network.
     In this case, skip to step 3.
   - If the controller is connected to the EtherNet/IP network via a communication module, the controller transmits the data to the backplane.
     In this case, proceed to step 2.
2. The EtherNet/IP communication module transmits the data to the EtherNet/IP network.
3. The FLEX 5000 EtherNet/IP adapter in the FLEX 5000 I/O system receives the data from the network and transmits it to the backplane.
4. The remote analog output module receives the data from the backplane and behaves as dictated by its configuration.

Remote Analog Output Module to Controller Data Transmission

When a FLEX 5000 analog output module receives new data and the requested data value is present on the RTB, the output module sends, or reads back a data value back to the controller and to the rest of the control system. The data value corresponds to the signal present at its terminals. This feature is called Output Readback.

In addition to the Output Readback, the output module sends other data to the controller at the RPI. For example, the module alerts the controller if a short circuit condition exists on the module.

The following events occur when a remote FLEX 5000 analog output module sends data to the controller at the RPI.

1. The module sends the data to the backplane.
2. The FLEX 5000 EtherNet/IP adapter in the FLEX 5000 I/O system sends the data over the EtherNet/IP network.
3. One of the following:
   - If the controller is directly connected to the EtherNet/IP network, it receives the input data from the network without need for a communication module.
   - If the controller is connected to the EtherNet/IP network through another communication module, the module transmits the data to its backplane and the controller receives it.

Listen Only Mode

Any controller in the system can listen to the data from an I/O module. An owner-controller, as described in Ownership on page 19, exchanges data with analog I/O modules.

Other controllers can use a Listen Only connection with the analog I/O module. In this case, the 'listening' controller can only listen to input data or output readback data. The listening controller does not own the module configuration or exchange other data with the module.

During the I/O configuration process, you can specify a Listen Only connection. For more information on Connection options, see Input Module Definition on page 76.

IMPORTANT Remember the following:

- If a controller uses a Listen Only connection, the connection must use the Multicast option. In this case, all other connections to the module, for example, the connection of the owner-controller, must also use the Multicast option.
- If a controller attempts to use a Listen Only connection to a module but the owner-controller connection uses the Unicast option, the attempt at a Listen Only connection fails.
  The 'Listen Only' controller receives data from the module as long as a connection between an owner-controller and module is maintained.
- If the connection between an owner-controller and the module is broken, the module stops sending data and connections to all 'listening controllers' are also broken.
- Connected HART devices cannot be added to Listen Only connections.

Protected Operations

To maintain the secure operation of your FLEX 5000 analog HART I/O module, operations that can disrupt module operation are restricted based on the module operating mode. Table 5 describes the restrictions.

Table 5 - Protected Operations on FLEX 5000 Analog HART I/O Modules

Current Module Operation	Activity							
	Firmware Update Request	Module Reset Request	Module Calibration Request(3)	Connection Request	Configuration Change	Connection or Data Format Change	Electronic Keying Change	RPI Change
Connection not running	Accepted							
Connection running	Rejected(1)			Accepted(4)	Accepted(5)	Not allowed(6)	Accepted(7)	
Firmware update is in process	Rejected							
Calibration is in process	Accepted(2)							

(1) A module calibration request is accepted when the module is connected and the owner-controller is in Program mode.
(2) The module accepts the requests and changes listed. Keep in mind, when the request or change is made, the calibration process is automatically aborted. We recommend that you wait for the module calibration to finish before attempting any of the requests or changes.
(3) When the request is made through the Module Properties dialog box.
(4) Only requests for Listen Only connections are accepted.
(5) Configuration change is accepted in the following scenarios:
- Changes are made in the Module Properties dialog box and you click Apply.
- Changes are made in the Configuration tags and you send a Reconfigure Module MSG to the module.
(6) The difference between Rejected and Not allowed is that rejected activities can be attempted in the Studio 5000 Logix Designer application but do not take effect. The activities that are not allowed, that is, attempts to change the Connection or Data Format used, do not occur in the Studio 5000 Logix Designer application.
For example, if you attempt to reset a module that is connected to the owner-controller, the Studio 5000 Logix Designer application executes the request and alerts you that it was rejected. If you attempt to change the data format on a module that is connected to an owner-controller, the Studio 5000 Logix Designer application does not execute the attempted change. The application only alerts you that the change is not allowed. In the case, if the change is attempted online, the Module Definition dialog box field that changes the data format is disabled.
(7) The change occurs after the connection is closed and reopened. You can close and reopen the connection in the following ways:
- Change the project while it is offline and download the updated project before going online again.
- Change the project while it is online and click Apply or OK in the Module Properties dialog box. In this case, before the change is made, a dialog box alerts you of the ramifications before the change is made.

HART Device Operation

Before using the HART capabilities, be sure that:

- the I/O module and the associated field device are working properly in the analog 4...20 mA mode.
- the channel is configured as 4...20 mA range with HART enabled.
- the field device is HART capable.
- no more than one HART field device is connected to each channel.
- Notch Filter of input channel or Ramping Rate of output channel is set to a valid value.

Input data of HART device, that is device status, dynamic, or device variable values and status, are sent to Logix Controller at the RPI.

At the RPI, not only does the module send input data of the HART devices to the controller, but also the controller sends data for the HART devices to the module. For example, the controller sends data to reset Configuration Changed status or initiate an execution of a pre-configured HART command.

IMPORTANT If you switch the controller to Program mode or inhibit an output module, it may cause the output channels to de-energize and the HART device to not power up.

To power up the HART device, switch the controller to Run mode and uninhibit the output module.

Protected Operations for HART Devices

To maintain the secure operation of your HART device, operations that can disrupt module operation are restricted based on the module operating mode. Table 6 describes the restrictions.

Table 6 - Protected Operations on HART Devices

Current Module Operation	Activity					
	Device Reset Request	Connection Request	Device Configuration Change	Device Connection or Data Format Change	Electronic Keying Change	RPI Change
Connection not running	Accepted					
Connection running	Rejected		Accepted(1)	Not allowed(2)	Accepted(3)	

(1) Device Configuration change is accepted if changes are made using FTD/DTM, handheld device, and HART commands.
(2) The difference between Rejected and Not allowed is that rejected activities can be attempted in the Studio 5000 Logix Designer application but do not take effect. The activities that are not allowed, that is, attempts to change the Connection or Data Format used, do not occur in the Studio 5000 Logix Designer application.
For example, if you attempt to reset a module that is connected to the owner-controller, the Studio 5000 Logix Designer application executes the request and alerts you that it was rejected. If you attempt to change the data format on a module that is connected to an owner-controller, the Studio 5000 Logix Designer application does not execute the attempted change. The application only alerts you that the change is not allowed. In the case, if the change is attempted online, the Module Definition dialog box field that changes the data format is disabled.
(3) The change occurs after the connection is closed and reopened. You can close and reopen the connection in the following ways:
- Change the project while it is offline and download the updated project before going online again.
- Change the project while it is online and click Apply or OK in the Module Properties dialog box. In this case, before the change is made, a dialog box alerts you of the ramifications before the change is made.
- RPI changes applied to one channel applies the same change to all channels in the configuration section.

Notes:

Common I/O Module Features

This chapter describes module features that are available on both FLEX 5000 HART input and output modules.

FLEX 5000 analog HART input modules convert an analog signal to a digital value. For example, the modules can convert the following:

- Volts
- Milliamps

You can configure FLEX 5000 HART input modules to support digital input signals when your application requires channel to channel isolation. The following types of discrete device types are supported:

- Digital Input
- IEC 61131-2 Type 3-d Digital Input

For information on digital input points, see Chapter 5

FLEX 5000 analog HART output modules convert a digital value to an analog signal. For example, the modules can convert the following:

- Volts
- Milliamps

FLEX 5000 analog HART enabled modules decodes HART information from signal embedded within the channel.

Software Configurable

You use the Studio 5000 Logix Designer application to configure the module, monitor system operation, and troubleshoot issues. You can also use the Studio 5000 Logix Designer application to retrieve the following information from any module in the system:

- Serial number

- Firmware revision information
- Product code
- Vendor
- Error and fault information
- Diagnostic information

By minimizing the need for tasks, such as setting hardware switches and jumpers, the software makes module configuration easier and more reliable.

Fault and Status Reporting

The FLEX 5000 analog HART I/O modules report fault and status data along with channel data. Fault and status data is reported in the following ways:

- Studio 5000 Logix Designer application
- Module status indicators

For more information on fault reporting, see the individual module feature chapters and Appendix A, Troubleshoot Your Module on page 107.

Module Inhibiting

Module inhibiting lets you indefinitely suspend a connection, including Listen Only connections, between an owner-controller and an analog I/O module without removing the module from the configuration. This process lets you temporarily disable a module, such as to perform maintenance.

IMPORTANT Once a module is inhibited, the connections to the module and attached HART devices are also closed and the CIP messaging to the HART devices is disabled.

You can use module inhibiting in the following ways:

- You write a configuration for an I/O module but inhibit the module to help prevent it from communicating with the owner-controller. The owner does not establish a connection and the configuration is not sent to the module until the connection is uninhibited.
- In your application, a controller already owns a module, has downloaded the configuration to the module, and is exchanging data over the connection between the devices.

You can use module inhibiting in these instances:

- You want to update an analog I/O module, for example, update the module firmware revision. Use the following procedure.
  a. Inhibit the module.
  b. Perform the update.
  c. Uninhibit the module.
- You use a program that includes a module that you do not physically possess yet. You do not want the controller to look for a module that does not yet exist. In this case, you can inhibit the module in your program until it physically resides in the proper slot.

To see where to inhibit a FLEX 5000 analog HART I/O module, see page 77.

Electronic Keying

Electronic Keying reduces the possibility that you use the wrong device in a control system. It compares the device that is defined in your project to the installed device. If keying fails, a fault occurs. These attributes are compared.

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, analog I/O module.
Product Code	The specific type of the product. The Product Code maps to a catalog number.
Major Revision	A number that represents the functional capabilities of a device.
Minor Revision	A number that represents behavior changes in the device.

The following Electronic Keying options are available.

Keying Option	Description
Compatible Module	Lets the installed device accept the key of the device that is defined in the project when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has the following characteristics: Same catalog number Same or higher Major Revision Minor Revision as follows: If the Major Revision is the same, the Minor Revision must be the same or higher. If the Major Revision is higher, the Minor Revision can be any number. Non-XT and XT version as follows: You can use an XT version of the module in place of a non-XT module. You **cannot** use a non-XT version of the module in place of an XT module.
Disable Keying	Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project. **WARNING**: Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We **strongly recommend** that you **do not use** Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.
Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.

Carefully consider the implications of each keying option when selecting one.

IMPORTANT Changing Electronic Keying parameters online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken.

If an I/O connection to a device is interrupted, the result can be a loss of data.

More Information

For more detailed information on Electronic Keying, see Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001.

Producer/Consumer Communication

FLEX 5000 analog HART I/O modules use the Producer/Consumer communication model to produce data without a controller polling them first. The modules produce the data and controllers consume it. That is, the owner-controller and controllers with a Listen Only connection to the module can consume it.

When an input module produces data, the controllers can consume the data simultaneously. Simultaneous data consumption eliminates the need for one controller to send the data to other controllers.

IMPORTANT Keep in mind, **only one controller** can own the I/O module. The FLEX 5000 analog I/O modules do not support multiple owners of the same module.

Other controllers must use a Listen Only connection to the module.

Status Indicators

Each FLEX 5000 analog HART I/O module has a status indicator on the front of the module that lets you check the health and operational status of a module. The status indicator displays vary for each module.

For more information on status indicators, see Appendix A, Troubleshoot Your Module on page 107.

Use CIP Sync Time with I/O Modules

CIP Sync™ is a CIP™ implementation of the IEEE 1588 PTP (Precision Time Protocol). CIP Sync provides accurate real-time (Real-World Time) or Universal Coordinated Time (UTC) synchronization of controllers and devices that are connected over CIP networks. This technology supports highly distributed applications that require timestamping, sequence of events recording, distributed motion control, and increased control coordination.

The 5094-IF8IH module is a CIP Sync slave-only device. There must be another module on the network that functions as a master clock. For more information on how to use CIP Sync technology, see the Integrated Architecture® and CIP Sync Configuration Application Technique, publication IA-AT003.

I/O modules can be used to capture timestamps. The advantage is that CIP Sync is system-wide, so timestamp values are consistent across all modules in the system.

Module Firmware

The FLEX 5000 analog HART I/O modules are manufactured with module firmware installed. If updated module firmware revisions are available in the future, you can update the firmware.

Updated firmware revisions are made available for various reasons, for example, to correct an anomaly that existed in previous module firmware revisions.

IMPORTANT PlantPAx connection and digital input mode support require firmware revision 3.0 or later.

You access updated firmware files at the Rockwell Automation Product Compatibility and Download Center (PCDC) at rok.auto/pcdc.

At the PCDC, you can use the module catalog number to check for firmware updates. If the catalog number is not available, no updates exist then.

Common Analog Channel Features

FLEX 5000 analog HART input and output channels share the following features:

- Rolling Timestamp of Data
- Floating Point Data Format
- Calibration
- Module Data Quality Reporting
- Alarm Latching
- Scaling
- Data Offset
- Module Accuracy

Rolling Timestamp of Data

The rolling timestamp is a continuously running 15-bit rolling timestamp that counts in milliseconds from 0…32,767 ms.

The rolling timestamp value is reported in the *I.Chox.RollingTimestamp* tag for the FLEX 5000 analog HART I/O modules.

Rolling Timestamp with the 5094-IF8IH Module

For FLEX 5000 analog HART input modules, whenever a module scans its channels, it also records the value of RollingTimestamp at that time. The controller program uses the last two rolling timestamp values to calculate the amount of time between the samples.

A system time change can cause a slight change in input sample timing. The rolling timestamp accurately reflects the change.

There can be jitter in the timing between samples before and after the system time change.

Rolling Timestamp with the 5094-OF8IH Module

For the FLEX 5000 analog HART output modules, the rolling timestamp value is updated when the output readback data signals are scanned.

IMPORTANT Rolling Timestamp is not the same as CIP Sync timestamp. For more information on CIP Sync timestamp, see Use CIP Sync Time with I/O Modules on page 32.

Floating Point Data Format

The FLEX 5000 analog HART I/O modules return channel data to the controller in the IEEE 32-bit floating point data format. In your Studio 5000 Logix Designer application, the data type is REAL.

The floating point data format lets you change the data representation of the selected channel. Although the full range of the module does not change, you

can scale your module to represent I/O data in specific terms for your application.

For more information on using scaling, see page 36.

Calibration

The FLEX 5000 analog HART I/O modules use precise analog components that maintain their specifications over time. The modules are calibrated via the following methods:

- Factory calibration when the modules are built.
- User-executed calibration.

For more information on how to calibrate a module, see Chapter 10, Calibrate the Module on page 99.

Digital inputs do not require calibration.

Module Data Quality Reporting

The FLEX 5000 analog HART I/O modules indicate the quality of channel data that is returned to the owner-controller. Data quality represents accuracy. Levels of data quality are reported via module input tags.

The following inputs indicate the level of data quality.

- I.Ch0x.Fault - This tag indicates that the reported channel data is inaccurate and cannot be trusted for use in your application. Do not use the reported channel data for control.

  If the tag is set to 1, you cannot trust the data reported. You must troubleshoot the module to correct the cause of the inaccuracy.

  Example causes of inaccurate data include the following:

  - Channel is disabled
  - Open Wire condition (input modules)
  - No Load condition (output modules)
  - Underrange/Overrange condition (input modules)
  - Short Circuit condition
  - Field Power Loss condition

  We recommend that you troubleshoot the module for the typical causes first.
- I.Ch0x.Uncertain - This tag indicates that the reported channel data can be inaccurate but the degree of inaccuracy is unknown. We recommend that you do not use the reported channel data for control.

  If the tag is set to 1, you know that the data can be inaccurate. You must troubleshoot the module to discover what degree of inaccuracy exists.

Example causes of uncertain data include the following:

- Data signal slightly outside the channel operating range
- The channel is over temperature
- Invalid sensor offset value
- Calibration fault on the channel
- Calibration is in process on the channel – Active calibration process on one channel can cause an indication of Uncertain data quality on other module channels simultaneously.

We recommend that you monitor the tags in your program to make sure that the application is operating as expected with accurate channel input data.

IMPORTANT Once the condition that causes the Fault or Uncertain tag to change to 1 is removed, the tag automatically resets to 0. The Studio 5000 Logix Designer application controls the tags. You cannot change the status of the tags.

Keep in mind that in some system configurations, the tag is not reset immediately after the condition is removed. The tag typically resets after a small delay.

Alarm Latching

When enabled, Alarm Latching lets you latch a module alarm in the set position once the alarm is triggered. The alarm remains set even if the condition causing it to occur disappears, until the alarm is unlatched.

Alarm latching is available on a per channel basis. You can latch the following alarms:

- Input modules - Process and Rate alarms
- Output modules - Clamp and Rate alarms

For more information on latching alarms on FLEX 5000 analog HART I/O modules, see the module-specific chapters and Chapter 8, Configure the Module on page 71.

Enable Latching

You can enable alarm latching in the following ways:

- Module Properties dialog box – To see where to latch alarms, see the following:
  - Input modules – *Alarms* category
  - Output modules – *Limits* category

  For more information on how to use the Module Properties dialog box, see Chapter 8, Configure the Module on page 71.
- Module tags – The alarm type determines which tag to change.

  For more information on module tags and how to use them, see Appendix B, Module Tag Definitions on page 117.

Unlatch Alarms

IMPORTANT Before you unlatch an alarm, make sure the condition that triggered the alarm no longer exists

Once an alarm is latched, you must manually unlatch it. You can use the module tags to unlatch an alarm. The alarm type determines which module tag to change.

For example, to unlatch a Low Low alarm on a FLEX 5000 analog HART input module, you set the Chox.LLAlarmUnlatch output tag to 1.

For more information on how to use the module tags, see Appendix B, Module Tag Definitions on page 117.

Scaling

When you scale a channel, you select two points that represent signal units, that is, a Low Signal and a High Signal. You also select two points that represent engineering units, that is, Low Engineering and High Engineering.

The Low Signal point equates to the Low Engineering point and the High Signal point matches the High Engineering point.

IMPORTANT In choosing two points for the low and high value of your application, you do not limit the range of the module. The module range remains constant regardless of how you scale it.

Scaling lets you configure the module to return data to the controller in signal units or in engineering units (listed as Percent of Full Scale in the Studio 5000 Logix Designer application).

For example, if you use the 5094-IF8IH module in Current mode with an input range of 4...20 mA, consider the following:

- To receive values in signal units, configure the module as follows:
  - Low Signal = 4 mA
  - High Signal = 20 mA
  - Low Engineering = 4 EU
  - High Engineering = 20 EU
- To receive values in Percent of Full Scale, configure the module as follows:
  - Low Signal = 4 mA
  - High Signal = 20 mA
  - Low Engineering = 0%
  - High Engineering = 100%

The returned value is indicated in the I.Chox.Data tag.

The following table shows values that can appear when using Percent of Full Scale.

Table 7 - Current Values Represented in Engineering Units

Current	Engineering Units Value	Value in *I.ChOx.Data* Tag
0.0 mA	-25.00%	-25.00
3.0 mA	-6.25%	-6.25
4.0 mA	0.0%	0.00
12.0 mA	50.0%	50.0
20.0 mA	100.0%	100.0
23.0 mA	118.75%	118.75

You configure Scaling on the Chox category in the Module Properties dialog box for each module. For more information on using the Module Properties dialog box, see Chapter 8, Configure the Module on page 71.

Data Offset

The FLEX 5000 analog HART input and output modules support offset features that let you compensate for any inaccuracy inherent to the input or output device that is connected to the channel. The offset value adjusts the input or output data value.

The following channel offset features are available:

- Sensor Offset – Available on FLEX 5000 analog HART input modules. For more information on using the Sensor Offset feature, see page 46.
- Channel Offset – Available on FLEX 5000 analog HART output modules. For more information on using the Channel Offset feature, see page 54.

Module Accuracy

Module accuracy represents the module accuracy when its ambient temperature is the same as the temperature at which the module was calibrated.

IMPORTANT For detailed and updated specifications, see FLEX 5000 Modules Specifications Technical Data, publication 5094-TD001.

Notes:

Analog HART Input Channel Features

The 5094-IF8IH and 5094-IF8IHXT input modules have eight individually isolated analog channels with HART and current sourcing support. Each channel supports connection to the following input types:

- Current
- Voltage
- 4...20 mA with HART

IMPORTANT Remember the following:

- This module also has features that apply to all FLEX 5000 analog HART I/O modules that are described in Chapter 3, Common I/O Module Features on page 29, in Chapter 5, Digital Input Point Features on page 49, and in Chapter 7, Common Features of HART Integration on page 61.
- You can configure the features that are described in this chapter with the Studio 5000 Logix Designer application.
  For more information on how to configure the module, see Chapter 8, Configure the Module on page 71.
- When input data is set to Analog and Discrete, the first 4 channels are dedicated analog inputs and are visible as analog inputs in the configuration tree view. The last 4 channels are dedicated digital inputs and can be configured through the Points page in the configuration tree view.

Module Features

The 5094-IF8IH and 5094-IF8IHXT input modules have the following features:

- Multiple Input Ranges
- Notch Filter
- Digital Filter
- Underrange/Overrange Detection
- Process Alarms
- Rate Alarm
- Sensor Offset
- Open Wire Detection
- Over Temperature Detection
- Field Power Loss Detection
- Overcurrent Protection

Multiple Input Ranges

The 5094-IF8IH module supports multiple input ranges. The input type that you choose during module configuration determines the available input ranges. An input type is chosen on a channel-by-channel basis.

Table 8 - Input Ranges

Input Type	Available Input Range
Current (mA)	• 0...20 mA • 4...20 mA
Voltage (V)	• -10...10V • 0...5V • 0...10V

To see where to choose an input range for the 5094-IF8IH module, see page 79.

Notch Filter

The Notch Filter is a built-in feature of the Analog-to-Digital converter (ADC) that removes line noise in your application. The removal of line noise is also known as noise immunity.

The Notch Filter attenuates the input signal at the specified frequency.

Choose a notch filter based on what noise frequencies are present in the module operating environment and any sampling requirements that are needed for control. For example, if the notch filter setting is 60 Hz, 60 Hz AC line noise and its overtones are attenuated.

The following Notch Filter settings are available on a 5094-IF8IH module:

- 5 Hz
- 10 Hz
- 15 Hz
- 20 Hz
- 50 Hz
- 60 Hz (default)
- 100 Hz
- 200 Hz
- 500 Hz
- 1,000 Hz
- 2,500 Hz
- 5,000 Hz
- 10,000 Hz

HART is supported from 5 Hz to 500 Hz only.

Relationship between Notch Filter Settings and RPI Setting

There is a relationship between a Notch Filter setting and the RPI rate.

- If you want greater noise suppression at the selected Notch Filter frequency and improved resolution, you use a slower input sample rate.

  For example, if you choose the 60 Hz notch filter setting and need better noise suppression and resolution, the recommended module minimum RPI is 60 ms.
- If you want a faster input sample rate at the selected Notch Filter frequency, the noise suppression and resolution is lesser.

  Using the previous example, if you choose the 60 Hz notch filter setting and need faster input sampling, the recommended module minimum RPI is 20 ms.

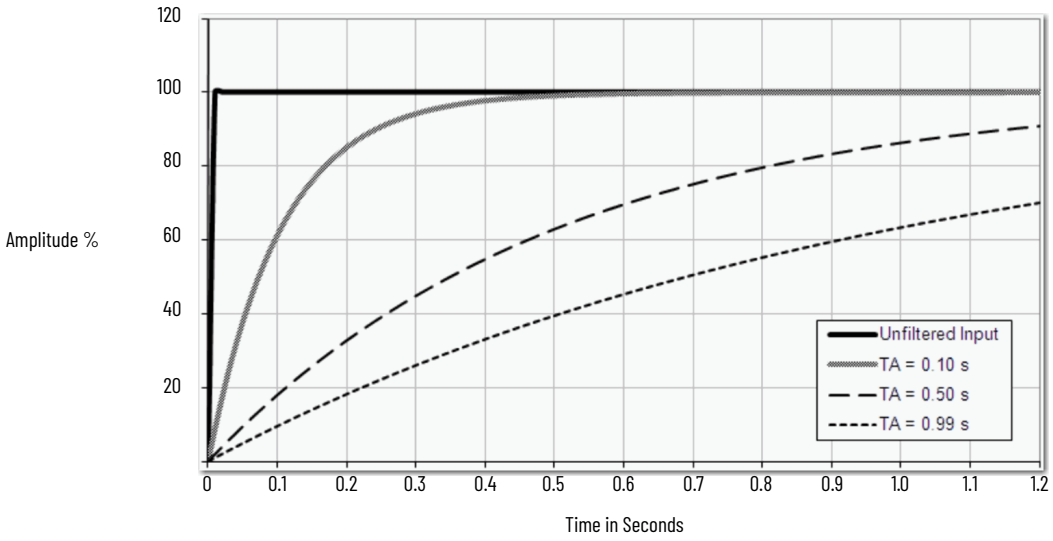
If the RPI is smaller than the channel scan time, the controller might not receive new data with each RPI. If over sampling is not referred, the minimum RPI recommended for different notch filters are as follows:

Notch Filter	Min RPI Without Over Sampling (ms)
5 Hz	201
10 Hz	101
15 Hz	68
20 Hz	51
50 Hz	21
60 Hz	18
100 Hz	11
200 Hz	6
500 Hz	2.5
1,000 Hz	2
2,500 Hz	1.5
5,000 Hz	1
10,000 Hz	1

To see where to choose a notch filter for the 5094-IF8IH module, see page 79.

Digital Filter

The Digital Filter is a first-order lag filter. It smooths input data noise transients on **each input channel**. This value specifies the time constant for a digital, first-order lag filter on the input. The input is 63% of the step change after the digital filter time has elapsed



The filter value is specified in units of milliseconds. A value of 0 (zero) disables the filter. The digital filter equation is as shown.

$$Y_n = Y_{n-1} + \frac{\Delta t * (X_n - Y_{n-1})}{\Delta t + TA}$$

Y_n = Present Output, Filtered Peak Voltage (PV)

Y_{n-1} = Previous Output, Filtered PV

Δt = Module Channel Update Time (seconds)

TA = Digital Filter time Constant (seconds)

X_n = Present Input, Unfiltered PV

IMPORTANT Remember the following:

- Digital Filter input data changes only when new input data is collected.
- If an Overrange or Underrange condition is detected before the Digital Filter input data is collected, the condition is indicated immediately. An immediate indication also applies to the Fault data for the input.

To see where to choose a digital filter for the 5094-IF8IH module, see page 79.

Underrange/Overrange Detection

Underrange/Overrange Detection detects when the 5094-IF8IH module is operating beyond limits set by the input range.

The module can read input signal levels outside the low and high signal values for each input range. The signal limits to which the module can read are thresholds. Only when the signal is beyond a threshold is an underrange or overrange condition that is detected and indicated.

For example, if you configure a 5094-IF8IH module channel to use the ± 10V input range, an overrange condition does not exist until the input signal exceeds 10.70V.

Table 9 lists the input ranges of the 5094-IF8IH module and the thresholds in each range before the module detects an underrange/overrange condition

Table 9 - Input Signal Threshold Ranges

Input Type	Range	Underrange Threshold	Overrange Threshold	Deadband Example(1)
Current (mA)	0...20 mA	< 0.11 mA	> 23.00 mA	0.07 mA
	4...20 mA	< 3 mA(2)		
Voltage (V)	±10.00V	< -10.70 V	>10.70V	0.04V
	0...5V	< -0.02 V	> 5.35V	0.02V
	0...10V	< -0.04 V	> 10.70V	0.04V

(1) The module has alarm deadband values for each range. The deadband lets a condition remain set despite it disappearing. For example, if a module uses a Current input type in the 4...20 mA range and the signal value goes below 3 mA, the underrange condition is triggered. Because of the 0.07 mA deadband, the condition is not cleared until the signal value reaches 3.07 mA. For more information on Alarm Deadbands, see page 44.

(2) Underrange is set at < 3 mA, but the *I:ChOx.Data* tag reports values as low as 0.0 mA. The condition is clamped when the signal reaches 3 mA.

IMPORTANT The Disable All Alarms feature, does not disable the underrange/overrange detection feature.

The Disable All Alarms feature disables **alarms** on the module. Underrange/Overrange detection is not an alarm. It is an indicator that channel data has gone beyond the absolute maximum or minimum, respectively, for the channel range.

To disable the Underrange/Overrange detection feature, you must disable the channel.

Underrange/overrange conditions are indicated when the following tags change to 1:

- *I.Chox.Underrange*
- *I.Chox.Overrange*

For more information on how to use the module tags, see Appendix B, Module Tag Definitions on page 117.

Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. The following are the user-configurable, alarm trigger points:

- High high
- High
- Low
- Low low

To use the Process Alarms, you must complete the following tasks:

- Enable the alarms
- Configure the trigger points

Enable Process Alarms

When the module tags are created, the Process Alarm tags are disabled by default.

To see where to enable Process Alarms for the 5094-IF8IH module, see page 80.

Configure Alarm Trigger Points

You must configure the Process Alarm with a trigger point. That is, set values in Engineering Units that, once the signal reaches the value, the alarm is triggered.

Process Alarm trigger points are related to the Scaling parameters that you configure for the channel. The Engineering Units that are established in Scaling determine the Process Alarm trigger points. That is, the available trigger point values can be in signal units or engineering units.

For example, consider a channel that uses the Current (mA) input type, the 4 mA...20 mA input range, and scales the High and Low Engineering values of 100 and 0, respectively. The available Process Alarm values range from 0...100.

In this case, if the High Limit alarm is set to 50 EU, when the input signal reaches 12 mA, the High Limit alarm is set. The alarm is set because Scaling was configured for Percentage of Full Scale and a signal value of 12 mA is 50% of the full scale of engineering units.

To see where to set the Process Alarm trigger points for the 5094-IF8IH module, see page 80.

Latch Alarms

Check Latch Process Alarms on the *Alarms* category to latch the process alarms. To see where to see where to latch Process Alarms on the 5094-IF8IH module, see page 80.

Unlatch Alarms

IMPORTANT	Before you unlatch an alarm, make sure the condition that triggered the alarm no longer exists.

Once an alarm is latched, you must manually unlatch it. To unlatch an alarm, change the output tag for that alarm.

For example, change the *O.Chox.LAlarmUnlatch* tag for the low alarm that you want to unlatch from 0 to 1.

IMPORTANT	After an alarm is unlatched, change the tag back from 1 to 0. You must change the tag from 0 to 1 to unlatch the alarm each time it is triggered. If you do not change the tag back to 0 and the alarm is latched again in the future, the alarm remains latched despite the Unlatch tag value being 1.

For more information on how to use the module tags, see Appendix B, Module Tag Definitions on page 117.

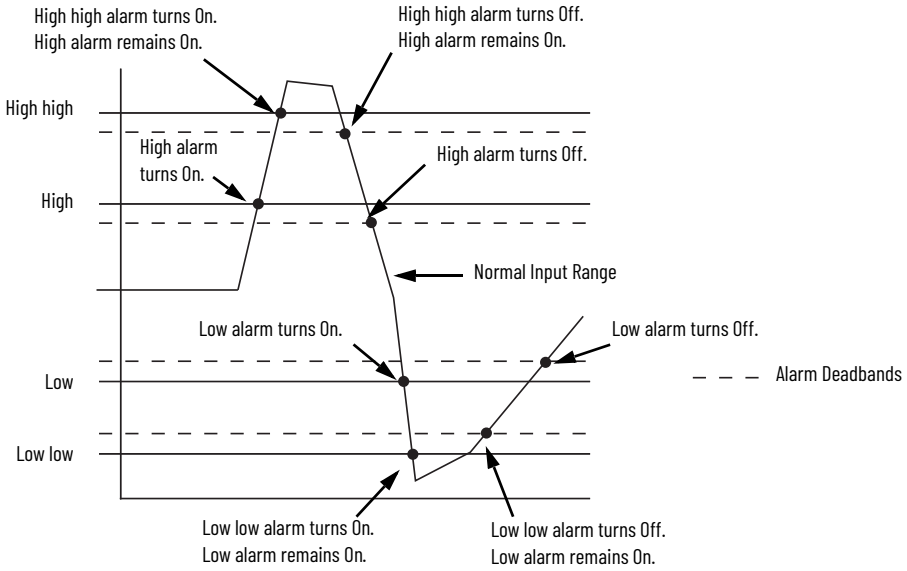
Alarm Deadband

You can configure an alarm deadband to work with these alarms. The deadband lets the process alarm status bit remain set, despite the alarm

condition disappearing, as long as the input data remains within the deadband of the process alarm.

The following graphic shows input data that sets each of the four alarms at some point during module operation. In this example, latching is disabled; therefore, each alarm turns Off when the condition that caused it to set ceases to exist.

Figure 4 - Alarm Deadband Alarm Settings



To see where to set the Alarm Deadband on the 5094-IF8IH module, see page 80.

Rate Alarm

The Rate Alarm defines the maximum rate of change between input samples in Engineering Units per second. If the Rate Alarm Limit is exceeded, the *I.Chox.RateAlarm* tag set to 1.

You can enable Rate Alarm latching. To see where to enable the Rate Alarm latching on the 5094-IF8IH module, see page 80.

Once the Rate Alarm is latched, you must change the *O.Chox.RateAlarmUnlatch* tag to 1.

You can unlatch the alarm at any point in the system operation. If you change the unlatch tag to 1 and the triggering condition remains, the alarm is immediately latched again.

We suggest that you unlatch the Rate Alarm only after the rate of change between input samples has returned below the Rate Alarm Limit value.

