FLEX I/O HART Analog Modules

Catalog Numbers 1794-IE8H, 1794-OE8H

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual Original Instructions

Important User Information

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

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

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

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

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

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

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

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

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

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

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

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

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

Preface

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About the FLEX I/O HART Analog Modules

Chapter 2

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Notes:

Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- Who should use this manual.
- The purpose of this manual.
- Related documentation.
- Supporting information for FLEX™ I/O modules.

About This Publication

This manual is a reference guide for FLEX I/O HART analog modules. It describes the procedures that you use to install, wire, and troubleshoot your modules. This manual:

- Explains how to install and wire your modules.
- Gives you an overview of the system.

Rockwell Automation recognizes that some of the terms that are currently used in our industry and in this publication are not in alignment with the movement toward inclusive language in technology. We are 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.

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting your FLEX I/O HART analog modules.

You must be able to program and operate a ControlNet® product and ControlNet network to make efficient use of a FLEX I/O module. If you do not, obtain the proper training before using this product.

About the Vocabulary

In this manual, we refer to:

- 1794-IE8H as the ‘input module’.
- 1794-OE8H as the ‘output module’.

Summary of Changes

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

Topic	Page
Updated template	throughout
Added inclusive language acknowledgment	7
Updated 1794-OE8H Data Formats table	22
Corrected wiring diagram for 1794-IE8H module on 1794-TB3G terminal base unit	36
Improved wording in two-wire transmitter device connection instructions	37
Added connection instructions for three-wire transmitter devices	37

Additional Resources

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

Resource	Description
FLEX I/O and FLEX I/O-XT Selection Guide, publication 1794-SG002	Provides specifications and details for selecting FLEX I/O and FLEX I/O-XT™ modules.
FLEX I/O HART Analog Modules Technical Data, publication 1794-TD018	Provides specifications for FLEX I/O HART analog modules (1794-IE8H, 1794-IF8IH, 1794-OE8H, 1794-OF8IH, 1794-IF8IHNFXT).
FLEX I/O 8 Input Hart Analog Module Installation Instructions, publication 1794-IN108	Describes how to install and wire the FLEX I/O HART analog input module (1794-IE8H, series B).
FLEX I/O 8 Output HART Module Installation Instructions, publication 1794-IN109	Describes how to install and wire the FLEX I/O HART analog output module (1794-OE8H, series B).
FLEX I/O ControlNet Adapters Installation Instructions, publication 1794-IN128	Describes how to install a FLEX I/O ControlNet adapter (1794-ACN15, 1794-ACNR15, 1794-ACNR15XT, series D)
FLEX I/O Terminal Base Units Installation Instructions, publication 1794-IN092	Describes how to install the FLEX I/O terminal base units (1794-TB2, 1794-TB2K, 1794-TB3, 1794-TB3K, 1794-TB3S, 1794-TB32, 1794-TB32S, 1794-TB32SK, 1794-TB32K, 1794-TB3G, 1794-TB3GK, 1794-TB3GS, 1794-TB3T, 1794-TB3TS, 1794-TBN, 1794-TBNK, 1794-TBNF, 1794-TB3SK, 1794-TB3GSK, 1794-TB3TK, 1794-TB3TSK).
Interconnect Cable Installation Instructions, publication 1794-IN012	Describes how to install the interconnect cable (1794-CE1, 1794-CE3).
FLEX I/O Power Supply Modules Installation Instructions, publication 1794-IN069	Describes how to install the FLEX I/O power supply (1794-PS13, 1794-PS13K, 1794-PS3, 1794-PS3K).
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

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

About the FLEX I/O HART Analog Modules

Read this chapter to familiarize yourself with the input and output analog modules.

What the FLEX I/O Analog I/O Modules Do

The 1794 HART input and output modules must be used in a ControlNet or EtherNet/IP™ network.

The 1794-IE8H module accepts up to eight analog inputs. The inputs are nonisolated and accept current in either of the following two ranges: 4…20 mA or 0…20 mA. The default input range is 0…20 mA. The inputs have both fixed hardware filters and selectable firmware digital filters.

Similarly, the 1794-OE8H module provides as many as eight analog outputs. The outputs are nonisolated and provide current in either of the following two ranges: 4…20 mA or 0…20 mA. The default output range is 0…20 mA.

Each module offers:

- Local microprocessor intelligence for advanced features.
- Full functionality without switches or jumpers.
- Multiple data ranges that can be independently programmed in channel groups.
- Lead breakage detection.
- Overrange/underrange alarms.
- Remote transmitter alarm.

How FLEX I/O Analog Modules Communicate with Programmable Controllers

FLEX I/O analog modules provide best utility when used with ControlNet products on the ControlNet network. Data connections are established between the I/O module and an Allen-Bradley® programmable controller to transfer information between the two at a scheduled rate.

Input module information is then automatically made available in the PLC data table through the data connection. Reciprocally, output data information determined by the controller program is also automatically transferred from the controller data table to the output module through the data connection.

In addition, when the data connection is originally established, configuration information for the module is automatically transferred to it over the network.

Events Following Power-up

You must apply +24V DC power to your FLEX I/O analog I/O modules. The following sequence of events occurs after power has initially been applied to your module:

1. The module begins an internal diagnostic check. The channel 0 indicator turns ON to indicate that the check has begun. The indicator turns OFF when the check is finished.
2. After the diagnostic check, module configuration information, that you have select and downloaded over the network, is applied by the module.

   For more information on configuration options, see Chapter 2
3. Following the module configuration download for the 1794-IE8H module, the module begins producing runtime data for the PLC processor.

   Following the module configuration download for the 1794-OE8H module, the module applies configuration data to output channels.
4. If any diagnostics or alarms are generated during normal module operation, the data is returned to the PLC processor.

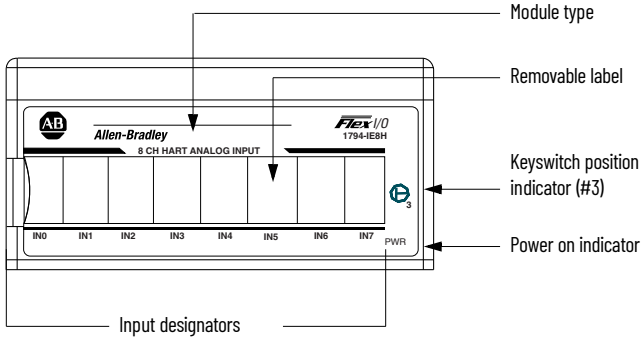
Physical Features of Your Analog I/O Module

The module label identifies the keyswitch position, wiring, and module type. Use the removable label to note individual designations per your application.

Indicators

Indicators are provided to identify input or output fault conditions, and to show when power is applied to the module. For example, the 1794-IE8H module is shown.

1794-IE8H



Use Alarms on the 1794-IE8H Module

The 1794-IE8H FLEX I/O module can generate four alarms:

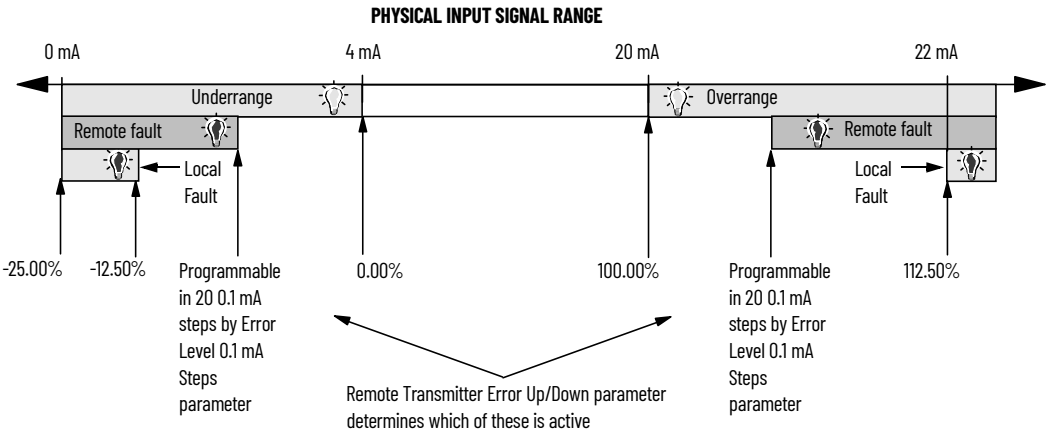
- Underrange
- Overrange
- Remote Fault
- Local Fault

These alarm conditions are described in general terms and as they relate to bits on the FLEX I/O module on the following pages. Figure 1 shows at what values these alarms are generated for Data Format 4.

Data Format Alarm Example

In this example, the normal active data range is 4...20 mA. The alarms are generated in three overlapping bands.

Figure 1 - Data Format Alarm Example



Overrange Alarm

The overrange alarm notifies you when module input is overrange. When the input signal exceeds 100% (20 mA), an Overrange Alarm is generated.

This alarm stays active at any value above 100% of range and is always enabled by the module.

Underrange Alarm

The underrange alarm works converse to the overrange. This feature notifies you when the input signal falls underrange. If the input signal falls below 0% (4 mA), an Underrange Alarm is generated.

This alarm stays active at any value below 0% of range and is always enabled by the module.

Remote Fault Alarm

The remote fault alarm is intended for use with remote transmitter loops.

For example, the remote transmitter may be measuring temperature and converting it to a standard mA signal. In such a loop, though, the input module can't determine the state of the loop on the far side of the transmitter. However, the remote transmitter may be capable of diagnosing a problem in the remote loop and signal the input module local loop with a preprogrammed out of range (high or low) value.

The remote fault alarm allows the 1794-IE8H module to work with transmitters like the one described. You must use the Remote Transmitter Error Up or Down feature, see Remote Transmitter Error Up or Down on page 16, to configure your application for Remote Fault notification.

For example, you must determine if you want a remote fault to cause high out-of-range values or low out-of-range values to be returned to the controller.

IMPORTANT Once the alarm is issued, it remains active as long as the input signal value remains above the programmed value.

Use Remote Fault Alarm to Determine High-High or Low-Low Alarm Levels

If you do not have a remote transmitter in your loop, this alarm can also be used to program a high-high or low-low alarm level between the levels that actuate the overrange or underrange alarms and the high or low local fault alarms.

IMPORTANT When establishing high-high or low-low alarms, you can only select one side (high or low). You must use the Remote Transmitter Error Up or Down feature with this alarm.

Programming the Remote Fault Alarm

For the remote fault alarm, you must program the threshold in 0.1 mA steps at any level on the high or low end of the input signal range. The remote fault alarm activates if your I/O module receives input signal values of:

- 100.63…111.88% (20.1…21.9 mA) on the high-end of input signal range

  or
- -0.63…-11.88% (3.9…2.1 mA) on the low end of input signal range

IMPORTANT This alarm is only active for one band, either on the high side of normal operation or the low side. The Remote Transmitter Error Up/Down parameter determines which side is active. See page 16 for a description of the Remote Transmitter Error Up/Down feature.

Local Fault Alarm

The local fault alarm notifies you when the loop to the transmitter or field device, if no transmitter is used, is open or shorted.

IMPORTANT Once the alarm is issued, it remains active as long as the input signal value remains in the programmed range.

- 112.50% (22 mA) or higher on the high-end of input signal range.

  This value indicates a short in the loop.

  or
- -12.50% (2 mA) or lower on the low end of input signal range.

  This value indicates an open wire condition in the loop.

The remote fault and local fault alarms are issued with the same bit whether the cause is under or overrange. Monitor the overrange and underrange bits in your programming software to determine if the problem is a high current or low current.

How to Use the HART Capabilities

Before using the HART capabilities, be sure that:

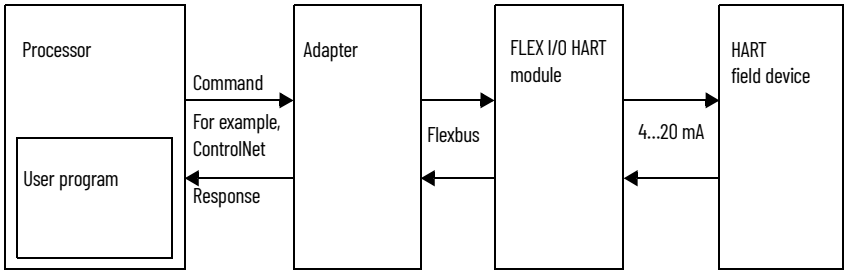
- The I/O module and the associated field device are working properly in the analog 4…20 mA mode.
- The I/O module is configured for 4…20 mA range.
- The field device is HART capable.

- No more than one HART field device is connected to each channel.
- Input filtering is set to a valid (defined) value.

HART Implementation Overview

The FLEX I/O HART modules act as intelligent HART multiplexers. Basically, the module learns which HART devices are attached to its channels and then routes HART messages, as appropriate, between the HART field devices and the Flexbus. Since the HART modules act as intelligent HART multiplexers, HART commands can be issued to the HART modules themselves.

Communication on the Flexbus occurs between the adapter and the HART module. The adapter converts these messages to the appropriate network format for communication with the controlling processor. The controlling processor gets its command from the user program, and stores the responses in its memory.



Notes:

Configurable FLEX I/O Analog Module Features

Table 1 describes the HART configurable features in this chapter.

Table 1 - Analog/Digital Configurable Features on the FLEX I/O Analog I/O Modules

1794-IE8H Input Module Features	1794-OE8H Output Module Features
Fault Mode	Output Enable
Remote Transmitter Error Up or Down	Module Fault State Mode
High Low Error Level	Local Fault Mode
Input Filter Cutoff	Digital Output
	Latch Retry Mode
	Global Reset
	Analog Digital State
Data Format	Analog Fault State
	Digital Fault State
	Data Format
	Fault Alarm

IMPORTANT You must use the I/O configuration portion of your controller programming software to select and configure these features. This manual assumes familiarity with the programming software. A brief description of each module feature is provided here. For more information on your programming software, see the software user manual.

Select Your FLEX I/O Analog Input Module's Operating Features

All features of the 1794-IE8H analog input module are independently configurable in two four-channel groups (channel 0...3 and channel 4...7).

IMPORTANT The default selection value for all parameters is 0.

Fault Mode

Your input modules can indicate various fault conditions, depending on the input signal value. Use the Fault Mode feature to enable or disable two alarms:

- Remote Fault alarm.
- Local Fault alarm.

Use your programming software to set the Fault mode bit to 0 to disable these alarms. Set the bit to 1 to enable them.

IMPORTANT Fault mode only enables or disables the Remote and Local Fault alarms. It does not affect the Underrange and Overrange alarms. They are always active.

For more information on the Remote Fault Alarm, see page 11. For more information on the Local Fault Alarm, see page 12.

Remote Transmitter Error Up or Down

A second feature of your input module that affects use of the Remote Fault alarm is the Remote Transmitter Error Up or Down feature. Used with the High Low Error level, this feature designates whether to display faults with input signal readings beyond the high or low signal levels that are normally used by the module.

When setting the Remote Transmitter Error Up or Down feature in your programming software, set this feature's bit to 0 to select up. Set the bit to 1 to select down.

For more information on the Remote Fault Alarm, see page 11. For more information on the Local Fault Alarm, see page 12.

High Low Error Level

High Low Error level sets the high and low signal levels at which your input modules indicate a signal fault. This feature works with the Remote Transmitter Error Up or Down.

If the Remote Fault Alarm feature is enabled and a remote fault occurs, the module detects and reports the fault, depending on how you configure the High Low Error level.

Use your programming software to set the high or low error levels.

Input Filter Cutoff

Eight available input filter settings allow you to choose the best roll-off frequency for input channels on your I/O module. When choosing a filter, remember that time filter selection affects your input signal's accuracy.

For example, if you choose the highest frequency of 10 Hz (filter 3), signal noise is more likely to affect the reading, but the slowest frequency of 0.5 Hz (filter 7) provides the most accurate signal due to incoming noise filtering.

See Table 2 to decide which input filter to use in your FLEX I/O analog I/O application:

Table 2 - Input Filter Frequency

Filter	7	6	5	4	3	2	1	0
Frequency	0.5 Hz (2 s)	1 Hz (1 s)	2 Hz (500 ms)	4 Hz (250 ms)	10 Hz (100 ms)	Reserved		

Choose the best input filter cutoff in your programming software.

Data Format

You must choose a module data format in your user program. Formats 8, 9, 10, and 15 are not used. If you select the data formats for a channel quad, a configuration fault occurs and is reported as Diagnostic Data 2. All data for that channel quad is set to zero.

- Formats 5, 12, 13, and 14 are 2's complement data formats, and return data in that form.
- 12 Formats are available.
- Default format is 0…20 mA.
- The data format that you select interprets input readings and returns them to the controller.

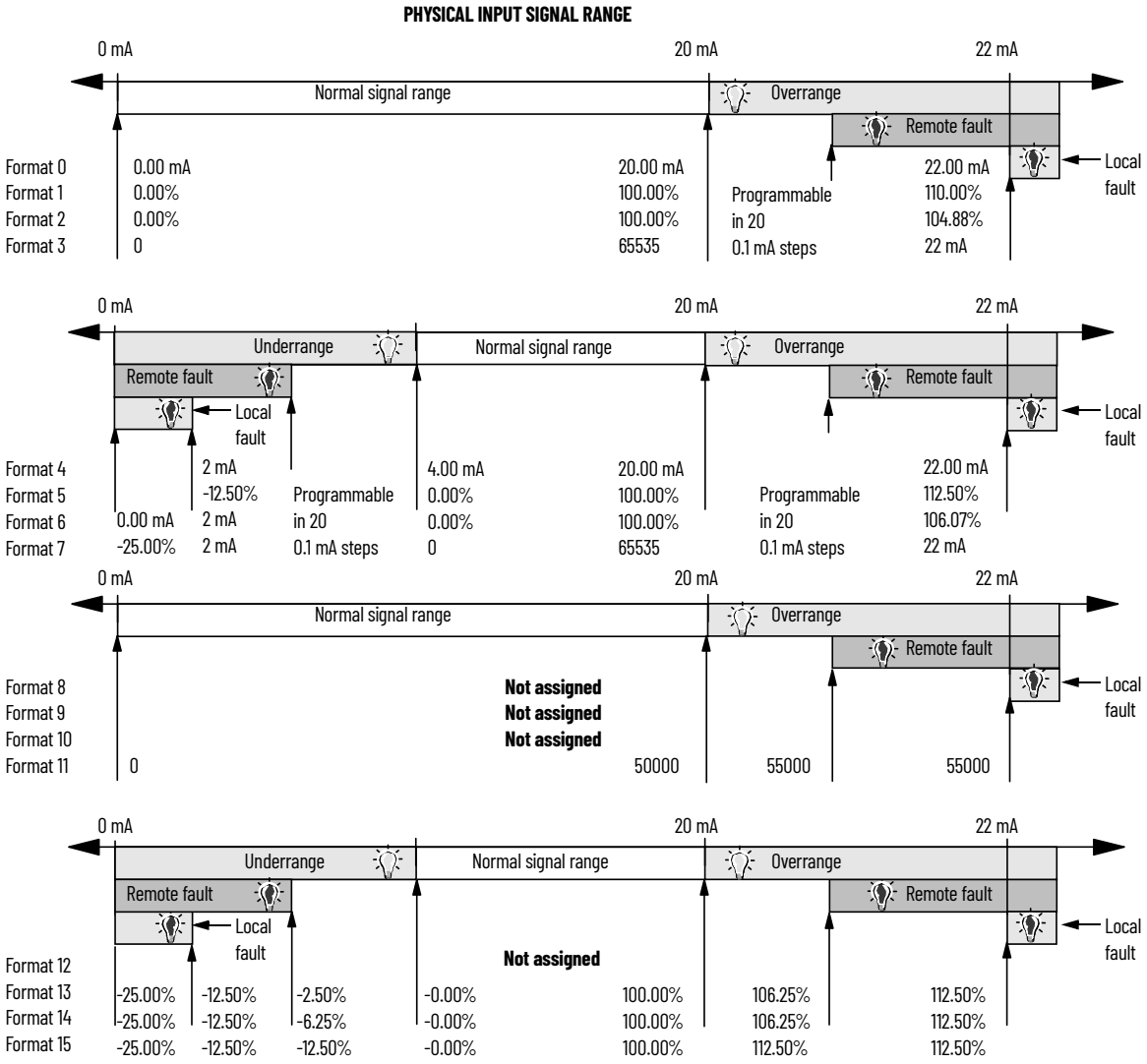
Table 3 - 1794-IE8H Data Formats

Data Format	Format	Resolution	Input Range	Module Data Processing	Data Table Value (Interpretation)	Count per mA	Error Steps
0	0…20 mA as mA	0.1% of 0…20 mA	0…22 mA	Datatable = 1000 (input)	0…22000 (0…22.000 mA)	1000	With error steps
1	0…20 mA as %	0.2% of 0…20 mA	0…22 mA	Datatable = 10000 $\frac{(\text{input})}{20}$	0…11000 (0…110.00%)	500	
2	0…20 mA as 0%	0.19% of 0…20 mA	0…22 mA	Datatable = 10000 $\sqrt{\frac{\text{input}}{20}}$ IF…Square_Root_Threshold < 10000 $\sqrt{\frac{\text{input}}{20}}$ Else…datatable = 0	0…10488 (0…104.88%)	524	
3	0…20 mA as unsigned integer	0.03% of 0…20 mA	0…20 mA	Datatable = 65535 $\frac{(\text{input})}{20}$	0…65535 (0…22 mA)	3276	
4	4…20 mA as mA	0.1% of 4…20 mA	2…22 mA	Datatable = 1000 (input)	2000…22000 (2.000…22.000 mA)	1000	

Table 3 - 1794-IE8H Data Formats (Continued)

Data Format	Format	Resolution	Input Range	Module Data Processing	Data Table Value (Interpretation)	Count per mA	Error Steps
5	4...20 mA as %	0.16% of 4...20 mA	2...22 mA	Datatable = 10000 $\left(\frac{\text{input-4}}{16}\right)$	-1250...+11250 (2's complement) (-12.50%...+112.50%)	625	With error steps
6	4...20 mA as 0%	0.17% of 4...20 mA	4...22 mA	Datatable = 10000 $\sqrt{\frac{\text{input-4}}{16}}$ IF...Square_Root_Threshold < 10000 $\sqrt{\frac{\text{input-4}}{16}}$ Else...datatable = 0	0...10607 (0...106.07%)	589	With error steps, underrange not allowed
7	4...20 mA as unsigned integer	0.03% of 4...20 mA	4...20 mA	Datatable = 65535 $\left(\frac{\text{input-4}}{16}\right)$	0...65535 (4...20 mA)	4095	With error steps
8	Not assigned						
9							
10							
11	0...20 mA as A/D count	0.04% of 0...20 mA	0...22 mA	Datatable = 55000 $\left(\frac{\text{input}}{22}\right)$	0...55000 (0...22 mA)	2500	All fixed
12	4...20 mA as %	0.16% of 4...20 mA	3.6...21 mA	Datatable = 10000 $\left(\frac{\text{input-4}}{16}\right)$	-250...+10625 (2's complement) (-2.50...+106.25%)	625	NAMUR NE 4 all fixed
13	4...20mA as %	0.16% of 4...20 mA	3...21 mA	Datatable = 10000 $\left(\frac{\text{input-4}}{16}\right)$	-625...+10625 (2's complement) (-6.25...+106.25%)		All fixed
14	4...20 mA as %	0.16% of 4...20 mA	2...22 mA	Datatable = 10000 $\left(\frac{\text{input-4}}{16}\right)$	-1250...+11250 (2's complement) (-12.50...+112.50%)		
15	Not assigned						

Data Formats and Error Ranges



Select Your FLEX I/O Analog Output Module's Operating Features

All features of the 1794-OE8H analog output module are independently configurable in two four-channel groups (channel 0...3 and channel 4...7).

