ControlLogix HART Analog I/O Modules

Catalog Numbers 1756-IF8H, 1756-IF8HK, 1756-IF8IH, 1756-IF8IHK, 1756-IF16H, 1756-IF16HK, 1756-IF16IH, 1756-IF16IHK, 1756-OF8H, 1756-OF8HK, 1756-OF8IH, 1756-OF8IHK

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.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

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.

These 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).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

Preface

ControlLogix HART Analog I/O Modules

Chapter 1

ControlLogix Module Operation

Chapter 2

1756-IF8H HART Analog Input Module

Chapter 3

Chapter 4

1756-IF8IH HART Isolated Analog Input Module

Chapter 5

1756-IF16H HART Analog Input Module

Chapter 6

1756-IF16IH HART Isolated Analog Input Module

Chapter 7

1756-OF8H HART Analog Output Module

Chapter 8

1756-OF8IH HART Isolated Analog Output Module

About This Publication

This manual describes how to install, configure, and troubleshoot ControlLogix® HART (Highway Addressable Remote Transducer) analog I/O modules.

We assume that you can program and operate an Allen-Bradley® ControlLogix programmable automation controller. If you can't, see the Logix 5000® controller documentation that is listed under Additional Resources before attempting to use these modules.

Rockwell Automation recognizes that some of the terms that are currently used in our industry and in this publication aren't in alignment with the movement toward inclusive language in technology. We're proactively collaborating with industry peers to find alternatives to such terms and making changes to our products and content. Please excuse the use of such terms in our content while we implement these changes.

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
Removed 1756-IF8IH, 1756-OF8IH, and 1756-IF16H from the lists of modules compatible with the 1492 analog interface module (AIFM) wiring system	11, 15, 202
Added information regarding Implicit Protected Mode	26
Updated screen captures and procedures regarding how to Configure and Calibrate Modules	129
Created Appendix for information regarding ControlNet® information	223
Created Appendix for Configure and Calibrate Modules With Older Programming Software	227
Added Calibration information to new Appendix regarding how to Configure and Calibrate Modules With Older Programming Software	249
Updated to include 1756-IF8H and 1756-IF16H Series B module information	Throughout
Added conformal coated product catalog numbers	Throughout

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation. You can view or download publications at rok.auto/literature.

Resource	Description
1756 ControlLogix I/O Modules Specifications Technical Data, publication 1756-TD002	Provides specifications for ControlLogix I/O modules, including the HART analog I/O modules.
Bulletin 1492 Digital/Analog Programmable Controller Wiring Systems Technical Data, publication 1492-TD008	Provides information for the AIFMs and pre-wired cables that can be used with the 1756-IF8H, 1756-IF16H, and 1756-OF8H modules.
ControlLogix System User Manual, publication 1756-UM001	Provides configuration and operational procedures for ControlLogix controllers.
Electronic Keying in Logix 5000 Control Systems Application Technique, publication LOGIX-AT001	Provides information on Electronic Keying in Logix 5000 control systems.
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.

Notes:

ControlLogix HART Analog I/O Modules

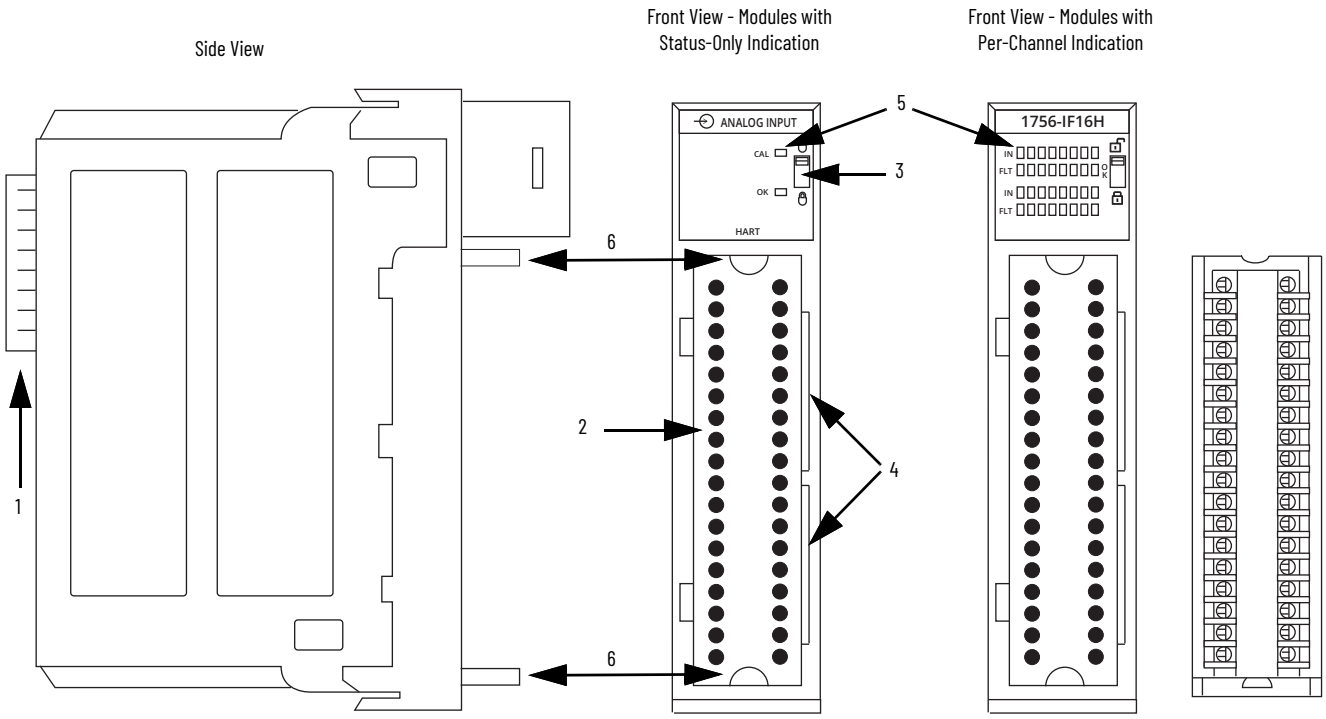
ControlLogix® HART analog I/O modules connect a Logix controller to your process. HART input modules (1756-IF8H, 1756-IF8HK, 1756-IF8IH, 1756-IF8IHK, 1756-IF16H, 1756-IF16HK, 1756-IF16IH, and 1756-IF16IHK) receive signals from process value transmitters and convert them to corresponding measurement values for use in the Logix controller (for example, temperature, flow, pressure, or pH). HART output modules (1756-OF8H, 1756-OF8HK, 1756-OF8IH, and 1756-OF8IHK) 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.

Catalog numbers followed by a "K" indicate ControlLogix HART analog I/O modules available with a conformal coating option. These modules have the same features as their regular counterparts, along with extended protection for use in harsh, corrosive environments.

Module Components

This figure shows the physical features of ControlLogix analog I/O modules.



Item	Description
1	**Backplane connector -** Connects the module to the ControlBus™ backplane.
2	**Connector pins -** Input/output, power, and ground connections are made through these pins with the use of an RTB (removable terminal block) or IFM (interface module).
3	**Locking tab -** Anchors the RTB or IFM cable on the module, which helps to maintain wire connections.
4	**Slots for keying -** Mechanically key the RTB to help prevent inadvertently making the wrong wire connections to the module.
5	**Status indicators -** Display the status of communication, module health, and input and output devices. Use these indicators to help in troubleshooting. Some modules offer calibration and module status-only indicator LEDs, whereas other modules offer additional per-channel status and fault indicator LEDs. For more information, see Use Module Indicators on page 193.
6	**Top and bottom guides -** Help to seat the RTB or IFM cable onto the module.

Module Accessories

These modules mount in a ControlLogix chassis and use a separately ordered removable terminal block (RTB) or 1492 analog interface module (AIFM) to connect all field-side wiring.

The ControlLogix HART analog I/O modules use one of the following RTBs and support these AIFMs.

Module	RTBs[1]	AIFMs[2]
1756-IF8H	• 1756-TBCH 36-position cage clamp RTB • 1756-TBS6H 36-position spring clamp RTB	• 1492-AIFM8-3 (current and voltage) • 1492-AIFM8-F-5 (current and voltage) • 1492-RAIFM8-3 (current and voltage)
1756-IF8IH	• 1756-TBCH 36-position cage clamp RTB • 1756-TBS6H 36-position spring clamp RTB	N/A
1756-IF16H	• 1756-TBCH 36-position cage clamp RTB • 1756-TBS6H 36-position spring clamp RTB	• 1492-AIFM16-F-3 (current and voltage)
1756-IF16IH	• 1756-TBCH 36-position cage clamp RTB • 1756-TBS6H 36-position spring clamp RTB	N/A
1756-OF8H	• 1756-TBNH 20-position NEMA RTB • 1756-TBSH 20-position spring clamp RTB	• 1492-AIFM8-3 (current and voltage) • 1492-RAIFM-8-3 (current and voltage)
1756-OF8IH	• 1756-TBCH 36-position cage clamp RTB • 1756-TBS6H 36-position spring clamp RTB	N/A

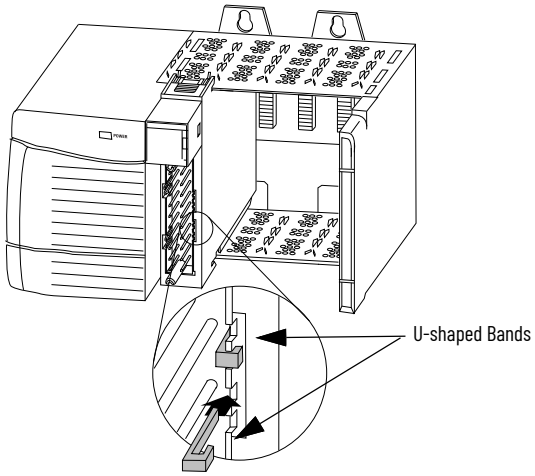
(1) Use an extended-depth cover (1756-TBEz) for applications with heavy gauge wiring or requiring additional routing space.
(2) See the AIFMs for the respective modules on page 202. Consult the documentation that came with it to connect all wiring.

ATTENTION: The ControlLogix system has been agency certified with only the ControlLogix RTBs (catalog numbers 1756-TBCH, 1756-TBS6H, 1756-TBNH, and 1756-TBSH). Any application that requires agency certification of the ControlLogix system with other wiring termination methods can require application-specific approval by the certifying agency.

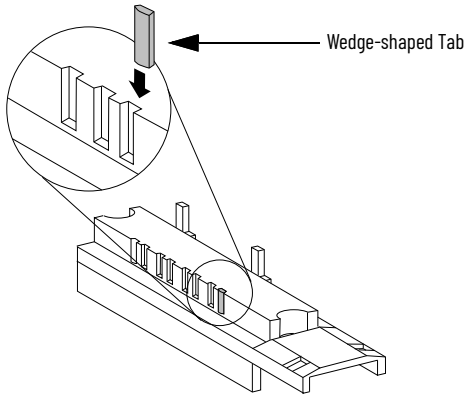
Key the Removable Terminal Block/Interface Module

Wedge-shaped keying tabs and U-shaped keying bands come with your RTB to help prevent connecting the wrong wires to your module. Key the positions on the module that correspond to unkeyed positions on the RTB. For example, if you key the first position on the module, leave the first position on the RTB unkeyed.

1. To key the module, insert the U-shaped band and push the band until it snaps into place.



2. To key the RTB/IFM, insert the wedge-shaped tab with the rounded edge first and push the tab until it stops.



You can reposition the tabs to re-key future module applications.

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.

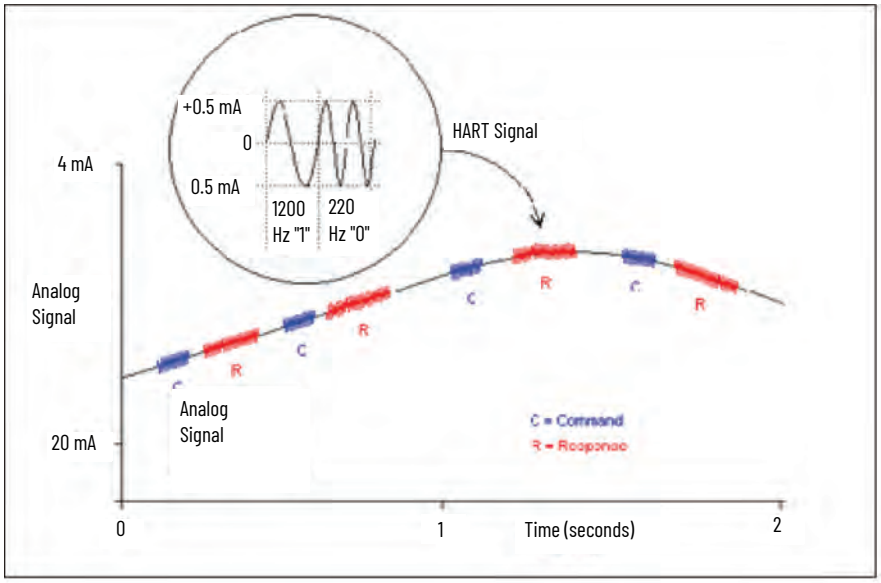
The ControlLogix HART analog I/O modules support the HART protocol and perform these operations:

- 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.
- Automatic collection of dynamic process data from the connected HART field device (for example, temperature, pressure, flow, or valve position).
- Facilitation of configuration and troubleshooting of the HART field device from your control room with FactoryTalk® AssetCentre service.

This figure(1) shows information about the 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
  - Common practice
  - General purpose
  - Device specific
- Large installed base
- Worldwide support

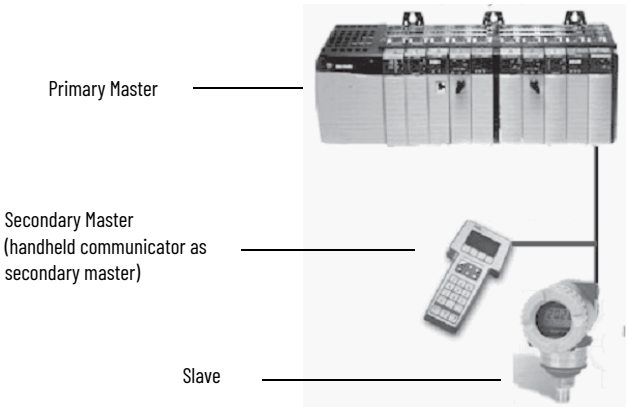


(1) The figure is from the HART Communication Protocol Specifications, April 2001, Revision 6.0, HART Communication Foundation, All Rights Reserved.

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

The ControlLogix HART analog I/O modules support command-response communication protocol and point-to-point wiring architecture.

The ControlLogix HART analog I/O modules can accept commands from either of two master devices. The controller is one of the master devices and continuously obtains information from the field device. The second master can be used for device maintenance, for example a handheld communicator, as shown here.



Integrated HART Networks

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 value (PV), secondary value (SV), third value (TV), and fourth value (FV). These values can represent mass flow, static pressure, temperature, total flow, and other conditions.

Device status information is also provided via HART. Instead of one process variable, with HART the controller sees four process variables, has a check on the mA signal, and has a reading of device status. HART connectivity provides all this information with no changes to the existing 4...20 mA wiring.

FDT/DTM technology via HART connectivity also provides remote configuration and troubleshooting of field devices by using software such as FactoryTalk AssetCentre or Endress+Hauser FieldCare software.

HART-enabled I/O Modules

The ControlLogix HART analog I/O modules have built-in HART modems, so there's no need to install external HART multiplexers or clip-on HART modems. The 1756-IF8H/A and 1756-OF8H/A modules have one HART modem per module. The 1756-IF8H/B, 1756-IF8IH, 1756-IF16H, 1756-IF16IH, and 1756-OF8IH modules have multiple HART modems, one per each channel.

Asset Management Software

You can use the HART analog I/O modules with asset management software, such as FactoryTalk AssetCentre software or Endress+Hauser FieldCare software. For more information, see Use HART Modules with Asset Management Software on page 181.

Timestamping

Controllers in the ControlLogix chassis maintain a system clock. This clock is also known as the coordinated system time (CST). You can configure your analog I/O modules to access this clock and time stamp input data or output echo data when the module multicasts to the system.

This feature provides accurate calculations of time between events to help you identify the sequence of events in fault conditions or in the course of normal I/O operation. The system clock can be used for multiple modules in the same chassis.

Each module maintains a rolling time stamp that is unrelated to the coordinated system time. The rolling time stamp is a continuously running 15-bit timer that counts in milliseconds.

When an input module scans its channels, it also records the value of the rolling time stamp. Your program can use the last two rolling time stamp values to calculate the interval between receipt of data or the time when new data was received.

For output modules, the rolling time stamp value is updated only when new values are applied to the Digital to Analog Converter (DAC).

Module Scaling

Use module scaling to specify the range of engineering units that corresponds to the analog input or output signal of a module. Choose two points along the module operating range and specify corresponding low and high engineering unit values for those points.

Scaling lets you configure the module to return data to the controller in units that match the quantity being measured. For example, an analog input module can report temperature in degrees Celsius or pressure in mbar. An analog output module can receive commands in the stroke % of a valve. Scaling makes it easier to use the values in your control program instead of using the raw signal value in mA.

For more information about scaling, see Scaling to Engineering Units on page 143.

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.

Attributes Compared During Electronic Keying

Attribute	Description
Vendor	The device manufacturer.
Device Type	The general type of the product, for example, digital 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.

Available Electronic Keying Options

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.
Disable Keying	Indicates that the keying attributes aren't 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. **ATTENTION**: 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.

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

ControlLogix Module Operation

A ControlLogix® controller must own every I/O module in the ControlLogix system. The owner controller stores configuration data for every module that it owns. The owner controller can be located locally (in the same chassis) or remotely (in another chassis), relative to the position of the I/O module. The owner controller sends configuration data to the I/O module to define the behavior of the module and begin operation within the control system. Each ControlLogix I/O module must continuously maintain communication with its owner to operate normally.

Typically, each module in the system has only one owner. Input modules can have multiple owners. Output modules are limited to one owner.

With the Producer/Consumer model, ControlLogix I/O modules can produce data without a controller polling them first. The modules produce the data and any owner or listen-only controller device can consume it.

For example, an input module produces data and any number of controllers can consume the data simultaneously. This feature minimizes the need for one controller to send data to another controller.

Direct Connections

A direct connection is a real-time data transfer link between the controller and the device that occupies the slot that the configuration data references. ControlLogix analog I/O modules use direct connections only.

When an owner controller downloads module configuration data, the controller attempts to establish a direct connection to each of the modules the data references.

If a controller has configuration data that references a slot in the control system, the controller periodically checks for the presence of a module there. When the presence of a module is first detected, the controller automatically sends the configuration data and one of the following events occurs:

- If the data is appropriate to the module found in the slot, a connection is made and operation begins.
- If the configuration data isn't appropriate, the module rejects the data and an error code displays in the software. For example, configuration data for a module can be appropriate except for a mismatch in electronic keying that prevents normal operation. For more information about error codes, see Module Configuration Errors on page 198.

The controller maintains and monitors its connection with a module. Any break in the connection (for example, module removal under power) causes the controller to set fault status bits in the data area that is associated with the module. You can use ladder logic to monitor this data area and detect module failures.

Input Module Operation

In the ControlLogix system, the owner controller does not poll analog input modules after a connection is established. The modules multicast their data periodically. Multicast frequency depends on the options that are chosen during configuration and the physical location of the module in the control system.

The communication or multicasting behavior of a module varies depending upon whether the module operates in a local or remote chassis (relative to the owner controller), based on network type. The following sections detail the differences in data transfers between these setups.

Input Modules in a Local Chassis

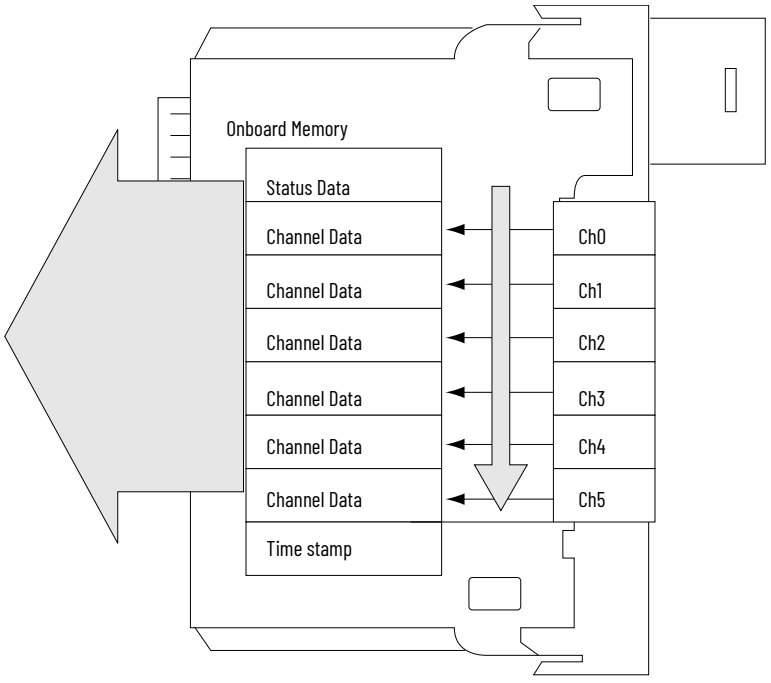
When a module resides in the same chassis as the owner controller, the following configuration parameters affect how and when the input module multicasts data:

- Real-time sample (RTS)
- Requested packet interval (RPI)

Real Time Sample (RTS)

This configurable parameter instructs the module to perform the following operations:

- Scan all of its input channels and store the data into onboard memory
- Multicast the updated channel data (and other status data) to the backplane of the local chassis

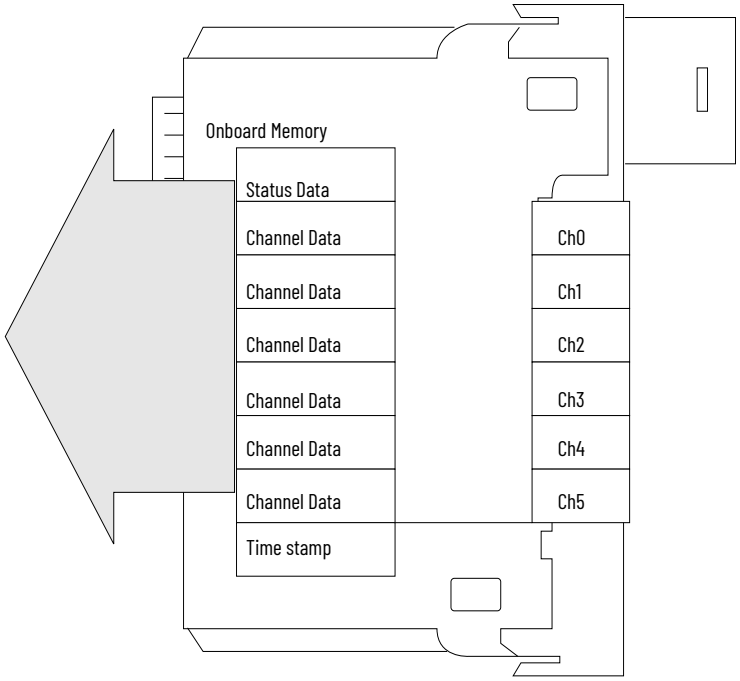


IMPORTANT The real-time sample value is set during the initial configuration with the Studio 5000 Logix Designer® application. This value can be adjusted at any time.

Requested Packet Interval (RPI)

The requested packet interval instructs the module to multicast its channel and status data to the local chassis backplane.

This configurable parameter also instructs the module to multicast the **current contents** of its onboard memory when the requested packet interval expires. (The module does not update its channels before the multicast.)

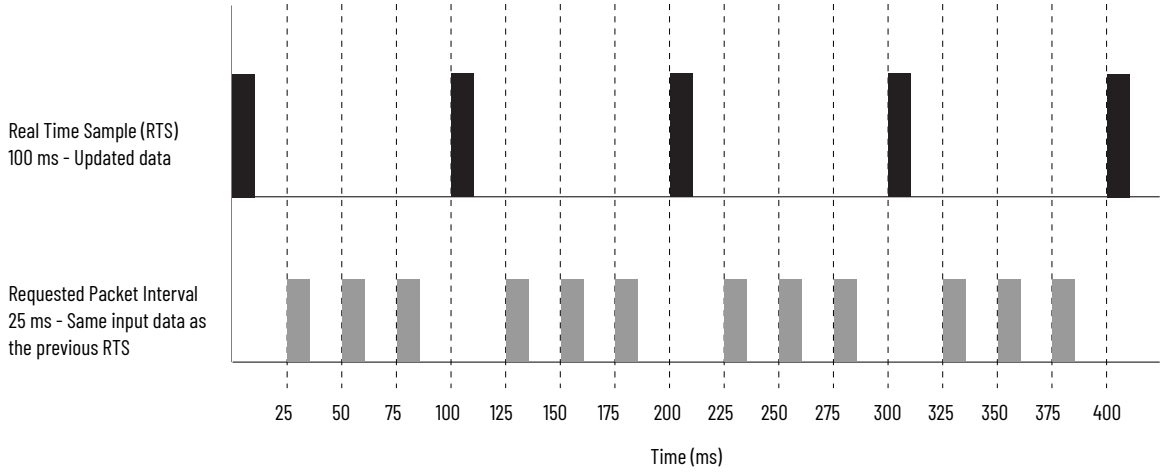


IMPORTANT The requested packet interval value is set during the initial module configuration with the Logix Designer application. This value can be adjusted when the controller is in Program mode.

If the real-time sample value is less than or equal to the requested packet interval, each multicast of data from the module has updated channel information. In effect, the module is only multicasting at the real-time sample rate.

If the real-time sample value is greater than the requested packet interval, the module multicasts at both the real-time sample rate and the requested packet interval rate. Their respective values dictate how often the owner controller receives data and how many multicasts from the module contain updated channel data.

In the example below, the real-time sample value is 100 ms and the requested packet interval value is 25 ms. Only each fourth multicast from the module contains updated channel data.



Trigger Event Tasks

When configured to do so, ControlLogix analog input modules can trigger execution of an event task in a controller. The event task feature lets you create a task that executes a section of logic immediately when an event (receipt of new data) occurs.

A ControlLogix analog I/O module can trigger event tasks each real-time sample, after the module has sampled and multicast its data. Event tasks are useful for synchronization of process variable (PV) samples and proportional integral derivative (PID) calculations.

IMPORTANT	ControlLogix analog I/O modules can trigger event tasks at each real-time sample, but not at the requested packet interval. For example, in the figure, an event task can be only triggered each 100 ms.

Input Modules in a Remote Chassis

For an input module in a remote chassis, the roles of requested packet interval and real-time sample behavior change slightly regarding data communication to the owner controller. This change depends on what network type is used to communicate with the modules.

Remote Input Modules Connected Via EtherNet/IP Network

When remote analog input modules are connected to the owner controller via an EtherNet/IP™ network, data is transferred to the owner controller in the following way:

- At the RTS interval or RPI (whichever is faster), the module broadcasts data within its own chassis.
- The 1756 Ethernet bridge in the remote chassis immediately sends the module data over the network to the owner controller. This condition occurs only if the time since the last data transmission is more than 25% of the module RPI. Otherwise, no data is sent.

  For example, if an analog input module has RPI = 100 ms, the Ethernet module sends module data immediately upon receipt if another data packet wasn't sent within the last 25 ms.

The Ethernet module either multicasts the module data to all devices on the network or unicasts to a specific owner controller depending on the setting of the Unicast option, as shown on page 135.

For more information, see the Guidelines to Specify an RPI Rate for I/O Modules section in the Logix 5000 Controllers Design Considerations Reference Manual, publication 1756-RM094.

Output Module Operation

The RPI parameter governs when an analog output module receives data from the owner controller and when the output module echoes data. An owner controller sends data to an analog output module **once per RPI**. Data isn't sent to the module at the end of the controller program scan.

When an analog output module receives **new data** from an owner controller (each RPI), it automatically multicasts, or echoes, a data value to the rest of the control system. This data value corresponds to the analog signal present at the output terminals of the module. This feature, called **Output Data Echo**, occurs whether the output module is local or remote.

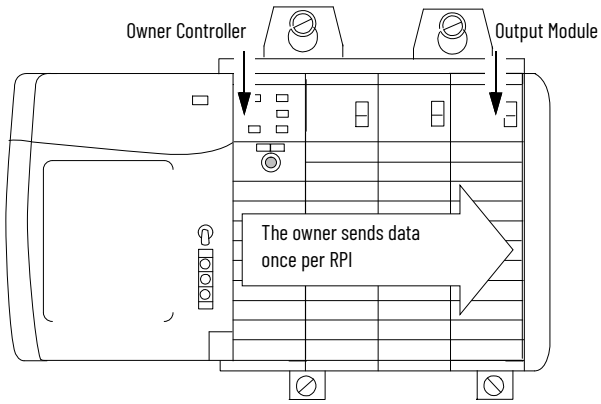
If the output module isn't responding according to how it has been programmed, it could be for one of the following reasons:

- The commanded value falls outside the Configured Limits and is therefore being clamped.
- The commanded value changed faster than the configured max Rate Limit, and is being clamped.
- The module is in Start-up Hold mode following a connection break or Run mode transition. The module is waiting for the control system to synchronize with the prevailing setting to facilitate a bumpless startup.

Depending on the length of the RPI relative to the length of the controller program scan, an output module can receive and echo data multiple times during one program scan. The output module does not wait for the end of the program scan to send data. When RPI is less than program scan length, the controller effectively lets the module output change values multiple times during one program scan.

Output Modules in a Local Chassis

By specifying an RPI value for an analog output module, you instruct the controller when to broadcast output data to the module. If the module resides in the same chassis as the owner controller, the module receives the data almost immediately after the controller sends it.



Output Modules in a Remote Chassis

For output modules in remote chassis, the role of RPI in getting data from the owner controller changes slightly, depending on the network.

Remote Output Modules Connected Via EtherNet/IP Network

When remote analog output modules are connected to the owner controller via an EtherNet/IP network, the controller multicasts data in the following way:

- At the RPI, the owner controller multicasts data within its own chassis.
- The EtherNet/IP communication module in the local chassis immediately sends the data over the network to the analog output module. This condition occurs as long as it hasn't sent data within a time frame that is 1/4 the value of the requested packet interval of the analog module.

Listen-only Mode

Any controller in the system can listen to the data from any I/O module (input data or echoed output data) even if the controller does not own the module. The controller does not have to own the configuration data of a module to listen to it.

During the I/O configuration process, you can specify a 'Listen-Only' mode as the Connection type on the Device Definition dialog. See page 131 for more details.

In Listen-Only mode, the controller and module establish communication without the controller sending any configuration data. Another controller owns the module being listened to.

IMPORTANT If a controller has a Listen-Only connection to a module, the module can't use the Unicast option for any connections over the EtherNet/IP network. See the Unicast option on page 135.

The Listen-Only controller continues to receive multicast data from the I/O module as long as a connection between an owner controller and the I/O module is maintained.

If the connection between all owner controllers and the module is broken, the module stops multicasting data and connections to all listening controllers are also broken.

Implicit Protected Mode

When in Implicit Protected Mode, a module is operational, but has implemented defenses against disruptive changes that would take the product out of service for the process.

Implicit Protected Mode is a security enhancement that occurs on the I/O module level and helps prevent unauthorized changes that can affect system behavior.

Enter and Exit Implicit Protected Mode

The module enters Implicit Protected Mode as soon as an I/O connection is established. The module exits Implicit Protected Mode as soon as all I/O connections through or to the module are stopped. Inhibiting the module will cause it to exit Implicit Protected Mode.

Restrictions Imposed by Implicit Protected Mode

Implicit Protected Mode helps prevent access to services that are not required after the device is configured and in normal operation. This mode disables features that can make the device vulnerable to disruptive actions. By doing so, it helps to reduce the attack surface. If the module is in Implicit Protected Mode and you attempt to perform any of the restricted tasks, you are alerted that such a task cannot be performed because the module is in Implicit Protected Mode.

When in Implicit Protected Mode, the module helps prevent execution of the following tasks:

- Updating the module firmware revision
- Calibration

Implicit Protected Mode Availability and Calibration Exceptions

Module	1756-IF8H		1756-IF8IH	1756-IF16H		1756-IF16IH	1756-OF8H	1756-OF8IH
Series	A	B	A	A	B	A	A	A
Implicit Protected Mode Available?	No	Yes	Yes	No	Yes	Yes	No	Yes
Can Calibrate in Run Mode Using Output Tags When In Implicit Protected Mode?(1)	-	-	Yes	-	-	-	-	Yes
Can Calibrate in Run Mode Using Output Tags When Not In Implicit Protected Mode?	-	-	No	-	-	-	-	No

(1) For more information about using Output tags to calibrate the 1756-IF8IH and 1756-OF8IH modules, see page 58 and page 120.

IMPORTANT Implicit Protected Mode is not configurable.

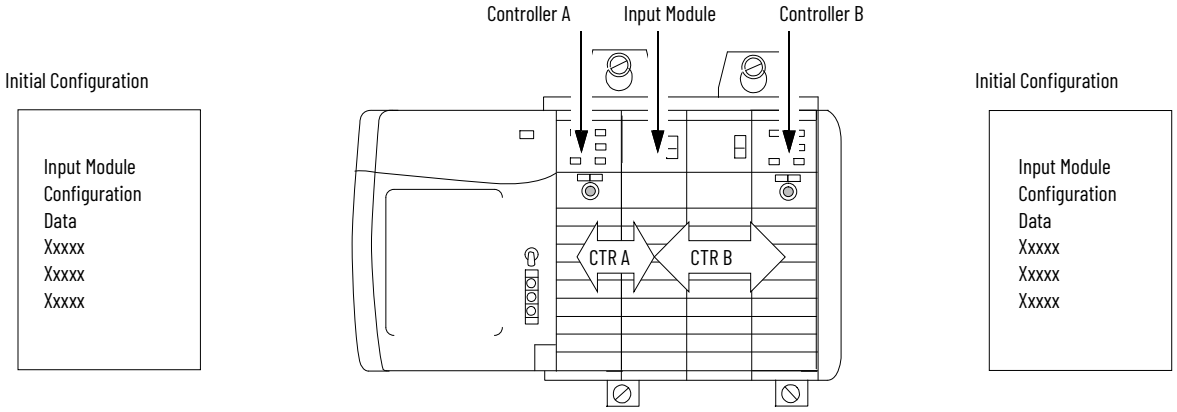
Multiple Owners of Input Modules

Because listening controllers lose their connections to modules when communication with the owner stops, the ControlLogix system lets you define multiple owners for input modules.

IMPORTANT Only input modules can have multiple owners. If multiple owners are connected to the same input module, they must maintain an identical configuration for that module.

In this example, Controller A and Controller B have both been configured as an owner of the input module.

Multiple Owners with Identical Configuration Data



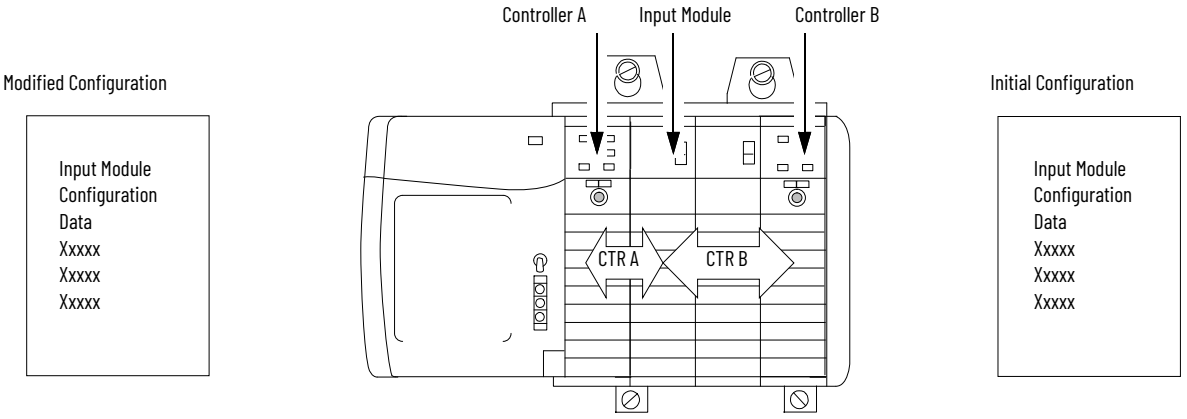
When multiple controllers are configured to own the same input module, the following events occur:

- When the controllers begin to download configuration data, both try to establish a connection with the input module.
- The controller data that arrives first establishes a connection.
- When data from the second controller arrives, the module compares it to its current configuration data (the data that was received and accepted from the first controller).
  - If the configuration data that the second controller sends matches the configuration data that the first controller sends, the connection is also accepted.
  - If any parameter of the second configuration data differs from the first, the module rejects the connection. The Logix Designer application alerts you to the rejected connection through an error message.

The module can continue to operate and multicast data even when one of the controllers loses its connection to the module. This feature is the advantage of multiple owners over a Listen-only connection.

Configuration Changes in an Input Module with Multiple Owners

You must be careful when you change the configuration data of an input module in a multiple owner scenario. When the configuration data is changed in one of the owners, for example, Controller A, and sent to the module, that configuration data is accepted as the new configuration for the module. Controller B continues to listen, unaware that any changes were made in the behavior of the module.



Controller B is unaware that the changes were made by Controller A.

IMPORTANT A dialog in the Logix Designer application alerts you to the possibility of a multiple owner situation. You can inhibit the connection before changing the configuration of the module using the same dialog. When changing the configuration for a module with multiple owners, we recommend that you inhibit the connection.

To help prevent other owners from receiving potentially erroneous data, follow these steps when changing a module configuration in a multiple owner scenario while online:

- For each owner controller, inhibit the controller connection to the module. You can inhibit the module in the software in the Connection view or in the dialog that warns of the multiple owner condition.
- Make the appropriate configuration data changes in the software, as described in the Logix Designer application section of this manual.
- Repeat the preceding steps for all owner controllers; make the same changes in all controllers.
- Disable the Inhibit option in each owner configuration.

Unicast Communication

Use unicast EtherNet/IP communication to reduce broadcast network traffic. Some facilities block multicast Ethernet packets as part of their network administration policy. You can configure multicast or unicast connections for I/O modules by using the Logix Designer application, version 18 or later.

Unicast connections do the following:

- Allow I/O communication to span multiple subnets
- Reduce network bandwidth
- Simplify Ethernet switch configuration

1756-IF8H HART Analog Input Module

Module Features

The 1756-IF8H module has the following features:

- Choice of three input data types
  - Analog only
  - Analog and HART PV
  - Analog and HART by channel

IMPORTANT The Analog and HART by Channel data type is available only for 1756-IF8H firmware revision 2.002 or later.

- Multiple current and voltage input ranges
- Module filter
- Real-time sampling
- Underrange and overrange detection
- Process alarms
- Rate alarm
- Wire-off detection
- Highway addressable remote transducer (HART) communication

Input Data Types

The Input Data type you choose determines which values are included in the Input tag of the module and the features that are available to your application. Select the Input Data type on the Device Definition dialog of the Studio 5000 Logix Designer® application. The following types are available for the 1756-IF8H module.

Data Types for the 1756-IF8H Module

Input Data Type	Description			
	Analog signal values	Analog status	HART secondary process variables and device health	HART and Analog data for each channel are grouped in tag
Analog Only	X	X		
Analog and HART PV	X	X	X	
Analog and HART by Channel(1)	X	X	X	X

(1) Available only for 1756-IF8H firmware revision 2.002 or later

Select Analog and HART PV if you prefer the members of the tag to be arranged similar to non-HART analog input modules. The analog values for all channels are grouped near the end of the tag. This option makes it easy to view all eight analog values at once.

Select Analog and HART by Channel if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This arrangement makes it easier to view all data that is related to one field device.

Input Ranges

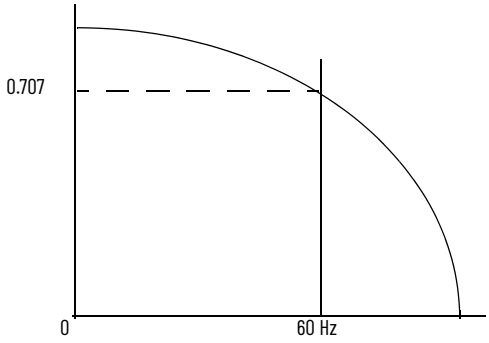
You can select from a series of operational ranges for each channel on the module. The range designates the minimum and maximum signals that are detectable by the module. Possible ranges include the following:

- -10...10V
- 0...5V
- 0...10V
- 0...20 mA
- 4...20 mA (HART instruments use this range.)

Module Filter

The module filter attenuates the input signal at the specified frequency and above. This feature is applied on a module-wide basis and affects all channels.

The module filter attenuates the selected frequency by approximately -3 dB or 0.707 of the applied amplitude. An input signal with frequencies above the selected frequency is attenuated more while frequencies below the selection receive no attenuation.



In addition to frequency rejection, a by-product of the filter selection is the minimum sample rate (RTS) that is available. For example, the 1000 Hz selection does not attenuate any frequencies less than 1000 Hz, and provides for sampling of all 8 channels within 18 ms. The 10 Hz selection attenuates all frequencies above 10 Hz and provides for sampling all 8 channels only within 488 ms.

IMPORTANT 60 Hz is the default setting for the module filter.
Do not use the 1000 Hz module filter with HART instruments.

Use these tables to choose a module filter setting.

Series A Module Filter Selections with Associated Performance Data

Module Filter Setting (-3 dB)	10 Hz	15 Hz	20 Hz	50 Hz	60 Hz	100 Hz	250 Hz	1000 Hz
Minimum Sample Time (ms) (RTS)[1]	488	328	248	88	88	56	28	18
Effective Resolution (+/-10V range)	17 bits	17 bits	17 bits	16 bits	16 bits	15 bits	14 bits	12 bits
	0.16 mV	0.16 mV	0.16 mV	0.31 mV	0.31 mV	0.62 mV	1.25 mV	5.0 mV
Effective Resolution (0...10V range)	16 bits	16 bits	16 bits	15 bits	15 bits	14 bits	13 bits	11 bits
	0.16 mV	0.16 mV	0.16 mV	0.31 mV	0.31 mV	0.62 mV	1.25 mV	5.0 mV
Effective Resolution (0...5V, 0...20 mA, 4...20 mA range)	15 bits	15 bits	15 bits	14 bits	14 bits	13 bits	12 bits	10 bits
	0.16 mV 0.63 µA	0.16 mV 0.63 µA	0.16 mV 0.63 µA	0.31 mV 1.25 µA	0.31 mV 1.25 µA	0.62 mV 2.5 µA	1.25 mV 5.0 µA	5.0 mV 20.0 µA
-3 dB Frequency	7.80 Hz	11.70 Hz	15.60 Hz	39.30 Hz	39.30 Hz	65.54 Hz	163.9 Hz	659.7 Hz
50 Hz Rejection	95 dB	85 dB	38 dB	4 dB	4 dB	2 dB	0.5 dB	0.1 dB
60 Hz Rejection	97 dB	88 dB	65 dB	7 dB	7 dB	2.5 dB	0.6 dB	0.1 dB

(1) Worst case settling time to 100% of a step change is double the real-time sample time.

Series B Module Filter Selections with Associated Performance Data

Module Filter Setting (-3 dB)	10 Hz	15 Hz	20 Hz	50 Hz	60 Hz	100 Hz	250 Hz	1000 Hz
Minimum Sample Time (ms) (RTS)[1]	488 ms	328 ms	248 ms	88 ms	88 ms	56 ms	28 ms	18 ms
Effective Resolution (+/-10V range)	17 bits	17 bits	17 bits	16 bits	16 bits	15 bits	14 bits	12 bits
	0.16 mV	0.16 mV	0.16 mV	0.32 mV	0.32 mV	0.64 mV	1.28 mV	5.12 mV
Effective Resolution (0...10V range)	16 bits	16 bits	16 bits	15 bits	15 bits	14 bits	13 bits	11 bits
	0.16 mV	0.16 mV	0.16 mV	0.32 mV	0.32 mV	0.64 mV	1.28 mV	5.12 mV
Effective Resolution (0...5V, 0...20 mA, 4...20 mA range)	15 bits	15 bits	15 bits	14 bits	14 bits	13 bits	12 bits	10 bits
	0.16 mV 0.63 µA	0.16 mV 0.63 µA	0.16 mV 0.63 µA	0.32 mV 1.26 µA	0.32 mV 1.26 µA	0.64 mV 2.52 µA	1.28 mV 5.04 µA	5.12 mV 20.16 µA
-3 dB Frequency	12.8 Hz	12.8 Hz	13.4 Hz	41.49 Hz	41.49 Hz	65 Hz	150 Hz	310 Hz
50 Hz Rejection	-88 dB	-88 dB	-84 dB	-4.3 dB	-4.3 dB	-1.6 dB	-0.25 dB	-0.01 dB
60 Hz Rejection	-93 dB	-93 dB	-87 dB	-6.2 dB	-6.2 dB	-2.4 dB	-0.36 dB	-0.02 dB

(1) Worst case settling time to 100% of a step change is double the real-time sample time.

Real-time Sampling

This parameter instructs the module how often to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data. This feature is applied on a module-wide basis.

During module configuration, you specify a real-time sampling (RTS) period and a requested packet interval (RPI) period. Both of these features instruct the module to multicast data, but only the RTS feature instructs the module to scan its channels before multicasting.

For more RTS information, see Real-time Sampling on page 31.

Underrange and Overrange Detection

The module detects when it's operating beyond the limits of the input range. Thisn't being measured accurately because the signal is beyond the measuring capability of the module. For example, the module can't distinguish between 10.25V and 20V.

This table shows the input ranges of the 1756-IF8H module and the lowest and highest signal available in each range before the module detects an underrange and overrange condition.

Low and High Signal Limits on the 1756-IF8H Module

Input Module	Available Range	Lowest Signal in Range	Highest Signal in Range
1756-IF8H	-10...10V 0...10V 0...5V 0...20 mA 4...20 mA	-10.25V 0V 0V 0 mA 3.42 mA	10.25V 10.25V 5.125V 20.58 mA 20.58 mA

Digital Filter

The digital filter smooths input data noise transients. This feature is applied on a **per channel** basis.

The digital filter value specifies the time constant for a digital first order lag filter on the input. It's specified in units of milliseconds. A value of 0 disables the filter.

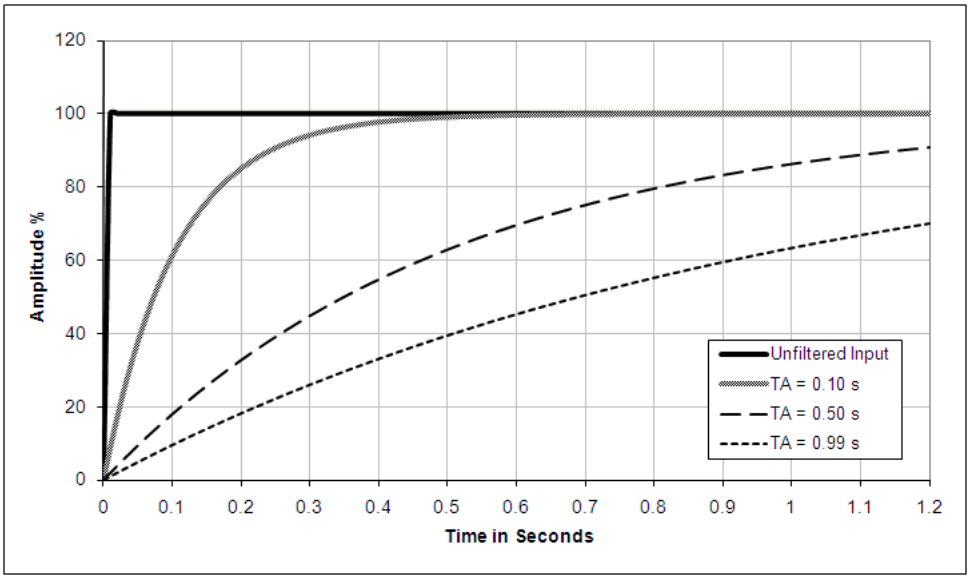
The digital filter equation is a classic-first-order lag equation.

$$Y_n = Y_{n-1} + \frac{[\Delta t]}{\Delta t + T_A} (X_n - Y_{n-1})$$

Y_n = present output, filtered peak voltage (PV)
Y_{n-1} = previous output, filtered PV
Δt = module channel update time (seconds)
T_A = digital filter time constant (seconds)
X_n = present input, unfiltered PV

This figure illustrates the filter response to a step input. When the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.

Filter Response to a Step Input



Process Alarms

Process alarms alert you when the module has exceeded configured high or low thresholds for **each channel**. You can latch process alarms. These alarms are set at the following configurable trigger points:

- High high
- High
- Low
- Low low

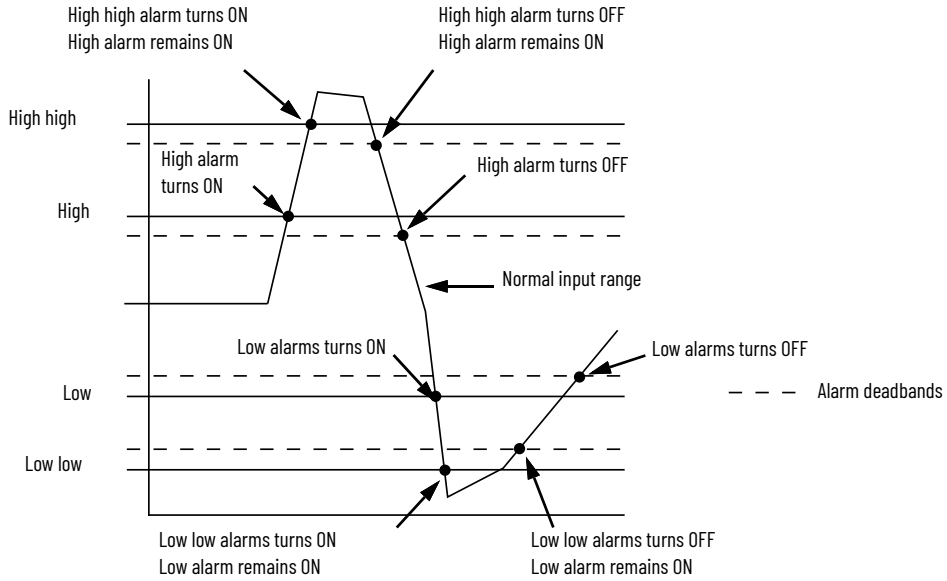
The values for each limit are entered in scaled engineering units.

Alarm Deadband

You can configure an alarm deadband to work with the process alarms. The deadband lets the process alarm status bit remain set, despite the disappearance of the alarm condition, as long as the input remains within the process alarm deadband.

This figure shows input data that sets each of the 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 returns to normal.

Input Data That Sets Each of the Alarms



Rate Alarm

The value for the Rate Alarm Limit is entered in scaled engineering units per second. The rate alarm triggers if the rate of change between input samples for each channel exceeds the specified rate-alarm trigger point for that channel. Rate Alarm uses the signal value after filtering by the Module Filter and before the Digital Filter is applied.

Wire-off Detection

The 1756-IF8H modules alert you when a signal wire is disconnected from one of its channels or the RTB is removed from the module. When a wire-off condition occurs for this module, two events occur:

- Input data for that channel changes to a specific scaled value.
- A fault bit is set in the input tag, which can indicate the presence of a wire-off condition.

Because 1756-IF8H modules can be applied in voltage or current applications, differences exist as to how a wire-off condition is detected in each application.

This table identifies the conditions that are reported in the input tag when a wiring anomaly is detected.

Wire-off Detection

	Input Range	Wiring Problem	Condition Reported in Input Tag			
			Input Data Changes to	ChXOverrange	ChXBrokenWire	ChXUnderrange
Voltage	-10V...+ 10V 0V ...+5V 0V...+10V	INx or INx removed	Maximum scaled value (overrange value)	1	1	
Current	0...20 mA	RTB removed or INx and I RTN-x jumper removed	Maximum scaled value (overrange value)	1	1	
		Only INx removed (jumper in place)	Minimum scaled value (underrange value)		0	1
		Only jumper removed	Maximum scaled value (overrange value)	1	1	
	4...20 mA	RTB removed or INx and I RTN-x jumper removed	Maximum scaled value (overrange value)	1	1	
		Only INx removed (jumper in place)	Minimum scaled value (underrange value)		1	1
		Only jumper removed	Maximum scaled value (overrange value)	1	1	

Wire the Module

Use this figure to wire the module for voltage and current inputs. HART communication is active with current inputs only.

1756-IF8H Voltage and Current Inputs

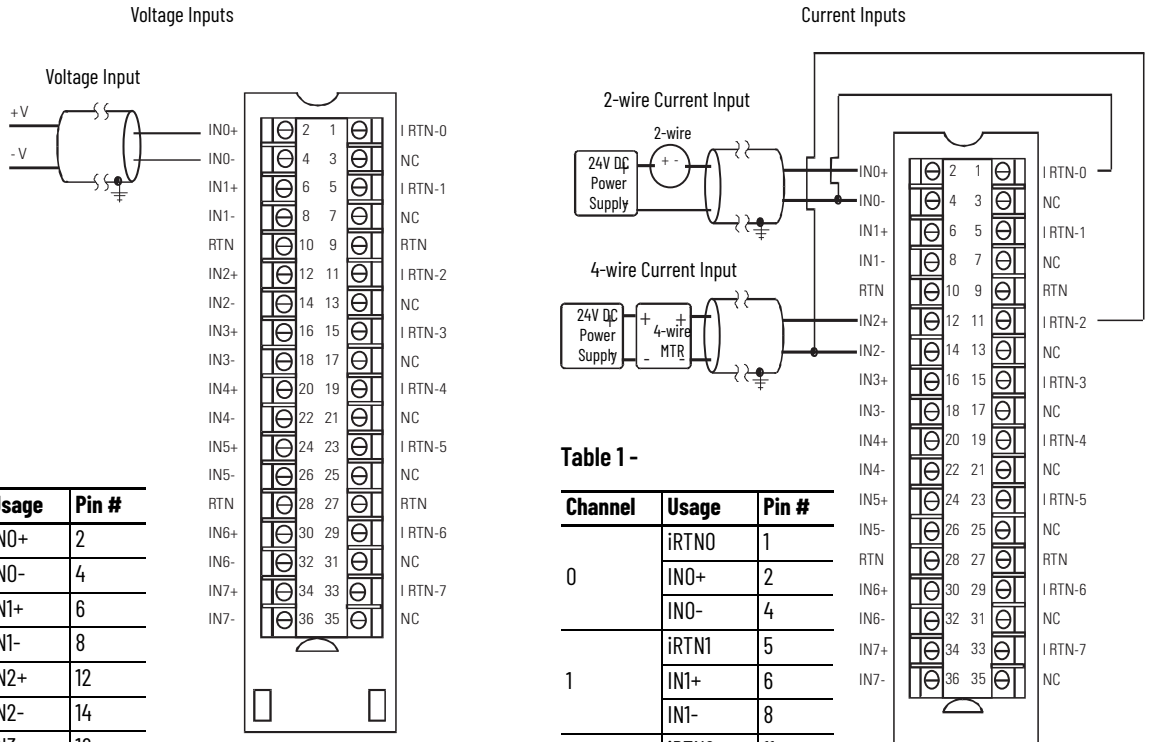


Table 1 -

Channel	Usage	Pin #
0	IN0+	2
	IN0-	4
1	IN1+	6
	IN1-	8
2	IN2+	12
	IN2-	14
3	IN3+	16
	IN3-	18
4	IN4+	20
	IN4-	22
5	IN5+	24
	IN5-	26
6	IN6+	30
	IN6-	32
7	IN7+	34
	IN7-	36

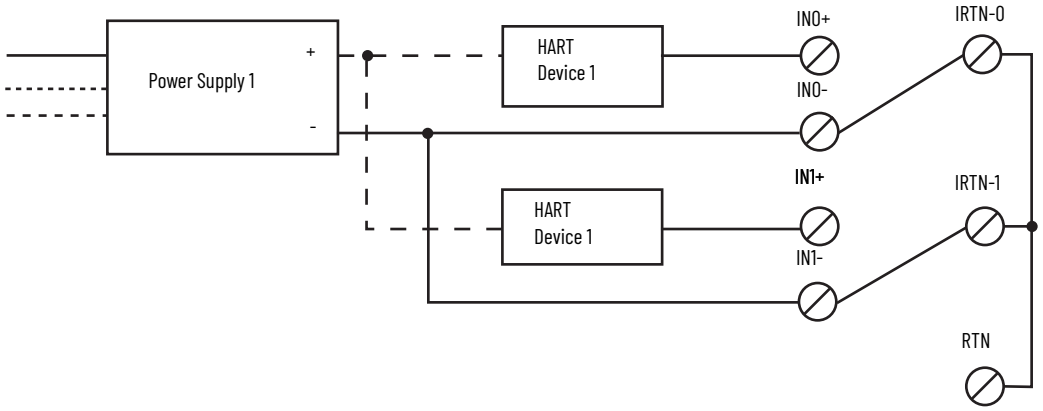
Table 1 -

Channel	Usage	Pin #
0	iRTN0	1
	IN0+	2
	IN0-	4
1	iRTN1	5
	IN1+	6
	IN1-	8
2	iRTN2	11
	IN2+	12
	IN2-	14
3	iRTN3	15
	IN3+	16
	IN3-	18
4	iRTN4	19
	IN4+	20
	IN4-	22
5	iRTN5	23
	IN5+	24
	IN5-	26
6	iRTN6	29
	IN6+	30
	IN6-	32
7	iRTN7	33
	IN7+	34
	IN7-	36

The 1756-IF8H is a differential input module. However, there are limitations on its use in differential mode. Anytime the low ends of the terminal block pins are connected together, they must also be jumpered to the RTN pin on the terminal block. There are two scenarios in which this condition happens.

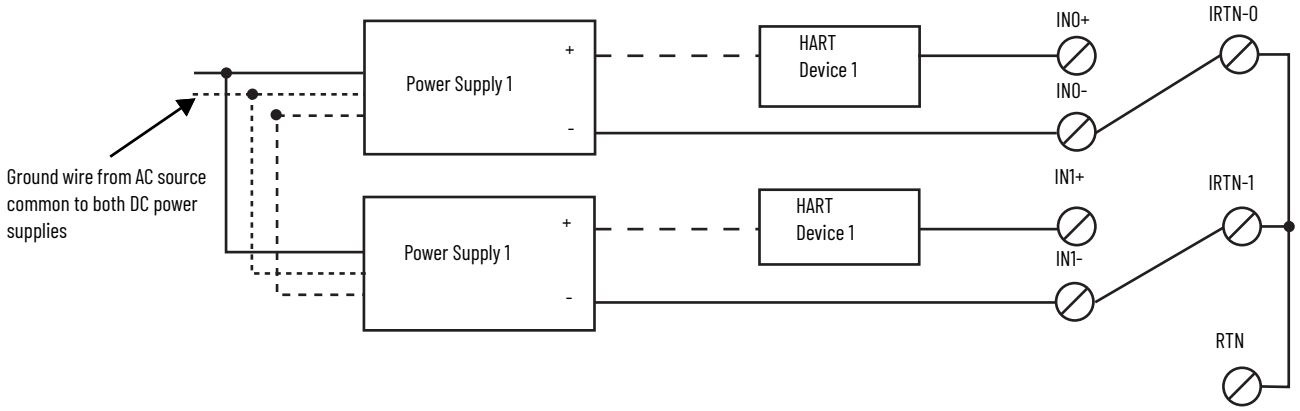
First, if one power supply is used for multiple devices, then the low ends from all channels are connected together and connected to the ground return of the power supply.

Single Power Supply with Multiple HART Devices



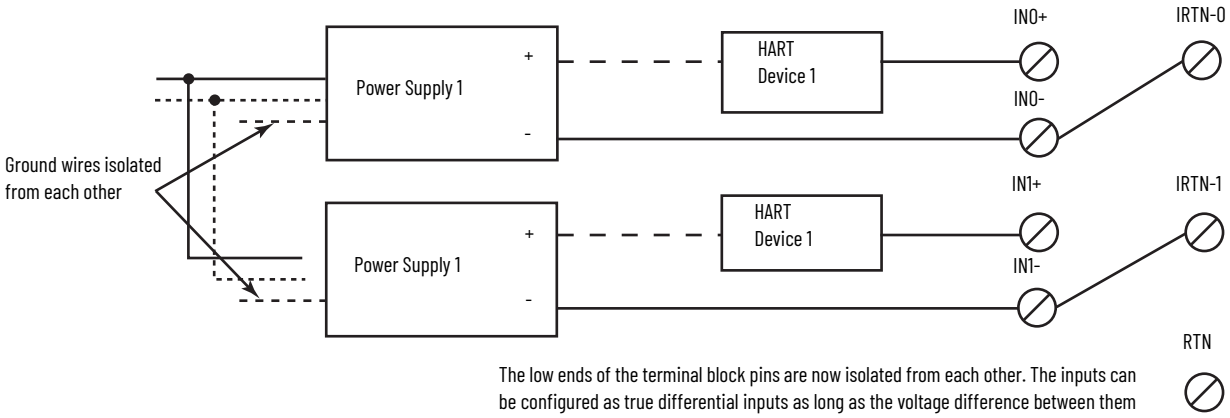
The second way for channels to share a ground is to have multiple power supplies connected to the same ground. In this case, the low ends of the channels are effectively connected together by the common ground of the power supplies.

Multiple Power Supplies with a Common Ground



For devices powered by individual supplies, when the ground potential of the supplies is expected to differ, differential mode is recommended. This practice helps prevent ground loop currents from flowing between the supplies. However, the potential difference allowable between the supplies must remain within specified limits.

Power Supplies with Isolated Grounds



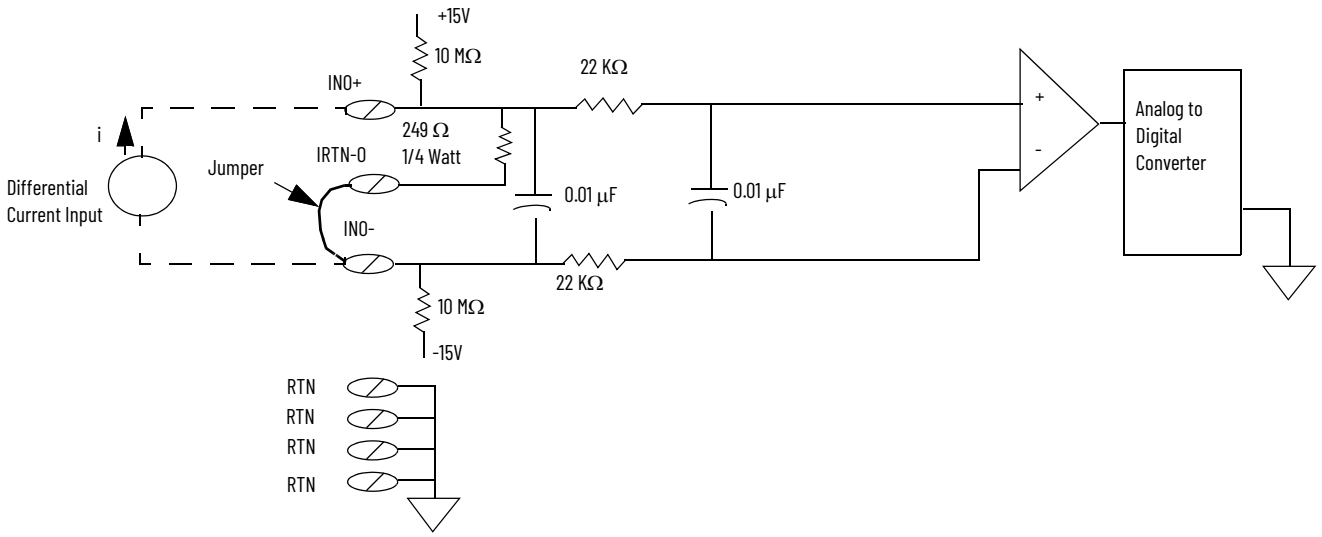
The low ends of the terminal block pins are now isolated from each other. The inputs can be configured as true differential inputs as long as the voltage difference between them does not exceed 7V.

We recommend that some devices, such as AC powered four-wire devices, be used in differential mode only. It's best if differential and single-ended input types aren't connected on the same terminal block. We recommend that you connect differential inputs and single-ended inputs to different terminal blocks.

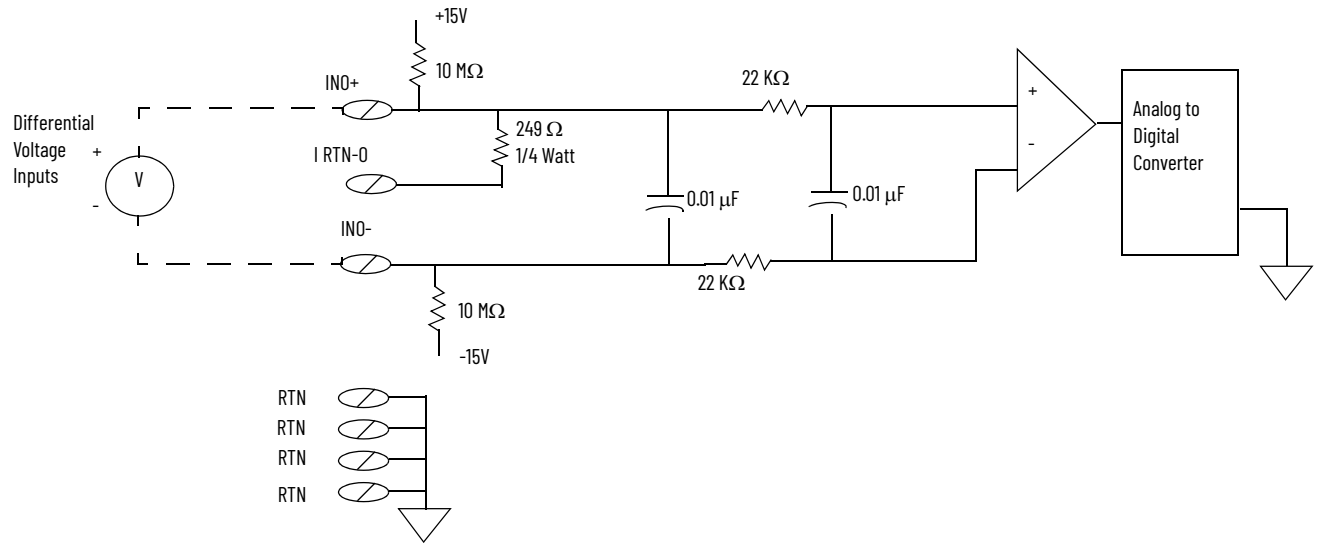
Circuit Diagrams

This section shows circuit diagrams for the 1756-IF8H module.

Simplified 1756-IF8H Current Input Circuit



Simplified 1756-IF8H Voltage Input Circuit



1756-IF8H Module Fault and Status Reporting

The 1756-IF8H module multicasts status/fault data to the controller with its channel data. The fault data is arranged to let you choose the level of granularity you desire to examine fault conditions. Three levels of tags work together to provide an increasing degree of detail as to the specific cause of faults on the module.

This table lists tags that you can examine in ladder logic to indicate when a fault has occurred.

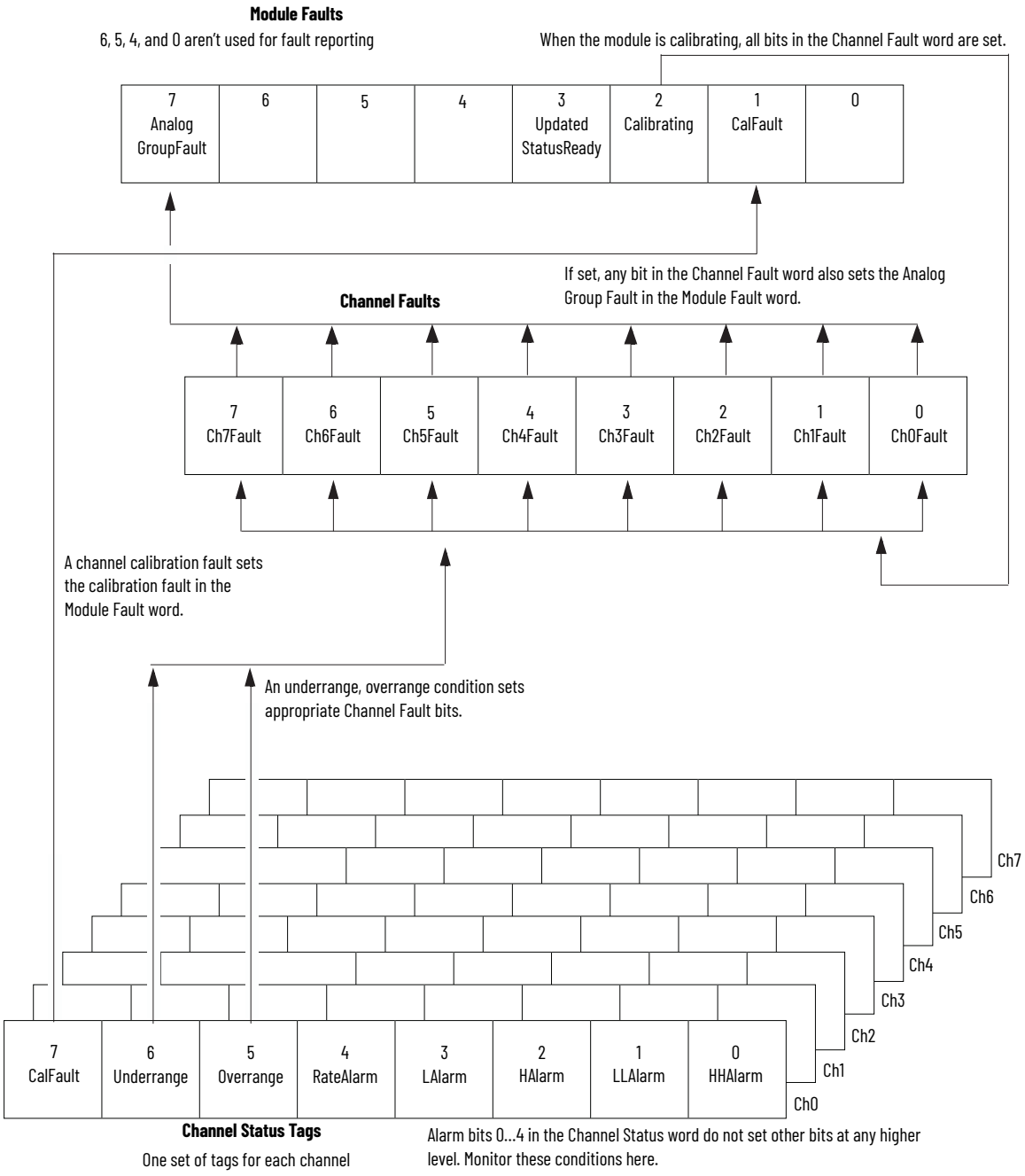
1756-IF8H Tags That Can Be Examined in Ladder Logic

Tag	Description	Tag Name Analog and HART PV	Tag Name Analog and HART by Channel[1]
Module Fault Word	This word provides fault summary reporting.	ModuleFaults	ModuleFaults
Channel Fault Word	This word provides underrange, overrange, and communication fault reporting.	ChannelFaults ChxFault	ChannelFaults ChxFault
Channel Status Word	These words provide individual channel underrange and overrange fault indications and report process alarms, rate alarms, and calibration faults.	ChxStatus	Chx.DeviceStatus Chx.DeviceStatus.AlarmStatus
HART Faults	These bits provide HART communication status.	HARTFaults, ChxHARTFault	Chx.DeviceStatus.HARTFault
HART Device Status	This data reports HART field device health.	HART.ChxDevice Status	Chx.DeviceStatus.FieldDeviceStatus

(1) Available only for 1756-IF8H firmware revision 2.002 or later

1756-IF8H Fault Reporting

This figure shows how the 1756-IF8H module reports faults.



1756-IF8H Module Fault Word Bits

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further to isolate the fault. This table lists tags that can be examined in ladder logic to indicate when a fault has occurred.

1756-IF8H Tags That Can Be Examined in Ladder Logic

Tag	Description
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalFault.

1756-IF8H Channel Fault Tags

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Underrange or Overrange condition. Examine this word for a nonzero value to check quickly for Underrange or Overrange conditions on the module.

This table lists conditions that set **all** Channel Fault word bits.

1756-IF8H Conditions That Set All Channel Fault Word Bits

This Condition Sets All Channel Fault Word Bits	And Causes the Module to Display the Following in the Channel Fault Word Bits
A channel is being calibrated	16#00FF
A communication fault occurred between the module and its owner-controller	16#FFFF

1756-IF8H Channel Status Tags

This table describes the channel status tags.

1756-IF8H Tags That Show Channel Status

Tag	Bit	Description
ChxCalFault	7	This bit is set if an error occurs during calibration for Channel *x*, which can cause a bad calibration. Also sets CalFault in the Module Faults.
ChxUnderrange	6	This bit is set when the analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value. Also sets Ch*x*Fault in the Channel Faults.
ChxOverrange	5	This bit is set when the analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value. Also sets Ch*x*Fault in the Channel Faults.
ChxRateAlarm(1)	4	This bit is set when the rate of change between input samples for each channel exceeds the specified rate-alarm trigger point for the channel. Both positive and negative changes can cause this alarm.
ChxLAlarm	3	This bit is set when the requested input value is less than the configured low limit value. It remains set until the requested input is greater than the low limit. If the bit is latched, it remains set until it's unlatched.
ChxHAlarm	2	This bit is set when the requested input value is greater than the configured high limit value. It remains set until the requested input is less than the high limit. If the bit is latched, it remains set until it's unlatched.
ChxLLAlarm	1	This bit is set when the requested input value is less than the configured low low limit value. It remains set until the requested input is greater than the low low limit. If the bit is latched, it remains set until it's unlatched.
ChxHHAlarm	0	This bit is set when the requested input value is greater than the configured high high limit value. It remains set until the requested input is less than the high high limit. If the bit is latched, it remains set until it's unlatched.

(1) Alarm bits 0...4 in the Channel Status word do not set other bits at any higher level.

Module Calibration

You can initiate calibration of the 1756-IF8H module via the Logix Designer application Calibration view.

The Calibration view in the Logix Designer application provides a button to initiate module calibration and a display of the results. Refer to Calibrate Your Module on page 154 for more information.

IMPORTANT When calibrating multiple channels of a 1756-IF8H module in voltage mode, in order to get the best accuracy (especially for the 5V range), channels must be calibrated individually with a single voltage source. One voltage source cannot be applied to all channels in parallel if 5V accuracy is important.

1756-IF8H Tag Definitions

This section describes the module-defined data types for the 1756-IF8H module and includes information for configuration and input tags.

Available tags depend on the selected input data format, as shown in this table.

1756-IF8H Input Data Choice and Tags

Input Data Choice	Tag	Main Module Defined Type	Subtype Used by Main Type
Analog Only	Configuration	AB:1756_IF8H:C:0	AB:1756_IF8H_ChConfig_Struct:C:0
	Input	AB:1756_IF8H_Analog:I:0	None
Analog and HART PV	Configuration	AB:1756_IF8H:C:0	AB:1756_IF8H_ChConfig_Struct:C:0
	Input	AB:1756_IF8H_HARTPV:I:1	AB:1756_IF8H_HARTData:I:1 AB:1756_IF8H_HARTStatus_Struct:I:1
Analog and HART by Channel	Configuration	AB:1756_IF8H:C:0	AB:1756_IF8H_ChConfig_Struct:C:0
	Input	AB:1756_IF8H_AnalogHARTbyChannel:I:0	AB:1756_IF8H_HARTDataAll_Struct:I:0 AB:1756_IF8H_HARTStatusAll_Struct:I:0

Configuration

This table describes the configuration tags available in the 1756-IF8H module.

1756-IF8H Configuration Tags - (AB:1756_IF8H:C:0)

Member Name	Type	Style	Description
ModuleFilter (bits 0...7)	SINT	Decimal	See the Series A Module Filter Selections with Associated Performance Data table on page 31.
RealTimeSample (bits 0...15)	INT	Decimal	Milliseconds between reading signal values. See Real Time Sample (RTS) on page 22 for more information.
ChxConfig (x=0...7)	AB:1756_IF8H_ChConfig_Struct:C:0		
Config	SINT	Binary	
RateAlarmLatch	BOOL	Decimal	ChOConfig.Config.4, After a Rate Alarm is detected, keep I.ChxRateAlarm set even after Rate returns to normal, until unlatched by CIP™ Service Message.
ProcessAlarmLatch	BOOL	Decimal	ChOConfig.Config.5, After a Process Alarm such as LL is detected, keep I.ChxLLAlarm set even after measurement returns to normal, until unlatched by CIP Service Message.
AlarmDisable	BOOL	Decimal	ChOConfig.Config.6, Do not report Process or Rate Alarms.
HARTEn	BOOL	Decimal	ChOConfig.Config.7, Enable HART communication. Must be 1 for valid HART data in Input Tag and Asset Management access to HART Field Device.
RangeType	SINT	Decimal	0 = -10...+10 V. 1 = 0...5 V. 2 = 0...10 V. 3 = 0...20 mA. 4 = 4...20 mA.
DigitalFilter	INT	Decimal	Time Constant of low pass filter in ms. See Digital Filter on page 32 for more information.

1756-IF8H Configuration Tags - (AB:1756_IF8H:C:0) (Continued)

Member Name	Type	Style	Description
RateAlarmLimit	REAL	Float	Maximum Ramp Rate value to trigger a Rate Alarm when the Input Signal rate of change exceeds the setpoint. See Set Module Resolution on page 145 for more information.
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than or equal to the minimum Input Range. See Set Module Resolution on page 145 for more information.
HighSignal	REAL	Float	Upper current value for scaling to engineering units. Default is 20 mA. Must be more than LowSignal and less than or equal to the maximum Input Range. See Set Module Resolution on page 145 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Set Module Resolution on page 145 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Set Module Resolution on page 145 for more information.
LAlarmLimit	REAL	Float	User value sets low limit that causes the module to trigger a low alarm.
HAlarmLimit	REAL	Float	User value sets high limit that causes the module to trigger a high alarm.
LLAlarmLimit	REAL	Float	User value sets low low limit that causes the module to trigger a low low alarm.
HHAlarmLimit	REAL	Float	User value sets high high limit that causes the module to trigger a high high alarm.
AlarmDeadband	REAL	Float	Specifies the deadband range for the alarm trigger point. See Alarm Deadband for more information.
CalBias	REAL	Float	Sensor Offset in engineering units added to the measured signal before reporting Ch0.Data.
PassthroughHandle Timeout	INT	Decimal	Seconds to keep a reply to a HART pass-through service request before discarding. 15 seconds recommended.
PassthroughCmdFreq_14(1)	BOOL	Decimal	Selects the policy for sending HART pass-through messages. See Input Module Pass-through Setting, Ratio, and Priority on page 137
PassthroughCmdFreq_15(1)	BOOL	Decimal	

(1) Series B modules do not support Pass-through Setting. Pass-through scanning is fixed at one pass-through per channel scan on Series B modules.

Analog Only

This table describes the input tags available in the Analog Only data format.