Sensor Offset

The Sensor Offset compensates for any known error on the sensor or channel to which the sensor is connected. The value is set in signal units and is added to the data value.

For example, consider an application that uses the Current (mA) input type with the 4...20 mA range and scaling at 0...100%. If a sensor has an error and the channel consistently reports current signal values by 0.2 mA lower than the actual value, you must set Sensor Offset to 1.25%.

You must use the *O.SensorOffset* tag to set the Sensor Offset. In the example above, the *O.Chox.SensorOffset* tag = 1.25.

For more information on how to use the module tags, see Appendix B, Module Tag Definitions on page 117.

Open Wire Detection

Open Wire Detection detects when a wire is disconnected from the channel. You must enable Open Wire Detection in the module configuration.

To see where to enable Open Wire Detection on the 5094-IF8IH module, see page 79.

Table 10 describes the results of an Open Wire condition occurring when the module is operating in each mode.

Table 10 - Open Wire Conditions

Mode	Cause of Detection	Resulting Module Behavior
Current (mA)	The input signal for a channel is below 100 µA.	• Input data for the channel changes to a specific scaled value corresponding to the Underrange value for the channel's Input Range. • The *I:Ch0x.OpenWire* tag changes to 1. • A fault occurs and the *I:Ch0x.Fault* tag is set to 1.
Voltage	Within +/- 0.1V.	• Input data for the channel shows the scaled engineering value of the actual signal. • The *I:Ch0x.OpenWire* tag changes to 1. • A fault occurs and the *I:Ch0x.Fault* tag is set to 1.

IMPORTANT The Disable All Alarms feature, does not disable the Open Wire Detection feature. The Disable All Alarms feature disables all alarms on the module.

The Open Wire Detection feature is not an alarm. It is an indicator that a wire has been disconnected from the channel but does not trigger an alarm.

To disable the Open Wire Detection feature, you must clear the Open Wire Detection checkbox in the module configuration.

Over Temperature Detection

The Over Temperature Detection feature indicates that the temperature conditions within which the module is operating are higher than the module operating limits.

When an Over Temperature condition exists, the I.Ch*ox*.OverTemperature tag is set to 1.

Field Power Loss Detection

The Field Power Loss Detection feature monitors for the loss of power at an input module channel. When field power to the module is lost, and when SA power is out of range, a channel-level fault is sent to the controller to identify the exact channel faulted.

Field Power Loss Detection has a corresponding tag that can be examined in the user program if a fault occurs. For information on modules, see Appendix B, Module Tag Definitions on page 117.

To see where to enable or disable field power detection, see page 78.

Overcurrent Protection

The module provides protections for overcurrent conditions caused by some mis-wiring scenarios.

If sensor power (24V) is shorted to I- at the terminal screws, the module detects the over current condition and cuts off the sensor power for 10 seconds to cool down the hardware. After the module re-enables the sensor power and checks if the overcurrent condition still exists. SSV Overcurrent Fault and Channel Fault are present in the Channel Diagnostics dialog before the overcurrent condition is cleared.

If sensor power (24V) is shorted to I+ at the terminal screws, the module detects the overcurrent condition and cuts off the input signal path for 25 s to cool down the hardware. After the module reconnects the input signal path and checks if the overcurrent condition still exists. Overrange Fault and Channel Fault are present in the input tag before the overcurrent condition is cleared.

IMPORTANT Do not short circuit current and voltage terminals as doing so may result in erroneous readings and, in some cases, may cause damage to the channel.

After the shorting is removed, the channel can return to normal operation in both cases.

Fault and Status Reporting

The 5094-IF8IH module sends fault and status data with channel data to the owner-controller and listening controllers. The data is returned via module tags that you can monitor in your Studio 5000 Logix Designer application.

With some exceptions, the 5094-IF8IH module provides the fault and data status in a channel-centric format. The tag names in the following table that include **Chox** represent channel-centric data. The **ox** represents channel number.

Table 11 - 5094-IF8IH Module - Channel Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets the Tag
Fault	ConnectionFaulted(1)	The owner-controller loses its connection to the module.
	ChOx.FieldPowerOff	The following conditions exist: • 0 = Field power is present • 1 = Field power is not present
	ChOx.Fault	The channel data quality is bad.
	ChOx.OpenWire	The following conditions exist: • 0 = Open wire condition does not exist or open wire detection is disabled. • 1 = Open wire condition exists, meaning the input value is below 100 µA or between ± 0.1V; the signal wire is disconnected from the channel or the RTB.
	ChOx.Underrange	The channel data is beneath the absolute min for this channel.
	ChOx.Overrange	The channel data is above the absolute max for this channel.
	ChOx.OverTemperature	The module is at a higher temperature than its rated operating limits.
Status	RunMode(1)	The module is in Run Mode.
	DiagnosticActive	Indicates if any diagnostics are active or if the prognostics threshold is reached.
	DiagnosticSequenceCount	A counter that increments when a diagnostic condition occurs or goes away. The counter is a rolling counter that skips 0 on rollovers.
	ChOx.Uncertain	The channel data can be imperfect but it is not known to what degree of inaccuracy.
	ChOx.NotANumber	The following conditions exist: • 0 = Last channel data received was a number • 1 = Last channel data received was not a number
	ChOx.LLAlarm	The following conditions exist: • The *I.ChOx.Data* tag value is less than the *C.ChOx.LLAlarmLimit* tag value or the alarm is latched. • The *O.ChOx.LLAlarmEn* tag is set. • Alarms are enabled for the channel.
	ChOx.LAlarm	The following conditions exist: • The *I.ChOx.Data* tag value is less than the *C.ChOx.LAlarmLimit* tag value or the alarm is latched. • The *O.ChOx.LAlarmEn* tag is set. • Alarms are enabled for the channel.
	ChOx.HAlarm	The following conditions exist: • The *I.ChOx.Data* tag value is greater than the *C.ChOx.HAlarmLimit* tag value or the alarm is latched. • The *O.ChOx.HAlarmEn* tag is set. • Alarms are enabled for the channel.
	ChOx.HHAlarm	The following conditions exist: • The *I.ChOx.Data* tag value is greater than the *C.ChOx.HHAlarmLimit* tag value or the alarm is latched. • The *O.ChOx.HHAlarmEn* tag is set. • Alarms are enabled for the channel.
	ChOx.RateAlarm	The following conditions exist: • The absolute change between consecutive channel samples exceeds the *C.ChOx.RateAlarmLimit* tag value or the alarm is latched. • The *O.ChOx.RateAlarmEn* tag is set. • Alarms are enabled for the channel.
	ChOx.CalFault	A calibration session for a channel was interrupted or failed. CalFault is reset by product reset or power cycle.
Status	ChOx.Calibrating	The channel is being calibrated.
	ChOx.Data	The channel data in scaled Engineering Units.
	ChOx.RollingTimestamp	A continuously running, 15-bit timer that counts in milliseconds and is not related to CIP Sync. Whenever a module scans its channels, it records the value of RollingTimestamp then. The controller program uses the last two rolling timestamp values to calculate the amount of time between the samples.

(1) This tag provides module-wide data and affects all channels simultaneously.

Digital Input Point Features

5094-IF8IH and 5094-IF8IHXT modules can be configured to work as digital input modules when channel-isolated digital input signal is required in a FLEX 5000 system. This chapter describes the user configuration required to support discrete connection type.

The 5094-IF8IH and 5094-IF8IHXT, once set to discrete connection type, support digital input type.

IMPORTANT Remember the following:

- This module also has features that apply to all FLEX 5000 analog HART I/O modules that are described in Chapter 3, Common I/O Module Features on page 29, in Chapter 5, Digital Input Point Features on page 49, and in Chapter 7, Common Features of HART Integration on page 61.
- You can configure the features that are described in this chapter with the Studio 5000 Logix Designer application.
  For more information on how to configure the module, see Chapter 8, Configure the Module on page 71.
- When input data is set to Analog and Discrete, the first 4 channels are dedicated analog inputs and are visible as analog inputs in the configuration tree view. The last 4 channels are dedicated digital inputs and can be configured through the Points page in the configuration tree view.

Module Features

The 5094-IF8IH and 5094-IF8IHXT digital input modules have the following features:

- Software Configurable Input Filters
- Type 3-d Open Wire Detection
- Type 3-d Short Circuit Detection

Software Configurable Input Filters

You can adjust On to Off and Off to On filter times through the Logix Designer application for all digital input points. These filters improve noise immunity within a signal.

A larger filter value affects the length of delay times for signals from these modules. The filter values are adjustable in the Points category of the Module Properties window.

Table 12 - Digital Input Point - Input Filter and Delay

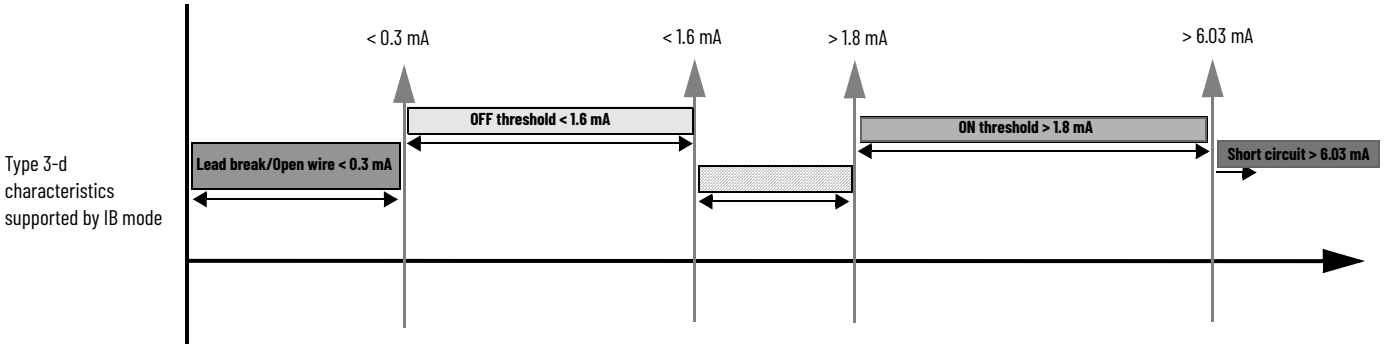
Input Filter Time (Off -> On)	Input Filter Time (On -> Off)
0 = 0 µs (default)	0 = 0 µs (default)
13 = 1 ms	13 = 1 ms
14 = 2 ms	14 = 2 ms
15 = 5 ms	15 = 5 ms
16 = 10 ms	16 = 10 ms
17 = 20 ms	17 = 20 ms
18 = 50 ms	18 = 50 ms

To see where to set the input filter values the 5094-IF8IH module, see page 79.

Type 3-d Diagnostics

Figure 5 shows the typical IEC 61131-2 Type 3-d based diagnostics behavior implemented in the module.

Figure 5 - Type 3-d Detection Levels



Type 3-d Open Wire Detection

While operating in Type 3-d digital input mode, you can enable detection of breakage in a wire connecting a sensor to the I/O terminals based on Input Type 3-d diagnostic characteristics as defined in IEC 61131-2.

IMPORTANT The diagnostics characteristics are compatible with IEC 60947-5-6 and NAMUR DIN 19234 for resistive inputs.

This open wire detection is only supported if you select IEC 61131-2 Type 3-d Digital Input as Discrete device type. You must enable Open Wire Detection in the module configuration.

To see where to enable Type 3-d Open Wire Detection on the 5094-IF8IH module, see page 80.

Digital Point Open Wire Condition

When the input signal for a digital point is below 0.3 mA, the I:Ptox.OpenWire tag changes to 1.

When the input signal for the digital point is over 0.35 mA, the I:Ptox.OpenWire tag is reset to 0 after 1 second of detecting the transition.

Type 3-d Short Circuit Detection

While operating in digital input mode, you can enable detection of short circuit between 24V and I+ based on Input Type 3-d diagnostic characteristics as defined in IEC 61131-2.

IMPORTANT The diagnostics characteristics are compatible with IEC 60947-5-6 and NAMUR DIN 19234 for resistive inputs.

This short circuit detection is only supported if you select IEC 61131-2 Type 3-d Digital Input as Discrete device type. You must enable Short Circuit Detection in the module configuration.

To see where to enable Type 3-d Short Circuit Detection on the 5094-IF8IH module, see page 80.

Digital Point Type 3-d Short Circuit Condition

When the input signal for a digital point is over 6.03 mA, the I:Ptox.Type3dShortcircuit tag changes to 1.

When the input signal for the digital point is below 6.0 mA, the I:Ptox.Type3dShortcircuit tag changes to 0.

Fault and Status Reporting

The 5094-IF8IH module sends fault and status data with point data to the owner-controller and listening controllers. The data is returned via module tags that you can monitor in your Studio 5000 Logix Designer application.

With some exceptions, the 5094-IF8IH module provides the fault and data status in a point-centric format. The tag names in the following table that include **Ptox** represent point-centric data. The **ox** represents point number.

Table 13 - 5094-IF8IH Module - Point Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets the Tag
Status	PtOx.Data PtOx.Pt.Data	The following conditions exist: • 0 = Input is Off • 1 = Input is On

Table 13 - 5094-IF8IH Module - Point Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets the Tag
Fault	Pt0x.Fault Pt0x.Pt.Fault	A fault is a roll-up of all the diagnostic conditions that the module can detect and indicates bad data. If there is a detailed data type member that indicates a given detected condition, this fault member does not affect the DiagnosticActive or DiagnosticSequenceCount members. However, if there is no detailed data type for a given detected condition, this fault member triggers both the DiagnosticActive member and increments/decrements the Diagnostic Sequence Count.
	Pt0x.Uncertain Pt0x.Pt.Uncertain	The module is operating outside its designed operating range. The following conditions exist: • 0 = Valid data • 1 = Data validity uncertain
	Pt0x.Type3dOpenwire	The following conditions exist: • 0 = Type 3-d Open Wire is not detected • 1 = Type 3-d Open Wire is detected
	Pt0x.Type3dShortcircuit	The following conditions exist: • 0 = Type 3-d Short Circuit is not detected • 1 = Type 3-d Short Circuit is detected

Analog HART Output Module Features

The 5094-OF8IH analog HART output module has eight isolated channels with HART support. Each channel supports connection to the following output types:

- Current
- Voltage
- 4...20 mA with HART

IMPORTANT Remember the following:

- This module also has features that apply to all FLEX 5000 analog HART I/O modules that are described in Chapter 3, Common I/O Module Features on page 29 and in Chapter 7, Common Features of HART Integration on page 61.
- You can configure the features that are described in this chapter with the Studio 5000 Logix Designer application.
  For more information on how to configure the module, see Chapter 8, Configure the Module on page 71.

Module Features

The 5094-OF8IH module has the following features:

- Multiple Output Ranges
- Channel Offset
- Hold for Initialization
- Connection Fault Handling
- Output Clamping
- Clamp Alarming
- Output Ramping/Rate Limiting
- Output Readback
- No Load Detection
- Short Circuit Protection
- Over Temperature Detection
- Field Power Loss Detection

Multiple Output Ranges

The 5094-OF8IH module offers multiple output ranges. The output type that you choose during module configuration determines the available ranges.

Table 14 - Output Ranges

Input Type	Available Output Range
Current (mA)	• 0...20 mA • 4...20 mA
Voltage (V)	• -10...10V • 0...5V • 0...10V

To see where to choose an output range for the 5094-OF8IH module, see page 83.

Channel Offset

The Channel Offset feature compensates for any error in actuator operation. The module allows an offset to be added to the output channel value sent from the controller. Values are entered in engineering units (EU). The default value for the channel offset is 0.0.

For example, consider an application that uses the Current (mA) output type with the 4...20 mA range and scaling at 0...100%. If a channel used in the output range 4...20 mA has an error that results in it consistently reporting 8 mA as 7.8 mA, you must account for the error by setting the Channel Offset to 1.25.

IMPORTANT The output readback data value reported via I.Ch0x.Data excludes Channel Offset.

To see where to set the channel offset for the 5094-OF8IH module, see page 83.

Hold for Initialization

Hold for Initialization causes outputs to hold present state until the value that is commanded by the controller matches the value at the output screw terminal within 0.1% of full scale, providing a bumpless transfer.

If Hold for Initialization is selected, outputs hold if there is an occurrence of any of these three conditions:

- Initial connection is established after power-up. The output data readback value goes to 0.0V or 0.0 mA.
- A new connection is established after a communication fault occurs, or the module is uninhibited.
- There is a transition to Run mode from Program state.
- The module loses SA power. In this case, the output readback data value goes to 0.0V or 0.0 mA.

The *I.Chox.InHold* tag for a channel indicates that the channel is holding.

To see where to enable Hold for Initialization for the 5094-OF8IH module, see page 83.

Connection Fault Handling

You can configure 5094-OF8IH output module behavior when a connection fault occurs, that is, the connection between the owner-controller and the output module breaks.

You must define the following:

- Output Behavior Immediately After a Connection Fault
- Fault State Duration After Connection Fault
- Final Fault State Value

Output Behavior Immediately After a Connection Fault

When the connection between an owner-controller and output module breaks, the output can behave in the following ways. The available options Fault Mode parameter is configured:

- Transition to a specific, user-defined value.
- Hold its last state.

  If you configure the output to hold its last state, the output remains at that state value until the following occurs:

  - The connection to the owner-controller is re-established.
  - The output returns to normal operation, as defined in the module configuration.

Fault State Duration After Connection Fault

If you configure the output to transition to a specific value after the connection breaks, you must define how long the output remains at the specified value before it transitions to a Final Fault State.

You can configure the output to remain at the specific value for the following times:

- Forever
- 1 second
- 2 seconds
- 5 seconds
- Ten seconds

After the Fault State Duration time expires, the output transitions to user-defined Final Fault State Value.

Final Fault State Value

The Final Fault State Value defines the value to which the output goes after the Fault State Duration time expires.

Output State Once Connection is Re-established

Once the connection between the owner-controller and output module is re-established, the output resumes normal operation.

To see where to set the Connection Fault Handling parameters for the 5094-OF8IH module, see page 83.

Output Clamping

Output Clamping limits the output from the analog module to remain within a range configured by the controller, even when the controller commands an output outside that range.

Once clamp values are set, if data received from the controller exceeds those clamps, the following events occur:

- The output value transitions to the clamp limit but not to the requested value.
- The appropriate limit alarm is triggered.

  For more information on limit alarms, see Clamp Alarming on page 57.

For example, an application can set the high clamp on a module for 8V and the low clamp for -8V. If a controller sends a value corresponding to 9V to the module, the module applies only 8V to its screw terminals.

You can disable or latch clamping alarms on a per channel basis. The alarms are disabled by default.

IMPORTANT	Clamp values are in engineering units and are **not automatically updated** when the scaling high and low engineering units are changed. Failure to update the clamp values can generate a very small output signal that could be misinterpreted as a hardware problem. For example, a FLEX 5000 analog output module channel that uses a Current (mA) output type with Clamping enabled has the following configuration parameters: • Scaling values: –High Engineering = 100.0000% –Low Engineering = 0.0000% • Clamp Limits: –High Clamp = 100.0000% –Low Clamp = 0.0000% If you change the Scaling High Engineering value to 90.0000%, the High Clamp value remains at 100.0000. **You must change** the High Clamp value to 90.0000 to make sure that the application continues to operate as expected.

To see where to set the high clamp and low clamp parameters for the 5094-OF8IH module, see page 84.

Clamp Alarming

Clamp Alarming works directly with Output Clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies signal values to the clamping limit. In addition, a limit alarm is triggered.

The following tags indicate that a clamping alarm was triggered. That is, the tag is set to 1.

- *I.Chox.LLimitAlarm*
- *I.Chox.HLimitAlarm*

For more information on using module tags, see Appendix B, Module Tag Definitions on page 117.

Output Ramping/Rate Limiting

Output Ramping limits the speed at which an analog output signal can change. This prevents fast transitions in the output from damaging the devices that an output module controls. Output Ramping is also known as Rate Limiting.

Table 15 describes the types of ramping that are possible.

Table 15 - Output Ramping Types

Ramping type	Description
Ramp in Run mode	When the module is in Run mode, ramping occurs to all new output values at the max ramp rate.
Ramp to Program mode	When the present output value changes to the Program value after a Program command is received from the controller.
Ramp to Fault mode	When the present output value changes to the Fault value after a communication fault occurs.

The maximum rate of change in outputs is expressed in engineering units per second (EU/s), is called the maximum ramp rate and set in the Ramp Rate field.

To see where to enable the **Ramp in Run mode** for the 5094-OF8IH module, see page 84.

To enable the other Output Ramping parameters, you must change module tags to 1.

- Ramp to Program Mode - *C.Chox.RampToProg*
- Ramp to Fault Mode and Final Fault State - *C.Chox.RampToFault*

For more information on using module tags, see Appendix B, Module Tag Definitions on page 117.

Output Readback

A FLEX 5000 analog HART output module measures the output signal at the screw terminals and sends the readback data to the controller. The readback

value is indicated in the *I.Chox.Data* and is represented in Engineering Units. Fault and status data are also sent. The data are sent at the RPI.

No Load Detection

No Load Detection detects when a signal wire is disconnected from the channel or the RTB.

IMPORTANT This feature is available only in Current (mA) mode.

The output range that is used with a FLEX 5000 analog HART output module determines the current below which a load is considered missing.

The *I.Chox.NoLoad* tag indicates the presence of a no load condition when it is set to 1.

The No Load Detection feature is disabled by default. You must enable the feature in your Studio 5000 Logix Designer application project. To enable No Load Detection, you must change the *C.Chox.NoLoadEn* tag to 1.

For more information on using module tags, see Appendix B, Module Tag Definitions on page 117.

Short Circuit Protection

Short Circuit Protection prevents damage that can result from driving a current from the channel greater than the maximum current level the channel can handle.

IMPORTANT This feature is available only in Voltage (V) mode.

A short circuit condition is detected when current exceeds 24.2 mA. The following occurs:

- The I.Ch*ox*.ShortCircuit tag is set to 1.
- The output turns off.
- The module checks if the short circuit is removed every 1.2 s.
- The module recovers after the short circuit is removed.

For more information on using module tags, see Appendix B, Module Tag Definitions on page 117.

Over Temperature Detection

The Over Temperature Detection feature indicates that the temperature conditions within which the module is operating are higher than the module operating limits.

When an Over Temperature condition exists, the I.Ch*ox*.OverTemperature tag is set to 1.

Field Power Loss Detection

The Field Power Loss Detection feature monitors for the loss of power at an output module channel. When field power to the module is lost or out of the 18...32V DC range, a channel-level fault is sent to the controller to identify the exact channel faulted.

Field Power Loss Detection has a corresponding tag that can be examined in the user program if a fault occurs. For information on modules, see Appendix B, Module Tag Definitions on page 117.

To see where to enable or disable field power detection, see page 82.

Fault and Status Reporting

The FLEX 5000 analog isolated output module sends fault and status data with channel data to the owner and listening controllers. The data is returned via module tags that you can monitor in your Studio 5000 Logix Designer application.

With some exceptions, as noted in the following table, the FLEX 5000 analog isolated output module provides the fault and data status in a channel-centric format.

Table 16 lists the FLEX 5000 analog output module fault and status tags available in the Studio 5000 Logix Designer application.

Table 16 - 5094-OF8IH Module- Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets Tag
Fault	ConnectionFaulted[1]	The owner-controller loses its connection to the module.
	Ch*Ox*.Fault	The channel data quality is bad.
	ChOx.NoLoad	A no load condition exists on the channel.
	ChOx.ShortCircuit	A short circuit condition exists on the channel.
	ChOx.OverTemperature	The module is at a higher temperature than its rated operating limits.
	ChOx.FieldPowerOff	Field power is not present on the channel.
Status	RunMode[1]	The module is in Run Mode.
	DiagnosticActive	Indicates if any diagnostics are active or if the prognostics threshold is reached.
	DiagnosticSequenceCount	A counter that increments when a diagnostic condition occurs or goes away. The counter is a rolling counter that skips 0 on rollovers.
	ChOx.Uncertain	The channel data can be imperfect.
	ChOx.InHold	The channel is holding until the received channel data is within 0.1% of full scale on the current channel data value.
	ChOx.NotANumber	The most recently received data value was not a number.
	ChOx.LLimitAlarm	The following conditions exist: • Alarms are enabled on this channel. • The channel data requested, indicated in the *O.ChOx.Data* tag, is less than the configured LowLimit or the alarm is latched.
	ChOx.HLimitAlarm	The following conditions exist: • Alarms are enabled on this channel. • The channel data requested, indicated in the *O.ChOx.Data* tag, is greater than the configured HighLimit or the alarm is latched.
	ChOx.RampAlarm	The channel is limited to changing the output at the Maximum Ramp rate or once was and is now latched.
	ChOx.CalFault	A calibration session for a channel was interrupted or failed. The CalFault tag is reset by product reset or power cycle.

Table 16 - 5094-0F8IH Module- Fault and Status Data Tags (Continued)

Data Type	Tag Name	Triggering Event That Sets Tag
Status	ChOx.Calibrating	The channel is being calibrated.
	ChOx.Data	The channel output readback data in scaled Engineering Units.
	ChOx.RollingTimestamp	15-bit timestamp that 'rolls' from 0…32,767 ms. Compatible with existing PID instruction to calculate sample deltas automatically.

(1) This tag provides module-wide data and affects all channels simultaneously.

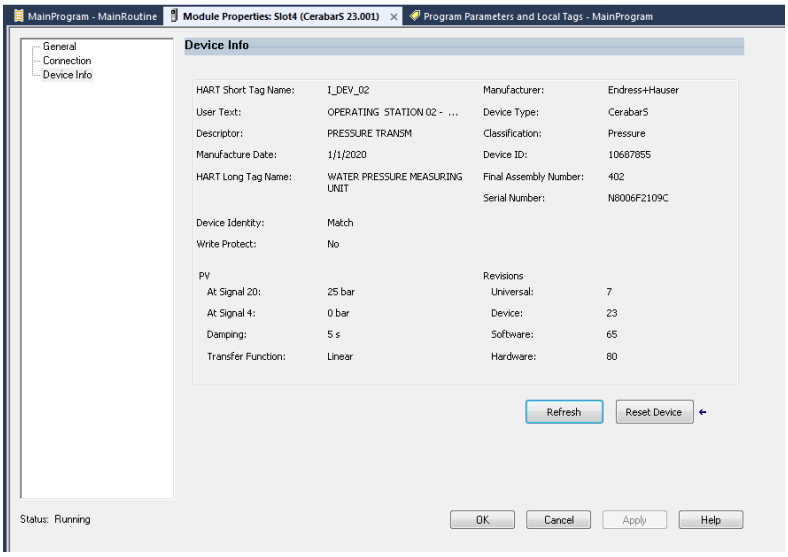
Common Features of HART Integration

HART Features

HART Device Information and Identity

You can use the Studio 5000 Logix Designer application to retrieve the following information from a HART device in the system:

- HART Short Tag Name
- User Text
- Descriptor
- Manufacture Date
- HART Long Tag Name
- Manufacturer
- Device Type
- Classification
- Device ID
- Final Assembly Number



IMPORTANT After a configuration change occurs in the device, the module needs some time, typically within 30 seconds, to refresh the data. Therefore the "Device Info" page might not reflect the latest configuration of the device immediately.

HART Device Inhibit

You can suspend data exchange between the controller and individual HART devices, either in off-line mode (applies after download) or online mode. Inhibition does not make the device cease operation. This option allows for maintenance of the device without faults being reported to the controller.

You can inhibit HART devices on the Connection page of the Properties dialog box for the HART device.

HART Device Electronic Keying

The electronic keying feature for HART devices automatically compares the expected device to the physical device before HART device connection is established. You can use electronic keying to help prevent connection to a HART device that does not match the type and revision expected.

For each HART device, the user-selected keying option determines if, and how, an electronic keying check is performed.

The three keying options that are available are:

- Exact Match
- Compatible Module (default)
- Disable Keying

Exact Match is an electronic keying protection mode that requires the physical HART device and the HART device that is configured in the software to match according to HART Expanded Device Type, major revision, and minor revision.

Compatible Module is the default setting. It allows the physical HART device to accept the key of the HART device configured in the software, provided that the configured device is one the physical device is capable of emulating. The exact level of emulation that is required is defined as following:

- HART Expanded Device Type must match.
- Major revision of the physical device must be greater or equal than the configured major revision.
- If Major revision exactly matched, minor revision of the physical device must be greater or equal than the configured minor revision if the configured minor revision is not 0.

Disable Keying indicates that the keying attributes are not considered when attempting to communicate with a HART device. Other attributes, such as data size and format, are considered and must be acceptable before HART connection is established. With Disabled Keying, HART connection may occur with a device other than the type specified in the I/O configuration tree with unpredictable results.

WARNING: Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss.
We strongly recommend that you do not use Disable Keying.
If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.

Producer / Consumer Data Connection Type Configuration

The Producer/Consumer data can be configured to communicate using a Data or a PlantPAx data connection type.

PlantPAx connection includes specific data required for the PlantPAx HART instruction.

Producer / Consumer Communication of HART Device

The Producer/Consumer communication between controller and HART device allows you to:

- Monitor HART device status or configuration change.
- Get PlantPAx specific data required for the PlantPAx HART instruction.(1)
- Get periodical update of dynamic variable data and status.
- Get periodical update of device variable data and status.
- Execute HART commands on-demand.

(1) For PlantPAx connection only.

Producer / Consumer Data Configuration

The Producer/Consumer data can be configured to include the following for each HART device:

- Up to four dynamic variables
- Up to eight device variables
- Up to four HART commands

HART Device Configuration Change Notification

If any configuration parameters are changed in a HART device for any reason, *ConfigurationChanged* bit is set to 1 in the produce data of the HART device that is used in Logix controller to inform the Studio 5000 Logix Designer application about the change. When this occurs, the application should:

1. Transit *ResetConfigurationChanged* bit from 0 to 1 in the consumer data.
2. Execute the Get HART Device Information Service. For more information on the Get HART Device Information Service, See CIP Object Model of HART Device on page 141.
3. Perform any other HART services needed to get other configuration data being managed by the Studio 5000 Logix Designer application.

Rolling Timestamp of Dynamic/Device Variable Data

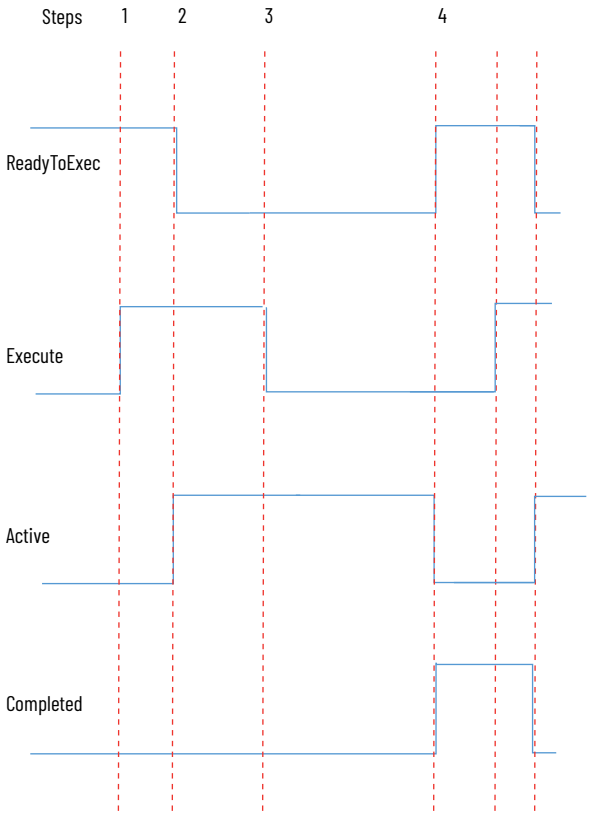
Whenever a HART module receives new HART Dynamic or Device variable data from a HART device, the module also records the value of RollingTimestamp at that time. The Logix 5000 controller uses the last two rolling timestamp values to calculate the amount of time between the samples.

Execute HART Commands through Producer / Consumer Data

These are some guidelines to execute HART commands through Producer / Consumer Data.

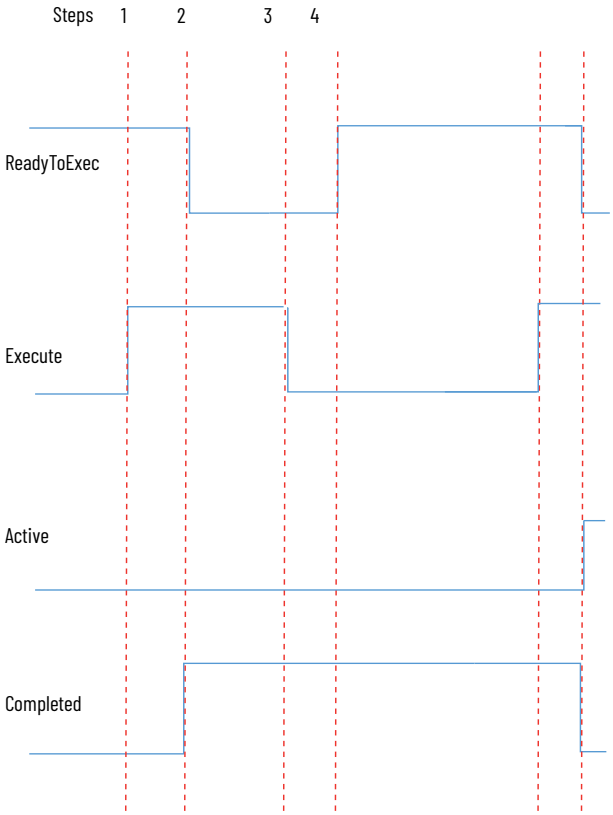
- A command execution starts with a rising edge of *Command.Execute* in the consumer data.
- *Command.ReadyToExecute* in the producer data is reported as 1 for a HART device when the HART device has no outstanding commands that are initiated from the consumer data and *Command.Execute* is 0 in the latest received consumer data.
- Set *Command.Execute* to 1 only when *Command.ReadyToExecute* is 1.
- After initiating a command execution, set it back to 0 once *Command.ReadyToExecute* of 0 in Producer data is received. *Command.ReadyToExecute* transitioning from 1 to 0 indicates that the HART module has received the command execution request.
- After a command is complete, check the status of all producer data in the *Command* tag before retrieving the response data of the command.

