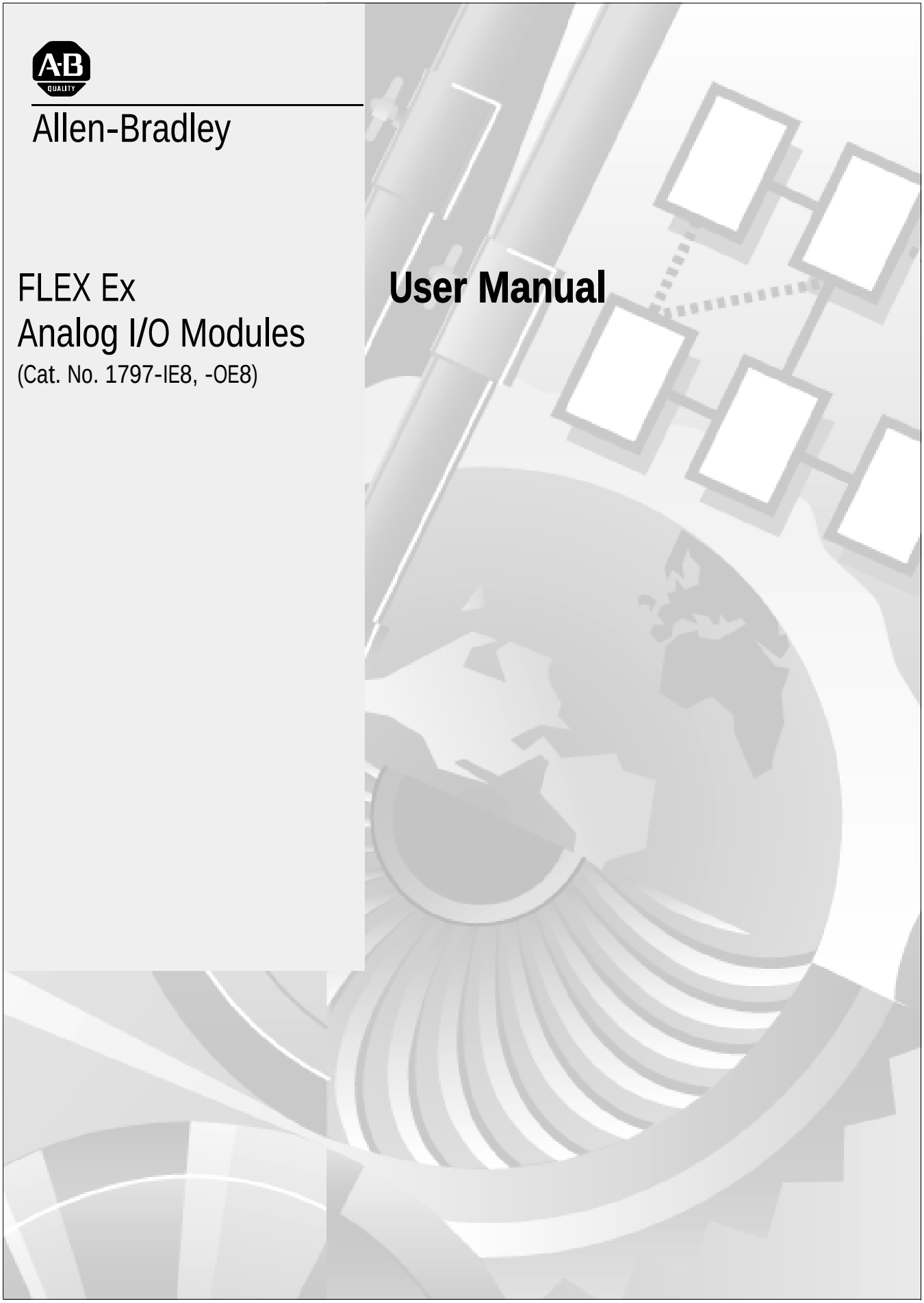


Allen-Bradley

FLEX Ex Analog I/O Modules

(Cat. No. 1797-IE8, -OE8)

User Manual

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss

Attention statements help you to:

- identify a hazard
- avoid a hazard
- recognize the consequences

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

Using This Manual

Why Read this Manual

This manual shows you how to use your FLEX Ex™ analog modules with the ControlNet Ex™ products and ControlNet 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 Ex product and ControlNet™ network to make efficient use of a FLEX Ex module.

About the Vocabulary

In this manual, we refer to the:

- 1797-IE8 as the “input module”.
- 1797-OE8 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 Ex Analog Modules	Describes module functionality and physical features
2	Understanding Module Features	Describes configurable module features and configuration bits
3	How to Install Your Analog Module	How to install and wire the module
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	Calibrating Your Module	Lists the tools needed, and the methods used to calibrate the module
6	Applying FLEX Ex Analog I/O Modules to the System	Describes how FLEX Ex is different from traditional control systems
7	Troubleshooting Your Module	How to use the indicators to troubleshoot your module
Appendix	**Title**	**Contents**
A	About the Specifications	Outlines module specifications and accuracy
B	Programming the FLEX Ex I/O Modules Using RIO	Explains how to program the 1797-IE8 and 1797-OE8 modules

For Additional Information

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

Catalog Number	Description	Publications	
		Installation Instructions	User Manual
1797 Series	FLEX Ex Product Data	1797-2.1 (Product data)	
1797 Series	FLEX Ex System Overview	1797-2.2 (System overview)	
1797 Series	ControlNet Ex System Cable Guide	1797-6.2.1 (System guide)	
1797-TB3	FLEX Ex Terminal Base	1797-5.1	
1797-TB3S	FLEX Ex Spring Clamp Terminal Base	1797-5.2	
1797-OE8	FLEX Ex 8 Output Analog Module	1797-5.3	1797-6.5.1
1797-IRT8	FLEX Ex RTD/Thermocouple/mV Module	1797-5.4	1797-6.5.2
1797-IE8	FLEX Ex 8 Input Analog Module	1797-5.5	1797-6.5.1
1797-OB4D	4 Output Module	1797-5.6	
1797-IBN16	FLEX Ex NAMUR Digital Input Module	1797-5.7	
1797-IJ2	2 Frequency Input Module	1797-5.9	1797-6.5.4
1797-PS2N 1797-PS2E	FLEX Ex Power Supplies	1797-5.12	
1797-ACNR15/B	ControlNetEx Adapter	1797-5.14	1797-6.2.1
1797-RPA, -RPFM	Fiber Hub	1797-5.15	1797-6.2.1
1797-TPR, - TPRS, -TPYR, -TPYS	FLEX Ex Taps	1797-5.18	1797-6.2.1
1797-CE1S, -CE3S, -CEFTN, -CEFTE	Interconnect Cables	1797-5.20	
1797-EXMK	Marker Kit	1797-5.23	

In Summary

This preface gave you information on how to use this manual efficiently. Move to Chapter 1 to learn about the FLEX Ex analog I/O modules.

Chapter 1

About the FLEX Ex Analog Modules

Chapter 2

Understanding Configurable FLEX Ex Analog Module Features

Chapter 3

How to Install Your FLEX Ex Analog Modules

Chapter 4

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

Chapter 5

Calibrating Your Module

Chapter 6

Applying FLEX Ex Analog I/O Modules

Chapter 7

Troubleshooting the FLEX Ex Analog I/O Modules

Specifications

Programming the FLEX Ex I/O Modules Using RIO

About the FLEX Ex Analog Modules

What this Chapter Contains

Read this chapter to familiarize yourself with the 1797-IE8 and 1797-OE8 analog modules.

What the FLEX Ex Analog I/O Modules Do

The 1797-IE8 module accepts up to 8 analog inputs. The inputs are non-isolated and will accept current in either of the following two ranges: 4-20mA or 0-20mA. The default input range is 0-20mA. The inputs have both fixed hardware filters and selectable firmware digital filters.

Similarly, the 1797-OE8 module provides up to 8 analog outputs. The outputs are nonisolated and will provide current in either of the following two ranges: 4-20mA or 0-20mA. The default output range is 0-20mA.

Both modules offer:

- 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

as well as a host of other module features.

How FLEX Ex Analog Modules Communicate with Programmable Controllers

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

Input module information is then automatically made available in the PLC data table through the data connection. Reciprocally, output data information determined by the 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 intrinsically safe +/-V power to your FLEX Ex analog I/O modules. The following sequence of events occurs after power has initially been applied to your module:

1. The module begins an interal diagnostic check. The channel 0 LED 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 **1797-IE8 module**, the module begins producing runtime data for the PLC.

   Following the module configuration download for the **1797-OE8 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.

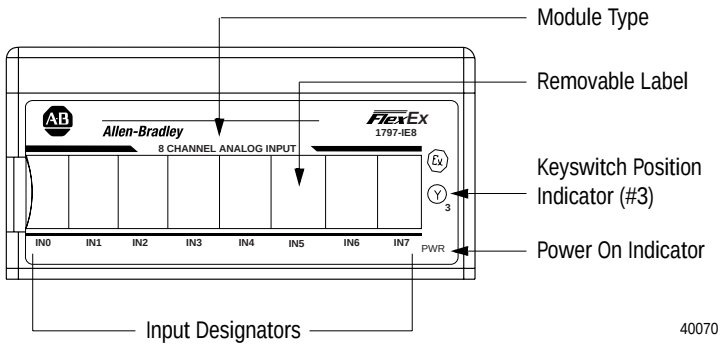
Physical Features of Your Analog I/O Module

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 1797-IE8 module is shown below.

1797-IE8



Using Alarms on the 1797-IE8 Module

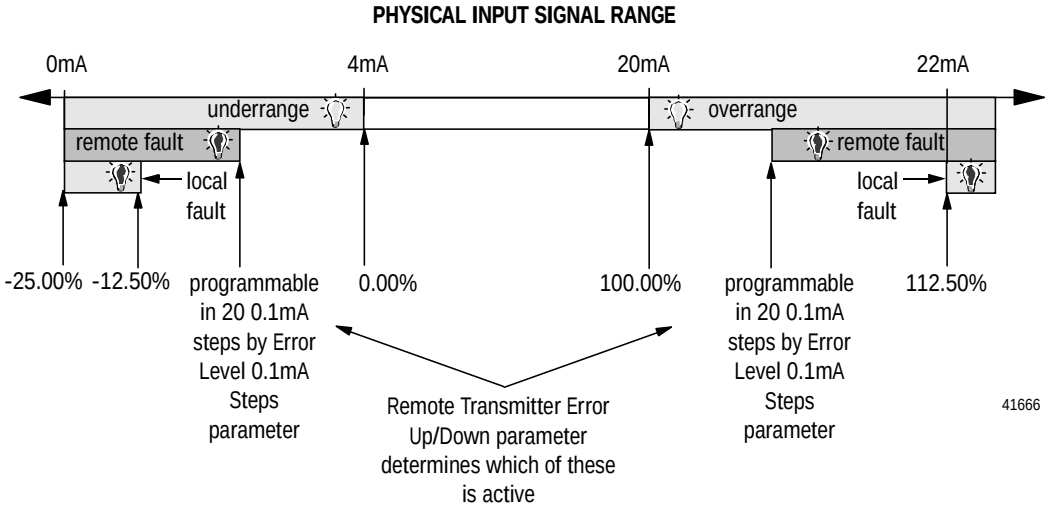
The 1797-IE8 FLEX Ex module is capable of generating four alarms:

- Underrange
- Overrange
- Remote Fault
- Local Fault

These alarm conditions are described in general terms and as they relate to bits on the FLEX Ex I/O module on the following pages. The graphic below 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 4-20mA. 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% (20mA), 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 in a fashion converse to the overrange. This feature notifies you when the input signal falls underrange. If the input signal falls below 0% (4mA), 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 primarily 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 1797-IE8 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.

Using 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 0.1mA 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% (20.1mA) to 111.88% (21.9mA) on the high end of input signal range

  or

- -0.63% (3.9mA) to -11.88% (2.1mA) 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% (22mA) or higher on the high end of input signal range - This value indicates a short in the loop.

  or

- -12.50% (2mA) 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.

Chapter Summary

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

Understanding Configurable FLEX Ex Analog Module Features

What this Chapter Contains

Read this chapter to familiarize yourself with configurable features on the 1797-IE8 and 1797-OE8 analog modules.

Use the table below to see what features this chapter describes.

Table 2.A
Configurable Features on the FLEX Ex Analog I/O Modules

1797-IE8 input module features:	1797-OE8 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.

Selecting a 1797-IE8 FLEX Ex Analog Input Module's Operating Features

All features of the 1797-IE8 analog input module are independently configurable in two four-channel groups (channel 0-3 & channel 4-7).

Important: The default selection value for all parameters is 0.

Fault Mode

Your 1797-IE8 module is 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 Remote and Local Fault alarms, see page 1-5.

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 Remote and Local Fault alarms, see page 1-5.

High Low Error Level

High Low Error level sets the high and low signal levels at which your input module 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 1200Hz (filter 0), signal noise is more likely to affect the reading, but the slowest frequency of 0.5Hz (filter 7) provides the most accurate signal due to incoming noise filtering.

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

Table 2.B
Input Filter Frequency

Filter:	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Frequency:	0.5Hz (2s)	1Hz (1s)	2Hz (500ms)	4Hz (250ms)	10Hz (100ms)	20Hz (50ms)	40Hz (25ms)	1200Hz (0.8ms)

Choose the best input filter cutoff in your programming software.

Data Format

You must choose a module data format in your user program. See Table 2.C on page 2-4 for an explanation of each bit. 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).