IMPORTANT The default selection value for all parameters is 0.

Local Fault Mode

The Local Fault Mode can be programmed to determine how the module responds to communications faults and internal module faults.

When setting the Local Fault Mode feature in your programming software, set this feature's bit to 0 to use the analog fault state or digital fault state only if a communications fault occurs. Set the bit to 1 to use the Analog Fault state or Digital Fault state if any fault occurs.

Latch Mode

Latch Mode determines channel operation under wire-off or lead-break fault conditions. This feature controls the operation of two channel groups, channels 0…3 and channels 4…7. Channel detection occurs on a continuous basis. If a fault is detected, the channel fault alarm is set.

If you enable Latch mode, when a fault occurs the fault remains latched in its fault state until you issue a Global Reset (see Global Reset on page 20). If you disable Latch mode, when a fault occurs the channel reports a fault until you correct the fault. Global Reset is not necessary if Latch mode is disabled.

In your programming software, set the Latch mode bit to 0 to disable the feature. Set the bit to 1 to enable it.

Global Reset

Global Reset works with Latch mode during fault conditions. If you enable Latch mode and a fault condition occurs, the channel operating with a fault remains in this condition (with analog or digital fault state implied) until you issue a Global Reset. The Global Reset feature resets all outputs of a particular channel group to accept normal system output data.

The Global Reset feature is an edge triggered signal. In your programming software, set the Global Reset bit to 1 for normal operation. Output reset occurs during the 1…0 transition.

Analog Digital State

You can configure your FLEX I/O analog output modules to work in an analog mode or digital mode with the Analog Digital State feature. Depending on which state you choose for your application, additional parameters must be configured for your module to react to fault conditions. See Analog Fault State on page 20 and Digital Fault State on page 21.

Set the Analog Digital State bit in your programming software to 0 for your module to operate in an analog state. Set the bit to 1 for your module to operate in a digital state. A selection bit is available to each channel.

Analog Fault State

The Analog Fault State feature determines how your I/O module reacts to faults when a channel is used in analog mode. After a fault condition occurs, the module may got to minimum value, maximum value, hold last state, or use analog fault state value.

Use your programming software to set the Analog Fault State bits on the I/O module for one of the following fault reactions:

- 0 = Minimum value
- 1 = Maximum value
- 2 = Hold last state
- 3 = Use analog fault state value

You can set these parameters independently for channels 0…1, 2…3, 4…5, and 6…7.

Analog Fault State Value

Specifies the fault state value of the analog output data to the module. The Module Data Format Control parameter controls the specific format. This data is used when the channel is in analog output mode and you configure the analog fault state to use analog fault state value.

Digital Fault State

The Digital Fault State feature determines how your I/O module reacts to faults when a channel is used in digital mode. After a fault condition occurs, the module may reset channel outputs or hold last state of the outputs.

Use your programming software to set the Digital Fault State bit to 0 to reset outputs. Set to 1 to hold last state of the outputs after a fault occurs. This feature is available on a per channel basis.

Data Format

You must choose a module data format in your user program. See 1794-OE8H Data Formats on page 22 for an explanation of each bit. Data Formats 2, 5, 6, 8, 9, 10, 12 and 15 are not assigned.

When choosing a data format, remember the following:

- If you select an unassigned Analog Data Format, the module sets Diagnostic Data to 2 for configuration failure and puts affected channels in the corresponding fault state.
- Assume that an unconfigured module channel pair has the default configuration of Analog Data Format 0, 0…20 mA, and Analog Mode Fault State minimum range. If you select a non-assigned format, then the diagnostic 2 for configuration failure is set and the module channel pair goes to the default fault state minimum range.
- If on the other hand, you change the configuration from the default, and then change it again to a non-assigned format, then the diagnostic bit 2 for configuration failure is set and the module goes to the fault state for the last valid configuration.
- Formats 13 and 14 are 2's complement data formats, and require data to the module in that form.
- Range: 0…15
- Default: 0

Data Table Reference: Data format, word 12 and 13, bits 0…3, bits 4…7

If the module that is out of range, the value is clipped and Diagnostic Data is set to 11 data out of range.

Figure 2 - Diagnostic Data Error 11 - Data Out of Range

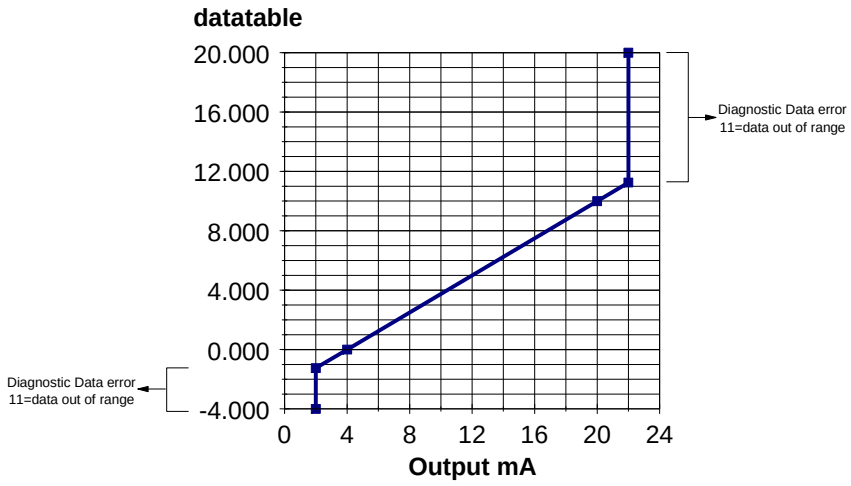


Table 4 - 1794-OE8H Data Formats

Data Format	Format	Resolution	Full Output Range	Module Data Processing	Data Table Value (Interpretation)	Count per mA	Analog Fault State
0	mA as 0...20 mA	0.1% of 0...20 mA	0...22 mA	Output = $\left(\frac{\text{datatable}}{1000}\right)$	0...22000 (0...22.000 mA)	1000	Min=0 mA Max=22 mA Hold last=hold Use FS value
1	% as 0...20 mA	0.2% of 0...20 mA	0...22 mA	Output = 20 $\left(\frac{\text{datatable}}{10000}\right)$	0...11000 (0...110.00%)	500	Min=0 mA Max=22 mA Hold last=hold Use FS value
2	Not assigned						
3	Unsigned integer as 0...20 mA	0.03% of 0...20 mA	0...20 mA	Output = 20 $\left(\frac{\text{datatable}}{65535}\right)$	0...65535 (0...22 mA)	3276	Min=0 mA Max=20 mA Hold last=hold Use FS value
4	mA as 4...20 mA	0.1% of 4...20 mA	2...22 mA	Output = $\left(\frac{\text{datatable}}{1000}\right)$	2000...22000 (2.000...22.000 mA)	1000	Min=2 mA Max=22 mA Hold last=hold Use FS value
5	4...20 mA	–	4...20 mA	Not assigned	–	–	–
6	4...20 mA		4...20 mA				
7	Unsigned integer as 4...20 mA	0.03% of 4...20 mA	4...20 mA	Output = 16 $\left(\frac{\text{datatable}}{65535}\right)$ + 4	0...65535 (4...20 mA)	4095	Min=4 mA Max=20 mA Hold last=hold Use FS value
8	Not assigned						
9							
10	Not assigned						
11	D/A count as 0...20 mA	0.28% of 0...20 mA	0...22 mA	Output = 22 $\left(\frac{\text{datatable}}{8000}\right)$	0...8000 (0...22 mA)	363	Min=0 mA Max=22 mA Hold last=hold Use FS value
12	4...20 mA	–	–	Not assigned	–	–	–
13	% as 4...20 mA	0.16% of 4...20 mA	3...21 mA	Output = 16 $\left(\frac{\text{datatable}}{10000}\right)$ + 4	-625 ...+10625 (2's complement) (-6.25...+106.25%)	625	Min=3 mA Max=21 mA Hold last=hold Use FS value
14	% as 4...20 mA	0.16% of 4...20 mA	2...22 mA	Output = 16 $\left(\frac{\text{datatable}}{10000}\right)$ + 4	-1250...+11250 (2's complement) (-12.50...+112.50%)	625	Min=2 mA Max=22 mA Hold last=hold Use FS value
15	Not assigned						

Fault Alarm

Fault Alarm selects whether the channel pair fault detection is enabled or disabled. There is a 100 Hz (10 ms) filter for wire off or lead break detection.

Use your programming software to set the Fault Alarm. Set the feature bit to 0 to disable the alarm. Set the bit to 1 to enable wire off/lead break fault detection.

Understand Image Table Mapping and Bit/Word Descriptions

Bit Descriptions

Table 5 describes bits used in image table mapping and bit/word descriptions.

Table 5 - Bit/Word Descriptions

Bits	Location	Definition
Ch	1794-IE8H Input and output maps 1794-OE8H Input and output maps	Channel
Ovr Alm	1794-IE8H Input map	Overrange Alarm
Und Alm	1794-IE8H Input map	Underrange Alarm
Rm Flt	1794-IE8H Input map	Remote Fault
Lo Flt	1794-IE8H Input map	Local Fault
Res Flg	1794-IE8H Input map 1794-OE8H Input map	Response Flag
U/D	1794-IE8H Output map	Up/down
Flt Md	1794-IE8H Output map	Fault Module
Cd Flg	1794-IE8H Output map 1794-OE8H Output map	Command Flag
Flt Alm	1794-OE8H Input map	Fault Alarm
Glbl Rst	1794-OE8H Output map	Global Reset
Lo Flt Md	1794-OE8H Output map	Local Fault Module
Alg Flt Ste	1794-OE8H Output map	Analog Fault State
Lth Rty	1794-OE8H Output map	Latch Retry
Dig Flt Ste	1794-OE8H Output map	Digital Fault State
Alg Dig Md	1794-OE8H Output map	Analog Digital Module
Diagnostic Status	1794-IE8H Input map 1794-OE8H Input map	Diagnostic Status
HRBD	1794-IE8H Input map 1794-OE8H Input map	HART Rebuild Flag
HRB	1794-IE8H Input map 1794-OE8H Input map	HART Readback Flag
HFAIL	1794-IE8H Input map 1794-OE8H Input map	HART Failure Flag
HTMT	1794-IE8H Input map 1794-OE8H Input map	HART Transmitter Flag
HCM	1794-IE8H Input map 1794-OE8H Input map	HART Communication Flag

Analog Input Module (1794-IE8H) Image Table Mapping

Table 6 - Input Map (Read Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
0	Channel 0 Input data															
1	Channel 1 Input data															
2	Channel 2 Input data															
3	Channel 3 Input data															
4	Channel 4 Input data															
5	Channel 5 Input data															
6	Channel 6 Input data															
7	Channel 7 Input data															
8	Ovr Alm CH 7	Ovr Alm CH 6	Ovr Alm CH 5	Ovr Alm CH 4	Ovr Alm CH 3	Ovr Alm CH 2	Ovr Alm CH 1	Ovr Alm CH 0	Und Alm CH 7	Und Alm CH 6	Und Alm CH 5	Und Alm CH 4	Und Alm CH 3	Und Alm CH 2	Und Alm CH 1	Und Alm CH 0
9	Rm Flt CH 7	Rm Flt CH 6	Rm Flt CH 5	Rm Flt CH 4	Rm Flt CH 3	Rm Flt CH 2	Rm Flt CH 1	Rm Flt CH 0	Lo Flt CH 7	Lo Flt CH 6	Lo Flt CH 5	Lo Flt CH 4	Lo Flt CH 3	Lo Flt CH 2	Lo Flt CH 1	Lo Flt CH 0
10	Reserved								H Rbd	Reserved			Diagnostic Status			
11	H Rb CH 7	H Rb CH 6	H Rb CH 5	H Rb CH 4	H Rb CH 3	H Rb CH 2	H Rb CH 1	H Rb CH 0	H Fail CH 7	H Fail CH 6	H Fail CH 5	H Fail CH 4	H Fail CH 3	H Fail CH 2	H Fail CH 1	H Fail CH 0
12	H Tmt CH 7	H Tmt CH 6	H Tmt CH 5	H Tmt CH 4	H Tmt CH 3	H Tmt CH 2	H Tmt CH 1	H Tmt CH 0	H Cm CH 7	H Cm CH 6	H Cm CH 5	H Cm CH 4	H Cm CH 3	H Cm CH 2	H Cm CH 1	H Cm CH 0

Where: CH = Channel
Ovr Alm = Over Range Alarm
Und Alm = Under Range Alarm
Rm Flt = Remote Fault
Lo Flt = Local Fault
H Rbd = HART Rebuild
H Rb = HART Readback
H Fail = HART Failure
H Tmt = HART Transmitter
H Cm = HART Communication

Table 7 - Configuration Map (Write Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓	Write															
0	Reserved		High and Low Error Level 0…3					U/D 0…3	Filter Cutoff 0…3			Data Format 0…3				Flt Md 0…3
1	Sqrt		High and Low Error Level 4…7					U/D 4…7	Filter Cutoff 4…7			Data Format 4…7				Flt Md 4…7

Where: U/D = Up/down
Flt Md = Fault Module
Sqrt = Square Root

Bit/Word Description for the Analog Input Module (1794-IE8H)

Table 8 - Fault Mode - Write Words 0 and 1

Word 0	Bit 00	Fault enable for channels 0…3
Word 1	Bit 00	Fault enable for channels 4…7

Where: 0 = Disabled
1 = Enable with wire-off and overload or short circuit

Table 9 - Add-On Filter Selections - Write Words 0 and 1

Word	Bits			Description
0	07	06	05	Channels 0…3
1	07	06	05	Channels 4…7
	0	0	0	Reserved - Module does not operate with these settings.
	0	0	1	
	0	1	0	
	0	1	1	10 Hz (100 ms)
	1	0	0	4 Hz (250 ms)
	1	0	1	2 Hz (500 ms)
	1	1	0	1 Hz (1 s)
	1	1	1	0.5 Hz (2 s)

Table 10 - Remote Transmitter Error Up/Down - Write Words 0 and 1

Word 0	Bit 08	Up/down channels 0…3
Word 1	Bit 08	Up/down channels 4…7
Where:	0 = remote fault is enabled by transmitter overrange 1 = remote fault is enabled by transmitter underrange	

Table 11 - Data Format - Write Words 0 and 1

	Bits				**Description**
Word 0	04	03	02	01	Data format for channels 0…3
Word 1	04	03	02	01	Data format for channels 4…7
	0	0	0	0	0…22 mA, with error steps (default)
	0	0	0	1	0…22 mA = 0…110%, with error steps
	0	0	1	0	0…22 mA = 0…104.8 %, square root, with error steps
	0	0	1	1	0…22 mA = 0…65,535, unsigned integer, with error steps
	0	1	0	0	2…22 mA, w/error steps
	0	1	0	1	2…22 mA = -12.5…112.5 %, with error steps
	0	1	1	0	4…22 mA = 0…106%, square root, with error steps
	0	1	1	1	4…20 mA = 0…65,535, unsigned integer, with error steps
	1	0	0	0	Not assigned
	1	0	0	1	Not assigned
	1	0	1	0	Not assigned
	1	0	1	1	0…22 mA = A/D count, with fixed error
	1	1	0	0	3.6…21 mA = NAMUR NE 43, with fixed error
	1	1	0	1	3…21 mA = -6.25…106.28 % with fixed error
	1	1	1	0	2…22 mA = -12.5…112.5 % with fixed error
	1	1	1	1	Not assigned

Table 12 - Error Level 0.1 mA Steps

	Bits					**Description**
Word 0	13	12	11	10	9	Error level channels 0…3
Word 1	13	12	11	10	9	Error level channels 4…7
	0	0	0	0	0	Disabled
						0.1 mA * step value = remote fault alarm threshold
						Examples
Data Format 2…22 mA - 12.5…112.5 %	0	0	1	1	1	Step value = 7, 0.1 mA * 7 = 0.7 mA Remote fault alarm at -4.38 % or +104.38%
	0	1	1	1	1	Binary value = 15, 0.1 mA * 15 = 1.5 mA Remote fault alarm at -9.38 % or + 109.38%

Analog Output Module (1794-OE8H) Image Table Mapping

Table 13 - Input Map (Read Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
0	Flt Alm ch7	Flt Alm ch6	Flt Alm ch5	Flt Alm ch4	Flt Alm ch3	Flt Alm ch2	Flt Alm ch1	Flt Alm ch0	Reserved				Diagnostic Status			
1	Reserved															
2	H Rb CH 7	H Rb CH 6	H Rb CH 5	H Rb CH 4	H Rb CH 3	H Rb CH 2	H Rb CH 1	H Rb CH 0	H Fail CH 7	H Fail CH 6	H Fail CH 5	H Fail CH 4	H Fail CH 3	H Fail CH 2	H Fail CH 1	H Fail CH 0
3	H Tmt CH 7	H Tmt CH 6	H Tmt CH 5	H Tmt CH 4	H Tmt CH 3	H Tmt CH 2	H Tmt CH 1	H Tmt CH 0	H Cm CH 7	H Cm CH 6	H Cm CH 5	H Cm CH 4	H Cm CH 3	H Cm CH 2	H Cm CH 1	H Cm CH 0

Where: CH = Channel
Flt Alm = Fault Alarm
H Rbd = HART Rebuild
H RB = HART Readback
H Fail = HART Failure
H Tmt = HART Transmitter
H Cm = HART Communication

Table 14 - Output Map (Write Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
0	Reserved		Glbl Rst	Reserved					Dig Out CH 7	Dig Out CH 6	Dig Out CH 5	Dig Out CH 4	Dig Out CH 3	Dig Out CH 2	Dig Out CH 1	Dig Out CH 0
1	Channel 0 Output Data															
2	Channel 1 Output Data															
3	Channel 2 Output Data															
4	Channel 3 Output Data															
5	Channel 4 Output Data															
6	Channel 5 Output Data															
7	Channel 6 Output Data															
8	Channel 7 Output Data															

Where: CH = Channel
Dig Out = Digital Output
Glbl Rst = Global Reset

Table 15 - Configuration Map (Write Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
0	Lo Flt Md	Reserved	Flt Md CH 2...3	Flt Md CH 0...1	Alg Flt Ste CH 2...3		Alg Flt Ste CH 0...1		Data Format CH 2...3				Data Format CH 0...1			
1	Lth Md CH 4...7	Lth Md CH 0...3	Flt Md CH 6...7	Flt Md CH 4...5	Alg Flt Ste ch 6...7		Alg Flt Ste ch 4...5		Data Format CH 6...7				Data Format CH 4...5			
2	Dig Flt Ste CH 7	Dig Flt Ste CH 6	Dig Flt Ste CH 5	Dig Flt Ste CH 4	Dig Flt Ste CH 3	Dig Flt Ste CH 2	Dig Flt Ste CH 1	Dig Flt Ste CH 0	Alg Dig Md CH 7	Alg Dig Md CH 6	Alg Dig Md CH 5	Alg Dig Md CH 4	Alg Dig Md CH 3	Alg Dig Md CH 2	Alg Dig Md CH 1	Alg Dig Md CH 0
3	Analog Fault State Value Channel 0															
4	Analog Fault State Value Channel 1															
5	Analog Fault State Value Channel 2															
6	Analog Fault State Value Channel 3															
7	Analog Fault State Value Channel 4															
8	Analog Fault State Value Channel 5															

Table 15 - Configuration Map (Write Words) (Continued)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
9	Analog Fault State Value Channel 6															
10	Analog Fault State Value Channel 7															

Where:
CH = Channel
Lo Flt Md = Local Fault Mode
Flt Md = Fault Mode
Alg Flt Ste = Analog Fault State
Lth Md = LatCH Mode
Dig Flt Ste = Digital Fault State
Alg Dig Md = Analog/Digital Mode
Cd Flg = Command Flag

Table 16 - Data Format Control

Data Format				Range	Resolution	Full Range	Interpretation	Data Table Value	Count per mA
0	0	0	0	0...20 mA	0.1 % of 0...20 mA	0...22 mA	0...22 mA	0...2000	1000
0	0	0	1		0.2 % of 0...20 mA		0...110 %	0...11000	500
0	0	1	0	Not Assigned					
0	0	1	1		0.03 % of 0...20 mA	0...20 mA	Unsigned integer	0...65535	3276
0	1	0	0	4...20 mA	0.1 % of 4...20 mA	2...22 mA	2...22 mA	2000...22000	1000
0	1	0	1	Not Assigned					
0	1	1	0						
0	1	1	1	4...20 mA	0.03 % of 4...20 mA	4...20 mA	Unsigned integer	0...65535	4095
1	0	0	0	Not Assigned					
1	0	0	1						
1	0	1	0						
1	0	1	1	4...20 mA	0.28 % of 0...20 mA	0...22 mA	D/A count	0...8000	363
1	1	0	0	Not Assigned					
1	1	0	1	4...20 mA	0.16 % of 4...20 mA	3...21 mA	-6.25...+106.25 %	-625...+10625	625
1	1	1	0			2...22 mA	-12.5...+112.5 %	-1250...+11250	625
1	1	1	1	Not Assigned					

1794-IE8H and 1794-OE8H Extended Configuration Data Table

The FLEX I/O HART modules are addressed by using an MSG or CIO instruction. When using one of these instructions, configure it to the following.