Figure 6 - A typical command execution sequence



1. To execute a HART command, set *Command.Execute* to 1 in the consume data when *Command.ReadyToExec* = 1 in the produce data of the HART device.
2. After the HART module receives the consume data, *Command.Active* = 1 and *Command.ReadyToExec* = 0 are reported in the produce data of the HART device.
3. Once the controller receives *Command.ReadyToExec* = 0, which means that the module has received the execution request, you can set *Command.Execute* to 0 in consume data.
4. When the HART command execution is complete, the HART module reports *Command.Completed* = 1 and *Command.ReadyToExec* = 1 in the produce data of the HART device together with the command result and response data.
5. To initiate another command execution, repeat steps 1 to 4.

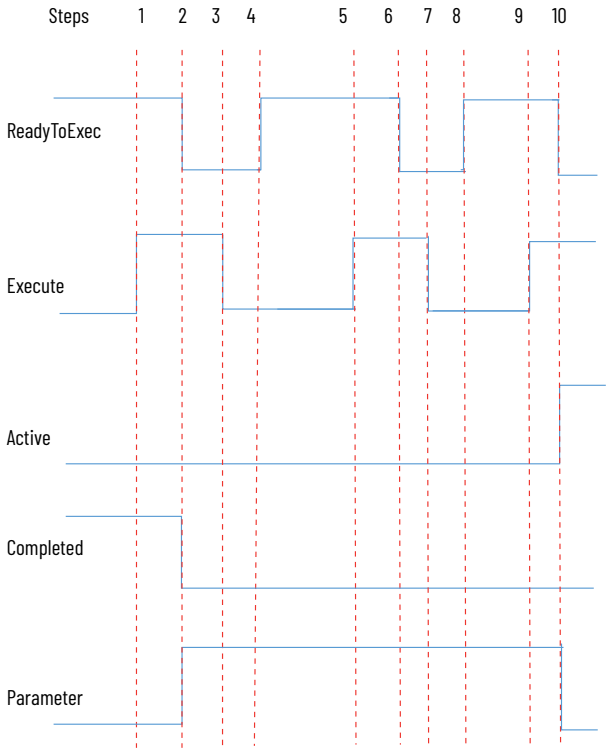
Figure 7 - Command completed within an RPI



1. To execute a HART command, set *Command.Execute* to 1 in the consume data when *Command.ReadyToExec* = 1 in the produce data of the HART device.
2. After the HART module receives the consume data, the HART command is completed within an RPI. Hence *Command.Completed* = 1 and *Command.ReadyToExec* = 0 are reported in the next produce data of the HART device. An active state is not reported for the command.
3. Once the controller receives *Command.ReadyToExec* = 0, set *Command.Execute* to 0 in the consume data.
4. When the HART module receives the consume data, the next produce data of the HART device reports *Command.ReadyToExec* = 1.

   To initiate another command execution, repeat steps 1 to 4.

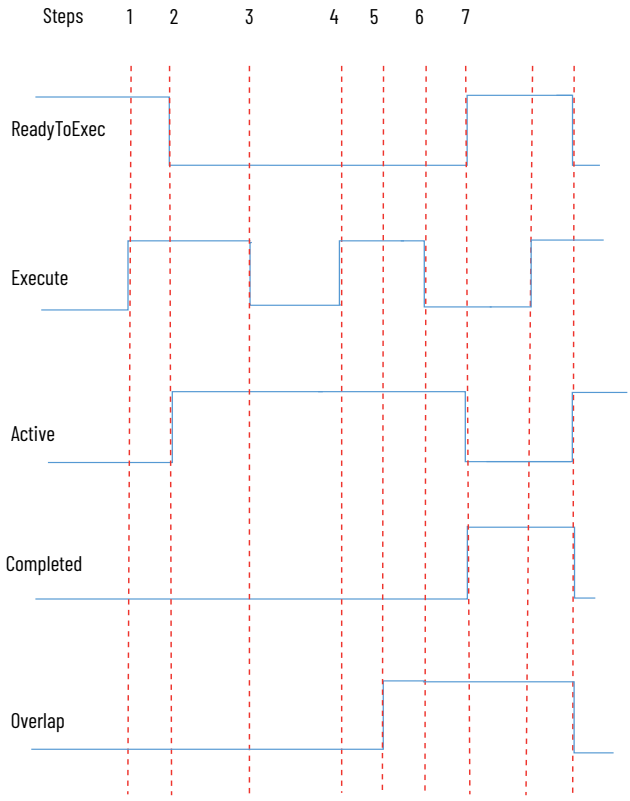
Figure 8 - Command with a parameter error



1. To execute a HART command, set *Command.Execute* to 1 in the consume data when *Command.ReadyToExec* =1 in the produce data of the HART device.
2. After the HART module receives the consume data, it verifies the request data and finds some parameters (for example, invalid chars for Packed ASCII or string length longer than configured) that cannot be converted to HART type successfully. The HART module reports *Command.Active* = 0, *<nameofcommand>.Command.ReadyToExec* = 0, *Command.Complete* = 0 and *Command.ParameterError* = 1 in the produce data of the HART device.
3. When the module receives *Command.ReadyToExec* = 0, set *Command.Execute* to 0 in the consume data.
   With *ParameterError* bit set, the execution is rejected due to errors in the command request data. *Command.ParameterErrorNumber* in the produce data indicates the index of the first invalid parameter in the command request data.
4. Once the HART module receives *Command.Execute* = 0, it reports *Command.ReadyToExec* = 1 in the produce data of the HART device.
5. Initiate a new execution by setting *Command.Execute* to 1 in the consume data.
6. When the HART module receives the consume data and finds that the command request data in the consume data still has errors, it reports *Command.ReadyToExec* = 0 and *Command.ParameterError* = 1 in the produce data of the HART device again.
7. Once the HART module receives *Command.ReadyToExec* = 0, the module receives latest execution request, set *Command.Execute* to 0 in the consume data.
   With *ParameterError* bit set, the latest execution request is rejected due to errors in the command request data.
8. The HART module reports *Command.ReadyToExec* = 1 in the produce data of the HART device.
9. To start a new execution, set *Command.Execute* to 1 in the consume data.

10. When the HART module receives the consume data and verifies that the command request data are all valid, it sends the command to the HART device and reports *Command.ReadyToExec* = 0, *Command.Active* = 1, and *Command.ParameterError* = 0 in the produce data of the HART device.

Figure 9 - Command overlap



1. Set *Command.Execute* to 1 in the consume data when *Command.ReadyToExec* = 1 in the produce data of the HART device.
2. After the HART module receives the consume data, *Command.Active* = 1 and *Command.ReadyToExec* = 0 are reported in produce data of the HART device.
3. Once the controller receives *ommand.ReadyToExec* = 0, the module receives the execution request and you can set *Command.Execute* to 0 in the consume data.
4. Without waiting for the outstanding command complete, set *Command.Execute* to 1 in the consume data again.
5. The HART module reports *Command.Overlap* = 1 in the produce data of the HART device.
6. Set *Command.Execute* to 0 in the consume data.
7. If *Command.Execute* is set to 0 in Step 6, after HART command execution is complete, the HART module reports *Command.Completed* = 1 and *Command.ReadyToExec* = 1 in the produce data of the HART device together with the command result and response data.

   To initiate another command execution, repeat steps 1 to 7. *Command.Overlap* is only cleared when a new command execution is started successfully.

Execute HART Commands through Explicit Messaging

FLEX 5000 analog HART I/O modules have the ability to allow users to define message instructions to send commands to HART devices. The CIP service is Service 0x4C of HART Process Device Object that is defined in CIP Volume 7B "Integration of HART Devices into the CIP Architecture" with an exception that Class ID 0x3B8 should be used for HART Process Device Object.

As executing HART commands through explicit messaging causes delays of updating dynamic or device variables in produce data of the HART device, periodical command execution through explicit messaging, for example, connected and cached message instruction, is not recommended.

Fault and Status Reporting

The FLEX 5000 analog HART module sends fault and status data for HART device, configured dynamic variables, and device variables in the produce data for each HART device.

Table 17 lists the HART device fault and status tags available in the Studio 5000 Logix Designer application.

Table 17 - Fault and Status Data Tags

Data Type	Tag Name	Triggering Event That Sets Tag
Fault	ConnectionFaulted[1]	The owner-controller loses its connection to the module.
	CurrentMismatch	The HART digital value does not match the analog module channel value.
	Malfunction	The device has detected a hardware error or failure.
	<NameOfVariable>.Ch.Fault	Data is inaccurate and cannot be trusted for use in the application.
	<NameOfVariable>.Ch.Underrange	The input signal at the channel is less than, or equal to, the min detectable signal.
	<NameOfVariable>.Ch.Overrange	The input signal at the channel is greater than, or equal to, the max detectable signal.
	Static.Fault	Indicates if the set of static data is valid. For PlantPAx connection only.
Status	RunMode[1]	The module is in Run Mode.
	DiagnosticActive	Indicates if any diagnostics are active or if the prognostics threshold is reached.
	DiagnosticSequenceCount	A counter that increments when a diagnostic condition occurs or goes away. The counter is a rolling counter that skips 0 on rollovers.
	CurrentSaturated	The loop current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.
	CurrentFixed	The loop current is being held at a fixed value and is not responding to process variations.
	MoreStatusAvailable	More status information is available than can be returned in the Field Device Status.
	ConfigurationChanged	HART device configuration is changed and the module has retrieved all HART device configuration data to be returned by the *Get HART Device Information* service
	<NameOfVariable>.Ch.Uncertain	Indicates that the channel data can be inaccurate but the degree of inaccuracy is not known.
	<NameOfVariable>.Ch.Data	The last good value received from the device.
	<NameOfVariable>.Ch.RollingTimestamp	RollingTimestamp is continuously running a 15-bit timer that counts in milliseconds
	<NameOfVariable>.Class	Device Variable Classification.
	<NameOfVariable>.Unit	Unit code.
	<NameOfVariable>.Manual	Indicates that the data value is manually controlled.
	<NameOfVariable>.Constant	Indicates that the data value is constant. It is set to 1 when variable status indicates "constant".
	Static.PVUnit	Unit code of PV. For PlantPAx connection only.
	Static.HARTRevision	HART protocol major revision number. For PlantPAx connection only.
	Static.HARTTagName	Assigned name of HART device. Same as Identity attribute 15. For PlantPAx connection only.
	Static.Descriptor	Descriptor of HART device. For PlantPAx connection only.
	Static.PVAtSignal4	PV Lower Range value. For PlantPAx connection only.
	Static.PVAtSignal20	PV Higher Range value. For PlantPAx connection only.

Table 17 - Fault and Status Data Tags (Continued)

Data Type	Tag Name	Triggering Event That Sets Tag
Status	Static.AdditionalDeviceStatus	Additional Device Status from HART command 48. For PlantPAx connection only.
	ChDataAtSignal4	This member is the engineering unit value of 4 mA according to the corresponding analog input channel configuration of the module. For PlantPAx connection only.
	ChDataAtSignal20	This member is the engineering unit value of 20 mA according to the corresponding analog input channel configuration of the module. For PlantPAx connection only.

(1) This tag provides module-wide data and affects all channels simultaneously.

Configure the Module

This chapter describes how to configure your FLEX 5000 analog HART input and output modules in a Studio 5000 Logix Designer application project. You can use the default module configuration or edit the module configuration.

IMPORTANT Consider the following:

- You must use the Studio 5000 Logix Designer application, version 32.02 or later, to configure the FLEX 5000 Analog HART I/O modules.
- This chapter does not explain the user-configurable module features that you can edit on different screens in your Studio 5000 Logix Designer application project.
  For detailed information about module features, see the following:
  - Chapter 3, Common I/O Module Features
  - Chapter 4, Analog HART Input Channel Features
  - Chapter 5, Digital Input Point Features
  - Chapter 6, Analog HART Output Module Features

Before You Begin

You must complete the following tasks before you can configure the module:

1. Create a Studio 5000 Logix Designer application project.
2. Add a FLEX 5000 EtherNet/IP adapter to the project.

   For more information on how to add a FLEX 5000 EtherNet/IP adapter to a Studio 5000 Logix Designer application project, see the FLEX 5000 EtherNet/IP Adapter User Manual, publication 5094-UM005.

IMPORTANT For 5094-IF8IH and 5094-IF8IHXT modules, do not short circuit current and voltage terminals as doing so may result in erroneous readings and, in some cases, may cause damage to the channel.

Create a New Module

After you create a Studio 5000 Logix Designer application project and add a FLEX 5000 EtherNet/IP adapter to the project, you can use the following methods to add modules to the project.

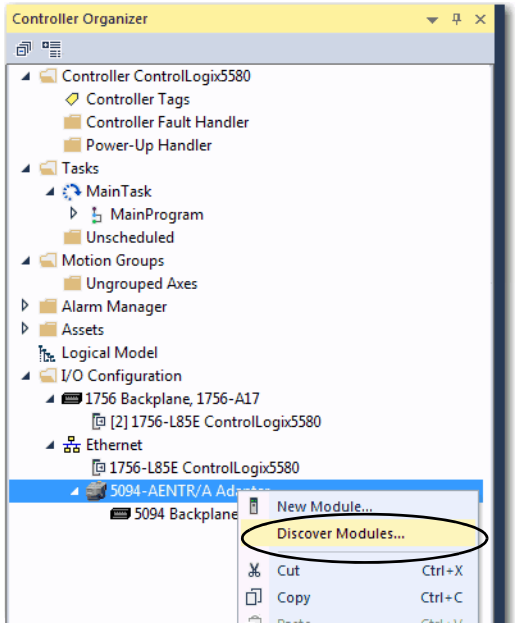
- Discover Modules

- New Module

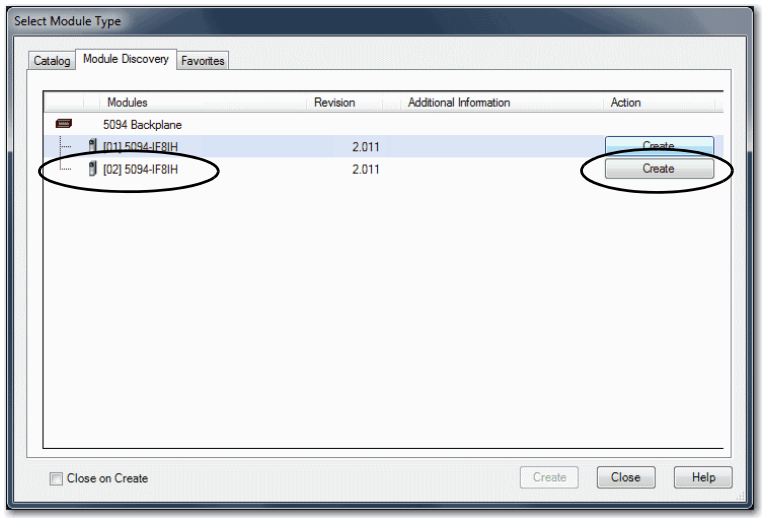
Discover Modules

To use the Discover Modules method with FLEX 5000 I/O modules, complete these steps.

1. Go online with your Studio 5000 Logix Designer application.
   The project must include a FLEX 5000 EtherNet/IP adapter.
2. Right-click the FLEX 5000 EtherNet/IP adapter and choose Discover Modules.
   The Studio 5000 Logix Designer application automatically detects available modules that are connected to the backplane.

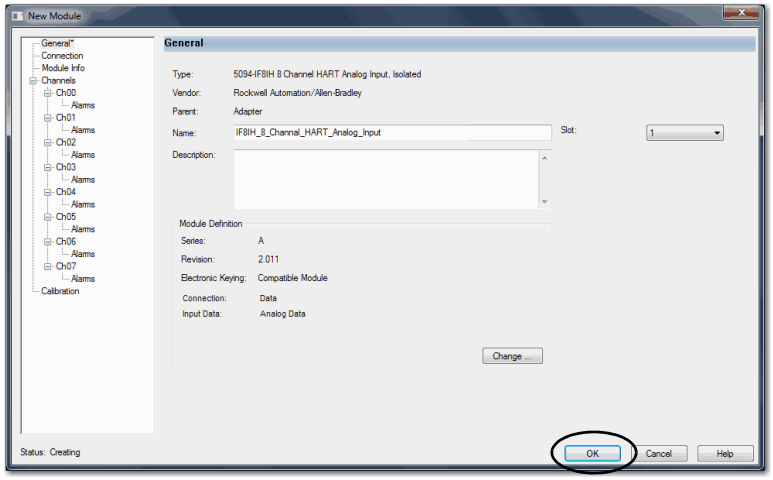


3. At the Select Module Type window, click Create to add the discovered module to your project.

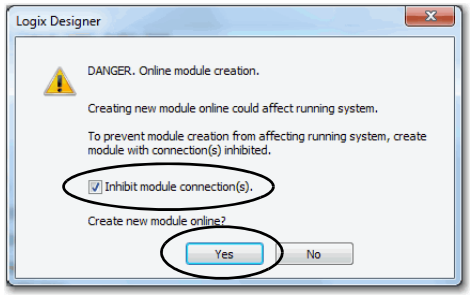


Note: If you select the Close on Create checkbox, the Module Discovery dialog box closes and you will need to start again at step 2 to add another module.

4. At the New Module window, configure the module properties and click OK.



5. At the warning dialog box, make sure that Inhibit module connection(s) is selected and click Yes.



6. Close the Select Module Type dialog box.

To add additional I/O modules with this method, complete one of the following:

- If you cleared the Close on Create checkbox when you created the first I/O module, repeat steps 3...6.
- If you selected the Close on Create checkbox when you created the first I/O module, repeat steps 2...6.

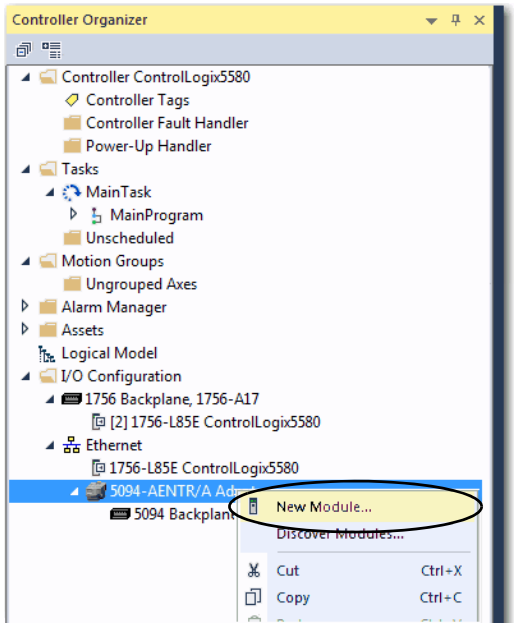
New Module

To use the New Module method with FLEX 5000 I/O modules, complete these steps.

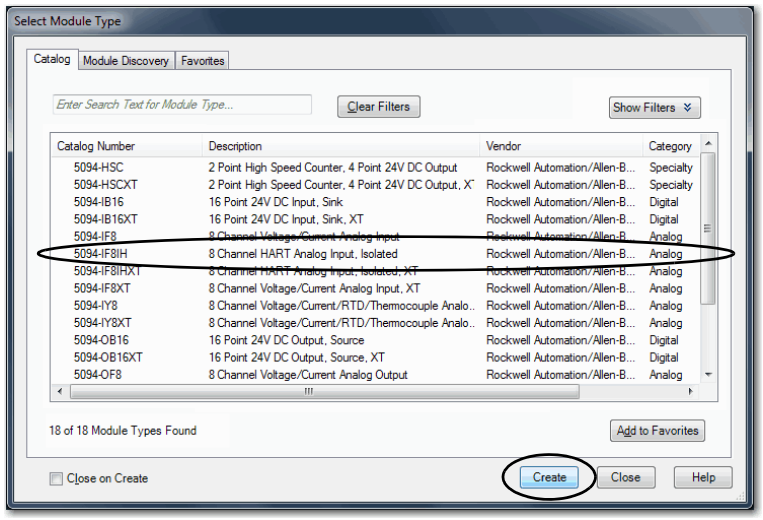
This example shows how to add an I/O module when the Studio 5000 Logix Designer application project is offline.

You can add new modules when the project is online, if desired. In this case, the steps are similar to the steps described in Discover Modules on page 72. One exception is that, in step 1, you choose New Module instead of Discover Modules.

1. Right-click FLEX 5000 EtherNet/IP adapter and choose New Module.



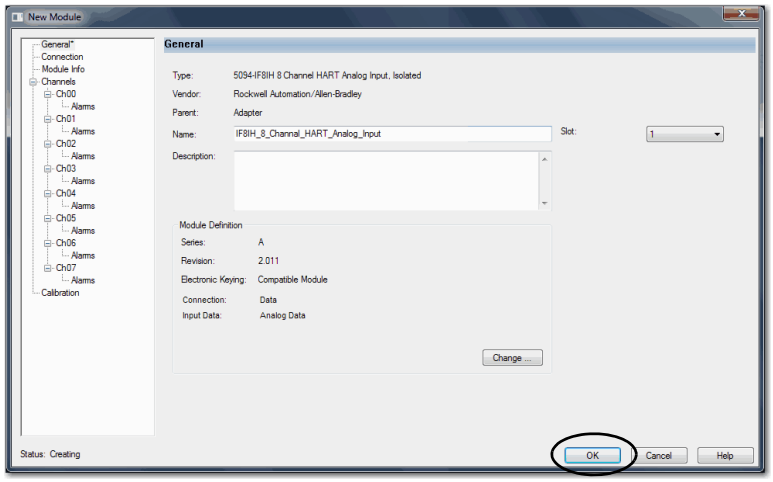
2. Select the module and click Create.



Note: If you select the Close on Create checkbox, the Module Discovery dialog box closes and you will need to start again at step 2 to add another module.

The New Module dialog box appears. It includes a list of categories on the left side. The number and type of categories varies by module type.

3. You can click OK to use the default configuration as shown or edit the module configuration. The rest of this chapter describes how to edit module configuration categories.



To add additional remote I/O modules with this method, complete one of the following:

- If you cleared the Close on Create checkbox when you created the first I/O module, repeat steps 2...3.
- If you did not clear the Close on Create checkbox when you created the first I/O module, repeat steps 1...3.

Edit the Module Configuration Common Categories

You click the category names in the New Module dialog box to view and change the configuration parameters that are associated with that module.

IMPORTANT This chapter shows how to edit configuration when you add the module to the Studio 5000 Logix Designer application project.

If you access the module configuration after the module has been added to the project, the dialog box is named Module Properties. The Module Properties dialog box shows the same categories as the New Module dialog box during the initial module creation steps.

Some new module configuration categories apply to all FLEX 5000 analog HART I/O modules. Some categories are specific to the module type.

For example purposes, the figures in this section are from a 5094-IF8IH module.

The following categories apply to both FLEX 5000 analog HART input and output modules and are described in this section:

- General Category
- Connection Category
- Module Info Category

General Category

The General category appears first when you create a module. The parameters in this category are the same for both FLEX 5000 analog HART input and output modules.

You use this category to complete the following tasks:

- Name the module.
- Assign a slot number. (required)
- Describe the module.
- Access the Module Definition.

Input Module Definition

Module Definition parameters are available on the General tab of the Module Properties dialog box in the Studio 5000 Logix Designer application project.

Table 18 describes the parameters on the Module Definition dialog box.

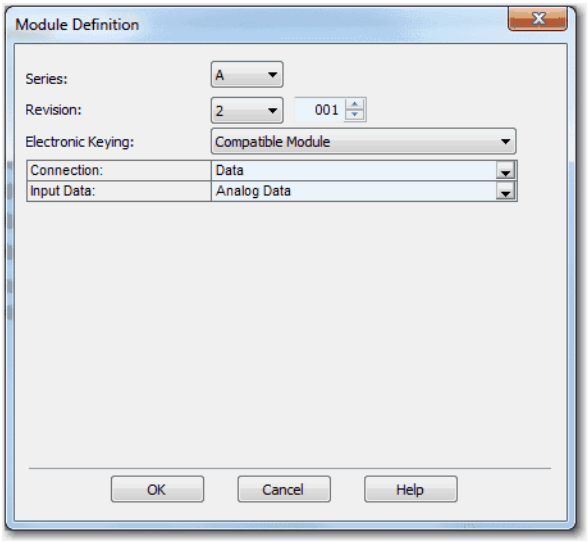


Table 18 - Module Definition Parameters

Parameter	Definition	Available Choices(1)
Series	Module hardware series	Module-specific
Revision	Module firmware revision, including major and minor revision levels	Module-specific
Electronic Keying	Software method by which you reduce the possibility of using the wrong device in a control system. For more information, see the following: • Electronic Keying on page 31 • Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001	Exact Match Compatible Module Disable Keying
Connection	Determines the following for the module type you configure: • Available configuration parameters • Data type transferred between the module and the controller • Which tags are generated when configuration is complete	Data Listen Only(2)
Input Data - Input modules only	All available configuration, input, and output data for the input module that is being defined.	Analog Data Analog and Discrete(3) Discrete(3)

(1) The range of available choices varies by module type.
(2) Controller and module establish communication without the controller sending any configuration or output data to the module. A full input data connection is established but depends on the connection between the owner-controller and the module.
(3) Discrete input data is only supported when using 5094-IF8IH or 5094-IF8IHXT modules with firmware revision 3.00 or later.

Output Module Definition

Module Definition parameters are available on the General tab of the Module Properties dialog box in the Studio 5000 Logix Designer application project.

Table 19 describes the output parameters on the Module Definition dialog box.

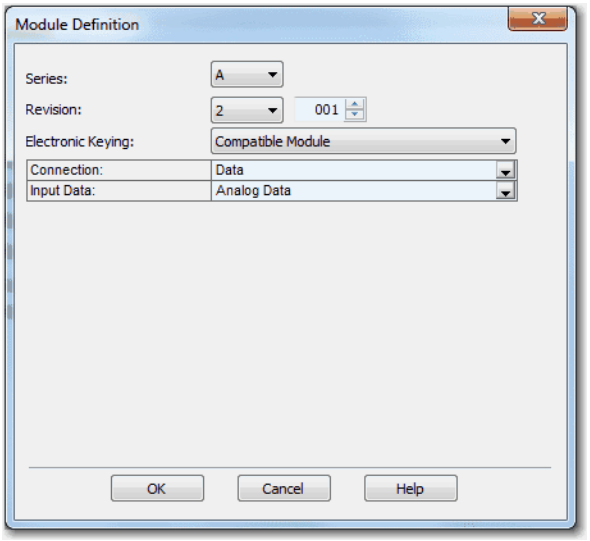


Table 19 - Module Definition Parameters

Parameter	Definition	Available Choices
Series	Module hardware series	Module-specific
Revision	Module firmware revision, including major and minor revision levels	Module-specific
Electronic Keying	Software method by which you reduce the possibility of using the wrong device in a control system. For more information, see the following: • Electronic Keying on page 31 • Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001	Exact Match Compatible Module Disable Keying
Connection	Determines the following for the module type you configure: • Available configuration parameters • Data type transferred between the module and the controller • Which tags are generated when configuration is complete	Data Listen Only(1)
Output Data - Output module only	All available configuration, input, and output data for the output module that is being defined.	Analog Data None - This choice is available only if you use the Listen Only Connection choice.

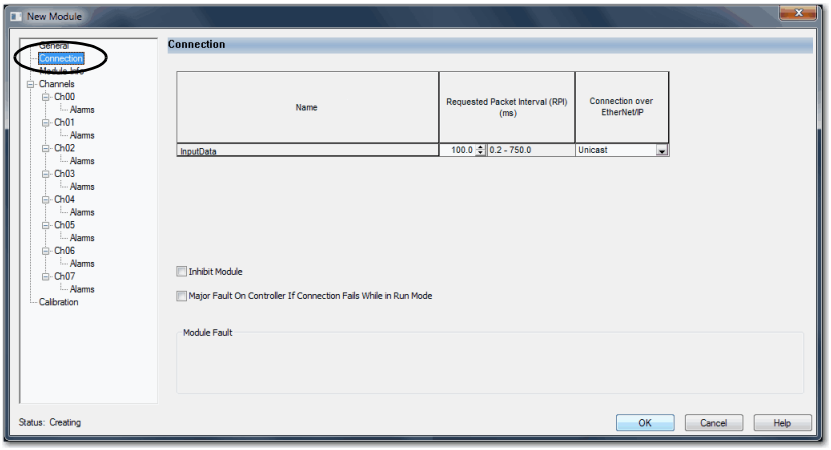
(1) Controller and module establish communication without the controller sending any configuration or output data to the module. A full input data connection is established but depends on the connection between the owner-controller and the module.

Connection Category

The Connection category lets you complete the following tasks:

- Set the RPI rate. For more information about the RPI, see Requested Packet Interval on page 21.
- Set the connection type to use on the EtherNet/IP network.
- For more information on Unicast and Multicast connections, see the EtherNet/IP Communication Modules in 5000 Series Systems User Manual, publication ENET-UM004.
- Inhibit the module. For more information on how to inhibit the module, see Module Inhibiting on page 30.
- Configure whether a connection failure while the controller is in Run module causes a major or minor fault.

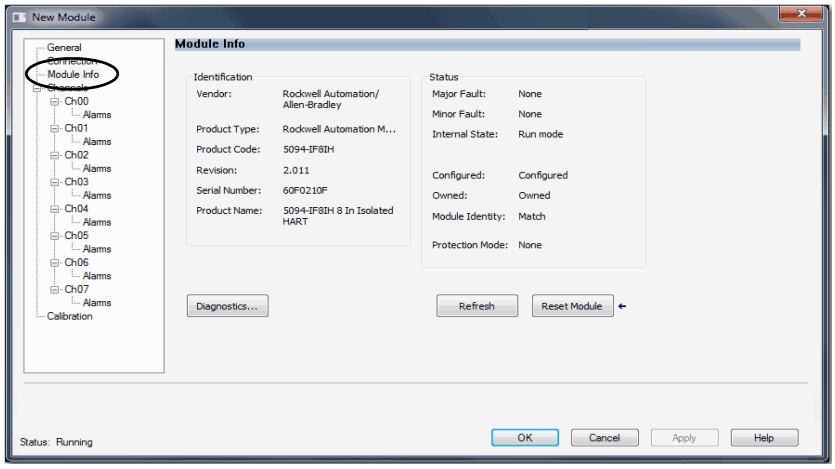
The Module Fault area of the Connection category is useful during module troubleshooting. For more information on the Module Fault area, see page 112



Module Info Category

The Module Info category displays module and status information about the module when the project is online. You can use this category to complete the following:

- Determine the identity of the module.
- Access module diagnostics
- Refresh the data on the screen
- Reset the module



Edit 5094-IF8IH Module Configuration Categories

In addition to the General, Connection, Module Info, and Points categories, the following categories are available when you configure a 5094-IF8IH module:

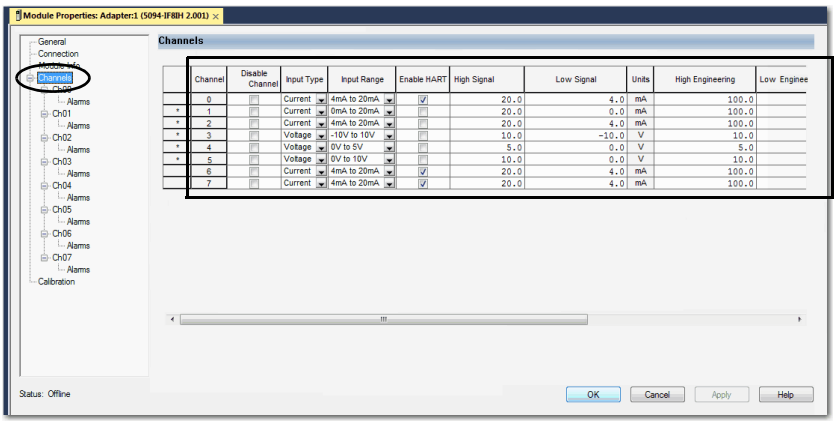
- Channels Category
- Points Category
- Calibration Category

IMPORTANT	If you use the Listen Only connection type, the Channels Category and Calibration Category do not appear.

Channels Category

The Channels category shows an overview of the configuration values for all module channels. The values for each parameter indicate how that particular channel is configured on that channel's category.

The following shows the Channels category for the 5094-IF8IH module.



IMPORTANT You can edit the fields on the Channels category dialog box.

We recommend that you change channel configuration on the specific channel categories as described in the rest of this section.

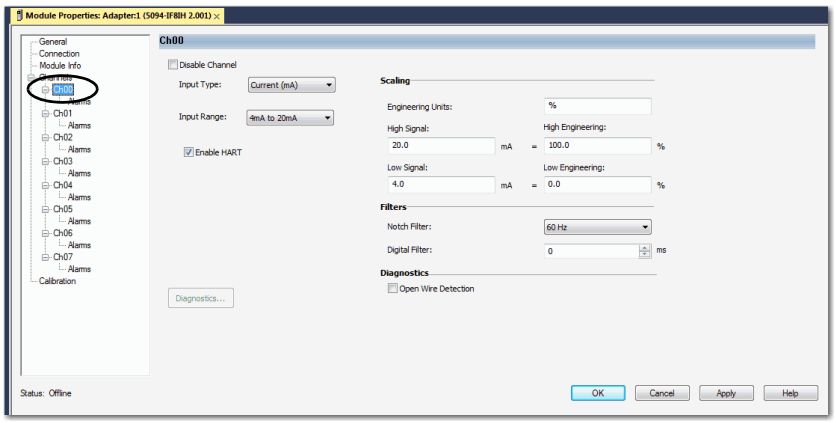
Use this view to monitor configuration for all channels on the module.