When using Table 2.C, remember the following:

- 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 0-20mA
- The data format selected interprets input readings and returns them to the PLC

Table 2.C
1797-IE8 Data Formats

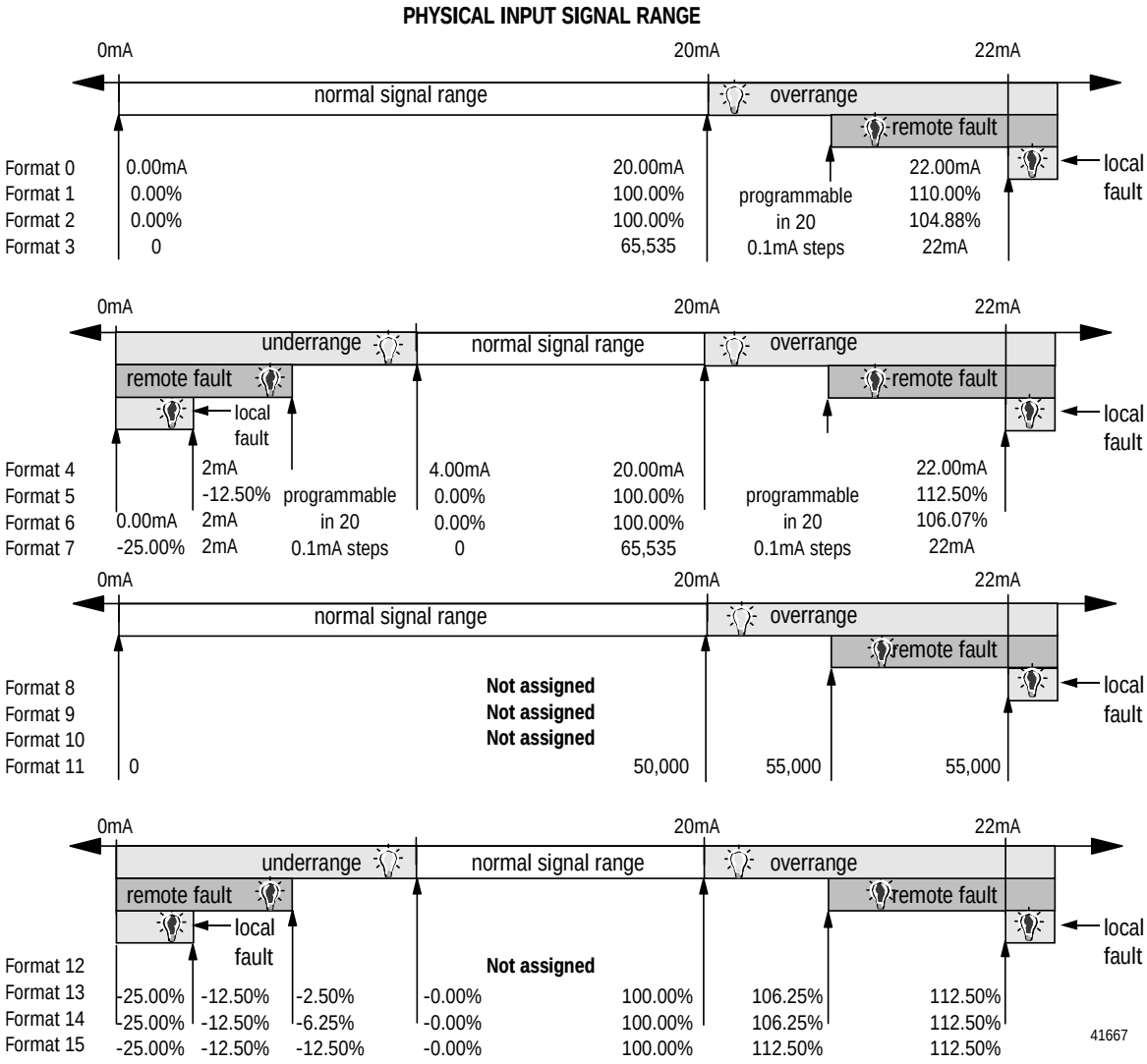
Data Format	Format	Resolution	Input Range	Module Data Processing	Data Table Value (interpretation)	Count per mA	Error Steps
0	0-20mA as mA	0.1% of 0-20mA	0-22mA	datatable = 1,000 (input)	0-22000 (0-22.000mA)	1000	with error steps
1	0-20mA as %	0.2% of 0-20mA	0-22mA	$\text{datatable} = 10{,}000 \left(\frac{\text{input}}{20} \right)$	0-11000 (0-110.00%)	500	with error steps
2	0-20mA as √%	0.19% of 0-20mA	0-22mA	$\text{datatable} = 10{,}000 \sqrt{\frac{\text{input}}{20}}$ IF . . . Square_Root_Threshold $< 10{,}000 \sqrt{\frac{\text{input}}{20}}$ Else . . . datatable = 0	0-10488 (0-104.88%)	524	with error steps
3	0-20mA as unsigned integer	0.03% of 0-20mA	0-20mA	$\text{datatable} = 65{,}535 \left(\frac{\text{input}}{20} \right)$	0-65,535 (0-22mA)	3276	with error steps
4	4-20mA as mA	0.1% of 4-20mA	2-22mA	datatable = 1,000 (input)	2000-22000 (2.000-22.000mA)	1000	with error steps

Table 2.C
1797-IE8 Data Formats

Data Format	Format	Resolution	Input Range	Module Data Processing	Data Table Value (interpretation)	Count per mA	Error Steps
5	4-20mA as %	0.16% of 4-20mA	2-22mA	$\text{datatable} = 10{,}000 \left(\frac{\text{input-4}}{16} \right)$	-1250 - +11250 (2'scomplement) (-12.50% - +112.50%)	625	with error steps
6	$4\text{-}20\text{mA}$ as $\sqrt{\%}$	0.17% of 4-20mA	4-22mA	$\text{datatable} = 10{,}000 \sqrt{\frac{\text{input-4}}{16}}$ IF . . . Square_Root_Threshold $< 10{,}000 \sqrt{\frac{\text{input-4}}{16}}$ Else . . . datatable = 0	0-10607 (0-106.07%)	589	with error steps, under-range not allowed
7	4-20mA as unsigned integer	0.03% of 4-20mA	4-20mA	$\text{datatable} = 65{,}535 \left(\frac{\text{input-4}}{16} \right)$	0-65,535 (4-20mA)	4095	with error steps
8	0-20mA			not assigned			all fixed
9	0-20mA			not assigned			all fixed
10	0-20mA			not assigned			all fixed
11	0-20mA as A/D count	0.04% of 0-20mA	0-22mA	$\text{datatable} = 55{,}000 \left(\frac{\text{input}}{22} \right)$	0-55000 (0-22mA)	2500	all fixed
12	4-20mA as %	0.16% of 4-20mA	3.6-21mA	$\text{datatable} = 10{,}000 \left(\frac{\text{input-4}}{16} \right)$	-250 - +10625 (2'scomplement) (-2.50% - +106.25%)	625	NAMUR NE 4 all fixed
13	4-20mA as %	0.16% of 4-20mA	3-21mA	$\text{datatable} = 10{,}000 \left(\frac{\text{input-4}}{16} \right)$	-625 - +10625 (2'scomplement) (-6.25% - +106.25%)	625	all fixed
14	4-20mA as %	0.16% of 4-20mA	2-22mA	$\text{datatable} = 10{,}000 \left(\frac{\text{input-4}}{16} \right)$	-1250 - +11250 (2'scomplement) (-12.50% - +112.50%)	625	all fixed
15	4-20mA			not assigned			all fixed

Data Formats and Error Ranges

The graphic below shows the data formats and error ranges for your FLEX Ex analog I/O modules.



Selecting a 1797-OE8 FLEX Ex Analog Output Module's Operating Features

All features of the 1797-OE8 analog input module are independently configurable in two four-channel groups (channel 0-3 & channel 4-7).

Important: The default slection value for all parameters is 0.

Output Enable

The Output Enable feature provides user control of the FLEX Ex I/O module's output channels.

At power-up, the ControlNet Ex adapter (1797-ACNR15) and the FLEX Ex I/O modules use a default state of no communications over the network. Use your programming software to change the Output Enable bit to 1 to begin communications over the network.

If network communication is ever lost during normal operations, the adapter resets the Output Enable bit to 0, and any connected I/O modules execute their fault routine, including transitioning to fault state and setting outputs to a user-defined fault state. When network communications resume, the adapter sets the Output Enable bit to 1 and normal I/O operations continue.

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 Retry Mode

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

If 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 Ex analog I/O module 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 2-9) 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 50% of range.

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 = 50% of range

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

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 Table 2.D on page 2-11 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 a non-assigned 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”, 0-20mA 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: 0-15, See Table 13
- Default: 0
- Data Table Reference: data format, word 12 and 13, bits 0-3, bits 4-7

Important: 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. See the graphic below.

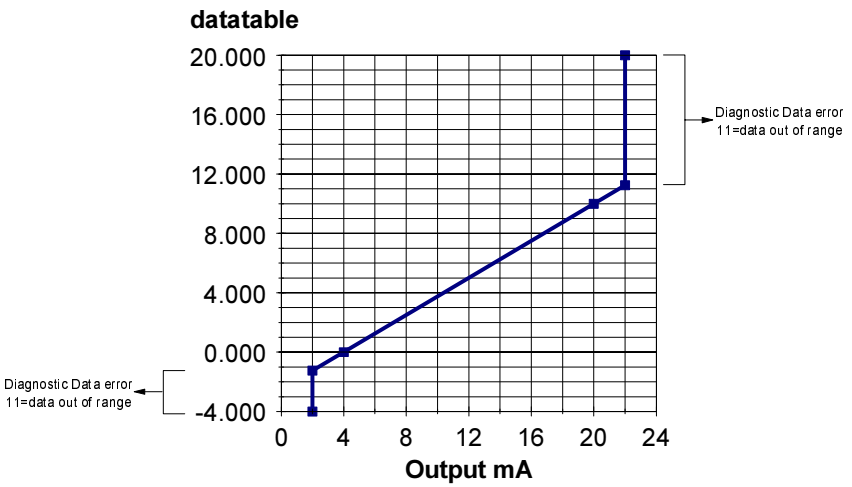


Table 2.D
1797-OE8 Data Formats

Data Format	Format	Resolution	Full Output Range	Module Data Processing	Data Table Value (Interpretation)	Count per mA	Analog Fault State
0	mA as 0-20mA	0.1% of 0-20mA	0-22mA	$\text{output} = \left(\frac{\text{datatable}}{1{,}000}\right)$	0-22000 (0-22.000mA)	1000	min=0mA max=22mA hold last=hold 50%=11mA
1	% as 0-20mA	0.2% of 0-20mA	0-22mA	$\text{output} = 20\left(\frac{\text{datatable}}{10{,}000}\right)$	0-11000 (0-110.00%)	500	min=0mA max=22mA hold last=hold 50%=11mA
2	0-20mA		0-22mA	not assigned			
3	unsigned integer as 0-20mA	0.03% of 0-20mA	0-20mA	$\text{output} = 20\left(\frac{\text{datatable}}{65{,}535}\right)$	0-65,535 (0-22mA)	3276	min=0mA max=20mA hold last=hold 50%=10mA
4	mA as 4-20mA	0.1% of 4-20mA	2-22mA	$\text{output} = \left(\frac{\text{datatable}}{1{,}000}\right)$	2000-22000 (2.000-22.000mA)	1000	min=2mA max=22mA hold last=hold 50%=12mA
5	4-20mA		4-20mA	not assigned			
6	4-20mA		4-20mA	not assigned			
7	unsigned integer as 4-20mA	0.03% of 4-20mA	4-20mA	$\text{output} = 16\left(\frac{\text{datatable}}{65{,}535}\right) + 4$	0-65,535 (4-20mA)	4095	min=4mA max=20mA hold last=hold 50%=12mA
8	0-20mA		0-20mA	not assigned			
9	0-20mA		0-20mA	not assigned			

Table 2.D
1797-OE8 Data Formats

Data Format	Format	Resolution	Full Output Range	Module Data Processing	Data Table Value (Interpretation)	Count per mA	Analog Fault State
10	0-20mA		0-20mA	not assigned			
11	D/A count as 0-20mA	0.28% of 0-20mA	0-22mA	$\text{output} = 22\left(\frac{\text{datatable}}{8{,}000}\right)$	0-8000 (0-22mA)	363	min=0mA max=22mA hold last=hold 50%=11mA
12	4-20mA			not assigned			
13	% as 4-20mA	0.16% of 4-20mA	3-21mA	$\text{output} = 16\left(\frac{\text{datatable}}{10{,}000}\right) + 4$	-625 - +10625 (2's complement) (-6.25% - +106.25%)	625	min=3mA max=21mA hold last=hold 50%=12mA
14	% as 4-20mA	0.16% of 4-20mA	2-22mA	$\text{output} = 16\left(\frac{\text{datatable}}{10{,}000}\right) + 4$	-1250 - +11250 (2's complement) (-12.50% - +112.50%)	625	min=2mA max=22mA hold last=hold 50%=12mA
15	4-20mA		4-20mA	not assigned			

Fault Alarm

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

Understanding 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.