- Class: 0x7D.
- Instance: Slot number (range from 1...8 with 1 being the I/O module closest to the adapter.
- Attribute: 0x66.
- Service: 0x0E for a get attribute single or 0x10 for a set attribute single Also, configure the communication path to the target I/O module.

For a set attribute single, configure two words as defined in Table 17 on page 28 to be sent to the I/O module.

For a get attribute single, two words configured as defined in Table 17 on page 28 are returned from the instruction.

Table 17 - 1794-IE8H and 1794-OE8H Extended Configuration Data Table

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
0	PMI CH 7	PMI CH 6	PMI CH 5	PMI CH 4	PMI CH 3	PMI CH 2	PMI CH 1	PMI CH 0	SME CH 7	SME CH 6	SME CH 5	SME CH 4	SME CH 3	SME CH 2	SME CH 1	SME CH 0
1	Reserved			HART readback threshold CH 4...7					HS LED	HS Inht	50/ 60 Hz	HART readback threshold CH 0...3				

Where: CH = channel
PMI = Primary Master Inhibit
SME = Secondary Master Enable
HS LED = HART status indicators
HS Inht = HART Status Inhibit

Secondary Master Enable (SME) and Primary Master Inhibit (PMI)

These 2 bits control a few module internal functions individually for channels 0...7.

Table 18 - SME and PMI Values

	Bits[1]	1 (Default)	2	3	4
PMI	8, 9, 10, 11, 12, 13, 14, 15	0	0	1	1
SME	0, 1, 2, 3, 4, 5, 6, 7	0	1	0	1
HART Smooth Filter		Pulsed	On	Off	On
Rebuild		On	On	Off	Off
HART Readback		On	On	Off	Off
Primary master		On	On	Off	Off
Secondary naster		Off	On	Off	On

(1) Where: CH 0 - bits 0 and 8; CH 1 - bits 1 and 9; CH 2 - bits 2 and 10; CH 3 - bits 3 and 11; CH 4 - bits 4 and 12; CH 5 - bits 5 and 13; CH 6 - bits 6 and 14; CH 7 - bits 7 and 15

HART Status Indicators

When this bit is set, the indicators are used for HART diagnostics. indicator behavior changes to show communication on HART with each indicator representing a HART loop. A flashing yellow indicator means that communication is being processed while a solid yellow indicator means that this device is in the transmitter list.

HART Status Inhibit

When this bit is set, the HART communication status is not shown in the real-time data table to enable compatibility. The appropriate areas are cleared with zeros.

50 Hz or 60 Hz Filter

The values are:

- 0 = 50 Hz (default).
- 1 = 60 Hz.

HART Readback Threshold

This bit delivers the percentage value, in steps of 1 %, of the threshold for forcing the HART readback indication. The maximum input signal deviation for HART analog modules is 31 %.

If there is no HART transmitter on the loop or if the loop is not in the transmitter list, the function is switched off internally in the I/O module. The values are:

- 0 = Disable indicator (default).
- 1…4 = Not supported from the I/O module (set to 5 internally).
- 5…31 = Percentage threshold data (5…31 %).

Notes:

Install Your FLEX I/O Analog Modules

Read this chapter to install the input and output analog modules.

Before You Install Your Analog Module

Before installing your FLEX I/O analog module:

Steps to Complete Before Installation

You Need To	As Described Under
Verify that the module is to be installed in a suitable enclosure	Removal and Insertion Under Power, page 31
Position the keyswitch on the terminal base	Install the Module, page 31

ATTENTION: These modules do not receive primary operational power from the backplane. +V and -V DC power must be applied to your module before installation. If power is not applied, the module position appears to the adapter as an empty slot in your chassis.

Removal and Insertion Under Power

ATTENTION:
- These modules are designed so you can remove and insert them under power. However, take special care when removing or inserting these modules in an active process. I/O attached to any module being removed or inserted can change states due to its input/output signal changing conditions.
- If you insert or remove the terminal base while backplane power is on, an electric arc can occur. This could cause an explosion in hazardous location installations.
- Be sure that power is removed or the area is nonhazardous before proceeding.

WARNING: When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure with proper wiring method that complies with the governing electrical codes.

Install the Module

Installation of the analog module consists of the following.

- Mounting the terminal base unit.

- Installing the analog I/O module into the terminal base unit.
- Installing the connecting wiring to the terminal base unit.

If you are installing your module into a terminal base unit that is already installed, proceed to Mount the Analog Modules on the Terminal Base Unit on page 35.

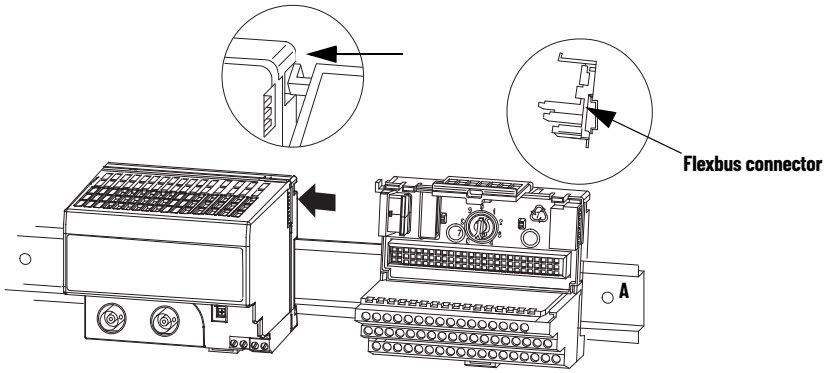
ATTENTION: Do not use the unused terminals on the terminal base unit. Using the terminals as supporting terminals can result in damage to modules and/or unintended operation of your system.

Mount on a DIN Rail

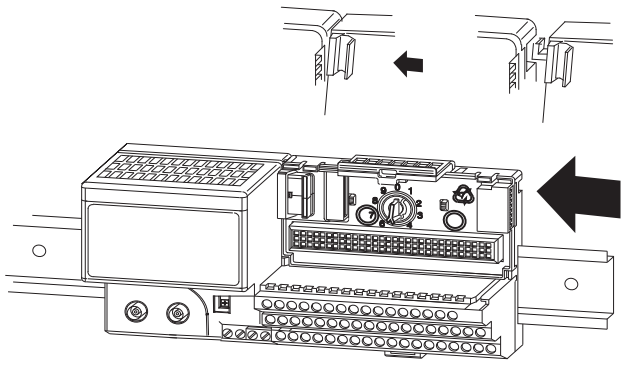
ATTENTION: Do not remove or replace a terminal base unit when power is applied. Interruption of the Flexbus can result in unintended operation or machine motion.

Install the Terminal Base Unit

1. Remove the cover plug in the male connector of the unit to which you are connecting this terminal base unit.
2. Make sure that the 16 pins in the male connector on the adjacent device are straight and in line so that the mating female connector on this terminal base unit will mate correctly.
3. Make sure that the female Flexbus connector is **fully retracted** into the base unit.
4. Position the terminal base at a slight angle over the 35 x 7.5 mm DIN rail **A** (Allen-Bradley part number 199-DR1).



5. Slide the terminal base over tight against the adapter (or proceeding terminal base). Make sure the hook on the terminal base slides under the edge of the adapter (or proceeding terminal base) and the Flexbus connector is fully retracted.

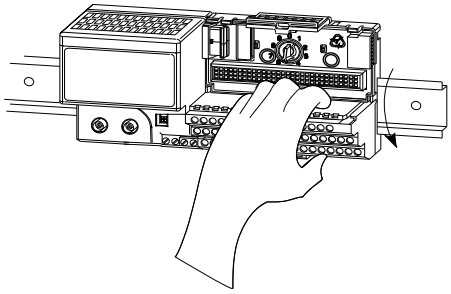


ATTENTION: Do not force the terminal base into the adjacent modules. Forcing the units together can bend or break the hook and allow the units to separate and break communication over the backplane.

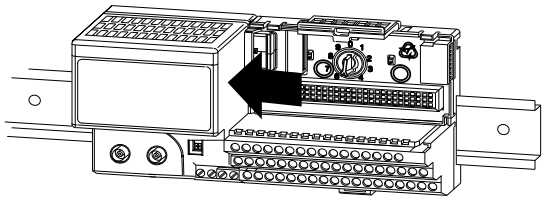
6. Rotate the terminal base onto the DIN rail with the top of the rail hooked under the lip on the rear of the terminal base.

   Use caution to make sure that the female Flexbus connector does not strike any of the pins in the mating male connector.

7. Press down on the terminal base unit to lock the terminal base on the DIN rail. If the terminal base does not lock into place, use a screwdriver or similar device to open the locking tab, press down on the terminal base until flush with the DIN rail and release the locking tab to lock the base in place.



8. Gently push the Flexbus connector into the side of the adapter (or proceeding terminal base) to complete the backplane connection.



9. For specific wiring information, see the installation instructions for the module you are installing in this terminal base unit.

   Terminal assignments are also given later in this chapter, see page 36.

10. Repeat the above steps to install the next terminal base unit.
11. Be sure that the Flexbus connector cover on the last terminal base unit is in place.

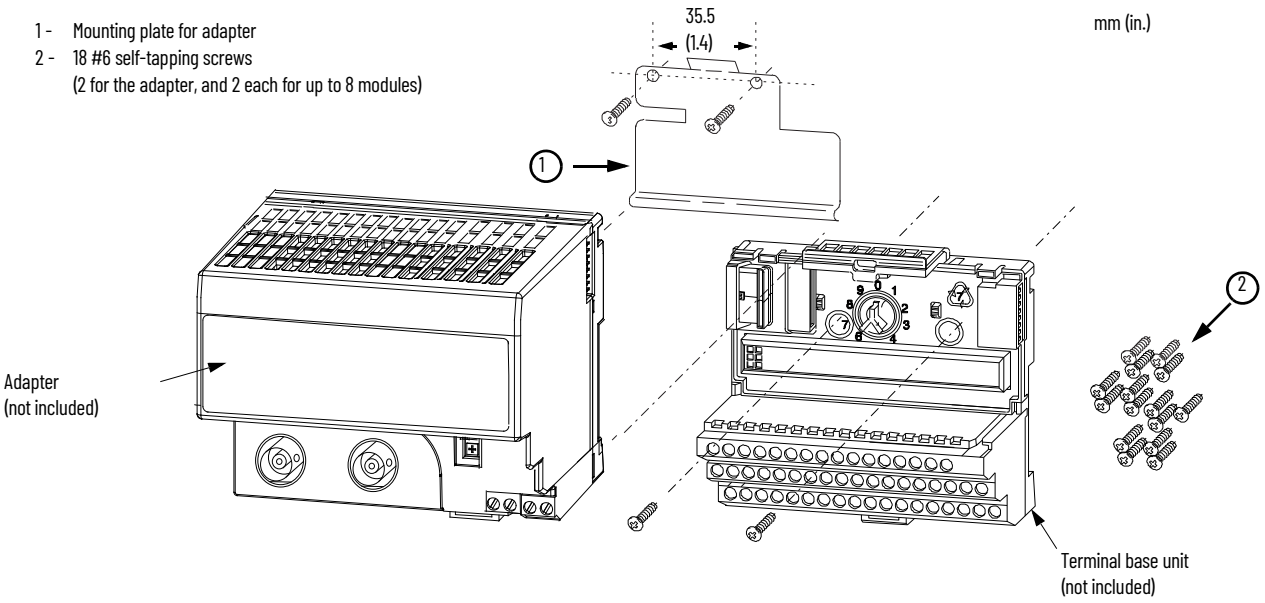
Mount on a Panel or Wall

Installation of a FLEX I/O system on a wall or panel consists of:

- Laying out the drilling points on the wall or panel.
- Drilling the pilot holes for the mounting screws.
- Mounting the adapter mounting plate.
- Installing the terminal base units and securing them to the wall or panel.

If you are installing your module into a terminal base unit that is already installed, proceed to Mount the Analog Modules on the Terminal Base Unit on page 35.

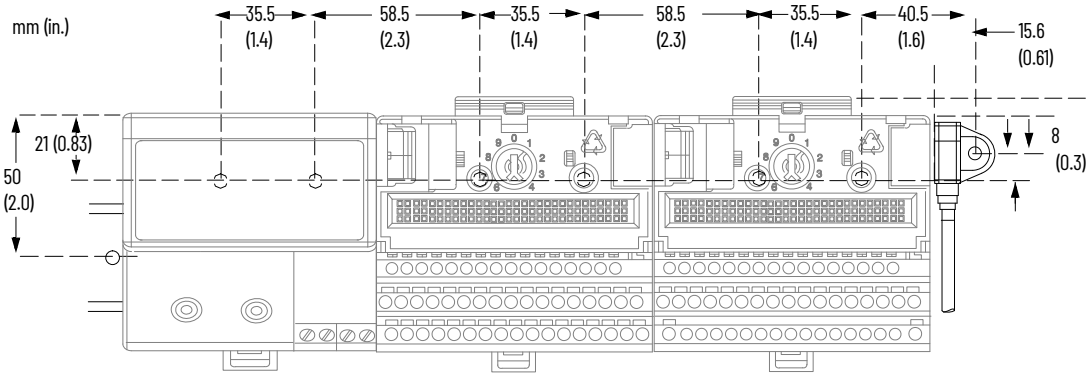
Use mounting kit 1794-NM1 for panel/wall mounting.



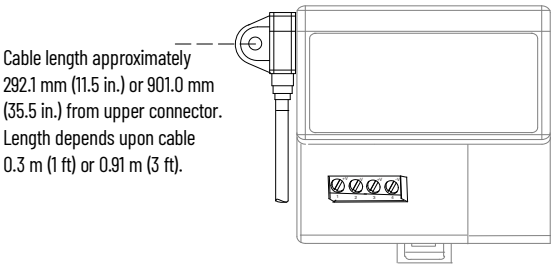
To install the mounting plate on a wall or panel:

1. Lay out the required points on the wall/panel as shown in the drilling dimension drawing

Drilling Dimensions for Panel/Wall Mounting of FLEX I/O



ATTENTION: Be careful of metal chips when drilling cable mounting holes. Do not drill holes above a system that has any modules that are installed.



2. Drill the necessary holes for the #6 self-tapping mounting screws.
3. Mount the mounting plate (1) for the adapter using two #6 self-tapping screws (18 included for mounting up to 8 modules and the adapter).

IMPORTANT Make sure that the mounting plate is properly grounded to the panel. See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

4. Hold the adapter (2) at a slight angle and engage the top of the mounting plate in the indention on the rear of the adapter.
5. Press the adapter down flush with the panel until the locking lever locks.

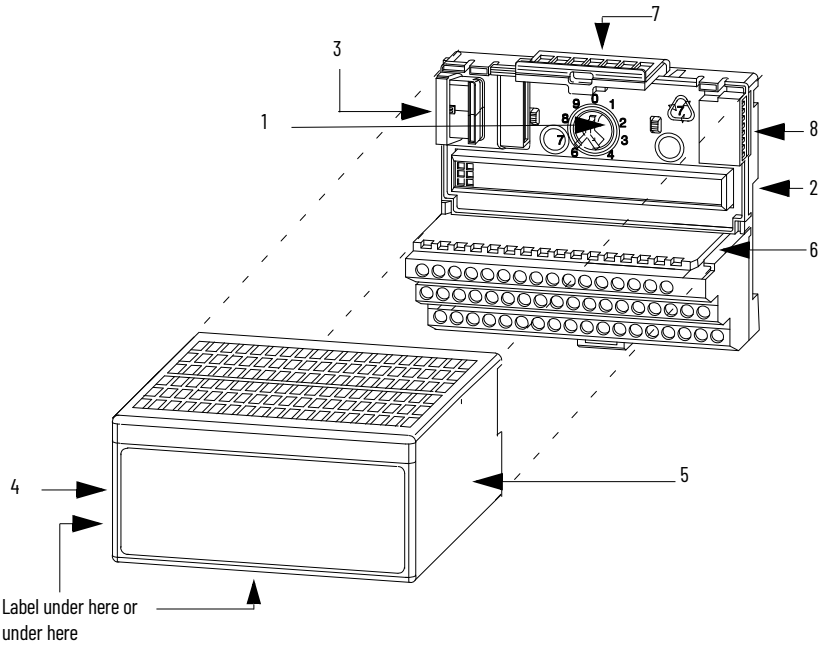
6. Position the terminal base unit up against the adapter and push the female bus connector into the adapter.
7. Fasten to the wall with two #6 self-tapping screws.
8. Repeat for each remaining terminal base unit.

Mount the Analog Modules on the Terminal Base Unit

The HART analog input and output modules mounts on a 1794-TB3G or 1794-TB3GS terminal base unit.

1. Rotate keyswitch (1) on terminal base unit (2) clockwise to position 3 for the 1794-IE8H or position 4 for the 1794-OE8H as required for each type of module.

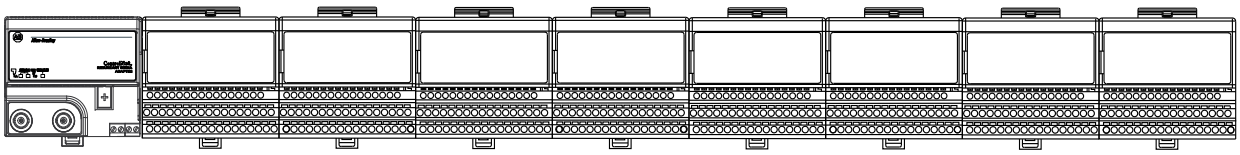
   Do not change the position of the keyswitch after wiring the terminal base unit.



2. Make sure that the Flexbus connector (3) is pushed all the way to the left to connect with the neighboring terminal base/adapter.

   You cannot install the module unless the connector is fully extended.
3. Make sure that the pins on the bottom of the module are straight so they align properly with the connector in the terminal base unit.
4. Position the module (4) with its alignment bar (5) aligned with the groove (6) on the terminal base.
5. Press firmly and evenly to seat the module in the terminal base unit. The module is seated when the latching mechanism (7) is locked into the module.
6. Remove cap plug (8) and attach another terminal base unit to the right of this terminal base unit if necessary.

   Make sure that the last terminal base has the cap plug (8) in place.



The adapter is capable of addressing eight modules. Do not exceed a maximum of eight terminal base units in your system.

Wire the Terminal Base Units

Wire the FLEX I/O HART analog input modules using the 1794-TB3G or the 1794-TB3GS terminal base unit.

ATTENTION: The FLEX I/O analog modules do not receive primary operational power from the backplane. +24V DC power must be applied to your module before operation. If power is not applied, the module position appears to the adapter as an empty slot in your chassis. If the adapter does not recognize your module after installation is completed, cycle power to the adapter.