ChOx Category

The Ch*ox* category, where *ox* represents the channel number, shows the configuration options available for the channel. You can use this category to complete the following:

- Enable/disable channel
- Select input type and range
- Enable HART
- Choose scaling options
- Select notch filter
- Choose digital filter
- Enable/disable open wire detection

The Scaling and Filter options correspond to the input type and range for the channel.

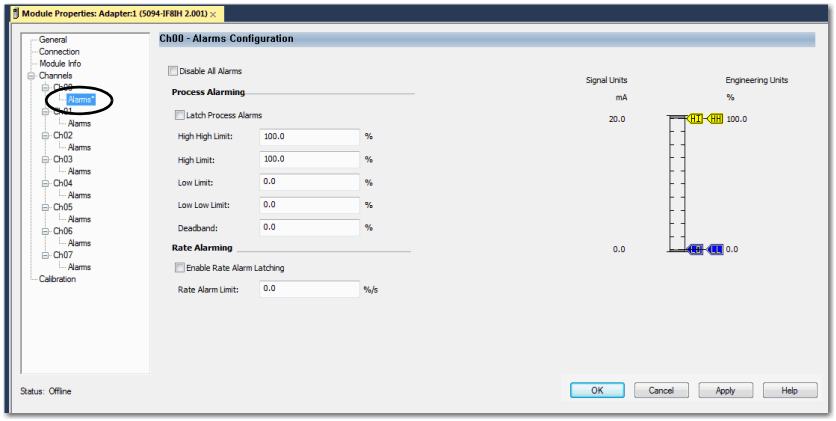


Open Wire Detection on input range -10V...10V operating mode is disabled.

If desired, you can disable the channel on this dialog box.

Alarms Category

Each channel on the 5094-IF8IH module has an Alarms category with which it is associated. The Signal Units correspond to the input type and range for the channel.



If desired, you can disable alarms on this dialog box.

Points Category

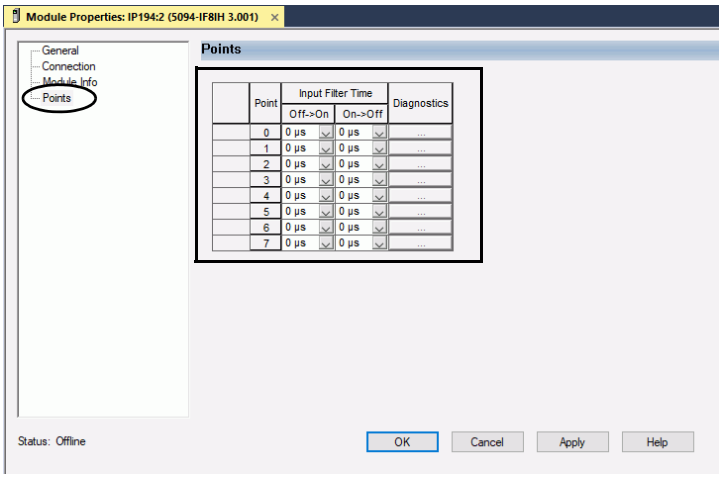
The Points category shows an overview of the configuration values for all digital input points.

Points Category

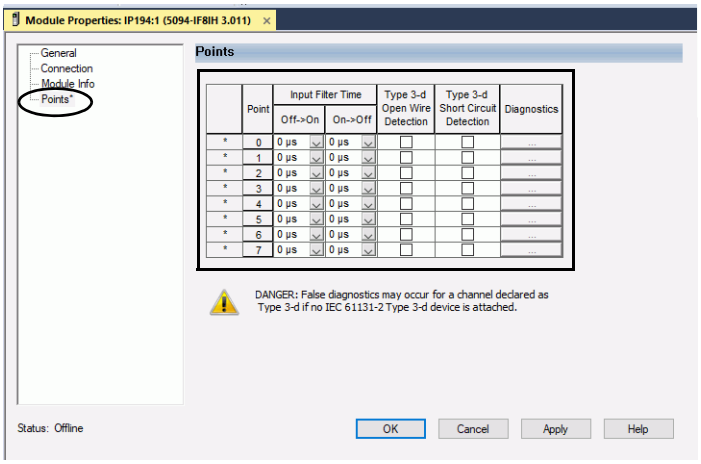
The Points category shows the configuration options available for the point. You can use this category to complete the following:

- Choose Input Filter Time
- Enable Type 3-d OpenWire Detection
- Enable Type 3-d ShortCircuit Detection
- Access the Points Diagnostics dialog

The following shows the Points category for any input device other than an IEC61131-2 Type 3-d digital input device.



The following shows the Points category for an IEC61131-2 Type 3-d digital input device.



The Points Diagnostics dialog shows the diagnostics assemblies for digital inputs based on the Discrete Type selected from the Modules Definition dialog.

Figure 10 - Point Diagnostic dialog for Digital Input

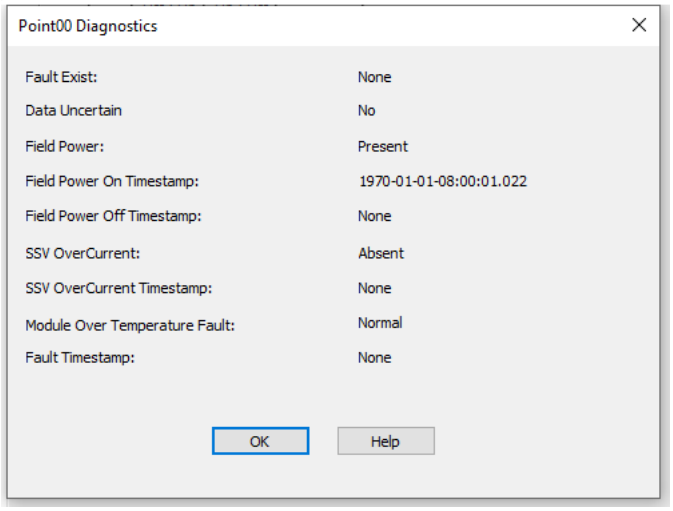
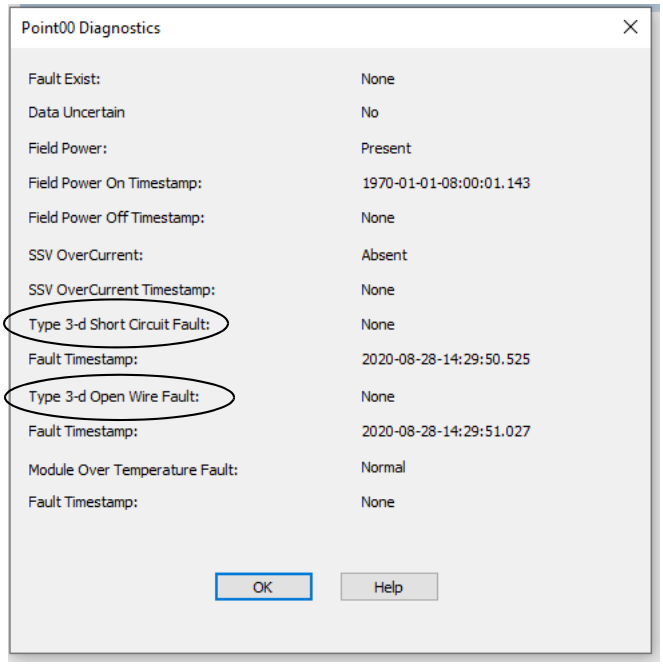


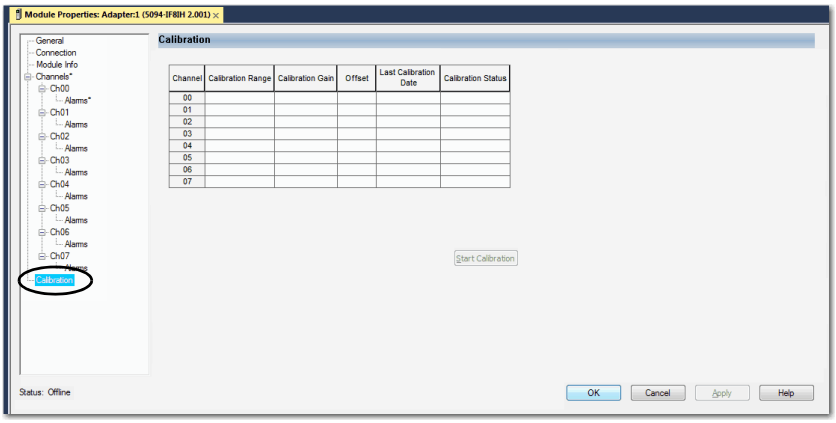
Figure 11 - Point Diagnostic dialog for Type 3-d Digital Input



Calibration Category

The Calibration category provides calibration information for all channels on the module. This category is blank when you add a module to the project.

Use this category during the calibration process. For more information on how to calibrate a module, see Chapter 10, Calibrate the Module on page 99.



IMPORTANT If Analog and Discrete is selected as Input Data in Module Definition, Channels 4...7 are removed from the Calibration page and the Calibration wizard pages.

Edit 5094-OF8IH Module Configuration Categories

In addition to the General, Connection, and Module Info categories, the following categories are available when you configure a 5094-OF8IH module:

- Channels Category
- Calibration Category

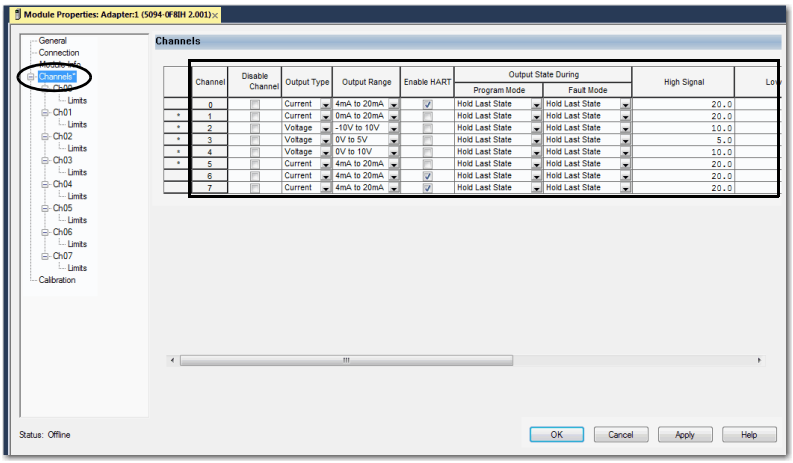
IMPORTANT If you use the Listen Only connection type, the Channels Category and Calibration Category do not appear.

Channels Category

The Channels category shows an overview of the configuration values for all module channels. The values for each parameter indicate how that particular channel is configured on that channel's category.

The following shows the Channels category for the 5094-OF8IH module.

IMPORTANT You can edit the fields on the Channels category dialog box.
We recommend that you change channel configuration on the specific channel categories as described in the rest of this section.
Use this view to monitor configuration for all channels on the module.

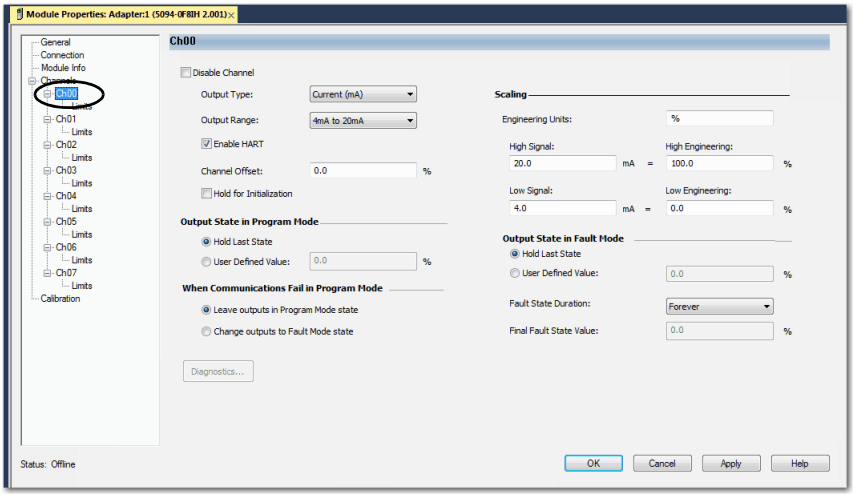


ChOx Category

The Ch*ox* category, where *ox* represents the channel number, shows the configuration options available for the channel. You can use this category to complete the following:

- Enable/disable channel
- Select output type and range
- Enable HART
- Choose scaling options
- Select program and fault mode output states
- Choose output state options

The Scaling options correspond to the output type and range for the channel.



If desired, you can disable the channel on this dialog box.

Limits Category

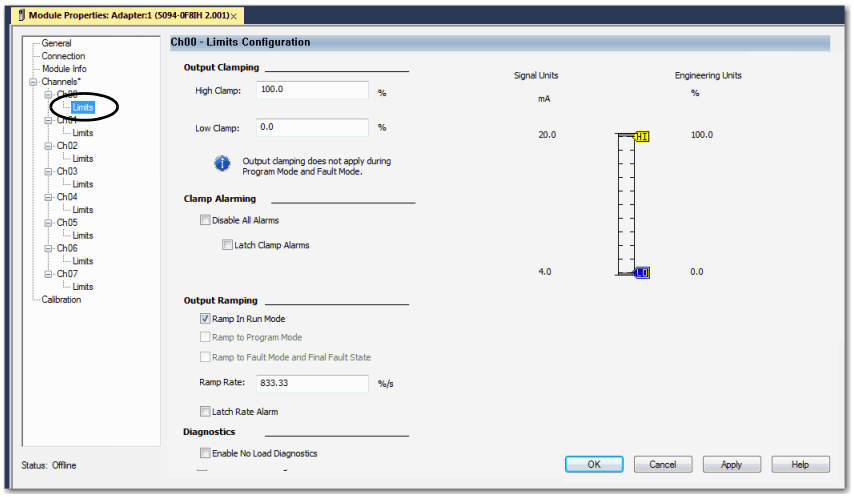
Each channel on the 5094-OF8IH module has a Limits category with which it is associated.

You can use this category to complete the following:

- Choose high clamp and low clamp output clamping.
- Enable/disable clamp alarms.
- Choose output ramp options

IMPORTANT When HART is enabled, ramp rate is limited to ≤ 833.33% /s.

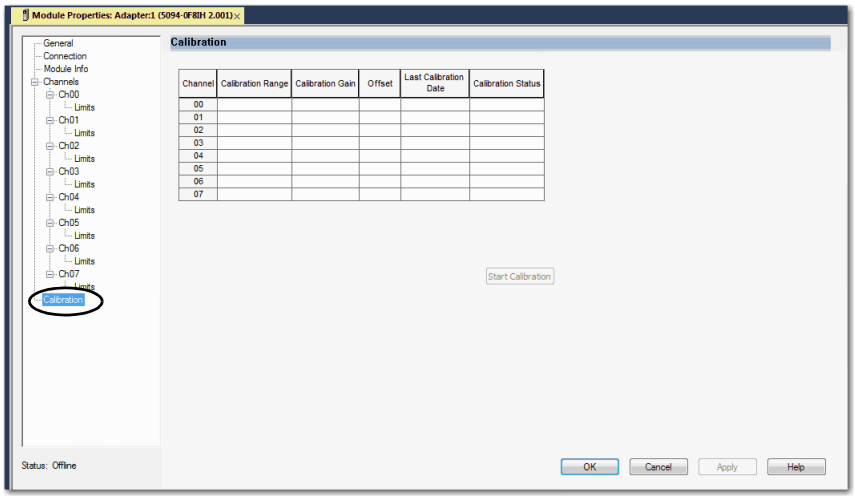
- Choose diagnostics options.



Calibration Category

The Calibration category provides calibration information for all channels on the module. This category is blank when you add a module to the Studio 5000 Logix Designer application project.

You use this category during the calibration process. For more information on how to calibrate a module, see Chapter 10, Calibrate the Module on page 99.

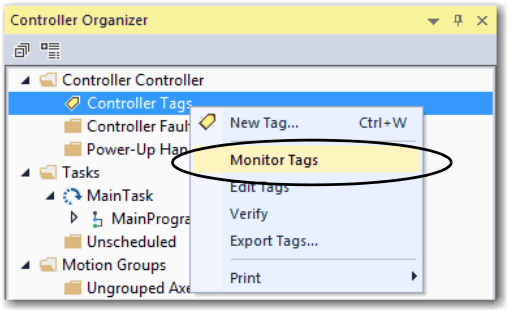


View the Module Tags

When you create a module, the Studio 5000 Logix Designer application creates a set of tags that you can view in the Tag Editor. Each configured feature on your module has a distinct tag that is available for use in the controller program logic.

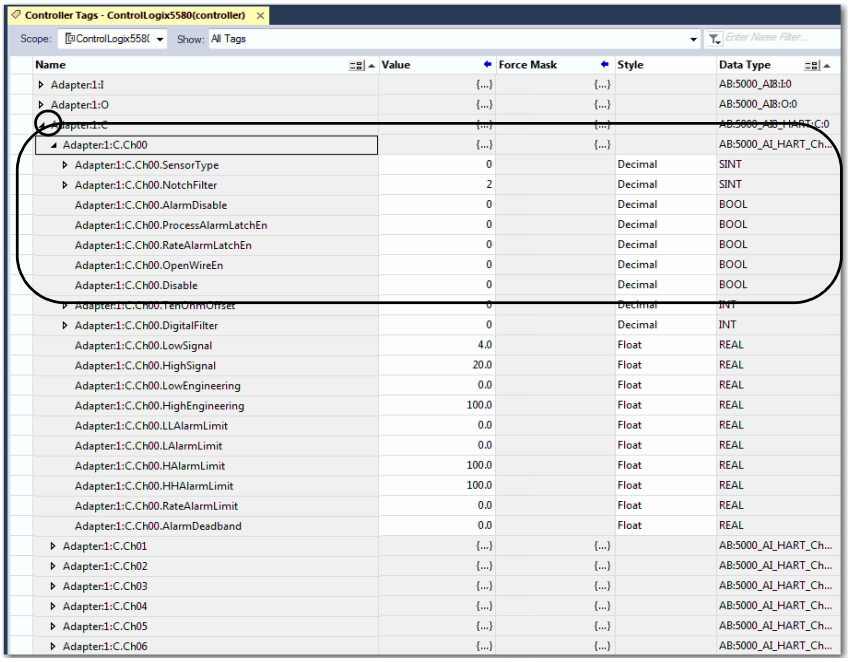
Complete the following steps to access the module tags.

1. In the Controller Organizer, right-click Controller Tags and choose Monitor Tags.



   The Controller Tags dialog box appears with data.

2. To view module tags as shown, click the ▷ symbols.



For more information on module tags, see Appendix B, Module Tag Definitions on page 117.

Configure HART Devices

This chapter describes how to configure the HART devices that are connected to your FLEX 5000 analog HART I/O modules in a Studio 5000 Logix Designer application project.

- Some HART device profiles are pre-loaded in the Studio 5000 Logix Designer application and are recognized when you connect them to HART enabled channels.
- Some HART devices need EDD information updates before you can use them.
- Some HART devices are not recognized and need generic profiles to connect to the channels.

IMPORTANT Consider the following:

- You must use the Studio 5000 Logix Designer application, version 32.02 or later, to configure the FLEX 5000 analog HART I/O modules.
- This chapter does not explain the user-configurable module features that you can edit on different screens in your Studio 5000 Logix Designer application project.

In an output module, the power to the field device is provided by the channel. If the channel is not energized the HART device will not be powered on.

Before You Begin

You must complete the following tasks before you can configure the HART device operations:

1. Create a Studio 5000 Logix Designer application project.
2. Add a FLEX 5000 EtherNet/IP adapter to the project.
3. Configure the FLEX 5000 analog HART input or output module.

   For more information on how to configure a FLEX 5000 analog HART I/O module in a Studio 5000 Logix Designer application project, See Configure the Module on page 71.
4. Set at least one channel Input Type to Current, configure the Input Range is for 4...20 mA, and check the Enable HART option.

Before using the HART capabilities, be sure that:

- the I/O module and the associated field device are working properly in the analog 4...20 mA mode.

- the field device is HART capable.
- no more than one HART field device is connected to each channel.
- input filtering is set to a valid (defined) value.

Create a New HART Device

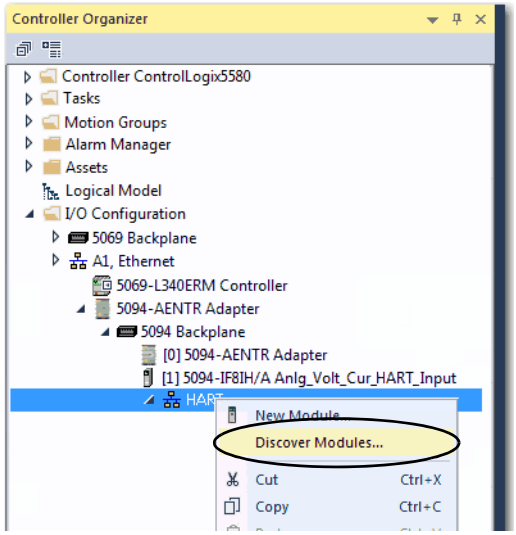
To add HART devices to your project, you can use the following methods.

- Discover HART Device
- New Device

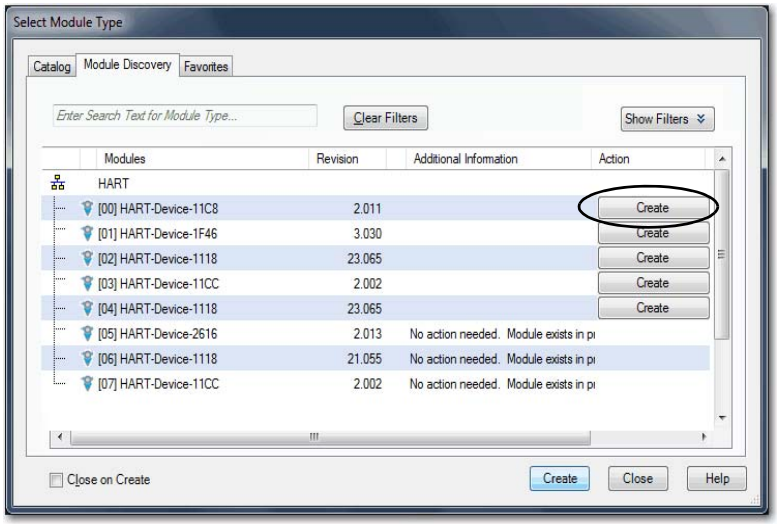
Discover HART Device

To use the Discover Modules method with HART devices that are already added to the list in Studio 5000 Logix Designer, complete these steps.

1. From the I/O Configuration tree, right-click the virtual HART bus below the FLEX 5000 analog HART I/O module and choose Discover Modules... The Studio 5000 Logix Designer application automatically detects available modules that are connected to the HART bus.



The Select Module Type dialog box appears.



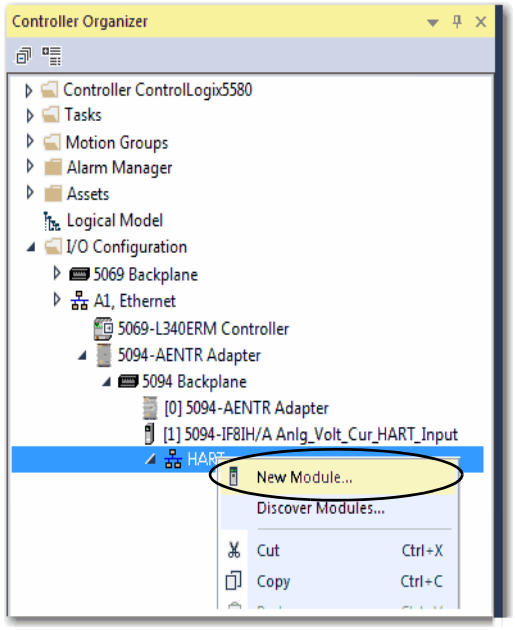
2. Select the HART device and choose Create to add the discovered module to your project.

   Note: If you select the Close on Create checkbox, the Module Discovery dialog box closes and you will need to start again at step 2 to add another module.

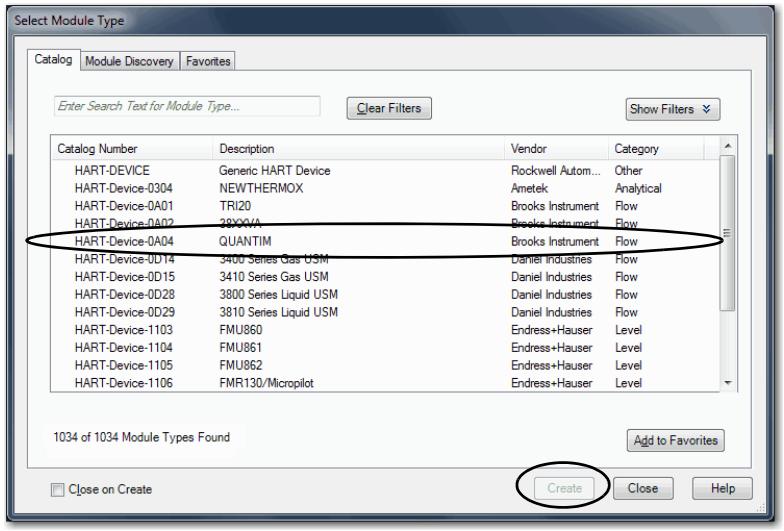
New Device

To use the New Module method with HART devices, complete these steps.

1. Right-click the virtual HART bus below the FLEX 5000 analog HART I/O module and choose New Module.



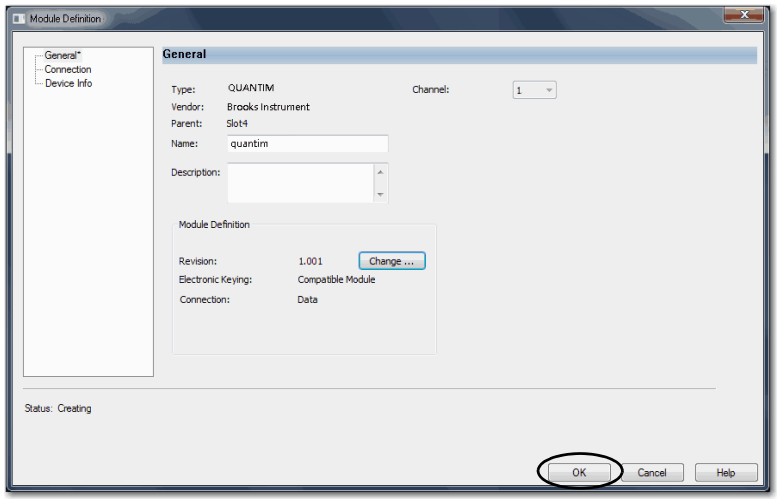
2. Select the device and click Create.



   Note: If you select the Close on Create checkbox, the Module Discovery dialog box closes and you will need to start again at step 1 to add another module.

The New Module dialog box appears. It includes a list of categories on the left side. The number and type of categories varies by module type.

3. You can click OK to use the default configuration as shown or edit the device configuration.



Add HART EDD File

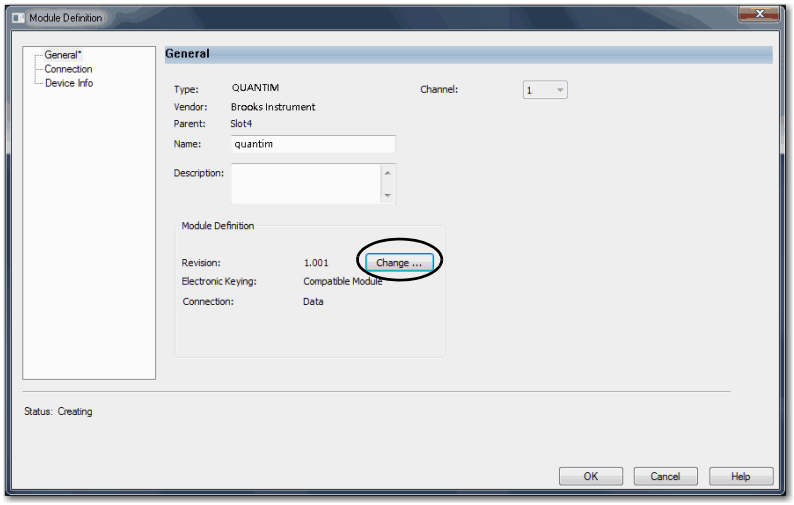
There are two scenarios for adding HART devices from the Module Definition dialog box:

- Update an EDD file for a specific HART device.
- Add an EDD file for a generic HART device.

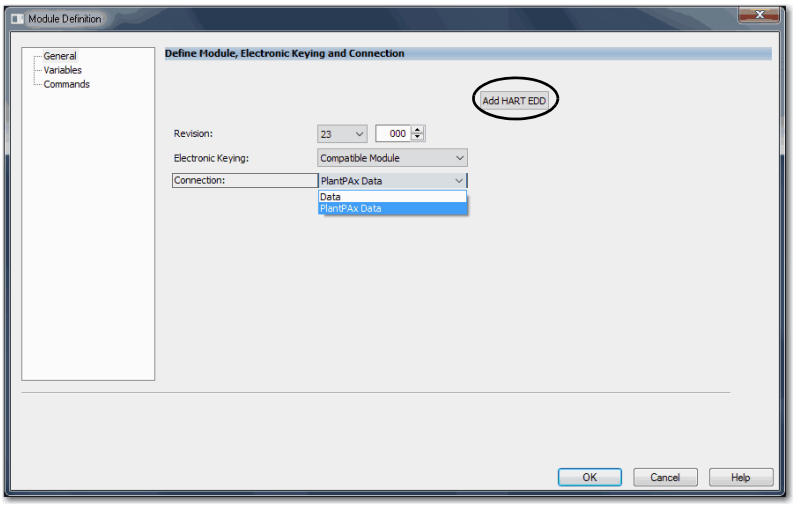
The HART device EDD files are included with most HART device profiles. If additional or newer EDD files are required, download the EDD file. This file may be available from the Documents and Downloads page at the FieldComm Group website https://www.fieldcommgroup.org. Otherwise request the file from the HART Device vendor.

Update an EDD file for a specific HART device

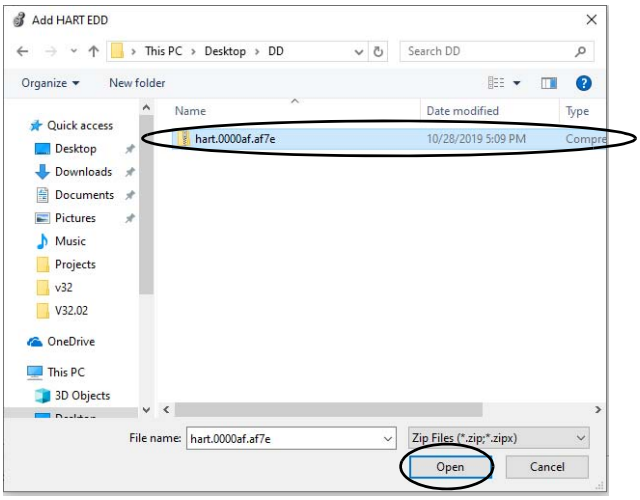
1. From the Module Definition dialog box - General tab, select Change...



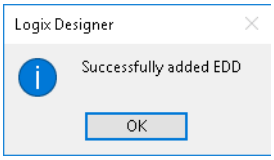
2. From the Module Definition dialog, select Add HART EDD.



3. In the Add HART EDD dialog box, browse to the location of the EDD file.



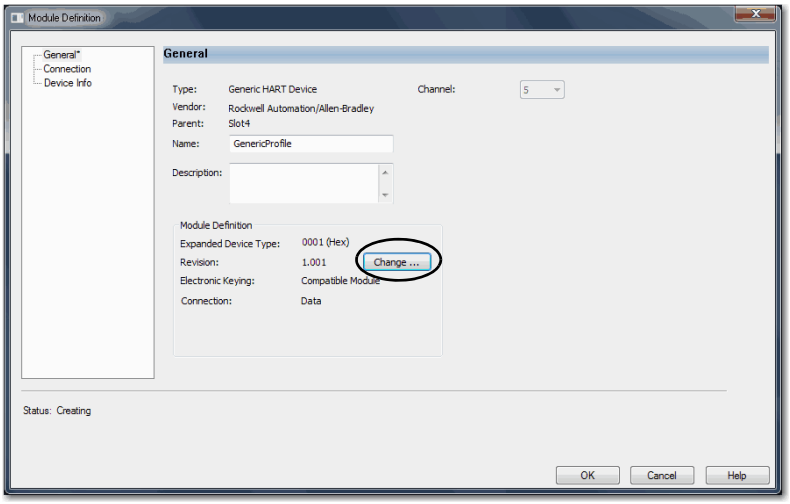
4. Select the HART EDD file and select Open.
5. The message Successfully added EDD appears.



