Allen-Bradley

FLEX I/O HART Analog Modules

1794-IE8H and 1794-OE8H

User Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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

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

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

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Throughout this manual we may 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.

IMPORTANT

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

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
- recognize the consequence

SHOCK HAZARD

Labels may be located on or inside the equipment to alert people that dangerous voltage may be present.

BURN HAZARD

Labels may be located on or inside the equipment to alert people that surfaces may be dangerous temperatures.

ATTENTION

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley publication 1770-4.1, for additional installation requirements pertaining to this equipment.

WARNING

If you insert or remove the module while backplane power is on, an electrical 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

If you connect or disconnect wiring while the field side power is on, an electrical 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.

ATTENTION

This product is grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (such as aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding.

ATTENTION

Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

North American Hazardous Location Approval

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The following information applies when operating this equipment in hazardous locations:		**Informations sur l'utilisation de cet équipement en environnements dangereux :**	
Products marked CL I, DIV 2, GP A, B, C, D are suitable for use in Class I Division 2 Groups A, B, C, D, hazardous locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.		Les produits marqués CL I, DIV 2, GP A, B, C, D ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.	
WARNING 	**EXPLOSION HAZARD** •Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. •Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. •Substitution of components may impair suitability for Class I, Division 2. •If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT** 	**RISQUE D'EXPLOSION** •Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. •Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. •La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. •S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

European Zone 2 Certification
(The following applies when the product bears the EEx Marking.)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15.

IMPORTANT Observe the following additional Zone 2 certification requirements.

- This equipment is not resistant to sunlight or other sources of UV radiation.
- The secondary of a current transformer shall not be open-circuited when applied in Class I, Zone 2 environments.
- Equipment of lesser Enclosure Type Rating must be installed in an enclosure providing at least IP54 protection when applied in Class I, Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Class I, Zone 2 environments

Important User Information 1-2
North American Hazardous Location Approval 1-4
European Hazardous Location Approval. 1-5

Preface

Why Read This Manual P-1
Who Should Read This Manual. P-1
About the Vocabulary P-1
What This Manual Contains P-1
For Additional Information. P-2

Table of Contents

Chapter 1

About the FLEX I/O HART Analog Modules

What This Chapter Contains 1-1
What the FLEX I/O Analog I/O Modules Do. 1-1
How FLEX I/O Analog Modules Communicate with Programmable Controllers 1-2
Events Following Power-up 1-2
Physical Features of Your Analog I/O Module 1-3
Indicators 1-3
Use Alarms on the 1794-IE8H Module 1-3
Data Format Alarm Example 1-4
Overrange Alarm 1-4
Underrange Alarm 1-4
Remote Fault Alarm 1-5
Local Fault Alarm 1-6
How to Use the HART Capabilities 1-7
HART Implementation Overview 1-7
Chapter Summary. 1-8

Chapter 2

Configurable FLEX I/O Analog Module Features

What This Chapter Contains 2-1
Select Your 1794-IE8H FLEX I/O Analog Input Module's Operating Features. 2-2
Fault Mode 2-2
Remote Transmitter Error Up or Down 2-2
High Low Error Level. 2-3
Input Filter Cutoff. 2-3
Data Format. 2-4
Select Your 1794-OE8H FLEX I/O Analog Output Module's Operating Features. 2-7
Local Fault Mode. 2-7
Latch Mode 2-7
Global Reset. 2-7
Analog Digital State 2-8
Analog Fault State 2-8
Analog Fault State Value 2-8

Digital Fault State. 2-8
Data Format. 2-9
Fault Alarm 2-11
Understand Image Table Mapping and Bit/Word Descriptions . . . 2-12
Bit Descriptions 2-12
Analog Input Module (1794-IE8H) Image Table Mapping. . . . 2-13
Bit/Word Description for the Analog Input Module (1794-IE8H) 2-14
Analog Output Module (1794-OE8H) Image Table Mapping . 2-16
1794-IE8H and -OE8H Extended Configuration Data Table 2-19
Secondary Master Enable (SME) and Primary Master Inhibit (PMI) 2-20
Chapter Summary. 2-21

Chapter 3

Install Your FLEX I/O Analog Modules

What This Chapter Contains 3-1
Before You Install Your Analog Module 3-1
Removal and Insertion Under Power 3-2
Install the Module 3-2
Mount on a DIN Rail 3-3
Mount on a Panel or Wall 3-5
Mount the Analog Modules on the Terminal Base Unit 3-7
Wire the Terminal Base Units 3-8
Connect Wiring to the FLEX I/O HART Analog Modules 3-8
Inputs/Outputs 3-8
Connections for the 1794-IE8H HART Analog Input Module on a 1794-TB3G Terminal Base Unit 3-9
Connections for the 1794-OE8H HART Analog Output Module on a 1794-TB3G or 1794-TB3GS Terminal Base Unit. 3-11
Ground the Module 3-12
Chapter Summary. 3-13

Chapter 4

Input, Output and Configuration File for the Analog I/O Modules on the ControlNet Network

What This Chapter Contains 4-1
Use Programming Software in Your FLEX I/O Application 4-2
About the ControlNet Adapter 4-2
Communication Over the FLEX I/O Backplane 4-3
Scheduled Data Transfer 4-3
Unscheduled Data Transfer 4-4
Module I/O Mapping 4-4
I/O Structure 4-4
Adapter Status Word 4-5
Fault State Data 4-6

Device Actions 4-7
Communication Fault Behavior 4-7
Idle State Behavior 4-7
Chapter Summary 4-8

Chapter 5

Calibrate Your Module

What This Chapter Contains 5-1
When and How to Calibrate Your FLEX I/O Analog I/O Module 5-1
Tools and Equipment 5-2
1794-IE8H Calibration Features 5-2
1794-IE8H Calibration Command Structure 5-3
1794-IE8H Calibration Command Byte 5-4
1794-IE8H Calibration Item Byte Channel-Mask 5-8
1794-IE8H Calibration with Offset and Gain 5-10
1794-OE8H Calibration Features 5-11
1794-OE8H Calibration Command Byte 5-12
1794-OE8H Calibration Item Byte Channel-Mask 5-17
1794-OE8H Calibration Flowchart Procedure 5-18

Chapter 6

Troubleshoot the FLEX I/O Analog I/O Modules

What This Chapter Contains 6-1
Status Indicators 6-1
1794-IE8H Module 6-1
1794-OE8H Module 6-2
Repair 6-2
Chapter Summary 6-2

Appendix A

Specifications

1794-IE8H HART Input Module A-1
1794-OE8H HART Output Module A-1
. . . . . A-1

Appendix B

FLEX I/O HART Module Commands

What This Appendix Contains B-1
Protocol Overview B-1
Universal Commands B-2
Common Practice Commands B-3
Device-Specific Commands B-3

Appendix C

Additional HART Protocol Information

What This Appendix Contains C-1
Message Structure C-1
Master-slave Operation C-1
Multiple Master Operation C-1

Transaction Procedure. C-2
Burst Mode (not supported) C-2
Universal Commands. C-7
Common Practice Commands. C-9

FLEX I/O HART Modules Network Messaging

Appendix D

What This Appendix Contains D-1
Communication D-1
Differences Between Attributes and Assembly Indexes D-3
HART Frame Enhancements D-6

Configure the 1794-IE8H Module in RSLogix 5000 Software Over the ControlNet Network

Appendix E

What This Appendix Contains E-1
Background Information E-1
Configuration E-2
Fault Mode E-2
Data Format Control E-2
Filter Cutoff E-4
Up/Down Bit. E-5
High and Low Error Level E-5
Square Root Threshold E-7
Input E-7
Analog Input Data E-7
Underrange Alarm E-7
Overrange Alarm E-8
Local Fault E-8
Remote Fault E-8
Diagnostic Status E-9

Configure the 1794-OE8H Module in RSLogix5000 Software Over the ControlNet Network

Appendix F

What This Appendix Contains F-1
Background Information F-1
Configuration F-2
Data Format Control F-2
Analog Fault State F-4
Fault Mode F-4
Local Fault Mode F-4
Latch Retry Mode. F-5
Analog/Digital Mode F-5
Digital Fault State. F-5
Analog Fault State Values F-6
Output. F-6
Digital Output Data F-6
Global Output Data. F-6
Analog Output Data F-7

Input F-7
Diagnostic Status Data F-7
HART Rebuild Bit F-7
Fault Alarm F-8
HART Failure F-8
HART Readback F-8
HART Communication F-9
HART Transmitter F-9

Index

Rockwell Automation Support . . . . . Back Cover
Installation Assistance . . . . . Back Cover
New Product Satisfaction Return . . . . . Back Cover

Why Read This Manual

This manual shows you how to use your FLEX I/O™ analog modules with the ControlNet™ products and ControlNet network, and EtherNet products and EtherNet network. The manual helps you install, program, and troubleshoot your module.

Who Should Read This Manual

You must be able to program and operate a ControlNet product and ControlNet network to make efficient use of a FLEX I/O module.

About the Vocabulary

In this manual, we refer to the:

- 1794-IE8H as the 'input module'
- 1794-OE8H as the 'output module'

What This Manual Contains

The following chart lists each chapter with its corresponding title and a brief overview of the topics covered in that chapter.

Chapter	Title	Contents
1	About the FLEX I/O HART Analog Modules	Describes module functionality and physical features
2	Configurable FLEX I/O Analog Module Features	Describes configurable module features and configuration bits
3	Install Your FLEX I/O Analog Modules	How to install and wire the modules
4	Input, Output and Configuration Files for the Analog I/O Modules on the ControlNet Network	Describes how to use these I/O modules over the ControlNet network
5	Calibrate Your Module	Lists the tools needed, and the methods used to calibrate the module
6	Troubleshoot the FLEX I/O Analog I/O Modules	How to use the indicators to troubleshoot your module
Appendix	**Title**	**Contents**
A	Specifications	Outlines module specifications and accuracy
B	FLEX I/O HART Module Commands	Explains how to program the analog modules
C	Additional HART Protocol Information	Discusses the HART protocol and provides references for additional information about the protocol

D	FLEX I/O HART Modules Network Messaging	How to communicate using MSG and CIO instructions
E	Configure the 1794-IE8H Module in RSLogix 5000 Software Over the ControlNet Network	How to configure your input module using RSLgix 5000.
F	Configure the 1794-OE8H Module in RSLogix5000 Software Over the ControlNet Network	How to configure your output module using RSLgix 5000.

For Additional Information

For additional information on FLEX systems and modules, refer to the following documents.