1756-IF8H Input Tags - Analog Only (AB:1756_IF8H_Analog:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Indicates a problem with analog data on Channel x or broken communication between the Logix controller and the 1756-IF8H module. Example: Set if the analog signal is larger than 20 mA.
ChxFault (Ch0...Ch7)	BOOL	Decimal	ChannelFaults.0...ChannelFaults.7
ChxBrokenWire (Ch0...Ch7)	BOOL	Decimal	ChannelFaults.8...ChannelFaults.15 Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this indication.
HARTFaults (Ch0...Ch7)	SINT	Binary	Indicates a problem with HART data from the Field Device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ChxHARTFault	BOOL	Decimal	HARTFaults.0...HARTFaults.7
ModuleFaults	SINT	Binary	Module level fault status bits
CalFault	BOOL	Decimal	(ModuleFaults.1) 1756-IF8H Module Calibration Failed.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration in progress.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
ChxStatus (Ch0...Ch7)	SINT	Binary	Indicates various alarms on the analog signal. Also sets Ch0Fault for Overrange, Underrange, and CalFault.
ChxHHAlarm	BOOL		ChxStatus.0 ChxData > ChxHHAlarmLimit. If Process Alarms are configured to Latch by setting ChxConfig.ProcessAlarmLatch this bit remains set even after the condition returns to normal, until reset via an explicit CIP message. This message can be sent from the Studio 5000 Logix Designer Module Properties Alarm dialog or from the Logix controller via a MSG instruction.
ChxLLAlarm	BOOL		ChxStatus.1 ChxData < ChxLLAlarmLimit If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched
ChxHAlarm	BOOL		ChxStatus.2 ChxData > ChxHAlarmLimit If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched

1756-IF8H Input Tags - Analog Only (AB:1756_IF8H_Analog:I:0) (Continued)

Member Name	Type	Style	Description
ChxLAlarm	BOOL		ChxStatus.3 ChxData < ChxLAlarmLimit If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched
ChxRateAlarm	BOOL		ChxStatus.4 ChxData changing faster than ChxRateAlarmLimit. Both Positive and Negative changes can cause this alarm. If ChxConfig.RateAlarmLatch is set, this alarm remains set until it's unlatched
ChxOverrange	BOOL		ChxStatus.5 Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value
ChxUnderrange	BOOL		ChxStatus.6 Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value
ChxCalFault	BOOL		ChxStatus.7 Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault
ChxData (Ch0...Ch7)	REAL	Float	Value of analog signal on Channel x after conversion to engineering units.
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Analog and HART PV

This table describes the input tags available in the Analog and HART PV data format.

1756-IF8H Input Tags - Analog and HART PV (AB:1756_IF8H_HARTPV:I:1)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Indicates a problem with analog data on Channel x or broken communication between the Logix controller and the 1756-IF8H module (bits 0...15). Example: Set if the analog signal is larger than 20 mA.
ChxFault (Ch0...Ch7)	BOOL	Decimal	ChannelFaults.0...ChannelFaults.7
ChxBrokenWire (Ch0...Ch7)	BOOL	Decimal	ChannelFaults.8...ChannelFaults.15 Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this condition.
HARTFaults	SINT	Binary	Indicates a problem with HART data from the field device on Channel *x* (bits 0...7). Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ChxHARTFault (Ch0...Ch7)	BOOL	Decimal	HARTFaults.0...HARTFaults.7
ModuleFaults	SINT	Binary	Module level fault status (bits 0...7)
CalFault	BOOL	Decimal	(ModuleFaults.1) 1756-IF8H Module Calibration Failed.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170. Updated Cmd 48 status data available.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
ChxStatus (Ch0...Ch7)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxFault for Overrange, Underrange, and CalFault.
ChxHHAlarm	BOOL		ChxStatus.0 ChxData > ChxHHAlarmLimit. If process alarms are configured to latch by setting ChxConfig.ProcessAlarmLatch this bit remains set even after the condition returns to normal, until reset via an explicit CIP message. This message can be sent from the Studio 5000 Logix Designer Module Properties Alarm dialog or from the Logix controller via MSG instruction.
ChxLLAlarm	BOOL		ChxStatus.1 ChxData < ChxLLAlarmLimit If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxHAlarm	BOOL		ChxStatus.2 ChxData > ChxHAlarmLimit If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched

1756-IF8H Input Tags - Analog and HART PV (AB:1756_IF8H_HARTPV:I:1) (Continued)

Member Name	Type	Style	Description
ChxLAlarm	BOOL		ChxStatus.3 ChxData < ChxLAlarmLimit If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxRateAlarm	BOOL		ChxStatus.4 ChxData changing faster than ChxRateAlarmLimit. Both positive and negative changes can cause this alarm. If ChxConfig.RateAlarmLatch is set, this alarm remains set until it's unlatched.
ChxOverrange	BOOL		ChxStatus.5 Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxUnderrange	BOOL		ChxStatus.6 Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxCalFault	BOOL		ChxStatus.7 Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ChxData	REAL	Float	Value of analog signal on Channel *x* after conversion to engineering units.
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.
HART	AB:1756_IF8H_HARTData:I:1, Contains HART field device health and dynamic process variables.		
ChxDeviceStatus	AB:1756_IF8H_HARTStatus_Struct:I:1, Channel xHART Device status info.		
Init	BOOL		Searching for or Initializing HART device. If this is 0 and Fail is 1, then HART isn't enabled on this channel. If both are 1, then 1756-IF8H is sending out HART messages attempting to establish communication with a HART device.
Fail	BOOL		HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the input tag are valid. (HART.PVStatus is also set to 0 to indicate this).
MsgReady	BOOL		Pass-through message reply is ready for query service.
CurrentFault	BOOL		Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL		The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-IF8H module via CIP MSG GetDeviceInfo, which clears this bit.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9)
Maintenance Required	BOOL	Decimal	Maintenance is needed.
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	Low power.
ChxPV	REAL	Float	Channel *x* HART PV value.
ChxSV	REAL	Float	Channel *x* HART SV value.
ChxTV	REAL	Float	Channel *x* HART TV value.
ChxFV	REAL	Float	Channel *x* HART FV value.
ChxPVStatus	SINT	Hex	Channel *x* HART PV status, see HART PV, SV, TV, and FV Status on page 210 for more information.
ChxSVStatus	SINT	Hex	Channel *x* HART SV status, see HART PV, SV, TV, and FV Status on page 210 for more information.
ChxTVStatus	SINT	Hex	Channel *x* HART TV status, see HART PV, SV, TV, and FV Status on page 210 for more information.
ChxFVStatus	SINT	Hex	Channel *x* HART FV status, see HART PV, SV, TV, and FV Status on page 210 for more information.

Analog and HART by Channel

1756-IF8H Input Tags - Analog and HART by Channel (AB:1756-IF8H_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Indicates a problem with analog data on Channel *x* or broken communication between the Logix controller and the 1756-IF8H module (bits 0...15) Example: Set if the analog signal is larger than 20 mA.
ChxFault	BOOL	Decimal	ChannelFaults.*x*
ModuleFaults	SINT	Binary	Module level fault status (bits 0...7)
CalFault	BOOL	Decimal	(ModuleFaults.1) 1756-IF8H module calibration failed.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
Chx (Ch0...Ch7)	AB:1756_IF8H_HARTDataAll_Struct:I:0, Channel 0 analog and HART data.		
Data	REAL	Float	Analog value in engineering units.
DeviceStatus	AB:1756_IF8H_HARTStatusAll_Struct:I:0, Channel 0 HART Device status info.		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this is 0 and Fail is 1, then HART isn't Enabled on this channel. If both are 1, then 1756-IF8H is sending out HART messages attempting to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this)
MsgReady	BOOL	Decimal	Pass-through message reply is ready for query service.
CurrentFault	BOOL	Decimal	Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL	Decimal	The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-IF8H module via CIP MSG GetDeviceInfo, which clears this bit.
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART Field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
AlarmStatus	SINT	Binary	Indicates various alarms on the analog signal. Also sets Ch0Fault for Overrange, Underrange, and CalFault.
HHAlarm	BOOL	Decimal	(AlarmStatus.0) If process alarms are configured to latch by setting Ch0Config.ProcessAlarmLatch this bit remains set even after the condition returns to normal, until reset via an explicit CIP message. This message can be sent from the Studio 5000 Logix Designer Module Properties Alarm dialog or from the Logix controller via MSG instruction.
LLAlarm	BOOL	Decimal	(AlarmStatus.1) If Ch0Config.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
HAlarm	BOOL	Decimal	(AlarmStatus.2) If Ch0Config.ProcessAlarmLatch is set, this alarm remains set until it's unlatched
LAlarm	BOOL	Decimal	(AlarmStatus.3) If Ch0Config.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
RateAlarm	BOOL	Decimal	(AlarmStatus.4) Ch0Data changing faster than Ch0RateAlarmLimit. Both positive and negative changes can cause this alarm. If Ch0Config.RateAlarmLatch is set, this alarm remains set until it's unlatched.
Overrange	BOOL	Decimal	(AlarmStatus.5) Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.

1756-IF8H Input Tags - Analog and HART by Channel (AB:1756-IF8H_AnalogHARTbyChannel:I:0) (Continued)

Member Name	Type	Style	Description
Underrange	BOOL	Decimal	(AlarmStatus.6) Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
CalFault	BOOL	Decimal	(AlarmStatus.7) Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9)
Maintenance Required	BOOL	Decimal	Maintenance is needed.
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	Low power.
PV	REAL	Float	Primary value. This value is the same value as signaled on the analog channel and is the most important measurement that is made by this device.
SV	REAL	Float	Secondary value.
TV	REAL	Float	Third value.
FV	REAL	Float	Fourth value.
PVStatus	SINT	Hex	Primary status. 16#C0 = Connected. 16#00 = Not Connected.
SVStatus	SINT	Hex	Secondary status. 16#C0 = Connected. 16#00 = Not Connected.
TVStatus	SINT	Hex	Third status 16#C0 = Connected. 16#00 = Not Connected.
FVStatus	SINT	Hex	Fourth status. 16#C0 = Connected. 16#00 = Not Connected.
CSTTimestamp	DINT[2]	Hex	Timestamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Notes:

1756-IF8IH HART Isolated Analog Input Module

Module Features

The 1756-IF8IH module is an isolated, 8-channel, current-only input module capable of HART communication on all channels. Each channel is individually configurable. The 1756-IF8IH module has the following features:

- Eight isolated, individually configurable input channels with a separate HART modem on each channel
- Channel-to-channel, channel-to-backplane, and channel-to-frame ground galvanic isolation at a continuous level of 250V AC rms
- Two input ranges: 0...20 mA and 4...20 mA
- Choice of four data types:
  - Analog Only
  - Analog and HART PV
  - Analog and HART by channel with Configure HART Device = No
  - Analog and HART by channel with Configure HART Device = Yes
- Supports full simultaneous HART 1200 baud bandwidth to all channels
- Channel ADC filter (one setting per module)
- Digital filtering (configurable per channel)
- Real-time sampling
- Auto-scanning of HART variables (PV, SV, TV, FV)
- HART pass-through interface
- Option to configure a HART device with user-supplied data. You can configure PV damping value, PV range values, PV transfer function, and PV units code. This option is available only when the data format is Analog and HART by Channel with Configure HART device = Yes
- User scaling of input data
- Time stamping
- Alarms and fault detection
  - Open wire detection(4...20 mA range)
  - Underrange and overrange detection
  - Fault reporting
  - Process and Rate alarms and alarm latching (if Configure HART Device = No)
  - Status indicator information
- User Calibration via CIP™ messaging
- Calibration via output word (available only when the data format is Analog and HART by Channel with Configure HART Device = Yes)
- Downloadable firmware using ControlFLASH™
- Add-on Profile (AOP)
- "Bumpless" configuration for a smooth transition in new configurations.
- Removal and insertion under power (RIUP)

HART Compatibility

The 1756-IF8IH functions as a HART master. It communicates with HART devices that have a HART revision of 5, 6, or 7. Each channel has its own HART modem and functions as a HART primary master.

The 1756-IF8IH module supports one HART device per channel.

The 1756-IF8IH module does not support burst mode, phase shift keying (PSK), or multi-drop network configuration. The module detects and turns off a bursting device at initial connection with the device.

HART Handheld Configurator

A HART handheld configuration tool can be connected to the HART device while the module is connected as long as the configuration tool is the secondary master.

Input Data Types

The Input Data type you choose determines which values are included in the Input tag of the module and the features that are available to your application. Select the Input Data type on the Device Definition dialog of the Studio 5000 Logix Designer® application. This table shows the available data types for the 1756-IF8IH module.

Data Types for the 1756-IF8IH Module

Input Data Type	Description						
	Analog signal values	Analog status	HART process variables and device health	Grouped HART and analog data for each channel	Configure HART device data	Process Alarms with latching	Rate Alarm
Analog Only	X	X				X	X
Analog and HART PV	X	X	X			X	X
Analog and HART by Channel, Configure HART Device = No	X	X	X	X		X	X
Analog and HART by Channel, Configure HART Device = Yes	X	X	X	X	X		

Choose Analog and HART PV if you prefer the analog values for all channels to be grouped near the end of the tag. This format makes it easy to view all eight analog values at once.

Choose Analog and HART by Channel if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This format makes it easier to view all data for one field device.

Input Ranges

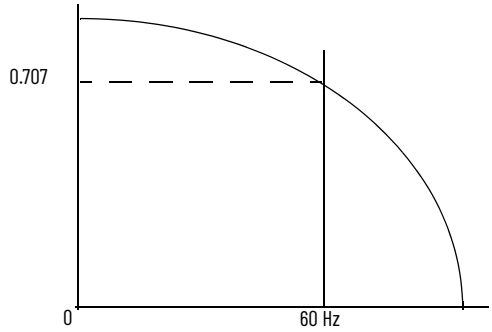
You can select one of two input ranges for each channel on the module. The range designates the minimum and maximum signals that are detectable by the module. These are the possible ranges:

- 0...20 mA
- 4...20 mA (HART instruments use this range.)

Module Filter

Each channel has an ADC filter that affects 50 Hz and 60 Hz rejection, noise, accuracy, and the minimum sample time (RTS). The module filter attenuates the input signal at the specified frequency and above.

The module attenuates the selected frequency by approximately -3 dB or 0.707 of the applied amplitude. An input signal with frequencies above the selected frequency is attenuated more while frequencies below the selection receive no attenuation.



A by-product of the filter selection is the minimum available sample rate (RTS). For example, the 1000 Hz selection does not attenuate frequencies less than 1104 Hz, but allows all 8 channels to be sampled within 15 ms. The 10 Hz selection attenuates all frequencies above 2.2 Hz but only allows all 8 channels to be sampled within 488 ms.

IMPORTANT 60 Hz is the default setting for the module filter. Do not use the 1000 Hz module filter with HART instruments.

There's one filter setting that is applied globally to all channels. Use this table to help choose a filter setting.

Module Filter Selections with Associated Performance Data for 1756-IF8IH

Module Filter Setting (-3 dB)	**10 Hz**	**15 Hz**	**20 Hz**	**50 Hz**	**60 Hz**	**100 Hz**	**250 Hz**	**1000 Hz**
Minimum Sample Time (RTS ms)	488	328	275	115	115	61	25	15
Effective Resolution (0...20 mA, 4...20 mA range)	18 bits	18 bits	18 bits	17 bits	17 bits	16 bits	16 bits	15 bits
	0.08 μA	0.08 μA	0.08 μA	0.16 μA	0.16 μA	0.32 μA	0.32 μA	0.64 μA
-3 dB Frequency	2.2 Hz	11.5 Hz	13.8 Hz	34.5 Hz	34.5 Hz	69.0 Hz	221 Hz	1104 Hz
50 Hz Common Rejection	100 dB	100 dB						
50 Hz Normal Rejection	95 dB	74 dB						
60 Hz Normal Rejection	95 dB	74 dB	97 dB					
60 Hz Common Rejection	100 dB	100 dB	100 dB					
Channel ADC Update Rate (samples per second)	30 SPS	50 SPS	60 SPS	150 SPS	150 SPS	300 SPS	960 SPS	4800 SPS
Settling Time	100 ms	80 ms	66.7 ms	26.7 ms	26.7 ms	13.3 ms	4.17 ms	0.83 ms

Digital Filter

The digital filter smooths input data noise transients. There's a separate digital filter for each channel.

The digital filter value specifies the time constant in milliseconds for a digital first order lag filter on the input. A value of 0 disables the filter.

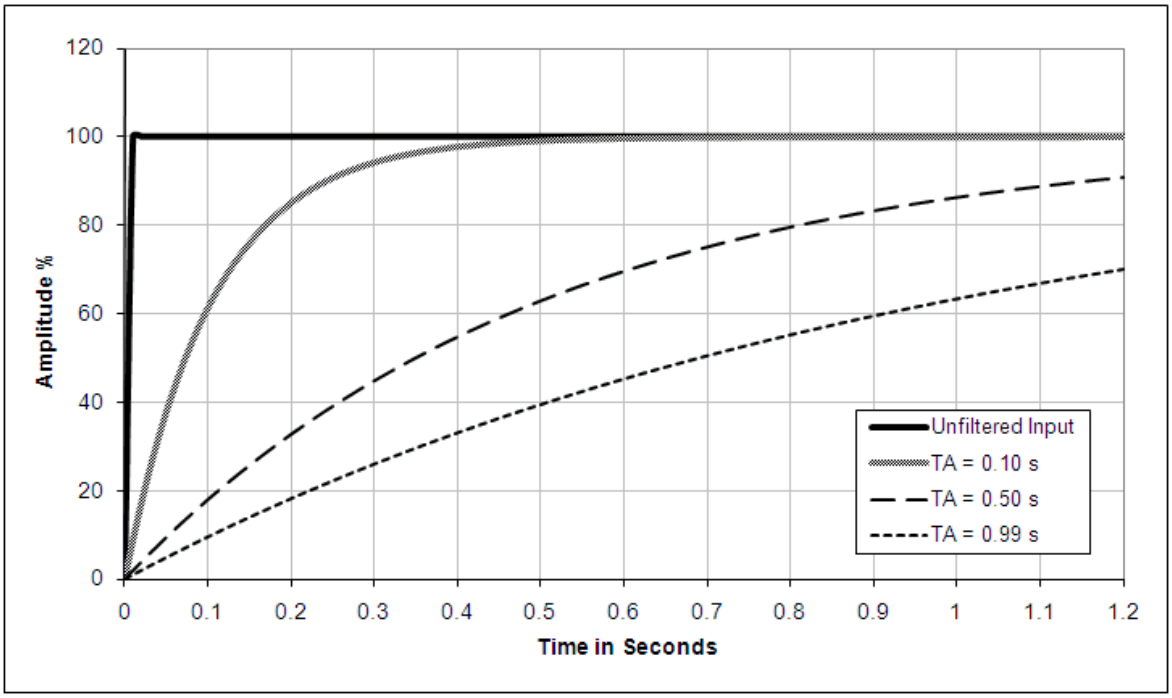
The digital filter equation is a classic first order lag equation:

$$Y_n = Y_{n-1} + \frac{[\Delta t]}{\Delta t + T_A} (X_n - Y_{n-1})$$

Y_n = present output, filtered peak voltage (PV)
Y_{n-1} = previous output, filtered PV
Δt = module channel update time (seconds)
T_A = digital filter time constant (seconds)
X_n = present input, unfiltered PV

This figure illustrates the filter response to a step input. When the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.

Filter Response to a Step Input



Real-time Sampling

This parameter instructs the module how often to scan its input channels and obtain new sampled data. After the channels are scanned, the module broadcasts that data (multicast or unicast) to the local chassis backplane. This feature is applied on a module-wide basis.

During module configuration, you specify a real-time sampling (RTS) period and a requested packet interval (RPI). Both of these features instruct the module to broadcast data, but only the RTS feature instructs the module to scan its channels before broadcasting.

For more RTS information, see Real Time Sample (RTS) on page 22.

Underrange and Overrange Detection

The module detects when it's operating beyond the limits of the input range. Thisn't being measured accurately because the signal is beyond the measuring capability of the module. For example, the module can't distinguish 20.58...30 mA.

This table shows the input ranges of the 1756-IF8IH module and the lowest and highest signal available in each range before the module detects an underrange and overrange condition.

Low and High Signal Limits on the 1756-IF8IH Module

Input Module	Available Range	Lowest Signal in Range	Highest Signal in Range
1756-IF8IH	0...20 mA	0 mA	20.58 mA
	4...20 mA	3.42 mA	20.58 mA

Open Circuit Detection

In the 4...20 mA range, if the signal wire to a channel opens, the module reports a negative full-scale value in the input data tag of the channel within 5 seconds. The module also sets the ChxBrokenWire status bit.

In the 0...20 mA range, an open-circuit condition results in a measured value of 0 mA, which is the same as a measured value of 0 mA when there isn't an open-circuit condition. The appropriate Underrange bit is set but the ChxBrokenWire bit isn't set.

Auto-Configure HART Device

The Auto-Configure HART device feature automatically configures a HART device with certain user-supplied values. Configurable values are PV Damping, PV Range, PV Range Units Code, and PV Transfer Function. You specify the configuration values in the Logix Designer application. One checkbox enables the PV damping value configuration and another enables configuration of PV range, PV transfer function, and PV units. The specified values are sent to the device at device connection time or if the module detects that the device configuration bit is set. See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153.

The specified values are sent to the device only if the feature is enabled and the module detects that the values in the device aren't within 1% of the values in the configuration tag. If the PV Range enable bit is set and the module detects that the device PV Units Code does not match the value in the configuration tag, the module sends the PV Units Code to the module. The PV Damping, PV units code, PV Upper and Lower Range values, and PV Transfer Function reside in the configuration table. If the write operation fails (for example, device write protected or unsupported values) then a status flag is set to indicate that the device isn't configured properly. If the write is successful, the module verifies that the PV Range and Damping values that are read from the device are within 1.0% of the values in the configuration tag. If they aren't, an error is flagged.

The valid range of HART configuration values depends on the HART device that is connected to the module. The Logix Designer application does not check that the values that are entered in the HART Command view are appropriate. Confirm on your own that valid values for your HART devices are used.

Rate Alarm

This feature isn't available if Configure HART Device = Yes.

The value for the Rate Alarm Limit is entered in scaled engineering units per second. The rate alarm triggers if the rate of change between input samples for a channel exceeds the specified rate-alarm trigger point for that channel. Rate Alarm uses the signal value after filtering by the Module Filter and before the Digital Filter is applied.

Process Alarms

This feature isn't available if Configure HART Device = Yes.

This feature enables you to specify alarm limits for input level and have the module report when those levels have been exceeded. It's available only if Configure HART Device = No. In module configuration, you specify values for high-high, high, low, and low-low limits. Process alarms can be latched.

Only status bits in the input table are affected during runtime after a valid configuration; no fault bit is set.

AlarmDeadband determines when the AlarmLimit bits are cleared. Once the bit is set by exceeding the AlarmLimit, it can't be cleared until the input has passed the deadband delta from the AlarmLimit value. For example, if the deadband is 0.5 and the HAlarmLimit is 10.0, the HAlarm status bit isn't cleared until the input is 9.5 or less. Likewise, if the LAlarmLimit is 1.0, the associated LAlarm bit would clear when the input is 1.5 or more for the same deadband value.

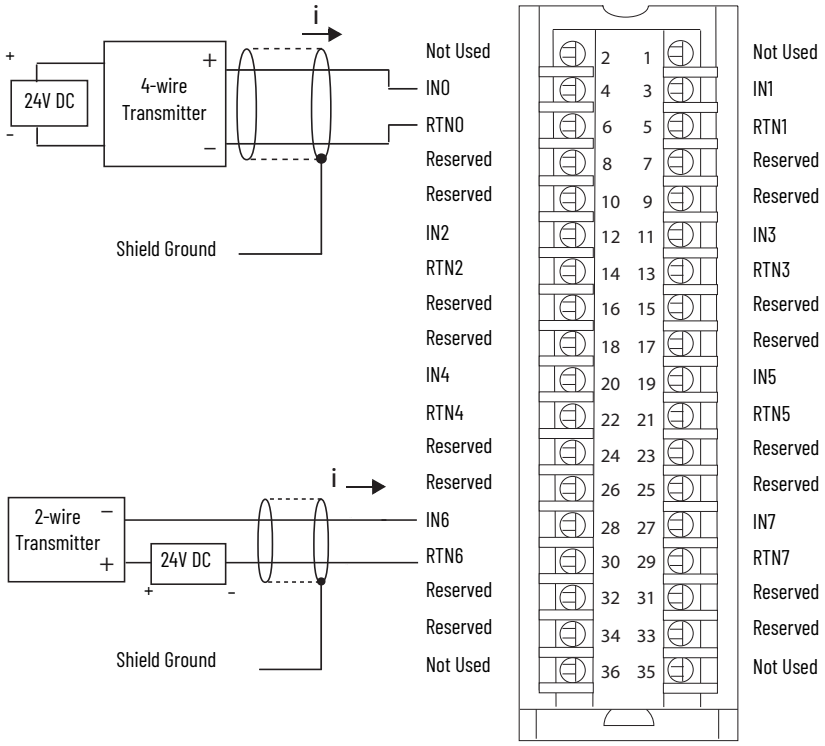
Alarm bits are cleared when the input falls inside the specified Alarm Limit. The exception is when ProcessAlarmLatch is set in the configuration. In that case, clearing alarm bits requires the command 'Unlatch Alarm Status' be issued to all alarms or individual alarms.

For more information, see Process Alarms on page 33.

Wire the Module

This figure shows module wiring information. We recommend using a separate power supply for each input to help maintain isolation.

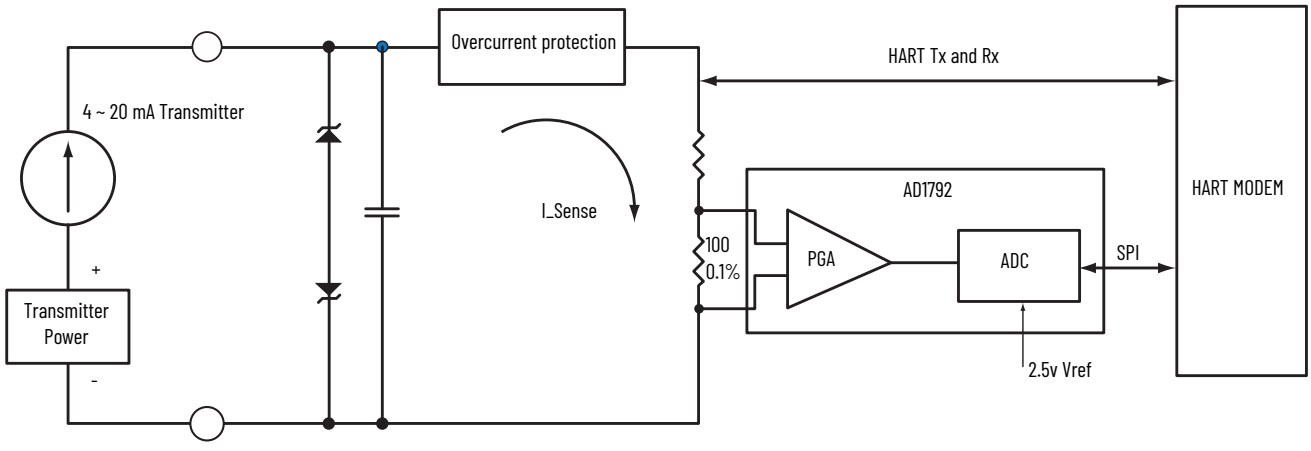
1756-IF8IH Wiring Diagram



Circuit Diagram

This figure is a simplified diagram of the input circuit that is used in the 1756-IF8IH module.

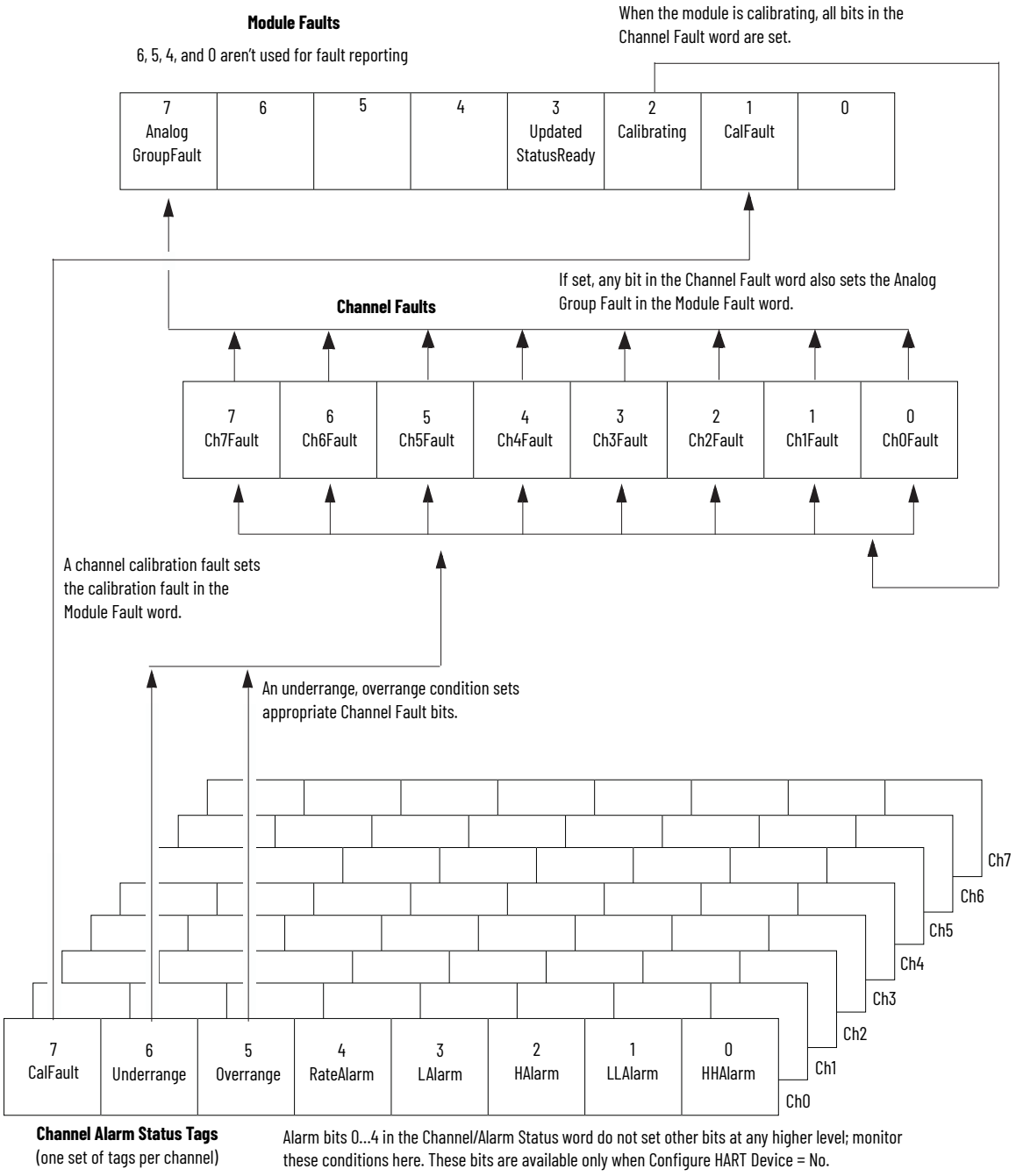
1756-IF8IH Simplified Input Circuit



1756-IF8IH Module Fault and Status Reporting

The 1756-IF8IH module multicasts status/fault data to the controller with its channel data. The fault data is arranged to let you choose the level of granularity you desire for examining fault conditions. Three levels of tags work together to provide an increasing degree of detail about the cause of faults on the module. This figure offers an overview of how faults are reported.

1756-IF8IH Module Fault Reporting



Channel Alarm Status Tags
(one set of tags per channel)

Alarm bits 0...4 in the Channel/Alarm Status word do not set other bits at any higher level; monitor these conditions here. These bits are available only when Configure HART Device = No.

This table lists tags that you can examine in ladder logic to indicate when a fault has occurred.

1756-IF8IH Tags That Can Be Examined in Ladder Logic

Tag	Description	Tag Name Analog and HART PV	Tag Name Analog and HART by Channel
Module Fault Word	This word provides fault summary reporting.	ModuleFaults	ModuleFaults
Channel Fault Word	This word provides underrange, overrange, and communication fault reporting.	ChannelFaults ChxFault	ChannelFaults ChxFault
Channel Status Word	These words provide individual channel underrange and overrange fault indications and reporting for process alarms, rate alarms, and calibration faults.	ChxStatus	Chx.DeviceStatus.AlarmStatus
HART Faults	These bits provide HART communication status.	HARTFaults	Chx.DeviceStatus.HARTFault
HART Device Status	This data reports HART field device health.	HART.ChxDevice Status	Chx.DeviceStatus.FieldDeviceStatus

1756-IF8IH Module Fault Word Bits

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further to isolate the fault. This table lists tags that can be examined in ladder logic to indicate when a fault has occurred.

1756-IF8IH Tags That Can Be Examined in Ladder Logic

Tag	Description
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalFault.

1756-IF8IH Channel Fault Tags

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Underrange or Overrange condition. Examine this word for a nonzero value to check for Underrange or Overrange conditions on the module.

This table lists conditions that set **all** Channel Fault word bits.

1756-IF8IH Conditions That Set All Channel Fault Word Bits

This Condition Sets All Channel Fault Word Bits	And Causes the Module to Display the Following in the Channel Fault Word Bits
A channel is being calibrated	16#00FF
A communication fault occurred between the module and its owner-controller	16#FFFF

Module Calibration

There are two ways to initiate calibration of the 1756-IF8IH module:

- Logix Designer application Calibration view
- Module Output Word

Module Calibration Via Logix Designer Application

The Calibration view in the Logix Designer application provides a button to initiate module calibration and a display of the results. Refer to Calibrate Your Module on page 154 for more information.

Module Calibration Via Output Word

The 1756-IF8IH module allows you to perform calibration by setting and clearing bits in the module output word. This method of calibration is available only when Configure HART Device = Yes. The module must be connected to a controller and the controller must be in run mode.

See Table on page 66 for descriptions of the tags in the 1756-IF8IH output word.

To perform a module calibration via the output word, set and clear bits in sequence to perform the calibration tasks. This table shows 1756-IF8IH calibration bits.

Step	Output Word Bit	Description
Set the calibration date	CalibrationDate	The date that you want to be associated with this calibration; typically the current date. Set the date before starting the calibration.
Initiate calibration	ChxCalibrate	Set this bit to initiate calibration, and keep it set until the calibration sequence is complete. If this bit clears before the calibration is complete, the calibration is aborted.
Perform low calibration	ChxCalLowRef	Perform low calibration at the low reference point (0.5 mA). Connect a valid low reference signal before setting this bit.
Perform high calibration	ChxCalHighRef	Perform high calibration at the high reference point (20 mA). Connect a valid high reference signal before setting this bit.
Abort calibration	ChxCalibrate ChxCalLowRef ChxCalHighRef	Setting all three calibration bits aborts calibration.

Module-defined Data Types, 1756-IF8IH Module

This section describes module-defined data types for the 1756-IF8IH module and includes information for configuration and input tags.

Available tags depend on the selected input data format, as shown in this table.

1756-IF8IH Input Data Choice and Tags

Input Data Choice	Tag	Main Module Defined Type	Subtype Used by Main Type
Analog Only	Configuration	AB:1756_IF8IH:C:0	AB:1756_IF8IH_ChConfig_Struct:C:0
	Input	AB:1756_IF8IH_Analog:I:0	None
Analog and HART PV	Configuration	AB:1756_IF8IH:C:0	AB:1756_IF8IH_ChConfig_Struct:C:0
	Input	AB:1756_IF8IH_HARTPV:I:1	AB:1756_IF8IH_HARTData:I:1 AB:1756_IF8IH_HARTStatus_Struct:I:1
Analog and HART by Channel Configure HART Device = No	Configuration	AB:1756_IF8IH:C:0	AB:1756_IF8IH_ChConfig_Struct:C:0
	Input	AB:1756_IF8IH_AnalogHARTbyChannel:I:0	AB:1756_IF8IH_HARTDataAll_1_Struct:I:0 AB:1756_IF8IH_HARTStatusAll_1_Struct:I:0
Analog and HART by Channel Configure HART Device = Yes	Configuration	AB:1756_IF8IH_HART_CMD:C:0	AB:1756_IF8IH_HART_ChConfig_Struct:C:0
	Input	AB:1756_IF8IH_AnalogHARTbyChannel_1:I:0	AB:1756_IF8IH_HARTDataAll_1_Struct:I:0 AB:1756_IF8IH_HARTStatusAll_1_Struct:I:0
	Output	AB:1756_IF8IH:O:0	None

Configuration - Configure HART Device = No

This table lists the configuration tags for the 1756-IF8IH module when Configure HART Device is set to No.

1756-IF8IH Configuration Tags, Configure HART Device = No (AB:1756_IF8IH_HART_CMD:C:0)

Member Name	Type	Style	Description
ModuleFilter	SINT	Decimal	See the Module Filter Selections with Associated Performance Data for 1756-IF8IH table on page 51. 0...10 Hz, 1...50 Hz, 2...60 Hz, 3...100 Hz, 4...250 Hz, 5...1000 Hz, 6...20 Hz, 7 = 15 Hz. 100 Hz is invalid if HART is enabled.
RealTimeSample	INT	Decimal	Milliseconds between reading signal values. See Real-time Sampling on page 31 for more information.
ChxConfig (Ch 0...Ch7)	AB:1756_IF8IH_ChConfig_Struct:C:0		
Config	SINT	Binary	
RateAlarmLatch	BOOL	Decimal	(Config.4) After a Rate Alarm is detected, keep I.ChxRateAlarm set even after Rate returns to normal, until unlatched by CIP Service Message.
ProocessAlarmLatch	BOOL	Decimal	(Config.5) After a Process Alarm such as LL is detected, keep I.ChxLLAlarm set even after measurement returns to normal, until unlatched by CIP Service Message.
AlarmDisable	BOOL	Decimal	(Config.6) Do not report Process or Rate Alarms.
HARTEn	BOOL	Decimal	(Config.7) Enable HART communication. Must be 1 for valid HART data in Input Tag and Asset Management access to HART Field Device.
RangeType	SINT	Decimal	0 = invalid, 1 = invalid, 2 = invalid, 3 = 0...20 mA, 4 = 4...20 mA
DigitalFilter	INT	Decimal	Time Constant of low pass filter in ms. See Digital Filter on page 52 for more information.
RateAlarmLimit	REAL	Float	Maximum Ramp Rate value to trigger a Rate Alarm when the Input Signal rate of change exceeds the setpoint. See Scaling to Engineering Units on page 143 for more information.
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than or equal to the minimum Input Range. See Scaling to Engineering Units on page 143 for more information.
HighSignal	REAL	Float	Upper current value for scaling to engineering units. Default is 20 mA. Must be more than LowSignal and less than or equal to the maximum Input Range. See Scaling to Engineering Units on page 143 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
LAlarmLimit	REAL	Float	PV Lower Range value.
HAlarmLimit	REAL	Float	PV Upper Range value.
LLAlarmLimit	SINT	Decimal	PV Range Units Code.

1756-IF8IH Configuration Tags, Configure HART Device = No (AB:1756_IF8IH_HART_CMD:C:0) (Continued)

Member Name	Type	Style	Description
HHAlarmLimit	SINT	Decimal	PV Transfer Function (see HART spec).
AlarmDeadBand	REAL	Float	Specifies the deadband range for the alarm trigger point. See Auto-Configure HART Device on page 53 for more information.
CalBias	REAL	Float	Sensor Offset in engineering units added to the measured signal before reporting Ch0.Data.
PassthroughHandleTimeOut	INT	Decimal	Response hold time in milliseconds.
PassthroughFreq_14	BOOL	Decimal	Selects the policy for sending HART pass-through messages. See Input Module Pass-through Setting, Ratio, and Priority on page 137
PassthroughFreq_15	BOOL	Decimal	

Configuration - Configure HART Device = Yes

This table lists the configuration tags for the 1756-IF8IH module when Configure HART Device is set to Yes.

1756-IF8IH Configuration Tags (AB:1756_IF8IH_HART_CMD:C:0)

Member Name	Type	Style	Description
ModuleFilter	SINT	Decimal	See the Module Filter Selections with Associated Performance Data for 1756-IF8IH table on page 51. 0…10 Hz, 1…50 Hz, 2…60 Hz, 3…100 Hz, 4…250 Hz, 5…1000 Hz, 6…20 Hz, 7 = 15 Hz. 100 Hz is invalid if HART is enabled.
RealTimeSample	INT	Decimal	Milliseconds between reading signal values. See Real-time Sampling on page 52 for more information.
ChxConfig (Ch 0…Ch7)	AB:1756_IF8IH_HART_ChConfig_Struct:C:0		
Config	SINT	Binary	
PVDampingConfigEn	BOOL	Decimal	(Config.0) Enable HART PV damping auto-configuration.
PVRangeConfigEn	BOOL	Decimal	(Config.1) Enable HART PV range auto-configuration.
HARTEn	BOOL	Decimal	(Config.7) Enable HART communication. Must be 1 for valid HART data in Input Tag and Asset Management access to HART Field Device.
RangeType	SINT	Decimal	3 = 0…20 mA, 4 = 4…20 mA (0, 1, and 2 are invalid).
DigitalFilter	INT	Decimal	Time Constant of low pass filter in ms. See Digital Filter on page 52 for more information.
PVDamping(1)	REAL	Float	PV Damping Value (HART Command 35, in seconds).
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than or equal to the minimum Input Range. See Scaling to Engineering Units on page 143 for more information.
HighSignal	REAL	Float	Upper current value for scaling to engineering units. Default is 20 mA. Must be more than LowSignal and less than or equal to the maximum Input Range. See Scaling to Engineering Units on page 143 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
PVLowerRange(1)	REAL	Float	PV Lower Range value (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVUpperRange(1)	REAL	Float	PV Upper Range value (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVUnits(1)	SINT	Decimal	PV Range Units Code (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVTransferFunction(1)	SINT	Decimal	PV Transfer Function (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
CalBias	REAL	Float	Sensor Offset in engineering units added to the measured signal before reporting Ch0.Data.
PassthroughHandleTimeOut	INT	Decimal	Response hold time in milliseconds.
PassthroughFreq_14	BOOL	Decimal	Selects the policy for sending HART pass-through messages. See Input Module Pass-through Setting, Ratio, and Priority on page 137.
PassthroughFreq_15	BOOL	Decimal	

(1) The valid range of HART configuration values depends on the HART device that is connected. The Logix Designer application does not check that the entered values for PVDampingValue, PVLowerRange/PVUpperRange, PVRangeUnitsCode, and PVTransferFunction are valid for the connected device. It is your responsibility to evaluate the entered values.

Input - Analog Only

This table describes the input tags available in the Analog Only data format for the 1756-IF8IH module.

1756-IF8IH Input Tags - Analog Only (AB:1756_IF8IH_Analog:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel fault status bits.
ChxFault (Ch 0...Ch7)	BOOL	Decimal	(ChannelFaults.0...ChannelFaults.7) A fault has occurred on the corresponding channel.
ChxBrokenWire (Ch 0...Ch7)	BOOL	Decimal	(ChannelFaults.8...ChannelFaults.15) Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFaults	SINT	Binary	HART Fault status bits.
ChxHARTFault (Ch 0...Ch7)	BOOL	Decimal	(HARTFaults.0...HARTFaults.7) Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ModuleFaults	SINT	Binary	Module fault status bits.
CalFault	BOOL	Decimal	(ModuleFaults.1) A calibration fault has occurred on one of the channels.
Calibrating	BOOL	Decimal	(ModuleFaults.2) A calibration is in progress.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a channel fault has occurred.
ChxStatus (Ch 0...Ch7)	SINT	Binary	Status bits for channel x.
ChxHHAlarm	BOOL	Decimal	(ChxStatus.1) ChxData > ChxHHAlarmLimit. If Process Alarms are configured to Latch by setting ChxConfig.ProcessAlarmLatch this bit remains set even after the condition returns to normal, until reset via an explicit CIP message. This message can be sent from the Studio 5000 Logix Designer Module Properties Alarm dialog or from the Logix controller via MSG instruction.
ChxLLAlarm	BOOL	Decimal	(ChxStatus.1) ChxData < ChxLLAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxHAlarm	BOOL	Decimal	(ChxStatus.2) ChxData > ChxHAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxLAlarm	BOOL	Decimal	(ChxStatus.3)ChxData < ChxLAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxRateAlarm	BOOL	Decimal	(ChxStatus.4) ChxData changing faster than ChxRateAlarmLimit. Both Positive and Negative changes can cause this alarm. If ChxConfig.RateAlarmLatch is set, this alarm remains set until it's unlatched.
ChxOverrange	BOOL	Decimal	(ChxStatus.5) Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxUnderrange	BOOL	Decimal	(ChOStatus.6) Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxCalFault	BOOL	Decimal	(ChOStatus.7) Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ChxData (Ch 0...Ch7)	REAL	Float	Value of analog signal on Channel *x* after conversion to engineering units.
CSTTimeStamp	DINT (2)	Hex	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimeStamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Input - Analog and HART PV

This table describes the input tags available in the Analog and HART PV data format for the 1756-IF8IH module.

1756-IF8IH Input Tags - Analog and HART PV (AB:1756_IF8IH_HARTPV:I:1)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel fault status bits.
ChxFault (Ch 0...Ch7)	BOOL	Decimal	(ChannelFaults.0...ChannelFaults.7) A fault has occurred on the corresponding channel.
ChxBrokenWire (Ch 0...Ch7)	BOOL	Decimal	(ChannelFaults.8...ChannelFaults.15) Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFaults	SINT	Binary	HART Fault status bits.
ChxHARTFault (Ch 0...Ch7)	BOOL	Decimal	(HARTFaults.0...HARTFaults.7) Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ModuleFaults	SINT	Binary	Module fault status bits.
CalFault	BOOL	Decimal	(ModuleFaults.1) A calibration fault has occurred on one of the channels.
Calibrating	BOOL	Decimal	(ModuleFaults.2) A calibration is in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a channel fault has occurred.
ChxStatus (Ch 0...Ch7)	SINT	Binary	Status bits for channel x.
ChxHHAlarm	BOOL	Decimal	(ChxStatus.1) ChxData > ChxHHAlarmLimit. If Process Alarms are configured to Latch by setting ChxConfig.ProcessAlarmLatch this bit remains set even after the condition returns to normal, until reset via explicit CIP message. This message can be sent from the Studio 5000 Logix Designer Module Properties Alarm dialog or from the Logix controller via MSG instruction.
ChxLLAlarm	BOOL	Decimal	(ChxStatus.1) ChxData < ChxLLAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxHAlarm	BOOL	Decimal	(ChxStatus.2) ChxData > ChxHAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxLAlarm	BOOL	Decimal	(ChxStatus.3)ChxData < ChxLAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
ChxRateAlarm	BOOL	Decimal	(ChxStatus.4) ChxData changing faster than ChxRateAlarmLimit. Both Positive and Negative changes can cause this alarm. If ChxConfig.RateAlarmLatch is set, this alarm remains set until it's unlatched.
ChxOverrange	BOOL	Decimal	(ChxStatus.5) Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxUnderrange	BOOL	Decimal	(ChOStatus.6) Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxCalFault	BOOL	Decimal	(ChOStatus.7) Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ChxData (Ch 0...Ch7)	REAL	Float	Value of analog signal on Channel *x* after conversion to engineering units.
CSTTimeStamp	DINT (2)	Hex	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimeStamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.
HART	AB:1756_IF8IH_HARTData:I:1		
ChxDeviceStatus (Ch 0...Ch7)	AB:1756_IF8IH_HARTStatus_Struct:I:1		
Init	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't enabled on this channel. If both are 1, then 1756-IF8IH is sending out HART messages to attempt to establish communication with a HART device.
Fail	BOOL	Decimal	HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the input tag are valid. (HART.PVStatus is also set to 0 to indicate this).
MsgReady	BOOL	Decimal	Pass-through message reply is ready for query service.
CurrentFault	BOOL	Decimal	Analog current measurement does not match the current reported by the field device over the HART network.
ConfigurationChanged	BOOL	Decimal	The field device configuration has changed and new field device configuration information can be obtained from the 1756-IF8IH module via CIP MSG GetDeviceInfo, which clears this bit.

1756-IF8IH Input Tags - Analog and HART PV (AB:1756_IF8IH_HARTPV:I:1) (Continued)

Member Name	Type	Style	Description
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9).
MaintenanceRequired	BOOL	Decimal	Maintenance is needed.
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	Low power.
ChxPV (Ch 0...Ch7)	REAL	Float	Channel *x* HART PV value.
ChxSV (Ch 0...Ch7)	REAL	Float	Channel *x* HART SV value.
ChxTV (Ch 0...Ch7)	REAL	Float	Channel *x* HART TV value.
ChxFV (Ch 0...Ch7)	REAL	Float	Channel *x* HART FV value.
ChxPVStatus (Ch 0...Ch7)	SINT	Hex	Channel *x* HART PV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxSVStatus (Ch 0...Ch7)	SINT	Hex	Channel *x* HART SV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxTVStatus (Ch 0...Ch7)	SINT	Hex	Channel *x* HART TV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxFVStatus (Ch 0...Ch7)	SINT	Hex	Channel *x* HART FV status. See HART PV, SV, TV, and FV Status on page 210 for more information.

Input - Analog and HART by Channel, Configure HART Device = No

This table describes the input tags available in the Analog with HART Channel Grouped data format for the 1756-IF8IH module when it's used in Legacy 1756-IF8IH mode.

1756-IF8IH Input Tags - Analog and HART by Channel, Configure HART Device = No (AB:1756_IF8IH_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel fault status bits.
ChxFault (Ch 0...Ch7)	BOOL	Decimal	(ChannelFaults.0...ChannelFaults.7) A fault has occurred on the corresponding channel.
ModuleFaults	SINT	Binary	Module fault status bits.
CalFault	BOOL	Decimal	(ModuleFaults.1) A calibration fault has occurred on one of the channels.
Calibrating	BOOL	Decimal	(ModuleFaults.2) A calibration is in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a channel fault has occurred.
Chx (Ch 0...Ch7)	AB:1756_IF8IH_HARTDataAll_Struct:I:0		
Data	REAL	Float	Analog value in engineering units.
DeviceStatus	AB:1756_IF8IH_HARTStatusAll_1_Struct:I:0		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and HARTCommFail is 1, then HART isn't enabled on this channel. If both are 1, then 1756-IF8IH is sending out HART messages attempting to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure, device not found, or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL	Decimal	Ladder passthrough message reply is ready for query service.
CurrentFault	BOOL	Decimal	Digital and analog values do not match (Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL	Decimal	The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-IF8IH module via CIP MSG GetDeviceInfo, which clears this bit.

1756-IF8IH Input Tags - Analog and HART by Channel, Configure HART Device = No (AB:1756_IF8IH_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	(FieldDeviceStatus.0) The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	(FieldDeviceStatus.1) A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	(FieldDeviceStatus.2) The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	(FieldDeviceStatus.3) The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	(FieldDeviceStatus.4) More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	(FieldDeviceStatus.5) A power failure or device reset occurred.
Changed	BOOL	Decimal	(FieldDeviceStatus.6) An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	(FieldDeviceStatus.7) The device detected a serious error or failure that compromises device operation.
AlarmStatus	SINT	Binary	Channel x alarm status bits.
HHAlarm	BOOL	Decimal	ChxData > ChxHHAlarmLimit. If Process Alarms are configured to Latch by setting ChxConfig.ProcessAlarmLatch this bit remains set even after the condition returns to normal, until reset via explicit CIP message. This message can be sent from the Studio 5000 Logix Designer Module Properties Alarm dialog or from the Logix controller via MSG instruction.
LLAlarm	BOOL	Decimal	ChxData < ChxLLAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
HAlarm	BOOL	Decimal	ChxData > ChxHAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
LAlarm	BOOL	Decimal	ChxData < ChxLAlarmLimit. If ChxConfig.ProcessAlarmLatch is set, this alarm remains set until it's unlatched.
RateAlarm	BOOL	Decimal	ChxData changing faster than ChxRateAlarmLimit. Both Positive and Negative changes can cause this alarm. If ChxConfig.RateAlarmLatch is set, this alarm remains set until it's unlatched.
Overrange	BOOL	Decimal	Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
Underrange	BOOL	Decimal	Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
CalFault	BOOL	Decimal	Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ExtDeviceStatus	INT	Binary	Extended device status (from HART cmd9).
MaintenanceRequired	BOOL	Decimal	Maintenance is needed.
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	Low power.
PV	REAL	Float	Channel x HART PV value.
SV	REAL	Float	Channel x HART SV value.
TV	REAL	Float	Channel x HART TV value.
FV	REAL	Float	Channel x HART FV value.
PVStatus	HEX	SINT	Channel x HART PV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
SVStatus	HEX	SINT	Channel *x* HART SV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
TVStatus	HEX	SINT	Channel *x* HART TV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
FVStatus	HEX	SINT	Channel *x* HART FV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
CSTTimeStamp	HEX	DINT (2)	
RollingTimeStamp	HEX	INT	

Input - Analog and HART by Channel, Configure HART Device = Yes

This table describes the input tags available in the Analog and HART by Channel data format for the 1756-IF8IH module when Configure HART Device = Yes.

1756-IF8IH Input Tags - Analog and HART by Channel, Configure HART Device = Yes (AB:1756_IF8IH_AnalogHARTbyChannel_1:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	(ChannelFaults.0…ChannelFaults.15) Channel Fault Bits.
ChxFault (Ch0…Ch7)	BOOL	Decimal	(ChannelFaults.0…ChannelFaults.7) Indicates that a fault has occurred on the corresponding channel.
ModuleFaults	SINT	Binary	ModuleFaults.0…ModuleFaults.7
CalFault	BOOL	Decimal	(ModuleFaults.1) A calibration fault has occurred.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration is in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Updated status from HART Cmd48 is available.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) A channel fault has occurred.
Chx (Ch0…Ch7)	AB:1756_IF8IH_HARTDataAll_1_Struct:I:0		
Data	REAL	Float	Analog value in engineering units.
DeviceStatus	AB:1756_IF8IH_HARTStatusAll_1_Struct:I:0		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and HARTCommFail is 1, then HART isn't enabled on this channel. If both are 1, then 1756-IF8IH is sending out HART messages to attempt to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure, device not found, or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL	Decimal	Ladder passthrough message reply is ready for query service.
CurrentFault	BOOL	Decimal	Digital and analog values do not match. (Analog current measurement does not match the current reported by the Field Device over the HART network.)
ConfigurationChanged	BOOL	Decimal	The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-IF8IH module via CIP MSG GetDeviceInfo, which clears this bit.
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	Communication error / command response.
FieldDeviceStatus	SINT	Binary	Field device status (bits 0…7).
PVOutOfLimits	BOOL	Decimal	(FieldDeviceStatus.0) The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	(FieldDeviceStatus.1) A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	(FieldDeviceStatus.2) The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	(FieldDeviceStatus.3) The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	(FieldDeviceStatus.4) More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	(FieldDeviceStatus.5) A power failure or device reset occurred.
Changed	BOOL	Decimal	(FieldDeviceStatus.6) An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	(FieldDeviceStatus.7) The device detected a serious error or failure that compromises device operation.
AlarmStatus	SINT	Binary	Alarm status (bits 0…7)
PVConfigFailed	BOOL	Decimal	(AlarmStatus.0) PV auto-config failed (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
Overrange	BOOL	Decimal	(AlarmStatus.5) Signal value is over the specified input range.
Underrange	BOOL	Decimal	(AlarmStatus.6) Signal value is under the specified input range.
CalFault	BOOL	Decimal	(AlarmStatus.7) Bad calibration.
ExtDeviceStatus	SINT	Binary	Extended device status (bits 0…7) (from HART cmd9)
MaintenanceRequired	BOOL	Decimal	(ExtDeviceStatus.0)
DeviceVariableAlert	BOOL	Decimal	(ExtDeviceStatus.1) Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	(ExtDeviceStatus.2)
CalibrationFault	BOOL	Decimal	Last attempted calibration for this channel failed.
Calibrating	BOOL	Decimal	Calibration for the channel is in progress.

1756-IF8IH Input Tags - Analog and HART by Channel, Configure HART Device = Yes (AB:1756_IF8IH_AnalogHARTbyChannel_1:I:0)

Member Name	Type	Style	Description
CalGoodLowRef	BOOL	Decimal	A valid Low Reference signal has been sampled on this channel.
CalBadLowRef	BOOL	Decimal	The Low Reference signal is grossly out of the expected range.
CalGoodHighRef	BOOL	Decimal	A valid high reference signal has been sampled on the channel.
CalBadHighRef	BOOL	Decimal	The high reference signal is grossly out of the expected range.
CalSuccessful	BOOL	Decimal	This bit is set after valid High and Low points are captured and the Calibrate bit in the output word has been cleared.
PV	REAL	Float	Channel x HART PV value.
SV	REAL	Float	Channel x HART SV value.
TV	REAL	Float	Channel x HART TV value.
FV	REAL	Float	Channel x HART FV value.
PVStatus	HEX	SINT	Channel x HART PV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
SVStatus	HEX	SINT	Channel *x* HART SV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
TVStatus	HEX	SINT	Channel *x* HART TV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
FVStatus	HEX	SINT	Channel *x* HART FV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
CSTimeStamp	HEX	DINT (2)	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimeStamp	HEX	INT	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Output - Analog and HART by Channel, Configure HART Device = Yes

This table describes the output tags available in the Analog and HART by Channel data format for the 1756-IF8IH module when Configure HART Device =Yes. Output tags aren't available in other 1756-IF8IH data formats.

1756-IF8IH Output Tags - Analog and HART by Channel, Configure HART Device = Yes (AB:1756_IF8IH:O:0)

Member Name	Type	Style	Description
ChxCalibrate (Ch 0...Ch7)	BOOL	Decimal	Initiates the Calibration Process. Must stay set through a valid LowReference and HighReference. Clearing prior Aborts Calibration.
ChxCalLowRef (Ch 0...Ch7)	BOOL	Decimal	Rising edge triggers a Low Calibration at the Low Reference Point (0.5 mA). Valid Low Reference signal must be connected before setting bit.
ChxCalHighRef (Ch 0...Ch7)	BOOL	Decimal	Rising edge triggers a High Calibration at the High Reference Point (20 mA). Valid High Reference signal must be connected before setting bit.
CalibrationDate	INT	Decimal	Date of most recent successful calibration.

1756-IF16H HART Analog Input Module

Module Features

The 1756-IF16H module has the following features:

- Choice of three data types
  - Analog only
  - Analog and HART PV
  - Analog and HART by channel
- 0…20 mA or 4…20 mA input ranges
- Module filter
- Real-time sampling
- Underrange and overrange detection
- Wire-off detection
- Highway addressable remote transducer (HART) communication

Input Data Types

The Input Data type you choose determines which values are included in the Input tag of the module and the features that are available to your application. Select the Input Data type on the Device Definition dialog of the Studio 5000 Logix Designer® application. This table shows the available data types for the 1756-IF16H module.

Data Types for the 1756-IF16H Module

Input Data Type	Description			
	Analog signal values	Analog status	HART secondary process variables and device health	HART and Analog data for each channel grouped in tag
Analog Only	X	X		
Analog and HART PV	X	X	X	
Analog and HART by Channel	X	X	X	X

- Choose Analog and HART PV if you prefer the members of your tag to be arranged similar to non-HART analog input modules. With this selection, the analog values for all channels grouped near the end of the tag. This arrangement makes it easy to view all 16 analog values at once.
- Choose Analog and HART by Channel if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This arrangement makes it easier to view all data that is related to one field device.

Input Ranges

You can select one of two input ranges for each channel on the module. The range designates the minimum and maximum signals that are detectable by the module. The two ranges are:

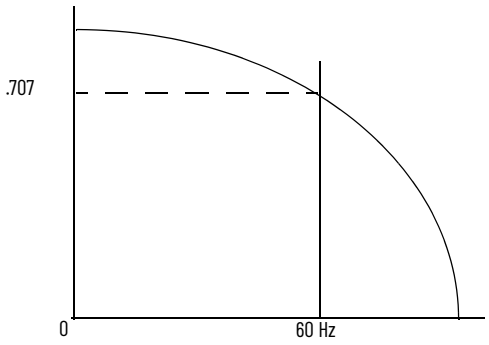
- 0…20 mA
- 4…20 mA (HART instruments use this range)

Module Filter

The module filter attenuates the input signal beginning at the specified frequency. This feature is applied on a module-wide basis, which affects all channels.

The module attenuates the selected frequency by approximately -3 dB or 0.707 of the applied amplitude.

An input signal with frequencies above the selected frequency is attenuated more while frequencies below the selection receive no attenuation.



A by-product of the filter selection is the minimum sample rate (RTS) that is available. For example, the 1000 Hz selection does not attenuate any frequencies less than 1000 Hz, and provides for sampling of all 16 channels within 11 ms. The 15 Hz selection attenuates all frequencies above 15 Hz and provides only for sampling all 16 channels within 328 ms.

IMPORTANT Do not use the 1000 Hz module filter with HART instruments.

IMPORTANT 60 Hz is the default setting for the module filter. This setting provides approximately 3 dB of attenuation of a 60 Hz input.

Series A Module Filter Selections with Associated Performance Data

Module Filter Selection (-3 dB) (1)	15 Hz	20 Hz	50 Hz	60 Hz	100 Hz	250 Hz	1000 Hz
Minimum Sample Time (RTS)	328 ms	275 ms	115 ms	115 ms	61 ms	25 ms	11 ms
Effective Resolution	18 bits	18 bits	17 bits	17 bits	16 bits	16 bits	15 bits
	0.08 µA	0.08 µA	0.16 µA	0.16 µA	0.32 µA	0.32 µA	0.64 µA
50 Hz Rejection	74 dB	48 dB	6 dB	6 dB	1 dB	0.1 dB	–
60 Hz Rejection	74 dB	97 dB	9 dB	9 dB	2 dB	0.2 dB	–

(1) Worst case settling time to 100% of a step change is double the real-time sample time.

Series B Module Filter Selections with Associated Performance Data

Module Filter Selection (-3 dB) (1)	15 Hz	20 Hz	50 Hz	60 Hz	100 Hz	250 Hz	1000 Hz
Minimum Sample Time (RTS)	328 ms	275 ms	115 ms	115 ms	61 ms	25 ms	11 ms
Effective Resolution	18 bits	18 bits	17 bits	17 bits	16 bits	15 bits	15 bits
	0.08 µA	0.08 µA	0.16 µA	0.16 µA	0.32 µA	0.64 µA	0.64 µA
50 Hz Rejection	-115 dB	-48.5 dB	-6.3 dB	-6.3 dB	-1.5 dB	-0.15 dB	-0.005 dB
60 Hz Rejection	-80.97 dB	-119.9 dB	-9.3 dB	-9.3 dB	-2.2 dB	-0.21 dB	-0.008 dB

(1) Worst case settling time to 100% of a step change is double the real-time sample time.

Real-time Sampling (RTS)

This parameter instructs the module how often to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data. This feature is applied on a module-wide basis.

During module configuration, you specify a real-time sampling (RTS) period and a requested packet interval (RPI) period. Both of these features instruct the module to multicast data, but only the RTS feature instructs the module to scan its channels before multicasting.

Underrange and Overrange Detection

The module detects when it's operating beyond the limits of the input range. This status indication tells you that the input signal isn't being measured accurately because the signal is beyond the measuring capability of the module. For example, the module cannot distinguish between 20.58 mA and 22 mA.

This table shows the input ranges of the 1756-IF16H module and the lowest and highest signal available in each range before the module detects an underrange and overrange condition.

Low and High Signal Limits on the 1756-IF16H Module

Module	Available Range	Lowest Signal in Range	Highest Signal in Range
1756-IF16H	0...20 mA	0 mA	20.58 mA
	4...20 mA	3.42 mA	20.58 mA

Digital Filter

The digital filter smooths input data noise transients. This feature is applied on a **per channel** basis.

The digital filter value specifies the time constant for a digital first order lag filter on the input. It's specified in units of milliseconds. A value of 0 disables the filter.

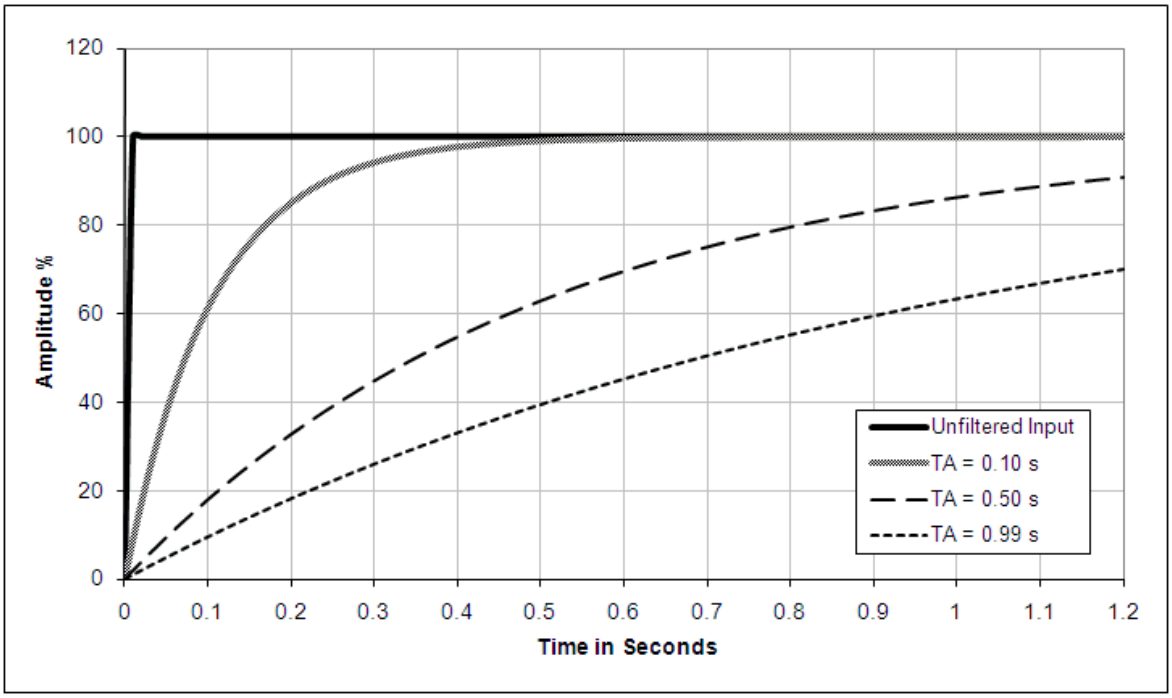
The digital filter equation is a classic-first-order lag equation.

$$Y_n = Y_{n-1} + \frac{[\Delta t]}{\Delta t + T_A} (X_n - Y_{n-1})$$

Y_n = present output, filtered peak voltage (PV)
Y_{n-1} = previous output, filtered PV
Δt = module channel update time (seconds)
T_A = digital filter time constant (seconds)
X_n = present input, unfiltered PV

This figure uses a step input change to illustrate the filter response. When the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.

Filter Response



Wire-off Detection

The 1756-IF16H module alerts you when a signal wire is disconnected from one of its channels or the RTB is removed from the module if the channel is configured for 4...20 mA range. When a wire-off condition occurs for this module, two events occur:

- Input data for that channel changes to the scaled value that corresponds to the Underrange condition.
- A fault bit is set in the input tag (Ch*xx*Underrange and Ch*xx*BrokenWire tags are set to 1), which can indicate the presence of a wire-off condition.

Wire the Module

Use this information to wire the current inputs.

1756-IF16H Module Current Inputs

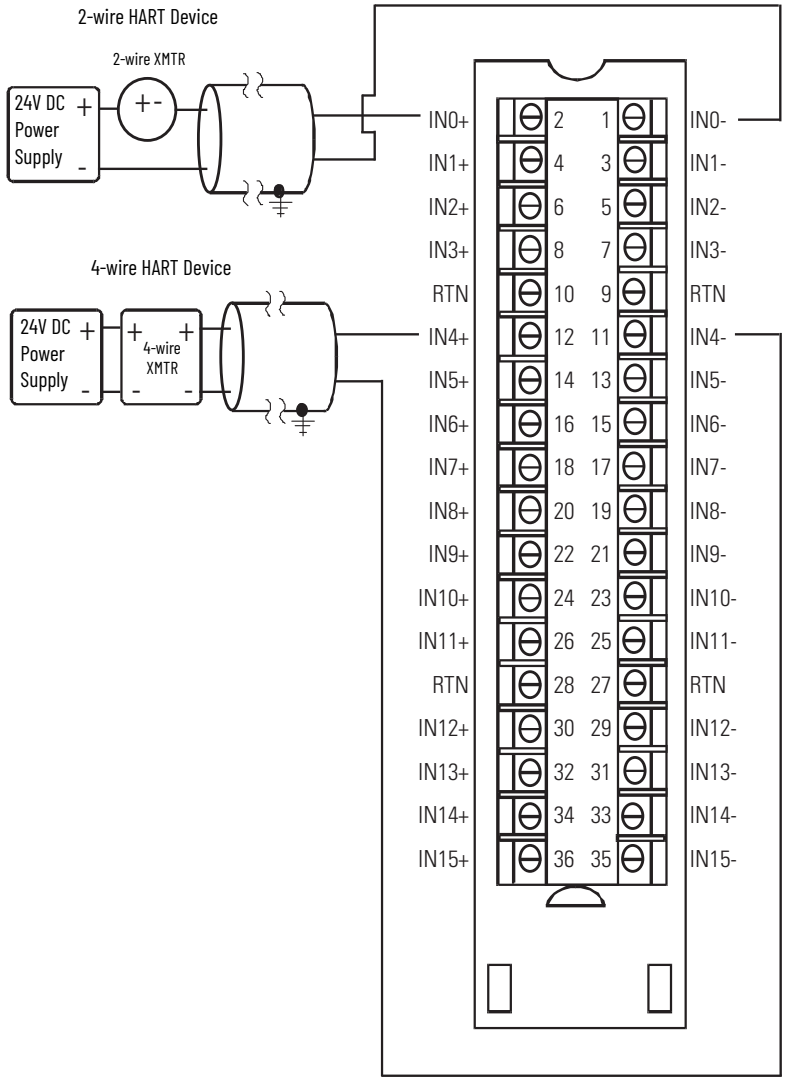


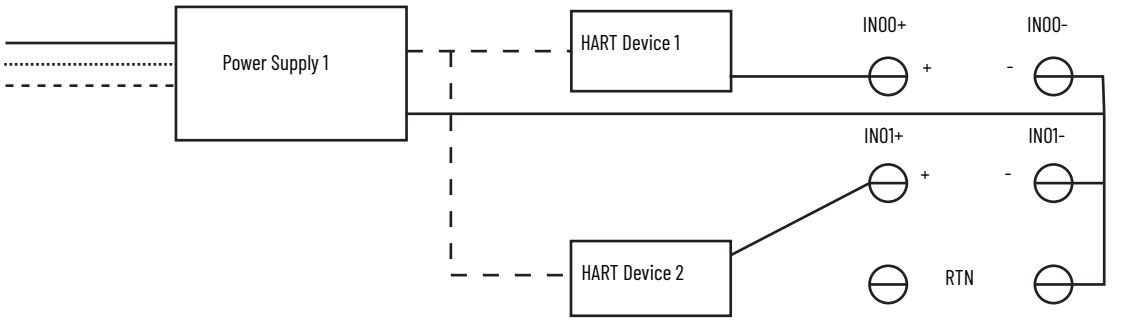
Table 1 -

Channel	Pin #	Usage	Usage	Pin #
00	2	IN00+	IN00-	1
01	4	IN01+	IN01-	3
02	6	IN02+	IN02-	5
03	8	IN03+	IN03-	7
	10	RTN	RTN	9
04	12	IN04+	IN04-	11
05	14	IN05+	IN05-	13
06	16	IN06+	IN06-	15
07	18	IN07+	IN07-	17
08	20	IN08+	IN08-	19
09	22	IN09+	IN09-	21
10	24	IN10+	IN10-	23
11	26	IN11+	IN11-	25
	28	RTN	RTN	27
12	30	IN12+	IN12+	29
13	32	IN13+	IN13+	31
14	34	IN14+	IN14+	33
15	36	IN15+	IN15+	35

The 1756-IF16H is a differential input module. However there are limitations on its use in differential mode. Anytime the low ends of the terminal block pins are connected together they must also be jumpered to the RTN pin on the terminal block. There are two scenarios in which this shared connection is needed.

First, if one power supply is used for multiple devices then the low ends from the channels are connected together and connected to the ground return of the power supply.

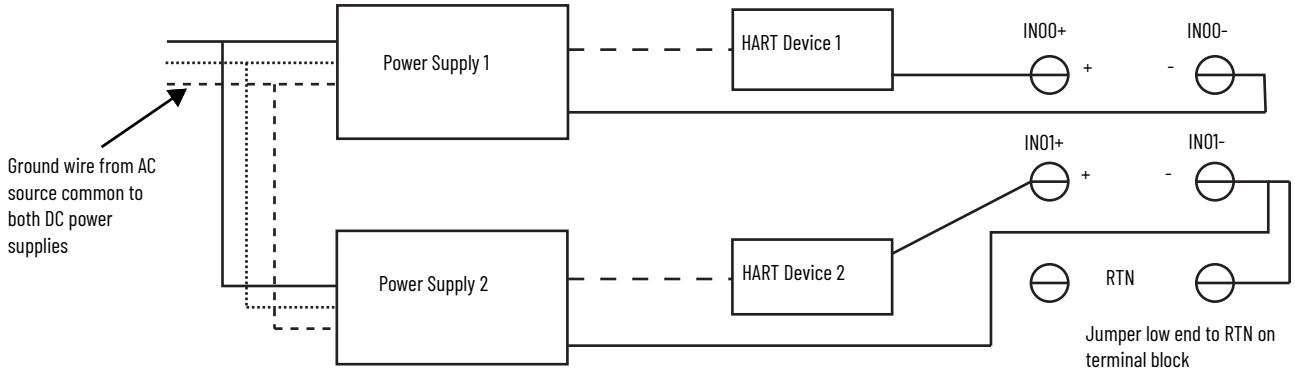
Single Power Supply with Multiple HART Devices



Because the low ends of the terminal block pins are connected together, they must also be connected to RTN.

Second, if multiple power supplies are used, they can be connected to the same ground. In this case, the low ends of the channels are effectively connected together by the common grounds of the power supplies.

Multiple Power Supplies with a Common Ground

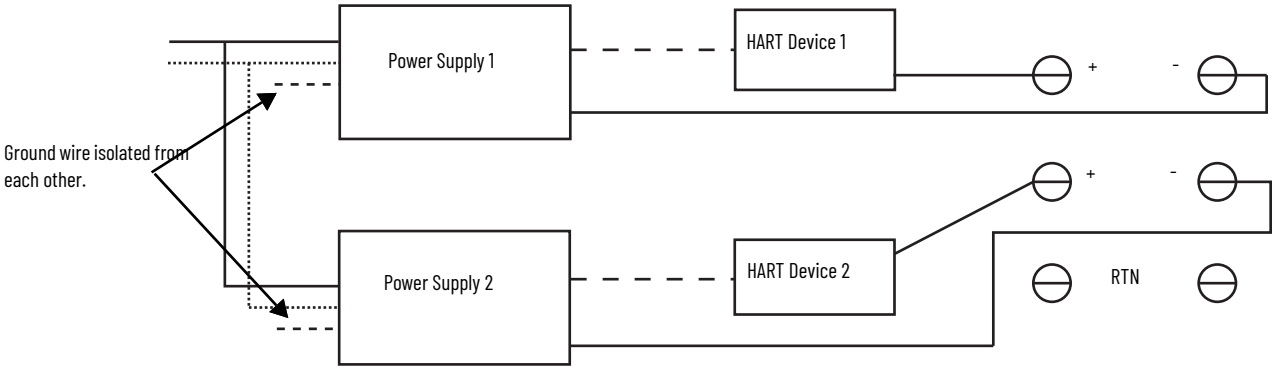


Jumper low end to RTN on terminal block

The low ends of the terminal block pins are hooked together via the common ground of the power supples and must be connected to the RTN pin.

For devices powered by separate supplies, when the ground potential of the supplies is expected to differ, differential mode is recommended. Using differential mode helps prevent ground loop currents from flowing between the supplies. However, the potential difference allowable between the supplies must remain within specified limits.

Power Supplies with Isolated Grounds



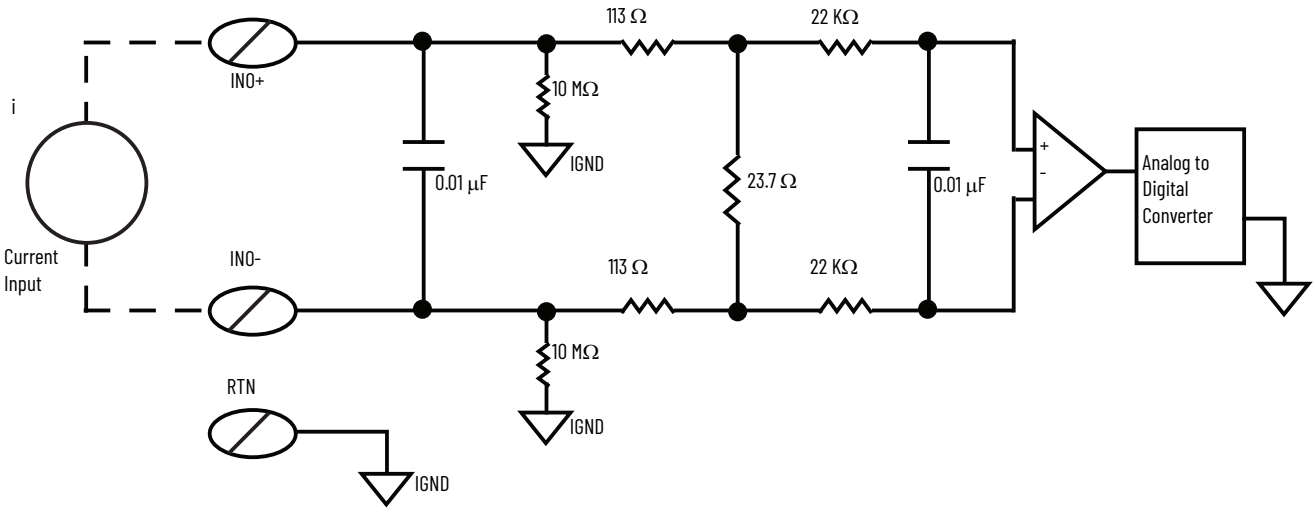
The low ends of the terminal block pins are now isolated from each other and the inputs can be configured as true differential inputs as long as the voltage difference between them does not exceed 7V.

Some devices, such as AC powered four wire devices, are recommended to be used in differential mode only. Combinations of differential and single-ended configurations are allowed but care must be taken to make sure that the differential input grounds really are isolated from the single-ended inputs.

Circuit Diagram

This figure is a simplified input circuit diagram for the 1756-IF16H module.

1756-IF16H Simplified Current Input Circuit



1756-IF16H Module Fault and Status Reporting

The 1756-IF16H module sends status/fault data to the controller with its channel data. The fault data is arranged to let you choose the level of granularity you desire for examining fault conditions. Three levels of tags work together to provide an increasing degree of detail as to the specific cause of faults on the module.