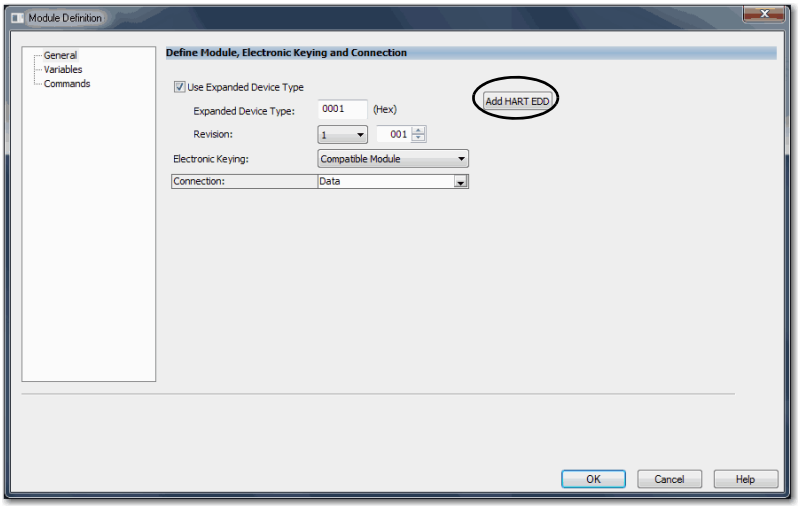
6. Select OK and the dialog box closes.

Add an EDD file for a generic HART device

1. From the Module Definition dialog box - General tab, select Change...

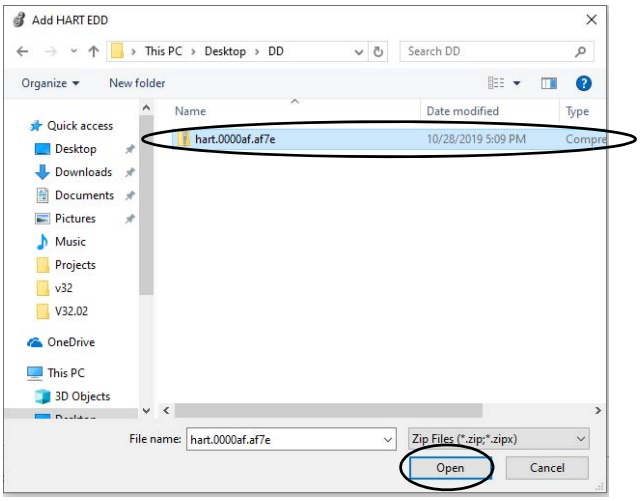


2. From the Module Definition dialog, enter the correct Expanded Device Type ID for the HART device, then select Add HART EDD.

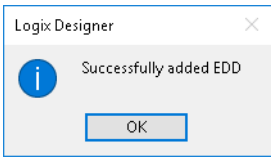


IMPORTANT The Expanded Device Type ID must match your device. If not, you will not be able to add an EDD file properly.

3. In the Add HART EDD dialog box, browse to the location of the EDD file.



4. Select the HART EDD file and select Open.
5. The message Successfully added EDD appears.



6. Select OK and the dialog box closes.

When configuring a device, an error message appears when:
- the selected file is not an EDD file
- an EDD file for the device is not included

Edit the Connection Definitions

Click the category names in the Module Definition dialog box to view and change the configuration parameters that are associated with that HART device.

Some new device configuration categories apply to all HART devices. Some categories are specific to the device type.

For example purposes, the figures in this section are from a device that is loaded from the HART device list in the Studio 5000 Logix Designer application.

The following categories apply to HART devices connected to either FLEX 5000 analog HART input or output modules and are described in this section:

- General Category
- Variables Category
- Commands Category

General Category

The General category appears first when you create a HART device. The parameters in this category vary depending on the type of device.

You use this category to configure:

- Device revision and software revision for the HART device.
- Electronic keying for the HART device.

IMPORTANT	Changing Electronic Keying when online interrupts connection to the device and any device that is connected through the device. If an I/O connection to a device is interrupted, data loss can occur.

- The type of connection used with the HART device.

The Connection parameter affects the configuration options available for Input Data and Output Data, and determines what data is exchanged between the owner-controller and the module.

Module Definition for a Specific HART Device

Module Definition parameters are available on the General tab of the Module Definition dialog box in the Studio 5000 Logix Designer application project. The categories and parameters vary depending on the type of HART device.

Table 20 describes the parameters on the Module Definition dialog box for a specific HART device.

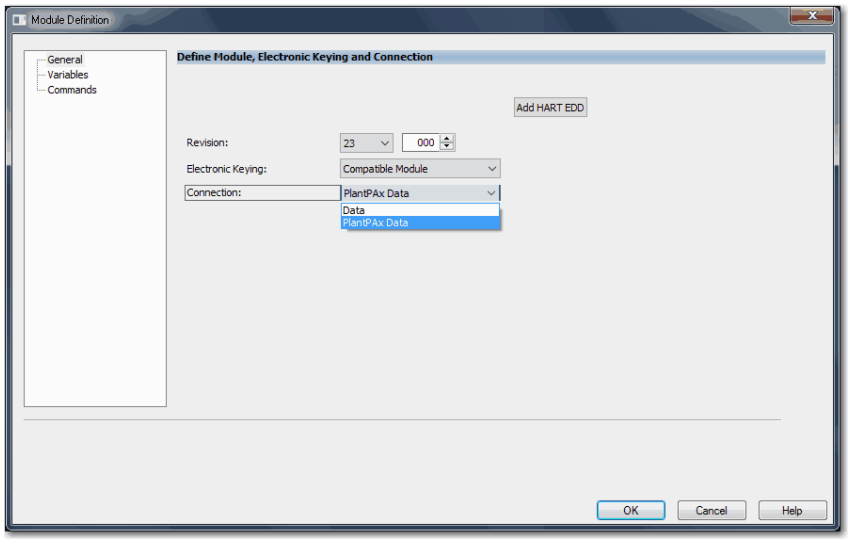


Table 20 - Module Definition Parameters

Parameter	Definition	Available Choices[1]
Add HART EDD	Select to open the Add HART EDD dialog box.	
Revision	Displays the device revision and software revision. The device revision is used to indicate the revision of the interface to the module. Valid device revision values are 0...254. Values larger than 126 do not support electronic key checking. Valid software revision values are 0...253.	Device-specific
Electronic Keying	Reduces the possibility of using the wrong device in a control system. **WARNING:** Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We strongly recommend that you do not use Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.	Exact Match Compatible Module Disable Keying[2]
Connection	Displays the I/O connection to the device.	Data PlantPAx Data

(1) The range of available choices varies by module type.
(2) Disabling keying is not recommended.

Module Definition for a Generic HART Device

Table 21 describes the parameters on the Module Definition dialog box for a generic HART device.

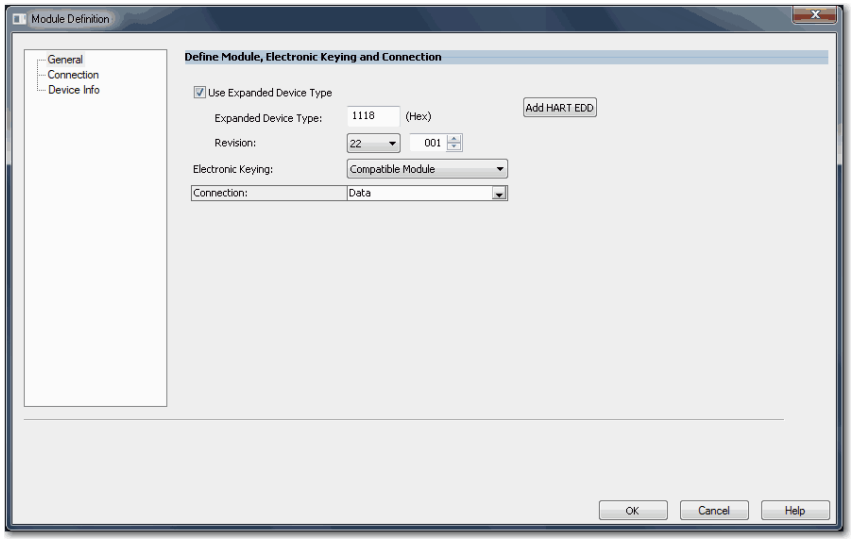


Table 21 - Module Definition Parameters

Parameter	Definition	Available Choices[1]
Use Expanded Device Type	Select the checkbox to enable expanded device type. **WARNING:** If you disable Use Expanded Device Type, the Electronic Keying options are limited to "Disable Keying" only. Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We strongly recommend that you do not disable the Use Expanded Device Type option. If you disable this option, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.	Enabled Disabled
Add HART EDD	Select to open the Add HART EDD dialog box.	
Expanded Device Type	Enter the device-specific device type.	
Revision	Select the device major and minor revisions.	
Electronic Keying	Reduces the possibility of using the wrong device in a control system. **WARNING:** Be extremely cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We strongly recommend that you do not use Disable Keying. If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.	Exact Match Compatible Module Disable Keying[2]
Connection	Displays the I/O connection to the device.	Data PlantPAx Data

(1) The range of available choices varies by module type.
(2) Disabling keying is not recommended.

Variables Category

Variable category is used to configure dynamic and device variables to be include in the input tag of the HART device. Use this category to complete the following tasks:

- Select Dynamic Variables.
- Select Device Variables.

Table 22 describes the parameters on the Variables dialog box.

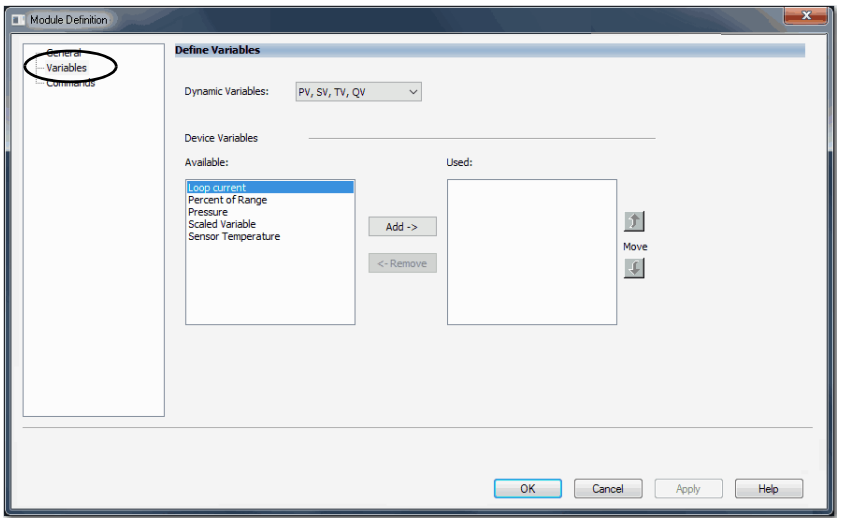


Table 22 - Variables Parameters

Parameter	Definition	Available Choices
Dynamic Variables	Displays the included Dynamic Variables.	<none> PV PV, SV PV, SV, TV PV, SV, TV, QV
Device Variables	Displays the Available and Used Device Variables. The Available list includes the names of all supported device variables, not including those in the Used list. The Used list contains the names of the selected device variables. The Used list is limited to 8 Device Variables. Move the Device Variables between the lists using Add and Remove.	
EDD file information	Displays information about the EDD file. • EDD file does not exist or cannot be opened. Appears if the not used EDD file cannot be found. For example, when an existing or new device is invoked on a computer that does not have the EDD file installed, and this EDD file was not used to configure the Device Variables or commands. • EDD file used for device configuration does not exist or cannot be opened. If the used EDD file cannot be found. For example, when an existing device is invoked on a computer that does not have the EDD file installed, and device variables and/or commands were configured. • No Device Variables defined in EDD file. If the EDD file is found, but does not define Device Variables. • Registered EDD file does not match EDD file used for device configuration. If one or more configured device variables and/or commands are not specified in the EDD file. For example, when the EDD file is modified and device variables are removed. • No Expanded Device Type specified If Use Expanded Device Type is not selected from the general profile.	

Commands Category

The Commands controls only appear when there is an associated EDD file and it displays the commands that are supported by the device. You can use the Commands category to define commands to be executed through input and output tags.

Table 23 describes the parameters on the Commands dialog box.

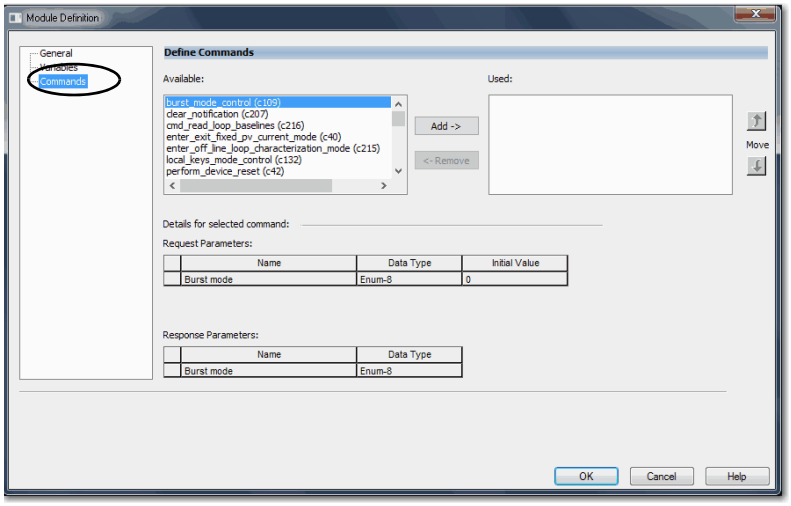


Table 23 - Commands Parameters

Parameter	Definition	Available Choices
Available	Displays the names of all supported Commands. The list does not include commands that are contained in the Used command list. Right-click to sort the list.	Sort Commands by Number Sort Commands by Name Sort Commands by Type
Used	Displays the list of commands that are selected for use. The Used list can contain four Commands (max).	
Add/Remove	Moves commands between the Available and Used lists.	
Move	Modifies the order Commands appear in the Used list.	
Details for selected commands	Request Parameters – Displays the name, HART data type, and initial value for each request parameter. Response Parameters – Displays the name and data type for each response parameter.	
EDD file information	Displays information about the EDD file. • EDD file does not exist or cannot be opened. Appears if the not used EDD file cannot be found. For example, when an existing or new device is invoked on a computer that does not have the EDD file installed, and this EDD file was not used to configure the Device Variables or commands. • EDD file used for device configuration does not exist or cannot be opened. If the used EDD file cannot be found. For example, when an existing device is invoked on a computer that does not have the EDD file installed, and device variables and/or commands were configured. • No Device Variables defined in EDD file. If the EDD file is found, but does not define Device Variables. • Registered EDD file does not match EDD file used for device configuration. If one or more configured device variables and/or commands are not specified in the EDD file. For example, when the EDD file is modified and device variables are removed. • No Expanded Device Type specified If Use Expanded Device Type is not selected from the general profile.	

Notes:

Calibrate the Module

The FLEX 5000 analog HART isolated input and output modules are calibrated during the manufacturing process. The accuracy of each module remains high throughout its lifespan. You are not required to calibrate the module.

You can calibrate on a per channel basis or in groups.

IMPORTANT This chapter describes a few example module calibration scenarios. It does not cover how to calibrate both FLEX 5000 analog HART input and output modules in all operating modes that the module supports.

Before You Begin

Consider the following before you begin:

- Controller State During Calibration

Controller State During Calibration

You must add the module to your Studio 5000 Logix Designer application project, as described in Chapter 8, Configure the Module on page 71, before you can calibrate it.

The project must be online with the owner-controller to calibrate FLEX 5000 analog HART I/O modules. You can calibrate in the following conditions:

- The controller in Program mode — either Remote Program or Program mode.

  We **recommend** that your module be in Program mode and not be actively controlling a process when you calibrate it.
- If there are no connections to the module.

IMPORTANT After calibrating the module, we recommend that you cycle power or reset the module.

Difference Between Calibrating an Input Module and an Output Module

The purpose of calibrating the FLEX 5000 analog HART I/O modules is the same for input and output modules, to improve the module's accuracy and repeatability. The procedures that are involved differs by module type:

- When you calibrate input modules, you use current or voltage reference signals to send a signal to the module to calibrate it.
- When you calibrate output modules, you use a digital multimeter (DMM) to measure the current or voltage signal the module is sending out.

To maintain your module's factory calibration accuracy, we recommend instrumentation with the specifications listed below. A high-resolution DMM can also be used to adjust a voltage/current calibrating source to its value.

Cat. No.	Channel Input Type	Calibrating Instrument Specifications
5094-IF8IH	Current (mA)	1.00...20.00 mA source ±100 nA current
	Voltage (V)	0...10V source ±2 µV voltage
5094-OF8IH	Current (mA)	DMM with resolution better than 0.15 µA
	Voltage (V)	DMM with resolution better than 1.0 µV

IMPORTANT Do not calibrate your module with an instrument that is less accurate than those recommended. The following events can result:

- Calibration appears to occur normally but the module gives inaccurate data during operation.
- A calibration fault occurs, forcing you to abort calibration.
- The *I.ChOx.CalFault* tag is set for the channel you attempted to calibrate.
- You can clear the tag by completing a valid calibration or cycling power to the module. In this case, you must recalibrate the module with an instrument as accurate as recommended.

Calibrate the Input Modules

You apply low and high signal references to the FLEX 5000 analog input module to calibrate it. The references must match the input range the channel is using.

Table 24 lists the input ranges and corresponding references that are used to calibrate the modules.

Table 24 - FLEX 5000 Analog Isolated Input Module Calibration References

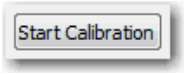
Input Type	Input Range	Low Calibration Reference	High Calibration Reference
Voltage (V)	-10...10V 0...10V	0.0V	10.0V
	0...5V	0.0V	5.0V
Current (mA)	0...20 mA 4...20 mA	4.0 mA	20.0 mA

Calibrate the 5094-IF8IH Module

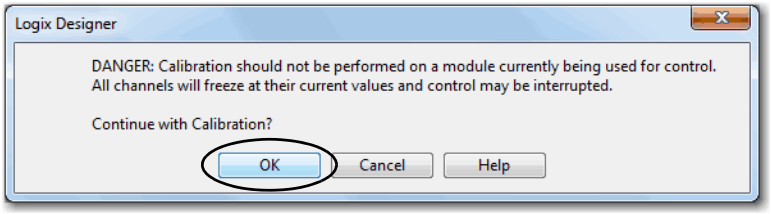
This example describes how to calibrate a channel on the 5094-IF8IH module for use with a Voltage (V) input type. Complete the following steps:

1. Connect the voltage calibrator to the channel being calibrated.

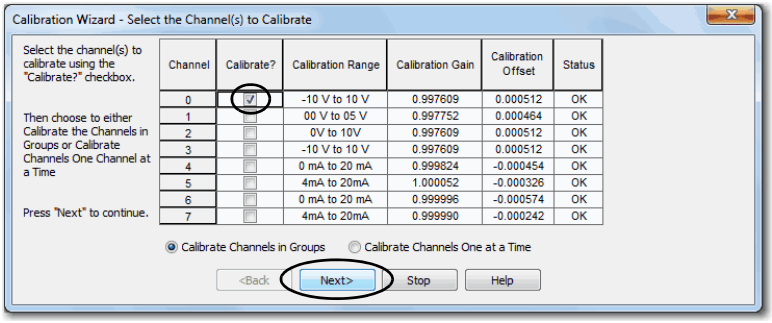
2. Go online with the project and make sure that the controller is in Program mode.
3. Confirm that the channel to be calibrated is enabled and configured for the correct Input Range.
4. On the Calibration category in the Module Properties dialog box, click Start Calibration.



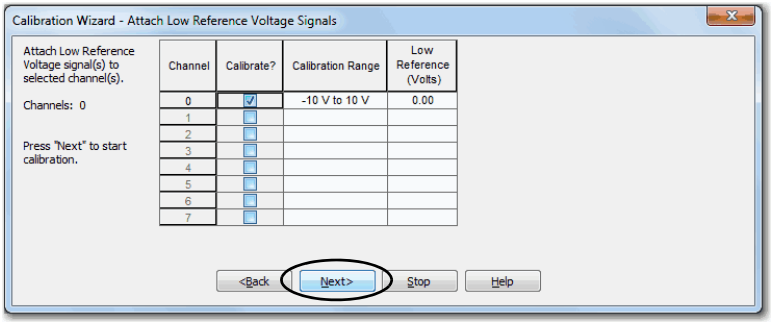
5. When the dialog box appears to confirm that you want to calibrate the channel, click OK.



6. Select the channel to calibrate and click Next.

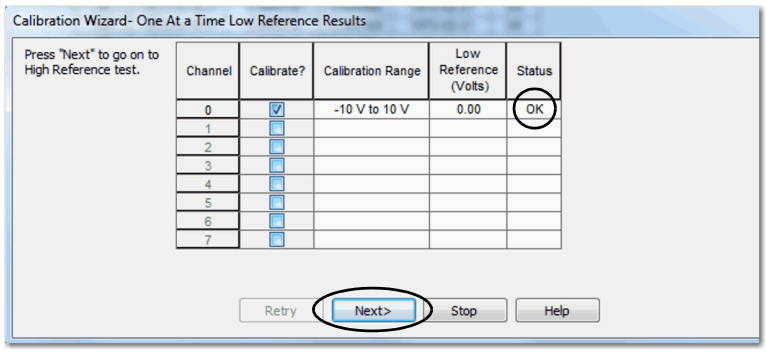


7. When the Attach Low Reference Voltage Signals dialog box appears, set the calibrator to the low reference and apply it to the channel.
8. Click Next.



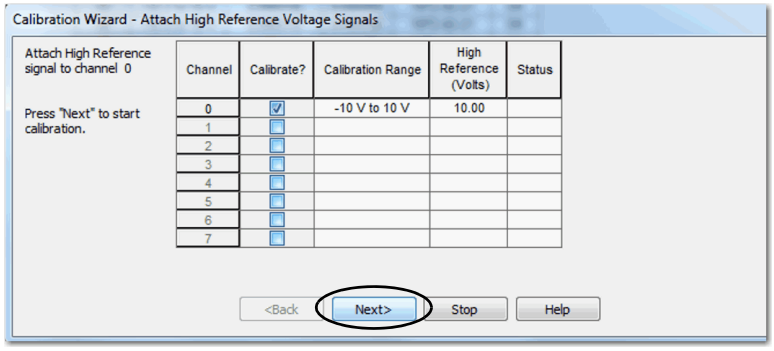
The One At a Time Low Reference Results dialog box appears and indicates the status of the calibrated channel.

9. If the status is OK, click Next.



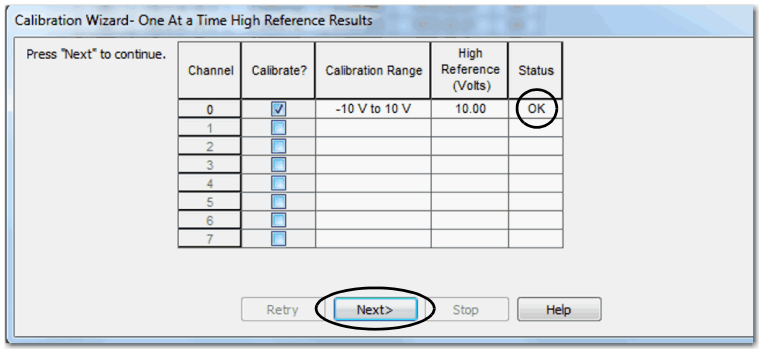
If the status is not OK, repeat the calibration process.

10. When the Attach High Reference Voltage Signals dialog box appears, set the calibrator to the high reference and apply it to the module.
11. Click Next.



The One At a Time High Reference Results dialog box appears and indicates the status of the channel after applying the low reference.

12. If the status is OK, click Next.



If the status is not OK, repeat the calibration process.

13. When the Calibration Completed dialog box appears, click Finish.
14. Cycle power.

Calibrate the Output Modules

When calibrating a FLEX 5000 analog isolated output channel, the Studio 5000 Logix Designer application commands the module to output specific signal levels. The signal type is determined by the output type being used by the channel.

Table 25 lists the output ranges and corresponding references that are used to calibrate the module.

Table 25 - FLEX 5000 Analog Isolated Output Module Calibration References

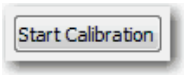
Output Type	Output Range	Low Calibration Reference Level	High Calibration Reference Level
Voltage (V)	-10...10V	-10.0V	10.0V
	0...10V	1.0V	10.0V
	0...5V	1.0V	5.0V
Current (mA)	0...20 mA	1.0 mA	20.0 mA
	4...20 mA	5.0 mA	20.0 mA

You must measure the actual level and record the results to account for any module inaccuracies.

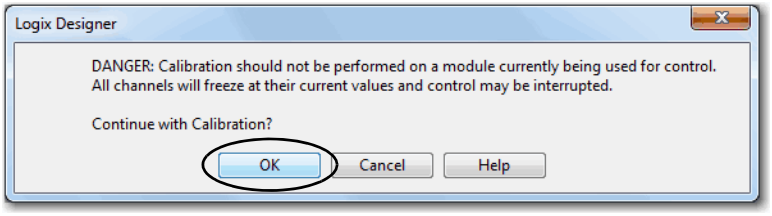
Calibrate a 5094-OF8IH Module

This example describes how to calibrate a channel on the 5094-OF8IH module for use with a Voltage (V) output type. Complete the following steps:

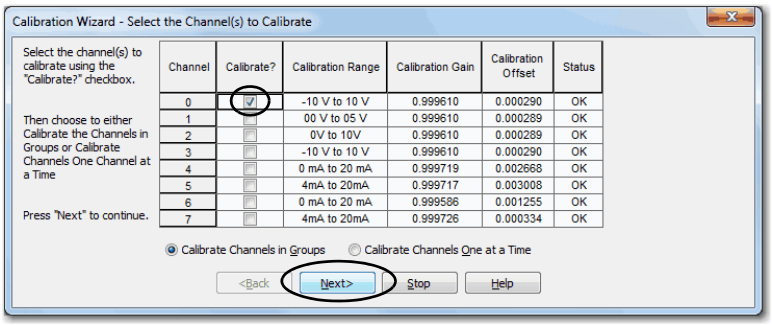
1. Connect the DMM to the channel being calibrated.
2. Go online with the project and make sure that the controller is in Program mode.
3. Confirm that the channel to be calibrated is enabled and configured for the correct Output Range.
4. On the Calibration category in the Module Properties dialog box, click Start Calibration.



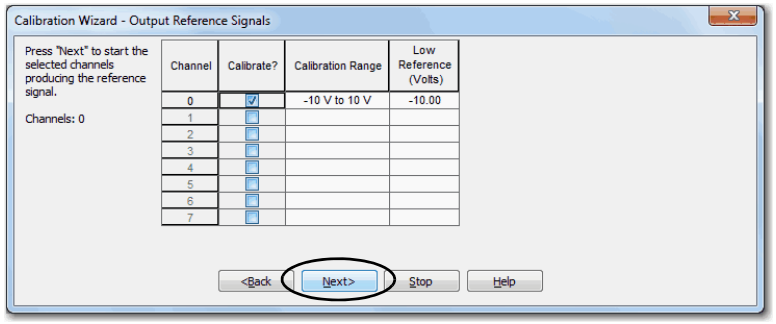
5. When the dialog box appears to confirm that you want to calibrate the channel, click OK.



6. Select the channel to calibrate and click Next.

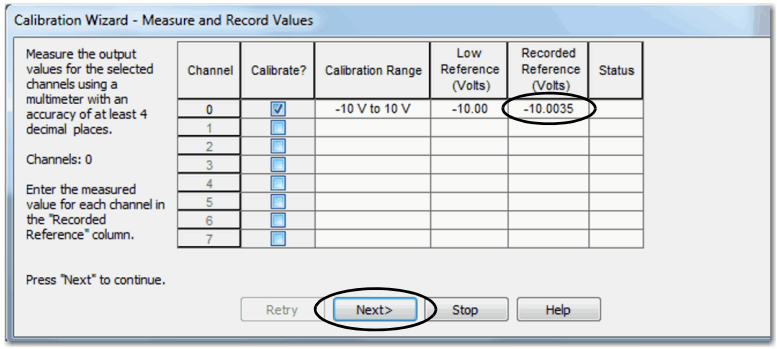


7. When the Output Reference Signals dialog box appears, click Next.



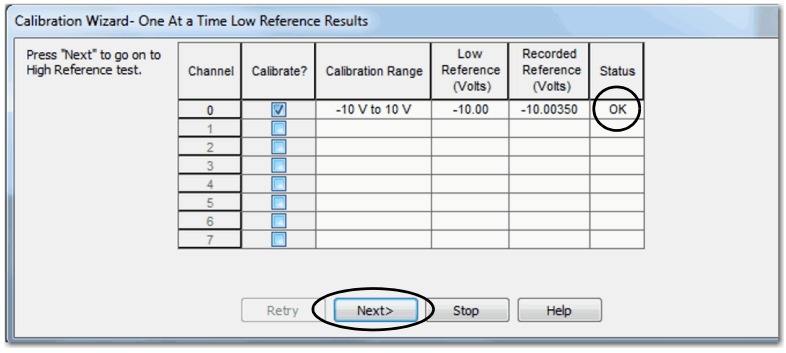
The Measure and Record Values dialog box appears.

8. Use a multimeter to measure the reference value of the channel.
9. In the Recorded Reference (Volts) column record the measured value and click Next.



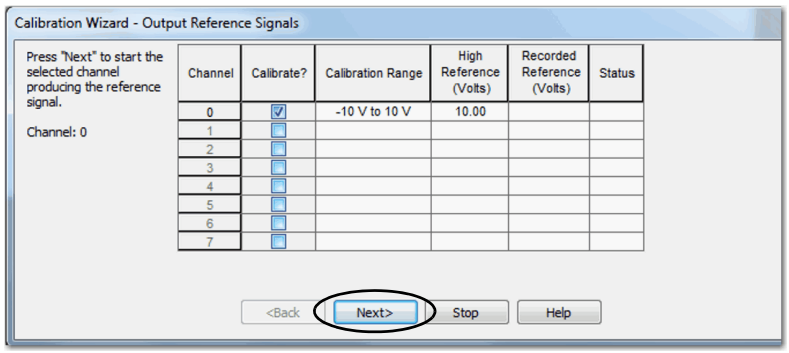
The One At a Time Low Reference Results dialog box appears and indicates the status of the calibrated channel.

10. If the status is OK, click Next.



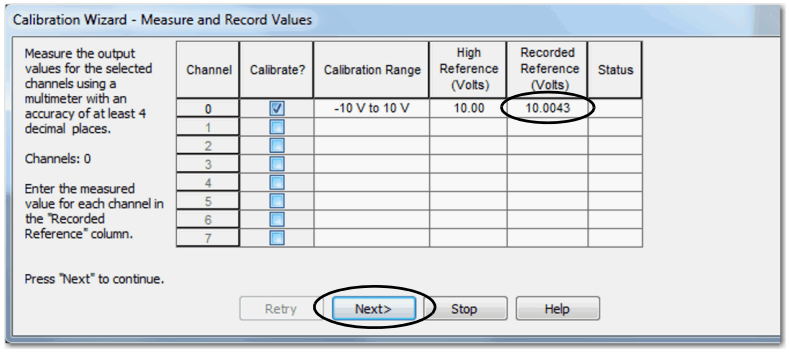
If the status is not OK, repeat the calibration process.

11. When the Output Reference Signals dialog box appears and indicates the channel to be calibrated for the high reference, click Next.



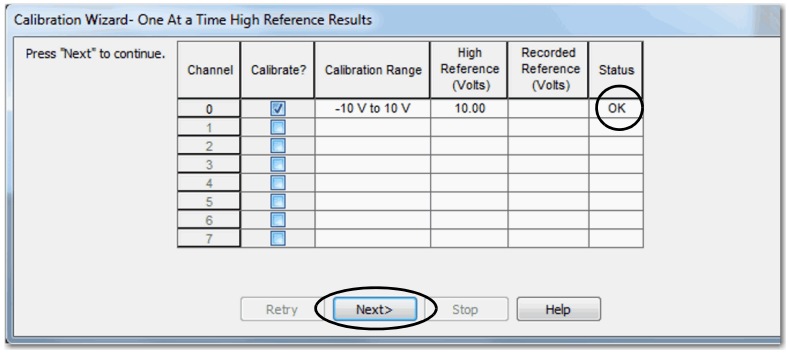
The Measure and Record Values dialog box appears.

12. Use a multimeter to measure the reference value of the channel.
13. In the Recorded Reference (Volts) column record the measured value and click Next.



The One At a Time High Reference Results dialog box appears and indicates the status of the calibrated channel.

14. If the status is OK, click Next.



If the status is not OK, repeat the calibration process.

15. When the Calibration Completed dialog box appears, click Finish.
16. Cycle power.

Notes:

Troubleshoot Your Module

FLEX 5000 analog HART I/O modules use the following status indicators:

- SA Power Indicator - This indicator operates the same for all FLEX 5000 analog I/O modules.
- Module Status Indicator - This indicator operates the same for all FLEX 5000 analog I/O modules.
- I/O Status Indicator - This indicator operates differently based on the module type.

SA Power Indicator

Table 26 describes the SA Power indicator on FLEX 5000 analog HART I/O modules.

Table 26 - SA Power Indicator - FLEX 5000 Analog HART I/O Modules

Indicator State	Description	Recommended Action
Off	The module is not powered.	Complete the following actions: 1. Confirm that the system is powered. 2. Confirm that the module is installed properly.
Steady green	There is SA power to the module.	None
Steady red	There is no SA power to the module.	Complete the following actions: 1. Confirm that the SA Power wiring on the terminal base is installed properly. 2. Check the following: – Confirm that there is sufficient voltage supplied to the module. – If an external power supply is used, confirm that the power supply is turned on. – If power is daisychained from the previous terminal base, confirm that the wiring on the previous terminal base is installed properly.

Module Status Indicator

Table 27 describes the Module Status indicator on FLEX 5000 analog HART I/O modules.

Table 27 - Module Status Indicator - FLEX 5000 Analog HART I/O Modules

Indicator State	Description	Recommended Action
Off	The module is not powered.	Complete the following actions: 1. Confirm that the system is powered. 2. Confirm that the module is installed properly.