Catalog Number	Voltage	Description	Publications	
			Installation Instructions	User Manual
1794		1794 FLEX I/O Selection Guide	1794–SG002	
1794-ACN	24V dc	ControlNet Adapter	1794–IN101	
1794-AENT		EtherNet/IP Adapter	1794-IN082	ENET-UM001
1794-ACNR	24V dc	Redundant Media ControlNet Adapter	1794–IN101	
1794-ACN15	24V dc	ControlNet Adapter	1794-IN101	CNET-UM001
1794-ACNR15	24V dc	Redundant Media ControlNet Adapter		CNET-UM001
1794-ADN	24V dc	DeviceNet Adapter	1794-IN099	1794–6.5.5
1794-ASB/E	24V dc	Remote I/O Adapter	1794–IN098	1794–UM009
1794-ASB2/D	24V dc	2–Slot Remote I/O Adapter		1794–UM059
1794-APB	24V dc	Profibus Adapter	1794-IN087	1794–UM057
1794-IB8	24V dc	8 Sink Input Module	1794-IN093	
1794-IB16	24V dc	16 Sink Input Module		
1794-IB32	24V dc	32 Sink Input Module		
1794-IV16	24V dc	16 Source Input Module	1794-IN095	
1794-OV16	24V dc	16 Sink Output Module		
1794-OV16P	24V dc	16 Protected Sink Output Module		

Catalog Number	Voltage	Description	Publications	
			Installation Instructions	User Manual
1794-OB8	24V dc	8 Source Output Module	1794-IN094	
1794-OB8EP	24V dc	8 Electronically Fused Output Module		
1794-OB16	24V dc	16 Source Output Module		
1794-OB16P	24V dc	16 Protected Source Output Module		
1794-OB32P	24V dc	32 Protected Source Output Module		
1794-IB10XOB6	24V dc	10 Input/6 Output Module	1794-IN083	
1794-IB16XOB16P	24V dc	16 Input/16 Output Module		
1794-OW8	24V dc	8 Relay Output Module	1794-IN019	
1794-IE8	24V dc	Analog 8 Input Module	1794-IN100	1794–6.5.2
1794-OE4	24V dc	Analog 4 Output Module		
1794-IE4XOE2	24V dc	4 Input/2 Output Analog Module		
1794-OF4I	24V dc	4 Output Isolated Analog Module	1794-IN037	1794–6.5.8
1794-IF4I	24V dc	4 Input Isolated Analog Module	1794-IN038	
1794-IF2XOF2I	24V dc	2 Input/2 Output Isolated Analog Module	1794-IN039	
1794-IR8	24V dc	8 RTD Input Analog Module	1794-IN021	1794–6.5.4
1794-IT8	24V dc	8 Thermocouple Input Module		1794–6.5.7
1794-IRT8	24V dc	8 Thermocouple/RTD Input Module	1794-IN050	1794–6.5.12
1794-IJ2	24V dc	2 Channel Frequency Input Module	1794-IN049	1794–6.5.11
1794-ID2	24V dc	2 Channel Frequency Input Module	1794-IN063	1794–6.5.15
1794-IP4	24V dc	2 Channel Pulse Counter Module	1794-IN064	1794–6.5.16
1794-VHSC	24V dc	Very High Speed Counter Module	1794IN067	1794–6.5.10
1794-IC16	48V dc	16 Input Module	1794-IN105	
1794-OC16	48V dc	Output Module		
1794-IA8	120V ac	8 Input Module	1794-IN102	
1794-IA8I	120V ac	Isolated 8 Input Module		
1794-IA16	120V ac	16 Input Module		
1794-OA8	120V ac	8 Output Module	1794-IN103	
1794-OA8I	120V ac	Isolated 8 Output Module		
1794-OA16	120V ac	16 Output Module		
1794-IM8	220V ac	8 Input Module	1794-IN104	
1794-OM8	220V ac	8 Output Module		

Catalog Number	Voltage	Description	Publications	
			Installation Instructions	User Manual
1794-TB2 1794-TB3		Cage Clamp Terminal Base Cage Clamp Terminal Base	1794-IN092	
1794-TBN		Terminal Base Unit		
1794-TBNF		Fused Terminal Base Unit		
1794-TB3T		Temperature Terminal Base Unit		
1794-TB3S		Spring Clamp Terminal Base Unit		
1794-TB3TS		Spring Clamp Temperature Base Unit		
1794-TB3G		Terminal Base Unit		
1794-TB3GS		Spring Clamp Terminal Base Unit		
1794-TB32		Cage Clamp Terminal Base Unit		
1794-TB32S		Spring Clamp Terminal Base Unit		
1794-CE1		Extender Cables	1794–5.12	
1794-CE3		Extender Cables		
1794-NM1		Mounting Kit	1794–5.13	
1794-PS13	24V dc	Power Supply	1794-IN069	
1794-PS3	24V dc	Power Supply		
FLEX Ex				
1797-IBN16	See note	16 NAMUR Digital Input Module	1797-5.7	
1797-OB4D	See note	4 NI, Ex Source Digital Output Module	1797-5.6	
1797-IE8	See note	8 Input Analog Module	1797-5.5	
1797-IE8H	See note	8 Input HART Module		
1797-IE8NF	See note	8 Input Analog Selectable Filter Module		
1797-OE8,	See note	Analog 8 Output Module	1797-5.3	
1797-OE8H	See note	Analog 8 HART Output Module		
1797-IRT8	See note	8 Thermocouple/RTD Input Module	1797-5.4	
1797-IJ2	See note	2 Channel Frequency Input Module	1797-5.9	
1797-TB3		Flex Ex Terminal Base Units	1797-5.1	
1797-TB3S		Flex Ex Terminal Base Units		
1797-BIC	See note	I.S. Bus Isolator	1797-5.13	
1797-CEC	See note	FLEX Ex Bus Connector		

Note: Intrinsically Safe Voltage

About the FLEX I/O HART Analog Modules

What This Chapter Contains

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

For Information About	See Page
What the FLEX I/O Analog I/O Modules Do	1-1
How FLEX I/O Analog Modules Communicate with Programmable Controllers	1-2
Physical Features of Your Analog I/O Module	1-3
Chapter Summary	1-8

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 network.

The 1794-IE8H module accepts up to 8 analog inputs. The inputs are nonisolated and will accept current in either of the following two ranges: 4 to 20 mA or 0 to 20 mA. The default input range is 0 to 20 mA. The inputs have both fixed hardware filters and selectable firmware digital filters.

Similarly, the 1794-OE8H module provides as many as 8 analog outputs. The outputs are nonisolated and will provide current in either of the following two ranges: 4 to 20 mA or 0 to 20 mA. The default output range is 0 to 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 (PLC) 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 PLC program is also automatically transferred from the PLC 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 via 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 the check has begun. The indicator turns OFF when the check is finished.

2. After the diagnostic check, module configuration information, selected by the user 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.

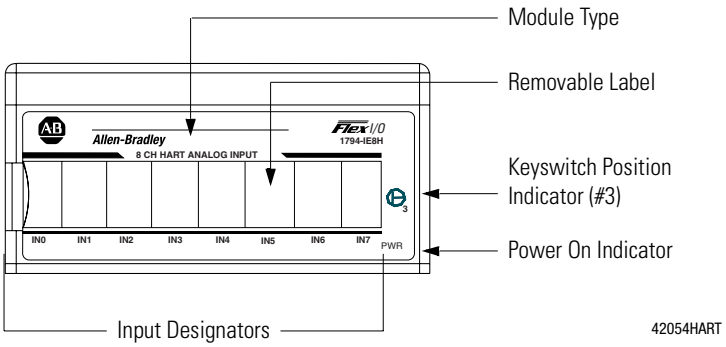
Physical Features of Your Analog I/O Module

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 below.

1794-IE8H



Use Alarms on the 1794-IE8H Module

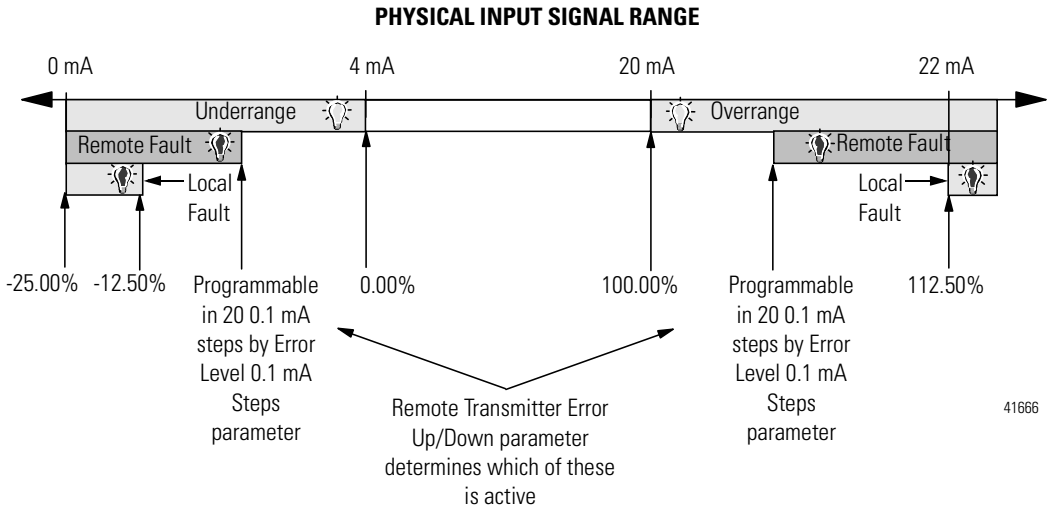
The 1794-IE8H FLEX I/O module is capable of generating four alarms:

- 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. The following graphic 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.



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 cannot 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 just described. You must use the Remote Transmitter Error Up or Down feature, see page 2-2, 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 which 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 in conjunction 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 input signal range. The remote fault alarm activates if your I/O module receives input signal values of:

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

  or

- -0.63 to -11.88% (3.9 to 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 2-2 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 an 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

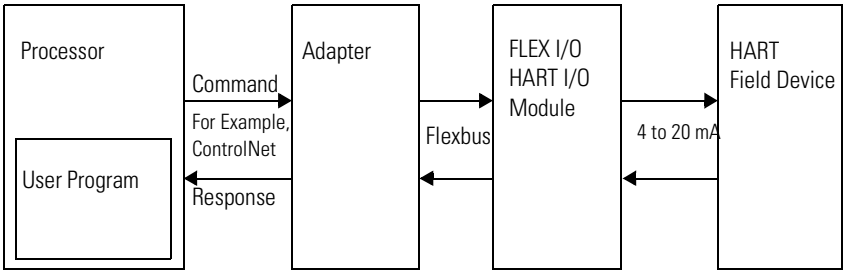
Before using the HART capabilities, be sure that:

- the I/O module and the associated field device are working properly in the analog 4 to 20 mA mode.
- the I/O module is configured for 4 to 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, storing the responses in its memory.



Chapter Summary

In this chapter, you learned about FLEX I/O analog I/O modules and HART module capabilities. Move on to Chapter 2 to learn about configurable features on your module.

Configurable FLEX I/O Analog Module Features

What This Chapter Contains

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

For Information On	See Page
Select Your 1794-IE8H FLEX I/O Analog Input Module's Operating Features	2-2
Select Your 1794-OE8H FLEX I/O Analog Output Module's Operating Features	2-7
Understand Image Table Mapping and Bit/Word Descriptions	2-12
Instance: Slot number (range from 1 to 8 with 1 being the I/O module closest to the adapter	2-19

HART configurable features described in this chapter include the following

Table 2.1 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
Data Format	Latch Retry Mode
	Global Reset
	Analog Digital State
	Analog Fault State
	Digital Fault State
	Data Format
	Fault Alarm

IMPORTANT You must use the I/O configuration portion of your PLC 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 1794-IE8H 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 to 3 & channel 4 to 7).

IMPORTANT The default selection value for all parameters is 0.

Fault Mode

Your input modules are capable of indicating 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 will only enable or disable 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 1-5. For more information on the Local Fault Alarm, see page 1-6.

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 in conjunction with the High Low Error level, this feature designates whether remote faults are displayed with input signal readings beyond the high or low signal levels 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 1-5. For more information on the Local Fault Alarm, see page 1-6.

High Low Error Level

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

If the Remote Fault Alarm feature is enabled and a remote fault occurs, the module will detect and report the fault, depending on how the High Low Error level is configured.

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 rolloff 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 2.2 to decide which input filter to use in your FLEX I/O analog I/O application:

Table 2.2 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 they are selected for a channel quad, a configuration fault will occur and will be reported as Diagnostic Data 2. All data for that channel quad will be set to zero (0).