This table shows the tags that can be examined in ladder logic to indicate when a fault has occurred.

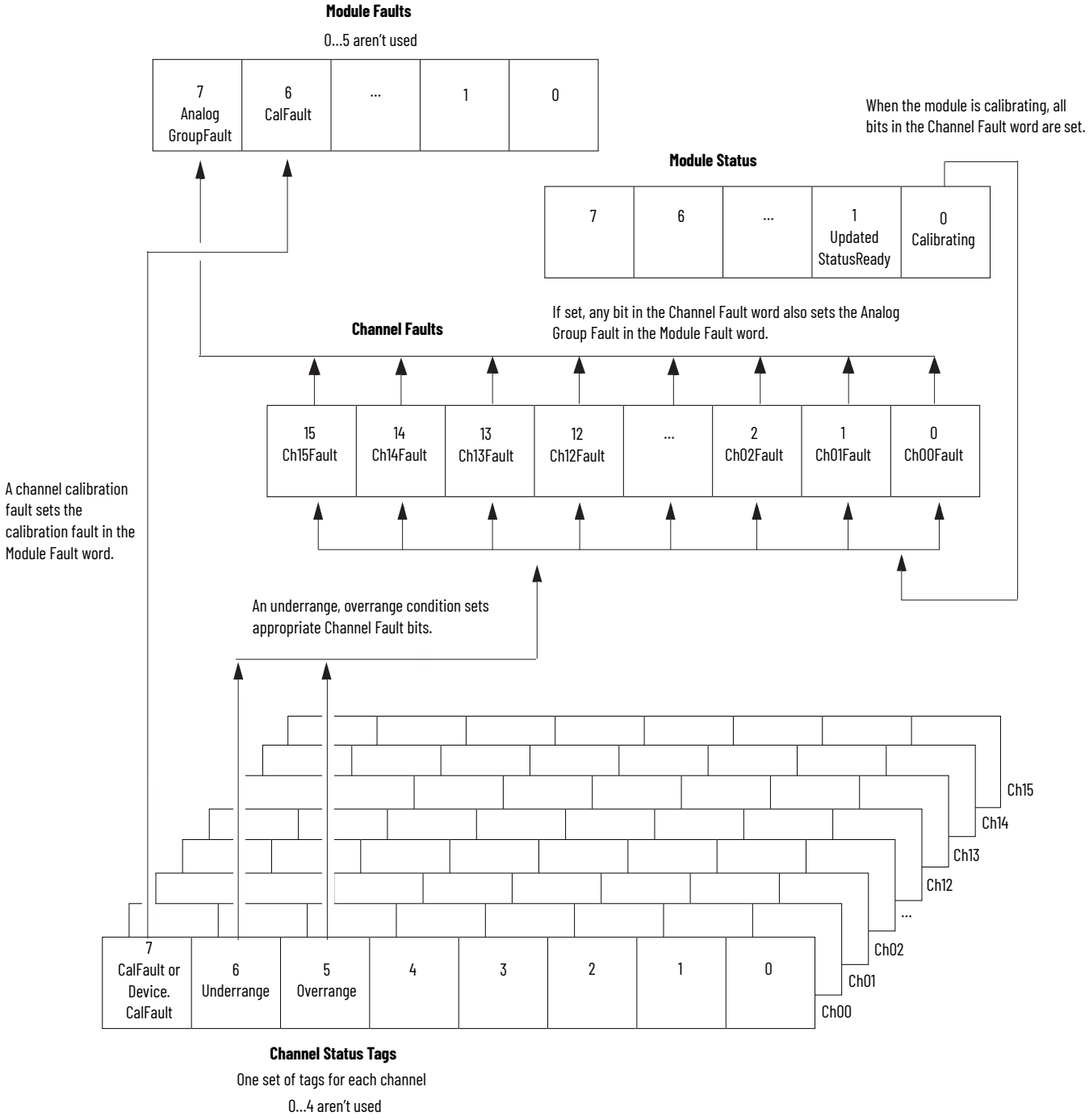
1756-IF16H Tags That Can Be Examined in Ladder Logic

Tag	Description	Tag Name Analog and HART PV	Tag Name Analog and HART by Channel
Module Fault Word	This word provides fault summary reporting.	ModuleFaults	ModuleFaults
Channel Fault Word	This word provides clamp and communication fault reporting.	ChannelFaults ChxxFault	ChannelFaults Chxx.Fault
Channel Status Tags	These words provide individual channel limit, hold, open wire, ramp status, and calibration faults.	ChxxStatus	Chxx.Device Status Chxx.DeviceStatus.AlarmStatus
HART Faults	This provides HART communication status.	HARTFaults, ChxxHARTFault	Chxx.DeviceStatus.HARTFault
HART Device Status	This provides HART field device health.	HART.ChxxDevice Status	Chxx.DeviceStatus.FieldDeviceStatus

1756-IF16H Module Fault Reporting

This figure offers an overview of the fault reporting process for the 1756-IF16H module.

1756-IF16H Module Fault Reporting



1756-IF16H Module Fault Word Bits

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further to isolate the fault. This table lists tags that can be examined in ladder logic to indicate when a fault has occurred.

1756-IF16H Tags That Can Be Examined in Ladder Logic

Tag	Description
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalFault.

1756-IF16H Channel Fault Tags

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Under or Overrange condition. Checking this word for a nonzero value is a quick way to check for Under or Overrange conditions on the module.

Channel Fault bits for all channels are also set (16#FFFF) if calibration is being performed or a communication fault has occurred between the module and its owner controller.

1756-IF16H Channel Status Tags

This table describes the channel status tags.

1756-IF16H Tags That Show Channel Status(1)

Tag	Bit	Description
Ch*xx*CalFault	7	This bit is set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault in the Module Faults.
Ch*xx*Underrange	6	This bit is set when the analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value. Also sets Ch*xx*Fault in the Channel Faults.
Ch*xx*Overrange	5	This bit is set when the analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value. Also sets Ch*xx*Fault in the Channel Faults.

(1) Bits 0...4 aren't used.

Module Calibration

You can initiate calibration of the 1756-IF16H module via the Logix Designer application Calibration view.

The Calibration view in the Logix Designer application provides a button to initiate module calibration and a display of the results. Refer to Calibrate Your Module on page 154 for more information.

Module-defined Data Types, 1756-IF16H Module

This section describes module-defined data types for the 1756-IF16H module and includes information for configuration and input tags.

Available tags depend on the selected input data format, as shown in this table.

1756-IF16H Input Data Choice and Tags

Input Data Choice	Tag	Main Module Defined Type	Subtype Used by Main Type
Analog Only	Configuration	AB:1756_IF16H:C:0	AB:1756_IF16H_ChConfig_Struct:C:0
	Input	AB:1756_IF16H_Analog:I:0	None
Analog and HART PV	Configuration	AB:1756_IF16H:C:0	AB:1756_IF16H_ChConfig_Struct:C:0
	Input	AB:1756_IF16H_HARTPV:I:0	AB:1756_IF16H_HARTData:I:0 AB:1756_IF16H_HARTStatus_Struct:I:0
Analog and HART by Channel	Configuration	AB:1756_IF16H:C:0	AB:1756_IF16H_ChConfig_Struct:C:0
	Input	AB:1756_IF16H_AnalogHARTbyChannel:I:0	AB:1756_IF16H_HARTDataAll_Struct:I:0 AB:1756_IF16H_HARTStatusAll_Struct:I:0

Configuration

This table describes the configuration tags available for the 1756-IF16H module.

1756-IF16H Configuration Tags (AB:1756_IF16H:C:0)

Member Name	Type	Style	Description
ModuleFilter (bits 0...7)	SINT	Decimal	See the Series A Module Filter Selections with Associated Performance Data table on page 68.
RealTimeSample (bits 0...15)	INT	Decimal	Milliseconds between reading signal values. See Real-time Sampling (RTS) on page 69 for more information.
ChxxConfig (xx = 00...15)	AB:1756_IF16H_ChConfig_Struct:C:0		
Config	SINT	Binary	
HARTEn	BOOL	Decimal	ChxxConfig.Config.7, Enable HART communication. Must be 1 for valid HART data in input tag and asset management access to HART field device.
RangeType	SINT	Decimal	0 = 0...20 mA 1 = 4...20 mA
DigitalFilter	INT	Decimal	Time constant of low pass filter in ms. See Digital Filter on page 70 for more information.
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than or equal to the minimum input range. See Scaling to Engineering Units on page 143 for more information.
HighSignal	REAL	Float	Upper current value for scaling to engineering units. Default is 20 mA. Must be more than LowSignal and less than or equal to the maximum input Range. See Scaling to Engineering Units on page 143 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
CalBias	REAL	Float	Sensor Offset in engineering units added to the measured signal before reporting Chxx.Data.
PassthroughHandle Timeout	INT	Decimal	Seconds to keep a reply to a HART pass-through service request before discarding; 15 seconds is recommended.

Analog Only

This table describes the input tags available in the Analog Only data format for the 1756-IF16H module.

1756-IF16H Input Tags - Analog Only (AB:1756_IF16H_Analog:I:0)

Member Name	Type	Style	Description
ChannelFaults (bits 0...15)	INT	Binary	Indicates a problem with analog data on Channel x or broken communication between the Logix controller and the 1756-IF16H module. Example: Set if the analog signal is larger than 20 mA.
ChxxFault (xx = 00...15)	BOOL	Decimal	ChannelFaults.0...ChannelFaults.15
Module Status	SINT	Binary	
Calibrating	BOOL		ModuleStatus.0, Calibration in progress
UpdatedStatusReady	BOOL		ModuleStatus.1, Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
ModuleFaults	SINT	Binary	Module level fault status bits (bits 0...5 not used)
CalFault	BOOL	Decimal	(ModuleFaults.6) 1756-IF16H Module Calibration Failed.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
BrokenWireFaults (bit 0...15)	INT	Binary	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this. If configured for 4...20 mA, a broken wire fault sets this bit.
ChxxBroken Wire	BOOL	Decimal	BrokenWireFaults.0...BrokenWireFaults.15
HARTFaults (Ch00...Ch15)	INT	Binary	Indicates a problem with HART data from the Field Device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ChxxHARTFault	BOOL	Decimal	HARTFaults.0...HARTFaults.15
ChxxStatus (xx = 00...15)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxxFault.
ChxxOverrange	BOOL		ChxxStatus.5 Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxxUnderrange	BOOL		ChxxStatus.6 Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxxCalFault	BOOL		ChxxStatus.7 Set if an error occurs during calibration for Chxx, which causes a bad calibration. Also sets CalFault.
ChxxData (xx = 00...15)	REAL	Float	Value of analog signal on Channel *xx* after conversion to engineering units.
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of Coordinated System Time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Analog and HART PV

This table describes the input tags available in the Analog and HART PV data format for the 1756-IF16H module.

1756-IF16H Input Tags - Analog and HART PV (AB:1756_IF16H_HARTPV:I:0)

Member Name	Type	Style	Description
ChannelFaults (bit0...15)	INT	Binary	Indicates a problem with analog data on Channel x or broken communication between the Logix controller and the 1756-IF16H module. Example: Set if the analog signal is larger than 20 mA.
ChxxFault (xx = 00...15)	BOOL	Decimal	ChannelFaults.0...ChannelFaults.15
ModuleStatus	SINT	Binary	
Calibrating	BOOL		(ModuleStatus.0) Calibration in progress.
UpdatedStatusReady	BOOL		(ModuleStatus.1) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
ModuleFaults	SINT	Binary	(bits0...5 not used)
CalFault	BOOL	Decimal	(ModuleFaults.6) 1756-IF16H Module Calibration Failed.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
BrokenWireFaults (bit 0...15)	INT	Binary	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
ChxxBroken Wire	BOOL	Decimal	BrokenWireFaults.0...BrokenWireFaults.15
HARTFaults	INT	Binary	Indicates a problem with HART data from the Field Device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ChxxHARTFault	BOOL	Decimal	HARTFaults.0...HARTFaults.15
ChxxStatus (xx = 00...15)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxxFault for Overrange, Underrange, and/or CalFault.
ChxxOverrange	BOOL		(ChxxStatus.05) Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxxUnderrange	BOOL		(ChxxStatus.06) Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxxCalFault	BOOL		(ChxxStatus.07) Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ChxxData (xx = 00...15)	REAL	Float	Value of analog signal on Channel xx after conversion to engineering units.
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of Coordinated System Time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.
HART	AB:1756_IF16H_HARTData:I:0, Contains HART field device health and dynamic process variables.		
ChxxDeviceStatus (xx = 00...15)	AB:1756_IF16H_HARTStatus_Struct:I:0, Channel 0 HART Device status info.		
Init	BOOL		Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't Enabled on this channel. If both are 1, then 1756-IF16H is sending out HART messages to attempt to establish communication with a HART device.
Fail	BOOL		HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL		Pass-through message reply is ready for Query service.
CurrentFault	BOOL		Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL		The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-IF16H module via CIP™ MSG GetDeviceInfo, which clears this bit.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART Field device. See Field Device Status Bit Mask Definitions on page 205 for more information.

1756-IF16H Input Tags - Analog and HART PV (AB:1756_IF16H_HARTPV:I:0) (Continued)

Member Name	Type	Style	Description
ExtDeviceStatus	SINT	Binary	Extended device status byte. Bit 0 is Maintenance Needed. Bit 1 is Device Variable Alert. Bit 2 is Low Power.
Ch*xx*PV (xx = 00...15)	REAL		Channel *xx* HART PV Value.
Ch*xx*SV (xx = 00...15)	REAL		Channel *xx* HART SV Value.
Ch*xx*TV (xx = 00...15)	REAL		Channel *xx* HART TV Value.
Ch*xx*FV (xx = 00...15)	REAL		Channel *xx* HART FV Value.
Ch*xx*PVStatus (xx = 00...15)	SINT		Channel *xx* HART PV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.
Ch*xx*SVStatus (xx = 00...15)	SINT		Channel *xx* HART SV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.
Ch*xx*TVStatus (xx = 00...15)	SINT		Channel *xx* HART TV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.
Ch*xx*FVStatus (xx = 00...15)	SINT		Channel *xx* HART FV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.

Analog and HART by Channel

This table describes the input tags available in the Analog with HART Channel Grouped data format for the 1756-IF16H module.

1756-IF16H Input Tags - Analog and HART by Channel (AB:1756-IF16H_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
ChannelFaults (bit0...15)	INT	Binary	Indicates a problem with analog data on Channel *xx* or broken communication between the Logix controller and the 1756-IF16H module. Example: Set if the analog signal is larger than 20 mA.
Ch*xx*Fault (xx = 00...15)	BOOL		ChannelFaults.*xx*
ModuleStatus	SINT	Binary	
Calibrating	BOOL	Decimal	(ModuleStatus.0) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleStatus.1) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
ModuleFaults	SINT	Binary	
CalFault	BOOL		(ModuleFaults.6) 1756-IF16H module calibration failed.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
Chxx (xx = 00...15)	AB:1756_IF16H_HARTDataAll_Struct:I:0, Channel xx analog and HART data.		
Data	REAL	Float	Analog value in engineering units.
DeviceStatus	AB:1756_IF16H_HARTStatusAll_Struct:I:0, Channel 00 HART Device status info.		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't Enabled on this channel. If both are 1, then 1756-IF16H is sending out HART messages to attempt to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL	Decimal	Pass-through message reply is ready for query service.
CurrentFault	BOOL	Decimal	Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL	Decimal	The field device configuration has changed and new field device configuration information can be obtained from the 1756-IF16H module via CIP MSG GetDeviceInfo, which clears this bit.
MaintenanceRequired	BOOL		Bit 0 of Extended Device Status (if using CMD 9, or from CMD 48 if supported).
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel xx. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.

1756-IF16H Input Tags - Analog and HART by Channel (AB:1756-IF16H_AnalogHARTbyChannel:I:0) (Continued)

Member Name	Type	Style	Description
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART Field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
AlarmStatus	SINT	Binary	Indicates various alarms on the analog signal.
DeviceVariableAlert	BOOL		AlarmStatus.4, Bit 1 of Extended Device Status. Device reports a problem with some measurement.
Overrange	BOOL		AlarmStatus.5, Signal value over range (over 20 MA).
Underrange	BOOL		AlarmStatus.6, Signal value under range. (less than 3.4 mA if configured for 4...20 mA).
CalFault	BOOL		AlarmStatus.7, Bad calibration.
PV	REAL	Float	Primary value. This is the same value as signaled on the analog channel and is the most important measurement that is made by this device.
SV	REAL	Float	Secondary value
TV	REAL	Float	Third value
FV	REAL	Float	Fourth value
PVStatus	SINT	Hex	Primary status 16#C0 = Connected 16#00 = Not Connected
SVStatus	SINT	Hex	Secondary status 16#C0 = Connected 16#00 = Not Connected
TVStatus	SINT	Hex	Third status 16#C0 = Connected 16#00 = Not Connected
FVStatus	SINT	Hex	Fourth status 16#C0 = Connected 16#00 = Not Connected
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Notes:

1756-IF16IH HART Isolated Analog Input Module

Module Features

The 1756-IF16IH module is an isolated, 16-channel, current-only input module capable of HART communication on all channels. Each channel is individually configurable.

The 1756-IF16IH module has the following features:

- 16 isolated, individually configurable input channels with a separate HART modem on each channel
- Channel-to-channel, channel-to-backplane, and channel-to-frame ground galvanic isolation at a continuous level of 250V AC rms
- Two input ranges: 0...20 mA and 4...20 mA
- Compatible tag layouts with the non-isolated 1756-IF16H module for use of the 1756-IF16IH module in existing systems:
  - 1756-IF16H compatible configuration Instance
  - 1756-IF16H compatible input data tag layouts for Analog Only, Analog and HART PV, and Analog and HART PV by Channel Grouped
- Supports full simultaneous HART 1200 baud bandwidth to all channels
- Channel ADC filter (one setting per module)
- Digital filtering (configurable per channel)
- Real-time sampling
- Auto-scanning of HART variables (PV, SV, TV, FV)
- HART pass-through interface
- User scaling of input data
- Time stamping
- Alarms and fault detection
  - Open wire detection(4...20 mA range)
  - Underrange and overrange detection
  - Fault reporting
- User Calibration via Add-on Profile (AOP)
- Downloadable firmware using ControlFLASH™ software
- Add-on Profile
- "Bumpless" configuration for a smooth transition in new configurations
- Removal and insertion under power (RIUP)

HART Compatibility

The 1756-IF16IH functions as a HART master. It communicates with HART devices that have a HART revision of 5, 6, or 7. Each channel has its own HART modem and functions as a HART primary master.

The 1756-IF16IH module supports one HART device per channel.

The 1756-IF16IH module does not support burst mode, phase shift keying (PSK), or multi-drop network configuration. The module detects and turns off a bursting device at initial connection with the device.

HART Handheld Configurator

A HART handheld configuration tool can be connected to the HART device while the module is connected as long as the configuration tool is the secondary master.

Input Data Types

The Input Data type you choose determines which values are included in the Input tag of the module and the features that are available to your application. Select the Input Data type on the Device Definition dialog of the Studio 5000 Logix Designer® application. This table shows the available data types for the 1756-IF16IH module.

Data Types for the 1756-IF16IH Module

Input Data Type	Description			
	Analog signal values	Analog status	HART process variables and device health	Grouped HART and analog data for each channel
Analog Only	X	X		
Analog and HART PV	X	X	X	
Analog and HART PV by Channel Grouped	X	X	X	X

- Choose Analog and HART PV if you prefer the members of your tag to be arranged similar to non-HART analog input modules. With this selection, the analog values for all channels are grouped near the end of the tag. This arrangement makes it easy to view all 16 analog values at once.
- Choose Analog and HART PV by Channel Grouped if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This arrangement makes it easier to view all data that is related to one field device.

Input Ranges

You can select one of two input ranges for each channel on the module. The possible ranges that designate the minimum and maximum signals detectable by the module are:

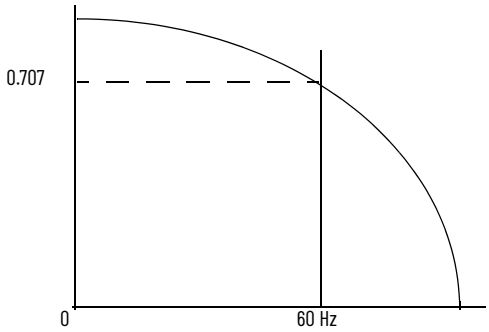
- 0...20 mA
- 4...20 mA (HART instruments use this range)

Module Filter

The module filter attenuates the input signal at the specified frequency and above. This feature is applied on a module-wide basis, which affects all channels.

The module attenuates the selected frequency by approximately -3 dB or 0.707 of the applied amplitude.

An input signal with frequencies above the selected frequency is attenuated more while frequencies below the selection receive no attenuation.



A by-product of the filter selection is the minimum available sample rate (RTS). For example, the 1000 Hz selection does not attenuate any frequencies less than 1000 Hz, and provides for sampling of all 16 channels within 11 ms. The 15 Hz selection attenuates all frequencies above 15 Hz and provides only for sampling all 16 channels within 328 ms.

IMPORTANT Do not use the 1000 Hz module filter with HART instruments.

IMPORTANT 15 Hz is the default setting for the module filter.

Use this table to choose a module filter setting.

Module Filter Selections with Associated Performance Data for 1756-IF16IH

Module Filter Setting (-3 dB)	15 Hz	20 Hz	50 Hz	60 Hz	100 Hz	250 Hz	1000 Hz
Minimum Sample Time (RTS)	328 ms	275 ms	115 ms	115 ms	61 ms	25 ms	11 ms
Effective Resolution (0...20 mA, 4...20 mA range)	18 bits	18 bits	17 bits	17 bits	16 bits	16 bits	15 bits
	0.08 μA	0.08 μA	0.16 μA	0.16 μA	0.32 μA	0.32 μA	0.64 μA
-3 dB Frequency	11.5 Hz	13.8 Hz	34.5 Hz	34.5 Hz	69.0 Hz	221 Hz	1104 Hz
50 Hz Common Rejection	100 dB	–	–	–	–	–	–
50 Hz Normal Rejection	74 dB	–	–	–	–	–	–
60 Hz Normal Rejection	74 dB	97 dB	–	–	–	–	–
60 Hz Common Rejection	100 dB	100 dB	–	–	–	–	–
Channel ADC Update Rate (samples per second)	50 SPS	60 SPS	150 SPS	150 SPS	300 SPS	960 SPS	4800 SPS
Settling Time	80 ms	66.7 ms	26.7 ms	26.7 ms	13.3 ms	4.17 ms	0.83 ms

Digital Filter

The digital filter smooths input data noise transients. There's a separate digital filter for each channel.

The digital filter value specifies the time constant in milliseconds for a digital first order lag filter on the input. A value of 0 disables the filter.

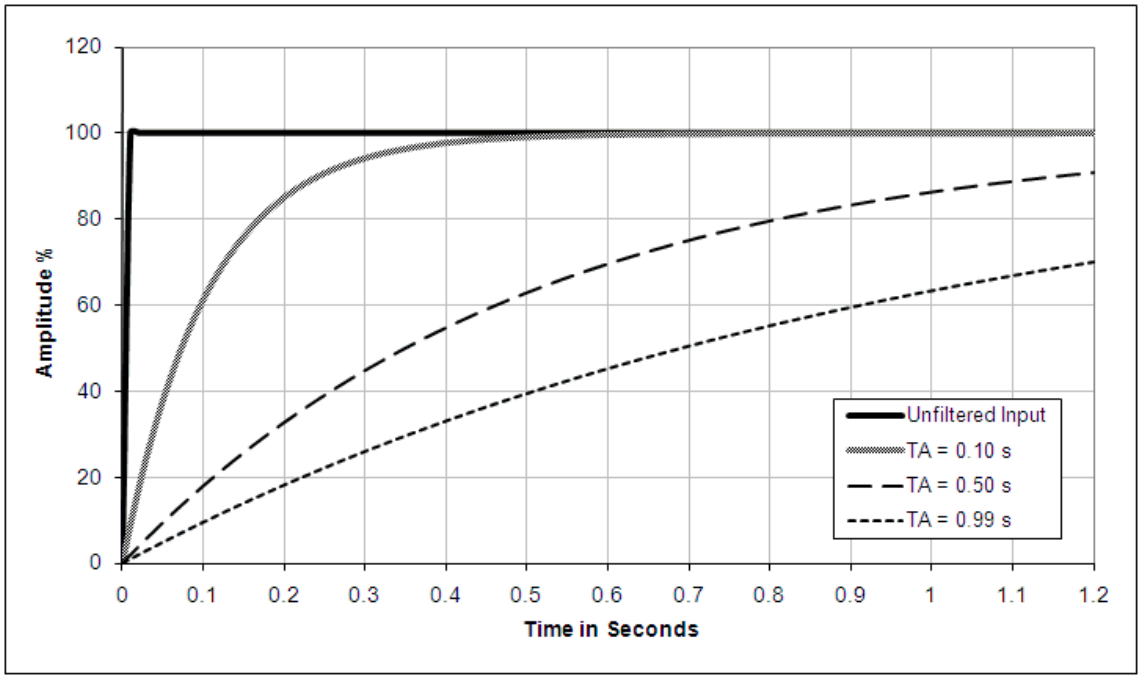
The digital filter equation is a classic-first-order lag equation:

$$Y_n = Y_{n-1} + \frac{[\Delta t]}{\Delta t + T_A} (X_n - Y_{n-1})$$

Y_n = present output, filtered peak voltage (PV)
Y_{n-1} = previous output, filtered PV
Δt = module channel update time (seconds)
T_A = digital filter time constant (seconds)
X_n = present input, unfiltered PV

This figure illustrates the filter response to a step input. When the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.

Filter Response to a Step Input



Real-time Sampling

This parameter instructs the module how often to scan its input channels and obtain new sampled data. After the channels are scanned, the module broadcasts that data (multicast or unicast) to the local chassis backplane. After the channels are scanned, the module multicasts that data. This feature is applied on a module-wide basis.

During module configuration, you specify a real-time sampling (RTS) period and a requested packet interval (RPI) period. Both of these features instruct the module to broadcast data, but only the RTS feature instructs the module to scan its channels before broadcasting.

For more RTS information, see Real Time Sample (RTS) on page 22.

Underrange and Overrange Detection

The module detects when it's operating beyond the limits of the input range. Thisn't being measured accurately because the signal is beyond the measuring capability of the module. For example, the module can't distinguish between 20.58...30 mA.

This table shows the input ranges of the 1756-IF16IH module and the lowest and highest signal available in each range before the module detects an underrange and overrange condition.

Low and High Signal Limits on the 1756-IF16IH Module

Input Module	Available Range	Lowest Signal in Range	Highest Signal in Range
1756-IF16IH	0...20 mA	0 mA	20.58 mA
	4...20 mA	3.42 mA	20.58 mA

Open Circuit Detection

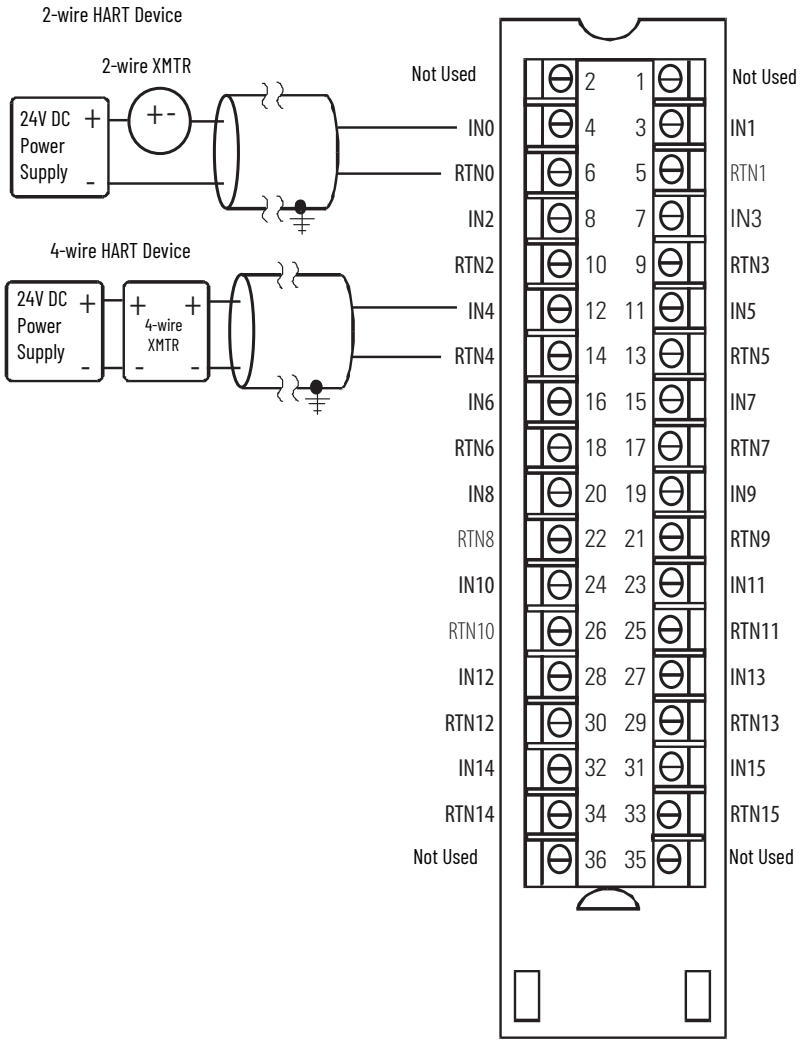
In the 4...20 mA range, if the signal wire to a channel opens, the module reports a negative full-scale value in the input data tag of the channel within 5 seconds. The module also sets the ChxBrokenWire status bit.

In the 0...20 mA range, an open-circuit condition results in a measured value of 0 mA, which is the same as a measured value of 0 mA when there isn't an open-circuit condition. The appropriate Underrange bit is set but the ChxBrokenWire bit isn't set.

Wire the Module

Use the information in this figure to wire the current inputs.

1756-IF16IH Current Inputs

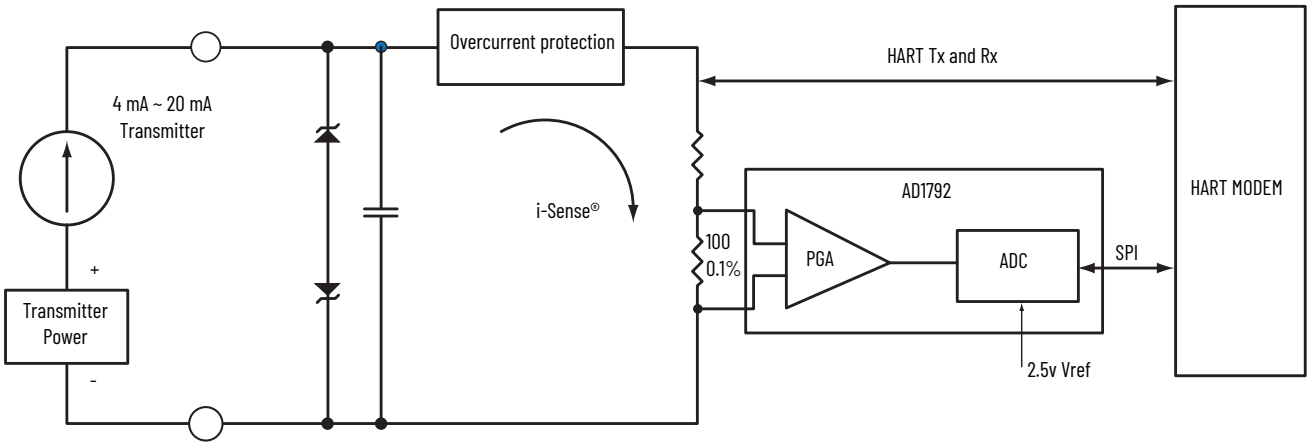


Pin #	Usage	Usage	Pin #
2	Not Used	Not Used	1
4	IN0	IN1	3
6	RTN0	RTN1	5
8	IN2	IN3	7
10	RTN2	RTN3	9
12	IN4	IN5	11
14	RTN4	RTN5	13
16	IN6	IN7	15
18	RTN6	RTN7	17
20	IN8	IN9	19
22	RTN8	RTN9	21
24	IN10	IN11	23
26	RTN10	RTN11	25
28	IN12	IN13	27
30	RTN12	RTN13	29
32	IN14	IN15	31
34	RTN14	RTN15	33
36	Not Used	Not Used	35

Circuit Diagram

This figure is a simplified input circuit diagram for the 1756-IF16IH module.

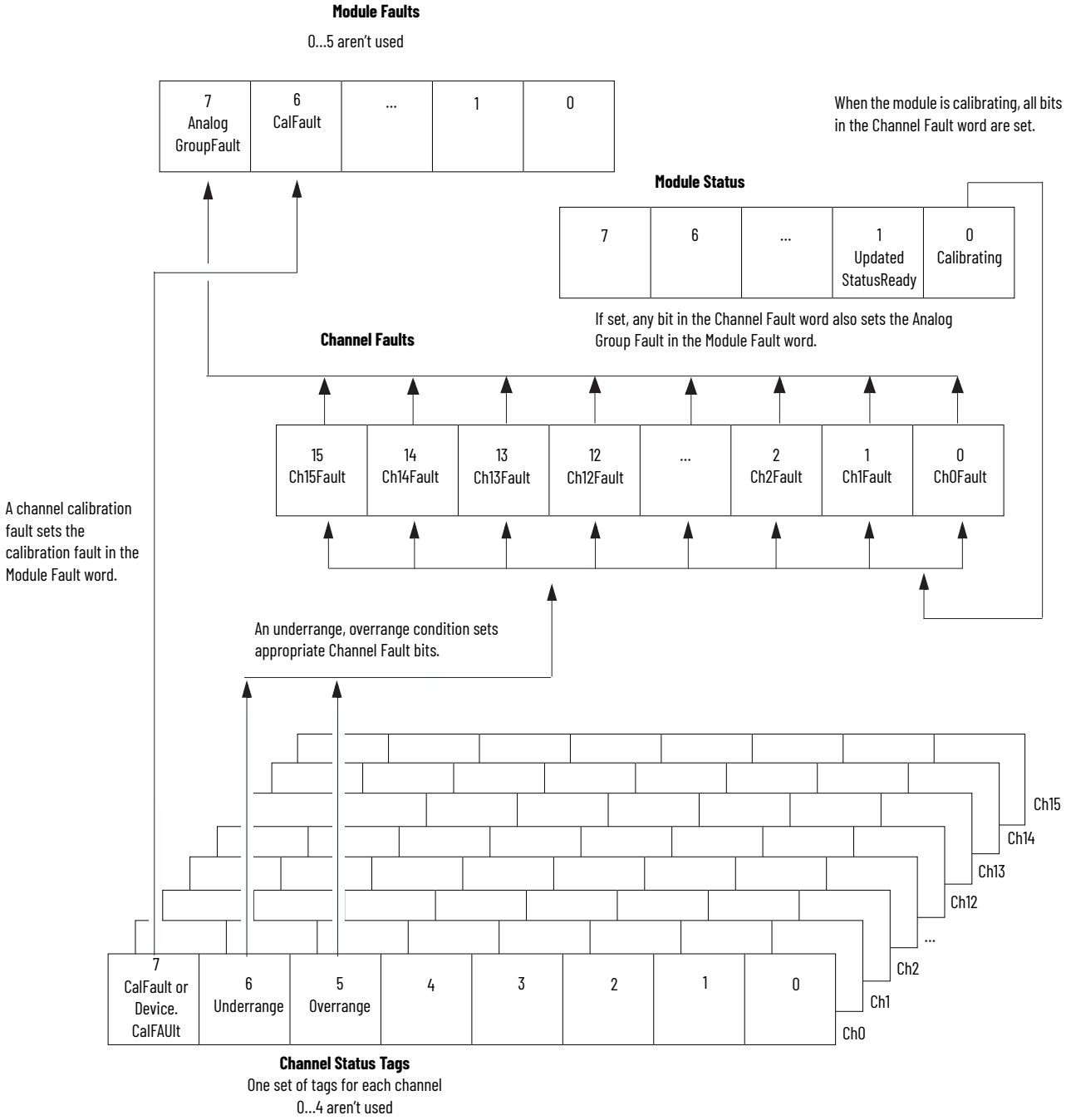
1756-IF16IH Simplified Current Input Circuit



1756-IF16IH Module Fault and Status Reporting

The 1756-IF16IH module sends status/fault data to the controller with its channel data. The fault data is arranged to let you choose the level of granularity you desire for examining fault conditions. Three levels of tags work together to provide an increasing degree of detail as to the specific cause of faults on the module. This figure offers an overview of the fault reporting process for the 1756-IF16IH module offers an overview of how faults are reported.

1756-IF16IH Module Fault Reporting



This table shows the tags that can be examined in ladder logic to indicate when a fault has occurred.

1756-IF16IH Tags That Can Be Examined in Ladder Logic

Tag	Description	Tag Name Analog and HART PV	Tag Name Analog and HART PV by Channel Grouped
Module Fault Word	This word provides fault summary reporting.	ModuleFaults	ModuleFaults
Channel Fault Word	This word provides clamp and communication fault reporting.	ChannelFaults Ch*xx*Fault	ChannelFaults Ch*xx*Fault
Channel Status Tags	These words provide individual channel limit, hold, open wire, ramp status, and calibration faults.	ChxxStatus	Ch*xx*.Device Status Ch*xx*.DeviceStatus.AlarmStatus
HART Faults	This provides HART communication status.	HARTFaults, ChxxHARTFault	Ch*xx*.DeviceStatus.HARTFault
HART Device Status	This provides HART field device health.	HART.ChxxDevice Status	Ch*xx*.DeviceStatus.FieldDeviceStatus

1756-IF16IH Module Fault Word Bits

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further to isolate the fault. This table lists tags that can be examined in ladder logic to indicate when a fault has occurred.

1756-IF16IH Tags That Can Be Examined in Ladder Logic

Tag	Description
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalFault.

1756-IF16IH Channel Fault Tags

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Under or Overrange condition. Checking this word for a nonzero value is a quick way to check for Under or Overrange conditions on the module.

1756-IF16IH Conditions That Set All Channel Fault Word Bits

This Condition Sets All Channel Fault Word Bits	And Causes the Module to Display the Following in the Channel Fault Word Bits
A channel is being calibrated	16#00FF
A communication fault occurred between the module and its owner-controller	16#FFFF

1756-IF16IH Channel Status Tags

This table describes the channel status tags.

1756-IF16IH Tags That Show Channel Status(1)

Tag	Bit	Description
ChxCalFault	7	This bit is set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault in the Module Faults.
ChxUnderrange	6	This bit is set when the analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value. Also sets Ch*xx*Fault in the Channel Faults.
ChxOverrange	5	This bit is set when the analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value. Also sets Ch*xx*Fault in the Channel Faults.

(1) Bits 0...4 aren't used.

Module Calibration

You can initiate calibration of the 1756-IF16IH module via the Logix Designer application Calibration view.

The Calibration view in the Logix Designer application provides a button to initiate module calibration and a display of the results. Refer to Calibrate Your Module on page 154 for more information.

Module-defined Data Types, 1756-IF16IH Module

This section describes module-defined data types for the 1756-IF16IH module and includes information for configuration and input tags.

Available tags depend on the selected input data format, as shown in this table.

1756-IF16IH Input Data Choice and Tags

Input Data Choice	Tag	Main Module Defined Type	Subtype Used by Main Type
Analog Only	Configuration	AB:1756_IF16IH:C:0	AB:1756_IF16IH_ChConfig_Struct:C:0
	Input	AB:1756_IF16IH_Analog:I:0	None
Analog and HART PV	Configuration	AB:1756_IF16IH:C:0	AB:1756_IF16IH_ChConfig_Struct:C:0
	Input	AB:1756_IF16IH_HARTPV:I:1	AB:1756_IF16IH_HARTData:I:1 AB:1756_IF16IH_HARTStatus_Struct:I:1
Analog and HART PV by Channel Grouped	Configuration	AB:1756_IF16IH:C:0	AB:1756_IF16IH_ChConfig_Struct:C:0
	Input	AB:1756_IF16IH_AnalogHARTbyChannel:I:0	AB:1756_IF16IH_HARTDataAll_1_Struct:I:0 AB:1756_IF16IH_HARTStatusAll_1_Struct:I:0

Configuration

This table describes the configuration tags available for the 1756-IF16IH module.

1756-IF16IH Configuration Tags (AB:1756_IF16IH:C:0)

Member Name	Type	Style	Description
ModuleFilter (bits 0...7)	SINT	Decimal	See the Module Filter Selections with Associated Performance Data for 1756-IF16IH table on page 85.
RealTimeSample (bits 0...15)	INT	Decimal	Milliseconds between reading signal values. See Real-time Sampling on page 86 for more information.
ChxxConfig (xx = 00...15)	AB:1756_IF16IH_ChConfig_Struct:C:0		
Config	SINT	Binary	
HARTEn	BOOL	Decimal	ChxxConfig.Config.7, Enable HART communication. Must be 1 for valid HART data in input tag and asset management access to HART field device.
RangeType	SINT	Decimal	0 = 0...20 mA 1 = 4...20 mA
DigitalFilter	INT	Decimal	Time constant of low pass filter in ms. See Digital Filter on page 86 for more information.
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than or equal to the minimum input range. See Scaling to Engineering Units on page 143 for more information.
HighSignal	REAL	Float	Upper current value for scaling to engineering units. Default is 20 mA. Must be more than LowSignal and less than or equal to the maximum input Range. See Scaling to Engineering Units on page 143 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
CalBias	REAL	Float	Sensor Offset in engineering units added to the measured signal before reporting Chxx.Data.
PassthroughHandle Timeout	INT	Decimal	Seconds to keep a reply to a HART pass-through service request before discarding; 15 seconds is recommended.

Analog Only

This table describes the input tags available in the Analog Only data format for the 1756-IF16IH module.

1756-IF16IH Input Tags - Analog Only (AB:1756_IF16IH_Analog:I:0)

Member Name	Type	Style	Description
ChannelFaults (bits 0 ... 15)	INT	Binary	Indicates a problem with analog data on Channel x or broken communication between the Logix controller and the 1756-IF16IH module. Example: Set if the analog signal is larger than 20 mA.
ChxxFault (xx = 00 ... 15)	BOOL	Decimal	ChannelFaults.0...ChannelFaults.15
Module Status	SINT	Binary	
Calibrating	BOOL		ModuleStatus.0, Calibration in progress
UpdatedStatusReady	BOOL		ModuleStatus.1, Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
ModuleFaults	SINT	Binary	Module level fault status bits (bits 0...5 not used)
CalFault	BOOL	Decimal	(ModuleFaults.6) 1756-IF16IH Module Calibration Failed.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
BrokenWireFaults (bit 0...15)	INT	Binary	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can be the cause. If configured for 4...20 mA, a broken wire fault sets this bit.
ChxxBroken Wire	BOOL	Decimal	BrokenWireFaults.0...BrokenWireFaults.15
HARTFaults (Ch00...Ch15)	INT	Binary	Indicates a problem with HART data from the Field Device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ChxxHARTFault	BOOL	Decimal	HARTFaults.0...HARTFaults.15
ChxxStatus (xx = 00...15)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxxFault.
ChxxOverrange	BOOL		ChxxStatus.5 Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxxUnderrange	BOOL		ChxxStatus.6 Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxxCalFault	BOOL		ChxxStatus.7 Set if an error occurs during calibration for Chxx, which causes a bad calibration. Also sets CalFault.
ChxxData (xx = 00...15)	REAL	Float	Value of analog signal on Channel *xx* after conversion to engineering units.
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of Coordinated System Time, which is a 64 bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Analog and HART PV

This table describes the input tags available in the Analog and HART PV data format for the 1756-IF16IH module.

1756-IF16IH Input Tags - Analog and HART PV (AB:1756_IF16IH_HARTPV:I:0)

Member Name	Type	Style	Description
ChannelFaults (bit0...15)	INT	Binary	Indicates a problem with analog data on Channel x or broken communication between the Logix controller and the 1756-IF16IH module. Example: Set if the analog signal is larger than 20 mA.
ChxxFault (xx = 00...15)	BOOL	Decimal	ChannelFaults.0...ChannelFaults.15
Module Status	SINT	Binary	
Calibrating	BOOL		(ModuleStatus.0) Calibration in progress.
UpdatedStatusReady	BOOL		(ModuleStatus.1) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.

1756-IF16IH Input Tags - Analog and HART PV (AB:1756_IF16IH_HARTPV:I:0) (Continued)

Member Name	Type	Style	Description
ModuleFaults	SINT	Binary	(bits0...5 not used)
CalFault	BOOL	Decimal	(ModuleFaults.6) 1756-IF16IH Module Calibration Failed.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
BrokenWireFaults (bit 0...15)	INT	Binary	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can be the cause.
ChxxBroken Wire	BOOL	Decimal	BrokenWireFaults.0...BrokenWireFaults.15
HARTFaults	INT	Binary	Indicates a problem with HART data from the Field Device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ChxxHARTFault	BOOL	Decimal	HARTFaults.0...HARTFaults.15
ChxxStatus (xx = 00...15)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxxFault for Overrange, Underrange, and/or CalFault.
ChxxOverrange	BOOL		(ChxxStatus.05) Analog signal is greater than or equal to the maximum detectable signal. Because the signal can't be measured, it can be significantly above the maximum value.
ChxxUnderrange	BOOL		(ChxxStatus.06) Analog signal is less than or equal to the minimum detectable signal. Because the signal can't be measured, it can be significantly below the minimum value.
ChxxCalFault	BOOL		(ChxxStatus.07) Set if an error occurs during calibration for Channel *x*, which causes a bad calibration. Also sets CalFault.
ChxxData (xx = 00...15)	REAL	Float	Value of analog signal on Channel xx after conversion to engineering units.
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of Coordinated System Time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.
HART	AB:1756_IF16IH_HARTData:I:0, Contains HART field device health and dynamic process variables.		
ChxxDeviceStatus (xx = 00...15)	AB:1756_IF16IH_HARTStatus_Struct:I:0, Channel 0 HART Device status info.		
Init	BOOL		Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't Enabled on this channel. If both are 1, then 1756-IF16IH is sending out HART messages to attempt to establish communication with a HART device.
Fail	BOOL		HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL		Pass-through message reply is ready for Query service.
CurrentFault	BOOL		Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL		The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-IF16IH module via CIP™ MSG GetDeviceInfo, which clears this bit.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART Field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
ExtDeviceStatus	SINT	Binary	Extended device status byte. Bit 0 is Maintenance Needed. Bit 1 is Device Variable Alert. Bit 2 is Low Power.
ChxxPV (xx = 00...15)	REAL		Channel *xx* HART PV Value.
ChxxSV (xx = 00...15)	REAL		Channel *xx* HART SV Value.
ChxxTV (xx = 00...15)	REAL		Channel *xx* HART TV Value.
ChxxFV (xx = 00...15)	REAL		Channel *xx* HART FV Value.
ChxxPVStatus (xx = 00...15)	SINT		Channel *xx* HART PV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxxSVStatus (xx = 00...15)	SINT		Channel *xx* HART SV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxxTVStatus (xx = 00...15)	SINT		Channel *xx* HART TV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxxFVStatus (xx = 00...15)	SINT		Channel *xx* HART FV Status. See HART PV, SV, TV, and FV Status on page 210 for more information.

Analog and HART PV by Channel Grouped

This table describes the input tags available in the Analog and HART PV by Channel Grouped data format for the 1756-IF16IH module.

1756-IF16IH Input Tags - Analog and HART PV by Channel Grouped (AB:1756-IF16IH_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Indicates a problem with analog data on Channel *xx* or broken communication between the Logix controller and the 1756-IF16IH module. Example: Set if the analog signal is larger than 20 mA.
Chx*x*Fault (xx = 00...15)	BOOL		ChannelFaults.*xx*
ModuleStatus	SINT	Binary	
Calibrating	BOOL	Decimal	(ModuleStatus.0) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleStatus.1) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
ModuleFaults	SINT	Binary	
CalFault	BOOL		(ModuleFaults.6) 1756-IF16IH module calibration failed.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
Chxx (xx = 00...15)	AB:1756_IF16IH_HARTDataAll_Struct:I:0, Channel xx analog and HART data.		
Data	REAL	Float	Analog value in engineering units.
DeviceStatus	AB:1756_IF16IH_HARTStatusAll_Struct:I:0, Channel 00 HART Device status info.		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't Enabled on this channel. If both are 1, then 1756-IF16IH is sending out HART messages to attempt to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL	Decimal	Pass-through message reply is ready for query service.
CurrentFault	BOOL	Decimal	Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL	Decimal	The field device configuration has changed and new field device configuration information can be obtained from the 1756-IF16IH module via CIP MSG GetDeviceInfo, which clears this bit.
MaintenanceRequired	BOOL		Bit 0 of Extended Device Status (if using CMD 9, or from CMD 48 if supported).
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can be the cause.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel xx. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These Field Device Status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART Field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
AlarmStatus	SINT	Binary	Indicates various alarms on the analog signal.
DeviceVariableAlert	BOOL		AlarmStatus.4, Bit 1 of Extended Device Status. Device reports a problem with some measurement.
Overrange	BOOL		AlarmStatus.5, Signal value over range (over 20 mA).
Underrange	BOOL		AlarmStatus.6, Signal value under range. (less than 3.4 mA if configured for 4...20 mA).
CalFault	BOOL		AlarmStatus.7, Bad calibration.
PV	REAL	Float	Primary value. This is the same value as signaled on the analog channel and is the most important measurement that is made by this device.
SV	REAL	Float	Secondary value
TV	REAL	Float	Third value
FV	REAL	Float	Fourth value
PVStatus	SINT	Hex	Primary status 16#C0 = Connected 16#00 = Not Connected

1756-IF16IH Input Tags - Analog and HART PV by Channel Grouped (AB:1756-IF16IH_AnalogHARTbyChannel:I:0) (Continued)

Member Name	Type	Style	Description
SVStatus	SINT	Hex	Secondary status 16#C0 = Connected 16#00 = Not Connected
TVStatus	SINT	Hex	Third status 16#C0 = Connected 16#00 = Not Connected
FVStatus	SINT	Hex	Fourth status 16#C0 = Connected 16#00 = Not Connected
CSTTimestamp	DINT[2]	Hex	Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	Time stamp that is taken at the time that the input data was sampled in millisecond resolution.

Notes:

1756-OF8H HART Analog Output Module

Module Features

The 1756-OF8H module has the following features:

- Choice of three data types
  - Analog only
  - Analog and HART PV
  - Analog and HART by channel

IMPORTANT The Analog and HART by Channel data type is available **only** for 1756-OF8H firmware revision 2.002 or later.

- 15-bit or 16-bit resolution
- Ramping and rate limiting
- Hold for initialization
- Open wire detection
- Clamping and limited
- Clamp and limit alarms
- Data echo

Input Data Types

The Input Data type you choose determines which values are included in the Input tag of the module and the features that are available to your application. Select the Input Data type on the Device Definition dialog of the Studio 5000 Logix Designer® application. The following data types are available for the 1756-OF8H module.

Data Types for the 1756-OF8H Module

Input Data Type	Description			
	Analog signal values	Analog status	HART secondary process variables and device health	HART and Analog data for each channel grouped in the tag
Analog Only	X	X		
Analog and HART PV	X	X	X	
Analog and HART by Channel[1]	X	X	X	X

(1) Available only for 1756-OF8H firmware revision 2.002 or later.

- Choose Analog and HART PV if you prefer the members of the tag to be arranged similar to non-HART analog input modules. With this selection, analog values for all channels grouped near the end of the tag. This arrangement makes it easy to view all eight analog values at once.
- Choose Analog and HART by Channel if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This arrangement makes it easier to view all data that is related to one field device.

Resolution

The output module can use 15-bit or 16-bit resolution.

Number of Significant Bits	Range	Resolution
16 bits	+/- 10.4V	320 μV
15 bits	0...20 mA 4...20 mA	0.65 μA

Ramping/Rate Limiting

Output ramping limits the speed at which an analog output signal can change. This feature helps prevent fast transitions in the output from damaging the devices that an output module controls. Ramping is also known as **rate limiting**.

This table describes the types of ramping that are possible.

1756-OF8H Types of Ramping

Type of Ramping	Description
Run mode ramping	This type of ramping occurs when the module is in Run mode and limits the rate at which the output changes from one commanded value to another.
Ramp-to-Program mode	This type of ramping occurs when the controller is placed in the Program mode. The present output value changes to the Program Value. If the connection to the module is inhibited, the Program mode value and ramp rate are applied.
Ramp-to-Fault mode	This type of ramping occurs when there's a communication or controller fault. The output signal changes to the fault value after a communication fault occurs.

The maximum rate of change in outputs is expressed in engineering units per second and called the **maximum ramp rate**.

For more information about how to set Ramp Rate on the output Limits view, see Set Output Module Limits on page 148.

Hold for Initialization

Hold for Initialization causes outputs to hold the present state until the value that the controller commands matches the value at the output terminal within 0.1% of full scale. This feature helps provide a bumpless transfer.

If Hold for Initialization is selected, outputs hold if any of these conditions occur:

- Initial connection is established after power-up.
- A new connection is established after a communication fault occurs.
- There's a transition to Run mode from Program state.

The ChxInHold bit for a channel indicates that the channel is holding.

Open Wire Detection

This feature detects when current flow isn't present at any channel. The 1756-OF8H module must be configured for 0...20 mA or 4...20 mA operation to use this feature. At least 0.1 mA of current must be flowing from the output for detection to occur.

When an open wire condition occurs at any channel, a status bit named ChxOpenWire is set for that channel.

Clamping and Limiting

The clamping feature limits the output from the analog module to remain within a range that the controller configures, even when the controller commands an output outside that range. This safety feature sets a high clamp and a low clamp.

Once clamps are set for a channel, any data that is received from the controller that exceeds the clamps sets a limit alarm and transitions the output to that limit but not beyond the configured clamp value. For example, suppose that an application sets the high clamp on a module for 8V and the low clamp for -8V. If a controller sends a value that corresponds to 9V to the module, the module applies only 8V to its screw terminals. The signal value that is applied is reflected in the Input Tag ChxData field.

Clamping limits are entered in engineering units.

Clamp and Limit Alarms

This function works directly with clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies the clamping limit to the signal value and sends a status bit to the controller, notifying it that the commanded output data value exceeds the clamping limits.

For example, if a channel has clamping limits of 8V and -8V but receives data to apply 9V, the module applies 8V to the screw terminals and sends a status bit to the controller. This status bit informs the controller that the 9V value exceeds the channel clamping limits.

Clamping alarms can be disabled or latched on a per channel basis. Clamping limits are entered in engineering units.

Data Echo

Data Echo automatically multicasts channel data values that match the analog value that is applied to the module screw terminals.

Fault and status data are also sent. If selected in the Input Data format, HART secondary process variables and device health are also sent.

An example is that I.ChxData is the echo of O.ChxData. The values can differ due to Ramp, Clamp, or Hold for Initialization.

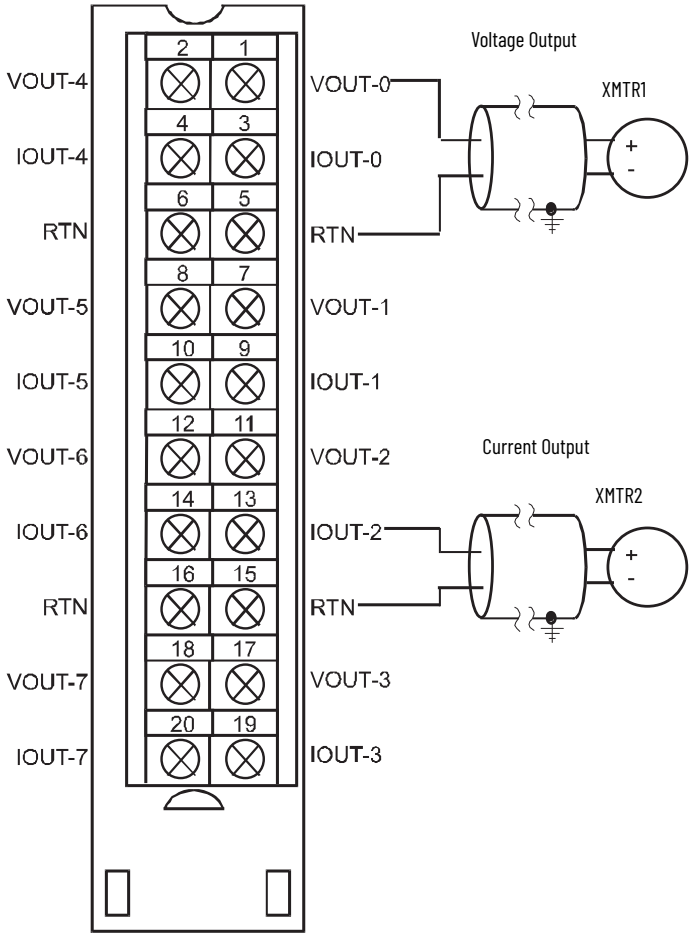
The echo value is the current level being attempted. If the wire is off or damaged, the actual current can be 0.

Wire the Module

Use this figure to wire the module. Voltage outputs use the terminal block pins labeled VOUT-# and RTN. Current outputs use the terminal block pins labeled IOUT-# and RTN.

HART communication is active with current outputs only.

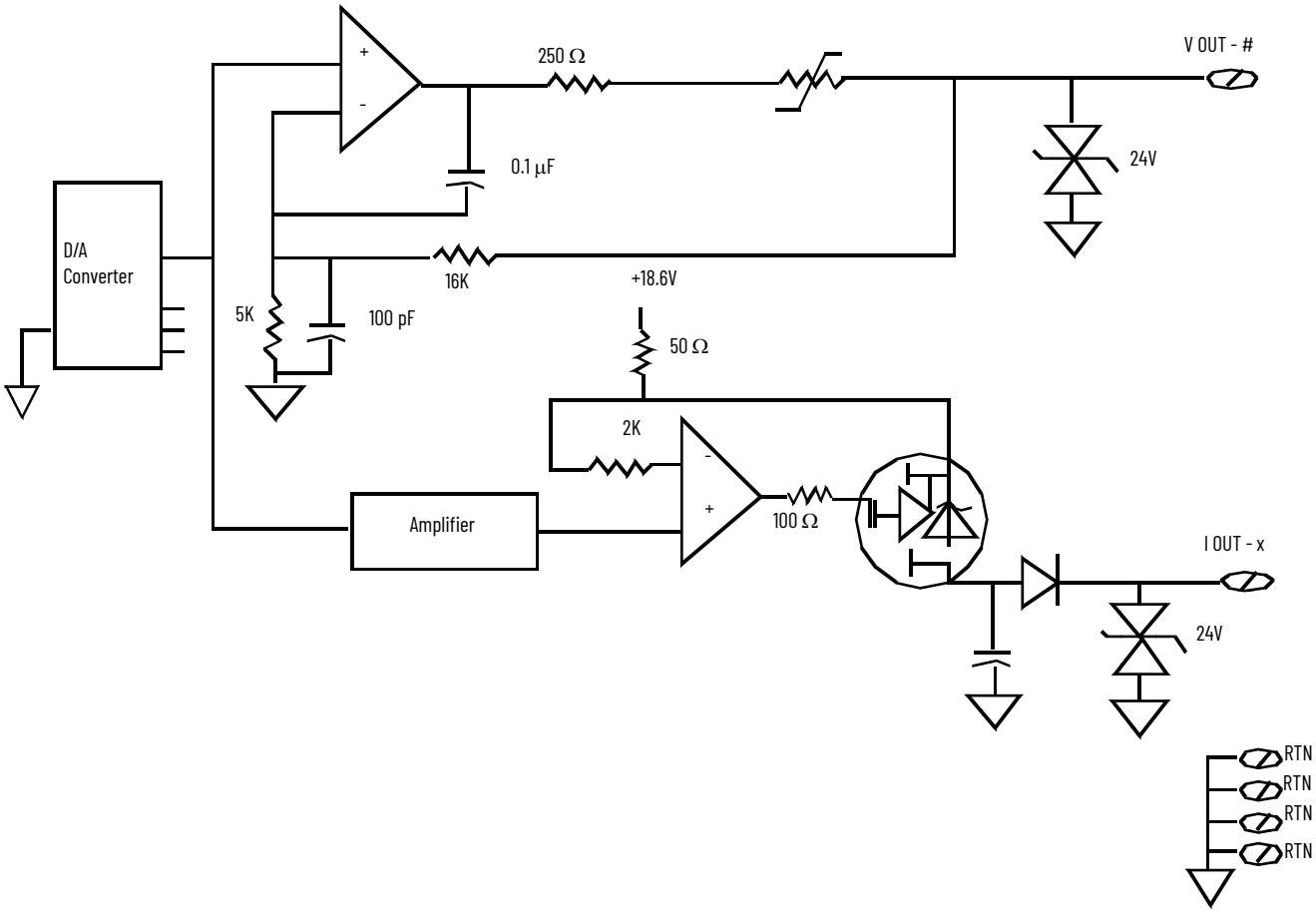
Wiring Diagram for the 1756-OF8H Module



Use Module Block and Output Circuit Diagrams

This figure shows the module output circuit diagram.

1756-OF8H Output Circuit Diagram



1756-OF8H Module Fault and Status Reporting

The 1756-OF8H modules multicast status and fault data to the controller with their channel data. The fault data is arranged to let you choose the level of granularity you desire for examining fault conditions.

Three levels of tags work together to provide increasing degree of detail as to the specific cause of faults on the module.

This table lists tags that you can examine in ladder logic to indicate when a fault occurred.

1756-OF8H Tags That Can Be Examined in Ladder Logic

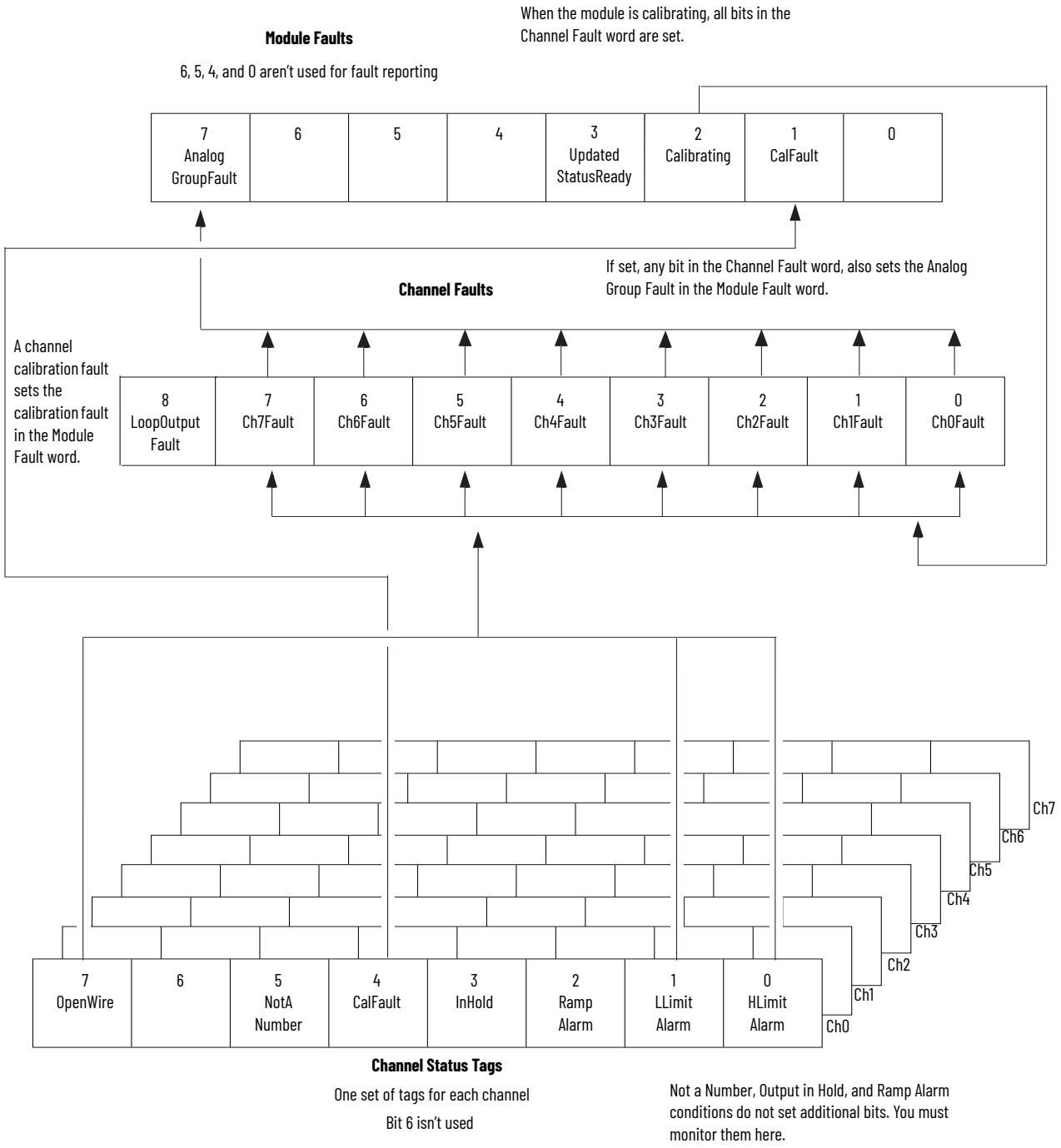
Tag	Description	Tag Name Analog and HART PV	Tag Name Analog and HART by Channel[1]
Module Fault Word	This word provides fault summary reporting.	ModuleFaults	ModuleFaults
Channel Fault Word	This word provides clamp and communication fault reporting.	ChannelFaults ChxFault	ChannelFaults ChxFault
Channel Status Tags	These words, one per channel, provide individual channel limit, hold, open wire, ramp status, and calibration faults.	ChxStatus	Chx.DeviceStatus Chx.DeviceStatus.AlarmStatus
HART Faults	This provides HART communication status.	HARTFaults, ChxHARTFault	Chx.DeviceStatus.HARTFault
HART Device Status	This provides HART field device health.	HART.ChxDevice Status	Chx.DeviceStatus.FieldDeviceStatus

(1) Available only for 1756-OF8H firmware revision 2.002 or later.

1756-OF8H Fault Reporting

This figure offers an overview of the fault reporting process.

1756-OF8H Module Fault Reporting



Module Fault Word Bits

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

This table lists tags that are found in the Module Fault word.

1756-OF8H Tags Found in the Module Fault Word

Tag	Description	Tag Name
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set.	AnalogGroupFault
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set.	Calibrating
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set.	CalFault

Channel Fault Word Bits

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has a High or Low Limit Alarm or an Open Wire condition (0…20 mA or 4…20 mA configurations only). When using the Channel Fault Word, the 1756-OF8H module uses bits 0…7. Checking this word for a nonzero condition is a quick way to check for these conditions on a channel.

This table lists the conditions that set **all** Channel Fault word bits.

1756-OF8H Conditions That Set All Channel Fault Word Bits

This Condition Sets All Channel Fault Word Bits	And Causes the Module to Display the Following in the Channel Fault Word Bits
A channel is being calibrated	16#00FF
A communication fault occurred between the module and its owner-controller	1#FFFF

Your logic monitors the Channel Fault bit for a particular output under the following conditions:

- You enable output clamping
- You're checking for an open wire condition (0…20 mA configuration only)
- You must know if the output module isn't communicating with the controller

Your logic can use the bit in Channel Faults, for example, Ch2Fault, to take failure recovery action, such as signaling CVFault on a PIDE function block.

Channel Status Tags

Any of the channel status words (eight words for 1756-OF8H modules), one for each channel, display a nonzero condition if that particular channel has faulted. Some of these bits set bits in other Fault words.

When the High or Low Limit Alarm bits (ChxHLimitAlarm or ChxLLimit Alarm) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (CalFault) is set in any of the words, the Calibration Fault bit (bit 11) is set in the Module Fault word. This table lists the conditions that set each of the word bits.

1756-OF8H Conditions That Set Each of the Word Bits(1)

Tag (status words)	Bit	Event That Sets This Tag
ChxOpenWire Chx.DeviceStatus.OpenWire	7	This bit is set only if the configured Output Range is 0...20 or 4...20 mA. The circuit must also become open due to a wire falling off or being cut when the output being driven is above 0.1 mA. The bit remains set until the correct wiring is restored.
ChxNotaNumber(2) Chx.DeviceStatus.NotANumber	5	This bit is set when the output value that is received from the controller is NotANumber (the IEEE NaN value). The output channel holds its last state.
ChxCalFault Chx.DeviceStatus.CalFault	4	This bit is set when an error occurred when calibrating. This bit also sets the appropriate bit in the Channel Fault word.
ChxInHold(2) Chx.DeviceStatus.InHold	3	This bit is set when the output channel is holding. The bit resets when the requested Run mode output value is within 0.1% of the full-scale current echo value.
ChxRampAlarm(2) Chx.DeviceStatus.RampAlarm	2	This bit is set when the requested rate of change of the output channel exceeds the configured maximum ramp rate requested parameter. It remains set until the output reaches its target value and ramping stops. If the bit is latched, it remains set until it's unlatched.
ChxLLimitAlarm Chx.DeviceStatus.LLimitAlarm	1	This bit is set when the requested output value is beneath the configured low limit value. It remains set until the requested output is above the low limit. If the bit is latched, it remains set until it's unlatched.
ChxHLimitAlarm Chx.DeviceStatus.HLimitAlarm	0	This bit is set 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 bit is latched, it remains set until it's unlatched.

(1) Bit 6 isn't used.
(2) This bit does not set additional bits at any higher level.

Module Calibration

You can initiate calibration of the 1756-OF8H module via the Logix Designer application Calibration view.

The Calibration view in the Logix Designer application provides a button to initiate module calibration and a display of the results. Refer to Calibrate Your Module on page 154 for more information.

Module-defined Data Types, 1756-OF8H Module

This section describes module-defined data types for the 1756-OF8H module and includes information for configuration, input, and output tags.

Available tags depend on the selected input data format, as shown in this table.

1756-OF8H Input Data Choice and Tags

Input Data Choice	Tag	Main Module Defined Type	Subtype Used by Main Type
Analog Only	Configuration	AB:1756_OF8H:C:0	AB:1756_OF8H_ChConfig_Struct:C:0
	Input	AB:1756_OF8H_Analog:I:0	None
	Output	AB:1756_OF8H:O:0	None
Analog and HART PV	Configuration	AB:1756_OF8H:C:0	AB:1756_OF8H_ChConfig_Struct:C:0
	Input	AB:1756_OF8H_HARTPV:I:1	AB:1756_OF8H_HARTData:I:1 AB:1756_OF8H_HARTStatus_Struct:I:1
	Output	AB:1756_OF8H:O:0	None
Analog and HART by Channel	Configuration	AB:1756_OF8H:C:0	AB:1756_OF8H_ChConfig_Struct:C:0
	Input	AB:1756_OF8H_AnalogHARTbyChannel:I:0	AB:1756_OF8H_HARTDataAll_Struct:I:0 AB:1756_OF8H_HARTStatusAll_Struct:I:0
	Output	AB:1756_OF8H:O:0	None

Configuration

This table describes the configuration tags available in the 1756-OF8H module.

1756-OF8H Configuration Tags (AB:1756_OF8H:C:0)

Member Name	Type	Style	Description
ProgToFaultEN	BOOL	Decimal	
ChxConfig (Ch 0...Ch7)	AB:1756_OF8H_ChConfig_Struct:C:0		
RampToFault	BOOL	Decimal	ConfigBits:9.
RampToProg	BOOL	Decimal	ConfigBits:8.
RampToRun	BOOL	Decimal	ConfigBits:7.
ProgMode	BOOL	Decimal	ConfigBits:6.
FaultMode	BOOL	Decimal	ConfigBits:5.
LimitAlarmLatch	BOOL	Decimal	ConfigBits:4.
RampAlarmLatch	BOOL	Decimal	ConfigBits:3.
AlarmDisable	BOOL	Decimal	ConfigBits:2.
HoldForInit	BOOL	Decimal	ConfigBits:1.
HARTEn	BOOL	Decimal	ConfigBits:0, HART enabled.
RangeType	INT	Decimal	0 = 0...20 mA. 1 = 4...20 mA.
MaxRampRate	REAL	Float	
FaultValue	REAL	Float	
ProgValue	REAL	Float	
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than minimum input range. See Scaling to Engineering Units on page 143 for more information.
HighSignal	REAL	Float	Upper current value for scaling to engineering units. Default is 10 mA. Must be more than LowSignal and less than maximum input range. See Scaling to Engineering Units on page 143 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
LowLimit	REAL	Float	Output signal is clamped at this value in engineering units even if Ch0Data is lower than this.
HighLimit	REAL	Float	Output signal is clamped at this value in engineering units if Ch0Data is larger than this.
CalBias	REAL	Float	Sensor offset in engineering units added to the measured signal before reporting Ch0.Data.

1756-OF8H Configuration Tags (AB:1756_OF8H:C:0) (Continued)

Member Name	Type	Style	Description
PassthroughHandleTimeout	INT	Decimal	Seconds to keep a reply to a HART pass-through service request before discarding. 15 seconds recommended.
PassthroughFreq_14[1]	BOOL	Decimal	Selects the policy for sending HART pass-through messages. See Output Module Pass-through Setting, Ratio, and Priority on page 139.
PassthroughFreq_15[1]	BOOL	Decimal	

(1) Series B modules do not support Pass-through Setting. Pass-through scanning is fixed at one pass-through per channel scan on Series B modules.

Analog Only

This table describes the input tags available in the Analog Only data format.

1756-OF8H Input Tags - Analog Only (AB:1756_OF8H_Analog:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	ChannelFaults.*x* Indicates communication fault or fault condition from ChXStatus. (bits 9...15 unused).
ChxFault (Ch 0...Ch7)	BOOL	Decimal	Indicates a channel fault on channel x.
LoopOutputFault	BOOL	Decimal	This is a hardware fault where the module has detected that the power supply to the isolated (analog) side of the board has failed (no power). It does not roll into any other bits. The OK status indicator is set to steady red.
HARTFaults	SINT	Binary	
ChxHARTFault	BOOL	Decimal	HARTFault.*x* Indicates a problem with HART data from the field device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ModuleFaults	SINT	Binary	
CalFault	BOOL	Decimal	(ModuleFaults.1) 1756-OF8H module calibration failed.
Calibrating	BOOL	Decimal	(ModuleStatus.2) Calibration in progress.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
ChxStatus (Ch 0...Ch7)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxFault for Overrange, Underrange, and CalFault.
ChxHLimitAlarm	BOOL	Decimal	(ChxStatus.0) The analog output signal is being limited by the ChxConfig.HighLimit value. If ChxConfig.LimitAlarmLatch is 1, the alarm is retained until explicitly reset.
ChxLLimitAlarm	BOOL	Decimal	(ChxStatus.1) The analog output signal is being limited by the ChxConfig.LowLimit value. If ChxConfig.LimitAlarmLatch is 1, the alarm is retained until explicitly reset.
ChxRampAlarm	BOOL	Decimal	(ChxStatus.2) Rate of change in ChxData exceeds ChxConfig.MaxRampRate. The change in ChxData divided by the RPI period determines the rate of change. Thus if a step change in Chx can't be reached via the configured MaxRampRate within one RPI, then ChxRampAlarm is set to 1. If ChxConfig.RampAlarmLatch is 1, then ChxRampAlarm remains set until explicitly reset using the CIP™ message even if the condition returns to normal. The CIP message can be sent via MSG instruction in the Logix controller or from the Module Properties Limit dialog in the Logix Designer application.
ChxInHold	BOOL	Decimal	(ChxStatus.3) Channel holding its last output value, waiting for the controller to match the value, indicating that bumpless initialization of the control loop is complete.
ChxCalFault	BOOL	Decimal	(ChxStatus.4) Fault during calibration of channel 0.
ChxNotANumber	BOOL	Decimal	(ChxStatus.5) ChxData isn't a valid floating point number.
ChxOpenWire	BOOL	Decimal	(ChxStatus.7) Only valid in current mode (example 4...20 mA). 1 indicates that no current is flowing, probably due to an open circuit.
ChxData (Ch 0...Ch7)	REAL	Float	Analog value actually output in engineering units. This can be different than output tag ChxData if the value exceeds the LowLimit or HighLimit, has a MaxRampRate applied, is being Held for initialization, or the controller is in Fault or Program mode.
CSTTimestamp	DINT[2]	Decimal	64-bit coordinated system time time stamp in microseconds of the last output update. Time base synchronized with other modules in the rack.
RollingTimestamp	INT	Decimal	16-bit time stamp in milliseconds. Time base local to the 1756-OF8H module.

Analog and HART PV

This table describes the input tags available in the Analog and HART PV data format.

1756-OF8H Input Tags - Analog Only (AB:1756_OF8H_HARTPV:I:1)

Member Name	Type	Style	Description
Channel Faults	INT	Binary	(bits 9...15 unused)
ChxFault	BOOL	Decimal	ChannelFaults.*x*, Indicates communication fault or fault condition from ChxStatus.
LoopOutputFault	BOOL	Decimal	ChannelFaults.8, This is a hardware fault where the module has detected that the power supply to the isolated(analog) side of the board has failed(no power). It does not roll into any other bits. The OK status indicator is set to steady red.
HARTFaults	SINT	Binary	
ChxHARTFault	BOOL	Decimal	HARTFault.*x* Indicates a problem with HART data from the field device on Channel *x*. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ModuleFaults	SINT	Binary	
CalFault	BOOL	Decimal	ModuleFaults.1, 1756-OF8H module calibration failed.
Calibrating	BOOL	Decimal	ModuleFaults.2, Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	ModuleFaults.3, Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
AnalogGroupFault	BOOL	Decimal	ModuleFaults.7, Indicates a fault has occurred on any channel (any of ChannelFaults).
ChxStatus (Ch0...Ch7)	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChxFault for Overrange, Underrange, and CalFault.
ChxHLimitAlarm	BOOL	Decimal	ChxStatus:0 The analog output signal is being limited by the ChxConfig.HighLimit value. If ChxConfig.LimitAlarmLatch is 1, the alarm is retained until explicitly reset.
ChxLLimitAlarm	BOOL	Decimal	ChxStatus:1 The analog output signal is being limited by the ChxConfig.LowLimit value. If ChxConfig.LimitAlarmLatch is 1, the alarm is retained until explicitly reset.
ChxRampAlarm	BOOL	Decimal	ChxStatus:2 Rate of change in ChxData exceeds ChxConfig.MaxRampRate. The change in ChxData divided by the RPI period determines the rate of change. Thus if a step change in Chx can't be reached via the configured MaxRampRate within one RPI, then ChxRampAlarm is set to 1. If ChxConfig.RampAlarmLatch is 1, then ChxRampAlarm remains set until explicitly reset using the CIP message even if the condition returns to normal. The CIP message can be sent via MSG instruction in the Logix controller or from the Studio 5000 Logix Designer Module Properties Limit dialog.
ChxInHold	BOOL	Decimal	ChxStatus:3 Channel holding its last output value, waiting for controller to match the value, indicating that bumpless initialization of the control loop is complete.
ChxCalFault	BOOL	Decimal	ChxStatus:4 Fault during calibration of channel x.
ChxNotANumber	BOOL	Decimal	ChxStatus:5 ChxData isn't a valid floating point number.
ChxOpenWire	BOOL	Decimal	ChxStatus:7 Only valid in current mode (example 4...20 mA). 1 indicates that no current is flowing, probably due to an open circuit.
ChxData	REAL	Float	Analog value actually output in engineering units. This value can be different than Output Tag ChxData if the value exceeds the LowLimit or HighLimit, has a MaxRampRate applied, is being Held for initialization, or the controller is in Fault or Program mode.
CSTTimestamp	DINT[2]	Decimal	64-bit coordinated system time timestamp in microseconds of the last output update. Time base synchronized with other modules in the rack.
RollingTimestamp	INT	Decimal	16-bit time stamp in milliseconds. Time base local to the 1756-OF8H module.
HART	AB:1756_OF8H_HARTData:I:1, Contains HART field device health and dynamic process variables This applies to AB:1756_OF8H_HARTPV:I:1 only; for details on what appears in the variables, see the Module-defined Data Type: AB:1756_OF8H_HARTData:I:1 table		
ChxDeviceStatus (Ch0...Ch7)	AB:1756_OF8H_HARTStatus_Struct:I:1, Channel 0 HART Device status info.		
Init	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't enabled on this channel. If both are 1, then the 1756-OF8H module is sending out HART messages attempting to establish communication with a HART device.
Fail	BOOL	Decimal	HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the input tag is valid. (HART. PVStatus is also set to 0 to indicate this).
MsgReady	BOOL	Decimal	Pass-through message reply is ready for query service.
CurrentFault	BOOL	Decimal	Analog current measurement does not match the current reported by the field device over the HART network.
ConfigurationChanged	BOOL	Decimal	The field device configuration has changed and new field device configuration information can be obtained from the 1756-OF8H module via CIP MSG GetDeviceInfo, which clears this bit.