Table 27 - Module Status Indicator - FLEX 5000 Analog HART I/O Modules (Continued)

Indicator State	Description	Recommended Action
Steady green	The module has a connection to the owner-controller and is operating normally.	None
Flashing green	One of the following conditions exists: • The module has powered up successfully. • The module does not have a connection to the controller. • A connection can result from missing, incomplete, or incorrect module configuration. • Connection to an output module is in the idle state.	Complete the following actions: • Troubleshoot your Studio 5000 Logix Designer application to determine what is preventing a connection from the module to the controller and correct the issue. • Confirm that the system conditions require the controller to be in Remote Run mode or Run mode, transition the controller to one of those modes.
Steady red	The module experienced a nonrecoverable fault.	Complete the following actions: 1. Cycle power to the module. 2. If the status indicator remains in the steady red state, replace the module.
Flashing red	One of the following conditions exists: • A module firmware update is in progress. • A module firmware update attempt failed. • The device has experienced a recoverable fault. • A connection to the module has timed out.	Complete one of the following: • Let the firmware update progress complete. • Reattempt a firmware update after one fails. • Use the Studio 5000 Logix Designer application to determine the cause of the module fault. The Connection and Module Info categories of the modules configuration indicate the fault type. To clear a recoverable fault, complete one of the following: – Cycle module power. – Click Reset Module in the Studio 5000 Logix Designer project via the Module Info category of the Module Properties dialog box. If the fault does not clear after cycling power and clicking Reset Module, contact Rockwell Automation Technical Support. • Use the Studio 5000 Logix Designer application to determine if a connection has timed out. The Connection category in the Module Properties for the module indicates the module state, including if a connection has timed out. If a connection has timed out, determine the cause and correct it. For example, a cable failure can cause a connection timeout.

FLEX 5000 Analog Isolated Input Modules Status Indicators

Figure 12 shows the status indicators on FLEX 5000 analog isolated input modules.

Figure 12 - FLEX 5000 Analog Isolated Input Module Status Indicators

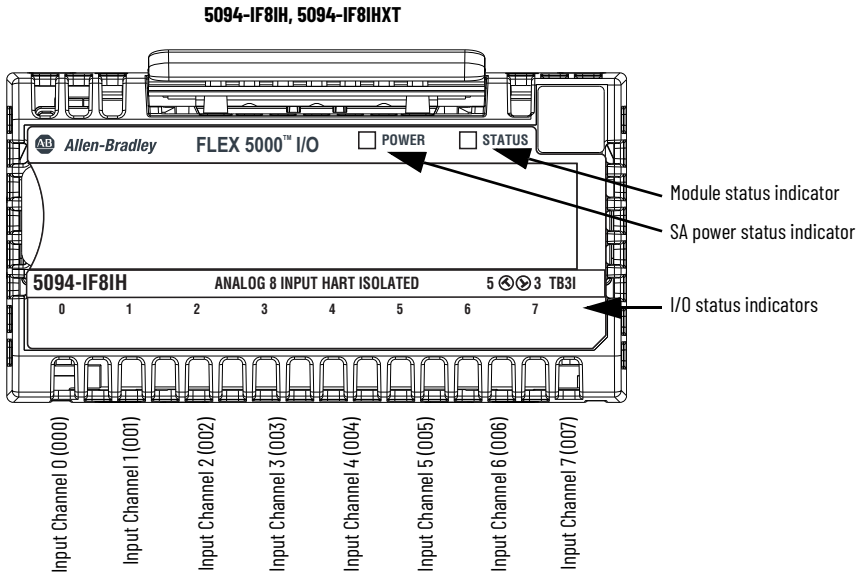


Table 28 describes the I/O status indicators on FLEX 5000 analog isolated input modules.

Table 28 - I/O Status Indicators - FLEX 5000 Analog Isolated Input Modules

Indicator State	Description	Recommended Action
Off	One of the following conditions exists: • The module is not powered. • The module is powered but no connection from the controller to module has been established. • The module is powered, but the input channel is disabled. • The module is powered, the channel is configured as digital input, and the input is off.	Complete one of the following: • None - If your application does not use the input channel. • If you expect the module to be powered but it is not, complete the following: – Confirm that the system is powered. – Confirm that the module is installed properly. • If the module is powered but the channel is not operating as expected, use the Studio 5000 Logix Designer application to confirm that the channel is not disabled and has a connection to the controller. The Connection category in the Module Properties for the module indicates if the module is running or faulted. If the module is faulted, the Connection category indicates error information affecting the state of the module.
Steady yellow	The analog input channel is operating normally or the digital input is on.	None
Steady red	An issue has occurred that is internal to the module. The following are example issues that can cause the status indicator to be steady red: • The module has experienced a non-recoverable fault. • A calibration fault occurred on the channel. • Other internal faults such as MCU fault.	Complete one of the following: • If the indicator is in the steady red state following the initial power-up sequence and remains in that state, replace the module. • If a calibration fault occurred, cycle power to the module. When the power-up sequence completes, the channel returns to the factory calibration setting. If the indicator remains in the steady red state after you cycle power, replace the module. • To return the module to the specified operating temperature range, complete the following: – Check the temperature at the module installation location and lower it if necessary. – Make sure the proper level of current is applied to the module. If not, change the current applied to an acceptable level. Module specifications, for example, acceptable operating temperature or applied current levels, are available in the FLEX 5000 Modules Specifications Technical Data, publication 5094-TD001.
Flashing red	One of the following conditions exists: • The input signal is overrange or underrange. • An SSV Over Current condition exists. • An Open Wire condition, that is, a wire is disconnected from the analog input channel or digital input point. • An over temperature warning is present on the channel. • There is no SA power to the module. • A short circuit condition exists on analog input channel or digital input point.	Complete one of the following: • Check the input signal to determine if it is overrange or underrange. • Check if the sensor is in fault mode. See the sensor documentation. • Check if there are any short circuits from SSV to I+. Remove the short circuit. • Check if there are any short circuits from SSV to I-. Remove the short circuit • Check the wiring at the analog input channel or digital input point. If necessary, reconnect the wire. • Locate and correct the cause of over temperature warning. • Check the wiring at the SA terminals to make sure that 24V DC power is present. If 24V DC power is not present, troubleshoot the SA power connection.
Alternating yellow/red	Calibration of analog input channel is in progress.	Finish the calibration process in the Studio 5000 Logix Designer application.

FLEX 5000 Analog Isolated Output Modules Status Indicators

Figure 13 shows the status indicators on FLEX 5000 analog isolated output modules.

Figure 13 - FLEX 5000 Analog Isolated Output Module Status Indicators

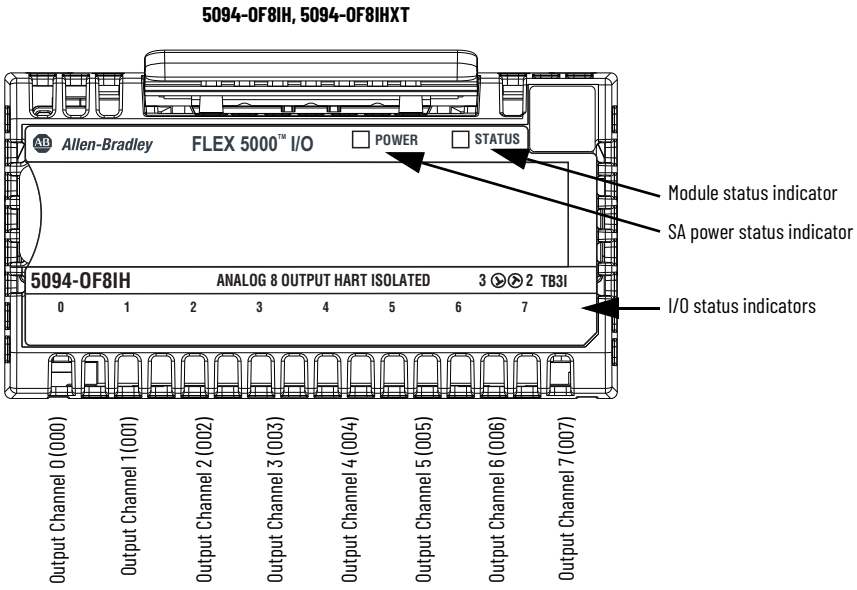


Table 29 describes the I/O status indicators on FLEX 5000 analog isolated output modules.

Table 29 - I/O Status Indicators - FLEX 5000 Analog Isolated Output Modules

Indicator State	Description	Recommended Action
Off	One of the following conditions exists: • The module is not powered. • The module is powered but no connection from the controller to module was ever established. • The module is powered, but the output channel is disabled.	Complete one of the following: • None - If your application does not use the output channel. • If you expect the module to be powered but it is not, complete the following: – Confirm that the system is powered. – Confirm that the module is installed properly. • If the module is powered but the channel is not operating as expected, use the Studio 5000 Logix Designer application to confirm that the channel is not disabled and has a connection to the controller. The Connection category in the Module Properties for the module indicates if the module is running or faulted. If the module is faulted, the Connection category indicates error information affecting the state of the module.
Steady yellow	The output channel is operating normally.	No action necessary.
Steady red	An issue has occurred that is internal to the module. The following are example issues that can cause the status indicator to be steady red: • The module has experienced a non-recoverable fault. • A calibration fault occurred on the channel. • The module is operating over its specified temperature. That is, an Over Temperature condition exists.	Complete one of the following: • If the indicator is in the steady red state following the initial power-up sequence and remains in that state, replace the module. • If a calibration fault occurred, cycle power to the module. When the power-up sequence completes, the channel returns to the factory calibration setting. If the indicator remains in the steady red state after you cycle power, replace the module. • To return the module to the specified operating temperature range, complete the following: – Check the temperature at the module installation location and lower it if necessary. – Make sure the proper level of current is applied to the module. If not, change the current applied to an acceptable level. Module specifications, for example, acceptable operating temperature or applied current levels, are available in the FLEX 5000 Modules Specifications Technical Data, publication 5094-TD001.

Table 29 - I/O Status Indicators - FLEX 5000 Analog Isolated Output Modules

Indicator State	Description	Recommended Action
Flashing red	One of the following conditions exists: • A wire is disconnected from the output. That is, a No Load condition exists. • The module is driving a current from the channel greater than the max current level the channel can handle. That is, a Short Circuit condition exists. • There is no SA power to the module.	One of the following: • Check the wiring at the output channel. If necessary, reconnect the wire. • Troubleshoot the application to make sure an acceptable level of current is driven from the channel. • Check the wiring at the SA terminals to make sure that 24V DC power is present. If 24V DC power is not present, troubleshoot the SA power connection.
Alternating yellow/red	Calibration is in progress.	Finish the calibration process in the Studio 5000 Logix Designer application.

Use the Studio 5000 Logix Designer Application for Troubleshooting I/O Modules

In addition to the status indicator display on the analog HART input or output module, the Studio 5000 Logix Designer application indicates the presence of fault conditions.

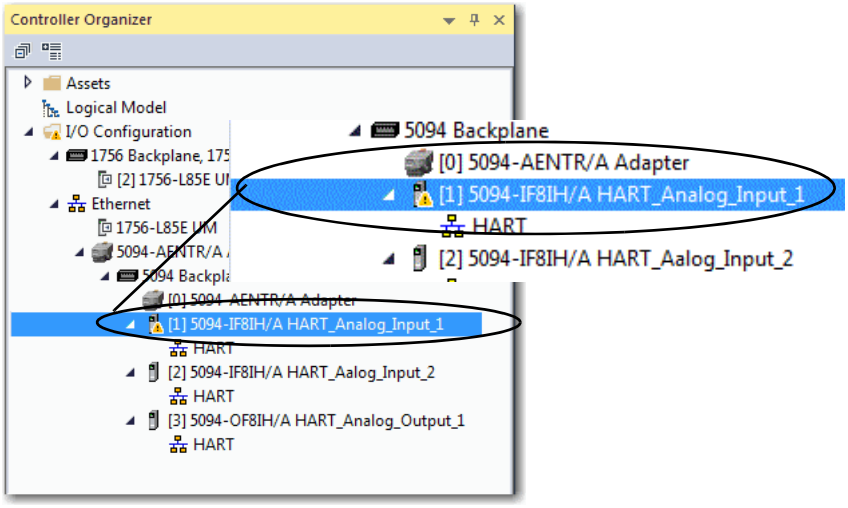
Fault conditions are reported in the following ways:

- Warning Signal in the I/O Configuration Tree
- Status and Fault Information in Module Properties Categories
- Studio 5000 Logix Designer Application Tag Editor

Warning Signal in the I/O Configuration Tree

As shown in Figure 14, a warning icon appears in the I/O Configuration tree when a fault occurs.

Figure 14 - Warning Signal in Controller Organizer



Status and Fault Information in Module Properties Categories

The Module Properties section in the Studio 5000 Logix Designer applications includes a series of categories. The number and types of categories varies by module type.

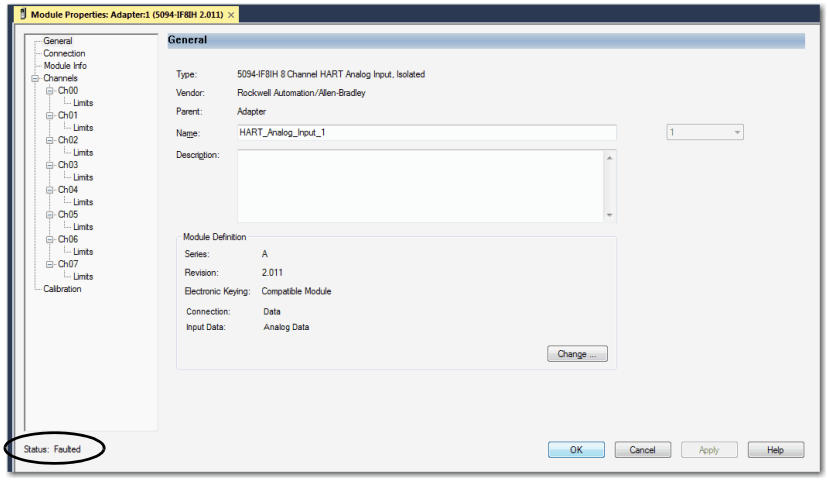
Each category includes options to configure the module or monitor the module's current status. The following are ways to monitor a module's state for faults:

- Module Status on General Category
- Module Fault Descriptions on Connection Category
- Module Fault Descriptions on Module Info Category

Module Status on General Category

As shown in Figure 15, the status of a module is indicated on the General category of the Modules Properties.

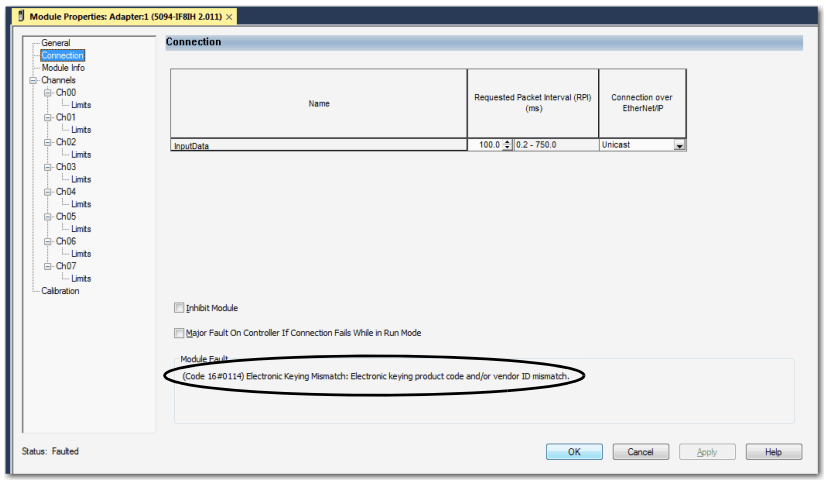
Figure 15 - Fault Message in Status Line



Module Fault Descriptions on Connection Category

As shown in Figure 16, a module fault description that includes an error code that is associated with the specific fault type is listed on the Connection category.

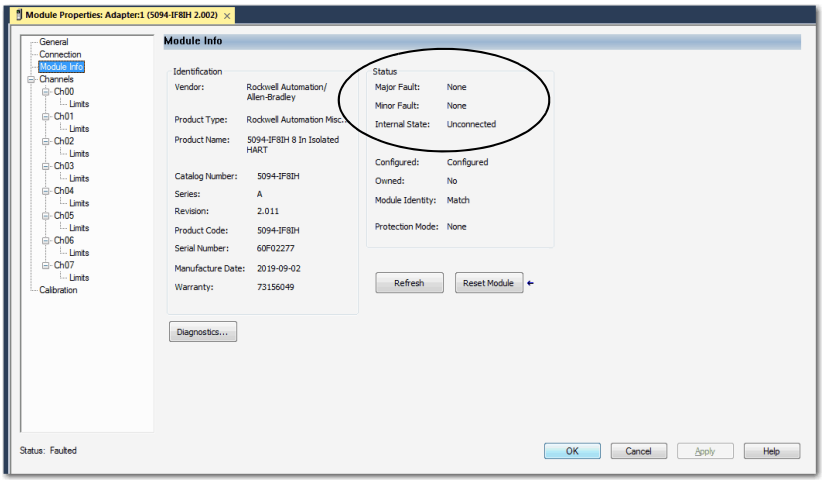
Figure 16 - Fault Description with Error Code



Module Fault Descriptions on Module Info Category

As shown in Figure 17, major and minor fault information is listed on the Module Info category.

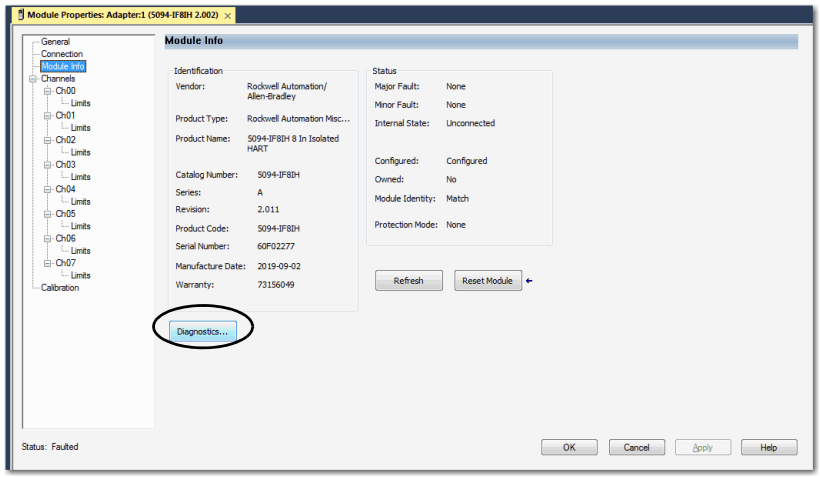
Figure 17 - Major and Minor Fault Information

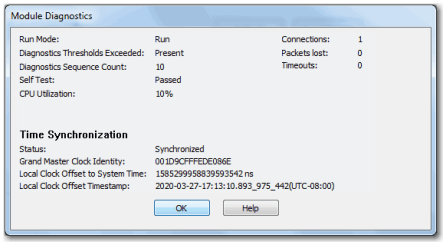


Module Diagnostics Dialog Box

Module Diagnostics are accessible from the Module Properties dialog box, as shown in Figure 18.

Figure 18 - Module Diagnostics

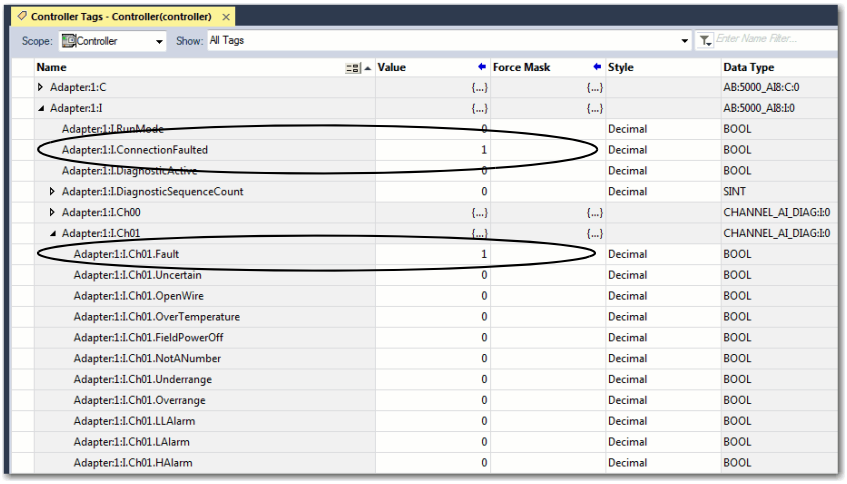




Studio 5000 Logix Designer Application Tag Editor

Figure 19 shows how fault conditions are indicated in the controller tags for the module.

Figure 19 - Fault Indication in Controller Tags



Troubleshoot HART Device

In addition to the status indicator display on the module, the Studio 5000 Logix Designer application indicates the presence of fault conditions.

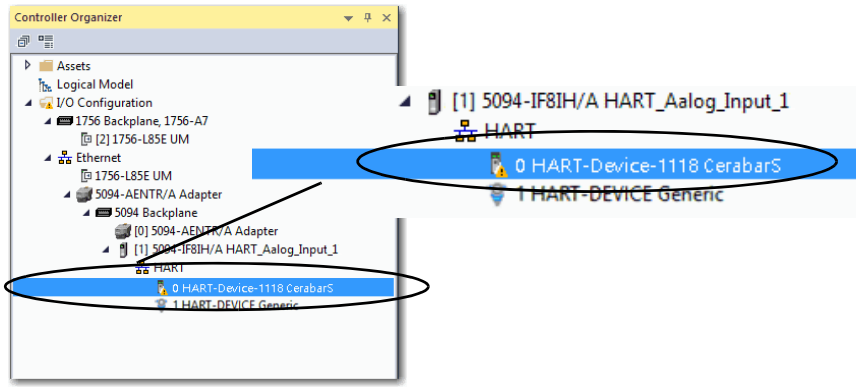
Fault conditions are reported in the following ways:

- Warning Signal in the I/O Configuration Tree
- Studio 5000 Logix Designer Application Tag Editor

Warning Signal in the I/O Configuration Tree

As shown in Figure 20, a warning icon appears in the I/O Configuration tree when a fault occurs.

Figure 20 - Warning Signal in Controller Organizer



If a warning signal appears in the I/O Configuration tree, make sure that

- the device is powered up and properly wired to the module.
- there are no electronic keying mismatches.

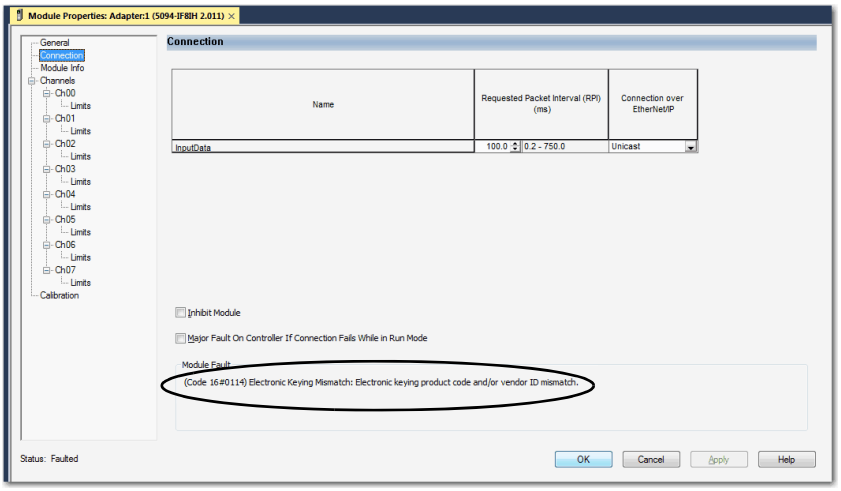
- there is no fault status on the analog channel.

Status and Fault Information in Module Properties Categories

The Module Properties section in the Studio 5000 Logix Designer applications includes a series of categories. The Connection category displays error messages.

As shown in Figure 21, a device fault description that includes an error code that is associated with the specific fault type is listed on the Connection category.

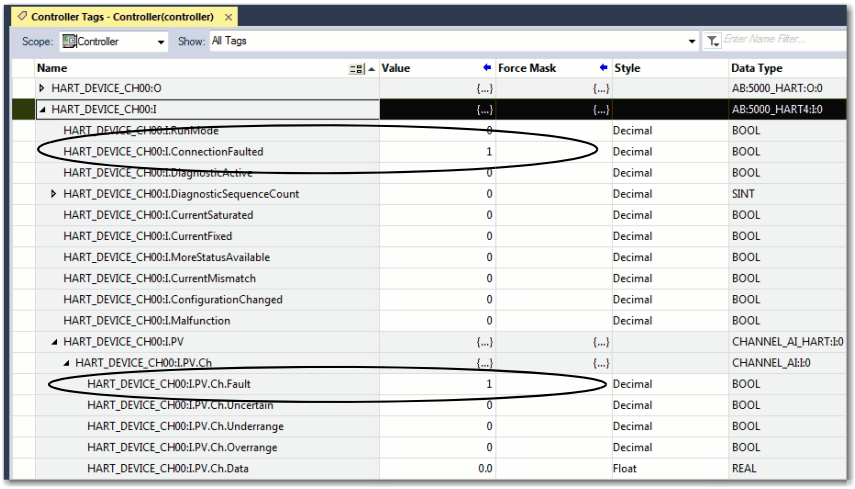
Figure 21 - Fault Description with Error Code



Studio 5000 Logix Designer Application Tag Editor

Figure 19 shows how fault conditions are indicated in the controller tags for the device.

Figure 22 - Fault Indication in Controller Tags



CIP Error Codes for HART Devices

Under different error conditions, error codes are returned for CIP messaging sent to HART devices. These error codes either display on the Connection page or show in CIP messaging responses.

Table 30 describes HART device common error codes and the recommended action:

Table 30 - HART Device Common Error Codes

Error Code	Description	Recommended Action
0x01/0x204	Timeout Possible timeout conditions: • Channel is not configured as HART-enabled. • I/O module owner connection to the controller is down. • No HART device is wired on the channel.	• Enable HART for channel. • Make sure that the owner connection to module is up. • Wire a HART device on the channel.
	• HART device is rebooting. • HART device discovery with Command 0 is in progress.	Retry
0x0C	Object in wrong mode	Retry
0x01/0x114	Electronic Keying mismatch. HART expanded device type mismatch	Correct the mismatch.
0x01/0x116	Electronic Keying mismatch. Major or Minor Revision mismatch	
0x02	No resource	Retry
0x20	Invalid parameter found in the CIP request	Correct the parameter.
0x1E	Service failed – HART command failed due to a link layer error.	Retry

Module Tag Definitions

Module tags are created when you add a module to the Studio 5000 Logix Designer application project.

The set of module tags that are associated with a module depends on the module type and Module Definition choices that are made during module configuration. For example, if you use a Listen Only Connection in the Module Definition, the Studio 5000 Logix Designer application creates only Input tags for that module.

The following types of tags are available with FLEX 5000 analog HART I/O modules:

- Configuration
- Input
- Output

The tables contained in this section list all tags available with a module. Not all tags in the list are used when that module type is added to a project. Tag use varies by module configuration.

Tag Name Conventions

The module tag names use defined naming conventions. The conventions are as follows:

Example tag name = Adapter:1:I.Ch00.Data

- Adapter = name of the FLEX 5000 EtherNet/IP adapter in the FLEX 5000 I/O system
- 1 = slot number
- I = tag type

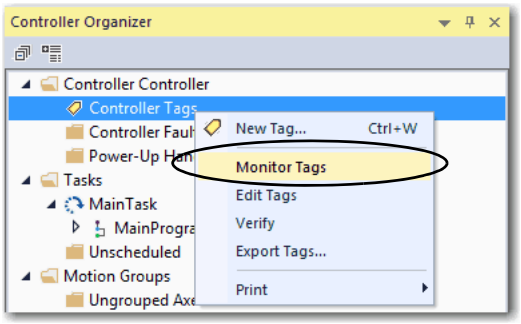
  The possible FLEX 5000 analog I/O tag types are C (configuration), I (input), and O (output).
- Ch00 = module channel number
- Data = tag function

In this case, Data represents the input data that is returned to the owner-controller.

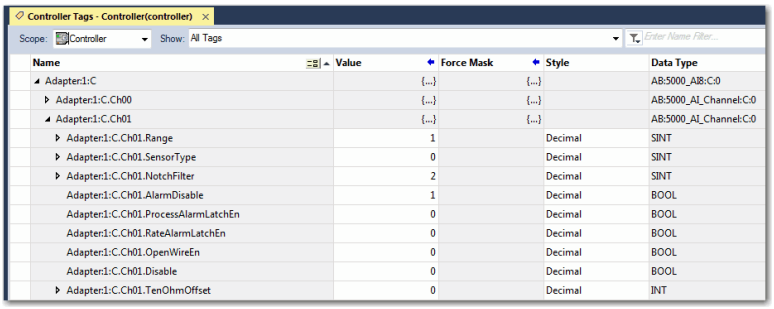
Access the Tags

You view tags from the Tag Editor.

1. Open your Studio 5000 Logix Designer application project.
2. Right-click Controller Tags and choose Monitor Tags.



3. Open the tags as necessary to view specific tags.



5094-IF8IH Module Tags

This section describes the tags that are associated with the 5094-IF8IH module.

Configuration Tags

Table 31 describes the 5094-IF8IH module configuration tags.

Table 31 - 5094-IF8IH Module - Configuration Tags

Name	Data Type	Definition	Valid Values
ChOx.Range	SINT	Channel's operating range	• 0 = -10...10V • 1 = 0...5V • 2 = 0...10V • 4 = 0...20 mA • 5 = 4...20 mA

Table 31 - 5094-IF8IH Module - Configuration Tags (Continued)

Name	Data Type	Definition	Valid Values
ChOx.NotchFilter	SINT	Notch Filter removes line noise for the channel.	• 0 = 10 Hz • 1 = 50 Hz • 2 = 60 Hz • 3 = 100 Hz • 4 = 200 Hz • 5 = 500 Hz • 6 = 1,000 Hz • 7 = 2,500 Hz • 8 = 5,000 Hz • 9 = 10,000 Hz • 13 = 5 Hz • 15 = 15 Hz • 16 = 20 Hz
ChOx.AlarmDisable	BOOL	Disables all alarms on the channel. **IMPORTANT**: Consider the following: • When if you change this tag to 0, that is, so alarms are not disabled, you must also enable the individual alarms for them to work. For example, if you want to use the Low Low alarm for a channel, you must set the *ChOx.AlarmDisable* to 0 and set the *ChOx.LLAlarmEn* output tag to 1 so the alarm is enabled. This applies to all alarms on the module. • Conversely, if you set this tag to 1, alarms are disabled regardless of the setting on the alarm enable tag for any alarm.	• 0 = Alarms are enabled • 1 = Alarms are disabled (default)
ChOx.ProcessAlarmLatchEn	BOOL	Configures Process alarms to latch until they are explicitly unlatched. The Process alarms include: • HighHigh alarm • High alarm • Low alarm • LowLow alarm	• 0 = Latching disabled (default) • 1 = Latching enabled
ChOx.RateAlarmLatchEn	BOOL	Configures the Rate alarm to latch until it is explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
ChOx.OpenWireEn	BOOL	Enable the input Open Wire diagnostic	• 0 = Disabled (default) • 1 = Enabled
ChOx.Disable	BOOL	Disables the channel. When a channel is disabled, the following occurs: • The I/O status indicator for the channel turns off. • The *ChOx.Fault* input tag is set to 1.	• 0 = Channel is enabled (default) • 1 = Channel is disabled
ChOx.HARTEn	BOOL	Enable HART communication on the channel.	• 1= HART Communication is enabled • 0 = HART Communication is disabled
ChOx.DigitalFilter	INT	A non-zero value enables the filter, providing a time constant in milliseconds used in a first order lag filter to smooth the input signal.	0 = Filter is turned off. Any value greater than zero = Filter value in milliseconds
ChOx.LowSignal	REAL	One of four points used in scaling. The low signal is in terms of the inputs signal units and corresponds to the low engineering term when scaled.	Current applications - Any value less than the high signal in range. • 0 = default for 0…20 mA range • 4 = default for 4…20 mA Voltage applications - Any value less than the high signal in range. • -10 = default for -10…10V range • 0 = default for 0…5V and 0…10V ranges
ChOx.HighSignal	REAL	One of four points used in scaling. The high signal is in terms of the inputs signal units and corresponds to the high engineering term when scaled.	Current applications - Any value greater than the low signal in range. • 20 = default for either current input range Voltage applications - Any value greater than the low signal in range. • 10 = default for 0…10V and -10…10V ranges • 5 = default for 0…5V range

Table 31 - 5094-IF8IH Module - Configuration Tags (Continued)

Name	Data Type	Definition	Valid Values
ChOx.LowEngineering	REAL	One of four points used in scaling. The low engineering helps determine the engineering units the signal values scale into. The low engineering term corresponds to the low signal value.	Any value less than the high engineering value. • Current applications: 0.0 = default • Voltage applications: Low signal = default. For example, with the -10...10V range, the default = -10.
ChOx.HighEngineering	REAL	One of four points used in scaling. The high engineering helps determine the engineering units the signal values scale into. The high engineering term corresponds to the high signal value.	Any value greater than the low engineering value. • Current applications: 100.0 = default • Voltage applications: High signal = default. For example, with the -10...10V range, the default = 10.
ChOx.LLAlarmLimit	REAL	The Low Low alarm trigger point. Causes the *ChOx.LLAlarm* to trigger when the input signal moves beneath the configured trigger point. In terms of engineering units.	0.0 = default
ChOx.LAlarmLimit	REAL	The Low alarm trigger point. Causes the *ChOxLAlarm* to trigger when the input signal moves beneath the configured trigger point. In terms of engineering units.	0.0 = default
ChOx.HAlarmLimit	REAL	The High alarm trigger point. Causes the *ChOxHAlarm* to trigger when the input signal moves above the configured trigger point. In terms of engineering units.	100.0 = default
ChOx.HHAlarmLimit	REAL	The High High alarm trigger point. Causes the ChOxHHAlarm to trigger when the input signal moves above the configured trigger point. In terms of engineering units.	100.0 = default
ChOx.RateAlarmLimit	REAL	The Rate alarm trigger point. Causes the ChOxRateAlarm to trigger when the input signal changes at a rate faster than the configured rate alarm. Configured in Engineering Units per second.	0 = Rate Alarm is not used Any value greater than zero = Trigger point
ChOx.AlarmDeadband	REAL	Allows a process alarm to remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm. The deadband value is subtracted from the High and High High Alarm Limits to calculate the deadband thresholds for these alarms. The deadband value is added to the Low and Low Low Alarm Limits to calculate the deadband thresholds for these alarms.	Any non-negative value 0 = default
PtOx.InputOffOnFilter	SINT	The amount of time that a signal must be in the on state before the input data indicates the on state. The amount of time is indicated using an enumeration. Not all products support all enumeration values. Ptxx depends on the number of counters that have been configured.	Off to On digital filter • 13 = 1 ms • 14 = 2 ms • 15 = 5 ms • 16 = 10 ms • 17 = 20 ms • 18 = 50 ms
PtOx.InputOnOffFilter	SINT	The amount of time that a signal must be in the off state before the input data indicates the off state. The amount of time is indicated using an enumeration. Not all products support all enumeration values. Ptxx depends on the number of counters that have been configured.	On to Off digital filter • 13 = 1 ms • 14 = 2 ms • 15 = 5 ms • 16 = 10 ms • 17 = 20 ms • 18 = 50 ms
PtOx.Type3dOpenWireEn	BOOL	Enable type 3-d open wire detection.	• 0 = disable Type 3-d Open Wire detection • 1 = enable Type 3-d Open Wire detection
PtOx.Type3dShortCircuitEn	BOOL	enable type 3-d short circuit detection.	• 0 = disable Type 3-d Short Circuit detection • 1 = enable Type 3-d Short Circuit detection

Input Tags

Table 32 describes the 5094-IF8IH module input tags.