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

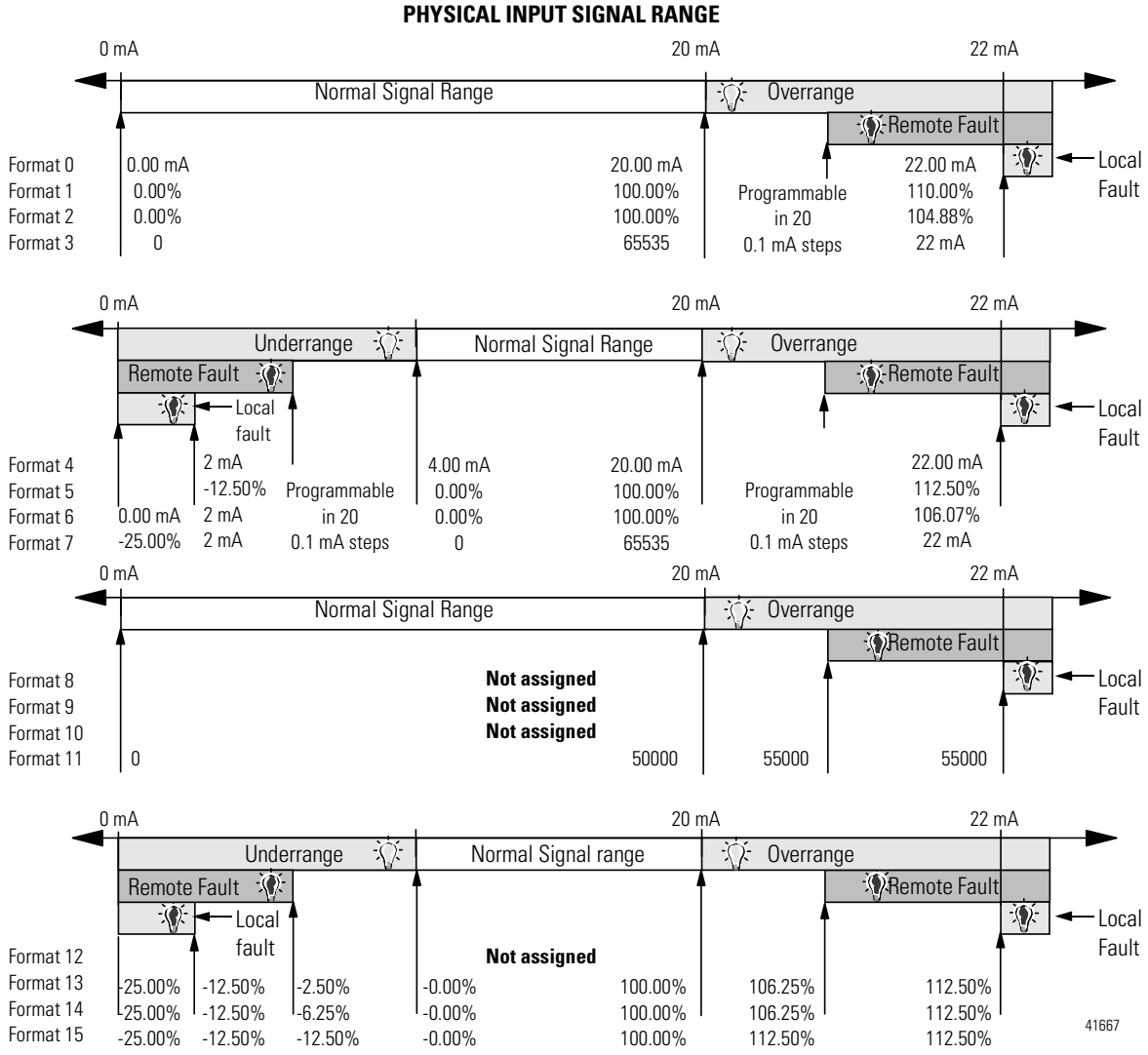
Table 2.3 1794-IE8H Data Formats

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 = $10000 \left(\frac{\text{input}}{20} \right)$	0…11000 (0…110.00%)	500	
2	0…20 mA as √%	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 = $65535 \left(\frac{\text{input}}{20} \right)$	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 2.3 1794-IE8H Data Formats

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	$\text{Datatable} = 10000 \left(\frac{\text{input-4}}{16} \right)$	-1250…+11250 (2'scomplement) (-12.50% … +112.50%)	625	With error steps
6	4…20 mA as √%	0.17% of 4…20 mA	4…22 mA	$\text{Datatable} = 10000 \sqrt{\frac{\text{input-4}}{16}}$ IF…Square_Root_Threshold $< 10000 \sqrt{\frac{\text{input-4}}{16}}$ Else…datatable = 0	0…10607 (0…106.07%)	589	With error steps, under-range not allowed
7	4…20 mA as unsigned integer	0.03% of 4…20 mA	4…20 mA	$\text{Datatable} = 65535 \left(\frac{\text{input-4}}{16} \right)$	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	$\text{Datatable} = 55000 \left(\frac{\text{input}}{22} \right)$	0…55000 (0…22 mA)	2500	All fixed
12	4…20 mA as %	0.16% of 4…20 mA	3.6…21 mA	$\text{Datatable} = 10000 \left(\frac{\text{input-4}}{16} \right)$	-250…+10625 (2'scomplement) (-2.50… +106.25%)	625	NAMUR NE 4 all fixed
13	4…20mA as %	0.16% of 4…20 mA	3…21 mA	$\text{Datatable} = 10000 \left(\frac{\text{input-4}}{16} \right)$	-625…+10625 (2'scomplement) (-6.25… +106.25%)		All fixed
14	4…20 mA as %	0.16% of 4…20 mA	2…22 mA	$\text{Datatable} = 10000 \left(\frac{\text{input-4}}{16} \right)$	-1250…+11250 (2'scomplement) (-12.50… +112.50%)		
15	Not Assigned						

Data Formats and Error Ranges



Select Your 1794-OE8H 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 to 3 and channel 4 to 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 to 3 and channels 4 to 7. Channel detection occurs on a continuous basis. If a fault is detected, the channel fault alarm is set.

If Latch mode is enabled when a fault occurs, the fault will remain latched in its fault state until a Global Reset (see below) is issued. If Latch mode is disabled when a fault occurs, the channel reports a fault until the fault is corrected. Global Reset is not necessary if Latch mode is disabled.

When using 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 in conjunction with Latch mode during fault conditions. If Latch mode is enabled and a fault condition occurs, the channel operating with a fault remains in this condition (with analog or digital fault state implied) until a Global Reset is issued. 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. Use your programming software to set the Global Reset bit to 1 for normal operation. Resetting of outputs occurs during the 1 to 0 transition.

Analog Digital State

You can configure your FLEX I/O analog output modules to work in an analog mode or digital mode using the Analog Digital State feature. Depending on which state you choose for your application, additional parameters (see the descriptions of Analog Fault State and Digital Fault State on page 2-8) must be configured for your module to react to fault conditions.

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 to 1, 2 to 3, 4 to 5, and 6 to 7.

Analog Fault State Value

Specifies the fault state value of the analog output data to the module. Specific format is controlled by the Module Data Format Control parameter. This data is used when the channel is in analog output mode and the analog fault state is configured 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 2-10 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 an unassigned Analog Data Format is selected, the module sets Diagnostic Data to 2 for configuration failure and puts affected channels affected in the corresponding fault state.
- An unconfigured module channel pair can be assumed to have the default configuration Analog Data Format 0, 0 to 20 mA and Analog Mode Fault State minimum range. If a non-assigned format is selected, 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, the configuration had been changed, from the default, and then it was changed 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 to 15
- Default: 0
- Data Table Reference: data format, word 12 and 13, bits 0 to 3, bits 4 to 7

If data is sent to the module which is out of range, the value will be clipped and Diagnostic Data will be set to 11 data out of range.

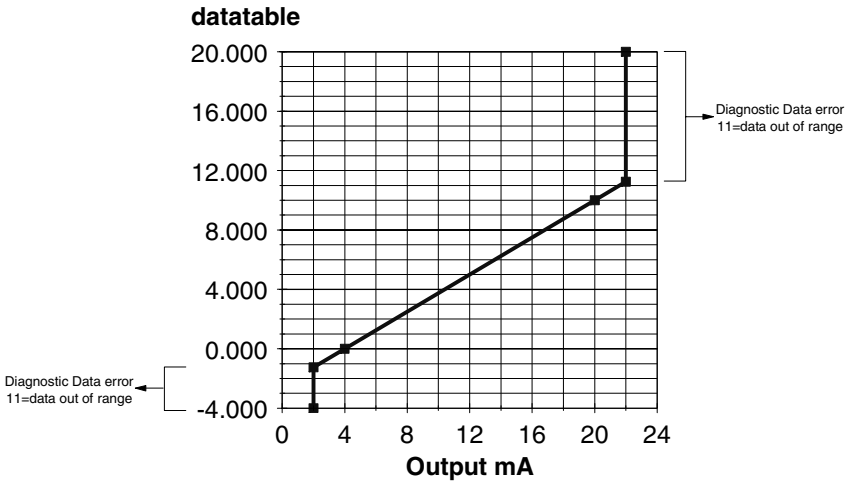


Table 2.4 1794-OE8H Data Formats

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	$\text{Output} = \left(\frac{\text{datatable}}{1000}\right)$	0…22000 (0…22.000 mA)	1000	Min=0 mA Max=22 mA Hold last=hold 50%=11 mA
1	% as 0…20 mA	0.2% of 0…20 mA	0…22 mA	$\text{Output} = 20\left(\frac{\text{datatable}}{10000}\right)$	0…11000 (0…110.00%)	500	Min=0 mA Max=22 mA Hold last=hold 50%=11 mA
2	Not Assigned						
3	Unsigned integer as 0…20 mA	0.03% of 0…20 mA	0…20 mA	$\text{Output} = 20\left(\frac{\text{datatable}}{65535}\right)$	0…65535 (0…22 mA)	3276	Min=0 mA Max=20 mA Hold last=hold 50%=10 mA
4	mA as 4…20 mA	0.1% of 4…20 mA	2…22 mA	$\text{Output} = \left(\frac{\text{datatable}}{1000}\right)$	2000…22000 (2.000…22.000 mA)	1000	Min=2 mA Max=22 mA Hold last=hold 50%=12 mA
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	$\text{Output} = 16\left(\frac{\text{datatable}}{65535}\right) + 4$	0…65535 (4…20 mA)	4095	Min=4 mA Max=20 mA Hold last=hold 50%=12 mA
8	Not Assigned						
9							

Table 2.4 1794-OE8H Data Formats

Data Format	Format	Resolution	Full Output Range	Module Data Processing	Data Table Value (Interpretation)	Count per mA	Analog Fault State
10	Not Assigned						
11	D/A count as 0…20 mA	0.28% of 0…20 mA	0…22 mA	$\text{Output} = 22\left(\frac{\text{datatable}}{8000}\right)$	0…8000 (0…22 mA)	363	Min=0 mA Max=22 mA Hold last=hold 50%=11 mA
12	4…20 mA	—	—	Not assigned	—	—	—
13	% as 4…20 mA	0.16% of 4…20 mA	3…21 mA	$\text{Output} = 16\left(\frac{\text{datatable}}{10000}\right) + 4$	-625…+10625 (2's complement) (-6.25…+106.25 %)	625	Min=3 mA Max=21 mA Hold last=hold 50%=12 mA
14	% as 4…20 mA	0.16% of 4…20 mA	2…22 mA	$\text{Output} = 16\left(\frac{\text{datatable}}{10000}\right) + 4$	-1250…+11250 (2's complement) (-12.50…+112.50%)	625	Min=2 mA Max=22 mA Hold last=hold 50%=12 mA
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

Use the table below to understand bits used in image table mapping and bit/word descriptions. Complete definitions of these feature documented below can be found in Chapter 2.