1756-OF8H Input Tags - Analog Only (AB:1756_OF8H_HARTPV:I:1) (Continued)

Member Name	Type	Style	Description
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9).
Maintenance Required	BOOL	Decimal	Maintenance is needed.
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	Low power.
ChxPV	REAL		Channel *x* HART PV value.
ChxSV	REAL		Channel *x* HART SV value.
ChxTV	REAL		Channel *x* HART TV value.
ChxFV	REAL		Channel *x* HART FV value.
ChxPVStatus	SINT		Channel *x* HART PV status, see HART PV, SV, TV, and FV Status on page 210 for more information.
ChxSVStatus	SINT		Channel *x* HART SV status, see HART PV, SV, TV, and FV Status on page 210 for more information.
ChxTVStatus	SINT		Channel *x* HART TV status, see HART PV, SV, TV, and FV Status on page 210 for more information.
ChxFVStatus	SINT		Channel *x* HART FV status, see HART PV, SV, TV, and FV Status on page 210 for more information.

Analog and HART by Channel

1756-OF8H Input Tags - Analog and HART by Channel (AB:1756-OF8H_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	(bits 9...15 unused).
ChxFault (Ch0...Ch7)	BOOL		ChannelFaults.0...ChannelFaults.7
LoopOutputFault	BOOL	Decimal	(ChannelFaults.8) This is a hardware fault where the module has detected that the power supply to the isolated(analog) side of the board has failed(no power). It does not roll into any other bits. The OK status indicator is set to steady red.
ModuleFaults	SINT	Binary	
CalFault	BOOL	Decimal	(ModuleFaults.1) 1756-OF8H module calibration failed.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Module has collected updated Additional Device Status from HART command 48. This status can be retrieved by using the Read Additional Status service, 16#4C. For more information about this service, see Read Additional Status (Service Code = 16#4C) on page 170.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a fault has occurred on any channel (any of ChannelFaults).
Chx (Ch0...Ch7)	AB:1756_OF8H_HARTDataAll_Struct:I:0, Channel 0 analog and HART data.		
Data	REAL	Float	Analog value in engineering units.
DeviceStatus	AB:1756_OF8H_HARTStatusAll_Struct:I:0, Channel 0 HART Device status info.		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and Fail is 1, then HART isn't enabled on this channel. If both are 1, then the 1756-OF8H module is sending out HART messages to attempt to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure or device not found or HART not enabled. If this bit is 1, none of the other data in the HART part of the input tag is valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL	Decimal	Pass-through message reply is ready for query service.
CurrentFault	BOOL	Decimal	Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL	Decimal	The field device configuration has changed and new field device configuration information can be obtained from the 1756-OF8H module via CIP MSG GetDeviceInfo, which clears this bit.

1756-OF8H Input Tags - Analog and HART by Channel (AB:1756-OF8H_AnalogHARTbyChannel:I:0) (Continued)

Member Name	Type	Style	Description
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply. See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ChStatus	SINT	Binary	Indicates various alarms on the analog signal. Also sets ChFault for Overrange, Underrange, and CalFault.
HLimitAlarm	BOOL	Decimal	Ch0.DeviceStatus.ChStatus:0 The analog output signal is being limited by the ChConfig.HighLimit value. If ChConfig.LimitAlarmLatch is 1, the alarm is retained until explicitly reset.
LLimitAlarm	BOOL	Decimal	Ch0.DeviceStatus.ChStatus:1 The analog output signal is being limited by the ChConfig.LowLimit value. If ChConfig.LimitAlarmLatch is 1, the alarm is retained until explicitly reset.
RampAlarm	BOOL	Decimal	ChStatus:2 Rate of change in Ch0.Data exceeds Ch0Config.MaxRampRate. The change in Ch0.Data divided by the RPI period determines the rate of change. Thus if a step change in Ch0.Data can't be reached via the configured Ch0Config.MaxRampRate within one RPI, then Ch0.DeviceStatusRampAlarm is set to 1. If Ch0Config.RampAlarmLatch is 1, then Ch0.DeviceStatusRampAlarm remains set until explicitly reset by using CIP message even if the condition returns to normal. The CIP message can be sent via MSG instruction in the Logix controller or from the Logix Designer Module Properties Limit dialog.
InHold	BOOL	Decimal	ChStatus:3 Channel holding its last output value, waiting for the controller to match the value, indicating that bumpless initialization of the control loop is complete.
CalFault	BOOL	Decimal	ChStatus:4 Fault during calibration of channel 0.
NotANumber	BOOL	Decimal	ChStatus:5 Ch0.Data isn't a valid floating point number.
OpenWire	BOOL	Decimal	ChStatus:7 Only valid in current mode (example 4...20 mA). 1 indicates that no current is flowing, probably due to an open circuit.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9)
Maintenance Required	BOOL	Decimal	Maintenance is needed.
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	Low power.
PV	REAL	Float	Primary value. This is the same value as signaled on the analog channel and is the most important measurement that is made by this device.
SV	REAL	Float	Secondary value.
TV	REAL	Float	Third value.
FV	REAL	Float	Fourth value.
PVStatus	SINT	Hex	Primary status. 16#C0 = Connected. 16#00 = Not Connected.
SVStatus	SINT	Hex	Secondary status. 16#C0 = Connected. 16#00 = Not Connected.
TVStatus	SINT	Hex	Third status. 16#C0 = Connected. 16#00 = Not Connected.
FVStatus	SINT	Hex	Fourth status. 16#C0 = Connected. 16#00 = Not Connected.
CSTTimestamp	DINT[2]	Hex	Coordinated system time.
RollingTimestamp	INT	Decimal	15-bit time from power on/reset in milliseconds.

Output

This table describes the output tags available in the 1756-OF8H module.

1756-OF8H Output Tags (AB:1756_OF8H:O:0)

Member Name	Type	Style	Description
ChxData (Ch0...Ch7)	REAL	Float	Value in engineering units to output on the analog signal of Channel x.

1756-OF8IH HART Isolated Analog Output Module

Module Features

The 1756-OF8IH module has the following features:

- Eight individually controllable output channels with an individual HART modem per channel
- HART pass-through interface
- Two output ranges (0…20 mA, 4…20 mA)
- Auto-scanning of HART variables (PV, SV, TV, FV)
- Option to auto-configure a HART device with user-specified PV damping value, PV upper and lower range values, PV transfer function, and PV units code
- Write HART variables interface for some variables
- Output data scaling
- Time stamping
- Floating point output data
- Ramping (rate limiting)
- Choice of four data types
  - Analog Only
  - Analog and HART PV
  - Analog and HART by Channel with Configure HART Device = Yes
  - Analog and HART by Channel with Configure HART Device = No
- User calibration via CIP™ messaging or output word
- 15-bit or 16-bit resolution
- Hold for initialization
- Open wire detection
- Clamp limit alarms
- Data echo

Input Data Types

The Input Data type you choose determines which values are included in the Input tag of the module and the features that are available to your application. Select the Input Data type on the Device Definition dialog of the Studio 5000 Logix Designer® application. The following data types are available for the 1756-OF8IH module.

Data Types for the 1756-OF8IH Module

Input Data Type	Description				
	Analog Signal Values	Analog Status	HART Secondary Process Variables and Device Health	HART and Analog Data for Each Channel Grouped Together in Tag	Configure HART Device
Analog Only	X	X			
Analog and HART PV	X	X	X		
Analog and HART by Channel, Configure HART Device = No	X	X	X	X	
Analog and HART by Channel, Configure HART Device = Yes	X	X	X	X	X

Choose Analog and HART PV if you prefer the members of your tag to be arranged similar to non-HART analog input modules. With this selection, the analog values for all channels grouped near the end of the tag. This arrangement makes it easy to view all eight analog values at once.

Choose Analog and HART by Channel if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This arrangement makes it easier to view all data that is related to one field device.

Powerup State

On power-up, the outputs of the 1756-OF8IH module are set to their reset state (0 mA) until module diagnostics and configuration are complete. Outputs are then set at their configured program values (ChxConfig.ProgValue).

Fault Mode Output State

You can choose the output state to be used when the module enters fault mode:

- Hold Last State
- User-defined Value (you can choose either to ramp to a specified value or to switch immediately to that value)

Ramping/Rate Limiting

Ramping limits the rate at which an analog output signal can change. This feature helps prevent fast transitions in the output from damaging the devices that an output module controls.

Ramping Types

Ramping Types	Description
Ramp-to-Run	When the module is in Run mode, it limits the rate at which the output changes from one commanded value to another.
Ramp-to-Program	When the controller goes into program mode, the present output value ramps to the configured Program Value. If the connection to the module is inhibited, the Program mode value and ramp rate are applied.
Ramp-to-Fault	When a communication fault occurs, the output signal ramps to the configured fault value.

The maximum rate of change in outputs is expressed in engineering units per second and called the **maximum ramp rate**.

For more information about how to set Ramp Rate on the output Limits view, see Set Output Module Limits on page 148.

Hold for Initialization

Hold for Initialization causes outputs to hold the present state until the value that the controller commands matches the value at the output terminal within 0.1% of full scale. This feature helps provide a bumpless transfer.

If Hold for Initialization is selected, outputs hold if any of these conditions occur:

- Initial connection is established after power-up.
- A new connection is established after a communication fault occurs.
- There's a transition from Program mode to Run mode.

The ChxInHold bit for a channel indicates that the channel is holding.

Open Wire Detection

This feature detects when current flow isn't present at the channel. At least 0.1 mA of current must be flowing from the output for detection to occur.

When an open wire condition occurs at any channel, a status bit named ChxOpenWire is set for that channel.

Clamping (Limiting)

Clamping limits the output from the analog module to remain within a range that the controller configures, even when the controller commands an output outside that range. This safety feature sets a high clamp value and a low clamp value.

Once clamps are set for a channel, data from the controller that exceeds the clamp values sets a limit alarm. The output transitions to that limit but not beyond the configured clamp value. For example, suppose that an application sets the high clamp on a module for 18 mA and the low clamp for 4 mA. If a controller sends a value that corresponds to 19 mA to the module, the module only applies 18 mA via its screw terminals. The signal value that is applied is reflected in the Input Tag ChxData field.

Clamping limits are entered in engineering units.

Clamp and Limit Alarms

This function works directly with clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies the clamping limit to the signal value and sends a status bit to the controller. This action notifies the controller that the commanded output data value exceeds the clamping limits.

For example, if a channel has a clamping limit of 18 mA but receives data to apply 19 mA, only 18 mA is applied via the screw terminals. The module sends a status bit to the controller to inform it that the 19 mA value exceeds the clamping limits of the channel.

Clamping alarms can be disabled or latched on a per channel basis. Clamping limits are entered in engineering units.

Data Echo

Data Echo automatically multicasts channel data values that match the analog value that is applied to the module screw terminals.

Fault and status data are also sent. If selected in the Input Data format, HART secondary process variables and device health are also sent.

An example is that I.ChxData is the echo of O.ChxData. They can be different due to Ramp, Clamp, or Hold for Initialization.

The echo value is the current level being attempted. If the wire is off or damaged, the actual current can be 0.

HART Device Auto-configuration

A HART device can be automatically configured with user-specified PV damping, PV range limits and units, and PV transfer function values. If enabled, configuration occurs when the device is connected or when the module detects that one of the two configuration bits is set. There's a separate configuration bit for PV damping value, and another for PV upper and lower range values, PV transfer function, and PV range units.

This feature is available only with the Analog and HART by Channel data format with Configure HART Device = Yes.

Write HART Variables

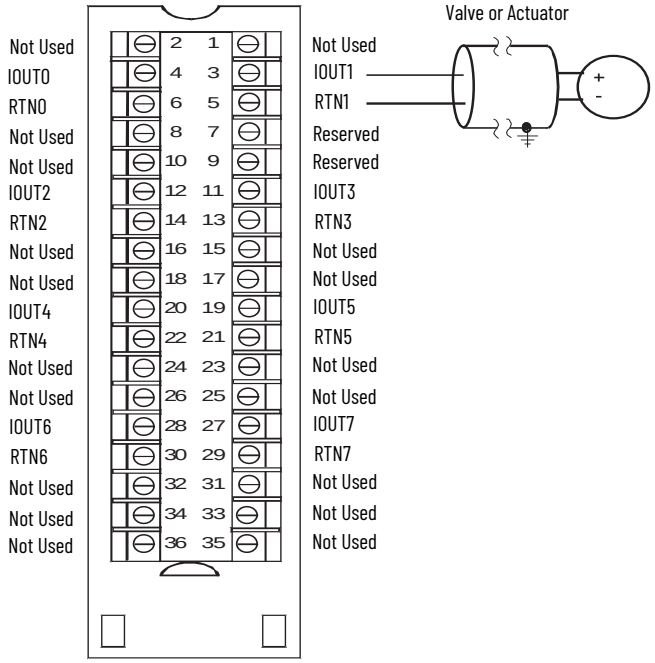
The module supports setting a limited number of HART variables via special use of the pass-through interface. See Use a CIP MSG to get HART Data on page 167 for more information.

Wire the Module

Use this figure to wire the module. The 1756-OF8IH module has only current outputs, which use the terminal block pins labeled IOUT# and RTN#.

For each output, HART communication is active only when it's enabled in the Logix Designer application.

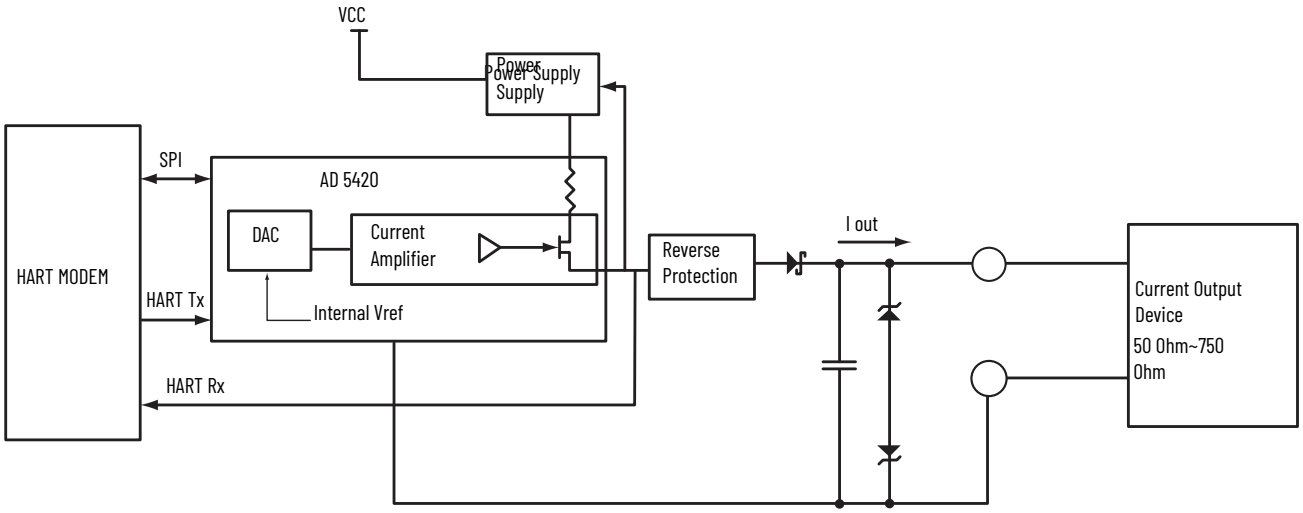
Wiring Diagram for the 1756-OF8IH Module



Output Circuit Diagram

This figure shows the module output circuit diagram.

1756-OF8IH Output Circuit Diagram



1756-OF8IH Module Fault and Status Reporting

The 1756-OF8IH modules multicast status and fault data to the controller with their channel data. The fault data is arranged to let you choose the level of granularity you desire for examining fault conditions.

Three levels of tags work together to provide an increasing degree of detail as to the specific cause of faults on the module.

This table lists tags that you can examine in ladder logic to indicate when a fault occurred.

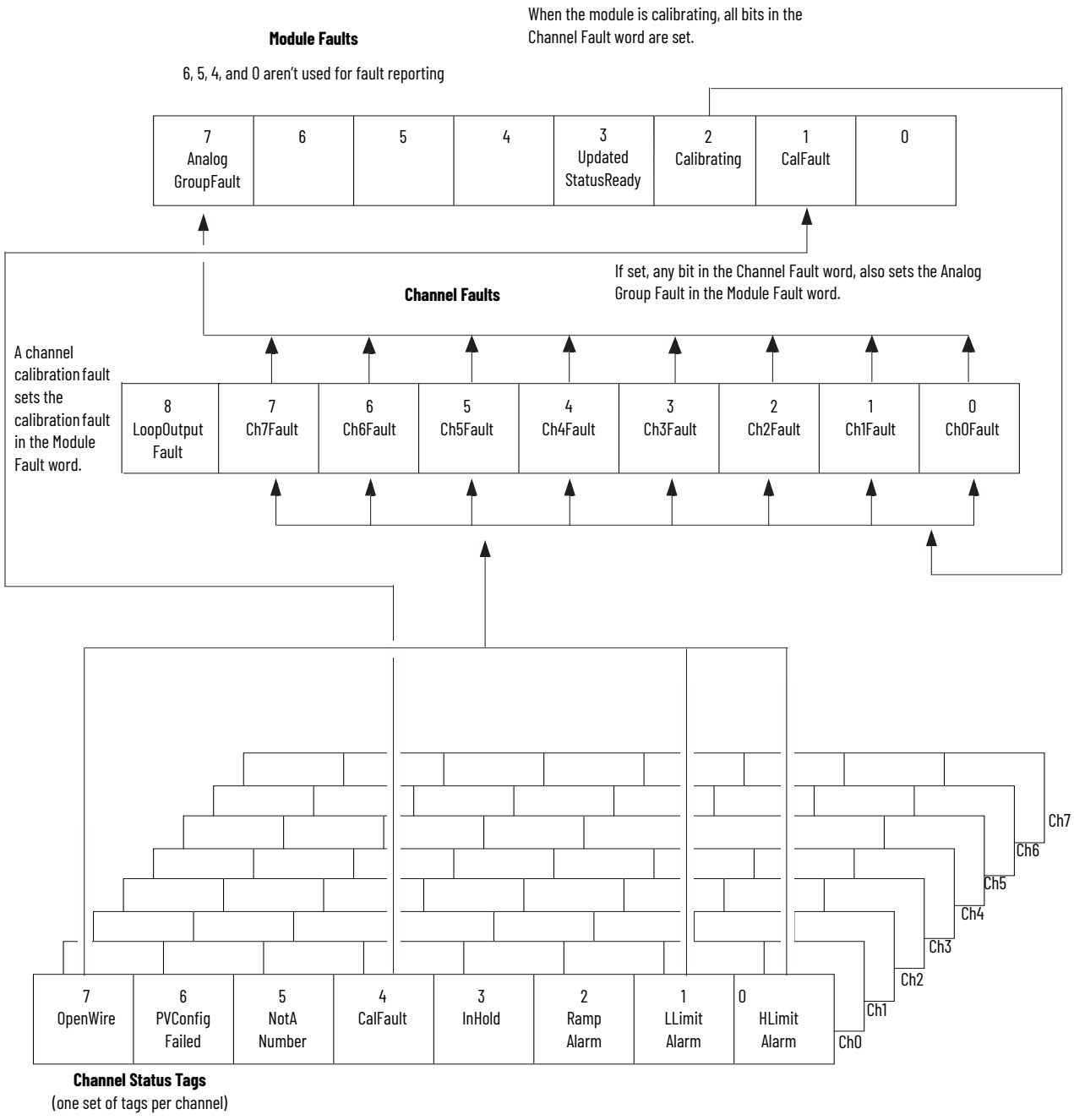
1756-OF8IH Tags That Can Be Examined in Ladder Logic

Tag	Description	Tag Name Analog and HART PV	Tag Name Analog and HART by Channel
Module Fault Word	The bits in this word are set when a fault of the corresponding type has occurred on any channel.	ModuleFaults	ModuleFaults
Channel Fault Word	These bits report faults that occur on the corresponding channel.	ChannelFaults ChxFault	ChannelFaults ChxFault
Channel Status Tags	These words, one per channel, indicate individual channel limit, hold, open wire, ramp status, and calibration faults.	ChxStatus	Chx.DeviceStatus Chx.DeviceStatus.AlarmStatus
HART Faults	The bits in this word show HART communication status for each channel.	HARTFaults, ChxHARTFault	Chx.DeviceStatus.HARTFault
HART Device Status	This data provides information about the HART field device.	HART.ChxDevice Status	Chx.DeviceStatus.FieldDeviceStatus

1756-OF8IH Module Fault Reporting

This figure offers an overview of the fault reporting process.

1756-OF8IH Module Fault Reporting



Notes:

- NotANumber, InHold, RampAlarm, and PVConfigFailed conditions do not set other bits; monitor them here.
- Bits 0 and 1 not used if Configure HART Device = Yes
- Bit 6 not used if Configure HART Device = No

Module Fault Word Bits

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

1756-OF8IH Tags Found in the Module Fault Word

Tag	Description	Tag Name
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set.	AnalogGroupFault
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set.	Calibrating
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set.	CalFault

Channel Fault Word Bits

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has a High or Low Limit Alarm or an Open Wire condition (4...20 mA configurations only). When using the Channel Fault Word, the 1756-OF8IH module uses bits 0...7. Check this word for a nonzero condition as a quick way to check for these conditions on a channel.

1756-OF8IH Conditions That Set All Channel Fault Word Bits

This Condition Sets All Channel Fault Word Bits	And Causes the Module to Display the Following in the Channel Fault Word Bits
A channel is being calibrated	16#00FF
A communication fault occurred between the module and its owner-controller	1#FFFF

Monitor the Channel Fault bit for a particular output in ladder logic for the following reasons:

- You enable output clamping, are checking for an open wire condition (4...20 mA configuration only)
- You must know if the output module isn't communicating with the controller

Your logic can use the bit in Channel Faults, for example, Ch2Fault, to take failure recovery action, such as signaling CVFault on a PIDE function block.

Channel Status Tags

Any of the channel status words (eight words for 1756-OF8IH modules, one for each channel) display a nonzero condition if that particular channel has faulted. Some of these bits set bits in other Fault words.

When the High or Low Limit Alarm bits (ChxHLimitAlarm or ChxLLimit Alarm) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (CalFault) is set in any of the words, the Calibration Fault bit (bit 11) is set in the Module Fault word. This table lists the conditions that set each of the word bits.

1756-OF8IH Conditions That Set Channel Status Word Bits(1), Configure HART Device = No

Tag (Status Words)	Bit	Event That Sets This Tag
ChxOpenWire Chx.DeviceStatus.OpenWire	7	This bit is set only if the circuit becomes open due to a wire falling off or being cut when the output being driven is above 0.1 mA. The bit remains set until the correct wiring is restored.
ChxNotaNumber(2) Chx.DeviceStatus.NotANumber	5	This bit is set when the output value that is received from the controller is NotANumber (the IEEE NaN value). The output channel holds its last state.
ChxCalFault Chx.DeviceStatus.CalFault	4	This bit is set when an error occurred when calibrating. This bit also sets the appropriate bit in the Channel Fault word.
ChxInHold(2) Chx.DeviceStatus.InHold	3	This bit is set when the output channel is holding. The bit resets when the requested Run mode output value is within 0.1% of the full-scale current echo value.
ChxRampAlarm(2) Chx.DeviceStatus.RampAlarm	2	This bit is set when the requested rate of change for an output channel would exceed the configured maximum ramp rate requested parameter. It remains set until the output reaches its target value and ramping stops. If the bit is latched, it remains set until it's unlatched.
ChxLLimitAlarm Chx.DeviceStatus.LLimitAlarm	1	This bit is set when the requested output value is beneath the configured low limit value. It remains set until the requested output is above the low limit. If the bit is latched, it remains set until it's unlatched.
ChxHLimitAlarm Chx.DeviceStatus.HLimitAlarm	0	This bit is set 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 bit is latched, it remains set until it's unlatched.

(1) Bit 6 isn't used.
(2) This bit does not set other bits at any higher level.

1756-OF8IH Conditions That Set Channel Status Word Bits(1), Configure HART Device = Yes

Tag (Status Words)	Bit	Event That Sets This Tag
ChxOpenWire Chx.DeviceStatus.OpenWire	7	This bit is set only if the circuit becomes open due to a wire falling off or being cut when the output being driven is above 0.1 mA. The bit remains set until the correct wiring is restored.
CHxPVConfigFailed Chx.DeviceStatus.PVConfigFailed	6	PV auto-configuration failed.
ChxNotaNumber(2) Chx.DeviceStatus.NotANumber	5	This bit is set when the output value that is received from the controller is NotANumber (the IEEE NaN value). The output channel holds its last state.
ChxCalFault Chx.DeviceStatus.CalFault	4	This bit is set when an error occurred when calibrating. This bit also sets the appropriate bit in the Channel Fault word.
ChxInHold(2) Chx.DeviceStatus.InHold	3	This bit is set when the output channel is holding. The bit resets when the requested Run mode output value is within 0.1% of the full-scale current echo value.
ChxRampAlarm(2) Chx.DeviceStatus.RampAlarm	2	This bit is set when the requested rate of change for an output channel would exceed the configured maximum ramp rate requested parameter. It remains set until the output reaches its target value and ramping stops. If the bit is latched, it remains set until it's unlatched.

(1) Bits 0 and 1 are not used.
(2) This bit does not set other bits at any higher level.

Module Calibration

There are two ways to initiate calibration of the 1756-OF8IH module:

- Logix Designer application Calibration view
- Module Output Word

Module Calibration Via Logix Designer Application

The Calibration view in the Logix Designer application provides a button to initiate module calibration and a display of the results. Refer to Calibrate Your Module on page 154 for more information.

Module Calibration Via Output Word

The 1756-OF8IH module allows you to perform calibration by setting and clearing bits in the module output word. This method of calibration is available only when Configure HART Device = Yes. The module must be connected to a controller and the controller must be in run mode.

See Output, Configure HART Device = Yes on page 128 for output bit descriptions.

To perform a module calibration via the output word, set and clear bits in sequence to perform the calibration tasks. This table shows the tags that are involved in calibration.

Step	Calibration Word Bits	Description
Initiate calibration	Ch[x].Calibrate	Set this bit to initiate calibration, and keep it set until the calibration sequence is complete. If this bit clears before the calibration is complete, the calibration is aborted.
Output low calibration reference	Ch[x].CalOutputLowRef	Sets the output to 4 mA.
Pass measured low calibration output to ChxData	Ch[x].CalLowRefPassed	Captures the low calibration value.
Output high calibration reference	Ch[x].CalOutputHighRef	Sets the output to 20 mA.
Pass measured high calibration output to Chx Data	Ch[x].CalHighRefPassed	Captures the high calibration value.
Finish calibration	Ch[x].CalFinished	Initiates calculation of the calibration for that channel. If all other channels have been calculated and complete, the calibration date is written and calibration ends.
Abort calibration	Ch[x].Calibrate Ch[x].CalOutputLowRef Ch[x].CalOutputHighRef	If necessary, this bit combination aborts calibration.
Set the calibration date	CalibrationDate	The date to be recorded with a successful calibration, typically the current date.

Module-defined Data Types, 1756-OF8IH Module

This section describes module-defined data types for the 1756-OF8IH module and include information for configuration, input, and output tags.

1756-OF8IH Configuration, Configure HART Device = No

1756-OF8IH Input Data Choice and Tags

Input Data Choice	Tag	Main Module Defined Type	Subtype Used by Main Type
Analog Only	Configuration	AB:1756_OF8IH:C:0	AB:1756_OF8IH_ChConfig_Struct:C:0
	Input	AB:1756_OF8IH_Analog:I:0	None
	Output	AB:1756_OF8IH:O:0	None
Analog and HART PV	Configuration	AB:1756_OF8IH:C:0	AB:1756_OF8IH_ChConfig_Struct:C:0
	Input	AB:1756_OF8IH_HARTPV:I:1	None
	Output	AB:1756_OF8IH:O:0	None
Analog and HART by Channel Configure HART Device = No	Configuration	AB:1756_OF8IH:C:0	AB:1756_OF8IH_ChConfig_Struct:C:0
	Input	AB:1756_OF8IH_AnalogHARTbyChannel:I:0	AB:1756_OF8IH_HARTDataAll_Struct:I:0
	Output	AB:1756_OF8IH:O:0	None
Analog and HART by Channel Configure HART Device = Yes	Configuration	AB:1756_OF8IH_HART_CMD:C:0	AB:1756_OF8IH_HART_ChConfig_Struct:C:0
	Input	AB:1756_OF8IH_AnalogHARTbyChannel_1:I:0	AB:1756_OF8IH_HARTDataAll_1_Struct:I:0
	Output	AB:1756_OF8IH:O:0	AB:1756_OF8IH_ChStruct:O:0

This table describes the configuration tags available in the 1756-OF8IH module when Configure HART Device is set to No.

1756-OF8IH Configuration Tags, Configure HART Device = No (AB:1756_OF8IH:O:0)

Member Name	Type	Style	Description
ProgToFaultEn	BOOL	Decimal	0 – Disabled. 1 – Enable programmed fault states. Determines how outputs can behave if a communication fault occurs while the module is in program mode. When set, the bit causes the outputs to transition to their programmed fault state. If not set, outputs remain in their configured program state despite a communications fault occurring.
ChxConfig (Ch 0...Ch7)	AB:1756_OF8IH_ChConfig_Struct:C:0		
RampToFault	BOOL	Decimal	Enables ramping of the output value to the value specified by FaultValue. MaxRampRate defines the transition ramp rate. HoldOnFault must be set to 1 if RampToFault is set to 1.
RampToProg	BOOL	Decimal	Selects the ramping behavior when the system transitions from Run to Idle/Program mode. Enable ramping of the output to the fvalue specified by IdleProgValue. MaxRampRate defines the ramp rate. HoldOnIdle must be set to 1 if RampToProg is set to 1 and MaxRampRate must be > 0.
RampToRun	BOOL	Decimal	Enables ramping of the output value during Run mode between the current output level and a newly requested output. MaxRampRate defines the transition ramp rate and must be > 0.
ProgMode	BOOL	Decimal	
FaultMode	BOOL	Decimal	
LimitAlarmLatch	BOOL	Decimal	Enables latching for the clamp limit alarms. Latching causes the limit alarms to remain set until an unlatch service is explicitly sent to the channel or alarm. (1 = enable, 0 = disable.)
RampAlarmLatch	BOOL	Decimal	Enables latching for the rate alarm. Latching causes the rate alarm to remain set until an unlatch service is explicitly sent to the channel or alarm. (1 = enable, 0 = disable.)
AlarmDisable	BOOL	Decimal	Disables all alarms for the channel: HLimitAlarm, LLimitAlarm, RampAlarm. (1 = disable alarms, 0 = do not disable alarms.)
HoldForInit	BOOL	Decimal	Configures the channel to hold, or not change, until initialized with a value within 0.1% of full scale or its current value when one of the following conditions occurs: • Module initial connection power-up. • Module transition from Program mode to Run mode. • Module re-establishes communication after a fault.
HARTEn	BOOL	Decimal	Enables HART communication.

1756-OF8IH Configuration Tags, Configure HART Device = No (AB:1756_OF8IH:O:0) (Continued)

Member Name	Type	Style	Description
RangeType	INT	Decimal	1 = 0…20 mA. 2 = 4…20 mA. (The 1756-OF8IH does not support voltage outputs.)
MaxRampRate	REAL	Float	Maximum allowable transition rate in user-specified scaling units per second. The value: • Must be greater than zero if RampToFault, RampToProg, or RampToRun is set. • Must equal zero if RampToFault, RampToProg, and RampToRun are all not set. • Can't be greater than 2 x full-scale maximum. When HART is enabled, the channel enforces a fixed maximum ramp rate regardless of RampToFault, RampToProg, and RampToRun settings; this is done to help avoid HART transmission noise.
FaultValue	REAL	Float	Communication fault output value.
ProgValue	REAL	Float	Program mode output value.
LowSignal	REAL	Float	Lower current value for scaling to engineering units. Default is 4 mA. Must be less than HighSignal and more than minimum input range. See Scaling to Engineering Units on page 143 for more information.
HighSigal	REAL	Float	Upper current value for scaling to engineering units. Default is 10 mA. Must be more than LowSignal and less than maximum input range. See Scaling to Engineering Units on page 143 for more information.
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
LowLimit	REAL	Float	Output signal is clamped at this value in engineering units even if Ch0Data is lower than this.
HighLimit	REAL	Float	Output signal is clamped at this value in engineering units if Ch0Data is larger than this.
CalBias	REAL	Float	Sensor offset in engineering units added to the measured signal before reporting Ch0.Data.
PassthroughHandleTimeout	INT	Decimal	Response hold time in seconds (0…255).
PassthroughFreq_14	BOOL	Decimal	Selects the policy for sending HART pass-through messages. See Output Module Pass-through Setting, Ratio, and Priority on page 139.
PassthroughFreq_15	BOOL	Decimal	

1756-OF8IH Configuration, Configure HART Device = Yes

This table describes the configuration tags available in the 1756-OF8IH module when Configure HART Device is set to Yes.

1756-OF8IH Configuration Tags, Configure HART Device = Yes (AB:1756_OF8IH_HART_CMD:C:0)

Member Name	Type	Style	Description
ProgToFaultEn	BOOL	Decimal	0 – Disabled. 1 – Enable programmed fault states. Determines how outputs can behave if a communication fault occurs while the module is in program mode. When set, the bit causes the outputs to transition to their programmed fault state. If not set, outputs remain in their configured program state despite a communications fault occurring.
ChxConfig (Ch 0…Ch7)	AB:1756_OF8IH_ChConfig_Struct:C:0		
RampToFault	BOOL	Decimal	Enables ramping of the output value to the value specified by FaultValue. MaxRampRate defines the transition ramp rate. HoldOnFault must be set to 1 if RampToFault is set to 1.
RampToProg	BOOL	Decimal	Selects the ramping behavior when the system transitions from Run to Idle/Program mode. Enable ramping of the output to the fvalue specified by IdleProgValue. MaxRampRate defines the ramp rate. HoldOnIdle must be set to 1 if RampToProg is set to 1 and MaxRampRate must be > 0.
RampToRun	BOOL	Decimal	Enables ramping of the output value during Run mode between the current output level and a newly requested output. MaxRampRate defines the transition ramp rate and must be > 0.
ProgMode	BOOL	Decimal	
FaultMode	BOOL	Decimal	
HoldForInit	BOOL	Decimal	Configures the channel to hold, or not change, until initialized with a value within 0.1% of full scale or its current value when one of the following conditions occurs: • Module initial connection power-up. • Module transition from Program mode to Run mode. • Module re-establishes communication after a fault.
HARTEn	BOOL	Decimal	Enables HART communication.
PVDampingConfigEn	BOOL	Decimal	
PVRangeConfigEn	BOOL	Decimal	

1756-OF8IH Configuration Tags, Configure HART Device = Yes (AB:1756_OF8IH_HART_CMD:C:0) (Continued)

Member Name	Type	Style	Description
RangeType	INT	Decimal	1 = 0…20 mA. 2 = 4…20 mA. (The 1756-OF8IH does not support voltage outputs.)
MaxRampRate	REAL	Float	Maximum allowable transition rate in user-specified scaling units per second. The value must meet these conditions: • Must be greater than zero if RampToFault, RampToProg, or RampToRun is set. • Must equal zero if RampToFault, RampToProg, and RampToRun are all not set. • Can't be greater than 2 x full-scale maximum. When HART is enabled, the channel enforces a fixed maximum ramp rate regardless of RampToFault, RampToProg, and RampToRun settings; this is done to help avoid HART transmission noise.
FaultValue	REAL	Float	Communication fault output value.
ProgValue	REAL	Float	Program mode output value
LowEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to LowSignal. See Scaling to Engineering Units on page 143 for more information.
HighEngineering	REAL	Float	Measured quantity in engineering units that results in a signal level equal to HighSignal. See Scaling to Engineering Units on page 143 for more information.
PVDamping	REAL	Float	PV Damping value in seconds (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVLowerRange	REAL	Float	PV Range low value (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVUpperRange	REAL	Float	PV Range high value (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVUnits	SINT	Decimal	PV Units (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
PVTransferFunction	SINT	Decimal	PV transfer function (See Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules) on page 153).
CalBias	REAL	Float	Sensor offset in engineering units added to the measured signal before reporting Ch0.Data.
PassthroughHandleTimeout	INT	Decimal	Response hold time in seconds (0…255).
PassthroughFreq_14	BOOL	Decimal	Selects the policy for sending HART pass-through messages. See Output Module Pass-through Setting, Ratio, and Priority on page 139.
PassthroughFreq_15	BOOL	Decimal	

1756-OF8IH Input - Analog Only

This table describes the input tags available in the Analog Only data format for the 1756-OF8IH module.

1756-OF8IH Input Tags - Analog Only Data Format (AB:1756_OF8IH_Analog:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel level fault status bits.
ChxFault (Ch 0…Ch7)	BOOL	Decimal	(ChannelFaults.0…ChannelFaults.7) Indicates a fault on the corresponding channel.
LoopOutputFault	BOOL	Decimal	Loop output failure. Set when 24V DC backplane power is below 17.5V (±1.2V).
HARTFaults	INT	Binary	HART fault status bits.
ChxHARTFault (Ch 0…Ch7)	BOOL	Decimal	(HARTFaults.0…HARTFaults.7) Indicates a HART fault on the corresponding channel.
ModuleFaults	INT	Binary	Module level fault status.
CalFault	BOOL	Decimal	A calibration fault has occurred on a channel.
Calibrating	BOOL	Decimal	Calibration is in progress.
AnalogGroupFault	BOOL	Decimal	Indicates that a channel fault has occurred.
ChxStatus (Ch 0…Ch7)	INT	Binary	Channel level status bits.
ChxHLimitAlarm (Ch 0…Ch7)	BOOL	Decimal	User value is equal to or greater than HighLimit configuration value. Automatically set to zero when AlarmDisable is set.
ChxLLimitAlarm (Ch 0…Ch7)	BOOL	Decimal	User value equal to or greater than LowLimit configuration value. Automatically set to zero when AlarmDisable is set.
ChxRampAlarm (Ch 0…Ch7)	BOOL	Decimal	Set when output is ramping to new user value. Cleared when ramping is complete. This bit isn't set if MaxRampRate is zero. This bit is always zero when the AlarmDisable configuration bit is set.
ChxInHold (Ch 0…Ch7)	BOOL	Decimal	If HoldForInit bit is set, the module is waiting for the appropriate Output word.
ChxCalFault (Ch 0…Ch7)	BOOL	Decimal	Set when calibration is invalid for this channel.
ChxNotANumber (Ch 0…Ch7)	BOOL	Decimal	Set when Output word has all 8 bits set.

1756-OF8IH Input Tags - Analog Only Data Format (AB:1756_OF8IH_Analog:I:0)

Member Name	Type	Style	Description
ChxOpenWire (Ch 0...Ch7)	BOOL	Decimal	Set when Output is commanded to at least 0.1 mA and the circuit is physically open. Open circuit indication can also exist if the load resistance exceeds specification.
ChxData (Ch 0...Ch7)	REAL	Float	Value of analog signal on Channel x after conversion to engineering units.
CSTTimestamp	DINT (2)	Decimal	64-bit Coordinated System Time. Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	15-bit time from power on/reset in milliseconds. This value is updated when the Output Table changes. If ramping is enabled, the value continuously updates until the output value reaches the user value. If the module has entered a faulted state, the value is updated continuously.

1756-OF8IH Input - Analog and HART PV

This table describes the input tags available in the Analog and HART PV data format for the 1756-OF8IH module.

1756-OF8IH Input Tags - Analog and HART PV Data Format (AB:1756_OF8IH_HARTPV:I:1)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel level fault status bits.
ChxFault (Ch 0...Ch7)	BOOL	Decimal	A fault has occurred on the corresponding channel.
LoopOutputFault	BOOL	Decimal	Loop output failure. Set when 24V DC backplane power is below 17.5V (±1.2V).
HARTFaults	INT	Binary	HART fault status bits.
ChxHARTFault (Ch 0...Ch7)	BOOL	Decimal	(HARTFaults.0...HARTFaults.7) Indicates a HART fault on the corresponding channel.
ModuleFaults	INT	Binary	Module level fault status.
CalFault	BOOL	Decimal	A calibration fault has occurred on a channel.
Calibrating	BOOL	Decimal	Calibration is in progress.
UpdatedStatusReady	BOOL	Decimal	Updated Cmd48 status data available.
AnalogGroupFault	BOOL	Decimal	Indicates that a channel fault has occurred.
ChxStatus (Ch0...Ch7)	INT	Binary	
ChxHLimitAlarm	BOOL	Decimal	User value is equal to or greater than HighLimit configuration value. Automatically set to zero when AlarmDisable is set.
ChxLLimitAlarm	BOOL	Decimal	User value equal to or greater than LowLimit configuration value. Automatically set to zero when AlarmDisable is set.
ChxRampAlarm	BOOL	Decimal	Set when output is ramping to new user value. Cleared when ramping is complete. This bit isn't set if MaxRampRate is zero. This bit is always zero when the AlarmDisable configuration bit is set.
ChxInHold	BOOL	Decimal	If HoldForInit bit is set, the module is waiting for the appropriate Output word.
ChxCalFault	BOOL	Decimal	Set when calibration is invalid for this channel.
ChxNotANumber	BOOL	Decimal	Set when Output word has all 8 bits set.
ChxOpenWire	BOOL	Decimal	Set when Output is commanded to at least 0.1 mA and the circuit is physically open. Open circuit indication can also exist if the load resistance exceeds specification.
ChxData	REAL	Float	Value of analog signal on Channel x after conversion to engineering units.
CSTTimestamp	DINT (2)	Decimal	64-bit Coordinated System Time. Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	15-bit time from power on/reset in milliseconds. This value is updated when the Output Table changes. If ramping is enabled, the value continuously updates until the output value reaches the user value. If the module has entered a faulted state, the value is updated continuously.
HART	AB:1756_OF8IH_HARTData:I:1		
ChxDeviceStatus (Ch0...Ch7)	AB:1756_OF8IH_HARTStatus_Struct:I:1		
Init	BOOL	Decimal	Initializing device.
Fail	BOOL	Decimal	Communication not established.
MsgReady	BOOL	Decimal	Ladder passthrough message reply ready.
CurrentFault	BOOL	Decimal	Digital and analog values do not match.
ConfigurationChanged	BOOL	Decimal	The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-OF8IH module via CIP MSG GetDeviceInfo, which clears this bit.

1756-OF8IH Input Tags - Analog and HART PV Data Format (AB:1756_OF8IH_HARTPV:I:1) (Continued)

Member Name	Type	Style	Description
ResponseCode	INT	Binary	HART communication status byte or Response code from a recent HART reply (first status byte). See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	INT	Binary	HART device status byte from a recent HART reply. Indicates the health of the HART field device. See Field Device Status Bit Mask Definitions on page 205 for more information.
PVOutOfLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ExtDeviceStatus	INT	Binary	Extended device status (from HART cmd9)xx.
MainetnanceRequired	BOOL	Decimal	
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow			Low power.
ChxPV (Ch 0...Ch7)			Channel *x* HART PV value.
ChxSV (Ch 0...Ch7)			Channel *x* HART SV value.
ChxTV (Ch 0...Ch7)			Channel *x* HART TV value.
ChxFV (Ch 0...Ch7)			Channel *x* HART FV value.
ChxPVStatus (Ch 0...Ch7)			Channel *x* HART PV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxSVStatus (Ch 0...Ch7)			Channel *x* HART SV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxTVStatus (Ch 0...Ch7)			Channel *x* HART TV status. See HART PV, SV, TV, and FV Status on page 210 for more information.
ChxFVStatus (Ch 0...Ch7)			Channel *x* HART FV status. See HART PV, SV, TV, and FV Status on page 210 for more information.

Analog and HART by Channel, Configure HART Device = No

This table describes the input tags available in the Analog and HART by Channel data format for the 1756-OF8IH module when Configure HART Device = No.

1756-OF8IH Input Tags - Analog and HART by Channel, Configure HART Device = No (AB:1756_OF8IH_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel level fault status bits.
ChxFault (Ch 0...Ch7)	BOOL	Decimal	A fault has occurred on the corresponding channel.
LoopOutputFault	BOOL	Decimal	(ChannelFaults.8) Loop output failure. Set when 24V DC backplane power is below 17.5V (±1.2V).
ModuleFaults	INT	Binary	Module level fault status bits.
CalFault	BOOL	Decimal	(ModuleFaults.1) Most recent calibration failed.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Updated Cmd48 status data available.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a channel fault has occurred.
Chx (Ch0...Ch7)	AB:1756_OF8IH_HARTDataAll_Struct:I:0		
Data	REAL	Float	Analog value in engineering units.
Device Status	AB:1756_OF8IH_HARTStatusAll_Struct:I:0		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this is 0 and HARTCommFail is 1, then HART isn't enabled on this channel. If both are 1, then 1756-OF8IH is sending out HART messages to attempt to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure, device not found, or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this).
MsgReady	BOOL	Decimal	Ladder passthrough message reply is ready for query service.
CurrentFault	BOOL	Decimal	Digital and analog values do not match (Analog current measurement does not match the current reported by the Field Device over the HART network.
ConfigurationChanged	BOOL	Decimal	The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-OF8IH module via CIP MSG GetDeviceInfo, which clears this bit.

1756-OF8IH Input Tags - Analog and HART by Channel, Configure HART Device = No (AB:1756_OF8IH_AnalogHARTbyChannel:I:0)

Member Name	Type	Style	Description
BrokenWire	BOOL	Decimal	Indicates that current isn't flowing through the module as expected. Broken wiring, RTB removal, or a powered-off field device can cause this.
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply (first status byte). See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	Field device status byte (second status byte).
PVOutOFLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ChxStatus (Ch0...Ch7)	SINT	Binary	
HLimitAlarm	BOOL	Decimal	User value equal to or greater than HighLimit configuration value. Automatically set to zero when AlarmDisable config bit is set.
LLimitAlarm	BOOL	Decimal	User value equal to or greater than the LowLimit configuration value. Automatically set to zero when AlarmDisable config bit is set.
RampAlarm	BOOL	Decimal	Set when Output is ramping to new user value. Cleared when ramping complete. This bit isn't set if MaxRampRate config value is 0. Automatically set to zero when the AlarmDisable config bit is set.
InHold	BOOL	Decimal	If the HoldForInit config bit is set, the module is waiting for the appropriate Output word.
CalFault	BOOL	Decimal	Set when calibration is invalid for this channel.
NotANumber	BOOL	Decimal	Set when Output word has all 8 bits set (bits 23...30).
OpenWire	BOOL	Decimal	Set when Output is commanded to at least 0.1 mA and the circuit is physically open. Open circuit indication can also exist if the load resistance exceeds specification.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9).
MaintenanceRequired	BOOL	Decimal	
DeviceVariableAlert	BOOL	Decimal	Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	
PV	REAL	Float	HART device primary value.
SV	REAL	Float	HART device second value.
TV	REAL	Float	HART device third value.
FV	REAL	Float	HART device fourth value.
PVStatus	SINT	Hex	HART device PV status.
SVStatus	SINT	Hex	HART device SV status.
VStatus	SINT	Hex	HART device TV status.
FVStatus	SINT	Hex	HART device FV status.
CSTTimestamp	INT (2)	Hex	64-bit Coordinated System Time. Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	15-bit time from power on/reset in milliseconds. This value is updated when the Output Table changes. If ramping is enabled, the value continuously updates until the output value reaches the user value. If the module has entered a faulted state, the value is updated continuously.

Analog and HART by Channel, Configure HART Device = Yes

This table describes the input tags available in the Analog and HART by Channel data format for the 1756-OF8IH module when Configure HART Device = Yes.

1756-OF8IH Input Tags - Analog and HART PV by Channel, Configure HART Device = Yes (AB:1756_OF8IH_AnalogHARTbyChannel_1:I:0)

Member Name	Type	Style	Description
ChannelFaults	INT	Binary	Channel level fault status bits.
ChxFault	BOOL	Decimal	A fault has occurred on the corresponding channel.
LoopOutputFault	BOOL	Decimal	(ChannelFaults.8) Loop output failure. Set when 24V DC backplane power is below 17.5V (±1.2V).
ModuleFaults	INT	Binary	Module level fault status bits.
CalFault	BOOL	Decimal	(ModuleFaults.1) Most recent calibration failed.
Calibrating	BOOL	Decimal	(ModuleFaults.2) Calibration in progress.
UpdatedStatusReady	BOOL	Decimal	(ModuleFaults.3) Updated Cmd48 status data available.
AnalogGroupFault	BOOL	Decimal	(ModuleFaults.7) Indicates that a channel fault has occurred.
Chx (Ch0...Ch7)	AB:1756_OF8IH_HARTDataAll_1_Struct:I:0		
Data	REAL	Float	Analog value in engineering units.
Device Status	AB:1756_OF8IH_HARTStatusAll_1_Struct:I:0		
HARTInit	BOOL	Decimal	Searching for or Initializing HART device. If this value is 0 and HARTCommFail is 1, then HART isn't enabled on this channel. If both are 1, then 1756-OF8IH is sending out HART messages to attempt to establish communication with a HART device.
HARTCommFail	BOOL	Decimal	HART communication failure, device not found, or HART not enabled. If this bit is 1, none of the other data in the HART part of the Input Tag are valid. (HART.PVStatus is also set to 0 to indicate this.)
MsgReady	BOOL	Decimal	Ladder passthrough message reply is ready for query service.
CurrentFault	BOOL	Decimal	Digital and analog values do not match (analog current measurement does not match the current reported by the Field Device over the HART network).
ConfigurationChanged	BOOL	Decimal	The Field Device configuration has changed and new Field Device configuration information can be obtained from the 1756-OF8IH module via CIP MSG GetDeviceInfo, which clears this bit.
Unused1	BOOL	Decimal	
HARTFault	BOOL	Decimal	Indicates a problem with HART data from the field device on Channel x. Examples are HART not enabled, HART device not connected, HART communication failure due to noise. These field device status conditions also cause this to be set: Device Malfunction, PV Out of Limits, Loop Current Saturated, and Loop Current Fixed.
ResponseCode	SINT	Binary	HART communication status byte or Response code from a recent HART reply (first status byte). See Response Code and Field Device Status on page 204 for more information.
FieldDeviceStatus	SINT	Binary	Field device status byte (second status byte).
PVOutOFLimits	BOOL	Decimal	The primary variable is beyond its operating limit.
VariableOutOfLimits	BOOL	Decimal	A device variable that is not mapped to the PV is beyond its operating limits.
CurrentSaturated	BOOL	Decimal	The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further.
CurrentFixed	BOOL	Decimal	The loop current is being held at a fixed value and isn't responding to process variations.
MoreStatus	BOOL	Decimal	More status information is available via command 48, 'Read Additional Status' information.
ColdStart	BOOL	Decimal	A power failure or device reset occurred.
Changed	BOOL	Decimal	An operation was performed that changed the configuration of the device.
Malfunction	BOOL	Decimal	The device detected a serious error or failure that compromises device operation.
ChStatus	SINT	Binary	
RampAlarm	BOOL	Decimal	(ChStatus.2) Set when Output is to a new user value. Cleared when ramping complete. This bit isn't set if MaxRampRate config value is 0. Automatically set to zero when the AlarmDisable config bit is set.
InHold	BOOL	Decimal	(ChStatus.3) If the HoldForInit config bit is set, the module is waiting for the appropriate Output word.
CalFault	BOOL	Decimal	(ChStatus.4) Set when calibration is invalid for this channel.
NotANumber	BOOL	Decimal	(ChStatus.5) Set when Output word has all 8 bits set (bits 23...30).
PVConfigFailed	BOOL	Decimal	(ChStatus.6)
OpenWire	BOOL	Decimal	(ChStatus.7) Set when Output is commanded to at least 0.1 mA and the circuit is physically open. Open circuit indication can also exist if the load resistance exceeds specification.
ExtDeviceStatus	SINT	Binary	Extended device status (from HART cmd9).
MaintenanceRequired	BOOL	Decimal	(ExtDeviceStatus.0)
DeviceVariableAlert	BOOL	Decimal	(ExtDeviceStatus.1) Device reports a problem with some measurement.
PowerLow	BOOL	Decimal	(ExtDeviceStatus.2)
CalibrationFault	BOOL	Decimal	Last attempted calibration for this channel failed.

1756-OF8IH Input Tags - Analog and HART PV by Channel, Configure HART Device = Yes (AB:1756_OF8IH_AnalogHARTbyChannel_1:I:0)

Member Name	Type	Style	Description
Calibrating	BOOL	Decimal	Calibration for the channel is in progress.
CalGoodLowRef	BOOL	Decimal	A valid Low Reference signal has been sampled on this channel.
CalBadLowRef	BOOL	Decimal	The Low Reference signal is grossly out of the expected range.
CalGoodHighRef	BOOL	Decimal	A valid high reference signal has been sampled on the channel.
CalBadHighRef	BOOL	Decimal	The high reference signal is grossly out of the expected range.
CalSuccessful	BOOL	Decimal	This bit is set after valid High and Low points are captured and the Calibrate bit in the output word has been cleared.
PV	REAL	Float	HART device primary value.
SV	REAL	Float	HART device second value.
TV	REAL	Float	HART device third value.
FV	REAL	Float	HART device fourth value.
PVStatus	SINT	Hex	HART device PV status.
SVStatus	SINT	Hex	HART device SV status.
VStatus	SINT	Hex	HART device TV status.
FVStatus	SINT	Hex	HART device FV status.
CSTTimestamp	INT (2)	Hex	64-bit Coordinated System Time. Time stamp that is taken at the time that the input data was sampled in terms of coordinated system time, which is a 64-bit value in microseconds coordinated across the modules in the 1756 backplane.
RollingTimestamp	INT	Decimal	15-bit time from power on/reset in milliseconds. This value is updated when the Output Table changes. If ramping is enabled, the value continuously updates until the output value reaches the user value. If the module has entered a faulted state, the value is updated continuously.

Output, Configure HART Device = No

This table describes the output tags available in the 1756-OF8IH module when Configure HART Device is set to No.

1756-OF8IH Output Tags, Configure HART Device = No (AB:1756_OF8H:O:0)

Member Name	Type	Style	Description
ChxData (Ch0...Ch7)	REAL	Float	Value in engineering units to output on the analog signal of Channel x.

Output, Configure HART Device = Yes

This table describes the output tags available in the 1756-OF8IH module when Configure HART Device is set to Yes.

1756-OF8IH Output Tags, Configure HART Device = Yes (AB:1756_OF8IH:O:0)

Member Name	Type	Style	Description
Ch	AB:1756_OF8IH_ChStruct:O:0[8]		
Chx (Ch0...Ch7)	AB:1756_OF8IH_ChStruct:O:0		
Calibrate	BOOL	Decimal	Bit 0 - Initiates the calibration process. Must stay set through a valid LowReference and HighReference sequence. Clearing this bit before this sequence is complete aborts calibration.
CalOutputLowRef	BOOL	Decimal	Bit 1 - Rising edge sets output to low calibration value (4 mA).
CaLOutputHighRef	BOOL	Decimal	Bit 2 - Rising edge sets output to high calibration value (20 mA).
CalLowRefPassed	BOOL	Decimal	Bit 3 - On rising edge, the value in ChxData represents the measured low cal output in mA.
CalHighRefPassed	BOOL	Decimal	Bit 4 - On rising edge, the value in ChxData represents the measured high cal output in mA.
CalFinished	BOOL	Decimal	Bit 5 - Rising edge triggers channel to use the High and Low reference measurements for calculating the calibration. Calibration state exits if successful.
ChData	REAL	Float	Value in engineering units to output on the analog signal of Channel x.
CalibrationDate	INT	Decimal	The date to be recorded upon successful calibration, typically the current date.

Configure and Calibrate Modules

This chapter includes screen captures that show the configuration and calibration of a ControlLogix® HART analog I/O module with one of the following:

- 1756 HART I/O Analog Add-On Profile (AOP), version 40.12.23 or later installed for Studio 5000 Logix Designer® application, version 35 or earlier
- Studio 5000 Logix Designer application, version 36 or later

These screen captures, showcasing an updated user interface, feature 1756-IF8H and 1756-IF8IH modules. However the procedures are similar for any ControlLogix HART analog I/O module with either update installed.

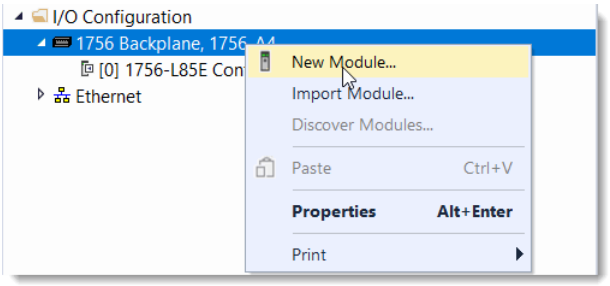
For information about configuration and calibration with older versions of programming software that feature the previous, tab-based user interface, see Appendix F.

Add a New Module

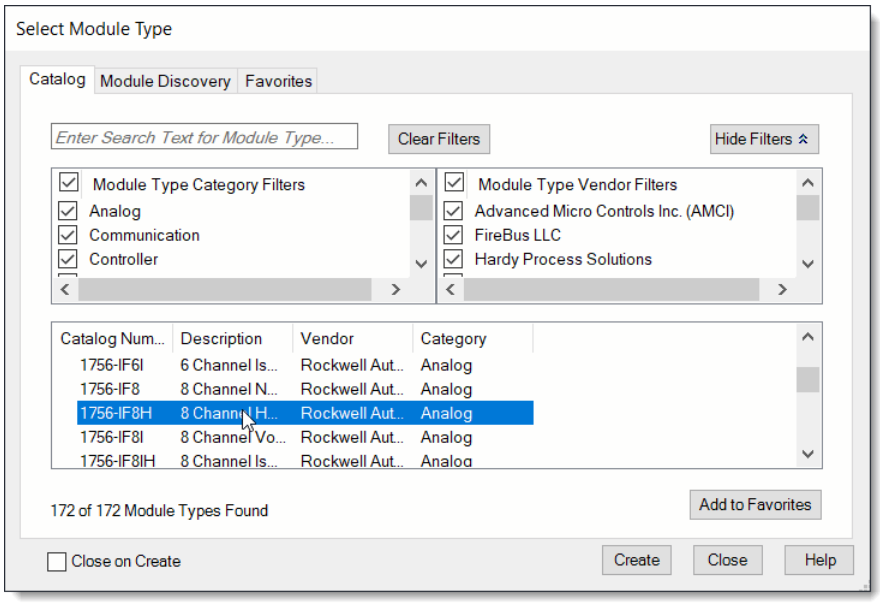
Follow these steps to add a ControlLogix HART analog I/O module to your Studio 5000 Logix Designer application project.

IMPORTANT You can't change any information in these views if you are in Hard Run mode. Hard Run mode means that the keyswitch is in the Run position.

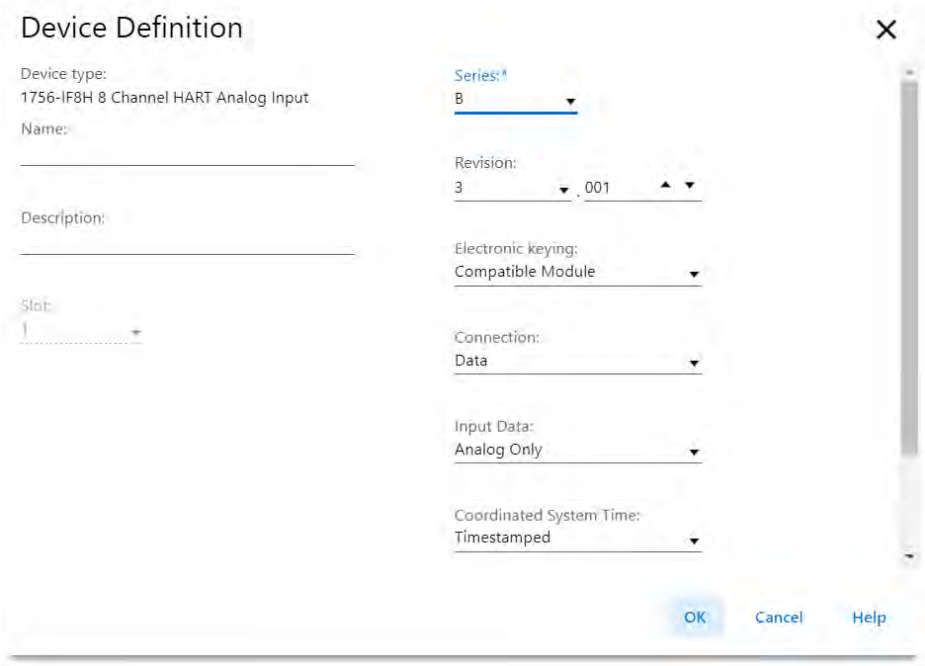
1. From the I/O Configuration tree, right-click the 1756 backplane and select New Module.



The Select Module Type dialog appears.



2. Find and select the module that you want to add, and select Create.
   The Device Definition dialog appears.

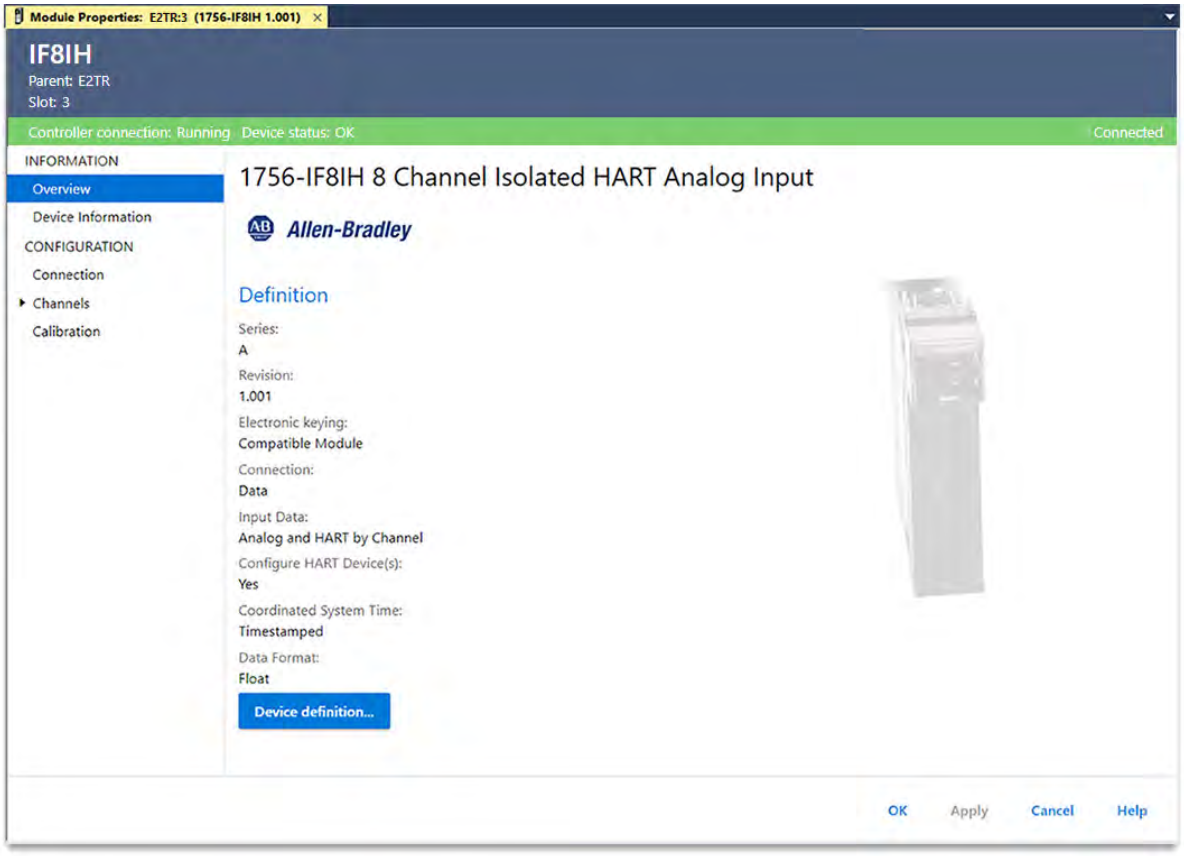


3. Enter a name for the module.
4. Select the slot number that matches the physical slot number of the chassis where the module is housed.
5. Make additional changes to the Device Definition as necessary.
6. Once the desired configuration is set, select OK.

Configure Your Module

To change your module configuration, on the Module Properties tab for the module, select Overview from the left navigation.

The Overview view appears.



You can review the current setup, or select Device Definition to modify these parameters.

Overview View and Module Definition Parameters

Parameter	Action	Values
Series	Select the series letter that matches the series of your module. This can be determined using FactoryTalk® Linx or by referencing the label on the side of your module.	Dropdown menu
Revision	Select the revision number that matches the major and minor revisions of your module.	Dropdown menu
Electronic Keying	Select the electronic keying method See Electronic Keying on page 20 for more information	• Exact Match • Compatible Module (default) • Disable Keying
Connection	Select the connection type	• Data • Listen-only - has no configuration data, doesn't send output data See Listen-only Mode on page 26 for more information.
Input Data	Select the input data mode	• Analog Only • Analog and HART PV • Analog and HART by Channel See HART Configuration for more information.
Configure HART Device(s) **NOTE:** Available only for the 1756-IF8IH and 1756-OF8IH modules when the Input Data format is Analog and HART by Channel.	Enable or disable the Configure HART Device(s) feature. If you select Yes, a HART Command view is added to the left navigation, in which you specify configuration values to be sent to the HART device.	Values that can be added in the HART Command view are PV Damping (seconds), PV Units, PV Upper Range, PV Lower Range, and PV Transfer Function.
Coordinated System Time	Not configurable	Timestamped
Data Format	Not configurable	Float

HART Configuration

The Input Data type that you select on the Device Definition dialog determines how HART field device data can be accessed.

HART field device data is gathered through the automatic collection of HART Field Device Process Variables and Health information. You can also access HART field device data with pass-through messages. See Use a CIP MSG to get HART Data on page 167 and Use HART Modules with Asset Management Software on page 181 for more information.

This table shows which configuration options provide HART data in the input tag and which provide pass-through message access.

HART Data Configuration Options

Input Data Format	Enable HART Checkbox (Channels or ChX view)	HART Data Input Tag Present?	HART Data Valid For This Channel?	Pass-through Message Access for MSG or Asset Management
Analog only	Not selected	No	No	No
	Selected			Yes
Analog and HART PV	Not selected	Yes	No	No
	Selected	Yes	Yes	Yes
Analog and HART by Channel	Not selected	Yes	No	No
	Selected	Yes	Yes	Yes

Choose Analog and HART PV if you prefer the members of the tag to be arranged similar to non-HART analog input modules. The analog values for all channels are grouped near the end of the tag. This option makes it easy to view all eight analog values at once.

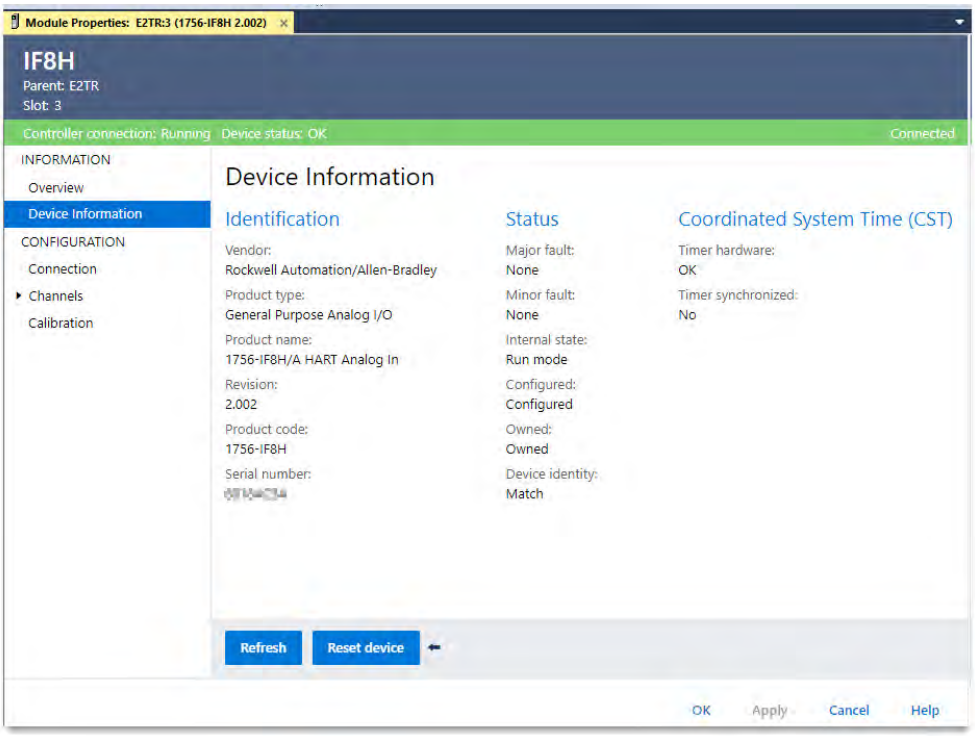
Choose Analog and HART by Channel if you prefer Status, Analog Value, and Device Status for each channel to be together in the tag. This arrangement makes it easier to view all data that is related to one field device.

Even if you don't enable HART on all channels, the Analog and HART PV and Analog and HART by Channel input tags include space for the data. However, this data space is marked with a HART Fault to indicate that the data isn't valid. This feature lets you add HART instruments later without disturbing the tag layout.

View Module Information and Status

To view identification, status, and other details about your module, select Device Information from the left navigation.

The Device Information view appears. The data that is displayed comes directly from the module when the project is online.



Identification

The Identification section lists the Vendor, Product Type, Product Name, Revision, Product code, and Serial number associated with your module.

Status

The Status section displays the current operational status of the module.

Parameter	Description	
Major Fault	None, Unrecoverable, or Recoverable.	
Minor Fault	None, Unrecoverable, or Recoverable. Recoverable can mean that you have a channel fault such as wire off.	
Internal State	Indicates the module mode.	
Configured	Indicates if an owner controller that is connected to the module configured the module. Once a module is configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module.(1)	
Owned	Indicates if an owner controller is connected to the module.(1)	
Module Identity	Displays Match or Mismatch. This field does not account for the Electronic Keying or Minor Revision selections for the module as specified on the Device Definition dialog.	
	Displays	**If the Physical Module**
	Match	For this condition to exist, the following elements of Device Information must mirror the values configured in the Device Definition: • Vendor • Module type (the combination of product type and code for a particular vendor) • Major revision
	Mismatch	Does not agree with what is specified on the Device Definition dialog.

(1) This information applies to the I/O module only and not to adapters, scanners, bridges, or other communication modules.

Coordinated System Time (CST)

The CST section of the Device Information view provides the following information:

Parameter	Description
Timer Hardware	Displays OK or faulted for the timer hardware.
Timer Synchronized	Displays yes if the module timer is coordinated with the master. Displays no if it isn't. This indicates if a CST master is providing a time reference to the module. To configure a controller to be the CST Time Master, right-click the controller in the I/O Configuration tree, and select Properties.

Refresh or Reset Device

Select Refresh to refresh the information display or select Reset Device to reset the module to its power-up state.

IMPORTANT You can refresh the module at any time while online, but you cannot reset the module when in implicit protected mode.

Resetting the module restores output signals to default conditions.

Apply Changes

If the following conditions exist when you select OK or Apply, the information that is displayed is automatically sent to the controller:

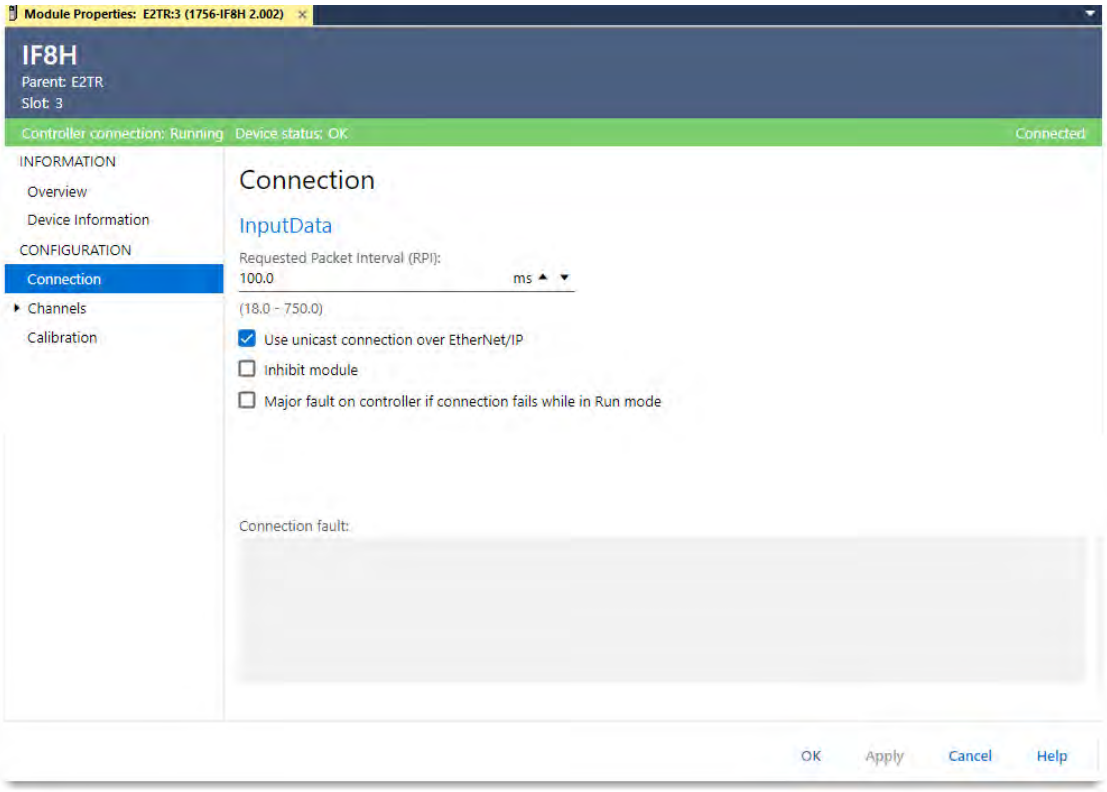
- You're online in Program, Remote Program, or Remote Run mode, and
- This controller is the owner controller, and
- You've changed the module configuration in the software.

The controller tries to send the information to the module (if the module connection isn't inhibited). If you do not select OK or Apply, your changes aren't sent to the controller.

Set Module Connection

To configure the connection between your input module and a controller, select Connection from the left navigation.

The Connection view appears.



These parameters can be configured in the Connection view.

Module Connection Parameters

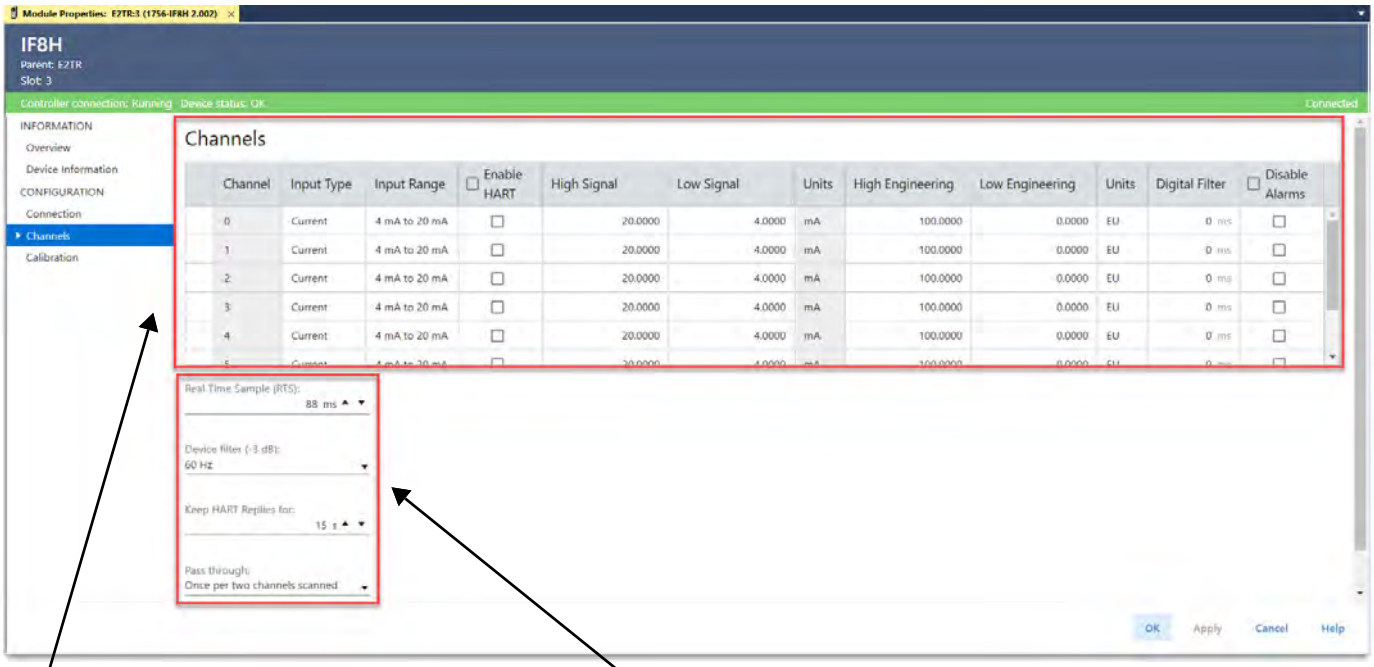
Parameter	Description
Requested Packet Interval (RPI)	Defines a specific rate at which the controller exchanges data with the configurable I/O module.
Inhibit Module	Prevents the controller from connecting to the module. Use only if you do not want the module to be put into service.
Major Fault on Controller If Connection Fails While in Run Mode	The Logix controller performs a major fault if communication to this I/O module fails.
Use Unicast Connection over EtherNet/IP™	Appears only for HART analog modules that use the Logix Designer application version 20 or later in a remote EtherNet/IP chassis. Use the default checkbox if there are no other controllers in 'Listen-Only' mode. Clear the checkbox if there are other 'listening' controllers in the system or if utilizing ControlLogix Redundancy.