Connect Wiring to the FLEX I/O HART Analog Modules

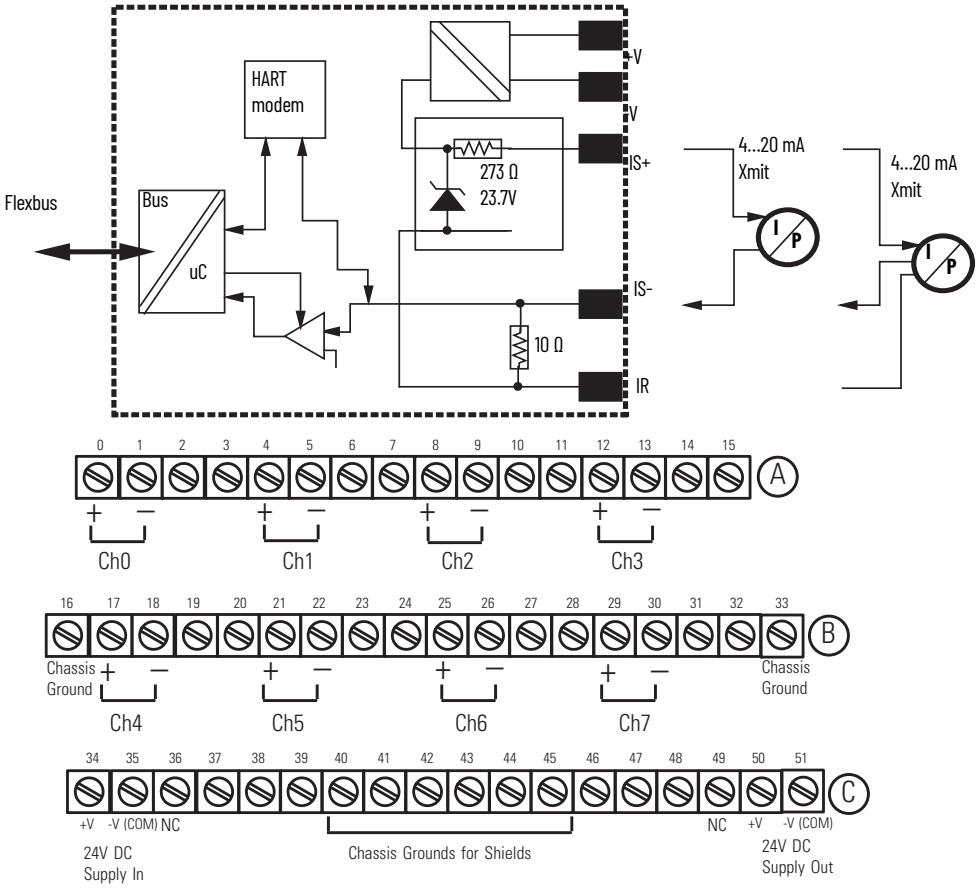
Inputs/Outputs

Each 1794-IE8H input can be operated from an analog field device signal, and each 1794-OE8H output channel can operate an analog field device.

The channels of the 1794-IE8H are electrically connected to each other and have a common plus-line. The channels of the 1794-OE8H are electrically connected to each other.

IMPORTANT When interconnecting several lines, you must consider the total accumulated power.

Figure 3 - Two-wire Connections for the 1794-IE8H Module on a 1794-TB3G Terminal Base Unit



(2-wire connection) (1794-TB3G shown)

+V = +24V DC= Terminals C-34 and C-50
-V = COM = C-35 and C-51
Chassis Ground = Terminals B-16, B-33, C-38, C-40…45, and C-47
NC = No connection
For daisy-chaining: Supply in – C-34 (+) and C-35 (-)
Supply out – C-50 (+) and C-51 (-)

For Two-wire Transmitter Devices

1. Connect the individual input wiring to (Input Source +) terminals (0, 4, 8, 12) on the 0...15 row (A) and on the 16...33 row (B) (terminals 17, 21, 25, 29) as indicated in Table 19.
2. Connect the associated input to the corresponding (Input Signal –) terminal (1, 5, 9, 13) on the 0...15 row (A), and on the 16...33 row (B) (terminals 18, 22, 26, 30) for each input as indicated in Table 19.
3. Connect +V DC power to terminal 34 on the 34...51 row (C).
4. Connect -V to terminal 35 on the 34...51 row (C).
5. If continuing power to the next terminal base unit, connect a jumper from terminal 50 (+V DC) on this base unit to +V DC power terminal on the next terminal base unit.

   If continuing common to the next terminal base unit, connect a jumper from terminal 51 (-V common) on this base unit to the -V common terminal on the next terminal base unit.

For Three-wire Transmitter Devices

1. Connect the individual input wiring to (Input Source +) terminals (0, 4, 8, 12) on the 0...15 row (A) and on the 16...33 row (B) (terminals 17, 21, 25, 29) as indicated in Table 19.
2. Connect the associated input to the corresponding (Input Signal –) terminal (1, 5, 9, 13) on the 0...15 row (A), and on the 16...33 row (B) (terminals 18, 22, 26, 30) for each input as indicated in Table 19.
3. Connect the associated input return to the corresponding signal return terminal (2, 6, 10, 14) on the 0...15 row (A), and on the 16...33 row (B) (terminals 19, 23, 27, 31) for each input as indicated in Table 19.
4. Connect +V DC power to terminal 34 on the 34...51 row (C).
5. Connect -V to terminal 35 on the 34...51 row (C).
6. If continuing power to the next terminal base unit, connect a jumper from terminal 50 (+V DC) on this base unit to +V DC power terminal on the next terminal base unit.

   If continuing common to the next terminal base unit, connect a jumper from terminal 51 (-V common) on this base unit to the -V common terminal on the next terminal base unit.

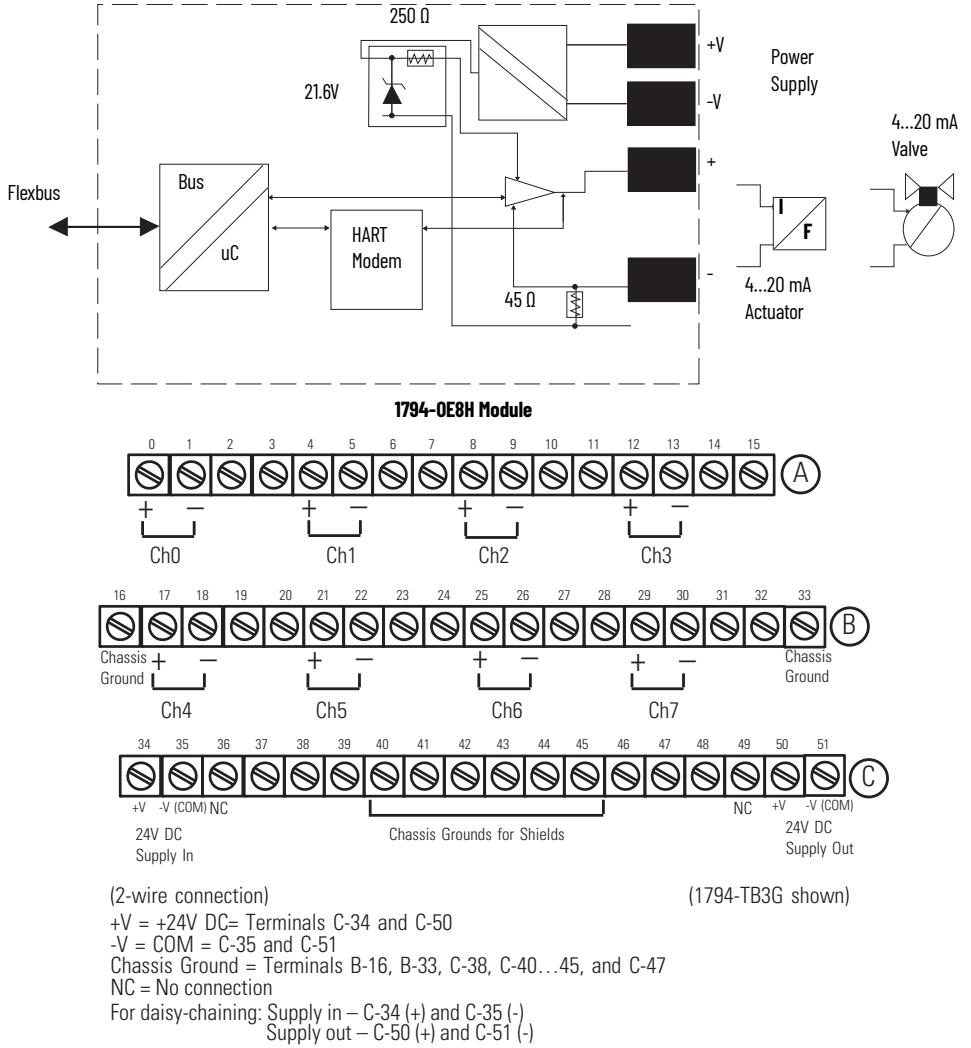
Table 19 - Wiring Connections for the 1794-IE8H HART Analog Input Module

Input	Input Source(1)	Input Signal(1)	Input Return(2)	Input	Input Source(1)	Input Signal(1)	Input Return(2)
Input 0	A-0	A-1	A-2	Input 4	B-17	B-18	B-19
Input 1	A-4	A-5	A-6	Input 5	B-21	B-22	B-23
Input 2	A-8	A-9	A-10	Input 6	B-25	B-26	B-27
Input 3	A-12	A-13	A-14	Input 7	B-29	B-30	B-31
+V	Terminals 34 and 50						
-V	Terminals 35 and 51						
Terminals 16, 33, 40, 41, 42, 43, 44, and 45 are connected to chassis ground.							

(1) For both 2-wire and 3-wire connections.
(2) For 3-wire connections only.

ATTENTION: Do not use the unused terminals on the terminal base unit. Using these terminals as supporting terminals can result in damage to the module and/or unintended operation of your system.

Figure 4 - Connections for the 1794-OE8H HART Analog Output Module on a 1794-TB3G or 1794-TB3GS Terminal Base Unit



(2-wire connection) (1794-TB3G shown)

+V = +24V DC= Terminals C-34 and C-50
-V = COM = C-35 and C-51
Chassis Ground = Terminals B-16, B-33, C-38, C-40…45, and C-47
NC = No connection
For daisy-chaining: Supply in – C-34 (+) and C-35 (-)
Supply out – C-50 (+) and C-51 (-)

1. Connect the individual output wiring to (+) terminals (0, 4, 8, 12) on the 0...15 row (A) and on the 16...33 row (B) (terminals 17, 21, 25, 29) as indicated in Table 20.
2. Connect the associated output to the corresponding (-) terminal (1, 5, 9, 13) on the 0...15 row (A), and on the 16...33 row (B) (terminals 18, 22, 26, 30) for each input as indicated in Table 20.
3. Connect +V DC power to terminal 34 on the 34...51 row (C).
4. Connect -V to terminal 35 on the 34...51 row (C).
5. If continuing power to the next terminal base unit, connect a jumper from terminal 50 (+V DC) on this base unit to +V DC power terminal on the next terminal base unit.
6. If continuing common to the next terminal base unit, connect a jumper from terminal 51 (-V common) on this base unit to the -V common terminal on the next terminal base unit.

Table 20 - Wiring connections for the 1794-OE8H Module

Output	Output +	Output –	Output	Output +	Output –
Output 0	A-0	A-1	Output 4	B-17	B-18
Output 1	A-4	A-5	Output 5	B-21	B-22
Output 2	A-8	A-9	Output 6	B-25	B-26

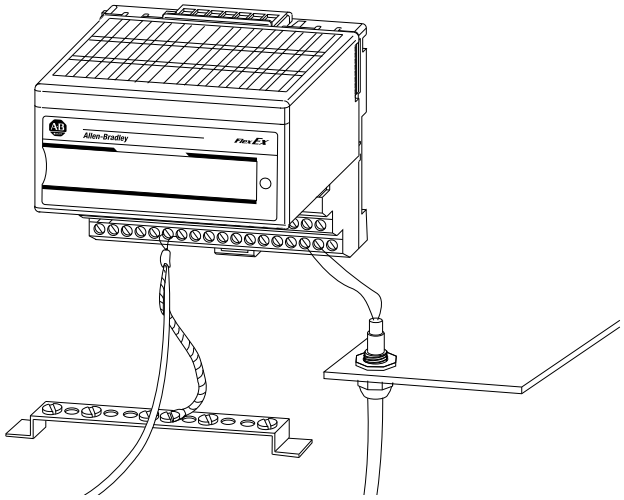
Table 20 - Wiring connections for the 1794-OE8H Module (Continued)

Output	Output +	Output –	Output	Output +	Output –
Output 3	A-12	A-13	Output 7	B-29	B-30
+V	Terminals 34 and 50				
-V	Terminals 35 and 51				
Terminals 16, 33, 40, 41, 42, 43, 44, and 45 are connected to chassis ground.					

ATTENTION: Do not use the unused terminals on the terminal base unit. Using these terminals as supporting terminals can result in damage to the module and/or unintended operation of your system.

Ground the Module

All I/O wiring must use shielded wire. Shields must be terminated external to the module, such as busbars and shield-terminating feed-throughs.



Notes:

Input, Output, and Configuration Files for Analog Modules on a ControlNet Network

IMPORTANT This chapter provides a brief description of the steps that you must take in your programming software to configure FLEX I/O modules and an overview of what occurs during configuration.

For a full explanation of how to use your programming software to perform module configuration, use the software online help.

Use Programming Software in Your FLEX I/O Application

When using FLEX I/O analog modules, you must perform I/O mapping and configure the ControlNet network before generating configuration data for your I/O modules.

For example, you may use RSNetWorx™ software to connect FLEX I/O modules to a ControlNet processor or scanner through a FLEX I/O ControlNet adapter (catalog number 1794-ACNR15). The I/O configuration portion of another programming software, for example the Studio 5000 Logix Designer® application, could be used to generate the configuration data for each I/O module in the control system.

Configuration data is transferred from the controller to the I/O modules when communication to the modules is first established.

Follow these general guidelines when configuring I/O modules.

1. Perform I/O mapping.
2. Configure all I/O modules.
3. Change to Run mode to initiate communication.
4. Download module configuration.

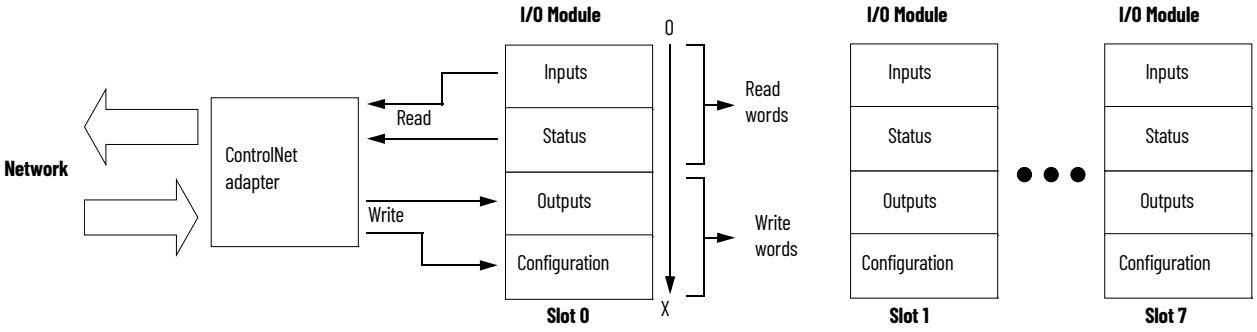
About the ControlNet Adapter

The FLEX I/O ControlNet adapter interfaces up to eight FLEX I/O modules to a ControlNet processor or scanner. The adapter can support ControlNet real-time data connections to individual modules or module groups. Each connection is independent of the others and can be from different processors or scanners.

Communication Over the FLEX I/O Backplane

One 1794-ACNR15/B ControlNet adapter can interface up to eight terminal base units with installed FLEX I/O modules, forming a FLEX I/O system of up to eight slots.

The adapter communicates to other network system components (typically one or more controllers, scanners, or programming terminals) over the ControlNet network. The adapter communicates with its I/O modules over the FLEX I/O backplane.



Configuration data is not continuously updated to the module.

Scheduled Data Transfer

Scheduled data transfer:

- Is continuous.
- Is asynchronous to the controller program scan.
- Occurs at the actual rate that is displayed in the Actual Packet Interval field on the programming software ControlNet I/O mapping (monitor) screen.

Unscheduled Data Transfer

Unscheduled operations include:

- Unscheduled nondiscrete I/O data transfers–through ControlNet I/O Transfer (CIO) instructions.
- Peer-to-peer messaging–through message (MSG) instructions.
- Messaging from programming devices.

Unscheduled messaging on a ControlNet network is nondeterministic. Your application and your configuration (for example, number of nodes, application program, NUT, and amount of scheduled bandwidth that is used), determine how much time there is for unscheduled messaging.

Module I/O Mapping

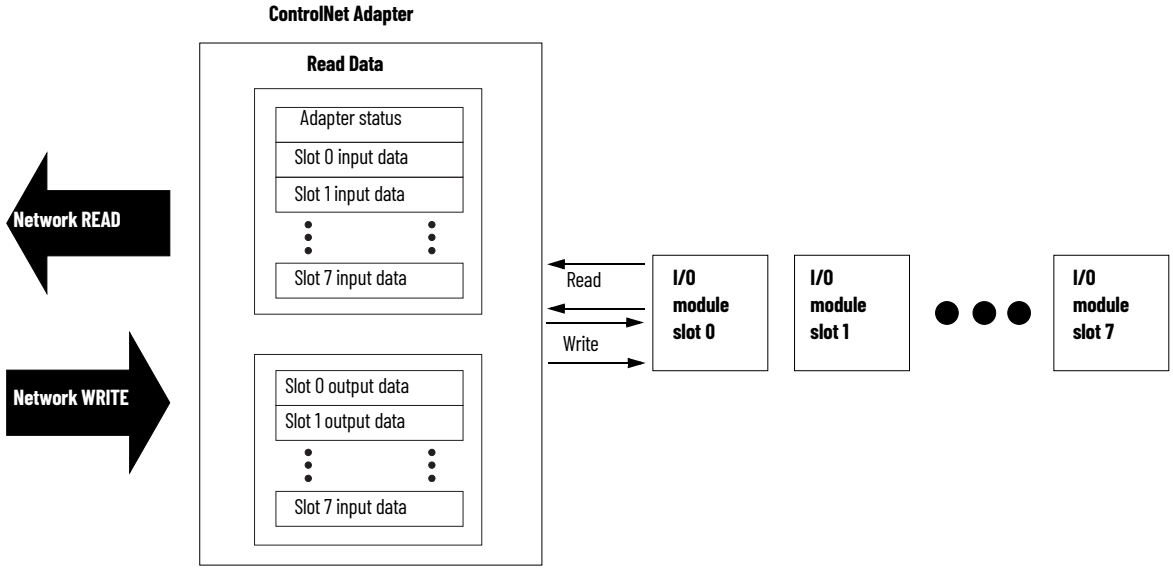
The I/O map for a module is divided into read words and write words. Read words consist of input and status words, and write words consist of output and configuration words. The number of read words or write words can be 0 or more.

The length of each I/O module's read words and write words vary in size depending on module complexity. Each I/O module supports at least one input word or one output word. Status and configuration are optional, depending on the module.

I/O Structure

The adapter receives output data in the order of the installed I/O modules. The adapter receives output data for slot 0 first, followed by the output data for slot 1, and so on, up to slot 7.

The adapter sends input data. The first word is the Adapter status word. This is followed by the input data from each slot, in the order of the installed I/O modules. The input data from slot 0 is first after the status word, followed by input data from slot 1, and so on, up to slot 7.



Adapter Status Word

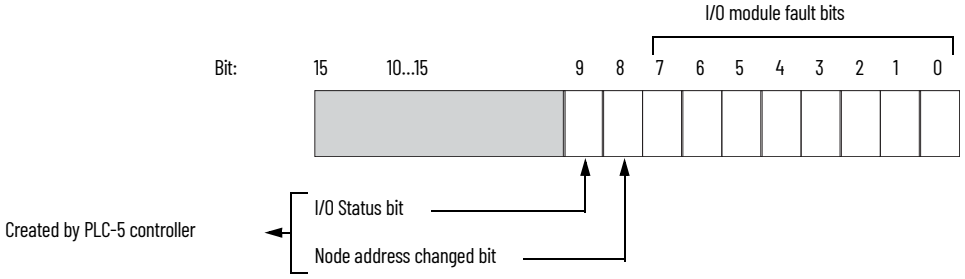
The status word consists of:

- I/O module fault bits – 1 status bit for each slot.

Additionally, in the case of a PLC-5® controller, it adds:

- Node address changed – 1 bit (created by PLC-5 controller).
- I/O status – 1 bit (created by PLC-5 controller).

The following FLEX I/O adapter status word for a PLC-5 controller results.



As an example, in a PLC-5 system, the adapter status word bit descriptions are shown in the following table.

Table 21 - Adapter Status Word Bit Descriptions

Bit Description	Bit	Explanation
I/O module fault	0	This bit is set (1) when an error is detected in slot position 0.
	1	This bit is set (1) when an error is detected in slot position 1.
	2	This bit is set (1) when an error is detected in slot position 2.
	3	This bit is set (1) when an error is detected in slot position 3.
	4	This bit is set (1) when an error is detected in slot position 4.
	5	This bit is set (1) when an error is detected in slot position 5.
	6	This bit is set (1) when an error is detected in slot position 6.
	7	This bit is set (1) when an error is detected in slot position 7.
Node address changed (created by PLC-5 controller)	8	This bit is set (1) when the node address switch setting has been changed since power-up.
I/O state (created by PLC-5 controller)	9	Bit = 0 -idle Bit = 1 - run
	10...15	Not used - set to 0

Possible causes for an I/O module fault are:

- Transmission errors on the FLEX I/O backplane.
- Failed module.
- Module removed from its terminal base.
- Incorrect module inserted in a slot position.
- Slot is empty.
- Slot contains a non-digital module.