Table 32 - 5094-IF8IH Module - Input Tags

Name	Data Type	Definition	Valid Values
RunMode	BOOL	Channel's operating state	• 0 = Idle • 1 = Run
ConnectionFaulted	BOOL	Indicates if a connection is running. The module sets this tag to 0 when connected. If the module is not connected, it changes the tag to 1.	• 0 = Connection running • 1 = Connection not running
DiagnosticActive	BOOL	Indicates if any diagnostics are active or if the prognostics threshold is reached.	• 0 = No diagnostics active • 1 = One or more diagnostics are active or the prognostics threshold is reached
DiagnosticSequenceCount	SINT	Increments for each time a distinct diagnostic condition is detected, and when a distinct diagnostic condition transitions from detected to not detected. Set to zero by product reset or power cycle. Wraps from 255 (-1) to 1 skipping zero.	-128...127 The value of 0 is skipped except during module power-up.
ChOx.Fault	BOOL	Indicates that channel data is inaccurate and **cannot be trusted** for use in the application. If the tag is set to 1, you must troubleshoot the module to correct the cause of the inaccuracy. **IMPORTANT**: Once the condition that causes the tag to change to 1 is removed, the tag automatically resets to 0.	• 0 = Good • 1 = Bad, causing fault The typical causes of uncertain data are the following: – Channel is disabled – Open Wire (input modules) or No Load (output modules) condition – Underrange/Overrange condition – Short Circuit condition We recommend that you first troubleshoot the module to see if the typical causes exist.
ChOx.Uncertain	BOOL	Indicates that the channel data can be inaccurate but the **degree of inaccuracy is not known**. If the tag is set to 1, you must troubleshoot the module to correct the cause of the inaccuracy. **IMPORTANT**: Once the condition that causes the tag to change to 1 is removed, the tag automatically resets to 0.	• 0 = Good data • 1 = Uncertain data The typical causes of uncertain data are the following: – Data signal slightly outside the channel operating range – The channel is over temperature. – Invalid sensor offset value – Calibration fault on the channel – Calibration is in process on the channel We recommend that you first troubleshoot the module to see if the typical causes exist.
ChOx.OpenWire	BOOL	The signal wire is disconnected from the channel or the RTB is removed from the module. Open Wire detection method: <0.1 mA for current and within ±0.1V for voltage	• 0 = Open Wire condition does not exist or Open Wire Detection is disabled • 1 = Open Wire condition exists. That is, a signal wire is disconnected from the channel or the RTB is removed from the module.
ChOx.OverTemperature	BOOL	Module is higher temperature than its operating limits. • If this tag is set to 1 but a fault does not exist on the channel, this tag is only an indication of operating conditions but the channel is functioning. • If this tag is set to 1 and a fault exists on the channel, the channel is not functioning.	• 0 = Module temperature is not over the operating limits • 1 = Module temperature is over the operating limits
ChOx.FieldPowerOff	BOOL	Field power is not present at the channel.	• 0 = Field Power is present • 1 = Field Power is not present
ChOx.NotANumber	BOOL	Indicates if the last received channel data was not a number. Typically when data for ChOx.SensorOffset in the output tag is not a number.	• 0 = Last channel data received was a number • 1 = Last channel data received was not a number
ChOx.Underrange	BOOL	Indicates that the channel data is beneath the underrange threshold for this channel. For example, when the channel operates in the 4...20 mA input range, the underrange threshold on the channel is ≤ 3.0 mA. If the input signal is 0 mA, this tag is set to 1.	• 0 = Channel data is not beneath the underrange threshold • 1 = Channel data is beneath the underrange threshold

Table 32 - 5094-IF8IH Module - Input Tags (Continued)

Name	Data Type	Definition	Valid Values
ChOx.Overrange	BOOL	Indicates that the channel data is above the overrange threshold for this channel. For example, when the channel operates in the 4...20 mA output range, the overrange threshold on the channel is ≥ 23.0 mA. If the input signal is 24 mA, this tag is set to 1.	• 0 = Channel data is not above the overrange threshold • 1 = Channel data is above the overrange threshold
ChOx.LLAlarm	BOOL	Triggered when the input data value is less than the Low Low alarm value. If latching is enabled, this alarm remains triggered until unlatched. If latching is not enabled, the alarm clears after the input data value is greater than the Low Low limit and the Alarm Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.LAlarm	BOOL	Triggered when the input data value is less than the Low alarm value. If latching is enabled, this alarm remains triggered until unlatched. If latching is not enabled, the alarm clears after the input data value is greater than the Low limit and the Alarm Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.HAlarm	BOOL	Triggered when the input data value is greater than the High alarm value. If latching is enabled, this alarm remains triggered until unlatched. If latching is not enabled, the alarm clears after the input data value is less than the High limit and the Alarm Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.HHAlarm	BOOL	Triggered when the input data value is greater than the High High alarm value. If latching is enabled, this alarm remains triggered until unlatched. If latching is not enabled, the alarm clears after the input data value is less than the High High limit and the Alarm Deadband.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.RateAlarm	BOOL	Triggered when the change between consecutive channel samples divided by the period of time between when the samples were taken exceeds the Rate Alarm. If latched, this tag remains set until it is unlatched.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.CalFault	BOOL	Indicates that the last attempted Calibration for this channel failed or there is no calibration data present. This tag is cleared, that is, set to 0, when power is cycled to the module.	• 0 = Calibration did not fail • 1 = Calibration failed
ChOx.Calibrating	BOOL	Indicates that the channel is currently being calibrated.	• 0 = Channel is not being calibrated • 1 = Channel is being calibrated
ChOx.Data	REAL	Channel data in scaled Engineering Units.	Any positive or negative value.
ChOx.RollingTimestamp	INT	Continuously running 15-bit timer that counts in milliseconds. Whenever an input module scans its channels, it also records the value of *RollingTimestamp* at that time. The user program can then use the last two *RollingTimestamp* values and calculate the interval between receipt of data or the time when new data has been received.	0 ...32767
PtOx.Data PtOx.Pt.Data	BOOL	Indicates the current digital input value.	• 0 = Input is Off • 1 = Input is On
PtOx.Fault PtOx.Pt.Fault	BOOL	A fault is a roll-up of all the diagnostic conditions that the module can detect and indicates bad data. If there is a detailed data type member that indicates a given detected condition, this fault member does not affect the *DiagnosticActive* or *DiagnosticSequenceCount* members. However, if there is no detailed data type for a given detected condition, this fault member triggers both the *DiagnosticActive* member and increments/decrements the Diagnostic Sequence Count.	• 0 = No fault exists • 1 = Fault exists
PtOx.Uncertain PtOx.Pt.Uncertain	BOOL	The module is operating outside its designed operating range.	0 = Valid data 1 = Data validity uncertain
PtOx.Type3dOpenwire	BOOL	Triggered when type 3-d open wire is detected.	0 = Type 3-d Open Wireis not detected 1 = Type 3-d Open Wire is detected
PtOx.Type3dShortcircuit	BOOL	Triggered when type 3-d short circuit is detected.	0 = Type 3-d Short Circuit is not detected 1 = Type 3-d Short Circuit is detected

Output Tags

Table 33 describes the 5094-IF8IH module output tags.

Table 33 - 5094-IF8IH Module - Output Tags

Name	Data Type	Definition	Valid Values
ChOx.LLAlarmEn	BOOL	Enables the Low Low alarm. **IMPORTANT**: To use this alarm, you must not only set the tag to 1. You must also make sure the *ChOx.AlarmDisable* configuration tag for the same channel is set to 0. If the *ChOx.AlarmDisable* configuration tag is set to 1, that is, alarms are disabled, this alarm does not work regardless of the tag value.	• 0 = Alarm is disabled • 1 = Alarm is enabled
ChOx.LAlarmEn	BOOL	Enables the Low alarm. **IMPORTANT**: To use this alarm, you must not only set the tag to 1. You must also make sure the *ChOx.AlarmDisable* configuration tag for the same channel is set to 0. If the *ChOx.AlarmDisable* configuration tag is set to 1, that is, alarms are disabled, this alarm does not work regardless of the tag value.	• 0 = Alarm is disabled • 1 = Alarm is enabled
ChOx.HAlarmEn	BOOL	Enables the High alarm. **IMPORTANT**: To use this alarm, you must not only set the tag to 1. You must also make sure the *ChOx.AlarmDisable* configuration tag for the same channel is set to 0. If the *ChOx.AlarmDisable* configuration tag is set to 1, that is, alarms are disabled, this alarm does not work regardless of the tag value.	• 0 = Alarm is disabled • 1 = Alarm is enabled
ChOx.HHAlarmEn	BOOL	Enables the High High alarm. **IMPORTANT**: To use this alarm, you must not only set the tag to 1. You must also make sure the *ChOx.AlarmDisable* configuration tag for the same channel is set to 0. If the *ChOx.AlarmDisable* configuration tag is set to 1, that is, alarms are disabled, this alarm does not work regardless of the tag value.	• 0 = Alarm is disabled • 1 = Alarm is enabled
ChOx.RateAlarmEn	BOOL	Enables the Rate alarm. **IMPORTANT**: To use this alarm, you must not only set the tag to 1. You must also make sure the *ChOx.AlarmDisable* configuration tag for the same channel is set to 0. If the *ChOx.AlarmDisable* configuration tag is set to 1, that is, alarms are disabled, this alarm does not work regardless of the tag value.	• 0 = Alarm is disabled • 1 = Alarm is enabled
ChOx.LLAlarmUnlatch	BOOL	Unlatches a latched Low Low Alarm at the first instance of the bit transitioning from 0 to 1.	• 0 = Low Low Alarm remains latched • 1 = Low Low Alarm unlatches
ChOx.LAlarmUnlatch	BOOL	Unlatches a latched Low Alarm at the first instance of the bit transition from 0 to 1.	• 0 = Low Alarm remains latched • 1 = Low Alarm unlatches
ChOx.HAlarmUnlatch	BOOL	Unlatches a latched High Alarm at the first instance of the bit transition from 0 to 1.	• 0 = High Alarm remains latched • 1 = High Alarm unlatches
ChOx.HHAlarmUnlatch	BOOL	Unlatches a set High High Alarm at the first instance of the bit transition from 0 to 1.	• 0 = High High Alarm remains latched • 1 = High High Alarm unlatches
ChOx.RateAlarmUnlatch	BOOL	Unlatches a set Rate Alarm at the first instance of the bit transition from 0 to 1.	• 0 = Rate Alarm remains latched • 1 = Rate Alarm unlatches
ChOx.SensorOffset	REAL	Compensates for any known offset error on the sensor or channel to which the sensor is connected. In terms of engineering units. The value of this tag is added to the measured value in engineering units and is used in the *ChOx.Data* input tag.	Any valid float value (We recommend that you use a value in the channel's operating range.) 0.0 = default

5094-OF8IH Module Tags

This section describes the tags that are associated with the 5094-OF8IH module.

Configuration Tags

Table 34 describes the 5094-OF8IH module configuration tags.

Table 34 - 5094-OF8IH Module - Configuration Tags

Name	Data Type	Definition	Valid Values
ChOx.Range	SINT	Channel's operating range	• 0 = -10...10V • 1 = 0...5V • 2 = 0...10V • 4 = 0...20 mA • 5 = 4...20 mA
ChOx.AlarmDisable	BOOL	Disables all alarms on the channel.	• 0 = Alarms are enabled • 1 = Alarms are disabled (default)
ChOx.LimitAlarmLatchEn	BOOL	Configures Limit alarms to latch until they are explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
ChOx.RampAlarmLatchEn	BOOL	Latches Ramp alarm when set so that does not clear until explicitly unlatched.	• 0 = Latching disabled (default) • 1 = Latching enabled
ChOx.NoLoadEn	BOOL	Enable the input No Load diagnostic	• 0 = Disabled (default) • 1 = Enabled
ChOx.Disable	BOOL	Disables the channel.	• 0 = Channel is enabled (default) • 1 = Channel is disabled
ChOx.FaultMode	BOOL	Determines output action when a connection fault occurs. At the fault occurrence, the output holds its last state or transitions to the value set in the Fault Value parameter. The channel continues the Fault Mode for the length of time set in the Fault Value State Duration parameter.	• 0 = Transition to user-defined value • 1 = Hold Last State (default)
ChOx.ProgMode	BOOL	Determines output action when the controller transitions to Program mode or the connection to the module is inhibited. At the transition to Program mode, the output holds its last state or transitions to the value set in the Program Value parameter.	• 0 = Transition to user-defined value • 1 = Hold Last State (default)
ChOx.ProgramToFaultEn	BOOL	Determines channel action if a connection faults while the module is in a safe state for Program mode. The channel can remain in the safe state for Program mode or transition to a safe state for Fault mode. If the channel remains in safe state for Program mode, the Final Fault State parameter is ignored.	• 0 = Remains in the Program state • 1 = Transitions to the safe state for the Fault mode
ChOx.RampInRun	BOOL	Enables Output Ramping when the module is in Run mode. Output changes during Run mode are limited to the Maximum Ramp Rate value.	• 0 = Ramping disabled (default) • 1 = Ramping enabled in Run mode
ChOx.RampToProg	BOOL	Enables Output Ramping when the controller transitions to Program mode. Output changes during Program mode are limited to the max Ramp Rate value.	• 0 = Ramping disabled (default) • 1 = Ramping enabled to Program mode state
ChOx.RampToFault	BOOL	Enables Output Ramping when the connection to the module faults. Output transitions to *FaultValue* and *FaultFinalState* are limited to the *MaximumRampRate*.	• 0 = Ramping disabled (default) • 1 = Ramping enabled to Fault mode state
ChOx.HoldForInit	BOOL	When set, configures the channel to hold, or not change, until initialized with a value within 0.1% of full scale of its current value when one of the following conditions occurs. • Module initial connection (power up) • Controller transition from Program mode back to Run mode • Module reestablishes communication after a fault • SA power is restored after being lost.	• 0= Output *O.ChOx.Data* signal immediately • 1= Hold last signal until initialization match

Table 34 - 5094-OF8IH Module - Configuration Tags (Continued)

Name	Data Type	Definition	Valid Values
ChOx.FaultValueStateDuration	SINT	Determines the length of time the *FaultMode* or *FaultValue* parameter value is held before the Final Fault State.	• 0 = Hold forever (default) • Any of the following: – 1, 2, 5, or 10 seconds
ChOx.MaxRampRate	REAL	Maximum rate at which the channel can transition to in Engineering Units/Second. This tag is used only if at least one of the following output ramping modes is enabled: • Ramp In Run • Ramp To Fault • Ramp To Program	Any value ≥ 0.0 1,000,000.00 = default If the MaxRampRate = 0.0, the ramp rate is limited to ramping the range full scale in one RPI.
ChOx.LowSignal	REAL	One of four points used in scaling. The low signal is in terms of the inputs signal units and corresponds to the low engineering term when scaled.	Current applications - Any value less than the high signal in range. • 0 = default for 0…20 mA range • 4 = default for 4…20 mA Voltage applications - Any value less than the high signal in range. • -10 = default for -10…10V range • 0 = default for 0…5V and 0…10V range
ChOx.HighSignal	REAL	One of four points used in scaling. The high signal is in terms of the inputs signal units and corresponds to the high engineering term when scaled.	Current applications - Any value greater than the low signal in range. • 20 = default for either current input range Voltage applications - Any value greater than the low signal in range. • 10 = default for 0…10V and -10…10V ranges • 5 = default for 0…5V range
ChOx.LowEngineering	REAL	One of four points used in scaling. The low engineering helps determine the engineering units the signal values scale into. The low engineering term corresponds to the low signal value.	Any value less than the high engineering value. • Current applications: 0.0 = default • Voltage applications: Low signal = default. For example, with the -10…10V range, the default = -10.
ChOx.HighEngineering	REAL	One of four points used in scaling. The high engineering helps determine the engineering units the signal values scale into. The high engineering term corresponds to the high signal value.	Any value greater than the low engineering value. • Current applications: 100.0 = default • Voltage applications: High signal = default. For example, with the -10…10V range, the default = 10.
ChOx.LowLimit	REAL	Lowest value to which the output can go based on the operating range established by the Output Clamping feature. The tag value is engineering units.	Any value lower than the HighLimit 0.0 = default
ChOx.HighLimit	REAL	Highest value to which the output can go based on the operating range that is established by the Output Clamping feature. The tag value is engineering units.	Any value higher than the LowLimit 0.0 = default
ChOx.Offset	REAL	Compensates for any known error on the sensor or channel to which the sensor is connected. The value is set in engineering units.	Any value (We recommend that you use a small value.) 0.0 = default
ChOx.FaultValue	REAL	Value to which the output changes if the following events exist: • Fault Mode = 0 • Either of the following: – Controller is in Run mode and the connection is lost – Controller is in Program mode, the connection is lost, and the *ProgamToFaultEn* tag is set	Any value 0.0 = default

Table 34 - 5094-OF8IH Module - Configuration Tags (Continued)

Name	Data Type	Definition	Valid Values
ChOx.ProgValue	REAL	Value to which the channel changes if the following events exist: • Program Mode = 0 • Controller transitions to Program mode	Any value 0.0 = default
ChOx.FaultFinalState	REAL	Value to which the channel changes if the following events exist: • Connection is lost • Time that is defined by the *FaultValueStateDuration* parameter has been exceeded Output transitions to *FaultValue* and *FaultFinalState* are limited to the *MaximumRampRate*.	Any value 0.0 = default
ChOx.HARTEn	BOOL	Enable HART communication on the channel.	• 1= HART Communication is enabled • 0 = HART Communication is disabled

Input Tags

Table 35 describes the 5094-OF8IH module input tags.

Table 35 - 5094-OF8IH Module - Input Tags

Name	Data Type	Definition	Valid Values
RunMode	BOOL	Channel's operating state	• 0 = Idle • 1 = Run
ConnectionFaulted	BOOL	Indicates if a connection is running. The module sets this tag to 0 when connected. If the module is not connected, it changes the tag to 1.	• 0 = Connection running • 1 = Connection not running
DiagnosticActive	BOOL	Indicates if any diagnostics are active or if the prognostics threshold is reached.	• 0 = No diagnostics active • 1 = One or more diagnostics are active or the prognostics threshold is reached
DiagnosticSequenceCount	SINT	Increments for each time a distinct diagnostic condition is detected, and when a distinct diagnostic condition transitions from detected to not detected. Set to zero by product reset or power cycle. Wraps from 255 (-1) to 1 skipping zero.	-128...+127 The value of 0 is skipped except during module power-up.
ChOx.Fault	BOOL	Indicates that channel data is inaccurate and **cannot be trusted** for use in the application. If the tag is set to 1, you must troubleshoot the module to correct the cause of the inaccuracy. **IMPORTANT**: Once the condition that causes the tag to change to 1 is removed, the tag automatically resets to 0.	• 0 = Good • 1 = Bad, causing fault The typical causes of uncertain data are the following: – Channel is disabled – No Load condition – Short Circuit condition We recommend that you first troubleshoot the module to see if the typical causes exist.
ChOx.Uncertain	BOOL	Indicates that the channel data can be inaccurate but the **degree of inaccuracy is not known**. If the tag is set to 1, you must troubleshoot the module to correct the cause of the inaccuracy. **IMPORTANT**: Once the condition that causes the tag to change to 1 is removed, the tag automatically resets to 0.	• 0 = Good data • 1 = Uncertain data The typical causes of uncertain data are the following: – Data signal slightly outside the channel operating range – Underrange/Overrange condition – The channel is over temperature. – Invalid offset value – Calibration fault on the channel – Calibration is in process on the channel We recommend that you first troubleshoot the module to see if the typical causes exist.
ChOx.NoLoad	BOOL	The signal wire is disconnected from the channel or the RTB is removed from the module. This condition is detected only when the channel is used in current mode.	• 0 = No Load condition does not exist • 1 = No Load condition exists. That is, a signal wire is disconnected from the channel or the RTB is removed from the module.

Table 35 - 5094-OF8IH Module - Input Tags (Continued)

Name	Data Type	Definition	Valid Values
ChOx.ShortCircuit	BOOL	A Short Circuit or Overcurrent condition exists. This condition is detected only when the channel is used in voltage mode.	• 0 = No Short Circuit or Overcurrent condition exists • 1 = Short Circuit or Overcurrent condition exists
ChOx.OverTemperature	BOOL	Module is higher temperature than its operating limits. • If this tag is set to 1 but a fault does not exist on the channel, this tag is only an indication of operating conditions but the channel is functioning. • If this tag is set to 1 and a fault exists on the channel, the channel is not functioning.	• 0 = Module temperature is not over the operating limits • 1 = Module temperature is over the operating limits
ChOx.FieldPowerOff	BOOL	Field power is not present at the channel.	• 0 = Field Power is present • 1 = Field Power is not present
ChOx.InHold	BOOL	Indicates that the channel is currently holding until the received data value is within 0.1% range full scale of the current data value.	• 0 = Channel is not holding • 1 = Channel is holding
ChOx.NotANumber	BOOL	Indicates that the last value received for the channel output data value was not a number.	• 0 = Last channel data received was a number • 1 = Last channel data received was not a number
ChOx.Underrange	BOOL	Indicates that the channel data is beneath the underrange threshold for this channel. For example, when the channel operates in the 4…20 mA output range, the underrange threshold on the channel is ≤ 3.6 mA. If the output signal is 0 mA, this tag is set to 1.	• 0 = Channel data is not beneath the underrange threshold • 1 = Channel data is beneath the underrange threshold
ChOx.Overrange	BOOL	Indicates that the channel data is above the overrange threshold for this channel. For example, when the channel operates in the 4…20 mA output range, the overrange threshold on the channel is ≥ 21.0 mA. If the output signal is 21 mA, this tag is set to 1.	• 0 = Channel data is not above the overrange threshold • 1 = Channel data is above the overrange threshold
ChOx.LLimitAlarm	BOOL	Triggered when the requested output value is below the configured Low Limit value. It remains set until the requested output is above the Low Limit. If the *ChOx.AlarmDisable* tag is set to 1, that is, the output signal is still clamped at the Low Limit value. But the Low Limit alarm is not triggered.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.HLimitAlarm	BOOL	Triggered when the requested output value is above the configured High Limit value. It remains set until the requested output is below the High Limit. If the *ChOx.AlarmDisable* tag is set to 1, that is, the output signal is still clamped at the High Limit value. But the High Limit alarm is not triggered.	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.RampAlarm	BOOL	Indicates that the analog output has been commanded to change value in a way such that the max Ramp Rate is exceeded	• 0 = Alarm is not triggered • 1 = Alarm is triggered
ChOx.CalFault	BOOL	Indicates that the last attempted Calibration for this channel failed. This tag is cleared, that is, set to 0, when power is cycled to the module.	• 0 = Calibration did not fail • 1 = Calibration failed
ChOx.Calibrating	BOOL	Indicates that the channel is currently being calibrated.	• 0 = Channel is not being calibrated • 1 = Channel is being calibrated
ChOx.Data	REAL	Indicates the signal value currently output at the RTB in scaled Engineering Units.	Any positive or negative value.
ChOx.RollingTimestamp	INT	Continuously-running 15-bit timer that counts in milliseconds. Whenever the output readback data value changes, the output module updates the value of the *RollingTimestamp*.	0…32767

Output Tags

Table 36 describes the 5094-OF8IH module output tags.

Table 36 - 5094-OF8IH Module - Output Tags

Name	Data Type	Definition	Valid Values
ChOx.LLimitAlarmUnlatch	BOOL	Unlatches a latched Low Limit alarm at the first instance of the bit transitioning from 0 to 1.	• 0 = Alarm remains latched (default) • 1 = Alarm is unlatched
ChOx.HLimitAlarmUnlatch	BOOL	Unlatches a latched High Limit alarm at the first instance of the bit transitioning from 0 to 1.	• 0 = Alarm remains latched (default) • 1 = Alarm is unlatched
ChOx.RampAlarmUnlatch	BOOL	Unlatches a latched Ramp alarm at the first instance of the bit transitioning from 0 to 1.	• 0 = Alarm remains latched (default) • 1 = Alarm is unlatched
ChOx.Data	REAL	The value that is converted to the signal on the RTB in scaled Engineering Units.	Any valid engineering unit

HART Device Tags

This section describes the tags that are associated with the HART device.

Input Tags

Table 37 describes the HART device input tags.

Table 37 - HART Device- Input Tags

Name	Data Type	Definition	Valid Values
RunMode	BOOL	Channel's operating state	• 0 = Idle • 1 = Run
ConnectionFaulted	BOOL	Indicates if a connection is running. The module sets this tag to 0 when connected. If the module is not connected, it changes the tag to 1.	• 0 = Connection running • 1 = Connection not running
DiagnosticActive	BOOL	Indicates if any diagnostics are active or if the prognostics threshold is reached. This bit is set when any of these conditions exist: • any channel Fault is set • HART Command #48 returns non-zero data • Malfunction is set • *MoreStatusAvailable* is set • *CurrentMismatch* is set	• 0 = No diagnostics active • 1 = One or more diagnostics are active or the prognostics threshold is reached
DiagnosticSequenceCount	SINT	Increments for each time a distinct diagnostic condition is detected, and when a distinct diagnostic condition transitions from detected to not detected. Reset device or cycle power to set it to zero. It wraps from 255 (-1) to 1, skipping zero.	-128...+127 The value of 0 is skipped except during module power-up.
CurrentSaturated	BOOL	The loop current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.	• 0 = Current not saturated • 1 = Current saturated
CurrentFixed	BOOL	The loop current is being held at a fixed value and is not responding to process variations.	• 0 = Current not fixed • 1 = Current fixed
MoreStatusAvailable	BOOL	More status information is available than can be returned in the Field Device Status. HART Command #48, R*ead Additional Status Information*, will provide this additional status information.	• 0 = More status not available • 1 = More status available
CurrentMismatch	BOOL	It is set to 1 if the HART digital value does not match analog module channel value.	• 0 = Current match • 1 = Current mismatch

Table 37 - HART Device- Input Tags (Continued)

Name	Data Type	Definition	Valid Values
ConfigurationChanged	BOOL	It is set to 1 after HART device configuration is changed and the module has retrieved all HART device configuration data to be returned by the *Get HART Device Information* service. This bit is used by Studio 5000 Logix Designer to allow it to perform any logic when the HART device configuration has changed. See HART Device Configuration Change Notification on page 64 for more information on how to use the command. **Note:** If the HART device does not support HART Command 38, only the first configuration change after the device boot-up can be detected and *ConfigurationChanged* in the input tag is set. All configuration changes after that are not detectable and *ConfigurationChanged* in the input tag will not be set for these changes.	• 0 = Configuration not changed • 1 = Configuration changed
Malfunction	BOOL	A hardware error or failure has been detected by the device. Further information may be available through HART Command #48.	• 0 = No hardware error or failure is detected by the device • 1 = Hardware error or failure is detected by the device
<NameOfVariable>.Ch.Fault[1] [2]	BOOL	Indicates that data is inaccurate and cannot be trusted for use in the application. **IMPORTANT:** Once the condition that causes the tag to change to 1 is removed, the tag automatically resets to 0. It is set to 1 when: • *Device Malfunction* in the field device status is set in the response of the command to retrieve this HART variable. • The command to retrieve this HART variable is not successful; no valid command response is received after 3 attempts; communication error is returned, or response code indicating an error is returned in the command response. • The HART variable value that is returned is NAN. • The device variable status indicates "process data status bad". • If this Device Variable is PV – when "primary variable out of limits in the field device status" is set in the response of the command to retrieve PV. • For HART 5 and 6 devices, and if this variable is SV, TV, or QV, when "non PV out of limits in field device status" is set in the response of the command to retrieve this HART Variable. • The *underrange* or *overrange* bit is set.	• 0 = Good • 1 = Bad, causing fault
<NameOfVariable>.Ch.Uncertain	BOOL	Indicates that the channel data can be inaccurate but the degree of inaccuracy is not known. **IMPORTANT:** Once the condition that causes the tag to change to 1 is removed, the tag automatically resets to 0. It is set to 1 when: • The device variable status indicates "process data status manual/fixed" or "poor accuracy". • The device variable status indicates "limit status constant" and process data status indicates "not bad".	• 0 = Good data • 1 = Uncertain data
<NameOfVariable>.Ch.Underrange	BOOL	Indicates that the input signal at the channel is less than, or equal to, the min detectable signal. It is set to 1 when device variable status indicates "low limited".	• 0 = Not underrange • 1 = Underrange
<NameOfVariable>.Ch.Overrange	BOOL	Indicates that the input signal at the channel is greater than, or equal to, the max detectable signal. It is set to 1 when device variable status indicates "high limited".	• 0 = Not overrange • 1 =Overrange
<NameOfVariable>.Ch.Data	REAL	The last good value received from the device. If a value has not yet been received from the device, the value is 0.0.	Any positive or negative value.
<NameOfVariable>.Ch.RollingTimestamp	INT	*RollingTimestamp* is a continuously running a 15-bit timer that counts in milliseconds (unrelated to the CIP Sync). For input modules, whenever a module scans its channels, it also records the value of *RollingTimestamp* at that time. Studio 5000 Logix Designer can then use the last two *RollingTimestamp* values and calculate the interval between receipt of data or the time when a new data is received.	0…32767

Table 37 - HART Device- Input Tags (Continued)

Name	Data Type	Definition	Valid Values
<NameOfVariable>.Class	USINT	Device Variable Classification If the HART device does not support device variables, it is set to 0.	0...255
<NameOfVariable>.Unit	USINT	Unit code	0...255
<NameOfVariable>.Manual	BOOL	Indicates that the data value is manually controlled. It is set to 1 when device variable status indicates "process data status manual/fixed" and limit status is "not limited".	• 0 = Data is not manual • 1 = Data is manual
<NameOfVariable>.Constant	BOOL	Indicates that the data value is constant. It is set to 1 when variable status indicates "constant".	• 0 = Data is not constant • 1 = Data is constant
Static.Fault	BOOL	Indicates if the set of static data is valid. **For PlantPAx connection only.**	• 0 = Static data isgood • 1 = Static data is bad
Static.PVUnit	USINT	Unit code of PV. **For PlantPAx connection only.**	1...253
Static.HARTRevision	USINT	HART protocol major revision number. **For PlantPAx connection only.**	5, 6, or 7
Static.HARTTagName	STRING	Assigned name of HART device. Same as Identity attribute 15. **For PlantPAx connection only.**	String with max 32 characters
Static.Descriptor	STRING	Descriptor of HART device. **For PlantPAx connection only.**	String with max 16 characters
Static.PVAtSignal4	REAL	PV Lower Rangevalue. **For PlantPAx connection only.**	Any value less than Static.PVAtSignal20
Static.PVAtSignal20	REAL	PV Higher Range value. **For PlantPAx connection only.**	Any value greater than Static.PVAtSignal4
Static.AdditionalDeviceStatus	SINT[25]	Additional Device Status from HART command 48. **For PlantPAx connection only.**	
ChDataAtSignal4	REAL	This member is the engineering unit value of 4 mA according to the corresponding analog input channel configuration of the module. **For PlantPAx connection only.**	Any value less than ChDataAtSignal20
ChDataAtSignal20	REAL	This member is the engineering unit value of 20 mA according to the corresponding analog input channel configuration of the module. **For PlantPAx connection only.**	Any value greater than ChDataAtSignal4
<NameOfCommand>.ReadyToExecute	BOOL	Indicates that the data value is constant. It is set to 1 when variable status indicates "constant". See Execute HART Commands through Producer / Consumer Data on page 64	• 0 = Ready to accept a new execution • 1 = Not ready to accept a new execution
<NameOfCommand>.Completed	BOOL	Indicates that a command execution is completed. See Execute HART Commands through Producer / Consumer Data on page 64	• 0 = No command has been completed or the current command execution is on-going • 1 = Execution has been completed
<NameOfCommand>.Active	BOOL	Indicates that a command execution is on-going. See Execute HART Commands through Producer / Consumer Data on page 64	• 0 = No command has been completed or the current command execution is on-going • 1 = Execution has been completed
<NameOfCommand>.Overlap	BOOL	Indicates that a new command execution request is received when the current execution is still on-going. It is only cleared when a new command execution has been started successfully. See Execute HART Commands through Producer / Consumer Data on page 64	• 0 = No overlapped execution request received after the last successfully started command execution • 1 = Overlapped execution request received
<NameOfCommand>.ERR	BOOL	Indicates that some unexpected result occurred for the latest command execution. The possible error conditions include: • command timeout • HART communication status bit set • HART module detects a communications error • *ResponseCode* value in the response packet indicates an error. The bit is cleared when a new execution is requested.	• 0 = No error in latest execution • 1 = error in latest execution
<NameOfCommand>.Warning	BOOL	It is set when the *ResponseCode* value in the response packet indicates a warning. The bit is cleared when a new execution is requested.	• 0 = No warning in latest execution • 1 = warning in latest execution
<NameOfCommand>.ParameterError	BOOL	Indicates that one of the request parameter values cannot be converted from CIP to HART. It is cleared when a new execution successfully starts with valid request parameter. See Execute HART Commands through Producer / Consumer Data on page 64	• 0 = No parameter error in latest execution • 1 = parameter error in latest execution

Table 37 - HART Device- Input Tags (Continued)

Name	Data Type	Definition	Valid Values
<NameOfCommand>.ParameterErrorNumber	SINT	If the *ParameterError* bit is set, this value indicates the index of the first request parameter that contains a value that cannot be converted from CIP to HART. This number is 0 based. **Note:** Command request parameters that are not included in the consume assembly (constants) are not included in the numbering.	0...127
<NameOfCommand>.ResponseCode	SINT	HART command response code of the last completed command execution.	0...127
<NameOfCommand>.<CommandResponseParameterName>	Variable	Response parameter of the command. The parameter name and type come from HART EDD file.	variable

(1) <NameOfVariable> could be PV, SV, TV, QV, or <NameOfDeviceVariable>.