Use the Channels View To Configure Multiple Channels

To configure multiple channels in a single view, select Channels from the left navigation.

IMPORTANT Unless specifically noted, parameters are not available in Run mode.

Channels View - Input Modules



Changes made to the parameters that are displayed in the Channels table apply only to the individual channel that is selected.

Changes made to the parameters located below the Channels table apply to all channels.

The Channels table found at the top of the Channels view displays a list of all channels and some of the parameters that you can configure per channel. Changes that are made in the Channels table apply only to the channel that's selected.

Input Module Channel Parameters in the Channels Table

Parameter	Action	Notes
Input Type	Select a value from the dropdown menu.	Indicates the input type as Current or Voltage. • The 1756-IF8IH module does not support voltage ranges
Input Range	Select a value from the dropdown menu.	If HART is enabled, the input range must be 0...20 mA or 4...20 mA.
Enable HART	Select or clear the checkbox for the channel.	• When HART isn't enabled for a channel: – HART messages aren't sent on this channel. – HART pass-through messages aren't sent. – HART data for this channel isn't updated in the input tag. • If you select a HART PV or HART by Channel input tag on the Device Definition dialog, process data (PV, SV, TV, and FV) from the HART instrument is included in the input tag. If you selected Analog only, the additional process data isn't included in the input tag. • Regardless of the choice of input tag, HART communication can be enabled for each channel to provide pass-through HART message access. If Enable HART isn't selected, this pass-through message access isn't available. • We recommend that you Enable HART for any channel that has a connected HART device. This selection is so that information can be displayed on the HART Device Information view and accessed by FactoryTalk AssetCentre software. • On the 1756-IF8H module, all channels share the HART modem. For this module, HART response time is better if you enable only the needed HART channels. The other input modules (1756-IF16H, 1756-IF16IH, and 1756-IF8IH) have a separate HART modem for each channel.

Input Module Channel Parameters in the Channels Table (Continued)

Parameter	Action	Notes
Scaling	Enter values for High Signal, Low Signal, High Engineering, and Low Engineering.	See Scaling to Engineering Units on page 143 for more information.
Digital Filter	Select a filter time constant value from 0…20100 ms.	This field is a first-order lag filter that smooths input transitions. It's called a digital filter because it's calculated in the software by the module, not by a hardware filter. Each channel has its own digital filter value. So each channel can have a unique digital filter setting to accommodate the specific device that is attached to that channel. For the module filter, one value is applied for all channels.
Disable Alarms	Select or clear the checkbox for the channel.	Determines whether the device generates process alarms.

Changes made to the parameters located below the Channels table on the Channels view of an input module apply to all channels listed in the table.

Parameters That Apply To All Input Channels

Parameter	Action	Notes
Real Time Sample (RTS)	Select a value from 18…10,000 ms.	• Determines the interval of time at which updated information is supplied to the controller. • The default is 88. • See Real Time Sample (RTS) on page 22 for more information. • See Real-Time Sample Values table on page 137 for RTS choices available for each Module Filter setting.
Device Filter (-3 dB)	Select a value from the dropdown menu.	• Because the digital HART communication signals are in the 1200…2400 Hz range, the module filter can't be set to 1000 Hz if HART is enabled. • See the Module Filter Values table on page 145 to select a value. • See Module Filter on page 30 (1756-IF8H) or page 51 (1756-IF8IH) for more information.
Keep HART Replies	Select a value from 1…255 s.	• HART replies that are received from the Field Device in response to pass-through messages that have been sent are kept for this long. Retrieve them within this time or the module discards them. • The default is 15. **IMPORTANT:** We do not recommend a value of less than 15 seconds. • See Use a CIP MSG to get HART Data on page 167 for more information.
Pass through[1]	Select a value from the dropdown menu.	• Determines how often pass-through messages occur. – Once per two channels scanned (default)- After two channels have PVs scanned to the input tag, a pass-through message is sent (if one is pending). – Once per module scan - Select this value if you want to minimize the impact pass-through message clients have on reading the PVs into the input tag. – Once per channel scan - After each channel has its PVs scanned to the input tag, a pass-through message is sent (if one is pending). Select this value if you want to give pass-through messages from clients, such as FactoryTalk AssetCentre, higher priority than reading PV, SV, TV, FV, and field device health into the input tag. See the Input Module Pass-through Setting, Ratio, and Priority table on page 137 for more information.

(1) Series B modules do not support Pass-through Setting. Pass-through scanning is fixed at one pass-through per channel scan on Series B modules.

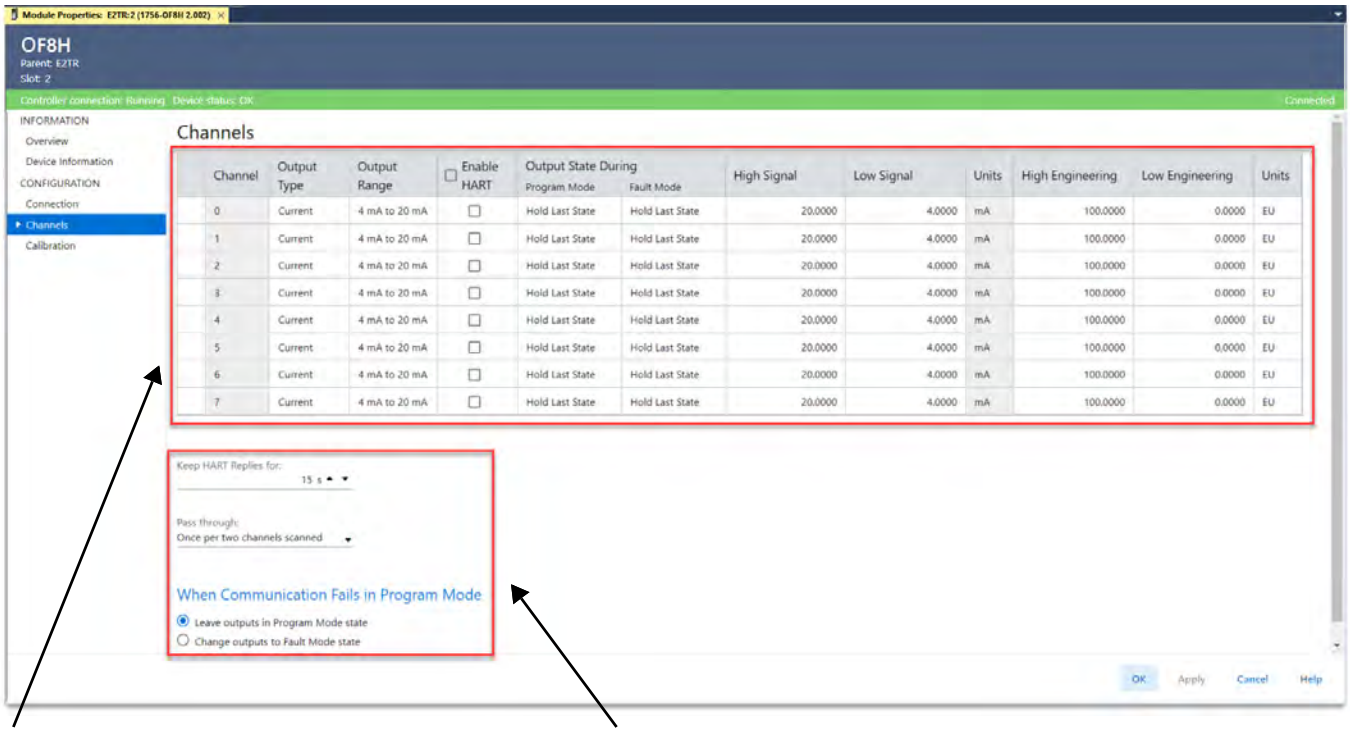
Real-Time Sample Values

Module Filter, Hz	Low Limit, ms	High Limit, ms
10	488	10,000
15	328	
20	248	
50	88	
60	88	
100 (default)	56	
250	28	
1000	18	

Input Module Pass-through Setting, Ratio, and Priority

Setting	Scan: Pass-through Ratio	Gives Priority to
Once per channel scan	1:1	Asset management
Once per two channels scanned	1:2	Default setting
Once per module scan	1:8	Input tag scan

Channels View - Output Modules



Changes made to the parameters that are displayed in the Channels table apply only to the individual channel that is selected.

Changes made to the parameters located below the Channels table apply to all channels.

The Channels table that is found at the top of the Channels view displays a list of all output channels and some of the parameters that you can configure per channel. Changes that are made in the Channels table apply only to the output channel that's selected.

Individual Output Channel Parameters in the Channels Table

Parameter	Action	Notes
Output Type	Choose a value from the dropdown menu	Indicates the output type as Current or Voltage. • The 1756-OF8IH module does not support voltage ranges.
Output Range	Choose a value from the dropdown menu	0…20 mA or 4…20 mA is required for HART.
Enable HART	Select or clear the checkbox for the channel.	• Unselected by default. • Output range must be 0…20 mA or 4…20 mA. • When a channel isn't enabled: – HART messages aren't sent on this channel. – HART pass-through messages aren't sent. – HART data for this channel isn't updated in the input tag. • If you selected HART PV or HART by Channel as the Input Data on the Device Definition dialog, process data (PV, SV, TV, and FV) from the HART instrument is included in the input tag. If you selected Analog only, the process data isn't included in the input tag. • Regardless of the choice of input tag, HART communication can be enabled for each channel to provide pass-through HART message access. If Enable HART isn't selected, this pass-through message access isn't available. • We recommend you Enable HART for any channel that has a HART device that is connected so that information can be displayed on the HART Device Information view. • One reason to disable HART communication is that each channel that is enabled requires time to scan, so enabling unnecessary channels reduces performance on the others. • On the 1756-OF8H module, all channels share the HART modem. For this module, HART response time is better if you enable only the needed HART channels. The 1756-OF8IH module has a separate HART modem for each channel.

Individual Output Channel Parameters in the Channels Table (Continued)

Parameter	Action	Notes
Output State In Program Mode	Select a value from the dropdown menu	Determines channel action when the controller transitions to Program mode. • Hold Last State causes the output to remain at the last value that is sent from the controller before being placed in Program Mode. • User Defined Value forces the output to whatever value is entered in the field. The value is entered in the ChX view in the engineering units that are defined by the scaling parameters for the channel.
Output State In Fault Mode	Select a value from the dropdown menu	Determines channel action when a fault occurs. • Hold Last State causes the output to remain at the last value that is sent from the controller before loss of communication. • User Defined Value forces the output to whatever value is entered in the field. The value is entered in the engineering units that are defined by the scaling parameters for the channel.
Scaling	Enter scaling values for High Signal, Low Signal, High Engineering, and Low Engineering	See Scaling to Engineering Units on page 143 for more information.

Changes made to the parameters located below the Channels table on the Channels view of an output module apply to all channels listed in the table.

Parameters That Apply To All Output Channels

Parameter	Action	Notes
Keep HART Replies	Select a value from 1...255 s	• HART pass-through message replies are kept for this time. HART replies that are received from the Field Device in response to pass-through messages that you have sent are kept for this long. You must retrieve them within this time or the module discards them. • The default is 15. **IMPORTANT:** We do not recommend a value of less than 15 seconds.
Pass through[1]	Select a value from the dropdown menu	• Determines how often pass-through messages occur. – Once per two channels scanned (default)- After 2 channels have PVs scanned to the input tag, a pass-through message is sent (if one is pending). – Once per module scan - Select this value if you want to minimize the impact pass-through message clients have on reading the PVs into the input tag. – Once per channel scan - After each channel has its PVs scanned to the input tag, a pass-through message is sent (if one is pending). Select this value if you want to give pass-through messages from clients such as FactoryTalk AssetCentre higher priority than reading PV, SV, TV, FV, and field device health into the input tag. See the Output Module Pass-through Setting, Ratio, and Priority table on page 139 for more information.
When Communication Fails in Program Mode	Select an option	Specifies the behavior of the outputs if communications fail in Program mode: • Leave outputs in Program Mode state • Change outputs to Fault Mode state

(1) Series B modules do not support Pass-through Setting. Pass-through scanning is fixed at one pass-through per channel scan on Series B modules.

Output Module Pass-through Setting, Ratio, and Priority

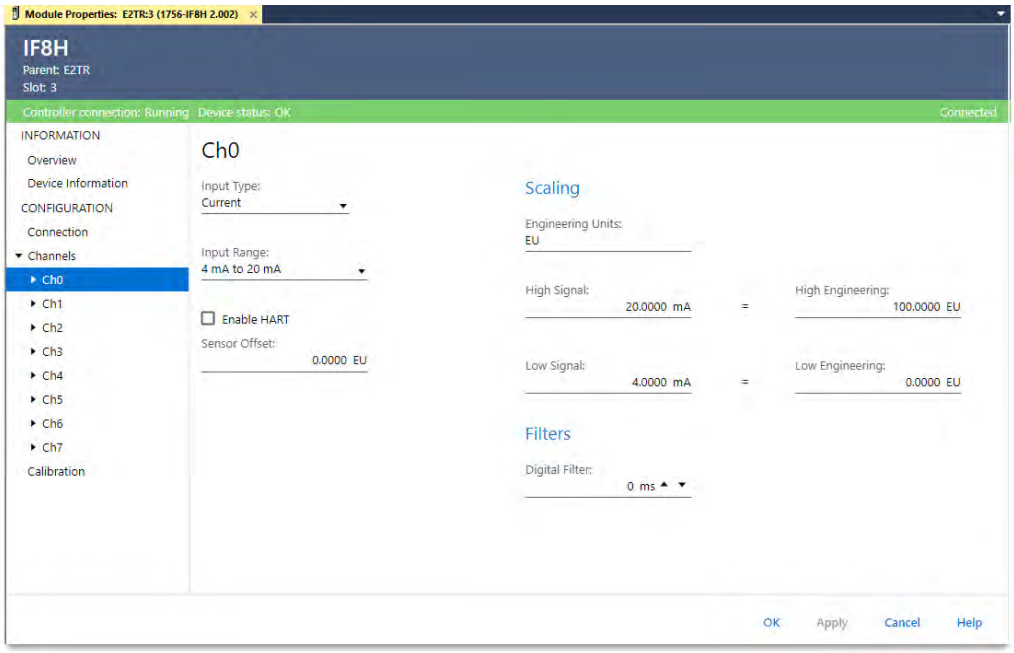
Setting	Scan:Pass-through ratio	Gives priority to
Once per channel scan	1:1	Asset management
Once per two channels scanned	1:2	Default setting
Once per module scan	1:8	Input tag scan

Use the ChX View To Configure a Single Channel

To configure the parameters for an individual module channel, expand Channels in the left navigation and select a specific ChX.

IMPORTANT Unless specifically noted, parameters are not available in Run mode.

ChX View - Input Modules

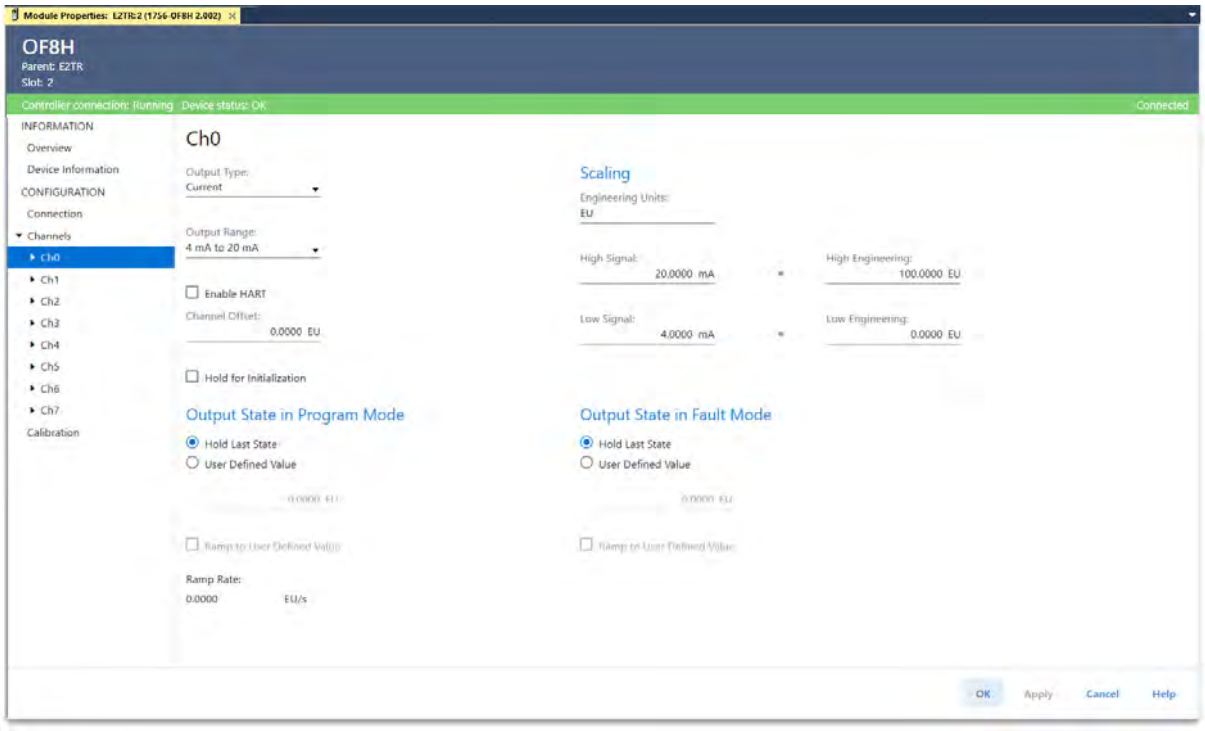


These parameters can be configured in the ChX view of an input module.

Input Module ChX View Channel Parameters

Parameter	Action	Notes
Input Type	Select a value from the dropdown menu.	Indicates the input type as Current or Voltage. • The 1756-IF8IH module does not support voltage ranges
Input Range	Select a value from the dropdown menu.	If HART is enabled, the input range must be 0...20 mA or 4...20 mA.
Enable HART	Select or clear the checkbox.	• When HART isn't enabled for a channel: – HART messages aren't sent on this channel. – HART pass-through messages aren't sent. – HART data for this channel isn't updated in the input tag. • If you select a HART PV or HART by Channel input tag on the Device Definition dialog, process data (PV, SV, TV, and FV) from the HART instrument is included in the input tag. If you selected Analog only, the additional process data isn't included in the input tag. • Regardless of the choice of input tag, HART communication can be enabled for each channel to provide pass-through HART message access. If Enable HART isn't selected, the pass-through message access isn't available. • We recommend that you Enable HART for any channel that has a connected HART device. This selection is so that information can be displayed on the HART Device Information view and accessed by FactoryTalk AssetCentre software. • On the 1756-IF8H module, all channels share the HART modem. For these modules, HART response time is better if you enable only the needed HART channels. The other input modules (1756-IF16H, 1756-IF16IH, and 1756-IF8IH) have a separate HART modem for each channel.
Sensor Offset	Enter the offset value in engineering units, which is added to the channel data after scaling the analog signal to engineering units.	Valid values are from -10,000,000 through 100,000,000. The default value is 0.0000.
Scaling	Enter values for High Signal, Low Signal, High Engineering, and Low Engineering.	See Scaling to Engineering Units on page 143 for more information.
Digital Filter	Select a filter time constant value from 0...20100 ms.	This field is a first-order lag filter that smooths input transitions. It's called a digital filter because it's calculated in the software by the module, not by a hardware filter. Each channel has its own digital filter value. So each channel can have a unique digital filter setting to accommodate the specific device that is attached to that channel. For the module filter, one value is applied for all channels.

ChX View - Output Modules



These parameters can be configured in the ChX view of an output module.

Output Module ChX View Channel Parameters

Parameter	Action	Notes
Output Type	Choose a value from the dropdown menu	Indicates the output type as Current or Voltage. • The 1756-OF8IH module does not support voltage ranges.
Output Range	Choose a value from the dropdown menu	0...20 mA or 4...20 mA is required for HART.
Enable HART	Select or clear	• When a channel isn't enabled: – HART messages aren't sent on this channel. – HART pass-through messages aren't sent. – HART data for this channel isn't updated in the input tag. • If you selected HART PV or HART by Channel as the Input Data on the Device Definition dialog, process data (PV, SV, TV, and FV) from the HART instrument is included in the input tag. If you selected Analog only, the process data isn't included in the input tag. • Regardless of the choice of input tag, HART communication can be enabled for each channel to provide pass-through HART message access. If Enable HART isn't selected, this pass-through message access isn't available. • We recommend you Enable HART for any channel that has a HART device that is connected so that information can be displayed on the HART Device Information view. • One reason to disable HART communication is that each channel that is enabled requires time to scan, so enabling unnecessary channels reduces performance on the others. • On the 1756-OF8H module, all channels share the HART modem. For this module, HART response time is better if you enable only the needed HART channels. The 1756-OF8IH module has a separate HART modem for each channel.
Channel Offset	Enter a value from -9,999,999...99,999,999 (float)	• The default value is 0.00. • The offset value is in engineering units. • The Channel Offset is added to the data value to determine signal level.

Output Module ChX View Channel Parameters (Continued)

Parameter	Action	Notes
Hold for Initialization	Select or clear	• Select this option to cause the module to hold the output signal unchanged until the output value received from the controller in the ChXData field is within 0.1% of the value being held. The output holds when the following occurs: – Powerup occurs (holds at zero) – A new connection is established (brings it out of fault state and it holds at the fault value from the previous configuration). – The controller returns to Run mode after Program mode (continues to hold at the configured value that was held in Program mode, see the Output State in the Channels view). • The output channel holding lets the controller synchronize with the output, enables smooth output transitions and avoids rapid transients when control resumes from an interruption. • The output can be ramping to the configured hold value when the transition occurs. In this case, it continues the ramp until it completes or until the output value from the controller is within the 0.1% of the output signal. When the Hold for Initialization option isn't selected, the output switches as quickly as possible to the first value commanded by the controller.
Scaling	Enter scaling values for High Signal, Low Signal, High Engineering, and Low Engineering	See Scaling to Engineering Units on page 143 for more information.
Output State in Program Mode	Select a value	Determines channel action when the controller transitions to Program mode. • Hold Last State causes the output to remain at the last value that is sent from the controller before being placed in Program Mode. • User Defined Value forces the output to whatever value is entered in the field. The value is entered in the ChX view in the engineering units that are defined by the scaling parameters for the channel. • Ramp to User Defined Value indicates that the output signal ramps from its last value to the User Defined Value at the Ramp Rate. If the checkbox is cleared, the output signal steps to the User Defined Value immediately on entering Program mode. This option is not available when Hold Last State is selected or in Run mode.
Output State in Fault Mode	Select a value	Determines channel action when a fault occurs. • Hold Last State causes the output to remain at the last value that is sent from the controller before loss of communication. • User Defined Value forces the output to whatever value is entered in the field. The value is entered in the engineering units that are defined by the scaling parameters for the channel. • Ramp to User Defined Value indicates that the output signal ramps from its last value to the User Defined Value at the Ramp Rate. If the checkbox is cleared, the output signal steps to the User Defined Value immediately on entering Fault Mode. This option is not available when Hold Last State is selected or in Run mode.
Ramp Rate	View the Ramp Rate	The output ramping limits the speed at which an analog output signal can change, thus helping to prevent fast transitions in output from damaging equipment that the output controls. • Available in Run mode. • Ramping in Run mode and the Ramp Rate are set in the ChX - Limits view.

Scaling to Engineering Units

Channel data values in the output tag can be in engineering units such as kg, m, or percent. To configure the relationship between engineering units and the physical signal in volts or mA, set the Low and High Signal and the Low and High Engineering values.

For example, suppose that you have a temperature transmitter that produces 4 mA current at -180 °C (-292 °F) and 20 mA current at +750 °C (1382 °F). If you want to use °C in your control program, configure the values as shown in this table.

	Signal	Engineering
High	20	750
Low	4	-180

If you're using HART field devices, we recommend setting Engineering High and Low to the field device Upper Range and Lower Range Values. This selection is so that the field device and module use the same engineering units. If online, these values are displayed on the HART Device Information view.

Scaling High and Low Signal

Set the High and Low Signal values for the module. The High Signal value must be greater than the Low Signal value.

Range[1]	Low Limit	High Limit
-10...10V	-10.00	10.00
0...20 mA	0.00	20.00
4...20 mA	4.00	20.00
0...5V	0.00	5.00
0...10V	0.00	10.00

(1) Voltage ranges aren't available in 1756-IF8IH and 1756-OF8IH modules.

Scaling High Engineering

Set the High Engineering value for the module. The High Engineering value must not equal the Low Engineering value. This value is in engineering units and corresponds with a signal value equal to the High signal.

Valid values are in the range of -10,000,000...100,000,000. The default value is 100.00.

Scaling High Engineering appears dimmed in Run and Hard Run mode.

Scaling Low Engineering

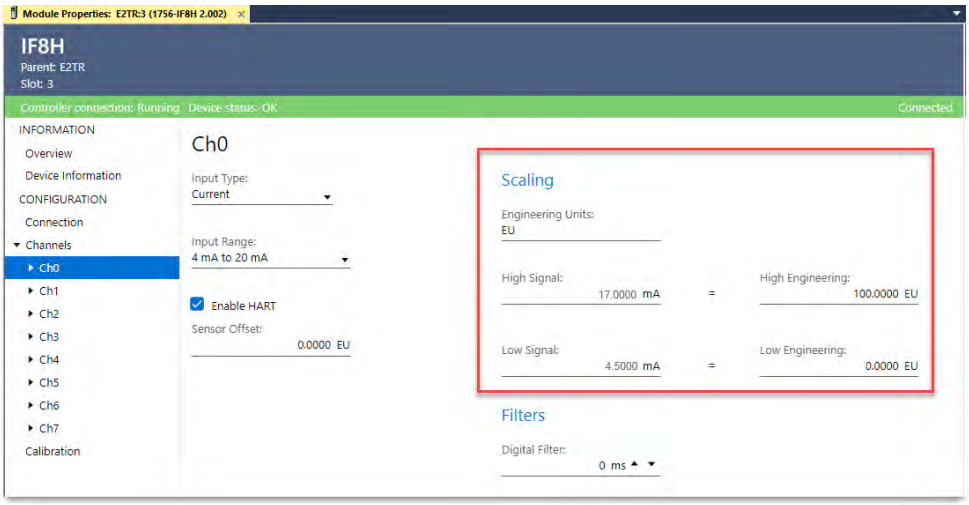
Set the Low Engineering value for the module. The Low Engineering value must not equal the High Engineering value. This value is in engineering units and corresponds with a signal value equal to the Low signal.

Valid values are in the range of -10,000,000...100,000,000. The default value is 0.00.

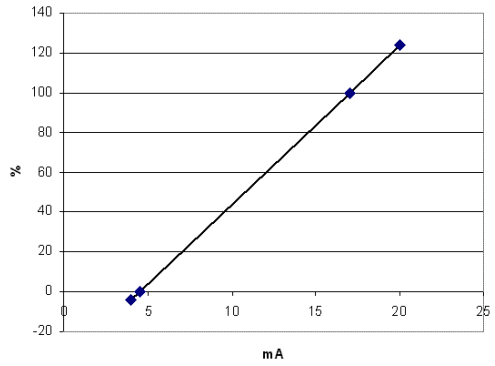
Scaling Low Engineering appears dimmed in Run and Hard Run mode.

Scaling Example

To configure the module to tell you how full a tank is, you'd want it to give 0% when the tank is empty and 100% when the tank is full. If the sensor that measures the tank signals 4.5 mA when the tank is empty and 17 mA when the tank is full, the configuration would be as shown.

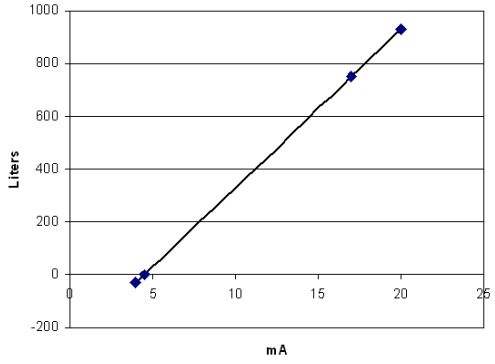


This configuration creates a relationship between the electrical signal that the tank gauge generates and the number that is sent to the Logix Controller for use in the control system. Graphically, the relationship looks like this:



The module measures the signals that are slightly higher and lower than the sensor provides for this tank. Setting the High or Low Engineering Units does not limit the values to within that range. The module still measures signals from 4...20 mA. In this example, if the module senses 20 mA, it reports that the tank is 124% full. A signal of 0 mA is reported as -4% full, or 'less than empty'.

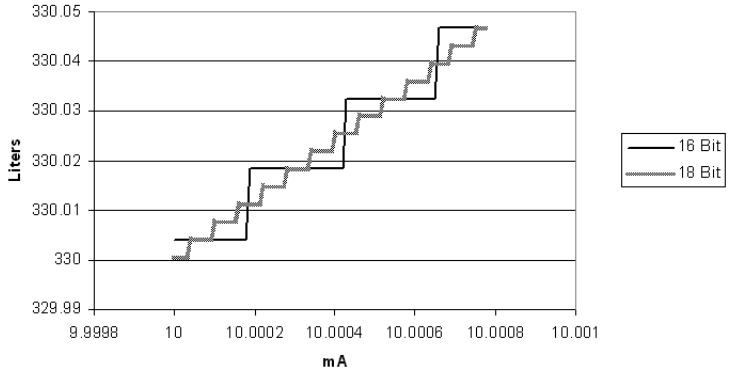
To have the tank level reported in liters instead of percent, put the capacity of the tank as the High Engineering value. If you have a 750 liter tank, as in the previous example, put 750 instead of 100 and you get the scaling relationship shown.



Set Module Resolution

Resolution is the smallest amount of change that the module can detect.

Resolution is sometimes expressed in bits. If 16 bits of resolution are available, the module can detect 65536 different signal values. If configured for 4...20 mA, it could discern the difference between 10...10.0003 mA, but it wouldn't distinguish between10...10.0002 mA.



Resolution affects how the module measures analog signals. Scaling converts the analog signal to Engineering Units for convenience in your control system. In the previous 16-bit example and the 750 liter tank example in the previous section, you would have a resulting resolution of 0.0146 liters. As the tank fills, the volume reading could jump from a reading of 250 liters to 250.015 liters without displaying any values between. Because of sampling, filtering, and RPI, you can see more or fewer intermediate values, depending on the fill rate.

The resolution of analog input modules depends on the module and the filter configuration. To measure a rapidly changing signal, a configuration with less resolution is used. For information about the resolution available, see the following locations.

Available Resolution for This Module	Page
1756-IF8H	30
1756-IF8IH	51
1756-IF16H	68
1756-IF16IH	85
1756-OF8H	98
1756-OF8IH	111

IMPORTANT Because these modules must provide for possible calibration inaccuracies, the resolution values represent the available analog-to-digital or digital-to-analog counts over the selected range, including a small amount of Overrange and Underrange.

Module Filter Values

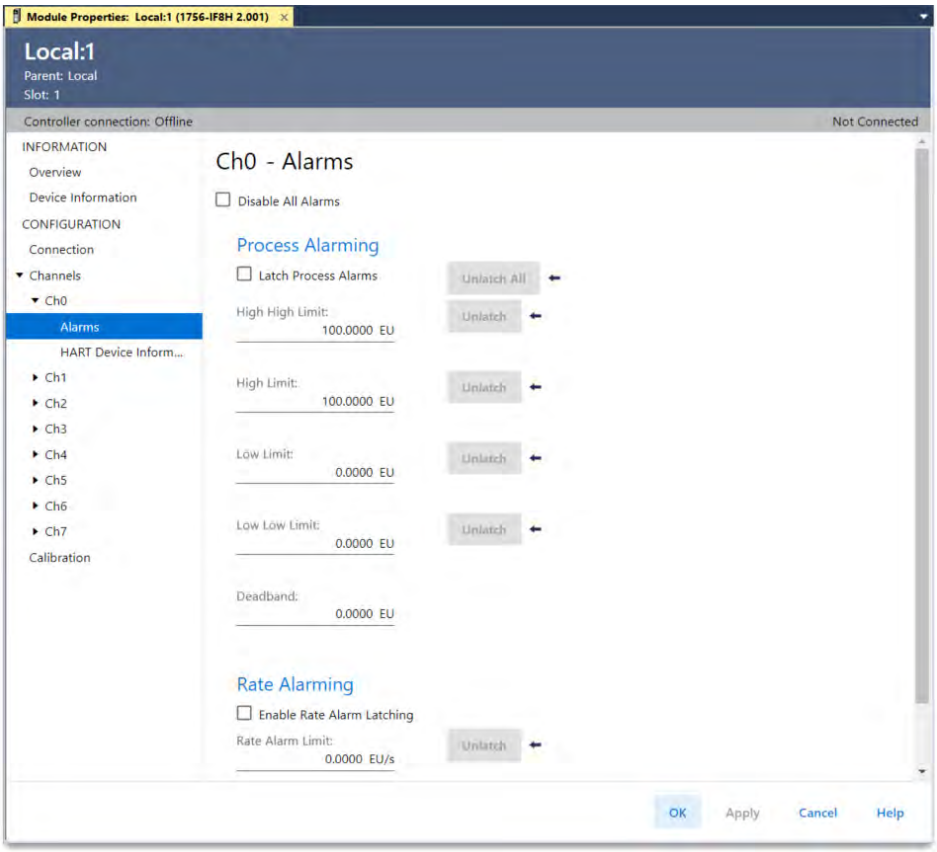
Module Filter, Hz	C.ModuleFilter
10(1)	0
15	7
20	6
50	1
60 (default)	2
100	3
250	4
1000(2)	5

(1) 10 Hz not supported in the 1756-IF16H or 1756-IF16IH modules.
(2) Do not select 1000 with HART enabled.

Set Input Module Alarms - 1756-IF8H, 1756-IF8IH

To configure alarm parameters for each individual input module channel, expand Channels in the left navigation, expand a specific ChX, and select Alarms.

The ChX - Alarms view appears.



Use these parameter descriptions to configure the alarms for the 1756-IF8H and 1756-IF8IH modules. For more information, see Process Alarms on page 33 or page 54, and Rate Alarm on page 33 or page 54.

ChX - Alarms view Parameters

Parameter	Action	Notes	Available in Hard Run Mode?
Disable All Alarms	Select	Disables all alarms for a channel.	No
Latch Process Alarms	Select	Maintains an alarm triggered condition for any of the process alarms, even after the condition ceases. The alarm unlatches only with an explicit message that acknowledges the alarm.	No
Process Alarming	Enter the values	• The High Engineering and Low Engineering parameters on the Channel or ChX view set the maximum and minimum values for these alarms. • Alarm thresholds are in engineering units. • A deadband appears around each value.	No
High High (HH)		• Sets the level of input to a channel that causes the module to set the High High alarm. • The alarm remains active until the input returns below this level by more than the deadband. • If Latch Process Alarms is selected, the ChXHHAlarm indication remains set until explicitly cleared.	
High (HI)		• Sets the level of input to a channel that causes the module to set the High alarm. • The alarm remains until the input returns below this level by more than the deadband. • If Latch Process Alarms is selected, the ChXHAlarm indication remains set until explicitly cleared.	
Low (LO)		• Sets the level of input on a channel that causes the module to set the Low alarm. • The alarm remains until the input returns above this level by more than the deadband. • If Latch Process Alarms is selected, the ChXLAlarm indication remains set until explicitly cleared.	
Low Low (LL)		• Set the level of input to a channel that causes the module to set a Low Low alarm. • The alarm remains until the input returns above this level, more than the deadband. • If Latch Process Alarms is selected, the ChXLLAlarm indication remains set until explicitly cleared.	

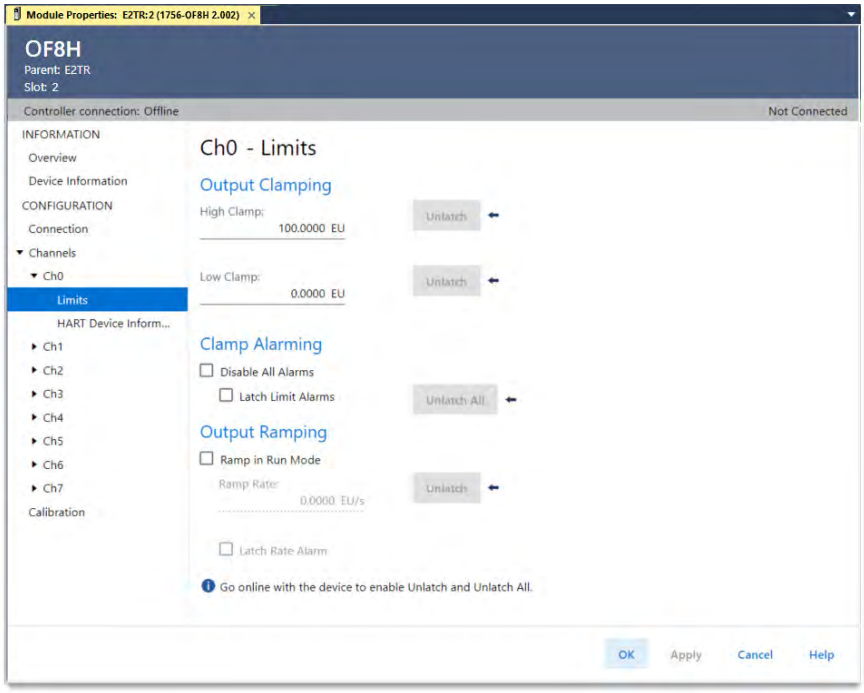
ChX - Alarms view Parameters (Continued)

Parameter	Action	Notes	Available in Hard Run Mode?
Deadband	Enter a value from 0.00...99,999,999.	• Select a value at which an alarm, once set, does not disable as long as the input value remains within the deadband range of the alarm trigger point. (This value in combination with the process alarms creates the range.) This configuration helps prevent the alarm from cycling on and off if the process value hovers near the alarm threshold. • The alarm deadband can be only half the distance between high and low alarm limits. • The default is 0.00 • For related information, see Alarm Deadband on page 33.	No
Enable Rate Alarm Latching	Select	When enabled, a Rate Alarm indication remains set, even when the alarm condition returns to normal. This latch lets you maintain the alarm even after the condition ceases. The alarm unlatches only with an explicit message that acknowledges the alarm.	No
Rate Alarm Limit	Enter an alarm limit value from 0.00...99,999,999.	• Enter a Maximum Ramp Rate value to trigger a Rate Alarm when the input signal rate of change exceeds the setpoint. • This configuration is useful for detecting rapid process changes. • The default is 0.00 • Set this alarm in engineering units/second.	No
Unlatch All	Select	• Unlatches all alarms. • Isn't available when the project is offline.	Yes
Unlatch	Select	• Unlatches the adjacent alarm condition. • Isn't available when the project is offline.	Yes

Set Output Module Limits

To configure limit parameters for each individual output module channel, expand Channels in the left navigation, expand a specific ChX, and select Limits.

The ChX - Limits view appears.



These parameters can be configured in the ChX - Limits view.

Output Module ChX - Limits view Parameters

Parameter	Action	Notes	Available in Hard Run Mode?
Limits	Enter the values or drag the corresponding flags on the slider bar to set the values.	• The High Engineering and Low Engineering parameters on the Channel or ChX view set the maximum and minimum values for these alarms. • Clamp limits are in engineering units. • To change the trigger points by whole numbers, hold down the shift key while dragging the flag on the slider bar. • See the Limits Example below for further explanation.	No
High Clamp (HI)		• The highest value that an output channel can reach in the control process. • -9,999,999...99,999,999, default is 100.00.	
Low Clamp (LO)		• The lowest value that an output channel can reach in the control process. • -9,999,999...99,999,999, default is 0.	
Ramp in Run Mode	Select	• Enables ramping in Run mode. • Ramping occurs between the current output level and any new output value received. • If ramping is enabled, the output can change only at the configured ramp rate limit.	No
Ramp Rate	Enter a value from 9,999,9999... 999,999,999, default is 0.	• Defines the maximum rate of change an output can make in engineering units/second. • Serves as a trigger point for a Ramp Rate Limit alarm when the Ramp in Run mode is selected. • Can also be uses to ramp a user-defined value in Program or Fault mode. • A non-editable copy of Ramp Rate is shown on the ChX view.	No
Unlatch All	Select	• Unlatches all alarms. • Isn't available when the project is offline.	Yes
Unlatch	Select	• Unlatches the adjacent alarm condition. • Isn't available when the project is offline.	Yes
Disable All Alarms	Select	Disables all alarms for a channel.	No
Latch Limit Alarms	Select	Maintains the high and low limit alarms even after the condition ceases. The high and low limit alarm is set if the requested output is beyond the clamp limit (>High or <Low). This is useful if you want to detect a transient alarm condition and preserve its indication until the alarm is explicitly unlatched. Select Unlatch to unlatch an alarm, or send a Common Industrial Protocol (CIP) message with the MSG instruction.	No
Latch Rate Alarm	Select	When enabled, a Rate Alarm indication remains set, even when the alarm condition returns to normal. This latch lets you maintain the alarm even after the condition ceases. The alarm unlatches only with an explicit message that acknowledges the alarm.	No

Limits Example

If your output controls a valve positioner that's configured to use Percent of Stroke for engineering units, you can enter 0 as the Low Clamp and 62 for High Clamp. Enter 62 only if you don't want the valve to be over 62% open at any time for any reason. Even if a PIDE instruction calculates the valve must open more to achieve process Setpoint, the output module clamps it to 62% open.

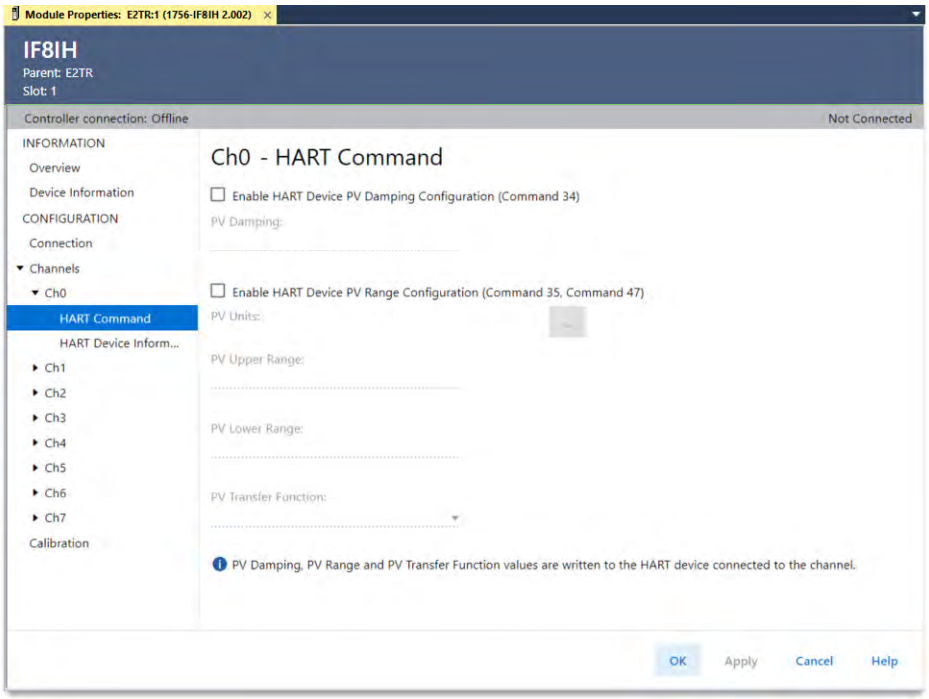
Configure HART Field Device

When Configure HART Device is set to Yes in the Device Definition settings of a 1756-IF8IH or 1756-OF8IH module, you can access the ChX - HART Command view.

The ChX - HART Command view allows you to configure and send PV Damping and PV Range values to the HART Field Device connected to the selected channel.

To configure the HART Field Device parameters for an individual module channel, expand Channels in the left navigation, expand a specific ChX, and select HART Command.

The ChX - HART Command view appears.



These HART Field Device parameters can be configured in the ChX - HART Command view.

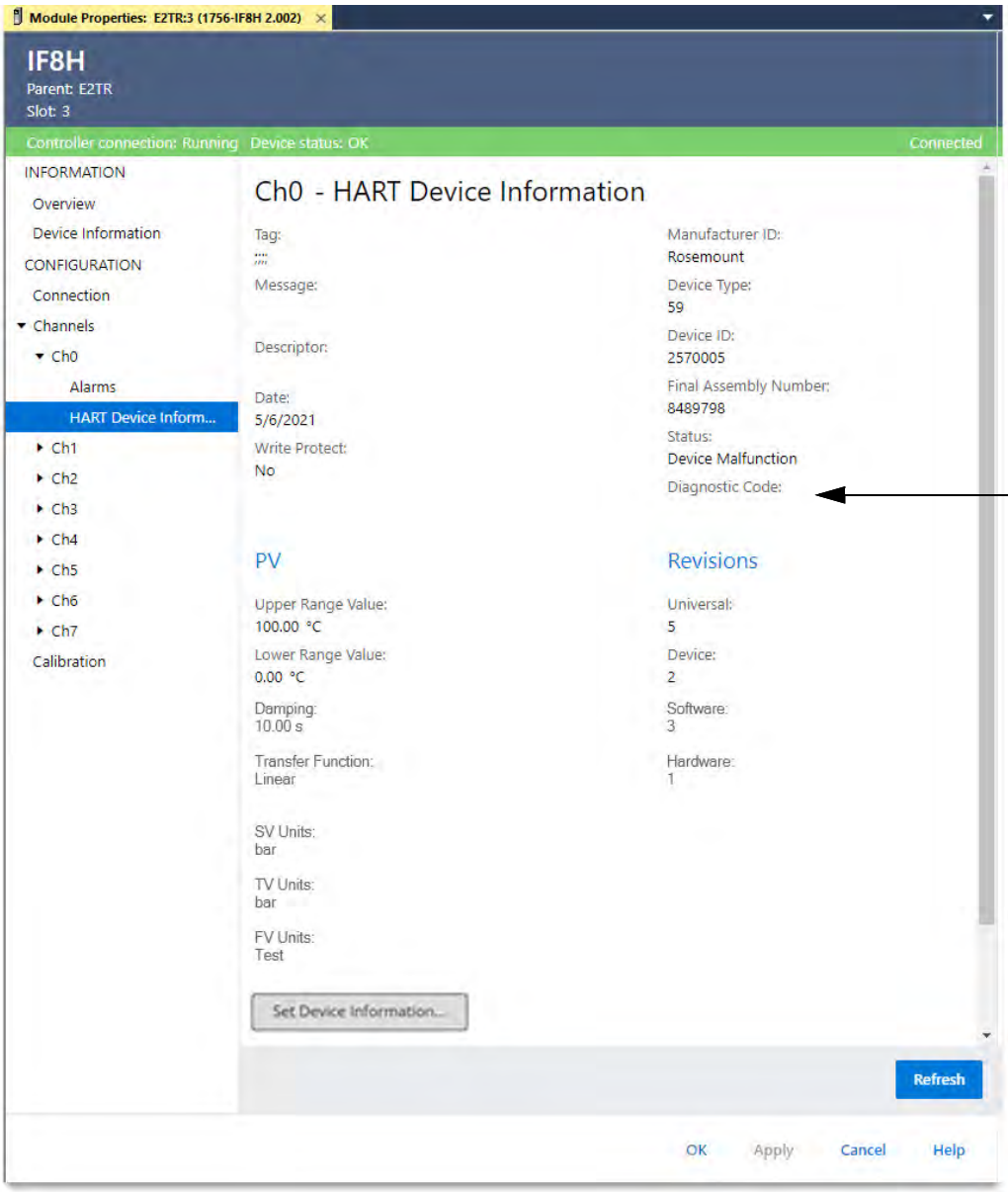
Checkbox	Parameter	Description
Enable HART Device PV Damping Configuration	PV Damping	Value that changes the response time of the HART Field Device to smooth variations in output readings caused by rapid changes in input.
Enable HART Device PV Range Configuration	PV Units	Engineering units for the HART PV. Select from the dropdown menu. See Appendix D for a list of unit codes.
	PV Upper Range	Highest value for PV in the specified engineering units.
	PV Lower Range	Lowest value for PV in the specified engineering units.
	PV Transfer Function	Form of the PV transfer function. Select from the dropdown menu.

View HART Device Information

IMPORTANT If you selected a Listen-Only communication format when you created the module, this view isn't available. These parameters are not available when the module is offline or HART is not enabled for the channel unless specifically noted, parameters are not available in Run mode.

To view information about the attached HART field device that the HART module collects, expand Channels in the left navigation, expand a specific ChX, and select HART Device Information.

The ChX - HART Device Information view appears.



Enhanced diagnostic and status codes are available here depending on your configuration.

These parameters can be examined in the ChX - HART Device Information view.

HART Device Information Parameters

Parameter	Description
Tag	Displays the tag name of the HART Field Device. The tag name is entered into the Field Device to indicate its location and purpose in the plant.
Message	Displays the text that was entered in the Message parameter of the HART Field Device. The use of this parameter can vary. One possible use is to store information such as who last calibrated the device, or reference to documentation.
Descriptor	Displays the Descriptor field from the HART Field Device. The Descriptor is a text message that can be stored in the device to help identify the device or it can be used for other plant-specific purposes.
Date	Displays the date that is entered in the device. This date is often used to record the last calibration date, but it's up to you to maintain it. It's displayed in the format that is selected for your computer with the Regional and Language settings on the Control Panel.
Write Protect	Displays a Yes or No indicating if the HART Field Device is write protected. If a device is write protected, some parameters can't be changed via HART communication. Sometimes devices do not indicate that the configuration has changed when their write-protect setting changes. This condition causes the previous value to remain displayed here. You can inhibit/uninhibit the HART module to refresh this value.
Manufacturer ID	Displays the manufacturer name (for example, Allen-Bradley or Endress + Hauser) or the numeric value for the manufacturer. Use the Company Identification Code table as a guide, as shown in Appendix E.
Device Type	Displays the device type for Endress + Hauser devices or a numeric value for all other manufacturer devices. Device type indicates the type of the device of the manufacturer, or product name. For example, Cerabar S pressure transmitters from Endress + Hauser have Device Type 7.
Device ID	Displays a number that represents the device ID. Device ID is a serial number that is assigned by the manufacturer that is unique among all devices that are produced by that manufacturer.
Final Assembly Number	Displays a number that represents the final assembly number. The Final Assembly Number is used for identifying the materials and electronics that comprise the field device. It's normally changed when electronics or other components are upgraded in the field. In some instances, this number references a drawing number.
Status	Channel status is available only for: • 1756-IF8H and 1756-OF8H firmware revision 2.002 or later • 1756-IF16H firmware revision 1.002 or later • 1756-IF16IH firmware revision 1.001 or later
Diagnostic Code	Device status is available only for: • 1756-IF8H and 1756-OF8H firmware revision 2.002 or later • 1756-IF16H firmware revision 1.002 or later • 1756-IF16IH firmware revision 1.001 or later
PV	In HART, the Primary Variable (PV) is signaled on the 4...20 mA analog channel. It can also be read back using HART messages. In many HART devices, the relationship between the PV and the analog signal can be adjusted. This area displays the following Process Variable attributes: • Upper Range Value - to use the same engineering units in your Logix controller as in the Field Device, enter this value in High Engineering on the HART Device Information view. • Lower Range Value - to use the same engineering units in your Logix controller as in the Field Device, enter this value in Low Engineering on the HART Device Information view. • Damping • Transfer Function - describes how the HART field device transforms the signal on its transducer to the PV. Usually Linear, but sometimes Square Root (for example, for flow), or other relationships.
Revision	Displays the following revision attributes. • Universal - denotes the version of the HART specification to which the device conforms. • Device • Software • Hardware
Refresh	Select to update all attributes that are displayed on this view for the corresponding channel.

When the HART Device Status is not OK, of the following messages will appear in place of the HART Device Information parameters in the view.

HART Device Status	Message
The HART module is offline	No online data is shown because the project is offline. (Standard message)
HART is enabled, but the HART Field Device isn't responding	No online data is shown because the HART device is initializing.
HART not found	No online data is shown because the HART device is not found.
HART isn't enabled for this channel	No online data is shown because the HART device is not enabled

Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules)

If a 1756-IF8IH or 1756-OF8IH module has Configure HART Device set to Yes and the controller is online and not in hard run mode, the Set Device Information button in the ChX - HART Device Information view is enabled.

Select the Set Device Information button and the Set Device Information dialog appears.

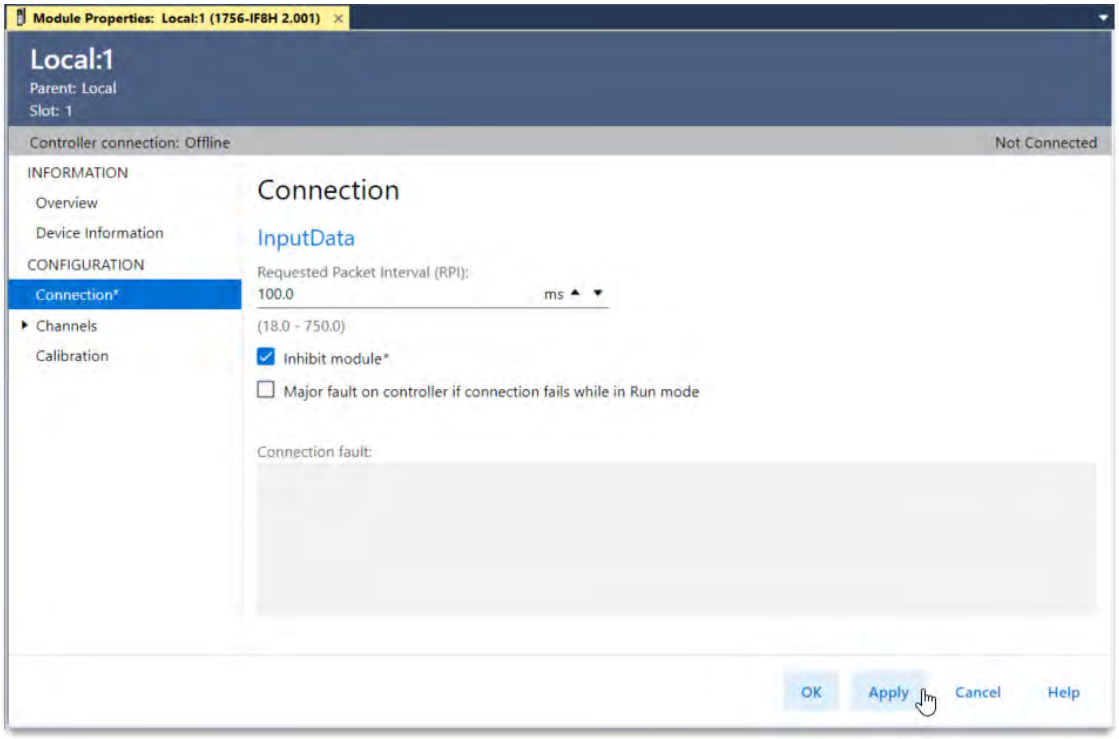
You can specify a tag name, message, and descriptor for the HART device on the selected channel. You can enter values in the text fields or copy existing entries that are already stored on the device. When you select OK, the specified values are sent to the device via HART messages.

Calibrate Your Module

Follow these steps to calibrate your module and view the calibration data that is exchanged via CIP™ messages for each channel.

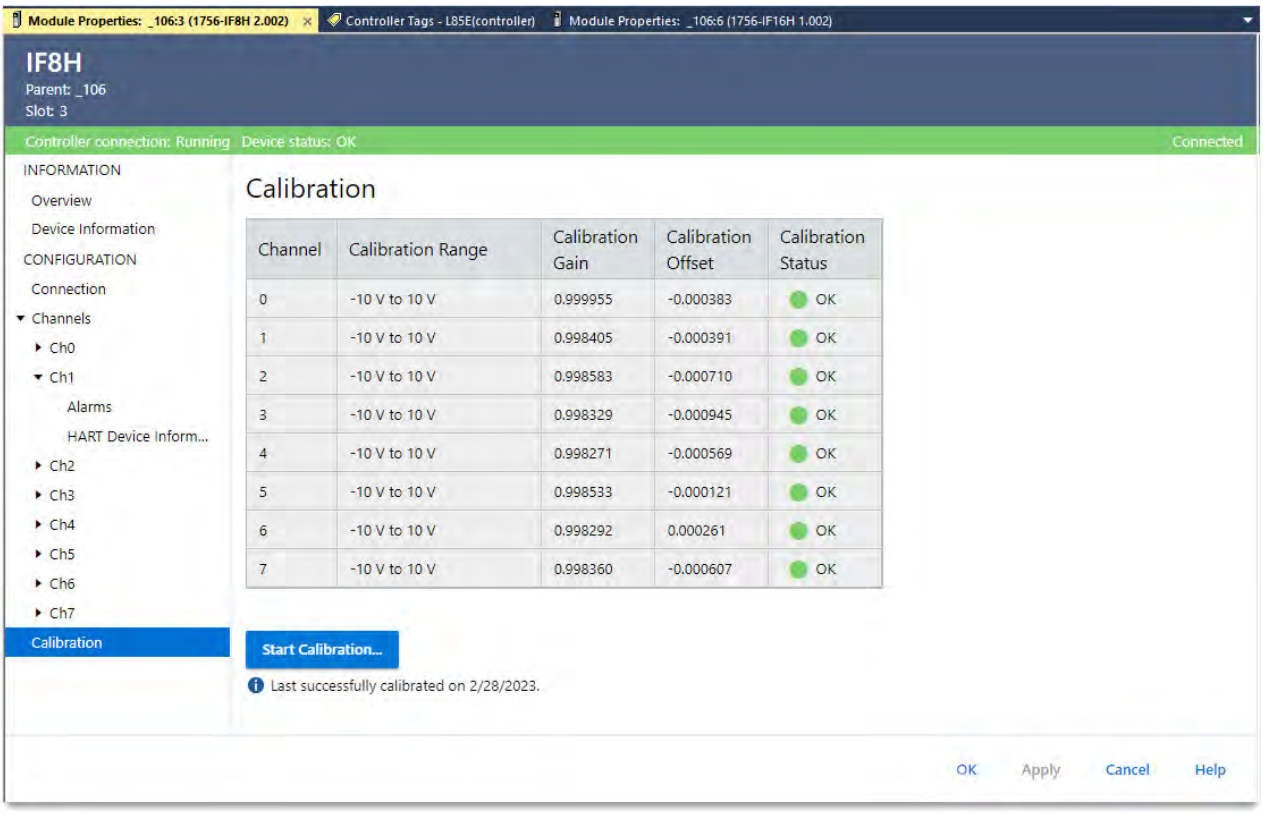
IMPORTANT The module must be online and not be in Implicit Protected Mode. We recommend that you inhibit your module before calibration.

1. Select Connection from the left navigation.
   The Connection view appears.



2. On the Connection view, select Inhibit Module.
3. Select Apply.
4. Select Calibrate from the left navigation.

The Calibration view appears.

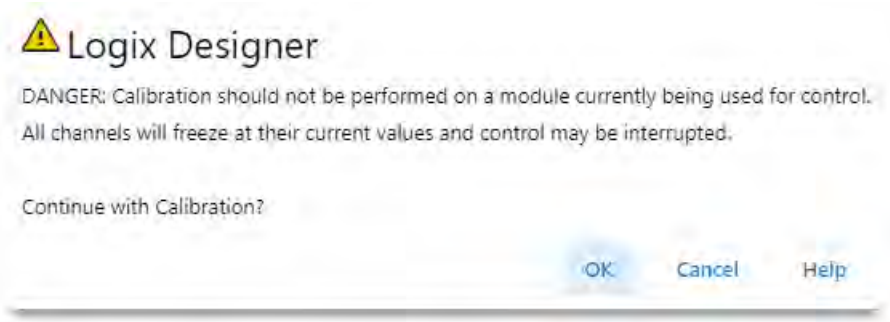


This table describes the data that is displayed on the Calibration view.

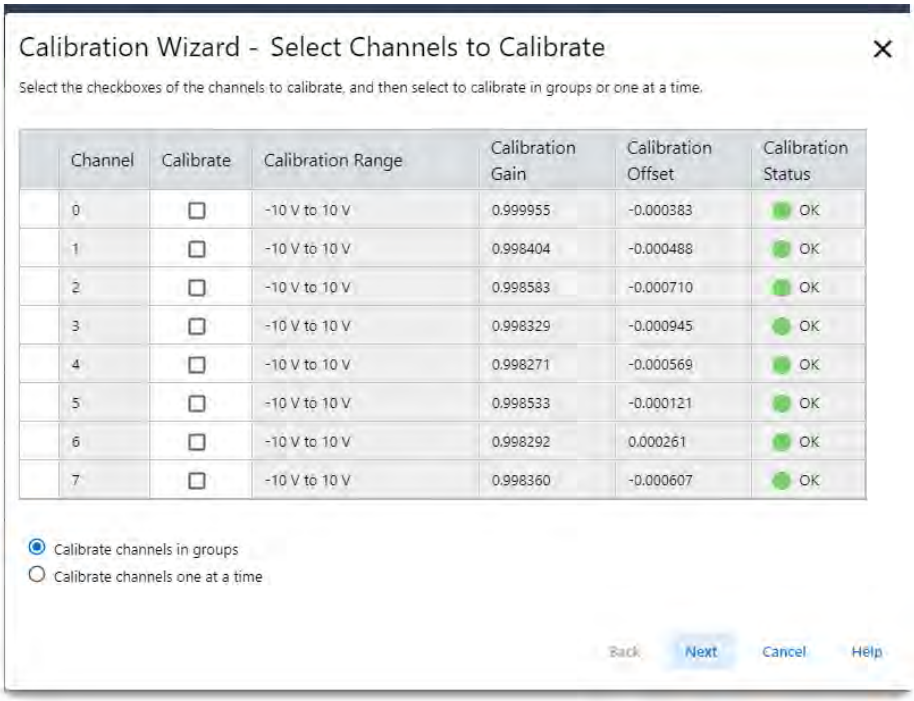
Parameter	Description (All Fields Are Read-only)
Calibration Range	Displays 0...20 mA for current channels or -10...10V for voltage channels, which are based on the output range selection on the Channels or ChX view.
Calibration Gain	Displays the calibration gain when the module is on line.
Calibration Offset	Displays the calibration offset when the module is on line.
Calibration Status	Displays OK or Error, depending on the result of the last calibration, when the module is on line.
Last Successful Calibration	Displays the date on which a successful calibration was most recently performed.

5. To start a module calibration, select Start Calibration. The Controller must be in "Program\Idle" mode. The module must be online with the controller and at least one channel must be selected to calibrate.

A warning appears, asking if you want to continue.



6. Select OK.
   The Calibration Wizard appears.

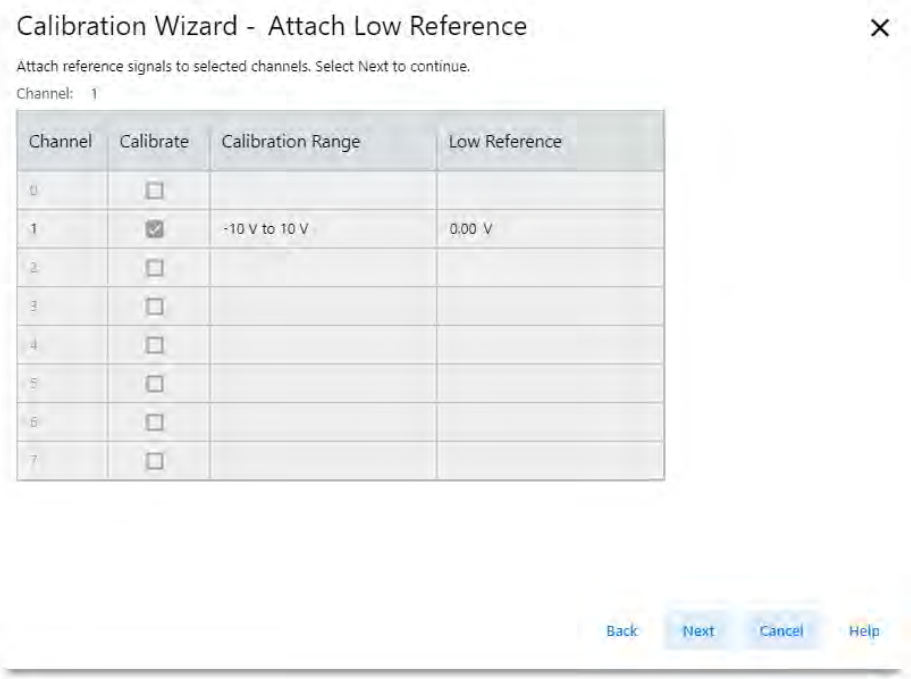


7. Select the desired channels for calibration, and use the radio button to calibrate all simultaneously, or individually.

IMPORTANT When calibrating multiple channels of a 1756-IF8H module in voltage mode, to get the best accuracy (especially for the 5V range), channels must be calibrated individually with a single voltage source. One voltage source cannot be applied to all channels in parallel if 5V accuracy is important.

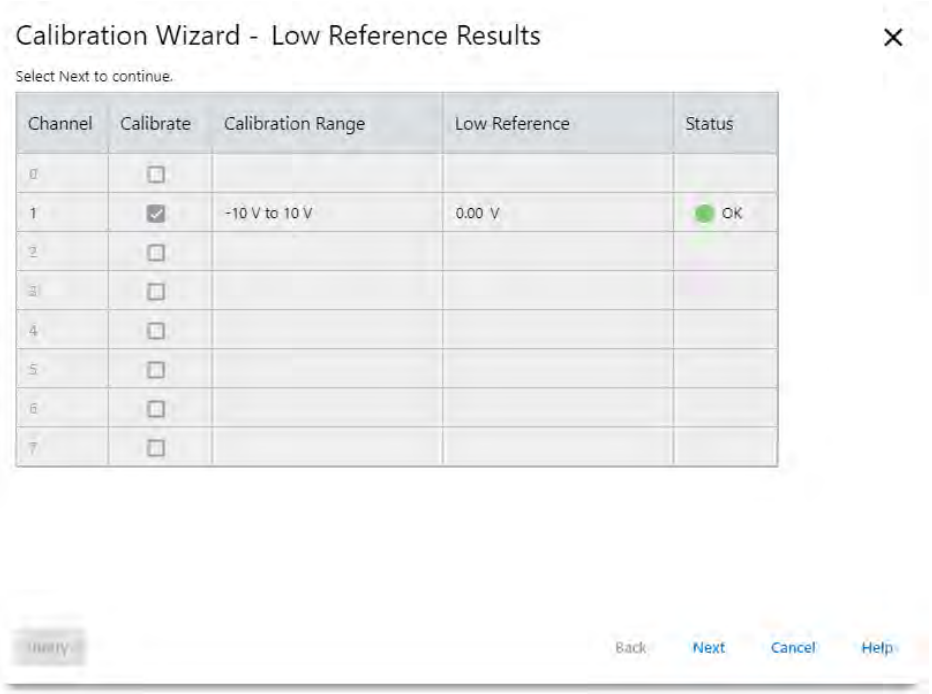
8. Select Next.

The Attach Low Reference dialog appears.



9. Connect a calibrated precision voltage source to the channel.
10. Set the current source to the low reference voltage.
11. Select Next.

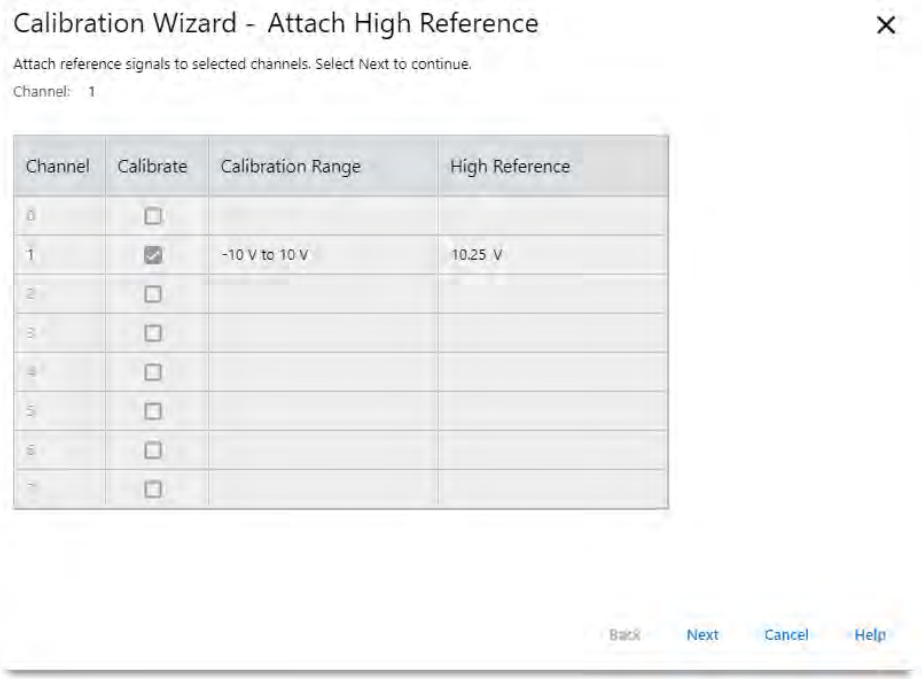
    The status of the channel after calibrating for a low reference appears. If the precision source is within range, the status column is populated with OK.



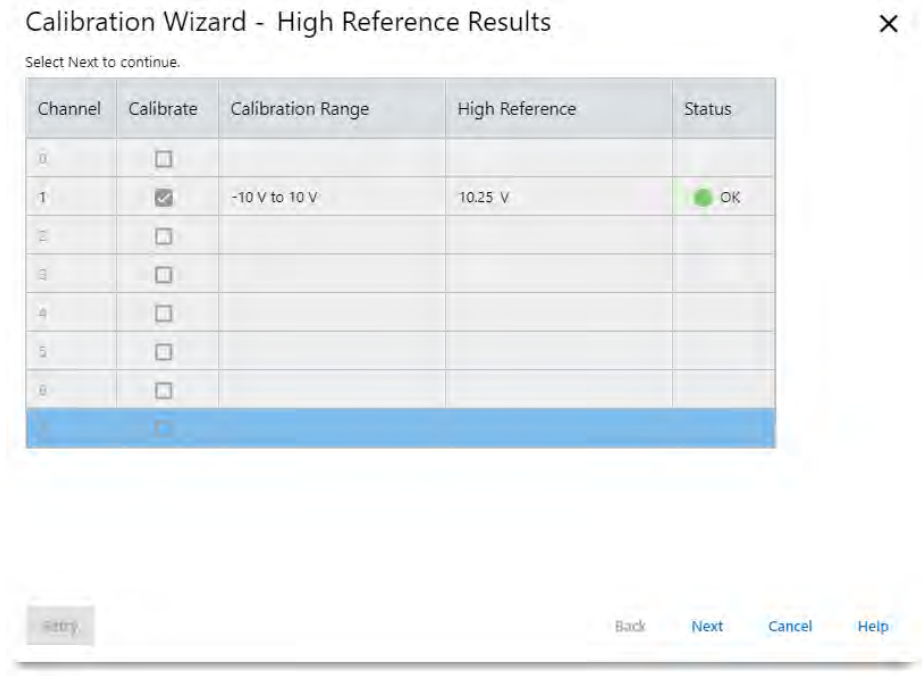
12. If any channel reports an error, return to step 8 and select Retry until the channel calibration status is OK.
13. If the error persists indefinitely, select Stop to exit calibration.

    The channel remains calibrated to the accuracy level achieved at the factory or as of the last field calibration.

14. Once the channel status is OK, select Next to proceed to the next channel.
15. Once the status of all channels is OK, select Next.
    The Attach High Reference dialog appears.

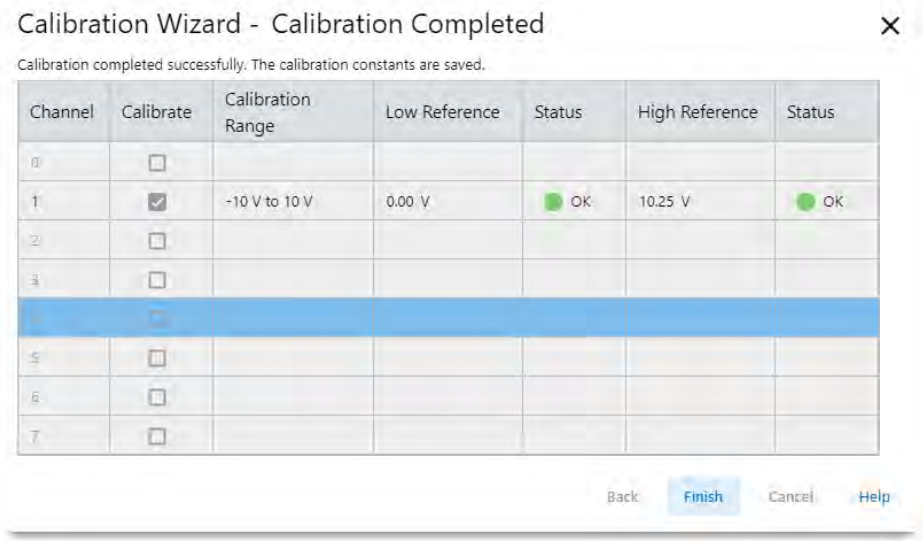


16. Set the current source to the high reference range. Set the precision source to the high reference noted in the high reference column. Click 'Next' to perform the calibration. The next channel will be ready for the high reference. Click 'Next' to proceed to calibrate the next channel.



17. Repeat step 9 until all selected channels are calibrated to the high reference. When all channels are calibrated to the high reference, click 'Next' again to complete calibration.

The Calibration Completed dialog appears.



18. Calibration is now complete. Select 'Finish' to close the Calibration Wizard.

    The Calibration view is now updated with the most recent calibration data.

Notes:

HART Data in the Input Tags

When HART data is included in the input tag and a channel has HART enabled, the ControlLogix® HART I/O module automatically collects HART data. The module also places the most common Dynamic Process Data and Device Health information directly in the input tag.

See the chapter for each module for a complete listing of the fields in the input, output, and configuration tags.

An overview of the HART data includes the following:

- HART Faults - At the beginning of the input tag included even if you select Analog Only input data tag format. These faults indicate that HART communication isn't successful or that the field device is reporting a problem such as Device Malfunction, Loop Current Saturated or PV out of Limit. For example, Ch0HARTFault is set if Ch0Config.HARTEn is 0 or if no HART Field Device is attached.
- HART Device Status - A collection of status indicators that reflect the HART communication details and overall device health.
  - Init - The module is searching for a HART device.
  - Fault - HART communication isn't successful. If this is 1 and Initializing is 0, probable cause is HART isn't enabled on this channel.
  - Message Ready - A HART pass-through message reply is ready to be collected by using the Pass-through Query CIP message. See Use a CIP MSG to get HART Data for more information.
  - Current Fault - The analog current doesn't match the readback of the current received over the HART communication. An inaccurate field device, faulty wiring, or water in the conduit can cause this. Sometimes a rapid change in the signal results in a transient current fault as the analog and digital representations are sampled at slightly different times and at different places in the signal path.
  - Configuration Changed - The Field Device configuration has changed and new Field Device configuration information can be obtained from the module via CIP MSG GetDeviceInfo, which clears this bit.
  - ResponseCode - HART Communication Status or Response Code. 0 means success. See HART Data in the Input Tags for details.
  - FieldDeviceStatus - HART device health, such as PV out of range or device malfunction. See Additional HART Protocol Information for details.
  - UpdatedStatusReady - indicates new device diagnostic information is available, which can be obtained by sending a CIP Message with Service 4C.

HART Dynamic Variables

Most HART devices can measure several different process characteristics or of deriving other measurements from directly sensed measurements. For example, many differential pressure transmitters can also sense the process temperature and can calculate the flow. These sensors can also calculate the volume in a tank based on a measurement of its head pressure and knowledge of tank geometry and product density.

The most important of these direct or derived measurements is assigned to the PV (Primary Variable) and the analog signal represents its value. Additional measurements can be read from the HART field device over the HART communication protocol. HART provides a standard message for reading four of the dynamic variables, called PV, SV, TV, and FV (sometimes called QV). These four dynamic variables are the four measurements of interest to a controller.

These four dynamic variables - PV, SV, TV, and FV - are automatically collected from the HART field device and placed in the input tag of the module in HART.ChxPV (for Analog and HART PV data format) or Chxx.PV (for Analog and HART by Channel data format). In some HART devices, the choice of which of the available measurements to assign to PV, SV, TV, and FV can be changed via configuration. In other more simple devices, the assignment is done at the factory and can't be changed.

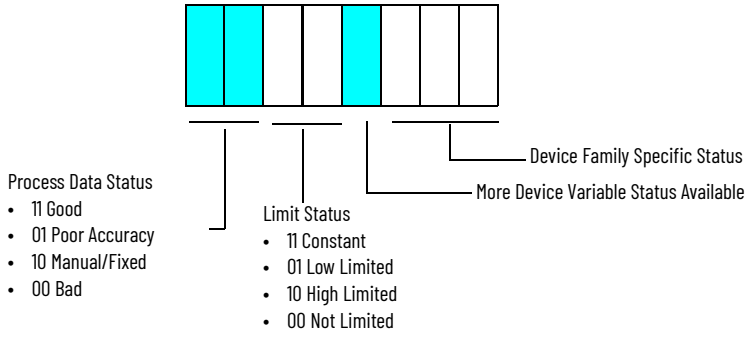
An example for a flowmeter can be:

- PV - Primary Variable. Flow Rate in Liters per Minute.
- SV - Secondary Variable. Process Temperature in °C.
- TV - Third or Tertiary Variable. Product Density in Grams per Cubic Centimeter.
- FV - Fourth or Quaternary Variable

An example for a Valve Positioner can be:

- PV - Primary Variable. Commanded position in %.
- SV - Secondary Variable. Actual position in %.
- TV - Third or Tertiary Variable. Air Pressure in PSI.
- FV - Fourth or Quaternary Variable. Loop current in mA.

In addition to the measurement value, HART devices can provide status information that indicates the quality of the measurement.



For example, if a valve positioner can't open any further, it can set its I.HART.Ch03.SVStatus to 2#11100000. This configuration indicates that the actual position value in the SV is Good (accurately measured) but is the subject of a High Limit. This status information can be used for windup control in PID loops and for other diagnostic purposes.

The module collects the PV, SV, TV, and FV data as described in this table.

Dynamic Variable Assignment(1)

HART Version	HART Device Reports PV, SV, TV, FV Assignments in Command 50	HART Command Used by 1756 Module to Collect PV, SV, TV, FV	Device Variable Codes Used in Command 9 for PV, SV, TV, FV
5	–	3	–
6	No	3	–
	Yes	9	As Reported in Command 50
7 or later	No	9	246, 247, 248, 249
	Yes		As Reported in Command 50

(1) Does not apply to the 1756-IF8H and 1756-OF8H modules, version 1.x, and the1756-IF16H and 1756-IF16IH modules, version 1.1

Command 3 does not provide PVStatus, SVStatus, TVStatus, or FVStatus. HART devices that indicate Command 3 have their Dynamic Variable Status values reported based on the communication status with the HART field device. If the Dynamic Variables are being collected without communication error, the Status value is 16#C0 (2#11000000), which means good. Otherwise, it's 0, meaning bad.