Fault State Data

The FLEX I/O HART modules provide storage for alternate module output data during communication faults or processor idle state. This fault state data verifies that a known output is applied to the output devices during the previously mentioned modes.

The processor or scanner software must include the means to specify this fault state data for each module. If applicable, this data is sent in the configuration block, see Understand Image Table Mapping and Bit/Word Descriptions on page 23.

Device Actions

Device actions include:

- Communication fault behavior.
- Idle state behavior.
- Input data behavior upon module removal.

Communication Fault Behavior

You can configure the response to a communication fault for each I/O module in its system. Upon detection of a communication fault, the module can:

- Leave the module output data in its last state (hold last state).
- Reset the module output data to zero (reset).
- Apply fault state data to the module output.

Idle State Behavior

The FLEX I/O HART module can detect the state of the controlling processor or scanner. Only two states can be detected: Run mode or Program mode (idle).

When Run mode is detected, the adapter copies the output data that is received from the processor to the corresponding module output. When Program mode is detected, the I/O module can be configured to:

- Leave the module output data in its last state (hold last state).
- Reset the module output data to zero (reset).
- Apply fault state data to the module output.

Notes:

Calibrate Your Module

Use this chapter to calibrate the FLEX I/O analog modules.

IMPORTANT This chapter provides a detailed method to perform module calibration with individual commands. This discussion is only given here to explain the general process.

In practice, you must use the I/O configuration portion of your programming software to calibrate your modules. The software executes the methodology explained here.

Calibrate Your FLEX I/O Analog I/O Module

Your module ships already calibrated. If a calibration check is required, the module must be in a FLEX I/O system.

Perform module calibration periodically, based on your application. You may need to calibration the module to remove module error due to aging of components in your system.

Tools and Equipment

Use the tools and equipment in Table 22 to calibrate your analog I/O modules:

Table 22 - Tools for Calibration

Tool or Equipment	Description	
Precision current source	0...22 mA, 0.01 µA resolution	Used for input modules
Precision current meter	0...22 mA, 0.01 µA resolution	Used for output modules
Industrial terminal and interconnect cable	Programming terminal for Allen-Bradley processors	

1794-IE8H Calibration Features

The following features are unique to the 1794-IE8H module:

- There are two different values per channel that you need to calibrate: gain and offset at room temperature – 25 °C (77 °F).
- All values are stored in the I/O module non-volatile EEPROM.

- You can calibrate each channel separately or a specified number of channels together in respect of one value.
- If you calibrate an offset value, the corresponding gain value is invalid because the gain value depends on the actual offset value. Therefore, calibrate the gain values after you calibrate the offset values.
- After calibration, you must transmit the actual date to the IOM and store it in the module non-volatile.
- You can set the whole calibration to default values by sending a reset command. The default date is Jan, 01, 2000.
- You can set a specified calibration value to default by sending a reset command for that channel.
- There is a special command to store the whole calibration data from RAM to EEPROM within the I/O module.
- If one value, except the calibration date, isn't calibrated yet, or if you set one value to default, the I/O module displays a calibration error within the Real-Time Data diagnostic field.

1794-IE8H Calibration Command Structure

Calibration of the HART I/O module is performed using data structures and MSG Ladder-logic instructions. The MSG instruction sends the data structure to a dedicated attribute in the FLEX I/O HART module and the associated response is read from the same attribute. The data structure contains commands and its associated parameters. Depending on the command, they are either writable or readable. Only one access, either read or write, is executable at a time.

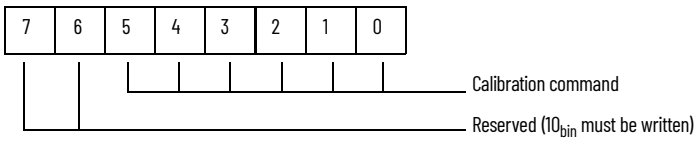
The Calibration data structure has four members: Command, Item, Data1, and Data2.

Table 23 - Calibration Data Structure

Attribute	Field Size	Implementation	Description	Value (Hex)	Access
67_{hex}	4 bytes	struct { USINT command; USINT item; USINT data1; USINT data2; } Calibration;	Calibration command; Additional command information; Data according to command; Data according to command	Conditional	Read or write

1794-IE8H Calibration Command Byte

The Calibration command byte uses the following format to **write** to the module:



The Calibration command byte uses the following format to **read** from the module:

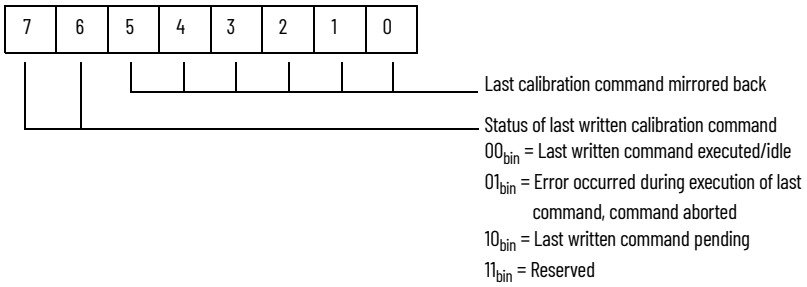


Table 24 - 1794-IE8H Calibration Command List

Calibration Command (Decimal) Bits 0...5	Function
0	Reserved
1	Calibrate offset at 25 °C (77 °F)
2	Calibrate gain at 25 °C (77 °F)
3...7	Reserved
8	Set all calibration values to default
9	Set one specified calibration value to default
10...13	Reserved(1)
14	Save calibration content to EEPROM
15...63	Reserved

(1) Used during manufacture of the product. Do not use.

Table 25 - 1794-IE8H Interpretation of Command Data Structure Content During Write Access

Command Byte			Item Byte	Data1 Byte	Data2 Byte
Reserved (Binary)	Command Bits 0...5 (Decimal)				
$10^{(1)}$	1	Calibrate offset at 25 °C (77 °F)	Channel-Mask	Reserved(4)	Reserved(4)
	2	Calibrate gain at 25 °C (77 °F)			
	3...7	Reserved(2)	–	Reserved(2)	–
	8	Set all calibration values to default	Reserved(4)	Reserved(4)	Reserved(4)
	9	Set one specified calibration value to default	Value identifier (0)		
	10	Reserved(3)	Reserved(3)	Reserved(3)	Reserved(3)
	11	Reserved(4)			
	12	Reserved(4)			
	13	Reserved(4)			
	14	Save calibration content to EEPROM	Reserved(4)	Reserved(4)	Reserved(4)
	15...63	Reserved(2)	–	–	–

(1) Always must be 10_{bin}.
(2) Do not use. Designated for future use.
(3) Reserved. Used during manufacture of the product. Do not use.
(4) In an attempt to write this byte, write 0.

Table 26 - 1794-IE8H Interpretation of Calibration Data Structure Content During Read Access (Idle Status)

Command Byte				Item Byte	Data1 Byte	Data2 Byte
Status (Binary)		Command Bits 0...5 (Decimal)				
00	Idle	0	Nothing is done. The state after power-on.	0	0	0
		1	Calibration of offset at 25 °C (77 °F) is done according to channel-mask	Channel-mask		
		2	Calibration of gain at 25 °C (77 °F) is done according to channel-mask			
		8	All calibration values are set to default	0		
		9	The specified calibration value is set to default	Value-identifier		
		10	Reserved[1]	Reserved[1]	Reserved[1]	Reserved[1]
		11	Reserved[1]			
		12	Reserved[1]			
		13	Reserved[1]			
		14	The calibration content is saved to EEPROM.	0	0	0

(1) Reserved. Used during manufacture of the product.

Table 27 - 1794-IE8H Interpretation of Calibration Data Structure Content During Read Access (Error Status)

Command Byte				Item Byte	Data1 Byte	Data2 Byte
Status (Binary)		Command Bits 0...5 (Decimal)				
01	Error	1	Calibration of offset at 25 °C (77 °F) according to channel-mask has failed	Channel-mask	0	0
		2	Calibration of gain at 25 °C (77 °F) according to channel-mask has failed			
		3...7	Unknown command is mirrored back	0		
		8	The calibration values are not set to default	0		
		9	The specified calibration value is not set to default	Value-identifier		
		10	Reserved[1]	Reserved[1]	Reserved[1]	Reserved[1]
		11	Reserved[1]			
		12	Reserved[1]			
		13	Reserved[1]			
		14	The calibration content could not be saved to EEPROM	0	0	0
		15...61	Unknown command is mirrored back			
		62	Reserved	Reserved	Reserved	Reserved
		63	Reserved			

(1) Reserved. Used during manufacture of the product. Do not use.

Table 28 - 1794-IE8H Interpretation of Calibration Data Structure Content During Read Access (Pending Status)

Command Byte				Item Byte	Data1 Byte	Data2 Byte
Status (Binary)		Command Bits 0...5 (Decimal)				
		1	Calibration of offset at 25 °C (77 °F)is in process according to channel-mask	Channel-Mask	0	0
		2	Calibration of gain at 25 °C (77 °F) is in process according to channel-mask			
		3...7	The unknown command is trying to be interpreted	x[2]	x[2]	x[2]
		8	All calibration values are set to default	0	0	0
		9	The specified calibration value is set to default	Value-identifier		
		10	Reserved[1]	Reserved[1]	Reserved[1]	Reserved[1]
10	Pending	11	Reserved[1]			
		12	Reserved[1]			
		13	Reserved[1]			
		14	The calibration content is saved to EEPROM	x[2]	x[2]	x[2]
		15...61	Unknown command is mirrored back	0	0	0
		62	Reserved	Reserved	Reserved	Reserved
		63	Reserved			

(1) Reserved. Used during manufacture of the product. Do not use.
(2) The received values are mirrored back.

1794-IE8H Calibration Item Byte Channel-Mask

The Calibration item byte channel-mask uses each bit of the byte to correspond to one channel: where 1 is *calibrate this channel* and 0 is *do not calibrate this channel*. The LSB corresponds to channel 0, for example, 0x03 ≥ channel 0 and 1 have to be calibrated.

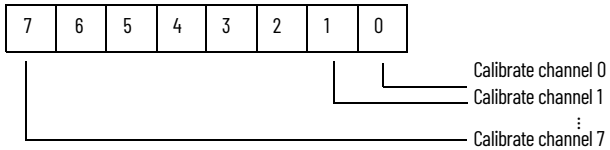


Table 29 - 1794-IE8H Calibration Item Byte Value Identifier List

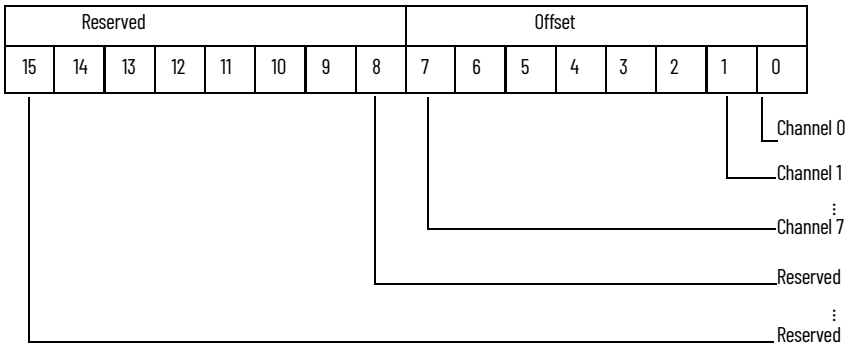
Identifier (Decimal)	Value	Access Rule
0	Offset channel 0	Read/write
⋮	⋮	⋮
7	Offset channel 7	Read/write
8	Gain channel 0	
⋮	⋮	⋮
15	Gain channel 7	Read/write
16...47	Reserved	–

Table 29 - 1794-IE8H Calibration Item Byte Value Identifier List (Continued)

Identifier (Decimal)	Value	Access Rule
48	Status mask offset	Read/write
49	Status mask gain	
50	Calibration day	
51	Calibration month	
52	Calibration year	
53	Checksum over calibration values	Read
54...255	Reserved	–

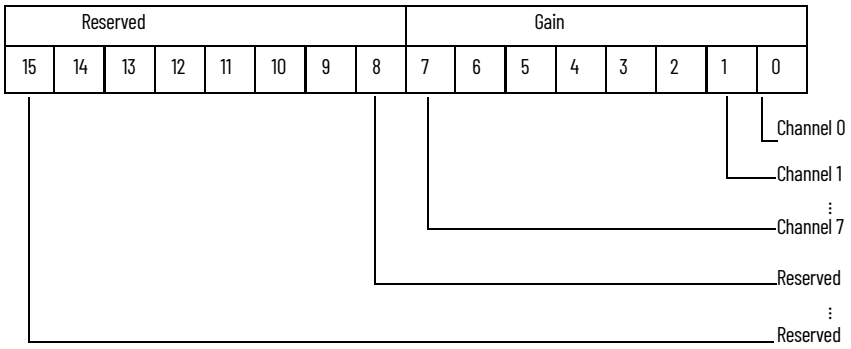
1794-IE8H Calibration Item Byte Value Identifier 48 (Status Mask Offset)

Each bit of the lower byte of this word corresponds to one channel. A logical 1 within the lower byte of the words means that this channel is calibrated according to offset at room temperature. A logical 0 means that this channel is not calibrating. In an attempt to write the upper byte of this word, write 0x00h. In an attempt to read the upper byte of this word, 0x00h is given back.



1794-IE8H Calibration Item Byte Value Identifier 49 (Status Mask Gain)

Each bit of the lower byte of this word corresponds to one channel. A logical 1 within the lower byte of the word means that this channel is calibrated according to gain at room temperature. A 0 means that this channel is not calibrating. In an attempt to write the upper byte of this word, write 0x00h. In an attempt to read the upper byte of this word, 0x00h is given back.



1794-IE8H Calibration with Offset and Gain

You must calibrate the offset from a channel before the gain is calibrated at the same channel, because the gain value depends on the offset value. During the calibration of offset, the corresponding gain value is declared invalid. Before all values are calibrated, there is a calibration error displayed within the Real-Time Data in the diagnostic status. After calibration is complete, the calibrated values are stored in the RAM area by the I/O module. Therefore, a store command is necessary to cause the I/O module to transfer the RAM content to the EEPROM.

Use the following guidelines when setting the offset and gain calibrations:

- To calibrate a channel according to offset, the corresponding channel must be sorted, or opened, so that the flow is 0.00 mA.
- To calibrate a channel according to the gain, the corresponding channel must be supplied with 20.00 mA.
- Set the I/O module ambient temperature in the range of ±5 of 25 °C (77 °F).
- Check the calibration status to see if it is idle or erroneous before sending the calibration command by reading attribute 67_{hex}.

Calibration Command Given Back by the I/O Module	Indicates
Idle or erroneous	Calibration is complete.
Pending	Poll the status again and recheck.
Does not correspond with the first written command.	Access conflict with another calibration device or another access error — repeat the calibration command.
Idle and it corresponds with the first written command.	Successful calibration by the module.

1794-OE8H Calibration Features

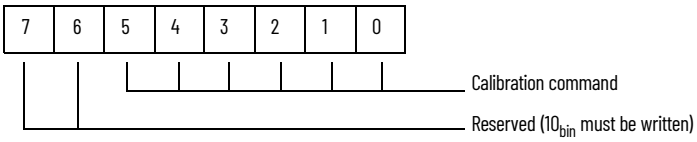
The following features are unique to the 1794-OE8H module:

- There are six values per channel that the I/O module uses to calculate the corresponding calibration values (offset and gain).
  - Min Scale DAC at 1500_{dec} about 1 mA.
  - Max Scale DAC at 6700_{dec} about 20 mA.
  - Current-read-back Min Scale at 1500_{dec} about 1 mA.
  - Current-read-back Max Scale at 6700_{dec} about 20 mA.
  - Voltage-read-back Min Scale at 1500_{dec}.
  - Voltage-read-back Max Scale at 6700_{dec}.
- The module internally calculated calibration values are:
  - Offset DAC.
  - Gain DAC.
  - Offset I-read-back.
  - Gain I-read-back.
  - Offset U-read-back.
  - Gain U-read-back.
- All calibration values are stored in the module nonvolatile EEPROM.

- Only one channel can be calibrated at a time according to one calibration value (max scale or min scale values).
- The actual date must be transmitted after calibration to the I/O module and stored in the module nonvolatile EEPROM. The data can be read out over the EDT channel.
- The whole calibration can be set to default values by sending a reset command. The default date is Jan, 01, 2000.
- A specified calibration value can be set to default by sending a reset command for that channel.
- There is a special command to store the whole calibration data from RAM to EEPROM within the I/O module.
- If one value, except the calibration date, isn't calibrated yet, or if you set one value to default, the I/O module displays a calibration error within the Real-Time Data diagnostic field.

1794-OE8H Calibration Command Byte

The Calibration command byte uses the following format to **write** to the module:



The Calibration command byte uses the following format to **read** from the module:

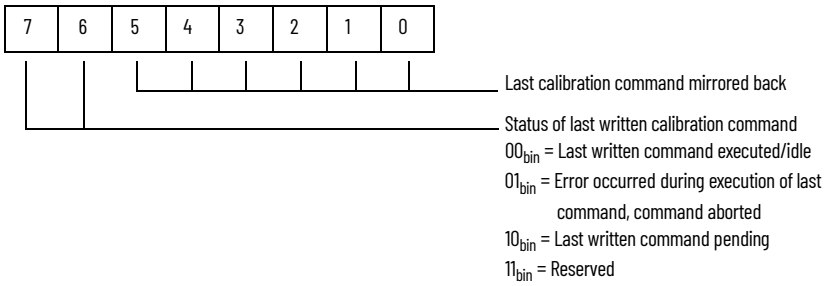


Table 30 - 1794-OE8H Calibration Command List

Calibration Command (Decimal) Bits 0...5	Function
0	Reserved
1	Calibration command min scale.
2	Calibration command max scale.
3	Write measured min scale value (Current, µA).
4	Write measured min scale value (Voltage, µV).
5	Write measured max scale value (Current, µA).
6	Write measured max scale value (Voltage, µV).
7	Reserved
8	Set all calibration values to default.
9	Set one specified calibration value to default.
10...13	Reserved(1)
14	Save calibration content to EEPROM.
15...63	Reserved

(1) Used during manufacture of the product. Do not use.

Table 31 - 1794-OE8H Interpretation of Command Data Structure Content During Write Access

Command Byte			Item Byte	Data1 Byte	Data2 Byte
Reserved (Binary)	Command Bits 0...5 (Decimal)				
10(1)	1	Calibration command min scale.	Channel-mask	Reserved(4)	Reserved(4)
	2	Calibration command max scale.			
	3	Write measured min scale value (Current, µA).		Value low-byte	Value high-byte
	4	Write measured min scale value (Voltage, µV).			
	5	Write measured max scale value (Current, µA).			
	6	Write measured max scale value (Voltage, µV).			
	7	Reserved(2)	–	–	–
	8	Set all calibration values to default.	Reserved(4)	Reserved(4)	Reserved(4)
	9	Set one specified calibration value to default.	Value-identifier (0)		
	10	Reserved(3)	Reserved(3)	Reserved(3)	Reserved(3)
	11	Reserved(4)			
	12	Reserved(4)			
	13	Reserved(4)			
	14	Save calibration data to EEPROM.	Reserved(4)	Reserved(4)	Reserved(4)
	15...63	Reserved(2)	–	–	–

(1) Always must be 10_{bin}.
(2) Do not use. Designated for future use.
(3) Reserved. Used during manufacture of the product. Do not use.
(4) In an attempt to write this byte, write 0.

Table 32 - 1794-OE8H Interpretation of Calibration Data Structure Content During Read Access (Idle Status)

Command Byte				Item Byte	Data1 Byte	Data2 Byte
Status (Binary)		Command Bits 0...5 (Decimal)				
00	Idle	0	Nothing is done. The state after power-on.	0	0	0
		1	The min scale value is supported at the outputs according to channel-mask.	Channel-mask		
		2	The max scale value is supported at the outputs according to channel-mask.			
		3	The written min scale value of Current was accepted.		Value low-byte	Value high-byte
		4	The written min scale value of Voltage was accepted.			
		5	The written max scale value of Current was accepted.			
		6	The written max scale value of Voltage was accepted.			
		7	Reserved[1]	Reserved[1]	Reserved[1]	Reserved[1]
		8	All calibration values are set to default.	0	0	0
		9	The specified calibration value is set to default.	Value-identifier		
		10	Reserved[2]	Reserved[2]	Reserved[2]	Reserved[2]
		11	Reserved[2]			
		12	Reserved[2]			
		13	Reserved[2]			
		14	The calibration content is saved to EEPROM.	0	0	0

(1) Do not use. Designated for future use.
(2) Reserved. Used during manufacture of the product.