Table 2.5 Bit/Word Descriptions

Bit(s)	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 2.6 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 2.7 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 2.8 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 2.9 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 will 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 2.10 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 2.11 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 2.12 Error Level 0.1mA 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
						0.1mA * step value = remote fault alarm threshold
						Examples
Data Format 2…22mA -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 2.13 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 2.14 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 2.15 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															
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 2.16 Data Format Control

Data Format				Range	Resolution	Full Range	Interpretation	Data Table Value	Count per mA
0	0	0	0	0…20mA	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…20mA	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 -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 to 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 the Extended Configuration Data Table to be sent to the I/O module.

For a get attribute single, two words configured as defined in the Extended Configuration Data Table will be returned from the instruction.

Table 2.17 1794-IE8H and -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 Read Back Threshold ch 4…7					HS LED	HS Inht	50/ 60 Hz	HART Read Back Threshold ch 0…3				

Where: ch = channel
PMI = Primary Master Inhibit
SME = Secondary Master Enable
HS LED = HART Status LEDs
HS Inht = HART Status Inhibit

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

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

Table 2.18 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 Read Back	On	On	Off	Off
	Primary Master	On	On	Off	Off
	Secondary Master	Off	On	Off	On

1 Where:
Ch0 - bits 0 and 8; Ch1 - bits 1 and 9; Ch2 - bits 2 and 10; Ch3 - bits 3 and 11;
Ch4 - bits 4 and 12; Ch5 - bits 5 and 13; Ch6 - bits 6 and 14; Ch7 - 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 currently 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 realtime data table to enable compatibility. The appropriate areas are cleared with zeroes.

50 or 60 Hz Filter

The values are:

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

HART Read Back Threshold

This bit delivers the percentage value, in steps of 1%, of the threshold for forcing the HART read back 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 to 4 = not supported from the I/O module (set to 5 internally)
- 5 to 31 = percentage threshold data (5 to 31%)

Chapter Summary

In this chapter, we told you about the FLEX I/O system and the analog I/O modules, and how they communicate with programmable controllers. Move to Chapter 3 to learn how to install your FLEX I/O analog module.

Notes:

Install Your FLEX I/O Analog Modules

What This Chapter Contains

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

For Information On	See Page
Before You Install Your Analog Module	3-1
Removal and Insertion Under Power	3-2
Install the Module	3-2
Connect Wiring to the FLEX I/O HART Analog Modules	3-8
Ground the Module	3-12
Chapter Summary	3-13

Before You Install Your Analog Module

Before installing your FLEX I/O analog module:

Table 3.1 Steps to Complete Before Installation

You Need To	As Described Under
Verify that the module will be installed in a suitable enclosure	Removal and Insertion Under Power, page Page 3-2
Position the keyswitch on the terminal base	Install the Module, page 3-7

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 will appear to the adapter as an empty slot in your chassis.

Removal and Insertion Under Power

WARNING

These module 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 electrical 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" on 3-7.

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.

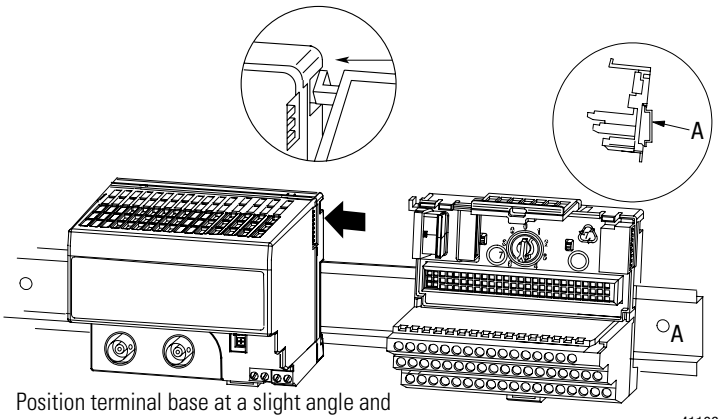
Install the Terminal Base Unit

1. Remove the cover plug in the male connector of the unit to which you are connecting this terminal base unit.

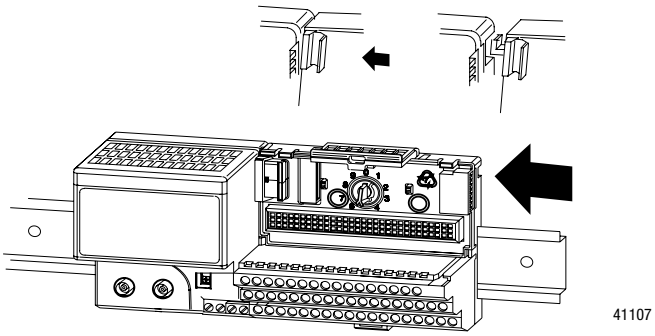
2. Check to make sure that the 16 pins in the male connector on the adjacent device are straight and in line so that the mating female connector on this terminal base unit will mate correctly.

3. Make certain that the female flexbus connector is **fully retracted** into the base unit.

4. Position the terminal base over the 35 x 7.5mm DIN rail **A** (A-B pt. no. 199-DR1).



Position terminal base at a slight angle and hooked over the top of the DIN rail A.



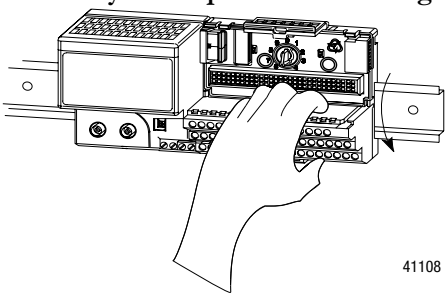
Slide the terminal base over tight against the adapter (or proceeding terminal base). Make sure the hook on the terminal base slides under the edge of the adapter (or proceeding terminal base) and the flexbus connector is fully retracted.

ATTENTION

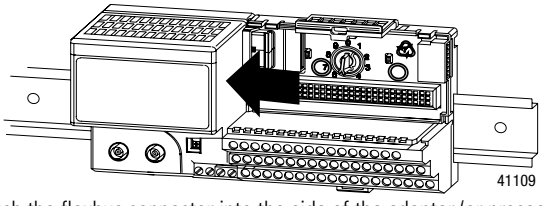
Do not force the terminal base into the adjacent modules. Forcing the units together can bend or break the hook and allow the units to separate and break communication over the backplane.

5. 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.



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.



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

6. For specific wiring information, refer to 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 3-8.

7. Repeat the above steps to install the next terminal base unit.

8. Be sure the flexbus connector cover on the last terminal base unit is in place.

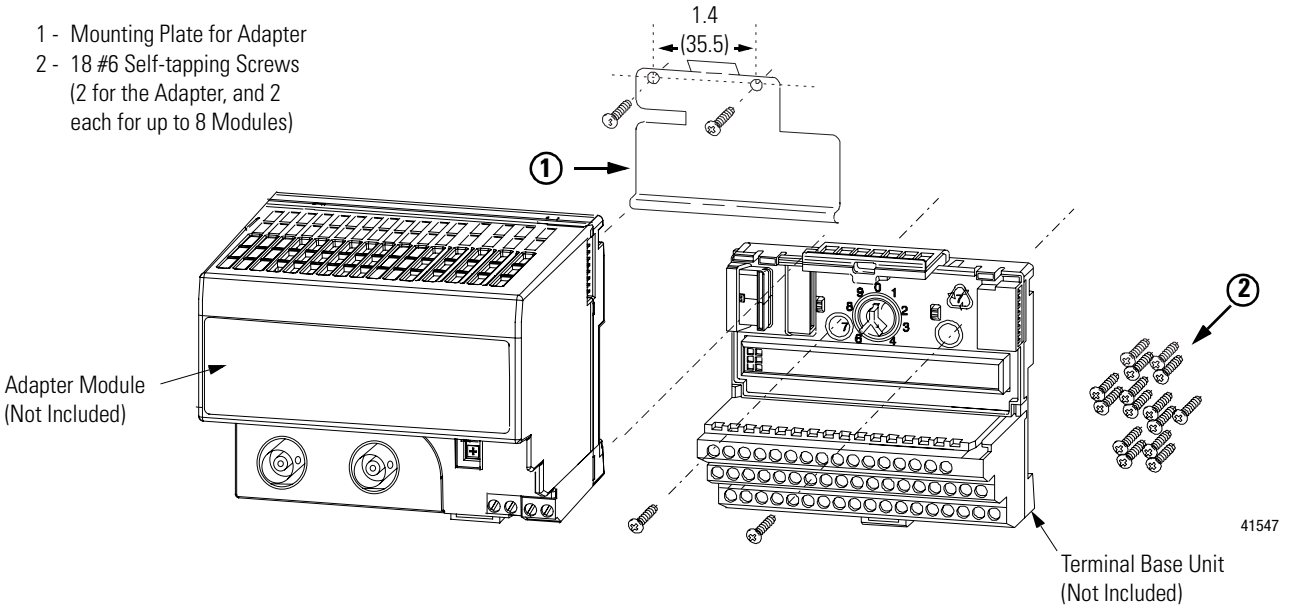
Mount on a Panel or Wall

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 3-7.

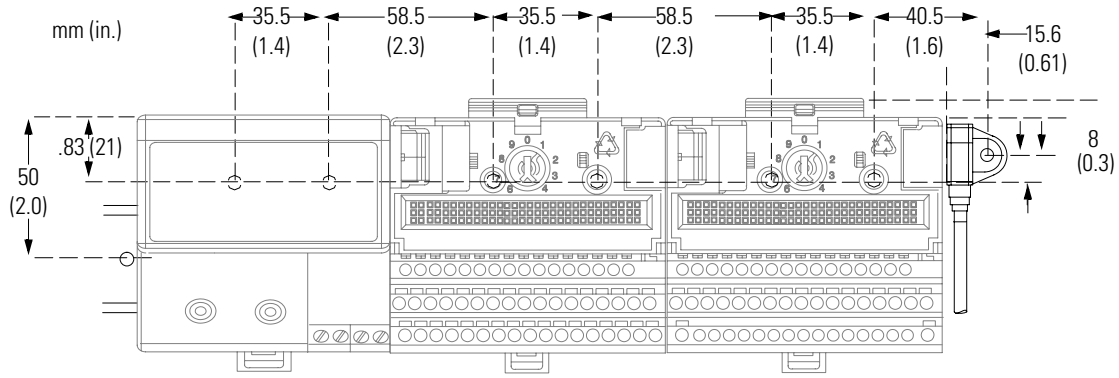
Use the mounting kit Cat. No. 1794-NM1 for panel/wall mounting.



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.

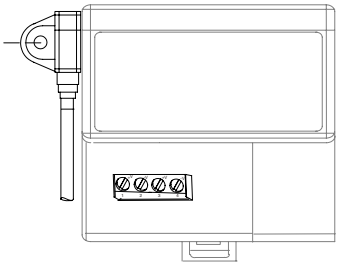
Drilling Dimensions for Panel/Wall Mounting of FLEX I/O



ATTENTION

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

Cable length approximately 292.1 mm (11.5 in.) or 901.0 mm (35.5 in.) from upper connector. Length depends upon cable 0.3 m (1 ft) or 0.91 m (3 ft).