Some devices do not have four dynamic variables. In this case, they can report a NaN value to indicate that they have no valid value for that parameter.

The dynamic variables do not update as fast as the analog signal. The actual rate depends on the number of channels that are configured for HART (for the 8-channel modules), the number of pass-through message commands, the presence of handheld communicators or other secondary masters, and the response speed of the field device.

When eight channels are in use on the non-isolated 8-channel modules, the HART update rate is in the **10-second range**.

IMPORTANT Verify that the actual HART update rate is appropriate for your application. Remember that pass-through message traffic, additional status information, secondary masters, and communication errors can delay the update rate. On the non-isolated 8-channel modules, because all channels share the HART modem, increased delay on one channel affects other channels also.

IMPORTANT Verify that HART data is valid by checking ChxFault, HARTFault, and values such as PVStatus and SVStatus.

How the Module Automatically Collects Data

The ControlLogix HART analog module automatically sends HART messages to characterize the HART field device and collect the dynamic variables. It also collects additional status information when the device indicates it's available. When the device indicates that its configuration has changed, HART messages are sent to reread the configuration information so that a current copy is cached in the modules.

The diagrams on page 164 and page 165 show the general flow of the startup characterization, response to a new configuration, and cyclic scanning of dynamic variables. Not shown are periodic checks of the current and reading the additional status information.

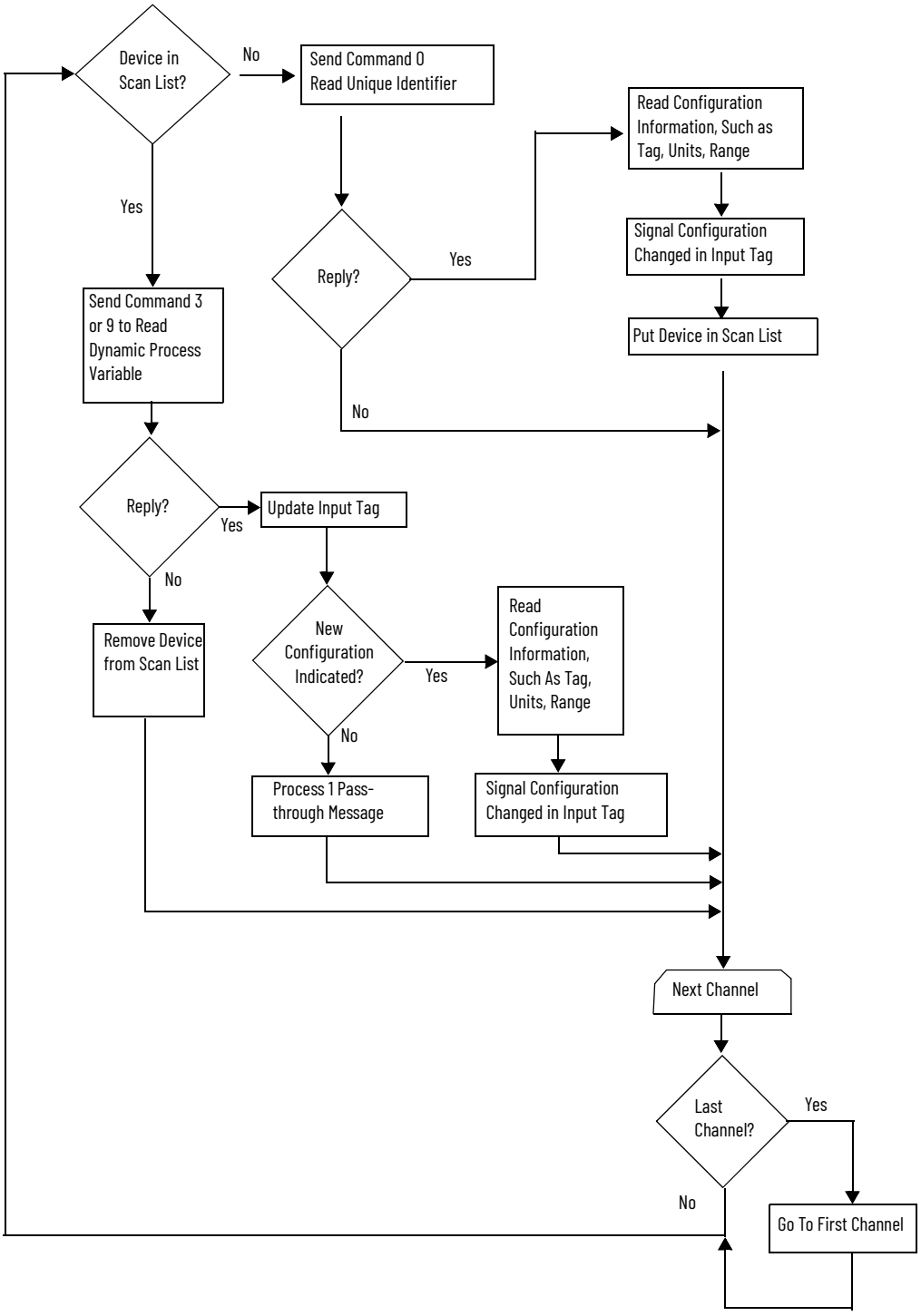
In addition to the HART activities outlined in the diagram, if there are HART pass-through messages to send, they're interleaved in the auto scanning. Logix controllers can send pass-through messages by using CIP MSG instructions, and Asset Management systems can send them.

HART messages are sent on only one channel at a time when you're using the 1756-IF8H or 1756-OF8H module. When you're using the 1756-IF8IH, 1756-OF8IH, 1756-IF16H, or 1756-IF16IH module, messages are sent on all channels simultaneously.

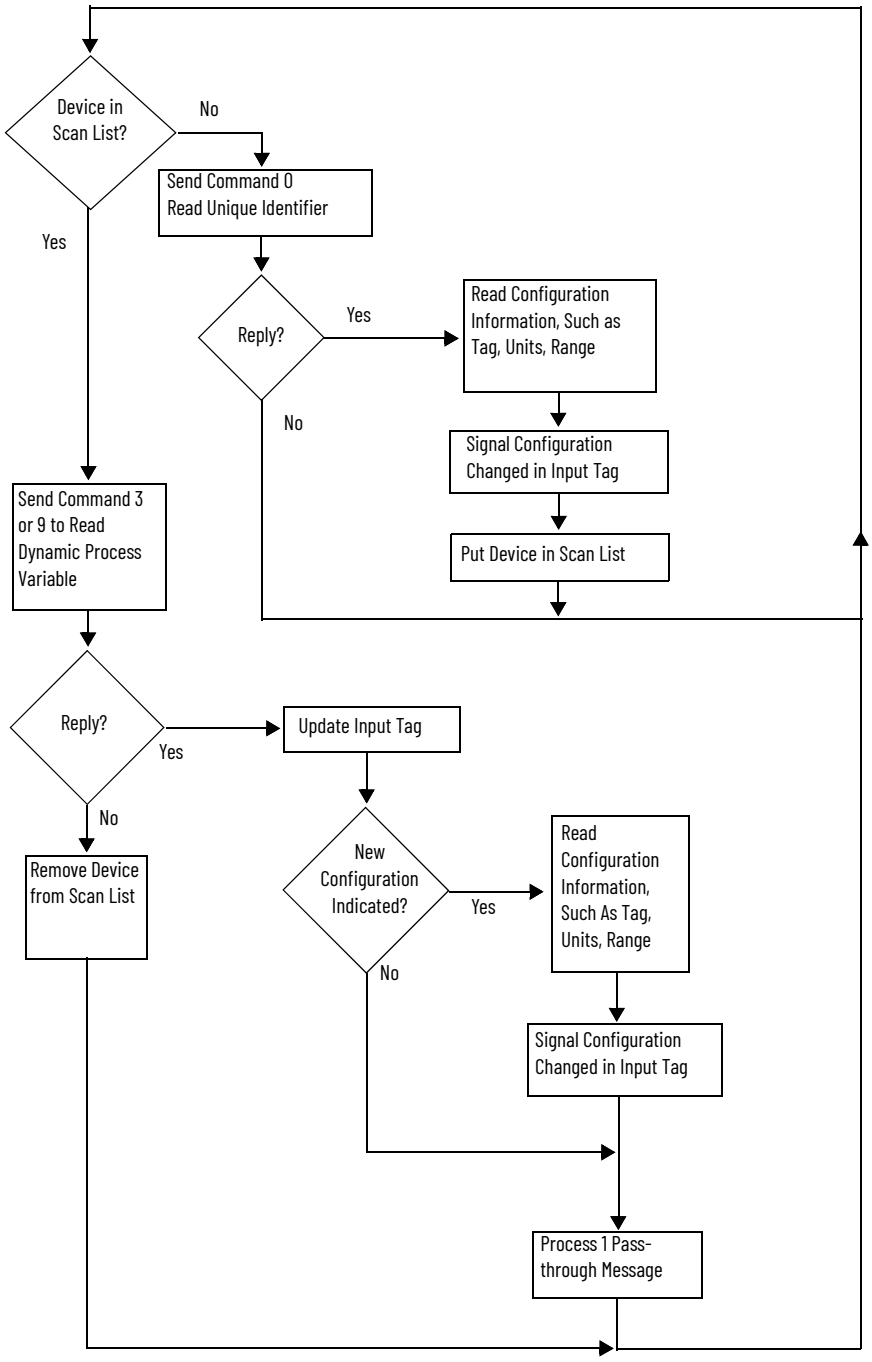
If the HART field device configuration is changed—from a handheld, asset management, or device faceplate—cyclic reading of the Dynamic Variables pauses briefly while the configuration changes are assimilated. The HART.ChxDeviceStatus.ConfigurationChanged status is set when the updated configuration is retrieved from the HART field device and stored in the module to indicate that new data is available for GetDeviceInfo CIP MSG.

See Use a CIP MSG to get HART Data for more information, and specifically page 176 for HART pass-through schedule choices.

1756-IF8H and 1756-OF8H Flowchart



1756-IF8IH, 1756-OF8IH, 1756-IF16H, and 1756-IF16IH Modules Flowchart



Notes:

Use a CIP MSG to get HART Data

This chapter shows how to use HART data in your Logix controller via MSG instructions. Examples of reasons to do this include the following:

- You need only occasional access to the data, and do not want to use the extra network capacity and memory that is required for the Analog with HART PV or Analog and HART by Channel input tags.
- You need extra information, such as device tag, ranges, or manufacturer-specific information.
- You must send a manufacturer-specific command to the HART device.

Usually, everything you must use a HART instrument is automatically collected and placed in the input tag, and these CIP™ MSG instructions aren't needed.

The 1756 ControlLogix® HART analog modules support these broad categories of MSG-based HART access:

- CIP formatted messages to retrieve common HART data cached in the module.
- CIP messages that contain HART formatted commands that are passed directly to the HART field device for processing. These messages are called pass-through messages.

By using these mechanisms your Logix controller has easy access to some commonly used data and, with some extra effort, access to any HART feature.

The features that are described in this chapter use MSG instructions. For more information and examples about MSG instructions, refer to Chapter 13, which explains how to use MSG instructions to unlatch alarms or reconfigure modules.

Use MSG Instructions to Access the HART Object

The HART Object that is contained in the module handles both categories of MSG. There's one HART Object for each channel. Some CIP messages can be sent to the Class Instance (Instance 0) of the HART object. Most MSGs are sent to a specific instance of the HART object that is associated with a particular channel.

This table shows channel and instance correspondence.

Channel	Instance
0	1
1	2
2	3
3	4
...	...
15	16

These tables show Service Codes for CIP services.

Class	Service Code	Function
16#35D	16#4B	Read Dynamic Variables
	16#4C	Read Additional Status
	16#4D	Get HART Device Information

Class	Service Code	Pass-through Messages
16#35D	16#4E	Init
	16#4F	Query
	16#50	Flush Queue

The 16# means that this number is Hex display style.

CIP Services to Access Common HART Data

You can get the following kinds of HART data easily from the HART object:

- HART field device information - Similar to data displayed on the Module Properties HART Device Information view of the Studio 5000 Logix Designer® application.
- Additional status - HART devices that support extended diagnostics can indicate in their Field Device Status that some additional diagnostic information is available.
- Dynamic variables - The same PV, SV, TV, FV that is in the input tag. The mapped Device Variable Code and the engineering units are included.

The data in these commands is returned in the format that is used by Logix controllers, so it's easy to use in your control program. HART data is natively in another format, called big-endian, but the module converts the values in these messages for you.

See the tables that list the data in the CIP messages and the example of getting the Device Info.

In the following sections, the definition CMD#0 byte 3, for example, means HART command 0, byte 3. If your field device user manual includes information about HART command responses, this information is helpful to you. Consult the HART protocol specification for further information on HART commands. See Appendix on page 203 for more information.

Read Dynamic Variables (Service Code = 16#4B)

The Read Dynamic Variables service does not contain data within the request packet. These tables show the reply packet structures for the Read Dynamic Variables service.

Reply Packet - Request Failed

Offset	Field	Data Type	Definition
0	Status	USINT	Command status
1	Pad		Pad byte
Reply size = 2 bytes			
Request Failed			

See Appendix on page 219 for an explanation of the engineering unit code numbers.

Reply Packet - Request Succeeded

Offset	Field	Data Type	Definition
0	Status	USINT	Command status
1	HARTCommandStatus		HART Device reply Status Byte # 1 (response code)
2	HARTFieldDeviceStatus		HART Device reply Status Byte # 2
3	HARTExtDevice Status		Status Byte returned from Cmd 9 or 0 for 5.x rev HART devices
4...7	PV	REAL	HART Primary variable
8...11	SV		HART Secondary variable
12...15	TV		HART Third variable
16...19	FV		HART Fourth variable

Reply Packet - Request Succeeded (Continued)

Offset	Field	Data Type	Definition
20	PV Units	USINT	Primary variable unit code
21	SV Units		Secondary variable unit code
22	TV Units		Third variable unit code
23	FV Units		Fourth variable unit code
24	PV Assignment Code		Primary variable assignment code
25	SV Assignment Code		Secondary variable assignment code
26	TV Assignment Code		Third variable assignment code
27	FV Assignment Code		Fourth variable assignment code
28	PV Status		1 byte status from Cmd 9(Rev 6.x) or if Rev 5.x device: 16#C0 = Connected 16#00 = Not Connected
29	SV Status		1 byte status from Cmd 9 or if Rev 5.x device: 16#C0 = Connected and Device provides this value in CMD 3 (that is, does not truncate) 16#00 = Not Connected
30	TV Status		1 byte status from Cmd 9 or if Rev 5.x device: 16#C0 = Connected and Device provides this value in CMD 3 (that is, does not truncate) 16#00 = Not Connected
31	FV Status		1 byte status from Cmd 9 or if Rev 5.x device: 16#C0 = Connected and Device provides this value in CMD 3 (that is, does not truncate) 16#00 = Not Connected
32...35	Loop Current	REAL	Device reported digital loop current value. (Value from Cmd 3 for Rev 5.x devices or Cmd 2 if Rev 6.x device)
Reply Size = 36 bytes			

Read Additional Status (Service Code = 16#4C)

The Read Additional Status service does not contain data within the request packet. These tables show the reply packet structures for the Read Additional Status service.

Reply Packet - Request Failed

Offset	Field	Data Type	Definition
0	Status	USINT	Command status
1	Pad		Pad byte
Reply size = 2 bytes			
Request Failed			

Reply Packet - Request Succeeded

Offset	Offset	Data Type	Definition
0	Status	USINT	Command status
1	Count		Number of Ext Status bytes available
2...26	Ext Status Bytes		Extended Status bytes returned by CMD48
7	Pad		Pad type
Reply Size = Instance 1...8: 2...28 bytes; Instance 0: 224 bytes. If sent to Instance 0, all channels of the module are included in the response, which results in 28 bytes per channel. This total is due to 27 bytes of response to the HART Read Additional Status plus 1 byte of pad to align the data to a 32-bit boundary.			

Get Device Information (Service Code 16#4D)

The Get Device Information service does not contain data within the request packet. These tables show the reply packet structures for the Get Device Information service.

Reply Packet - Request Failed

Offset	Field	Data Type	Definition
0	Status	USINT	Command status
1	Pad		Pad byte
Reply size = 2 bytes			

Reply Packet - Request Succeeded

Offset	Field	Data Type	Definition[1]
0	Status	SINT	Command status
1	Manufacturer ID		CMD#0, Byte 1 If this byte is ≥ 16#E0, refer to byte offset 10 and 11 for the extended manufacturer identification.
2	Device Type		CMD#0, Byte 2
3	Preamble		CMD#0, Byte 3
4	Universal Command Code		CMD#0, Byte 4
5	Transducer Spec Code		CMD#0, Byte 5
6	Software Revision		CMD#0, Byte 6
7	Hardware Revision		CMD#0, Byte 7
8	Flags		CMD#0, Byte 8
9	Pad_1 for 16-bit alignment		
10...11	Extended Manufacturer ID		CMD#0, Byte 1 if HART revision is < 7 CMD#0, Bytes 17...18 if HART revision is ≥ 7
12. . .15	Device ID Number	DINT	CMD#0, Bytes 9...11
16...27	Tag	HARTTag	CMD#13, Bytes 0...5 See HARTTag String Type on page 174 for more information.
28...47	Descriptor	HARTDescriptor	CMD#13, Bytes 6...17 See HARTDescriptor String Type on page 174 for more information.
48	DateDay	SINT	CMD#13, Byte 18
49	DateMonth		CMD#13, Byte 19
50...51	DateYear	INT	CMD#13, Byte 20 (+ 1900)
52...55	Final AssemblyNumber	DINT	CMD#16, Bytes 0...2
56...91	Message	HARTMsg	CMD#12, Bytes 0...23 See HARTMsg String Type on page 174 for more information.
92	PVCode	SINT	CMD#50, Bytes 0, 16#ff if not supported
93	SVCode		CMD#50, Bytes 1, 16#ff if not supported
94	TVCode		CMD#50, Bytes 2, 16#ff if not supported
95	FVCode		CMD#50, Bytes 3, 16#ff if not supported
96	PVUnits		CMD#3, Byte 4
97	SVUnits		CMD#3, Byte 9, 0 if not present
98	TVUnits		CMD#3, Byte 14, 0 if not present
99	FVUnits		CMD#3, Byte 19, 0 if not present
100	TransferFunction		CMD#15, Byte 1
101	RangeUnits		CMD#15, Byte 2
102...103	Expanded Device Type Code		CMD#0, Byte 2 if HART revision is < 7 CMD#0, Bytes 1...2 if HART revision is ≥ 7
104...107	PVLowerRange	REAL	CMD#15, Bytes 3...6
108...111	PVUpperRange		CMD#15, Bytes 7...10
112...115	DampingValue		CMD#15, Bytes 11...14

Reply Packet - Request Succeeded (Continued)

Offset	Field	Data Type	Definition[1]
116	WriteProtectCode	SINT	CMD#15, Byte 15
117	Pad_8 for 32-bit alignment		
118...119	Private Label Manufacturer 16 bit		CMD#0, Byte 2 if HART revision is < 7 CMD#0, Bytes 19...20 if HART revision is ≥ 7
Reply Size = 120 bytes			

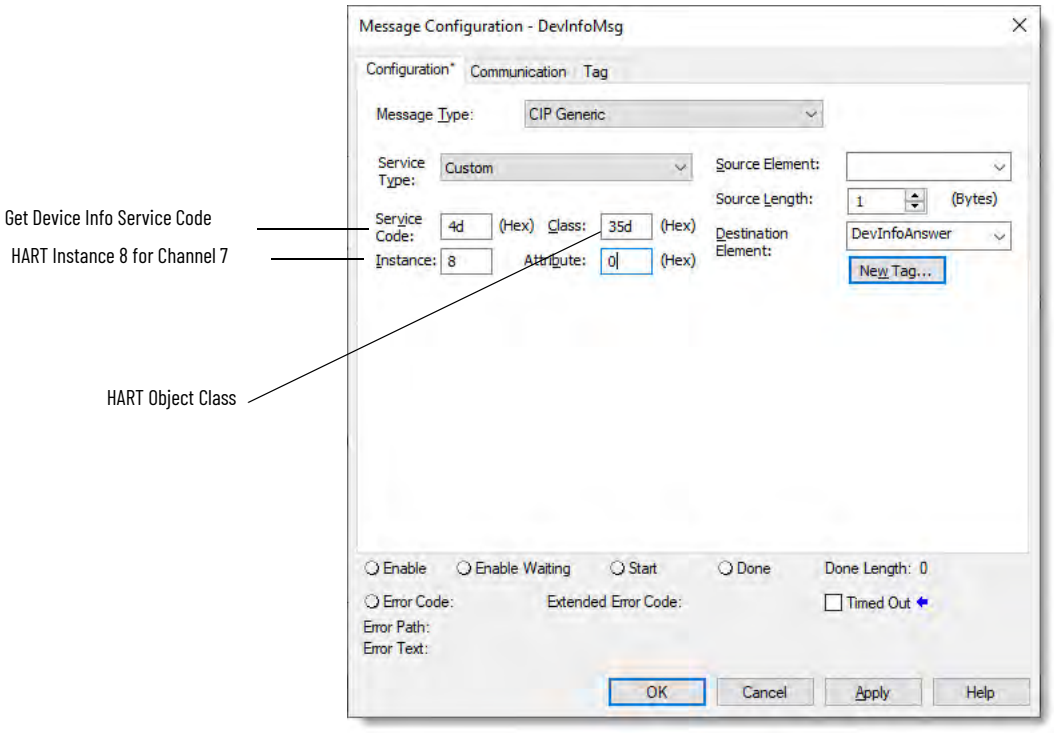
(1) See Appendix B on page 203 for related information.

Use a CIP Generic MSG to get HART Device Information

In this example, this rung of ladder logic retrieves fresh HART device information whenever the 1756-IF8H, 1756-IF8IH, 1756-IF16H, 1756-IF16IH, 1756-OF8H, or 1756-OF8IH module indicates that a new configuration is available.

If the Device Information is critical to your application, be sure to check for .ER errors and implement a recovery strategy.

This figure is the Message Configuration dialog.



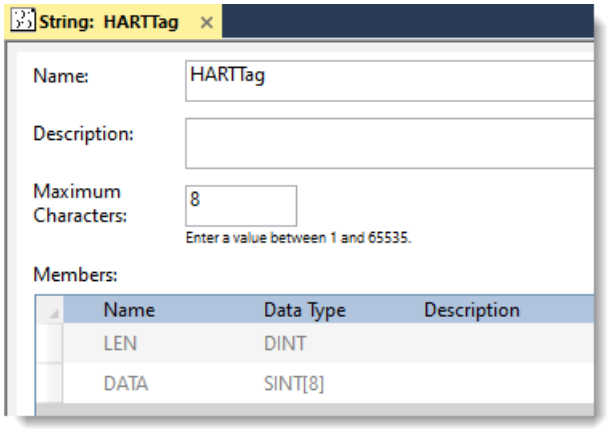
The device information for the HART Device on channel 7 is read and put in DevInfoAnswer.

The Destination tag is as shown in the Controller Tags dialog.

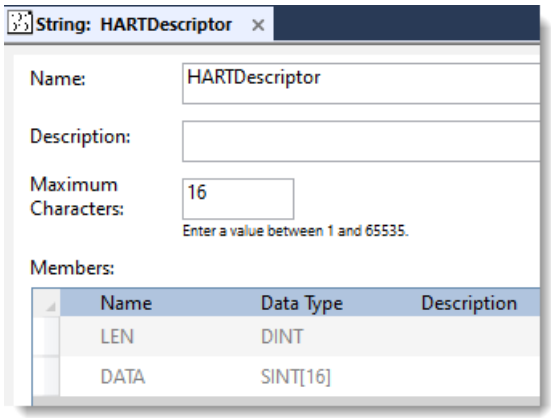
Name	Value	Force Mask	Style	Data Type
DevInfoAnswer	{...}	{...}		HARTGetDeviceInf
DevInfoAnswer.Status	0		Decimal	SINT
DevInfoAnswer.Manufacturer	38		Decimal	SINT
DevInfoAnswer.DeviceType	13		Decimal	SINT
DevInfoAnswer.Preamble	6		Decimal	SINT
DevInfoAnswer.UniversalCommandCode	5		Decimal	SINT
DevInfoAnswer.TransducerSpecRev	2		Decimal	SINT
DevInfoAnswer.SoftwareRev	4		Decimal	SINT
DevInfoAnswer.HardwareRev	96		Decimal	SINT
DevInfoAnswer.Flags	0		Decimal	SINT
DevInfoAnswer.pad1	0		Decimal	SINT
DevInfoAnswer.pad2	0		Decimal	SINT
DevInfoAnswer.pad3	0		Decimal	SINT
DevInfoAnswer.DeviceID	111016		Decimal	DINT
DevInfoAnswer.Tag	'NEW_TAG1'	{...}		HARTTag
DevInfoAnswer.Descriptor	'NEW DESCRIPTOR_1'	{...}		HARTDescriptor
DevInfoAnswer.DateDay	3		Decimal	SINT
DevInfoAnswer.DateMonth	1		Decimal	SINT
DevInfoAnswer.DateYear	2008		Decimal	INT
DevInfoAnswer.FinalAssemblyNumber	111016		Decimal	DINT
DevInfoAnswer.Message	'THIS IS A TEST MESSAGE 32 CH...	{...}		HARTMsg
DevInfoAnswer.PVCode	-1		Decimal	SINT
DevInfoAnswer.SVCode	-1		Decimal	SINT
DevInfoAnswer.TVCode	-1		Decimal	SINT
DevInfoAnswer.FVCode	-1		Decimal	SINT
DevInfoAnswer.PVUnits	33		Decimal	SINT
DevInfoAnswer.SVUnits	32		Decimal	SINT
DevInfoAnswer.TVUnits	-6		Decimal	SINT
DevInfoAnswer.FVUnits	-6		Decimal	SINT
DevInfoAnswer.TransferFunction	0		Decimal	SINT
DevInfoAnswer.RangeUnits	33		Decimal	SINT
DevInfoAnswer.pad6	0		Decimal	SINT
DevInfoAnswer.pad7	0		Decimal	SINT

The following figures show string types for HARTTag, HARTDescriptor, and HARTMsg.

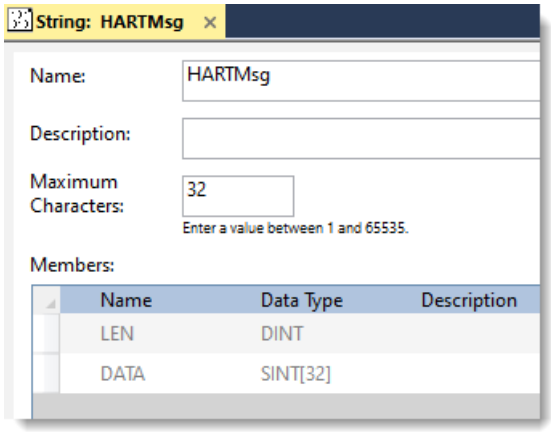
HARTTag String Type



HARTDescriptor String Type



HARTMsg String Type



For more information and sample code demonstrating a HART device Get Device Information Message, see Knowledgebase Technote, *1756 I/O HART Message Sample Code: Get Device Information*.

IMPORTANT	You must sign in to the Rockwell Automation website before accessing the Knowledgebase.

Use CIP Services to Pass-through a HART Message to a HART Field Device

The HART object supports these CIP messages for HART pass-through messaging: Pass-through Init, Pass-through Query, Flush Queue (rarely needed).

With these three CIP messages, your Logix controller can format the individual bytes of a HART command, send it to a HART field device, and retrieve the response in HART format.

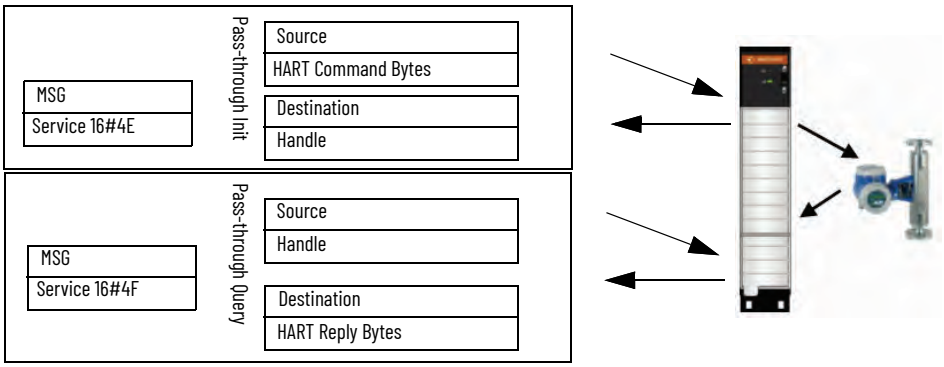
Native HART data is in another format than used by Logix controllers. HART uses the big-endian format and Logix uses the little-endian format. This means the order of the bytes in a number is in the opposite order so they must be reversed before use. Logix little-endian means that the least significant byte of a number is stored at the lowest address (array index).

Logix also aligns data on boundaries that permit fast access and HART packs them into the smallest space. HART encodes text strings using 6 bits per letter into a format called Packed ASCII. When using pass-through messaging, your Logix program must be aware of these data layout issues.

The pass-through message CIP services that are supported by the HART object are simplified. The module provides the 5-byte address that is required by HART messages and the Checksum is calculated automatically for you.

Follow these steps to send a HART pass-through message.

1. Send a CIP message to tell the 1756-IF8H, 1756-IF8IH, 1756-IF16H, 1756-IF16IH, 1756-OF8H, or 1756-OF8IH module to send a message to a HART field device (Init).
2. Send a CIP message to retrieve the HART Reply from the 1756-IF8H, 1756-IF8IH, 1756-IF16H, 1756-IF16IH, 1756-OF8H, or 1756-OF8IH module (Query).



If your input tag includes the HART PV data, a status indicator HART.ChxDeviceStatus.MsgReady tells your program that a HART reply is ready to retrieve with the Pass-through Query command.

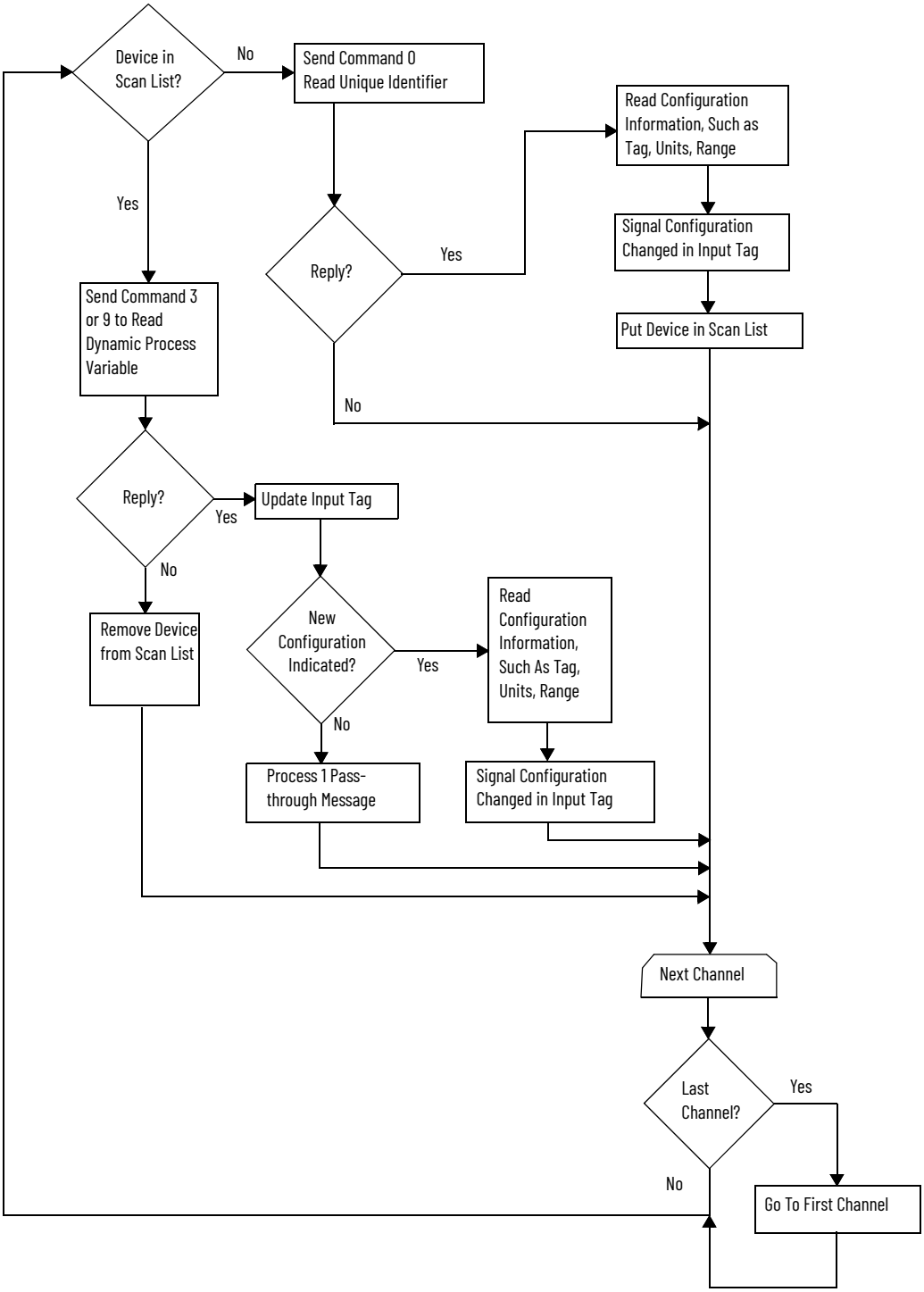
The CIP reply from the Init service includes a number that is called the handle. This handle identifies the HART message that was placed in a queue for transmission to the field device. When the reply is received and MsgReady is set to 1, your Logix controller sends a Query containing that same handle to retrieve the HART reply. The reason these steps are necessary is that it can take a long time for the HART command to be transmitted and a reply received. If all eight channels are in use, the time for a reply would be about 10 seconds if there was no other pass-through traffic.

HART Module Scanning Diagram with Pass-through Messages

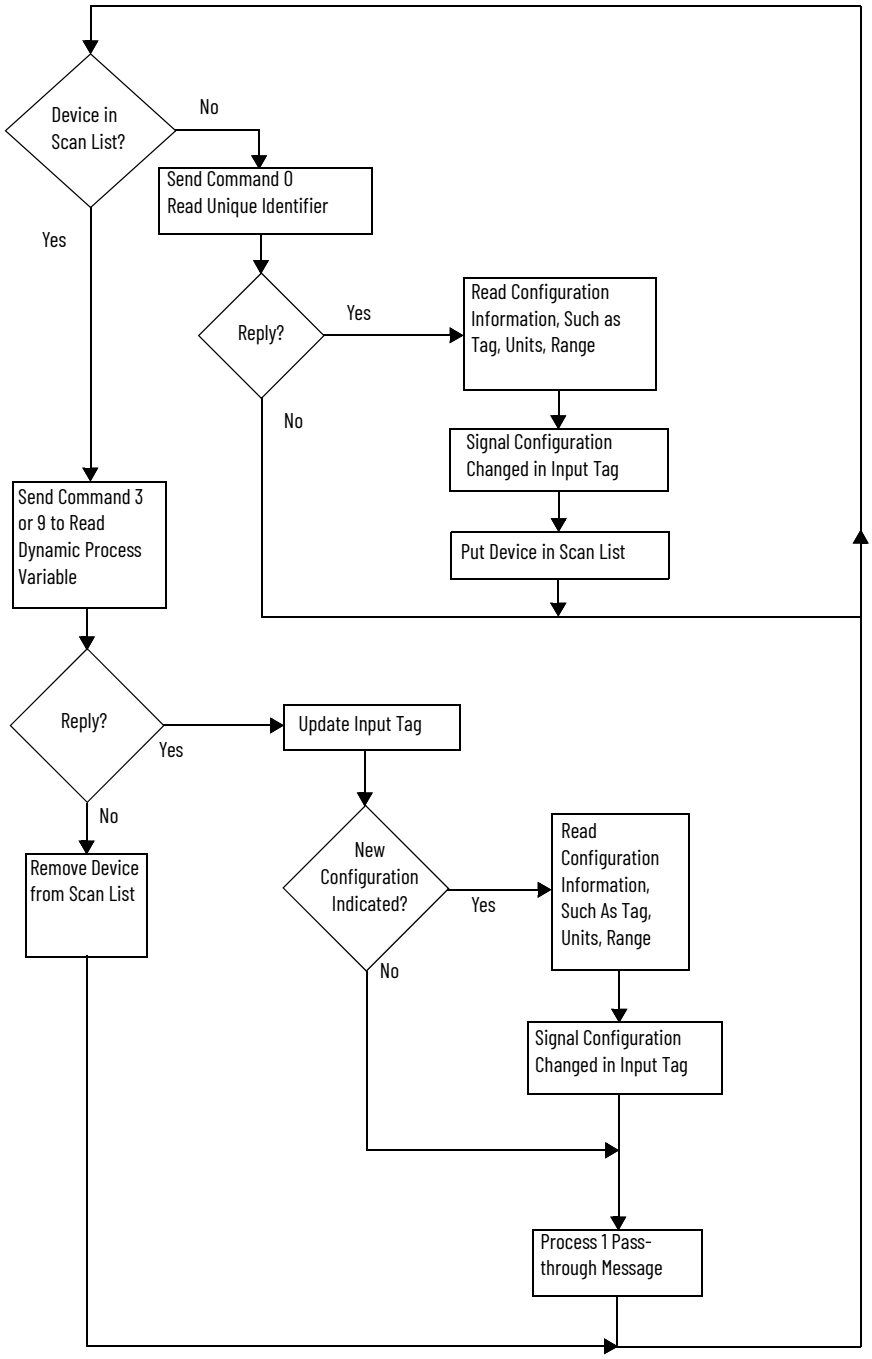
When HART pass-through messages are being sent, the normal data acquisition sequence is modified as shown in the diagram. In this case, the Pass-through is configured to send one pass-through message for each channel scanned.

It can be configured for lower priority in the Channels view of the Module Properties.

1756-IF8H and 1756-OF8H Flowchart



1756-IF8IH, 1756-OF8IH, 1756-IF16H, and 1756-IF16IH Modules Flowchart



HART Pass-through CIP Message Layout Details

See the tables in this section for pass-through information.

Pass-through Init (Service Code 16#4E)

These tables show the request and reply packet structures for the Pass-through Init service.

Short Format (Ladder) Request Packet (Service Code 16#4E)

Offset	Field	Data Type	Definition
0	HART Command	USINT	HART Command Number(1) (2)
1	HART Data Size	USINT	Number of Data Bytes for Selected HART Command(1)(2)
2...256	HART Data bytes	As many bytes as in HART Data Size	HART Command Data(1)
Request Size = 2...257 bytes			

(1) See Appendix B on page 203 for more information.
(2) If this field is displayed as SINT in the Logix Designer application, values > 127 appear negative.

Long Format (Logix) Request Packet (Service Code 16#5B, 16#5F)

Offset	Field	Data Type	Definition
0	Start or Delimiter		
1...5	Long Form Address		Number of Data Bytes for Selected HART Command(1)(2)
6	HART Command	USINT	HART Command Number(1) (2)
7	Request Data Count		
2...256	HART Data bytes	As many bytes as in HART Data Size	HART Command Data(1)
Request Size = 2...257 bytes			

(1) See Appendix B on page 203 for more information.
(2) If this field is displayed as SINT in the Logix Designer application, values > 127 appear negative.

Short Format (Ladder) Reply Packet

Offset	Field	Data Type	Definition
0	Status	USINT	Command status 32 = Busy (queues full) - try again later 33 = Initiated - command started - send Query to get the reply 35 = Dead - Device not online
1	HART Command	USINT	Echo of HART Command number(1)
2	Handle	USINT	Handle Used in Query Operation(1)
3	Queue space remaining	USINT	Number of queues still Available for This Channel(1) If status (bit 0) is 35, refer to Pass-through Error Codes on page 179 for the error code description.
Reply Size = 4 bytes			

(1) If this field is displayed as SINT in the Logix Designer application; values > 127 appear negative.

Long Format (Logix) Reply Packet

Offset	Field	Data Type	Definition
0	Status	USINT	Command status 32 = Busy (queues full) - try again later 33 = Initiated - command started - send Query to get the reply 35 = Dead - Device not online
1	HART Command	USINT	Echo of HART Command number(1)
2	Handle	USINT	Handle Used in Query Operation(1)
3	Queue Number or Reason Code	USINT	The queue number in which the request was placed
4	Queue space remaining	USINT	Number of queues still Available for This Channel(1)
5	Device Data Changed Flag	BOOL (one byte, 0 or 1)	Signals that the "Device Information" data has changed
Reply Size = 4 bytes			

(1) If this field is displayed as SINT in the Logix Designer application, values > 127 appear negative.

Pass-through Query (Service Code 16#4F)

These tables show the request and reply packet structures for the Pass-through Query service.

Request Packet

Offset	Field	Data Type	Definition
0	Handle	USINT	Handle for Query (from Handle Field in Long Format (Logix) Reply Packet)(1)
Request Size = 1 byte			

(1) If this field is displayed as SINT in the Logix Designer application, values > 127 appear negative.

Reply Packet

Offset	Offset	Data Type	Definition
0	Status	USINT	Query Status 00 = Success 34 = Running - try again later 35 = Dead (See MsgReady in Input Tag)
1	HART Command	USINT	Echo of HART Command(1)
2	HART CommStatus	USINT	HART Reply Status Byte #1 (response code)(1)
3	HART FieldDeviceStatus	USINT	HART Reply Status Byte #2(1) If status (bit 0) is 35, refer to the Pass-through Error Codes on page 179 for the error code description.
4	Data Size	USINT	Number of Data Bytes in Reply for HART Command(1)
5...259	HART Reply Data ...	USINT	Data Bytes Returned in Data Field of HART Reply to Requested Command(1)
Reply Size = 6...260 bytes			

(1) If this field is displayed as SINT in the Logix Designer application, values > 127 appear negative.

Pass-through Error Codes

This table defines the error codes that are received when the pass-through status (bit 0) is Dead (35).

Pass-through Error Codes

Value	Definition	Notes
16#81	No response from HART device	
16#82	Invalid long frame address	Applies to only FULL-HART format
16#83	Invalid HART message checksum	Applies to only FULL-HART format
16#84	HART Command not allowed (blocked by module)	Applies to only Ladder Pass-through
16#85	Invalid channel selected	N/A for 1756-IF16H and 1756-IF16IH modules
16#86	Channel isn't HART Enabled	
16#87	Channel does not have a device that is connected	Module hasn't established HART communication on this channel
16#89	Size of CIP message too small to hold size of HART message	Module reviews HART data size field in request and validates that the incoming CIP message size is large enough to send all data
16#8A	Invalid handle	Applies to only Query message
16#8B	Invalid start delimiter	Applies to only FULL-HART format

The 16# means that this number is Hex display style.

Flush Queue (Service Code= 16#50)

The Flush Queue service does not contain data within the request and reply packets.

Flush Queue can be sent to have a ControlLogix HART Analog I/O module discard any pending HART replies awaiting a query command. These replies are automatically discarded after a period, which is configurable in the Channels view of the Module Properties. This value is usually 15 seconds. Unless you must discard the replies faster than 15 seconds, you do not need to use this Flush Queue command.

HART Pass-through Message Ladder Logic Example

You use HART Pass-through Messaging to send HART commands. For example, HART command 18 writes the tag, descriptor, and date.

For more information and sample code demonstrating the setup of HART command 18, specifically, see Knowledgebase Technote, *1756 I/O HART Message Sample Code: pass-thru Message*. The sample code can be referenced as an example of how to send any pass-through message command. Additional information HART commands can be found in Appendix B.

Instance 1 means Channel 0 within the INIT message.

For HART command 18, data will need ASCII packed and unpacked.

For add-on instructions for the ASCII pack and unpack operation, see Knowledgebase Technote, *1756 I/O HART Message Sample Code: AOI instructions for handling HART Packed ASCII format*.

HART Read Dynamic Variables Example

The principles of the HART Pass-through Message Ladder Logic Example can be applied to sending HART command 9, which reads Device Variables from the HART field device. You send the list of the Device Variable codes that you want, and the field device responds with its values, units, classification, and status.

For this specific operation, the information obtainable via HART command 9 can instead be obtained more easily by using service 4B messaging.

For an example of a Reading Dynamic Variables with service 4B, see Knowledgebase Technote, *1756 I/O HART Message Sample Code: Read Dynamic Variables*.

Use HART Modules with Asset Management Software

Considerations for Asset Management Systems

The following must be considered before using the I/O modules with asset management systems, such as FactoryTalk® AssetCentre or Endress+Hauser FieldCare systems.

- HART must be enabled before any asset management system access is possible, including scanning for multiplexers, if supported by your asset management software. You do not need to include HART PV or HART by Channel data in your input tag. You must select the Enable HART option in the ChX view, however.
- The Logix controller must be connected to the I/O module. If the Logix controller isn't connected, the module configuration wasn't sent to the HART module, and the channel isn't yet configured for HART access.
- If you use a handheld HART communicator and configuration tool, such as Rosemount 275 or Meriam, configure the tool as the secondary master. The Meriam handheld has a high-speed mode, which assumes it's the only master present. In this mode, the handheld can conflict with the I/O module. Usually, the Meriam handheld automatically detects the proper setting, but if not, set it manually.
- The ConfigurationChanged indication in the Field Device Status is automatically reset by the I/O module. Asset management systems can miss this indication if they're offline at the time of a change.
- A separate configuration-changed indication is in the field device status for the primary master (1756-IF8H, 1756-IF8IH, 1756-IF16, or 1756-IF16IH module) and secondary master (handheld, for example). The I/O modules do not reset the secondary master configuration changed status.

HART traffic from asset management pass-through messages or from secondary masters slows the update rate of HART data in the controller or other pass-through message clients.

With 1756-IF8H Series A and 1756-OF8H Series A modules, extra traffic on one channel affects other channels. With all other HART modules or series, this is not the case.

Frequently Asked Questions

Read this section for answers to frequently asked questions.

How do you use ControlLogix® HART analog I/O modules as part of an asset management system?

HART I/O modules let most asset management software packages communicate through the modules to HART field devices. Use RSLinx® software to let the asset management software communicate through the NetLinx networks and the 1756 backplane.

Which RSLinx software is required to support asset management software?

You need RSLinx Classic software with a Professional, Gateway, or OEM activation.

What else is required to use asset management software with a ControlLogix® HART analog I/O module?

For Field Device Tool (FDT)/Device Type Manager (DTM) based asset management software such as E+H FieldCare, you use communication DTMs from Rockwell Automation. These same communication DTMs also work in FactoryTalk AssetCentre software. For non-FDT/DTM based asset management software, such as Emerson AMS, use Connects software, available from Spectrum Controls.

What is FDT/DTM?

FDT/DTM is a technology for managing intelligent devices.

E+H FieldCare asset management software is an FDT frame application. The frame application runs the DTM files. The DTM files are executable files that are provided by control and device vendors. There are communication DTMs and device DTMs.

We provide communication DTMs for components in the integrated architecture. Companies such as Endress+Hauser and Metso provide device DTMs for their instruments and valves. The device DTMs provide visualization of the parameters that are necessary to configure, monitor, and maintain the devices. See https://www.fdtgroup.org/ for more information on FDT/DTM technology and to search for registered DTMs.

What communication DTMs are used with ControlLogix HART analog I/O modules?

Go to the Rockwell Automation Product Compatibility and Download Center (rok.auto/pcdc), select Downloads by Product, search for "1756 DTM", and chose the desired version.

Can I get asset management software from Rockwell Automation?

FactoryTalk AssetCentre provides you with a centralized tool for securing, managing, versioning, tracking and reporting automation-related asset information across your entire facility. It can do this automatically, with limited additional management oversight or work from employees. FactoryTalk AssetCentre can impact uptime, productivity, quality, employee safety, or regulatory compliance. For more information, see https://www.rockwellautomation.com/en-us/products/software/factorytalk/maintenancesuite/assetcentre.html

What version of Connects software by Spectrum Controls is needed for the ControlLogix HART analog I/O modules?

Use Spectrum Connects software, version 6.0 or later. This software is needed only for asset management software that is not FDT/DTM-based.

What if a DTM isn't available for my HART field device?

A generic DTM is available (included with FieldCare) that provides basic access to devices.

Use Ladder Logic to Unlatch Alarms and Reconfigure Values

The information in this chapter applies only to the following modules:

- 1756-IF8H, 1756-IF8HK
- 1756-OF8H, 1756-OF8HK
- 1756-IF8IH, 1756-IF8IHK (when Configure HART Device(s) = No)
- 1756-OF8IH, 1756-OF8IHK (when Configure HART Device(s) = No)

This information does not apply to the following modules, as Alarms and Limits aren't available:

- 1756-IF16H, 1756-IF16HK
- 1756-IF16IH, 1756-IF16IHK
- 1756-IF8IH, 1756-IF8IHK (when Configure HART Device(s) = Yes)
- 1756-OF8IH, 1756-OF8IHK (when Configure HART Device(s) = Yes)

Using Message Instructions

In ladder logic, you can use message instructions to send occasional services to any ControlLogix® I/O module. Message instructions send an explicit service to the module and cause specific behavior to occur, for example, the unlatching of a high alarm.

Message instructions maintain the following characteristics:

- Messages use unscheduled portions of system communication bandwidth.
- One service is performed per instruction.
- Performing module services does not impede module functionality, such as sampling inputs or applying new outputs.

Processing Real-time Control and Module Services

Services that are sent via message instructions aren't as time critical as the module behavior defined during configuration and maintained by a real-time connection. Therefore, the module processes messaging services only after the needs of the I/O connection are met.

For example, you want to unlatch all process alarms on the module, but real-time control of your process still occurs using the input value from that same channel. Because the input value is critical to your application, the module prioritizes the sampling of inputs ahead of the unlatch service request. This prioritization lets input channels be sampled at the same frequency and the process alarms be unlatched in the time between sampling and producing the real-time input data.

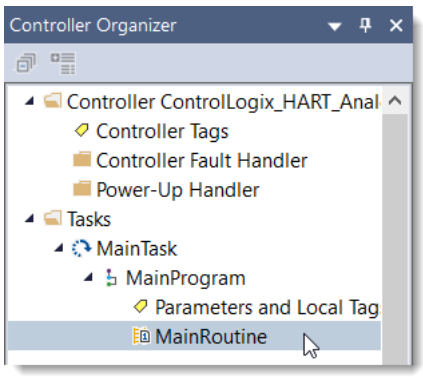
One Service Performed Per Instruction

Message instructions cause a module service to be performed once per execution. For example, if a message instruction sends a service to the module to unlatch the high high alarm on a particular channel, the high high alarm for that channel unlatches. The alarm can be set on a subsequent channel sample. The message instruction must then be re-executed to unlatch the alarm a second time.

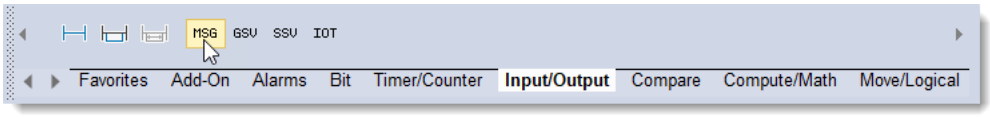
Creating a New Tag

Do these steps to create a tag by writing ladder logic in the Main Routine.

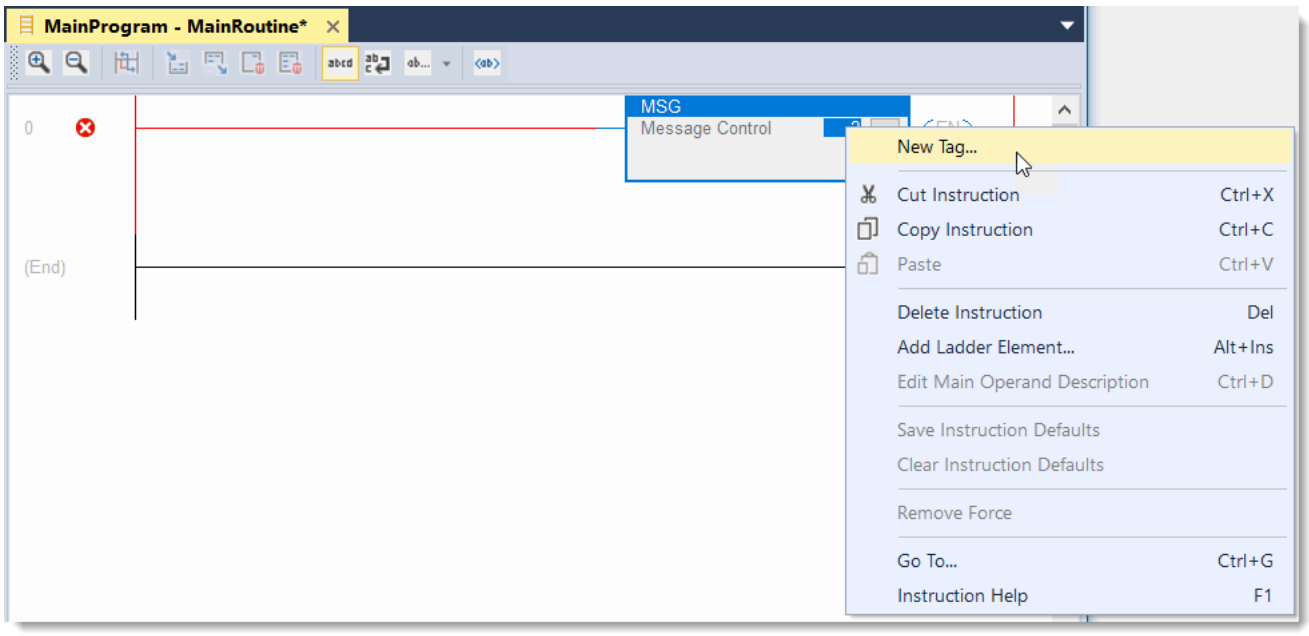
1. Double-click MainRoutine (if necessary, expand the MainProgram by selecting the triangle to the left).



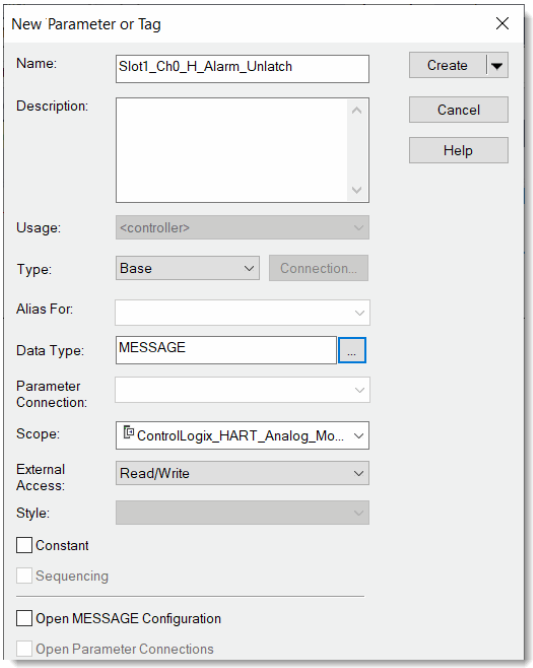
2. Add a message instruction to a rung by selecting MSG on the toolbar above the ladder project.



3. Create a tag for the message instruction that you're adding.
   a. Right-click the question mark (?).
   b. Select New Tag.



The New Parameter or Tag dialog appears.



4. On the New Parameter or Tag dialog, complete these steps:
   a. Name the tag.
   b. Verify that MESSAGE is the Date Type.
   c. From the Scope pull-down menu, select the Controller.
   d. Verify that Base is the Type.

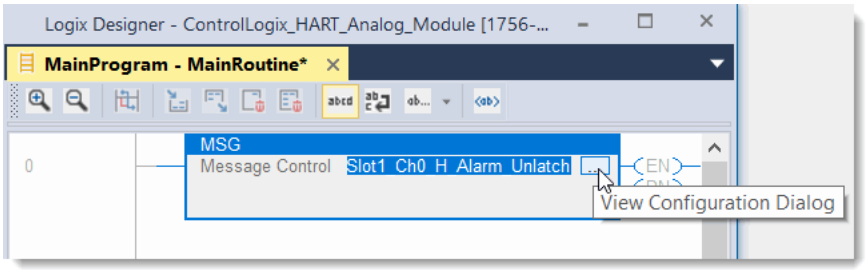
IMPORTANT We suggest you name the tag to indicate the module service that the message instruction sends. In the example, the message instruction is used to unlatch a high alarm, and the tag name reflects this.

5. Select Create.

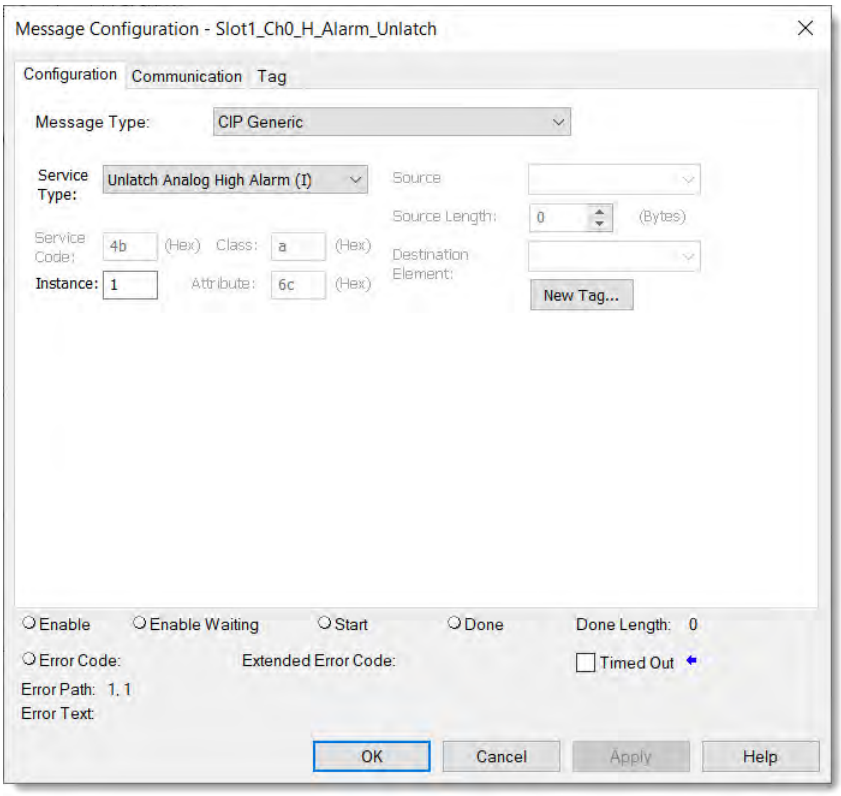
Enter Message Configuration

After you create a tag, enter message configuration.

Select the small box with the ellipsis to access the Message Configuration dialog.



The Message Configuration dialog will appear.



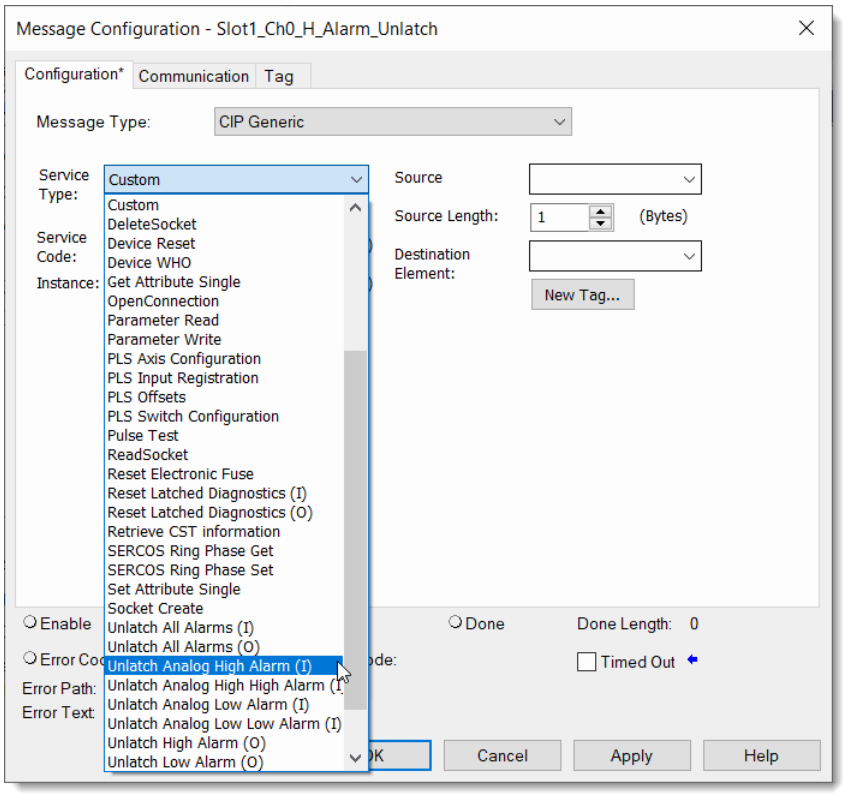
The Configuration tab of the Message Configuration dialog provides information on what module service to perform and where to perform it. For example, unlatch high alarms (module service) on channel 0 of a module (where to perform the service).

IMPORTANT The Studio 5000 Logix Designer® application defaults information, such as the following, depending on the message type:

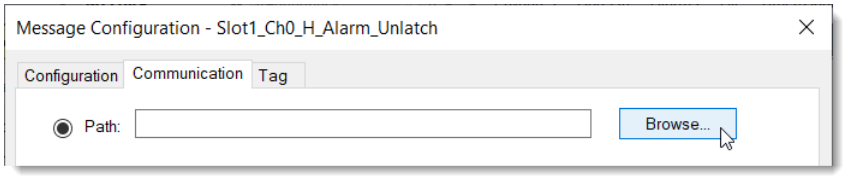
- Service type
- Service Code
- Class
- Instance
- Attribute
- Source element
- Source length
- Destination

You're required to select a Service type and configure the Instance field. Instance represents the module channel on which the service is performed, if appropriate.

From the Service Type pull-down menu, select a service. Available services include unlatching high high, high, low low, low, ramp, and rate alarms.

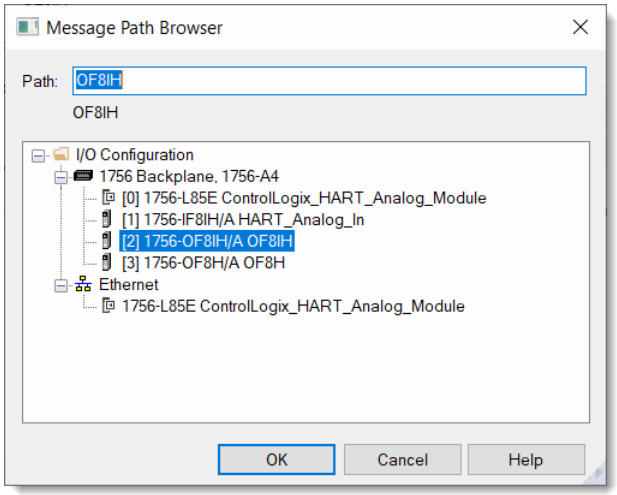


The Communication tab of the Message Configuration dialog provides information on the path of the message instruction. For example, the slot number of a 1756-OF8IH module distinguishes exactly for which module a message is designated.



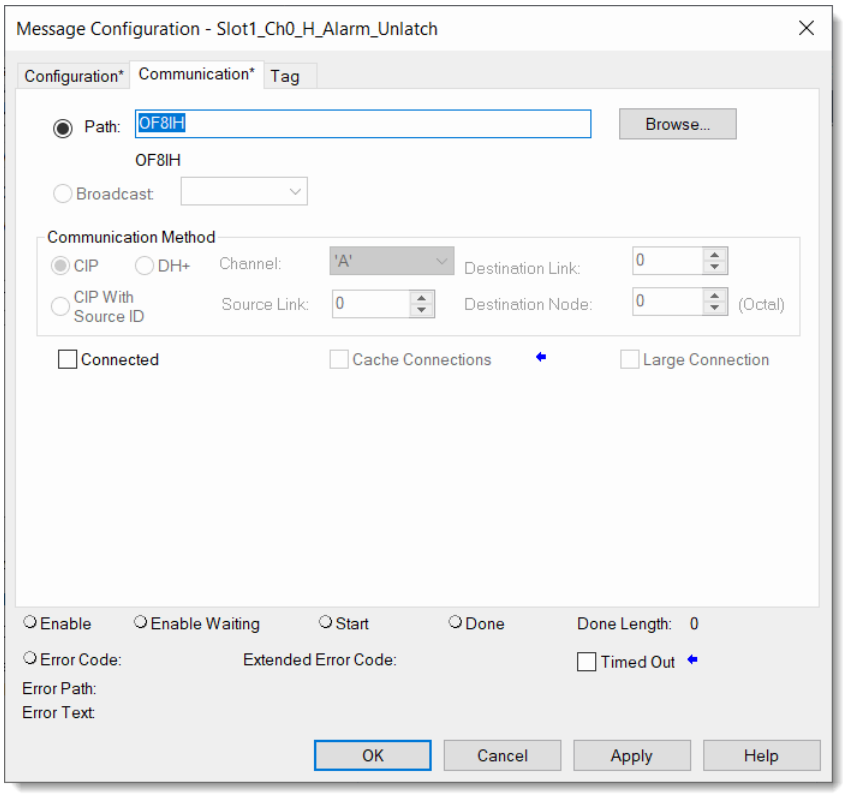
1. To see a list of the I/O modules in the system, select Browse.
2. Select a module from the list.

   The name that you provided for the I/O module during initial module configuration appears in the Path field.



3. Select OK.

   The module name appears in the Path field on the Communication tab of the Message Configuration dialog.



Unlatch Alarms in the 1756-IF8H or 1756-IF8IH Module

The ladder logic rungs 0...4 in this example show how to unlatch the High high, High, Low, Low low, and Rate alarms.

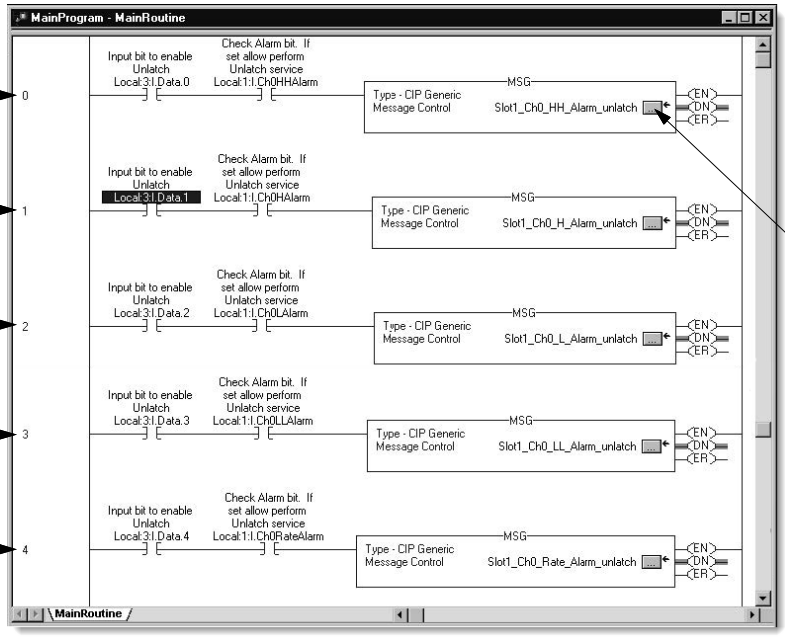
Rung 0 unlatches the high high alarm.

Rung 1 unlatches the high alarm.

Rung 2 unlatches the low alarm.

Rung 3 unlatches the low low alarm.

Rung 4 unlatches the rate alarm.



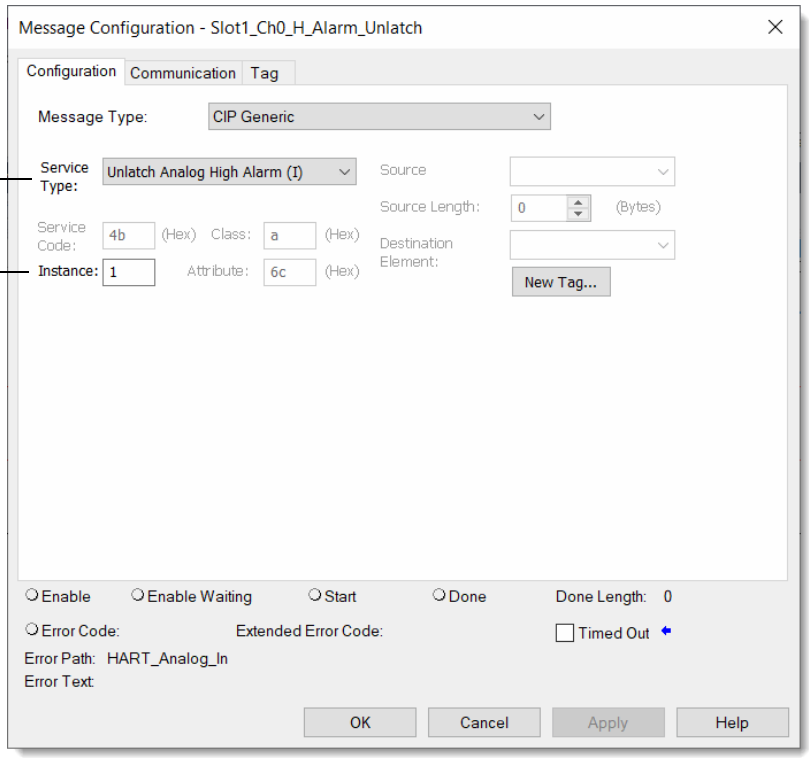
Select the box in each rung to see the configuration and communication information dialog that is associated with it.

IMPORTANT An I/O module must be configured to latch alarms, before you can perform unlatch services using ladder logic. If a module that is not configured to latch alarms receives an unlatch service, the message instruction errors.

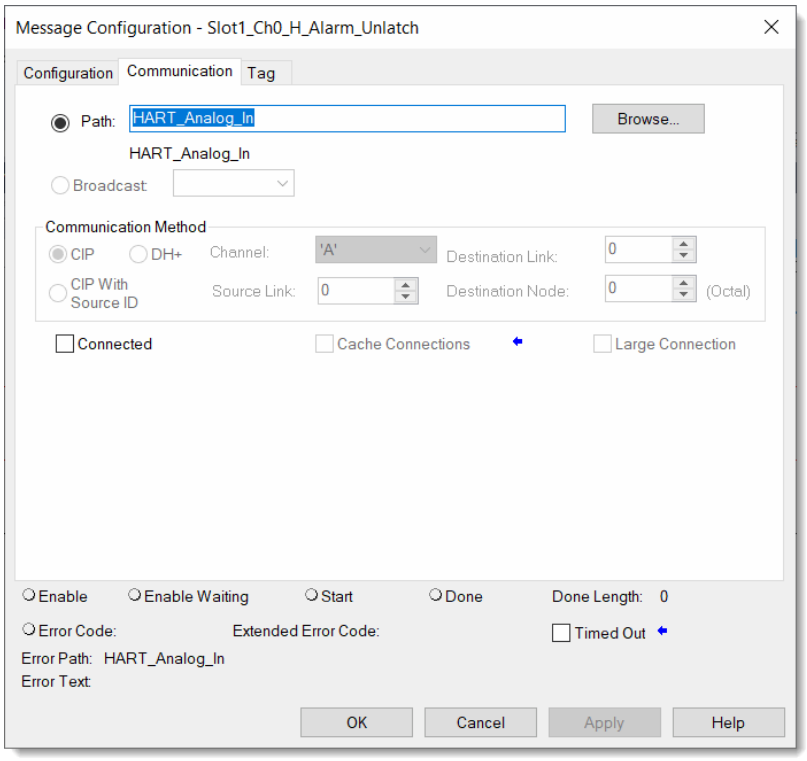
All alarms for channel 0 can be unlatched simultaneously with one message instruction by leaving the Attribute box blank.

Select a service type and configure the instance.

Instance 1 is for channel 0.



This example shows the communication path for Rung 0.



IMPORTANT An I/O module must be configured to latch alarms, before you can perform unlatch services using ladder logic. If a module that is not configured to latch alarms receives an unlatch service, the message instruction errors.

All alarms for channel 0 can be unlatched simultaneously with one message instruction by leaving the Attribute box blank.

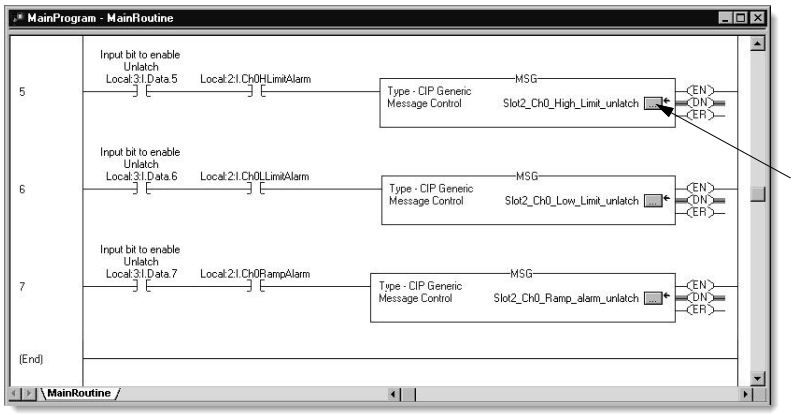
Unlatch Alarms in the 1756-OF8H or 1756-OF8IH Module

The ladder logic rungs 5...7 in this example show how to unlatch the high limit, low limit, and ramp alarms.

Rung 5 unlatches the high limit alarm.

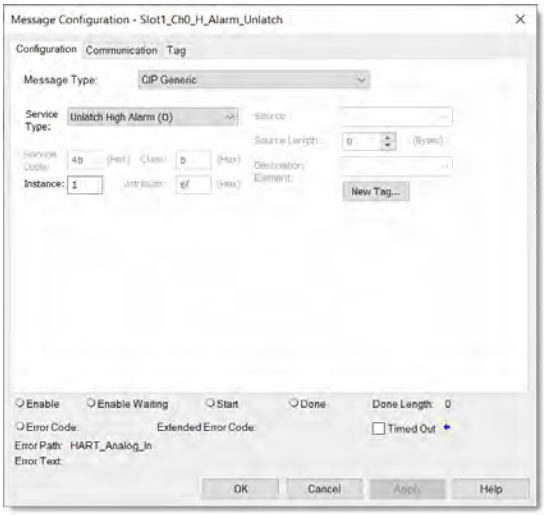
Rung 6 unlatches the low limit alarm.

Rung 7 unlatches the ramp alarm.

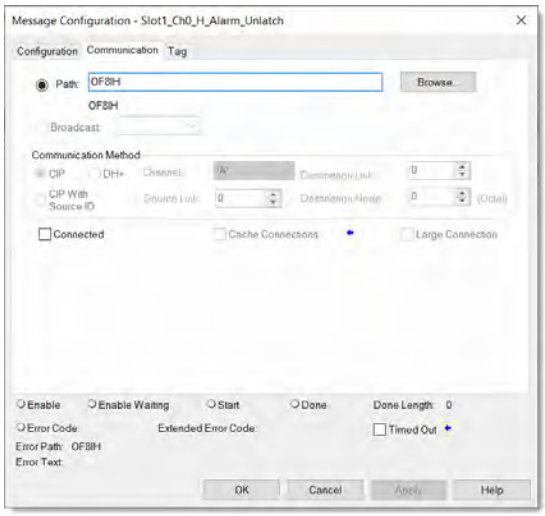


Select the box in each rung to see the configuration and communication information dialog that is associated with it.

From the Configuration dialog for Rung 5, you can select a service type and configure the instance.



This example shows the communication path for Rung 5.



IMPORTANT Name an I/O module to set the message path under the communication dialog for that module.

Reconfigure a Module

It's sometimes advantageous to change the functional operation of a module in the ControlLogix system automatically via ladder logic rather than using the Logix Designer application to reconfigure a module. This way, changes in the process can dictate when the reconfiguration takes place rather than performing that function manually.

IMPORTANT Limit reconfiguration of analog modules via ladder to functions that involve **the changing of values only**. We do not recommend the use of ladder logic to enable or disable features. Use the Logix Designer application to enable or disable these features.

Use the steps in this example when reconfiguring a module via ladder logic.

1. Move the new configuration parameters to the Configuration portion of the tag structure that is associated with the module.
2. Use a message instruction to send a Reconfigure Module service to the same module.

Before the new configuration parameters are sent to the module, make sure that their relationship to each other is in a format the module accepts.

These tables list module parameters that you can change via ladder logic:

Analog Input Module Parameters

Feature	Restriction
High engineering value	Must not be equal to low engineering value
Low engineering value	Must not be equal to high engineering value
High-High alarm value	Must be greater than or equal to high alarm value
High alarm value	Must be greater than low alarm value
Low alarm value	Must be less than high alarm value
Low-Low alarm value	Must be less than or equal to low alarm value
Deadband	Must be less than half of high alarm minus low alarm

Analog Output Module Parameters

Feature	Restriction
High clamp value(1)	Must be greater than low clamp value
Low clamp value(1)	Must be less than high clamp value

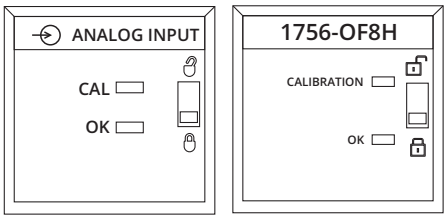
(1) The values for a user-defined state at Fault or Program (set during initial configuration) must fall within the range of the High and Low Clamp values.

Troubleshoot the Module

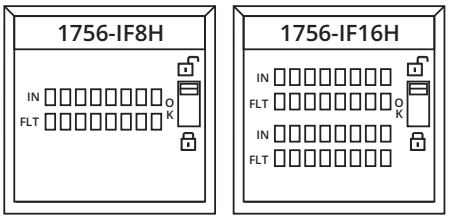
Use Module Indicators

HART analog I/O modules have indicators to show module status.