Table 33 - 1794-OE8H Interpretation of Calibration Data Structure Content During Read Access (Error Status)

Command Byte				Item Byte	Data1 Byte	Data2 Byte
Status (Binary)		Command Bits 0...5 (Decimal)				
01	Error	3	The written min scale value of Current was not accepted/internal readback erroneous.	Channel-mask	Value low-byte	Value high-byte
		4	The written min scale value of Voltage was not accepted/internal readback erroneous.			
		5	The written max scale value of Current was not accepted/internal readback erroneous.			
		6	The written max scale value of Voltage was not accepted/internal readback erroneous.			
		7	Reserved(1)	Reserved(1)	Reserved(1)	Reserved(1)
		8	The calibration values are not set to default.	0	0	0
		9	The specified calibration value is not set to default.	Value-identifier		
		10	The specified calibration value is not written.		Value low-byte	Value high-byte
		11	Reserved(2)	Reserved(2)	Reserved(2)	Reserved(2)
		12	Reserved(2)			
		13	Reserved(2)			
		14	Reserved(2)			
		15...61	Unknown command is mirrored back.	0	0	0
		62	The specified setup value is not written(3).	Setup value-identifier	Value low-byte	Value high-byte
		63	The setup data could not be saved to EEPROM(3).	0	0	0

(1) Do not use. Designated for future use.
(2) Reserved. Used during manufacture of the product. Do not use.
(3) Only for internal use. Do not use for calibration purposes.

Table 34 - 1794-OE8H Interpretation of Calibration Data Structure Content During Read Access (Pending Status)

Command Byte				Item Byte	Data1 Byte	Data2 Byte
Status (Binary)		Command Bits 0...5 (Decimal)				
10	Pending	1	Calibration command number 1 is in interpretation now.	Channel-mask	0	0
		2	Calibration command number 2 is in interpretation now.			
		3	The written min scale value of Current is in interpretation now.		Value low-byte	Value high-byte
		4	The written min scale value of Voltage is in interpretation now.			
		5	The written max scale value of Current is in interpretation now.			
		6	The written max scale value of Voltage is in interpretation now.			
		7	Reserved(1)	Reserved(1)	Reserved(1)	Reserved(1)
		8	All calibration values are set to default now.	0	0	0
		9	The specified calibration value is set to default now.	Value-identifier		
		10	Reserved(2)	Reserved(2)	Reserved(2)	Reserved(2)
		11	Reserved(2)			
		12	Reserved(2)			
		13	Reserved(2)			
		14	The calibration data is saved to EEPROM right now.	0	0	0
		15...61	The unknown command is trying to be interpreted.	x2	x2	x2
		62	The specified setup-value is written now.	Setup value-identifier	Value low-byte	Value high-byte
		63	The setup data is saved to EEPROM right now.	0	0	0

(1) Do not use. Designated for future use.
(2) Reserved. Used during manufacture of the product. Do not use.

1794-OE8H Calibration Item Byte Channel-Mask

The Calibration item byte channel-mask uses each bit of the byte to correspond to one channel: where 1 is calibrate this channel and 0 is do not calibrate this channel. The LSB corresponds to channel 0, for example, 0x03 ≥ channel 0 and 1 have to be calibrated. Only one channel can be calibrated at a time. If there are more channels that are selected within the calibration commands, the I/O module signals an error.

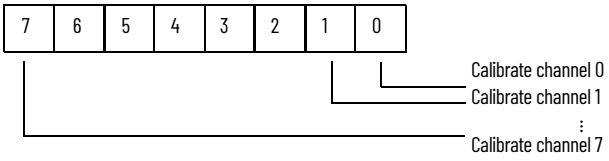
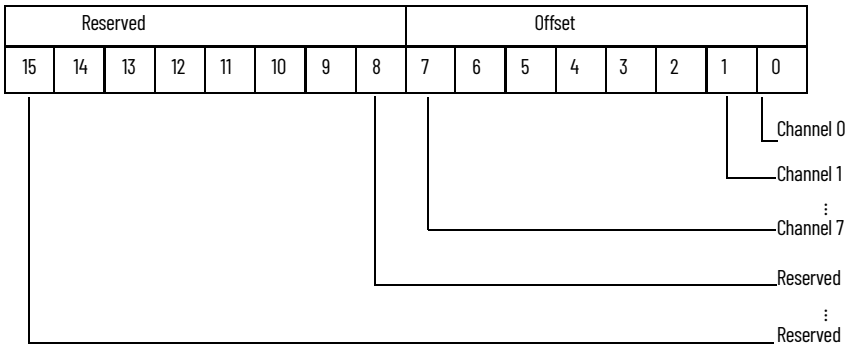


Table 35 - 1794-OE8H Calibration Item Byte Value Identifier List

Identifier (Decimal)	Value	Access Rule
0	Offset channel 0	Read/write
…	…	
7	Offset channel 7	
8	Gain channel 0	
…	…	
15	Gain channel 7	
16	Offset current-readback channel 0	
…	…	
23	Offset current-readback channel 7	
24	Gain current-readback channel 0	
…	…	
31	Gain current-readback channel 7	
32	Offset voltage-readback channel 0	
…	…	
39	Offset voltage-readback channel 7	
40	Gain voltage-readback channel 0	Read/write
…	…	
47	Gain voltage-readback channel 7	
48	Status mask calibration	
49	Reserved	
50	Calibration day	
51	Calibration month	
52	Calibration year	
53	Checksum over calibration values	Read
54…255	Reserved	–

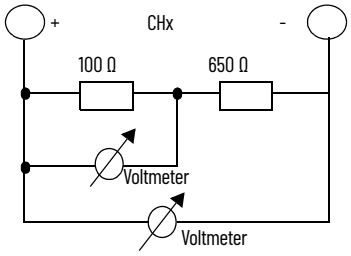
1794-OE8H Calibration Item Byte Value Identifier 48 (Status Mask Calibration)

Each bit of the lower byte of this word corresponds to one channel. A logical 1 within the lower byte of the words means that this channel is completely calibrated. A logical 0 means that this channel is not completely calibrated. In an attempt to write the upper byte of this word, write 0x00h. In an attempt to read the upper byte of this word, 0x00h is given back.

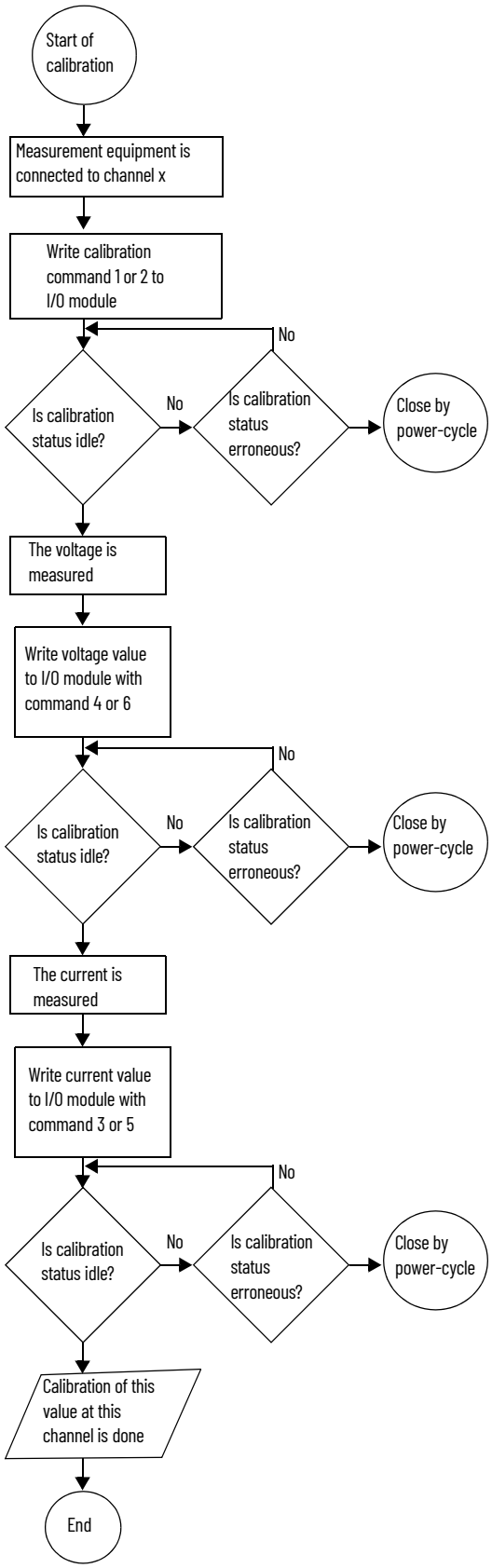


1794-OE8H Calibration Flowchart Procedure

Perform the calibration at ambient room temperature, ±5 of 25 °C (77 °F), according to the procedure flowchart. Each channel is calibrated one after the other. The current is measured indirectly with a precision voltmeter that is placed across a precision 100 W resistor.



Before all values are completely calibrated, a calibration error displays within the Real-Time Data field in the diagnostic status field. After calibration is complete, the I/O module stores the calibrated values in the RAM area. Therefore, you must send a store command to cause the I/O module to transfer the RAM content to the EEPROM. Therefore, you must send a store command to cause the I/O module to transfer the RAM content to the EEPROM.


Start of calibration
Measurement equipment is connected to channel x
Write calibration command 1 or 2 to I/O module
No
Is calibration status idle?
No
Is calibration status erroneous?
Close by power-cycle
The voltage is measured
Write voltage value to I/O module with command 4 or 6
No
Is calibration status idle?
No
Is calibration status erroneous?
Close by power-cycle
The current is measured
Write current value to I/O module with command 3 or 5
No
Is calibration status idle?
No
Is calibration status erroneous?
Close by power-cycle
Calibration of this value at this channel is done
End

Notes:

Troubleshoot the FLEX I/O Analog I/O Modules

Read this chapter to troubleshoot your I/O module.

Status Indicators

1794-IE8H Module

The 1794-IE8H module has one power indicator that is on when power is applied to the module and one status indicator for each input.

A = Status indicators
B = Insertable labels for writing individual input designations
C = Power indicator

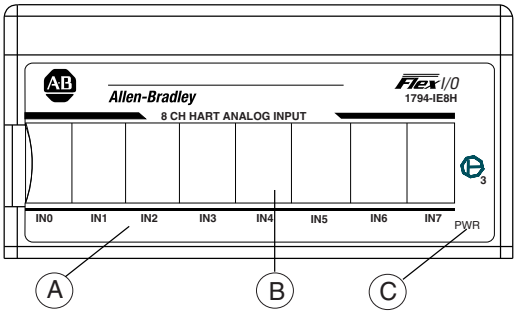


Table 36 - 1794-IE8H Status Indicators

Indicator	Color	State	Meaning
Status	Red	On	At power-up – Channel 0 indicator lights at power-up until all internal diagnostics are checked. After successful power-up, the indicator goes off if no fault is present. After successful power-up – Indicates a critical fault (diagnostic failure, and so on).
		Blinking (when faults are enabled, and bit set).	Indicates a noncritical channel fault.
	Yellow	On/blinking	HART device was found on the associated channel (when configured).
Power	–	Off	Module not powered.
	Green	On	Module receiving power.
		Blinking	No Flexbus communication.

1794-OE8H Module

The 1794-OE8H module has one power indicator that is on when power is applied to the module, and one status indicator for each input.

A = Status indicators
B = Insertable labels for writing individual input designations
C = Power indicator

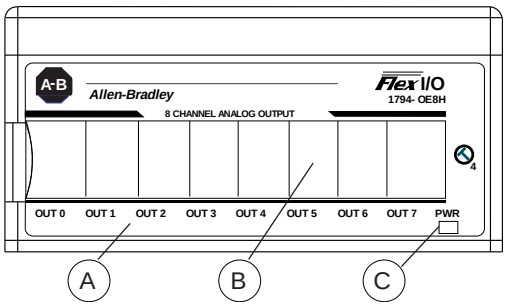


Table 37 - 1794-OE8H Status Indicators

Indicator	Color	State	Meaning
Status	Red	On	At power-up – Channel 0 indicator lights at power-up until all internal diagnostics are checked. After successful power-up, the indicator goes off if no fault is present. After successful power-up – Indicates a critical fault (diagnostic failure, and so on).
		Blinking (when faults are enabled, and bit set).	Indicates a noncritical channel fault.
	Yellow	On/blinking	HART device was found on the associated channel (when configured).
Power	–	Off	Module not powered.
	Green	On	Module receiving power.
		Blinking	No Flexbus communication.

Repair

This module is not field repairable. Any attempt to open this module voids the warranty. If repair is necessary, return this module to the factory.

See FLEX I/O 8 Input HART Analog Module Installation Instructions, publication 1794-IN108 and FLEX I/O 8 Output HART Module Installation Instructions, publication 1794-IN109 for complete specifications.

FLEX I/O HART Module Commands

Read this appendix to learn the module commands to and from FLEX I/O HART modules.

Protocol Overview

HART field communications protocol is widely accepted in the industry as the standard for digitally enhanced 4...20 mA 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 three groups and provides read/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, which can be carried out by many devices though, not all.
- Device-specific commands provide access to functions that may be unique to a particular device.

Universal Commands

Table 38 - Universal HART Module Commands

Command		Action	Meaning
0	Read	Read unique device identification.	Twelve-byte device identifiers are given in the response.
1		Read HART variables (process values).	Commands are only supported for compatibility purposes and are without any meaning. The transmitters, that is, the scan function, have the following functions. • Read primary variable. • Read primary variable as current (in mA) and percent range). • Primary variable is read as a current (in mA) and four predefined dynamic variables.
2		–	–
3		–	–
11		Read unique identifier associated with tag.	The response is a twelve-byte device identifier if the given tag matches the tag of the multiplexer.
12		Read message.	Read the 32-bit message (also see command bit 17).
13		Selection switch markings in hand, read description and date.	Read the eight-digit selection switch marking (tag) and the 16-digit time and date.
17	Write	Write message.	The 32-digit message is written (also see command bit 12).
18		Write tag, description, and date.	Save an 8-digit (tag), a 16-digit description and date.

Common Practice Commands

Table 39 - Common Practice HART Module Commands

Command		Action	Meaning
38	Write	Reset configuration changed flag.	Delete status information.
41		Perform device self-test.	Performs the device self-test similar to turning on the power supply. If no error occurs, the malfunction status message is deleted (if it had been set).
42		Perform device reset.	Immediately after the command is confirmed, a reset of the device HART processor is performed.
48	Read	Read additional device status.	–

Device-specific Commands

Table 40 - Device-Specific HART Module Commands

Command		Action	Meaning
128	Read	Read parameter assignment of the multiplexer.	The current parameter assignment is read from the multiplexer.
129		Read loop status.	The status of the current loop can be read with this command. The following information is supplied: • Hardware fault. • Rebuild running for this loop. • Scan activated for this loop. • Search for the transmitter because it has disappeared. • Transmitter not responding (disappeared). • Transmitter responding again (appeared). • Another transmitter responded instead (mismatched).
130		Transmitter list.	The address of the transmitters that were recognized on the current loops are returned.

Table 40 - Device-specific HART Module Commands (Continued)

Command		Action	Meaning
131	Read	Read static data of transmitters.	For the given long frame addresses, the function returns the following transmitter data: • Current loop number, 0…15. • Polling address. • Supported HART revision. • Minimum count of required preambles, 5…20.
132	Write	Write static data of transmitters.	Write static data (see command bit 131). A preamble length outside of the range 5…20 is set to 5 or 20.
133		Delete transmitters from the transmitter list.	Transmitters with the given long frame addresses are removed from the transmitter list and the scan list.
134	Read	Read scan list.	The extended addresses of the transmitters are returned.
135		Read dynamic data of transmitters.	For the given long frame addresses, the function returns the following transmitter data: • Selected scan command. • Long frame address. • HART data.
136		Read scan status of the transmitters.	For the given long frame addresses, this command returns the scan status of the transmitters (0 = scan disabled, 1 = scan enabled).
137	Write	Write scan status of the transmitters.	For the given long frame addresses, this command sets the scan status of the transmitters (0 = disable scan, 1 = enable scan).
138	Read	Read error overview of the transmitters.	This command returns the OR combination of communication errors and status response bits.
139	Write	Delete fault overview of transmitters.	This command deletes/removes the OR combination of communication errors and status response bits.
140	Read	Read the number of command requests and errors of transmitters.	Communication statistic that contains the number of commands sent to the transmitter and the number of commands that failed.
141	Write	Delete the number of command requests and errors of the transmitters.	Reset the communication statistic.
142	Read	Read counts of host communications.	Communication statistic concerning the multiplexer.
143	Write	Reset counts of host communications.	Reset the communication statistic.
144	Read	Read retry limits.	Retries if busy, 0…11 (default is 0). Retries if communication errors, 0…11 (default is 2).
145	Write	Write retry limits.	–
146	Read	Read scan command.	During scan, HART commands 1, 2, or 3 (see command bit 144) can be executed.
147	Write	Select scan command.	–
148	Read	Read scan status.	Used to specify or read the status of the scan function. 0 = scan function disabled (default after power-up). 1 = Normal scan function activated. 2 = Special scan function activated (see command bits 158 and 159).
149	Write	Write scan status.	–
152	Read	Read loop search type.	The loop search type determines the polling address that is used to search for a device that has not responded after multiple requests (disappeared, see also command bit 129). For IS-RPI-HART has a fixed setting: 1 = single transmitter, unknown (single unknown) first short addresses of 0…15.
154	Write	Rebuild up to eight specified loops.	–

Table 40 - Device-specific HART Module Commands (Continued)

Command		Action	Meaning
158	Read	Read special scan parameters.	The current special parameters and, if available, the transmitter data are returned for the given loop. These are: • Loop number. • Error flag (0 = ok, 1 = special scan not active). • Polling address (always 0, no multi-drop). • Minimum number of data bytes for special scan. • Selected scan command. • Long frame address. • Number of available data bytes. • The data bytes themselves (if any).
159	Write	Write special scan parameters.	The threshold data length (0…62) and the scan command to be used can be written for the given current loop and polling addresses (must be 0).
164	Read	Cached data reply Cmd 0, 13, 16.	The results of commands 0, 13, and 16 are combined in a response protocol.

Additional HART Protocol Information

Message Structure

This section describes the transaction procedure, character coding, and message structure of the HART protocol. These correspond to layer 2, the datalink layer, of the OSI protocol reference model.

Master-slave Operation

HART is a master-slave protocol. This means that each message transaction is originated by the master; the slave (field) device only replies when it receives a command message that is addressed to it. The reply from the slave device acknowledges that the command has been received, and may contain data that is requested by the master.

Multiple Master Operation

The HART protocol allows for two active masters in a system, one primary and one secondary. The two masters have different addresses, therefore each can positively identify replies to its own command messages.

Transaction Procedure

HART is a half-duplex protocol; after completion of each message, the FSK carrier signal must be switched off, to allow the other station to transmit. The carrier control timing rules state that the carrier should be turned on not more than 5-bit times before the start of the message (that is, the preamble) and turned off not 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 is no reply to a command within the expected time, the master should retry the message. After a few retries, the master should close the transaction, since presumably the slave device or the communication link has failed.

After each transaction is completed, the master should pause for a short time before sending another command, to allow an opportunity for the other master to break in if it wishes. This way, two masters (if they are present) take turns to communicate with the slave devices. Typical message lengths and delays allow two transactions per second.

Burst Mode (not supported)

To achieve a higher data rate, some field devices implement an optional burst mode. When switched into this mode, a slave device repeatedly sends a data message, as though it had received a specific command to do so. Special commands, 107, 108, and 109, are used to start and stop this mode of operation, and to choose which command should be assumed. If burst mode is implemented, commands 1, 2, and 3 must be supported; other commands are optional. There is a short pause after each burst message to allow a master device to send a command to stop the burst mode operation, or to initiate any other single transaction, after which burst messages will continue.

Generally, burst mode is only useful if there is just one field device that is attached to a pair of wires, since only one field device on a loop can be in burst mode at any one time. In burst mode, more than three messages can be transmitted per second.

The actual HART message between the FLEX I/O HART module and the field device follows the standard HART messaging protocol.

Preamble	Start character	Address	Command	Byte count	[Response code]	Data	Checksum

Preamble

The preamble is a number of hexadecimal FF characters that precede all frames sent to the HART field device. The size depends on the field devices being used, but it can be from 2 to 32 hexadecimal. The default is 10. The Smart Transmitter Interface inserts the required preamble before each packet or frame transmission to the HART device. The preamble is done automatically so that you do not have to program the host processor to do so.

Start Character

The start character of a HART message indicates the frame's format, the source of the message, and if it is using burst mode.

Table 41 - Start Character Byte Definitions

Frame Type	Short Frame Addressing (hex)	Long Frame Addressing (hex)
Master To slave	02	82
Slave To master	06	86
Burst mode from slave	01	81

HART Address

The Smart Transmitter Interface addresses HART field devices that use either a short or long frame address format, as specified by the HART delimiter byte. A short frame address is 1 byte long. A long frame address is 5 bytes long and includes a unique 32-bit identifier encoded within each field device by the manufacturer.

HART field device addressing is device-dependent. Some devices do not support long frame addressing while others only recognize short frame addressing for HART Command 0. In this situation, use HART Command 0 to determine the long frame address, and then use long frame addressing for all other HART commands. Consult the documentation that is provided with your field device for details about the addressing formats that it supports.