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

IMPORTANT

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

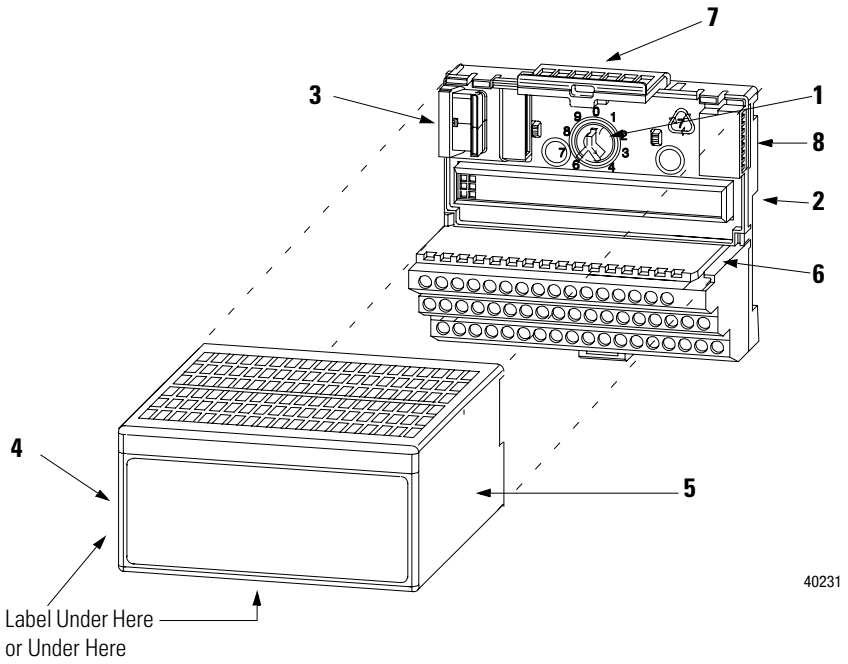
4. Hold the adapter (2) at a slight angle and engage the top of the mounting plate in the indention on the rear of the adapter module.
5. Press the adapter down flush with the panel until the locking lever locks.
6. Position the terminal base unit up against the adapter and push the female bus connector into the adapter.
7. Secure 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.



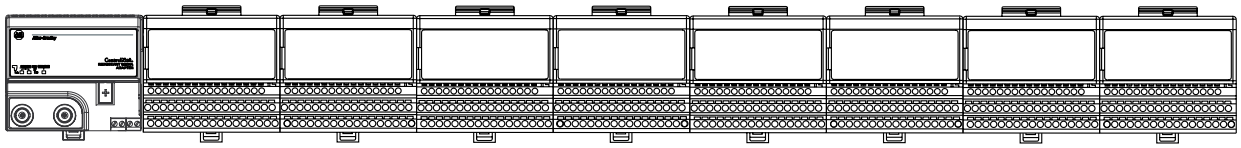
2. Make certain the flexbus connector (3) is pushed all the way to the left to connect with the neighboring terminal base/adapter.

   You cannot install the module unless the connector is fully extended.

3. Make sure the pins on the bottom of the module are straight so they will 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 required.

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



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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

Wiring the FLEX I/O HART analog input modules is done 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 will appear 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

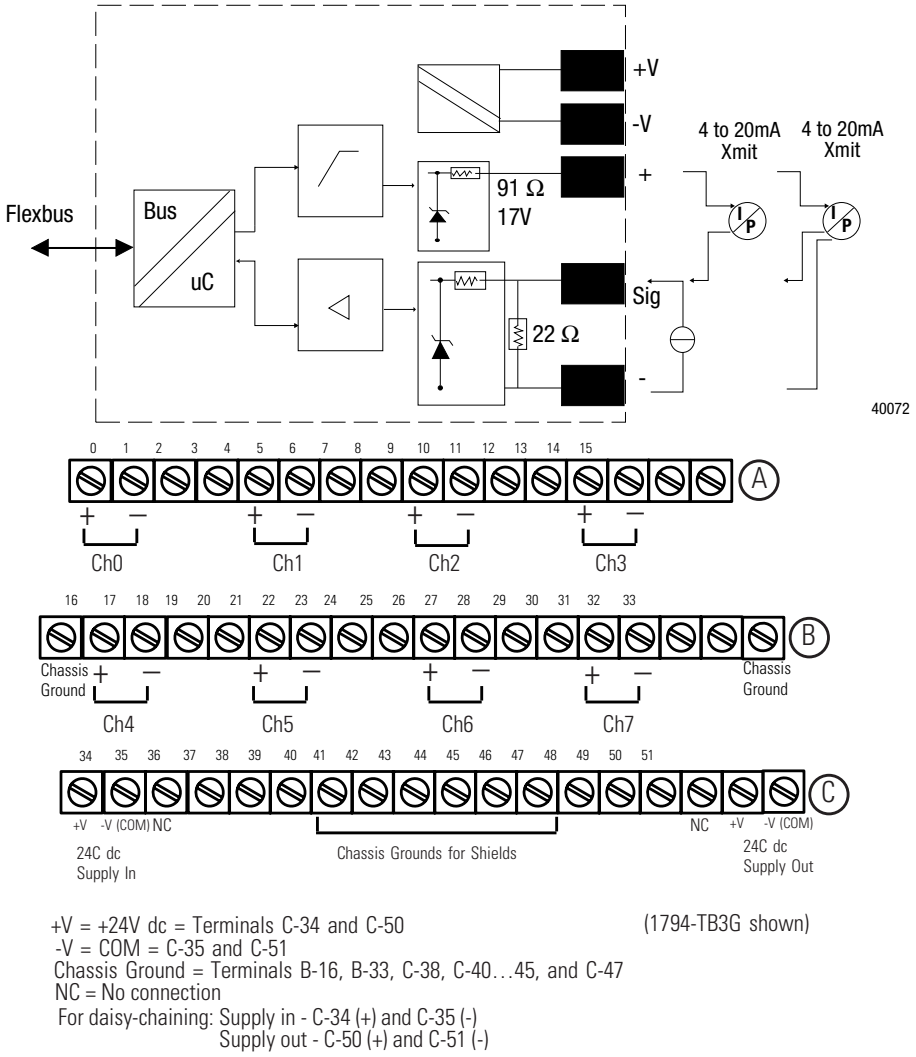
Inputs/Outputs

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.

Connections for the 1794-IE8H HART Analog Input Module on a 1794-TB3G Terminal Base Unit



+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 (-)

(1794-TB3G shown)

40071

For Two-wire Transmitter Devices

1. Connect the individual input wiring to (+) terminals (0, 4, 8, 12) on the 0 to 15 row (A) and on the 16 to 33 row (B) (terminals 17, 21, 25, 29) as indicated in the table below.

2. Connect the associated input to the corresponding (sig) terminal (1, 5, 9, 13) on the 0 to 15 row (A), and on the 16 to 33 row (B) (terminals 18, 22, 26, 30) for each input as indicated in the table below.

3. Connect +V dc power to terminal 34 on the 34 to 51 row (C).

4. Connect -V to terminal 35 on the 34 to 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 3.2 Wiring Connections for the 1794-IE8H HART Analog Input Module

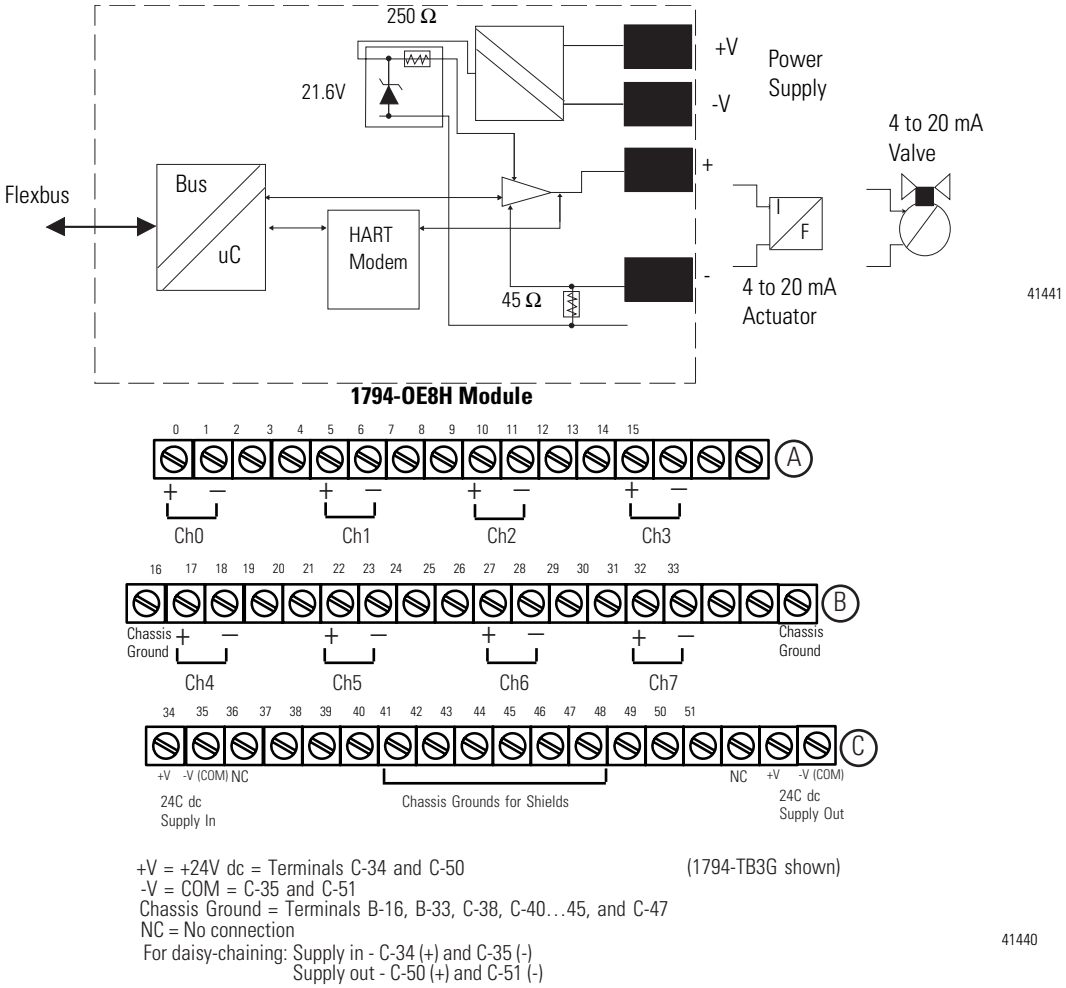
Input	Input Source	Input Signal	Input Return	Input	Input Source	Input Signal	Input Return
Input 0	A-0	A-1	A-2	Input 4	B-17	B-18	B-19
Input 1	A-4	A-5	A-6	Input 5	B-21	B-22	B-23
Input 2	A-8	A-9	A-10	Input 6	B-25	B-26	B-27
Input 3	A-12	A-13	A-14	Input 7	B-29	B-30	B-31
+V	Terminals 34 and 50						
-V	Terminals 35 and 51						

Terminals 16, 33, 40, 41, 42, 43, 44, and 45 are connected to chassis ground.

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.

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



1. Connect the individual output wiring to (+) terminals (0, 4, 8, 12) on the 0 to 15 row (A) and on the 16 to 33 row (B) (terminals 17, 21, 25, 29) as indicated in the table below.

2. Connect the associated output to the corresponding (-) terminal (1, 5, 9, 13) on the 0 to 15 row (A), and on the 16-33 row (B) (terminals 18, 22, 26, 30) for each input as indicated in the following table.