Bit: (s):	Location:	Definition:
Ch	1797-IE8 Input and output maps 1797-OE8 Input and output maps	Channel
Ovr Alm	1797-IE8 Input map	Overrange Alarm
Und Alm	1797-IE8 Input map	Underrange Alarm
Rm Flt	1797-IE8 Input map	Remote Fault
Lo Flt	1797-IE8 Input map	Local Fault
Res Flg	1797-IE8 Input map 1797-OE8 Input map	Response Flag
Out Enbl	1797-OE8 Output map	Output Enable
U/D	1797-IE8 Output map	Up/down
Flt Md	1797-IE8 Output map	Fault Module
Cd Flg	1797-IE8 Output map 1797-OE8 Output map	Command Flag
Flt Alm	1797-OE8 Input map	Fault Alarm
Glbl Rst	1797-OE8 Output map	Global Reset
Lo Flt Md	1797-OE8 Output map	Local Fault Module
Alg Flt Ste	1797-OE8 Output map	Analog Fault State
Lth Rty	1797-OE8 Output map	Latch Retry
Dig Flt Ste	1797-OE8 Output map	Digital Fault State
Alg Dig Md	1797-OE8 Output map	Analog Digital Module
Diagnostic Status	1797-IE8 Input map 1797-OE8 Input map	Diagnostic Status

Analog Input Module (1797-IE8) Image Table Mapping

Input Map (Read Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓	**Read**															
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													Diagnostic Status			
11	Res Flg	Module command response							Module response data							

Where: ch = channel
Ovr Alm = Overrange Alarm
Und Alm = Underrange Alarm
Rm Flt = Remote Fault
Lo Flt = Local Fault
Res Flg = Response Flag

Output Map (Write Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓	Write															
0			High and Low Error Level					U/D 0-3	Filter Cutoff 0-3			Data Format				Flt Md
1			High and Low Error Level					U/D 0-3	Filter Cutoff 0-3			Data Format				Flt Md
2	Cd Flg	Module command							Module command data							

Where: Out Enbl = Output Enable
U/D = up/down
Flt Md = Fault Module
Cd Flg = Command Flag

Bit/Word Description for the Analog Input Module (1797-IE8)

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

"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	Hardware filtering only (default filtering)
	0	0	1	40Hz (25ms)
	0	1	0	20Hz (50ms)
	0	1	1	10Hz (100ms)
	1	0	0	4Hz (250ms)
	1	0	1	2Hz (500ms)
	1	1	0	1Hz (1s)
	1	1	1	0.5Hz (2s)

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

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	0-22mA, w/error steps (default)
	0	0	0	1	0-22mA = 0 to 110%, w/error steps
	0	0	1	0	0-22mA = 0 to 104.8%, square root, w/error steps
	0	0	1	1	0-22mA = 0 to 65,535, unsigned integer, w/error steps
	0	1	0	0	2-22mA, w/error steps
	0	1	0	1	2-22mA = -12.5% to 112.5%, w/error steps
	0	1	1	0	4-22mA = 0 to 106%, square root, w/error steps
	0	1	1	1	4-20mA = 0 to 65,535, unsigned integer, w/error steps
	1	0	0	0	Not assigned
	1	0	0	1	Not assigned
	1	0	1	0	Not assigned

	Bits				Description
	1	0	1	1	0-22mA = A/D count, w/fixed error
	1	1	0	0	3.6-21mA = NAMUR NE 43, w/fixed error
	1	1	0	1	3-21mA = -6.25 to 106.28% w/fixed error
	1	1	1	0	2-22mA = -12.5 to 112.5% w/fixed error
	1	1	1	1	Not assigned

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 to 112.5%	0	0	1	1	1	Step value = 7, 0.1mA * 7 = 0.7mA Remote fault alarm at -4.38% or +104.38%
	0	1	1	1	1	Binary value = 15, 0.1mA * 15 = 1.5mA Remote fault alarm at -9.38% or + 109.38%

Analog Output Module (1797-OE8) Image Table Mapping

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					Diagnostic Status			
1	Res Flg	MODULE Command Response							MODULE Response Data							

Where: ch = channel
Flt Alm = Fault Alarm
Res Flg = Response Flag

Bit/Word Descriptions for the Analog Output Module (1797-OE8)

Output Map (Write Words)

Bit →	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word ↓																
0	Out Enbl	Glbl Rst	RESERVED						Dig Out ch7	Dig Out ch6	Dig Out ch5	Dig Out ch4	Dig Out ch3	Dig Out ch2	Dig Out ch1	Dig Out ch0
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															
9	Lo Flt Md		Flt Md ch 2-3	Flt Md ch 0-1	Alg Flt Ste ch2-3		Alg Flt Ste ch0-1		Data Format ch2-3				Data Format ch0-1			
10	Lth Rty 4-7	Lth Rty 0-3	Flt Md ch 6-7	Flt Md ch 4-5	Alg Flt Ste ch6-7		Alg Flt Ste ch4-5		Data Format ch6-7				Data Format ch4-5			
11	Dig Flt Ste ch7	Dig Flt Ste ch6	Dig Flt Ste ch5	Dig Flt Ste ch4	Dig Flt Ste ch3	Dig Flt Ste ch2	Dig Flt Ste ch1	Dig Flt Ste ch0	Alg Dig Md ch7	Alg Dig Md ch6	Alg Dig Md ch5	Alg Dig Md ch4	Alg Dig Md ch3	Alg Dig Md ch2	Alg Dig Md ch1	Alg Dig Md ch0
12	Cd Flg	MODULE Command							MODULE Command Data							

Where: ch = channel
Dig Out = Digital Output
Lo Flt Md = Local Fault Mode
Flt Md = Fault Mode
Alg Flt Ste = Analog Fault State
Lth Rty = Latch Retry
Dig Flt Ste = Digital Fault State
Alg Dig Md = Analog/Digital Mode
Out Enbl = Output Enable
Glbl Rst = Global Reset

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 0-20mA	0-22mA	0-22mA	0-22000	1000
0	0	0	1	0-20mA	0.2% of 0-20mA	0-22mA	0-110%	0-11000	500
0	0	1	0	0-20mA		0-20mA	not assigned		
0	0	1	1	0-20mA	0.03% of 0-20mA	0-20mA	unsigned integer	0-65,535	3276
0	1	0	0	4-20mA	0.1% of 4-20mA	2-22mA	2-22mA	2000-22000	1000
0	1	0	1	4-20mA		4-20mA	not assigned		
0	1	1	0	4-20mA		4-20mA	not assigned		
0	1	1	1	4-20mA	0.03% of 4-20mA	4-20mA	unsigned integer	0-65,535	4095
1	0	0	0	0-20mA		0-20mA	not assigned		
1	0	0	1	0-20mA		0-20mA	not assigned		
1	0	1	0	0-20mA		0-20mA	not assigned		
1	0	1	1	0-20mA	0.28% of 0-20mA	0-22mA	D/A count	0-8000	363
1	1	0	0	4-20mA			not assigned		
1	1	0	1	4-20mA	0.16% of 4-20mA	3-21mA	-6.25 to +106.25%	-625 to +10625	625
1	1	1	0	4-20mA	0.16% of 4-20mA	2-22mA	-12.5 to +112.5%	-1250 to +11250	625
1	1	1	1	4-20mA		4-20mA	not assigned		

Chapter Summary

In this chapter, we told you about the FLEX Ex 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 Ex analog module.

How to Install Your FLEX Ex Analog Modules

What this Chapter Contains

Read this chapter to install the 1797-IE8 and 1797-OE8 analog modules.

Before You Install Your Analog Module

Before installing your FLEX Ex analog module:

You need to:	As described under:
Verify that the module will be installed in a suitable metal enclosure	Installation in Zone 1, page 3-3
Position the keyswitch on the terminal base	Installing the Module, page 3-9

ATTENTION: These modules do not receive primary operational power from the backplane. +/-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.

Compliance to European Union Directives

If this product has the CE mark, it is approved for installation within the European and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet the Council Directive 89/336/EC Electromagnetic Compatibility (EMC) by applying the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2 EMC - Generic Emission Standard, Part 2 - Industrial Environment
- EN 50082-2 EMC - Generic Immunity Standard, Part 2 - Industrial Environment

This product is intended for use in an industrial environment.

Ex Directive

This product is tested to meet the Council Directive 94/9/EC (ATEX 100a) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres by applying the following standards:

- EN50014:1992, Electrical Apparatus for Potentially Explosive Atmospheres
- EN50020:1994, Electrical Apparatus for Potentially Explosive Atmospheres - Intrinsic Safety “i”
- prEN50284:1997, Special requirements for construction, test and marking of electrical apparatus of equipment group II, category 1G

Installation in Zone 1

This module must not be exposed to the environment. Provide a suitable metal enclosure.

ATTENTION: This module cannot be used in an intrinsically safe environment after it has been exposed to non-intrinsically safe signals.

Electrostatic Charge

Protect the system against electrostatic charge. Post a sign near this module: **Attention! Avoid electrostatic charge.** For your convenience, a sign which can be cut out and posted is included in this user manual before the back cover.

Removal and Insertion Under Power

ATTENTION: 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.

Installing the Module

Installation of the analog module consists of:

- 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 "Mounting the Analog Modules on the Terminal Base" on page 9.

ATTENTION: Make certain that you power this terminal base module combination with an instrinsically safe power supply. Do not exceed the values listed in the specifications for the terminal base or module.

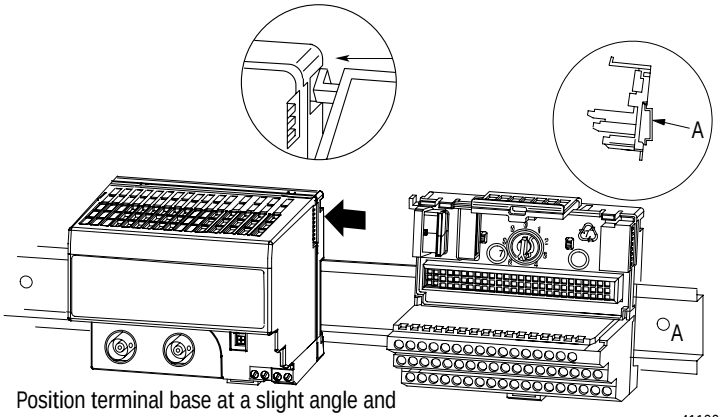
Do not use the unused terminals on the terminal base unit. Using the terminals as supporting terminals can result in damage to modules and/or unintended operation of your system.

Mounting 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.

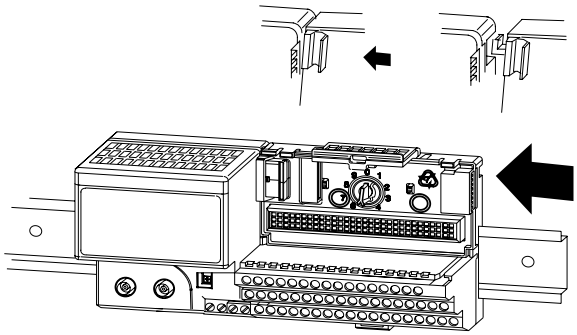
1. Remove the cover plug in the male connector of the unit to which you are connecting this terminal base unit.
2. Check to make sure that the 16 pins in the male connector on the adjacent device are straight and in line so that the mating female connector on this terminal base unit will mate correctly.
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.

41106



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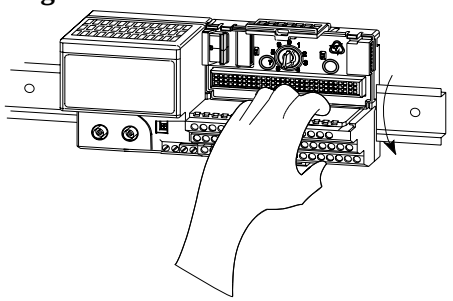
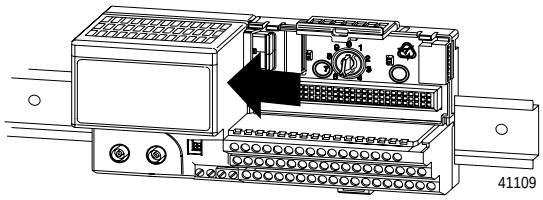
Slide the terminal base over tight against the adapter (or proceeding terminal base). Make sure the hook on the terminal base slides under the edge of the adapter (or proceeding terminal base) and the flexbus connector is fully retracted.

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 3-11.