Modules with Status-Only Indication



Modules with Per-Channel Indication



Status Indicators for Modules with Per-Channel Indication

Indicator(s)	Status	Description
OK	Steady Green	The module is in a normal operating state with an active connection
OK	Flashing Green	The module passed internal diagnostics and does not yet have a connection or does have a connection and the controller is in Program mode
OK	Flashing Red	Previously established communication has timed out or a firmware update is in progress
OK	Steady Red	Module has encountered a major fault
IN	Steady Yellow	The channel is operating as expected
IN	Flashing Yellow	The channel is being calibrated
IN	OK Indicator is Steady Red and All Channels Flash Yellow 4 Times, Then Pause	Invalid serial number or hardware revision. Major nonrecoverable. Send the module in for repair
IN	Off	The channel isn't in use or is faulted
FLT	Off	The channel is operating as expected or it isn't in use
FLT	Steady Red	The channel is faulted. Possible causes of the fault include: • Underrange/overrange detection • CRC from ADC always Bad • Wire off detection
FLT	Flashing Red	The channel is faulted and is being calibrated

Status Indicators for Modules with Status-Only Indication

OK Status Indicator State	CAL or Calibration Status Indicator State	Module State	Notes
Steady Red	Steady Green	Power on/initialization	Initial state. Status indicator power-on test
Flashing Green	Off	Normal operation	The module has passed internal diagnostics, but isn't currently performing connected communication
Steady Green	Off	Normal operation	Normal run mode; inputs being multicast
Flashing Green (if not connected) Steady Green (if connected)	Flashing Green, fast with no pauses	Calibration	Calibration in progress
Flashing Red	Off	Lost connection	Communication between controller and module has been lost (timed out)
Flashing Red	Steady Green	Firmware update	Firmware update in progress
Steady Red	Off	Fault	Hardware fault; check to see if module must be replaced
Off	Off	Abnormal	Hardware fault
Orange	Off	Abnormal	Hardware fault
Steady Red	Flashing Green	Firmware update	Firmware Download in Process; wait for the download to complete
Steady Red	Flashing Green with pauses	Fault	See status indicator blink codes for modules with status-only indication(1)

(1) Under fault conditions, the module specifies the fault via the CAL or Calibration status indicator blink code.

Status Indicator Blink Codes for Modules with Status-Only Indication

If OK Is	and CAL or Calibration Status Indicator Flashes	Condition	Recommended Action
Steady Red	3 Blinks	ASIC EEPROM CRC isn't valid	Nonrecoverable - send the module in for repair
Steady Red	5 Blinks	Boot code section has failed the CRC check	Nonrecoverable - send the module in for repair
Steady Red	6 Blinks	Application code section has failed the CRC check	Try reprogramming the module firmware. If condition persists, send the module in for repair
Steady Red	9 Blinks	Stored calibration data is corrupt and can't be read No calibration is applied to input data	Major nonrecoverable - send the module in for repair
Steady Red	10 Blinks	Module firmware watchdog timer has timed out	Try resetting the module. If the condition persists, send the module in for repair
Steady Red	13 blinks	HART processor hardware fault. A communication error has occurred between the main CPU and HART CPU	Nonrecoverable - send the module in for repair
Steady Red	14 blinks	HART CPU firmware fault. The HART CPU detected a fault and communicated it to the main CPU	Nonrecoverable - send the module in for repair

To see fault status, select the Device Information view on the Module Properties tab of the Studio 5000 Logix Designer® application. A channel fault, such as wire off, is displayed as a 'Recoverable' minor fault.

General Troubleshooting Tips

When troubleshooting, consider these typical problems:

- Select the Enable HART option in the Logix Designer application if you want any HART communication access to the channel. This configuration is required for communication from asset management and pass-through messages.
- Select an Input Tag Data Format that includes HART if you want to use the secondary process variables and device health information in your controller or display it in the FactoryTalk® View software.
- On the 1756-IF8H module, put a jumper wire from IN0- to I-RTN-0 if you use 4...20 mA devices.
- On the 1756-IF8H 1756-IF16H, and 1756-IF16IH modules, do not tie RTN-X together if you're mixing 2-wire and 4-wire HART devices on the same module.
- Channel buttons in the Logix Designer application apply only to the currently displayed dialog.

- From the RSLinx® software, if you select RSWho and see 1756-Module, install the EDS file available from the Rockwell Automation Product Compatibility and Download Center at rok.auto/pcdc.
- In some versions of the Logix Designer application or RSLogix 5000® software, the profiles for the ControlLogix® HART analog I/O modules aren't included. Access the Rockwell Automation Product Compatibility and Download Center at rok.auto/pcdc and download the Add-on Profile (AOP).
- In RSLogix 5000 software, version 15 and later or the Logix Designer application, with an error about ControlNet® Attribute, use Scheduled Connections, or shutdown and restart the RSLogix 5000 software or the Logix Designer application.
- If you can't find HART data, look in the subfield Local:7:I.HART at the bottom of the tag or in chassis:7:I.Chxx.PV for data that are grouped by channel.

When troubleshooting, consider these more obscure problems.

- The same device appears to be connected to every channel because a wiring problem causes signals to get connected across channels. In some cases, loose IRET wires cause the path to ground to flow through other channels.
- If Keep HART Replies for XX seconds is set small – less than 5 seconds, the module throws away replies before you get a chance to retrieve them. This action affects both MSG pass-through messages and PC-based asset management, such as FieldCare software. We recommend 15 seconds for this parameter.
- Be sure that you have a HART device. Foundation Fieldbus, PROFIBUS PA, and plain 4...20 devices look the same on the outside and power up OK.
- Write protect jumper isn't reported correctly. This condition gets refreshed only if the device reports it changed. Endress+Hauser and Rosemount devices do not. Disable HART then re-enable HART to get it refreshed on the HART Device Info dialog.

For issues encountered while troubleshooting the pass-through message, use these tips:

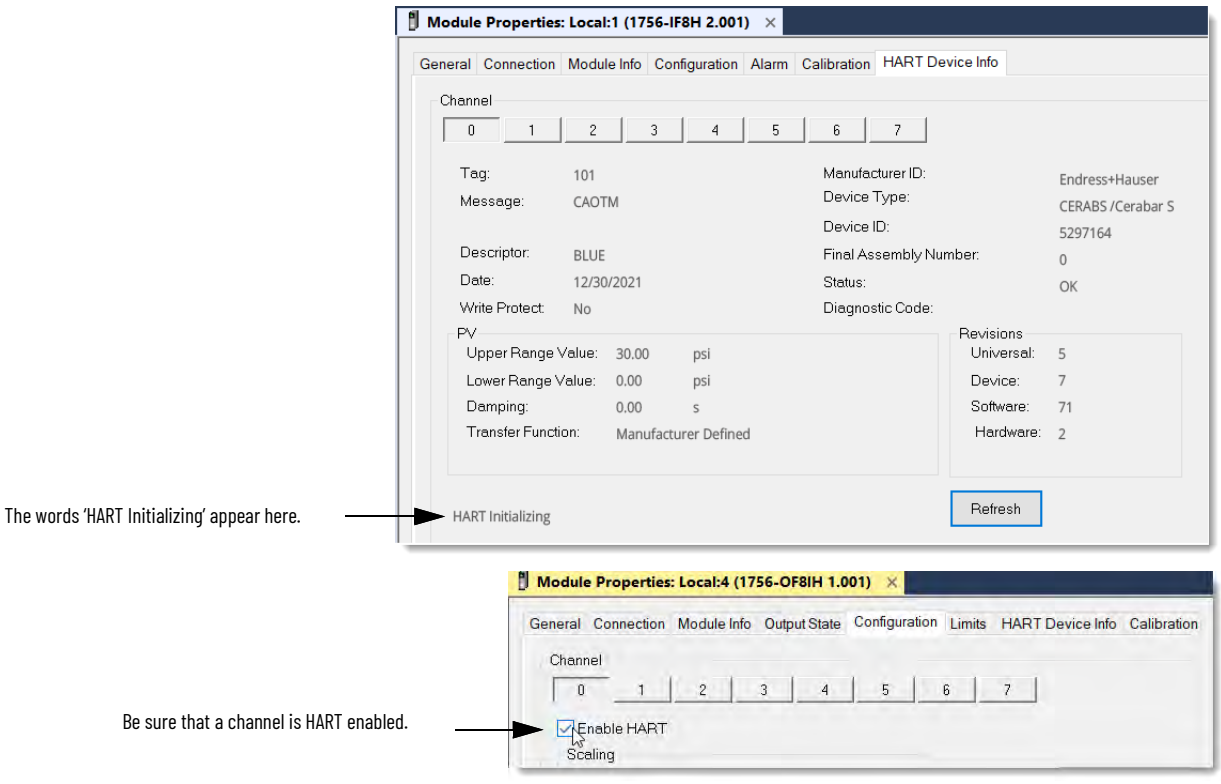
- Check module-specific online help.
- Copy the Handle to the Query.
- Check sizes of MSG and HART command.
- Check packing, alignment, and byte ordering.
- Use MsgReady.
- Name tags and UDTs similarly to group them together for convenience. For example, start the related tags with the same prefix.
- Check .ER and Status.

For input tag troubleshooting, use these tips:

- Local:7:I.Ch0Fault – if 1, suspect wiring/instrument problem.
- Local:7:I.Ch0HARTFault – if 1, check Local:7:C.HARTEn (Enable HART).
- Local:7:I.HART.Ch0DeviceStatus.Init – HART is enabled, but still trying to get a response from the device.
- Local:7:I.HART.Ch0DeviceStatus.Fail – HART is disabled, or not responding.
- Local:7:I.HART.Ch0DeviceStatus.CurrentFault – the measured mA current doesn't match what is reported via HART. A recent change in value can cause this condition. It's intended to indicate a current leak, such as water in the conduit.
- Local:7:I.HART.Ch0DeviceStatus.ResponseCode – if negative, there's a communication problem. If positive, the device is indicating some problem with the command. 16#40 means command not supported.
- Local:7:I.HART.Ch0DeviceStatus.FieldDeviceStatus – 0 is good; refer to Help or see the Response Codes and Field Device Status on page 204 for more information.
- Local:7:I.HART.Ch0PVStatus – 16#C0 is good. 0 is bad. This condition could indicate a communication problem or something wrong with the device. For example, with SVStatus, this condition could mean that the device does not support multiple measurements.

When working with the HART Device Info dialog for troubleshooting, use these tips:

- HART Initializing means that HART is enabled, but not communicating. If this condition persists for 10 seconds after you select Refresh several times, suspect a HART communication problem or no device.
- Be sure that a channel is HART Enabled in the Channel view.
- Be sure that values appear, meaning HART communication is okay.
- Check PV values Local:7:I:HART.Ch0PV or Local:12:I.Ch00.Data for numbers that are changing.
- Check analog values Local:7:I:Ch0Data or Local:12:I.Ch00.Data for numbers that are changing; for the 1756-OF8H module, check that is valid.
- You must have a Logix connection for asset management to deliver the configuration to the module. From the Module Properties dialog, select HART Device Info to see if it shows information.



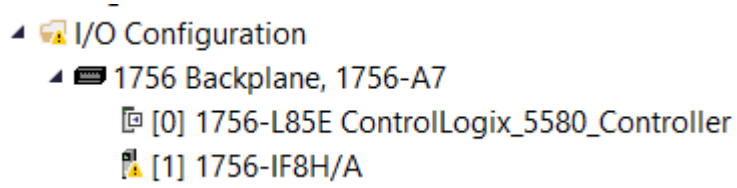
The words 'HART Initializing' appear here.

Be sure that a channel is HART enabled.

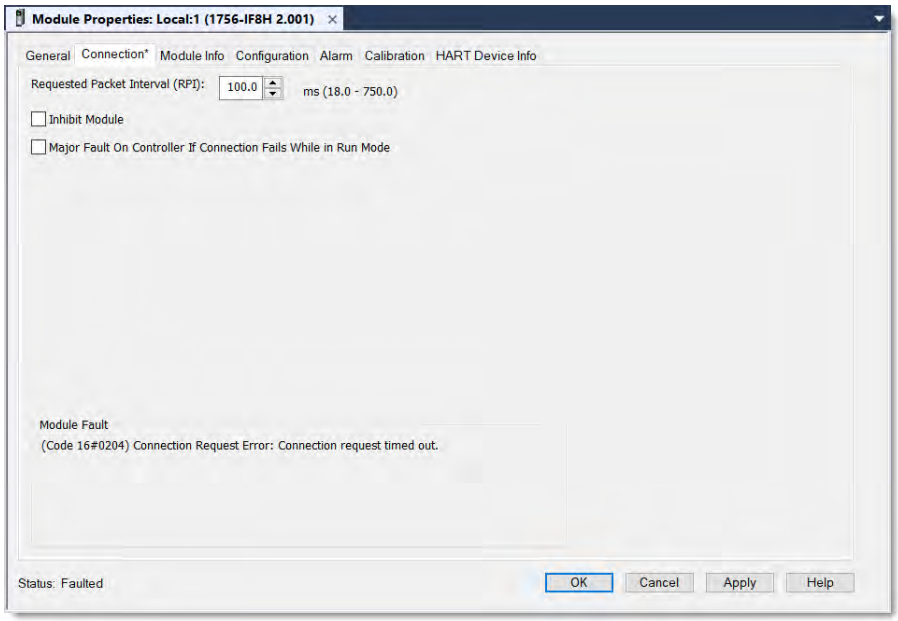
Use the Logix Designer Application to Troubleshoot a Module

In addition to the status displayed on the module, the Logix Designer application alerts you to fault conditions in one of these ways:

- Warning symbol in the I/O Configuration next to the module - This symbol appears when the connection to the module is broken



- Fault message in a status line
- Notification in the Tag Monitor
  - General module faults
  - Diagnostic faults
- Status on the Module Info Page



Module Configuration Errors

In the Logix Designer application, if "(Code 16#0009) Module Configuration Rejected: Parameter Error" is displayed in the Connection view of the Module Properties tab, the additional fault code value describes the configuration error.

Additional Fault Codes - Module Level

This table shows error codes that are used by ControlLogix HART Analog I/O modules for module level conditions. These are conditions that do not occur in a specific channel.

HART analog I/O Module Level Error Codes

Additional Fault Codes	Description
16#0001	Configuration revision number invalid Valid numbers are 0 or 1
16#0002	Filter value invalid
16#0003	RTS invalid
16#0004	Pass-through handle timeout
16#1001	Configuration does not match In a multiple owner setup, with the configuration revision number set to 1, the configurations must match

The 16# means that this number is Hex display style.

Additional Fault Codes - Channel Level

Each module has channel level error codes that are specific to the individual modules. These channel level error codes, which display in the Connection view of the Module Properties tab, are described in this section.

1756-IF8H, 1756-IF8IHChannel Level Error Codes
Channel *x* Extended Status = Channel 0 Error Value + (*x* *16)

	Channel								Channel Status
	0	1	2	3	4	5	6	7	
Additional Fault Codes	16#0005	16#0015	16#0025	16#0035	16#0045	16#0055	16#0065	16#0075	Process Alarm Latch Set and Disable All Alarms Set
	16#0006	16#0016	16#0026	16#0036	16#0046	16#0056	16#0066	16#0076	Rate Alarm Latch Set and Alarm Disable Set
	16#0007	16#0017	16#0027	16#0037	16#0047	16#0057	16#0067	16#0077	Invalid Input Range
	16#0008	16#0018	16#0028	16#0038	16#0048	16#0058	16#0068	16#0078	Invalid Digital Filter
	16#0009	16#0019	16#0029	16#0039	16#0049	16#0059	16#0069	16#0079	Invalid Rate Alarm
	16#000A	16#001A	16#002A	16#003A	16#004A	16#005A	16#006A	16#007A	High Signal and/or Low Signal outside of selected input range
	16#000B	16#001B	16#002B	16#003B	16#004B	16#005B	16#006B	16#007B	High Signal ≤ Low Signal
	16#000C	16#001C	16#002C	16#003C	16#004C	16#005C	16#006C	16#007C	Sensor Offset set to NaN
	16#000D	16#001D	16#002D	16#003D	16#004D	16#005D	16#006D	16#007D	High Engineering = Low Engineering
	16#000E	16#001E	16#002E	16#003E	16#004E	16#005E	16#006E	16#007E	Invalid HART rate, HART rate fixed at 1:1
	16#000F	16#001F	16#002F	16#003F	16#004F	16#005F	16#006F	16#007F	High Alarm < Low Alarm
	16#0010	16#0020	16#0030	16#0040	16#0050	16#0060	16#0070	16#0080	Low Low Alarm > Low
	16#0011	16#0021	16#0031	16#0041	16#0051	16#0061	16#0071	16#0081	High High alarm < High Alarm
	16#0012	16#0022	16#0032	16#0042	16#0052	16#0062	16#0072	16#0082	Invalid Alarm Deadband

1756-IF16H and 1756-IF16IH Modules Channel Level Error Codes
Channel *x* Extended Status = Channel 0 Error Value + (*x* *16)

	Channel								Channel Status
	0	1	2	3	4	5	6	7	
Extended Fault Codes	16#0007	16#0017	16#0027	16#0037	16#0047	16#0057	16#0067	16#0077	Invalid Input Range
	16#0008	16#0018	16#0028	16#0038	16#0048	16#0058	16#0068	16#0078	Invalid Digital Filter
	16#000A	16#001A	16#002A	16#003A	16#004A	16#005A	16#006A	16#007A	High Signal and/or Low Signal outside of selected input range
	16#000B	16#001B	16#002B	16#003B	16#004B	16#005B	16#006B	16#007B	High Signal ≤ Low Signal
	16#000C	16#001C	16#002C	16#003C	16#004C	16#005C	16#006C	16#007C	Sensor Offset set to NaN
	16#000D	16#001D	16#002D	16#003D	16#004D	16#005D	16#006D	16#007D	High Engineering = Low Engineering
	Channel (cont.)								
	8	9	10	11	12	13	14	15	
Extended Fault Codes	16#0087	16#0097	16#00A7	16#00B7	16#00C7	16#00D7	16#00E7	16#00F7	Invalid Input Range
	16#0088	16#0098	16#00A8	16#00B8	16#00C8	16#00D8	16#00E8	16#00F8	Invalid Digital Filter
	16#008A	16#009A	16#00AA	16#00BA	16#00CA	16#00DA	16#00EA	16#00FA	High Signal and/or Low Signal outside of selected input range
	16#008B	16#009B	16#00AB	16#00BB	16#00CB	16#00DB	16#00EB	16#00FB	High Signal ≤ Low Signal
	16#008C	16#009C	16#00AC	16#00BC	16#00CC	16#00DC	16#00EC	16#00FC	Sensor Offset set to NaN
	16#008D	16#009D	16#00AD	16#00BD	16#00CD	16#00DD	16#00ED	16#00FD	High Engineering = Low Engineering

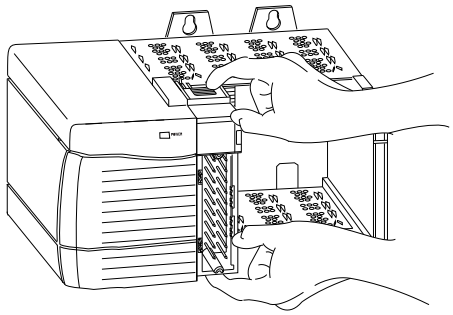
1756-OF8H and 1756-OF8IH Modules Channel Level Error Codes
Channel *x* Extended Status = Channel 0 Error Value + (*x* *22)

	Channel								Channel Status
	0	1	2	3	4	5	6	7	
Additional Fault Codes	16#0005	16#001B	16#0031	16#0047	16#005D	16#0073	16#0089	16#009F	Bad Ramp Latch
	16#0006	16#001C	16#0032	16#0048	16#005E	16#0074	16#008A	16#00A0	Bad Clamp Latch
	16#000A	16#0020	16#0036	16#004C	16#0062	16#0078	16#008E	16#00A4	Bad Ramp to Idle
	16#000B	16#0021	16#0037	16#004D	16#0063	16#0079	16#008F	16#00A5	Bad Ramp to Fault
	16#000C	16#0022	16#0038	16#004E	16#0064	16#007A	16#0090	16#00A6	Invalid Input Range
	16#000D	16#0023	16#0039	16#004F	16#0065	16#007B	16#0091	16#00A7	Bad Max Ramp
	16#000E	16#0024	16#003A	16#0050	16#0066	16#007C	16#0092	16#00A8	Bad Fault Value
	16#000F	16#0025	16#003B	16#0051	16#0067	16#007D	16#0093	16#00A9	Bad Idle Value
	16#0010	16#0026	16#003C	16#0052	16#0068	16#007E	16#0094	16#00AA	Signal Out of Range
	16#0011	16#0027	16#003D	16#0053	16#0069	16#007F	16#0095	16#00AB	Low Signal Greater or Equal to High Signal
	16#0012	16#0028	16#003E	16#0054	16#006A	16#0080	16#0096	16#00AC	Sensor Offset set to NaN
	16#0013	16#0029	16#003F	16#0055	16#006B	16#0081	16#0097	16#00AD	High Engineering Equal to Low Engineering
	16#0014	16#002A	16#0040	16#0056	16#006C	16#0082	16#0098	16#00AE	Invalid HART Rate
	16#0015	16#002B	16#0041	16#0057	16#006D	16#0083	16#0099	16#00AF	Bad Clamp

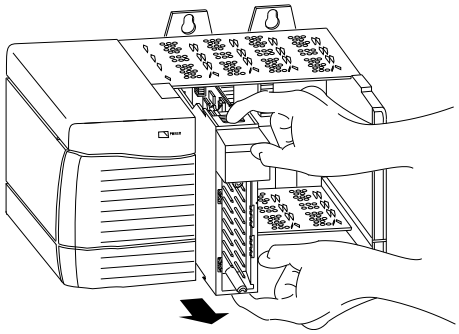
Remove the Module

Follow these steps to remove a module.

1. Push in the top and bottom locking tabs.



2. Pull the module out of the chassis.



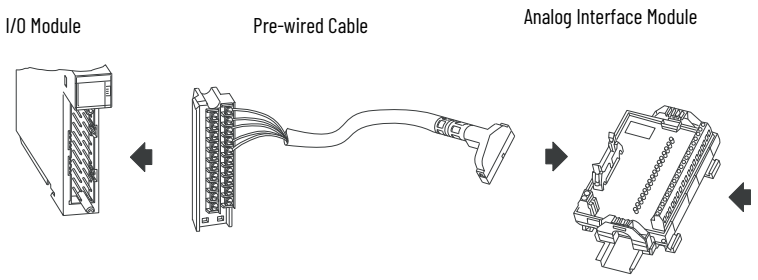
Use 1492 Wiring Systems with Your Analog I/O Module

Wiring System Uses

As an alternative to buying removable terminal blocks and connecting the wires yourself, you can buy a wiring system with these items:

- Analog interface modules (AIFM) that mount on DIN rails and provide the output terminal blocks for the I/O module - Use the AIFMs with the pre-wired cables that match the I/O module to the interface module. This section provides a list of the AIFMs available for use with ControlLogix® analog I/O modules.
- I/O module-ready pre-wired cables - One end of the cable assembly is a removable terminal base that plugs into the front of the I/O module. The other end has individually color-coded conductors that connect to a standard terminal block.

Analog Interface Modules



IMPORTANT The ControlLogix system has been agency certified using the ControlLogix removable terminal bases (RTBs) only (for example, catalog numbers 1756-TBCH, 1756-TBNH, 1756-TBSH, and 1756-TBS6H). Any application that requires agency certification of the ControlLogix system that uses other wiring termination methods can require application-specific approval by the certifying agency.

These tables list the AIFMs and pre-wired cables that can be used with the 1756-IF8H, 1756-IF16H, and 1756-OF8H modules.

IMPORTANT For the latest list, see the Digital/Analog Programmable Controller Wiring Systems Technical Data, publication 1492-TD008.

Analog Interface Module and Pre-wired Cables

I/O Cat. No.	Mode	AIFM Cat. No. (Fixed Terminal Block)	AIFM Cat. No. (RTB Socket Assembly)	AIFM Type	Description	Pre-wired Cable[2] (x=cable length)
1756-IF8H	Current	1492-AIFM8-3	1492-RAIFM8-3[1]	Feed-through	8-channel input or output with 3 terminals/channel	1492-ACABLExUD
		1492-AIFM8-F-5	–	Fused	8-channel input with 24V DC BF indicators and 5 terminals/channel	
	Voltage	1492-AIFM8-3	1492-RAIFM8-3[1]	Feed-through	8-channel input or output with 3 terminals/channel	1492-ACABLExUC
		1492-AIFM8-F-5	–	Fused	8-channel input with 24V DC BF indicators and 5 terminals/channel	
1756-IF16H	Single-ended Current	1492-AIFM16-F-3	–	Fused	16-channel input with 24V DC BF indicators and 3 terminals/channel	1492-ACABLExUB
1756-OF8H	Current	1492-AIFM8-3	1492-RAIFM-8-3[1]	Feed-through	8-channel input or output with 3 terminals/channel	1492-ACABLExWB
	Voltage					1492-ACABLExWA

(1) Compatible RTB plug; 1492-RTB8N (screw-style terminals) or 1492-RTB8P (push-in style terminals). Order plugs separately.
(2) Cables are available in lengths of 0.5 m (19.69 in.), 1.0 m (39.37 in.), 2.5 m (98.43 in.), and 5.0 m (196.85 in.). To order, insert the code for the desired cable length into the catalog number in place of the x: 005=0.5 m, 010=1.0 m, 025=2.5 m, 050=5 m. Example: 1492-ACABLE025TB is for a 2.5 m cable, and the letters TB.

I/O Module-ready Pre-wired Cables

Cat. No.[1]	Number of Conductors[2] [3]	Conductor Size	Nominal Outer Diameter	Removable Terminal Block at the I/O Module End
1492-ACABLExUB	20 conductors	22 AWG	8.4 mm (0.33 in.)	1756-TBCH
1492-ACABLExUC	9 twisted pairs		6.8 mm (0.27 in.)	
1492-ACABLExUD				
1492-ACABLExWA				1756-TBNH
1492-ACABLExWB				

(1) Cables are available in lengths of 0.5 m (19.69 in.), 1.0 m (39.37 in.), 2.5 m (98.43 in.), and 5.0 m (196.85 in.). To order, insert the code for the desired cable length into the catalog number in place of the x: 005=0.5 m, 010=1.0 m, 025=2.5 m, 050=5 m. Example: 1492-ACABLE025TB is for a 2.5 m cable, and the letters TB.
(2) Each cable for analog I/O has an overall shield with a ring lug on a 200 mm (8.87 in.) exposed drain wire at the I/O module end of the cable.
(3) Not every connection is always used.

Additional HART Protocol Information

This appendix describes the HART protocol and provides references for additional information about the protocol. Consult the HART protocol specification and vendor-provided documentation for specifics on HART commands.

This appendix provides the following:

- HART protocol background information
- Common practice command sets
- Extended command sets
- References to additional information

HART Field Communication Protocol is widely accepted in the industry as the standard for digitally enhanced 4...20mA communication with smart field instruments. The HART Protocol message structure, command set, and status are discussed in this appendix.

The HART command set is organized into these groups and provides read and write access to a wide array of information available in smart field instruments:

- Universal commands provide access to information that is useful in normal plant operation such as the instrument manufacturer, model, tag, serial number, descriptor, range limits, and process variables. All HART devices must implement universal commands.
- Common practice commands provide access to functions that many devices can perform.
- Device-specific commands provide access to functions that can be unique to a particular device.

Message Structure

Read this section for a description of the transaction procedure, character coding, and message structure of the HART protocol. These correspond to layer 2 (data link layer) of the OSI protocol reference model.

Master-slave Operation

HART is a master-slave protocol. This means that the master originates each message transaction; the slave (field) device replies when it receives a command message that is addressed to it. The reply from the slave device acknowledges that the command was received and can contain data that the master requested.

Multiple Master Operation

The HART protocol provides for two active masters in a system: one primary and one secondary. The two masters have different addresses. Each can positively identify replies to its own command messages. The 1756-IF8H, 1756-IF8IH, 1756-IF16H, 1756-IF16IH, 1756-OF8H, or 1756-OF8IH module acts as primary master. A secondary master, such as a handheld configuration device, can also be connected.

Transaction Procedure

HART is a half-duplex protocol. After completion of each message, the FSK carrier signal must be switched off to let the other station transmit. The carrier control timing rules state the following:

- Not to turn on the carrier more than 5 bit times before the start of the message (the preamble)
- Not to turn off more than 5 bit times after the end of the last byte of the message (the checksum)

The master is responsible for controlling message transactions. If there's no reply to a command within the expected time, the master retries the message. After a few retries, the master ends the transaction, because presumably the slave device or the communication link has failed.

After each transaction is completed, the master pauses for a short time before sending another command, to provide an opportunity for the other master to break in if it wishes. This way, the two masters (if they're present) take turns communicating with the slave devices. Typical message lengths and delays allow two transactions per second.

Burst Mode

The ControlLogix® HART analog modules do not support burst mode.

Response Code and Field Device Status

Two bytes of status that are also called the response code and field device status are included in every reply message from a field or slave device. These two bytes convey communication errors, command response problems, and field device status. If an error is detected in the outgoing communication, the most significant bit (bit 7) of the first byte is set to 1. The details of the error are also reported in the rest of that byte. The second byte is then all zeros.

Communication errors are typically errors that are detected by a UART (parity overrun and framing errors). The field device also reports overflow of its receive buffer and any discrepancy between the message content and the checksum received.

In the Studio 5000 Logix Designer® application, if the leftmost bit of the ResponseCode is set, it displays a negative number. In this case, the ResponseCode represents a communication fault. Change the display format to hexadecimal to interpret communication status.

If the leftmost bit of the ResponseCode is 0 (value 0...127), then there was no communication error and the value is a ResponseCode from the HART field device. Response codes indicate if the device performed the command. 0 means no error. Other values are errors or warnings. To understand the ResponseCode, contact your HART field device manufacturer or the HART specification.

Response Codes and Field Device Status

Response Code		Description	
If Bit 7 is	And Bits 6...0 are		
1	16#40	Parity Error	Vertical parity error - The parity of one or more of the bytes received by the device wasn't odd
1	16#20	Overrun Error	Overrun error - At least one byte of data in the receive buffer of the UART was overwritten before it was read (for example, the slave did not process an incoming byte fast enough)
1	16#10	Framing Error	Framing error - The UART did not detect the Stop Bit of one or more bytes received by the device (for example, a mark or 1 wasn't detected when a Stop Bit should have occurred)
1	16#08	Checksum Error	Longitudinal parity error - The Longitudinal Parity that was calculated by the device did not match the Check Byte at the end of the message
1	16#04	(Reserved)	Reserved - Set to zero
1	16#02	RX Buffer Overflow	Buffer overflow - The message was too long for the receive buffer of the device
1	16#01	(undefined)	Reserved - Set to zero
0	0	No command-specific error	

Response Codes and Field Device Status (Continued)

Response Code		Description
If Bit 7 is	And Bits 6...0 are	
0	1	(undefined)
0	3	Value too large
0	4	Value too small
0	5	Not enough bytes in command
0	6	Transmitter-specific command error
0	7	In Write-protect mode
0	8	Update Failed - Update In Progress - Set to Nearest Possible Value
0	9	Applied Process Too High - Lower Range Value Too High - Not In Fixed Current Mode
0	10	Applied Process Too Low - Lower Range Value Too Low - MultiDrop Not Supported
0	11	In MultiDrop Mode - Invalid Transmitter Variable Code - Upper Range Value Too High
0	12	Invalid Unit Code - Upper Range Value Too Low
0	13	Both Range Values Out of Limits
0	14	Pushed Upper Range Value Over Limit - Span Too Small
0	16	Access restricted
0	32	Device busy
0	64	Command not implemented

If no error was detected in the outgoing communication, the second byte contains status information that pertains to the operational state of the field or slave device.

Field Device Status Bit Mask Definitions

Bit	Bit Mask	Definition
7	16#80	Device malfunction - The device detected a serious error or failure that compromises device operation
6	16#40	Configuration changed - An operation was performed that changed the configuration of the device
5	16#20	Cold start - A power failure or device reset occurred
4	16#10	More status available - More status information is available via command 48, Read Additional Status Information
3	16#08	Loop current fixed - The loop current is being held at a fixed value and isn't responding to process variations
2	16#04	Loop current saturated - The loop current has reached its upper or lower endpoint limit and can't increase or decrease any further
1	16#02	Non-primary variable out of limits - A device variable that is not mapped to the PV is beyond its operating limits
0	16#01	Primary variable out of limits - The PV is beyond its operating limit

IMPORTANT The 16# means that this number is Hex display style.

HART Universal Commands

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP™ MSG
0	Read Unique Identified		None		0 1 2 3 4 5 6 7 8 9...11	254 (expansion) Manufacturer identification code Manufacturer device type code Number of preambles required Universal command revision Device-specific command revision Software version Hardware revision Device function flags[2] Device ID number	 (H) (B)		x x x x x x x x x x
1	Read primary variable				0 1...4	PV units code Primary variable	 (F)	 x	x x
2	Read current and percent of range		None		0...3 4...7	Current (mA) Primary variable %	(F) (F)	x x	x x

HART Universal Commands (Continued)

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP™ MSG
3	Read current and four (predefined) dynamic variables		None		0...3 4 5...8 9 10...13 14 15...18 19 20...23	Current (mA) PV units code Primary variable SV units code Secondary variable TV units code Third variable FV units code Fourth variable[3]		 x x x x	x x x x x x x x x
6	Write polling address	0	Polling address			As in command			
11	Read unique identifier associated with tag	0...5	Tag	(A)	0...11				
12	Read message		None		0...23	Message (32 characters)	(A)		x
13	Read tag, descriptor, date				0...5 6...17 18...20	Tag (8 characters) Descriptor (16 characters) Date	(A) (A) (D)		x x x
14	Read PV sensor information				0...2 3 4...7 8...11 12...15	Sensor serial number Units code for sensor limits and min span Upper sensor limit Lower sensor limit Min span	(B) (F) (F) (F)		
15	Read output information				0 1 2 3...6 7...10 11...14 15 16	Alarm select code Transfer function code PV/range units code Upper range value Lower range value Damping value (seconds) Write-protect code Private-label distributor code	 (F) (F) (F)		x x x x x x
16	Read final assembly number		None		0...2	Final assembly number	(B)		x
17	Write message	0...23	Message (32 characters)	(A)		As in command			
18	Write tag, descriptor, date	0...5 6...17 18...20	Tag (8 characters) Descriptor (16 characters) Date	(A) (A) (D)					
19	Write final assembly number	0...2	Final assembly number	(B)					
48	Read additional device status		Starting in HART version 7, the data in the command could be the same as in the reply.		0...5 6...7 8 9 10 11 12 13 14...24	Device-specific status Operational modes Standardized status 0 Standardized status 1 Analog channel saturated Standardized status 2 Standardized status 3 Analog channel fixed[4] Device-specific status	s[5]		x x x x x x x x x

(1) (A) = Packed ASCII, (B) = 3-byte integer, (D) = Date, (F) = Floating Point (HART format), (H) = HART flag
(2) Bit 6 = multisensor device. Bit 1 = EEPROM control required. Bit 2 = protocol bridge device.
(3) Truncated after last supported variable.
(4) 24 bits each LSB...MSB refers to AO #1...24.
(5) Sint [ ]

Common Practice Commands

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP MSG
33	Read transmitter variables		None		0 1 2...5 6 7 8...11 12 13 14...17 18 19 20...23	Transmitter variable code for slot 0 Units code for slot 0 Variable for slot 0 Transmitter variable code for slot 1 Units code for slot 1 Variable for slot 1 Transmitter variable code for slot 2 Units code for slot 2 Variable for slot 2 Transmitter variable code for slot 3 Units code for slot 3 Variable for slot 3[2]	 (F) (F) (F)		
34	Write damping value	0...3	Damping value (seconds)	(F)		As in command	(F)		
35	Write range values	0 1...4 5...8	Range units code Upper-range value Lower-range value	 (F) (F)			(F) (F)		
36	Set upper-range value (= push SPAN)		None			None			
37	Set lower-range value (= push ZERO)								
38	Reset 'configuration changed' flag								
39	EEPROM control	0	EEPROM control code[3]			As in command			
40	Enter/exit Fixed Current mode	0...3[4]	Current (mA)	(F)		As in command			
41	Perform device self-test		None			None			
42	Perform master reset								
43	Set (trim) PV zero								
44	Write PV units	0	PV units code			As in command			
45	Trim DAC zero	0...3	Measured current (mA)						
46	Trim DAC gain	0...3		(F)					
47	Write transfer function	0	Transfer function code						
48	Read additional device status		Moved to Universal Commands in HART version 7.			See 48 in Universal Commands			
49	Write PV sensor serial number	0...2	Sensor serial number			As in command			
50	Read dynamic variable assignments		None	0 1 2 3		PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			x x x x
51	Write dynamic variable assignments	0 1 2 3	PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			As in command			
52	Set transmitter variable zero	0	Transmitter variable code						
53	Write transmitter variable units		Transmitter variable code						

Common Practice Commands (Continued)

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP MSG
54	Read transmitter variable information		Transmitter variable code		0 1...3 4 5...8 9...12 13...16	Transmitter variable code Transmitter variable sensor serial Transmitter variable limits units code Transmitter variable upper limit Transmitter variable lower limit Transmitter variable damping value (seconds)	 (F) (F) (F)		
55	Write transmitter variable damping value	0 1...4	Transmitter variable code Transmitter variable damping value (seconds)			As in command			
56	Write transmitter variable sensor serial number	0 1...3	Transmitter variable code Transmitter variable sensor			As in command			
57	Read unit tag, description, date		None		0...5 6...17 18...20		(A) (A) (D)		x x x x
58	Write unit tag, descriptor, date	0...5 6...17 18...20	Unit tag (8 characters) Unit descriptor (16 characters) Unit date	(A) (A) (D)					
59	Write number of response preambles	0	Number of response preambles						
60	Read analog output and percent of range	0	Analog output number code		0 1 2...5 6...9	Analog output number code Analog output units code Analog output level Analog output percent of range			
61	Read dynamic variables and PV analog output		None		0 1...4 5 6...9 10 11...14 15 16...19 20 21...24	PV analog output units code PV analog output level PV units code Primary variable SV units code Secondary variable TV units Tertiary variable FV units code Fourth variable	 (F) (F) (F) (F) (F)	 x x x x	 x x x x x x x x
62	Read analog outputs	0 1 2 3[5]	Analog output number; code for slot 0 Analog output number; code for slot 1 Analog output number; code for slot 2 Analog output number; code for slot 3[6]	0 1 2...5 6 7 8...11 12 13 14...17 18 19 20...23		Slot 0 analog output number code Slot 0 Slot 0 level Slot 1 Slot 1 Slot 1 level Slot 2 Slot 2 Slot 2 level Slot 3 Slot 3 Slot 3 level[7]	 (F) (F) (F) (F)		
63	Read analog output information	0	Analog output number code		0 1 2 3 4...7 8...11 12...15	Analog output number code Analog output alarm select code Analog output transfer function code Analog output range units code Analog output upper-range value Analog output lower-range value Analog output additional damping value (seconds)	 (F) (F) (F)		

Common Practice Commands (Continued)

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP MSG
64	Write analog output additional damping value	0 1...4	Analog output number code Analog output additional damping value (seconds)	 (F)					
65	Write analog output range value	0 1 2...5 6...9	Analog output number code Analog output range units code Analog output upper-range value Analog output lower-range value	 (F) (F)					
66	Enter/exit Fixed Analog Output mode	0 1 2...6	Analog output number code Analog output units code Analog output level[8]	 (F)					
67	Trim analog output zero	0 1 2...6	Analog output number code Analog output units code Externally measured analog output level	 (F)					
68	Trim analog output gain	0 1 2...6	Analog output number code Analog output units code Externally measured analog output level	 (F)					
69	Write analog output transfer function	0 1	Analog output number code Analog output transfer function code						
70	Read analog output endpoint values	0	Analog output number code		0 1 2...5 6...9	Analog output number code Analog output endpoint units code Analog output upper endpoint value Analog output lower endpoint value			
107	Write Burst mode transmitter variables (for command 33)	0 1 2 3	Transmitter variable code for slot 0 Transmitter variable code for slot 1 Transmitter variable code for slot 2 Transmitter variable code for slot 3			As in command			
108	Write Burst mode command number	0	Burst mode command number			As in command			
109	Burst mode control	0	Burst mode control code (0 = exit, 1 = enter)						
110	Read all dynamic variables		None		0 1...4 5 6...9 10 11...14 15 16...19	PV units code PV value SV units code SV value TV units code TV value FV units code FV value	 (F) (F) (F) (F)	 x x x x	x x x x x x x x

(1) (A) = Packed ASCII, (B) = 3-byte integer, (D) = Date, (F) = Floating Point (HART format), (H) = HART flag
(2) Truncated after last requested code. Truncated after last requested variable.
(3) 0 = burn EEPROM, 1 = copy EEPROM to RAM.
(4) 0 = exit Fixed Current mode.
(5) Truncated after last requested code.
(6) Truncated after last requested code.
(7) Truncated after last requested level.
(8) Not a number exits Fixed-output mode.

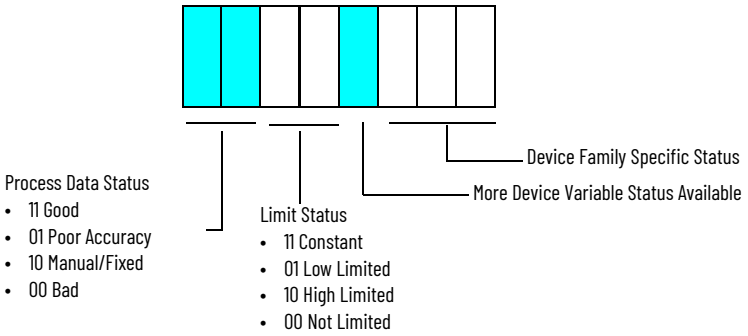
HART PV, SV, TV, and FV Status

HART PV, SV, TV, and FV are dynamic variables that contain the values of device variables, which are various direct or indirect process measurements that are performed by the HART field device.

Some devices let a set of their internal device variables be mapped to the PV, SV, TV, FV dynamic variables that are automatically collected in the 1756-IF8H Input Tag.

This mapping is part of the field device configuration, performed via a handheld configurator or asset management system, such as FactoryTalk® AssetCentre or Endress+Hauser FieldCare system.

HART PVStatus, SVStatus, TVStatus, FVStatus are known as Device Variable Status values. These Status values are composed of groups of bits that indicate the quality of the associated device variable.



The Limit Status can be used to control windup in PID loops.

HART PV, SV, TV, and FV Status Values

HART PV, SV, TV FV Status Values			Quality		Limit		More Status Available?		Device Family Specific	
Decimal	Hex	Binary							Binary	Decimal
0	0	00000000	00	Bad	00	Not Limited	0	No	000	0
1	1	00000001	00	Bad	00	Not Limited	0	No	001	1
2	2	00000010	00	Bad	00	Not Limited	0	No	010	2
3	3	00000011	00	Bad	00	Not Limited	0	No	011	3
4	4	00000100	00	Bad	00	Not Limited	0	No	100	4
5	5	00000101	00	Bad	00	Not Limited	0	No	101	5
6	6	00000110	00	Bad	00	Not Limited	0	No	110	6
7	7	00000111	00	Bad	00	Not Limited	0	No	111	7
8	8	00001000	00	Bad	00	Not Limited	1	Yes	000	0
9	9	00001001	00	Bad	00	Not Limited	1	Yes	001	1
10	A	00001010	00	Bad	00	Not Limited	1	Yes	010	2
11	B	00001011	00	Bad	00	Not Limited	1	Yes	011	3
12	C	00001100	00	Bad	00	Not Limited	1	Yes	100	4
13	D	00001101	00	Bad	00	Not Limited	1	Yes	101	5
14	E	00001110	00	Bad	00	Not Limited	1	Yes	110	6
15	F	00001111	00	Bad	00	Not Limited	1	Yes	111	7
16	10	00010000	00	Bad	01	Low Limited	0	No	000	0
17	11	00010001	00	Bad	01	Low Limited	0	No	001	1
18	12	00010010	00	Bad	01	Low Limited	0	No	010	2

HART PV, SV, TV, and FV Status Values (Continued)

HART PV, SV, TV FV Status Values			Quality		Limit		More Status Available?		Device Family Specific	
Decimal	Hex	Binary							Binary	Decimal
19	13	00010011	00	Bad	01	Low Limited	0	No	011	3
20	14	00010100	00	Bad	01	Low Limited	0	No	100	4
21	15	00010101	00	Bad	01	Low Limited	0	No	101	5
22	16	00010110	00	Bad	01	Low Limited	0	No	110	6
23	17	00010111	00	Bad	01	Low Limited	0	No	111	7
24	18	00011000	00	Bad	01	Low Limited	1	Yes	000	0
25	19	00011001	00	Bad	01	Low Limited	1	Yes	001	1
26	1A	00011010	00	Bad	01	Low Limited	1	Yes	010	2
27	1B	00011011	00	Bad	01	Low Limited	1	Yes	011	3
28	1C	00011100	00	Bad	01	Low Limited	1	Yes	100	4
29	1D	00011101	00	Bad	01	Low Limited	1	Yes	101	5
30	1E	00011110	00	Bad	01	Low Limited	1	Yes	110	6
31	1F	00011111	00	Bad	01	Low Limited	1	Yes	111	7
32	20	00100000	00	Bad	10	High Limited	0	No	000	0
33	21	00100001	00	Bad	10	High Limited	0	No	001	1
34	22	00100010	00	Bad	10	High Limited	0	No	010	2
35	23	00100011	00	Bad	10	High Limited	0	No	011	3
36	24	00100100	00	Bad	10	High Limited	0	No	100	4
37	25	00100101	00	Bad	10	High Limited	0	No	101	5
38	26	00100110	00	Bad	10	High Limited	0	No	110	6
39	27	00100111	00	Bad	10	High Limited	0	No	111	7
40	28	00101000	00	Bad	10	High Limited	1	Yes	000	0
41	29	00101001	00	Bad	10	High Limited	1	Yes	001	1
42	2A	00101010	00	Bad	10	High Limited	1	Yes	010	2
43	2B	00101011	00	Bad	10	High Limited	1	Yes	011	3
44	2C	00101100	00	Bad	10	High Limited	1	Yes	100	4
45	2D	00101101	00	Bad	10	High Limited	1	Yes	101	5

This Device Variable Status byte is a new HART feature in HART protocol revision 6 and many HART devices do not yet support it. For those devices, the module creates a status value that is based on the communication status of the device.

If the PV, SV, TV, FV are being collected without communication errors, the value is set to 16#C0, which indicates Good, Not Limited. Otherwise, the value is set to 0, which indicates Bad, Not Limited, no specific information available.

Notes:

Manufacturer Identification Codes

This appendix identifies the manufacturer with their assigned code.

Decimal	Hex	Company Name
1	01	Acromag
2	02	Allen-Bradley
3	03	Ametek
4	04	Analog Devices
5	05	ABB
6	06	Beckman
7	07	Bell Microsenser
8	08	Bourns
9	09	Bristol Babcock
10	0A	Brooks Instrument
11	0B	Chessell
12	0C	Combustion Engineering
13	0D	Daniel Industries
14	0E	Delta
15	0F	Dieterich Standard
16	10	Dohrmann
17	11	Endress+Hauser
18	12	ABB
19	13	Fisher Controls
20	14	Foxboro
21	15	Fuji
22	16	ABB
23	17	Honeywell
24	18	ITT Barton
25	19	Thermo MeasureTech
26	1A	ABB
27	1B	Leeds & Northup
28	1C	Leslie
29	1D	M-System Co.
30	1E	Measurex
31	1F	Micro Motion
32	20	Moore Industries
33	21	PRIME Measurement Products
34	22	Ohkura Electric
35	23	Paine
36	24	Rochester Instrument Systems
37	25	Ronan
38	26	Rosemount
39	27	Peek Measurement
40	28	Actaris Neptune

Decimal	Hex	Company Name
41	29	Sensall
42	2A	Siemens
43	2B	Weed
44	2C	Toshiba
45	2D	Transmation
46	2E	Rosemount Analytic
47	2F	Metso Automation
48	30	Flowserve
49	31	Varec
50	32	Viatran
51	33	Delta/Weed
52	34	Westinghouse
53	35	Xomox
54	36	Yamatake
55	37	Yokogawa
56	38	Nuovo Pignone
57	39	Promac
58	3A	Exac Corporation
59	3B	Mobrey
60	3C	Arcom Control System
61	3D	Princo
62	3E	Smar
63	3F	Foxboro Eckardt
64	40	Measurement Technology
65	41	Applied System Technologies
66	42	Samson
67	43	Sparling Instruments
68	44	Fireye
69	45	Krohne
70	46	Betz
71	47	Druck
72	48	SOR
73	49	Elcon Instruments
74	4A	EMCO
75	4B	Termiflex Corporation
76	4C	VAF Instruments
77	4D	Westlock Controls
78	4E	Drexelbrook
79	4F	Saab Tank Control
80	50	K-TEK
81	51	SENSIDYNE, INC
82	52	Draeger
83	53	Raytek
84	54	Siemens Milltronics PI
85	55	BTG
86	56	Magnetrol
87	58	Metso Automation
88	59	Siemens Milltronics PI
89	59	HELIOS
90	5A	Anderson Instrument Company
91	5B	INOR
92	5C	ROBERTSHAW
93	5D	PEPPERL+FUCHS

Decimal	Hex	Company Name
94	5E	ACCUTECH
95	5F	Flow Measurement
96	60	Courdon-Haenni
97	61	Knick
98	62	VEGA
99	63	MTS Systems Corp.
100	64	Oval
101	65	Masoneilan-Dresser
102	66	BESTA
103	67	Ohmart
104	68	Harold Beck and Sons
105	69	rittmeyer instrumentation
106	6A	Rossel Messtechnik
107	6B	WIKA
108	6C	Bopp & Reuther Heinrichs
109	6D	PR Electronics
110	6E	Jordan Controls
111	6F	Valcom s.r.l.
112	70	US ELECTRIC MOTORS
113	71	Apparatebau Hundsbach
114	72	Dynisco
115	73	Spriano
116	74	Direct Measurement
117	75	Klay Instruments
118	76	CiDRA CORP.
119	77	MMG AM DTR
120	78	Buerkert Fluid Control Systems
121	79	AALIANT Process Mgt
122	7A	PONDUS INSTRUMENTS
123	7B	ZAP S.A. Ostrow Wielkopolski
124	7C	GLI
125	7D	Fisher-Rosemount Performance Technologies
126	7E	Paper Machine Components
127	7F	LABOM
128	80	Danfoss
129	81	Turbo
130	82	TOKYO KEISO
131	83	SMC
132	84	Status Instruments
133	85	Huakong
134	86	Duon System
135	87	Vortek Instruments, LLC
136	88	AG Crosby
137	89	Action Instruments
138	8A	Keystone Controls
139	8B	Thermo Electronic Co.
140	8C	ISE Magtech
141	8D	Rueger
142	8E	Mettler Toledo
143	8F	Det-Tronics
144	90	Thermo MeasureTech
145	91	DeZURIK
146	92	Phase Dynamics

Decimal	Hex	Company Name
147	93	WELLTECH SHANGHAI
148	94	ENRAF
149	95	4tech ASA
150	96	Brandt Instruments
151	97	Nivelco
152	98	Camille Bauer
153	99	Metran
154	9A	Milton Roy Co.
155	9B	PMV
156	9C	Turck
157	9D	Panametrics
158	9E	R. Stahl
159	9F	Analytical Technologies Inc.
160	A0	FINT
161	A1	BERTHOLD
162	A2	InterCorr
163	A3	China BRICONTE Co Ltd
164	A4	Electron Machine
165	A5	Sierra Instruments
166	A6	Fluid Components Intl
167	A7	Solid AT
168	A8	Meriam Instrument
169	A9	Invensys
170	AA	S-Products
171	AB	Tyco Valves & Controls
172	AC	Micro Matic Instrument A/S
173	AD	J-Tec Associates
174	AE	TRACERCO
175	AF	AGAR
176	B0	Phoenix Contact
177	B1	Andean Instruments
178	B2	American Level Instrument
179	B3	Hawk
180	B4	YTC
181	B5	Pyromation Inc.
182	B6	Satron Instruments
183	B7	BIFFI
184	B8	SAIC
185	B9	BD Sensors
186	BA	Andean Instruments
187	BB	Kemotron
188	BC	APLISENS
189	BD	Badger Meter
190	BE	HIMA
191	BF	GP:50
192	C0	Kongsberg Maritime
193	C1	ASA S.p.A.
194	C2	Hengesbach
195	C3	Lanlian Instruments
196	C4	Spectrum Controls
197	C5	Kajaani Process Measurements
198	C6	FAFNIR
199	C7	SICK-MAIHAK

Decimal	Hex	Company Name
200	C8	JSP Nova Paka
201	C9	MESACON
202	CA	Spirax Sarco Italy
203	CB	L&J TECHNOLOGIES
204	CC	Tecfluid S.A.
205	CD	Sailsors Instruments
206	CE	Roost
207	CF	KOSO
208	D0	MJK
209	D1	GE Energy
210	D2	BW Technologies
211	D3	HEINRICHS
212	D4	SIC
213	D5	HACH LANGE
214	D6	Exalon Instruments
215	D7	FAURE HERMAN
216	D8	STI S.r.l.
217	D9	Manometr-Kharkiv
218	DA	Dalian-Instruments
219	DB	Spextrex
220	DC	SIPAI Instruments
221	DD	Advanced Flow
222	DE	Rexa. Koso America
223	DF	General Monitors, Inc.
224	E0	Manufacturer Expansion
249	F9	HART Communication Foundation
24576	6000	ExSaf
24577	6001	SEOJIN INSTECH
24578	6002	TASI FLOW
24579	6003	Daihan Control
24580	6004	APM
24581	6005	ORANGE INSTRUMENTS. UK
24582	6006	BARTEC
24583	6007	Detcon
24584	6008	MSA
24585	6009	METROVAL
24586	600A	Etalon Rus
24587	600B	JOGLER
24588	600C	KSB
24589	600D	Richter CT
24590	600E	NET SAFETY
24591	600F	SECanada
24592	6010	SUPCON
24593	6011	DKK - TOA
24594	6012	Dwyer Instruments
24595	6013	FineTek
24596	6014	Top Worx Inc.
24597	6015	Hoffer Flow Controls
24598	6016	Dust Networks
24599	6017	Forbes Marshall
24600	6018	All Measures, Ltd.
24601	6019	MACTek
24602	601A	CSI

Decimal	Hex	Company Name
24603	601B	TC Fluid Control
24604	601C	Rohrback Cosasco
24605	601D	AirSprite
24606	601E	Microcyber Inc.
24607	601F	TIG
24608	6020	ifm prover Gmbh
24609	6021	FLEXIM
24610	6022	TOKIMEC.INC
24611	6023	SBEM
24612	6023	SkoFlo Industries, Inc.
24613	6024	StoneL Corporation
24614	6026	EUREKA FLOW
24615	6027	BEKA associates
24616	6028	Capstar Automation
24617	6029	Pulsar
24618	602A	Elemer
24619	602B	Soft Tech Group

Engineering Unit Code Numbers

Code Number Details

This table maps engineering unit code numbers to their meaning and abbreviations. These codes are used in the process variable range display.

Unit Codes	Description from HART Specification	Abbreviated Units
1	inches of water at 20 °C (68 °F)	inH2O (20 °C or 68 °F)
2	inches of mercury at 0 °C (32 °F)	inHg (0 °C or 32 °F)
3	feet of water at 20 °C (68 °F)	ftH2O (20 °C or 68 °F)
4	millimeters of water at 20 °C (68 °F)	mmH2O (20 °C or 68 °F)
5	millimeters of mercury at 0 °C (32 °F)	mmHg (0 °C or 32 °F)
6	pounds per square inch	psi
7	bars	bar
8	millibars	mbar
9	grams per square centimeter	g/square cm
10	kilograms per square centimeter	kg/square cm
11	pascals	Pa
12	kilopascals	kPa
13	torr	torr
14	atmospheres	atm
15	cubic feet per minute	cubic ft/min
16	gallons per minute	usg/min
17	liters per minute	L/min
18	imperial gallons per minute	impgal/min
19	cubic meter per hour	cubic m/h
20	feet per second	ft/s
21	meters per second	m/s
22	gallons per second	usg/s
23	million gallons per day	million usg/d
24	liters per second	L/s
25	million liters per day	ML/day
26	cubic feet per second	cubic ft/s
27	cubic feet per day	cubic ft/d
28	cubic meters per second	cubic m/s
29	cubic meters per day	cubic m/d
30	imperial gallons per hour	impgal/h
31	imperial gallons per day	impgal/d
32	Degrees Celsius	°C
33	Degrees Fahrenheit	°F
34	Degrees Rankine	°R
35	Kelvin	°K
36	millivolts	mV
37	ohms	ohm
38	hertz	hz
39	milliamperes	mA

Unit Codes	Description from HART Specification	Abbreviated Units
40	gallons	usg
41	liters	L
42	imperial gallons	impgal
43	cubic meters	cubic m
44	feet	ft
45	meters	m
46	barrels	bbl
47	inches	in
48	centimeters	cm
49	millimeters	mm
50	minutes	min
51	seconds	s
52	hours	h
53	days	d
54	centistokes	centistokes
55	centipoise	cP
56	microsiemens	microsiemens
57	percent	%
58	volts	V
59	pH	pH
60	grams	g
61	kilograms	kg
62	metric tons	t
63	pounds	lb
64	short tons	short ton
65	long tons	long ton
66	milli siemens per centimeter	millisiemens/cm
67	micro siemens per centimeter	microsiemens/cm
68	newton	N
69	newton meter	N m
70	grams per second	g/s
71	grams per minute	g/min
72	grams per hour	g/h
73	kilograms per second	kg/s
74	kilograms per minute	kg/min
75	kilograms per hour	kg/h
76	kilograms per day	kg/d
77	metric tons per minute	t/min
78	metric tons per hour	t/h
79	metric tons per day	t/d
80	pounds per second	lb/s
81	pounds per minute	lb/min
82	pounds per hour	lb/h
83	pounds per day	lb/d
84	short tons per minute	short ton/min
85	short tons per hour	short ton/h
86	short tons per day	short ton/d
87	long tons per hour	long ton/h
88	long tons per day	long ton/d
89	deka therm	Dth
90	specific gravity units	specific gravity units
91	grams per cubic centimeter	g/cubic cm
92	kilograms per cubic meter	kg/cubic m

Unit Codes	Description from HART Specification	Abbreviated Units
93	pounds per gallon	lb/usg
94	pounds per cubic feet	lb/cubic ft
95	grams per milliliter	g/mL
96	kilograms per liter	kg/L
97	grams per liter	g/L
98	pounds per cubic inch	lb/cubic in
99	short tons per cubic yard	short ton/cubic yd
100	degrees twaddell	°Tw
101	degrees brix	°Bx
102	degrees baume heavy	BH
103	degrees baume light	BL
104	degrees API	°API
105	percent solids per weight	% solid/weight
106	percent solids per volume	% solid/volume
107	degrees balling	degrees balling
108	proof per volume	proof/volume
109	proof per mass	proof/mass
110	bushels	bushel
111	cubic yards	cubic yd
112	cubic feet	cubic ft
113	cubic inches	cubic in
114	inches per second	in/s
115	inches per minute	in/min
116	feet per minute	ft/min
117	degrees per second	°/s
118	revolutions per second	rev/s
119	revolutions per minute	rpm
120	meters per hour	m/hr
121	normal cubic meter per hour	normal cubic m/h
122	normal liter per hour	normal L/h
123	standard cubic feet per minute	standard cubic ft/min
124	bbl liq	bbl liq
125	ounce	oz
126	foot pound force	ft lb force
127	kilo watt	kW
128	kilo watt hour	kW h
129	horsepower	hp
130	cubic feet per hour	cubic ft/h
131	cubic meters per minute	cubic m/min
132	barrels per second	bbl/s
133	barrels per minute	bbl/min
134	barrels per hour	bbl/h
135	barrels per day	bbl/d
136	gallons per hour	usg/h
137	imperial gallons per second	impgal/s
138	liters per hour	L/h
139	parts per million	ppm
140	mega calorie per hour	Mcal/h
141	mega joule per hour	MJ/h
142	british thermal unit per hour	BTU/h
143	degrees	degrees
144	radian	rad
145	inches of water at 15.6 °C (60 °F)	inH20 (15.6 °C or 60 °F)

Unit Codes	Description from HART Specification	Abbreviated Units
146	micrograms per liter	micrograms/L
147	micrograms per cubic meter	micrograms/cubic m
148	percent consistency	% consistency
149	volume percent	volume %
150	percent steam quality	% steam quality
151	feet in sixteenths	ft in sixteenths
152	cubic feet per pound	cubic ft/lb
153	picofarads	pF
154	milliliters per liter	mL/L
155	microliters per liter	microliters/L
156	percent plato	% plato
157	percent lower explosion level	% lower explosion level
158	mega calorie	Mcal
159	Kohms	kohm
160	mega joule	MJ
161	british thermal unit	BTU
162	normal cubic meter	normal cubic m
163	normal liter	normal L
164	standard cubic feet	normal cubic ft
165	parts per billion	parts/billion
235	gallons per day	usg/d
236	hectoliters	hL
237	megapascals	MPa
238	inches of water at 4 °C (39.2 °F)	inH20 (4 °C or 39.2 °F)
239	millimeters of water at 4 °C (39.2 °F)	mmH20 (4 °C or 39.2 °F)

Remote Connections Via a ControlNet Network

This appendix offers reference information regarding connecting with ControlLogix® HART analog I/O modules in a remote chassis via a ControlNet® network.

For more information about ControlLogix ControlNet modules, see the *ControlNet Network Configuration User Manual*, publication CNET-UM001.

For information about how to migrate from an existing ControlNet network to an EtherNet/IP™ network, see the *ControlNet to EtherNet/IP Migration Reference Manual*, publication CNET-IN005.

Using RSNetWorx and RSLogix 5000 Software

The I/O configuration portion of the RSLogix 5000® programming software generates the configuration data for each I/O module in the control system, whether the module is in a local or remote chassis. A remote chassis, also known as networked, contains the I/O module but not the module's owner-controller. A remote chassis can be connected to the controller via a scheduled connection on the ControlNet network or an EtherNet/IP network.

RSLogix 5000 configuration data is transferred to the controller during the program download and later transferred to the appropriate I/O modules. I/O modules in the local chassis, and modules in a remote chassis connected via the EtherNet/IP network, or unscheduled connections on the ControlNet network, are ready to run as soon as the configuration data has been downloaded. However, to enable scheduled connections to I/O modules on the ControlNet network, you must schedule the network by using RSNetWorx for ControlNet software.

Running RSNetWorx™ software transfers configuration data to I/O modules on a scheduled ControlNet network and establishes a network update time (NUT) for the ControlNet network that is compliant with the desired communication options that are specified for each module during configuration.

Anytime a controller references a scheduled connection to I/O modules on a scheduled ControlNet network, you must run RSNetWorx software to configure the ControlNet network.

See the following general steps when configuring I/O modules.

1. Configure all I/O modules for a given controller by using RSLogix 5000 programming software and download that information to the controller.
2. If the I/O configuration data references a scheduled connection to a module in a remote chassis that is connected via the ControlNet network, run RSNetWorx for ControlNet software to schedule the network.
3. After running RSNetWorx software, perform an online save of the RSLogix 5000 project so the configuration information that RSNetWorx software sends to the controller is saved.

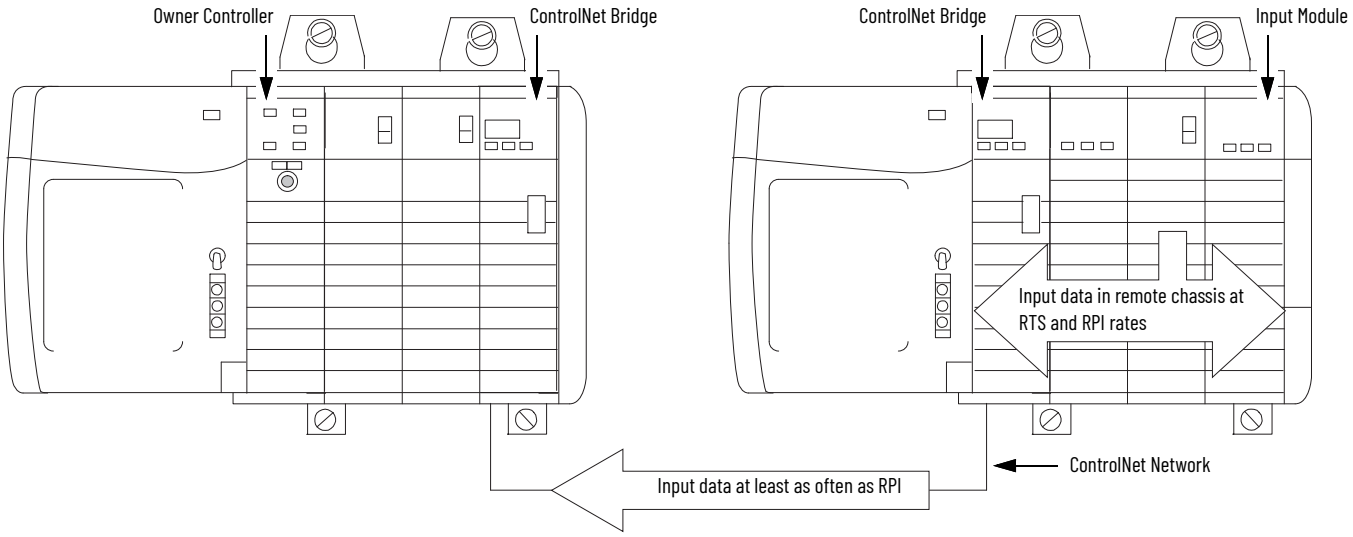
IMPORTANT You must run RSNetWorx for ControlNet software whenever a new I/O module is added to a scheduled ControlNet chassis. When a module is permanently removed from a remote chassis, we recommend that you run RSNetWorx for ControlNet software to reschedule the network and optimize the allocation of network bandwidth.

Remote Input Modules Connected Via ControlNet Network

Consider the case of an analog I/O module that is connected to the owner controller via a scheduled ControlNet® network. In this case, the RPI and real-time sample interval define when the module multicasts data **within its own chassis**. Only the RPI value, however, determines how often the owner controller receives module data over the network.

The specified RPI not only instructs the module to multicast data within its own chassis, but reserves a spot in the data stream that flows across the ControlNet network. The timing of this reserved spot does not coincide with the exact RPI value. The control system makes sure that the owner controller receives data at least as often as the specified requested packet interval.

Input Module in Remote Chassis with Requested Packet Interval Reserving Spot in Flow of Data



The reserved spot in the network data stream and the module real-time sample is asynchronous. So there are best and worst case scenarios as to when the owner controller receives updated channel data from the module in a networked chassis.

- **Best Case Scenario -** the module performs a real-time sample multicast with updated channel data just before the reserved network slot is made available. In this case, the remotely located owner controller receives the data almost immediately.
- **Worst Case Scenario -** the module performs a real-time sample multicast just after the reserved network slot has passed. In this case, the owner controller does not receive updated data until the next scheduled network slot.

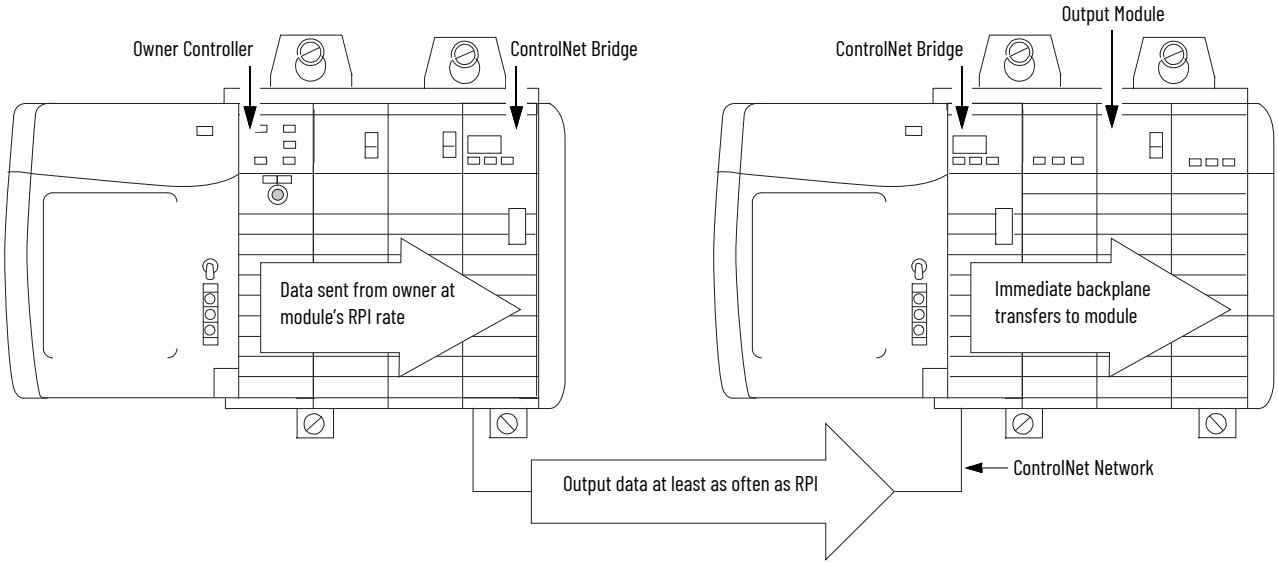
RPI, not real-time sample interval, dictates when module data is sent over the network. Therefore, we recommend that you set the RPI less than or equal to the real-time sample interval. This setting helps make sure that the owner controller receives updated channel data with each receipt of data.

Remote Output Modules Connected Via ControlNet Network

The RPI value instructs the controller to multicast output data within its own chassis, and reserves a spot in the stream of data that flows across the ControlNet network. These conditions occur when remote analog output modules are connected to the owner controller via a scheduled ControlNet network.

The timing of this reserved spot does or does not coincide with the exact value of the requested packet interval. However, the control system makes sure that the output module receives data **at least as often** as the specified requested RPI.

Output Module in Remote Chassis with Requested Packet Interval Reserving a Spot in Flow of Data



The reserved spot on the network and when the controller sends the output data are asynchronous. So there are best and worst case scenarios as to when the module receives the output data from the controller in a networked chassis.

- **Best Case Scenario -** the controller sends the output data just before the reserved network slot is available. In this case, the remotely located output module receives the data almost immediately.
- **Worst Case Scenario -** the controller sends the data just after the reserved network slot has passed. In this case, the module does not receive the data until the next scheduled network slot.

IMPORTANT These best and worst case scenarios indicate the time that is required for output data to transfer from the controller to the module once the controller has produced it.

The scenarios do not consider when the module receives new data (updated by the user program) from the controller. That result is a function of the length of the user program and its asynchronous relationship with the requested packet interval.

Notes:

Configure and Calibrate Modules With Older Programming Software

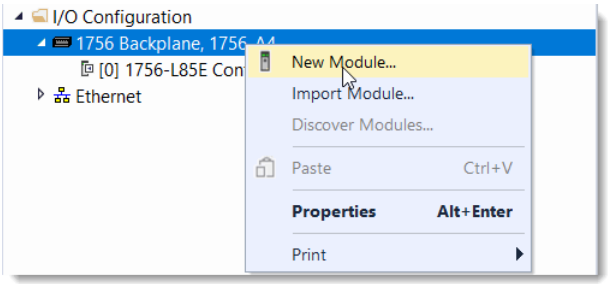
This appendix features screen captures that show the configuration and calibration of a 1756-IF8IH or 1756-IF8H ControlLogix® HART analog I/O module with 1756 HART I/O Analog Add-On Profile (AOP), version 8.01.04 or earlier installed for Studio 5000 Logix Designer® application, version 35 or earlier. The procedures are similar for all HART analog I/O modules running this configuration.

Add a New Module

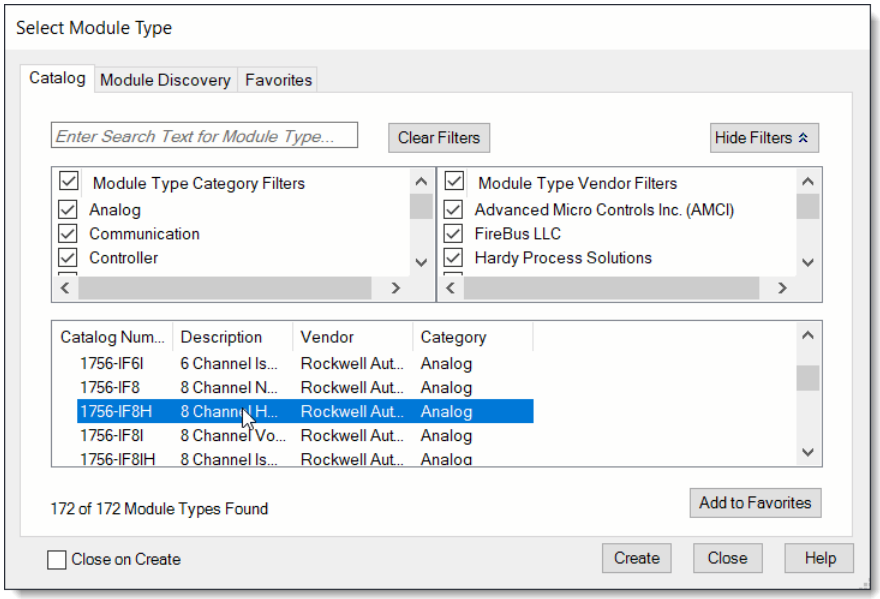
Follow these steps to add a ControlLogix HART analog I/O module to your Studio 5000 Logix Designer® application project.

IMPORTANT You can't change any field in these tabs if you are in Hard Run mode. Hard Run mode means that the keyswitch is in the Run position.

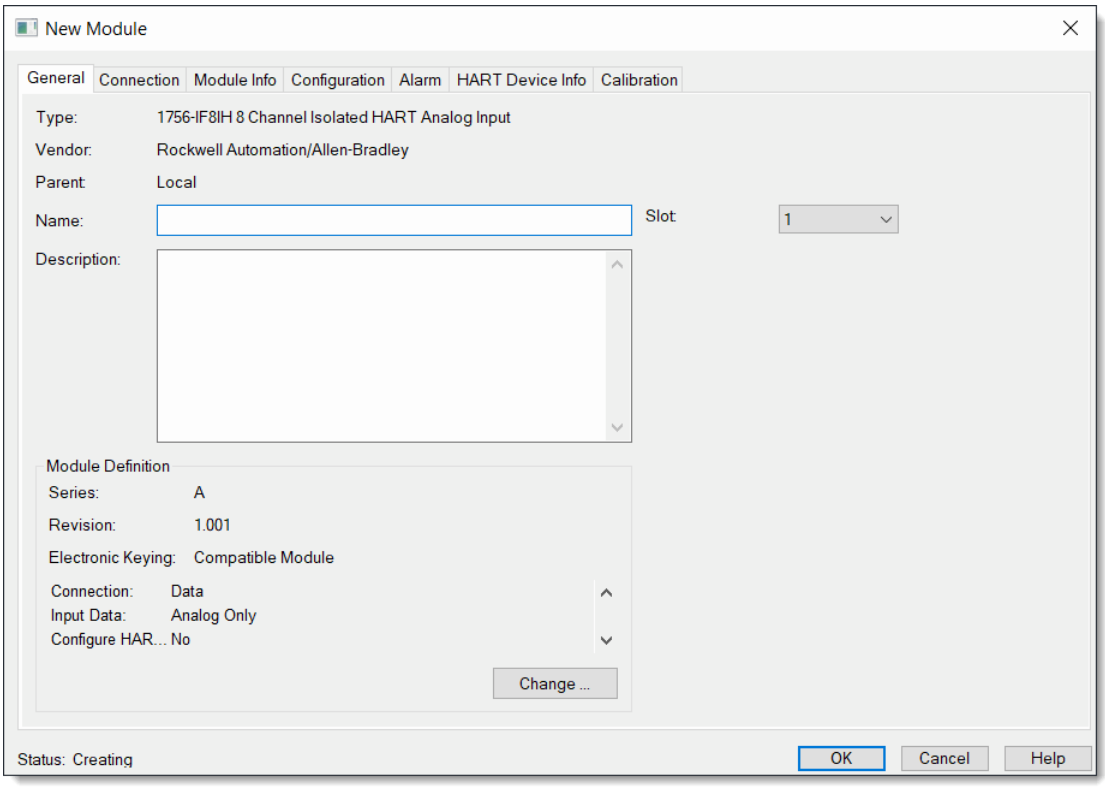
1. From the I/O Configuration tree, right-click the 1756 backplane and select New Module.



2. In the Select Module Type dialog, find and select the module that you want to add.



3. Select Create.
   The New Module dialog appears.

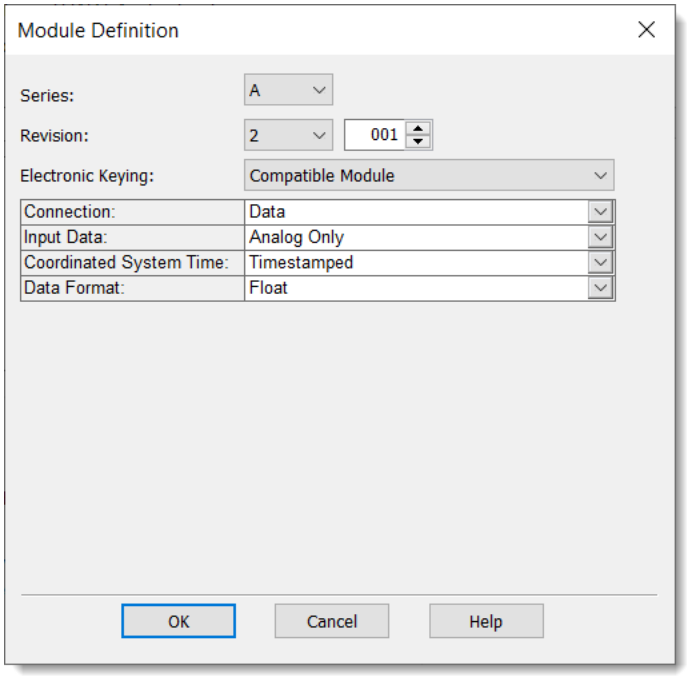


4. On the General tab:
   a. Enter a name for the module.
   b. Select the slot number that matches the physical slot number of the chassis housing the module.
   c. To use the default configuration, select OK.

Customize Your Module

To create a custom configuration for your module, select Change on the General tab.

The Module Definition dialog appears.



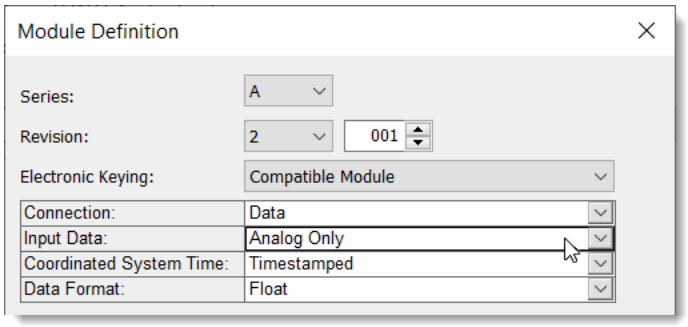
Use the settings on the Module Definition dialog to:

- Define the module's series and revision.
- Select the electronic keying.
- Configure the connection and data formats.