3. Connect +V dc power to terminal 34 on the 34 to 51 row (C).

4. Connect -V to terminal 35 on the 34 to 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 3.3 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
Output 3	A-12	A-13	Output 7	B-29	B-30
+V	Terminals 34 and 50				
-V	Terminals 35 and 51				

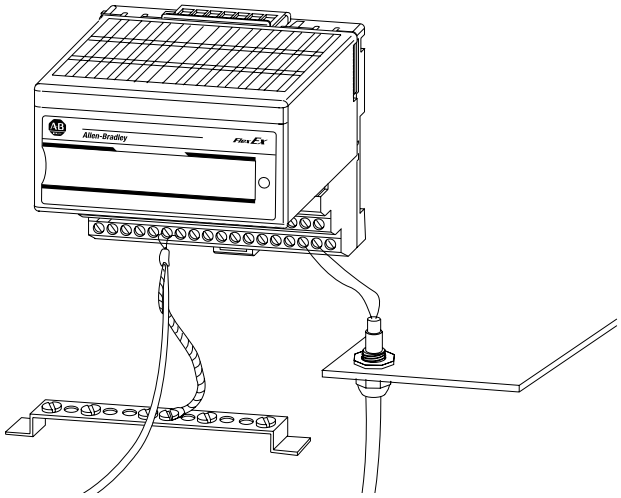
Terminals 16, 33, 40, 41, 42, 43, 44, and 45 are connected to chassis ground.

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 bus bars and shield-terminating feed throughs.



Chapter Summary

In this chapter, we told you how to install your input module in an existing programmable controller system and how to wire to the terminal base units.

Move to chapter 4 to learn about input, output and configuration files for the HART analog I/O modules on the ControlNet network.

Input, Output and Configuration Files for the Analog I/O Modules on the ControlNet Network

What This Chapter Contains

Read this chapter to familiarize yourself with input, output and configuration files for analog I/O modules on the ControlNet network.

For Information On	See Page
Use Programming Software in Your FLEX I/O Application	4-2
About the ControlNet Adapter	4-2
Communication Over the FLEX I/O Backplane	4-3
I/O Structure	4-4
Fault State Data	4-6
Device Actions	4-7
Chapter Summary	4-8

In this chapter, you will learn about:

- using software to configure the FLEX I/O modules.
- the ControlNet Adapter.
- I/O structure.
- fault state data.
- communication fault data.
- idle state behavior.
- input data behavior upon module removal.

IMPORTANT This chapter provides a brief description of the steps 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 (cat. no. 1794-ACNR15). The I/O configuration portion of another programming software, for example RSLogix5 software, 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.

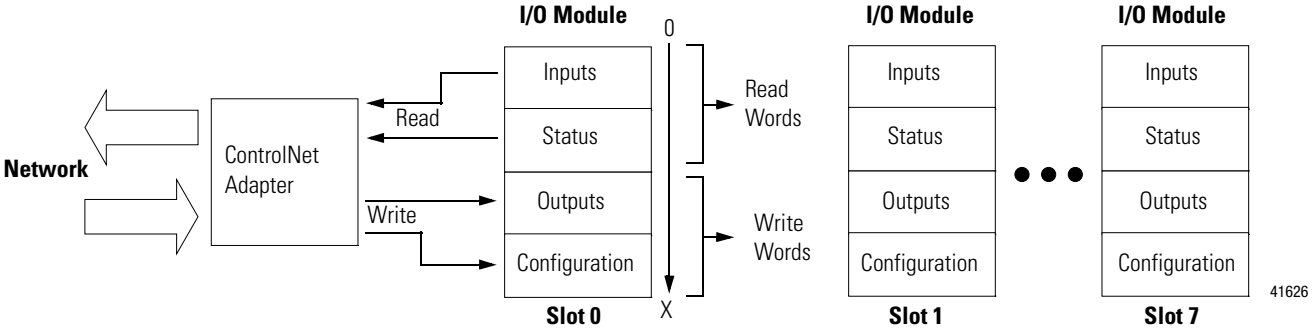
About the ControlNet Adapter

The FLEX I/O ControlNet adapter interfaces up to 8 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 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 used), determine how much time there is for unscheduled messaging.

Module I/O Mapping

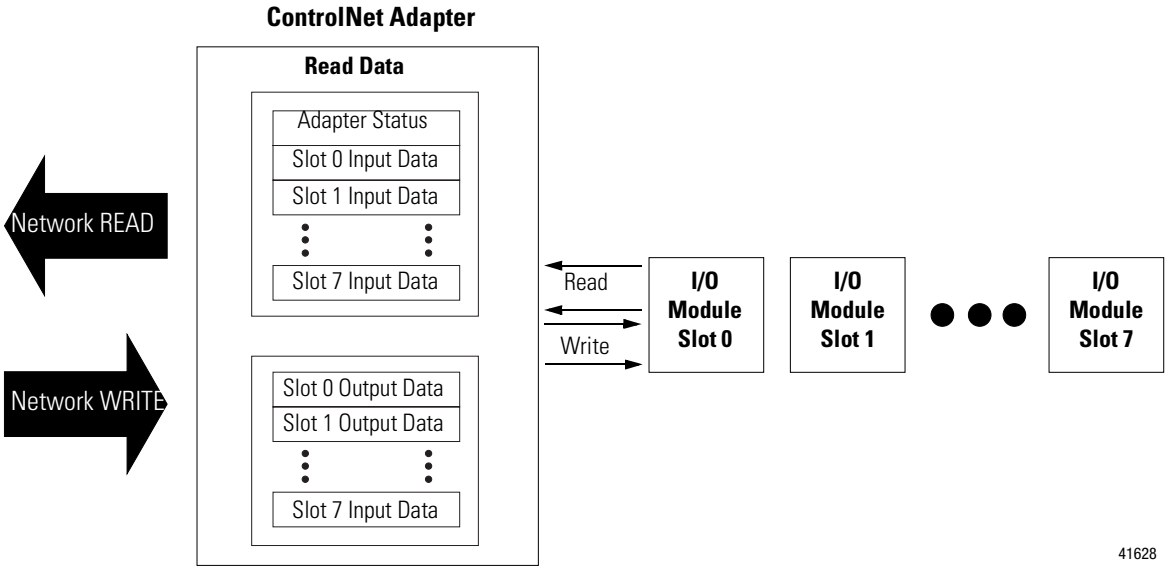
The I/O map for a module is divided into read words and write words. Read words consist of input and status words, and write words consist of output and configuration words. The number of read words or write words can be 0 or more.

The length of each I/O module's read words and write words vary in size depending on module complexity. Each I/O module will support at least 1 input word or 1 output word. Status and configuration are optional, depending on the module.

I/O Structure

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

Input data is sent by the adapter. 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

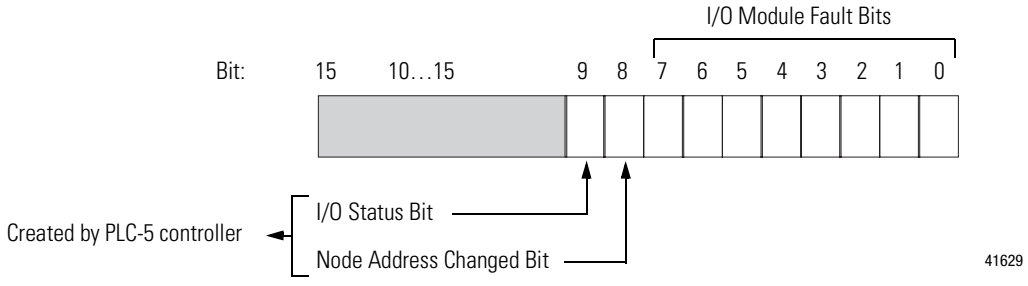
The status word consists of:

- 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 4.1 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 provides storage for alternate module output data during communication faults or processor idle state. This fault state data assures that a known output will be 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 Image Table Mapping on page 2-12.

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 2 states can be detected: Run mode, or Program mode (idle).

When Run mode is detected, the adapter copies the output data 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

Chapter Summary

In this chapter you learned about input, output and configuration files for the analog I/O modules on ControlNet. Move to Chapter 5 to learn how to calibrate your module.

Calibrate Your Module

What This Chapter Contains

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

For Information On	See Page
When and How to Calibrate Your FLEX I/O Analog I/O Module	5-1
Tools and Equipment	5-2
1794-IE8H Calibration Features	5-2
1794-IE8H Calibration Command Structure	5-3
1794-IE8H Calibration Command Byte	5-4
1794-IE8H Calibration Item Byte Channel-Mask	5-8
1794-IE8H Calibration with Offset and Gain	5-10
1794-OE8H Calibration Features	5-11
1794-OE8H Calibration Command Byte	5-12
1794-OE8H Calibration Item Byte Channel-Mask	5-17
1794-OE8H Calibration Flowchart Procedure	5-18

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.

When and How to Calibrate Your FLEX I/O Analog I/O Module

Your module is shipped 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. Module calibration may also be required to remove module error due to aging of components in your system.

Tools and Equipment

Use the following tools and equipment to calibrate your analog I/O modules:

Table 5.1 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 A-B family processors	

1794-IE8H Calibration Features

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

- There are two different values per channel that need to be calibrated: gain and offset at room temperature (25 °C).
- 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 an offset value is calibrated, 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, the actual date must be transmitted to the IOM and stored in the module non-volatile.
- 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-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 HART I/O 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.

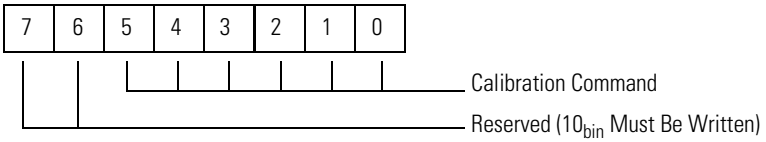
The Calibration data structure has four members: Command, Item, Data1, and Data2.

Table 5.2 Calibration Data Structure

Attribute	Field Size	Implementation	Description	Value (Hex)	Access
67_{hex}	4 byte	struct {		Conditional	Read or write
		USINT Command;	Calibration command;		
		USINT Item;	Additional command information;		
		USINT Data1;	Data according to command;		
		USINT Data2;	Data according to command		
		} Calibration;			

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:

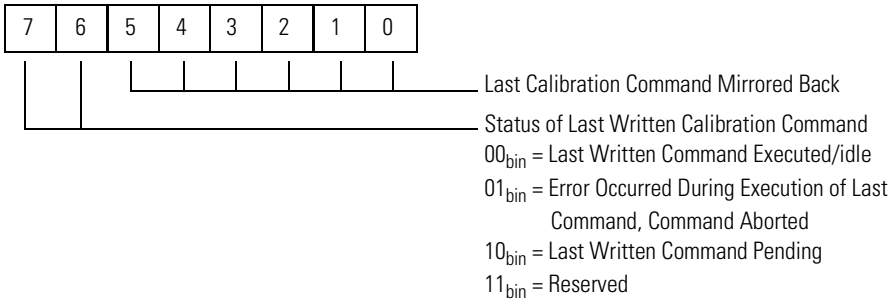


Table 5.3 1794-IE8H Calibration Command List

Calibration Command (Decimal) Bits 0…5	Function
0	Reserved
1	Calibrate offset at 25 °C
2	Calibrate gain at 25 °C
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 5.4 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	Channel-Mask	Reserved[4]	Reserved[4]
	2	Calibrate gain at 25 °C			
	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 attempt to write this byte, write 0.

Table 5.5 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 is done according to channel-mask	Channel-Mask		
		2	Calibration of gain at 25 °C 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 5.6 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 according to channel-mask has failed	Channel-Mask	0	0
		2	Calibration of gain at 25 °C 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 5.7 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)				
10	Pending	1	Calibration of offset at 25 °C is in process according to channel-mask	Channel-Mask	0	0
		2	Calibration of gain at 25 °C 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]
		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.