(2) <NameOfVariable> could be LoopCurrent (for PlantPAx connection only).

Output Tags

Table 38 describes the HART device output tags.

Table 38 - HART Device- Output Tags

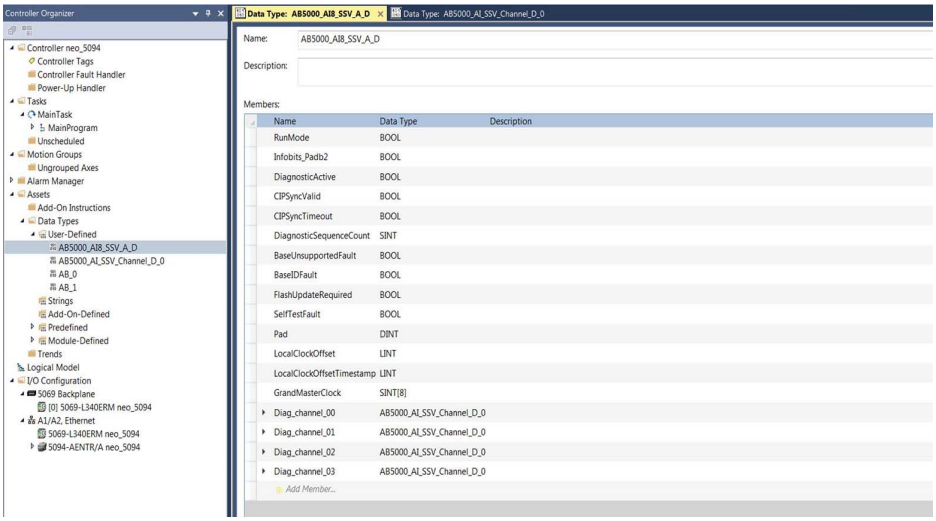
Name	Data Type	Definition	Valid Values
ResetConfigurationChanged	BOOL	When the HART module reads this bit transition from 0 to 1, it resets the *ConfigurationChanged* bit in the produce data. See HART Device Configuration Change Notification on page 64 for more information on how to use the command.	• 0 = Configuration change not reset • 1 = Configuration change reset
<NameOfCommand>.Execute	BOOL	When the HART module reads this bit transition from 0 to 1, it initiates this HART command.	• 0 = HART command not executed • 1 = HART command executed
<NameOfCommand>.<CommandRequestParameterName>	Variable	Request parameter of the command. The parameter name and type come from HART EDD file.	Variable

Notes:

Module Diagnostic Assembly

Create User-defined Diagnostic Assembly Types

You can use the Logix Designer application to create user-defined Diagnostic Assembly types.



From the Controller Organizer pane, expand Data Types and create user-defined types for the 5094-IF8IH module:

1. Analog Input 8 Channel Diagnostic Assembly A
   - DATATYPE: AB:5000_AI8_SSV_A:D:0
   - Instance ID: 0x387 (903)
   - Size = 352 bytes

Follow the information in Table 39 to add each member.

Table 39 - Diagnostic Assembly Instance 903

Name	Data Type	Byte
RunMode	BOOL	1
InfoBits_Pad1[1]	BOOL	
DiagnosticActive	BOOL	
CIPSyncValid	BOOL	
CIPSyncTimeout	BOOL	
DiagnosticSequenceCount	SINT	1
Diagbits_Pad1	SINT	2
Diagbits_Pad2	BOOL	
Diagbits_Pad3	BOOL	
BaseUnsupportedFault	BOOL	
BaseIDFault	BOOL	
FlashUpdateRequired	BOOL	
SelftTestFault	BOOL	

Table 39 - Diagnostic Assembly Instance 903 (Continued)

Name	Data Type	Byte
Pad	DINT	4
LocalClockOffset	LINT	8
LocalClockOffsetTimestamp	LINT	8
GrandMasterClockID	SINT[8]	8
Diag_Channel_00	User defined(2)	80
Diag_Channel_01	User defined	80
Diag_Channel_02	User defined	80
Diag_Channel_03	User defined	80

(1) These data types act as padding to ensure byte alignment. They can be renamed.

(2) User defined type for AB:5000_AI_SSV_Channel:D:0 Table 41.

2. Analog Input 8 Channel Diagnostic Assembly B
   - DATATYPE: AB:5000_AI8_SSV_B:D:0
   - Instance 0x388 (904)
   - Size = 320 bytes

Follow the information in Table 40 to add each member.

Table 40 - Diagnostic Assembly Instance 904

Name	Data Type	Byte
Diag_Channel_04	User defined(1)	80
Diag_Channel_05	User defined	80
Diag_Channel_06	User defined	80
Diag_Channel_07	User defined	80

(1) User defined type for AB:5000_AI_SSV_Channel:D:0 Table 41

Follow the information in Table 41 to add each channel member.

Table 41 - AB:5000_AI_SSV_Channel:D:0

Name	Data Type	Byte
DiagBits_Pad1	BOOL	
Fault	BOOL	
Uncertain	BOOL	
OpenWire	BOOL	
DataBits_Pad2	BOOL	
OverTemperature	BOOL	
FieldPowerOff	BOOL	
DiagBits_Pad3	BOOL	2
PowerOffRangeMismatch	BOOL	
DataBits_Pad4	BOOL	
DataBits_Pad5	BOOL	
DataBits_Pad6	BOOL	
DataBits_Pad7	BOOL	
DataBits_Pad8	BOOL	
DataBits_Pad9	BOOL	
DataBits_Pad10	BOOL	
CalFault	BOOL	
Underrange	BOOL	
Overrange	BOOL	2
SSVOvercurrent	BOOL	
DiagBits_Pad	SINT	

Table 41 - AB:5000_AI_SSV_Channel:D:0 (Continued)

Name	Data Type	Byte
Pad	INT	2
InternalErrorCount	SINT	1
CalRange	SINT	1
CalOffset	REAL	4
CalGain	REAL	4
CalLastDate	LINT	8
OpenWireTimestamp	LINT	8
OverTemperatureTimestamp	LINT	8
UnderrangeTimestamp	LINT	8
OverrangeTimestamp	LINT	8
FieldPowerOnTimestamp	LINT	8
FielPowerOffTimestamp	LINT	8
SSVOvercurrentTimestamp	LINT	8

3. Discrete 8 Channel Diagnostic Assembly(1)
   - DATATYPE: AB:5000_DI8_Type3d:D:0
   - Instance ID: 0x3DB (987)
   - Size = 480 bytes

Follow the information in Table 42 to add each member.

Table 42 - Diagnostic Assembly Instance 987

Name	Data Type	Byte
RunMode	BOOL	1
InfoBits_Pad1(1)	BOOL	
DiagnosticActive	BOOL	
CIPSyncValid	BOOL	
CIPSyncTimeout	BOOL	
DiagnosticSequenceCount	SINT	1
Diagbits_Pad1	SINT	2
Diagbits_Pad2	BOOL	
Diagbits_Pad3	BOOL	
BaseUnsupportedFault	BOOL	
BaseIDFault	BOOL	
FlashUpdateRequired	BOOL	
SelftTestFault	BOOL	
Pad	DINT	4
LocalClockOffset	LINT	8
LocalClockOffsetTimestamp	LINT	8
GrandMasterClockID	SINT[8]	8
Diag_Channel_00	User defined(2)	56
Diag_Channel_01	User defined	56
Diag_Channel_02	User defined	56
Diag_Channel_03	User defined	56
Diag_Channel_04	User defined	56
Diag_Channel_05	User defined	56
Diag_Channel_06	User defined	56
Diag_Channel_07	User defined	56

(1) These data types act as padding to ensure byte alignment. They can be renamed.

(2) User defined type for AB:5000_DI_TYPE3D_Channel:D:0 Table 44.

(1) Available for firmware revision 3.011 or higher.

4. Discrete 4 Channel Diagnostic Assembly[1]
   - DATATYPE: AB:5000_DI4_Type3d:D:0
   - Instance 0x3DA (986)
   - Size = 256 bytes

Follow the information in Table 43 to add each member.

Table 43 - Diagnostic Assembly Instance 986

Name	Data Type	Byte
RunMode	BOOL	1
InfoBits_Pad1[1]	BOOL	
DiagnosticActive	BOOL	
CIPSyncValid	BOOL	
CIPSyncTimeout	BOOL	
DiagnosticSequenceCount	SINT	1
Diagbits_Pad1	SINT	2
Diagbits_Pad2	BOOL	
Diagbits_Pad3	BOOL	
BaseUnsupportedFault	BOOL	
BaseIDFault	BOOL	
FlashUpdateRequired	BOOL	
SelftTestFault	BOOL	
Pad	DINT	4
LocalClockOffset	LINT	8
LocalClockOffsetTimestamp	LINT	8
GrandMasterClockID	SINT[8]	8
Diag_Channel_04	User defined[2]	56
Diag_Channel_05	User defined	56
Diag_Channel_06	User defined	56
Diag_Channel_07	User defined	56

(1) These data types act as padding to ensure byte alignment. They can be renamed.

(2) User defined type for AB:5000_DI_TYPE3D_Channel:D:0 Table 44.

Follow the information in Table 44 to add each channel member.

Table 44 - AB:5000_DI_TYPE3D_Channel:D:0

Name	Data Type	Byte
DataBits_Pad1	BOOL	2
Fault	BOOL	
Uncertain	BOOL	
DataBits_Pad2	BOOL	
DataBits_Pad3	BOOL	
OverTemperature	BOOL	
FieldPowerOff	BOOL	
DataBits_Pad4	BOOL	
PowerOffRangeMismatch	BOOL	
DataBits_Pad5	BOOL	
DataBits_Pad6	BOOL	
DataBits_Pad7	BOOL	
DataBits_Pad8	BOOL	
DataBits_Pad9	BOOL	
DataBits_Pad10	BOOL	
DataBits_Pad11	BOOL	

Table 44 - AB:5000_DI_TYPE3D_Channel:D:0 (Continued)

Name	Data Type	Byte
DiagBits_Pad1	BOOL	2
DiagBits_Pad2	BOOL	
DiagBits_Pad3	BOOL	
SSVOvercurrent	BOOL	
Type3dOpenWire	BOOL	
Type3dShortcircuit	BOOL	
DiagBits_Pad	SINT	
Pad1	INT	2
InternalErrorCount	SINT	1
Pad2	SINT	1
OverTemperatureTimestamp	LINT	8
Type3dOpenWireTimestamp	LINT	8
Type3dShortcircuitTimestamp	LINT	8
FieldPowerOnTimestamp	LINT	8
FieldPowerOffTimestamp	LINT	8
SSVOvercurrentTimestamp	LINT	8

From the Controller Organizer pane, expand Data Types and create user-defined types for the 5094-OF8IH module:

1. Analog Output 8 Channel Diagnostic Assembly A
   - DATATYPE: AB:5000_AO8_A:D:1
   - Instance ID: 0x381 (897)
   - Size = 304 bytes

Follow the information in Table 45 to add each member.

Table 45 - Diagnostic Assembly Instance 897

Name	Data Type	Byte
RunMode	BOOL	1
InfoBits_Pad1(1)	BOOL	
DiagnosticActive	BOOL	
CIPSyncValid	BOOL	
CIPSyncTimeout	BOOL	
DiagnosticSequenceCount	SINT	1
Diagbits_Pad1	SINT	2
Diagbits_Pad2	BOOL	
Diagbits_Pad3	BOOL	
BaseUnsupportedFault	BOOL	
BaseIDFault	BOOL	
FlashUpdateRequired	BOOL	
SelftTestFault	BOOL	
Pad	DINT	4
LocalClockOffset	LINT	8
LocalClockOffsetTimestamp	LINT	8
GrandMasterClockID	SINT[8]	8
FieldPowerOnTimestamp	LINT	8
FieldPowerOffTimestamp	LINT	8
Diag_Channel_00	User defined(2)	64

Table 45 - Diagnostic Assembly Instance 897 (Continued)

Name	Data Type	Byte
Diag_Channel_01	User defined	64
Diag_Channel_02	User defined	64
Diag_Channel_03	User defined	64

(1) These data types act as padding to ensure byte alignment. They can be renamed.

(2) User defined type for AB:5000_AO_Channel:D:1 Table 47.

2. Analog Output 8 Channel Diagnostic Assembly B
   - DATATYPE: AB:5000_AO8_B:D:1
   - Instance 0x382 (898)
   - Size = 256 bytes

Follow the information in Table 46 to add each member.

Table 46 - Diagnostic Assembly Instance 898

Name	Data Type	Byte
Diag_Channel_04	User defined(1)	64
Diag_Channel_05	User defined	64
Diag_Channel_06	User defined	64
Diag_Channel_07	User defined	64

(1) User defined type for AB:5000_AO_Channel:D:1 Table 47.

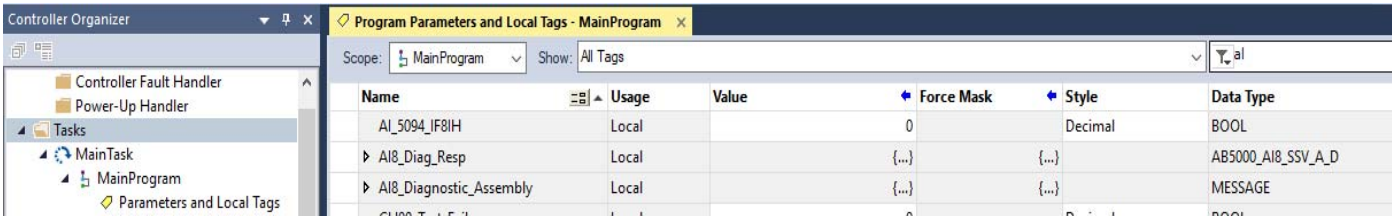
Follow the information in Table 47 to add each channel member.

Table 47 - AB:5000_AO_Channel:D:1

Name	Data Type	Byte
DiagBits_Pad1	BOOL	2
Fault	BOOL	
Uncertain	BOOL	
NoLoad	BOOL	
ShortCircuit	BOOL	
OverTemperature	BOOL	
FieldPowerOff	BOOL	
DiagBits_Pad2	SINT	
CalFault	BOOL	2
DataBits_Pad	SINT	
Pad	INT	2
InternalErrorCount	SINT	1
CalRange	SINT	1
CalOffset	REAL	4
CalGain	REAL	4
CalLastDate	LINT	8
NoLoadTimestamp	LINT	8
ShortCircuitTimestamp	LINT	8
OverTemperatureTimestamp	LINT	8
FieldPowerOnTimestamp	LINT	8
FielPowerOffTimestamp	LINT	8

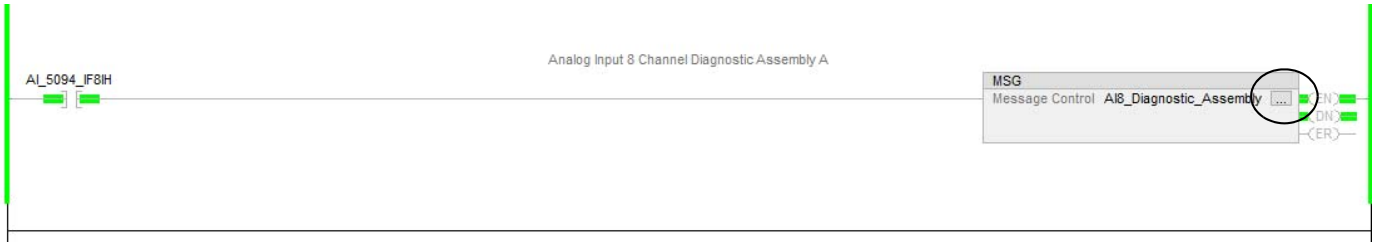
Create Message Type User Tags

Create MESSAGE type user tags for requests and associated response user tags for each of the new user-defined diagnostic assembly types.



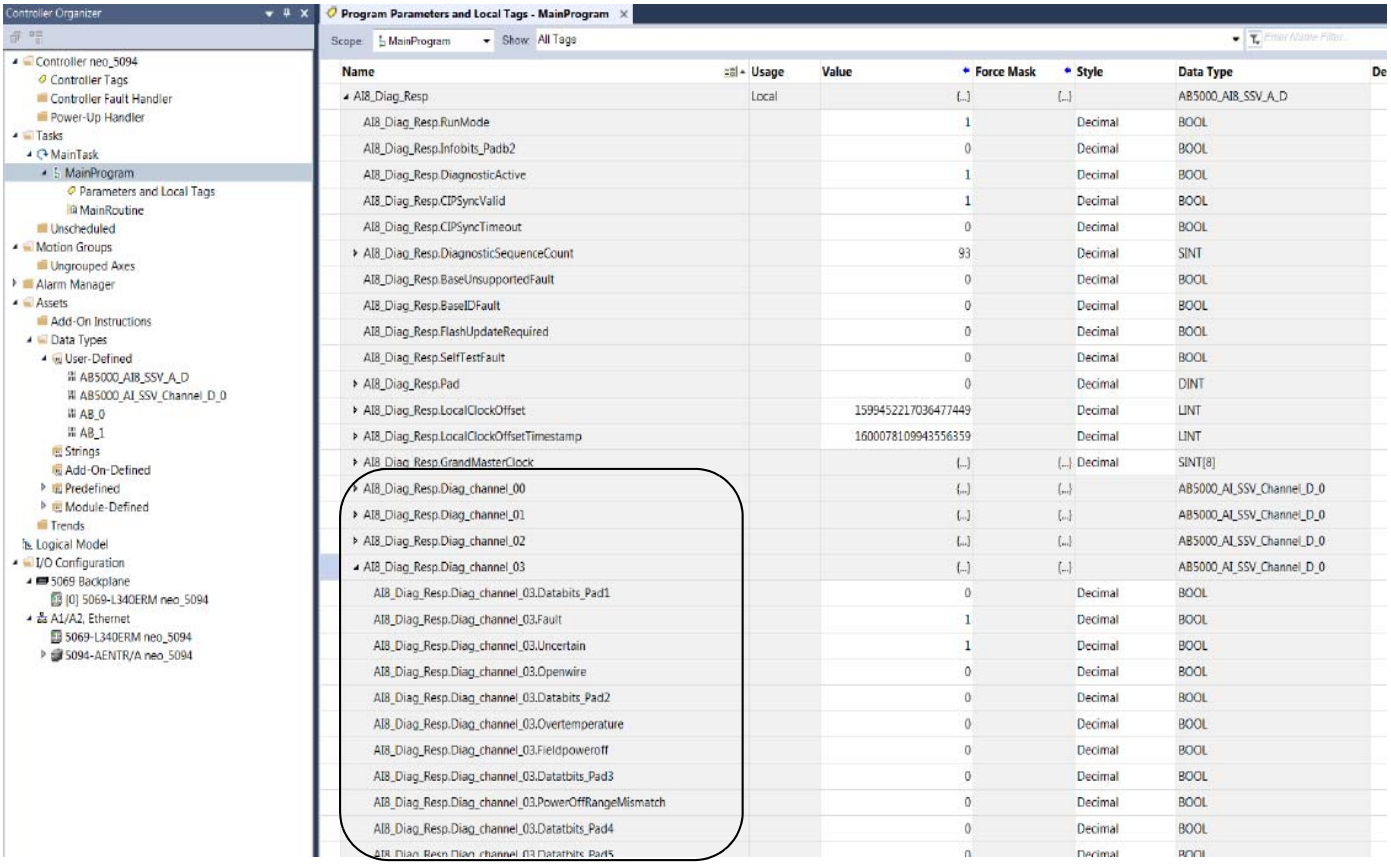
From the Controller Organizer pane, expand Tasks > MainTask > MainProgram

3. Create MESSAGE type user tags for each request
4. Create associated response user tags for each new user-defined diagnostic assembly types.
5. Add the user tags to your ladder program.



6. Expand the message tag ... to open the message configuration dialog
7. On the Configuration tab, select:
   - Service type: Get Attribute Single
   - Class: 4
   - Attribute: 3
   - Instance:
     903 Analog Input 8 Channel Diagnostic Assembly A,
     904 Analog Input 8 Channel Diagnostic Assembly B,
     987 Discrete 8 Channel Diagnostic Assembly,
     986 Discrete 4 Channel Diagnostic Assembly,
     897 Analog Output 8 Channel Diagnostic Assembly A, or
     898 Analog Output 8 Channel Diagnostic Assembly B
   - Destination element: User-defined type suitable for the instance entered.
8. On the Communication tab, select the path to the module that you wish to send the messages to.
9. Download the project and set to Run mode.

You can monitor the user defined tag values from the Program Parameters and Local Tags window, under the MainProgram task in the Controller Organizer pane.


Controller Organizer
Controller neo_5094
Controller Tags
Controller Fault Handler
Power-Up Handler
Tasks
MainTask
MainProgram
Parameters and Local Tags
MainRoutine
Unscheduled
Motion Groups
Ungrouped Axes
Alarm Manager
Assets
Add-On Instructions
Data Types
User-Defined
AB5000_AI8_SSV_A_D
AB5000_AI_SSV_Channel_D_0
AB_0
AB_1
Strings
Add-On-Defined
Predefined
Module-Defined
Trends
Logical Model
I/O Configuration
5069 Backplane
[0] 5069-L340ERM neo_5094
A1/A2, Ethernet
5069-L340ERM neo_5094
5094-AENTR/A neo_5094
Program Parameters and Local Tags - MainProgram
Scope: MainProgram
Show: All Tags
Name
Usage
Value
Force Mask
Style
Data Type
AI8_Diag_Resp
Local
{...}
{...}
AB5000_AI8_SSV_A_D
AI8_Diag_Resp.RunMode
1
Decimal
BOOL
AI8_Diag_Resp.Infobits_Padb2
0
Decimal
BOOL
AI8_Diag_Resp.DiagnosticActive
1
Decimal
BOOL
AI8_Diag_Resp.CIPSyncValid
1
Decimal
BOOL
AI8_Diag_Resp.CIPSyncTimeout
0
Decimal
BOOL
AI8_Diag_Resp.DiagnosticSequenceCount
93
Decimal
SINT
AI8_Diag_Resp.BaseUnsupportedFault
0
Decimal
BOOL
AI8_Diag_Resp.BaseIDFault
0
Decimal
BOOL
AI8_Diag_Resp.FlashUpdateRequired
0
Decimal
BOOL
AI8_Diag_Resp.SelfTestFault
0
Decimal
BOOL
AI8_Diag_Resp.Pad
0
Decimal
DINT
AI8_Diag_Resp.LocalClockOffset
1599452217036477449
Decimal
LINT
AI8_Diag_Resp.LocalClockOffsetTimestamp
160007810994356359
Decimal
LINT
AI8_Diag_Resp.GrandMasterClock
{...}
{...}
Decimal
SINT[8]
AI8_Diag_Resp.Diag_channel_00
{...}
{...}
AB5000_AI_SSV_Channel_D_0
AI8_Diag_Resp.Diag_channel_01
{...}
{...}
AB5000_AI_SSV_Channel_D_0
AI8_Diag_Resp.Diag_channel_02
{...}
{...}
AB5000_AI_SSV_Channel_D_0
AI8_Diag_Resp.Diag_channel_03
{...}
{...}
AB5000_AI_SSV_Channel_D_0
AI8_Diag_Resp.Diag_channel_03.Databits_Pad1
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Fault
1
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Uncertain
1
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Openwire
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Databits_Pad2
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Overtemperature
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Fieldpoweroff
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Databits_Pad3
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.PowerOffRangeMismatch
0
Decimal
BOOL
AI8_Diag_Resp.Diag_channel_03.Databits_Pad4
0
Decimal
BOOL

CIP Object Model of HART Device

The information in this chapter provides guidelines for communicating with ControLogix controllers that use CIP.

Object Model of HART Device

Table 48 defines the CIP objects for each HART device.

Table 48 - CIP Object Model of HART Device

Object Class	Number of Instances	Supported Services
Identity (1, 1_{hex})	1	See CIP Specification Volume 7B.
Message Router (2, 2_{hex})	1	• Get Attribute – get attribute 1 • Get Attributes – get Attribute 1
Connection Manager Object (6, 6_{hex})	1	• Get Attribute – get attributes 1...8 • Set Attribute – reset attributes 1...8 to 0 • Get Attributes All – get attributes 1...8 • Set Attributes All – reset attributes 1...8 to 0 • Forward Open and Forward Close for class 3 connections
Extended HART Process Device (952, $3B8_{hex}$)	1	See Object-specific Services of Extended HART Process Device on page 141

Object-specific Services of Extended HART Process Device

Table 49 defines additional object-specific services of the extended HART process device.

Table 49 - Object-specific Services of Extended HART Process Device

Service Code (Hex)	Class	Instance	Service Name	Service Description
0x4B	$3B8_{hex}$	1	Execute_Command_HART_Types	Defined in HART Process Device object, Chapter 5 of CIP Specification Volume 7B.
0x4C	$3B8_{hex}$	1	Execute_Command_CIP_Types	Executes the specified HART command. The Command Request and Response Data Bytes are specified in CIP types.
0x4E	$3B8_{hex}$	1	Get_HART_Device_Information	Returns a copy of cached Device Configuration Information read previously from the HART device. Data that is returned by this service are relatively static – identity, tag, dynamic variable device, variable code, unit, and so on.

Execute_Command_CIP_Types Service (0x4C)

Service 4C of Extended HART Process Device follows the definition of Service 4C of HART Process Device Object in CIP Specification, Volume 7B with some exceptions.

Table defines the exceptions that override some of the HART to CIP Type mapping defined in CIP Specification, Volume 7B.

HART to CIP Type Mapping Overrides

HART Type	HART Type Definition	CIP Type
Latin-1	67 (43) followed by USINT specifying number of characters	Logix String(1)
Packed	68 (44) followed by USINT specifying number of characters	Logix String(2)

(1) Logix STRING consists of two members: Logix STRING.LEN (DINT) and Logix STRING.DATA (Array of SINT). The value of the LEN member is the index of the first DATA member with a value of 0. If there is no DATA member with a value of 0, the LEN member value is set to the size of the DATA array.
(2) Footnote (1) applies to the unpacked version of the string.

GET_HART_DEVICE_INFORMATION Service (0x4E)

Table 50 defines the parameters of successful Get response.

Table 50 - GET_HART_DEVICE_INFORMATION Successful Response Parameters

Bytes Offset in Response	Name	Data Type	Parameter Description
0	ExpandedDeviceType	USINT	CMD#0, Bytes 1...2
2	Preamble	USINT	CMD#0, Byte 3
3	UnivCmdCode	USINT	CMD#0, Byte 4
4	TransSpecRev	USINT	CMD#0, Byte 5
5	SoftwareRevision	USINT	CMD#0, Byte 6
6	HardwareRevision	USINT	CMD#0, Byte 7
7	Flags	USINT	CMD#0, Byte 8
8	DeviceIDNumber	BYTE	CMD#0, Bytes 9...11 (3 bytes) Device ID number plus a byte of pad (value 0), in Little Endian format.
12	MinPreambles	UDINT	CMD#0, Byte 12 (0 if *UnivCmdCode* is 5)
13	MaxDeviceVariables	USINT	CMD#0, Byte 13 (0 if *UnivCmdCode* is 5)
14	ConfigChangeCounter	USINT	CMD#0, Bytes 14...15 (0 if *UnivCmdCode* is 5)
16	ExtendedFieldDeviceStatus	BYTE	CMD#0, Byte 16 (0 if *UnivCmdCode* is 5)
17	Pad 1 for alignment	Octet	The value is 0
18	ManufacturerIDCode	UINT	CMD#0, Bytes 17...18 if *UnivCmdCode* is 7 or higher CMD#0, Byte 1 cast to a UINT if *UnivCmdCode* is 5 or 6
20	PrivateLabelDistCode	UINT	CMD#0, Bytes 19...20 (0 if *UnivCmdCode* is 5 or 6)
22	DeviceProfile	USINT	CMD#0, Byte 21 (0 if *UnivCmdCode* is 5 or 6)
23	Pad 2 for alignment	Octet	The value is 0
24	TagSize	UDINT	Number of characters in *TagString*. Always 8 bytes. **Note:** *TagSize* and *TagString* may be represented in Logix as a String data type (with max length 8).
28	TagString	USINT[8] (8 bytes unpacked ASCII)	CMD#13, Bytes 0...5 (1)
36	DescriptorSize	UDINT	Number of characters in *DescriptorString*. Always 16 bytes. **Note:** *DescriptorSize* and *DescriptorString* combine to form a Logix String data type.
40	DescriptorString	USINT[16] (16 bytes unpacked ASCII)	CMD#13, Bytes 6...17
56	DateDay	USINT	CMD#13, Byte 18 (2)

Table 50 - GET_HART_DEVICE_INFORMATION Successful Response Parameters (Continued)

Bytes Offset in Response	Name	Data Type	Parameter Description
57	DateMonth	USINT	CMD#13, Byte 19
58	DateYear	UINT	CMD#13, Byte 20 (+ 1900)
60	LongTagSize	UDINT	Number of characters in *LongTagString*. Either 0 bytes or 32 bytes. **Note:** *LongTagSize* and *LongTagString* may be represented in Logix as a String data type (with max length 32). This value will be 0 when the HART Device does not support CMD#20.
64	LongTagString	USINT[32] (32 bytes unpacked ASCII)	CMD#20, Bytes 0...31
96	FinalAssemblyNumber	UDINT	CMD#16, Bytes 0...2 (3 bytes) plus a pad byte (value 0) for 32-bit alignment. In Little Endian format. (Namely, CIP representation, not HART representation). This value normally identifies the materials and electronics that comprise the device.
100	MessageSize	UDINT	Number of characters in *MessageString*. Always 32 bytes. Some may be spaces and other special characters. This and the following field combine to form a standard Logix String data type.
104	MessageString	USINT[32] (32 bytes unpacked ASCII)	CMD#12, Bytes 0...23, unpacked to normal ASCII representation
136	PVCode	USINT	CMD#50, Bytes 0, 0xff if not supported. PV assignment code
137	SVCode	USINT	CMD#50, Bytes 1, 0xff if not supported. SV assignment code
138	TVCode	USINT	CMD#50, Bytes 2, 0xff if not supported. TV assignment code
139	QVCode	USINT	CMD#50, Bytes 3, 0xff if not supported. QV assignment code
140	PVUnits	USINT	CMD#3, Byte 4
141	SVUnits	USINT	CMD#3, Byte 9, 0 if not present
142	TVUnits	USINT	CMD#3, Byte 14, 0 if not present
143	QVUnits	USINT	CMD#3, Byte 19, 0 if not present
144	TransferFunction	USINT	CMD#15, Byte 1
145	RangeUnits	USINT	CMD#15, Byte 2
146	Pad 3 for alignment	Octet [2]	The value is 0
148	PVUpperRange	REAL	CMD#15, Bytes 3...6
152	PVLowerRange	REAL	CMD#15, Bytes 7...10
156	DampingValue	REAL	CMD#15, Bytes 11...14
160	WriteProtectCode	USINT	CMD#15, Byte 15
161	Pad 4 for alignment	Octet [3]	The value is 0

(1) HART native representation packs ASCII characters into 6 bits each. This is an expanded representation, suitable for direct display on ASCII devices.
(2) A Date code that is used by the master for record keeping (for example, Last Or Next Calibration Date).

Notes:

Numerics

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

R

S

T

U

V

Notes:

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

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