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

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

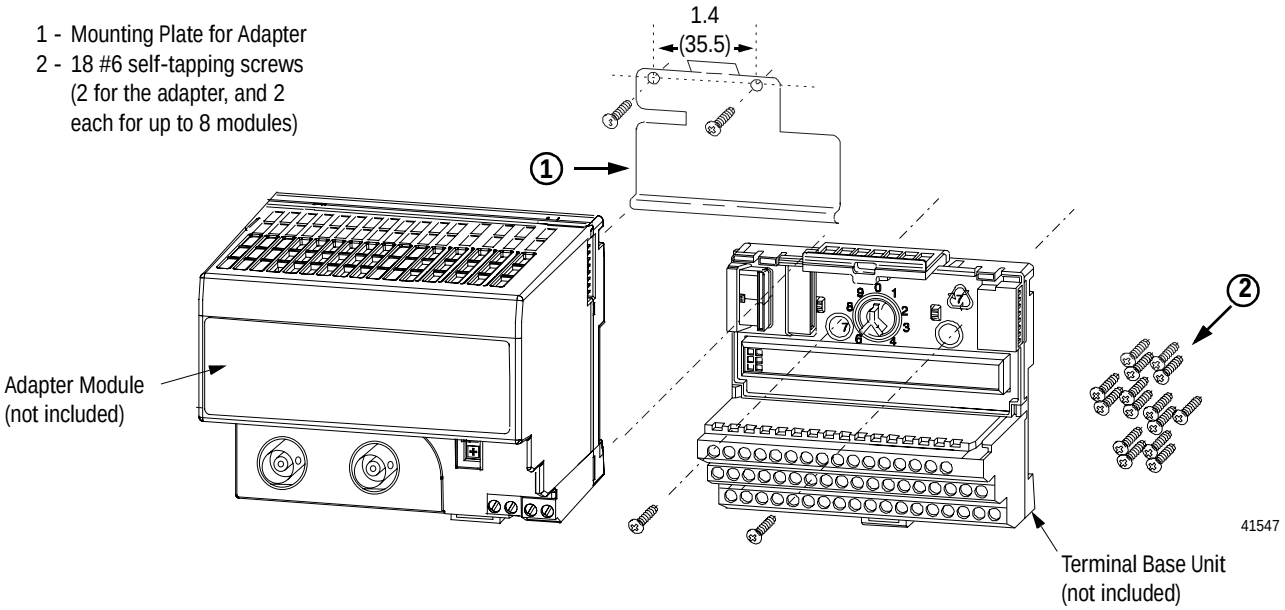
Panel/Wall Mounting

Installation 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 Mounting the 1797-IE8 Analog Input or 1797-OE8 Analog Output Module on the Terminal Base Unit on page 3-9.

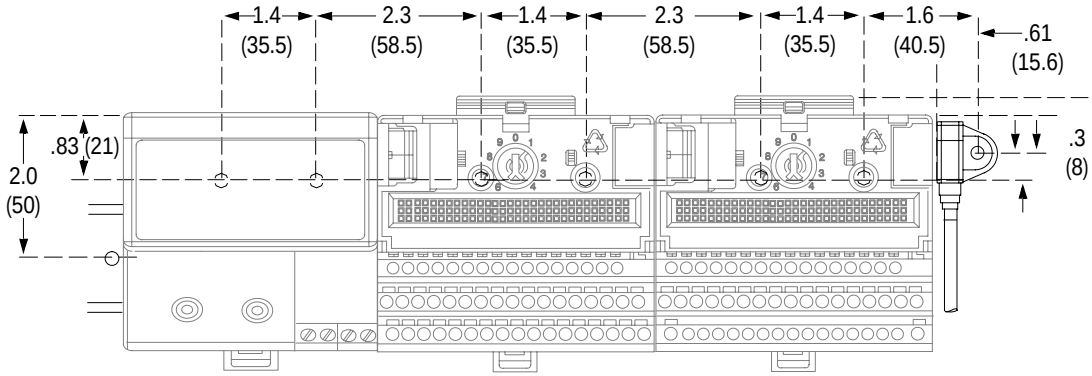
Use the mounting kit Cat. No. 1794-NM1 for panel/wall mounting.



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.

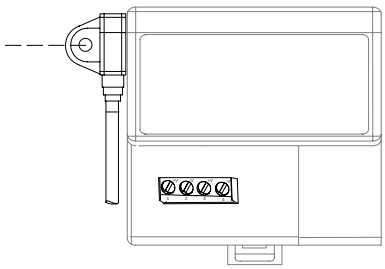
Drilling Dimensions for Panel/Wall Mounting of FLEX Ex I/O



Inches
(Millimeters)

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 11.5 (292.1) or 35.5 (901.0) from upper connector [length depends upon cable -1ft (0.3m) or 3ft (0.091m)]



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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.

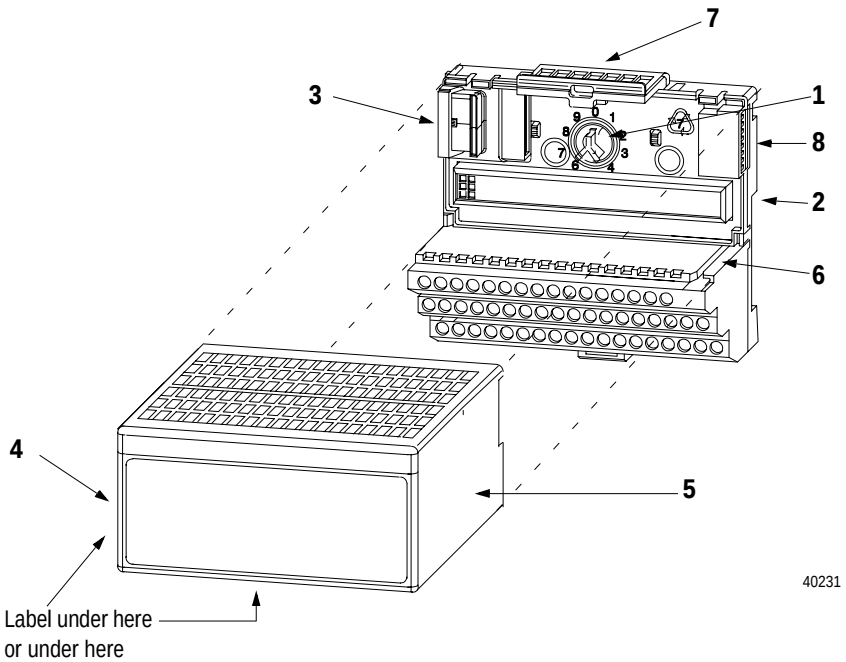
7. Secure to the wall with two #6 self-tapping screws.

8. Repeat for each remaining terminal base unit.

Mounting the 1797-IE8 Analog Input or 1797-OE8 Analog Output Module on the Terminal Base Unit

The 1797-IE8 and 1797-OE8 modules mount on a 1797-TB3 or TB3S intrinsically safe terminal base unit.

1. Rotate keyswitch (1) on terminal base unit (2) clockwise to position 3 for the 1797-IE8 or position 4 for the 1797-OE8 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.

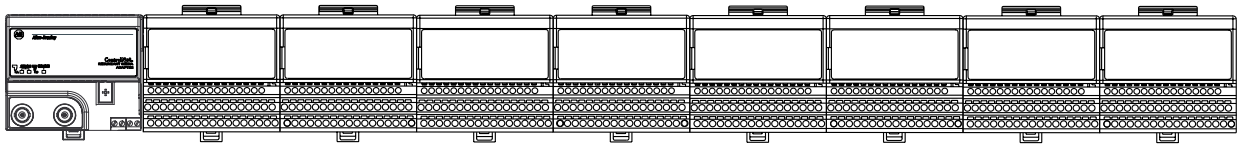
3. Make sure the pins on the bottom of the module are straight so they will align properly with the connector in the terminal base unit.

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. Make certain that you only connect terminal base units to other intrinsically safe system modules or adapters to maintain the integrity of the intrinsically-safe backplane.

7. Remove cap plug (8) and attach another intrinsically safe 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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Important: The adapter is capable of addressing eight modules. Do not exceed a maximum of eight terminal base units in your system.

Wiring the Terminal Base Units

Wiring the FLEX Ex I/O analog modules is done through the 1797-TB3 and 1797-TB3S terminal base units.

ATTENTION: The FLEX Ex analog I/O modules do not receive primary operational power from the backplane. +/-V 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.

Make certain that you power these modules with an intrinsically safe power supply. Do not exceed the values listed in the specifications for the modules.

Connecting Wiring to the FLEX Ex I/O Analog Modules

Inputs/Outputs

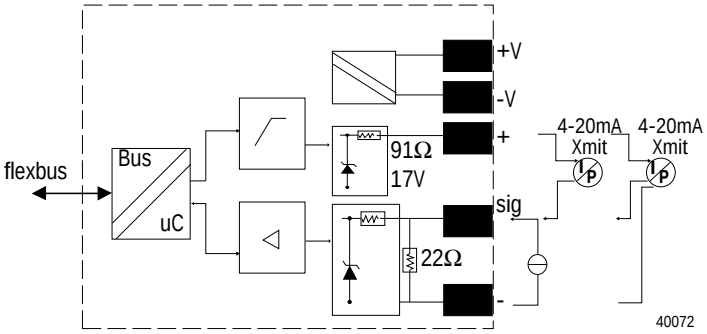
Each 1797-IE8 input can be operated from an analog field device signal, and each 1797-OE8 output channel can operate an analog field device. **Do not apply any non-intrinsically safe signals to these modules**.

Important: When using an intrinsically safe electrical apparatus according to EN50020, the European Community directives and regulations must be followed.

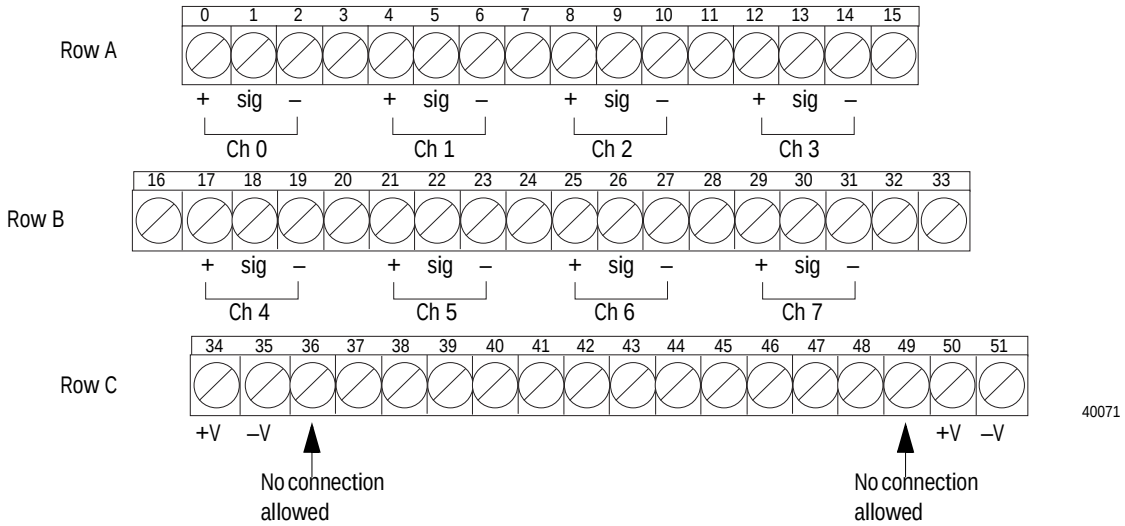
The channels of the 1797-IE8 are electrically connected to each other and have a common plus-line. The channels of the 1797-OE8 are electrically connected to each other.

Important: When interconnecting several lines, you must consider the total accumulated power and check for intrinsic safety.

Connections for the 1797-IE8 Module.



1797-IE8 Module



For Two-Wire Transmitter Devices

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

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

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

4. Connect -V to terminal 35 on the 34-51 row (C).

5. If continuing power to the next terminal base unit, connect a jumper from terminal 50 (+V) on this base unit to terminal 34 on the next base unit.

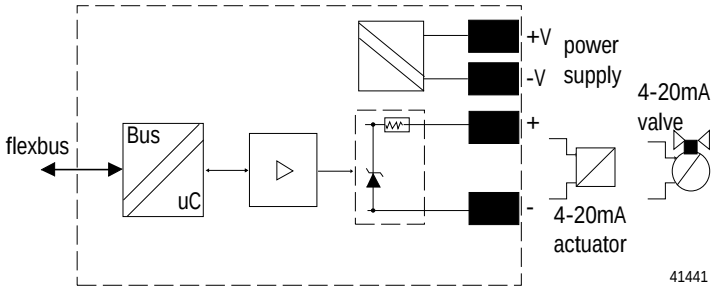
6. If continuing common to the next terminal base unit, connect a jumper from terminal 50 (-V) on this base unit to terminal 35 on the next base unit.

Wiring connections for the 1797-IE8 Module

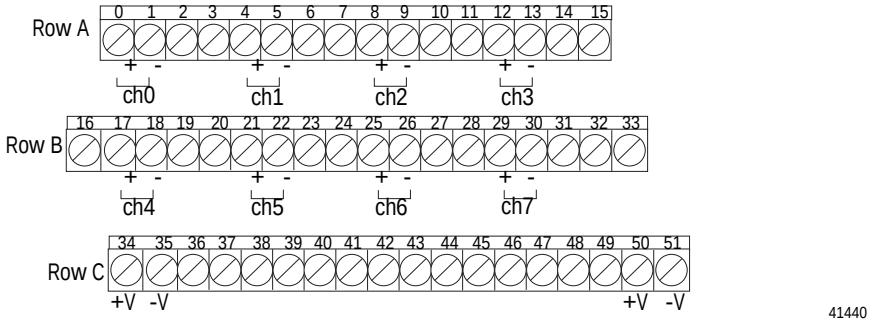
Input	Input Source	Input Signal	Input Return	Input	Input Source	Input Signal	Input Return
Input 0	A-0	A-1	A-2	Input 4	B-17	B-18	B-19
Input 1	A-4	A-5	A-6	Input 5	B-21	B-22	B-23
Input 2	A-8	A-9	A-10	Input 6	B-25	B-26	B-27
Input 3	A-12	A-13	A-14	Input 7	B-29	B-30	B-31
+V	Terminals 34 and 50						
-V	Terminals 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 1797-OE8 Module



1797-OE8 Module



No connections allowed to terminals 2, 3, 6, 7, 10, 11, 14, 15, 19, 20, 23, 24, 27, 28, 31, 32, 36, 37, 38, 39, 46, 47, 48, 49

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

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

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

4. Connect -V to terminal 35 on the 34-51 row (C).

5. If continuing power to the next terminal base unit, connect a jumper from terminal 50 (+V) on this base unit to terminal 34 on the next base unit.