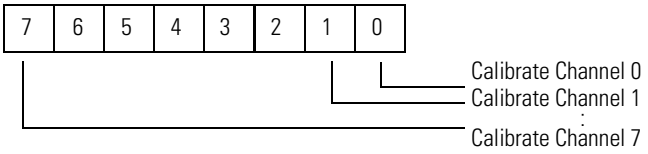
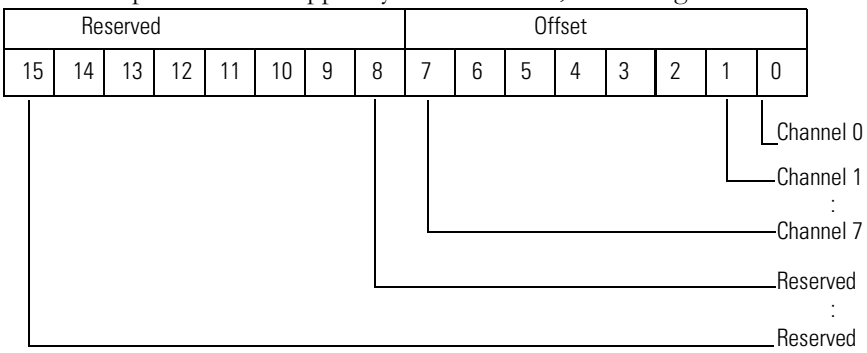


Table 5.8 1794-IE8H Calibration Item Byte Value Identifier List

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	—
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	—

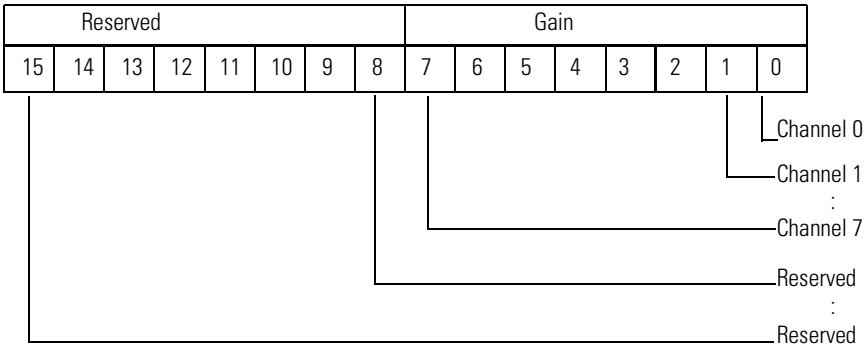
1794-IE8H Calibration Item Byte Value Identifier 48 (Status Mask Offset)

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 words 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 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 flow is 0.00 mA.
- To calibrate a channel according to gain, the corresponding channel must be supplied with 20.00 mA.
- Set the I/O module ambient temperature in the range of 25(±5) °C.
- 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

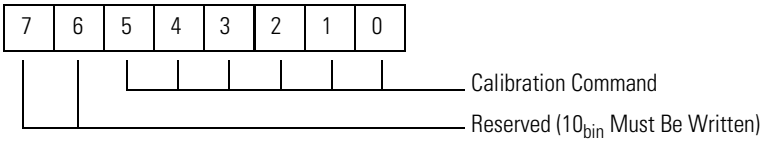
1794-OE8H Calibration Features

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:

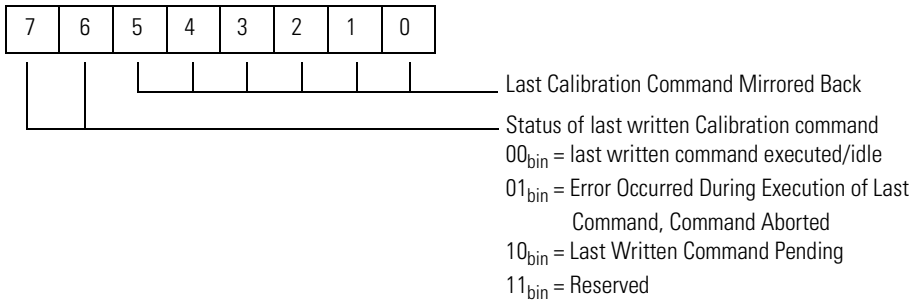


Table 5.9 1794-OE8H Calibration Command List

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, uA)
4	Write measured min scale value (Voltage, uV)
5	Write measured max scale value (Current, uA)
6	Write measured max scale value (Voltage, uV)
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 5.10 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, uA)		Value low-byte	Value high-byte
	4	Write measured min scale value (Voltage, uV)			
	5	Write measured max scale value (Current, uA)			
	6	Write measured max scale value (Voltage, uV)			
	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 attempt to write this byte, write 0.

Table 5.11 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 5.12 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 read back erroneous	Channel-mask	Value low-byte	Value high-byte
		4	The written min scale value of Voltage was not accepted/internal read back erroneous			
		5	The written max scale value of Current was not accepted/internal read back erroneous			
		6	The written max scale value of Voltage was not accepted/internal read back 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 5.13 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	x^2	x^2	x^2
		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, e.g., 0x03 ≥ channel 0 and 1 have to be calibrated. Only one channel can be calibrated at a time. If there are more channels selected within the calibration commands, the I/O module signals an error.

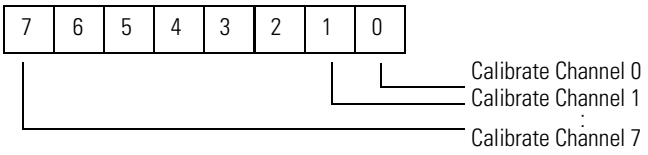
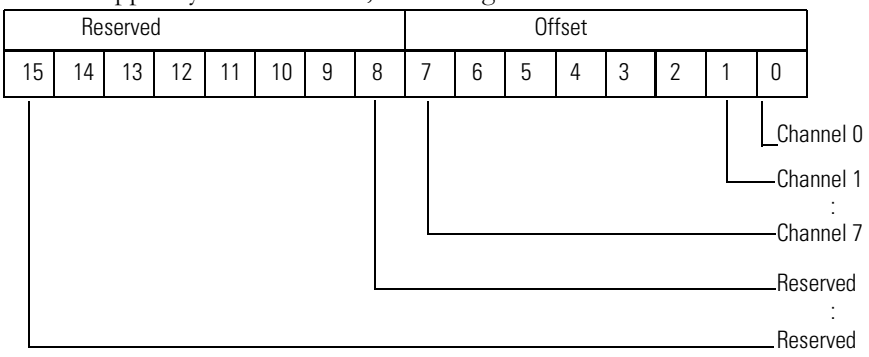


Table 5.14 1794-OE8H Calibration Item Byte Value Identifier List

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-read-back channel 0	
…	…	
23	Offset current-read-back channel 7	
24	Gain current-read-back channel 0	
…	…	
31	Gain current-read-back channel 7	
32	Offset voltage-read-back channel 0	
…	…	
39	Offset voltage-read-back channel 7	
40	Gain voltage-read-back channel 0	Read/write
…	…	
47	Gain voltage-read-back 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	—

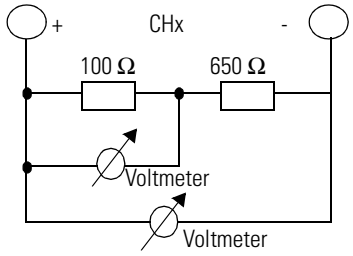
1794-OE8H Calibration Item Byte Value Identifier 48 (Status Mask Calibration)

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.

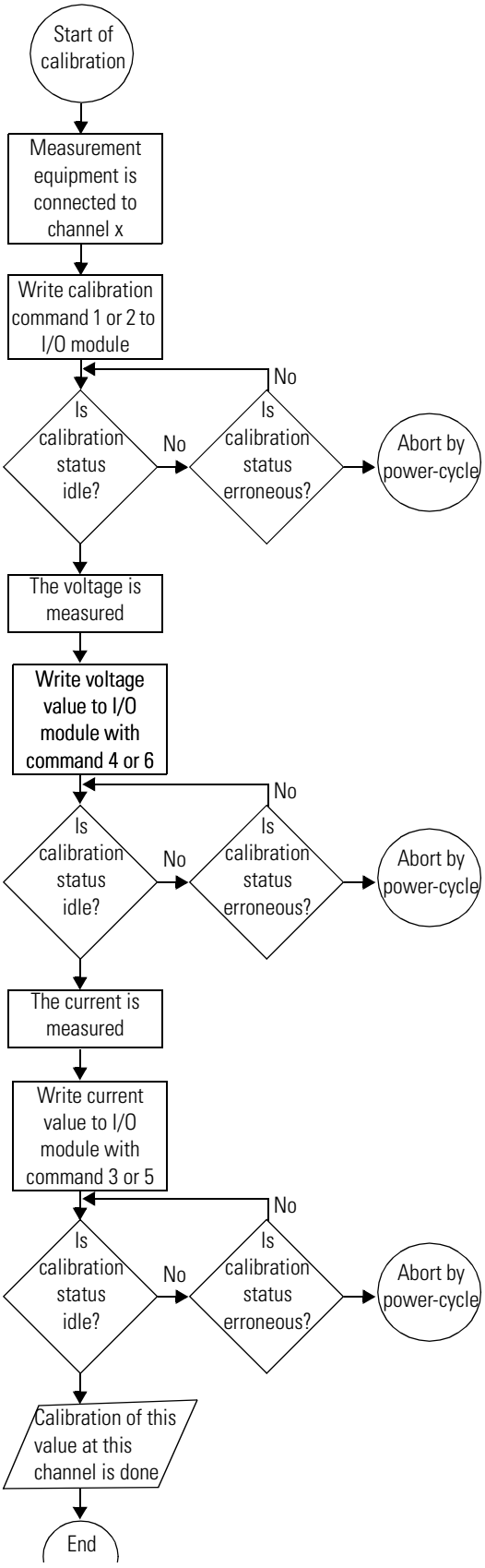


1794-OE8H Calibration Flowchart Procedure

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



Before all values are completely calibrated, a calibration error is displayed 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 totransfer the RAM content to the EEPROM Therefore, you must send a store command to cause the I/O module totransfer 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
Is calibration status idle?
No
Is calibration status erroneous?
No
Abort by power-cycle
The voltage is measured
Write voltage value to I/O module with command 4 or 6
Is calibration status idle?
No
Is calibration status erroneous?
No
Abort by power-cycle
The current is measured
Write current value to I/O module with command 3 or 5
Is calibration status idle?
No
Is calibration status erroneous?
No
Abort by power-cycle
Calibration of this value at this channel is done
End

Notes:

Troubleshoot the FLEX I/O Analog I/O Modules

What This Chapter Contains

Read this chapter to troubleshoot your I/O module.

For Information On	See Page
Status Indicators	6-1
Repair	6-2
Chapter Summary	6-2

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

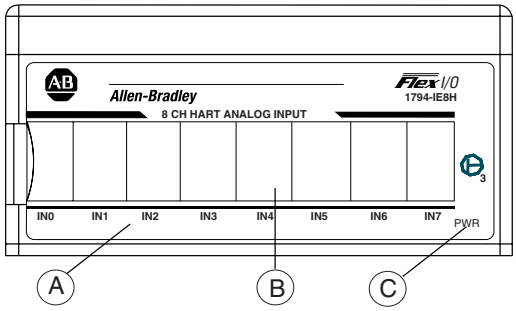


Table 6.1 1794-IE8H Status Indicators

Indicator	Color	State	Meaning
Status	Red	On	At power up – Channel 0 indicator lights at powerup until all internal diagnostics are checked. After successful powerup, the indicator goes off if no fault is present. After successful powerup – Indicates a critical fault (diagnostic failure, etc.)
		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

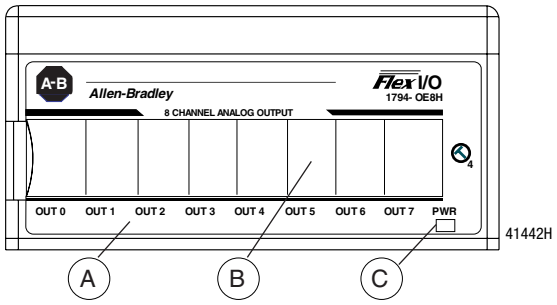


Table 6.2 1794-OE8H Status Indicators

Indicator	Color	State	Meaning
Status	Red	On	At power up – Channel 0 indicator lights at powerup until all internal diagnostics are checked. After successful powerup, the indicator goes off if no fault is present. After successful powerup – Indicates a critical fault (diagnostic failure, etc.)
		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 will void the warranty. If repair is necessary, return this module to the factory.