HART Command

This one-byte field specifies the HART command that is to be sent by the Smart Transmitter Interface to the field device. Many commands are device-dependent. Consult the documentation that is provided with your field device for details about the commands supported. Set this field to a device-recognizable command before sending the packet to the Smart Transmitter Interface.

Table 42 - Representative of HART Universal Commands

Universal Command (dec)	Description	Expected Response
0	Read unique identifier.	Unique 32-bit device identifier, revision levels, number of preambles required.
1	Read primary variable.	Primary variable in floating point (IEEE 754 format).
2	Read primary variable current and percent of range.	Primary variable in milliamperes and percents.
3	Read dynamic variables and primary variable current.	Primary variable and up to 4 predefined dynamic variables.
6	Write polling address.	Assigned polling address - short form.
11	Read unique identifier associated with tag.	Unique 32-bit device identifier, revision levels, number of preambles required.

Byte Count

This one-byte field indicates the number of bytes to follow this field excluding the check byte. Valid values are 0...113. Insert the number of bytes required for this packet before transmitting it.

Data

This field specifies a number of data bytes associated with the command number that is given in the command field. Set the number of data bytes to the appropriate value for the command in question. The valid range is from 0 to 113. Only use this field when you write data to the HART device.

Check Byte

The Smart Transmitter Interface calculates the value of this field and transmits it to the field device as the last byte of a packet. The field device verifies the integrity of the received data packet by checking this byte. Since the Smart Transmitter Interface calculates this byte, you can set this field to a null (00).

Response Code

This two-byte code contains the HART field device status as sent by that device. Field devices that detect a communication error set the most significant bit, bit 7, of the first byte and identify the error in the other 7 bits. If the last message was received without error, the field device clears bit 7 and returns a device-dependent response in the other 7 bits.

The second byte of this response code returns the operating status of HART field devices. This byte may default to 0 when a communications error occurs as indicated by bit 7 of the first byte being set.

IMPORTANT The host processor ignores any values in the data field when a communications error is detected.

Table 43 - HART Protocol — Communication Error Code

Bit	Error Code	Description
7	Communications Error	If set, the field device has detected a communications error. Bits 0...6 indicate the type of error.
6	Vertical Parity Error	The parity of one or more of the bytes received by the HART field device is incorrect.
5	Overrun Error	At least 1 byte of data in the receive buffer of the HART field device was over-written before it was read.
4	Framing Error	The stop bit of one or more bytes received by the HART field device is not detected.
3	Longitudinal Parity Error	The longitudinal parity calculated by the HART field device does not match the longitudinal parity byte at the end of the packet.
2	Reserved	Set to 0.
1	Buffer Overflow	The packet is too long for the receive buffer of the HART field device.
0	Undefined	Not defined.

Table 44 - HART Field Device Error Codes

Bit	Error Code	Description
7	Field Device Malfunction	The HART field device has detected an internal hardware error or failure.
6	Configuration Changed	The HART field device executed a write or set command.
5	Cold Start	Power has been removed and reapplied, resulting in the reinstallation of the setup information. The first HART command to recognize this condition automatically resets this flag. This flag may also be set following a master reset or self-test.
4	More Status Available	More status information is available and can be read using command #48. Read additional status information.
3	Primary Variable Analog Output Fixed	The analog and digital outputs for the primary variable are held at their requested value. They do not respond to the applied process.
2	Primary Variable Analog Output Saturated	The analog and digital outputs for the primary variables are beyond their limits and no longer represent the true applied process.
1	Nonprimary Variable Out of Limits	The process applied to a sensor, other than that of the primary variable, is beyond the operating limits of the device. To identify the variable, use command #48, read additional status information.
0	Primary Variable Out of Limits	The process applied to the sensor for the primary variable is beyond the operating limits of the device.

Universal Commands

Table 45 - Universal Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
0	Read unique identifier.	—	None	—	0	254 (expansion)	—
					1	Manufacturer identification code	
					2	Manufacturer device type code[1]	
					3	Number of preambles required	
					4	Universal command revision	
					5	Device-specific command revision	
					6	Software version	
					7	Hardware revision	
					8	Device function flags[2]	(H)
					9...11	Device ID number	(B)
1	Read primary variable.	—	—	—	0	PV units code	—
					1...4	Primary variable	(F)
2	Read current and percent of range.	—	None	—	0...3	Current (mA)	(F)
					4...7	Primary variable	
3	Read current and four (predefined) dynamic variables.	—	None	—	0...3	Current (mA)	—
					4	PV units code	
					5...8	Primary variable	
					9	SV units code	
					10...13	Secondary variable[3]	
					14	TV units code	
					15...18	Third variable	
					19	FV units code	
					20...23	Fourth variable	
6	Write polling address.	0	Polling address	—	—	As in command	—

Table 45 - Universal Commands (Continued)

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
11	Read unique identifier associated with tag.	0...5	Tag	(A)	0...11	As Command 0	–
12	Read message.	–	None	–	0...23	Message (32 characters)	(A)
13	Read tag descriptor, date.	–	None	–	0...5	Tag (8 characters)	(A)
					6...17	Descriptor (16 characters)	(A)
					18...20	Date	(D)
14	Read PV sensor information.	–	None	–	0...2	Sensor serial number	–
					3	Units code for sensor limits and minimum span	
					4...7	Upper sensor limit	(F)
					8...11	Lower sensor limit	
					12...15	Minimum span	
15	Read output information.	–	None	–	0	Alarm select code	–
					1	Transfer function code	
					2	PV/range limits code	
					3...6	Upper range value	
					7...10	Lower range value	
					11...14	Damping value (seconds)	(F)
					15	Write protect code	
					16	Private-label distributor code	
16	Read final assembly number.	–	None	–	0...2	Final assembly number	–
17	Write message.	0...23	Message (32 characters)	(A)	–	As in command	–
18	Write tag descriptor, date.	0...5	Tag (8 characters)	(A)	–	As in command	–
		6...17	Descriptor (16 characters)				
		18...20	Date	(D)			
19	Write final assembly number.	0...2	Final assembly number	–	–	As in command	–

(1) Bit 2 = protocol bridge device.
(2) Bit 0 = multi-sensor device, bit 1 = EEPROM control required.
(3) Truncated after last supported variable.

Common Practice Commands

Table 46 - Common Practice Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
33	Read transmitter variables.	—	None[2]	—	0	Transmitter variable code for slot 0	—
					1	Units code for slot 0	
					2…5	Variable for slot 0	(F)
					6	Transmitter variable code for slot 1	—
					7	Units code for slot 1	
					8…11	Variable for slot 1	(F)
					12	Transmitter variable code for slot 2[6]	—
					13	Units code for slot 2	
					14…17	Variable for slot 2	(F)
					18	Transmitter variable code for slot 3	—
					19	Units code for slot 3	
					20…23	Variable for slot 3	(F)
34	Write damping value.	0…3	Damping value (seconds)	(F)	—	As in command	(F)
35	Write range values.	0	Range units code	—	—	As in command	(F)
		1…4	Upper range value	(F)			—
		5…8	Lower range value				(F)
36	Set upper range value (push SPAN button).	—	None	—	—	None	—
37	Set lower range value (push ZERO button).	—	None	—	—	None	—
38	Reset configuration changed flag.	—	None	—	—	None	—
39	EEPROM control.	0[1]	EEPROM control code	—	—	As in command	—
40	Enter/edit fixed current mode.	0…3	Current (mA)[3]	(F)	—	As in command	—
41	Perform device self-test.	—	None	—	—	None	—
42	Perform master reset.	—	None	—	—	None	—
43	Set (trim) PV zero.	—	None	—	—	None	—
44	Write PV units.	0	PV units code	—	—	As in command	—
45	Trim DAC zero.	0…3	Measured current (mA)	—	—	As in command	—
46	Trim DAC gain.	0…3	Measured current (mA)	(F)	—	As in command	—
47	Write transfer function.	0	Transfer function code	—	—	As in command	—
48	Read additional device status.	—	None	—	0…5	Device-specific status	(B)
					6…7	Operational modes	—
					8…10	Analog outputs saturated[7]	(B)
					11…13	Analog outputs fixed.[8]	
					14…24	Device-specific status	
49	Write PV sensor serial number.	0…2	Sensor serial number	—	—	As in command	—

Table 46 - Common Practice Commands (Continued)

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
50	Read dynamic variable assignments.	–	None	–	0	PV transmitter variable code	–
					1	SV transmitter variable code	
					2	TV transmitter variable code	
					3	FV transmitter variable code	
51	Write dynamic variable assignments.	0	PV transmitter variable code	–	–	As in command	–
		1	SV transmitter variable code				
		2	TV transmitter variable code				
		3	FV transmitter variable code				
52	Set transmitter variable zero.	0	Transmitter variable code	–	–	As in command	–
53	Write transmitter variable units.	0	Transmitter variable code	–	–	As in command	–
		1	Transmitter variable units code				
54	Read transmitter variable information.	–	Transmitter variable code	–	0	Transmitter variable code	–
					1...3	Transmitter variable sensor serial number	
					4	Transmitter variable limit units code	
					5...8	Transmitter variable upper limit	(F)
					9...12	Transmitter variable lower limit	
					13...16	Transmitter variable damping value (seconds)	
					17...20	Transmitter variable minimum span	
55	Write transmitter variable damping value.	0	Transmitter variable code	–	–	As in command	–
		1...4	Transmitter variable damping value (seconds)				
56	Write transmitter variable sensor serial number.	0	Transmitter variable code	–	–	As in command	–
		1...3	Transmitter variable sensor				
57	Read unit tag, descriptor, date.	–	None	–	0...5	As in command	(A)
					6...17		
					18...20		(D)
58	Write unit tag, descriptor, date.	0...5	Unit tag (8 characters)	(A)	–	As in command	–
		6...17	Unit descriptor (16 characters)				
		18...20	Unit date	(D)			
59	Write number of response preambles.	0	Number of response preambles	–	–	As in command	–
60	Read analog output and percent of range.	0	Analog output number code	–	0	Analog output number code	–
					1	Analog output units code	
					2...5	Analog output level	
					6...9	Analog output percent of range	

Table 46 - Common Practice Commands (Continued)

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
61	Read dynamic variables and PV analog output.	—	None	—	0	PV analog output units code	—
					1...4	PV analog output level	(F)
					5	PV units code	—
					6...9	Primary variable	(F)
					10	SV units code	—
					11...14	Secondary variable	(F)
					15	TV units code	—
					16...19	Third variable	(F)
					20	FV units code	—
					21...24	Fourth variable	(F)
62	Read analog outputs.	0	Analog output number code for slot 0	—	0	Slot 0 analog output number code	—
					1	Slot 0 units code	
					2...5	Slot 0 level	(F)
		1	Analog output number code for slot 1		6	Slot 1 analog output number code	—
					7	Slot 1 units code	
					8...11	Slot 1 level	(F)
		2	Analog output number code for slot 2		12	Slot 2 analog output number code	—
					13	Slot 2 units code	
					14...17	Slot 2 level	(F)
		3	Analog output number for slot 3		18	Slot 3 analog output number code	—
					19	Slot 3 units code	
					20...23	Slot 3 level	(F)
63	Read analog output information.	0	Analog output number code	—	0	Analog output number code	—
					1	Analog output alarm select code	
					2	Analog output transfer function code	
					3	Analog output range units code	
					4...7	Analog output upper range value	(F)
					8...11	Analog output lower range value	
					12...15	Analog output additional damping value (seconds)	
64	Write analog output additional damping value.	0	Analog output number code	—	—	As in command	—
		1...4	Analog output additional damping value (seconds)	(F)			

Table 46 - Common Practice Commands (Continued)

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
65	Write analog output range value.	0	Analog output number code	–	–	As in command	–
		1	Analog output range units code				
		2...5	Analog output upper range value	(F)			
		6...9	Analog output lower range value				
66	Enter/edit fixed analog output mode.	0	Analog output number code	–	–	As in command	–
		1	Analog output units code				
		2...5	Analog output level[4]	(F)			
67	Trim analog output zero.	0	Analog output number code	–	–	As in command	–
		1	Analog output units code				
		2...5	Externally measured analog output level	(F)			
68	Trim analog output gain.	0	Analog output number code	–	–	As in command	–
		1	Analog output units code				
		2...5	Externally measured analog output level	(F)			
69	Write analog output transfer function.	0	Analog output number code	–	–	As in command	–
		1	Analog output transfer function code				
70	Read analog output endpoint values.	0	Analog output number code	–	0	Analog output number code	–
					1	Analog output endpoint units code	
					2...5	Analog output upper endpoint value	
					6...9	Analog output lower endpoint value	
107	Write burst mode transmitter variables (for Command #33).	0	Transmitter variable code for slot 0	–	–	As in command	–
		1	Transmitter variable code for slot 1				
		2	Transmitter variable code for slot 2				
		3	Transmitter variable code for slot 3				
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)	–	–	As in command	–

Table 46 - Common Practice Commands (Continued)

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
110	Read all dynamic variables.	—	None	—	0	PV units code	—
					1...4	PV value	(F)
					5	SV units code	—
					6...9	SV value	(F)
					10	TV units code	—
					11...14	TV value	(F)
					15	FV units code	—
					16...19	FV value	(F)

(1) 0 = burn EEPROM, 1 = copy EEPROM to RAM.
(2) Truncated after last requested code.
(3) 0 = edit fixed current mode.
(4) Not a number when fixed output mode.
(5) A = ASCII string (packed four characters in 3 bytes).
F = floating point data type (4 bytes) per IEEE 754,
D = date (day, month, year-1900).
B = bit mapped flags.
Unmarked types are 8-, 16-, or 24-bit integers.
(6) Truncated after last requested variable.
(7) 24 bits each.
(8) LSB and MSB return to AO #1...#24.

Notes:

FLEX I/O HART Modules Network Messaging

Communication

The messaging between the processor and the HART I/O module is handled through MSG or CIP™ instructions, depending on the processor type. These ladder logic instructions need specific details for proper operation. In particular, they need four items:

- **Class**

  The Class value for FLEX is 7D hex.
- **Instance**

  The Instance is a number from 1 to 8. This number indicates the module location relative to the adapter connected directly to the adapter.
- **Service**

  The Service value is 0E hex for Get Attribute Single and 10 hex for Set Attribute Single. Use a Service value of 0E hex to read data from the adapter and 10 hex to write data to the adapter.
- **Attribute**

  The Attribute value is based on details that are shown in Table 47.

Table 47 - Attribute Values

Attribute (Hex)	Assembly Index	Length (Byte)	Read/write	Description
HART Common Group				
66	7	4	R	Extended configuration
67	8		R	Calibration
Host Access Group 1				
68	9	2	R/W	Grant for group 1 access
69	10	6	R	Response status information group 1
6A	11	16	R	Status of loops
6B	12	100	R/W	HART request/response buffer group 1
6C	13	70	R/W	HART request/response buffer group 1
6D	14	56	R/W	HART request/response buffer group 1
6E	15	42	R/W	HART request/response buffer group 1
6F	16	32	R/W	HART request/response buffer group 1
70	17	24	R/W	HART request/response buffer group 1
71	18	18	R/W	HART request/response buffer group 1

Table 47 - Attribute Values (Continued)

Attribute (Hex)	Assembly Index	Length (Byte)	Read/write	Description
72	19	14	R/W	HART request/response buffer group 1
73	20	12	R/W	HART request/response buffer group 1
74	21	8	R/W	HART request/response buffer group 1
Host Access Group 2				
75	22	2	R/W	Grant for group 2 access
76	23	6	R	Response Status Information group 2
77	24	16	R	Status of loops
78	25	100	R/W	HART request/response buffer group 2
79	26	70	R/W	HART request/response buffer group 2
7A	27	56	R/W	HART request/response buffer group 2
7B	28	42	R/W	HART request/response buffer group 2
7C	29	32	R/W	HART request/response buffer group 2
7D	30	24	R/W	HART request/response buffer group 2
7E	31	18	R/W	HART request/response buffer group 2
7F	32	14	R/W	HART request/response buffer group 2
80	33	12	R/W	HART request/response buffer group 2
81	34	8	R/W	HART request/response buffer group 2

Differences Between Attributes and Assembly Indexes

The two Host Access Groups on the module let two different hosts communicate simultaneously to the module and its associated field devices. The Attribute that is used by MSG or CIO instructions send the attribute number to the adapter. The I/O modules use Assemblies. The adapter cross-references the requested Attribute to the corresponding Assembly and forwards it to the associated FLEX I/O HART module for processing.

Messages are sent and received through the multiple HART Request/Response buffers in the same Host Access Groups. To maximize data throughput, these buffers are different sizes.

EXAMPLE If a message from the module was expected to have 23 bytes, the message would fit into Attributes 6B...70 hex for Host Access Group 1. Therefore, the response could be obtained by reading any of these attributes.

If you read the Attribute, 100 bytes would be returned containing 23 expected bytes and 77 zero-filled bytes. To send the extra 77 bytes takes additional time and slows down the response time. Therefore, use the Attribute that best fits the expected message size.

If you attempt to get the response from Attribute 74 hex, an error message would be reported. All messages that contain HART commands and responses to and from the FLEX I/O modules are enhanced while standard HART messages are used between the I/O module and the field device. The Error message is an example of these enhancements.

Table 48 - Standard HART Message

Preamble	Start Character	Address	Command	Byte Count	(Response Code)	Data	Checksum

The Preamble syncs the field devices to the I/O module. Once the HART message is received in the I/O module, the Preamble is no longer needed. The FLEX I/O HART modules can queue up to four HART commands, meaning that the module needs a method to identify the HART response to the associated command.

Table 49 - Write HART Command Contained in a MSG or CIO Instruction

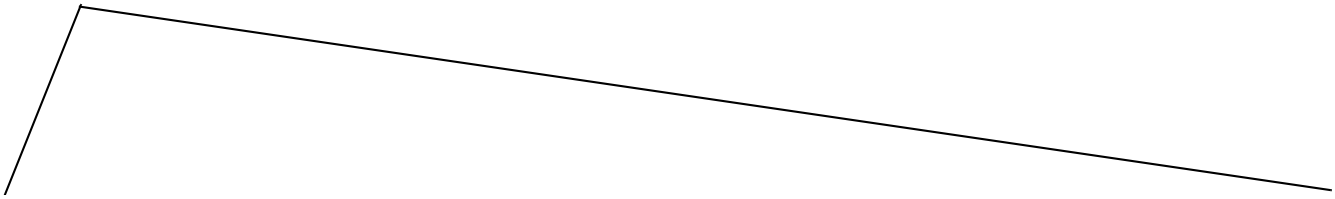
Handle (1 Byte)	Start Character	Address	Command	Byte Count	(Response Code)	Data	Checksum

Handle replaces Preamble. Handle is a number that you supply so that the module returns the Handle with the associated response from the HART command.

The response from the HART command is reformatted to add this handle and to add additional status information.

Figure 5 - Response from the HART Command

Status (6 Bytes)	Start Character	Address	Command	Byte Count	(Response Code)	Data	Checksum



Byte	0		1	2	3	4				5		
Bit	0...2	3...7	0...7	0...7	0...7	0...3	4	5	6	7	0	1	2...7
	Response Source	Next Assembly Index		CH	Handle	Response Error	Assembly Access Error	Chained Data	Request Allowed	Loop Status Available	Lock	Cold Start	Response

The six header bytes are added in the front of the HART message response while the remaining format is unchanged. These 6 bytes contain the following information:

Value	Meaning
0	Not valid (default)
1	Source is HART response
2	Source is scan data
3	Cmd 48 response
4...7	Reserved

- **Next Assembly Index**
  Pointer to assembly for next access.
- **Channel**
  The actual channel to which contents are related.

Value	Meaning
0...7	Channel of I/O module
0x20	FLEX I/O HART module itself

- **Handle**
  This indicates the Handle of the response.
- **Response Error**
  In the following table, values 6...10 are communication errors.

Value	Meaning
0	No error
1	Timeout on HART loop
2	Invalid long frame address
3	Locked
4	Request overflow
5	Response not available
6	Parity error
7	Overrun error
8	Framing error
9	Checksum error
10	Rx buffer overflow
11...15	Reserved

- **Assembly Access Error**

Value	Meaning
0	Access to assembly is invalid
1	Access not valid; take next assembly (See next assembly pointer)

- **Chained Data**

Value	Meaning
0	No chained data in next assembly
1	Chained data in next assembly

- **Request Allowed**

Value	Meaning
0	Request not allowed
1	Request allowed

- **Loop Status Available**
  New loop status is available in Status of Loops assembly.
- **Lock**
  To protect against a second HART host communicating to modules, the HART_lock bit is set in the Group for Group assembly.

Value	Meaning
0	Not locked
1	Locked

- **Cold Start**

  Cold Start indicates that the HART I/O module has made a cold start and the bit is reset when it was first read.

HART Frame Enhancements

Attribute 69 hex for Host Access Group 1 contains only 6 bytes. Since every HART response starts with these six status bytes, this attribute only contains this information. In addition, you must account for these six status bytes when selecting the associated response Attribute. Add 6 bytes to the size of the HART response to accommodate the status bytes.

If you do not know the size of the expected response from the HART module, read Attribute 69 hex for Host Access Group 1. The returned data indicates which Assembly Index contains the response. Once you get this index, issue a MSG or CIO to the associated Attribute. For example, if the Assembly Index is 14, issue a MSG or CIO to Attribute 6D hex.