6. If continuing common to the next terminal base unit, connect a jumper from terminal 51 (-V) on this base unit to terminal 35 on the next base unit.

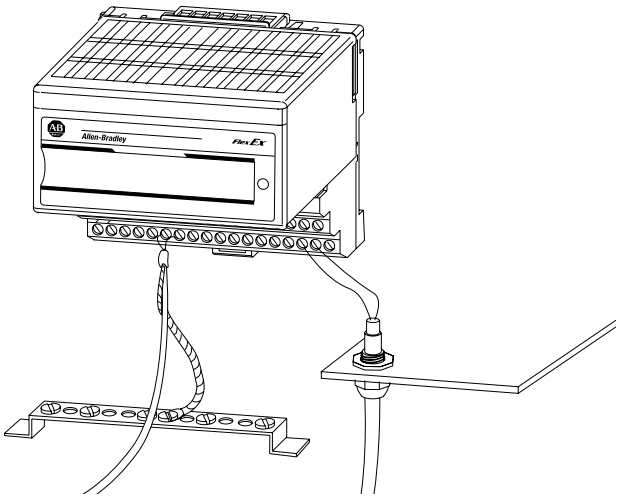
Wiring connections for the 1797-OE8 Module

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.

Grounding 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.



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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 analog I/O modules on ControlNet.

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 ControlNet.

In this chapter, you will learn about:

- using software to configure the FLEX Ex I/O modules
- ControlNet Ex 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 Ex 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.

Using Programming Software in Your FLEX Ex Application

When using FLEX Ex 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 **RS**NetWorx™ to connect FLEX Ex I/O modules to a ControlNet processor or scanner through a FLEX Ex ControlNet Ex adapter (cat. no. 1797-ACNR15). The I/O configuration portion of another programming software, for example **RS**Logix5™ 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 and download

4. module configuration.

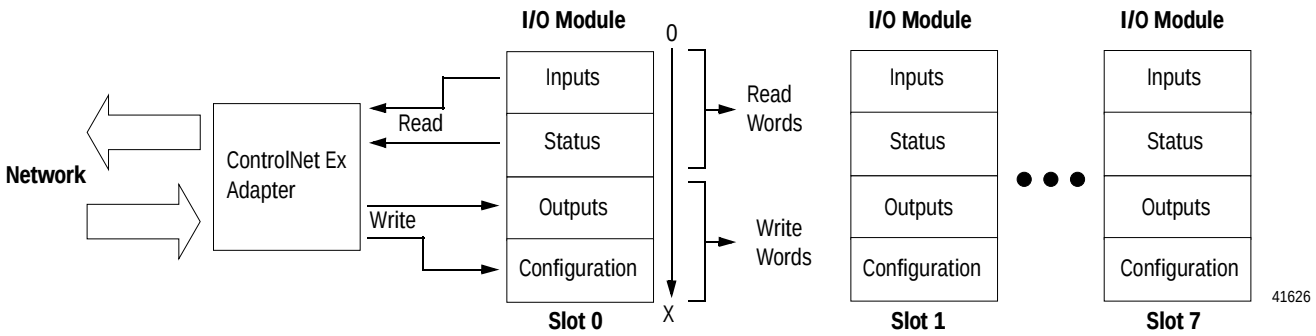
About the ControlNet Ex Adapter

The FLEX Ex ControlNet Ex adapter interfaces up to 8 FLEX Ex 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 Ex Backplane

One 1797-ACNR15/B ControlNet Ex adapter can interface up to eight terminal base units with installed FLEX Ex modules, forming a FLEX Ex system of up to eight slots.

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



Important: 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 non-discrete 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 non-deterministic. Your application and your configuration–number of nodes, application program, NUT, amount of scheduled bandwidth used, etc.–determine how much time there is for unscheduled messaging.

Module I/O Mapping

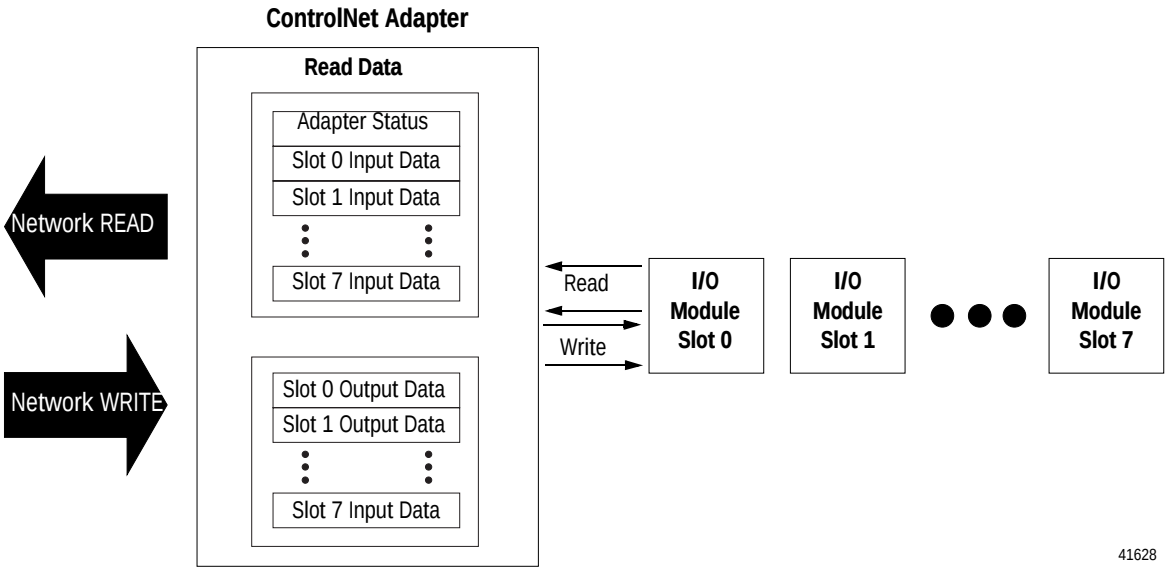
The I/O map for a module is divided into read words and write words. Read words consist of **input and status words**, and write words consist of **output and configuration words**. The number of read words or write words can be 0 or more.

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.

The first word of input data sent by the adapter 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

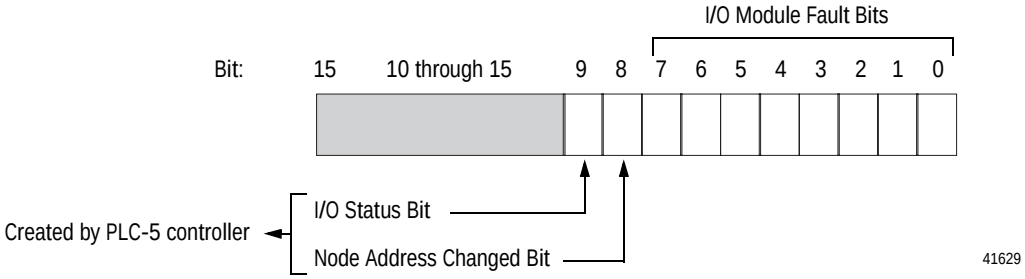
The status word consists of:

- 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 Ex 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.

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 though 15	Not used – set to 0

Possible causes for an **I/O Module Fault** are:

- transmission errors on the FLEX Ex backplane
- a failed module
- a module removed from its terminal base
- incorrect module inserted in a slot position
- the slot is empty
- the slot contains a non-discrete module

Fault State Data

The ControlNet Ex adapter 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 2-13.

Device Actions

Device actions include:

- communication fault behavior
- idle state behavior
- input data behavior upon module removal

Communication Fault Behavior

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

Important: If the Output Enable bit transitions from 1 to 0 (by resetting the module output data or applying fault state data), the module uses internal analog or digital fault state bits, depending on user configuration, to determine the state of the outputs.

Idle State Behavior

The ControlNet Ex adapter 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 adapter 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

Important: If the Output Enable bit transitions from 1 to 0 (by resetting the module output data or applying fault state data), the module uses internal analog or digital fault state bits, depending on user configuration, to determine the state of the outputs.

Input Data Behavior upon Module Removal

I/O module input data sent by the adapter upon module removal is configurable. The adapter can:

- reset the module input data sent by the adapter to zero (reset)
- leave the module input data sent by the adapter in the last state before module removal (hold last state)

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.

Calibrating Your Module

What This Chapter Contains

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

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

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

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

Your module is shipped to you already calibrated. If a calibration check is required, the module must be in a FLEX Ex 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.

ATTENTION: Your FLEX Ex analog I/O modules are intrinsically safe equipment. This module cannot be used in instrinsically safe environment after having been exposed to non-intrinsically safe signals.

Use one of the following general methods to calibrate your module:

- Use intrinsically safe equipment to calibrate the module.
- Use factory trained personnel under controlled conditions to calibrate the modules with non-intrinsically safe equipment to maintain your module's intrinsic safety certification.

ATTENTION: With the second method, extreme care must be exercised by the calibration personnel to avoid compromising the intrinsically safe characteristics or your modules. This method may never be used in a hazardous environment.

Tools and Equipment

To calibrate your analog I/O modules, you will need the following tools and equipment:

Tool or Equipment:	Description:	
Precision Current Source	0-22mA, 0.01µA resolution	Used for 1797-IE8 module
Precision Current Meter	0-22mA, 0.01µA resolution	Used for 1797-OE8 module
Industrial Terminal and Interconnect Cable	Programming terminal for A-B family processors	

Using Calibration Module Command Words

Module calibration is supported by Module Command words. See your module data tables in Chapter 3 to determine which words are the Module Command words. They are always the last read word and last write word. The Module Command word is broken into two parts the upper byte is the command and the lower byte is the data.

A CIO is used to structure a calibration command and submit it to the network. This includes the command and any data.

MODULE Command Word

R/W	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	cmd flag	MODULE calibration command							MODULE calibration command data							

Typical MODULE Calibration Command Word

The controller sends a MODULE calibration command word over the network, onto the flexbus and to the module.

Calibration Command Word

R/W	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
write	cmd flag	Calibration All Channels							sub-Command 0-255							
write	cmd flag	Calibration By Channel							Channel Select 0-15				sub-Command 0-15			

The I/O module may do a number of things based on the particular calibration command data sent by the controller. The table below shows the general structure of calibration commands.

The calibration command structure instructs the module to calibrate individual channels or to calibrate all channels at once. If all channels are to be calibrated at once, a single calibration command is sent along with calibration command data selecting the calibration type to be accomplished. If individual channels are to be calibrated, again, a single calibration command is sent. The calibration command data specifies the specific channel and calibration type to be accomplished.

General Calibration Command Structure

MODULE Calibration Command		MODULE Calibration Command Data		
Command	Meaning	Data (up nibble)	Data (low nibble)	Meaning
		channel	command	
0	Commands Idle	x	x	command method is idle
1	No Operation	x	x	no operation is required
4	General Calibration by Channel	0-7	0	zero min and max scale coefficients
		0-7	1-15	not used
		8-15	0-15	not used
5	Min Scale Calibration by Channel	0-7	0	input = 1mA
		0-7	1-15	not used
		8-15	0-15	not used

6	Max Scale Calibration by Channel	0-7	0	input = 21mA
		0-7	1-15	not used
		8-15	0-15	not used
36	Calibration all Channels			
	General Calibration all Channels	0	0	zero min scale and max scale coefficients
		0	1-15	not used
	Min Scale Calibration all Channels	1	0	input = 1mA
		1	1-15	not used
	Max Scale Calibration all Channels	2	0	input = 21mA
		2	1-15	not used
		3-15	0-15	not used

For example, based on the table below, command 4 0 0 asks for zeroing the min and max coefficients of channel 0. All results are complete with this one command.

Example MODULE Calibration Commands and Data

R/W	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Read	cmd flag	MODULE command response							MODULE response data							

Once the slave completes the calibration command, the module echoes back the command and data in the MODULE response word, see the General MODULE Response Word below. The controller is informed the calibration sequence is complete.

General MODULE Response Word

Once the I/O module echoes the command and data it will not treat the continued presence of the same calibration command as a signal to perform that command again. If the user wants to perform the same calibration again, a “No Operation” command must be sent from the controller to the module first.

The following tables show typical command sequences.