Chapter Summary

In this chapter you learned how to troubleshoot the FLEX I/O analog modules. Refer to publications 1794-IN108 and 1794-IN109 for complete specifications for your module.

Specifications

1794-IE8H HART Input Module

Refer to publication 1794-IN108 for complete specifications for the 1794-IE8H HART Input module.

1794-OE8H HART Output Module

Refer to publication 1794-IN109 for complete specifications for the 1794-OE8H HART Output module.

Notes:

FLEX I/O HART Module Commands

What This Appendix Contains

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 to 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 B.1 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, i.e., 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 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 bit 12)
18		Write tag, description, and date	Save an 8-digit (tag), a 16-digit description and date

Common Practice Commands

Table B.2 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 B.3 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 • Searching for the transmitter because it has disappeared • Transmitter not responding (disappeared) • Transmitter responding again (appeared) • Another one responded instead of it (mismatched)
130		Transmitter list	The address of the transmitters that were recognized on the current loops are returned

Table B.3 Device-Specific HART Module Commands

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 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	Thou slain returns ORed communication errors and ORed status bits
139	Write	Delete fault overview of transmitters	This command returns 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

Table B.3 Device-Specific HART Module Commands

Command		Action	Meaning
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 in case of busy, 0…11 (default is 0) Retries in case of communication errors, 0…11 (default is 2)
145	Write	Write retry limits	—
146	Read	Read the in his joy SCAN command	During SCAN, HART commands 1, 2, or 3 (see bit 144) can be executed
147	Write	Select SCAN command	—
148	Read	Read SCAN status	This is 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 bits 158 and 159)
149	Write	Write SCAN status	—
152	Read	Read loop search type	The loop search type determines the polling address used to search for a device that has not responded after multiple requests (disappeared, see also 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 B.3 Device-Specific HART Module Commands

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 multidrop) • Minimum number of data bytes for jubjub bird 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

What This Appendix Contains

This appendix discusses the HART protocol and provides references for additional information about the protocol. The appendix provides:

- HART protocol background information
- Command practice command sets
- Extended command sets
- References to additional information

Message Structure

This section describes the transaction procedure, character coding, and message structure of the HART protocol. These correspond to layer 2, the data-link 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 addressed to it. The reply from the slave device acknowledges that the command has been received, and may contain data 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 abort 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 at communicating 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 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. This is done automatically so you do not have to program the host processor to do this.

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 C.1 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 using either a short or long frame address format, as specified by the HART delimiter byte. A short frame address is one byte long. A long frame address is five 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 al other HART commands. Consult the documentation provided with your field device for details about the addressing formats 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 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 C.2 Representative of HART Universal Commands

Universal Command (dec)	Description	Expected Response
0	Read unique indentifier	Unique 32-bit device indentifier, 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 to 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 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 writing 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 detecting a communications error set the most significant bit, bit 7, of the first byte and identify the error in the other seven bits. If the last message was received without error, the field device will clear bit 7 and return a device-dependent response in the other seven 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 C.3 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 one 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 was 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 C.4 HART Field Device Error Codes

Bit	Error Code	Description
7	Field Device Malfunction	An internal hardware error or failure has been detected by the HART field device.
6	Configuration Changed	A write or set command has been executed by the HART field device.
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 will 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 C.5 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 revision	
					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 C.5 Universal Commands

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 = multisensor device, bit 1 = EEPROM control required.

(3) Truncated after last supported variable.

Common Practice Commands

Table C.6 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	—

Table C.6 Common Practice Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
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 number	—	—	As in command	—
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				

Table C.6 Common Practice Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
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 C.6 Common Practice Commands

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)

Table C.6 Common Practice Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
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)			
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)			

Table C.6 Common Practice Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type[5]	Byte	Data	Type[5]
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 end point values	0	Analog output number code	—	0	Analog output number code	—
					1	Analog output end point units code	
					2…5	Analog output upper end point value	
					6…9	Analog output lower end point 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 C.6 Common Practice Commands

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) No a number when fixed output mode.

(5) A = ASCII string (packed 4 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

What This Appendix Contains

This appendix discusses:

- How to communicate with the FLEX I/O HART modules via the MSG or CIO instruction
- The differences between Attributes and Assembly Indexes
- Enhancements to the HART frame

Communication

The messaging between the processor and the HART I/O module is handled via MSG or CIO 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 between 1 and 8. This number indicates the module location relative to the adapter module. Use 1 for the module 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 the Attribute Values table.

Table D.1 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
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 at the same time to the module and its associated field devices. The Attribute used by MSG or CIO instructions send the attribute number to the adapter module. 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. Sending these 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 containing 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 D.2 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 D.3 Write HART Command Contained in a MSG or CIO Instruction

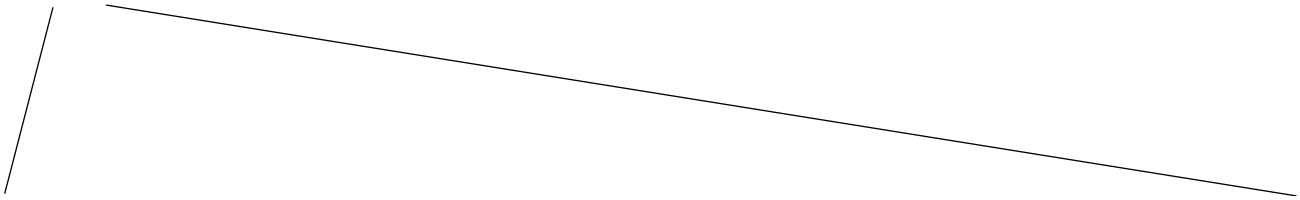
Handle (1 Byte)	Start Character	Address	Command	Byte Count	(Response Code)	Data	Checksum

Handle replaces Preamble. Handle is a number 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 D.1 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
	Resp Source	Next assy index		Ch	Handle	Resp Error	Assy Access Error	Chain Data	Req allow	Loop status avail	Lock	Cold Start	Res

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

- Response Source

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

  Pointer to assembly for next access.

- Channel

  The actual channel to which actual 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 through 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 six bytes. Since every HART response starts with these six status bytes, this attribute only contains this information. In addition, you need to account for these six status bytes when selecting the associated response Attribute. Add six 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 via 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 prior to the module obtaining it from the field device. In this case, a Response Not Available response is returned in the Response Error field. The module assumes another request will gather the response.

Configure the 1794-IE8H Module in RSLogix 5000 Software Over the ControlNet Network

What This Appendix Contains

This appendix provides the information needed to configure the 1794-IE8H analog input module in RSLogix 5000 software 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 will only work when the Data Format control is configured for a 4 to 20 mA range. The default configuration when using the generic profile is 0, which configures the module for a 0 to 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

Refer to the following tables for configuration information.

Fault Mode

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

Fault Mode	Bit 0
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 Bits									
4	**3**	**2**	**1**	**Range**	**Resolution**	**Full Range**	**Interpretation**	**Data Value Table**	**Count per mA**
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 of the filter bits to 0, which is an invalid value. You must set these bits to a valid value or you will get a diagnostic error value of 2.

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 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)
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
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 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
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

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
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 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

Configure the 1794-OE8H Module in RSLogix5000 Software Over the ControlNet Network

What This Appendix Contains

This appendix provides the information needed to configure the 1794-OE8H analog output module in RSLogix 5000 software 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 will only work when the Data Format control is configured for a 4 to 20 mA range. The default configuration when using the generic profile is 0, which configures the module for a 0 to 20 mA range.

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

Refer to 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
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 Bits				Range	Resolution	Full Range	Interpretation	Data Value Table	Count per mA
3	2	1	0						
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

.

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]

	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

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

Disabled	0
Enabled	1

Local Fault Mode

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

Communications Fault	0
Any Fault	1

Latch Retry Mode

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

Retry	0
Latch	1

Analog/Digital Mode

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	0
Digital	1

Digital Fault State

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

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

Refer to 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]
5	[Adapter Name]:[Slot]:O.Data[6]
6	[Adapter Name]:[Slot]:O.Data[7]
7	[Adapter Name]:[Slot]:O.Data[8]

Input

Refer to 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

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A

Alarms
- 1794-IE8 module 1-3
  - local fault 1-3, 1-6
  - overrange 1-3, 1-4
  - programming remote fault 1-6
  - remote fault 1-3, 1-5
  - underrange 1-3, 1-4
  - using fault mode with local fault alarm 2-2
  - using fault mode with remote fault alarm 2-2
  - using remote fault alarm to determine alarm levels 1-5

Analog Digital State
- 1794-OE8 module 2-8

Analog Fault State
- 1794-OE8 module 2-8

B

Bit Descriptions
- image table mapping 2-12

Bit/Word Description
- 4 output/4 input module 2-17

C

Calibration 5-1
- periodic 5-1
- tools 5-2
- tools and equipment 5-2

Communication Fault Behavior 4-7

ControlNet Network 1-2, 4-2, 4-4

D

Data Format
- 1794-IE8 module 2-4

Digital Fault State
- 1794-OE8 module 2-8

Drilling Dimensions
- wall/panel mounting 3-6

F

Fault Mode
- 1794-IE8 module 2-2
  - enabling/disabling local fault alarm 2-2
  - enabling/disabling remote fault alarm 2-2

H

High Low Error Level
- 1794-IE8 module 2-3

I

Idle State Behavior 4-7

Image Table Mapping 2-12
- 1794-IE8 bit/word descriptions 2-14
- 1794-IE8 module 2-13
- 1794-OE8 bit/word descriptions 2-17
- 1794-OE8 module 2-16

Input Filter Cutoff
- 1794-IE8 module 2-3

Installation 3-2
- module 3-7

K

Keyswitch
- using on the terminal base unit 3-7

L

Latch Retry Mode
- 1794-OE8 module 2-7

Local Fault Mode
- 1794-OE8 module 2-7

M

Module
- shipping state
  - calibration 5-1

Module I/O Mapping 4-4

Module Installation 3-7

Module Status
- indicators 1-3

Mounting
- on terminal base 3-7

Mounting Kit
- cat. no. 1794-NM1 3-5

O

Output Enable
- 1794-OE8 module 2-7

P

Panel/Wall Mounting 3-5
- drilling dimensions 3-6

Programming Software 4-2

R

Remote Transmitter Error Up or Down
1794-IE8 module 2-2
Removal and Insertion Under Power (RIUP) 3-2

S

Scheduled Data-Transfer
over the FLEX Ex backplane 4-3
Specifications
1794-IE8 module A-1

T

Tools
calibration 5-2
Troubleshooting
1794-IE8 module indicators 6-1
1794-OE8 module indicators 6-2
module indicators 1-3
module repair 6-2
Two-Wire Transmitter Devices
connecting to the 1794-IE8 module 3-9

U

Unscheduled Data-Transfer
over the FLEX Ex backplane 4-4

W

Wall/Panel Mounting 3-5
Wiring
1794-IE8 module 3-10
1794-IE8 module 3-9
1794-OE8 module 3-11, 3-12
1794-TB3 and 1794-TB3S terminal base units 3-8
terminal base units 3-8

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