The Response Error field indicates if the response is available. Once a HART command is issued, it takes a small amount of time to send the message through HART protocol to the field devices, time for the field device to interpret the command, and time to send the response back to the FLEX I/O HART module. During this time, you could request the response before the module obtains it from the field device. In this case, a Response Not Available response is returned in the Response Error field. The module assumes that another request gathers the response.

Notes:

Configure the Input Module in Studio 5000 Logix Designer Application Over the ControlNet Network

This appendix provides the information that is needed to configure the 1794-IE8H analog input module in the Studio 5000 Logix Designer application over the ControlNet network using version 13 or earlier and the generic profile.

Background Information

Make sure that your Comm-Format is set to Input Data - INT so that you can set the output size to 0. In the FLEX generic profile, you need these sizes:

- Input – 8.
- Output – 0.
- Config – 2.
- Status – 5.

IMPORTANT HART commands only work when the Data Format control is configured for a 4...20 mA range. The default configuration when using the generic profile is 0, which configures the module for a 0...20 mA range. The filter cutoff defaults to 0 as well, which is invalid. The filter cutoff must be set to a valid value for the module to operate in any mode.

Adapter Name is what you named the ControlNet adapter when it was originally created.

Slot is the position of the FLEX module in the rack, starting with zero.

Configuration

See the following tables for configuration information.

Fault Mode Bit

Channel	Bits
0...3	[Adapter Name]:[Slot]:C.Data[0].0
4...7	[Adapter Name]:[Slot]:C.Data[1].0

Fault Mode Bit Description

Fault Mode	Bit
Disabled	0
Enabled	1

Data Format Control

Channel	Bits
0...3	[Adapter Name]:[Slot]:C.Data[0].1
	[Adapter Name]:[Slot]:C.Data[0].2
	[Adapter Name]:[Slot]:C.Data[0].3
	[Adapter Name]:[Slot]:C.Data[0].4
4...7	[Adapter Name]:[Slot]:C.Data[1].1
	[Adapter Name]:[Slot]:C.Data[1].2
	[Adapter Name]:[Slot]:C.Data[1].3
	[Adapter Name]:[Slot]:C.Data[1].4

Data Format

Data Format Bits				Range	Resolution	Full Range	Interpretation	Data Value Table	Count per mA
4	3	2	1						
0	0	0	0	0...20 mA	0.1% of 0...20 mA	0...22 mA	0...22 mA	0...22000	1000
0	0	0	1	0...20 mA	0.2% of 0...20 mA	0...22 mA	0...110%	0...11000	500
0	0	1	0	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
0	0	1	1	0...20 mA	0.3% of 0...20 mA	0...20 mA	Unsigned integer	0...65535	3276
0	1	0	0	4...20 mA	0.1% of 4...20 mA	2...22 mA	2...22 mA	2000...22000	1000
0	1	0	1	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
0	1	1	0	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
0	1	1	1	4...20 mA	0.3% of 4...20 mA	4...20 mA	Unsigned integer	0...65535	4095
1	0	0	0	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
1	0	0	1	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
1	0	1	0	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
1	0	1	1	0...20 mA	0.28% of 0...20 mA	0...22 mA	D/A count	0...8000	363
1	1	0	0	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
1	1	0	1	4...20 mA	0.16% of 4...20 mA	3...21 mA	-6.25...+106.25%	-625...+10625	625
1	1	1	0	4...20 mA	0.16% of 4...20 mA	2...22 mA	-12.5...+112.5%	-1250...+11250	625
1	1	1	1	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid

Filter Cutoff

The generic profile sets all filter bits to 0, which is an invalid value. You must set these bits to a valid value or you get a diagnostic error value of 2.

Filter Cutoff Bit

Channel	Bits
0...3	[Adapter Name]:[Slot]:C.Data[0].5
	[Adapter Name]:[Slot]:C.Data[0].6
	[Adapter Name]:[Slot]:C.Data[0].7
4...7	[Adapter Name]:[Slot]:C.Data[1].5
	[Adapter Name]:[Slot]:C.Data[1].6
	[Adapter Name]:[Slot]:C.Data[1].7

Filter Cutoff Bit Description

Filter Cutoff Bits			Description
7	6	5	
0	0	0	Not valid
0	0	1	Not valid
0	1	0	Not valid
0	1	1	10 Hz (100 ms)
1	0	0	4 Hz (250 ms)

Filter Cutoff Bit Description (Continued)

Filter Cutoff Bits			Description
7	6	5	
1	0	1	2 Hz (500 ms)
1	1	0	1 Hz (1 s)
1	1	1	0.5 Hz (2 s)

Up/Down Bit

Channel	Bits
0…3	[Adapter Name]:[Slot]:C.Data[0].8
4…7	[Adapter Name]:[Slot]:C.Data[1].8

Up/Down Bit Description

Up/Down Bit	Description
0	Up
1	Down

High and Low Error Level

Channel	Bits
0…3	[Adapter Name]:[Slot]:C.Data[0].9
	[Adapter Name]:[Slot]:C.Data[0].10
	[Adapter Name]:[Slot]:C.Data[0].11
	[Adapter Name]:[Slot]:C.Data[0].12
	[Adapter Name]:[Slot]:C.Data[0].13
4…7	[Adapter Name]:[Slot]:C.Data[1].9
	[Adapter Name]:[Slot]:C.Data[1].10
	[Adapter Name]:[Slot]:C.Data[1].11
	[Adapter Name]:[Slot]:C.Data[1].12
	[Adapter Name]:[Slot]:C.Data[1].13

High and Low Error Level Description

High and Low Error Bits					Description
13	12	11	10	9	
0	0	0	0	0	Disabled
0	0	0	0	1	0.1 mA
0	0	0	1	0	0.2 mA
0	0	0	1	1	0.3 mA
0	0	1	0	0	0.4 mA
0	0	1	0	1	0.5 mA
0	0	1	1	0	0.6 mA
0	0	1	1	1	0.7 mA
0	1	0	0	0	0.8 mA
0	1	0	0	1	0.9 mA
0	1	0	1	0	1.0 mA
0	1	0	1	1	1.1 mA
0	1	1	0	0	1.2 mA
0	1	1	0	1	1.3 mA
0	1	1	1	0	1.4 mA
0	1	1	1	1	1.5 mA
1	0	0	0	0	1.6 mA
1	0	0	0	1	1.7 mA

High and Low Error Level Description (Continued)

High and Low Error Bits					Description
13	12	11	10	9	
1	0	0	1	0	1.8 mA
1	0	0	1	1	1.9 mA
1	0	1	0	0	2.0 mA

Square Root Threshold

Bits
[Adapter Name]:[Slot]:C.Data[1].14
[Adapter Name]:[Slot]:C.Data[1].15

Square Root Threshold Description

15	14	Range
0	0	Disabled
0	1	2%
1	0	5%
1	1	10%

Input

Analog Input Data

Channel	Words
0	[Adapter Name]:[Slot]:I.Data[0]
1	[Adapter Name]:[Slot]:I.Data[1]
2	[Adapter Name]:[Slot]:I.Data[2]
3	[Adapter Name]:[Slot]:I.Data[3]
4	[Adapter Name]:[Slot]:I.Data[4]
5	[Adapter Name]:[Slot]:I.Data[5]
6	[Adapter Name]:[Slot]:I.Data[6]
7	[Adapter Name]:[Slot]:I.Data[7]

Underrange Alarm

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[8].0
1	[Adapter Name]:[Slot]:I.Data[8].1
2	[Adapter Name]:[Slot]:I.Data[8].2
3	[Adapter Name]:[Slot]:I.Data[8].3
4	[Adapter Name]:[Slot]:I.Data[8].4
5	[Adapter Name]:[Slot]:I.Data[8].5
6	[Adapter Name]:[Slot]:I.Data[8].6
7	[Adapter Name]:[Slot]:I.Data[8].7

Overrange Alarm

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[8].8
1	[Adapter Name]:[Slot]:I.Data[8].9
2	[Adapter Name]:[Slot]:I.Data[8].10
3	[Adapter Name]:[Slot]:I.Data[8].11
4	[Adapter Name]:[Slot]:I.Data[8].12

Overrange Alarm (Continued)

Channel	Bits
5	[Adapter Name]:[Slot]:I.Data[8].13
6	[Adapter Name]:[Slot]:I.Data[8].14
7	[Adapter Name]:[Slot]:I.Data[8].15

Local Fault

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[9].0
1	[Adapter Name]:[Slot]:I.Data[9].1
2	[Adapter Name]:[Slot]:I.Data[9].2
3	[Adapter Name]:[Slot]:I.Data[9].3
4	[Adapter Name]:[Slot]:I.Data[9].4
5	[Adapter Name]:[Slot]:I.Data[9].5
6	[Adapter Name]:[Slot]:I.Data[9].6
7	[Adapter Name]:[Slot]:I.Data[9].7

Remote Fault

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[9].8
1	[Adapter Name]:[Slot]:I.Data[9].9
2	[Adapter Name]:[Slot]:I.Data[9].10
3	[Adapter Name]:[Slot]:I.Data[9].11
4	[Adapter Name]:[Slot]:I.Data[9].12
5	[Adapter Name]:[Slot]:I.Data[9].13
6	[Adapter Name]:[Slot]:I.Data[9].14
7	[Adapter Name]:[Slot]:I.Data[9].15

Diagnostic Status

Bits
[Adapter Name]:[Slot]:I.Data[10].0
[Adapter Name]:[Slot]:I.Data[10].1
[Adapter Name]:[Slot]:I.Data[10].2
[Adapter Name]:[Slot]:I.Data[10].3

Diagnostic Status Description

Diagnostic Description	Bit 3	Bit 2	Bit 1	Bit 0
Normal	0	0	0	0
Calibration failure	0	0	0	1
Configuration failure	0	0	1	0
Message failure	0	0	1	1
Lead break detection	0	1	0	0
EEPROM failure	0	1	0	1
RAM failure	0	1	1	0
ROM failure	0	1	1	1
Calculation failure	1	0	0	0
Data out of range	1	0	1	1

Notes:

Configure the Output Module in Studio 5000 Logix Designer Application Over a ControlNet Network

This appendix provides the information that is needed to configure the 1794-OE8H analog output module in the Studio 5000 Logix Designer application over the ControlNet network using version 13 or earlier and the generic profile.

Background Information

Make sure that your Comm-Format is set to Data - INT. In the FLEX generic profile, you need these sizes:

- Input – 0
- Output – 9
- Config – 11
- Status – 4

IMPORTANT HART commands only work when the Data Format control is configured for a 4...20 mA range. The default configuration when you use the generic profile is 0, which configures the module for a 0...20 mA range.

Adapter Name is what you named the ControlNet adapter when you originally created it.

Slot is the position of the FLEX I/O module in the rack, starting with zero.

Configuration

See the following tables for configuration information.

Data Format Control

Channel	Bits
0 and 1	[Adapter Name]:[Slot]:C.Data[0].0
	[Adapter Name]:[Slot]:C.Data[0].1
	[Adapter Name]:[Slot]:C.Data[0].2
	[Adapter Name]:[Slot]:C.Data[0].3
2 and 3	[Adapter Name]:[Slot]:C.Data[0].4
	[Adapter Name]:[Slot]:C.Data[0].5
	[Adapter Name]:[Slot]:C.Data[0].6
	[Adapter Name]:[Slot]:C.Data[0].7

Data Format Control (Continued)

Channel	Bits
4 and 5	[Adapter Name]:[Slot]:C.Data[1].0
	[Adapter Name]:[Slot]:C.Data[1].1
	[Adapter Name]:[Slot]:C.Data[1].2
	[Adapter Name]:[Slot]:C.Data[1].3
6 and 7	[Adapter Name]:[Slot]:C.Data[1].4
	[Adapter Name]:[Slot]:C.Data[1].5
	[Adapter Name]:[Slot]:C.Data[1].6
	[Adapter Name]:[Slot]:C.Data[1].7

Data Format

Data Format Bits									
3	2	1	0	Range	Resolution	Full Range	Interpretation	Data Value Table	Count per mA
7	6	5	4						
0	0	0	0	0...20 mA	0.1% of 0...20 mA	0...22 mA	0...22 mA	0...22000	1000
0	0	0	1	0...20 mA	0.2% of 0...20 mA	0...22 mA	0...110%	0...11000	500
0	0	1	0	Not valid					
0	0	1	1	0...20 mA	0.3% of 0...20 mA	0...20 mA	Unsigned integer	0...65535	3276
0	1	0	0	4...20 mA	0.1% of 4...20 mA	2...22 mA	2...22 mA	2000...22000	1000
0	1	0	1	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
0	1	1	0	Not valid	Not valid	Not valid	Not valid	Not valid	Not valid
0	1	1	1	4...20 mA	0.3% of 4...20 mA	4...20 mA	Unsigned integer	0...65535	4095
1	0	0	0	Not valid					
1	0	0	1	Not valid					
1	0	1	0	Not valid					
1	0	1	1	0...20 mA	0.28% of 0...20 mA	0...22 mA	D/A count	0...8000	363
1	1	0	0	Not valid					
1	1	0	1	4...20 mA	0.16% of 4...20 mA	3...21 mA	-6.25...+106.25%	-625...+10625	625
1	1	1	0	4...20 mA	0.16% of 4...20 mA	2...22 mA	-12.5...+112.5%	-1250...+11250	625
1	1	1	1	Not valid					

Analog Fault State Bits

Analog Fault State for Channel	Bits
0	[Adapter Name]:[Slot]:C.Data[3]
1	[Adapter Name]:[Slot]:C.Data[4]
2	[Adapter Name]:[Slot]:C.Data[5]
3	[Adapter Name]:[Slot]:C.Data[6]
4	[Adapter Name]:[Slot]:C.Data[7]
5	[Adapter Name]:[Slot]:C.Data[8]
6	[Adapter Name]:[Slot]:C.Data[9]
7	[Adapter Name]:[Slot]:C.Data[10]

Analog Fault State Bit Description

Analog Fault State Bit	Bits 9 or 11	Bits 8 or 10
Min value of data range	0	0
Max value of data range	0	1
Hold last state	1	0
Analog fault state value	1	1

Fault Mode Bit

Channel	Bits
0 and 1	[Adapter Name]:[Slot]:C.Data[0].12
2 and 3	[Adapter Name]:[Slot]:C.Data[0].13
4 and 5	[Adapter Name]:[Slot]:C.Data[1].12
6 and 7	[Adapter Name]:[Slot]:C.Data[1].13

Fault Mode Bit Description

Fault Mode	Bit
Disabled	0
Enabled	1

Local Fault Mode

The Local Fault Mode uses bit [Adapter Name]:[Slot]:C.Data[0].15.

Local Fault Mode Bit Description

Local Fault Mode	Bit
Communications fault	0
Any Fault	1

Latch Retry Mode

Latch Retry Mode Bit

Channel	Bits
0...3	[Adapter Name]:[Slot]:C.Data[1].14
4...7	[Adapter Name]:[Slot]:C.Data[1].15

Latch Retry Mode Bit Description

Latch Retry Mode	Bit
Retry	0
Latch	1

Analog/Digital Mode Bits

Channel	Bits
0	[Adapter Name]:[Slot]:C.Data[2].0
1	[Adapter Name]:[Slot]:C.Data[2].1
2	[Adapter Name]:[Slot]:C.Data[2].2
3	[Adapter Name]:[Slot]:C.Data[2].3
4	[Adapter Name]:[Slot]:C.Data[2].4
5	[Adapter Name]:[Slot]:C.Data[2].5
6	[Adapter Name]:[Slot]:C.Data[2].6
7	[Adapter Name]:[Slot]:C.Data[2].7

Analog/Digital Mode Bit Description

Analog/Digital Mode	Bit
Analog	0
Digital	1

Digital Fault State Bits

Channel	Bits
0	[Adapter Name]:[Slot]:C.Data[2].8
1	[Adapter Name]:[Slot]:C.Data[2].9
2	[Adapter Name]:[Slot]:C.Data[2].10
3	[Adapter Name]:[Slot]:C.Data[2].11
4	[Adapter Name]:[Slot]:C.Data[2].12
5	[Adapter Name]:[Slot]:C.Data[2].13
6	[Adapter Name]:[Slot]:C.Data[2].14
7	[Adapter Name]:[Slot]:C.Data[2].15

Digital Fault State Bit Description

Digital Fault State	Bit
Reset	0
Hold last state	1

Analog Fault State Values

Channel	Bits
0	[Adapter Name]:[Slot]:C.Data[3]
1	[Adapter Name]:[Slot]:C.Data[4]
2	[Adapter Name]:[Slot]:C.Data[5]
3	[Adapter Name]:[Slot]:C.Data[6]
4	[Adapter Name]:[Slot]:C.Data[7]
5	[Adapter Name]:[Slot]:C.Data[8]
6	[Adapter Name]:[Slot]:C.Data[9]
7	[Adapter Name]:[Slot]:C.Data[10]

Output

See the following tables for output information.

Digital Output Data

Channel	Bits
0	[Adapter Name]:[Slot]:O.Data[0].0
1	[Adapter Name]:[Slot]:O.Data[0].1
2	[Adapter Name]:[Slot]:O.Data[0].2
3	[Adapter Name]:[Slot]:O.Data[0].3
4	[Adapter Name]:[Slot]:O.Data[0].4
5	[Adapter Name]:[Slot]:O.Data[0].5
6	[Adapter Name]:[Slot]:O.Data[0].6
7	[Adapter Name]:[Slot]:O.Data[0].7

Global Output Data

The Global reset bit goes in bit [Adapter Name]:[Slot]:O.Data[0].14.

Analog Output Data

Channel	Bits
0	[Adapter Name]:[Slot]:O.Data[1]
1	[Adapter Name]:[Slot]:O.Data[2]
2	[Adapter Name]:[Slot]:O.Data[3]
3	[Adapter Name]:[Slot] O.Data[4]
4	[Adapter Name]:[Slot]:O.Data[5]

Analog Output Data (Continued)

Channel	Bits
5	[Adapter Name]:[Slot]:O.Data[6]
6	[Adapter Name]:[Slot]:O.Data[7]
7	[Adapter Name]:[Slot]:O.Data[8]

Input

See the following tables for input information.

Diagnostic Status Data

Diagnostic Description	Bit 3	Bit 2	Bit 1	Bit 0
Normal	0	0	0	0
Calibration failure	0	0	0	1
Configuration failure	0	0	1	0
Message failure	0	0	1	1
Lead break detection	0	1	0	0
EEPROM failure	0	1	0	1
RAM failure	0	1	1	0
ROM failure	0	1	1	1
Calculation failure	1	0	0	0
Data out of range	1	0	1	1

HART Rebuild Bit

The HART rebuild bit is [Adapter Name]:[Slot]:I.Data[0].7.

Fault Alarm

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[0].8
1	[Adapter Name]:[Slot]:I.Data[0].9
2	[Adapter Name]:[Slot]:I.Data[0].10
3	[Adapter Name]:[Slot]:I.Data[0].11
4	[Adapter Name]:[Slot]:I.Data[0].12
5	[Adapter Name]:[Slot]:I.Data[0].13
6	[Adapter Name]:[Slot]:I.Data[0].14
7	[Adapter Name]:[Slot]:I.Data[0].15

HART Failure

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[2].0
1	[Adapter Name]:[Slot]:I.Data[2].1
2	[Adapter Name]:[Slot]:I.Data[2].2
3	[Adapter Name]:[Slot]:I.Data[2].3
4	[Adapter Name]:[Slot]:I.Data[2].4
5	[Adapter Name]:[Slot]:I.Data[2].5
6	[Adapter Name]:[Slot]:I.Data[2].6
7	[Adapter Name]:[Slot]:I.Data[2].7

HART Readback

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[2].8
1	[Adapter Name]:[Slot]:I.Data[2].9
2	[Adapter Name]:[Slot]:I.Data[2].10
3	[Adapter Name]:[Slot]:I.Data[2].11
4	[Adapter Name]:[Slot]:I.Data[2].12
5	[Adapter Name]:[Slot]:I.Data[2].13
6	[Adapter Name]:[Slot]:I.Data[2].14
7	[Adapter Name]:[Slot]:I.Data[2].15

HART Communication

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[3].0
1	[Adapter Name]:[Slot]:I.Data[3].1
2	[Adapter Name]:[Slot]:I.Data[3].2
3	[Adapter Name]:[Slot]:I.Data[3].3
4	[Adapter Name]:[Slot]:I.Data[3].4
5	[Adapter Name]:[Slot]:I.Data[3].5
6	[Adapter Name]:[Slot]:I.Data[3].6
7	[Adapter Name]:[Slot]:I.Data[3].7

HART Transmitter

Channel	Bits
0	[Adapter Name]:[Slot]:I.Data[3].8
1	[Adapter Name]:[Slot]:I.Data[3].9
2	[Adapter Name]:[Slot]:I.Data[3].10
3	[Adapter Name]:[Slot]:I.Data[3].11
4	[Adapter Name]:[Slot]:I.Data[3].12
5	[Adapter Name]:[Slot]:I.Data[3].13
6	[Adapter Name]:[Slot]:I.Data[3].14
7	[Adapter Name]:[Slot]:I.Data[3].15

T

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