Typical All Channels Calibration Command Sequence

Host Command Sequence										
command number	MODULE command	MODULE data								
		7	6	5	4	3	2	1	0	
36	calib all chls, zero min & max	0				0				
36	calib all chls, min scale	1				0				
36	calib all chls, max scale	2				0				
0	Commands idle	0				0				

Slave Command Sequence										
command number	MODULE command response	MODULE response data								
		7	6	5	4	3	2	1	0	
36	calib all chls, zero min & max	0				0				
36	calib all chls, min scale	1				0				
36	calib all chls, max scale	2				0				
0	Commands idle	0				0				

Typical Channel by Channel Calibration Command Sequence

Host Command Sequence										
command number	MODULE command	MODULE data								
		7	6	5	4	3	2	1	0	
4	calib ch0, zero min & max	0				0				
4	calib chl, zero min & max	1				0				
5	calib ch0, min scale	0				0				
5	calib ch1, min scale	1				0				
6	calib ch0, max scale	0				0				
6	calib ch1, max scale	1				0				
0	Commands idle	0				0				

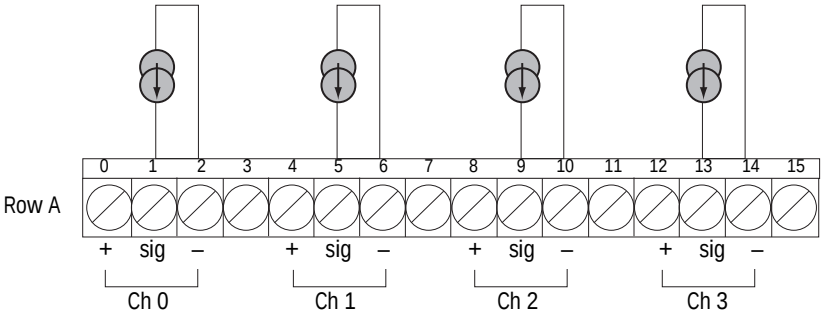
Slave Command Sequence										
command number	MODULE command response	MODULE response data								
		7	6	5	4	3	2	1	0	
4	calib ch0, zero min & max	0				0				
4	calib chl, zero min & max	1				0				
5	calib ch0, min scale	0				0				
5	calib ch1, min scale	1				0				
6	calib ch0, max scale	0				0				
6	calib ch1, max scale	1				0				
0	Commands idle	0				0				

Calibrating the 1797-IE8 Module

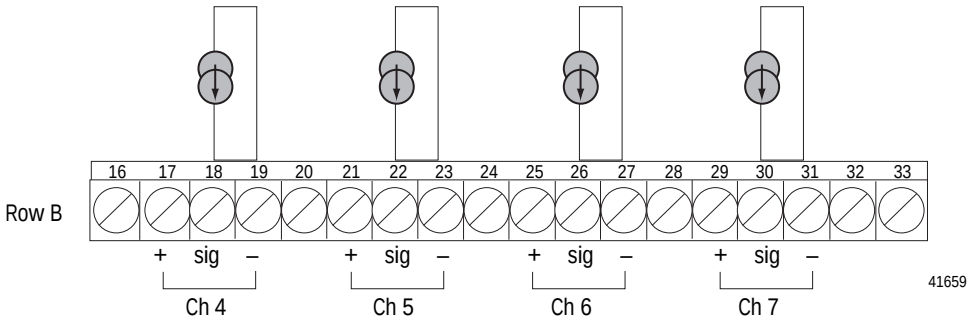
To calibrate the 1797–IE8 module use the following steps:

1. Attach the precision current source(s) to the module.

Precision Current Sources



Precision Current Sources



2. Send a message to the module instructing it to perform **Zero Min and Max Scale Coefficients**.
3. Await an echo message from the module announcing that it has performed **Zero Min and Max Scale Coefficients**.
4. Apply 1mA, (minimum scale calibration input(s),) to the module.
5. Send a message to the module instructing it to perform **Min Scale Calibration**.
6. Await an echo message from the module announcing that it has performed **Min Scale Calibration**.
7. Apply 21mA, (maximum scale calibration input(s),) to the module.
8. Send a message to the module instructing it to perform **Max Scale Calibration**.

9. Await an echo message from the module announcing that it has performed **Max Scale Calibration**.

10. After all channels are calibrated, send a message to the module instructing it to go to **Commands Idle** state.

The following table shows the calibration MODULE command definitions.

MODULE Command Definitions

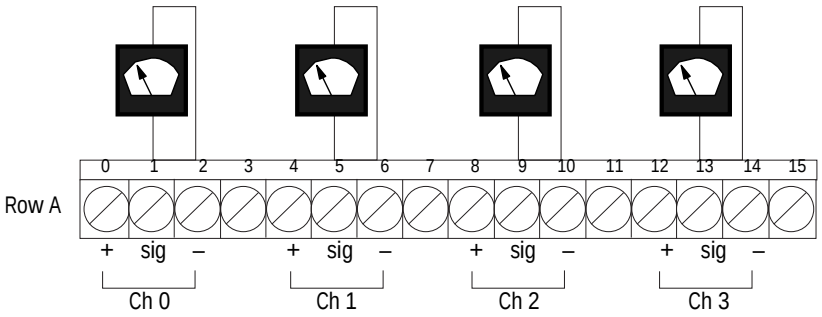
MODULE Calibration Command		MODULE Calibration Command Data		
Command	Meaning	Data (up nibble)	Data (low nibble)	Meaning
		channel	command	
0	Commands Idle	x	x	command method is idle
1	No Operation	x	x	no operation is required
4	General Calibration by Channel	0-7	0	zero min and max scale coefficients
		0-7	1-15	not used
		8-15	0-15	not used
5	Min Scale Calibration by Channel	0-7	0	input = 1mA
		0-7	1-15	not used
		8-15	0-15	not used
6	Max Scale Calibration by Channel	0-7	0	input = 21mA
		0-7	1-15	not used
		8-15	0-15	not used
36	Calibration all Channels			
	General Calibration all Channels	0	0	zero min scale and max scale coefficients
		0	1-15	not used
	Min Scale Calibration all Channels	1	0	input = 1mA
		1	1-15	not used
	Max Scale Calibration all Channels	2	0	input = 21mA
		2	1-15	not used
		3-15	0-15	not used

Calibrating the 1797-OE8 Module

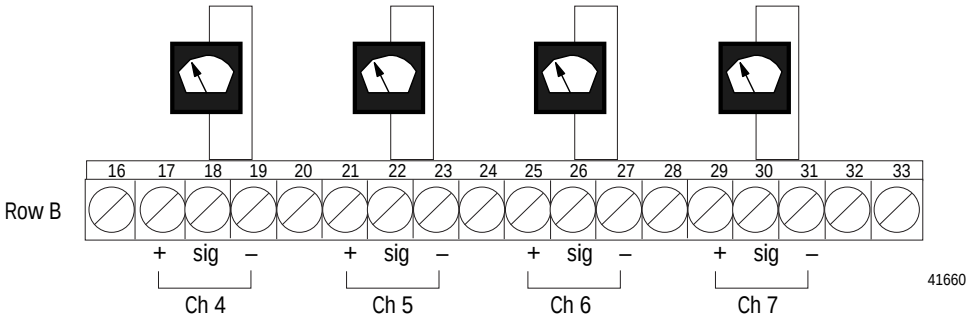
To calibrate the 1797–OE8 module use the following general method:

1. Attach the precision current meters(s) to the module.

Precision Current Sources



Precision Current Sources



2. Send a message to the module to set its Output Enable bit to 1. This enables its outputs.

3. Send a message to the module instructing it perform **Zero Min and Max Scale Coefficients**.

4. Await an echo message from the module announcing that it has performed **Zero Min and Max Scale Coefficients**.

5. Send a message to the module instructing it to perform **Min Scale Calibration** (1mA) on the channel(s).

6. Await an echo message from the module announcing that it has performed **Min Scale Calibration**.

7. Record the value indicated by the channel(s) precision current meter into the appropriate channel's(s') data table location.

8. Send a message to the module instructing it to **Accept Value in Channel Data Word as Min Scale Calibration** on the channel(s).

9. Await an echo message from the module announcing that it has performed **Accept Value in Channel(s) Data Word(s) as Min Scale Calibration** on the channel(s).

10. Send a message to the module instructing it to perform **Max Scale Calibration** (21mA) on the channel(s).

11. Await an echo message from the module announcing that it has performed **Max Scale Calibration**.

12. Record the value indicated by the channel(s) precision current meter into the appropriate channel's(s') data table location.

13. Send a message to the module instructing it to **Accept Value in Channel(s) Data Word(s) as Max Scale Calibration** on the channel(s).

14. Await an echo message from the module announcing that it has performed **Accept Value in Channel(s) Data Word(s) as Max Scale Calibration** on the channel(s).

15. After all channels are calibrated, send a message to the module instructing it to go to **Commands Idle** state.

The following table shows the calibration MODULE command definitions.

Calibration MODULE Command Definitions

MODULE Calibration Command		MODULE Calibration Command Data		
Command	Meaning	Data (up nibble)	Data (low nibble)	Meaning
		channel	command	
0	Commands Idle	x	x	command method is idle
1	No Operation	x	x	no operation is required
4	General Calibration by Channel	0-7	0	zero min scale and max scale coefficients
		0-7	1-15	not used
		8-15	0-15	not used
5	Min Scale Calibration by Channel	0-7	0	output = 1mA
		0-7	1	accept value in channel data word as min scale calibration
		0-7	2-15	not used
		8-15	0-15	not used
6	Max Scale Calibration by Channel	0-7	0	output = 21mA
		0-7	1	accept value in channel data word as max scale calibration
		0-7	2-15	not used
		8-15	0-15	not used
36	Calibration all Channels			
	General Calibration all Channels	0	0	zero min scale and max scale coefficients
		0	1-15	not used
	Min Scale Calibration all Channels	1	0	output = 1mA
		1	1	accept values in channel data words as min scale calibration
		1	2-15	not used
	Max Scale Calibration all Channels	2	0	output = 21mA
		2	1	accept values in channel data words as max scale calibration
		2	2-15	not used
		3-15	0-15	not used

Chapter Summary

In this chapter, you learned how to calibrate your FLEX Ex analog I/O modules. Move to Chapter 6 to see how to apply FLEX Ex analog I/O modules.

Applying FLEX Ex Analog I/O Modules

What this Chapter Contains

Read this chapter to learn how to use entity parameters when electrically interconnecting your FLEX Ex analog I/O module in a hazardous area.

The FLEX Ex system is different from traditional control systems used the intrinsic safety in its ability to be located directly in hazardous areas and to embrace high speed network-based control.

Evaluate the Application

Follow these steps when designing a FLEX Ex system for your application:

1. Define the area classification.
2. Select protection method(s).
3. Match field devices and I/O modules.
4. Optimize power distribution.
5. Layout the ControlNet Ex network.

An explanation of each of these steps is provided in this chapter.

Define the Area Classification

Before you can determine what components will make up your FLEX Ex system, you must define the area in which that system will operate. You must determine the following:

- classification method
- hazard
- temperature rating

Decide Classification Method

Your application location will usually decide whether the classification method is Zone or Class/Division, but the system designer may make this determination. **FLEX Ex is certified for Zone method only**. Certification is pending for Division method.

Determine Hazard

Hazard–typically gas, dust, or fibers–is determined by the material being processed. For example, a coal mine will generally be rated for dust and methane gas hazards. **FLEX Ex is certified for gas hazard only**. Certification is pending for attaching wiring to FLEX Ex I/O modules from a dust and fiber hazardous area.

Determine Temperature Rating

The spontaneous ignition temperature of the hazard in your application determines the temperature rating. For example, an application with a hydrogen hazard may use equipment with a temperature rating of T1 because hydrogen's ignition temperature is 550°C. **FLEX Ex is certified as a T4 system**.

Select Protection Method(s)

Although the FLEX Ex system primarily uses the Intrinsic Safety protection method, the system uses all methods listed below.

Table 6.A
Protection Methods for Hazardous Applications

Protection Method	Designation[1]	Method of Achieving Protection
Intrinsic Safety	EEx_{ia}/EEx_{ib}	Energy Limiting
Encapsulation	EEx_{m}	Segregation
Increased Safety	EEx_{e}	Refined Mechanical Design
Flameproof	EEx_{d}	Containment

1 In the Non-Incendive protection method, n: used locally in the United States and United Kingdom.
In the Intrinsic Safety method, ia: Zone 0, 1, 2 & ib: Zone 1, 2

Important: As not all protection methods are applicable for all locations, consult local certifying agencies to determine acceptable protection methods for your application.

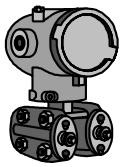
Match Field Devices and I/O Modules

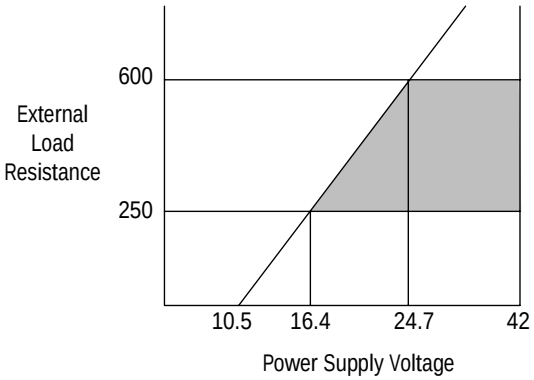
You must match field devices and I/O modules for your application to function properly. Consider the following:

- Verify field device and I/O module operational characteristics
- Match entity parameters of field devices and I/O modules

P/I Analog Transmitter Functional and IS Parameters

The figure below shows a typical pressure to current analog transmitter. Two types of characteristics are shown, functional and IS.





4-20mA IS
P/I Transmitter
10.5-42V operate
EEx ia IIC T4
Ui=30V
Ii=165mA
Ci=22.5nF
Li=730uH

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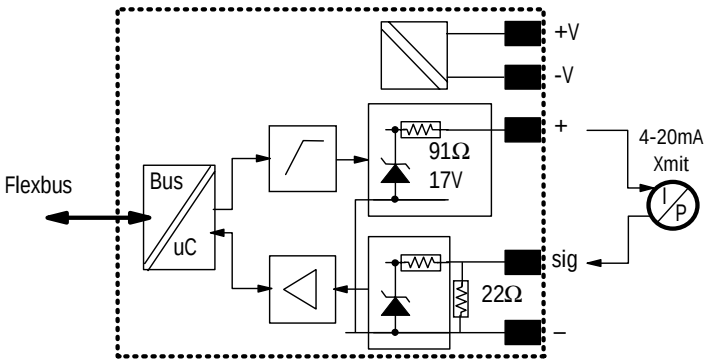
1797-IE8 Functional and IS Parameters

The figure below provides data, on the Flex Ex analog input module, which can be matched to this transmitter.