Parameter	Action	Values
Series	Select the series letter that matches the label on the side of your module.	Pull-down menu
Revision	Select the revision number that matches the label on the side of your module; make sure that the minor revision number also matches.	Pull-down menu
Electronic Keying	Select the electronic keying method See Electronic Keying on page 20 for more information	• Exact Match • Compatible Module (default) • Disable Keying
Connection	Select the connection type	• Data - has more tabs on the Module Properties dialog than Listen-only because of configuration settings for alarms • Listen-only - has no configuration data, does not send output data See Listen-only Mode on page 26 for more information.
Input Data	Select the input data mode	• Analog Only • Analog and HART PV • Analog and HART by Channel See HART Configuration for more information.
Configure HART Device	Select whether to enable the Configure HART Device feature. This feature is available only for the 1756-IF8IH and 1756-OF8IH modules when the data format is Analog and HART by Channel. If you select Yes, a HART Command tab is added to the configuration dialog, in which you specify configuration values to be sent to the HART device.	Values that can be added in the HART Command tab are PV Damping (seconds), PV Units, PV Upper Range, PV Lower Range, PV Transfer Function.
Coordinated System Time	Not configurable	Timestamped
Data Format	Not configurable	Float

HART Configuration

The Input Data selection that you make in the Module Definition dialog determines how HART field device data can be accessed. Access the Module Definition dialog from the General tab.



HART field device data is gathered through the automatic collection of HART Field Device Process Variables and Health information. You can also access HART field device data with pass-through messages. See Use a CIP MSG to get HART Data on page 167 and Use HART Modules with Asset Management Software on page 181 for more information.

This table shows which configuration options provide HART data in the input tag and which provide pass-through message access.

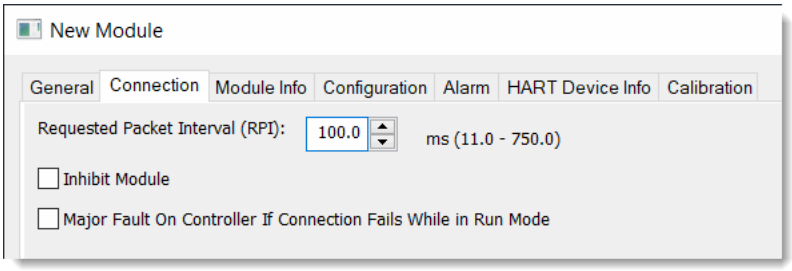
HART Data Configuration Options

Input Data Format	Enable HART Checkbox (Configuration Tab)	HART Data Input Tag Present?	Pass-through Message Access for MSG or Asset Management
Analog only	Not selected	No	No
	Selected		Yes
Analog and HART PV	Not selected	Fields present in tag, but data for this channel not valid	No
	Selected	Yes	Yes
Analog and HART by Channel	Not selected	Fields present in tag, but data for this channel not valid	No
	Selected	Yes	Yes

Even if you aren't enabling HART on all channels, the Analog and HART PV input tag includes space for the data. However, this data space is marked with a HART Fault to indicate that the data isn't valid. This feature lets you add HART instruments later without disturbing the tag layout.

Set Module Connection

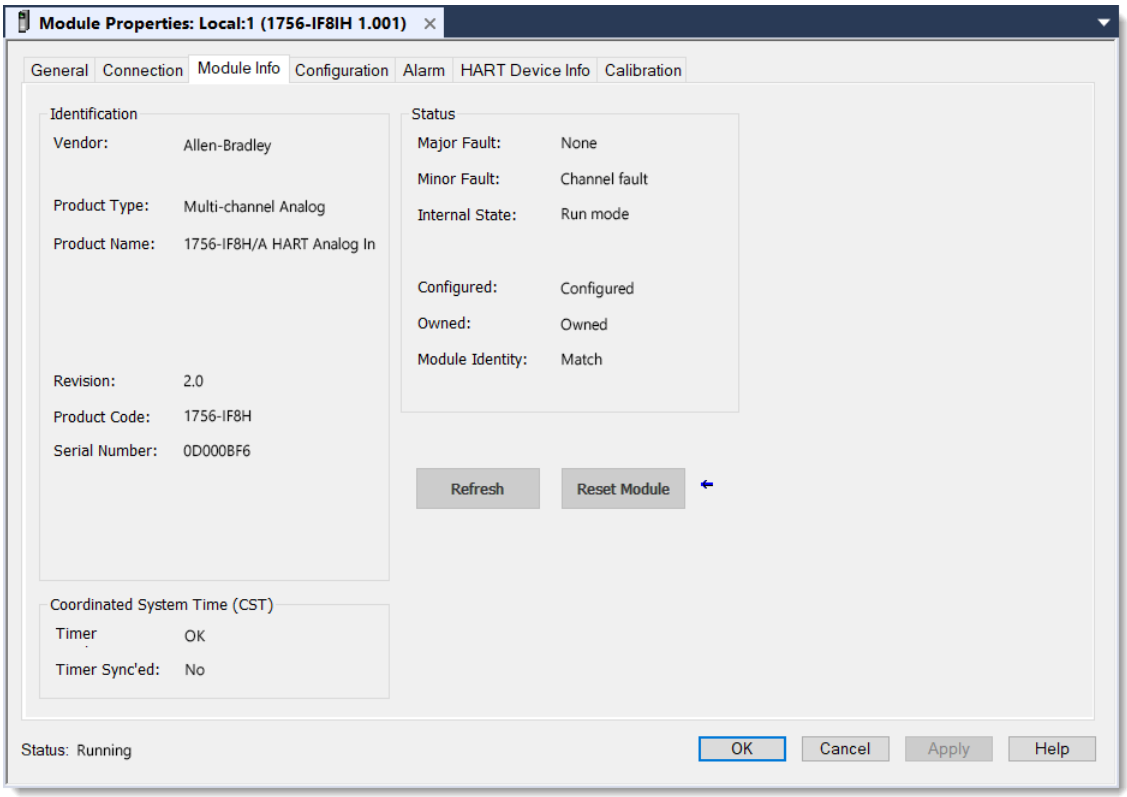
Use the following information to make selections on the Connection tab.



Parameter	Description
Requested Packet Interval	Defines when the module multicasts its data onto the local chassis backplane.
Inhibit Module	Helps prevent connection to the module. Use only if you do not want the module to be put into service.
Major Fault on Controller If Connection Fails While in Run Mode	The Logix controller performs a major fault if communication to this I/O module fails.
Use Unicast Connection over EtherNet/IP™	Appears only for HART analog modules that use the Logix Designer application version 18 or later in a remote EtherNet/IP chassis. Use the default checkbox if there are no other controllers in 'Listen-Only' mode. Clear the checkbox if there are other 'listening' controllers in the system.

View Module Information

The Module Info tab displays module and status information. This tab is populated with data that comes directly from the module. The information on this window is displayed when the project is online.



Status

The Status box in the right-hand column of the Module Info tab displays the current operational stats of the module.

Parameter	Description	
Major Fault	None, Unrecoverable, or Recoverable.	
Minor Fault	None, Unrecoverable, or Recoverable. Recoverable can mean that you have a channel fault such as wire off.	
Internal State	Indicates the module mode.	
Configured	Indicates if an owner controller that is connected to the module configured the module. Once a module is configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module.(1)	
Owned	Indicates if an owner controller is connected to the module.(1)	
Module Identity	Displays Match or Mismatch as described in the table. This field does not account for the Electronic Keying or Minor Revision selections for the module as specified on the General tab.	
	Displays	**If the Physical Module**
	Match	Agrees with what is specified on the General tab. For the Match condition to exist, the following items must agree: • Vendor • Module type (the combination of product type and product code for a particular vendor) • Major revision
	Mismatch	Does not agree with what is specified on the General tab.

(1) This information applies to the I/O module only and does not apply to adapters, scanners, bridges, or other communication modules.

Coordinated System Time (CST)

The CST box in the lower, left-hand column of the Module Info tab provides the following information.

Parameter	Description
Timer Hardware	Displays OK or faulted for the timer hardware.
Timer Sync'ed	Displays yes if the module timer is coordinated with the master. Displays no if it isn't. This indicates if a CST master is providing a time reference to the module. Configure a controller to be the CST Time Master on the Controller Properties tab.

Refresh or Reset Module

Select Refresh to refresh the information or select Reset Module to reset the module to its power-up state.

IMPORTANT	Resetting the module breaks connections and restores output signals to default conditions.

Apply Changes

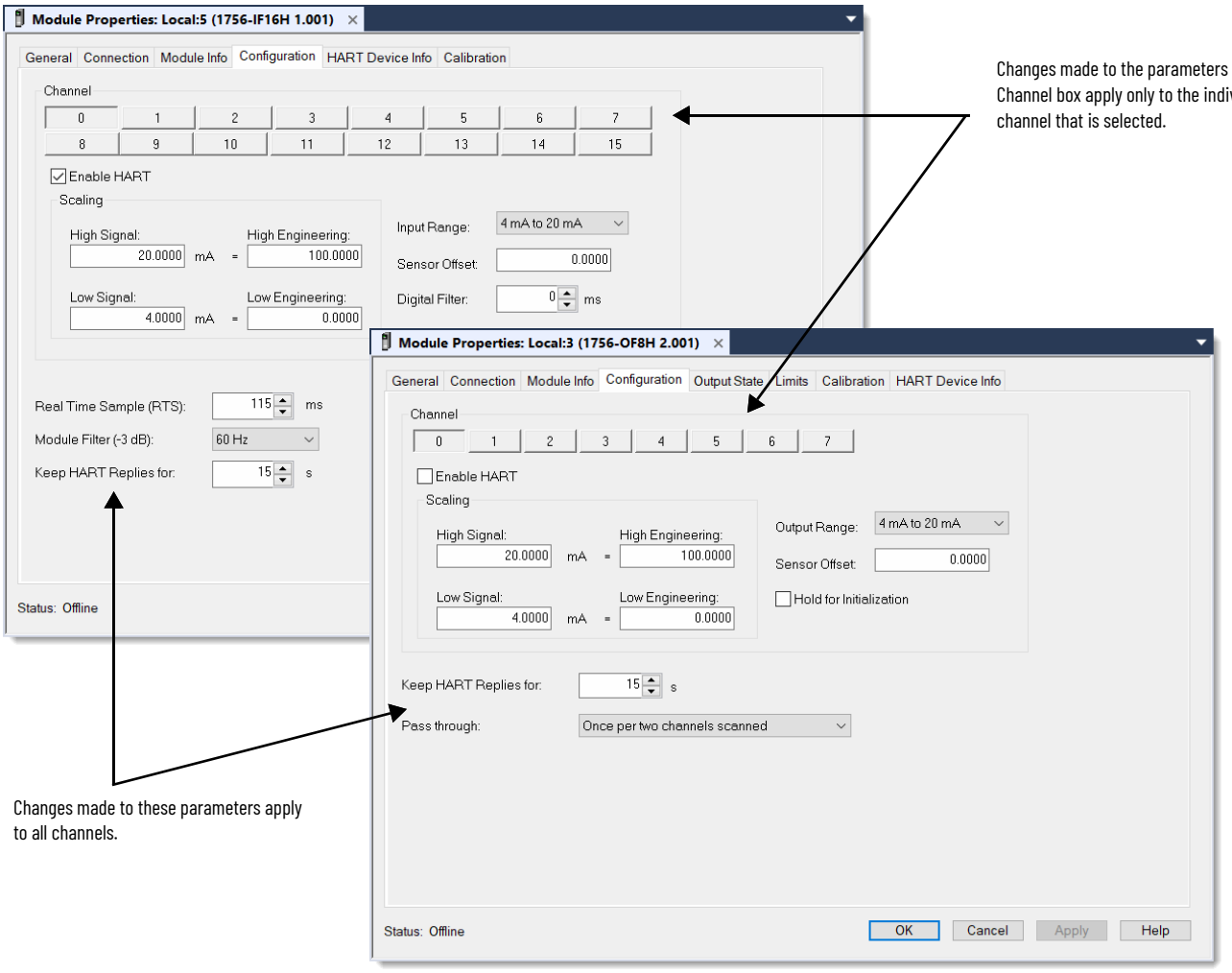
If the following conditions exist when you select Apply or OK, the information is automatically sent to the controller:

- You're online in Program, Remote Program, or Remote Run mode, and
- This controller is the owner controller, and
- You've changed the module configuration in the software.

The controller tries to send the information to the module (if the module connection isn't inhibited). If you do not select OK or Apply, your changes aren't sent to the controller.

Configure Channels

The following information describes how to configure the module channels. Differences among the modules are noted.



Changes made to the parameters in the Channel box apply only to the individual channel that is selected.

Changes made to these parameters apply to all channels.

Configure Individual Input Channels

With an individual channel selected, use this table to configure the parameters in the Channel box that apply to the individual channels.

Parameter	Action	Notes	Available in Hard Run Mode?
Enable HART	Select or unselect for the selected channel.	• If HART is enabled, the input range must be 0…20 mA or 4…20 mA. • When HART isn't enabled for a channel: – HART messages aren't sent on this channel. – HART pass-through messages aren't sent. – HART data for this channel isn't updated in the input tag. • If you select a HART PV or HART by Channel input tag on the General tab, process data (PV, SV, TV, and FV) from the HART instrument is included in the input tag. If you selected Analog only, the additional process data isn't included in the input tag. • Regardless of the choice of input tag, HART communication can be enabled for each channel to provide pass-through HART message access. If Enable HART isn't selected, this pass-through message access isn't available. • We recommend that you Enable HART for any channel that has a connected HART device. This selection is so that information can be displayed on the HART Device Info tab and accessed by FactoryTalk® AssetCentre software. • You can select Enable HART on some channels and not on others if only some channels have HART field devices attached. • On the 1756-IF8H and 1756-OF8H modules, all channels share the HART modem. For these modules, HART response time is better if you enable only the needed HART channels. The other modules (1756-IF16H, 1756-IF16IH, 1756-IF8IH, and 1756-OF8IH) have a separate HART modem for each channel.	No
Scaling	Enter values for High Signal, Low Signal, High Engineering, and Low Engineering.	See Module Resolution on page 240 for more information.	No
Input Range	Select a value from the pull-down menu.	• 0…20 mA or 4…20 mA is required for HART. • The 1756-IF8IH and 1756-OF8IH do not support voltage ranges.	No
Sensor Offset	Enter a value from -9,999,999…99,999,999 (float).	• The default value is 0.00. • The offset value is in engineering units. • The Sensor Offset is added to the data value to determine signal level.	No
Digital Filter	Select a filter time constant value from 0…20100 ms.	This field is a first-order lag filter that smooths input transitions. It's called a digital filter because it's calculated in the software by the module, not by a hardware filter. Each channel has its own digital filter value. So each channel can have a unique digital filter setting to accommodate the specific device that is attached to that channel. For the module filter, one value is applied for all channels.	No
For descriptions of the other boxes, such as Real Time Sample (RTS), see Configure All Input Channels on page 238.			

Configure Individual Output Channels

With an individual channel selected, use this table to configure the parameters in the Channel box that apply to the individual channels.

Parameter	Action	Notes	Available in Hard Run Mode?
Enable HART	Select or clear	• Unselected by default. • Output range must be 0…20 mA or 4…20 mA. • When a channel isn't enabled: – HART messages aren't sent on this channel. – HART pass-through messages aren't sent. – HART data for this channel isn't updated in the input tag. • If you selected a HART PV or HART by Channel input tag on the General tab, process data (PV, SV, TV, and FV) from the HART instrument is included in the input tag. If you selected Analog only, the process data isn't included in the input tag. • Regardless of the choice of input tag, HART communication can be enabled for each channel to provide pass-through HART message access. If Enable HART isn't selected, this pass-through message access isn't available. • We recommend you Enable HART for any channel that has a HART device that is connected so that information can be displayed on the HART Device Info tab. • One reason to disable HART communication is that each channel that is enabled requires time to scan, so enabling unnecessary channels reduces performance on the others.	No
Scaling	Enter scaling values for High Signal, Low Signal, High Engineering, and Low Engineering	See Scaling to Engineering Units on page 236 for more information.	No
Output Range	Choose a value from the pull-down menu	0…20 mA or 4…20 mA is required for HART.	No
Sensor Offset	Enter a value from -9,999,999…99,999,999 (float)	• The default value is 0.00. • The offset value is in engineering units. • The Sensor Offset is added to the data value to determine signal level.	No
Hold for Initialization	Select or clear	• Select this option to cause the module to hold the output signal unchanged until the output value received from the controller in the ChxData field is within 0.1% of the value being held. The output holds when the following occurs: – Powerup occurs (holds at zero) – A new connection is established (brings it out of fault state and it holds at the fault value from the previous configuration). – The controller returns to Run mode after Program mode (continues to hold at the configured value that was held in Program mode. • The output channel holding lets the controller synchronize with the output, enables smooth output transitions and avoids rapid transients when control resumes from an interruption. • The output can be ramping to the configured hold value when the transition occurs. In this case, it continues the ramp until it completes or until the output value from the controller is within the 0.1% of the output signal. When the Hold for Initialization option isn't selected, the output switches as quickly as possible to the first value commanded by the controller.	No

Scaling to Engineering Units

Channel data values in the output tag can be in engineering units such as kg, m, or percent. To configure the relationship between engineering units and the physical signal in volts or mA, set the Low and High Signal and the Low and High Engineering values.

For example, suppose that you have a temperature transmitter that produces 4 mA current at -180 °C (-292 °F) and 20 mA current at +750 °C (1,382 °F). If you want to use °C in your control program, configure the values as shown in this table.

	Signal	Engineering
High	20	750
Low	4	-180

If you're using HART field devices, we recommend setting Engineering High and Low to the field device Upper Range and Lower Range Values. This selection is so that the field device and module use the same engineering units. If online, these values are displayed on the HART Device Info tab.

Scaling High and Low Signal

Set the High and Low Signal values for the module. The High Signal value must be greater than the Low Signal value.

Range[1]	Low Limit	High Limit
-10...10V	-10.00	10.00
0...20 mA	0.00	20.00
4...20 mA	4.00	20.00
0...5V	0.00	5.00
0...10V	0.00	10.00

(1) Voltage ranges aren't available in 1756-IF8IH and 1756-OF8IH modules.

Scaling High Engineering

Set the High Engineering value for the module. The High Engineering value must not equal the Low Engineering value. This value is in engineering units and corresponds with a signal value equal to the High signal.

Valid values are in the range of -10,000,000...100,000,000. The default value is 100.00.

Scaling High Engineering appears dimmed in Hard Run mode.

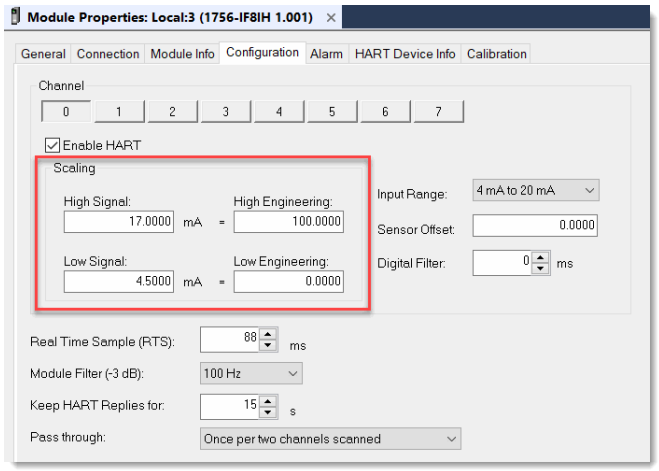
Scaling Low Engineering

Set the Low Engineering value for the module. The Low Engineering value must not equal the High Engineering value. This value is in engineering units and corresponds with a signal value equal to the Low signal.

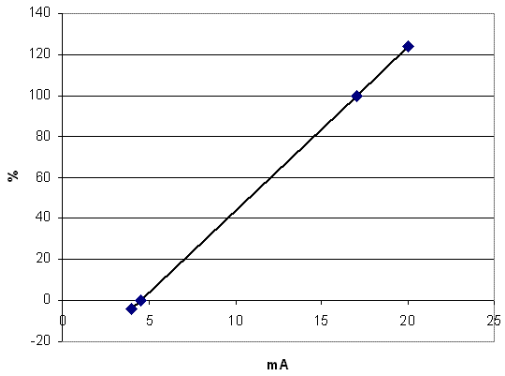
Valid values are in the range of -10,000,000...100,000,000. The default value is 0.00.

Scaling Example

To configure the module to tell you how full a tank is, you would configure scaling to give you 0% when the tank is empty and 100% when the tank is full. Suppose the sensor that measures the tank signals 4.5 mA when the tank is empty and 17 mA when the tank is full. You would configure scaling as shown.

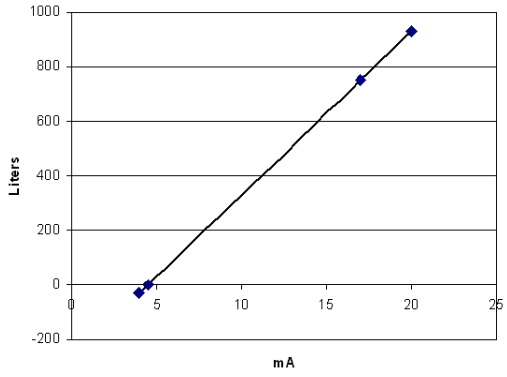


This configuration creates a relationship between the electrical signal the tank gauge generates and the number sent to the Logix Controller for use in the control system. Graphically, the relationship looks like this:



The module measures signals slightly higher and lower than the sensor provides for this tank. Setting the High or Low Engineering Units does not limit the values to within that range. The module still measures signals from 4...20 mA. In this example, if the module senses 20 mA, it reports that the tank is 124% full. A signal of 0 mA is reported as -4% full, or 'less than empty'.

To have the tank level reported in liters instead of percent, put the capacity of the tank as the High Engineering value. If you have a 750 liter tank, as in the previous example, put 750 instead of 100 and you get the scaling relationship shown.



Configure All Input Channels

Use this table to configure the parameters on the Configuration tab that apply to all channels.

Parameter	Action	Notes	Available in Hard Run Mode?
Real Time Sample (RTS)	Select a value from 0...10,000 ms.	• Determines the interval of time at which updated information is supplied to the controller. • The default is 88. • See Real Time Sample (RTS) on page 22 for more information. • See the Real-Time Sample Values table on page 238 for RTS choices available for each Module Filter setting.	No
Module Filter (-3 dB)	Select a value from the pull-down menu.	• Because the digital HART communication signals are in the 1200...2400 Hz range, the module filter can't be set to 1000 Hz if HART is enabled. • See the Module Filter Values table on page 240 to select a value. • See Module Filter on page 30 (1756-IF8H) or page 51 (1756-IF8IH) for more information.	No
Keep HART Replies	Select a value from 1...255 s.	• HART replies that are received from the Field Device in response to pass-through messages that have been sent are kept for this long. Retrieve them within this time or the module discards them. • The default is 15. **IMPORTANT:** We do not recommend a value of less than 15 seconds. • See Use a CIP MSG to get HART Data on page 167 for more information.	No
Pass through(1)	Select a value from the pull-down menu.	• Determines how often pass-through messages occur. – Once per two channels scanned (default)- After two channels have PVs scanned to the input tag, a pass-through message is sent (if one is pending). – Once per module scan - Select this value if you want to minimize the impact pass-through message clients have on reading the PVs into the input tag. – Once per channel scan - After each channel has its PVs scanned to the input tag, a pass-through message is sent (if one is pending). Select this value if you want to give pass-through messages from clients, such as FactoryTalk AssetCentre, higher priority than reading PV, SV, TV, FV, and field device health into the input tag. See the Input Module Pass-through Setting, Ratio, and Priority table on page 238 for more information.	No

(1) Series B modules do not support Pass-through Setting. Pass-through scanning is fixed at one pass-through per channel scan on Series B modules.

Real-Time Sample Values

Module Filter, Hz	Low Limit, ms	High Limit, ms
10	488	10000
15	328	
20	248	
50	88	
60	88	
100 (default)	56	
250	28	
1000	18	

Input Module Pass-through Setting, Ratio, and Priority

Setting	Scan: Pass-through Ratio	Gives Priority to
Once per channel scan	1:1	Asset management
Once per two channels scanned	1:2	Default setting
Once per module scan	1:8	Input tag scan

Configure All Output Module Channels

Use this table to configure the parameters on the Configuration tab that apply to all channels of an output module.

All Channels Configuration Parameters

Parameter	Action	Notes	Available in Hard Run Mode?
Keep HART Replies	Select a value from 1...255 s	• HART pass-through message replies are kept for this time. HART replies that are received from the Field Device in response to pass-through messages that you have sent are kept for this long. You must retrieve them within this time or the module discards them. • The default is 15. **IMPORTANT:** We do not recommend a value of less than 15 seconds.	No
Pass through(1)	Select a value from the pull-down menu	• Determines how often pass-through messages occur. – Once per two channels scanned (default)- After 2 channels have PVs scanned to the input tag, a pass-through message is sent (if one is pending). – Once per module scan - Select this value if you want to minimize the impact pass-through message clients have on reading the PVs into the input tag. – Once per channel scan - After each channel has its PVs scanned to the input tag, a pass-through message is sent (if one is pending). Select this value if you want to give pass-through messages from clients such as FactoryTalk AssetCentre higher priority than reading PV, SV, TV, FV, and field device health into the input tag. See the Output Module Pass-through Setting, Ratio, and Priority table on page 239 for more information.	No

(1) Series B modules do not support Pass-through Setting. Pass-through scanning is fixed at one pass-through per channel scan on Series B modules.

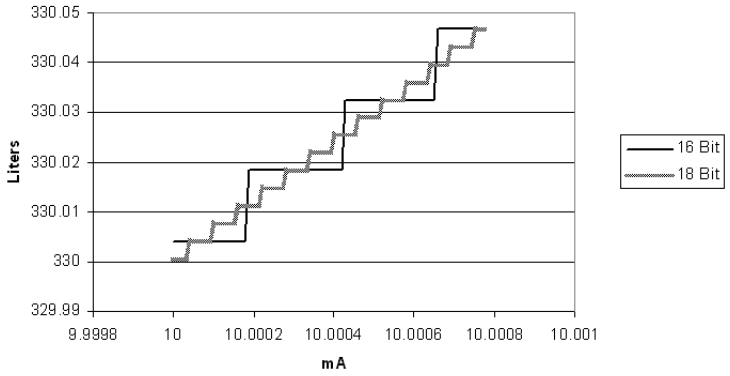
Output Module Pass-through Setting, Ratio, and Priority

Setting	Scan:Pass-through ratio	Gives priority to
Once per channel scan	1:1	Asset management
Once per two channels scanned	1:2	Default setting
Once per module scan	1:8	Input tag scan

Module Resolution

Resolution is the smallest amount of change that the module can detect.

Resolution is sometimes expressed in bits. If 16 bits of resolution are available, the module can detect 65536 different signal values. If configured for 4…20 mA, it could discern the difference between 10…10.0003 mA, but it wouldn't distinguish between10…10.0002 mA.



Resolution affects how the module measures analog signals. Scaling converts the analog signal to Engineering Units for convenience in your control system. In the previous 16-bit example and the 750 liter tank example in the previous section, you would have a resulting resolution of 0.0146 liters. As the tank fills, the volume reading could jump from a reading of 250 liters to 250.015 liters without displaying any values between. Because of sampling, filtering, and RPI, you can see more or fewer intermediate values, depending on the fill rate.

The resolution of analog input modules depends on the module and the filter configuration. To measure a rapidly changing signal, a configuration with less resolution is used. For information about the resolution available, see the following locations.

Available Resolution for This Module	Page
1756-IF8H	30
1756-IF8IH	51
1756-IF16H	68
1756-IF16IH	85
1756-OF8H	98
1756-OF8IH	111

IMPORTANT Because these modules must provide for possible calibration inaccuracies, the resolution values represent the available analog-to-digital or digital-to-analog counts over the selected range, including a small amount of Overrange and Underrange.

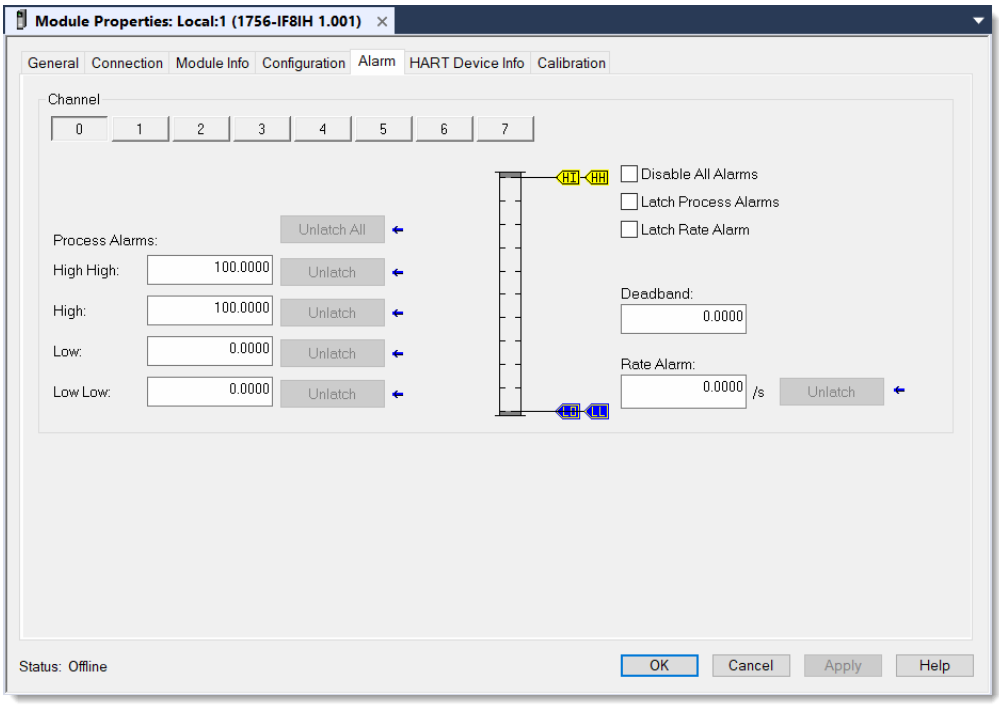
Module Filter Values

Module Filter, Hz	C.ModuleFilter
10(1)	0
15	7
20	6
50	1
60 (default)	2
100	3
250	4
1000(2)	5

(1) 10 Hz not supported in the 1756-IF16H or 1756-IF16IH modules.
(2) Do not select 1000 with HART enabled.

Set Input Module Alarms - 1756-IF8H, 1756-IF8IH

The following information describes how to configure the parameters on the Alarm tab for the 1756-IF8H and 1756-IF8IH modules. For more information, see Process Alarms on page 33 or page 54, and Rate Alarm on page 33 or page 54.



With an individual channel selected, use these parameters to configure the alarms.

Alarm Tab Parameters

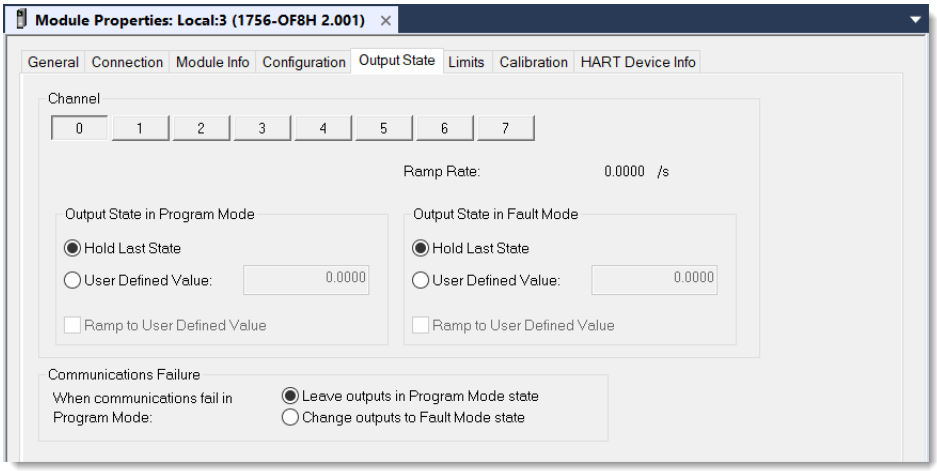
Parameter	Action	Notes	Available in Hard Run Mode?
Process Alarms	Enter the values or drag the corresponding flags on the slider bar to set the values.	• The High Engineering and Low Engineering parameters on the Configuration tab set the maximum and minimum values for these alarms. • Alarm thresholds are in engineering units. • To change the trigger points by whole numbers only, hold down the shift key while dragging the flag on the slider bar. • A deadband appears around each value.	No
High High (HH)		• Sets the level of input to a channel that causes the module to set the High High alarm. • The alarm remains active until the input returns below this level by more than the deadband. • If Latch Process Alarms is selected, the ChXHHAlarm indication remains set until explicitly cleared.	
High (HI)		• Sets the level of input to a channel that causes the module to set the High alarm. • The alarm remains until the input returns below this level by more than the deadband. • If Latch Process Alarms is selected, the ChXLAlarm indication remains set until explicitly cleared.	
Low (LO)		• Sets the level of input on a channel that causes the module to set the Low alarm. • The alarm remains until the input returns above this level by more than the deadband. • If Latch Process Alarms is selected, the ChXLAlarm indication remains set until explicitly cleared.	
Low Low (LL)		• Set the level of input to a channel that causes the module to set a Low Low alarm. • The alarm remains until the input returns above this level, more than the deadband. • If Latch Process Alarms is selected, the ChXLLAlarm indication remains set until explicitly cleared.	
Disable All Alarms	Select	Disables all alarms for a channel.	No
Latch Process Alarms	Select	Maintains an alarm triggered condition for any of the process alarms, even after the condition ceases. The alarm unlatches only with an explicit message that acknowledges the alarm.	No
Latch Rate Alarm	Select	When enabled, a Rate Alarm indication remains set, even when the alarm condition returns to normal. This latch lets you maintain the alarm even after the condition ceases. The alarm unlatches only with an explicit message that acknowledges the alarm.	No

Alarm Tab Parameters (Continued)

Parameter	Action	Notes	Available in Hard Run Mode?
Deadband	Enter a value from 0.00...99,999,999.	• Select a value at which an alarm, once set, does not disable as long as the input value remains within the deadband range of the alarm trigger point. (This value in combination with the process alarms creates the range.) This configuration helps prevent the alarm from cycling on and off if the process value hovers near the alarm threshold. • The alarm deadband can be only half the distance between high and low alarm limits. • The default is 0.00 • For related information, see Alarm Deadband on page 33.	No
Rate Alarm	Enter an alarm limit value from 0.00...99,999,999.	• Enter a Maximum Ramp Rate value to trigger a Rate Alarm when the input signal rate of change exceeds the setpoint. • This configuration is useful for detecting rapid process changes. • The default is 0.00 • Set this alarm in engineering units/second.	No
Unlatch All	Select	• Unlatches all alarms. • Isn't available when the project is offline.	Yes
Unlatch	Select	• Unlatches the adjacent alarm condition. • Isn't available when the project is offline.	Yes

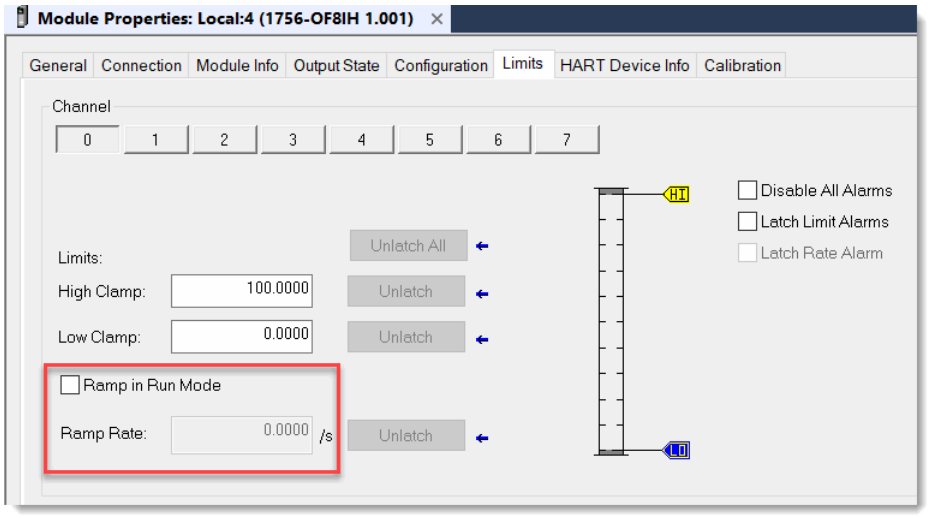
Set Output Module Behavior

The 1756-OF8H and 1756-OF8IH modules have an Output State tab. With an individual channel selected, the Output State tab lets you program output behavior in Program and Fault modes.

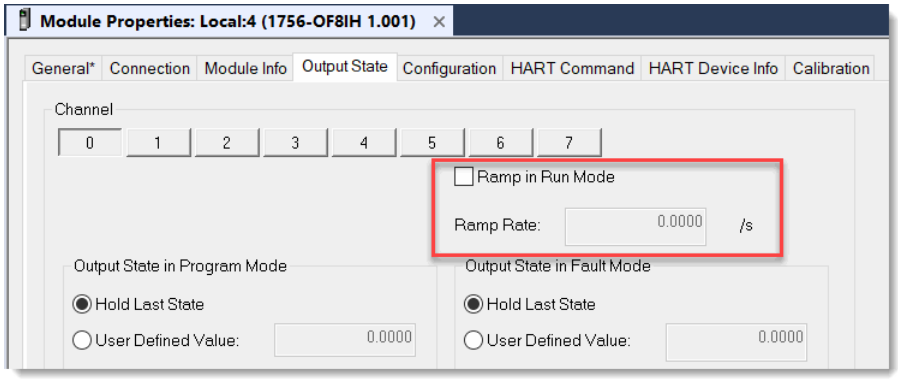


Ramp Rate

The Ramp Rate limits the speed at which an analog output signal can change. This value helps prevent fast transitions in output from damaging equipment that the output controls. This feature is available in Run mode. Ramping in Run mode and the ramp rate are set on the Limits tab.



For the 1756-OF8IH module with Configure HART Device set to Yes, ramping in Run mode and ramp rate are set on the Output State tab.



Output State in Program Mode

These parameters aren't available in Hard Run mode.

Selecting	Configures the Output Channel for the Following When the Controller Transitions from Run to Program Mode
Hold Last State	Leave the current output at its last value.
User-Defined Value	Go to the specific value when the owner controller is switched into Program mode. If you select this, enter a value from 9,999,999...99,999,999, default is 0.
Ramp to User-Defined Value	If Hold Last State - this field is disabled. User-Defined Value - select if you want the output to ramp to the user-defined value at the specified ramp rate. The ramp rate is selected from the output Limits tab. If unselected, the output signal steps to the User-Defined Value immediately on entering Program mode.

Output State in Fault Mode

These parameters aren't available in Hard Run mode.

The module enters Program mode state if the Connection from Logix is inhibited. If communication later fails, all channels of the module remain in Program mode.

Select	To configure the output module to one of these
Hold Last State	Leave the output signal at its last value.
User-Defined Value	Go to a specific value if a fault occurs. If you select this parameter, enter a value from -9,999,999...99,999,999, default is 0.
Ramp to User-Defined Value	If Hold Last State - This field is disabled. If User-Defined Value - You can select this if you want the output to ramp to the user-defined value at the specified ramp rate. The ramp rate is selected on the output Limits tab. If unselected, the output signal steps to the user-defined value immediately on entering Fault mode.

The output signal goes to Fault mode when the controller faults or when communication between an output module and its controller is lost. Output State in Fault Mode appears dimmed in Hard Run mode.

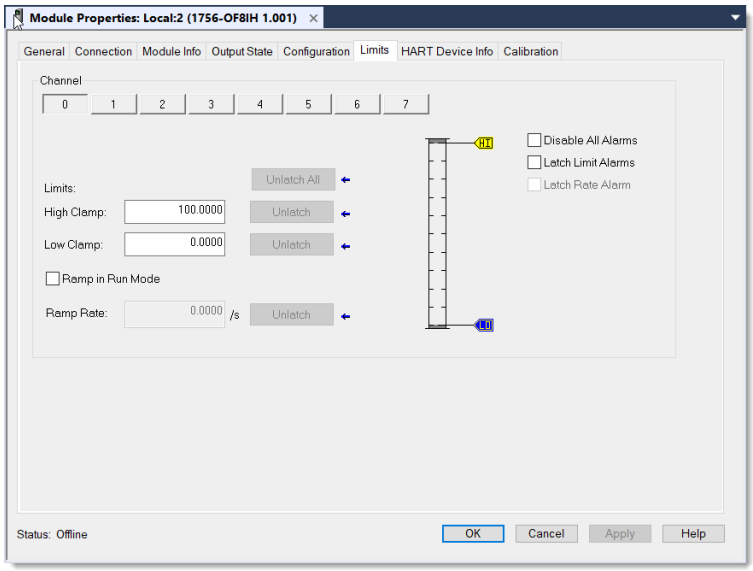
Communication Failure

If communication fails while in Run mode, the output signal goes to its Fault Mode state. If communication fails while in Program mode, the output signal behaves as follows.

Select	To
Leave outputs in Program mode state	Leave the output signal at the configured Program mode value
Change output to Fault mode state	Change output signal at configured Fault mode value if a communication fails (connection from controller breaks)

Set Output Module Limits

Use this information to configure the parameters on the Limits tab.



With an individual channel selected, use these parameters to configure the limits.

Output Module Limits Parameters

Parameter	Action	Notes	Available in Hard Run Mode?
Limits	Enter the values or drag the corresponding flags on the slider bar to set the values.	• The High Engineering and Low Engineering parameters on the Configuration tab set the maximum and minimum values for these alarms. • Clamp limits are in engineering units. • To change the trigger points by whole numbers, hold down the shift key while dragging the flag on the slider bar. • See the Limit Example below for further explanation.	No
High Clamp (HI)		• The highest value that an output channel can reach in the control process. • -9,999,999...99,999,999, default is 100.00.	
Low Clamp (LO)		• The lowest value that an output channel can reach in the control process. • -9,999,999...99,999,999, default is 0.	

Output Module Limits Parameters (Continued)

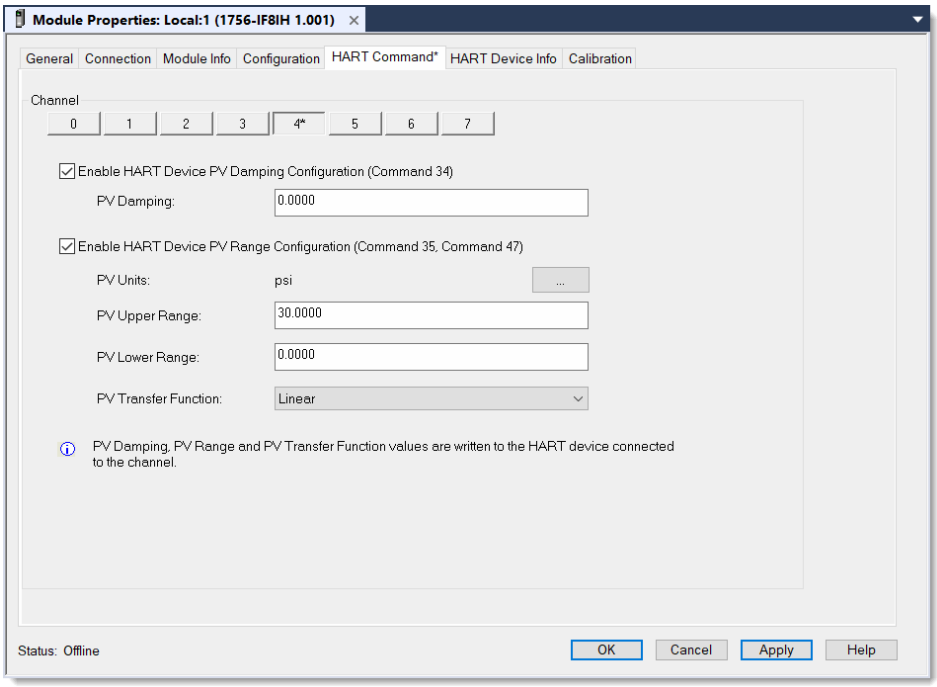
Parameter	Action	Notes	Available in Hard Run Mode?
Ramp in Run Mode	Select	• Enables ramping in Run mode. • Ramping occurs between the current output level and any new output value received. • If ramping is enabled, the output can change only at the configured ramp rate limit.	No
Ramp Rate	Enter a value from 9,999,9999... 999,999,999, default is 0.	• Defines the maximum rate of change an output can make in engineering units/second. • Serves as a trigger point for a Ramp Rate Limit alarm when the Ramp in Run mode is selected. • Can also be uses to ramp a user-defined value in Program or Fault mode. • A non-editable copy of Ramp Rate is shown on the Output State tab.	No
Unlatch All	Select	• Unlatches all alarms. • Isn't available when the project is offline.	Yes
Unlatch	Select	• Unlatches the adjacent alarm condition. • Isn't available when the project is offline.	Yes
Disable All Alarms	Select	Disables all alarms for a channel.	No
Latch Limit Alarms	Select	Maintains the high and low limit alarms even after the condition ceases. The high and low limit alarm is set if the requested output is beyond the clamp limit (>High or <Low). This is useful if you want to detect a transient alarm condition and preserve its indication until the alarm is explicitly unlatched. Select Unlatch to unlatch an alarm, or send a Common Industrial Protocol (CIP) message using the MSG instruction.	No
Latch Rate Alarm	Select	When enabled, a Rate Alarm indication remains set, even when the alarm condition returns to normal. This latch lets you maintain the alarm even after the condition ceases. The alarm unlatches only with an explicit message that acknowledges the alarm.	No

Limit Example

If your output controls a valve positioner that's configured to use Percent of Stroke for engineering units, you can enter 0 as the Low Clamp and 62 for High Clamp. Enter 0 only if you don't want the valve to be over 62% open at any time for any reason. Even if a PIDE instruction calculates the valve must open more to achieve process Setpoint, the output module clamps it to 62% open.

Set HART Command - 1756-IF8IH, 1756-OF8IH

When Configure HART Device is set to Yes for the 1756-IF8IH and 1756-OF8IH modules, a HART Command tab appears in the Module Properties dialog.

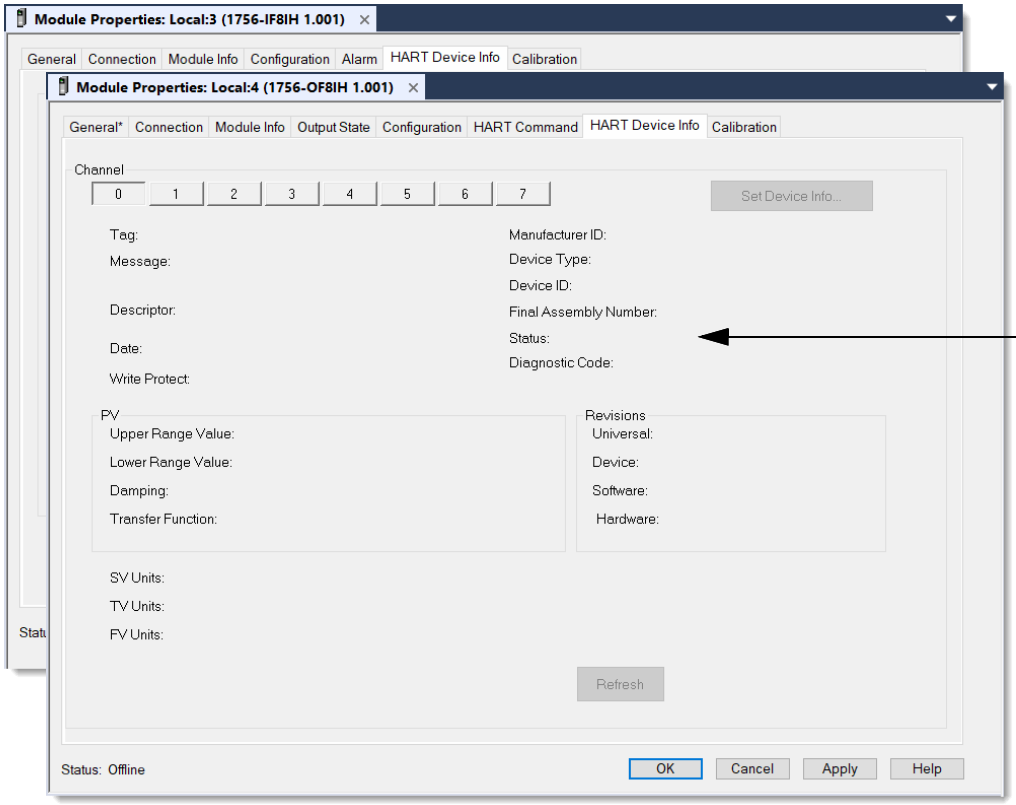


With an individual channel selected on the HART Command tab, you can specify the HART device parameters for that channel. These values are sent to the HART device.

Checkbox	Parameter	Description
Enable HART Device PV Damping Configuration	PV Damping	
Enable HART Device PV Range Configuration	PV Units	Engineering units for the HART PV. Select from the pull-down menu. See Appendix E for a list of unit codes.
	PV Upper Range	Highest value for PV in the specified engineering units.
	PV Lower Range	Lowest value for PV in the specified engineering units.
	PV Transfer Function	Form of the PV transfer function. Select from the pull-down menu.

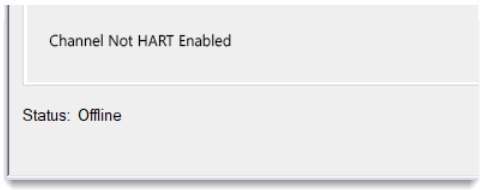
View HART Device Information

With an individual channel selected, the HART Device Info tab displays information about the attached HART field device that the HART module collects.

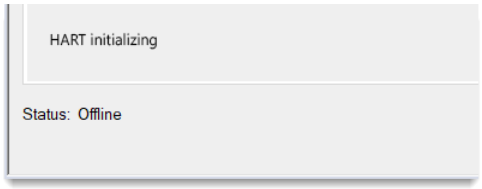


Enhanced diagnostic and status codes are available here depending on your configuration.

- If you selected a Listen-Only communication format when you created the module, this tab isn't available.
- If HART isn't enabled for this channel, Channel Not HART Enabled is displayed.



- If HART is enabled, but the HART Field Device isn't responding, HART initializing is displayed.

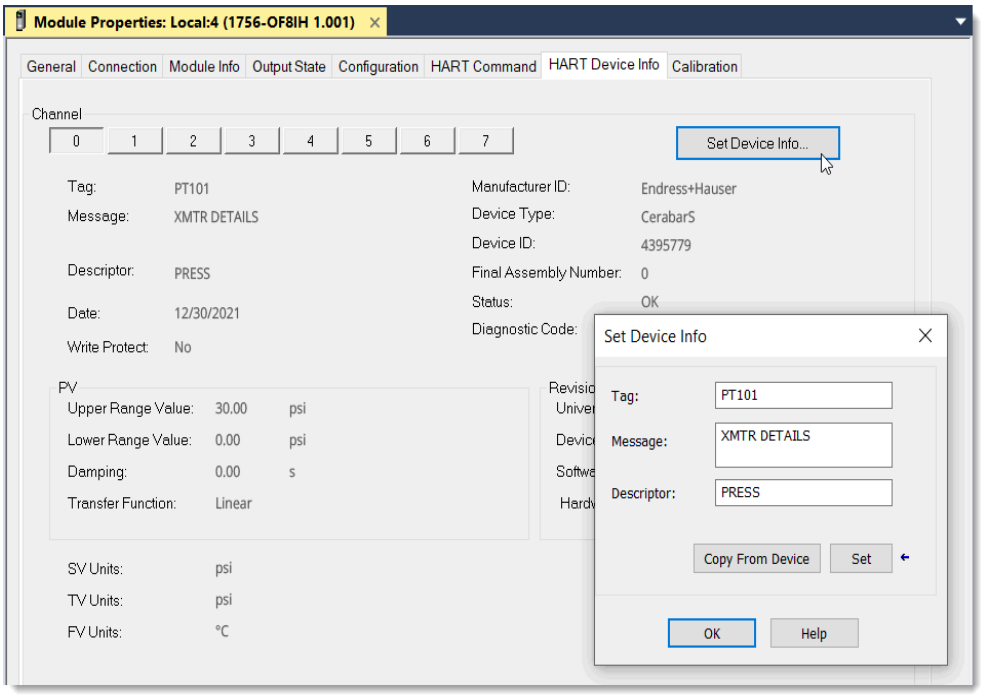


HART Device Info Tab

Parameter	Description
Channel	Select a channel to display the parameters for the corresponding channel.
Refresh	Select to update all attributes that are displayed on this tab for the corresponding channel.
Tag	Displays the tag name of the HART Field Device. The tag name is entered into the Field Device to indicate its location and purpose in the plant.
Message	Displays the text that was entered in the Message parameter of the HART Field Device. The use of this parameter can vary. One possible use is to store information such as who last calibrated the device, or reference to documentation.
Descriptor	Displays the Descriptor field from the HART Field Device. The Descriptor is a text message that can be stored in the device to help identify the device or it can be used for other plant-specific purposes.
Date	Displays the date that is entered in the device. This date is often used to record the last calibration date, but it's up to the end user to maintain it. It's displayed in the format that is selected for your computer with the Regional and Language settings on the Control Panel.
Write Protect	Displays a Yes or No indicating if the HART Field Device is write protected. If a device is write protected, some parameters can't be changed via HART communication. Sometimes devices do not indicate that the configuration has changed when their write-protect setting changes. This condition causes the previous value to remain displayed here. You can inhibit/uninhibit the HART module to refresh this value.
Manufacturer ID	Displays the manufacturer name (for example, Allen-Bradley or Endress + Hauser) or the numeric value for the manufacturer. Use the Company Identification Code table as a guide, as shown in Appendix E.
Device Type	Displays the device type for Endress + Hauser devices or a numeric value for all other manufacturer devices. Device type indicates the type of the device of the manufacturer, or product name. For example, Cerabar S pressure transmitters from Endress + Hauser have Device Type 7.
Device ID	Displays a number that represents the device ID. Device ID is a serial number that is assigned by the manufacturer that is unique among all devices that are produced by that manufacturer.
Final Assembly Number	Displays a number that represents the final assembly number. The Final Assembly Number is used for identifying the materials and electronics that comprise the field device. It's normally changed when electronics or other components are upgraded in the field. In some instances, this number references a drawing number.
Status	Channel status is available only for: • 1756-IF8H and 1756-OF8H firmware revision 2.002 or later • 1756-IF16H firmware revision 1.002 or later • 1756-IF16IH firmware revision 1.001 or later
Diagnostic Code	Device status is available only for: • 1756-IF8H and 1756-OF8H firmware revision 2.002 or later • 1756-IF16H firmware revision 1.002 or later • 1756-IF16IH firmware revision 1.001 or later
PV	In HART, the Primary Variable (PV) is signaled on the 4…20 mA analog channel. It can also be read back using HART messages. In many HART devices, the relationship between the PV and the analog signal can be adjusted. This area displays the following Process Variable attributes: • Upper Range Value - to use the same engineering units in your Logix controller as in the Field Device, enter this value in High Engineering on the Configuration tab. • Lower Range Value - to use the same engineering units in your Logix controller as in the Field Device, enter this value in Low Engineering on the Configuration tab. • Damping • Transfer Function - describes how the HART field device transforms the signal on its transducer to the PV. Usually Linear, but sometimes Square Root (for example, for flow), or other relationships.
Revision	Displays the following revision attributes. • Universal - denotes the version of the HART specification to which the device conforms. • Device • Software • Hardware

Set HART Device Information (1756-IF8IH and 1756-OF8IH Modules)

For the 1756-IF8IH and 1756-OF8IH modules with Configure HART Device set to Yes, a Set Device Info button appears on the HART Device Info tab. The Set Device Info button is enabled when the controller is on line and not in hard run mode. Selecting Set Device Info displays a dialog that lets you specify a tag name, message, and descriptor for the HART device on the selected channel. You can enter values in the text fields or copy existing entries that are already stored on the device. When you select OK, the specified values are sent to the device via HART messages.

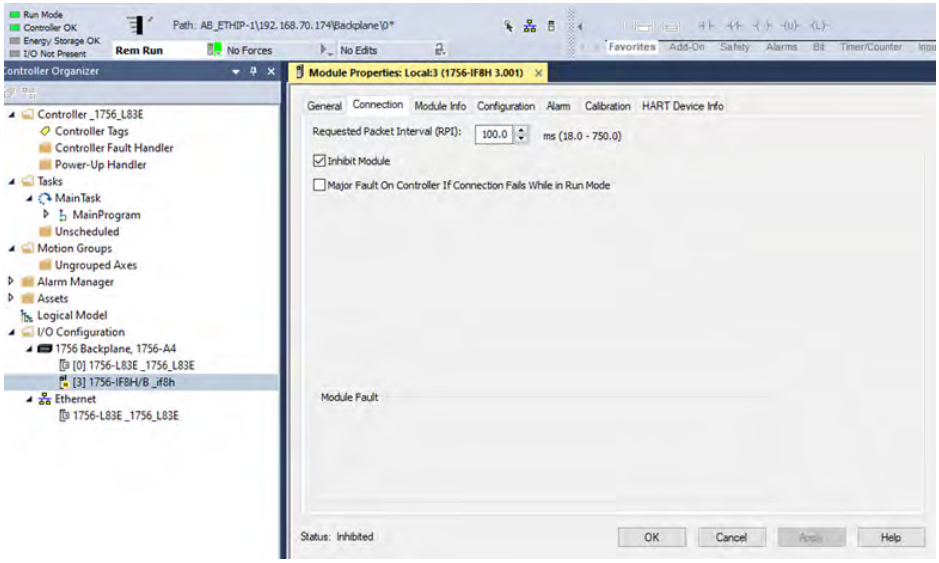


Calibrate a Module

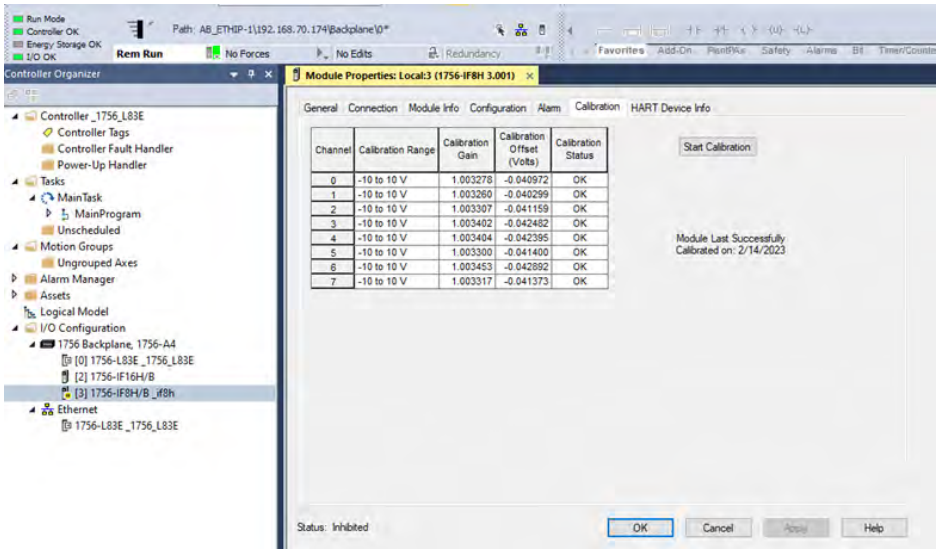
Follow these steps to calibrate your module and view the calibration data that is exchanged via CIP™ messages for each channel.

IMPORTANT The module must not be in Implicit Protected Mode. We recommend that you inhibit your module prior to calibration.

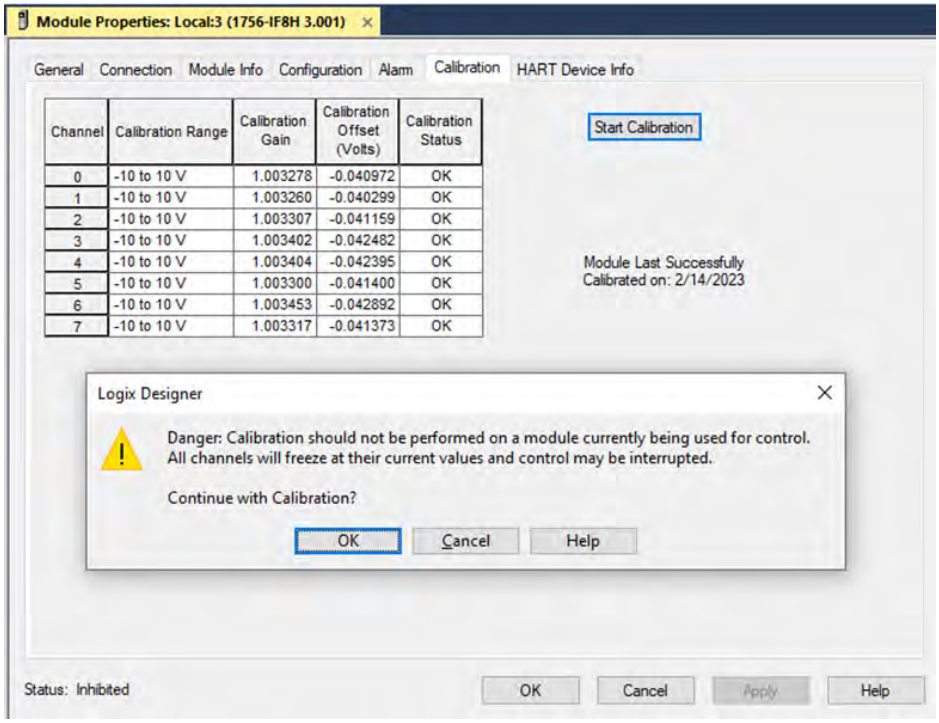
1. On the Connection tab, select Inhibit Module.



2. Select Apply.
3. On the Calibration Tab, select Start Calibration.

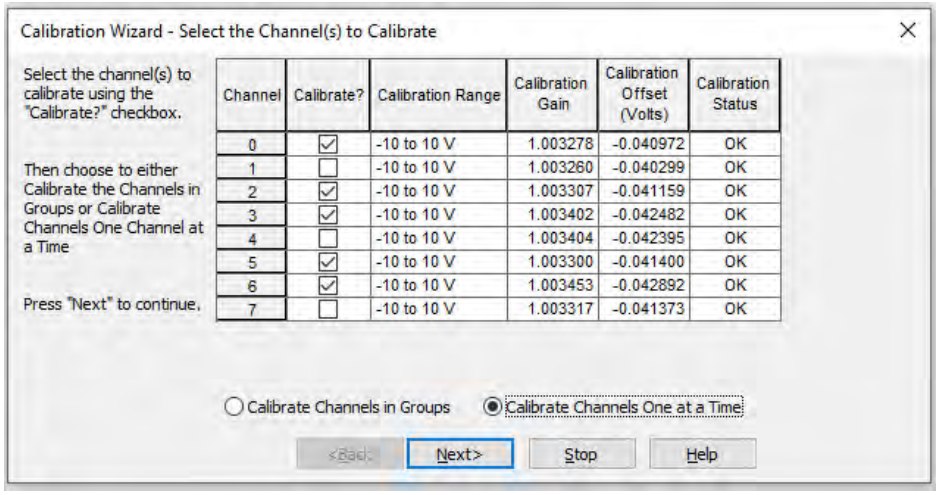


A warning appears, asking if you want to continue.



4. Select OK.

   The Calibration Wizard appears.

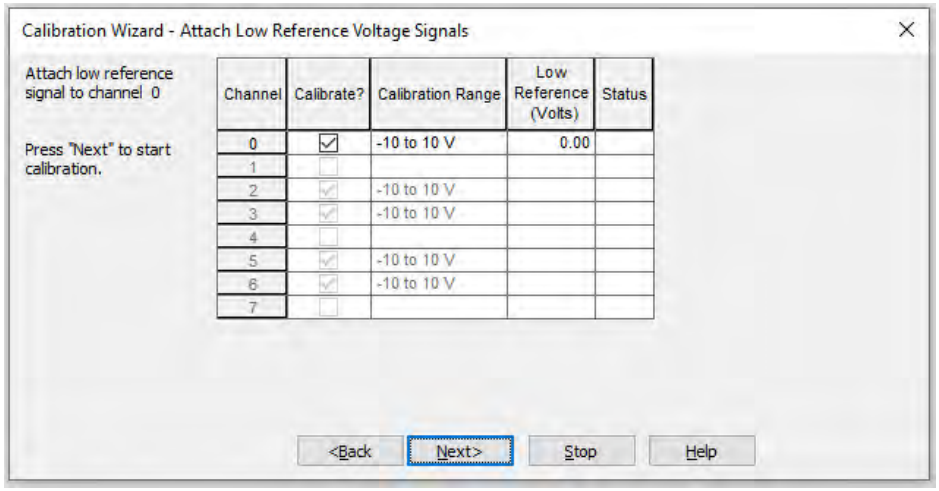


5. Select the desired channels for calibration, and use the radio button to calibrate all simultaneously, or individually.

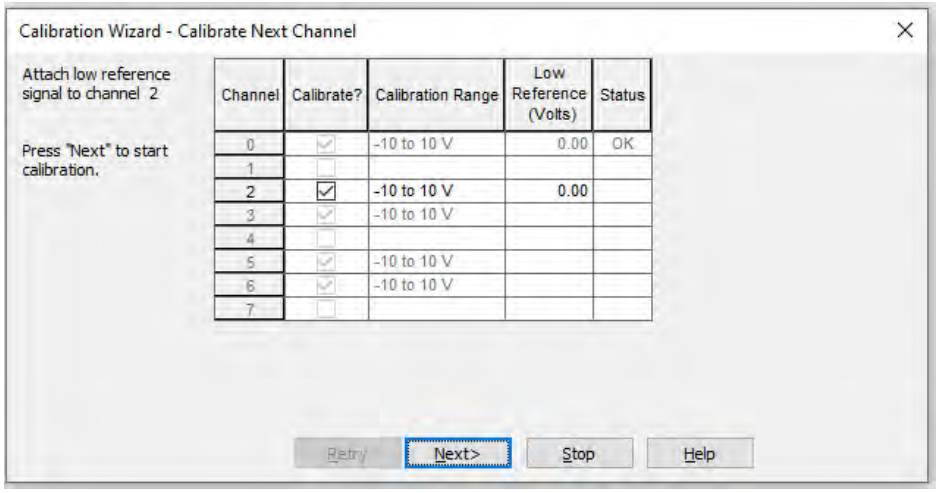
IMPORTANT When calibrating multiple channels of a 1756-IF8H module in voltage mode, in order to get the best accuracy (especially for the 5V range), channels must be calibrated individually with a single voltage source. One voltage source cannot be applied to all channels in parallel if 5V accuracy is important.

6. Select Next.

   The Attach Low Reference Voltage Signals dialog appears.



7. Attach a calibrated precision voltage source to the channel.
8. Set the current source to the low reference voltage.
9. Select Next.

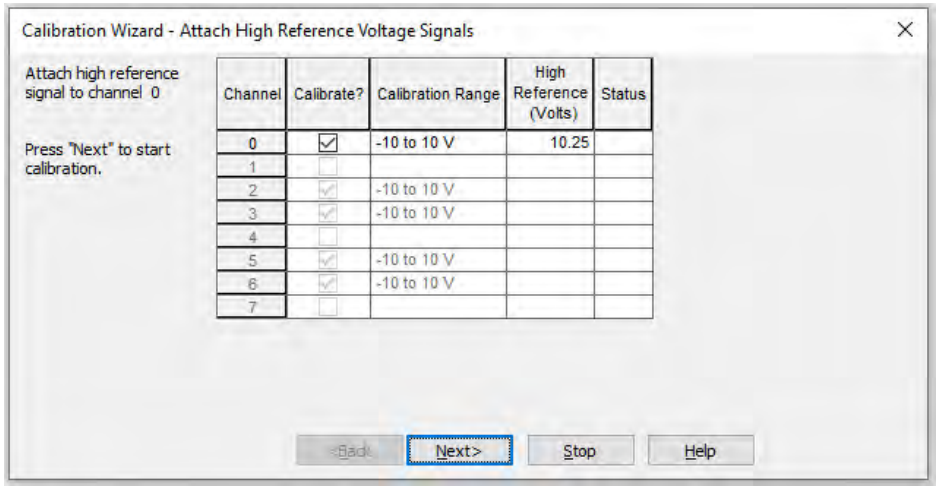


The status of the channel after calibrating for a low reference will appear.

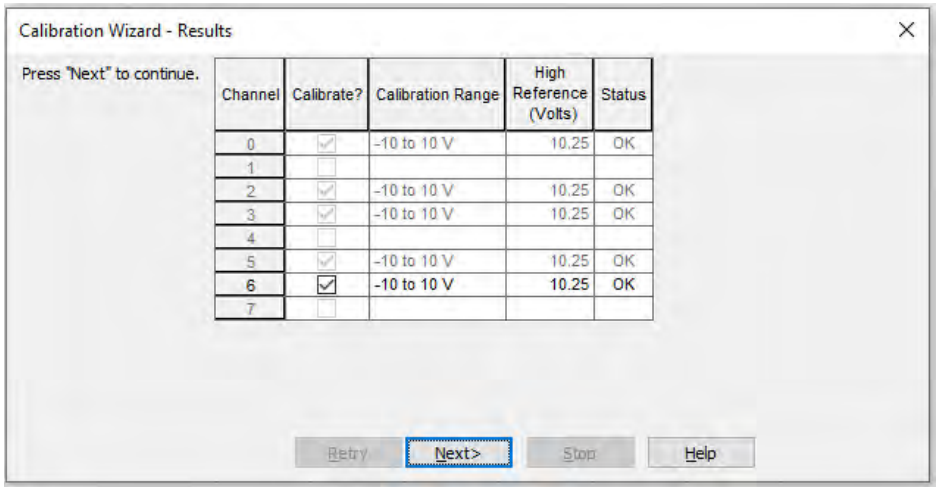
10. If any channel reports an error, return to step 8 and select Retry until the channel calibration status is OK.

    If the error persists indefinitely, select Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory, or the last field calibration.
11. Once the channel status is OK, select Next to proceed to the next channel.
12. Once the status of all the channels is OK, select Next.

    The Attach High Reference Voltage Signals dialog appears.



13. Set the current source to the high reference voltage.
14. Select Next.

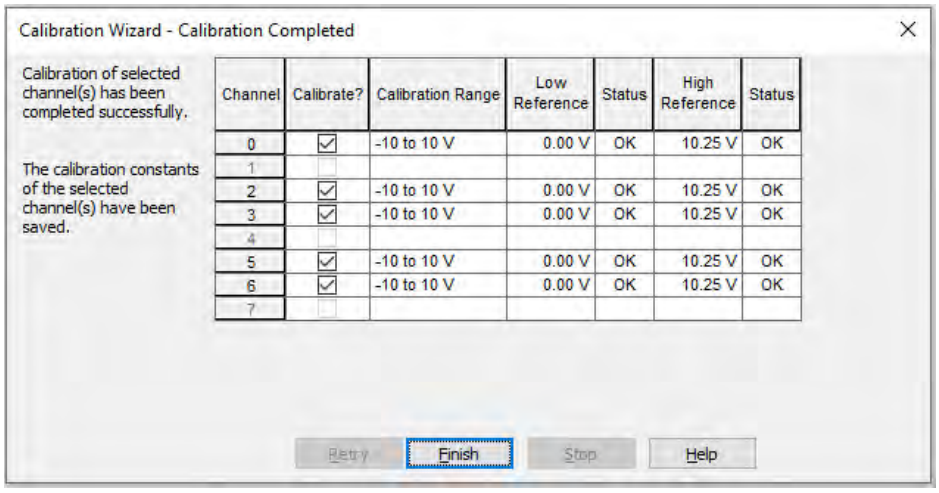


The status of the channel after calibrating for a high reference will appear.

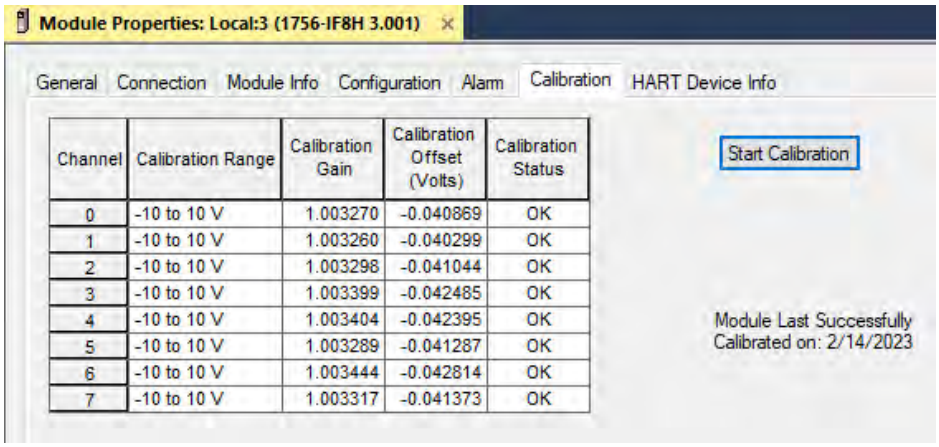
15. If any channel reports an error, return to step 13 and select Retry until the channel calibration status is OK.

    If the error persists indefinitely, select Stop to exit calibration. The channel remains calibrated to the accuracy level achieved at factory, or the last field calibration.
16. Once the channel status is OK, select Next to proceed to the next channel.
17. Once the status of all the channels is OK, select Next.

    The Calibration Completed dialog appears.



18. Select 'Finish' to close the dialog.



The Calibration tab is updated with the most recent calibration data.

This table describes the data that is displayed on the Calibration tab.

Parameter	Description (All Fields Are Read-only)
Calibration Range	Displays 0...20 mA for current channels or -10...10V for voltage channels, which are based on the output range selection on the configuration tab.
Calibration Gain	Displays the calibration gain when the module is on line.
Calibration Offset	Displays the calibration offset when the module is on line.
Calibration Status	Displays OK or Error, depending on the result of the last calibration, when the module is on line.
Last Successful Calibration	Displays the date on which a successful calibration was most recently performed.

Notes:

The following terms and abbreviations are used throughout this manual.

balanced circuit 1) A circuit whose two sides are electrically alike and symmetrical to a common reference point, usually ground. 2) Contrasted with **unbalanced circuit** (page 257).

broadcast Data transmissions to all addresses.

CIP Acronym for Common Industrial Protocol; a communication protocol, or language, between industrial devices. CIP™ provides seamless communication for devices on DeviceNet®, ControlNet®, and EtherNet/IP™ networks.

compatible match An Electronic Keying Protection mode that requires the physical module and the module that is configured in the software to match according to vendor, catalog number, and major revision. The minor revision of the module must be greater than or equal to that configured.

connection The continuous communication mechanism from the controller to an I/O module in the control system.

ControlBus The backplane that is used by the 1756 chassis.

coordinated system time (CST) Timer value, which is kept synchronized for all modules within one ControlBus™ chassis. The CST is a 64-bit number with microsecond resolution.

differential 1) Pertaining to a method of signal transmission through two wires. The transmission always has opposite states. The signal data is the polarity difference between the wires; when one is high, the other is low. Neither wire is grounded. The circuit can be either a balanced circuit, a floating circuit, or a circuit with a high-impedance path to ground from either end. Used regarding encoders, analog I/O circuits, and communication circuits. 2) Contrasted with **single-ended** (page 256).

direct connection An I/O connection, where the controller establishes an individual connection with I/O modules.

disable keying An option that turns off all electronic keying to the module. Requires no attributes of the physical module and the module that is configured in the software to match. A connection is attempted to the module even if it is the wrong type.

download The process of transferring the contents of a project on the workstation into the controller.

electronic keying A system feature that makes sure that physical module attributes are consistent with what was configured in software.

exact match An Electronic Keying Protection mode that requires the physical module and the module that is configured in the software to match identically, according to vendor, catalog number, major revision, and minor revision.

field side Interface between user field wiring and I/O module. In this glossary, see related entry for system side.

flash update The process of updating the firmware of the module.

fourth value (FV) Also abbreviated as QV for quaternary value, this dynamic variable contains the fourth value of Device Variables, which are direct or indirect process measurements by a HART field device.

frequency shift keying A method of using frequency modulation to send digital information that is used by HART field devices.

Hard Run mode Mode where keyswitch of controller is in Run position.

HART Acronym for highway addressable remote transducer.

inhibit A ControlLogix® process that lets you configure an I/O module, but prevent it from communicating with the owner-controller. In this case, the controller does not establish a connection.

Input Data format Format that defines the type of information that is transferred between an I/O module and its owner-controller. This format also defines the tags that are created for each I/O module.

interface module (IFM) A pre-wired removable terminal block (RTB).

listen-only connection An I/O connection that lets a controller monitor I/O module data without owning the module, sending it a configuration, or controlling its outputs.

major revision A module revision that is updated any time there is a functional change to the module, and results in an interface change with software.

minor revision A module revision that is updated any time there is a change to the module that does not affect its function or software user interface.

multicast Data transmissions that reach a specific group of one or more destinations.

multiple owners A configuration setup where multiple owner-controllers use the same configuration information to simultaneously own an input module.

network update time (NUT) The smallest repetitive time interval in which the data can be sent on a ControlNet network. The NUT can be configured over the range from 2...100 ms using RSNetWorx™ software.

owner-controller The controller that creates and stores the primary configuration and communication connection to a module.

primary value (PV) Dynamic variable that contains the primary value of Device Variables, which are direct or indirect process measurements by a HART field device. See page 16 for more information.

Program mode In this mode, the controller program is not executing. Inputs are actively producing data. Outputs are not actively controlled and go to their configured Program mode state.

remote connection An I/O connection where the controller establishes an individual connection with I/O modules in a remote chassis.

removable terminal block (RTB) Field wiring connector for I/O modules.

removal and insertion under power (RIUP) ControlLogix feature that lets you install or remove a module or RTB while power is applied.

requested packet interval (RPI) A configurable parameter that defines when the module will multicast data.

Run mode In this mode, the controller program is executing. Inputs are actively producing data. Outputs are actively controlled.

secondary value (SV) Dynamic variable that contains the secondary value of Device Variables, which are direct or indirect process measurements by a HART field device.

service A system feature that is performed on user demand.

single-ended 1) Unbalanced, as when one side is grounded. See **unbalanced circuit** (page 257) 2) Contrasted with **differential** (page 255).

system side Backplane side of the interface to the I/O module. In this glossary, see related entry for field side.

tag A named area of the memory of the controller where data is stored like a variable.

third value (TV) Dynamic variable that contains the tertiary, or third, value of Device Variables, which are direct or indirect process measurements by a HART field device.

timestamping ControlLogix process that stamps a change in input, output, or diagnostic data with a time reference that indicates when that change occurred.

unbalanced circuit 1) A circuit whose two sides are electrically dissimilar, as when one side is grounded. 2) Contrasted with **balanced circuit** (page 255).

Notes:

Numerics

A

C

D

E

F

G

H

I

K

L

M

N

O

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

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 compliance information on its website at rok.auto/pec.

Rockwell Otomasyon Ticaret A.Ş. Kar Plaza İş Merkezi E Blok Kat:6 34752, İçerenköy, İstanbul, Tel: +90 (216) 5698400 EEE Yönetmeliğine Uygundur

Connect with us.

rockwellautomation.com — expanding **human possibility**®

AMERICAS: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
EUROPE/MIDDLE EAST/AFRICA: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
ASIA PACIFIC: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846
UNITED KINGDOM: Rockwell Automation Ltd. Pitfield, Kiln Farm Milton Keynes, MK11 3DR, United Kingdom, Tel: (44)(1908) 838-800, Fax: (44)(1908) 261-917

Publication 1756-UM533F-EN-P - August 2023
Supersedes Publication 1756-UM533E-EN-P - November 2016