Analog Input
V>17V at I=0mA
V>15.5 at I=20mA
V>15V at I=22mA
0-22mA Measurement Range
EEx ia/ib IIB/IIC T4
Uo<23.7V
Io<92.5mA

IIB	IIC
Ca=560nF	Ca=66nF
La=10mH	La=2.5mH

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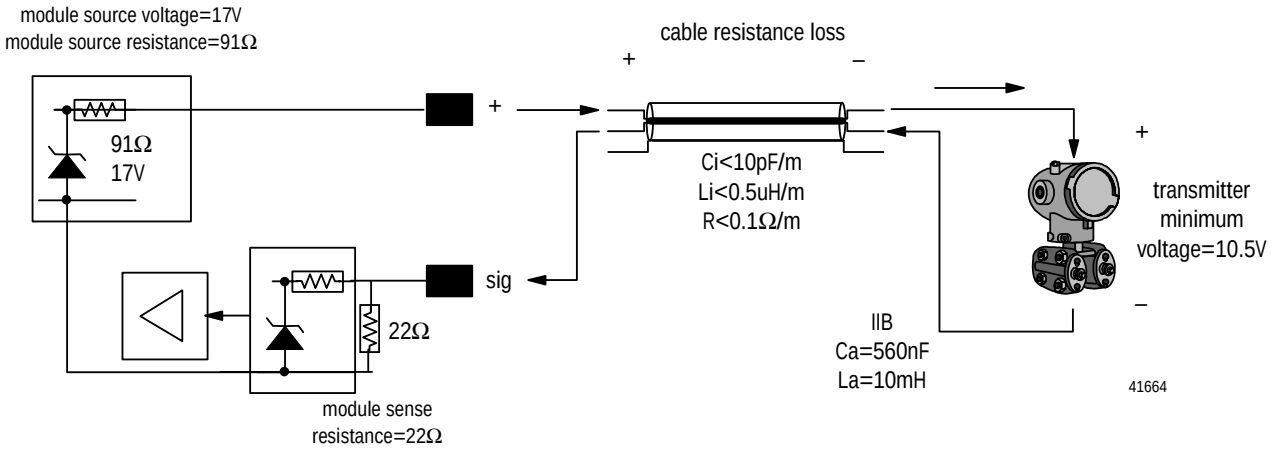
Loop Functionality Verification

The functional characteristics will be checked first. The figure below shows the general situation which must be analyzed for proper loop function.

On the left are the module components of the voltage source to run the loop and its internal source resistance. In the center is the cable. It represents a loss with regard to its resistance. Cable resistance is a function of cable length. On the right is the transmitter, which has a minimum voltage it must see to function properly.



The loop must function properly under maximum signal current conditions, in this case 22mA. As can be seen the key variable, which must be determined, is the total loop resistance. This may be determined with the following equation:

$$Rtotal = \frac{(17\text{-}10.5)}{0.022} = 295\Omega$$

Once Rtotal is known, you must determine the actual cable resistance that can be accommodated. This is the difference between Rtotal and the module internal source and sense resistances: Rcable=295-91-22=182Ω

Rcable is used to determine the wiring length allowed between the module and the transmitter:

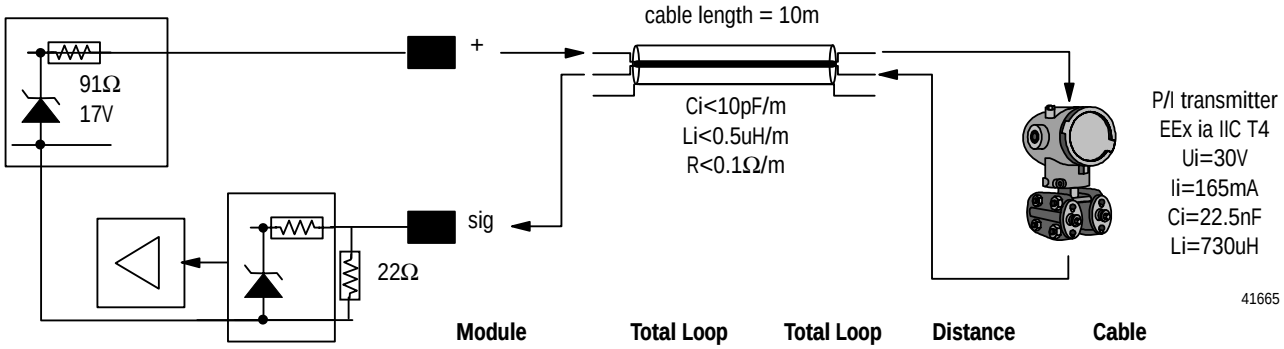
$$Cable\_length = \frac{182}{2*0.1} = 910m$$

Note, the “2” in the denominator of the equation is necessary to account for the resistance of both cable conductors (signal source “+” and signal and return “sig”).

Intrinsic Safety Entity Verification

Next we must determine if the pressure to current analog transmitter and the Flex Ex analog input module are compatible from an IS perspective. We will make this determination for a IIC gas application.

The figure below shows an extraction of pertinent information from the figures on pages 6-3.



1797-IE8 Analog Input
EEx ia/ib IIB/IIC T4
Uo<23.7V
Io<92.5mA

IIB	IIC
Ca=560nF	Ca=66nF
La=10mH	La=2.5mH

Module		Total Loop		Total Loop		Distance		Cable
Uo	< or =	Ui	=	Ui				
Io	< or =	Ii	=	Ii				
Ca	> or =	Ci	=	Ci	+	(length	*	Ci per length)
La	> or =	Li	=	Li	+	(length	*	La per length)

Module		Module		Module		Distance		Cable
Uo<23.7V	< or =	Ui=30V	=	Ui=30V				
Io<92.5mA	< or =	Ii=165	=	Ii=165				
Ca=66nF	> or =	Ci=22.6nF	=	Ci=22.5nF	+	(10m	*	Ci=10pF/m)
La=2.5mH	> or =	Li=735uH	=	Li=735uH	+	(10m	*	La=0.5uH/m)

In the figure above, three key items are shown, the field device the interconnecting cabling and the Flex Ex module (in this example, a 1797-IE8). The entity verification is done for the gas group IIC. As the table shows, the module's entity parameters are compared to the combination of the transmitter and the wiring entity parameters.

The module's entity parameters are shown in the Module column on the left. They must be compared with the parameters shown in the Total Loop column, in the manner shown. The values in the Total Loop column are determined in the following manner:

- Total Loop U_i = Transmitter U_i
- Total Loop I_i = Transmitter I_i
- Total Loop C_i = (Transmitter C_i + Cabling C_i per length) X (cable length)
- Total Loop L_i = (Transmitter L_i + Cabling L_i per length) X (cable length)

As long as the Module and Total Loop entity parameters satisfy the inequalities shown the loop is acceptable for use in the hazardous environment.

I/O

The 1797-IE8 and 1797-OE8 modules comply fully to and provide simple entity parameters. These modules can directly interface with a wide variety of intrinsically safe controls and instrumentation. Because all field device power is supplied directly from the I/O module, no extra wiring or power sources are needed in a hazardous area.

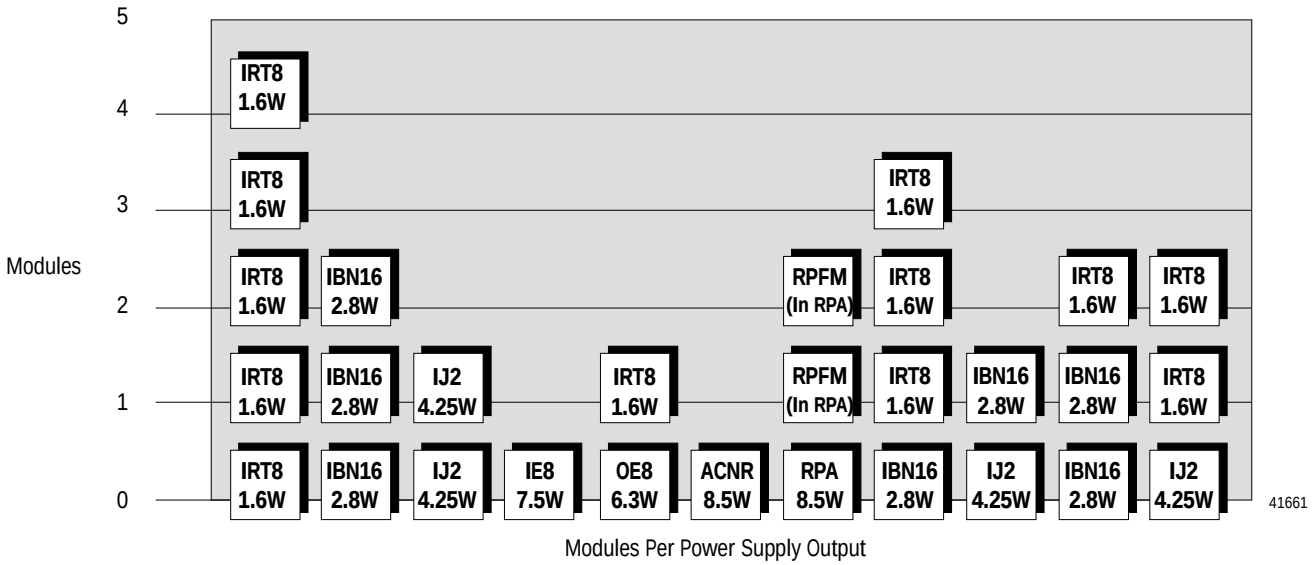
Finally, these modules maintain intrinsic safety in hazardous areas by providing isolation from other modules in the system as well as intrinsic safety segregation between channels on the same module.

Optimize Power Distribution

Your FLEX Ex system must use adequate power supplies to support the physical locations determined earlier in this chapter. Each FLEX Ex I/O module in the system is rated for input power, and the FLEX Ex power supply is rated in the number of output channels and power available from each channel.

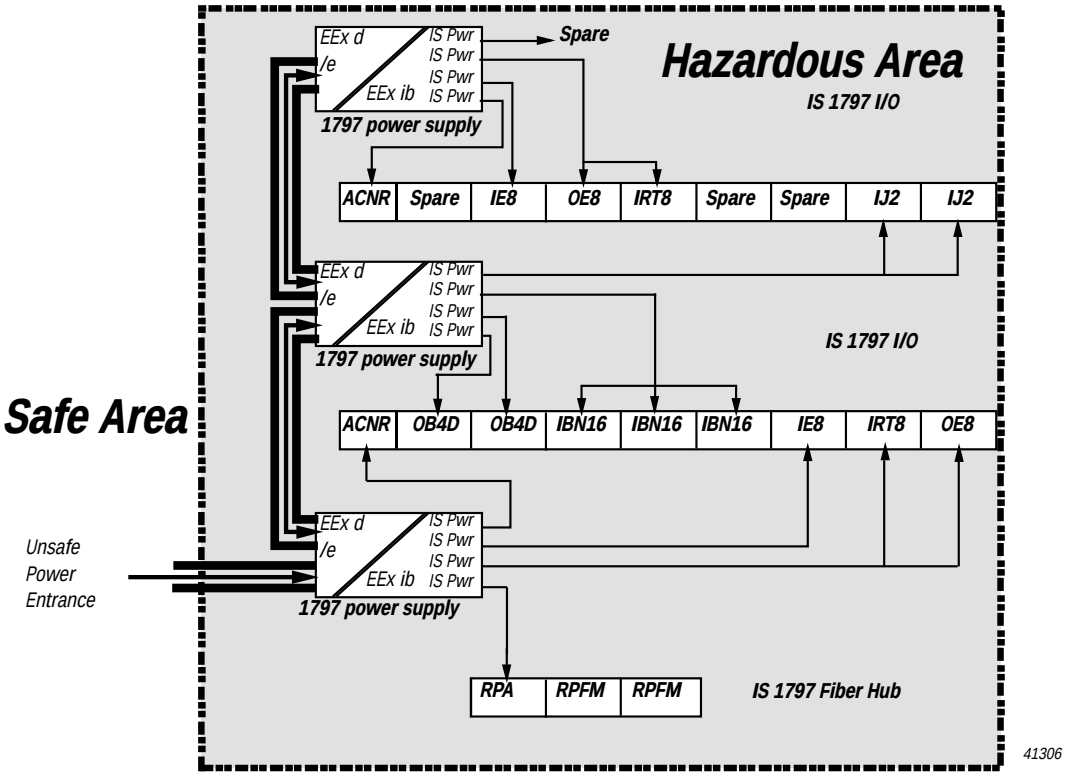
Assigning Power Supplies

Note the amount of power each module requires and assign it to a power supply output. Continue to assign modules to the power supply output until the supply's output power rating is consumed. The graphic below shows the number of modules per power supply output.



Important: Each power supply output in the FLEX Ex system is rated for 8.5W. Modules can be attached to the output until their combined power equals that number. Do not exceed the power supply maximum of 8.5W.

Assign the next module to another output as before. When all four power supply outputs are utilized, add another power supply to the system, see the figure below.



ATTENTION: Power supply outputs can never be paralleled. Paralleling outputs voids all intrinsic safety certifications.

Power Supply Considerations

When applying power, consider the certain characteristics of the wire connecting the power supply output to a module's power input. The wire cannot exhibit more than:

- 0.1Ω of resistance (+V and -V combined)
- 800nF of capacitance
- 10μF of inductance

Typically, these restrictions will yield wiring lengths of not more than 3.5m or 5.8m (1.5mm^2 and 2.5mm^2 wire respectively) without the use of special wiring or wiring methods.

Chapter Summary

In this chapter you learned how to apply the FLEX Ex analog I/O modules. Move to Chapter 7 to learn about troubleshooting your modules.

Troubleshooting the FLEX Ex Analog I/O Modules

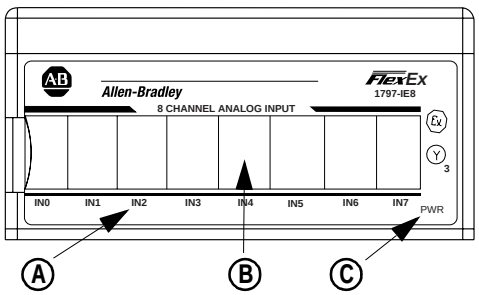
What this Chapter Contains

Read this chapter to troubleshoot your I/O module.

Status Indicators

1797-IE8 Module

The 1797-IE8 module has one power indicator that is on when power is applied to the module and one status indicator for each input.

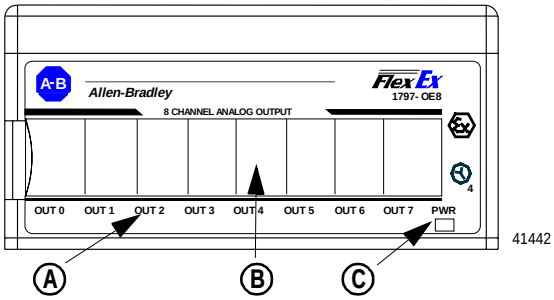


A = Status indicators
B = Insertable labels for writing individual input designations
C = Power indicator

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
Power		Off	Module not powered
	Green	On	Module receiving power

1797-OE8 Module

The 1797-OE8 module has one power 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

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
Power		Off	Module not powered
	Green	On	Module receiving power

Repair

This module is not field repairable. Any attempt to open this module will void the warranty and IS certification. If repair is necessary, return this module to the factory.

Chapter Summary

In this chapter you learned how to troubleshoot the FLEX Ex analog I/O modules. Move to Appendix A to see the specifications for your module.

Specifications

1797-IE8 Specifications

Number of Inputs	8 single-ended, non-isolated
IS Input Type	EEx ia IIB/IIC T4, Class I, II, III Division 1 Group A-G
IS Module Type	EEx ib IIB/IIC T4, Class I Division 1 Group A-D
Resolution	16 bits
Transfer Characteristics Accuracy at 20°C (68°F) Temperature Drift	 0.1% of output signal range 0.005%/C of output signal range
Functional Data Range	>15V @22mA >17V @ 0mA
Data Format	Configurable
Step Response to 99% of FS	4ms
Indicators	8 red fault indicators 1 green power
Output (Intrinsically Safe) (16 pin male and female flexbus connector)	$U_i \leq 5.8V$ dc $I_i \leq 400mA$ L_i = Negligible $C_i \leq 1.35\mu F$
Isolation Path Input to Power Supply Input to Flexbus Input to Input Power Supply to Flexbus	Isolation Type Galvanic to DIN EN50020 Galvanic to DIN EN50020 None Galvanic to DIN EN50020
Power Supply (+V, -V intrinsically safe)	$U_i \leq 9.5V$ dc $I_i \leq 1A$ L_i = Negligible C_i = Negligible
Module Field-side Power Consumption	7.5W
Power Dissipation	5.2W
Thermal Dissipation	17.75 BTU/hr
Module Location	Cat. No. 1797-TB3 or -TB3S
Conductor Wire Size	12 gauge ($4mm^2$) stranded maximum 3/64in (1.2mm) insulation maximum

Dimensions	46mm x 94mm x 75mm (1.8in x 3.7in x 2.95in)
Weight	200g (approximately)
Keyswitch Position	3
Environmental Conditions Operational Temperature Storage Temperature Relative Humidity Shock Operating Nonoperating Vibration	 -20 to +70°C (-4 to +158°F) -40 to +85°C (-40 to +185°F) 5 to 95% noncondensing Tested to 15g peak acceleration, 11(+1)ms pulse width Tested to 15g peak acceleration, 11(+1)ms pulse width Tested 2g @ 10-500Hz per IEC68-2-6
Agency Certification	II (1) 2G EEx ia/ib IIB/IIC T4
Certificate of Conformity	DMT 98 ATEX E 020 X

I/O Entity Parameters

Measurement input (sig to -) for ch 0 to ch 7 (terminals: 1-2; 5-6; 9-10; 13-14; 18-19; 22-23; 26-27; 30-31)

	Protection	**Group**	**Allowed Capacitance**	**Allowed Inductance**
U_0 = 5V I_0 = 1mA P_0 = 1.3mW	EEx ia	IIB	1000µF	1H
U_i = 28V I_i = 93mA C_i and L_i negligible		IIC	100µF	1H

Source output (+ to sig) for ch 0 to ch 7 (terminals: 0-1; 4-5; 8-9; 12-13; 17-18; 21-22; 25-26; 29-30)

	Protection	**Group**	**Allowed Capacitance**	**Allowed Inductance**
U_0 = 23.7V I_0 = 92.5mA P_0 = 548mW	EEx ia	IIB	560nF	10mH
		IIC	66nF	2.5mH
If concentrated capacitance and/or inductance are available, use the following values.	EEx ia	IIB	320nF	10mH
		IIC	60nF	2mH

Source output plus measurement input (+ to -) for ch 0 to ch 7 (terminals: 0-2; 4-6; 8-10; 12-14; 17-19; 21-23; 25-27; 29-31)

	Protection	Group	Allowed Capacitance	Allowed Inductance
U_0 = 23.7V I_0 = 93.5mA P_0 = 555mW	EEx ia	IIB	560nF	10mH
		IIC	66nF	2.5mH
If concentrated capacitance and/ or inductance are available, use the following values.	EEx ia	IIB	320nF	10mH
		IIC	60nF	2mH

1797-OE8 Specifications

Number of Outputs	8 single-ended, non-isolated
IS Output Type	EEx ia IIB/IIC, Class I, II, III Division 1 Groups A-G
IS Module Type	EEx ib IIB/IIC T4, Class I Division 1 Groups A-D
Resolution	13 bit
Transfer Characteristics Accuracy at 20°C (68°F) Temperature Drift	 0.1% of output signal range 0.010%/C of output signal range
Load Range Current Voltage Available at 22mA Load	 0-22mA >11V 0-500Ω @ 22mA
Data Format	Configurable
Step Response to 99% of FS	4ms
Indicators	8 red fault indicators 1 green power
Output (Intrinsically Safe) (16 pin male and female flexbus connector)	$U_i \leq$ 5.8V dc $I_i \leq$ 400mA L_i = Negligible $C_i = \leq$ 1.35µF
Isolation Path Output to Power Supply Output to Flexbus Output to Output Power Supply to Flexbus	Isolation Type Galvanic to DIN EN50020 Galvanic to DIN EN50020 None Galvanic to DIN EN50020
Power Supply (+V, -V Intrinsically Safe)	$U_i \leq$ 9.5V dc $I_i \leq$ 1A L_i = Negligible C_i = Negligible
Module Field-Side Power Consumption	6.3W
Power Dissipation	5.4W

Thermal Dissipation	18.4 BTU/hr
Module Location	Cat. No. 1797-TB3 or -TB3S Terminal Base Unit
Conductors Wire Size	12 gauge (4mm^2) stranded maximum 1.2mm (3/64in) insulation maximum
Dimensions	46 x 94 x 75mm (1.8 x 3.7 x 2.95in)
Weight	200g (approximately)
Keyswitch Position	4
Environmental Conditions Operational Temperature Storage Temperature Relative Humidity Shock Operating Non-Operating Vibration	 -20 to +70^{0}C (-4 to +158^{0}F) -40 to +85^{0}C (-40 to +185^{0}F) 5 to 95% noncondensing Tested to 15g peak acceleration, 11(+1)ms pulse width Tested to 15g peak acceleration, 11(+1)ms pulse width Tested 2g @ 10-500Hz per IEC68-2-6
Agency Certification	II (1) 2G EEx ia/ib IIB/IIC T4
Certification of Conformity	DMT 98 ATEX E 032X

I/O Entity Parameters

Signal output (+ to -) for ch 0 to ch 7 (terminals: 0-1; 4-5; 8-9; 12-13; 17-18; 21-22; 25-26; 29-30)

	Protection	**Group**	**Allowed Capacitance**	**Allowed Inductance**
U_0 = 21V I_0 = 93mA P_0 = 145mW	EEx ia	IIB	1.27µF	10mH
		IIC	188nF	3mH
If concentrated capacitance and/or inductance are available, use the following values.	EEx ia	IIB	400nF	10mH
		IIC	80nF	2mH

Programming the FLEX Ex I/O Modules Using RIO

What this Chapter Contains

Read this appendix to program the 1797-IE8 and 1797-OE8 analog modules.

Enter Block Transfer Instructions

The FLEX Ex analog I/O modules communicate with the PLC processor through bidirectional block transfers. This is the sequential operation of both read and write block transfer instructions.

Before you configure the module, you need to enter block transfer instructions into your ladder logic. The following example programs illustrate the minimum programming required for communication to take place between the module and a PLC processor. These programs can be modified to suit your application requirements.

A configuration block transfer write (BTW) is initiated when the analog module is first powered up, and subsequently only when the programmer wants to enable or disable features of the module. The configuration BTW sets the bits which enable the programmable features of the module, such as filters and signal ranges, etc. Block transfer reads are performed to retrieve information from the module.

Block transfer read (BTR) programming moves status and data from the module to the processor's data table. The processor user program initiates the request to transfer data from the module to the processor. The transferred words contain module status, channel status and input data from the module.

Your program should monitor status bits, block transfer read and block transfer write activity.

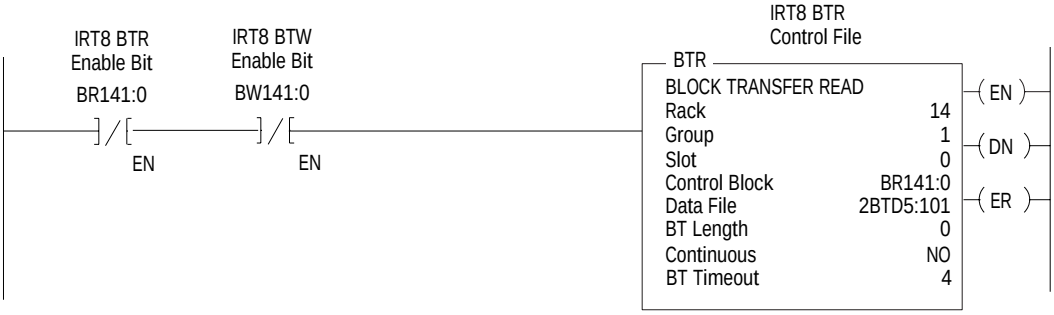
Using the PLC-5C Processor

Block transfer instructions with the PLC-5C processor use a control file and a data file. The block transfer control file contains the data table section for module location, the address of the block transfer data file and other related data. The block transfer data file stores data that you want transferred to the module (when programming a BTW) or from the module (when programming a BTR).

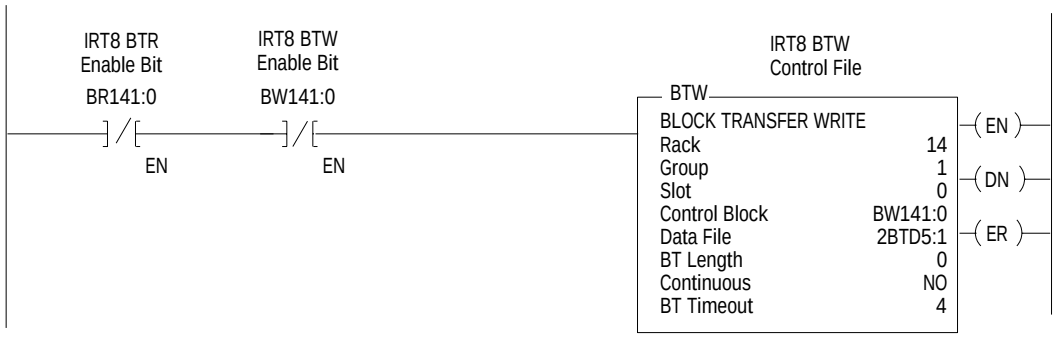
The programming terminal will automatically select the control file based on rack, group and module, and whether it is a read or write. **A different block transfer control file is used for the read and write instructions for your module.** A different block transfer control file is required for every module.

PLC-5/250 Processor Program Example

Rung 1STEPO:1
The IRT8 module is located in rack 14, I/O group 1, slot 0. The data obtained by the PLC-5/250 processor from the IRT8 module is placed in the data table starting at 2BTD5:101, and with the default length of 0, is 11 words long. The length can be any number between 0 and 11.



Rung 1STEPO:1
The IRT8 module is located in rack 14, I/O group 1, slot 0. The data sent to the IRT8 module from the PLC-5/250 processor is from the data table starting at 2BTD5:1, and with a default length of 0, is 4 words long.
Valid BTW lengths: 0, 1, 2, 3, and 4.



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Publication 1797-6.5.1 - April 1999

PN 955126-45